Background

1. Many people in Hong Kong are being exposed at home to high levels of traffic noise above the planning standard contained in the Hong Kong Planning Standards and Guidelines. This is due to factors including scarcity of habitable land, immense demand for housing, commuter and freight transport and insufficient attention on the environment during the rapid development in the 1970s and early 1980s.

2. Since the mid 1980s, the government has given attention to preempting traffic noise problems when planning land use and new roads. New road projects are required to go through the environmental impact assessment process to identify potential adverse environmental impacts and take steps to prevent their occurrence. The noise covers at Kwun Tong Bypass near Choi Hung Estate and Richland Gardens are successful examples of mitigation measures identified and provided through the planning process. However, the planning efforts alone could not solve the traffic noise problems already existed.

3. The government has also taken various steps including implementation of abatement programmes to tackle traffic noise. Under a Noise Abatement Measures in School Programme, classrooms affected by traffic noise are provided with good acoustic insulation and air-conditioning to restore a quieter environment for learning. Highways have been resurfaced with a low noise material to bring down the noise impacts on nearby dwellings. To ensure individual vehicles do not produce excessive noise, all vehicles including lorries and buses for first registration are required to comply with stringent noise emission standards following those adopted in Europe and Japan.

4. While the measures implemented or committed helped to improve the situation, they could not rectify all noise problems caused by the large fleet of vehicles on our roads. The government issued in 1993 the second review of the 1989 White Paper indicating the intention to review the practicality of reducing noise from existing roads. One possible way to do so is to retrofit barriers on existing roads to abate the noise. But, retrofitting barrier on existing road is by no means

straight forward since there are many constraints to be considered.

Study Approach

5. Given the large number of roads and residential developments in Hong Kong, it is necessary to adopt a reasonable and pragmatic approach to identify the roads which are causing noise problem and whether these roads could be retrofitted with noise mitigation measures in the form of barrier, cantilever barrier, semi-enclosure or enclosure. Mitigation measures such as resurfacing roads with low noise material being implemented under the existing policy are not repeated in this study.

6. There are over 3000 roads in the territory. Before establishing a particular road section is noisy and that it has the potential to be retrofitted with barrier, there is no point to go in too much details such as detailed investigation on conflicts with underground utilities. For obvious reasons, retrofitting measures should not compromise traffic safety or emergency vehicle access. With the assistance of a set of criteria established through the study, roads that are noisy and have potential for retrofitting barriers are scoped or screened for detailed investigation.

7. In the study, a road is taken to be a "noisy road" if noise from traffic on the road would exceed 70 dB(A) L10(1h) at the façade of noise sensitive receivers (NSRs) [planning noise standard at residential building recommended in the Hong Kong Planning Standards and Guidelines]. A road is taken to have the potential for retrofitting barriers if preliminary evaluation indicates there is no insurmountable constraints on that particular road to preclude direct mitigation measures in the form of barrier, cantilever barrier, semi-enclosure or enclosure.

8. Roads scoped or screened by the above process were then further investigated in the engineering feasibility study. In the engineering feasibility study, preliminary engineering designs on appropriate mitigation measures were carried out and site specific constraints including services and facilities underground and any side effects resulting from the implementation of mitigation measures were identified and evaluated. Specific aspects like space requirement,

road user safety, fire-fighting concern, 'buildability', environmental implication were carefully looked into. Problems that might occur due to the retrofitting noise mitigation measures were thoroughly considered to identify whether they were surmountable. Apart from providing advice on the type of mitigation measures that would be feasible to build on specific road sections being studied to abate noise, the engineering feasibility study also developed a set of guiding principles or criteria as "working tools" to facilitate review on the practicality of retrofitting barriers in other roads.

9. Using the "working tools" developed, a review on the noisy roads and flyovers in the territory was taken to ascertain those that are technically feasible for retrofitting mitigation measures.

10. A list of road section and/or flyover that could be retrofitted with barriers were compiled after the review.

Scoping Exercise

11. Scoping exercises were conducted in 1994/95 and 1996/97 for at-grade roads and flyovers respectively. The same approaches were adopted throughout the exercises.

12. Purpose of the scoping exercise was to:

a. establish a set of screening criteria for selection of noisy road that could be retrofitted with barriers;
b. conduct initial noise assessment so as to identify "noisy" road sections or flyovers;
c. appraise the noisy roads and flyovers on potential for retrofitting barriers; and
d. compile a list of road sections and flyovers that have potential for retrofitting barriers for further investigation.

13. To facilitate the scoping exercise, all existing road sections and flyovers were grouped into different categories i.e. expressway, primary roads, district roads and local access roads.

14. Noise sensitive receivers as defined in the Hong Kong Planning Standards and Guidelines were included for assessment. Courts of

law and educational institutions being provided with acoustic insulation and air-conditioning were not included in the scoping exercise.

15. To avoid duplicating efforts, existing road sections or flyovers under the following circumstances had been excluded from the screening process and noise assessment :

a. the road section or flyover was being planned for widening or improvement with on going environmental impact assessment to identify adverse noise impacts and practicable noise mitigation measures;
b. noise mitigation measures had already been provided or would be provided in accordance with previous EIA studies, (however, the scoping exercise also looked into location where there were vigorous traffic noise complaints);
c. there was no existing NSRs in close proximity to the road section or flyover. This included situations where NSRs had been demolished or being redeveloped; and
d. road section in tunnel or underpass since the enclosed road would not have significant noise impacts on sensitive uses.

16. Initial Noise Assessment had been conducted to determine the extent of the noise impacts from existing road sections and flyovers on NSRs in the vicinity. To ensure consistency, the noise assessment followed the "Calculation of Road Traffic Noise" procedures developed by the United Kingdom Department of Transport, 1988. In order to provide representative situation for consideration while confining the data to a manageable size, noise levels at the nominal or typical façade of each road section or flyover had been assessed. The typical façade was taken to locate at a nominal distance from and at 5m above the road with 160 degree unscreened view of the road section or flyover ([not all buildings or flats near the road are exposed to the same high traffic noise level] since noise at individual flats would depend on height, location of the flats and any structure which may screen the line-of-sight to the road.) In addition, data and basic assumptions as outlined below were adopted for traffic noise assessment :

a. traffic flows and percentages of heavy vehicle during peak traffic

hours published in the latest available "The Annual Traffic Census" were used;

b. for roads with only annual daily traffic data available, the peak hour flows and percentages of heavy vehicles were proportioned from core traffic counting stations within the same group;
c. the posted speed limit of each road type (i.e. 50 kph for urban roads, 70 or above kph for expressways) were used;
d. the road gradient were categorized as 0, 3, 6, 9, 12 or 15% as estimated from 1:5000 survey maps; and
e. as the traffic census include most roads where there were substantial traffic, roads with no available traffic data from the census were assumed not noisy in the study. This assumption was also supported by analysis of complaint records which indicated that these roads were not the target of traffic noise complaint.

17. Various government departments, including Fire Services Department, Transport Department, Housing Department, Highways Department and Territory Development Department have been consulted for their respective concerns related to safety requirement and operational constraints for erection of barriers on existing at-grade roads and flyovers. Although some of the known constraints and specific requirements could be overcome by appropriate engineering designs, the following constraints have been found insurmountable for retrofitting barriers on existing at-grade roads and flyovers where there are :-

a. blockage or obstruction to fire fighting or emergency access;
b. insufficient space for installation;
c. violating safety sightline requirements;
d. insufficient space between flyovers and NSRs as well as space for independent structural support in the case of flyovers;
e. significant impact on public / business activities; and
f. significant impact on existing road structures, i.e. flyovers, central dividers etc.

18. The initial noise assessment in the scoping exercise had identified 663 at-grade roads and 114 flyovers as noisy. [Remarks: For consistency in counting, sections of road under the same "name" have been rationalized following specific "name" of the road in later stage of the study. After rationalization, the number of roads and

flyovers that are noisy became 655.] After testing against various anticipated constraints, 18 at-grade roads and 11 flyovers had been shortlisted to be having potential for retrofitting barriers for further investigation.

19. Appendices I & II are list of the 18 at-grade roads and 11 flyovers recommended for further investigation.

Engineering Feasibility Study

20. The engineering feasibility study for the selected 18 at-grade road sections and the 3 selected flyovers commenced in 1996 and 1997 respectively after the scoping exercise.

21. The engineering feasibility study was to take on board a detailed engineering investigation of the road sections and flyovers that had been identified having potential for retrofitting in the scoping exercise. The engineering feasibility study had assessed different mitigation options for each road sections and flyovers in terms of acoustic effectiveness and potential conflicts with existing utilities, structure, foundation and pedestrian access. Compliance with road safety, fire fighting and emergency access requirements as stipulated in relevant codes of practice and government regulations were examined in the assessment. The best option for implementation in each case was obtained through a scheme evaluation system established for evaluating pros and cons of different options. The engineering feasibility study had also derived "working tools" from investigation results in the study for evaluating whether any particular at-grade road or flyover is engineering feasible for retrofitting barriers.

22. Due to development subsequent to the scoping exercise and for optimizing resources, the engineering feasibility study had finally looked into 14 at-grade roads and 3 flyovers. This was because 4 of the 18 at-grade roads shortlisted in the scoping exercise, namely Island Eastern Corridor, Hiram's Highway, Tolo Highway and Ting Kok Road were under concurrent improvement and related environmental impact studies at that time and were thus excluded from the feasibility study. On the other hand, 3 flyovers (out of 11 identified in the scoping exercise) representing typical

flyover-receiver configurations and types of mitigation measures have been selected for detailed engineering feasibility study. This approach helped to optimize resources as well as the time required for the detailed study. The 3 flyovers studied were Kwai Chung Road Flyover, Tsing Tsuen Bridge and Ap Lei Chau Bridge.

23. In the course of the study, special attentions had been given in investigating whether there are insurmountable constraints in retrofitting barriers on at-grade roads or flyovers. Due consideration on the following aspects had been given in evaluating whether retrofitting barriers on a particular road is feasible:

a. traffic engineering and road safety: noise barriers should not compromise road safety in any aspect or become a hazard to road user. Specific requirements such as visibility and sight stopping distance in relation to vehicle speed, acceleration and deceleration rates, horizontal and vertical alignments of road and driver behaviour were considered.
b. fire fighting and emergency access: noise barriers should not obstruct the operation of emergency vehicles such as fire engines and ambulances nor equipment and plant such as fire hydrants and valves.
c. space requirements: foundation of noise barriers should be kept clear from the underground infrastructure. The foundation should be wholly outside any box culverts, major pipelines and lot boundaries with a clearance of 1 to 3 m as appropriate.
d. pedestrian access and street-level commercial activities: noise barriers should not obstruct pedestrian flows or interfere with street-level activities such as loading and unloading, vehicular access to buildings and commercial activities.
e. environmental side effects: noise barriers should not aggravate or should minimize side effects of local air quality and visual / landscape impact.
f. social impact: noise barriers should minimize social impacts such as severance of housing developments, creation of black spot for crime, accumulation of debris etc.

24. Key findings of the engineering feasibility studies are :-

a. the feasibility of retrofitting barriers on existing roads and flyovers, would be highly dependent on local site constraints, the type and

layout of noise sensitive developments to be protected.

b. retrofitting noise mitigating measures in the form of barrier, cantilever barrier, semi-enclosure and / or enclosure were found feasible for most of the at-grade road sections studied. The exception was Tung Tau Tsuen Road where sightline problems concerning the safety of pedestrians and car drivers prohibit erection of any form of barriers there.

c. retrofitting noise mitigating measures in the form of barrier, cantilever barrier, semi-enclosure and / or enclosure on independent structures were found feasible for two flyovers studied while not feasible in the case of Kwai Chung Road Flyover. The main reason that Kwai Chung Road Flyover could not be retrofitted with barriers was due to lack of space for footings of the supporting structures.

d. a "working tool" or simplified assessment procedures as a set of guiding principles were derived for evaluating whether retrofitting barriers on particular road section or flyover is technically feasible. This helped to avoid having to go through lengthy assessment before committing to a detailed feasibility study.

25. The guiding principles developed for reviewing existing at-grade roads and flyovers are in Appendices III & IV respectively.

Review Based On The Guiding Principles

26. A review of roads territory-wide using the guiding principles derived was conducted in 1998/1999. The review was to identify, using the set of "working tool" developed in the engineering feasibility study, whether particular at-grade road or flyover, other than those studied in the engineering feasibility study, could be retrofitted with barriers. The review has taken into consideration the up-to-date information in road-receiver situation. The remaining 8 of the 11 flyovers screened in the scoping exercise had been included in the review.

27. The review had identified and tested in accordance with the established "working tool" to ascertain feasibility of retrofitting barriers on particular road as well as the type and extent of barrier. The review had also provided cost estimates of the recommended barriers for reference.

28. For the same reasons, the review also did not include road sections or

flyovers that were under circumstances as described in paragraph 15 above to avoid duplicating of efforts.

29. The review had examined all roads and flyovers. 655 roads (including flyovers) were identified as noisy. 9 at-grade road sections and 4 flyovers were identified in the review to be feasible for retrofitting barriers.

30. It should be noted that roads identified in the review as feasible for retrofitting barriers had not undergone detailed engineering feasibility nor investigation into the site condition. As such, the extent and actual siting of mitigation measures need to be verified prior to implementation.

31. Appendices V & VI list the 655 noisy roads and the 29 roads (including 6 flyovers) that are feasible for retrofitting barriers.

Conclusion

32. From the series of studies, it is identified that 29 existing roads (including 6 flyovers) are feasible to be provided with barriers at an estimated cost of HK$ 2,340 million benefiting 24,000 dwellings.

33. As retrofitting barriers on 29 roads is a massive project, it is necessary to prioritize the noise mitigation works programme. It is recommended to accord higher priority to roads with high noise levels and large number of affected dwellings.

34. In pursuing the retrofitting programme, the design of the barriers should be carefully considered to prevent them from being unduly obtrusive. Possible design and the use of transparent material that would enhance the landscape and visual quality or make the project visually compatible with the surrounding should be fully explored. Visual impacts, air quality, maintenance as well as public disturbance during the construction should be carefully considered and minimized in detailed design of the barriers.