

The Effect of Flow Path on Nitrate and Atrazine Attenuation in a Bioretention Swale



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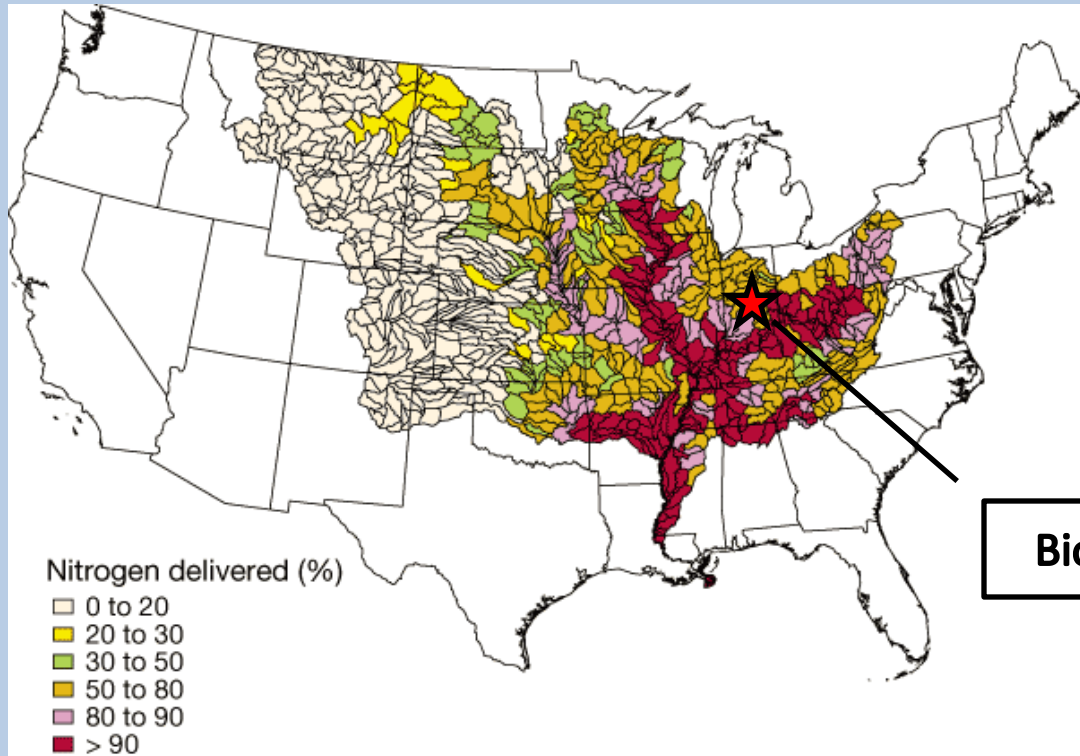
Center for Earth and Environmental Science

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Percentage of Nitrogen Exported to Gulf of Mexico from Interior Watersheds



Biowale Location

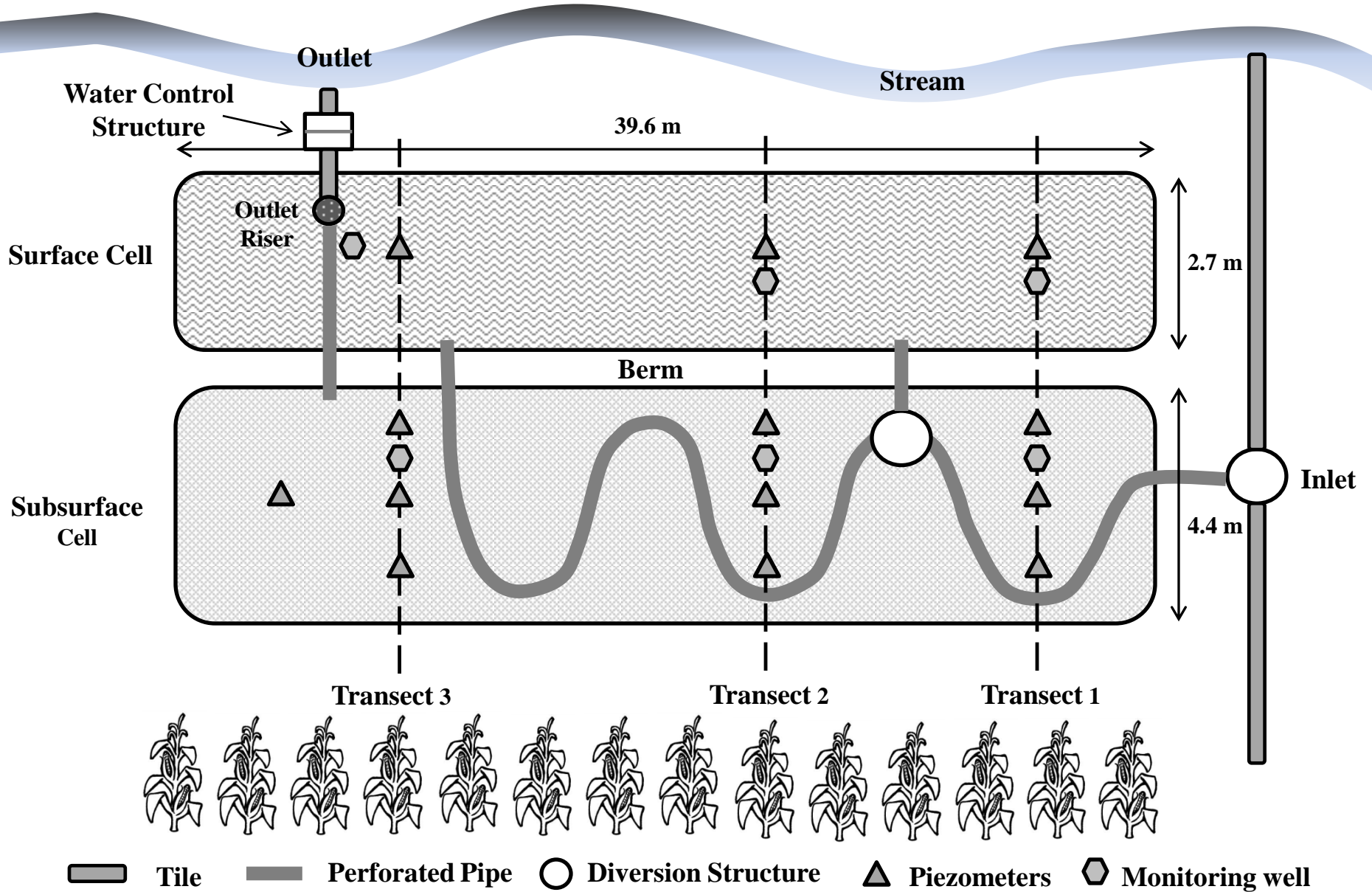
<http://www.nature.com/nature/journal/v403/n6771/images/403758ac.2.gif>

Export of nutrients and herbicides from tile-drained agricultural fields of the U.S. Midwest contributes to eutrophication and deterioration of water quality in the Mississippi River Basin

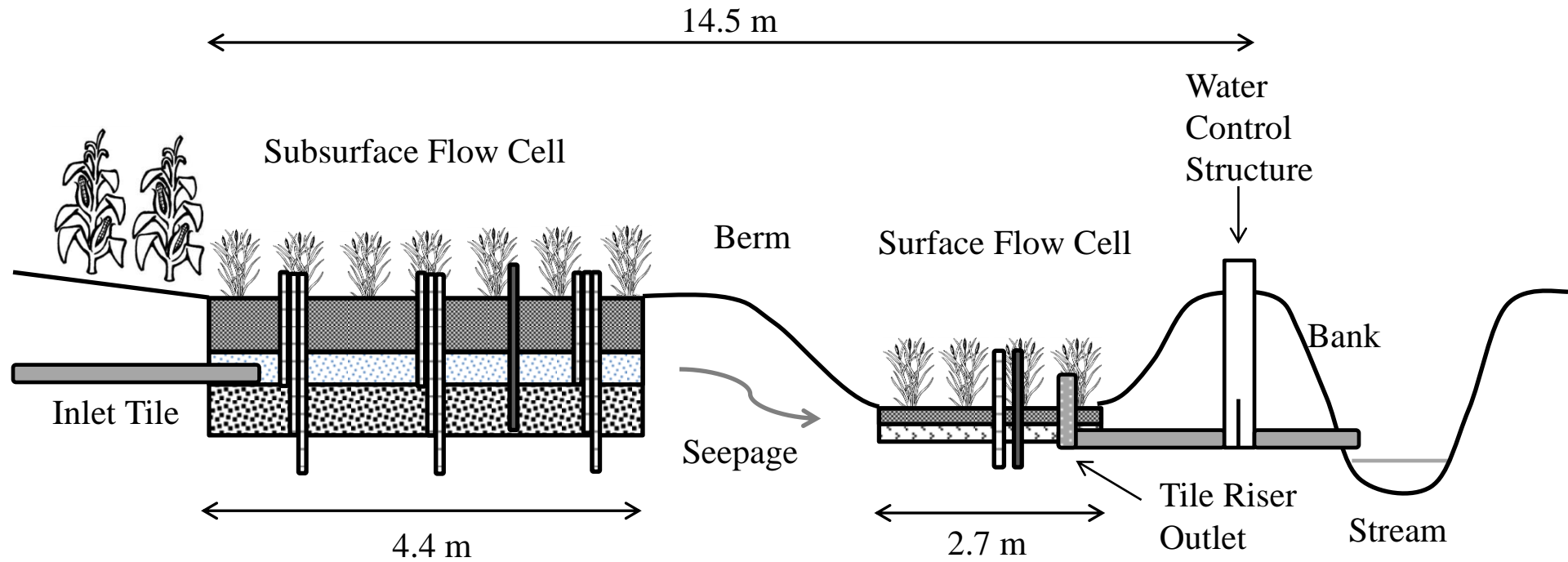
Project Importance





- This project focuses on removal efficiency of both nutrients (nitrate) and herbicides (atrazine) in a constructed treatment wetland
- In the bioswale design we attempt to address several contaminants by using a combination of subsurface flow and surface flow cells




Bioswale Layout



Monitoring Well and Piezometer Locations

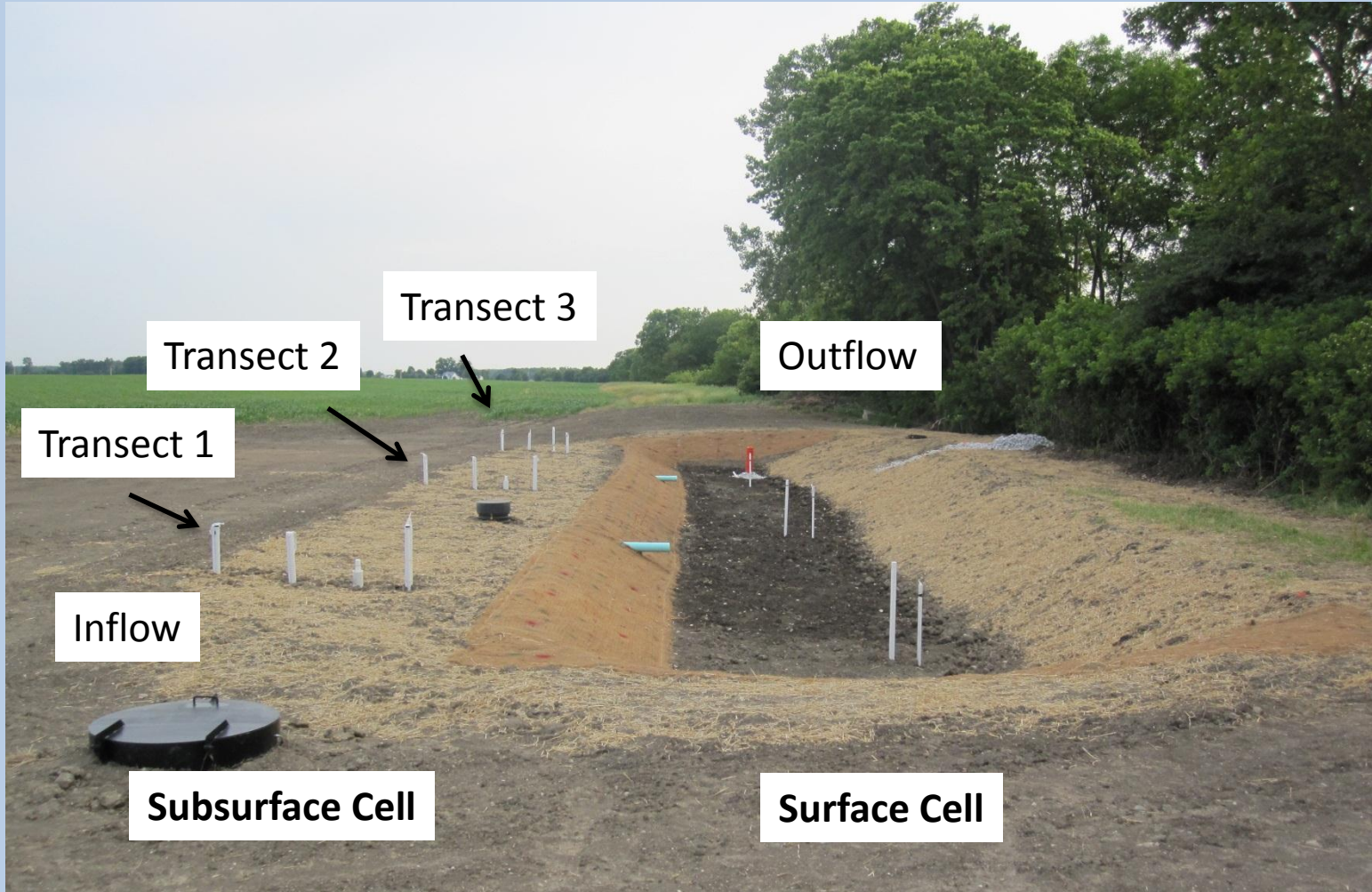


-  Native Soil (0.6m depth)
-  Pea Gravel (0.3m depth)
-  Gravel (d 2.5cm) and Bark Mulch (0.6m depth)
-  Gravel (d 2.5cm)

-  Tile
-  Piezometer
-  Monitoring Well

*Drawing Not to Scale

Bioswale Layout



One Month after Installation: July 11, 2011



April 2012 (4.53 cm of rainfall)



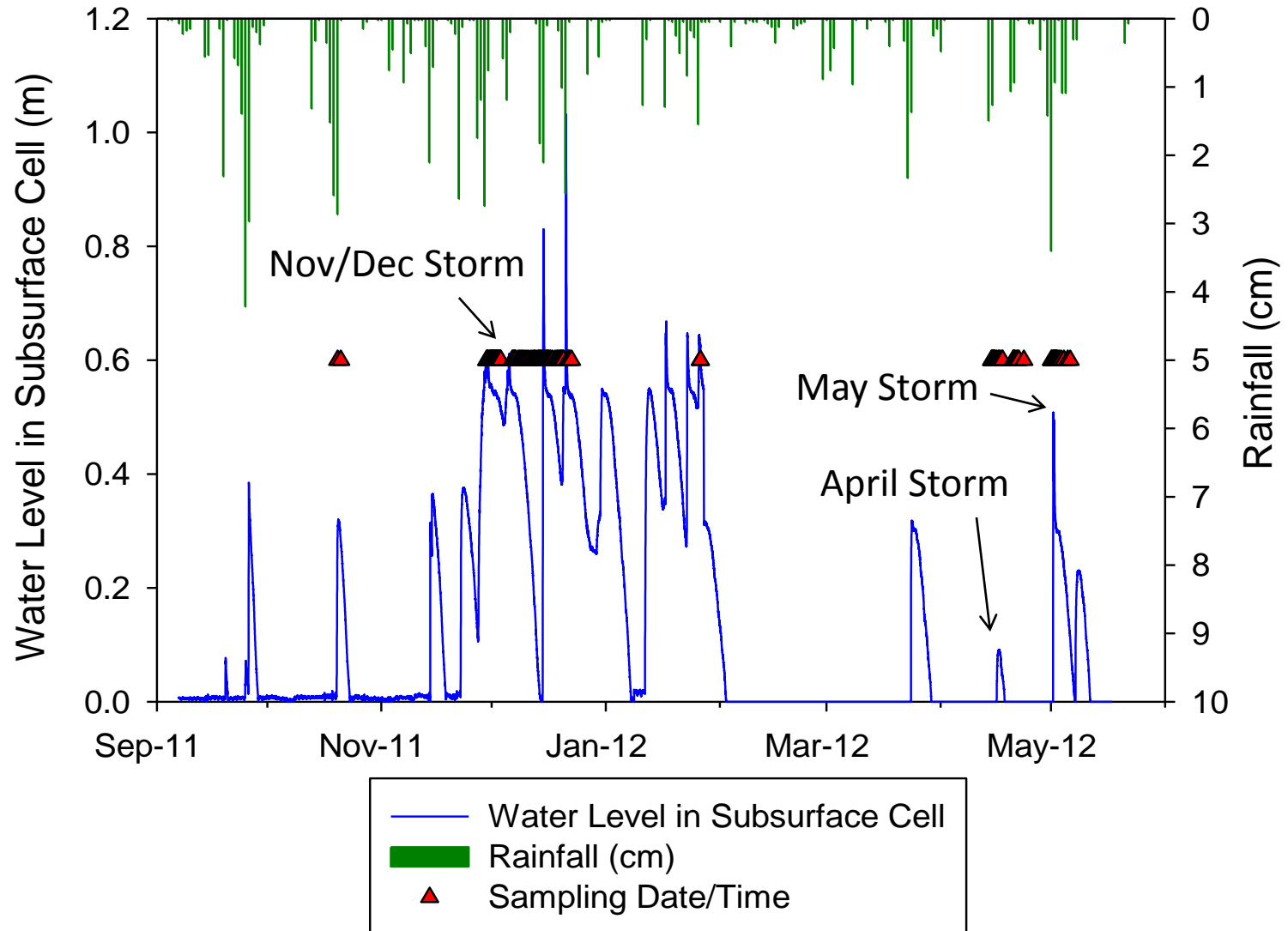
Discussion Points

- Water quality parameters measured and monitoring methodology
- Analysis of Results for NO_3 and atrazine
 - 3 storm events
 - November to December 2011
 - April 2012
 - May 2012

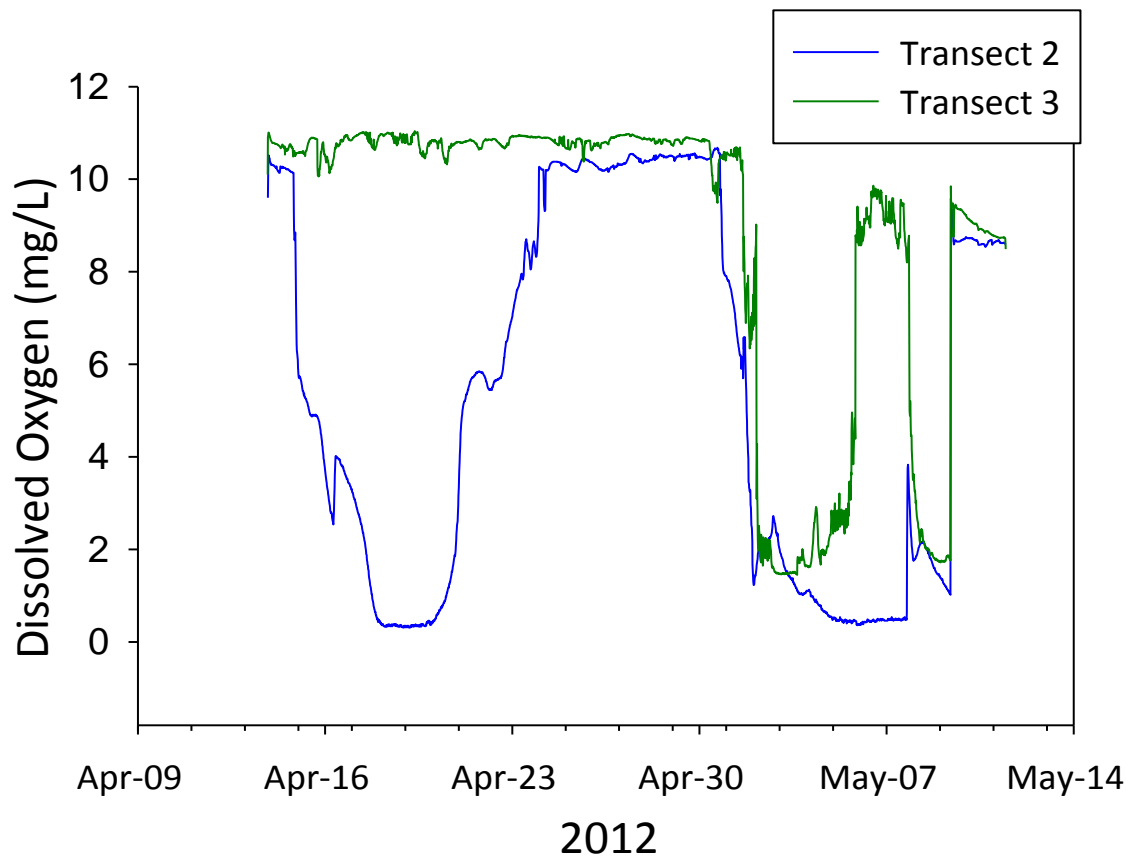
Water Quality Analyses and Monitoring Methodology

Parameters measured	Frequency of monitoring	Method
Dissolved Oxygen, Temperature, Conductivity, pH, Oxidation-Reduction Potential, Discharge	Continuous monitoring	YSI 600XLM Multi-Parameter Water Quality Sonde
NO_3 , NO_2 , TKN, NH_3 , SRP, Cl, SO_4	Select storm event sampling	Photometric method
Atrazine	Select storm event sampling	Enzyme-linked immunosorbent assay
DOC	Select storm event sampling	Elemental analyzer

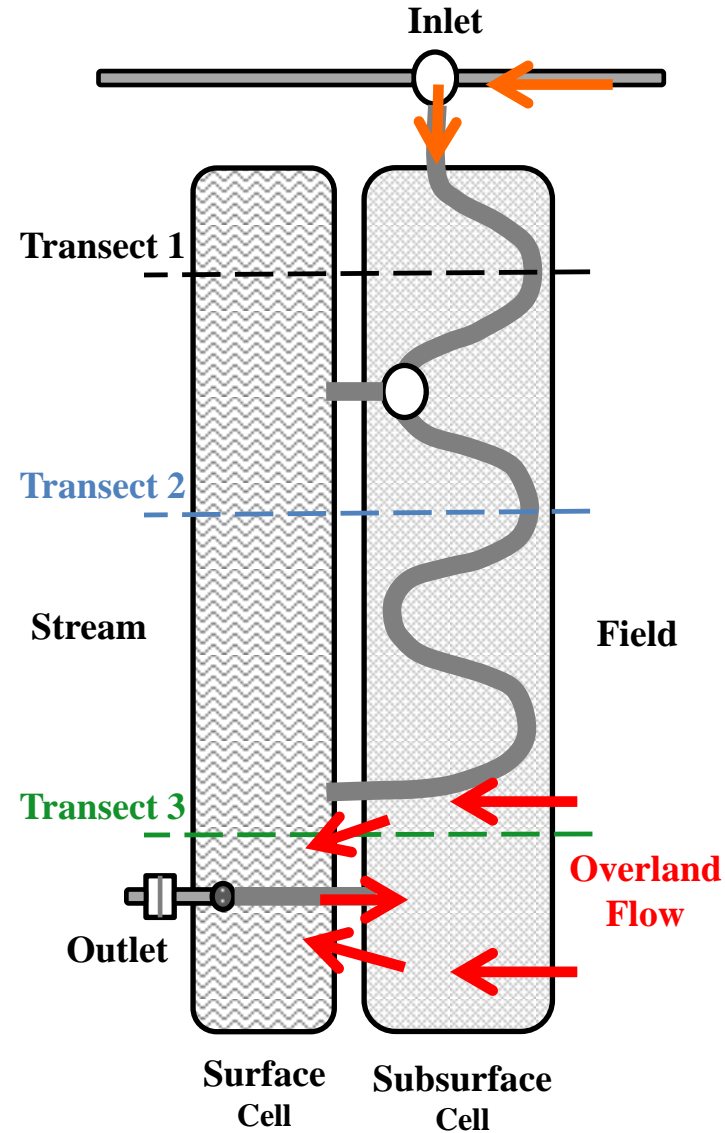
Water Level in Bioswale and Sampling Events



Dissolved Oxygen from Transect 2 and 3 Subsurface Cell Monitoring Wells

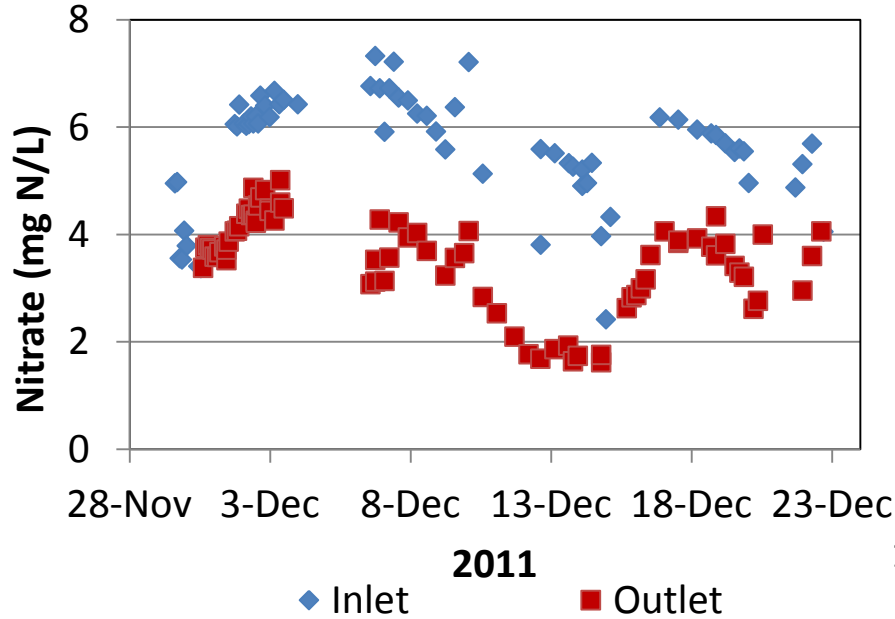


Low DO levels at T2 but not T3 during April storm due to backflow from surface cell



Nitrate – November Storm (6.35 cm rain event)

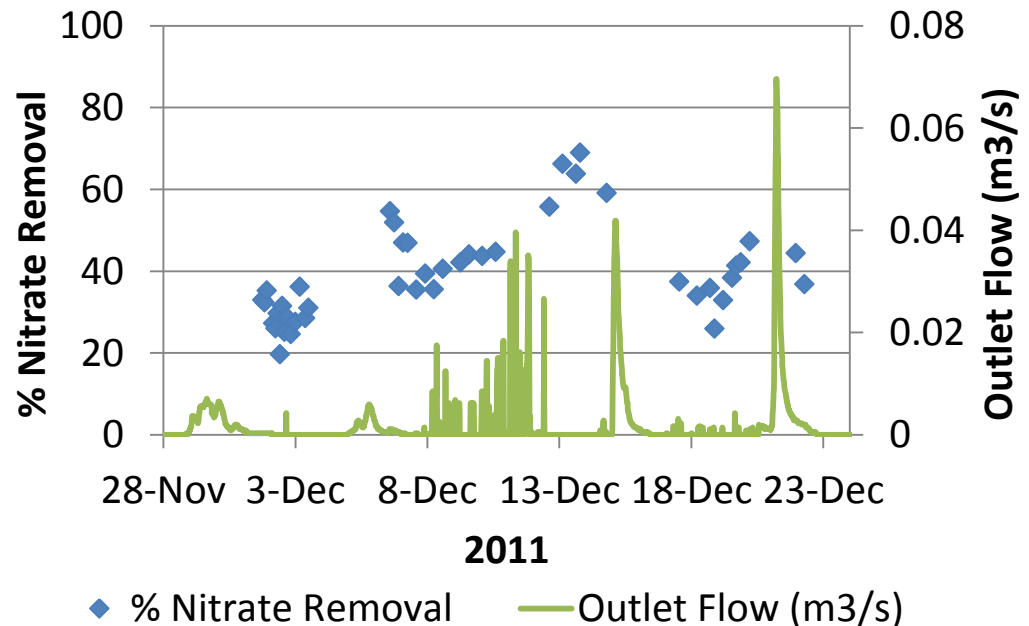
Nitrate Concentrations



Average decrease in $\text{NO}_3\text{-N}$ concentration: 2.0 mg N/L

20-70% $\text{NO}_3\text{-N}$ removal

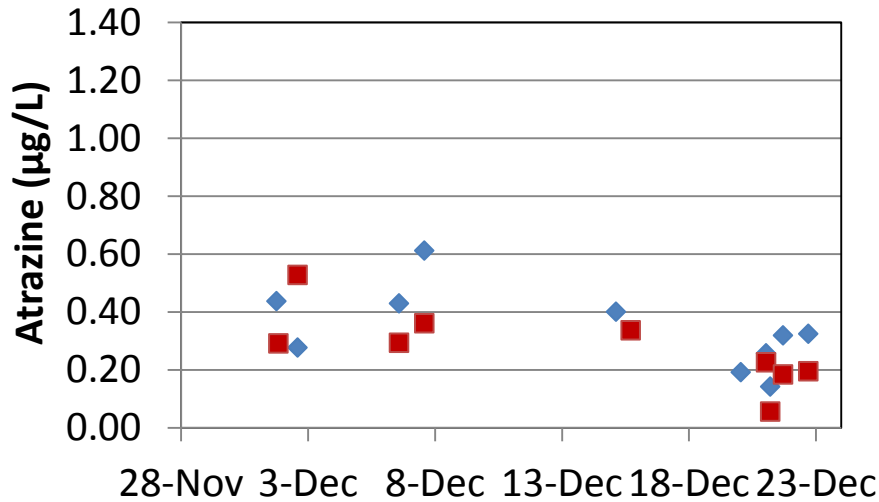
Nitrate Percent Removal



Continuous flow into bioswale and possibly longer HRT allowed for increased nitrate removal

Atrazine – November Storm (6.35 cm rain event)

Atrazine Concentrations

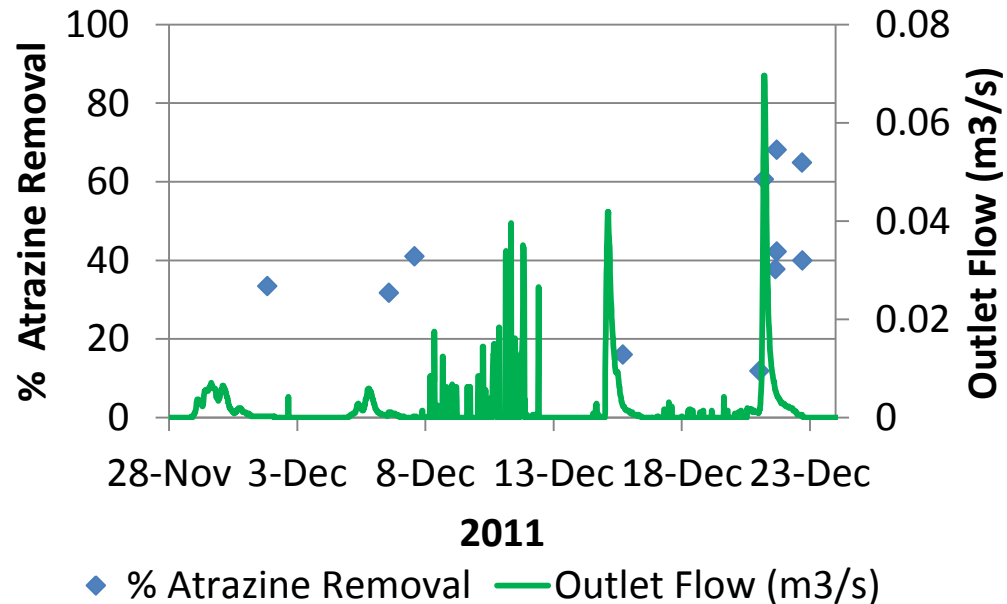


Average decrease in atrazine concentration: 0.05 µg/L

10-70% atrazine removal

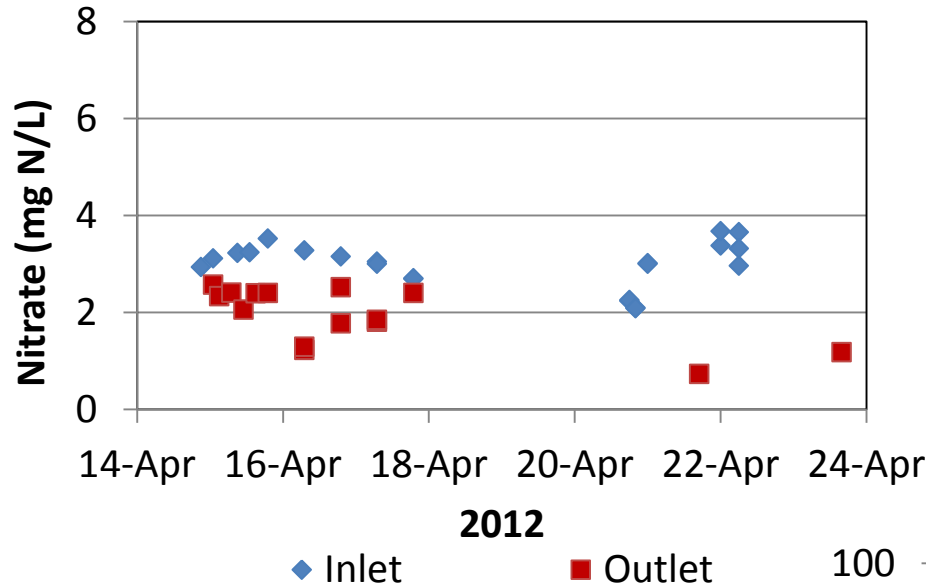
Continuous flow into bioswale and possibly longer HRT allowed for increased atrazine removal

Atrazine Percent Removal



Nitrate – April Storm (4.53 cm rain event)

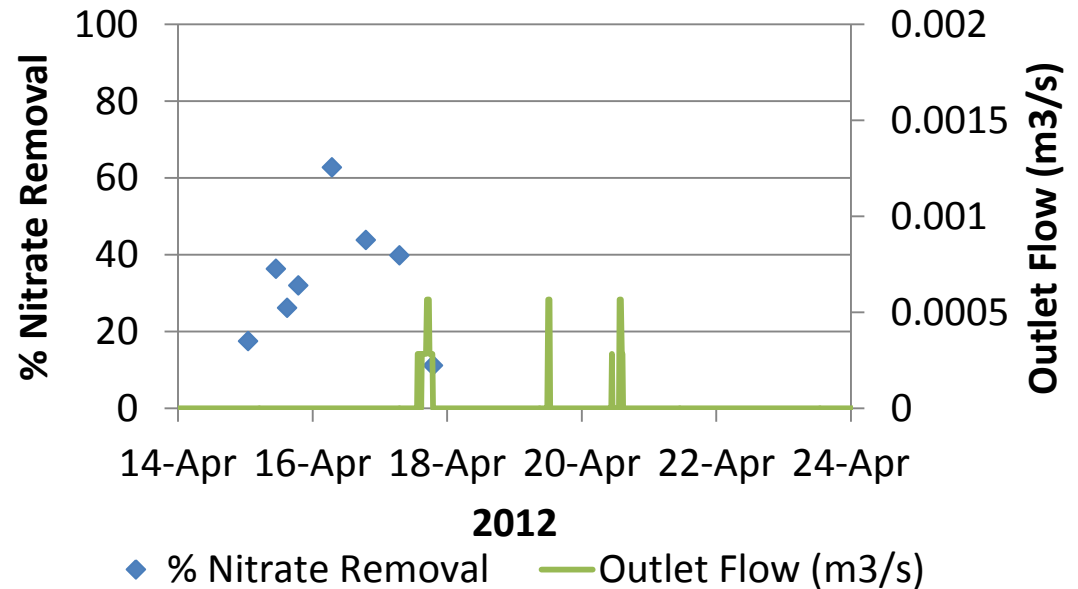
Nitrate Concentrations



Average decrease in $\text{NO}_3\text{-N}$ concentration: 1.2 mg N/L

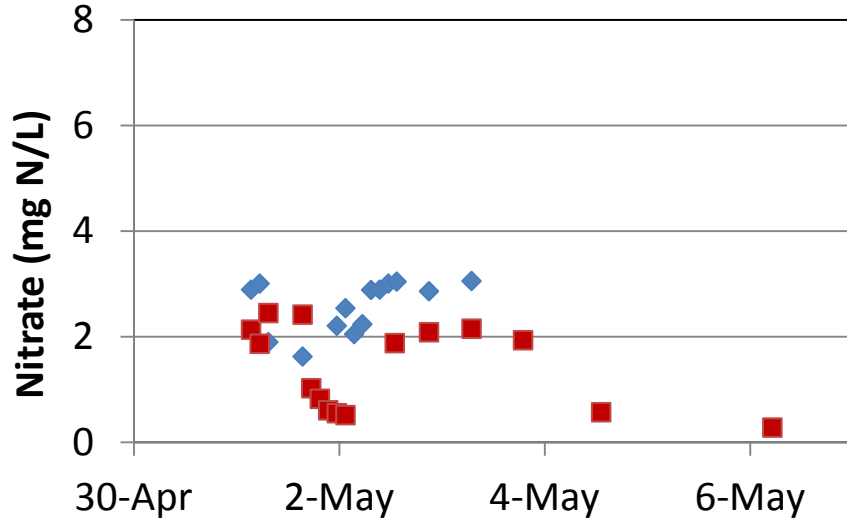
10-65% $\text{NO}_3\text{-N}$ removal

Nitrate Percent Removal



Nitrate – May Storm (3.18 cm rain event)

Nitrate Concentrations



Average decrease in $\text{NO}_3\text{-N}$ concentration: 1.1 mg N/L

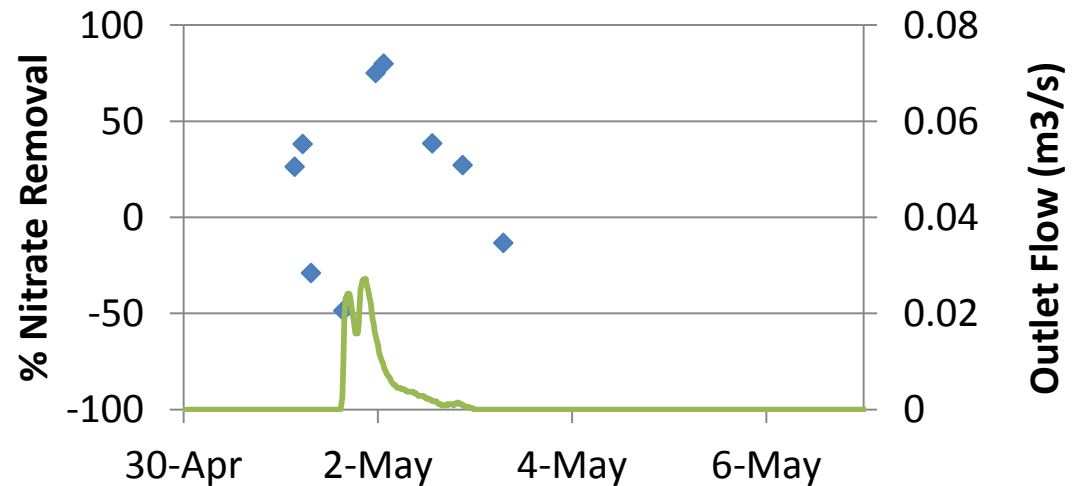
Variable $\text{NO}_3\text{-N}$ removal

2012

◆ Inlet ■ Outlet

Overland flow mixing with water in surface cell affects $\text{NO}_3\text{-N}$ concentrations and removal results

Nitrate Percent Removal

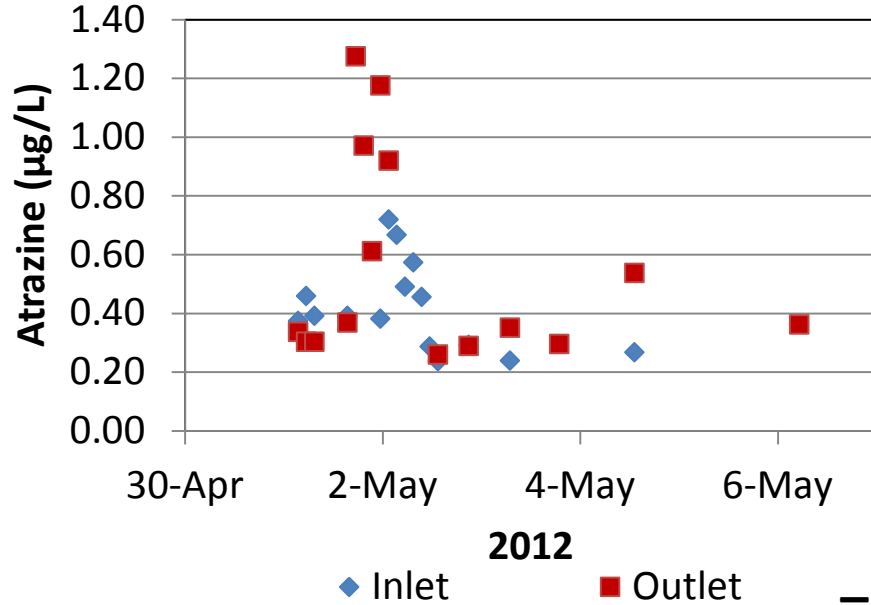


2012

◆ % Nitrate Removal — Outlet Flow (m³/s)

Atrazine – May Storm (3.18 cm rain event)

Atrazine Concentrations

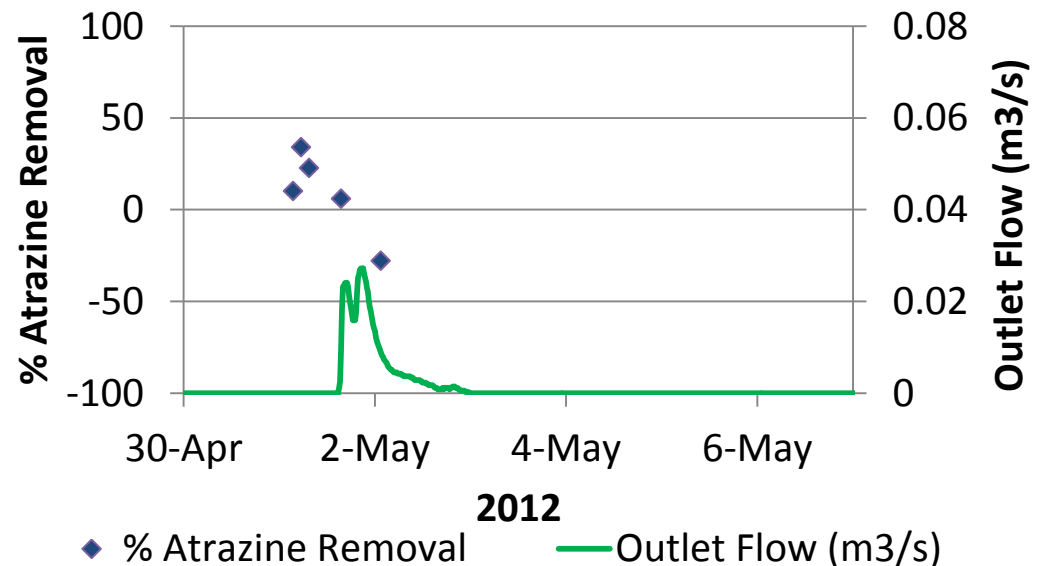


Average increase in atrazine concentrations from inlet to outlet of 0.14 µg/L

Variable atrazine removal

Particle associated atrazine in overland flow water affects results

Atrazine Percent Removal



Summary

- Continuous flow through system in Nov-Dec resulted in sustained and efficient NO₃ removal
- Overland flow water observed and appears to affect efficiency of system for both nitrate and atrazine attenuation
- Atrazine attenuation was variable, most likely due to bypassing the bioswale by overland flow

Future Work

- Adjust system to redirect overland flow
- Hydraulic retention time tracer tests and manipulation
- Run additional analyses for NO_2 , NH_3 , TKN, SRP, Cl, SO_4 , DOC

Acknowledgements

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