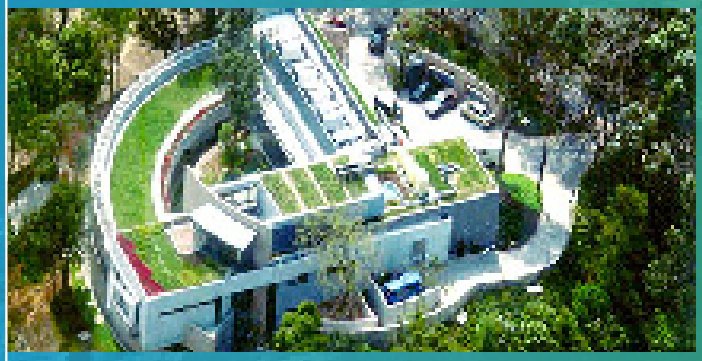
Architectural Services Department

Study on GREEN ROOF Application in Hong Kong

Executive Summary



雅邦 Urbis Limited

in association with
Leigh & Orange Ltd

ARCHITECTURAL SERVICES DEPARTMENT

STUDY ON GREEN ROOF APPLICATION IN HONG KONG

FINAL EXECUTIVE SUMMARY

URBIS LIMITED

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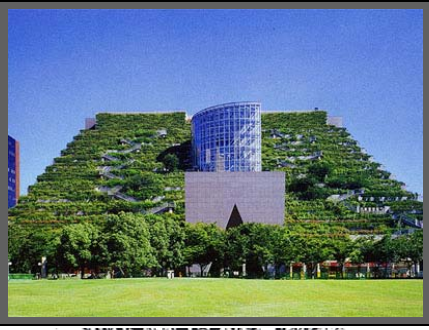
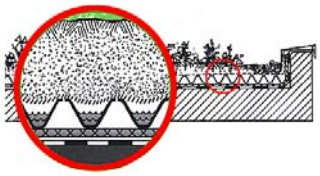
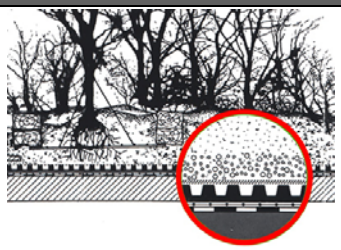
1 GREEN ROOFS OVERVIEW

1.1 BACKGROUND AND GREEN ROOF DEFINITIONS

1.1.1 A 'Green Roof' is a vegetated space that is structurally integrated on top of a man made structure. The word 'roof' in this context refers to any continuous surface designed for the protection of inhabitants from the elements, whether open or closed on the sides. The vegetated space may be below, at, or above grade; located on a podium deck, a 'sky garden' on an intermediate floor level, or at the very top level of the building; but in all cases the plants are not planted in the ground.

1.1.2 There are two main types of green roofs:

- Extensive Green Roofs, that are lightweight, have a narrow plant range, and are geared for low maintenance; and
- Intensive Green Roofs that have deep soils, a wide plant choice and are geared for recreational use by human beings.

	Extensive Green Roof	Intensive Green Roof
		
Typical details		
Brief description	• thin soil (50mm-150mm thick) • little or no irrigation • low maintenance ($0.8/m²/year to $2.25/m²/year) • extensive application over large area	• deep soil (200mm-2000mm thick) • irrigation • normal maintenance ($6.5/m²/year to $44/m²/year) • intensive capital and maintenance input for optimal benefits
Advantages	• lightweight (80 kg/m² to 150 kg/m²) • low maintenance • suitable for retrofit projects • relatively inexpensive ($400/m² to $1,000/m²) • suitable for large areas • suitable for roofs with 0-30° slope • can leave vegetation to develop spontaneously	• diverse utilization of roof (i.e. for recreation, growing food, as open space) with direct benefit to owner • greater diversity of plants and habitats • greater insulation properties • can simulate a wildlife garden on the ground • can be made very attractive • often visually accessible
Disadvantages	• more limited choice of plants • usually no access for recreation or other uses • may be visually unattractive to some in the dry season	• relatively higher cost ($1,000/m² to $5,000/m²) • not usually suitable for green roof retrofit projects • greater weight loading (300kg/m² to 3,300kg/m²) • greater need for energy, water, and materials etc.

(Images: source and copyright © (above) EarthPledge (2005) and (below) Zinco Ltd.)

1.1.3 The Study finds that the green roof industry is well established in Europe, particularly Germany and is rapidly becoming popular in North America and in some parts of Asia.

1.1.4 In Hong Kong *Intensive Green Roofs* are already well-established in the form of podium gardens. *Extensive Green Roofs*, on the other hand, are better-suited to retro-fitting projects which have their own technical constraints, and are not yet well-established in Hong Kong. Despite Intensive Green Roofs being well-established, a consolidated approach to green roof techniques and standards is still needed.

1.2 GREEN ROOF BENEFITS

1.2.1 The benefits of Green Roofs are numerous and well-researched overseas. All of the benefits are of some value to Hong Kong, in varying degrees. These benefits can be grouped as 1) Amenity and Aesthetic, 2) Environmental, and 3) Economic benefits.

Amenity and Aesthetic Benefits

- Leisure and Functional Open Space - In a dense urban environment with limited areas of ground level open space flat roofs present enormous potential in providing urban dwellers with the amenity and recreational space essential for healthy living. In Hong Kong this benefit is deemed highly significant.
- Visual Amenity Value - An obvious and significant benefit of a green roof is the potentially attractive view offered to overlooking buildings. This is of great importance in a dense urban environment such as Hong Kong, where it is considered to have a high significance if a large number of green roofs are established.
- Health and Therapeutic Value - Psychological studies have demonstrated that the restorative effect of natural scenery holds the viewer's attention, diverts their awareness away from themselves and worrisome thoughts and elicits a meditation-like state[1]. This is deemed to have only a moderate significance in the Hong Kong context and largely depends on the location and use of any particular green roof.

Environmental Benefits

- Air Quality - Vegetation has a large surface area and is able to filter out fine air-borne particles. Studies have shown that 1 sq.m. of grass can remove 0.2 kg of airborne particles per year.[2] Foliage can also absorb significant amounts gaseous pollutants lodging the material in their tissue. This benefit is deemed to be of moderate significance but only if large areas are covered.
- Reducing the Urban Heat Island Effect - Hong Kong is no exception to the Urban Heat Island effect, a phenomenon caused by the many hard surfaces which trap latent heat, poor air circulation and a pollution cover which blankets and keeps heat within the city. The addition of green roofs is deemed to be of moderate significance in dealing with this problem, but only if large areas are covered.
- Ecological and Wildlife Value - The enhancement of biodiversity through the use of green roofs is closely linked to the type of vegetation being used. This will probably have a low to moderate significance for Hong Kong and depends on the location and species used.
- Water Management - In urban areas, man-made hard surfaces (roads, paving, roofs, etc.) are impermeable and drainage schemes for these surfaces are devised to remove rainwater from

(1) [1] Ulrich (1992), pp96 & 94

(2) [2] Green Roofs for Healthy Cities Coalition (2002).

them as fast and efficiently as possible. Green roofs slow this process down by reducing the total run-off and by spreading the residual run-off over a longer period, which can dramatically influence a city's infrastructure and maintenance costs. However, unlike many cities where this benefit is a significant incentive for green roofs, Hong Kong's urban form and close proximity to the sea makes benefit of low to moderate significance to Hong Kong.

Economic Benefits

- Building Insulation & Energy Efficiency - One of the most important tangible benefits that green roofs offer the private sector is reduced maintenance and cooling costs due to increased building insulation and energy efficiency. Singaporean studies have measured roof temperatures on a range of materials and vegetation. The conclusions were dramatic - conventional roof day-night temperature fluctuations were as high as 30°C (with peak roof temperatures reaching 57°C). Temperature fluctuations of a green roof, on the other hand, were only around 3°C. Other research in Shanghai shows that room temperature reductions of 2°C can be expected with the addition of a green roof, at least on the top floor of any building.[3] This research also states that other studies have found room temperature reductions to be as much as 4-5°C. Similar supporting research in Singapore translates this into a net annual energy savings of around 15% (results applicable to a five-storey commercial building – the closest available model and climate equivalent to Hong Kong).[4] Local studies have confirmed the findings, showing that roof surface temperatures in Hong Kong can be dramatically reduced by about 18° to 26°C during August [5] and by 10° to 15°C during sunny days in November and December.[6] In Hong Kong, this benefit is considered to have a high significance though the benefits are likely to be appreciated by upper floors only.
- Green Building Assessment & Public Relations - Green building assessment schemes exist in several countries, including Hong Kong (under the HK-BEAM system). Their purpose is to encourage environmentally sound building practice. There is also considerable public relations value in projecting an environmentally conscious image for a building development or organisation. Green roofs can contribute to the credit rating of developments assessed under such schemes and can be a highly visible way in which a development can draw attention to its environmental 'credentials', which may contribute to increased property value. In Hong Kong this benefit is deemed to be of moderate significance.
- Increased Roof Life - Studies have demonstrated that green roofs, when properly constructed, can extend the life of a roof. Degradation by ultraviolet light and the constant expansion and contraction caused by daily extremes of temperature are the prime cause of the disintegration, cracking, delamination and splitting of roofing materials. Green roofs insulate the materials from ultraviolet light and reduce the thermal extremes, thus prolonging roof life. In Hong Kong most developers build to sell immediately, and would thus not reap the long term benefits. This benefit is therefore generally considered to be of low significance in Hong Kong. However, for government owned buildings this benefit would be appreciated and its significance is considered to be moderate.

(3) [3] ZHAO Ding-guo & XUE Wei-cheng (2005)

(4) [4] Wong (2002)

(5) [5] Oriental Daily 25 September 2006, reporting on research findings at HKU by Prof. Jim

(6) [6] Report on Thermal Performance of Roof Green Features at EMSD Headquarters Building, Energy Efficiency Office, EMSD December 2006

1.2.2 Although all green roof benefits will be noticeable, the major benefits for Hong Kong are considered to be:

- Increased *Leisure and Functional Open Space*.
- Increased *Visual Amenity.*
- Improved *Building Insulation & Energy Efficiency*
- Green roofs at a significant scale also contribute towards numerous city-wide environmental benefits. These include improved water-management, air quality and mitigation of the urban heat island effect.

1.3 GREEN ROOF OPPORTUNITIES IN HONG KONG

1.3.1 Hong Kong's urban form, context and climate are unique. In older urban areas with small lot sizes, buildings tend to be tall and finger-like, providing minimal roof-greening opportunities and limited economic/visual benefits. However, newer urban areas tend often to have larger lot sizes with more suitable roof greening opportunities. Hong Kong also has numerous roof-greening opportunities on other infrastructure buildings, such as covered walkways, noise enclosures, ferry piers, pumping stations and vent buildings.

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1.4 GREEN ROOF CONSTRAINTS & CONSIDERATIONS FOR IMPLEMENTATION IN HONG KONG

1.4.1 As intensive green roofs are widely occurring in Hong Kong it is apparent that any constraints presented by the construction of intensive green roofs have already been overcome. The technical issues associated with *intensive green roofs* are well understood by the local construction industry. On the other hand, with no incentive and minimal knowledge about the emerging technologies, there are very few examples of *extensive green roofs* in Hong Kong.

1.4.2 The constraints or barriers against the development of green roofs (which apply in Hong Kong to differing degrees for intensive and extensive green roofs), fall into five categories, namely:

- Lack of knowledge and awareness
- Lack of incentive / statutory mandate
- Economic constraints
- Lack of available roof area
- Technical issues and risks associated with uncertainty

1.4.3 From a physical and climatic point of view, Green Roofs in Hong Kong have their own unique difficulties. These include: 1) high winds, 2) high summer rainfall with low winter rainfall, 3) high & exposed buildings, and 4) Hong Kong has little experience in using low-maintenance plant species that fit the defining criteria of extensive green roofs.

2 DESIGN & TECHNICAL GUIDELINES

2.1 ROOF TYPE SCENARIOS IN HONG KONG

2.1.1 In Hong Kong there are three main green roof scenarios – Sky Gardens, Podium Gardens (New Buildings) and Existing/Low-maintenance Buildings.



(Left) Sky Gardens (Source and copyright © Greenlink Küsters Ltd., 2006), (Centre) Podium Gardens, (Source and copyright © ArchSD, 2005), (Right) Existing Buildings (Source and copyright © Urbis Ltd., 2006)

- Sky Gardens are found on high-rise buildings, usually 20 storeys and above. Sky Gardens are usually designed as part of the building and may be intensive or extensive green roofs depending on their usage. Unique and critical green roof issues often relating to sky gardens include: extreme growing conditions, safety, rooftop utilities, water pressure, waterproofing, hauling of materials, and narrow plant selection for extreme conditions.
- Podium Gardens are usually 2 to 5 storeys high forming the base of a residential or office tower. These gardens are usually intended for full access by the building occupants or the public and are therefore always intensive green roofs. Unique and critical green roof issues often relating to podium gardens include: safe public access (including barrier-free access), safety, refuge floor space, waterproofing, planting design, and critical plant selection criteria (often for very shady conditions in places).
- Existing and low-maintenance buildings include existing office and residential towers and other buildings such as public infrastructure buildings. Due to weight constraints and the need for low maintenance, extensive green roofs would generally be prescribed. Unique and critical green roof issues often relating to existing and low-maintenance buildings include: state of the existing roof, structural loading capacity and waterproofing, safety (for maintenance primarily), critical growing media (lightweight, inert, well-drained, well-aerated, fire-resistant and nutrient retentive) and critical plant selection criteria (which grows in lightweight shallow soils, is wind and drought tolerant, and has non-invasive roots).

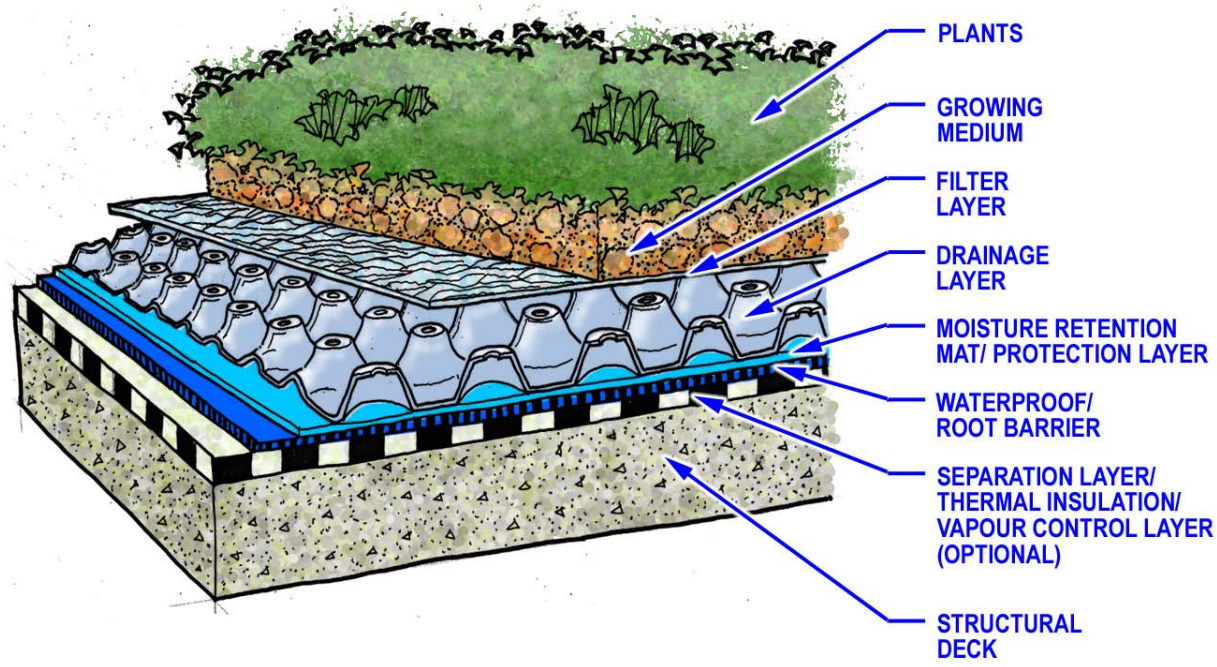
2.2 DESIGN & TECHNICAL GUIDELINES

2.2.1 Green roofs are feasible on any properly designed roof deck, including steel, wood, concrete, plastic or composites, as long as the necessary structural considerations are met. The basic components of green roof systems are basically the same for *intensive* and *extensive green roofs* and are presented in the figures below. Numerous specialised layers may vary from the figures below and may cater for unique conditions such as steep slope scenarios. The basic functions of these systems include 1) weatherproofing the roof, 2) protection of the roof surface from root penetration, 3) drainage, and 4) support and growth of the vegetation layer.

Waterproofing

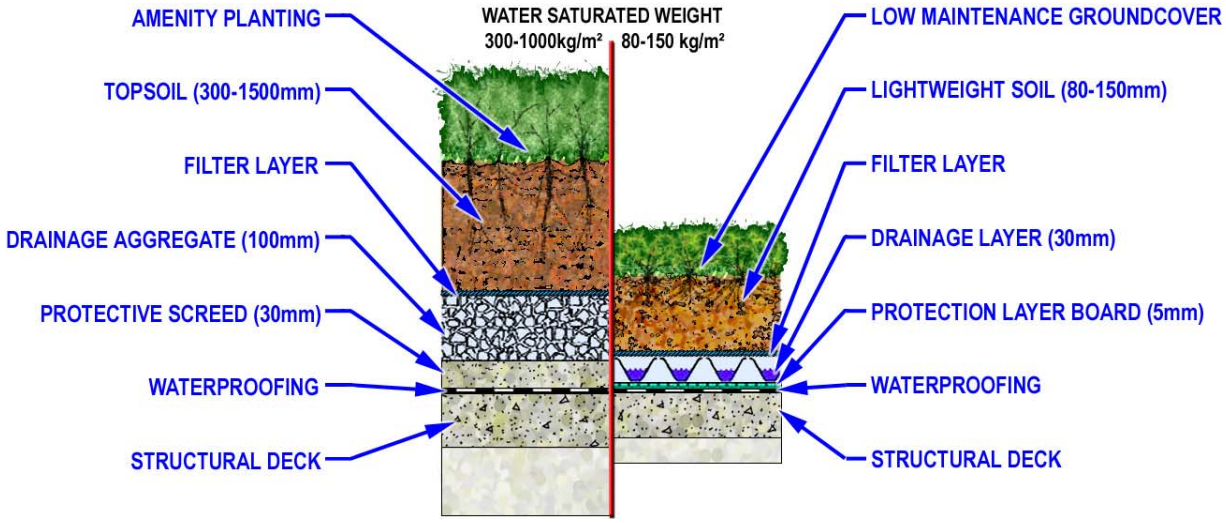
2.2.2 As with any roofing, waterproofing is arguably the most important pre-requisite of a green roof. Numerous waterproofing systems exist which include 1) *bitumen/asphalt roofing felt or bituminised fabrics*, 2) *SBS modified bituminous membrane sheets set in SEBS polymer modified bitumen* and *coal tar pitch/polyester built-up systems, 3) Fluid Applied Membranes*, 4) *Single-ply roof membranes,* and 5) *Concrete admixture water-proofing.*

Basic Components of a Green Roof System (Intensive and Extensive)



(Source and copyright © Urbis Ltd., 2006)

Conventional (Intensive) and Lightweight (Extensive) Green Roof Systems



(Source and copyright © Urbis Ltd., 2006, adapted from drawings from Greenlink Küsters Ltd.)
Note: Intensive green roof weights of 300-1000kg/m² refer to the most shallow soil depth needed for amenity groundcover or lawn grass (300mm). A soil depth conducive for successful tree growth (1500mm deep) is likely to weigh around 3300kg/m², excluding the weight and wind-loading pressure of the trees.

Root Barrier

2.2.3 In lightweight extensive green roofs root-barrier protection is often part of the waterproofing. A separate root protection barrier is needed if the waterproofing layer contains bitumen, asphalt, or any other organic material because any penetration by roots also provides access for micro-organisms which can attack these organic oil-based materials. Intensive green roofs may need a far more robust root protection system capable of withstanding the penetration of tree roots. These are often thick hard plastic sheets or even metal sheets (usually copper) for exceptionally vigorous roots.

Protection Layer

2.2.4 Protection layers are usually a non-woven geo-textile that protects the waterproofing from mechanical damage. The application of protection layers is more critical if the drainage layer uses a more primitive granular mix. Protective screeds are conventionally used in intensive green roofs.

Drainage Layer and Filter Layers

2.2.5 The main purpose of the drainage layer is to drain excess water or underflow as rapidly as possible to prevent prolonged saturation. The operative word is excess, meaning that drainage is only necessary if the growing medium has reached saturation point. The drainage layer also helps to aerate the substrate. Providing internal airflow, below and through the substrate, the drainage layer also helps to reduce the vacuum which occurs due to wind uplift along the edges of an extensive green roof that has no parapet edge. There are three main types of drainage materials: 1) *Granular Materials* (gravel, stone chips, broken clay tiles, clinker, scoria (lava rock), pumice, expanded shale, or LECA), 2) *Porous mats* (made from numerous materials including recycled materials such as clothing and car seats, and behaving much like sponges), and 3) *Lightweight plastic or polystyrene drainage modules* (made of High Density Polyethylene or High Impact Polystyrene, some designs store reserve water allowing plants to derive additional moisture).

2.2.6 The filter layer prevents fine material being washed down into the drainage layer. Non-woven filter layers are ideal for most circumstances (having superior filtration) though woven versions may be considered for heavy duty applications.

Growing Medium / Substrate / Soils

2.2.7 The general requirements of all growing media are the same, namely: 1) efficient moisture retention, 2) excess water easily drained, 3) well aerated 4) able to absorb and supply nutrients, 5) retains its volume over time; and 6) provides adequate anchorage for plants. Additional requirements important for green roofs include: 1) being light weight, 2) having adequate water retention capacity; 3) being inert in a sub-tropical climate; and 4) having fire resistant properties. Lightweight growing media may be created using natural, artificial, or waste minerals. Lava (scoria) & pumice, perlite, vermiculite, light expanded clay aggregate (LECA), rockwool, and numerous other materials are typically used.

Lightweight Fills and Thermal Insulating Layers

2.2.8 Lightweight fills are used primarily on Intensive Green Roofs to create differences in level. Another use may be to create sculptural contours to hide utilities or to liven up the flat surfaces commonly associated with extensive green roofs. Lightweight fills are usually made of some expanded material which has air in it. As such they are often very good thermal and acoustic insulators. In extensive green roofs they are sometimes used only for these reasons - as a *thermal insulating layer*. Lightweight fills include: 1) *Extruded Polystyrene Sheets*, 2) *Polystyrene Cement 3) Autoclaved Aerated Concrete, 4) Foamed Concrete* and 5) *Other Cements (perlite, vermiculite, and LECA)*.

Irrigation

2.2.9 There are three principal ways of irrigating green roofs: 1) *Manual Hose Irrigation* – typically a 20m hose pipe connected to water points every 40 metres, 2) *Fully Automatic Irrigation Systems* - a programmed system that irrigates at set times, running continuously with minimal supervision; and 3) *Semi-Automatic Irrigation Systems* - a programmed system with various manual override options that are activated as needs require. Manual watering (with hose) is reliable, robust and tried-and-tested. Its main draw-back is its high labour costs. Automatic irrigation systems are controlled (usually electrically) to irrigate areas of planting without human intervention. They are able to deliver precise water quantities at very specific times. For automated irrigation systems there are two major dispersal categories:

- *Sprinkler Head Systems* which are more robust but not as accurate as other dispersal systems with water being lost due to wind and evaporation (a constraint on many green roofs).
- *Drip Irrigation Systems* deliver a more efficient use of water but are more expensive and are prone to deterioration under UV light (a constraint often associated with many green roofs).

2.3 MAINTENANCE CONSIDERATIONS

2.3.1 *Extensive green roofs* have been developed specifically to be low-maintenance. *Intensive green roofs,* on the other hand, are built for human usage and have maintenance considerations directly comparable to the maintenance of amenity planting at ground level locations.

2.3.2 Maintenance requirements of green roofs are determined by many factors – height, micro-climate, soil types, soil depth, irrigation, species used and access.

2.3.3 (Access is most often the most crucial factor influencing maintenance costs). Hong Kong's sub-tropical climate (high rainfall and humidity) necessitates higher maintenance requirements than in temperate climes. It remains to be determined whether the almost-zero maintenance achieved on some extensive green roofs in Europe can be achieved in Hong Kong. Maintenance operations include:

- Waterproof Inspections
- Drainage Inspections
- Removal of Litter
- Electricity and Lighting
- Plant Health Inspections
- Replacement planting
- Irrigation
- Pruning
- Mowing & Grass Cutting
- Fertilizing
- Disease & Pest Control
- Weeding

2.4 GREEN ROOF COST ESTIMATES FOR HONG KONG

2.4.1 Other major considerations are capital and recurrent costs. In Hong Kong, the "extra over" capital costs associated with Green Roofs (for both Extensive and Intensive Green Roofs) are not high relative to total building costs.

- Intensive Green Roofs usually range from $ 1,000 /m² to $ 5,000 /m² (market average: $2,000/m²)[7]
- Extensive Green Roofs usually range from $ 400 /m² to $ 1,000 /m² (market average: $500/m²) [8]

2.4.2 Recurrent costs are also not high. The maintenance labour requirements associated with intensive green roofs are directly comparable with those associated with at-grade park operations, which vary widely between easily accessed sites to very inaccessible or remote sites. The maintenance requirements for extensive green roofs are untested in Hong Kong. Beijing and Shanghai experience shows that as little as 1 to 3 minutes per m² per year is needed for extensive green roofs (if designed correctly and with low-maintenance plants). These facts translate into the following recurrent costs:

- Intensive Green Roofs usually range from $ 6.5 /m²/year to $ 44 /m²/year (average: $20/m²/year) [9]
- Extensive Green Roofs are estimated to range from $ 0.8 /m²/year to $2.25 /m²/year.

3 RECOMMENDATIONS

3.1 GREEN ROOF DIRECTIONS FOR HONG KONG

3.1.1 The most significant Green Roof benefits for Hong Kong are: A) to increase the amenity of the city, B) to increase the usable green space, and C) to improve building energy savings. Consequently, it is considered that Intensive Green Roofs should continue to be promoted as the prime direction for the future of green roofs in Hong Kong. Extensive Green Roofs could be considered for retro-fitting projects, after assessing technical, management and maintenance constraints, for situations where intensive green roofs are not practical.

3.1.2 The long term objective of green roofs is to achieve collective environmental benefits through city-wide application. Various steps are needed to achieve this. They are divided below into Short, Medium and Long Term Goals.

(7) [7] Capital costs for intensive green roofs include all components above the roof slab. Conventional Quantity Surveying methods are not done in a manner which allows for discrete isolation of total green roof costs from other building costs. The range of figures provided ($1000/m² to $5000/m²) should be used as a rough guide only having been derived from a small sample size. The average capital costs of $2000/m² is based on two publicly accessible roof gardens currently being built above new KCRC and MTR stations in Hong Kong (assessed independently). These sites are easily accessible with components and finishes that are not overly costly (soft-landscaping components are estimated to cost around $800/m² and hard-landscaping costs around $3200/m²). The highest end of the typical green roof range is estimated to be around $5000/m² and is based on a roof garden currently being built as part of a Macau casino complex. It has elaborate and thematic designs and finishes, is more difficult to access on a 5 storey podium, and has a separate landscaping contract resulting in very expensive crane operations being hired separately. Higher costs are theoretically possible but the practical range of $1000/m²-$5000/m² is currently based on real projects.

(8) [8] Capital costs for extensive green roofs are usually built as retro-fit projects and are therefore easily isolated into discrete green roof costs. The range of $400/m² to $1000m² is based on several local quotations and on the prices available for a variety of materials that may be used. Capital costs include all components above the roof slab.

(9) [9] Recurrent costs for intensive green roofs are highly dependant on access and costs associated with the type of green roof being installed (i.e. its usage). Typical podium roof garden horticultural costs are estimated to be around 30% higher than at-grade costs. The horticultural costs are estimated to cost between $6.5/m²/year to $20/m²/year. Additional costs may push this value up to $44/m²/year if: 1) the site is difficult to access, 2) there are dangerous working conditions, 3) small areas are covered, 4) refuse collection is expected in high traffic areas, 5) problematic pests are encountered, 6) if high maintenance plants are used and 7) if electricity and lighting costs are included. The average recurrent cost for intensive green roofs (all-inclusive) is therefore estimated to be around $20/m²/year.

3.2 RECOMMENDATIONS AND THE WAY FORWARD

Short Term Recommendations

3.2.1 *Dissemination of information* through the media is recommended to actively promote green roofs and to foster better understanding of their potential benefits.

3.2.2 *Trade Shows* demonstrating green roof technologies are recommended for Hong Kong.

3.2.3 *Engaging with stakeholders* (including real estate professionals, construction industry representatives, developers and suppliers) is recommended to encourage green roof development in Hong Kong.

3.2.4 *Government should lead by example* by continuing to implement green roofs on all new buildings, and to review the retro-fitting of green roofs for existing roofs.

3.2.5 *Introducing rating systems and elements of competition* should be maintained and strengthened by expanding the role of green roofs in CEPAS and HK-BEAM labelling systems, especially after local data and research on building efficiencies is available.

3.2.6 *Pilot schemes and further research* is needed to fulfil the need for more local information on green roofs. Information is needed to more accurately determine: 1) changes to ambient temperature, building surface and interior temperatures; 2) changes in pollution and particulate levels; and 3) changes in water runoff. The goal is to accurately determine building energy efficiencies applicable to Hong Kong's unique climate and building forms. Further horticultural research is also needed to determine the viability of different species for extensive green roofs.

Medium and Long Term Recommendations

3.2.7 *Collating citywide scientific data* on green roofs is recommended. This would involve doing cost-benefit analysis studies to establish the geographical extent to which green roofing could be achieved in Hong Kong, and the resultant benefits that would be enjoyed by the community. This could take the form of a G.I.S. study. Monitoring of green roofs on a regular basis is also recommended. This would provide knowledge of the progress over time and would assist the formulation of effective policies and incentives to promote green roofs.

3.2.8 *Developing reliable standards* (e.g. similar to Germany's FLL Guidelines) is suggested to promote industry confidence and to prevent low-quality products and construction from entering the market. Although podium gardens are well-established in Hong Kong, there are still no standards ensuring quality in this field. The development of standards should cover extensive and intensive green roofs.

3.2.9 *Reviewing Government policy* is suggested to maximise the amount of greening possible in the city, after collective environmental/economic benefits have been proven and are supported by public consultations. There are numerous green roof policies around the world that may be considered and adapted for Hong Kong's needs. These policies used abroad should always be viewed in the context of each city's physical composition, social values and individual case settings. The approaches adopted elsewhere should not necessarily be copied directly in Hong Kong. Also, Hong Kong requires a thorough understanding of the costs and benefits, technical standards, horticultural requirements and unique market forces before evaluating the need and direction of policy and regulations. It is therefore premature, at this stage, to make recommendations on policy. There are many concepts tried elsewhere that may be considered. These include: 1) *Direct Incentives to the Private Sector*, such as cash grants towards capital costs, 2) *Indirect Incentives to the Private Sector,* such as GFA bonuses for the provision of green roofs, or even 3) the introduction of the *Polluters Pay Concept,* based on the "eco-tax/carbon tax" concept against polluters, where the provision of a green roof might be used to reduce this tax because of its contribution towards energy efficiency.