Nutrient Removal Mechanisms in a Cold Climate Gravel Wetland

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The 2009 New Hampshire Joint Water and Watershed Conference
Concord, NH

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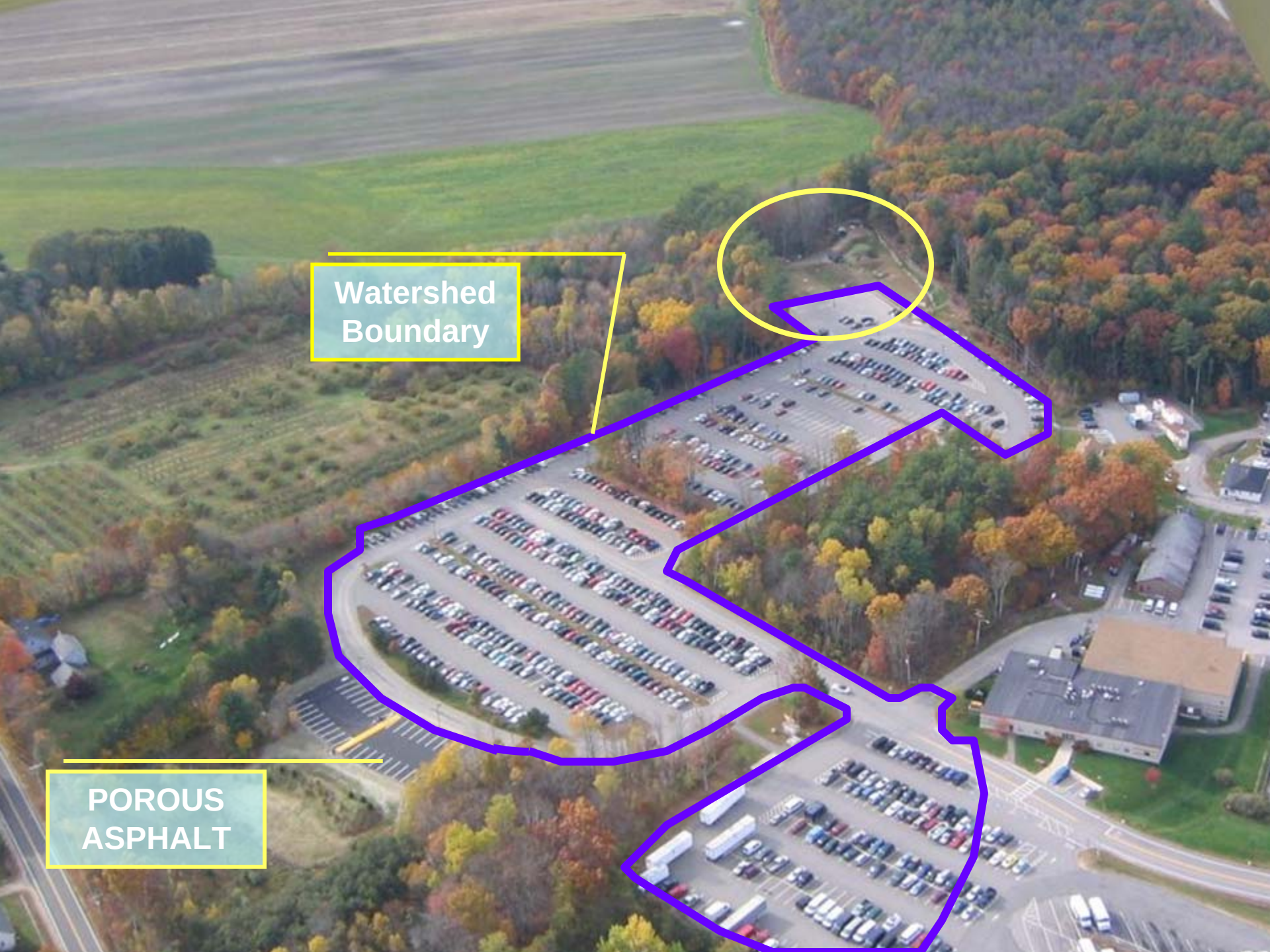
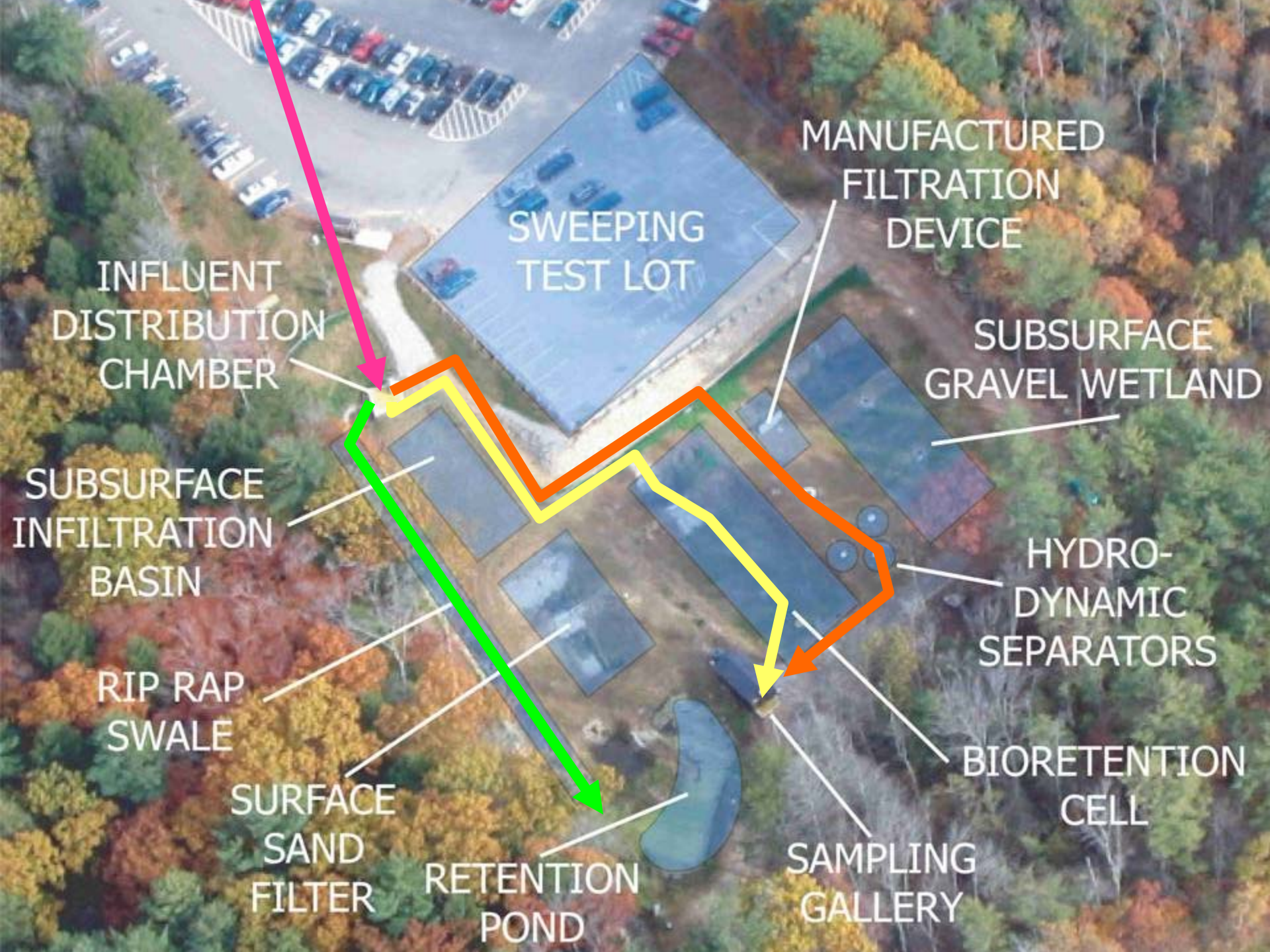
Dedicated to the protection of water resources through effective stormwater management

- Research and development of stormwater treatment systems

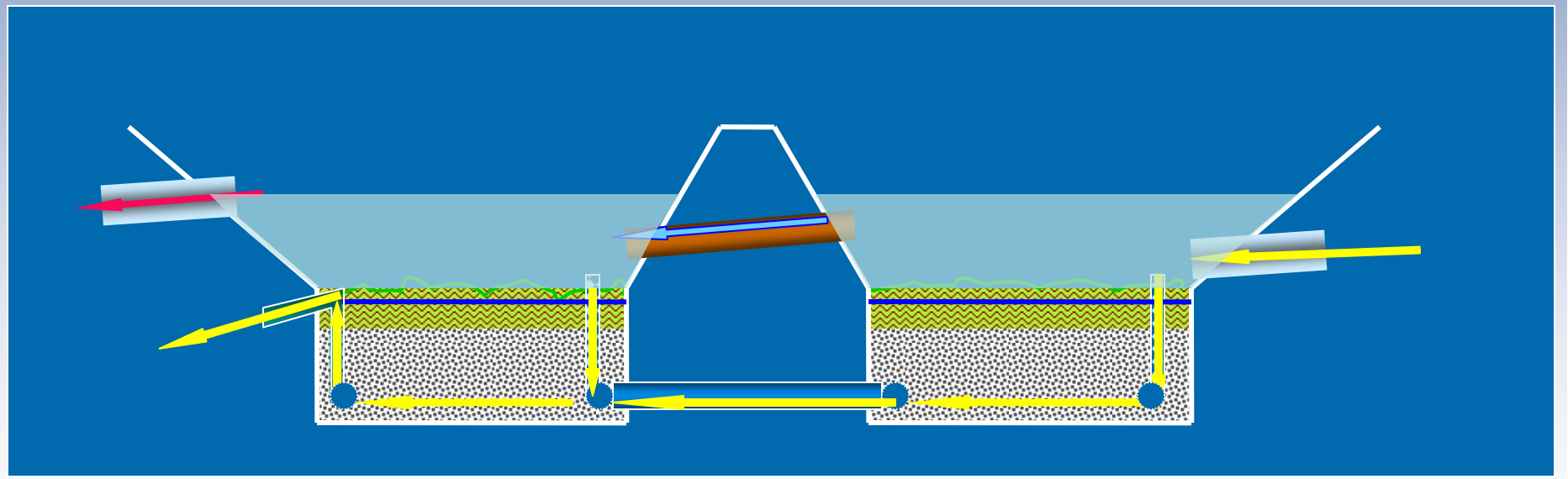

Watershed Boundary
POROUS ASPHALT


SWEEPING TEST LOT
MANUFACTURED FILTRATION DEVICE
INFLUENT DISTRIBUTION CHAMBER
SUBSURFACE GRAVEL WETLAND
SUBSURFACE INFILTRATION BASIN
HYDRO-DYNAMIC SEPARATORS
RIP RAP SWALE
BIORETENTION CELL
SURFACE SAND FILTER
RETENTION POND
SAMPLING GALLERY

Gravel Wetland

2 horizontal flow subsurface gravel cells, preceded by a flooded forebay. Designed to treat a 1-acre catchment with a peak flow of 1cfs.

Flow through the Gravel Wetland



NEIWPCC-UNH
Project Goals

- Validation of constructed gravel wetland as a best management practice (BMP) for nutrient reduction
- Investigation of the nutrient (nitrogen and phosphorus) removal mechanisms and efficiencies of constructed gravel wetlands
- Provide state and federal environmental managers and their partners with an enhanced understanding of constructed gravel wetlands as a tool to reduce nutrient loading from stormwater to aid in environmental decision-making

Project Phases

- **1. Develop study parameters**
- **2. Develop QAPP**
- **3. Collect, monitor and analyze samples**
- **4. Interpret data and develop final report with recommendations**
- **5. Outreach and technology transfer**

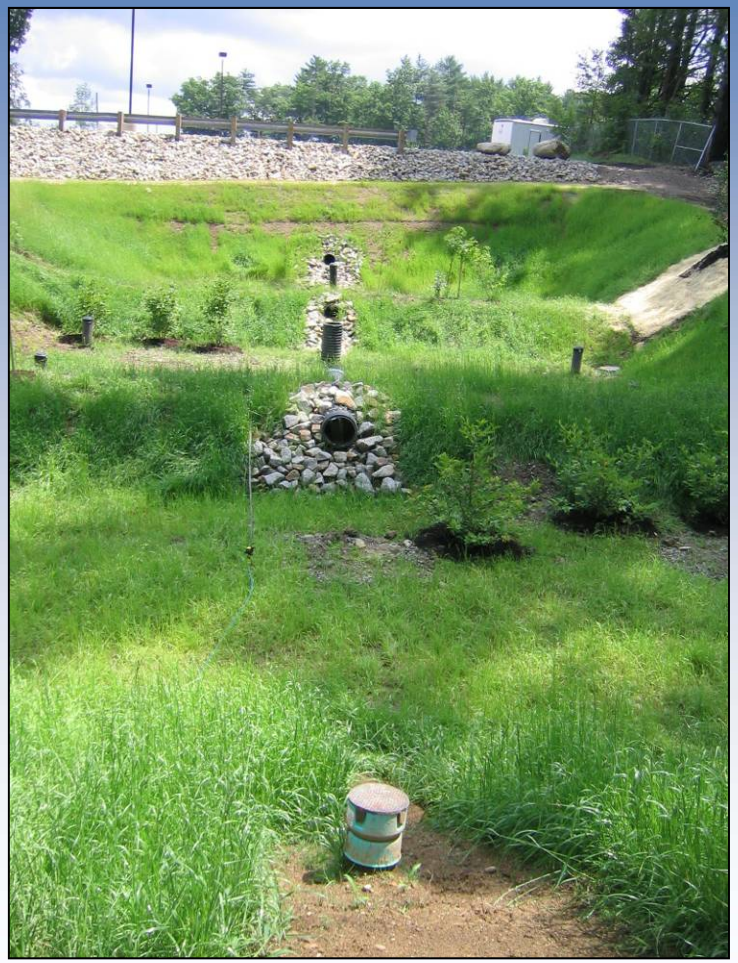
Sampling Plan

- 6 storm events
  - 3 cold weather events (Nov – Apr)
    - 1 Discrete sample
    - 2 Flow-weighted composite samples
  - 3 warm weather events (May – Oct)
    - 1 Discrete sample
    - 2 Flow-weighted composite samples

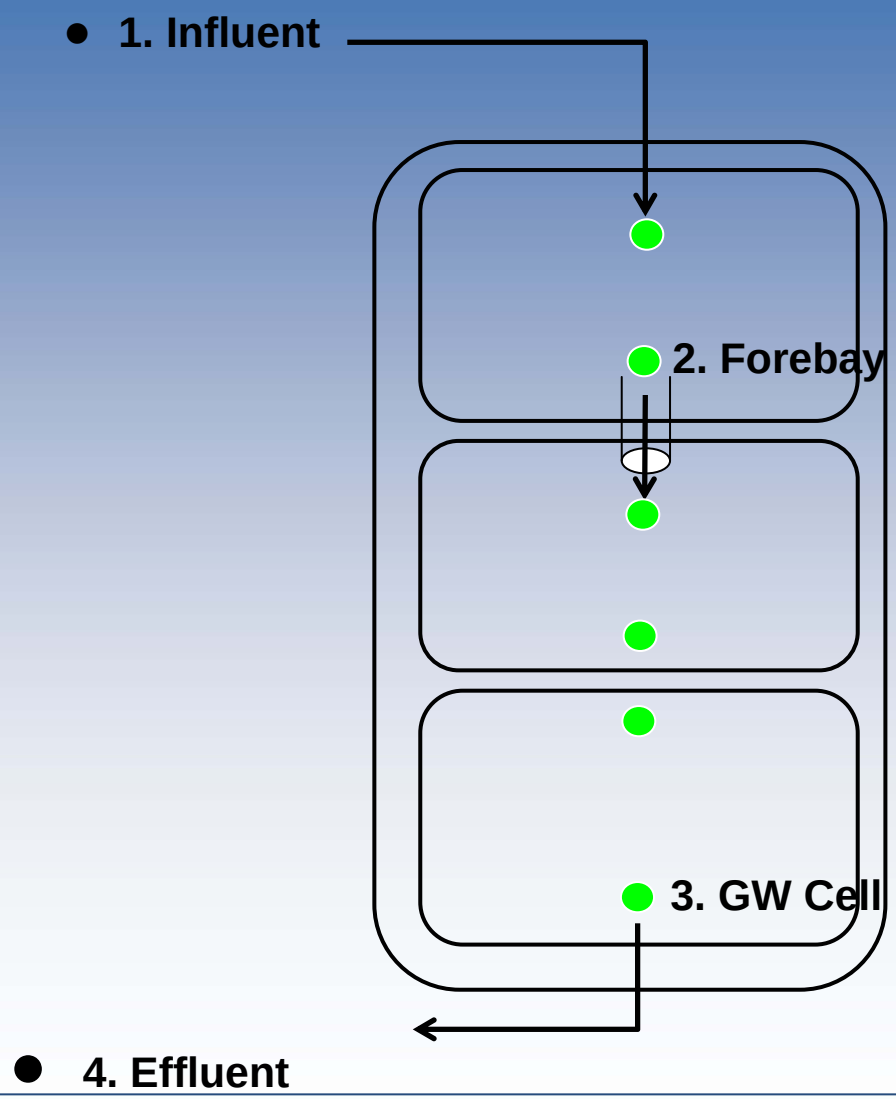
What are we sampling?

Analyte	Detection Limit (mg/L)
Total Dissolved Nitrogen	0.07 mg N/l
Particulate Nitrogen	15 ug N/l
Ammonia	5 ug N/L
Nitrate	5 ug N/l
Nitrite	3 ug N/l
Total Phosphorus	20 ug P/l
Total Dissolved Phosphorus	20 ug P/l
Ortho-Phosphate	5 ug P/l
Sulfate	0.1 ug S/l

Gravel Wetland
Sampling within the system



Sampling Locations



4 sampling locations

1. Influent
2. Forebay
3. Last well
4. Effluent

● Water chemistry

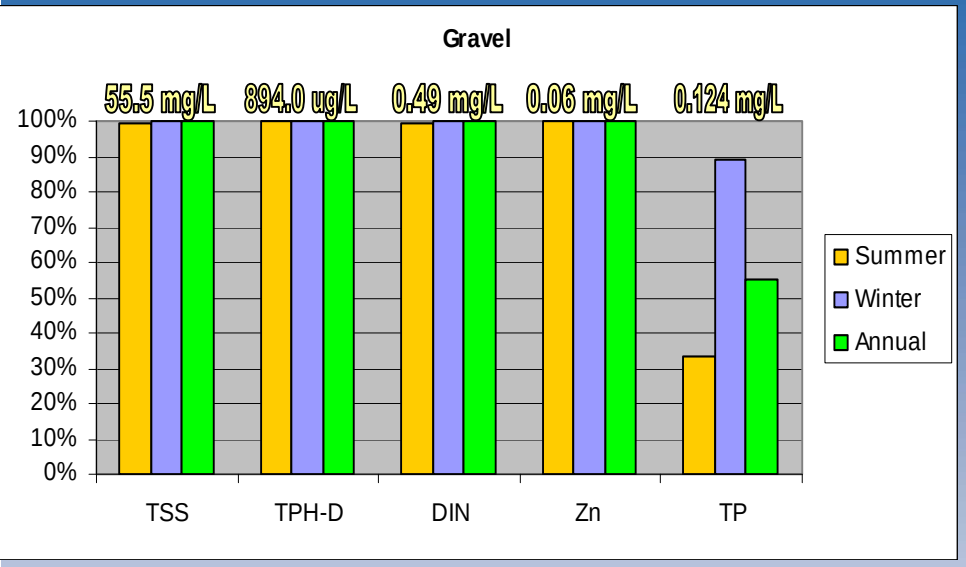
How do we collect samples?

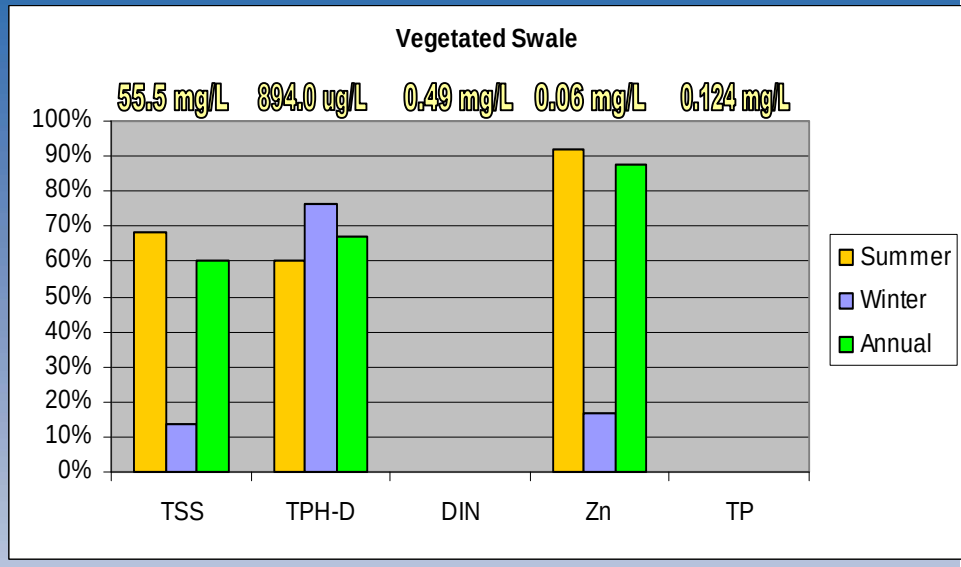
Automated ISCO sampler

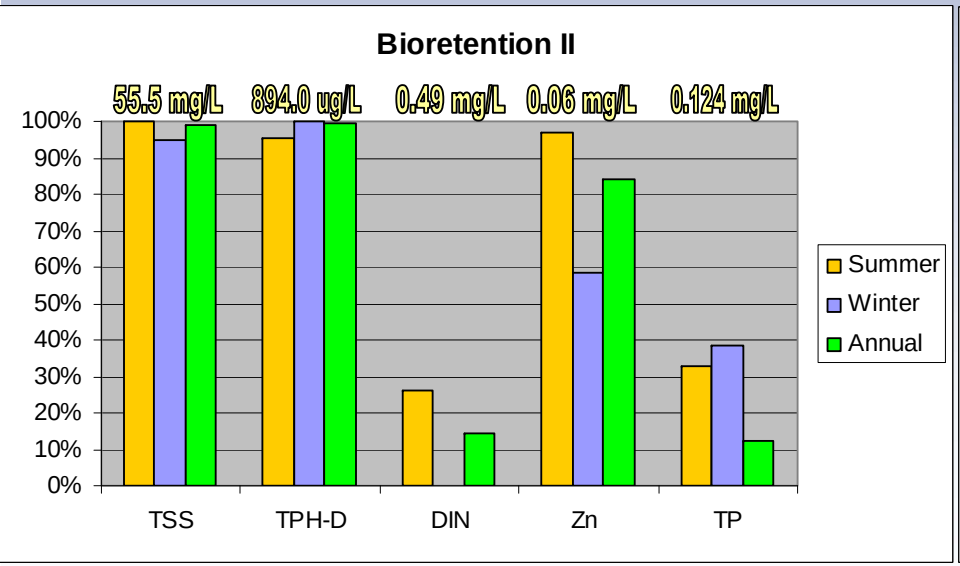
Programming the ISCO to capture stormwater samples (influent) at the Distribution Box

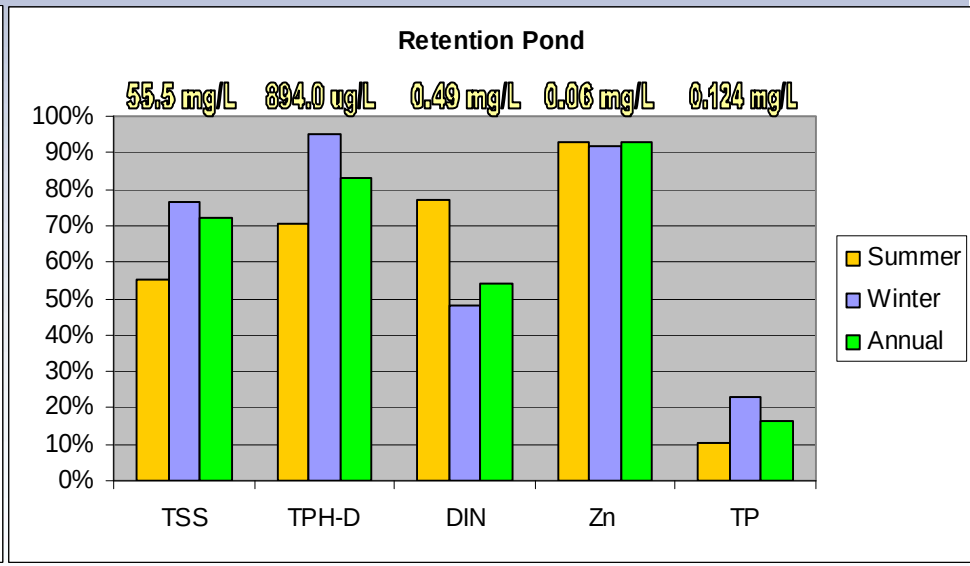
Water quality measurements using a YSI 556 in the forebay of the gravel wetland

Seasonal Variations in Performance

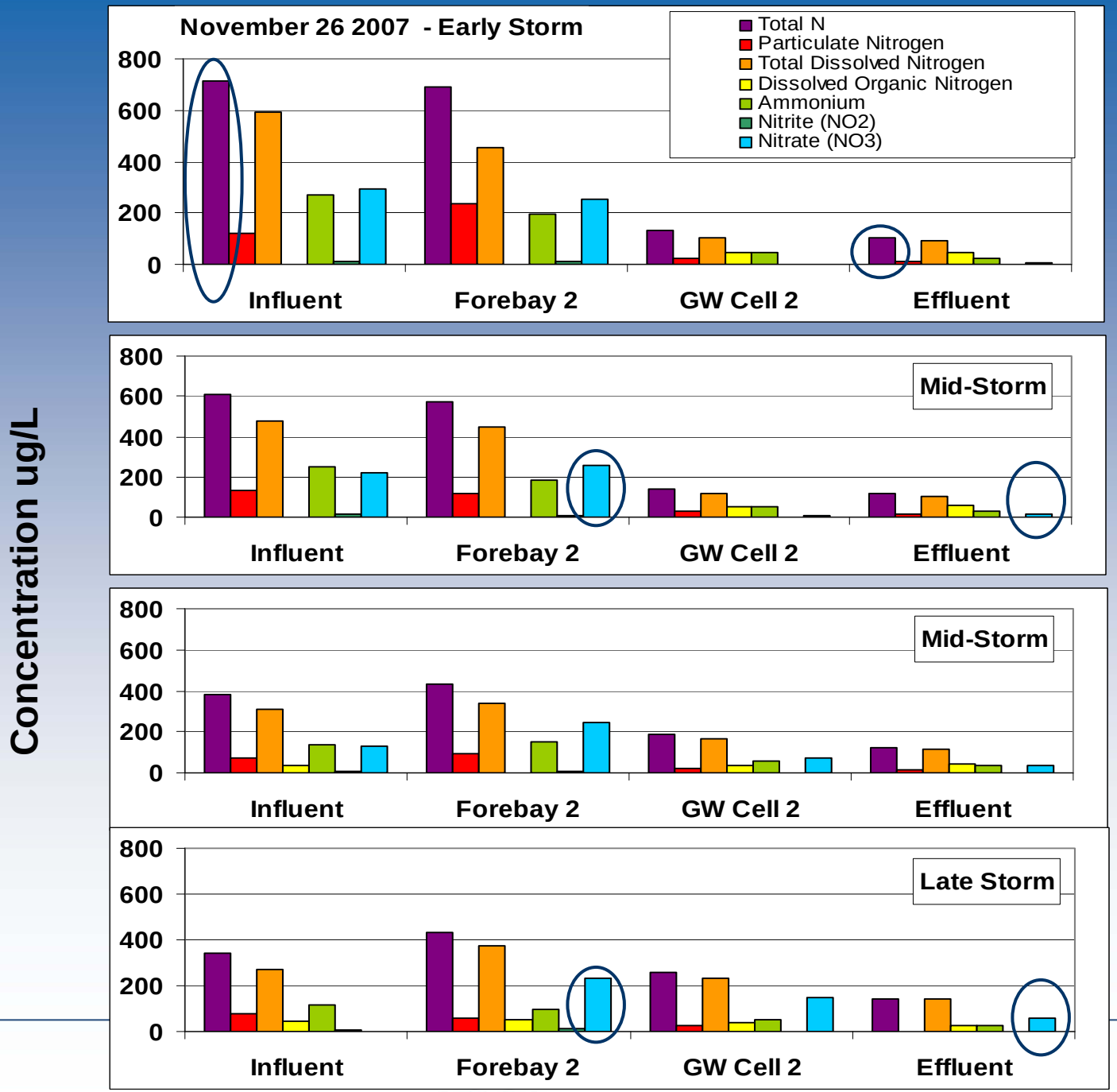


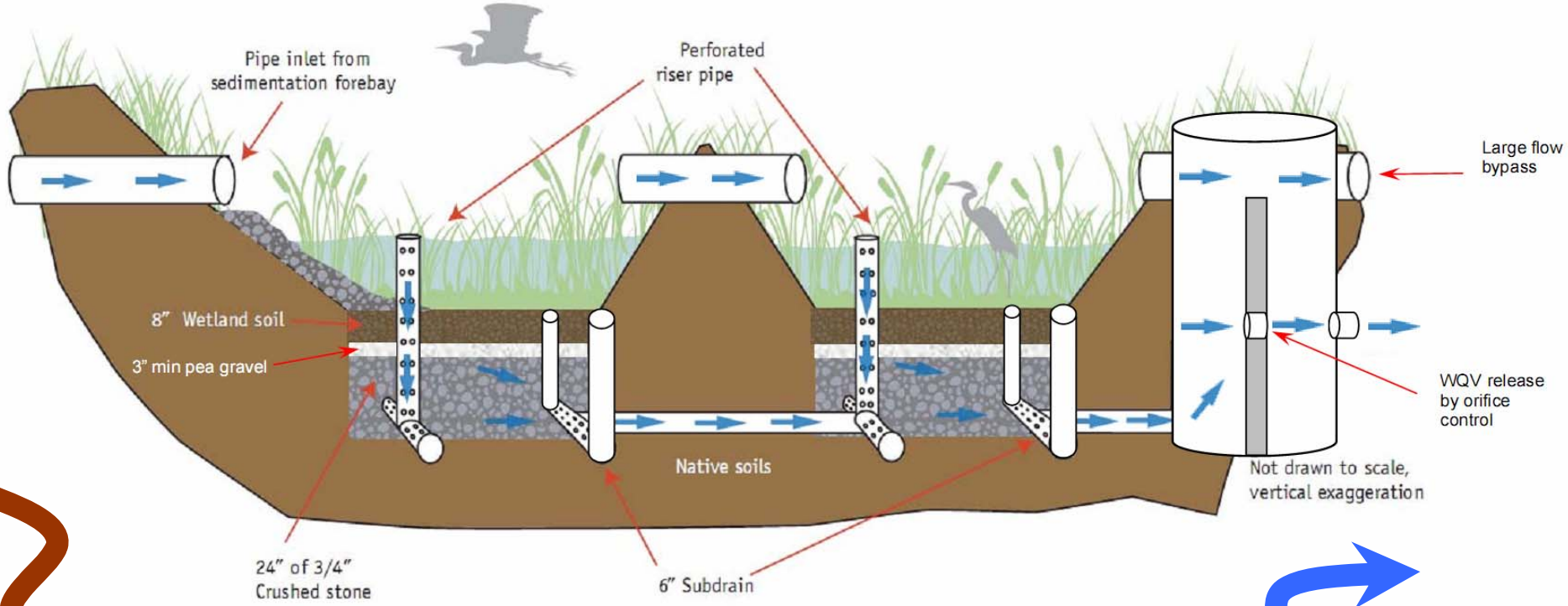






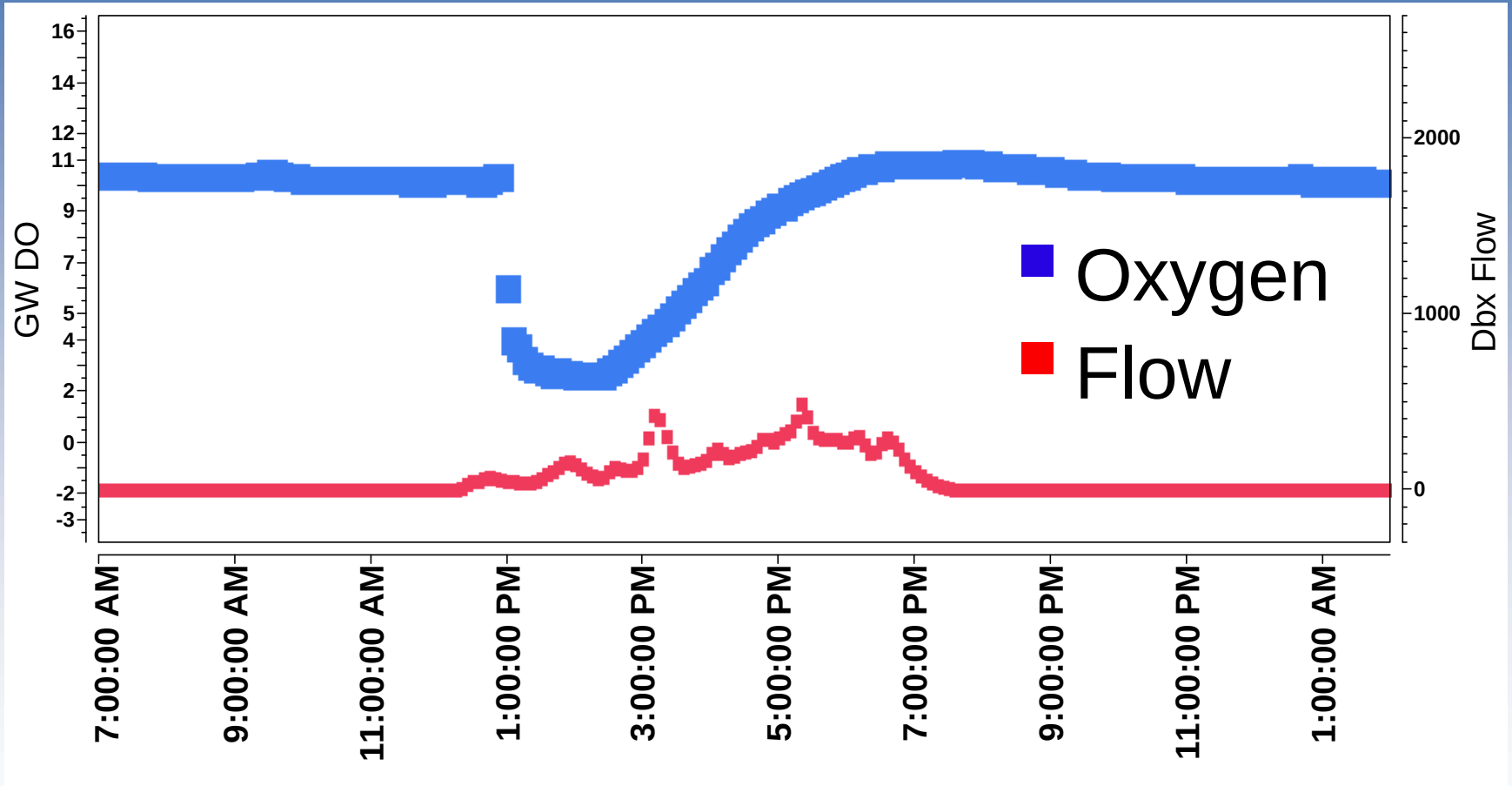
NITROGEN

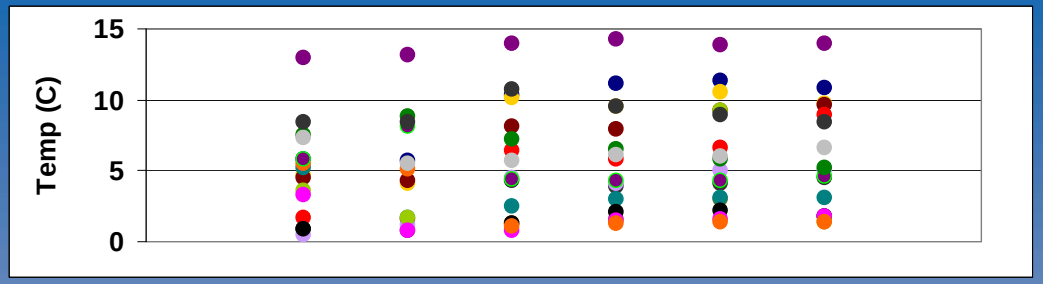

Concentration ug/L
November 26 2007 - Early Storm
Total N
Particulate Nitrogen
Total Dissolved Nitrogen
Dissolved Organic Nitrogen
Ammonium
Nitrite (NO2)
Nitrate (NO3)
Mid-Storm
Mid-Storm
Late Storm
800
600
400
200
0
Influent
Forebay 2
GW Cell 2
Effluent

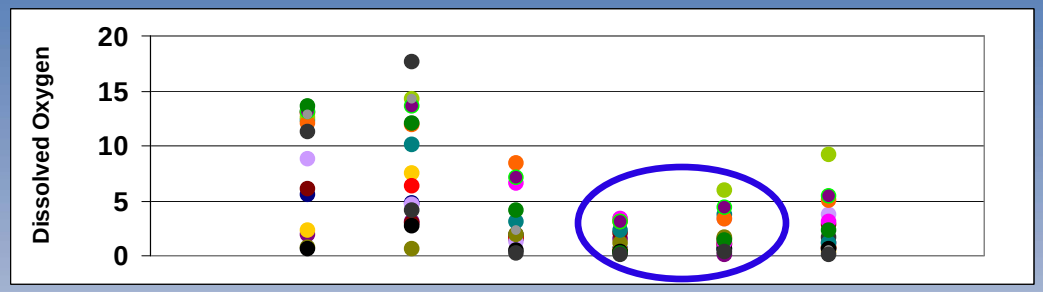


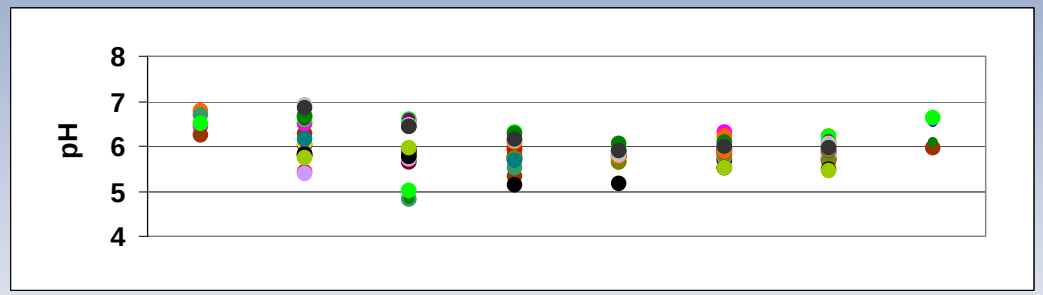
Organic N	NH4 N02 NO3	N2 (gas)
Source	Aerobic Zone	Anaerobic Zone
Runoff and plant material	Forebay and surface of gravel wetland	Subsurface gravel wetland

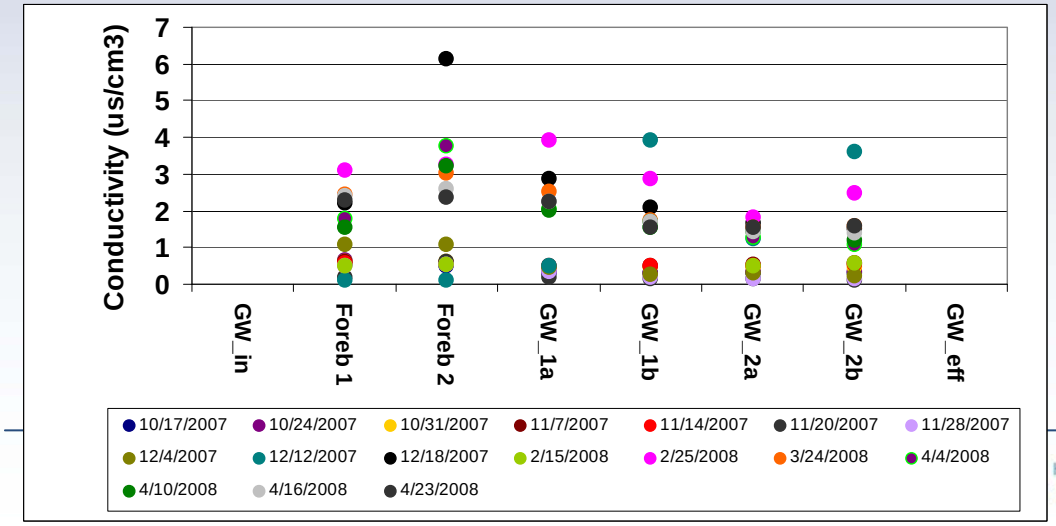
Dissolved Oxygen in Gravel Wetland Effluent

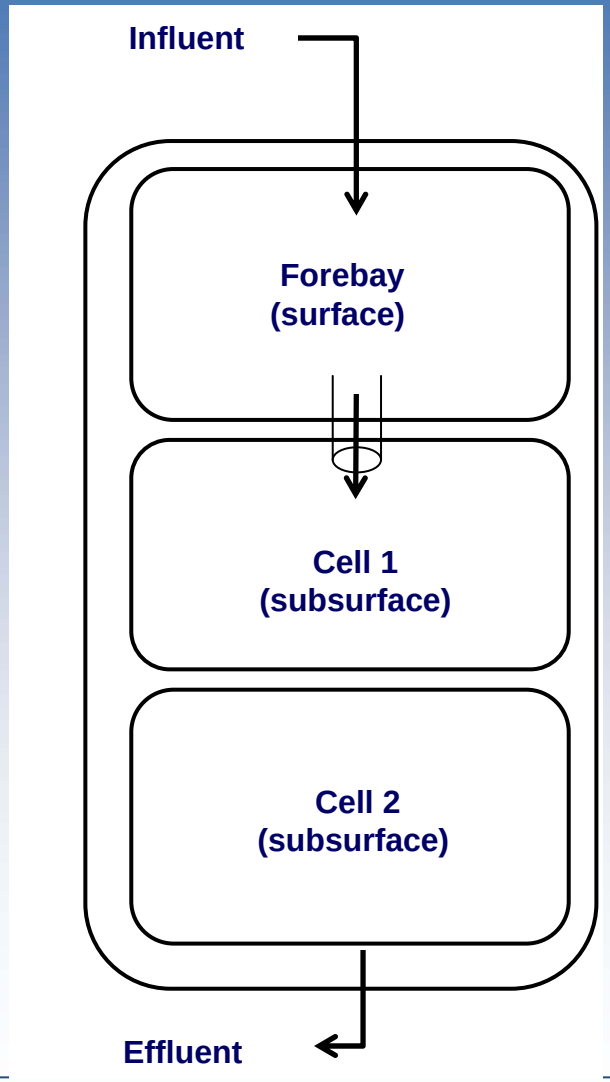












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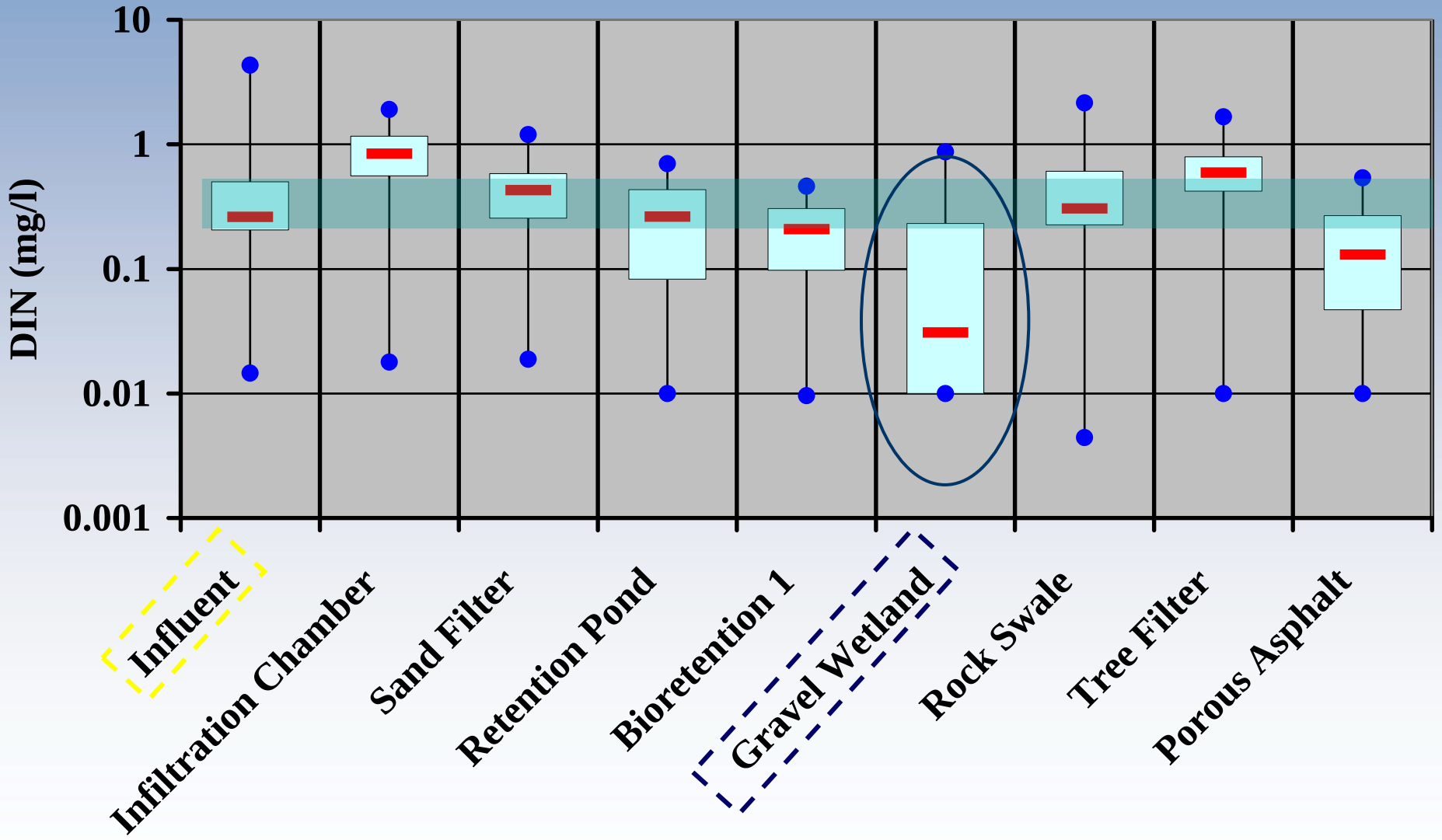
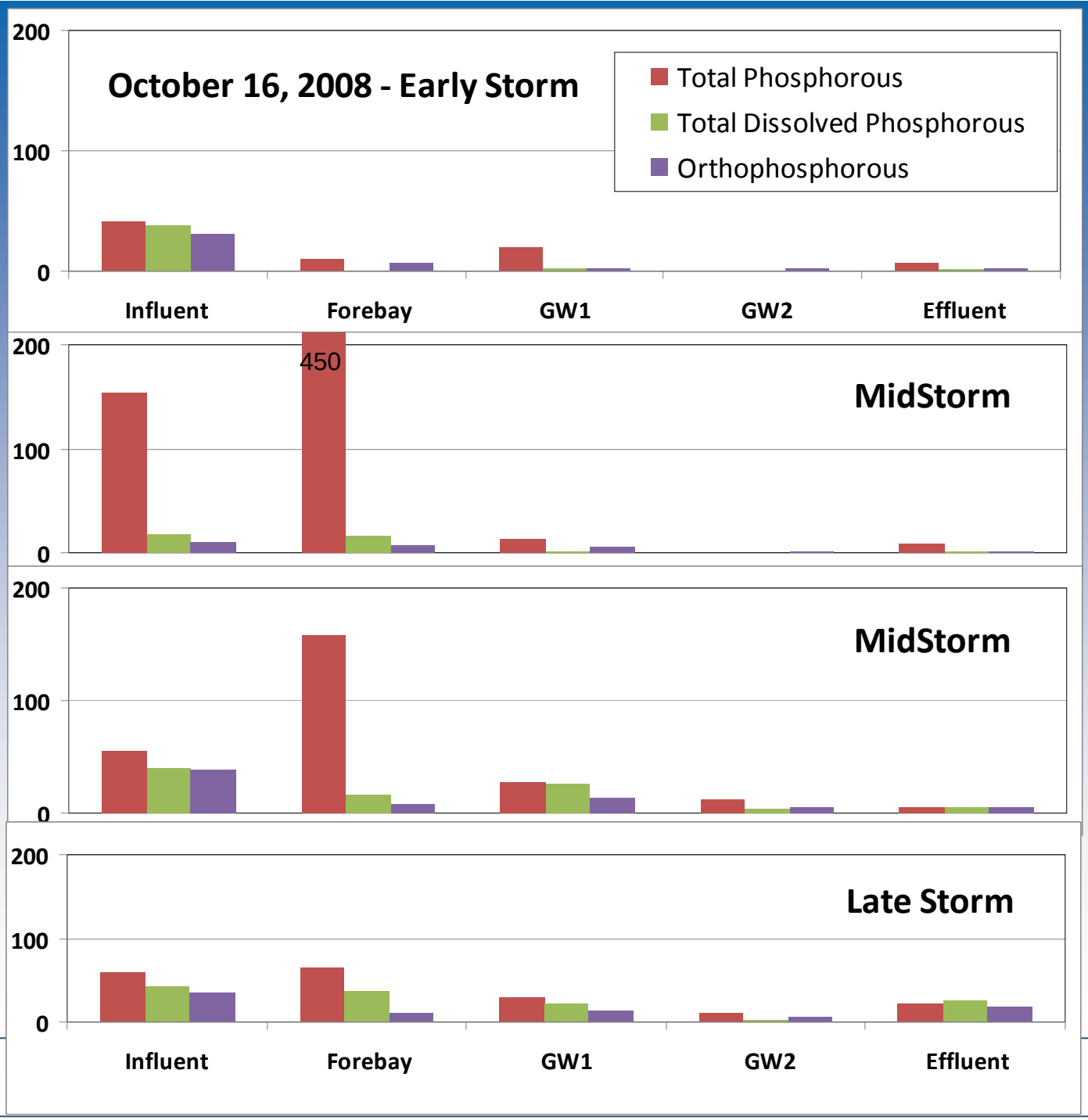
Dissolved Inorganic Nitrogen



Phosphorus


October 16, 2008 - Early Storm
Total Phosphorous
Total Dissolved Phosphorous
Orthophosphorous
MidStorm
450
MidStorm
Late Storm
200
100
0
Influent
Forebay
GW1
GW2
Effluent
Concentration ug/L

Forebay Maintenance - June 2008

Conclusions

Nitrogen

Excellent removal – Aerobic/anaerobic treatment chain requires low oxygen concentrations in subsurface

Progression from organic to inorganic forms

Early storm high concentrations have higher removal

Phosphorus

Moderate removal – Sorption and filtration in gravel substrate

High Total P concentrations removed

Better removal in the winter?

Forebay maintenance may be required to eliminate additional sources

Funding

- FY06 EPA Assessment and Watershed Protection Program Grants (AWPPG)
  - NPS Program National Priority
    - Validation of Constructed Gravel Wetland as a BMP for Nutrient Pollution Reduction

Acknowledgements

- UNH Stormwater Center
  - Robert Roseen, PhD, PE
  - Alison Watts, PhD, PG
  - James Houle
  - Kim Farah, PhD
- NEIWPCC
  - **Laura Chan**
  - **Heather Gilbert**
  - **Marianna Vulli**
  - **Mike Jennings**
  - **Claire Whittet**

- **Technical Advisory Committee**
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  - **Megan Moir, VT DEC**
  - **Thelma Murphy, EPA Region 1**
  - **Sally Snyder, CT DEP**
  - **Kerry Strout, NEIWPCC**

- **EPA Project Officer**
  - **Bryan Rittenhouse, EPA HQ**

Questions?