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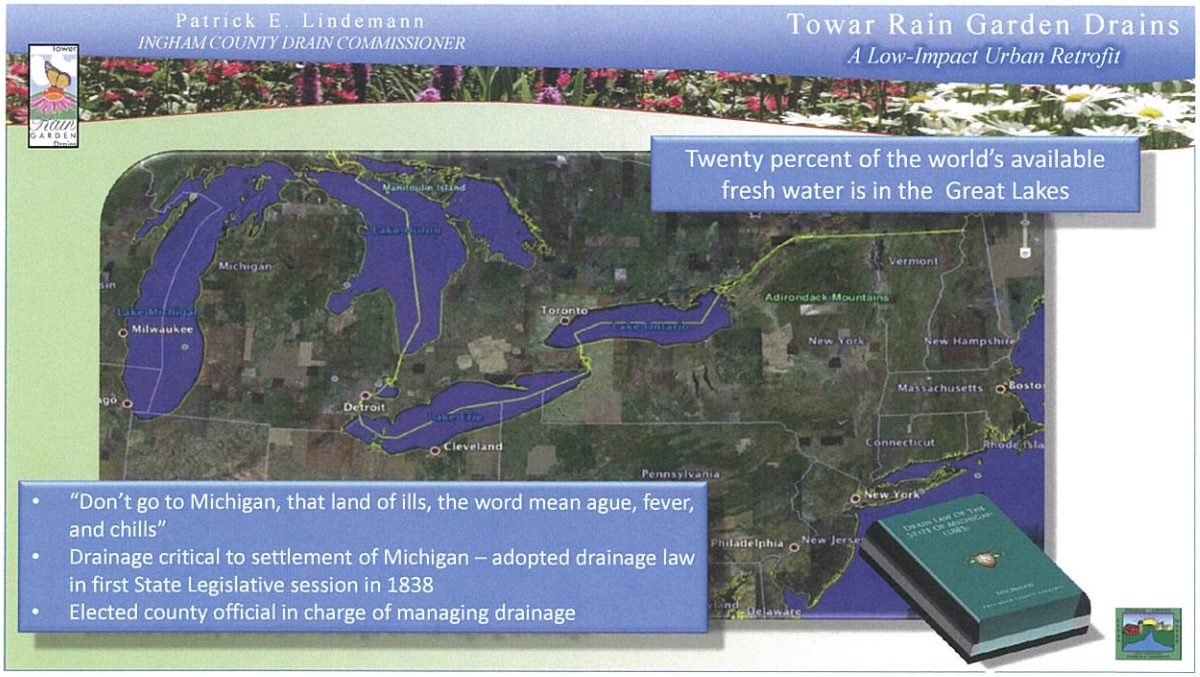
Towar Rain Garden Drains
A Low-Impact Urban Retrofit

Towar Rain Garden Drains:

A Michigan Urban Retrofit Low Impact Stormwater Management System

[redacted]

What Color is Your Infrastructure? - Lawrence Technological University - September 23, 2011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Twenty percent of the world's available fresh water is in the Great Lakes
Michigan
Milwaukee
Toronto
Detroit
Cleveland
Vermont
Adirondack Mountains
New York
New Hampshire
Massachusetts
Connecticut
Pennsylvania
Philadelphia
New Jersey
Delaware
"Don't go to Michigan, that land of ills, the word mean ague, fever, and chills"
Drainage critical to settlement of Michigan – adopted drainage law in first State Legislative session in 1838
Elected county official in charge of managing drainage


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Towar Rain Garden Drains are in the headwaters of the Great Lakes
Saginaw
Muskegon
Grand Rapids
Flint
Holland
Lansing
Shelby Township
West Bloomfield Township
Kalamazoo
Battle Creek
Ann Arbor
Detroit

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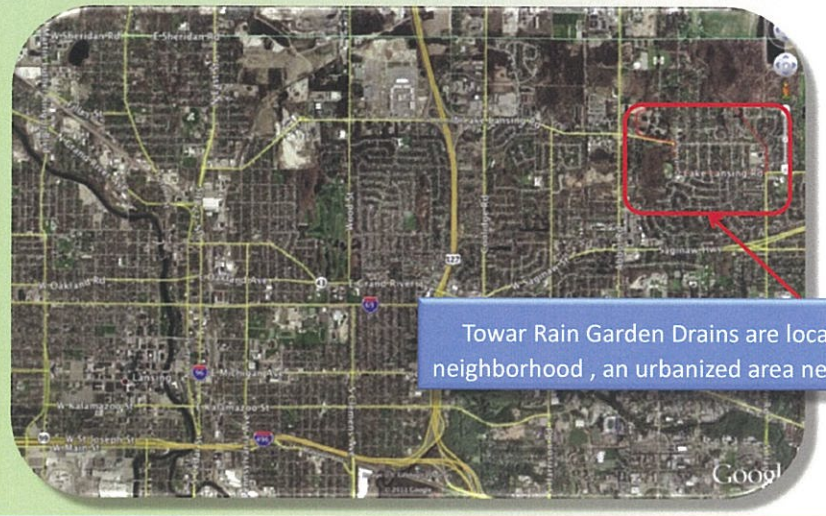

Towar Rain Garden Drains are located in Towar Gardens neighborhood , an urbanized area near state capital, Lansing

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Towar Gardens neighborhood:

- Approximately 200-acre area
- Over 400 single-family homes & several multi-family and commercial developments
- Affordable housing
- Platted originally in 1920s-1940s
- 40% Impervious

Towar Gardens developed over the years with no organized drainage system for collection or conveyance of stormwater which resulted in widespread and longstanding flooding

Flooding along Roadways – Roads in Poor Repair & Impassable at Times

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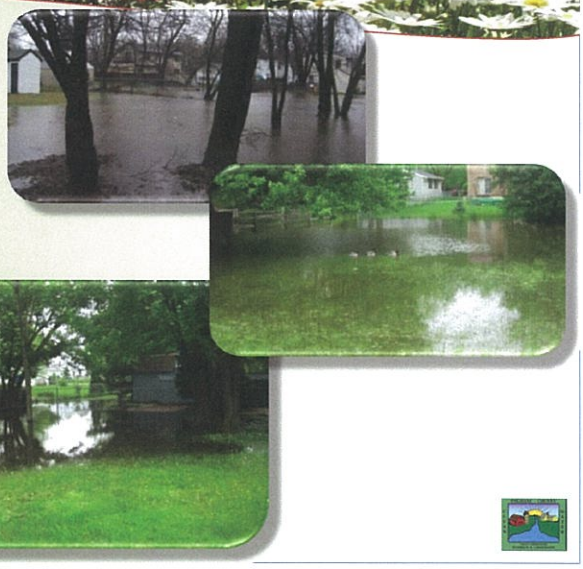
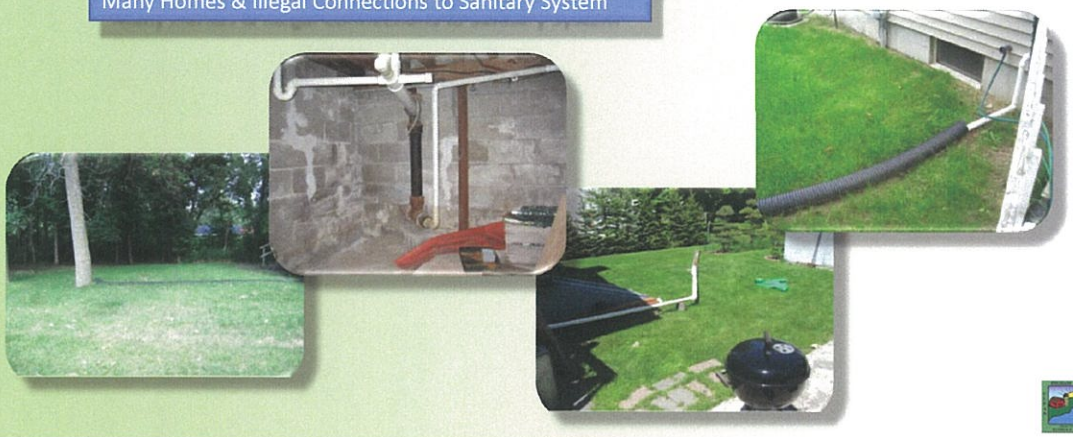
Flooding in Yards

Standing water could remain for days after 30-minute rainfall or less than one-year storms resulting in loss of use of private property and unhealthy conditions



Flooding of Basements - Sump Pumps Ran Constantly in Many Homes & Illegal Connections to Sanitary System



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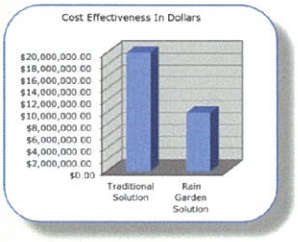
Why LID for Towar Gardens?

- Allowed for feasibly overcoming site constraints
  - Flat, low-lying topography with poorly-drained soils
  - Narrow rights-of-way with multiple utility conflicts
  - Rear yards lower than front yards
  - Downstream outlet elevation limitations for gravity flow
  - Lack of available land for detention w/o removing affordable housing
- Cost of conventional system was prohibitive for 400 modest homes ($20 million vs. $9.8 million)
- Met NPDES Phase II requirements



What are the Towar Rain Garden Drains?

- 200-acre watershed
- 10-year pipe design; 100-year detention design
- 8.25 miles of drain constructed
  - Collection and treatment system: underdrained rain gardens and roadside ditches (150 rain gardens/5.6 acres)
  - Conveyance system: roadway concrete drain pipes (none larger than 24")

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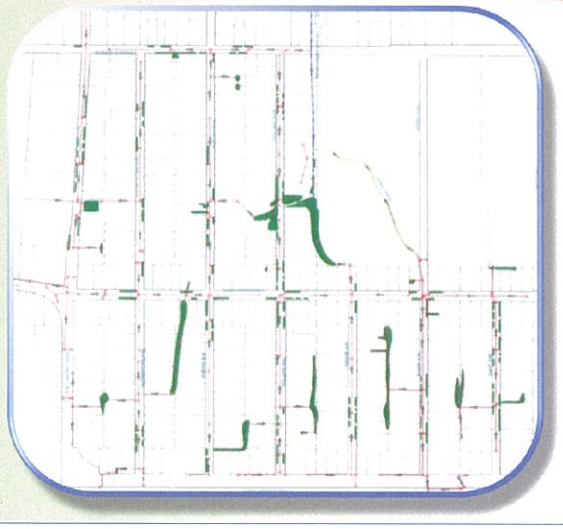
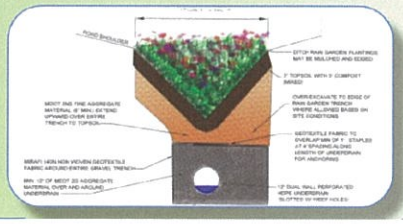
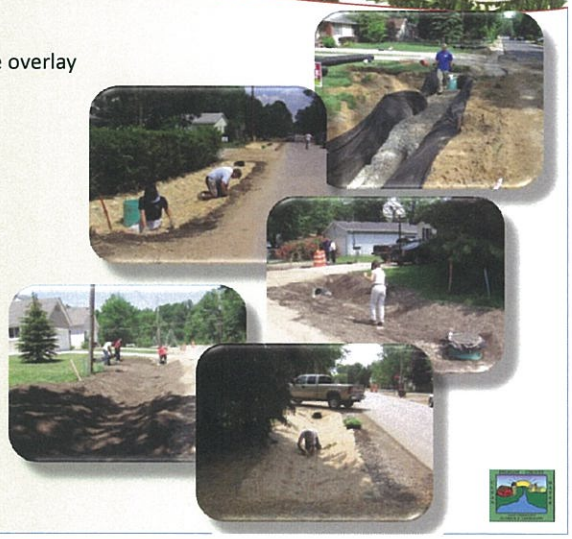
Overall System Treatment Train



Roadside Rain Gardens

- Underdrained infiltration bed with amended soil profile overlay
- Small, most 400 to 4,000 square feet
  - 6" topsoil/compost
  - 6" sand (geotextile fabric separating aggregate)
  - 12" aggregate
  - 12" underdrain (perforated dual wall HDPE, non-wrapped)
  - Overflow weir





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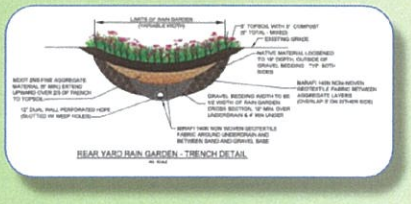
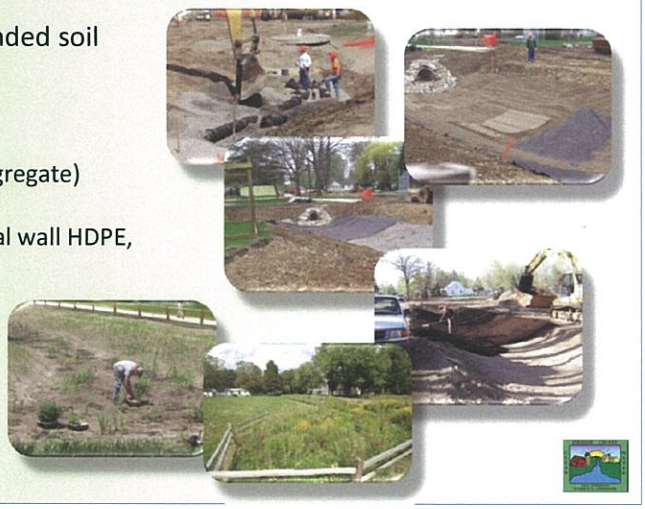
Read Yard Rain Gardens

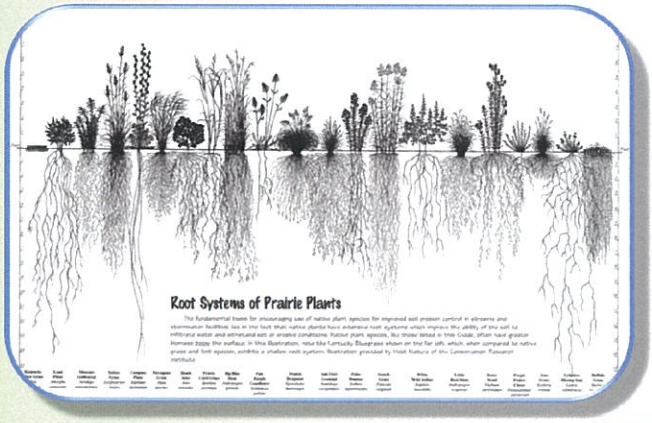
- Underdrained infiltration bed with amended soil profile overlay
- Large, most 0.10 to 0.50 acres
  - 6" topsoil/compost
    6" sand (geotextile fabric separating aggregate)
  - 12" aggregate
  - 12" underdrain on most (perforated dual wall HDPE, non-wrapped)





Regional Indigenous Plants

- Why are they important?
- What is different about native plants?
- What's wrong with using hybrids?
- Compromise is sometimes necessary.



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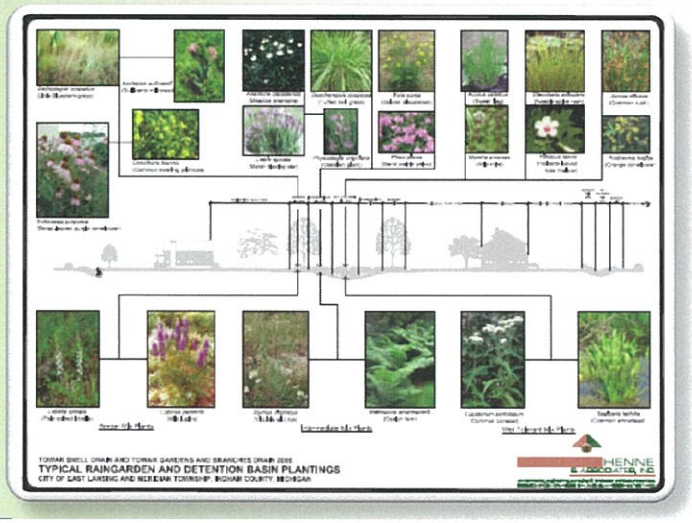
Planting Design

Plant Team

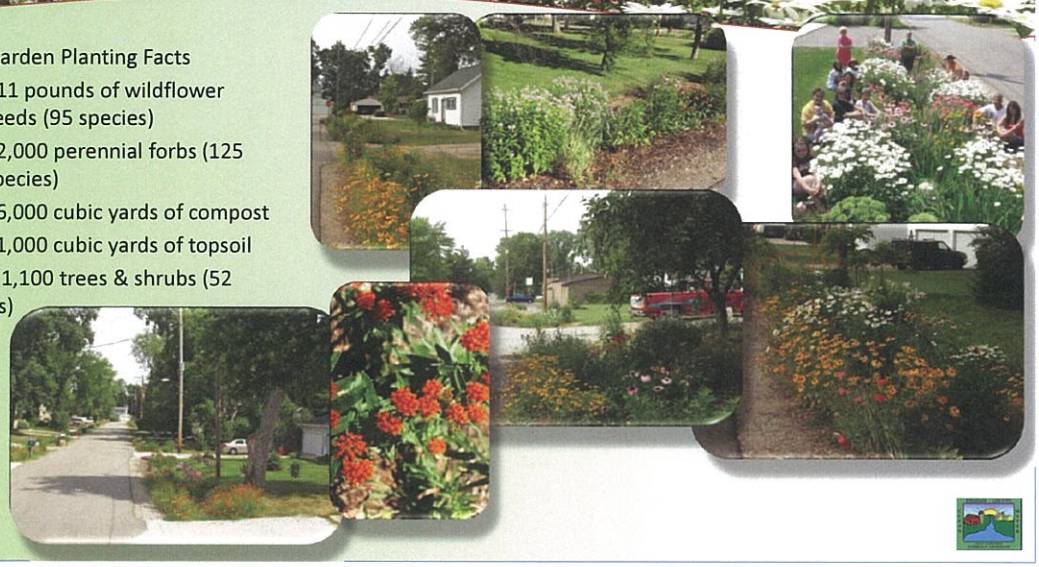
- Wetland Scientist
- Soil Scientist
- Arborist
- Botanist



Rain Garden Planting Facts

- 111 pounds of wildflower seeds (95 species)
- 52,000 perennial forbs (125 species)
- 36,000 cubic yards of compost
- 51,000 cubic yards of topsoil

Note: 1,100 trees & shrubs (52 species)



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Project Constructed March 2006 – December 2007

So what is the difference in Towar Gardens Post-Construction?

- Before
  - Many complaints of flooding of structures, streets and property reported after minor rainfall.
  - Landowner surveys revealed that 64% had drainage problems and 13.5% had basement flooding
- After
  - Put to the Test: No flooding observed, no drainage or flooding reported.

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Before

After

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Before

After

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Before

After

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Before

After

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Before

After

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After

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Before

After

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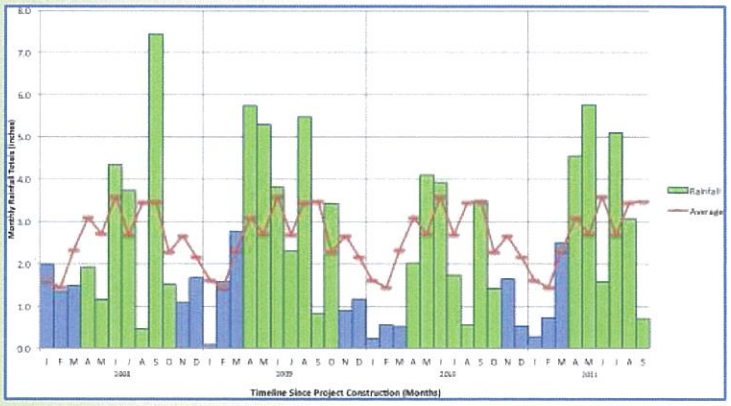
Towar Rain Garden Drains tested post construction by 420 rainfall events

- **Eighteen of 45 months had above average rainfall (4 of the 18 were dormant months)**
- **Three events were 10-year or greater (1 of the 3 was 50-year event)**

ANALYSIS OF POST CONSTRUCTION RAINFALL BY MONTH



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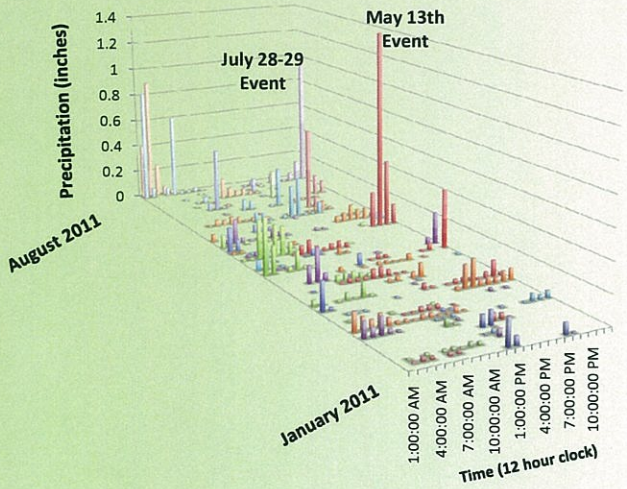
May 13th, 2011
One of the Three 10-year or Greater Events



Growing Season Event – May 13th, 2011

12 hours after 2.32", 4 hour duration rainfall
(10-year event)

Dormant Season Event
2/27/2009

12 hours after snowmelt and
0.8", 5 hour duration rainfall (< 2-month event)

Growing Season Event
5/28/2009

18 hours after
3.44", 5 hour duration rainfall (50-year event)

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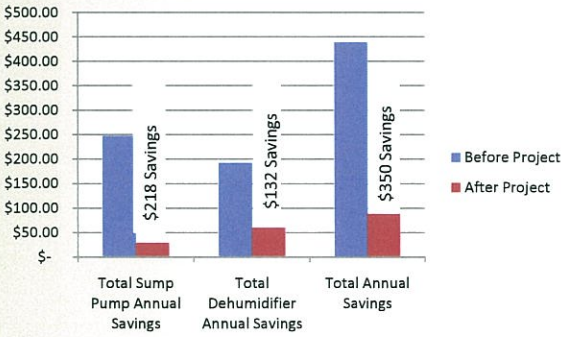
Analysis Of Sump Pump And Dehumidifier Operating Costs (Pre & Post Construction)

Based On Records From Two Flood Prone Homes

- Pre-construction: homeowners frequently reported sump pump use "all the time"
- Post-construction: homeowners frequently report reduction in sump pump use
- Estimated total annual savings of $350 per home recorded
- Average annual assessment is $255 per home recorded



Performance Testing of Flow and Water Quality for Natural and Synthetic Events

- For natural runoff events – three vegetated rain gardens tested
- For synthetic runoff events – same three rain gardens tested, along with turf rain garden and turf ditch. (Nutrients were added to the influent water to determine removal efficiency)
- Data collected with ISCO auto-samplers and ISCO flow meters including the following:
  - Flow, Depth, Duration, Volume
  - TSS, TP, TN

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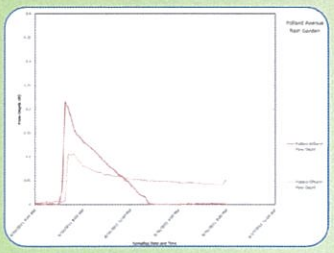
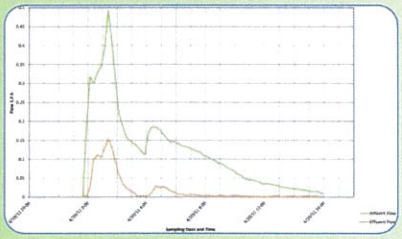
Typical Depth and Flow Hydrographs (Vegetated Rain Garden – Natural Events)





General Results of Natural Event Testing

- All rain gardens effectively reduced peak discharge, ranging from 34% to 100% (81% average)
- Eight of the twenty events held 100% of runoff volume (produced no effluent).

Volume reduction is function of

- antecedent conditions
- site factors
- storm intensity
- elevation of overflow weir

General Results of Infiltration and Water Quality Testing

(Rain Gardens were designed to dewater in less than 24 hours. All tests recorded dewatering within 1 hour)

Vegetated Rain Garden

- High infiltration rate
- Treated runoff (Tested TSS, TP,TN)

Turf Rain Garden

- Low infiltration rate
- Bypassed most runoff w/o treatment (Tested TP, TN)

Turf Ditch

- No Infiltration
- No treatment (Tested TP, TN)

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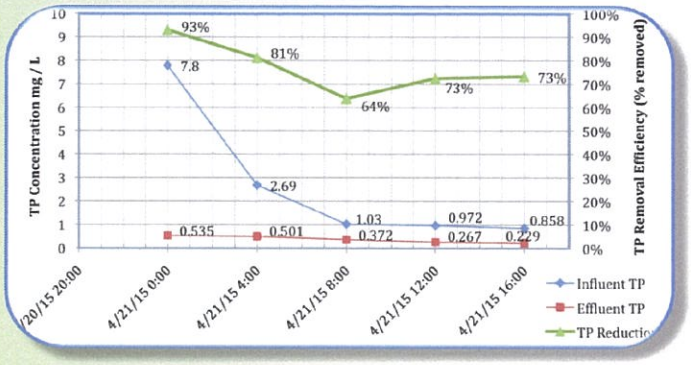
Water Quality

TSS Removal Efficiency, 4/21/11 Natural Event in Vegetated Rain Garden

The first flush removal of TSS averaged 94%, ranging from 80 to 100%.

Water Quality

TP Removal Efficiency, 4/21/11 Natural Event in Vegetated Rain Garden



The first flush removal of TP averaged 71%, with a range from 29 to 94%.

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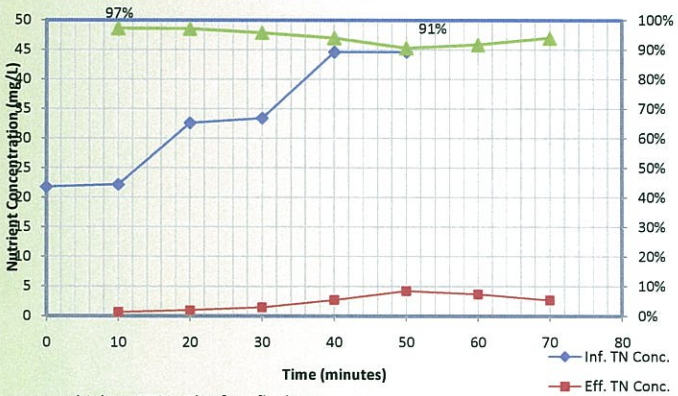
Water Quality

TN Removal Efficiency 6/15/11 Synthetic Event in Vegetated Rain Garden



The first flush TN removal with synthetic events was as high as 97% . The first flush TN removal with natural events averaged 27%, ranging from 15 to 38% (small sample set).

Performance Conclusions

- Treatment effectiveness is primarily a function of infiltration
  - Infiltration capacity and treatment effectiveness highest in vegetated rain gardens
  - Infiltration capacity and treatment effectiveness lower in turf rain garden
  - Infiltration capacity and treatment effectiveness absent in turf ditch
- Peak flow reduction significant in vegetated rain gardens
- Treatment capacity drops by 50% or more when mulch and deep-rooted native vegetation replaced with turf grass
- Although not tested, the infiltration data suggest that larger turf rain gardens (perhaps 2 to 5 times larger) could remove pollutants as well as vegetated rain garden
- Turf ditches do little other than convey water

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Towar Rain Garden Drains Retrofit

- Eliminates flooding
- Removes pollutants
- Reduces volume / peak discharge
- Lowers cost of drainage infrastructure
- Increases property values
- Adds aesthetic amenity
- Creates sense of place

Given the success of Towar Rain Garden Drains, why not more retrofits like it?

Challenges of large-scale LISMS

- ***Neophobia***
  - Public
  - Public officials / Regulatory agencies
  - Engineers
- ***"In your face" infrastructure***
  - Interaction between public and infrastructure
  - Aesthetics
- ***Complexity of design and execution***
  - Relative newness and lack design guidance
  - Knowledgeable professionals

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Question and Answers