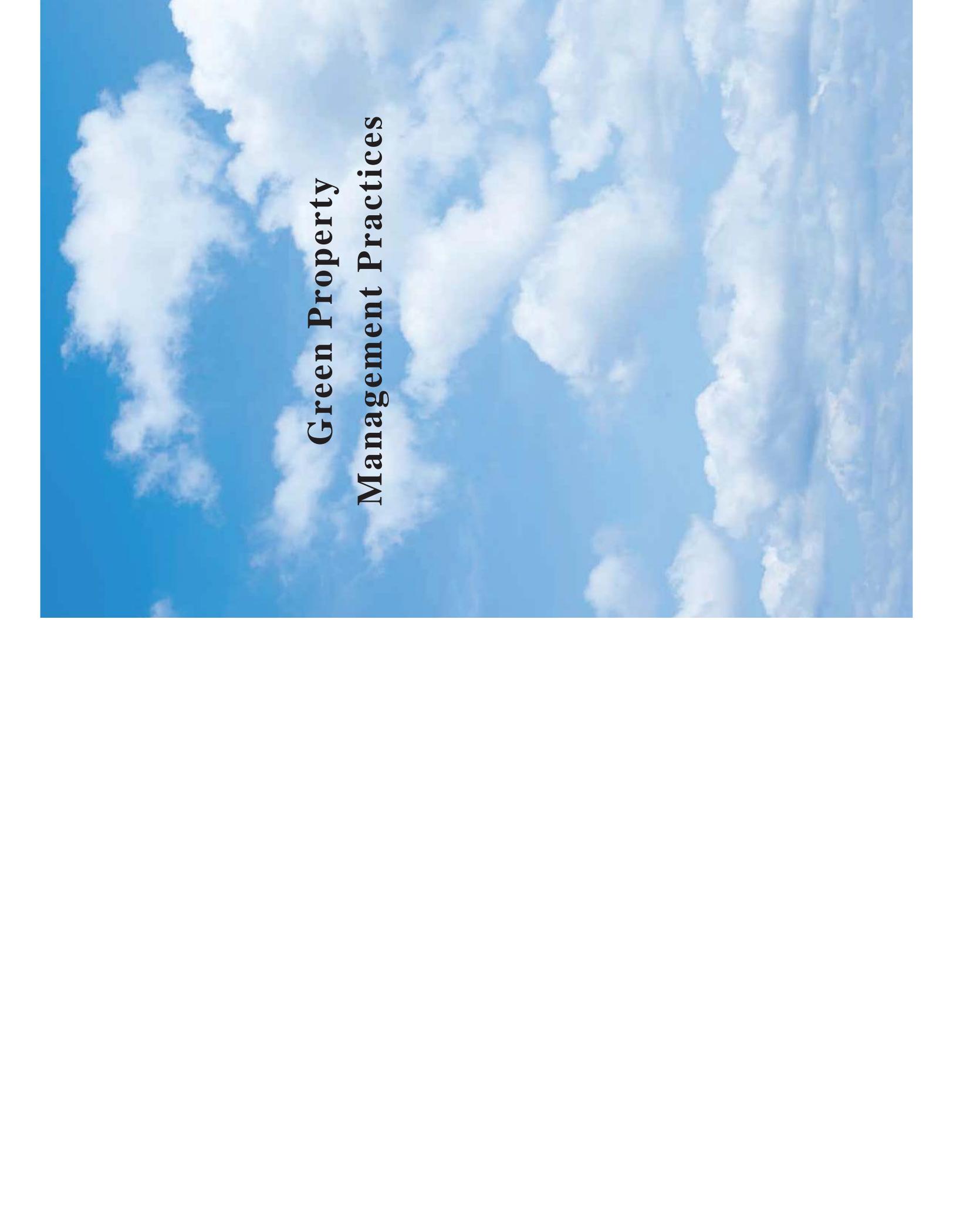




THE HONG KONG INSTITUTE OF
SURVEYORS

香港測量師學會

**GREEN PROPERTY
MANAGEMENT PRACTICES**



Green Property Management Practices

FOREWORD

Over the last decades, with the rapid development and expansion of human activities as a combination of population growth, technological advancement, resources utilization and waste disposals, our eco-system has been greatly affected. Hence, there is an imminent need for us to focus more efforts on the protection and rational utilization of natural resources to prevent further damage to the environment. Hong Kong is one of the most densely populated metropolises in the world. Its real estate sector, consisting of massive energy consumers, has a crucial and pivotal role to contribute to evolving Hong Kong into a greener and a more sustainable built-up environment.

Maintaining a sustainable living environment is always the mission of professional surveyors. As a reputable and responsible component of The Hong Kong Institute of Surveyors (HKIS), the Property and Facility Management Division has taken the lead to develop the industry with commitments and intelligent sustainable solutions. Moreover, it is our social responsibility to educate and help develop the community towards a greener and eco-friendly one for our future generations.

Hence, our Division has, with the joined endeavours and kind contributions of renowned scholars and experienced practitioners, compiled and published this Green Property Management Practices to provide professional property and facility managers and practitioners as well as those involved in related businesses and activities with the best practices and latest development in green property management and operations.

I would like to take this opportunity to express my sincere thanks to Sr Charles C. K. HUNG for kindly convening the working committee and coordinating the overall writing process of all chapters for this Practices and of course my gratitude to Sr Oliver Y. K. CHAN for his great contributions in collating and editing the papers to compile this Green Property Management Practices.

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I truly realize that this Practices is by no means exhaustive and requires updating from time to time to cope with the advancement of the built assets and the expectation of the society. Moreover, further detailed studies and researches on the intricate relationships among the areas covered in this publication together with any emerging areas that may have to be included are also worth considering. All in all, we welcome any suggestions and comments on the areas covered when constructive feedback will be collected and incorporated into future editions.

Sr Dr. Edmond K.W. CHENG
Chairman
Property and Facility Management Division
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April 2015

PREFACE

The intent of the Green Property Management Practices is to promote public awareness on the importance and good practices of green management and operations, which should be adopted not only at the occupation stage of properties but also in the design and construction stages of the built assets. This publication also provides guidance for professional property and facility managers in delivering value-added management services to all users, aiming at maintaining a sustainable living environment.

This publication consists of eight chapters, which we believe has provided a comprehensive coverage of the major aspects related to the issues. Chapter 1 introduces the general concepts of green property management, from management systems, protection policies, and impact assessments to alignment of contractors and suppliers to the community at large. Chapters 2 to 6, being the main body of the publication, provide practical guides for professional property and facility managers and practitioners in managing the use of energy and water, indoor air quality, waste handling and landscaping waste. Chapter 7 outlines the legal requirements and obligations in environmental protection and control. Chapter 8, being the last section of the publication, highlights the emergent opportunities arising from technological advancements for those interested in sustainable management applications and environmental friendly designs.

All those who have taken part in collecting the information and the writing process for this publication are gratefully acknowledged as follows:

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I do hope that the readers will find the Green Property Management Practices useful and practical on their property and facilities management operations. In addition, more people will be encouraged to take drastic enough actions on environmental protection and green management so that we can make a difference to the Earth.

Sr Oliver Y.K. CHAN
Editor of Green Property Management Practices
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 April 2015

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1.1 Introduction

Hong Kong (HK) has a population of over seven million living in about 2.3 million domestic units within a small area of only 1,104 sq. km.¹ Due to the mountainous nature of these beautiful islands whereby human habitation is mainly scattered along the coastal area, no one would disagree that HK is a densely populated city (Figure 1.1).



Figure 1.1 View over Hong Kong

Human activities consume vast amounts of natural resources, such as water for drinking and cleansing, coal for generation of electricity, petroleum for transportation and timber for manufacturing of various end products including paper, furniture, building finishes, etc. HK as one of the busiest business centres on the Earth is no different in this respect. Uncontrolled extraction of these natural resources seriously endangers our ecosystem. Adding to these effects are our domestic activities, such as disposal of domestic waste, routine cleansing and maintenance activities, interior decoration and building renovation, all of which adversely affect the environment to some extent.

¹ Civil Engineering and Development Department <<http://www.ceadd.gov.hk/eng/about/organisation/int.htm>>

To provide a sustainable living environment to future generations, it is thus crucial to have an appropriate green strategy while occupying our properties. To provide guidance on green property management, the Property and Facility Management Division of the Hong Kong Institute of Surveyors introduces this Green Property Management Practices to professional property and facility managers as a reference. The Institute will not only confine its recommendations on green management at the occupation stage of properties, but also promote a green design concept that professional project managers and architects may make reference in designing their buildings.

1.2 Need for Green Property Management

Traditionally, property management companies used to provide services such as security, cleansing, maintenance and financial management of the day-to-day operation of properties. While awareness on sustainability has grown and gained popularity, professional property and facility managers are also required to provide value-added environmental management services, such as recycling, energy saving and waste reduction, to the property users.

Considering the limited resources circumscribed by the fixed annual management budget, most property managers will inevitably put more emphasis on the following activities, which cause the most detrimental effect to the environment:

- (a) Daily refuse or waste collection and disposal;
- (b) Routine cleansing and maintenance operations; and
- (c) Fit-outs, decoration and building renovation.

Refuse or waste, essentially those containing food remains or being dumped, generates unpleasant odours. Routine collections or disposal operations, particularly those transported by large refuse trucks or conveyed through vertical refuse chutes, may generate irritating noise and vibration. Dried waste as a result of product consumption, such as paper, cardboard, tin cans, plastic bottles and electronic waste, can easily be recycled but, if they are left unattended and mixed with damped waste, will eventually increase the burden of landfill.

Routine cleansing and maintenance operations inevitably use chemicals, such as cleaning agents, wax, paints and thinner, which may emit irritating odours and occasionally be flammable. These chemicals, particularly those in oil-based solvents, contain volatile organic compounds (VOCs), which may cause hazardous effect to the air quality. Uncontrolled release of chemical waste to our coastal waters may also cause damage to marine life. Besides, operation of cleansing and maintenance equipment, like vacuum cleaners, grinders, pumps, power drills, exhaust fans and mechanical tools, generates dust, noise and vibration causing nuisance to our daily life and leisure. Building facilities, such as lifts, escalators, mechanical ventilation and air-conditioning systems, and emergency generators, if lacking proper servicing and maintenance, will also generate noise and vibration, which are detrimental to the living environment, not to mention the extra energy and fuel to compensate their deficient performance.

It is a common practice in HK that homebuyers will carry out interior fit-outs and decoration of their premises before occupation. Such activities will, to varying extents, require removal of finishes or fixtures provided by developers. Similarly, building renovation, in connection with building dilapidation, will customarily require stripping off existing finishes such as paints, rendering, tiles or waterproofing materials. Both activities will give rise to vast amounts of construction waste and, if not properly recycled, will also add to the account of landfill. Furthermore, these activities generate other forms of pollution, such as dust, noise, odours, volatile fumes and VOCs, which may cause nuisance and health hazards.

Therefore, environmental management systems should be adopted by property management companies to enable the aforementioned activities to be controlled within a sustainable limit.

1.3 Environmental Management System

A stringent environmental management system assists an organizational in achieving the objective of controlling all essential environmental aspects and impacts in connection with its daily and routine activities, products and services, through planned operational and documentary control,

towards continual improvement of its environmental performance targets. For instance, the ISO (International Organization for Standardization) 14001 Environmental Management System (EMS), applicable to the property and facility management services, has been widely adopted by organizations in HK. In fact, the effectiveness of an EMS relies predominantly on the formulation of a full set of coherent documents, including an EMS manual, operation procedures and works instructions as references by different levels of internal users, and containing varying levels of details.

1.3.1 Environmental protection policy

Top management commitment is the key success factor of an EMS. Commitment on one hand can be demonstrated by the additional resources provided to different internal departments as well as varying levels of staff:

- (a) Engagement of management consultants to conduct assessment of potential environmental aspects and impacts arising from the routine property management activities, and to derive a practical environmental plan and targets to control and measure subsequent performance;
- (b) Engagement of management consultants to formulate a full set of EMS control documents;
- (c) Assignment of senior managerial staff with sufficient supporting human resources to look after the daily operation of the EMS and to report regularly to a designated internal management review committee chaired by a senior director. The committee shall meet frequently to review the performance of the environmental plan and any preset targets;
- (d) Assignment of an internal audit team to conduct periodic audits and reviews on the environmental performance and effectiveness of the EMS;
- (e) Engagement of an external accreditation and audit body to scrutinise the EMS independently and regularly; and

- (f) Provision of training to all staff on implementation of the EMS and other environmental management issues.

Commitment on the other hand requires a coherent management policy providing guiding principles for all employees as a reference. According to ISO14001:2004 Section 4.2, the written environmental policy requires:

“Top management shall define the organization’s environmental policy and ensure that, within the defined scope of its environmental management system, it

- (a) is appropriate to the nature, scale and environmental impacts of its activities, products and services;
- (b) includes a commitment to continual improvement and prevention of pollution;
- (c) includes a commitment to comply with applicable legal requirements and with other requirements to which the organization subscribes which relate to its environmental aspects;
- (d) provides the framework for setting and reviewing environmental objectives and targets;
- (e) is documented, implemented and maintained;
- (f) is communicated to all persons working for or on behalf of the organization; and
- (g) is available to the public.”

An organization implementing ISO14001 EMS shall formulate its own environmental management policy, which tallies with the ISO14001 requirements and are applicable to its daily activities. The senior managerial staff, who is assigned to look after the EMS, shall monitor and control the organizational activities to comply with policy requirements.

1.3.2 Environmental aspect and impact assessment

As a continuous effort following the initial assessment by the appointed consultant, property managers shall formulate and implement the subsequent procedure to identify the ever varying environmental aspects that may possibly arise from an organization's activities, products and services. Further assessment shall also be carried out to ascertain the extent of any significant impacts of the organization's activities, products and services on the environment. Such assessment shall at the same time identify any legal requirements which will be related to the environmental aspects, and how these requirements can be fully complied with. Thereafter, proper operating and working procedures shall be established to guide all employees on controlling the effect of these environmental aspects and impacts.

An environmental impact assessment undertaken by a property management organization usually takes the following steps:

- (a) Review and identify all routine operational activities which generate environmental impacts. These activities may include energy consumption, waste disposal, material procurement, sewage discharge, noise production, storage of chemicals, etc.;
- (b) Conduct field inspections and investigations of various properties to evaluate the possible environmental effects that may arise from these activities;
- (c) Review all relevant documents and records including legislative requirements in connection with these activities;
- (d) Hold discussions with affected staff; and
- (e) Formulate an environmental aspects record summary, which codifies a list of environmental aspects and the likely environmental impacts, classifications, importance ratings and essential control measures, to minimize the impact of these aspects.

1.3.3 Environmental objectives, targets and programme

To enable an organization to control environmental aspects effectively and for continuous improvement, property managers should formulate environmental objectives and targets in connection with various activities, products and services of the organization. The objectives and targets shall be practically measurable and consistent with the environmental policy. Taking into account all legal requirements, property managers should conduct regular monitoring and evaluation to ascertain whether organizational objectives and targets are achieved by means of a planned programme of actions within a reasonable time frame. Adequate resources should be committed by the top management to implement the programme of actions through delegation of responsibility to respective staff within the organization.

Typical environmental targets are:

- (a) amount of solid waste recycled within a specific period of time;
- (b) amount of energy saved within a specific period of time;
- (c) amount of paper utilized within a specific period of time; and
- (d) indoor air quality (IAQ) improved, such as amount of carbon dioxide (CO₂) reduced, within a specific period of time.

1.4 Education and Awareness Building

Implementation of an EMS shall not merely be an internal procedure of an organization; otherwise the awareness of green property management will only be confined to its staff unilaterally. To enable sustainable and continuous success of green property management community-wide, property managers shall also devise a mechanism to influence other stakeholders within as well as outside its business environment. These common stakeholders are:

- (a) contractors and suppliers of the organization;
- (b) customers of the organization, including building owners, occupiers and visitors; and
- (c) the community.

1.4.1 Contractors and suppliers

Raising the green awareness of contractors and suppliers may be the easiest way among all three groups of stakeholders.

Before inclusion of contractors or suppliers onto a tenderer list, a pre-qualification exercise should be conducted to evaluate their competence and past environmental performance. Accreditation of ISO14001 certification may be one of the selection criteria, and an achievement of a green award is to be given an extra rating.

During the subsequent tendering exercise, a set of green practice procedures should be added to the tender specification so that tenderers are aware of making allowance of any special environmental requirements. Examples of these requirements are the utilization of low-VOC or non-VOC products, the provision of health and safety tools and equipment for their staff on handling chemicals, and the opening of an account with the Environmental Protection Department (EPD) for the Construction Waste Charging Scheme.

During the contract period, staff of the contractors or suppliers should be nominated to attend in-house environmental awareness training of the organization. A practice guide and on-the-job demonstrations should be provided to their on-site staff so as to familiarize themselves with the daily operations. Whenever there is any emergency evacuation drill conducted in a property, such as a fire drill, their staff should also be deployed to participate in the rehearsal to enhance their emergency preparedness.

1.4.2 Customers of the organization

For property managers, there are a number of ways, broadly categorized as direct involvement and indirect participation, to convey the environmental protection message to customers.

Direct involvement aims to recruit suitable and enthusiastic customers sparing their own leisure time and willingness to promote environmental protection awareness and to organize green events. Appointing green ambassadors and organizing green design competitions are the two common methods. Green ambassadors assist property managers as leaders of green events, such as visits, seminars, recycling programmes, hiking and planting days, whereas winners of green design competitions, through their own green design concepts, help property managers promote the importance of environmental protection and promulgate recycling and waste reduction.

Indirect participation aims to attract those less interested customers with limited leisure time to participate occasionally in the environmental activities organized by property managers or green ambassadors. To arouse customers' interest, property managers can make use of ad hoc environmental seminars, workshops, exhibitions and green competitions, like competing in recycling quantity among different blocks of an estate. Property managers may also construct permanent green corners within a designated space of an estate or a building to make available updated environmental information, such as record photos of visits, competition and leisure activities or information provided regularly by the EPD, to customers. If there are surplus planters, property managers may designate the planters as a plant nursery so that customers especially children may be trained to grow their own plants in this area. All these arrangements aim to build up neighbouring relationship and sense of belonging to residents, especially children who will be educated with a green and environmental care culture.

1.4.3 Community

Communication of the green message to the community at large appears to be the most difficult and ineffective task relative to the other two groups of stakeholders. Although property managers sometimes face an outcome the effectiveness of which is very difficult to measure, such effort cannot be saved and must form part of an effective environmental programme.

Green programmes may be in the form of paying periodic visits to schools, colleges, elderly homes or youth centres in the vicinity, and through face-to-face discussions and workshops, to promote the concept of green property management especially to the children and youth in the area.

Property managers may also prepare in advance handy promotion leaflets, video clips and newsletters for distribution during external visits and for internal training workshops. Besides, property managers may construct a green corner in its corporate or estate website so as to sustain continual awareness of green management among the community.

1.5 Publicity and Achievements

Gaining public recognition accelerates the momentum of occupiers to become more actively involved in green management issues. In addition, it provides an incentive to the on-site property management staff to dedicate significant effort to enable the green activities to be a success. Ultimately, by taking this opportunity, the reputation and image of the property management organizations will also be well established through having good corporate green responsibility.

Raising publicity and achieving public recognition is by no means an easy task and basically may take two forms; namely (a) a self-assessment of environmental performance and an achievement of certification by competent external organizations, and (b) initiation of environmental improvements and subsequent participation of open competitions and achievements of renowned green awards.

Well-known green certifications for property management organizations in HK include:

- (a) ISO 14001 EMS Accreditation;
- (b) Building Environment Assessment Method (BEAM Plus) of Hong Kong Green Building Council Accredited Scheme;
- (c) IAQ Certification Scheme of the EPD;
- (d) Quality Water Recognition Scheme for Building of the Water Supplies Department (WSD);
- (e) Gold Wastewise Logo of the EPD;

- (f) Energy Efficiency Registration Scheme for Building of Electrical and Mechanical Services Department (EMSD); and
- (g) Source Separation Programme of the EPD.

Other open certifications closely related to quality, environmental, safety and hygiene management are:

- (a) ISO 9001 Quality Management System Accreditation;
- (b) OHSAS 18001 Occupational Health and Safety Management System Accreditation;
- (c) Occupational Safety Charter of Occupational Safety and Health Council; and
- (d) Workplace Hygiene Charter of Occupational Safety and Health Council.

Examples of green award competitions in HK are:

- (a) Green Building Award of the Professional Green Building Council;
- (b) Best Landscape Award of the Leisure and Cultural Services Department;
- (c) Hong Kong Awards for Environmental Excellence of Environmental Campaign Committee;
- (d) Hong Kong Awards for Industries – Environmental Performance of the Business Environment Council;
- (e) Best Landscaping LPMit Features Award of Geotechnical Engineering Office;
- (f) A&D Trophy Awards of Perspective Ltd.;
- (g) RFP Outstanding Office Space Awards Asia of RFP Magazine;
- (h) MIPIM Asia Awards of MIPIMASIA; and
- (i) FuturArc Green Leadership Award of FuturArc Journal.

1.6 Conclusion

The success and effectiveness of implementing green and sustainable property management must start from the design of building with green and energy-efficient facilities, followed with a documented and systematic environmental management during the operation and maintenance stage. Owners and occupiers should be educated with green culture and

encouraged to participate in the environmental programmes while occupying and using the buildings and facilities. An achievement of public recognition of the effort and dedication of a property manager will definitely provide an accelerated momentum for moving forward on green management.

2.1 Imminent Need to Promote Energy Efficiency

Global warming is a major driver to reduce energy consumption. Developed countries including the US and European nations have committed to reduce their carbon emission to mitigate the rate of global warming. For example, as the country with the fifth highest GHG generation per capita in 2010,² Australia is committed to reduce 25% and 80% of its GHG emission compared with 2000 levels by 2020 and 2050 respectively.³ Various measures, such as promoting use of renewable energy, improving energy efficiency and encouraging greening, will be adopted.

In HK, due to lack of land and resources to develop renewable energy, the government focuses on reducing electricity consumption in buildings, which accounts for 90% of local energy consumption. Under the HK3030 Campaign, it has been proposed to reduce 30% of the electricity consumption of buildings by 2030 as compared to 2005 level.

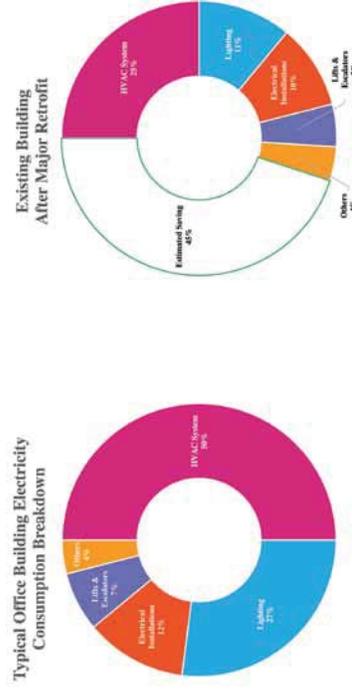


Figure 2.1 Typical Office Building Electricity Consumption Breakdown and Potential Saving

² World Resources Institute, *List of Countries Ranked by Greenhouse-Gas Emissions Per Capita in 2010*

³ Department of Climate Change and Energy Efficiency of Australian Government, *Australia's Emissions Reduction Targets*

By adopting energy efficient technologies, property managers can achieve significant saving in building energy and hence reduce operating costs as illustrated in Figure 2.1⁴ above. Energy saving measures on major building installations are introduced in the following sections.

2.2 Preparatory Work

Before implementing energy saving measures, registered energy assessors should be employed to conduct an energy audit and a carbon audit for the building. In 2012, the Building Energy Efficiency Ordinance (BEEO) was enacted requiring owners of commercial buildings to carry out an energy audit on the four key types of central building services installation, namely air-conditioning installation, lighting installation, electrical installation, and lift and escalator installation, in accordance with the Code of Practice for Building Energy Audit every 10 years.⁵ Besides, carbon audits should be conducted in accordance with the Carbon Audit Guidelines issued by the EPD and EMSD (Figure 2.2).⁶



Figure 2.2 Code of Practice for Building Energy Audit (Left) and Guidelines on Carbon Audit (Right)

⁴ The Hong Kong Green Building Council, “HK3030” A Vision for A Low Carbon Sustainable Built Environment in Hong Kong by 2030

⁵ EMSD, Code of Practice for Building Energy Audit (2012)

⁶ EPD & EMSD, Guidelines to Account for and Report on Greenhouse Gas Emissions and Removals for Buildings (Commercial, Residential or Institutional Purposes) in Hong Kong (2010)

2.2.1 Energy audit

An energy audit assesses the performance of a building to ensure that the energy consuming equipment or systems are being used efficiently. For existing buildings, the BEEO has enacted a schedule for carrying out energy audits as shown in Table 2.1.⁷

Table 2.1 Schedule of First Energy Audit for Existing Building Required by the BEEO

Date of Issue of Occupation Approval in Respect of the Building	Period within which the First Energy Audit must be Carried Out
On or after 1 January 1988	12 months from 21 September 2012
After 31 December 1977 but before 1 January 1988	24 months from 21 September 2012
After 31 December 1969 but before 1 January 1978	36 months from 21 September 2012
On or before 31 December 1969	48 months from 21 September 2012

Firstly, the scope of the energy audit is defined and an audit team is established to prepare a timetable and a budget for the exercise. After collecting the building information, the audit team will conduct site inspections and measurements. Lastly, the audit team will analyse the data collected, identify energy management opportunities (EMOs), establish the payback period of different EMOs, and recommend improvement actions and measures.

According to Code of Practice for Building Energy Audit, the EMOs are classified into three categories based on their cost and complexity for implementation:

Category I

Housekeeping measures with no cost investment and without any disruption to building operations, such as switching off lighting or air-conditioners when not in use and adjusting chillers operating set-points in different load conditions.

⁷ HK SAR Law, Cap 610, Building Energy Efficiency Ordinance

Category II

Changes in operational measures with low cost investment and minor disruption to building operations, such as replacing traditional T8 fluorescent tubes with T5 fluorescent tubes or light-emitting diodes (LED) lighting.

Category III

Improvements with relatively high cost investment and much disruption to building operations, such as replacing chillers, adding variable speed drives, and installing power factor correction equipment.

2.2.2 Carbon audit

A carbon audit, sometimes referred to as a “carbon footprint”, measures and records the amount of GHGs emitted in a building. The major source of GHG emissions in HK is electricity generation. Therefore, by analysing the GHG emissions in a building, we can find strategic means to reduce electricity consumption.

According to the Carbon Audit Guidelines, the CO₂ emissions in 2008 are derived as follows:

- (a) 0.54kg and 0.84kg for every kWh consumption purchased from China Light and Power Company and Hong Kong Electric Company respectively;
- (b) 0.424kg for every m³ of fresh water consumption due to electricity used for fresh water processing by the WSD;
- (c) 0.172kg for every m³ of fresh water consumption due to electricity used for sewage water processing by the Drainage Services Department; and
- (d) 0.593kg for every unit of town gas purchased from Hong Kong and China Gas Company.

When preparing a carbon audit report, it is necessary to ascertain the scope of work on physical boundaries and operational boundaries of the report based on the condition of the building concerned as well as to determine the reporting period, usually one year for the accounting cycle. Then the data and information should be collected and analysed based on the GHG performance among the three scopes below in accordance to the Carbon Audit Guidelines.

Scope 1 – Direct Emissions and Removals

Direct GHG emissions from sources, such as generators, stoves and, leakage from refrigeration systems, and GHG removal from new planting of trees.

Scope 2 – Energy Indirect Emissions

Indirect GHG emissions from the generation of purchased electricity and town gas.

Scope 3 – Other Indirect Emissions

Indirect GHG emissions other than those under Scope 2, such as electricity used for fresh water or sewage processing by utility companies.

2.2.3 Planning for energy efficiency

To develop an effective energy saving plan, property managers should observe the following:

- (a) Design an energy saving plan and preventive maintenance plan according to the audit findings;
- (b) Document the obtained information properly;
- (c) Conduct periodic reviews on collected data;
- (d) Study the consumption profile and operational efficiency;
- (e) Compare and analyse the results year to year;
- (f) Benchmark against other buildings using the EMSD Online Energy Consumption Indicators;⁸ and
- (g) Outperformer to do better, underperformer to improve.

⁸ HK SAR EMSD, *Energy Consumption Indicators and Benchmarks for Residential, Commercial and Transport Sectors*, <<http://ecib.emsd.gov.hk/te/index.htm>>

2.3 Energy Saving in Building Operations

In modern buildings, electrical and mechanical (E&M) installations, such as air conditioning, lighting, lifts and escalators, and electrical equipment and appliances, attribute the vast majority of energy consumption of building operations. Consequently, we should focus on the energy saving measures applicable to E&M installations.

In October 1998, the EMSD began promoting the application of the Building Energy Code (BEC) and issued four sets of Code of Practices for Lighting, Air Conditioning, Electrical, and Lift and Escalator Installations, which stipulate the minimum energy performance standards of these installations. In April 2003, the EMSD launched the fifth code, the performance-based BEC, which focuses on the total energy consumption in a building as compared to its energy budget.

Under the BEC 2012, the EMSD consolidated and issued the latest Code of Practice for Energy Efficiency of Building Services Installation to further tighten the requirements for building energy performance (Figure 2.3 below). The BEEO also mandates all buildings completed on or after 21 September 2012 and any major retrofitting works covering an internal floor area not less than 500m² to comply with the design standards stipulated in the latest BEC.

According to the BEEO and BEC, effective energy saving measures for E&M installations in new buildings and in existing buildings can be identified, and are elaborated in the subsequent sections.

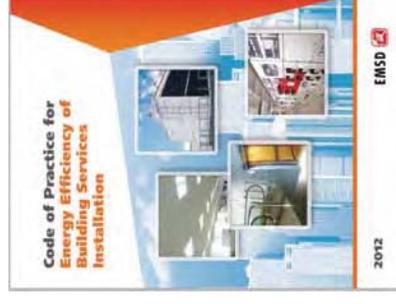


Figure 2.3 Code of Practice for Energy Efficiency of Building Services Installation

2.3.1 Lighting installations

Lighting installations account for around 27% of the total energy consumption in buildings. The BEC stipulates the following energy saving measures:

- (a) Avoid over-illumination. The Chartered Institution of Building Services Engineers (CIBSE) has established a set of guidelines on the recommended illuminance level in lux at different areas in buildings with different purposes of use, for example, 500 lux for general offices and 300 lux for general offices incorporated with task lighting.⁹
- (b) Use high efficiency lighting, such as LED and T5 fluorescent lighting with electronic ballasts, which have lower electricity consumption with the same luminance output and better heat dissipation resulting in less air conditioning loading. In addition, LED lighting requires little maintenance and its life expectancy is comparatively longer. The aforesaid lighting may be used for the general lighting at offices and car-parks, exterior decorative lighting, exit sign boards at exit routes, and the like;

⁹ CIBSE, The Society of Light and Lighting (SLL) (2012), *The SLL Code for Lighting*

- (c) Use time or photocell switches to control the operating time of lighting, especially exterior lighting;
- (d) Use motion detectors to control the lighting at locations where lighting usage is infrequent, such as back corridors and lift lobbies (Figure 2.4);



Figure 2.4 Motion Sensor

- (e) Adopt natural light by operating the lighting controls to switch off the lighting fixtures near external glass panes or at light wells during daytime;
- (f) Switch off any lighting when not in use; and
- (g) Use compact fluorescent lighting under the Mandatory Energy Efficiency Labelling Scheme (MEELS) in accordance with the Energy Efficiency (Labelling of Products) Ordinance, Cap. 598 (Figure 2.5).¹⁰



Figure 2.5 Code of Practice on Energy Labelling of Products

¹⁰ HKSAR EMSD, *Code of Practice on Energy Labelling of Product* (October 2014)

2.3.2 Heating, ventilation and air conditioning installations

A typical office building consumes around 50% of energy on its heating, ventilation and air conditioning (HVAC) system. To reduce energy consumption by HVAC installations, the following measures, as suggested in the BEC, should be adopted:

- (a) Use water cooled chillers, if feasible, for centralized air conditioning systems. The efficiency of a water cooled chiller (coefficient of performance of about 5.7) is much higher than that of an air cooled chiller (coefficient of performance of about 3.0) (Figures 2.6 and 2.7). In other words, the power consumption of water cooled chillers to yield the same cooling loading will be less;



Figure 2.6 Water-cooled Chiller



Figure 2.7 Cooling Tower

- (b) Use variable refrigerant volume (VRV) systems for localized air conditioning systems in compact areas (Figure 2.8). A VRV system is very flexible in operation with different usage patterns,

especially for part load conditions. Precise level control can react to the exact condition in each room. Individual control promotes an economical and efficient system, and minimizes the electricity consumption;



Figure 2.8 VRV System¹¹

(c) Use heat pumps for centralized hot water systems or temperature regulated swimming pools. The electricity consumption of a heat pump is much lower than that of an electrical boiler when providing the same heat load capacity (Figure 2.9). The by-product of a heat pump, i.e. cold water, can be used in the chilled water system of a chiller system to enhance the heat exchange efficiency;



Figure 2.9 Heat Pump¹²

(d) Clean filters, fans and coils periodically to optimize the efficiency of the equipment;

¹¹ DAIKIN < http://www.daikin.com.hk/ic/products/VRV_X_system_list.php>
¹² CCCME < <http://www.cccme.org.cn/products/detail-4919685.aspx#>>

(e) Adjust the cooling setpoint temperature at thermostats or building management systems (BMSs) to ensure spaces are not overcooled avoiding excessive energy consumption (Figure 2.10 and Table 2.2);

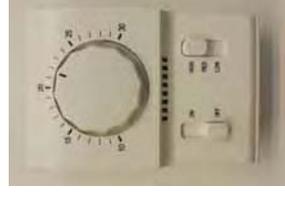


Figure 2.10 Thermostat Control

Table 2.2 Recommended Comfort Criteria from CIBSE¹³

Building Type	Recommended Summer Operative Temperature Range
Office	22-24°C
Retail	21-25°C
Hotel	21-23°C
Restaurant	24-25°C

(f) Switch off air conditioning units when not in use; and
 (g) Use room air conditioners certified under the EMSD's MEELS.

2.3.3 Electrical appliances

Electrical appliances generally consume around 12% the energy consumption in a building. To reduce energy consumption by electrical appliances, the following measures, as given in the BEC, should be adopted:

¹³ CIBSE, Guide A: *Environmental Design (2006)*

- (a) Switch off appliances or equipment when not in use;
- (b) Ensure load balance among three phases by monitoring at the main switch board or measuring by portable power analysers (Figure 2.11);



Figure 2.11 Portable Power Analysers

- (c) Install harmonic filters to enhance the power quality;
- (d) Install capacitor banks to achieve a better power factor to enhance the efficiency (Figure 2.12);



Figure 2.12 Capacitor Bank

- (e) Use soft starting mechanism, such as variable speed drives for motors, to avoid large starting current; and

- (f) Use electrical appliances with Grade 1 energy labels under the EMSD's MEELS.

2.3.4 Lift and escalator services

The power consumption of lift and escalator services constitutes about 7% of building energy use. To reduce the consumption, the following energy saving measures, as suggested in the BEC, should be implemented:

- (a) Use variable voltage variable frequency drives or direct current motors for the drive system of lifts and escalators to avoid large starting current;
- (b) Apply a modified counter-weight system to reduce the unnecessary weights to yield the balance between a lift car and its counter-weight;
- (c) Use an electric drive with a re-generator to transform the kinetic energy to electricity when a lift car is moving. The electricity generated could be fed into the building electricity distribution system;
- (d) To save travelling time and energy consumption for lift cars to reach the top floors, adjust some of the lift cars to park at mid-levels of a building after a certain idle time at off-peak hours;
- (e) Use motion detectors to switch off ventilation fans and portions of lighting after a lift has idled for a specific duration;
- (f) Use motion detectors to start and stop an escalator depending on whether there is any people riding on it and it has been idle for a specific duration; and
- (g) Switch off some of the lifts and escalators during off-peak hours.

2.4 Conclusion

To achieve effective energy saving, an energy audit and a carbon audit should be conducted to analyse the current consumption and to identify the target areas for improvement. Based on the findings, property managers should establish an energy saving plan, implement it, review the implementation, and benchmark the performance of the building against the best performers periodically. These exercises should be carried out day by day and year on year in order to yield significant energy savings.

To implement an energy saving plan smoothly and to achieve excellence, the concept, needs and benefits of energy saving should be relayed to both landlords and tenants. All participants should be well informed to deliver the best results.

There are limitations in implementing energy saving programmes in buildings without energy saving design features. In these cases, property managers may need to spend money to enhance the system design to achieve significant energy savings. On occasions, the payback period may be deemed too long and the landlord may not be willing to undertake the enhancement. Therefore, it is preferable to incorporate energy efficient designs during the construction period. In fact, this practice is becoming more common due to the tightening of regulations and the adoption of certification processes such as BEAM Plus (Figure 2.13).



Figure 2.13 HKGBC Beam Plus Existing Buildings (v.1.2)

A new version of BEAM Plus for Existing Buildings (Version 1.2) was introduced in January 2013.¹⁴ This provides an effective evaluation of the performance of buildings and services system design to help reduce the energy consumption of existing buildings.

¹⁴ Hong Kong Green Building Council, *BEAM Plus for Existing Buildings (Version 1.2)*(2012)

3.1 Introduction

Water management is often overlooked due to its readiness and reliability. However, the energy consumption associated with water treatment and water heating is notable. In fact, the WSD is one of the largest electricity users in HK. Furthermore, rainfall in HK is insufficient to meet the demand and thus HK relies heavily on water imported from the Dongjiang River in neighbouring Guangdong Province (Figures 3.1 and 3.2). The WSD anticipates further growth in water demand if we maintain our consumption pattern. Therefore, an effective water conservation programme is important and will demonstrate our corporate social and environmental responsibility whilst saving money.

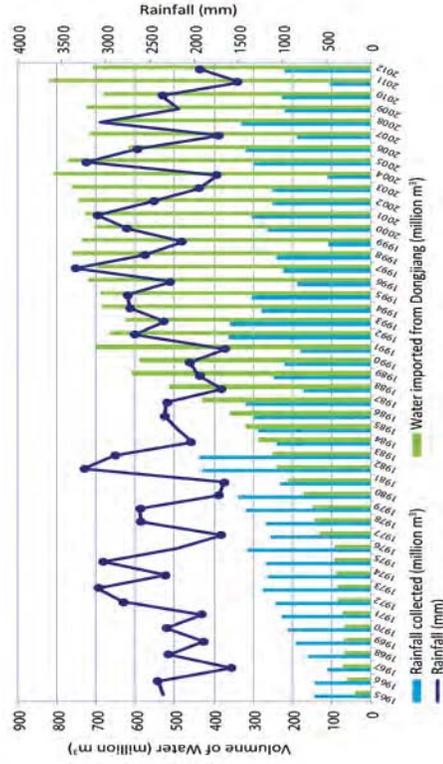


Figure 3.1 HK Annual Rainfall and Amount of Water Collected¹⁵

¹⁵ Su Liu (July 2013), "One Country, Two Systems", *Hong Kong's Water Resources Management*

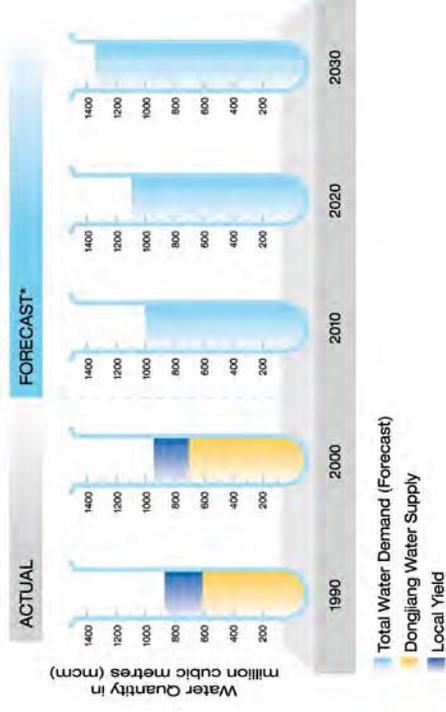


Figure 3.2 WSD Forecast on Water Demand¹⁶

3.2

Water Management Principles

Developing a water management plan is a logical, step-by-step process, involving more than just conducting a cost-benefit analysis and preparing a report. To be successful, a water management plan should not only consider the technical side, such as installing efficient plumbing fixtures, but also the human side, such as changing users' long-standing operating procedures and water using habits. Property managers also need to look at managing water use so that they comply with the laws, make cost-effective decisions, document their savings and observe the following principles according to the water management hierarchy in Figure 3.3:

- (a) Avoid leakage;
- (b) Reduce the amount of water used by equipment or processes, e.g. using ultra low-flow toilets and automatic shut-off faucets;

¹⁶ Water Supplies Department (2008), *Total Water Management*

- (c) Reuse water for other uses, e.g. storing drain-off water due to water tank cleaning for future use; and
- (d) Recycle water for other uses after treatment, e.g. grey water recycling.

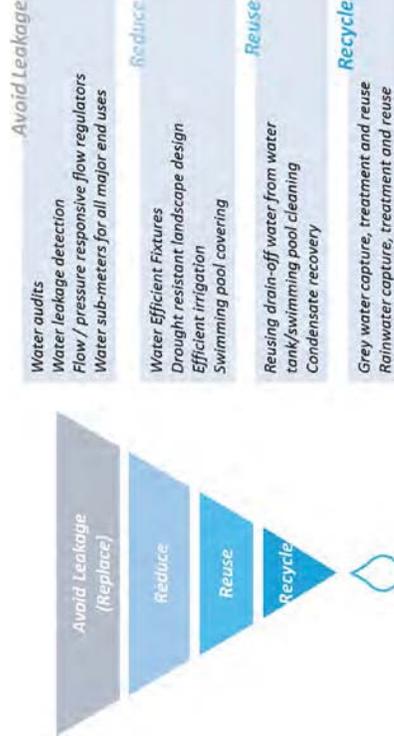


Figure 3.3 Water Management Hierarchy

Water use does not exist in a vacuum. Conserving water within a building also affects other building systems. Typical examples are:

- (a) reduction in hot water usage reduces energy use;
- (b) reducing air conditioning use, through energy conservation, trims the water use associated with cooling;
- (c) water conservation reduces wastewater flows; and
- (d) reduction in water use and waste water reduces the volume of waste water going to waste water treatment plants.

3.3 Water Management Planning

Although developing a water management plan may be time-consuming for property managers, it enhances their understanding of where and how much water is used throughout the facility, where best to implement conservation efforts, and what benefits can be expected from implementation of the management actions. The goals should be

expressed in terms of percentage or volume of water saved, including dates for when the goals will be achieved. Figure 3.4 illustrates a roadmap for the water management planning process:



Figure 3.4 Water Management Planning

3.3.1 Purpose and scope of water audits

A water audit provides a better understanding on how the water is consumed and facilitates identification of water management opportunities for property managers. There is no standard for water audit currently. However, BEAM Plus v1.2 for Existing Buildings Water Use 5 provides a general requirement on producing a water audit, namely:

“The report shall include water consumption records, operation and maintenance records, etc. for all areas of water use, but may exclude water consumption by tenants. The report shall include a spreadsheet listing each water-using fixture and end use data, such as:

- *Frequency of floor cleaning and water volume per use;*
- *Frequency of garden irrigation and water volume per use;*
- *Frequency, duration and water volume per use of each fixture in kitchens and laundry; and*
- *Frequency of male and female daily uses of the water-using fixture, duration per use, and water volume per use.”*

3.3.2 Water data collection

Before starting the water use survey, collect all the existing information. This will save time during the survey. The personnel who are familiar with the daily operations can be very helpful. The information to be collected includes:

- (a) building floor plans and a list of water meters;
- (b) water and sewer bills for the last three years, if available;
- (c) sub-meter consumption data for three years, if available. Irrigation and cleansing water are normally individually metered;
- (d) facility operating, maintenance and janitorial work schedules, and facility occupants and visitors schedules;
- (e) lists of all water using equipment with manufacturers' recommended or specified flow rates, whichever available;
- (f) a complete inventory of plumbing fixtures with details of water efficiency labelling;

- (g) any prior water and energy survey results; and
- (h) submission details of the WSD's Quality Water Recognition Scheme for Buildings, if applicable.

Sample water data collection forms are included in Appendix.

3.3.3 Water audit process

The extent of a water audit will depend upon the size of the building, the complexity of its systems, and the audit budget. The following steps should be performed while recording the information:

- (a) Compare and identify the water consumption of last 36 months through water bills records to observe the water usage pattern and trend;
- (b) Walk through the facility, and through direct observation, identify and list any water-using fixtures including water-using process equipment, cooling towers, boilers, ice machines, etc.;
- (c) Determine and log the amount of water used by each type of plumbing fixture or device within the facility. If the flow rate of fixture is not readily available, a bucket can be used to collect water for a defined time period, e.g. 60 seconds. By measuring the volume of water collected and dividing by the time for collection, the flow rate can be calculated as follows:

$$\text{Fixture Flow Rate (L/s)} = \frac{\text{Volume of Water (L)}}{\text{Time (s)}}$$

- (d) Install temporary water meters to gauge water usage by large water-using equipment, e.g. cooling tower, wherever possible. Check whether its water consumption rate is higher than rated unnecessarily;
- (e) Record operating hours for each water consuming activity such as irrigation;

- (f) Verify operating schedules and the number of building occupants during different periods in the day;
- (g) Determine daily facility consumption rates from water meter and submeter readings and other sources; and
- (h) Note any issues that have an impact on water consumption. Leaking faucets/valves and outdated fixtures are examples of observation that should be recorded.

3.3.4 Water balance estimation

After completing the audit, the water uses should be grouped by category as follows:

- (a) Domestic plumbing (restroom consumption such as toilets, urinals, showers and faucets);
- (b) Heating and cooling (evaporative cooler and/or cooling tower make-up, boiler blow-down, etc.);
- (c) Kitchen plumbing (ice machines, food preparation, dishwashers, etc.);
- (d) Process water (process cooling, rinsing operations, chemical dilution, etc.);
- (e) Water features (pools, spas, fountains, etc.);
- (f) Landscape irrigation; and
- (g) Cleansing.

Grouping the water uses of a facility will generate an estimated water balance, which will provide an estimate of the total amount of water that the facility consumes on a daily and annual basis (see Figure 3.5 below). It will also be useful to separate the data for different periods in a year to analyse the seasonal change in water uses.



Figure 3.5 Example Water Balance Diagram

3.4 Water Management Opportunities

After a water audit, property managers will be able to identify which area uses the largest amount of water. This information should facilitate the determination of the most suitable water management opportunities (WMOs).

A plan should be developed to outline the feasibility of each WMO by presenting simple cost/benefit analyses and projected payback periods where applicable. The plan should include actions that are no-cost or low-cost, actions that require capital expenditure, and actions that require changes in water use procedures by facility personnel. Current or proposed water/wastewater rates should be used when determining the costs and benefits of the actions. Initial cost should not be the only consideration but also the consequential saving in reduced water cost over time. Computing the payback period¹⁷ will be useful for preliminary evaluation.

Property managers can choose from a wide variety of water management options. The hierarchy in Figure 3.3 above shows different options with the most effective measures on the top. Some options simply involve altering the water use of building occupants while others may involve changing the hardware or way fixtures and equipment are operated and maintained.

¹⁷
$$\text{Payback Period (Year)} = \frac{\text{Initial set-up cost (\$)}}{\text{Annual saving in operation (\$)}}$$

3.4.1 Avoiding leakage

Avoiding wastage due to leakage is one of the most cost-effective measures with a prominent outcome. Without proper metering and monitoring, losses due to leakage can attribute to 10% to 30% building water use.¹⁸

(a) Water audits

Leakage can be determined from the difference between the meter value and actual consumption assessed in a water audit.

(b) Water leakage detection

Leaks should be identified and repaired as quickly as possible. The following actions can be performed to improve the detection of leakage:

- Perform visual and audio inspection in the facility regularly.
- Take note of any unexpected water sounds and wet floors;
- Install a leakage detection system and connect it to the BMS;
- Monitor the meter reading during the shut off of water-consuming equipment to observe any significant difference; and
- Educate building users to report any leaks immediately to reduce the amount of water lost due to leakage.



(c) Submetering for all major end uses

Effective submetering improves the accountability for water usage and facilitates the development of management plan and associated monitoring.

LEED v2.2 requires installing separate metering for indoor water risers, process water use and outdoor irrigation systems. Property managers can further install sub-meters to measure and collect water usage consumption information for major water uses. Australia's building rating system, Green Star, requires the following water uses, if applicable, to be metered:

- Bathrooms;
- Showers;
- Evaporative heat rejection systems;
- Irrigation systems;
- Wash-down systems;
- Recycled water supply; and
- Rainwater supply.

¹⁸ U.S. EPA (Oct 2013), *WaterSense at Work – Best Management Practices for Commercial and Institutional Facilities*

- (d) Flow / pressure responsive flow regulators

Valves can be installed in distribution systems to reduce the pressure in plumbing and thus decrease the risk of pipe leakage. When adopting this approach, special care should be taken to ensure sufficient water pressure is provided at outlets.

3.4.2 Reducing water usage

Eliminating unnecessary demand in water use would be the next step which property managers should consider. These measures will usually result in long-term and recurring savings over the lifetime of the building.

- (a) Water efficient fixtures

Plumbing fixtures constitute a large proportion of building water use. With the use of water efficient fittings, consumption can be significantly reduced. The water efficiency labelling scheme (WELS) provides useful guidance in selection of the most efficient fittings.



Image Copyright: HKSAR Water Supplies Department

In addition to water flow rates, the operation mode of fixtures should be considered before procurement. Water closets with dual-flush model are highly recommended. Installing a toilet with '6L/3L' dual flush is a common option that guarantees saving (Figure 3.6).



Figure 3.6 Toilet with dual-flush buttons¹⁹

To further reduce water consumption on flushing, waterless urinals can be adopted. They are designed to ensure that no odour will be emitted from the urinals while requiring no water for flushing. However, proper cleaning and maintenance for waterless urinal is crucial to maintain performance. Property managers should consult manufacturers for their requirements.

Table 3.1 Maximum Flow Rate for Water Fixtures

	BEAM Plus v1.2	LEED v2009
Water closets	6.7 L/flush	4.8 L/flush
Urinals	4.1 L/flush	3 L/flush
Bathroom faucets	7.4 L/min	Residential 6.6 L/min Commercial 1.5 L/min
Kitchen faucets	7.4 L/min	6.6 L/min
Showers	8.5 L/min	7.5 L/min

¹⁹ Armitage Shanks <<http://www.armitage-shanks.co.uk/images/gallery/1.jpg>>

Most green building labelling schemes demands the use of efficient water devices. For example, BEAM Plus v1.2 requires 10% saving from predefined benchmark while LEED v2009 requires 20% saving. Table 3.1 above identifies the recommended water fixture flow rates to meet the minimum level of water saving requirements in different schemes.



(b)

Drought resistant landscape design

By selecting native, low-water-use plants and reducing turf areas, water use on landscape can be minimised. Examples of local drought tolerant plant species are:²¹



Schefflera hetaphylla (鵝掌柴)



Sansevieria species (虎尾蘭類)



Polyscias species (假沙梨類)



Rhapis excelsa (棕竹)

Image copyright: Hong Kong Herbarium

To minimise water use, property managers should adopt the following measures in landscape design:

- Group plants with similar water needs together;
- Serve high-traffic pedestrian paths with landscape plants instead of turf;
- Aerate or amend soil regularly to improve its water-absorbing and retaining capacity;
- Cover soil with mulches to avoid direct sunshine; and
- Remove weeds that will compete for water and nutrients.

²⁰ U.S. EPA (2012), *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities*

²¹ Steering Committee on Greening, Landscape and Tree Management (2014) <http://www.greening.gov.hk/en/planting_knowledge/species_for_planting.html>

(c) Efficient irrigation

Irrigation systems should be incorporated with timers and/or moisture sensors so that the irrigation process will only be operated when necessary to reduce amount of water needed.

Drip irrigation should be used instead of sprinklers. Drip irrigation facilitates deep watering and can be adjusted to meet the needs of different kinds of plants (Figure 3.7).



Figure 3.7 Drip Irrigation²²

To minimise water usage, property managers should implement the following efficient irrigation practices:

- Adjust irrigation schedule monthly according to climate condition;
- Water at night or before sunrise, which is the most ideal period for plants to fully absorb water; and
- If water runoff is a problem, irrigate at a higher frequency but with less water.

²² Top Arch Green House < <http://tagreenhouse.com/irrigation-system-2/> >



(d) Swimming pool covering

Evaporation is one of the major sources of water loss for outdoor swimming pools. Covering swimming pools with blankets during closing hours can avoid contact of pool water with open air and thus reduce loss due to evaporation.

3.4.3 Reusing water

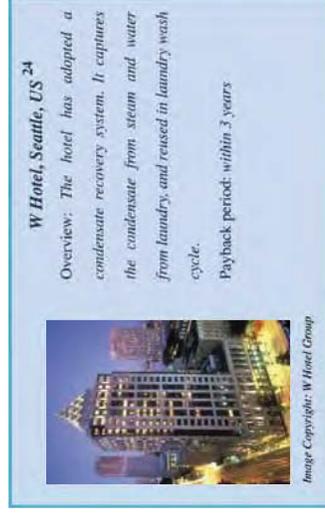
Property managers should consider reusing water for more cycles before discharging into the sewage system. This strategy can be implemented in process activities such as:

- (a) Reusing water drain-off from water tanks or swimming pools
- Instead of directly discharging the water generated from the cleaning of water tanks or swimming pools into sewage, such water can be collected for future use in irrigation or cleansing.

²³ U.S. EPA (2012), *WaterSense at Work: Best Management Practices for Commercial and Institutional Facilities*

(b) Condensate recovery

Although air-conditioning condensate is non-potable, it can be utilised in other processes such as subsurface irrigation or cleansing.



(b) Rainwater capture, treatment and use

Rainwater harvest systems can be used to reduce reliance on potable water. The treated water can be used for flushing, irrigation or laundry.

3.5 Formulation of Water Management Plan

Once specific WMOs have been selected, prioritise them in a way that can maximize water, energy, and financial savings while improving occupant comfort. At the same time, communication with building users and their participation are necessary during planning. After consultation, a comprehensive work plan and schedule should be developed.

With reference to BEAM Plus EB, a water management plan should at least include the following items:

- How the plan is communicated to building users and staff at all levels;
- Monitoring arrangement for plan and water consumption;
- Water saving measures undertaken, in progress and to be implemented; and
- Quantifying the planned saving.

Clear and specific targets must be set to assess the effectiveness of implementation. BEAM Plus provides guidance in setting targets.

3.4.4 Recycling water

Recycling water measures generally require a higher initial cost as it requires retrofitting the entire building system. Nevertheless, if further reduction in water use is desired, the following measures can be considered:

- Grey water capture, treatment and reuse
 - Grey water collected from basins and showers can be used for flushing, irrigation or laundry after treatment.

²⁴ Enwave Seattle (2014) <<http://www.enwaveseattle.com/case-study-cost-and-water-savings.htm>>

Table 3.2 summarises the requirements of BEAM Plus EB on water use. For more details, please refer to the reference guide issued by the BEAM Society.

Table 3.2 BEAM Plus EB v1.2 Requirements on Water Use

Target	Credit	Description
Reduction in potable water use	WUp2, WU1	- >10% saving compared to benchmark cases - Only consider water taps and shower heads water usage
Avoid leakage	WU2	- Mechanism for monitoring water leakage at fresh water distribution systems
Efficient irrigation	WU3	- Use of different technology and good landscape planning to reduce >50% irrigation by potable water
Water recycling	WU4	- Adoption of rainwater harvesting and/or greywater recycling that results in >5% reduction in potable water use
Reduction of sewage discharge	WU6	- >20% reduction compared to benchmark cases - Only consider discharge from water closet flush systems

3.6 Implementation and Monitoring

After developing the water management plan, property managers will proceed with the execution. However, it does not end at this stage. Water management requires continuous monitoring and revision to guarantee smooth operation. Therefore, property managers should perform the following actions:

- Regularly collect feedback from building users and adjust the plan accordingly;
- Carefully monitor the progress to ensure targets can be achieved; and
- Constantly review the plan and revise the targets.

3.7 Employee Participation

Employee participation is one of the critical successful factors for effective water management. The following sections will suggest how to secure employees' trust and involvement.

3.7.1 Dedicated management team

With the support of management, employee participation should begin with the formation of a team committed to carrying out the investigation and implementation of the water management plan. The water management team may consist of the following members (Figure 3.8):

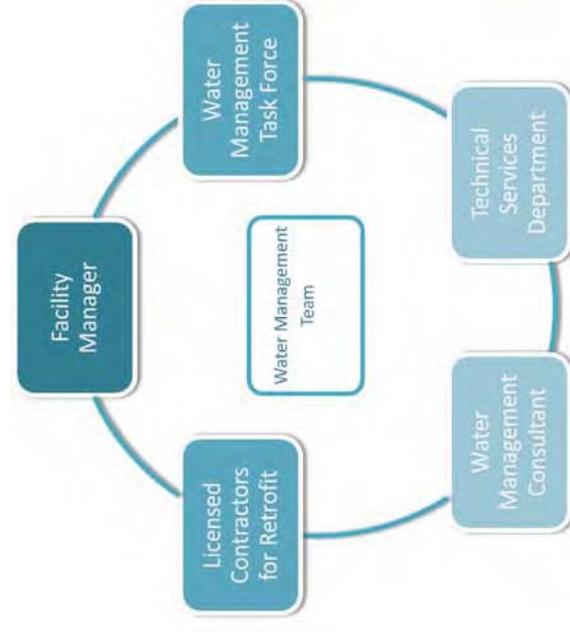


Figure 3.8 Water Management Team Composition

3.7.2 Facility-wide participation

The effectiveness of water management may be reduced if employees and building users do not actively participate in it. To promote the developed plan and increase the audiences' environmental awareness, property managers should adopt the approach outlined below in Figure 3.9:

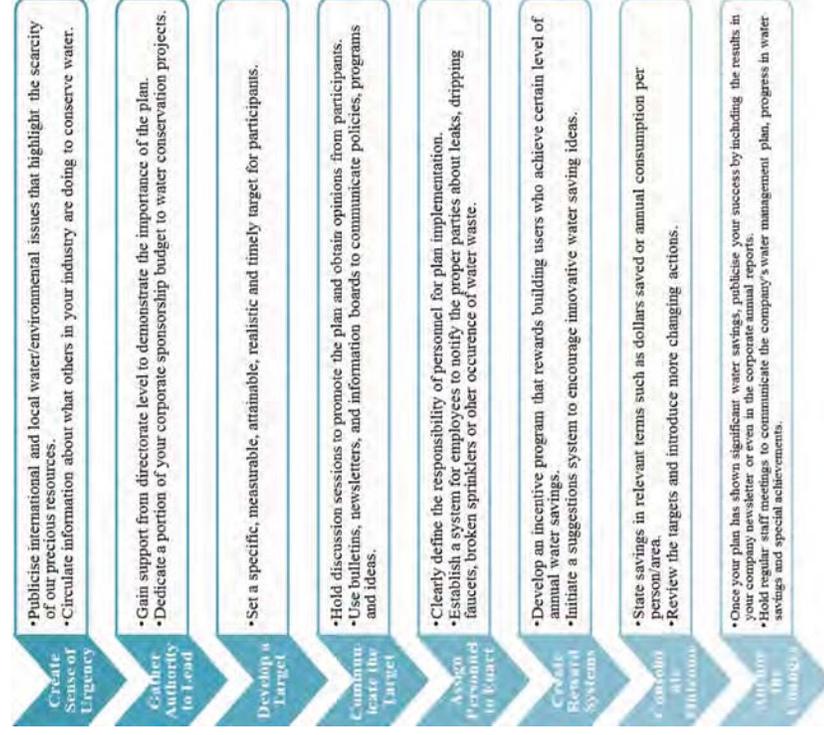


Figure 3.9 Water Management Education Process

3.7.3 Employee education

To attain the desired outcome from the water management plan, buy-in from building users is indispensable. A change in users' water-using habit is one of the most effective and cost-efficient WMOs. Through educational programmes and activities, property managers can convince others to undergo a behavioural change in water consumption. The following concepts should be promoted:

- Save when you shower – reduce shower length
- Most conventional showers use 10-20 litres of water per minute. By reducing the time spent in the shower, the water use is vastly reduced.
- Save water in kitchen
- Wait to use dishwashers until there is a full load. Fill the sink to wash vegetables instead of letting the water run constantly. Fill a pitcher with drinking water and store it in the refrigerator, thus eliminating the wasteful practice of running the tap while waiting for water to cool.
- Recycle or reuse water

Use water from cooking to water potted plants. For example, rinsing rice grains, boiling vegetables and steaming dumplings would leave plenty of nutrients in the water. Watering with reused water can reduce the need of adding artificial fertilizer and potable water consumption.

3.8 Conclusion

Water management planning shares similar procedures as energy saving management as mentioned in Chapter 2. Data collection is always the first step in planning. Both information on own facility and other similar buildings have to be gathered to perform analysis and comparison. Carrying out a water audit allows property managers to understand the

usage of water more thoroughly. It is highly recommended to undertake water audits regularly to keep updated on the current situation.

After collecting the required details, property managers should select the water-saving actions for the facility accordingly. The measures mentioned previously are only a few of the many possible WMOs that can be implemented. For more details and other choices, managers may consult professional property and facility managers and/or water management consultants and/or qualified contractors. The WSD website and BEAM Plus for Existing Building v1.2 also provide guidance on water management practice.

Implementation of plans and active involvement of building users must go hand-in-hand in order to obtain the best result. There are different ways to encourage participation but communication should be the first priority for users to understand its purpose. The ultimate goal of water management is to create a behavioural change in water users with assistance from water-saving equipment.

4.1 Introduction

Indoor Air Quality (IAQ) is defined by the World Health Organization as “the physical and chemical nature of indoor air, as delivered to the breathing zone of building occupants, which produces a complete state of mental, physical and social well-being of the occupants, and not merely the absence of disease or infirmity.” Property Managers should concentrate efforts on IAQ as outdoor air quality is dealt with globally and locally.

4.2 Importance of IAQ

On average, people spend most of their time indoors. Good IAQ safeguards their health, contributes to their comfort and well-being, and improves workplace productivity.

On the contrary, poor IAQ may lead to discomfort and ill health, higher absenteeism with sick leave and lower work performance, and increased staff turnover and complaints or company liability (Figure 4.1). Research has been performed in a smart building in Europe and indicated that improving IAQ by increasing ventilation rate can improve work performance by around 1-3%.

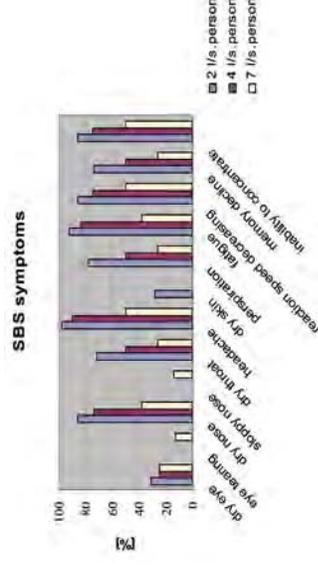


Figure 4.1 Occurrence of Sick Building Syndrome (SBS) Symptoms at Different Ventilation Rates²⁵

²⁵ Sentkova & Badida (2012), “Perceived Indoor Discomfort, Performance and Productivity”, *Journal of Civil Engineering and Architecture*

4.3 Common Factors Affecting IAQ

From a management point of view, the main factors affecting the IAQ of the built environment include air pollution due to renovation activities, chemical emissions from building materials, emissions from office equipment, infiltration of outside pollutants, body effluents and occupants activities, ventilation practices and rates, and building maintenance and cleaning habits.

IAQ is affected by physical factors and sources of contamination. Physical factors, including temperature, relative humidity and air movement, establish the thermal acceptability. Common sources of indoor air contaminants are:

- (a) high CO₂ concentration due to high occupancy;
- (b) VOC emissions from painting and decoration activities;
- (c) VOC emissions from consumer products, such as pesticide and cleaning agents;
- (d) formaldehyde emissions from pressed wood furniture;
- (e) biological contaminants from mould growth on damp surfaces and dirty air ducts;
- (f) dust and particulates from internal processes and ambient sources, such as renovation processes;
- (g) radon emissions from building materials;
- (h) combustion products, such as carbon monoxide and oxides of nitrogen from vehicle exhaust; and
- (i) ozone generated from office equipment with UV sources.

4.4 IAQ Certification Scheme

The HK Government introduced a voluntary IAQ Certification Scheme for Offices and Public Places in 2003 to improve IAQ and promote the public awareness of its importance. The scheme aims to recognize good IAQ management practice and to provide incentives for building owners to pursue the best level of IAQ. With effect from 1 February 2008, all IAQ assessments should be conducted by the Hong Kong Inspection Body Accreditation Scheme (HKIAS) accredited Certificate Issuing Body (CIB).

An owner can choose to certify an entire building or certain parts/floors of a building. Typical IAQ certified locations are mainly in private office buildings, club houses, public areas of residential buildings, and government offices. Certification has recently been popular in shopping centres, banks, retail shops and hotels.

There are two levels of IAQ objectives to suit the needs of different premises/buildings:

- (a) Excellent Class represents the highest level of IAQ that a high specification and comfortable building should have; and
- (b) Good Class represents IAQ which provides protection to the public at large including the young and the aged.

4.4.1 IAQ parameters

As shown in Table 4.1 below,²⁶ a total of 12 IAQ parameters, including three physical parameters, eight chemical parameters and one biological parameter, should be measured.

Table 4.1 IAQ Objectives for Offices and Public Places

Parameters	Units	8 Hour Average	
		Good	Excellent
Room Temperature	°C	< 25.5	20 – 25.5
Relative Humidity	%	< 70	40 - 70
Air Movement	m/s	0.3	< 0.2
Carbon Dioxide	ppm	< 1000	< 800
Carbon Monoxide	µg/m ³	< 10,000	< 2,000
Respirable Suspended Particulate	µg/m ³	< 180	< 20
Nitrogen Dioxide	µg/m ³	< 150	< 40
Ozone	µg/m ³	< 120	< 50
Formaldehyde	µg/m ³	< 100	< 30
Total Volatile Organic Compounds	µg/m ³	< 600	< 200
Radon	Bq/m ³	< 200	< 150
Airborne Bacteria	Cfu/m ³	< 1,000	< 500

²⁶ HKSAR Indoor Air Quality Management Group (2003), *A Guide on Indoor Air Quality Certification Scheme for Offices and Public Places*

Physical parameters include room temperature, relative humidity and air movement. In Excellent Class, the temperature is between 20 to 25.5°C, the relative humidity is between 40 to 70%, and the air movement is below 0.2m/s.

Chemical parameters include CO₂, carbon monoxide, nitrogen dioxide, respirable suspended particulates, ozone, formaldehyde, total VOCs and radon. CO₂ is produced via human metabolism and used as an indication of ventilation adequacy. Carbon monoxide or nitrogen dioxide is produced from incomplete combustion mostly from vehicular exhaust. Respirable suspended particulates of various sizes are produced from mechanical processes. Ozone is mainly produced from office equipment using high energy UV sources. Formaldehyde is a common component in synthetic materials, such as pressed boards, glues and resins in furniture. Total VOCs are commonly emitted from painting and adhesives. Radon is an odourless and colourless gas formed during the breakdown of radium and mostly found in granite materials.

Biological parameter is airborne bacteria mainly from contaminated mechanical ventilation air conditioning (MVAC) systems.

4.4.2 Sampling consideration and compliance requirements

Choose the location for an IAQ assessment, which may be a whole building or specific areas of a building such as a lift lobby, an individual floor and a tenant's unit.

Determine the area involved and number of sampling points required according to Table 4.2 below.

Other associated sampling points should also be incorporated. These include the ambient sample normally at least one sample measured at fresh air intake, the control sample being 10% of the total field samples, and the duplicate sample at 10% of the total field samples.

Table 4.2 Minimum Number of Sampling Points Required for IAQ Assessment

Total Floor Area to be Certified (m ²)	Minimum No. of Sampling Points
< 3,000	1 per 500 m ²
3,000 - < 5,000	8
5,000 - < 10,000	12
10,000 - < 15,000	15
15,000 - < 20,000	18
20,000 - < 30,000	21
> = 30,000	1 per 1,200 m ²

Generally, the compliance requirements should be at least 80% of sample points of each parameter complying with the relevant IAQ objectives. For the chemical and biological parameters, no sample points should exceed 50% of the relevant IAQ objectives. In addition, for physical parameters, no sample points should exceed 10% of the relevant objectives or fall outside 10% of the upper or lower limit if a range is used.

4.4.3 IAQ assessment procedure

A six-step approach is commonly found in IAQ assessments as follows:

- (a) Collect background information of the subject building, such as building usage, nearby traffic conditions, floor layout plan, design and layout of MVAC system, normal work activities, occupancy density of the area and previous complaint records;
- (b) Conduct a walk-through inspection for basic parameters, for instance, temperature, relative humidity, CO₂, respirable suspended particulates, and total VOCs. The types of activities undertaken and condition of MVAC systems are to be assessed;
- (c) Select appropriate locations for sampling by identifying representative areas like the open office or office with high occupancy density. Convenience to tenants should be taken into consideration;

- (d) Prepare a checklist for initial IAQ preparation work on improvement if any. For example, fine tune the MVAC system according to the daily housekeeping and maintenance;
- (e) Conduct detailed IAQ assessments through an HKIAS CIB; and
- (f) Re-assess if remedial work is required. Process the report and certification.

Upon completion, the CIB will submit a duly completed report to the IAQ Information Centre. An IAQ certificate number will be granted with registration at web-site of the IAQ Centre (<http://www.iaq.gov.hk>).

In respect of certificate renewal, only CO₂ and respirable suspended particulates will be assessed for the second to fifth years in normal situation. For the fifth re-certification, the full list of IAQ parameters in Table 4.1 should be measured and certified to start another five-year cycle. The assessment process is detailed in A Guide on Indoor Air Quality Certification Scheme (Figure 4.2).



Figure 4.2 A Guide on Indoor Air Quality Certification Scheme

4.5 Air Quality Management in Carparks

Carbon monoxide and nitrogen oxide are the most relevant air pollutants inside car parks. Totally enclosed parking areas are usually situated underground and require mechanical ventilation to improve the air quality. Conventional ventilation systems include supply and exhaust fans, ducts, diffusers and carbon monoxide monitoring system. As ducting is usually required, relatively high ceiling height is needed. Otherwise, coring of small holes through the beams may be feasible subject to structural assessment.

4.5.1 Ductless direct axial jet fans

To address the problem of limited room height, a ductless ventilation system with direct axial jet fans and carbon monoxide monitoring system can be used (Figure 4.3). Both induction and direct air transfer are adopted in this system. This generates a large induced air flow rate with zone control available. Quantity control is feasible. The noise level is lower than that of a conventional system.



Figure 4.3 Ductless Direct Axial Jet Fans

According to the computer fluid dynamics assessment, the locations of jet fans can be determined to transport fresh air from supply points to all areas through jet fans and then to the extract outlet fans. In this system, no ducting is required.

This system reduces air flow resistance and the main fan can be designed with a smaller size, thus reducing its noise level, power consumption and the associated duct size.

Sensors for carbon monoxide are located uniformly and can activate the system on demand. This monitoring system is designed to deal with the pollution level by operating the fans when the carbon monoxide concentration is above the design parameter, thus saving energy over a traditional time clock system.

4.6 Air Quality Management in Offices

4.6.1 Use of high efficiency air filters

Variable-air-volume MVAC systems with reheat and humidity control functions are frequently provided in office buildings to introduce and disperse fresh air and to maintain comfort. In case traditional low efficiency wire mesh air filters are provided, it may be possible to replace them with high efficiency air filters to improve the air quality. This will increase the amount of particulates removed from the air supplied to the building, and hence improve the IAQ.

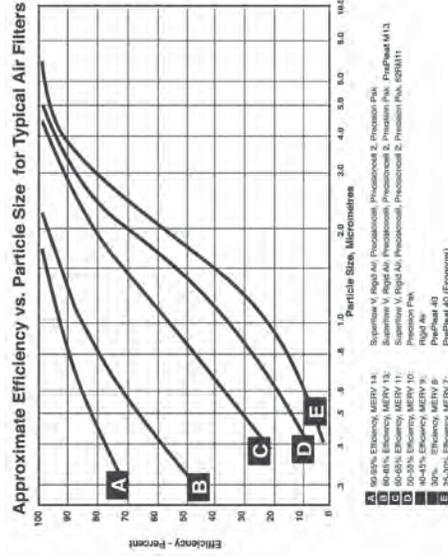


Figure 4.4 Different Minimum Efficiency Rating Value (MERV) against Particle Size Filtered²⁷

²⁷ Flanders, Filter Efficiency Guide
<http://www.flanderscorp.com/files/FlandersFFI_literature/PB3001_FilterEff.pdf>

When replacing existing filters with high efficiency units, the increase in fan pressure should be duly considered to ensure the replacement will not result in an excessive increase in fan power consumption (see Figure 4.4 above).

4.6.2 Regular maintenance of ventilation systems

To provide good IAQ, it is crucial to perform regular maintenance of MVAC systems as follows:

- Air distribution dampers are functioning properly and cleared of obstruction;
- Filters are installed and maintained properly;
- Drain pans are thoroughly cleaned, properly drained and without visible mould growth;
- Diffusers and exhaust outlets are separated properly to avoid short circuit;
- Regular cleaning and maintenance schedule are established and implemented;
- Mechanical rooms are clean and free of contaminants; and
- Exhaust fans operate properly.

4.6.3 Post-certification management

To ensure the IAQ being maintained at the certified level, post-certification management is required:

- Implement proper operation and maintenance of MVAC systems and ensure fresh air intakes are neither blocked nor in potential polluted locations, such as garage entries, exhaust vents and truck loading areas;
- Place computers and heat-generating equipment away from MVAC sensors to avoid inaccurate temperature control;
- Avoid potential pollutant sources:

- Handle renovation materials properly to minimize the induction of high level of particulates in the indoor environment;
 - Select formaldehyde free furnishings;
 - Isolate areas to be renovated from non-affected areas and MVAC systems and schedule the activities for evenings and weekends if possible;
 - Remove plastic wrappings from partitions, carpet rolls and other new materials before they are brought into the space. Expose them to dry, clean locations outside the building for a few days before installation, and
 - Select low-VOC products for housekeeping and pest control. Provide separate ventilation if necessary.
- (d) Set clear procedures for responding to IAQ-related complaints and keep proper records of reported cases and associated follow-ups. This will facilitate diagnosis of IAQ and delivery of effective solutions.

4.7 Air Quality Management in Residential Premises

4.7.1 Refuse chamber

In accordance with the Building (Refuse Storage and Material Recovery Chambers and Refuse Chutes) Regulations APP 35, it is required to provide mechanical ventilation capable of generating three air changes per hour of fresh air. However, this statutory requirement may not be sufficient to mitigate the odour in some refuse chambers.

Furthermore, it is a statutory requirement to provide air purification in refuse chambers. There are different methods recognised by the Buildings Department for purifying air:

- (a) Chemical air scrubbers can remove or neutralise acidic pollutants, such as sulphur dioxide, in the exhaust airstream (Figure 4.5). Air is forced through reacting chemicals, typically limestone, and acidic compounds will be filtered out. Different reacting agents may be selected to remove targeted pollutants.



Figure 4.5 Chemical Air Scrubber²⁸

- (b) Bio-oxygen generators consist of electrode tubes that produce electrons and create strongly magnetic oxygen clusters (Figure 4.6). Pollutants, bacteria and odours can be removed by reacting with the oxygen clusters. Some bio-oxygen generators are designed to fit within the mixing plenum to provide air purification for typical office buildings.



Figure 4.6 Bio-Oxygen Odour Control Unit²⁹

²⁸ Abatement Technologies <<http://www.abatement.com/restoration/restoration-port-air-scrub-pred1200.html>>

²⁹ Bio-Oxygen Australia Pty. Limited <<http://www.bio-oxygen.com.au>>

- (c) Photocatalytic-oxidation reactors utilise photocatalysts, usually Titanium Dioxide (TiO₂), to absorb radicals (Figure 4.7). VOCs are oxidized by the photocatalysts resulting in better IAQ. This type of reactors can be integrated into HVAC systems with the benefits of low power consumption, long service life and minimum maintenance. The technology will be further discussed in Chapter 8.

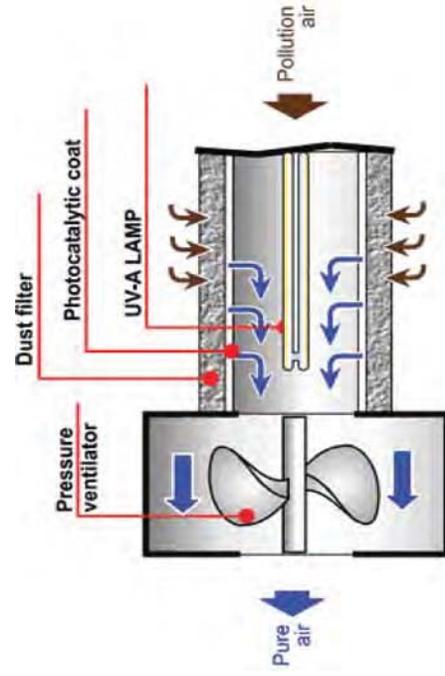


Figure 4.7 Photocatalytic Air Purifier³⁰

4.7.2 Indoor common area

Some buildings without a refuse chute inside refuse rooms may encounter severe odour problems in the course of refuse transportation, particularly bad odours remaining inside lifts. Active air purification inside the lifts may mitigate the odour problem.

4.8 Conclusion

IAQ management refers to the control of physical factors and common sources of indoor air pollutants from various activities. Physical factors, including temperature, relative humidity and air movement, form the thermal acceptability. Common sources of indoor air pollutants include concentration of CO₂; emission of VOCs, formaldehyde, radon and ozone from various sources; biological contaminants, dust and particulates; and combustion products such as carbon monoxide and oxides of nitrogen.

The voluntary IAQ Certification Scheme introduced by the HK Government helps building users know the quality of indoor air and encourages them to pursue the best level of IAQ. The scheme possesses two classes of objectives, namely, Excellent Class and Good Class. All IAQ assessments including twelve parameters have to be conducted by HKIAS accredited CIB. IAQ assessment procedure commences from the collection of information on the usage and operation of the ventilation system of the subject building. A walk-through inspection for basic parameters such as temperature, relative humidity, CO₂, respirable suspended particulates, and total VOCs is normally conducted. It is usual to carry out sampling selection and preparation work first and then to conduct a detailed IAQ assessment and process the report and certification.

In general, the compliance requirements should be at least 80% of sample points of each parameter complying with the relevant IAQ objectives. For the chemical and biological parameters, no sample points should exceed 50% of the relevant IAQ objectives. Moreover, for physical parameters, no sample points should exceed 10% of the relevant objectives or fall outside 10% of the upper or lower limit if a range is used. In respect of certificate renewal, only CO₂ and respirable suspended particulates will be assessed for the second to fifth years in normal situation. For the fifth re-certification, full list of IAQ parameters should be measured and certified to start another five-year cycle.

In short, the Chapter provides the keynotes of IAQ management to building users and stakeholders for pursuing the best level of IAQ. Where appropriate, additional specific information or advice on the planning and implementing an IAQ management programme should be sought from professional property and facility management surveyors or IAQ consultants.

³⁰ RUSNANO <<http://en.rusnano.com/press-centre/news/88561>>

5.1 Introduction

Every year, the generation rate of municipal solid waste in HK grows continuously from 0.97 kg per capita within thirty years. Compared with other neighbouring countries such as Taipei and South Korea, HK has relatively large household waste load (Figure 5.1). Currently, there are three major landfills to accommodate the waste disposed in HK but they will gradually reach their capacities by 2019 if the disposal rate remains unchanged. Before the government and the society come up with an effective solution to the overfilled problem, property managers should implement various measures to reduce waste generated from building operations.

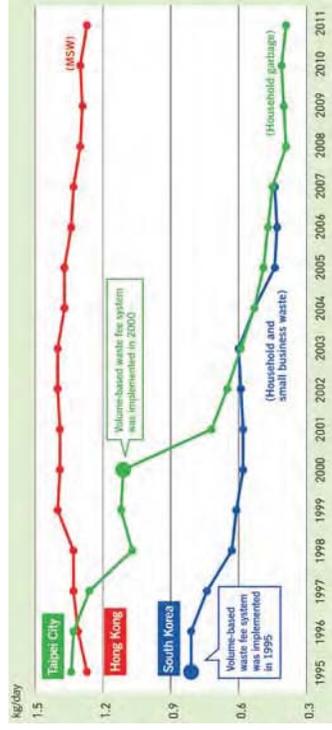


Figure 5.1 Waste Disposal Rates in Hong Kong, Taipei and South Korea³¹

5.2 Major Sources of Waste

There are a number of sources of waste generation in connection with routine property management activities. The majority of these activities not only generate waste but also cause other environmental problems such as pollution and nuisance. Property managers should pay particular attention to the common sources of waste as follows:

- Domestic or commercial trade waste generated by occupiers;
- Waste generated from routine operations and maintenance works; and
- Bulk solid waste generated from fit-outs, decoration or building renovation.

5.2.1 Domestic or commercial trade waste

Every property occupier will, to a large extent, produce either domestic or trade waste while performing their daily activities, such as living, dining, leisure, sale, manufacture, service provision or other similar operations. Especially when being moistened and mixed with food remains, the waste becomes part of the bulk refuse, which will be conveyed to the property's refuse collection station if not separated and recycled initially at source.

The mass volume of refuse, if left unattended, may give rise to the following issues:

- Generation of odours, waste water and possibly bacteria, and attracting insects and rats resulting in hygienic and environmental problems;
- Noise nuisance caused by machines, such as extraction systems and refuse trucks, while loading and unloading of refuse and possibly from vertical refuse chutes when conveying refuse throughout a building;
- Accumulation of large disposed articles, such as furniture, electrical appliances and pallet boards, which may give rise to blockage of buildings/estate roads and emergency vehicular access;
- Smoke generated by refuse trucks or other diesel engine cleaning equipment causing air pollution; and

³¹ HKSAR Environmental Bureau (2013), *Hong Kong Blueprint for Sustainable Use of Resources 2013-2022*

- (e) Chemical or medical refuse from irresponsible commercial occupiers resulting in hygienic problems and causing particular hazards to innocent cleansing workers who lack proper protection.

To minimize the adverse impact on environment, property managers should take the following measures:

- (a) Adopt an indoor refuse collection station arrangement. If the original design of the station is an open yard, a permanent roof with sufficient natural ventilation should be constructed;
- (b) Perform regular cleansing and disinfection of refuse collection stations, refuse bins, refuse chutes and other refuse conveying equipment and containers;
- (c) Install a proper extraction system to control refuse truck exhaust;
- (d) Discharge sewage and waste water produced from building operations to a proper foul water sewer in a sanitary manner;
- (e) Eliminate unnecessary and prolonged accumulation of refuse; and
- (f) Schedule noisy operations, e.g. refuse chute operations, to a less disturbing time and implement measures to reduce impact noise.

5.3 Waste from Routine Operations and Maintenance

It is a common practice for property managers to assign maintenance staff to perform minor repairs and maintenance to property on a regular basis. These jobs require using building materials, tools and equipment, hence, the need to store spare parts in the property. Repairs and maintenance activities may also require cutting and removal of existing finishes/fittings and generation of debris, which are all attributed to construction waste.

In addition, other routine operations, such as cleansing, pestisiding and grease trap clearance, add to the waste account and occasionally involve chemicals which require special treatment before disposal. Even building

management offices may generate waste, including paper, electronic waste, etc., and also require special attention.

To reduce waste generated from routine and maintenance activities, property managers should implement the following measures:

- (a) Minimise refurbishment of common areas and encourage building occupants to do likewise; and
- (b) Implement regular recycling programme for sorting and recycling of operational waste.

5.4 Waste from Fit-outs, Decoration and Renovation

Fit-outs, decoration and renovation generate lots of solid waste. Commencing in January 2006, the EPD implemented the Construction Waste Disposal Charging Scheme, which is also applicable to the property management sector. Contractors undertaking construction work with a value of \$1,000,000 or above are required to open a billing account with the EPD for that particular contract and have to pay disposal charges. For work valued under \$1,000,000, building owners, contractors or property management companies may also open a billing account for such purpose.

Major building work will also cause air, noise and possibly water pollution if not properly controlled and managed. Pollution to air, such as generation of dust, odours, volatile fumes and VOCs, is a common phenomenon. Noise may cause irritation and nuisance particularly to residential occupiers while surface water drains may be contaminated by construction wastewater.

Property managers should formulate effective measures to enhance the awareness of occupiers and to minimize the generation of waste from fit-outs, decoration and renovation:

- (a) Establish proper house rules and a fit-out guide, by making reference to Deed of Mutual Covenant and the EPD requirements, requiring occupiers or owners to notify the management office before such work is to be carried out. The rules and guide

should be posted at a prominent place of the building or estate, and/or on an intranet for occupants and owners to download;

- (b) Establish a proper registration system requiring all contractors to register with the management office their intended construction work. Formulate proper working procedures and require occupiers and contractors to dispose waste properly;
- (c) Charge a fit-out deposit so that, whenever any contractors breach the house rules or the fit-out guide, the deposit can be used as a tool to compel them to remedy unauthorized work or dumping of waste;
- (d) Identify and maintain a list of units or areas of which fit-out, decoration or renovation activities are being carried out so that security guards conduct frequent patrols to these locations, paying particular attention to possible pollution and accumulation of waste. Enhanced patrol and access control at entrances are also essential means to monitor fire safety;
- (e) Remind contractors of the Construction Waste Charging Scheme of the EPD and request for waste transaction records where applicable. Property managers should consider opening a billing account with the EPD directly and be reimbursed by occupiers and/or contractors for waste disposal charges;
- (f) Require contractors to obtain noise permits from the EPD before noisy works are carried out;
- (g) Require contractors to register as a chemical waste producer at the EPD and ensure chemicals are being collected and disposed by licensed collectors;
- (h) Report to the EPD on any offence such as unauthorized dumping of construction waste; and
- (i) Implement regularly green activities, such as exhibitions, workshops and training, for residents and occupiers to promote awareness on environmental protection.

To minimize nuisance and disturbance to occupiers, the following operating guides are useful when carrying out fit-outs, decoration or renovation:

- (a) Schedule noisy operations, such as cutting and drilling, to a less disturbing time;
- (b) Arrange a temporary retreat for occupiers;
- (c) Designate an area for temporary storage of construction waste;
- (d) Utilize rubber wheel trolleys for transporting materials and waste;
- (e) Close the main entrance door of individual unit under decoration all the time during the work period. In case windows are to be opened, ensure the exhausted air, probably containing dust and fumes, should not cause nuisance to neighbours during the work period;
- (f) Provide air purifiers in enclosed work areas to remove odours, dust, VOCs and the like;
- (g) Moisten and/or vacuum work areas regularly;
- (h) Install temporary dust screens and/or noise barrier screens to isolate dusty or noisy work areas; and
- (i) Provide temporary mechanical ventilation to remove dust and fumes, especially when painting work is being carried out in a confined or semi-confined space.

5.5 Control of VOCs

Many building materials we have in our homes, such as paints, carpets and adhesives, composite wood products and upholstery fabrics, release VOCs. Some other materials that may be handled by property managers in daily building operations, including cleaning and disinfecting chemicals, organic solvents, printing ink and petroleum products, also contain VOCs. VOCs

have a long lasting detrimental effect on the environment causing air pollution in terms of odours, hazardous fumes and smog, and attributing to the formation of ozone and fine particulates in the atmosphere. Smog would be particularly severe in stagnant weather condition, and may reduce our visibility, irritate our eyes, nose and throat, and worsen our respiratory system. It is particularly harmful to children and the elderly. Prolonged exposure to severe smog may cause permanent damage to lung tissue and increase the risk of cancer, liver damage, kidney damage and central nervous system damage.

The following are effective measures for preventing or minimizing VOC emissions:

- (a) Use zero-VOC or low-VOC products;
- (b) Use water-based paints, primers and sealers;
- (c) Use brushes or rollers instead of spray rigs to minimize utilization of solvents and thinners;
- (d) Use inorganic cleaning solvents;
- (e) Avoid using aerosol consumer products such as air fresheners and insecticides;
- (f) Procure products or materials with products/materials safety data sheets, which contain information on the potential hazards and how to work safely with the chemical products/materials;
- (g) Procure products or materials with minimum packaging as printing generates VOCs;
- (h) Use prefabricated products to avoid on-site cutting and painting; and
- (i) Adopt partial touch-up instead of comprehensive repainting, wherever appropriate.

In case procurement of VOC-containing products or materials and their storage in a building or estate are necessary, property managers should implement the following best practices:

- (a) Maintain proper records and stock levels of VOC-containing products or materials;
- (b) Store in airtight containers and in a cool place. The containers should be sealed tightly to avoid evaporation;
- (c) Stack properly to avoid accidental spillage and wastage as a result of container breakage;
- (d) Separate VOC-containing products or materials from other flammable items to reduce fire risk;
- (e) Provide training to staff who handle VOC-containing products or materials;
- (f) Provide natural ventilation or, if not possible, mechanical ventilation to storage spaces; and
- (g) Discard empty containers of VOC-containing products and materials as chemical waste.

5.6 Principle of Waste Management

To promote green management and a sustainable culture, all property management staff should observe a coherent waste management principle, i.e. 3-R Principle - “Reduce”, “Reuse” and “Recycle”, in every stage of waste production and management.

5.6.1 Reduction of waste

Reduction of waste starts from reduction of consumption and utilization. Property managers should exercise effective control on material/product consumption and utilization and avoid unnecessary cutting, wastage,

spillage, breakage or mechanical damage by vandalism. To arouse the awareness of occupiers about reduction of waste, property managers should also exhibit notices at prominent places to remind users to reduce the consumption of consumables, such as using less tissue paper in toilets and less plastic bags for shopping.

To reduce waste, property managers should adhere to the following guidelines:

- (a) Implement regular maintenance and servicing to building facilities and equipment to reduce wear and tear, improve their functional performance and efficiency, reduce the utilization of energy or fuels, and minimize the need for replacement of parts and components;
- (b) Replace components and parts only when they are beyond economical repair;
- (c) To minimize natural deterioration and obsolescence, keep spare parts and components in stock at a minimum while being able to maintain performance and operational reliability;
- (d) Make precise ordering to avoid over-sized/under-sized items and associated cuttings;
- (e) Procure facilities, machines and equipment with good energy performance, a long life expectancy, and zero/low chemical consumption;
- (f) Exercise proper storage, stacking, and protection of fragile components and parts to avoid accidental damage. Similar arrangement should be provided to storage of fuels, such as liquefied petroleum gas (LPG) and diesel, to avoid leakage/spillage. Proper records of inflow and outflow of the aforesaid goods should be maintained to avoid overstocking;

- (g) Minimize the usage of products containing VOCs, chemicals or other hazardous content, such as cleaning agents, and establish a proper control system in this regard; and
- (h) Adopt two-side copying, electronic filing and emailing to reduce paper consumption.

5.6.2 Re-utilization of waste

When consumption or utilization cannot be further reduced, property managers should consider the principle of reuse and implement the following measures:

- (a) Adopt demountable or removable design for building components, such as office partitions, paving blocks and ceiling access panels, so that future relocation and opening up can be proceeded without damaging the associated structure;
- (b) Pack and store properly building materials/chemicals, of which their packaging has been opened due to partial consumption but before contamination, for future reuse;
- (c) For air-conditioning systems, pack and store the refrigerant which has been temporarily removed for overhauling of chillers or for other purpose in tightly sealed containers to avoid contamination and leakage;
- (d) Request contractors to implement waste separation at source to enable reuse of inert construction waste, such as broken stones, tiles, concrete and bricks, arising from building renovation. The inert waste is useful for reclamation if these inert materials are separated from other biodegradable waste like timber; and
- (e) Reuse printed paper on the other side. Reuse paper folders repeatedly until they are damaged.

5.6.3 Recycling of waste

Recycling is also an effective method to reduce the burden on our already congested landfills. However, this approach should be adopted only as the last resort, i.e. after reduction and reuse of waste have been fully considered and practiced. Prior planning is a critical success factor to facilitate effective recycling of waste:

- (a) Encourage waste separation at source in domestic buildings by participation of the EPD programme. The EPD introduced a territory-wide waste recovery programme in January 2005 to facilitate waste separation at household level to increase the recovery of domestic waste. Property managers should obtain funds from building owners for provision of respective containers and arrange recycling contractors for such purpose;
- (b) Encourage waste separation at source on construction/renovation sites;
- (c) Implement and promote recycling of domestic or commercial trade waste from operations and maintenance activities, or those generated by contractors' activities. Items used to be recycled include but not limited to:
 - waste paper;
 - scrap metals;
 - wooden furniture and the like;
 - plastic bottles or bags;
 - printers, copiers or facsimile ink;
 - batteries;
 - electrical appliances; and
 - used clothes.
- (d) Encourage recycling in the community and formulate a proper procurement policy which facilitates the adoption of stationery, materials, facilities or other similar products made from recycled materials;

- (e) Recycle the remains or waste arising from routine maintenance operations, such as chemicals, lubricant and oil, to avoid contamination of sewers through unauthorized discharge. Recycling activities should be performed by contractors licensed by the EPD and proper records should be maintained;
- (f) Regularly inspect estate roads, carparks and the like for any leakage or unauthorized dumping of oil; and
- (g) Organize a secondary market for goods exchange between owners and occupiers.

6.1 Introduction

Over the past 50 years, the released volume of CO₂ and other greenhouse gases (GHGs) has increased rapidly. When the demand of energy increases, more fossil fuels are burnt. Consequently, the increase in GHGs emissions intensifies the natural greenhouse effect causing global warming. From 1906 to 2005, the average temperature of the Earth has risen by 0.74°C. In HK, the average temperature has been rising at a rate 0.22°C/decade since 1983 and is anticipated to increase by 4.8°C during the decade 2090 – 2099³² (Figure 6.1).

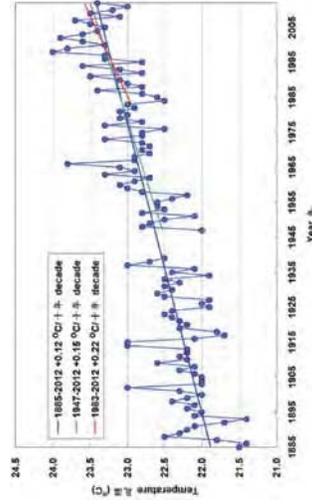


Figure 6.1 HK Annual Mean Temperature from 1885-2012³³

Besides global warming, the urban heat island (UHI) effect is one of the reasons why our city suffers a hotter environment than its surrounding rural areas. The core urban area of HK is a concrete jungle with a high density of buildings, paved surfaces and hard landscapes. All these elements absorb and store the sun's heat and hence the urban area is warmer than the countryside. At night, these elements continue to release the absorbed heat reducing the ability of the city to cool down.

³² HKSAR Environmental Protection Department, *Effects of Climate Change in HK*, <http://www.epd.gov.hk/epd/english/climate_change/local_effects.html>

³³ HKSAR Hong Kong Observatory, *Observed Climate Change in HK*, <http://www.hko.gov.hk/climate_obs_hk_temp_e.htm>

Research has shown that the average difference in temperature between the urban and rural areas in HK is around 7°C to 8°C in the winter and 5°C to 6°C in the summer.³⁴ The temperature difference is due to the widespread use of air-conditioners to maintain a comfortable internal environment, alongside the concrete jungle in the urban area. Air conditioners lower the temperature typically through a refrigeration cycle, but sometimes using evaporation or free cooling. In the cooling process, heat is absorbed from indoors and transferred outdoors. The rejected heat further increase the outdoor temperature, with the situation becoming worse as more air conditioners are turned on to combat the higher temperatures (Figure 6.2).

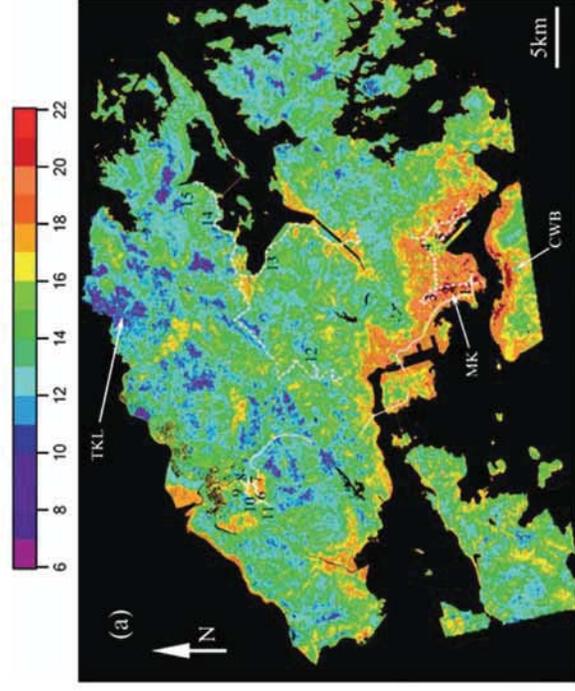


Figure 6.2 Satellite-derived Surface Temperature of HK on 31 Jan 2007³⁵

³⁴ The Hong Kong Polytechnic University (2008), *Top-notch Experts to Assess Impact of Urban Heat Island Effects*

³⁵ Fung et al. (2009), Derivation of Nighttime Urban Air Temperature Using a Satellite Thermal Image

6.2 Greening the Built Environment

The UHI effect mainly arises from forest loss and vegetation clearance caused by rapid and continuous urbanisation. Therefore, we should plant trees, shrubs and flowers around the city to enhance the built environment.

Greening beautifies the environment by adding aesthetic quality and human dimension to the urban design for creation of a more pleasant cityscape and providing sense of seasonal change that enhances the visual interest of the city scene and vibrancy of the city life (Figure 6.3). Furthermore, greening benefits the Earth and improves the ecological condition. For instance, vegetation improves microclimate by providing sun shades and windbreaks, absorbing heat and reducing the temperature of hard surfaces, and enhancing the humidity, helps contain flying dust, and counters the effects of environmental pollutants, consumes CO₂ emissions and enhances the supply of oxygen. Suitable trees and plants of indigenous species will provide food and habitats for wildlife and hence maintain the ecology of the area and conserve wildlife. Deciduous trees are also preferred because they can provide shade in the summer while allowing sunlight to filter through in the winter.



Figure 6.3 Landscape Design in New World Centre (Left) and the Avenue of Stars (Right)

However, landscape irrigation represents a significant portion of potable or other natural surface water consumption within the territory. Improper irrigation not only wastes valuable water, but excess irrigation water also carries fertilizers, pesticides and other pollutants to ground and surface waters. To reduce water consumption, save money and maintain a healthy landscape, water conservation/reduction techniques, such as rainwater harvesting and xeriscaping, should be adopted, local species that require minimal irrigation should be selected, and appropriate irrigation scheduling should be implemented. The reduction in water use has been addressed in Chapter 3.

6.3 Provision of Green Roofs

Installation of green roofs, which provide an effective thermal insulation, is an effective way to control solar gain in a building and thus reduces cooling loads and local air temperature. Under sunlight, the surface temperature on a building's roof may reach up to 55°C. However, after introducing a green roof, most of the solar energy will be absorbed by trees, grasses and ground cover and the surface temperature of the roof will be decreased significantly. Indeed, the absorbed heat is not stored in the building, but lost to surrounding slowly through the process of transpiration by plants. Consequently, the building's roof is maintained at a relatively low temperature.

For the past decade, green roofs have become popular in HK. Since 2001, the HK Government has incorporated podium and rooftop landscape design in new government buildings such as hospitals, schools and office buildings. Nowadays, many landscape companies provide green roof project service to clients. There are two main types of green roofs; namely intensive and extensive (Figure 6.4). Intensive green roofs are often designed for podium gardens with variety of plants and contain rich content of human usage while extensive green roofs are usually made up of ground cover and easy to maintain. The design of green roofs and their characteristics will be further elaborated in Chapter 8.



Figure 6.4 Intensive (Left) and Extensive (Right) Green Roof Garden

6.4 Landscape Maintenance

Professional management and maintenance is essential to keep a landscape safe, healthy, sustainable and attractive. Poor maintenance, such as over-spray and improper watering techniques, will damage our environment and thus transgresses the purpose of greening. Proper planning and design is a prerequisite to build a functional and enjoyable landscape. Property managers should consider what kind of plants is required, where they should be planted and what their characteristics are. Otherwise, the greening may have unexpected and undesirable consequences. For example, a property manager purchased some fruit trees like papaya trees according to residents' request. The trees attracted various types of insects because of their smell and the taste of their fruit. To kill the insects, the landscape contractor used lots of insecticides and chemicals, which not only damaged the ozone layer but also caused harm to residents' health.

Furthermore, organic pesticides for pest and insect control should be selected, whenever necessary:

- (a) Allround (Abamectin 1.8% EC) (2P226) 蟲蟎敵
- (b) Kingbo (Oxymatrine 0.2% + Psoralen 0.4% L) (2P291) 清源保
- (c) Trilogy (Neem 70% W/W EC) (2P262) 三益苦楝油
- (d) SK EnSpray (Mineral Oil 99% EC) (2P193) 綠油油

To protect our environment, organic fertilizers should also be specified and used:

- (a) 350 NutriSmart 綠營高生態肥
- (b) Wellgrow 豐收壹號
- (c) Dynamic Lifter 活力有機肥
- (d) GreenNeem Pellet 綠環苦楝粒

As indicated above, there is a registration number assigned to each type of pesticide by the Agriculture, Fisheries and Conservation Department indicating these pesticides are safe and accepted by the HK Government. When selecting pesticides, only registered products should be specified. Moreover, property managers have to pay attention to the following aspects of landscape maintenance.

6.4.1 Soil test

Soils suffering from depleted organic matter and excessive compaction are commonly seen in urban environments. To promote healthy plant growth, it is necessary to perform soil tests to determine the soil pH, nutrient levels, organic matter and necessary soil amendments. Based on the testing results, fertilizing should be proceeded as necessary.

6.4.2 Variety of plants

Replacement of plants is indispensable for maintaining a fresh and attractive garden. During replacement, drought-tolerant native and non-native trees, shrubs, groundcovers and perennials growing in the garden should be chosen. Since these kinds of plants achieve the same objective of shade, colour, texture and seasonal interest, the original landscape design will be retained in the garden.

6.4.3 Mulching

Adding compost and mulch to soil has to be done at least once a year. When compared with unmulched planting areas, mulching reduces water use by reducing evaporation and runoff.

6.4.4 Irrigation system

As discussed in Chapter 3, effective irrigation should be utilised to minimise the water consumption for landscaping. Effective irrigation systems can deliver water to root zone directly so that water consumption can be reduced by 50% to 70%. A sprinkler head with low-angle and low-volume is also an effective irrigation device for garden and lawn areas. Moreover, property managers should separate zones for planting areas and lawns to match watering requirements and provide less frequent watering but longer timing to promote deeper rooting.

6.4.5 Timing for fertilizing and pruning

In dry seasons, fertilizing and pruning should be avoided since these activities stimulate plant growth and increase water consumption (Figure 6.5).



Figure 6.5 Pruning

6.5 Control and Monitoring

Proper landscape design and maintenance create a friendly environment for residents and wildlife. Using effective irrigation systems, planting drought-resistant plants, installing green roofs, applying proper mulch, reducing water consumption and avoiding use of chemicals and pesticides are the latest trend in sustainable landscape design. In many cases, landscape maintenance is outsourced to landscape companies. Their

gardeners may know how to trim and water the plants daily but lack expertise in maintaining an environmentally-friendly garden. Therefore, professional property and facility managers should establish a corporate environmental policy, including the avoidance, reduction and control of environmental pollution, and coach the landscape contractors to implement sustainable landscaping management.

7.1 Introduction

Effective property management enhances the quality of living. Apart from security, safety and hygiene, people are also concerned about the environment of their living and working places. Therefore, it is important for property managers to develop various environmental protection measures in response to the soaring expectations of the public. Meanwhile, the legislation stipulates specific environmental protection requirements, and non-compliance with these requirements may attract legal liabilities.

7.2 Noise

The Noise Control Ordinance (NCO) (Cap. 400) provides control on most types of environmental noise in HK. Some exceptions are occupational noise, which is governed by the Industrial Undertakings Ordinance (Cap. 59), and noise caused by aircrafts, which is governed by the Civil Aviation (Aircraft Noise) Ordinance (Cap. 312). Under the NCO, environmental noise is classified into six categories according to its locations and sources:

- (a) noise from domestic premises and public places (general neighbourhood noises);
- (b) noise from construction sites;
- (c) noise from places other than domestic premises, public places or construction sites (industrial and commercial noises);
- (d) noise from intrude alarm systems;
- (e) noise from noisy products; and
- (f) noise from motor vehicles.

7.2.1 Noise from domestic premises and public places

Section 4 of the NCO prohibits making of noise which is a source of annoyance to any person during 11:00 p.m. to 7:00 a.m., or at any time on a general holiday. Not only the noise maker, the owner, tenant, or occupier may also be charged if they knowingly permit the noise.

Under Section 5 of the NCO, typical nuisance noise is caused by:

- (a) playing any musical or other instrument, including any record or cassette player or radio or television apparatus;
- (b) using any loudspeaker, megaphone, or other device or instrument for magnifying sound;
- (c) playing any game or engaging in any pastime;
- (d) carrying on a trade or business;
- (e) operating any air-conditioning or ventilation system;
- (f) keeping any animal or bird; and
- (g) making noise for attracting attention to his goods, wares or trade in or near any public place is an offence.

The maximum penalty for committing an offence under the above section is a fine of HK\$10,000.

When management offices receive complaints about neighbourhood noise, they should inspect the place and give appropriate advice or warning to the noise makers. If the situation is not improved, they should seek assistance from the police.

7.2.2 Noise from construction sites

Under Section 6 of the NCO, between the hours of 7 p.m. to 7 a.m., or at any time on a general holiday, when a construction noise permit is not in force, using powered mechanical equipment for the purpose of carrying out any construction work, carrying out percussive piling, and carrying out prescribed construction work are offences. However, the owner or tenant may perform construction work in their premises if only one piece of portable powered mechanical equipment is used.

The maximum penalty for these offences is \$100,000 fine for first conviction, \$200,000 fine for second or subsequent conviction and \$20,000 fine for each day for continuous offence.

Renovation often involves noisy operations, such as breaking, drilling, hammering scaffolding and material handling. To minimize the nuisance, property managers should ask contractors to implement the following measures:

- (a) Restrict noisy operation and use of noisy equipment, such as hand-held breakers or electric drills, to less sensitive hours of the day;
- (b) Use quiet machines, such as hydraulic crushers for demolition;
- (c) Use noise barriers or absorbers when using noisy machines;
- (d) Liaise with the most affected residents to schedule noisy works in mutually acceptable hours and periods;
- (e) Avoid noisy activities before 9 a.m.; and
- (f) Fit noise mufflers to noisy machines.

In addition, property managers should perform the following functions:

- (a) Make residents aware of the statutory requirements through posters, letters or internal publications or the like;
- (b) Alert residents to any provisions under the Deed of Mutual Covenant in relation to the residents' rights and responsibilities/obligations; and
- (c) Act as a mediator in resolving environmental complaints.

7.2.3 Noise from places other than domestic premises, public places or construction sites

Common industrial and commercial noises fall within this category. Typical examples are noise from ventilation systems of restaurants, and noise from discos and karaoke boxes.

The principles, procedures, guidelines, standards and limits for the measurement and assessment of noise emanating from commercial and

industrial premises are set out in the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites.

Under Section 13 of the NCO, when the EPD is satisfied that noise emanating from such place is a source of annoyance to any person in any place considered to be a noise sensitive receiver in any Technical Memorandum, or does not comply with any standard or limit contained in Technical Memorandum, the EPD may serve a noise abatement notice to the owner, tenant or occupier of the place. The person served with the notice should abate the noise by a specified date and ensure that the noise emanating from such place does not exceed any limit or standard specified in the notice. The EPD will then conduct compliance inspection. If the noise emanated still exceeds the limit specified in the notice, the recipient of the notice will be prosecuted.

The maximum penalty for this offence is \$100,000 fine for first conviction, \$200,000 fine for second or subsequent conviction, and \$20,000 fine for each day for continuing offence.

Bars, discos and karaoke boxes may commit this offence easily because, if they are too close to the Noise Sensitive Receivers (NSRs) and inadequate noise pollution control measures are implemented, the crowd noise, music and singing noise may create nuisance. Property managers should advise the business to implement adequate noise control measures as follows:

- (a) Install thick resilient pads underneath the sound speakers or their supports to reduce noise transmission through building structures to neighbours;
- (b) Avoid hanging large or strong bass sound speakers on the ceiling to reduce transmission of low frequency noise and vibration to other floors;
- (c) Locate sound speakers away from corners of premises;
- (d) Maintain the volume of sound systems at low levels to avoid causing nuisance to neighbours;

- (e) Install double doors made of acoustic insulation or sound-absorbing materials at the entrance to avoid noise leakage to outside; and
- (f) Warn the customers at the entrance not to scream and speak loudly in order not to create any noise annoyance to nearby residents.

7.2.4 Noise from intruder alarm systems

Under Section 13A of the NCO, intruder alarm systems should be provided with an efficient automatic device which will cause any audible signal to cease not more than 15 minutes after the activation of the signal. A person who controls the intruder alarm system is liable to a fine at level 3 and to imprisonment for three months if he fails to comply with the rule.

Section 13B of the NCO stipulates that the registered owner of a vehicle who has an intruder alarm system installed in should ensure that the intruder alarm system is provided with an efficient automatic device and it should not emit any audible signal caused otherwise than by an act of direct physical contact with the vehicle, whether that act is intentional or unintentional, and the audible signal must cease within five minutes after the activation of the signal. The maximum penalty for non-compliance is a fine at level 3.

If intruder alarm systems of cars or shops are activated and the audible signal does not cease, property managers should contact the owner as soon as possible.

7.2.5 Noise from noisy products

The ventilation systems (chillers, water cooling towers, exhaust fans, etc.) of restaurants may create excessive noise. Property managers should advise restaurants to implement adequate noise control measures as follows:

- (a) Place noisy equipment inside a plant room with thick walls;
- (b) Locate the equipment away from nearby and future NSRs;

- (c) Choose equipment of low noise brands or models;
- (d) Conduct regular maintenance, such as lubricating moving parts, tightening loosen parts (bolts/nuts, driving belts, panels, etc.), replacing worn-out components (bearings) and inspecting equipment alignment;
- (e) Install silencers at air inlets and outlets;
- (f) Apply damping materials on the vibrating duct work; and
- (g) Adjust the operation mode, such as reducing fan speed and switching off non-essential equipment at night.

The lift systems, pumping systems and emergency generators of buildings are also potential sources of noise. To avoid committing the offence, property managers should implement the following:

- (a) Locate the plant rooms away from nearby and future NSRs, for example, placing them on the rooftop;
- (b) Isolate the emergency generators from the building structure by use of inertia blocks and vibration isolators;
- (c) Provide flexible connectors between the emergency generators and associated pipework to avoid structural vibration transmission;
- (d) Use vibration isolators for attaching pipes to walls, ceilings or floors;
- (e) Conduct regular maintenance, such as lubricating moving parts, tightening loosen parts, replacing worn-out components and inspecting equipment alignment;
- (f) Choose silent type exhaust fans for the lifts;
- (g) Install silencers at the exhaust outlets;
- (h) Provide flexible connectors between fans and ducts; and

- (i) Seek professional advice from acoustic consultants/contractors, whenever applicable.

During the waste handling process, noise may be produced. Control measures include:

- (a) avoiding the use of refuse chutes for hard objects and fragile glass;
- (b) installing rubber pads/lining to the metal doors of refuse chute loaders at domestic floors to reduce impact noise when closing;
- (c) avoiding using refuse chutes, moving the waste containers, and loading refuse to refuse collection vehicles during noise sensitive hours, such as early morning and midnight hours;
- (d) locating the refuse stations away from domestic premises;
- (e) using waste containers with soft rubber wheels; and
- (f) installing noise barriers, enclosures or silencers at the exhaust outlets of refuse stations.

7.3 Air

The Air Pollution Control Ordinance (APCO), Cap. 311 is the principal law for managing HK's air quality.

7.3.1 Air pollution abatement notice

Under Section 10 of the APCO, if the EPD is satisfied that the emission of air pollutants from a polluting process is causing or contributing to air pollution which exists or which is imminent, the EPD may give an air pollution abatement notice to the owner of the premises or to the person carrying out the activity requiring him to:

- (a) cease the emission of air pollutants from the premises or to cease the operation of the polluting process;

- (b) reduce the emission of air pollutants from the premises or polluting process; and
- (c) take other steps to abate the emission of air pollutants from the premises or polluting process.

Non-compliance with the requirements of the notice is an offence. The maximum penalty is \$100,000 fine for first conviction, \$200,000 fine and six months imprisonment for second or subsequent conviction and \$20,000 fine for each day for continuing offence.

7.3.2 Prevention of discharge of noxious or offensive emissions

Under Section 12 of the APCO, the owner of any premises used for the conduct of any specified process shall use the best practicable means for preventing the emission of noxious or offensive emissions from such premises, and for preventing the discharge, whether directly or indirectly, of such emissions into the atmosphere, and for rendering such emissions where discharged harmless and inoffensive. Non-compliance with the rule is an offence and the maximum penalty is \$200,000 fine and six months imprisonment, and \$20,000 fine for each day for continuing offence.

7.3.3 Renovation

Renovation may involve complex building and demolition operations such as carpentry, electricity and plumbing works, fixture removal, interior decorative works. Those activities are prone to cause dust and unpleasant odours.

The Air Pollution Control (Construction Dust) Regulation (APC(CD)R), Cap. 311R sets out the regulatory requirements to control dust emissions from construction works. Under Section 5 of the APC(CD)R, the contractor responsible for a construction site where a regulatory work is being carried out shall ensure that the work is carried out in accordance with the Dust Control Requirements prescribed in the Schedule. The maximum penalty for this offence is a level 4 fine for first conviction, level 5 fine for second or subsequent conviction and \$5,000 fine for each day for continuing offence.

Part II of the Schedule specifies the Control Requirements for Regulatory Works. For example, exterior building surface renovation has to follow specified dust control measures to prevent air pollution. Moreover, the General Control Requirements and Control Requirements for Individual Activities as set out in Part III & IV of the Schedule shall be observed if relevant activities are conducted. For instance, if pneumatic or power-driven drilling, cutting and polishing is carried out, water or a dust suppression chemical shall be continuously sprayed on the surface, unless the process is accompanied by the operation of an effective dust extraction and filtering device.

To minimize air nuisance, property managers should ensure contractors to:

- (a) avoid venting renovation exhaust to common areas and only discharge process exhaust to well ventilated places. Keep the main door closed and properly seal gaps to prevent causing nuisance to neighbours;
- (b) maintain good communication with neighbours to understand the effectiveness of environmental nuisance prevention measures taken;
- (c) separate the renovation work areas from common places with suitable partitions in commercial premises;
- (d) select and use building products without or with low VOCs;
- (e) store VOC-containing products in air-tight containers;
- (f) use mechanical ventilation devices such as fans and blowers to collect emissions from high polluting operations and cleanse them with effective air pollution control devices such as filters and absorbent materials before discharging to well ventilated places;
- (g) keep dusty materials wet on handling and spray water before breaking, grinding operations;
- (h) fit vacuum cleaners to grinding, sand papering or wood cutting machines;

- (i) maintain good house-keeping and frequent cleaning of the surrounding areas;
- (j) use enclosable containers or skips for temporary storage of renovation waste. Dusty materials should be covered entirely with clean impervious sheeting to prevent fugitive emission; and
- (k) for dump trucks carrying dusty materials, cover their loads entirely with clean impervious sheeting before leaving a construction site and all the way between the site and the receiving point to prevent leaking of dusty materials from these vehicles.

7.3.4 Operation of restaurants

Restaurants using conventional fossil fuels are subjected to the regulatory requirements of the Air Pollution Control (Fuel Restriction) Regulations, the Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alternation) Regulations (APC(FOC)(IA)R), Cap. 311A, and the Air Pollution Control (Smoke) Regulations (APC(S)R), Cap. 311C.

Under Regulation 4 of the (APC(FOC)(IA)R), if the occupier of any premises intends to carry out installation of or alteration to a furnace, oven or chimney, he should submit the plans showing the elevations and plan views to the EPD for approval. The maximum penalty for this offence is \$50,000 fine and \$500 fine for each day for continuing offence.

Under Regulation 3 of the APC(S)R, an owner of any premises who operates any chimney or relevant plant from which dark smoke is emitted for more than six minutes in any period of four hours or for more than three minutes continuously at any one time commits an offence. The maximum penalty is \$20,000 fine for the first conviction, and \$20,000 fine and three months imprisonment for subsequent conviction.

Restaurant emissions such as cooking odour or greasy fumes are subject to the control of the Air Pollution Control Ordinance. The Authority can take enforcement action against the owner of restaurant if the restaurant emissions are causing or contributing to air pollution. Failure to comply with an air pollution abatement notice commits an offence and is liable to hefty penalty.

To prevent causing air pollution, property managers should advise restaurant owners to:

- (a) take due environmental consideration in planning stage and carefully select business venues with proper locations and adequate space for placing exhaust outlets;
- (b) avoid exhaust outlets in close proximity to air sensitive receptors;
- (c) locate exhaust outlets in a well ventilated places for good dispersion;
- (d) seek advice from environmental professionals when locating exhaust outlets;
- (e) use smokeless fuels such as gas and electricity;
- (f) prevent conducting high emitting cooking processes outdoor;
- (g) install appropriate air pollution abatement systems to control cooking fumes and / or odours, such as electrostatic precipitators along with activated carbon filters, for cooking activities which produce strong emissions;
- (h) conduct regular cleaning and maintenance of all air pollution control equipment; and
- (i) adopt automatic switch-on function to synchronize the operation of cooking devices with air pollution control equipment.

7.3.5 Emergency generators

Emergency generators discharge combustion products on operations and may emit excessive smoke if they are inadequately maintained. Such plants are subjected to the regulatory requirements of the Air Pollution Control (Fuel Restriction) Regulations (APC(FR)R), Cap. 311L, the Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alternation) Regulations (APC(FOC)(IA)R), Cap. 311A, and the Air Pollution Control (Smoke) Regulations (APC(S)R), Cap. 311C.

Under the Air Pollution Control (Fuel Restriction) Regulations (APC(FR)R), Cap. 311L, diesel fuel users in industrial and commercial sectors must use ultra-low sulphur diesel (ULSD) with a sulphur content of not more than 0.005% by weight.

In case the total power generation capacity of all the diesel generators, physically and electrically connected, in the same premises exceeds 5MW, the establishment is liable to be controlled under a Specified Process licence for the operation.

To prevent air pollution, property managers should adopt the following preventive measures:

- (a) It is highly desirable to locate chimney outlets (preferably with the generator sets sited to the uppermost floor) at the building roof rather than at low level or the podium. Should it be not viable, it is essential to locate chimney outlets at such a place where the ventilation is good and distant from the nearby inhabitants as farthest as possible such that their emissions will not cause or contribute to any forms of air pollution;
- (b) Procure high-efficiency diesel generators and use ULSD;
- (c) Carry out regular maintenance to prevent excessive air emissions;
- (d) Avoid no-load tests;
- (e) Perform dummy load tests to simulate duty operation for emission and performance check; and
- (f) Install exhaust after-treatment systems, such as exhaust purifiers, soot filters or particulate traps, to reduce particulate emission and to convert hazardous carbon monoxide and hydrocarbon to CO₂ and water.

7.3.6 Asbestos removal

If asbestos containing materials (ACMs) are handled inappropriately, asbestos fibres will be released. If inhaled, these fibres will remain in the body for many years and increase health risks due to such exposure. Therefore, asbestos abatement work is controlled under the APCO.

Under Section 79 of the APCO, when the EPD believes that any premises may release asbestos, it may issue a notice to require the responsible person to take measures or steps and within the time as specified to prevent, control, reduce or eliminate the release of asbestos, hire a registered asbestos consultant to prepare an investigation report and to prepare an asbestos management plan, and/or hire other registered asbestos professionals to carry out any asbestos abatement work or work involving the handling of any ACMs. Non-compliance with the requirements of the notice is an offence. The maximum penalty is \$100,000 fine for first conviction, \$200,000 fine and six months imprisonment for second or subsequent conviction, and \$20,000 fine for each day for continuing offence.

When handling ACMs in existing buildings, property managers should adopt the following approach:

- (a) Employ a registered asbestos consultant to conduct asbestos investigation and prepare an asbestos management plan before starting large scale renovation in old buildings;
- (b) For newer buildings, enquire the developer, architect and management company about the known/likely presence of ACMs and, where necessary, employ a registered asbestos consultant to conduct asbestos investigation and prepare an asbestos management plan;
- (c) Implement the asbestos management plan to maintain all remaining ACMs; and
- (d) Employ a registered asbestos contractor for any asbestos abatement including removal.

7.4 Water

Water Pollution in HK is controlled by the Water Pollution Control Ordinance (WPCO), Cap 358. Under Section 8 of the WPCO, it is an offence to discharge any waste or polluting matter into the waters of HK in a water control zone. It is also an offence to discharge polluted water into stormwater drains.

7.4.1 Operation of restaurants

The operation of restaurants may create water pollution problems, including blockage of foul drains, overflow of grease traps and leakage of wastewater to roadside areas.

To prevent the nuisance created, property managers should ensure restaurants to take the following measures:

- (a) Apply a licence from the EPD before discharging effluent from grease traps;
- (b) Install above-ground grease traps at an easily accessible location to facilitate ease of cleaning and maintenance;
- (c) Provide communal grease traps as far as possible for better efficiency and economy;
- (d) Use properly designed and constructed grease traps with provision for the daily removal of screened solids and trapped grease;
- (e) Install screening devices at the grease trap inlets and remove the screened solids daily;
- (f) Remove the accumulated bottom sludge regularly;
- (g) Engage registered grease trap waste collectors for regular cleaning and overhauling of grease traps;
- (h) Properly archive cleaning records and keep the cleaning records for the past six months for the EPD's inspection;

- (i) Conduct regular maintenance checks on the condition and routing of the drainage systems and repair any drainage defects immediately;
- (j) Ensure updated drainage plans kept in management offices;
- (k) Check drainage plans to confirm a correct drainage route before carrying out drainage works to ensure that the wastewater is discharged into foul sewers instead of stormwater drains;
- (l) Ensure the use of manhole covers with correct identification of the drain types; and
- (m) Prohibit outdoor food preparatory work and washing activities at the back lanes.

7.4.2 Operation of wastewater treatment plant

Discharge of wastewater from treatment plants should comply with the terms and conditions of a licence issued by the EPD. Property managers should adhere to the following guidelines:

- (a) Apply and comply with the licence conditions from the EPD for privately built sewage treatment plants;
- (b) Conduct regular self-monitoring checks to ensure the quality of the effluent discharged meeting the prescribed standard;
- (c) Develop an audit system, such as employing independent checkers, to monitor the performance of the maintenance contractors/operators of sewage treatment plants;
- (d) Maintain an updated operation and maintenance manual as well as formulate an emergency plan;
- (e) Carry out regular maintenance; and
- (f) Maintain the general cleanliness of the sewage treatment plants and ensure every part of the plants is readily accessible for maintenance and repair at all time.

7.5 Waste

Under Section 16A of the Waste Disposal Ordinance, Cap. 354 (WDO), it is prohibited to dump waste in public places, on Government land, or on private premises without the consent of the owner or occupier. Attention should also be paid to the prior notification procedures for construction waste disposal on private land (with a total deposition area of over 20 square meters) required under Sections 16B and 16C of the WDO.

Furthermore, the handling, storage, collection and disposal of chemical waste, such as asbestos waste generated from asbestos removal described in paragraph 7.3.6 above, are subject to the control under the WDO and its subsidiary Waste Disposal (Chemical Waste)(General) Regulation.

7.5.1 Renovation

Renovation which involves demolition and painting is likely to generate waste. Property managers should ensure contractors to implement the following measures:

- (a) Notify the management office when they intend to carry out renovation works;
- (b) Maintain a record of the renovation waste generated from the premises undergoing renovation works;
- (c) Avoid the accumulation of renovation waste;
- (d) Separate the non-recyclable materials into inert materials (e.g. soil, concrete and bricks) and non-inert materials (e.g. general rubbish);
- (e) Dispose non-recyclable materials properly and regularly. Inert materials should be disposed at public filling areas while non-inert materials should be disposed at landfills;
- (f) Establish separated areas or individual containers for collection of different recyclable materials, e.g. paper, wood, metal and plastic;

- (g) If chemical waste is produced, register as a chemical waste producer with EPD, ensure proper packaging, labelling and storage of the waste, and engage licensed collectors to deliver the waste to licensed disposal facilities for proper disposal/treatment;
- (h) Reuse residual paint and solvent as far as possible; and
- (i) Participate in recycling programmes, such as Fluorescent Lamp Recycling Programme, Rechargeable Batteries Recycling Programme and Computer Recycling Programme.

7.5.2 Refuse collection activities

The amount of waste loads and rate of waste recovery of a building are closely related to the practice of refuse collection. Property managers and owners' corporations should adopt the following good practices:

- (a) Make house rules to facilitate waste separation and recycling;
- (b) Provide appropriate and sufficient waste separation and recovery facilities within the common parts of the development convenient to the owners and occupiers, which consist of material that will not cause any fire hazard and placed in locations so as not to cause obstruction to any fire escape route;
- (c) Provide suitable waste separation facilities such as containers and shelves in refuse rooms for collection of recyclables from each building floor;
- (d) Arrange and participate in waste reduction programmes, including the Programme on Source Separation of Domestic Waste organized by the EPD to encourage residents' participation in source separation;
- (e) Keep the waste separation facilities in a clean and working condition, and arrange periodic collection of recyclable materials for recycling with cleansing contractors or recyclers;

- (f) Organize activities to promote environmental awareness of the owners and occupiers of the development and encourage their participation;
- (g) Organise periodic programmes for the collection of other specific types of recyclables such as used clothes, old books, computers, electrical and electronic appliances, rechargeable batteries, etc. and donate reusable items to charitable organizations;
- (h) Notify residents of waste separation arrangements including the location of waste separation facilities on each floor, and types of recyclables to be recovered;
- (i) Post up posters outside refuse rooms and next to recycling bins to encourage residents to separate their waste and explain what types of waste can be recycled; and
- (j) Organize environmental education and publicity activities, such as waste-to-gift exchange programmes, recycling competitions and Lunar Year-end recycling campaigns, to increase residents' environmental awareness and participation in waste separation.

7.5.3 Management of waste collection contractors

Improper operation of Refuse Collection Vehicles³⁶ (RCV) may create nuisance including spread of odour, dripping of leachate and spattering of waste. To reduce nuisance caused by RCVs, property managers should review their refuse collection contracts to require the collection contractors to:

- (a) Use fully enclosed RCVs which are equipped with metal tailgate cover and waste water sump tank;
- (b) Close the RCV tailgate cover immediately after collection of waste at each pick-up point;
- (c) Compress all collected waste into the vehicle body and ensure that no waste is left on hopper;

³⁶ A refuse collection vehicle is a goods vehicle which is equipped with a loading device to load garbage from collection bins and a rear compactor to reduce waste volume.

- (d) Inspect the RCV tailgate cover, waste water sump tank and rubber seal between tailgate and vehicle body regularly, and ensure they are in good conditions; and
- (e) Follow the guidelines in the Code of Practice on the Operation of Refuse Collection Vehicles.³⁷

Property managers should also conduct regular inspections on RCVs serving their premises and feedback any problem identified to their contractors for rectification.

7.6 Conclusion

Although in many cases property managers are not the offenders of environmental offences, they have important roles in preventing such offences be committed. They can contribute in creating a green living environment by selecting suitable and responsible tenants for the premises in the shopping centres, drafting and enforcing the Deed of Mutual Covenant, and mediating disputes between residents. Therefore, it is important for property managers to get familiar with the environmental legislations, guidelines and pollution control measures. Implementing pollution control measures may not be easy because they often incur extra expenses on residents, owners of business and property management companies. However, these must be done because it is everyone's right and desire to enjoy a clean environment and thus it is everyone's obligation to reduce pollution.

³⁷ Environmental Protection Department
<http://www.epd.gov.hk/epd/english/environment/inhk/waste/guide_ref/files/CoP_RCVs.pdf>

8.1 Introduction

Green buildings can reduce CO₂ emissions and promote energy saving, resulting in cooling down of the earth and creation of a healthier work and living environment. Green buildings may incorporate sustainable materials in their construction and involve the use of environmentally friendly technologies. The initial up-front costs of green buildings may be higher than the conventional ones, which however can be offset by the economic gains apparently through life cycle assessments.

Latest environmentally friendly technologies and materials, like green roofs, photocatalysts, permeable pavers and wood plastic composite, are introduced in the following sections.

8.2 Green Roofs

8.2.1 Specifications

A green roof is a roof covered with plants growing in a specially made medium forming an integral part with the existing roof structure. This should be differentiated from a traditional roof garden, where planting is done in freestanding containers and planters, located on an accessible roof deck. The layers of a contemporary green roof system, from the top down, include:³⁸

- (a) the plants, often specially selected for particular applications;
- (b) an engineered growing medium, which may not include soil;
- (c) a landscape or filter cloth to contain the roots and the growing medium, while allowing for water penetration;
- (d) a specialized drainage layer, sometimes with built-in water reservoirs;
- (e) the waterproofing/roofing membrane, with an integral root repellent; and
- (f) the roof structure, with traditional insulation either above or below.

A pictorial illustration of the major components of a green green is given in Figure 8.1 below.

³⁸ Steven Peck and Monica Kuhn, *Design Guidelines for Green Roofs*, Ontario Association of Architects

8.2.2 Intensive and extensive green roofs

Green roofs can be categorized as intensive and extensive and intensive, depending on the depth of planting medium, choice of plants and amount of maintenance required (Figures 8.3).

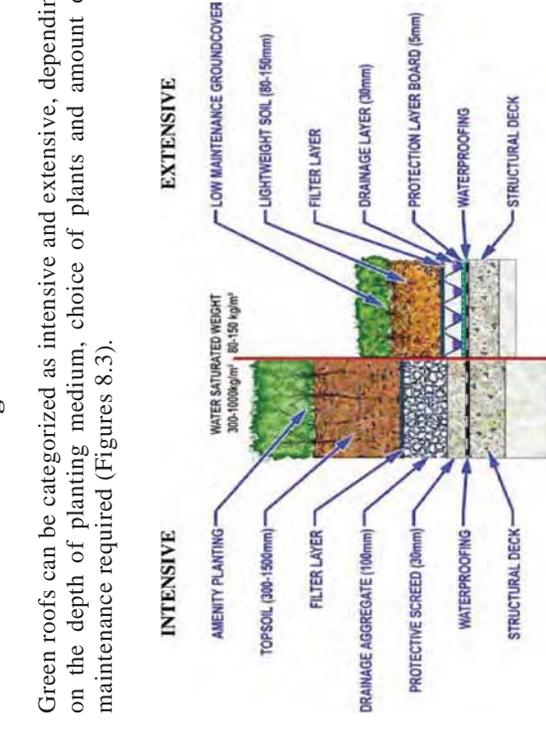


Figure 8.3 Intensive and Extensive Green Roof Systems⁴¹

An intensive green roof has thicker growing medium, usually more than 25 cm. It has an outlook of an ordinary garden with trees and shrubs on the top. It requires regular maintenance and imposes heavy loading on the existing structure.

Extensive green roofs are often not accessible and are characterized by low weight, low plant diversity, low capital cost and minimal maintenance requirements. The vegetation should be capable of surviving in both hot and cold seasons and requiring little watering and examples of drought tolerant plant species are given in Chapter 6. For residential properties, the construction of extensive green roofs is normally technically viable and more popular. The design of the extensive green roof systems should preferably meet the suggested following requirements listed in Table 8.1:

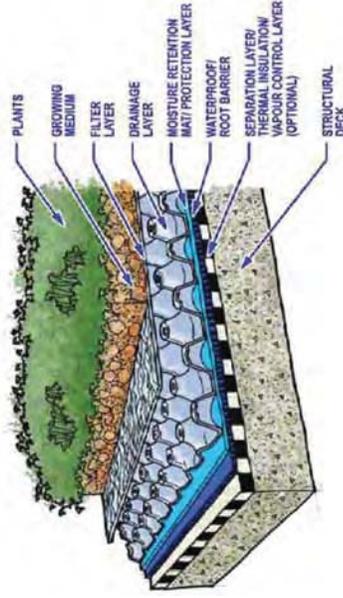


Figure 8.1 Major Components of a Green Roof³⁹

Prior to the installation of a green roof system, it is vital to inspect the existing roof condition and its rainwater discharge system. Water outlets for an automatic irrigation system should be provided wherever possible. The irrigation system should be capable of switching to manual mode. Access for maintenance and installation of stainless steel inspection chambers with lockable devices should also be provided (Figure 8.2).



Figure 8.2 Sectional and Isometric Views of Inspection Chambers⁴⁰

³⁹ Architectural Services Department (December 2007), Study on Green Roof Application in Hong Kong, Urbis Ltd
⁴⁰ Greenroofs.com <http://www.greenroofs.com/archives/gf_dec07.htm>
 Zinco <<http://www.zinco.ca/inspectionchambers.html>>

⁴¹ Architectural Services Department (December 2007), Study on Green Roof Application in Hong Kong, Urbis Ltd

Table 8.1 Recommended Design Criteria for Extensive Green Roofs

Properties	Requirements
Weight (fully saturated)	< 1.3 kPa
Overall thickness	< 250mm
Coverage of vegetation	>75 % before the end of defects liability period
Colour	At least 3 colours of plants capable of significant seasonal colour changes
Irrigation	2 times per month
Fertilization Frequency	2 times per 3 year
Inspection Chamber Cleansing	Once a month
Weeping Clearing Frequency	Once a year
Plant Health Inspection	Once a month
Disease and pest control	2 times per year
Defects Liability Period	12 months
Warranty	10 years
Budget Price	\$1,000 – 1,200 per sq.m.

8.2.3 Application and benefits

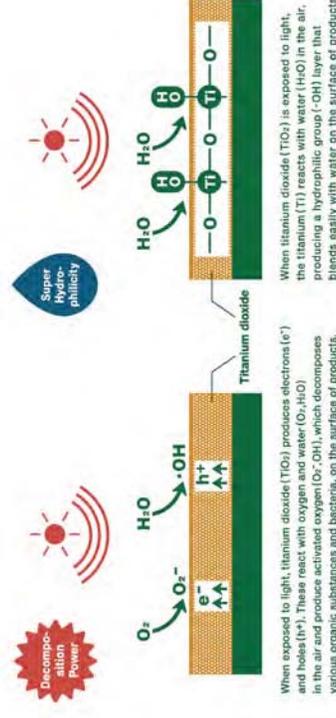
In response to the government's promotion of the Green Policy, the provision of green roofs is getting popular in commercial and residential buildings. Not only will it enhance the amenity and aesthetic values, but contributes to the environmental benefits through the increase of insulation value, thereby reducing the consumption of energy in the long run. Many examples are found on precinct pavilions, commercial blocks, ancillary buildings, shorter residential blocks in estates where block heights vary, and even covered walkways.

The design and implementation of a green roof project is relatively straight forward, provided all relevant issues, such as use, location, structure, access

and exits, plants and maintenance, are thoroughly considered and dealt with. Nonetheless, just as each site, each building, each building owner and each end user are different, every green roof installation will be unique.

8.3 Photocatalysts

Photocatalysis is a chemical reaction which utilizes solar/light energy and TiO_2 as a catalyst for converting air pollutants such as nitrogen oxide and sulphur dioxide to less toxic forms (Figure 8.4). It performs the diverse functions of decomposition of air and water contaminants, deodorization, self-cleaning, anti-fogging and anti-bacterial action.

Figure 8.4 Photocatalytic Process by TiO_2 ⁴²⁴² TOTO Ltd, Japan (2011)

There are two types of reactions, namely, photocatalytic effect and hydrophilic properties, under the ultraviolet radiation, as follows:

- Photocatalytic effect – TiO_2 serves as a catalyst, which facilitates the reaction between light, oxygen and humidity whereby activated oxygen is emitted, resulting in the decomposition of organic pollutants and gases. The effect can be regenerated when exposed to natural or artificial lighting.
- Hydrophilic properties – Under the light irradiation, water on TiO_2 surface spreads to form a thin film which prevents static electricity. Dirt and grease are lifted to the surface such that it can be washed away easily (Figure 8.5).



Figure 8.5 Hydrophilic Properties of TiO_2 ⁴³

8.3.1 Photocatalytic tiles

Photocatalytic tiles can be used for toilets, laboratories, kitchens, external walls and where hygiene is essential (e.g. hospitals and markets). They possess the same physical properties, including abrasion and chemical resistance, as conventional tiles, but are about 30%-40% more expensive. TiO_2 coating, burned-in at high temperature, has the following advantages:

- Anti-bacterial effects – The photocatalytic reaction activates the oxygen molecules which decompose bacteria and fungi. The rate of elimination of common bacteria can be quantified in the laboratory test under Japan Industrial Standard Z 2801:2000;
- Easy to clean – Dirt and grease are prevented from collecting, thus reducing the use of cleaning agents. It is effective against staining caused by microbes, urine and mould; and
- Remove odours – Disagreeable odours like ammonia, mouldy odours and formaldehyde are dispelled by the activated oxygen.

8.3.2 Self-cleaning coating

Self-cleaning coating, a combination of photocatalyst and nano technology, is a transparent and water-based coating system for concrete, glass and painted surfaces. It is usually applied by spraying and can be directly applied on clean surfaces, i.e. no special preparation required before application. It has excellent anti-fouling, chemical and abrasion resistance, rust prevention characteristics and is as easy to use as conventional coatings. It provides long-lasting clean façade and hygiene benefits, thus creating a comfortable environment.

8.3.3 Air pollutant removal pavers

Air pollutant removal pavers consist of a concrete base layer made from cement and recycled aggregates and a thin surface layer made of cement, various aggregate materials and a small amount of TiO_2 (see Figures 8.6 and 8.7 below).⁴⁴ They have good compressive strength and bond strength

⁴³ TOTO Ltd, Japan (2011)

⁴⁴ Laputa Eco-Construction Material Co., Ltd. <<http://www.laputa-eco.com>>

between top layer of TiO₂ and bottom layer. Their appearance is similar to that of ordinary precast concrete pavers with a wide choice of colours.

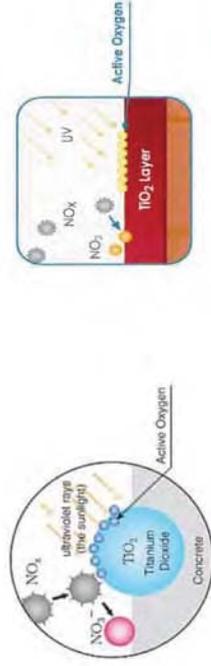


Figure 8.6 TiO₂ for Removing Air Pollutant **Figure 8.7** Incorporating TiO₂ into Concrete Paving

The constituents of air pollutant removal pavers contain recycled waste glass instead of using sand, thereby increasing the porosity. This enhances their air pollutant removal ability. Light can be carried to a greater depth activating the TiO₂ on the surface as well as within the surface layer. The porosity of the surface layer effectively increases the area available for reaction with the pollutants.

In view of their ability to remove air pollutants, air pollutant removal pavers are to be used for polluted areas like industrial estates, despite being more expensive than ordinary concrete pavers.

8.4 Permeable Paving Systems

Permeable paving systems, an alternative to traditional impervious pavement, allow storm water to drain through them and into a stone reservoir where water is infiltrated into the underlying native soil or temporarily detained. While the specific design may vary, all permeable pavements have a similar structure, consisting of a surface pavement layer, an underlying stone aggregate reservoir layer and a filter layer or fabric installed on the bottom (Figure 8.8). Permeable pavers are broadly classified into two major categories, namely solid blocks and pervious blocks:

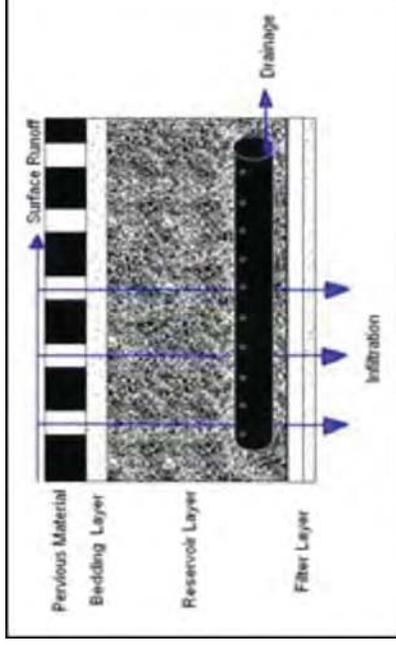


Figure 8.8 Cross Section of Typical Permeable Pavement⁴⁵

(a) Solid blocks (impermeable block)

They are small surfacing blocks or interlocking blocks with joints, grass pavers, or open-cell pavers. Water enters the joint between solid pavers or open cells of pavers and flow through an “open-graded” base into the subgrade (Figure 8.9).

(b) Pervious blocks

These blocks consist of micro gaps on the surface of blocks. Water penetrates to ground through the internal void of the blocks.

⁴⁵ Biological and Agricultural Engineering, NC State University
<<http://www.bae.ncsu.edu/stormwater/PublicationFiles/PermPave2008.pdf>>

One of the major concerns for maintaining a permeable paving system is to prevent clogging of the void spaces within the surface material. Therefore, all contributing catchment areas should be stabilized, i.e. paved, grassed and vegetated to prevent sediment loads. Depending on the system, occasional sweeping or mechanical suction brushing of debris will be required to ensure that the void spaces do not clog. The surface should not be sealed or repaved with non-porous materials. As a teaching tool for the public and as a reminder of maintenance obligations, educational signage should be installed wherever porous pavers are used.

8.5

Wood Plastic Composite

The wood-plastic composites (WPCs) are composite materials made of mixed natural fibres, such as bamboo/wood powder, re-cycled thermoplastics, and chemical additives. These materials are strong, moisture resistant, anti-slip, termite and insects-proof. The surface looks like natural wood appearance with minimal maintenance, i.e., no painting, no glue, etc. WPCs are extruded from high pressure and temperature machines. Each piece is knot-free and consistent in size, colour and length. WPCs do not share the common problems associated with timber, like rotting and warping, but has the durability of plastic with at least a 10-year warranty against cracking, peeling, splitting and rotting.

Scratches, cuts and grooves can be eliminated by using a wire brush. Weathering will help return the brushed area to its original appearance. Cleaners containing sodium hypochlorite may be used for better effects. Furthermore, WPCs have a wide choice of colours which allow more flexibility for interior and architectural design. They require much less maintenance than pressure-treated wood although their initial costs are comparatively higher than natural timber.

Nowadays, WPCs are widely used for outdoor deck flooring, park benches, pergolas, fences, landscaping timbers and children play equipment (Figure 8.10 below). Recently, this technology has been applied to the manufacturing of surface water grating and manhole covers in China as well.

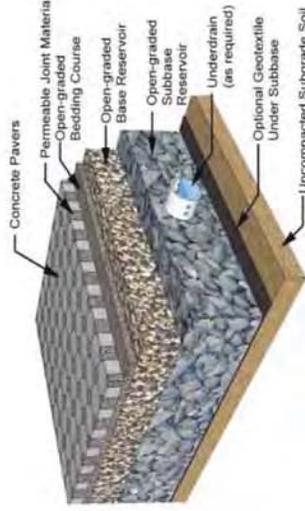


Figure 8.9 Typical Details of Permeable Paving Systems⁴⁶

The main advantages of these permeable paving systems are as follows:

- Reduce stormwater run-off and pollutants;
- Recharge ground water;
- Reduce the chance of flooding; and
- Increase dry-weather flow in rivers.

Permeable paving systems are suitable for low traffic roads, parking lots, driveways, pedestrian plazas and walkways. They are ideal for site with limited space for other surface storm water best management practices. However, they should not be applied in pollution hot spots such as vehicles fuelling, service or demolition areas, outdoor storage and handling areas for hazardous material, and heavy industry sites.

Permeable paving systems should be designed and installed in accordance with the manufacturer's specifications. To optimize water infiltration through permeable pavers, the slope of the surface should range from 0.5 percent to two percent. Besides, the sub-base design depends on the site condition. Perforated pipe may be needed to install on the top of the sub-grade for discharging the draining of excess water.

⁴⁶ Interlocking Concrete Pavement Institute, Herndon, VA, Permeable Interlocking Concrete Pavement-selection design, construction and Maintenance (Third Edition)



Figure 8.10 Typical Wood Plastic Composite Products⁴⁷

8.6

Conclusion

New buildings may be designed, built and operated to be green buildings. Existing building can also become green through remodelling, retrofitting and improved operations. To maximise the economic and environmental performance of buildings, green buildings may incorporate sustainable materials in their construction (e.g. made from renewable resources), create healthy indoor environments with minimal pollutants (e.g. reduced product emissions), and feature landscaping that reduces water usage (e.g. using native drought tolerant plants).

Green buildings may cost more up front, but can save money over the life of the building through lower operating costs, which are most likely to be fully realized when incorporated at the project's conceptual design phase with the assistance of an integrated multidisciplinary project team. In view of their acquaintance with users' requirements and building operations, professional property and facility managers should be recruited into the project team as early as possible to act at the forefront of new technologies in developing environmentally friendly designs.

⁴⁷ Biowood Australia <<http://biowoodaustralia.com.au/>>

APPENDIX: Sample Water Data Collection Forms

Water Audit Summary	
Building Information	
Building Name:	
Building Address:	
Date of commencement of water audit:	
Date of commencement of water audit:	
Information Checklist	
1) Building floor plans	Y N/A
2) List of water meters	
3) Past water and sewer bills	
4) Submeter consumption data	
5) Facility operating, maintenance and janitorial work schedules	
6) Facility occupants and visitors schedules	
7) List of water-using equipment	With manufacturers' recommended/specified flow rate
8) Complete inventory list of plumbing fixture	With information in flow rate and water efficiency labeling
9) Prior water and/or energy audit results	
10) Submission details of the WSD's Quality Water Recognition Scheme, if applicable	

LIST OF ABBREVIATIONS

ACMs	asbestos containing materials			
APCO	Air Pollution Control Ordinance			
APC(CD)R	Air Pollution Control (Construction Dust) Regulation			
APC(FOC)(IA)R	Air Pollution Control (Furnaces, Ovens and Chimneys) (Installation and Alternation) Regulations			
APC(S)R	Air Pollution Control (Smoke) Regulations			
BEAM	Building Environment Assessment Method			
BEC	Building Energy Code			
BEE0	Building Energy Efficiency Ordinance			
BMSs	building management systems			
CEDD	Civil Engineering and Development Department			
CIBSE	Chartered Institution of Building Services Engineers			
CO ₂	Carbon dioxide			
E&M	electrical and mechanical			
EMOs	Energy Management Opportunities			
EMS	environmental management system			
EMSD	Electrical and Mechanical Services Department			
EPD	Environmental Protection Department			
GHG	greenhouse gas			
HK	Hong Kong			
HVAC	heating, ventilation and air conditioning			
IAQ	Indoor air quality			
ISO	International Organization for Standardization			
LED	Light-emitting Diodes			
MEELS	Mandatory Energy Efficiency Labelling Scheme			
MVAC	Mechanical ventilation air conditioning			
NCO	Noise Control Ordinance			
NSRs	Noise Sensitive Receivers			
RCV	Refuse Collection Vehicles			
TiO ₂	Titanium dioxide			
UHI	Urban heat island			
ULSD	ultra-low sulphur diesel			
VOC	volatile organic compounds			
VRV	variable refrigerant volume			
WDO	Waste Disposal Ordinance			
		WELS		water efficiency labeling scheme
		WMOs		water management opportunities
		WPCs		wood-plastic composites
		WPCO		Water Pollution Control Ordinance
		WSD		Water Supplies Department

DISCLAIMER

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