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Mitigation Measures against Road Traffic Noise in Selected Places

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C O N T E N T S

Executive Summary

1. This research studies the mitigation measures against road traffic noise implemented in Japan, Taiwan, the State of New South Wales (NSW) and the State of Victoria (Victoria) in Australia, the State of California (California) in the United States and Hong Kong. Of particular relevance is the use of noise barriers to relieve the impact of traffic noise on those residents living in areas close to newly-built highways.

Japan

2. The Basic Environment Law and the Environmental Impact Assessment Law are the main legislation on road traffic noise control. The road traffic noise limits vary in respect of zone categories and time periods. For example, the noise limits during day-time and night-time in residential areas are 55 adjusted decibels (dB(A)) and 45 dB(A) respectively. The Japanese government has also designated a specific set of road traffic noise limits for areas which are adjacent to roads.

3. When new roads are scheduled to be built, environmental impact assessment should be carried out to evaluate the environmental impact. If the predicted noise level exceeds the prescribed limit, mitigation measures should be provided to maintain the quality of living. In most cases, the government installs noise barriers to reduce the noise impact on the affected residents. For an existing road, if the noise level is suspected to have exceeded the prescribed limit, the affected residents may request the local government to install noise barriers.

4. The government has adopted new technologies in designing noise barriers, which help reduce the height of noise barriers and redirect the propagation of noise. Examples of noise barriers of advanced technology include: multiple-edge type noise barriers, noise barriers incorporating noise reducers and active soft edge noise barriers.

5. The government has favoured the use of low-noise surface materials to reduce road traffic noise.

Taiwan

6. The major legislation on road traffic noise control is the Noise Pollution Control Act. The road traffic noise limits vary in respect of the types of noise control zones and time periods. For example, the road traffic noise limit for an extremely quiet noise control zone (such as low-density residential districts) in the evening is 45 dB(A).

7. The Taiwanese government is committed to providing mitigation measures against road traffic noise, which include the installation of noise barriers if the predicted noise level for new roadways exceeds the prescribed limit. In cases involving existing roadways, residents may request the competent authority to measure the noise levels. If the result exceeds the prescribed noise limit, the competent authority will adopt appropriate measures to solve the problem.

8. The government studies the feasibility of resurfacing roads with low-noise materials to reduce the traffic noise levels.

NSW

9. The main legislation on road traffic noise control is the Environmental Planning and Assessment Act. The determination of road traffic noise limits depends on the types of development and time periods. For example, the noise limits during day-time and night-time for new roads and freeways are 55 dB(A) and 50 dB(A) respectively. For existing roads or freeways where no redevelopment is taking place, the noise limits during day-time and night-time are 60 dB(A) and 55 dB(A) respectively.

10. In most cases, the NSW government implements mitigation measures against road traffic noise for new roads and freeways, including installing noise barriers if the noise level exceeds the prescribed limit. However, the government will consider a number of factors before making the final judgement, including: (a) the amount of noise reduction provided and the number of people affected; (b) the cost of mitigation measures considered and (c) the community preferences.

11. For existing roads, the government implements the noise abatement programme to reduce the noise impact on the residents nearby. However, owing to the fact that the government resources for noise abatement on existing roads are generally limited, treatments may only be provided on a priority basis.

12. The technologies developed for noise barriers include: barriers with novel-shaped cappings, absorbing edge barriers, longitudinal-profiled edge barriers and barriers with active control techniques.

13. The government surfaces the roads with low-noise materials to reduce traffic noise if the road speed limit is greater than 80 km per hour.

Victoria

14. The principal environmental legislation is the Environment Protection Act. The road traffic noise limit for new and upgraded roads is 63 dB(A), while the noise limit is higher at 68 dB(A) for existing roads.

15. The Victoria government publishes detailed guidelines on the measurement of road traffic noise to ensure that all measurements are of high quality and are consistent over time. One of the requirements is that the acoustic personnel should have professional qualification.

16. Where roads and freeways are built, or where existing roads or freeways are widened and buildings previously protected from traffic noise are exposed to noise, the traffic noise level should be reduced to the prescribed limits or the noise level that would have prevailed if the road improvements have not occurred, whichever is the greater. For existing roads, the government has formulated a noise abatement programme.

17. The government uses quieter pavement surfaces, where practicable, on freeways and major roads.

California

18. The California Environmental Quality Act is the major legislation on road traffic noise control. The prescribed road traffic noise limits depend on the land use activity categories only. In regard to residences, the noise limit is 67 dB(A).

19. There are three basic programmes under which the government may install noise barriers in California: (a) new freeway projects; (b) freeway widening projects and (c) the Community Noise Abatement Programme (CNAP). The government states that under CNAP, some noise barriers may not be retrofitted because of the lack of funds.

20. In California, the measure of resurfacing roads with low-noise materials is not popular. The government requires that any single noise mitigation measure should have an impact of at least 5 dB(A) reduction. Resurfacing roads with low-noise materials may only have an impact of 3 dB(A) to 4 dB(A) reduction.

Hong Kong

21. The major law on road traffic noise control is the Environmental Impact Assessment Ordinance, which requires all new designated projects such as construction of roads and railways to carry out detailed assessments on the potential noise impact of the projects, thereby encouraging noise reduction measures to be taken to meet the noise guidelines set out in the Hong Kong Planning Standards and Guidelines. The maximum statutory road traffic noise limit for residential developments is 70 dB(A).

22. When measuring road traffic noise, the Environmental Protection Department (EPD) may contract out private companies to perform the tasks. EPD explains that given the limited resources within the department, there is a need to outsource some of the road traffic noise measurement works. EPD does conduct selective spot checks to ascertain the measurement results. However, some acoustic professionals point out that the practice of contracting out private companies to measure road traffic noise may affect the quality of measurements.

23. The existing policy for planning new roads or implementing projects involving substantial widening of existing roads is that the relevant government departments and developer(s) must ensure that traffic noise at sensitive receivers will stay within the noise limit. For a case of substantial widening of existing roads, the Government will provide mitigation measures if the road traffic noise level has increased by at least 1 dB(A) as a result of the construction project. Mitigation measures considered include: installing noise barriers, adjusting the alignment of the road(s) and using low-noise materials for surfacing the roads.

24. Some local professional institutes and an academic raise the concern that the Government has depended too much on the use of noise barriers to mitigate road traffic noise. They argue that the Government may effectively tackle the road traffic noise problem by means of: (a) land use planning; (b) co-ordination work among government departments; (c) low-noise road surfacing and (d) traffic management measures. The Government responds that various constraints/difficulties should be taken into account when considering the proposed measures.

25. In Hong Kong, it is a standard government practice to pave high-speed roads (i.e. roads with a speed limit of 70 km per hour or above) with low-noise surfacing materials. However, the general application of such materials on low-speed local roads is still at the development and trial stage.

Mitigation Measures against Road Traffic Noise in Selected Places

Chapter 1 – Introduction

1.1 Background

1.1.1 Matters relating to mitigation of traffic noise, in particular the installation of noise barriers[1] in new roads, have often sparked off extensive discussions at meetings of the Public Works Subcommittee (PWSC) and the Finance Committee of the Legislative Council (LegCo). In addition, the problem of excessive traffic noise from existing roads, at which no mitigation measures were provided when the roads were built, has also been raised from time to time at the meetings between LegCo Members and members of District Councils. During the past two years, such complaints were raised at meetings with four District Councils, namely North, Kwai Tsing, Kowloon City and Sham Shui Po District Councils. The discussions are generally related to the lack of proactive measures to address the noise impact arising from the construction of new roads or widening of existing roads. These discussions have often led to questions on the Government's policies on the retrofitting of noise barriers and assessment of noise levels.

1.1.2 To tackle this subject, it had been suggested by Members at various forums that a comprehensive study should be conducted with a view to understanding the present government policy and mechanism in determining the need for mitigation measures and the scope of measures, including noise barriers, which can be put in place. The study should also cover the measures and improvement works undertaken by other densely populated urban cities under similar circumstances. As the mitigation of traffic noise falls within the terms of reference of the Panel on Environmental Affairs (the EA Panel) of LegCo, it was agreed that the study be steered by the EA Panel, with all Members, in particular members of PWSC, invited to participate in the study.

1.1.3 The issues and circumstances which have led to substantial discussions at PWSC and meetings with District Councils are summarized as follows:

(a) policy in determining the existing prescribed road traffic noise limits as criteria for providing noise mitigation measures for new and existing roads;

(b) policy in providing mitigation measures for existing roads connecting or adjacent to the new road to be constructed where the noise level at the existing roads already exceeds the prescribed noise limit, but the existing roads are considered to be outside the scope of the new road project;

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[1] In this research, the term noise barriers may also refer to noise enclosures.

(c) methodology for measuring the traffic noise level at noise sensitive receivers (NSRs), such as residential dwellings and schools, and the appropriateness of the methodology in determining if the noise level is within the prescribed noise limits and hence no noise mitigation measures should be provided;

(d) factors and considerations for deciding the type of noise mitigation measure(s), including noise barriers, air-conditioning and double-glazed windows for affected residents, to be taken into account;

(e) type of noise barriers (e.g. vertical or cantilever noise barriers; semi-enclosures or full enclosures) to be installed and the choice of materials for the barriers;

(f) structural and fire-fighting constraints on and solutions to the installation of noise barriers or other mitigation measures on existing roads; and

(g) extent of foundation works to be provided under a new road project to allow for the installation of noise barriers in the future to cater for possible new developments along the new road.

1.1.4 Under such circumstances, the Research and Library Services Division (RLSD) of the LegCo Secretariat was requested to conduct a research on mitigation measures against road traffic noise in selected places. Of particular relevance is the use of noise barriers to relieve the impact of traffic noise on those residents living in areas close to newly-built highways.

1.2 Scope of research

1.2.1 This study covers mitigation measures against road traffic noise in the following places:

(a) Japan;

(b) Taiwan;

(c) the State of New South Wales (NSW) in Australia;

(d) the State of Victoria (Victoria) in Australia;

(e) the State of California (California) in the United States; and

(f) Hong Kong.

1.2.2 Japan is selected because it enacted the Basic Environmental Law in 1993 and the Environmental Impact Assessment Law in 1999 to reduce road traffic noise. In particular, article 16 of the Basic Environmental Law requires the government to establish noise standards. To meet the statutory requirements, the government installs noise barriers in existing residential areas along highways and railway lines. Furthermore, the noise barriers installed are of innovative designs and relatively light due to the use of advanced technology.

1.2.3 Taiwan is selected because it amended the Noise Control Act in 1999, which has strengthened noise control measures and established noise standards for public and private areas. As a result, the government installs noise barriers along highways and railway lines to reduce the noise impact on the affected residents.

1.2.4 NSW and Victoria in Australia are chosen because they have carried out their own noise abatement programme against road traffic noise. Among the mitigation measures, installing noise barriers is a common one. Furthermore, according to some academics in Hong Kong, Australia has also produced high-quality noise barriers with good aesthetic design.

1.2.5 California is chosen because it is a common practice in the state to use noise barriers to provide mitigation of traffic noise. In addition, the noise barriers employed are considered by some academics in Hong Kong to be of high quality, with frequent use of lighter materials and innovative designs to create visual interest.

1.2.6 Hong Kong is included in the study with a view to providing an overview of the present situation in Hong Kong, and identifying ways to improve the mitigation measures against traffic noise in Hong Kong with reference to the practices adopted in the other selected places.

1.2.7 The mitigation measures against road traffic noise are examined in the following aspects:

(a) major legislation on road traffic noise control;

(b) prescribed road traffic noise limits;

(c) assessment of road traffic noise;

(d) installing noise barriers;

(i) government policy on the use of noise barriers to mitigate road traffic noise

(ii) design of and materials chosen for noise barriers

(iii) technical constraints on and safety considerations of installing noise barriers

(iv) procedure for installing noise barriers

(v) cost of noise barriers

(vi) examples of noise barriers installed with relatively light materials and innovative designs

(e) reducing road traffic noise at source;

(f) land use planning;

(g) resurfacing roads with low-noise materials;

(h) installing double-glazed windows and air-conditioning for the affected residents; and

(i) other measures.

1.2.8 The analysis chapter provides a comparison of the mitigation measures against road traffic noise in the selected places.

1.3 Methodology

1.3.1 This study adopts a desk research method, which involves Internet research, literature review, documentation analysis and correspondence with relevant authorities.

Chapter 2 – Japan

2.1 Major legislation on road traffic noise control

2.1.1 The Basic Environment Law and the Environmental Impact Assessment Law are the main legislation on road traffic noise control in Japan. In particular, Article 16 of the Basic Environment Law requires the Japanese government to establish noise limits, which are considered desirable for the preservation of the living environment and conducive to the protection of human health.

2.1.2 In addition, the Environmental Impact Assessment Law stipulates that the government and developer(s) should conduct an environmental impact assessment to evaluate the environmental impact before undertaking any property development and transportation projects. If necessary, mitigation measures should be provided to maintain the quality of living.

2.2 Prescribed road traffic noise limits

2.2.1 In Japan, the road traffic noise limits vary in respect of zone categories and time periods. For example, the noise limits during day-time (6 am – 10 pm) and night-time (10 pm – 6 am of the following day) at residential areas (i.e. zones A and B) should not exceed 55 dB(A)[2] and 45 dB(A) respectively (see Table 1).

Table 1 — Road traffic noise limits in respect of type of zone categories and time periods

Zone category	Road traffic noise limit	
	Day-time (dB(A))	Night-time (dB(A))
AA	50	40
A and B	55	45
C	60	50

Notes: (1) AA zone requires particular quietness.
(2) A zone is almost exclusively for residential purpose.
(3) B zone is primarily for residential purpose.
(4) C zone has a substantial number of residences mixed with commercial and industrial establishments.

Source: Ministry of the Environment, Japan.

[2] Sound is measured in units called decibels (dB). For road traffic noise, an adjustment, or weighting, of the high- and low-pitched sound is made to approximate the way that an average person hears sound. The adjusted sound is called "A-weighted decibel levels" dB(A).

2.2.2 The government has designated a specific set of road traffic noise limits for areas which are adjacent to roads. As regards areas adjacent to roads of two or more lanes in zone B and areas adjacent to roads with one or more lanes in zone C, the road traffic limits during day-time and night-time are 65 dB(A) and 60 dB(A) respectively. In addition, the government has treated the areas adjacent to roads that sustain major arteries of traffic[3] as special cases, in which the road traffic noise limits during day-time and night-time are set at higher levels of 70 dB(A) and 65 dB(A) respectively (see Table 2).

Table 2 — Road traffic noise limits in respect of areas which are adjacent to roads and time periods

Area category	Road traffic noise limit	
	Day-time (dB(A))	Night-time (dB(A))
Areas adjacent to roads of two or more lanes in zone A	60	55
Areas adjacent to roads of two or more lanes in zone B and areas adjacent to roads with one or more lanes in zone C	65	60
Areas adjacent to roads that sustain major arteries of traffic	70	65

Source: Ministry of the Environment, Japan.

2.3 Assessment of road traffic noise

2.3.1 The principles of assessing road traffic noise are summarized as follows:

(a) Select the measurement points where people are likely to be disturbed by road traffic noise. This step is intended to identify black spots and ensure an effective quantification of noise levels in areas where roads are in service. As a rule, measurements are taken from a height of 1.2 to 1.5 m above ground level.

(b) Noise levels due to road traffic may vary spatially and in different time periods. Statistical sampling techniques may be used for the accurate determination of the acoustical environment of an area.

[3] Roads that sustain major arteries of traffic refer to national highways, prefectural roads and municipal roads of four lanes or more.

Measurement periods should be as long as necessary to obtain an effective measurement of day-night, weekly, and seasonal noise variations for the area. As a general rule, at least one measurement must be taken for typical noise conditions during each of the following periods: morning, day-time, evening and night-time. The minimum measurement period generally used is 10 minutes.

(c) When noise measurements are not possible for a required period, calculation methods can be applied to estimate sound levels generated by the road traffic.

2.4 Installing noise barriers

Government policy on the use of noise barriers to mitigate road traffic noise

2.4.1 When new roads are scheduled to be built, environmental impact assessment should be carried out to evaluate the environmental impact. If the predicted noise level exceeds the prescribed limit, mitigation measures should be provided to maintain the quality of living. In most cases, the government adopts the measure of installing noise barriers which is considered by the government to effectively reduce the noise impact on the affected residents.

2.4.2 For an existing road, if the noise level is suspected to have exceeded the prescribed limit, residents may request the local government to install noise barriers. In response, the local government will first carry out noise measurement and inform the residents of the result. The local government will also provide the result to the administrator of the road and negotiate with him or her about whether mitigation measures should be implemented. The residents will be informed of the details of the negotiation process and the final decision.

Design of and materials chosen for noise barriers

2.4.3 Noise barriers are designed to cut off direct sound from various sources, aiming to diminish noise levels through energy losses that are created upon the occurrence of sound diffraction. While the effect of noise barriers varies with such factors as barrier height and the distance between the noise barrier and sound receiving points, a reduction of 10 dB(A) is usually achieved at the edge of the road with two-metre high noise barriers being placed on the flat road.

2.4.4 There are various types of noise barriers installed in Japan, including vertical and cantilever noise barriers, and semi-enclosures. Materials used for noise barriers usually involve concrete, wood, light-transmitting glass, sound-absorbing metal, fibre reinforced plastic and ceramics.

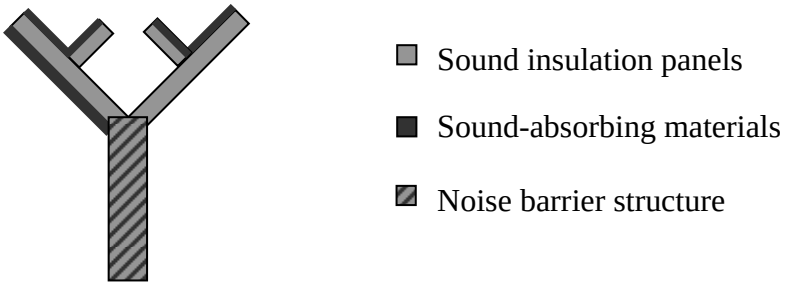
New technologies for noise barriers

2.4.5 Based on information provided by the Japanese government and a leading noise barrier manufacturer in Japan, there are new technologies in designing noise barriers, which help reduce the height of noise barriers and redirect the propagation of noise. The details of these new barriers are summarized below.

Multiple-edge type noise barriers

2.4.6 The multiple-edge noise barriers are designed to enhance sound insulation effects through their branched edges mounted at the top, which increase the number of diffractions and in turn interference with reflected waves. It is more effective if sound-absorbing materials are affixed to both the surfaces facing the sound source and the top surfaces of the branched edges (see Figure 1).

Figure 1 — Shape of multiple-edge noise barriers



Noise barriers incorporating noise reducers

2.4.7 This type of noise barriers is designed to reduce noise diffraction by taking advantage of the fact that noise reducers affixed to the top of the barriers can effectively divert noise generated from a road to move along the reducer surfaces. By installing noise reducers, the height of noise barriers can be reduced.

Active soft edge noise barriers

2.4.8 Technologies involved in this form of noise control are to allow secondary noise, which has the same amplitude as primary noise but the opposite phase to it, to interfere with the original noise, thereby offsetting it. In practice, multiple active soft edge (ASE) devices are mounted on the top edge of a noise barrier to reduce diffraction of sound.

Technical constraints on and safety considerations of installing noise barriers

2.4.9 As at the publication of this research report, RLSD has not been able to obtain the required information.

Procedure for installing noise barriers

2.4.10 As at the publication of this research report, RLSD has not been able to obtain the required information.

Cost of noise barriers

2.4.11 As the cost of noise barriers varies based on a number of factors such as barrier height, materials used and ground conditions, the government is not able to provide any rough estimates on the cost of a typical noise barrier.

Examples of noise barriers installed with relatively light materials and innovative designs

2.4.12 The Japanese government and the noise barrier manufacturer surveyed have provided a total of nine examples of noise barriers installed with relatively light materials and innovative designs.

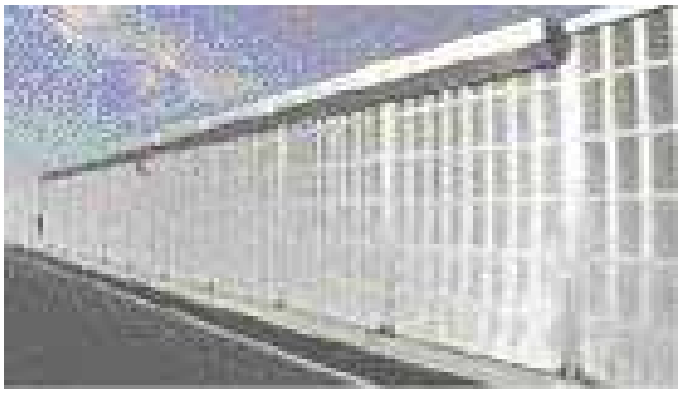
Transparent noise barriers commonly installed in Japan.

Noise barriers with vegetation making people feel more comfortable.

Sound absorbing device attached on the top edge of a noise barrier.

An example of noise barriers which can effectively diffract and absorb sound.

An example of sound-diffraction barriers.



Active soft edge noise barriers installed in Japan.

Multi-diffraction sound-absorbing noise barriers produced in Japan.

An example of light weight noise barriers using aluminum frame and polycarbonate plate.

Noise barriers installed along busy roads.

2.5 Other mitigation measures

Reducing road traffic noise at source

2.5.1 Under the Road Transportation Vehicles Law, the Japanese government is empowered to establish permissible motor vehicle noise limits and to periodically inspect the conditions of motor vehicles. To further reduce road traffic noise pollution, the government has plans to tighten permissible limits, crack down on illegal vehicle modifications such as muffler alterations, encourage research and development of better noise reduction technologies, and promote the sale and use of low-noise vehicles such as electric cars.

Land use planning

2.5.2 Incorporating mitigation of traffic noise in town planning strategies, the government has undertaken the following measures:

(a) zoning land and planning urban projects with the considerations of noise factor;

(b) building bypasses and ring roads; and

(c) establishing buffer zones on both sides of a road.

Resurfacing roads with low-noise materials

2.5.3 As another measure to mitigate traffic noise, the government has favoured the use of porous asphalt surfaces to reduce noise from tire friction. Generally speaking, low-noise pavement can attain a reduction of noise from 3 dB(A) to 5 dB(A). Examples of low-noise pavements in Japan are National Highway No. 1, Tomei Expressway and Meishin Expressway. The government is currently investigating the use of double-layered porous asphalt pavements and porous elastic road surface[4] to improve the condition of roads so as to reduce noise.

Installing double-glazed windows and air-conditioning for the affected residents

2.5.4 In some residential areas affected by traffic noise, the government may provide subsidies for the affected residents to install double-glazed windows if direct engineering remedies such as noise barriers and low-noise pavements cannot be implemented. However, the number of beneficiaries is usually small because of the government's financial constraints.

Managing traffic flows

2.5.5 The government also implements the following traffic control measures to reduce noise pollution:

(a) improving public transportation networks;

(b) installing advanced traffic management systems that respond instantaneously to traffic conditions; and

(c) implementing bus-only lane scheme.

[4] Porous elastic pavement uses rubber chips (granulated rubber) made from scrap tires as a major component, which are bonded together with polyurethane resin. The bonded granulated rubber structure is then attached to concrete pavement using a resin-based adhesive to form the resultant porous elastic pavement.

Adopting advanced construction methods

2.5.6 To tackle road traffic noise pollution, the Japanese government has adopted advanced construction methods, which are:

(a) employing a jointless construction method for elevated roads and bridges; and

(b) installing sound-absorbing panels on the underside of elevated roads.

Employing a jointless construction method for elevated roads and bridges

2.5.7 On elevated roads or bridges, vehicle wheel loads are directly imposed on expansion units such as expansion joints. The resulting wear on pavement surfaces over time can create bumps as well as propagate vibration and noise caused by the impact on the roadside areas. The jointless construction method is designed to suppress noise from structures of bridges and elevated roads through elimination of the noise source, which is achieved by connecting the girders or making the pavement more seamless.

2.5.8 In general, there are two types of jointless methods. In the "buried expansion" method, the expansion units are eliminated from bridges. In the "connection" method, the expansion units are removed, making the bridge structure more seamless through connection of either a part or all of the girders. Both methods can help reduce noise levels.

Installing sound-absorbing panels on the underside of elevated roads

2.5.9 Most of the underside surfaces of existing elevated roads are made from sound-reflective materials. In the case of a multi-level roadway structure, these materials not only reflect noise from roads on lower levels but also amplify it.

2.5.10 The adoption of sound-absorbing panels helps reduce roadside noise, especially in urban areas, as they can absorb reflected noise if they are attached to the underside of elevated roads or the wall surface of depressed roads. Materials that can be used for the panels are aluminum fibre, aluminum foam and glasswool. The underside sound-absorbing panels installed on the Hanshin Expressway in Japan have shown a noise reduction effect of 3 dB(A) to 6 dB(A).

Chapter 3 – Taiwan

3.1 Major legislation on road traffic noise control

3.1.1 The major legislation on road traffic noise control in Taiwan is the Noise Pollution Control Act, which is formulated to maintain a quiet environment and the living quality of the public. Under this Act, the Taiwanese government is required to set road traffic noise limits and adopt necessary mitigation measures to ensure that the noise levels should not exceed the prescribed limits.

3.2 Prescribed road traffic noise limits

3.2.1 The road traffic noise limits vary in respect of the types of noise control zones and time periods. For example, the road traffic noise limit for an extremely quiet class 1 noise control zone (such as low-density residential districts) in the evening is 45 dB(A). However, in a class 4 noise control zone (such as industrial parks) during day-time, the limit is at a much higher level of 75 dB(A) (see Table 3).

Table 3 — Road traffic noise limits in respect of type of noise control zones and time periods

Noise control zone (class)	Road traffic noise limit		
	Morning (5 am – 7 am) and evening (8 pm – 10 pm) (dB(A))	Day-time (7 am – 8 pm) (dB(A))	Night-time (10 pm – 5 am of the following day) (dB(A))
1	45	50	40
2	55	60	50
3	60	65	55
4	70	75	65

Notes: (1) Class 1 zone refers to the areas which particularly require quietness. Examples are low-density residential districts and hospitals.

(2) Class 2 zone refers to the areas provided mainly for residential use. Examples are high-density residential districts and schools.

(3) Class 3 zone refers to the areas provided mainly for commercial and industrial uses along with a large number of residences. Examples are selected high-density residential districts and commercial districts.

(4) Class 4 zone refers to the areas provided mainly for industrial uses. Examples are industrial parks and airport.

Source: Environmental Protection Administration, Taiwan.

3.2.2 The government has specified higher road traffic noise limits if the areas are adjacent to roadways[5]. For example, a road traffic limit of 71 dB(A) is allowed during day-time in class 1 and class 2 noise control zones, which are adjacent to roadways (see Table 4).

Table 4 — Road traffic noise limits in respect of areas which are adjacent to roadways and time periods

Noise control zone	Road traffic noise limit		
	Morning and evening (dB(A))	Day-time (dB(A))	Night-time (dB(A))
Class 1 and class 2: Areas which are adjacent to roadways	69	71	63
Class 3 and class 4: Areas which are adjacent to roadways	73	74	69

Note: (1) The road traffic noise limits are slightly higher for wider roadways.

Source: Environmental Protection Administration, Taiwan.

3.3 Assessment of road traffic noise

3.3.1 The government has imposed the following requirements when assessing road traffic noise:

(a) Measurements should be made at property boundaries or at a complainant's property. Microphone should be placed between 1.2 and 1.5 m above ground level.

(b) The humidity should be low and the wind speed should be less than five m per second.

(c) The measurement exercise should last for 24 hours continuously.

(d) The measurement report should contain the following information: the name of the responsible officer, the purpose of the measurement, results, the type of instrument used, the atmospheric conditions[6] and the measurement date.

[5] The width of a roadway should be at least six m.

[6] These conditions include wind direction and speed, temperature, atmospheric pressure and humidity.

3.4 Installing noise barriers

Government policy on the use of noise barriers to mitigate road traffic noise

3.4.1 The government is committed to providing mitigation measures against road traffic noise, which include the installation of noise barriers if the predicted noise level for new roadways exceeds the prescribed limit.

3.4.2 In cases involving existing roadways, residents may request the competent authority to measure the noise levels. If the result exceeds the prescribed noise limit, the competent authority will adopt appropriate measures to solve the problem.

3.4.3 The government has so far spent more than NT$400 million [7] (HK$92 million) for installing noise barriers along new and existing roadways.

Design of and materials chosen for noise barriers

3.4.4 While the government has not published any noise barrier design guidelines, the following three factors are usually considered when installing noise barriers:

(a) the height of noise barriers;

(b) wind and static loadings; and

(c) budget limit.

3.4.5 The commonly-used materials for noise barriers in Taiwan are concrete, aluminium and glass sheets.

Technical constraints on and safety considerations of installing noise barriers

3.4.6 Among the engineering considerations, the government considers wind and static loadings as more important.

Procedure for installing noise barriers

3.4.7 As at the publication of this research report, RLSD has not been able to obtain the required information.

[7] The average exchange rate in 2005 was NT$1 = HK$0.24.

Cost of noise barriers

3.4.8 As at the publication of this research report, RLSD has not been able to obtain the required information.

Example of noise barriers installed with relatively light materials and innovative designs

3.4.9 The Taiwanese government has not provided any example of noise barriers installed with relatively light materials and innovative designs. Nonetheless, the Hong Kong Institute of Acoustics (HKIOA) has provided a picture of noise barriers installed in Taiwan.

Noise barriers installed in Taiwan.

3.5 Other mitigation measures

Reducing road traffic noise at source

3.5.1 To reduce road traffic noise at source, the government requires all motor vehicles to comply with the noise emission standards.

Land use planning

3.5.2 As at the publication of this research report, RLSD has not been able to obtain the required information.

Resurfacing roads with low-noise materials

3.5.3 The government is studying the feasibility of resurfacing roads with low-noise materials to reduce the traffic noise levels.

Installing double-glazed windows and air-conditioning for the affected residents

3.5.4 The government does not provide any subsidies for installing double-glazed windows and air-conditioning for the affected residents because of the huge costs involved and the government's budget constraints.

Chapter 4 – The State of New South Wales in Australia

4.1 Major legislation on road traffic noise control

4.1.1 The main legislation on road traffic noise control in Australia is the Environmental Planning and Assessment Act (EPAA), which applies to NSW. This planning instrument requires that environmental impacts associated with developments must be assessed to the fullest extent possible, with regard to all matters affecting or likely to affect the environment. Road traffic noise is among the impacts on the environment that need to be assessed.

4.2 Prescribed road traffic noise limits

4.2.1 The determination of road traffic noise limits depends on the types of development and time periods (see Table 5). For example, the noise limits during day-time (7 am – 10 pm) and night-time (10 pm – 7 am of the following day) for new roads and freeways are 55 dB(A) and 50 dB(A) respectively. For existing roads or freeways where no redevelopment is taking place, the noise limits during day-time and night-time are 60 dB(A) and 55 dB(A) respectively.

Table 5 — Road traffic noise limits in respect of type of developments and time periods

Type of developments	Road traffic noise limit	
	Day-time (dB(A))	Night-time (dB(A))
New residential developments affected by road or freeway traffic noise	55	50
Redevelopment of existing roads or freeways	60	55
Existing roads or freeways where no redevelopment is taking place	60	55

Source: Road and Traffic Authority, NSW.

4.3 Assessment of road traffic noise

4.3.1 Road traffic noise levels can be evaluated by two alternative means: measurement and prediction. In measurement methods, acoustical instruments such as sound level meters are used to make direct measurements of noise. In prediction methods, noise levels are calculated through simulating real or predicted situations by means of mathematical models, based on acoustical theories of sound emission and propagation. In most cases, measurement and prediction methods are combined to provide a more effective assessment.

Road traffic noise measurement

4.3.2 Road traffic noise measurement can be conducted in open-field areas or under controlled conditions in anechoic chambers. Formal measurement methods focus on the selection of time periods and locations of measurement point. Different measurement durations are chosen according to the aim of the study. For a proper assessment of day-time and night-time conditions, the period of noise measurement may last up to 24 hours.

4.3.3 When variations of traffic flow with time of day are known, the durations can be shortened and the results corrected by mathematical formulae. In most cases, the measurement period adopted in NSW is 30 minutes.

4.3.4 Measurement points must be selected according to human activity in the study site. Preferred locations are those where both the highest noise levels are expected and more human activity takes place or is likely to take place.

4.4 Installing noise barriers

Government policy on the use of noise barriers to mitigate road traffic noise

4.4.1 In most cases, the NSW government implements mitigation measures against road traffic noise for new roads and freeways, including installing noise barriers if the noise level exceeds the prescribed limit. However, the government will consider a number of factors before making the final judgement, including:

(a) the amount of noise reduction provided and the number of people affected;

(b) the cost of mitigation measures considered; and

(c) the community preferences.

Noise abatement programme

4.4.2 For existing roads, the NSW government implements the noise abatement programme to reduce the noise impact on the residents nearby. To be eligible for noise treatment, the property concerned should meet the following four requirements:

(a) the property is located on an existing state or federal road and the road is not subject to any upgrading works;

(b) the noise levels at the property are at least 65 dB(A) during day-time or 60 dB(A) during night-time;

(c) there has been at least one noise complaint; and

(d) the treatment of the property is deemed cost-effective, equitable and practical.

4.4.3 Noise abatement treatments include noise barriers, noise mounds and quieter pavement surfaces. The installation of noise barriers and mounds must be able to reduce noise levels at the most affected property by at least 5 dB(A) for funding to be provided. Since the provision of quieter pavements results in reductions in noise levels of between 2 dB(A) and 4 dB(A) only, it should only be considered in conjunction with other treatments such as noise barriers.

4.4.4 Residents who believe that they are adversely affected by road traffic noise can contact the NSW government and ask to be registered under the noise abatement programme. A registration form and a document containing further explanation of the programme will be provided to the residents. The registration form enables the residents to provide contact information and details regarding the noise issue and their residence. The government will use such information to begin its investigation into whether treatment under the noise abatement programme is appropriate.

Discussion on the implementation of the noise abatement programme

4.4.5 Owing to the fact that the NSW government resources for noise abatement on existing roads are generally limited, treatments are provided on a prioritized basis. Accordingly, fulfilment of the aforementioned requirements does not necessarily mean that noise abatement is provided.

4.4.6 Furthermore, retrofitting of engineering-type noise controls is generally not recommended as a suitable strategy for addressing undesirable road traffic noise when no upgrading or redevelopment is occurring. The main reason for this arrangement is that there are often high costs and practical difficulties associated with retrofitting noise barriers.

4.4.7 In practice, noise treatments are usually provided only when 80% of the affected properties have not had a change in ownership for the previous seven years, and the properties were granted development consent before 1 January 2000. Noise abatement for new developments in locations already exposed to road traffic noise is primarily the responsibility of the relevant developers, local councils which granted the development consent, builders, owners and occupants.

Design of and materials chosen for noise barriers

4.4.8 The NSW government has provided detailed guidelines for designing noise barriers, which are summarized below:

(a) noise barriers must be considered in three dimensions as architectural objects, and be consistent with the design of other elements in the corridor in which the noise barriers are located. Consideration must be given to opening up views of the surrounding landscape and built forms for road users as well as district views for residents. Detail is less important to road users travelling at speed than the residents nearby;

(b) noise barriers should follow the road geometry in vertical alignment. It is generally preferable that the top edge is parallel to the road and smooth, particularly in urban and sub-urban areas. If stepping is needed, it should be ordered and regular. Minor steps are preferable to larger steps. Irregular or random stepping in both height and frequency should be avoided;

(c) noise barriers should generally be parallel to the road in horizontal alignment. Curved barriers or stepped barriers can be attractive and can add character;

(d) in most instances, it is better to screen noise barriers with planting. If space is limited, planting can also be used to break down the scale of a barrier. Generally speaking, the higher the barrier is, the larger is the width of planting needed in front of it;

(e) colours should be subdued. Neutral dark greys, dark greens and grey browns are preferable. Primary colours should generally be avoided or used with careful consideration. Painted patterns should be avoided;

(f) generally speaking, plain barriers are preferable; however, patterns on concrete can add interest. They should be simple, of a limited palette and repetitive. Natural and more traditional materials generally do not need to be textured;

(g) for cost and aesthetic reasons, materials should be selected for durability, resistance to staining, deterrence to vandalism and graffiti, safety and fire resistance; and

(h) concrete has great strength and flexibility in design. Masonry has local interest and is suited to a more domestic scale. Lightweight concrete is cost-effective when used in large scale and is also flexible in design terms. Stone is expensive but adds character and can be effective in highly sensitive scenic or heritage areas. Timber has a more domestic scale and is useful away from the road along property boundaries. It is unobtrusive but needs consideration with regard to maintenance and fire damage. The installation of clear barriers in polycarbonate and laminated glass can be expensive but is the only method if noise is determined to be mitigated and views protected. Metal barriers are generally only used for absorptive purposes and in rare circumstances.

4.4.9 Materials chosen for noise barriers include timber, precast concrete panels, lightweight aerated concrete, fibre cement panels, and transparent acrylic panels with profiled steel cladding.

New technologies for noise barriers

4.4.10 According to the NSW government, there have been advances in noise barrier design, albeit slowly, over recent years. Existing technology is largely based on the relatively simple concept that increasing sound attenuation requires an increase in barrier height. Nevertheless, higher barriers are more expensive to install. The higher cost is primarily because the taller the barrier is, the greater is the wind loads which must be resisted, and this naturally increases the structural cost. Accordingly, research has been aimed at increasing sound attenuation without increasing barrier height.

4.4.11 The technologies developed to date include:

(a) Barriers with novel-shaped cappings: the simplest ones are T-shaped tops or tops with multiple edges. They have been found to increase attenuation of 2 dB(A) to 3 dB(A) over conventional barriers at specific receiver points. Other developments include much more complex top edge shapes which create destructive interference around the top of the barrier. Increased attenuation of 3 dB(A) to 5 dB(A) is possible. It is important to note that such noise barriers will not necessarily give equal protection to all points behind the noise barriers.

(b) Absorbing edge barriers: these barriers gain attenuation by attaching an absorbing edge to the top of the wall. The edges may be simple curved sections, cylinders or mushroom shapes. Increased attenuation of 3 dB(A) is possible.

(c) Longitudinal-profiled edge barriers: these barriers utilize regular or "random" profiles along the top of the barriers to reduce noise. They are at an early stage of development.

(d) Barriers with active control techniques: a series of individual devices is attached to the top of a barrier with each device being individually controlled and tuned to a different frequency range to increase attenuation. These barriers are still in the development stage, and may possibly increase attenuation between 5 dB(A) and 10 dB(A).

Technical constraints on and safety considerations of installing noise barriers

4.4.12 The NSW government has not provided any guidelines on technical constraints and safety considerations when installing noise barriers. Nonetheless, the NSW government states that any noise barrier installed in the state should meet the following specifications:

(a) The barrier must withstand wind loadings for the appropriate terrain.

(b) Prior to the formal acceptance of any barrier type, the structural elements must be approved by the NSW government.

(c) The barrier must have a mass of no less than 10 kg per sq m of surface area.

(d) The overall sound transmission loss through the barrier material must not be less than 30 dB (a test certificate from an approved laboratory is required).

(e) The barrier must have a design life of 20 years and must be guaranteed for five years.

(f) The barrier must have no gaps or holes in it, or likelihood of them occurring through natural causes, thus allowing noise to pass through.

(g) The barrier must be designed so that it will not reverberate.

(h) The barrier must be acceptable from an aesthetic point of view.

(i) All the components of the barrier must have physical durability with respect to exposure to sun, water, wind, air pollutants and temperature changes.

(j) Maintenance requirements of the noise barrier should be minimal.

(k) Sound absorption materials must have acoustic durability.

(l) Sound absorption materials should have flame, fuel and smoke ratings that are low enough for them to be used safely beside a highway.

Procedure for installing noise barriers

4.4.13 As at the publication of this research report, RLSD has not been able to obtain the required information.

Cost of noise barriers

4.4.14 Table 6 presents the comparative costs per linear metre for the supply and installation of four-metre high noise barriers on flat land. As a number of factors will influence costs, these figures may only be used as a comparison guide only. Furthermore, new technology can reduce costs for traditionally expensive materials such as laminated glass.

4.4.15 According to the NSW government, capital costs are not the only costs which should be considered. More important considerations are durability of materials chosen and maintenance cost.

Table 6 — Cost of noise barriers in respect of type of materials

Type of materials	Cost per m (AUS$)
Reinforced concrete	
Plain concrete	1,925
Textured concrete	2,555 - 3,090
Curved concrete	2,480
Concrete block	
Lightweight panel wall	969 - 1,425
Plain concrete block	1,607
Brick wall	
Standard face brick wall	2,300
Stone wall	
Natural local stone	2,760
Gabion wall	
Gabion wall with earth core	3,135
Timber wall	
Standard timber wall	866
Clear wall	
Clear acrylic wall	At least 3,500
Metal wall	
Lightweight metal wall	5,800
Absorptive surface	
Proprietary absorptive noise screen	2,740

Note: The average exchange rate in 2005 was AUS$1 = HK$5.9.

Source: Road and Traffic Authority, NSW.

Examples of noise barriers installed with relatively light materials and innovative designs

4.4.16 The NSW government has provided a total of eight examples of noise barriers of various designs installed in NSW.

Example of barriers successfully co-ordinating form, consistency, colour and context.

Wall geometry following the road.

Regular stepping visually acceptable, creating an even rhythm.

Planting used to screen a simple wall at the top of the cutting.

Consistent form, context and colour achievable with less expensive elements.

Noise barrier of good design being a public art.

Combination of urban design and engineering creating an attractive noise enclosure in Melbourne.

Successful urban design outcome achieved through collaboration among engineers, designers and artists.

4.5 Other mitigation measures

Reducing road traffic noise at source

4.5.1 The NSW government reduces road traffic noise at source by:

(a) controlling traffic volumes;

(b) promoting the use of public transport and more efficient freight transport, including rail freight;

(c) imposing more stringent noise standards for new vehicles[8], reflecting the latest economically available technologies;

[8] The government introduced new noise standards for light and heavy vehicles in January 2005 to reduce road traffic noise at source. It is required that new cars are 3 dB(A) quieter, while new trucks and buses are between 4 dB(A) and 7 dB(A) quieter than previous noise standards.

(d) replacing older, noisier vehicles progressively; and

(e) educating drivers, transport operators, repairing service providers and the public about their roles of traffic noise reduction.

Land use planning

4.5.2 Future road traffic noise problems can often be avoided through zoning mechanisms that do not permit noise sensitive land uses along transport corridors. Recreational, commercial and light industrial establishments can effectively provide buffer zones between busy roads and residential communities.

4.5.3 In reality, there are limited opportunities to avoid incompatible zonings in many locations, particularly where noise sensitive developments have already occurred. Development control plans and site-specific development approval conditions may help ensure that future developments utilize noise-affected sites in an acoustically effective manner and that the layout, height, design and acoustic insulation of new buildings minimize the noise impact.

Resurfacing roads with low-noise materials

4.5.4 According to the government, based on the findings of transport researches, road tyre noise appears to dominate traffic noise when vehicles are travelling at around 70 km per hour. This means that in areas with posted speeds of 70 km per hour or more, the reduction of road tyre noise can be an effective noise reduction measure.

4.5.5 The type of road surface may significantly affect the level of traffic noise generated by pavement surface/tyre interactions. A rough and irregular surface causes the tyre to vibrate and emit noise. However, a perfectly smooth surface creates noise as well, because air trapped between the tyre and the road cannot easily escape and the movement of this air causes a hissing sound. Fine irregularities or texture within the road surface can assist in the removal of trapped air, thus reducing air pumping, whilst simultaneously not causing deformation and vibration of the tyre.

4.5.6 The current arrangement is at speeds greater than 80 km per hour, low-noise road surface materials are used to reduce traffic noise caused by surface/tyre interactions. The reduction may be up to 4 dB(A).

Installing double-glazed windows and air-conditioning for the affected residents

4.5.7 The government seldom provides double-glazed windows and air-conditioning for the affected residents because of budget constraints.

Chapter 5 – The State of Victoria in Australia

5.1 Major legislation on road traffic noise control

5.1.1 The principal environmental legislation in Victoria is the Environment Protection Act, which has the purpose of creating a legislative framework for the protection of the environment having regard to the principles of environment protection.[9]

5.1.2 A major practical application of the Environment Protection Act is to formulate the State Environmental Protection Policies (SEPPs). So far, SEPPs have been developed to manage the beneficial use of the environment with respect to air, water, soil, noise, etc. However, there is currently no SEPP for the control of road traffic noise, and the state government is in the process of developing a draft SEPP Road Traffic Noise for public consultation in 2006.

5.2 Prescribed road traffic noise limits

5.2.1 Unlike the practices in some of the places studied, Victoria does not have day-time and night-time noise limits. Table 7 below shows that the road traffic noise limit for new and upgraded roads is 63 dB(A), while the noise limit is higher at 68 dB(A) for existing roads.

Table 7 — Road traffic noise limit in respect of type of roads

Type of roads	Road traffic noise limit (dB(A))
New and upgraded roads	63
Existing roads	68

Source: Victoria Roads Corporation.

[9] The principles of environment protection include: (a) integration of economic, social and environmental considerations; (b) intergenerational equity; and (c) conservation of biological diversity and ecological integrity.

5.3 Assessment of road traffic noise

5.3.1 The state government has published detailed guidelines on the measurement of road traffic noise to ensure that all measurements are of high quality and are consistent over time. The following requirements should be observed by acoustic personnel.

(a) Reliability of the instruments used: Sound level meters, tape recorders and data loggers shall comply with the government's requirements. Field checks of instruments shall be carried out with a piston phone, portable calibrator or other portable checking devices prior to and on completion of the measurements.

(b) Professional qualification of acoustic personnel: A person holding a degree or diploma in electrical or mechanical engineering, a degree or diploma in science with a major in physics or such other qualifications and experience as approved by the Superintendent of the Victoria Roads Corporation [10], shall be responsible for: (i) overseeing the calibration of the instruments; (ii) supervising the instrument operator; and (iii) certifying that the results presented are a true record. Instrument operators shall be adequately trained and then supervised by the person responsible for certification.

(c) Microphone position: The microphone shall be substantially unobstructed and shall be located one m from the centre of the most exposed window of a habitable room on the lowest habitable level of the building under consideration. Where the prescribed position is inaccessible for some reasons, a site which is considered to be equivalent shall be used, subject to the approval by the Superintendent. A note of this shall be included in the final report.

(d) Measuring locations: All locations where noise is determined to be measured require the approval of the Superintendent. These locations are generally the locations where noise levels have previously been measured or calculated during the construction and post-construction phases of a project. Direct comparisons can then be made of the acoustic environment in the before and after situation.

It is essential that a clear photographic record of each microphone position, with respect to the exposed facade, is presented in the report. A map of the measurement locations with respect to the noise source(s) should be included in the report.

[10] The Superintendent supervises the assessment of road traffic noise.

(e) Measuring periods: The measuring period shall be over 24 hours.

(f) Weather conditions: The ideal weather conditions for measuring traffic noise is fine with little or no wind. However, these conditions are not always available and so the instrument operator should ensure that environmental conditions which may significantly affect the noise levels are controlled within appropriate limits.

The weather conditions throughout the measurement period must be reported. As a minimum, the morning and afternoon wind speed and direction as well as rain events must be covered.

(g) Traffic conditions: The level of traffic noise is dependent to a large extent on the volume, speed and mix of vehicle types. To ensure that the general traffic conditions are being measured, measurements shall only be carried out between Mondays and Fridays unless otherwise directed.

5.4 Installing noise barriers

Government policy on the use of noise barriers to mitigate road traffic noise

5.4.1 Where roads and freeways are built, or where existing roads or freeways are widened and buildings previously protected from traffic noise are exposed by removal of buildings required for widening, the traffic noise level should be reduced to the prescribed limits or the noise level that would have prevailed if the road improvements have not occurred, whichever is the greater.

5.4.2 For existing roads, the government has formulated a noise abatement programme, which has the following key elements:

(a) the government will retrofit noise barriers on existing roads that have previously diagnosed to be eligible for noise treatment[11]. However, the government will not ameliorate road traffic noise where new buildings are built next to existing or future roads;

(b) retrofitting will be considered when the traffic noise levels exceed 68 dB(A); and

(c) when determining what measures can be employed to achieve the target noise limit, consideration is given to the practicability and cost-effectiveness of the measures.

[11] RLSD asked the government of Victoria to clarify this statement. However, as at the publication of this research report, there has not been any reply.

Design of and materials chosen for noise barriers

5.4.3 The government sets out two principles to provide guidance in the selection of appropriate noise barriers, which are:

(a) using materials and designs which are effective in reducing the overall level of traffic noise; and

(b) ensuring that noise barriers do not significantly overshadow or unreasonably reduce daylight to adjoining properties.

5.4.4 The safety of the community and road users is a paramount consideration in the design of noise barriers. In effect, the design of a particular noise barrier depends upon consideration of space, cost, aesthetics and the desired level of sound reduction. A noise barrier must also be continuous and solid, with few, if any, holes, cracks or openings.

5.4.5 As regards the materials chosen for noise barriers, timber, pre-cast concrete panels, lightweight aerated concrete, fibre cement panels, transparent acrylic panels and profiled steel cladding are often used in Victoria. Materials used for a noise barrier should be chosen for appearance as well as cost and effectiveness.

Technical constraints on and safety considerations of installing noise barriers

5.4.6 The state government of Victoria has not provided any guidelines on technical constraints and safety considerations when installing noise barriers. Nonetheless, the Victoria government states that any noise barrier installed in the state should meet the following specifications:

(a) The barrier must withstand wind loadings for the appropriate terrain.

(b) Prior to the formal acceptance of any barrier type, the structural elements are required the approval of the government. The barrier must have a mass of no less than 15 kg per sq m of surface area.

(c) The overall sound transmission loss through the material of which the barrier is scheduled to be constructed must not be less than 30 dB.

(d) The barrier must have a design life of 20 years and be guaranteed for five years.

(e) The barrier must have no gaps or holes in it, or the likelihood of them occurring through natural causes, thus allowing noise to pass through.

(f) The barrier must be designed such that it will not reverberate.

(g) The barrier must be designed and built in an acceptable manner so that noise will not pass underneath it.

(h) The barrier must be acceptable from an aesthetic point of view.

(i) All the components of a noise barrier must have physical durability with respect to exposure to sun, water, wind, air pollutants and temperature changes.

(j) Maintenance requirements of any noise barriers should be minimal. Their appearance should not deteriorate excessively over time and their finishes should not require regular cleaning or painting.

(k) Noise barrier materials should have flame, fuel and smoke ratings that are low enough for them to be used safely beside a highway.

It can be seen that the specifications adopted in Victoria and NSW are very similar.

Procedure for installing noise barriers

5.4.7 As at the publication of this research report, RLSD has not been able to obtain the required information.

Cost of noise barriers

5.4.8 As there are a number of factors such as barrier height, ground conditions, site constraints and materials used which may affect the construction costs, the figures provided in Table 8 below serve as a guiding reference only.

Table 8 — Cost of noise barriers in respect of type of materials

Type of materials	Cost per sq m (AUS$)
Timber	250
Concrete	300
Acrylic	450
Lightweight concrete	300

Note: The average exchange rate in 2005 was AUS$1 = HK$5.9.

Source: Victoria Roads Corporation.

Examples of noise barriers installed with relatively light materials and innovative designs

5.4.9 The government has provided four examples of noise barriers installed with relatively light materials and innovative designs.

Tall concrete and acrylic barriers used to protect residences from heavily-trafficked freeway and also reduce over-shadowing of residences.

Timber barriers extensively used around Melbourne due to their lower prices and more natural appearance.

Recycled plastic being cheap and more environmental friendly.

Lightweight concrete barriers used
where an aesthetic appearance is important.

5.5 Other mitigation measures

Reducing road traffic noise at source

5.5.1 The government reduces noise emissions at source by:

(a) imposing more stringent noise standards for motor vehicles; and

(b) promoting and supporting measures that reduce engine and brake noises.

Land use planning

5.5.2 The government encourages compatible land use next to major roads by:

(a) working with the relevant planning authorities to ensure that wherever possible, permitted land uses beside busy roads are relatively insensitive to noise; and

(b) promoting the development of building regulations which take into account both the noise level outside and the type of activity proposed inside the building.

Resurfacing roads with low-noise materials

5.5.3 The government uses quieter pavement surfaces, where practicable, on freeways and major roads.

Installing double-glazed windows and air-conditioning for the affected residents

5.5.4 The government seldom provides double-glazed windows and air-conditioning for the affected residents because of financial constraints.

Chapter 6 – The State of California in the United States

6.1 Major legislation on road traffic noise control

6.1.1 The California Environmental Quality Act (CEQA), being the major legislation on road traffic noise control in California, has stipulated that a determination must be made whether a proposed project will substantially increase the existing noise levels for adjacent areas. If there is a substantial increase in the noise level, mitigation measure(s) should be provided, taking account of factors such as feasibility and cost-effectiveness.

6.1.2 In practice, the determination of whether a noise increase is considered to be substantial is dependent, in part, on the existing noise level. The government considers an increase in the noise level to be substantial when the proposed project results in an increase of the following amounts at the affected property.

(a) the proposed project makes the predicted noise levels exceed the existing noise levels by 12 dB(A) or more; or

(b) the predicted noise levels exceed the prescribed noise limits.

6.2 Prescribed road traffic noise limits

6.2.1 Unlike the practices in some of the places studied, California does not have day-time and night-time noise limits. The prescribed road traffic noise limits depend on the land use activity categories only. In regard to residences, which belong to category B, the noise limit is 67 dB(A) (see Table 9 below).

Table 9 — Road traffic noise limits in respect of land use activity categories

Land use activity category	Road traffic noise limit (dB(A))	Description of activities
A	57	Lands on which serenity and quietness are of extraordinary significance.
B	67	Examples are residences, schools, churches, libraries and hotels.
C	72	Developed lands, properties, or activities not included in categories A and B above.

Source: Department of Transportation, the State of California.

6.3 Assessment of road traffic noise

6.3.1 Noise measurement can be done by prediction methods and measurement methods. In practice, the government has adopted the prediction methods with the use of the Federal Highway Administration Traffic Noise Model (FHWA), which is an advanced computerized model for predicting noise impact in the vicinity of highways.

6.3.2 FHWA contains a large number of components, which include:

(a) five standard vehicle types, as well as user-defined vehicles;

(b) constant-flow and interrupted-flow traffic;

(c) effects of different pavement types and graded roadways; and

(d) sound-level computations.

6.4 Installing noise barriers

Government policy on the use of noise barriers to mitigate road traffic noise

6.4.1 There are three basic programmes under which the government may install noise barriers in California:

(a) new freeway projects;

(b) freeway widening projects; and

(c) the Community Noise Abatement Programme (CNAP) to build noise barriers on existing freeways.

6.4.2 In order for an area to be qualified for CNAP, it must meet all of the following criteria:

(a) residential properties were built prior to the construction of the freeway or prior to a major widening project;

(b) hourly noise levels exceed the 67 dB(A) threshold;

(c) the implementation of the programme must be able to achieve at least a reduction of 5 dB(A); and

(d) the cost does not exceed US$35,000[12] (HK$273,000) per residential unit (in 1987 dollars).

6.4.3 The government states that the availability of CNAP funds is usually a problem. As the demand for noise barriers has far exceeded the funding to build them, a priority waiting list has been developed, which is based on a formula, taking into account factors such as noise levels, number of living units and cost-effectiveness.

Design of and materials chosen for noise barriers

6.4.4 The majority of noise barriers built in California have hard, sound-reflecting surfaces. However, sound-absorbing barriers may also be installed in some areas. Transparent noise barriers, constructed using polycarbonate panels, may also be installed to ensure that the views will not be blocked.

6.4.5 Noise barriers are commonly made of masonry block, wood, stucco, precast concrete and metal. The selection of materials is normally made based on factors, such as aesthetics, durability, maintenance, cost and the public opinion.

6.4.6 As regards new materials for noise barriers, the government has recently approved a total of five new products to abate traffic noise. All of the new products are lighter than traditional masonry or cement barriers. One product, Sound Fighter, is an absorptive material that can be used in cases where reflective noise is a problem. Since none of the new materials is cost competitive with masonry walls, the government has not applied any of these materials to barrier systems installed on highway projects.

Technical constraints on and safety considerations of installing noise barriers

6.4.7 The engineering problem in many areas is seismic stability of barrier height, which means that wind loading is the major concern even with the use of lightweight materials.

Procedure for installing noise barriers

6.4.8 As at the publication of this research report, RLSD has not been able to obtain the required information.

[12] The average exchange rate in 2005 was US$1 = HK$7.8.

Cost of noise barriers

6.4.9 The actual cost of noise barriers can often be more than US$2 million (HK$15.6 million) per mile under normal conditions and can become more than US$3 million (HK$23.4 million) a mile if noise barriers have to be placed on bridges or involve other special designs, such as retaining walls.

Examples of noise barriers installed with relatively light materials and innovative designs

6.4.10 As at the publication of this research report, RLSD has not been able to obtain the required information.

6.5 Other mitigation measures

Reducing noise at the source

6.5.1 Reduction of traffic noise at the source is considered the most effective control. Therefore, the government encourages and supports legislation to require reduction in motor vehicle noise where advances in motor vehicle engineering permit.

Land use planning

6.5.2 The government encourages those who plan and develop land and local authorities controlling development or planning land use near known highway locations to exercise their powers and responsibility to minimize the effect of highway vehicle noise through appropriate land use control. For example, cities and counties are empowered to control development by the adoption of land use plans and zoning, building and housing regulations.

Resurfacing roads with low-noise materials

6.5.3 In the US, including California, the measure of resurfacing roads with low-noise materials is not popular. Both the federal and state governments require that any single noise mitigation measure should have an impact of at least 5 dB(A) reduction. Resurfacing roads with low-noise materials may only have an impact of 3 dB(A) to 4 dB(A) reduction.

Installing double-glazed windows and air-conditioning for the affected residents

6.5.4 The government does not normally install double-glazed windows and air-conditioning for the affected residents because of budget constraints. Noise insulation may be provided only when severe traffic noise impact is anticipated and normal abatement measures are physically not feasible or are economically unreasonable. When considering any special abatement measures, it must be demonstrated that the affected activities experience traffic noise impact to a far greater degree than other similar activities adjacent to highway facilities. In essence, it means that private residential dwelling units should have after-project exterior noise levels of 75 dB(A) or more, or the project causes an increase of 30 dB(A) or more in noise over the predicted noise level if no project was constructed.

Chapter 7 – Hong Kong

7.1 Major legislation on road traffic noise control

7.1.1 The major law on road traffic noise control in Hong Kong is the Environmental Impact Assessment Ordinance (EIAO) (Cap. 499), which requires all new designated projects[13] (DP) to carry out detailed assessments on the potential noise impact of the projects, thereby encouraging noise reduction measures to be taken to meet the noise guidelines set out in the Hong Kong Planning Standards and Guidelines[14] (HKPSG).

7.2 Prescribed road traffic noise limits

7.2.1 HKPSG requires that the maximum statutory road traffic noise limit for residential developments is 70 dB(A), which applies to the external facade at openable windows for ventilation of habitable rooms.[15] Unlike the practices in some of the places studied, Hong Kong does not have day-time and night-time standards. Furthermore, this traffic noise standard is relatively lax as compared with other places studied such as Japan, NSW and Victoria.

Discussion on the prescribed road traffic noise limits

7.2.2 RLSD has asked the Government, HKIOA, the Hong Kong Institution of Engineers (HKIE) and Professor Tang Shiu-keung of the Department of Building Services Engineering of the Hong Kong Polytechnic University to provide comments on:

(a) whether the prevailing road traffic noise limit can effectively protect the Hong Kong residents from road traffic noise; and if not,

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[13] Under Schedule 2 of EIAO, there is a full list of designated projects requiring environmental permits. Examples include: (a) roads, railways and depots; (b) airport and port facilities; and (c) waste storage, transfer and disposal facilities.

[14] HKPSG is a government manual of criteria for determining the scale, location and site requirements of various land uses and facilities. This manual is applied to planning studies, preparation and revision of town plans and development control.

[15] The technical background in arriving at the noise standard for residential development, i.e. 70 dB(A) in Chapter 9 of HKPSG, is set out in the report entitled *"Background to Noise Guidelines in Proposed Revisions to the Hong Kong Planning Standards and Guidelines"*. The Report, prepared in the mid-1980s, was endorsed by the then Land Development Policy Committee on 25 January 1985. According to the minutes of the said Committee meeting, the relevant government authorities had been consulted on the proposed noise control measures. However, there was no information showing that the Government had consulted the legislature on this issue.

(b) whether the Government should tighten the road traffic noise limit.

Their views on these two issues vary and are summarized as follows:

The Government

7.2.3 There is no uniform international noise limit for traffic noise. Overseas places have adopted various noise limits which take into account local circumstances and community response to noise.

7.2.4 In considering what is appropriate for Hong Kong, it should be noted that most overseas places are less densely populated, with less space constraints on development, better separation of residential and commercial/industrial districts and predominantly low-rise residential houses. These factors make it practicable for some of these places to adopt and achieve a more stringent traffic noise limit.

7.2.5 The Government's priority is to ensure that the current traffic noise standard for residential developments (i.e. 70 dB(A)) is complied with for new road projects, and that engineering and non-engineering measures are, as far as practicable, implemented for existing roads to reduce the traffic noise to levels below the standard in order to bring relief to the affected residents.

Hong Kong Institute of Acoustics

7.2.6 According to HKIOA, the traffic noise limit adopted in Hong Kong is higher than those adopted in most of the other places. HKIOA believes that Hong Kong should lower the limit with a view to improving the prevailing noise pollution. Hong Kong has a unique noise problem compared to other metropolitan cities in the world in that it is not uncommon that high-rise residential buildings are built next to heavily-trafficked highways. There is no particular means to tackle road traffic noise unless all these roads are enclosed or at least built with semi-enclosures. However, because of safety and traffic sightline considerations, it is not possible to enclose all the roads in the territory. In sum, lowering the noise limit may not solve the problem but may only give rise to "false hope" to the public.

7.2.7 HKIOA is sceptical about the effectiveness of the suggestion of adopting the night-time noise limits practised in other places to protect the affected residents by means of banning unnecessary commercial freight (such as container trucks and heavy goods vehicles) going into the residential districts. In the first place, Hong Kong does not have a distinct residential district. Secondly, residential buildings are built adjacent to commercial and industrial establishments, which have business activities all day long. Therefore, it is very difficult to apply the night-time noise limits in Hong Kong, without interrupting the normal business operations.

7.2.8 In HKIOA's view, lowering the noise limit is not a solution to address the traffic noise problems. The best approach is for the Government to revamp the whole planning mechanism. Efforts must be put to avoid constructing residential developments next to heavily-trafficked roads and transportation infrastructures. Consideration must also be given to avoid roads going into residential areas.

Hong Kong Institution of Engineers

7.2.9 HKIE presents a different view and supports the need to review the prescribed noise limits, taking account of the practices adopted in other places. HKIE also comments that the Government should consider not only the concern of the noise-affected residents but also other relevant factors, including the implications of a possible larger buffer distance between roads and residences as well as the uses of land. Overall, HKIE agrees that the prevailing noise limit may need to be tightened.

Professor Tang Shiu-keung

7.2.10 Tightening the noise limit may only work in new towns where everything including town planning starts from scratch. In urbanized areas, the noise level may have already exceeded the current limit and further tightening the limit does not bring any direct benefit to the affected residents.

7.3 Assessment of road traffic noise

Circumstances under which road traffic noise will be measured

7.3.1 The Government has identified the following circumstances under which road traffic noise will be measured:

(a) when the traffic noise situation is being evaluated in formulating and developing noise policies and noise abatement programmes;

(b) when the performance of noise mitigation measures such as noise barriers, low-noise road surfacing and traffic management schemes is being evaluated; and

(c) when responding to requests from LegCo Members on traffic noise information.

Methodology of measuring road traffic noise

7.3.2 The Government has adopted provisions in the guidelines entitled *"Calculation of Road Traffic Noise"* (CRTN) published by the United Kingdom (UK) government as the prediction and measurement methods for assessing road traffic noise in Hong Kong. In fact, CRTN has been prescribed in HKPSG since the mid-1980s and adopted in the environmental impact assessment (EIA) study for designated projects under EIAO since April 1998. The details of the prediction and measurement methods are summarized below.

The prediction method

7.3.3 The prediction method is a method of predicting noise at a reception point from a road scheme. It consists of five main steps:

(a) dividing the road scheme into one or more segments such that the variation of noise within each segment is small;

(b) calculating the basic noise level at a reference distance of 10 m away from the nearside carriageway edge for each segment;

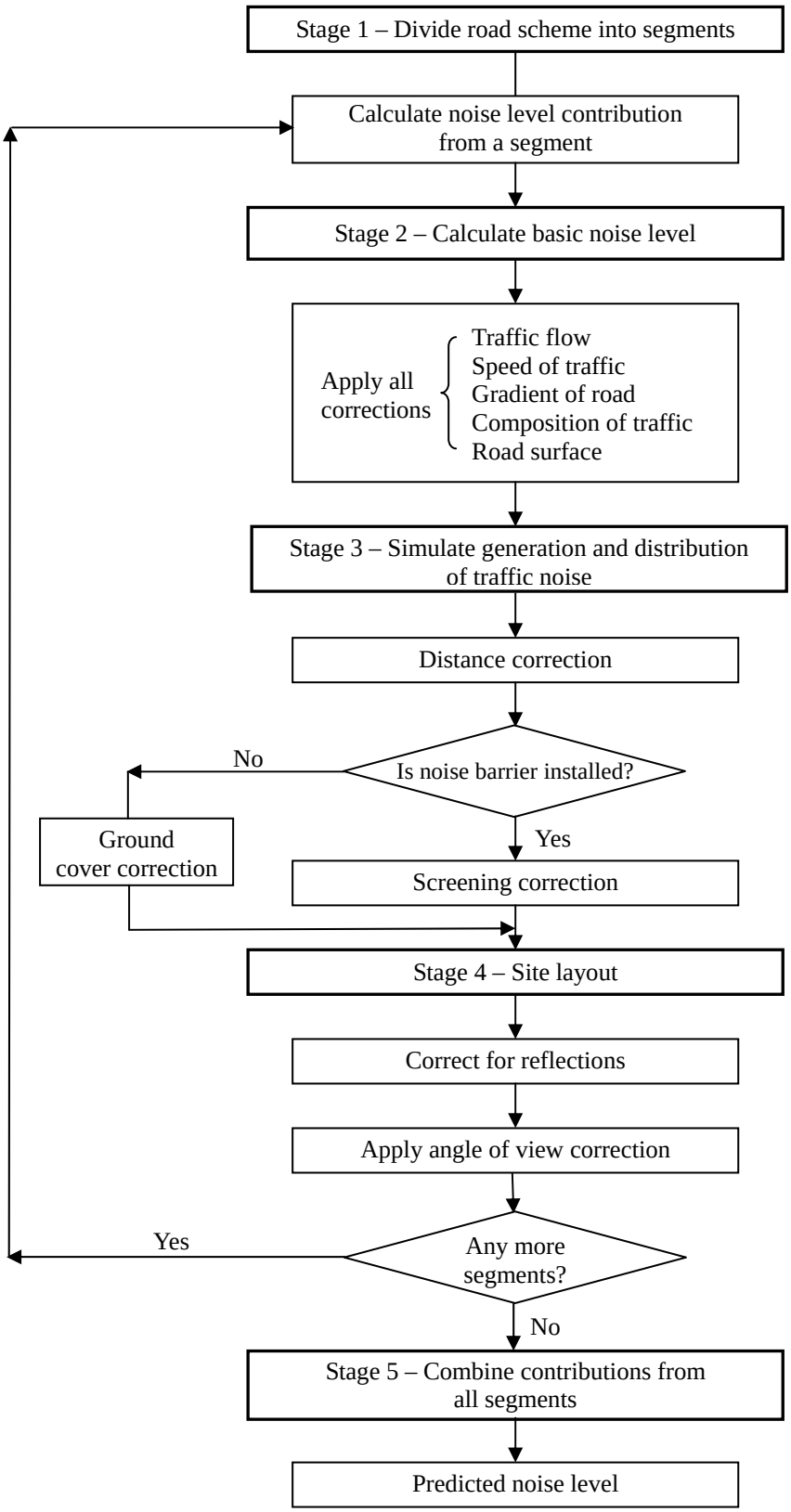
(c) assessing for each segment the noise level at the reception point, taking into account distance attenuation and screening of the source line;

(d) correcting the noise level at the reception point to take into account site layout features including reflections from buildings and facades, and the size of the source segment; and

(e) combining the contributions from all segments to give the predicted noise level at the reception point for the whole road scheme.

7.3.4 The above steps are shown diagrammatically in Chart 1 on the next page.

Chart 1 — Flow chart for predicting noise from road schemes



The measurement method

7.3.5 The measurement method consists of measuring the noise generated from an actual flow of traffic on a road. Generally speaking, the measurement position is required to be close to the road so that other traffic or extraneous noises do not influence the measured level. The measured level is adjusted to give a noise level at 10 m from the nearside carriageway edge by applying the necessary corrections.

7.3.6 In practice, the measurement method may be used where:

(a) traffic conditions fall outside the range of validity of the prediction method;

(b) traffic or site layout conditions are sufficiently complex or unusual to make the use of standard traffic data unreasonable; or,

(c) measurement provides a more economic method of determining the particular level of traffic noise.

Overall, the authority concerned is recommended to use the prediction method unless it is considered inappropriate under the circumstances of a particular case.

Physical conditions for measurement

7.3.7 The following conditions should prevail throughout the measurement period.

(a) Road surface: Measurements should be made when the road surface in the measurement area is dry.

(b) Wind: Measurements should be made where (i) the wind direction is such as to give a component from the nearest part of the road towards the reception point exceeding the component parallel to the road; (ii) the average wind speed at a height of 1.2 m and mid-way between the road and the reception point is not more than two m per second in the direction from the road to the reception point; and (iii) the wind speed at the microphone in any direction should not exceed 10 m per second. In all cases, it is recommended that a wind shield be used on the microphone and that measurements should only be carried out when the peaks of wind noise at the microphone are 10 dB(A) or more below the measured value.

Measuring equipment

7.3.8 Equipment used for the measurement should be capable of satisfying the specification adopted in the UK. As regards calibration, evidence of general compliance with the requirements can be based upon manufacturers' published technical data but regular (not less than annual) checking is necessary to ensure that equipment is correctly calibrated.

Measurement procedure

7.3.9 The following procedure should be adopted when carrying out the measurements:

(a) Microphone position: The measurement point should be chosen so that the view of the road in question is substantially unobstructed and should normally be not less than four m and not more than 15 m from the nearside edge of the carriageway. The microphone should normally be placed at a height of 1.2 m above the road surface and with the diaphragm or other sound-sensitive surface horizontal.

(b) Sampling times: The minimum sample time period leading to a valid measurement depends on the required number of samples per minute and on the total traffic flow, in vehicles per hour, passing the measuring point (in order to ensure that measurements include an adequate sample of vehicles).

(c) Traffic counts: Where possible, the measurements of traffic flow and composition should be concurrent with measurements of the traffic noise.

Analysis of data

7.3.10 For any given sample, the noise level registrations are analyzed to identify the number of samples exceeding the predetermined noise levels.

Discussion on the methodology adopted in determining road traffic noise levels

7.3.11 Both HKIOA and Professor Tang comment that the Government's methodology in determining road traffic noise levels is considered appropriate and in line with many overseas practices.

Example in Hong Kong illustrating the measurement of road traffic noise in a residential site

7.3.12 The Government has provided an empirical example to illustrate how road traffic noise is measured in a residential site. The report on traffic noise measurement of So Kwun Po Road at Vienna Garden conducted in July 2005 is summarized below.

Background of the case

7.3.13 The Civil Engineering and Development Department (CEDD, the then Territory Development Department) conducted a preliminary environmental review in January 2001 for improvement on junctions including Kai Keng Roundabout and local widening of roads in Sheung Shui and Fanling for further development in Area 36. The result indicated that the junction improvement works would not attract additional traffic to the area after the completion of the works. Therefore, it was not anticipated that the works would result in a significant increase in the noise level of the nearby noise sensitive receivers.

7.3.14 At the May 2005 meeting between LegCo Members and North District Council (NDC) members, the latter were concerned about the noise problems generated from the Kai Leng Roundabout Widening project.

7.3.15 At the resulting case conference held on 18 July 2005, the Environmental Protection Department (EPD) was requested to measure the traffic noise situation after the completion of the Kai Leng Roundabout Widening project. As such, the traffic noise measurement was conducted at So Kwun Po Road near Vienna Garden on 26 July 2005.

Noise measurement

7.3.16 The details of the noise measurement included:

(a) Date and time: The measurement taken after the completion of the Kai Leng Roundabout Widening project was carried out at 16:30 on 26 July 2005.

(b) Survey personnel: The noise measurement was conducted by staff inspector of EPD.

(c) Noise measurement location: The measurement location M1 was at 1/F, Block 1, Vienna Garden directly facing So Kwun Po Road. The location M1 was shown in the following map.

(d) Observations:

(i) Weather conditions: Weather during the measurement was fine and dry without the presence of rain or fog. Wind speed and direction were steady and without gusty wind.

(ii) Road surface conditions: It was observed that the road surface condition was dry.

(iii) Other noise sources: There was no construction noise or other source of noise in the vicinity affecting the measurement.

(e) Traffic data: According to CRTN, the number of vehicles and the percentage of heavy vehicles were counted on site for both directions on the road section.

(f) Instrumentation:

(i) All measurement instruments complied with the standards set by EPD.

(ii) Calibration of instruments: The sound level meter was calibrated on site by a calibrator immediately before the measurement and after the completion of the measurement.

(g) Results: The noise measurement and traffic count data were recorded in Table 10 below.

Table 10 — Results of noise measurement and traffic count data

Results of noise measurement		
Location	**Time/date**	**Noise level**
M1 1/F, Block 1, Vienna Garden	16:30/26 July 2005	72.6 dB(A)
Traffic count data		
Location	**Number of vehicles per hour**	**Percentage of heavy vehicle**
So Kwun Po Road	1 084	46%

(h) Conclusion: Noise measurement was conducted at 1/F, Block 1, Vienna Garden directly facing So Kwun Po Road after the completion of the Kai Leng Roundabout Widening project. The measured noise level was 72.6 dB(A).

Professional qualification and training of personnel responsible for measuring road traffic noise

7.3.17 As regards road traffic noise measurement, it is very important that the personnel who conduct the measurement are properly trained in terms of using the measuring instrument and understanding the methodology. As such, RLSD has asked both HKIOA and the Government to comment on whether the acoustic personnel are properly trained and qualified for measuring road traffic noise.

Hong Kong Institute of Acoustics

7.3.18 According to HKIOA, although measuring traffic noise is not a difficult task, given the compact environment of Hong Kong, one needs to be careful of some factors. For instance, one needs to determine whether the noise comes from the stream of traffic being measured or from other sources. HKIOA suggests that the Government should establish a system requiring only qualified professionals to conduct such measurement. HKIOA also volunteers to assist the Government by offering training courses for people who are involved in noise measurements.

The Government

7.3.19 In response to RLSD's enquiry, EPD confirms that it has contracted out private companies to measure road traffic noise. EPD explains that given the limited resources within EPD, there is a need to outsource some of the road traffic noise measurement works. EPD does conduct selective spot checks to ascertain the measurement results. However, some acoustic professionals point out that the practice of contracting out private companies to measure road traffic noise may affect the quality of measurements.

7.3.20 According to the Government, only qualified acoustic professionals can conduct road traffic noise assessment including measurement. The Professional Persons Environmental Consultative Committee (ProPECC) issued the practice note PN1/97 in 1997. Under this practice note, traffic noise calculation following the CRTN procedures (i.e. both prediction and measurement methods) would need to be endorsed by a corporate member of HKIOA.

7.3.21 The Government adds that HKIOA is the only prominent local professional institute in the acoustic profession. To be a corporate member of HKIOA, a person has to be educated in acoustics or a discipline relevant to the practice of acoustics and to have had at least three years of experience (one year gained in Hong Kong) in responsible work which demands acoustical knowledge or its application.

7.3.22 As for HKIOA's suggestion of requiring the relevant personnel to attend training courses, the Government believes that an individual professional should keep abreast of the latest technological development in the professional field on his or her own initiative. According to the Government, it recognizes that HKIOA organizes courses, seminars and workshops on a regular basis to allow their members and other professionals to continuously develop in their profession. For example, there is a professional diploma course in acoustics and noise in which proper application of noise measuring instrument and how to conduct noise measurement are included.

7.4 Government policy on the provisions of mitigation measures against road traffic noise

7.4.1 The existing policy for planning new roads[16] or implementing projects involving substantial widening of existing roads[17] is that the relevant government departments and developer(s) must ensure that traffic noise at sensitive receivers will stay within the noise limit. For the case of substantial widening of existing roads, the Government will provide mitigation measures if the road traffic noise level has increased by at least 1 dB(A) as a result of the construction project.

7.4.2 The Government emphasizes that through a defined vigorous assessment procedure, if the predicted traffic noise exceeds the noise limit or the road traffic noise level increases by 1 dB(A) or more, the project proponent must adopt all practicable direct measures, including installing noise barriers or enclosures, adjusting the alignment of the road(s), and using low-noise materials for surfacing to reduce the impact on users of noise-sensitive buildings in the neighbourhood.

7.4.3 For existing roads[18], the Government introduced the following administrative measures in November 2000 to address the noise impact on the affected residents:

(a) engineering solutions, by way of retrofitting noise barriers and enclosures, and resurfacing with low-noise materials, should be implemented where practicable at existing excessively noisy roads (i.e. roads generating traffic noise in excess of the noise limit of 70 dB(A)); and

(b) traffic management solutions, such as speed control, traffic diversion and restricting use by heavy vehicles, should be fully explored and implemented where practicable on a case by case basis where engineering solutions are impracticable or where engineering solutions alone are inadequate in reducing the noise to a level below the noise limit.

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16 A1 of Part 1 of Schedule 2 of EIAO defines a new road as a road which is an expressway, trunk road, primary distributor road or district distributor road, including newly constructed roads, and major extensions or improvements to existing roads, and is designated a project requiring Environmental Permit.

17 Schedule 1 of EIAO defines "major extensions or improvements to existing roads" as a physical addition, alteration or re-alignment to existing roads which results in an adverse environmental impact as defined in the Technical Memorandum.

18 For "existing roads", section 9(2)(g) of EIAO provides that a project listed in Part 1 of Schedule 2 that has commenced construction, or been in operation before EIAO comes into operation is exempt from the provision of EIAO so far as the construction and operation of the project is concerned.

7.4.4 The findings of a study published in 2000 showed that out of about 3 000 roads in Hong Kong, 655 of them were classified as noisy roads (i.e. roads generating traffic noise in excess of the 70 dB(A) noise limit). After the completion of some feasibility studies, 29 existing roads have been identified for retrofitting, and 72 roads have been identified as candidates for resurfacing with low-noise surfacing materials.

Discussion on government policy regarding the provisions of mitigation measures against road traffic noise

7.4.5 There have been recent complaints regarding the lack of mitigation measures to reduce the noise impact on the people who live adjacent to noisy roads, and to address the noise impact arising from the construction of new roads or widening of existing roads. (Please see Appendix I regarding the cases handled by the Complaints Division of LegCo Secretariat.) Against this background, Members have expressed concerns and asked the Government to look into a number of issues.

Definitions of "new roads" and "existing roads"

7.4.6 As discussed above, the definitions of "new roads" and "existing roads" affect the Government's decision on whether mitigation measures are provided against road traffic noise. When handling the complaint case of Route 8 – Ching Cheung Road Widened Road, Members have considered that the Government, in differentiating between "new roads" and "existing roads", is over-refined, technical and subjective.

7.4.7 In view of Members' concern, RLSD has asked the Government whether it has any plans to review or amend the legal definitions of those terms. The Government replies that it is open to any suggestions; however, it does not find the need to amend the above definitions at present.

Policy on the provision of mitigation measures only if the road traffic noise has increased by 1 dB(A) or more as a result of the widening of the road

7.4.8 Regarding the rationale behind the implementation of mitigation measures only if there is an 1 dB(A) or more increase in noise, the Government explains that the criterion is used to determine whether or not the extension or improvement works under consideration would cause an adverse noise impact and hence become a DP under EIAO.

7.4.9 For those road projects not classified as a DP under EIAO (which are usually roads serving the local community) undergoing modification, there are administrative procedures requiring the government departments responsible for the works to evaluate the potential environmental impacts (including road traffic noise) and implement practicable measures if the modification works are found exceeding the relevant noise criteria in HKPSG and cause an increase of 1 dB(A) or more.

7.4.10 The Government further elaborates that in acoustic term, a 1 dB(A) difference in noise level would generally be considered as just or barely noticeable. The 1 dB(A) principle has long been adopted by the Government in considering the eligibility of residential flats exposing to noise generated from new road projects for provision of noise insulation.

7.4.11 According to the Government, the same 1 dB(A) consideration has been adopted in the UK to determine the eligibility for noise insulation treatment for new roads or major modification of roads. Additionally, there are other places adopting a similar approach though the yardstick may be different. In NSW of Australia, the relevant authority may implement noise mitigation measures only if the predicted noise level exceeds the existing noise level by more than 2 dB(A).

7.4.12 The Government states that, after considering the relevant factors, the adoption of the 1 dB(A) or more criterion to assess whether the extension or improvement to existing roads would cause adverse impact is a very stringent and pragmatic approach.

Responsibilities of the developer(s)

7.4.13 RLSD has asked the Government to explain and clarify the responsibilities between the Government and the developer(s) with regard to the provision of appropriate mitigation measures against road traffic noise, and the way of keeping the public informed about the responsibilities of the relevant parties. The Government responds that the responsibilities of providing appropriate noise mitigation measures would depend on different situations.

7.4.14 For new roads categorized as a DP under EIAO, the details of noise mitigation measures including noise barriers and low-noise road surfacing, and which parties are responsible for the related implementation can be found in the relevant EIA reports. The softcopies of all EIA reports can be found on EPD's EIAO website (http://www.epd.gov.hk/eia/). Alternatively, the public can visit the statutory EIAO Register in EPD's office to read the hard copies of these EIA reports

7.4.15 For existing roads under the retrofitting barrier programme, government departments such as the Highways Department (HyD) and CEDD would be responsible for implementing these noise mitigation measures.

7.4.16 For proposed residential developments being considered by the Town Planning Board (TPB), the responsibility of providing noise mitigation would rest with the developer(s) to implement the types of noise mitigation measures recommended in the assessment reports submitted by the developer(s) or the Authorized Persons on their behalf to fulfil the TPB requirement. The implementation of these measures would be included as approval conditions as necessary.

Progress report on noise mitigation measures

7.4.17 Pursuant to the identification of 29 existing roads for retrofitting noise barriers and 72 existing road sections for resurfacing with low-noise materials in 2000, the Government provided progress reports on implementing mitigation measures for these identified roads to both the EA Panel and the Panel on Transport in February 2003 and December 2004 respectively. RLSD has requested the Government to provide a further update on the progress as well as any plan for addressing the noise problem of the 655 classified noisy roads.

7.4.18 The Government replies that the progress report published in December 2004 is the latest report available. Out of the 101 identified roads and road sections, the Government has identified 36 existing road sections for which preliminary investigations have shown that retrofitting works are technically feasible. Among the 36 road sections, the installation of noise barriers for three of them is now underway. Funding for another 18 road sections has been allocated and the Government expects to complete the construction of barriers for these road sections by 2011. As for the remaining 15 road sections, the Government will seek funding under the Public Works Programme for the implementation of the related work. The Government states that it will continue to review the need for and feasibility of retrofitting noise barriers on suitable existing road sections on a regular and needed basis. Upon the results of these reviews, more road sections might be added to the list of 36 road sections in the future.

7.4.19 In parallel, the Government has included 72 road sections in the programme to resurface with low-noise road resurfacing materials for noise mitigation. The programme is expected to be completed by 2010. (Please see Appendix II for the progress report of the mitigation measures implemented/considered for those noisy roads identified in 2000.)

7.4.20 For road sections where engineering solutions mentioned above are infeasible, night-time traffic management schemes would be considered where practicable. For example, a scheme banning franchised buses and cross boundary buses has been put in place for Texaco Road.

7.4.21 According to the Government, in the longer term, the noise impact of existing roads should be addressed in a comprehensive manner through urban renewal and better town planning efforts. The Government has pledged that it will continue to improve the living environment of those who are affected by excessive traffic noise from existing roads. Hong Kong, like many metropolitan cities in the world, experiences the traffic noise problem, which can be created by a combination of factors such as scarce habitable land, a concentrated road transport network, immense housing demand and a lack of environmental concern in the past few decades. This problem is believed by the Government to be an inherited problem which cannot be totally solved due to various existing constraints.

7.5 The use of noise barriers against road traffic noise

7.5.1 To tackle the road traffic noise problem, noise barriers are commonly installed in Hong Kong. However, HKIOA, HKIE and the Hong Kong Institute of Architects (HKIA) and Professor Tang all raise the concern that the Government has depended too much on the use of noise barriers to mitigate road traffic noise. Their arguments are as follows:

The Hong Kong Institute of Acoustics

7.5.2 HKIOA regards that the tendency of the Government to install noise barriers to reduce noise if situations allow may not solve the problem. The Government should also consider other means such as low-noise road surfacing and traffic management schemes. In view of the substantial monetary inputs for installing barriers on existing roads, HKIOA suggests that the Government should study whether installing noise barriers on existing roads is cost-effective.

The Hong Kong Institution of Engineers

7.5.3 HKIE suggests that the government policy on the use of noise barriers to mitigate road traffic noise should be reviewed. The installation of noise barriers, if technically feasible, is an effective tool to mitigate traffic noise but it should not be the only means. The construction of noise barriers may be a nuisance itself to the residents. Other measures such as low-noise road surfacing and traffic management measures (e.g. quieter buses and electric vehicles) should also be considered.

7.5.4 Traffic noise is often produced by the traffic of heavy vehicles, which can be mitigated by putting in place traffic management measures with properly planned road networks to divert heavy trucks away from residential areas. This should be the best solution to those existing built-up areas.

7.5.5 Noise barriers, especially those built on bridges, are very costly as their installation raises the foundation and structure costs exponentially due to the wind pressure attracted. Indeed, the root problem is that land planned for residential developments, in particular those for high-rise buildings, is placed too close to busy roads. If land use is planned properly, there can be green areas and open space separating roads and buildings, or with those low-rise or non-noise sensitive buildings located in front, and the high-rise ones at the back. With these planning arrangements, noise barriers, if needed, will only be limited to short ones, thus less costly to install. These requirements, if properly considered during the stage of land use planning and land sales, can be specified in the development of land in the proximity of busy roads.

The Hong Kong Institute of Architects

7.5.6 HKIA has provided a detailed description of their views, which are presented below.

(A) Proper improvement on the planning principle and production of the Outline Zoning Plan (OZP)[19]

7.5.7 HKIA considers that the existing design and production of OZP are not up to the requirement of planning a complex and dense city like Hong Kong. The current OZP is more like a land-use planning layout on two-dimensional principles, under which the city is being caved into different land uses subject to the jurisdiction of various government departments. In Hong Kong, the dense and compact living environment demands a more integral three-dimensional (3-D) planning that would help save space and also tackle the noise problem. In addition, using Government, Institution or Community (G/IC) zoned buildings and schools as a noise shield for residential developments is not a proper way of planning, neither is erecting noise barriers of poor aesthetic design. In sum, HKIA suggests that an overall revision of the planning and land use approach adopted by the Government should be the ultimate way to solve the noise problems.

[19] OZP is a kind of statutory plans prepared by TPB under the Town Planning Ordinance. It is basically a plan that shows the proposed land-use zoning and major road systems of individual planning scheme areas. Each plan is accompanied by a Schedule of Notes which shows, for a particular zone, the uses always permitted (Column One Uses) and uses that would require permission from TPB (Column Two Uses) upon application.

(B) Aesthetic and humane approach instead of engineering-led approach in town planning

7.5.8 Major cities in the world have used town planning and urban design to create interesting public spaces integrated with a proper car and pedestrian system. The Government's present town planning method is too functional, with engineering of highway being the main leading factor. The reason for such method is historical and it requires re-assessment. At present, OZP is being cut into clusters of functional areas. A more human-first approach and a reconciliation of the feeling of the men/women on the street as the design parameter leading the town planning design can better solve the problem.

(C) Co-ordination work among government departments

7.5.9 At present, a highway and its surrounding land are under different jurisdictions, with the construction and maintenance of the highway being the responsibility of HyD, the traffic on the highway being regulated by the Transport Department (TD) and the surrounding land being regulated by Lands Department (LD) and other departments. HyD and TD have no landscape engineers/architects working on the aesthetic aspects when planning the construction or improvement of a highway. Besides, the consultants involved in integrating the highway design and its surroundings in urban design are usually members of an engineering-led team.

(D) Mitigation at its source

7.5.10 HKIA believes that the most effective method of noise control is to mitigate noise at its source. Therefore, the construction budget for highways should go beyond the minimum cost of constructing a highway and noise barriers only. The underlying urban design concept demands an integral design approach involving various departments and changes the present co-ordinated approach where the public indirectly have to pay for the cost. The integral approach of using landscape earth-beams, half-sunken highways or deck-over constructions may reduce the total number of footbridges and noise barriers installed.

Professor Tang Shiu-keung

7.5.11 Professor Tang does not believe that there is any problem with the current policy on using noise barriers. Nonetheless, other noise reduction options such as constructing more bypasses and controlling traffic flows may also be considered.

The Government

7.5.12 In Hong Kong, land is a precious and scarce resource, especially considering that there is always substantial demand for various development needs such as housing, employment and recreational spaces, and access and transport is an inseparable part of the development. In meeting these needs, the Government suggests that it would realistically assess the opportunities and constraints and arrive at an optimal solution in addressing competing demand whilst achieving a good living environment. In many situations, roadside noise barriers and enclosures are the only solutions considered practicable by the Government to meet the noise standards in road construction.

7.5.13 The Government considers noise abatement and control as a corporate effort through prudent planning of land use and design of road project as well as noise control, which fall within the jurisdiction of different bureaux and departments, with HKPSG serving as a guide in the planning stage. The general context before the role of land use planning in addressing the traffic noise is detailed below.

(A) Land use planning measures to abate road noise

7.5.14 In the planning of new development areas and in the course of urban redevelopment, the Government employs some land use planning measures to avoid creating new environmental problems and seize opportunities for environmental improvement as far as practicable, including:

(a) promoting rail-based development so as to reduce reliance on highways and hence road traffic generation;

(b) using the underground/sunken road design at suitable locations to reduce land severance and minimize environmental impacts to adjoining residents;

(c) locating trunk roads and primary distributors in the periphery of the development areas to:

(i) reduce developable areas that will be subject to road noise; and

(ii) divert through-traffic away from the development core areas;

(d) concentrating the majority of the resident population within the 500 m walk-in catchments of the railway station to:

(i) promote mass transit;

(ii) encourage walking as a mode of transportation; and

(iii) minimize the need for feeder service;

(e) locating noise-sensitive receivers away from the sources generating excessive noise levels as far as practicable; and

(f) shielding off noise sources through planning noise-insensitive uses or landscaped earth bunds along major known noise sources as a buffer as far as possible.

7.5.15 Many of these measures are exemplified in the planning of the various existing and proposed new development areas, including Tung Chung, South East Kowloon, Kwu Tung North and Hung Shui Kiu.

(B) Constraints faced by the Government

7.5.16 According to the Government, in reality, the above measures are by no means panacea, especially where land is so scarce in Hong Kong. There are limitations in applying these measures, as elucidated below:

(a) It is not possible to rely on rail only and put all roads underground. Roads are sometimes unavoidable, and in fact are often part of a development, especially to provide connection with areas not served by railway and access to various development sites and for servicing and emergency vehicles.

(b) The sole use of buffer as a mitigation measure is not practicable in the context of Hong Kong where land resource is limited. Full compliance with the buffer distance would sterilize a large area of land resources, not to mention that in many cases such an extent of open land may not exist at all. Hence, the screening measure often becomes the only realistic option.

7.5.17 Due to land constraints, noise non-sensitive uses would usually be proposed at the buffer areas so as to reduce the land area for the sole purpose of buffer. However, it is still impossible to fully use the buffer area because:

(a) there are usually inadequate noise non-sensitive uses to occupy all the buffer areas;

(b) many noise non-sensitive uses such as open space and G/IC facilities have to be located close to the residents they serve. Locating them solely for the purpose of noise mitigation would cause inconvenience to the users and defeat other planning objectives; and

(c) some noise non-sensitive uses may themselves be sensitive to air pollutant and hence not suitable to be located adjacent to major roads, such as recreational uses.

(C) Noise mitigation for a single road/road widening project

7.5.18 If only a single new road project or road widening is involved in the plan, particularly in the existing urban area, there are usually more constraints and less flexibility to adopt land use planning measures because of more limited land space and the presence of existing buildings. Notwithstanding such constraints, the project proponent would still need to consider how the noise impact could be reduced to an acceptable level through choosing a better alignment and using low noise surfacing materials. If these measures are inadequate, the proponent will have to consider mitigating the noise at source through erection of noise barriers or enclosures.

(D) Existing road noise

7.5.19 Noise from existing roads is more difficult to tackle, mainly due to the presence of existing developments along the road alignments.

(E) Responses to the views expressed by the professional institutes

7.5.20 The Government remarks that the noise mitigation problem is very complicated and that noise barriers are neither relied upon nor preferred as the sole mitigation measure. Instead, they are part of a comprehensive package of noise mitigation measures, which includes what the professional institutes have recommended. In considering the package of measures to be used, cost effectiveness of noise barriers would need to be taken into account.

- The Outline Zoning Plans

7.5.21 According to the Government, OZPs are prepared to provide development certainty and serve as a tool in development control. It has been proven to be very effective and efficient in a compact city with keen competing demand like Hong Kong. In preparing or amending an OZP, the Planning Department (PD) will analyze the opportunities and constraints of each scheme area and its context carefully and advise TPB of all the relevant social, economic and physical considerations before an OZP is gazetted or amended. Therefore, although the OZPs appear in a two-dimensional format, there are detailed design parameters on plot ratio, site coverage, building height, building setback, footpath width, etc. to ensure a better living environment, and in some cases, specifically for addressing noise problem and aesthetic issues. Some zonings on an OZP also require submission of master layout plans on the scale, layout and design of the developments.

- Aesthetics consideration

7.5.22 The Government considers that Hong Kong has its own development needs, and thus any urban design principles have to be specifically tailored for the local situation. At the macro level, PD mainly focuses on broad design parameters such as building heights and massing, the three-dimensional relationship of buildings with the city's backdrops (e.g. ridgelines) and natural and cultural heritage (e.g. the harbour, countryside and buildings of conservation value), disposition of landmarks, and connectivity of public routes and spaces on the overall cityscape.

7.5.23 PD is progressively translating the urban design and landscape guidelines at the district level through the preparation of Area Improvement Plans, Pedestrian Plans and Greening Plans for key commercial/tourist areas, older urban cores and waterfront areas. These Plans provide a planning framework covering improvements to the urban design, streetscape/landscape and pedestrian environment and identify improvement proposals for relevant government departments and property developers to take forward.

7.5.24 PD is mindful of not imposing excessively restrictive control to limit design flexibility down to individual building designs, forms and facade treatment, which are details to be left best to the private sector.

7.5.25 To facilitate government and private professionals in the planning and development process to pay regard to the urban design merits and impacts of proposals, PD has incorporated a set of urban design guidelines in HKPSG. The guidelines cover major land uses and specific major urban design issues including massing and intensity in urban fringe areas and rural areas, development height profile, waterfront sites, public realm, streetscape, heritage, breezeways and view corridors, and stilted structures. These guidelines should apply wherever practicable in the plan making and development control processes.

Co-ordination work by the Government

7.5.26 The Government explains that the administration and management of highways are entirely within the ambit of HyD, not TD. There are landscape architects in HyD to look after the aesthetic aspects of a highway.

7.5.27 Any noise barrier or enclosure erected as part of the project has to be submitted to the Advisory Committee on the Appearance of Bridges and Associated Structure[20] (ACABAS) for consideration. This arrangement ensures that any structural measures to abate noise are aesthetically pleasing and compatible with the local environment.

[20] ACABAS consists of representatives from relevant government departments and professional institutions such as HKIE and HKIA.

Mitigation at source

7.5.28 The Government states that it always considers land use planning measures, direct and indirect technical mitigation measures in a preferential order to address traffic noise. Given the development needs and practicality of various measures under different situations, the Government shares the views with the professional institutes and noise barrier manufacturers that an integral approach in tackling the problem is needed. Landscaped buffer, half-sunken highways and decking over, and other relevant measures, will be duly considered and adopted whenever feasible and practicable.

Design of and materials chosen for noise barriers

7.5.29 Both the design of and materials chosen for noise barriers depend on a number of factors, including acoustical properties, visual impact, safety concerns, durability, fire resistance, daylight and tunnel effect, ease of installation and maintenance.

7.5.30 In general, noise barriers can be divided into three categories:

(a) reflective types (transparent and non-transparent);

(b) absorptive types (non-transparent); and

(c) other forms, such as earth landscaped mound and retaining structures.

7.5.31 The Government commonly uses reflective transparent noise barrier materials and glass to minimize the visual impact. However, transparent materials are noise reflecting, which should be taken into account in the design. For an absorptive type, it is typically made up of a perforated cover sheet or glass fibred reinforced concrete enclosing sound-absorbent materials. Where space is available, the use of landscaped mound and retaining structures may be a visually attractive and acoustically effective mitigation option.

7.5.32 Apart from acoustic performance, the following factors are also considered in selecting the suitable design and materials of noise barriers:

Safety and vehicle impact

7.5.33 In view of the likelihood of noise barriers being struck by an errant vehicle, they should be protected from the impact of errant vehicles by a vehicle restraint system, resulting in un-tensioned corrugated beam barriers or concrete profile barriers. Where noise barriers are required to be installed on bridge structures, the risk associated with noise barriers on flyovers falling onto vehicle and pedestrian paths upon impact by vehicles should also be considered in the design.

Fire resistance

7.5.34 Noise barriers, in particular those made up of transparent materials, are prone to fire hazards. Various materials behave differently under fire. For example, glass is not combustible but it may shatter under fire.

Visual impact

7.5.35 The visual impact of roadside barriers on the adjoining communities as well as road users is a consideration in the design of roadside barriers. To enhance the public's understanding of the visual impact associated with the design of roadside barriers, government departments are encouraged to apply, where possible, the 3-D presentation approach and visualization technologies for consultation with the adjoining communities. The objective is to design the noise barriers with appropriate scale and character that blend into the local environment. Concerning the road users, the design should be aimed at avoiding a "tunnel impression effect" through appropriate forms and visual treatment of the noise barriers. Incorporation of transparent panels and landscaping around the noise barriers may be considered to accomplish this purpose.

Glare effect

7.5.36 Metallic and transparent materials can produce "glare" effects to motorists at certain incident angles, which would be a nuisance to nearby residents. Special treatment on the surface of the noise barrier materials should be applied to minimize this effect.

Aesthetic design

7.5.37 To soften the visual impact of noise barriers, government departments are required to pay due attention to their aesthetic design. They should consult the relevant District Councils, and explore designs that would enhance the landscape and visual quality or make the noise barriers visually compatible with the vicinity. They are encouraged to apply, where possible, the 3-D presentation approach and visualization technologies to enhance the public's understanding of the visual consideration.

7.5.38 ACABAS has been set up to promote the importance of the final appearance of bridges and other structures as a criterion for design, and to stimulate interest in the appearance of these structures, including noise barriers and enclosures, associated with the highway system. The roles of ACABAS are:

(a) to advise the Government on standards to be applied and procedures to be adopted to achieve high aesthetic quality of design for bridges and associated structures and to promulgate general guidance on such matters; and

(b) to scrutinize individual design proposals for bridges and associated structures from the aesthetic and visual impact points of view and to make recommendations for acceptance or necessary design revisions.

Discussion on the design of and materials chosen for noise barriers

7.5.39 HKIOA, HKIE and a leading noise barrier manufacturer have expressed views on the design of and materials chosen for noise barriers, and the Government has also provided some comments.

The Hong Kong Institute of Acoustics

7.5.40 For high barriers or enclosures, which are commonly installed in Hong Kong given the high-rise nature of residential buildings and their close proximity to highways, the structural support may inevitably be larger and hence more massive. The design of these supporting structures depends on a number of factors, particularly safety. In that aspect, whether one can have a barrier system of lighter weight is very much dependent on the safety requirement.

7.5.41 As regards the visual quality design of noise barriers, HKIOA opines that visual impact is very subjective. High and massive barriers are inevitably less attractive visually and it is probably more costly to utilize them for constructing aesthetically pleasing structures. Nonetheless, HKIOA shares the view of many sectors of the community that the aesthetic design of the existing barriers in use could be done in better ways.[21]

7.5.42 One possible way to improve is to have open competition for the barrier design so that the public can have an opportunity to participate in the decision process. Another way is through consultation and release of adequate information. The Government may consider making use of the latest development of information technology so that the public, in particular the residents affected by the traffic noise, can visualize the barriers as built some years later from their flats so that they can prepare their mindset for the barriers. The residents may also be provided a venue to voice out their concerns during consultation.

[21] In recent years, there have been public criticisms regarding the aesthetic design of noise barriers installed in Hong Kong. The issues arising from the provision of noise barriers along the widened Tolo Highway are discussed in Appendix III.

The Hong Kong Institution of Engineers

7.5.43 On the design of noise barriers, HKIE believes that it may be beneficial to review the design standard for adding noise barriers, including those on existing or new bridges so that structural adequacy can be accurately and safely assessed. For example, it is unlikely to have full vertical loads during a typhoon period and the design wind pressure for noise barriers in build-up areas can be assessed using the wind tunnel test for a cost-effective solution. Furthermore, the review can also place particular emphasis on cost-effectiveness and aesthetic consideration.

7.5.44 As to the noise barrier materials, HKIE considers that those materials currently used in Hong Kong are nearly the best available in the market. There are only a small number of manufacturers producing such barriers and the cost is very high. More advanced materials are available at an even higher cost.

7.5.45 According to HKIE, noise barriers screen noise mainly by virtue of their surface density which varies among heavier and lighter materials. Therefore, whether or not lighter materials can be used depends on the amount of noise reductions required. Employing lighter materials has the advantage of being able to build higher barriers so that more residents can be shielded off from the road. This may be attractive in the Hong Kong context because of the high-rise nature of buildings. However, high noise barriers may also be undesirable, not only from the visual point of view, but also from the natural ventilation and possibly natural lighting viewpoints. Meanwhile, noise barriers can be designed to be more aesthetically pleasing but they will undoubtedly be more expensive.

7.5.46 HKIE believes that to search for advanced or state-of-the-art noise barrier materials is only a technological fix to tackle the problem being created. The crux of the problem is not the weight of the materials but the wind load they attract, and thus lighter materials do not help. The Government should therefore go back to the root of the problem – separating roads and developments so as to reduce the extent and height of noise barriers. There is no quick panacea to the problem and re-planning the whole urban setting is the best solution.

Professor Tang Shiu-keung

7.5.47 Professor Tang opines that the use of light weight materials does not help much. More advanced technology on sound control does not seem to be helpful as most of the constraints are not related to acoustics. He suggests that the use of the active soft edge type noise barriers or active control may help reduce the height of the barrier and redirect the propagation of noise.

The leading noise barrier manufacturer

7.5.48 According to a noise barrier manufacturer surveyed, all the noise barriers constructed in Hong Kong involve a combination of metallic sound absorptive panels and transparent panels. This is regarded as the best choice so far.

7.5.49 In the manufacturer's view, the *"Structures Design Manual for Highways and Railways"* issued by HyD contains a very stringent set of criteria for professional designers to conform to, which has limited their flexibility in offering alternative and innovative proposals.

7.5.50 When retrofitting noise barriers on existing roads become necessary, the manufacturer considers it useful for the Government to think about relaxing the structural requirements which are the major restriction. It also suggests some other means to reduce the wind load imposed on the structures, including "Noise Reducers" and "Acoustic Louvre Barriers".

7.5.51 Noise reducers are sound reducing devices installed along the top of conventional vertical barriers to reduce visual intrusion and increase sound reduction of the barriers. Noise reducers are used commonly in Japan and Europe and demonstrated to provide measurable sound reduction and help reduce the height of barriers to some extent.

7.5.52 Employing acoustic louvre barriers as an alternative to conventional solid absorptive panels may reduce dynamic load resistance and result in a corresponding reduction in overall load imposed on the noise barrier systems. However, the exact loading implication has to be verified by structural engineers.

The Government

7.5.53 The Government claims that although noise barriers installed in Hong Kong appear to be bulky and heavy, it is the structural members of the supporting framework of the noise barrier panels that give this impression. The sizes of these members are determined based on established engineering design standards in order to withstand different loadings imposed on the noise barriers, including wind loads under typhoon conditions and vehicular collision loads. The weight of the noise barrier panels only accounts for a relatively small proportion of the total design load.

7.5.54 Responding to HKIOA's suggestion of improving the aesthetic design of noise barriers by holding open design competitions, conducting consultation and releasing adequate information, the Government remarks that it has a well established mechanism in the design process to ensure that the noise barrier design is aesthetically pleasing and public opinions are being taken into account. The Government has also published guidelines to facilitate dissemination of information and concept. In any event, the Government will consider holding an open competition on noise barrier designs for suitable projects.

7.5.55 As regards the proposed review of safety requirements, the Government's view is that the current design practice has already taken into account the various loading combinations under different conditions. For example, it is not considered that full vertical vehicle loadings would occur concurrently with the loading caused by typhoons. Additionally, an appropriate wind pressure head is adopted for the design of noise barriers depending on their location in each case. The Government considers that the design standard is well established by striking a balance between cost-effectiveness and safety, and is suitable in the Hong Kong situation.

Technical constraints on and safety considerations of installing noise barriers

7.5.56 Given the urbanized environment of the territory, it is generally agreed that many technical and safety constraints need to be overcome when installing noise barriers. The major constraints include structural integrity, space limitation, traffic safety, fire fighting and emergency requirements, and socioeconomic concerns. These constraints are particularly prominent in case of retrofitting noise barriers on existing roads where the existing site conditions may pose further limitations to barrier installation. Examples of the technical and safety constraints encountered in Hong Kong are discussed below:

New noise barrier structures should not obstruct emergency access or fire fighting

7.5.57 Noise barriers should not be provided at an emergency vehicle access. It is essential that the affected facades should be within the reach of fire engines. In general, vehicular access with a minimum width of six m should be provided adjacent to an affected facade. If an obstruction exists, the distance between the point accessible by a fire engine and the farther-most facade should be less than 10 m. For flyovers, the Fire Services Department normally requires that a 4.5 m horizontal clearance should be maintained between the outermost edge of the flyover and an adjacent building. Noise barriers should not impede normal operation and maintenance of fire hydrants. Emergency crossing to the opposite side of a road should be maintained. Full enclosure type barriers exceeding 230 m may need to comply with road tunnel fire safety requirements.

New noise barriers should not undermine road safety or impede pedestrian and vehicular movements

7.5.58 The new noise barrier structures should not undermine road safety or impede pedestrian and vehicular movements. The principle of "See and be Seen" must not be violated. This is particularly essential for noise barriers close to an existing junction where the new structures may affect the sightline of both pedestrians and drivers. The desirable minimum stopping distance should be maintained at road bends where noise barriers are erected for sightline consideration.

New noise barriers should not interfere with commercial activities or cause social disruptions

7.5.59 This constraint is to ensure that the location of new noise barrier structures will not interfere with street-level commercial activities such as shops, restaurants and cinemas.

There should be adequate space and structural capability (applicable to flyovers) for supporting the noise barrier/enclosure

7.5.60 There should be sufficient space to accommodate the noise barrier or enclosure structures including their foundation without causing obstruction to pedestrian flow or other social and commercial activities. When erecting noise barriers on existing flyovers, the structural capacity of the flyovers must be checked to ensure that they are capable to support the additional loads arising from the noise barriers.

7.5.61 Other considerations may include the need of implementing temporary traffic management to cope with traffic and pedestrian demands during the construction of the barriers.

Discussion on the technical constraints on and safety considerations of installing noise barriers

7.5.62 Both HKIOA and Professor Tang confirm that the concerns raised by the Government are all relevant.

<u>Procedure for installing noise barriers</u>

7.5.63 In general, implementation of public works projects, including noise barriers, should follow the procedures stipulated in the Project Administration Handbook for Civil Engineering Works (PAH).

7.5.64 According to PAH, during the planning stage, when the project scope, layout and general form of the proposed noise barrier scheme and implementation programme are determined and agreed among relevant government departments, the relevant District Council should be consulted on the proposed scheme. Since the traditional two-dimensional (2-D) presentation by means of photos and maps may not easily be understood by the general public, especially for proposed noise barrier schemes in a compact environment with numerous high-rise buildings, road project proponents are encouraged to apply, where possible, the 3-D presentation approach and visualization technologies to enhance the public's understanding of the visual design of the proposed noise barrier schemes. The extent, layout and appearance of the works are taken into account when working at comments from the District Council, and before the layout/scope of the works is finalized (i.e. before proceeding to detailed design).

7.5.65 Upon an agreement on the layout of the works, the proposed noise barrier scheme is gazetted under the Roads (Works, Use and Compensation) Ordinance. The scheme and layout plan are available for public inspection for a period of two months and the public can comment and object to the proposed scheme. The proposed scheme may subsequently be modified or special conditions may be imposed taking into account comments from the objectors to improve or avoid the effect of the proposed works.

7.5.66 If a noise barrier proposal forms part of a designated project under EIAO, the proposed barrier scheme is also available for public inspection and comments received thereupon are taken into account before the EIA report is finalized and endorsed by the Director of Environmental Protection.

Cost of noise barriers

7.5.67 The construction cost of conventional noise barriers using reflective or absorptive panel materials very much depends on the barrier height, ground conditions, site constraints and any need for diversion of underground utilities. For vertical or cantilevered barriers up to about eight m high under favourable ground conditions, normally spread concrete footings would be adequate to support the noise barrier structure. For noise barriers with height exceeding eight m or founded on weak foundation materials and noise enclosure, piled foundation is normally required to support the noise barrier structure. Typical ranges of the construction costs are listed in Table 11 below for reference.

Table 11 — Cost of noise barriers and enclosures

Type of noise barriers and enclosures	Cost per sq m (HK$)
Noise barriers on spread footing	3,000 to 5,000
Noise barriers on piles	7,000 to 10,000
Noise enclosures	10,000 to 18,000

Source: Environmental Protection Department, Hong Kong Government.

Use of advanced technology by the Government in designing noise barriers

7.5.68 The Government claims that it is determined to keep abreast of the latest technological developments around the world, such as the use of new construction materials for noise barriers, and other new technologies in noise mitigation for suitable application in Hong Kong. An example is quoted below by the Government for illustration of its efforts in searching for advanced technology in designing noise barriers.

7.5.69 According to the Government, it has supported and taken part in arranging world-renowned noise control researchers and practitioners to share with it the latest trend in noise mitigation to enable local professionals as well as government officials to have better understanding of the latest technology and development in controlling road traffic noise. In December 2003, both EPD and HyD were the supporting and sponsoring organizations among others in organizing a Symposium on "International Trends in Designing Noise Barriers" which attracted over 150 participants from the related professionals as well as the public sector. The symposium provided the Government with updated information on the latest technologies in tackling road traffic noise.

"Over-hang" type noise barriers

7.5.70 There is a suggestion that the Government should consider installing the "over-hang" type noise barriers. This design is believed to be able to effectively avoid imposing the loading onto a flyover, thus solving the loading problem. As such, RLSD has asked the Government and two noise barrier manufacturers to explain the technological details and the cost of the "over-hang" type noise barriers.

The Government

7.5.71 The Government explains that the so-described "over-hang" type noise barrier[22] is in fact an independent structure supporting noise barrier along a flyover to mitigate the traffic noise generated from it. The structure itself is physically separated from the flyover and founded on ground independently. Therefore, there is no loading directly imposed from the noise barrier on the flyover. As the supporting structure together with the noise barrier is required to be above the carriageway level of the flyover for adequate noise protection, the structure is usually very massive in order to sustain the wind loading and the loading from the cantilevered part of the noise barrier. While this design would have the benefit of not imposing additional loading on the flyover, additional land intake is required for accommodation of this structure plus extra space between the flyover and the structure which is allowed for inspection/maintenance operations.

7.5.72 The construction cost of the "over-hang" type noise barriers is significantly higher and such massive structure is normally aesthetically undesirable. In practice, the construction cost of the "over-hang" type noise barriers using reflective or absorptive panel materials depends on the structure and barrier height, ground conditions, site constraints and any need for diversion of underground utilities. For easy reference, the typical range of such cost is about HK$300,000 to HK$500,000 per linear meter.

7.5.73 Whilst it should be recognized that the acoustic performance of noise barriers cannot match with that of a noise enclosure, including an "over-hang" type noise barrier, the latter's cost is usually higher. For cost comparison purpose, eight m high noise barriers are chosen for comparing with enclosures. Whilst normally-spread concrete footings are adequate for vertical or cantilevered barriers up to eight m high, piled foundations are usually required to support noise enclosures as well as noise barriers with height exceeding eight m or founded on weak foundation materials. Typical ranges of their construction cost are listed in Table 12 below for reference. The cost of the "over-hang" type noise barriers is found to be significantly higher than that of other commonly installed noise barriers.

[22] In general, such type of noise barriers is described as an "independent structure for noise barriers/enclosures". Pile foundations are provided to support the noise barriers so that there is no loading imposed onto the flyover.

Table 12 — Typical range of construction cost in respect of selected types of noise barriers

Type of noise barriers	Typical range of construction cost (HK$)
Eight m high noise barriers on spread footing (i.e. commonly installed noise barriers)	24,000 to 40,000 per linear meter
Eight m high noise barriers on piles (i.e. "over-hang" type noise barriers)	56,000 to 80,000 per linear meter

Source: Highways Department, Hong Kong Government.

Noise barrier manufacturers

7.5.74 The two noise barrier manufacturers surveyed have generally shared the views regarding the "over-hang" type noise barriers as the Government.

Examples of noise barriers installed with relatively light materials and innovative designs

7.5.75 Noise barriers with transparent panels have been widely used in Hong Kong for their relatively light weight and nature of less visual impact. Some of the examples are:

Noise barriers installed at the Island Eastern Corridor.

An example of noise barriers constructed with relatively light materials and a design blending with the surrounding environment, locating at Kam Tin Road near the junction to Tsing Long Highway.

Noise barriers installed along Tin Wah Road between Tin Shing Road and Tin Kwai Road.

Examples of noise barriers which are commonly installed in Hong Kong

7.5.76 The Government has also provided three examples of noise barriers which are commonly installed in Hong Kong.

Vertical noise barriers at Kam Tin Bypass.

Cantilever noise barriers along Kam Tin Road outside Ko Po Tsuen, Yuen Long.

Partial noise enclosures along section of Ma On Shan Bypass near Monte Vista.

7.6 Other mitigation measures

Reducing road traffic noise at source

7.6.1 The obvious approach to mitigate road traffic noise at source is to make the vehicles themselves quieter through noise emission control. The Government introduced the Noise Control (Motor Vehicles) Regulation in 1995, requiring all newly registered vehicles to comply with the noise standards. The regulation was amended in 2002 to keep Hong Kong's vehicle noise standards in line with the standards adopted in Europe and Japan. In the long run, as the existing vehicle fleet is gradually replaced by vehicles which comply with the more stringent standards, the overall traffic noise level in Hong Kong should be reduced.

Land use planning

7.6.2 The Government has adopted land use planning against traffic noise, aiming to avoid incompatible uses, i.e. sensitive uses and noisy roads, being put close to each other. Traffic noise problems can be prevented or reduced using planning measures such as alternative land use arrangements, buffer separations between roads and noise sensitive developments, and alternative road alignments. Where applicable and depending on the buffer distance, the above measures can eliminate or reduce traffic noise that would otherwise be generated by the originally planned roads, or, for the planned receivers, affected by the roads in the vicinity.

7.6.3 However, the Government states that the means of alternative land uses/alignments and road/receiver separations may not always be achievable in urbanized areas. In case there are constraints rendering the above measures not achievable, noise reduction designs like use of noise-tolerant buildings as screening structures and provision of noise barriers, are incorporated at the earliest stage of the planning process.

Resurfacing roads with low-noise materials

7.6.4 It is a standard government practice to pave high-speed roads (i.e. roads with a speed limit of 70 km per hour or above) with low-noise surfacing materials. The employment of low noise materials would reduce the road/tyre interaction noise on high-speed and low-speed roads by up to 3 dB(A) and 5 dB(A) respectively. However, the general application of such materials on low-speed local roads is still at the development and trial stage.

7.6.5 Unfavourable local road geometry and traffic conditions such as frequent start-stop movements, many turning movements and loading/unloading activities, and a high percentage of heavy vehicles cause rapid wear and tear, resulting in an uneven road surface and the need for frequent resurfacing. The Government estimates that while a local road with normal asphalt surface needs resurfacing every six years, one with low-noise surfacing materials requires resurfacing at least once every three years. Accordingly, the adoption of low-noise materials may result in higher maintenance costs, more traffic disruption and inconvenience to drivers, pedestrians and shop operators. The Government thus considers it necessary to select suitable road sections for surfacing with such materials. The Government has identified 72 existing local road sections for a trial resurfacing programme with low-noise surfacing materials. At present, about 20 of such road sections have been laid with low-noise road surfacing. The Government has pledged to monitor the performance of these roads for two years, and aims to complete the resurfacing of the remaining road sections by 2010.

7.6.6 In view of the higher costs associated with the conventional low-noise surfacing materials, HyD has been developing more durable low-noise surfacing materials including polymer modified friction course which is used under the trial programme to assess its long-term acoustic performance and durability. The trial programme is being implemented in phases and is scheduled for completion by 2010.

7.6.7 In the course of exploring new technologies of low-noise road surfacing, the Government invited a world-renowned specialist to conduct a workshop on "Development of Tyre/Road Noise Emission and Control" in 2005 to enable professionals from EPD and HyD to be informed of the latest development in application of low-noise road surfacing materials.

Cost of resurfacing roads with low-noise materials

7.6.8 The cost of laying low-noise surfacing is about HK$100 – HK$120 per sq m, while that for normal road surfacing is about HK$50 – HK$60 per sq m. Additional cost may also be required for modifications of road drainage in conjunction with low-noise surfacing.

7.6.9 The annual maintenance cost of low-noise surfacing is about HK$40 – HK$50 per sq m, while that for normal road surfacing is about HK$10 per sq m.

Installing double-glazed windows and air-conditioning for the affected residents

7.6.10 The Government states that the provision of noise insulation in forms of air-conditioning and well gasketted windows to the affected residents is very costly. With a total of approximately 300 000 residential units affected by excessive traffic noise on the existing road system, the liability on the public purse to provide such insulation is estimated to be at least HK$15 billion assuming an average cost of HK$50,000 per residential unit, excluding recurrent and replacement expenditure. The assumed cost of providing insulation includes cost to replace or improve existing windows of an affected residential unit, air-conditioners, additional or improved electric cabling in the building as well as replacement of the building transformer where required.

7.6.11 The Government expects that new questions may arise from taking such insulation measures, including higher electricity bills for the residents. The air ventilation may also be affected if the residents have to close their windows all the time, which may not be good for their health.

Managing traffic flows

7.6.12 The applicability of traffic management measures may depend on a number of factors, which include:

(a) the number of dwellings benefited and affected;

(b) whether there is an alternative route to cope with the diverted traffic;

(c) whether the noise problem may be shifted from one location to another; and

(d) whether the measure is supported by local residents, transport trades, District Council members and LegCo Members.

7.6.13 The effectiveness of traffic management measures is subject to the traffic composition and conditions. Depending on the percentage of heavy vehicles in the flow and the total volume of traffic, noise reduction of up to 3 dB(A) may be achieved for banning heavy vehicles. Traffic noise may be reduced by up to 1 dB(A) if the speed limit is reduced from 70 km per hour to 50 km per hour.

Chapter 8 – Analysis

8.1.1 Matters relating to mitigation measures against road traffic noise, in particular the installation of noise barriers, have been discussed by Members at meetings of the Public Works Subcommittee, the Finance Committee, and the Panels on Environmental Affairs and Transport. Their concerns can generally be grouped into the following four aspects:

(a) assessment of road traffic noise;

(b) government policy on the provision of mitigation measures against road traffic noise;

(c) use of noise barriers against road traffic noise; and

(d) other mitigation measures.

8.1.2 Focusing on the four aspects, the following paragraphs discuss the findings of this study and issues which Members may wish to consider when deliberating on this subject.

8.2 Assessment of road traffic noise

Circumstances under which road traffic noise will be measured

8.2.1 The Government has identified the following circumstances under which road traffic noise will be measured:

(a) when the traffic noise situation is being evaluated in formulating and developing noise policies and noise abatement programmes;

(b) when the performance of noise mitigation measures such as noise barriers, low-noise road surfacing and traffic management schemes is being evaluated; and

(c) when responding to requests from LegCo members on traffic noise information.

8.2.2 In the selected places studied, the measurement of traffic noise is also triggered off under circumstances similar to those adopted in Hong Kong.

Methodology adopted in determining road traffic noise levels

8.2.3 In regard to the places studied in this research, the road traffic noise levels can be evaluated by two alternative means: measurement and prediction. In measurement methods, acoustical instruments such as sound level meters are used to make direct measurements of noise. In prediction methods, noise levels are calculated through simulating real or predicted situations by means of mathematical models, based on acoustical theories of sound emission and propagation. In most cases, measurement and prediction methods are combined to provide a more effective or merely operative assessment.

Road traffic noise measurement

8.2.4 Among the overseas places studied, the State of Victoria (Victoria) in Australia has published detailed guidelines on the measurement of road traffic noise to ensure that all measurements are of high quality and consistent over time. Requirements on the reliability of the instruments used, professional qualification of the acoustic personnel, microphone position, measurement locations, measurement periods, weather conditions and traffic conditions are all set out in the guidelines.

8.2.5 In Hong Kong, when measuring road traffic noise, the Government has adopted the guidelines entitled *"Calculation of Road Traffic Noise"* (CRTN) published by the United Kingdom (UK) government. The guidelines have stringent requirements on the physical conditions for measurement, measuring equipment, measurement procedure and analysis of data.

Professional qualification and training of personnel who measure road traffic noise

8.2.6 The Victoria government demands that acoustic personnel should have professional qualification to ensure their measurements are of high quality and consistent over time. It is required that a person holding a degree or diploma in electrical or mechanical engineering, a degree or diploma in science with a major in physics or such other qualifications and experience as approved by the Superintendent of the Victoria Roads Corporation, shall be responsible for: (i) overseeing the calibration of the instruments; (ii) supervising the instrument operator; and (iii) certifying that the results presented are a true record. Instrument operators shall be adequately trained and supervised by the person responsible for certification.

8.2.7 The Hong Kong Institute of Acoustics (HKIOA) comments that it is very important that the personnel who conduct the measurement are properly trained in terms of using the measurement instrument and understanding the methodology. HKIOA suggests that the Government should establish a system requiring only qualified professionals to conduct such measurement. In this aspect, HKIOA may assist the Government by offering training courses for people who are involved in noise measurements.

8.2.8 According to the Hong Kong Government, it has contracted out the measurement of road traffic noise to private companies. EPD explains that given the limited resources within EPD, there is a need to outsource some of the road traffic noise measurement works. EPD does conduct selective spot checks to ascertain the measurement results. However, some acoustic professionals point out that the practice of contracting out the measurement of road traffic noise to private companies may affect the quality of measurements.

8.2.9 The Government also states that the practice note PN1/97 has been issued to assist professionals in planning residential developments against road traffic noise. Under this practice note, traffic noise calculation following the CRTN procedures would need to be endorsed by a corporate member of HKIOA. Nonetheless, the Government does not require any professional qualification for personnel who measure road traffic noise and has not offered any training courses to its staff.

8.2.10 As for HKIOA's suggestion of requiring the relevant personnel to attend training courses, the Government considers that professionals should keep abreast of the latest technological development in their own professional field on their own initiative. The Government is aware that HKIOA organizes courses, seminars and workshops on a regular basis for the continuous development of their members and other professionals in their profession.

Prescribed road traffic noise limits

8.2.11 In Japan, Taiwan, the State of New South Wales (NSW) in Australia, Victoria and the State of California (California) in the United States, the road traffic noise limits are determined on the basis of zone categories, types of roads, time periods, or a combination of these factors. For example, in Japan and Taiwan, the road traffic noise limits are higher if the areas concerned are adjacent to main roads or expressways. The noise limits for residences in all the overseas places studied range between 52 dB(A) and 68 dB(A). As regards Hong Kong, the road traffic noise limit for residential developments is 70 dB(A), which is applicable to all time periods. Hence, it appears that Hong Kong's traffic noise limit is relatively lax as compared with the other places studied.

8.2.12 In response to RLSD's enquiry, HKIOA and the Hong Kong Institution of Engineers (HKIE) have expressed different views on:

(a) whether the prevailing road traffic noise limit can effectively protect the Hong Kong residents from road traffic noise, and if not;

(b) whether the Government should tighten the road traffic noise limit.

8.2.13 According to HKIOA, given the fact that high-rise residential buildings are built next to heavily-trafficked highways and all the noisy roads cannot be enclosed or at least built with semi-enclosures because of safety and traffic sightline considerations, lowering the noise limit may not solve the problem. In addition, Hong Kong may not be able to adopt the night-time noise limits practised in other places to protect the affected residents by means of banning commercial freight because it does not have a distinct residential zone. On the other hand, HKIE supports the need to review the prescribed noise limits, taking account of the practices adopted in other places.

8.2.14 Both HKIOA and HKIE share the view that the Government needs to revamp the whole planning mechanism. Efforts must be put to avoid constructing residential developments next to heavily-trafficked roads and transportation infrastructures.

8.3 Government policy on the provision of mitigation measures against road traffic noise

Planning new roads and substantial widening of existing roads

8.3.1 In planning new roads and substantial widening of existing roads, the governments of the overseas places studied are committed to implementing measures against road traffic noise. The common measures undertaken against road traffic noise are installing noise barriers and resurfacing roads with low-noise materials.

8.3.2 In Hong Kong, the policy of providing mitigation measures for planning new roads and substantial widening of existing roads is similar to the overseas practices. The relevant government departments and developer(s) must ensure that traffic noise at sensitive receivers stays within the noise limit. For the case of substantial widening of existing roads, the Government will provide mitigation measures if the road traffic noise level increases at least 1 dB(A) as a result of the construction project.

8.3.3 Members have raised the concern that the Government's definitions of "new roads" and "existing roads" are over refined, technical and subjective. As such, RLSD has asked the Government whether it has any plans to review or amend the legal definitions of those terms. The Government replies that it is open to any suggestions; however, it does not find the need to amend the above definitions at the present moment.

8.3.4 Members have also asked the Government to consider amending the existing policy of providing mitigation measures only if road traffic noise increases 1 dB(A) or more as a result of the widening of the road concerned. The Government responds that a 1 dB(A) difference in noise level would generally be considered as just or barely noticeable. Such eligibility requirement is also adopted in the UK. In sum, the Government considers that the approach is already stringent and pragmatic.

Existing roads which do not have any upgrading or redevelopment

8.3.5 The experiences of the overseas places studied can be grouped into two categories, which are discussed below.

Japan and Taiwan

8.3.6 In Japan and Taiwan, the current policies are similar. For an existing road, if the noise level is suspected to have exceeded the prescribed limit, residents may request the local government to install noise barriers. In response, the local government will first carry out noise measurement and inform the residents of the result. The local government will also provide the result to the administrator of the road and negotiate with him or her about whether mitigation measures should be implemented. The residents will be informed of the details of the negotiation process and the final decision.

NSW, Victoria and California

8.3.7 For existing roads without any planned upgrading or redevelopment, the governments of NSW, Victoria and California have all implemented a formal noise abatement programme to reduce the noise impact on the residents of the affected areas. On the other hand, the governments will generally not ameliorate road traffic noise where new buildings are built next to existing or future roads, partly due to limited financial resources.

8.3.8 To be eligible for noise treatment, the property concerned should meet certain requirements, such as the noise level at the property exceeding the specified limit and the measures being practicable and cost-effective. In reality, the property concerned may not receive any noise insulation treatments because of the government's financial constraints.

Hong Kong

8.3.9 In the case of Hong Kong, similar to the experiences of NSW, Victoria and California, the Government has implemented measures to address the noise impact on residents in their neighbourhoods:

(a) engineering solutions, by way of retrofitting of noise barriers and enclosures, and resurfacing with low-noise materials, should be implemented where practicable at existing excessively noisy roads; and

(b) traffic management solutions should be fully explored and implemented where practicable on a case by case basis where engineering solutions are impracticable or where engineering solutions alone are inadequate in reducing the noise to a level below the noise limits.

8.3.10 The Government admits that Hong Kong, like many metropolitan cities in the world, experiences the traffic noise problem, due to a combination of factors including scarce habitable land, a concentrated road transport network, immense housing demand and a lack of environmental concern in the past few decades. It does not believe that such an inherited noise problem can be totally solved due to various existing constraints.

8.4 The use of noise barriers against road traffic noise

8.4.1 Noise barriers are commonly installed in Hong Kong. However, HKIOA, HKIE, the Hong Kong Institute of Architects (HKIA) and Professor Tang Shiu-keung of the Department of Building Services Engineering of the Hong Kong Polytechnic University all raise the concern that the Government depends too much on the use of noise barriers to mitigate road traffic noise. Their arguments are summarized as follows:

(a) As installing noise barriers on existing roads needs substantial public funding, the Government should study whether this approach is cost-effective. The construction of noise barriers itself may also be a nuisance to the nearby residents;

(b) The Government should also consider other means, such as low-noise road surfacing and traffic management measures (e.g. quieter buses and electric vehicles), to tackle the problem of road traffic noise; and

(c) In the longer term, the Government should plan the road networks more properly to divert heavy trucks away from residential areas and construct green areas and open space separating roads and buildings. With these planning arrangements, noise barriers, if needed, will be limited to short ones, thus less costly. These requirements can be specified in the development of land in the proximity of busy roads during the stage of land use planning and land sales.

8.4.2 The Government responds that the issue of abating road traffic noise is very complicated and that it neither relies upon nor prefers noise barriers as the sole mitigation measure. Instead, they are part of a comprehensive package of noise mitigation measures, which includes what the professional institutes have recommended. In considering the package of measures to be used, cost effectiveness of noise barrier would also be taken into account.

8.4.3 In practice, the Government states that it always considers land use planning measures, direct and indirect technical mitigation measures in a preferential order to address traffic noise. Given the development needs and practicality of various measures under different situations, the Government shares the views with the professional institutes and noise barrier manufacturers that an integral approach in tackling the problem is needed. Landscaped buffer, half-sunken highways and decking over, and other relevant measures, will be duly considered and adopted whenever feasible and practicable.

Materials chosen for noise barriers

8.4.4 Among the places studied, the decision of choosing materials for noise barriers depend on a number of common factors, including acoustical properties, visual impact, safety concerns, durability, fire resistance, and ease of installation and maintenance.

8.4.5 Similar materials are used for noise barriers in the places studied, including concrete, light-transmitting glass, sound-absorbing metal and fibre-reinforced plastic. HKIE and a leading noise barrier manufacturer state that as to the noise barrier materials, those being used in Hong Kong are among the best available in the market.

Uses of relatively light materials for noise barriers

8.4.6 According to the local parties surveyed in this research, although noise barriers installed in Hong Kong appear to be bulky and heavy, it is the structural members of the supporting framework of the noise barrier panels that give this impression. The sizes of these members are determined based on established engineering design standards in order to withstand the loading imposed on the noise barriers. Indeed, the weight of the noise barrier panels themselves only accounts for a relatively small proportion of the total load.

8.4.7 HKIE and the noise barrier manufacturer surveyed state that the "Structures Design Manual for Highways and Railways" issued by the Highways Department has been used for many years as the basis for designing noise barriers in Hong Kong. The manual contains a very stringent set of criteria for professional designers to conform to, which has limited their flexibility of offering alternative and innovative proposals. They recommend that the Government should review the design standard for installing noise barriers, and relax the restrictive structural requirements if possible.

8.4.8 The Government responds that the current design practice has already taken into account the various loading combinations under different conditions. It considers the design standard well established by striking a balance between cost-effectiveness and safety, and suitable for the situation in Hong Kong.

New technologies for noise barriers

8.4.9 Japan, NSW and the noise barrier manufacturer surveyed have provided information on new technologies in designing noise barriers, which help reduce the height of noise barriers and redirect the propagation of noise. Examples of noise barriers with new designs are as follows:

(a) The multiple-edge noise barriers are designed to enhance sound insulation effects through their branched edges mounted at the top, which increase the number of diffractions and in turn interference with reflected waves. They are more effective if sound-absorbing materials are affixed to both the surfaces facing the sound source and the top surfaces of the branched edges.

(b) The noise barriers incorporating noise reducers are designed to reduce noise diffraction by taking advantage of the fact that noise reducers affixed to the top of the barriers can effectively divert noise generated from a road to move along the reducer surfaces.

(c) The active soft edge noise barriers have adopted noise control technologies to allow secondary noise, which has the same amplitude as primary noise but the opposite phase to it, to interfere with the original noise, thereby negating it. In practice, multiple active soft edge devices are mounted on the top edge of a noise barrier to reduce diffraction of sound.

8.4.10 In Hong Kong, the Government states that it is determined to keep abreast of the latest technological developments around the world, such as the use of new construction materials for noise barriers, and other new technologies in noise mitigation for suitable application in Hong Kong. According to the Government, it has supported and taken part in arranging world-renowned noise control researchers and practitioners to share with it the latest trend in noise mitigation to enable local professionals as well as government officials to have better understanding of the latest technology and development in controlling road traffic noise.

Aesthetic design of noise barriers

8.4.11 Among the places studied, NSW has provided some useful guidelines on the aesthetic design of noise barriers:

(a) noise barriers must be considered in three dimensions as architectural objects, and be consistent with the design of other elements in the corridor in which the noise barriers are located. Consideration must be given to opening up views of the surrounding landscape and built form for road users as well as district views for residents;

(b) noise barriers should follow the road geometry in vertical alignment. It is generally preferable that the top edge is parallel to the road and smooth, particularly in urban and sub-urban areas. If stepping is needed, it should be ordered and regular;

(c) noise barriers should generally be parallel to the road in horizontal alignment. Curved barriers or stepped barriers can be attractive and can add character;

(d) in most instances, it is better to screen noise barriers with planting. If space is limited, planting can also be used to break down the scale of the barriers;

(e) colours should be subdued. Neutral dark greys, dark greens and grey browns are preferable. Primary colours should generally be avoided or used with careful consideration. Painted patterns should be avoided; and

(f) generally speaking, plain barriers are preferable; however, patterns on concrete can add interest. They should be simple, of a limited palette and repetitive. Natural and more traditional materials generally do not need to be textured.

8.4.12 In Hong Kong, there have been public criticisms regarding the aesthetic design of noise barriers installed in recent years. In particular, HKIOA opines that the aesthetic design of noise barriers can be done in better ways in Hong Kong. It suggests that the Government should hold open competitions on barrier designs so that the public can take part in the decision process.

8.4.13 Another way to improve the acceptability of the aesthetic design of noise barriers suggested by HKIOA is through consultation and release of adequate information. It recommends that the Government should consider making use of the latest development of information technology so that the public can visualize the barriers as built some years later from their flats to prepare their mindset for the barriers.

8.4.14 In response to HKIOA's suggestions, the Government states that it has a well-established mechanism in the design process to ensure that the noise barrier design is aesthetically pleasing and public opinions are being taken into account. The Government has also published guidelines to facilitate dissemination of information and concept. In any event, the Government will consider holding open competitions on barrier designs for suitable projects.

Technical constraints on and safety considerations of installing noise barriers

8.4.15 The overseas places studied in this research have not provided detailed information on technical constraints on and safety considerations of installing noise barriers. The major safety consideration in the selected places is wind loading, which is also applied to Hong Kong.

8.4.16 The Government has provided a list of constraints on installing noise barriers, including structural integrity, space limitation, traffic safety, fire fighting and emergency requirements, and socioeconomic concerns. The constraints are particularly prominent in case of retrofitting noise barriers on existing roads where the existing site conditions may pose further limitations to barrier installation. Both HKIOA and Professor Tang confirm that the constraints discussed by the Government are all relevant.

Procedure for installing noise barriers

8.4.17 In this study, the governments of the overseas places studied have not provided information on the procedure for installing noise barriers. Hence, RLSD has not been able to discuss this topic.

Cost of noise barriers

8.4.18 This study indicates that there are a number of factors, such as barrier height, ground conditions, site constraints and materials used, which may affect the construction costs of noise barriers. Accordingly, there is no standard formula to determine the cost of noise barriers.

8.4.19 In any event, the government of NSW points out that new technology can reduce costs for traditionally expensive materials such as laminated glass. In addition, construction costs are not the only costs involved. More important considerations are durability of the materials and maintenance costs.

Examples of noise barriers installed with relatively light materials and innovative designs and commonly-installed noise barriers in Hong Kong

8.4.20 RLSD has obtained a total of 25 examples of noise barriers installed with relatively light materials and innovative designs, covering Japan, Taiwan, NSW, Victoria and Hong Kong. For details, please refer to pages 9 – 12 for Japan, page 18 for Taiwan, pages 28 – 30 for NSW, pages 37 – 38 for Victoria and pages 77 – 78 for Hong Kong. In addition, the Government has provided three examples of commonly-installed noise barriers in Hong Kong (see page 79).

8.5 Other mitigation measures

Reducing road traffic noise at source

8.5.1 The governments of the places studied have adopted similar measures to reduce road traffic noise at source, including:

(a) imposing permissible noise emission limits;

(b) promoting the use of public transport; and

(c) cracking down illegal vehicle modifications such as muffler alterations.

8.5.2 In addition to the above measures implemented, the Japanese government particularly encourages research and development of better noise reduction technologies and promotes the sale and use of low-noise vehicles such as electric cars.

Land use planning

8.5.3 As regards land use planning, the governments of the places studied have undertaken the following measures:

(a) zoning land and planning urban projects with the consideration of the noise factor;

(b) building bypasses and ring roads; and

(c) establishing buffer zones on each side of a road.

8.5.4 In Hong Kong, both HKIOA and HKIE have encouraged the Government to plan the city more properly, thus reducing the required instances of installing noise barriers.

Resurfacing roads with low-noise materials

8.5.5 The governments of Japan, NSW, Victoria and Hong Kong implement the measure of resurfacing roads with low-noise materials to reduce noise from tire friction. Generally speaking, low-noise pavement can attain a reduction of noise from 3 dB(A) to 5 dB(A).

8.5.6 In Hong Kong, it is a standard government practice to pave high-speed roads with a speed limit at 70 km per hour or above with low-noise surfacing materials. Both HKIOA and HKIE suggest that the Government may consider resurfacing all roads with low-noise materials to reduce road traffic noise.

Cost of resurfacing roads with low-noise materials

8.5.7 According to the Government, the cost of resurfacing roads with low-noise materials is about HK$100 – HK$120 per sq m, while that for normal road surfacing is about HK$50 – HK$60 per sq m. Additional cost may also be required for modifications of road drainage in conjunction with low-noise surfacing.

8.5.8 The annual maintenance cost of low-noise surfacing is about HK$40 – HK$50 per sq m, while that for normal road surfacing is about HK$10 per sq m.

8.5.9 Information on the cost of resurfacing roads with low-noise materials in the overseas places studied is not available.

Installing double-glazed windows and air-conditioning for the affected residents

8.5.10 In this research, the measures of installing double-glazed windows and air-conditioning for the affected residents are seldom implemented among the places studied because of the governments' financial constraints.

8.5.11 In Hong Kong, the Government expects that new questions may arise from taking such insulation measures, including higher electricity bills for the residents. The air ventilation within the affected residences may also be affected if the residents have to close their windows all the time, which may not be good for their health.

Adopting advanced construction methods

8.5.12 To tackle road traffic noise pollution, Japan has adopted some advanced construction methods, which are:

(a) employing a jointless construction method for elevated roads and bridges; and

(b) installing sound-absorbing panels on the underside of elevated roads.

Employing jointless construction method for elevated roads and bridges

8.5.13 On elevated roads or bridges, vehicle wheel loads are directly imposed on expansion units such as expansion joints. The resulting wear on pavement surfaces over time can create bumps as well as propagate vibration and noise caused by the impact on the roadside areas. The jointless construction method is designed to suppress noise from structures of bridges and elevated roads through elimination of the noise source, which is achieved by connecting the girders or making the pavement more seamless.

Installing sound-absorbing panels on the underside of elevated roads

8.5.14 Most of the underside surfaces of existing elevated roads are made from sound-reflective materials. In the case of a multi-level roadway structure, these materials not only reflect noise from roads on lower levels but also amplify it. The adoption of sound-absorbing panels helps reduce roadside noise, especially in urban areas, as they can absorb reflected noise if they are attached to the underside of elevated roads or the wall surface of depressed roads. The underside sound-absorbing panels installed on the Hanshin Expressway in Japan have shown a noise reduction effect of 3 dB(A) to 6 dB(A).

Appendix I

Cases relating to traffic noise impact of existing roads handled by the Complaints Division of the Legislative Council Secretariat

Background

A.I.1 On account of the dense development projects in Hong Kong, it is common for roads to be built in close proximity to residential blocks. Excessive traffic noise from the increasingly busy traffic has become a serious nuisance to residents living close to the roads. While statutory requirements have provided protection for residents in respect of new roads, the situation for existing roads is far from satisfactory. Many existing roads do not meet the conditions for retrofitting noise barriers due to spatial and other environmental constraints, and the only remedies are possibly for the Government to implement traffic control measures or resurface the roads with low-noise materials. As these measures cannot solve the problem effectively, traffic noise impact of existing roads often becomes the subject of complaint cases handled by the Complaints Division of the LegCo Secretariat, and related concerns are raised during meetings between members of District Councils and LegCo Members as well.

A.I.2 Members handled five complaint cases relating to the traffic noise impact of existing roads lodged by District Councils or deputations between October 2004 and September 2005. This appendix presents a summary of these five cases together with Members' concerns.

Complaint cases

Case No. One: Route 8 – Ching Cheung Road widened section

A.I.3 A section of Ching Cheung Road was widened to accommodate two slip roads connecting Ching Cheung Road and the main carriageway of Route 8. However, residents of a residential estate adjacent to the road section, Nob Hill, felt aggrieved as no noise abatement facilities were provided at the section. They sought Members' assistance in November 2004. The residents pointed out that the Route 8 Environmental Impact Assessment (EIA) report revealed that no noise monitoring points were set up at Nob Hill facing Ching Cheung Road. They were dissatisfied that the Government regarded Ching Cheung Road as an "existing road" notwithstanding the road widening works, and refused to retrofit noise barriers on this section whereas such facilities would be erected on the section adjacent to Mei Foo Sun Chuen. The residents were of the view that the scale of the Ching Cheung Road widening works was extensive enough for it to be re-defined as a "new road". They were also dissatisfied that the Government had not consulted them on the project. Members held two case conferences with representatives of the Government to follow up the complaint. Members of the Sham Shui Po District Council also raised concerns on the same road during their meeting with LegCo Members in June 2005.

Appendix I (cont'd)

A.I.4 Regarding the Route 8 EIA report, the Environmental Protecton Department (EPD) explained that the EIA report revealed that Ching Cheung Road was the major source of noise for Nob Hill while Route 8 would only increase the traffic noise of Ching Cheung Road by less than 1 dB(A). As such, EPD concurred with the EIA report that there was no need to set up noise monitoring points at Nob Hill facing Ching Cheung Road. HyD also agreed that Route 8 would not lead to a significant increase in the noise level of Ching Cheung Road. In view of the residents' concerns about monitoring points, HyD subsequently conducted a noise assessment at the facade of Nob Hill and its view was substantiated.

A.I.5 Members sought clarification from the Government as to the reason for providing, for the same road, noise barrier facilities at the Mei Foo Sun Chuen section whereas Nob Hill, which was not too far away, was treated differently. The Government explained that the Route 8 slip road adjacent to Mei Foo Sun Chuen was a new separate viaduct and was a new road under the Environmental Impact Assessment Ordinance (EIAO).

A.I.6 In the EIA report, the traffic noise impact of the slip road in Mei Foo Sun Chuen had been assessed to exceed the statutory limit of 70 dB(A). It was, therefore, necessary to provide noise barriers in compliance with EIAO. The Government advised that whether the Ching Cheung Road widened section at the facade of Nob Hill should be regarded as a "new road" had to be examined in accordance with the interpretation in Schedule 1 to EIAO, i.e. "major extensions or improvements to existing roads" meaning a physical addition, alteration or re-alignment to existing roads which would result in an adverse environmental impact as defined in the Technical Memorandum of EIAO; otherwise EIAO would not be applicable.

A.I.7 To answer this question, the Government noted that the slip road connecting Route 8 ended to the east of Nob Hill. Moreover, the Route 8 EIA report stated that Ching Cheung Road was an existing road, its traffic flow would not increase significantly as a result of the operation of Route 8, and the traffic noise of Ching Cheung Road after widening would increase by not more than 1 dB(A). As such, EPD considered the noise impact arising from the improvement works insignificant, and the Ching Cheung Road widened section could not be defined as a "new road".

A.I.8 Members did not subscribe to the Government's explanation and considered that the Government, in differentiating between "new roads" and "existing roads", had been over refined, technical and subjective.

Appendix I (cont'd)

A.I.9 Members also explored the feasibility of shifting the widened section to the opposite carriageway for the purpose of maintaining the existing distance between Nob Hill and Ching Cheung Road. HyD requested a consultant to study accordingly. The consultant advised that such relocation would require further widening of the current westbound carriageway by eight m. The widened section would be very close to the existing ancillary buildings of the Lai Chi Kok Public Swimming Pool. In addition, the headroom of Lai Wan Road running underneath Ching Cheng Road would be reduced to less than two m, after taking into account the crossfall and carriageway widening work. As such, the proposal was not feasible. Besides, such significant modifications to the road layout would involve complications in revising the awarded construction contract, re-gazettal of the road scheme and variation of the Environmental Permit.

A.I.10 On the retrofitting of noise barriers, EPD and HyD conducted a study on the feasibility of the proposal. The study revealed that it was technically not feasible to retrofit noise barriers on this site. As Ching Cheung Road Flyover was built many years ago, there was no spare structural carrying capacity to support the additional noise barriers or enclosures. An independent structure would have to be built as support if noise barriers were to be retrofitted. However, King Lai Lane between Nob Hill and Ching Cheung Road did not have adequate space for construction of this independent structure. An independent study conducted by the Civil Engineering and Development Department (CEDD) subsequently came up with the same conclusion.

A.I.11 The Government pointed out that in considering the impact on Nob Hill, it had taken into account traffic noise on the existing Ching Cheung Road and the future roads connecting Route 8, including the Ching Cheung Road widening works. The developer had complied with the Practice Notes for Professional Persons and provided direct and indirect noise mitigation measures for Nob Hill, including the provision of window insulation and air-conditioners. As such, the Government would only undertake to resurface with low-noise materials and improve the connection joints on the relevant section, but would not provide other traffic noise mitigation measures. The Government emphasized that it had never considered the request of retrofitting noise barriers from a financial perspective.

A.I.12 As regards consultation, HyD explained that it had consulted the Kwai Tsing Provisional District Board in July 1999 and further consulted the Kwai Tsing District Council in early 2002 on the Route 8 project, including the Ching Cheung Road improvement works. None raised objection to the project. HyD also exhibited the Route 8 EIA report for public inspection from September to October 1999 to solicit public views, and did not receive any objections or comments. The Route 8 project was endorsed by the Executive Council in July 2001, and the construction works commenced in November 2002 after LegCo approved the funds for the project in June 2002.

Appendix I (cont'd)

Case No. Two: Road section of Lai Chi Kok Road adjacent to Liberte

A.I.13 In December 2004, Members met with a deputation representing the residents of Liberte on Lai Chi Kok Road. The dwellings of the private housing estate facing Lai Chi Kok Road had been suffering from traffic noise which came mainly from heavy vehicles and container trucks which bumped suddenly when running past the connection joints on the road section. The residents were often woken up by the sudden noise at night. The deputation alleged that the developer of Liberte had failed to provide noise mitigation measures as required under the Practice Notes for Professional Persons. They requested the Government to implement remedial measures and finance the installation of double-glazed windows for the affected units.

A.I.14 At the ensuing case conference, the Government pointed out that the relevant departments had studied several noise mitigation options, including the erection of noise barriers on Lai Chi Kok Road adjacent to Liberte and along the West Kowloon Corridor. However, as the West Kowloon Corridor was a flyover built many years ago, there was no spare structural carrying capacity to support the additional noise barriers, and neither was there adequate space on the road underneath this section of the flyover for the construction of an independent structure. As such, it was technically not feasible to erect noise barriers on this section.

A.I.15 The Government pointed out that the responsibility for providing traffic noise mitigation measures might rest with the Government, the developer, or both parties, depending on individual circumstances. The developer had complied with the Practice Notes for Professional Persons and provided direct and indirect noise mitigation measures for Liberte, including raising the height of the podium and providing suitable window insulation and air-conditioners for the units affected by traffic noise, which exceeded the planning standards. Hence, the Government could not agree to finance the installation of double-glazed windows for those units.

A.I.16 Regarding Members' suggestion to reduce the speed limit of the ramp near Liberte from 70 km per hour to 50 km per hour, the Government reckoned that lowering the speed limit might not alleviate the noise impact significantly and would create a "speed trap" and undermine road safety. The Government would use low-noise materials and install new expansion joints at the section to minimize the noise generated by the sudden bumping of heavy vehicles.

Appendix I (cont'd)

Case No. Three: Road section of Tseung Kwan O Road near Hing Tin Estate

A.I.17 The road section at Tseung Kwan O Road near Hing Tin Estate and Hong Wah Court was identified by the Government in 2000 as one of the 29 existing noisy roads for retrofitting noise barriers. However, when the EA Panel discussed the subject matter in January 2005, the Government said that for technical reasons, it would not proceed with the retrofitting work. The residents suspected that the Government's move was aimed at achieving savings in resources and thus they sought help from LegCo Members in February 2005.

A.I.18 Members held three case conferences with the representatives of the Government to follow up the complaint. The Government explained the major difficulties for erecting noise barriers on this section as follows:

(a) the erection of noise barriers on the site would involve the resumption of a slope on the private land near Hing Tin Estate, and the resumption of private land for retrofitting works was inconsistent with the prevailing policy;

(b) the construction of the foundation work at the footpath would create problems in two aspects: the works could hardly proceed as the space at the footpath was insufficient for the purpose, and the public utilities currently underneath the footpath would have to be relocated beneath the carriageway during the construction of the noise barriers. As Tseung Kwan O Road was a very busy highway with a daily throughput of over 90 000 vehicles, the entire Kwun Tong and Sai Kung districts would experience heavy traffic congestion during the construction and maintenance works periods. This would cause serious social disruptions and was inconsistent with the considerations under the prevailing noise mitigation policy; and

(c) the erection of noise barriers on the site was not cost-effective and an adverse aesthetic impact was envisaged.

A.I.19 Members considered the Government's explanation unacceptable. They pointed out that it was unreasonable for the Government to decide against the erection of noise barriers based on factors such as difficulties in land resumption, traffic disruptions by road closure, cost-ineffectiveness and aesthetic impact.

Appendix I (cont'd)

A.I.20 Upon Members' insistence, the Government ultimately advised that it would consider a new alternative and study the retrofitting of a cantilevered noise barrier of five m vertical height with a three m bend on the central divider of Tseung Kwan O Road. The noise barrier would overshadow the uphill bound carriageway of Tseung Kwan O Road to insulate traffic noise from the uphill bound, while both the uphill and downhill bound carriageways would be resurfaced with low-noise materials. It was envisaged that the cantilevered noise barrier could reduce the noise level of this section by a maximum of 5 dB(A), and the resurfacing a maximum of 3 dB(A), making a maximum reduction of 8 dB(A) in total. A total of 1 900 dwellings in Hing Tin Estate and Hong Wah Court exposed to noise impact then could expect to experience a reduction of 1 dB(A) to 3 dB(A) in general after the retrofitting. Among them, the noise level suffered by 950 dwellings could be reduced by 3 dB(A) to 8 dB(A). Nevertheless, it was estimated that 1 650 out of the 1 900 dwellings would continue to suffer from the traffic noise nuisance in excess of the limit. The Government also informed Members that the construction cost of the cantilevered noise barrier of about HK$60 million was more cost-effective and efficacious than the earlier concepts.

A.I.21 Notwithstanding the provision of the new alternative, Members remained dissatisfied that the Government's pendulum decision had caused much trouble for the residents. Apart from reminding the Government of the need to take heed of the aesthetic and visual impact of the noise barriers during the retrofitting, Members were also concerned that whilst the alternative could alleviate the nuisance for a minority of the residents, the problem remained unresolved for the majority. As such, Members decided to refer the subject to the EA Panel for follow-up.

Case No. Four: East Kowloon Corridor (EKC)

A.I.22 At the meeting with LegCo Members in February 2005 when the issue of the traffic noise impact of EKC on residents in the neighbourhood was discussed, members of the Kowloon City District Council (KCDC) requested the Government to study seriously the feasibility of retrofitting noise barriers on EKC.

A.I.23 At the ensuing case conference, EPD explained to Members that it engaged a consultant in 1995 and 1997 respectively to assess the technical feasibility of retrofitting noise barriers on the existing excessively noisy roads in the territory, including EKC. The findings of the assessment revealed that, as the road surface along EKC could not provide adequate space for retrofitting, noise barriers would obstruct fire services access, undermine rescue operations to the nearby residential units, and interfere seriously with commercial activities.

Appendix I (cont'd)

A.I.24 Given that KCDC raised concerns about the traffic noise impact of EKC repeatedly on many occasions, and the Government's response did not contain any detailed data, Members requested the Government to review the situation and ascertain if any of the road sections of EKC was suitable for retrofitting noise barriers. HyD subsequently re-examined the loadings and structural capacity of EKC. The findings revealed that EKC was already loaded to 90% of its structural capacity. HyD considered that even with advancement in technology, the maximum heights of noise barriers that could be accommodated by the bridge were two m along the edges and three m along the central divider on condition that some existing bridge bearings would have to be strengthened or replaced.

A.I.25 The Government noted that adjacent to EKC were some 2 000 dwellings facing Chatham Road North and Kowloon City Road that were exposed to noise levels in the range of 74 dB(A) to 84 dB(A). Only a few of the affected dwellings at lower floors would benefit from the retrofitting of noise barriers, with noise levels reduced down to 70 dB(A). The middle- to upper-floor dwellings would not benefit from the retrofitting at all.

A.I.26 Having considered the constraints on the technical feasibility of retrofitting noise barriers and strengthening the bridge bearings, the negative implications on traffic and noise disturbance during construction, and the limited number of dwellings that would be benefitted, the Government considered retrofitting noise barriers of a feasible height was not an effective solution to the traffic noise problem along EKC. Hence, it did not agree with the retrofitting. As regards Members' suggestion of installing insulation windows and air-conditioners for the dwellings fronting EKC, the Government said that the number of affected dwellings was around 2 000 and the capital cost would be around HK$100 million assuming an average cost of HK$50,000 per residential unit. As the installation of insulation windows was not in line with the prevailing policy, the Government could not accede to the request. Members decided to refer the subject to the EA Panel as it was a policy issue.

Case No. Five: Traffic and railway maintenance works in the North District

A.I.27 At the meetings with LegCo Members in 2004 and 2005, members of the North District Council (NDC) opined that since the operation of 24-hour passenger and cargo clearance services at the control points across the border, residents living along Fanling Highway had been suffering from the noise nuisance of vehicles day and night, especially the noise generated by heavy vehicles. Although the Government had proceeded to retrofit noise barriers on two sections of Fanling Highway at Fanling Centre and Choi Yuen Estate, residents of other housing estates along Fanling Highway, such as Dawning Views, Avon Park and Ka Fuk Estate, remained exposed to the road noise nuisance constantly. The Government had not drawn up any implementation schedule despite the residents' persistent request for erecting noise barriers on Fanling Highway.

Appendix I (cont'd)

A.I.28 NDC also pointed out that the noise level at the Kai Leng Roundabout had been well over 70 dB(A) before widening works at the road section commenced. Given that an extra lane was added to the road section after the completion of the above works, NDC requested the Government to erect noise barriers on the section but it had refused to do so. As a result, the teachers and students of the schools and residents of the housing estates nearby had no choice but continued to put up with the nuisance.

A.I.29 Members held three case conferences with the Government on the problem. Members noted that EPD engaged a consultancy firm in October 2004 to conduct a preliminary feasibility study on retrofitting noise barriers on five sections of Fanling Highway from San Tin Interchange to Dawning Views. The consultant assessed the five sections to be suitable for installation of noise barriers, and proposed one to two options for each section. The entire works programme was expected to take seven years. As the residents were already exposed to the serious noise nuisance, which would probably be aggravated due to the increasing population in the nearby residential blocks, Members urged the Government to adopt the option which would offer better protection for the residents and expedite the implementation of the schedule of the programme.

A.I.30 Members also requested the Government to consider retrofitting some of the noise barriers dismantled from the Tolo Highway on the section of Fanling Highway near Dawning Views in order to solve the problem expeditiously through making use of existing resources. EPD said that it would bid for the necessary resources from the Financial Services and the Treasury Bureau once it learnt of which option Members supported.

A.I.31 Although the option supported by Members would be implemented at the end, Members remained dissatisfied that the majority of the 4 000 households living in the sections along Fanling Highway would have to continue to put up with the nuisance of traffic noise in excess of 70 dB(A). They considered it necessary for the policy to be reviewed and decided to refer it to the EA Panel for discussion.

A.I.32 As for the Kai Leng Roundabout widening works, CEDD and EPD said at the case conference that it was envisaged that the noise level would only increase slightly from 72.4 dB(A) to 72.9 dB(A) after the completion of the road widening works (i.e. the provision of an extra south bound lane at So Kwun Po Road) and the intake of public housing at Fanling 36 Area in the vicinity. Given that the improvement works would not lead to a significant increase of traffic noise (i.e. an increase of 1 dB(A) or more) in the area, no noise barriers would be erected on this section.

Appendix I (cont'd)

A.I.33 EPD also pointed out that Vienna Garden, situated at the junction of So Kwun Po Road and Pak Wo Road, was very close to the carriageway. The erection of noise barriers of an average height would not be effective in alleviating the traffic noise unless higher barriers were erected to shield the residents' view of the road including the wheels and engines of the vehicles. In fact, the proposed erection of noise barriers on this junction was also not feasible due to road safety considerations. Besides, the tilted road surface of So Kwun Po Road made it more vulnerable to the damage caused by the pressure from running vehicles. Hence, the Government had no intention to surface the road with low-noise materials either.

A.I.34 With an intake of around 21 000 people to the 10 public housing blocks to be completed between April 2006 and March 2007 at Fanling 36 Area, Members found it hard to believe the Government's assessment that the traffic noise of the roundabout would only increase by 0.5 dB(A). For this reason, Members asked the Government to re-consider the residents' request and provide as early as possible noise mitigation measures, such as window insulation for the residents, surfacing the junction with low-noise materials and resurfacing the damaged road sections regularly. They further requested the Government to measure the actual noise level after the intake of the public housing at Fanling 36 Area. Members also deemed it necessary for the Government to consider means for addressing the noise problem caused by road widening works from a rational and objective perspective, and clarify the criteria for defining extended roads as "new roads".

Issues for Members' consideration for follow-up

A.I.35 In view of the above, the Complaints Division has suggested that Members may consider following up with the Government on the issues presented below:

Policy review

A.I.36 For existing roads exposed to excessive traffic noise impact, the prevailing Government policy is to retrofit noise barriers/enclosures where practicable or adopt other non-engineering solutions. However, the Government will not provide quality window and air-conditioning for residents. As many people in Hong Kong are suffering from the ordeal of excessive noise which costs them not only their productivity but also their own money for medical treatment, and the community, including LegCo and District Councils, is concerned about the problem, Members may invite the Government to consider reviewing its policy so as to improve the living environment, health and productivity of Hong Kong people. The review may include whether the policy on provision of quality window and air-conditioning will be relaxed to make it applicable to both existing and new roads.

Appendix I (cont'd)

Progress report on noise mitigation measures

A.I.37 Pursuant to the identification in 2000 by the Government of 29 existing roads for retrofitting noise barriers/enclosures and 72 existing road sections for resurfacing with low-noise materials, the Government provided progress reports to the EA Panel and the Panel on Transport in February 2003 and December 2004. In order to guard against cases such as Tseung Kwan O Road where the Government reneged on its undertaking, and to facilitate monitoring of progress by Members, Members may wish to ask the Government to formalize the reporting arrangement and report progress to the Panels on a yearly basis.

Other noise abatement measures

A.I.38 The Government pointed out in 2000 that even with the retrofitting programme, only a few road sections out of the 655 excessively noisy roads already identified would be covered by the programme and 600 such roads remained to be dealt with. As such, Members may invite the Government to advise whether it has taken other remedial measures for the 600 roads, as well as the details of such measures.

Cost-effectiveness

A.I.39 One of the factors considered by the Government for erection of noise barriers/enclosures appears to be their cost-effectiveness. Members may wish to invite the Government to elaborate on this aspect and discuss its acceptability.

Road extension works

A.I.40 If the extension work at an existing road is a designated project under the Environmental Impact Assessment Ordinance (Cap. 499) and is thus regarded as a new road project or a major extension to the existing road, the Government will conduct an environmental assessment to assess the noise impact and consider the erection of noise barriers/enclosures on the road section. Otherwise, it appears that the Government will consider whether noise barriers/enclosures will be erected on the extended road based on the criteria of whether the noise of the road section will increase by 1 dB(A) or more. In this connection, Members may invite the Government to clarify the criteria for defining extension works as "major extensions" and "new roads" respectively, explore whether the criteria should be revised from a more objective and rational perspective, and study the rationality of the criteria that the noise of existing roads must increase by 1 dB(A) or more before the retrofitting of noise barriers can be considered.

Appendix I (cont'd)

Design of noise barriers/enclosures

A.I.41 In handling these complaint cases, Members considered that the outlook of the retrofitted noise barriers/enclosures should not have negative visual impacts. The Government undertook in 2000 that it would adopt designs that would fit the surrounding environment as far as possible when proceeding with the retrofitting programme. Members may invite the Government to introduce the latest designs and advise the efficacy in this respect.

Role of the Environment Protection Department

A.I.42 At the meetings with Members, some deputations complained that EPD had not played its part in protecting the environment nor safeguarding the residents' health and interests. In many cases, the requests of the residents could not gain the support of EPD. Members handling the above cases also considered that EPD should play the role of a "gatekeeper" on the residents' behalf. In this connection, Members may invite the Government to give its response and advise whether EPD can uphold the vision of "serving the people" by playing a more positive role in environmental protection.

Responsibilities of the developers

A.I.43 The Government has informed Members that the developers of buildings have the responsibilities to alleviate the noise nuisance of existing roads for the residents. In this connection, Members may invite the Government to study whether the developers can enhance their efforts in this respect.

Public consultation

A.I.44 Although the Government has consulted the relevant District Councils prior to proceeding with new road/road extension works, such consultation is often conducted years before the commencement of the works and the information provided to District Councils at the time are often not comprehensive. As such, Members may explore with the Government whether it can consult and inform District Councils and the residents more frequently on the progress of the works and provide specific details. Members may also invite the Government to note especially the views of residents who have moved into the newly completed housing estates in the vicinity after the first round of consultation with a view to taking appropriate improvement measures.

Source: Legislative Council Secretariat (2005b).

Appendix II

Progress report of the mitigation measures implemented/considered for the noisy roads identified in 2000 (as at December 2004)

List of retrofit projects and implementation schedule

Ref no	Road section	Public Works Programme (PWP) category	Tentative schedule	
			Commencement	Completion
Group I – Funding has been approved by the Finance Committee (two road sections)				
1.	Fanling Highway (near Choi Yuen Estate)(1)	A	August 2004	December 2005
2.	Fanling Highway (near Fanling Centre)(1)	A	August 2004	December 2005
Group II – Funding has been earmarked in Resources Allocation Exercise (RAE) (12 road sections)				
3.	Cheung Pei Shan Road(2)	B (2004 (RAE)	June 2005	December 2007
4.	Ma On Shan Road(2)	B (2004 RAE)	October 2005	October 2007
5.	Yuen Shin Road (near Kwong Fuk Estate)(3)	B (2004 RAE)	August 2006	April 2008

Notes: (1) The noise barrier panels recovered from the Tolo Highway will be used on these two sections of Fanling Highway.

(2) Retrofitting works will be carried out by CEDD to tie in with adjoining road works.

(3) The noise barrier panels recovered from the Tolo Highway will be used on this section of Yuen Shin Road near Kwong Fuk Estate. In view of the residents' concerns, the two sections of Yuen Shin Road, near Kwong Fuk Estate and Fu Shin Estate respectively, have been resurfaced with low-noise materials on a trial basis. The low-noise material surface will likely reduce the noise impact on Fu Shin Estate to only slightly above 70 dB(A) and thus the need for retrofitting of noise barriers on this section concerned has to be further examined in consultation with the Tai Po District Council.

Appendix II (cont'd)

Ref no	Road section	PWP category	Tentative schedule	
			Commencement	**Completion**
Group II – Funding has been earmarked in Resources Allocation Exercise (12 road sections) (cont'd)				
6.	Tseung Kwan O Road (near Tsui Ping (South) Estate)	B (2004 RAE)	December 2007	December 2010
7.	Tuen Mun Road (Tsuen Wan)(4)	B (2003 RAE)	May 2006	December 2011
8.	Tuen Mun Road (Sam Shing Hui)(4)			
9.	Tuen Mun Road (Tsing Lung Tau)(4)	B (2004 RAE)		
10.	Tuen Mun Road (Castle Peak Bay)(4)	B (2003 RAE)	May 2006	December 2011
11.	Tuen Mun Road (Anglers' Beach)(4)			
12.	Tuen Mun Road (Sham Tseng)(4)			
13.	Tuen Mun Road (Yau Kom Tau)(4)			
14.	Tsing Tsuen Bridge (Tsuen Wan and Tsing Yi)	B (2004 RAE)	December 2007	December 2010

Note: (4) Retrofitting works for the seven sections of Tuen Mun Road will be implemented under 'PWP Item no. 746TH - Reconstruction and improvement of Tuen Mun Road project'.

Appendix II (cont'd)

Ref no	Road section	PWP category	Tentative schedule
Group III – Funding to be sought through Resources Allocation Exercise (seven road sections)			
15.	Tseung Kwan O Road (near Hing Tin Estate)	C	Subject to the results of detailed reviews, funding to be sought through the normal resources allocation mechanism under the public works programme.
16.	Hoi On Road		
17.	Tai Chung Kiu Road		
18.	Che Kung Miu Road		
19.	Po Lam Road North		
20.	Hung Mui Kuk Road/Che Kung Miu Road		
21.	Tin Sam Street		
Group IV – Not yet included in the public works programme (15 road sections)			
22.	Fung Shue Wo Road (Tsing Yi Estate to Tsing King Road Roundabout)	N/A	Technical feasibility study being finalized.
23.	Sha Tin Road		
24.	Po Ning Road		
25.	Shun Lee Tsuen Road		
26.	Kwun Tong Bypass		
27.	Yuen Wo Road		
28.	West Kowloon Corridor		Technical feasibility study to commence in due course.
29.	Heung Yip Road		
30.	Ma Wang Road		
31.	Sau Mau Ping Road		
32.	Tai Po Road (Sham Shui Po)		
33.	Chai Wan Road		
34.	Castle Peak Road (Ping Shan)		
35.	Castle Peak Road (Hung Shui Kiu)		
36.	Ap Lei Chau Bridge (near Shan Ming Street)		

Appendix II (cont'd)

Low-noise resurfacing programme

Road no	Road	From	To	Implementation timetable
Phase I (24 sections)				
1.	Pik Wan Road	Tak Shing House	Tak Shui House	Works completed.
2.	Cox's Road	Austin Road	Jordan Road	Work to commence and be completed tentatively in 2005-06.
3.	Fa Yuen Street	Prince Edward Road West	Boundary Street	Works completed.
4.	Hing Wah Street	Cheung Sha Wan Road	Un Chau Street	Works completed.
5.	Kimberley Road	Nathan Road	Observatory Road	Work to commence and be completed tentatively in 2005-06.
6.	Mong Kok Road	Shanghai Street	Tong Mi Road	Works completed.
7.	Nam Cheong Street	Cheung Sha Wan Road	Lai Chi Kok Road	Commencement delayed due to other works in the area. Works to be completed tentatively by 2007-08.
8.	Oak Street	Cherry Street	Ivy Street	Works completed.
9.	Portland Street	Argyle Street	Waterloo Road	Commencement delayed due to other works in the area. Works to be completed tentatively by 2007-08.
10.	Public Square Street	Ferry Street	Canton Road	Works completed.
11.	Reclamation Street	Public Square Street	Argyle Street	Commencement delayed due to other works in the area. Works to be completed tentatively by 2007-08.
12.	Sai Yee Street	Prince Edward Road West	Boundary Street	Works completed.
13.	Un Chau Street	Hing Wah Street	Tonkin Street	Work to commence and be completed tentatively in 2005-06.
14.	Waterloo Road	Ferry Street	Shanghai Street	Work to commence and be completed tentatively in 2005-06.

Appendix II (cont'd)

Road no	Road	From	To	Implementation timetable
Phase I (24 sections) (cont'd)				
15.	Yen Chow Street	Hai Tan Street	Lai Chi Kok Road	Commencement delayed due to other works in the area. Works to be completed tentatively by 2005-06.
16.	Lai Chi Kok Road	Tonkin Street	Hing Wah Street	Technical feasibility under review.
17.	Tonkin Street	Cheung Sha Wan Road	Un Chau Street	Works completed.
18.	Shanghai Street	Public Square Street	Kansu Street	Technical feasibility under review.
19.	Un Chau Street	Tonkin Street	Yen Chow Street	Work to commence and be completed tentatively in 2005-06.
20.	Shanghai Street	Argyle Street	Dundas Street	Work to commence and be completed tentatively in 2005-06.
21.	Embankment Road	Prince Edward Road West	Boundary Street	Works completed.
22.	Shek Kip Mei St	Tai Po Road	Woh Chai Street	Work to commence and be completed tentatively in 2005-06.
23.	Tai Hang Tung Road	Tong Yam Street	Tat Chee Avenue	Work to commence and be completed tentatively in 2005-06.
24.	Yim Po Fong Street	Shantung Street	Waterloo Road	Works completed.

Appendix II (cont'd)

Road no	Road	From	To	Implementation timetable
Phase II (22 sections)				
25.	Aberdeen Main Road	Aberdeen Praya Road	Aberdeen Reservoir Road	Works to be completed tentatively in 2007-08.
26.	Connaught Road West	Des Voeux Road West	Water Street	Technical feasibility under review.
27.	Electric Road	Gordon Road	Wing Hing Street (Tsing Fung Street)	Review to be finalized with parties concerned. Works to be completed tentatively in 2008-09.
28.	Java Road	Tong Shui Road	Tin Chiu Street	
29.	King's Road	Healthy Street West	Java Road	
30.	Kingston Street	Paterson Street	Gloucester Road	Works completed.
31.	Lockhart Road	Arsenal Street	Percival Street	Review to be finalized with parties concerned. Works to be completed in 2009-10.
32.	Queen's Road West	Des Voeux Road West	Hill Road	Works to be completed tentatively in 2005-06.
33.	Whitty Street	Des Voeux Road West	Queen's Road West	
34.	Johnston Road	Luard Road	Fleming Road	Review to be finalized with parties concerned.
35.	Wong Nai Chung Road	Sing Woo Road	Broadwood Road	Works to be completed tentatively in 2007-08.
36.	Queen's Road West	Western Street	Water Street	
37.	Wong Nai Chung Road	Sports Road	Broadwood Road	
38.	Hennessy Road	Fleming Road	Stewart Road	Works to be completed tentatively in 2005-06.
39.	Queen's Road East	Queensway	Kennedy Road	Review to be finalized with parties concerned.
40.	Chi Kiang Street	To Kwa Wan Road	Ma Tau Wai Road	Works to be completed tentatively in 2008-09.
41.	Ma Tau Kok Road	Kowloon City Road	Ma Tau Chung Road	
42.	Wuhu Street	Gillies Ave. South	Chatham Road North	Technical feasibility under review.
43.	To Kwa Wan Road	Kwei Chow Street	Chi Kiang Street	To tie in with the adjoining road works to be carried out by the Kowloon-Canton Railway Corporation (KCRC). Works to be completed tentatively in 2010.
44.	To Kwa Wan Road	Mok Cheong Street	Ma Tau Kok Road	
45.	Lomond Road	Argyle Street	Prince Edward Road	Works to commence and be completed tentatively in 2005-06.
46.	Nga Tsin Wai Road	Tak Ku Ling Road	Junction Road	Technical feasibility under review.

Appendix II (cont'd)

Road no	Road	From	To	Implementation timetable
Phase III (New Territories East - 12 sections)				
47.	Jockey Club Road	Po Shek Wu Road	Man Kam To Road	Review study commenced in May 2004 for completion in June 2005. Funding for resurfacing to be sought depending on the review results.
48.	Jockey Club Road	Lung Sum Avenue	San Fung Avenue	
49.	Ma Sik Road	Jockey Club Road	Tin Ping Road	
50.	Tai Po Tai Wo Road	On Cheung Road	Nam Wan Road	
51.	Tai Po Tai Wo Road	Ting Kok Road	Ting Tai Road	
52.	Nam Wan Road	Nga Wan Road	Pan Chung Road	
53.	Shatin Rural Committee Road	Tai Po Road – Shatin Section	Yuen Wo Road	
54.	Sha Tin Wai Road	Ngan Shing Street	Ngau Pei Sha Street	Review study commenced in May 2004 for completion in June 2005. Funding for resurfacing to be sought depending on the review results.
55.	Sha Tin Wai Road	Sha Tin Road	Ngan Shing Street	
56.	Tai Chung Kiu Road	Sha Kok Street	Sha Tin Wai Road	
57.	Chiu Shun Road	Po Ning Road	Ngan O Road	
58.	Chui Tin Street	Che Kung Miu Road	Cul-de-sac	

Appendix II (cont'd)

Road no	Road	From	To	Implementation timetable
Phase III (New Territories West - 14 sections)				
59.	Castle Peak Road	Tuen Mun Heung Sze Wui Road	Hing Ping Road	Review study commenced in May 2004 for completion in June 2005. Funding for resurfacing to be sought depending on the review results.
60.	Castle Peak Road	Pui To Road	Tuen Mun Heung Sze Wui Road	
61.	Tuen Mun Heung Sze Wui Road	Tuen Hing Road	Siu Lun Street	
62.	Tuen Mun Heung Sze Wui Road	Siu Lun Street	Hoi Chu Road	
63.	Wu Shan Road	Lung Mun Road	Wu King Road	
64.	Long Ping Road	Fung Chi Road	Long Ping Road INT.	
65.	Yuen Long Main Road	Tai Tong Road	Fung Cheung Road	
66.	Yuen Long On Ning Road	Tai Kiu Road	Wang Chau Road	
67.	Ma Miu Road	Yuen Long On Ning Road	Ma Wang Road	
68.	Castle Peak Road	Ping Ha Road	Tin Ha Road	
69.	Chung On Street	Sha Tsui Road	Yeung Uk Road	
70.	Yeung Uk Road	Tai Ho Road	Chung On Street	
71.	Kwai Foo Road	Kwai Chung Road	Hing Fong Road	
72.	Kwai Yik Road	Kwai Chung Road	Hing Fong Road	

Appendix III

The issues arising from the provision of noise barriers along the widened Tolo Highway

Background

A.III.1 To cope with increasing traffic demand, the Government commenced the widening works of the 5.4 km section of Tolo Highway between Island House Interchange and Ma Liu Shui Interchange from a dual 3-lane to a dual 4-lane carriageway in March 1999.

A.III.2 Noise barriers were erected along Tolo Highway to provide noise mitigation to noise-sensitive existing and planned developments. According to the Government, the provision of noise barriers was in accordance with the recommendations of EIA for the Tolo Highway widening project completed in April 1997. Under EIAO, the Government was required to consider noise impacts on planned as well as existing uses.

Criticisms and concerns about the noise barriers installed along the widened Tolo Highway

A.III.3 In November 2002, there were public criticisms about the noise barriers installed along the widened Tolo Highway. As such, the Transport Panel and the EA Panel held a series of meetings between November 2002 and February 2003 to solve the problem.

A.III.4 Major criticisms and concerns raised by Members and the public are summarized below:

(a) the Government did not consult the local District Councils and affected residents on the design and choice of materials for the noise barriers properly;

(b) the visual intrusion caused by the opaque noise barrier panels blocked nearby residents' beautiful sea view, thus destroying the aesthetic value of the place;

(c) the use of unpleasant colours (i.e. blue and green) for the noise barriers along both sides of the highway might make drivers suffer from dizziness and discomfort when driving through;

Appendix III (cont'd)

(d) the Government should not install any noise barriers in advance of future reclamation and property developments that might take years for completion;

(e) noise barriers had been installed outside the Hong Kong Science Park even though the facility said it did not need them; and

(f) the Government might need to consider introducing legislative amendments to provide greater flexibility in the provision of noise barriers under EIAO.

Outcome of the incident

A.III.5 In response to the criticisms and concerns, the Government undertook a review of the noise impact assessment and the design of the noise barriers in November 2002. The Government completed the review in January 2003 and modified the installation programme. A total of 1 920 m of noise barriers were removed and 1 460 m were trimmed down, leaving the total length of the noise barriers built in Tolo Highway to about 5 000 m. An additional cost of around HK$8 million was required for recovering the noise barrier materials from the Tolo Highway project.

A.III.6 Some of the noise barrier materials recovered from the Tolo Highway project were then reused in the following three retrofitting projects:

(a) Fanling Highway near Choi Yuen Estate;

(b) Fanling Highway near Fanling Centre; and

(c) Yuen Shin Road near Kwong Fuk Estate.

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