A Presentation of the

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IOWA STATE UNIVERSITY
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South Dakota
Cooperative Extension Service

November 23, 2010 Owatonna, MN

Iowa Bioreactor Demonstration Project

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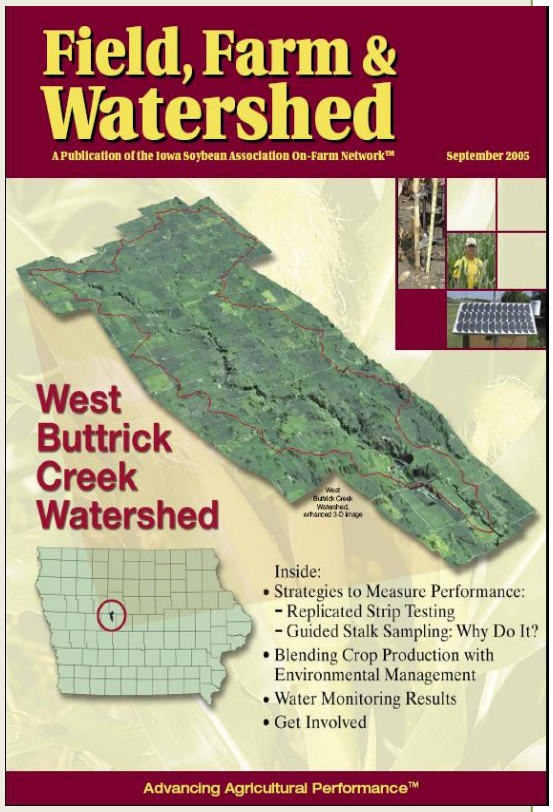
ENVIRONMENTAL PROGRAMS AND SERVICES

MINNESOTA/IOWA DRAINAGE RESEARCH FORUM
NOVEMBER 23, 2010
OWATONNA, MINNESOTA

ISA Environmental Program

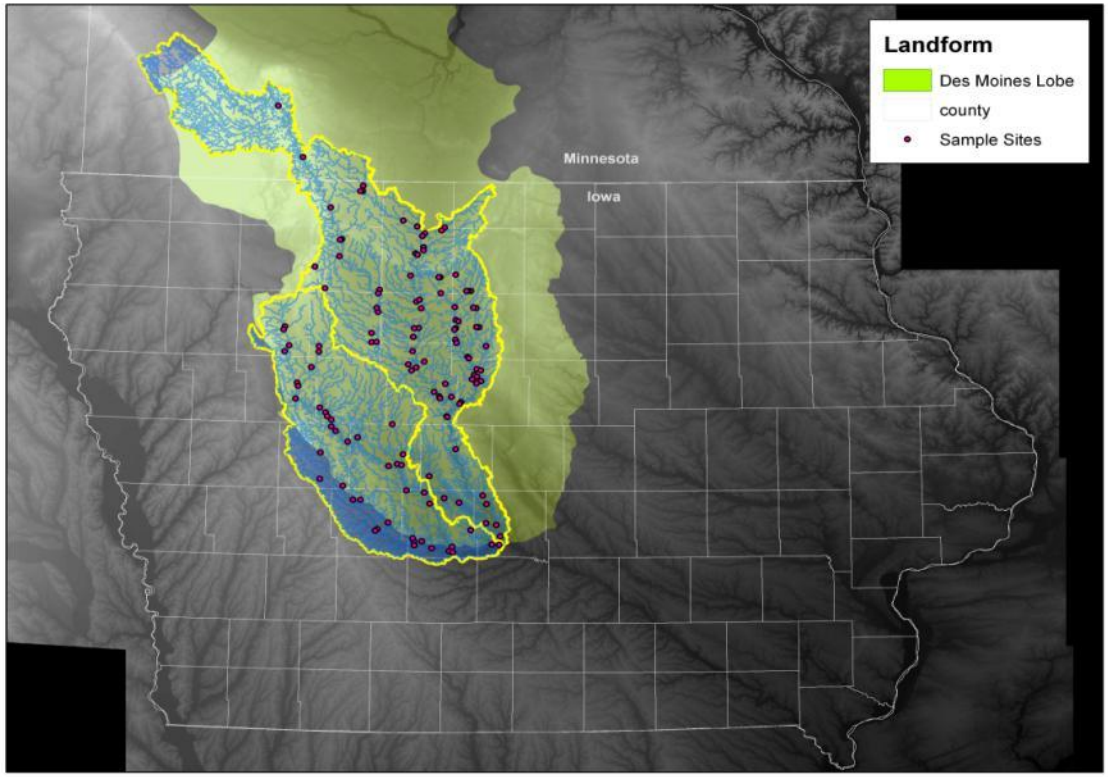
- Provide leadership for agriculture; have impact.
  - **Environment**
  - **Policy**
  - **Profitability**
- Seeking and capturing performance; tools/ techniques to help farmers address issues.
- Apply science to gain understanding, impact and profit
- Crosses multiple geographic scales
- Valuing cooperative partnerships and collaborations
- Provide value to membership and Iowa farmers.



Partnerships

- ISA works with a variety of partners in each watershed
- Each partner provides necessary expertise or support
- ISA's role is project coordination, watershed planning, farmer outreach/interface, and technical assistance

Agriculture's Clean Water Alliance



- 13 fertilizer dealers in the Raccoon/Des Moines River watersheds.
- Sell and apply most of the nitrogen used on 5 million acres of cropland in the watershed.
- Leading private sector sponsor of water quality monitoring
- Code of Practice
- Bioreactor demonstration study

Mission: To reduce the nutrient loss – specifically nitrate – from farm fields and to keep the nutrients from entering the Raccoon River and Des Moines River and its tributaries.

Objectives of ACWA

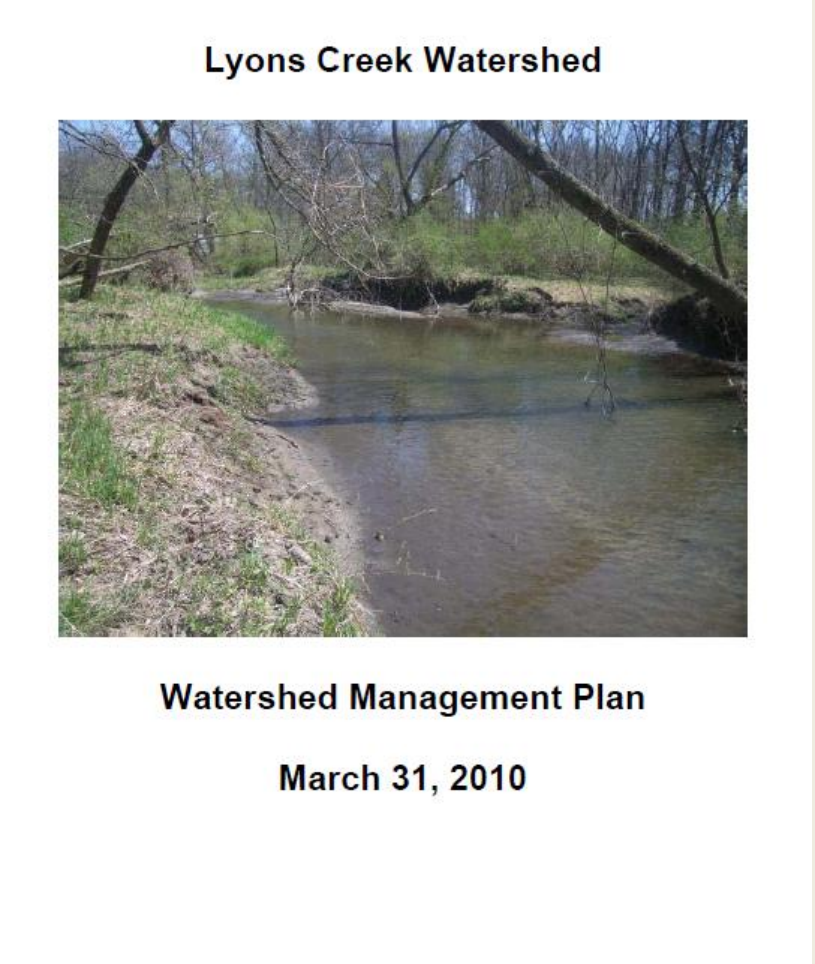
- Position ACWA as a credible source of data regarding nutrients entering the Raccoon and Des Moines River.
- Establish ACWA as a bridge between science and its application on the land.
- Apply “best management practices” to encourage
  - Sound economics
  - Strong environmental stewardship

Bioreactor Demo and Evaluation

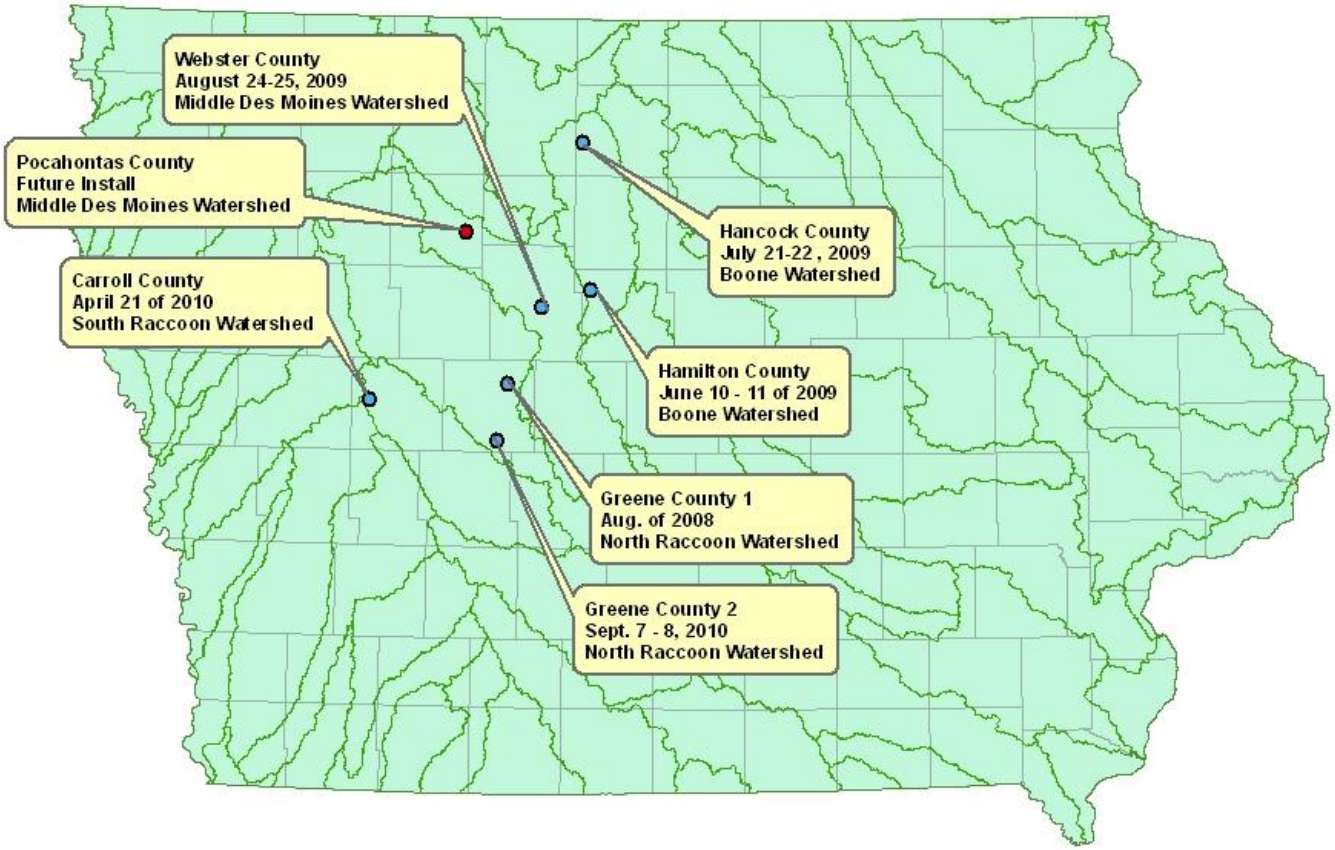
- End of the tile treatment process
- ACWA initiated project; 2008
- Partnering with Sand County Foundation
- Worked with ISU on initial design; and Iowa NRCS and ISU on interim standard
- Currently 6 sites installed; 7th pending

Watershed Planning

- A comprehensive plan for the watershed
  - Farmer involvement; locally-led
  - Inventories available data
  - Identifies water quality concerns
  - Outlines resources and partners available
  - Provides guidance on steps needed to address the concerns
- Set of integrated solutions; no silver bullet
- Infield/Edge of Field
- MRBI practice list
- Implementation



ACWA/Sand County Foundation Bioreactor Installations



Site Selection

- Tile size typically 6 – 8”
- Nearby tiles?
- Filter strip width
- Water table issues?
- Sandy or rocky bottom

Site Survey

Design Considerations

- Perpendicular or parallel to the stream
- Site located within land that is enrolled in a conservation program?
- Future plans for the sight, is filter strip width going to be adjusted in future?
- Drainage district

Installation Process

1. Place control structures
2. Excavate pit
3. Fill with wood chips
4. Roll geo-fabric over wood chips
5. Cover pit with soil, minimum 18 – 24 inches
6. Re-seed area

- Set upper and lower
- Pull stop logs before placing
- Use non-perf for 5 – 10 ft. at upper control

Place Control Structures

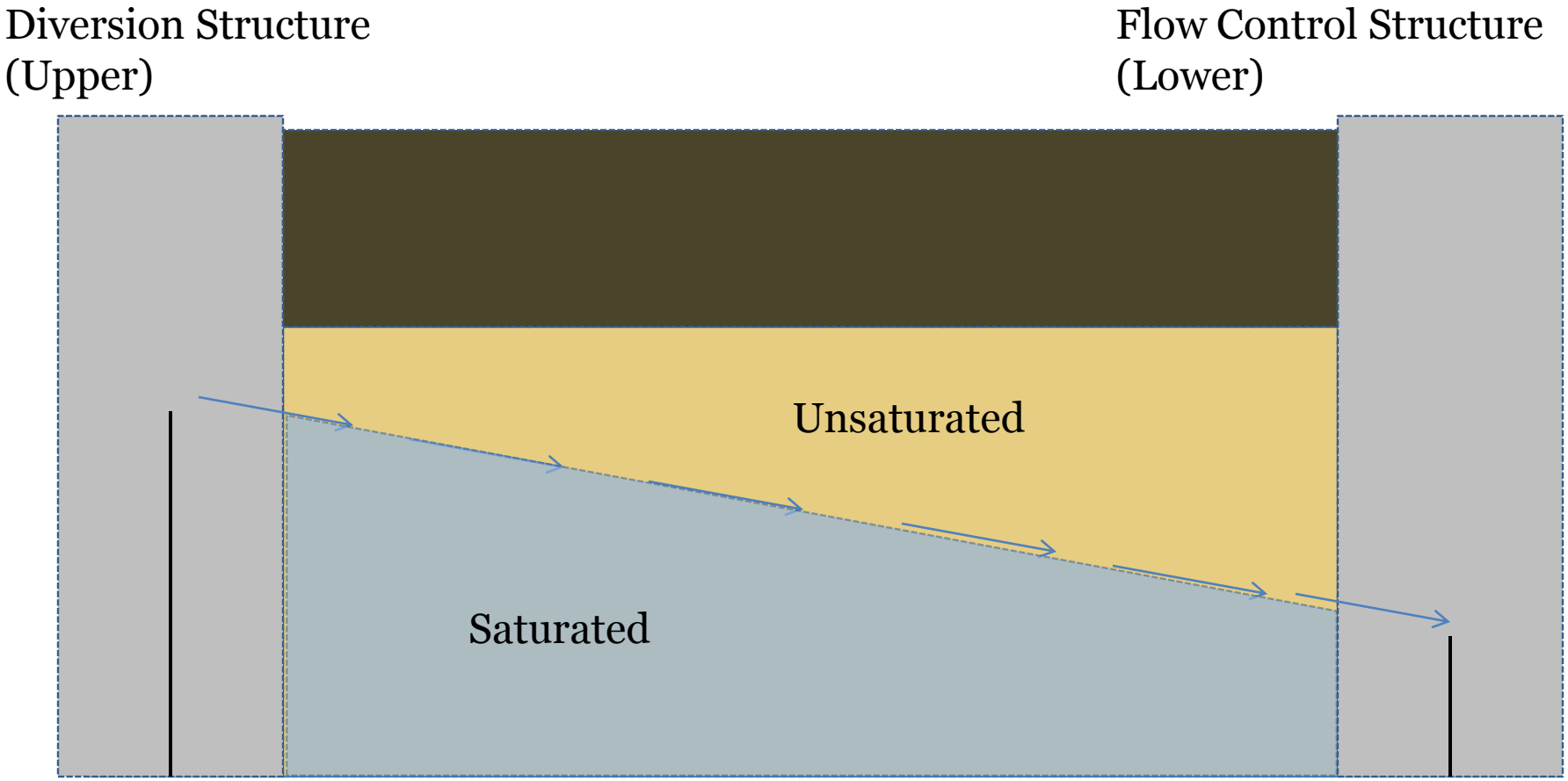
- Plastic lining

- If in-line match grade of tile

Excavate the pit

- 100 cubic yards/ semi load
- Minimum 2.5 – 3 ft. depths
- Deeper at upper end
- Order 20% more than needed

Fill with wood chips


Diversion Structure
(Upper)
Flow Control Structure
(Lower)
Unsaturated
Saturated

Allows water to move through, but prevents soil from settling into the wood chips.

Roll out geo-fabric

- Minimum 18”
- Mound to account for possible settling
- Consider what to do with spoil

Cover with soil

- FSA requires re-seeding

- Re-growth is usually shorter

Re-seed the area

	Costs, $				
Site	**Structures**	**Contractor**	**Wood Chips**	**Supplies**	**Total**
Greene	2,750	5,250	1,245†	500	**9,745**
Hamilton	1,640	--‡	2,400	350	**4,390**
Hancock	1,970	1,800	3,350	560	**7,680**
Webster	1,270	1,890	3,000	780	**6,940**
Carroll	1,640	5,030	4,650	500	**11,820**
Greene 2	1,480	2,710	2,520	400	**7,110**

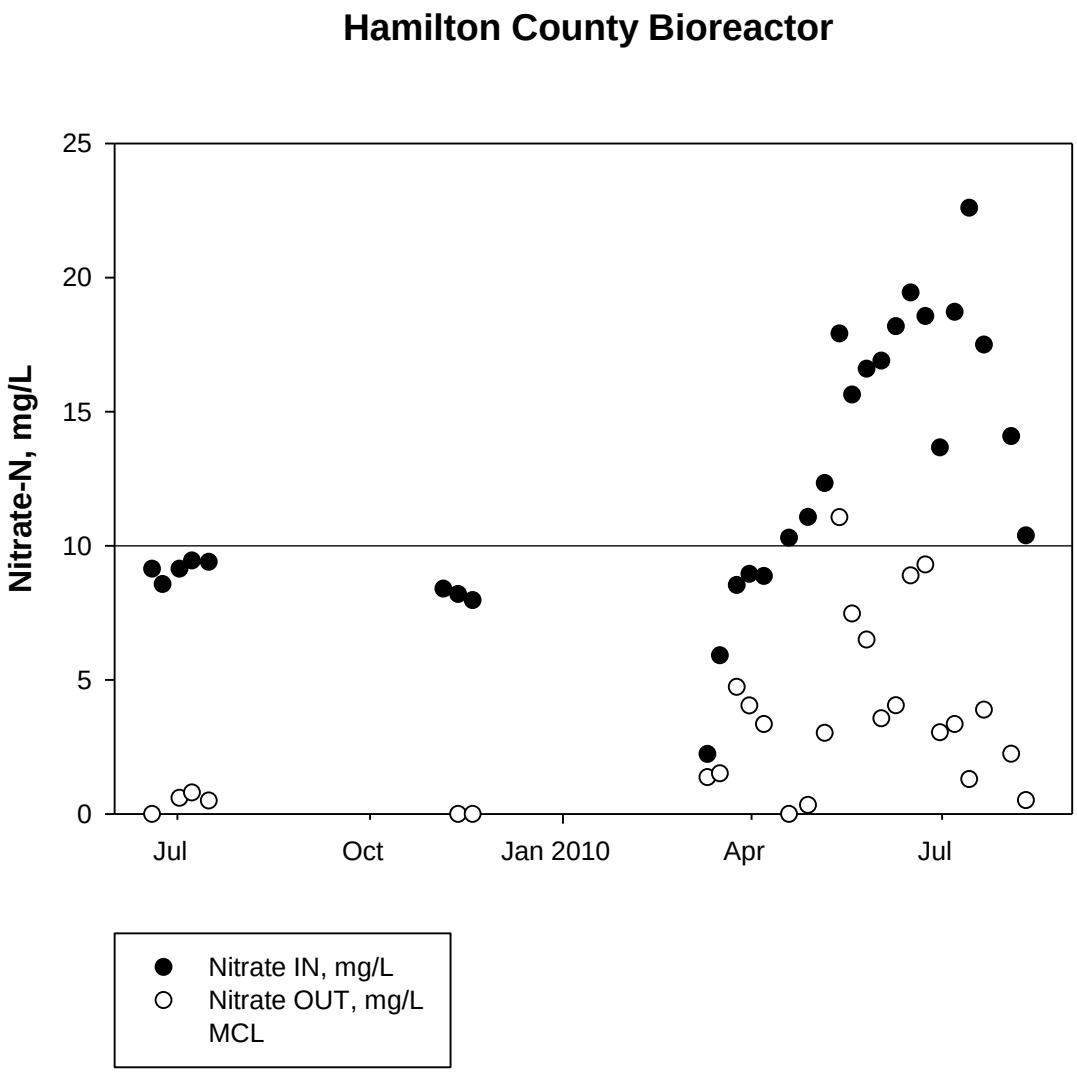
† Half of wood chips were donated

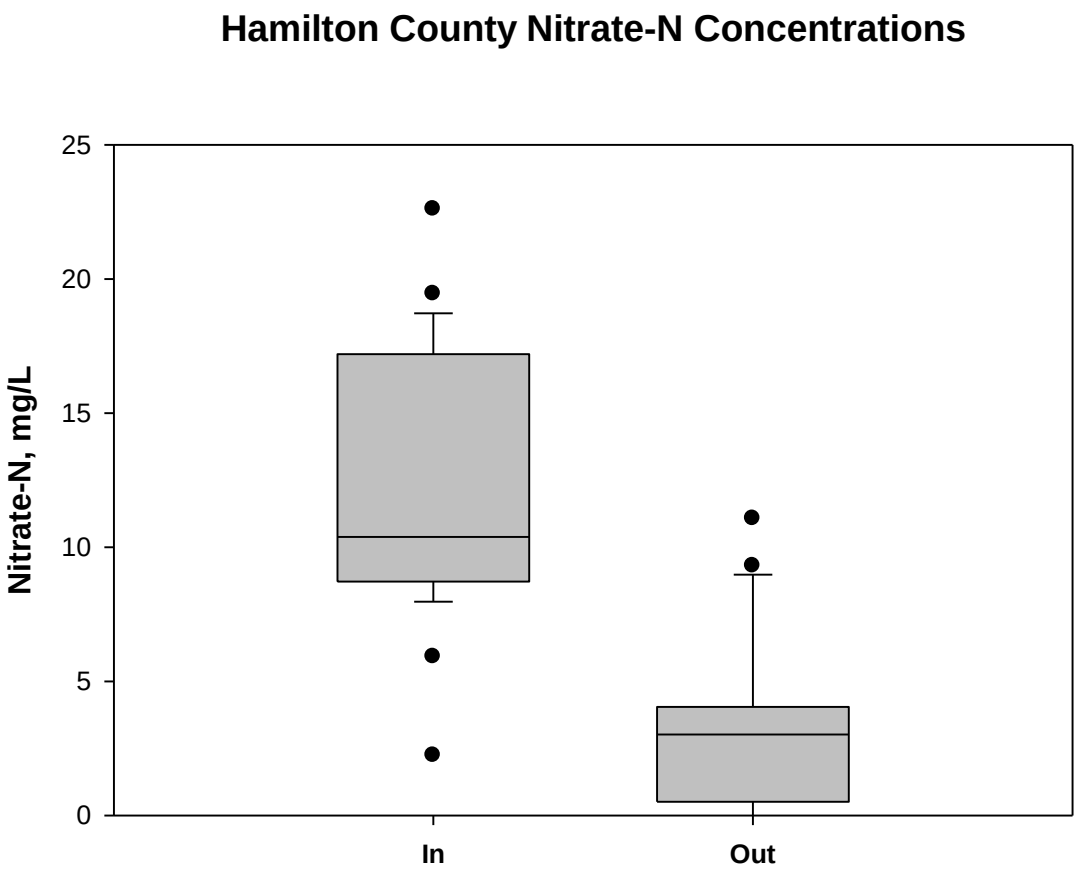
‡ Contractor services donated by Willie Ubben Jr.

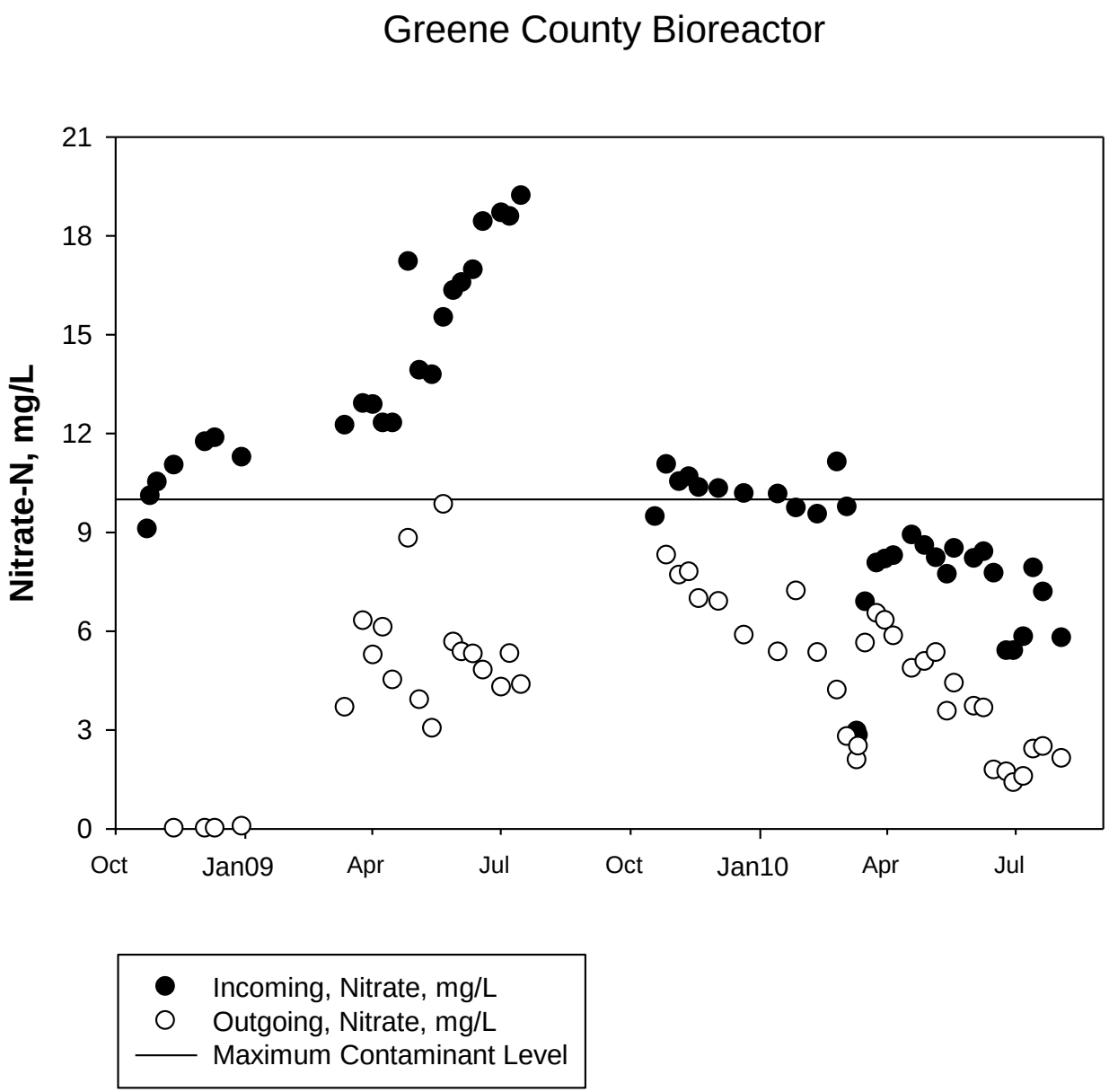
* Estimation from contractor, not final number

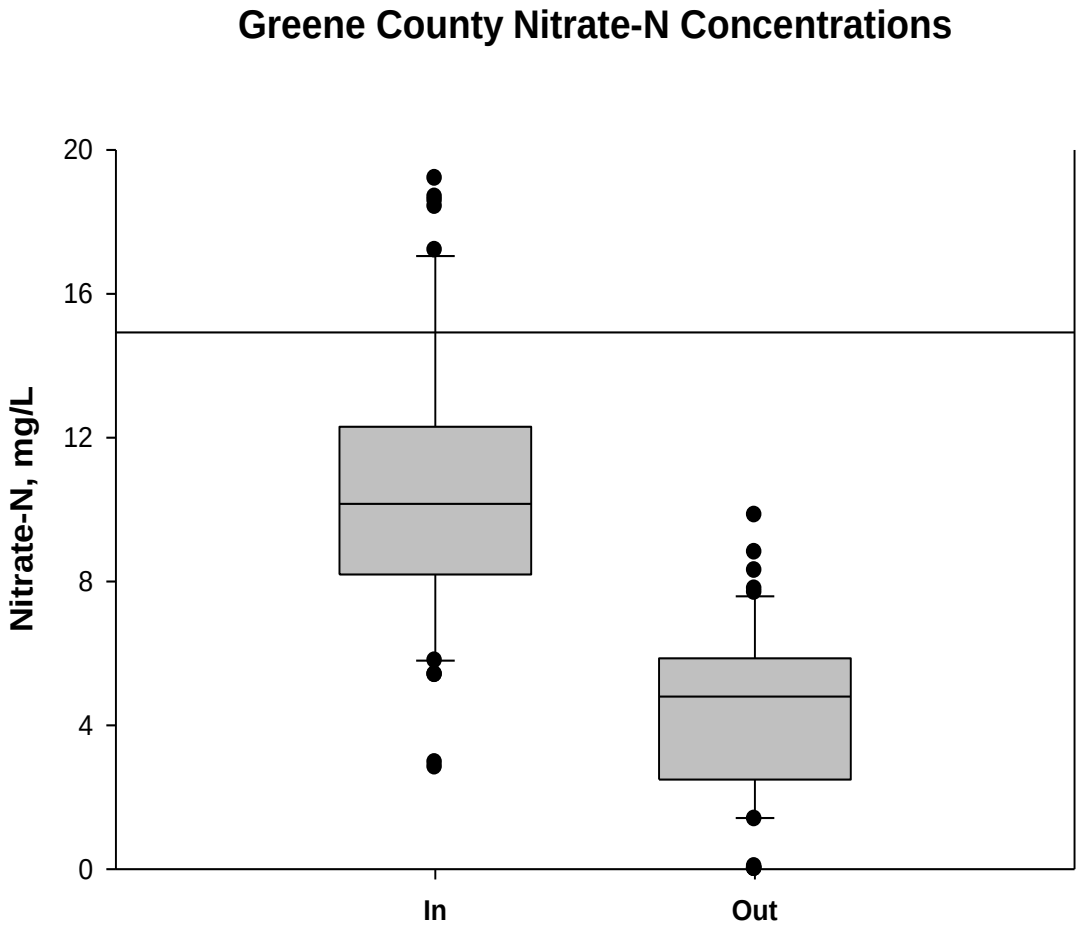
Bioreactor Monitoring

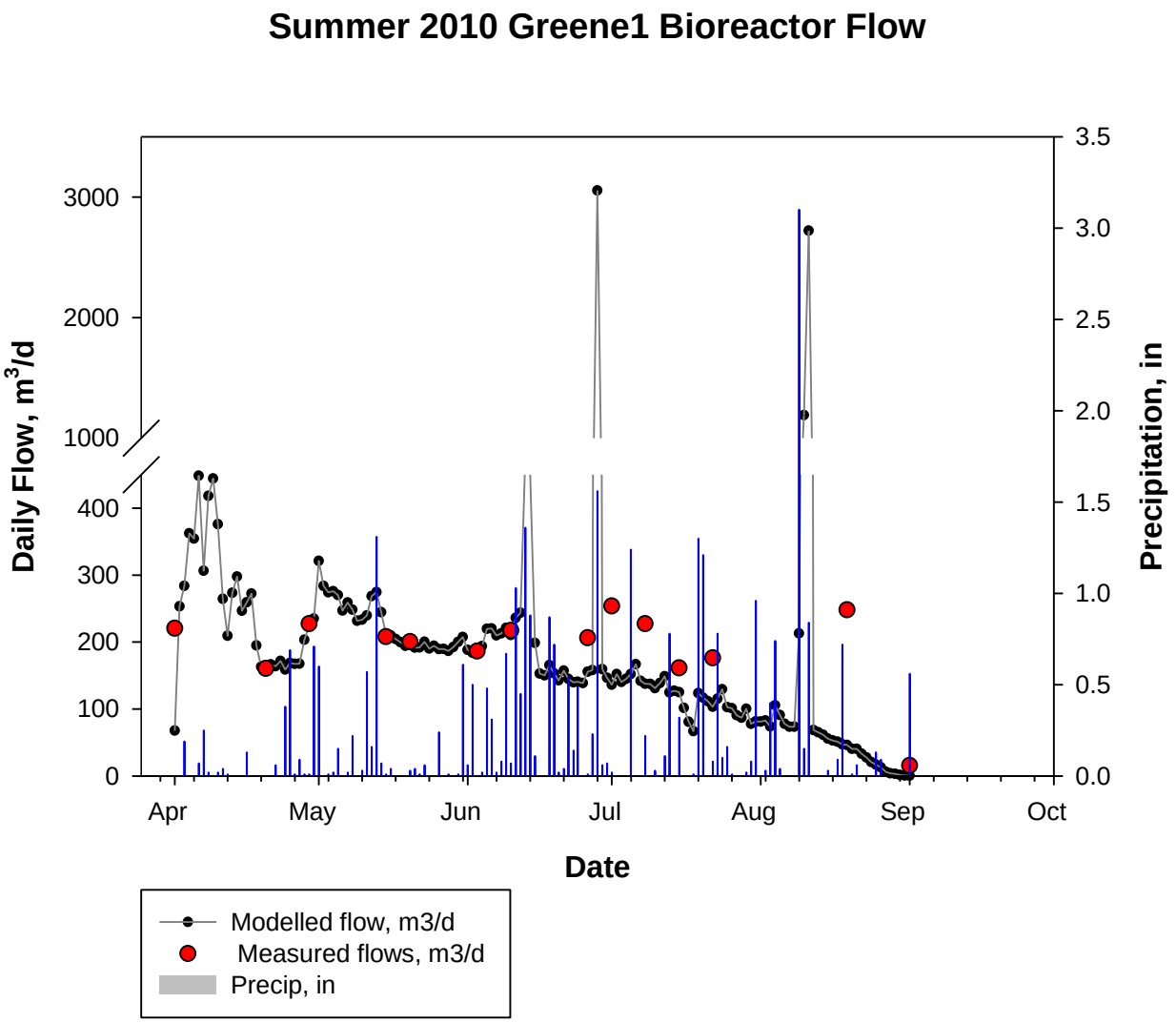
- Weekly to bi-weekly samples
- Nitrate, DO, and temperature
- Sulfates, TN, and TOC
- Flow measurements

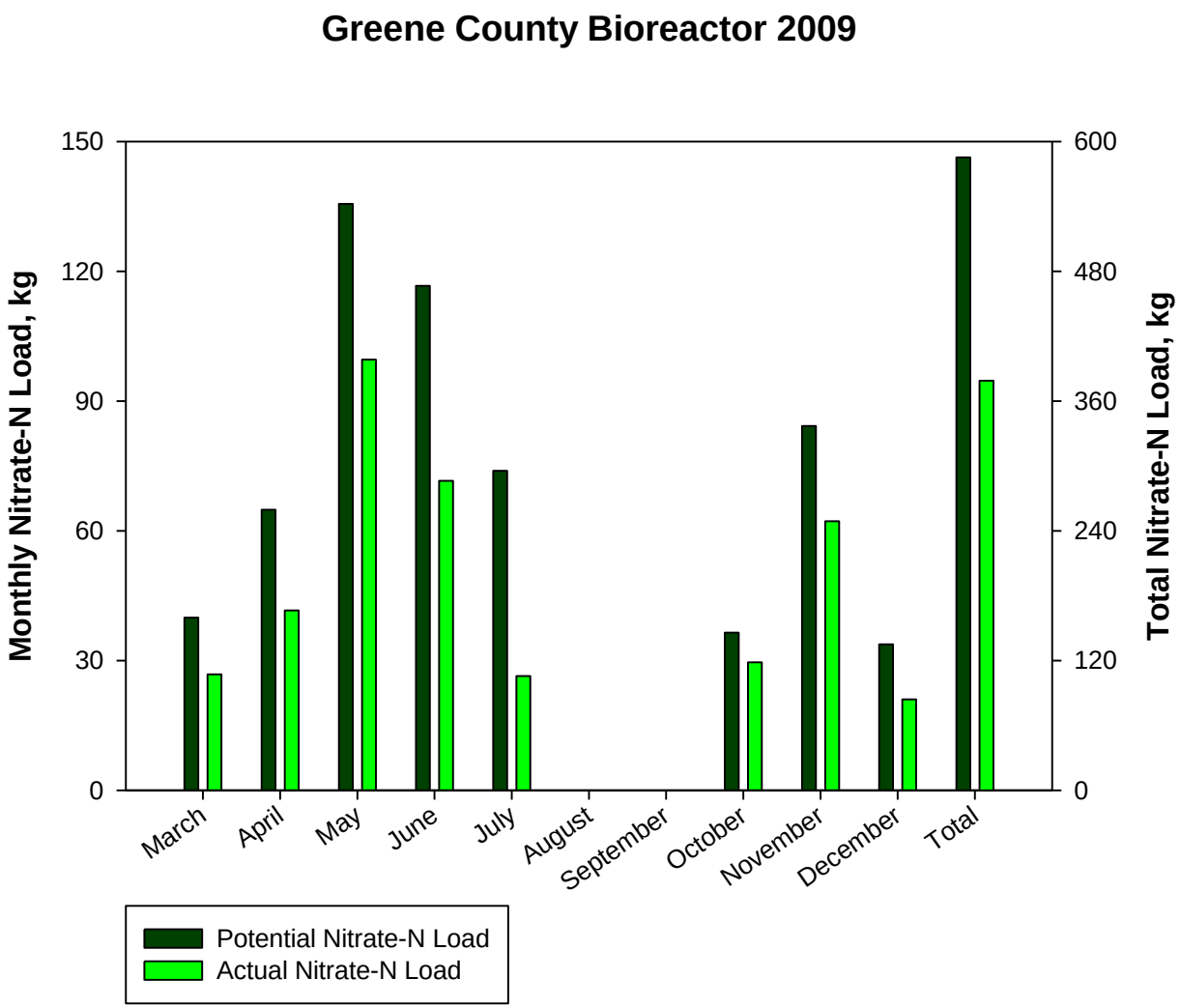

Hamilton County Bioreactor
Nitrate-N, mg/L
25
20
15
10
5
0
Jul
Oct
Jan 2010
Apr
Jul
Nitrate IN, mg/L
Nitrate OUT, mg/L
MCL


Hamilton County Nitrate-N Concentrations
Nitrate-N, mg/L
25
20
15
10
5
0
In
Out


Greene County Bioreactor
Nitrate-N, mg/L
21
18
15
12
9
6
3
0
Oct
Jan09
Apr
Jul
Oct
Jan10
Apr
Jul
Incoming, Nitrate, mg/L
Outgoing, Nitrate, mg/L
Maximum Contaminant Level


Greene County Nitrate-N Concentrations
Nitrate-N, mg/L
20
16
12
8
4
0
In
Out


Summer 2010 Greene1 Bioreactor Flow
Daily Flow, m3/d
Precipitation, in
Date
3000
2000
1000
400
300
200
100
0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Apr
May
Jun
Jul
Aug
Sep
Oct
Modelled flow, m3/d
Measured flows, m3/d
Precip, in


Greene County Bioreactor 2009
Monthly Nitrate-N Load, kg
Total Nitrate-N Load, kg
150
120
90
60
30
0
600
480
360
240
120
0
March
April
May
June
July
August
September
October
November
December
Total
Potential Nitrate-N Load
Actual Nitrate-N Load

Cost Effectiveness

Practice	US $ (kg-N^{-1})	Source
Bioreactor	2.39 -15.17	Schipper et al. (2010)
Soil Testing & Side Dressing N fertilizer	1.15	Saleh et al. (2007)
Drainage water mgmt.	2.71	Jaynes and Thorp (2008)
Wetlands	3.26	Hyberg (2007)
Fall cover crops	11.06	Saleh et al. (2007)

Table from Schipper et al. 2010

Management

- Diversion Control Structure (Upper)
  - Lower before field operations
  - Raise after spring operations, and after harvest
- Flow Control Structure (Lower)
  - Raise during periods of low temperature
  - Lower once water temperatures rise
  - Remove all stop logs during periods of no flow
- Monitoring performance

Iowa Interim Standard

- Design for 10 year life span
- Avoid Equipment travel over the bioreactor
- Designed to treat base flow using DC of 0.125 in/d or a minimum of 20% of peak flow
- Periodic monitoring

Incentives

- No benefit to producer
- Increases rankings for competitive programs such as MRBI
- Tax credit?

Concerns

- Life span
  - How to replace wood chips
- Missing peak flows
- Larger tile lines
- TA for installation

Thank You

Special thank you to our collaborators and supporters –

- USDA Natural Resources Conservation Service
- Des Moines Water Works
- Sand County Foundation
- Agriculture's Clean Water Alliance.

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