Annex A

Feasibility Study for

Establishment of Air Ventilation Assessment System

Gist of Draft Study Findings

May 2005

建築 中大

Vision

Towards the delivery of a quality and comfortable urban environment

Asia's world city HONG KONG

Prologue

Highly congested urban spaces are a feature of Hong Kong rarely seen in many developed countries. Efforts to maximize capturing the wind availability through better urban design and planning must be the key focus of improving air ventilation for Hong Kong.

Hong Kong is one of the densest populated cities in the world. High-density living has the advantages of efficient land use, effective public transport and infrastructure, as well as the benefits of closer proximity of daily amenities. The "sunk cost" of high-density living is that it is more difficult to optimize urban design for the benefits of the natural environment – daylight and natural air / wind ventilation. Good planning and building designs are critically important.

The unique urban fabric of Hong Kong is the field of study. Its pattern of streets, building heights, open spaces, density, features, landscape and so on determine the environmental quality (natural air ventilation, solar radiation, daylight, air temperature, etc) both within buildings and outside.

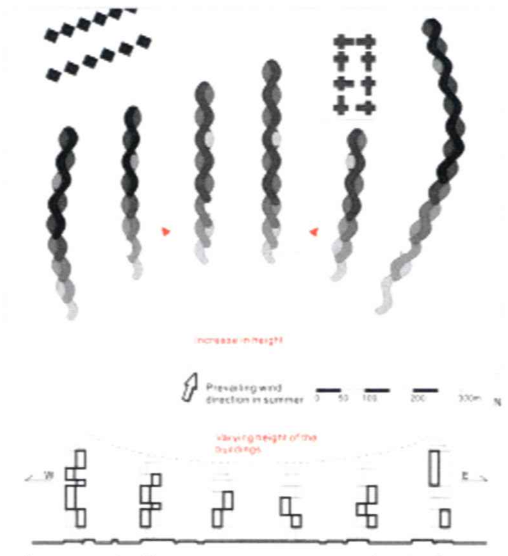
The Consultant Team, together with a number of local and international experts, has made qualitative assessments of issues and problems facing urban Hong Kong. Some of their more important views of our built environment could be summarized as follows:

- A lack of well considered network of breezeways and air paths towards the prevailing wind.
- Tall and bulky buildings closely packed together forming an "effective" windbreak to the urban fabric behind.
- Uniform building heights resulting in wind skimming over the top and not being re-routed into the urban fabric.
- Tight, narrow streets not aligning with the prevailing wind, and with very tall buildings on both sides, resulting in very deep urban canyons.

- A lack of general urban permeability (few open spaces, no or minimal gaps between buildings or within buildings, and excessive podium structure).
- Large building lots with buildings not designed for wind permeability and forming wind barriers.
- Projections from buildings and obstruction on streets further intrude into the breezeways and air paths.
- A general lack of greenery, shading and soft landscape in the urban areas.

Design and assessment tools are beneficial to assist the government, planners, engineers, architects, designers and industry stakeholders to better optimize air ventilation for our city. An underlying spirit of the Study is to promote more scientific based urban interventions – conceptually described as a form of "urban acupuncture" – for enhanced, long-term livability in the high-density urban context of Hong Kong. The Study focuses on the fundamental mission: "**How to design and plan our city fabric for better natural air ventilation?**"

It is not the purpose of this Study to address air ventilation performance of individual building / indoor space designs nor the air quality impact assessment for air pollutants control, which are respectively governed by the Buildings Ordinance and Environmental Impact Assessment Ordinance. Nevertheless, it is inevitable that there may be interfaces between the recommendations to be evolved in this Study and these two ordinances.



Design studies were conducted to hypothesize what a high density city might look like if air ventilation is optimized. This serves as a visual indication of the kind of guidelines and methodologies needed.

Wind for What?

Indoor Comfort

Effective ventilation of interior spaces improves health and comfort of occupants. A certain minimum air change rate (ACH) is needed to ensure a healthy indoor environment. In addition, to achieve a comfortable thermal environment in the summer months of Hong Kong, a steady indoor air movement of around **1 m/s** across the occupant space is desirable. To maximize ventilation potentials of interior spaces, it is important to ensure a conducive outdoor macro wind movement environment, and design the building and openings of the interior space appropriately.

Outdoor Comfort

In the hot tropical summer months of Hong Kong, when under shade, a steady wind at pedestrian level of around **1.5 m/s** will be beneficial for providing thermal relief and a comfortable outdoor urban environment. Properly laid out urban patterns and street widths, careful disposition of building bulks and heights, open spaces and their configurations, breezeways and air paths, and so on are all important parameters.

Pollution Dispersion

In general, higher wind movement of a certain characteristics across the urban fabric will assist the dispersion of anthropogenic pollution. A steady wind of at least **1 m/s** or greater may assist. However, it should be noted that pollution should best be tackled at sources and Environmental Protection Department (EPD) has already established guidelines and mechanisms to deal with the issue.

Wind Gust and Safety

In general, high turbulent wind in excess of **12 m/s** will cause safety concerns to pedestrians – especially when coupled with colder temperature in winter. Localized wind shelters or canopies may be needed for some exposed locations.

In summary

Taking into account the above, various climatic and urban factors, and given Hong Kong's high density conditions, it is opined that, for planning considerations:

> Optimizing or **maximising air ventilation through the city fabric is the focus of air ventilation assessment (AVA)**. In general, on the whole "the more air ventilation the better" – save some isolated wind problems that in most cases could be dealt with locally. Given the natural wind availability of the site, a high probability of a general breeze at pedestrian level of at least 1.5 m/s is a useful criterion of AVA.

Background

" To promote better layout of building blocks in the city, we are examining the practicality of stipulating air ventilation assessment as one of the considerations, similar to traffic and infrastructure capacities, for all major development or redevelopment proposals and in future planning. We propose to consult stakeholders on the measurement, scope and mechanism of application and other detailed requirements for an air ventilation assessment "

Team Clean
8.2003

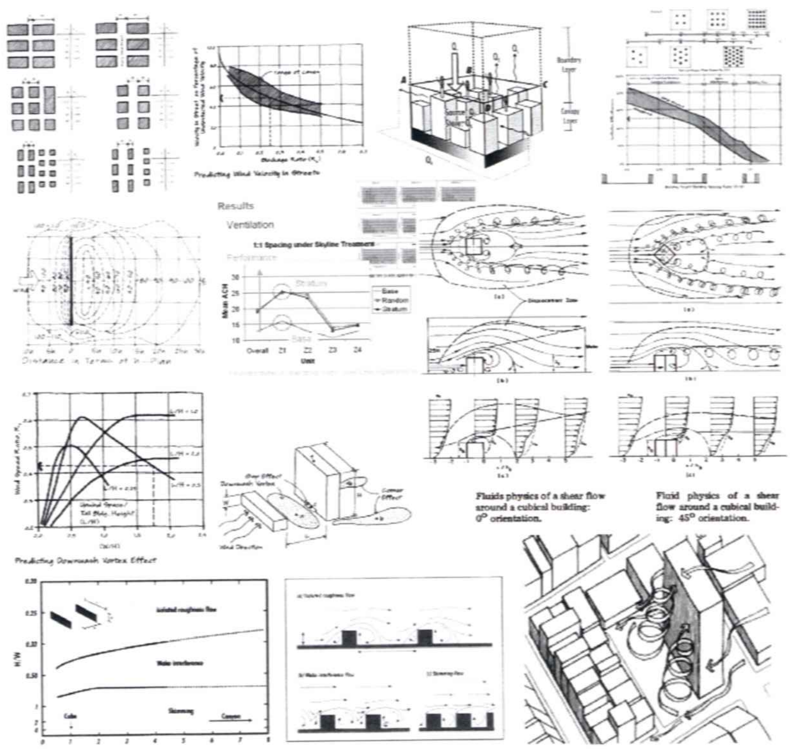
TEAM CLEAN
全城清潔策劃小組

There are calls from the community for measures to improve the quality of our urban living environment. Among the recommendations in the Team Clean Final Report, it is proposed to examine the practicality of stipulating air ventilation assessment as one of the considerations for all major development or redevelopment proposals and in future planning.

Planning Department has been requested by Team Clean to discuss among Government departments and consult relevant professional institutes and stakeholders on the standards, scope and mechanism for application of an **Air Ventilation Assessment (AVA) System**.

Study Objective

Explore the feasibility of establishing some protocols to assess the effects of major planning and development proposals on external air movement for achieving an acceptable macro wind environment.



Current state-of-the-art wind science has been referred, appropriated and further developed to guide our understanding and action towards the design of a wind environment for our city.

The Consultant Team

The Study requires expertise of many disciplines. A consultant team of specialists and professionals has been assembled:

Project Director

- **Professor Essy Baniassad, CUHK, HKSAR**
  (Chair Professor and Head of Department of Architecture)

CUHK Investigators

- **Professor Edward Ng, CUHK, HKSAR**
  (Expert of environmental and sustainable design)
- **Professor Tsou Jin Yeu, CUHK, HKSAR**
  (Expert of computational fluid dynamics [CFD])

Supporting Consultants

- **Ms Iris Tam and Mr Geoffrey Chan, City Planning Consultants Ltd.**
  (Town planners)
- **Mr Anton Davis, RWDI, Canada**
  (Expert of wind tunnel studies)

Local / International Experts

- **Professor Baruch Givoni, UCLA, USA**
  (Expert of thermal comfort, urban climatic design & human physiology)
- **Professor Lutz Katzschner, Kassel University, Germany**
  (Expert of urban climatology and Urban Climatic Mapping)
- **Professor Kenny Kwok, HKUST, HKSAR**
  (Expert of wind tunnel and wind engineering)
- **Professor Shuzo Murakami, Keio University, Japan**
  (Expert of wind studies, urban heat island & assessment methodology)
- **Professor Mat Santamouris, University of Athens, Greece**
  (Expert of urban physics, urban climatology & air ventilation design)
- **Dr Wong Nyuk Hien, NUS, Singapore**
  (Expert of thermal comfort, wind studies & urban heat island)

Local / International Advisors

- **Professor Phil Jones, Cardiff University, UK**
  (Expert of wind studies and CFD)
- **Professor Lam Kin-Chi, CUHK, HKSAR**
  (Expert of environmental geography and EIA)
- **Mr Anthony Ng, CUHK, HKSAR**
  (Architect)
- **Professor Wong Tze Wai, CUHK, HKSAR**
  (Expert of community medicine and health issues)

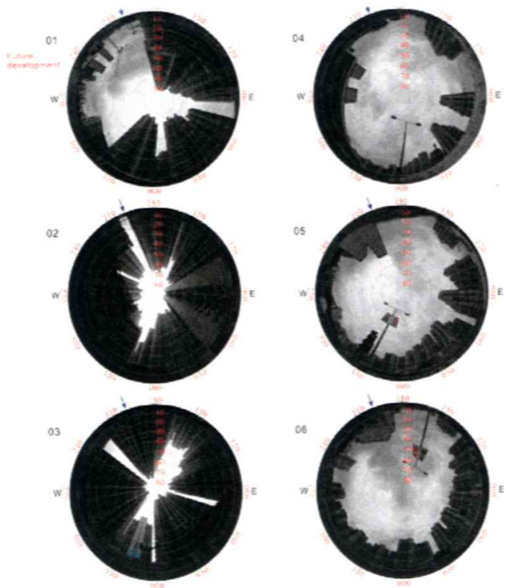
Project Co-ordinator

- **Mr Kam-Sing Wong, CUHK, HKSAR**
  (Architect)

Tasks

To meet the study objective, the following tasks have been conducted:

- A desktop study to review the state-of-the-art of current knowledge and its limitations and experiences gained from similar studies.
- A preliminary review to understand the current urban conditions of Hong Kong in order to identify key problems and issues.
- Explore the possibility to establish performance criteria needed for considering the impact of development on wind environment.
- Explore the feasibility to develop a practical and cost effective assessment methodology.
- Examine the practicality of an effective implementation mechanism.
- Establish principles and good practice for the use of professionals and practitioners in the shaping of the built environment for better wind environment.



For example, sky view factor has been used to examine the exposure of the urban fabric to the natural environment.

Key Recommendations of International Experts

A study of this nature is unprecedented. A number of eminent scholars around the world have been asked to provide a qualitative assessment of our urban environment, (refer to international experts on page 8). Mongkok and Tseung Kwan O were taken as the typical examples of the Metro Area and New Town in Hong Kong for discussion.

Their main recommendations are summarized below. Some of the comments are specifically relevant to the Metro Area.

General

- **Breezeway / Air path / Sea Breeze**

  As a general rule, the more air ventilation to the streets, the better it will be for these dense urban areas.

  The overall permeability of the district has to be increased at the ground level. This is to ensure that the prevailing wind traveling along breezeways and major roads can penetrate deep into the district. This can be achieved by proper linking of open spaces, creation of open plazas at road junctions, maintaining low-rise structures along prevailing wind direction routes, and widening of the minor roads connecting to major roads.

  Also avoid obstruction of the sea breeze. Any localised wind problem along the waterfront should be dealt with locally and not affect the overall air ventilation of the city.

- **Podium / Site Coverage**

  The effect of building layout (especially in terms of building site coverage) has a greater impact than that of building height on pedestrian wind environment. Stepping building heights in rows would create better wind at higher levels if differences in building heights between rows are significant.

  The "podium" structures commonly found in Hong Kong are not desirable from the viewpoint of maximizing wind available to pedestrians. The podia with large site coverage not only block most of the wind to pedestrians (affecting comfort and air quality), but also minimize the "air volume" near the pedestrian level (affecting air quality).

- **Building Disposition**

Proper orientation and layout of the buildings with adequate gaps between buildings are needed. Stagger the arrangement of the blocks such that the blocks behind are able to receive the wind penetrating through the gaps between the blocks in the front row.

In case of a new town like Tseung Kwan O, to avoid obstruction of the sea breeze, the axis of the buildings should be parallel to the prevailing wind.

In order to maximize the wind availability to pedestrians, towers should preferably abut the podium edge that faces the main pedestrian area/street so as to enable most of the downwash wind to reach the street level. (However, attention is also drawn to the concern of too strong gust, especially for exposed areas and areas near waterfront, which may affect pedestrian safety. Localized ameliorating device such as canopy may be required.)

- **Building Height**

Vary the heights of the blocks with decreasing heights towards the direction where the prevailing wind comes from. If not, it is better to have varying heights rather than similar / uniform height.

Given the extremely high density of the urban fabric and narrow streets, a probable strategy for improving the air ventilation is by varying building heights for diverting winds to the lower levels. Nonetheless, assessment will be required to further quantify the actual performance of such potential in view of the common deep urban canyon situations in Hong Kong.

- **Building Permeability**

The provision of permeability / gap nearer to the pedestrian level is far more important than that at high levels.

Create permeability in the housing blocks. Try to create voids at ground level to improve ventilation for pedestrians. This will improve not only the air movement at the ground level (thus improving the pedestrian comfort), but also help to remove the pollutants and heat generated at ground level. The channeling effect created by the void also helps to improve the ventilation performance for those residential units at the lower floors.

Creation of openings in the building blocks to increase their permeability may be combined with appropriate wing walls that will contribute to pressure differences across the building facades and thus will permit the air to flow through the openings of the building. The wing walls have to be designed according to the known standards.

For very deep canyons or very tall building blocks, mid-level permeability may be required to improve the ventilation performance for those occupants situated at mid-floors.

- **Cool Materials**

Use of cool sinks, like trees, water, etc, as well as the use of cool materials in the pavements, streets and building facades will contribute highly to decrease absorption of solar radiation and lower air and radiant temperatures in the summer. Cool materials are characterized by high solar reflectivity and/or high emissivity. For streets, the use of asphalt with a high percentage of white aggregates should be considered.

- **Urban Greenery**

  Encourage proper planting of trees where possible in order to provide shade and cooling (helps lower the ambient temperature) for pedestrians due to evapotranspiration, and to filter pollution. Trees and urban landscape will be beneficial for enhancing thermal comfort of pedestrians, although trees can sometimes lower the wind speed.

- **Minimization of Decentralized Heat Generation**

  Decrease the rate of the anthropogenic heat generated. This can be achieved either by decreasing car use in the area and by introducing central air conditioning systems, or if possible by district cooling systems. This can allow the proper channeling of the heat extracted from the air conditioning systems. District cooling system should be considered since the district is with high building density. The heat extracted can even be recovered for heating.

- **Active Ventilation System for Deep Urban Canyons**

  In order to improve the ventilation at the very narrow streets, especially in deep canyons, active ventilation system may be considered, e.g. using vertical chimneys / stacks that transfer air from the canyons to higher levels above the buildings. Such chimneys will also contribute to decrease in pollution.

Metro Area

- **Street Widening / Building Setback**

  Widening of streets / breezeways and providing gaps between buildings are considered of high effectiveness. However, it may not be necessary to widen streets not along the direction of the prevailing wind. For Mongkok district, the proposal of street widening is strongly supported. To be effective, the building setback may be in the order of 5m on each side for those streets along the prevailing wind direction.

- **Projecting Obstructions**

  Massive projecting obstructions, such as elevated walkways, may adversely affect the wind environment at pedestrian level, as observed in Mongkok. Signage is preferably of the vertical type in order to minimize wind blockage, particularly in those areas with a high density of projecting signs over streets.

Engagement of Stakeholders

As the beginning of the Study, the Consultant Team conducted a Brainstorming Workshop to present some of the Consultant's initial ideas of approaching the Study and to provide a common platform for views and experiences sharing from stakeholders who would contribute to the study process.

The Brainstorming Workshop, held on 17 December 2003, was attended by multi-stakeholder groups representing various professional organizations, business groups, academic institutes, citizens groups and government agencies. A workshop discussion paper was circulated before the meeting.

The discussion ranged over a large number of issues. Written comments were further received after the workshop meeting. The views may be summarized as follows:

- There was in-principle support for the Study to ensure that air ventilation aspects would be well accounted for during both planning and development stages. There was considerable expression of interest for co-operation amongst the participants in the further steps of the Study.
- There were strong support that an AVA System is considered beneficial to the community at large and should be introduced to Hong Kong. There was a high degree of consensus urging for more permeable built-form towards enhancing air penetration to our built environment, especially at the street and podium levels.
- It was opined that guidelines developed in other countries might not be directly applicable to the high-density situation in Hong Kong. The Study is original and unprecedented; it will require research support and local data collection.
- It is inevitable that there will be a price tag towards a better urban environment. Public acceptance and support are needed. Co-ordination between government departments, adaptation by the industry stakeholders, education and awareness raising are all important for a successful launch of actions.

Since the initial engagement of stakeholders, the Study team has made advances towards a better understanding of the issues and problems involved, examined the state-of-the-art knowledge and know-how, noted their limitations; and recommended assessment criteria, methodology and implementation actions and some urban design principles for application of the initial AVA system. This paper shares the key findings of this feasibility study before finalisation. It provides an informed agenda for discussion, and serves as the basis to solicit further views on the way forward.

Assessment Criteria

In Hong Kong, given its congested and high density urban fabric, in general, "the more air ventilation through the city fabric, the better". It is recommended that the desirable wind environment for Hong Kong should be:

> For 50% of the time of the year, wind velocity should be at least or more than **1.5 m/s** at pedestrian level (2m above ground). This will allow an optimum wind environment for air ventilation in general. It also provides some benefits in lowering thermal stress in the summer months. If desired, the criterion may be further studied to take into account the seasonal effects of the wind environment.
>
> AND
>
> Throughout the year, the occurrence of maximum 10-minute average wind speed that exceeds **12 m/s** should be limited to below once per year (excluding typhoons). If desired, the criterion may be further studied to take into account ranges of outdoor activities and exposure.

The criteria stated here capture the desirable wind environment at the lower wind velocity for thermal comfort and better air ventilation for the city. In addition, they capture the wind environment at the upper wind velocity for pedestrian safety considerations.

Having defined the criteria of the desirable wind environment both for the lower and the upper limits, given the current conditions of Hong Kong, it must be pointed out that the focus of the AVA is to encourage urban design and planning so that wind has a "higher" chance to permeate through the urban fabric.

It is therefore recommended that, overall speaking, one should pay more attention to the lower limit of wind for thermal comfort and air ventilation, and that **achieving the lower limit should take precedence** in AVA. It is opined that as far as the higher limit is concerned, localized mitigation, for example provision of canopies, trees and wind breaks, may help to solve the problem.

Assessment Approaches

There could be 2 approaches to AVA – **performance based** and **quantitative guidelines based**.

Performance Based

The performance based approach is a set of standard procedures for project proponents to demonstrate that their proposals meet the preset performance criteria and requirements with the need to go through the testing procedures.(1)

Quantitative Guidelines Based

On the other hand, the quantitative guidelines based approach is the result of simplification of a performance requirement given certain assumption of circumstances of the context. It is a set of quantitative design guidelines that applicants may wish to apply in order that the development proposals would be deemed to satisfy the preset performance criteria and requirements if they follow the guidelines without the need to go through the testing procedures.(2)

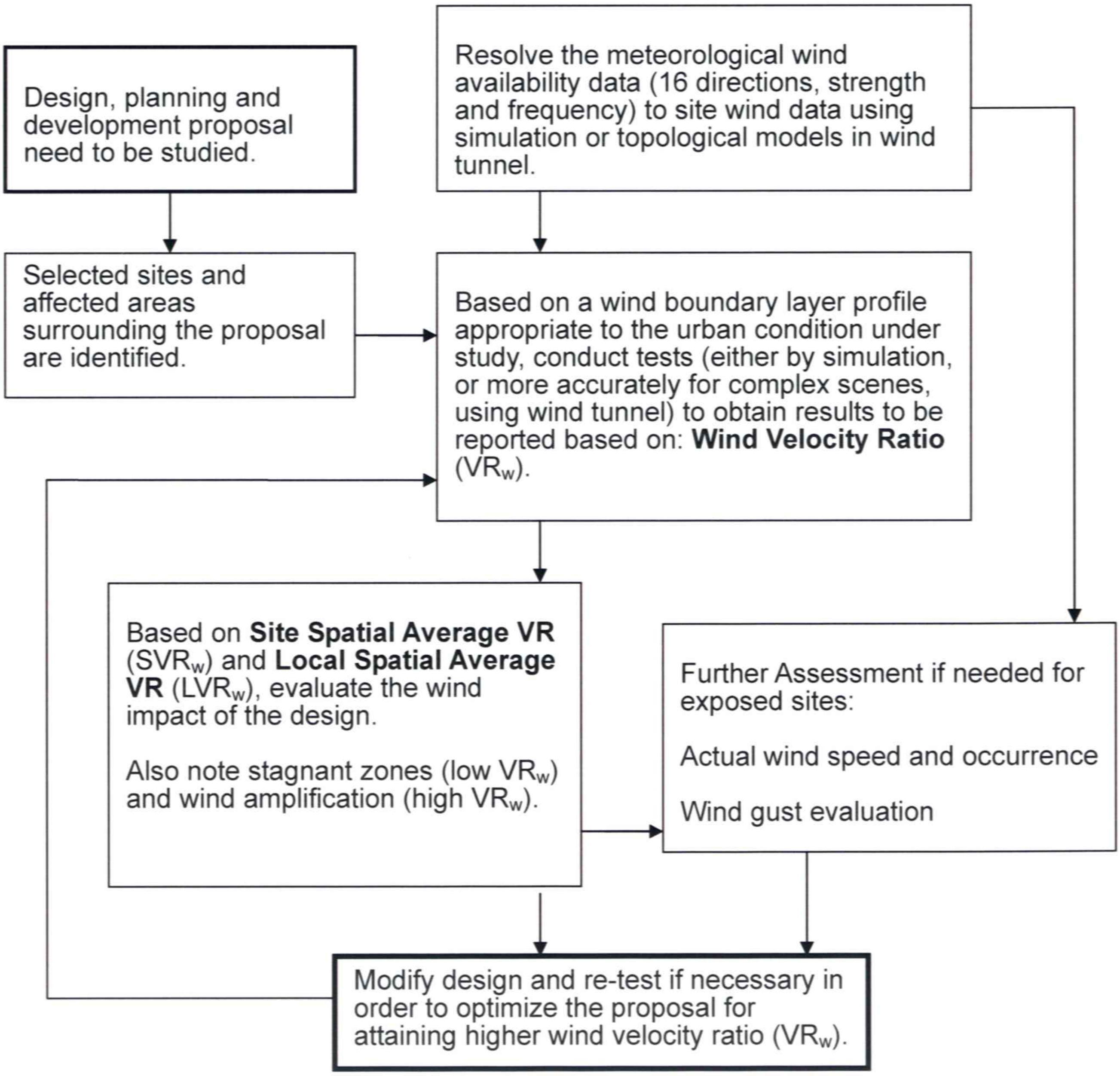
(1) For example, a project proponent might wish to demonstrate directly that the proposal could achieve a certain wind environment using wind tunnel modeling. One may then state that the proposal could on average provide a satisfactory wind environment based on obtaining and analyzing the wind velocity of the test points.

(2) Alternatively, a project proponent might wish to refer to certain quantitative guidelines that state for example the relationship between building height and street width, or building bulk and voids. By following the quantitative guidelines, the proposal will be deemed to satisfy the nominated wind standard.

Examples of quantitative guidelines based on various indices.

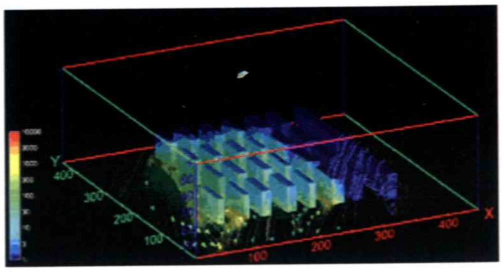
Assessment Approaches - Performance Based

Optimizing wind availability of a site through better urban design is the key focus of the AVA system. There are many assessment methodologies. This Study recommends the use of Wind Velocity Ratio. **Wind Velocity Ratio** (VR_w) is defined as the ratio of wind available at the pedestrian level (V_p) at 2m above ground and the wind availability of the site at the top of the wind boundary layer (V_∞), usually taken as 650m above city centre. Hence, [$VR_w = V_p / V_\infty$]. This ratio is affected solely by the buildings extent, geometry, and configuration on ground. It is a simple indicator to signify the effects of developments on the wind environment. The higher the value of VR_w, the lesser the impact of the design to the wind availability of the site, and the lesser its impact to the macro wind environment.



Wind Tunnel and CFD

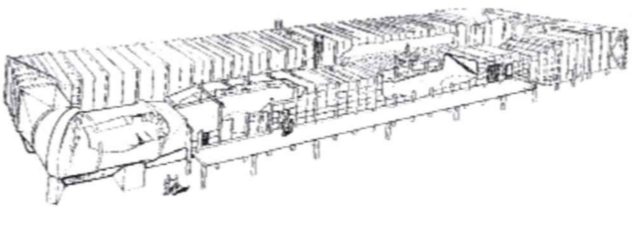
Wind tunnel and Computational Fluid Dynamics (CFD) may be used to conduct the AVA tests.



Wind tunnel is a mature technology. It has been used successfully in numerous wind related studies around the world. International standards, guidelines and methodology exist to ensure reliable results. For example, *American Society of Civil Engineers (ASCE) – Wind Tunnel Studies of Buildings and Structures* is a respected manual for specialists in the field. Well established wind tunnel facilities with knowledgeable staff are readily available around the world. In Hong Kong, the HKUST Wind Wave Facility is one such example.

Computational Fluid Dynamics (CFD) is a newer technology. It may cope with the "strong wind" regions of some less complicated conditions. The advantage of CFD is that it is cheaper than wind tunnel for less demanding tasks. Validation and verification are issues. And CFD is known to be inadequate when predicting wind at the 'slow regions' – typically at the leeward side of the building. Although very sophisticated CFD technology (for example Large Eddy Simulation) is available, the time, computer resources and the highly skilled specialists needed may make it impractical. As such, the use of CFD must be with caution at the moment.

Based on past international researches, given the complex urban geometry of Hong Kong, experts of the study unanimously opine that for AVA, wind tunnel should be a recommended tool. Typically, a wind tunnel study of a 2-hectare site costs about HK$400,000. It could take 1 to 3 months to conduct.



Expertises Required for Conducting AVA

- Some knowledge of atmospheric science and wind sciences;
- Some knowledge or appreciation of design and planning; and
- Some knowledge of wind tunnel methodology and application.

It is expected that qualified engineers e.g. mechanical engineers, physicists, environmental scientists, and atmospheric scientists with training and experiences in working with wind tunnel would be the competent persons to conduct AVA.

Assessment Approaches –
Quantitative Guidelines Based

Performance based tests are robust and reliable when conducted properly. However, they could only be conducted "after" the proposal is done and for evaluative and comparative performances. Moreover, they can be time consuming to conduct – especially if the proposals have to go through iterative processes.

Development of quantitative guidelines, ratios and indexes for the AVA should be considered. For example, Building (Planning) Regulations require that "a habitable room must be provided with window area of at least 1/10th of its floor area for daylighting and opening of at least 1/16th of its floor area for natural ventilation". The performance equivalence of this quantitative guideline may be assessed in terms of Daylight Factor and Air Change Rate respectively. These simple ratios not only allow project proponents to observe easily, but they also facilitate designs for project proponents at an early stage and decision makers to assess effectively.

Subject to further local data collection, research and consultation, some of the possible quantitative guidelines can be developed with respect to the notion of "openness index" (e.g., the amount of open space / openness near and around the development [site or local level] that are of the kind, shape, position and quality that will affect the effectiveness of wind moving around the site) and "building form index" (e.g., the geometry of urban fabric, the dimensions of building height, street width and length and their relationships, etc.), and ultimately in term of a single index, say "**permeability index**" (a 3-dimensional view of the relationship between urban geometry and urban wind climate). Researches are needed to develop these quantitative guidelines. Typically, they can be conducted using parametric evaluation, repeated testing with various settings and configurations, on-site validation, and statistical analysis of results of a large number of different cases using wind tunnel tests.

Permeability Index

An example of parametric test conducted in a wind tunnel in NUS Singapore by the consultant team.

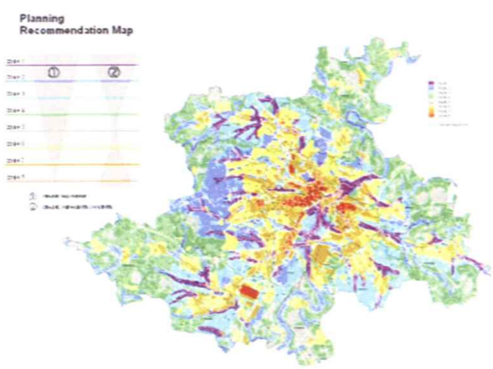
Proposal for Staged Implementation

In view of the time required for further scientific researches on different aspects of the urban climate and its correlation with urban geometry, the Study recommends that AVA be implemented in four key stages. The key stages and their corresponding timeframe are illustrated in the following figure. These four stages are not sequential and may be carried out concurrently but the durations are different.

	Year 1	Year 2	Year 3	Year 4
Stage A – Performance-based Evaluation with Technical Brief but without Benchmark Standards *Establishment of a generic framework and methodology for AVA to enable objective* ***comparison*** *between different design options and formulation of qualitative urban design guidelines.*		Immediately	Immediately	
Stage B – Urban Climatic Mapping [1] *Identification of climatically problematic/ sensitive areas that require particular attention or in need of planning and design interventions.*	1-2 Years	1-2 Years		
Stage C –Performance-based Evaluation with Technical Specifications and Benchmark Standards *Establishment of a set of objective* ***assessment standards*** *and criteria for AVA.*	2-3 Years	2-3 Years	2-3 Years	
Stage D – Quantitative Guidelines *Formulation of quantitative design guidelines to enable the practitioners to grasp the basic and most important design requirements for a well-ventilated urban environment at an early design stage.*	2-4 Years	2-4 Years	2-4 Years	2-4 Years

[1] What is Urban Climatic Map?

Instead of assessing a proposal when it arises, it is beneficial to be pro-active in such a way that the wind availability and needs of a site could be identified beforehand. Urban Climatic Map offers such a possibility. Developed initially in Germany and now used by planners in Germany, the map scientifically identifies the wind issues of a particular area. Based on the severity of the issue at hand, sensitive areas warranting special planning requirements could be identified. For example, if a proposal is located on or next to a major air path to the city, particular care and tests could be demanded.



At the **initial stage (Stage A)**, an advisory approach is recommended for the application of AVA system. The Government and quasi-government organizations (e.g. Urban Renewal Authority and Housing Authority) may take the initiative in undertaking AVA during preparation/ major review of town plans and for major development projects. The air ventilation impact of different development options may be "compared" to find out the relative performance in air ventilation with a view to achieving a climatically favourable urban form. The requirement for undertaking AVA may be implemented through administrative means, e.g. practice notes, technical circulars for Government departments and Hong Kong Planning Standards and Guidelines (HKPSG). The private sector should also be encouraged to conduct AVA on a voluntary basis whenever there is a concern that air ventilation may be severely affected by development proposals.

At the **completion of Stages B, C and D**, a widely accepted assessment method and a set of definitive assessment standards and criteria could be established in detail. It would then enable the Government to ascertain the types of project/ circumstances that should warrant an AVA. With definitive assessment standards/criteria and the availability of an urban climatic map, it would provide a stronger case for more extensive application to private projects, and for consideration of a regulatory approach, if necessary. For example, in Tokyo* and Sydney**, AVA has been incorporated into the statutory environmental and planning frameworks.

* *Tokyo Metropolitan Government EIA Ordinance requires that all project over 100,000 sq.m. GFA be subjected to wind study.*

** *In Central Sydney, the Local Environmental Plan under the Environmental, Planning & Assessment Act requires wind effects reports to be submitted with development applications for all buildings taller than 45m above street level.*

Application of AVA in Initial Stage

At the initial stage when the "Urban Climatic Map" and benchmarking are not yet available, the Government/ quasi-government organizations are still encouraged to undertake AVA where practicable under any one of the following circumstances:

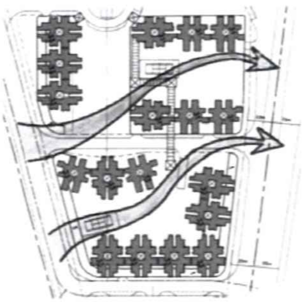
- Preparation of new town plans and major revision of such plans.
- Development that deviates from the statutory development restriction(s) other than minor relaxations.
- Erection of building structure within a designated breezeway.
- Urban renewal development that involves agglomeration of sites together with closure and building over of existing streets.
- Development with shielding effect on waterfront, particularly in confined airsheds.
- Large-scale development with a high density, e.g. site area over 2 hectares and an overall plot ratio of 5 or above, development with a total GFA of 100,000 sq.m. or above.

- Massive elevated structures over a road in the dense urban areas.

- For developments situated in an exposed location where there is no apparent shielding from the approaching wind, an assessment of the potential occurrence of windy conditions that may affect the safety of pedestrians should also be included.

Qualitative Urban Design Guidelines

Before further stages of AVA are developed, based on the advice of international experts, the following design guidelines provide useful design reference for better air ventilation. Some of them reinforce the current urban design guidelines already set out in the HKPSG, while a few are additional guidelines which should be considered for further enhancing the quality of our built environment.



Breezeway / Air path

It is important for better urban air ventilation in a dense, hot-humid city to let more wind penetrate through the urban district. Breezeways can be in forms of roads, open spaces and low-rise building corridors through which air reaches inner parts of urbanised areas largely occupied by high-rise buildings. Projecting obstructions over breezeways/air paths should be avoided to minimize wind blockage.

Orientation of Street Grids

An array of main streets, wide main avenues and/or breezeways should be aligned in parallel, or up to 30 degrees to the prevailing wind direction, in order to maximize the penetration of prevailing wind through the district.

Linkage of Open Spaces

Where possible, open spaces may be linked and aligned in such a way to form breezeways or ventilation corridors. Structures along breezeways/ventilation corridors should be low-rise.

Non-building Area

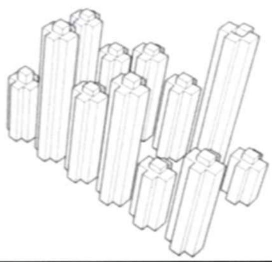
The tendency for many developments to maximize views to certain direction and site development potential often results in congested building masses and minimum spaces between buildings to meeting Building (Planning) Regulations. Compact developments on large sites are particularly impeding air movement. Development plots should be laid out and orientated to maximize air penetration by aligning the longer frontage in parallel to the wind direction and by introducing non-building areas and setbacks where appropriate.

Waterfront Sites

Waterfront sites are the gateways of sea breezes and land breezes due to the sea cooling and sun warming effects. Buildings along the waterfront should avoid blockage of sea/land breezes and prevailing winds.

Scale of Podium

The 100% site coverage for non-domestic part of developments up to some 15m high as permitted under the Building (Planning) Regulations often results in large podia. For large development/ redevelopment sites particularly in the existing urban areas, it would be critical to increase permeability of the podium structure at the street levels by providing some ventilation corridors or setback in parallel to the prevailing wind. Where appropriate, a terraced podium design should be adopted to direct downward airflow, which can help enhance air movement at the pedestrian level and disperse the pollutants emitted by vehicles.

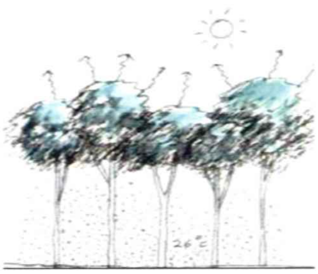


Building Heights

Height variation should be considered as much as possible with the principle that the height decreases towards the direction where prevailing wind comes from. The stepped height concept can help optimize the wind capturing potential of the development itself.

Building Disposition

Where practicable, adequately wide gaps should be provided between building blocks to maximize the air permeability of the development and minimize its impact on wind capturing potential of adjacent developments. The gaps for enhancing air permeability are preferably at a face perpendicular to the prevailing wind. Towers should preferably abut the podium edge that faces the concerned pedestrian area/street so as to enable most of the downwash wind to reach the street level.



Shading and greenery

Tall trees with wide and dense canopy should be planted along streets / entrance plazas / setback areas for maximizing pedestrian comfort – reducing urban heat island effect while avoiding blockage to air movements at the pedestrian level.

Cool materials

Use of cool materials in the pavements and building facades to decrease absorption of solar radiation. Cool materials are characterized by high solar reflectivity and if possible by high emissivity. For streets, the use of asphalt with a high percentage of white aggregates has to be considered. A large water body can also serve as a cool sink.