Prince George's County, MD, received the EPA's 1998 first-place National Excellence Award for Municipal Stormwater Management Programs for its pioneering work on LID.

In **1999**, Prince George's County, with the support of the USEPA, developed a national guidance manuals on the LID approach.

美國土木工程學會（ASCE）發起主辦 LID 國際研討會 2004年第一屆在馬里蘭大學舉辦，以後陸續在威爾明頓（Wilmington）、西雅圖（Seattle）、舊金山（San Francisco）、費城（Philadelphia）、聖保羅（St. Paul）、休斯頓（Houston）舉辦

2016國際城市低影響開發(LID)學術大會在北京舉辦

Low Impact Development 2010
REDEFINING WATER IN THE CITY
ASCE-EWRI

April 11-14, 2010 美國舊金山

- 開發建設勢必造成不透水面積增加，若於設計規劃階段即融入歐、美先進國家推行之「低衝擊開發（low impact development, LID）」以及「綠色基礎建設（Green Infrastructure）」的嶄新都市集水區（Urban Watershed）管理觀念，將可降低開發對水環境所帶來的衝擊。
- 將綠色元素融入開發基地中，達到節能減碳、改善空氣品質、減緩暴雨逕流等減輕開發行為對環境衝擊之觀念。


Use LID practice
restore the volum
restore groundwa
eliminate flashy f
reduce nuisance
Use LID practice
urban runoff
Use LID practice
sources of impair
Stream, Gravel R
river
Specifically targe
index of biologic
from poor
EWRI
ENVIRONMENTAL & WATER RESOURCES INSTITUTE
ASCE


r Quality Simulation
lates mobile and immobile fractions of
phorus in two layers of the bioretention cell
zone and deeper soil) based on pH.
pH is a good way to determine phosphorus
ioning, especially in an infiltration-based
where infiltration rates are generally slow
gh to allow soil and water pH to equilibr
meters necessary for a kinetic model
ry uncertain, difficult to meas
orders of magnitude.
EWRI
ENVIRONMENTAL & WATER RESOURCES INSTITUTE


Low impact development, the saviour of the 21st century city, or a 20th century suburban irrelevance?

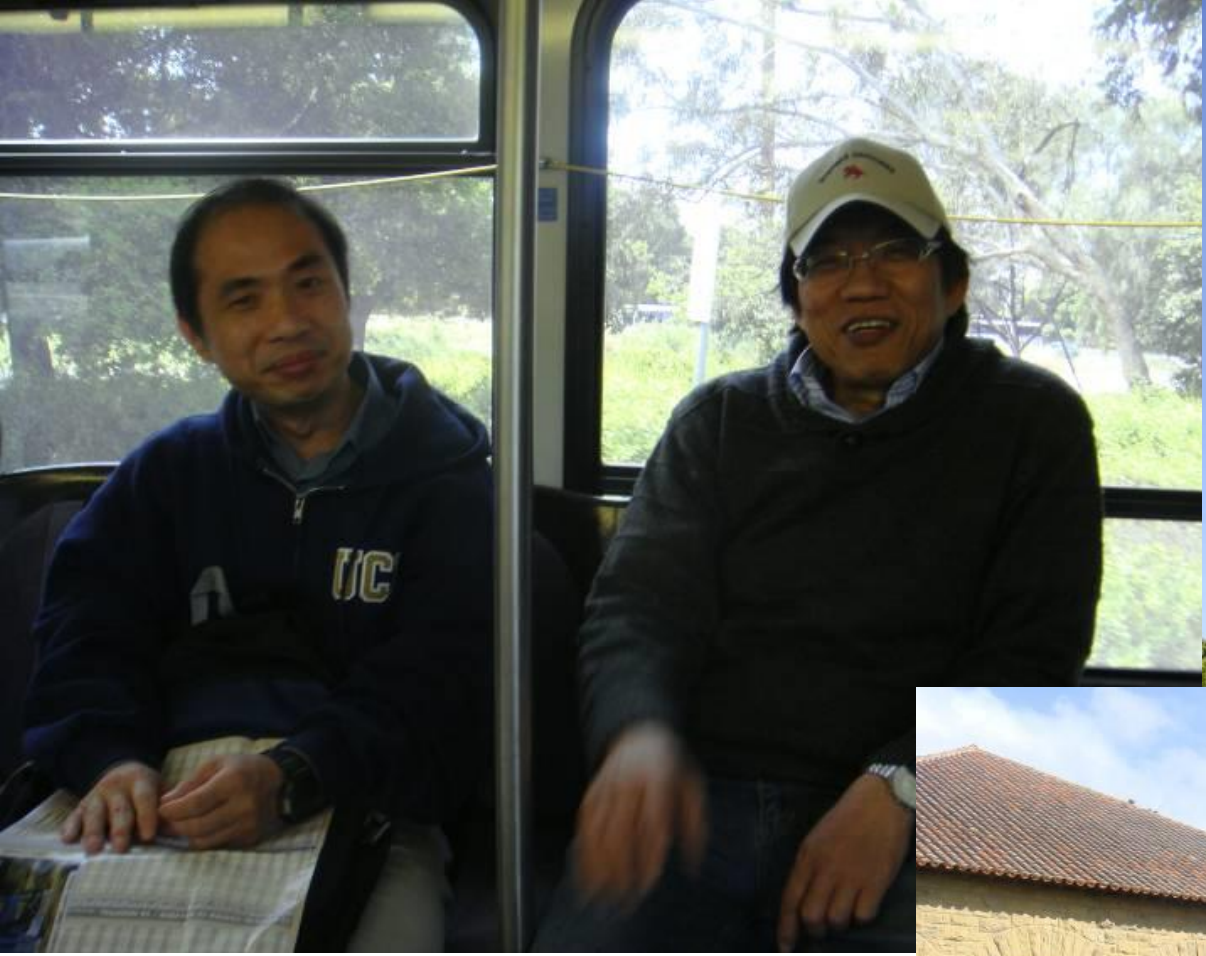

Introduction
Urban flood
EWRI

LID 2010 issues

- A National Assessment of Rainwater Harvesting: Challenges, Needs, and Recommendations
- Advances in LID BMP Design Methods—Lessons Learned
- Case Studies
- Computational Methods
- Constructing LID Facilities
- Costs of LID
- Education, Training, Outreach

LID 2010 issues

- Incorporating LID into New Developments
- LID and Reimagining Cities
- LID and Sustainability
- Overcoming Institutional and Other Barriers to LID Implementation
- Recent Monitoring/Performance Findings
- Site Design Considerations
- Watershed Retrofit with LID



2013 International Low Impact Development Symposium August 18-21, 2013 Saint Paul, Minnesota

會議期間每天有 7-12 Concurrent Session Tracks（共 290 presentations），參加人數超過 1,000人（包括專家學者、顧問公司、政府單位等），交流最新 LID 的研究、案例、政策、成本以及教育宣導等多方面成果，是參與 LID 工作者最佳資訊交換平台

EVALUATING LID RUNOFF CONTROL EFFICIENCY IN TAIPEI TECH ECO-CAMPUS WITH SUSTAIN MODEL

Chi-Feng Chen[1], Jen-Yang Lin[2], Yi-Lung Chen[2]
[1]Department of Natural Resources, Chinese Culture University, Taipei, Taiwan
[2]Department of Civil Engineering, National Taipei University of Technology , Taipei, Taiwan

Introduction

National Taipei University of Technology (Taipei Tech) is located in the central Taipei city, Taiwan. In order to improve the campus environment and to create the unique interaction between campus and city, an eco-campus program has started in 2003. Until now, the total of 73 low impact development (LID) facilities were built, including pervious pavements, green roofs, bioretention cells, dry detention ponds, infiltration trenches, rainwater barrels, and grass belts. However, the contributions of applied LID on runoff reduction did not be assessed. This study utilized a LID assessment tool, System for Urban Stormwater Treatment and Analysis Integration Model (SUSTAIN), to evaluate the runoff control efficiency produced by these LIDs.

SUSTAIN model

SUSTAIN model was developed by USEPA (http://www.epa.gov/nrmrl/wswrd/wq/models/sustain/). SUSTAIN model can evaluate the performance of various types of BMP/LID facilities at different watershed scales.

Results and discussion

The simulation time is 2010 to 2011. The placement of LID in Taipei Tech in SUSTAIN model is as Fig.1.

The significant results are:

1. Identifying the base line. When comparing only the scenarios with or without LID in developed watershed, the LID benefit will be underscored and less than the base line that excluding the predeveloement runoff.
2. LID benefit. The LIDs helps to reduce 13% annual runoff and 20% peak flow rate in Taipei Tech campus.
3. Contributions of various LID types. Pervious pavements contributed to the 75% of the runoff reduction. The unit runoff reductions are ranged from 0.4 to 1.1 m^3/m^2 .

Conclusions

This study is the first case of employing SUSTAIN model in Taiwan and this experience should be benefit to the international applicability of this model. The results illuminate the efficiency of the applied LIDs; however, the results still need to be verified by monitoring data. This is an challenge that we are working on to date.

Taipei Tech eco-campus

Starting from 2003, the total of 73 LID facilities were built and most pavement were replaced by pervious pavements.

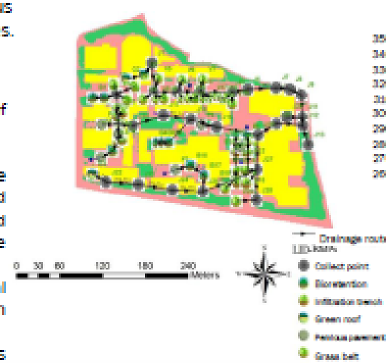


Figure 1 LID placement of Taipei Tech in SUSTAIN.

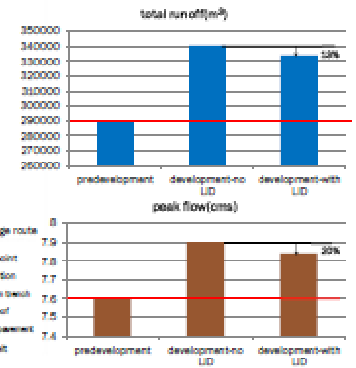


Figure 2 Results of SUSTAIN simulations under two year data.

Table 1 Unit runoff reduction for LID types (m^3/m^2).

LID/BMP types	Total runoff reduction (m^3)	Total surface area(m^2)	Unit runoff reduction (m^3/m2)
Bioretention cell	581	533	1.09
Pervious pavement	5,042	4,523	1.11
Green roof	231	308	0.78
Grass belt	837	2128	0.39
Infiltration trench	608	152	0.40

2013 International Low Impact Development Symposium
Program At A Glance

Sunday, August 18, 2013

Pre-Symposium Short Courses (pre-registration required.)

		Meeting Room 2	Meeting Room 3	Meeting Room 4	Meeting Room 5	Meeting Room 6
8:00 a.m.-12:00 noon		Intro to LID	Rainwater Harvesting		WinSLAMM	
1:00-5:00 p.m.		Advances in Design	Incorporating LID	Operation and Maintenance	WinSLAMM	Community Stormwater
1:00-5:00 p.m.	Sponsor Exhibits Set Up & Symposium Registration Opens					

Day 1: Short Courses

Monday, August 19, 2013

Time Slot	Session	Track 1 Meeting Room 2-3	Track 2 Meeting Room 4-6	Track 3 Meeting Room 7-9	Track 4 Meeting Room 10-12	Track 5 Meeting Room 13-15	Track 6 Ballroom A	Track 7 Ballroom E
8:30 a.m.	Ballroom BCDFGH - Plenary Presentation Welcome to Minnesota *John Linc Stine*, Commissioner, Minnesota Pollution Control Agency Low Impact Development: Retooling Communities for the 21st Century *Avi Friedman*, Ph.D., Professor of Architecture and Director, Affordable Homes Research Group, McGill University, Montreal, Quebec, Canada							
10:20	Refreshment Break, Posters, and Exhibits - Ballroom Concourse							
10:50 AM	A	Green Infrastructure for CSO Communities	LID Research Panel	Urban Trees and Stormwater Management	LID Education Approaches and Results	Benchmarking, Sizing and Optimization of LID Practices	Implementation Strategies for LID Retrofits	Commercial and Institutional Success and Challenges
12:20 p.m.	Ballroom BCDFGH - Luncheon Presentation Luncheon Presentation: Integrating Art Upstream in the Stormwater Design *Buster Simpson*, Artist, Seattle, Washington							
1:40	B	LID Codes and Ordinances Case Studies	Bioretention Performance	Permeable Pavement Performance	Home Owner Directed Education Programs	LID Optimization Modeling	Commercial Applications of LID	The Art of LID: Creating a Sense of Place Through Infrastructure Design
3:10	Refreshment Break, Posters, and Exhibits							
3:40	C	LID Performance Standards	Municipal Applications and Monitoring Results	Bioretention Performance	Statewide Stormwater Education Programs	BMP Performance Modeling	LID Commercial and Industrial Applications	The Art of LID: Unique LID Designs
5:10	Poster Session and Exhibit Reception with Cash Bar - Ballroom Concourse							
6:00	Symposium Picnic at Harriet Island							

11個主題

	Policies, Ordinances and Regulatory Compliance
	LID Practices
	Education and Outreach
	Modeling and Computations
	Retrofitting and Redevelopment
	Planning and Design
	Design and Construction
	Financing and Cost Benefit
	LID Applications
	Monitoring and Measurements
	Maintenance of LID Practices

Day 2: 7 sessions

Tuesday, August 20, 2013

Time Slot	Session	Track 1 Meeting Room 2-3	Track 2 Meeting Room 4-6	Track 3 Meeting Room 7-9	Track 4 Meeting Room 10-12	Track 5 Meeting Room 13-15	Track 6 Ballroom A	Track 7 Ballroom E	Track 8 Ballroom B	Track 9 Ballroom C	Track 10 Ballroom D	Track 11 Ballroom F	Track 12 Ballroom G
8:30 a.m.	D	EPA Stormwater Rule Making	Bioretention Media	LID Implementation Strategies for Achieving Water Quality Goals	Publications and Approaches for Mainstreaming LID	LID Modeling	LID Retrofits to Meet Load Reduction Goals	LID Planning for Climate Change Adaption	Pervious Pavements	Modeling, Testing and Verification of LID	Sustainable Cities of the Future and Social Technical Models	Performance Monitoring of Multiple LID Practices	Green Infrastructure Standards, Construction and Inspection
10:15	Poster Session and Break - Ballroom Concourse												
10:45	E	Municipal Green Infrastructure Programs	Bioretention Nutrient Removal	Green Roof Performance	Developing, Compairing and Reviewing LID Manuals	Modeling BMP Performance	LID Retrofits and Stream Restorations	LID Planning for Climate Change Adaption	LID Highways	Financing and Trading	Greening the Twin Cities Light Rail	Monitoring Bioretention and Rainwater Harvesting Systems	Urban Trees as a LID Source Control Measure
12:15 p.m.	Lunch on your own, Poster, and Exhibits - Ballroom Concourse												
1:45	F	Partnerships to Establish State LID Approaches for Compliance	Institutional Acceptance and Lessons Learned from an Owner Perspective	Bioretention Media, Stormwater Reuse and Prioritizing Maintenance	Partnerships Moving LID Forward	Evaluating LID with SWMM and Sustain	Assessment and Strategic Planning to Meet Load Reduction Goals	Green Streets	LID Parking Lots	Cost Effectiveness of LID Practices	New York, CSO, and Complete Streets Bioswale Applications	Proprietary Devices	Best of WEFTEC 2013
3:15	Refreshment Break, Posters, and Exhibits - Ballroom Concourse												

Last Updated 8/12/2013

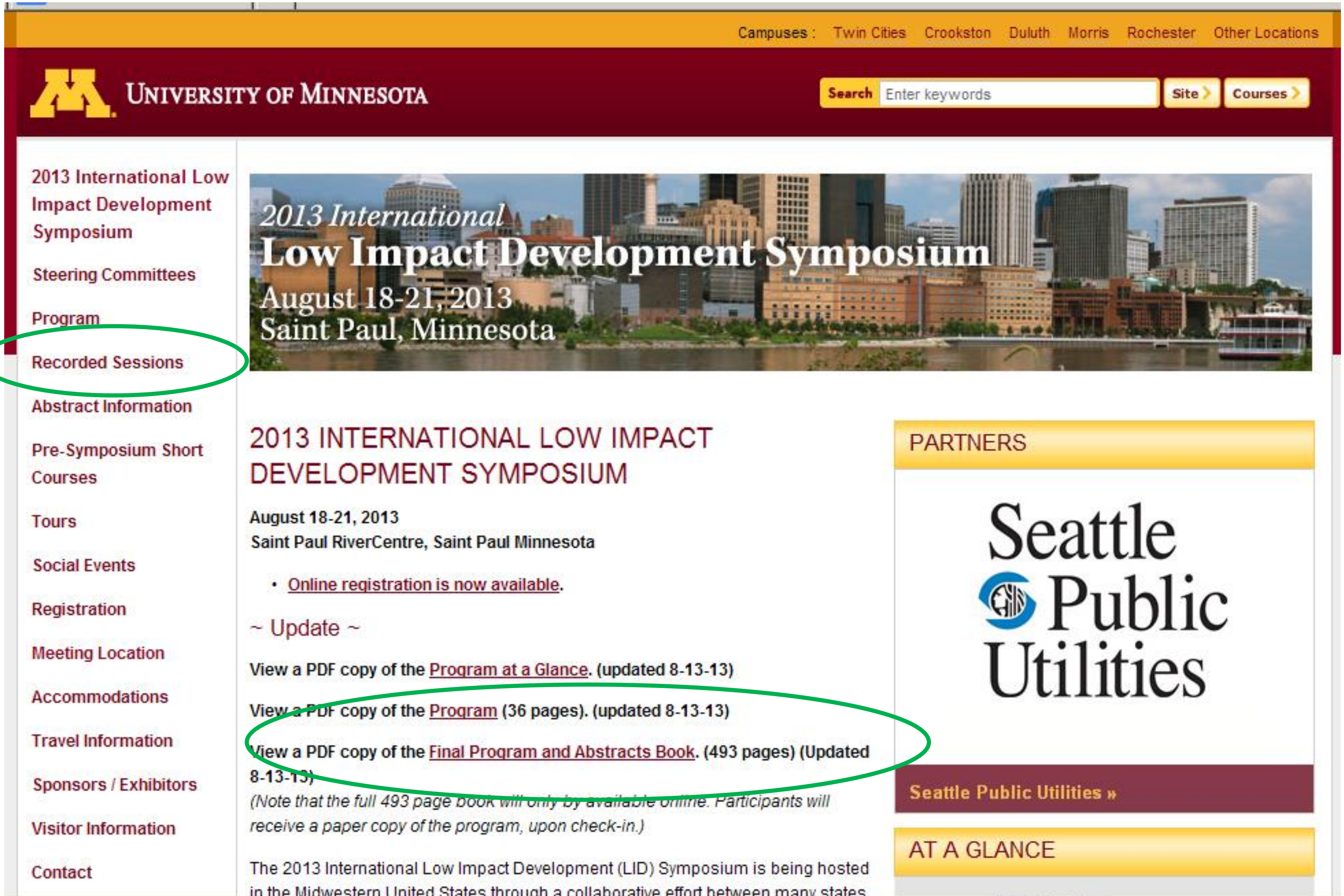
Day 3: 12 sessions

3:45-5:15	G	LID and Land Use Regulations	Harvesting and Reuse	Bioretention Vegetation Performance	Interactive LID Education for Local Elected Officials	Watershed Scale LID Modeling Case Studies	Integrated Stormwater Management Retrofits for Water Quantity and Quality	GI Planning and Design	LID Construction Lessons Learned	Cost of LID Practices	Regional Fire Station, Medical Campus, Collage Campus	Performance Monitoring of Multiple Practices	Urban Pollutant Loads and Street Sweeping
5:45	Hydrosocial River Boat Tour (Sign up onsite required)												
Wednesday, August 21, 2013													
Time Slot	Session	Track 1 Meeting Room 2-3	Track 2 Meeting Room 4-6	Track 3 Meeting Room 7-9	Track 4 Meeting Room 10-12	Track 5 Meeting Room 13-15	Track 6 Ballroom A	Track 7 Ballroom E	Track 8 Ballroom B	Track 9 Ballroom C	Track 10 Ballroom D	Track 11 Ballroom F	Track 12 Ballroom G
8:30 a.m.	H	Taking LID to City Streets Case Studies	Enhancing Bioretention Performance	Green Roof Performance	Approaches to Education and Outreach (In-Person, Online, Self-Directed)	LID Modeling for CSO Communities	GI Planning and Implementation	Infiltration Rates	Green Streets and Bioretention	Maintenance of LID Practices	LID Applications for Light Rail	LID Monitoring and the International Database	Local Leaders Needs and Assistance to Home Owner Education
10:15	Refreshment Break, Posters, and Exhibits - Ballroom Concourse												
10:45-12:15	I	Green Infrastructure! to Meet MEP and TMDLs	Bioretention Media	Green Roof Plants and Growing Media	Education and Audience Assessment	LID Modeling for Flooding	Watershed Scale Strategic Planning for LID Retrofitting	Planning and Design	Targeting Effective LID Implementation and a LID Construction Manual	Design, Installation and Maintenance of Bioretention	Commercial Infill, Industrial Park, Stormwater Park, Low Income Housing Applications		
12:30-4:30	Field Tours (box lunches included) (pre-registration required)												

Day 4: 12 sessions
下午：technical tours

7-12 Concurrent Session Tracks

With 290 presentations, and over 1,000 expected attendees, this could be the largest LID Symposium to date http://www.cce.umn.edu/2013-International-Low-Impact-Development-Symposium/



Campuses : Twin Cities Crookston Duluth Morris Rochester Other Locations

UNIVERSITY OF MINNESOTA

Search Enter keywords Site Courses

- 2013 International Low Impact Development Symposium
- Steering Committees
- Program
- Recorded Sessions
- Abstract Information
- Pre-Symposium Short Courses
- Tours
- Social Events
- Registration
- Meeting Location
- Accommodations
- Travel Information
- Sponsors / Exhibitors
- Visitor Information
- Contact

2013 International
Low Impact Development Symposium
August 18-21, 2013
Saint Paul, Minnesota

2013 INTERNATIONAL LOW IMPACT DEVELOPMENT SYMPOSIUM

August 18-21, 2013
Saint Paul RiverCentre, Saint Paul Minnesota

- Online registration is now available.

~ Update ~

View a PDF copy of the Program at a Glance. (updated 8-13-13)

View a PDF copy of the Program (36 pages). (updated 8-13-13)

View a PDF copy of the Final Program and Abstracts Book. (493 pages) (Updated 8-13-13)
(Note that the full 493 page book will only by available online. Participants will receive a paper copy of the program, upon check-in.)

The 2013 International Low Impact Development (LID) Symposium is being hosted in the Midwestern United States through a collaborative effort between many states

PARTNERS

Seattle Public Utilities

Seattle Public Utilities »

AT A GLANCE

Opening

11個主題

	Policies, Ordinances and Regulatory Compliance
	LID Practices
	Education and Outreach
	Modeling and Computations
	Retrofitting and Redevelopment
	Planning and Design
	Design and Construction
	Financing and Cost Benefit
	LID Applications
	Monitoring and Measurements
	Maintenance of LID Practices

LID Practices

- LID Research Panel: 4 presenters (90mins)
  - Soil moisture
  - LID is alive
  - LID and GI (carbon budget and biodiversity)
  - Dissolved pollutants (40-50%. Sorption and biodegradation are two treatment processes.)

LID Practices

Bioretention Performance

- Evaluating residential disconnected downspouts as stormwater control measures (four sites with different area, slope, route length, 65% reduction)
- Soluble reactive phosphorus removal mechanisms using soil amendment strategies (Fe^{3+}, Al^{3+})
- Swale and filter strip for sediment removal (particle size, settling equation, settling reduction efficiency, swale benefit)
- Runoff reduction of a planter by installing gravel columns (逢甲許少華教授)

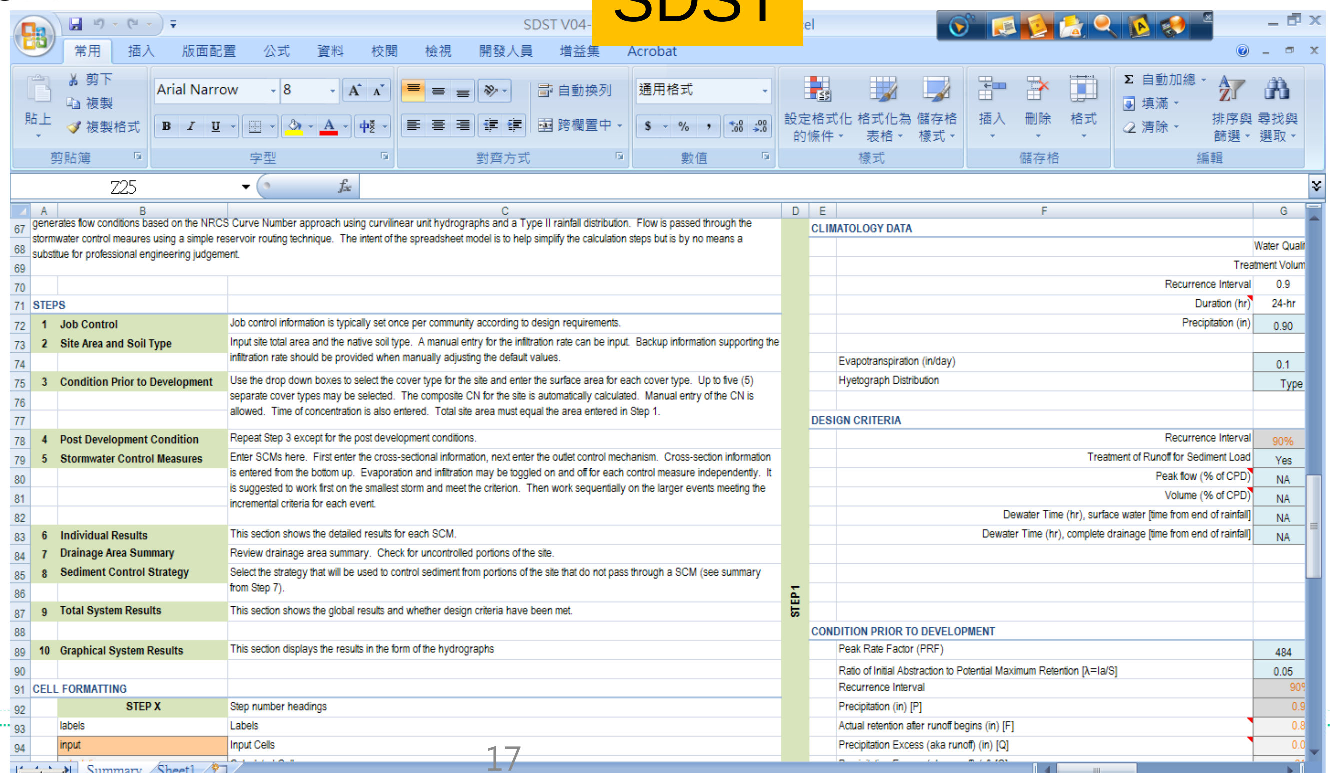
LID Practices

- PCA for assessing Bioretention media performance (北京清華師範大學)
- Bioretention ability to retain pollutants as a function of engineered soil type and depth
  - Standard is 3 ft, suggesting to 2 ft
  - TSS remove to >80%, but outlet TP> inlet TP
  - Use additives to reduce dissolved P

Modeling and computation

- A site development spreadsheet tool to design and size stormwater control measures (SCM)
  - Tetra Tech

SDST



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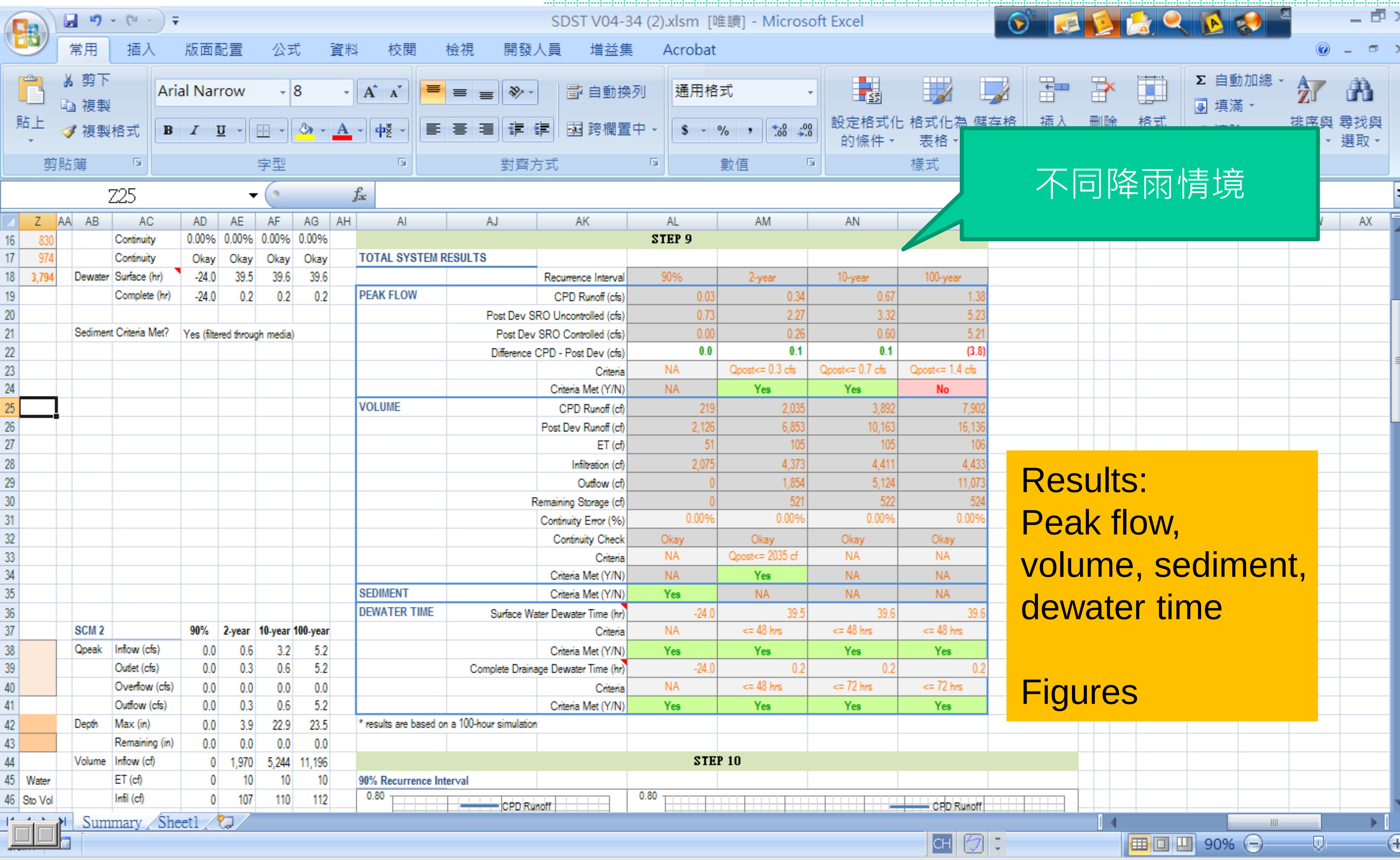
WERC



	Recurrence Interval	90%	2-year	10-year	100-year
PEAK FLOW	CPD Runoff (cfs)	0.03	0.34	0.67	1.38
	Post Dev SRO Uncontrolled (cfs)	0.73	2.27	3.32	5.23
	Post Dev SRO Controlled (cfs)	0.00	0.26	0.60	5.21
	Difference CPD - Post Dev (cfs)	0.0	0.1	0.1	(3.8)
	Criteria	NA	Qpost<= 0.3 cfs	Qpost<= 0.7 cfs	Qpost<= 1.4 cfs
	Criteria Met (Y/N)	NA	Yes	Yes	No
VOLUME	CPD Runoff (cf)	219	2,035	3,892	7,902
	Post Dev Runoff (cf)	2,126	6,853	10,163	16,136
	ET (cf)	51	105	105	106
	Infiltration (cf)	2,075	4,373	4,411	4,433
	Outflow (cf)	0	1,854	5,124	11,073
	Remaining Storage (cf)	0	521	522	524
	Continuity Error (%)	0.00%	0.00%	0.00%	0.00%
	Continuity Check	Okay	Okay	Okay	Okay
	Criteria	NA	Qpost<= 2035 cf	NA	NA
	Criteria Met (Y/N)	NA	Yes	NA	NA
SEDIMENT	Criteria Met (Y/N)	Yes	NA	NA	NA
DEWATER TIME	Surface Water Dewater Time (hr)	-24.0	39.5	39.6	39.6
	Criteria	NA	<= 48 hrs	<= 48 hrs	<= 48 hrs
	Criteria Met (Y/N)	Yes	Yes	Yes	Yes
	Complete Drainage Dewater Time (hr)	-24.0	0.2	0.2	0.2
	Criteria	NA	<= 48 hrs	<= 72 hrs	<= 72 hrs
	Criteria Met (Y/N)	Yes	Yes	Yes	Yes

SCM 2		90%	2-year	10-year	100-year
Qpeak	Inflow (cfs)	0.0	0.6	3.2	5.2
	Outlet (cfs)	0.0	0.3	0.6	5.2
	Overflow (cfs)	0.0	0.0	0.0	0.0
	Outflow (cfs)	0.0	0.3	0.6	5.2
Depth	Max (in)	0.0	3.9	22.9	23.5
	Remaining (in)	0.0	0.0	0.0	0.0
Volume	Inflow (cf)	0	1,970	5,244	11,196
	ET (cf)	0	10	10	10
	Infil (cf)	0	107	110	112

不同降雨情境

Results:
Peak flow, volume, sediment, dewater time

Figures

Modeling and computation

- A summary of tools and their application
  - Tetra Tech.

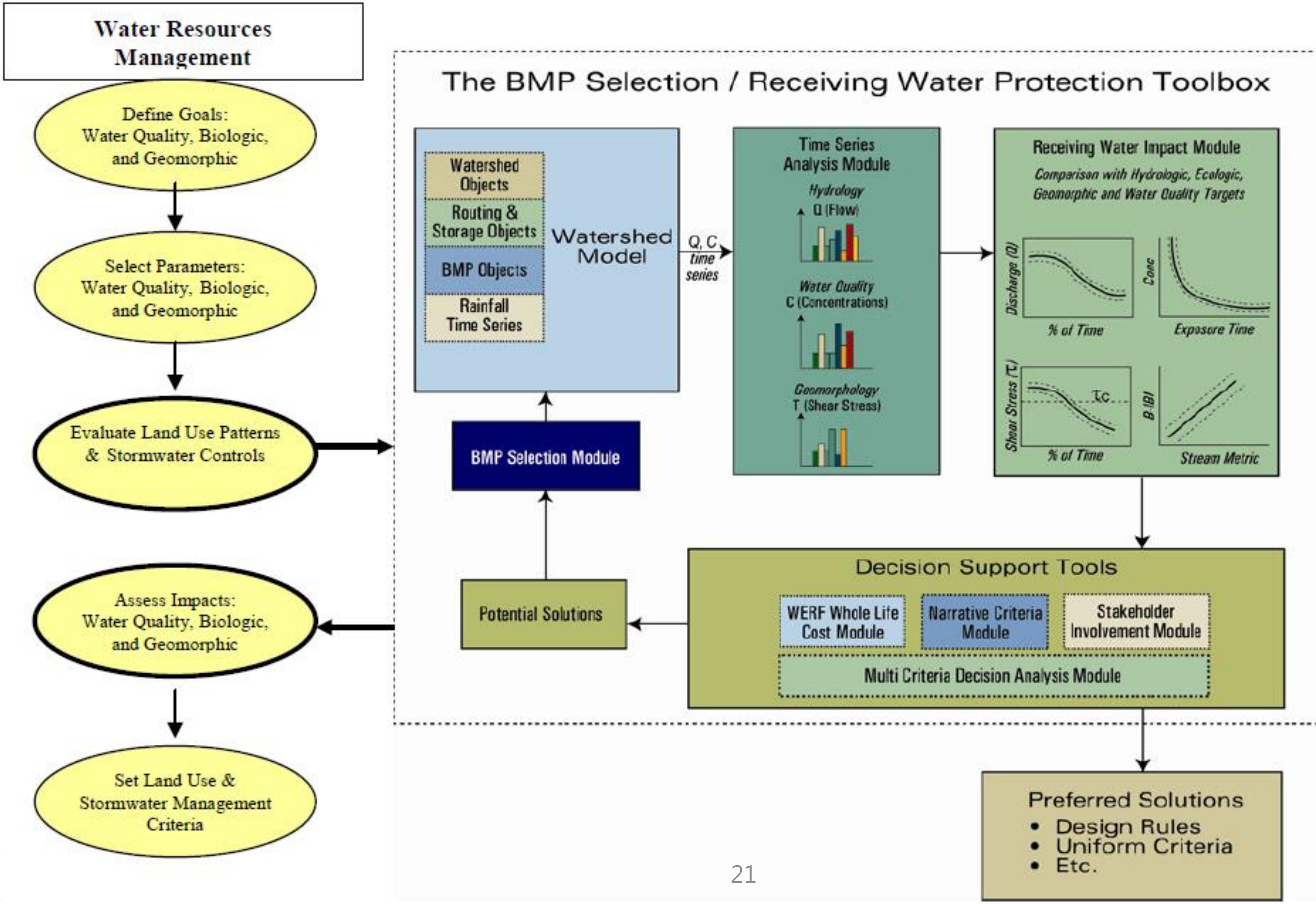
	Water Quality	Volume	Costing	User Interface	Complexity	Public Domain	Site-Scale	Watershed-Scale	Planning	Design
GREEN VALUES	X	X	X	WEB	SIMPLE	X	X		X	
EPA SW CALC		X		WEB	SIMPLE	X	X		X	
WERF SELECT	X	X	X	EXCEL	MODERATE	X	X		X	
MAPSHED/GWLF	X	X		GIS	MODERATE	X		X	X	
STEPL	X	X		EXCEL	MODERATE	X		X	X	
CWP RRM	X	X		EXCEL	MODERATE		X		X	
SET	X	X	X	EXCEL	MODERATE		X		X	
LIDRA		X	X	WEB	MODERATE	X	X		X	
L-THIA	X	X		WEB	MODERATE	X	X	X	X	
i-TREE HYDRO	X	X		GIS	COMPLEX	X		X	X	
SDST		X		EXCEL	MODERATE					X
RECARGA		X		WEB	MODERATE	X	X			X
WinSLAMM	X		X	WEB	MODERATE	X	X			X
SWMM	X	X		GRAPHICAL	COMPLEX	X	X	X	X	X

Model Summary Table

Modeling and computation

- Simulating lone-term performance of bioretention in Prince George’ s County
  - Tetra Tech. (SUSTAIN)
- Distributed BMP performance algorithms of the BMP selection/receiving water protection Toolbox
  - Geosyntec Consultants. (Water Environment Research Foundation (WERF) project)($50)

The BMP selection/receiving water protection Toolbox



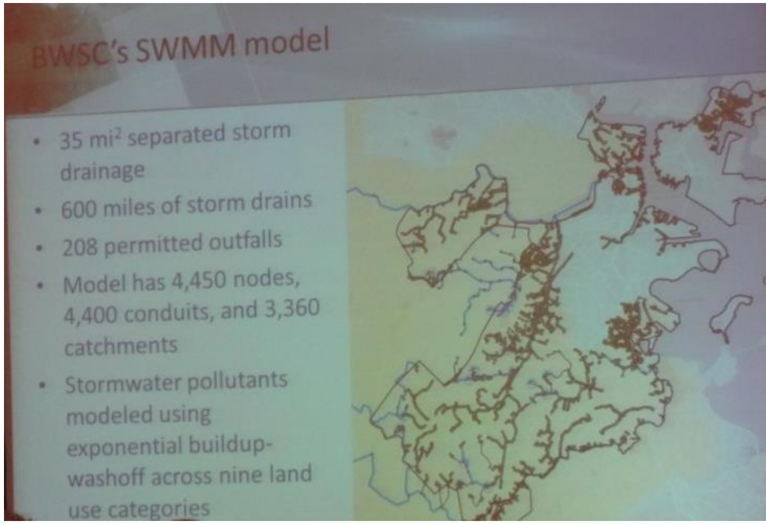
Modeling and computation

- Challenge of selecting a WQ model
  - 34 criteria, suggest 6 models from 24 models
  - L-THIA, STEP-L, MapShed, P8, SWAT, SWMM
- Comparison of tools for SCM modeling
  - 14 tools
  - Green Value Stormwater Calculator, National Stromwater Calcultor, BMP SELECT, MapShed, STEPL, Runoff Reduction Tool, Site Evaluation Tool, LIDRA, L-THIA, i-Tree Hydro, SDST, RECARGA, WinSLAMM, SWMM

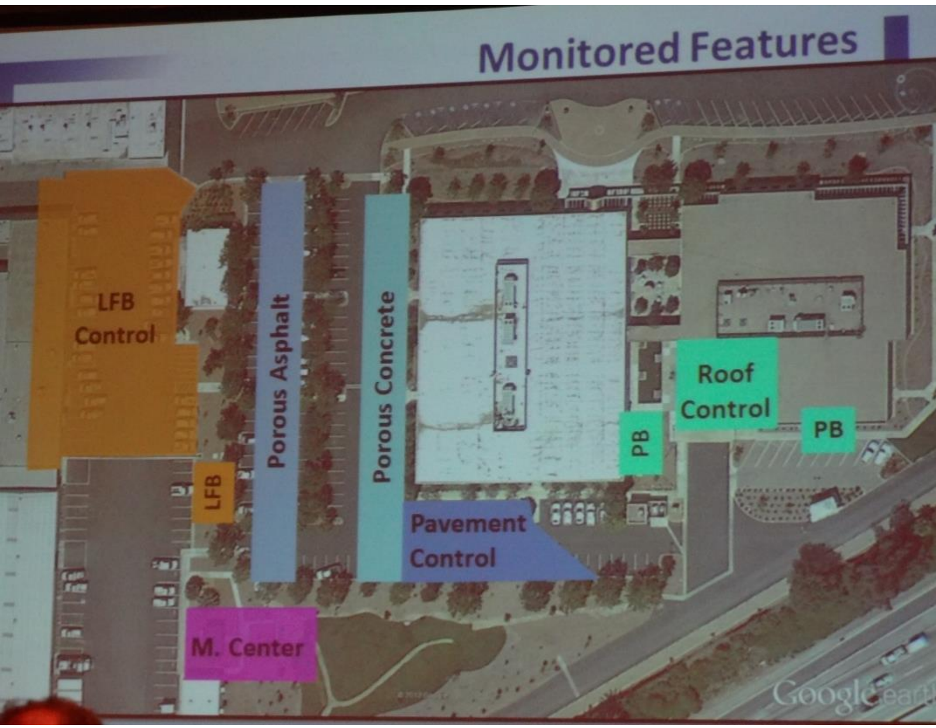
Modeling and computation

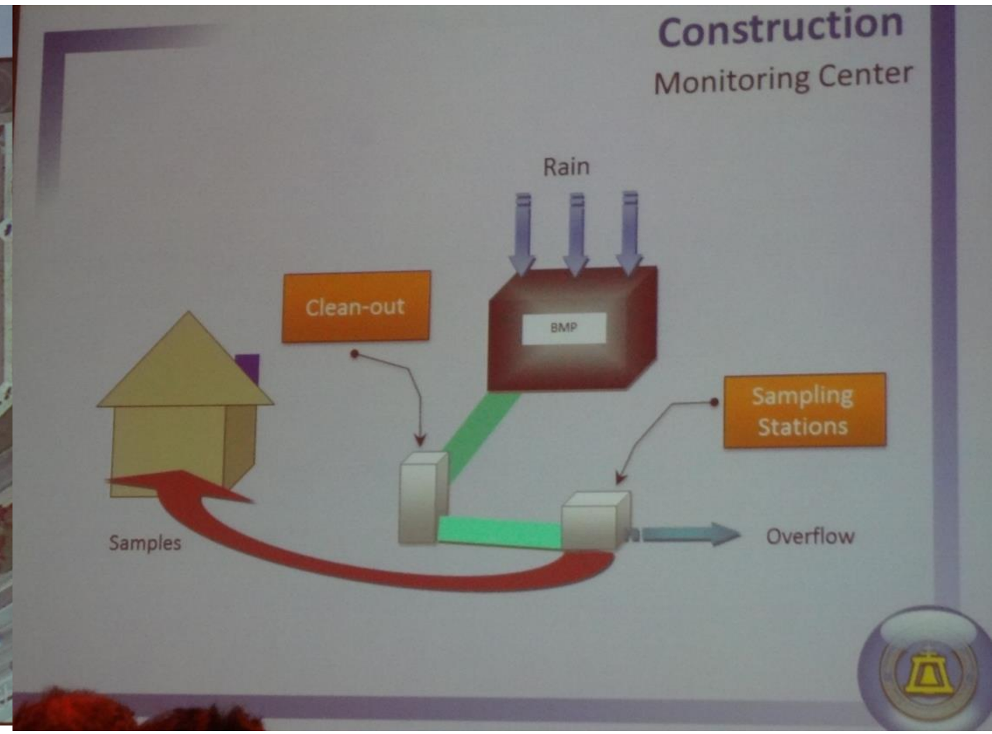
Evaluating LID with SWMM and SUSTAIN

- Modeling LID in Boston to comply with Stormwater Permits and TMDLs
- Verification of SWMM for LID
- Modeling LID using SWMM LID controls (Boston’s watershed)
- SUSTAIN in basin-scale planning



Monitoring and Measurements





Riverside, CA

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Technical Tour

- Mississippi Water Management Organization (MWMO) office
- University of Minnesota’ s TCF Football Stadium
- Lowry Avenue Bridge over the Mississippi River.
- Green Line

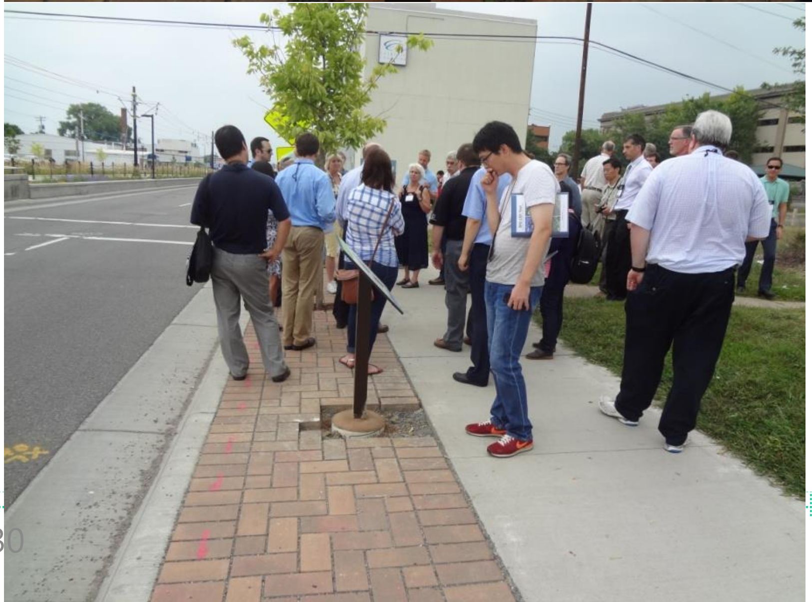
Mississippi Water Management Organization (MWMO) office

University of Minnesota’s TCF Football Stadium

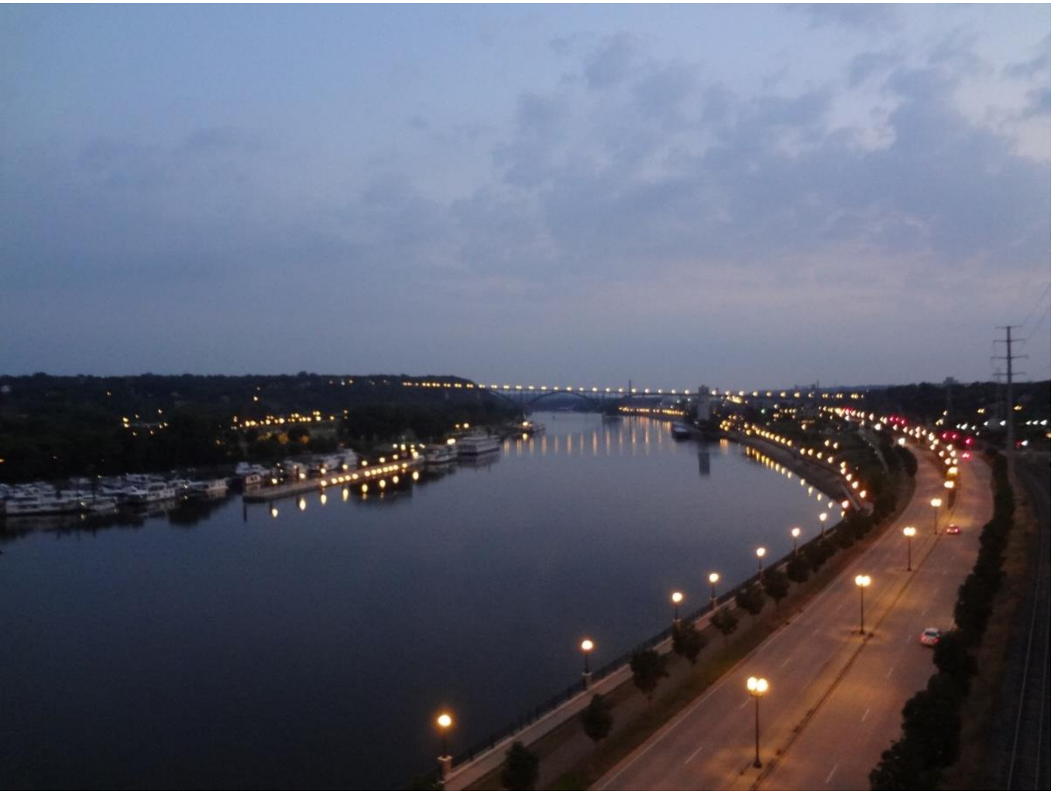
Green Line

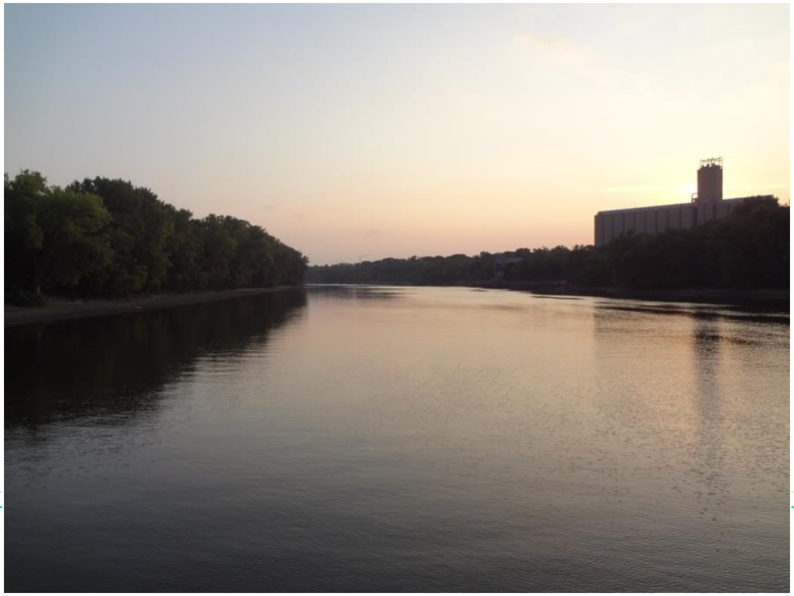

PUTTING DOWN ROOTS
Why?


ROOTING OUT POLLUTION
Trees along the Green Line help reduce pollution in the Mississippi River. Here's how—
Polluted rainwater usually flows from streets into storm drains and right to the river. But here, storm drains take up the flow and send it into long underground trenches filled with soil and rock and planted with trees. The trees sink their roots into the rocks where the water is stored. Extra water the trees don't need seeps deeper into the ground and is filtered by the layers of rock and soil.
1,000 trees are planted on the Green Line
Polluted rainwater enters the trench
Soil and tree roots filter pollution
Cleaner water in the Mississippi
Polluted rainwater
Permeable pavers
Polluted rainwater
Storm drain
Modified soil
Original soil
Rock
Roots channeling water
Why?
Polluted rainwater carries dirt, oil and trash to the Mississippi River when it flows from streets into storm drains. Rain gardens, stormwater planters and rock trenches on side streets were built along the Green Line to clean polluted rainwater before it reaches the river. The Green Line on University Avenue also has the longest stretch of tree trench in Minnesota — five miles!



Mississippi River





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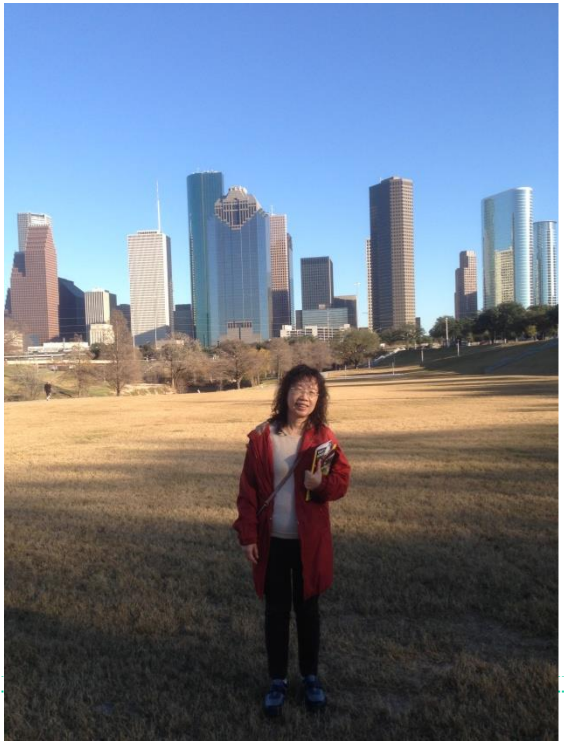
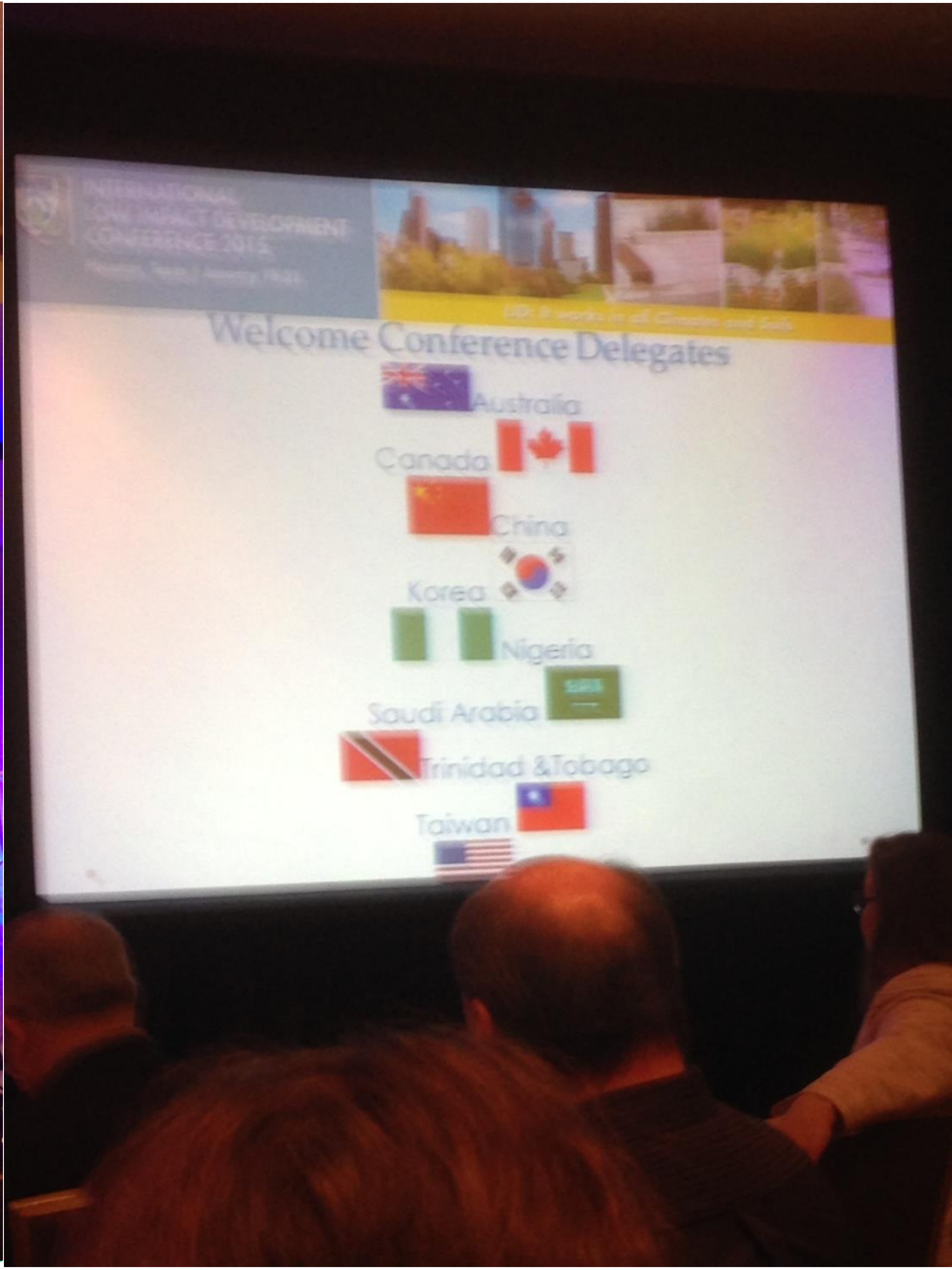
Low Impact Development 2015

IT WORKS IN ALL CLIMATES AND SOILS

ASCE-EWRI

January 19-21 在美國 Houston, Texas




Welcome Conference Delegates
Australia
Canada
China
Korea
Nigeria
Saudi Arabia
Trinidad &Tobago
Taiwan

Computational Methods

Real time control

Use of various models for evaluating expected performance

Optimization

Education, Training Outreach

Community and Neighborhood Involvement and Acceptance of LID

Engaging K-12 audiences

Public outreach

Green Infrastructure Construction

Descriptions of actual implementation projects

Green Infrastructure Performance Studies

Rainwater harvesting

Bioretention

Green roofs

Permeable pavement

Landscape, Planning, and Site Design

Green Alleys

Innovative LID design

Urban retrofit

Groundwater recharge

Human health and well-being

LID in Texas

Challenges for implementation over the Edwards aquifer

LID in Coastal Areas

Watershed restoration along the coast

Maintenance and Whole Life Costs

Lessons from the UK

低衝擊開發(LID)處理暴雨課題

- 處理雨水(保水) 跟暴雨(防洪) 是不同議題！
- 暴雨是在極端天候下，處理洪峰的基礎設施（濾波能力，扭力問題）：**Gray Infrastructure**
- 雨水是一個綜合可持續供水的基盤設施，包括保水、排水及供水分配：**Green Infrastructure**
- 美國3M概念（major, minor, micro）

LID 設施說明

LID 設施說明

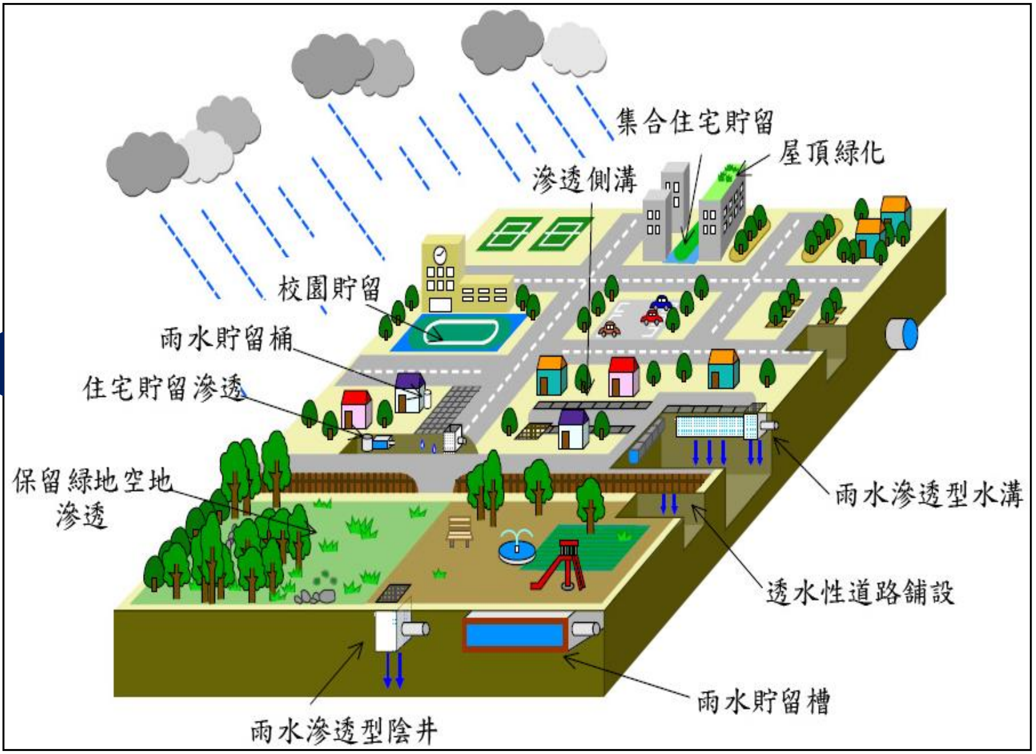
單一設施介紹與設計

- 設施的基本說明
- 設施案例
- 設施的使用限制與條件
- 設計參數與設計參考圖說

(1) 植生滯留槽
(2) 草溝
(3) 透水鋪面
(4) 綠屋頂
(5) 樹箱過濾設施
(6) 雨水儲留利用設施
(7) 其它入滲型設施

整體設計概念說明

- 低衝擊開發整體概念
- LID設施評估設計流程
- LID設施的篩選原則



LID 設施說明

單一設施介紹與設計

植生滯留槽(bioretention)

一、設施基本說明

植生滯留槽（bioretention）屬於入滲型設施，可以採小面積且小區塊的形式設計，並且可以配合整體造景的需求，設計成景觀花園，故又可以稱之為雨花園(rain garden)，可設置於建築物間的空地或綠地及停車場或道路之分隔島。

LID 設施說明

單一設施介紹與設計

植生滯留槽(bioretention)

二、設施案例

道路設施用地

LID 設施說明

單一設施介紹與設計

植生滯留槽(bioretention)

二、設施案例

建築社區用地

LID 設施說明

單一設施介紹與設計

植生滯留槽(bioretention)

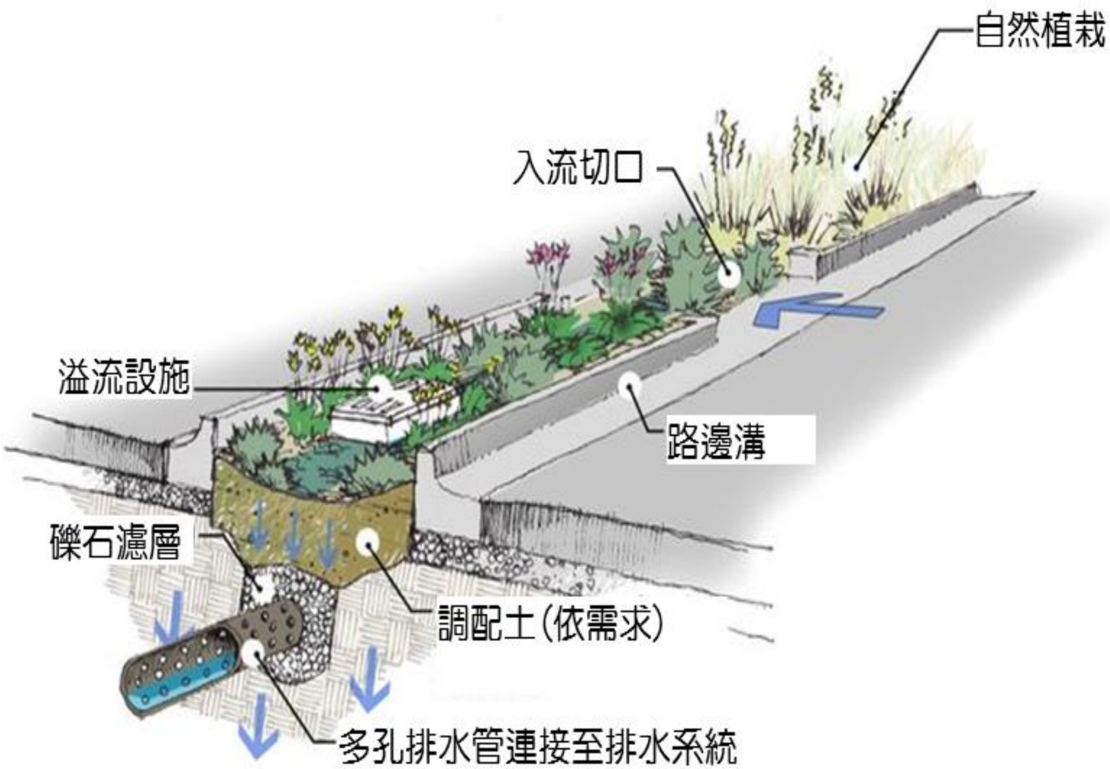
三、設施使用限制與條件

- 植生滯留槽不等同於滯洪池，無法處理大面積的排水。
- 設施可能被逕流水中的懸浮顆粒阻塞而降低其入滲效能，故必要時應設置預處理系統。
- 一般而言，設施所需面積約為總集水面積的5%~20%。
- 設施不宜設置於太陡削的邊坡，以免因邊坡沖蝕而產生災害，一般而言，坡度不宜大於20%。
- 若設置於停車場內，則可能會減少停車場之有效停車數量。
- 視設施所在地區而異，植生滯留槽的設置成本有可能會高於傳統之暴雨逕流處理設施。

LID 設施說明

單一設施介紹與設計

草溝(bioswales)



一、設施基本說明

又稱為植生溝(vegetated swales)，既是排水系統並兼具滲透功用，設施主要利用樹木及草類等植生來控制雨水之逕流速率，為自然且經濟之方式。草溝不但具有暴雨逕流雨水滲透效能，亦可增加景觀營造的價值，故又可稱之為生態草溝(bioswales)，一般施作於道路側或中央分隔設施。

LID 設施說明

單一設施介紹與設計

草溝(bioswales)

二、設施案例






LID 設施說明

單一設施介紹與設計

草溝(bioswales)

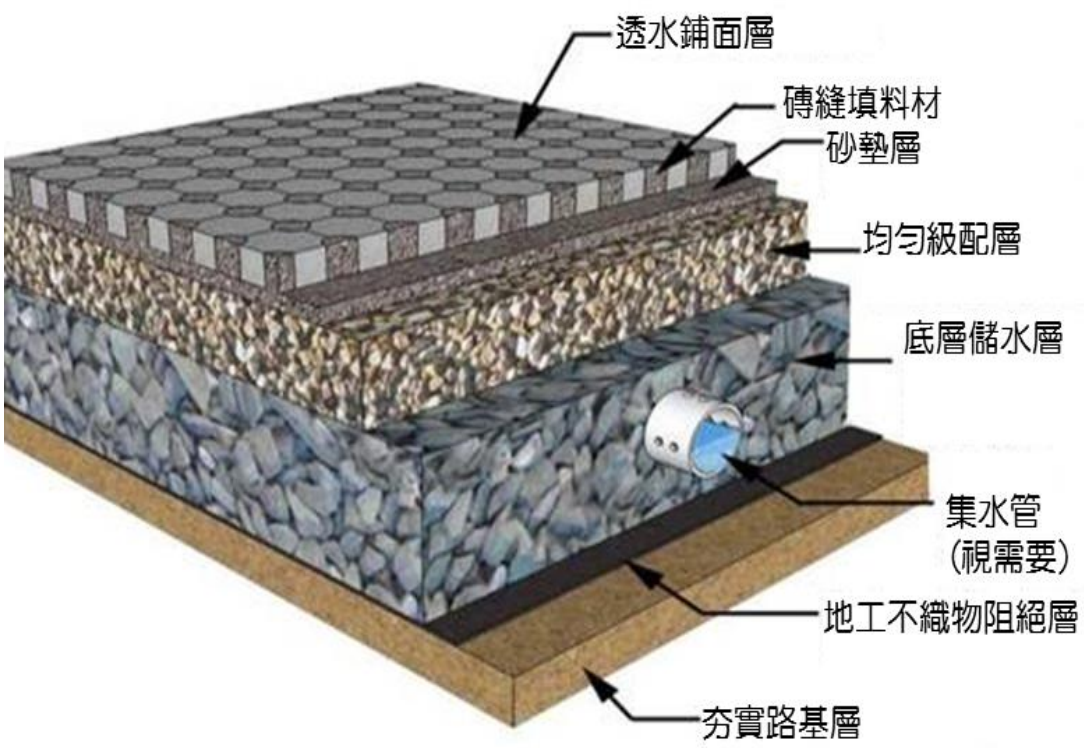
三、設施使用限制與條件

- 不當的設施設置可能會造成系統的阻塞並且無法達到水中污染物的淨化成效，在坡度較陡削的地區，植生密度是決定設施成敗的重要關鍵因素。
- 應儘可能的將草溝之間串聯。
- 對於有密集道路或設施穿越的地區不太合適設置草溝。
- 草溝對於水中磷酸鹽及細菌的去除能力差。
- 因草溝往往緊鄰道路設置，故容易受駕駛路邊停車或道路維護人員作業時損壞。

LID 設施說明

單一設施介紹與設計

透水鋪面(permeable pavements)



一、設施基本說明

又稱多孔隙鋪面 (porous pavements)，因具有將雨水滲透至地下之功能，故可以補注地下水並且因鋪面可以透氣，不會導致土壤中缺氧，對地下微生物之生長有所助益，而健康的土壤微生物系統將可以幫助水質淨化，達到水質再利用的功效。

LID 設施說明

單一設施介紹與設計

透水鋪面(permeable pavements)

二、設施案例






LID 設施說明

單一設施介紹與設計

透水鋪面(permeable pavements)

三、設施使用限制與條件

- 透水鋪面將來的維護管理費用與設施維修頻率較高，因此不適用於後續維護不易的地區。
- 設置成本較其它LID高，故應審慎評估其成本效益。
- 不適用暴雨逕流水中含有大量沈澱物的地區，因為容易造成透水鋪面層的阻塞。
- 對於有頻繁的交通量或大型車輛通行的道路，則透水鋪面需有足夠的強度來抵抗上部載重，然往往造價不斐。
- 因鋪面面層材往往會施作防滑塗料，因此可能會造成透水性能下降。

LID 設施說明

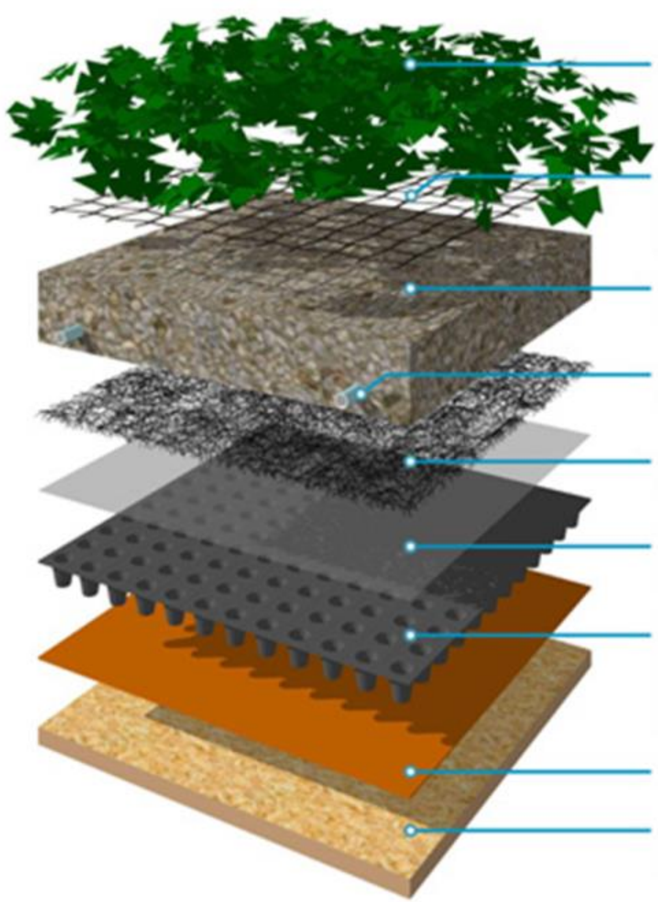
單一設施介紹與設計

透水鋪面(permeable pavements)

LID 設施說明

單一設施介紹與設計

綠屋頂(vegetated roof covers/green roofs)



一、設施基本說明

係指在屋頂上種植植栽並進行綠化，藉由綠屋頂的土壤層之蓄水能力，達到儲留的目的，並藉由植生層的物理性攔阻與生物性反應，達到水質淨化的成效。

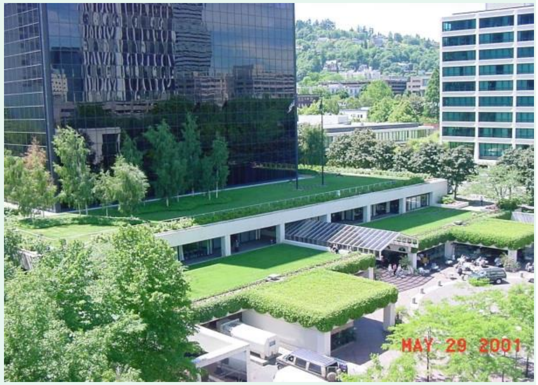
LID 設施說明

單一設施介紹與設計

綠屋頂(vegetated roof covers/green roofs)

二、設施案例

薄層型(粗放型)綠屋頂



LID 設施說明

單一設施介紹與設計

綠屋頂(vegetated roof covers/green roofs)

二、設施案例

花園型(精緻型)綠屋頂






LID 設施說明

單一設施介紹與設計

綠屋頂(vegetated roof covers/green roofs)

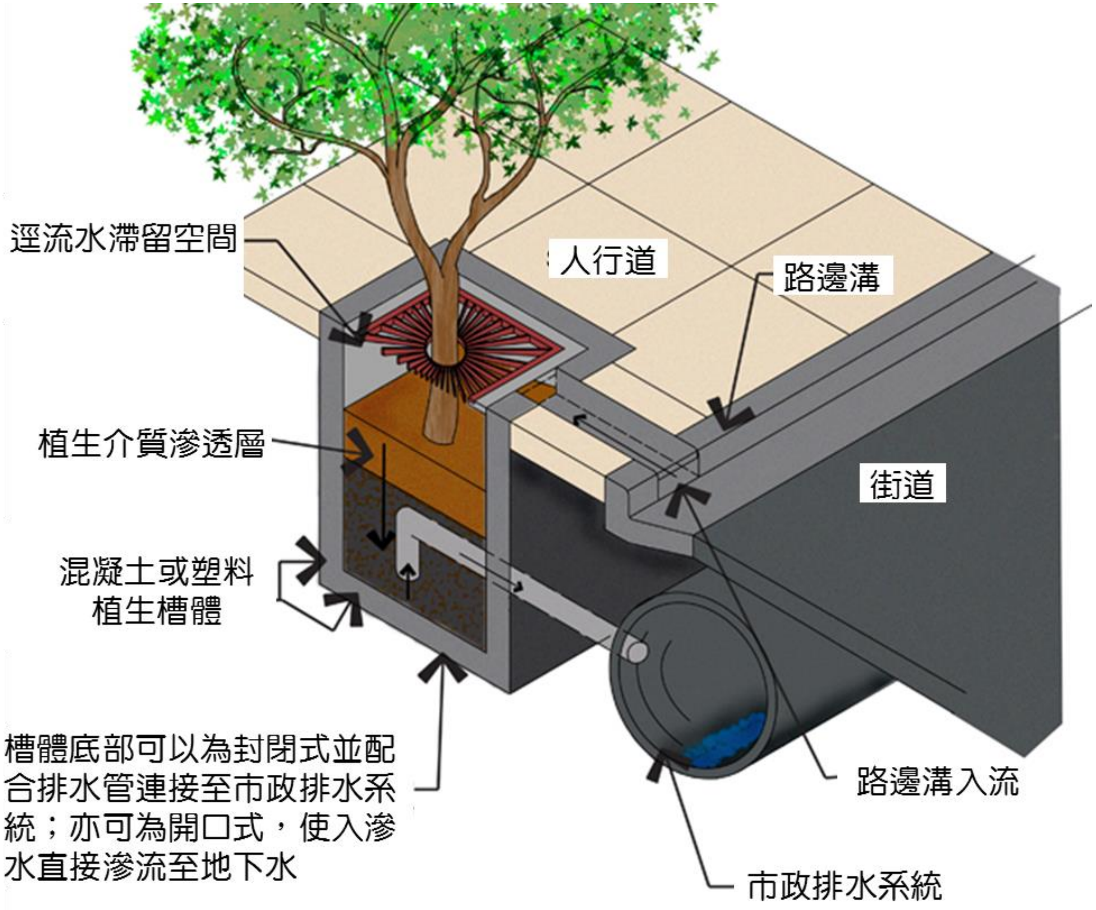
三、設施使用限制與條件

- 薄層型綠屋頂，一般只供人們觀賞，極少進入，其植物生長介質厚度在10~30 cm，以低矮灌木、草花和抗旱性強的地被植物、草皮為主。花園型綠屋頂種植介質厚度在30~60cm或以上，
- 綠屋頂施作應設計約2度之坡度以利排水。屋頂坡度大於15度以上，45度以下之屋頂綠化，應儘量做薄層型綠化。屋面坡度大於45度，盡量避免施做綠屋頂。
- 12層以上的建築物屋頂綠化，較適合施作薄層型綠化。
- 花園型屋頂綠化屋頂設計，其屋面承載應≧450kg/m^2；薄層型屋頂綠化屋頂設計，其屋面承載應≧200kg/m^2。

LID 設施說明

單一設施介紹與設計

樹箱過濾設施(tree box filters)



一、設施基本說明

樹箱過濾設施是一種結合物理性化學性與生物性過濾的暴雨逕流收集與污染整治LID設施，不同於傳統封閉的混凝土樹台，樹箱過濾系統具有獨特的開放式設計不僅可以為“潔淨的”雨水直接垂直入滲補充天然地下水，而且還具有側開口，以允許更多的滲透，及無限制根系生長使樹木健康生長。

單一設施介紹與設計

樹箱過濾設施(tree box filters)

LID 設施說明

單一設施介紹與設計

樹箱過濾設施(tree box filters)

二、設施案例






LID 設施說明

單一設施介紹與設計

樹箱過濾設施(tree box filters)

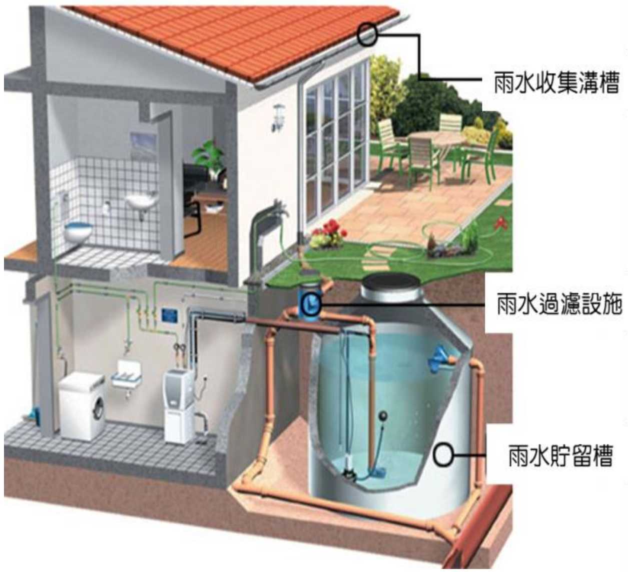
三、設施使用限制與條件

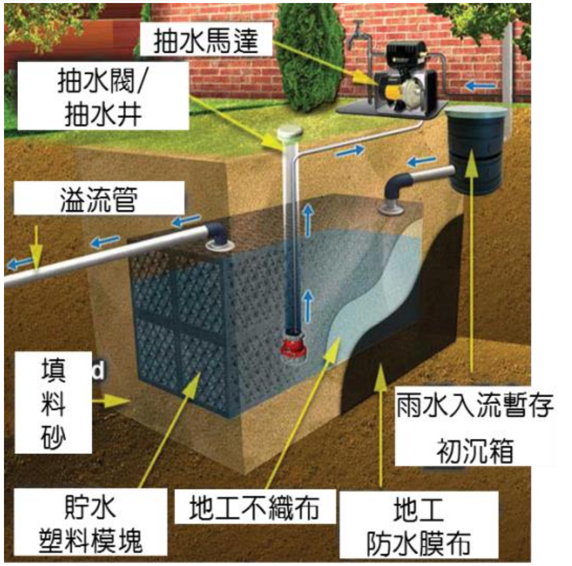
- 封閉式的樹箱過濾設施需連接至市政排水，並且需設有暴雨溢流設施，以避免因雨水積存於樹箱內，致使植株死亡。
- 樹箱過濾設施需有定期的維護管理，尤其是入流口需保持暢通，若有樹葉或垃圾等阻塞，應加以清除。
- 掃街車清洗街道時，避免直接將含高量懸浮顆粒的污水沖洗進入樹箱內，以避免內部阻塞而影響其入滲能力。

LID 設施說明

單一設施介紹與設計

雨水儲留利用設施(rainwater harvesting systems)





(a) 雨水蓄水桶
Rainwater barrels

(b) 地下蓄水槽
Underground water storage tanks

(c) 地下蓄水塑膠模塊
Underground water storage facilities

LID 設施說明

單一設施介紹與設計

雨水儲留利用設施(rainwater harvesting systems)

二、設施案例			
雨水蓄水桶			
地下蓄水槽			

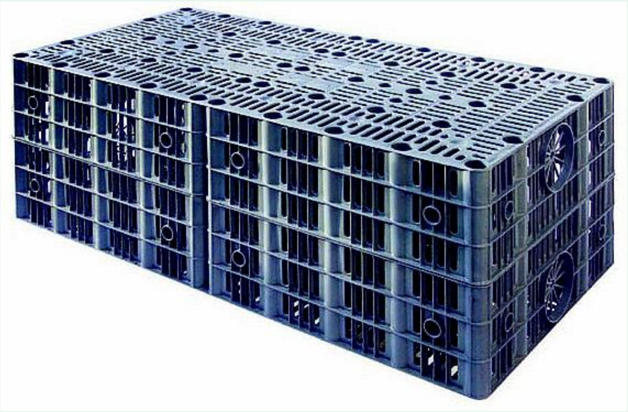
LID 設施說明

單一設施介紹與設計

雨水儲留利用設施(rainwater harvesting systems)

二、設施案例

地下蓄水塑膠模塊



LID 設施說明

單一設施介紹與設計

雨水儲留利用設施(rainwater harvesting systems)

三、設施使用限制與條件

- 雨水貯留利用系統具有有限的貯水能力，一旦水位達到其貯留上限時，雨水貯留系統便不再具有降低暴雨逕流的能力。
- 雨水貯留利用系統具有降低暴雨逕流的能力，但大都不具有雨水淨化的能力。
- 系統安裝需由有經驗的人員來操作，以避免系統回收水與飲用水交叉污染的機會。
- 部份的產品可能具有專利，難以廣泛應用於公共工程。

LID 設施說明

單一設施介紹與設計

雨水儲留利用設施(rainwater harvesting systems)

形式	優點	缺點
雨水蓄水桶	• 位置選擇靈活 • 安裝方便，不存在基礎結構設計問題	• 通常只能收集屋頂及屋雨水 • 規模較小 • 分散管理
地下蓄水槽	• 規模可靈活變化 • 管理簡單	• 建造成本高 • 需進行基礎結構設計 • 不能拆卸再利用
地下蓄水塑膠模塊	• 規模可靈活變化 • 可以安裝成不同形狀，不受地形限制 • 可以拆卸再利用	• 建造成本高 • 產品可能有專利問題

LID 設施說明

單一設施介紹與設計

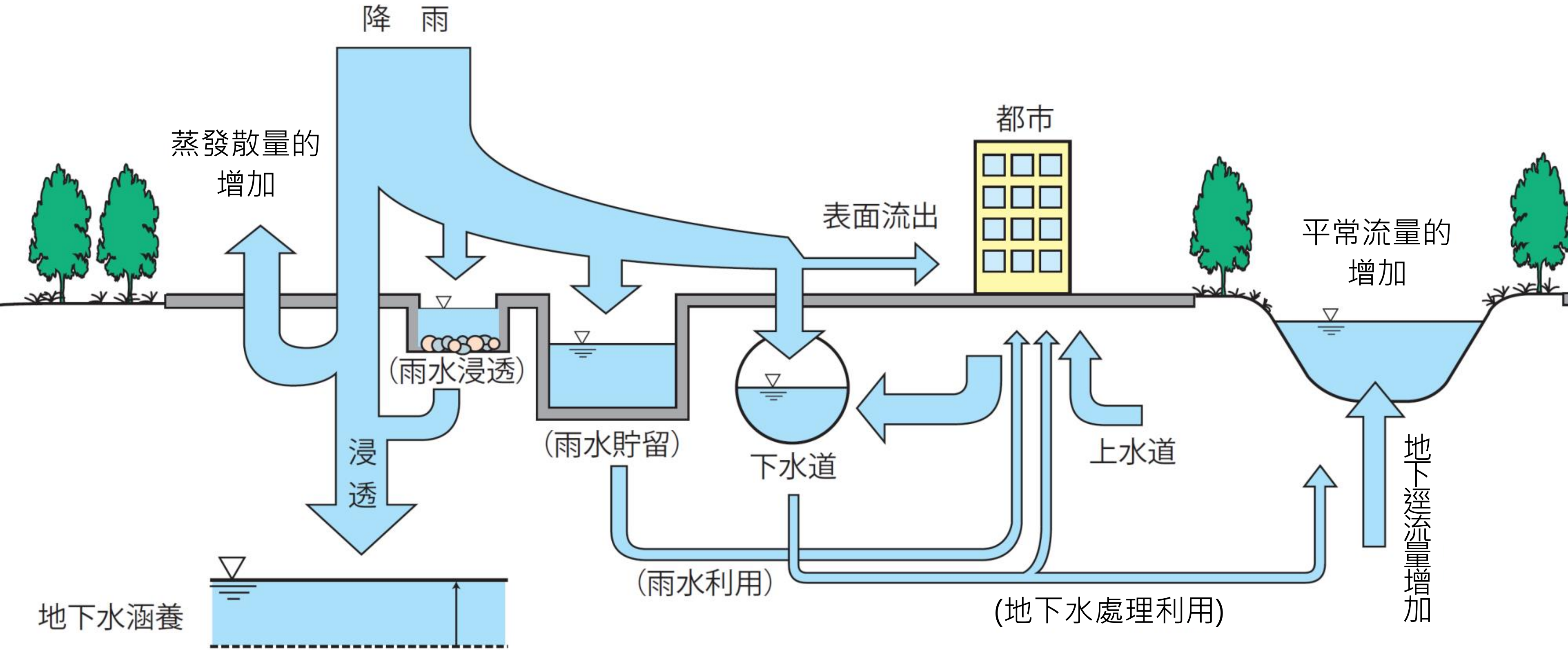
滲透排水管

滲透井

滲透溝

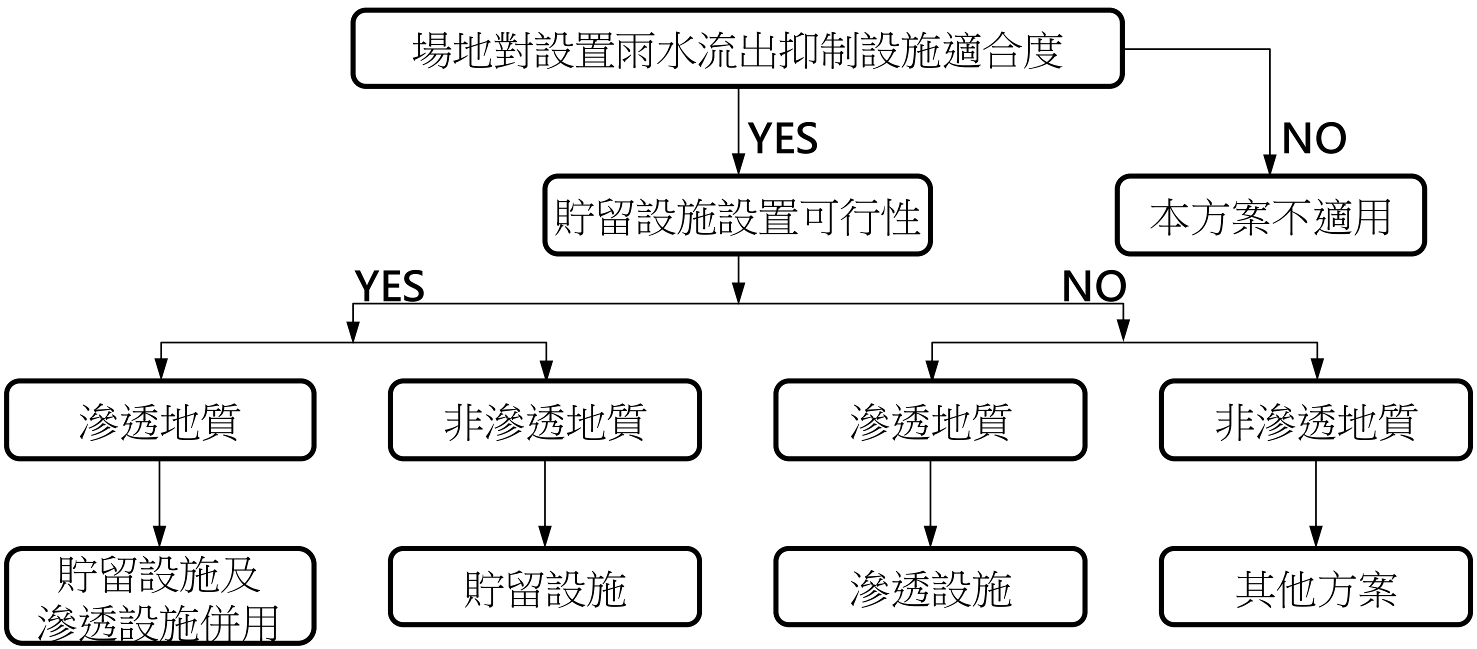
整體設計概念說明

LID整體概念



整體設計概念說明

LID設施評估設計流程



Ⅲ 國內外案例說明

國內案例介紹-植生滯留槽

案例一：高雄市博愛路三段捷運生態園區，寬度約120cm
目的：處理道路逕流雨水

案例三：台北科技大學第一、第四教學大樓&土木館周圍
目的：處理建築物外牆及屋頂逕流雨水

國內案例介紹-植生滯留池

案例一(台中市)：不涉及開挖整地的純建築行為，申請案送到台

案例二：林口區現有29處滯洪池

案例三：台中西屯區秋紅谷公園(2012年09月完工)

國內案例介紹-透水鋪面

案例一(透水磚)：台北市文山區行政中心周邊人行道，總長300m，寬度4.8m，累積雨量小於30mm，入滲率可達80%

案例二(透水磚)：古亭國小周邊人行道

案例三(排水瀝青)：五楊高架

案例四(植草磚)：總統府停車場

案例五(其它)：JW工法

國內案例介紹-草溝/入滲溝

案例一(礫石溝)：台中生活圈2號線環中路高架橋工程

案例二(礫石溝)：新北市淡水區

案例三(礫石溝)：台北市淡水河

案例四(草溝)：台東水利會馬背調整池旁邊溝

案例五(草溝)：台北市北投區奇岩新社區

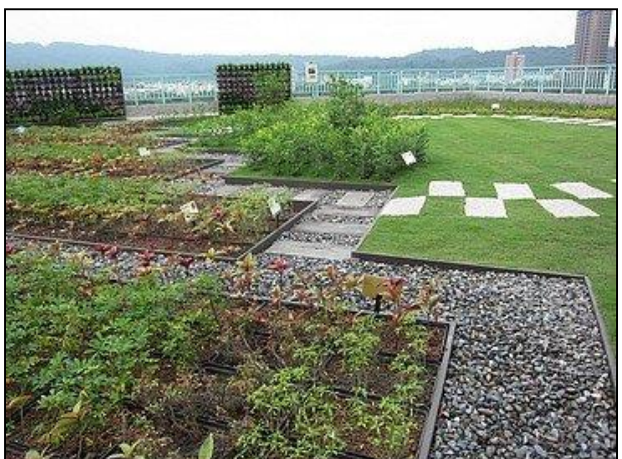
案例三(草溝)：台北市北投區幸福公園

國內案例介紹-綠屋頂

案例一：台北市花新生三館

案例二：八里區長坑國小

案例三：新竹工研院51館



案例四：成大綠色魔法學校

案例五：新莊運動休閒中心

案例六：信義區行政中心