FINAL REPORT

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Mass Transit Railway Corporation

Lantau and Airport Railway: *Environmental Impact Study: Final Report*

Volume 3: Technical Annexes

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Lantau and Airport Railway:
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Volume 3: Technical Annexes

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For and on behalf of ERM Hong Kong

Approved by: C. Ma

Position: MANAGING DIRECTOR

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Evaluation Criteria used in the Lantau and Airport Railway Environmental Impact Study

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A1 *INTRODUCTION*

This Annex sets out the criteria which were used by ERM in this study to evaluate the significance of the environmental impacts that are likely to occur during the construction and operation of the LAR. These evaluation criteria were selected, and their use in the study agreed with officers of the EPD, on the basis of three separate factors:

- ERM's professional view on the most appropriate criteria to use for the study.
- A review of the previous environmental studies which have been carried out in relation to the LAR and other developments associated with it or its vicinity.
- Discussions with officers of the EPD on the most appropriate criteria to use.

An important element in this choice was the need to both ensure consistency with the previous environmental studies undertaken in relation to the LAR and to utilise criteria which were acceptable to EPD, and to MTRC as the client for the study.

Table A1.1a overleaf sets out the evaluation criteria which were used in the previous studies referred to in the review, while *Table A1.1b* summarises the criteria which ERM used in this study. The remainder of this Annex sets out these evaluation criteria in more detail.

It should be noted that this Annex is not exhaustive, and some particular criteria used in the LAR EIS (*eg* in relation to odours) are not referred to here,as they apply only to a specific location on the LAR alignment. Subjective criteria used (*eg* in relation to visual impacts) are also not included here. These criteria are, however, identified in the relevant other Technical Annexes in this volume as appropriate.

Table A1.1a *Evaluation Criteria used in Previous Environmental Studies Relating to LAR*

Category of Impact	Feasibility Study	Lantau Fixed Crossing	North Lantau Development	New Airport Masterplan
Noise (construction)	$L_{Aeq,30min}$ <75dB, or <5dB(A) above background if above 70dB (Urban), or <10dB(A) above background (Rural) as advised by EPD. Noise Control Ordinance requirements for nighttime.	None other than statutory requirements under NCO.	L_{Aeq} <75dB during daytime. NCO requirements for nighttime.	$L_{Aeq,30min}$<70dB during daytime. NCO requirements for nighttime.
Noise (operational)	$L_{Aeq,24hour}$ <65dB, or $L_{AMAX,nighttime}$ <85dB From HKPSG.	As for Feasibility Study. Also NCO limits.	As for Feasibility Study. Also NCO limits.	Not considered.
Air Quality (construction)	Ave. concs. TSP 260μgm^{-3} for 24 hours (not to be exceeded more than once per year) and 80 μgm^{-3} annually. Ave. concs. RSP 180μgm^{-3} for 24 hours (not to be exceeded more than once per year) and 55μgm^{-3} annually. From HKPSG.	As for Feasibility Study.	Not considered.	As for Feasibility Study.
Air Quality (operational)	As for construction.	As for Feasibility Study.	As for Feasibility Study.	As for Feasibility Study.
Water Quality (construction)	WQOs for Victoria Harbour WCZ. WQO for freshwaters as defined by EPD. HKPSG criteria for marine mud.	WQOs for Western Buffer WCZ.	Not considered.	WQOs for North Western Waters WCZ
Water Quality (operational)	As for construction.	As for construction.	WQOs for North Western Waters WCZ	As for construction.

Table A1.1a (cont.) Evaluation Criteria used in Previous Environmental Studies Relating to LAR (Cont.)

Category of Impact	North Lantau Expressway	Western Harbour Crossing	Central and Wan Chai Reclamation	West Kowloon Expressway
Noise (construction)	As for Feasibility Study.	Daytime limit of 80dB(A), as advised by EPD. NCO requirements for nighttime.	$L_{Aeq,5min}$ <75dB during daytime. NCO requirements for nighttime.	$L_{Aeq,30min}$ <75dB during daytime. NCO requirements for nighttime.
Noise (operational)	As for Feasibility Study. Also NCO limits.	Not applicable	Not applicable.	Not applicable.
Air Quality (construction)	As for Feasibility Study.	As for Feasibility Study.	As for Feasibility Study. Additionally, maximum 1 hour ave. conc. of 500μgm^{-3}.	As for Feasibility Study. Additionally, maximum 1 hour ave. conc. of 500μgm^{-3}.
Air Quality (operational)	As for Feasibility Study.	As for Feasibility Study.	As for Feasibility Study.	As for Feasibility Study.
Water Quality (construction)	As for New Airport Masterplan Study.	As for Feasibility Study.	As for Feasibility Study, except for marine mud, draft Works Branch Technical Circular No./92 *"Marine Disposal of Dredged Muds"*.	As for Feasibility Study.
Water Quality (operational)	As for New Airport Masterplan Study.	As for Feasibility Study.	As for construction.	As for Feasibility Study.

Table A1.1b Summary of Evaluation Criteria used in the LAR EIS study

Category of Impact	Evaluation Criteria
Construction Phase	
Noise	$L_{Aeq,30min}$ ≤75dB daytime (*except sundays and holidays*), as proposed by MTRC[1] NCO requirements within the NCO restricted hours.
Air Quality	Air Quality Objectives from HKPSG
Water Quality	Water Quality Objectives for various marine Water Quality Zones (whether gazetted or not). WQO for freshwaters as defined by EPD where available. HKPSG criteria for marine mud.
Operational Phase	
Noise	NCO requirements, but final evaluations to be discussed and agreed with EPD[2].
Air Quality	As for construction phase.
Water Quality	As for construction phase.

Notes: (1) Where ambient noise levels are greater than 70 dB $L_{Aeq,30min}$, baseline measurements will be documented for subsequent determination that the noise contribution from LAR does not exceed 75 dB $L_{Aeq,30min}$.

(2) HKPSG criteria were also be used. However, because of the proposed frequency of service on the LAR, $L_{Aeq,30min}$ was of more importance than L_{MAX} and $L_{Aeq,24hour}$, and the NCO $L_{Aeq,30min}$ daytime criterion is more stringent except under exceptional circumstances.

A2 CONSTRUCTION PHASE

A2.1 NOISE

The Noise Control Ordinance (NCO) will apply to construction works undertaken for the LAR. This categorises construction activities into two types, each of which is controlled by a system of Construction Noise Permits as outlined below.

A2.1.1 *General Construction Work*

The NCO prohibits construction work using powered mechanical equipment between 19.00 and 07.00 or at any time on a public holiday, unless the contractors have been issued with a Construction Noise Permit. EPD issues these permits on the basis of the criteria set out in their *"Technical Memorandum on Noise from Construction Work other than Percussive Piling"* which are reproduced in *Tables A2.1a* and *A2.1b* below:

Table A2.1a EPD Area Sensitivity Ratings (ASRs) for Non-percussive Construction Noise

Type of Area	Not Affected	Indirectly Affected	Directly Affected
Rural Area	A	B	B
Low density residential area	A	B	C
Urban area	B	C	C
Areas other than those above.	B	B	C

Table A2.1b Basic Noise Levels (BNLs) to be applied as Criteria to the Area Sensitivity Ratings

Time Period	ASR "A"	ASR "B"	ASR "C"
Evening (19.00–23.00) and Sundays/holidays (07.00–23.00)	60	65	70
Nighttime (23.00–07.00)	45	50	55

From this, and on the basis of discussions with officers of the EPD's Noise Policy Group, it has been agreed that the criterion which ERM will use for the assessment of construction noise in this study is generally that $L_{Aeq,30min}$ daytime facade noise levels at NSR should not exceed 75 dB(A), except on general holidays. At other times, the criteria set out in the *Technical Memorandum* will be applied.

A2.1.2 *Piling Works*

The NCO prohibits percussive piling between 19.00 and 7.00 and on holidays unless specifically exempted by an order made by the Governor. For piling work carried out during the daytime, a Construction Noise Permit must again be acquired. The criteria applied in considering applications for Construction Noise Permits are set out in the *"Technical Memorandum on Noise from Percussive Piling"*. These are reproduced *Table A2.1c* below:

Table A2.1c ***Acceptable Noise Levels (ANLs) for Daytime Percussive Piling***

Type of Receptor	Acceptable Noise Level (dB(A))
Noise Sensitive Receptor (NSR) with no windows or other openings.	100
NSR with central air conditioning systems.	90
NSR with windows or other openings but without central air conditioning system.	85

It should be noted that for hospitals, clinics, schools, courts of law or other particularly sensitive receptors, the ANL is 10 dB(A) below that quoted in *Table A2.1c*.

ERM adopted the ANLs from the Technical Memorandum as the criteria to evaluate the significance of $L_{Aeq,5min}$ facade noise levels caused by piling operations during the construction of the LAR for the purposes of this study.

A2.2 AIR QUALITY

In evaluating the predicted air quality impacts during construction of the LAR, ERM used the Air Quality Objectives (AQOs) which are set out in the *Hong Kong Planning Standards and Guidelines (HKPSG)*. These are reproduced in *Table A2.2a* overleaf:

Table A2.2a *Hong Kong Air Quality Objectives*

Pollutant	Concentration in $\mu g/m^{-3}$ (1)				
	Averaging Time				
	1 hour(2)	8 hours(3)	24 hours(3)	3 months(4)	1 year(4)
Sulphur dioxide	800		350		80
Total suspended particulates			260		80
Respirable suspended particulates(5)			180		55
Nitrogen dioxide	300		150		80
Carbon monoxide	30000	10000			
Ozone(6)	240				
Lead				1.5	

Notes:
(1) Measured at 298°K (25°C) and 101.325 kPa (one atmosphere).
(2) Not to be exceeded more than 3 times per year.
(3) Not to be exceeded more than once per year.
(4) Arithmetic means.
(5) RSPs are particles with a nominal aerodynamic diameter of 10 micrometres or smaller.
(6) Photochemical oxidants are determined by measurement of ozone only.

In addition, for dust impacts, a further criterion of 500 $\mu g\ m^{-3}$ was adopted as an acceptable level for Total Suspended Particulates, as advised by EPD.

In the vicinity of the Kwai Chung Park Tunnels (Contract 509), which are to be built across the former Gin Drinkers Bay landfill site, TLV for landfill gas and risk criteria for PHI have been set in the separate engineering design and HAZOP study commissioned by MTRC relating to this contract.

A2.3 WATER QUALITY

The Water Quality Objectives (WQOs) applicable to each of the various Water Control Zones (WCZs) in the vicinity of the LAR alignment were used. This was the case whether the WCZs have been gazetted or not. Similarly, WQOs for freshwaters were used as appropriate. For marine mud, the guidelines set out in *"Deep Bay Guidelines for Dredging, Reclamation and Drainage Works"* were used, as advised by HKPSG, and Works Branch Technical Circular *"Marine disposal of Dredged Muds"* provided criteria to evaluate contamination, and further guidance.

A3 OPERATIONAL PHASE

A3.1 NOISE

Following discussions with officers of the EPD Noise Policy Group, it was agreed that the criteria which ERM used in the EIS study to evaluate the predicted effects of operational noise likely to be caused by the LAR would be those set out as acceptable in the *"Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises or Construction Sites"*. These are reproduced in *Table A3.1a* below. The Area Sensitivity Ratings referred to are as set out in *Table A2.1a* above.

Table A3.1a Acceptable Noise Levels (ANLs) to be used as Operational Noise Criteria for the LAR EIS Study

Time Period	ASR "A"	ASR "B"	ASR "C"
Day (07.00–19.00)	60	65	70
Evening (19.00–23.00)	60	65	70
Night (23.00–07.00)	50	55	60

It was also agreed with EPD that where predictions made during the course of the EIS study indicated that the levels set out in *Table 3.1a* could not be practically achieved (taking account of the provision of reasonable levels of noise mitigation), ERM would discuss the options for dealing with this with EPD prior to the issuing of the Final Report. However, in the event, this was found not to be necessary.

It was specifically agreed with EPD that for the purposes of the EIS study, Luk Keng Tsuen (Yam O) and Ma Wan would be considered as having an ASR of "B", with all other areas being "C".

The HKPSG gives the following recommendations for rail traffic noise limits:

- $L_{Aeq, 24\ hour}$ 65 dB
- $L_{AMax\ (2300\ to\ 0700)}$ 85 dB

For NSRs that are sensitive to noise at night, the NCO nighttime criterion applied to the nighttime period 0630 to 0700, of $L_{Aeq, 0630\ to\ 0700}$ 60dB, for ASR C, was found to be about 6dB more stringent than the HKPSG $L_{Aeq, 24\ hour}$ level of 65 dB, for the headways and hours of operation (see table B4.2a) of the LAR. This result comes about for two reasons. Firstly the nighttime L_{Aeq} level of the NCO is 5dB lower than that of the HKPSG. Secondly, the $L_{Aeq, 0630\ to\ 0700}$ will be approximately 1 dB higher than the $L_{Aeq, 24\ hour}$ because of the proposed frequency of service before 0700 (54 train pass–bys are expected between 0600 and 0700 whereas 1063 and 896 pass–bys are expected in the whole 24 hour period for the Hong Kong to Tsing Yi and the Tsing Yi to Tung Chung sections of the LAR respectively). Therefore, if the NCO criteria were predicted to be met at these headways, the HKPSG criterion for $L_{Aeq,24hours}$ must also necessarily have been met.

The L_{AMAX} levels were evaluated against the HKPSG criterion of 85 dB(A) between 2300hrs and 0700hrs. However, because of the headways proposed between 2300hrs and 0700hrs, the NCO $L_{Aeq, 30\ minute}$ criteria are generally more stringent.

Noise arising from impact and wheel squeal sources were be evaluated in terms of L_{AMAX} with reference to background noise levels.

Noise from fixed sources were be evaluated in accordance with HKPSG, *ie* using a criterion 5dB(A) less than the ANL.

A3.2 *AIR QUALITY*

As for the construction phase, the Air Quality Objectives (AQOs) of the HKPSG were used as the criteria to evaluate the predicted air quality impacts likely to occur during the operation of the LAR. These are set out in *Table A2.2a* above.

A3.3 *WATER QUALITY*

As was noted in relation to water quality impacts arising during construction of the LAR in *Paragraph A2.3* above, the Water Quality Objectives (WQOs) applicable to each of the various Water Control Zones (WCZs) in the vicinity of the LAR alignment were used to assess impacts arising form the operation of the railway for the purposes of the EIS study. This was the case whether the WCZs have been gazetted or not. Similarly, WQOs for freshwaters were used as appropriate.

Annex B

Noise Impacts

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B1 *INTRODUCTION*

Annex B addresses the noise and vibration impacts arising from the construction and operation of the Lantau and Airport Railway (LAR). The route has been divided into seven sections following the District Board boundaries, impacts have then been assessed for each District individually.

The report is divided into seven sections, as follows:

- Baseline Conditions: the existing conditions are presented to provide a baseline for the assessment of impacts; where these conditions are expected to change during the lifetime of the project the anticipated future conditions are also described; the major noise sensitive receivers (NSRs) have been identified along the entire route, are listed and their locations indicated.
- Potential Sources of Noise: potential sources of construction noise are detailed for each District; the potential sources of operational noise impacts will be similar throughout the LAR route and are discussed in general, rather than site specific, terms.
- Assessment Methodologies: are described for each type of noise impact including: general construction operations; percussive piling; blasting; noise from fixed plant; and train rolling noise.
- Prediction of Impacts: the impacts upon each noise sensitive area are predicted in quantitative form detailing the noise levels which are expected at the NSRs. Construction and operational impacts are considered separately.
- Evaluation of Impacts: the predicted impacts are evaluated against planning criteria and unacceptable impacts identified for mitigation.
- Mitigation Measures: are described for all unacceptable impacts, these measures are designed to reduce noise levels to within planning guidelines.

B2 BASELINE CONDITIONS

B2.1 CENTRAL AND WESTERN DISTRICT

B2.1.1 Existing Conditions

Noise in the vicinity of the proposed construction site for Hong Kong Station and Tunnels is generally characterised by road and marine traffic noise.

B2.1.2 Future Conditions

The noise climate in the area during the operational phase of Hong Kong Station will be dominated by traffic noise from the new D3 road and the various other roads proposed for the reclamation area. Noise levels are likely to be high in absolute terms.

B2.1.3 Noise Sensitive Receivers

NSRs are defined by the Hong Kong Planning Standards and Guidelines (HKPSG), the Noise Control Ordinance (NCO) and the **Technical Memorandum on Noise from Construction Work Other than Percussive Piling** (TM1) as listed below.

- Residential uses:
  - All domestic premises including temporary housing.
- Institutional Uses:
  - Educational institutions including kindergarten and nurseries;
  - hospitals;
  - medical clinics;
  - homes for the aged;
  - convalescent homes;
  - places of public worship;
  - libraries;
  - courts of law;
  - performing arts centres;
  - auditoria; and
  - amphitheatres.
- Others:
  - Hotels;
  - hostels;
  - country parks; and
  - offices.

NSRs have been identified with reference to previous environmental studies undertaken in relation to the LAR, and have been updated by site surveys and by referring to survey sheets and development plans.

The United Building, which contains residential properties, and the Mandarin, Furama and Victoria Hotels were considered to be the nearest NSRs for construction activities associated with construction of Hong Kong Station and Tunnels. The Victoria Hotel is also identified as an NSR in respect of dredging operations for the Immersed Tube Tunnel.

The following locations are within 120 m of the site boundary and were considered as NSRs for the assessment of percussive piling only (**Technical Memorandum on Noise from Percussive Piling** (TM2)), since they contain offices but none of the building uses stipulated in TM1:

- Exchange Square;
- General Post Office;
- Hang Seng Bank New Headquarters;
- Connaught Centre;
- International Building;
- Harbour Building;
- United Building; and
- City Hall.

The eight NSRs above have been assumed to have central air conditioning systems as well as a direct line of sight to the piling rigs during the construction phase. The residential properties in the United Building have been assessed for general construction activities.

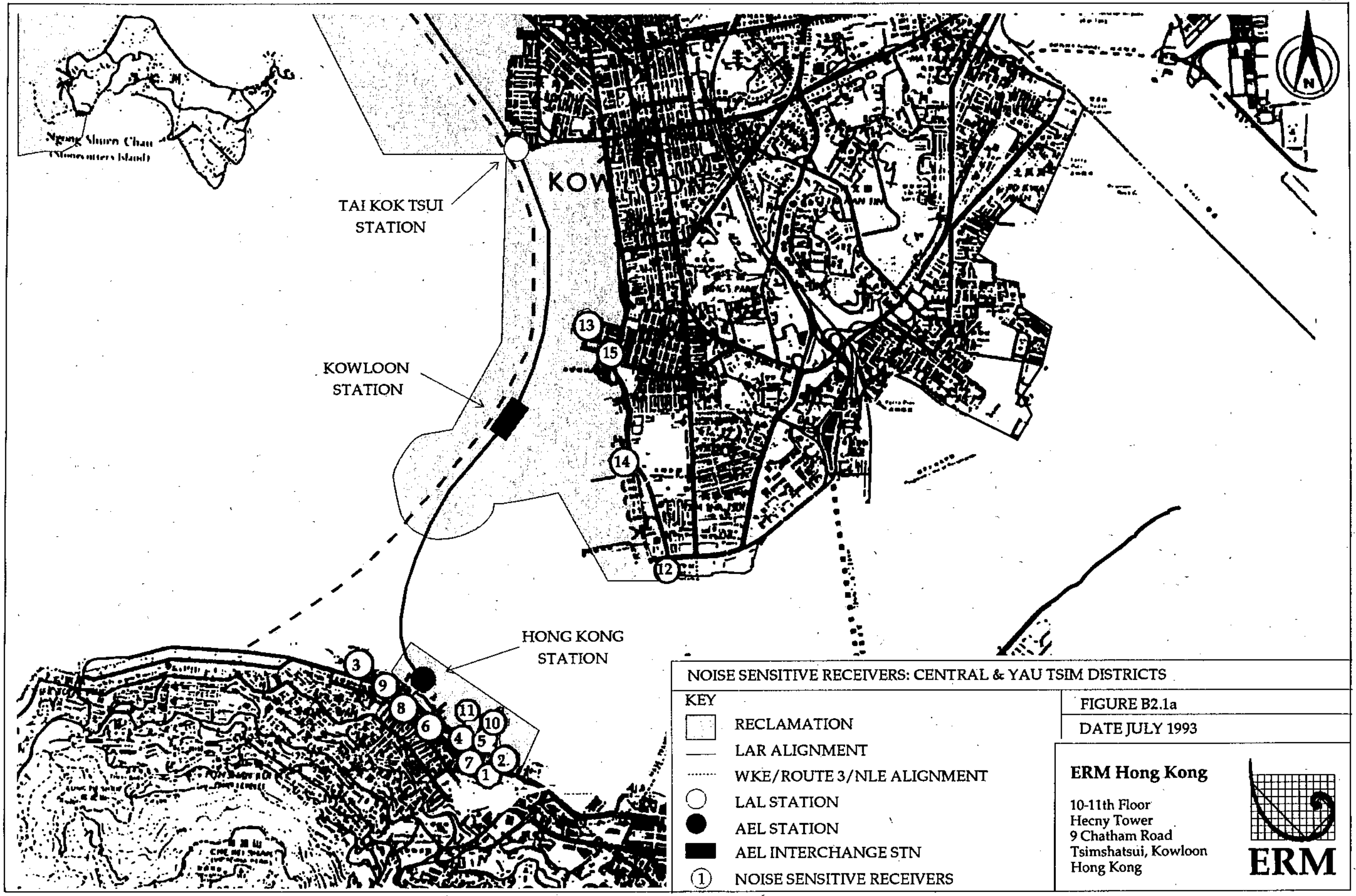
Some of the NSRs identified in the Particular Specification for this section, in particular, the Macau Ferry Terminal and Harbour City, are considered to be too far away from the construction activities to require consideration. These locations are thus not included in the current assessment.

Two new NSRs, sensitive use areas which currently do not exist, will need to be considered for operational impacts these are:

- the development above Hong Kong Station; and
- the Commercial Development Ares (CDA) on the C1 site immediately West of the station.

Therefore, for the construction and operational phases, a total of 13 NSRs were identified for consideration in this District, these are shown in *Figure B2.1a* and are listed below.

01 – Mandarin Hotel
02 – Furama Hotel
03 – Victoria Hotel
04 – Exchange Square
05 – General Post Office
06 – Hang Seng Bank New Headquarters



NOISE SENSITIVE RECEIVERS: CENTRAL & YAU TSIM DISTRICTS

FIGURE B2.1a

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

07 – Connaught Centre
08 – International Building
09 – Harbour Building
09a– United Building
09b– City Hall
10 – The development above Hong Kong Station
11 – The Commercial development on C1 site west of the station.

B2.2 *YAU TSIM DISTRICT*

B2.2.1 *Existing Conditions*

The land for this section of the alignment is currently an uncompleted part of the West Kowloon Reclamation (WKR) project, consequently the existing noise climate is not pertinent to this study.

B2.2.2 *Future Conditions*

The future environment will include the reclaimed land upon which Kowloon Station will be built, as well as new developments in the form of road systems and residential, commercial and government projects. Residential and commercial developments which will be constructed above the station will potentially be exposed to noise from chillers, fans, and air handling units.

Many of the new developments in the vicinity of the Kowloon to Tai Kok Tsui Tunnels, including road systems and residential, commercial and government projects, will be constructed in the vicinity of the Works Site concurrently with the LAR construction.

The Airport Express Line (AEL) and Lantau Line (LAL) trains will introduce a new source of noise and vibration into the area with the potential to give rise to significant impacts at nearby properties. Apart from the LAR, a number of major new roads will be built on this section of the WKR. These will immediately take large volumes of traffic away from the existing Kowloon road system and so introduce considerable sources of road traffic noise into the area. Traffic flows, and therefore noise levels, are expected to increase significantly in the years following the opening of these roads. For example, by the year 2011 the West Kowloon Expressway (WKE) is expected to handle over 9000 vehicles per peak hour and the new P1 trunk road is expected to handle over 3000 vehicles in each direction per peak hour. Hence the noise climate in the area, and therefore at the NSRs of interest to this study, will be greatly influenced by traffic noise which is likely to be high, in absolute terms.

B2.2.3 *Noise Sensitive Receivers*

Immersed Tube Tunnel

There are two NSRs which will be impacted by construction work associated with the Immersed Tube Tunnel. These are Victoria Hotel and the Hong Kong Cultural Centre.

Kowloon Station and Tunnels

Within 500 m of the proposed worksites for Kowloon Station and Tunnels there are two noise sensitive neighbourhoods. These neighbourhoods contain many receivers, located in one area, at similar distances from the worksite of interest. As many of the receivers in a neighbourhood can be conveniently assessed with one calculation, use of the neighbourhood facilitates an assessment by reducing the duplication of calculations that would be necessitated by the consideration of multiple receivers. The NSRs and the minimum distances to major work areas are listed in *Table B2.2a*.

Table B2.2a Noise Sensitive Receivers

Noise Sensitive Neighbourhood	Sensitive Use	Distance to Station (m)	Distance to Tunnels (m)
Man Wui and Man Cheong Streets	Residential Towers	250	N/A
Canton Road	Royal Pacific Hotel	530	710
	Residential and Educational	530	800
	Medical and Dental Clinics	530	750

Distances have been calculated according to Clause 2.7 of TM1. This clause stipulates a methodology for calculating the distance from the Powered Mechanical Equipment (PME) on a worksite to a particular NSR.

Kowloon to Tai Kok Tsui Tunnels

The reclamation area which will incorporate the Kowloon to Tai Kok Tsui Tunnels is bounded by existing land delineated by Cherry Street in the north, Ferry Street to the east, and Man Cheong Street to the southeast. Within 500 m of this section of the alignment there are six noise sensitive neighbourhoods which need to be taken into consideration. These noise sensitive neighbourhoods and their distances from the worksite are detailed in the *Table B2.2b*.

Table B2.2b *Noise Sensitive Receivers*

Noise Sensitive Receivers	Sensitive Uses	Distance to LAR (m)
Cherry Street, Tai Kok Tsui	Residential blocks Sharon Lutheran school Ming Kei College	360 450 475
Hoi King Street, Tai Kok Tsui	Residential buildings	160
Ferry Street, Yau Ma Tei	Residential blocks Yau Ma Tei Catholic Primary School	500 500
Tai Kok Tsui Station Related Development (Site B), Tai Kok Tsui	Residential buildings	50
School and Service Centre for Elderly, Tai Kok Tsui	Secondary/Primary School Service centre for the elderly	110 110
Man Cheong Street, Yau Ma Tei	Residential blocks	260

It is important to note that the Tai Kok Tsui Station Related Development (Site B), will not become operational until after the construction of this phase of the LAR is completed. As a result it has not been assessed as an NSR in the construction phase of this section of the LAR.

Current Outline Development Plans (ODP) indicate that in the northeast region of the WKR an education and service centre area will be developed behind a car park, a community service centre and an indoor recreational facility. As the car park, community service centre and indoor recreational facility have non–noise sensitive uses it is assumed that they will adequately screen the education and service area from road traffic noise. As a result of this screening, it is also assumed that the education and service centre will be adequately protected from construction noise impacts from construction of this section of the LAR. Construction noise impacts are therefore not considered to have a significant effect on this planned development area.

In addition to the areas listed above, there is also a proposed government facility near to the southern end of the alignment. Little information is currently available about this development, however, it has been assumed, because of its close proximity to the WKE, that it will be designed to have a non–noise sensitive use. As a result it has not been classified as an NSR in this study.

Therefore, a total of four noise sensitive neighbourhoods were identified in this District, these are shown in *Figure B2.1a* and are listed below.

12 – Hong Kong Cultural Centre
13 – Mah Wui and Man Cheong Streets: Residential towers
14 – Canton Road: Royal Pacific Hotel, Residential/Educational area, Medical/Dental Clinics
15 – Ferry Street, Yau Ma Tei: Residential blocks/schools

B2.3 Mong Kok District

B2.3.1 *Existing Conditions*

The majority of the land for this section of the alignment is currently an uncompleted part of the WKR project, however, existing land will border the site for the proposed station on the east side. The existing land incorporates a bus terminus, residential and commercial areas, a ferry pier, and small roads. As a result, the existing environment is dominated by road and marine traffic noise.

B2.3.2 *Future Conditions*

The future environment will include the reclaimed land which Tai Kok Tsui Station will be built upon as well as new development in the form of road systems and residential, commercial and government projects. The WKE will be constructed immediately to the west of the proposed station. Other roads, including the north and southbound carriageways of the P1 trunk road, will also introduce substantial levels of traffic noise into the area so that the noise environment in the vicinity of the proposed station will be dominated by road traffic and construction noise.

B2.3.3 *Noise Sensitive Receivers*

Within 500 m of the proposed worksites there are three noise neighbourhoods which need to be taken into consideration, they are listed in *Table B2.3a* below.

Table B2.3a Noise Sensitive Receivers

Noise Sensitive Receiver	Sensitive Use	Distance to Station (m)	Distance to Underpass (m)
Foo Kwai Street	9 Storey Residential Buildings	150	155
Cherry Street/Hoi King Street Intersection	4 Storey Residential Buildings	100	35
Hoi King Street	4 Storey Residential Buildings	110	45
Cherry Street	Residential Buildings	350	225
	Sharon Lutheran School	475	350
	Ming Kei College	425	300

Noise monitoring was carried out at Hoi King Street, the nearest residential area to the proposed station and Cherry Street worksites, in June 1993. Daytime noise levels were L_{A90} 63 dB and $L_{Aeq,\,1\,hr}$ 67 dB, with buses in the Bus terminus at the Tai Kok Tsui Ferry Pier being the dominant noise source. At night ambient noise levels dropped to a minimum of L_{A90} 53 dB and $L_{Aeq,\,1\,hr}$ 55 dB.

It should be noted that the Hoi King Street residential buildings are screened from the Cherry Street Underpass construction by the residential units at the junction of Cherry Street and Hoi King Street. This screening is estimated to reduce noise levels 10 dB(A) and is incorporated as a barrier correction in this assessment.

In addition to the NSRs already identified, the proposed MTRC Tai Kok Tsui Station Related Developments (TKTSRD) CDA, comprising four development sites around the station, will become new NSRs for the operational phase of the LAR. Sites A and D will be developed for commercial uses only, and sites B and C will comprise mixed commercial and residential uses. Site B will include five residential towers (towers 5 to 9) located on a split level podium along the Western side of the site. approximately 50 m from the nearest line of the LAR south of the station. The nearest NSR in site C will be approximately 140 m from the nearest of the LAR lines as they emerge from the northern end of the station.

To the North of TKTSRD Site C is a residential site R1 approximately 200 m away from the LAR, and two school sites approximately 100 m from the alignment.

For the operational stage, the majority of the existing NSRs in the area of Foo Kwai Street, Cherry Street and Hoi King Street will be well screened from the station, and the section of the LAR included in Contact 505, by the proposed 17 storey office block in TKTSRD site A.

Nine NSRs were identified in this District, these are shown in *Figure B2.3a* and are listed below.

16 – Cherry Street, Tai Kok Tsui
17 – Hoi King Street, Tai Kok Tsui
18 – MTRC Tai Kok Tsui Station Related Development (Site B)
19 – School and Service Centre for Elderly, Tai Kok Tsui
20 – Foo Kwai Street
21 – Wong Tai Street, Tai Kok Tsui;
22 – MTRC Tai Kok Tsui Station Related Development Site C;
22a– Planned residential site R1 North of MTRC Tai Kok Tsui Station Related Development Site C; and
22b– Planned school site North of MTRC Tai Kok Tsui Station Related Development Site C

B2.4 SHAM SHUI PO DISTRICT

B2.4.1 Existing Conditions

A baseline noise survey was carried out at fourteen sites along the existing waterfront during the WKR Study covering the region from Tai Kok Tsui to Lai Chi Kok Formation prior to the WKE study.
A baseline noise survey was also undertaken as part of the Route 3 EA which included the area from Lai Chi Kok to Kwai Chung Road Viaduct. For the Route 3 assessment, the measurement locations were in Ting Kau, Tsing Yi, Kwai Chung and Mei Foo Sun Chuen; those locations pertinent to this section of the alignment are shown in *Table B2.4a*.

Table B2.4a Selected Results from Route 3 Noise Survey (dB)

NSR	$L_{A90, 60 min}$	$L_{A10, 60 min}$	$L_{Aeq, 60 min}$
Cheung Ching Estate	64.5	68.5	66.9
Cheung Wan Temporary Housing Area	58.5–62.0	63.0–67.5	61.5–65.5
Ching Lai Court	75.0–77.0	78.5–80.9	77.0–78.9
Mei Foo Sun Chuen South	61.9–67.8	65.0–72.5	63.5–71.5

It should be noted that these baseline measurements were taken during daytime hours (0700–1900).

B2.4.2 Future Conditions

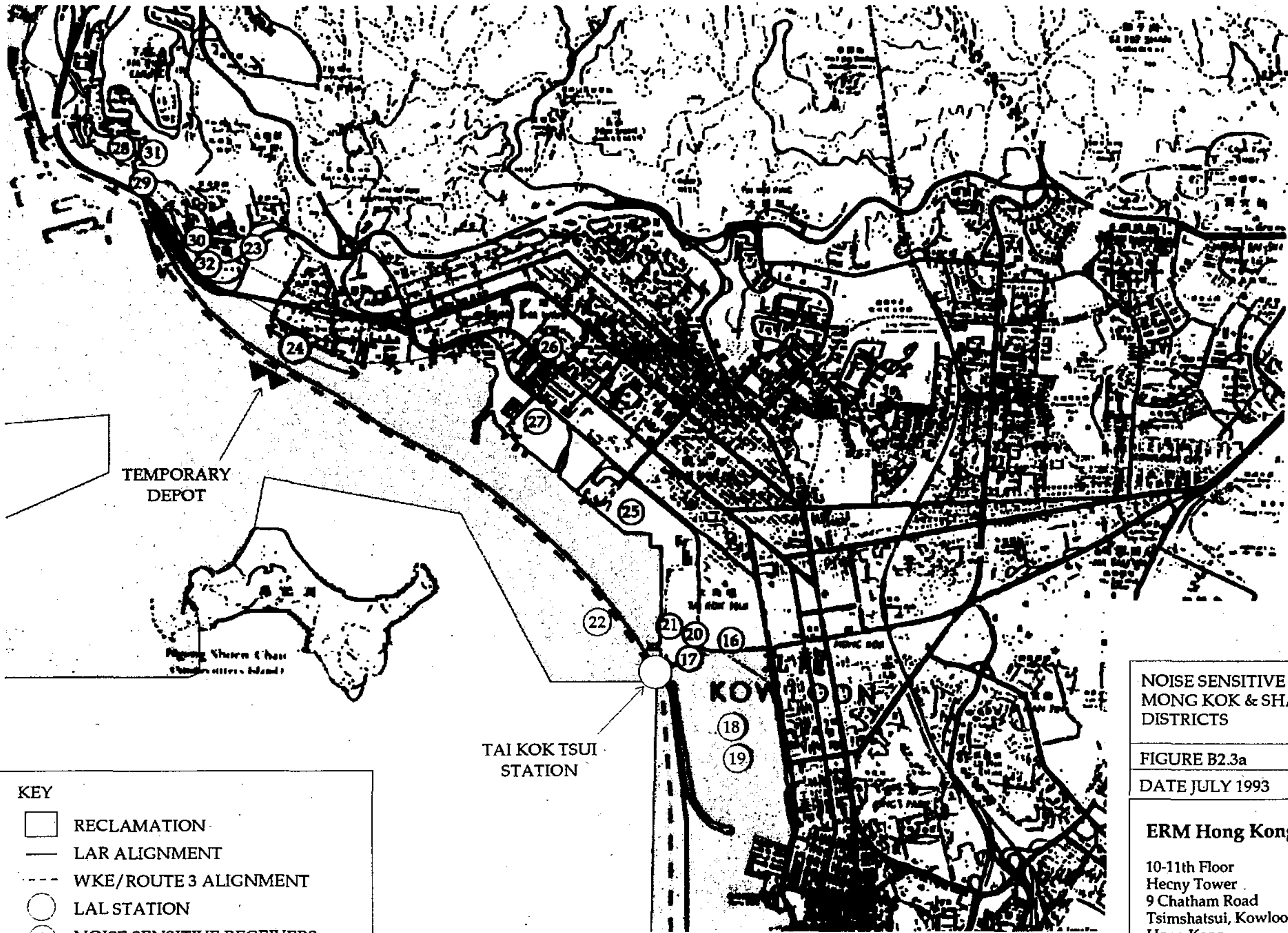
Future baseline noise levels during construction of the LAR are likely to be affected by noise from construction of the WKE, Route 3 and the WKR. During the operational phase of the LAR ambient noise levels will be elevated by traffic noise from the WKE and Route 3.

B2.4.3 Noise Sensitive Receivers

Tai Kok Tsui to Lai Chi Kok Formation

For the construction phase, the NSRs relating to this section of the alignment are:

- Ching Lai Court;
- Nam Cheong Estate;
- Mei Foo Sun Chuen, Lai Chi Kok;
- Waterfront Annex of Haking Wong Technical School, Lai Chi Kok;
- Fat Tseung Street Temporary Housing Area, Sham Shui Po;
- Nam Cheong Estate, Sham Shui Po;
- Wong Tai Street, Tai Kok Tsui;
- Hoi King Street, Tai Kok Tsui; and
- Cherry Street, Tai Kok Tsui.



KEY

- RECLAMATION
- LAR ALIGNMENT
- WKE/ROUTE 3 ALIGNMENT
- LAL STATION
- (1) NOISE SENSITIVE RECEIVERS

NOISE SENSITIVE RECEIVERS: MONG KOK & SHAM SHUI PO DISTRICTS

FIGURE B2.3a

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

For the operational phase, seven NSRs have been selected for the assessment of noise from trains on this section of the railway, as shown in *Figure B2.3a*:

- Mei Foo Sun Chuen – 21 storey;
- Haking Technical Institute – 2 storey;
- Nam Cheung Estate – 16 storey;
- Site C, MTRC Tai Kok Tsui Station Related Development – 25 storey; and
- Site C, MTRC Tai Kok Tsui Station Related Development – 25 storey;
- Residential site R1 North of MTRC Tai Kok Tsui Station Related Development Site C – 25 storey; and
- School site North of MTRC Tai Kok Tsui Station Related Development Site C – 10 storey.

This list of NSRs is considered to include the locations nearest to the alignment in all areas where train noise may potentially cause significant impacts. All NSRs have an area sensitivity rating (ASR) of 'C' as determined by reference with the NCO.

Existing residential properties in Tai Kok Tsui are, in some cases, relatively close to the LAR alignment. The nearest existing building to the alignment is a 14 storey industrial building in Kok Cheung Street. The proposed high rise office developments of sites A and D of the Tai Kok Tsui Station Related Development (in their current layout), and this existing industrial building will offer sufficient screening to the properties behind that these NSRs are unlikely to experience significant train noise impacts.

The two NSRs for site C of the MTRC Tai Kok Tsui Station Related Development are on opposite sides (facing West, and facing South) of tower number 27, which will be the worst effected residential tower that in the site (these are discussed in more detail in section 5). The residential portion of this development has been carefully designed incorporating reduced aspect towers that face away from the West Kowloon Expressway (WKE). This form of mitigation against traffic noise is expected to also be affective in mitigating against potential train noise impacts as the LAR alignment is close to the WKE in this area.

Lai Chi Kok to Kwai Chung Road Viaducts

For the construction phase, existing surveys of NSRs completed during the Airport Railway Feasibility Study (ARFS) and the Route 3 assessment were referenced. According to these reports, in this region there are 7 NSRs which are within 400 m of the LAR alignment. These are:

- Chan Nam Cheong Memorial School;
- Block 19, Cho Yiu Chuen Estate;
- Winifred Mary Cheung Morninghope School for the Physically Handicapped;
- Princess Margaret Hospital Government School of General Nursing & Quarters;
- Lai King Terrace (Government Quarters);

- Ching Lai Court; and,
- Mei Foo Sun Chuen South.

The proposed development on the WKR in the area of the temporary depot will not include any sensitive land uses. The ODP for the area indicates that the surrounding land will be used as a container site and an industrial area. The nearest NSR is the high rise residential estate at Mei Foo Sun Chuen this lies some 275 m to the north of the depot site boundary and is separated from the depot by the WKE/LAR formation. The location is shown in *Figure B2.3a*.

For the operational phase, six NSRs have been selected for the assessment of noise from trains on this section of the railway, as shown in *Figure B2.3a*:

- Block 19, Cho Yiu Estate – 12 storey residential block;
- Chan Nam Cheong Memorial School;
- Winifred Mary Cheung Morninghope School – two storey;
- Princess Margaret Hospital – 14 storey;
- Ching Lai Court – 18 storey; and
- Mei Foo Sun Cheung – 21 storey;

This list of NSRs is considered to include the locations nearest to the alignment in all areas where train noise may potentially cause significant impacts. All NSRs have an ASR of C, under the NCO.

In this District 10 NSRs were considered as part of the construction and operational phase assessments. These NSRs and their locations are as shown in *Figure B2.3a*. For completeness, these NSRs are listed below.

23 – Ching Lai Court
24 – Mei Foo Sun Chuen South
25 – Nam Cheong Estate
26 – Waterfront Annex of Haking Wong Technical School, Lai Chi Kok
27 – Fat Tseung Street Temporary Housing Area, Sham Shui Po
28 – Chan Nam Cheong Memorial School
29 – Winifred Mary Cheung Morninghope School
30 – Princess Margaret Hospital
31 – Block 19, Cho Yiu Chuen Estate
32 – Lai King Terrace, Government Quarters.

B2.5 KWAI TSING DISTRICT

B2.5.1 Existing Conditions

Lai King Station and Tunnels

The existing noise climate around the proposed South Portal on Lai King Hill is dominated by high levels of traffic noise from Kwai Chung Road. Noise surveys carried out by the Environmental Protection Department (EPD) at the Winifred Mary Cheung Morninghope School For Mentally Handicapped Children have shown daytime (0700–1900) facade traffic noise levels to be above L_{Aeq} 70 dB.

The noise climate along the tunnel alignment is dominated by traffic noise from Lai King Hill Road. This point, however, is not entirely relevant to this study as the areas above the tunnels are only likely to be affected by ground–borne noise and vibration from the railway which, if noticeable, will impact the noise environment within buildings.

At Lai King Station the noise climate is dominated by road noise from traffic on Kwai Chung Road. Traffic noise from Lai King Hill Road and noise from activities within a nearby container terminal are also significant.

Detailed noise surveys have been completed at three NSRs around the Station site. At locations that are not screened from Kwai Chung Road background noise levels are above L_{A90} 70 dB during the day and around L_{A90} 65 dB at night. At the facade of Yeung King House that faces away from Kwai Chung Road, the closest facade to the station site, background noise levels are around L_{A90} 65 dB during the day and around L_{A90} 55 dB at night. At the south facing facade of Ming King House background noise levels are above L_{A90} 70 dB during the day and around L_{A90} 65 dB at night. Even as early as 0600, the L_{Aeq} noise level is 69 dB(A) at this location, and $L_{Aeq,\,0700-1900}$ was recorded as 74 dB.

Kwai Chung Park

Existing noise levels in the area which is to become Kwai Chung Park are also likely to be relatively high as it is surrounded by both industrial buildings and major roads. Noise monitoring was carried out in the centre of Kwai Chung Park in June 1993. Daytime, free field noise levels of L_{A90} 58 dB and $L_{Aeq,\,1\,hr}$ 63 dB, and minimum night–time levels of L_{A90} 54 dB and $L_{Aeq,\,1\,hr}$ 56 dB were recorded. The principle noise sources in the area were activities in nearby container terminals and in the bordering industrial blocks.

At the Tsuen Wan Crematorium, due north of the northern end of this section, the main noise source is noise from industrial buildings on Wing Lap Street. Noise surveys carried out in May 1993 showed background noise levels of around L_{A90} 65 dB during the day and around L_{A90} 55 dB at night.

Rambler Channel Bridge

The existing noise climate in the region of the proposed Rambler Channel Bridge is characterised by industrial noise in the east, and more predominantly, road traffic noise at the Tsing Yi end.

Tsing Yi Station

The region surrounding the site for the proposed Tsing Yi Station incorporates residential developments, container terminals and large roads. Currently, the site for the proposed station is a container storage area and is used by large numbers of trucks. Tsing Tsuen and Tsing King Roads, connecting Tsing Yi Island with the New Territories, bring a large volume of road traffic into and out of the region. As a result the current noise environment is dominated by road traffic noise and noise from trucks loading and unloading in the container area.

Noise monitoring was carried at the 17th floor of On Pak House, the nearest residential tower of Cheung On Estate to the site, in June 1993. Traffic on Tsing Tsuen Road and Tsing King Road were the major noise sources in the area during the day and at night. In the daytime period (0700–1900) ambient noise levels were found to be L_{A90} 70 dB and $L_{Aeq, 1\,hr}$ 73 dB, with traffic noise, $L_{A10, 1\,hr}$, levels above 76 dB at most times. At night (2300–0700) the noise levels dropped greatly to a minimum of L_{A90} 53 dB and $L_{Aeq, 1\,hr}$ 62 dB.

Daytime monitoring was also carried out in St Paul's Village, at the house nearest to the proposed station worksite. Ambient noise levels were recorded to be L_{A90} 61–64 dB and $L_{Aeq, 1\,hr}$ 71 dB, while traffic noise, $L_{A10, 1\,hr}$, levels were approximately 74 dB. Intermittent noise from vehicular movements on the site itself contributed to the noise climate at St. Paul's Village, although Tsing Tsuen and Tsing King Roads were the dominant noise sources.

Tsing Yi Tunnels

The area to the east of the construction site for the proposed Tsing Yi Tunnels contains residential developments, container terminals and large roads, while the area to the west is mostly sparsely populated, undeveloped terrain. As a result, to the east of the site, the current noise environment is dominated by road traffic noise and noise from trucks loading and unloading in the container area, while to the west the environment is dominated by sounds common in a rural setting.

Noise monitoring was carried out in June 1993 at the 34th floor of On Kong House, Cheung On Estate which will be the nearest residential tower to the tunnelling worksite at the East Portal of the Tsing Yi Tunnels. Daytime noise levels were constant at L_{A90} 62 dB and $L_{Aeq, 1\,hr}$ 64 dB, resulting from traffic on Fung Shue Wo Road and Tsing Yi Road West. At night, these levels followed a steady decline and were recorded to be L_{A90} 58 dB and $L_{Aeq, 1\,hr}$ 59 dB at 0400.

B2.5.2 *Future Conditions*

Lai King Station and Tunnels

The WKE and other roads, including the north and southbound carriageways of the P1 trunk road, will introduce substantial levels of traffic noise into the area so that the noise environment in the vicinity of the proposed station will be dominated by road traffic and construction noise.

It should be noted, however, that the completion of WKE/Route 3 will change the pattern of vehicle flows on Kwai Chung Road, generally leading to a decrease in traffic. A number of mitigation options are being considered by the Highways Department to reduce the effects on sensitive receptors of traffic noise produced by the proposed Route 3 in this area. It is therefore likely that the regional traffic noise climate in the area will change and the level of protection from noise impacts afforded to sensitive receptors will be improved. However, since Route 3 will be an additional source of traffic noise in the area and it will cater for increased traffic volumes, it is likely that traffic will still be the dominant noise source and the overall noise climate is unlikely to be significantly changed.

Kwai Chung Park

In addition to the LAR, the Rail Development Study has been proposed that the North West New Territories Line (NWL) will also pass through Kwai Chung Park. To the south of the park, the land will be redeveloped to accommodate the proposed Route 3 Expressway. The existing open area in this region is to be reprovisioned as a sewage treatment facility. Further south, additional roads are proposed for the Lai King Station area. As a result, the future noise climate may have slightly higher baseline noise levels than at present.

Rambler Channel Bridge

For the area to the west of the Rambler Channel Bridge predicted traffic flows in the year 2001 on Tsing King Road are expected to be approximately 1240 vehicles (morning peak hour figure) with 28% heavy vehicles. The addition of Route 3 traffic onto the Rambler Channel southern bridge will further elevate traffic noise levels in the area.

Tsing Yi Station And Viaducts

Tsing Yi Town Park is proposed immediately to the south east of Tsing Yi station. Work on the park is expected to begin in 1993, with completion in 1994-5. The swimming pool complex to the south of the site and adjacent to the park is also expected to commence construction in 1993, with completion in 1995. Development on the west bank of the Rambler Channel is also proposed during the period 1994-95. This will include a waterfront promenade, and a section along the side of the station site.

Should these proposals proceed as currently planned, the construction works would coincide with that of the LAR. This suggests that the construction works for the separate projects may require particular control to avoid cumulative environmental impacts (particularly from dust and noise). The extent of any such potential cumulative effect is, however, dependent upon the works sequences for each project, which are not known at the present time.

The future environment around Tsing Yi Station will include new development in the form of expanded road systems and residential, commercial and government projects. A residential and commercial development will be constructed around and above the station, which will introduce noise from chillers, fans, and air handling units. By the year 2011 traffic noise from the major roads in the area is expected to have increased significantly. For example Tsing Tsuen road will be extended to a flyover above the Tam Kon Shan Interchange and will become a major feeder road to the NLE and peak morning hour total traffic flows are expected to increase from 2530 measured in 1991 to 6240 in 2011. This will introduce an additional road traffic noise source immediately to the North of the viaducts. Hence traffic noise, which already dominates the noise climate of the area, is expected to increase significantly.

B2.5.3 *Noise Sensitive Receivers*

Lai King Station and Tunnels

The tunnel section will pass below the highly populated Lai King residential district. As a result there is the potential for impact at multi-storey residential towers, schools, and a training centre. The following locations are the NSRs which are closest to the proposed construction sites for the tunnel section:

- Yin Lai Court;
- houses in Yuet Lai Yuen (including Lai Ha House, Lai Wah House and Lai Wan House);
- Clothing industry training centre;
- Block 13/Chung Ling Sheh of Cho Yiu Chuen;
- Asbury Methodist Primary School;
- Salvation Army Home Block A; and
- Block F in Cho Yiu Chuen.

The NSRs above are assumed to have no central air conditioning systems and a direct line of sight to the construction site.

The existing Lai King Station has multi-storey residential blocks on all but its western side. The following locations are the NSRs which are closest to the proposed construction site for the new station:

- Blocks 1 to 4 Lai King Estate;
- Block 5, Lai King Estate (Yeung King House);
- Block 6, Lai King Estate (On King House);

- Yin Lai Court;
- Lok Sin Tong Lau Sai Yan Primary School;
- houses in Yuet Lai Yuen (including Lai Ha House, Lai Wah House and Lai Wan House); and
- Blocks 12 (Kai Him Lau) and 13 of Cho Yiu Chuen.

The NSRs above are assumed to have no central air conditioning systems (with the exception of the Lok Sin Tong School, which already has been provided with secondary glazing and air conditioning as traffic noise mitigation measures) and have a direct line of sight to the construction site.

The distances of NSRs used in the construction noise calculations are given in *Tables B2.5a* and *Table B2.5b*.

Table B2.5a ***NSRs and their Distances to the Site Boundary and to Respective Notional Source Positions***

NSR Name	Minimum Plan Distance to Site Boundary (m)	Distance to Notional Source Position (m)
Station Worksite:		
Blocks 1 to 4 Lai King Estate	105	130
Block 5, Lai King Estate (Yeung King House)	15	40
Block 6, Lai King Estate (On King House)	55	115
Yin Lai Court	35	60
Lok Sin Tong Lau Sai Yan Primary School	70	120
Lai Ha House, Yuet Lai Yuen	60	85
Lai Wah House, Yuet Lai Yuen	50	90
Lai Wan House, Yuet Lai Yuen	60	100
Most northerly house in Yuet Lai Yuen	80	90
Blocks 12 (Kai Him Lau) and 13 of Cho Yiu Chuen	110	150

Table B2.5b NSR Slant Distance to Tunnels

NSR	Distance to AEL (m)	Distance to LAL (m)
Yin Lai Court (impacted by new station construction)	55	55
Yeung King House (Lai King Estate)	40	40
Lai Wan Hse (Yuet Lai Yuen)	65	65
Clothing Industry Training Centre	30	16
Block 13/Chung Ling Sheh (Cho Yiu Chuen)	40	40
School (Asbury Methodist Primary)	50	55
Salvation Army Home (Block A)	45	36
Block F (Cho Yiu Chuen)	40	40

Of the NSRs identified, the majority may potentially be affected by noise or vibration during the operational phase of the LAR. Airborne train noise is only likely to affect the WMC Morninghope School for the Mentally Handicapped, and Cho Yiu Chuen near the south portal. Ming King House, Lai King Estate and Lok Sin Tong Lau Sai Yan Primary school may be affected by train noise, but this would result from trains on the Lai King Viaducts and is discussed later.

Ground–borne noise and vibration may potentially affect most of the NSRs but the following four have been selected as those with the shortest slant distances to the tunnels, and therefore the most likely to be affected;

- Yeung King House, Lai King Estate;
- The Clothing Industry Training Centre;
- Asbury Methodist Primary School; and
- Block F, Cho Yiu Chuen Estate.

South Portal Worksite

The Winifred Mary Cheung Morninghope School For The Mentally Handicapped, situated on Lai King Hill Road, comprises a number of two storey buildings that are currently exposed to high levels of traffic noise from traffic on Lai King Hill Road and Kwai Chung Road. Part of the upper floor of the buildings to the rear of the school site have a direct line of sight onto the Kwai Chung Road below and will be within only a few meters of the proposed worksite at the South portal of the Lai King Tunnels.

The School has had no air conditioning and so has relied on open windows for ventilation in the hotter months of the year. As a result of the high levels of traffic noise already experienced at the school a noise insulation package is being offered by the Government under a scheme for *Noise*

Abatement Measures For Schools Affected By Road Traffic Noise. The package is due to be installed during the summer of 1993 and will include the following:

- Air conditioning to all classrooms on the perimeter of the site, the windows of these classrooms will be sealed following the installation; and
- secondary glazing to four classrooms experiencing the highest noise levels (L_{Aeq} above 75 dB).

This assessment assumed that these measures will be in place before the commencement of construction work at the South Portal worksite and will remain in place for the lifetime of the LAR.

Three additional NSRs are in the vicinity of the South Portal Construction Site. These are Chan Nam Cheong Memorial School, Block A of the Salvation Army Home (NSR 7) and a building on Cho Yiu Estate at the junction of Lai King Hill Road and King Cho Road. The NSRs and their applicable distances to South Portal construction sites are given below:

Table B2.5c *Noise Sensitive Receivers for the South Portal Worksite*

NSR	Distance to South Portal (metres)	Distance to Caisson Wall Construction (metres)
WMC Morninghope School	30 (worst)/ 50 (general)	5 (worst)/10 (general)
Salvation Army Home	125	160
Chan Nam Cheong Memorial School	90	110
Cho Yiu Chuen	80	80

It should be noted that Cho Yiu Chuen Estate will be screened from caisson wall construction by the WMC Morninghope School. This screening should reduce noise levels by 10 dB(A) and will be included in the subsequent assessment.

Lai King Viaducts

Near Lai King Station there are two sensitive receivers that are most likely to be effected by construction noise from the construction works to be carried out by the government for the Lai King Viaducts:

- Lok Sin Tong Lau Sai Yan Primary School; and
- Ming King House, Lai King Estate.

Ming King House, which is a seventeen storey block, is assumed to have no central air conditioning system. Lok Sin Tong Lau Sai Yan Primary School is close to the noisy Kwai Chung Road and has already been installed with secondary glazing and an air conditioning system. The school is a seven storey building and is considered as an NSR during the daytime only. The distances used in the construction noise calculations are given in *Table B2.5d* below.

Table B2.5d ***NSRs and their Distances to the Site Boundary and to Respective Notional Source Positions***

NSR Name	Minimum Plan Distance to Site Boundary (m)	Distance to Notional Source Position (m)
Ming King House, Lai King Estate	85	90
Lok Sin Tong Lau Sai Yan Primary School	65	70

The ground floor of these NSRs is approximately 20 m above the level of the viaducts.

Kwai Chung Park

Kwai Chung Park will not be open to the public during the construction works. Although not classified as an NSR in the NCO, the recreational space offered by Kwai Chung Park is considered sensitive to noise during the operation of the LAR. The proposed pavilion, at the highest point of the park, is considered to be the worst case noise assessment location.

Within 500 m of the alignment in Kwai Chung Park there is only one NSR, the funeral parlour and crematorium associated with the nearby Tsuen Wan cemetery. The crematorium is assumed not to be a residence and so will only be considered an NSR during daytime hours (0700–1900).

There are many residential developments to the northeast of the Kwai Chung Park site. However, as they are at a minimum distance of 700 m from the site on the far side of Highway Number 2, they are too distant to be considered as NSR's for the purposes of this assessment.

The NSRs considered to be within the possible zone of influence of operational noise from this section of the LAR are as follows:

- Tsuen Wan Crematorium;
- Ming King House; and
- Lok Sin Tong Lau Sai Yan Primary school (secondary glazed with air conditioning).

The proposed redevelopment of Kwai Chung Park may introduce areas of passive recreation near to the LAR alignment. Users of these facilities are likely to be sensitive to train noise to some degree. However, the park will not be an NSR according to the definition contained in TM1.

Rambler Channel Bridge

Severn NSRs were found to be located within 500 m of the Rambler Channel Bridge or Tsing Yi promenade (which is to be used for Work Areas during construction). These were:

- Riviera Gardens;
- Greenfield Garden;
- Tsuen Wan Crematorium;
- Cheung On Estate;
- St. Paul's Village;
- Tsing Yi Garden; and
- Marine Department Offices.

The most critical NSRs in the vicinity of the Work Areas are Riviera Gardens, Greenfield Garden, Tsuen Wan Crematorium and St. Paul's Village due to their proximity to the sites, the likely levels of background noise that will exist prior to construction and the type of intervening ground. Noise impacts at the Tsuen Wan Crematorium are possible both due to bridge construction and due to construction of the viaduct. However, the crematorium is only considered as an NSR during the daytime since it is assumed that it will not operate during the night.

Cheung On Estate is currently affected by traffic noise from the busy Tsing Tsuen Road. Noise impacts at this location are mainly dependent upon any increase in heavy goods vehicles due to the construction programme. The assessment for this NSR thus concentrates on road traffic noise.

The closest NSR in Tsing Yi Garden is further from the Work Areas than the closest NSR in Greenfield Garden (excluding Tsing Yi Station worksite which will mainly be used for construction of the station). Any source-based mitigation measures that are found necessary to reduce construction noise to acceptable levels at the latter NSR will thus also mitigate noise at the former. For this reason, the assessment concentrates on the reduction of noise at Greenfield Garden.

The Marine Department Offices are located approximately 20 m north of the bridge alignment, on the East coast of the Rambler Channel, and have window mounted, rather than central, air conditioning. The offices are on the second floor of a two storey building (the first floor being unoccupied). All other NSRs are assumed to have windows or other openings and no central air conditioning system.

Of the severn NSRs identified above four are considered for the operational phase.

- Riviera Gardens;
- Greenfield Garden;
- Tsuen Wan Crematorium; and
- Marine Department Offices.

In addition, the residential development at podium level above Tsing Yi Station is considered. Of the twelve residential towers in this development, Tower 1 overlooking the Rambler Channel has been identified as the nearest NSR.

Four of the five NSRs identified are residential developments and are therefore sensitive to noise at night, whilst the crematorium and the Marine Department offices are considered NSRs only for the daytime period.

Tsing Yi Station And Viaducts

Within 500 m of the Tsing Yi Station worksite there are eight noise sensitive neighbourhoods, the NSRs and the minimum distances to major work areas are listed in the table below. The locations of the NSRs are shown in *Figure B2.5a*.

Table B2.5e ***Noise Sensitive Receivers***

Noise Sensitive Receiver	Sensitive Use	Distance to Station (m)	Distance to Viaduct (m)
School at Cheung On Estate	School	75	160
On Pak House, Cheung On Estate	Residential Block	70	65
On Chiu House, Cheung On Estate	Residential Block	185	70
On Tao House	Residential Block	400	145
On Yun House, Cheung On Estate	Residential Block	310	145
Broadview Gardens	Residential Block	250	225
School at Tsing Yi Estate	School	370	245
School at St. Paul's (Lam Tin) Village	School	175	50
St. Paul's (Lam Tin) Village	Residential Block	80	75

Of the NSRs identified above the majority may potentially be affected by noise during the operational phase of the LAR. In addition the residential towers above the proposed station will be NSRs.

Six residential NSRs have been selected for the assessment of noise from trains on the viaducts, as shown in *Figure B2.5a*:

- New three storey buildings in the North of St Paul's village;
- On Chiu House, Cheung On Estate, 35 storey tower (Cheung On West);
- On Pak House, Cheung On Estate, 35 storey tower (Cheung On East);
- Tower 7, Tsing Yi Station, new 35 storey development above podium;
- On Tao House; and
- Broadview Gardens.

Information obtained from the Kwai Tsing District Office suggests that the small group of buildings mapped at the extreme North of St Paul's village, approximately 40 m plan distance from the nearest (AEL up) line, are disused or demolished and there are no plans to rebuild on their sites. In this area the nearest NSR in St Paul's village is therefore taken as the new three storey residential buildings.

Tsing Yi Tunnels

Within 1500 m of the proposed worksites for the tunnels there are fourteen noise sensitive neighbourhoods, the locations of the NSRs are shown in *Figure B2.5a*. The NSRs and the minimum distances to major work areas are listed in *Table B2.5f*.

Table B2.5f *Noise Sensitive Receivers*

Noise Sensitive Receiver	Use	Distance to East Portal (m)	Distance to Nearest Blasting Site (m)
School at Cheung On Estate	School	200	215
Cheung On Estate	Residential Block	160	180
Tsing Yi Estate	Residential Block	350	390
School at Tsing Yi Estate	School	275	370
Feng Shue Wo	Temporary Housing Area	255	275
Tsing Yan	Temporary Housing Area	400	40
Tsing On	Temporary Housing Area	215	320
Cheung Hang Estate	Residential Blocks	215	75
Ching Wah Estate	Residential Blocks	945	825
	School	925	820
Liu To	Village	810	540
Ngau Kok Wan	Village	1450	600
Yau Kom Tau	Village	960	380
Cheung Shue Tau	Village	550	225
Ting Kau	Residential	1250	1400

It should be noted that these receivers are not all of the same type and are not affected by the same level of construction noise. As a result, according to TM1, the NSRs will have different ASRs and so different Acceptable Noise Levels (ANL) for impacts from construction.

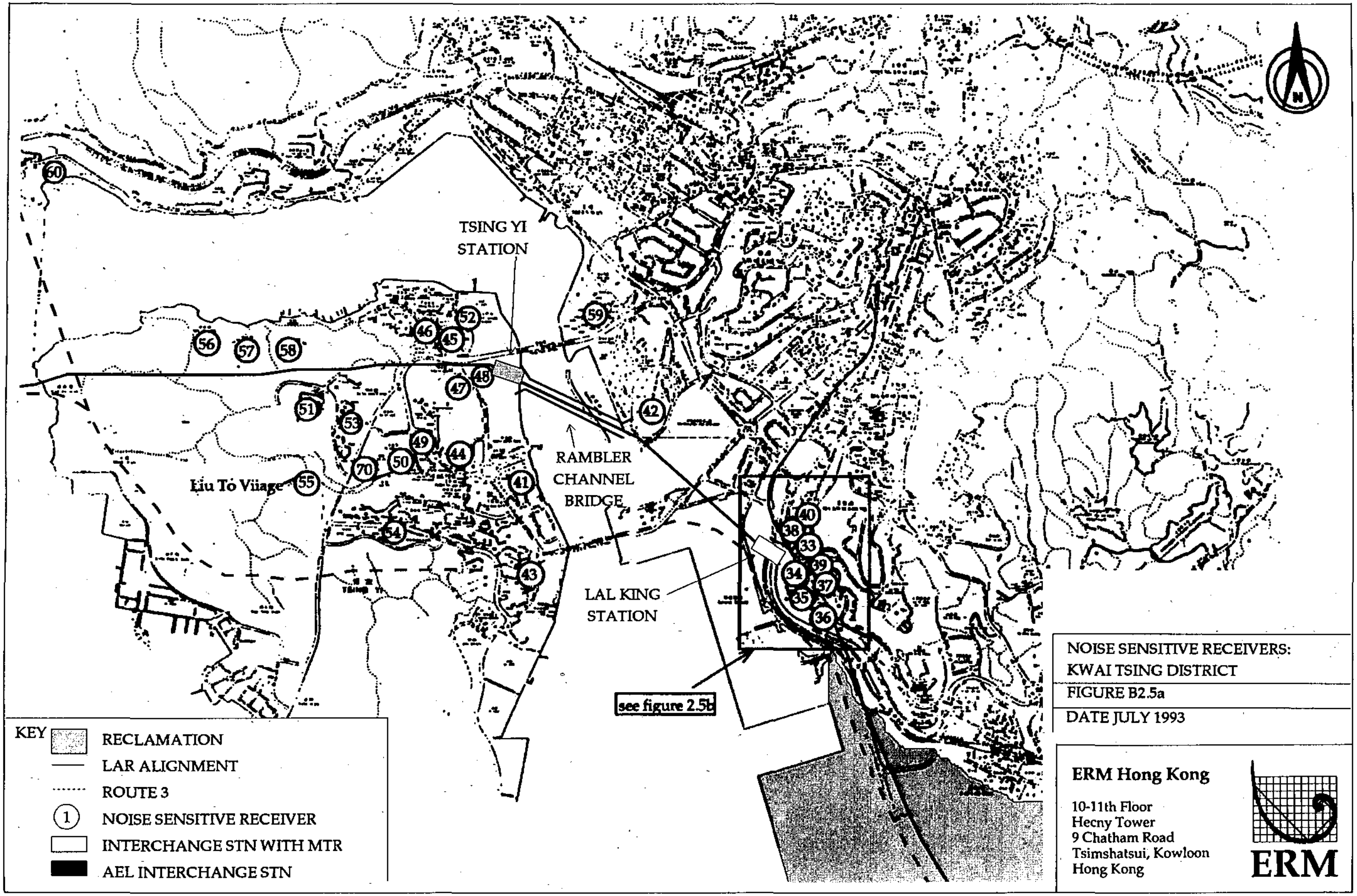
The village of Ngau Kok Wan and Liu To are rural villages unaffected by the Tsing Yi urban area and so are given an ASR of 'A'. The villages of Yau Kom Tau and Cheung Shue Tau are indirectly affected by industrial sources and road networks in and around the Tsing Yi urban area and are village type developments. Therefore these NSRs are given an ASR of 'B'. Cheung Hang Estate, Ching Wah Estate, Fung Shue Wo and Tsing Yan Temporary Housing Areas are urban areas unaffected by influencing factors in the Tsing Yi area and so are given an ASR of ' B'. All other NSRs are directly or indirectly affected urban areas and so are given an ASR of 'C'. The ANLs for these three classes of receivers are set out in *Table A2.1b* of *Annex A*.

Tsing Yan Temporary Housing Area and the planned district hospital to the west of Cheung Hang Estate have also been considered as NSRs for the operational phase.

A total of 30 NSRs were identified in this District, these are shown in *Figure B2.5a* and listed below.

33 – Yin Lai Court
34 – Clothing industry training centre
35 – Asbury Methodist Primary School
36 – Salvation Army Home Block A
37 – Cho Yiu Chuen Estate
38 – Lok Sin Tong Lau Sai Yan Primary School
39 – Yuet Lai Yuen Estate
40 – Lai King Estate
41 – Greenfield Garden
42 – Tsuen Wan Crematorium
43 – Cheung Ching Estate
44 – Tsing Yi Garden
45 – Cheung On Estate, On Pak House
46 – Cheung On Estate, On Yun House
47 – St. Paul's (Lam Tin) Village
48 – Towers 1 & 7, residential development above Tsing Yi Station
49 – Tsing Yi Estate
49a– Broadview Gardens
50 – Feng Shue Wo Temporary Housing Area
51 – Tsing Yan Temporary Housing Area
52 – Tsing On Temporary Housing Area
53 – Cheung Hang Estate and proposed District Hospital
54 – Ching Wah Estate
55 – Liu To Village
56 – Ngau Kok Wan Village
57 – Yau Kom Tau Village
58 – Cheung Shue Tau Village
59 – Riviera Gardens
59a– Marine Department Offices
60 – Ting Kau

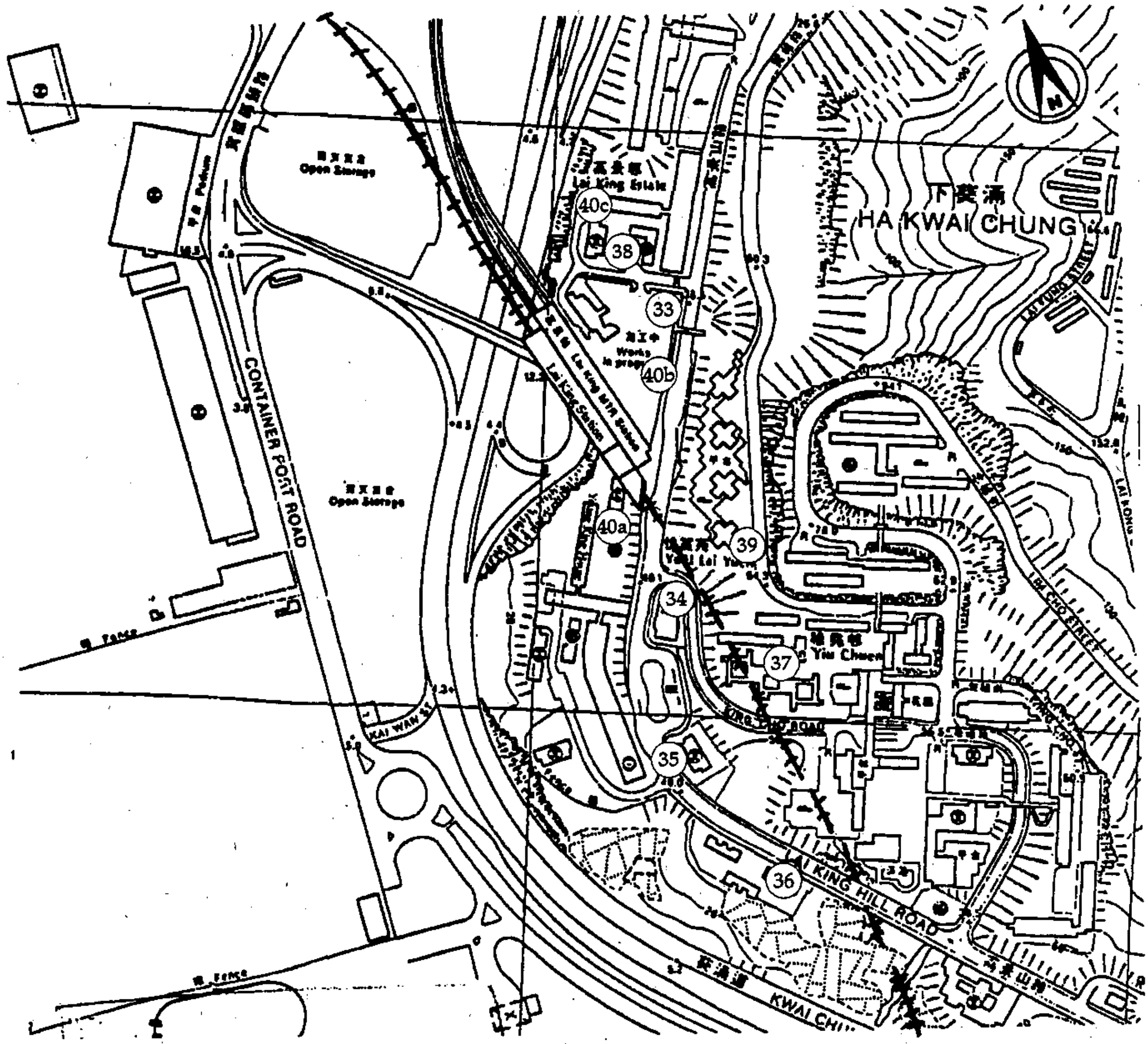
Figure 2.5b shows the NSRs around Lai King Station in more detail.



NOISE SENSITIVE RECEIVERS: KWAI TSING DISTRICT

FIGURE B2.5a

DATE JULY 1993



NOISE SENSITIVE RECEIVERS
33 - YIN LI COURT
34 - CLOTHING INDUSTRY TRAINING CENTRE
35 - ASBURY METHODIST PRIMARY SCHOOL
36 - SALVATION ARMY HOME BLOCK A
37 - CHO YIU CHUEN ESTATE
38 - LOK SIN TONG LAU SAI YAN PRIMARY SCHOOL
39 - YUET LAI YUEN ESTATE
40a - LAI KING ESTATE, YEUNG KING HOUSE
40b - LAI KING ESTATE, ON KING HOUSE
40c - LAI KING ESTATE, MING KING HOUSE

NOISE SENSITIVE RECEIVERS: LAI KING STATION
FIGURE B2.5b
DATE SEPTEMBER 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

B2.6 *TSUEN WAN DISTRICT*

B2.6.1 *Existing Conditions*

The three areas in which bridge construction will take place (West Tsing Yi, Central Ma Wan and Northeast Lantau Island), are generally rural and sparsely populated. Areas of habitation are generally characterised as low density residential areas. The noise environment in these regions is dominated by sounds common to rural areas.

The region of the site for the proposed Lantau Tunnels is also made up of mostly sparsely populated, undeveloped terrain. From the vantage point of the Lantau Tunnels, Ma Wan Island is located 1 km to the northeast of this region and the New Territories over 1 km to the north.

B2.6.2 *Future Conditions*

West Tsing Yi, central Ma Wan and northeast Lantau Island will in the future develop into more urban areas with larger and more developed road networks. On Lantau Island, the operation of the NLE is expected to increase the ambient noise levels in the north, while in west Tsing Yi the operation of the Route 3 Expressway is expected to generate higher noise levels as a result of the large volumes of traffic it will carry. Ma Wan Island will also experience the construction of more infrastructure, roads and high rise residential structures. As a result, the future environment will be dominated by road traffic noise.

B2.6.3 *Noise Sensitive Receivers*

Lantau Fixed Crossing

On Lantau Island, five NSRs were identified within the sphere of influence of the Lantau Fixed Crossing. These were the villages of:

- San Po Tsui;
- Tai Chuen;
- Yi Chuen;
- Tso Wan; and
- Fa Peng.

Twelve other NSRs, in five neighbourhoods, were identified to the east across the channel from North Lantau, on Ma Wan Island. These noise neighbourhoods were:

- Ma Wan Town, 5 sites;
- Tin Liu, 3 sites;
- Lau Fa Tseun, 2 sites;
- Tai Lung; and
- a Temple.

All of these NSRs were identified as village type developments in rural areas.

In the vicinity of Tsing Yi Island four NSRs were identified:

- Ngau Kok Wan;
- Yau Kom Tau;
- A proposed District Hospital and Cheung Hang Estate; and
- Ching Wah Court.

Three other NSRs were located in the Castle Peak region, to the north across the channel from Tsing Yi Island. These receivers are located over 1 km from the LAR alignment, however, blasting and 24 hour working are both possible so there exists the possibility that these residential developments could be affected by construction noise. These NSRs were:

- Tsing Lung Tau;
- Sham Tseng; and
- Ting Kau, 5 sites.

All of these NSRs were identified as low density residential areas consisting of low–rise or isolated high–rise developments. As a result of the environmental setting and the distance from construction works, the developments were given an Area Sensitivity Rating (ASR) of "A".

The following NSRs were considered for the assessment of operational noise impacts:

- Lau Fa village;
- East coast of Ma Wan Island;
- West coast of Ma Wan Island;
- Ma Wan Town;
- Tin Liu village; and
- San Po Tsui.

Lantau Tunnels

The region around the Lantau Tunnels alignment is very mountainous and sparsely populated. As a result many potential sensitive receivers are screened by the surrounding geography. Within 1500 m of the proposed worksite at the West Portal there is one NSR, located at Tsing Chau Tsai, which is approximately 75 m from the main work area. However, any residents of this village will be relocated prior to the commencement of construction works. Other NSRs in the area have not been assessed because they are located behind topographical features which will screen them from construction activities.

Five NSRs were considered for the assessment of impacts during the operational phase. Those selected as the nearest NSRs are:

- San Po Tsui – approximately 400 m from the east portal;

- Tai Chuen – approximately 400 m from the east portal;
- Yi Chuen – approximately 500 m from the east portal;
- Tso Wan – approximately 600 m from the east portal; and
- Tsing Chau Tsai – approximately 75 m from the west portal.

Eighteen NSRs are located in this District, these are shown in *Figure B2.6a* and listed below.

61 – San Po Tsui
62 – Tai Chuen
63 – Yi Chuen
64 – Tso Wan
65 – Fa Peng
66 – Ma Wan Town
67 – Tin Liu
68 – Lau Fa Tsuen
69 – Tai Lung
70 – a Temple
71 – Tsing Lung Tau
72 – Sham Tseng
73 – Ting Kau
74 – East coast of Ma Wan Island
75 – West coast of Ma Wan Island
76 – Tsing Chau Tsai

B2.7 ISLANDS DISTRICT

B2.7.1 Existing Conditions

A noise survey in the North Lantau region was conducted at two NSRs as part of the North Lantau Expressway (NLE) study. Both of these NSRs are pertinent to the construction noise assessment for the LAR in North Lantau.

The noise survey was conducted in November 1990 at Luk Keng Tsuen and Pak Mong. At Luk Keng Tsuen, the free-field $L_{Aeq, 1\,hr}$ level varied between approximately 50 dB and 66 dB whilst background (L_{A90}) noise levels were in the range 46–60 dB. At Pak Mong, the free-field $L_{Aeq, 1\,hr}$ level varied between approximately 31–56 dB whilst background (L_{A90}) noise levels were in the range 28–42 dB.

The existing noise environment was reported to be typical of a quiet rural setting – there were no major noise sources. Minor sources included a chicken farm, off-shore lumbering activities, marine traffic, the local community and intermittent hammering in dockyards .

The region of the site for the proposed Depot at Siu Ho Wan is made up of mostly sparsely populated, undeveloped terrain although the Depot itself will be built on newly reclaimed land.

The existing environment in the vicinity of the proposed Tung Chung New Town was reported to be rural, sparsely populated and undeveloped. A baseline noise survey was undertaken in early 1991 as part of the NLD study. Background L_{A90} noise levels were in the range 25–45 dB.

The new airport will be built on land comprising the existing Chek Lap Kok Island and a reclaimed section of land to the west of the island. Chek Lap Kok Island is uninhabited and the noise climate may be characterised as that common to rural, undeveloped areas.

B2.7.2 *Future Conditions*

Conditions along the North Lantau coast are changing rapidly and already most of the areas described above are now dominated by construction noise from the North Lantau Development (NLD) and the NLE.

The future environment will include the reclaimed land which Tung Chung Station will be built upon as well as new development in the form of road systems, schools, residential development and commercial and government projects making up Tung Chung New Town. The NLE will be constructed to the south of the proposed town at a distance of about 100 m. Other roads within the town will introduce traffic noise into the area. Overall, the noise environment in the vicinity of the proposed station will be dominated by road traffic noise.

The future environment around the east coast of Chek Lap Kok Island will include the new airport, commercial development and new roads and expressways, such as the NLE. As a result, the future environment will be dominated by road traffic and airport and airplane noise.

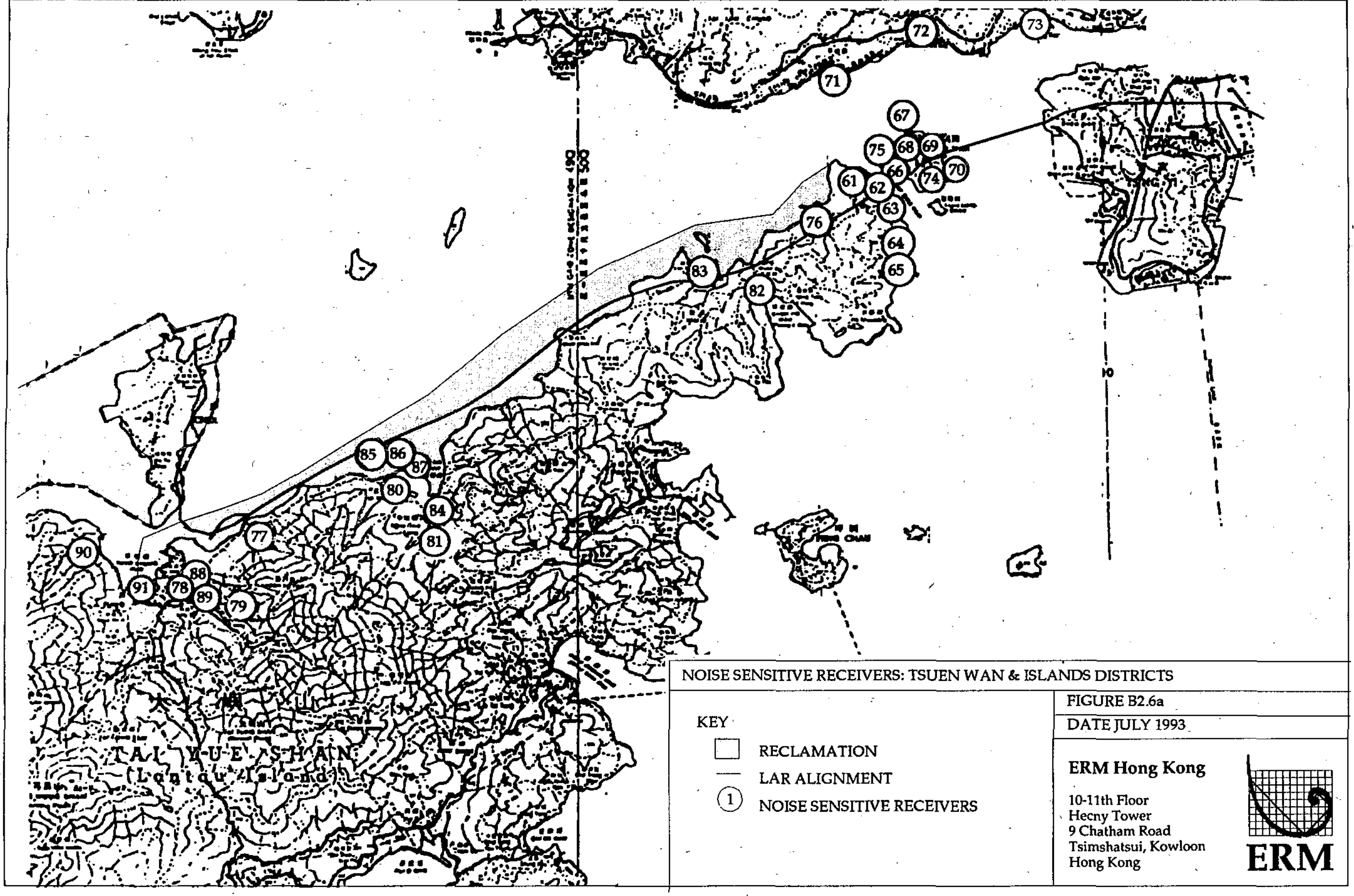
B2.7.3 *Noise Sensitive Receivers*

North Lantau Coast

Along the North Lantau coast, NSRs were identified in both the NLD and NLE studies. As part of the NLD noise assessment, impacts were assessed at eleven (for report TR18) and twelve (for report TR20) 'noise neighbourhoods'. Some of the neighbourhoods were common to both assessments. These neighbourhoods were identified as areas likely to be affected by noise from NLD construction. Six of these neighbourhoods are directly relevant to the construction noise assessment of the LAR; these are, from TR18 (with associated codes):

- N1: Tai Po Village and Youth Camp;
- N2: Ma Wan Chung and Ma Wan Villages;
- N3: Shan Ha Village; and,
- N4: Fui Yiu Ha, Sheung Ling Pei, Ha Ling Pei, Wong Ka Wai and Lung Tseng Tau Villages;

and from TR20:



NOISE SENSITIVE RECEIVERS: TSUEN WAN & ISLANDS DISTRICTS

FIGURE B2.6a

DATE JULY 1993

KEY

RECLAMATION

LAR ALIGNMENT

(1) NOISE SENSITIVE RECEIVERS

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

- PM: Pak Mong; and,
- TLG: Ngau Kwu Long, Tin Liu, Tai Ho San Tsuen.

According to TR20, many of the existing settlements in North Lantau which fall within the development areas will be cleared or re-sited (for example, Tai Po will be re-located during Phase 1 of the reclamation). After the first occupation of Phase 1, the only ASR 'A' areas will be villages or other low density developments located close to construction works.

Eleven NSRs were identified as part of the construction noise assessment for the NLE study. Most of these NSRs are of relevance to the assessment of the LAR. Those locations not included in the above lists are shown below (with their associated codes):

- Y11: Wan Tuk;
- Y21, Y22: Luk Ken Tsuen;
- T11, T12, T13: Tai Ho Wan; and,
- C11: Ka Loon Tsuen.

Siu Ho Wan Depot And Tai Ho Wan

Within 2000 m of the proposed Depot Work Sites at Siu Ho Wan there are five NSRs. The NSRs and the minimum distances to major work areas are listed in the table below. The locations of the NSRs, as referenced at the end of this section, are shown in *Figure B2.6a*.

Table B2.7a *Noise Sensitive Receivers*

Noise Sensitive Receiver	Sensitive Use	Distance to Depot Building (m)	Distance to At-grade Track (m)	Distance to Grade Separation (m)
Ngau Kwun Long	Village	1750	1450	1275
Tin Liu	Village	1570	1420	1150
Tai Ho San Tsuen	Village	1985	1685	1410
Pak Mong	Village	1600	1300	1400
Tai Ho Wan	Temple	960	810	750

The proposed development on the North Lantau Reclamation (NLR) at Siu Ho Wan will include a number of sensitive land uses that will be considerably nearer to the depot than existing NSRs. The area to the east of the depot will form an industrial area, and to the south no NSRs have been identified. The nearest NSRs are those shown in areas 14, 27 and 29 of the ODP for the Tai Ho Wan region. No recommendations are given for the preferred layout of these areas. However for the assessment of the worst case, it is assumed that these sites will include NSRs on the site boundary nearest to the depot and with an unobstructed view of the depot site. The three worst case NSRs are listed below:

- Residential, assumed high rise, in commercial/residential area 27;
- residential, assumed high rise, in special residential area 14; and
- secondary school (assumed 10 storey high) in Government, institution and community area 29.

These NSR locations are shown in *Figure B2.6a* and in more detail in *Figure B5.7b.*

In addition to these planned NSRs near the Depot site, a number of other sensitive landuses are planned on the reclamation at Siu Ho Wan. There is potential for impacts from train noise at the following planned noise sensitive areas.

- Home Ownership Scheme residential site, area 15, assumed high rise;
- Residential site R2, area 18, assumed high rise;
- Home Ownership Scheme residential site, area 22, assumed high rise; and
- Pak Mong Village, (expanded area), area 32, assumed low rise residential;

These NSR locations are shown in *Figure B5.7b.*

Tung Chung

Within 750 m of the proposed Tung Chung Station Work Sites there are six NSRs which need to be taken into consideration. The NSRs and there minimum distances to major work areas are listed in *Table B2.7b* below.

Table B2.7b *Noise Sensitive Receivers*

Noise Sensitive Receiver	Sensitive Use	Distance to Station (m)	Distance to Tunnels (m)
Tai Po Village	Residential--Village	485	150
Youth Camp	Children's Camp	350	400
Christian Church	Place of Worship	395	N/A
Ma Wan Chung Village	Residential--Village	450	N/A
Wong Nai Uk Village	Residential--Village	550	N/A
Ma Wan Village	Residential--Village	675	N/A

As the surrounding area is rural and the NSRs are predominantly village developments, the ASR for the region is specified as 'A' during the construction phase.

It should be noted that Tai Po Village is to be relocated in 1993 and construction work on this section of the alignment is due to commence in 1994. As a result of this scheduling and the possibility for delays in relocation, noise impacts at this NSR are assessed only for the construction phase, operational noise impacts being irrelevant.

The Christian Church, Wong Nai Uk Village, and Ma Wan Village have not been assessed as they are located behind a 50–75 m high ridge which screens them from the station worksite.

In addition to the NSRs already discussed, the proposed new town will introduce a large number of new NSRs into the area around the station and the alignment of the LAL and AEL. Around the station, eight residential towers in development areas R1(d1) and R1(d2), and the special residential home ownership scheme area (HOS RS) are proposed. The LAL tunnel alignment passes above the Commercial site C(k), the Government, institution and community sites G/IC (o) and (t), and residential sites R1(b2), and (c1). Residential sites R1(c2) and (y) will be within approximately 70 m and 150 m respectively of the LAL portal, or LAL at grade, as it rises out of cut and cover tunnel to the East of the new town. The primary schools S(3) and secondary school S(1) will be located approximately 120 m and 80 m from the LAL tunnel alignment respectively, and roughly 12 m north of the AEL alignment. 34 residential cruciform towers will be located roughly 150 m north of the AEL alignment as it follows a gentle arc through the new town. Nine NSR locations (A to I) have been selected from the above list for the assessment of train noise, and are discussed in more detail (and shown in a figure) in *Section 5.7*.

Airport Works

NSRs have been identified with reference to previous environmental studies undertaken in relation to LAR, and have been updated by referring to survey sheets and development plans. The NSRs identified are as follows:

- Ma Wan Chung;
- Residential towers in area R1(a) of Tung Chung new town; and
- Residential towers in area R1(d) of Tung Chung new town;

Ma Wan Chung is located more than 800 m from the bridge beyond the residential towers in area R1(a) of Tung Chung New Town. The mitigation measures proposed for R1(a) will therefore be adequate to ensure that impacts at Ma Wan Chung are also mitigated, and hence no assessment has been undertaken at Ma Wan Chung.

The northern most residential tower in area R1(a), to the north of the AEL alignment, will be approximately 200 m from the southern end of the bridge, while the nearest residential tower in area R1(d), near Tung Chung LAL station, will be approximately 400 m from the bridge.

Sixteen NSRs are identified within this District, these are shown in *Figure B2.6a* and listed below.

77 – Tai Po Village and Youth Camp
78 – Ma Wan Chung and Ma Wan Villages
79 – Shan Ha Village
80 – Pak Mong
81 – Ngau Kwu Long, Tin Liu, Tai Ho San Tsuen

82 – Wan Tuk
83 – Luk Ken Tsuen
84 – Tai Ho Wan
85 – Residential, assumed high rise, in commercial/residential area 27
86 – Residential, assumed high rise, in special residential area 14
87 – Secondary School (assumed 10 storey high) in Government, institution and community area 29
88 – Christian Church
89 – Wong Nai Uk Village
90 – San Tau
91 – Residential towers and schools in Tung Chung new town, nine NSRs in total (see *Section 5.3*)

B3 POTENTIAL SOURCES OF IMPACT

B3.1 INTRODUCTION

The potential sources of noise impact during the construction phase are described by district in *Sections 3.2* to *3.7* below. *Section 3.8* describes the potential sources of impact during the operational phase, which in many cases are common to several districts. Where this is not the case, the potential impacts during the operational phase are described individually.

B3.2 CENTRAL AND WESTERN DISTRICT

B3.2.1 *Hong Kong Station and Tunnels*

Potential sources of impact for this phase include all PME, including percussive piling rigs, and construction-related traffic. Plant teams for the various construction activities that will be taking place as part of this contract were assumed, based on available information. For noise from construction activities other than percussive piling, predictions were made for the three noisiest phases of station construction. These activities were assumed to be site clearance, excavation and backfilling. For predictions of percussive piling noise, two diesel hammer rigs driving sheet steel piles were assumed to be acting at the nearest point on the site boundary to the respective NSR.

In practice, the Mandarin Hotel has no direct line of sight to the worksite. Intervening buildings will provide acoustic screening and so a correction of -10 dB(A) has thus been assumed for this NSR.

B3.2.2 *Immersed Tube Tunnel*

The potential sources of noise impact from the works for the immersed tube tunnel are restricted to dredging activities. The dredged spoil will be transported away from the site by barge rather than by truck so impacts to receivers close to the road system in and around Central are not expected. As the Kowloon side of the tunnel will be built exclusively on reclaimed land, at a distance of over a kilometre from the existing central Kowloon district, impacts from noise need only be assessed on the Hong Kong side of the Harbour.

B3.3 YAU TSIM DISTRICT

B3.3.1 *Kowloon Station and Tunnels*

This section of the alignment will consist of two different components, Kowloon Station and a cut and cover tunnel. Each of these sections has associated construction activities which have the potential to impact upon nearby NSRs.

During station construction there are assumed to be four main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- excavation;
- station box construction (including piling); and,
- building erection.

For the cut and cover tunnel sections there are assumed to be four main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- excavation;
- piling of the foundations; and,
- backfilling and compaction.

B3.3.2 *Kowloon to Tai Kok Tsui Tunnels*

The section of the alignment to the north of Kowloon Station will consist of two separate sections: a cut and cover tunnel and an open cut section. Each of these sections has associated construction activities which have the potential to affect nearby NSRs.

For the cut and cover tunnel sections there are assumed to be four main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- excavation;
- piling of the foundations; and,
- backfilling and compaction.

As the land upon which the station, tunnels and cutting will be built is entirely reclamation, no site clearance procedures will be necessary.

The open cut construction method is similar to the cut and cover construction, however, it will not include any backfilling or tunnel section fabrication activities.

Due to the nature of the reclaimed land, it is assumed that non-percussive piling techniques will be adequate for all piling operations. As a result, percussive piling has not been included in the assessment of any construction activities necessary for the completion of this section of the alignment.

For all of these activities there will be noise associated with the movement of vehicles on and off the site. These impacts will be assessed separately.

B3.4 MONG KOK DISTRICT

B3.4.1 *Tai Kok Tsui Station*

This section of the alignment will consist of two separate worksites, Tai Kok Tsui Station and Cherry Street Underpass. The construction of Cherry Street Underpass will be entrusted works, carried out as part of the WKE construction rather than as an MTRC contract. However, due to the proximity of the sites and the potential for cumulative impacts, both sites have been considered in this assessment.

For station construction there are assumed to be five main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- piling of the foundations over the Cherry Street Underpass;
- excavation;
- station box construction (including piling); and,
- building erection.

For the Cherry Street Underpass there are assumed to be three main activities capable of producing significant noise impacts at NSRs. These are:

- Excavation;
- piling; and,
- backfilling.

As the land upon which the station and tunnels will be built is entirely reclamation, no site clearance procedures will be necessary. Also because of the nature of the reclaimed land, it is assumed that non-percussive piling techniques will be adequate for all piling operations. As a result, percussive piling has not been included in the assessment of any construction activities necessary for the completion of this contract.

For all of these activities there will be noise associated with the movement of vehicles onto and off of the site. These impacts will be assessed separately.

B3.5 SHAM SHUI PO DISTRICT

B3.5.1 *Tai Kok Tsui to Lai Chi Kok Formation*

Piling operations, general construction equipment and haulage were cited as being the main sources of construction noise in the ARFS for the study area.

According to the WKE study, piling, superstructure construction, roadworks, and construction traffic were cited as being the main sources of construction noise for this area.

B3.5.2 *Lai Chi Kok to Kwai Chung Road Viaducts*

The main activities that will provide the potential sources of noise are construction of the LAR and Route 3 viaducts as part of Contract 507 and general construction work and tunnelling at the Lai King Hill South Portal as part of Contract 508.

B3.5.3 *Mei Foo Temporary Depot*

The temporary nature of the proposed depot at Mei Foo and the operations to be undertaken will necessitate many varied noisy activities taking place in the open.

The main noise sources around the depot site are as follows;

- Train rolling noise (including wheel squeal);
- train mounted plant (air conditioners etc);
- materials stockpiling and handling;
- train loading;
- track and station equipment prefabrication; and
- road vehicles serving the depot.

The function of the depot is such that it will be fully operational from 0700-2300 with a reduced level of activity continuing throughout the night. It is estimated that some 75 people will work at the depot with a further 75 using it as a base for operations elsewhere along the track construction.

B3.6 KWAI TSING DISTRICT

B3.6.1 *Lai King Station and Tunnels*

Lai King Station will consist of a concrete box with short platform tunnels under Lai King Hill Road. Substantial excavation into the hill-side will be required prior to station construction. Construction work will also include utilities diversions on Lai King Hill Road, construction of retaining walls and demolition of Lai King Community Hall and other structures. Work is expected to begin at 0700 and continue until 2300.

Construction plant and equipment that will be used during these activities will act as potential sources of noise impact to NSRs, this includes PME and construction-related traffic. Particularly noisy activities at the station worksite are predicted to be:

- Site clearance;
- demolition of Lai King Community Hall;
- excavation to the south of the construction site; and
- construction of the station.

The tunnel section will consist of four separate tunnels which will be blasted into the rock structure underlying the Lai King area. Tunnelling will proceed northwards from the south Portal worksite. It is projected that three blasts will be performed per driven bore in each of the four tunnel sections, this will result in approximately 12 blasts per day. Rubble from the tunnel site will be collected by typical excavation plant and trucked away for disposal. Operations within the tunnels are expected to be continuous, but operation of mechanical plant on the surface is expected to be restricted from 1900–2300 and banned between 2300–0700 in order to comply with any Construction Noise Permit (CNP) granted.

Construction plant and equipment that will be used during these activities will act as potential sources of noise impact to NSRs, this includes PME, blasting materials and construction–related traffic. Particularly noisy activities are predicted to be blasting and removal of rubble.

As most of the construction activities will take place within the tunnels themselves, the majority of the potential impacts for this phase of construction will be well screened and will only affect NSRs in the immediate vicinity of the South Portal site. These will consequently be the focus of the assessment. However, possible noise and vibration effects from blasting could affect other residential areas located above the tunnel.

Construction work at the South Portal worksite will consist of four main phases. The first phase will be the construction of a caisson wall around the boundary of the WMC Morninghope School for the Mentally Handicapped and the anchoring of the school foundations. This will be carried out concurrently with the second phase, the blasting and excavation of the hill section to the south of the school, to provide a foundation for the at grade track section of the LAR. The third phase will be the use of the excavated hill section as a tunnelling worksite while the fourth phase will be the construction of the at–grade track section and impulse fan containment structures.

Particularly noisy activities are assumed to be:

- Construction of the caisson wall;
- blasting;
- removal of blasted spoil and rubble;
- work site traffic;
- construction of the at grade track section; and
- tunnel ventilation and operation of fans and compressors.

Near Lai King Station, the proposed viaduct construction, to be undertaken by the government, has the potential to cause noise impacts at the NSRs in Lai King Estate and Lok Sin Tong Lau Sai Yan Primary School. Generally, viaduct construction includes three separate phases of construction. These phases are:

- Set up and site clearance;
- piling of the foundation; and
- construction of the structure.

B3.6.2 *Kwai Chung Park*

The LAR construction work in Kwai Chung Park will comprise two major concurrent activities:

- Excavation of the landfill, piling of the railway foundations and construction of the viaducts; and
- transportation and disposal of the displaced landfill material.

It has been proposed that the passage through the landfill will be on viaduct within an open cut with piled foundations. For the first of the operations identified above, there are six main activities which have the potential to cause environmental noise impacts around Kwai Chung Park. These include:

- Set–up and site clearance;
- construction of access roads;
- excavation of the landfill material;
- piling the foundation;
- construction of the viaduct superstructure; and
- landscaping.

Material excavated from the landfill will be disposed of off–site at an appropriate landfill. There are two activities associated with the disposal of the landfill material which have the potential to cause impact at NSRs. These are truck loading/barge loading and transportation of the material to the disposal site.

As both processes, construction and disposal, can take place simultaneously, this study will assess the probable combined effects of both activities acting in parallel.

B3.6.3 *Rambler Channel Bridge*

Potential sources of noise impact during the construction of the Rambler Channel Bridge will include PME and construction–related traffic. Vibration levels from piling (which is assumed to the source producing the highest levels of vibration during the course of the proposed works) generally becoming imperceptible at distances greater than 75 m. As all vibration sensitive receivers are located farther than 75 m from possible vibration–emitting sources, construction vibration impacts are not expected.

B3.6.4 *Tsing Yi Station and Viaducts*

The construction of Tsing Yi Station can be divided into three elements, the station, the viaducts and a bus terminus. Each of these elements has associated construction activities which have the potential to impact upon nearby NSRs.

During station construction there are assumed to be three main activities capable of producing significant noise impacts at NSRs. These are:

- Excavation;
- piling; and
- building erection.

The bus terminus will be assumed, as a worst case, to have the same phases of construction and the same plant inventories as the station itself.

For the viaduct section there are assumed to be three main activities capable of producing significant noise impacts at NSRs. These are:

- Access roads;
- piling of the foundation; and
- viaduct superstructure construction.

Due to the noise sensitivity of the surrounding area it is assumed that non-percussive piling techniques will be employed for all piling operations.

B3.6.5 *Tsing Yi Tunnels*

There will be three areas of activity required to form the Tsing Yi Tunnels; the tunnels themselves and the East and West Portal worksites. Each of these operation areas has associated construction activities which have the potential to impact upon nearby NSRs.

Within the tunnel section, as all activities will be taking place underground, blasting is assumed to be the only activity capable of producing significant noise impacts at NSRs.

For the East Portal worksite there are assumed to be three main activities capable of producing significant noise impacts at NSRs. These are:

- Site clearance;
- access road construction;
- removal of blasting spoil and rubble.

For the West Portal worksite there will be one main activity capable of producing significant noise impacts at NSRs, the construction of the tunnel ventilation building. Due to the location of the West Portal and the mountainous terrain of the region, none of the NSRs in the region have direct line of sight to the worksite. As a result the NSRs in the region are not anticipated to experience significant impacts.

It is assumed that non-percussive piling techniques will be employed for all piling operations.

B3.7 *Tsuen Wan District*

B3.7.1 *Lantau Fixed Crossing*

The LFC bridge construction can be divided into three separate construction areas. These are the Tsing Ma Bridge, which will span the region between Tsing Yi Island and Ma Wan Island, the Ma Wan Viaducts, which will span Ma Wan Island, and the Kap Shui Mun Bridge, which will span the region between Ma Wan Island and Lantau Island.

For Tsing Ma Bridge construction there are five activities which have the potential to cause significant noise impacts at NSRs. These are:

- Ma Wan anchorage and substructure;
- Ma Wan/Tsing Yi Tower construction;
- Tsing Yi anchorage and substructure;
- suspension cable construction; and
- deck superstructure.

For the Ma Wan Viaducts there are three activities which have the potential to cause significant noise impacts at NSRs. These are:

- Construction of piers A to H;
- concrete batching; and
- haul road traffic.

For the Kap Shui Mun Bridge, in addition to the deck superstructure, there are four activities planned at both the Lantau and Ma Wan work sites which have the potential to cause significant noise impacts at NSRs. These are:

- Dredging and reclamation;
- anchorage;
- tower construction; and
- pier construction.

Construction of a traction sub-station and ventilation building at the East Portal of the Lantau Tunnels will be entrusted to Government and will be included within the LFC Contract.

B3.7.2 *Lantau Tunnels*

There will be no construction work for the LAR at the East Portal, all tunnelling will be from the western end. For the West Portal worksite there are assumed to be two main activities capable of producing significant noise impacts at NSRs. These are:

- Removal of blasting spoil and rubble; and
- ventilation building construction.

As most of the blasting for the tunnels will occur underground and the blasting will not take place within any vicinity directly below existing NSRs, blasting noise and vibration will most probably not be capable of causing significant impacts at NSRs. As a result, blasting is not considered a potential source of disturbance to local residents in the North Lantau region.

The removal of blasting spoil and rubble, however, will move spoil from the tunnels to an above ground worksite, at the portal, and so will include surface construction operations which will be capable of causing disturbance to nearby NSRs. Construction noise for these 'mucking out' operations will be dominated by truck traffic which will be used to transport the spoil away from the worksite to the appropriate disposal area.

The entrusted ventilation building construction will be divided into three activities:

- Excavation of the foundations;
- piling of the foundations; and
- building erection.

In addition to the construction activities listed above, construction traffic noise has the potential to cause impacts throughout the construction phase and so will be assessed in parallel with the construction activities. It is assumed that non–percussive piling techniques will be employed for all piling operations.

B3.8 ISLANDS DISTRICT

B3.8.1 North Lantau Coast

Potential sources of noise impact for this section of the LAR will be primarily due to the laying of foundations and track laying for the railway line.

B3.8.2 Siu Ho Wan Depot

Construction activities at the depot worksite will be divided between two main activities, either construction of the depot buildings or construction associated with the at–grade track and separation structures.

The depot, since it will be a service centre for the LAR trains, will consist of buildings for washing and repair of the vehicles. These buildings will be built entirely above ground. In the current design for the depot, building construction is dominated by construction of the Main Depot Building. As a result it is this building that will be assessed for the construction phase as it is the largest building on the site and will take the longest time to build.

No foundation will be laid for the at–grade tracks, however, excavation and foundation work will be needed when the track overhead line masts are installed. In addition, the three concrete box grade separation structures, two of which will be to the west of the main depot building and one of which will be to the east, will require excavation, foundation and fabrication work.

As a result, there will be three main activities that will be assessed for this phase of the LAR. These are:

- Foundation laying and track overhead line mast erection;
- the construction of the concrete box grade separation structures; and
- Main Depot Building erection.

B3.8.3 *Tung Chung Station*

Construction work in this area will consist of two separate sections: the station, and a cut and cover tunnel. Each of these sections has associated construction activities which have the potential to impact nearby NSRs.

For station construction there are assumed to be four main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- excavation;
- station box construction; and
- building erection.

For the cut and cover tunnel section there are assumed to be four main activities capable of producing significant noise impacts at NSRs. These are:

- Construction of access roads;
- excavation;
- piling of the foundations; and
- backfilling.

As the land upon which the station and tunnels will be built is entirely reclamation, no site clearance procedures will be necessary and it is assumed that non–percussive piling techniques will be adequate for all piling operations.

B3.8.4 *Airport Works*

For airport construction, four activities were identified as being capable of producing significant impacts at nearby NSRs. These were:

- Excavation and reclamation;
- dredging and dumping;
- building and infrastructure construction; and
- percussive piling.

Noise impacts arising from construction works relating specifically to this section of the LAR were not identified separately in the NAMP assessment. It is assumed that these would fall into the building and services phase of the assessment.

B3.9 OPERATIONAL IMPACTS

Impacts during the operational phase of the LAR can be categorised into two main types: noise and vibration from rolling stock; and noise from fixed plant. Specific details will vary at different sections of the alignment but the general mechanisms will be the same. This section will discuss the potential for impacts from the LAR system in broad terms, specific details will be addressed in the predictive assessment.

B3.9.1 *Train Noise and Vibration*

Train movements can lead to two types of impact, noise and vibration.

Vibrational effects can occur anywhere along the alignment where suitable ground conditions occur. In practice, however, most of the route will lie on reclamation which does not readily transmit vibrational energy, and only in areas where the track runs over solid rock, or is in very close proximity to NSRs, is there potential for vibration impacts.

The main noise source from the trains will be the interaction of the train wheels with the rails. This interaction results in noise being radiated away from the train wheels and rails and is referred to as *rolling noise*. Energy is also transferred through the track mounting system into the ground. This energy, if in sufficient quantity can be perceptible as ground vibration or may radiate from nearby structures as *re–radiated noise*. The following may also be significant sources of noise from trains:

- Air conditioning units;
- traction motors;
- gearboxes;
- motor cooling equipment; and
- compressors (for doors and brakes).

The design of the plant mounted on the rolling stock is required to achieve an environmental noise specification of 68 dB(A) at 7.5 m from the centre line of the train. Hence, although the noise levels from each of the above components is not known, it can be assumed that their total noise level will not exceed this specified limit.

Re–radiated noise could potentially be the source of noise impacts from the LAR in two separate ways. Firstly, where the tracks are at grade, energy transmitted into the ground and reaching the building foundations of an NSR may radiate noise directly into that building. However, since all at grade track will be ballasted (ballasted track offers a good degree of isolation) and will mainly be on reclaimed land (which does not readily transmit vibrational energy), this source of re–radiated noise is unlikely to give rise to significant impacts. Secondly, on elevated sections, energy transmitted into the supporting structure (viaduct or bridge) may radiate from that structure as air–borne noise and propagate to the NSR via a similar route as train rolling noise. It is therefore possible to consider this second mechanism by applying an appropriate correction to the level of rolling noise, for elevated sections of the LAR. This is the method adopted in this study, and the rational behind the correction for re-radiated noise is described below.

For trains running on elevated concrete structures, with the tracks mounted rigidly, an amplification of 6 dB(A) is not unusual. However concrete structures carrying *ballasted track* can sometimes be slightly quieter than when trains pass in the open [1]. This can be partly attributed to the effects of wayside noise barriers that are typically present on concrete bridges and viaducts, but the result also implies that structure-borne noise radiating from the structure is well mitigated by the resilience offered by the ballast.

The current proposal for viaduct sections of the LAR is a twin block track mounting system called the Sonneville system which offers independent support blocks for the two rails. Each mounting offers two levels of elastic support: Firstly, the rail fastening includes a rail pad which provides resilience between the rail and the mounting block; Secondly, the mounting block provides additional mass and is isolated from the supporting structure by a rubber boot comprising microcellular pads below the block and ribbed sidewalls that allow vertical movement. The system is designed to the particular requirements of each railway and has been tailored to the specifications of the LAR. The system typically provides resilience similar to that of ballasted track. Hence it is reasonable to assume that since the proposed Sonneville system provides a degree of resilience similar to that of ballast, structure-borne noise radiated from viaducts is likely to produce an amplification significantly less than 6 dB(A).

In the absence of detailed information at the beginning of the study it was necessary to proceed with the assessment on the basis of a sensible assumption as to the amplification factor that would result from trains running on viaducts assuming the sonneville system were used. From the information available it was considered that an amplification of 1 dB(A) was reasonable. Accordingly, re-radiated noise from viaducts has been modelled as being at a level 9 dB(A) below the level of train rolling noise that would result in the absence of any barriers. Hence re-radiated noise, modelled in this way is at a level that is independent of any noise barrier that might be considered.

The design of the Sonneville system, as tailored to the LAR, progressed through the study period and in August 1993 two papers were released on the subject of the vibration isolation performance that is would achieve on the LAR. The first [2], by a track dynamics expert commissioned by MTRC, reported a theoretical analysis of the performance of sonneville system in the conditions presented by the LAR. The second [3], by MTRC,

[1] Sources Of Railway Noise, The Transportation Noise Reference Book, Chapter 14, Butterworths.

[2] Dynamic Response of the Sonneville System, Dr S L Grassie, May 1993

[3] Memo on Re-radiated noise from the LAR with the Sonneville System, Dr G Frommer, July 1993

incorporated this analysis into a theoretical modelling of noise re-radiated from the surface of a typical section of LAR viaducts. This paper concluded that re-radiated noise from viaducts would be effectively controlled by the Sonnneville system and the "minus 9 dB assumption" described above could be considered as a worst case, although it was unlikely that re-radiated noise levels would in fact be that high in any areas.

The level of noise re-radiated from the viaduct is inversely proportional to the mass of the structure. The two papers above also reported the theoretical result that for a doubling of the mass of the structure the level of noise re-radiated is reduced by 6 dB. Accordingly, re-radiated noise from twin viaducts has been modelled as being at a level 15 dB(A) below the level of train rolling noise.

Grinding or squealing noises which may be produced by trains on sharp bends and points can be produced by two mechanisms. Firstly, because the wheel axles do not have differentials, the wheels are forced to skid along the rails. Secondly, where a bend has a radius of less than a critical value (typically approximately 200 m) a check rail may be required which the inside wheels rub against. This second effect may also result if a check rail is required over points. It is understood that the radii of the LAL and AEL lines are generally not less than 300 m. Hence a check rail will not be required and these types of noises are unlikely to be produced as a result of that mechanism. However, there is a potential for these noises from trains as they pass over points on the line. The LAR train wheels, while monoblock in construction, are likely to have laminated webs. This design will reduce the level of squeal noise radiated from the wheel.

It is sometimes thought that noise from trains can increase around tunnel portals. As a train leaves a tunnel the rise in noise from it is very much more rapid than for a train passing in the open. This has the effect of making the train appear louder due to the rapid rise in noise level. This is however, a subjective effect, and the modelling methodology described in *Section 4.2* has been shown to hold true in these situations since actual measured noise levels show no significant increase around tunnel portals.

Siu Ho Wan Depot

The potential for impacts at Siu Ho Wan Depot on North Lantau is increased due to the nature of the site layout and the timing of activities. Also, because of operational constraints, the trains must enter and leave the depot by the western entrance so the depot fan area is located at that end of the depot nearest to the planned development sites in Tai Ho Wan.

The majority of trains passing through the track fan area will negotiate two bends before coming to rest in the appropriate siding. The radii of these bends are such that there is potential for wheel squeal caused by the "stick-slip" movement of the wheel treads over the rails. This action provides excitation of the resonant modes of the wheels, leading to the characteristic squeal noise. It transpires that the current configuration of the track fan area is such that roughly 90% of trains entering the stabling area have the potential to produce this noise if adequate mitigation is not incorporated.

Trains at slow speed, moving into the train washer, located some 60 m within the western end of the depot site, will have train mounted plant running. As 20 trains coming out of service in the period 0100 to 0130 will pass through this washer, the section of track leading to it will be occupied by a slow moving train for a large proportion of the time. Noise emissions from train mounted plant on trains in this location have the potential to impact NSRs in area 27.

B3.9.2 *Noise from Fixed Plant*

Fixed plant noise will arise from a number of sources, these will be located at station sites, tunnel ventilation buildings and other ancillary buildings.

The main contribution to fixed plant noise will be from the ventilation systems of which there are three main types:

- Station ventilation;
- traffic area ventilation; and
- trackway and tunnel ventilation.

Although mechanical tunnel ventilation systems will not routinely be used for the LAR, fans will be fitted into the ventilation shafts for use in congested or emergency situations where trains are not moving through the tunnel or when it is necessary to exhaust smoke in the event of fire. These fans would also need to be tested periodically. Tunnel ventilation will normally occur through the piston effect of the moving train pushing stale air out in front of the train and drawing fresh air in behind.

There will also be an additional contribution from other components of the air conditioning system, namely:

- Heat exchange and chiller plant;
- water pumping stations; and
- traction transformer buildings.

The use of effective noise control equipment is expected to be included in the station designs to ensure no adverse impacts from these items of plant.

Other station activities will generate noise, these will include:

- Public address announcements;
- pedestrian movements; and
- trains idling at platforms.

None of these are considered likely to cause impacts beyond the station structure.

The trackform within stations is being designed to control structure-borne noise and vibration within stations to acceptable levels. Additionally it is assumed that the architectural and engineering designs for the station buildings will incorporate measures to further mitigate impacts from structure-borne noise and vibration.

B3.9.3 *Track Maintenance*

The proposed headways and hours of operation of the AEL and LAL lines are such that the frequent maintenance of the tracks and rolling stock will be essential. Maintenance operations on the track have the potential for noise disturbance to the local community. The main noise sources will be:

- Rail grinding operations;
- ballast cleaning; and
- ballast tamping.

These three operations can be undertaken by specialist track mounted machines that will operate at night, outside the operational hours of the railways. Rail grinding will be required along the entire alignment, whilst ballast tamping and occasional cleaning will not be required on elevated or underground sections where other trackforms are used. Additionally other less significant maintenance operation will take place, largely using hand tools and comparatively quiet equipment.

Rail grinding will be essential, not only for safety, passenger comfort and vehicle wear reasons, but also because it will play an important role in avoiding the increase in rolling noise by reconditioning the rail surface. Rail grinding is likely to be a noisy operation that will be required several times a year on the majority of the alignment. The machine used will move slowly along the line and is likely to cause some disturbance to nearby NSRs. However, the ensuing benefit in reducing train rolling noise will be considerable.

Ballast cleaning involves the temporary removal of ballast from below the sleepers for sieving, and is an intrinsically noisy operation. However, it is likely to be required only very occasionally (approximately every 10 years). Ballast tamping however, which is performed to adjust the line and level of the track, will be required on a much more regular basis. The tamping machine works by lifting each sleeper in turn, inserting vibrating tines on either side of the rail to make the ballast flow, and then returning the rail to its new location. The machines tend to be noisy because of the out of balance forces required for vibrating the tines rapidly wear the supporting bearings which soon become noisy.

Noise barriers and covers installed to mitigate train noise impacts will help to mitigate noise impacts from track maintenance activities at some of the nearest NSRs. The following mitigation measures are recommended..

- The rail grinding machine, ballast tamping and cleaning machines should be designed to be as quiet as possible. The sections of the machine directly involved in the rail grinding or ballast tamping should be partially enclosed in an acoustic housing, and the vehicle engine and ancillary equipment should be suitably silenced.

- Potentially affected residents should be pre-warned of the scheduling of night-time maintenance activities.

B3.9.4 *Rambler Channel Bridge*

The Reference Design for the Rambler Channel Bridge has been reviewed and whilst it is not specified that the bridge should necessarily be constructed of concrete it appears that the specification for the bridge will be met by a structure that is predominantly concrete.

Several Authors have reported amplifications of up to 20 dB in train noise levels from trains running on relatively lightweight steel bridge structures. There are in essence two elements of the railway/bridge system that determine the level of re-radiated noise that the structure will produce. These are firstly the resilience offered by the track mounting system and secondly the internal damping and stiffness of the bridge structure.

The current proposal for the trackform on the Rambler Channel Bridge is the Sonneville system, as proposed for viaduct and tunnel sections of the LAR, and described earlier in this section. Since the bridge is a design and build contract, the contractors design will determine the internal damping and stiffness of the structure.

Rolling noise is likely to be at levels close to the assessment criteria (as reported later in this Annex). The attenuation offered by wayside noise barriers and, on the Western approach to Tsing Yi Station by a noise cover, is essential in achieving these criteria. It therefore follows that re-radiated noise must be controlled so as to offer only a small increase in the *total train noise* level. Furthermore the performance of the wayside noise barriers and the noise cover would be severely compromised if re-radiated noise did contribute significantly to the total train noise level. In light of the mitigation of re-radiated noise likely to be offered by the proposed Sonneville track mounting system it was considered that a reasonable target level for re-radiated noise from the bridge was a level 9 dB below that of rolling noise (at a given speed). This would ensure that an amplification of less than 1 dB would result.

It will be the responsibility of the contractor to provide a bridge design that is sufficiently stiff and incorporates enough internal damping so that, with the given track mounting system, this target is achieved.

B3.9.5 ***Lantau Fixed Crossing***

An earlier study by British Rail Research (BRR) [1], concluded that significant noise impacts could result at nearby NSRs, from noise re-radiated from the bridge and viaduct structures of the Lantau Fixed Crossing, if an appropriate structural and trackform design was not adopted.

Tsing Ma Bridge

As a result of the conclusions of the BRR study, four main options for the trackform on the Tsing Ma Bridge were considered. These were:

- Case 1 – Direct fastenings using the "Cologne Eggs" as given in the Tender Specification;
- Case 2 – "Cologne Egg" type baseplates on an inverted channel type steel plinth or rail bearer rigidly secured to the waybeam deck plate;
- Case 3 – Plain baseplate on precast concrete blocks on resilient pads; and
- Case 4– As Case 2 with plain base plates and with the rail bearer separated from the waybeam deck plate by resilient bearings.

Detailed investigation into the acoustic behaviour of the track and bridge indicated that significant noise energy would be transmitted into the bridge structure for the Cases 1 and 2. Case 3 was therefore developed within the constraints of the bridge design. Difficulties encountered in developing sound engineering details for Case 3 led to the further development of Case 4.

It was considered that improved acoustic performance could be achieved by increasing the track mass and improving the isolation of the track from the bridge. These two improvements could be explored because the bridge could accommodate an increased mass of 1.5 Tonnes m^{-1}, and the allowable track depth could be increased from 300 mm to 765 mm. Rupert M Taylor, a UK-based consultant in acoustics, was commissioned to give further advise on how to improve the acoustic performance of the system for inclusion in a tender addendum for the bridge.

The preliminary findings of this work were that it was not possible to design a trackform that would completely prevent additional noise from the bridge, but significant noise reduction could be achieved by the use of a relatively stiff rail pad with a resiliently supported massive base block below. The four systems listed above, or variations of them, were studied by a simplified finite difference modelling technique. The analysis resulted in a ranking of the proposed system with Case 3 being the most effective,

[1] Stainworth, C. (1991) – "Lantau Fixed crossing, Hong Kong: Assessment of Noise due to Trains" – Report No. LR-SAV-001 – British Rail Research/Mott MacDonald Hong Kong.

and Case 4 being second, at reducing noise generated in the bridge structure.

For engineering reasons Case 3 was rejected and Case 4 was selected as the best practical means of minimising noise from the bridge. A Tender Addendum was subsequently issued based on recommendations given in the report.

Kap Shui Mun and Ma Wan Viaducts

These viaducts are to be designed by the contractors, and the approach adopted for the Tsing Ma bridge could therefore not be used. It was decided that because of the complexity in assessing the noise re-radiated from structures of this type, a purely performance type specification was not appropriate for inclusion in the tenders, and instead an Environmental Reference Scheme (ERS) would be developed that would clearly state the Governments requirements, thus reducing uncertainty during the tender evaluation process.

The results of the BRR study suggested that it was unlikely that noise at the closest NSRs on Ma Wan could be completely mitigated (see Section 5.6.1 for predicted noise levels), and the approach adopted was therefore to minimise noise emissions from the viaduct as far as is practicable, rather than to attempt to achieve a specific standard. To this end the following decisions were made in the development of the ERS.

- The Ma Wan Viaduct would be of concrete because of its proximity to NSRs.

- A fairly heavy floating track support system would be adopted to isolate the tracks from the structure.

- The design of the track supporting slabs and the members that support them would be controlled within the tender specification, as these elements were critical to the reduction of noise generated within the bridge structure, even if the tracks were well isolated from it.

- A high level of track maintenance would be required, as corrugations in the track running surface would significantly increase the energy transferred into the supporting structure and therefore the noise potentially radiated from it. The calculation of noise levels from the viaducts given in the report assume that the rails would be lightly ground on a monthly basis to forestall incipient corrugations.

B3.9.6 Chek Lap Kok Bridge

This bridge will carry the AEL lines across the 200 m wide sea channel between Tung Chung and Chek Lap Kok Island. The bridge will be of concrete construction and is expected to be broadly similar to a twin viaduct design. Hence, noise re-radiated from the bridge is modelled as being at a level 15 dB(A) below the level of train rolling noise.

B4 ASSESSMENT METHODOLOGY

B4.1 CONSTRUCTION IMPACTS

B4.1.1 General Construction Noise

A methodology for assessing noise from construction has been developed based on the relevant Technical Memoranda. The assessment was undertaken in two parts – for noise from general construction activities (**Technical Memorandum On Noise From Construction Work Other Than Percussive Piling – TM1**) and for noise from percussive piling (**Technical Memorandum On Noise From Percussive Piling – TM2**). The criteria used are discussed in *Annex A*. In general, the methodology was as follows:

- Identify the NSRs for each worksite;
- assume plant teams for construction activities based on available information;
- assign sound power levels (SWLs) to teams based on the relevant TM;
- calculate distance attenuation and barrier corrections; and
- predict Sound Pressure Levels (L_{Aeq}s) at NSRs.

An assessment of impacts is then made by a comparison of the predicted noise levels with the appropriate noise level criteria. The relevant noise criteria are as given in *Annex A*.

The methodology used in the ARFS for predicting noise from the piling and general construction activities was as defined in **TM1**. The noise level exceedences at NSRs from these sources were categorized as 'severe', 'moderate' or 'low'. The assessment of noise from haulage was based on British Standard 5228 and the Calculation of Road Traffic Noise (CRTN); assumptions included traffic flows, route, speed and distance to nearest NSRs. A qualitative assessment of noise and vibration from blasting was included in the study.

For the Route 3 assessment, the main activities were assigned plant teams, and noise levels were calculated using the methodology given in TM1. Two scenarios were considered, individual activities in isolation and activities in combination, according to the construction programme.

B4.1.2 Assumed Construction Plant Inventories

Construction of the LAR was assumed to include four main types of construction operations. These were station construction, cut and cover tunnel construction, viaduct construction and spoil removal from blasting activities. Each of these operations was assumed, in turn, to be further divided into specific sub-activities. The breakdown of these activities and the plant teams assumed for each activity are given in the sections below.

Station Construction

Station construction was assumed to be subdivided into five main activities. These are site clearance, access road construction, excavation, station box construction and building erection. The assumed plant inventories for each of these activities are given in *Tables B4.1a–e* below.

Table B4.1a *Site Clearance Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Generator	2	108+3(1)
Compressor	1	104
Excavator	1	112
Loader	1	112
Bulldozer	1	115
Lorry	2	112+3

Notes: (1) For two units with the same SWL the total SWL is increased by 3 dB (for four units the increase is 6 dB).

The total SWL for all plant, calculated at one notional point, is 120 dB(A).

Table B4.1b *Access Road Construction Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Bulldozer	1	115
Compressor	1	104
Excavator/Loader	2	112+3
Roller Vibrator	1	108
Lorry	2	112+3
Poker Vibrator	1	113
Lorry Mixer	2	109+3

The total SWL for all plant, calculated at one notional point, is 122 dB(A).

Table B4.1c *Excavation Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Compressor	1	104
Tower Crane	2	95+3
Tracked Crane	1	112
Tracked Loader	1	112
Concrete Mixer	1	96
Ventilation Fan	1	108
Concrete Lorry Mixer	1	109
Lorry	2	112+3

The total SWL for all plant, calculated at one notional point, is 119 dB(A).

Table B4.1d *Station Box Construction Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Tracked Excavator	4	112+6
Mobile Crane	2	112+3
Bored Piling Rig, large diameter, oscillator	2	115+3
Bentonite Filtering Plant	1	105
Hydraulic Vibratory Driver	2	118+3 [(1)]
Lorry	4	112+6
Compressor	2	104+3
Concrete Lorry Mixer	2	109+3

The total SWL for all plant, calculated at one notional point, is 126 dB(A).

(1) Reference 53 from Part 4 of the British Standard on Noise Control on Construction and Open Sites (BS5228:Part 4:1992). This sheet steel piling rig vibrates at 26 Hz and is recommended for sand and gravel.

Table B4.1e *Building Erection Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Hand tools	Various	105
Compressor	4	104+6
Generator	4	108+6
Tower Crane	7	95+9
Concrete Pump	3	109+5
Dump Truck	3	117+5
Trucks	3	112+5

The total SWL for all plant, calculated at one notional point, is 125 dB(A).

Cut and Cover Tunnel Construction

Cut and cover tunnel construction was assumed to be subdivided into five main activities. These are site clearance, access road construction, excavation, piling of the foundations and backfilling. The assumed plant inventories for each of these activities, except for site clearance and access road construction (which are the same as given above in the station construction section) are given in *Tables B4.1f–h* below.

Table B4.1f *Excavation Plant Inventory*

Plant	Number	Sound Power Level
Bulldozer	2	115+3
Compressor	3	104+5
Excavator	2	112+3
Loader	2	112+3
Lorry	4	112+6

The total SWL for all plant, calculated at one notional point, is 123 dB(A).

Table B4.1g *Backfilling Plant Inventory*

Plant	Number	Sound Power Level
Excavator	2	112+3
Loader	1	112
Vibrator Roller	1	108
Lorry	4	112+6

The total sound power level for all plant calculated at one notional point is 121 dB(A).

Table B4.1h ***Piling Plant Inventory***

Plant	Number	Sound Power Level
Lorry Mixer	3	109+5
Poker Vibrator	4	113+6
Piling, Large Diameter Bored, Oscillator	2	115+3
Piling, Diaphragm Wall, Bentonite Filtering Plant	1	105
Water Pump	2	103+3
Concrete Pump	1	109

The total sound power level for all plant calculated at one notional point is 123 dB(A).

Other Works

At Siu Ho Wan Depot, construction activities will include overhead line mast erection and the construction of grade separation units. The assumed plant inventories are given in *Tables B4.1i* and *j*.

Table B4.1i ***Overhead Line Mast Erection Plant Inventory***

Plant	Number	Sound Power Level (dB(A))
Wheeled Excavator	1	112
Wheeled Crane	1	112
Lorry	2	112+3
Lorry Mixer	1	109
Concrete Pump	1	109

The total SWL for all plant, calculated at one notional point, is 119 dB(A).

Table B4.1j ***Concrete Grade Separator Construction Plant Inventory***

Plant	Number	Sound Power Level (dB(A))
Hand Tools	1	105
Lorry	2	112+3
Concrete Pump	1	109
Lorry Mixer	1	109

The total SWL for all plant, calculated at one notional point, is 117 dB(A).

Viaduct Construction

Viaduct construction was assumed to be subdivided into two main activities, piling of the foundations and superstructure construction. The assumed plant inventories for these activities are given in *Tables B4.1k* and *l* below.

Table B4.1k Viaduct Piling Plant Inventory

Plant	Number	Sound Power Level (dB(A))
Wheeled Loader	1	112
Wheeled Excavator	1	112
Pneumatic Breaker (silenced)	3	110+5
Compressor (silenced)	3	100+5
Lorry Mixer	1	109
Poker Vibrator	3	113+5
Water Pump	3	103+5
Bentonite Filtering Plant	1	105
Bored Piling Rig, large diameter, oscillator	1	115

The total SWL for all plant, calculated at one notional point, is 123 dB(A).

Table B4.1l Viaduct Superstructure Plant Inventory

Plant	Number	Sound Power Level (dB(A))
Wheeled Loader	2	112+3
Lorry Mixer	1	109
Compressor	3	104+5
Concrete Pump	2	109+3
Poker Vibrator	4	113+6
Wheeled Crane	2	112+3
Lorry	1	112

The total SWL for all plant, calculated at one notional point, is 123 dB(A).

Rubble Removal for Blasting Activities

Spoil removal for blasting activities was assumed to be comprised of only one activity. The assumed plant inventory for this activity is given in *Table B4.1m* below.

Table B4.1m *Spoil Removal/Tunnel Construction Plant Inventory*

Plant	Number	Sound Power Level (dB(A))
Gantry Crane (electric)	1	95
Batching Plant	1	108
Concrete Pumps	2	109+3
Lorry	4	112+6
Fans	3	108+5
Generators	3	108+5

The total SWL calculated for all plant, at one notional point, is 121 dB(A).

B4.1.3 *Blasting*

The control of all blasting operations in Hong Kong is vested in the Mines and Quarries (M&Q) Division of the Civil Engineering Department (CED). Permits for the storage and use of explosives must be obtained from the Mines and Quarries Division which also stipulates particular restrictions on blasting procedures.

For Hong Kong a conservative limiting peak particle velocity (ppv) of 25 mm s^{-1} for reinforced concrete structures, below which no damage to the structures are likely, is recommended. Both the MTRC and China Light and Power company (CLP) recommend 25 mm s^{-1} ppv to minimise the risk of damage to their structures from vibration. Water retaining structures tend not to be as resilient as buildings, and the Water Supplies Department recommends 13 mm s^{-1} ppv to minimise damage to their structures from vibration impacts.

A methodology for estimating the likely levels of vibration is given by the Dupont formula, which when tailored to the situation in Hong Kong can be used to give indicative vibration levels. However, the M&Q Division of the CED require an assessment of blasting vibration and its effects on nearby structures to be carried out by qualified blasting specialists, and submitted to them for approval. This assessment will be carried out by the specialist contractor prior to commencement of the works at each site. Hence a detailed assessment of blasting vibration is outside the scope of this study. It should however, be noted that the controls on blasting likely to be required to safeguard nearby structures will provide a degree of mitigation of the possible impacts on nearby sensitive landuses.

B4.2 OPERATIONAL IMPACTS

B4.2.1 *Train Rolling Noise*

Source Noise Level

Since the design of the rolling stock for the LAL and the AEL is not yet finalised, there is no definitive source noise data available. The appropriate source noise level has been the subject of a study undertaken by ERM. Three main sources of information have been studied.

First, a table of results titled "**Wayside Noise Level From Trains At 25 m At 135 km/h**" was supplied by EPD Noise Policy Group giving measured noise levels for 11 different types of train. The data presented indicated noise levels centred around 89 dB. However, there were a number of shortcomings in the data set. There was no explanation or allowance for the differing origins of the data for the different train types, which had been obtained from a number of sources; for example, the differences in the measurement techniques and conditions. The train brake type was not given for five of the train types, a significant omission, as it is widely recognised that tread brakes lead to considerably higher noise levels, whereas the LAR train will be disc braked. Ranges of levels were given for three train types, and were not qualified, and in one case covered 10 dB. The levels had been corrected for speed as 30 log (speed), possibly leading to inaccuracies when considering the LAR reference speed of 135 kph, particularly since a number of the train types presented were not intended to achieve such a speed and, therefore, such a correction could give misleading results.

Thus insufficient information was available to qualify each of the noise levels used or their applicability (in particular the train brake type is generally not specified). It was therefore considered that the data set could not be taken to give an accurate estimate of the noise level expected from the LAR trains.

Second [1], a review of documented noise measurements of rolling stock, similar in design and function to that of the LAR, was undertaken. A selection of existing and generally older designs of rolling stock were studied, and it was concluded that an $L_{AMax,\ (fast)}$ level of 86 dB was typical of this class of rolling stock. The reported noise levels were made over speeds applicable to the LAR, and in general measured by Ashdown Environmental Ltd, giving a consistency of approach, methodology etc.

The third source of information is the MTRC specification for the LAR rolling stock. Whilst the measured noise data studied was of existing stock that are generally several years old using older designs, the LAR trains will be a brand new design and consequently can be expected to be quieter.

[1] Lantau Airport Railway - Review of Rail Rolling Stock Noise Emission Levels, Ashdown Environmental Ltd, February 1993

The MTRC specification for the design of the rolling stock is:

- Design level of 80 dB; and
- Maximum allowable level upon delivery of 81 dB ±2 (ie 83 dB).

These noise levels refer to a train passing at 135 kph on ballasted track, and measured at a distance of 25 m in accordance with ISO 3095: 1975. The specification also requires the use of specialist acoustic consultants and a rigorous scheme of design goals and checking procedures to ensure this environmental noise specification is achieved. It is recognised that after delivery of the rolling stock, noise levels will increase due to wear on the train wheels and rail surfaces. The extent of this increase depends critically on the level of maintenance (in particular of wheel and rail re-grinding) undertaken through the lifetime of the railway.

MTRC are committed to a high level of maintenance for the LAR, and additionally the train wheels and rails will be designed to minimise wear. Increases in train noise during the operation of the railway will be detected by a programme of noise monitoring at NSRs, a permanent monitoring station (maybe in Kwai Chung Park) and possibly an on-train monitoring system (see Annex G). These will be used to trigger increased maintenance of the train wheels and the rail surfaces to reduce the increase in noise, so that this increase, due to degradation of the wheel and rail surfaces will be limited. It is anticipated that a limit of not more than 3 dB increase could be achieved. Hence, the MTRC specification suggests that an operating noise level of 83 dB will be achieved.

As discussed above, the first source was considered to be of limited value in establishing an appropriate train noise level for the LAR and the third source could not be verified until after delivery of the rolling stock. Since the 89 dB level was necessarily based on information available at the time, which was subsequently augmented, and acknowledging MTRC's committment to a proactive and stingent maintenance programme, while the achievement of the MTRC specification cannot be guarenteed, it was decided that the assessment should be based on an agreed reasonable worst case scenario.

EPD, MTRC and ERM concluded that the assessment, and the mitigation, of train noise in the Final Report should, therefore, be based on an "86 dB(A) Train" and that the LAR be designed to incorporate the appropriate mitigation. However, the precise mitigation requirements will only be known once the actual LAR train noise level has been established. MTRC will phase the implementation of these mitigation measures in an appropriate manner to meet the NCO limits.

LAR Operational Details

The train lengths for 2011 (and onwards) will be;

- LAL (8 car) 185 m
- AEL (10 car) 232 m

The preferred service pattern for the LAR in the year 2012 (the year for which operational impacts will be assessed for the purposes of the LAR EIS) is shown in *Table B4.2a*.

Table B4.2a ***Lantau and Airport Railway Service Patterns: 2012 Preferred Case (Headways in minutes)***

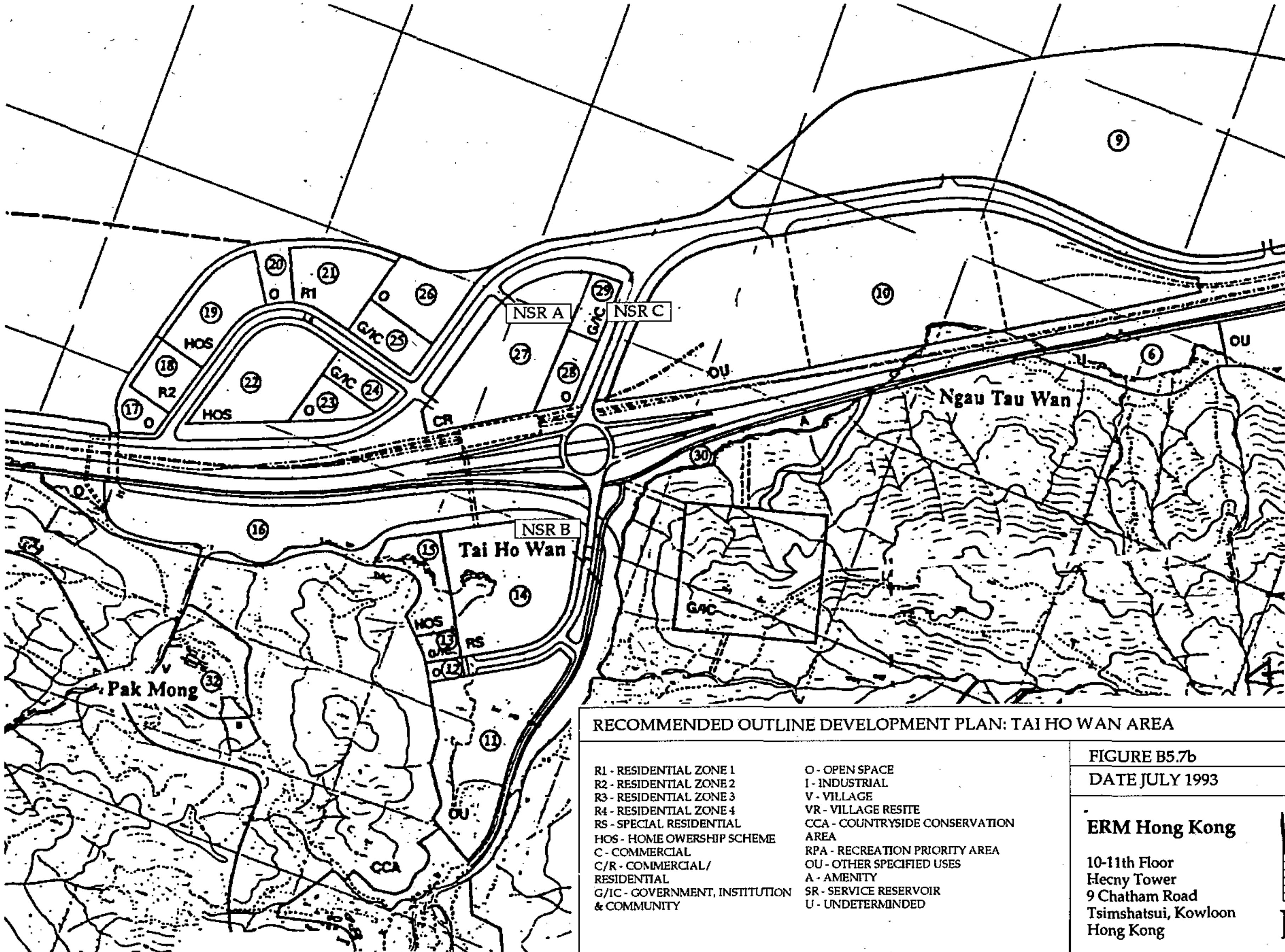
Time Period	LAL - Hong Kong to Tsing Yi	LAL - Tsing Yi to Tung Chung	Airport Railway
0600–0700	4.5	4.5	4.5
0700–1000	2.3	4.5	4.5
1000–1630	4.5	4.5	4.5
1630–2000	2.3	4.5	4.5
2000–0100	8	8	8

The $L_{Aeq,30\,min}$ daytime (0700–2300) train noise assessment criterion is 10 dB higher than the night–time $L_{Aeq\,30\,min}$ criterion (see *Annex A*). Therefore, for the daytime criterion to be more stringent than the night–time, the daytime headway would have to be roughly one tenth that of the night–time headway (all other factors being equal). *Table B4.2a* indicates that this is not the case and the period from the start of the days service (assumed to be at or before 0630) is by far the most critical, where the assessment criterion is most likely to be exceeded. The assessment therefore considers this period, except in cases where the NSR is occupied only during the daytime. In these instances, where only the daytime criterion is applicable, the peak daytime headways have been considered in addressing a worst case assessment.

Train speed profiles, supplied by MTRC have been used to allocate a speed to the trains on each of the four tracks, for each 100 m segment of the alignment. In areas where complex screening effects are experienced, the track segmentation has been done in 50 m lengths.

Chapter 15 of the Transportation Noise Reference Book reports that L_{AMAX} for British Rail MK 3 Stock increases as 30 x log (speed). It is recognised that the AEL and LAL trains will be broadly similar to this type of train, and in particular will have the same type of braking system, disc brakes. (It is widely recognised that different types of braking systems produce different train rolling noise levels). This relationship between train speed and noise level has been assumed in this study.

Predictions of $L_{Aeq\,30\,min}$ and L_{AMax} train noise levels were made in all cases. However, the L_{AMax} levels are in general not reported because the $L_{Aeq\,30\,min}$ was the limiting criterion. This comes about as a result of the high frequency of service that the LAR will offer, and because the railway is sufficiently distant from all NSRs. A train noise level equal to the L_{AMax} criterion of 85 dB, given in the HKPSG, would be produced by the 86 dB train at a distance of 44 m from the railway for a train at the maximum



RECOMMENDED OUTLINE DEVELOPMENT PLAN: TAI HO WAN AREA

R1 - RESIDENTIAL ZONE 1
R2 - RESIDENTIAL ZONE 2
R3 - RESIDENTIAL ZONE 3
R4 - RESIDENTIAL ZONE 4
RS - SPECIAL RESIDENTIAL
HOS - HOME OWERSHIP SCHEME
C - COMMERCIAL
C/R - COMMERCIAL/ RESIDENTIAL
G/IC - GOVERNMENT, INSTITUTION & COMMUNITY
O - OPEN SPACE
I - INDUSTRIAL
V - VILLAGE
VR - VILLAGE RESITE
CCA - COUNTRYSIDE CONSERVATION AREA
RPA - RECREATION PRIORITY AREA
OU - OTHER SPECIFIED USES
A - AMENITY
SR - SERVICE RESERVOIR
U - UNDETERMINDED

FIGURE B5.7b

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

speed of 135 kph. With the exception of the WMC Morninghope School, which is screened from the railway, no NSRs are closer than this distance from the alignment, and hence L_{AMax} 85 dB will not be exceeded. Additionally, it should be noted that in many cases where train noise will be audible at NSRs the L_{AMax} noise levels will be lower because of reduced train speed. L_{AMax} levels at the Mary Winifred Cheung Morninghope School are discussed in *Section B6.5.1*.

Prediction Methodology

All predictions of train noise have been carried out by Ashdown Environmental Ltd, a UK base Consultancy, using their own Train Noise Prediction Model (TNPM) which is described below.

Unlike road traffic noise there is no accepted methodology for the calculation of railway noise in Hong Kong, or in the UK. Empirically based procedures for train noise calculation have been developed by Ashdown Environmental Ltd as part of their work on the assessment of noise and vibration impacts associated with a variety of projects, including the KCR line from Kowloon to Lo Wu and the following in the UK:

- the British Rail Channel Tunnel Rail Link;
- the Network Southeast Thameslink; and
- sections of the London Underground.

Modelling Methodology

The modelling methodology was developed based on an extensive review of previous research and noise measurements taken adjacent to the high speed French railway services Train à Grande Vitesse (TGV).

The methodology encompasses all major influences on train noise levels, these are listed below.

- Source: type of train; train speed; track type; points; and flange squeal.
- Propagation: land topography; noise mitigation (barriers, bunds); cuttings; embankments; air absorption; and ground attenuation.
- Receptor: angle of view; and building facade effects.

The effects of noise re-radiated from elevated structures has been treated separately (outside the TNPM).

The train source noise level is input as an L_{AMax} at 25 m. Corrections for train speed are:

- L_{AMax} varies as 30 log (speed); and
- L_{Aeq} (or L_{AX}), varies as 20 log (speed).

Corrections for distance (geometric spreading), ground, and air absorption are:

- L_{AMax} varies as 14.5 log (distance/25 m);
- L_{Aeq} (or L_{AX}), varies as 10 log (distance/25 m);
- ground absorption (in dB) = distance/(130 x mean height of propagation); and
- air absorption (in dB) = distance/120.

Screening losses from intervening topography and noise barriers that are located between the source and the receiver are calculated by conventional path difference algorithms. For a path difference of d, attenuation for reflective wayside noise barriers is calculated by:

- $d < 0$: $e^{(1.1958 + 14d)}$ dB(A);
- $0 < d < 0.01$: 3.3 dB(A); and
- $d > 0.01$: $11d^{0.262}$ dB(A).

For absorptive barriers, ie those faced with acoustically absorptive material, or naturally absorptive barriers such as cuttings and bunds, the attenuation is calculated by:

- $d < 0$ $e^{(1.63+12d)}$ dB(A); and
- $d > 0$ 10 log(2.5+30(d+0.025)) dB(A).

Corrections for reflection off the facade at the NSR are made by:

- L_{AMax} 2.5 dB; and
- L_{Aeq} 1.5 dB.

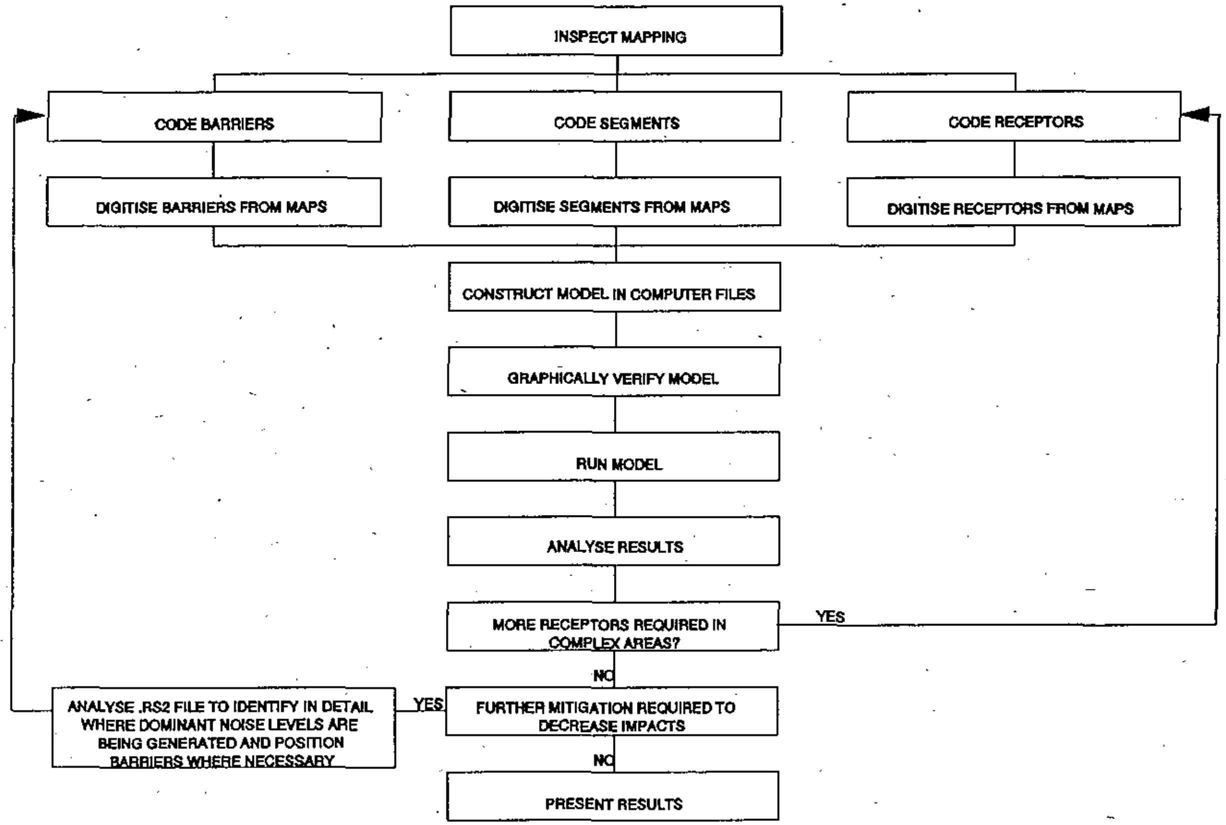
The Modelling Procedure

Before calculations are undertaken it is first necessary to select and define on the project drawings, receptors, segments of the railway line (generally 100 m long) and noise barriers (including both existing barriers such as houses and topography, and also proposed amelioration measures). This information is digitised directly from the drawings and stored in text files containing Quality Assurance data such as the map number as well as all the data required for the calculations. Train headways and speed profiles are assigned to each railway segment at this stage. The noise contribution from each segment is calculated using an angle of view correction of the form: 10 log ½(cos(alpha) + cos(beta)) where alpha and beta are the angles subtended by the lines from the source to either end of the segment.

Graphical representations of the layout of all the information input are generated on-screen to ensure accuracy of the data coding. The model is then run to produce a simple output file showing just the predicted levels at each NSR, and a very much more detailed results file, called the RS2 file, that reports all the constituent parts of every calculation conducted at each NSR. This file is then studied to identify exactly which parts of the railway alignment have generated the noise impact and therefore require mitigation.

The modelling procedure is shown schematically in *Figure B4.2a*.

Figure B4.2a *FLOW DIAGRAM FOR THE CALCULATION OF TRAIN NOISE USING TNPM*



Validation Of the Model

The methodology has been validated against 940 train noise measurements from the TGV-Atlantique service together with measurements of a large number and variety of British Rail trains. In addition, the methodology has been validated against measurements of the KCRC service in Hong Kong and measurements of the London Underground Limited services in the UK.

Although the effect of train type could not be studied, the calculation methodologies for other elements of the prediction process were studied in detail. The results indicated that train noise levels can be reliably predicted at distances up to 800 m from the track. The residual errors are attributable to a number of factors, including meteorological effects, that have an increasingly significant influence on the propagation of noise as distance from the source increases.

The validation exercises carried out on the KCRC are reported in the **KCRC Train Noise Assessment Report, December 1991.** This study comprised measurements at over 50 locations in order to cover a full range of NSR situations. The train source terms were validated at speeds covering the range 40–115 kph. NSR locations were selected to include positions close to railway stations so as to include a slow moving stopping trains. The location included:

- Tai Wai Station – opposite platforms;
- Sha Tin Station – 150 m from station;
- Sheung Shui Station – 300 m from station;
- Fo Tan Station – 200 m from station; and
- Tai Po Market Station – opposite platforms.

It is anticipated that further research will improve the correlation between calculated and measured noise levels, however the procedures contained in the TNPM provide a sufficiently robust methodology for the evaluation of the impact of train noise. A full description of the model is given in **PR William, RA Hood, KM Collins, and RJ Greer, Validation Of The AEL Methodology For The Calculation Of Train Noise, presented at the Polmet '91 Conference.**

Noise Barriers

Four types of wayside noise barriers have been considered as possible mitigation measures:

- Type 1 – reflective noise barrier, with a superficial density of 30 kg m^{-2} to a height of 1.4 m above the top of rail height, as offered by the parapet in the typical viaduct design.

- Type 2 – As type 1, but incorporating acoustic panelling to a depth of 75 mm on the inside surface to make it acoustically absorptive.
- Type 2a – A 3.8 m high (ie to the height of the top of the carriage) vertical barrier, the lower section as for type 1 and the upper section (from 1.4 m above top of rail height) being transparent, with a superficial density of 20 kg m^{-2}, so as to preserve the view from the carriages.
- Type 2b – As type 2a but with acoustic treatment on the inside surfaces up to a height of 1.4 m above top of rail height.

Type 2b barriers have been modelled as absorptive over their entire inside area. It is understood that any section of barrier above window level (window level is not yet known, but a worst case of 1.4 m above top of rail height is assumed) will need to be transparent to preserve views from the carriages. Hence these sections cannot have absorptive treatment to their full height and their acoustic performance will be compromised. The modelling of such partially absorptive barriers has not been attempted as it would not be possible to validate the predictions against measured data since, to the Consultants knowledge, this type of barrier has never been used. However, since the benefit of absorptive barriers is gained by reducing the build up of reverberant noise at low level around the bogie sets, it is considered unlikely that the omission of acoustic treatment to the upper portion of the barriers would compromise their performance by more than 1 dB(A).

In general barriers are modelled at a distance of 2575 mm from the track centre line. This is the case for the type 1 barrier offered by the typical viaduct design. Barrier heights are given relative to the height of the top of the rails.

Where enclosures are considered, it will generally be possible to ventilate these on the side that faces away from the NSR without compromising the acoustic performance of the enclosure.

B4.2.2 Re-radiated Noise

Noise re-radiated from single viaducts has been modelled as being at a level 9 dB(A) below the level of train rolling noise that would result in the absence of any barriers. Noise re-radiated from twin viaducts (ie those carrying two railway lines) has been modelled as being at a level 15 dB(A) below the level of rolling noise. The rationale behind this assumption is explained in *Section 3.8*.

B5.1 CENTRAL AND WESTERN DISTRICT

B5.1.1 *Hong Kong Station and Tunnels*

Construction Impacts

Analysis of likely construction activities have enabled an inventory of sound power levels (SWLs) for the various plant teams to be identified for the three assumed noisiest phases of construction of Hong Kong Station. These noisiest phases of construction were considered to be site clearance, excavation and backfilling activities. Indicative sound power levels for the plant teams needed to perform these operations were taken from **Technical Memorandum on Noise from Activities other than Percussive Piling** (TM1), as the precise plant used depends upon the working methods of the chosen contractor.

Facade noise levels at the NSRs were calculated based on the above sound power levels and corrections and distance attenuation values given in TM1 and **Technical Memorandum on Noise from Percussive Piling** (TM2).

General Construction Activities

Table B5.1a Predicted Construction Noise Levels (dB $L_{Aeq,\ 30\ min}$)

Noise Sensitive Receiver	Distance to Notional Source Point (m)	Site Clearance	Excavation	Backfilling
Mandarin Hotel[1]	250	57	60	58
Furama Hotel	450	62	65	63
Victoria Hotel	280	66	69	67
United Building	100	75	78	76
City Hall	300	65	68	66

Note: (1) Calculations for this NSR include −10 dB barrier correction.

Excavation activities are predicted to create the highest noise levels.

Percussive Piling Activities

Table B5.1b ***Predicted Piling Noise Levels (dB $L_{Aeq, 30 min}$)***

Noise Sensitive Receiver	Minimum Distance to Work Site Boundary (m)	Worst Case Facade Noise Level[1]
Exchange Square	15	105
General Post Office	35	97
Harbour Building	40	95
Hang Seng Bank New Headquarters	50	93
United Building	50	93
Connaught Centre	85	88
International Building	110	85

Note: (1) The worst case was predicted to be the operation of two diesel hammer rigs driving sheet steel piles with a combined sound power level of 135 dB(A) on the site boundary at the closest point to the respective NSR.

Operational Impacts

As discussed previously, no noise or vibration impacts are expected to arise in cases where the LAR track is on reclaimed land and is fully enclosed either inside a station structure or within a tunnel. Therefore no predictions of noise or vibration have been made, and the issue is discussed qualitatively in *Section 6.1.1*.

There is insufficient data available for the assessment of noise levels of fixed plant associated with station operations at present, however, it is possible to estimate the maximum acceptable noise level of such equipment by back-calculation and is considered under impact evaluation in *Section 6.1.1*.

B5.1.2 *Immersed Tube Tunnel*

Construction Impacts

For this phase of the contract, dredging was assumed to be the noisiest construction activity. The nearest NSR to the site of dredging on the Hong Kong side is Victoria Hotel and the nearest on the Kowloon side is the Hong Kong Cultural Centre in central Kowloon.

Table B5.1c ***Predicted Construction Noise Levels (dB $L_{Aeq, 30 min}$)***

Noise Sensitive Receiver	Distance from Dredgers (m)	Worst Case Facade Noise Level[1]
Victoria Hotel	150	75
Hong Kong Cultural Centre	1375	55

Note: (1) For a worst case assessment it has been assumed that three dredgers will be used simultaneously at any one notional point with a combined SWL of 123 dB(A).

Operational Impacts

No noise impacts are expected from the operation of the LAR below Victoria Harbour.

B5.2 YAU TSIM DISTRICT

B5.2.1 *Kowloon Station and Tunnels*

Construction Impacts : Station Construction

Station construction noise will be dominated by four main activities. These are access road construction, station excavation, station box formation and building erection. The analysis of these construction activities plus the likely methods of working has enabled an inventory of plant teams and site total sound power levels to be drawn up and analysed.

Access road construction was assessed by evaluating the likely PME which would be used for removing spoil plus the plant necessary for concrete mixing, laying, and setting.

For the excavation process, PME with the capability of removing large quantities of spoil within the station boundaries were evaluated.

Station box construction, essentially the foundations and underground sections of the station, was assessed by assuming that noise would be produced predominantly by cranes, trucks and foundation constructing PME. Two types of piling rigs were assessed for the foundations. Vibratory piling rigs were modelled for the driving of sheet steel piles, while large diameter, oscillating, bored piling rigs were assumed for the emplacement of bored piles. The pile formation process was assumed to need bentonite grout, so the operation of a bentonite filtering plant was included in the assessment.

For the building erection phase, handtools, lorries, and cranes were assumed to be the dominant forms of PME employed.

Construction Impacts : Cut and Cover Tunnel Construction

Cut and cover tunnel construction noise will be dominated by four main activities. These activities are access road construction, excavation, piling of the foundations and backfilling over the fabricated tunnel sections.

Access road construction, the excavation process and piling were all assessed as in the station construction section, though on a different scale due to differences in the shape of the worksite and scale of the project. The backfilling operation was evaluated by modelling PME of a similar nature to those employed in the excavation process.

The worst case for noise impacts at the NSRs exists if both station construction and tunnel construction occur simultaneously. *Table B5.2a* shows this worst case by assessing the noisiest tunnel construction activity, excavation, acting in parallel with each of the station construction activities.

Table B5.2a *Tunnel and Station Construction Activity Noise Levels (dB $L_{Aeq, 30\ min}$)*

Noise Sensitive Receiver	Access Road	Excavation	Station Box	Building Erection
Man Wui and Man Cheong Streets	69	66	73	72
Canton Road:				
Royal Pacific Hotel	65	64	68	67
Residential	65	63	68	67
Clinic	65	63	68	67

Estimates for the volume of truck traffic on haul roads in the vicinity of the station predict 35 trucks per hour in the worst case. Assuming that a truck has a SWL of 112 dB(A), truck traffic is predicted to have a worst case $L_{Aeq, 30min}$ noise level at NSRs of 57 dB(A). This is well within the daytime noise level criterion of 75 dB(A). It should be noted that if truck traffic operations are evaluated in parallel with the station and tunnel construction activities, predicted noise levels in the table above will increase by at most 1 dB(A). As a result, haulage traffic activities are not anticipated to make a significant contribution to the noise environment near the contract worksite in light of the higher station and tunnel construction operation noise levels.

Operational Impacts

As discussed above, in relation to Hong Kong Station and Tunnels, no noise predictions are considered necessary for train noise and vibration where, as in this case, the LAR is in tunnel (and station) on reclaimed land. Similarly, the effects of fixed plant noise will be evaluated qualitatively because the precise prediction of noise levels is not possible due to the limited available data.

B5.2.2 *Kowloon to Tai Kok Tsui Tunnels*

For this contract construction noise will be dominated by four main activities. These are access road construction, excavation, sheet piling and backfilling operations. The majority of the contract will involve cut and cover tunnel construction, however, there is a 100 m section just before Tai Kok Tsui Station which will involve only open cut construction activities. As a result, the most northerly NSRs, those near the station, have been assessed for open cut construction as well as backfilling (the distance for backfilling operations being different from those for open cut construction) while all others have been assessed for those operations pertaining to cut and cover tunnel construction.

Access road construction was assessed by evaluating the likely PME which would be used for removing spoil plus the plant necessary for concrete mixing, laying, and setting. Access road construction during this contract will be limited, as there will be a paved section of existing road leading from Man Cheong Street to the Public Cargo Works Area (PCWA) which will be used by the construction traffic.

For the excavation process, PME with the capability of removing large quantities of spoil were evaluated. It was noted that the tunnel cutting will proceed from the south end of the site to the north end and that excavated material will be stored close to the cut.

Due to the loose nature of the reclaimed material it was understood that sheet piles would be necessary to provide integrity to the tunnel foundations. For this stage of construction, vibratory piling rigs driving sheet piles were evaluated.

Backfilling was evaluated by noting that excavated material, rather than spoil transported from other areas, would be used as capping material to complete the tunnel.

The predicted noise levels at each of the NSRs is set out in *Table B5.2b.*

Table B5.2b *Kowloon to Tai Kok Tsui Tunnels Construction Activity Noise Levels (dB $L_{Aeq,30\ min}$)*

Noise Sensitive Receiver Neighbourhood	**Noise Sensitive Receiver**	**Access Road**	**Excavation**	**Piling**	**Backfilling**
Cherry Street	Res blocks	66	67	67	62
	Sharon School	64	65	65	62
	Ming Kei College	63	64	64	62
Hoi King St	Res. blocks	73	74	74	66
Ferry Street	Res. blocks	63	64	64	62
	YMT Cath. School	63	64	64	62
Man Cheong St	Res. blocks	69	70	70	68

Figure B2.3a shows the locations of the listed NSRs. Cherry Street and Hoi King Street have been assessed for construction impacts from the construction of the open cut and for the backfilling operation of the cut and cover tunnel section (further south), while all other receivers have been assessed for cut and cover tunnel operations. For the Cherry Street and Hoi King Street NSRs, the distances from the backfilling operations were:

- Cherry Street; residential blocks, 440 m; Sharon School, 490 m; Ming Kei College, 525 m.
- Hoi King Street; Residential blocks, 315 m.

Disposal of Surplus Spoil

It has been proposed that most of the material that will not be used on the site be removed by barge and then to the appropriate disposal site. The barges would be moored in the reprovisioned PCWA. There are no NSRs to the west of the alignment, and all noise impacts from disposal activities would be appreciably less than impacts from construction operations, however, other site traffic will use the road network. The worst case scenario for this proposal is for 20 trucks per hour entering or leaving from the site close to the Man Cheong Street residential blocks. The $L_{Aeq, 30\,min}$ at these NSRs has been calculated to be 53 dB for this level of traffic. Addition of this noise level to those calculated in the table above will not make a significant contribution (at most 1 dB(A) increase) to the level of predicted noise impacts.

Operational Impacts

Most of this section of the LAR will be contained in a tunnel and will not, therefore, give rise to noise impacts. The final 250 m of track (approximately 100 m in Contract 504 and 150 m in Contract 505) to the south of Tai Kok Tsui Station will be laid in a cutting and this give rise to the possibility of noise affecting NRSs in site B of the Station Related Developments. Noise levels at the nearest NSRs have been predicted in the Tai Kok Tsui Station assessment which is discussed below.

B5.3 MONG KOK DISTRICT

B5.3.1 *Tai Kok Tsui Station*

Construction Impacts : Station Construction

For this contract station construction noise will be dominated by five main activities. These are access road construction, piling, excavation, station box construction and building erection.

The construction procedure for Tai Kok Tsui Station has been assumed to be the same as that outlined for Kowloon Station (see Section B5.2.1) with the addition that prior to the excavation phase the area of the station directly above the Cherry Street Underpass will be strengthened through the emplacement of bored piles.

Construction Impacts : Cherry Street Underpass Construction

Construction work for the underpass will be entrusted to Government, noise for the underpass will be dominated by three main activities. These are excavation, piling and backfilling.

The Eastern Approach of the underpass will be excavated as an open cut with work proceeding from the east to the west. For the excavation process, PME with the capability of removing large quantities of spoil were evaluated.

As the underpass will pass through reclamation, mainly sand and gravel, steel piles will be driven on either side of the road to retain the cut. For this operation a hydraulic vibratory piling rig driving steel sheet piles was evaluated.

It is assumed that after the open cut sections have been piled and excavated the edges will be covered by a layer of fill to even out the landscape. This operation was evaluated by noting that PME similar to that used for the excavation phase would be employed.

The worst case for noise impacts at the NSRs exists if both station construction and tunnel construction occur simultaneously. The table below, *Table B5.3a*, shows this worst case by assessing the noisiest station construction activity, station box construction, acting in parallel with each of the underpass construction activities. For the Cherry Street Underpass, the assumed SWLs for the different phases of construction were:

Excavation:	121 dB(A);
Piling:	118 dB(A); and
Backfilling:	119 dB(A).

Table B5.3a ***Station and Underpass Construction Activity Noise Levels (dB $L_{Aeq,\ 30\ min}$)***

Noise Sensitive Receiver	Excavation	Piling	Backfilling
Foo Kwai Street	79	79	79
Cherry St/Hoi King St Intersection	87	85	85
Hoi King Street	81	81	81
Cherry Street:			
Residential Buildings	73	72	72
Sharon Lutheran School	70	69	69
Ming Kei College	71	70	71

Estimates for the volume of truck traffic on haul roads in the vicinity of the underpass and the station predict 15 trucks per hour in the worst case. Truck traffic is predicted to have the greatest impact at NSRs at the Cherry Street/Hoi King Street Intersection of $L_{Aeq,\ 30min}$ 58 dB, this is well within the daytime noise level limits of 75 dB(A). Addition of this noise level to those calculated in the table above will not make a significant contribution (at most 1 dB(A) increase) to the level of predicted noise impacts.

The assessment of cumulative impacts from both cut and cover tunnel construction (Kowloon to Tai Kok Tsui Tunnel) and Tai Kok Tsui Station/Cherry Street Underpass construction indicate that Hoi King Street Residences will need special consideration. This consideration will be detailed in the next section.

Operational Impacts

The layout of the residential tower blocks in TKTSRD Site B is shown in *Figure B5.3a*. It can be seen that the five residential towers along the western boundary are of a reduced aspect design in order to provide mitigation against traffic noise from the WKE and P1 roads. Predictions have been made at the northern and southern rear facades (these being the worst affected facades which have openable windows in the reduced aspect tower design) of tower numbers five and nine. The predicted train noise levels based on the LAR operating details and the established alignment of the lines are given in *Tables B5.3b*.

Table B5.3b ***Facade Noise Levels (0630–0700) for the 86 dB train (dB $L_{Aeq, 30min}$)***

Noise Sensitive Receiver	No barriers
Tower 5 northern facade TKTSRD site B(1)	37–38
Tower 5 southern facade TKTSRD site B(1)	55–56
Tower 9 northern facade TKTSRD site B(1)	56–57
Tower 9 southern facade TKTSRD site B(1)	<40

Note: (1) For tower blocks the range of levels covers the range of NSR heights.

B5.4 SHAM SHUI PO DISTRICT

B5.4.1 *Tai Kok Tsui to Lai Chi Kok Formation*

Construction Impacts

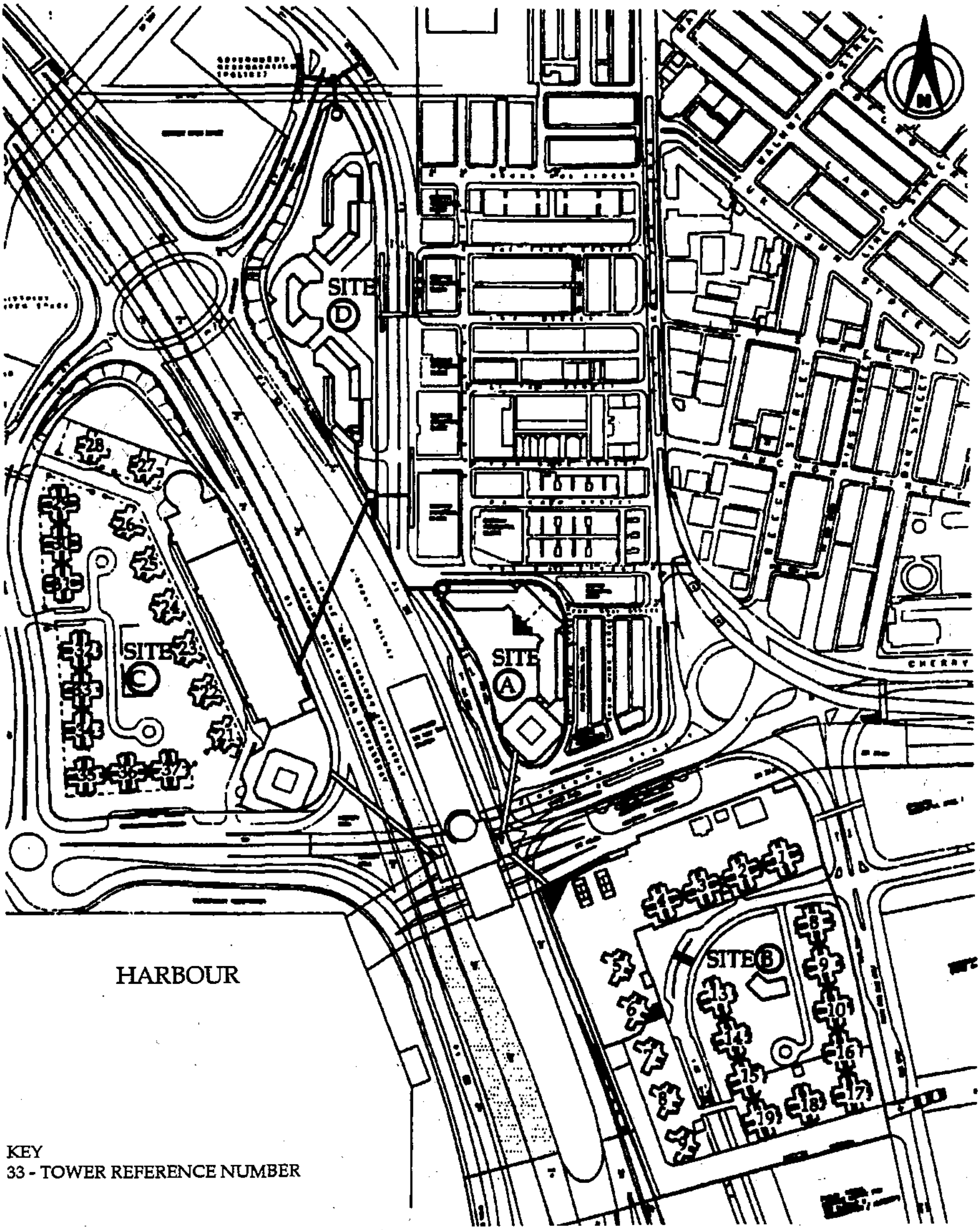
Within this area the LAR track constructions are entrusted works and therefore no new predictive work has been undertaken. The evaluation of impacts has been based entirely on previous studies.

Operational Impacts

For all NSRs predictions were made at the first and top floors, and (with the exception of the Haking Institute, which has only two floors) at a middle height floor.

For the northern part of this section of the LAR the WKE will be above the lines. The potential screening effects offered by the WKE were investigated, and it was concluded that because of the configuration of the lines and the shallow angle of view under the WKE structures that many NSRs will have, no significant screening will result.

The industrial and other buildings proposed on the reclamation to the North of Nam Cheung Estate will act to screen proposed sensitive landuses behind them (to their East) from both road noise from the WKE and train noise from the LAR. Nam Cheung Estate will also gain some screening in this way.



NSRs IN THE TAI KOK STATION
RELATED DEVELOPMENT CDA

FIGURE B5.3a
DATE 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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Noise predictions have been made for three cases; the no barrier case, and for two barrier option scenarios. The barriers modelled in these two barrier option scenarios are listed in *Table B5.4a*. The exact location of the barriers is referenced relative to the chainage of the AEL Up line, and all barriers are assumed to be approximately 2575 mm from the centre line of the stated track. *Figure B5.4a* shows the approximate chainage of the AEL Up and the NSRs in this area for reference.

Table B5.4a ***Barrier Scenario 1, Optimised For The 86 dB Train***

Barrier Type	**Railway Line**	**NSR Protected**	**Start Chainage (AEL Up)**	**Finish Chainage (AEL Up)**	**Length (m)**
Type 2b, 3.8 m absorptive	North of AEL Up	24(1)	2400	3400	1000
Type 2b, 3.8 m absorptive	North of LAL Dn	24(1)	2400	3400	1000
Type 2, 1.4 m absorptive	North of LAL Dn	25	600	1100	500
Type 2, 1.4 m absorptive	North of AEL Dn	25	600	1100	500
Type 2, 1.4 m absorptive	North of AEL Up	25	600	1100	500
Type 2, 1.4 m absorptive	North of LAL Up	25	600	1100	500

Note: (1) Includes mitigation for contract 507

In modelling for the situation in 2011, four separate lines are assumed, since between the opening of the LAR and 2011 it is anticipated the two lines in this area (up and down) will be increased to four separate lines for the LAL and AEL up and down lines. This note is also relevant to the Lai Chi Kok to Kwai Chung Road Viaducts section of the LAR below.

Figure B5.3a shows the layout of the residential tower blocks in TKTSRD Site C. It can be seen that residential towers 21 to 28 are of a reduced aspect design as discussed above for site B of the same development. Towers 21 to 26 are set back from the LAR and are located to benefit from screening by the 30 m high non-sensitive buildings that run along the eastern side of the site. Therefore, Tower 27 will be the tower most exposed to train noise from the LAR (Tower 28 being further set back). Predictions have been made at the western and southern rear facades (these being the worst affected facades which have openable windows in the reduced aspect tower design) of Tower 27.

Table B5.4b gives the predicted noise levels at each NSR. The three predicted noise levels for each NSR are for the low, medium and high receiver heights at the NSR. Re-radiated noise is not considered as this section of the alignment will be ballasted track at grade.

Table B5.4b *Facade Noise Levels (0630–0700) for the 86 dB train (dB $L_{Aeq, 30\ min}$)*

Noise Sensitive Receiver	Total Noise, No Mitigation	Total Noise, Barrier Scenario 1
NSR 24 Mei Foo Sun Chuen (southern end)	64,65,66	57,58,60
NSR 26 Haking Wong Technical Institute	60,60[(1)]	59,59[(1)]
NSR 25 Nam Cheong Estate	63,63,63	59,59,60
NSR 22 TKTSRD Site C Tower 27 (North)	59,60,60	59,60,60
NSR 22 TKTSRD Site C Tower 27 (South)	51,52,52	51,52,52
NSR 22a Residential site R1 North of TKTSRD site C	56,57,59	56,57,59
NSR 22b Schools North of TKTSRD site C	61,63,64[(1)]	61,63,64[(1)]

Note: (1) Worst case, peak period, daytime headways used.

B5.4.2 *Lai Chi Kok to Kwai Chung Road Viaducts*

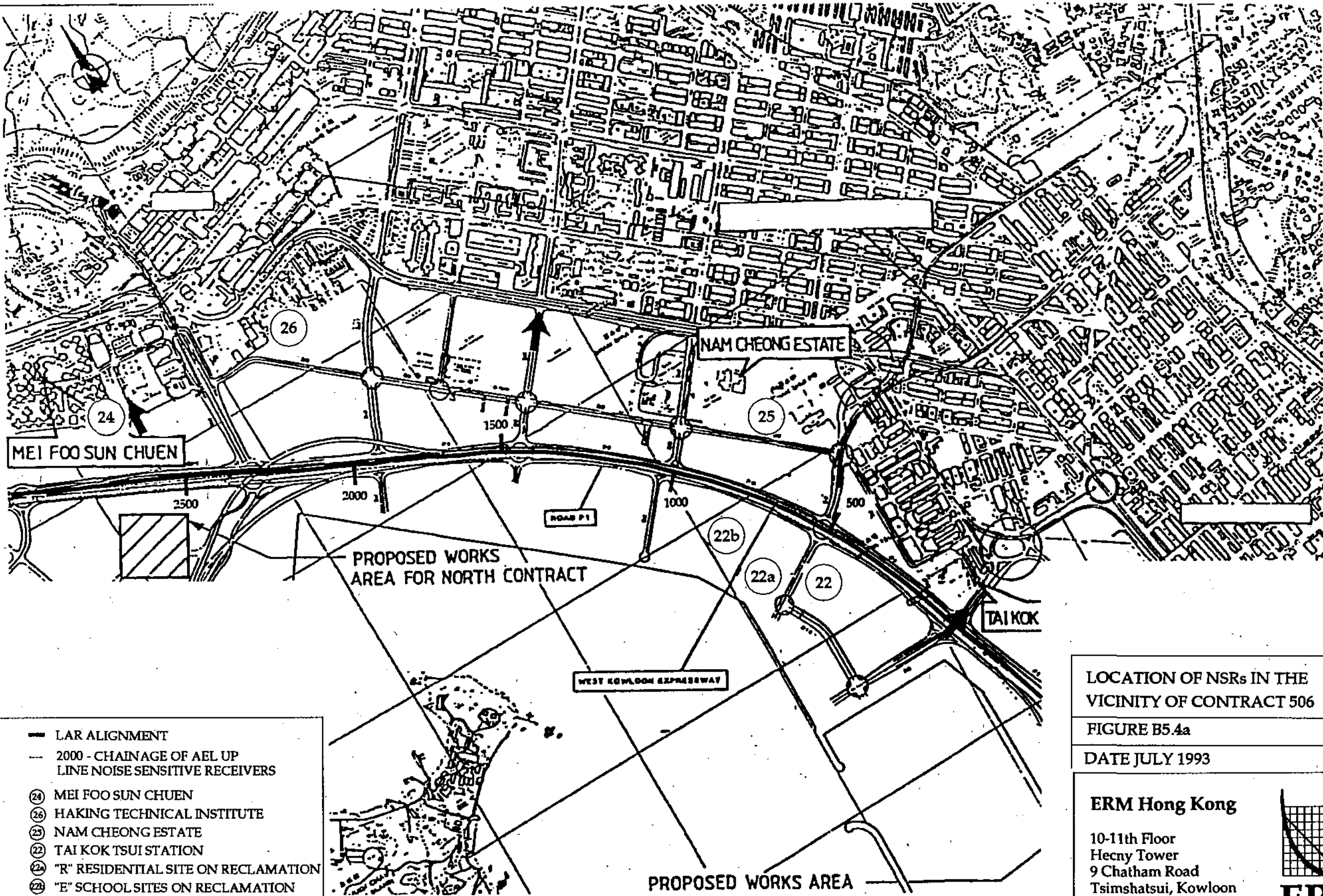
Construction Impacts

Within this area the LAR track constructions are entrusted works and therefore no new predictive work has been undertaken. The evaluation of impacts has been based entirely on previous studies.

Operational Impacts

For the WMC Morninghope School four prediction points on facades facing the railway have been modelled, with predictions made at ground and first floors. The layout of the school was established by two site visits. The details of the proposed cut and retaining caisson wall, that will be formed to allow the alignment to meet the proposed portal location just below Lai King Hill Road, were obtained from Acer Consultants. 1:200 scale survey maps of the existing topography were used for the modelling of the area in order to have a good degree of confidence in the accuracy of the complex screening of train noise that would result from the topography of the area. Predictions were made at 1st, 6th, and 12th floors of the southern facade of block 19, Cho Yiu Estate, which has no windows in its western facade. It was found that the caisson wall, being a 20 m high vertical structure, will act as an effective noise barrier, screening the NSRs above. In particular Block 19, Cho Yiu Chuen Estate is well screened in this way and also by the WMC Morninghope School.

For the Princess Margaret Hospital (NSR 30), Ching Lai Court (NSR 23) Mei Foo Sun Cheung (NSR 24) predictions were made at the first and top floors, and at a middle height floor.



LOCATION OF NSRs IN THE VICINITY OF CONTRACT 506

FIGURE B5.4a

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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The Princess Margaret Hospital NSR comprises staff accommodation, all of which has balconies on the facade overlooking the alignment. A 2 dB(A) screening effect has been allowed for these NSRs at all heights. Ching Lai Court has a number of blanked facades overlooking the railway. Noise predictions have therefore been made at the worst case facades, which have a slightly restricted angle of view onto the alignment.

This section of the LAR will be on embankment from the Lai Chi Kok Interchange (AEL up chainage 3000) to AEL up chainage 3700, and on twin elevated concrete viaduct from AEL Up chainage 3700 to north of Kwai Chung road. Hence consideration has been given to the levels of noise likely to be re-radiated from the viaduct structures. For these twin viaducts re-radiated noise is calculated from the assumption that its level will be equal to the unscreened air-borne noise level minus 15 dB(A) as discussed in *Section 3.8*.

The LAR will be directly below the Route 3 structure from the Lai Chi Kok Interchange to AEL Up chainage 4200. The Route 3 structure is about 40 m wide and varies in height between about 7-10 m above the LAR. In this location Route 3 will offer screening to certain NSRs. The shallow angle of view from some NSRs looking under Route 3 in many cases implies little screening. The following screening effects have been included in the modelling of train noise.

- Total screening of the lines south of AEL Up chainage 4200 for NSRs around type Lai King Tunnel south portal;
- No screening from the eastern viaduct;
- 10 dB(A) screening of the lines on the western viaduct for NSRs 23 and 30 at high level; and
- No screening for NSRs 23 and 30 at middle and low levels, or at NSR 24 at all levels.

The screening of the western viaduct by the eastern viaduct and barriers on it, is included in the modelling.

The barriers modelled in the noise predictions are listed in *Table B5.4c* and the predicted facade noise levels are shown in *Table 5.4d*. The exact location of the barriers is referenced relative to the chainage of the AEL Up line and all barriers are assumed to be approximately 2575 mm from the centre line of the stated track. *Figure B5.4b* shows the approximate chainage of the AEL Up and the NSRs in this area for reference.

Table B5.4c *Optimised Barrier Scenario For The 86 dB Train*

Barrier Type	Railway Line	NSR Protected	Start Chainage (AEL Up)	Finish Chainage (AEL Up)	Length (m)
Type 2b, 3.8 m absorptive	North of AEL Up	24(1)	2400	3400	1000
Type 2b, 3.8 m absorptive	North of LAL Dn	24(1)	2400	3400	1000
Type 2, 1.4 m absorptive	North of AEL Dn	23,30,31	3400	4500	1100
Type 2, 1.4 m absorptive	North of LAL Dn	23,30,31	3400	4500	1100
Type 2, 1.4 m absorptive	North of AEL Up	23,30,31	3400	4500	1100
Type 2, 1.4 m absorptive	North of LAL Up	23,30,31	3400	4500	1100

Note: (1) Includes mitigation for contract 506

Type 2b barriers have been modelled as absorptive over their entire inside area as discussed in *Section 4.2*.

Table B5.4d gives the predicted levels of re-radiated and air-borne noise, and their total at each NSR. The range of predicted noise levels covers the range of receiver heights (and in the case of the WMC Morninghope School, the four receiver locations) considered.

Table B5.4d *Facade Noise Levels (0630–0700) for the 86 dB train (dB $L_{Aeq,\ 30\ min}$)*

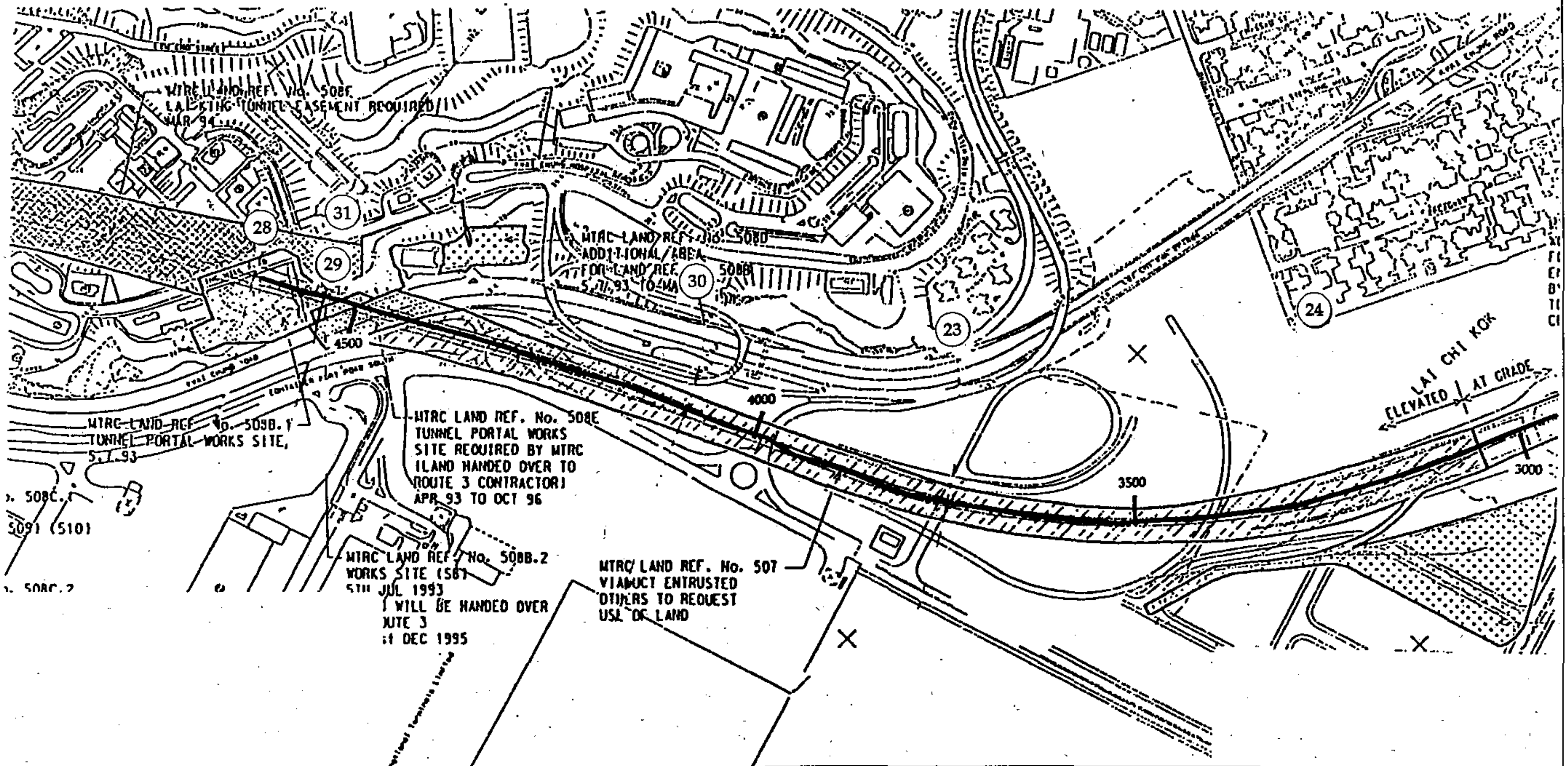
NSR	Re-radiated Noise	Total Noise No Mitigation	Total Noise Barrier Scenario 1
NSR 28 Chan Nam Cheong School(1)	48,50	51,57	51,57
NSR 31 Cho Yiu Chuen Estate	43,43,43	58,59,61	53,54,56
NSR 29 WMC Morninghope School(2)	43,54	61,65	61,61
NSR 30 Princess Margaret Hospital	48,49,48	65,65,62	59,60,59
NSR 23 Ching Lai Court	48,48,48	64,64,61	59,60,60
NSR 24 Mei Foo Sun Cheun (northern end)	34,34,34	65,65,64	57,58,60

Note: (1) Worst case daytime headways.
(2) Four prediction locations assessed, worst case daytime headways.

B5.4.3 *Mei Foo Temporary Depot*

Construction Impacts

Impact predictions for the temporary depot as Mei Foo have been based on the work undertaken for the Siu Ho Wan Depot on North Lantau. The



LOCATION OF NSRs IN THE VICINITY OF CONTRACT 507

KEY

- LAR ALIGNMENT
- 4000 - CHAINAGE OF AEL UP LINE NOISE SENSITIVE RECEIVERS

(23) CHING LAI COURT
(24) MEI FOO SUN CHUEN
(28) CHAN NAM CHEUNG MEMORIAL SCHOOL
(29) W.M.C. MORNINGHOPE SCHOOL
(30) PRINCESS MARGARET HOSPITSAL
(31) BLOCK 19, CHO YIU ESTATE

FIGURE B5.4b

DATE JULY 1993

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9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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predictions of noise levels at Tai Ho Wan are likely to be considerably higher than at Mei Foo due to the greater frequency of train movements. These results have been applied at Mei Foo as a worst case scenario.

Operational Impacts

The Depot will not be used after the completion of the construction phase of the LAR.

B5.5 KWAI TSING DISTRICT

B5.5.1 *Lai King Station*

Construction Impacts : South Portal Worksite

Plant for the activities listed in the previous section have been assumed based on available information so that noise levels can be predicted at NSRs for the assumed noisiest phases of construction. Blasting impacts will be discussed in *Section 6*.

Table B5.5a provides the results of worst case predictions for the noisiest phases of construction. Due to the special construction requirements for the tunnel and the South Portal in this area, the assumed construction plant inventory for this section was different than the one outlined in *Section 4.1.2*. As a result, the assumed sound power levels for the different construction phases were different as well. The SWLs for the different construction phases were:

- Caisson Wall Construction: 113 dB(A);
- Blasting/Removal of Spoil: 122 dB(A);
- Tunnelling (spoil removal): 121 dB(A).

Table B5.5a Predicted Levels for Noisiest Construction Phases (dB $L_{Aeq,\ 30\ min}$)

NSR Name	Facade Noise Level (dB(A)) due to:			
	Caisson Wall Construction	**Spoil Removal**	**Tunnelling**	**At Grade Track Foundations**
Salvation Army Home (Block A)	64	75	74	75
Chan Nam Cheong Memorial School	67	78	77	78
Cho Yiu Estate	60	79	78	79
WMC Morninghope School	94 (worst case) 83 (general case)	88 (worst case) 83 (general case)	87 (worst case) 82 (general case)	88 (worst case) 83 (gen case)

All worst case calculations have assessed the impacts at the closest point to the NSR and are, therefore, likely to be of comparatively brief duration. The calculation for the general case for the caisson wall includes a distance correction as well as a 5 dB(A) correction for work taking place inside a caisson hole beneath the surface.

Construction Impacts: Station Worksite

Plant teams for the construction activities have been based on available information so that noise levels can be predicted at NSRs for the assumed noisiest phases of construction. As Lai King Station is not to be constructed on reclamation, it was assumed that excavator-mounted breakers and chippers would be necessary for many phases of the construction. As a result, the calculated SWLs for the different phases of construction are different from those outlined in *Section 4*. The sound power levels assumed for each phase of construction were as follows:

Site Clearance:	128 dB(A);
Demolition of Community Hall:	125 dB(A);
Excavation of Construction Site:	129 dB(A);
Station Construction:	112 dB(A).

Table B5.5b provides the results of worst case predictions for the noisiest phases of construction, with no mitigation measures incorporated.

Table B5.5b ***Worst Case Facade Noise Levels at NSRs due to Assumed Noisiest Construction Activities (dB $L_{Aeq,\ 30\ min}$)***

Noise Sensitive Receiver	Facade Noise Level due to:			
	Site Clearance	Demolition of Lai King Community Hall [1]	Excavation	Construction of Station
Blocks 1 to 4 Lai King Estate[2]	81	75	82	65
Block 5, Lai King Estate (Yeung King House)	91	94	92	75
Block 6, Lai King Estate (On King House)	82	82	83	66
Yin Lai Court[2]	87	81	88	71
Lok Sin Tong Lau Sai Yan Primary School[2]	81	75	82	65
Lai Ha House, Yuet Lai Yuen[2]	84	82	85	68
Lai Wah House, Yuet Lai Yuen[2]	84	83	85	68
Lai Wan House, Yuet Lai Yuen[2]	83	82	84	67
Most northerly house in Yuet Lai Yuen[2]	84	80	85	68
Blocks 12 (Kai Him Lau) and 13 of Cho Yiu Chuen[2]	79	82	80	63

Note: (1) The distance used in calculations for this activity were taken to be from the NSR to Lai King Community Centre. It should be particularly noted that the demolition work associated with the Community Centre will only last for three weeks.
(2) Predicted noise levels assume no screening effects.

The results given in *Table B5.5b* can be considered as 'worse case' since plan distances (rather than slant distances) were used. For receivers at similar heights to construction activities, the slant distance will be very similar to the plan distance, and therefore no overestimate of the construction noise level will have occurred. For receivers located considerably higher than the noise source, a slight overestimation may have occurred, as the actual separation distance will be slightly greater than the distance assessed. For example, where the receiver is as high above the source as it is distant from it, an overestimate of 1.5 dB is introduced.

Peak construction traffic flows were assumed to be 30 vehicles per hour, the average speed of the vehicles being 50 kph. The source SWL was taken as 112 dB(A). The traffic was assumed to use Lai King Hill Road and an assessment was made for the nearest Yuet Lai Yuen house (25 m from the road) and the nearest Yin Lai Court block (20 m from the road).

The facade noise level due to construction traffic at the nearest Yuet Lai Yuen house to the road was predicted to be $L_{Aeq, 30\,min}$ 66 dB and at the nearest Yin Lai Court block to the road, $L_{Aeq, 30\,min}$ 67 dB.

Noise from vehicles moving on site is included in the levels predicted in *Table B5.5b*.

Construction Impacts : LAR Viaducts

Noise from the construction of the LAR Viaducts north of Lai King Station (which is entrusted to Government) was not assessed in the Route 3 EA. However, Highways Department and the Route 3 Project Team have undertaken to carry out such an assessment in order to ensure that these works will not produce noise levels exceeding the requirements of the NCO or the $L_{Aeq, 30\,min}$ 75 dB noise level recommended by the EPD for daytime working.

Operational Impacts

For the viaducts North of Lai King Station, Ming King House is the NSR most likely to be impacted by train noise. For each of the single viaducts re-radiated noise is calculated as the air-borne noise level minus 9 dB (see *Section 3.8*). The Route 3 road structure re-joins the LAR alignment north of Lai King station so that beyond about 330 m all the train lines are completely screened by the Route 3 structure above them.

In order to consider the potential cumulative noise impacts from the LAR and the existing Tsuen Wan Line (TWL) in this area, consideration has been given to the possible contribution that the TWL could make to the level of train noise from the LAR. It is currently not possible to measure noise from the TWL at Ming King House because of the high levels of road traffic noise in the area (See *Section B2.5.1*), and detailed calculation of noise from the TWL are hindered by uncertainties in the future train source noise level, 0630-0700 hours headways, and speed profiles. Both the LAL and TWL trains will be stopping at Lai King Station where as the AEL trains will not. Hence, an indication of the likely future contribution of noise from the TWL to the total level of train noise is found by considering the predicted contribution of the LAL trains to the total noise from the LAR. It was found that with Type 1 barriers (the TWL has parapet barriers similar to these) the LAL noise level is about 6 dB below the total noise level from the LAR. It is the much faster AEL trains that are the dominant noise source. Hence it is unlikely that the TWL will contribute significantly to noise from the LAR. Furthermore, the train speeds are likely to be lower on the TWL than on the LAL, making the contribution still lower.

The predicted noise levels for trains on the viaducts North of Lai King Station are given in *Table B5.5c*.

Table B5.5c *Facade Noise Levels (0630-0700) for the 86 dB train (dB $L_{Aeq, 30\ min}$)*

NSR	No barriers	Type 1 barriers[2]	Type 2 barriers[3]
Ming King House [1]			
Re-radiated Noise	52.0-54.5	52.0-54.5	52.0-54.5
Air-borne Noise	61.0-63.5	55.6-60.2	53.6-58.7
Total Noise Level	**62-65**	**57-61**	**56-60**

Notes: (1) The range of levels covers the range of NSR heights from ground to 17th floor.
(2) Type 1 barriers are offered by the typical viaduct design.
(3) Type 2 barriers on the East side of all lines between the station and 50 m beyond the point at which each line passes under the Route 3 structure (approximately 380 m for the LAL and 290 m for the AEL).

B5.5.2 *Kwai Chung Park*

Construction Impacts

For this contract construction noise is expected to be dominated by six main activities. These are site clearance, access road construction, excavation, piling, viaduct construction and backfilling.

Site clearance is likely to involve an excavator for levelling activities, a loader for collection of material, and a truck for transfer purposes. Topsoil collected during this stage will be stockpiled on site for reuse as backfill. Construction plant will tend to move as a team around the site.

Excavation was assessed by evaluating plant similar to that used for the site clearance operation, however, the scale of the operation was increased to accommodate the larger amount of spoil to be excavated and removed.

To ensure that the railway support structure has a firm position in the landfill material, the foundation will be piled. As the landfill has an average total depth of fill of 55 m which is covered with a layer of inert material, piling will need to take place to a depth of at least 60 m to reach solid rock.

The piling sequence will consist of the emplacement of approximately 52 large diameter bored piles. To minimise the scattering of fill material the waste will be penetrated with a retrievable steel casing forced into the ground by a hydraulic casing oscillating machine. The fill material will then be drawn out with the use of clamshell grabs. The hard granite at the bottom of the pile will be penetrated by means of a reverse circulation drilling rig equipped with a heavy duty roller bit. After this, the bore will be filled with concrete. As the temporary casing is extracted, the casing void will be filled with bentonite grout.

Viaduct construction was assumed to include piling rigs for foundation operations as well as track laying equipment and concrete mixing and tamping PME.

Backfilling operations were assumed to include PME similar in size and purpose to that used for the excavation process.
The construction through Kwai Chung Park will move over a distance ranging from 160–380 m from the Tsuen Wan crematorium, with an average distance of about 270 m. The distance of 160 m is used for a worst case scenario, while the distance of 210 m will be used as the appropriate notional source location assessment scenario. The predicted noise levels for these two scenarios are given in *Table B5.5d*.

Table B5.5d *Construction Noise Levels at the Tsuen Wan Crematorium (dB $L_{Aeq,\ 30\ min}$)*

Phase	Worst case	Notional source case
Set Up	71	69
Access Roads	73	71
Excavation	73	71
Piling	74	72
Viaduct Construction	74	72
Backfilling/Slope Preparation	72	70

It should be noted that as construction for this section of the LAR will take place in a landfill, the construction plant inventory is slightly different from that assumed for the other contracts. In particular, the SWL for all PME for the excavation phase was calculated to be 122 dB(A).

On–Site Truck Loading

Excavated material will be disposed of off–site It is proposed that the excavated spoil will be trucked to the Pillar Point Landfill for disposal. From the amount of material to be transported and the period for excavation, it has been estimated that a likely maximum of 43 trucks making a total of 170 trips per day would be necessary. These trucks would each typically constitute a SWL of 117 dB(A).

The average distance of truck loading areas from the crematorium would be approximately 150 m. It is predicted that loading, using four trucks and a loader, would produce 75 dB(A) at the facade of the crematorium. If this is carried out simultaneously with the excavation, piling or viaduct construction phases then levels of 78 dB(A) are predicted, in the worst case, at the facade of the crematorium.

The off–site disposal at Pillar Point Landfill will be accessed from No 2 Highway which runs from Kwai Chung Park through Tsuen Wan and then into Tuen Mun. It is recommended that the truck traffic use the existing access roads near the site. These roads are positioned such that they shuttle traffic away from the NSRs, towards Rambler Channel, and quickly transfer trucks onto major roads where their nuisance potential is minimised.

Analysis of the road network near the park indicates that the following would be the recommended routing for trucks to Pillar Point:

- Access road (150–500 m);
- Kwai Hei Street (150 m);
- Kwai Yue Street (450 m);
- Kwai Tai Road (400 m);
- Kwai Ching Road (500 m); and
- Tsuen Wan Road (Highway No 2).

As is indicated, this route has a total distance of less than 2 km. Kwai Ching Road is a major road as it is the extension of the South Tsing Yi Bridge into the Lai King area while Tsuen Wan Road is heavily travelled at all times. Flow rates for Tsuen Wan Road as recorded just north of the site are as follows (according to the Hong Kong Annual Traffic Census, 1991):

- From Kwai Ching to Texaco Road on Tsuen Wan Road, Average Annual Daily Traffic (AADT) was 103,190 vehicles.

- From Texaco Road to Hoi Hing intersection on Tsuen Wan Road, AADT was 77,890 vehicles.

On this routing, trucks would come close only to one NSR, the crematorium, before moving onto the major roads. The closest point of approach to the crematorium would be on Kwai Hei Street at a distance of 100 m. As this road is only 150 m long, a reasonable worst case scenario would be for 2 trucks to be on this road at one time. Assuming 10 trucks per hour at a distance of 100 m from the crematorium, a noise level of $L_{Aeq, 30 min}$ 59 dB is predicted. Hence there would be no significant increase to the predicted construction noise levels at the crematorium from the addition of noise from off-site truck traffic.

In addition to impacts from construction and truck transport from construction activities at Kwai Chung Park, the Tsuen Wan Crematorium will be subject to simultaneous impacts from construction on the Rambler Channel Bridge and Viaducts. These cumulative impacts are assessed in the following section (*Section B5.5.3*).

Operational Impacts

In the case of Kwai Chung Park, the maximum daytime $L_{Aeq, 30 min}$ has been calculated at the proposed pavilion which overlooks the LAR alignment. This pavilion is close to the top of the cutting slope at the highest proposed part of the park. It will therefore be one of the most exposed parts of the park, and consequently represents a worst case.

The predicted noise levels at the pavilion are 70 and 63 $L_{Aeq, 30 min}$ daytime, assuming no barriers and Type 1 barriers respectively. In most areas of the park, the noise levels experienced would be considerably lower than these levels, not only because of the attenuation over distance, but also due to the natural screening provided by the proposed topography of the park itself.

B5.5.3 *Rambler Channel Bridge*

Construction Impacts

Table B5.5e provides the results of worst case noise predictions during a period when construction work is taking place at the majority of the bridge piers. For work on the piers the SWL was taken as 120 dB(A) for each of bored piling, spreadfooting and columns work and the batching plant operations, 122 dB(A) for reclamation work and 125 dB(A) for all other activities.

Table B5.5e ***Predicted Worst Case Facade Noise Levels – Not Including Percussive Piling (dB $L_{Aeq,\ 30\ min}$)***

Work Site	**Riviera Gardens**	**Greenfield Garden**	**Tsuen Wan Crematorium (1)**	**St. Paul's Village**
Tsing Yi Station	64	59	46	65
Pier 1	64	63	48	66
Pier 4(2)	64	63	54	59
Pier 5	61	60	65	56
Pier 6	64	64	75	60
Pier 7	58	57	75	54
TOTAL	**71**	**69**	**78**	**70**

Notes: (1) Calculations include a barrier correction for Piers 1 and 4.
(2) There are no concurrent activities at Piers 2 and 3.

The predicted L_{Aeq} noise levels at the Crematorium from construction of the viaduct for the 'worst' case and the notional source case (for construction work at a typical part of the viaduct) are shown in *Table B5.5f*.

Table B5.5f ***Facade Noise Levels at Tsuen Wan Crematorium due to Construction of Viaduct (dB $L_{Aeq,\ 30\ min}$)***

Phase	**Worst Case**	**General Case**
Site Clearance	75	72
Foundations	77	74
Construction	79	76

Facade noise levels for the NSRs affected by percussive piling from the bridge are given in *Table B5.5g*.

Table B5.5g Facade Noise Levels at NSRs for Worst Case Percussive Piling at Rambler Channel Bridge (dB $L_{Aeq,\,30\,min}$)

Work Site	Riviera Gardens	Greenfield Garden	Crematorium [1]	St. Paul's Village
Pier 6	74	74	85	70
Piers 3 and 5	80	76	77	73
Pier 3	77	77	75	74
Piers 3 and 4	80	80	79	76
Piers 1 and 2	80	79	75	81
Pier 1	77	76	71	79

Note: (1) Barrier corrections are included for Piers 1 to 4.

Noise levels from piling on the viaduct site are estimated to be L_{Aeq} 92 dB(A) as the worst case. The noise prediction methodology in TM2 does not account for air attenuation or ground absorbtion and, therefore, over longer distances the actual noise levels may be calculated to be slightly higher than is actually the case.

A Marine Department Office is located within the worksite and approximately 20 m from the location of pier 6 of the bridge. In this location the offices will be exposed to noise from a variety of PME and noise levels will vary greatly from one day to the next throughout the construction period. It is, however, likely that the highest noise levels will result from works centred at the pier 6 location. During bridge construction, plant similar to that listed in *Table B4.1j* for viaduct superstructure works will be present, and the resulting noise levels will be about $L_{Aeq,\,30\,min}$ 92 dB at the nearest facade of the office. Noise levels during percussive piling at the pier 6 location will be about $L_{Aeq,\,30\,min}$ 105 dB.

Cumulative Construction Noise Impacts from other LAR Construction Activities

As noted in the previous section (Kwai Chung Park), there is a high probability that the Crematorium will be exposed to cumulative impacts from both Kwai Chung Park LAR construction operations and Rambler Channel Bridge/Viaduct LAR construction operations. As a result, these cumulative impacts need to be assessed as a worst case situation.

The worst case for cumulative impacts can be evaluated by assessing the Rambler Channel Viaduct construction in combination with the Kwai Chung Park construction phases and the on-site truck loading operation. This assessment predicts that the worst case noise levels at the Tsuen Wan Crematorium will be 82 dB(A) (short duration) and 80 dB(A) (general case).

Construction Traffic

The potential for noise impacts from construction traffic can be assessed by considering the increase in traffic noise that would result by adding the construction traffic to the otherwise expected traffic flow on the road. The expected traffic flows on Tsing King road are approximately 1200 vehicles per hour, (see *Section 2.5*). The basic noise level from CRTN for vehicles travelling at an assumed 75 kph for a flow of 1200 vehicles per hour is L_{A10} 73 dB. Applying a correction of +4 dB(A) for an assumed 26% heavy vehicles, and -2 dB(A) for propagation over an assumed distance to the nearest NSR of 20 m, gives a predicted noise level of L_{A10} 75 dB at the nearest NSR.

For construction traffic movements to provide more than a 1 dB(A) (ie imperceptible) increase in this noise level during construction of the Rambler Channel Bridge, the noise level due to construction related traffic must be at least 4 dB(A) below the existing level. A peak hour construction related traffic flow of 160 heavy vehicles per hour would produce such a noise level at an NSR 20 m away (assuming a speed of 75 kph). Since the site will generate significantly fewer construction vehicles than this, no significant noise impacts from construction traffic are expected.

Operational Impacts

The predicted train noise levels based on the LAR operating details and the design details contained in the Reference Design are given in *Table B5.5h* below. The bridge will carry the four lines on two decks, one above the other. The two lines on the lower deck will be separated by the central structure of the bridge, whilst those on the top deck will run next to one another. The bridge Reference Design includes solid parapets adjacent to all four lines with no central barrier on the upper deck, these will be equivalent to 1.4 m Type 1 noise barriers. The contribution from re-radiated noise from the bridge is calculated by assuming the target level of 9 dB below the train rolling noise level, excluding the attenuation offered by the parapet, is exactly achieved.

Table B5.5h ***Predicted Facade Noise Levels ($L_{Aeq,(0630-0700)}$) for the 86 dB train***

NSR	Noise Level
Tower 1 Tsing Yi Station (1)	54–61
Riviera Gardens (1)	48–55
Greenfield Gardens (1)	47–54
The Crematorium	65(2)

Notes: (1) For tower blocks the range of levels covers the range of NSR heights.
(2) Daytime am or pm peak, $L_{Aeq, 30 min}$, daytime headways used.

The predicted train noise levels in *Table B5.5h*, are below the assessment criterion at all NSRs except Tower 1, Tsing Yi Station where an exceedence of 1 dB is predicted.

The bridge will be approximately 20 m from the Marine Department Offices in the PCWA on the east coast of the Rambler Channel, and will pass at high level almost directly over the offices. In this location the offices will be completely screened from the airborne noise path from trains on the bridge, and noise re-radiated from the underside of the bridge structure will dominate. Based on the LAR operating conditions given in *Section 4*, and the assumption for re-radiated noise given above, noise levels have been predicted to be about $L_{Aeq, 30 min}$ 68 dB and L_{AMax} 80 dB. Noise levels in the PCWA will, in the worst case (close to the bridge) be similar to these.

B5.5.4 Tsing Yi Station

Construction Impacts

For this contract three main activities were evaluated. These were construction of Tsing Yi Station, construction of the bus terminus located directly north of the station and construction of the Tsing Yi Viaducts, which connect the tunnels to the west to the station.

Station Construction

For this contract, station construction noise will be dominated by three main activities. These are ground excavation, piling of the foundations and building erection.

For the excavation process, PME with the capability of removing large quantities of spoil within the station boundaries were evaluated. Large diameter, oscillating, bored piling rigs were assumed for the emplacement of bored piles during the foundation laying process. The pile formation process was assumed to need bentonite grout, so the operation of a bentonite filtering plant was included in the assessment. For the building erection phase of station construction, handtools, lorries, and cranes were assumed to be the dominant forms of PME employed.

Bus Terminus Construction

The bus terminus was assumed, as a worst case, to have the same phases of construction and the same plant inventories as the station itself. Therefore, the assessment of the bus terminus followed the same procedure as that outlined for the station, above.

Viaduct Construction

For this contract, viaduct construction noise will be dominated by three main activities. These are access road construction, piling of the foundations and viaduct superstructure construction.

Access road construction was assessed by evaluating the likely PME which would be used for removing spoil plus the plant necessary for concrete mixing, laying, and setting.

Piling and superstructure construction were assumed to include bored piling rigs for foundation operations as well as track laying equipment and concrete mixing and tamping PME.

The worst case for noise impacts at the NSRs will exist when both station construction/bus terminus construction and viaduct construction occur simultaneously. *Table B5.5i* below shows this worst case by assessing the noisiest station construction activity, building erection, acting in parallel with each of the viaduct construction activities.

Table B5.5i *Viaduct and Station Construction Noise Levels (dB $L_{Aeq, 30 min}$)*

Noise Sensitive Receiver	Activity		
	Access Road Construction	Piling	Superstructure
School at Cheung On Estate	84	84	84
On Pak House, Cheung On Estate	85	86	86
On Chiu House, Cheung On Estate	81	82	82
On Tao House	75	76	76
On Yun House, Cheung On Estate	76	76	76
Broadview Gardens	74	75	75
School at Tsing Yi Estate	72	73	73
St. Paul's Village	84	85	85

This table indicates that station/bus terminus construction in combination with viaduct construction have the potential to cause the most severe impacts at NSRs.

Cumulative Impacts from other LAR Contracts

The only NSR which may, potentially, suffer cumulative impacts from the Rambler Channel Bridge construction as well is St. Paul's Village (noise levels were assessed in the previous section to be 70 dB(A) in the worst case). As this prediction did not take into account screening from the station worksite and Tsing Yi Station/Viaduct worksite construction noise, levels have been predicted to be significantly higher (85 dB(A), mitigated to 75 dB(A)) no significant cumulative impacts are anticipated at St. Paul's Village from these two adjacent LAR construction contracts during daytime hours. For evening and works on general holidays, as St. Paul's Village has been given an ASR of 'C', there is the possibility for cumulative impacts exceeding the appropriate criterion of 70 dB(A) if Station/Viaduct/Bridge construction is not further mitigated.

Tsing Yi Tunnels : East Portal Work Site

For this contract, tunnel construction noise will be dominated by three main activities. These are site clearance, access road construction and spoil removal/tunnel construction. Site clearance and access road construction must precede spoil removal and tunnel construction and so cannot be assessed in combination.

Site clearance is likely to involve an excavator for levelling activities, a loader for collection of material, and a truck for transfer purposes. Topsoil collected during this stage will be stockpiled on site for reuse as backfill. Construction plant will tend to move as a team around the site. Access road construction was assessed by evaluating the likely PME which would be used for removing spoil plus the plant necessary for concrete mixing, laying, and setting.

The removal of blasting spoil and rubble will move spoil from the tunnels to an above ground worksite, at the portal, and so will include surface construction PME such as trucks, cranes and generators which will be capable of causing disturbance to nearby NSRs. Construction noise for these 'mucking out' operations will be dominated by truck traffic which will be used to transport the spoil away from the worksite to the appropriate disposal area. The predicted noise levels for each phase of construction at the NSRs are shown in *Table B5.5j*.

Table B5.5j *East Portal Work Site Construction Noise Levels (dB $L_{Aeq, 30\ min}$)*

Noise Sensitive Receiver	Site Clearance	Access Road Construction	Spoil Removal/ Tunnel Construction
School at Cheung On Estate	69	71	70
Cheung On Estate	71	73	72
Tsing Yi Estate	64	66	65
School at Tsing Yi Estate	66	68	67
Feng Shue Wo	67	69	68
Tsing Yan	63	65	64
Tsing On	68	70	69
Cheung Hang Estate	68	70	69
Ching Wah Estate	56	58	57
Liu To	57	59	58
Ngau Kok Wan	52	54	53
Yau Kom Tau	55	57	56
Cheung Shue Tau	60	62	61
Ting Kau	53	55	54

These results indicate that construction activities are likely to produce significant impacts at NSRs during the evening and night.

Cumulative Impacts from Other LAR Contracts

The NSRs which have the potential for cumulative impacts from Tsing Yi Tunnel construction and Tsing Yi Station/Viaduct construction are the westernmost building of Cheung On Estate, Cheung Hang Estate, Tsing Yi Estate, Tsing On THA and Feng Shue Wo THA. These buildings may suffer cumulative impacts during the daytime and evening (no night-time work is planned) as Station/Viaduct construction has the potential for generating impacts above 65 dB(A), unmitigated, at the NSRs. Mitigating both construction operations will allow the NSRs to be protected from excessive disturbance.

Operational Impacts

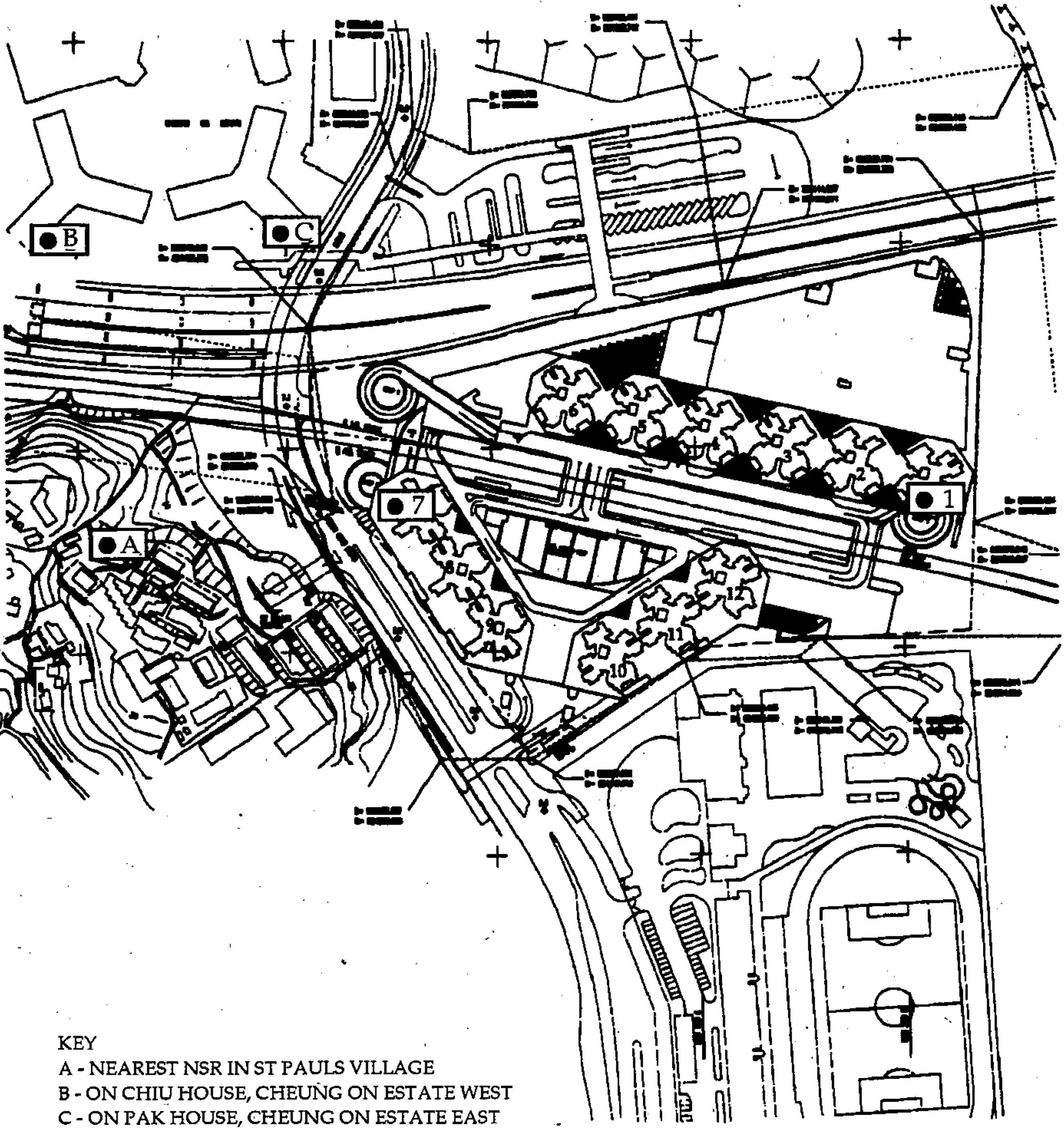
Specific details of the modelling of this section of the LAR include:

- The screening offered by the viaduct structures supporting the four LAR lines and the two turnout lines (as depicted in Ove Arup and Partners drawings dated November 1992) on noise emissions from any one line.
- The screening offered by the cover to the upper lines as they leave the station, extending to the edge of the station podium.
- Type 1, 1.4 m reflective barriers are included on both sides of all lines, in all barrier scenarios, as these will be offered by the standard viaduct design.

The screening offered by Tsing Tsuen road has not been modelled, but as this will only be significant for low level receivers in the Cheung On Estate, where noise levels are lower as a result of substantial screening from wayside noise barriers, this is not considered an unreasonable approximation. Re-radiated noise is calculated from the assumption that its level will be equal to the unscreened air-borne noise level minus 9 dB(A), as discussed earlier.

Figure 5.5a shows the locations used for the prediction of train noise from the Tsing Yi viaduct.

Table B5.5k gives the predicted levels of re-radiated and air-borne noise, and their total at each NSR. For residential towers, where a range of receiver heights exists, noise levels are reported for three receiver heights; 35th, 19th and first floor. The predicted noise levels are separated by commas and are given in the above order. Where a single noise level is given, it applies to the worst case, highest receiver location. At St. Paul's village (which comprises only low rise residential buildings) only the worst case, top floor, noise levels are reported.



KEY
A - NEAREST NSR IN ST PAULS VILLAGE
B - ON CHIU HOUSE, CHEUNG ON ESTATE WEST
C - ON PAK HOUSE, CHEUNG ON ESTATE EAST
1 - TOWER 1 TSING YI STATION
7 - TOWER 7 TSING YI STATION

FIGURE B5.5a - NSRs AROUND TSING YI STATION

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

Table B5.5k Facade Noise Levels (0630–0700) for the 86 dB Train (dB $L_{Aeq,\ 30\ min}$)

NSR	Type 1 barriers(2)	Type 2 barriers(3)	Type 2a barrier (4)
St Paul's village			
Air–borne noise	61	59	55
Re–radiated noise	56	56	56
Total	62	61	58
On Chiu House, Cheung On Estate			
Air–borne Noise	60,57,51	59,55,48	58,55,50
Re–radiated noise	51,52,52	51,52,52	51,52,52
Total	61,58,55	60,57,53	59,57,54
On Pak House, Cheung On Estate			
Air–borne noise	57,55,50	56,54,46	58,54,48
Re–radiated noise	49,49,49	49,49,49	49,49,49
Total	58,56,52	57,55,51	57,55,52
Tower 7, Tsing Yi Station			
Air–borne noise	49,52,55	49,52,54	49,51.53
Re–radiated noise	40,43,46	40,43,46	40,43,46
Total	50,52,55	50,52,55	49,52,54

Notes:
(1) Levels to the nearest dB may lead to apparent discrepancies in summing contributions.
(2) Type 1, standard 1.4 m parapet barrier along both sides, full length, of all viaducts .
(3) Type 2, 1.4 m barrier with acoustic treatment, extending from station to pier 6 (180 m).
(4) Type 2a, 3.8 m barrier extending from station to pier 6 (180 m).

In addition to the four nearest NSRs covered above, train noise predictions were made at Broadview Gardens and On Tao House, Cheung On Estate which are further from the LAR alignment. It was found that with the mitigation required for the four NSRs covered in *Table 5.5k* the predicted train noise levels would be no higher than $L_{Aeq,\ 30\ min\ (2300-0700)}$ 55 dB at Broadview Gardens, and $L_{Aeq,\ 30\ min\ (2300-0700)}$ 59 dB at On Tao House.

B5.6 *TSUEN WAN DISTRICT*

B5.6.1 *Lantau Fixed Crossing*

Construction Impacts

As this section of the LAR will be entrusted works, no new noise predictions have been made for the construction phase of this contract. The relevant predictions made in previous studies are discussed in the following section on the evaluation of impacts.

Operational Impacts

Noise levels were predicted for the two elevated structures in previous studies (see *Section 3.8.5*). Computer modelling showed, that in terms of the $L_{Aeq, 24 hr}$, noise levels from the two structures would be as follows:

- Kap Shui Mun Bridge – approximately 2 dB(A) higher than from track at grade; and
- Ma Wan Viaducts – approximately the same as from track at grade.

The predicted night–time noise levels ranged between $L_{Aeq, 30 min}$ 57–65 dB depending on the distance of the NSR and the screening of the air–borne noise path offered by the bridge structure. Unavoidable approximations and assumptions in the calculations were stated and it was estimated that these could imply errors in the predicted levels of a few decibels.

The predicted levels are above the requirements of the Noise Control Ordinance but it was concluded that the levels were far lower than they might have been, with $L_{Aeq, 24 hr}$ levels up to 14 dB lower than if the hypothetical structures considered in previous reports had been built.

B5.6.2 Lantau Tunnels

Construction Impacts

For this contract two construction operations were evaluated. These were tunnel construction and related activities and ventilation building construction.

Tunnel Construction

Tunnel construction noise was assumed to be dominated by the removal of spoil and activities at the portal site. As the majority of blasting activities associated with the tunnel will be at a depth of more than several metres underground and no blasting activities will take place directly beneath an NSR, it was assumed that blasting impacts would not be significant.

The removal of blasting spoil and rubble will move spoil from the tunnels to an above ground worksite, at the portal, and so will include surface construction PME such as trucks, cranes and generators which will be capable of causing disturbance to nearby NSRs. Construction noise for these 'mucking out' operations will be dominated by truck traffic which will be used to transport the spoil away from the worksite to the appropriate disposal area.

Ventilation Building Construction

Ventilation building construction noise was assumed to be dominated by three main activities. These were excavation of the foundations, bored piling of the foundations, and building erection.

The worst case for noise impacts at the village exists if both spoil removal construction and ventilation building construction occur simultaneously.

Table 5.6a below shows this worst case by assessing the spoil removal/tunnelling construction activity acting in parallel with each of the ventilation building construction activities.

Table B5.6a ***Spoil Removal and Ventilation Building Construction Noise Levels (dB(A))***

Noise Sensitive Receiver (NSR)	$L_{eq, 30 min}$ at the facade of NSRs:		
	Excavation	Piling	Building Erection
Tsing Chau Tsai	82	82	83

The table indicates that the proposed construction activities singly or in combination have the potential to produce severe impacts at NSRs in the Tai Tsing Chau area, however, Tsing Chau Tsai village will have been relocated before the start of construction work and therefore no impacts are expected.

Construction Traffic

It has been estimated that a peak level of 600 m^3 per day of spoil will be generated by work in the tunnels. Removal of this spoil would require approximately 60 truckloads per day, or assuming a 24 hour day, roughly three vehicles per hour. Using the methodology outlined in **Section A.3.4.2 of BS 5228:Part1:1984 for the assessment of mobile plant on haul roads,** it is predicted that the peak truck traffic noise levels at Tsing Chau Tsai Village would be 55 dB(A). In the light of this low level impact, there would be no significant increase to the predicted construction noise levels at the village from the addition of noise from construction truck traffic.

Operational Impacts

No impacts are predicted during the operational phase.

B5.7 Islands District

B5.7.1 Lantau Formation and Viaducts

Construction Impacts

As this section of the LAR is entrusted works, no new noise predictions have been made for the construction phase of this contract. The relevant predictions made in previous studies are discussed in the following section on the evaluation of impacts.

Operational Impacts

For most of the LAR formation the AEL and LAL lines follow the same course. The impacts at Tung Chung have been considered separately as the AEL and LAL lines follow different routes, these are discussed in *Section B5.7.3* below.

Train speed profiles, supplied by MTRC have been used to establish the likely speed of trains. At Yam O, AEL trains will pass through the area at approximately 137 kph, whereas LAL trains stopping at Yam O station will not reach speeds above 100 kph in the area.

The headland on which Luk Keng Tsuen village is situated has been modelled to account for topographical screening effects, and two NSRs are considered, A and B at the East and West of the village.

In Yam O the barrier modelled is approximately 1 km long and would extend West from Yam O station located on the North side of the northern line. The NSR locations are shown in *Figure 5.7a* and the results are given in *Table B5.7a*.

Table B5.7a ***Predicted Facade Noise Levels (0630–0700) for the 86 dB Train (dB $L_{Aeq, 30 min}$)***

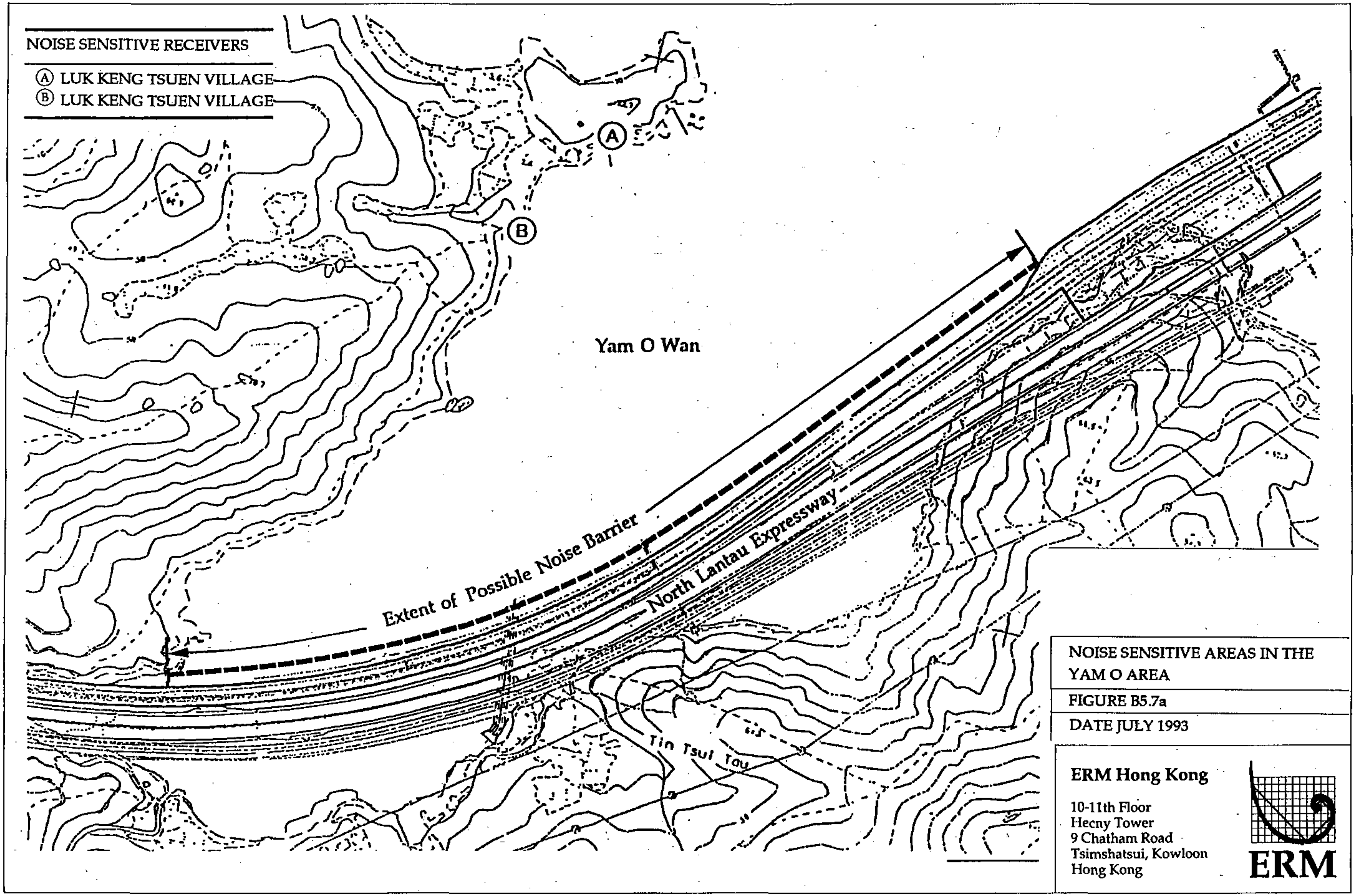
Noise Sensitive Receiver	No Barrier	200 m Type 1 Barrier(1)	1 km Type 1 Barrier(1)	1 km Type 2 Barrier(1)
Luk Keng Tsuen Village				
NSR A	58	58	56	54
NSR B	59	58	57	55

Notes: (1) 1.4 m reflective barrier on the North side of the northern line.
(2) 1.4 m absorptive barrier on the North side of the northern line.

At Tai Ho Wan five planned noise sensitive development sites, and the existing Pak Mong Village have been assessed for train noise impacts (see *Figure 5.7b*). Since the development of the planned sites is not scheduled until 2011 there are currently no indications of the site layouts that will be adopted for each.

However, a preliminary assessment has been carried out assuming that the recommendations of the NLD Study (**TR20 Report**) are implemented to mitigate road traffic noise from the NLE. This report recommends road barriers, a low noise road surface for the NLE in this area, and a set back distance of 176 m for all sensitive development.

Worst case preliminary predictions of train noise have been made for these locations assuming 40 storey (110 m high) standard cruciform residential towers are built exactly on this set back line within each site with no screening from the LAR. These preliminary predictions should be revised when site layout information becomes available for these sites.



NOISE SENSITIVE AREAS IN THE YAM O AREA

FIGURE B5.7a

DATE JULY 1993

Predictions at existing NSRs in Pak Mong village assume the highest existing building to be 15 m above reclamation level with a greatly restricted angle of view of the railway between two berms. The predicted levels are given in *Table 5.7b*.

Table 5.7b *Predicted Facade Noise Levels (0630 to 0700) for the 86 dB train (dB $L_{Aeq, 30 min}$)*

Area/ NSR	Landuse	Distance from LAR	No barriers	Barrier type recommended (performance)	Indicative barrier length required (m)
14	RS (residential	240	62(1)	Type 1 (3 dB)	300
15	HOS (residential)	240	62(1)	Type 1 (3 dB)	600
18	R2 (residential)	150	64	Type 2a (5 dB)	300
22	HOS (residential)	150	64	Type 2a (5 dB)	500
27	CR (residential	120	65	Type 2a (5 dB)	600
32	village (residential)	450	55 (1)	None	

Note: (1) No screening effects from NLE assumed.

These preliminary barrier recommendations would imply Type 1 barriers to the south of the lines from about 200 m east of the NLE interchange to about 700 m to west and Type 2a barriers to the north of the lines from about 100 m east of the interchange to about 1300 m to the west.

The planned Pak Mong village expansion area (area 32) could include low rise residential buildings as close as 370 m from the LAR. Being low rise, they are likely to benefit from acoustic screening from the NLE structure, and it is unlikely that levels above $L_{Aeq, 30 min}$ 55 dB will result.

B5.7.2 *Siu Ho Wan Depot*

Construction Impacts

Construction noise for this contract will be dominated by three main activities. These are overhead line mast erection, concrete grade separator construction and construction of the main depot building.

The overhead line mast construction noise will be dominated by PME needed for excavation and the laying of concrete while the concrete grade separator construction noise will be dominated by PME associated with the mixing, laying and settling of concrete.

Depot building construction noise will be dominated by the building erection phase which will incorporate trucks, cranes and concrete mixing and laying equipment.

Noise impacts for the NSRs will first be evaluated for each separate construction activity and then for the combined effect of all operations occurring simultaneously. These are shown in *Table B5.7c*. For this assessment the following SWLs were assumed for the three major construction activities:

- Overhead Line Mast Erection: 119 dB(A);
- Grade Separator Construction: 117 dB(A);
- Building Erection: 125 dB(A).

Table B5.7c *Facade Noise Levels (dB LAeq, 30 min)*

Noise Sensitive Receiver	Overhead Line Mast Erection	Grade Separator Construction	Building Erection	Combined Impact
Tai Ho Wan Temple[1]	46	45	50	52
Tin Liu Village	51	51	56	58
Pak Mong Village	52	49	56	58
Ngau Kwun Long Village	51	50	55	57
Tai Ho San Tsuen Village	50	49	54	56

Note: (1) All results include a barrier correction of 10 dB for attenuation due to topography.

The noise levels predicted above indicate that there will be no exceedence of the NCO limits during the proposed working period of 0700–2300 seven days a week.

Operational Impacts

The prediction of noise levels from trains in the depot fan area is inherently difficult because of the uncertainty in the levels of noise from wheel squeal. One possible approach is to use measured data from an existing depot to establish the source terms for wheel squeal. However, this approach was not considered reliable in this case because the engineering design of the track and rolling stock will be new, and measured data from older designs could be misleading. Instead a theoretical modelling method has been used.

The operating conditions have been used in Ashdown Environmental Ltd's TNPM for the depot track fan and stabling area to predict the levels of train noise expected at each of the three NSRs. Since there are several possible methods of mitigating wheel squeal the levels are predicted with and without wheel squeal noise.

The corrections for wheel squeal have been modelled with reference to the research of R Lotz [1] and are applied as follows:

(1) Lotz, R Railroad and Rail Transit Noise Sources, Journal of Sound and Vibration (1977) 51(3), 319–336.

- curve radius >274 m : no correction;
- curve radius 183 m – 274 m : +10 dB(A); and
- curve radius <183 m : +20 dB(A).

Three planned development sites containing sensitive landuses around the depot have been considered as the NSRs most likely to be impacted. These are shown on *Figure 5.7b.*

The results obtained for the 86 dB train, assuming each receiver includes a facade directly facing the track fan area with an unobstructed view, are given in *Table B5.7d.*

Table B5.7d ***Predicted Noise Levels for Train Movements Within The Depot Track Fan and Stabling Areas***

NSR	Without Wheel Squeal		With Wheel Squeal	
	$L_{Aeq,\ 0100-0130}$ (dB)	$L_{AMAX,F}$ (dB)	$L_{Aeq,\ 0100-0130}$ (dB)	$L_{AMAX,F}$ (dB)
A Residential, area 27	47	49	56	68
B Residential, area 14	44	47	48	62
C. School, area 29[1]	49	52	59	72

Note: (1) Daytime occupation only.

Noise levels in the busy night–time period (0100–0130) will be above $L_{Aeq,\,30\,min}$ 50 dB and, $L_{AMax,\,F}$ 60 dB if wheel squeal occurs as predicted with no mitigation. However, mitigation in the form of laminated train wheels and track lubrication will reduce wheel squeal noise. If wheel squeal can be completely mitigated, noise levels at NSR A will be close to $L_{Aeq,\,30\,min}$ 50 dB with L_{AMax} levels 2 to 3 dB higher. The noise levels at other times of the night will be considerably lower, than these due to the comparatively minor level of train movement activity at other times.

Noise levels from other sources within the Depot site are predicted and assessed together in *Section 6.*

B5.7.3 *Tung Chung Station and Tunnels*

Construction Impacts

Station Construction

As this station will be built on reclaimed land, the construction procedure for Tung Chung Station has been assumed to be the same as that outlined for Kowloon Station (see *Section B5.2.1*).

Cut and Cover Tunnel Construction

Cut and cover tunnel construction noise will be dominated by four main activities. These activities are access road construction, excavation, piling of the foundations and backfilling over the fabricated tunnel sections.

Access road construction, the excavation process and piling were all assessed as in the station construction section, though on a different scale due to differences in the shape of the worksite and scale of the project. The backfilling operation was evaluated by modelling PME of a similar nature to those employed in the excavation process.

The worst case for noise impacts at the Youth Camp will be when both station construction and tunnel construction occur simultaneously. *Table B5.7e* shows this worst case by assessing the noisiest station construction activity, station box construction, acting in parallel with each of the cut and cover tunnel construction activities.

Table B5.7e ***Cut and Cover Tunnel Construction and Station Construction Noise Levels at NSRs (dB $L_{Aeq, 30min}$)***

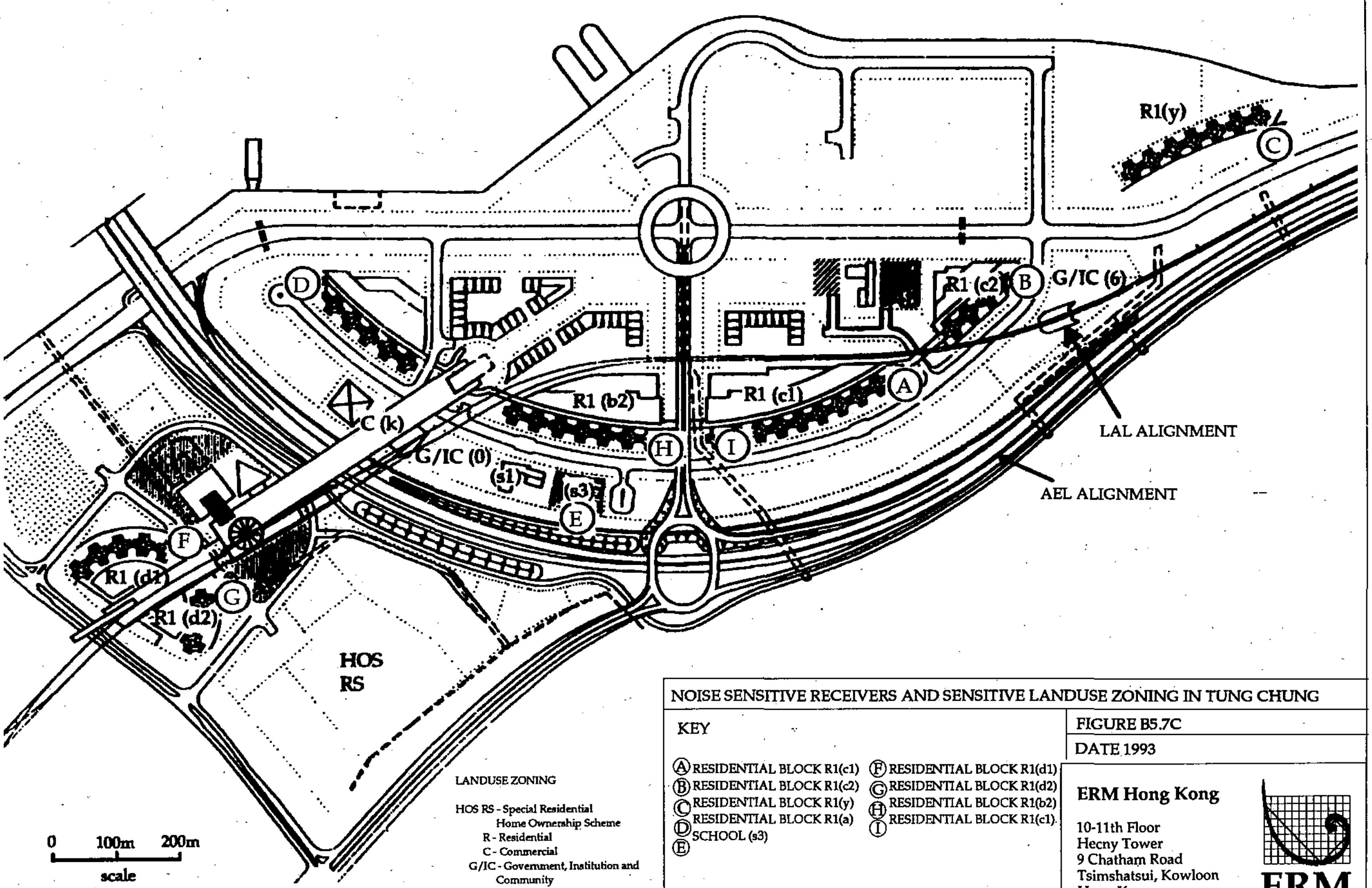
Noise Sensitive Receiver	Construction Activity			
	Access Road Construction	Excavation	Piling	Backfilling
Youth Camp	71	72	72	71

Operational Impacts

Of the large number of NSRs discussed in *Section 2.7* nine have been selected for the prediction of train noise in Tung Chung new town. These are shown in *Figure 5.7c*. Area R1(y) to the east of the LAL portal, is proposed for residential use although the layout of seven towers, as shown in *Figure 5.7c*, is provisional only. Hence two cases have been studied, with and without these seven towers, so as to recommend provisional mitigation measures for site R1(y) that should be allowed for, and re-assessed once details of the site layout are available.

A preliminary assessment has also been completed for the HOS RS site to the east of the LAL station, based on a site layout that adopts the recommendation of the NLE EA ie a 136 m setback from the NLE for all noise sensitive uses. A detailed assessment should be completed once information on the proposed site layout is available.

The Tung Chung Town Centre Study proposed that additional mitigation of traffic noise should be achieved, at the 34 residential towers facing the NLE, by protecting the windows of the tower wings facing the NLE with noise barrier fins, or by keeping openable windows away from these facades. As



LANDUSE ZONING

HOS RS - Special Residential Home Ownership Scheme
R - Residential
C - Commercial
G/IC - Government, Institution and Community
S - School

NOISE SENSITIVE RECEIVERS AND SENSITIVE LANDUSE ZONING IN TUNG CHUNG

FIGURE B5.7C

DATE 1993

KEY

A RESIDENTIAL BLOCK R1(c1)
B RESIDENTIAL BLOCK R1(c2)
C RESIDENTIAL BLOCK R1(y)
D RESIDENTIAL BLOCK R1(a)
E SCHOOL (s3)
F RESIDENTIAL BLOCK R1(d1)
G RESIDENTIAL BLOCK R1(d2)
H RESIDENTIAL BLOCK R1(b2)
I RESIDENTIAL BLOCK R1(c1)

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

details of this design are not yet finalised, it has been assumed that no openable window in the nearest wing of these 34 towers to the NLE will face the NLE (and therefore the AEL lines), and the worst affected facades will be those of the recessed units with facades parallel to the AEL alignment. These recessed units will have a reduced angle of view of the AEL due to screening by the adjacent wings of the towers.

For the eight towers near the LAL station it has been assumed that such a restriction will not be needed, since these towers are further from the NLE, and the worst case facades have been assessed.

Not all facades of the schools will be sensitive to noise (ie have openable windows). The western school will have a sensitive facade facing the railway, while the eastern school will not. Only sensitive facades have been modelled. In assessing the mitigation required for the schools, consideration is given to the train pass by L_{AMax} as well as the $L_{Aeq, 30\,min}$ noise level (this is discussed further in *Section 6.7*)

In Tung Chung, AEL trains will be travelling at approximately 135 kph through the town area, whereas LAL trains in the vicinity of the tunnel portal at the East end of the town will be travelling at approximately 115 kph.

Specific details of the modelling of these sections of the LAR include the following factors.

- The orientation of noise sensitive facades is assumed to be as discussed above.
- Possible screening effects from the hill to the west of the NLE Interchange are ignored, as a worst case assumption, in the absence of engineering drawings of the railway cutting.
- Predictions have not been made at ground floor receivers due to uncertainty in the detail of the intervening ground and the ground absorption and screening effects that could result. Low level receivers are in no case the worst affected NSRs, as the attenuation of wayside noise barriers and other screening effects always reduced at higher levels.
- The bund to the South of the NLE, West of the NLE interchange was modelled as 6 m high.
- The bund to the North of the NLE, West of the NLE interchange was modelled as 10.5 m high.
- The AEL will run in a tunnel approximately 110 m in length under the NLE Interchange.
- Residential towers were assumed to be 38 floors high, and the schools are assumed to be 6 storeys high.

- The contribution of train rolling noise reflected off of a noise barrier behind a train is not considered to be significant since the train itself will offer effective screening of the reflected noise.

The LAL tunnel portal is assumed to rise from a level of –0.5 m PD at the tunnel portal to grade (+7.0 m PD) 350 m after exiting the portal. Noise barriers on the LAL have been modelled 5000 mm from the point midway between the LAL up and down lines. It is assumed that the horizontal alignment of the tracks cannot be adjusted, and that because of the proximity of the LAL to the AEL lines East of the portal it is not possible to consider extending the tunnel eastward. For this reason enclosures extending eastward from the tunnel portal have been considered.

Because of the complexity of the possible barrier options that have been considered, in addition to the no barrier unmitigated case, an optimised barrier scenario is reported. The results are given in *Table 5.7f*.

The optimised barrier scenario comprises the following barriers (mitigation for the case including site R1(y) is given in brackets). Barrier lengths reference to the NLE interchange, are measured from the central north/south axis of the interchange:

- A Type 2b, 3.8 m high absorptive barrier on the northern side of the AEL Down line (the northern of the two AEL lines) from the southern end of the Sea Channel Bridge (approximately 900 m from west of the NLE Interchange) to 950 m east of the NLE interchange (extended to 1250 m from interchange for site R1(y);

- A Type 2, 1.4 m high absorptive barrier on the northern side of the AEL Up line from the southern end of the Sea Channel Bridge (approximately 900 m from west of the NLE Interchange) to 950 m east of the NLE interchange (extended to 1250 m from interchange for site R1(y);

- A 260 m long enclosure over the AEL lines from 120 m west of NLE Interchange to 380 m west of that point;

- A 6 m high enclosure over the LAL lines extending for 220 m to the east of the LAL tunnel portal (extended to 550 m from the portal for site R1(y);

Barriers are located 2600 mm from the centre line of the nearest track. It is understood that there is adequate space provision to accommodate a central barrier between the AEL lines.

Table 5.7f gives the modelling results. The noise levels given are for the mitigation measures described in the barrier scenarios above, excluding the provisional barriers recommended for Site R1(y). The noise levels with the additional mitigation measures for Site R1(y) are given in brackets. The noise levels at 19th and 38th floors are given respectively, separated by a comma, for the worst case facade (as discussed above) for each NSR. Predictions at two facades of NSR B are given for additional information.

Table 5.7f *Predicted Facade $L_{Aeq,(0630\ to\ 0700)}$ for the 86 dB train (dB)*

NSR	No Barriers	Barrier Scenario
A	63,63	56,59
B1 western wing	63,63	55,58
B2 eastern wing	66,65	58,60 (54,56) (2)
C	67,66	(59,59) (2)
D	63,62	58,59
E1 Secondary school(1)	74 L_{AMax} 88	41 L_{AMax} 68
E2 Primary School(1)	74 L_{AMax} 88	48 L_{AMax} 73
F	58,57	58,57
G	56,56	56,56
H	63,62	52,56
I	63,63	57,59

Notes: (1) Top floor, peak Daytime levels calculated from peak daytime headways.
(2) Noise levels in brackets are with provisional mitigation measures for site C included.

The optimisation of the barriers was carried out to achieve noise levels that just meet the required criteria. In optimizing the length of the enclosure over the AEL lines that will protect the schools the appropriate criteria were an $L_{Aeq,30\ min}$ of 65 dB and an L_{AMax} level of 70 to 75 dB (see *Section 6.7.3*). In this case, the L_{AMax} criterion proved to be more stringent than the L_{Aeq} criterion.

The preliminary predictions for the HOS RS site gave noise levels of below $L_{Aeq,30\ min}$ 60 dB for 0630–0700, suggesting that the barriers included for traffic noise mitigation and train noise mitigation to the other sites would be provide adequate mitigation of train noise to this area.

The location of the Youth Camp is such that the AEL lines are about 180 m away, and are behind a 10.5m traffic noise barrier, or within a tunnel under the NLE interchange, at their closest approach to the Youth Camp. Train noise impacts are not expected at the Youth Camp.

B5.7.4 *Airport Works*

Construction Impacts

As with the previous sections of the LAR where construction will be entrusted, no new noise impact predictions have been made. The results from existing studies are reviewed in the following section.

Operational Impacts

Noise at NSRs in Tung Chung, from trains passing on the Chek Lap Kok Bridge will add to the noise levels produced by trains on the AEL within Tung Chung new town. This section of the AEL alignment has been modelled as a whole and the results are given in the section above.

B6.1 CENTRAL AND WESTERN DISTRICT

B6.1.1 Hong Kong Station and Tunnels

Construction Impacts

Significant construction impacts are expected at United Building from unmitigated daytime (0700-1900) construction operations and, as a result, mitigation measures will be necessary. If evening (1900-2300) or all day on general holiday (0700-2300) construction is required then severe impacts are expected at United Building from unmitigated construction activities. If night-time (2300-0700) construction is required at the station worksite, significant impacts are expected at the Mandarin, Furama and Victoria Hotels. Impacts are not expected from construction of the tunnels for the subway provided percussive piling is not used. Mitigation measures are therefore necessary for construction activities for all parts of each day.

Significant impacts from percussive piling on the station site boundary are expected at Exchange Square, General Post Office, Hang Seng Bank New Headquarters, Harbour Building, United Building and Connaught Centre. Percussive piling is expected to occur close to Exchange Square. Vibration levels from such an activity are likely to produce significant impacts upon the occupants of offices and other internal areas. Mitigation measures are therefore necessary to limit vibration impacts.

The waste assessment for the LAR EIS provided an assessment of likely construction traffic required to transport spoil and other materials from the station worksite. This study predicted 200 lorry movements per day. Traffic noise levels in Central are already high, however, noise levels from such a large flow of construction vehicles may have the potential to produce significant impacts at NSRs in this area. It is therefore recommended that all spoil from this worksite is moved by barge rather than by lorry.

Operational Impacts

It is assumed that the design of the station will incorporate measures which will safeguard against noise impacts to the development situated on the station roof.

Ground-borne Noise

There are no legal limits or guidelines for acceptable levels of ground-borne noise in buildings in Hong Kong. Trains passing under the commercial development on the C1 site will be moving at speeds no greater than approximately 60 kph as they brake into, or accelerate out of, the station. The track mounting system in the tunnels will be as for the immersed tube tunnel, the Sonneville twin block system, as discussed in *Section 3.8*. In view of the maximum speed of trains passing under the development, and the mitigation offered by the proposed track mounting system, it is considered unlikely that significant impacts will result from the movement of trains between the station and the sea wall.

Noise From Fixed Plant

At this stage of the study, there is insufficient information available about the types and SWLs of any equipment which may be used at these locations. Therefore, an alternative approach has been adopted by attempting to identify the maximum acceptable SWL for plant, given the location of the source and its juxtaposition to NSRs.

The NSRs considered in relation to this were:

- *The Victoria Hotel at the Macau Ferry Terminal*: This is situated approximately 200 m from the Ventilation Building.
- *Government Offices at Rumsay Street*: Located approximately 175 m from the Ventilation Building and the heat exchanger/chiller plant.
- *Government Offices at the Harbour Building*: Located approximately 100 m from the Ventilation Building and the heat exchanger/chiller plant.
- *Planned commercial Development on site C1*: Located at approximately 200 m from the planned pumping station.

At these distances, and assuming low resistance openings in the facades of plant buildings facing the NSRs, it is estimated that a SWL of 100 dB(A) would be allowable before noise impacts in excess of the criteria set out in the NCO would be experienced at any NSR. Depending on the exact location and the design of the plant facilities SWLs up to 115 dB(A) may be acceptable in some cases, but a detailed assessment would be required to show compliance with the NCO.

Noise From Station Activities

Since the future noise levels in the area around the station are expected to be high, due predominantly to traffic noise, it is unlikely that noise generated by activities associated with the operation of the station will cause significant noise impact here or at any of the LAR stations.

B6.1.2 Immersed Tube Tunnel

Construction Impacts

The worst case maximum sound pressure level at the facade of Victoria Hotel, as a result of dredging activities, is predicted to be 75 dB(A). This noise level is equal to the daytime (0700–1900) construction noise criteria and above the evening (1900–2300) and night–time (2300–0700) criteria, thus significant impacts are expected during the evening and during night-time hours at Hotel Victoria.

Operational Impacts

The passage of LAR trains through the immersed tube tunnel is unlikely to result in any significant noise impacts because of the absence of any NSRs above the alignment and the lack of an efficient sound transmission path to land based NSRs. Furthermore, the proposed Sonneville twin block track mounting system will ensure that impacts from ground-borne noise, as sometimes experienced in buildings above shallow railway tunnels, will be avoided for future NSRs beyond the northern and southern ends of the tunnel.

B6.2 *YAU TSIM DISTRICT*

B6.2.1 *Immersed Tube Tunnel*

Construction Impacts

During dredging activities the predicted maximum sound pressure level at the facade of the Cultural Centre is 55 dB(A). This noise level is equal to the night-time criteria discussed in *Annex A*, thus no significant impacts are expected at this NSR.

Operational Impacts

No significant noise impacts are predicted during the operational phase.

B6.2.2 *Kowloon Station and Tunnels*

Construction Impacts

At those NSRs where both station and tunnel construction activities can impact simultaneously, the noise levels are predicted to be at worst 2-3 dB(A) below the acceptable daytime (0700-1900) limit of $L_{Aeq, 30min}$ 75 dB. As a result no noise mitigation measures, beyond good construction practice, are recommended for this contract.

Operational Impacts

It is assumed that the design of the station will incorporate measures to prevent structure borne vibration impacts from affecting the roof-top development.

Ground-borne Noise

In view of the maximum speed of trains passing near the development, the minimum separation distance of 40 m, the ground attenuation likely in reclaimed ground, and the mitigation offered by the proposed track mounting system, it is considered unlikely that significant impacts will result from the movement of trains between the station and the sea wall.

Noise From Fixed Plant

A noise impact assessment was carried out by Arup Acoustics for the proposed residential and commercial development above Kowloon Station and a report was produced in March 93.

Regarding the air-borne noise sources, residential blocks above the station top development are identified to be the nearest sensitive uses of concern. In the report, an ASR of "B" was assigned in accordance with the **Technical Memorandum on the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites** (TM3), giving an Acceptable Noise Level (ANL) for the operation during the night-time period of 55 dB(A). In order to achieve this level, an allowable overall noise level of 68 dB(A) at 1 m from the ventilation openings was recommended based on the following assumptions:

- 5 dB(A) margin for planning under HKPSG;
- 3 dB(A) correction for tonality;
- air vents at distance of 22-44 m from nearest residential flat; and
- equal contributions from the major sources.

Absorption treatments were recommended to reduce the reverberant noise level in the plantroom. Recommendation for wall and ceiling treatment was 100 mm thick fibreglass linings with perforated galvanised iron cover sheet, a minimum density of 40 kg m^{-3} was required for wall linings. Fitting of acoustics shrouds at cooling air intakes of motors was also recommended.

A number of recommendations on plant vibration control were also made. For vibration isolation of the chillers, pumps and associated pipework services, the following recommendations were made:

- Pumps - inertia base with a mass ratio (base to pump) of 1.5 minimum with anti-vibration steel spring mountings;
- Chillers - isolated with steel spring and neoprene; and
- Steel springs with a minimum static deflection of 25 mm.

Particular concern was also raised for the pump rooms located below the podium of each residential tower block and the following recommendations were made:

- Pumps - inertia bases and flexible pipe connectors;

- Vertical pumps - 200 mm thick concrete inertia base on steel spring mountings, or 300 mm floating inertia base on kinetic glass fibre pads; and

- Water valves - quiet valve types should be used and provision should be made for retrofitting with pressure reducing valves if necessary.

B6.2.3 *Kowloon to Tai Kok Tsui Tunnels*

Construction Impacts

Predicted noise levels at the Hoi King Street residential blocks, for construction activities associated with excavation work, will equal the daytime (0700–1900) noise criterion, $L_{Aeq, 30min}$ 75 dB. Noise impacts at the other NSRs have been predicted to be generally more than 5 dB(A) below the acceptable daytime noise limit.

Cumulative impacts from Kowloon Station and Tunnels in concert with the Kowloon to Tai Kok Tsui Tunnels have the potential for creating higher noise levels at the Man Wui and Man Cheong Street Residences. In the worst case (station box construction at Kowloon Station coinciding with either excavation or piling activities at the cut and cover tunnels), construction noise levels are predicted to equal 75 dB(A) at the Man Wui and Man Cheong Street Residences. As a result, standard mitigation measures should be employed to protect residents against excessive noise levels.

Operational Impacts

Ground Vibration

The short section of the open lines between the tunnel portal and Tai Kok Tsui station will either use the Sonneville track mounting system or ballasted track.

Both the Sonneville system and ballasted track offer good isolation of train vibration from the ground below. Being on reclamation, the ground will comprise sandy gravels and fill material whose granular composition typically dampens ground vibration far more effectively than solid rock. Furthermore the alignment is a minimum of 50 m from the nearest NSR. It is therefore considered unlikely that ground–borne vibration will reach levels sufficiently high to have significant impacts on the adjacent land uses of the TKTSRD Site B or the other proposed landuses immediately to the south of that site.

Train Rolling Noise

No exceedence of the assessment criteria is predicted, implying no significant impacts from train rolling noise.

Fixed Plant

The ventilation building will be located at the highway reserve of the planned main Route 3 interchange at Yau Ma Tei. Within 100 m of this location the only alternative landuse will be the following which will be south of TKTSRD Site B:

- an indoor recreation facility (at WKR site S4.1);

- a multi-storey carpark (at S4.2); and
- a neighbourhood community centre (at S4.3).

These premises are not generally regarded as noise sensitive uses and will not imply any restrictions on noise emissions from the ventilation building.

The nearest residential tower in TKTSRD Site B will be about 180 m from the ventilation building. Potential impacts from noise emission from the ventilation shafts can be evaluated by considering the allowable noise level at this tower given by the ANLs in accordance with TM3. The concerned sensitive user will also be directly affected by traffic noise from the WKE, and taking an ASR of "C", the ANLs for the operation in the night-time period will be 60 dB(A). Allowing a 5 dB(A) margin for planning as recommended in the HKPSG, a 3 dB(A) penalty for tonal effects, and 6 dB(A) correction to allow for equal contribution from the four major ventilation shafts, each shaft would be required to achieve a noise level of 46 dB(A) at the nearest NSR.

Using a distance attenuation of 53 dB(A) (assuming hemi-spherical propagation), the maximum equivalent sound power level allowable for each of the ventilation shafts openings is calculated to be 96 dB(A). It is recommended that the shaft openings are orientated away from NSRs. In this way higher sound power levels would be permissible, provided that the requirements of the NCO, as described above, are met.

B6.3 MONG KOK DISTRICT

B6.3.1 Tai Kok Tsui Station

Construction Impacts

As construction work is planned for the period 0800-1800, the applicable noise criterion is the daytime (0700-1900) level recommended by the EPD, which is $L_{Aeq, 30min}$ 75 dB. Noise predictions indicate that only the NSRs in the Cherry Street and Hoi King Street neighbourhoods are expected to receive noise impacts that will not exceed the daytime limit. As a result, mitigation measures are required for the station and the underpass construction activities in order to ensure that the NSRs in the Foo Kwai, Hoi King, and Cherry Street/Hoi King Intersection neighbourhoods are protected from excessive noise levels. The most severe impacts, 10-12 dB(A) above the applicable criterion, are predicted to occur in the Cherry Street/Hoi King Street Intersection neighbourhood.

Cumulative impacts, at the Hoi King residences, from the cut and cover construction operations (Kowloon to Tai Kok Tsui Tunnels) working in concert with the station/underpass construction operations will not be substantially greater than station/underpass construction alone. However, as the noise levels at the Hoi King residences, from cut and cover operations alone, are predicted to be 74 dB(A), the maximum noise levels, at Hoi King Street, from both tunnel and station/underpass operations will each need to be reduced to about 72 dB(A). In addition, the cut and cover operations impacts at the Hoi King Residences need to be reduced to about 70 dB(A) to meet the daytime noise criterion of 75 dB(A).

It should be noted that the development at CDA Site B, adjacent to the station site, will be constructed simultaneously with the station. In its early stages it will add to noise levels at the Hoi King Street residential units, while in its later stages it may act as a screen, reducing station construction noise impacts at these same units.

Operational impacts

Noise from trains within the station is not expected to cause significant noise emissions because all platforms of the station will be fully enclosed.

Fixed Plant

In accordance with TM3, the NSRs will be directly affected by the traffic noise along the WKE, taking an ASR of "C", the ANL for operation during the night-time period will be 60 dB(A).

Regarding the station fixed sources, the allowable noise emission to meet the noise criteria at the nearest Site C Block can be derived based on the following assumptions:

- 5 dB(A) margin for planning under HKPSG;
- 3 dB(A) correction for tonality; and
- equal contributions from two ventilation openings (at about 50 m distance) and four chillers (at about 130 m distance) as the major sources.

It was calculated that the allowable equivalent sound power level for each of the four trackway exhaust fan ventilation openings is 86 dB(A), and that for each of the four chillers is 94 dB(A). Regarding the traction substation, the allowable equivalent sound power level is calculated to be 94 dB(A).

B6.4 SHAM SHUI PO DISTRICT

B6.4.1 Tai Kok Tsui to Lai Chi Kok Formation

Construction Impacts

According to the ARFS, predictions indicate that moderate impacts are expected at Nam Cheong Estate and severe impacts are expected in the Tai Kok Tsui region.

The key predictions for construction noise impacts according to the WKE study were:

- daytime construction activities were predicted to cause minimal noise impacts on the identified NSRs along the waterfront of West Kowloon;

- evening and night-time noise impacts were predicted to be significant at all receivers in the northern section, maximum construction noise levels were predicted to exceed the night-time ANL by 10-15 dB(A) over a substantial period of the construction; and

- major noise sources during construction were identified as the noisy items of plant on site rather than construction traffic.

The most effective single noise control measure was deemed to be the inclusion of noise control limits and the requirements for noise monitoring in the tender and contract documents. It was concluded that Contractors should be required to submit detailed noise mitigation proposals for complying with the noise control limits.

Operational Impacts

The Haking Technical Institute (NSR 26) is assumed to be occupied, and therefore sensitive to noise, only during the day. The predicted daytime noise level of $L_{Aeq, 30\ min}$ 60 dB is below the daytime assessment criterion of $L_{Aeq, 30\ min}$ 70 dB and therefore no mitigation is required. Noise levels at this NSR are also slightly reduced by the mitigation considered for NSR 24, Mei Foo Sun Chuen.

No impacts are predicted at the residential and school sites north of TKTSRD Site C.

Barriers comprising two long lengths of Type 2b barriers extending south from Contract 507 past Mei Foo Sun Chuen, and four 500 m lengths of Type 2 barriers by Nam Cheung Estate, are sufficient to mitigate the exceedances at Mei Foo Sun Chuen and Nam Cheung Estate.

B6.4.2 *Lai Chi Kok to Kwai Chung Road Viaducts*

Construction Impacts

Predictions in the ARFS indicate that moderate impacts are expected at Chan Nam Cheong Memorial School and severe impacts are expected at Winifred Mary Cheung Morninghope School for the Mentally Handicapped. Mitigation of these impacts is the responsibility of Highways Department as these works are entrusted too them.

The noise criteria for the Route 3 report were:

- the daytime general construction noise impact shall be assessed in terms of $L_{eq, 30\ min}$;
- measurements shall be taken at the facades of the nearest NSRs; and,
- noise levels for urban areas shall not exceed $L_{eq,30\ min}$ 75 dB(A).

Noise limit criteria were established for assessing Route 3 construction noise impact based on the baseline noise survey detailed above. The criteria for the NSRs of relevance to the LAR assessment were as follows (the subscript R3 is used to identify the NSR numbering used in the Route 3 EA):

- NSRs 16_{R3} to 20_{R3} and 25_{R3} – 81 dB(A);
- NSR 21_{R3} – 75 dB(A).

No significant noise impacts from the construction of Route 3 were anticipated in this area. This was due to noise limits being set against already high baseline noise levels.

The conflicting recommendations of these two reports, the ARFS and the Route 3 EIA, were due to the use of different baseline noise criteria for the area. The more stringent daytime criterion, 75 dB(A), used in the ARFS, was also used in the current study. As a result, the recommendations of the ARFS were used as a foundation for this study.

Operational Impacts

The Route 3 EA recommended a number of mitigation options that could be incorporated to ensure that no NSRs were predicted to have traffic noise levels in excess of the HKPSG criteria.

The highest (ie at the worst case facade) train noise level predicted at the WMC Morninghope School (NSR 29) is $L_{Aeq, 30\,min}$ (0700–1900) 65 dB. Since this level is below the NCO criterion of $L_{Aeq, 30\,min}$ (daytime) 70 dB no additional mitigation should be required. However, L_{AMax} levels are likely to be up to 80 dB at some windows and may be disruptive to normal classroom activities. It is therefore recommended that additional acoustic insulation and air conditioning (to allow windows to remain closed) would be beneficial.

At block 19, Cho Yiu Estate (NSR 31), for the no mitigation case, noise levels are predicted to be 1 dB above the NCO night-time criterion of $L_{Aeq, 30\,min}$ 60 dB, and hence a degree of mitigation is required. For the Princess Margaret Hospital (NSR 30), Ching Lai Court (NSR 23), and Mei Foo Sun Chung (NSR 24) exceedances of 4–5 dB are predicted.

Implementation of the barrier scenario given in *Table B5.4c* will ensure that no significant impacts will result from train noise.

B6.4.3 Mei Foo Temporary Depot

Construction Impacts

The temporary depot will only be operational during the construction phase of the LAR from August 1995 to mid–1997, it will be used as a base for permanent way and engineering activities. The noise climate during the operational phase of the depot is likely to be dominated initially by construction noise and subsequently by traffic noise from the WKE day and night.

The study of wheel squeal for the Siu Ho Wan Depot indicated that at a distance of 300 m (the minimum distance to the NSR) a noise level of 56 dB $L_{Aeq, 30\ min}$ and 68 dB L_{AMax} could be expected. These levels are within the criteria for daytime and evening work of 75 dB(A) and 70 dB(A) respectively without any additional noise control.

Materials stockpiling and handling, the loading of engineering trains and other open air activities will produce noise levels of a similar magnitude to other general construction activities in the area. They will, however, be of limited duration and frequency and are unlikely to make a significant contribution to the overall noise levels.

It is assumed that deliveries of materials and heavy goods will be limited to daytime hours, and most depot staff will be bussed in or use public transport. The additional road traffic will not be significant when compared to other development traffic and so it is not believed it will cause significant impacts at nearby NSRs. The depot is be considered to be a construction site, and will therefore require a Construction Noise Permit in order to operate in restricted hours.

B6.5 *KWAI TSING DISTRICT*

B6.5.1 *Lai King Station*

Construction Impacts

South Portal Work Site

Some windows of WMC Morninghope School facing Kwai Chung Road will be fitted with secondary glazing (as supplied by others to mitigate existing high levels of traffic noise) prior to construction work on this project . However, it is recommended that all the windows facing the construction site be given secondary glazing prior to the start of construction. The type of secondary glazing to be installed will provide about a 10–15 dB(A) reduction in sound pressure levels inside the school compared to the open window situation. As the day time noise level limit is 75 dB(A), this mitigation measure effectively raises this limit to 85–90 dB(A). If, in addition to secondary glazing, a 3 m hoarding is erected at the boundary of the school to screen all impacts from the direction of Kwai Chung Road, an additional 5 dB(A) of reduction is predicted.

From *Table B5.5a*, it may be seen that the only activity which would not be acceptably mitigated by these two measures would be the 'worst case' for building the caisson wall. Without further mitigation, the facade noise levels at the school during the ground breaking phase of caisson wall construction would be up to 89 dB(A), 4 dB(A) above the effective limit with secondary glazing. Further mitigation is recommended to reduce noise impacts at the school during this activity.

Careful timing of activities and the use of mobile barriers around the caisson hole drilling sites will reduce facade noise levels at the school to acceptable levels for all phases of construction. The barriers are described in *Section 7.5.1* and will be noted in the particular specification for the work.

The use of hand held breakers to form the caisson wall at the top of the South Portal worksite may be a source of significant ground vibration. Whilst this vibration may, on occasions, be perceptible in WMC Morninghope School, it will offer significantly less impact to the occupants of the school than if a large diameter piling rig or large pneumatic/hydraulic breaker were used.

The predicted noise levels at Chan Nam Cheong Memorial School and Cho Yiu Estate are up to 4 dB above the daytime recommended noise level. Mitigation in the form of a noise barrier along the Lai King Road site boundary is therefore required.

Lai King Station

The predicted noise levels for construction work at the station worksite are consistently above the daytime, evening and night-time construction noise criteria given in *Annex A*, except during the building erection phase. Significant impacts are thus expected to occur at all of the identified NSRs at some stage of the construction programme, and the use of mitigation measures to alleviate these impacts will be essential. The results of a detailed review of the possible mitigation measures available to provide the required reduction in construction noise levels is given in *Section 7.5.1*.

Construction Vibration

Measurements of vibration from construction plant have shown that, even from percussive piling equipment, levels generally fall to imperceptibility beyond approximately 100 m from the source. Imperceptible levels are reached at much smaller distances from other plant such as excavators and dozers. Since vibration-sensitive receivers lie within 100 m of the probable positions of vibration-emitting plant, perceptible levels of ground vibration are likely to be experienced at some NSRs. No percussive piling will be used for this contract and therefore blasting is likely to be the source of the highest levels of vibration during construction.

For blasting there are two effects which need to be assessed, vibration in structures and air overpressure.

Vibration

Blasting activities are likely to result in disturbance in the form of ground vibration and noise to the occupants of NSRs around the South Portal and in a corridor above the tunnel alignments. It is considered that the full mitigation of these effects would place unreasonable constraints upon the Contractor.

Air Overpressure

The detonation of explosives leads to the generation and propagation of airborne waves or air overpressure. These pressure waves consist of energy over a wide range of frequencies, some are audible and are known as sound waves, while most are at frequencies below the audible range, less than 20 Hz.

The weakest part of a structure exposed to overpressure is usually the windows. Air overpressure values of 150 dB could be sufficient to damage a badly mounted window pane with most windows breaking at 170 dB. Air overpressure values in excess of 180 dB are sufficient to damage structures.

No NSRs will have a direct view of the blasting site, so that it can be concluded that no damage to windows and building structures should result from air overpressure associated with the blasting.

However, the audible portion of the air overpressure may be disturbing to the occupants of schools and residential buildings in the vicinity of the South Portal and a corridor above the tunnel alignments. Additionally maximum levels of vibration permitted to impact upon MTRC E&M equipment in the area will limit vibration and air overpressure impacts considerably.

Operational Impacts

Ground-borne Noise And Vibration

In Hong Kong there are currently no legislative controls over ground-borne noise (apart from Section 2.4 of TM3) and vibration levels perceived by residents caused either by train operations or during construction. However, appropriate planning criteria against ground-borne noise and vibration are reviewed.

The effects of ground-borne vibration are dependent on the frequency as well as the level of vibration, additionally, human perception is less sensitive to transient vibration than steady state vibration. The following train-induced ground-borne vibration limits are proposed for initial planning purposes as recommended by a study [(1)] completed for MTRC on vibration from the construction and operational of railways, (with reference to BS 6472 and German DIN 4150).

- Train-induced (operational phase) vibration limit : 0.6 mm s^{-1} and 1 mm s^{-1} ppv for residential and commercial premises respectively.

Experience suggests that disturbance from underground railways is usually dominated by the effects of ground-borne noise, and if this can be mitigated then the effects of ground-borne vibration are usually also

(1) [Ref 1] "Planning against vibration and noise from mass transit systems and construction in a Metropolis", W.K.W. Hong, Polmet 91.

mitigated to acceptable levels. There is no universally accepted criteria for ground-borne noise in Hong Kong or the UK, but suitable values can be derived from a number of sources. London Underground Limited (LUL) reported during the planning of the Jubilee Line extension that complaints from ground-borne noise from trains are unlikely below levels of 40 dB(A). This result is the conclusion of a study into complaints from railway noise received by London Transport from 1969 to 1979, carried out by the London Transport Executive Office of The Scientific Adviser. This level has subsequently been adopted by LUL as a design criterion for all types of building use, including residential.

The American Public Transit Association (APTA), in the Transportation Noise Reference Book, suggests a Maximum level for ground-borne noise of 35-40 dB(A) for dwellings in high density residential areas.

In view of these references the following design goal is considered appropriate;

- A maximum ground-borne noise level of L_{AMax} 40 dB(A) should be achieved at all residential properties.

Ground-borne Noise And Vibration: Assessment Methodology

An initial assessment of the levels of ground-borne noise and vibration at the four NSRs nearest to the tunnels has been undertaken. The current proposal for the trackform within the tunnels is the Sonneville twin block system, as proposed for other sections of the LAR. The full specification for the system is not yet available, but its benefit in reducing the level of vibrational energy transferred into the track supporting structure is recognised. It is reported as offering a degree of vibration isolation at least as good as that of ballasted track. This assessment has therefore taken the approach of considering the likely impacts from ground-borne noise and vibration for ballasted track. These impacts can then be used as an indicator of the possible impacts that might result with the Sonneville system.

The predictions have been based on a series of measurements made above tunnels in a similar type of rock. The results suggest that for ballasted track ground-borne noise levels would be below 40 dB(A) at Asbury Methodist Primary school, Block F, Cho Yiu Chuen Estate, and Yuen King House, however, at the Clothing Industry Training Centre levels above 40 dB(A) would be expected. Higher levels would probably be acceptable at the training centre, and it can therefore be concluded that if ballasted track were used in the Lai King Tunnels, significant impacts from ground-borne noise and vibration would be unlikely. Since the Sonneville system will perform as well as ballasted track, (and probably significantly better) no significant ground-borne noise and vibration impacts are expected.

Train Rolling Noise

The assessment of train noise impacts at NSRs around the Southern Portal of the Lai King Tunnels have been reported in the previous section above.

Fixed Plant

The NSRs potentially affected from fixed plant within the station are currently being directly or indirectly affected by traffic noise along Kwai Chung Road. Considering the possible night–time operation of the fixed noise sources, and including intermittency and facade corrections of 3 dB(A) each, the appropriate assessment criterion, according to the Technical Memorandum is a Target Noise Level (TNL) of 54 dB(A) at this receptor.

Based on the preliminary design information, an estimation can be made of the SWL of the potential noise sources. It is estimated from comparative measurements [(1)] that the sound power level at the two ventilation shafts connected with the AEL tunnels is about 87 dB(A). The sound power level for the tunnel ventilation fans is calculated to be 109 dB(A) based on the fan noise prediction equation in *ASHRAE (American Society of Heating, Refrigeration, and Air Conditioning Engineers) Handbook 1987*, and the fan design requirement of 90 $m^3 s^{-1}$ air volume and 1000 Pa static pressure.

Noise prediction was based on calculations given the critical path between the fixed sources and the upper level of Yeung King House (at a slant distance of about 40 m). The results are as follows:

- An L_{eq} of 50 dB(A) is predicted at Yeung King House as a result of AEL trains noise passing through the ventilation shafts. This is acceptable in comparison with TNL of 54 dB(A) and hence no impacts are expected.
- Tunnel ventilation fans are designed with up–stream and downstream silencers. To meet the TNL of 54 dB(A), the required attenuation of the silencers is calculated to be more than 15 dB(A). Standard silencers can offer performances that easily surpass this requirement, and hence significant noise impacts are not expected from tunnel ventilation fans.
- Taking into account the cumulative noise contribution from the ventilation shafts, the individual sound power level for each of the three chillers must be no higher than 87 dB(A). To achieve this, it is likely that enclosed housings will be required for compressors, and silencers will be needed at air intakes and discharges.

The design of Lai King Mid–tunnels Ventilation Building was at an early stage at the time of writing. It is therefore recommended that this issue should be re–considered, in order to ensure compliance with the ANL minus 5 dB(A) noise criterion, as design detail becomes available. However in view of the traffic noise insulation treatment soon to be supplied to the WMC Morninghope school, and the 50 m separation of the two buildings, it is unlikely that significant noise impacts will result from the proposed modifications.

(1) Measurements of SEL inside ventilation shafts were taken for eight train passages in a tunnel of the Jubilee Line in London, UK, roughly midway between Baker Street and Bond Street Stations. The train speeds were 50–60 kph, and the mean values of SEL was 90 dB(A). Noise contribution of the passing of AEL trains are estimated from these measurements allowing for the train speed of 135 kph and headway of 4.5 minutes.

B6.5.2 *Kwai Chung Park*

Construction Impacts

Predicted noise levels at the crematorium will be above 75 dB(A) for certain phases of construction, and thus mitigation measures are recommended for these construction phases if necessary. These noisy construction periods will exist when on-site truck loading, for the off-site disposal of spoil, is carried out simultaneously with the LAR railway construction, in particular during the excavation and piling phases of construction.

Operational Impacts

Current proposals for the whole of this section of the LAR are that the rails of all lines will be mounted on the Sonneville system. Within Kwai Chung Park the ground underlying the tracks will be landfill material which, although not a material commonly studied for its vibration transfer characteristics, is likely to dampen ground vibration extremely effectively. Furthermore there are no NSRs in this area close enough to the lines to be effected by ground-borne vibration. On the viaducts North of Lai King Station energy transferred through the track mounting system may potentially radiate from the viaduct structure. Re-radiated noise from the viaduct has been calculated using the minus 9 dB assumption described earlier.

It can be seen from *Table 5.5e* that, in order to achieve the $L_{Aeq, 30\,min}$ 60 dB night-time criterion, Type 2 barriers are required on the eastern side of all lines between the station and 50 m beyond the point at which each line passes under the Route 3 structure. For the LAL lines this is a distance of approximately 380 m and for the AEL lines this is a distance of approximately 290 m.

The predicted levels for the peak daytime periods will be roughly 1.5 dB higher implying that the daytime criterion of $L_{Aeq, 30\,min}$ 70 dB will be met at the Lok Sin Tong Lau Sai Yan Primary school. It is assumed that this school is only sensitive to noise during the day. Furthermore, the effect of the secondary glazing already in place on all windows of the school facing the viaduct, will be to further reduce train noise levels inside, so that no significant impacts on the activities within the school are to be expected.

The assessment of noise impacts at the Tsuen Wan Crematorium is included in the following section concerning the Rambler Channel Bridge.

For evaluating the likely impacts of train noise on the users of Kwai Chung Park, a criterion of 70 dB(A) $L_{Aeq, 30\,min}$ daytime was suggested by ERM on the basis of the nature of the park itself, the characteristics of the surrounding areas and the existing background noise levels. After discussions with EPD Noise Policy Group, it was agreed that this criterion was acceptable to them. Applying this criterion to the reported predictions, it may be concluded that the resulting predicted noise levels will be below the adopted criterion, even if no wayside barriers are provided.

Notwithstanding this, it is recommended that Type 1 barriers are used to ensure that the LAR does not significantly affect the noise climate in the proposed Kwai Chung Park.

B6.5.3 *Rambler Channel Bridge*

Construction Impacts

Impacts are predicted to occur at the Crematorium during the daytime (0700–1900) mainly due to construction work at Piers 6 and 7 (the Crematorium is not considered sensitive to noise in the evening and night-time periods). At Riviera Gardens, impacts from bridge construction are predicted to occur during the evening and night (1900–0700), whilst at Greenfield Garden and St Paul's Village, impacts are expected during the night-time (2300–0700) period only.

Daytime impacts at the Crematorium during the viaduct construction phase are expected as a worst case to occur during foundation work and construction of the viaduct superstructure. Percussive piling at Pier 6 (and Pier 7 if percussive piling is used at that pier) and the laying of the foundations for the viaduct are the activities predicted to produce the most severe impacts at the Crematorium. The possibility for severe cumulative impacts have been predicted at the Crematorium if construction of (Piers 6 and 7 of) the bridge, the viaduct and the construction through the landfill occur together. Additional mitigation is proposed in section 7.

The predicted construction noise levels at the Marine Department Offices are more than 10 dB above the daytime assessment criterion implying significant impacts to activities within the offices. Although the existing noise levels in the area are high, mitigation measures are recommended. Noise levels from percussive piling at this location are more than 15 dB above the ANL of $L_{Aeq, 30\ min}$ 85 dB for this type of NSR, given in TM2 implying that impacts are expected, and the hours of operation would have to be restricted, in order to gain a Construction Noise Permit (CNP) for these works.

In is not anticipated that construction-related traffic in the vicinity of the Rambler Channel, and in particular close to the Cheung On Estate, during peak flow will be greater than 60 vehicles per hour. Considering existing and predicted traffic flows in the area, such an increase in heavy vehicle flows is not predicted to produce impacts at nearby NSRs. However, construction traffic noise should be monitored periodically to ensure that this is the case.

Operational Impacts

The predicted train noise levels are below the assessment criterion at all NSRs except Tsing Yi Station. The exceedence in the assessment criteria at this location is 1 dB, suggesting impacts of marginal significance are likely. It has been calculated that a noise cover over the Rambler Channel western approach extending from the station as far as the sea wall (approximately 50 m) would achieve the assessment criterion at Tsing Yi Tower 1.

Train noise levels at the Marine Department offices will be below the daytime assessment criterion of $L_{Aeq, 30 min}$ 70 dB implying no significant impacts. Levels of train noise under the bridge in the PCWA will not be substantially above the likely levels of noise produced by the general activities in that area, although the maximum noise levels during train pass–bys could have some influence on the operation of the facility. For example, train noise may affect the audibility of public address announcements and reversing sirens in the area, and it may be necessary to modify operational procedures to overcome these potential problems. However, the works area is not considered to be an NSR, and specific mitigation measures are not considered necessary.

B6.5.4 Tsing Yi Station

Construction Impacts

As daytime and evening construction is anticipated, construction activities have been proposed for 0700–2300 seven days per week, the applicable noise limit for Monday through Saturday daytime (0700–1900) is 75 dB(A) while evenings (1900–2300) and all day Sunday have a lower limit of 70 dB(A) (ASR 'C', according to the NCO). As worst case impacts at all NSRs, except for the School at Tsing Yi Estate, exceed the daytime criterion, mitigation measures will be required to reduce noise to acceptable levels. The worst case impacts exist at On Pak House, Cheung On Estate, where noise levels are predicted to exceed the daytime criterion of 75 dB(A) by up to 11 dB(A) and the evening criterion by 16 dB(A).

Operational Impacts

Impacts are not expected at Tsing Yi Station Tower 7 since levels no higher than 54 dB expected. A Type 2a barrier on the south side of the viaducts, and Type 2 barriers on the north (all extending from the station to pier 6) would reduce $L_{Aeq, 0630-0700}$ levels to the following:

- St Paul's village: 58 dB;
- Cheung On Estate, On Chiu House : 53–60 dB;
- Cheung On Estate, On Pak House : 51–57 dB; and
- Tsing Yi Station Tower 7 : 49–54 dB.

This combination of barriers would ensure that no significant impacts are to be expected. Indeed, the level of traffic noise likely to be present in the area may well allow some train movements to go unnoticed at certain NSRs.

Fixed Plant

The potential structure–borne noise concern and possible control measures identified in *Section 3* should be considered in the detail design of the respective plant systems.

Regarding the air–borne noise impacts, the six major station ECS ventilation shafts, and to a lesser degree the traction transformer station, are likely to be of concern. In accordance with TM3, the low level receivers at the planned station top development will be screened from traffic noise and an ASR of 'B' is used for the assessment. The ANL for operation at the night–time period will be 55 dB(A). Allowing a 5 dB planning margin for cumulative sources as recommended in the HKPSG implies a criterion of L_{Aeq} 50 dB. Noise from the traction substation and the ventilation shafts is likely to have a tonal character, for which a penalty of 3 dB(A) is recommended in the TM. Hence the total noise from these sources should be designed to achieve a level of 47 dB at the nearest NSR.

Since the location of each source is not known it is not possible to recommend a particular maximum sound power level for each, and it must be recommended that the design level of 47 dB for the total noise level should be adopted in the design of the plant.

The traction transformer station will be located under the track alignment in the west end of the station. The residential towers above the podium will be well screened from this location so that the nearest NSRs are likely to be in St Paul's village at a distance of about 70 m. If a further 5 dB is allowed for the cumulative effects of other station plant, the transformer station should be designed to achieve a level of 42 dB(A) at 70 m. This implies a maximum SWL of 84 dB(A).

The silencing requirements for each of the ventilation shafts should be determined once the locations are known. However, by way of an example, for a shaft located 10 m from a residential tower in the station top development, in order to achieve a level of 42 dB(A) (to allow 5 dB contribution for other noise sources), a maximum sound power level of 67 dB(A) would have to be achieved. It is recommended that wherever possible the ventilation shafts are located well away from the residential towers and the orientation be chosen to provide additional mitigation.

Train Mounted Plant Noise

A train leaving the station and reaching 60 kph at 200 m would take about 24 seconds to leave the station. Considering the contribution of noise from the AEL up and LAL up lines on top of the viaduct only (the turn outs are expected to be essentially inactive during the night–time 2300–0700 period as they serve to allow LAL Up trains to turn round and return to Hong Kong Station only during peak daytime hours), a total of 27 trains would enter and leave the station in any one hour. The $L_{Aeq, 30\,min}$ facade noise level from train mounted plant at a distance of 40 m, (the plan distance to Tower 7 of the residential development above Tsing Yi station), would be 57 dB(A). The level of train rolling noise (air–borne plus re–radiated) is predicted to be up to $L_{Aeq, 30\,min}$ 57 dB. The unscreened distance is likely to be larger than 40 m. Also it is unlikely that plant noise from the trains would be equally distributed along the full length of the train. Hence although train mounted plant may contribute to the overall noise levels at Tsing Yi Station Tower 7, the total noise level from trains on the viaducts is unlikely to be higher than

$L_{Aeq, 30 min}$ 57–60 dB. Clearly at other more distant NSRs train mounted plant would offer a lesser contribution. Hence no significant impacts are expected from train mounted plant.

B6.5.5 *Tsing Yi Tunnels*

Construction Impacts

Tunnel Blasting

It is not expected that structural damage will occur from blasting, however, it is possible that the audible portion of the air overpressure, and ground-borne noise will be disturbing to the occupants of villages and residential buildings in the vicinity of the East and West Portals and a corridor around the tunnel alignment.

East Portal Worksite Construction

Noise predictions for the proposed construction activities have shown that there is potential for unmitigated operations to generate significant to severe impacts at NSRs for both evening and night-time operations. As construction activities have been proposed for 6 days a week, 24 hours per day, it is clear that mitigation will be necessary to meet the requirements of the NCO. Daytime and evening cumulative impacts with Tsing Yi Station/Viaducts have the potential for causing significant impacts at Cheung On Estate, Tsing Yi Estate, Broadview Gardens and Feng Shue Wo THA. As a result mitigation will also be necessary for daytime periods.

Operational Impacts

Ground-borne Noise

It is assumed that the track mounting system in the tunnels, as for much of the elevated and underground sections of the LAR, will be the Sonneville system. In view of the separation of the tunnels and the nearest NSRs, and the vibration isolation offered by the Sonneville system, it is considered unlikely that significant impacts will result from the movement of trains in the tunnels.

Noise From Fixed Plant

No significant impacts are expected from the fixed plant associated with the tunnels.

B6.6 *TSUEN WAN DISTRICT*

B6.6.1 *Lantau Fixed Crossing*

Construction Impacts

The LFC EA reported that in the vicinity of the Tsing Ma Bridge few exceedances have been predicted for evening construction work at the indicated NSRs, however, all indicated NSRs have been predicted to experience significant to severe construction noise impacts from night-time construction activities. The worst exceedances (ie by up to 18 dB(A)), were predicted to occur at the Castle Peak NSRs.

Severe exceedances have been predicted for both evening and night-time construction work at the indicated NSRs for both the Kap Shui Mun Bridge and Ma Wan Viaducts construction activities. The worst evening and night-time exceedances for Kap Shui Mun Bridge construction, 36 dB(A) and 51 dB(A), respectively, were predicted to occur at the North Lantau NSRs. The worst evening and night-time exceedances for Ma Wan Viaducts construction, 29 dB(A) and 42 dB(A), respectively, were predicted to occur at the Ma Wan NSRs.

Many mitigation methods were assessed, however, it was concluded that no amount of mitigation would be able to reduce noise levels at receivers so that they fully comply with the NCO. As a result, it was recommended that the Contractor apply for an Executive Council (ExCo) exemption (this has subsequently been obtained).

In the North Lantau region this exemption will relax night-time construction noise limits by 25 dB(A), from an $L_{Aeq, 30\,min}$ of 45 dB to 70 dB and evening noise limits by 15 dB(A), from an $L_{Aeq, 30\,min}$ of 60 dB to 75 dB. In the region of Castle Peak the Exco exemption will relax night-time construction noise limits 10 dB(A), from an $L_{Aeq, 30\,min}$ of 45 dB to 55 dB. To comply with the relaxed limits it was recommended that the Contractor use quiet plant, acoustic enclosures, and mobile noise barriers.

Operational Impacts

The predicted train noise levels are above the requirements of the NCO but it was concluded that the levels were far lower than they might have been, with $L_{Aeq, 24\,hr}$ levels up to 14 dB lower than if the hypothetical structures considered in previous reports had been built.

Clauses specifying the Environmental Reference Scheme (ERS) were included in the tender documents and it was concluded that the best practicable means of reducing noise had been adopted by the design requirements stated in the ERS.

B6.6.2 *Lantau Tunnels*

Construction Impacts

Severe construction impacts were predicted at NSRs in Tsing Chau Tsai (*ie* in excess of 35 dB(A) above the night–time criterion) for unmitigated construction activities, and it is recommended that all NSRs are relocated prior to the commencement of the construction works.

Operational Impacts

For the evaluation of noise impacts from the traction substation, equal noise contribution is assumed from the 3 major noise sources; the two ventilation shafts and the traction transformer station. Of the NSRs in the area, Tai Chuen is located on the alignment of the Kap Shui Mun Bridge and it is assumed that it will be re–located. Tso Wan is some 600 m away and screened by the natural topography and is unlikely to be significantly impacted by the traction station. San Po Tsui and Yi Chuen will therefore be the potentially most affected NSRs.

During operation of the LAR, the noise environment at San Po Tsui and Yi Chuen, being exposed to traffic noise from the NLE, will be changed significantly. In accordance with TM3, they will be indirectly affected by the NLE, implying an ASR of "B", the ANL for operation at the night–time period will be 55 dB(A). San Po Tsui, being the nearer of the two NSRs is the most likely to be effected, and will therefore require the greater restriction on noise emissions from the plant.

The TNL, allowing for equal contribution from each of the three major sources in building is 42 dB(A). This is calculated as:

- 55 dB(A) (night–time ANL for ASR of B);
- minus 5 dB(A) (margin for planning under HKPSG);
- minus 3 dB(A) (tonal correction); and
- minus 5 dB(A) (provision for equal contributions from 3 major sources).

The allowable equivalent SWL for each of the two ventilation shafts and the traction substation (assumed as point sources over a reflection plane), taking the geometric attenuation of 60 dB(A), will be 99 dB(A).

The location of the ventilation building is at Tsing Chau Tsai which is on the alignment of the planned NLE, and which is not identified as a NSR in the EIA study for the NLE. Hence these village houses are assumed to be relocated prior to the operation of the LAR. The nearest NSR to the ventilation building will therefore be San Po Tsui which is more than 1 km north east and screened by a knoll (more than 100 m PD). The potential of noise nuisance from the ventilation building is therefore small, and there will be no specific noise constraint on the design of the installation.

Assuming that Tsing Chau Tsai Village is relocated, no significant impacts are expected from train noise at the West Portal.

B6.7 ISLANDS DISTRICT

B6.7.1 Lantau Formation and Viaducts

Construction Impacts

The four noisiest NLD construction activities identified were:

- Tung Chung Land Formation (use of 10 pneumatic drills) – 76 dB(A) at Tai Po Village and Youth Camp and 78 dB(A) at Ma Wan Chung and Ma Wan Villages;
- Site formation in Tung Chung (20 trucks on-site) – 82 dB(A) at Tai Po Village and Youth Camp;
- Dredging using marine plant in Tung Chung – 66 dB(A) at Tai Po Village and Youth Camp; and,
- Reclamation using marine plant in Tung Chung – 66 dB(A) at Tai Po Village and Youth Camp.

Percussive piling was predicted to produce no higher than 85 dB(A) at the identified neighbourhoods.

The NLE study identified eleven major activities for the Yam O section and ten for the Tai Ho section which were assessed. Maximum levels at each NSR for the entire NLE construction programme were in the range 58–78 dB(A). The locations with the highest predicted maximum noise levels were Luk Ken Tsuen, Pak Mong and Tai Ho Wan.

As part of the assessment, the assumption was made that reclamation and dredging could occur throughout the non-restricted and the restricted periods but that other activities could work only until 2300. This would allow for the situation where contractors may wish to work beyond 1900 hours to make up lost time.

It was predicted that there would be unacceptable noise impacts at NSRs (including Planning Areas) from many activities associated with all NLD construction phases. The consultants concluded that reclamation and dredging are likely to produce unacceptable noise levels during night-time working and that this should not be permitted unless the noise levels in the NCO can be achieved.

The NLD (TR18) study concluded that four main activities would cause severe impacts at Tai Po Village and the Youth Camp) and one activity would cause severe impacts at Ma Wan Chung and Ma Wan Villages. However, most activities were predicted to cause low to moderate impacts at NSRs. It was concluded that a CNP would be required for percussive piling in the daytime, and that percussive piling would not be allowed during the restricted hours.

The criteria used in the NLE study were developed to take into account the economic feasibility of implementing them from the contractors viewpoint, the feasibility of enforcing them and the prevailing background noise levels at the NSRs. The study concluded that the noise criterion must be higher than the ambient noise measured in $L_{Aeq, 30 min}$. Based on this conclusion, and using their professional judgement and the measured ambient noise levels, the consultants recommended daytime criteria in the range 60–75 dB(A), evening criteria in the range 55–65 dB(A) and night–time criteria in the range 45–50 dB(A).

Daytime impacts were expected at some of the dwellings in Wan Tuk, Pak Mong, Tai Ho Wan and Tin Liu at various times during the construction phase. Impacts were expected at all identified NSRs during unmitigated night–time construction work.

Since it was assumed that the contractor would want the flexibility to work 24 hour days during construction work for the NLD, some form of mitigation was deemed necessary. Recommended mitigation measures from TR18 and TR20 were:

- Silencing of all on–site equipment by using enclosures, baffles, mufflers or silencers, particularly if night–time working is required;
- the use of quiet equipment as far as is practicable;
- mitigation at the Tai Po (19 properties) and Youth Camp receivers by the installation of window insulation and air–conditioning units;
- the use of on–site noise management; and,
- the minimisation of evening and night–time working.

It was emphasized that contracts should be designed, phased and planned to minimise noise. Sound insulation was not considered for Ma Wan Chung and Ma Wan Villages and these NSRs were considered to be adequately screened from construction noise by the berm.

Noise monitoring during restricted periods was recommended for Tai Po Village, the Youth Camp, and Ma Wan Cheung Village. It was suggested that daily measurements should be made unless complaints were received, in which case the frequency of measurements should be increased.

The mitigation measures that were deemed necessary for daytime NLE construction activities were:

- Scheduling activities to avoid parallel operations of several sets of equipment close to a receiver;
- siting of equipment as far as is practical from NSRs; and
- scheduling noisy operations for periods with high background noise.

Additional mitigation measures were deemed necessary in order to allow evening working (use of silenced equipment and temporary noise barriers) and night–time working (as for evening working plus reducing the numbers of operating items of powered mechanical equipment).

Operational Impacts

The EPD have advised that Luk Keng Tsuen Village should be considered as having an ASR of B, implying an assessment criterion of $L_{Aeq, 30 min}$ (2300–0700) 55 dB. It can be seen from *Table B5.7a* that in order to achieve this a 1000 m long Type 2 barrier would be required. There are proposals for a river/coastal feeder terminal near Kuk Keng Tsuen in the Lantau Port and Western Harbour Development Studies. This may change the situation at Luk Keng Tsuen significantly (for example screening could change), and it is therefore recommended that the provision of noise barriers should be re-assessed when full information on the proposals are available.

The EPD have advised that Pak Mong village, near Tai Ho Wan should be considered as having an ASR of B, implying an assessment criterion of $L_{Aeq, 30 min}$ (2300–0700) 55 dB. It can be seen from *Table B5.7b* that no mitigation is required at Pak Mong village.

When Tai Ho Wan is further developed, after the opening of the LAR, the nature of the area will change so that the ASR of the new development sites will be C, implying an assessment criterion of $L_{Aeq, 30 min}$ (2300–0700) 60 dB. It is recommended in *Section 5* that a further assessment of train noise impacts to the planned development sites in Tai Ho Wan should be carried out when site layouts are available. However, the results of the preliminary (worst case) assessment reported in *Table B5.7a* suggest that there is potential for impacts from train noise in development areas 14,15,18,22, and 27, and provision for noise barriers should be made.

B6.7.2 Siu Ho Wan Depot

Construction Impacts

Construction noise levels are predicted to be below the limits for daytime (0700–1900) and evening (1900–2300) working, no night-time (2300–0700) construction activities are planned.

Operational Impacts

A large number of noise sources have been identified, all of which could potentially contribute to noise levels at planned NSRs around the Depot site. For some of these it has been possible to estimate the source strength, and this allows prediction of their contribution to the overall noise levels at NSRs. For others the source strength will depend on the design of the particular facility, so that it is not possible to predict their contribution to the overall noise level at NSRs.

Noise impact from the depot is assessed by reference to TM3. Discussions with the EPD concluded that NSRs A,B and C should be assigned an ASR of B which implies ANLs of $L_{Aeq, 30 min}$ 65 dB for daytime and evening (0700–2300) and 55 dB for night-time (2300 –0700). This assessment concentrates on night-time impacts at NSR A (the closest residential NSR) and also discusses daytime impacts on NSR C, the secondary school which is assumed to be unoccupied at night.

HKPSG suggests that, in order to allow for the cumulative effects of other future noise sources, 5 dB should be subtracted from the ANL when setting a noise limit for planning purposes. This implies noise limits of $L_{Aeq, 30 min}$ 50 dB at night and 60 dB during the day. The HKPSG also gives a L_{AMax} criterion for train noise of 85 dB although this is not necessarily applicable to noise from depots. The TM also specifies further corrections for tonal and intermittent noise sources.

Wheel squeal is assessed not only in terms of its contribution to the $L_{Aeq, 30 min}$ but also in terms of the maximum noise levels it produces and the potential for sleep disturbance and annoyance. The likelihood of an intermittent noise source such as wheel squeal causing sleep disturbance or annoyance at a residential property is dependent on the ambient noise levels. The higher the ambient noise levels, the less likely a particular level of intermittent noise is to be annoying. The future noise levels at NSRs in the area 27 site are not known, but are likely to be elevated by the NLE and activity in the rest of the Tai Ho Wan development area. Discussions with the EPD suggested that wheel squeal producing noise levels significantly above $L_{AMax, Fast}$ 60 dB at residential NSRs may cause annoyance or sleep disturbance. It should however be noted that these are subjective effects that cannot be predicted with any real degree of certainty, and whilst the NCO gives provision for serving a noise abatement notice if annoyance results, neither the NCO nor the HKPSG give any rigid planning criterion for the avoidance of annoyance. Indeed, because of the nature of noise annoyance such a planning criterion could not be offered.

Where it has been possible to predict noise levels from individual sources, these are assessed with respect to the above criteria. Where this has not been possible, a suitable environmental noise performance specification is proposed. Allowance for the addition of noise levels produced by the different sources within the depot is made by targeting the noise level from any one source to achieve $L_{Aeq 30 min}$ 40 dB.

Train movements and Wheel Squeal

Noise from wheel squeal is predicted to elevate the noise produced by train movements to be above the assessment criteria in terms of L_{Aeq} and L_{Amax} noise level, and it is recommended that mitigation measures should be adopted to reduce wheel squeal as far as possible. The options available and the possible noise benefits are discussed in *Section* 7.

Train Mounted Plant

The stabling tracks will consist of 2 x 10 car train berths, end to end. In order to assess the worst case, it is assumed that the 10 trains which will be stabled with train mounted plant running will be spread across the full width of the stabling area to the west of the central spine, ie immediately east of the track fan area. It is assumed that the noise specification of

68 dB(A) at 7.5 m is exactly met along the full length of each train. In this arrangement it is assumed that a noise level of 68 dB(A) would result at a distance of about 7.5 m above the trains over the whole of this part of the stabling area, an area of roughly 100 m by 240 m.

The method used to calculate noise levels at NSRs is taken from CONCAWE [(1)] recommendations. This planar noise source is assumed to radiate into a hemispherical surface (of equal loudness) of radius 520 m (the distance from the centre of this plane to NSR A) on which NSR A is located. The distance attenuation is calculated as 10 x the log of the ratios of these areas. The two areas are approximately 1,700,000 m^2 and 24,000 m^2 giving 19 dB distance loss. Draft ISO DIS 9613 [(2)] suggests a directivity correction of −5 dB for this situation. Adding a standard facade correction of +3 dB, gives a total loss of −21 dB implying a noise level of approximately 47 dB(A) at NSR A. A more precise calculation would be possible once further information on train mounted plant noise is available.

The noise level at NSR B will be lower than this, and NSR C is occupied only during the day when trains are not stabled.

It is considered that although the predicted level is below the $L_{Aeq, 30 min}$ 50 dB criterion, mitigation measures should be adopted because of the approximation in the calculated level and to allow for contributions from other depot noise sources.

Noise from train mounted plant on trains entering the train washer is assessed assuming that within the period 0100–0130 there will be a train entering the washer from the west at all times. This is likely to be the case as 20 trains of length 230 m, end to end, moving at 2.5 m s^{-1}, would require a full half hour to pass through the washer.

If train mounted plant is approximated to a line source at 80 m from the nearest boundary of site 27 (NSR A), a noise level of 61 dB(A) is expected, and hence mitigation is required. For site 14 (NSR B) at 280 m, a single train behaves as a line source up to approximately 75 m (train length 230 m/π) and as a point source beyond, resulting in a noise level of 50 dB(A).

Train Exterior Washing

A noise level of about 70 dB(A) at 5 m from the train washer is anticipated. If it is assumed that this measurement is typical of levels measured on a cylindrical conformal area of radius 7 m, and that the washer will be 50 m long, the approximate sound power level of the washer can be estimated as 70 dB plus 10 x the log of the conformal area, ie approximately 100 dB(A). The nearest part of area 27 is only 150 m from the washer implying a facade noise level of roughly 51 dB(A). Since the washer is likely to operate almost

(1) CONCAWE report of 81 the propagation of noise from petroleum and petrochemical complexes to neighbouring communities.

(2) Draft ISO DIS 9613 Acoustics. Attenuation of Sound during propagation outdoors, Part: A general method of calculation.

continuously in the period 0100–0130 when most trains arrive at the depot, and because of the cumulative effects from other depot noise sources, mitigation of washer noise is required.

Central Chiller Compound

NSR A is approximately 400 m from the chiller compound, if a SWL of 115 dB(A) is assumed then a level of 58 dB(A) can be expected at NSR A. Mitigation of chiller noise will, therefore, be required.

Main Depot Building

The main depot building is approximately 380 m long by 70 m wide. An internal noise level no higher than L_{Aeq} 70 dB is anticipated and the building envelope could offer 25 dB(A) of insulation. A noise level of L_{Aeq} 55 dB is therefore assumed at 1 m from the building. The noise contributions from the walls are considered insignificant compared with that of the roof, assuming all plant noise emissions meet the assumed level of 55 dB(A) at 1 m from the building.

The methodology used to calculate train mounted plant noise above, is used to calculate the noise level at NSR A resulting from noise radiating from the roof of the building. NSR A is approximately 700 m from the centre of the building, ie located on a hemisphere of area approximately 3,000,000 m^2, centred at the main building. The predicted level at NSR A is then:

- 55 dB – 10 log (3,000,000/380 x 70) – 5 (directivity) + 3 (facade) = 33 dB(A)

Hence no mitigation is required beyond that assumed to be offered by the building envelope, and in fact it will be possible to reduce this assumed performance in order to set a performance specification for the whole building, including plant noise from ventilation and other openings.

Railway Test Track

In the worst case, a train being tested at night will pass NSR A at a distance of approximately 35 m if it overruns to the west of the depot. The HKPSG recommends a night-time facade L_{AMAX} of 85 dB for a train pass by.

This level is achieved at a distance of 35 m at a speed of 125 kph and as the maximum speed on the test track will be 80 kph no significant impact is expected.

Other Buildings

For the following potentially noisy buildings it has not been possible to predict the likely levels of environmental noise:

- Traction Substation;
- underfloor wheel lathe building; and

- other ancillary buildings.

It is recommended that an environmental noise performance specification applying at the nearest NSR is set for each of these other buildings. This is discussed in *Section 7*.

B6.7.3 Tung Chung Station and Tunnels

Construction Impacts

It is understood that Tai Po Village will be relocated prior to commencement of the construction works. The noise levels at the Youth Camp, from both activities operating in parallel, are below the daytime limit but exceed the evening (1900–2300) noise level criteria of 60 dB(A). As construction activities are expected to operate for 16 hours per day, from 0700–2300, it is recommended that the mitigation measures be employed so that noise levels at the Youth Camp will meet the NCO regulations.

The NLE EIA (Tung Chung Section) reported that noise levels could be as high as $L_{Aeq, 30\,min}$ 88 dB during the cutting and excavation of earthworks at Tai Po and Kei Tau Kok and recommended that the Youth Camp should be supplied with a noise insulation package in order to allow the construction activities of the NLE to proceed during the night. This insulation package would also provide adequate mitigation to allow the LAR construction works to proceed at night, and would reduce the mitigation requirements for other periods.

The noise levels at Ma Wan Chung Village do not show any exceedances for day time activity (0700–1900), however, there are small exceedances (2–3 dB(A)) for evening activity (1900–2300). It should be noted that Ma Wan Chung Village is located behind a series of vegetation–covered ridges which vary between 27–50 m in elevation, while the village is located at an elevation of roughly 3 m. The effect of the ridges and the vegetation should give at least an additional 10 dB(A) in noise reduction over the values listed above. As exceedances, for calculations without screening, were between 2–3 dB(A), and the natural geography and vegetation should reduce noise levels by at least 10 dB(A), it is predicted that noise levels at Ma Wan Chung Village will not exceed the limitations specified in the NCO. As a result no mitigation is recommended for the village.

Operational Impacts

Ground Vibration

There are no legal limits or guidelines for acceptable levels of ground–borne noise (apart from Section 2.4 of TM3) in buildings in Hong Kong. LAL trains will pass under the Commercial site C(k) and the Government, institution and community sites G/IC (o) and (t), and residential sites R1(b2), (c1), and (c2). Whilst it is possible that Government, institution and community buildings will be directly above the LAL, residential towers have been positioned so as to be no closer to 10 m plan distance from the alignment. Trains will reach speeds of approximately 100 kph as they pass close to the residential towers in the East of the new town.

It is assumed that the track mounting system in the tunnels will be the Sonneville system, as for the much of the elevated and underground sections of the LAL. Being on reclamation, the ground will comprise sandy gravels and fill material whose granular composition typically dampen ground vibration far more effectively. In light of the separation of the tunnels from residential towers, the type of ground, the reduced train speeds, and the information available on the Sonneville track mounting system, significant impacts from ground-borne noise and vibration are not expected.

Train Rolling Noise

The residential tower blocks in this area have been assigned an ASR of C by the EPD. EPD have advised that the schools, (NSRs E1 and E2), should not be exposed to noise levels above $L_{Aeq, 30 min}$ of 65 dB, and L_{AMax} levels should not be above the L_{AMax} levels expected from traffic, expected to be about 70 to 75 dB. Because of the proximity of the schools to the AEL lines it is the L_{AMax} criterion that has determined the amount of mitigation required.

In the absence of any train noise mitigation measures in Tung Chung, noise levels at the majority of the residential towers would be between 2-6 dB above the night-time assessment criterion of $L_{Aeq, 30 minute}$ 60 dB. Additionally, noise levels at the schools would be about 9 dB above the assessment criterion of $L_{Aeq, 30 minute}$ 65 dB and about 13 dB above the L_{AMax} criterion of 70 to 75 dB. The barrier scenario described in *Section B5.7.3* have been developed to mitigate these potential impacts. These include a section of enclosure over the AEL lines next to the schools.

No impacts are expected at the Youth Camp. The results of a preliminary assessment suggest that no impacts will occur in the HOS EA site south of the LAL station provided the mitigation measures proposed in the NLE EA (ie set back and traffic noise barriers) are adopted. This preliminary assessment should however, be reviewed once site layout detail is available for this site.

The scenario offers complete compliance with the requirements of the NCO and includes provisional mitigation recommendations for the R1(y) site. These should be reviewed by further assessment once information on the proposed site layout is available.

Fixed Plant

Noise emission for the station ECS ventilation shaft can be evaluated by considering the allowable noise level as perceived by the Tung Chung New Town residential developments, which is subject to the limit of the ANLs in accordance with TM3. The concerned sensitive user will also be indirectly affected by the traffic noise along the planned NLE, and taking an ASR of "C", the ANLs for the operation in the night-time period will be 60 dB(A).

Allowing a 5 dB(A) margin for planning as recommended in the HKPSG, a 3 dB(A) penalty for tonal effects, and 6 dB(A) correction to allow for equal contribution from the 4 major ventilation shafts, each shaft would be required to achieve a noise level of 46 dB(A) at the nearest NSR.

The NLE EA recommended a set-back distance of 136 m and a high noise barrier for the mitigation of traffic noise in the Housing Authority Department site (area 11). Assuming that this set-back distance is adopted, the nearest residential tower to the ventilation shafts would be approximately 70 m to the south. Hence, using a distance attenuation of 45 dB(A) and assuming hemi-spherical propagation, the preliminary maximum equivalent SWL allowable for each of the ventilation shafts openings is calculated to be about 88 dB(A). It is recommended that the shaft openings are orientated away from NSRs. In this way higher sound power levels would be permissible, provided that the requirements of the HKPSG, as described above, are met.

Evaluation of the noise impact from the other station plantrooms and the tunnel ventilation buildings should be carried out as the design proceeds.

Noise From Station Activities

The layout of the proposed land uses around the station area shows that commercial, Government, institution and community land uses will border the station with a residential development in the area above the over-run tunnels. Hence, since the future noise levels in the area around the station are expected to be dominated by road traffic noise from the NLE, it is unlikely that noise generated by activities associated with the operation of the station will cause significant noise impact.

B6.7.4 Airport Works

Construction Impacts

The NAMP EIA reported that the NSRs in the Tung Chung area (Tai Po, Ma Wan Chung) would not experience noise levels in excess of applicable NCO limits for evening activity; however, night-time activities were predicted to produce construction noise impacts in excess of 10 dB(A) over NCO limits. Noise levels at San Tau Village were predicted to exceed evening levels by 1 dB(A) and night-time levels by up to 15 dB(A).

Percussive piling was predicted to produce no higher than 75 dB(A) at the noise neighbourhoods. As a result, it was concluded that daytime piling would be permitted.

Operational Impacts

Train noise from the Sea Channel Bridge are assessed in the section above on Tung Chung. It is not anticipated that there will be any NSRs close to the railway alignment within the airport site, so no impacts are expected.

Impacts due to percussive piling noise are predicted to occur at Exchange Square, General Post Office, Hang Seng Bank New Headquarters and Connaught Centre. The mitigation measures needed to avoid impacts from these activities will be agreed between the Contractor and the EPD as conditions in the CNP that will be required for these works. It may be that percussive piling at the station worksite will only be possible within the hours 0800–0900, 1230–1330 and 1700–1800. It is also recommended that schedules of percussive piling shall be supplied to the affected parties.

Vibration impacts are predicted to occur at Exchange Square due to percussive piling on the station worksite. If alternative techniques are unavailable then percussive piling within 100 m of Exchange Square or other vibration sensitive receiver should be avoided whenever possible.

Operational Impacts

The proposed track mounting system is likely to provide adequate mitigation of ground-borne noise.

While no major noise constraints on the recommended locations of the various elements of plant associated with the operation of the Hong Kong Station and Tunnels has been identified, the following measures are recommended to mitigate any likely impacts.

Major ventilation discharges and openings in buildings housing noisy plant should be oriented away from NSRs (eg facing towards the harbour).

Where openings may face onto public areas (eg the proposed promenade along the shore of the new reclamation), these should be fitted with acoustic louvres or other suitable attenuation hardware.

Additional mitigation measures, in the form of acoustic treatment to plant, may be required to achieve compliance with the ANL minus 5 dB criteria. All plant should be designed to achieve a maximum noise level of $L_{Aeq,\,30\,min}$ 55 dB at the nearest facade of all NSRs except the facade of Victoria hotel that overlooks the harbour, where a noise level of $L_{Aeq,\,30\,min}$ 50 dB must be achieved.

B7.2.2 Immersed Tube Tunnel

Construction Impacts

In light of the evening and night-time impacts predicted to occur at Victoria Hotel it is suggested that all dredging near the proposed site of Hong Kong Station shall be accomplished during daytime (0700–1900) hours. If necessary, evening dredging would require a CNP which may limit the locations at which dredging could be undertaken in restricted hours. For example dredging may only be possible if carried out at least 250 m from Victoria Hotel, in the Central harbour region, and night-time (2300–0700) dredging may only be possible if carried out with a maximum of one dredger at any site, located at least 800 m from the Hong Kong side of the harbour. Alternatively a quieter dredging technique could be used.

Operational Impacts

The track mounting system proposed for the immersed tube tunnel has been selected partly because of the benefits it offers in requiring low levels of maintenance whilst ensuring that track alignment tolerances can be taken up during installation, but also to offer mitigation against the possible impacts of ground-borne noise on planned NSRs at either end of the tunnel.

B7.3 *YAU TSIM DISTRICT*

B7.3.1 *Kowloon Station and Tunnels*

Construction Impacts

No noise mitigation measures, other than proper construction site practice and maintenance, will be required as no significant noise impacts are predicted during the construction phase for this section of the LAR.

Operational Impacts

The proposed track mounting system is likely to provide adequate mitigation of ground-borne noise.

Acoustic silencers for the station ventilation fans will be necessary, and the attenuation requirement should be defined in the detailed system design to limit the overall L_{Aeq} noise level at 1 m from the ventilation openings to 68 dB(A).

Consideration of absorptive lining in plantroom, and vibration isolation of machinery equipment, mainly pumps, chillers, and pipeworks are recommended in the detail system design.

B7.3.2 *Kowloon to Tai Kok Tsui Tunnels*

Construction Impacts

This section of the LAR construction works will be entrusted to Government. Construction work has been proposed to take place between 0800–1800 and no evening or night-time works are planned. Noise levels for piling and excavation work on the LAR have been predicted to be slightly below the noise level criterion, $L_{Aeq, 30min}$ 75 dB, at the Hoi King Street residential blocks during the daytime (0700–1900); while cumulative impacts from Kowloon Station construction and the cut and cover tunnel construction have been predicted to generate noise levels of 75 dB(A) at the Man Wui and Man Cheong Residences. It is therefore recommended, in light of other concurrent construction activities in the area, that the Government contracts that include the construction of these tunnels should specify mitigation measures (such as a 3.5 m noise barrier on the eastern side of the site for Man Wui and Man Cheong Streets and a 3.5 m noise barrier along the northern site boundary for Hoi King Street/Cherry Street Intersection) to be applied to control noise impacts upon these neighbourhoods. These mitigation measures, as well as proper construction site practice and maintenance will ensure that residents of affected neighbourhoods are not subject to noise levels in excess of the acceptable limit.

Operational Impacts

The maximum equivalent SWL allowable for each of the ventilation shafts openings in the tunnel ventilation building is 96 dB(A). It is recommended that the shaft openings are orientated away from NSRs. In this way higher sound power levels would be permissible, provided that the requirements of the HKPSG are met.

B7.4 MONG KOK DISTRICT

B7.4.1 Tai Kok Tsui Station

Construction Impacts

As the assessment has predicted severe impacts from unmitigated construction activities at many of the NSRs near the proposed Tai Kok Tsui Station, mitigation measures are required. Exceedances of daytime noise limits are above 10 dB(A) in some cases and standard mitigation measures may not be effective in achieving compliance. Therefore, the following are recommended for the station worksite:

- 3.5 m high noise barrier along the northern site boundary of the station;
- 3.5 m high noise barrier along the eastern site boundary of the station;
- moveable noise barriers to enclose piling rigs in operation;
- silenced or 'quiet' plant;
- on–site noise level management.

Mitigation of noise impacts from the Cherry Street underpass should be included in the relevant Government Contracts, since these works are entrusted to Government. The construction of the Cherry Street underpass is potentially responsible for significant impacts, and it is likely that the following would be required:

- 6 m high noise barrier along the northern site boundary of the underpass;
- moveable noise barriers to enclose piling rigs in operation;
- silenced or 'quiet' plant; and
- on–site noise level management.

In light of cumulative impacts it is necessary that the cut and cover tunnel to the south, the underpass and the station be assessed simultaneously. For the benefit of NSRs at the intersection of Cherry and Hoi King Streets, the area hardest hit by cumulative impacts, it is recommended that in addition to the use of noise barriers, site source SWLs be reduced simultaneously at both station and underpass worksites to ensure compliance with the daytime noise criterion. To reduce impacts in the worst case, station site source SWLs should not exceed 120 dB(A) and underpass worksite SWLs should not exceed 118 dB(A). If the construction noise impacts are properly mitigated for this neighbourhood by the implementation of the above mitigation measures, it is expected that all NSRs will be protected from excessive noise.

Operational Impacts

No mitigation is required for train noise.

Acoustic silencers for the station ventilation fans will be necessary, and the attenuation requirement should be defined in the detailed system design to limit the equivalent SWL (overall for all the fans connected) at the ventilation shaft openings to below 86 dB(A).

The equivalent SWL for each of the chiller units should be limited to be 94 dB(A). If noisier units are required, appropriate noise control measures will be required to achieve this limit.

The equivalent SWL for the traction substation building should be limited to below 94 dB(A). The noise reduction due to the housing effect of the station building will be adequate provided that the water cooling option is adopted for the transformers.

B7.5 SHAM SHUI PO DISTRICT

B7.5.1 Tai Kok Tsui – Lai Chi Kok – Kwai Chung Road Viaducts

Construction Impacts

This section of the LAR formation from Tai Kok Tsui to Kwai Chung Road Viaducts will be entrusted works and, therefore, the only construction noise impacts in this area attributable to the LAR will be from the temporary depot at Mei Foo (Contract 520). For activities carried out at the depot during the daytime and evening (0700–2300) it is not considered likely that any unacceptable impacts will arise. However, in order to ensure that the cumulative effect of depot noise and noise from the WKE/LAR construction and operational activities remains within acceptable noise limits a number of mitigation methods may be considered.

In order to minimise wheel squeal the following methods should be considered:

- increasing the radii of curves in the track fan area;
- rail or wheel tread lubrication;
- damped or resilient wheels on rolling stock;
- noise barriers or vehicle skirts.

It is likely that in this case the last of these methods would be impractical or ineffective.

All the noise sources on the depot site can be controlled by screening measures. Building and stockpile placement should be considered in order to screen loading operations and any noisy fabrication work which cannot be contained within buildings. In addition it may be possible to use the northern site boundary fence as a noise barrier by constructing a bank surmounted by a solid fence.

If any noisy night-time (2300-0700) activities are necessary then some or all of the above measures will be necessary, particularly to control wheel squeal, in order to demonstrate that acceptable levels can be achieved when applying for a CNP. It may be necessary for trains to sound their horns, as a safety check before leaving the depot and this practice also has the potential to cause sleep disturbance in the early morning (0530 onwards). It may be necessary to adopt strict operational controls for horn testing.

Impacts upon NSRs in this area, from the Lai King Tunnel South Portal (in Kwai Tsing District) construction works, are discussed in *Section 7.6.1* below.

Operational Impacts

Table B7.5a details the noise barrier requirements for this section of the alignment, locations are specified by reference to the chainage of the AEL Up line, and the boundary between this section (LAR Contract 506) and the section further North (LAR Contract 507) is taken to be at 3000 m on this chainage.

Table B7.5a ***Recommended Noise Barriers For The 86 dB Train***

Barrier Type	Railway Line	NSR Protected	Start Chainage (AEL Up)	Finish Chainage (AEL Up)	Length (m)
Type 2b, 3.8 m absorptive	North of AEL Up	24	2400	3000	600
Type 2b, 3.8 m absorptive	North of LAL Dn	24	2400	3000	600
Type 2, 1.4 m absorptive	North of LAL Dn	25	600	1100	500
Type 2, 1.4 m absorptive	North of AEL Dn	25	600	1100	500
Type 2, 1.4 m absorptive	North of AEL Up	25	600	1100	500
Type 2, 1.4 m absorptive	North of LAL Up	25	600	1100	500

B7.6 *KWAI TSING DISTRICT*

B7.6.1 *Lai King Station*

Construction Impacts

South Portal Worksite

Some windows of WMC Morninghope School facing Kwai Chung Road will be fitted with secondary glazing (as supplied by others to mitigate existing high levels of traffic noise) prior to construction work on this project. It is recommended that all the remaining windows facing the construction site be given secondary glazing prior to the start of construction. The type of secondary glazing to be installed should be an additional internal sealed glass panel and should provide about a 10–15 dB(A) reduction in sound pressure levels inside the school compared to the open window situation.

To further minimise impacts at the school, it is recommended that a 3 m noise barrier be erected around the boundary of the school on the side facing the construction site, prior to any construction activities. It is further recommended that this noise barrier be extended to the east of the school boundary, along Lai King Hill Road, to the eastern edge of the worksite, to protect the other local NSRs on Lai King Hill Road from portal construction impacts.

To mitigate the noisiest phase of the caisson wall construction, it is recommended that all caisson hole formation activities be carried out behind moveable, noise barriers and that wherever possible the ground breaking operations should be carried out during times least likely to affect the operations of the school.

For general construction work in the evening (1900 to 2300) and during general holidays (including Sundays), the maximum noise levels from the site will need to be reduced in order to obtain a CNP to undertake the works. To achieve this further reduction in site source SWLs, it is recommended that equipment associated with the ventilation of tunnels during construction should be placed, where possible, inside the tunnels in order to minimise noise impacts.

Lai King Station and Tunnels

Even with the use of all usual measures of noise control, NSRs (in particular Yeung King House) are likely to experience residual impacts during the noisiest phases of construction. In order to mitigate these effects during the noisy excavation phase it is recommended that the southern section of the construction site should be covered in an effective noise–reducing structure, to form a noise enclosure over the portal area, inside of which all the noisy rock breaking activities can be undertaken.

It is recommended that quiet plant should be used to further reduce noise levels for all phases of work. The Contractor should be required to supply to MTRC the SWLs of all equipment to be used on the site and to submit calculations to demonstrate that compliance with the recommended daytime noise level of $L_{Aeq, 30 min}$ 75 dB is achievable by the chosen plant and methods of working on the site (including the specified noise cover).

A detailed review of the combined effectiveness of a noise cover over the southern section of the site, and the use of quiet plant was carried out. The study showed that for the assumed plant teams, with the noise cover in place, and the SWL of no single item of plant exceeding 115 dB, the number of windows to NSRs where construction noise levels could potentially exceed the daytime assessment criterion of $L_{Aeq, 30 min}$ 75 dB could be reduced from over 1500 windows to dwellings to about twelve. It is anticipated that the chosen contractor will be able to demonstrate that the potential for impacts of less than 3 dB to this small number windows to dwellings in Lai King Estate Blocks 5 and 6 can be avoided by his particular choice of plant and operational procedures.

Noise impacts during the demolition of the Lai King Community Centre are largely due to the assumed use of percussive concrete breaking equipment. It is recommended that percussive breakers are not used for this work, and instead concrete nibblers are employed. Other quiet plant will also be required to achieve the recommended noise level.

In order to reduce noise levels at NSRs on the upper floors of surrounding residential towers it is recommended that loading and unloading should be carried out away from the southern boundaries of the site where practical and materials should be lowered and not dropped. In addition, stationary plant such as compressors and generators should be located away from the southern site boundary or within the noise enclosure.

Although noise levels from construction traffic are not predicted to exceed the criteria given in *Annex A*, the proximity of Lai King Hill Road to NSRs, and the impacts that are already predicted to occur due to construction work on the site itself suggest that, in order to mitigate overall noise levels from construction activities construction vehicles are advised to use Kwai Chung Road if practical.

Blasting activities are likely to result in some form of disturbance in the form of ground vibration and noise to certain NSRs around the South Portal and in a corridor above the tunnel alignments. It is considered that unreasonable constraints on the Contractor would be necessary to fully mitigate these effects. However, it is recommended that the impact of these effects should be reduced by making sure the persons likely to be affected are aware of the source of the disturbance and that the magnitude of blasting has been adequately controlled to minimise the risk of damage to their properties and MTRC structures.

In addition, it is recommended that the disturbance from vibration and noise impacts from blasting could be further reduced by ensuring that all potentially affected persons are aware of the timing of blasting operations. In this way, the potential shock and surprise which may arise from the blasting procedure could be alleviated and particularly sensitive activities could be rescheduled to avoid these periods.

Operational Impacts

Although the requirements for train noise are likely to be met at WMC Morninghope School, the predicted L_{AMax} noise levels are less than ideal and it is recommended that secondary glazing should be applied to all windows of classrooms immediately adjacent to the proposed railway. It has been recommended above that secondary glazing should be supplied to mitigate construction noise impacts, and it is envisaged that since the same windows will be affected by train noise during the operation of the railway, no additional secondary glazing will be required, over and above that supplied prior to the construction works.

It is a requirement of the contractor that he design all fixed plant to meet the required planning noise criterion of 5 dB below the ANL given in the NCO. To achieve this a specific target noise level of 54 dB(A) must be met at Yeung King House. This is likely to necessitate silencers on the tunnel ventilation fans achieving more than 15 dB(A) of attenuation. The rooftop chillers proposed on the station shall be designed with acoustic treatment to the compressors and air intake and discharge to achieve a sound power level of 87 dB(A) each.

On the viaducts north of Lai King station, Type 2 barriers are recommended on the East side of all lines between the station and 50 m beyond the point at which each line passes under the Route 3 structure. For the LAL lines this is a distance of approximately 380 m and for the AEL lines this is a distance of approximately 290 m.

B7.6.2 *Kwai Chung Park*

Construction Impacts

It is recommended that to ensure compliance with the daytime noise level criterion, if necessary, mobile noise barriers be erected as close as is practical to operational plant to screen the Crematorium from construction noise. In addition, a 3 m noise barrier should be erected along the first 100 m of the western boundary of the work site between operational plant and the Crematorium and a 3.5 m barrier will also be required between the Crematorium and any on-site truck loading. Use of these measures will ensure that the Tsuen Wan Crematorium is protected from excessive noise levels.

Operational Impacts

In order to mitigate the possible train noise impacts in Kwai Chung Park it is recommended that a Type 1 barrier should be provided on the west side of the up AEL line and on the east side of the future proposed turnout for the down New Territories Line, for the whole section of the LAR alignment through Kwai Chung Park.

In addition, the design of the Park facilities should consider potential train noise impacts and two mitigation measures should be incorporated. Firstly, the more peaceful recreation activities, and therefore the more noise sensitive, should be located well away from the proposed LAR alignment. Secondly, space provision should be made along the perimeter of open cut sections of the line to allow for bunding or landscaping to hide noise barriers that are to be provided in these areas.

B7.6.3 *Rambler Channel Bridge*

Construction Impacts

Mitigation measures are aimed at the use of inherently quiet plant and phasing to avoid concurrent noisy activities. During the construction noise assessment, it was established that the Crematorium was the critical NSR during the daytime due to its proximity to the worksites. Piers 6 and 7 are the closest bridge worksites to this NSR and they will govern noise levels at the NSR during construction. It is recommended that the contractor is restricted to work on Piers 1 to 5, the Tsing Yi Station worksite and Pier 6 or Pier 7 during daytime hours (0700–1900). If concurrent work on Piers 6 and 7 is required during the daytime, plant on these Piers will need to be further controlled.

During construction of the viaduct, noise from plant is likely to cause impacts at the Crematorium during the daytime (0700–1900) unless work on the viaduct is carried out as far from the Crematorium as is practicable. It is assumed that the Crematorium is not sensitive to noise during the evening and night. When daytime work close to the Crematorium is necessary, it is recommended that only essential items of plant are used and that dump trucks, vibratory equipment and other 'noisy' plant is not used or is acoustically screened or silenced, a maximum daytime SWL of 117 dB(A) is recommended. In addition a 4 m barrier should be erected in front of the viaduct, along its entire length, between all plant in operation and the Tsuen Wan Crematorium.

For general construction work in the evening (1900–2300) and general holidays (including Sundays), Riviera Gardens was identified as an NSR at which significant impacts were possible. Work in restricted hours will require a CNP. In order to minimise impacts mitigation should be included so that concurrent activities of powered mechanical equipment will be limited to not more than four piers. Alternatively, the total SWL for all plant at any one pier could be limited to 115 dB(A).

Night–time work would also require a CNP. To mitigate general noise impacts at all NSRs to an acceptable level during any night time (2300–0700) construction activities, the bridge work should be limited to a maximum of two piers. The total source SWL at any one pier should be below 107 dB(A). The incorporation of these mitigation measures may allow a CNP to be granted.

The Crematorium and the Marine Department Offices are particularly sensitive to noise from percussive piling at Pier 6 (and Pier 7 if piling is required at this pier). Possible mitigation measures include controlling the noise at source by either limiting the number of piling rigs or using quieter equipment. Any percussive piling at Pier 6 should be limited to the hours 0800–0900 and 1230–1330 and 1700–1800, subject to CNP requirements.

Construction of the viaduct may also produce impacts from percussive piling at the Crematorium and it is recommended that noise levels and operating hours are constrained to the hours 0800–0900 and 1230–1330 and 1700–1800, and to comply with the requirements of the NCO in order to minimise impacts.

If required, concurrent work at the viaduct and at Piers 6 and 7 of the bridge is likely to produce impacts at the Crematorium during the day. In this case the control on noise levels and phasing of activities would be necessary.

Whilst not technically an NSR, construction noise levels at the Marine Department Offices are likely to cause significant impacts, and it is unlikely that noise barriers or quiet plant could provide adequate mitigation because the offices are situated within the worksite area. Because the offices are at first floor level, noise barriers would have limited effect, and it is recommended that those facades of the building facing the construction works should be supplied with noise insulation in the form of secondary glazing, and additional air conditioners if required (if the existing air conditioning is inadequate).

Operational Impacts

A noise cover will be required extending from Tsing Yi Station to the sea wall, approximately 50 m in length, to provide noise mitigation for the nearest residents of the Tsing Yi Station.

It is essential to the effectiveness of the wayside noise barriers (along the entire length of the structure) and the noise cover (at the western approach) that the vibrational energy radiated from the bridge structure as airborne noise is controlled to a suitable level. If this is not achieved, these mitigation measures may result in little benefit.

The design of the bridge should be such that for the given LAR rolling stock, trackform (the Sonneville system) and operating conditions, the total noise from the bridge, ie the noise from the direct airborne noise from the train wheel/rail interaction and from noise re-radiated from the bridge structure, measured as $L_{AMax, fast}$ at 25 m in any direction, shall be no more than 1 dB(A) higher than the total train noise measured on ballasted track at grade, at any speed in the range 20–135 kph. (Total train noise excludes noise from train-mounted plant such as air conditioning units, traction motors etc). It is recommended that the contractor should be required to carry out a finite element analysis of the noise radiated from the bridge under the action of a train passing over it. This modelling should be used to demonstrate that the proposed design offers sufficient stiffness and internal damping in the bridge structure to achieve the above stated noise level.

B7.6.4 *Tsing Yi Station and Viaducts*

Construction Impacts

As the assessment has predicted significant impacts from unmitigated construction activities at many of the NSRs near the proposed Tsing Yi Station and Viaducts, mitigation is required to ensure that NSRs are protected from excessive noise levels. Exceedances of daytime noise limits are in excess of 10 dB(A) at some NSRs and, therefore, standard mitigation measures may not be effective in achieving compliance. The following mitigation measures are recommended in order to reduce noise levels at NSRs:

- silenced or 'quiet' plant;
- on-site noise level management;
- 4 m high noise barriers along the north and south sides of the viaducts;
- 3.5 m moveable noise barriers placed next to particularly noisy plant in operation where practical; and
- 5 m high noise barriers along the western site boundary of the station worksite.

It is recommended, for the worst case impacts (NSRs at Cheung On Estate and St. Paul's Village) that compliance with day time limits be achieved by reducing site total source SWLs simultaneously at the station/bus terminus worksite to a maximum of 120 dB and at the viaduct worksite to a maximum of 118 dB(A).

Evening work and Sunday work is not recommended. However, if work must proceed at these times then noise levels and activities will need to be controlled further in order to obtain a CNP. The recommendations for further control include the following.

All construction work on the Bus Terminus which is carried out during evening hours (1900–2300) or all day Sunday (0700–2300) should have a total SWL of not more than 113 dB(A). If Bus Terminus construction is to be carried out in parallel with work from the Station and/or the Viaducts, the following guidelines should be followed:

- If Bus Terminus construction is to be carried out in parallel with Station or Viaduct construction, the total SWL for all plant should not exceed 110 dB(A);

- If Bus Terminus construction is to be carried out in parallel with Station and Viaduct construction, the total SWL for all plant should not exceed 108 dB(A).

- In compiling plant for operations for evening construction activities, the Contractor should consult the list of quiet plant outlined at the beginning of this mitigation section.

All construction work on the Viaducts which is carried out during evening hours (1900–2300) or all day Sunday (0700–2300) should have a total SWL of not more than 111 dB(A). If Viaduct construction is to be carried out in parallel with work from the Station and/or the Bus Terminus, the following guidelines should be followed:

- If Viaduct construction is to be carried out in parallel with Station or Bus Terminus construction, the total SWL for all plant should not exceed 108 dB(A);

- If Viaduct construction is to be carried out in parallel with Station and Bus Terminus construction, the total SWL for all plant should not exceed 106 dB(A).

- In compiling plant for operations for evening construction activities, the Contractor should consult the list of quiet plant outlined at the beginning of this mitigation section.

All construction work on the Station, which is carried out during evening hours (1900–2300) or all day Sunday (0700–2300) must have a total SWL not more than specified values. If the total SWL of plant is expected to exceed the specified value the work should only be carried out during weekday daytime hours (0700–1900) or should be relocated to a site farther away from NSRs.

If Station construction is to be carried out in parallel with work from the Viaducts and/or the Bus Terminus, the following guidelines should be followed:

- If Station construction is to be carried out in parallel with Viaduct or Bus Terminus construction, the total SWL for all plant should not exceed 3 dB(A) less than the appropriate limit listed above;

- If Station construction is to be carried out in parallel with Viaduct and Bus Terminus construction, the total SWL for all plant should not exceed 5 dB(A) less than the appropriate limit listed above.

Operational Impacts

A cover is required over the upper viaducts within the station site extending from the station structure as for at Tsing King Road. Within the station itself the upper tracks will be covered by upper levels of the station and development structure.

A Type 2a barrier is recommended on the south side of the viaducts, and Type 2 barriers on the north side, all extending from the station to pier 6, a distance of approximately 180 m. No barriers are required on the turn out viaducts other than the standard parapet barrier.

To help avoid noise impacts from fixed plant, the following measures should be adopted.

Acoustic silencers for the station ventilation fans will be necessary, and the attenuation requirement should be defined in the system detailed design to ensure compliance with the noise criteria given in *Section 6.5.4*.

Openings to the traction transformer station should be diverted away from sensitive uses. Water cooling of transformers is preferred, but may not be possible, and the allowable equivalent SWL of any openings to the station housing should be limited to below 84 dB(A).

B7.6.5 *Tsing Yi Tunnels*

Construction Impacts

Only Cheung On Estate has been predicted to receive impacts, due to cumulative noise impacts from the tunnelling and pre–tunnelling operations in parallel with Tsing Yi Station/Viaduct construction, which will exceed day time (0700–1900) noise limits. As a result mitigation is recommended specifically for daytime activities. For daytime and evening activities for the Tsing Yi Tunnels, it is recommended that a 3.5 m high noise barrier be erected prior to any construction activities, between the plant in operation and the westernmost tower of Cheung On Estate.

Five NSRs, Cheung Hang Estate, Cheung On Estate, Tsing Yi Estate, Feng Shue Wo THA and Tsing On THA have all been predicted to receive cumulative impacts (from station/viaduct and tunnels) which will exceed evening (1900–2300) or daytime holiday (0700–1900, including Sundays) noise limits. The exceedances of 2–5 dB(A) are not excessive and so the use of the noise barriers specified below for night time activities (4 m site boundary and 3.5 m moveable barriers) and site plant SWL restrictions should be adequate to reduce noise levels to below the evening noise criterion. For evening construction work, total site SWL should be limited to 117 dB(A) in order to comply with NCO regulations. Use of these measures should be adequate to ensure that sensitive receivers are protected from excessive impacts, subject to CNP approval. It should be noted that schools are operational only during daytime hours and so have only been assessed in the light of these noise limits.

It has been predicted, in addition, that there will be significant noise impacts from unmitigated construction activities at local NSRs for night–time (2300–0700) activities. Any night time working will require a CNP and the exact mitigation measures will be agreed between the Contractor and the EPD. However, the following mitigation measures may be adequate to ensure that NSRs are protected from excessive noise levels.

As exceedances of night time noise levels are in excess of 15 dB(A) at some of the nearby NSRs (Cheung Hang Estate, Cheung On Estate), standard mitigation measures are unlikely to be effective in achieving compliance with the applicable noise limits. Therefore, a number of special options are recommended in order to reduce noise levels at NSRs. These are the use of:

- silenced or 'quiet' plant;
- on-site noise level management;
- 3.5 m moveable noise barriers placed next to plant in operation where practical;
- 4 m high noise barriers along entire site boundary; and
- night-time restrictions on plant and activities.

To reduce noise levels at the worksite for night time activities, wherever possible, mobile plant and equipment should be placed within the tunnel portal between 2300-0700. In addition, no spoil material should be removed by truck between 2300-0700 hours unless it can be carried out in an acceptable manner. Similarly no site clearance, access road or building construction should be undertaken between 2300-0700. Use of these mitigation measures, plus the noise barriers and silenced equipment, should ensure that local NSRs are protected from noise levels in exceedance of the criteria specified in the NCO.

Operational Impacts

No mitigation measures are required for the operational phase.

B7.7 TSUEN WAN DISTRICT

B7.7.1 *Lantau Fixed Crossing*

Construction Impacts

To comply with the relaxed limits of the ExCo Exemption of the NCO it is recommended in the LFC EA that "at-source" mitigation measures, such as quiet plant, acoustic enclosures and mobile noise barriers, should be employed. In addition, noise insulation is recommended for all of the identified NSRs in North Lantau and on Ma Wan Island.

Operational Impacts

The relevant studies have recommended specific mitigation measures to minimise the noise generated by the movement of trains over the three elements of the LFC. These are described as follows:

- For the Tsing Ma Bridge a tender addendum was issued for incorporation into the contract, specifying a very particular trackform design; and

- For the Kap Shui Mun and Ma Wan Viaducts an ERS, giving very specific requirements for the trackform and its supporting structure, was included in the contract tender documents.

The normal noise limits set in the NCO have been relaxed for the LFC due to the exceptional engineering constraints involved in the design, and the implied noise impacts have been accepted by Government.

B7.7.2 *Lantau Tunnels*

Construction Impacts

The relocation of Tsing Chau Tsai village has removed the only NSR in this area, consequently no mitigation measures will be required.

Operational Impacts

As discussed in *Section 6*, residents in Tsing Chau Tsai village will have been relocated prior to the opening of the LAR. This being the case, no mitigation of train noise is required at the western portal. It is recommended that the design of the traction station at the eastern portal ensures that an equivalent sound power level of 99 dB(A) is achieved for each of the two ventilation shafts and for the overall noise breakout from the transformer station.

B7.8 *ISLANDS DISTRICT*

B7.8.1 *Introduction*

In general, the recommendation of mitigation measures for the construction activities along the North Lantau coast do not fall within the remit of this study, as the construction works will be entrusted to Government, and they will be responsible for ensuring adequate mitigation is incorporated into the relevant Contracts. There are two areas where this will not be the case, these are the Depot at Siu Ho Wan and the Section of the LAL comprising Tung Chung Station and Tunnels. The mitigation measures for construction works in these two areas are discussed below.

The mitigation measures for the operation of the railway are assessed for the whole of this section of the alignment, and are reported under three separate headings.

B7.8.2 *Siu Ho Wan Depot*

Construction Impacts

No noise mitigation measures, other than proper construction site practice and maintenance, will be required as no significant noise impacts are predicted during the construction phases.

Operational Impacts

The NSRs are assumed to be in the worst possible location within the areas of noise sensitive land use shown in the outline development plan of the area. The assessment has shown that the depot will comprise many noise sources that could impact these NSRs, in particular train noise, wheel squeal and train mounted plant noise are likely to cause impacts if no mitigation measures are adopted in the Depot design.

It is recommended that mitigation measures should be incorporated into the planning and design of the noise sensitive uses identified such that there is an element of built-in noise screening. It is considered that this would be good planning practice. However it is also recognised that this may place unwanted restrictions on potential developers of the sites, and no such screening has been assumed in the assessment (ie the worst case has been assessed, with sensitive facades looking onto the Depot).

Wheel Squeal

The following methods are available to minimise wheel squeal:

- rail or wheel tread lubrication;
- damped or resilient wheels; and
- damped rails.

The rails in the fan area will be lubricated, either by railside greasers, or by a train mounted method. In addition, the train wheels will be damped by the laminated web wheel design. This is expected to reduce the incidence of wheel squeal considerably. Because of the nature of the mechanism that produces wheel squeal it is not possible predict how often wheel squeal will result if these forms of mitigation are implemented. In order to consider the likely reduction in the $L_{Aeq, 30\,min}$ noise levels that could be achieved, it is assumed that the number of wheel squeals resulting with mitigation can be reduced by a factor of 8. This would result in a reduction in the $L_{Aeq, 30\,min}$ noise level from wheel squeal of about 9 dB, and this would reduce the total noise level from train movements to about $L_{Aeq, 30\,min}$ 50 dB and hence the $L_{Aeq, 30\,min}$ assessment criterion would be achieved.

It is unlikely that these forms of mitigation would result in a significant reduction in the L_{AMax} noise level of wheel squeal, and hence it is likely that the assessment level of L_{AMax} 60 dB will be exceeded (a level of about L_{AMax} 68 dB is predicted). Hence the predictions suggest that impacts will result. It is unlikely to be practical or particularly effective to damp the rails in the fan area, but further mitigation could be achieved by the use of noise barriers or a noise cover in the fan area. However, since it is not possible to know if wheel squeal will result in annoyance at nearby residential areas, it is not considered appropriate to install such additional mitigation measures initially. The development of Tai Ho Wan area 27 (and other noise sensitive sites) will take place as part of the phase 4 reclamation in about 2011. Hence, it is recommended that the depot is designed in such a way that noise barriers or a noise cover could be installed, if required at a later date.

Before the opening of adjacent noise sensitive developments, an assessment of the actual level of wheel squeal (and other noise sources from the depot), and their potential for annoyance at nearby NSRs should be undertaken, and the appropriate mitigation installed at that time.

Train mounted Plant

Noise from train mounted plant passing into the western train washer is expected to produce excessive noise levels between 0100–0130 at area 27. It is therefore recommended that, if proven necessary, all unnecessary train mounted plant including air conditioning units should be turned off before the trains approach the entrance to the depot. Additionally the movements of trains should be controlled so as to prevent queuing at the approach to the depot.

The following operational practices should be adopted to control noise emissions from stabled trains:

- all train mounted plant should be turned off on empty trains that are not being cleaned;
- train mounted plant, other than air conditioner units, should be switched off if not needed, on trains being cleaned; and
- trains should be stabled at the east end of the stabling area whenever possible.

Train Exterior Washer

The train exterior washer building should be designed to achieve an overall sound power level of 89 dB(A). This is likely to require the total enclosure of noisy pieces of equipment, and enclosing the washing operation as far as is possible.

Central Chiller Compound

The chillers should be designed with acoustic treatment to achieve a total SWL of 97 dB(A). If this cannot be achieved by treatment "at source", acoustic screens should be designed to enclose the compound.

Main Depot Building

The assumed noise insulation offered by the building envelope is 25 dB(A). This implies a noise level of about 55 dB(A) immediately outside the building. However a higher level can be tolerated without risk of exceeding the assessment criterion, and it is recommended that the building envelope and all building services noise emissions should be designed to achieve a level of 60 dB(A) at 1 m from any part of the building.

Other buildings and Facilities

A number of potentially noisy buildings and facilities will be included within the depot site, such as a traction substation, an underfloor wheel lathe building, and other ancillary buildings. Because the limited scope for mitigation of some external noise sources such as train noise and train mounted plant noise is limited, it is recommended that these buildings be designed to achieve substantial mitigation wherever practicable. The design for each building should achieve a noise level no higher than $L_{Aeq, 30\ min}$ 40 dB at the nearest NSR

Other Noise Sources

It may be necessary for trains to sound their horns, as a safety check before leaving the depot and going into service. This practice has the potential to cause sleep disturbance in the early morning (0530 onwards). In order to avoid disturbance to local residents it may be necessary to adopt strict operational controls, such as designating a location distant from NSRs, or even a building or enclosure, for horn testing. Alternatively a low level, or low pressure (for air powered horns), testing procedure may be possible.

Further operational noise control procedures may be required for other noisy outdoor activities. For example the use of public address systems may need to be controlled to avoid annoyance at nearby NSRs. These sources should be assessed following the opening of the depot, so that appropriate mitigation measures can be adopted prior to the opening of the nearby noise sensitive developments planned for around 2011.

B7.8.3 ***Lantau Formation and Viaducts***

Construction Impacts

The construction of this section of the LAR will be entrusted to Government. The specification of the required mitigation measures should be included in the relevant Government contracts.

Operational Impacts

At Yam O, near Luk Keng Tsuen village, it may be necessary to provide barriers to protect the village from train noise impact. However, because of the proposals for a river/coastal feeder terminal near Kuk Keng Tsuen this recommendation should be reviewed when more information on these proposals is available. It is therefore recommended that provision for the following barriers is made, subject to the results of the recommended future assessment.

Provision should be made for a Type 2, 1.4 m absorptive barrier 2575 mm to the north of the centre of the northern line, stretching roughly 1000 m west from Yam O Station.

It is recommended in *Section B5.7.1*, that a further assessment of train noise impacts to the planned development sites in Tai Ho Wan should be carried out when site layouts are available. However, the results of the preliminary (worst case) assessment suggest that there is potential for impacts from train noise in development areas 14, 15, 18, 22 and 27. It is therefore recommended that the design of the LAR in this region should make provision for the following barriers:

- Type 2a barriers to the north of both lines, approx length 1400 m; and
- Type 1 barriers to the south of both lines, approx length 900 m each.

In this way, it can be assured that the barrier requirements that are recommended in the future detailed assessment of the development sites can be accommodated at that time. It should be noted that it is possible that the actual barrier requirements will be less than that for which provision will have been made, as a result of self screening and mitigation offered within the development sites, and if the actual train noise level is lower than the 86 dB assessment level.

B7.8.4 Tung Chung

Construction Impacts

Construction of the AEL through Tung Chung will be entrusted to Government and the specification of the required mitigation measures should be included in the relevant Government contracts. This section describes the mitigation measure recommended for the construction of the LAL station and tunnels in Tung Chung.

It is understood that Tai Po Village will be relocated prior to construction activities. As the Youth Camp has not been designated for relocation, appropriate mitigation should be employed on site to ensure that evening and night–time activities do not exceed the noise criteria specified in the NCO. These mitigation measures would be agreed between the Contractor and the EPD in order that a CNP could be issued for the works. However, the following gives an indication of the level of mitigation that would be required.

As exceedances of evening (1900–2300) noise levels would be in excess of 10 dB(A) at the Youth Camp, standard mitigation measures may not be effective in achieving compliance with the applicable noise limits. There are a number of special options available to reduce high noise levels at NSRs from construction works, these include use of:

- Silenced or 'quiet' plant;
- on–site noise level management;
- moveable noise barriers placed next to noisy plant in operation, such as piling rigs;
- 4 m high noise barriers along the station's east site boundary; and

- 3.5 m high noise barrier along the south site boundary of the cut and cover tunnel construction site, 200 m in length, centred above the Youth Camp.

Quiet plant or reduced plant teams should be employed during evening hours (1900–2300) such that station site SWLs are limited to a maximum level of 118 dB(A) and cut and cover tunnel site SWLs are limited to a maximum level of 115 dB(A).

Use of these measures should be effective in reducing noise impacts at the Youth Camp from LAR construction activities, during the hours 1900–2300, to levels in compliance with NCO requirements. It is likely that nighttime working would only be possible if noise insulation is supplied.

Operational Impacts

In Tung Chung the following mitigation measures are required to ensure that train noise from the AEL and LAL is at acceptable levels.

Although no impacts are expected at the HOS RS site south of the LAL station, a further assessment should be completed to review this finding once detailed information on the site layout is available. This will be particularly important if the recommendations of the NLE EA are not adopted.

The noise barriers required for the optimized barrier scenario, comprising the following. Barrier lengths reference to the NLE interchange, are measured from the central north/south axis of the interchange.

- A Type 2b, 3.8 m high absorptive barrier on the northern side of the AEL Down line (the northern of the two AEL lines) from the southern end of the Sea Channel Bridge (approximately 900 m from west of the NLE Interchange) to 950 m east of the NLE interchange;

- A Type 2, 1.4 m high absorptive barrier on the northern side of the AEL Up line (the southern of the two AEL lines) from the southern end of the Sea Channel Bridge (approximately 900 m from west of the NLE Interchange) to 950 m east of the NLE interchange;

- A 260 m long enclosure over the AEL lines from 120 m west of the central (north/south) axis of the NLE interchange to 380 m west of that point;

- A 6 m high enclosure over the LAL lines extending for 220 m to the east of the LAL tunnel portal;

  It is recommended that provision is made for the following mitigation measures that are indicative of the additional mitigation likely to be needed when Site R1(y) is developed (scheduled for after the phase 4 reclamation in 2011);

- The Type 2b barrier on the AEL Down line should be extended by 300 m at the eastern end to reach a point 1250 m east of the NLE interchange; and

- The Type 2, 1.4 m high absorptive barrier on the northern side of the AEL Up line should be extended to reach a point 1250 m from interchange;

- The enclosure should be extended by 330 m to be 550 m long.

A further assessment will be required for Site R1(y) when information on the proposed site layout is available.

The enclosures recommended above protect NSRs on only one side of the railway, and can therefore be open on the other side avoiding the need for mechanical ventilation.

Fixed Plant

The equivalent sound power level for each of the ventilation shafts of the station ECS should be limited to 88 dB(A). It is recommended that the shaft openings are orientated away from NSRs. In this way higher sound power levels would be permissible, provided that the requirements of the HKPSG are met. Controls on noise emissions from the other station plantrooms and the tunnel ventilation buildings should be carried out as the design proceeds.

B7.8.5 *Airport Works*

Construction Impacts

As a result of high night-time noise levels at NSRs, the NAMP EIA recommended both "at source" and "at receiver" mitigation measures. To mitigate noise at source the study recommended the construction of a +10 m PD berm at the southern tip of Chek Lap Kok (to break the line of sight between NSRs and noise generating plant), the use of rock drills with a SWL not in excess of 110 dB(A) and planning of the excavation phase to shield Tai Po from noise generating plant. To mitigate noise at receiver, noise insulation was recommended for 19 units within Tai Po Village and 40 units at San Tau Village.

Operational Impacts

The requirements for train noise mitigation for the Sea Channel Bridge are discussed in *Section B7.8.4* above. The Sonneville track mounting system is expected to provide adequate vibration isolation of the tracks on the bridge, based on the current assumptions for the performance of the Sonneville system, and that the bridge is concrete in construction.

No train noise mitigation measures are required on Chek Lap Kok Island.

Annex C

Air Quality Impacts

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C1 *INTRODUCTION*

C1.1 *SCOPE AND PURPOSE OF THE ANNEX*

This annex addresses the air quality impacts of the construction and operation of the Lantau and Airport Railway (LAR).

The annex is largely concerned with identifying the likely impacts of dust, particularly during the construction of the LAR. Other pollutants which have been considered, during both the construction and operational phases, include landfill gas, odours and ozone. Measures for the mitigation of the air quality impacts identified are also recommended.

C1.2 *ORGANISATION OF THE ANNEX*

The remainder of the Annex is arranged as follows:

- *Section C2* describes the baseline air quality in the vicinity of the alignment of the LAR.
- *Section C3* identifies the potential sources of air quality impacts.
- *Section C4* describes the basic methodology applied in the assessment of air quality impacts.
- *Section C5* predicts the extent and magnitude of impacts during both the construction an operational phases.
- *Section C6* evaluates the significance of the predicted impacts by reference to the criteria set out in *Annex A* for use in the LAR EIS.
- *Section C7* describes the measures recommended for the mitigation of adverse air quality impacts.

C2 BASELINE CONDITIONS

C2.1 INTRODUCTION

This Section describes the baseline air quality conditions along the proposed LAR alignment. The baseline conditions provide a description of the existing and future background levels of air pollution in these areas against which the extent and magnitude of air quality impacts likely to arise during the construction and operation of the LAR may be compared.

The baseline conditions are described under three headings:

- Existing conditions;
- Future conditions; and
- Sensitive receptors.

C2.2 EXISTING CONDITIONS

Data on existing air quality has been taken from the following sources:

- EPD monitoring stations; and
- Previous environmental studies undertaken in relation to the LAR.

The various data available are shown in *Table C2.2a*.

C2.3 FUTURE CONDITIONS

C2.3.1 *General*

Prior to the construction of the LAR commencing, the construction of a number of other infrastructure and core airport projects will have started. Indeed, some of these, such as the entrusted works for the North Lantau Expressway (NLE), have already begun. These projects will cause impacts on air quality which may significantly change the existing conditions recorded in the results of the monitoring reported in *Section* C2.2.

In addition, by the time that the LAR becomes operational, these core projects and other developments which will have impacts on air quality will have to be taken into account in defining the baseline conditions for the assessment of the operational impacts of the LAR.

This section therefore sets out, as far as is possible, the information which is available regarding the impacts of such other developments, so that the future baseline conditions may be defined. *Table C2.3a* lists the key previous environmental reports which have been undertaken in relation to such developments which have been reviewed and taken account of in defining the future baseline conditions for the LAR EIS.

Table C2.2a Existing Air Quality Monitoring Results ($\mu g\ m^{-3}$)

Location	Yearly TSP Average	Daily TSP Average	Hourly TSP Average	Yearly RSP Average	Daily RSP Average	Hourly RSP Average
Central and Western[1]	75	220	n/a	60	158	n/a
Tsim Sha Tsui[1]	71	214	n/a	53	135	n/a
Sham Shui Po[1]	105	236	n/a	75	169	n/a
On King House[2]	n/a	98	n/a	n/a	56	n/a
Kwai Chung[1]	95	225	n/a	53	165	n/a
East Tsing Yi[3]	121	n/a	48	n/a	n/a	n/a
Ma Wan Chung[4]	n/a	n/a	n/a	7	n/a	48
North Lantau[4]	40	80	n/a	n/a	20	40
Tung Chung[4]	15	n/a	n/a	15	n/a	n/a

Sources: (1) EPD Air Quality Monitoring Stations, 1991 Results.
(2) Route 3 EIA.
(3) North Lantau Expressway EIA.
(4) North Lantau Development Study.

Table C2.3a Key Previous Environmental and Other Studies Reviewed in the LAR EIS

Airport Railway Feasibility Study
Central and Wanchai Reclamation Development Phase 1 Focused Environmental Assessment Study
Draft Ma Wan Environmental Impact Assessment
Lantau Fixed Crossing Environmental Assessment
New Airport Masterplan Environmental Assessment
North Lantau Expressway Environmental Assessment Report
North Lantau Development Study
Route 3 Study Technical Report 19: Environmental Assessment
Tung Chung Town Centre Study
West Kowloon Reclamation Study Environmental Assessment
West Kowloon Expressway Environmental Assessment
Western Harbour Crossing Study

C2.3.2 *Central and Yau Tsim Districts*

The worst case dust concentrations predicted as occurring during the construction phase of the Central and Wanchai Reclamation are shown in *Table C2.3b.*

The major components of the West Kowloon Reclamation (WKR) will have to be completed before work on the LAR construction can commence and, therefore, cumulative dust impacts are not considered to be significant.

After completion of the reclamations, depending upon changes in emission controls (especially for vehicles), the major sources of air pollutants affecting the Central and Yau Tsim areas are unlikely to change a great deal. It is expected that the air quality of the two areas may deteriorate slightly due to increase in traffic flows on new road networks associated with the WKR and Central Reclamation and their associated developments.

C2.3.3 *Mong Kok and Sham Shui Po Districts*

The major sources of air pollutants affecting these Districts are again unlikely to alter a great deal, although some deterioration due to increases of traffic on new trunk road networks planned to go through the WKR and feeder roads serving the associated developments can be expected.

C2.3.4 *Kwai Tsing District*

Apart from the planned major highways which will pass through the area, such as Route 3 and the proposed expressway to the new airport, there will be no new major sources of air quality impacts in the vicinity of the LAR

Table C2.3b *Predicted Worst Case 1-hour Average TSP Concentrations at Sensitive Receivers in Central during Construction of the Central and Wanchai Reclamation*

Receiver		TSP Concentration ($\mu g\ m^{-3}$)
2.	90 Connaught Road Central	100
3.	Sincere Building	108
4.	International Building	115
5.	New Hang Seng Bank Building	117
6.	24–32 Connaught Road	110
7.	Wang Kee Building	98
8.	Chuang's Plaza	97
9.	Win Lung Bank Building	93
10.	Fung House	86
11.	Euro Trade Centre	83
12.	World Wide House	79
13.	Swire House	80
14.	Mandarin Oriental	82
15.	General Post Office	155
16.	Exchange Square	142

Source: Central Reclamation Phase 1 Focused EIA Study, Table 3.14, pp. 3–21.

alignment in this District. It is anticipated that the future air quality in terms of TSP, RSP and NO_x may deteriorate due to the additional traffic flows on these new proposed trunk roads.

C2.3.5 *Tsuen Wan and Islands Districts*

On Lantau, the future air quality will be affected by the proposed NLE, Lantau Fixed Crossing (LFC), local traffic, industrial, domestic and commercial emissions associated with the North Lantau Development (NLD) on top of the background air quality. The future air quality of the area was predicted in the LFC and NLE environmental assessments and the results are shown in *Tables* C2.3c and C2.3*d*.

Table C2.3c ***Predicted Pollutant Concentrations – Operation Stage of Lantau Fixed Crossing (including Background)***

Sensitive Receiver	CO (1 hr) (ppm)	CO (8 hr) (ppm)	NO_2 (1 hr) (ppm)	NO_2 (24 hr) (ppm)	RSP (24 hr) $\mu g\ m^{-3}$
Tso Wan	1.6	1.2	0.08	0.04	80
Dockyard 1 (Tsing Chau Wan)	1.6	1.2	0.08	0.04	80
Dockyard 2 (Tsing Chau Wan)	1.6	1.2	0.08	0.04	80
Dockyard 3 (Tsing Chau Wan)	1.7	1.2	0.08	0.04	80

Source: Lantau Fixed Crossing EIA Final Report, Table 2.21, P.2.18.

Table C2.3d ***Predicted Pollutant Concentrations ($\mu g\ m^{-3}$) at Wan Tuk***

Pollutant	Averaging Time		
	1 – Hour	8 – Hour	24 – Hour
CO	240	221	N.A
RSP	57	N.A	31
NO_2	226	N.A	132

Note: N.A. denotes *Not Available*
Source: North Lantau Expressway EIA, Table 5.4, P.5/10.

The future air quality of the area will still remain within the AQO. Future background air quality will also be affected by the new Black Point power station in the New Territories which could increase the levels of NO_x, CO and SO_2 in North Lantau by the year 2011 and the New Airport at Chek Lap Kok. The future air quality of the area was predicted in the NLD EA – Topic Report 10. The study predicted pollutant concentrations at Ma Wan Chung which should give a general view of the future air quality for the

Tung Chung area. *Table C2.3e* shows the pollutant concentrations predicted at Ma Wan Chung.

Table C2.3e ***Predicted Air Quality in Ma Wan Chung***

Pollutant	Pollutant Concentrations ($\mu g\ m^{-3}$) (AQO in bracket)	
	Yearly Average	1–hour Average
NO_2	30 (80)	200 (300)
CO	–	1487 (30,000)
SO_2	17 (80)	392 (800)
RSP	7 (55)	48 (180)

Source: North Lantau Development Environmental Assessment – Topic Report 10, Mott MacDonald Ltd., 1991.

The New Airport Master Plan (NAMP) EA assessed the air quality impacts from the operation of the airport. The modelling results showed that no significant air quality impacts will result from the operation of the airport and the predicted Carbon Monoxide (CO) and Nitrogen Dioxide (NO_2) levels were well within the AQOs.

C2.4 SENSITIVE RECEPTORS

C2.4.1 *Definition of Sensitive Receptors*

The HKPSG define sensitive uses generally as *"land uses which, by virtue of the nature of the activities thereon or the resources therein, are susceptible to the influence of residuals or physical changes generated by polluting uses"* [1]. Specifically in relation to air quality impacts, the following are defined as sensitive uses:

- Residential areas;
- Nurseries;
- Homes for the aged;
- Hospitals and clinics;
- Schools; and
- Active recreational activities [2].

The following paragraphs describe the locations of the Air Sensitive Receptors identified in relation to the alignment of the LAR.

(1) Environmental Protection Department/Planning Department (1991) - "Environmental Guidelines for Planning in Hong Kong: An Extract from the Hong Kong Planning Standards and Guidelines" - Hong Kong Government - Appendix 2.1, pp18.

(2) Environmental Protection Department/Planning Department (1991) - Ibid - Appendix 3.2, pp.27.

C2.4.2 *Location of Air Sensitive Receptors*

Central and Yau Tsim Districts

Sensitive receptors were identified along the southern boundary of the works area for the LAR Hong Kong Station construction site, and they are mainly offices with centralized ventilation systems. These receptors may also be affected by the works for the Immersed Tube Tunnel. The identified sensitive receptors are:

1. Harbour Building.
2. 90 Connaught Road Centre.
3. Sincere Building.
4. International Building.
5. New Hang Seng Bank Building.
6. 24–32 Connaught Road.
7. Wang Kee Building.
8. Chuang's Plaza.
9. Win Lung Bank Building.
10. Fung House.
11. Euro Trade Centre.
12. World Wide House.
13. Swire House.
14. Mandarin Oriental.
15. General Post Office.
16. Exchange Square.
17. City Hall.
18. Prince of Wales Building.

The nearest sensitive receptors that will be exposed to the construction dust impacts from the construction of the LAR identified along the existing waterfront of West Kowloon are:

19. Ferry Street, Yau Ma Tei (Residential).
20. Man Cheong Street, Yau Ma Tei (Residential).
21. King George V Park, Jordan (Park, with active recreational uses).
22. Canton Road, Tsim Sha Tsui (Government Medical/Dental Clinics).
23. Canton Road, Tsim Sha Tsui (Residential).
24. Canton Road, Tsim Sha Tsui (Kowloon Park with active recreational uses, Schools and Hotels).

The locations of these are shown in *Figure C2.4a*

Mong Kok and Sham Shui Po Districts

The sensitive receptors which were identified in relation to this section of the LAR and West Kowloon Expressway (WKE) Alignment are:

25. Man Cheong Street, Yau Ma Tei (Residential).
26. Hoi King Street, Tai Kok Tsui (Residential).
27. Wong Tai Street (Residential)

28 Cherry Street (Residential)
29 Sharon Lutheran School,
30 Ming Kei College
31 Mei Foo Sun Chuen, Lai Chi Kok (Residential).
32 Mei Foo Sun Chuen, Lai Chi Kok (Community Centre).
33 Mei Foo Sun Chuen, Lai Chi Kok (Delia Memorial School).
34 Waterfront Annex of Haking Wong Technical School, Lai Chi Kok (Technical school).
35 Fat Tseung Street Temporary Housing Area, Sham Shui Po (Temporary housing area).
36 Nam Cheong Estate, Sham Shui Po, (Residential).
37 Nam Cheong Estate, Sham Shui Po, (Public open space).

The locations of these are shown in *Figure C2.4b*

Kwai Tsing District

The sensitive receptors identified along the LAR alignment between Lai King and Tsing Yi are:

38 Princess Margaret Hospital, Government School of General Nursing and Quarters, Kwai Chung (Hospital, School and quarters).
39 Ching Lai Court, Kwai Chung (Residential).
40 Yuet Lai Yuen, Lai King (Residential).
41 Block 1, Lai King Estate (Residential).
42 Block 3, Lai King Estate (Residential).
43 Block 4, Lai King Estate (Residential).
44 Block 5, Lai King Estate (Residential).
45 Block 6, Lai King Estate (Residential).
46 Lok Sin Tong Lau Sai Yan School, Lai King.
47 Yin Lai Court, Lai King (Residential).
48 Chan Nam Cheong Memorial College, Lai King.
49 Winifred Mary Cheung Morninghope School.
50 Crematorium, Kwai Chung.
51 Riviera Gardens, Kwai Chung (Residential).
52 St Paul's (Lam Tin Village), Tsing Yi (Residential).
53 Tsing Yi Estate, Tsing Yi (Residential).
54 Chueng On Estate, Tsing Yi (Residential).
55 Cheung On Estate, Tsing Yi (School).
56 Ching Tai Court, Tsing Yi (Residential).
57 Tsing Yi Estate, Tsing Yi (School).
58 St Paul's (Lam Tin Village), Tsing Yi (School).

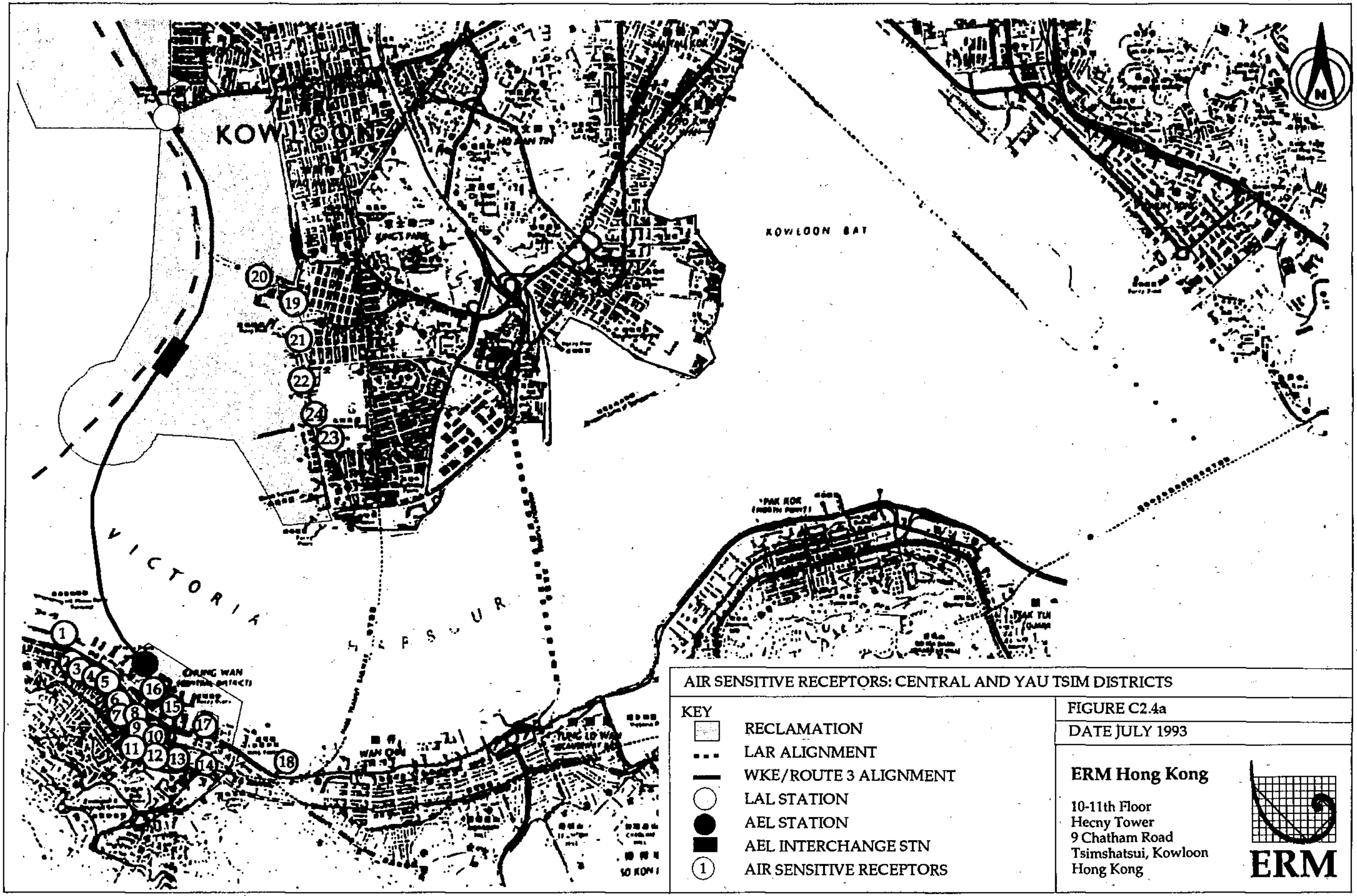
The locations of these are shown in *Figure C2.4c*

Tsuen Wan and Islands Districts

The sensitive receptors identified along the LAR alignment on Ma Wan and Lantau Island are:

59 Tung Wan Bay
60 Tin Liu (Residential).
61 Football Ground on Ma Wan (Active Recreation).
62 Ma Wan Town (Residential).
63 Lau Fa Village (Residential).
64 Tso Wan (Residential).
65 Sha Lau Tong Wan
66 Wan Tuk (Hut)
67 Yiu Lian Dockyard (proposed)
68 Luk Keng Tsuen A
69 Luk Keng Tsuen B
70 Tin Tsui Tau, Yam O
71 Tai Ho Wan (Temple)
72 Tai Ho Wan B
73 Ngau Kwu Long
74 Pak Mong
75 Ka Loon Tsuen
76 Tai Po (Residential).
77 Tai Po Youth Camp (Residential).
78 Ma Wan Chung (Residential and Places of Worship).
79 Sha Lo Wan (Residential).
80 Kau Liu (Residential).
81 Tin San (Residential).
82 San Tau (Residential).
83 Tung Chung (Recreation Camp).
84 Sha Tsui Tau.

The locations of these are shown in *Figure C2.4d*



AIR SENSITIVE RECEPTORS: CENTRAL AND YAU TSIM DISTRICTS

FIGURE C2.4a

DATE JULY 1993

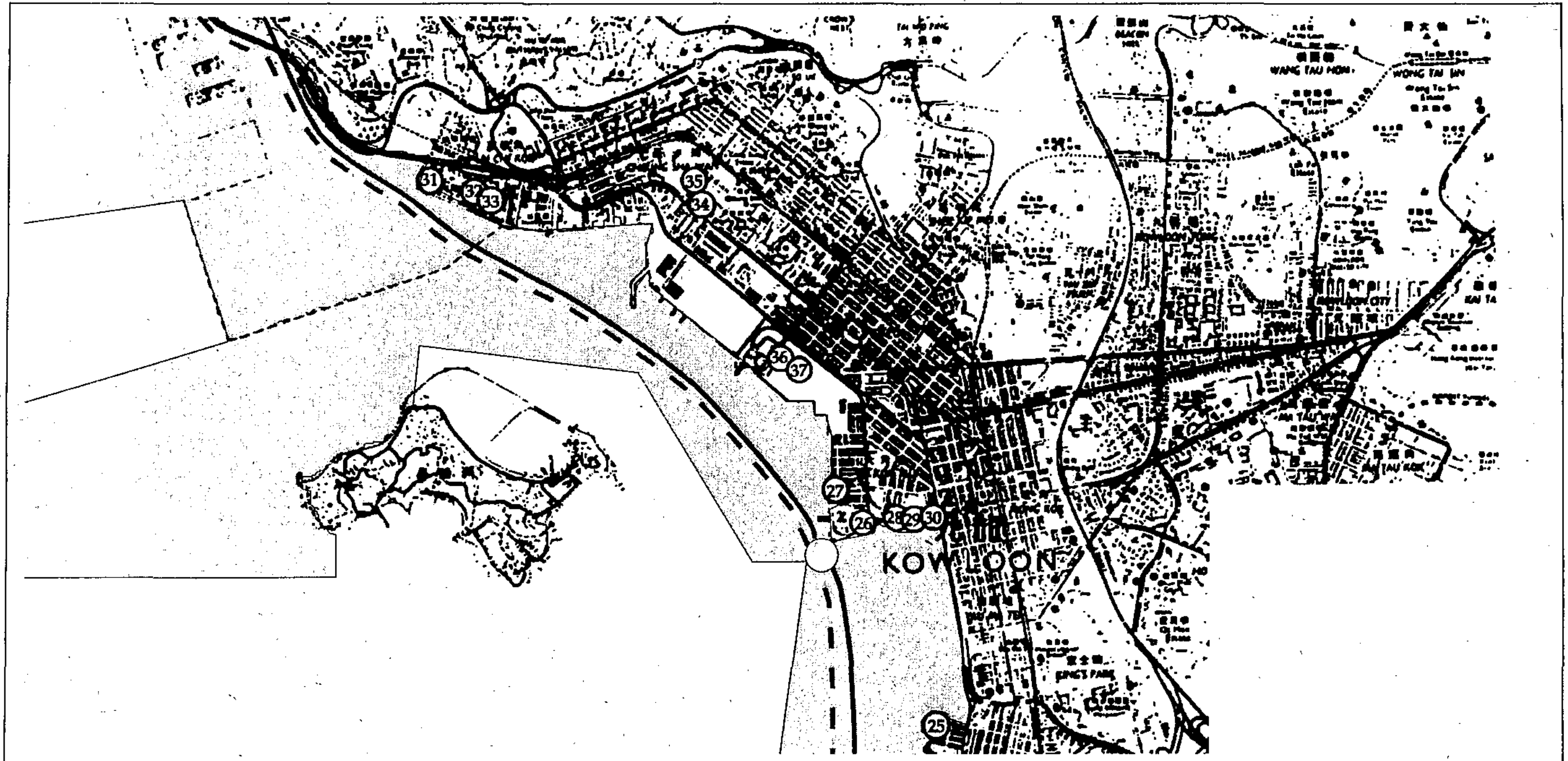
KEY

- RECLAMATION
- LAR ALIGNMENT
- WKE/ROUTE 3 ALIGNMENT
- LAL STATION
- AEL STATION
- AEL INTERCHANGE STN
- (1) AIR SENSITIVE RECEPTORS

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



AIR SENSITIVE RECEPTORS: MONG KOK & SHAM SHUI PO DISTRICTS

FIGURE C2.4b

DATE JULY 1993

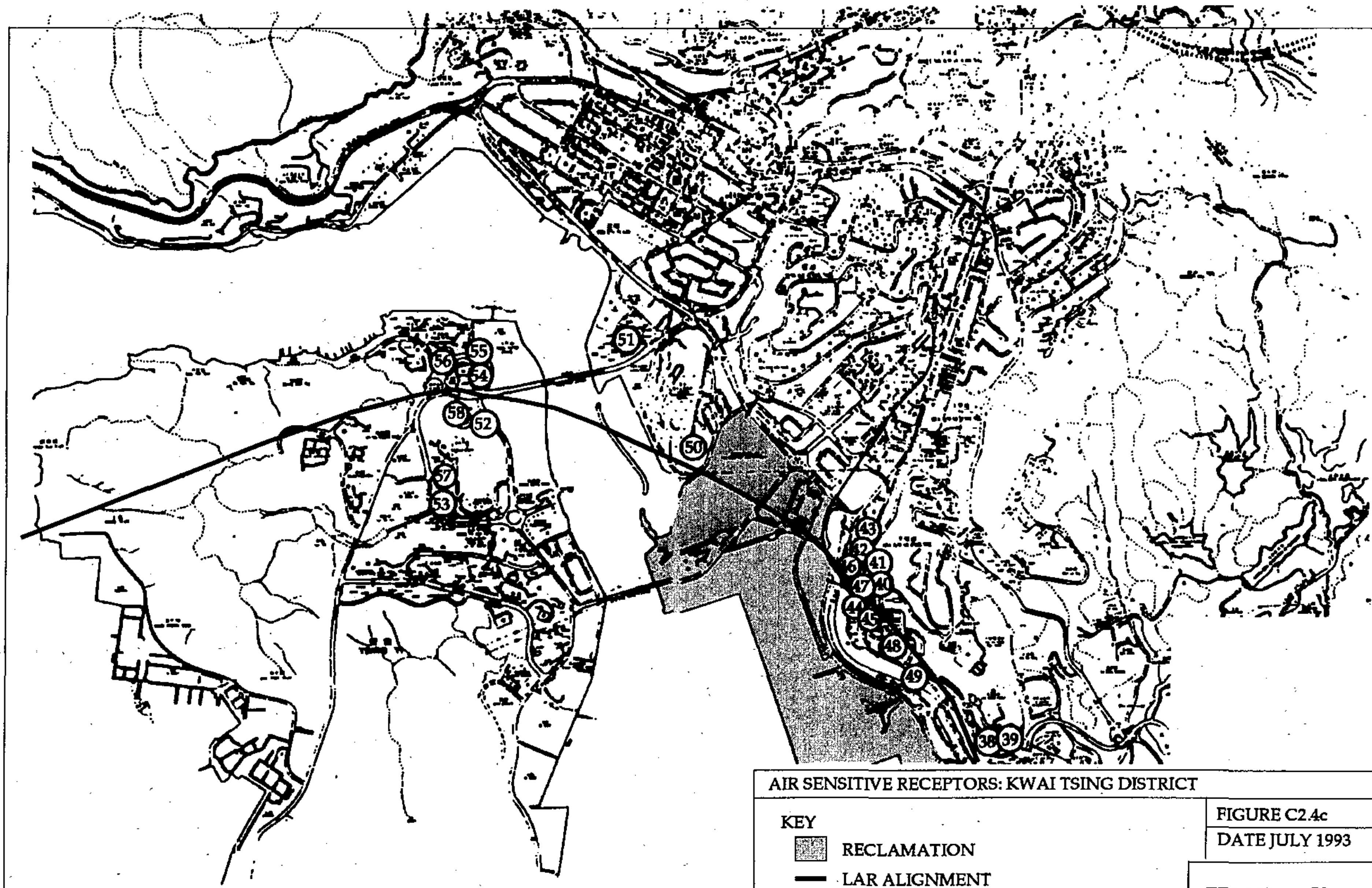
KEY

- RECLAMATION
- LAR ALIGNMENT
- WKE/ROUTE 3 ALIGNMENT
- LAL STATION
- (1) AIR SENSITIVE RECEPTORS

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



AIR SENSITIVE RECEPTORS: KWAI TSING DISTRICT

KEY

RECLAMATION

LAR ALIGNMENT

(1) AIR SENSITIVE RECEPTORS

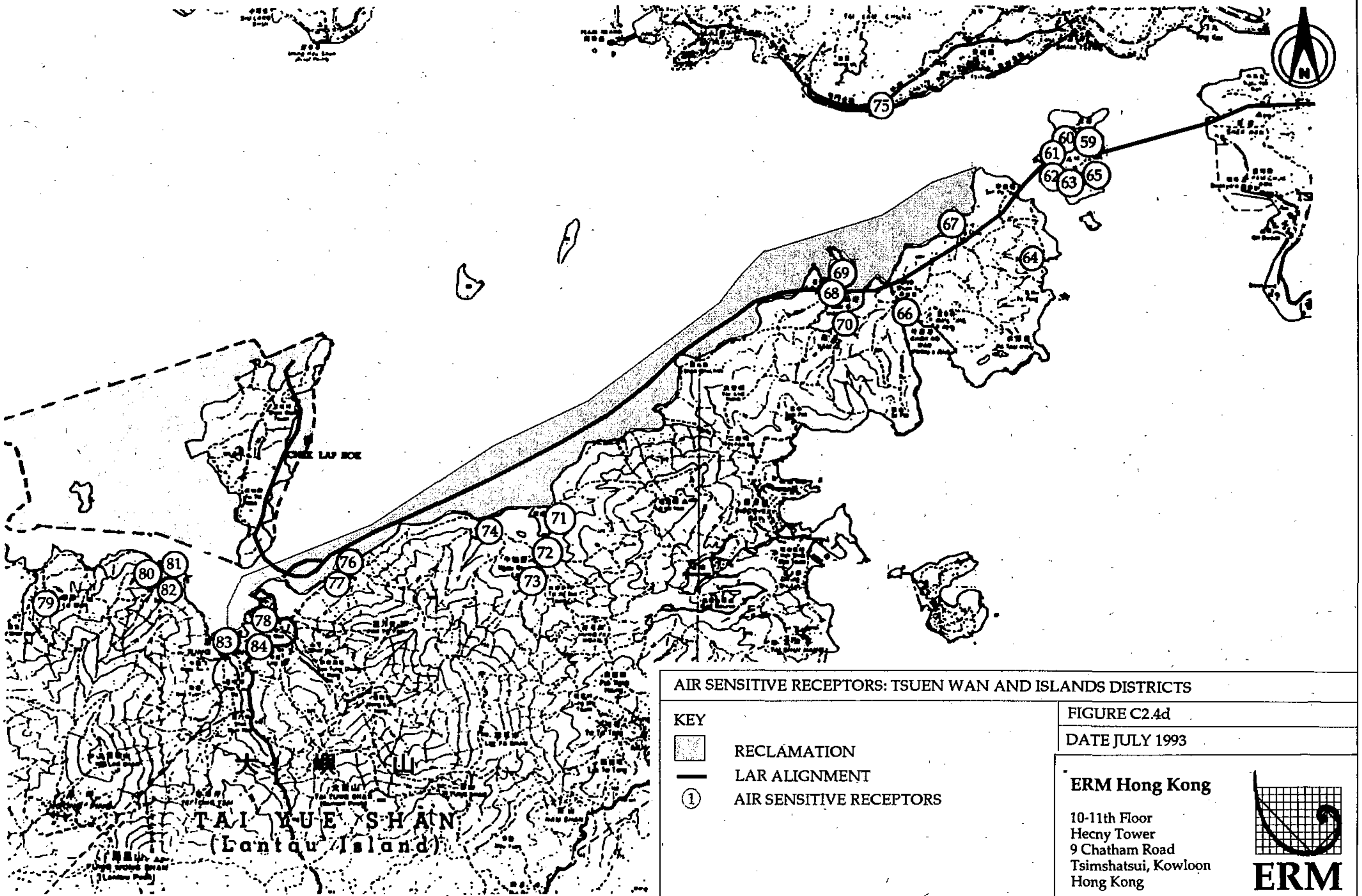
FIGURE C2.4c

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



AIR SENSITIVE RECEPTORS: TSUEN WAN AND ISLANDS DISTRICTS

FIGURE C2.4d

DATE JULY 1993

KEY

RECLAMATION

LAR ALIGNMENT

① AIR SENSITIVE RECEPTORS

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

C3 POTENTIAL SOURCES OF IMPACT

C3.1 INTRODUCTION

This Section examines the potential sources of air quality impacts arising as a result of the construction and operation of the LAR. In general, most impacts will be likely to occur during the construction phase due to the generation of dust.

C3.2 SOURCES OF IMPACT DURING THE CONSTRUCTION PHASE

C3.2.1 General

The atmospheric pollutants which may arise during the construction phase include dust and vehicular emissions. Other sources of pollutants are more dependant on the types of construction activities which may be used to build the LAR. These may include:

- Dust emissions;
- Gases and odours; and
- Vehicular emissions.

These potential sources are discussed in the following paragraphs, with an assessment (where appropriate) of their extent, magnitude and significance being given in *Sections C5* and *C6* below.

C3.2.2 Dust Emissions

Dust will be the primary cause of air pollution impacts during the construction of the LAR. Potential sources of dust emissions will be:

- *Site preparation* – from groundbreaking, removal of material and movement of vehicles on site.
- *Excavation* – from removal of material for cut and cover tunnels and foundations.
- *Tunnelling* – from blasting, excavation and handling of debris.
- *Materials handling* – from the movement of dusty materials on-site (*eg* by the use of conveyors and drops), and from vehicles off-site.
- *Stockpiling* – wind erosion of dry materials stored on-site.
- *Vehicle and plant movements* – dust raised by wheeled or tracked vehicles moving on unmade roads or working areas.

- *Concrete batching and finishing* – from the use of cement and grinding machines in these operations.

In addition, diesel–powered vehicles and plant will emit particulate and gaseous exhaust emissions.

C3.2.3 *Gases and Odours*

The excavations which will be carried out where the alignment of the LAR crosses the former Gin Drinkers Bay Landfill Site in cut at Kwai Chung Park could lead to the release of landfill gases, with potential impacts in terms of risk, odours and effects on human health.

The potential sources of odour in the vicinity of Kwai Chung Park during the construction of the LAR will be:

- Odour in the landfill gas;
- Exposure of waste during excavation;
- Handling of waste during removal; and
- Transportation of waste.

C3.2.4 *Vehicular Emissions*

Atmospheric emissions from construction machinery and vehicles will include the following gases:

- Nitrogen oxides (NO_x);
- Hydrocarbons (HCs); and
- Particulate matter.

The significance of these emissions will be dependant on several factors, including the number of vehicles, the background concentrations and the proximity of air sensitive receptors (ASRs). In the context of the urban areas of Hong Kong through which the LAR alignment will run, the numbers of construction vehicles and plant are unlikely to be sufficient to significantly increase background concentrations of these pollutants. Even in the rural areas of North Lantau, the dispersion rate of additional pollutants will be greater than in the built–up areas and the existing construction projects in progress (*ie* the LFC, the NLE and Chek Lap Kok Airport) will have already significantly worsened air quality. The contribution from construction vehicles and plant associated with the construction of the LAR will therefore be relatively small, and will have little or no impact.

In view of this, no further consideration is given to this issue in this Technical Annex.

C3.3 *SOURCES OF IMPACT DURING OPERATION*

C3.3.1 *General*

The sources of air quality impacts which will occur during the operation of the LAR include:

- Dust generation;
- Ozone generation;
- Gaseous and particulate emissions; and
- Landfill gas.

These are discussed in turn in the following paragraphs.

C3.3.2 *Dust Generation*

Dust generation during the operation of the LAR will be created by the abrasion and wear of track, electrical pick-up gear and rolling stock (*eg* from braking systems), aerodynamic effects of passing trains, and from some maintenance activities.

As most of the LAR will be in the open, the relatively small amounts of dust which will be generated from these sources are likely to be quickly dispersed and not lead to significant air quality impacts. In relation to the tunnelled sections, monitoring and analysis of both deposited and suspended particles on the London Underground system in 1982 [1] indicated a high proportion of iron which originates from the wear of the train wheels and track. However, the overall quantities involved are very small and at these levels inhalation of iron or its oxide is not generally considered to be hazardous to health.

C3.3.3 *Ozone Generation*

Tropospheric ozone can be generated from electrical arcing between the trains and the power sources. Atmospheric oxygen molecules (O_2) are dissociated to form very active oxygen atoms (O). They can combine with additional oxygen molecules to form ozone (O_3).

Ozone is a powerful oxidant and therefore reacts with almost all biological substances. The effect of exposure to ozone on human health is dependant principally on the concentration and the length of exposure. In the short term, elevated concentrations of 200μg m^{-3} may result in eye irritation, while respiratory effect are observed at concentrations in excess of this.

As the reactions which lead to ozone formation require the presence of sunlight, operation of the tunnelled sections will not result in any ozone generation. Ozone monitoring carried out on the London Underground system in the 1940's indicated ozone levels so low as not to warrant further

(1) London Regional Transport (1982) - "Dust in the London Underground" - UK Health and Safety Executive Occasional Paper Series: OP4 - HMSO.

work. Even in the open sections of the route, it should be noted that only extremely small quantities will be emitted, and that ozone is generally very quickly dispersed.

C3.3.4 *Gaseous and Particulate Emissions*

Gaseous and particulate emissions will occur during operation of the LAR from exhaust emissions of equipment used for maintenance operations. This equipment will be operated on a routine but infrequent basis, and it is consequently not likely that any significant air quality impacts will arise from this source.

C3.3.5 *Landfill gas*

The possibility exists for the entry of landfill gas into the cut section of the LAR where the alignment passes through the former Gin Drinkers Bay landfill at Kwai Chung Park. Landfill gas is potentially flammable under certain conditions, and may have implications for human health. However, a current engineering design study in relation to this section of the LAR has incorporated measures such as venting and the use of gas-impermeable coatings to reduce these risks. This is discussed further in *Section C7.3*. Also, the selection of an open-cut formation through the park removes the risk of any build-up of gas. Consequently, the main impact relating to landfill gas is likely to be that of odour. However, given the rate of emission of the gas and the proximity of the nearest air sensitive receptor (see *Section C2.4.2*), there are unlikely to be any significant odour impacts from this source.

C4 ASSESSMENT METHODOLOGY

C4.1 INTRODUCTION

This Section describes the methods which have been adopted to predict the air quality impacts which will arise during the construction and operation of the LAR.

C4.2 CONSTRUCTION DUST

C4.2.1 *Dispersion Modelling*

A Gaussian dispersion model, the Short Term Industrial Source Complex Dispersion Model (ISCST), was used to predict the dust levels from the various construction activities at sensitive receptors. Worst-case meteorological conditions of 2 m s^{-1} wind speed under atmospheric stability class 'D' and with wind blowing towards the receptor were used in the modelling exercise. Based on the ISCST's user guide, the gravitational settling velocity was calculated by assuming one category of particle size (0–30 μm) and a particle density of 2,500 kg m^{-3}. This gives a gravitational settling velocity of 0.03 m s^{-1} and a reflection coefficient of 0.68.

The model predictions are on an hourly basis and all the results are primarily hourly dust levels. Since wind directions and speeds vary significantly throughout a day, it is likely that this would result in a lower daily average TSP level at a specific location than the hourly average TSP level, which was predicted under the assumed worst-case meteorological conditions (ie constant worst-case wind direction and low wind speed towards the receptors in an hour). The results were compared to the EPD's recommended hourly TSP limit of 500 $\mu g\ m^{-3}$. This hourly limit is not statutory but has been used in many construction dust assessment in Hong Kong as a contractual clause.

For a number of key ASRs in the Kwai Tsing area, a more detailed data set was used to predict 24 hour average dust levels for comparison with the 24 hour AQO. Sequential hourly meteorological data for 1992 from Hong Kong International Terminal were applied to the ISCST model. The key receptors were as follows:

Contract 508

- Lai King Estate Block 5
- WMC Morninghope School

Contracts 510 and 511

- Cheung On Estate
- St Paul's Village

- Cheung On Estate
- St Paul's Village

In addition, the 95 percentile of the daily average TSP level recorded at EPD's station was adopted as the background dust level.

C4.2.2 *Background TSP Levels*

In order to estimate a reasonable and representative background dust level that can be used in this assessment under different meteorological conditions, the annual average dust levels monitored at EPD's stations in 1992 and dust concentrations monitored by other consultancy studies were adopted as background dust levels. The background dust levels used in the assessment are tabulated in *Table C4.2a*.

Table C4.2a ***Background Dust Levels***

Construction	Background TSP Level ($\mu g\ m^{-3}$)	Source
Central and Yau Tsim Districts		
Hong Kong Station and Tunnels (*C501*)	147	95 percentile of the daily average dust level measured at EPD Central/Western Station
Immersed Tube Tunnel (*C502*)	147	As *C501*.
Kowloon Station and Tunnels (*C503*)	157	95 percentile of the daily average dust level measured at EPD Tsim Sha Tsui Station.
Kowloon – Tai Kok Tsui Tunnels (*C504*)	157 (*for Yau Ma Tei Area*)	As *C503*.
	180 (*for Tai Kok Tsui Area*)	95 percentile of the daily average dust level measured at EPD Sham Shui Po Station.
Mong Kok and Sham Shui Po Districts		
Tai Kok Tsui Station (*C505*)	180	95 percentile of the daily average dust level measured at EPD Sham Shui Po Station.
Tai Kok Tsui – Lai Chi Kok Formation (*C506*)	–	*The prediction results were extracted from WKE EA.*
Lai Chi Kok to Kwai Chung Road Viaducts (*C507*)	–	*The prediction results were extracted from Route 3 EA.*
Kwai Tsing District		
Lai King Station and Tunnel (*C508*)	157	95 percentile of the daily average dust level measured at EPD Kwai Chung Station.
Kwai Chung Park (*C509*)	As *C508*.	As *C508*.
Rambler Channel Bridge (*C510*)	As *C508*.	As *C508*.
Tsing Yi Station and Viaduct (*C511*)	As *C508*.	As *C508*.
Tsing Yi Tunnels (*C512*)	As *C508*.	As *C508*.
Tsuen Wan and Islands Districts		
Lantau Fixed Crossing (*C513*)	177 (*Max Hourly*)	NLDS EA
Lantau Tunnels (*C514*)	40 (*Daily Average*)	NLE EA
Lantau Formation and Viaducts (*C515*)	80 (*1 hour average*) 40 (*24 hour average*)	Port & Airport Development Strategy Study
Tung Chung Station and Tunnels (*C516*)	15	NLDS EA
Airport Works (*C517*)	–	*The prediction results were extracted from NAMP EA.*

The daily average TSP level of 40 $\mu g\ m^{-3}$ was taken to be the background dust level for North Lantau from the NLE EA, as annual average dust levels were not available for the study area. Dust levels monitored at East Tsing Yi for the LFC EA were considered high for area like North Lantau (see discussion in *Section 4.3.2* and *Section 3.4.3* of Working Paper 13 [1]), as the area is far from any industrial sources. Therefore background dust level adopted in the LFC EA is not considered appropriate for North Lantau.

It should be noted that the daily maximum TSP level is not normally recommended as a representative background because it might occur under specific but rare meteorological conditions, and would be more likely to be influenced by localised dust sources.

C4.2.3 *Dust Emission Rates and Worst Case Scenario*

The dust emission rate from construction activities is dependant on the total area of the Works Sites where construction activities are taking place and the levels of these activities. The potential drift distance of dust particles is governed by the emission height, the particle terminal settling velocity and the degree of atmospheric turbulence.

Particles with a diameter of between 30–100 μm are likely to experience impeded settling. Depending on the atmospheric conditions, these particles would settle out up to 100 m from the source of emission. It is generally recognized that dust nuisance to sensitive receptors is mainly caused by particles with diameter less than or equal to 30 μm, which is the effective demarcation size of TSP. Therefore, for the purpose of this assessment, only TSP impacts are considered.

Estimation of emission factors was made in accordance with the *US EPA – Compilation of Air Pollutant Emission Factors, AP–42, 4th Edition, 1985*. The worst case scenarios of dust emissions are usually anticipated during the early stage of construction. For Contract 514, for example, most of the tunnel excavation works will be carried out during the first year of construction. Therefore, it is assumed in the dust impact assessment that worst case dust impacts will occur during the first year of construction. The emission factors are shown in *Table C4.2b* for easy illustration.

(1) ERM (Hong Kong) (1993) – "Lantau and Airport Railway Environmental Impact Study: *Working Paper 13: East Lantau Tunnels (Contract 514)*" – Mass Transit Railway Corporation – pp.33–34 and pp.13–17.

Table C4.2b Emission Factors

Construction Activities	Emission Factors	Remarks
General Construction Activities	1.16×10^{-4} g m^{-2} s^{-1}	Assume typical silt content and moderate activity level
Tunnel Excavation by Blasting with explosives	96.5 kg blast^{-1} hr^{-1}	Assume 1 blast per hour; typical hole depth of 5 m and a blast area of 20 m^2 (estimated from the volume of rock excavated per day 600 m^3 and 6 blasts per day)
Concrete Batching	0.12 kg m^{-3} of concrete	Assume uncontrolled operations
	0.012 kg m^{-3} of concrete	Assume good control – 90 % dust capture and removal
Lorries Movements over Unpaved Haul Roads	2,850 g veh^{-1} km^{-1}	Assume Typical silt content of 30%, vehicle speed of 20 kph, and vehicle weight of 14 tonne
Excavated Material Handling/Backfilling	Insignificant	Insignificant due to the high moisture content of excavated sandfill of 30–40 %.
Excavated Material Stockpiling	Insignificant	Ditto

C4.3 *ODOURS FROM THE FORMER GIN DRINKERS BAY LANDFILL*

C4.3.1 *Odour Assessment*

A Gaussian dispersion model, the short term Industrial Source Complex Dispersion Model (ISCST), was used to predict the concentration of the odorous chemicals from the excavation site to the boundary of Kwai Chung Park in order to determine the dilution factor and the odour level.

Meteorological data from the Hong Kong International Terminal (HIT) were used in the odour assessment. It was assumed for the purposes of this assessment that the construction works at Kwai Chung Park will be carried out 16 hours per day. Therefore, diurnal distribution of atmospheric stability was considered in the assessment. According to the meteorological statistics at HIT, the most frequent stability classes during day time are 'D' and 'B' respectively. The most frequent wind speed concurrent to these stability classes is 2 m s^{-1}. At night-time, stability class 'F' and 1 m s^{-1} wind speed are most frequent. The following meteorological conditions were input to the model:

Table C4.3a ***Pasquill Stability Classes and Wind Speeds***

Stability Class	Wind Speed (m s^{-1})
B	2
D	2
F	1

ISCST was used to predict 1 hour odour level and the predicted odour levels were converted to 5 second figures. Correction multipliers to convert predicted hourly figures to 5–sec values were used to account for the effects of human response to odour. The results were compared to EPD's recommended 5 odour units over 5–sec averaging time.

Correction from hourly to 3–min figures

A power–law relationship that relates the ratio of one averaging time to another has been utilized by various environmental agencies to convert hourly figures to 3–minute figures. The relationship is:

$$X_{3\text{-min}} = X_{1\text{-hr}}(t_{1\text{-hr}} / t_{3\text{-min}})^{p}$$

where X_x is the concentration under different averaging periods; and p is stability dependent (B:0.5; D:0.2; and F:0.167).

Correction from 3–min to 5–sec figures

The converted ISCST 3–min figures tend to underestimate the odour values by a factor of 10 under stability class 'D' and by a factor of 5 for stability class 'E' [1]. It is considered reasonable to assume these observed odour levels were based on a rather short averaging time as these levels had been compared to a fluctuating puff model of typical 2–sec averaging time. As an estimate, these two multiplier factors will be used for stability classes 'D' and 'F' for converting 3–min results to 5–sec results. Another study [2] recommended that a multiplier of 10 should be used for converting 3–min figures to 5–sec figures for unstable atmospheric conditions.

Table C4.3b shows the correction multipliers used in the odour assessment.

(1) Richard, A.D., Martha, A.O. and Ned O., *Odour Modelling – Why and How, Recent Developments and Current Practices in Odour Regulations, Controls and Technology. A&WMA, 1991.*

(2) Keddie, A.W.C., *Dispersion of Odours, Odour Control – A Concise Guide, Warren Spring Laboratory,1980.*

Table C4.3b *Multipliers for correcting 1-hr predicted figures to 5-sec figures*

Stability	Multiplier for corrections		
	1-hr to 3-min (A)(1)	3-min to 5-sec (B)(2)	Overall 1-hr to 5-sec (A x B)
B	4.5	10	45
D	1.82	10	18.2
F	1.65	5	8.3

(1) From the empirical power-law relationship.
(2) Quoted from Ref [1] for stabilities 'D' and 'F', and from Ref [2] for stability 'B'.

C4.3.2 *Odour Emission Rates*

The emission rate of odorous chemicals at the former Gin Drinkers Bay landfill site will be dependant on the total area of exposed excavation site. ***Butyl and Propyl Benzene, Limonene*** and ***Methanethiol,*** which require the greatest dilutions, are taken as the odour indicators in the odour assessment. Estimation of concentrations of the four odorous chemicals in the landfill gas are based on a study carried out by Young and Parker [(1)]. The odour emission rates from the excavated cuts, are estimated from a site investigation study **(Kwai Chung Park Section HAZOP and Related Services Sub-Consultancy: Volume 3 Appendix E - 1, ERM, April 1993)** and the Finite Element Gas Analysis Subroutine (FEGAS) model developed by ERM Hong Kong.

The FEGAS model uses three coupled first order differential equations. These equations simulate the reaction of the conversion of carbon in waste to methane and carbon dioxide. Each equation has a different rate constant depending on whether the waste is readily, moderately or slowly degradable. The model takes into account both the quantity of potential methane producing carbon which is lost through aerobic decay of waste prior to onset of methanogenesis and the lag time between waste emplacement and methane generation. The model has also the facility to take into account the carbon which is converted to microbial biomass, the proportion which may be lost as leachate and the overall fraction of biodegradable carbon which may be present in the waste.

In order to determine the worst case for methane emission/exposure rates, it is assumed that all gas generated migrates to the cutting (ie. during construction, the works site acts as a large-scale venting trench). Using a works area of 2.8ha. These maximum rates are indicated in *Table C4.3c*:

(1) Young and Parker (1983) - "The Identification and Possible Environmental Impact of Trace gases and Vapours In Landfill Gas" - Waste Management and Research.

Table C4.3c ***Methane and Carbon Dioxide Emission Rates***

Calculation	Methane		Carbon Dioxide	
	$m^3\ m^{-2}\ hour^{-1}$	$m^3\ hour^{-1}$	$m^3\ m^{-2}\ hour^{-1}$	$m^3\ hour^{-1}$
(1)	9.8×10^{-3}	274	7.5×10^{-3}	209
(2)	23.5×10^{-3}	657	15.7×10^{-3}	438

Note (1) Based on the empirical surface emission analysis, assuming a 30%, 20% and 50% of the whole Site has 'thin' cover, 'intermediate' cover and 'thick' cover respectively.
(2) Based on the theoretical FEGAS forecast.

To be conservative, Calculation (2) is taken to be the hypothetical worst case emission for odour assessment. From this, the following *Table C4.3d* is formulated:

Table C4.3d ***Assumed At-source Odour Concentrations and Emissions***

Compounds	Odour Concentrations (o.u.)	Emission Rate ($m^3\ m^{-2}\ hr^{-1}$)[3]
Young and Parker Study[1]		
Butyl Benzene	1400	
Propyl Benzene	1700	
Limonene	400	39.2×10^{-3}
Methanethiol	5000	
Analysis Results of Kwai Chung Park		
Ethyl Benzene[2]	5	39.2×10^{-3}

Note (1) Based on the Young and Parker Study.
(2) To be conservative, this figure is two times of the maximum analysis result of the nine available samples.
(3) FEGAS forecast, total emission rate taken to be the sum of CH_4 and CO_2.

C4.4 OPERATIONAL IMPACTS

As is noted in *Section C3.3*, the quantities of various air pollutants which will be generated during operation of the LAR are anticipated to be small, and no significant air quality impacts are considered likely to be caused as a result of these. In the light of this, the impacts on air quality arising from the operation of the LAR are only considered in qualitative terms for the purposes of this assessment.

C5 PREDICTED IMPACTS

C5.1 CONSTRUCTION IMPACTS

C5.1.1 *Central and Yau Tsim Districts*

The Central and Wanchai Reclamation Phase I will be carried out concurrently with the MTRC contract for the Hong Kong Station (Contract 501) and the Immersed Tube Tunnel (Contract 502). The assessment has considered the potential cumulative impacts from the Central Reclamation works. The Immersed Tube tunnel construction will commence before the Hong Kong Station and Tunnels. As the Immersed Tube Tunnel construction is comparatively less extensive than the Hong Kong Station construction and the excavated material will be wet, no significant dust impacts are expected to arise from the tunnel construction.

The predicted maximum hourly average dust concentration at the representative points from the construction of the Hong Kong Station and Central Reclamation are given in *Table C5.1a.*

The construction of LAR Contract 503 will be carried out concurrently with the WKE, LAR Contract 504 and the Western Harbour Crossing (WHC). Therefore, the air quality assessment has taken into account of the cumulative construction dust impacts from these four projects. The predicted dust levels are shown in *Table C5.1b.*

Construction works associated with the WKE will be carried out at the same time as Contract 504. This air quality assessment has taken into account these additional dust impacts, and has made further assumptions about the dust contributions from the construction of the Comprehensive Development Areas (CDAs) close to the Contract 504 alignment which are associated with Tai Kok Tsui Station. Table *C5.1c* sets out the predicted dust levels associated with these activities.

C5.1.2 *Mong Kok and Sham Shui Po Districts*

The construction of LAR Contract 505 will be carried out concurrently with the WKE, LAR Contract 504 and the Tai Kok Tsui CDAs. This assessment has, therefore, taken into account the cumulative construction dust impacts from these four projects. The predicted dust levels associated with the construction of Contract 505 are set out in *Table C5.1d.*

Table C5.1a ***Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 501 ($\mu g\ m^{-3}$)***

Receptor	From Hong Kong Station	From Central Reclamation[2]
Harbour Building	707	n/a
90 Connaught Road Central	662	172
Sincere Building	812	180
International Building	272	187
New Hang Seng Bank Building	692	189
24-32 Connaught Road	447	182
Wang Kee Building	512	170
Chuang's Plaza	647	169
Win Lung Bank Building	642	165
Fung House	612	158
Euro Trade Centre	532	155
World Wide House	512	151
Swire House	779	152
Mandarin Oriental	422	154
General Post Office	598	227
Exchange Square	612	214
City Hall	602	n/a
Prince of Wales Building	672	n/a

Note: (1) Background dust level of 147 $\mu g\ m^{-3}$ was added to the prediction results (See *Table C4.2a*).
(2) Central & Wan Chai Reclamation, Central Reclamation Phase I - Focused Environmental Impact Assessment Study.
n/a denotes "Not Available".

Table C5.1b ***Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 503 ($\mu g\ m^{-3}$)***

Project	Activities (unmitigated)	Ferry Street	Man Cheong Street	King George V Park	Canton Road
LAR Contract 503 - Kowloon Station	General construction activities (eg excavation)	126	165	100	75-100
	Concrete Batching Process	30	25	35	32-50
	Background Dust Level	157	157	157	157
	Total	294	340	282	254-292
LAR Contract 504 - Tai Kok Tsui Tunnels(1)	Handling of Excavated Material	n/a	319	n/a	n/a
	Concrete Batching Process	n/a	120	n/a	n/a
	Excavated Material Stockpiling	n/a	80	n/a	n/a
	Background	n/a	157	n/a	n/a
	Total	n/a	676	n/a	n/a
Western Harbour Crossing(2)	Total	n/a	486(4)	n/a	n/a
West Kowloon Expressway(3)	Dust from unpaved haul road (Northern Section)	2690	1940	1510	1100
	Dust from unpaved haul road (Southern Section)	3100	6580	3370	2230
	Concrete Batching	n/a	560	n/a	n/a

Note (1) ERM, LAR EIS Working Paper 5 - Tai Kok Tsui Tunnels.
(2) Environmental Assessment of the Western Harbour Crossing.
(3) Preliminary Report Vol.3 - Environmental Assessment of the West Kowloon Expressway.
(4) Estimated from the maximum concentration at Man Wai Street.
(5) n/a denotes 'not available'.

Table C5.1c ***Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 504 ($\mu g\ m^{-3}$)***

Construction	Potential Dust Sources		Man Cheong Street	Hoi King Street
LAR's Kowloon - Tai Kok Tsui Tunnels (C504)	1)	Handling of Excavated Material	319	122
	2)	Concrete Batching Process	120	138
	3)	Stockpiling	80	109
	Background Dust		157	180
	Total		676	549
MTRC's Tai Kok Tsui Comprehensive Developments(1)			n/a	900
West Kowloon Expressway(2)	1)	Concrete Batching Process	560	n/a
	2)	Stockpiling		
			3	n/a
	3)	Dust from haul road		
			6580	5670

Note: (1) EIA of the MTRC's Tai Kok Tsui Comprehensive Development (in progress).
(2) West Kowloon Expressway, Preliminary Report Vol.3 - Environmental Assessment.
(3) n/a denotes figures not available.

Table C5.1d Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 505 ($\mu g\ m^{-3}$)

Project	Activities (unmitigated)	Wong Tai Street	Hoi King Street	Cherry Street
LAR Contract 505 - Tai Kok Tsui Station	General construction activities (eg excavation)	85	173	69-152
	Concrete Batching Process	40	25	24
	Background	180	180	180
	Total	295	372	266-349
LAR Contract 504 - Tai Kok Tsui Tunnels[1]	Handling of Excavated Material	n/a	122	n/a
	Concrete Batching Process	n/a	138	n/a
	Excavated Material Stockpiling	n/a	109	n/a
	Background	n/a	180	n/a
	Total	n/a	549	n/a
MTRC's Tai Kok Tsui Comprehensive Developments[2]	Total	700	900	300-900
West Kowloon Expressway[3]	Dust from unpaved haul road (Northern Section)	8530	7720	3890
	Dust from unpaved haul road (Southern Section)	4720	5670	2670

Note (1) LAR EIS Working Paper 5 - Tai Kok Tsui Tunnels.
(2) EIA of the MTRC's Tai Kok Tsui Comprehensive Developments (in progress).
(3) Preliminary Report Vol.3 - Environmental Assessment of the West Kowloon Expressway.
(4) n/a denotes 'not available'. However, an approximate hourly TSP concentration of 100 $\mu g\ m^{3}$ may be assumed for each of the three tabulated activities of Contract 504.

Contract 506 and 507 are entrusted works, and these will be built as part of the works for the WKE and Route 3. *Table C5.1e* illustrates the predicted dust concentrations at the identified ASRs along the alignment of the Northern Section of the WKE.

Table C5.1e ***Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 506 ($\mu g\ m^{-3}$)***

ASR	Construction Activities			
	Concrete Batching	Aggregate Stockpiling	Trucks over unpaved haul roads	
			Northern Section	Southern Section
Mei Foo Sun Chuen	500	2	5150 (2210)	320 (130)
Haking Wong Technical School	300	1	3960 (1690)	520 (220)
Fat Tsuen Street THA	n/a	n/a	7470 (3300)	910 (390)
Nam Cheong Estate	n/a	n/a	7130 (3060)	1650 (710)
Wong Tai Street	n/a	n/a	8530 (3670)	4720 (2020)
Hoi King Street	n/a	n/a	7720 (3310)	5670 (2430)
Cherry Street	n/a	n/a	3890 (1670)	2670 (1140)

Note (1) n/a denotes "not available".
(2) Figures in bracket are the predicted RSP levels.
(3) Source: **WKE Preliminary Report Vol.3 - Environmental Assessment, Tables 5.1 and 5.2.**

It should be noted that the dust concentrations for the northern and southern sections of the WKE were predicted under different worst-case wind directions and therefore are not able to be combined. However, based on the results obtained, it is unlikely that the combined contributions from both sections should be very different from the sole contribution of the northern section. For the above ASRs, the worst case wind directions are likely to be south-easterlies through south-westerlies. In Hong Kong, easterly winds blow over 75% of the time so that Mei Foo Sun Chuen could be in a downwind position over a substantial period of construction. Dry and windy days which occur more often in winters when the prevailing winds are northerlies may have less detrimental effect on the receivers since the WKE alignment is to the west of the sensitive development in West Kowloon.

Table 5.1f illustrates the predicted dust concentrations at the identified ASRs along the Viaduct section of Route 3 between Mai Foo Roundabout during construction.

Table C5.1f ***Predicted Worst Case 1-hour Dust Concentrations during Construction of Contract 507 ($\mu g\ m^{-3}$)***

ASRs	TSP(1) ($\mu g\ m^{-3}$)	RSP(2) ($\mu g\ m^{-3}$)
Princess Margaret Hospital	39	20
Ching Lai Court	300	160
Mei Foo Sun Cheun	105	53

Note (1) Average size of dust particle for TSP is assumed to be less than 100 μm.
(2) Average size of dust particle for RSP is assumed to be less than 10 μm.
(3) Source : Technical Report No.19 for Route 3, Environmental Impact Assessment - Table 5.13. All the results were predicted at 1.5 m above ground.

The above predicted dust levels were based on worst case situations which are unlikely, eg, area sources were assumed to cover the whole of the Works Area designated but actual construction activities would only be a small percentage of the Works Area.

C5.1.3 *Kwai Tsing District*

In the Lai King area, the construction of Route 3 and LAR Contract 509 will be carried out concurrently with Contract 508. This air quality assessment therefore takes into account of the construction dust impacts from Route 3 and Contract 509 works.

The predicted maximum dust concentrations at the identified nearest ASRs arising during the construction of Contract 508 are given in *Tables C5.1g* and *C5.1h*.

Table C5.1g ***Predicted Worst Case 1-hour TSP Impacts from Contract 508 ($\mu g\ m^{-3}$)***

Location of ASR	C508 (1)	C509 (1)	Route 3 Construction
Yin Lai Court	355	315	n/a
Yuet Lai Yuen	342	n/a	n/a
Block 1, Lai King Estate (LKE)	302	n/a	n/a
Block 3 (LKE)	272	n/a	236
Block 4 (LKE)	264	n/a	n/a
Block 5 (LKE)	422	n/a	n/a
Block 6 (LKE)	455	n/a	102
Lok Sing Tong School	297	289	152
WMC Morninghope School	*(1272)*	n/a	7
Chan Nam Cheong School	*(1192)*	n/a	n/a

Note: (1) A background TSP level of 157 $\mu g\ m^{-3}$ is added.
(2) n/a denotes figures not available.
(3) Figures in italics and parenthesis denote exceedances of the recommended hourly limit of 500 $\mu g/m^3$.

Table C5.1h ***Predicted 24 hour TSP impacts from Contract 508 ($\mu g\ m^{-3}$)***

Key Receptors	Site Preparation	Main Construction Period
Lai King Estate - Block 5	68 (225)	68 (225)
WMC Morninghope School	25 (182)	118 (275)[2]

Note (1) Figures in brackets include a background TSP level of 157 $\mu g\ m^{-3}$, this is the 95 percentile of the daily average dust level measured at EPD Kwai Chung Station.

(2) Denotes exceedance of an hourly dust level of 500 $\mu g\ m^{-3}$ or the daily AQO of 260 $\mu g\ m^{-3}$.

As already discussed, construction activities associated with Route 3 and Contract 508 will be carried out concurrently with Contract 509. The predicted maximum hourly average dust concentrations at ASRs in the vicinity of Kwai Chung Park are given in *Table C5.1i*. No simple addition of dust impacts was made due to the uncertainty in the actual construction programmes of the projects.

Table C5.1i ***Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 509 ($\mu g\ m^{-3}$)***

Receptor	Route 3 Construction[1]	MTRC Contract	
		509	508
Lok Sin Tong	152	289	297
Yin Lai Court	n/a	315	355

Note : (1) Results from Route 3, Technical Report - Environmental Impact Assessment.

(2) n/a denotes 'not available'.

(3) The worst case 1-hour TSP impacts from C508 and C509 have taken into account of a background TSP level of 157 $\mu g\ m^{-3}$.

Odour impacts which are predicted to occur in the vicinity of Kwai Chung Park during the construction of the LAR, due to landfill gas migration from the former Gin Drinkers Bay Landfill, at selected distances away from the boundary of Works Area, are illustrated in the following *Tables C5.1j* and *C5.1k*.

Table C5.1j *Concentrations (o.u.) of odorous compounds during construction of Contract 509 under neutral stability and a wind speed of 2 m s^{-1}*

Buffer Distance (m)	Odour Concentrations (o.u.) on 5-sec averaging period					
	Butyl Benzene	Propyl Benzene	Limonene	Methane-thiol	Ethyl Benzene	Total
50	0.62	0.75	0.18	2.21		3.76
100	0.51	0.62	0.15	1.83		3.11
150	0.44	0.53	0.12	1.56		2.66
200	0.38	0.46	0.11	1.36		2.31
250	0.33	0.41	0.10	1.20	Negligible	2.03
300	0.29	0.36	0.08	1.05		1.79
350	0.26	0.31	0.07	0.92		1.57
400	0.23	0.28	0.06	0.81		1.38

Note (1) Total odour concentrations (o.u.) are taken to be the arithmetic sum of the individual odour concentration.

Table C5.1k *Total odour concentrations (o.u.) during construction of Contract 509 under different meteorological conditions*

Buffer Distance (m)	Odour Concentrations (o.u.) on 5-sec averaging period		
	B2	D2	F1
50	5.00	3.76	5.58
100	3.98	3.11	4.98
150	3.18	2.66	4.47
200	2.48	2.31	4.05
250	1.92	2.03	3.70
300	1.50	1.79	3.41
350	1.20	1.57	3.16
400	0.97	1.38	2.92

Note (1) B2 conditions represent B class stability and a wind speed of 2 m s^{-1} (daytime); D2 conditions represent neutral or D class stability and a wind speed of 2 m s^{-1} (daytime); and F1 conditions represent F class stability and a wind speed of 1 m s^{-1} (night-time).

(2) Total odour concentrations (o.u.) are taken to be the arithmetic sum of the individual odour concentration.

General construction dust impacts from the Rambler Channel Bridge should be insignificant as the works site is more than 300 m from the nearest sensitive receptors such as St Paul's Village as demonstrated in *Table C5.1l*.

Table C5.1l ***Maximum Hourly Dust Concentrations ($\mu g\ m^{-3}$) during Construction of the Rambler Channel Bridge***

ASR	Rambler Channel Bridge (1)	Cumulative Impacts (2)
Cheung On Estate	151	1016 (+157) (3)
St Paul's Village	153	729 (+157)

Note: 1) The dust concentrations predicted at the sensitive receptors are from modelling results.
2) The potential cumulative impacts are based on the Airport Railway Feasibility Study.
3) The number in brackets is the annual average TSP concentration (at Kwai Chung, 1992) taken to be the background and can be added to the potential cumulative impacts as an indication of the overall dust level at the receptors.

On Tsing Yi, the construction of the LAR Station (Contract 511) will be carried out concurrently with the Rambler Channel Bridge. Therefore, this air quality assessment takes into account of the cumulative construction dust impacts from these two contracts. These are set out in *Table C5.1m*.

The construction of LAR Contract 512 will likely be carried out concurrently with Contract 511 - Tsing Yi Station and Viaduct and Contract 510 - Rambler Channel Bridge. Therefore, this air quality assessment takes into account of the overall cumulative dust impacts from these three projects. Predicted dust impacts in the vicinity of Contract 512 are shown in *Table C5.1n*.

Table C5.1m ***Predicted Maximum Hourly and Daily TSP ($\mu g\ m^{-3}$) Concentrations from Contract 511***

Sensitive Receptors	Contract 510 (Total[1] Hourly Impacts)	Contract 511 (Hourly Impacts)				Cumulative Hourly Impacts[2] (Contracts 510 + 511 + background[4])	Cumulative Daily Impacts[3] (Contract 510 + 511 + background)
		General construction activities	Trucks movements over unpaved roads	Concrete batching process	Total		
Cheung On Estate	~151	124-404	20-64	25-116	140-420	448-729	274-389(318)[5]
School at Cheung On Estate	162	426	85	152	430	749	394
Ching Tai Court	<150	153	27	34	177	504	289
School at Tsing Yi Estate	<150	147	20	25	172	<479	<239
School at St Paul's Village	<150	248	35	58	306	<613	<271
St Paul's Village	153	382	44	90	430	740	304(409)[5]

Note (1) ERL, LAR EIS Working Paper No.4 - Rambler Channel Bridge.
(2) Simple arithmetic addition of individual total impacts.
(3) Simple arithmetic addition of individual total impacts with persistence factors shown in *Table 4.3b, WP 10 of LAR EIS.*
(4) The background TSP level is taken to be 157 $\mu g\ m^{-3}$ for both hourly and daily TSP impacts.
(5) Figures in brackets were calculated using sequential hourly met data.

Table C5.1n Predicted Maximum Hourly and Daily TSP ($\mu g\ m^{-3}$) Concentrations from Contract 512

Sensitive Receptors (+ distance from 512 Works site)	Hourly TSP			Daily TSP		
	Site Formation Works	Tunnelling Works		Site Formation Works	Tunnelling Works	
		Early Stage	Later Stage		Early Stage	Later Stage
School at Cheung On Estate (400 m)	43	725*	35	2	6	2
Cheung On Estate (350 m)	57	965*	42	2	30	2
Cheung On Estate (250 m)	126	2005*	95	4	60	4
Cheung Tai Court (150 m)	120	2115*	140	5	75	5
Cheung On Estate (30 m)	147	2590*	653*	20	365(307)*	35(15)
School at Tsing Yi Estate (250 m)	85	1480*	80	5	85	5
School at St Paul's Village (300 m)	85	1455*	60	3	50	3
St Paul's Village (400 m)	55	925*	40	2	25(305)*	2(10)

Note (1) Figures with asterisk * denote exceedance of the hourly TSP limit of 500 $\mu g\ m^{-3}$ or the daily TSP AQO of 260 $\mu g\ m^{-3}$.
(2) Figures in brackets were calculated using sequential hourly met data.

C5.1.4 *Tsuen Wan and Islands Districts*

The construction of the Lantau Fixed Crossing (Contract 513) has been entrusted to the Government, and is currently underway. For the purposes of the LAR EIS, the assessment of air quality impacts has been taken from the LFC EA [(1)]. The construction of Route 3 will be carried out concurrently with later stages of Contract 513, and the LFC EA also considered the potential combined dust impacts from this development. Blasting on Ting Tau Northern Section and Tsing Yi Section and traffic from unpaved haul roads on Tsing Yi were identified as the major dust sources from Route 3 construction. These construction activities were scheduled to last from February 1992 to June 1994 which will coincide with Periods 1, 2 and 3 of the construction of the LFC. Combined impacts from blasting and haul roads for LFC construction were included in the assessment for the 3 construction periods. *Table C5.1o* sets out the predicted dust impacts associated with the construction of the LFC.

The construction of the North Lantau Tunnels (Contract 514) will be carried out concurrently with the NLE and LFC. Therefore, the air quality assessment has considered the cumulative construction dust impacts from these developments. The construction programme of the North Lantau Road as part of the LFC is uncertain but as indicated in the LFC EA that the North Lantau Road will not be constructed in Period 1 of its construction, therefore dust impacts from the construction of North Lantau Road were not considered when assessing the cumulative dust impacts. When considering the cumulative impacts from LFC, dust impacts from Period 1 of its construction were used to present the maximum cumulative dust impacts to the receptors. Dust impacts predicted during construction of Contract 514 are set out in *Table C5.1p*.

(1) Mott MacDonald Hong Kong Ltd *et al* (Undated) - "Lantau Fixed Crossing: Environmental Assessment" - Hong Kong Government Highways Department - 2 vols.

Table C5.1o *Maximum Predicted Dust Levels during Construction of Lantau Fixed Crossing* ($\mu g\ m^{-3}$)

Sensitive Receiver	Period 1						Period 2						Period 3					
	LFC (a) (c)		Route 3 (a)		Combined Impact		LFC (a) (c)		Route 3 (a)		Combined Impact		LFC (a) (c)		Route 3 (a)		Combined Impact	
	1 hr	24 hr	1 hr	24 hr	24 hr (a)	24 hr (b)	1 hr	24 hr	1 hr	24 hr	24 hr (a)	24 hr (b)	1 hr	24 hr	1 hr	24 hr	24 hr (a)	24 hr (b)
Tung Wan Bay	4450	1020	1000	20	1040	1217	650	70	1000	20	90	267	650	80	1000	20	100	277
Tin Liu	2560	620	920	20	640	817	220	30	920	20	50	227	370	30	920	20	50	227
Ma Wan Football Ground	2910	1050	740	20	1070	1247	220	30	740	20	50	227	370	40	740	20	60	237
Ma Wan Town	4590	1660	850	10	1670	1847	260	40	850	10	50	227	230	40	850	10	50	227
Lau Fa	13550	6220	910	10	6230	6407	300	40	910	10	50	227	300	40	910	10	50	227
San Po Tsui	5130	510	740	7	520	694	90	3	740	7	10	187	160	5	740	7	10	192
Yi Chuen	5580	400	720	7	410	584	120	1	720	7	8	185	250	3	720	7	10	190
Tso Wan	1550	100	640	6	110	283	70	1	640	6	7	184	210	2	640	6	8	183
Sha Lau Tong Wan	6490	1480	980	10	1490	1667	1910	310	980	10	320	497	1900	310	980	10	320	497

Notes: (a) Excludes background levels
(b) Includes a background of 177 $\mu g\ m^{-3}$
(c) LFC excludes North Lantau Road

Source: *Lantau Fixed Crossing EIA Final Report, Table 2.4, P.2.7.*

Table C5.1p Predicted Worst Case 1-hour TSP Concentrations during Construction of Contract 514 (μg m^{-3})

Projects	Activities (unmitigated)	Tso Wan	Proposed Yiu Lian Dockyard	Wan Tuk
		1-hour	1-hour	1-hour
LAR Contract 514 (East Lantau Tunnels)	Blasting at Western Portal	–	17,350	322
	General Construction Activities	33	323	20
	Concrete Batching at Western Portal	–	0	0
	Background Dust Level	40	40	40
	Total	73	363 (with blasting 17669)	60 (with blasting 380)
Lantau Fixed Crossing[1]	Dust impacts from construction of LFC and Route 3 *(without inclusion of dust from the construction of the North Lantau Road)*	2190[3]	–	–
North Lantau Expressway[2]	Dust impacts from various construction activities discussed in *Section* 3.2	–	–	140

Notes: (1) Lantau Fixed Crossing EA Final Report
(2) North Lantau Expressway EA
(3) The maximum 1-hour dust concentrations were simple summation of the dust concentrations predicted from the construction of LFC and Route 3.

The construction of the North Lantau Formation and Viaducts for the LAR (Contract 515) will be entrusted to the Government to be undertaken as part of the NLE construction contracts, and will be carried out concurrently with the North Lantau Development (NLD) Phase I construction. Therefore, this assessment has also considered the potential combined impacts from the construction associated with the NLD, although no simple summation has been made. The predictions of these impacts have been taken from the environmental assessments undertaken for these two projects [(1), (2)] and are set out in *Table C5.1q*.

The construction of Siu Ho Wan Depot (Contract 518) will be carried out concurrently with the NLD and also the NLE and LAR entrusted works (Contract 515). It is therefore necessary to take cumulative effects into account when assessing the air quality impacts. The predicted dust levels during the construction period, at Tai Ho Wan Temple the nearest sensitive receiver, are shown in *Table C5.1r*.

The construction of Tung Cheung Station and Tunnels (Contract 516) will be carried out concurrently with the North Lantau Development, the New Airport at Chek Lap Kok and Tung Chung Town Centre Redevelopment. Therefore, this assessment takes into account of the cumulative construction dust impacts from these projects. The predicted dust levels during construction of Contract 516 are shown in *Table C5.1s*.

The construction of the LAR within the area of the new Chek Lap Kok Airport (Contract 517) will be entrusted to the Provisional Airport Authority as part of the airport contracts. For the purposes of this study, the predicted impacts arising from this have been taken from the New Airport Masterplan EA Study. These works will be carried out concurrently with the Phase 1 construction of NLD. Therefore, the LAR EIS has also taken into account of the potential combined dust impacts from NLD. The results of this are shown in *Table C5.1t*.

(1) Mott MacDonald Hong Kong Limited *et al* (1991) - "**North Lantau Expressway: Environmental Assessment Report, Yam O and Tai Ho Sections**" - Hong Kong Government Highways Department.

(2) Mott MacDonald Hong Kong Limited *et al* (1992) - "**North Lantau Development Study**" - Territory Development Department, South West New Territories Office - Various volumes.

Table C5.1q Predicted Dust Levels during Construction of Contract 515 ($\mu g\ m^{-3}$)

Location	Dust Impacts from NLE				Dust Impacts from NLD (1)		
	TSP 24-hour	RSP 24-hour	TSP 1-hour	RSP 1-hour	TSP 24-Hour	TSP 1-Hour	RSP 24-Hour
Background Level (2)	40	20	80	40			
Wan Tuk	100	79	140	99			
Luk Keng Tsuen A	42	22	85	45			
Luk Keng Tsuen B	41	21	81	44			
Tin Tsui Tau	255	238	295	258			
Tai Ho Wan Temple	59	20	99	40	800	38,182	455
Tai Ho Wan A	40	20	80	40	450	13,636	273
Tai Ho Wan B	40	20	80	40			
Ngau Kwu Long	40	20	80	40			
Pak Mong	41	20	80	40			
Ka Loon Tsuen	53	20	95	40			

Notes (1) The North Lantau Development – EA, Topic Report 18.
(2) Predicted levels include background levels.

Table C5.1r Predicted Maximum Hourly TSP Concentrations at Tai Ho Wan Temple

Projects	Activities (unmitigated)	Maximum Hourly TSP Concentrations ($\mu g\ m^{-3}$)
LAR Contract 518 – Siu Ho Wan Depot	General Construction Activities	129
	Batching Process	3
	Background Dust Level	20
	Total	**149**
North Lantau Development [1]	Phase 1 Construction	46,000 (Daily average 800 $\mu g\ m^{-3}$)
North Lantau Expressway[2]	Total	99 (Daily average 59 $\mu g\ m^{-3}$)

Note (1) North Lantau Development EIA
(2) North Lantau Expressway EA

Table C5.1s Predicted Maximum Hourly Dust Concentrations during Construction of Contract 516

Projects	Activities (unmitigated)	Maximum Hourly TSP Concentrations ($\mu g\ m^{-3}$)		
		Tai Po	Tai Po Youth Camp	Ma Wan Chung
		1-hour	1-hour	1-hour
LAR Contract 516 (Tung Chung Station and Tunnels)	General construction activities (eg excavation)	207	81	164
	Concrete Batching Process	65	11	9
	Vehicle Movements on Unpaved Road	200	37	223
	Background			
	Total	487	144	223
New Airport Master Plan[1]	Blasting	5882	3666	3399
	Excavation/Reclamation	212	124	95
	Total (24 hours average)	416	222	200
North Lantau Development[2]	General construction activities	n/a	2500 (140)[3]	3250 (370)[3]

Note (1) New Airport Master Plan, Maunsell.
(2) North Lantau Development – Topic Report 20.
(3) 24 hour average TSP concentration in bracket.
(4) n/a denotes *'Not Available'*.

Table C5.1t ***Predicted Dust Levels during Construction of LAR Contract 517 ($\mu g\ m^{-3}$)***

Receptor		Qtr No.1			Qtr No.2			Qtr No.3			Qtr No.4			Qtr No.5			Qtr No.6			Qtr No.7		
No	Location	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr	Blast	Exv/ Rec	24-hr
1	Sha Lo Wan	420	9	25	616	37	35	437	34	27	312	25	20	251	16	14	170	16	14	127	16	13
2	Sha Lo Wan	401	13	27	509	37	43	360	33	29	257	25	22	206	35	28	134	34	28	111	34	28
3	Sha Lo Wan	308	15	24	802	49	48	568	44	38	404	32	27	324	47	38	217	46	37	166	46	37
4	Kau Liu	1,205	20	73	3,343	103	187	2,364	103	144	1,633	87	97	1,268	44	71	784	20	43	346	19	23
5	Tin Sam	1,286	29	69	3,789	106	244	2,696	91	168	1,863	78	111	1,445	47	98	889	21	54	440	17	27
6	San Tau	855	25	44	3,592	101	205	2,545	80	156	1,758	65	104	1,364	46	79	843	23	45	400	14	27
7	Tung Chung (Ruin)	689	8	56	2,287	81	160	1,602	54	106	1,108	37	69	865	36	65	544	18	37	192	11	17
8	Tung Chung (Rec Camp)	533	9	26	2,492	103	187	1,748	72	131	1,208	42	84	942	36	68	590	19	40	270	11	20
9	Sha Tsui Tau	667	9	35	2,488	109	191	1,750	86	142	1,209	55	95	941	39	70	586	19	39	253	11	17
10	Ma Wan Chung	1,026	11	51	4,533	171	327	3,246	130	240	2,247	84	155	1,740	60	118	1,066	27	66	418	14	29
11	Ma Wan Chung	1,193	13	59	5,882	212	416	4,292	164	311	2,987	111	208	2,313	79	156	1,404	33	85	509	17	35
12	Tai Po (Youth Camp)	748	14	43	3,666	124	222	2,600	83	164	1,796	60	115	1,393	51	88	860	17	47	393	9	24
13	Tai Po	1,035	16	51	3,399	95	200	2,403	81	150	1,660	46	106	1,289	38	80	798	16	45	423	9	24

Notes:
(1) TSP size range 0 to 30 µg.
(2) Reported values represent highest predicted levels for each receptor from all potential "worst case" wind directions. Background values not included.
(3) "Worst case" wind angles from the north across the project site.
(4) Blast levels based on a single one hour event per day.
(5) Exv/Rec (Excavation/Reclamation) levels based on a single one hour combined contributions from excavation/loading, hauling, unloading, drilling and overburden removal.
(6) 24-hr, (24-hour) levels based on a single one hour blast event + 19.35 hours of Exv/Rec operations.

C5.2 *IMPACTS DURING OPERATION*

C5.2.1 *Emissions Directly Associated with LAR Operation*

As is noted in *Section* C3.3 of this Annex, all of the identified sources of air pollutants during the operation of the LAR will only give rise to very small levels of emissions and concentrations, as follows:

- *Dust generation:* will be relatively small in magnitude, and will be quickly dispersed naturally where the LAR track is in the open, or by mechanical ventilation in the tunnelled sections.

- *Ozone generation:* will similarly be small in magnitude. As the formation of ozone requires reaction in sunlight, concentrations in the tunnelled sections will be minimal. Even in relation to the open sections of the LAR, however, only small quantities will be emitted and ozone is generally very quickly dispersed.

- *Gaseous and particulate emissions:* from equipment used for maintenance will only arise when this equipment is used. Although this will be routine, it will however be infrequent, allowing dispersal to occur. Consequently, concentrations of pollutants from this source will be small.

- *Vehicular gaseous and particulate emissions:* arising from the extensive vehicle circulation areas within some of the stations (*eg* at Central and Tsing Yi). These may lead to the build–up of noxious gases in the confined spaces below ground, but it is anticipated that mechanical ventilation will be provided to preclude this occurring.

- *Ventilation exhaust:* under normal operation, ventilation exhaust is non–toxic and obnoxious fumes will not expected. However, under emergency conditions such as the case of fire, exhaust vents from the LAR tunnels and stations may be used as smoke extraction vents.

C5.2.2 *Landfill Gas and Odour*

At Kwai Chung Park, as is noted in *Section* C3.3.5, the LAR alignment will pass in cutting through the former Gin Drinker's Bay Landfill. There is, consequently, a potential for the filtration of landfill gas (LFG) into the railway operational areas, which could cause odour nuisance. In addition to the source concentrations of odorous compounds in the LFG, the possibility of odour nuisance will also depend on measures to control the LFG, the design and air change rate of the compartment's ventilation system, speed of the train, etc.

The LAR train will take only a few seconds to run through the whole section. In addition, the proposal included in the ARFS for this section to be in cut–and–cover tunnel has been reviewed, and the decision has been made to replace this with an open cut as this is an inherently safer option, which will not allow accumulation of any landfill gas emissions within LAR structures. Moreover, there will be measures to control the LFG, such as the inclusion of a low permeability cover over the cut areas and a trackform of concrete slab coated with protective and low permeability material. It is considered highly unlikely that the methane concentrations would reach the noticeable or dangerous levels. These control measures for LFG will also minimize the probable odour migration to other associated facilities. Aerodynamic effects caused by the movement of trains will further disperse any odour concentrations. Therefore, it is concluded that no odour nuisance is anticipated during normal operation of the Railway.

C6 *EVALUATION OF IMPACTS*

C6.1 *INTRODUCTION*

In this Section, the air quality impacts which were predicted to occur during the construction of the LAR in *Section C5.1* of this Annex are evaluated to determine their significance. This will be done by comparing the extent and magnitude of the predicted impacts with the air quality evaluation criteria set out in *Section A2.2* of *Annex A* of this report.

Specific evaluation of the air quality impacts predicted to occur during the operation of the LAR is not made, because as is noted in *Section C5.2* of the Annex, the extent and magnitude of the will be minimal, and therefore do not warrant further investigation.

Table C6.1a shows the locations where the predicted dust concentrations from the construction of the LAR including background dust levels exceed the recommended 1-hour dust limit of 500 $\mu g\ m^{-3}$. This table only shows predicted exceedences from MTRC's contracts.

C6.2 *EVALUATION OF IMPACTS*

C6.2.1 *Central and Yau Tsim Districts*

Most of the buildings along Connaught Road are centrally ventilated and the dust impacts, from construction works, upon these ASRs are likely to be less significant than the predicted levels. For all the air sensitive receptors examined in the vicinity of the worksite for the new Hong Kong Station, high levels of TSP from the construction works were predicted which would exceed the hourly limit of 0.5 mg m^{-3} for construction dust. Therefore, dust suppression mitigation measures are required on site to reduce dust impacts on the surrounding areas to acceptable levels.

In Kowloon, reviewing the previous environmental studies undertaken in relation to developments concurrent with the construction of the LAR indicated that the dust impacts from the construction of the WKE were likely to be much more significant than the other three projects. The predicted maximum dust impacts at the selected receptors from the construction of Contract 503 alone range from 168–254 $\mu g\ m^{-3}$, and are relatively low if compared to the EPD-recommended hourly limit of 500 $\mu g\ m^{-3}$. These maximum impacts will only occur in the first year of construction of Contract 503, when most of the bulk excavation works including the excavation of the Station and the South Cut and Cover Tunnels take place. However, the cumulative dust impacts from all construction activities under different projects would likely to cause the dust concentrations at the sensitive receptors to exceed the recommended hourly limit.

Table C6.1a *Table of exceedences*

Receptor	Percentage of the 1-hour dust limit of 500 $\mu g\ m^{-3}$	Construction Activity
Central and Yau Tsim Districts		
Contract 501 – Central and Wanchai Reclamation		
Harbour Building	127	Excavation/Earthworks
90 Connaught Road Central	118	Excavation/Earthworks
Sincere Building	148	Excavation/Earthworks
New Heng Seng Bank Building	124	Excavation/Earthworks
Chuang's Plaza	115	Excavation/Earthworks
Win Lung Bank Building	114	Excavation/Earthworks
Fung House	108	Excavation/Earthworks
Swire House	141	Excavation/Earthworks
General Post Office	105	Excavation/Earthworks
Exchange Square	108	Excavation/Earthworks
City Hall	106	Excavation/Earthworks
Harbour Building	127	Excavation/Earthworks
Prince of Wales Building	120	Excavation/Earthworks
Contract 504 – Tai Kok Tsui Tunnels		
Man Cheong Street	118	Overall impacts from excavation/earthworks, concrete batching and stockpiling

Receptor	Percentage of the 1–hour dust limit of 500 $\mu g\ m^{-3}$	Construction Activity
Contract 512 – Tsing Yi Tunnels		
School at Chung On Estate (400m from works site)	145	Early stage of tunnelling works
Cheung On Estate (350m from works site)	193	Early stage of tunnelling works
Cheung On Estate (240m from works site)	401	Early stage of tunnelling works
Cheung Tai Court (150 from works site)	423	Early stage of tunnelling works
Cheung On Estate (30m from works site)	518	Early stage of tunnelling works
	131	Later stage of tunnelling works
School at Tsing Yi Estate (250m from works site)	296	Early stage of tunnelling works
School at St Paul's Village (300m from works site)	291	Early stage of tunnelling works
St Paul's Village (400m from works site)	185	Early stage of tunnelling works
Contract 514 – Lantau Tunnels		
Proprosed Liu Yuin Dockyard	3470	Blasting at Western Portal

In addition, given that the predicted maximum hourly TSP impacts from Contract 503 are considerably lower than the recommended hourly limit, Contract 503 alone would unlikely to pose any threat to the daily AQO for TSP even if a background of 71 $\mu g\ m^{-3}$ is added. On the other hand, the cumulative impacts from all the different projects may threaten the daily AQO for TSP because of the excessively significant impacts from the construction of the WKE. Therefore, since the existing air quality in the area is already experiencing high levels of dust, cumulative dust impacts from the various projects will further threaten the annual AQO.

Further north along the LAR alignment, the previous environmental studies reviewed for the LAR EIS indicated that the dust impacts from the construction of WKE were likely to be more significant than other projects. For sensitive receptors along Hoi King Street, the construction dust impacts from the MTRC's Tai Kok Tsui Comprehensive Developments are likely to be more significant than that from the construction of Contract 504. The predicted maximum dust concentrations at the representative sensitive receptors from the construction of Contract 504 are relatively high. However, all these activities would be carried out in different locations and the individual maximum impact would occur under different worst-case wind direction. Therefore, the overall dust impact will be smaller than the sum of these individual maximum impact associated with the particular construction activity. It would be unlikely that the construction of Contract 504 alone would exceed the recommended hourly limit of 500 $\mu g\ m^{-3}$. However, it is considered likely that the combined dust impacts from all construction activities under different projects may cause the dust concentrations at the sensitive receptors to exceed the EPD-recommended hourly limit.

C6.2.2 *Mong Kok and Sham Shui Po Districts*

In the vicinity of the proposed Tai Kok Tsui Station, the available data indicated that the dust impacts from the construction of the WKE were much more significant than other concurrent construction projects. Also, the construction dust impacts from the Tai Kok Tsui Comprehensive Developments are likely to be more significant than those from the adjacent station and tunnel works. The predicted maximum dust impacts at the selected receptors from the construction of Contract 505 alone range from 168-303 $\mu g\ m^{-3}$, and are relatively low if compared to the EPD-recommended hourly limit of 500 $\mu g\ m^{-3}$. These maximum impacts will only occur in the first year of construction of Contract 505 when most of the bulk excavation, backfilling and site formation works take place. However, the cumulative dust impacts from all construction activities under different projects would likely to cause the dust concentrations at the sensitive receptors to exceed the recommended hourly limit. Given that the predicted maximum hourly TSP impacts from Contract 505 are considerably lower than the recommended hourly limit, Contract 505 would unlikely to pose any threat to the daily AQO for TSP even when the background of 105 $\mu g\ m^{-3}$ is added. On the other hand, the cumulative impacts from all the different projects may threaten the daily AQO for TSP because of the excessively significant impacts from the construction of the WKE. Since the existing air quality in the area is already experiencing high levels of dust and exceedence of the annual AQO for TSP was recorded in 1991, cumulative impacts will further threaten the annual AQO.

The WKE EA indicated that in relation for the entrusted works to construct the LAR Contract 506 and the WKE, concrete batching could create dust nuisance at Mei Foo Sun Chuen under worst case winds if the batching operations are uncontrolled. Predicted dust concentrations from unpaved haul roads are very much higher than the acceptable level for construction dust during the construction of the northern section of the WKE. Aggregate stockpiling is not predicted to result in any major dust impacts. Similarly, no significant impacts were predicted in the vicinity of the LAR Contract 507 and the mitigation measures and monitoring programme detailed in the WKE EA should ensure that dust concentrations are within acceptable levels.

C6.2.3 *Kwai Tsing District*

At Lai King, the construction works are likely to produce significant short term dust levels at the key ASRs. The dust level at WMC Morninghope School for the mentally handicapped is predicted to be in excess of the 24 hour AQO for TSP. The predicted 24 hour dust impacts at Lai King Estate Block 5 is within the 24 hour AQO for TSP. These are the worst case predictions which assume that the tunnel blasting operations are exposed. This high level of dust will only occur during the early stage of tunnelling. During the later stages of construction, the blasting operations will be carried out within the tunnel and the dust impacts at the key ASRs will be greatly reduced.

In the vicinity of Kwai Chung Park, dust impacts from the construction of the LAR/Route 3 Viaduct between Kwai Chung Park and Lai King Station on the identified sensitive receptors are well below the EPD's recommended dust limit of 500 $\mu g\ m^{-3}$. The sensitive receptors at Lai King may experience high levels of dust due to cumulative effects from the concurrent construction works in the area.

With regard to the possible odour impacts from construction activities at the former Gin Drinker's Bay Landfill, a buffer distance of about 50 m from the boundary of the Works Area would be adequate to render odour concentrations below nuisance level of 5 o.u. on 5-sec averaging time during daytime construction. Whereas during night-time construction, a buffer distance of 100 m would be more appropriate. The nearest industrial developments along Kwai Tak Street, Kwai Tai Road and Kwai Hei Street are more than 200 m away from the boundary of the Works Area. Therefore, it is unlikely that odour nuisance would be anticipated at these industrial developments even when night-time construction activities are to be carried out, not to mention the distant residential developments in the Kwai Tsing district. It is likely that odour nuisance would only be anticipated at the boundary of the Park when the construction activities are carried out close to it. These represent the sections of Kwai Ching Road and Kwai Hei Street that are close to the Works Area.

To the east of the Rambler Channel, in the vicinity of the Rambler Channel Bridge, no significant dust impacts were identified as likely to occur during the construction of the LAR.

Dust impacts from Contract 511 are more significant than that from Contract 510. The cumulative dust impacts from Contracts 510 and 511 are significant and would be likely to result in an exceedance of the 24 hour AQO for TSP when the background levels are included. The maximum dust impacts from Contract 511 would exceed the 24 hour AQO for TSP at both key ASRs as shown in *Table C5.11*. However, it should be noted that high dust levels were predicted from general construction activities carried out at construction sites with a total area of 53,300 m^2. It is unlikely that construction activities will be occurring all over the construction site simultaneously and some of the site will also be built upon, hence the potential impacts will be reduced.

During the early stage of tunnelling works, blasting from Contract 512 alone will cause the 24 hour AQO for TSP to be exceeded at Cheung On Estate and St Paul's Village. This high level of dust will only occur during the early stage of tunnelling. During the later stages, blasting operations will be carried out within the tunnel and the dust impacts at the ASRs will be significantly reduced.

In view of the potential dust impacts at the key receptors, it is considered that dust control measures should be implemented during the construction of the LAR in order to reduce the overall dust impacts, measures are recommended in *Section C.7.2.1*.

It should be pointed out that the predicted dust impacts at the key receptors are based on construction activities being carried out throughout the whole of the construction site. However, it is unlikely that construction activities will be carried out all over the site simultaneously and therefore the potential dust impacts at the key receptors will have been overestimated.

C6.2.4 Tsuen Wan and Islands Districts

In the LFC EA, the highest hourly TSP and RSP levels were estimated to be 13550 and 6660 $\mu g\ m^{-3}$ from LFC construction. The hourly TSP levels predicted at the ASRs, with the exception of concentrations predicted at Yi Chuen and Tso Wan, will exceed the EPD's recommended TSP limit of 500 $\mu g\ m^{-3}$. Period 1 of the LFC construction will cause the greatest dust impacts to the ASRs. The major contributor to the 1-hour predictions will be Route 3 construction. Drilling, blasting and vehicle movements on unpaved haul roads are the dust sources which will cause major dust impacts to the ASRs. The combined impacts from the Route 3 and LFC construction will pose a threat to the daily AQO for TSP and RSP of 260 and 180 $\mu g\ m^{-3}$ respectively. Period 1 of the LFC construction and Route 3 construction will cause the greatest daily dust impacts. The highest 24 hour TSP and RSP levels were predicted to be 6407 and 2976 $\mu g\ m^{-3}$ which have exceeded the daily AQO for TSP and RSP. Only dust concentrations predicted at Tso Wan were within the 24 hour AQO. 24-hour TSP dust levels predicted for Periods 2 and 3 at Tung Wan Bay will marginally exceed the AQO.

In respect of the East Lantau Tunnels (Contract 514), the dust impacts from the general construction of the tunnels on the surrounding environment will be within the EPD's recommended hourly dust limit of 500 $\mu g\ m^{-3}$. High dust concentrations were predicted at the proposed Yiu Liun dockyard due to blasting. It should be noted that blasting will only last for a very short period of time. The maximum hourly average TSP levels predicted at the receptors due to general construction activities range from 73 $\mu g\ m^{-3}$ to 363 $\mu g\ m^{-3}$. These maximum impacts will only occur in the first year of construction of Contract 514, when most of the bulk excavation works take place. As the East Lantau Tunnels are far from Wan Tuk, dust concentrations predicted here due to general construction activities carried out at the western portal were predicted to be around 60 $\mu g\ m^{-3}$. Even if the addition of dust impacts from the construction of NLE (*ie* 100 $\mu g\ m^{-3}$) were made, the cumulative maximum hourly dust concentrations at Wan Tuk will remain within the recommended hourly limit. In addition, given that the predicted maximum hourly TSP impacts from Contract 514 are considerably lower than the recommended hourly limit, Contract 514 alone would not to pose any threat to the daily AQO for TSP.

In respect of the North Lantau Formation and Viaducts for the LAR and the NLE, which will be entrusted works undertaken by the Government, the NLE EA predicts that blasting and drilling will give rise to high short term levels of dust at source. A peak concentration of 230,000 $\mu g\ m^{-3}$ over an averaging period of 1 hour was predicted at Yam O. Despite the relatively high hourly dust concentration due to blasting, the recommended hourly TSP level of 500 $\mu g\ m^{-3}$ will not be exceeded at any of the ASRs. Peak 24 hourly concentrations of TSP may reach 9000 mg m^{-3}, however the impact will be confined to a relatively small area close to the source. Dust emission will be centred on the major blasting and drilling operation at Yam O Tuk and the Port Peninsula road and the haul roads at Yam O and Tai Ho. Concentrations of TSP and RSP will decline rapidly away from the source. The 24 hour averaged TSP and RSP levels predicted at the ASRs will not exceed the AQO. This is due to the relatively large distances between sources and receptors. The maximum 24 hour averaged TSP and RSP levels were predicted at Tin Tsui Tau where the predicted particulate concentration will approach the AQO. Due to the short duration of blasting and drilling, they will not cause any significant impact on sensitive receptors when considering dust impacts averaged over 24 hour period.

Also in relation to Contract 515, CO, SO_2 and NO_2 results for an one hour averaging period vary with distance from the asphalt mixing plant.. Emission from the asphalt mixing plant will not pose any significant impacts on the air quality at any of the ASRs. Emission of CO, SO_2 and NO_2 were predicted to be within the AQOs.

The cumulative impacts from all the developments in the area will pose a threat to the daily AQO for TSP of 260 $\mu g\ m^{-3}$. From the construction of the Lantau Fixed Crossing only, the predicted 24 hour average dust levels at

San Po Tsui, Yi Chuen and Tso Wan have exceeded the daily AQO for TSP. The daily dust level predicted at Wan Tuk from the construction of the NLE was within the daily AQO.

The dust impacts from the construction of Siu Ho Wan Depot will not exceed the AQO, however, the cumulative effects with other North Lantau projects are likely to be significant.

In the area of Tung Chung Town Centre, dust concentrations at the receptors are predicted to exceed the EPD's recommended dust limit of 500 $\mu g\ m^{-3}$ due to the Quarter 2 construction of the airport at Chek Lap Kok and the Phase 2 of the NLD. However the NAMP EA also considered the impacts from the most frequent wind direction, easterly winds, at Chek Lap Kok. Under easterly winds dust impacts from construction activities carried out at Chek Lap Kok for the new airport on the receptors along the northern coast of Lantau would be minimal.

Construction of the Tung Chung Station and Tunnels alone is unlikely to cause significant dust impacts on the receptors. The maximum hourly dust concentration predicted at the receptors ranging from 144 $\mu g\ m^{-3}$ to 487 $\mu g\ m^{-3}$. The maximum hourly TSP level of 487 $\mu g\ m^{-3}$ is predicted at Tai Po. However it should be noted that Tai Po village is scheduled to be relocated in 1993. The NAMP and the NLD EAs have also indicated the potential 24 hours average dust impacts due to their construction. The cumulative impacts from all the different developments in the area will pose a threat to the daily AQO for TSP of 260 $\mu g\ m^{-3}$. From the construction of the new airport at Chek Lap Kok only, the predicted 24 hours average dust level at Tai Po has exceeded the daily AQO for TSP. The dust levels predicted at Ma Wan Chung due to the construction associated with the North Lantau Development has also exceeded the daily AQO for TSP.

Within the area of the new Chek Lap Kok Airport (Contract 517), The most significant dust impacts identified in the NAMP EA were from blasting, excavation/loading, hauling, dumping, drilling and over burden removal. Worst case prediction of TSP and RSP concentrations was made at 13 receptors on the northern coast of Lantau. The highest predicted worst case one hour TSP levels were expected from blasting operations. The worst dust impacts will occur during Quarter 2 construction. The maximum worst case hourly TSP and RSP concentrations at ASRs from blasting were predicted to be 5882 $\mu g\ m^{-3}$ and 538 $\mu g\ m^{-3}$ respectively. The EPD's 1-hour TSP limit was exceeded at all the ASRs due to blasting in Quarter 2 construction. The impacts from excavation and reclamation were much lower than that from blasting where the maximum worst case hourly TSP and RSP levels were predicted to be 212 $\mu g\ m^{-3}$ and 26 $\mu g\ m^{-3}$ respectively. Contract 517 will be carried out when the site formation works for the airport are near completion. The 1-hour dust impacts on the receptors should be similar to the dust impacts predicted for 7th quarter. The maximum 1-hour TSP and RSP concentrations predicted at the ASRs from blasting were 509 $\mu g\ m^{-3}$ and 122 $\mu g\ m^{-3}$ respectively during the 7th quarter construction. The EPD's 1-hour TSP limit was only exceeded at Receptor 11 at Ma Wan Chung. The TSP concentration predicted at all the other receptors were well within the EPD's 1-hour TSP limit.

The maximum worst case 24-hour TSP and RSP levels were predicted to be about 416 $\mu g\ m^{-3}$ and 43 $\mu g\ m^{-3}$ respectively during the 2nd Quarter construction. The RSP level predicted at the 13 receptors on Lantau Island under different periods of construction were well within the 24-hour AQO for RSP of 180 $\mu g\ m^{-3}$. These 24-hour RSP levels include contributions from both blasting and excavation/reclamation works. However, the 24-hour TSP levels predicted during 2nd quarter construction at Ma Wan Chung have exceeded the 24-hour AQO for TSP. The 24 hour dust impacts should be similar to those predicted for the 7th quarter construction when the 24-hour TSP and RSP levels predicted at the ASRs were well within the AQO.

Under the most probable scenario (ie with wind direction from the east and 5 m s^{-1} wind speed), the predicted hourly TSP levels and 24-hour RSP levels at the receptors from both blasting and excavation reclamation works were well within the AQO and the EPD's recommended TSP limit. The impacts from the construction of NLD will pose significant dust impacts on North Lantau. The combined impacts will be greater and mitigation measures should be adopted when carrying out Contract 517 in order to minimize the overall dust impacts on the surrounding area.

C7 *MEASURES FOR MITIGATION*

C7.1 *INTRODUCTION*

In this section, ERM's recommended measures to avoid potentially significant air quality impacts, or to reduce these to acceptable levels, during the construction and operation of the LAR are set out. In relation to these, reference is made in this section to the MTRC's General Specification for all LAR construction contracts and the Particular Specifications which will relate to each of the individual contracts. In addition, suggestions for the guidance of contractors in following good environmental management practices on site, which will assist them in complying with the requirements of the General and Particular Specifications are also given.

Following this, an assessment is made of the extent to which these measures, if implemented, would reduce the level of impacts identified in *Section C5* of this annex, and thereby demonstrate how the statutory requirements of the Air Pollution Control Ordinance may be met.

C7.2 *CONSTRUCTION PHASE*

C7.2.1 *Dust Impacts*

General

In general terms, construction activities should be carried out and managed in such a way that they are not causing any adverse dust impacts on nearby sensitive receivers. This principle has been covered in the General Specification (GS) as:

> **The Contractor shall devise and arrange methods of working to minimise dust emissions, and shall provide experienced personnel with suitable training to ensure that these methods are implemented. (GS Clause 3.2.1)**

When construction plant, equipment or methods of working are believed to cause serious dust or other air pollutant emissions, they should be inspected and remedial measures be taken. Remedial measures should include alternation, variation and modification of that particular plant and equipment. In terms of tender requirements, these have been adequately covered by clauses 3.2.2 and 3.2.3 of the General Specification which clearly define the role of the Engineer as well as the responsibility of the Contractor.

> **If after commencement of the Works the Construction Plant, equipment or methods of working are believed by the Engineer to be causing serious air pollution impacts, they shall be inspected and remedial proposals be drawn by the Contractor, consented to by the Engineer,**

and implemented. In developing these remedial measures, the Contractor will be expected to inspect and review all dust sources that may be contributing to the pollution impacts. Where such remedial measures include the use of additional or alternative Constructional Plant or equipment such Constructional Plant or equipment shall not be used on the Works until the Engineer's consent has been given. Where remedial measures include maintenance or modification of Constructional Plant or equipment which has received the consent of the Engineer such Constructional Plant or equipment shall not be used on the Works until such maintenance or modification is completed and the adequacy of the maintenance of modification is demonstrated to the satisfaction of the Engineer. (GS Clause 3.2.2)

In the event that remedial measures for which consent has been given by the Engineer are not being implemented and serious impacts persist, the Engineer may direct the Contractor to suspend work until the measures are implemented. (GS Clause 3.2.3)

To avoid violation of the Air Pollution Control Ordinance (APCO), the installation of fuel-consuming equipments and usage of fuel on Site should be in compliance with the various APCO's provision (eg. Furnace, Ovens and Chimneys Regulation, Fuel Restriction Regulations, and Dust and Grit Emission Regulation). The Code of Construction Practice (CCP) should include the instructions that:

- The Contractor should not install any furnace, boiler or other similar plant or equipment using any fuel that may produce air pollutants without the prior written consent of the Director of Environmental Protection (DEP) pursuant to the Air Pollution Control Ordinance.

- A furnace, boiler or other similar plant and equipment should not emit during each hour when the said is consuming liquid fuel, dust or grit in excess of 0.4% of the total fuel fired in kg/hr.

Some other general good housekeeping practices including no burning of debris on Site and the provision of adequate dust suppression plants should also be included as tender requirements. Clauses 3.1.9 and 3.2.17(h) of the General Specification are appropriate :

No burning of debris, construction wastes or vegetation shall be allowed on the Site. (GS Clause 3.1.9)

The provision of adequate dust suppression plant including water bowsers with spray bars. (GS Clause 3.2.17(h))

Earthworks and Excavation

Earthworks and excavation activities usually result in substantial amount of soil being exposed and under dry and windy conditions, these will give rise to wind blown dust. To minimise dust emission, the amount of soil exposed and the dust generation potential should be kept as low as possible. These can be accomplished by re-vegetation of completed earthworks, surface compaction and minimizing the extent of soil exposed. Clause 3.2.17(i) of the General Specification ensures that Contractors control wind blown dust generation by requiring that:

Areas of reclamation shall be completed, including final compaction, as quickly as possible consistent with good practice to limit the creation of wind blown dust. (GS Clause 3.2.17(i))

Moreover, the following control measures should also be included in the Code of Construction Practice (CCP):

- The Contractor should ensure that completed earthworks are hydroseeded and/or revegetated as soon as possible.

- The Contractor should minimise the extent of soil exposed at any one time.

Materials Stockpiling and Handling

Stockpiling of materials will inevitably incurs an element of double-handling and as such, the Contractor should try to ensure that the amount of stockpiling is minimised. Moreover, there is a potential that exposed stockpiles of loose materials will be eroded by strong winds. Where the stockpiles are located close to sensitive receivers, off-site fugitive dust emissions could create a nuisance. To mitigate against this potential impact, all large stockpiles should be protected against the effects of eroding winds. Clause 3.2.17(a) of the General Specification contained measures to control dust impacts from concrete aggregate.

However, it was considered that the threshold size of $20m^3$ was too stringent in most cases and the clause should also be allowed to include other types of stockpiles. Therefore, this clause should be amended and included in the PS by that:

Stockpiles of sand and aggregate greater than $50m^3$ for use in concrete manufacture shall be enclosed on three sides, with walls extending above the pile and 2 m beyond the front of the pile. (GS Clause 3.2.17(a))

To allow sufficient buffer distance between stockpile and sensitive receivers, stockpiles should be located at least 100m away from any nearby sensitive uses. This should be included in the CCP which should state that:

- Stockpiles should be located at least 100m away from any sensitive uses wherever practical.

Other control measures like the application of enclosed or semi–enclosed windboards along conveyor belts, enclosed conveying point and frequent water spraying to reduce dust emission should also be considered. The following Clauses from the General Specification should be appropriate:

Effective water sprays shall be used during the delivery and handling of all raw sand and aggregate, and other similar materials, when dust is likely to be created and to dampen all stored materials during dry and windy weather. (GS Clause 3.2.17(b))

Conveyor belts shall be fitted with windboards, and conveyor transfer points and hopper discharge areas shall be enclosed to minimize dust emission. All conveyors carrying materials which have the potential to create dust shall be totally enclosed and fitted with belt cleaners. (GS Clause 3.2.17(d))

Where dusty materials are being discharged to vehicles from a conveying point at a fixed transfer point, a three–sided roofed enclosure with a flexible curtain across the entry shall be provided. Exhaust fans shall be provided for this enclosure and vented to a suitable filter system. (GS Clause 3.2.18(b))

Cement and other very fine materials should be stored in enclosed silos fitted with some kind of high level alarm indicator to control filling and to avoid overfilling. Any exhaust or vent from the silos should be equipped with efficient bag filter with adequate and frequent mechanical cleaning. In terms of tender requirements, these have been adequately described by the following Clauses of the General Specification:

Cement and other such fine grained materials delivered in bulk shall be stored in enclosed silos fitted with a high level alarm indicator. The high level alarm indicators shall be interlocked with the filling line such that in the event of the hopper approaching an overfull condition, an audible alarm will operate, and the pneumatic line to the filling tanker will close. All air vents on cement silos shall be fitted with suitable fabric filters provided with either shaking or pulse–air cleaning mechanisms. The fabric filter area shall be determined using an air to cloth ratio (filtering velocity) of 0.01–0.03 m/s. (GS Clause 3.2.17(e))

Weigh hoppers shall be vented to a suitable filter. (GS Clause 3.2.17(f))

The filter bags in the cement silo dust collector must be thoroughly shaken after cement is blown into the silo to ensure adequate dust collection for subsequent loading. (GS Clause 3.2.17(g))

Concrete Batching

Concrete batching is classified as a specified process because of its potentially significant dust emissions if uncontrolled. Currently, EPD is preparing the best practicable means requirements for Cement Works (Concrete Batching Plant). The Air Pollution Control (Amendment) Ordinance 1993 will require the owner of batching plant with a capacity exceeding 50 tonnes to apply for a licence. The following instructions should be included in the CCP:

- The Contractor should apply for a Licence for the batching plant under the Specified Process "Cement Works" before the commencement of the construction activity. The Contractor should also design and operate the plant in accordance with the provisions laid down in the Best Practicable Means Requirements.

To allow sufficient buffer distance between batching plant and sensitive receivers, the batching plant should be located as far from any nearby receiver as practicable. A 100 m buffer distance from other uses is recommended and should be included in the CCP as:

- The batching plant should be located as far away from any sensitive uses as practical. A 100 m buffer distance from other uses should be recommended.

Construction Vehicles

When a vehicle travels on an unpaved road, particles are lifted and dropped from the rolling wheels. Dust emissions can be reduced by controlling parameters like vehicle weight, speed and road surface moisture contents, as well as avoiding soil from being stirred up by mechanical disturbance. Clauses 3.2.17(c) and 3.2.17(j) of the General Specification ensures that Contractors control dust emissions from vehicle movements by requiring that:

Areas within the Site where there is a regular movement of vehicles shall have an approved hard surface and be kept clean of loose surface material. (GS Clause 3.2.17(c))

Unless otherwise approved by the Engineer the Contractor shall restrict all motorized vehicles on the Site to a maximum speed of 15 km per hour and confine haulage and delivery vehicles to designated roadways inside the Site. (GS Clause 3.2.17(j))

To avoid eroded soil from being stirred up by mechanical disturbance, vehicle exhausts should be adequately directed upwards. This should be reflected in the CCP as:

- All off-road vehicle exhausts should be directed vertically upwards where possible, or directed away from the ground as a minimum standard.

Since most of the construction vehicles are used for transportation of potentially dust generating materials such as cement and aggregate for concrete batching and general building materials, provision of proper fitting side and tail boards covered by tarpaulin should be required. Clause 3.2.18(c) of the General Specification should be appropriate:

Any vehicle with an open load carrying area used for moving potentially dust producing materials shall have properly fitting side and tail boards. Materials having the potential to create dust shall not be loaded to a level higher than the side and tail boards, and shall be covered by a clean tarpaulin in good condition. The tarpaulin shall be properly secured and shall extend at least 300 mm over the edges of the sides and tail boards. (GS Clause 3.2.18(c))

To ensure that the construction vehicles moving away from the Site will not cause deposition of soil or dust on public roads, wheel-wash troughs and hoses should be provided at traffic exits. Clause 1.3 of the Particular Specification for Contract 502 (Appendix L) requires wheel washing and vehicle cleansing and states:

The wheel washing and vehicle washing facilities provided and maintained by the Contractor shall include the following or equivalent except where, due to the limited use of an exit, the Engineer agrees to other measures appropriate to the nature and duration of the Contractor's operations:

(a) a temporary concrete hardstanding of sufficient size to accomodate two large vehicles, laid to falls with drainage channels and sump.

(b) high pressure air and water jets (minimum 120 psi)

(c) wheel spinning equipment capable of acting on all mud from vehicles to the satisfaction of the Engineer.

(PS Clause 1.3.1)

The wheel washing and vehicle washing facilities shall remove all mud from vehicles to the satisfaction of the Engineer. (PS Clause 1.3.2)

The Contractors shall make alternative arrangements for wheel washing and high pressure hosing should the installed equipment fail to function. (PS Clause 1.3.3)

Compliance with the above shall not relieve the Contractor of any responsibility for complying with the requirements of the Highway Authority, nor from his obligations under the Contract. (PS Clause 1.3.4).

It is recommended that these or similar clauses should be applied to all the LAR contracts, by their incorporation into the General Specification or each of the Particular Specifications.

Blasting Operations

As identified in the air quality assessment, blasting operation is the most significant dust generating activity, mitigation measures to control emissions are essential. Therefore, the CCP should include the following instructions:

- The Contractor should arrange his blasting techniques and take appropriate precautions to minimize dust generation.

- The Contractor should apply licence/permit for the uses of explosives for blasting under the Dangerous Goods Ordinance Chapter 295.

C7.2.2 *Odours*

To minimise odour emissions from handling excavated waste in transit and stockpiled, the following new tender clauses are suggested.

The Contractor shall ensure that any excavated landfill waste is removed for disposal as soon as they are generated from excavation.

The Contractor shall ensure any landfill waste stockpile left on site and during transit is properly covered, and the stockpiles of wastes are removed as soon as possible.

The Contractor shall ensure on-site excavation is completed in the shortest period possible.

The Contractor shall ensure any wet waste arising during pile construction will be handled as soon as possible and mixed with drier waste and layered with soil.

The Contractor shall handle leachate and bentonite slurry in a closed-loop system of pipes and tanks to avoid odour emission.

The Contractor shall use covered containers, trucks, or barges to transport waste for off-site disposal to avoid odour emission. Such equipments shall be sealed so far as is practical and provided with leachate collection and removal facility for proper disposal.

In order to minimise and avoid complaints due to odours, off-site route for wastes transportation to an approved disposal site should not pass through area with large population, if at all possible. This should be reflected in the CCP by advising that:

- the Contractor should select appropriate routing for transportation of waste if off-site disposal is to be adopted, and agree this with the Commissioners for Transport and the Police. The Contractor shall ensure the route is selected as to minimise travelling through areas of high population density.

C7.3 *OPERATIONAL PHASE*

C7.3.1 *Ventilation and Plant*

Although no significant air quality impacts are predicted to occur in the operational phase of the LAR, as is noted in *Section C5.2* of this annex, the following recommendations will help to ensure that this is the case:

- As mechanical ventilation to ensure good indoor air quality is envisaged within the LAR stations and tunnels, the location and direction of ventilation exhausts should be carefully chosen so that they would not introduce any adverse impacts on nearby sensitive receptors. The ventilation exhausts should not be allowed to face any sensitive receptors directly.

- As the general air conditioning system within the Stations is to be used for emergency smoke extraction during fire, the location and direction of the ventilation exhausts should also be carefully chosen as noted above. Moreover, the choice of fire extinguisher systems should also be carefully examined to ensure that its uses would not result in any adverse air quality impacts.

The above considerations and recommendations should be incorporated into E&M design.

C7.3.2 *Landfill Gas*

As was noted in *Section C5.2.2*, there will be the potential for the infiltration of landfill gas into the operational areas of the LAR at Kwai Chung Park. In order to reduce any risk posed by the presence of landfill gas to an acceptable minimum, and reduce the generation of leachate, an engineered capping system has been designed to cover both the base and the slopes of the cutting. An additional function of the system in the base of the cutting is to provide an adequately stable working platform for the heavy equipment involved in the construction of the railway section.
The capping system may include the following elements:

- *An above waste drainage layer*, comprised of crushed rock on the base and *Geodrain* on the slopes, to prevent potential perched leachate tables exerting hydraulic pressure on the geomembrane, and provide a horizon for gas movement;

- *A geomembrane gas/water barrier*, comprised of Low Density Polyethylene (LDPE) to prevent gas egress and water ingress, with a layer of geotextile above and below, to provide protection against penetration by the crushed rock;

- *A sub-surface drainage layer*, comprised of crushed rock on the base and *Geodrain* on the slopes, to provide a drainage pathway for infiltrated rainwater. At the toe of the slopes, this layer will contain a subsoil drain to direct collected water to the drainage system at the extremities of the cutting; and

- *A fill/soil layer*, to provide protection for the geomembrane and a growing medium to accept hydroseeding as a minimum. A flexible drainage system will be installed on this layer to control surface water.

This arrangement is fairly typical of landfill closure capping systems and is expected to have an infiltration rate of less than 5% of precipitation. The presence of a sub-soil drainage layer above the geomembrane will prevent build up of a hydraulic head and thus reduce water infiltration, through any breaches in the geomembrane, to a minimum. In addition, on the cutting slopes, the surface drainage system and the slope angle will considerably reduce the incidence of infiltration through the fill. The base of the cutting is mainly sheltered by the viaduct section of the railway, which have their own collection and discharge systems.

C7.4 EVALUATION OF MITIGATION MEASURES

C7.4.1 *Introduction*

In this section, the effectiveness of the recommended measures to mitigate construction dust impacts during the construction of the LAR is evaluated. This has been done by estimating the amount of dust suppression which is likely to result if the mitigation measures recommended are implemented and adhered to by the contractors, and comparing these with the evaluation criteria agreed with EPD for use in this study as set out in *Annex A* of this report. In predicting the amount of likely dust suppression, it has been assumed there will be:

- 50% [1] reduction through frequent watering during construction activities;

- 90% dust removal from controlled concrete batching process; and

- 60 % reduction in dust emission potential from truck movements over unpaved haul roads by restricting speed to 15-20 kph and by frequent surface watering and compacting;

- 90% dust removal from controlled blasting and the fitting of secure covers at tunnel ends as blasting proceeds inward from the tunnel portals.

(1) Jutze, G.A., K. Aetell, Jr., and W. Parker. Investigation of Fugitive Dust-Sources Emissions and Control. Publication No. EPA-450/3-74-046a. June 1974.

- 70% [1] reduction in dust emission potential from controlled material handling operations; and

- 80% [2] reduction in dust emission potential from storage piles of various material.

C7.4.2 *Central and Yau Tsim Districts*

From the prediction results presented in *Section C5.1.1* showed the potential construction dust impacts from Contract 501 to sensitive receptors along Connaught Road would exceed the hourly TSP limit of 500 $\mu g\ m^{-3}$. Mitigation measures and good on-site management recommended in *Section C7.2* should be adopted during the construction phase of Contract 501. *Table C7.4a* shows the construction dust impacts from Contract 501 when the recommended mitigation measures are in place.

Table C7.4a ***Mitigated Maximum Hourly Dust Impact ($\mu g\ m^{-3}$) from Contract 501***

Receptor	Mitigated Dust Impacts [1]
Harbour Building	427
90 Connaught Road Central	405
Sincere Building	480
International Building	210
New Heng Seng Bank Building	420
24-32 Connaught Road	297
Wang Kee Building	330
Chuang's Plaza	397
Win Lung Bank Building	395
Fung House	380
Euro Trade Centre	340
World Wide House	330
Swire House	463
Mandarin Oriental	285
General Post Office	373
Exchange Square	380
City Hall	375
Prince of Wales Building	410

Note (1) A background TSP level of 147 $\mu g\ m^{-3}$ is included.

[1] R. Bohn, et al., Fugitive Emissions From Integrated Iron and Steel Plants, EPA-600/2-78-050, U.S. Environmental Protection Agency, Washington, DC, March 1978.

[2] G.A. Jutze and K. Axetell, Investigation Of Fugitive Dust, Volume I: Source, Emissions and Control, EPA-450/3-74-036a, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

Although construction impacts from Contract 502 alone will not lead to significant dust impacts, see *Section C5.1.1.*, combined impacts from concurrent construction work in the area may pose a threat to the hourly TSP target. Therefore dust suppression measures and good on-site management as recommended in *Section C7.2* should be adopted during the construction of Contract 502.

As noted in *Section C5.1.1*, although the construction of Contract 503 alone will only produce relatively low dust levels if compared to the recommended hourly limit, the concurrent construction programmes with other projects are likely to produce unacceptable dust levels. Mitigation measures and good on-site management practice as recommended in *Section C7.2* should therefore be adopted during the construction phase of Contract 503. However, it must be made clear that even with the implementation of these mitigation measures, the cumulative dust impacts on the selected receptors will still be primarily affected by the construction of the WKE and the prevailing high background dust levels. *Tables C7.4b* and *C7.4c* illustrate the construction dust impacts from Contract 503 and Contract 504 respectively, when the recommended mitigation measures are in place.

Table C7.4b *Mitigated Maximum Hourly Dust Impacts ($\mu g\ m^{-3}$) from Contract 503*

Activities (mitigated)	Ferry Street	Man Cheong Street	King George V Park	Canton Road
General construction activities including excavation	63	83	50	38–50
Concrete batching process	3	3	4	3–5
Background	157	157	157	157
Total	223	243	211	198–212

Table C7.4c *Mitigated Maximum Hourly Dust Impacts ($\mu g\ m^{-3}$) from Contract 504*

Activities (mitigated)	Man Cheong Street	Hoi King Street
Handling of Excavated Material	96	37
Concrete Batching Process	12	14
Stockpiling	16	22
Background	157	180
Total	281	253

C7.4.3 *Mong Kok and Sham Shui Po Districts*

As discussed in *Section C5.1.2,* although the construction of Contract 505 alone will only produce relatively low dust levels if compared to the EPD-recommended hourly limit, the concurrent construction programmes of other projects are likely to produce unacceptable dust levels. Therefore, it is recommended that mitigation measures and good on-site management practice as set out in *Section C7.2* should be adopted during the construction phase of Contract 505. However, it must be made clear that even with the implementation of the following measures, the cumulative dust impacts on the selected receptors will still be primarily affected by the construction of WKE and the prevailing high background dust levels. *Table C7.4d* illustrates the construction dust impacts from Contract 505 when the recommended mitigation measures are in place.

Table C7.4d ***Mitigated Maximum Hourly Dust Impacts ($\mu g\ m^{-3}$) from Contract 505***

Activities	Wong Tai St	Hoi King St	Cherry St
General Construction activities	43	87	35-76
Concrete Batching Process	4	3	3
Background	180	180	180
Total	227	270	218-259

The construction of Contracts 506 and 507 will be entrusted to the Government as part of the works for the WKE. The dust mitigation measures which will be implemented in relation to these contracts are discussed in the EA carried out for the WKE. An evaluation of the effectiveness of the recommended dust suppression measures in this report [(1)], while not quantifying the benefits, does claim that dust impacts will be reduced to acceptable levels.

C7.4.4 *Kwai Tsing District*

Tables C7.4e and *C7.4f* shows the potential dust impacts from Contract 508 when the recommended mitigation measures are adopted.

(1) Freeman Fox Maunsell *et al* (1991) - "West Kowloon Expressway: Volume 3 Environmental Assessment" - Hong Kong Government Highways Department - pp. 54-55.

Table C7.4e ***Mitigated Maximum Hourly Dust Impacts from Contract 508 ($\mu g\ m^{-3}$)***

Location	C508 (1)
Yiu Lai Court	259
Yuet Lai Yuen	233
Block 1, Lai King Estate (LKE)	223
Block 3 (LKE)	202
Block 4 (LKE)	192
Block 5 (LKE)	292
Block 6 (LKE)	236
Lok Sin Tong School	219
WMC Morninghope School	272
Chan Nam Cheong School	262

Note (1) A background TSP level of 157 $\mu g\ m^{-3}$ is added.

Table C7.4f ***Mitigated 24 hour dust impact ($\mu g\ m^{-3}$) from Contract 508***

Key ASRs	Site Preparation	Main Construction Period
Lai King Estate - Block 5	34 (191)	34 (191)
WMC Morninghope School	13 (170)	59 (216)

(1) Figures in brackets include a background TSP level of 157 $\mu g\ m^{-3}$, this is the 95 percentile of the daily average dust level measured at EPD Kwai Chung Station.

Table C7.4g illustrates the mitigated dust impacts from Contract 509 to the sensitive receptors. It can be seen from *Table C7.4g* that the potential impacts will be further reduce and the dust impacts from Contract 509 alone will meet the EPD's recommended 1-hour dust limit of 500 $\mu g\ m^{-3}$.

Table C7.4g ***Mitigated Maximum Hourly Dust Impacts ($\mu g\ m^{-3}$) from Contract 509***

Receptor	C509	Total C509 + background (1)
Lok Sin Tong	66	223
Yiu Lai Court	79	236

Note (1) A background TSP level of 157 $\mu g\ m^{-3}$ is added.

Table C7.4h illustrates the cumulative construction dust impacts from Contracts 510 and 511 when the recommended mitigation measures are put in place. It may be seen that there will be compliance of the EPD-recommended hourly limit and the daily AQO.

Table C7.4h ***Predicted Maximum Mitigated Construction Dust Concentrations from Contracts 510 and 511 ($\mu g\ m^{-3}$)***

Sensitive Receptors	Contract 510 (Total Hourly Impacts)	Contract 511 (Hourly Impacts)				Cumulative Hourly Impacts[2] (Contracts 510, 511 & background[4])	Cumulative Daily Impacts[3] (Contracts 510 + 511 + background)
		General construction activities	Trucks movements over unpaved roads	Concrete batching process	Total		
Cheung On Estate	40	62–202	8–26	3–12	70–244	260–419	201–271(228)
School at Cheung On Estate	48	213	34	15	258	433	279
Ching Tai Court	<40	77	11	4	92	<279	<209
School at Tsing Yi Estate	<40	74	8	3	90	<280	189
School at St Paul's Village	<40	124	14	6	152	<336	<205
St Paul's Village	40	191	18	9	230	412	225(272)

Note (1) Assuming 50% dust suppression by frequent watering during general construction activities; 90% dust removal from controlled concrete batching processes; and 60% reduction in dust emission potential from truck movements over unpaved roads.

(2) Simple addition of individual total impacts.

(3) Simple addition of individual total impacts with conservative persistence factors shown in *Table 4.3b, WP 10 LAR EIS.*

(4) The background TSP level is taken to be 157 $\mu g\ m^{-3}$ for both hourly and daily TSP impacts.

(5) Figures in brackets were calculated from sequential hourly met data.

Tables C7.4i and *C7.4j* illustrate the construction dust impacts from Contract 512 and the cumulative dust impacts with Contracts 510 and 511 when the recommended mitigation measures are put in place. The early stage of tunnelling of Contract 512 has been assumed as the worst case. There will be compliance with the EPD–recommended hourly limit and the daily AQO will be met even under the worst case cumulative dust impacts.

Table C7.4i ***Predicted Maximum Mitigated Hourly and Daily TSP ($\mu g\ m^{-3}$) Concentrations from Contract 512***

Sensitive Receptors	Hourly TSP			Daily TSP		
	Site Formation Works	Tunnelling Works		Site Formation Works	Tunnelling Works	
		Early Stage	Later Stage		Early Stage	Later Stage
School at Cheung On Estate	22	75	10	1	2	2
Cheung On Estate	30	100	15	1(7)[(1)]	4(15)	2(8)
Cheung On Estate	63	200	35	2	7	2
Cheung On Estate	60	214	55	3	8	2
Cheung On Estate	75	295	240	10	45	15
School at Tsing Yi Estate	43	160	20	3	10	2
School at St Paul's Village	43	150	16	2	6	2
St Paul's Village	27	100	10	1(7)	3(15)	2(5)

Note (1) Figures in brackets were calculated using sequential hourly met data.

With the recommended dust suppression measures, no exceedances of the 24 hour AQO for TSP will result at Cheung On Estate, however, the 24 hour AQO for TSP will be exceeded marginally at St Paul's Village. It should be noted that of the total dust level only 40% is due to construction works, the remaining 60% is from background sources.

The use of mitigation measures will prevent dust levels from the Contract 512 tunnelling works from threatening the 24 hour AQO.

Table C7.4j ***Predicted Maximum Mitigated Hourly and Daily TSP ($\mu g\ m^{-3}$) from Contracts 510, 511 and 512***

Sensitive Receptors	Cumulative Hourly Impacts		Cumulative Daily Impacts	
	C510, C511 and C512	Total(1)	C510, C511 and C512	Total(1)
School at Cheung On Estate	252	409	106(86)(2)	263(243)
Cheung On Estate	244	401	92	249
Cheung On Estate	242	399	50	207
Cheung On Estate	230	387	46	203
Cheung On Estate	325	482	65	222
School at Tsing Yi Estate	186	343	35	192
School at St Paul's Village	187	344	50	207
St Paul's Village	250	407	85(130)	242(287)

Note (1) A background TSP level of 157 $\mu g\ m^{-3}$ has been included.
(2) Figures in brackets have been calculated from sequential hourly met data.

C7.4.5 *Tsuen Wan and Islands Districts*

According to the Lantau Fixed Crossing EA, Construction dust impacts during construction of Contact 513 may be reduced substantially with the combination of the control methods and the highest level of 1-hour and 24-hour average TSP (due to haul road traffic) estimated at Lau Fa could be reduced to about 650 $\mu g\ m^{-3}$ and 260 $\mu g\ m^{-3}$, respectively. Provided strict mitigation measures are applied to Route 3 and LFC contracts, the works may be carried out with little or no exceedence of the 24-hour AQO for dust. The recommended 1-hour dust limit of 500 $\mu g\ m^{-3}$ will be exceeded on occasions during the early works for the LFC.

The construction activities associated with Contract 514 have been predicted to produce high dust levels, especially during the tunnelling and excavation operations for the East Lantau Tunnels. In light of the possible significant cumulative dust impacts due to the number of developments in the area, mitigation measures and good on-site management should be adopted during the construction phase, although impacts from construction will be of short duration. *Table C7.4k* illustrates the construction dust impacts from Contract 514 when the recommended mitigation measures are put in place.

Table C7.4k *Predicted Mitigated Construction Dust Concentrations from Contract 514 ($\mu g\ m^{-3}$)*

Sensitive Receptors	Contract 514 (Maximum Hourly Dust Concentration $\mu g\ m^{-3}$)				
	Blasting	General Construction Activities	Concrete Batching	Background TSP Level	Total
Tso Wan	–	17	–	40	57
Proposed Liu Yuin Dockyard	1735	162	0	40	1937
Wan Tuk	32	10	0	40	80

Due to the potential significant cumulative impacts from other construction in the area, mitigation measures should be adopted in order to reduce the level of dust emission from Contract 515. The NLE EA recommended a number of mitigation measures should be incorporated into tender clauses, together with monitoring and audit requirements. These recommendations were included in the NLE Final Report and Appendix C of that report. No quantified evaluation of the effectiveness of these measures is given in the report, but it is stated that the measures will be suitable to ensure compliance with the AQO.

The effects of mitigating dust impacts from the construction of Siu Ho Wan Depot (Contract 518) at Tai Ho Wan Temple are shown in *Table C7.4l* below.

Table C7.4l *Mitigated Maximum Hourly Dust Impacts ($\mu g\ m^{-3}$) from Contract 518*

Activities (mitigated)	**Maximum Hourly TSP Concentration $\mu g\ m^{-3}$**
Construction activities including excavation	65
Concrete batching process	0
Background Dust Level	20
Total	85

Table C7.4m sets out the predicted dust levels during the construction of Contract 516 when the recommended mitigation measures are in place.

Table C7.4m ***Predicted Mitigated Construction Dust Concentrations from Contract 516 ($\mu g\ m^{-3}$)***

Sensitive Receptors	Contract 516 (Maximum Hourly Dust Concentration $\mu g\ m^{-3}$)			
	General construction activities	Trucks movements over unpaved roads.	Concrete batching process	Total [(1)]
Tai Po	104	150	7	276
Tai Po Youth Camp	40	28	1	84
Ma Wan Chung	80	26	1	125

Note (1) The annual average TSP level of 15 $\mu g\ m^{-3}$ adopted from the North Lantau Development environmental assessment for Tung Chung is taken as the background.

In the vicinity of the new airport at Chek Lap Kok (Contract 517), the NAMP recommended dust suppression measures to be implemented during the construction phase. However, no quantified evaluation of the effectiveness of these measures is given in the report.

C7.4.6 Conclusions

The prediction of dust impacts is based on an assumption that construction activities will be carried out simultaneously over the whole of the construction site, however, this is not normally the case. If construction activities are carried out over half of the construction site, the potential dust impacts at the ASRs will be further reduced by 50%. It is also difficult to assess the effectiveness of a 2 m hoarding at the site boundary on dust propagation and no allowance has been made for such effects. Therefore, it is very likely that the potential dust impacts at the ASRs have been overestimated by a considerable amount.

MTRC is committed to an Environmental Monitoring and Audit programme (see *Annex G*) which will play a pivotal role in minimising the potential for dust impacts by providing the necessary information to instigate actions to reduce dust emissions before they reach significant levels.

When detailed construction programmes have been defined, it may be possible to arrange the scheduling of construction activities in order to reduce the dust impacts at the ASRs to a minimum. Additional mitigation measures may also be developed, for instance, in order to further reduce the potential hourly dust impacts at the ASRs, the frequency of watering could be increased depending on the level of construction activities and when high dust levels are recorded during construction.

Annex D

Water Quality Impacts

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D1 INTRODUCTION

D1.1 SCOPE AND PURPOSE OF THE ANNEX

Annex D addresses the impacts upon water quality arising from the construction and operation of the LAR.

D1.2 STRUCTURE OF THE ANNEX

After this introduction, the Annex is divided into six further sections, which are described briefly below:

- *Section D2* describes the existing and future baseline water quality conditions in the vicinity of the LAR alignment.
- *Section D3* identifies potential sources of impact during construction and operation of the LAR.
- In *Section D4* Assessment Methodologies are described for each type of discharge.
- *Section D5* predicts the impacts upon each Water Control Zone (WCZ) in quantitative and qualitative form. Construction and operational impacts are considered separately.
- In *Section D6* the predicted impacts are evaluated against EPD criteria and unacceptable impacts identified for mitigation.
- In *Section D7* mitigation measures are described for all unacceptable impacts, these measures are designed to reduce impacts to acceptable levels.
- *Section D8* details procedures to ensure the efficacy of the proposed mitigation measures and also provides contingency plans to deal with any system failures.

D2 BASELINE CONDITIONS

D2.1 EXISTING CONDITIONS

D2.1.1 *Victoria Harbour Water Control Zone*

Victoria Harbour is a polluted water body which suffers from high turbidity, serious oxygen depletion in the bottom waters, and serious faecal pollution in the form of very high counts of *E. Coli.* Although 1990 showed some improvements in dissolved oxygen (DO) concentration and numbers of *E. coli* with respect to 1989, other important factors either deteriorated or remained the same. Inorganic Phosphorus (P) is high and compliance was not achieved, however, the annual mean values for inorganic Nitrogen (N) are below the limit. The Sewage Strategy Study concluded that Nitrogen is the limiting nutrient in Hong Kong waters.

Lack of improvement in water quality is due to continuing discharges of untreated domestic and industrial wastes directly into the harbour. Results from water and sediment quality monitoring collected by EPD in 1989 and 1990 are summarised in *Tables D2.1a* and *D2.1b.* Monitoring stations are located in the main flow channel of the harbour rather than near the reclamation area, but give an indication of the local water quality.

Table D2.1a Sediment and Water Quality in Victoria Harbour (Annual Averages for 1989)(1)

Sediment Parameter	Level (mg kg^{-1} ds)	Water Parameter	Level
TOC(2)	2.0	DO (% Saturation (Satn))	
TKN	770	Surface	62.0
TP	700	Bottom	52.0
PCB	0.056	BOD (mg l^{-1})	1.1
PAH	0.023	Turbidity (NTU)	6.0
Cd	4.5	Suspended Solids (mg l^{-1})	4.8
Cr	38.0	Inorganic N (mg l^{-1})	0.34
Zn	160.0	Orthophosphate P (mg l^{-1})	0.04
Cu	210.0	Chlorophyll–a (μg l^{-1})	3.6
Pb	88.0	*E. coli* (Number per 100 ml)	5900
Hg	0.4		
Ni	20.0		
As	5.9		

(1) Source: Western Harbour Crossing Study Final Report, Volume 5, April 1991.
(2) TOC levels given in % ds.

Table D2.1b Summary Statistics of 1990 Water Quality of Victoria Harbour (EPD, 1991)

Determinand		Harbour East and Central	Harbour West
Temperature (°C)	Surface	22.906 (16.010–28.923)	22.965 (15.900–28.875)
	Bottom	22.409 (15.630–28.695)	22.571 (15.810–28.436)
Salinity (ppt)	Surface	30.868 (26.407–32.890)	30.198 (22.312–32.440)
	Bottom	31.566 (28.380–33.695)	31.192 (27.279–32.623)
DO (% satn.)	Surface	72.412 (25.000–145.960)	80.183 (28.696–145.960)
	Bottom	61.405 (34.047–96.580)	69.188 (42.952–116.172)
pH		8.258 (7.687–8.763)	8.279 (7.740–8.831)
Secchi Disc (m)		2.091 (0.800–6.000)	2.050 (0.500–5.000)
Turbidity (NTU)		5.105 (1.633–18.167)	5.596 (1.500–17.500)
SS (mg l^{-1})		5.200 (0.833–20.000)	6.362 (0.833–28.333)
BOD_5 (mg l^{-1})		1.134 (0.140–3.310)	0.836 (0.175–1.997)
Inorganic N (mg l^{-1})		0.282 (0.136–0.620)	0.282 (0.063–0.557)
Total N (mg l^{-1})		0.862 (0.395–1.505)	0.864 (0.415–2.690)
PO_4 –P (mg l^{-1})		0.040 (0.002–0.107)	0.034 (0.002–0.076)
TP (mg l^{-1})		0.089 (0.027–0.240)	0.075 (0.027–0.133)
Chlorophyll a (μg l^{-1})		3.267 (0.200–31.333)	3.206 (0.233–15.333)
E. coli (Number per 100 ml)		3374 (27–44000)	692 (27–18000)

Note: 1. Except as specified, data presented are depth average data.
2. Data presented are annual means except for *E. coli* data which are annual geometric means.
3. Data enclosed in brackets indicate the ranges.

The topmost sediments are generally characterised by high organic matter content, high sulphide content from biodegradation, high nutrient levels, and very high concentrations of heavy metals and polychlorinated biphenyls (PCBs). Marine muds are classified by their heavy metal content and an exceedance of a specified classification level limit for any one metal within a sample is sufficient for the mud to take on that classification. As the topmost harbour sediments contain levels of Cadmium, Copper, Lead, and Zinc which exceed the highly contaminated classification (Class C), this sediment must be classified as highly contaminated. Biological mapping of the harbour, through the use of benthic communities, indicates that there are abiotic zones in poorly flushed areas like sewage discharge points and typhoon shelters while the central channel is only mildly affected by pollution due to rapid dilution and dispersion by tidal flushing.
Data from the Contaminated Spoil Management Study (EPD 1991) indicates high values of Mercury and Zinc and extreme concentrations of Copper and Lead in the marine sediments in the vicinity of the reclamation area.

Water quality in the North West Kowloon area of Victoria Harbour is generally poor with high BOD and *E. coli* levels and low DO concentrations. This is due to the large volumes of untreated domestic and industrial effluent that are discharged via storm water drains and/or foul sewers into the area. Similarly, the Kowloon North Camber typhoon shelter is heavily polluted by organic wastes. DO concentrations are low, and very high BOD and *E. coli* counts have been measured.

The Yau Ma Tei typhoon shelter is also heavily polluted by organic wastes and has low levels of dissolved oxygen and high BOD and *E. Coli* counts as indicated in *Table D2.1c*.

Where the LAR alignment passes through Kwai Tsing District the Airport Railway Feasibility Study (ARFS) states that the ultimate receiving water for discharges of ground and surface waters will be the Rambler Channel. Under the Water Pollution Control Ordinance (WCPO), the eastern side of Rambler Channel falls within the Victoria Harbour WCZ whilst the western side is within the Western Buffer WCZ, WCZs are shown in *Figure D2.1a*. The water quality in Rambler Channel is well documented by the EPD marine water quality monitoring programme.

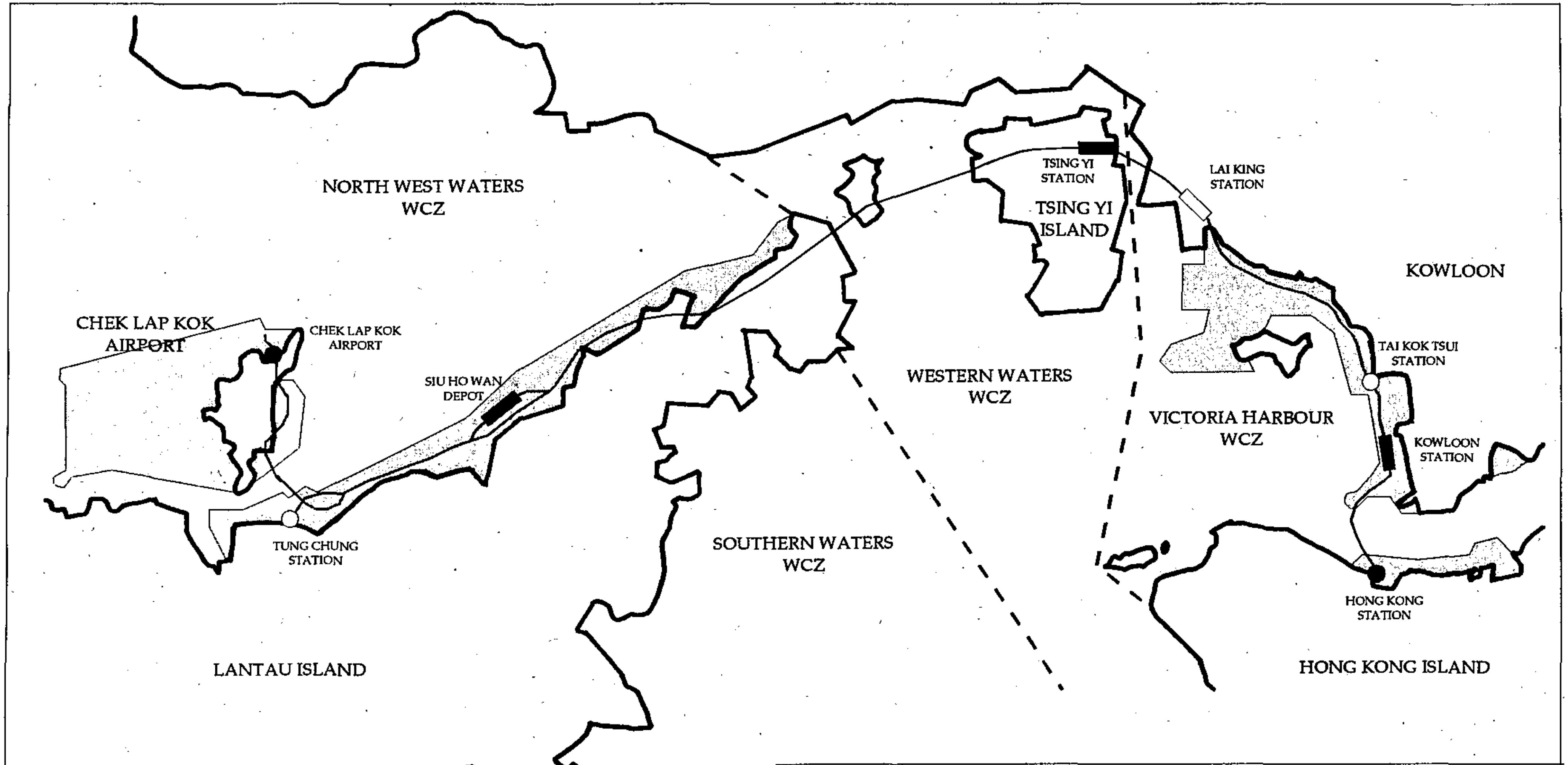
Water quality monitoring by EPD revealed that average water quality conditions are generally acceptable, but unacceptably high *E. coli* and SS levels occur on occasions along with low DO concentrations (just over 30% saturation). BOD values are below 3 mg l^{-1} and thus are acceptable. PO_4–P is high and compliance was not achieved. However, the annual mean values for Inorganic–N are below the limit.

Table D2.1c ***Summary Statistics of Water Quality of West Kowloon***

Determinand		North West Kowloon	Yau Ma Tei Typhoon Shelter
Temperature (°C)	Surface	23.117 (16.000–29.733)	21.983 (15.300–27.100)
	Bottom	22.879 (15.900–28.626)	21.917 (15.300–27.100)
Salinity (ppt)	Surface	30.131 (24.398–33.550)	28.800 (23.140–30.870)
	Bottom	30.535 (25.086–33.580)	29.020 (23.000–31.330)
DO (% satn.)	Surface	53.249 (13.529–128.099)	8.452 (2.200–22.000)
	Bottom	50.435 (15.594–106.587)	18.190 (3.200–43.000)
pH		8.081 (7.105–8.829)	7.672 (7.440–8.015)
Secchi Disc (m)		1.484 (0.800–3.200)	0.967 (0.500–1.200)
Turbidity (NTU)		6.743 (1.650–29.250)	7.625 (4.033–12.250)
SS (mg l^{-1})		7.186 (1.833–23.000)	4.167 (1.667–6.833)
BOD_5 (mg l^{-1})		1.529 (0.225–5.155)	3.075 (1.880–3.655)
Inorganic N (mg l^{-1})		0.461 (0.052–0.806)	1.063 (0.524–1.850)
Total N (mg l^{-1})		1.084 (0.435–1.943)	1.701 (1.371–2.117)
PO_4 –P (mg l^{-1})		0.065 (0.002–0.130)	0.123 (0.065–0.160)
TP (mg l^{-1})		0.114 (0.027–0.237)	0.183 (0.115–0.225)
Chlorophyll a (μg l^{-1})		3.887 (0.200–18.667)	1.411 (0.200–3.350)
E. coli (Number per 100 ml)		8914 (67–120000)	63889 (33000–100000)

(1) Except as specified, data presented are depth average data.
(2) Data presented are annual means except for *E. coli* data which are annual geometric means.
(3) Data enclosed in brackets indicate the ranges.

Source: Marine Water Quality in Hong Kong 1990.



WATER CONTROL ZONES

KEY

- RECLAMATION
- LAR ALIGNMENT
- WATER CONTROL ZONES
- LAL STATION
- AEL STATION
- INTERCHANGE STN WITH MTR
- AEL INTERCHANGE STN

FIGURE D2.1a

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

The ARFS noted that the main surface watercourse in the vicinity is the Kau Wa Keng Stream which drains into Lai Chi Kok Bay. EPD monitoring data for this stream indicate compliance with Water Quality Objectives (WQO) for watercourses in the area, but exceedance of the NH_3N objective is by an order of magnitude. The Water Supplies Department (WSD) have indicated that no recent data is available for groundwater quality within this area.

D2.1.2 *Western Buffer Water Control Zone*

The water quality in the typhoon shelter at the Rambler Channel is considered satisfactory. As indicated in *Table D2.1d,* the dissolved oxygen was usually maintained at or above 50% saturation, the eutrophic potential is moderate and faecal pollution is not severe.

Analysis of sediments from the Rambler Channel as reported in the ARFS are shown in *Table D2.1e.* Comparison was made against different classifications of sediment as stipulated in the *EPD Technical Circular No 1-1-92, Classification of Dredged Sediments for Marine Disposal.* Definitions of the classifications are given below.

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 disposed 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.

Table D2.1d Summary Statistics of Water Quality of Rambler Channel

Determinand		Rambler Channel	Typhoon Shelter Rambler Channel
Temperature (°C)	Surface	23.194 (15.950–29.674)	21.966 (15.100–27.100)
	Bottom	22.640 (15.890–28.503)	22.050 (15.100–28.300)
Salinity (ppt)	Surface	29.023 (20.620–32.150)	29.713 (26.320–31.330)
	Bottom	30.661 (25.637–32.270)	29,953 (26.400–31.700)
DO (% satn.)	Surface	70.192 (37.600–132.416)	50.819 (34.000–64.000)
	Bottom	59.771 (44.866–79.638)	51.635 (41.600–59.500)
pH		8.277 (7.860–8.813)	8.064 (7.825–8.220)
Secchi Disc (m)		1.775 (0.900–5.000)	1.241 (0.500–2.000)
Turbidity (NTU)		5.872 (1.950–27.000)	7.210 (3.900–11.000)
SS (mg l^{-1})		5.352 (1.500–17.333)	11.069 (2.667–29.333)
BOD_5 (mg l^{-1})		1.146 (0.170–2.745)	1.991 (0.877–3.710)
Inorganic N (mg l^{-1})		0.352 (0.102–0.982)	0.356 (0.082–0.628)
Total N (mg l^{-1})		0.940 (0.515–3.123)	1.172 (0.670–2.390)
PO_4 –P (mg l^{-1})		0.052 (0.002–0.136)	0.084 (0.022–0.297)
TP (mg l^{-1})		0.097 (0.033–0.253)	0.163 (0.050–0.527)
Chlorophyll a (μg l^{-1})		1.759 (0.233–9.800)	1.410 (0.533–2.567)
E. coli (Number per 100 ml)		978 (67–99500)	808 (433–1533)

(1) Except as specified, data presented are depth average data.
(2) Data presented are annual means except for *E. coli* data which are annual geometric means.
(3) Data enclosed in brackets indicate the ranges.

Source: Marine Water Quality in Hong Kong 1990.

Table D2.1e ***Sediment Quality in the Rambler Channel*** (1)

Parameter	Test Result on Dry Basis (mg kg^{-1})						
	Cd	Cr	Cu	Hg	Ni	Pb	Zn
	7.1	**110**	**670**	**0.21**	**86**	**99**	**160**
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

(1) Source: Airport Railway Feasibility Study Final Report, Volume 3.

It should be noted that for sediments to be classified within a particular class, only the concentration of one metallic species need be exceeded. The dredged material will be classified as Class C that is seriously contaminated. Disposal of the mud will require prior approval from the Fill Management Committee.

The existing beach water quality at Tung Wan, prior to the commencement of construction works on the Lantau Fixed Crossing (LFC) was considered to be generally good and improving, with *E. coli* and dissolved oxygen values complying with the WQO.

The marine water quality conditions within the project area were established from EPD monitoring data. Seasonal values derived for the marine stations show compliance with the WQO for dissolved oxygen and *E. coli*. The WQO for ammonia was breached however at all three stations. Comparison of seasonal values for beach water quality at Tung Wan and at the adjacent marine station indicate that a reduction in water quality occurs locally. The bay may provide a degree of protection from main stream pollutants although once pollutants have entered the bay they would have a long retention time.

Discharges from the construction works for the Lantau Tunnels are likely to enter the nearby marine waters off North Lantau via the drainage system. Under the WPCO, these marine waters fall within two WCZs; the North Western WCZ that is to the north of Lantau Island and the Western Buffer WCZ to the east. Drainage from the construction works at the western end of the tunnels will therefore discharge into the North Western WCZ and that from the eastern end into the Western Buffer WCZ.

The water quality in the Western Buffer WCZ to the west of Tsing Yi Island and the Lantau North area of the North Western Waters are summarised in *Table D2.1f*.

Table D2.1f ***Summary Statistics of Water Quality In The Western Buffer and North Western WCZs***

Determinand		Tsing Yi Island (west)	Lantau North
Temperature (°C)	Surface	22.791 (16.050–28.341)	24.074 (17.020–29.825)
	Bottom	22.180 (15.980–27.971)	23.185 (16.990–28.443)
Salinity (ppt)	Surface	29.532 (16.050–32.470)	26.495 (14.697–31.479)
	Bottom	31.632 (31.010–33.916)	29.632 (24.270–33.360)
DO (% satn.)	Surface	85.289 (39.880–135.309)	100.925 (70.580–151.633)
	Bottom	71.371 (41.606–108.500)	84.017 (56.071–121.420)
pH		8.331 (7.910–8.710)	8.356 (7.967–8.817)
Secchi Disc (m)		2.183 (1.300–3.400)	2.077 (1.300–2.600)
Turbidity (NTU)		6.610 (2.300–14.733)	6.044 (2.433–13.967)
SS (mg l^{-1})		5.215 (1.000–14.500)	4.797 (1.500–9.000)
BOD_5 (mg l^{-1})		0.731 (0.087–1.677)	0.870 (0.043–1.827)
Inorganic N (mg l^{-1})		0.233 (0.146–0.491)	0.282 (0.035–0.542)
Total N (mg l^{-1})		0.632 (0.378–1.064)	0.751 (0.526–0.982)
PO_4 –P (mg l^{-1})		0.026 (0.003–0.084)	0.020 (0.002–0.035)
TP (mg l^{-1})		0.101 (0.040–0.497)	0.103 (0.043–0.537)
Chlorophyll a (μg l^{-1})		1.468 (0.533–5.133)	2.475 (0.467–8.500)
E. coli (no. per 100 ml)		190 (10–1000)	94 (0–653)

(1) Except as specified, data presented are depth average data.
(2) Data presented are annual means except for *E. coli* data which are annual geometric means.
(3) Data enclosed in brackets indicate the ranges.

Source: Marine Water Quality in Hong Kong 1990.

D2.1.3 *North Western Waters Water Control Zone*

In general, mean water quality conditions are considered to be good in the North Lantau area. The summary data indicates that these North Western Waters are well oxygenated in both surface and bottom layers, and BOD and *E. coli* levels are generally low. The seasonal data show average SS concentrations are lower in the wet season. Seasonal variations are also evident in the oxidised nitrogen values with average wet season values two to three times higher than those recorded in the dry season. This is due to the pollutant load transported by the Pearl River and the flushing of stream beds and nullahs during the wet season. Chlorophyll–a concentrations also increase during the wet season with associated high DO values, which suggests daytime blooming of algae.

The NLE EA states that although these data are not specific to the study area they do provide an insight into water quality conditions within the North Western WCZ.

There is no existing data on water quality for the Kap Shui Mun Channel within the Western Buffer Waters. The nearest EPD monitoring station for this WCZ is located at Tsing Yi Island West on the other side of Ma Wan Island, and hence, water quality data pertain to areas relatively remote from the study area. However, given this is a rural area, in which catchment drainage from streams and surface water runoff should be unpolluted and the existence of a Marine Fish Culture Zone at Ma Wan, water quality within the channel is anticipated to be good.

The existing water quality conditions in the vicinity of the Airport Works were established from EPD monitoring data. A comparison of the maximum values reported from the monitoring stations NM1–NM5 for 1989–90 with the WQO for this zone indicates that water quality generally complies with the WQO except for pH and total inorganic nitrogen.

D2.2 *FUTURE CONDITIONS*

D2.2.1 *Victoria Harbour Water Control Zone*

Victoria Harbour is not yet gazetted as a Water Control Zone (WCZ) under the WPCO. Although there are no water quality objectives for Victoria Harbour in place limits on dissolved oxygen (DO), inorganic nitrogen, organic nitrogen, and numbers of *E. coli* are likely after gazetting. Furthermore, standards for effluent discharge to environmental waters will be defined by EPD and will be specified in licence conditions for any new discharge within the WCZ according to the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewage Systems, Inland and Coastal Waters* (TM).

Water quality may decline temporarily as a result of reclamation and construction activities between 1991–1995. The channel between Stonecutters Island and Lai Chi Kok will be closed under the reclamation work and this will result in reduced tidal flushing. The water quality is therefore anticipated to deteriorate, particularly to the east of Stonecutters Island, with weak tidal forces restricting dilution and dispersion of discharges to the area.

Water quality in Victoria Harbour is expected to improve by 2006. At this time there will be greater constriction of flow within the central harbour area due to reclamations on both shores, however, Victoria Harbour will have been gazetted as a Water Control Zone for over a decade. In addition, Stages I and II of the Strategic Sewage Disposal Scheme (SSDS) and the implementation of the Chemical Waste Regulations which controls the discharge of chemical waste from the industry should have already been implemented. Water quality modelling by EPD for the year 2006, based on the prior implementation of the SSDS, found a marked improvement in overall DO concentrations for a number of reclamation scenarios investigated. Sediment quality will take more time than the water to improve due to the reservoir of pollutants and their low, individual flushing rates.

The Route 3 EIA Report stated that if the realigned breakwater is used in Rambler Channel then it will not be possible for the water to stagnate, and thus levels of *E. coli*, ammoniacal nitrogen and BOD will only change marginally from the existing levels. It is therefore considered reasonable to assume that there will be no detectable deterioration in water quality in the Channel when the structure is completed. The report recommends that drainage facilities, (including oil interceptors), be provided for road tunnels in order that no contaminated tunnel discharge can enter the watercourses, and hence Rambler Channel.

D2.2.2 *Western Buffer Water Control Zone*

Tsing Yi lies within the Western Buffer WCZ, which was declared on 1st June 1993, to the west. The water quality in the Western Buffer is required to comply with the WQO established for the WCZ, and any discharges to these receiving waters are controlled by the TM. The water quality is therefore expected to improve due to the reduced pollution loading which should result from gazetting and the subsequent phased implementation of the SSDS.

The works programme for the Lantau Tunnels is scheduled to commence in April 1994 and continue until February 1996. The construction of the North Lantau Expressway (NLE) and LFC will therefore be concurrent with the construction works for the tunnels.

The NLE EA Report identified that water quality may be affected by dredging, reclamation, disposal of spoil or construction wastes from work sites and general construction activities. The report concluded that although the impacts of dredging on local water quality could be significant, it is unlikely that the mariculture zones at Ma Wan will be affected. In addition, careful control of effluents arising on-site will be required at work sites. Mitigation measures will be required to limit potential impacts of dredging and effluent disposal on the receiving water quality during the construction phase, and spill action plans are recommended to minimise the potential for transportation of pollutants towards sensitive receivers.

D2.2.3 *North Western Waters Water Control Zone*

The LFC EA Report identified the main concerns being the impacts on the Fish Culture Zone at Kung Tsai Wan resulting from changes in water current and directions after the reclamation, and the accidental release of oils, chemicals and other polluting materials from the two work sites. The WAHMO modelling concluded that water quality at Kung Tsai Wan could deteriorate from increased pollution during spring tides as the net current velocity is predicted to reduce. However, the net current flow is away from the bay and therefore pollutants resulting from any accidental spillages would be transported away from the works site and dispersed by the main tidal flow in the Kap Shui Mun Channel. The report concluded that the Bridge is not likely to have major water quality impacts either locally or further afield.

The North Western WCZ was declared on 1 April 1992. The water quality in the North Western Waters is required to comply with the WQO established for this WCZ, and any discharges to these receiving waters are controlled by the TM. The water quality is therefore expected to improve due to the reduced pollution loading which should result with the Western Buffer Waters gazetted as a WCZ and the subsequent phased implementation of the SSDS.

The time period for such improvements in water quality depends on many factors and it should be noted that the pollutant loads transported by the Pearl River will still influence the quality of the North Western Waters, particularly during ebb tides. However, the provision of proper sewerage and new urban and catchment drainage under the North Lantau Development (NLD) provides the opportunity to achieve high water quality standards in the adjacent receiving waters.

In addition, NLD EA states that Ma Wan Chung, (the major existing pollution source in Tung Chung), is likely to be cleared early in the NLD. This should result in an immediate improvement in the water quality in Tung Chung. Furthermore, new urban sewerage and catchment drainage under the NLD provides the opportunity to achieve high water quality standards in the adjacent receiving waters.

D2.3 SENSITIVE RECEIVERS

D2.3.1 *Victoria Harbour*

There are no sensitive biological receivers within Victoria Harbour, although there are sea water intakes located in the immediate vicinity of the proposed immersed tube tunnel on both Kowloon and Hong Kong Island. Some of these intakes are being reprovisioned as a result of the West Kowloon and

Central and Wan Chai reclamations. Others, such as those intakes at South West Kowloon will remain in their existing positions during the reclamation work.

It is understood from the West Kowloon Reclamation Study that sensitive sea water intakes on the West Kowloon coastline will be reprovisioned and protected by silt curtains during the reclamation works. It is anticipated that intakes to the east of the Macau Ferry Terminal on Hong Kong Island will be similarly protected during the construction phase of the Central and Wan Chai reclamation.

According to the HKPSG, the Kowloon North Camber typhoon shelter is a WSR. However, under the WKR scheme, the typhoon shelter area will be reclaimed and the existing typhoon shelter will be relocated off the new West Kowloon shoreline, together with the larger Yau Ma Tei typhoon shelter. There are no major biologically sensitive receivers such as mariculture zones, commercial fisheries or shellfisheries within the vicinity nor are there any gazetted beaches near the site.

The ARFS states that discussions with WSD confirmed that there are no known abstractions of groundwater within the area of the Lai Chi Kok to Kwai Chung Road Viaducts and that the rail alignment does not impinge on water gathering grounds. However, a small stream exists at the south portal site and runs from Lai King Hill Road to Kwai Chung Road. Groundwater drawdown is not considered likely to cause localised environmental problems. The Kau Wa Keng Stream is not abstracted for any significant use and is therefore unlikely to be affected by groundwater drawdown from tunnel boring in the adjacent catchment.

D2.3.2 *Western Buffer.*

According to the HKPSG, water sensitive receivers relevant to the Northern coast of Tsing Yi Island are gazetted bathing beaches along the Castle Peak Road such as Sham Tseng and Ting Kau. There are no biological sensitive receivers in the immediate vicinity. The nearest fish culture zone is at Ma Wan which is over 1.5 Km west of the Tsing Yi Island.

D2.3.3 *North Western Waters*

The following existing WSRs, along the North Lantau coast, which may be affected by the construction works have been identified.

- *Fishing Grounds:* These extend between North Lantau and Castle Peak. This area is a favoured spawning ground because of warm, shallow inlets and bays and abundant food supply;

- *Mariculture Zone:* This operation exists at Kung Tsai Wan off Ma Wan Island. A small operation currently exists at Tung Chung Wan which will be removed before construction of the NLE commences.

- *Streams:* There are a number of small streams in the North Lantau area. Water quality, particularly in the upland sections, is considered to be good as there are few sources of pollution.

- *Shellfisheries:* At Tung Chung and Tai Ho Wan shellfish are harvested along the shoreline for both market and local consumption. However, these shellfishing areas will be lost following development of the North Lantau coast east of Tung Chung.

- *Bathing Beaches:* There are a number of small beaches on Ma Wan and North Lantau and although not gazetted, they are popular recreational areas. On North Lantau only those at Sha Lo Wan and San Tau are likely to remain after completion of the NLD.

- *Proposed SSSI:* Sea Grass (*Zostera nana*) is found at San Tau, on the west side of Tung Chung Wan Bay. The World Wide Fund for Nature have made an application to have this designated a Site of Special Scientific Interest.

- *Pak Mong Wetlands:* The wetlands comprise the main ecological feature in the area with mangrove communities.

- *Mangrove*: Mangrove habitats are found on the intertidal mudflats. However, the mudflats will be reclaimed under land development at Tai Ho Wan.

Proposed WSR also include the marine waters of East Tung Chung Bay and Sea Channel, as identified in the NLD Preferred Concept Plan and the semi-enclosed embayment at Tai Ho Wan, formed between the reclamation for the NLE and the existing coastline, as identified in the NLDS.

There are no seawater intakes at present in the NLD area.

D3 POTENTIAL SOURCES OF IMPACT

D3.1 CONSTRUCTION ACTIVITIES

D3.1.1 General

Many of the construction activities will be essentially the same at all sites along the LAR route. These will be considered in detail at the first location at which they occur and potential impacts noted briefly at subsequent locations. Site specific impacts will also be addressed at the relevant points along the LAR formation.

The major sources of water quality impacts that can arise from the construction activities are as follows:

- Construction runoff and drainage;
- General construction activities; and
- Sewage effluents.

These potential impacts are discussed below.

D3.1.2 Construction Runoff and Drainage

Runoff and drainage from construction sites may contain increased loads of sediments, other SS and contaminants. Potential sources of pollution from site drainage include:

- Runoff and erosion from site surfaces, drainage channels, earthworking and stockpiles;

- Dewatering of reclamation material;

- Bentonite slurries and other grouting materials;

- Concrete batching plant washout and drainage from dust suppression sprays; and

- Fuel, oil and lubricants from construction and tunnelling equipment.

Full dewatering will be required prior to excavation in order to preload the underlying alluvium and to minimise post construction settlement. Full dewatering will be carried out for approximately one month. Effluent will be discharged into Victoria Harbour via a temporary drainage.

Construction runoff and drainage may cause both physical and biological effects, the physical effects are:

- Construction spoil may block channels; and

- High SS concentrations may result in the requirement for increased frequency of cleaning of seawater intake screens and may accelerate the erosion of intake and circulation systems.

The biological effects are:

- Eutrophication caused by the nutrient content of the eroded soil;
- Smothering by release of bentonite clays; and
- Toxicity caused by mixtures of hydrocarbons and grouting materials.

Liquors containing significant quantities of concrete and cement derived materials may result in the following primary effects:

- Localised increases in turbidity and discoloration;
- Localised elevations in pH; and
- Accretion of high pH solids.

A number of secondary effects may also result:

- Toxic effects to marine biota due to elevated pH values;

- Reduced decay rates of faecal micro–organisms due to decreased light penetration; and

- Localised increases in the proportion of un–ionised ammonia.

D3.1.3 *General Construction Activities*

Construction activities which have the potential to cause water pollution are detailed below.

- Debris and rubbish such as packaging and used construction materials, including floating refuse.

- Liquid spillages: a number of liquids are likely to be stored on site such as oil, diesel, solvents etc. Any spillages are likely to result in water quality impacts.

- Water derived from dust suppression equipment at concrete batching plants and haul roads.

- Rainfall runoff from the work areas which may contain dust, fuel, oil, paint, bentonite, or waterproofing agents.

- Maintenance pumping at the tunnel portals during sealing and de–watering of the tunnel.

D3.1.4 *Sewage Effluents*

Sewage effluents from the site, arising from sanitary and catering facilities provided for the construction workforce have the potential to cause water pollution. Canteen facilities are likely to generate significant BOD loads as a result of food preparation and washwaters.

Sewage from on-site construction workforce may be connected to local sewer system at the site. If connection to local sewer is not possible, appropriate disposal facility such as chemical toilets.

D3.1.5 *Impacts Associated with Specific Locations*

Central Reclamation Phase 1

The areas of most concern with regard to the Phase 1 reclamation works and the predicted impacts on water quality are summarised in *Table D3.1a* below. The Central Reclamation EIA recommended mitigation measures for remedial works on the sewerage and drainage infrastructure in order to reduce pollutant loading from stormwater discharges, and thereby ameliorate the predicted water quality impacts of the new reclamation and the embayments.

Table D3.1a ***Summary of Potential Water Quality Impacts***

Area	Predicted Impacts		
	Stormwater discharge	Dredging works	Floating refuse
West of western reclamation bund, near Macau Ferry Terminal	Insignificant	Short term increases in SS when dredging inshore	Visible if present
Within embayment between reclamation bunds	Increases in *E. coli*	Increase in SS, possible decrease in DO	Screened from public view
East of eastern reclamation, near Star Ferry Terminal	Slight decrease in DO, increase in nutrients and *E. coli*	Short term increases in SS when dredging inshore	Visible if present

The marine sediment analysis programme conducted under Central Reclamation Phase 1 indicated that the sediments are highly contaminated with heavy metals. The chemical effects of sediment resuspension are therefore likely to be significant as the potential exists for adverse impacts on marine biota caused by the disturbance of these contaminated sediments. The use of a closed grab dredger has been specified in the contract documentation to minimise impacts during dredging. Use of medium or large closed grab dredgers in an enclosed site, such as reclamation embayments, is considered an acceptable dredging method for the highly contaminated (Class C) sediments by EPD.

Therefore, the study has enabled the potential water quality impacts arising from the construction activities for the reclamation work to be minimised. The implications of the presence of contaminated marine mud were also evaluated.

Immersed Tube Tunnel

There are five main activities which have the potential to affect water quality in Victoria Harbour. These are:

- Dredging of marine mud;
- Backfilling of the dredged trench;
- Transport of marine mud;
- Disposal of marine mud; and
- General construction activities (eg. effluent discharge, spillages).

The main potential impact from dredging arises from the physical disturbance of the sea bed and the subsequent release of solids to the water column. The most impact will occur during the dredging of the finer marine muds. This turbidity and sediment increase can then have the following biological implications:

- Reduction in light penetration and therefore the potential for photosynthesis;

- Depletion of dissolved oxygen due to the high BOD exerted by anaerobic sediments lifted into the water column;

- Enrichment of waters through the release of soluble nutrients from decomposing organic matter, mostly nitrogen loading from ammonia;

- Release of toxins, mainly in the form of heavy metals, dispersed into the water column; and

- Loss of faunal habitat by siltation, destruction of filter feeders by smothering and damage to fish by abrasion of gill filaments and clogging of the opercular cavity.

The implications of increased sediment load on mechanical water sensitive receivers can be as follows:

- Damage to pump impellers and erosion of chiller unit fins in sea water intakes by large particulates;

- Organic "scaling" on heat exchanger plates in sea water intakes, which reduces efficiency.

Backfilling with marine sand and gravel is not expected to generate significant quantities of fines as this material is required to be coarse grained. The first layer, which is installed as a foundation, is likely to be pumped to the site as a sand/water mixture to form a compacted sand mattress below the tunnel sections. Following the laying of the tunnel sections granular fill will be placed at the side of the units to act as a locking fill. Above this layer (between 1.5–2.0 m above tunnel sections) general fill will be placed, followed by rock armour to prevent damage to the tunnel roof.

The dredged material will be lifted out of the water by a dredger and placed onto a waiting barge, which will then transport the material to a gazetted dump site. During the process of transportation mud can enter the water through spillage or leakage. During transportation there are potentially three main ways for the mud to be accidentally dumped into the harbour:

- Spillage when placing the mud onto the barge from the dredger;

- Leakage of the mud from the barge during transport; and

- Spillage when transferring mud to the dump site from the barge.

If adequate care is taken in each of these three instances the impact on the surrounding water can be kept to a minimum.

Open water disposal of dredging spoil taken from polluted waterbodies can lead to the release of contaminants and the potential for bioaccumulation in the food chain. EPD requires that significantly contaminated spoil must be disposed of in a controlled way to reduce the potential for long term hazardous effects on the environment.

West Kowloon Reclamation

Construction activities on the WKR will have the same potential impacts as those described for Hong Kong Station. The main areas of concern will be:

- Construction run off and drainage;
- General construction activities; and
- Sewage effluents.

Lai King Station and Tunnels

The construction of Lai King Station and Tunnels will involve substantial excavation into the hillside to accommodate both the platform tunnels and concrete structures in open excavation. The stream at the south portal site will be diverted and a new reinforced concrete culvert provided.

The Water Supplies Department (WSD) saltwater pumping station at the end of Fat Tseung Road, Sham Shui Po and the MTRC seawater intake sited at Lai Chi Kok, next to the incinerator, are potential receptors. Construction activities may adversely affect the saltwater intake by increasing the SS content of the intake water.

Tunnel construction below the water table will require the pumping of groundwater. The possibility exists that the groundwater in the area of the rock bored tunnels south of Lai King Station may be contaminated. (Groundwater analysis conducted approximately 10 years ago on samples of well water at Kwai Chung Stadium, approximately 1 km north of the tunnels, indicated the presence of toxic chemicals. Leachate from Gin Drinker's Bay Landfill, some 330 m away, was identified as a potential source of contamination). Groundwater discharged during the construction of the bored tunnels may therefore be contaminated. Furthermore, groundwater drawdown has the potential to affect the structural stability of adjacent buildings.

Kwai Chung Park

Kwai Chung Park, the former Gin Drinkers Bay Landfill, is a completed landfill site. The site was developed from marine reclamation and there is no underlain leachate containment or collection system. A system of subsoil drains was installed around the perimeter of the site at the toe of the slopes with the intercepted leachate discharged into the surrounding sewerage network. However, photographic evidence indicates that leachate from the site is apparently dispersing and polluting a wide area.

A number of ground investigation works have been carried out at the landfill . There is considerable variation in the analysis of leachate with wide variations in sodium and chloride concentrations. Similar variations are also evident in analysis results for COD, BOD and NH_3–N. There are also large variations in contaminant concentrations in leachate and waste. All investigations concur that site conditions are alkaline with a pH of approximately 8.

Results indicate that groundwater quality impacts are confined to the western and possibly the southern side of the site, the migration of leachate in these areas is apparently limited by movement of the regional groundwater flow and possibly the sub–soil perimeter drainage system.

The leachate generation capacity of the Gin Drinker's Bay was estimated using the USEPA HELP (*H*elp *E*stimate *L*eachate *P*roduction) computer model [1]. It is predicted that at a cover infiltration rate of 500 mm yr^{-1}, the landfill would generate 149,000 m^3 yr^{-1} of leachate and the radial flow rate on the landfill perimeter will be 4.7 l s^{-1}. Since the waste is underlain by marine clays, sands and silt which are unable to underdrain the waste effectively, the leachate flow will be predominately horizontal, moving outwards radially, towards the edge of the landfill.

It is estimated that 90% of the leachate could be effectively intercepted by the perimeter subsoil drain. Therefore, the estimated daily leachate generation will be 370 m^3 per day.

Rambler Channel Bridge

The proposed Rambler Channel Bridge will cross the Rambler Channel between Kwai Chung and Tsing Yi. Support piers will be built to span the channel. Of concern to water quality impacts will be the four piers that will be located within the Channel. Three of these will be built within the main Channel while one will be within the typhoon shelter. Construction work

(1) Binnie Consultants Limited (1992) – "Restoration of Urban Landfill Study, Landfill Leachate Assessment" - Working Paper 6.

for the bridge is scheduled to commence in December 1993 and is expected to be completed by August 1996.

Potential impacts from the construction of the bridge will primarily arise from dredging activities. It is understood that there will be limited dredging in the main channel. Construction of the piers will involve the use of cofferdams created by sheet piling. Marine mud will be extracted from within the cofferdam, and any dispersion will be confined to within the enclosed area. Dredging will be carried out for pier protection works within the typhoon shelter.

Work on the bridge piers will commence in late 1993 and will continue into late 1994. Bore piling works will take around 6–15 weeks at each pier. It is estimated that about 10,000 m^3 of excavated/dredged material will be removed from the construction for the six bridge piers. Dredging will only be carried out for the pier in the typhoon shelter while the other piers will involve the use of cofferdam where dredging in open water will not be required. The amount of sediment released by various dredging operations reported that irrespective of the type of dredger, the amount of silt stirred up ranges from 0.5–3.0% of the total amount of dredged material. Assuming a 3% loss of sediment to the water column and approximate dredged volume of 1700 m^3, the mass of dispersed solids is estimated to be around 48 m^3 per pier.

The potential water quality impacts will be associated with the following aspects:

- Sediment re–suspension in the water column;
- Sediment dispersion; and
- Release of non–inert material.

Tsing Yi Tunnels

A section of the Tsing Yi Tunnels which cross Tsing Yi run about 140 m beneath the existing Tsing Yi North High Level Fresh Water (FW) and Salt Water (SW) Service Reservoir and 160 metres north of the Low Level FW and SW Service Reservoir.

Tunnel construction below the water table on Tsing Yi may require the pumping of groundwater. The groundwater here is essentially `clean' and can be readily discharged to stormwater drain.

Lantau Fixed Crossing

Of particular concern is the potential impact on water movement and water quality arising from extending the embayment at Tung Wan by constructing the Tsing Ma Bridge pier and west anchorage at To Tei Kung Kok. Suspended solids released during the construction works could be transported to the beach at Tung Wan under conditions of E–SE winds during slack tides.

Reclamation to provide a work site at the western entrance to Penny's Bay may affect local water movements and water quality. The construction of the Kap Shui Mun Bridge will involve reclamation on Ma Wan, north of Lung Ha Wan and the bay between Tai Chuen and San Po Tsui on North Lantau. The report identified the main concerns being the impacts on the Mariculture Zone at Kung Tsai Wan resulting from changes in water current and directions after the reclamation, and the accidental release of oils, chemicals and other polluting materials from the two work sites.

Underwater blasting from excavation in the Kap Shui Mun Channel or on the north of Ma Wan for the LFC may result in impacts on the Mariculture Zone at Kung Tsai Wan.

North Lantau Development and North Lantau Expressway

Water quality may be affected by dredging, reclamation, disposal of spoil or construction wastes from work sites and general construction activities. The NLDS concluded that impacts from dredging and reclamation works at Tung Chung, Tai Ho East and Siu Ho Wan are not anticipated to be significant unless there are excessive levels of suspended sediments in tailwaters from marine fill or at dredging faces (which is considered unlikely to occur). The impacts from dredging and fill activities are expected to be only local to the reclamation site and impacts further afield are unlikely. However, pollution from construction support facilities and general work sites may be significant. The Report recommends that effluents should be controlled through contract clauses and Table 10a of the Technical Memorandum will be used as a standard to approve contractors proposals and for water quality monitoring. The NLDS TR10 EA states that changes in water movements, water quality and sedimentation in these water bodies will be mainly as a result of the impact of the New Airport Reclamation and operational emissions from the airport rather than the NLD Reclamation.

The NLE EA Report identified that the formation of the semi-enclosed bay, between the NLE reclamation and existing coastline at Tai Ho Wan, could have an impact on water quality during the dry season if surface water runoff rates are low and pollution loads increase. The Report concluded that provided adequate water exchange between Tai Ho Wan and the sea is maintained potential impacts on water quality should be minimal during the wet season and acceptable in the dry season. In addition, the report concluded that the impacts of dredging and effluent disposal on local water quality could be significant. Mitigation measures will be required to limit potential impacts on the receiving water quality during the construction phase and spill action plans are recommended to minimise the potential for transportation of pollutants towards sensitive receivers.

Reclamation for the New Airport is anticipated to have a major impact on water movements. The New Airport Masterplan EIA reported on WAHMO modelling of initial layouts for the airport reclamation and concluded that far field effects were likely to be small. However near field, flow patterns were predicted to change and of particular concern is the conclusion that velocities to the east of the airport in East Tung Chung Bay will reduce. Impacts on sedimentation, particularly in East Tung Chung Bay will therefore result if flows between Chek Lap Kok and Lantau are reduced and water quality will also deteriorate in this area due to lack of flushing.

The Preferred Concept Plan selected for the NLD contains a tidal sea channel between the southern boundary of the New Airport and the North Lantau coastline. The WAHMO model was used to examine water quality within the sea channel by considering flushing volumes, and peak and mean velocities along the channel. Results from water quality models showed that retaining a sea channel would benefit the water quality within East Tung Chung Bay. The proposed sea channel design was therefore introduced into the PCP to mitigate the above potential significant impacts, by enhancing flushing within East Tung Chung Bay and therefore maintaining water quality in this area.

D3.2 *Impacts during Operation*

Operational impacts will be broadly similar along the entire LAR formation and are discussed generically below. Site specific impacts are also considered.

The main sources of water quality impacts that may arise during the operational phase of the LAR are discussed below. These are:

- Track runoff and tunnel drainage;
- cooling water discharges; and
- sewage effluents.

Discharges of trackbed runoff and pumped tunnel drainage may be contaminated with SS (including metals from track grindings and corrosion of rolling stock and other equipment) and oil and grease arising from seepage or accidental spills. In addition, maintenance activities such as washing and servicing of carriages and trackbeds will generate wastewaters.

Outflows from the MTRC water-cooled air conditioning system may give rise to temperature effects in the receiving waters. The cooling water discharges are warmer and hence less dense than the seawater, and will therefore tend to spread as a relatively thin surface layer with little mixing.

Sewage effluents will arise from sanitary and catering facilities provided at stations and at the Depot. Restaurants are likely to generate BOD loads as a result of food preparation and washwaters.

In addition there is potential for impacts to arise as a result of leachate generation from the cutting through Kwai Chung Park and disruption of water flows caused by the Rambler Channel Bridge.

The Depot on North Lantau will be a major source of waste water from the maintenance and heavy cleaning facilities as well as runoff from the extensive open areas of the site.

D4 ASSESSMENT METHODOLOGY

D4.1 IMPACTS DURING CONSTRUCTION

D4.1.1 General

The WQOs will be used to assess the significance of potential water quality impacts resulting from construction activities, such as discharge of contaminated runoff. Further, the TM issued under the WPCO, sets limits for effluents discharged into inshore and marine waters. Also, should any contaminated marine muds be excavated, EPD Technical Circular No 1-1-92 will provide criteria to evaluate the marine sediment contamination. The above assessment criteria are discussed in *Annex A*.

D4.1.2 The Sediment Plume Model

Water Quality and Hydraulic Modelling (WAHMO) was undertaken by Water and Hydraulic Research (WHR) to simulate sediment dispersion and dissolved oxygen level in the Rambler Channel and surrounding waters. The modelling included representations of the piers of the existing North and South Bridges in the Rambler Channel as well as the bridge piers and rock islands of the planned Rambler Channel Bridge and Tsing Yi Route 3 South Bridge.

The dispersal of fine sediment released into the water column by dredging at the sites of the planned rail bridge piers was simulated using the sediment plume dispersal model, SEDPLUME–RW. This model is based on a random walk representation of turbulent dispersion. In the present application, SEDPLUME–RW used tidal flow fields computerised by the two–layer flow model as input data to simulate sediment transport, setting, deposition and re–erosion. The sediments represented by the model are mixtures of fine silt and clay grains, with sizes less than about 0.06 mm, released into the water column near the sea bed during dredging. Coarser sediments released into the water column will settle rapidly to the sea bed, and will not be dispersed beyond the dredged area.

SEDPLUME–RW was run using the base case dry season neap tide flow model results as input data. The 25 m output grid dimension was used. A single sediment source releasing sediment continuously at a rate of 1 kg s^{-1} was positioned at the planned location of Pier 2 of the Tsing Yi Rail Bridge. This site was chosen for the source term because sediment released here by dredging during the construction of Pier 2 will probably be dispersed over a larger area than sediment released at any of the other bridge pier sites. The rate of sediment loss, taken to the 1 kg s^{-1}, was not possible to prescribe with any certainty. In previous studies of dredging of uncontaminated sediments in open waters in Hong Kong, for the rates of working assumed for grab dredgers, sediment losses of this order of magnitude have been used. In the Rambler Channel where the bed sediments may be contaminated, careful dredging practice could result in lower sediment losses. In addition, if the main construction activity takes place within coffer dams, again lower sediment losses than 1 kg s^{-1} could be expected.

A dredger working in this area would probably release fine sediment near the sea bed but, in the modelling study, sediment was released at the sea surface in order to simulate the worst case suspended sediment concentrations which could occur if disturbed fine sediment were mixed throughout the water column by tidal currents or wave activity. The model was run for several diurnal cycles (each diurnal cycle consisting of two neap tides) until simulated conditions repeated approximately over consecutive cycles. The sediment properties specified as input data were those derived for Hong Kong slack water mud deposits during the WAHMO study and used in subsequent SEDPLUME-RW simulations of dredging-related mud dispersion in Hong Kong coastal waters.

D4.1.3 *Water Quality Objectives*

The TM defines acceptable discharge limits to different types of receiving waters. Under the TM, effluents discharged into inshore and marine waters are subject to standards for particular volumes of discharge (as stated in Tables 10a and 10b of the TM). These are defined by EPD and specified in licence conditions for any new discharge within a WCZ. In addition, it stipulates that new effluents will not be allowed within 100 m of a seawater intake point, and substances that are prohibited from foul sewers and coastal waters are listed.

The WQO for Victoria Harbour WCZ are not gazetted at the time of writing but are expected to be declared in the near future under the provisions of the WPCO.

Under the Sewage Strategy Study, all beneficial uses were assigned to the North Western WCZ with particular attention to maintain marine and beachwater quality, and include guidelines and limits on DO, Ammonia and *E.coli*. There are also general limits for Inorganic Nitrogen within these waters which are specified on the basis of controlling algal growth in quiescent areas. The WQO established for the North Western Waters are summarised in *Table D4.1a*. The WQO for the Western Buffer WCZ were declared on 1st June 1993 under the provisions of the WPCO. Proposed WQO have been specified for all beneficial uses for this water body.

WQO are also specified to promote the aesthetic qualities of the waters. These state that there should be no objectionable odours or discolouration of the water and that tarry residues, floating wood, articles of glass, plastic, rubber or any other substance should be absent. Mineral oil should not be visible on the water surface, nor surfactants producing lasting foams and no recognisable sewage-derived debris should be present. Therefore, the water quality of the study area during the construction phase has been assessed according to the North Western Waters WQO and the proposed Western Buffer WQO.

Table D4.1a ***Water Quality Objectives for North Western Waters***

Water Quality Parameter	Objective	Part(s) of Zone
E. Coli	Annual geometric mean not to exceed 610/100 ml.	Secondary contact recreation subzones
D.O. within 2 m of bottom	Not less than 2 mg/l for 90% of samples	Marine Waters
Depth average D.O.	Not less than 4 mg/l for 90% of samples.	Marine waters
pH value	To be in the range 6.5 – 8.5, change due to waste discharge no to exceed 0.2.	Marine waters except bathing beach subzones
Salinity	Change due to waste discharge no to exceed 10% of natural ambient level.	Whole zone
Temperature change	change due to waste discharge not to exceed 2°C.	Whole zone
Suspended solids	Waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
Toxicants	Not to be present at levels producing significant toxic effect.	Whole zone
Unionized ammonia	Annual mean not to exceed 0.021 mg/l.	Whole zone
Nutrients	Not to be present in quantities that cause excessive algal growth. Annual mean depth average inorganic nitrogen not to exceed 0.5 mg/l.	Marine waters except Castle Peak subzone

Source: Marine Water Quality in Hong Kong for 1991, EPD/WPG 1993.

D4.2 *Impacts During Operation*

The tidal flow simulations were performed using the two dimensional, twin layer, model of tidal flows originally set up for the WAHMO study applied to simulate tidal currents in the Rambler Channel.

During the study of the New Tsing Yi South Bridge, tidal flow model simulations were performed which included representations of the bridge piers and rock islands of the planned Rambler Channel Bridge and Tsing Yi Duplicate South Bridge, as well as the piers of the existing bridges in the Rambler Channel, in the model's bathometric data set.

The model was run to simulate dry season neap tide flows using the same boundary conditions and the base case simulations and the effects of the rail bridge piers on tidal currents were assessed by comparison of the model results before and after the inclusion of the piers in the model.

Dry season neap tide conditions were used because bacterial plume simulations carried out during the previous Rambler Channel Crossing Study indicated that concentrations during these tides would be marginally higher than at other times.

The results of the base tidal flow simulation in the area of the planned Tsing Yi Rail Bridge were compared with the results of the simulation which included the rail bridge piers.

The New Airport Masterplan did not address potential water quality impacts arising from railway track runoff. However, an evaluation was made of the likely impact of airport stormwater, on the basis of reported stormwater quality for other airports and for general urban runoff, which is considered to be similar in nature.

The potential impact of pollutant loads discharged into the sea channel between North Lantau and Chek Lap Kok from the southern part of the airport reclamation was assessed. WAHMO modelling of sediment transport, deposition and erosion was conducted to simulate existing conditions and those following the airport reclamation.

D5 PREDICTED IMPACTS

D5.1 IMPACTS DURING CONSTRUCTION

D5.1.1 General

At this stage of the LAR Project there is insufficient data available to make accurate predictions of the volume and likely contents of runoff. Additionally, a number of sections of the LAR construction will be entrusted works over which MTRC will have no control and therefore only general mitigation measures are included in this assessment. A number of site specific activities have been assessed in detail and these are discussed below.

D5.1.2 Immersed Tube Tunnel

Dredging of Marine Muds

Up to 700,000 m^3 of dredged material is projected to consist of approximately 81% marine mud deposits, 18% alluvium, and 1% completely decomposed granite or bedrock. Alluvium, being inorganic and mostly inert, would not be expected to exert a significant oxygen demand or contribute significantly to nutrient release to the surrounding water body. The data projected in the *Table D5.1a* therefore represents the characteristics of the marine mud deposits alone.

Table D5.1a Predicted Suspended Solids Loading

Characteristics	Numerical Data
Volume of dredged material	700,000 m^3
Volume of dredged marine mud (81% of material by volume)	570,000 m^3
Total mass of marine mud dredged	770,000 tonnes
Losses to water column on dredging	3%
Mass of dispersed solids	23,100 tonnes
COD exerted by dispersed solids	800 tonnes
Assuming BOD:COD=0.5; BOD exerted	400 tonnes
NH3-N loading	0.24 tonnes

As the dredging is scheduled to take roughly 12 months to complete the potential loads to the water column would be (assuming 50 weeks of work and a 6 day working week; 300 days):

- 77 tonnes per day of suspended solids;
- 2.7 tonnes per day of COD loading;
- 1.3 tonnes per day of BOD loading; and

- 0.0008 tonnes per day of NH_3–N loading.

It should be noted that much of the material which enters the water column will resettle rapidly and the less dense material will be dispersed by tidal action over several days. This means that most likely the BOD estimate is a potential maximum, and in most cases the full 5 day BOD will not be exerted.

According to the Sewage Strategy Study, estimates of the current levels of daily sewage effluent loading in Victoria Harbour from South Kowloon, Wan Chai West, and Central are:

- 55 tonnes per day of suspended solids;
- 147 tonnes per day COD loading;
- 55 tonnes per day BOD loading; and
- and 5.6 tonnes per day NH_3–N loading.

Transportation of Marine Muds

During the transport process there is the possibility of losses of material to the sea due to overloading, erosion during travel, loss at the disposal site, and cleaning of the barges after unloading. If bottom–dumping barges are used for transport, the capacity of a single load should be 750 m^3 or 1500 m^3; dependent on the size of the barge used. The values for loss during loading and travel have not been quantified, however, experience suggests that quantities lost can be quite high. Values of loss for unloading, however, do exist:

- 1–5% loss by volume (dependent on the size of the vessel and volume of the load) for open bottom–dumping into gazetted borrow areas where material is stripped from the descending spoil cloud;

- 1–4% loss by volume (dependent on the size and type of barge) if materials are washed out of the hopper after the dumping procedure.

For the capacities per barge listed above, the unloading procedures have the following potential for sediment loading:

- 15–68 m^3, or 20–93 tonnes, of material lost per unloading and cleaning of a 750 m^3 barge;

- 30–136 m^3, or 40–186 tonnes, of material lost per unloading and cleaning of a 1500 m^3 barge.

As additional losses are expected from the loading and transport process and as these numbers are not substantially different from the daily losses due to dredging, mitigation will be necessary so that practices are followed to limit turbidity near sensitive receivers.

D5.1.3 *Kwai Chung Park*

Additional Contaminated Liquor Generation

Moisture ingress into the waste mass during the construction phase of the railway will result from the excavation of the cutting and construction of piles as follows:

- *Excavation of Cutting* : Excavation for the cut will cause waste to be exposed and increase leachate generation from rain infiltration. Based on the current programme schedule, the excavation of waste and reinstatement i.e. capping will take place between July and December. Rainfall infiltration over the cut construction period is estimated to be around 4650 m^3 whereas the estimated infiltration for "untouched" surface is estimated to be around 4000 m^3. The overall net effect on the leachate generation for the cutting area of the site is a minimal 650 m^3 during construction. This will be less than half of a percent of the total annual leachate production of 149,000 m^3 as estimated by *Binnie Consultants Ltd.*

  The cut area will benefit from the new cap and cover arrangement in that it will result in a lower infiltration rate of 5% as opposed to the 15% infiltration rate under the current condition. This 10% difference over the plan area of the cutting is equivalent to 4560 m^3 per year after completion of the works.

- *Construction of Piles*: During the grab excavation, a minimal head of water above the surrounding groundwater level will be maintained in order to create a positive hydraulic head within the bore. This will reduce the ingress of leachate into the base of the temporary casing. In addition, gas emissions through the base of the bore will be suppressed, and the presence of water will reduce the incidence of sparks from the grab operation, improving the safety of the process. Once rock is reached, a boring tool will be used which uses recirculated water to flush the cuttings up the centre of the boring string to settlement tanks, before being reintroduced at the bottom of the bore.

  The pile casing and reinforcement will be inserted with the contaminated water present in the bore, and the concrete poured using a tremie pipe. The fluids within the bore will be displaced by the concrete pour, and will be collected or pumped into a holding tank for later re-use. The diluted leachate present in the bore is considered not to have a deleterious effect on the concrete. With a minimal difference in head between the surrounding water table and the inside of the bore, no losses of the fluid from the temporary casing into the site are expected.

  By reducing the amount of leachate ingress into the bore, the initial contamination will be diluted by the addition of water to maintain a head, whilst at the same time water will be added to replace the volume of excavated materials. It is envisaged that following the rock boring stage, the fluid may be re-used. For the purposes of this estimate, allowance has been made for re–use up to 4 times before disposal is required due to unacceptable contamination of the fluid.

The total volume of the piles is approximately 13,000 m^3, with a flooded (saturated waste) volume in the order of 7000 m^3. With a minimal head being maintained in the bores, the volume of water required will be approximately equal to the flooded volume.

The volume of contaminated water requiring disposal will be dependant upon the frequency of use in the pile bore process. To conserve water, the contractor may choose to re–use the water a number of times before it is deemed to be unfit for use, either on health risk grounds, or chemical interference with the concreting process.

Another alternative would be not to add water during piling but potential problems such as gas emission and sparks will need to be resolved. This method would only generate a total of around 700 m^3 of liquid for disposal.

Leachate will also be removed from the bore in the saturated wastes taken by grab. Based on a 20% porosity [1] and a 50% drain back into the bore, the volume of exported leachate has been conservatively estimated to be 700 m^3. Liquid generation from piling is estimated to be up to 7,000 m^3 in total, based on a worst case of 52 piles and piling period of 42 weeks.

- *Contaminated Liquors from Vehicle Wash Facilities*: Vehicle washdown facilities will be required for haulage vehicles leaving the site with wastes from excavation and piling to prevent off–site contamination. A settlement and recirculation system of 80 m^3 will be in use and water can be replenished regularly based on the level of contamination.

  Depending on the waste disposal arrangement, excavated waste will have to be transported offsite. Vehicle washing will have to be replenished around every 14 days and an estimated total volume of 240 m^3 will arise during the excavation period. But for the piling phase, the volume of material to be removed will be much less than during the excavation period. Water for vehicle washing used will be negligible.

Liquids for Disposal

Two activities producing liquid requiring disposal will include recirculated water flushings from piling and vehicle washing. As noted above, a total of up to 7,000 m^3 of water will be generated from piling activities, with a further 240 m^3 arising from vehicle washing over a six–week period.

(1) Binnie Consultants Limited (1992) – "Restoration of Urban Landfills Study: Leachate Assessment" – Working Paper No.8.

D5.1.4 *Rambler Channel Bridge*

Main Channel

Simulated suspended mud concentrations in the upper and lower model layers at the times of low water, peak flood tide currents, high water and peak ebb tide currents as well as the simulated mud deposit distributions at the same times are obtained. It should be noted that SEDPLUME-RW simulates the increase in suspended sediment concentrations generated by construction and dredging activities. It does not simulate the natural background sediment concentration field.

The expected movement of the suspended sediment plume northward from Pier 2 on the flood tide and southward on the subsequent ebb tide were predicted. Concentrations in the sediment plume only exceed 10 ppm in the upper layer within about 400 m of Pier 2 at low and high water, and in a small patch near the northwestern limit of the upper layer plume at peak flood. Concentrations greater than 1 ppm only occur within 3 km to the south and 2 km to the northwest of Pier 2.

Mud deposition occurs over the full area covered by the suspended mud plume. No significant reduction in deposits occurs at any time during the tidal cycle, indicating that, even at times of peak current speeds on a dry season neap tide, the tidal bed shear stress is not sufficiently high to cause significant re–erosion of sediment. However, long term bed levels in the Rambler Channel are assumed to the naturally stable and so re–erosion and further dispersion of the disturbed sediment could be expected to take place on spring tides.

Typhoon Shelter

The fate of any sediment lost to suspension during construction work in the typhoon shelter was examined, a float track was simulated to study the water movements. It was found that it took 4 hours for a float released at high water to leave the typhoon shelter on the neap tide. Considering the depth of the shelter and the settling velocity of the sediment (assumed minimum velocity of 1 mm s^{-1}), the peak tidal currents of less than 0.05 m s^{-1}, most of the disturbed sediment is expected to re–settle within the shelter and it is unlikely that any significant mass of sediment would escape the typhoon shelter to be dispersed in the main flows in the Rambler Channel. No plume simulation of sediment losses in the typhoon shelter, however, were carried out.

D5.1.5 *Lantau Fixed Crossing*

The WAHMO physical model was used to assess the potential impacts on water quality subsequent to formation of the anchorage and pier protection island for Tsing Ma Bridge. This involved determining alterations to current speeds and direction, and in particular water movement patterns, both within and immediately outside Tung Wan Bay. Results of the modelling were examined to identify the potential for pollutants to enter the bay during and after construction. It was concluded that there would be increased water circulation within Tung Wan following construction of Tsing Ma Bridge, in particular during the wet season, and water exchange rates between Tung Wan and mainstream flows are also likely to increase. It is identified that impacts on water quality would be dependent on the quality of inflow waters.

WAHMO modelling was also undertaken to assess potential impacts on water quality following reclamation for the Penny's Bay works site, which could reduce the entrance to the Bay by up to 50%, and for the construction of the Kap Shui Mun Bridge.

D5.1.6 *Lantau Formation and Viaducts*

In the Tai Ho Section, where ambient current velocities are low (0.1–0.2 m s^{-1}) only very fine particles will be transported from the dredging site. Particles which are larger than silt are likely to settle close to the point of release. Current velocities are greater in the Yam O Section (0.4–0.6 m s^{-1}) and therefore the possible distances covered by sediment plumes will be higher.

An estimate of the distance over which the impacts of dredging could be measured was made for both the Tai Ho and Yam O Section. It should be noted that these estimates are worst case assumptions. This involved the calculation of possible increases in SS concentrations at certain distances from the dredger. The daily dredging rate was assumed to be 7000 m^3 over a 24 hour period and it was estimated that approximately 1% of material will be lost at the dredging face.

D5.2 IMPACTS DURING OPERATION

D5.2.1 *Track Runoff and Tunnel Drainage*

Limited quantities of waste water from track runoff and tunnel seepage will arise during operation, but these discharges may be contaminated with SS (including metals from track grindings and corrosion of rolling stock and other equipment) and oil and grease arising from seepage or accidental spills. For metals, the estimated annual mean increase in concentrations in the receiving waters is estimated to be 50 $\mu g\ l^{-1}$. Outside stations and depots, where trains will not normally be stationary, it is unlikely that significant levels of contaminants will be produced.

D5.2.2 *Cooling Water Discharges*

Detailed information on the operating characteristics of the MTRC water cooled air-conditioning system is not available at this stage in the development of the LAR Project.

Daily flow rates from the station cooling systems are expected to exceed the maximum discharge of 6000 m^3 per day specified under the TM. The governing criteria will, therefore, be the WQO for the appropriate WCZ, that is to say, the effluent discharge should not cause the normal daily temperature range to change by more than 2°C.

The Consultants have estimated that, based on a worst case scenario of some 24000 m^3 of cooling water per day at a temperature of 10°C above intake level, the 2°C temperature envelope would be confined to an area approximately 120 m offshore.

D5.2.3 *Sewage Effluents*

Sewage generated at the stations will be required to meet the requirements of the TM in order to be acceptable to the sewerage network for treatment at a sewage treatment plant.

D5.2.4 *Leachate at Kwai Chung Park*

As a result of the construction of the LAR across the park, a new cut surface will be formed along the alignment. A recent study (**Kwai Chung Park HAZOP Studies and Related Services Sub-Consultancy: Addendum to Technical Note 3 - Contaminated Water Arisings and Disposal, ERM in association with Babtie Oakervee, August 1993**) has investigated the impacts upon infiltration and leachate generation.

A reduction in infiltration and subsequent leachate production is predicted. The reduction in infiltration of the newly treated cut when compared to the existing landfill surface is expected to be approximately 4650 m^3 during the 6 month excavation period which will be reflected in a similar reduction in leachate production.

D5.2.5 *Rambler Channel Bridge*

Current directions will be slightly modified by the rail bridge construction within about 75 m of the bridge piers. Maximum current speeds increase slightly between Piers 1 and 2 and Piers 2 and 3, as a result of the increased flow confinement, whilst maximum speeds between Piers 3 and 4 are slightly reduced by the bridge pier construction. Small changes in peak current speeds occur to the north and south of the bridge piers following bridge construction, but these changes are not apparent more than 250 m to the north of the bridge and 750 m to the south. These changes are caused by small re-alignments of the flow caused by the rail bridge piers.

As expected from the small changes in current speed described above, the tidal discharges through the Rambler Channel are not significantly affected by the rail bridge construction. Following the construction, the southward residual discharge decreases by less than 0.2%, whilst the maximum northward and southward discharges decrease by approximately 0.4% and 0.5% respectively.

D5.2.6 *Siu Ho Wan Depot*

The maintenance and heavy cleaning facilities at the Depot will comprise:

- Rolling stock maintenance facilities consisting of a heavy cleaning facility and two rolling stock washing plants;
- Fixed train maintenance equipment consisting of two train wash plants;
- A rolling stock underframe cleaning station;
- An acid removal and final rinse station located over the underframe cleaning station; and
- A bogie wash plant.

Wastewaters generated at these washing and cleaning plants may be contaminated with Suspended solids (SS), oil, grease, detergent and acid. In addition, if aluminium bodied cars are utilised, wastewaters arising from acid washing may contain metals such as aluminium oxide from the bodysides and iron oxide from other components.

D6 EVALUATION OF IMPACTS

D6.1 INTRODUCTION

The significance of the identified potential water quality impacts arising from the construction and operational activities are assessed in this section. The criteria used for evaluating the impacts are related to the degree of change in water quality parameters, as compared to the range of natural fluctuation of the baseline conditions and the requirements of the proposed WQO for the WQZs.

D6.2 IMPACTS DURING CONSTRUCTION

D6.2.1 *Dredging*

The oxygen demand exerted as a result of dredging activity will therefore be relatively low compared with that which already exists from sewage discharges into this part of Victoria Harbour. The nutrient loading potential from the dredging activity is negligible in comparison with the current sewage discharge levels presently entering the Harbour and so should have negligible impact on the integrity of biological life in the Harbour. Furthermore, the majority of the immersed tube tunnel passes through the central part of the Harbour, which is frequently swept with high velocity flows. These flows should quickly disperse the material over a wider area and so dilute its concentration and impact on the surrounding waters.

The potential suspended solids load, however, is high in comparison with current sewage discharges and mitigation measures will be required particularly when water quality monitoring shows unacceptable turbidity at or near sensitive receivers due to the construction activities of the tunnel.

D6.2.2 *Backfilling*

Backfilling is not expected to produce large amounts of suspended solids due to the general use of coarse grained materials in the process. If fine grain material is used then mitigation measures will need to be employed to reduce turbidity and the loading of suspended solids into the surrounding waters.

D6.2.3 *Disposal of Marine Muds*

All of the dredged spoil from the immersed tube tunnel route can only be accepted at authorised dump sites. Analytical results for marine muds on the Western Harbour Crossing (WHC) route have shown that the most contaminated mud has heavy metal concentrations that fall within the guidelines for already existing dump sites at Cheung Chau, East of Ninepins, or Mirs Bay. Less contaminated mud can also be accepted at existing dump sites, the actual sites to be chosen on the basis of availability and the volume of mud needing disposal. As the samples for the WHC study were taken from areas that are located very close to the region which will be dredged for the immersed tube tunnel, it is probable that the dredged spoil from the MTRC route will also be deemed acceptable to be disposed of at existing dump sites. As dump sites already exist for disposal of the spoil, there should not be any significant impact of this material on the Hong Kong environment. However, the contractor should still be required to confirm contamination levels by carrying out a survey and analysis of the muds prior to dredging.

D6.2.4 *Construction Runoff and Drainage*

The greatest volume of construction runoff will occur at the station locations where the works site comprises the station area with an additional 25 m surround, all of which may be exposed to erosion. Of most concern are the physical effects of construction runoff as increased SS concentrations have the potential to cause adverse impacts on the performance of seawater intakes.

Runoff occurring as a result of precipitation or dust suppression activities on construction sites at the approaches to the tunnel is likely to cause elevated turbidity in near shore areas if drains discharge directly into the harbour, especially during heavy rainfall. It is very likely that such runoff will lead to high levels of loading of suspended solids into near shore waters. The resulting turbidity will lead to discolouration of waters and potential damage to sea water intakes. Such potential problems can be avoided through appropriate mitigation measures.

Victoria Harbour WCZ may be gazetted before construction is completed and The Western Buffer and North West Waters WCZs are already gazetted. All discharges containing pollutants are subjected to WPCO control and to the requirements of the TM.

The physical effects of dewatering and construction runoff will be a concern as increased SS concentrations have the potential to cause adverse impacts on the performance of seawater intakes as well as on the aesthetic quality of the harbour water. For seawater intakes, ARFS recommends that the acceptable SS level should be 180 mg l^{-1}. With appropriate measures to control and treat construction runoff and drainage, it is unlikely that the SS level in the surrounding water will exceed this level.

At this stage in the development of the LAR Project there is insufficient data available to enable estimates of the volumes of likely discharges and amounts of possible contaminants to be made, and therefore the significance of this impact cannot be fully evaluated. Water quality data from EPD monitoring in Victoria Harbour show SS concentrations for 1990 ranging from 1.8–23.0 mg l^{-1} in the North West Kowloon area and from 0.8–20.0 mg l^{-1} in the Harbour Central area. Although concentrations are likely to be slightly higher than this close inshore, due to the effects of stormwater discharges, there would be some margin for increase before unacceptable levels of SS were reached. Reprovisioning of the intakes on the southern part of the WKR is scheduled for 1994–5. Since the construction work for Kowloon Station and Tunnels will commence in January 1994, measures to control and treat construction runoff and drainage should be implemented given the potentially significant impact of increased solids concentrations on seawater intakes.

Kowloon North Camber typhoon shelter is heavily polluted by organic wastes. Therefore given the existing poor water quality in this area, further deterioration in water quality would be particularly undesirable. In view of the potential impacts described arising from construction runoff and drainage, controls should be applied.

Water quality data from EPD monitoring in Rambler Channel show SS concentrations for 1990 ranging from 1.500–17.333 mg l^{-1}. Although concentrations are likely to be slightly higher than this close inshore, due to the effects of stormwater discharges, there would be some margin for increase before unacceptable levels of SS were reached.

Reprovisioning of the intakes on the northern part of the WKR is scheduled for 1995–6. Since the construction work for the Lai King Station and Tunnels will commence in 1994 and continue until 1996, measures to control and treat construction runoff and drainage should be implemented given the potentially significant impact of increased solids concentrations on seawater intakes. It should be noted that the channel between Stonecutters Island and Lai Chi Kok will be closed under the reclamation work and therefore the reprovisioned MTRC seawater intake will not be a potential receptor. The stream at the south portal site is polluted and adjoins an existing concrete culvert. The diversion of the stream and the provision of a new culvert will therefore not be significant.

D6.2.5 *General Construction Activities*

The effects on water quality from other construction activities is likely to be minimal. Site boundary security will need to be maintained and good construction practice should be observed to ensure that litter, fuels and solvents do not gain access to the harbour waters. (Floating refuse in particular would have a significant impact on the aesthetic quality of the harbour waters).

D6.2.6 *Sewage Effluents*

Sewage effluents may be discharged to the public sewerage system near the works site. If connection to the foul sewer is not possible, interim facilities, such as chemical toilets, will be necessary to treat the sewage arising from the on-site construction workforce. In addition, pretreatment of the effluent may be required to comply with the effluent standards in the TM for discharges into foul sewers leading to Government sewage treatment plants.

Provided that sewage from on site construction workforce receives adequate treatment or can be directed to the local sewer, effects from sewage arisings should not be significant. The TM standards for effluents discharged to the inshore and marine waters of the Victoria Harbour WCZ should be readily achieved with installation of the appropriate treatment units.

D6.2.7 *Landfill Leachate*

A new leachate drainage system and treatment plant is planned for Kwai Chung Park to treat leachate from the restored landfill. However, the plant will not be in operation until the middle of 1995. Construction is to take place between April 1994 to September 1996. Excavation and piling activities will be carried out during the early stage of construction. Interim disposal of waste water produced as a result of construction will be by disposal to foul sewer.

D6.2.8 *Groundwater Drawdown and Discharge*

It has been confirmed with the WSD that there are no known abstractions of groundwater for potable or other significant uses within the study area. In addition, the Kau Wa Keng Stream is not abstracted for any significant use and is therefore unlikely to be affected by groundwater drawdown from tunnel boring in the adjacent catchment. Hence, groundwater drawdown is not considered likely to result in any adverse impacts.

In view of the distance of the bored tunnels from Gin Drinker's Bay Landfill, approximately 1 km, the possibility that the groundwater in the area of the tunnels is contaminated is considered slight. It is recommended that groundwater samples are analysed during geotechnical site investigations to enable the detection of any contaminants and thereby establish the acceptability of the drainage for direct discharge.

It is unlikely that there will be abstraction of groundwater for potable or significant uses in the Tsing Yi area and hence, disruption to the groundwater table will not result in any adverse impacts.

D6.2.9 *Rambler Channel Bridge*

SEDPLUME–RW, the computer model of suspended sediment dispersal, has been used to simulate worst–case suspended sediment concentrations likely to be associated with a dredger working at the site of Pier 2 of the planned rail bridge. The model predicted that, for a sediment source term of $1\ kg\ s^{-1}$, suspended sediment concentrations associated with the planned dredging would only exceed 1 ppm within 3 km to the south and 2 km to the northwest of Pier 2. Concentrations exceeding 10 ppm are only likely to occur in an area no wider than 400 m. During dredging on dry season neap tides, sediment deposition from the dredger plume is likely to occur throughout the plume area.

The results of suspended sediment concentrations in the Rambler Channel from the Environmental Protection Department's (EPD) marine water quality monitoring programme (published as **Marine Water Quality in Hong Kong, EPD**) are tabulated in *Table D6.2a*.

Table D6.2a Natural Suspended Sediment Concentrations in the Rambler Channel

Year	Annual Mean (ppm)	Range (ppm)
1986	6.7	2.5 – 33.0
1987	7.6	2.3 – 27.8
1988	9.9	1.3 – 64.0
1989	9.2	2.0 – 26.7

It can be seen from this data that natural suspended sediment concentrations are low. Within a short distance of the simulated construction activity (400 m) for the assumed dredging losses, increases in suspended sediment concentrations of 10 ppm are predicted to occur. This increase is equivalent to the annual mean background concentration. However, the resulting total suspended sediment concentration would still be within the natural range of suspended sediment concentrations. It is expected that the dredging and construction activity would be of relatively short duration and any physical impacts of the disturbed sediment are not expected to be significant.

The sediment plume model has been used in several previous studies of sediment losses to suspension during dredging operations. However, there has been no field data with which to calibrate the model to confirm the rates of sediment losses, especially for non dredging construction activities. In the absence of more detailed information, it is thought that the rate of sediment loss assumed in this study is conservative for activities not involving dredging. Monitoring during different construction stages would be required to confirm the results of this study.

In the EPD report on Marine water quality, 1990, the highest Total Organic Carbon content in the bed sediments was given as 2.5% of the dry solids in Victoria Harbour and inner Tolo Harbour. Water quality monitoring results on the BOD_5 Concentration as obtained from EPD's **Marine Water Quality in Hong Kong** are given in *Table D6.2b*. For the suspended sediment concentrations of less than 10 mg l^{-1} predicted to occur over the main area of the plume, the increase in oxygen demand is expected to be small and well within the natural range of the measured BOD for the relatively short duration of the dredging and construction works which could impact on sediment concentrations. It should also be noted that, on spring tides, when water velocities should be larger in general than on neap tides, increases in suspended sediment concentrations should be slightly smaller than on the neap tide simulated in this study.

Table D6.2b ***Natural BOD_5 Concentrations in the Rambler Channel***

Year	Annual Mean (mg l^{-1})	Range (mg l^{-1})
1986	1.2	0.04 - 2.5
1987	1.0	0.2 - 2.7
1988	1.2	0.2 - 3.1
1989	1.1	0.3 - 2.6

As already discussed dredging in open water will be avoided by prior construction of cofferdams at the pier sites. Marine mud will be extracted within the cofferdams and mud dispersion will entirely be contained within the enclosure. Disturbance to surrounding water will only be limited to the placement of the cofferdams and the loading of barges and vessel movements. This construction method will be practised for the construction of the bridge piers with the exception of the one in the typhoon shelter where dredging will be necessary for pier protection.

Modelling results revealed that concentrations exceeding 10 ppm will likely happen within 400 m from the simulated construction activities, it is expected that the resulting SS levels would still be within the natural range of suspended sediment concentrations. It is envisaged that dredging and construction activities will not have any significant impact on the channel sediments. Good construction practices as discussed below are essential to ensure minimal impact on the surrounding water quality.

D6.2.10 *Lantau Fixed Crossing*

Changes in water movements will be progressive over the construction of the Tsing Ma pier and anchorage reclamations and the works site. The modelling predicted that sediment could be transported towards the bathing beach and affect water quality, at least visually. However, the total amount of sediment deposited will be small and over a short time period. It is concluded that the impact on water quality will be minimal and that changes in water movements will not cause significant changes in the beach profile.

The modelling results for the Penny's Bay works site indicated that even if the entrance to the bay is reduced, water within the Bay would be exchanged with mainstream flows. However, pollutants entering the bay could be retained for a long period and may exert an oxygen demand. It is stated that the extent of impact on water quality would depend on the nature and quantity of pollutant, state of tide and location of discharge. The worst case situation identified would be for pollutants released in the inner part of the bay during neap tides and in the dry season. It is concluded that reclamation in Penny's Bay is unlikely to result in unacceptable water quality impacts.

Modelling undertaken for the Kap Shui Mun works site indicated that water quality at Kung Tsai Wan could deteriorate from increased pollution during spring tides as the net current velocity is predicted to reduce. However, the net current flow is away from the bay and therefore pollutants resulting from any accidental spillages would be transported away from the works site and dispersed by the main tidal flow in the Kap Shui Mun Channel. The report concluded that the Kap Shui Mun Bridge is not likely to have major water quality impacts either locally or further afield. It is stated that impacts from works for the Bridge should be included as part of the EA carried out by the contractor if underwater blasting is required.

D6.2.11 *North Lantau Formation and Viaducts*

Dredging Activities

It is predicted that in the Tai Ho section the settling zone could be within 10 m of the dredger and thus the impacts of dredging are likely to be localised. It is stated that sensitive receivers such as fish fry and benthic biota are likely to be rapidly eliminated.

In the Yam O Section, the worst case estimate that the distance the sediment plume could travel in the first hour after release is about 2 km. It is considered unlikely therefore that the mariculture zone at Ma Wa will be affected by increases in SS concentrations.

It is stated that sediment analysis will provide an insight into whether or not dissolved materials may be released into the water column. Sediments are considered unlikely to be significantly contaminated by nutrients and therefore the potential for the occurrence of red tides is minimal.

Reclamation

The settling zone will be close to the point of release due to the partial seawall construction (which provides a barrier), the particle size of sand (high settling velocity) and low current velocities in the area. The potential impact on water quality outside the immediate area is therefore anticipated to be small.

It is recommended that reclamation for work sites fill in existing embayments where possible, thus minimising impacts on water movement. Areas where water movements are particularly slow or where reclamation will increase pollution retention periods should be avoided, such as Yam O Wan, Tai Ho Wan and Siu Ho Wan.

Construction Runoff and Drainage

The primary concern in relation to water quality is the potential for contaminated construction runoff and drainage to cause adverse impacts to the major biological sensitive receivers in the area. Drainage into the coastal waters off North Lantau should be controlled as the introduction of polluted waters is likely to have detrimental effects on fishing grounds in this area. (Fish nursery grounds require good water quality). The fishing grounds could still remain in these waters following the NLE and NLD Reclamation.

However, the sheltered and shallow inlets which are used for spawning will be lost, and the diversity of the species in the area is likely to diminish.

Of particular importance is the maintenance of existing water quality for the Fish Culture Zone at Kung Tsai Wan. Discharge of any polluted drainage into the Kap Shui Mun Channel would therefore be undesirable. However, it is likely that discharge will be to the west, as this is the natural direction of drainage.

Some of the streams in the area may require diversion during the construction phase. Construction activities will concentrate at the tunnel portals and the diversion of stream courses where necessary is therefore not expected to be significant. However, construction runoff and drainage should be controlled to prevent pollutants from entering these surface waters, which are considered to be of good water quality.

At this stage in the development of the LAR Project there is insufficient data available to enable estimates of the volumes of likely discharges and possible contaminants to be made, and therefore the significance of this impact can not be fully evaluated. However, it is important that the quality of discharges into the adjacent coastal waters are strictly controlled in order to maintain good water quality and to minimise impacts on the existing fishing grounds. In view of the potential impacts described arising from construction runoff and drainage, measures to control and treat construction runoff and drainage should be implemented.

The mangrove habitats at Pak Mong wetlands are currently thriving in a brackish environment. However, the maintenance of existing levels of water exchange is unlikely to be achieved in the embayed area, particularly in the dry season. With the highly seasonal nature of precipitation patterns, embayed areas will experience fluctuations in salinity, turbidity and temperature (NLDS TR10 Revised EA Report). It is not certain, therefore, whether there will be sufficient ingress of seawater into the embayment to maintain the brackish conditions. Given the seasonal variability in SS concentrations in these waters, however, variations in levels are not anticipated to give rise to significant impacts.

Of concern is the potential for contaminated construction runoff and drainage to cause adverse impacts in the sensitive marine waters of East Tung Chung Bay and the sea channel.

Drainage into East Tung Chung Bay should also be controlled as the introduction of polluted waters is likely to have detrimental effects on fishing grounds in this area. The fishing grounds could still remain in these waters following the Tung Chung and New Airport Reclamation. However, the sheltered and shallow inlets which are used for spawning will be lost, and the diversity of the species in the area is likely to diminish. (The Marine Fish Culture Zone and shellfisheries will not remain and therefore have not been included as sensitive receivers in this assessment).

The sea grass at San Tau is currently thriving in a marine environment in which SS concentrations vary seasonally. It is considered that this species is probably highly tolerant of fluctuating water quality conditions. Water quality impacts such as increased SS concentrations are therefore not anticipated to be significant. The beaches along the north Lantau coastline are not expected to be affected by construction runoff and drainage in view of the considerable distance from the Tung Chung Reclamation, on which the station and tunnel will be located. (The nearest beach at San Tau is located at a distance of approximately 2 km west of the reclamation).

It is important that the quality of discharges into the sea channel and East Tung Chung Bay are strictly controlled in order to maintain good water quality and to minimise impacts on the existing fishing grounds. The function of the sea channel is to flush East Tung Chung Bay and this can only be achieved if water quality is maintained at a high standard.

Sewage Effluents

In general, sewage effluents should be discharged to the public sewerage system near the works site. However, as there are no existing foul sewers to connect to in the area, it is likely that interim sewage treatment facilities will be necessary to pretreat the sewage arising from the on-site construction workforce, (such as packaged sewage treatment plants), before discharge to the adjacent coastal waters. TM standards should be applied to any sewage effluent discharges in view of the sensitivity of the receiving waters along the North Lantau coastline. Special attention will need to be given to the prevention of uncontrolled discharges to the coastal waters and discharges into the streams should not be permitted. The effect of sewage discharge provided it receives adequate treatment should not be significant.

D6.3 IMPACTS DURING OPERATION

D6.3.1 *Track Runoff and Tunnel Drainage*

With appropriate mitigation measures implemented as outlined in the following section, discharges of track runoff and tunnel drainage will have minimal impacts on the surrounding water quality.

D6.3.2 *Sewage Effluents*

The effect of sewage discharges provided it receives adequate treatment should not be significant.

The PCP for the NLD includes a sewage treatment works and outfall at Siu Ho Wan. A rising main along the utility reserve parallel to the North Lantau Expressway will convey sewage from new developments in the NLD area, such as the Depot and Tung Chung Station, to the Siu Ho Wan Sewage Treatment Works.

D6.3.3 *Cooling Water Discharges*

Maximum daily flow rates from the station cooling systems are expected to exceed the maximum discharge of 6000 m^3 per day specified under the TM. The governing criteria will, therefore, be the WQO for the appropriate WCZ, that is to say, the effluent discharge should not cause the normal daily temperature range to change by more than 2°C.

The Consultants have estimated that, based on a worst case scenario of some 24000 m^3 of cooling water per day at a temperature of 10°C above intake level, the 2°C temperature envelope would be confined to an area approximately 120 m offshore. As there are no biologically sensitive receivers such as mariculture zones, or bathing beaches, within this zone, no unacceptable impacts are anticipated. It is considered that the increase in water temperature may have a beneficial impact in that it will accelerate the biological decomposition of sewage effluent.

It is anticipated that the 3 ppm dose rate proposed for cooling water treatment will result in residual chlorine levels within the 1.0 mg l^{-1} (ppm equivalent) limit. In addition, as has been noted, there are no sensitive marine ecological or recreational receivers in the area; the nearest mariculture zone is at Ma Wan and the nearest gazetted beaches are at Sham Tseng and Ting Kan.

Significant impacts from the cooling water discharge into the Rambler Channel are not, therefore, anticipated.

D6.3.4 *Leachate Generation*

The construction of the LAR through Kwai Chung Park is predicted to result in a net overall reduction in leachate generation.

D6.3.5 *Depot Maintenance and Heavy Cleaning Facilities Drainage*

Contaminated wastewaters from the washing and cleaning plants will require collection and treatment on site to meet the standards as stipulated in the Technical Memorandum (TM), prior to discharge to the foul sewer or the inshore waters of the North Western WCZ. An on–site wastewater treatment plant should provide the required treatment of effluent discharges.

A drainage system will be provided throughout the Depot and ancillary buildings. This will collect the washwaters and acid wastewaters arising at all the washing and cleaning plants. Drainage channels will be incorporated in the design of the heavy cleaning facility to collect any effluent which may spill out of the car doors during the cleaning process. In addition, the wash plants will contain drainage, settlement tanks and recirculation valves, and the bogie wash plant equipment will be contained inside a structure to prevent overflow and contamination of adjacent areas.

D7 *MEASURES FOR MITIGATION*

D7.1 *IMPACTS DURING CONSTRUCTION*

D7.1.1 *Dredging*

The dredging process can lead to large amounts of suspended solids being released into the water column. To mitigate against this potential impact, proper precautions should be taken during the dredging process to ensure that all losses of material to the surrounding waters is minimised. Clause 2.2 of Appendix N of the Particular Specification ensures that Contractors minimise impacts from dredging.

The Contractor shall take pollution avoidance measures which shall include, but shall not be limited to, the following:

(a) mechanical grabs shall be designed and maintained and used to avoid spillage and shall seal tightly. While being lifted, closed grabs shall be used;

(b) cutterheads of suction dredgers shall be suitable for the material being excavated and shall minimise overbreak and sedimentation around the cutter;

(c) where trailing suction hopper dredgers are used for dredging of marine mud, overflowing from the dredger, and operation of lean mixture overboard systems, will not be permitted;

(d) all Constructional Plant shall be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;

(e) all pipe leakages are to be repaired promptly and Constructional Plant is not to be operated with leaking pipes;

(f) the Works shall cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water;

(g) barges shall be fitted with tight fitting seals to their bottom openings to prevent leakage of material;

(h) any other pollution minimising devices, including the provision of silt curtains, that may be required to achieve the water quality objectives defined in Appendix K. (Clause 2.2, Appendix N of the Particular Specification)

Dredging of contaminated mud is especially hazardous because of the potential for the release of contaminants into the water column during the excavation process, and so clause 2.1a of Appendix O of the Particular Specification ensures that only dredgers which minimise disturbance and agitation of the sediment are employed in this part of the dredging process;

> **Dredging of contaminated marine mud shall only be undertaken by a suitable grab dredger using a closed watertight grab. (Clause 2.1a, Appendix O of the Particular Specification)**

As a performance specification rather than a method specification is currently employed in Hong Kong, there is little to add regarding methodology. The contractor, however, under the performance specification is required to monitor water quality on a regular basis to ensure compliance with all applicable guidelines. To ensure an unbiased monitoring of the work area surroundings, an independent monitoring agent should be employed by the contractor, as specified in clause 4.1 in Appendix K of the Particular Specification;

> **The Contractor shall appoint an Independent Consultant/Laboratory, approved by the Engineer, who shall undertake all Water Quality Monitoring. (Clause 4.1, Appendix K of the Particular Specification)**

Furthermore the guidelines on proper monitoring methodology are addressed in clause 5.4 in Appendix K of the Particular Specification;

(a) **'Baseline' conditions for the various water quality parameters are to be established prior to the commencement of the marine works under the Contract. The Contractor shall establish the 'Baseline' conditions which shall be subject to the Approval of the Engineer by measuring the following water quality parameters: turbidity, dissolved oxygen concentration (DO in mg/litre), dissolved oxygen saturation (DOS in %), temperature and suspended solids at all Designated Monitoring Stations on four sampling days per week, at mid-flood and mid-ebb, for four consecutive weeks within six weeks of the Date for Commencement of the Works. All measurements of temperature, dissolved oxygen concentration, dissolved oxygen saturation and turbidity shall be carried out in situ at three water depths, namely, 1 m below water surface, mid-water depth, and 1 m above sea bed. Water samples for suspended solids analysis shall be taken at the same three depths. Baseline water quality levels shall be checked by the Contractor at each location at three-monthly intervals. At least one such baseline water quality check shall be carried out when construction activities are not taking place; (Clause 5.4a, Appendix K of the Particular Specification)**

(b) **During the Execution of the Works, monitoring shall be undertaken on two working days a week. Monitoring at each station shall be undertaken at both mid-ebb and mid-flood on the same day. The interval between sets of samplings on different days shall not be less than thirty six hours. The values of turbidity, DO, DOS, temperature and suspended solids shall be determined in accordance with Clause 4 above. Two measurements at each depth of each**

station shall be taken. The probes must be retrieved out of water after the first measurement and then redeployed for the second measurement. Where the difference in value between the first and second readings of each set is more than 25% of the value of the first reading, the reading shall be discarded and further reading shall be taken. For the purpose of evaluating the water quality, all values shall be depth averaged; (Clause 5.4b, Appendix K of the Particular Specification)

(c) **Should the monitoring programme record levels of turbidity, suspended solids or dissolved oxygen which are, in the opinion of the Engineer, indicative of a deteriorating situation such that, in the opinion of the Engineer, closer monitoring is required, then the Engineer may direct that monitoring shall be undertaken daily at each Designated Monitoring Station until the recorded depth averaged values of these parameters indicate to the satisfaction of the Engineer an improving and acceptable level of water quality. (Clause 5.4c, Appendix K of the Particular Specification)**

D7.1.2 *Backfilling*

It is suggested that measures are taken to ensure that the release of fines during backfilling be limited to minimise the loading of solids into the water column. Appropriate mitigation is not adequately addressed in either the General or Particular Specifications for the backfilling process. The following additions to the Code of Construction Practice are recommended;

- **All fill material should be placed carefully near the point of emplacement rather than by dumping from a holding barge at the water surface;**

- **The fill should be released underwater via an elongated chute or by direct placing via a bucket.**

D7.1.3 *Transportation of Marine Muds*

Loss of material during transport can be substantial. To mitigate against this potential impact to the water body the mud should be loaded with a minimum of loss to the surroundings and should be well contained at all times during the transport process. Clauses 1.7 to 1.10 of Appendix N of the Particular Specification ensures that contractors take due care during loading and transport of marine muds;

- **Dredged materials shall be transported to the disposal area in suitable well maintained vessels which do not permit any leakage or escape of material. (Clause 1.7, Appendix N Particular Specification)**

- **Loading of barges shall be controlled to prevent splashing of dredged material to the surrounding water and barges shall not be filled to a level which will cause overflowing of material or polluted water during loading or transportation. Any material shall be cleaned from**

decks and exposed fittings before the vessels are moved. (Clause 1.8, Appendix N of the Particular Specification)

- **Adequate freeboard shall be maintained on barges to ensure that decks are not washed by wave action. (Clause 1.9, Appendix N of the Particular Specification)**

- **Immediately after the dredged material has been unloaded at the disposal area the barge shall be sealed. Any material which has accumulated on the deck or other exposed parts of the vessel shall be removed and placed in the hold or hopper. Under no circumstances shall decks be washed clean in a way that would permit material to be released overboard. Hoppers and holds may not be flushed with water to remove any remaining material and shall remain tightly closed at all times. (Clause 1.10, Appendix N of the Particular Specification)**

These mitigation measures are detailed further in clause 2.2 of Appendix N of the Particular Specification and are detailed in D7.1.1 above.

Clause 2.1(b), Appendix O of the Particular Specification also ensures that Contractors take due care during transport and discharge of contaminated marine muds;

(b) **transport of contaminated marine mud shall be by split barges of not less than 750 m^3 capacity; well maintained and capable of rapid opening and discharge at the disposal area; (Clause 2.1b in Appendix O of the Particular Specification)**

D7.1.4 *Disposal of Marine Muds*

Inadequate care taken during disposal of material at dump sites can lead to contamination of waters surrounding the disposal area. To mitigate against this potential impact marine muds should be disposed of only at appropriate dumping grounds and should be disposed of so as to minimise the impact on the surrounding waters. Clauses 1.6 to 1.8 of Appendix O of the Particular Specification ensures that dump sites are picked with due consideration and are adequately managed by requiring;

- **Bathymetric surveys shall be carried out by the Independent Hydrographic Surveyor of the mud disposal area(s). Details shall be submitted to the Engineer, Secretary of the Fill Management Committee and the Director of Marine. (Clause 1.6, Appendix O of the Particular Specification)**

- **Bathymetric surveys shall be carried out over the disposal area(s) at the following times during the allocation period:**

  (a) a base-line survey before the disposal commences,

  (b) intermediate surveys at three-monthly intervals from the commencement of dumping, and

(c) **a final survey within two weeks after disposal has been completed. (Clause 1.7, Appendix O of the Particular Specification)**

- **The bathymetric surveys shall be carried out over the entire extent of the disposal area(s) with depth soundings of the sea bed to be continuously recorded on a line spacing no wider than 50 m for the base-line and final surveys and on a line spacing no wider than 75 m for the intermediate surveys. Separate copies of all these surveys, both on paper and on electromagnetic media, shall be forwarded to the Director of Marine and the Secretary of the Fill Management Committee. The survey method used shall be approved by the Secretary of the fill Management committee before commencement of the base- line survey. Additional surveys may be required by the director of Marine, as for example in cases where disposal works are being carried out in or adjacent to navigation channels. (Clause 1.8, Appendix O of the Particular Specification)**

Clauses 1.1–1.3 of Appendix M of the Particular Specification ensure that the contamination of the marine muds is adequately specified by requiring;

- **The Contractor shall be responsible for determining the extent of contaminated marine deposits at the tunnel Site. The Contractor shall carry out investigation, sampling and testing of mud in accordance with this Appendix and shall agree with the FMC and EPD the extent and nature of contaminated and uncontaminated materials to be dredged. (Clause 1.1, Appendix M of the Particular Specification)**

- **The Contractor shall be responsible for complying with any requirement of EPD or FMC for any dredging or reclamation works at the casting facility, marine borrow areas or any other work area the Contractor uses. (Clause 1.2, Appendix M of the Particular Specification)**

- **The Contractor shall submit details to EPD and FMC of the programme for sampling and testing the mud for their approval. On completion of the sampling and testing the Contractor shall produce and submit to the Engineer a Sediment Quality Report which shall be used as the basis for agreeing the extent of contamination with EPD. (Clause 1.3, Appendix M of the Particular Specification)**

Clauses 1.3 and 1.4 of Appendix N of the Particular Specification ensure that the Contractor disposes of marine muds properly by requiring;

- **Uncontaminated mud shall not be dumped other than in dumping grounds as may be approved for the purpose by the Director of Environmental Protection and in accordance with the Dumping at Sea Act (Overseas Territories) Order 1975. Contaminated mud shall only be dumped in designated dumping areas. The areas made available for dumping may be reduced at any time during the Contract, given reasonable notice, by the Director of Environmental Protection or the**

Secretary of the Fill Management Committee. (Clause 1.4, Appendix N of the Particular Specification)

Clauses 1.1 and 1.2 of Appendix O of the Particular Specification ensure that contaminated mud is not dumped at certain locations and that dumping is controlled to minimise impact on the environment by requiring;

- **All mud dumped within the south Cheung Chau or East of Nine Pins marine disposal area shall be uncontaminated. Prior confirmation in writing of this shall be obtained from the Director of Environmental Protection. The same shall apply to any mud which the Secretary of the Fill Management Committee has agreed may be disposed of in exhausted marine borrow pits. (Clause 1.1, Appendix O of the Particular Specification)**

- **Water quality monitoring shall be carried out during the dumping of mud in marine disposal areas. Requirements for water quality monitoring are given in Appendix K. The extent of monitoring shall be agreed with Director of Environmental Protection and the Secretary of the Fill Management Committee. (Clause 1.2, Appendix O of the Particular Specification)**

Clause 1.5, Appendix O of the Particular Specification ensures that material is placed in an orderly and well controlled manner in the dumping area by requiring;

- **The dredged material shall be placed in successive even layers not exceeding 3 m thick, over the seabed commencing in the deepest part of the disposal area in such a manner that, when all of the materials have been placed, the final surface of the placed material in each layer is horizontal and sensibly level. (Clause 1.5, Appendix O of the Particular Specification)**

D7.1.5 *General Construction*

Site runoff from work areas has the potential to increase the turbidity in surrounding waters. Clauses 3.1.4–3.1.8 of the General Specification ensures that waters adjacent to construction sites do not become fouled with high levels of construction runoff by requiring;

- **The Contractor shall be responsible for ensuring no earth, rock or debris is deposited on public or private rights of way as a result of his operations, including any deposits arising from the movement of plant or vehicles. The Contractor shall provide a washpit or a wheel washing and/or vehicle cleaning facility as specified at the exits from the Site whence excavated material is hauled, to the consent of the Engineer. Water in wheel washing facilities shall be changed at frequent intervals and sediments shall be removed regularly. The Contractor shall provide a hard surfaced road between the wheel washing facilities, and the public or private right of way onto which the exit joins. (Clause 3.1.4 of the General Specification)**

- **The Contractor shall at all times ensure that all existing stream courses and drains within and adjacent to the Site are kept safe and free from any debris and any excavated materials arising from the Works. The Contractor shall ensure that chemicals and concrete agitator washings are not deposited in watercourses. (Clause 3.1.5 of the General Specification)**

- **All water and other liquid waste products arising on the Site shall be collected, removed from Site via a suitable and properly designed temporary drainage system and disposed of at a location and in a manner that will cause neither pollution nor nuisance. In addition, the effluents shall comply with the standards stated in the "Technical Memorandum on Standards for Effluents discharged into Drainage and Sewerage Systems, Inland and Coastal Waters" for the appropriate Water Control Zone, whether or not the zone has been declared as one subject to control of discharges. (Clause 3.1.6 of the General Specification)**

- **The Contractor shall construct, maintain, remove and reinstate as necessary temporary drainage works and take all other precautions necessary for the avoidance of damage to works of adjacent contracts or to adjacent properties by flooding and silt washed down from the Works. He shall also provide adequate precautions to ensure that no spoil or debris of any kind is allowed to be pushed, washed down, fall or be deposited on land or on the seabed adjacent to the Site. (Clause 3.1.7 of the General Specification)**

- **In the event of any spoil or debris from the Works being deposited on adjacent land or seabed or any silt washed down to any area, then all such spoil, debris and silt shall be immediately removed and the affected land or seabed and areas restored to their natural state by the Contractor to the satisfaction of the Engineer. (Clause 3.1.8 of the General Specification)**

All site construction runoff and drainage should be controlled and treated given the potential for adverse water quality impacts on adjacent coastal waters, and to protect any fishing grounds in the area. The following measures to help prevent the contamination of surface and marine waters during the construction period are recommended for inclusion in the CCP.

- **The boundaries of critical areas of earthworks should be marked and surrounded by dykes or embankments for flood protection.**

- **Temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a silt retention pond.**

- **Permanent drainage channels should also incorporate sediment basins or traps, and baffles to enhance deposition rates.**

- **All traps (temporary or permanent) should also incorporate oil and grease removal facilities.**

- **A minimum of two retention ponds or settlement tanks should be used at any one location, one of which shall be an emergency overflow, or as agreed with EPD.**

- **Sediment traps must be regularly cleaned and maintained by the contractor. Daily inspections of such facilities should be required of the contractor.**

- **Oily contents of the traps should be collected and transferred to an appropriate disposal facility, such as the Government Chemical Waste Treatment Facility at Tsing Yi.**

- **Water from concrete batching plants must also pass through sediment traps and settlement tanks. Again, these must be regularly cleaned and maintained by the contractor.**

- **Collection of spent bentonite or other grouts in a separate slurry collection system for either cleaning and reuse or disposal to landfill.**

- **All drainage facilities must be adequate for the controlled release of storm flows.**

- **Minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff.**

- **Discharge points for construction runoff should be located away from any temporary embayments formed in the concurrent NLD reclamation.**

Furthermore, clauses 3.3.1–3.3.5 ensure that site water is properly disposed of and is adequately treated by requiring;

- **The Contractor shall not discharge directly or indirectly (by runoff) or cause or permit or suffer to be discharged into any public sewer, storm–water drain channel, stream–course or sea, any effluent or foul or contaminated water or cooling or hot water without the prior consent of EPD who may require the Contractor to provide, operate and maintain at the Contractor's own expense, within the premises or otherwise, suitable works for the treatment and disposal of such effluent or foul or contaminated or cooling or hot water. (Clause 3.3.1 of the General Specification)**

- **If any office, site canteen or toilet facilities is erected, foul water effluent shall, subject to Clause 3.3.1 above, be directed to a foul sewer or to a sewage treatment facilities either directly or indirectly by means of pumping. (Clause 3.3.2 of the General Specification)**

- **The Contractor's attention is drawn to the Buildings Ordinance, the Water Pollution Control Ordinance, and the Technical Memorandum on "Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters" issued by EPD. (Clause 3.3.3 of the General Specification)**

- **In order to reduce the amount of suspended solids in effluent to the levels quoted in the Technical Memorandum referred to in Clause 3.3.3 herein, the Contractor shall install setting tanks followed by one or a combination of:**

  (a) Multiple-plate thickeners;
  (b) Centrifuges;
  (c) Mechanical Filters; and
  (d) Hydrocyclones. (Clause 3.3.4 of the General Specification)

- **All equipment shall be regularly cleaned and maintained in good working order. (Clause 3.3.5 of the General Specification)**

Sites and site waters can be fouled by materials, such as oil and sludge, used in the construction process. These materials should be reclaimed, recycled, and reused if possible. If the materials cannot be reused they should be disposed of properly. These issues should be addressed in the Site Management section of the CCP which should include the following Clauses.

- **Oil interceptors should be used on main drainage channels which discharge to surface water or to the sewer system.**

- **Spent bentonite or other grouts should be collected in a separate slurry collection system for cleaning and/or reuse.**

- **All non-reusable sludge should be collected and contained for disposal offsite at a landfill.**

D7.1.6 *Kwai Chung Park*

A leachate treatment plant is planned for Kwai Chung Park, but is not likely to be operational until 1995, after construction of the LAR has commenced. In the meantime, an interim method of deposal for waste water produced from the works will be required. The preferred option is for disposal to foul sewer.

Therefore the following Particular Specification clauses are recommended:

Contaminated run-off from untreated waste surfaces shall be separated from clean surface water drainage systems. Contaminated run-off shall be discharged to foul sewer.

Contaminated liquors or additional leachate generation from construction activities shall be disposed to foul sewer.

Construction work will be carried out in a old landfill site where leachate can be a potential problem. It is important that precautionary measures be taken at various stages of construction to minimise its impact on water quality. The following clauses therefore should be incorporated in the Particular Specification:

Vehicle washing facilities with a settlement tank and recirculation system shall be provided for vehicles leaving the site. Wash water shall be changed regularly.

Water damping of dust sources shall be controlled to prevent generation of unnecessary discharges.

To minimise the potential generation of leachate, it is proposed that excavation to be carried out during the dry season. The following advice is recommended for inclusion in the CCP:

- **Excavation should be scheduled, if possible, during the dry season, i.e. between November and March to minimise the leachate generation.**

The effect of removing the present capping system and creation of the open cutting could lead to large volumes of additional leachate generation as a result of rain infiltration. It is essential that the following clauses be included in the Particular Specification:

Cut slopes shall be finished and treated immediately with low permeability layers. (New Clause)

Effective surface drainage measures and hydroseeding shall be provided to reduce erosion and the generation of leachate. (New Clause)

Adequate drainage shall be provided to avoid the bottom of the cutting becoming water logged and subsequently hindering efficient plant and equipment movement.(New Clause)

For contaminated liquor, spillages may arise during the transport of excavated material or during transport for subsequent disposal to treatment works. The following advice is recommended for inclusion in the CCP:

- **Contaminated liquor spillages should be cleaned up immediately using methods agreed with the Engineer.**

D7.1.7 *Tsing Yi Tunnels*

The proposed tunnel alignment passes 140 metres beneath an existing WSD water reservoir. It is unlikely that the tunnel will affect the structure of the reservoir. However, special measures may be required to safeguard integrity of existing WSD reservoir. Depending on the tunnelling method used, reprovisioning or draining may be necessary during the tunnel excavation of the section beneath the reservoir. Blasting operations within 50 m of a WSD water retaining structure will require prior approval from the Director of Water Supplies.

D7.1.8 *Lantau Fixed Crossing*

There may be safety implications in having a public bathing beach close to a major construction site. Therefore, it is recommended that consideration be given to restricting use of the beach or even closing it during the construction phase. Discharges from activities at the Penny's Bay work site should be controlled by enforcement of the TM and it is recommended that domestic effluent be discharged off the southern face of the reclamation rather than within Penny's Bay. The provision of adequate drainage for work sites and during the operation phase is considered essential. The formulation of a spill action plan is recommended for both the construction and operation phases of the Project.

D7.1.9 *Lantau Tunnels*

Construction work for the proposed tunnels will be carried out concurrently with other construction activities such as the LFC and the NLE. It is important that appropriate measures be implemented to minimise the cumulative impacts associated with the ongoing construction and development in the area.

In the event that a significant impact on water quality is predicted to occur as a result of the construction works of Contract 514 the following mitigation measure is recommended:

- All site construction runoff and drainage should be controlled and treated given the potential for adverse water quality impacts in the adjacent streams and coastal waters, and to protect fishing grounds in the area.

D7.1.10 *Lantau Formation and Viaducts*

Measures are proposed to minimise the impacts of dredging on water quality and also to outline remedial action to be taken in the event that WQO are breached. Dredging options include the use of low impact dredging techniques, closed grabs, and not allowing hoppers to overflow while filling.

Adequate and appropriate facilities will be required for disposal of waste arising at work sites. Packaged sewage treatment plants are appropriate for pretreatment of domestic effluent prior to discharge. A minimum requirement of grit and grease traps will be mandatory at all work sites.

It is recommended that a spill action plan be formulated so that any spillages arising from construction activities may be dealt with quickly and effectively. When spillages are oil or petroleum based, the first priority is to contain the material as quickly as possible. This may be achieved by the use of containment booms and application of adsorbent material to the spillage. If there is no alternative but to discharge washout waters from batching plants to a receiving water body, these should be within a pH range of 6–9 with SS concentrations no greater than 30 mg l^{-1}.

The NLD Report also contained a Construction Phase Action Plan which detailed mitigation measures proposed for each major component of the development and recommended clauses for inclusion in contract documentation to minimise impacts.

D7.1.11 *Siu Ho Wan Depot*

Construction work for the proposed Depot will be carried out concurrently with other construction activities for the NLD and NLE. It is important that appropriate measures be implemented to minimise the cumulative impacts associated with the ongoing construction and development in the area.

D7.1.12 *Airport Works*

It was recommended in the NAMP that in order to minimise site runoff and its associated impacts, drainage from exposed site areas should be channelled to a series of sediment traps. Maintenance of the sediment traps on a regular basis is considered essential since progressive volume reduction reduces their removal efficiency.

The report states that no water from batching plant should be discharged directly to sea. All areas surrounding the batching plants should be concrete paved, with all hard standing areas being laid to fall to specially constructed settlement tanks. Washing down of haul vehicles or wheel wash facilities should also be located in areas where collection and subsequent sedimentation of suspended solids is possible. All water should be recycled and used for further dust suppression and rinsing purposes. The sedimentation and water recycling systems must be maintained on a regular basis to ensure that they are effective.

It is stated that should any washwaters or other wastewaters be discharged to sea, they will require to be licensed under the Water Pollution Control Ordinance and to comply with the discharge limits stipulated in the TM.

The report stated that for the Building and Infrastructure Contract, each contractor involved should be required to provide portable sewage facilities and to arrange appropriate collection and disposal facilities, ie. pumping out into collection vehicles and barging to an off–site disposal facility.

D7.2 *IMPACTS DURING OPERATION*

The operational phase of the LAR is unlikely to result in any significant water quality impacts. The potential for contaminated track runoff and tunnel drainage to arise will be the major concern of the railway operation. Provided discharges meet the standards stipulated in the TM no adverse impacts on water quality are anticipated.

The following measures have been identified to mitigate potentially significant impacts on water quality as a result of the railway operation.

To reduce the volume of tunnel drainage arising, it will be necessary to minimise seepage into the tunnel from the surroundings. The design of the tunnel will take into account the appropriate measures to prevent ingress of groundwater.

It is recommended that the operator should regularly inspect the lining and seals of the tunnels to monitor ingress of groundwater, and take any appropriate actions to reduce the volume of tunnel drainage arising from this source.

Discharges from the track and tunnels must be controlled to comply with the TM under the WPCO. The TM states that for effluent discharges into storm water drains, the water quality standards should be as for receiving waters downstream, namely the WCZ. Track runoff and seepage should be properly diverted and connected to appropriate drainage systems where necessary.

It is recommended that drainage systems at stations and the Tai Ho Wan Depot incorporate traps to collect SS in drainage or runoff (including metals) and interceptors to collect oil and grease. Oily contents of the traps should then be disposed of to the Chemical Waste Treatment Centre.

The efficiency of silt traps and oil interceptors is highly dependent on regular cleaning and maintenance, and an appropriate frequency (*eg* weekly) should be specified to ensure that these remain effective.

Procedures should also be developed concerning maintenance activities, such as washing of trackbeds, to ensure volumes of effluents (including chemical pollutants) and wastewater arising are minimised .

The design of the Rambler Channel Bridge should address the problem of debris becoming trapped by minimising flow restrictions around the piers.

It is recommended that consideration be given to a combined pollution control plan for all North Lantau Projects, this should include formulating a spill action plan.

The following measures are recommended to mitigate potentially significant impacts on water quality as a result of the Depot operation.

- Procedures for maintenance and cleaning practices shall be implemented such that the volume of all wastewaters or effluents arising are minimised, and recycling practices adopted where possible.

- All store areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity.

- Wastewaters and effluents arising from maintenance and heavy cleaning facilities should be collected in appropriate drainage systems and connected to the on-site wastewater treatment plant for the required treatment to comply with the TM.

- A surface water drainage system should also be provided.

Annex E

Land Use and Visual Impacts

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E1 INTRODUCTION

E1.1 SCOPE AND PURPOSE OF THE ANNEX

This annex addresses the land use and visual impacts which will be associated with the construction and operation of the Lantau and Airport Railway (LAR).

E1.2 ORGANISATION OF THE ANNEX

The remainder of this annex is organised as follows:

- *Section E2* describes the basic methodology applied in the assessment of land use and visual impacts.
- *Section E3* describes the baseline land use and visual conditions along the alignment of the LAR.
- *Section E4* identifies the potential sources of land use and visual impacts likely to arise from the construction and operation of LAR.
- *Section E5* predicts the extent and magnitude of impacts, and evaluates their significance during both the construction and operation of the LAR.
- *Section E6* describes the measures recommended for the mitigation of adverse land use and visual impacts.

E2 ASSESSMENT METHODOLOGY

E2.1 LAND USE IMPACTS

The prediction of land use impacts during both the construction and operational phases of the LAR has been based on the identification of sites where existing or proposed land uses would be in conflict with the LAR proposals in terms of the construction sites or the operational railway being a "bad neighbour" for certain types of land use. In making this evaluation, reference has been made to the most recently-published Government land planning proposals in Outline Development Plans or Outline Planning Zones. As well as the consideration given to noise and air quality impacts described in *Annexes B* and C, the possible presence of any significant ecological habitats which would be lost or damaged during construction has been reviewed during the study, and none were identified.

Given that the planning studies for the LAR and the areas surrounding the alignment have been well co-ordinated, it was anticipated that no significant planning conflicts were likely to be identified.

It should also be noted that issues relating to the feasibility of constructing the LAR and the choice of alignment were considered in the ARFS, and are not discussed further in the LAR EIS.

E2.2 VISUAL IMPACTS

The likely impacts of the LAR on landscape/townscape and visual resources were assessed by undertaking the following tasks:

- Delineation of visual catchment, identification of the immediate visual characteristics and appraisal of its visual quality.
- Identification of visually sensitive receptors, analysis of visibility of project and determination of sensitivity levels.
- Identification of the visual characteristics of the project during the construction and operational phases and assessment of the potential visual impact on sensitive receptors.
- Evaluation of impacts and identification of any areas of significant impact.
- Identification of appropriate mitigation measures to minimise significant impacts.

This assessment was largely based on information presented in the previous environmental studies, these are discussed in full in the relevant Working Papers. Site visits, and a review of aerial photographs and maps, were also undertaken to gather further information and to allow a detailed assessment of the extent and magnitude of impacts. The assessment of visual impacts was essentially based on a professional, subjective evaluation of the "degree of fit" of the LAR proposals into the receiving environment in visual terms, the identification of areas of visual concern and the analysis of the physical sources of impact.

The studies which were reviewed to provide information for the visual assessment were:

- Freeman Fox Maunsell (March 1991) – **"Airport and Railway Feasibility Study" (ARFS)** – Chapter 7 – Highways Department.
- Western Harbour Crossing Consultants (April 1991) – **"Western Harbour Crossing Study"** – Volume 5, Chapter 7 – Highways Department.
- Freeman Fox Maunsell (1991) – **"West Kowloon Expressway – Volume 3, Environmental Assessment"** – Chapter 8 – Highways Department.
- Scott Wilson Kilpatrick & Partners et al (undated) – **"Route 3 EIA – Technical Report No 19"** – Chapter 7 – Highways Department.
- Mott MacDonald Hong Kong Ltd (1991–2) – **"North Lantau Development Study: Topic Report TR10"** – Chapter 6 – Territory Development Department.
- Mott Macdonald Hong Kong Ltd (1991) – **"North Lantau Expressway – Environmental Assessment Report: Yam O and Tai Ho Sections"** – Chapter 7 – Highways Department.
- Mass Transit Railway Corporation et al (June 1992) – **"Tung Chung Town Centre Study"** – Chapter 11 – MTRC.
- Greiner–Maunsell et al (December 1991) – **"New Airport Master Plan – EIA"** – Chapters 15 and 27 – Provisional Airport Authority.

E3 BASELINE CONDITIONS

E3.1 INTRODUCTION

This section describes the baseline land use and visual conditions along the proposed route of the LAR alignment. The baseline conditions provide a description of the existing land uses and visual quality in these areas against which the extent and magnitude of the land use and visual impacts which are likely to arise during the construction and operation of the LAR may be compared.

The baseline conditions are described under three headings:

- Existing conditions;
- Future conditions;
- Sensitive receptors.

E3.2 EXISTING CONDITIONS

E3.2.1 Land Use

From the proposed terminus of the LAR in Central to a point just south of Lai King, the LAR will be built entirely on land which is yet to be, or is currently being, reclaimed (except for where the LAR will pass under Victoria Harbour via the Immersed Tube Tunnel (Contract 502)). Therefore, there are no existing land uses to be considered in relation to these sections of the route.

Similarly, the sections of the LAR alignment on North Lantau, from the Western Portal of the East Lantau Tunnels (Contract 514) to the new airport, will also all be on reclaimed land, and again there are no existing land uses to be considered in relation to these sections of the route.

In Lai King, the predominant landuse is residential, with associated facilities such as schools and shopping. Kwai Chung Road separates the industrial areas to the west from the residential areas. The expanse of roads in this area already creates severance between these areas, particularly for pedestrians. To the north of the existing Lai King Station are high rise residential/commercial and industrial buildings in Kwai Fong. Kwai Chung Road and the existing MTRC Tsuen Wan Line are dominant features in the area.

On the coastal plain and associated reclaimed land, the container terminals stretch south towards Lai Chi Kok and Mei Foo. This area extends from South Tsing Yi Bridge southwards and will extend further with future planned reclamations.

To the north-west of Lai King, the elevated LAR viaduct will pass over Kwai Chung Road, then across the open container storage area until meeting the new Route 3 highway. The railway will be accommodated beneath Route 3 and within the highway structure. The viaduct will then run along Kwai Tai Road and Kwai Tsing Road. The surrounding landuses include the container stacking area and the housing area to the east of Kwai Chung Road. To the west of this, the LAR alignment passes through Kwai Chung Park, which was formerly the Gin Drinker's Bay Landfill and will be restored. However, it has yet to be gazetted as a park and is not currently open to the public. The surrounding area is predominately industrial with factory and godown buildings to the north and south of the Park. There is a crematorium complex at the north-west boundary of the park and the Tsuen Wan Chinese Permanent Cemetery located further north.

The alignment will then cross the Rambler Channel to Tsing Yi, passing close to residential, commercial and open space areas before entering a tunnelled section. After this, it will cross the new Tsing Ma Bridge (currently under construction), pass close to residential areas on Ma Wan and then cross the Kap Shui Mun Channel and enter a further tunnelled section on North-east Lantau.

E3.2.2 *Visual Quality*

In terms of visual quality, the areas through which the LAR alignment will run may be classified into three types:

- In *Hong Kong* and *West Kowloon*, the LAR will be built on newly reclaimed land bordering densely urbanised areas, dominated by high rise commercial, office and residential developments. The typhoon shelter that has been reprovisioned to the western edge of the of the reclamation, together with a number of dumb lighters is very visually intrusive. The juxtaposition with Victoria Harbour provides some long-distance viewing opportunities. Although the visual quality around the Harbour itself may be described as high, for most of this area the quality is generally poor, although some individual architectural features and longer distance views have merit.

- In *Kwai Tsing District*, the visual quality may again be characterised as urban, but dominated mostly by industrial buildings, container port and public cargo-handling activities and high-rise residential blocks. The scale of the main arterial roads in this area is also very intrusive. In general, the visual quality of the area may be described as poor.

- In *North Lantau*, the existing character of the area is rural, and visual quality is high. The landforms of North Lantau, with high ridges, deep valleys and plunging coastline is particularly dramatic, while vegetation patterns are distinctive and contribute to the character of the different areas. Relatively extensive areas of woodland exist on the lower reaches of the hillsides on the coastal strip and in the valleys, while the open hillsides are characterised by a low scrub and grassland vegetation. Visibility in the area is high due to the topography, with long-distance views of the area being afforded from many points along the opposite coast in the North-west New Territories. However, reclamation works currently in progress relating to the new airport and the North Lantau Development have degraded the visual quality of North Lantau significantly, and this process will continue with the continuing planned urbanisation of the area (see *Paragraph E3.3.2* below).

E3.3 *FUTURE CONDITIONS*

E3.3.1 *Future Land Uses*

Central and Yau Tsim Districts

In Central and West Kowloon, the reclaimed areas through which the LAR alignment will be developed intensively with high-rise commercial, office and residential buildings. According to the most recent Outline Zoning Plan (Plan No. S/H4/3 proposed amended version) of the Central District, planned land uses in the area surrounding the new Hong Kong Central Station will include:

- The western portal of a 2.5 km long waterfront trunk road tunnel;
- Sites C1 (in conjunction with the station site), C10, C11 and C12 proposed for commercial developments;
- Utilities such as the electric substation/telephone exchange and the gas pressure reduction station to the north;
- Tram reserve and the waterfront promenade further north of the site;
- The southern boundary will adjoin mainly existing buildings along Connaught Road, including the Harbour Building, Hang Seng Bank New Headquarters Building, Exchange Square and the General Post Office; and
- An extensive road network around the Station.

These are indicated in *Figure E3.3a*.

In West Kowloon, according to the Layout Plans (Plans 8 to 11, 1993) for the southern section of the reclaimed area, the future land uses in the vicinity of Kowloon Station and tunnels (illustrated in *Figure E3.3b*) will include:

- The Western Harbour Crossing (WHC) portal and the associated toll plaza;
- A Comprehensive Development Area (CDA) above the Station which is one of the largest developments along the line;
- Commercial developments to the south and east of the Station;

- A public transport terminus, District open space and promenade in the waterfront area;
- A public cargo working area (PCWA) to the west of the Station;
- A public transport terminus, a primary school and residential developments further to the east of the station, behind the blocks of commercial buildings;
- An indoor recreation centre to the south-west; and
- District open space and Government offices to the north of the Station.

In the ares adjacent to the Kowloon–Tai Kok Tsui tunnels, the following uses are proposed in the Outline Development Plan for the area, and shown in *Figure E3.3c*:

- Comprehensive Development Area over Tai Kok Tsui station including a public transport terminus to the north of the tunnels;
- Indoor recreation centre, car park, service centre for the elderly, schools and community centre to the east;
- Public Cargo Working Area with Marine Department Administration building to the west; and
- Amenity areas and a road interchange network above the central and southern section of the tunnel.

In addition, there will be two major drainage reserves built into the WKR.

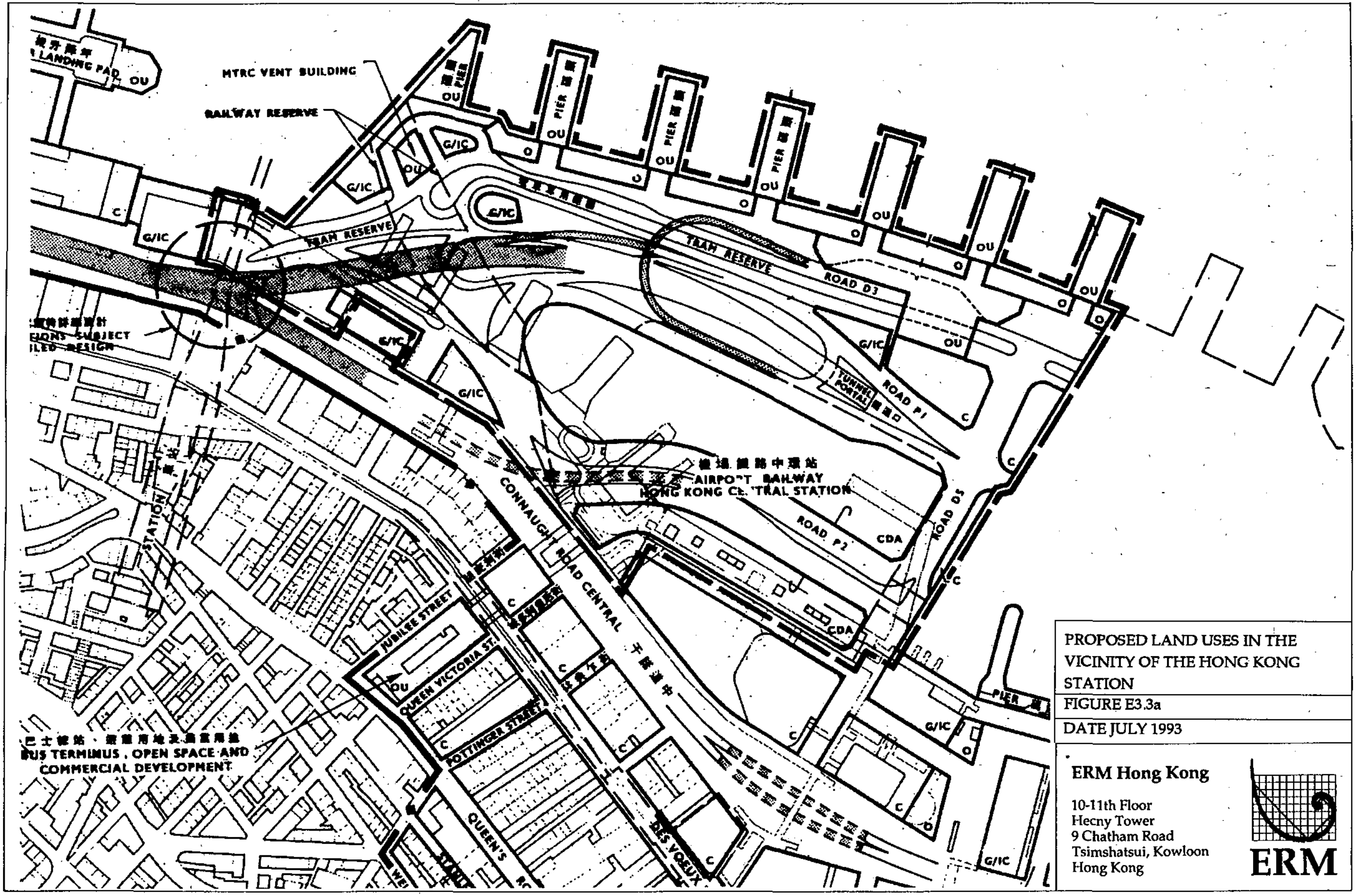
Mong Kok and Sham Shui Po Districts

In this area, the reclaimed areas to the west of the LAR/Route 3 alignment will accommodate the enlarged container port facilities planned as Container Terminals 7 and 8.

Kwai Tsing District

In the Lai King and Kwai Chung areas, the most recent Kwai Chung Outline Zoning Plan (SK/C/8, July 1992) and Outline Development Plan (D/KCW/2, November 1990), show no significant planned changes to the existing pattern of land uses. A new sewage treatment plant is proposed to be located to the north of the LAR alignment to the southeast of Kwai Chung Park. Also, after the completion of construction works for the LAR, the park itself will be restored and landscaped, and then formally gazetted as a park and opened to the public.

On Tsing Yi, the future land uses in the vicinity of the new Tsing Yi Station include:



PROPOSED LAND USES IN THE VICINITY OF THE HONG KONG STATION

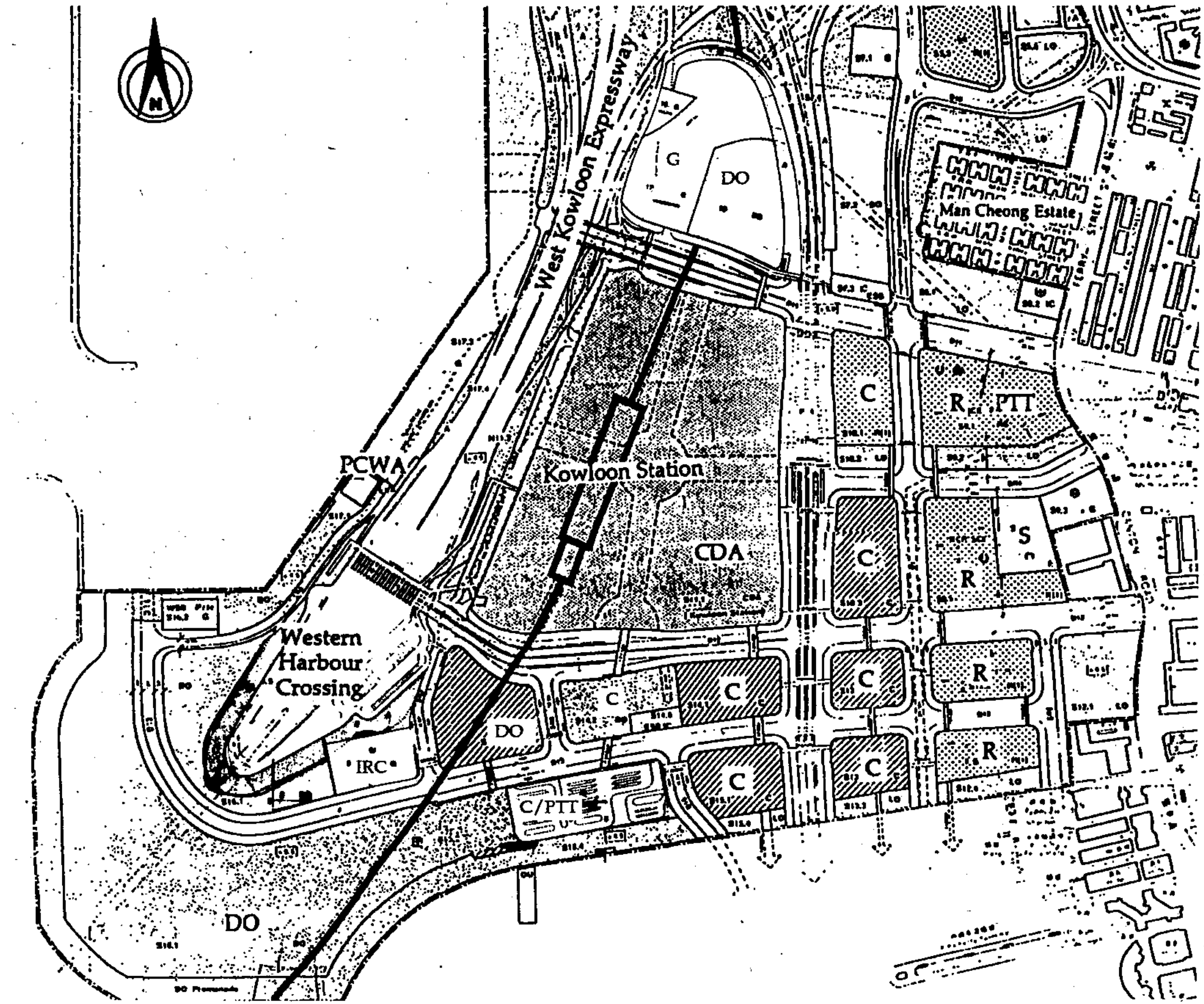
FIGURE E3.3a

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



KEY

R	RESIDENTIAL
C	COMMERCIAL
G	GOVERNMENT
S	SCHOOL
PTT	PUBLIC TRANSPORT TERMINUS
DO	DISTRICT OPEN SPACE
IRC	INDOOR RECREATION CENTRE
CDA	COMPREHENSIVE DEVELOPMENT AREA

PLANNED LAND USES IN THE VICINITY OF CONTRACT 503

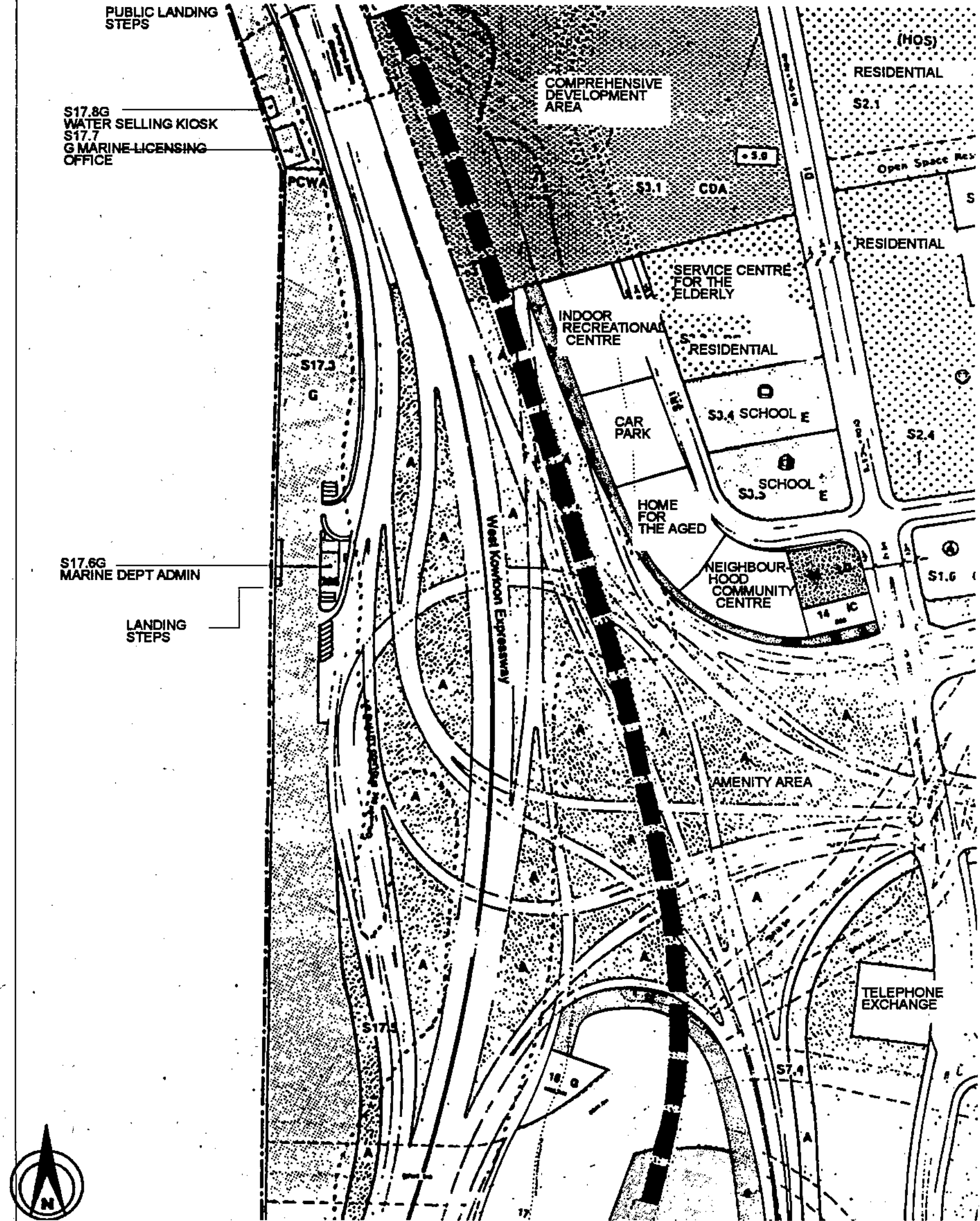
FIGURE E3.3b

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



PROPOSED LAND USES IN THE VICINITY OF THE TAI KOK TSUI-NEW KOWLOON STATION TUNNEL

FIGURE E3.3c

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

- A waterfront promenade along the north-eastern coast of the island;
- A swimming pool complex south of the Station;
- Tsing Yi Town Park;
- Tsing Yi North Bridge;
- A Comprehensive Development Area at Nga Ying Chau;
- Residential blocks above the Station, at the Cheung On Estate and St. Paul's Village.

These planned land uses are shown in *Figure E3.3d.*

Tsuen Wan and Islands Districts

On Ma Wan, substantial development is planned for the northern part of the island, with 280 village-style houses and a further 280,000 m^3 of other housing being provided, together with recreational facilities and supporting utilities.

On North-east Lantau, the area where the LAR will run in tunnel will chiefly remain as a Landscape Protection Area.

On the reclaimed areas along the North Lantau coastline, substantial new urban development will take place, particularly at Tai Ho Wan and Tung Chung, where complete new settlements will be built.

At Chek Lap Kok, the new international airport is also currently being built.

E3.3.2 *Future Visual Quality*

Central and Yau Tsim Districts

In Central and West Kowloon, the visual character of the newly-reclaimed areas will be intensely urban, with new high-rise developments being built on a grid pattern, and major transport links being provided. Individual developments, design of urban spaces and the juxtaposition of new developments with the harbour may all contribute to the creation of areas with high urban visual quality, although other areas may be considered to be of poor quality due to the proximity of buildings to one another and the intrusiveness of traffic.

Mong Kok and Sham Shui Po Districts

In these areas, visual quality will be dominated by the buildings and activities associated with Container Terminals 7 and 8, and transport links to these (including Route 3). As such, future visual quality will be poor.

Kwai Tsing District

The visual quality of the Lai King, Kwai Chung and Tsing Yi areas will remain generally poor as at present, and may be worsened by increased traffic levels. However, the reinstated Kwai Chung Park will provide a positive visual element in the area, and the visual quality of the waterfront areas near the north bridge in Tsing Yi will be improved following the development of the waterfront promenade and Tsing Yi Town Park.

Tsuen Wan and Islands Districts

The construction of the Lantau Fixed Crossing will introduce a strong new visual element into the area, which will have both positive and negative effects on long-distance views.

On North Lantau, a fundamental change in the visual quality of the area will take place due to the urbanisation associated with the North Lantau Expressway, the North Lantau Developments and the new airport. The essentially rural character of the area will be lost, and the visual quality will inevitably worsen as a result. However, good design may help ensure that a high-quality urban environment which is also sympathetic to its natural background is created.

E3.4 SENSITIVE RECEPTORS

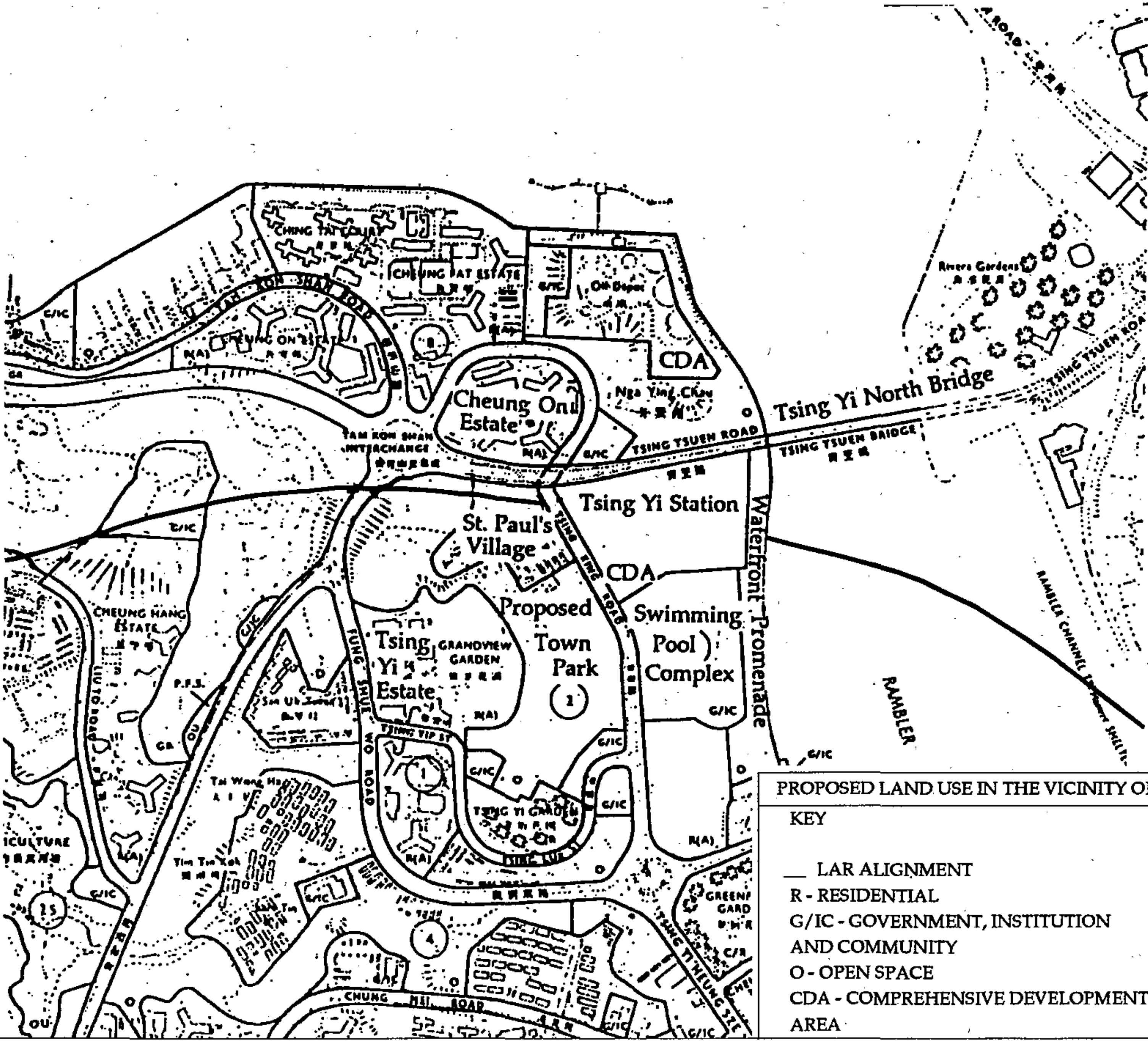
Sensitive receptors in terms of visual quality are identified in this assessment as people in their homes and users of open space areas. Occupants of commercial and industrial areas, and other public buildings are considered to be less sensitive. Viewers in transit, such as roads and ferries, are not considered to be sensitive receptors, as their line of vision and length of exposure are both limited. However, the exception to this in relation to this assessment are people using ferries in Victoria Harbour, which is a popular attraction for tourists and other visitors to Hong Kong.

Sensitive receptors that are closer to the LAR alignment generally will have a higher visibility than those further away, and are considered to have a higher sensitivity. The sensitivity [1] is defined as follows:

- High Sensitivity: Foreground view (0–0.5 km)
- Medium Sensitivity: Middle ground view (0.5–1 km)
- Low Sensitivity: Background view (1–2 km)

Table E3.4a sets out the sensitive receptors identified in each of these categories, and their locations are indicated in *Figures E3.4a* to *E3.4d*.

[1] Modified from: Smardon, R.C., Palmer, J.F. and Fellman, J.P. (eds.)(1986) – "Foundations for Visual Project Analysis" – John Wiley and Sons, pp.55.



PROPOSED LAND USE IN THE VICINITY OF CONTRACT 511

KEY

__ LAR ALIGNMENT
R - RESIDENTIAL
G/IC - GOVERNMENT, INSTITUTION AND COMMUNITY
O - OPEN SPACE
CDA - COMPREHENSIVE DEVELOPMENT AREA

FIGURE E3.3d

DATE JULY 1993

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9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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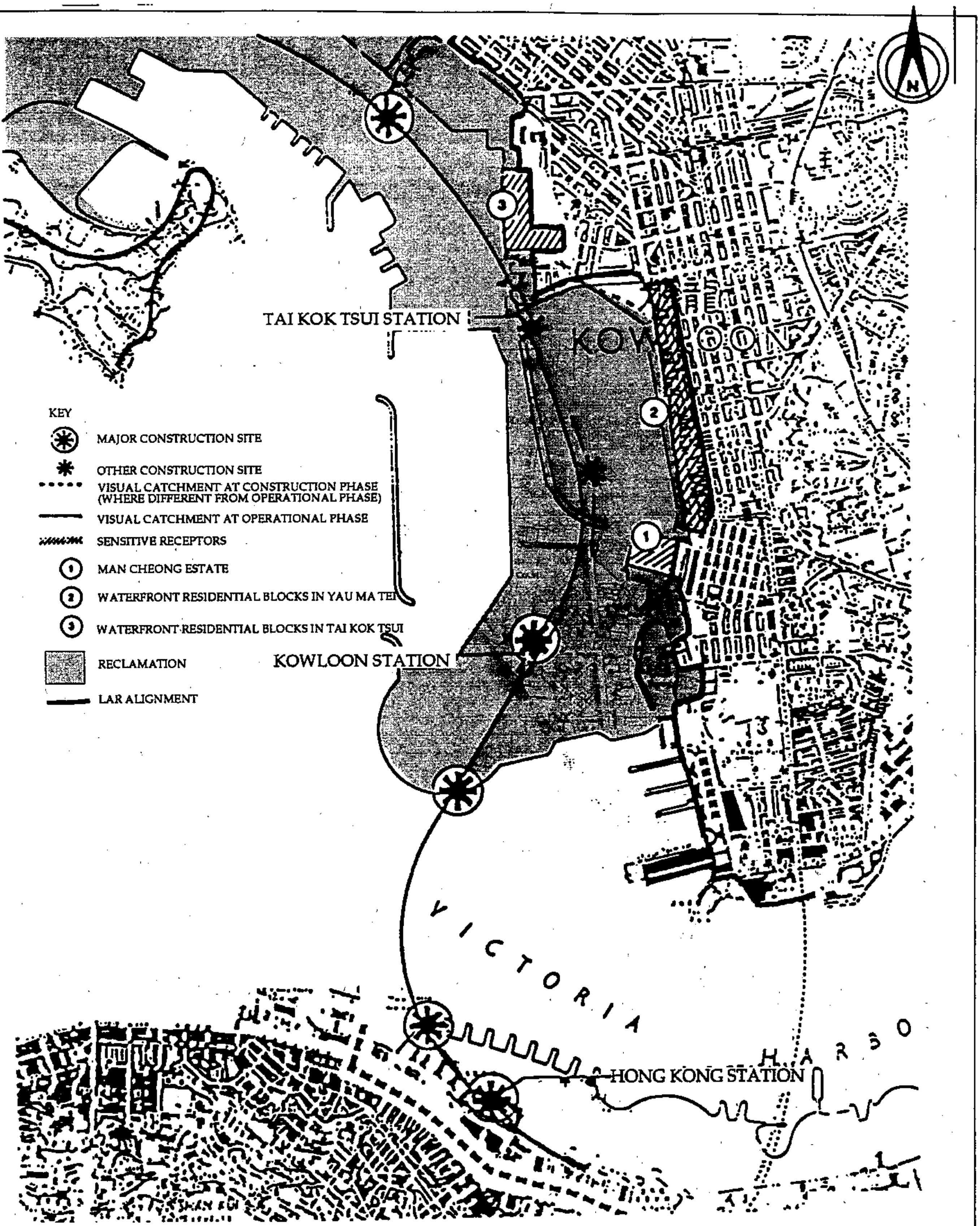
Table E3.4a Visually-sensitive Receptor Locations in the Vicinity of the LAR Alignment

District	High Sensitivity	Medium Sensitivity	Low Sensitivity
Central and Yau Tsim	Waterfront promenade in Central.	Man Cheong Estate. Victoria Hotel. Waterfront estates in Tsim Sha Tsui and Yau Mau Tei. Harbour ferries.	Other commercial and office buildings in Central and Tsim Sha Tsui. Elevated waterside walkway, Tsim Sha Tsui.
Mong Kok and Sham Shui Po		Waterfront Estates in Tai Kok Tsui and Sham Shui Po.	
Kwai Tsing	Lai King Estate. Yin Lai Court. Yuet Lai Yuen. Cho Yiu Chuen. Kwai Chung Park. Cheung On Estate. St. Paul's Village. Broadview Garden. Serene Garden. Tsing Yi Town Park. Waterfront Promenade, Tsing Yi.	Estates in Kwai Fong. Riviera Gardens. Waterside Plaza.	Other residential blocks in Lai King. Cheung Hang Estate. Cheung Hong Estate. Cheung Ching Estate.
Tsuen Wan and Islands		Lantau Country Park. Tung Chung Village. Ngau Kwu Long Village Tai Ho San Tsuen Village	Tuen Mun. Sham Tseng. Other locations in the West New Territories.



IMMEDIATE VISUAL CATCHMENT AND SENSITIVE RECEPTORS: CENTRAL AND YAU TSIM DISTRICTS

FIGURE E3.4a

DATE JULY 1993

ERM Hong Kong

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Hecny Tower
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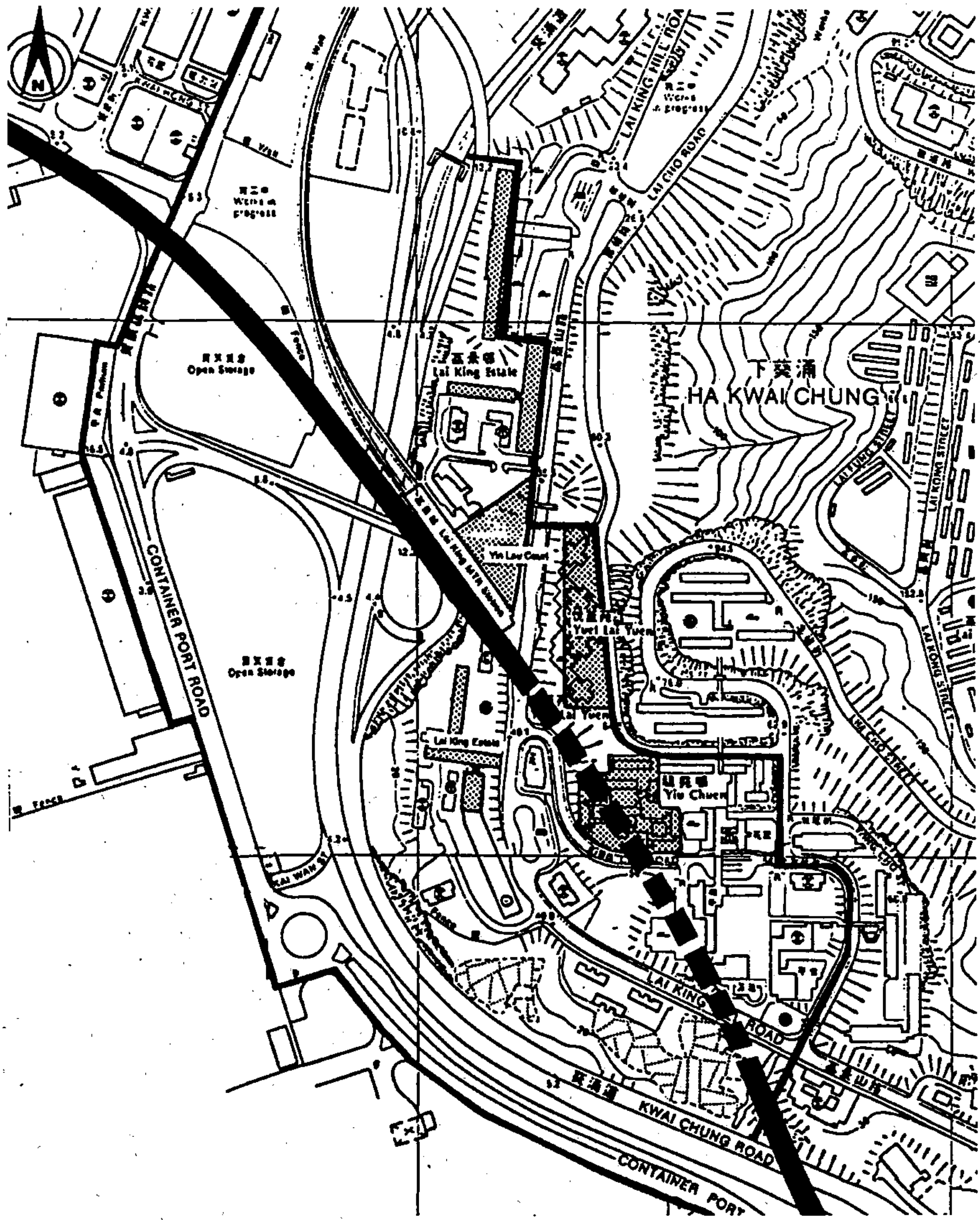
Tsimshatsui, Kowloon
Hong Kong

ERM



IMMEDIATE VISUAL CATCHMENT AND SENSITIVE RECEPTORS: LAI KING AREA

FIGURE E3.4b

DATE JULY 1993

KEY

- LAR ALIGNMENT
- VISUAL CATCHMENT
- BOUNDARY
- SENSITIVE RECEPTORS

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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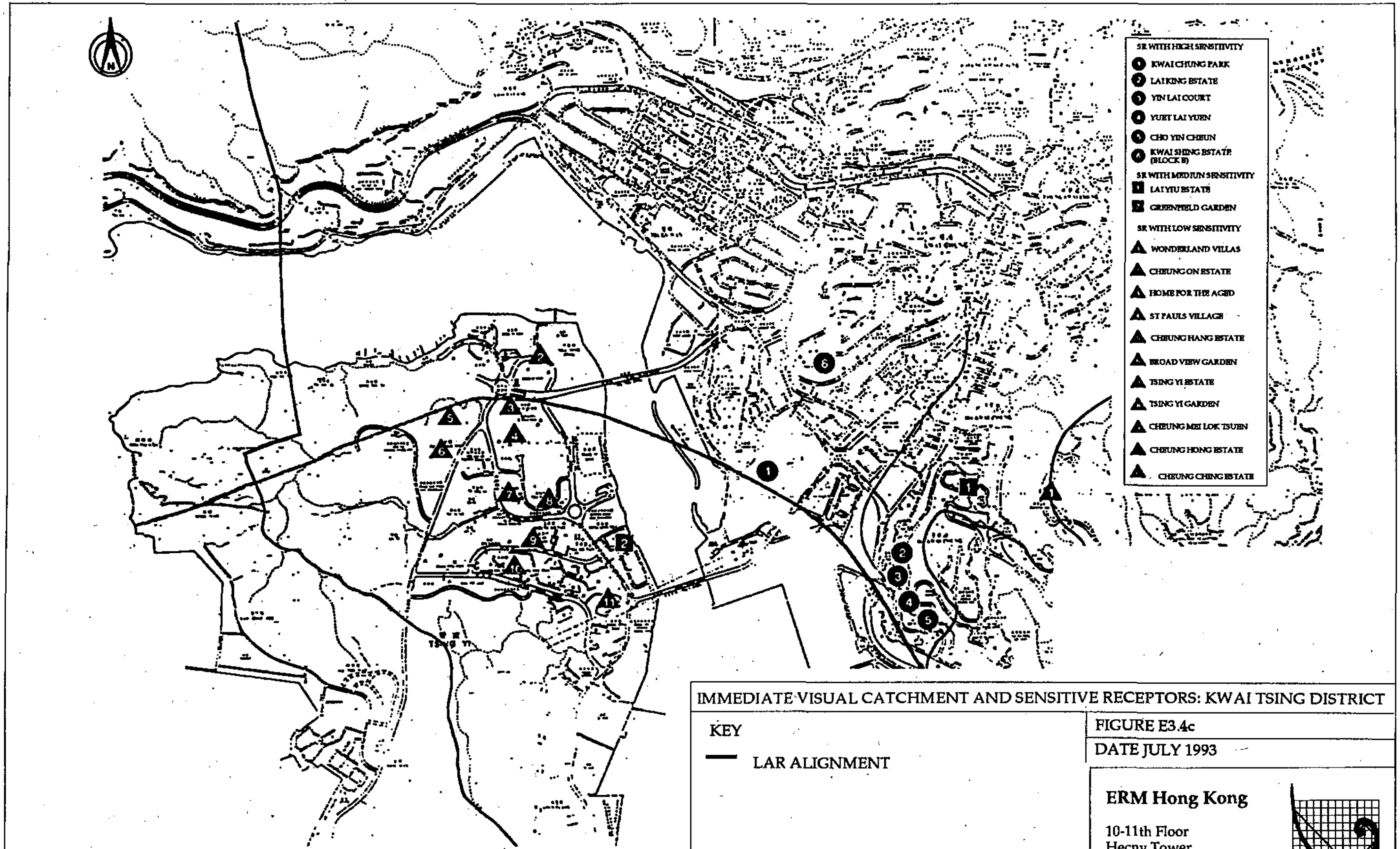

IMMEDIATE VISUAL CATCHMENT AND SENSITIVE RECEPTORS: KWAI TSING DISTRICT

KEY

LAR ALIGNMENT

FIGURE E3.4c

DATE JULY 1993

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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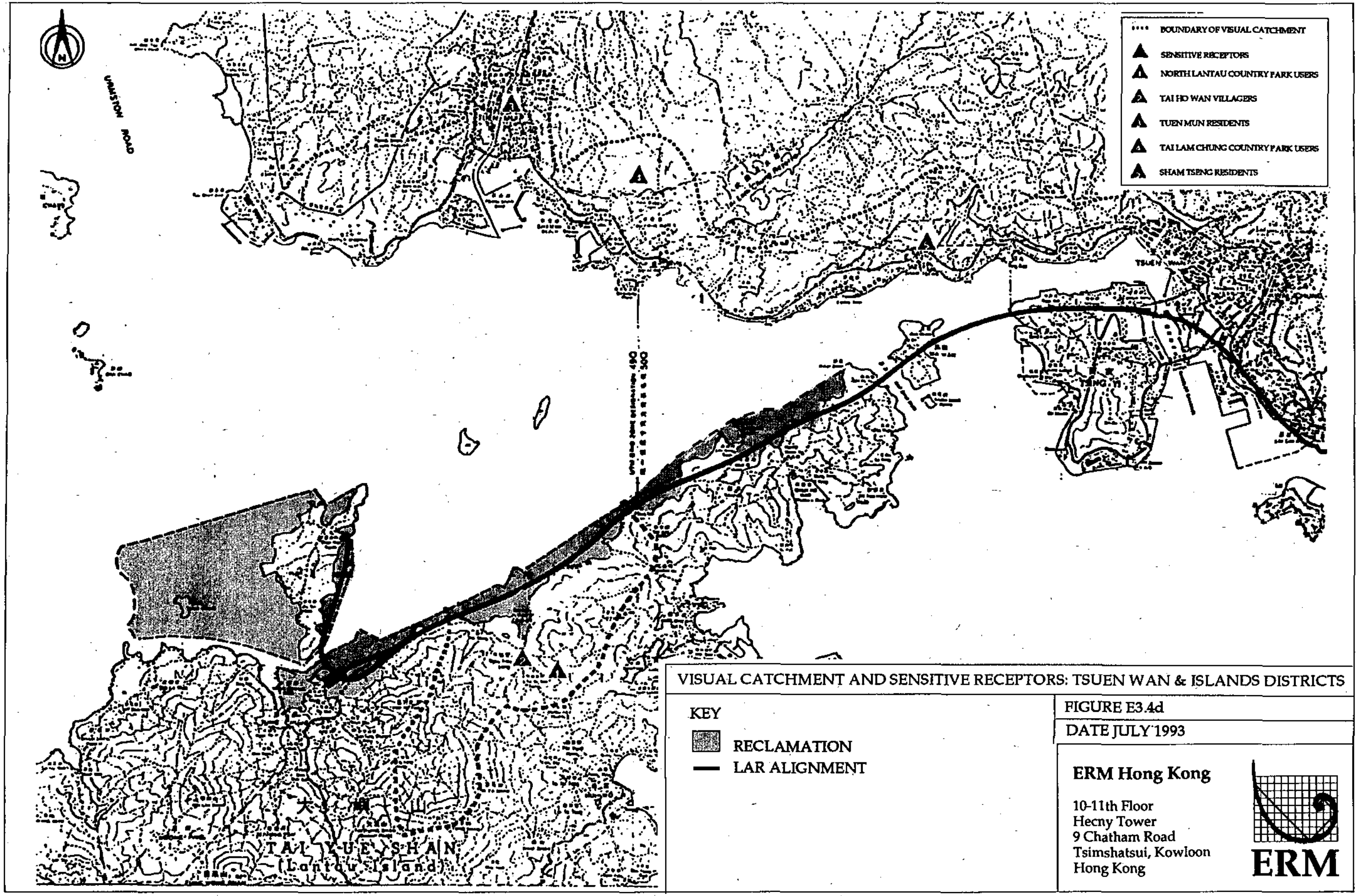

VISUAL CATCHMENT AND SENSITIVE RECEPTORS: TSUEN WAN & ISLANDS DISTRICTS

FIGURE E3.4d

DATE JULY 1993

KEY

RECLAMATION

LAR ALIGNMENT

ERM Hong Kong

10-11th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

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E4 POTENTIAL SOURCES OF IMPACT

E4.1 INTRODUCTION

In this section, the potential sources of land use and visual impacts which are likely to arise during the construction and operation of the LAR are identified.

E4.2 IMPACTS DURING CONSTRUCTION

E4.2.1 *Land Use Impacts*

Impacts affecting land use during the construction of the LAR may arise from the following:

- *Direct impacts on property:* Arising from the permanent occupation of land and the demolition of buildings.

- *Temporary land take:* The occupation of land during the construction period for activities associated with the construction works.

- *Disruption and severance:* The disruption of existing or proposed land uses as a result of environmental impacts (*eg* noise) arising from the construction of the LAR. Also the effects on development potential of sites which are partly occupied or fragmented by the alignment, or where access to sites is reduced.

- *Impacts on ecology:* The loss of or damage to ecological habitats due to temporary or permanent occupation of land, or through the release of contaminants to air or water. This can also result due to disturbance from noise impacts.

E4.2.2 *Visual Impacts*

Impacts on visual quality which may occur during the construction of the LAR will include:

- The temporary blocking of views by the presence of plant, equipment and structures associated with the construction of the LAR.

- The introduction of temporary visual elements into the landscape or townscape, such as site hoardings and construction plant and equipment (*eg* tower cranes), leading to a qualitative change in views. This may also include lighting where night–time working take place.

- On–site activities, such as the removal of spoil, where the movement of vehicles and equipment may have temporary effects on visual quality.

- Opening up views or exposing new visual elements through the demolition of buildings etc.

- Removal of existing visual elements in the landscape or townscape, *eg* through building demolition or excavation for cuttings.

E4.3 IMPACTS DURING OPERATION

E4.3.1 *Land Use Impacts*

Impacts on land use which may be caused when the LAR comes into to operation will include:

- Permanent land take for the LAR, precluding its use for other purposes.

- Conflicts with existing land use planning and zoning policies, where the LAR would represent a "bad neighbour" to existing and proposed land uses.

- Severance effects, where accessibility to and between different land uses may be affected, again possibly in conflict with existing land use planning and zoning policies.

- Increased development pressures in the vicinity of the LAL and AEL stations resulting from the improvements in accessibility at these locations.

E4.3.2 *Visual Impacts*

Visual impacts during the operation of the LAR will be likely to arise from:

- The loss of existing views due to obstruction by LAR structures.

- The opening of new views due to changes in topography or vegetation.

- The loss of existing key visual features, through changes in topography (*eg* through earthworks), the removal of vegetation or the demolition of buildings.

- The introduction of new visual elements into the landscape or townscape, with consequent visual intrusion or enhancement. These may related directly to the LAR (*eg* bridges or viaducts), or may be more indirect effects associated with reclamation or CDA buildings over LAR stations.

- Qualitative changes to views, as structures associated with the LAR will provide a new visual focus in some instances, depending on both the scale of the structures themselves, their setting and the relationships between these.

- Transient and mobile visual elements provided by the LAR trains.

E5 *PREDICTED IMPACTS*

E5.1 *IMPACTS DURING CONSTRUCTION*

E5.1.1 *Land Use Impacts*

Central and Yau Tsim Districts

As the new Hong Kong Central Station for the LAR is to be built on the proposed new Central and Wanchai Reclamation, there will be no land use impacts arising from the construction of the LAR in Central District.

Similarly, as the LAR alignment in Yau Tsim District is to be built on the new West Kowloon Reclamation, there will also be no land use impacts in this area during the construction of the LAR.

Mong Kok and Sham Shui Po Districts

As the LAR alignment through these Districts will be built on the areas newly reclaimed for Container Terminals 7 and 8, there will be no land use impacts arising from the construction of the LAR.

Kwai Tsing District

The works for constructing the new Lai King Station will require substantial excavation into the hillside to the south of the existing Lai King Station to accommodate both the platform tunnels and concrete structures in open excavation. As a result of this work, the Lai King Community Hall and the existing cantilevered walkways to the south of the station will have to be demolished. In addition, the pedestrian access to the station and the Kwai Chung Road footbridge will also be disrupted. It is understood that replacement stairways in structural steelwork and a temporary staircase to Yeung King House will be built during the advance works period in order to alleviate the problem.

Also at Lai King, much of the construction work will be concentrated on both ends of the tunnel portals, and therefore land use and indirect severance impacts will be most significant in these areas. Beside the permanent occupation of the amenity area at the southern portal, tunnel blasting, excavation activities, and the associated construction traffic may cause intense inconvenience and interference to the nearby residents. Sensitive receivers which may be affected by these activities will include:

- *North Works Area:*
  - Passengers using the existing Lai King station;
  - Residents of Yin Lai Court;
  - Lok Sin Tong – Lau Sai Yan School;
  - Residents of Yuet Lai Yuen;

- Residents of Yeung King House and On King House in Lai King Estate.

- *South Works Area:*

  - Residents of the Salvation Army Hostel;
  - WMC Morninghope School for the Mentally Handicapped;
  - Blocks E and F of Cho Yiu Chuen;

In addition, as the tunnel will be excavated by use of explosives and may involve up to fifteen explosions per day in the mornings and late evenings, significant noise and vibration impact may result along the tunnel alignment. Buildings potentially affected by the vibration may include:

- Yuet Lai Yuen;
- Kai Him Lau and Chung Ling Sheh of Cho Yiu Chuen;
- Methodist Asbury Primary School;
- Block E, F and the carpark at Cho Yiu Chuen;
- The Salvation Army Hostel.

This issue is discussed further in *Annex B*.

The construction of Contract 509 of the LAR will involve direct occupation of land within the existing Kwai Chung Park, although this is not considered as a particularly significant landuse impact as the area is not presently officially gazetted as a park, is not open to the public and will be restored after the construction works are complete. The construction of the viaduct on Kwai Tsing Road and Kwai Tai Road will however disrupt the existing traffic movement in the area. In addition, as a result of the construction of the viaduct and the Route 3 alignment, part of the container stacking area near the Container Port Road will also have to be given up.

At Tsing Yi Station construction Work Areas, there will be disruption to the traffic along Tsing Tsuen Road, Tsing King Road and the Tam Kon Shan Interchange. Accessibility will be reduced, thereby causing a severance effect between the areas north and south of Tsing Tsuen Road. Residential areas in the vicinity of the Work Sites may be affected by noise and dust generated by construction activities. Cumulative impacts may arise due to concurrent activities associated with the swimming pool complex, the town park and other residential developments in the vicinity. The Works Areas around Tsing Yi Station are expected to be occupied up until 1997. During the later stages of construction, the swimming pool complex and the adjacent town park may be affected by construction traffic, noise and dust generation, and other general nuisance entailing from local traffic diversions.

For the area around Tam Kon Shan Interchange where construction works for the LAR viaduct will be concentrated, the limited space available in the immediate area may result in the loss of amenity land and vegetation. Disruption due to the temporary cargo handling area is not considered likely to be severe as similar facilities will be provided on the island in the future.

In the west of Tsing Yi, the LAR tunnels will pass through the ridgeline underground, and significant direct land use impacts are therefore unlikely. However, the alignment in tunnel may pass close beneath the Water Services Department reservoir in this area, with consequent potential impacts on the water-retaining structure. This is discussed further in *Annex D*. Permanent land take will be necessary at the portal areas and will result in loss of some amenity area in the Green Belt. In addition, temporary land take by construction Works Areas including site offices, material storage, reinforcement preparation, concrete batching etc will occur, and will lead to temporary loss of amenity area.

Disruption and severance impacts are likely to occur as there are a number of construction projects being carried out at the same time, especially at the western end of the Tsing Yi tunnels. However, as there are no sensitive land uses at this location, the significance of the impacts will be limited. In addition, the Tsing Yan THA may potentially be affected by vibration caused by tunnelling works, and this is discussed further in *Annex B*. The graves and the pavilion are also potentially affected by the construction activities.

Tsuen Wan and Islands Districts

On north-east Lantau, the areas that may be affected by the construction of the tunnels are the amenity area and the village at Tsing Chau Tsai. The pier at Tsing Chau Wan is expected to be closed down when the reclamation for the North Lantau Development is constructed. Temporary land take by construction Works Areas including site offices, material storage, reinforcement preparation, concrete batching etc will occur. In addition, disruption and severance impacts are likely to occur as there are a number of construction projects being carried out at the same time in the same area. The villagers at Tsing Chau Tsai will be affected by the construction activities due to their close proximity and should be relocated before Works start. Impacts on other areas are not expected to be significant as surrounding land mainly comprises construction works areas of concurrent projects.

The impact on existing land uses on most of North Lantau will be minimal because of the relative isolation of the northern coast of Lantau and the fact that the NLE will be constructed primarily on reclamation. Access to the sea will be cut off by the construction works. At Ta Shui Wan, major viaduct and reclamation construction will remove access from Penny's Bay to the northern coast and the sea. The pier facility for Pak Mong Village, adjacent to Tai Ho Wan, will be removed. In general works areas will revert to alternative uses or be incorporated into the reclamation and development areas for North Lantau development after the construction of the LAR is complete. The works area adjacent to Ta Pang Po will revert to a utility landing area. Informal landing areas within the bays at Siu Ho Wan and Tai Ho Wan for small craft will not be possible during construction.

E5.1.2 *Visual Impacts*

Central and Yau Tsim Districts

In general, the presence of construction plant and materials, dredgers and barges, spoil heaps, access roads, site traffic, general working areas and night–time lighting (including security lighting) may cause a visual disturbance. However, the construction works for the Hong Kong and Kowloon Station sites will be viewed against the backdrop of the surrounding reclamation and development works concurrently taking place, and the visual intrusion to the tourists in ferries due to the construction of the stations will be considerably reduced. Nevertheless, mitigation measures will be necessary to further reduce the potential impact. From more distant view points, the scale of the surrounding urban framework will reduce the perceived level of impact. Consequently, the intrusion on the panoramic view of Hong Kong from Kowloon will not be significant.

Mong Kok and Sham Shui Po Districts

In these Districts, the construction works for the LAR will be undertaken against the backdrop of other construction works being undertaken on the reclaimed areas. Consequently, no additional visual impacts are likely to arise from these sources.

Kwai Tsing District

Here again, construction activities described above will result in visual disruption. In particular in these Districts, impact from off–site haulage activities may extend well beyond the immediate area.

The construction works at Lai King station will have significant visual impact on sensitive receptors in Lai King Estate and Yin Lai Court, both of which are close to the works site. The sensitive receptors in Kwai Fong will have a middle ground view of the construction works and the impacts will be low to moderate. However, the highly industrial nature and poor visual quality of the surrounding area will reduce the visual significance of the construction activities. Cho Yiu Chuen is the only sensitive receptor of the Lai King tunnels south portal works which will intrude on the views of the residents. However, the presence of the Kwai Chung Road Corridor and the container facilities background will lessen the effects of the intrusion.

The alignment for the viaducts between Lai King and Kwai Chung Park will be through industrial areas and transport corridors, and therefore the construction works are not anticipated to have significant visual impact. There will be the concurrent construction of Route 3 in the vicinity of the viaduct section, and this may increase visual intrusion, although not to a significant degree.

The excavation of the cut through Kwai Chung Park potentially could have considerable impact the area, although the park is not officially gazetted and is not open to the public. Also, due to the screening effect of the container terminal buildings, housing estates in Lai King can only see small parts of the park through the road space between the buildings. There will only be an impact on Block 1 of Lai King Estate which will have a relatively unobstructed view of the works. However, the highly industrial nature and poor visual quality of this area will reduce the visual significance of construction activities. The main cut and piling works will be largely screened from Block 8 of Kwai Shing Estate by the elevated northern part of the park. However, any operations above the ridgeline of the park may be visible, and may cause impacts. The visually disturbed background with cranes, mechanical lifting device, electricity pylons and chimneys, will to some extent reduce the significance of these. The residents in Tsing Yi, Riviera Garden and Lai Yiu will have middle to background views of the works in Kwai Chung Park against the surrounding industrial establishments, although the impact is not expected to be significant.

On Tsing Yi, construction activities at the Station site will have considerable impact on all the sensitive receptors identified previously, in particular those in close proximity to the site. As the large work areas at the site will be situated at the existing open storage area with an untidy appearance, the impact would be reduced to some extent. Most part of the LAR viaducts on Tsing Yi will be constructed along an existing transport corridor and enclosed by the vegetated ridgeline and housing. Visual impacts therefore will not be significant and will be limited to the residents of Cheung On Estate only. There will be recreational developments being constructed concurrently with the LAR in the vicinity of the Station site. The construction works of these developments will be visible by the same sensitive receptors and would have a cumulative effect.

Tsuen Wan and Lantau Districts

The tunnelling work at the portals will result in visual disruption and affect the landscape quality of the area. Construction activities at the eastern portal will have high visual impacts on Ma Wan residents as the existing landscape is relatively natural. Mitigation measures such as improved site layout and organisation, height restriction on plants and screening will be necessary to reduce the potential impacts and appropriate mitigation measures will be required to minimise the impacts.

For sensitive receptors from the west New Territories, the construction activities at the western portal area, which is elevated, will disrupt the overall views of the 'natural' landscape of Lantau Island. In addition, the concurrent construction works of the NLD, NLE and LFC will have cumulative impacts on the sensitive receptors.

E5.2 *IMPACTS DURING OPERATION*

E5.2.1 *Land Use Impacts*

Central and Yau Tsim Districts

Most of the Hong Kong Station will be located within the newly formed Central and Wan Chai Reclamation area, and consequently many of the above potential impacts will have been avoided and resolved during the planning stage of the development. The area surrounding the future station will mainly be commercial with large areas reserved for essential transportation facilities and district open space. At this stage, it is understood that the Station itself is zoned as a comprehensive development area. The above-ground development will comprise of office, retail and hotel elements, which has the potential of incorporating into the nearby Site C1 for comprehensive commercial development. Therefore, the development is not considered as incompatible with the surrounding landuses. In fact, the Station offers the opportunity for further developments and could form an extension of the existing CBD to the new waterfront with additional office and retail accommodation. A number of footbridges and elevated walkways have actually been planned to integrate the various land uses together.

Similarly, the new Kowloon Station will also be mostly underground within the West Kowloon Reclamation, and will also have a CDA built above by others. Here again, no significant land use impact is envisaged.

Mong Kok and Sham Shui Po Districts

As the LAR/Route 3 alignment through these Districts will run exclusively on reclaimed land, the pattern of land uses in the immediate proximity of the LAR has been planned to accommodate this, *eg* by the designation of buffer zones to help protect nearby residential areas to the west of the LAR alignment against potentially adverse noise and air quality impacts arising from both the LAR and Route 3. Consequently, no significant land use impacts are anticipated to be caused in this area.

Kwai Tsing District

In the Lai King area, parts of the amenity land areas at the southern tunnel portal, and the area adjacent to the existing Lai King station will be permanently occupied by LAR structures. The Lai King Community Hall will also be demolished.

To the west of Kwai Chung Road, besides the permanent occupation of land at viaduct foundations, the LAR viaduct together with the Route 3 alignment will reduce the area for container stacking which is currently under short term tenancy agreement. At the same time, the height of container stacking may have to be reduced at certain areas where sufficient headroom is not available.

The cutting through Kwai Chung Park will have no significant impacts once the railway is operational, as the cut will be landscaped and integrated into the overall design of the restored park before this becomes open to the public, and should not therefore affect the park's amenity value. However, there will be a short length of elevated structure passing through the western edge of the park, which will marginally restrict access within the park.

West of the park, there will be permanent land–take for the pier foundations for the Rambler Channel Bridge which may have some effects on the operation of the cargo working area and the planned waterfront promenade on Tsing Yi.

On Tsing Yi, the permanent land take by the viaduct in the green belt area will place restrictions on any future land use under the structure and may cause a loss of amenity area, although significant impact from the permanent land take by the Station is not expected. The viaduct may also represent a 'bad neighbour' to surrounding land uses due to the visual intrusion, and operational noise and air impacts. Areas that potentially will be affected include the swimming pool complex, town park, St. Paul's Village, Cheung On Estate and the waterfront promenade. Similar effects due to the Station should be limited as it is within an enclosed structure.

Significant severance effects in Tsing Yi are not expected as pedestrian access in the area is provided via the CDA above the Station, while existing roads are adequate to ensure vehicular accessibility. No land use impacts are anticipated in relation to the tunnelled section of the LAR on Tsing Yi.

Tsuen Wan and Islands Districts

The Lantau Fixed Crossing and tunnelled section of the LAR on North Lantau will not lead to any significant land use impacts.

The LAR and North Lantau Expressway alignments, generally at grade, will effectively sever the north of Lantau from the sea. Vehicle access will be possible at the intersection at Ta Shui Wan and Tai Ho Wan to the respective future development at Penny's Bay and the Tai Ho Valley. Any future development at Siu Ho Wan, Yam O Wan or other adjacent site areas would be accessible only by means of local feeder roads. The only land area severed from Lantau by the NLE will be the large headland area at Luk Keng. Resident population groups could be isolated except by sea access. In addition, an archaeological area has been identified on the Luk Keng peninsula. Again, the only means of access to this area in future will be by sea. The presence of the NLE along the coastline at Tai Ho Wan will have fung shui implications for the burial grounds at Pak Mong and the two temples at Tai Ho.

E5.2.2 *Visual Impacts*

Central and Yau Tsim Districts

In Central and Yau Tsim Districts, the LAR alignment will be completely underground. With the exception of the Hong Kong and Kowloon stations, which will be incorporated into major CDA developments, the only structures associated with the LAR which will be visible will be the tunnel ventilation buildings on the new waterfronts in Central and Kowloon. As such, no significant impacts on visual quality will arise due to the presence or operation of the LAR.

Mong Kok and Sham Shui Po Districts

Through Mong Kok and Sham Shui Po Districts, the LAR alignment will share the Route 3 viaduct structures. These will be at grade between Tai Kok Tsui Station and Mei Foo Roundabout, and elevated between here and the southern tunnel portals at Lai King. The LAR will be accommodated beneath Route 3 within the structures. As such, there will be no additional impacts on visual quality which will be attributable specifically to the LAR in this section of the alignment.

Kwai Tsing District

The southern tunnel portal at Lai King will have a moderate visual impact on Cho Yiu Estate and there will be permanent loss of amenity land at this point. In addition, there is the possibility of damage to existing vegetation on the upper slopes. The redevelopment and extension of Lai King Station to accommodate the LAR will result in a more massive and visually intrusive structure. This will be partially mitigated by building the station into the existing rock face. However, it will remain highly visible from the housing estates at Lai King.

Kwai Chung is a highly industrial area, dominated by manufacturing and related activities. Although relatively enclosed, the area is overlooked by sensitive receptors in Lai King Estate and Kwai Chung Park. The railway through this area will be elevated and visible. However, the impact of the elevated structure will be less intrusive than it would be elsewhere, due to the industrial character of the area, and the proximity of the similar Route 3 structure. The alignment passing through the Park in cut will provide substantial screening. In addition, MTRC will be using the services of a landscape designer from RSD in preparing a layout for the restored park. Nevertheless, there will be moderate visual impacts on the Lai King Estate and Kwai Chung Park.

The Rambler Channel Bridge may lead to some visual intrusion due to presence of a newly-introduced conspicuous element and the blocking of views. However, the extent of this is unlikely to be significant because the existing bridges between Kwai Chung and Tsing Yi already limit the potential for long-distance views in the area.

The existing site which will be developed to accommodate the Tsing Yi Station is used for open storage and has an untidy appearance. The design of the station and its associated commercial/residential development, aiming to create a positive architectural feature and a landmark, will have a positive effect on the visual quality of the area. The potential visual impact on the users of the open spaces in Tsing Yi will mean that sensitive design and landscape treatment of the station and its access and other associated structures will be required to ensure an attractive appearance. Since the alignment of the LAR viaduct on Tsing Yi will be along an existing transport corridor with established visual character, significant visual impacts are not anticipated. Impacts also are not anticipated in relation to the tunnelled section of the LAR on Tsing Yi.

Tsuen Wan and Islands Districts

Because of their scale, the major bridge structures associated with the Lantau Fixed Crossing cannot be effectively screened, and they will change the character of the landscape completely. However, the impact will generally be a positive one, as the design of the Tsing Ma Bridge will act as a cultural or civic feature for Hong Kong and a symbol for the city.

On North Lantau, the tunnelled section will have no visual impacts. Also, the visual impacts associated with the North Lantau Developments and the new airport at Chek Lap Kok will completely outweigh any additional impacts associated specifically with the LAR.

E6 MEASURES FOR MITIGATION

E6.1 INTRODUCTION

In this section, ERM's recommended measures to avoid potentially significant land use and visual impacts, or to reduce these to acceptable levels, during the construction and operation of the LAR are set out. In relation to these, reference is made in this section to the MTRC's General Specification for the LAR (which will form part of the tender documentation for all LAR construction contracts) and the Particular Specifications which will relate to each of the individual contracts. In addition, suggestions for the guidance of contractors in following good environmental management practices on site, which will assist them in complying with the requirements of the General and Particular Specifications, are also given.

E6.2 CONSTRUCTION PHASE

E6.2.1 *Land Use Impacts*

As is noted in *Section E5.1.1*, some land use impacts relating to severance effects and the nature of constructions sites as a "bad neighbour" to certain types of land use have been identified as likely to occur during the construction of the LAR. However, none of these are likely to be significant. The following clauses which have already been included in the General Specification for the LAR construction contracts are considered likely to be sufficient to contain any possible land use impacts of these types:

The Contractor shall provide and maintain Approved fencing and lighting around the Works Areas when or where necessary for the safety and convenience of the public or others or as directed. (General Specification Clause 5.2.1(b))

The Contractor shall refrain from depositing rubbish or causing nuisance or permitting nuisance to be caused and, except where Approved by the Engineer, depositing earth on or removing earth from the Works Areas. (General Specification Clause 5.2.1(c))

On completion of the Works, or earlier if so instructed by the Engineer, the Contractor shall remove all Temporary Works except where permitted and reinstate the Works Areas to the extent, standards and details indicated in the Contract or as directed by the Engineer. (General Specification Clause 5.2.1(d))

The Contractor shall refrain from obstructing manholes, utility access points and the like. (General Specification Clause 5.2.1(e))

Work other than that necessary for completion of the Contract shall not be carried out on the Works Area. (General Specification Clause 5.2.2)

While the Contractor is in possession of a footpath he shall provide means of distributing loads imposed by Constructional Plant and traffic and prevent damage to Utility Services. (General Specification Clause 5.2.3)

The Contractor shall erect, maintain, alter where necessary and remove on completion where ordered, all temporary fencing and gates. The types required are specified in the Contract. Where existing fences are considered adequate, the Contractor shall, if instructed by the Engineer, take possession of and maintain such fences. (General Specification Clause 5.6.1)

The Contractor shall demolish, break up and remove temporary buildings, structures and obstructions on the Site including foundations in the way of or otherwise affected by the Works as described in the Particular Specification or as directed by the Engineer. Adequate precautions shall be taken, including any necessary temporary supports, to prevent any damage to property not scheduled for demolition. (General Specification Clause 5.8.1)

Specifically in relation to traffic generated from the construction sites for the LAR, the CCP should include the following general advice applicable to all LAR construction contracts:

- The Contractor should ensure that where pedestrian routes exist in the vicinity of Works sites, that these are maintained or reasonable alternatives or are provided throughout the construction period.
- Existing pavement widths around the Work Areas should be maintained except where these exceed 2 metres.
- Clear signing should be provided at all times for each pedestrian route, with the number of changes to all temporary layouts kept to the minimum possible consistent with necessary working arrangements.
- All openings or obstructions on the carriageway and footway should be barricaded with a continuous rail (lit at night).
- Subject to agreement with the Commissioner for Transport, headroom clearance over footways should be a minimum of 2.3m. A horizontal clearance of 0.6m should be provided from the kerb-line, where practicable, for any hoarding projection under 5.1m high, to avoid fouling by vehicles.
- All pedestrian routes diverted onto the carriageway should be clearly defined by continuous barriers, constructed to the reasonable requirements of the Commissioner for Transport.
- Subject to agreement with the Commissioner for Police, lorries entering or leaving the Work Areas should only be allowed to cross footways under the control of a competent backsman.

- **After completion of the works all materials arising from the works should be cleared from the road leaving the same in a clean and tidy condition to reasonable requirements of the Commissioner for Transport.**

- **Where Works traffic has to use public access roads the Contractor should take necessary precautions to prevent damage to roads and kerbs and footpaths.**

- **Should any damage be caused by the Contractor's activities to roads, kerbs or footpaths in the vicinity of the Work Area, he should carry out the temporary or permanent reinstatement necessary to return these to their original state.**

- **As required by the Commissioner of Police, there should be no day-time or overnight parking of lorries on-street in the vicinity of any Work Area. Drivers waiting to enter or leave the site should switch off their engines.**

In addition, it is suggested that the Code of Construction Practice (CCP) for *Contract 508* (Lai King Station and Tunnels) should include the following:

- **The Contractor should avoid the disruption of pedestrian access in the vicinity of the existing Lai King Station as far as possible. However, if this is found unavoidable, the contractor should divert the existing access and provide any necessary temporary footbridge and replacement stairways in structural steelworks. As far as possible this should be constructed during the advance works period in order to alleviate the problem.**

- **The Contractor should minimise the disturbance of the existing hillside and vegetation in the vicinity of the South Portal Works Areas as far as possible. Any inevitable vegetation loss should be restored, for example, by planting to assimilate the portal structure into the surrounding area.**

No specific recommendations in relation to the mitigation of land use impacts are made in relation to any of the other LAR construction contracts.

E6.2.2 *Visual Impacts*

As is noted in *Section E5.1.2*, some impacts have been identified as likely to occur during the construction of the LAR. However, none of these are likely to be significant. In addition, some of the measures recommended above in relation to land use impacts during the construction of the LAR would also have the effect of helping to minimise any impacts on visual quality. The following advice is also suggested for inclusion in the CCP:

- **Reusable screen hoardings, not of rainforest origin, should be erected around each Work Area to provide a clear site boundary and to protect existing landscape features.**

- **Site office/buildings should be arranged to provide low level screening of unsightly features, where this is consistent with necessary working arrangements.**
- **Height of plant, building and stockpiles should be controlled by the following measures where practical;**
  - **The height of temporary buildings should be restricted to a minimum.**
  - **Construction activities should be restricted to low levels as far as practicable consistent with necessary working arrangements.**
  - **Maximum heights of spoil heaps or material stockpiles should be restricted to reduce visual impact.**
  - **The time for which tall equipment is erected should be minimised.**
- **Visually recessive colours should be used for temporary buildings to help blend in with the background.**
- **Any artificial screens (eg for noise control) should be painted in appropriate colour schemes.**
- **Location of tall machinery shall be restricted to as few points as possible consistent with necessary working arrangements.**
- **Working Areas shall be organised into definable activities, as far as is consistent with necessary working arrangements, to help provide a more coherent visual character.**
- **The luminosity of any lighting at the site should be restricted to a minimum level necessary for security and safety. Low-level lighting should be used, and be located and directed so that it does not cause undue intrusion into adjacent sensitive receptors.**
- **Work Areas should be landscaped to improve the appearance of these sites. For example, steep cut slopes can be hydroseeded with grass or grass with shrub and tree seeds included while less steep slopes can be notch-planted directly.**

E6.3 OPERATIONAL PHASE

As is noted in *Section E5.2*, no significant land use or visual impacts are predicted to occur during the operation of the LAR. Therefore, ERM have made no recommendations for mitigation measures relating to these categories of impact.

Annex F

Waste Management

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F1 INTRODUCTION

F1.1 SCOPE AND PURPOSE OF THE ANNEX

This annex addresses the waste management issues which will arise during the construction and operation of the LAR, including the environmental impacts associated with these.

F1.2 ORGANISATION OF THE ANNEX

The remainder of this annex is arranged as follows:

- *Section F2* identifies the potential sources of waste arisings during the construction and operation of the LAR and the environmental impacts associated with these.
- *Section F3* reviews the options for the collection, storage, transport and disposal of waste arising from the LAR.
- *Section F4* estimates the quantities of waste arisings from the LAR in both the construction and operational phases.
- *Section F5* recommends measures for the proper handling and disposal of waste arisings from the LAR, and for the mitigation of environmental impacts associated with this.

F2 POTENTIAL SOURCES OF IMPACTS

F2.1 GENERAL

Activities during the construction of the LAR will result in the generation of a variety of wastes and can be divided into distinct categories based on their nature and ultimate disposal sites. These include:

- Excavated and inert material suitable for reclamation and fill;
- Excavated contaminated material from a former landfill;
- Dredged marine spoil, possibly contaminated;
- General construction waste;
- Chemical waste;
- General refuse.

Waste is likely to be generated during the operation of the LAR from the following sources:

- LAR Stations and trains (*eg* from litter collection, staff sanitary and catering facilities, commercial and office activities etc.).

- Maintenance activities (*eg* oils and grease, discarded components).

The main sources of impacts associated with operational, domestic and commercial wastes arising during the operation of the LAR are the possible effect of the quantities generated on disposal capacity and the proposed arrangements for handling and disposal of these wastes.

The definitions for each of these categories and the nature of their arisings and potential impacts are discussed in detail in the following sections.

F2.2 EXCAVATED MATERIAL

F2.2.1 Reclaimed Areas

Excavated material from the works located on reclaimed areas in Central, West Kowloon and North Lantau will arise from the tunnels, cuttings and station areas. This excavation material will comprise primarily marine sands which has been used as reclamation fill in these areas, although there is a small possibility of some contaminated marine muds being excavated, depending on the exact depth and location of the excavation works carried out. Given the likely inert nature of most this material, reuse on-site or at reclamations is not likely to have any significant environmental impact. The only likely impacts associated with the excavated material are related to air quality and dust generation during excavation, stock piling and transportation. These are discussed further in *Annex* C. Where contaminated marine deposits are excavated (depending on the extent of contamination as defined by Technical Circular 92) the spoil may need to be disposed of in conjunction with marine spoil following consultation with the Fill Management Committee (FMC) and the Environmental Protection department (EPD). The quantity of marine spoil and contaminated land spoil can only be determined once a detailed excavation plan and spoil analysis has been carried out by the contractor on award of tender. Issues relating to marine deposits are discussed further in *Section* F2.2.2 below.

F2.2.2 *Material from Dredging*

The construction of the Western Immersed Tube Tunnel and the Rambler Channel Bridge will involve the utilisation of marine vessels including dredgers and barges, in addition to land based sites. These activities will result in the generation of a variety of wastes from dredging, construction, maintenance, workers and other general activities.

Dredging activities will result in the excavation of large volumes of marine spoil requiring disposal. The potential environmental effects of spoil disposal will vary according to the level of contamination of the muds. Previous studies for the Western Harbour Crossing and the Central and Wanchai Reclamation have indicated that a significant proportion (*ie* up to 50%) of this material amy be contaminated. In general, water quality impacts from marine disposal may include:

- Suspension of solids in the water column during dredging and mud dumping with the likely consequence of reducing the dissolved oxygen level;
- Disturbance and suspension of previously dissolved organic and inorganic materials such as ammonia sulphides and heavy metals;
- Release of suspended solids due to leakages and overflowing of the barges during transportation.

All of the above can result in a deterioration in water quality and may result in an adverse effect on marine biota.

F2.2.3 *Tunnelling Works in Rock*

Excavated material from the tunnelling works at Lai King, Tsing Yi and East Lantau will comprise largely of rock material. Given the inert nature of this material, reuse on-site or at reclamations is not likely to have any significant environmental impact. The only likely impacts associated with the excavated material are related to air quality and dust generation during excavation, stockpiling and transportation, which are discussed in *Annex C*.

F2.2.4 *Excavation at Kwai Chung Park*

At Kwai Chung Park (Contract 509), the LAR alignment will pass in cut through the former Gin Drinkers Bay Landfill. Excavated material from the former landfill will comprise:

- Exhumed waste.

- Contaminated inert material consisting primarily of completely decomposed granite (CDG).

- Uncontaminated cover material consisting primarily of CDG.

Typical domestic waste composition in Hong Kong consists of paper (20%), putrescibles (33%), plastics (17%), textiles (10%) and miscellaneous wastes(13%). Other constituents include leather, rubber, wood, metal and glass which make up the remaining 10%. Commercial waste sources are from junk, waste from commercial premises, markets, and paper. Waste from industrial premises is made up of plastic, wood, rags, glass, rubber, tannery and other miscellaneous wastes. Waste from construction works includes inert materials, wood and bamboo. Other non-municipal solid waste consists of marine dredgings, spoil, semi-solid waste including sewage sludge, livestock waste, water works waste/sludge; special waste including animal carcasses, clinical products and condemned goods; chemical waste including pulverised fuel ash (PFA), fuel bottom ash (FBA) and secondary waste which is made up of incinerator ashes and associated waste.

The exact nature of waste deposited in the former Gin Drinkers Bay is largely unknown. A paper released in 1981 [(1)] estimated that the majority of waste in GDB was domestic waste (100%). However, a more recent paper [(2)] estimated that a high percentage of the waste is likely to be inert material.

Disposal of uncontaminated cover material is not likely to have adverse environmental impacts. However, if exhumed waste and contaminated material is not disposed of in a suitable designed, managed and operated site, a number of adverse environmental impacts may result.

These may include:

- Odour impacts.

- Presence of pests, vermin and scavengers.

- Deterioration of water quality in the area surrounding the disposal site due to the presence and production of leachate.

- Emission and potential migration of asphyxiating, flammable and explosive gases.

- Visual impact.

(1) Draft Report to Yuncken Freeman-*EBC Joint Venture on Geotechnical Assessment of Proposed Controlled Tip Development at GDB* - Golder Associates - January 1991.

(2) *Technical Report No. 49 - Landfill Gas and Chemical Investigation of Gin Drinkers Bay Landfill* - SPHW for Highways Department, May 1991.

F2.3 *Construction Waste*

Waste will arise from a number of different activities carried out by the contractors during construction and maintenance activities and may include:

- Wood from formwork;
- Equipment and vehicle maintenance parts;
- Materials and equipment wrappings;
- Unusable cement/grouting mixes.

The volume of construction waste generated will be dependant on the contractor's operating procedures and site practices, and hence cannot be quantified at this stage. Due to the inert nature of most construction waste, disposal is not likely to raise long term environmental concerns. Construction waste must not be disposed of at a landfill site if it contains more that 20% inert material by volume, and therefore the Government encourages segregation of wastes at construction sites. Inert materials may be disposed of at a public dump, while putrescible materials (*eg* wood) must be disposed of at a landfill. However, the storage and stockpiling of construction waste prior to utilisation on site or disposal can lead to the generation of dust and may be visually intrusive. In addition, disposal of these materials at landfill will consume valuable void space which is required for domestic and industrial wastes.

The main impacts resulting from the disposal of construction wastes are expected to come from their transport to the various disposal sites. These potential impacts may result in additional noise impacts, possible congestion due to increased traffic loadings and dust and exhaust emissions from the haul vehicles. Disposal by barge, where this is feasible, may reduce these impacts, although barge transport may have potential impacts upon water quality from spills and wind blown dust during both handling and transport.

F2.4 *Chemical Waste*

Chemical Waste as defined under the *Waste Disposal (Chemical Waste)(General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the Regulations. A complete list of such substances is provided under the Regulations. Substances likely to be generated by both marine and land based activities during the construction of the LAR will for the most part arise from the maintenance of plant and equipment. These may include, but need not be limited to the following:

- Spent filter cartridges containing heavy metals;
- Scrap batteries or spent acid/alkali from their maintenance;
- Brake clutch linings containing asbestos materials;

- Oil retrofitting;
- Mechanical machining producing spent mineral oils/cleaning fluids;
- Equipment cleaning activities producing spent solvents/solutions which may be halogenated.

Chemical wastes pose serious environmental and health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Chemical Waste Regulations*. These hazards include:

- Toxic effects to workers;
- Adverse effect on water quality from spills;
- Odour;
- Fire hazards;
- Disruption of sewage treatment works where waste enters the sewage system.

F2.5 *General Refuse arising during the Construction Period*

General refuse includes any waste that does not fit into any of the categories previously described. The presence of a construction site will result in the generation of a variety of general refuse requiring disposal. General refuse may include newspapers, food wastes and packaging, waste paper, etc and will generally be disposed to landfill.

The storage of general refuse has the potential to give rise to adverse environmental impacts including:

- Odour if the waste is not collected frequently (*eg* daily);
- Presence of pests and vermin if the waste storage area is not well maintained and cleaned regularly;
- Windblown litter;
- Visual impact.

Disposal at sites other than approved landfills can result in the following:

- Odour impacts at the disposal point since appropriate odour control measures would not be provided, such as daily cover;
- Presence of pests, vermin and scavengers at the disposal sites;

- Deterioration of water quality in the area surrounding the disposal site due to the production of leachate, and the absence of adequate leachate collection and treatment facilities;

- Visual impact.

F2.6 *WASTE ARISINGS DURING OPERATION*

F2.6.1 *Waste from Station Operations*

During operation of the LAR stations, the bulk of waste arisings will be commercial waste, consisting primarily of general refuse from commercial operations such as restaurants and shops and the public, together with a relatively small amount of construction waste from maintenance and refurbishment activities. At the terminal stations (*ie* Hong Kong, Tsing Yi, Tung Chung and Chek Lap Kok), there additionally will be waste arisings from the cleaning and removal of refuse from trains. Waste not collected frequently from designated disposal areas via appropriate means, such as dustbins and refuse collection points, and therefore allowed to accumulate may have the following impacts:

- Odour if waste is not collected regularly;
- Presence of rats and vermin;
- Visual impact.

All of the above have environmental and hygiene implications. The potential impacts from the disposal of this waste during operation of the Station would be the same as the impacts from disposal of general waste during the construction phase (see *Section F2.5*).

F2.6.2 *Maintenance Activities*

During operation of the LAR depot at Siu Ho Wan, waste arisings will typically consist of:

- Industrial waste;
- Chemical waste; and
- General refuse.

Industrial waste storage is unlikely to have adverse environmental impacts, however, it may pose a visual impact and would eventually need to be removed from site if not reused. Chemical waste, as noted in *Section F2.4*, can pose environmental and health and safety risks if not stored and disposed of correctly. General waste issues are discussed in *Section F2.5*.

F3 *STORAGE, COLLECTION, TRANSPORT AND DISPOSAL OPTIONS*

F3.1 *EXCAVATED MATERIAL*

It is likely that disposal of this material would be to nearby construction works where it could be re-used. Given the quantity of material to be exported and its suitability for use in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. The sandfill from reclaimed areas may require de-watering prior to disposal.

For transportation to these sites, covered trucks could be used. Should disposal at nearby sites not be possible and transportation is designated to sites requiring marine access, such Chek Lap Kok or to other sites, the material may be transported by barge.

F3.2 *MARINE DEPOSITS*

In order to minimise any potential adverse effects from marine disposal, the Hong Kong Government has allocated gazetted marine disposal areas which are allocated by the FMC and EPD depending on the level of contamination of the spoil to be disposed of and its quantity. In addition, contractors must satisfy the appropriate authorities that the contamination levels of the muds have been analysed and recorded. Knowledge of the levels of contaminants present will be required by EPD prior to the commencement of dredging and disposal to ensure that the correct dredging, handling and disposal procedures are followed. Specific dredging procedures which are required to minimise any potential adverse effects on water quality have been discussed in *Annex D* of this report concerning Water Quality Impacts.

In relation to the construction of the LAR, potential disposal sites for uncontaminated muds include South Cheung Chau, the Ninepins, Urmston Road and Outer Deep Bay. Contaminated mud is likely to be disposed of at East and/or South Sha Chau with the identification of a second disposal pit under consideration to provide additional void space for dumping contaminated spoil.

F3.3 *EXCAVATED LANDFILL MATERIAL*

ERM, following discussions with EPD, has identified the new strategic landfill located at the West New Territories (WENT) as the most suitable off-site disposal point for material excavated from the former Gin Drinkers Bay Landfill during construction of the LAR. WENT was initially due to open for receipt of waste in mid 1993, although the contract for operation of the site was not awarded until May 1993, and the site is unlikely to be open before late 1993. Two transport options have been considered, road and marine. The proximity to the Rambler Channel could permit the use of barges or lighters for onward passage to WENT, where a number of berthing points may be made available. Availability of berthing at the WENT landfill is presently being reviewed by EPD with regard to the contractors programme. Transport of the waste and contaminated material to the barge loading point would most likely be by covered truck or containers which could shuttle waste from the excavation areas to the barge. Should transport by barge not be recommended, transport by road could be carried out using various containers and vehicle types, having specific requirements for control of odour and liquid discharges.

F3.4 CONSTRUCTION WASTE

F3.4.1 General Construction Waste

In accordance, with the New Disposal Arrangements for Construction Waste issued in 1992 by the EPD and the Civil Engineering Department (CED), disposal of construction waste can either be at a specified landfill, or at a public dumping ground. Depending on the nature of the construction wastes generated, surplus construction waste not suitable for re-use on-site will be collected by a waste collector under arrangement with the Contractor and deposited at a suitable public dump or designated landfill. The Contractor should ensure that the necessary waste disposal permits are obtained prior to the collection of the waste.

At the present time the only available landfill site designated for construction waste is at Pillar Point Valley. West New Territories (WENT), South-East New Territories (SENT) and North-East New Territories (NENT) landfills will only receive construction waste with less than 20% inert material by volume in accordance with the specifications. Special arrangements would be required for the disposal of construction wastes containing more than 20% inerts at these sites. Many Port and Airport Developments (PADS) related contracts, reclamations or other public dumps have a requirement to import fill material from elsewhere. In addition, due to the limited void space at landfills for disposal of domestic and industrial waste in Hong Kong, disposal at these reclamation sites or an approved public dump would be the preferred method of disposal.

As far as possible it would advantageous for the Contractor to recycle as much of the construction waste on-site, in order to reduce the requirement to import additional materials. In addition, recycling would reduce the collection, transportation and disposal of the construction waste and any associated charges by the transport contractor. At the present time, Government has not implemented a charging policy for the disposal of construction wastes, although it is understood that this is currently under development and may be introduced at landfills in 1994 at the earliest.

F3.4.2 *Chemical Waste*

Chemical waste will arise principally as a result of maintenance activities. Again, it is difficult to quantify the amount of chemical waste which will arise from the construction activities since it will be highly dependant on the Contractor's on-site maintenance requirements and the amount of plant utilised.

The Chemical Waste Treatment Facility located at Tsing Yi was opened in June 1993 and is the point of disposal for all chemical wastes in the territory. The contractor operating the chemical waste treatment facility also operates marine and land collection service for chemical waste producers. Disposal of chemical wastes in this manner will ensure that environmental and health and safety risks are reduced to a minimum provided that correct storage procedures are instigated on-site and on the marine vessels. At the present time there is no charge for this collection and disposal service, however, there is currently a registration fee of HK$200. The construction contractors should contact Enviropace, the Chemical Waste Treatment Facility operator, who offer both a land and marine chemical waste collection service and supply the necessary storage media for these wastes. In addition, the Contractor should contact the EPD to ensure that the handling and disposal methods for the wastes in question are appropriate.

F3.4.3 *General Refuse*

The amount of general refuse which is likely to arise cannot be quantified at this time as it will be largely dependant on the size of the workforces employed by the contractors, and the implementation of site practices.

General refuse generated on-site should be stored and collected separately from other construction and chemical wastes. The contractor may arrange for barge transport (more likely via a small marine vessel given the likely small volume of this waste) for unloading at Kwai Chung Incinerator Plant, West Kowloon Transfer Station or another approved facility as appropriate.

Alternately, transport of this waste could be by barge or by truck to the modular incinerator at Mui Wo on Lantau Island as recommended for the airport construction works in the Airport Masterplan. However, this facility currently has little spare capacity , although the Outlying Islands Transfer Stations may serve as a alternative. The removal of waste from the site should be arranged on a daily basis by the contractor to minimise any potential odour impacts, minimise the presence of pests, vermin and other scavengers and prevent unsightly accumulation of waste.

F4 PREDICTED WASTE ARISINGS

F4.1 INTRODUCTION

In this section, predictions are made of the amount of waste arisings which are likely to be generated during the construction of the LAR. However, due to the information available at this stage in the development of the proposals, it has only been possible to make definite estimates of the amounts of excavated material which would arise from the various LAR construction contracts. Further information is required about the precise nature of the construction methods, size of workforce and contractors' working arrangements to be used before estimates of general construction waste, chemical wastes and general refuse may be made. A summary of predicted excavated material arisings is given in *Table F4.1a*.

Similarly, it is not possible to make predictions of the amounts of waste likely to be generated from the operation of the railway and associated developments until more details are available about the CDA developments at the various LAR stations. However, it is anticipated that the nature and overall magnitude of waste arisings should not be sufficient to require any special arrangements for its handling, transport and disposal.

F4.2 CENTRAL AND YAU TSIM DISTRICTS

On Hong Kong Island, the preparation work for the new Central Station will result in the excavation of approximately 660,000 m^3 (550,000 m^3 from Contract 501 and 150,000 m^3 from 501A) of excavation material some of which will be saturated. Should analysis determine that this spoil is not contaminated it will be dewatered and temporarily stockpiled with other inert construction waste, pending reuse on site or collection and ultimate disposal to public dump or at landfill. This excavation is to take place over the first year of construction and assuming continuous operation will lead to the generation of approximately 1800 m^3 per day of spoil. Should none of this spoil be used for reinstatement or cover on site and disposed of solely by truck it will require approximately 200, 14-tonne vehicle loads per day to transport this spoil. Given the number of vehicle movements and the associated impacts of this transport such as dust, noise and increased traffic loading in the already congested Central area, barge transport to reclamation areas or public dumps requiring suitable fill material may be appropriate. One or two barge transports a day supplemented by road transport for the remainder would be the most appropriate method for transport of the excavated material.

Dredging works for the Immersed Tube Tunnel will take place in two phases. Bulk dredging will be carried out from late 1993 for 12 months and will generate approximately 550,000 m^3 of marine spoil requiring disposal. In addition, trim dredging will take place over an 11 month period from

Table F4.1a ***Predicted Excavated Material Arisings during LAR Construction (,000 m^3)***

(Figures in brackets indicates material which will be reused on–site, and therefore will not require disposal)

Route Section	Contract	Sandfill	Sandfill/ Bentonite and granite	Rockfill	Marine Deposits	Rock	Contaminated Landfill Material	Clay, Sand and Granite
Central and	501	660	–	–	possible	–	–	–
Yau Tsim	502	–	–	30	650	–	–	–
	503	1,157 (296)	169	–	possible	–	–	–
	504	804	–	–	–	–	–	–
Mong Kok and	505	60 (12)	–	–	–	–	–	–
Sham Shui Po	506/507	n/a	n/a	n/a	n/a	n/a	–	n/a
				–	–	50	–	–
Kwai Tsing	508	–	–					
	509	–	–	–	–	–	152	98
	510	–	–	–	10	–	–	3
	511	–	–	–	–	–	–	108
	512	–	–	–	–	130	–	–
Tsuen Wan and	513	n/a	n/a	n/a	n/a	n/a	–	n/a
Islands	514	65	–	–	–	–	–	–
	515	n/a	n/a	n/a	n/a	n/a	–	n/a
	516	600 (180)	–	–	–	–	–	–
	517	n/a	n/a	n/a	n/a	n/a	–	n/a
	518	95	–	–	–	–	–	–
Totals		2,953	169	30	660	190	152	209

mid–1994 and will generate a further 100,000 m^3. These muds are not deemed suitable for disposal at landfill or public land based dumping areas due to their moisture content and potential level of contaminants and will need to be transported by barge to designated marine dumping sites. Assuming that the necessary permits are obtained and dredging will take place seven days a week, over a one year period, approximately 1644 m^3 per day of marine muds requiring disposal will be generated. Once bulk dredging for each tunnel segment is complete, trim dredging will be carried out just prior to the placement of each segment. Assuming trim dredging will take place continuously over the 11 month period, this will result in the production of approximately 303 m^3 per day of marine muds which would require disposal.

Preparation work for the Immersed Tube Tunnel will result in the excavation of approximately 30,000 m^3 of rockfill from the seawall of the WKR. It is likely that the contractor will stockpile this excavation for reinstatement and reconstruction once the tunnel work has been completed. Therefore, there is no requirement for disposal of this non–marine material. Should there be a surplus of rockfill requiring disposal it should be stockpiled with other inert construction waste pending collection and ultimate disposal to public dump or at landfill.

On Kowloon side, excavation and piling for Kowloon Station and the adjacent tunnels is expected to generate the following:

- 169,000 m^3 of material containing sandfill and/or bentonite and weathered granite; and

- 1,157,000 m^3 of sandfill with a moisture content of 30–40%.

From this material, 296,000 m^3 has been designated for reuse on–site as backfilling material or in the case of material containing bentonite, used in diaphragm wall construction or bored piles. The remaining 1,030,000 m^3 of this material would therefore need to be exported. The sandfill may require dewatering prior to reuse on–site or transport. It is likely that disposal of this material would be to nearby construction works. Given the relatively large quantity of material to be exported and its suitability for use in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. For transport to these sites, covered trucks would be used and during peak periods approximately 125 haul vehicles per day would be required. Should disposal at nearby sites not be possible and transportation is designated to sites requiring marine access, such Chek Lap Kok or to other land based sites, the material may be transported by truck to a barge loading point for transport by barge.

For the tunnels between Kowloon and Tai Kok Tsui Station, the construction of which will be entrusted to the Government to be undertaken as part of the West Kowloon Expressway contract, it is estimated some 803,700 m^3 of reclamation fill sand will be excavated.

F4.3 *MONG KOK AND SHAM SHUI PO DISTRICTS*

The excavation works for Tai Kok Tsui Station (Contract 505) are expected to generate some 60,000 m^3 of sandfill. It would be recommended that wherever possible any suitable material be reused on-site for landscaping, cover and fill material. From this material, 12,000 m^3 has been designated for reuse as backfill in the Station construction. The remaining 48,000 m^3 of this material would therefore need to be exported. The excavated material may require dewatering prior to reuse on-site or transportation. It is likely that disposal of this material would be to nearby construction works. Given the relatively large quantity of material to be exported and its suitability for use in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. For transportation to these sites, covered trucks would be used and during peak periods up to 75 haul vehicles per day may be required. Should disposal at nearby sites not be possible and transportation is designated to sites requiring marine access, such Chek Lap Kok or to other land based sites, the material may be transported by truck to a barge loading point for transportation by barge.

Contracts 506 and 507 between Tai Kok Tsui and Lai King will be entrusted to the Government and constructed as part of the West Kowloon Expressway (WKE) contract. The environmental assessment undertaken for the WKE did not specifically quantify the amount of excavated reclamation fill material which would arise for Contracts 506 and 507 of the LAR.

F4.4 *KWAI TSING DISTRICT*

At the Southern Portal of the Lai King Tunnels, tunnelling for Contract 508 will result in the excavation of approximately 50,000 m^3 of excavated rock. This excavation is to take place over the 14 months and continuous operation will lead to a peak arising of 600 m^3 per day of rock material requiring disposal. Assuming that none of this material is suitable for re-use on site, transportation by truck to a disposal point will require about 60 haul vehicles (120 trips) per day.

Bulk excavation of soft material and rock will also be carried out adjacent to the existing Lai King Station as part of the advance works for site preparation (Contract 508A). However, no estimate of the amount of material to be excavated from here is available at this time.

At Kwai Chung Park, the excavation of the cutting for the LAR through the former Gin Drinkers Bay Landfill will result in the excavation of over 250,000 m^3 of material. Of this over 224,000 m^3 is likely to be exported off-site, and would comprise approximately:

- 114,000 m^3 of waste from the open cut;
- 5,300 m^3 from the pile bores above the water table;
- 7,300 m^3 from the pile bores below the water table;
- 98,000 m^3 of capping material.

It is likely that approximately 5,000 m^3 of the capping material could be suitable for re-use, while the balance will be disposed of at a landfill. It also possible that some further small contaminated wastes could arise from works for the viaduct abutments at either side of the Park, although these have not be quantified.

In relation to the Rambler Channel Bridge, land based bored piling for Piers 1 and 6 will result in the excavation of approximately 3,000 m^3 of alluvial clay, sand and completely degraded granite. It is likely that the contractor will stockpile this excavation for reinstatement and use wherever possible on site for spread footing and general fill, thus minimising the requirement for disposal of this material and the need to import addition fill material.

The amount of excavated material which would be suitable for this purpose is unknown, however, it is not likely that a large proportion of this material would be re-used. The timing of the land based piling is such that Pier 6 will be piled in late 1993 and early 1994 over a four week period, resulting in the generation of 54 m^3 per day of material. Piling for Pier 1 is scheduled from June to July 1994, over a six week period, resulting in the generation of 36 m^3 per day of material. This excavated material not reused on-site will be treated as general construction waste and stockpiled with other inert construction waste.

Bored piling for the bridge is scheduled to take place from early to mid-1994 and will generate approximately 10,000 m^3 of marine spoil. These muds are not deemed suitable for disposal at landfill or public land based dumping areas due to their moisture content and potential level of contaminants and will need to be transported by barge to designated marine dumping sites. No maintenance dredging work is envisaged once the Bridge is completed. Marine piling is scheduled to take place over a five month period and provided the necessary permits are obtained, can take place over 24 hours, seven days a week. This will result in the generation of approximately 67 m^3 per day of marine muds consisting primarily of marine sand and clay.

On Tsing Yi, the total surplus of excavated material from the construction of the station and viaducts is expected to be approximately 108,000 m^3. It is expected that during peak periods of excavation, (ie. during the first year of construction), the equivalent of 15 truck loads per hour may be required to remove this material. A temporary pier will be provided to the north of the construction site to allow barge transport of excavated material to help minimise some of the potential impacts associated with this.

Excavation from the tunnelling in the west of Tsing Yi is expected to generate a total of 130,000 m^3 of rock spoil requiring disposal. During peak excavation activities, approximately 600 m^3 per day of spoil will be generated. It is likely that disposal of this material would be to nearby construction works on North Lantau. Given the quantity of material to be exported and its suitability for use in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. For transportation to these sites, it is likely that the material will be moved via the temporary pier to the north of Tsing Yi Station and then transported by barge, to Chek Lap Kok or to other such sites.

F4.5 *TSUEN WAN AND ISLANDS DISTRICTS*

The Lantau Fixed Crossing (Contract 513) is currently being constructed by the Government. Information regarding the likely characteristics, volume and scheduling of excavated and dredged material was not given in the environmental assessment of the project.

Excavated material from the tunnelling works at East Lantau will comprise largely of rock material. Given the inert nature of this rock material, reuse on-site or at reclamations is not likely to have any significant environmental impact. The only likely impacts associated with the excavated material are related to air quality and dust generation during excavation, stockpiling and transport, which are discussed in *Annex C*. During tunnelling, the rock excavated will reach a peak of 600 m^3 per day . All rock will be disposed of off-site, although no specific disposal location has been identified at this stage. This will require the equivalent of approximately 60 lorry loads per day to remove the spoil, which is likely to be transported by barge. The total spoil removed from the tunnels will be approximately 65,000 m^3.

The Lantau Formation and Viaducts (Contract 515) will be built by the Government as entrusted works, being part of the North Lantau Expressway contract. The environmental assessment for the North Lantau Expressway did not specifically identify the amount of excavated material which would be generated during the construction of this section of the LAR alignment.

At Siu Ho Wan, excavation from the depot construction is expected to generate a total of 95,300 m^3 of saturated sand from the reclamation requiring disposal. It is likely that disposal of this material would be to nearby construction works on North Lantau. Given the quantity of material to be exported and its suitability for use in reclamations or nearby developments with a material deficit, the material should be exported to such nearby sites. However, prior to transportation, some degree of dewatering may be required. For transport to these sites, covered trucks would be used and during peak periods approximately 60 haul loads per day would be required.. Should disposal at nearby sites not be possible and transport to sites requiring marine access is needed, such Chek Lap Kok or to other sites, the material may be transported by barge. In any event, transport by barge may be the only available route as the construction of access roads is unlikely to be completed by the time that the excavation work for Contract 518 is carried out.

At Tung Chung (Contract 516), approximately 100,000 m^3 of marine sands will be excavated for the construction of the LAL Station on reclaimed land, together with a further 500,000 m^3 for the cut-and-cover tunnels. Some of the material will be stockpiled on site for use in backfilling with the remaining quantity (approximately 70%) exported from site. Hence, the total surplus of excavated material is expected to be approximately 420,000 m^3. It would be recommended that wherever possible any material be reused on-site for landscaping, cover and fill material. It is likely that disposal of this material would be to nearby construction works in the North Lantau area and possibly Chek Lap Kok. Given the relatively large quantity of material to be exported and its suitability for use in reclamations or other developments with a material deficit, the material should be exported to such nearby sites. Barge transport would be used for Chek Lap Kok and for other land based sites on North Lantau, covered trucks would be used. During peak periods up to 25-30 haul trucks per hour may be required to remove this material.

In the vicinity of the new airport at Chek Lap Kok, the construction of the LAR will be entrusted to the Provisional Airport Authority as part of the new airport works. The environmental assessment for the airport did not specifically identify the amount of excavated material from the construction of the LAR which will require disposal.

F5 MEASURES FOR MITIGATION

F5.1 INTRODUCTION

In this section, ERM's recommended measures to avoid potentially significant environmental impacts associated with waste arisings from the construction and operation of the LAR and the recommended storage, transportation and disposal options, or to reduce these to acceptable levels, are set out. In relation to these, reference is made in this section to the MTRC's General Specification for the LAR (which will form part of the tender documentation for all LAR construction contracts) and the Particular Specifications which will relate to each of the individual contracts. In addition, suggestions for the guidance of contractors in following good environmental management practices on site, which will assist them in complying with the requirements of the General and Particular Specifications, are given.

F5.2 MARINE MUD DISPOSAL AND FLOATING REFUSE

F5.2.1 Marine Mud

It is considered that the MTRC *Particular Specification for Contracts 501, 502 and 503, Clause 14* in conjunction with *Appendices, N* adequately addresses the necessary requirements for spoil disposal and states:

- **The Contractor shall remove from Site all spoil from whatever source and shall make his own arrangements for its disposal.**

- **The Contractor shall confirm and advise with FMC and EPD the estimated volume of materials to be dredged and proportion of contaminated materials. The provisional disposal areas for contaminated and uncontaminated materials are shown on Drawing No.502/T/01/TMI/C10/003. Formal allocation will be made by FMC after the extent of contaminated mud has been determined.**

- **The Contractor is referred to Particular Specification Appendices M, N, and O which specify the requirements of the EPD and FMC with respect to the disposal of dredged materials and contamination testing.**

- **The Contractor shall make a formal application to the Director of Environmental Protection Department (DEP) for a dumping licence and ensure that the licence conditions are met to DEP's satisfaction. (PS for C501, 502 and 503 Clause 14.5)**

Clause 11.2 of the Particular Specification for Contract 510 states that transport of contaminated marine mud shall be by split barge of not less than 750 m^3 capacity. However, should a small quantity of contaminated marine mud require disposal, particularly during trim dredging where smaller volumes are generated, this clause may not be suitable. The accumulation of excavated marine mud, if not disposed of within a short period, may create odour impacts. The relevant clause should be amended to read as follows:

Transport of designated contaminated marine mud shall be by split barge of not less than 750 m³ capacity unless prior approval is obtained from FMC and EPD (PS for 510 Clause 11.2 (b)).

The Code of Construction Practice (CCP) should also advise that in relation to Contracts 501, 502, 503 and 510:

- **The Environmental Protection Department will require the contractor to employ competent consultants to establish the level and extent of contamination of marine muds prior to the commencement of dredging works, to ensure that the correct dredging, handling and disposal procedures are followed.**

F5.2.2 Floating Refuse

The Contractor should mitigate against the generation of floating refuse and the removal of any such material will be the Contractor's responsibility. *Clause 14.5* of the *Particular Specification* for contract 502 adequately covers this issue with the following:

The Contractor shall take precautions to prevent any extraneous materials being dropped or deposited in the harbour, and if such material is so dropped, it shall be immediately removed by the Contractor. (PS for 502, Clause 14.5)

F5.3 Segregation of Wastes

In order to ensure that all waste is disposed of in an appropriate manner, waste should be separated by category on–site by the contractor. The criteria for sorting solid waste is described in *New Disposal Arrangements for Construction Waste* issued in 1992 by the EPD and the CED. Waste containing in excess of 20% by volume of inerts should be segregated from waste with a larger proportion of putrescibles. Inerts are described as material being soil, rock, asphalt, concrete, brick, cement/plaster, building debris and aggregates, and any other general materials which would not bio–degrade.

The segregation of these solid wastes has been specified under *Clause 3.1.10* of the MTRC *General Conditions of Contract*. However, this clause does not identify materials requiring separate storage and disposal at the Chemical Waste Treatment Facility due to be commissioned in April 1993 and would need to be included as part of the MTRC Contract Requirements.

The Consultants would recommend that all waste, be segregated into the following categories which have been previously defined:

- Excavated material or construction waste suitable for reclamation or fill;
- Construction waste for disposal at public dump or landfill;
- Chemical waste;
- General refuse.

The different categories of wastes should be segregated, stored, transported and disposed in the manner described in *Section F3.*

The MTRC *General Specification, Clause 3.1.10* calls for the segregation of inert and non-inert wastes and specifies their disposal sites as follows;

> **The Contractor shall segregate construction waste materials into inert and non-inert and chemical waste categories, and he shall dispose of them as follows :**
>
> **(a) Inert construction waste material when deemed suitable for reclamation or land formation shall be disposed of at public dumping areas.**
>
> **(b) Inert material deemed unsuitable for reclamation or land formation and non-inert construction waste material shall be disposed of at public landfills.**
>
> **(c) Chemical waste as defined by *Schedule 1* of the *Waste Regulations (Chemical) 1992*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste disposed of at the Chemical Waste Treatment Facility located at Tsing Yi. (General Specification, Clause 3.1.10)**

The CCP should also advise that:

- **In relation to the collection and disposal of chemical wastes from worksites, The Contractor should contact Enviropace (the operator of the Chemical Waste Treatment Facility at Tsing Yi) who offer both a land and marine chemical waste collection service and supply the necessary storage media for these wastes. The Contractor should also contact the Environmental Protection Department to help ensure that the handling and disposal methods used for chemical wastes are appropriate.**

F5.4 *STORAGE, COLLECTION AND TRANSPORTATION OF WASTE*

The CCP (Site Management Section) should include instructions which ensure that approved waste collectors are used and that appropriate measures to minimise adverse impacts including windblown litter and dust from the transportation of these wastes.

The CCP should state:

- **Only licensed waste collectors authorised to collect the specific category of waste concerned shall be employed. It is the Contractor's responsibility to ensure that appropriate measures to minimise windblown litter and dust during transportation be employed by the waste collector in accordance with *Clause 3.2.18 (c)* of the *General Specification.***

- **The necessary waste disposal permits must be obtained from the appropriate authorities should they be required in accordance with the Waste Disposal Ordinance (Cap 354) and Waste Disposal (Chemical Waste) (General) Regulation (Cap 354).**

- **Collection of general refuse shall be carried out daily or as often as required in agreement with the Engineer.**

- **The waste storage areas shall be well maintained and cleaned regularly to the satisfaction of the Engineer.**

- **Where appropriate, the Contractor should consider the use of barges for the transport of waste from worksites, particularly in respect of excavated materials suitable for reuse, in preference to the use of road vehicles.**

F5.5 WASTE ARISINGS DURING OPERATION

Waste management as described previously is not considered likely to have significant adverse environmental impacts during the operation of the LAR, and no mitigation methods over and above current MTR regular operation practices would be warranted.

Annex G

Environmental Monitoring and Audit Requirements

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G1 *INTRODUCTION*

G1.1 *SCOPE AND PURPOSE OF THE ANNEX*

In this Annex, the basic requirements for the environmental monitoring and audit (EM & A) work which will be undertaken during the construction and operation of the LAR are set out, together with a description of how these will relate to the implementation of the environmental mitigation measures which have been described elsewhere in this report.

The Executive of the MTRC has decided that the Corporation itself, as the proponent of the LAR, will undertake the EM & A work required during its construction and operation, most likely through the services of an independent environmental consultant hired by MTRC specifically for this purpose. MTRC have already considered expressions of interest from consultants to undertake this work, and intend to issue invitations to tender in the near future.

MTRC has already begun to prepare the Consultants' brief, and a more detailed manual of EM & A requirements and procedures. In this annex, ERM sets out the EM & A requirements which it is recommended should form the basis of this manual, taking account of the findings of the LAR EIS and the requirements already incorporated into the General Specification for the LAR works and the Particular Specifications for the contracts which have already been let (*ie* Contracts 502 and 510).

G1.2 *OBJECTIVES OF THE MONITORING AND AUDIT PROGRAMME*

The overall objectives of the monitoring and audit programme which will be undertaken during the construction and operation of the LAR are as follows:

- To provide a data base against which the short or long term environmental effects associated with the LAR may be determined;
- to verify the environmental impacts predicted in the LAR EIS;
- to monitor the performance of the project and to provide an early indication if any of the environmental mitigation measures, identified in this report and/or implemented by the contractors, fail to achieve acceptable standards (*ie* the regulatory requirements, standards and Government policies set out in *Annex A*);
- to take remedial action if unexpected problems or unacceptable impacts arise; and
- to provide data to enable an environmental audit to be undertaken.

G1.3 STRUCTURE OF THE ANNEX

After this introductory section, the rest of this annex is structured as follows:

- *Section G2* describes the general arrangements proposed for the EM & A work, and discusses how these will relate to the measures for mitigation recommended in the LAR EIS to ensure acceptable levels of environmental protection are achieved.
- *Section G3* sets out the requirements relating to noise during construction and operation of the LAR,
- *Section G4* gives the recommended requirements for air quality during the construction phase.
- *Section G5* provides the requirements pertaining to water quality during construction.

G2 *GENERAL ARRANGEMENTS*

G2.1 *Introduction*

In this Section, the various elements of the recommended EM & A requirements are described, and the means by which these will inter-relate is also discussed.

As was noted in *Paragraph G1.3*, one of the objectives of the EM & A requirements is to ensure that acceptable levels of environmental protection are achieved during the construction and operation of the LAR, and that the recommended measures for the mitigation of environmental impacts are indeed being effective. This will be achieved by MTRC taking responsibility for the EM & A work, and through the application of *Event Contingency Plans* to deal with the incidence of unacceptable pollution events, either in the course of normal construction working or through unforseen circumstances.

Figure G2.1a shows in graphic form the inter-relationships between the implementation of the recommended mitigation measures, the EM & A programme and the Event Contingency Plans. The roles of each of these respective elements is further discussed in the following paragraphs.

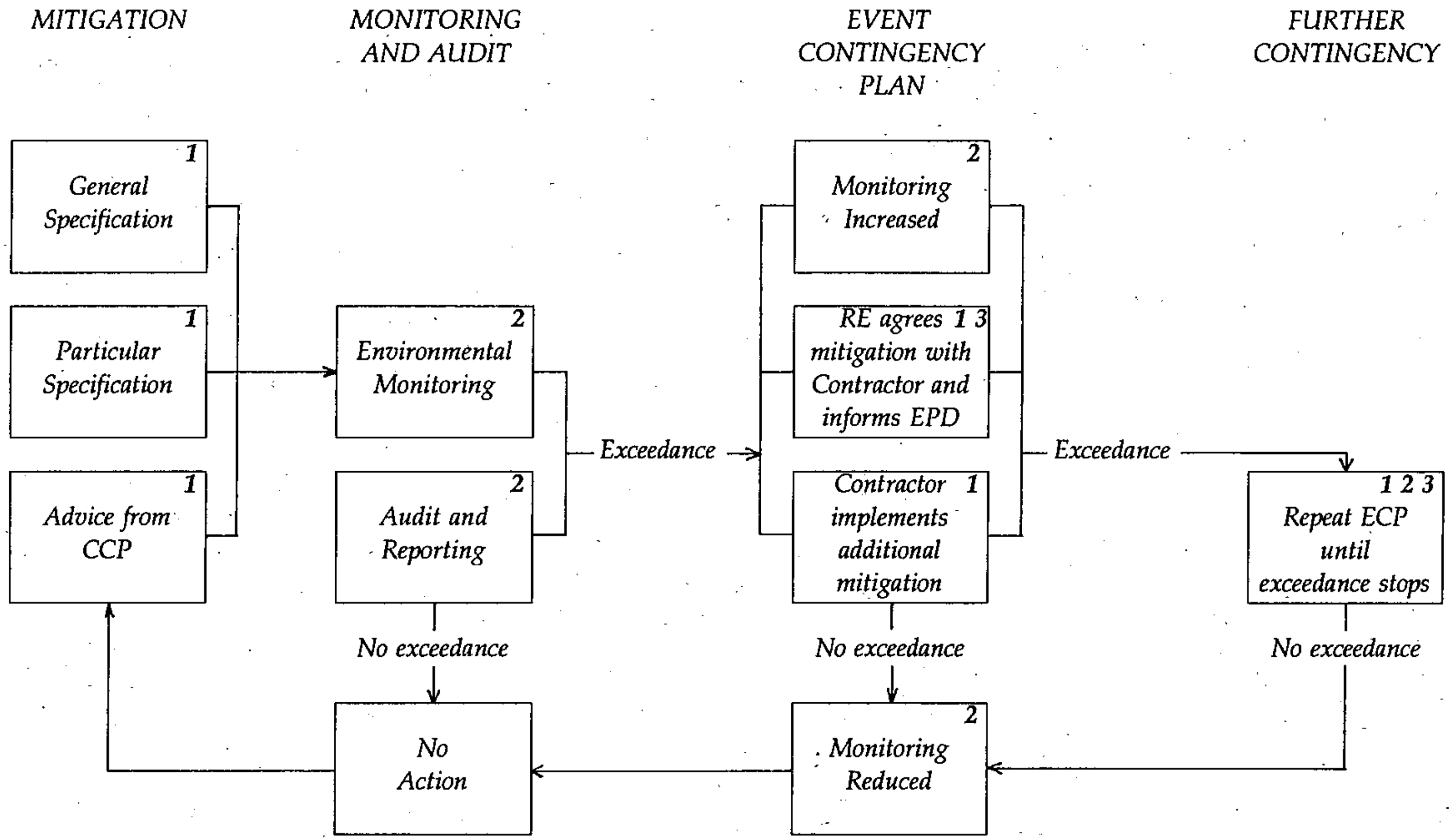
G2.2 *Measures for Mitigation*

The measures for mitigation which have been recommended by ERM for each of the various types of environmental impact likely to occur during the construction and operation are detailed in each of the relevant Technical Annexes in this report. These fall into three categories:

- The *General Specification* sets out a number of measures for mitigation which will apply generally to all the LAR construction contracts. These measures, which include *for example* such features as wheel-wash facilities for lorries provided at site entrances to reduce dust impacts, will be included in the construction contracts, and the contractors will be obliged to comply with these or face the appropriate penalties.

- The *Particular Specifications* for each of the construction contracts also sets out measures for mitigation which will be contractual obligations, with which the contractors must comply. In this case, the measures typically relate specifically to impacts which will be likely to occur from an individual contract. Examples of such measures include noise barriers at specific locations around construction sites. In addition, the Particular Specifications will include details of the operational noise barrier requirements for the LAR. This is because the foundations for these will need to be provided as part of the construction contracts.

Figure G2.1a Implementation of Mitigation Measures and Environmental Monitoring and Audit



(Responsibilities for tasks are denoted thus: 1 – Contractor, 2 – MTRC's Consultants, 3 – MTRC's Resident Engineer)

- *The Codes of Practice* set out further recommendations for mitigation measures, which the contractors will be advised to adopt. The *Code of* Construction Practice (CCP) contains advice on measures which cannot be included as clauses in the construction contracts, as they could place unacceptable restrictions on the contractors' choice of working methods and arrangements and could also expose MTRC to excessive cost penalties. Their exclusion from the contracts also provides both the contractors and MTRC with more flexibility in the choice and implementation of mitigation measures where the measures specified prove to be inappropriate, or perhaps inadequate. The *Code of Operational Practice* contains advice on the management of environmental problems which might arise during operation, for which there is no obvious place in the construction contracts.

G2.3 *ENVIRONMENTAL MONITORING AND AUDIT*

The monitoring of the environmental impacts for which MTRC is responsible will be carried out by independent environmental consultants, yet to be appointed by MTRC. The monitoring work will include:

- In the *Construction* phase, this assessment has identified sensitive receivers along the LAR route where noise and dust monitoring will be required. Water quality monitoring will only be required for Contracts 502 and 510. In addition, an odour patrol will be used at Kwai Chung Park (Contract 509).

- In the *Operational* phase, noise impacts will be monitored.

Also, other monitoring will be undertaken by MTRC during the construction of the LAR, although this will not directly relate to environmental impacts. During the blasting for tunnelling works, vibration monitoring will be carried out to ascertain that no damage to structures is being caused. At Kwai Chung Park, landfill gas monitoring will be carried out for safety reasons. These categories of monitoring are not discussed further in this report.

In order that the environmental monitoring may be audited, MTRC have begun work on devising strict procedures and protocols for carrying out, recording and reporting this work. The procedures will form part of the environmental consultant's contract and they will be obliged to comply with these. These procedures, protocols and reporting formats will be set out in an EM & A Manual which will be produced as the first task of the independent consultants after they have been appointed, probably before the end of 1993.

The monitoring protocols and reporting formats will be agreed with EPD prior to this work beginning on site.

G2.4 *EVENT CONTINGENCY PLANS*

The purpose of the Event Contingency Plans (ECPs) is to provide, in association with the monitoring and audit activities undertaken by MTRC's consultants, procedures for ensuring that if any significant pollution (either accidental or through inadequate implementation of mitigation measures on the part of the contractor) does occur, that the cause of this is quickly identified and remedied, and that the risk of a similar event re-occurring is reduced.

The principle upon which the ECPs are based is the prescription of procedures and actions associated with the recording of certain defined levels of pollution recorded by the environmental monitoring during construction phase of the LAR. These levels are:

- *Trigger Levels:* beyond which there is an indication of a deteriorating ambient environment for which a typical response could be more frequent monitoring.
- *Action Limits:* beyond which appropriate remedial actions may be necessary to prevent environmental quality from going beyond the *Target Limits,* which would be unacceptable.
- *Target Limits:* Statutory limits stipulated in the relevant pollution control ordinances, HKPSG guidelines or Environmental Quality Objectives established by EPD. If these are exceeded, works should not proceed without appropriate remedial action, including a critical review of plant and working methods.

ERM's recommendations for the format of the ECP's to be used during construction of the LAR are set out in the following sections of this annex.

G3 *NOISE*

G3.1 *CONSTRUCTION ACTIVITIES*

Noise levels will be monitored by MTRC's consultants both before and during construction in order to ascertain whether noise levels have increased due to the works and whether remedial measures are necessary. The basis for such monitoring is set out Clauses *3.5.9* to *3.5.12* of the General Specification for the LAR works as set out below (It should be noted that these clauses have been amended to take account of the fact that the MTRC's own consultants will undertake the monitoring:

> **Baseline monitoring shall be carried out by the MTRC's Consultant for a period of at least 2 weeks, with measurements to be taken daily at locations and to a schedule agreed with the Engineer. Baseline monitoring shall be completed within 3 weeks of the date of the Letter of Acceptance being issued to the Contractor.** (General Specification Clause 3.5.9, as amended).
>
> **Checking of baseline noise levels shall be carried out by the MTRC's Consultant at each location at intervals of 12 weeks. At least one such baseline noise quality level check shall be carried out every month. The checking shall be carried out when construction activities are not taking place.** (General Specification Clause 3.5.10, as amended)
>
> **The MTRC's Consultant shall carry out construction noise monitoring procedures in accordance with the following:**
>
> (a) **All measurements shall be carried out by suitably experienced staff.**
>
> (b) **A schedule of proposed noise measurement times and locations shall be prepared by the Consultant on a monthly basis and submitted to the Engineer for his consent at least two weeks before the commencement of the scheduled period.**
>
> (c) **The measurement frequency shall be at least once per week at each location and measurements shall be taken at times chosen to fairly represent normal construction activities. In addition, the Engineer may instruct that supplemental measurements be made at other times.**
>
> (d) **The sound level meters used shall comply with the International Electrotechnical Commission Publications 651: 1979 (type 1) and 804: 1985 (type 1) specifications, as referred to in the Technical Memorandum to the Noise Control Ordinance. Before and after each set of readings, the meter shall be checked against a calibrated noise source and the result included in the MTRC**

Consultant's report. A drift of more than 1 dB(A) will be considered as invalidating the readings.

(e) **The construction noise level monitoring shall be carried out at a distance of 1,000 mm from the external facade of buildings at the locations identified in Clause G3.5.11(b), and the Consultant shall be responsible for arranging access. Alternative sites may be permitted or agreed by the Engineer if difficulties arise in obtaining access, or if the locations become unsuitable. Particular monitoring points elsewhere are to be subject to the Engineer's consent.**

(f) **The exact location and direction of the noise monitoring at each location shall be as set out in the Particular Specification or as directed by the Engineer.**

(g) **Construction noise levels shall be recorded as the $L_{eq(30\ min)}$ measurements during the daytime on normal weekdays and three consecutive $L_{eq\ (5\ min)}$ measurements during the restricted hours, at each of the locations, to the agreed schedule.**

(h) **The results of all construction noise impact monitoring shall be forwarded by the MTRC's Consultant to the Engineer within 24 hours of the measurements being taken.** (General Specification Clause 3.5.11, as amended)

The MTRC's Consultant shall supply to the Engineer every month 3 hard copies and 3 electronic copies of a monitoring and audit report, to an agreed format, giving the dates, times of each series of measurements and equipment in use. The actual measurements of each recording, together with comments on any discarded measurements, shall also be submitted. (General Specification Clause 3.5.12, as amended)

NSRs have been identified, pursuant to Clause 3.5.4 of the General Specification, in the vicinity of the construction sites during the course of the LAR EIS. Those where it is recommended by ERM that noise monitoring is undertaken during the construction works are listed below, the numbers in brackets are those used to identify the NSRs in *Annex B*. Monitoring stations shall be set up at these locations. The exact location and direction of monitoring equipment shall be agreed with the Engineer.

Contract 501:
- Mandarin Hotel (01)
- Exchange Square (04)
- General Post Office (05)
- Hang Seng Bank New Headquarters (06)
- United Building (09a)
- City Hall (09b)

Contract 502:
- Victoria Hotel (03)

Contract 503:
- Man Cheong Street, residential block (13)
- Canton Road, residential block (14)

Contract 505:
- Sharon Lutheran School (16)
- Hoi King Street/Cherry Street Intersection, residential block (17)
- Foo Kwai Street, residential block (20)

Contract 508:
- Winifred Mary Cheung Morninghope School (29)
- Block 19, Cho Yiu Chuen (31);
- Yuet Lai Yuen Estate, Lai Wan House (39)
- Lai King Estate, Yeung King House (40a)
- Lai King Estate, On King House (40b)

Contract 509:
- Lok Sin Tong Lau Sai Yan Primary School (38)
- Lai King Estate, Ming King House (40c)
- Tseun Wan Crematorium (42)

Contract 510:
- Greenfield Garden (41)
- Riviera Gardens (59)

Contract 511:
- Cheung On Estate, On Pak House (45a)
- Cheung On Estate, On Chiu House (45b)
- Cheung On Estate, school (45c)
- St Pauls (Lam Tin) Village, new residential block to the north (47a)
- St Pauls (Lam Tin) Village, residential block to the east (47b)

Contract 512:
- Cheung On Estate, On Tao House (45d)
- Tsing Yi Estate, school (49)

Contract 516:
- Tai Po Youth Camp (77)

In relation to these, it should be noted that other noise sources (such as road traffic) will make a significant contribution to the noise climate. For this reason it is recommended that the daytime construction noise limit shall be 75 dB(A), but with the proviso that the Engineer shall interpret the monitoring results in the light of potential influencing factors such as road traffic.

Not all of the NSRs identified during this study have been recommended as monitoring locations; if a group of NSRs are judged to be similarly affected by noise from the site then the closest has been chosen as the monitoring position and represents all of the NSRs in the group.

G3.2 *EVENT CONTINGENCY PLAN (ECP) FOR CONSTRUCTION NOISE*

Unexpected impacts are possible, in which case remedial action is necessary. Therefore, the General and Particular Specifications for each of the contracts will include provision for an Event Contingency Plan for excessive noise impacts. This will be as follows:

The Contractor shall use an Event Contingency Plan in order that complaints about construction noise during the course of the works are acted upon in the correct way. Trigger, Action and Target Limits shall be the basis for the plan, the definition of which shall be:

- **Trigger Limit – The receipt of one documented complaint about construction noise by the Contractor, the Engineer or the EPD.**

- **Action Limit – The receipt of more than one documented complaint about construction noise by the Contractor, the Engineer or the EPD in the course of a two week period.**

- **Daytime Target (Noise Level) Limit – $L_{Aeq,\,30\,min}$ 75 dB(A) at Noise Sensitive Receptors for construction work not involving percussive piling between 0700 and 1900 hours on normal weekdays.**

- **Target (Noise Level) Limits at other times – the appropriate criteria levels given in the Technical Memoranda 'Noise from Construction Work other than Percussive Piling' and 'Noise from Percussive Piling'.**

If after commencement of the works the Trigger Limit is reached, the Contractor shall fully investigate the complaint and identify the noise source or sources responsible for it, agree appropriate action with the Engineer and mitigate these sources so as to avoid its recurrence.

If after commencement of the works the Action Limit is reached, the Contractor shall fully investigate the complaint and establish the noise source or sources responsible for it , agree appropriate action with the Engineer and mitigate these sources so as to avoid its recurrence. The MTRC's Consultant shall also increase the frequency of such construction noise measurements that are being made pursuant to Clause 3.5.11 of the General Specification. (Particular Specifications).

If after commencement of the Works the Constructional Plant, equipment or methods of working are believed by the Engineer to be causing serious noise pollution impacts, or the Target Limit is reached, they shall be inspected and remedial proposals drawn up by Contractor, approved by the Engineer, and implemented. In developing these remedial measures, the Contractor will be expected to review all

construction noise sources that may be contributing to the pollution impacts, and propose changes to plant locations and scheduling of activities, installation of plant soundproofing, provision of alternative plant, erection of sound barriers around part of the Site or the location of construction noise sources, or any other measures that may be effective in reducing noise. Where such remedial measures include the use of additional or alternative Constructional Plant or equipment, such Constructional Plant or equipment shall not be used on the Works until the Engineer's consent has been given. Where remedial measures include maintenance or modification of previously approved Constructional Plant or equipment such Constructional Plant or equipment shall not be used on the works until such maintenance or modification is completed and the adequacy of the maintenance or modification is demonstrated to the satisfaction of the Engineer. (General Specification Clause 3.5.7, as amended)

In the event that remedial measures for which consent has been given by the Engineer are not being implemented and serious impacts persist, the Engineer may direct the Contractor to suspend work until the measures are implemented. (General Specification Clause 3.5.8)

G3.3 OPERATIONAL ACTIVITIES

G3.3.1 Introduction

The construction of the LAR will include provision for the building of a number of noise mitigating structures, such as wayside barriers and noise covers. These have been designed to control train noise to meet levels of acceptability at NSRs close to the alignment. Very few of these operational noise barriers recommended by ERM in the LAR EIS will actually be required to reduce excessive noise impacts when the LAR opens in 1997. The frequency of service and the length of trains will be increased to accommodate growing demand on the LAR over time, and this will lead to an increase in noise levels. As these levels approach the acceptable limits (*ie* as specified in the NCO and/or HKPSG), the barriers will be erected to ensure that operational noise levels from the LAR do not exceed these limits. The monitoring of operational noise levels will form the mechanism by which the necessity to provide the recommended barriers is identified.

Also, because there will be a number of neighbourhoods where noise levels in the year 2011 are predicted to be close to the acceptable limits (even when mitigation is in place), and because it has been shown that train noise can increase noticeably during operation if inadequate maintenance is performed, it will be important to monitor train noise in order to protect NSRs from unacceptable noise levels. It should however be noted that MTRC propose a high degree of maintenance including regular rail grinding and wheel trueing.

It is recommended that two forms of noise monitoring should be undertaken throughout the lifetime of the railway, and a third should be considered. Firstly, occasional short term noise monitoring at specified NSRS should carried out, to check for exceedances of acceptable levels. Secondly, a permanent monitoring station should be set up, to measure the noise levels from individual trains, and to identify any train that has become unusually noisy, so that remedial action can be taken. Thirdly consideration should be given to the use of a testing train to run along the lines to identify any sections of track near to NSRs where the rail surface has deteriorated sufficiently that noise levels show a noticeable increase in that area (alternatively some other technique could be adopted to achieve this aim). This monitoring regime is recommended to minimise increases in train noise but, as explained below, it may not be possible to monitor for compliance with the NCO criteria.

Possible techniques that could be used to implement these three systems are outlined below, although details of the monitoring regime will be developed by consultation with the EPD, and the operator will be responsible for developing them into a fully usable form.

All monitoring of train noise should be carried out by suitably trained personnel, and with calibrated equipment conforming to the relevant TM under the NCO.

G3.3.2 *Monitoring At NSRs*

$L_{Aeq, 30\ min}$ and L_{AMax} noise levels should be measured at the most affected facade of the following NSRs for a single period from 0630 – 0700, immediately after the opening of the railway (although a number of other commissioning noise survey exercises may also be undertaken at this time) and periodically thereafter:

- Tower 9, site B, Tai Kok Tsui Station Related Property Development;
- Tower 27, site C, Tai Kok Tsui Station Related Property Development;
- Nam Cheong Estate;
- Mei Foo Sun Chuen;
- Ching Lai Court;
- Princess Margaret Hospital;
- Block 19, Cho Yiu Estate;
- Winifred Mary Cheung Morninghope School;
- Ming King House, Lai King Estate;
- Tower 1, Tsing Yi Station Development;
- Tower 7, Tsing Yi Station Development;
- St Paul's village;
- On Tao House, Cheung On Estate;
- On Chiu House, Cheung On Estate;
- Ma Wan (7 NSRs are identified in *Table 4.2* of the LFC EIA);
- Commercial/residential Area 27 at Siu Ho Wan Depot;
- Residential Development in Tai Ho Wan (after 2011);
- Luk Keng Tsuen Village;
- Residential Area R1(a) at Tung Chung;
- Residential Areas R1(b2) at Tung Chung; and
- Residential Area R1(c2) at Tung Chung

These noise measurements will unavoidably include contributions from other noise sources in the vicinity of the NSR, for example traffic noise from the WKE and NLE. For this reason, the results will need careful interpretation, and it will be difficult to establish if train noise from the LAR is at acceptable levels, or indeed if train noise from the LAR is contributing significantly to the measured levels at all. Because of this problem, the two additional monitoring systems described below will also be adopted, and it may be possible to omit certain of the listed NSRs (where background noise is dominant) from the monitoring programme. Also in relation to this, it may be useful to take sample noise measurements at the NSRs during intervals when there is no train noise. However, it is not possible to gauge the practicality of this option at this stage.

G3.3.3 *Permanent Noise Monitoring Station*

In order to monitor noise from individual trains and to identify at the earliest possible time any train that has become particularly noisy, a single permanent noise monitoring station will used. The location of this station will be such that all AEL and LAL trains pass it (ie it must be South of Tsing Yi Station as some north-bound trains turn back there), background noise levels are not excessive, and trains pass at relatively high speed. Kwai Chung Park may be an optimum location.

Noise monitoring equipment should be installed in an MTRC building (eg a signalling station or purpose built facility) approximately 10-20 m from the nearest railway line. The monitoring equipment should be linked by modem to the Central Control Centre at Tsing Yi Station where train scheduling will be tied in to a noise data logging system so that the train reference numbers can be identified for each train pass by monitored. L_{AMax} and SEL noise levels will be recorded against each train in the LAR fleet. The data should be studied to identify any trains that show a significant increase in noise level. At this stage it is difficult to predict the spread in train noise levels that could be monitored, but it may be that an increase in L_{AMax} and SEL of 3 dB would be a usable trigger level. Trains showing a significant increase in noise level should be considered for maintenance, including inspection of the wheel surfaces and re-grinding and trueing of offending wheels.

G3.3.4 *On Train Monitoring*

A method of monitoring noise levels with a train mounted noise measuring system may be the best way of identifying increases in noise from sections of track that have developed rail corrugations. Inspection of the tracks may be capable of measuring the depth of corrugations directly, but the depth of corrugation that is required to produce significant elevation in train rolling noise is not well established at this time (although rail corrugation depths of greater than 0.1 mm should be avoided), so a direct noise measurement approach would be preferable.

This monitoring exercise is aimed at identifying sections of track near NSRs that have become corrugated, and should be re-ground, ahead of regular re-grinding that is likely to take place 2–3 times a year, so as to avoid significant increase in rolling noise in that area.

An LAR carriage or other vehicle could be modified to house a rolling noise measurement system comprising of four microphones mounted close (say 1 m) to each wheel/rail interaction point for two wheels for each track. For each track the two microphones could be mounted as far apart as possible and in locations away from noise sources other than rolling noise. The noise monitoring vehicle should be run along all sections of the LAL and AEL lines near to NSRs periodically, at a constant speed (the speed should be selected to optimise the clarity of the rolling noise signal over other noise sources), while noise measurements are made at each microphone. The measured levels could be fed into a data logger, along with the train location in terms of the chainage and line reference, for subsequent analysis. Comparison between the levels measured at different microphones on the same track (ie measurements made above the same piece of track, but at slightly different times) and noise levels recorded on previous runs should be used to identify sections of track near to NSRs where rail corrugations are producing significant increases in train rolling noise levels. At this stage it is difficult to predict the spread in noise levels that could be monitored, but it may be that an increase of 3 dB would be a usable trigger level. When the trigger level is reached, further monitoring and inspection of the identified section of track should be carried out, and if corrugation is found to be responsible for the significant increase in noise levels, then that section of track should be re-ground without delay (ie ahead of the routine re-grinding schedule).

G4 *AIR QUALITY*

G4.1 *INTRODUCTION*

In this section, requirements for the monitoring and audit of air quality impacts during the construction of the LAR are recommended. These requirements are incorporated into the General and Particular Specifications for the LAR construction contracts. However, as noted above, it has now been decided by MTRC that the Corporation will take responsibility for undertaking this monitoring, by commissioning an independent environmental consultant. Therefore, many references to the Contractor in the specifications will need to be amended to refer to MTRC's independent environmental consultants. The recommendations are made under the following headings:

- Monitoring and audit protocols;
- Event Contingency Plan;
- Locations for monitoring.

G4.2 *MONITORING AND AUDIT PROTOCOLS*

G4.2.1 *General*

The General Specification requires that:

> **The MTRC's Consultant shall carry out monitoring of air quality for suspended particles throughout the Contract period.**
> (General Specification Clause 3.2.4, as amended)

The following practices should be adopted to ensure that the monitoring regime is successful:

> **Total Suspended Particulate concentrations shall be measured by the "High Volume Method for Total Suspended Particulates" as described in Part 50 of Chapter 1 Appendix B of Title 40 of the Code of Federal Regulations of the United States Environmental Protection Agency (40 CFR). All samples collected as part of the monitoring programme shall be analysed by a laboratory approved by the Engineer in the following categories and the results shall be forwarded to the Engineer.** (General Specification Clause 3.2.5, as amended)

> **The MTRC's Consultant shall provide the following equipment within two weeks of the date of the letter of acceptance:**
>
> (a) **a suitable direct reading dust meter capable of reading 1 hr TSP in the range of 0.1–100 mg m^{-3}.**

(b) **High volume air samplers, associated equipment and shelters complying with the requirements of Part 50 of Chapter 1 of 40 CFR.**

(c) **The high volume samplers should be equipped with electronic mass flow controls.** (General Specification Clause 3.2.6, as amended)

The samplers, equipment and shelters shall be constructed so as to be transferable between monitoring stations. (General Specification Clause 3.2.7)

At each monitoring station, the Consultant shall, unless otherwise agreed with the Engineer, construct a hardstanding surrounded by a galvanised wire fence with a lockable access gate and suitable access. (General Specification Clause 3.2.8, as amended)

In addition, the EM & A manual should advise that:

- All equipment, calibration kit, etc., should be clearly labelled to assist in quality assurance.

G4.2.2 *Baseline Monitoring*

The General Specification notes that:

(a) **The MTRC's Consultant shall carry out baseline monitoring for air quality and agree with the Engineer ambient TSP levels at each specified monitoring location. The baseline monitoring shall be carried out for a continuous period of at least two weeks with daily ambient measurements to be taken every day at each monitoring location and at least three times per day for hourly sampling when the highest dust impacts are expected. Baseline monitoring resulting in a 24 hour and a 1 hour baseline value shall be completed within 3 weeks of the date of the letter of acceptance.**

(b) **MTRC's Consultant shall record the wind speed and direction during dust sampling to the satisfaction of the Engineer.**(General Specification Clause 3.2.10, as amended)

Checking of baseline air quality levels shall be carried out at each location at 12 week intervals. At least one such baseline air quality level check shall be carried out each month. The checking shall be carried out when construction activities are not taking place. (General Specification Clause 3.2.11)

G4.2.3 *Impact Dust Monitoring*

The General Specification notes that:

> **A quarterly schedule of monitoring activities shall be submitted to the Engineer for approval 4 weeks prior to the commencement of the scheduled period. Regular daily dust monitoring undertaken by the MTRC's Consultant during the course of the Contract shall, subject to requirements hereunder, be undertaken at any one or more of the monitoring stations at least once every 6 days for each selected monitoring station or as instructed by the Engineer.**
>
> **1-hour dust monitoring measurements shall be carried out three times per day, at least once every 6-days, during the expected highest dust impacts.** (GS Clause 3.2.12, as amended)

G4.2.4 *Reporting and Audit*

The Event Contingency Plan in *Section* G4.3 contains a full monitoring and report procedure. However, the following amended Clause 3.2.16 should also be included in the General Specification:

> **The MTRC's Contractor shall submit 3 copies of the monthly dust monitoring report to the Engineer within 10 days of the following month, in both printed and magnetic form, to an agreed format. This should include a brief account of construction activities during the month, an interpretation of the significance of the monitoring results by verifying compliance and highlighting any failure to comply with the target levels, and an account of the remedial measures recommended and taken by the Contractor as a result.**
>
> **Exceedence of the target levels shall be reported immediately to the Engineer as well as the progress of the findings and remedial action taken. The event should also be included in the monthly report subsequently.**
>
> **All the collected samples shall be kept for 6 months before disposal, all the data/records shall be retained permanently by MTRC after completion of the whole project. MTRC's Consultant shall be responsible for organizing all monitoring data/records to establish the record of air quality change associated with the construction of the LAR.**

G4.3 EVENT CONTINGENCY PLAN (ECP) FOR DUST MONITORING

As noted in *Paragraph* G2.4, the principle upon which the ECP is based is the prescription of procedures and actions associated with the measurement of certain defined levels of air pollution, recorded by the environmental monitoring process, during the construction phase of the LAR. The trigger, action and target levels for air quality during construction of the LAR are recommended as:

- *Trigger*: 30% increase above the baseline monitoring data. The level beyond which there is an indication of deteriorating ambient environmental quality.
- *Action*: Average value of the Trigger and Target levels. The level beyond which appropriate remedial actions is necessary to prevent the environmental quality from going beyond the target limits.
- *Target*: Air Quality Objective (AQO) value of the corresponding pollutants and 500 micrograms per cubic meter at standard temperature (25°C) and pressure (1.0 bar) for one hour dust level, the levels beyond which the health of the public will be at risk.

The ECP for exceedence of various levels shown in *Table G4.3a* should be strictly observed.

G4.4 *Locations for Dust Monitoring*

Table G4.4a sets out the recommended locations for dust monitoring stations during the construction of the LAR. The carrying out of monitoring at these locations should be included in the Particular Specification for each of the relevant construction contracts for the LAR.

Table G4.4a Recommended Locations for LAR Construction Dust Monitoring

Route Section	Recommended Locations
Central and Yau Tsim Districts	*Contract 501:* Exchange Square; Swire House; General Post Office; Harbour Building; and Hang Seng Bank New HQ Building. *Contract 503:* Man Cheong Street.
Mong Kok and Sham Shui Po Districts	*Contract 505:* Hoi King Street; and Cherry Street.
Kwai Tsing District	*Contract 508:* Yuet Lai Yuen; Lai King Estate (Blocks 1, 3, 4, 5 and 6); Yin Lai Court; Lok Sin Tong Lau Sai Yan Primary School; Chan Nam Cheong Memorial College; and WMC Morninghope School. *Contracts 510 and 511:* St Paul's Village; Tsing Yi Estate; and Cheung On Estate. *Contract 512:* Ching Tai Court; Cheung On Estate; and School on Tsing Yi Estate.
Tsuen Wan and Islands District	*Contract 514:* Yiu Liun Dockyard. *Contract 516:* Ma Wan Chung; and Tai Po Youth Camp.

Table G4.3a Dust Monitoring Event Contingency Plan

Event	Action: Environmental Monitor (MTRC's Consultant)	Resident Engineer (MTRC)	Contractor
TRIGGER LIMIT			
Exceedence	Identify source. Repeat measurement to confirm findings. Inform Engineer. Increase monitoring frequency. Discuss with Engineer for remedial actions required. If remedies required, contact Engineer to make arrangements. If problem is short term, continue monitoring. If exceedence stops, additional monitoring can be ceased.	Notify Contractor. Check monitoring data and Contractor's working methods. Discuss with Contractor for remedial works, if necessary.	Rectify any unacceptable practice. Consider changes to working methods.
ACTION LIMIT			
Exceedence	Identify source. Repeat measurement to confirm findings. Inform Engineer. Increase monitoring frequency. Discuss with Engineer remedial actions required. If exceedence continues, arrange meeting with Engineer to identify further appropriate mitigation measures. If exceedence stops, additional monitoring can be ceased.	Confirm receipt of notification of failure in writing Notify Contractor. Check monitoring data and Contractor's working methods. Discuss with Environmental Monitor and Contractor on remedial actions to be provided. Ensure remedial actions properly implemented.	Submit proposals for remedial actions to Engineer within 3 working days upon notification. Amend proposals if appropriate. Implement the agreed proposals.
TARGET LIMIT			
Exceedence	Identify source. Repeat measurement to confirm findings. Inform Engineer. Increase monitoring frequency. Investigate the cause of exceedence. Arrange meeting with Engineer to discuss the remedial actions to be taken. Assess effectiveness of Contractor's remedial actions and keep Engineer informed of the results. If exceedence stops, additional monitoring can be ceased.	Confirm receipt of notification of failure in writing. Notify Contractor. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented. Discuss with Environmental Monitor and the Contractor remedial actions to be provided. Review Contractor's remedial actions whenever necessary to assure their effectiveness.	Take immediate action to avoid further exceedence. Submit proposals for remedial actions to Engineer within 3 working days upon notification. Implement the agreed proposals. Resubmit proposals if problem still not under control.

G4.5 *ODOUR MONITORING AT KWAI CHUNG PARK*

To ensure that no odour nuisance is caused at the site boundary of the Kwai Chung Park and at any sensitive receptor, odour monitoring should be carried out. These should include odour patrol and the more 'objective' olfactometric measurements.

Several olfactometric measurements may be carried out during the early stage of construction in order to provide information with regard to the likely odour concentrations in terms of odour units. During the later stage of construction, if required, olfactometric measurements will be carried out at a frequency to be agreed with EPD.

Routine odour monitoring can be accomplished by an odour patrol carried out as part of the duties of the Contractor's Site Safety Officer audited by MTRC. The effectiveness of odour mitigation measures in place can be assessed by periodically repeating the odour patrol and comparing results to some baseline evaluation. The CCP should advise thus:

- The duties of the Site Safety Officer (SSO) should include the carrying out of an odour patrol, at a frequency to be agreed with the Engineer, over the Site boundary. Patrolling should be scheduled for times corresponding to normal construction activities and should include all time periods such as morning, afternoon, evening and night-time.
- Wind directions should be recorded prior to and during each patrol for use in analysing results.
- The patrolling should be carried out over the entire Site boundary, the location and strength of identifiable odours from the Works Area at each observation stop (a total of 7 stops is recommended) should be recorded. Desensitisation due to olfactory fatigue should be avoided. Odour intensities detected may be categorized into the following classes:

0 Slight	No odour perceived or an odour so weak that it cannot be readily characterized or described.
2 Moderate	Identifiable odour, moderate.
3 Strong	Identifiable odour, strong.
4 Extreme	Severe odour.

- All odours, whether related to the construction works or not, shall be recorded using this odour intensity scale. The results together with general wind conditions shall be handed to the Engineer.
- Prior to landfill excavation commencing, the Contractor shall carry a baseline odour survey for a period of one week.

An Event Continency Plan for unacceptable odour events, based on the findings of odour patrol and frequency of public complaints, is set out in *Table G4.5a*. The definitions of odour trigger/action/target limits are as follows:

- *Trigger* : one independently documented complaint about odour, or recording of a slight odour on 2 consecutive patrols;
- *Action* : more than one independently documented complaint within 2 weeks, or recording of a moderate odour on 2 consecutive patrols; and
- *Target* : more than 3 independently documented complaints within 2 weeks, or recording of an strong odour on 2 consecutive odour patrols.

Table G4.5a Event Contingency Plan for Odour Events

Event	Action: Environmental Monitor (Site Safety Officer)	Resident Engineer (MTRC)	Contractor
TRIGGER LIMIT			
Exceedence	Identify source. Repeat odour patrolling to confirm findings. Inform Engineer. Increase patrolling frequency. Discuss with Engineer for remedial actions required. If remedies required, contact Engineer to make arrangements. If problem is short term (*ie* less than 24 hours), continue patrolling. If exceedence stops, additional odour patrolling can be ceased.	Notify Contractor. Check patrolling data and Contractor's working methods. Discuss with Contractor for remedial works, if necessary.	Rectify any unacceptable practice. Consider changes to working methods.
ACTION LIMIT			
Exceedence	Identify source. Repeat odour patrolling to confirm findings. Inform Engineer. Increase patrolling frequency. Discuss with Engineer remedial actions required. If exceedence continues, arrange meeting with Engineer to identify further appropriate mitigation measures. If exceedence stops, additional patrolling can be ceased.	Confirm receipt of notification of failure in writing Notify Contractor. Check patrolling data and Contractor's working methods. Discuss with Environmental Monitor and Contractor on remedial actions to be provided. Ensure remedial actions properly implemented.	Submit proposals for remedial actions to Engineer within 3 working days upon notification. Amend proposals if appropriate. Implement the agreed proposals.
TARGET LIMIT			
Exceedence	Identify source. Repeat patrolling to confirm findings. Inform Engineer. Increase patrolling frequency. Investigate the cause of exceedence. Arrange meeting with Engineer to discuss the remedial actions to be taken. Assess effectiveness of Contractor's remedial actions and keep Engineer informed of the results. If exceedence stops, additional patrolling can be ceased.	Confirm receipt of notification of failure in writing. Notify Contractor. Carry out analysis of Contractor's working procedures to determine possible mitigation to be implemented. Discuss with Environmental Monitor and the Contractor remedial actions to be provided. Review Contractor's remedial actions whenever necessary to assure their effectiveness.	Take immediate action to avoid further exceedence. Submit proposals for remedial actions to Engineer within 3 working days upon notification. Implement the agreed proposals. Resubmit proposals if problem still not under control.

G5 *WATER QUALITY*

G5.1 *INTRODUCTION*

In this section, requirements for the monitoring and audit of water quality impacts during the construction of the LAR are suggested. These requirements were incorporated into the General and Particular Specifications for the LAR construction Contracts 502 and 510. However, as noted above, it has now been decided by MTRC that the Corporation will take responsibility for undertaking this monitoring, by commissioning an independent environmental consultant. Therefore, many references to the contractor may need to be amended to refer to the MTRC's independent environmental consultants.

G5.2 *CONSTRUCTION ACTIVITIES*

It is the responsibility of the Contractor to monitor water quality, in the form of data on mean suspended solids and mean DO concentrations, at several locations around the dredging area. If the water quality deteriorates below the requirements set prior to dredging then the dredging contractor is required to take action to rectify the situation. Monitoring should be carried out at stations located on transects laid approximately perpendicular to the immersed tube tunnel route. The stations should be laid out in pairs with one station near the works area, to monitor effects of dredging, and another placed at an appropriate distance from the site to act as a control. An exceedence of limits at the near station when the remote station shows compliance will indicate the need for stricter mitigation measures. Changes in background water quality due to other factors, besides construction, would be expected to trigger non-compliance at both the near-works and remote stations.

Clause 5.2 of Appendix K of the Particular Specifications for Contract 502 specify that ten monitoring stations should be placed at the perimeter of the works area, however, no mention is made of the need for control stations. Therefore this clause should be amended to read;

- **Water quality monitoring within Victoria Harbour shall be undertaken at ten Designated Monitoring Stations located as directed by the Engineer. These stations will be located at the perimeter of the site and due to their likely location within marine fairways must be in place only for the duration of the testing and are to be boat based. The provisional location of the stations is shown on Drawing No. 502/T/01/TMI/C01/003. Five additional stations shall be implemented to act as controls for the works area monitoring stations. The location of these stations will be decided by the Engineer but it is recommended that they be placed, preferably upstream of the work site, on a transect whose line of site intersects the tunnel roughly at a right angle and which passes through one of the existing works area monitoring sites.**

(amended, from Clause 5.2 in Appendix K of the Particular Specification for Contract 502)

Clauses 3.3.6–3.3.8 of the General Specification ensure that water quality conditions prior to construction are adequately assessed by requiring;

- **Baseline conditions for the various water quality parameters shall be established at the commencement of the Works. The Contractor shall establish the baseline conditions by measuring the following water quality parameters at all designated monitoring stations:**

  (a) turbidity;
  (b) dissolved oxygen concentration (DO in mg/L);
  (c) dissolved oxygen saturation (DOS in %);
  (d) suspended solids;
  (e) temperature; and
  (f) water depth.

  Measurements are to be taken on 4 sampling days per week, at mid-flood and mid-ebb, for 4 consecutive weeks. All measurements shall be taken in-situ and at 3 water depths, namely, 1,000 mm below water surface, mid-water depth, and 1,000 mm above sea bed, except that in water depth less than 6,000 mm the mid-depth measurement may be omitted. Equipment for measuring the parameters described in Clause 3.3.6 shall be to the approval of the Engineer.(Clause 3.3.6 of the General Specification)

- **Checking of baseline water quality levels shall be carried out by the Contractor at each location at three-monthly intervals. At least one such baseline water quality level check shall be carried out each month. The checking shall be carried out when construction activities are not taking place.**

  During the course of the works, impact monitoring shall be undertaken 3 working days per week. The values of turbidity, suspended solids, DO and DOS shall be determined. Two measurements at each depth monitoring station shall be taken. Where the difference in value between the first and second readings of each set is more than 25% of the value of the larger reading, the readings shall be discarded and further readings shall be taken. For the purpose of evaluating water, all values shall be depth averaged. (Clause 3.3.7 of the General Specification)

- **Response of sensors and electrodes should be checked with certified standard solutions before each reading. The turbidity meter shall be calibrated to establish the relationship between turbidity readings (in "Nephelometric Turbidity Units" NTU) and levels of suspended solids (in mg/L).** (Clause 3.3.8 of the General Specification)

Clauses 3.3.9 to 3.3.10 of the General Specification, and Clauses 7.3 to 7.4 of Appendix K of the Particular Specifications for Contracts 502 and 510, ensure that action is taken quickly if water quality deteriorates by requiring constant communication between the Contractor and the Engineer;

- **At monthly intervals at times to be agreed with the Engineer, the Contractor shall provide to the Engineer a summary report in both printed and electromagnetic media form, to an Approved format, giving details of all water quality data obtained in that month. This will include a summary report of any repeat monitoring remedial measures taken to maintain or improve the water quality.** (Clause 3.3.9 of the General Specification)

- **Samples will be taken once per week from each point of discharge into a water course on the site, analysed by the Contractor and results reported to the Engineer within 24 hours of the results being obtained.** (Clause 3.3.10 of the General Specification)

- **When any Station Result for turbidity, suspended solids or dissolved oxygen exceeds the Alarm or Action Levels (as defined in the following Clause 8), the Contractor will notify the engineer within one hour of the result being known.** (Clause 7.3 in Appendix K of the Particular Specification for Contracts 502 and 510)

- **When in the opinion of the Engineer, monitoring indicates a significant deterioration in water quality, the Engineer shall instruct the Contractor to take action. The level of deterioration and the action to be taken will be based upon the Action Plan.** (Clause 7.4 in Appendix K of the Particular Specification for Contracts 502 and 510)

G5.3 *EVENT CONTINGENCY PLAN (ECP) FOR WATER QUALITY*

Clauses 3.3.11 to 3.3.12 of the General Specification and Clauses 8.1–8.3 and Table K.1 of Appendix K of the Particular Specification for Contracts 502 and 510 (shown in *Table G5.3a*) ensure that adequate action is taken should water quality deteriorate below specified limits by requiring that;

- **Should the results exceed the values allowed in the "*Standards for Effluents discharged into drainage and sewerage systems, Inland and Coastal Waters*" or the EPD's requirements:**

  (a) **The frequency of readings will be increased to a level to be decided by the Engineer in the circumstances.**

  (b) **The Contractor shall institute measures so as to comply with the Specification; or**

  (c) **The polluting operations shall be suspended at the Engineer's direction until the Contractor demonstrates that the additional measures are sufficient to ensure compliance with the Specification.** (General Specification, Clause 3.3.11)

- **In the event that the remedial measures for which consent has been given by the Engineer are not being implemented and serious impacts persist, the Engineer may direct the Contractor to suspend works until the measures are implemented.** (General Specification, Clause 3.3.12)

- **Should the Station Result indicate a deterioration in water quality as evidenced by suspended solids or dissolved oxygen levels or by increase in turbidity, the following Action Plan should be followed.** (Clause 8.1 in Appendix K of the Particular Specifications for Contracts 502 and 510)

- **Any action taken by the Engineer under this Clause shall not relieve the Contractor of any of his responsibilities or obligations under the Contract.** (Clause 8.3 in Appendix K of the Particular Specifications for Contract 502 and 510)

An action plan will be necessary to show the responsibilities of the relevant parties. The proposed action level for the action plan in Table K.1 of the Particular Specifications was considered relatively high for the suspended solids and low for the DO level. Table K.1 has therefore been amended as shown in *Table G5.3a* :

Table G5.3a *Trigger, Action and Target Levels for Water Quality*

Parameter	Trigger Level	Action Level	Target Level
Suspended Solids	Station result >30% above the maximum baseline level.	Station result >30% above the mean same day upstream control station recording.	Station result persistently >30% above the mean same day upstream control station recording.
Dissolved Oxygen	Station result <4 mg/litre dissolved oxygen for 90% of samples and/or <2 mg/litre dissolved oxygen for 90% of samples taken 2 m above bottom.	Station result <30% below the mean same day upstream control station.	Station result persistently <30% below the same day mean level recorded at upstream control stations.

(Amended Table K.1 from Particular Specifications for Contracts 502 and 510)

Annex H

List of Abbreviations

List of Abbreviations

Abbreviation	Definition
AEL	Airport Express Line
ANL	Acceptable Noise Level
APCO	Air Pollution Control Ordinance
AQO	Air Quality Objectives
ASR	Area Sensitivity Rating (for noise)
ASR	Air Sensitive Reciever
BOD	Biochemical Oxygen Demand
BU	Beneficial Uses (for water)
CBD	Central Business District
CCP	Code of Construction Practice
CDA	Comprehensive Development Area
CED	Civil Engineering Department
CLK	Chek Lap Kok
COP	Code of Operational Pratice
dB	Decibel
dB(A)	"A"-weighted decibel
DEP	Director of Environmental Protection
DO	Dissolved Oxygen
E and M	Electrical and Mechanical
ECP	Event Contingency Plan
ECS	Environmental Control System
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIS	Environmental Impact Study
EPD	Environmental Protection Department
Exco	Executive Council
FMC	Fill Management Committee
GI\C	Government, Institional or Community use
GS	General Specification
HKPSG	Hong Kong Planning Standards and Guidelines
ISCST	Industrial Source Complex Short Term Model
ISO	Iternational Standards Organiasation
L_{A10}	The noise level exceeded for 10% of the time, "A"-weighted
L_{A90}	The noise level exceeded for 90% of the time, "A"-weighted

Abbreviation	Definition
L_{Aeq}	Continuous Equivilent Noise Level, "A"-weighted
LAL	Launtau Line
L_{AMAX}	Maximum noise level, "A"-weighted
LAR	Lantau and Airport Railway
LFC	Lantau Fixed Crossing
MTRC	Mass Transit Railway Corporation
NAMP	New Airport Masterplan
NCO	Noise Control Ordinance
NENT	North-east New Territories
NLD	North Lantau Development
NLE	North Lantau Expressway
NSR	Noise Sensitive Receptor
NWW	North West Waters
ODP	Outline Development Plan
OZP	Outline Zoning Plan
PA	Public Address
PADS	Ports and Airport Developments
PCD	Pollution Contol Division
PCP	Preferred Concept Plan
PCWA	Public Cargo Working Area
PME	Powered Mechanical Plant
PS	Particular Specification
RSP	Respirable Suspended Particulates
SENT	South-east New Territories
SR	Sensitive Receptor
SS	Suspended Solids
SSDS	Strategic Sewage Disposal Scheme
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
TEF	Trackway Exhaust Fan
THA	Temporary Housing Area
TM	Technical Memorandum
TSF	Tunnel Supply Fan
TSP	Total Suspended Particulates
TVF	Tunnel Ventilation Fan
TWL	Tsuen Wan Line
USEPA	United States Environmental Protection Agency

Abbreviation	Definition
WAHMO	Water Quality and Hydraulic Model
WCZ	Water Control Zone
WENT	West New Territories
WHC	Western Harbour Crossing
WKE	West Kowloon Expressway
WKR	West Kowloon Reclamation
WPCO	Water Pollution Control Ordinance
WQO	Water Quality Objectives
WSD	Water Supplies Department
WSR	Water Sensitive Receivers

Annex I

Second Draft Final Report - Responses to Comments

CONTENTS

RESPONSES TO COMMENTS FROM EPD I1

RESPONSES TO COMMENTS FROM OTHER GOVERNMENT DEPARTMENTS I18

Comment	Response
Summary Table Of Mitigation Measures	
(1) Note (3) - It appears that all those items under "General Mitigation Measures" with suffix (3) pointed out that only the general mitigation measures for Land Use/Visual Impact and Waste Management are recommended for all sites but not the others. Please clarify and amend the statement. Our comments on the table are based on the assumption that items with suffix (3) will be applied to all sites except otherwise stated.	Note (3) should not contain the reference to Land Use/Visual Impact or Waste Management, this will be deleted from the Final Report.
(2) Note (6) - I am not able to identify the locations of the monitoring stations in Annex G, Volume 3.	Recommended locations are listed on pages G8-9 and G12 for Noise, page G18 for Air Quality and page G23 for Water Quality.
(3) Construction Activities - a) "Water Quality: (D7.1.9)" is required for C514. b) "Water Quality: (D7.1.11)" is required for C518.	It was not felt necessary to include these references as the General Mitigation Measures (D7.1.5) cover the aspects addressed in D7.1.9 and D7.1.11 in much greater detail.
(4) Operational Activities - a) It is doubtful why mitigation measures for water quality is not required in C509. b) In C517, reference to general measures should be B7.7.5.	No operational impacts have been predicted for this section and therefore EM&A is not considered necessary. The reference to B7.7.5 will be amended as advised.
(5) Operational EM&A - It is doubtful why EM&A are not required for C504, C508 and C509.	EM&A for noise are detailed specifically for each Contract, no impacts are predicted for air or water and therefore no EM&A recommendations are made for these aspects.
Comments on Annex H - EM&A **General** (1) In figure H2.1a, it is preferable to have the following amendments: a) The box "Audit and Reporting" under Monitoring and Audit is replaced by "Environmental Audit and "No Action " by "Reporting". b) The box "RE agrees mitigation with Contractor" under Event Contingency Plan is replaced by "RE agrees mitigation with Contractor and informs EPD where appropriate".	Noted, the point (b) will be amended as advised. However, it is considered inappropriate to alter the other headings as it will affect the overall pattern of the Figure.

Comment	Response
(2) H2.2, last paragraph - While MTRC have a preference to incorporating some of the recommended mitigation measures into the Code of Construction Practice (CCP) instead of GS or PS, we are concerned that the Contractor may ignore some of the essential mitigation measures simply because they are only advice in the CCP but not contract conditions/specifications.	Noted. However, it is considered unduly restrictive to impose specific mitigation measures on the Contractor, who may choose to use alternative methods. The responsibility of meeting the TAT levels must be clearly the contractor's.
For instance in Annex B7.4.1, it is identified that unmitigated construction activities cause exceedance of 10 dB(A) and standard mitigation measures may not be effective. A 3.5 m high noise barrier is recommended. Would the consultant please advise us how the Engineer can enforce this measure if the Contractor chooses not to follow this essential recommendations in the CCP?	It is clearly MTRC's responsibility to ensure the Contractor's performance meets the contractual performance standard. The requirement to meet specified noise levels at the NSRs will be required in the Contract; thus the Contractor will have to demonstrate how this will be achieved.
We are also worried that the Contractor will chose not to follow the CCP and implement nothing until any complaint comes about or monitoring and audit results indicate exceedance. We do not have strong objection to the concept of CCP provided that there are practical means to enforce the CCP.	The EM&A procedure will ensure that environmental criteria are met, by whatever methods the Contractor chooses, before statutory limits are exceeded.
Air Monitoring	
(3) Section H4.2.3 - Please amend the second para as below: "1-hour dust monitoring shall be carried out at least three times for every 6-days during the expected highest dust impacts".	Noted, the text will be amended as advised
(4) Section H4.5 - As commented earlier, odour patrol monitoring should be carried out "daily". Also the odour intensities should be categorised as below: 0 Not detected — No odour perceived 1 Slight — Identifiable odour, slight 2 Moderate — Identifiable odour, moderate. 3 Strong — Identifiable odour, strong. 4 Extreme — Severe odour.	Noted, the typographic error in the list will be amended as advised.
Noise Monitoring	
(5) Target limits in Section H2.4 - For the avoidance of doubt, please amend the first sentence to read "...control ordinance, HKPSG or Environmental Quality Objectives established by EPD."	Noted, this will be amended as advised.

Comment	Response
(6) Monitoring at NSRs in Section H3.3.2 - It would be prudent to replace the word "nearest" in the first line by "most affected". The bullet for Cheung On Estate should be amended to read: "• On Tao House, Cheung On Estate; • On Chiu House, Cheung On Estate."	Noted, this will be amended as advised.
Water Quality	
(7) 1st sentence of para H5.2 - The Contractor should be responsible for monitoring water quality, in form of turbidity, suspended solids and DO concentration, at three depths of each of the several locations around the dredging area. The word "mean" should be removed.	Noted, mean will be removed. However water quality measurements will be limited to SS and DO only.
(8) Our Water Services Group recently requested ERM to fax the Drawing 502/T/01/TM1/C01/003 (a plan showing the 10 proposed monitoring stations) to us. Unfortunately, the locations of the five control stations have not yet been consolidated in this plan. In this regard, we are unable to say if the distribution of the monitoring stations as a whole are acceptable or not. Would MTRC or ERM let us have their proposals asap.	The proposals will be submitted as soon as they are available.
(9) Table H5.3a - As turbidity is one of the parameters being monitored, it is reasonable to establish the TAT levels for turbidity as well. This can make full use of the turbidity measurements as a "quick" indicator of sediment/turbidity impact because unlike SS values, turbidity readings can be measured in situ on field. In view of suspended solid is closely related to turbidity, I therefore propose to use the same set of TAT levels as SS. Also I propose some minor changes of wording in the TAT levels for SS to clarify the meaning of the word "persistently".	Monitoring will be to the requirements of ACP Procedure 312 - Attachment 2, this does not include turbidity monitoring.
Table H5.3a should include Turbidity with the same Trigger, Action and Target descriptions as for SS. The Target should read "Station results persistently (2 times)...".	Noted, however the use of "2 times" is not the same as "persistently".
(10) Using two samples should also change the DO Trigger to "Station's surface or middle layer DO <4 mg/l and/or bottom layer <2 mg/l.	Noted, this will be amended as advised.
(11) Second last para of p H23 - There is no need to establish the relationship between turbidity and SS and therefore the last sentence can be deleted.	Noted, this will be amended as advised.

Comment	Response
Air Group (W C Mok)	
We have no further comments on the revised modelling results. However, it would be useful if you could comment in S 1.5 on whether the marginal exceedance at Lam Tin Village can be reduced to levels within AQOs by the additional mitigation measures that you have mentioned.	A comment will be added to Section 5.2.2 and C7.4.4 to the effect that additional mitigation will be applied if required.
I) Air Quality	
Main Report	
(1) For section 5.2.2 and section 7 (conclusion), it appears that the Consultant has not incorporated the results of the revised air quality assessment for the 24-hour TSP levels, that submitted to APG on 5-11-93 and have been incorporated in the DFR Vol 3 (Technical Annexes), for Contracts 508, 510, 511 and 512.	The results of the revised study do not materially affect the overall findings as described in volume 2.
Technical Annexes, Annex C	
(2) Section C4.2.2 Background TSP Levels, etc - It's quite confusing that some predictions are using annual average dust levels as background while some use the 95 percentile of the daily average dust levels. To be more consistent throughout the Report, The Consultant should use the background dust levels as stated in Table C2.4a. As a result, would the Consultant please rewrite section C4.2.2 and recalculate the predictions, just simple addition, using the appropriate background levels in Table C4.2.2.	Unfortunately it was not possible to complete all the alterations before Volume 3 was issued. The text will be reviewed and amended before the Final Report is produced.
(3) Section C5.1.3 Kwai Tsing District - The predicted 24 hour TSP impacts at Lai King Estate Block 5 and WMC Morninghope School, using sequential hourly meteorological data, are not given in the Report.	As the figures in Section *C5.1.3* for Contract 508 relate to hourly concentrations only it was not considered appropriate to alter them.
II) Water Quality	
Main Report	
(1) p 93, Table 7.1a - For construction activities, direct sewage discharge to public sewer if available; and sand trap/oil interceptors to prevent pollution in the drainage system are recommended to be incorporated as General Mitigation Measures.	The control of sewage discharge is covered by Clause 3.3.1 of the General Specification. The second point is effectively covered by Clause 3.1.6 of the General Specification, it was not considered appropriate to impose specific mitigation measures on the Contractor.

Comment	Response
Technical Annexes	
(2) p D46, last para - According to p D62, 2nd penultimate para, the drainage system of the heavy cleaning facilities will be connected to the on-site wastewater treatment plant for the required treatment to comply with TM. This description is recommended to be included also in this paragraph.	The second sentence of the last para on page D48 will be amended to read ".... at all the washing and cleaning plants".
III) Waste Management	
(1) From the marine dumping control and general waste disposal point of view, I have no specific comment on Revised Draft Final Report and the Technical Annexes A & F. However, I would like to remark that the Project Proponent should follow the procedures in the Works Branch Technical Circular No 22/92 if there are works which involve the marine disposal of dredged mud. In general, a majority of the procedures are to be undertaken by the design engineer at the pre-contract stage. The Contractor should be reminded of the timing if parts of these procedures, like designing a detailed excavation plan and estimation of contamination levels, are executed by the contractor at the post tender stage as stipulated in para F2.2.1 and F5.2.1 of the Annex. Please note that Enviropace Ltd, the operator of the Chemical Waste Treatment Centre, will not collect wastes other than those acceptable into the centre for treatment. For instance, only the spent electrolyte of batteries will be accepted. Solid waste such as battery casings and asbestos waste will not be accepted. The waste producer has the responsibility to segregate their waste and arrange for the proper disposal with licensed disposal contractors as required.	Your comments have been noted and will be passed on to MTRC as appropriate.

Comment	Response
Kwai Chung Park	
(2) Regarding the works for Kwai Chung Park, I have found the following statements which indicate that all leachate generated will be disposed of direct to foul sewer. This does not meet our requirement on effluent discharge in compliance with the TM standards. We will not accept discharging effluent in exceedance of TM standards into foul sewer without any treatment. The statements are, and I quote from the report:	The proposed method of disposal of contaminated liquors from the site has now been agreed to be by disposal to foul sewer. It has been predicted that the discharge will meet all the TM standards with the exception of nitrogen concentrations and that this will not significantly affect the receiving waters. This method of disposal is considered to be the appropriate option and on-site treatment to remove nitrogen is not considered practicable.
(3) *p 64 S5.2.3 Water Quality Predicted Impacts; "This (leachate generated) will be disposed to foul sewer."*	On p64, S5.2.3 **Contaminated Water** not **Leachate** is described as being "...disposed of to foul sewer". It is not anticipated that undiluted leachate will be extracted during construction activities.
(4) Section 5.2.2, p63 - Please specify for how long the landfill waste will be stockpiled before it is removed and where it will be stockpiled.	Waste will be stockpiled within a bunded area within the worksite and removed "as soon as possible" after approval for disposal is given by EPD, it is not reasonable to specify a precise timescale.
(5) Section 5.2.3, p64 - Please briefly describe the arrangement for treatment of the waste water. Will any treatment plant be built and at which location of the foul sewer will the waste water be discharged.	It is not considered necessary to treat the waste water before disposal and therefore it is not proposed that any treatment plant be built. Waste water will enter the on-site 150 mm foul drain near the RSD building.
Technical Annex	
(6) Besides, in the Technical Annexes, pD22, Section D3.1.5 Kwai Chung Park paragraph - there is the sentence "Photographic evidence indicates that leachate from the site is apparently dispersing and polluting a wide area." This could be misleading as no site tests have been carried out to prove it, As I commented earlier, it seems more likely that the plume was due to coloured effluent discharged from bleaching and dyeing factories nearby.	It is generally accepted by EPD (See minutes of the LAR EIS SMG 17/5/93) that the Gin Drinkers Bay landfill is polluting the local waterbodies due to the lack of an underlying membrane to prevent leachate egress as noted in EPD's study on the Restoration of Urban Landfills. The overall result of the construction of the LAR through Kwai Chung Park will be to reduce the infiltration rate into the landfill which should reduce the rate of leachate egress. The discolouration of the waters may be due to a number of different sources of contamination, the Consultants consider that the landfill is one of the major ones.
IV Risk Concerns	
(1) Contract 507 & 509, p10-11 - Since open cut (without tunnel) structure option has been adopted for the viaduct through the Kwai Chung Park, I have no further comment to make from off-site risks point of view.	Noted.

Comment	Response
(2) Contract 510, p11 - The bridge spanning the Rambler Channel may have impact on the risk associated with CRC Nga Ying Chau (NYC) Oil Depot and Tsuen Wan DGA. Preliminary hazard assessment is recommended to review the collisions involving DGs vessels and the consequence of fire/explosion and/or toxic releases if TWDGA or NYC Oil Depot is not to be relocated before the construction of Rambler Channel Bridge. Marine Department should also be invited to comment in this connection.	There will be no effect upon the CRC NYC Oil Depot as their vessels do not use the Rambler Channel. ERM are undertaking a risk assessment of TWDGA as a separate study and consideration will be given to the findings, when available. Marine Department have played an active part in the consultation process for the LAR EIS and have not raised this issue.
(3) Contract 515 & 518, p13 - Any development falls within the consultation zone of Siu Ho Wan WTWs which has not been considered during the hazard assessment of this chlorine PHI should be submitted with details for our review to see if further risk assessment is required or not.	The MTRC developments and railway operation were included in the *North Lantau Water Supply Project, Environmental and Hazard Assessment Appendix H - Hazard Assessment Report, ERL April 1992*. No further assessment is considered necessary.
V Visual Impacts	
(4) Main Report - There is a general lack of visual presentation in the report. Photographs/photomontages showing major views should be included as far as possible for illustration. Presumably, detailed landscaping plans would be circulated by the MTRC for our comments once available.	Because of the nature of this project it has not been appropriate to include visual presentations. Most of the alignment is either below ground or contained within highway structures for which drawings are not yet available. Similarly the final station designs have not yet been prepared and therefore any attempts to present the visually appearance of the LAR are likely to be misleading.
VI Environmental Monitoring and Audit	
Main Report	
(1) In the revised DFR, the consultant has not incorporated all our previous comments. The following are the outstanding items:	
a) We have requested the consultant to elaborate the "alternative approach" as suggested in their response to our comments (item i of my comments to response). This suggestion has not been included in the revised DFR.	The "alternative approach" was a suggestion as to how non-statutory levels for air quality might be included in the EM&A process. It was intended only as a starting point for a possible discussion, rather than a detailed proposal.
b) Regarding the EM&A Manual, the consultant has not recommended when this should be prepared. In their response to our initial comment, they just said "in due course" which is too vague.	It is not possible to present the schedule for the production of the EM&A Manual until MTRC has awarded the EM&A Contact.

Comment	Response
c) The consultant recommended that dust monitoring stations be set up *during the first year of construction works* for both Mong Kok and Shamshuipo and Kwai Tsing Districts. The consultant has explained in their response that this is because dusty activities will chiefly occur in the first year. We would be glad if the consultant can explicitly state that no dust monitoring is required after the first year because *there will not be any construction related dust problem.*	Whilst construction continues, dust impacts are possible, it is not intended that monitoring stations operate *only* during the first year of construction works.
Technical Annex	
(2) Section G3.1, pG8; Section G4.2.2, pG17; Section G5.3, p25 - To facilitate our review of the monthly EM&A reports, we need six copies of the EM&A reports in printed form for each month, together with a diskette containing those monitoring data in the agreed format.	
(3) G2.2 - Our queries on the advanced copy of the Technical Annexes regarding the implementation of mitigation measures tabled in Code of Construction Practice.	Your previous comments on the EM&A Annex have been discussed above.
VII Noise	
Main Report	
(1) Contract 515 in S2.2.3 - For the avoidance of doubt, please confirm in this para. that the LAR along the NLE will only consist of 2 tracks.	Noted, the text will be amended as suggested.
(2) Contract 501 and 501A in S2.3.2 - The statement "Excavated material will be removed from the site by road to an appropriate disposal site" is contrary to the <u>confirmed</u> recommendation that all spoil from this worksite is moved by barge rather than by lorry. Pleased delete this statement.	Noted, references to road transport will be deleted.
(3) Noise and Vibration in S3.2.6 - It was agreed that City Hall, a replacement for Furama Hotel, should be added in the list of NSRs for monitoring.	Noted, this will be amended as advised.
(5) Table 4.3b - All "AEL Down" should read "AEL Up".	Noted, this will be amended as advised.
(6) Noise in S5.2.6 - It was agreed that Broadview Gardens should be added in the list of NSRs for monitoring.	It is considered that monitoring in two locations at St Paul's Village and the school at Tsing Yi Estate will provide adequate cover for Broadview Gardens.

Comment	Response
(7) Table 5.3b - Based on the drawings supplied to us on 21.10.93, the AEL and LAL lines should be running on separate tracks rather than sharing tracks. Since this would affect the effectiveness of the Type 2 barriers protecting Cheong On Estate, please confirm and revise the description.	The LAL and AEL will use shared tracks on the Tsing Yi Viaducts.
The Type 1 barriers offered by the typical viaduct design included in the train noise modelling in Contracts 509 and 511 should also be specified.	Noted, Type 1 barriers on the shared lines from pier 6 to the tunnel portal will be added.
(8) Predicted Impacts in S6.2.1 - "Tai Ching Chau" in the 2nd para. should read "Tsing Chau Tsai".	Noted, this will be amended as advised.
(9) Noise in S6.2.6 - It was agreed that the 1st sentence should be amended to read "In relation to the construction of <u>Siu Ho Wan Depot</u> and Tung Chung Station ....."	No monitoring is necessary for construction at Siu Ho Wan and therefore any change to the present text would be misleading.
(10) Predicted Impacts in S6.3.1 - The statement that "At the Depot Site, noise levels from train movements in the busiest night-time periods will be approximately LAeq, 30min 50 dB and LAmax 60 dB and will therefore be within the NCO requirements" is not in line with the assessment contained in the Technical Annexes and our comments. This statement is not acceptable and need revision.	Noted, this will be amended to clarify the situation.
(11) S7 - The 1st bullet should be revised to read "..... environmental protection, the HKPSG and EPD's established standards."	Noted, this will be amended as advised.
(12) Table 7.1a - We fail to find the enclosure for C507 nor B7.4.3 in the Technical Annexes. Please clarify.	Noted the Table will be altered to cover these three points.
The enclosure for Schools S(1) and S(3) in Tung Chung should also be listed in this table.	
For C518, "/cover" should be added after "barriers".	
Annex B	Noted, the residential properties will be described in a separate assessment.
(13) Noise Sensitive Receivers in Section B2.1.3 - We are not aware that the residential properties in United Building have central air conditioning system. Please review your assessment with respect to percussive piling.	

Comment	Response
(15) Figure B2.3a - The LAR alignment indicated in this figure skews very much to the south and is misleading. In fact, NSR 22 should be at the southwestern side of the LAR alignment. Revision is necessary.	Noted, this will be amended as advised.
(16) Lai Chi Kok to Kwai Chung Road Viaducts in Section B2.4.3 - It was agreed that Chan Nam Cheong Memorial School should be included in the list of NSRs for assessment of noise from trains. Please amend as agreed.	Noted, this will be amended as advised.
(17) Table B2.5e - On Tao House should be at the west of On Yun House. We believe that the distance to station given in this table for them should be interchanged. Please revise.	Noted, this will be amended as advised.
(18) Tsing Yi Station and Viaducts in Section B2.5.3 - Assessment of noise from trains for On Tao House and Broadview Gardens should also be presented as they could not be represented by other NSRs.	Noted, this has now been completed and included in the report.
(18) Lantau Tunnels in Section B2.6.3 - It was agreed that assessment of construction noise to Yi Chuen would be added to the DFR. Please supplement.	There will be no LAR construction at the east portal. All tunnelling will be from the west and the construction of the ventilation building will be entrusted.
(19) Tung Chung in Section B2.7.3 - It has been clarified that the primary school S(3) and secondary school S(1) are only at about 12m, not 60m, north of AEL alignment. Please revise.	Noted, the assessment has been amended in the light of this information.
(20) Figure B2.6a - The LAR alignment indicated in this figure skews very much to the north in the Yam O area and is misleading. NSR 83 should be at the northern side of the LAR alignment. Revision is necessary.	Noted, this will be amended as advised.

Comment	Response
(21) Source Noise Level in Section B4.2.1 (a) Starting from "there were a number ....." of the 3rd sentence of the 2nd para. to the end of the 3rd para. should be moved to the last para. after the 1st sentence. (b) "However, it is considered reasonable to use 89 dB as a worst operating scenario in the absence of final design of rolling stock." should be added after the 2nd sentence of the 2nd para. (c) Please add "To enable the study to proceed before of rolling stock finalized, 86 and 89 trains were adopted for assessment during most time of the study" at the end of the 4th para. (d) Please insert "which is available at a very late stage of the EIS" at the end of the 1st sentence of the 5th para. (e) Please also insert "after careful study" at the end of the 1st sentence of the last para. (f) Please replace "may be based on outdated information" contained in the last para. by "appears to be a reasonable worst scenario under MTRC's stringent and aggressive maintenance programme".	The text has been amended in the light of these comments.
(22) Table B5.4a - "AEL Dn" should read "AEL Up" for the Type 2b barrier to protect NSR 24.	Noted, this will be amended as advised.

Comment	Response
(23) Tables B5.4b and B5.4c	
(a) The Type 1 barriers to the AEL Dn and LAL Up lines for NSR 24 may prove abortive because they are not necessary for the 86 dB train. Should alternative package of barriers be worked out for the 83 dB train under such circumstances?	All reference to the 83 dB(A) Train has been deleted from the Final Report.
(b) According to WP15, the predicted noise levels without mitigation should range from 64-66 dB(A) (ground absorption not significant for high level receivers) rather than remaining constant at 64 dB(A). Please revise.	Noted, the levels will be revised to 64, 65, 66.
(c) Also, the predictions for NSRs 22a and 22b are less than the submission on 27.9.93. Please clarify.	Noted, levels without mitigation will be amended to 56, 57, 59 for NSR 22a and 61, 63, 64 for NSR 22b.
(d) For NSR 25, in view of the prediction at NSR 24, we believe that the noise levels at high level should be around 64/65 dB(A). Please review and provide sample calculation/modelling parameters as necessary.	This has been rechecked and remains at 63 dB. The important aspect is the mitigation measures with which we are in agreement.
(24) Figure B5.4a - The annotations as well as the locations of NSRs 22a and 22b should be interchanged to follow the text.	Noted, this will be amended as advised.
(25) Table B5.4d - The length of the Type 2 barrier north of the AEL Dn line for NSRs 23, 30, 31 should read "1100" instead of "2100".	Noted, this will be amended as advised.
(26) Table B5.4f - We believe that the re-radiated noise level at NSR 29 should not be as high as 60 dB(A). Please review and revise.	Noted, the levels will be amended to 43, 54.
(27) Table B5.5a - Based on the distances listed in Table B2.5c, we believe that the predicted construction noise levels (dB(A)) at WMC Morninghope School should be as follows,	We have reviewed the calculations and whilst agreeing with the General Cases, believe that the Worst Cases for Spoil Removal, Tunnelling and Track Foundation should each be 1 dB higher at 88, 87, 88 respectively.

	Caisson Wall	Spoil Removal	Tunnelling	Track Foundation
Worst Case	94	87	86	87
General Case	83	83	82	83

Please review and confirm.

Comment	Response
(28) Table B5.5f - Based on the total SWL obtained from Table B4.1f, we believe that the worst case construction noise level at the crematorium for excavation should be 74 dB(A) rather than 73 dB(A). Please review and confirm.	The lower figure is due to the more yielding nature of the excavated material and is discussed in the paragraph below the Table.
(29) On-Site Truck Loading in Section B5.5.2 - It has been clarified that loading of the trucks with spoil prior to transport would produce <u>75</u> dB(A) (based on a total SWL of 124 dB(A) from excavator/loader and dump trucks) at the facade of the crematorium rather than 72 dB(A). Please revise.	Your figures are accepted and the text will be amended as advised, based on a total SWL of 123 dB(A) which gives the same results.
Consequently, the worst case facade noise levels of the crematorium should be <u>78</u> dB(A) for simultaneous <u>excavation, piling or viaduct construction</u> activities.	Noted, this will be amended as advised.
(30) Table B5.5i - We noted that the predicted facade noise levels for worst case percussive piling at Rambler Channel Bridge have been revised downwards. However, due to large distance separations between the work sites and receivers, care must be taken in using these figures.	Noted, a rider will be added to the text to this effect.
(31) Construction Impacts in Section B5.5.3 - We do not consider the new estimated LAeq noise level of 89 dB(A) (at the crematorium) for piling on the viaduct site is justified. Please review if the original prediction of 92 dB(A) should be reinstated.	89 dB(A) is correct based on a distance of 75 m.
(32) Cumulative Construction Noise Impacts from other LAR Construction Activities in Section B5.5.3 - In the light of the above comment and revision in prediction given in Table B5.5h, the predicted general case noise level at the crematorium should be <u>80</u> dB(A) rather than 78 dB(A).	Noted, this will be amended as advised.
(33) Operational Impacts in Section B5.5.3 - For the avoidance of doubt, please describe the height of the solid parapets with reference to top of rail.	Noted, this will be amended as requested.
Due to the proximity of the Marine Department Offices, we believe that the predicted train noise levels are very much on the low side. Please review and provide the modelling parameters for reference.	The predictions are correct as the offices will be below the LAR structure and only re-radiated noise will impact.
(34) Table B5.5k - Based on WP10, we believe that the predictions for On Tao House and On Yun House should be interchanged. Please review.	Noted, this will be amended as advised.
(35) Figure B5.5a - The building names of NSRs B and C should be "On <u>Chiu</u> House" and "On <u>Pak</u> House" respectively.	Noted, this will be amended as advised.

Comment	Response
(36) Table B5.5m Assessments for On Tao House and Broadview Gardens should also be presented in this table.	As agreed in a fax dated 29/11/93 this has been added as text below the Table.
(37) Operational Impacts in Sections B5.7.1 and Table 5.7b - The Type 2a barriers contained in the preliminary barrier recommendations stop approximately in front of Area 18. We believe that the barriers should be extended further west to achieve the necessary noise reduction. Please review and confirm.	Noted, the barrier has been extended 100 m to the west.
(38) Construction Impacts in Section B5.7.2 - The assumed SWLs of 119 dB(A) and 117 dB(A) for overhead line mast erection and grade separator construction are new in this study. Please elaborate on how these figures are derived.	Additional Tables have been included in *Section B4.1.2* giving the plant breakdown.
(39) Operational Impacts in Section B5.7.3	
(a) For the avoidance of doubt, please specific the location of the 200m long enclosure over the AEL lines under both scenarios with reference to the school sites.	The mitigation measures and the text describing them were agreed, subject to minor edits, in ERM's fax dated 30/11/93. These have been included in the text.
(b) It should be noted that the Type 2a barrier on the northern side of AEL lines from 900m east of the NLE interchange to 1150m east of the interchange under Scenario B may not be necessary for the 86 dB train. Should alternative be worked out in Scenario B under such circumstances?	
(c) Please check and confirm if the 4th bullet under Barrier Scenario B is compatible with Barrier Scenario A.	
(d) We believe that the predictions for the HOS RS site are on the low side. Please review and provide the modelling parameters for reference.	

Comment	Response
(40) Table 5.7f	These amendments have been undertaken (see the previous response).
(a) The prediction under no barriers for NSR A is considered on the low side. The noise levels at NSR A should be no less than that of NSR I.	
(b) Based on Table 5.2b of WP11, the predicted facade noise levels at NSR C from LAL alone already reached 66, 66 dB(a) in the absence of barriers. Please clarify why the AEL has no (or little) contribution to the overall noise levels under the case of "No Barriers".	
(c) Barrier Scenario A would result in train noise levels 2 to 4 dB(A) less than the NCO limit for the 86 dB(A), at NSR E. Revision is necessary.	
(d) In view of the proximity of NSR E, assessment in terms of LAmax should also be provided.	
(41) Construction Impacts in Section B6.1.1 - "Harbour Building" should be added among the NSRs in the 1st sentence of the 2nd para.	Noted, this will be amended as advised.
(42) Construction Impacts in Section B6.4.2 - The 2nd para. should be revised to read "the noise criteria for the Route 3 Contract ....."	Noted, this will be amended as advised.
For the avoidance of doubt, the 3rd to the last para. should be rewritten to evaluate the impacts based on the 75 dB(A) daytime criterion.	This will be reviewed when a final version of HyD's Desk Top Study is available.
(43) Operational Impacts in Section B6.5.4 - "54 dB" in the 1st para. should read "55 dB".	We have reviewed our calculations and consider 54 dB to be correct.
(44) Fixed Plant in Section B6.5.4 - The 2nd sentence of the 2nd para. should be revised to read "In accordance with TM3, the low level receivers in the planned station top development will be screened from traffic noise and an ASR of 'B' is used for assessment."	Noted, this will be amended as advised.
(45) Operational Impacts in Section B6.7.1 - Luk Keng Tsuen is a village. ASR "C" could not be assigned to it. The discussion about changing the assessment criteria is misleading and should be deleted.	Noted, the ASR rating will be amended, however the recommendation for future assessment will be retained.
(46) Operational Impacts in Section B6.7.2 - The sentence "The HKPSG also give a LAmax criterion for train noise of 85 dB" contained in the 3rd para. is not for noise from depot. To avoid misunderstanding, this sentence should be deleted.	Noted, the sentence will be rewritten to avoid misunderstanding.

Comment	Response
(47) Fixed Plant in Section B6.7.3 - "NCO" in the last sentence of the 2nd para. should read "HKPSG".	Noted, this will be amended as advised.
(48) Construction Impacts in Section B7.3.2 - Unless the recommended 3.5m high noise barriers for Man Wui and Man Cheong Streets and for Hoi King Street/Cherry Street Intersection have been agreed by Highways Department, it would not be appropriate to give such recommendations in the report. Please review.	Until the final version of the Hyd Desk Top Study is available these comments are not superseded.
(49) Operational Impacts in Section B7.3.2 - "NCO" in the last sentence should read "HKPSG".	Noted, this will be amended as advised.
(50) Table B7.4a - "AEL Dn" should read "AEL Up" for the Type 2b barrier to protect NSR 24.	Noted, this will be amended as advised.
(51) Lai King Station and Tunnels in Section B7.5.1 - The terms "windows" and "windows to NSRs" in the 3rd para. should be replaced by dwellings/rooms as appropriate. Also, please quantify the present predicted residual impact in these "windows" and point out their locations for reference.	Noted these points will be amended as advised.
(52) Operational Impacts in Section B7.5.1 - The word "legal" should be deleted from the 1st sentence of the 2nd para.	Noted, this will be amended as advised.
(53) Construction Impacts in Section B7.5.3 - Please delete "However noise is controlled on the remaining piers," from the 3rd sentence of the 4th para. Given that a noise level of 105 dB(A) from percussive piling has been predicted at the Marine Department Offices, "1200-1400 and 1630-1800" contained in the 5th para. should be revised to read "1230 to 1330 and 1700 to 1800".	Noted, these points will be amended as advised.
(54) Construction Impacts in Section B7.5.5 - The recommended SWL of 118 dB(A) for evening construction work contained in the 2nd para. would still result in noise level higher than the NCO limit of 65 dB(A) at Cheung Hang Estate. Please review and revise.	Noted, the recommended level will be changed to 117 dB(A).
(55) Operational Impacts in Section B7.6.2 - It was agreed that the 2nd sentence should be revised to read "..... is required at the western portal. It is recommend that the design of the traction station at the eastern portal ensures ....."	Noted, this will be amended as advised.

Comment	Response
(56) Wheel Squeal in Section B7.7.2 - The reduced incidence of wheel squeal by a factor of 8 appears to be an example rather than a reasonable assumption. Substantiation on why this factor is used is necessary.	The wheel squeal reduction factor is from a paper by British Rail, however, the text will be amended to give a more thorough explanation.
(57) Operational Impacts in Section B7.7.3 - In the light of the previous comment, we believe that the "1300m" in the 1st bullet under the 3rd para. should be revised to read "1400m each". Please review and confirm.	Noted, this will be amended as advised.
(58) Construction Impacts in Section B7.7.4 - Please revise the 2nd sentence in the 2nd para. to read "As the Youth Camp ..... relocation, appropriate mitigation ....."	Noted, this will be amended as advised.
(59) Fixed Plant in Section B7.7.4 - "NCO" in the 3rd sentence should read "HKPSG".	Noted, this will be amended as advised.
(60) Target Limits in Section G2.4 - We have pointed out many times that HKPSG is not established by EPD. For the avoidance of doubt, please amend the first sentence to read "..... control ordinances, HKPSG or Environmental Quality Objectives established by EPD."	Noted, this will be amended as advised.
(61) Section G3.1 - It was agreed that City Hall, a replacement for Furama Hotel, as well as Block 19, Cho Yiu Chuen and Broadview Gardens should be added in the lists of NSRs identified for monitoring under Contracts 501, 508 and 511 respectively.	City Hall will be added. However WMC Morninghope School will cover Cho Yiu Chuen and as discussed previously, Broadview Gardens is also covered by other sites.
(62) Monitoring at NSRs in Section G3.3.2 - It would be prudent to replace the word "nearest" in the 1st line by "most affected".	Noted, this will be amended as advised.

Comment	Response
Commissioner of Police (DD Traffic)	
(1) My only comment on the revised DFR is concerning the method of removal of spoil generated by C501/C501A: it is important that as much spoil as possible is removed by barge and therefore I much prefer the emphasis placed on barge movements apparent in para 3.2.5, lines 8 to 10, than in para 2.3.2, lines 25 to 27 - perhaps the text can be modified accordingly.	Noted, para 2.3.2 will be amended to indicate the same preference as para 3.2.5.
(2) I would otherwise merely like to reiterate our major concerns in the development of the LAR & areas that will receive our special attention, viz:- (a) C501/C501A as above; (b) C508 - ingress/egress via Kwai Chung Road; (c) C509 - removal of hazardous materials & security of site; and (d) C511 & C512 - impact of works on north Tsing Yi roads.	Noted.
Highways Department - Airport Railway Division	
(a) As advised by S for T, the official name for the railway is "Airport Railway" and not "Lantau and Airport Railway"	Since EIS considers both the Airport Express Line and the Lantau Line they are described collectively as the Lantau and Airport Railway.
(b) The Second Draft Final Report has changed the name from "West Kowloon Station" to "Kowloon Station". I think this will confuse with the Kowloon Station of KCRC.	The change is as instructed by MTRC.
(c) Section 2.2.1, 1st para. The 600 m overrun tunnels has not yet been agreed. My comments on 24 September 1993 still stand.	This figure is as advised by MTRC.
(d) Section 2.2.3, 2nd para, last sentence. Only a section of the LAR viaducts will be accommodated beneath the new Route 3 highway within the structure.	Noted, this will be amended as advised.
(e) Figure 2.3b. As stated in my comments on 13 October 1993 the construction programme for concurrent projects was not inclusive. Projects, such as the West Kowloon Reclamation, Jubilee Street Underpass etc, should also be included. I wonder whether these projects were considered when assessing the cumulative impact. Please also incorporate the start date and the completion date of Route 3 in accordance with the letter from our Route 3 Project Office dated 15 October 1993.	Whilst every effort to maintain accuracy has been made, this Table is for indicative purposes only and is not necessarily inclusive of every development in the Territory traversed by the LAR route. Furthermore, as the dates of some projects are still not fixed, the dates indicated may be subject to further change. Cumulative impacts for these projects were considered in the LAR EIS.

Comment	Response
(f) Regarding the works entrusted to the Highways Department, I understand that ERM has assessed the mitigation measures provided for in the WKE contract. I would like to know whether the measures are sufficient and whether the provisions recommended in Section 4.2.1 are still required.	Whilst the mitigation measures are considered acceptable, ERM still believe that the specific mitigation measures, in *Section 4.2.1* or similar, are necessary.
(g) Section 4.2.1, P.49 of the Report, Measures for Mitigation, 2nd para. Our WKE Project Office have the following questions:-	
"Why does ERM only recommend a 3.5 m barrier for TKT station works compared to 6 m for CSU when TKT are larger works and closer to the sensitive receivers?"	The CSU site is considerably closer to Hoi King St than the station site and the 6 m barrier is required for CSU construction noise.
"What extreme noise is ERM expecting at CSU as the piling work is bored piles?"	Excavation and bored piling are the main noise sources. However the WKE Contractor may choose a different construction methodology to that proposed by MTRC. If this is the case it could alter the level of noise impacts and therefore, the required mitigation measures.
(h) Section 4.2.2, 2nd para. "Dust concentrations from unpaved haul roads...". This sentence must be amended to make reference to WKE dust mitigation measures eg add at the beginning of the sentence the word "Uncontrolled" and add at the end of the sentence "if dust mitigation measures are not implemented".	All predicted impacts are given without the application of any mitigation measures for all worksites, including MTRC's and HyD's.
(i) Section 4.2.5, 2nd para. "constructed as part of the WKE contract" should be "constructed as part of the WKE and Route 3 contracts".	Noted, this will be amended as advised.
(j) Section 5.2.1, 4th para. Please note that Route 3 EA was for Route 3 only and did not include AR viaducts.	Noted, this will be amended to read "Route 3 Viaducts".
(k) Section 6.3.1. It is still unclear about the location of the proposed noise barriers. I suggest to indicate the locations on a sketch.	As has been previously stated, the scale of the maps which would be required to show barrier locations with sufficient precision precludes their use in this Report; locations are clearly described in Table 6.3a, p86.
(l) Table 7.1a. For C507 Operational Activities, "enclosure" has been found to be unnecessary. The reference should be B7.4.2.	Noted, this will be amended as advised.

Comment	Response
(m) Regarding to your responses to my comments on 24 September 1993, I have the following comments:-	
a) Section 2.3.2. Please clarify whether the predicted 200 lorry movements per day stated in WP1 Section 4.2.4 have already taken into account that the majority of the spoil would be removed by barges. If not, then what is the predicted lorry movements.	The preferred removal method is by barge; the 200 lorry movements represent a worst case consideration which led to the recommendation that barges should be used.
Regarding the combined impact, your responses to my comments on WP1 stated that this will be taken into account of in the Final Report. Please confirm that your report have included the above combined impact.	See previous comment.
b) Section B5.4.2. I note that the screening effect of Route 3 and WKE viaducts were investigated in the Second Draft Final Report.	Noted.
Chief Engineer/Route 3	
(1) The 4th paragraph of section 5.2.1 on page 59 is subject to change taking into account the findings of the Desk Top Study recently circulated.	The Desk Top Study was not available in time to be included in the EIS DFR II. If made available, the findings will be included as an addendum to the Final Report.
(2) HyD is yet to receive any written confirmation from MTRC as regard the height and type of noise barrier to be used in the entrusted railway viaducts. Up to this moment the height of the railway parapets specified in the Contract remains as 1.25 m above rail level in most of the locations.	Confirmation has been provided.
South West New Territories Development Office	
(1) General - The consideration of disposal of used bentonite slurry in bentonite slurry wall construction should be presented in more details. Appropriate places for dumping or disposal of the used bentonite slurry should be identified. Moreover, the effects of the bentonite slurry wall construction such as spillage and leakage of the bentonite slurry on the adjacent sites and drainage system and the appropriate mitigation measures should be addressed in the contractor's method statement for the bentonite slurry wall construction.	The control of the storage and use of construction materials and their impacts upon the environment has been discussed in detail in both Volume 2 and, more extensively, in Volume 3 of the EIS. This level of assessment has been accepted by EPD.

Comment	Response
(2) Page 28, Contract 516 - Should bentonite slurry wall construction be adopted for the tunnel construction at Tung Chung, this office and other concerned parties should be kept informed of the contractor's method statement.	
(3) Figure 2.3b, Construction Programme for Concurrent Projects - As advised in my previous letter of 22.9.93, the Tung Chung Phase I infrastructure construction is scheduled to commence in early June 1994 for completion in end November 1996. Please amend the programme accordingly.	Figure 2.3b is for indicative purposes only and as schedules are frequently altered, certain dates will inevitably be superseded.
Transport Department - Port and Airport Development Branch	
(1) Para 2.3.2 - What will be the maximum traffic flows generated/attracted during peak hours during the construction of Contract 501 and 501A? These should be clearly indicated in the report.	The preferred transport route for construction materials is by barge rather than lorry which will minimise road traffic impacts.
(2) For contracts 503, 503A and B, I am not convinced that the traffic flows are not expected to exceed 2-3 vehicles per hour at peak times for a workforce peaking at 600-700. Will all the workers walk to the worksite? Please elaborate and clarify.	The figures given relate specifically to construction traffic, as is common practice in Hong Kong, it is not expected that workers will arrive individually by private vehicle but will either use public transport or be bussed in.
Islands District Office	
My only comment is on the measures for mitigation of noise for Contract 516, as laid down in Table 7.1a (p 99). As Tai Po Village has already been cleared to make way for the construction of the North Lantau Expressway, I do not think it appropriate to include the relocation of this village as on of the mitigation measures.	This will be amended as advised.
Planning Department, Hong Kong (CTP/PADS Plan D)	
(1) Section 3.3.1, p 44 - Regarding the 83 dB(A) and 86 dB(A) scenarios, the study should demonstrate that it is practically feasible to achieve an operational level of 83 dB(A) rather than merely saying that MTRC is confident to achieve it. As the mitigation costs for the two different scenarios vary significantly (Sec 7, p 92), there must be sound justification if MTRC is to adopt the 83 dB(A) scenario.	MTRC are confident that the LAR rolling stock will be supplied to their design requirements and that the 83 dB(A) scenario will be achieved. Since this cannot be proven, however, until the rolling stock has been tested under operational conditions, provision for the 86 dB(A) mitigation measures are being incorporated within the project design.

Comment	Response
(2) Section 4.2.1, p47 - There is very little information regarding the temporary depot off Mei Foo Sun Chuen and more information should be given. Although the depot is within DPO/TW's area of responsibility, I am not sure that PlanD has been properly consulted. Also, the text only states that the temporary depot is within acceptable limits for daytime and evening work without any additional noise control but there is no mention of the effects/acceptability associated with any night-time working.	The temporary depot is not expected to lead to significant noise impacts, general mitigation measures recommended on p 49 will be sufficient to ensure that noise levels are effectively controlled. PlanD has been consulted throughout the EIS process. PlanD have been provided with copies of all the Working Papers for the LAR Contracts and representatives have also attended the SMG meetings.
(3) Section 4.2.1, p 49 - Noise barriers along the western boundary of the Tai Kok Tsui Station should also be provided in anticipation of further reclamation in the new typhoon shelter (West Kowloon Reclamation Phase 2). Please note that Metroplan has proposed additional residential development within WKR Phase 2 beyond year 2011. Omission of such noise barriers will constrain land use planning in the future reclamation west of Tai Kok Tsui Station. Incorporation of the noise barriers should, therefore, be regarded as absolutely essential.	It is beyond the remit of this study to consider developments that are, as yet, unconfirmed. As was pointed out by the Chairman at the last SMG, developments which are planned in the future must accommodate the railway rather than *vice versa*.
Mitigation measures for the Tai Kok Tsui traction substation have not been suggested and should be included since they are required primarily to take into account the proposed schools in the vicinity.	No significant impacts are predicted and therefore no mitigation is necessary.
Tables 4.3a and 4.3b - It is not clear if the two different scenarios result in the same noise barrier heights in addition to the different barrier lengths proposed. Are the noise barrier heights recommended in the text the same under the two scenarios, or has only one scenario been assumed?	The heights, and types, of noise barrier are clearly described in the Table notes. For the 83 dB(A) Train barriers are 1.4 m high, and for the 86 dB(A) Train either 1.4 or 3.8 m, high as indicated.
Section 5.3.1 (Table 5.3b) - The original proposal for the 100 m long noise cover over the LAR tracks between Tsing Yi Station and the sea wall has now been reduced to 50 m. I assume this is on the basis of the LAR train noise limitation set at 86 dB(A). This needs to be confirmed. (ref also my previous comments for p 44)	The requirements for the noise barriers are clearly detailed for the two train scenarios as stated on p 70.
Section 7 - Accepting the recommendations as they are in the report, there has to be a firm commitment by MTRC who are now required to confirm strict adherence to these recommendations and to ensure that the agreed mitigation measures are incorporated into the appropriate MTRC contracts documents and implemented accordingly.	Noted.

Comment	Response
Hong Kong Housing Authority	
(1) Table 4.3a and 4.3b - There is no specific indication of the location of the NSRs mentioned in these tables. It would be useful to include plans in the Final Report showing the locations of the respective NSRs. This comment also applies to Tables 5.3a & b and 6.3a & b.	Plans showing the positions of the NSRs are included in Volume 3 of the Report which contains more detailed discussions of mitigation measures. Whilst it is impracticable to include these plans in Volume 2, the NSRs will be identified by name in the Final Report.
(2) Contract 511, Turnback Siding - It is noted that a turnback siding will be constructed west of Tsing Yi Station just south of HD's Cheung On Estate. No specific details are given in the DFR II about the mitigating measures for this facility. In order to ensure protection of out residents from excessive noise level during the construction and operation phases, it is suggested that detailed mitigating measures which satisfy HKPSG requirements to be included in the Final Report for both construction and operation phases.	The construction of the turnback siding was assessed as part of the viaduct construction and also considered in the cumulative impact assessment of construction from C510, 511 & 512. Operational noise is not considered to be a problem given the low train speeds on this section.