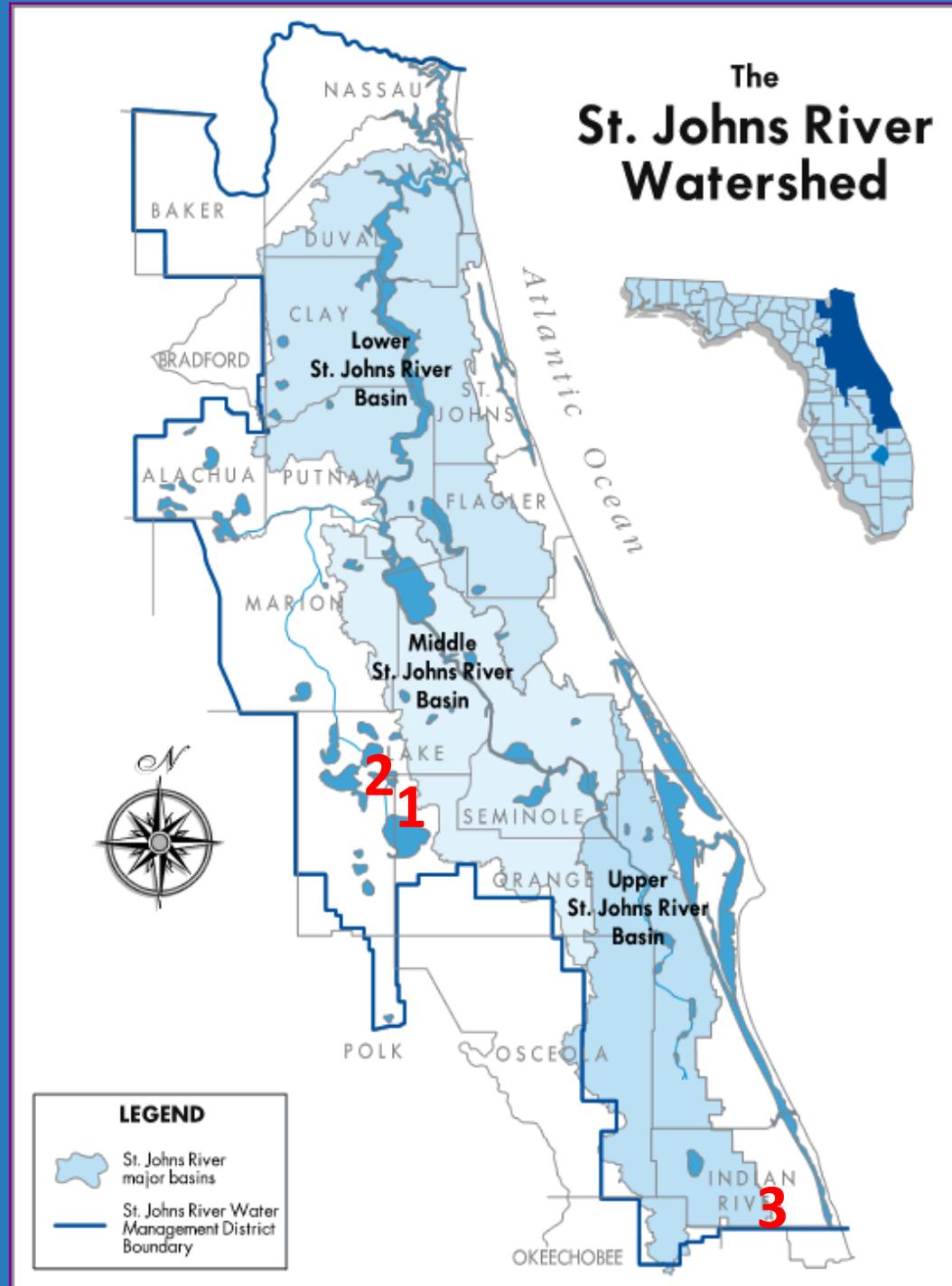


# **Monitoring the Efficacy of Chemical Amendments for Nutrient Control in Wetland Restorations**

**Vickie Hoge  
NWQMC  
May 4, 2016**

# St. Johns River Water Management District



# The challenge

- The District purchased approximately 11,000 ha of former row crop farms in the Apopka and Emeralda Marsh basins during the 1990's to reduce external P loading to water bodies
- Expected legacy phosphorus flux from just the Apopka north shore was expected to reach 158 metric tons (3 mg P/m<sup>2</sup>)



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# Various stages of reflooding

- **1) Apopka** – Muck farmland (8,000 ha) left in dry condition
- **2) Emerald Marsh** – Muck farmland (800 ha) already reflooded, various depths, some with heavy vegetation
- **3) Blue Cypress Marsh** – (243 ha) never farmed, but subjected to high nutrient water from broken levee, shallow with heavy vegetation



# Methods of choosing products

- Lab studies (UF)
- Adsorption isotherms
- Literature reviews – In house and contracted
- Chemical characterization
- Physical characterization
- Toxicity studies (FDEP)
- Leaching studies (TCLP and SPLP)
- Mesocosm field plot
- Large field plots (0.8 ha)



# Batch incubation studies – UF (1996)

- Calcium carbonate
- Calcium hydroxide
- Aluminum sulfate (alum)
- Ferric chloride
- Dolomite
- Various combinations





**Dry aluminum sulfate, Al WTR,  $\text{CaCO}_3$  WTR, and lime  
Water Treatment Residuals (WTR)**

**Field scale plots – Aluminum based WTR  
3.6 wet tons/ac**



**Field scale plots - Application of calcium hydroxide  
2.0 and 2.8 tons lime/ac (30% slurry)**



**Alum WTR**

**Ca(OH)<sub>2</sub>**

**Control**

**Ca(OH)<sub>2</sub>**





$\text{Ca(OH)}_2$

Control

Alum WTR

Gypsum

# Alum water treatment residual

- By-product of drinking water treatment process
- Source water is Lake Washington
- Extremely high P bonding capacity – 60 mg P/dry g of residual
- Available for FREE in Melbourne, FL



# Central processing site – Zellwood, FL



## Temporary truck scale



# Rotary drum screen





**Dose = 6.5 to 10 wet tons per acre**





- Calibration – every few hours on each of 4 spreaders

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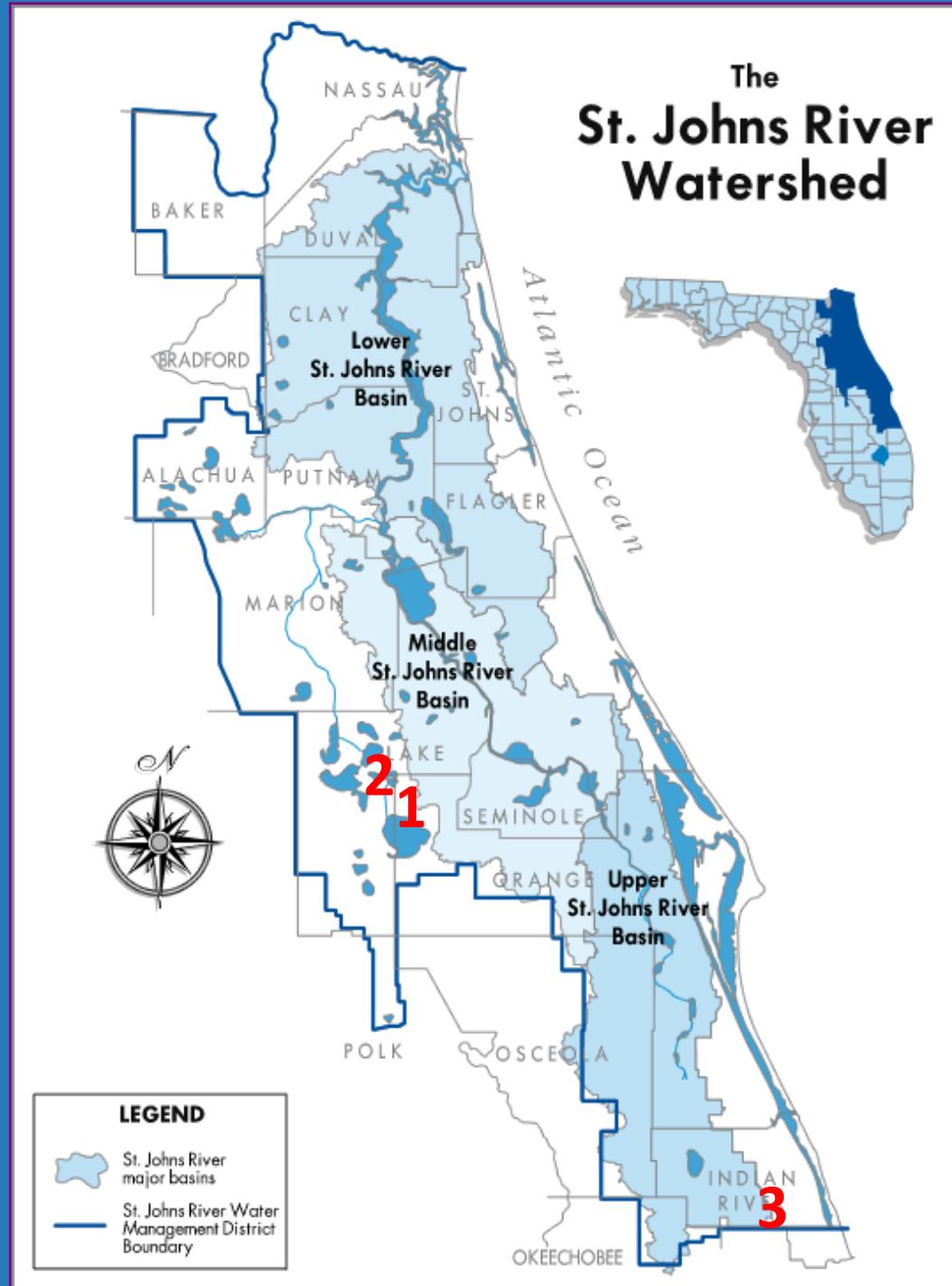


# Final stats for land applicaton

- Project ran from 1999 - 2009
- 59,974 metric tonnes were applied on 2,877 ha
- \$2.5 m in contracts for trucking, processing, and application (not internal costs, lab fees or experimental work)



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# Condition of sites

- All flooded
- Some to be treated for water column P
- Some to be treated for wc/sediments
- Various stages of vegetation thickness and water depth

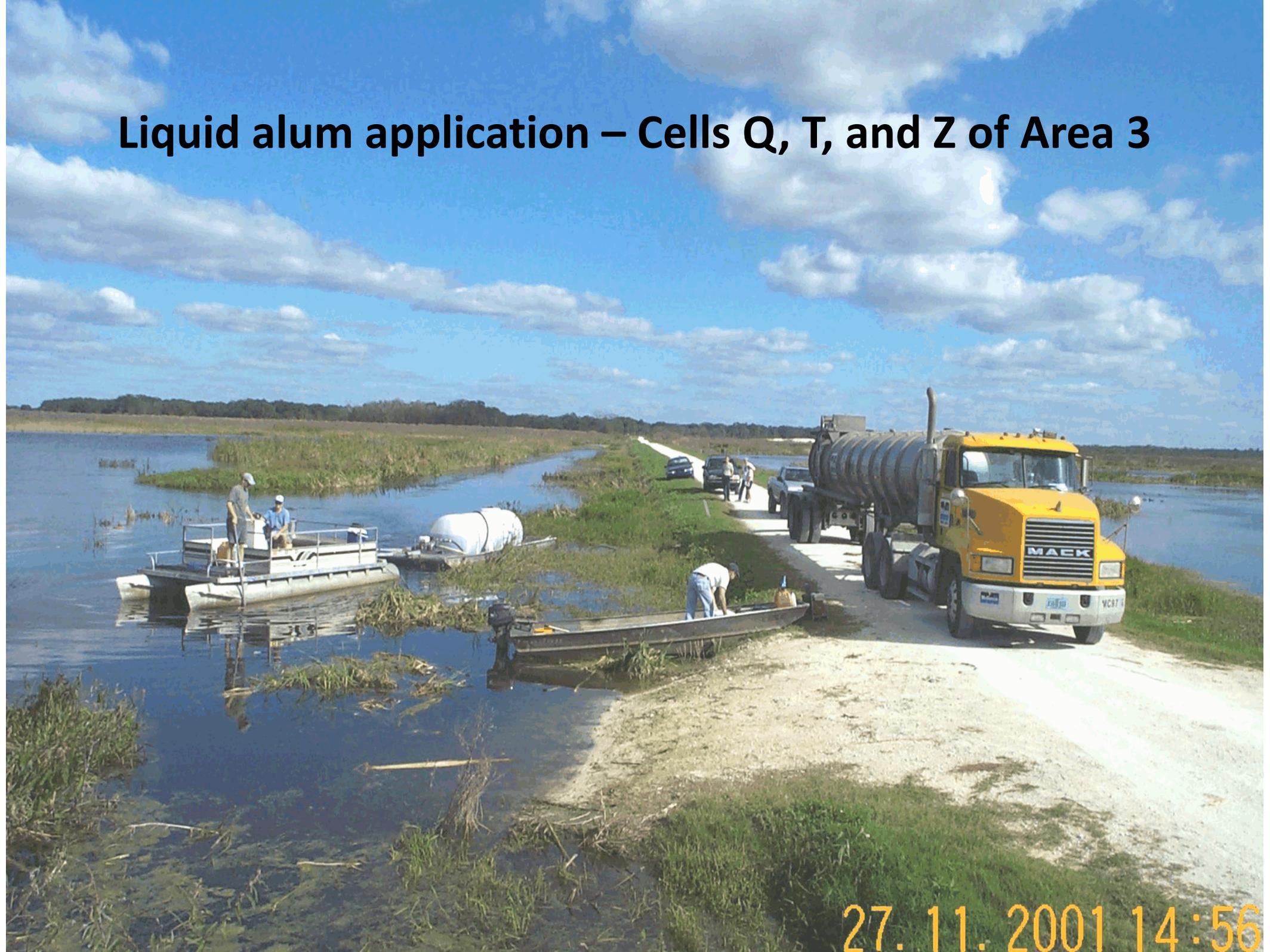


# Jar tests



Photo courtesy of DB Environmental

# Liquid alum application – Cells Q, T, and Z of Area 3



27. 11. 2001 14:56

# “Cookie Cutter”



24. 7. 2001 08:29



9. 11. 2001 12:26



27. 11. 2001 15:09

An aerial photograph of a marsh area. A prominent white line, likely a road or canal, runs diagonally across the upper portion of the image. Below this line, a large, dark, irregularly shaped area indicates the application of liquid alum. The surrounding marsh vegetation is a mix of green and brownish-yellow. The text 'Liquid alum application by MarshMaster™ on Cells Q, T, and Z' is overlaid in the upper left quadrant.

**Liquid alum application by MarshMaster™  
on Cells Q, T, and Z**

15. 3. 2002 14:01

# Liquid alum and sodium aluminate application – Area 7









# Barge Results

Area	Year	Dose Applied (mg Al/L)	Δ TP-T Water Column (%)	Cost/kg P removed (\$) Water Column
3-Q	2001	3.18	-62	275
3-Z	2002	10.31	-57	
3-T	2002	6.64	-59	
4	2002	9.15	-72	550
5-1	2003	9.37	-91	13
5-2	2005	9.68	-60	53
7	2003	19.9	-97	38
2	2004	12.6	-53	1,857
LHCA-1	2008	26.9	-44	137
LHCA-2	2010	29.0	-62	83



# Economics of barge application

- \$748/ha – includes treatment design plus application
- \$41/kg P removed – water column effects only

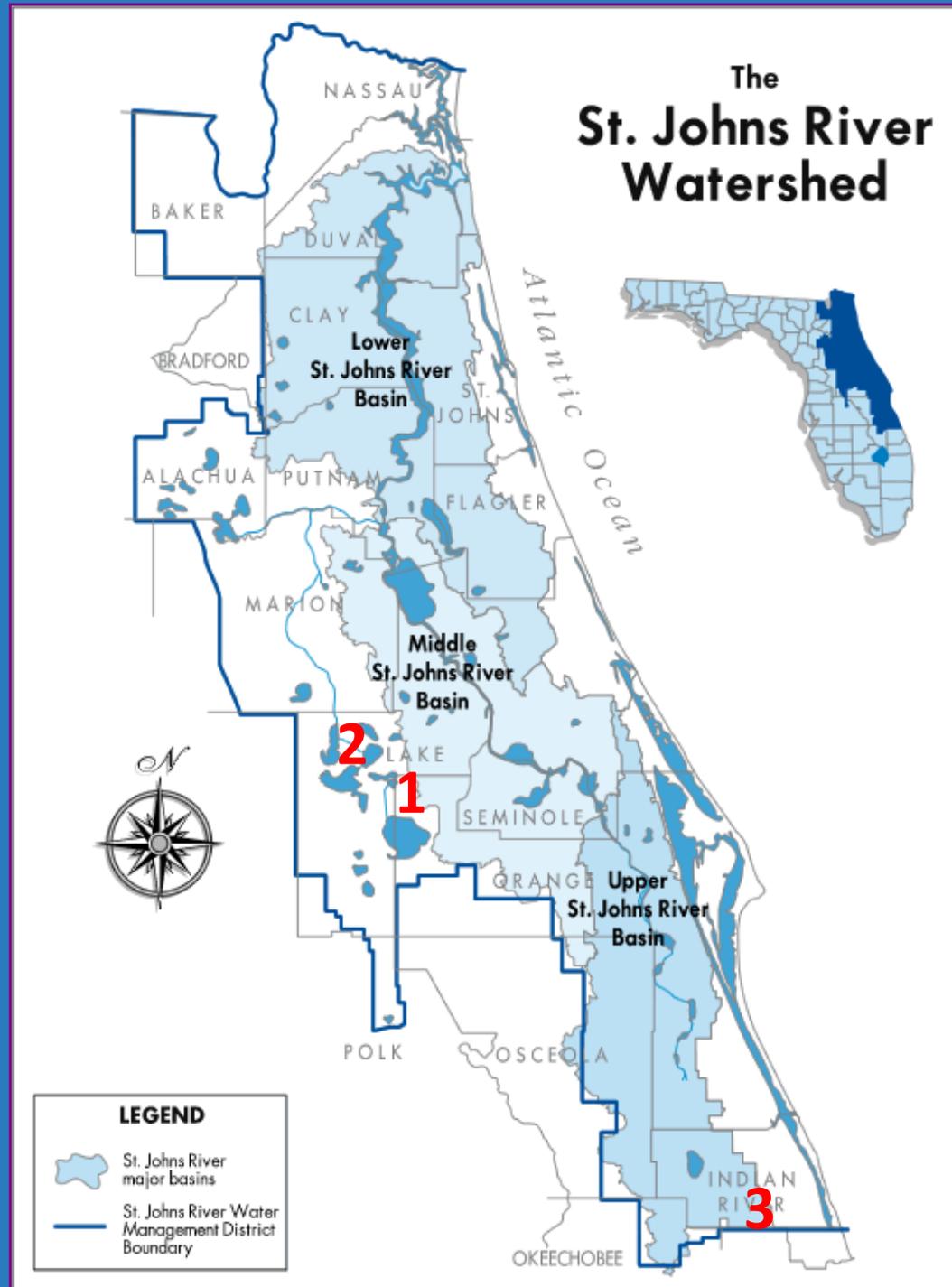




2004/12/15



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# Enclosure study – Al WTR, Baraclear™, Ferric WTR, and granular alum







**Baraclear- Aluminum sulfate/bentonite product**



# Treatment Effects on PO<sub>4</sub>-D

- PO<sub>4</sub>-D reductions occurred immediately
- PO<sub>4</sub>-D was significantly reduced by all treatments

Baraclear = granular alum < Al-WTR =  
Fe-WTR < Control



Ansin West Tract  
of  
Blue Cypress  
Marsh

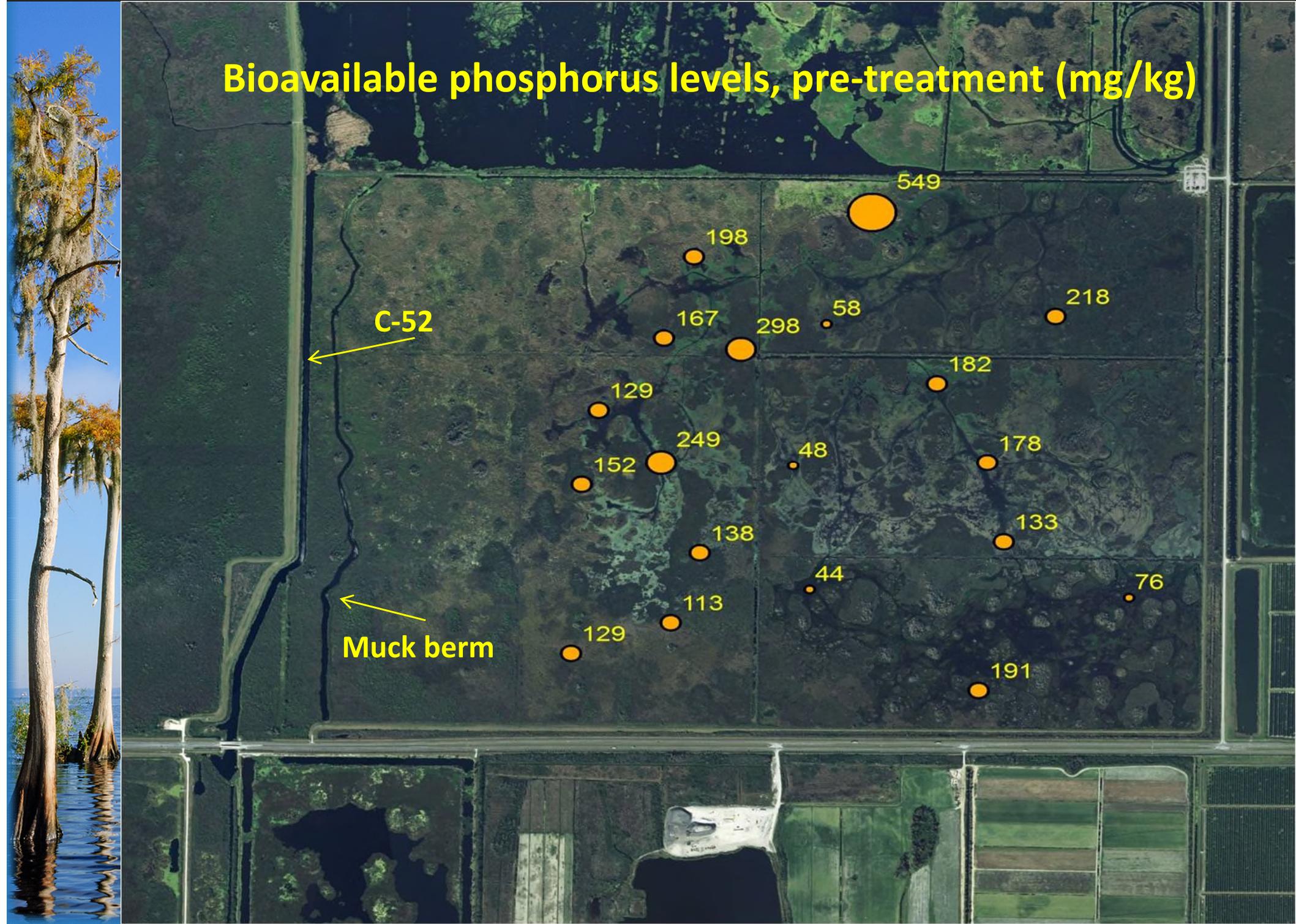


# Challenge

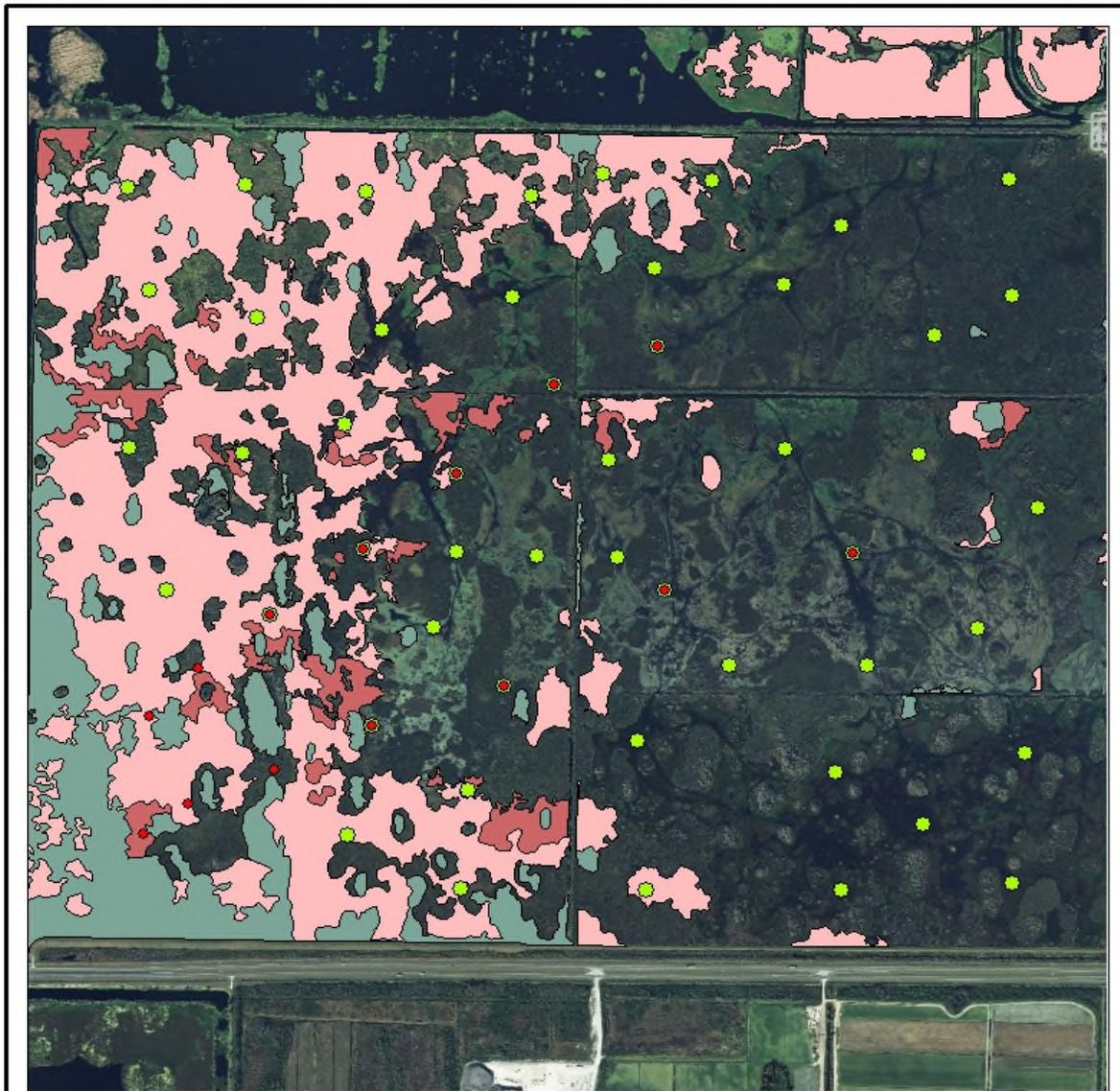
- Elevated bioavailable phosphorus in sediments covering 243 ha of Ansin West of Blue Cypress Marsh.
- Expanding coverage of cattail
- Reduced habitat for endangered Snail Kite
- Heavily vegetated and very shallow



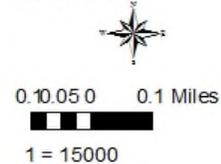
Bioavailable phosphorus levels, pre-treatment (mg/kg)



**Cattail  
encroachment  
(in pink)  
Pre-treatment**



## Ansin West Alum Project Soil Station Locations



### Legend

- 2005 Soil Sampling
- Proposed 2011 Alum Sampling

#### 2008 BCWMA veg

##### Herbaceous Wetland

- Cattail
- Cattail/Sawgrass

##### Shrub Wetland

- Willow Swamp
- Mixed Shrub

The St. Johns River Water Management District prepares and uses this information for its own purposes and this information may not be suitable for other purposes. This information is provided as is. Further documentation of this data can be obtained by contacting: St. Johns River Water Management District, Geographic Information Systems Program Management, P.O. Box 1429, 4049 Reid Street Palatka, Florida 32178-1429 Tel: (386) 329-4176.



# Plan

- Bid out chemical contract
- Use annual spray contractor
- Spray Clearcast™ - July 2012
- Prescribed burn – August 2012
- Apply granular alum – late August 2012
- Annual vegetation surveys
- Aerial photography
- Post-treatment sediment sampling





08.29.2012 08:28



EMERGENCY RELEASE PULL

IFR ONLY

SUPER CRUISE

CAUTION: DO NOT ATTEMPT TO OPERATE IN THIS MODE UNLESS YOU HAVE RECEIVED THE NECESSARY TRAINING AND ARE CURRENTLY IN THE AIR. THIS MODE IS INTENDED FOR USE IN EMERGENCIES ONLY. ALWAYS WEAR YOUR SEATBELT AND FASTEN YOUR SAFETY BELT. ALWAYS WEAR YOUR SAFETY BELT. ALWAYS WEAR YOUR SAFETY BELT.

08.29.2012 08:49

INCREASE



08.29.2012 09:21



08.29.2012 09:24



08.29.2012 09:26



N53AG

RESTRICTED

JC

AIR

08.29.2012 13:35



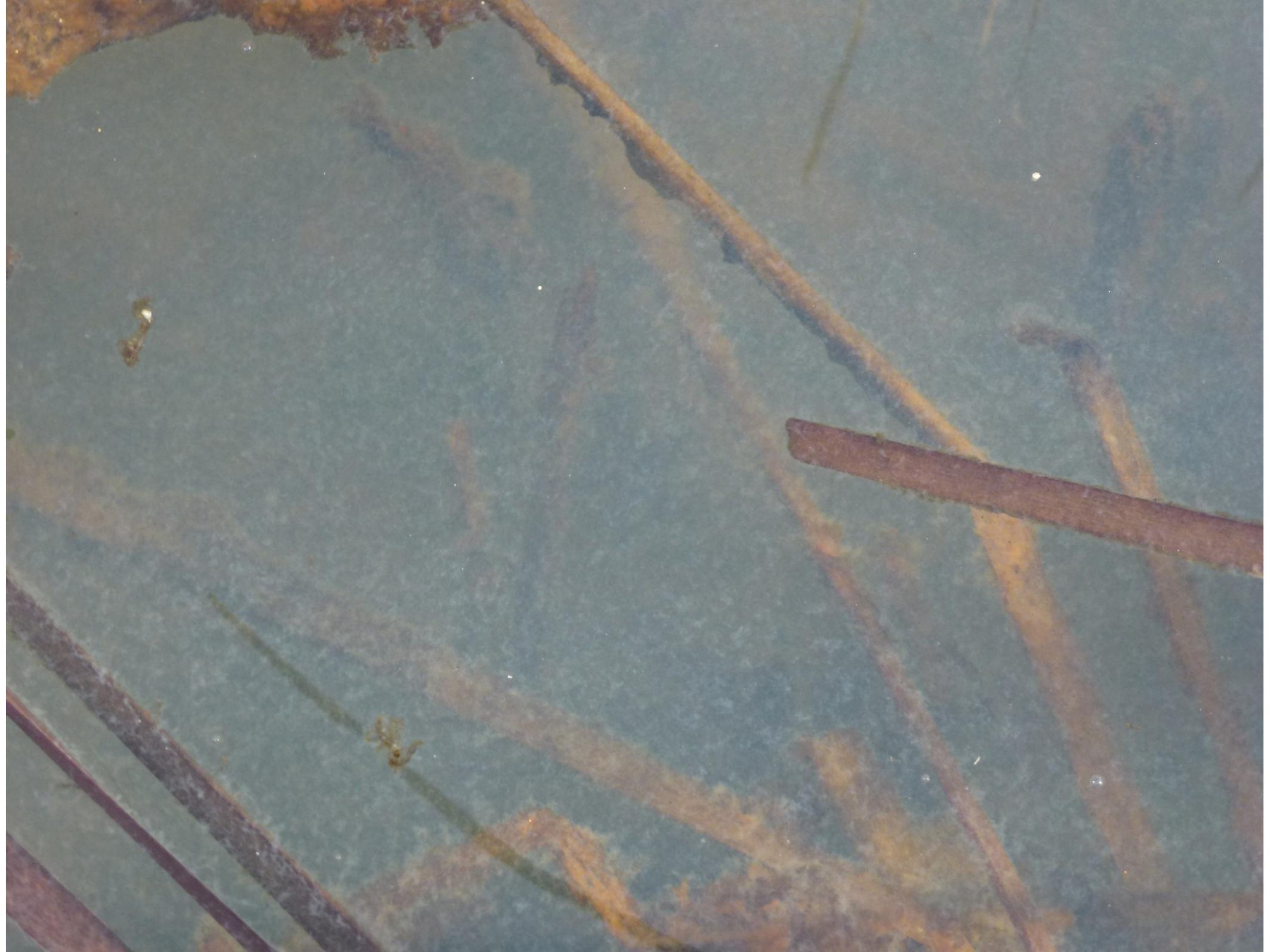
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# Results - vegetation

- Almost total loss of *Typha* on all transects
- Impacts to other species variable depending on transect
- Appearance of extensive areas of *Chara zeylanica* on 75% of transects likely due to changes in alkalinity and water clarity



May 2012

# St. Johns River Water Management District

May 2012



Transect 1

May 2013



# St. Johns River Water Management District

May 2012



Transect 6

May 2013



# St. Johns River Water Management District

May 2012



Transect 8

May 2013



# Cost of aerial treatment

- Alum – \$89,220 (165,240 kg)
- Spray crew – \$119,150 (2.5 days)
- Sediment sampling - \$37,648
- = \$1,013/ha
- Barge applications ~ \$748/ha



# UF Snail Kite survey – March 2014

0 0.125 0.25 0.5 Miles



1 male and 2 females  
N 3058917  
E 533149



1 juvenile and 1 female  
N 3058789  
E 533196



1 female and 1 male  
N 3057809  
E 534395



# Summary

- Can complete P binding projects in various situations
- Dry land – manure spreaders with WTR's
- Deep open water – barges w/ liquid alum
- Shallow marsh – MarshMaster™, airboat, and aerial granular alum applications



# Conclusion

- **Chemical amendments can be used to reduce the timeline for wetland restorations in highly impacted former farm fields with large stores of legacy phosphorus**

