



New Horizon in Greening - Skyrise Greenery : **Green Roof and Vertical Greening Study in Drainage Services Department**

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Content

1. Overview of Green Roof and Vertical Greening Work
2. Research Study



Overview of DSD Greening Works

Greening Work	Year				
	2007	2008	2009	2010	2011
Tree Planting	3,600	1,500	3,700	2,800	2,600
Shrub Planting	116,000	153,000	293,000	620,000	136,000
Green Roof	760m ²	865m ²	365m ²	3,625m ²	6,500m ²



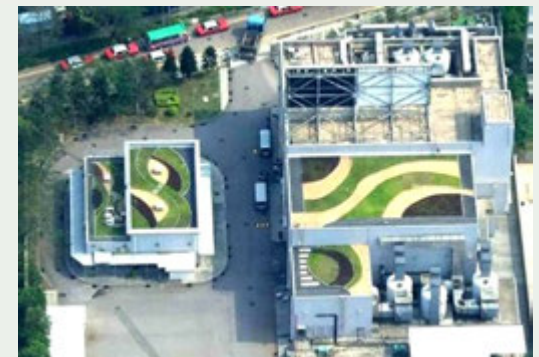
Completed Green Roof

Wan Chai East and Wan Chai West Sewage Screening Plants



Location Plan

- Completed in June 2007
- Area : 760m²





Completed Green Roof

Sheung Wan Stormwater Pumping Station



Location Plan

- Completed in Oct 2009
- Area : 310m²





Completed Green Roof

Ma On Shan Sewage Pumping Station



Location Plan

- Completed in March 2010
- Area : 625m²





Completed Green Roof Sha Tin Sewage Treatment Works



Location Plan

- Completed in March 2010
- Area : 2,800m²





Examples of Green Roof Under Construction



Jordan Valley Box Culvert SPS



Kowloon City Sewage Interception



Ha Tsuen Sewage Pumping Station



Retrofit Green Roof Programme

Batch 1 (Dec 2011)

1. Yuen Long Kau Hui PS
2. Tai Po Tai Yuen SPS
3. Shek Wu Hui STW
4. Tung Chung SPS
5. Siu Hong SPS
6. Ha Tsuen SPS
7. Pak Shek Kok SPS No. 1
8. Peng Chau STW and PS
9. Tseung Kwan O STW
10. Kwun Tong Screening Plant

Batch 2 (Dec 2012)

11. Shum Shui Po PS No.1
12. Central Screening Plant
13. Anchor Street PS
14. To Kwa Wan Screening Plant
15. Tai Po Shui Wai Floodwater PS
16. Waterboat Dock PS

Batch 3 (Dec 2013)

17. Pak Shek Kok SPS No. 2
18. Pak Shek Kok SPS No. 3
19. Nam Sang Wai SPS
20. Kam Tin SPS
21. Sha Po SPS
22. Au Tau PS



Vertical Greening Work



Before greening



After greening

Tai Hang Tung Flood Pumping Station

- **System Adopted :**
Self-climbing vines and 12 vertical metal frames with potted planters
- **Plant Species :**
Asparagus densiflorus
'Sprengeri' (天冬),
Ficus pumila (薜荔) and
Parthenocissus himalayana
(爬牆虎)



April 2007



January 2010

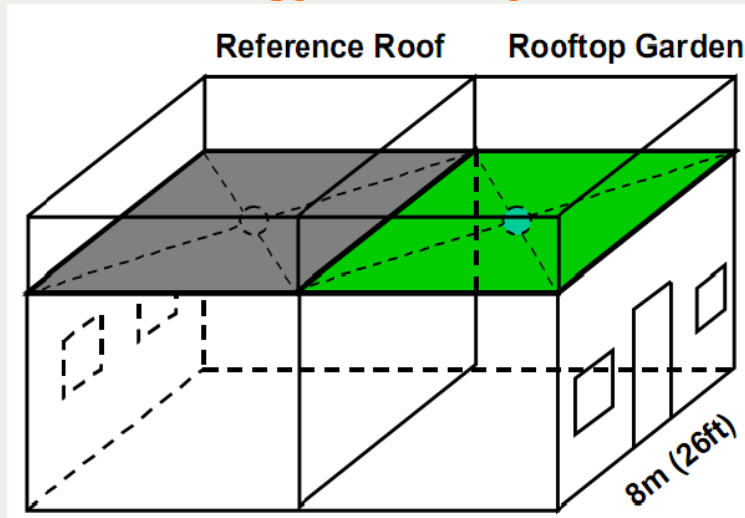


Research Study

Application of Green Roof at Wan Chai East Sewage Screening Plants

Start	Completion	Objective
11/2008	9/2009	<ul style="list-style-type: none"> To review the general performance of the green roof To study the thermal performance of the green roof

Methodology of Study



Reference Roof vs Green Roof



Automatic temperature logger

- Automatic temperature loggers
- Outdoor and indoor
- Summer and winter
- 5-minute intervals



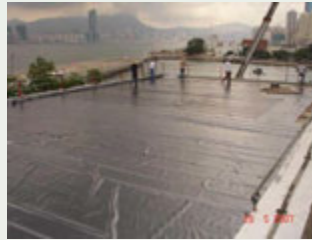
Application of Green Roof at Wan Chai East Sewage Screening Plants

Finding 1 :

General performance

1. System components:

- root barrier
- drainage layer
- growing medium



generally functioned well.

2. The 3 plant species :

- *Rhoeo discolor* (蚌花)
- *Arachis duranensis* (蔓花生)
- *Sedum lineare* (佛甲草)



behaved differently as to self-sustainability and maintenance requirements.

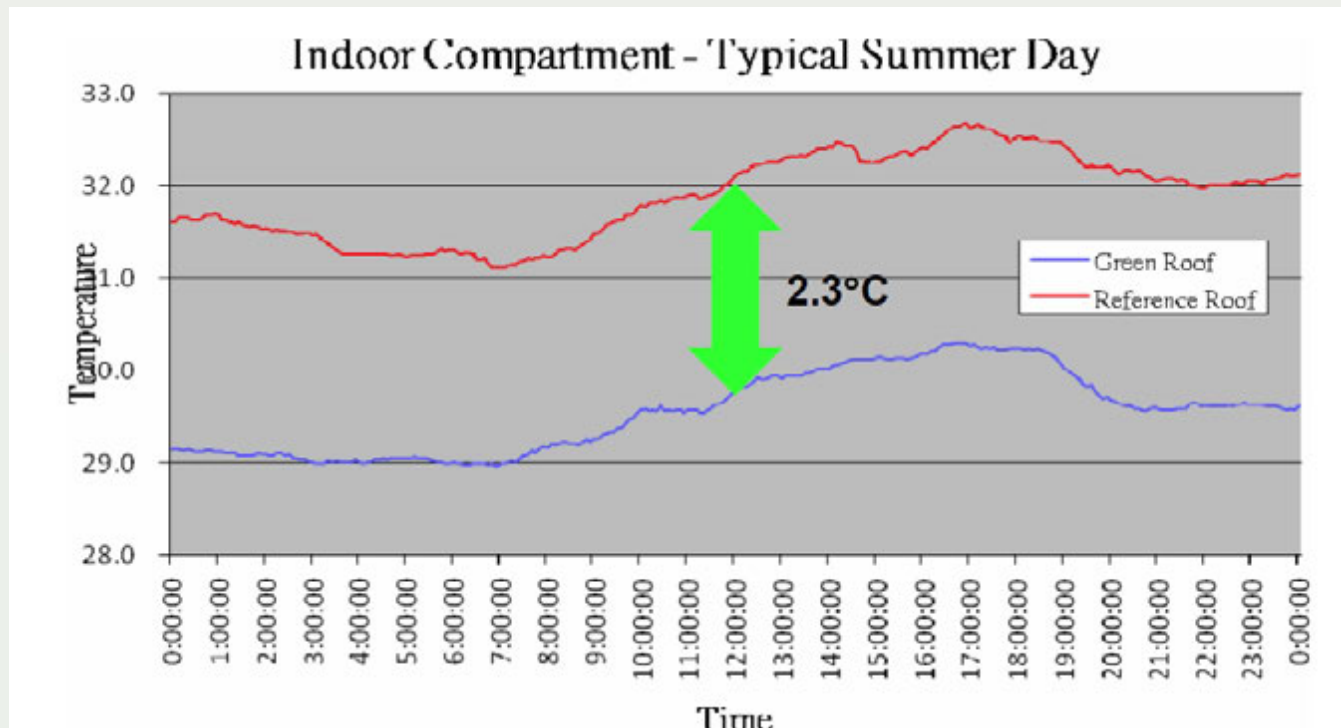


Application of Green Roof at Wan Chai East Sewage Screening Plants

Finding 2 :

Thermal performance

1. Indoor temperature lowered by 1.5 to 2.3°C throughout the year.
2. Temperature reduction are the same to all 3 species.





Green Roof Trial Planting

Start	Completion	Objective
11/2009	3/2011	<ul style="list-style-type: none"> To observe growth of 12 plant species under different maintenance levels in watering and weeding frequency

- 7 planting panels
(Size: 6m x 2m)
- Each panel with 12 planting trays
(Size: 1m x 1m)



Overview of Trial Planting



Green Roof Trial Planting

Plant Species



Bryophyllum pinnatum (Air-plant)
(落地生根)



Catharathus roseus
(Rose Periwinkle)
(長春花)



Alternanthera ficoidea
'Tricolor'
(Joseph's Coat) (彩莧草)



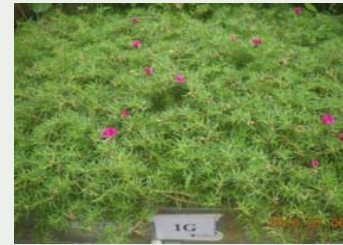
Kalanchoe blossfeldiana
(Kalanchoe) (長壽花)



Coleus blumei
(Skullcapilce Coleus) (洋紫蘇)



Mentha spicata
(Spearmint) (綠薄荷)



Portulaca grandiflora
(Moss-rose) (松葉牡丹)



Setcreasea purpurea
(Purple heart) (紫鴨跖草)



Zephyranthes candida
(Autumn Zephyrlily) (葱蘭)



Alternanthera dentata
cv. *Rubiginosa*
(Rubiginosa Calico Plant)
(紅龍草)



Tradescantia Zebrina
(Wandering Jew) (吊竹草)



Sansevieria trifasciata
'Golden Hahnii'
(Golden Bird's Nest Snake
Plant) (金邊短葉虎尾蘭)



Interim Observation

Species	General Condition
<i>Bryophyllum pinnatum</i> (Air-plant) (落地生根)	Good
<i>Catharathus roseus</i> (Rose Periwinkle) (長春花)	Fair
<i>Alternanthera ficoides</i> 'Tricolor' (Joseph's Coat) (彩莧草)	Dead
<i>Kalanchoe blossfeldiana</i> (Kalanchoe) (長壽花)	Fair
<i>Coleus blumei</i> (Flame nettle) (洋紫蘇)	Dead
<i>Mentha spicata</i> (Peppermint) (薄荷)	Dead
<i>Portulaca grandiflora</i> (Moss-rose) (松葉牡丹)	Fair
<i>Sansevieria trifasciata</i> 'Golden Hahnii' (Golden Bird's Nest Snake Plant) (金邊短葉虎尾蘭)	Poor
<i>Setcreasea purpurea</i> (Purple Heart) (紫錦草)	Fair
<i>Zephyranthes candida</i> (Autumn Zephyrlily) (風雨花)	Good
<i>Alternanthera dentate</i> cv. 'Ruliginosa' (紅龍草)	Poor
<i>Zebrina pendula</i> (Wandering Jew) (吊竹梅)	Fair





Study of Green Roofs: Green Roof Guidelines, Water Quality and Peak Runoffs

Start	Completion	Objective
12/2010	6/2013	<ul style="list-style-type: none"> • To conduct wind tunnel tests and develop wind suction numerical models for evaluating wind damage to green roof • To investigate the benefits of green roofs in runoff water quality improvement and peak runoff mitigation • To establish a guideline for planning requirements and design and maintenance criteria for green roof system



Study Site on Sludge Thickening House





Vertical Greening Study



Study Site - Shatin STW



- Four circular concrete sludge tanks
- Size of tank : 27m(Dia) x 13m(H)

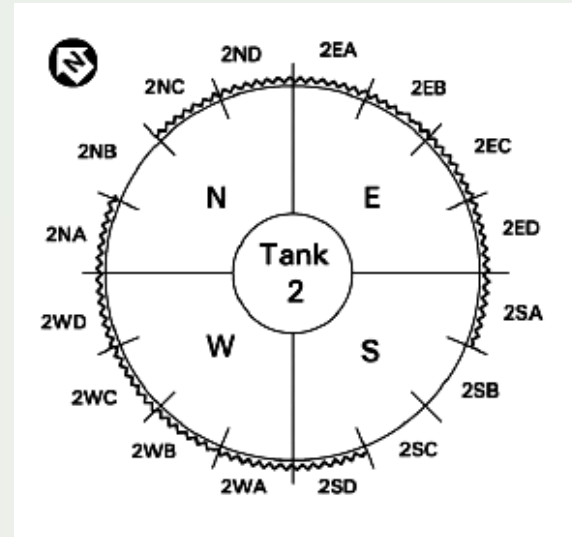
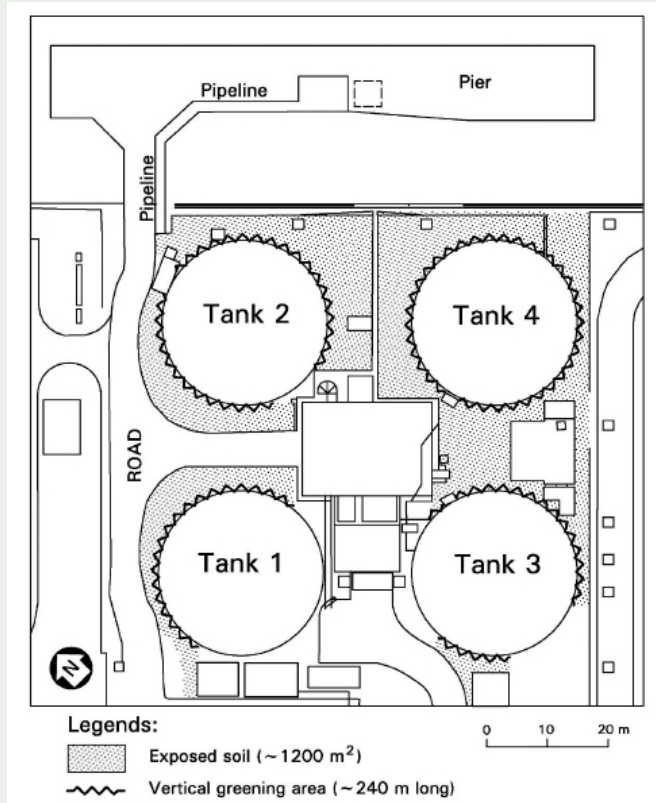


Programme

Period	Activities
Jul 2009 to Nov 2009	<ul style="list-style-type: none"> • Design and tendering
Dec 2009 to Mar 2010	<ul style="list-style-type: none"> • Construction of supporting frame and planting
Apr to May 2010	<ul style="list-style-type: none"> • Installation and calibration of monitoring equipment
Jun 2010 to Jan 2011	<ul style="list-style-type: none"> • Maintenance of plants • Monitoring of plant growth • Collection of data • Interim report
Feb 2011 to Dec 2011	<ul style="list-style-type: none"> • Continual maintenance and monitoring of plants, data collection • Data analysis and interpretation • Final report



Experimental Design



Experimental Plot : 2EA

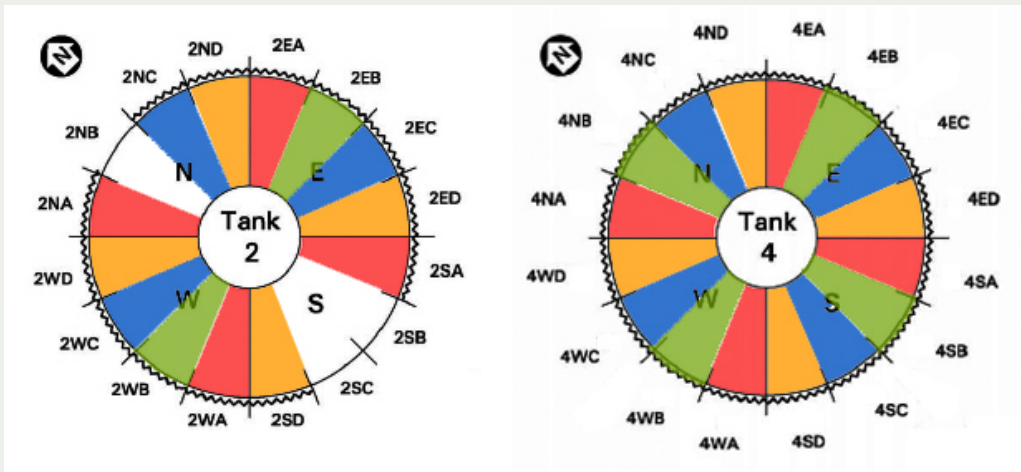
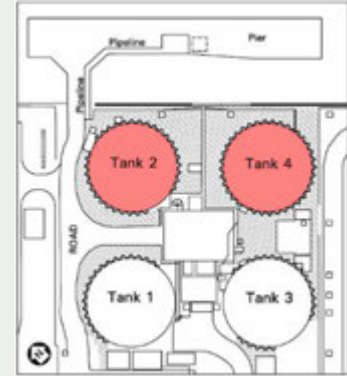
Tank no. _____
 Quarter _____
 Sector no. _____

- Each tank with four quarters (90° each) : north, east, south, and west
- Each quarter with four sectors (22.5°, 5 m wide each) : A, B, C and D
- Total 45 experimental plots



Experiment I : Site Factor Effect

- Location : Tanks 2 and 4
- Site factor : orientation, soil quality and plant species



Sector A : *Campsis grandiflora*
(Chinese Trumpet-creeper) (凌霄)



Sector B : *Bauhinia corymbosa*
(Camel's Foot) (首冠藤)



Sector C : *Ficus pumila*
(Creeping Fig) (薜荔)

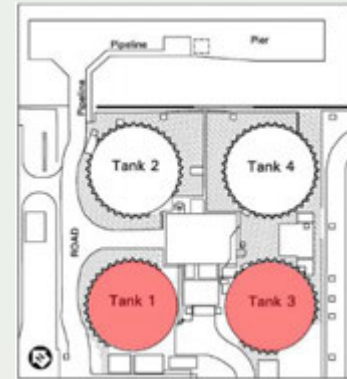


Sector D : *Pyrostegia venusta*
(Fire-cracker Vine) (炮仗花)



Experiment II : Climber Species Trial

- Location : Tanks 1 and 3
- Study the growth and performance of 16 climber species

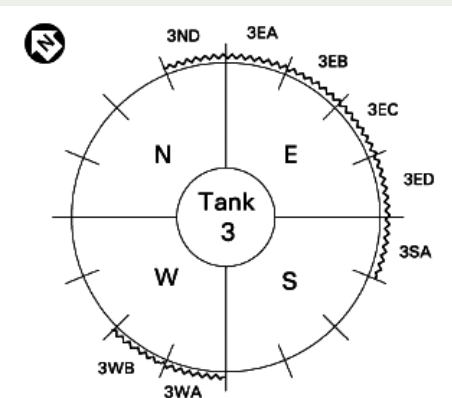
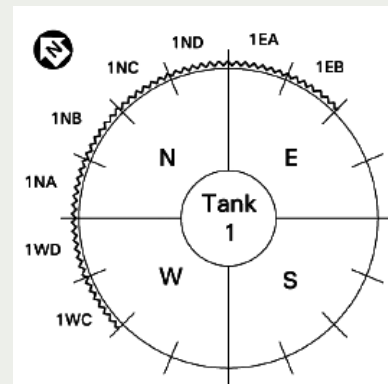


Tank 1 (with wire meshes)

- *Lonicera japonica* (金銀花)
- *Quisqualis indica* (使君子)
- *Antigonon leptopus* (珊瑚藤)
- *Vitis vinifera* (葡萄)
- *Pseudocalymma alliaceum* (蒜香藤)
- *Podranea ricasoliana* (紫雲藤)
- *Bougainvillea spp.* (簕杜鵑)
- *Wisteria sinensis* (紫藤)

Tank 3

- *Parthenocissus dalzielii* (異葉爬山虎)
- *Hedera helix* (常春藤)
- *Philodendron scandens* (心葉蔓綠絨)
- *Ficus pumila cv. variegata* (花葉薛荔)
- *Epipremnum aureum* (綠蘿)
- *Syngonium podophyllum 'White Butterfly'* (白蝴蝶)
- *Hedera nepalensis var. sinensis* (中華長春藤)
- *Trachelospermum jasminoides* (絡石)



Podranea ricasoliana
(Pink Trumpet Vine) (紫雲藤)

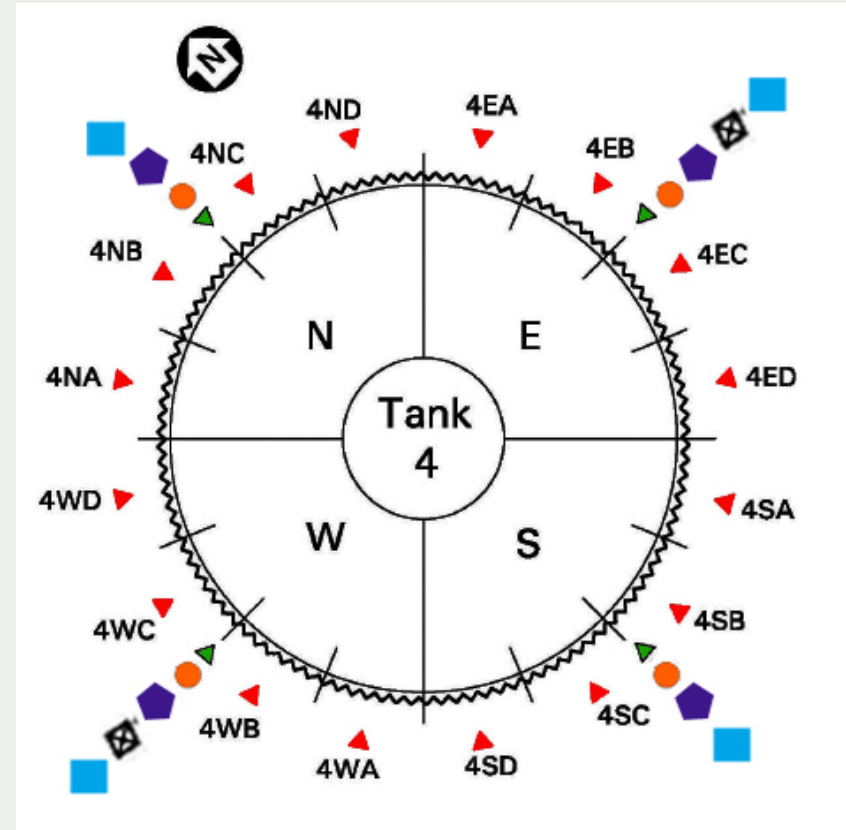
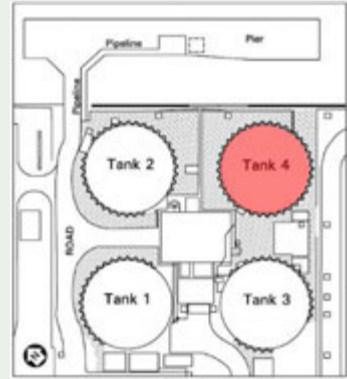


Philodendron scandens
(Small Heartleaf Philodendron)
(心葉蔓綠絨)



Experiment III : Monitoring of Cooling Effect

- Location : Tank 4
- Equipment installed:
 - A. Infrared temperature sensor
 - B. Solar radiation sensor
 - C. Air temperature and relative humidity sensor
 - D. Soil moisture sensor
 - E. Data logger





Interim Observation



**Tank 1
(with wire meshes)**



**Tank 3
(self climbing plants)**





Interim Observation



Tank 2
(testing of site factors)



Tank 4
(testing of site factors
and monitoring of
cooling effect)



THANK YOU

