4. NOISE

4.1 Introduction

This section provides an evaluation of the noise impacts arising from the construction and operational phases of the MOS Extension. The proposed alignment, depot and stations for the MOS Extension will be either at grade or on elevated superstructure. Activities during the construction and operational phases have the potential to cause noise impacts to the surrounding area. Appropriate mitigation measures are recommended, where necessary, in order to mitigate any adverse impacts.

4.2 Government Legislation and Standards

4.2.1 Construction Noise

General

The principal items of legislation relating to the control of construction noise in Hong Kong are the *Noise Control Ordinance* (NCO) (Cap 400) and the *Environmental Impact Assessment Ordinance* (EIAO) (Cap 499). Various Technical Memoranda, which stipulate control approaches and criteria, have been issued under the NCO and EIAO. The following TMs are applicable to the control of noise from construction activities:

- Technical Memorandum on Noise from Percussive Piling (PP-TM);
- Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM);
- Technical Memorandum on Noise from Construction Work in Designated Areas (DA-TM); and
- Technical Memorandum on Environmental Impact Assessment Process (EIAO TM).

Percussive Piling

Percussive piling is prohibited at any time on Sundays and public holidays and during the weekday evening and night-time hours (1900-0700 hours, Monday through Saturday). A Construction Noise Permit (CNP) is required for such works during the weekday daytime hours (0700-1900 hours, Monday through Saturday).

When assessing a CNP application for the carrying out of percussive piling, the Noise Control Authority is guided by the PP-TM. The Noise Control Authority will look at the difference between the Acceptable Noise Levels (ANLs), as promulgated in the PP-TM, and the Corrected Noise Levels (CNLs) that are associated with the proposed piling activities. Depending on the level of noise impact on nearby Noise Sensitive Receivers (NSRs), the Noise Control Authority would determine the time periods for percussive

piling operation; *Table 5A* of PP-TM is reproduced in *Table 4.2a* below. However, each application is treated on a "case by case basis" and may not receive approval.

Table 4.2a Permitted Hours of Operation for Percussive Piling (not involving the use of diesel, pneumatic and/or steam hammers)

Amount by which CNL exceeds ANL	Permitted hours of operation on any day not being a holiday
more than 10 dB(A)	0800 to 0900 and 1230 to 1330 and 1700 to 1800
more than 0 dB(A) and less than or equal to 10 dB(A)	0800 to 0930 and 1200 to 1400 and 1630 to 1800
no exceedance	0700 to 1900

For any educational institutions identified by this EIA Study, the ANLs should be adjusted by a -10 dB(A) correction factor in the noise assessment, taking account of the relative noise sensitivity of these uses.

The Government is committed to phase out the use of diesel, pneumatic and steam hammer pile drivers, which are particularly noisy. Such pile drivers cannot be used after 1 October 1999. In preparation for the incoming legislative control, the Government has already (since July 1997) administratively banned the use of diesel hammers in Government projects.

As the issuance of a CNP by the Noise Control Authority would depend on the application submitted by the Contractor, noise assessment of percussive piling activities has been excluded from this EIA Study.

General Construction Works

Noise arising from general construction works during normal working hours (ie 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of buildings is guided by the EIAO TM. The recommended noise standards are presented in *Table 4.2b*.

Table 4.2b EIAO TM Daytime Construction Noise Limit ($L_{eq,\ 30\ min}$ dB(A))

Uses	Noise Standards
Domestic Premises	75
Educational Institutions (normal periods)	70
Educational Institutions (during examination periods)	65

In view of their similar noise sensitivity, the daytime construction noise standard for educational institutions (during normal periods) should be employed for other sensitive uses including hospitals, temples, churches, day nurseries and care centres.

The NCO provides statutory controls on general construction works during the restricted hours (ie 1900-0700 hours Monday to Saturday and at any time on Sundays and public

holidays). The use of powered mechanical equipment (PME) for the carrying out of construction works during the restricted hours would require a CNP. The Noise Control Authority is guided by the GW-TM when assessing such an application.

When assessing an application for the use of PME, the Noise Control Authority will compare the ANLs, as promulgated in the GW-TM, and the CNLs (after accounting for factors such as barrier effects and reflections) associated with the agreed PME operations. A CNP may be issued if the CNL is equal to or less than the ANL. The ANLs are related to the noise sensitivity of the area in question and these will be judged by the Noise Control Authority at the time of the CNP application. As conditions may vary between the time of the EIA for a project and the time of a CNP application, the assignment of any Area Sensitivity Ratings in the EIA is not binding upon the Noise Control Authority. Similarly, such references bear no contractual validity with KCRC's own particular specifications. The relevant ANLs are shown in *Table 4.2c* below.

Table 4.2c Acceptable Noise Levels (ANL, $L_{eq, 5\,min}$ dB(A))

Time Period	Area Sensitivity Rating		
	A	B	C
All days during the evening (1900-2300 hours) and general holidays (including Sundays) during the day and evening (0700-2300 hours)	60	65	70
All days during the night-time (2300-0700 hours)	45	50	55

In addition to the general controls on the use of PME during the restricted hours, the Noise Control Authority has implemented a more stringent scheme via the DA-TM. The DA-TM regulates the use of five types of Specified Powered Mechanical Equipment (SPME) and three types of Prescribed Construction Work (PCW), which are non-PME activities, in primarily densely populated neighbourhoods called Designated Areas (DAs). The SPME and PCW are:

SPME:

- Hand-held breaker
- Bulldozer
- Concrete lorry mixer
- Dump truck
- Hand-held vibratory poker

PCW:

- Erection or dismantling of formwork or scaffolding
- Loading, unloading or handling or rubble, wooden boards, steel bars, wood or scaffolding material
- Hammering

In the interest of offering additional protection to the population, the carrying out of PCW is generally banned inside a DA. As for the use of SPME, it would be necessary to comply with DA-TM noise level requirements that are 15 dB(A) more stringent than those listed in the GW-TM before a CNP may be issued.

There are some factors affecting the assessment results of a CNP application, such as the assigning of Area Sensitivity Rating, ANLs etc. The Noise Control Authority would decide these at the time of assessment of such an application based on the contemporary situations/conditions. It should be noted that the situations/conditions around the sites may change from time to time.

Despite any description or assessment made in the subsequent paragraphs, the Noise Control Authority will be guided by the Technical Memorandum (Memoranda) in assessing an application, once filed, for a Construction Noise Permit (CNP). The Authority will consider all the factors affecting their decision taking contemporary situations/conditions into account. Nothing in this report shall bind the Authority in making their decision. There is no guarantee that a CNP will be issued. If a permit is to be issued, the Authority shall include any condition it thinks fit, and such conditions shall be followed while the works covered by the permit are being carried out. Failure to comply with any conditions could result in the cancellation of the permit and prosecution action under the NCO.

4.2.2 Operational Phase Noise Assessment Criteria

The assessment criteria regarding noise impacts associated with the revenue and non-revenue rolling stock during the operational phase of railway development are detailed in *Section 4.5.2*.

4.3 Sensitive Receivers and Baseline Conditions

Noise sensitive uses have been identified in this EIA Study based on the guidelines in the NCO and the EIAO TM. A comprehensive list of all the identified NSRs was prepared and presented in the *Baseline Sensitive Receivers Report, Tai Wai to Ma On Shan EIA*, issued on 18 March 1999. These sensitive receivers include residential uses, educational institutions, hospitals, homes for the aged, centres for the performing arts, hostels and country parks.

NSRs representative of the worst affected receivers during the operational phase within 300m wither side of the alignment for both revenue and non-revenue rolling stock. The representative NSRs selected for assessment purposes are presented in Annex F2 of Volume 2 - Technical Annexes. Figures 4.5a - 4.5r in Annex F1 shows the locations of all the identified NSRs.

NSRs representative of the worst affected receivers during the construction phase have been considered within a corridor of 300 m either side of the alignment. The representative NSRs selected for assessment purposes are presented in *Table 4.3a* below.

Figures 4.3a-r, presented in *Annex B* of *Volume 2 - Technical Annexes*, show the locations of all the identified NSRs; and *Table 4.3b*, also in *Annex B* of *Volume 2 - Technical Annexes*, provides information on the NSRs. The window glazing systems of existing schools, clinics and health care centres observed during site visits are also detailed in *Annex B* of *Volume 2 - Technical Annexes* for ease of reference.

Table 4.3a Selected Representative Noise Sensitive Receivers for Construction Noise Assessment

NSR No.	Descriptions
Hin Keng to Tai Wai	
2	Keng Hau Road No.20-22
5	Hin Hing House, Hin Keng Estate
7	Hin Yeung House, Hin Keng Estate
9	Carmel Alison Lam Primary School
12	Scattered Residential Properties
13	Sha Tin Garden
16	Carado Garden Block 3
18	Scattered Residential Properties
20	Tin Sam Village Nos. 184-187
21	Christian Alliance School
23	Holford Garden
24	Grandway Garden Block 2
26	Sun Ming House, Sun Chui Estate
28	Sha Tin Tsung Tsin Secondary School & Ng Yuk Sec. School
Tai Wai to Sha Tin Tau	
34	Man Lai Court, Block 2
38	San Tin Village
41	Koo Arm Temple
42	Lei Uk Tsuen No. 11-15
43	Immaculate Heart of Mary School
50	Shek Yuk House, Chun Shek Estate
Sha Tin Tau to Sha Kok Street	
52	Sha Tin Tau No.3-5
53	Ecclesia Bible College
55	Tsang Tai Uk

NSR No.	Descriptions
57	L.S.T. Chan Co Chak Primary School
58	Ming Shun Lau, Jat Min Chuen
62	Pok Man House, Pok Hong Estate
64	Tin Ka Ping Salvation Army Primary School
65	Pok Tat House, Pok Hong Estate
67	Ming Yan Lau, Jat Min Chuen
69	Pok Yue House, Pok Hong Estate
75	Pok Tai House, Pok Hong Estate
77	Osprey House, Sha Kok Estate
78	Sand Martin House, Sha Kok Estate
Sha Kok Street to City One Shatin	
83	Sha Tin Wai Nos.1-2
84	Oriole House, Sha Kok Estate
86	Ashley Garden
88	Iris Garden
90	Caritus H.W.Lee Care & Attention Centre
92	Wong Uk Village Nos. 3-4
92a	Wong Clan Ancestral Hall
93	Green Leaves Garden Block B
94	Prince of Wales Hospital
96	Prince of Wales Hospital Accommodation
97	Pamela Youde Child Assessment Centre/ School Dental Clinic
100	Yue Kwan House, Yue Tin Court
101	Residential Development (WIP)
City One Shatin to Shek Mun	
102	Yau Kam Yuen Prevocational School
109	Lam Kau Mow Secondary School
110	City One Shatin Block 36
111	City One Shatin Block 33
113	Planned Residential Development
Shek Mun to Chevalier Garden	

NSR No.	Descriptions
123	Pictorial Garden Juniper Court
124	Shatin Hospital
126	Shatin Hospital Quarters
128	Fisherman's New Village No. 113
129	Fisherman's New Village No. 3-4
133	Ma On Shan Tsung Tsin Secondary School
134	Tai Shui Hang Village No. 1-3
135	Kam Tai Court Block J (WIP)
Chevalier Garden to Heng On	
136	Proposed Residential Development on Area 77
137	Proposed Residential Development to the South of Vista Paradise
138	Proposed Residential Development east of Area 86B
139	Proposed Health & Welfare Building and Undesignated Site "G" on Area 90B
140	Ngan On House, Kam On Court
142	Chinese YMCA College
Heng On to Ma On Shan	
144	Vista Paradise
146	Toi Shan Association Wong Tat To Memorial School
149	St. Francis Church
153	Ma On Shan Area 90 Phase 6 Development
156	The Waterside
158	Sun Shine City Block L
159	Sun Shine City Block M
160	Tolo Place Block 4
Ma On Shan to Lee On	
162	Bayshore Towers Block 3
164	Fu Fai Garden Block 1
167	Ma On Shan Health Care & Elderly Centre
170	Villa Athena Block 5
171	Saddle Ridge Garden Block 5
173	Caritas Ma On Shan Practical School

NSR No.	Descriptions
174	Wu Kwai Sha New Village Nos. 1-3
175	Lung Sing House, Kam Lung Court
177	Lee Wing House, Lee On Estate
179	Residential Development to the East of Lee On Estate (WIP)
180	Li Po Chun United World College

Hin Keng to Tai Wai

The major land uses close to the proposed alignment are residential and recreational. Hin Keng Estate and residential developments along Keng Hau Road are most likely to be impacted during the construction phase. Most of the NSRs have openable windows and will not be screened by surrounding structures from construction noise. Properties to the north of the proposed alignment will be screened by the embankment of the existing KCR railway, however, some noise impacts from construction activities would still be likely.

The noise climate around the work sites is dominated by the existing KCR railway and the traffic on the nearby road network in the vicinity. Roadways contributing to the background noise include Che Kung Miu Road and Mei Tin Road.

Tai Wai to Sha Tin Tau

The region surrounding the proposed work sites for Tai Wai Station and Depot, and the railway alignment from Tai Wai to Sha Tin Tau currently consists of residential buildings and recreational areas. Noise from traffic on Che Kung Miu Road and Lion Rock Tunnel Road are the dominant noise sources in the area. The existing KCR railway also contributes to the background noise level.

The Christian Alliance School, Sha Tin Tsung Tsin Secondary School and Grandway Garden are the nearest NSRs likely to be impacted during the construction phase. All of the NSRs identified within this section have openable windows.

Sha Tin Tau to Sha Kok Street

In the vicinity of the proposed alignment and station sites at Sha Tin Tau and Sha Kok Street, major sensitive uses identified include residential buildings and schools. Tin Ka Ping Salvation Army Primary School and Pok Man House of Pok Hong Estate are located in close proximity to the alignment and would be likely to be affected by construction noise. Residential blocks located to the south of Sha Kok Street would also be impacted during the construction phase. Background noise levels are mainly from traffic on Lion Rock Tunnel Road, Sha Kok Street and the local access roads in the area.

Sha Kok Street to City One, Shatin

The area surrounding the proposed construction sites between Sha Kok Street and City One consists of residential buildings, a hospital and schools. The nearest residential developments are Ashley Garden and Iris Garden which would be impacted by the construction works of the proposed railway development. Wong Uk Village and the residential properties along Kong Pui Street and to the north of Chap Wai Kon Street are also likely to be affected by construction noise. The existing noise climate in the area is dominated by the traffic noise from Shatin Wai Road, Tai Chung Kiu Road and other local access roads.

City One to Shek Mun

For this section of the proposed alignment, the region surrounding the proposed construction sites consists of residential buildings and schools. Identified NSRs in this section are listed in *Table 4.3a*. The existing noise climate in the area is affected by traffic noise from Tate's Cairn Highway and noise emissions from industrial premises in Shek Mun. The nearest NSRs are Yau Kam Yuen Prevocational School and the residential buildings of City One Shatin.

Shek Mun to Chevalier Garden

There are currently two residential developments, namely Pictorial Garden and Fishermen's New Village, which would be impacted during the construction of the proposed railway scheme. Traffic on Tate's Cairn Highway, Ma On Shan Road and Tolo Highway Interchange are the dominant sources of ambient noise in the area. The major land use at Shek Mun is for industrial purposes and the main residential developments are over 300 m away from the proposed site location, they are therefore not considered in this assessment. The nearest NSR is Juniper Court of Pictorial Garden which would be impacted by alignment construction.

Representative NSRs have been selected and are listed in *Table 4.3a*. All the identified NSRs have openable windows and a direct line of sight to the construction sites.

Chevalier Garden to Heng On

The area surrounding the proposed construction sites from Chevalier Garden to Heng On Station consists of residential buildings and schools. The nearest residential developments which would be impacted during the construction of the proposed railway development are those proposed at Area 77 and Area 90B, and those south of Vista Paradise and east of Area 86B, together with Ngan On House within the Heng On Estate. The existing noise climate in the area is affected by the traffic noise from Ma On Shan Road, Sai Sha Road and the other local access roads.

Heng On to Ma On Shan

From Heng On Estate to Ma On Shan Station, most of the identified NSRs close to the railway development are residential buildings, and primary and secondary schools. Residential developments likely to be impacted by construction noise include Vista Paradise, Sunshine City and the Ma On Shan Centre.

The existing noise climate is dominated by traffic noise from Sai Sha Road and Ma On Shan Road. Representative NSRs in the vicinity of the proposed construction sites have been identified and are listed in *Table 4.3a*. All NSRs have openable windows and a direct line of sight to construction noise sources.

Ma On Shan to Lee On

The last section of the proposed railway development runs from Ma On Shan to Lee On Estate. Major land uses close to the proposed work sites are mainly residential and recreational. The background noise level is contributed to by the traffic on Sai Sha Road and local assess roads. The nearest NSRs to be impacted during the construction phase include Villa Athena Block 5 and Lee Wing House of Lee On Estate. NSRs for this section of the proposed railway are listed in *Table 4.3a*.

4.4 Construction Impacts

4.4.1 Potential Sources of Impact

Potential impacts on nearby NSRs during the construction phase of the project will mainly arise from PME operating on the construction work sites. The proposed alignment and stations will be at grade or elevated.

The railway extension construction works will include the following key activities:

- at-grade alignment construction;
- standard viaduct construction;
- construction for special long span structures (viaduct or cable-stayed structures);
- station and Depot construction;
- reprovisioning remedial and improvement works associated with the railway extension embracing of road improvement works, box culvert construction and drainage diversions, footbridge and pedestrian subway construction; and
- material handling at work sites for railway system contractors.

Particularly noisy activities during the construction phase of the Project are predicted to be:

- site preparation and clearance - use of earthmoving machinery and vehicles;

- excavation - use of excavators and loaders for drainage and minor retaining wall construction;
- piling - use of bored piling machinery for the construction of subsurface retaining structures;
- station and Depot structure - use of general construction plant and equipment;
- pile cap and superstructure construction - use of mobile crane, concrete mixer lorry and other construction plant;
- viaduct erection and span construction - use of general construction plant and equipment;
- material handling - use of lorries and mobile cranes; and
- site traffic - use of lorries for material delivery and spoil removal.

Night-time working may be necessary for the erection of viaduct units which will be delivered by road transportation. The contractor should follow the requirement and procedure stipulated in GW-TM and DA-TM for any construction works required during the restricted hours (19:00 - 07:00). As previously mentioned in *Section 4.2*, a CNP is required for such night-time construction activities. Sheet piling may also be required for temporary works and advance works. A percussive pile driving method would most probably be employed for these activities. According to PP-TM, a CNP is required for such percussive piling activities. Noise assessment for these activities is excluded from this study.

Noise impacts are likely during rail/track installation, overhead lines and cables installation, rail grinding and maintenance activities. As advised by KCRC, where practicable, these activities will be undertaken within an enclosed system and noise impacts to nearby NSRs will be limited. KCRC will also apply for a noise permit for any rail grinding activities and all other maintenance activities which are required to be undertaken during the night-time or other restricted hours periods. These activities are therefore excluded in the subsequent noise assessment of this EIA Study.

4.4.2 Assessment Methodology

The assessment of noise impacts from the construction of MOS Extension has been undertaken based on the procedure outlined in GW-TM. For this EIA Study, only daytime construction noise impacts associated with the railway extension are addressed. Any works within the restricted hours period and any percussive piling activities will be assessed in accordance with the requirements in GW-TM, DA-TM and PP-TM by the Noise Control Authority, when the contractor applies for a CNP for the works. In general, the methodology is as follows:

- identify representative NSRs that may be affected by the construction works;
- determine plant items for corresponding construction activities, based on the plant inventories agreed by KCRC;

- assign sound power levels (SWLs) to construction plant based on the information in GW-TM and other appropriate sources;
- calculate the correction factors based on the distance between the NSRs and the notional noise source point at the work sites and facade reflection; and
- calculate the predicted noise levels at NSRs in the absence of any mitigation measures.

Annex C in *Volume 2 - Technical Annexes*, presents the separation distances between the selected NSRs and the MOS Extension work sites. Cumulative noise levels are also presented, by assuming that the identified works will be undertaken at the same time and in close proximity to the identified NSRs.

Alignment Construction

The proposed alignment will be either at-grade or on elevated viaduct sections. Part of the alignment for the sections between Hin Keng and Tai Wai, and from Shek Mun to Chevalier Garden (the section from Tate's Cairn Highway to the Tai Sha Hang Channel) will be at grade. The vertical alignment of these at-grade sections will more or less follow the existing ground level and the railway will run within the existing railway reserve.

The majority of the proposed MOS Extension alignment will be on elevated, standard viaduct structures, however, special long span viaduct sections or cable-stayed structures will be constructed at critical sections of the alignment. These sections include those next to Che Kung Miu Road and the Shing Mun River Channel (north-east of Tai Wai Station); the segment crossing over Sui Tan CLP sub-station near Wong Uk Village; the segment over the highway reserve of Tate's Cairn Highway from Shek Mun Station; the section between Chevalier Garden and Sai Sha Road roundabout, which would cross over the interchange of the Ma On Shan Road and Sai Sha Road and; the segment over a proposed roundabout on Sai Sha Road before Lee On Station.

Information on the plant requirements for the construction activities were provided by KCRC and the engineering consultants, and the SWL of each plant item was based on the GW-TM. Construction activities and the total combined SWL of specific operations for at-grade sections, standard viaduct sections and the construction of special long span structures are listed in *Tables 4.4a, 4.4b* and *4.4c* respectively. The plant inventories for the construction activities are described in detail in *Annex D* of *Volume 2 - Technical Annexes*.

Table 4.4a Total SWLs for Construction Activities - At Grade Section

Construction Activities	Total SWL (dB(A))
Site Clearance	115
Excavation for and Construction of Drainage	115
Excavation for Minor Retaining Wall	119

Construction Activities	Total SWL (dB(A))
Formation Preparation	114

Table 4.4b Total SWLs for Construction Activities - Standard Viaduct Section

Construction Activities	Total SWL (dB(A))
Site Clearance	115
Bored Piling	118
Pile Cap Construction	123
Superstructure Construction	121
Viaduct Erection	112

Table 4.4c Total SWLs for Construction Activities - Special Long Span Structures

Construction Activities	Total SWL (dB(A))
Site Clearance	117
Bored Piling	118
Pile Cap Construction	121
Superstructure Construction	121
Span Construction	112

Station Construction

The MOS Extension will consist of nine stations, and the station structures will be on viaduct, with concourses at ground level, except for Chevalier Garden, Ma On Shan and Lee On Stations, where both platforms and concourses of these stations will be elevated.

Information on the plant requirements for the construction of the depot and station structures was provided by the engineering consultants. The SWL of each plant item was based on the GW-TM. Construction activities and the total combined SWL of specific operation is listed in *Table 4.4d*. The plant inventories for the construction activities are described in detail in *Annex D* of *Volume 2 - Technical Annexes*.

Table 4.4d Total SWLs for Construction Activities - Station Construction

Construction Activities	Total SWL (dB(A))
Site Clearance	115
Bored Piling Works for Station Construction	121
Pile Cap Construction	122
Superstructure Construction	120

Reprovisioning, Remedial and Improvement Works

Together with the works for the railway extension, there are other works proposed namely Reprovisioning, Remedial and Improvement Works (RRIWs), to be undertaken to either enable the construction of the proposed MOS Extension scheme, or to cope with the future transportation demands association with the railway operations. These include:

- reprovisioning of a box culvert for construction of the proposed railway depot at Tai Wai;
- modification to the footbridge ramp to the Che Kung Miu Road roundabout footbridge network for construction of the proposed Public Transport Interchange at Tai Wai;
- realignment of the footpath and bicycle track along the Shing Mun River promenade adjacent to Sha Tin Tau Station for construction of the proposed railway viaduct;
- reprovisioning of a box culvert for construction of proposed Sha Tin Tau Station;
- modification of the road junction at Lion Rock Tunnel Road and Che Kung Miu Road for construction of the proposed railway viaduct;
- temporary provisioning and permanent modification of the Tsang Tai Uk Recreation Ground for construction of proposed railway viaduct;
- reprovisioning of the ball courts and lorry parking spaces of Pok Hong Estate along Sha Kok Street affected by the construction of the proposed railway viaduct and proposed Sha Kok Street Station;
- reprovisioning of part of Kong Pui Street Rest Garden affected by the construction of the proposed railway viaduct;
- modification of the bus terminus adjacent to the Prince of Wales Hospital for construction of the proposed railway viaduct;
- modification of the road in Shek Mun Area for construction of proposed Shek Mun Station;
- lowering of the northbound carriageway of the Tate's Cairn Highway for construction of the proposed railway viaduct;
- modification of Sunshine City Plaza and Ma On Shan Plaza for construction of the proposed footbridge link from Ma On Shan Station to the two developments;
- reprovisioning of sign gantries on the Tate's Cairn Highway; and
- modification of roads near Lee On Station;

These RRIWs have been categorised into four main types of works: road improvement works; drainage/box culvert construction; footbridges and pedestrian subway constructions. The noise impacts at identified NSRs during the construction phase of

these works are addressed in this study. Information on the plant requirements for the works stated above were predicted based on the plant used for similar scale construction projects and agreed by KCRC's Construction Engineers. The SWL of each plant item was based on the GW-TM. Construction activities and the total combined SWL of specific operations are listed in *Tables 4.4e-h*. The plant inventories for the construction activities are described in detail in *Annex D* of *Volume 2 - Technical Annexes*.

Table 4.4e Total SWLs for Construction Activities - Road Improvement Works

Construction Activities	Total SWL (dB(A))
Excavation	120
Placement of Road Base	119
Kerbing	114
Levelling of New Road	113
Road Paving	118

Table 4.4f Total SWLs for Construction Activities - Footbridge Construction

Construction Activities	Total SWL (dB(A))
Excavation for Foundation	120
Bored Piling	100
Concreting for Pile Cap and Bridge Structure	116
Formwork and Reinforcement	112

Table 4.4g Total SWLs for Construction Activities - Drainage Works/Box Culvert Construction

Construction Activities	Total SWL (dB(A))
Excavation	118
Preparation of Formation	115
Laying of Pipes	112
Formwork and Reinforcement	112
Construction of Manhole	114
Backfilling	113

Table 4.4h Total SWLs for Construction Activities - Subway Construction

Construction Activities	Total SWL (dB(A))
Excavation	118
Preparation of Formation	115
Formwork and Reinforcement	112

Construction Activities	Total SWL (dB(A))
Backfilling	113

Works Area for Railway System Contractors

To facilitate the railway system contractors to store, setup, prepare and install appropriate equipment and systems for the MOS Extension, seven 'off site' works areas have been identified along the railway extension. These sites, namely A to G, and are presented in *Figures 2.1a-c*. It has been assumed that material handling and delivery will be the only noisy activity associated with these work sites in which lorry and mobile crane would be used. The SWL of these plant items was based on the GW-TM and the predicted total combined SWL of material handling would be 115 dB(A), as detailed in *Annex D* of *Volume 2 - Technical Annexes*.

4.4.3 Prediction of Impacts

Details of construction noise calculations are given in *Annex E* of *Volume 2 - Technical Annexes*. *Tables 4.4i-q* present the maximum predicted noise levels at the representative NSRs under the worst case scenario without specific mitigation measures, during the key construction stages for the MOS Extension. Façade noise levels at the NSRs were calculated based on the SWLs and corrections for distance attenuation and facade reflection as given in GW-TM.

Table 4.4i Hin Keng to Tai Wai - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
2	Keng Hau Road No.20-22	72	-	-	78(3)	-	-	-	-	-	79(4)
5	Hin Hing House, Hin Keng Estate	68	-	-	71	-	-	-	-	-	73
7	Hin Yeung House, Hin Keng Estate	70	-	-	70	-	-	-	-	-	73
9	Carmel Alison Lam Primary School	68	-	-	71(1)	-	-	-	-	-	73(3)
12	Scattered Residential Properties	76(1)	-	-	75	-	-	-	-	-	78(3)
13	Sha Tin Garden	70	-	-	72	-	-	-	-	-	74
16	Carado Garden Block 3	67	-	-	73	-	-	68	-	-	75
18	Scattered Residential Properties	80(5)	-	-	78(3)	-	-	67	-	-	82(7)
20	Tin Sam Village Nos. 184-187	70	-	-	78(3)	-	-	75	-	-	80(5)
21	Christian Alliance School	78(8)	-	-	77(7)	-	-	87(17)	-	-	88(18)
23	Holford Garden	70	-	-	72	-	-	72	-	-	76(1)
24	Grandway Garden Block 2	-	79(4)	-	82(7)	-	-	-	74	-	84(9)
26	Sun Ming House, Sun Chui Estate	-	71	-	73	-	76(1)	-	-	-	79(4)
28	Sha Tin Tsung Tsin Secondary School & Ng Yuk Sec. School	-	74(4)	74(4)	78(8)	78(8)	73(3)	-	-	-	83(13)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4j Tai Wai to Sha Tin Tau - Predicted Unmitigated Construction Noise Level (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
34	Man Lai Court, Block 2	-	79(4)	76(1)	73	74	-	-	-	-	82(7)
38	San Tin Village	-	74	73	73	71	-	-	-	-	79(4)
41	Koo Arm Temple	-	79(9)	-	78(8)	-	-	-	72(2)	-	82(12)
42	Lei Uk Tsuen No. 11-15	-	83(8)	-	81(6)	-	-	-	73	62	85(10)
43	Immaculate Heart of Mary School	-	77(7)	69	74(4)	74(4)	-	-	-	-	81(11)
50	Shek Yuk House, Chun Shek Estate	-	80(5)	-	81(6)	78(3)	-	83(8)	75	67	87(12)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4k Sha Tin Tau to Sha Kok Street - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
52	Sha Tin Tau No.3-5	-	86(11)	-	76(1)	82(7)	-	72	67	65	88(13)
53	Ecclesia Bible College	-	75(5)	-	72(2)	72(2)	-	67	65	66	79(9)
55	Tsang Tai Uk	-	79(4)	-	-	72	-	-	-	-	80(5)
57	L.S.T. Chan Co Chak Primary School	-	83(13)	-	-	-	-	-	-	-	83(13)
58	Ming Shun Lau, Jat Min Chuen	-	75	-	-	-	-	-	-	-	75
62	Pok Man House, Pok Hong Estate	-	90(15)	-	69	-	-	-	-	-	90(15)
64	Tin Ka Ping Salvation Army Primary School	-	88(18)	-	71(1)	-	-	-	-	-	88(18)
65	Pok Tat House, Pok Hong Estate	-	77(2)	-	73	-	-	-	-	-	78(3)
67	Ming Yan House, Jat Min Chuen	-	85(10)	-	77(2)	-	-	-	-	-	85(10)
69	Pok Yue House, Pok Hong Estate	-	84(9)	-	84(9)	-	-	-	-	-	87(12)
75	Pok Tai House, Pok Hong Estate	-	76(1)	-	85(10)	-	-	-	-	-	86(11)
77	Osprey House, Sha Kok Estate	-	77(2)	-	77(2)	-	-	-	-	-	80(5)
78	Sand Martin House, Sha Kok Estate	-	78(3)	-	81(6)	-	-	-	-	-	83(8)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4I Sha Kok Street to City One Shatin - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
83	Sha Tin Wai Nos.1-2	-	82(7)	-	75	-	-	-	-	-	83(8)
84	Oriole House, Sha Kok Estate	-	83(8)	-	83(8)	-	-	-	-	-	86(11)
86	Ashley Garden	-	86(11)	67	70	-	-	-	-	-	86(11)
88	Iris Garden	-	88(13)	69	68	-	-	-	-	-	88(13)
90	Caritus H.W.Lee Care & Attention Centre	-	85(15)	72(2)	-	-	-	-	-	-	85(15)
92	Wong Uk Village Nos.3-4	-	85(10)	78(3)	-	-	-	-	-	-	86(11)
92a	Wong Clan Ancestral Hall	-	82(12)	81(11)	-	-	-	-	-	-	84(14)
93	Green Leaves Garden Block B	-	85(10)	83(8)	-	-	-	-	-	-	87(12)
94	Prince of Wales Hospital*	-	82(12)	81(11)	70	-	-	-	-	-	85(15)
96	Prince of Wales Hospital Accommodation	-	72	68	71	-	-	-	-	-	75
97	Pamela Youde Child Assessment Centre/ School Dental Clinic *	-	94(24)	70	82(12)	-	82(12)	-	-	-	95(25)
100	Yue Kwan House, Yue Tin Court	-	80(5)	67	85(10)	-	79(4)	-	-	-	87(12)
101	Residential Development (WIP)	-	86(11)	-	86(11)	-	72	-	-	-	89(14)

Note: Figure in bracket indicates the level of noise exceedance.

(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

Table 4.4m City One Shatin to Shek Mun - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
102	Yau Kam Yuen Prevocational School	-	86(16)	-	89(19)	-	68	-	-	-	90(20)
109	Lam Kau Mow Secondary School	-	86(16)	-	83(13)	-	66	-	-	-	88(18)
110	City One Shatin Block 36	-	80(5)	-	74	-	-	-	-	-	81(6)
111	City One Shatin Block 33	-	84(9)	-	68	66	-	-	-	-	85(10)
113	Planned Residential Development	-	80(5)	-	80(5)	79(4)	-	-	-	67	85(10)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4n Shek Mun to Chevalier Garden - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
123	Pictorial Garden Juniper Court	78(3)	-	-	-	-	-	-	-	-	78(3)
124	Shatin Hospital *	78(8)	-	-	-	-	-	-	-	-	78(8)
126	Shatin Hospital Quarters	80(5)	-	-	-	-	-	-	-	-	80(5)
128	Fisherman's New Village No.113	76(1)	-	-	-	-	-	-	-	-	76(1)
129	Fisherman' New Village No.3-4	76(1)	-	-	-	-	-	-	-	-	76(1)
133	Ma On Shan Tsung Tsin Secondary School	-	79(9)	-	73(3)	73(3)	-	-	72(2)	-	81(11)
134	Tai Shui Hang Village No. 1-3	-	74	-	75	73	-	-	77(2)	-	81(6)
135	Kam Tai Court Block J (WIP)	-	77(2)	-	78(3)	79(4)	-	-	78(3)	-	84(9)

Note: Figure in bracket indicates the level of noise exceedance.

(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

Table 4.4o Chevalier Garden to Heng On - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
136	Proposed Residential Development on Area 77	-	80(5)	76(1)	77(2)	79(4)	-	-	67	-	84(9)
137	Proposed Residential Development to the South of Vista Paradise	-	83(8)	-	73	72	-	-	64	67	84(9)
138	Proposed Residential Development east of Area 86B	-	77(2)	68	68	-	-	-	-	-	78(3)
139	Proposed Health & Welfare Building and Undesignated Site "G" on Area 90B	-	83(8)	-	83(8)	85(10)	-	-	90(15)	68	92(17)
140	Ngan On House, Kam On Court	-	77(2)	-	84(9)	84(9)	-	-	71	68	88(13)
142	Chinese YMCA College	-	88(18)	-	87(17)	87(17)	-	-	91(21)	68	95(25)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4p Heng On to Ma On Shan - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
144	Vista Paradise	-	87(12)	-	78(3)	77(2)	-	-	72	68	88(13)
146	Toi Shan Association Wong Tat To Memorial School	-	81(11)	-	71(1)	69	-	-	66	68	82(12)
149	St. Francis Church	-	80(10)	-	68	-	-	-	-	61	81(11)
153	Ma On Shan Area 90 Phase 6 Development	-	86(11)	-	68	-	-	-	-	-	86(11)
156	The Waterside	-	81(6)	-	71	-	-	-	-	-	81(6)
158	Sun Shine City Block L	-	81(6)	-	78(3)	-	-	-	-	-	83(8)
159	Sun Shine City Block M	-	84(9)	-	88(13)	-	-	-	-	-	89(14)
160	Tolo Place Block 4	-	88(13)	-	84(9)	-	-	-	-	-	90(15)

Note: Figure in bracket indicates the level of noise exceedance.

Table 4.4q Ma On Shan to Lee On - Predicted Unmitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
162	Bayshore Towers Block 3	-	78(3)	-	86(11)	-	89(14)	-	-	-	91(16)
164	Fu Fai Garden Block 1	-	83(8)	-	83(8)	-	72	-	-	-	86(11)
167	Ma On Shan Health Care & Elderly Centre *	-	90(20)	-	70	-	-	-	-	-	90(20)
170	Villa Athena Block 5	-	85(10)	-	-	-	-	-	-	-	85(10)
171	Saddle Ridge Garden Block 5	-	81(6)	-	-	-	-	-	-	-	81(6)
173	Caritas Ma On Shan Practical School	-	84(14)	-	-	-	-	-	-	-	84(14)
174	Wu Kwai Sha New Village Nos. 1-3	-	81(6)	-	-	-	-	-	-	-	81(6)
175	Lung Sing House, Kam Lung Court	-	82(7)	67	-	-	-	-	-	-	82(7)
177	Lee Wing House, Lee On Estate	-	86(11)	73	73	72	-	-	-	-	87(12)
179	Residential Development to the East of Lee On Estate (WIP)	-	73	72	88(13)	95(20)	-	-	-	-	95(20)
180	Li Po Chun United World College	-	70	-	68	-	-	-	-	-	72(2)

Note: Figure in bracket indicates the level of noise exceedance.

(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

4.4.4 Evaluation of Unmitigated Impacts

Hin Keng to Tai Wai

Predicted construction noise levels at the NSRs within this section of the proposed MOS Extension are shown in *Table 4.4i*. Noise impacts in the range of 1 to 17 dB(A) were predicted at nearby residential and educational uses. The maximum noise level predicted was 87 dB(A) at Christian Alliance School (NSR 21). This resulted from excavation activities during box culvert construction. Due to the limited buffer distance, this NSR will also be impacted by excavation works associated with the construction of the minor retaining wall during the alignment construction. These works are predicted to result in a noise exceedance of 8 dB(A).

High noise levels were also predicted at Sha Tin Tsung Tsin Secondary School & Ng Yuk Secondary School (NSR 28) during station construction and road improvement works (construction of public transport interchange), with predicted exceedances of 8 dB(A) beyond the assessment criterion. The noisiest activities identified were excavation works and pile cap construction. Predicted worst case cumulative noise impacts for this section were in the range of 1 to 18 dB(A).

Tai Wai to Sha Tin Tau

During the construction of this section of the proposed alignment, adverse construction noise impacts would be likely at the identified NSRs as indicated in *Table 4.4j*. The range of predicted construction noise impacts was 1 to 9 dB(A), whilst the predicted worst case cumulative noise impacts were in the range of 4 to 12 dB(A). Koo Arm Temple (NSR 41) will be the worst affected NSR, with a predicted exceedance of 9 dB(A) above the construction noise limit during pile cap construction for the viaduct structures.

Noise impacts are also predicted at NSR 41, Lei Uk Tsuen No. 11-15 (NSR 42) and Shek Yuk House of Chun Shek Estate (NSR 50) with exceedances of up to 8 dB(A) during pile cap construction for the proposed station. Excavation works during box culvert construction will generate noise impacts at NSR 50, with a noise exceedance of 8 dB(A). Road improvement works identified within this section will results in noise impacts of up to 4 dB(A) at the Immaculate Heart of Mary School (NSR 43) and NSR 50.

Sha Tin Tau to Sha Kok Street

Adverse impacts from the construction of the proposed alignment from Sha Tin Tau to Sha Kok Street would be expected as shown by the predicted results in *Table 4.4k*. Most of the NSRs would experience noise levels exceeding the daytime limit, particularly during the pile cap and superstructure construction stages.

A maximum level of 90 dB(A) was predicted at Pok Man House of Pok Hong Estate (NSR 62) during pile cap construction for the viaduct structures. In terms of predicted

noise impact, Tin Ka Ping Salvation Army Primary School (NSR 64) would be impacted, with the predicted noise level exceeding the daytime construction noise limit by 19 dB(A) during pile cap construction for the viaduct structures. The level of impact would be increased during the examination periods. Construction impacts in the region of 1 to 10 dB(A) would be likely during station construction. An exceedance of 10 dB(A) was predicted at Pok Tai House of Pok Hong Estate (NSR 75) during pile cap construction for the proposed station. Noise impacts of up to 7 dB(A) were also predicted in conjunction with the road improvement works. Worst predicted cumulative noise impacts were in the range of 3 to 18 dB(A).

Sha Kok Street to City One Shatin

Exceedances of up to 24 dB(A) at the identified NSRs were predicted within this section of the proposed alignment during the pile cap construction for viaduct structures. With reference to the prediction results stated in *Table 4.4l*, Pamela Youde Child Assessment Centre and School Dental Clinic (NSR 97) would be the worst impacted during pile cap construction, with a predicted noise level of 94 dB(A). However, the clinic has already been equipped with centralised air conditioning with only a few, deeply recessed windows facing south, thus, noise impacts to this NSR during the construction phase would be limited.

The sensitive operations of the Child Assessment Centre of NSR 97 such as hearing tests are conducted in specified acoustic rooms that are not directly facing the proposed alignment. Therefore, no noise exceedances would be expected. Notwithstanding this, the Contractor will be required by the Particular Specification for the works to ensure that the works do not give rise to unacceptable groundborne and airborne noise levels in accordance with ANSI S3.1-1991 (Maximum Permissible Ambient Noise Levels for Audiometric Test Room). The Contractor will also be required to monitor noise levels continuously at this location and stop works should the ANSI S3.1-1991 criteria be exceeded at any time required for audiometric testing.

The Prince of Wales Hospital is also equipped with centralised air-conditioning and fixed window glazing, consequently, noise impacts are not expected at this NSR.

For the construction of the special long span structure over Sha Tin Road, a noise exceedance of 11 dB(A) has been predicted at Wong Clan Ancestral Hall. Construction works for the proposed City One Station will lead to adverse noise impacts in the range of 8 to 11 dB(A) at Oriole House of Sha Kok Estate, Yue Kwan House of Yue Tin Court, and the planned residential development next to Chap Wai Kon Street. The construction of the proposed footbridge will also lead to a noise impact of approximately 4 dB(A) at Yue Kwan House of Yue Tin Court. Predicted worst case cumulative noise impacts for this section are in the range of 8 to 15 dB(A).

City One Shatin to Shek Mun

In the vicinity of the alignment, most of the schools and residential developments will be adversely impacted by construction noise as shown in *Table 4.4m*. A maximum level of

86 dB(A) has been predicted during the pile cap construction activities at Lam Kau Mow Secondary School (NSR 109) and Yau Kam Yuen Prevocational School (NSR 102).

During the construction phase of City One Station, the maximum noise level predicted was 89 dB(A) at Yau Kam Yuen Prevocational School (NSR 102). Lam Kau Mow Secondary School will also be impacted by the construction works, with a predicted noise exceedance of 13 dB(A). Worst case cumulative noise exceedances of up to 20 dB(A) were predicted for this section.

Shek Mun to Chevalier Garden

NSRs identified within this section of the proposed alignment will be affected by both the at-grade alignment construction and the standard viaduct construction. For those NSRs close to the at grade section, exceedances of up to 8 dB(A) have been predicted and are shown in *Table 4.4n*. A maximum noise level of 78 dB(A) was predicted at Juniper Court of Pictorial Garden (NSR 123) and Sha Tin Hospital (NSR 124). Sha Tin Hospital has been equipped with fixed window glazing and has centralised air-conditioning; noise impacts at this NSR are therefore not expected. For those NSRs close to the elevated section, a maximum noise exceedance of 9 dB(A) has been predicted at Ma On Shan Tsung Tsin Secondary School (NSR 133).

During construction of Chevalier Garden Station, noise impacts of up to 3 dB(A) have been predicted at Ma On Shan Tsung Tsin Secondary School and Kam Tai Court (NSR 135) during piling, pile cap and superstructure construction. Adverse noise impacts of about 4 dB(A) are also predicted at identified NSRs from road improvement and subway construction works. The range of worst case cumulative noise impacts was 1 to 11 dB(A), depending on the separation distance and the type of works concerned.

Chevalier Garden to Heng On

Adverse noise impacts from construction activities are likely at the NSRs within this section of the alignment as shown in *Table 4.4o*. A maximum noise level of 91 dB(A) was predicted at the Chinese YMCA College (NSR 142), due to the excavation works associated with the construction of the subway. With regard to the works associated with standard viaduct construction, the range of noise impacts predicted was 2 to 18 dB(A) at the selected NSRs. A maximum noise exceedance of 17 dB(A) was also predicted at NSR 142 due to the pile cap construction for the proposed Heng On Station. Noise exceedance of about 1 dB(A) have been predicted at the Residential Development at Area 77 (NSR 136) during pile cap and superstructure construction for the special long span viaduct section, as shown in *Table 4.4o*.

Road improvement works at Sai Sha Road are also predicted to generate noise impacts in the range of 9 to 17 dB(A) at the proposed Residential Development at Area 90B, Ngan On House of Kam On Court and the Chinese YMCA College. The noisiest activities identified were excavation works, placement of road base and road paving activities. The worst case predicted cumulative noise impacts for this section were in the range of 3 to 25 dB(A).

Heng On to Ma On Shan

Most of the identified NSRs within this section of the proposed development would be impacted by construction noise. Noise exceedances in the region of 2 to 13 dB(A) were predicted as shown in *Table 4.4p*. A maximum noise level of 88 dB(A) was predicted at Tolo Place Block 4 (NSR 160) during the pile cap construction works.

During the construction of Ma On Shan Station, adverse noise impacts, in the range of 1 to 13 dB(A), would be likely at most of the NSRs. A maximum noise level of 88 dB(A) was predicted at Sun Shine City Block M (NSR 159). Cumulative noise impacts were predicted to be in the range of 6 to 15 dB(A) for this section of the alignment.

Ma On Shan to Lee On

Adverse noise impacts were predicted for this section of alignment. Works from viaduct construction are predicted to lead to noise impacts in the range of 6 to 20 dB(A), especially during pile cap construction. Within this section of the alignment, a maximum noise level of 90 dB(A) was predicted at the Ma On Shan Health Care and Elderly Centre (NSR 167). Given the fact that fixed window glazing and centralised air-conditioning units have been installed at this NSR, noise impacts during the construction phase are not expected. With reference to the predicted results in *Table 4.4q*, the range of predicted noise impacts during station construction is 8 to 13 dB(A). The residential development to the east of Lee On Estate (NSR 179) will also be impacted by the works with a predicted exceedance of 13 dB(A) above the noise limit.

Road improvements works next to the proposed Lee On Station are predicted to generate a noise impact of up to the 20 dB(A) above the assessment criteria at NSR 179. The worst predicted cumulative noise impacts are predicted to be in the range of 2 to 20 dB(A) for this section.

4.4.5 Mitigation Measures

The predicted noise levels in the preceding section show that construction activities are likely to give rise to adverse daytime noise impacts at most of the identified NSRs. Mitigation measures are therefore required and the following forms of mitigation have been considered:

- use of good site practice to limit noise emissions at source;
- use of quiet plant and working methods;
- use of temporary and movable noise barriers; and
- reduction in the number of plant operating in critical areas close to NSRs.

Use of Quiet Plant and Working Methods

The use of quiet plant is identified to be a feasible solution to tackle the adverse impacts associated with the construction works. The Contractor would be able to obtain particular models of plant that are quieter than the noise levels stated in GW-TM. The benefits achievable in this way will depend on the Contractor's chosen construction methods, and it is considered too restrictive to specify that the Contractor has to use specific models or items of plant for the construction operations. It is therefore both preferable and practical to specify an overall plant noise performance specification in terms of the total SWL for all PME on site so that the Contractor is allowed some flexibility to select plant to suit his needs.

Quiet PME is defined as PME whose actual SWL is less than the value specified in GW-TM for the same item of plant. *Table 4.4r* provides examples of specific silenced PME which is known to be available, together with details of the corresponding SWLs of the plant as taken from the British Standard *Noise Control on Construction and Open Sites. BS 5228:Part 1:1997*. The information provided in this report regarding the SWLs of silenced equipment is for reference only. The total SWLs for each construction activity with the recommended silenced PMEs are detailed in *Annex D* of *Volume 2 - Technical Annexes*.

Table 4.4r Sound Power Levels for Specific Silenced PME

PME	BS 5228		SWL dB(A)	Relative Size or Power Rating (where applicable)
	Table No.	Ref. No.		
Excavator	C3	79	101	52kW
Lorry	C7	121	98	10t
Concrete Lorry Mixer	C6	35	100	$5m^3$
Poker Vibrator, Hand-held	C6	32	100	-
Grader	C3	76	111	-
Roller, Vibratory	C3	116	106	50kW
		115	102	9kW
Air Compressor	C7	25	98	$7m^3$/min
Mobile Crane	C7	109	103	56kW
Loader	C3	97	105	52kW
Road Roller	C3	114	108	5kW
Concrete Pump	C6	36	106	100kW

*Remark: BS 5228:Part 4:1992 refers

Some of the noisiest construction activities include excavation works, placement of road base and road paving in which dump trucks have been proposed to be used. In order to reduce the level of noise emissions from these activities, lorries have been recommended, and agreed with KCRC, as a suitable replacement. In addition, mini-concrete cruncher was also recommended in this Study to substitute hand-held breaker for any concrete breaking activities in pile cap construction, excavation works for foundation and preparation of formation. It is believed that these plant substitutions can satisfy the functional and operational requirements of construction activities and at the same time, reduce the level of noise impact at nearby NSRs.

It should be noted that whilst various types of silenced equipment can be found in Hong Kong, the Noise Control Authority, when processing a CNP application, will apply the noise levels specified in the GW-TM, unless the noise emission of a particular piece of equipment can be validated by certificate or demonstration. The onus is therefore placed on the Contractor to prove that his plant deployment meets with the quiet plant noise levels should he choose this method of noise mitigation. With the use of quiet plant on site, the overall noise reduction in the worst case predicted unmitigated noise levels would be 2 to 16 dB(A) depending on the type of quiet plant selected.

Temporary and Movable Noise Barriers

Movable barriers that can be located close to noisy plant can be very effective at screening NSRs from particular items of plant or noisy operations. Movable barriers of 3 to 5 m height with a small cantilevered upper portion and skid footing can be located within a few metres of static plant and within about 5 m or more of mobile equipment such as excavator and mobile crane etc such that the line of sight is blocked by the barriers viewed from the NSRs. It would be possible for the Contractor to provide purpose-built noise barriers or screens constructed of appropriate material (minimum superficial density of 15 kg/m^2) located close to operating PME, in order to reduce the noise impact to the surrounding sensitive uses. Certain types of PME, such as generators and compressors, can be completely screened by portable barriers giving a total noise reduction of 10 dB(A) or more.

Based on the NSR heights and site geometry, it is estimated that movable noise barriers of this type can achieve a 10 dB(A) noise reduction for static plant and 5 dB(A) noise reduction for mobile plant provided that they are properly arranged before any activities proceed. The noise screening benefit for the general plant types considered in this study is listed as follows:

- stationary plant - 10 dB(A) screening for PME such as air compressor, water pump, generator, concrete pump, winch, bar bender, vibratory compactor and poker vibrator; and
- mobile plant - 5 dB screening for PME such as excavator, loader, truck mixer, roller, mini-concrete cruncher, asphalt paver and mobile crane.

Any barriers designed by the contractor should satisfy this noise performance in order to control the emission of noise from PME. The Contractor should pay particular attention to ensure barriers are close fitting around plant items thereby gaining greater benefit, but, since this cannot be guaranteed such measures are left to the Contractor's own planning of the construction works.

Reducing the Numbers of Plant Operating in Critical Areas Close to NSRs

In general the number of plant should be left to the choice of the Contractor so that in combination with the selection of quiet plant, any further reduction in the total plant noise level, or the site specific maximum sound power levels, as described above, can be achieved. It will be appropriate to restrict the number of operating PME within certain parts of the site that are very close to the NSRs in order to reduce the level of noise impacts. This method could be more effective for activities associated with foundation work, station box and excavation activities in which a large number of PME are anticipated, but not all of them would be utilised at the same time. A noise reduction of up to 6 dB(A) could be achieved if the number of PME used on site is reduced to one, as estimated from the predicted values.

Assessment of Construction Noise with Mitigation Measures

Without mitigation measures, construction activities associated with the MOS Extension are predicted to cause exceedances of the 75 dB(A) and 70 dB(A) limits at most of the NSRs. In addition to the use of good site practice, three mitigation packages, as outlined below, have been reviewed and considered in this EIA Study to develop the required control measures for tackling the predicted noise impacts:

- M1 - Use of Quiet/Silenced PMEs;
- M2 - M1 with the use of temporary noise barriers; and
- M3 - M2 with reduction in the number of operating PME.

As it is considered too restrictive to insist that the Contractor uses specific items of plant, recommendations for mitigation to achieve the applicable noise criterion have been specified as a combination of noise barriers and a plant noise performance specification. This performance specification requires the Contractor to incorporate 'quiet' plant not exceeding the SWL as given above or reduced plant inventories into construction activities so that noise levels at nearby NSRs are kept below the relevant noise level.

The noise levels with the implementation of the proposed mitigation measures have been predicted and investigated. The predicted mitigated noise levels are described below and the results are shown in *Tables 4.4s-aa.*

Table 4.4s Hin Keng to Tai Wai - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
2	Keng Hau Road No.20-22	65/-/-	-	-	69/-/-	-	-	-	-	-	70/-/-
5	Hin Hing House, Hin Keng Estate	61/-/-	-	-	62/-/-	-	-	-	-	-	65/-/-
7	Hin Yeung House, Hin Keng Estate	63/-/-	-	-	61/-/-	-	-	-	-	-	65/-/-
9	Carmel Alison Lam Primary School	62/-/-	-	-	62/-/-	-	-	-	-	-	65/-/-
12	Scattered Residential Properties	69/-/-	-	-	66/-/-	-	-	-	-	-	71/-/-
13	Sha Tin Garden	63/-/-	-	-	63/-/-	-	-	-	-	-	66/-/-
16	Carado Garden Block 3	60/-/-	-	-	63/-/-	-	-	54/-/-	-	-	65/-/-
18	Scattered Residential Properties	73/-/-	-	-	68/-/-	-	-	53/-/-	-	-	74/-/-
20	Tin Sam Village Nos. 184-187	63/-/-	-	-	68/-/-	-	-	62/-/-	-	-	70/-/-
21	Christian Alliance School	71(1)/70/70	-	-	67/64/58	-	-	73(3)/69/69	-	-	76(6)/73(3)/ 73(3)
23	Holford Garden	64/-/-	-	-	62/-/-	-	-	59/-/-	-	-	67/-/-
24	Grandway Garden Block 2	-	67/-/-	-	73/-/-	-	-	-	60/-/-	-	74/-/-
26	Sun Ming House, Sun Chui Estate	-	59/-/-	-	64/-/-	-	64/-/-	-	-	-	68/-/-
28	Sha Tin Tsung Tsin Secondary School & Ng Yuk Sec. School	-	63/59/54	64/60/55	68/65/59	70/69/69	61/54/54	-	-	-	74(4)/71(1)/ 70

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4t Tai Wai to Sha Tin Tau - Mitigated Construction Noise Level (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
34	Man Lai Court, Block 2	-	67/-/-	66/-/-	64/-/-	66/-/-	-	-	-	-	72/-/-
38	San Tin Village	-	62/-/-	63/-/-	64/-/-	63/-/-	-	-	-	-	69/-/-
41	Koo Arm Temple	-	67/64/-	-	69/65/-	-	-	-	58/55/-	-	71(1)/68/-
42	Lei Uk Tsuen No. 11-15	-	71/-/-	-	72/-/-	-	-	-	59/-/-	51/-/-	75/-/-
43	Immaculate Heart of Mary School	-	65/62/-	59/55/-	65/61/-	66/66/-	-	-	-	-	71(1)/68/-
50	Shek Yuk House, Chun Shek Estate	-	68/65/-	-	72/68/-	70/70/-	-	69/65/-	62/59/-	56/53/-	76(1)/74/-

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4u Sha Tin Tau to Sha Kok Street - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
52	Sha Tin Tau No.3-5	-	74/70/-	-	67/63/-	74/73/-	-	58/54/-	53/51/-	54/51/-	77(2)/75/-
53	Ecclesia Bible College	-	63/-/-	-	63/-/-	64/-/-	-	53/-/-	51/-/-	56/-/-	69/-/-
55	Tsang Tai Uk	-	68/-/-	-	-	64/-/-	-	-	-	-	69/-/-
57	L.S.T. Chan Co Chak Primary School	-	71(1)/68/-	-	-	-	-	-	-	-	71(1)/68/-
58	Ming Shun Lau, Jat Min Chuen	-	63/-/-	-	-	-	-	-	-	-	63/-/-
62	Pok Man House, Pok Hong Estate	-	78(3)/75/-	-	60/56/-	-	-	-	-	-	78(3)/75/-
64	Tin Ka Ping Salvation Army Primary School	-	77(7)/73(3)/68	-	62/58/52	-	-	-	-	-	77(7)/73(3)/68
65	Pok Tat House, Pok Hong Estate	-	65/-/-	-	63/-/-	-	-	-	-	-	67/-/-
67	Ming Yan House, Jat Min Chuen	-	73/-/-	-	67/-/-	-	-	-	-	-	74/-/-
69	Pok Yue House, Pok Hong Estate	-	72/69/-	-	75/71/-	-	-	-	-	-	77(2)/73/-
75	Pok Tai House, Pok Hong Estate	-	65/61/-	-	76(1)/72/-	-	-	-	-	-	76(1)/73/-
77	Osprey House, Sha Kok Estate	-	65/-/-	-	67/-/-	-	-	-	-	-	69/-/-
78	Sand Martin House, Sha Kok Estate	-	67/-/-	-	71/-/-	-	-	-	-	-	73/-/-

Note: Figure in bracket indicates the level of noise exceedance. Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4v Sha Kok Street to City One Shatin - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
83	Sha Tin Wai Nos.1-2	-	71/-/-	-	66/-/-	-	-	-	-	-	72/-/-
84	Oriole House, Sha Kok Estate	-	72/68/-	-	74/70/-	-	-	-	-	-	76(1)/72/-
86	Ashley Garden	-	74/-/-	56/-/-	60/-/-	-	-	-	-	-	74/-/-
88	Iris Garden	-	76/73/-	59/55/-	59/55/-	-	-	-	-	-	76(1)/73/-
90	Caritus H.W.Lee Care & Attention Centre	-	73(3)/70/-	62/58/-	-	-	-	-	-	-	74(4)/70/-
92	Wong Uk Village Nos. 3-4	-	73/-/-	67/-/-	-	-	-	-	-	-	74/-/-
92a	Wong Clan Ancestral Hall	-	70/66/-	70/67/-	-	-	-	-	-	-	73(3)/70/-
93	Green Leaves Garden Block B	-	73/69/-	73/69/-	-	-	-	-	-	-	76(1)/72/-
94	Prince of Wales Hospital *	-	70/66/-	71(1)/67/-	61/57/-	-	-	-	-	-	74(4)/70/-
96	Prince of Wales Hospital Accommodation	-	60/-/-	57/-/-	62/-/-	-	-	-	-	-	65/-/-
97	Pamela Youde Child Assessment Centre/ School Dental Clinic *	-	82(12)/79(9)/74(4)	60/56/51	72(2)/69/63	-	70/62/62	-	-	-	83(13)/79(9)/74(4)
100	Yue Kwan House, Yue Tin Court	-	68/65/-	56/53/-	76(1)/72/-	-	67/60/-	-	-	-	77(2)/73/-
101	Residential Development (WIP)	-	75/71/-	-	77(2)/73/-	-	61/53/-	-	-	-	79(4)/75/-

Note: Figure in bracket indicates the level of noise exceedance.
Predicted Noise Levels with Mitigation M1/M2/M3.
(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

Table 4.4w City One Shatin to Shek Mun - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
102	Yau Kam Yuen Prevocational School	-	74(4)/70/65	-	79(9)/76(6)/70	-	56/49/49	-	-	-	80(10)/77(7)/71(1)
109	Lam Kau Mow Secondary School	-	75(5)/71(1)/66	-	74(4)/70/64	-	54/46/46	-	-	-	77(7)/74(4)/68
110	City One Shatin Block 36	-	69/-/-	-	65/-/-	-	-	-	-	-	70/-/-
111	City One Shatin Block 33	-	73/-/-	-	59/-/-	58/-/-	-	-	-	-	73/-/-
113	Planned Residential Development	-	68/-/-	-	71/-/-	71/-/-	-	-	-	57/-/-	75/-/-

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4x Shek Mun to Chevalier Garden - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
123	Pictorial Garden Juniper Court	71/-/-	-	-	-	-	-	-	-	-	71/-/-
124	Shatin Hospital *	71(1)/70/-	-	-	-	-	-	-	-	-	71(1)/70/-
126	Shatin Hospital Quarters	73/-/-	-	-	-	-	-	-	-	-	73/-/-
128	Fisherman's New Village No.113	69/-/-	-	-	-	-	-	-	-	-	69/-/-
129	Fisherman' New Village No.3-4	70/-/-	-	-	-	-	-	-	-	-	70/-/-
133	Ma On Shan Tsung Tsin Secondary School	-	68/64/-	-	64/60/-	65/64/-	-	-	58/56/-	-	71(1)/68/-
134	Tai Shui Hang Village No. 1-3	-	62/-/-	-	66/-/-	65/-/-	-	-	64/-/-	-	71/-/-
135	Kam Tai Court Block J (WIP)	-	65/-/-	-	69/-/-	71/-/-	-	-	64/-/-	-	74/-/-

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

Table 4.4y Chevalier Garden to Heng On - Mitigated Predicted Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
136	Proposed Residential Development on Area 77	-	68/-/-	65/-/-	68/-/-	71/-/-	-	-	54/-/-	-	75/-/-
137	Proposed Residential Development to the South of Vista Paradise	-	71/-/-	-	64/-/-	64/-/-	-	-	50/-/-	57/-/-	73/-/-
138	Proposed Residential Development east of Area 86B	-	65/-/-	57/-/-	59/-/-	-	-	-	-	-	67/-/-
139	Proposed Health & Welfare Building and Undesignated Site "G" on Area 90B	-	72/68/63	-	74/70/64	77(2)/76(1)/76 (1)	-	-	76(1)/73/72	57/54/54	81(6)/79(4)/78(3)
140	Ngan On House, Kam On Court	-	65/61/57	-	75/71/65	76(1)/75/75	-	-	58/55/53	57/54/54	79(4)/77(2)/76(1)
142	Chinese YMCA College	-	76(6)/72(2)/68	-	78(8)/75(5)/68	79(9)/78(8)/ 78(8)	-	-	77(7)/74/73	57/54/54	84(14)/82(12)/80(10)

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4z Heng On to Ma On Shan - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
144	Vista Paradise	-	75/71/-	-	69/65/-	69/68/-	-	-	59/56/-	57/54/-	77(2)/74/-
146	Toi Shan Association Wong Tat To Memorial School	-	70/66/-	-	61/58/-	61/60/-	-	-	53/50/-	58/54/-	71(1)/68/-
149	St. Francis Church	-	68/-/-	-	59/-/-	-	-	-	-	50/-/-	69/-/-
153	Ma On Shan Area 90 Phase 6 Development	-	74/-/-	-	59/-/-	-	-	-	-	-	74/-/-
156	The Waterside	-	69/-/-	-	61/-/-	-	-	-	-	-	70/-/-
158	Sun Shine City Block L	-	69/-/-	-	69/-/-	-	-	-	-	-	72/-/-
159	Sun Shine City Block M	-	72/68/63	-	78(3)/75/69	-	-	-	-	-	79(4)/76(1)/70
160	Tolo Place Block 4	-	76(1)/73/-	-	75/71/-	-	-	-	-	-	79(4)/75/-

Note: Figure in bracket indicates the level of noise exceedance.

Predicted Noise Levels with Mitigation M1/M2/M3.

Table 4.4aa Ma On Shan to Lee On - Mitigated Construction Noise Levels (dB(A))

NSR	Description	Max. PNL - At-grade, Alignment Construction	Max. PNL - Standard Viaduct Construction	Max. PNL - Special Long Span Viaduct Construction	Max. PNL - Station Construction	Max. PNL - Road Improvement	Max. PNL - Footbridge Construction	Max. PNL - Box Culvert Construction	Max. PNL - Subway Construction	Max. PNL - Works Area for Railway System Contractors	Worst Case Max. Cumulative PNL
162	Bayshore Towers Block 3	-	66/63/-	-	76(1)/73/-	-	77(2)/69/-	-	-	-	80(5)/75/-
164	Fu Fai Garden Block 1	-	72/68/-	-	74/70/-	-	60/52/-	-	-	-	76(1)/72/-
167	Ma On Shan Health Care & Elderly Centre *	-	79(9)/75(5)/70	-	61/57/51	-	-	-	-	-	79(9)/75(5)/70
170	Villa Athena Block 5	-	74/-/-	-	-	-	-	-	-	-	74/-/-
171	Saddle Ridge Garden Block 5	-	69/-/-	-	-	-	-	-	-	-	69/-/-
173	Caritas Ma On Shan Practical School	-	72(2)/69/-	-	-	-	-	-	-	-	72(2)/69/-
174	Wu Kwai Sha New Village Nos. 1-3	-	69/-/-	-	-	-	-	-	-	-	69/-/-
175	Lung Sing House, Kam Lung Court	-	70/-/-	56/-/-	-	-	-	-	-	-	70/-/-
177	Lee Wing House, Lee On Estate	-	75/71/-	62/59/-	64/60/-	64/63/-	-	-	-	-	76(1)/72/-
179	Residential Development to the East of Lee On Estate (WIP)	-	61/57/53	62/58/53	78(3)/75/69	87(12)/86(11)/86(11)	-	-	-	-	87(12)/86(11)/86(11)
180	Li Po Chun United World College	-	58/-/-	-	59/-/-	-	-	-	-	-	62/-/-

Note: Figure in bracket indicates the level of noise exceedance.
Predicted Noise Levels with Mitigation M1/M2/M3.
(*) NSR equipped with fixed window glazing and centralised air-conditioning units.

Good Site Practices

Whilst the effects are not easily quantifiable, good site practices and noise management can considerably reduce the impact of construction activities on nearby NSRs. The following measures should be followed during each phase of construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme;
- machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or throttled down to a minimum;
- plant known to emit noise strongly in one direction, should, where possible, be orientated so that the noise is directed away from nearby NSRs;
- silencers or mufflers on construction equipment should be properly fitted and maintained; and
- mobile plant should be sited as far away from NSRs as possible.

The noise benefits of these techniques can vary according to specific site conditions and operations, and while they would provide some attenuation, they cannot be assumed to guarantee a precise level of noise mitigation; these "good house keeping" measures will be implemented and enforced by contract administration.

Hin Keng to Tai Wai

Potential adverse noise impacts associated with the at-grade alignment construction, viaduct construction, station construction, footbridge and subway construction and road improvement works in this section can, in most cases, be controlled with the use of quiet plant (Mitigation Package M1). For the works close to Christian Alliance School, such as at-grade alignment construction and construction of box culvert, Mitigation Package M2 is required in order to reduce the predicted noise impact.

Residual cumulative noise impacts of up to 3 dB(A) have been predicted at Christian Alliance School (NSR 21), even with the implementation of Mitigation Package M3. These impacts can be eliminated by avoiding simultaneous activities associated with the construction of the proposed box culvert, the proposed station and the road improvement works in the vicinity of this NSR.

Site inspection has revealed that this school has already been provided with steel-framed openable window glazing and air-conditioning units. It is considered that with this configuration and with the windows kept closed during the Project's construction phase, a noise reduction of about 10 dB(A) can be achieved; insitu testing will be undertaken to ensure adequate glazing provision to the school. However, mitigation measures to control noise emission from construction activities should be considered at the first place and employed on-site in order to reduce the potential noise nuisance.

Tai Wai to Sha Tin Tau

With the implementation of Mitigation Package M1 (use of quiet plant), all the identified adverse noise impacts at nearby NSRs during viaduct construction, station construction, road improvement works, construction of box culvert and the proposed subway can be mitigated. Cumulative noise impacts previously identified can be mitigated with Mitigation Package M2 (use of quiet plant and noise barriers). Residual noise impacts at all the identified NSRs within this section are not expected with the implementation of the recommended mitigation measures.

Sha Tin Tau to Sha Kok Street

Noise impacts due to the construction of viaduct would be mitigated with the use of quiet construction equipment, noise barrier and by reducing the number of operating equipment on site (Mitigation Package M3). Mitigation Package M1 is also recommended to eliminate the noise impacts from road improvement works, construction of box culvert and subway, as indicated in *Table 4.4u*. During the construction of station structure, Mitigation Package M2 is required, especially for the works close to Pok Hong Estate.

The predicted residual cumulative noise impacts can be mitigated by avoiding simultaneous construction activities being undertaken at work sites close to the affected NSRs through appropriate planning and scheduling of construction works. With the suggested mitigation measures in place, no residual noise impacts are likely.

Sha Kok Street to City One

As indicated in *Table 4.4v*, Mitigation Package M2 (use of quiet plant and noise barrier) is recommended to reduce the noise impacts arising from the construction of viaduct and station structure. Although residual noise impact was predicted at NSR 97 (Pamela Youde Child Assessment Centre/School Dental Clinic), the potential noise nuisance would be unlikely as this NSR has already been equipped with centralised air conditioning and fixed window glazing.

The use of quiet plant (Mitigation Package M1) is recommended to reduce the noise impacts from the construction of the special long span structures and the proposed footbridge. Cumulative noise impacts previously identified can be mitigated through the implementation of Mitigation Package M2. As an alternative to package M2, the cumulative noise impacts can also be eliminated by preventing simultaneous construction activities near the affected NSRs with specific mitigation measures taken in place at specific location.

City One Shatin to Shek Mun

As indicated in *Table 4.4w*, after the implementation of Mitigation Package M3 (use of quiet plant, noise barrier and by reducing the number of operating construction equipment) for viaduct and station construction, all the predicted noise impacts at the

nearby schools (NSRs 102 and 109) would be reduced to within the acceptable noise limit during daytime construction period.

Other NSRs within this section would be protected with Mitigation Package M1 (use of quiet plant) for viaduct construction, station construction, road improvement works and footbridge construction. To address the cumulative noise impacts during the construction phase of the Project, avoidance of simultaneous construction activities near the schools are recommended together with the proposed control measures.

Shek Mun to Chevalier Garden

Potential noise impacts in this section, which are predicted to result from the works associated with the alignment construction, the construction of Chevalier Garden station, the road improvement works and the subway construction works, can be controlled with the use of quiet plant and movable barriers (Mitigation Package M2). No residual noise impacts have been identified for this section.

Chevalier Garden to Heng On

For the alignment and station construction within this section of the proposed MOS Extension, the full Mitigation Package M3 (use of quiet plant, noise barrier and reducing the number of operating equipment) is required especially for the works close to NSR 142 (Chinese YMCA College). Mitigation Package M2 (use of quiet plant and noise barriers) is also required during subway construction in order to reduce the likely construction noise nuisance on the nearby sensitive uses.

As indicated in *Table 4.4y*, after exhausting all the possible direct mitigation measures, residual noise impacts are predicted at NSR 142 and at the proposed development on Area 90B (NSR 139) during road improvement works. Due to the small buffer distances, the excavation works, levelling of road and road paving activities in road improvement works would lead to residual noise impacts at these NSRs. The expected time period of noise impacts at these NSRs would be about one to two months, dependent on the actual construction programme of the works.

Site inspection has revealed that NSR 142 is equipped with steel-framed openable window glazing only. It is therefore recommended to provide appropriate window glazing and air-conditioning units to this school, as a last resort to mitigate the noise impacts during the construction phase. The schedule of the required indirect technical remedies should be defined during the detailed design stage and implemented by KCRC. For the predicted residual noise impacts at NSR 139 (1 dB(A) beyond the daytime noise standard), it is expected that the time period of the exceedance will be short, in comparison with the construction of the whole railway extension. It is believed that detailed information on construction sequence, construction method and programme will be available after the detailed design stage and an effective Environmental Management Plan would be developed by the Contractor in order to ensure no adverse noise impacts from the works. It is the Contractor's responsibility to ensure his recommended measures are practical and at the same time can fulfill the requirement of the construction

programme. The Contractor should seek to develop other alternatives or other quieter working method in order to reduce the predicted noise nuisance at this NSR.

The noise impacts caused by the works for the special long span viaduct would be well mitigated by using quiet/silenced equipment. To address the cumulative noise impacts during the construction phase of the Project, avoidance of simultaneous construction activities near NSRs 139, 140 and 142 are recommended.

Heng On to Ma On Shan

After the implementation of the Mitigation Package M2 (use of quiet plant and noise barriers) for viaduct and station construction, no residual noise impacts were predicted at the identified NSRs. Regarding the works for the road improvement and subway construction, the use of quiet plant is recommended. No residual noise impacts have been identified for this section.

Ma On Shan to Lee On

In order to reduce the noise impacts caused by the construction works, Mitigation Package M2 (use of quiet plant and noise barriers) is recommended for viaduct construction, station construction and the construction of footbridge. Residual noise exceedance of up to 11 dB(A) was predicted at NSR 179 (Residential Development to the East of Lee On Estate), as a result of the works associated with road improvement. Due to the small buffer distance, excavation works, levelling of road and road paving activities in the road improvement stage would lead to residual noise impact at this NSR. It is expected that the duration of the noise exceedances will be about one to two months, dependent on the actual construction programme of the works. It is believed that detailed information on construction sequence, construction method and programme will be available after the detailed design stage and an effective Environmental Management Plan would be developed by the Contractor in order to ensure no adverse noise impacts from the works. It is the Contractor's responsibility to ensure his recommended measures are practical and at the same time can fulfill the requirement of the construction programme. The Contractor should develop other alternatives or other quieter working method for these works in order to reduce the noise impact.

The Ma On Shan Health Care & Elderly Centre has already been provided with fixed window glazing and air-conditioning, noise impacts at this NSR are not expected. To address the cumulative noise impacts during the construction phase of the Project, avoidance of simultaneous construction activities near NSR 179 is recommended.

4.4.6 Cumulative and Residual Impacts

Cumulative impacts from the construction works would result if the noisiest construction activities were undertaken concurrently at any two or more construction sites close to the NSRs. It is therefore recommended to avoid simultaneously noisy activities to eliminate the cumulative noise impact. This is especially critical at the sections from Sha Kok Street to City One Shatin, and during the construction of the City One Shatin station: the

alignment section from Chevalier Garden to Heng On; the alignment from Heng On to Ma On Shan and the construction of Ma On Shan station; and the work sites between Ma On Shan to Lee On. It is recommended that noisy plant should not be operated concurrently at the above work sites which are adjacent to each other.

Residual noise impacts have been identified at the proposed development on Area 90B (NSR 139), Chinese YMCA College (NSR 142) and the residential development to the east of Lee On Estate (NSR 179) as shown in *Table 4.4bb* below arising from road improvement works. The existing glazing systems of the effected school and health centre should be reviewed by insitu testing during the detailed design stage and should be upgraded if necessary in order to protect these sensitive premises. The construction methodology and construction equipment to be used on site for road improvement works should also be reviewed when more detailed information is available (ie. in the detailed design stage), and a more effective mitigation package should be sought by the Contractor to reduce the predicted residual impacts based upon latest innovation and development. However, in the areas where noise exceedances have been identified after the application of mitigation, should the Contractor's own efforts to practicably control impacts be in-sufficient, the KCRC's Independent Environmental Checker should agree with the EPD a practical trigger limit for works in these areas and this be detailed in the EM & A Manual. It is recommended that the limit be appropriately cognisant of both the impact of the mitigation measures on the works programme and thus the duration of adverse impact, and the level of the residual exceedance.

Table 4.4bb Details of Construction Noise Exceedance

NSR No.	Description of NSR	Level of Residual Noise Exceedance Predicted	Estimated Time Period of Noise Impact	Road Improvement Works Causing Noise Exceedance
139	Proposed Health & Welfare Building and Undesignated Site "G" on Area 90B	1 dB	Two days[1]	Operating Grader
142	Chinese YMCA College	1 dB	Two days[1]	Placement of road base
		8 dB	Two days[1]	Operating Grader
		5 dB	Two days[1]	Road paving
		3 dB	Two days[1]	Excavation at Subway Construction
179	Residential Development to the East of Lee On Estate (WIP)	3 dB	Two days[1]	Placement of road base
		11 dB	Two days[1]	Operating Grader
		7 dB	Two days[1]	Road paving

Note [1] The actual time period causing noise exceedance will depend on the actual construction programme of the works, which will be available during the detailed design stage. The period of works is expected to last one to two months.

As a high degree of noise control is required to avoid adverse noise impacts, regular monitoring at the NSRs will be required during the construction phases. The purpose of the monitoring will be to examine the effectiveness of all the on-site measures, to enable the Contractor to be aware of his environmental performance and provide necessary action if the assessment criteria are exceeded. Monitoring will also provide a direct response mechanism for the Project Proponent to manage the Contractor's action in effecting reductions in noise emissions at specific areas. The monitoring requirements are described in *Section 12.4* of this report.

With the adoption of appropriate measures, as stated above, and the implementation of an effective monitoring regime which focuses the Contractor's attention on any potential adverse impacts and thereby triggers appropriate corrective actions, it is expected that the residual impacts can be reduced to acceptable levels in accordance with the EIAO TM requirements. Where unavoidable impacts occur even with the implementation of the Contractor's best practicable works methodology and mitigation plan, it is considered that the residual impacts can be kept to the minimum practicable duration.

4.4.7 Conclusions

This assessment has predicted that the unmitigated construction noise impacts associated with the MOS Extension will be high at the nearby NSRs. Standard mitigation measures have been identified which can reduce the noise levels to within the noise criteria at most of the NSRs. These measures include good site practises, use of quiet and silenced construction plant and working method, installation of temporary movable barriers next to operating construction equipment, and reducing the number of construction plant being used on site. The combination of these measures is required in order to mitigate the noise impacts at the nearby NSRs.

With the recommended measures, construction noise impacts can be controlled to within the required noise limit at the majority of NSRs. Residual noise impacts in the range of 1 to 11 dB(A) are, however, still predicted from road improvement works at the proposed development on Area 90B (NSR 139), Chinese YMCA College (NSR 142) and the residential development to the east of Lee On Estate (NSR 179) but are expected to be of short duration. It is therefore recommended that the existing glazing systems of the affected school and health centre should be reviewed during the detailed design stage and should be upgraded if necessary.

Whilst an exhaustive review of available mitigation measures and construction methodologies has been undertaken by the Proponent in the preparation of the EIA, it is recognised that with future innovation and development as well as a greater level of plant detail being available nearer the time of construction, the Contractor may be able to offer alternative quieter methods. It is therefore recommended that for the affected residential premises, the construction methodology and the type of construction equipment that is to be used on site during road improvement works should be reviewed when more detailed information is available and, where practicable, the Contractor should develop either an alternative working method, alternative plant requirements or other practical mitigation proposals in order to minimise the noise impacts. However, in the areas where the Contractor's own efforts are incapable of practicably controlling impacts to the required levels, KCRC's Independent Environmental Checker should agree with the EPD a practical trigger limit for works in these areas and this be detailed in the EM & A Manual. It is recommended that the limit be appropriately cognisant of both the impact of mitigation measures on the works programme and thus the duration of adverse impact, and the level of the residual exceedance.

Regular monitoring of noise at NSRs is recommended during the Project's construction phase in order to ensure the environmental performance of the works. With the adoption of appropriate measures and the implementation of an effective monitoring exercise which focuses the Contractor's attention to any potential adverse impact and thereby triggers appropriate corrective actions, it is expected that the residual impacts can be reduced to acceptable levels in accordance with the EIAO TM requirements. Where unavoidable impacts occur even with the implementation of the Contractor's best practicable works methodology and mitigation plan, it is considered that the residual impacts can be kept to the minimum practicable duration.

4.5 Operational Noise

4.5.1 Methodology

Introduction

Operational airborne noise impacts will arise from the following potential sources:

- airborne noise from revenue (passenger) rolling stock and train induced vibration in elevated structures reradiated as noise;
- airborne and structureborne noise from non-revenue rolling stock undertaking routine checking and maintenance - essential to ensure the safe engineering condition of the rail system as well as the smoothness of the rail for the control of rail/wheel interaction noise ;
- maintenance activities at the Depot and movements in and out of the Depot; and,
- fixed electrical and mechanical plant (including ventilation systems), which are likely to be sources of noise within the vicinity of passenger stations and traction substations.

Spatial Scope

The spatial scope of the operational noise assessment is defined by the distance from the sources of airborne noise at which the operational noise criteria described in *Section 4.5.2* are likely to be exceeded. Prior to the introduction of the EIAO TM, the HKPSG indicates that a typical separation distance of 85 m is required between the track and the facade of sensitive properties to achieve compliance with the acceptable noise criteria which have since been incorporated within the EIAO TM. However, each individual railway is inherently different in terms of rolling stock, trackform and structural design as well as levels of service, speed and the environment through which it passes. This technical assessment, therefore, specifically addresses the parameters that will govern noise emission and its subsequent propagation in the receiver environment to define a scope of mitigation measures adequate to meet acceptable noise criteria.

Technical Scope

The technical scope of the operational noise study is described below.

Revenue Rolling Stock

For airborne noise from operating trains, the assessment methodology draws upon an expected rolling stock design noise level which has previously been adopted by MTRC for the Lantau Airport Railway (LAR) and is based on a disc braked Electric Multiple Unit (EMU). The same specification has also been adopted by KCRC for the proposed West Rail rolling stock, on the basis of MTRC's achievement of noise limits set for the rolling stock contractor and the positive feedback from a survey by KCRC West Rail of manufacturers for West Rail rolling stock that the limits are achievable.

The specifications for the MTRC LAR and KCRC West Rail rolling stock have been agreed with the EPD with an allowance for normal deterioration in rail and rolling stock conditions, taking account of the worst case operating scenario. Therefore, an identical source term has been used for the proposed MOS extension on the basis of the achievement of rolling stock noise limits through a managed specification and the need to take account of the worst case scenario in the environmental assessment process. This source term is based upon the maximum noise level during a train passby (L_{Amax}) of 85.5 dB on continuously welded rail laid on ballasted track at a speed of 130 kph and measured at a distance of 25 m. While the maximum speed for the MOS Extension is 100 kph, empirically derived relationships for speed and noise are used to determine noise levels at actual operating conditions close to NSRs. At 100 kph on ballasted track the MOS source term is L_{max} 82.1 dB at 25 m, whereas on viaducts with a maximum speed of 80 kph, the source term is L_{max} 81.2 at 25 m and includes an acoustic reflection of the train in the concrete viaduct deck that is not apparent along the ballasted sections of track. These source terms will be used in the procurement of the MOS rolling stock as a performance specification to be achieved by the successful tenderer and thus ensure compliance with the EIA.

While the above specification is applied to noise generally attained at higher speeds, at slower speeds other sources will also be controlled by performance specification. Air conditioning units to be mounted on the roof of the train will operate during all revenue services and these will be limited by a specification of 57 dB(A) at a distance of 15 m from the train. Although this specification is lower than for trains on other systems that typically operate within tunnels, the limit has been achieved in Sydney and since adopted by the contractors who will supply the new KCRC West Rail rolling stock.

Non-revenue Rolling Stock

Noise will also be generated by rolling stock operating during the non-revenue hours of the railway typically between 0200 and 0500. These will be used to support maintenance operations in the transporting of personnel and plant for inspection and remedial works. As overhead line power supply may need to be turned off for safety and other requirements, the rolling stock will be independently powered locomotives. These will

typically trail a short rake of flat bed wagons, ballast tamping machines and rail grinding apparatus.

The noise level for the locomotive will be limited by procurement specification to be L_{Amax} 71 dB on viaduct at 25 m for maximum speed (50 kph) and is based upon known availability to ensure a successful tender. For trailing flat bed wagon stock and other equipment, a typical L_{Amax} noise level for "worst case" flat bed rolling stock is used in this assessment based upon four axles per wagon with disc braking. The source term for this rolling stock is L_{Amax} 73.1 dB on viaduct at 25 m and at a speed of 50 kph and typical of disc braked wheels. As with the locomotives, the noise level for other rolling stock will be limited by this specification in the future tendering for supply.

Structure Radiated Noise

Uncontrolled structure radiated noise has the potential to exceed mitigated airborne noise in terms of the A-weighted acceptability noise criteria adopted in Hong Kong and create low frequency rumble noise which can be very noticeable, but not necessarily contribute to overall A-weighted noise levels. However, inherent in the proposed viaduct design, as developed by extensive analysis through the KCRC West Rail project, is a package of mitigation measures to minimise both overall A-weighted and low frequency noise for all sections of the elevated MOS alignment. With these measures, for a MOS EMU train travelling at 80 kph on viaduct, the wayside noise level from the viaduct section will be L_{Amax} 56 dB at a distance of 25 m as shown by *Figure 4.5a* and derived in *Annex G*. This level will be set as performance specification to be achieved by the viaducts contractor and thus ensure compliance with the EIA.

The achievement of this specification is derived by an integrated design approach to both the structural form of the viaduct and the track support system above. This is comprised of a two tiered resilient track support system comprising a KCRC West Rail viaduct with Floating mini-Slab Track (FST) at a resonant frequency of 16 Hz and low stiffness shear type baseplates (Cologne Eggs) of 13 KN/mm above a highly impedant viaduct cross-section.

Train Noise Mitigation Measures

The previous *RDS Phase II Tai Wai to Ma On Shan: MV4 Environmental Study* identified a potential need for extensive use of high track side barriers and full enclosures to mitigate operational noise impacts which resulted in significant changes to the visual appearance of the areas through the railway would pass. The Study predates the extensive work undertaken for the KCRC West Rail project to develop a package of mitigation measures that avoids the use of extensive lengths of full enclosure and high noise barriers on elevated structure. A major output from this project and the culmination of the six month study, was the development of the innovative "Multi-plenum System" which has been shown to outperform conventional noise barriers. In addition to the integrated design approach to minimise reradiated noise from elevated structure, the measures will provide the highest level of total noise control known for an elevated railway without full

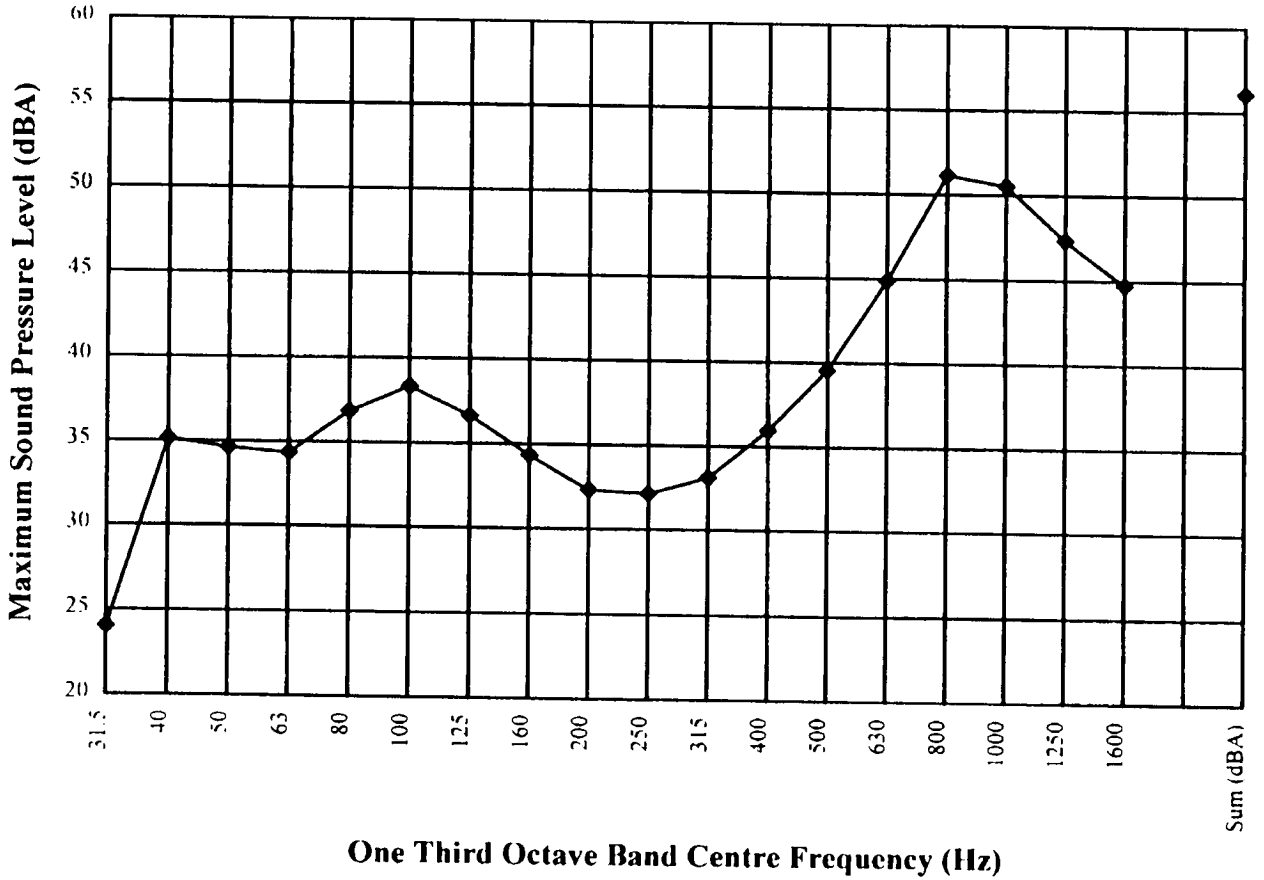

FIGURE 4.5a

STRUCTUREBORNE (RERADIATED) NOISE - KCRC SINGLE & TWIN VIADUCTS WITH 16Hz FST AND 13KN/mm
COLOGNE EGGS-EMU AT 80kph AND 25m DISTANCE

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DATE: 16/0899

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enclosure (see *Section 4.5.5*). An in-depth description of the development and analysis of the Multi-plenum System and integrated viaduct design is presented in two technical papers in *Annex G*.

This EIA presents an assessment of KCRC's commitment to apply to all elevated sections of the alignment on viaduct the Multi-plenum System with FST.

Depot And Fixed Plant Noise

Noise levels from fixed plant and activities associated with the Depot are not expected to present insurmountable impacts with the use of standard mitigation to be defined as the detailed design progresses. Although the Depot will be fully enclosed, the standard use of either noise barrier screening or enclosure mitigation measures will be sufficient for other fixed plant such as traction substations and transformers. An "at-source" noise specification is presented in this EIA to ensure all sources of fixed plant noise will be designed and controlled to meet the statutory criteria described in *Section 4.5.2* below. These at-source noise limits will be tuned to ensure there will be no cumulative impact arising from both train and fixed plant operations.

4.5.2 Assessment Criteria

Revenue Train Noise

Railway noise is controlled under the Noise Control Ordinance (NCO) and the subsidiary Technical Memorandum on Noise From Places Other Than Domestic Premises, Public Places or Construction Sites (IND-TM) which also describes the appropriate technical principles and assessment procedures. Acceptable Noise Levels (ANL) are stipulated in IND-TM as the noise criteria and are dependent on the ASR defined and the time period of the day. The ASR of a NSR is determined by the type of area containing it and the presence of any influencing factors such as industrial areas, major roads and airports.

A variety of ASRs have been identified by the Environmental Protection Department during consultation on the Draft EIA and based upon the IND-TM. These are shown in *Annex F2* and the locations of NSRs shown by *Annex F1*. Table 4.5a below shows the ANLs corresponding to the assigned ASRs for MOS.

Table 4.5a Area Sensitivity Rating and Acceptable Noise Level

Area Sensitivity Rating (ASR)	Acceptable Noise Level (ANL), $L_{eq,\ 30\ minutes}$
A	60 dB(A), 0700 - 2300 and 50 dB(A), 2300 - 0700
B	65 dB(A), 0700 - 2300 and 55 dB(A), 2300 - 0700
C	70 dB(A), 0700 - 2300 and 60 dB(A), 2300 - 0700

For NSRs adjacent to both East Rail and MOS, more stringent noise limits have been adopted to for the possibility of cumulative noise impacts. For these NSRs the criterion noise level is ANL-5 dB(A).

The EIAO TM provides further criteria for assessing railway noise. These criteria are specified in terms of the A-weighted maximum noise level and daily railway noise exposure, as shown in *Table 4.5b*. For noise from the MOS Extension to be within the acceptable levels, all criteria given in *Tables 4.5a & b* should be met.

Table 4.5b HKPSG Train Noise Criteria

Parameter	Criterion level in dB(A)
Maximum A-weighted sound pressure level, L_{max}	85
Equivalent continuous sound level, $L_{eq\ 24hours}$	65

All noise levels quoted in this report are $L_{Aeq30min}$, unless otherwise specified.

Non-revenue Rolling Stock

The principal items of legislation relating to the control of construction noise in Hong Kong are the *Noise Control Ordinance* (NCO) (Cap 400) and the *Environmental Impact Assessment Ordinance* (EIAO) (Cap 499). Various Technical Memoranda, which stipulate control approaches and criteria, have been issued under the NCO and EIAO. The following TMs are deemed by EPD to be applicable to the control of noise from non-revenue rolling stock that may be employed in connection with railway maintenance:

- Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM);
- Technical Memorandum on Environmental Impact Assessment Process (EIAO TM).

As described in Section 4.4.1, maintenance activities and rail grinding will be undertaken under a CNP to be applied for by KCRC. Despite any description or assessment made in the subsequent paragraphs, the Noise Control Authority will be guided by the Technical Memorandum (Memoranda) in assessing an application, once filed, for a Construction Noise Permit (CNP). The Authority will consider all the factors affecting their decision taking contemporary situations/conditions into account. Nothing in this report shall bind the Authority in making their decision. There is no guarantee that a CNP will be issued. If a permit is to be issued, the Authority shall include any condition it thinks fit, and such conditions shall be followed while the works covered by the permit are being carried out. Failure to comply with any conditions could result in the cancellation of the permit and prosecution action under the NCO.

Noise arising from general construction works during normal working hours (ie 0700 to 1900 hours on any day not being a Sunday or public holiday) at the openable windows of

buildings is governed by the EIAO TM. The recommended noise standards are presented in *Table 4.5c*.

Table 4.5c EIAO TM Daytime Construction Noise Limit ($L_{eq, 30\ min}$ dB(A))

Uses	Noise Standards
Domestic Premises	75
Educational Institutions (normal periods)	70
Educational Institutions (during examination periods)	65

In view of their similar noise sensitivity, the daytime construction noise standard for educational institutions (during normal periods) should be employed for other sensitive uses including hospitals, temples, churches, day nurseries and care centres. However, as all maintenance works will be undertake at night these criteria may never be applied.

The NCO provides statutory controls on general construction works during the restricted hours (ie 1900-0700 hours Monday to Saturday and at any time on Sundays and public holidays). The use of powered mechanical equipment (PME) (deemed to include non-revenue rolling stock by EPD) for the carrying out of construction works (and railway maintenance works) during the restricted hours would require a CNP. The Noise Control Authority is guided by the GW-TM when assessing such an application.

When assessing an application for the use of PME, the Noise Control Authority will compare the ANLs, as promulgated in the GW-TM, and the CNLs (after accounting for factors such as barrier effects and reflections) associated with the agreed PME operations. A CNP may be issued if the CNL is equal to or less than the ANL. The ANLs are related to the noise sensitivity of the area in question and these will be judged by the Noise Control Authority at the time of the CNP application. As conditions may vary between the time of the EIA for a project and the time of a CNP application, the assignment of any Area Sensitivity Ratings in the EIA is not binding upon the Noise Control Authority. Similarly, such references bear no contractual validity with KCRC's own particular specifications. The relevant ANLs are shown in *Table 4.5d* below.

Table 4.5d Acceptable Noise Levels (ANL, $L_{eq, 5\ min}$ dB(A))

Time Period	Area Sensitivity Rating		
	A	B	C
All days during the evening (1900-2300 hours) and general holidays (including Sundays) during the day and evening (0700-2300 hours)	60	65	70
All days during the night-time (2300-0700 hours)	45	50	55

There are some factors affecting the results of a CNP application, such as the assignment of Area Sensitivity Rating, ANLs etc. which will be decided upon by the Noise Control Authority at the time of assessment based upon the contemporary situations/ conditions.

It should be noted that the situations/ conditions around the site may vary according to the Noise Control Authority.

Fixed Plant Noise

Noise from fixed sources such as station air conditioning plant, traction substations and the Depot are required to comply with the EIAO TM. The assessment of impacts from fixed noise sources, will normally be conducted with reference to IND-TM and all sources should be located and designed such that the noise level at the façade of the nearest NSRs is at least 5 dB(A) lower than the appropriate ANL as stated in the EIAO TM. In addition, the cumulative noise from train operations and fixed plant should not exceed the ANL.

4.5.3 Potential Train Noise Sources

In the operational phase, airborne train rolling noise, emissions from the vehicle air-conditioning system and structurally radiated noise from viaducts could lead to adverse noise impacts on the surrounding NSRs. The extent of impacts will critically depend on the speed of the trains, the specification of ancillary equipment, choice of trackform components, structural design of the viaducts, the extent of airborne noise mitigation and the distance to the surrounding sensitive uses.

Other sources of train noise which will require management of the noise specification through the detailed design and vehicle procurement process include noise from trains would be from the air conditioning units, traction motors, gearboxes, motor cooling equipment and compressors for doors and brakes.

Noise impacts from wheel squeal is likely to be generated on curves with a radius of less than 200 m where the wheels are forced to slide against the rail on the tight curve. The likelihood of wheel squeal is dependent upon a number of factors including the design of the bogie, the geometry of the wheel/rail interface, curve radius, the operational speed of the train and the standards of track maintenance. However, it should be noted that the alignment design has been optimised to achieve a minimum curve radius of not less than 200 m within the operational sections of the alignment.

Stations

Nine stations are planned for the MOS Extension at: Tai Wai; Sha Tin Tau; Sha Kok Street; City One Shatin; Shek Mun; Chevalier Garden; Heng On; Ma On Shan; and Lee On. Noise sources associated with stations include announcements, human activity, undercar equipment and, principally, noise emissions from air conditioning units.

In the detailed modelling of the stations, an open design with the Multi-plenum System has been defined. It is understood that high noise barriers would result in the stations being fully enclosed and therefore requiring the provision of air conditioning as the remaining small gap between the barrier and rain canopy structure would not allow sufficient ventilation of the platform area.

Non-revenue Train Operations

To facilitate KCRC's maintenance of the MOS Extension, the independently powered locomotive and flat bed wagon rolling stock will regularly use the line during the night-time system shutdown.

For maintenance work undertaken during these times, as described in *Section 4.4* and *Section 4.5.2 above*, the KCRC will be required to obtain a *Construction Noise Permit*. This work will also include periodic track grinding and ballast tamping.

Track grinding will take place along the entire track length before the railway opens, and thereafter as required to maintain the rail surface free of corrugation. The occurrence of corrugation is difficult to predict and dependant on a number factors including trackform design and wheel condition. In addition, ballast tamping may occasionally be required for the at-grade sections of the alignment. The maintenance programme will, therefore, be developed as the characteristics of the system become known through operation. During this time, the requirements of KCRC's *Construction Noise Permit* will be defined and appropriate mitigation measures employed to ensure the *Noise Control Ordinance* criteria will be met.

Transformers and Traction Sub-stations

Transformers and substations are needed to provide the power supply for the railway. Magnetostrictive forces inside the transformer core result in noise emissions which can be intrusive due to their tonal nature. Other noise sources include transformer cooling and motor generator sets.

The location of fixed plant noise sources is shown by *Figures 4.5a-r* in *Annex F1*.

Tai Wai Depot

The Tai Wai Depot will provide stabling and maintenance facilities for the majority of trains operating on the MOS Extension. The facilities most likely to be a potential noise source in the depot site include the following:

- maintenance for passenger stock;
- running maintenance shed;
- heavy maintenance for EMUs;
- workshop and stores; and,
- underfloor wheel lathe.

All of these noise sources will, however, be fully enclosed within the Depot building together with the stabled trains and the rail fan entry. Enclosure of the Depot will ensure that announcements and human noise, train whistles, train rolling noise (and potentially wheel squeal) in the fan and noise from train mounted ancillary equipment in the fan and stabling areas will not affect the surrounding environment.

A total of nine, two berth, stabling tracks will be included within the depot. Trains along these tracks are likely to generate noise during start up and shut down periods only and during these periods the main source of noise will be the train mounted ancillary equipment and vehicle air-conditioners. These sources will be limited by specification to 57 dB(A) at 15 m to ensure no impacts arise during operation on the MOS Extension at stations. With the noise attenuation provided by the fabric of the Depot building, no impacts from Depot stabling will arise. Additionally, the trackwork design and layout within the Depot is expected to minimise the likelihood of delays in launching the trains into service and thus minimising the dwell times of idling trains within the depot and consequently the noise generated. Since the duration of this type of noise is largely dependent on the train scheduling and management within the depot, potential noise impacts will be prevented through the implementation of good management and site practices as well as the fabric of the Depot building envelope.

It is proposed that two train washes, one acid and one water/detergent, are provided at the Depot. Each train is expected to be washed using water/detergent daily, requiring train washes on 66% of the train entries to the depot each day. Acid washes will be required much less frequently, at most, every 30 days. With careful specification of washer noise levels it is expected that no adverse impacts at the nearby NSRs (the nearest is currently 80 m away) will occur.

Heavy internal cleaning of trains will also be carried out within the Depot building at intervals of 30 days per train. It is proposed that only one heavy cleaning track will be necessary which will allow cleaning of two trains per day. It is anticipated that the major noise associated with heavy cleaning will be the train mounted equipment such as air conditioning units and compressors which may be required to operate to provide staff comfort and door operation. However, as identified above, the noise specification of these units and the fabric of the Depot building will be ensure no adverse impacts will arise.

The Depot will provide both preventative and corrective maintenance for the EMU fleet. It is proposed that all the maintenance areas including maintenance tracks and the underfloor lathe are enclosed. Noise levels within these enclosed working areas are likely to be restricted to around $L_{Aeq,8hour}$ 85 dB for occupational safety reasons and given that the Depot will be enclosed, the building envelope will be sufficient to ensure no impacts at nearby NSRs. Attention will, however, need to be paid to the size and location of ventilation louvers serving the maintenance areas in the detailed design of the Depot building envelope: where practicable, these should be located and designed to face away from the closest and most sensitive NSRs and consideration given to reducing noise levels in accessible areas close to the louvers.

A traction substation and chiller plant will be required to provide traction power and ventilation to the Depot. These sources will be located outside of the building and therefore appropriate mitigation measures will be required in the detailed design, with particular regard to the location of adjacent NSRs and potential tonal characteristics to ensure no adverse impacts.

Wheel squeal is most likely to occur on the rail fan areas within the Depot building, owing to the necessity to use a number of curves with small radii of approximately 200 m (KCRC design standard). The tight curves are imposed by spatial constraints within the depot area and the occurrence of squeal will be related to the curve radius and the wheel base of the vehicle bogie. Assuming a bogie wheel base of 2.5 m the 200 m radius curve will result in occasional wheel squeal. It is likely that water or grease lubrication will be sufficient, but further consideration may need to be given to restraining rails and rail head profiles.

Detailed assessment for train rolling noise outside of the Depot building envelope is included in the operational noise modelling results (see *Section 4.5.5*) and noise barrier mitigation has been identified to ensure the *Noise Control Ordinance* criteria will not be exceeded. Additionally, augmentation of rolling noise from points and cross-overs has also been included within this assessment. However, noise from all operations within the Depot building will be adequately controlled by the design of the building envelope. Fixed plant noise from the external sources including train wash, traction substation and chillers are assessed in *Section 4.5.6* to provide at-source noise limits for the detailed designers to achieve.

4.5.4 Train Noise Assessment Methodology

Airborne Noise

Airborne train noise has been modelled using a detailed prediction methodology agreed with the EPD. This methodology provides for calculation of $L_{Aeq,30min}$ or $L_{Aeq,24hour}$ in the reference time bands given in the EIAO TM and NCO, based upon maximum noise levels (L_{Amax}) for individual train passbys.

The L_{Aeq} noise levels have been calculated using the following methodology :

- variation in L_{max} airborne noise due to train speed :

  $= 30 \cdot \text{Log}_{10} (v_1/v_2)$ dB;

- variation in L_{max} structureborne noise due to train speed :

  $= 25 \cdot \text{Log}_{10} (v_1/v_2)$ dB;

- integration of theoretical time history for train rolling noise with dipole directivity[1] : SEL (sound exposure level) = $L_{max} + 10 \cdot \text{Log}_{10}(l/v) + 10.5 - 10 \cdot \text{Log}_{10}((4D/4D^2 + 1) + 2 \tan^{-1}(1/2D))$ dB, where :

  l = train length (m)

[1] A Guide to the Measurement and Prediction of the Equivalent Noise Level (L_{eq}). The Noise Advisory Council. HMSO. London. 1978

v = train speed (kph)

d = distance from track (m)

D = d/l

- noise barrier screening after Maekawa and Multi-plenum System attenuation as described by technical papers presented in *Annex G*;
- augmentation of airborne noise levels on viaduct by radiation of floating slab and rails as presented in *Annex G*;
- distance attenuation from each point source location within an array along the track alignment at 20m summation intervals (synthesis of line source) = $20 \cdot \text{Log}_{10}$ d1/d2 (dB) and no angle of view correction for worst-case;
- augmentation in noise due to switches, crossings and thermal expansion joints = +7 dB(A);
- 30-minute equivalent continuous energy level (L_{eq}) = SEL + $10 \cdot \text{Log}_{10}$ (n_i/assessment period e.g. 1800 or 86400 s) dB, where :

  n_i = number of trains with identical noise characteristics within the 30 minute or 24 hour minute assessment period

- Facade reflection of +2.5 dB(A).

All airborne noise calculations (and structureborne noise calculations - see below) are performed in octave band frequencies based on empirical data collected from the MTRC Kwai Fong viaduct, Tsing Ma Bridge and other systems in the United States, and modified for track conditions using finite element analysis. Vehicle air conditioning noise is defined based on the West Rail vehicle specification and based upon empirical data of obtained in Sydney.

The assessment and mitigation presented in this EIA is based upon a maximum service expectation of an eight car (200 m) train length.

ERM Rail Noise Model Input Data

All structural and direct airborne noise sources have been modelled for the entire alignment using the ERM Rail Noise Model, based upon the above source data and the engineering information, timetable and speed profiles described below. The model has been developed by ERM over the last ten years to undertaken acoustic analyses of a large scale schemes using CAD input data for alignment and encoded methodologies based the standard acoustic principles and empirical data described above. This model was successfully employed in the West Rail EIA and has previously been agreed with the EPD.

KCRC's CAD design files for the alignment which present vertical and horizontal alignment have been electronically incorporated into the ERM Rail Noise Model. The

speed profiles are based upon expected rolling stock acceleration performance of +/- 1 m/s-1 to and from the maximum speeds of 80 kph and 100 kph on the viaduct and ballasted section of track respectively.

The KCRC's expected ultimate peak train headways during the peak hour are 2.5 minutes, a daytime off-peak headway of 5 minutes and a night-time (late evening and early morning - 23.00-07.00) headway of 6 minutes. As an example of unmitigated noise levels beside the ballasted section of MOS and with a maximum train speed of 100 kph, Table 4.5c presents an assessment against all the IND-TM and EIAO TM criteria at a notional distance of 25 m from the alignment :

Table 4.5e Unmitigated MOS Noise Levels at 25 m, 100 kph Train Speed

Criteria	Noise Limit	MOS Noise Level	Exceedance
IND-TM ASR A, Night-time	50	71	21
IND-TM ASR B, Night-time	55	71	16
IND-TM ASR C,Night-time	60	71	11
IND-TM ASR A, Daytime	60	74	14
IND-TM ASR B, Daytime	65	74	9
IND-TM ASR C, Daytime	70	74	4
HKPSG, 24 hour	65	71	6
HKPSG, Maximum	85	85	0

Table 4.5e highlights that the night-time timetable will trigger the IND-TM criteria before the EIAO TM criteria. Therefore, the NCO criterion will be the prime noise limit as compliance with daytime limits and the $L_{Aeq,24hour}$ and L_{Amax} noise limits will be achieved if night-time criteria are met. Schools will not be subject to the night-time criterion, unless there is residential accommodation for caretaker staff but have been assessed against this limit as daytime compliance will then be assured.

The night-time noise levels will be dominated by revenue trains. Non-revenue rolling stock will generally only move out to a destination then return later in the night-time period but before revenue services begin. For one non-revenue train movement, the noise level without mitigation measures will be $L_{Aeq,30min}$ 53 dB at a maximum speed of 50 kph and 25 m distance.

The proposed alignment consists of track at-grade, low fill and retained embankment and on viaduct and therefore the use of ballasted track on ties for the at grade sections has been used as a base case. For the ballasted track sections both conventional noise barriers and the Multi-plenum System will be assessed. Track on viaduct (in this Study) has been defined in the brief as comprising the Multi-plenum System (see description below) and to this may be added additional height edge walls up to a maximum of around 2 m (total above deck height of approximately 4.5 m) for single viaducts to prevent excessive overturning moments around the bridge bearings through wind loading.

In the specification of the ballasted track alignment a containment wall height of 2 m is present throughout this section of the alignment. Additional barrier heights above this are specified up to a maximum of 3 m.

The Multi-plenum System

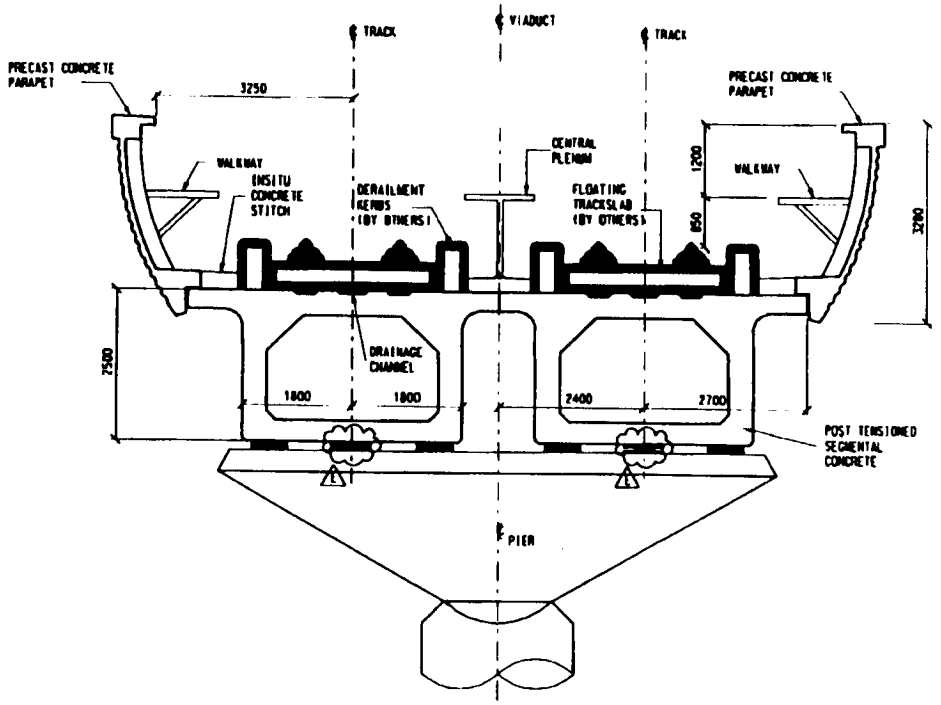
The principal mitigation measures inherent in the Multi-plenum System, as developed for West Rail, and to be used on all viaduct sections of MOS are:

- to reduce vibration transmission to the viaduct structure using track mounted on a soft baseplate upon a floating mini slab;
- to reduce airborne noise emissions using a system of absorptively lined cascading plena comprising an under vehicle plenum created with vehicle skirts and under walkway plena on either side of the viaduct - for twin viaducts, an additional central plenum is created with a capped central wall; and
- to further reduce airborne noise levels with an edge wall provided for walkway safety which may be increased in height with additive noise barriers to provide additional mitigation.

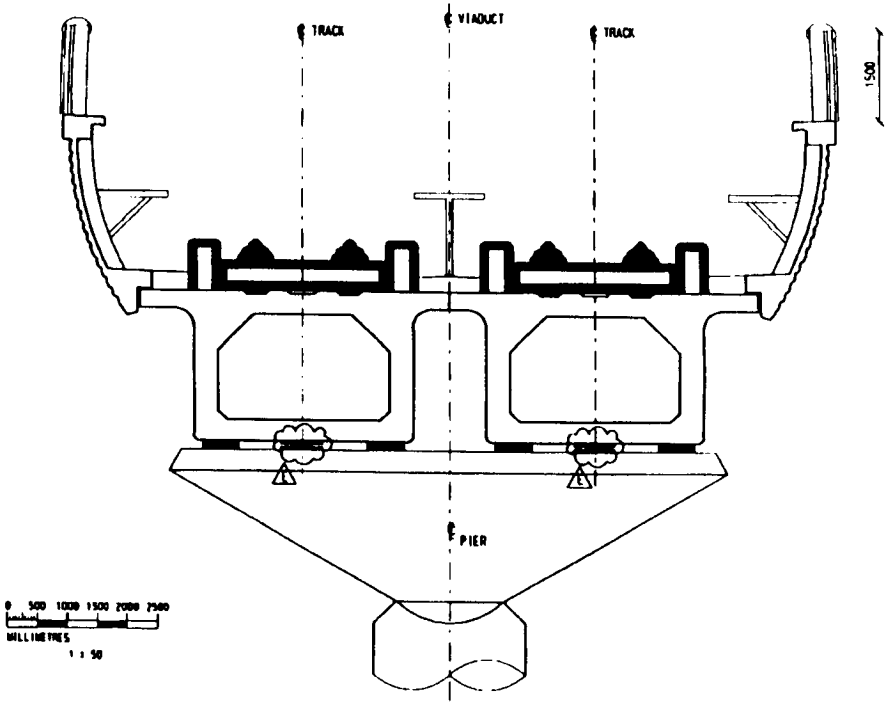
In normal running, vehicle skirts would extend to approximately 250 mm above the derailment containment up stand on the floating slab thus creating the first plenum. The walkways required at the side of the track are given by the need for passengers to alight between stations in the case of an emergency and provide for a second plenum. On tangent track, there would be a gap of approximately 250 mm between the edge of the plenum and the side of the car.

As shown in *Figures 4.5b,c&d* for track with a floating mini slab, the edge of the viaduct will extend to 1200 mm above the side of the walkway (approximately 2100 mm above top of rail) and will form an additional barrier for low-rise receivers. This is required to be lined with absorbing material to enhance its acoustic performance and prevent train-barrier reflection. Where required, this barrier can be extended upward to provide additional acoustic control; or at crossover tracks where the central plenum will be absent, full enclosure can be provided.

With the Multi-plenum System, the source of air-borne wheel/rail noise from the train can be considered to be the gaps at the top of the two plena on either side of the car. The effective sound power level radiated from these plena depends on the source level generated at the wheel/rail interface, the size of the plena, the extent and effectiveness of absorbing material in the plena and the size of the gap at the outlet of each plenum. For twin track viaduct sections, the effectiveness of the central plenum (referred to as the inboard plenum) is lower than that of the outboard plenum due to its smaller volume. The noise level emanating from the top of each plenum has been derived in terms of the maximum pass by noise spectrum at 25 m from the train and agreed with EPD for the West Rail project. These calculations indicate an attenuation of approximately 18 dB(A) compared with the initial source noise level for the outboard plenum, and approximately



TWIN TRACK VIADUCT
NO NOISE BARRIERS



TWIN TRACK VIADUCT
WITH STANDARD NOISE BARRIERS

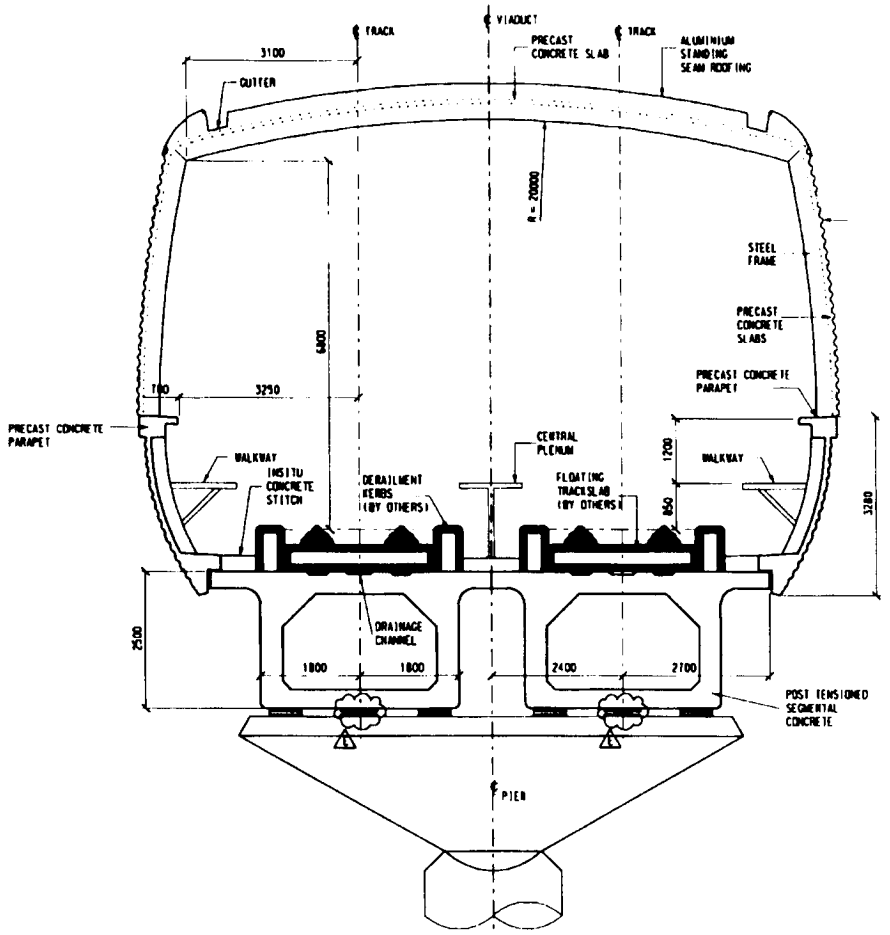
FIGURE 4.5b

TYPICAL CROSS SECTIONS OF TWIN TRACK DECKS

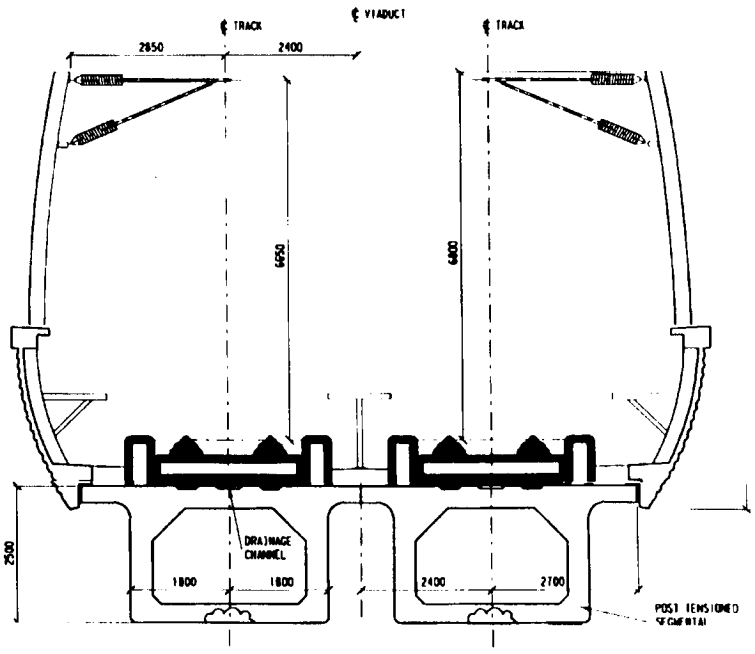
FILE: C1890m
DATE: 19/08/99

Environmental
Resources
Management

ERM



TWIN TRACK VIADUCT WITH FULL NOISE ENCLOSURE



TWIN TRACK VIADUCT WITH OHLE MASTS

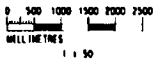


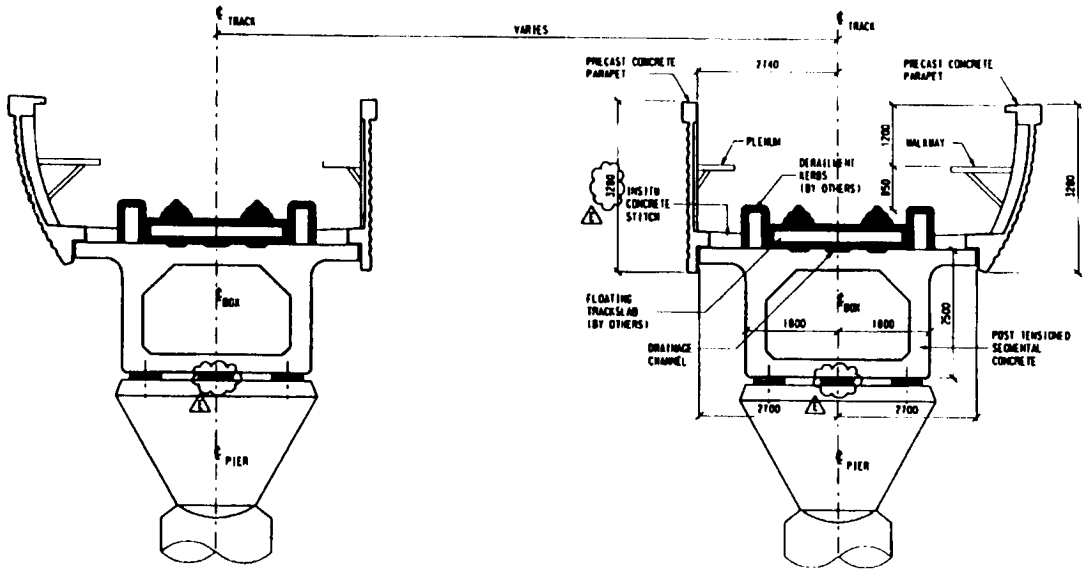
FIGURE 4.5c

TYPICAL CROSS SECTIONS OF TWIN TRACK DECKS

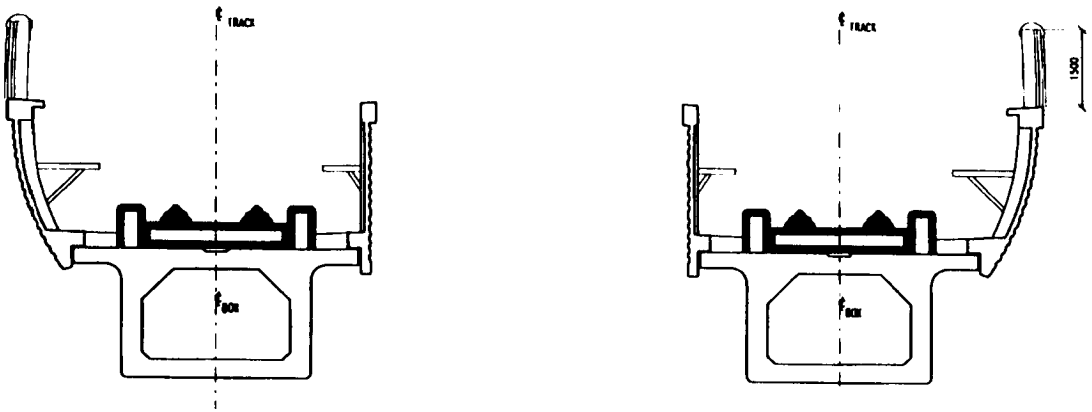
FILE: C1890m1
DATE: 19/08/99

Environmental Resources Management

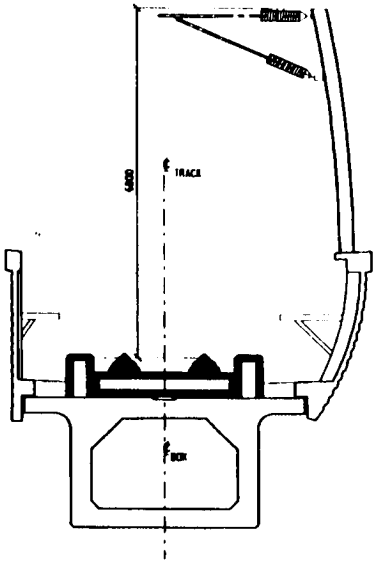
ERM



SINGLE TRACK VIADUCTS
NO NOISE BARRIERS



SINGLE TRACK VIADUCTS
WITH STANDARD NOISE BARRIERS



SINGLE TRACK VIADUCT WITH OHLE MAST

FIGURE 4.5d

TYPICAL CROSS SECTIONS OF SINGLE TRACK DECKS

FILE: C1890m2
DATE: 19/08/99

Environmental
Resources
Management

ERM

14-15 dB(A) for the inboard plenum can be achieved. The system will always outperform the attenuation given by conventional line side barriers of an equivalent height given the additional performance of the plena.

For enclosures, the source of noise is generated by both the plain rail sections and the wheel traversing discontinuities in the rail head at switches. Attenuation is provided by the fabric of the enclosures and also their length to allow sufficient attenuation of the augmented rail noise over distance. The internal surfaces of the enclosures are lined with absorptive material to minimise the effects of reverberant noise.

All noise mitigation measures will be implemented for day one of operations.

4.5.5 Prediction of Train Noise

ERM Rail Noise Model Definition

The ERM Rail Noise Model has been defined with the NSR locations, the track alignment and assumed trackform. The model incorporates the entire length of both the east-bound and west-bound tracks, using co-ordinates of the track centres at 20 m intervals. From these co-ordinates, the alignments of noise sources were generated representing the inboard and outboard plena, the structure-radiated noise for viaducts and on-board air conditioning plant. Noise sources representing the undercar plenum for ballasted track have been determined with an increased gap of 600 mm between the skirt and track bed. In addition, barrier alignments were generated at the position of the top of the standard walkway edge wall and conventional barriers for the ballasted track sections were offset with allowance for a minimum walkway clearance as given by the Multi-plenum System dimensions. For the at-grade section of the between Shek Mun Station and Chevalier Gardens, the alignment will be contained by 2 m high retaining walls lined with absorptive material: additional barrier heights are defined as necessary above these walls.

Rail expansion joints have been defined by KCRC in the following locations shown in *Table 4.5f* below. At these locations, a point source is defined in the model to represent the passage of the train wheels over the discontinuity in the rails. Scarf joints and short switch type joints are found to augment noise maximum noise levels by around 7 dB(A) whereas long switch joints are 3 dB(A) quieter.

Table 4.5f Locations of Thermal Expansion Joints In Rail

Approximate Chainage Reference		Type of Joint
13,795	(both up and down track)	Long Switch Joint
13,925	(both up and down track)	Scarf Joint
15,296	(both up and down track)	Scarf Joint
15,436	(both up and down track)	Scarf Joint
18,114	(both up and down track)	Scarf Joint

Approximate Chainage Reference		Type of Joint
18,284	(both up and down track)	Scarf Joint
18,524	(both up and down track)	Scarf Joint
21,210	(both up and down track)	Scarf Joint
21,360	(up track)	Long Switch Joint
21,360	(down track	Scarf Joint

Similarly, the additional noise generated by crossover track is defined as a series of point sources representing the wheels traversing the toe and nose of each switch joint. The locations and types of joint included in the model are listed in *Table 4.5g* below.

Table 4.5g Locations of Long Crossover Switches

Track	Type of Switch	Approximate Chainage
down	Point - Toe	10,470
down	Point - Nose	10,483
down	Point - Toe	10,585
down	Point - Nose	10,598
down	Point - Toe	10,998
down	Point - Nose	11,011
down	Point - Toe	11,158
down	Point - Nose	11,145
down	Point - Toe	11,187
down	Point - Nose	11,120
up	Point - Toe	10,509
up	Point - Nose	10,496
up	Point - Toe	10,651
up	Point - Nose	10,638
up	Point - Toe	11,106
up	Point - Nose	11,119
up	Point - Toe	11,230
up	Point - Nose	11,217
up	Point - Toe	10,580
up	Point - Nose	10,600

In the ERM *Rail Noise Model*, for plain continuously welded rail, the noise for a 20 m section along the alignment is summed and corrected from reference conditions for train speed. This correction is determined by the rolling stock speed profiles and line speed limits of 100 kph for at-grade ballasted track and 80 kph for viaducts.

For each identified NSR, the model calculates the summed contribution of noise from each 20 m section of track (comprising for viaducts the inboard and outboard plena, air-conditioner noise and structural noise for each track or, for ballasted track, noise from the nearest rail and air-conditioner noise for each track) and individual point sources for joints etc, taking account of the noise emission level, distance, and attenuation due to any barriers which break line-of-sight to the source.

Where NSR's represent high-rise buildings, it is not obvious which level will be most affected by noise, since at higher levels the barrier attenuation decreases, but the distance from the source increases. For this reason, where the maximum height of an NSR is greater than 40 m above the ground, calculations were carried out at 20 m intervals down from the top of the building to determine the most-affected location.

Assessment Results for Revenue Operations

The results of the assessment are presented in detail in *Annex G* for all NSRs potentially affected along the alignment. In the assessment of MOS, the following additional mitigation measures (to standard parapet and retaining walls) defined in *Table 4.5h* below and shown by *Figures 4.5a-r* in *Annex F1* will be provided by KCRC to ensure the noise criteria will be met.

A summary of the results is presented in *Table 4.5i* below for sample NSRs along the alignment.

Table 4.5h Additional Mitigation Measures

Section	Approximate Chainage	Mitigation
Hin Keng to TAW	10,000-10,400, down	7.4 m Cantilever barrier(ii)
	10,400-10,900, down	2 m Noise barrier(ii)
TAW to SKS	12,720-12,880, up	2 m Noise barrier above 2.1 m parapet wall
CI0 to SHM	14,587-14,717, down	Enclosure
SHM to CHG	15,860-16,120, down	3 m Noise barrier above 2 m containment wall
CHG to HEO	18,565-18,693, down	Enclosure
HEO to MOS	19,480-19,560, down	1.5 m Noise barrier above 2.1 m parapet wall
MOS to LEO	21,010-21,175, down	Enclosure

Notes: (i) Barrier height is above standard viaduct parapet (ii) Mitigation to be reviewed in detailed design stage in order to take full account of the latest East Rail retroactive noise mitigation provisions and improve the effectiveness of deployment of mitigation measures to both railways.

As shown in *Table 4.5h* above, additional mitigation is required for some NSRs adjacent to points and cross-overs as the airborne noise increases as the wheel traverses the discontinuity in the rail head profile. On viaducts, structure borne noise will also increase and as the central plenum of the Multi-plenum System cannot be maintained, less airborne noise attenuation will be achieved.

The full enclosure should be concrete and lined with an absorptive material. The Multi-plenum system should be integrated with the enclosure end; a minimum 15 m overlap is necessary but it is recommended that the System be taken as far into the enclosure as the kinematics envelope will permit.

All other track in this assessment is assumed to be continuously welded rail except at expansion joints and switches.

All mitigation measures will be implemented for day one of operations.

Table 4.5i Predicted Night-time Results With An Eight Car Revenue Train ($L_{Aeq,30min}$ dB)

NSR No.	NSR Description	Section Location	Noise Level ($L_{Aeq,30min}$ dB)			Comments
			Lp	Bar	Ht	
3	29 Keng Hau Road	Depot	44	Y	7.4m	At grade section: air-borne rolling noise dominant, cantilever barrier is proposed
42	Manlai Court Block 1	TAW to STT	52	nr[(i)]	0	Viaduct : air borne noise dominant
43	Manlai Court Block 2	TAW to STT	52	nr	0	Viaduct : air borne noise dominant
37	Lei Uk Tsuen 12 to 15	TAW to STT	50	nr	0	Viaduct : air borne rolling noise and air-con noise dominant
39	Sha Tin Tau 3	STT to SKS	50	nr	0	Viaduct : air borne rolling noise and air-con noise dominant
46	Pok Man House	STT to SKS	55	Y	2m[(ii)]	Viaduct : air borne rolling noise and air-con noise dominant : close to exceedance of criterion with a future 8 car rake
58	Pok Tai House	SKS to CIO	55	nr	0	Viaduct at station: air-con noise dominant
60	Sha Tin Wai	SKS to CIO	49	nr	0	Viaduct : noise from air-con dominant
65	Ashley Garden	SKS to CIO	54	nr	0	Viaduct : air borne rolling noise dominant
70 & 72	Wong Uk Village	SKS to CIO	53	nr	0	Viaduct : noise from air-con dominant
79 & 80	Pamela Youde Centre	SKS to CIO	53	nr	0	Viaduct : noise from air-con dominant; groundborne noise and vibration impacts to be review in detailed design stage
109	Juniper Court	SHM to CHG	60	Y	3m[(iii)]	At grade low fill : airborne rolling noise dominant on at grade track. Requires 3 m barrier.
122	Residential Development Site	SHM to CHG	57	nr	0	At grade / low fill : airborne rolling noise dominant on at grade track.
126	Residential Development Site	SHM to CHG	55	Y	noise enclosure	Viaduct close to station: air borne rolling noise dominant

NSR No.	NSR Description	Section Location	Noise Level ($L_{Aeq,30min}$ dB)			Comments
			Lp	Bar	Ht	
129	GI/C Development Site	HEO	55	nr	0	Viaduct at station : air-con noise dominant
137	The Waterside	HEO to MOS	54	nr	0	Viaduct : air borne noise dominant
143	Fok On Garden	HEO to MOS	53	nr	0	Viaduct : air borne noise dominant
158	Ma On Shan Block 2	MOS	53	nr	0	Viaduct : air borne rolling noise and air-con noise dominant
161	Villa Athena Block 1	MOS to LEO	52	nr	0	Viaduct : air borne noise dominant
152	Saddle Ridge Garden Block 3	MOS to LEO	52	nr	0	Viaduct : air borne noise dominant
166	Villa Athena Block 6	MOS to LEO	50	nr	0	Viaduct : air borne noise dominant
159	Saddle Ridge Garden Block 6	MOS to LEO	53	nr	0	Viaduct : air borne noise dominant
169	Lung Yiu House Kam Lung Court	MOS to LEO	54	nr	0	Viaduct : air borne noise dominant
175	Lee Wing House, Lee On Estate	MOS to LEO	54	Y	noise enclosure	Viaduct : air borne noise dominant
178	Symphony Bay	LEO	50	nr	0	Viaduct : air borne noise dominant

Notes :(i) Barriers not required (nr) (ii) Barrier located above 2.1m parapet wall on viaduct structure

(iii) Barrier located above 2m containment wall (iv) Noise levels presented in the table are a summary of the full results presented in Annex G.

Mitigation for Future NSRs

While the above mitigation measures will ensure that noise levels are within relevant criteria at all existing NSRs, the possibility of future noise-sensitive development close to the track has also been considered. The requirements for noise mitigation for such future development cannot be set out precisely, as they depend on the location of the development, its height and the ASR that would be assigned under the NCO.

To assess the potential for operational noise form the railway to affect possible future potential developments, three locations were selected along the track, representing the range of track speeds and other operational conditions which exist in this section. At each location, noise levels were calculated at hypothetical NSRs with various heights, situated at various distances from the track. These levels were then used to determine the minimum distances from the track at which an NSR could be located in order to comply with criteria of 55 dB(A) L_{eq} (ASR B) and 60 dB(A) L_{eq} (ASR C) for the hour 0600-0700. Calculations were then repeated with additional edge barrier heights of 2m and 4m, to determine the effect of these barriers on the minimum allowable distance. Results from this analysis are presented in *Tables 4.5j* and *4.5k* below.

Table 4.5j Minimum Distance from Nearest Track to new NSR to meet criterion of 55 dB(A) L_{eq}

			Additional Edge Barrier Height, m		
Chainage	NSR	Building Height, m	0	2	4
19500	148	15	10	10	10
		45	40	30	30
		75	10	10	10
		105	10	10	10
		135	10	10	10
18240	133	15	10	10	10
		45	20	20	10
		75	10	10	10
		105	10	10	10
		135	10	10	10

Table 4.5k Minimum Distance from Nearest Track to new NSR to meet criterion of 60 dB(A) L_{eq}

			Additional Edge Barrier Height, m		
Chainage	NSR	Building Height, m	0	2	4
18300	124	15	10	10	10
		45	10	10	10
		75	10	10	10
		105	10	10	10
		135	10	10	10
15100	113a	15	20	20	10
		45	10	10	10
		75	10	10	10
		105	10	10	10
		135	10	10	10

From *Table 4.5k* above, it is clear that if the ASR for a new development is C, then in most cases buildings of any height could be located quite close to the track. On the other hand, to meet the noise requirements for ASR B, mid-storey receivers may require the development to be set back in the region of 20 to 40m depending on location.

The structural design of the viaduct has been specified to accommodate high sided barriers and sections of full enclosure of a limited length up to 230m. The length of any enclosure required is limited by safety and ventilation requirements.

The Multi-plenum System will always provide greater attenuation than a mitigation solution based solely on noise barriers and, as such, the application of the System will effectively reduce overall barrier heights and consequent visual intrusion. In line with the Corporation's Commitment to noise control, the Multi-plenum System provides the flexibility for future enhancement as edge wall barrier heights can be incrementally extended for increased noise attenuation form 1.2m up to full enclosure. This will provide Government with greater flexibility in the long term land use planning of the areas through which MOS passes and will facilitate development to be considered in much closer proximity to the railway than would otherwise be the case. Developers of these sites may approach the Corporation to discuss the appropriateness of their site layout with respect to railway noise and the implementation of at-source mitigation such as noise barriers.

Performance Specification of Mitigation Measures

To ensure the acoustic adequacy of noise barriers both beside at-grade track and above the standard viaduct parapet, the sound transmission loss shall not be less than *Table 4.5l* below for any arbitrary one square metre of noise barrier.

Table 4.5l Sound Transmission Loss Through Noise Barriers

Octave Band Centre Frequency (Hz)	125	250	500	1k	2k	4k
Transmission Loss (dB)	20	30	30	30	30	30

To ensure the acoustic adequacy of enclosures at crossovers, the sound transmission loss shall not be less than *Table 4.5m* below for any arbitrary one square metre of noise enclosure.

Table 4.5m Sound Transmission Loss Through Crossing Enclosures

Octave Band Centre Frequency (Hz)	125	250	500	1k	2k	4k
Transmission Loss (dB)	38	38	38	48	56	62

To ensure the acoustic adequacy of sound absorptive material to be applied to the inner faces of noise barriers, enclosures and the Multi-plenum System, the random sound absorption coefficient shall not be less than *Table 4.5n* below.

Table 4.5n Absorption Coefficient of Barriers, Enclosures and Multi-plenum System

Octave Band Centre Frequency (Hz)	125	250	500	1k	2k	4k
Random Sound Absorption Coefficient (α)	0.2	0.6	0.75	0.85	0.9	0.9

Sound absorption panels shall be fixed to the inside surface of the roof of the full enclosure. 100% of the roof area within 1 m of the ends of the enclosure shall be covered with sound absorption treatment. For the remainder of the roof area, as much area as practicable shall be covered, but not less than 80%. Sound absorption material shall be applied to the walls of the full enclosure by either panels or spray on treatment. 100% of the wall area within 1 m of the ends of the enclosure shall be covered with sound absorption treatment. For the remainder of the wall, as much wall area as practicable

shall be covered, but not less than 80%. The sound absorption coefficient of any arbitrary one square of the material shall be not less than that specified in *Table 4.5n*.

For all material specification the KCRC shall ensure appropriate methods of testing to international standards are employed by suppliers. Suitable longevity specifications should also be employed to suit the KCRC's future maintenance expectation of the mitigation measures to ensure continued compliance with the NCO and EIAOTM.

Non-revenue Operations

The results of the assessment are presented in detail in *Annex G* for all NSRs potentially affected along the alignment. These demonstrate that no further mitigation measures to those identified above for revenue operations are required. No noise exceedances of the GW-TM NCO criteria are therefore expected.

Non-normal Operations

Overrun tracks will be provided to the north of the platforms at Lee On Station. These are required by railway safety procedures and will not normally be used; their only use being in the event of a train overrunning the platform. Whilst the likelihood of this small, this event may occur at Lee On and other stations. However, since trains will be decelerating on their approach to platforms, the any additional noise from an overrun will be negligible. In these instances, it is likely that the train will only overrun by a maximum of one train carriage and then immediately reverse back to the station platform. In this event, no significant augmentation of the predicted noise levels presented in *Annex G* is expected.

Cumulative Noise Impacts

The potential for cumulative noise impact exists within the corridor shared by East Rail and MOS between Hing Keng and Tai Wai. This EIA study has taken account of potential cumulative noise impacts in line with past good practice that is advocated by the *Hong Kong Kong Planning Standards and Guidelines* for other sources controlled by the *Technical Memorandum for the Assessment of Noise from Places Other than Domestic Premises, Public Places or Construction Sites* as issued under the *Noise Control Ordinance*: that is to meet a design target of 5 dB(A) below the appropriate acceptable noise level.

Whilst strictly in accordance with the *Noise Control Ordinance* two adjacent premises may not be subject cumulative noise limits, it has been opined that enforcement action may be taken in respect of a cumulative noise exceedance arising from adjacent railway systems being operated by the same company. This implies that should one railway already generate noise at an NSR to be equal to the legal Acceptable Noise Level under the *Noise Control Ordinance* then, theoretically, the contribution from another railway nearby and owned by the same company must be at least 10 dB(A) to ensure no contribution. If both railways were to be allocated equal share of a cumulative quota, then both would be allowed 3 dB(A) less than the ANL. If one railway was in exceedance

before the introduction of the noise criteria and one another in compliance afterwards. then the issue becomes more complicated and a solution less obvious other than committing to bringing both railways into full cumulative compliance.

Without the problem of East Rail's grander age to the *Noise Control Ordinance*, the possible enforcement of cumulative noise limits for railways has significant implication when applied in practice. For example, NSR 3, 29 Keng Hau Road, has a predicted noise level of 44 dB to comply with the HKPSG cumulative criteria of ANL-5 dB(A). To achieve this level, a 7.4 m high cantilevered noise barrier is required over the MOS Depot access tracks; tracks which in fact are only used in the launch and decommissioning of service and a barrier height which far exceeds any other conventional barrier to be employed on the full speed operating sections of the MOS alignment. To achieve a criterion of ANL-10 dB(A) (i.e. 40 dB(A) which is ANL-10dB(A)), KCRC commit to further extend this cantilevered barrier to fully enclose the tracks by either contiguous fabric or with a small opening or louvre on the eastern side tuned to give sufficient noise attenuation to the dominant residual noise source. On the operating MOS railway elsewhere, full enclosure is only required for special tracks at some crossovers locations.

The cost of mitigating the MOS depot tracks would more realistically be better put to reducing East Rail noise at source since these tracks are closer to the NSR, East Rail trains are travelling at a higher speed and the noise from East Rail is dominant. Similar examples also occur at NSR 17, Shatin Heights, NSR 35, Kam Cheong Building, NSR 38, Wing Fu Building, NSR 40, Moon Wah Building, NSR 41, Lai Sing Mansion, and NSR 10 and 13 Hin Keng Estate where KCRC commit to providing additional barriers of 2-3m on parapet wall or between tracks to meet ANL-10 dB(A) criteria.

To consider further mitigation of East Rail within the corridor shared with MOS as subsequent study to this EIA, KCRC has taken the opportunity to implement wider control of rail noise and achieve improved effectiveness in its deployment of noise control measures. The study will be undertaken by KCRC during the detailed design phase of MOS to fully review the appropriate integration of retroactive noise mitigation for East Rail with mitigation proposed for MOS. The study will seek a holistic solution to achieve full compliance of cumulative noise with the *Noise Control Ordinance*. If an improved solution results from this review, it is KCRC's intention to apply for variation of the future environmental permit.

4.5.6 Fixed Plant Noise Assessment

Noise from fixed plant installations associated with the proposed railway extension has been assessed and evaluated in this section. In the absence of any detailed information and at-source noise specification of the proposed fixed plant, a quantitative approach has been adopted in the assessment of fixed plant noise to define these limits for the future detailed design of the fixed plant installation and buildings. This includes a review of location of the proposed fixed plant and the nearest NSR which would be potentially affected; determine the acceptable noise limit of NSR based on the assigned Area

Sensitivity Rating and the requirement of EIAO TM; and calculate the maximum allowable total sound power level of the fixed installation at-source.

Fixed plant installations have been proposed at the following locations:

- feeder/traction station, chillers and wash bay facilities within Tai Wai Depot;
- switch gear compound proposed to the north of Tai Wai Depot and next to the existing electric sub-station;
- track section cabin proposed to the south of City One Station and next to Chap Wai Kon Street;
- proposed station plant to the east of Chevalier Garden Station, next to Hang Tak Street;
- proposed station plant to the west of Heng On Station and next to Sai Sha Road; and
- feeder substation proposed to the east of Lee On Station, possibly south of Lok Wo Sha Lane, although the exact location will be determined during the detailed design stage.

Table 4.5o below presents the details of noise assessment for the proposed fixed plant. The worst affected NSRs are selected and their corresponding noise limit, based on the Area Sensitivity Rating previous assigned have been used in the calculations. The maximum allowable sound power level of the proposed fixed installation was calculated based on the night-time noise criterion of the selected NSR (NCO night-time noise limit minus 5 dB(A)), the attenuation of noise due to separation distance and noise reflection from building facade. Acoustic characteristics of the noise source including tonality, impulsiveness and intermittency, which are unknown at this stage of study, have been excluded in the assessment but will be required to be taken account of in the detailed design. The predicted railway noise level at individual NSR was also considered to take account of the cumulative effect and check against the NCO night-time noise criterion.

In any event, EPD advise the ASR assumed here is for indicative assessment only given that the details of the plant layout are not yet available and the buildings' layout is only provisional. It should be noted that fixed noise sources are controlled under *Section 13* of the NCO. Nothing in this report shall bind the Noise Control Authority in assessing noise from these sources upon the receipt of complaints. The Authority shall assess the noise impacts based on the contemporary conditions/ situations.

In any event, EPD advise the ASR assumed here is for indicative assessment only given that the details of the plant layout are not yet available and the buildings' layout is only provisional. It should be noted that fixed noise sources are controlled under *Section 13* of the NCO. Nothing in this report shall bind the Noise Control Authority in assessing noise from these sources upon the receipt of complaints. The Authority shall assess the noise impacts based on the contemporary conditions/ situations.

Table 4.5o Fixed Plant Noise Assessment

NSR	Fixed Plant Considered	Separation Distance (m)	Max. Predicted Railway Noise Level, $L_{eq,\ 30\ min}$ (dB(A))	EIAO TM Fixed Plant Noise Limit (NCO Noise Limit-5dB) (dB(A))	Max. Allowable Sound Power Level (dB(A))
Carado Garden Block 6 (NSR 15, Fig. 4.5b)	Feeder/Traction Station in Depot	125	48	50	93
Carado Garden Block 6 (NSR 15, Fig. 4.5b)	Chillers within Depot	125	48	50	93
Shatin Heights (NSR 17, Fig. 4.5b)	Wash Bay Facilities within Depot	160	49	55	102
City One Shatin Block 36 (NSR 90, Fig. 4.5g)	Track Section Cabin	70	55	50	86
Tai Shui Hang No. 14-15 (NSR 123, Fig. 4.5l)	Station Plant, close to CHG Station	85	48	55	97
G/IC Site to the south of Vista Paradise (NSR 129, Fig. 4.5n)	Station Plant, close to HEO Station	20	55	50	75
Li Po Chun United World College	Proposed Feeder Substation	130*	negligible	50	97

* The exact location of the proposed feeder substation will be determined during the detailed design stage.

The maximum allowable total sound power level of feeder/traction station and chillers within Tai Wai Depot was calculated to be 93 dB(A) as shown by *Table 4.5o*. For the wash bay facilities, the total sound power level from the fixed installations should not exceed 102 dB(A). No adverse noise impacts on the nearby NSRs would be likely when these specifications are strictly followed in the detailed design. Other proposed fixed installations such as the station plant close to Chevalier Garden Station and the proposed feeder substation to the east of Lee On Station, the maximum allowable total sound power level should not exceed 97 dB(A) in order to ensure no adverse impacts arising from these fixed sources. The total sound power level of these fixed installations at near Heng On Station and City One Shatin should be designed to within 75 dB(A) and 86 dB(A) respectively in order to eliminate the potential cumulative impact noise.

With the consideration of noise specification proposed for the fixed plant in the detailed design, no noise impacts on the nearby NSRs are anticipated. The detailed design of all the fixed plant should ensure no exceedance of the noise limits stipulated in NCO and

EIAO TM, and ensure that noise emissions to public areas will not exceed 70 dB(A) as a good engineering practice.

4.5.7 Noise Monitoring and Maintenance Requirements

Monitoring of rolling stock emissions will be required to determine maintenance requirements for vehicles. This will comprise a permanent monitoring location close to the Depot so that noise levels can be attributed to specific rolling stock. As soon as exceedances of a reference noise levels given in *Section 4.5.1* is detected, the fault will be diagnosed for remedial action. This may include routine wheel profiling and checking of mechanical sources and their silencing equipment. As operating conditions at the monitoring point will not be the same as the reference noise data at maximum speed and 25m distance etc., appropriate corrections and good acoustical practice as defined in *Section 4.5.4* shall be applied to determine accurate comparison.

Periodic inspection of the track for wear and the presence of corrugation will be undertaken by KCRC track maintenance personnel. In particular, where corrugation is detected, rail grinding will be carried out by the KCRC. Its should be noted that it is in the KCRC's best interests to ensure the early removal of corrugation since long term build up will permanently alter the material structure of the rail head. The frequency for grinding will be dependant on the actual operational characteristics of the permanent way system and rolling stock. This will be determined together with the need to maintain rail head profiles for the minimisation of wear.

4.5.8 Conclusions

The operational noise assessment has demonstrated that the proposed scheme will comply with the NCO and EIAO TM. Based upon the package of mitigation measures developed for West Rail, application of the Multi-plenum System to the MOS Extension will ensure there will be no exceedances of the noise criteria. Within stations, the Multi-plenum System with the standard edge wall provision for walkway safety and a good noise specification for vehicle air-conditioning units will be sufficient to meet acceptable criteria.

Full enclosures will be required to control airborne noise from some crossovers and shall be integrated with the Multi-plenum System.

Noise impacts from the Tai Wai Depot and associated plant will be controllable with mitigation measures including the proposed full enclosure of the Depot. Noise from fixed plant will be limited by maximum sound power levels defined by this EIA and used as a target by the detailed designers to ensure the Noise Control Ordinance and EIAO TM criteria will be met. This can only be undertaken once the design of the plant housing or boundary treatments are known and therefore this requirement is defined in the Implementation Schedule along with procedures to maintain rolling stock and track noise levels.

KCRC has elected to consider further mitigation of East Rail within the corridor shared with MOS as subsequent study to this EIA. This will enable the Corporation opportunity to implement wider control of rail noise and achieve improved cost effectiveness in its deployment of noise control measures. The study will be undertaken by KCRC during the detailed design phase of MOS to fully review the appropriate integration of retroactive noise mitigation for East Rail with mitigation proposed for MOS. The study will seek a holistic solution to achieve full compliance of cumulative noise with the *Noise Control Ordinance* and will be submitted to EPD for approval as a requirement of the MOS EIA Implementation Schedule and Environmental Permit. The agreement to undertake this study is made solely on the basis that the performance criteria set forth by the MOS EIA are solely given by the *Noise Control Ordinance*. No description of infrastructure within the EIA shall commit the KCRC to achieve noise levels either above or below the requirements of the *Noise Control Ordinance*.

Provided the above recommendations are undertaken no residual impacts are expected.