

GREEN ROOF SCHEME



20th Dec 2010

Hong Kong Architecture Centre

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Organizer



Co-Organizer



Source of Funding



Project Dissemination

Presentation of Findings

- Introduction (Phase 1 – Phase3)
- Summary of Phase 1 Feasibility Stage and dissemination
- Phase 2 Implementation Stage
- Phase 3 Maintenance Stage
- Way Forward

PROJECT STAGES

Phase 1 – Feasibility Stage

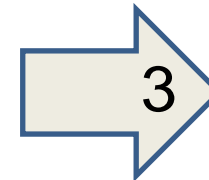
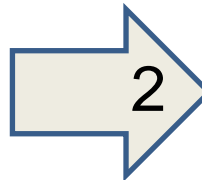
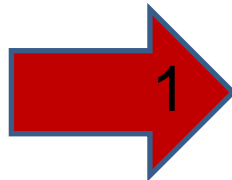
Investigate and evaluate the possibility to install sustainable features and greenings on existing roof tops of schools.

Phase 2 – Implementation Stage

Design and propose schemes of implementation; construct with participation of students to ensure knowledge of sustainability is disseminated.

Phase 3 – Maintenance Stage

Monitor the usage of newly implemented 'Green Roofs' through bi-weekly visit and record any findings in report format.



All stages with Knowledge Dissemination

STAGE 1 DISSEMINATION

Feasibility Stage

Investigate and evaluate the possibility to install sustainable features and greenings on existing roof tops of schools.

Knowledge Dissemination at Stage 1

August 2008	Meeting with School Representatives
September 2008	Visit to School with Green Roof installed
October 2008	Sharing Session
November 2008	Workshop #1
March 2009	Workshop #2
January 2010	Feasibility study report findings
August 2010	Presentation of Feasibility Stage

SUMMARY of FINDINGS (Stage 1)

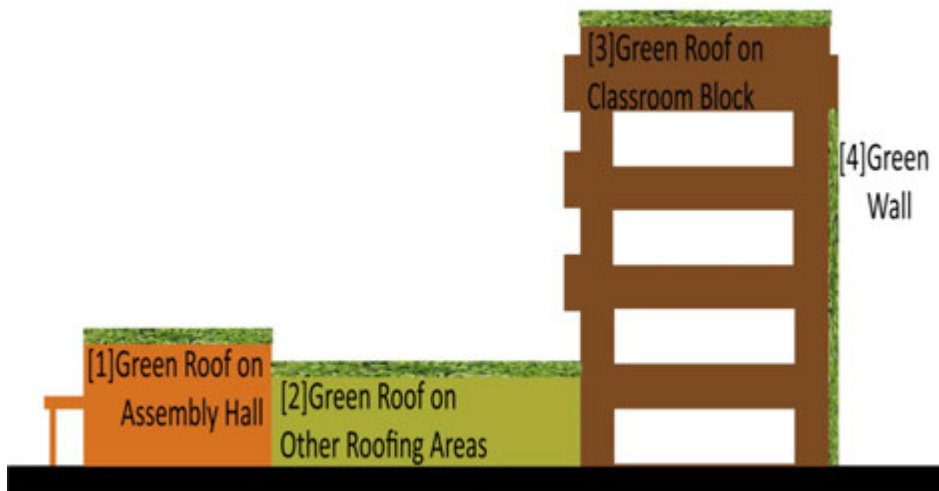
1. Site Inspection Findings
2. Green Roof Design Solutions



Background Information

Year of Construction	No. of Schools
Before 1960s	1
1960s to 1970s	3
1970s to 1980s	1
1980s to 1990s	4
1990s to 2000s	6
2000s to 2010s	2

Location of Green Roofs



Location of Green Roof	No. of Schools
[1] only	0
[2] only	8
[3] only	2
[4] only	1
[1] + [2]	1
[1] + [3]	1
[1] + [4]	0
[1] + [2] + [3] + [4]	0
[2] + [3]	1
[2] + [4]	0
[3] + [4]	1
[1] + [2] + [3]	2
[1] + [2] + [4]	0
[1] + [3] + [4]	0
[2] + [3] + [4]	0
TOTAL	17

Planting System

Selection of Planting System	No. of Schools
Planter Area (extensive, thin soil) (with planting) only	2
Organic Cultivation Area (thick soil) (without planting) only	0
Both planter area and organic cultivation	15

Summary

- A total of around **1,950sqm** of extensive, thin soil **planter area** is provided, per calculation of the quantity surveyors (QS);
- A total of around **500sqm** of thick soil **organic cultivation area** is provided, per calculation of the quantity surveyors (QS);

Total Solution



[1]Solar Panels



[2]Micro Wind Turbines [3]Irrigation System



[4]Fences/ Gates

Choice of Renewable Energy	No. of Schools
[1] only	0
[2] only	0
[3] only	0
[4] only	0
[1] + [2]	0
[1] + [3]	7
[1] + [4]	0
[1] + [2] + [3] +[4]	0
[2] + [3]	0
[2] + [4]	0
[3] + [4]	0
[1] + [2] + [3]	0
[1] + [2] + [4]	0
[1] + [3] + [4]	6
[2] + [3] + [4]	4
TOTAL	17

Remark: 1 school with potential water leakage

Structural Assessment

- Assume the loading capacity of accessible roof is 2kpa, and that of non-accessible roof is 0.75kpa.
- Soil depth for planter area should not exceed approx.120mm, and that for organic cultivation area should not exceed approx.240mm.
- Retain space to spread loading, of organic cultivation, within a particular structural grid.
- All remedial works must be completed prior to the beginning of Green Roof implementation.
- Due to structural constraint, to exhaust possible Green Roof systems with minimum loading.
- Since the limited structural loading of existing roof is already taking up by the green roof system, gathering and other student activities should be taken place in the surrounding areas, not on the top of the Green Roof planters.
- No. of students and teaching staff to access a Green Roof per time must be limited.
- No structural strengthening works is anticipated.

Safety and Accessibility



- To install fence and gate to avoid students and staff to reach the roof edge, plant rooms, micro wind turbines, irrigation tank, pump room control panel, etc.



- The lowermost 150mm of a protective barrier not less than 1100mm should be built solid.
- Widening of exit doors to 900mm wide should be carried out wherever necessary.



- New connection between corridor and assembly hall roof wherever necessary.

Waterproofing status

- Both thorough building survey and testing on potential water leakage must be done prior to the installation of Green Roof System.
- Both separation layer / membrane and drainage & filter layer are required to be in place prior to the installation of planters and irrigation system.

Drainage and Irrigation system

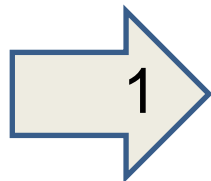
- All roofs have existing drainages, but need to be protected from blocking during and after the installation of Green Roof System.
- Equipment such as water recycling plant can be located on the roof of the adjacent annex block / building if applicable.
- Schools without existing water and electrical supplies on the roofs can consider branching out from the existing provision.



PROJECT STAGES

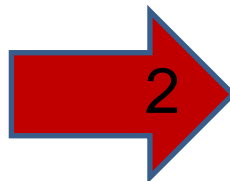
Phase 1 – Feasibility Stage

Investigate and evaluate the possibility to install sustainable features and greenings on existing roof tops of schools.



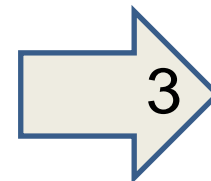
Phase 2 – Implementation Stage

Design and propose schemes of implementation; construct with participation of students to ensure knowledge of sustainability is disseminated.



Phase 3 – Maintenance Stage

Monitor the usage of newly implemented 'Green Roofs' through bi-weekly visit and record any findings in report format.



All stages with Knowledge Dissemination

Stage 2 – Implementation Stage

Introduction

Viability of installing sustainable energy equipments, such as wind turbine and Photovoltaic (PV) Module, is subject to the findings of feasibility study. The most feasible option will be selected for each school.

In the implementation and maintenance stage, we will seek separate approval for funding by ECF again. Schools will be divided into packages; each package will consist of a number of schools. Tender will be put forward for each package.

Cost of knowledge dissemination, subject to selection of activities and means to share knowledge & experience, will be proposed in details and submitted separately for ECF committee's approvals in the forth-coming stages.

Key Items to be included in Stage 2

Once schools are proven to be feasible for the implementation of 'Green Roof' and the sustainable provisions, they will be organized into packages for the Implementation and Maintenance Stages. Cost will be estimated based on the building works and associate renewable energy provisions per school are as follow:

1. Vegetation for Green Roof – Extensive
2. Automatic Watering Sprinkler / Drip Irrigation System
3. Wind Turbine (optional)
4. Photovoltaic (PV) Module (optional)
5. Measuring Equipments
6. Maintenance of Vegetation and Water Sprinkler
7. Maintenance of Wind Turbine (optional)
8. Maintenance of PV Module (optional)
9. Project Design and Management Fee (12% of Sub Total) (various)
10. Contingency (10% of Sub Total) (various)

General items to be included in Stage 2

1. Clearance of any blocked drains / outlets and cleaning before commencement works
2. Inspection, survey(s) and ponding test, waterproofing test & similar
3. Replacement of existing roofing and roof coverings and changes to existing roof drainage elements
4. Rain sensors, moisture sensors, weather station or automatic irrigation provisions
5. Enlargement of doorways and replacement of door & ironmongery (in a few cases)
6. Additional conventional power provisions and lighting provisions

General items to be included in Stage 2

8. Plants to be Organic Cultivation Areas (if any)
9. Garden furniture
10. Initial maintenance and establishment
11. Spares and replacement parts
12. Consultant fees and reimbursable
13. Fluctuation in prices between September 2009 and time of commencement of work
14. The temperature measuring instruments could be installed inside the classroom for continuous measurement.
15. Spaces for astronomy and/or meteorological activities to be reserved.

Special items to be included in Stage 2

Special items to be included in the cost estimation for Stage 2 (in some schools wherever applicable)	No. of schools applicable
Mains back up to drip irrigation system	9
Improvement works to existing green roof	1
Monitoring system for the micro wind turbines	6
Maintenance service fee for the micro wind turbines	6
Structural certification for the structural supports for the micro wind turbines	6

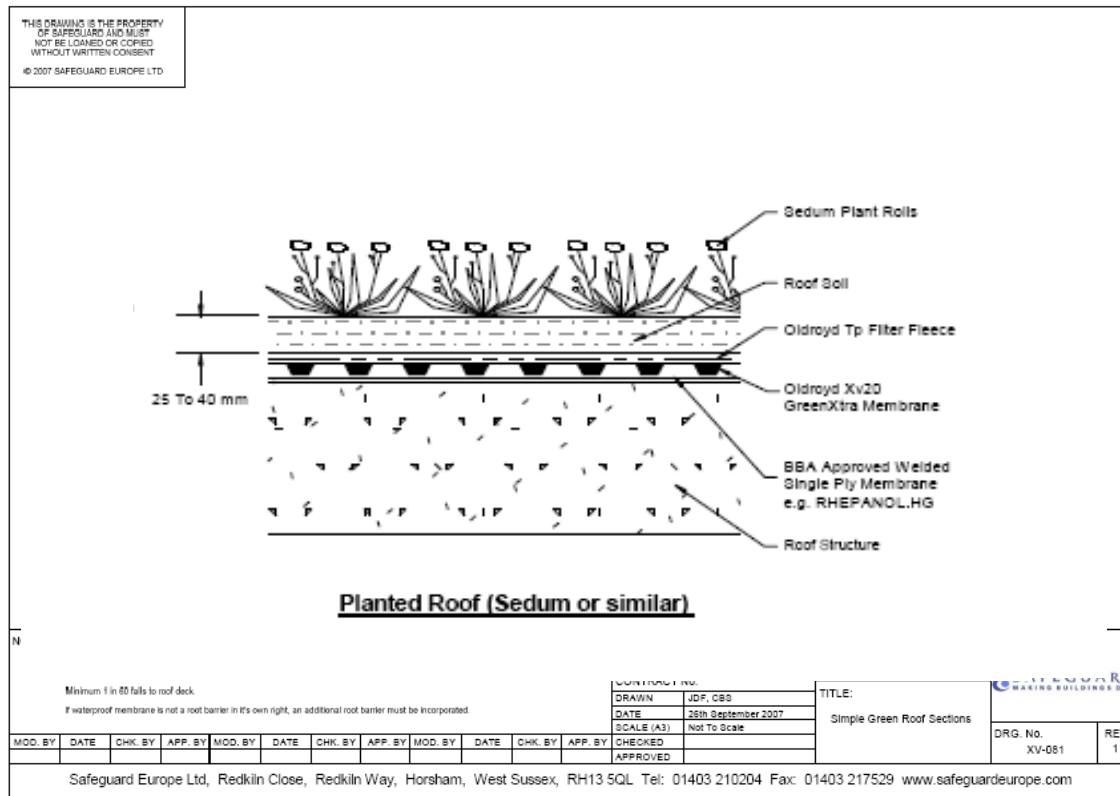
Special items to be included in Stage 2

Special items included in the cost estimation for Stage 2 (in some schools wherever applicable)	No. of schools applicable
Structural certification for the structural supports for additional lightweight metal catwalk	1
Provisions for connection to grid for PV system	11
Software and Monitoring System for PV system (simple monitoring system is provided)	11
RSE design and endorsement to government departments for PV system	17
RSE design and endorsement to government departments for connection bridge	1

Special items to be included in Stage 2

Special items to be included in the cost estimation for Stage 2 (in some schools wherever applicable)	No. of schools applicable
Enclosure or new protection measures for existing pipe work running on floor of roof	4
Fence and gate barrier or enclosure to elements such as PV panel, irrigation tank & pump (if required)	2
"More lighting, proper drains, guard rail with smaller mesh to avoid children climbing up on the fence, improved accessibility"	1

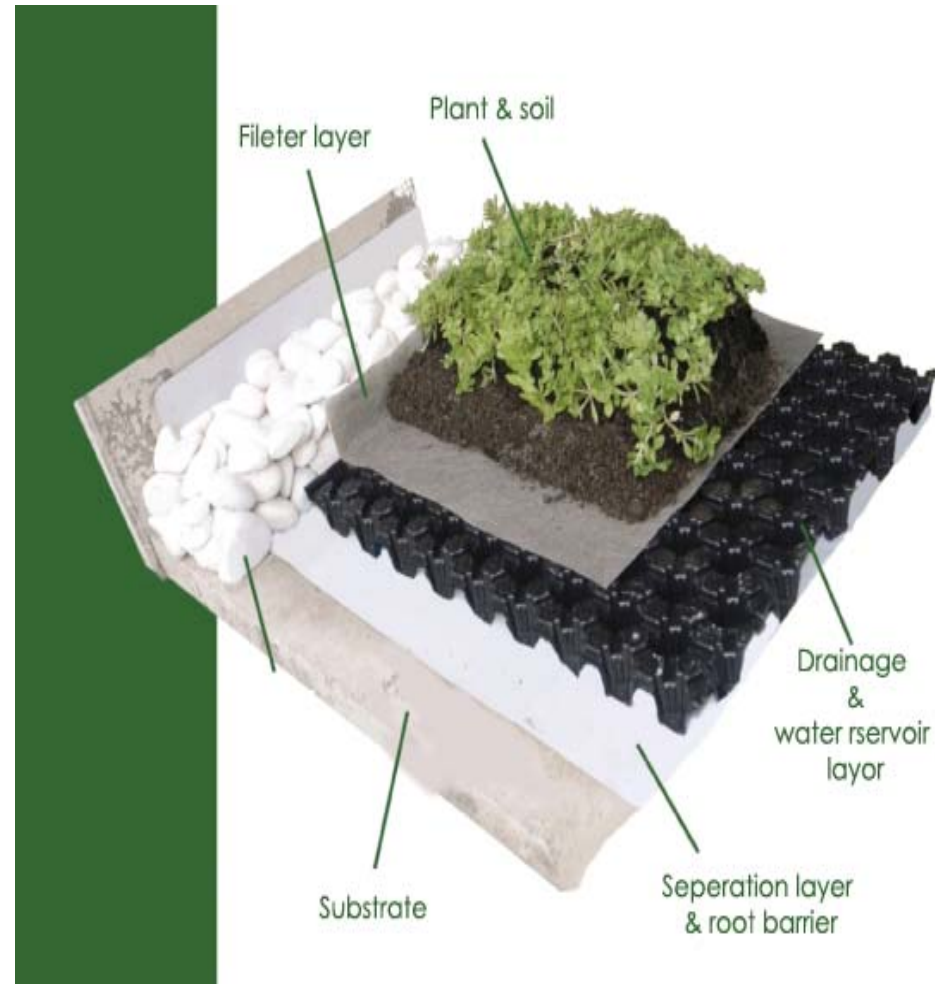
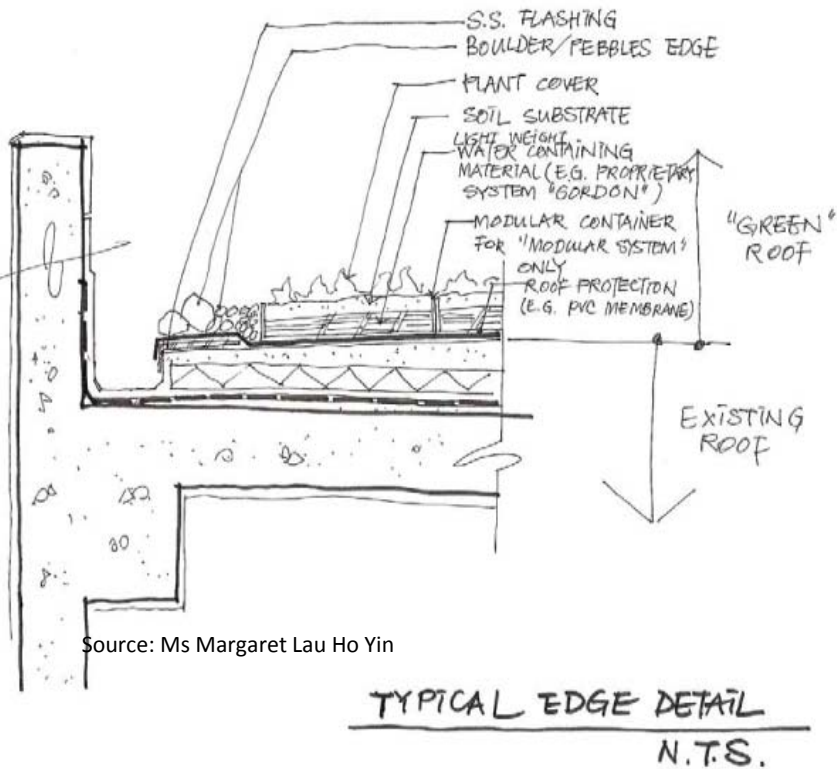
Green Roof Systems



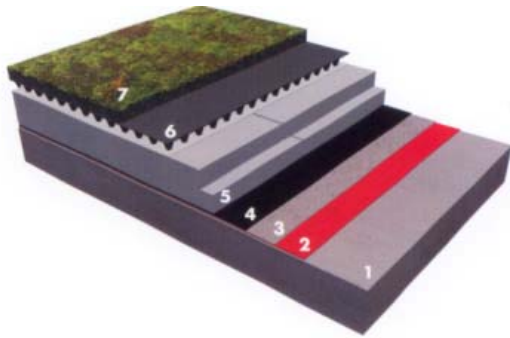
Indicative photos/diagrams of green roof systems, actual systems may be different to the pictured.

- <http://www.safeguardeurope.com/application>
- (Source: http://www.safeguardeurope.com/applications/green_roofs_flat.php)

Green Roof Systems (Option1)



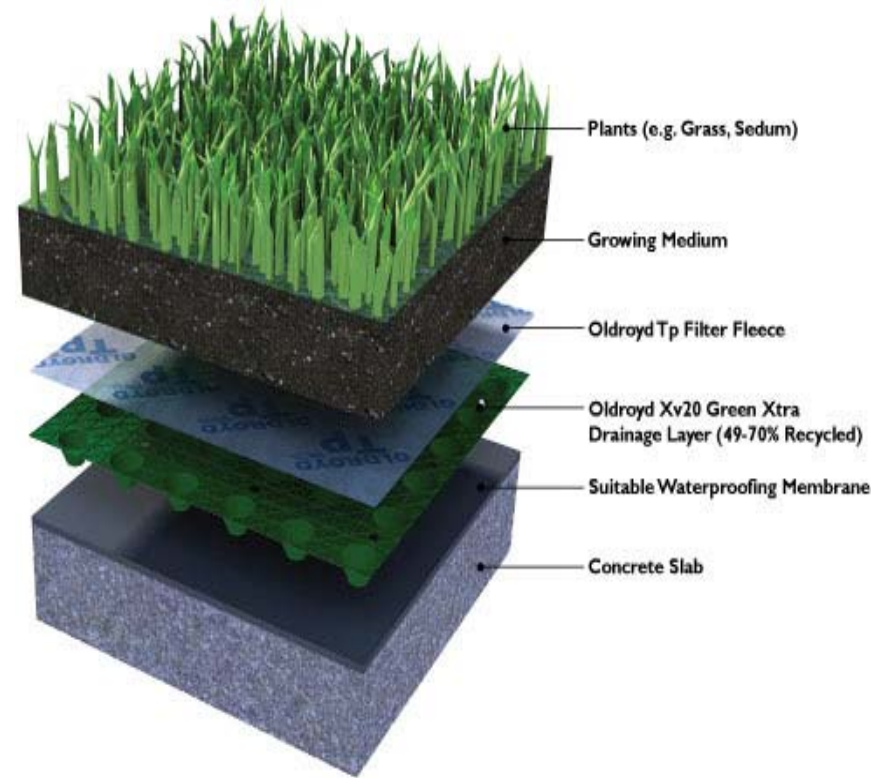
Green Roof Systems (Option2)



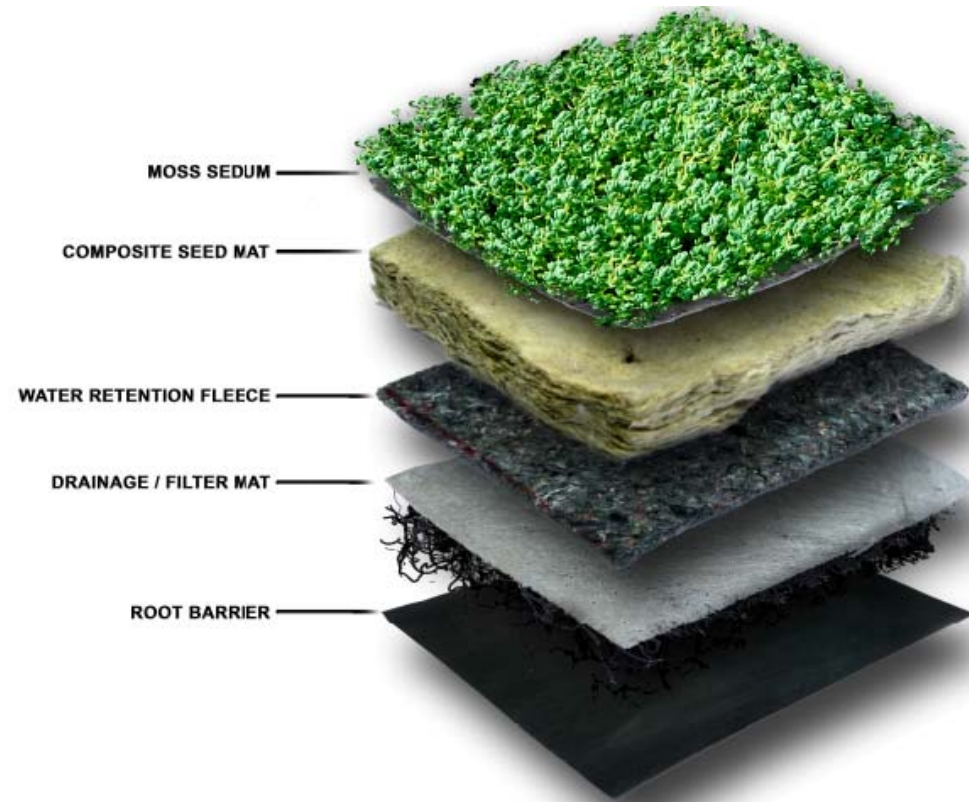
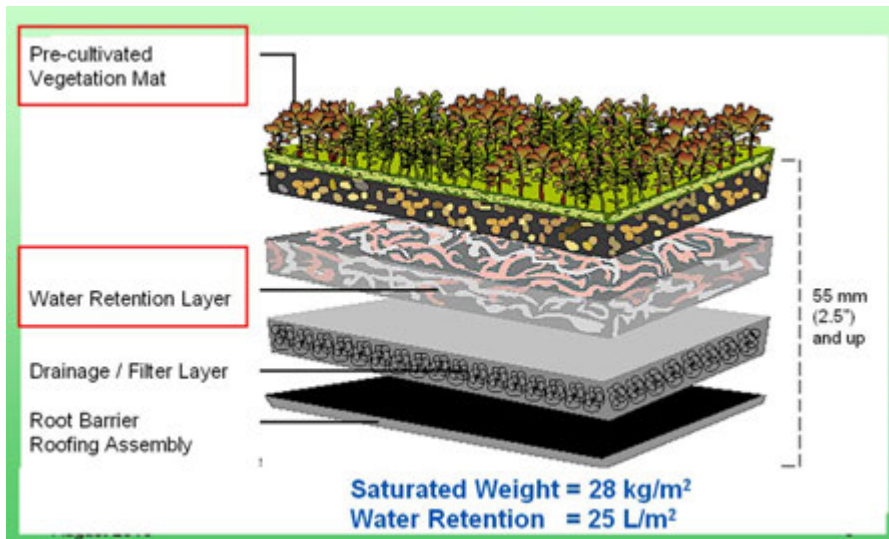
Extensive Green Roof System Flat

7. Sedum & Growing Medium
 6. Drainage Layer and Geotextile
 5. Liquid Plastics' Inverted Roof Board
 4. Decothane Roof Resistant Top Coat
 3. Reemat Premium
 2. Decothane Roof Resistant Base Coat
 1. Roof Deck
- Wet weight: 80kg/m²

There are many proprietary systems available in the market for Green Roof System. The main concept is to keep the existing roof finish and structure intact. A separation layer of membrane is required. Then a drainage and water retaining layer will be laid underneath the growing medium. Depending on the types of plants, the thickness of the growing medium can be adjusted from minimum of 40mm to maximum 200mm as far as the roof can withstand the imposed loading.

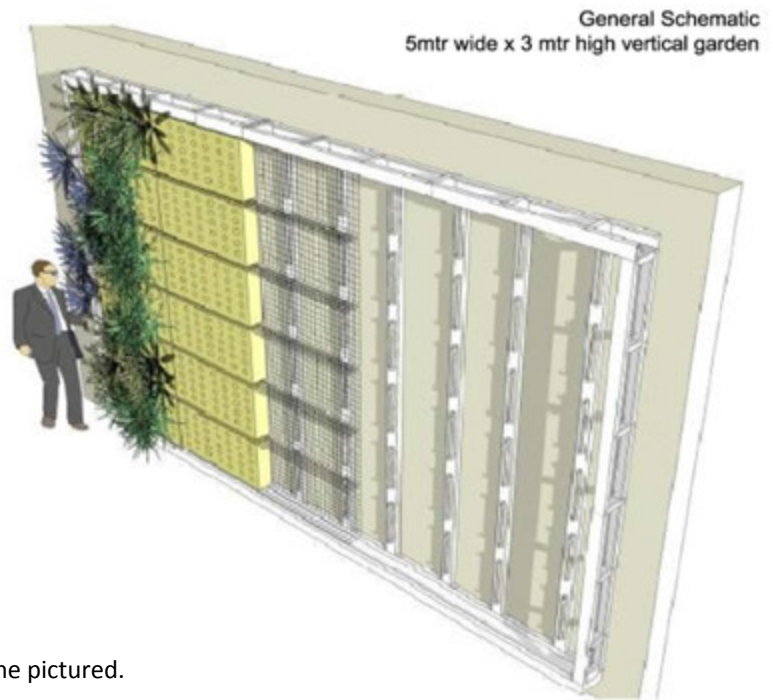


Green Roof Systems (Option3)



Green-wall System

A green wall system is an alternative to a horizontal planter system. A green wall acts as a medium for planting where the plants are planted on the vertical surface. Due to the limitation of structural loading imposed on the roof structure, a structural analysis is advised before implementation of the green wall system.



Indicative photos/diagrams of green wall systems, actual systems may be different to the pictured.

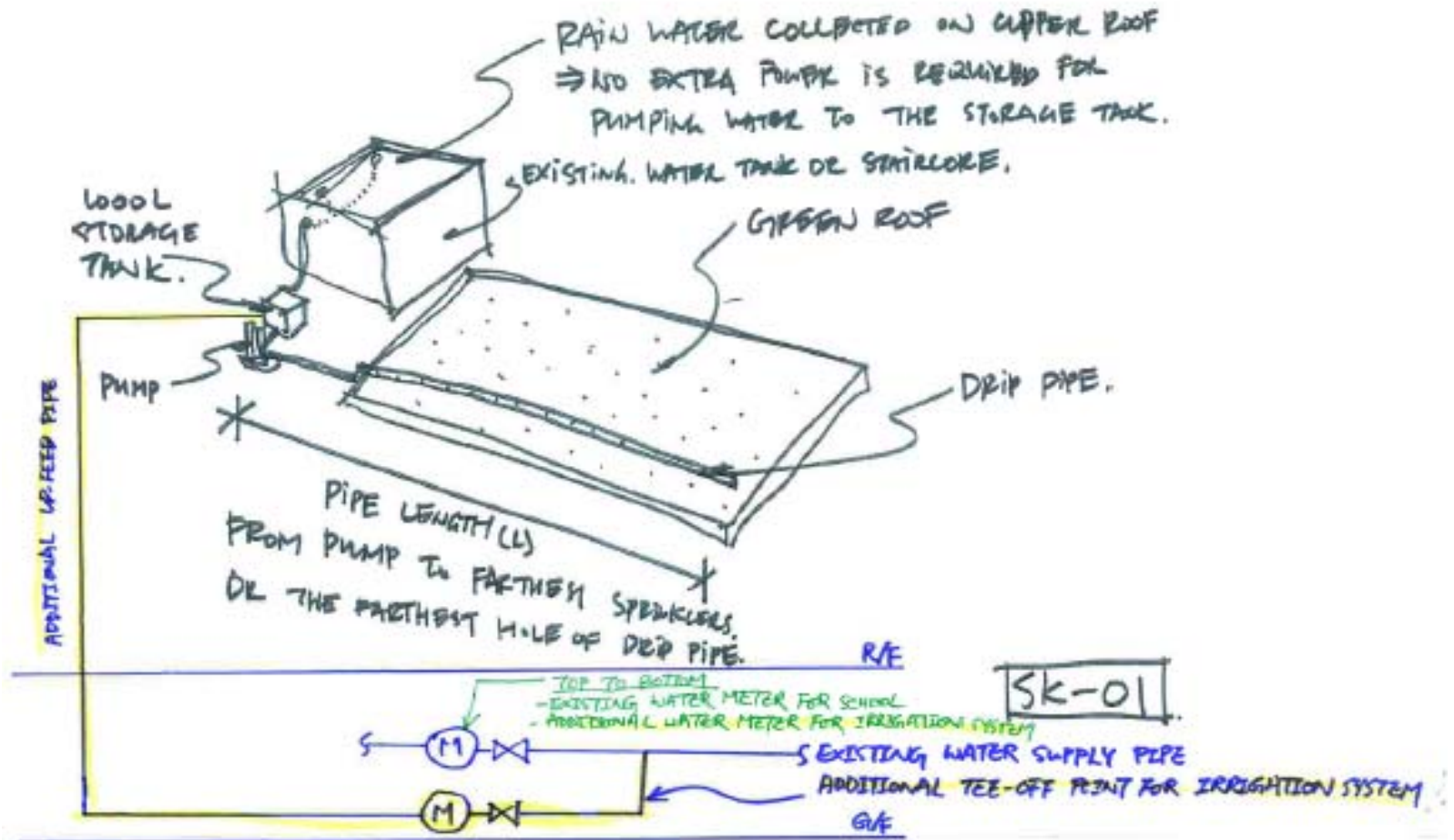
Selection of Plants

- Under the current statutory requirement, students and school staff are not recommended to stay or walk on the planters / planting areas due to loading issue.
- Apart from record taking and maintenance, no school activities is to be arranged on the entire roof area after the implementation of Green Roof system. Such arranged could be reviewed.
- The total number of people to access the roof area per time could be limited after the installation of Green Roof system for activities there.



In adopting an extensive Green Roof system, the relatively shallow growing medium means they are much lighter in weight than intensive Green Roof system. The plants selected require low maintenance and are short growing, hardy species such as sedums, mosses and herbaceous plants, which are not designed for foot traffic.

Irrigation & Drainage



1. Downpipe filter (also acts as tank overflow)
2. Submersible pump with integral flow controller and dry running protection
3. Suction filter
4. Junction box
5. Weatherproof mains socket outlet
6. Tank access cover
7. Isolating valve
8. Further tanks may be added to increase capacity

Renewable Energy as Supplementary Electricity Sources

Micro Wind Turbines



Photovoltaic (Solar) Panels



Micro Wind Turbines or Solar (photovoltaic) Panels are proposed to provide necessary power supply to the water pump and filter. Depending on the site conditions, on a site with large buildings to cast shadows on the solar panels, wind turbines will be used where as on a site with good south facing area with little or no obstruction to this sun light, solar panels can be used.

Stage 2 – Implementation Stage

Application for Stage 2

Budget to include, but not limited to, the following items:

1. Budget for rain water collection system
2. Professional fees (e.g. fee to hire an authorized person)
3. Timber stud works
4. Lightning diversion system
5. Cost of any other man-power

Stage 2 – Implementation Stage

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GREEN ROOF SCHEME - IMPLEMENTATION STAGE

Schedule of Work - Flow Chart

ID	Task Name	Critical Path	Duration (weeks)	Month #1	Month #2	Month #3	Month #4	Month #5	Month #6	Month #7	Month #8	Month #9	Month #10	
1	Engagement of Consultancy	Y	6											
2	Engagement of Project Manager		6											
3	Detail Design	Y	4											
4	Structural Assessment and Certification	Y	-											
5	Submission to Government Departments	Y	8											
6	Confirmation by Schools		3											
7	Preparation for Tendering		2											
8	Tender for Roofing System		3											
9	NSC - Tender for Renewable Energy System		3											
10	Tender for contractor		3											
11	Award of Tender	Y	5											
12	Implementation of Green Roof system	Y	16											
13	Completion of Works	Y	-											

Estimated Project Duration (No. of weeks):

39

Stage 2 – Implementation Stage

Key Works for Stage 2

- Identification of tender packages for all feasible schools
- Outstanding maintenance works to be completed
- Consultancy Service to be engaged by HKAC including the Structural assessment and certification, whenever necessary submitted to relevant Government Authorities
- Confirmation and agreement of the Green Roof detail design by the School Representatives
- Tender for the special roofing systems for all feasible schools
- Tender for the contractors for different packages

Participating Schools

List of Participating Schools

- Buddhist Chan Shi Wan Primary School
- Buddhist Wing Yan Primary School
- Chan Shu Kui Memorial School
- China Cholinness Church Living Spirit College
- Chiu Yang Por Yen Primary School
- Fung Kai Lui Man Shek Tong Secondary School
- Henrietta Secondary School
- Lee I Yao Memorial Secondary School
- Lingnan Hang Yee Memorial Secondary School
- Ma Chan Duen Hey Memorial College
- Pui Ying Secondary School
- Shak Chung Shan Memorial Catholic Primary School
- SKH Bishop Baker Secondary School
- St. Bonaventure Catholic Primary School
- Tuen Mun Ju Ching Chu Secondary School
- Wong Shiu Chi Secondary School
- Yaumati Catholic Primary School

Project Team

Steering Committee

Ms. Agnes NG
Dr. Ronald LU
Mr. Humphrey WONG
Ms. Margaret LAU
Ir. Reuben CHU
Ir. Victor CHEUNG
Mr. Leslie CHEN
Mr. LIU Man Lee
Dr. Sam HUI
Mr. Xylem LEUNG

- **Team A**
Margaret LAU
Tony HO
Margaret LAM
Clarence HO
Derek CHIU
Mary CHAN
Paul LEE
Savio TSOI
Matthew CHUNG
Kelvin KAN
- **Team B**
CHAN Kig Ming
FOO Chi Hin
LAM Tsz Fung
LAU Wai Yan Sofia
LIU Chun Man

- **Team C**
Shannon HO
Billy CHAN
Peggy SETO
Gavin LIN
Fanie WOO
Henry CHAN
Karly LUI
Calvin CHAN
LAM On Yi Connie

- **Team D**
Ruffina THILAKARATNE
David WINCEY
Dylan O'BRIEN
Billy LO
Louise O'BRIEN
James ACUNA
Renee LAU

Other Professional Helpers

Mr. Philip LO
Mr. Anselm CHOW
Ms. Judy LEUNG
Mr. Joe LIU
Mr. Elvin CHEUNG
Mr. Kevin WONG
Mr. Leo KWOK
Ms. Ling LAM
Ir. WONG Wai Hing
Ms. Kat CHAN

Sharing of Knowledge & Experience

- Educate students, teachers, public the concepts & functions of:
 - Green Roofs
 - Renewable Energy
 - Organic Farming
 - Carbon Cycle
- How to protect our earth
- Draw their attentions



Green Roof



The Chicago City Hall
(Its green roof helps cool the building
and minimize water run-off.)



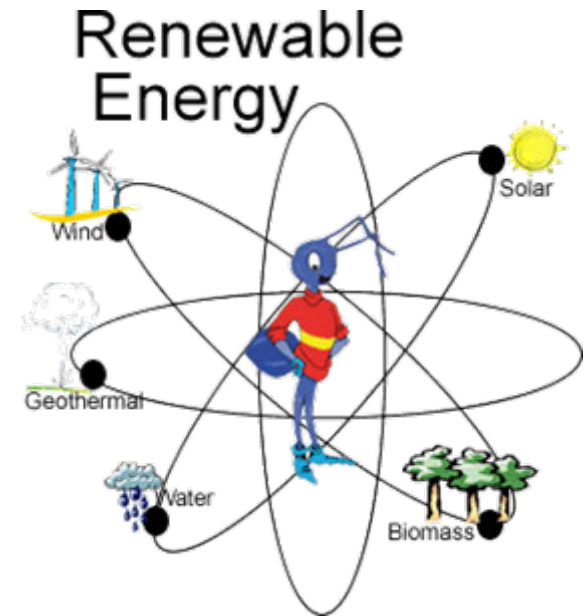
Homes with green roof structures in Norway

Source: Green Roofing in Portland OR:
Embracing Living
Roof Systems for Your Home |
RoofPortland.com
<http://www.roofportland.com/news-and-articles/guide-to-live-roofs-embracing-green-roof-systems-in-portland/>

- Disseminate the concept:
 - Nowadays Functions of Green Roof
 - Reduce in-house temperature
 - Reduce Power Consumption
 - Minimize water run-off
 - Solve Water Drainage Problem in the city
 - Beauty and functions of green roof in the past
 - “Green Idea”
 - Smart Green Generation
- Learning Activities at the green roof
 - Student Teams to maintain the green roofs
 - On-site learning activities and observations
 - Let the students and parents feel, smell and appreciate green features

Renewable Energy

- Disseminate the concept:
 - Different types and nature of renewable energy
 - Importance of renewable energy for the environment
 - The difference effects of “Carbon Cycle” - Renewable Energy vs Fossil Energy



Source: Renewable Sources of Energy
<http://renewablesourcesofenergy.com/>

Community Organic Farming



Eco Farm & Eco Terrace Projects: Community Organic Farming in Hong Kong

Community Organic Farming



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Community Organic Farming



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Thank You