Low Impact Development/Green Infrastructure Workshop
San Antonio, Texas

Bioretention for Stormwater Quality Improvement in Texas

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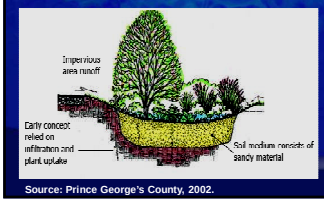
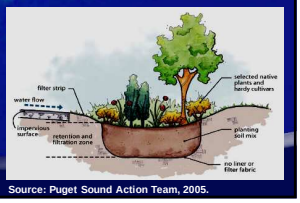
Bioretention Concept

- A terrestrial-based, water quality and water quantity control practice
- Using chemical, biological and physical properties of plants, microbes and soils for removal of pollutants from stormwater runoff
- On-site source control
- No permanent water pool (completely drains in 24 hours)



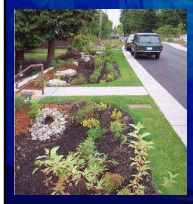
Source: Prince George's County, 2002.



Source: Puget Sound Action Team, 2005.

Potential Applications

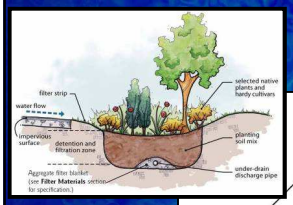
- Residential areas (also called rain gardens)
- Commercial / institutional areas
- Highway corridors


Puget Sound Action Team, 2005.

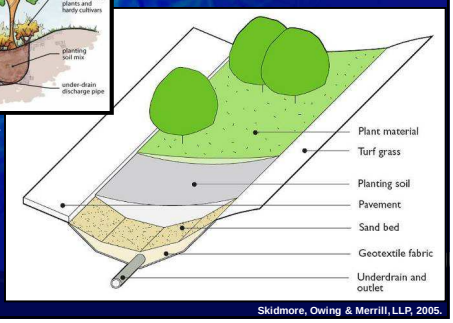

http://www.ence.umd.edu


Prince George's County, 2002.

Bioretention Design



Puget Sound Action Team, 2005.



Skidmore, Owing & Merrill, LLP, 2005.

Design Variations

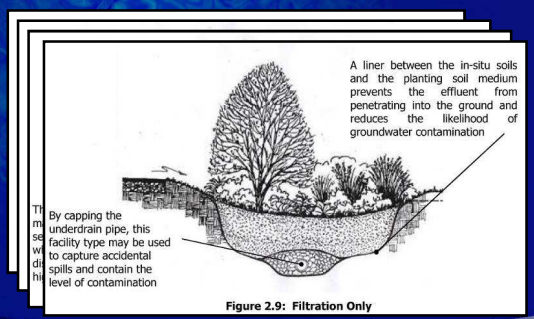
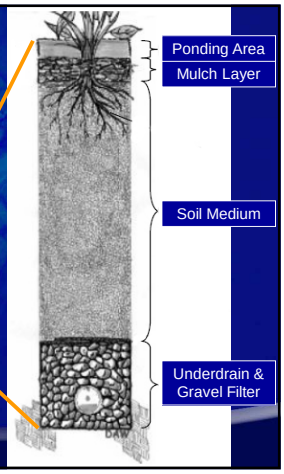


Figure 2.9: Filtration Only

Bioretention Manual.

Components

- Pretreatment (optional)
- Flow entrance
- Ponding area
- Vegetation
- Mulch layer
- Soil Medium
- Gravel layer
- Underdrain outlet (optional)
- Overflow bypass

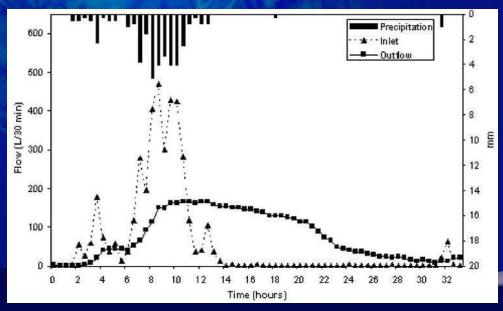


PGC, 2002.

Performance of Bioretention

Peak Flow Mitigation

- Bioretention mitigates flashy stormwater runoff



Dietz & Clausen. 2005

Pollutant Removal

- Properly designed and constructed bioretention can achieve moderate removal of nutrients and excellent removal of heavy metals

Pollutant	TSS	Fecal Coliform	*E. Coli*	Cu	Pb	Zn	Fe
% mass removal*	57%	82%	71%	83%	92%	77%	>96%

Pollutant	NO_{3+2}-N	NH_3-N	TKN	TN	TP	O&G	PAH
% mass removal*	31%	69%	39%	56%	28%	98%	90%

*Median values in previous literature

The Project

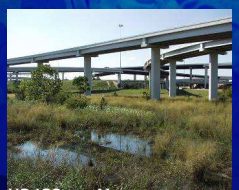
TxDOT 0-5949

Purpose

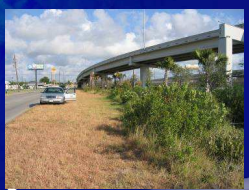
- Investigate the applicability and identify benefits and drawbacks of bioretention BMPs in Texas, specifically for highway related applications

Unique Significance of TxDOT 0-5949

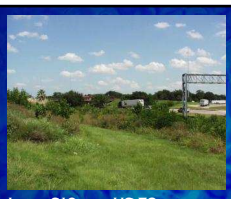
- Highway environment (roadsides, interchanges)
- Texas climate/soil/plants



US 183 and Mopac interchange naturalization project



Roadside naturalization in Corpus Christi



Loop 610 and US 59 interchange in Houston

US 290 and Mopac 1 in Austin

TxTag Parking Lot in Austin

Project Overview

- Duration of four years (FY08-12)
- Laboratory pilot experiments (budgeted)
- Field demonstration projects (participants' budget)

TxDOT Advisory Team

- Stephen Ligon (PD)
- Craig Dunning
- Amy Foster
- John Moravec
- David Zwernemann

Research Team

- Ming-Han Li (PI), TTI/TAMU
- Kung-Hui (Bella) Chu (co-PI), TAMU
- Beverly Storey, TTI
- Jett McFalls, TTI
- Derrold Foster, TTI
- Chan Yong Sung, TAMU
- Myung Hee Kim, TAMU

Major Tasks

- Reviewing literature and cases
- Identifying applicable situations and candidate projects
- Laboratory experiments
- Field demonstration projects
- Deliverables (design guides and reports)
- Implementation (future goal)

Facilities

- Hydraulic, Sedimentation and Erosion Control Laboratory, TTI
- Environmental engineering labs, Texas A&M University

Work in Progress

- Literature review – completed; draft under review
- Laboratory experiment – installed; runoff test being conducted
- Field demonstration
  - TTI Gilchrist Building detention ponds retrofit
  - Austin District (SH45-SH130 Interchange, TxTag Parking lot)
  - Bryan District (SH6-SH21 Interchange)

Experiments

Lab Pilot Experiment (Box Test)

- Focus on TSS and metal removal
  → no need of denitrification
  → no saturation zone
  → may need satuation zone for survival
- Five bioretention cells of 6' long, 6' wide, and 4' deep
- Column test was conducted to determine soil/compost ratio prior to box test

Column Test

Sand : Compost ratio	5 : 5	6 : 4	**7 : 3**
Soil infiltration rate	12.0	10.5	**9.75** in/hr

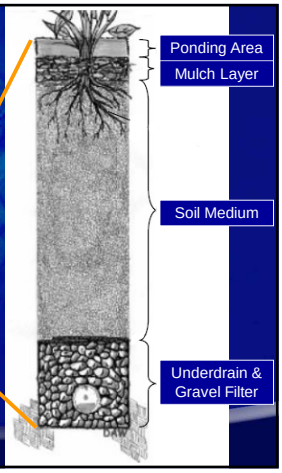
Box Transformation

Box Transformation

Box Transformation

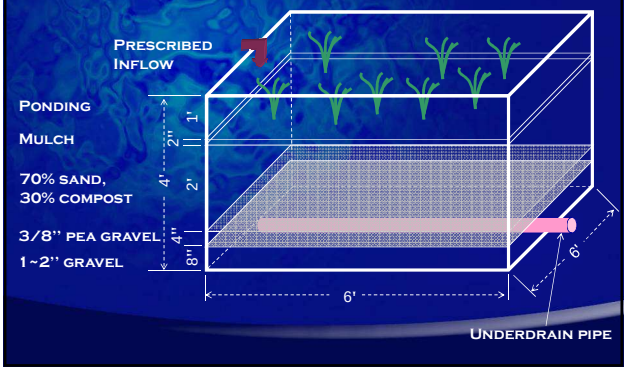
Components

- Pretreatment (optional)
- Flow entrance
- Ponding area
- Vegetation
- Mulch layer
- Soil Medium
- Gravel layer
- Underdrain outlet (optional)
- Overflow bypass

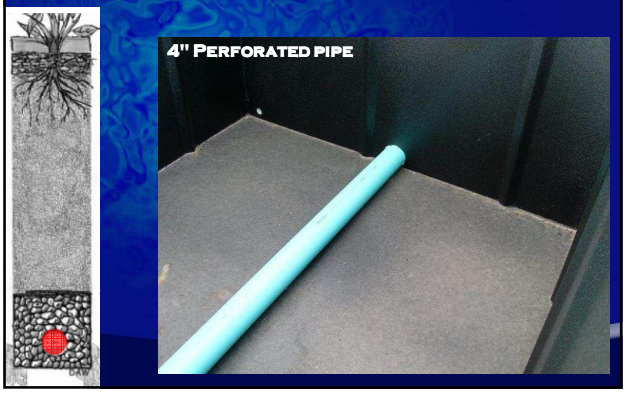


PGC, 2002.

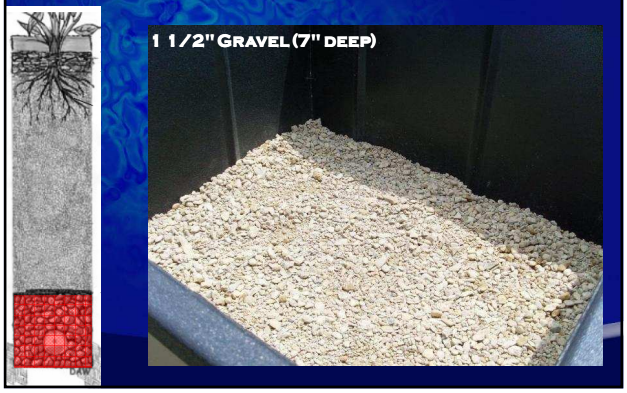
Pilot Bioretention Schematics



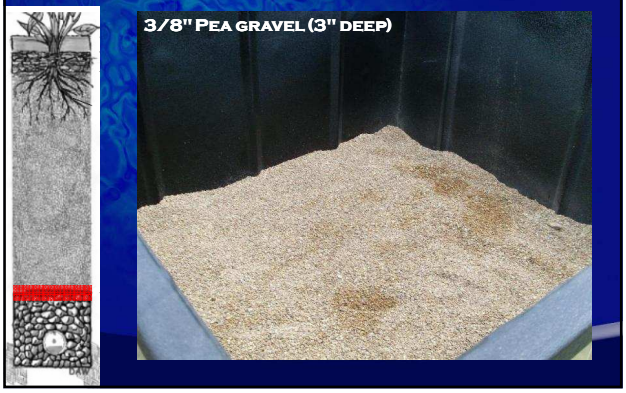
Installation by Layer



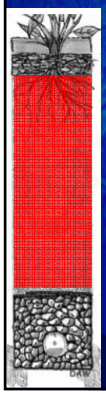
Installation by Layer



Installation by Layer

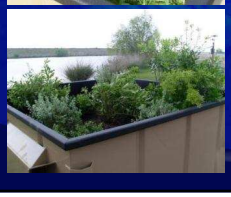


Installation by Layer



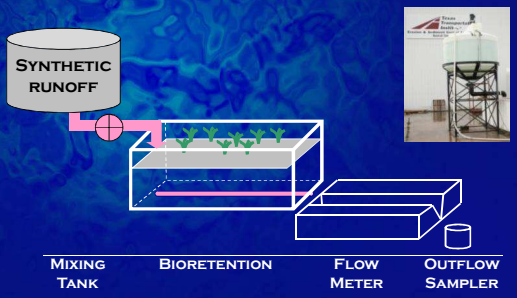
7:3 Sand/compost mix (24" deep)

Tested Vegetation

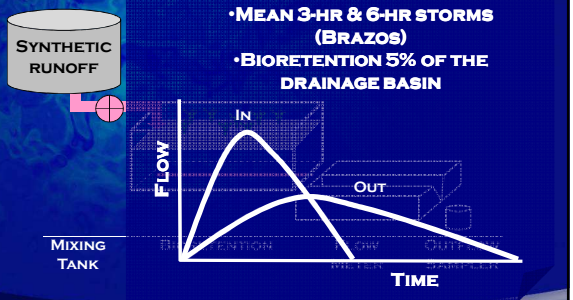


- Box 1: Control
- Box 2: Bermudagrass
- Box 3: Native grasses
- Box 4: TxDOT Bryan District standard seed mix (sand)
- Box 5: Shrubs
  - Wax Myrtle
  - Dwarf Yaupon Holly
  - Texas Sage (Cenizo)

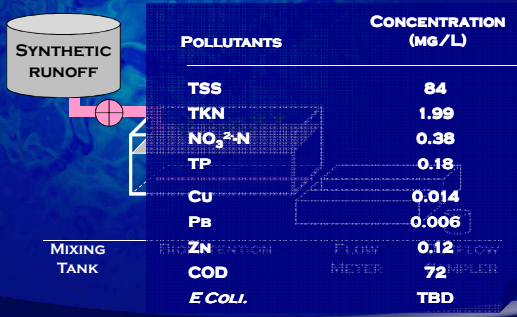
Runoff Test Schematics



Runoff Test Schematics



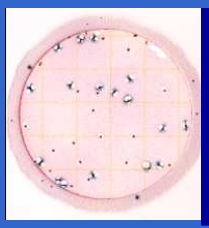
Runoff Test Schematics



Pollutants	Concentration (mg/L)
TSS	84
TKN	1.99
$NO_3^{2-}N$	0.38
TP	0.18
Cu	0.014
Pb	0.006
Zn	0.12
COD	72
E Coli.	TBD

Quantification of *E coli.*

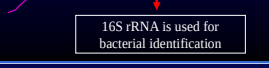
Plate count
(Colony forming units/ volume)



PCR-based Molecular
(# 16S rRNA gene copies/ volume)

All Bacteria Have Genomic DNA

- Genomic DNA => blueprint for living cells
- 16S rRNA => Biomarker



16S rRNA is used for bacterial identification

Field Demonstration: Candidate Sites

Site 1 (Austin)
TxTag Parking Lot
Detention Pond Retrofit

Site 2 (Austin)
SH45 - SH130 Interchange

Site 3 (College Station)
TTI Parking Lot
Detention Pond Retrofit

Site 4 (Bryan)
SH 6 – SH 21 Interchange

In Closing

- TxDOT 0-5949 will end in 2012
- Large scale bioretention worth of research
- Semi-arid region application

Sample Literature

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