Quantifying Enhanced BMP's and Overview of Ranking Process for TCAA-Water Management Partnership Cost Share Program.

Mark Clark
Wetlands and Water Quality Extension Specialist
Soil and Water Sciences Department, UF/IFAS

Outline of Presentation

- Load reduction estimates for Irrigation Drainage Tile
- Ranking process of BMP's associated with TCAA-WMP cost-share program
- New investigation looking at UF/IFAS P fertilizer recommendations and runoff.

Agriculture's Role in Water Quality Protection

- The Legislature provided for agricultural operations to implement BMPs as the preferred means to help meet TMDLs and otherwise protect water quality [s. 403.067(7) and (12), F.S.]

- Agricultural operations within BMAP areas have two options:

  Enroll in and implement FDACS BMP

  OR

  Follow an FDEP- or WMD-prescribed water quality monitoring plan at the producer's own expense (complicated and costly)

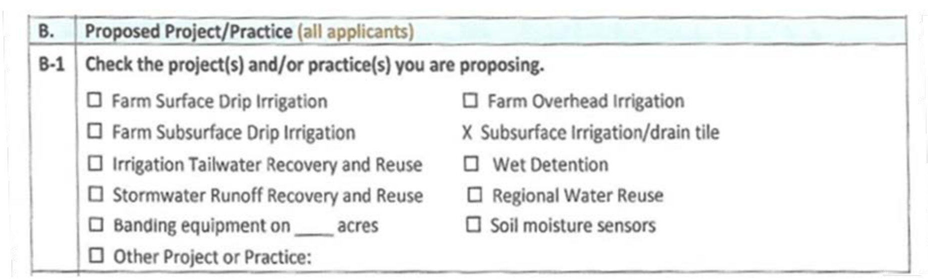
- Failure to do either could bring enforcement action by FDEP or the applicable WMD.

Slide provided by FDACS OAWP

Is Implementation of BMPs Enough?

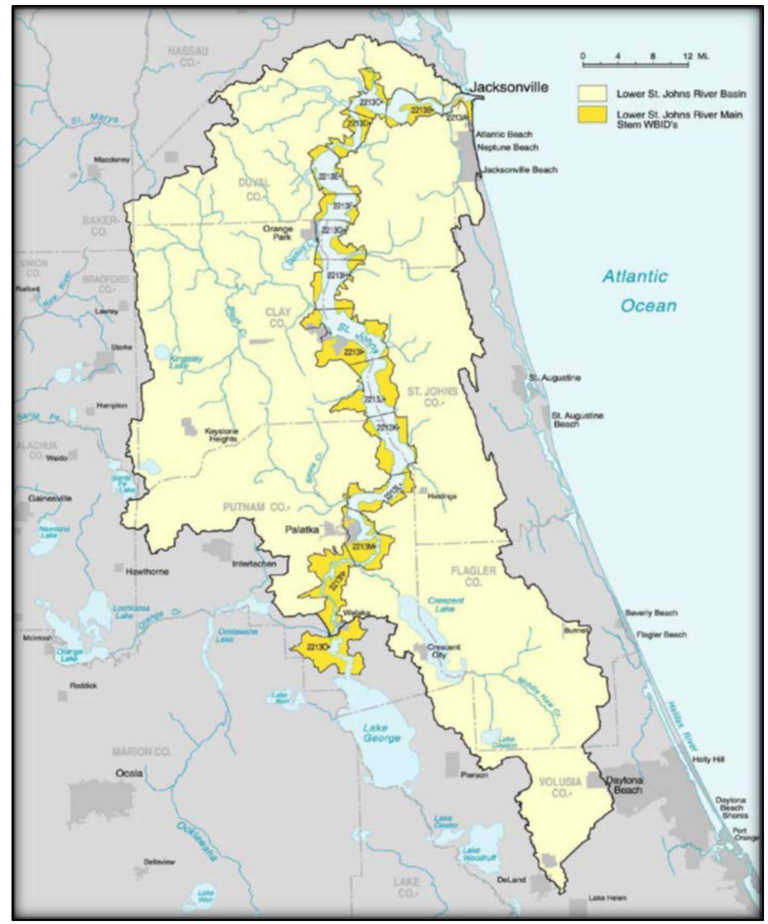
- Adopting BMPs does not necessarily mean that load reduction targets are achieved, only that levels are reduce to those that are "technically and economically feasible" for a commodity to implement.
- If estimated load reduction from BMPs does not achieve the load reduction required by the TMDL for agricultural land use then additional measures are required.
- The cost of these additional reductions are typically shared with society because agriculture commodities cannot directly pass cost onto consumer like urban or other point sources often can.
- Additional load reductions typically come in the form of:
  - regional treatment systems
  - "cost share" programs
    - Federal, State, Water Management Districts

Tri-County Agricultural Area Water Management Partnership

- Lower St. Johns River has a TMDL for Nitrogen and Phosphorus.
- Agriculture BMPs almost fully enrolled.
- Regional treatment systems helping to reduce loads.
- State and federal cost share programs underway to improved farm irrigation and nutrient management.
- 

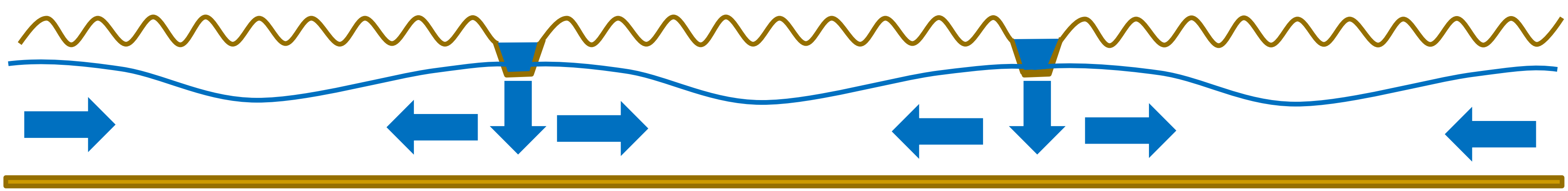
B.	Proposed Project/Practice (all applicants)	
B-1	Check the project(s) and/or practice(s) you are proposing:	
	☐ Farm Surface Drip Irrigation	☐ Farm Overhead Irrigation
	☐ Farm Subsurface Drip Irrigation	X Subsurface Irrigation/drain tile
	☐ Irrigation Tailwater Recovery and Reuse	☐ Wet Detention
	☐ Stormwater Runoff Recovery and Reuse	☐ Regional Water Reuse
	☐ Banding equipment on ____ acres	☐ Soil moisture sensors
	☐ Other Project or Practice:	

- Irrigation Drainage Tile (IDT) is one of several practices being evaluated.



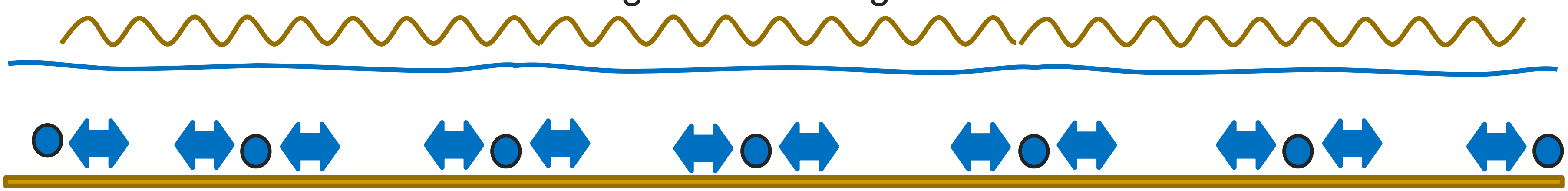
Conventional "Seepage" Irrigation

- Inefficient water use.
- Uneven moisture regime for crop.
- Crop loss due to flooding and limited drainage control.
- Significant particulate runoff of N and P.



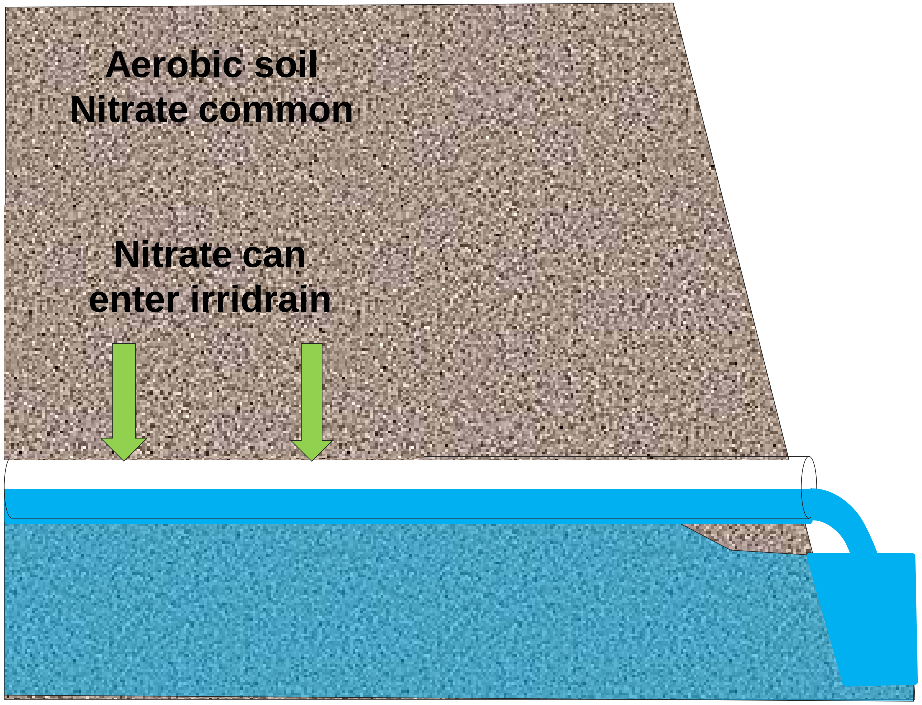
Irrigation Drainage Tile

Irrigation Drainage Tile

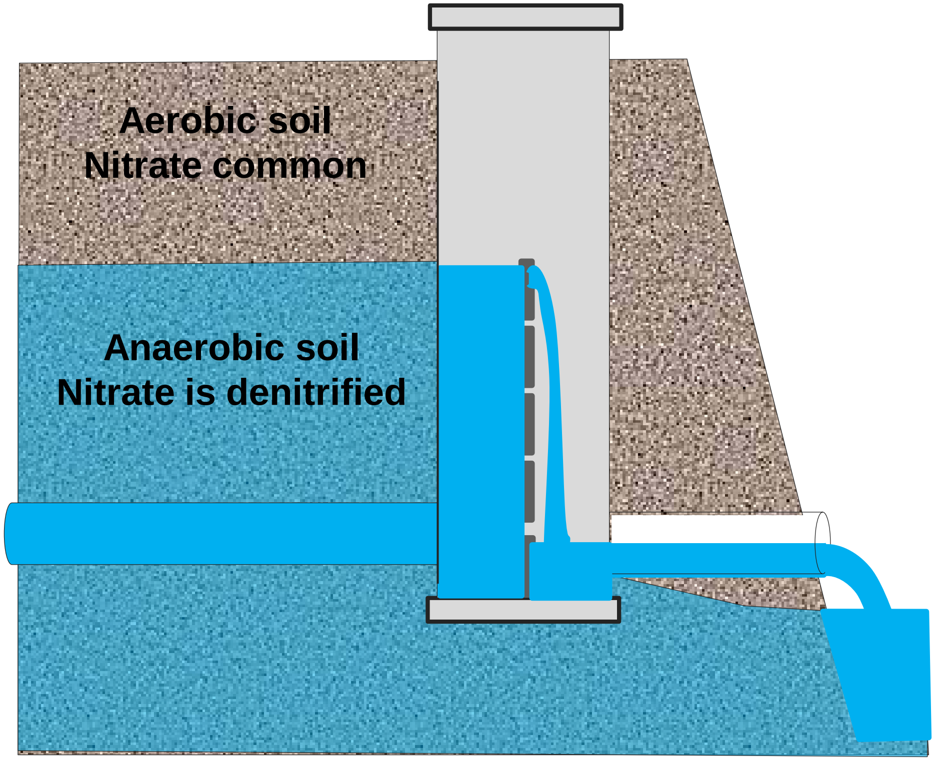


Free Drainage vs. Controlled Drainage

Free Drainage

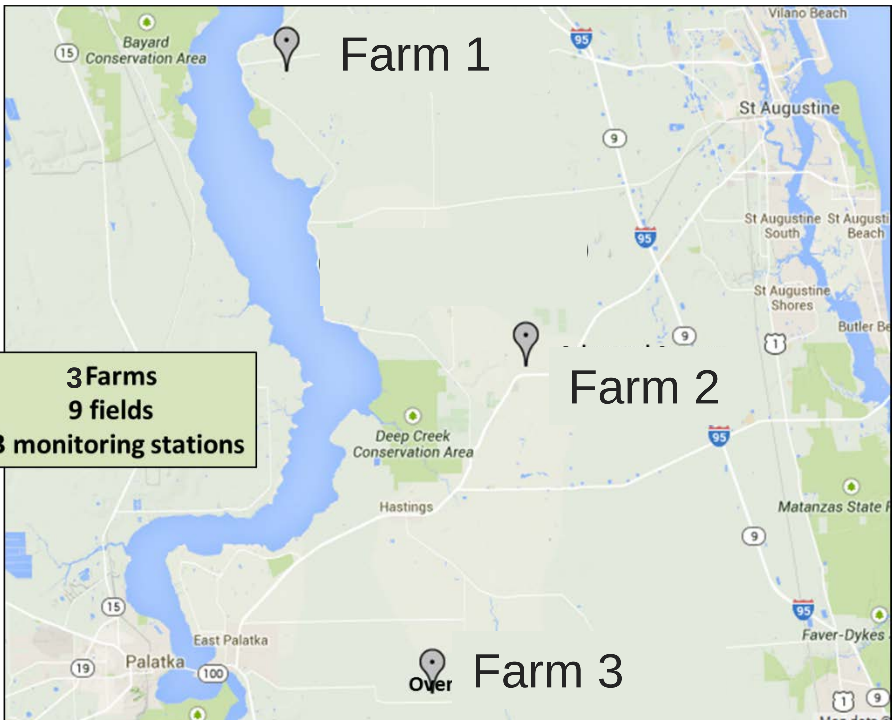


Controlled Drainage



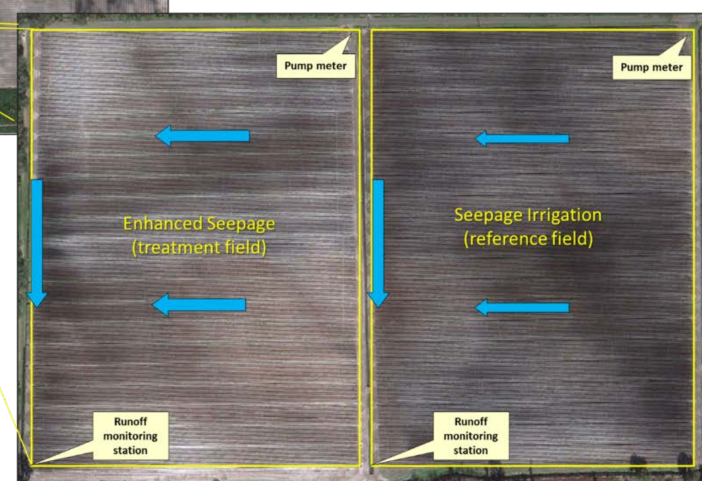
Study Sites and Monitoring Design

Cooperators in the Tri-County Agricultural Area

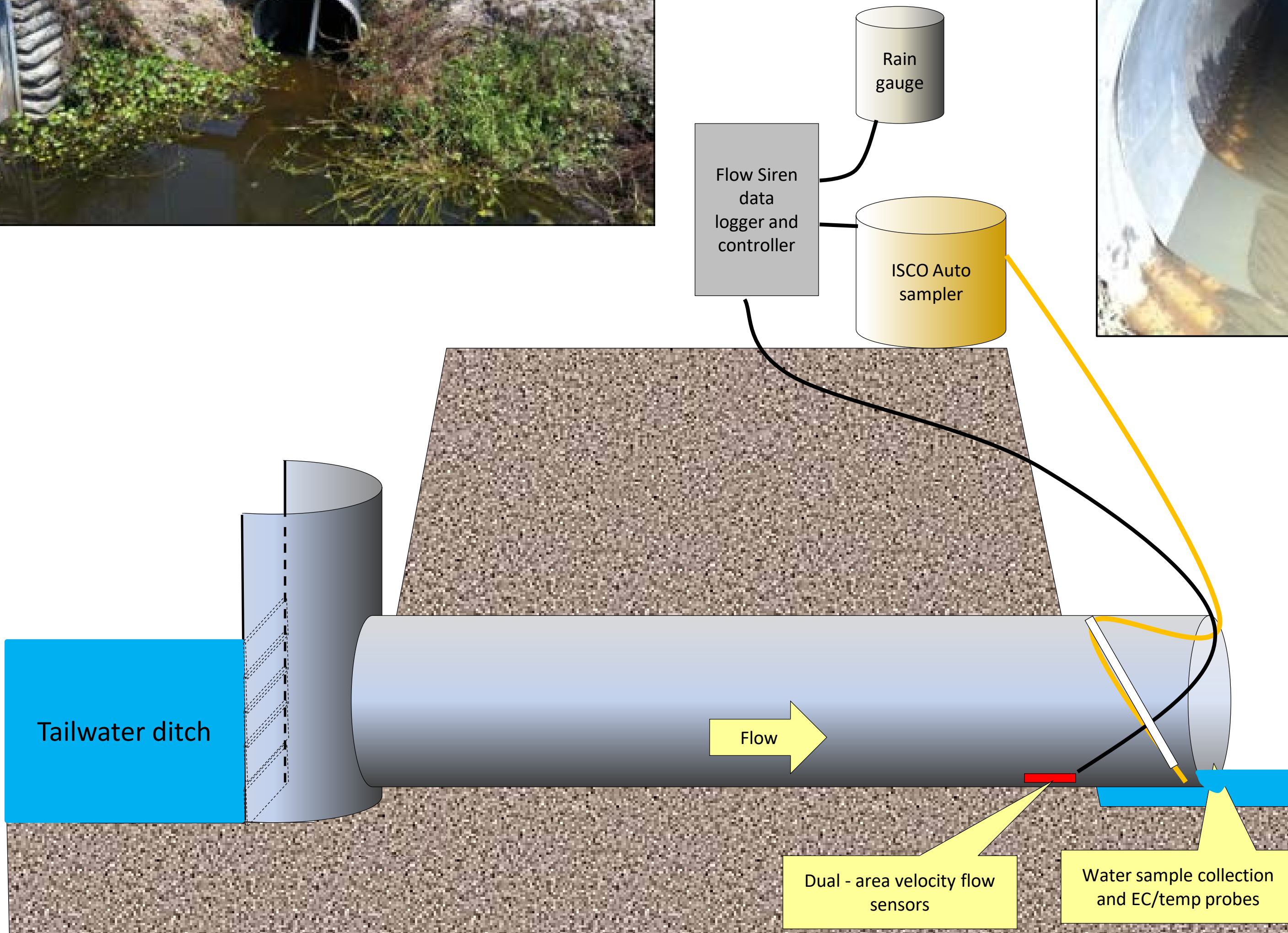


3 Farms
9 fields
13 monitoring stations

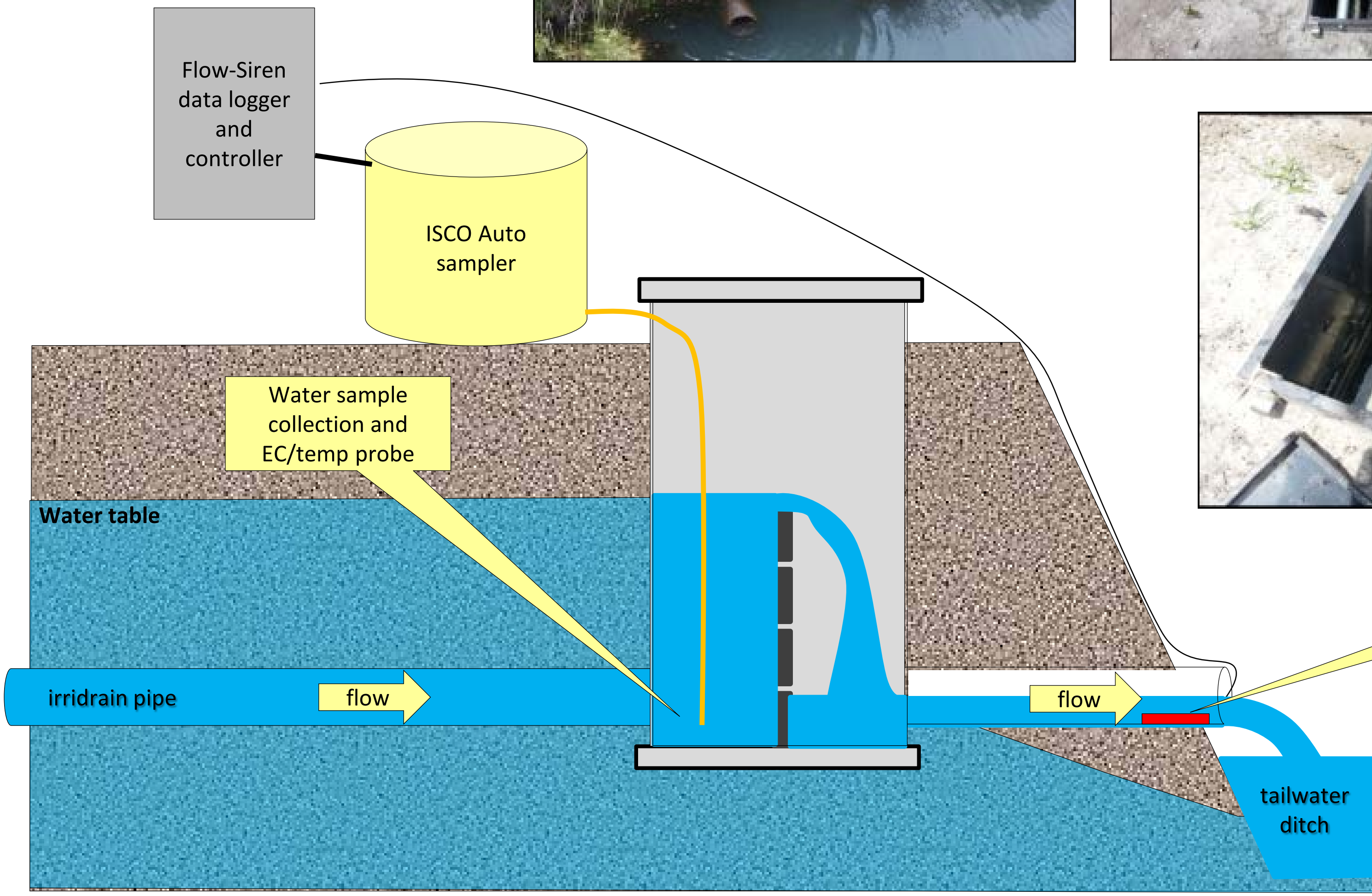
Paired Watershed Design



Surface Water Monitoring Station



IDT Monitoring Station



Monitoring

- Year 1
  - August 2014 - July 2015
- Year 2
  - June 2016 - May 2017

- Monitoring Parameters
  - Surface runoff
    - Continuous monitoring of
      - Depth (x2) and velocity(x2) = flow
      - rainfall, electrical conductivity, temperature
    - Flow weighted water quality sampling for TN and TP
    - Weekly grab samples for
      - NH_4, NO_x, TKN, Ortho-P, TP
      - DO, pH, conductivity
  - Irrigation water
    - Flow meter monitoring
    - Monthly sample for
      - NH4, NOx, TKN, Ortho-P, TP
      - Electrical conductivity

Water Use and Runoff

Year 1

Farm	Irrigation	Runoff
	% reduction relative to control field	
Picolata Farm	42%	58%
Sykes and Cooper Farm	27%	40%
Tater Farms	52%	53%
Overall change	**40.3%**	**50.3%**

Year 2

Farm	Irrigation	Runoff
	% reduction relative to control field	
Picolata Farm	31%	32%
Sykes and Cooper Farm	-4%	37%
Smith Farm	29%	23%
Tater Farms	23%	23%
Overall change	**19.8%**	**28.8%**

Irrigation Use Average *30.1% decrease*

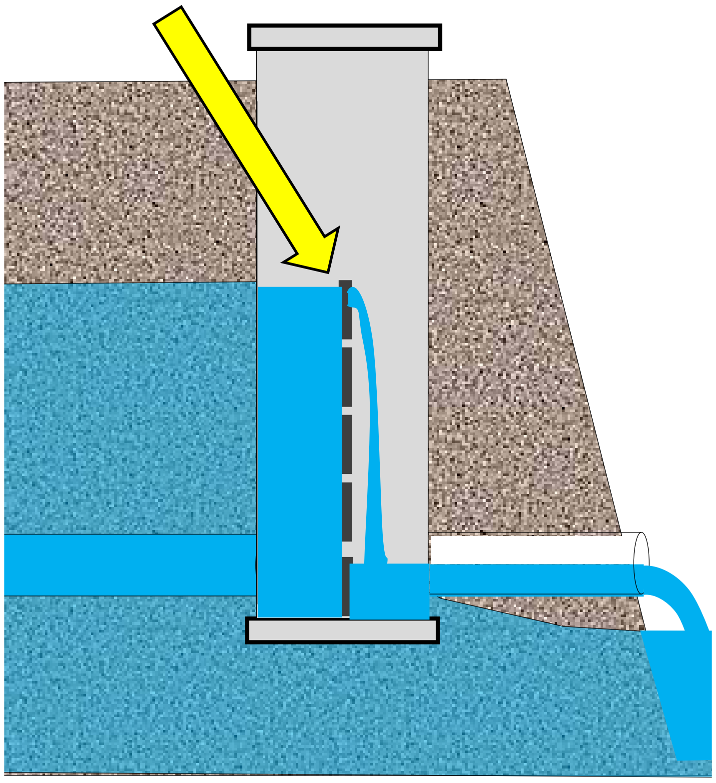
Field Runoff Average *39.6% decrease*

Factors influencing irrigation efficiency and rainfall capture

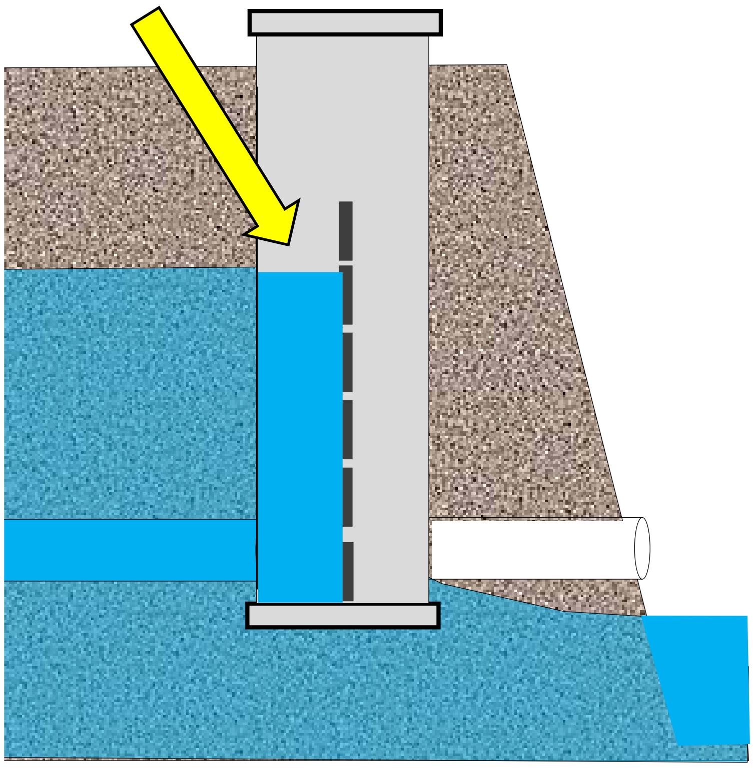
- Available soil storage.

Every 4-6" of "freeboard" provides approximately 0.25-.50" of rainfall captured (1" = 27,000 gallons of water/acre).

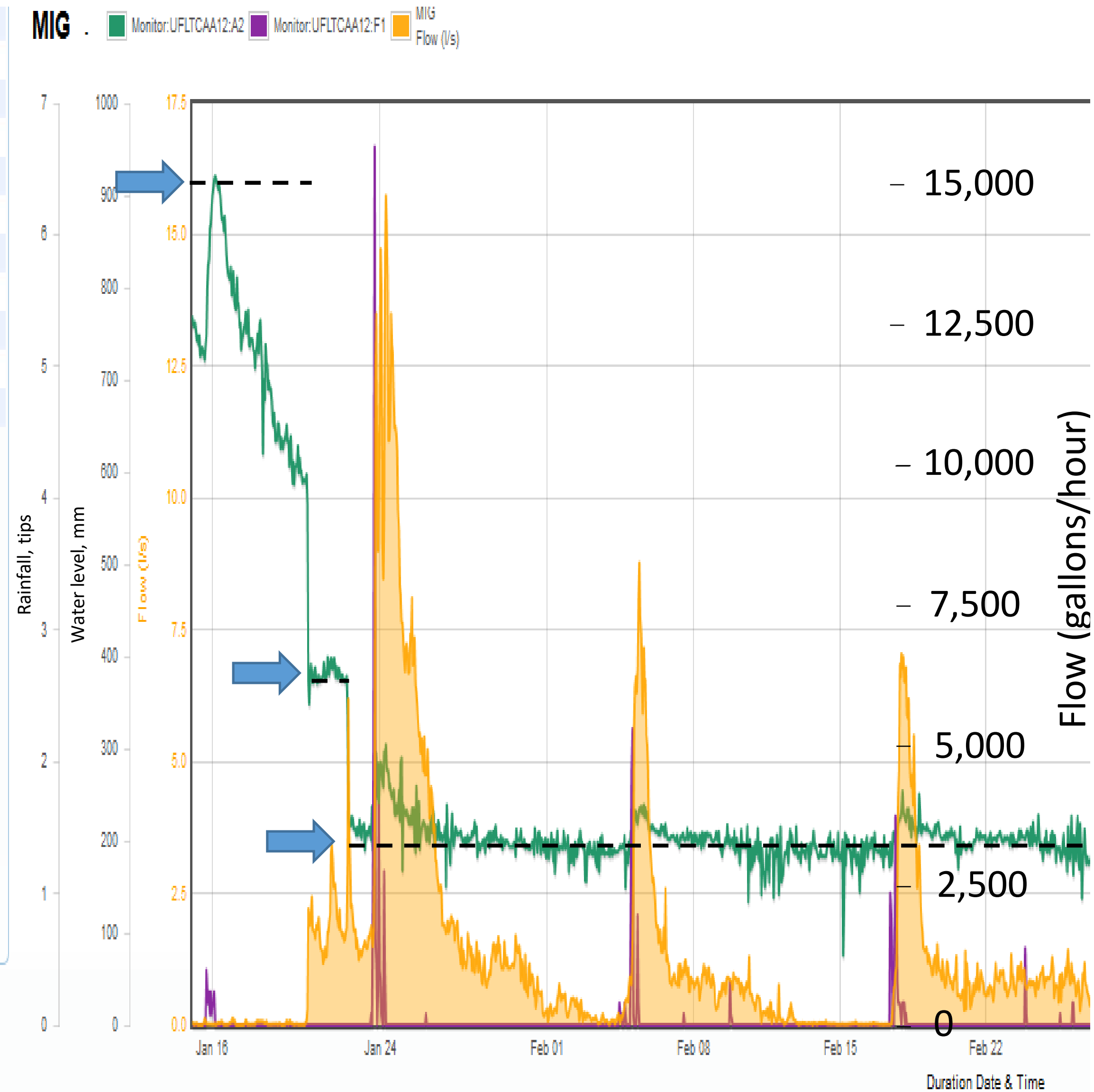
No storage



storage



Observation - Water Storage and Board Height



Water Level Management Guidance to Increase Water Storage and Conservation

- While irrigating, consider keeping boards higher than target elevation to reduce water loss.
- Check control structure for irrigation overflow between 8 and 10am and between 4 and 6pm
  - Minimum irrigation related flow should occur over board in the morning.
  - No irrigation overflow should occur in the evening.
    - Adjust inflow rate to IDT (if possible) to minimize excess discharge during these times.
    - If flow adjustment is not possible then consider cyclical irrigation.
- Anticipate rain events when possible and stop irrigation in advance to develop storage capacity.
  - Increased control/response time with IDT allows more flexibility.

- Rationale
  - Rain event storage is based on “freeboard” behind control structure.
  - Overflow during irrigation regularly apparent and reduces efficiency.

Phosphorus Load Reduction

Year 1

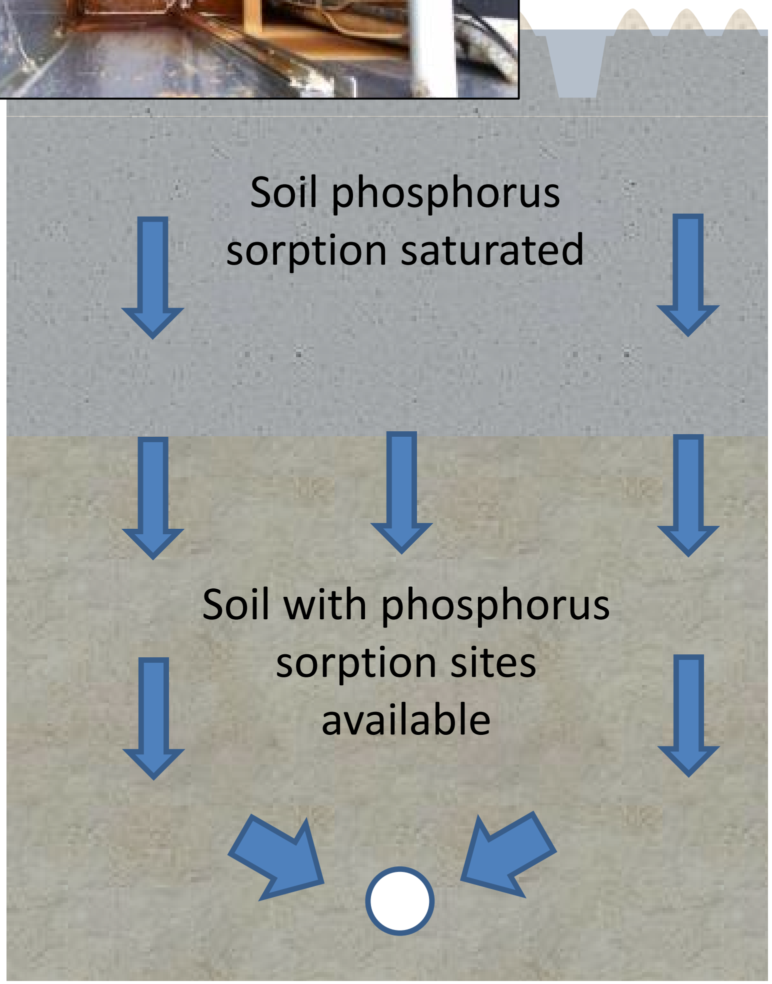
Farm	Concentration	Load
	% reduction relative to control field	
Picolata Farm	-26%	10%
Sykes and Cooper Farm	30%	41%
Tater Farms	88%	89%
Overall change	**31%**	**47%**

Year 2

Farm	Concentration	Load
	% reduction relative to control field	
Picolata Farm	26%	38%
Sykes and Cooper Farm	-17%	26%
Smith Farm	6%	25%
Tater Farms	58%	72%
Overall change	**18%**	**40%**

Farm Total Phosphorus Concentration Average 24.5% decrease
Farm Total Phosphorus Load Average 43.5% decrease

Why is Phosphorus Lower in the IDT system?



Conventional Seepage

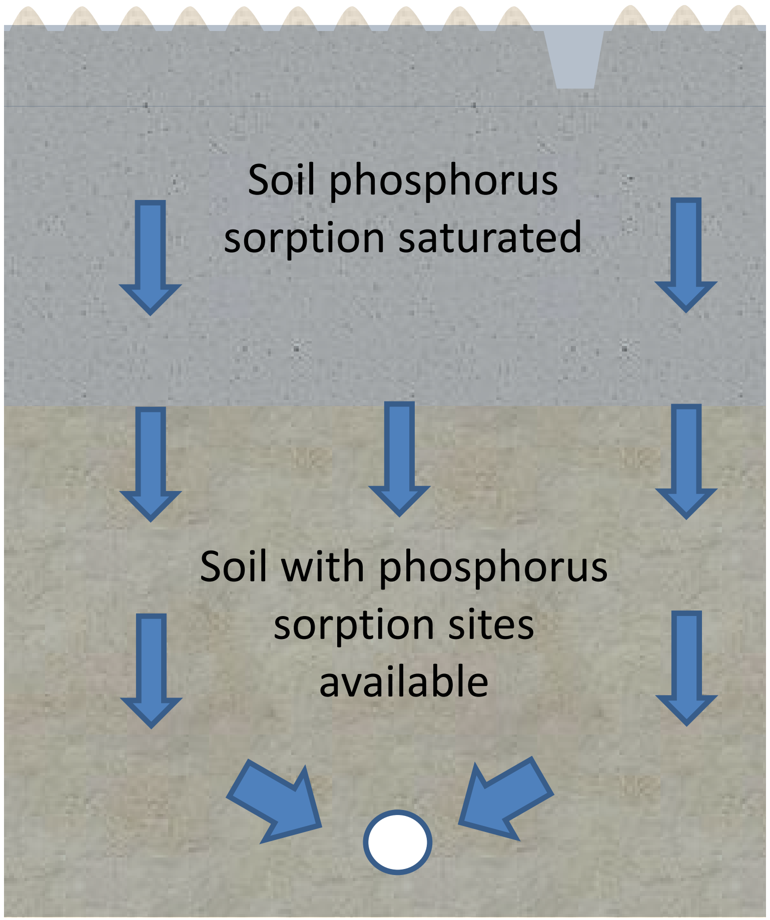
- Surface runoff leads to particulate phosphorus transport
- Limited vertical movement of phosphorus into area with sorption sites.

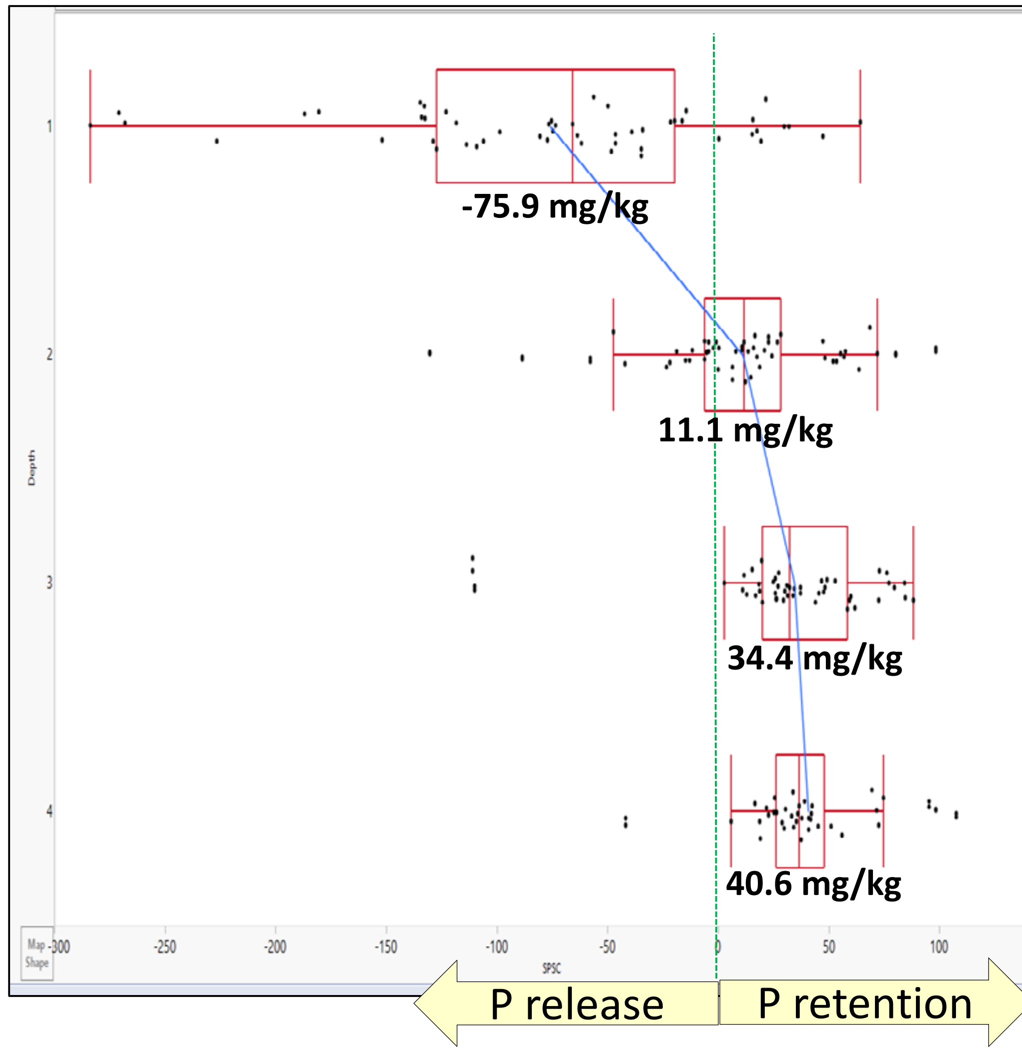
Irrigation Drainage Tile

- Less surface runoff reducing particulate transport
- Increased water movement into areas with phosphorus sorption sites

Soil Phosphorus Storage Capacity = SPSC

-Soil test indicating amount of phosphorus that will be bound or released from soil.
-Value is based on the ratio of extractable Phosphorus to Iron and Aluminum in soil.
-A negative value indicates mg/kg of P likely released from soil.
-A positive value indicates the mg/kg of P likely retained by soil.
-6 IDT fields, 180 soil samples tested.





Nitrogen Load Reduction

Year 1

Farm	Concentration	Load
	% reduction relative to control field	
Picolata Farm	11%	45%
Sykes and Cooper Farm	-18%	37%
Tater Farms	17%	20%
Overall change	**3%**	**34%**

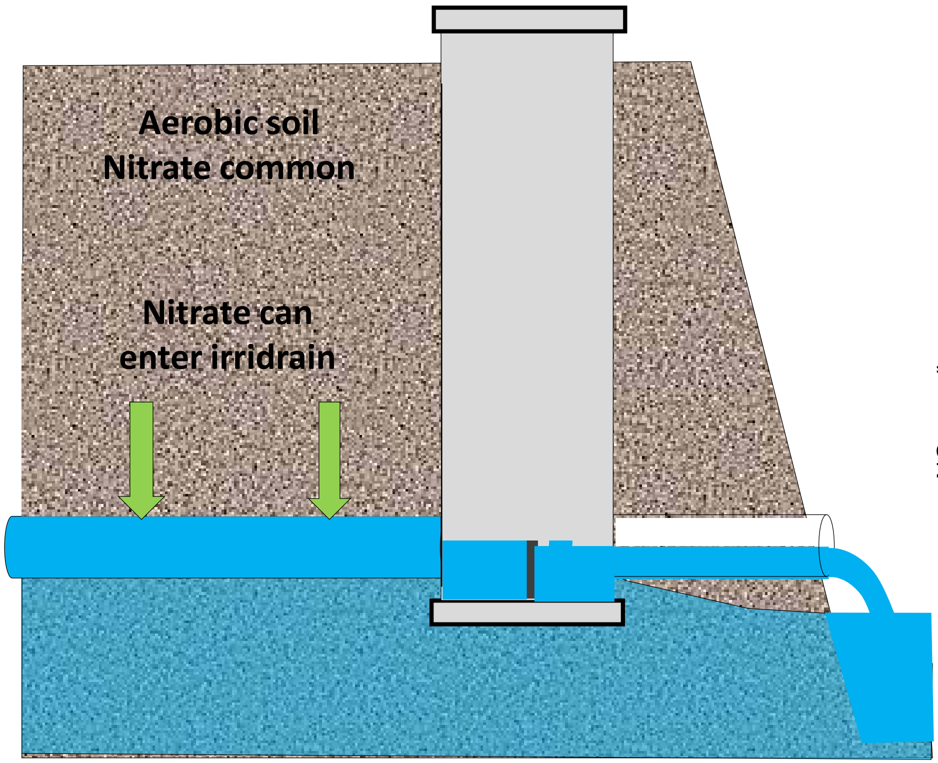
Year 2

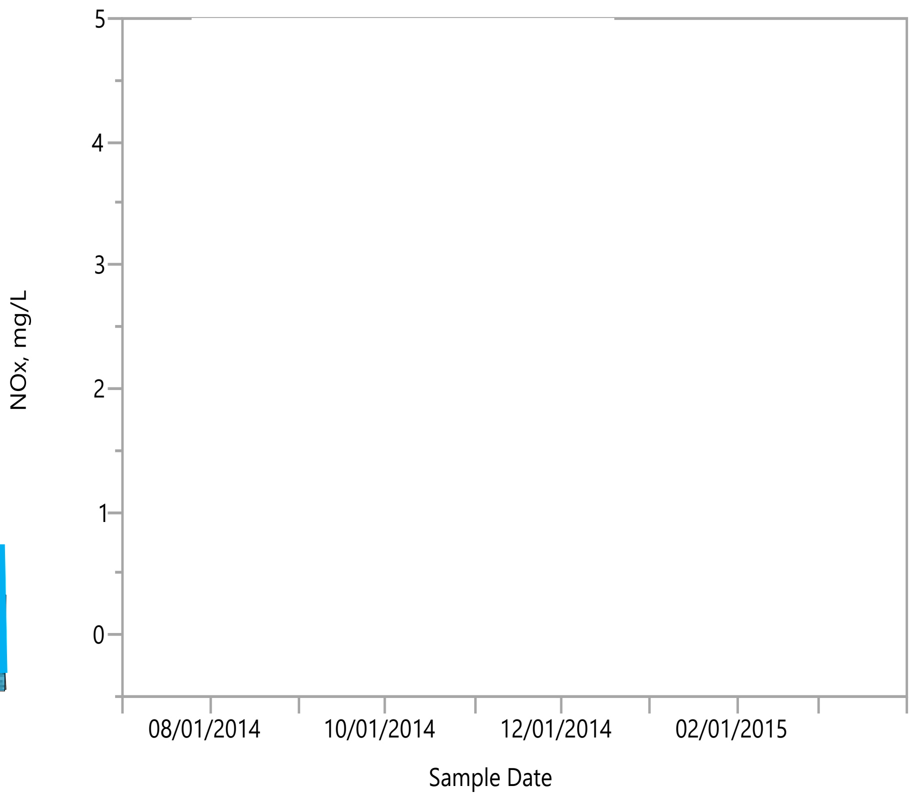
Farm	Concentration	Load
	% reduction relative to control field	
Picolata Farm	-18%	28%
Sykes and Cooper Farm	14%	36%
Smith Farm	-19%	2%
Tater Farms	30%	45%
Overall change	**2%**	**28%**

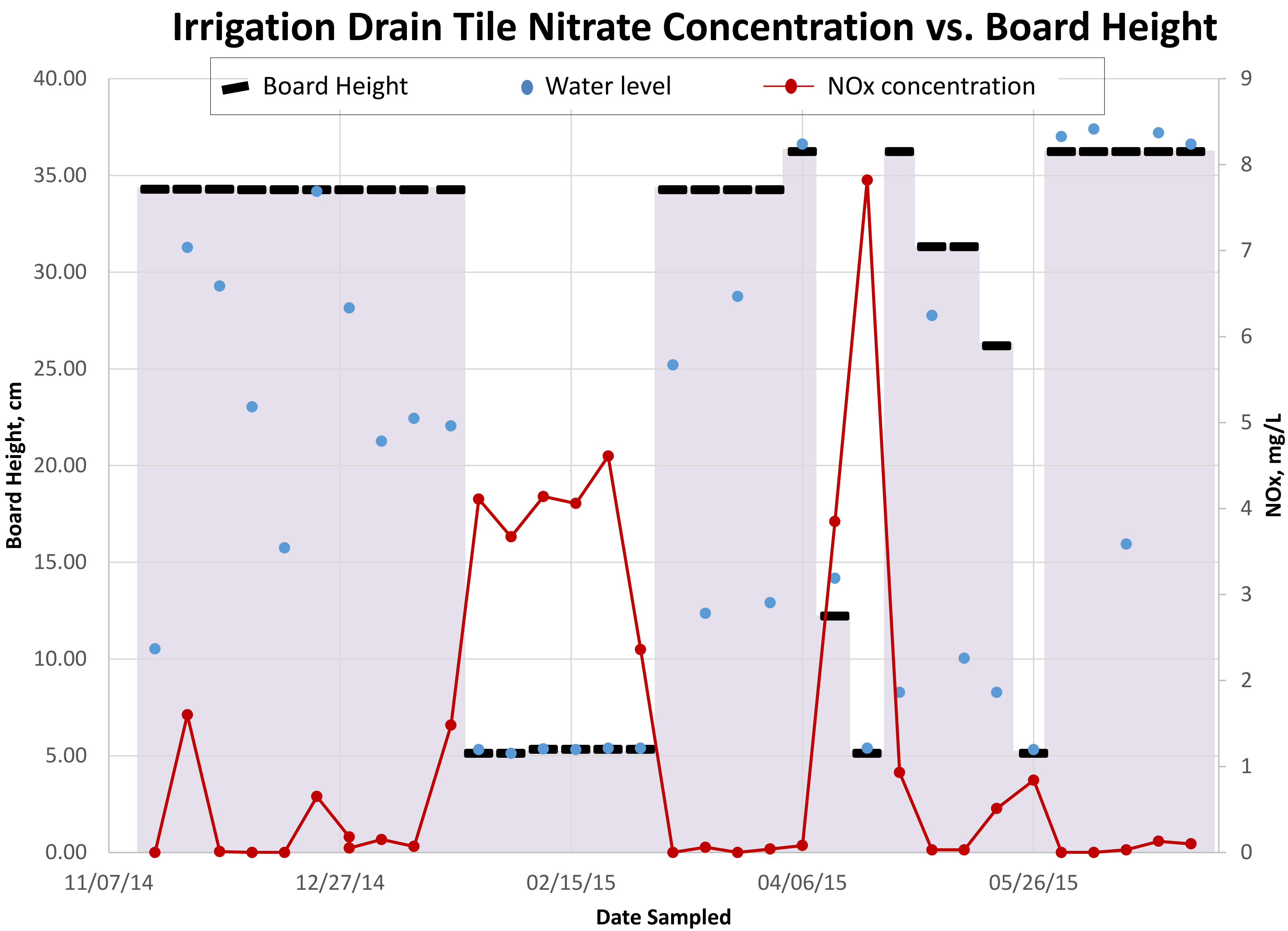
Farm Total Nitrogen Concentration Average 2.5% decrease
Farm Total Nitrogen Load Average 31% decrease

What Management Factors Influence Nitrogen Concentration?

- Management of minimum board height



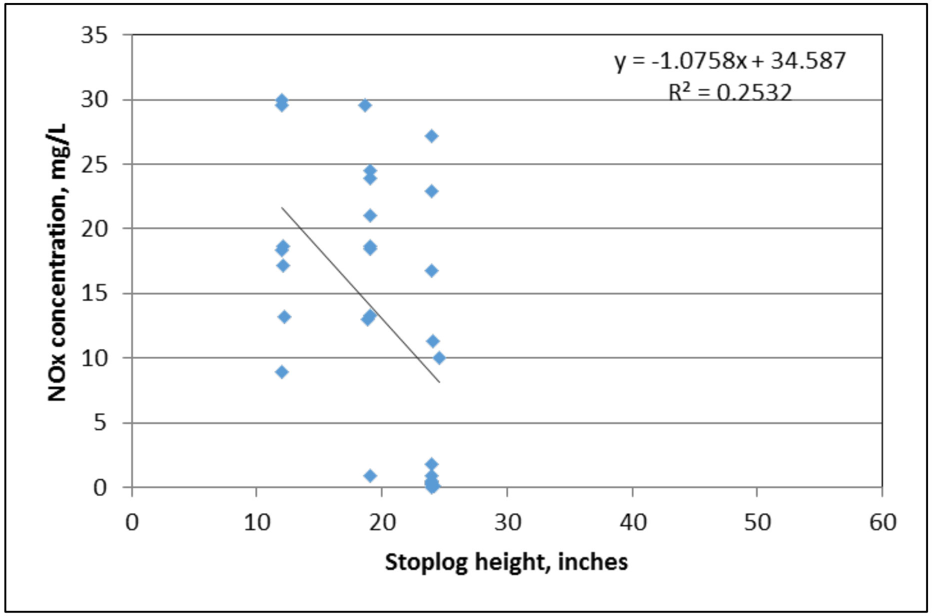


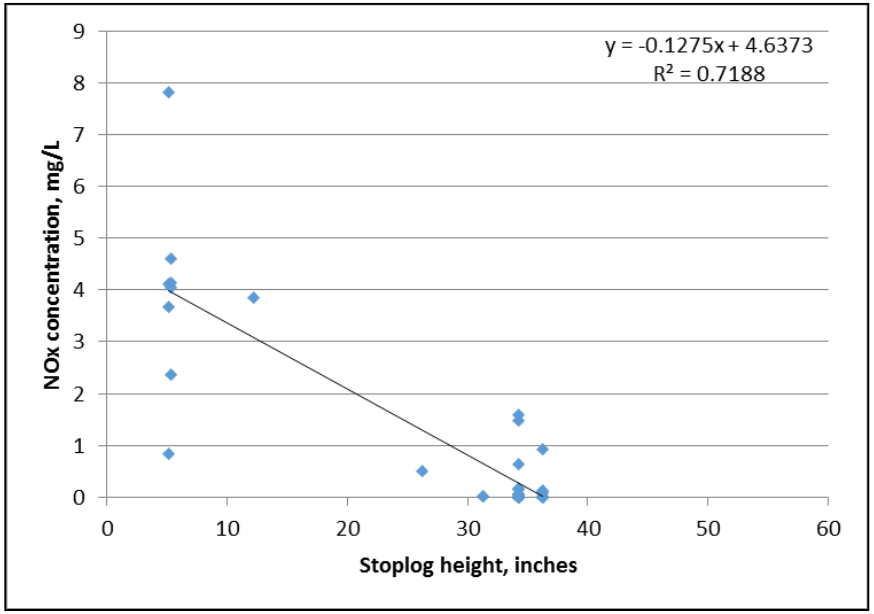

Irrigation Drain Tile Nitrate Concentration vs. Board Height
Board Height
Water level
NOx concentration
Board Height, cm
NOx, mg/L
Date Sampled
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
9
8
7
6
5
4
3
2
1
0
11/07/14
12/27/14
02/15/15
04/06/15
05/26/15

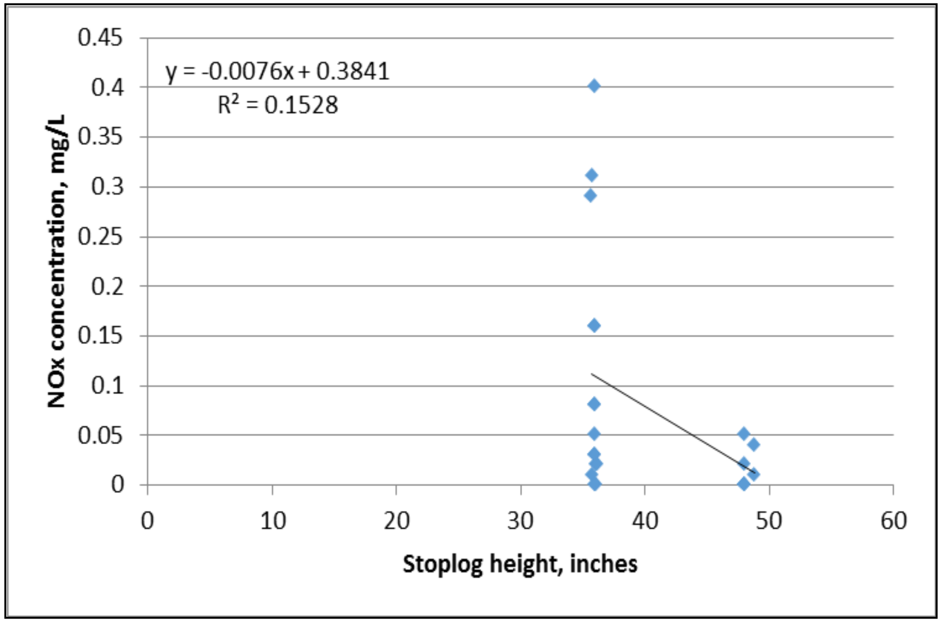
Nitrogen treatment zone

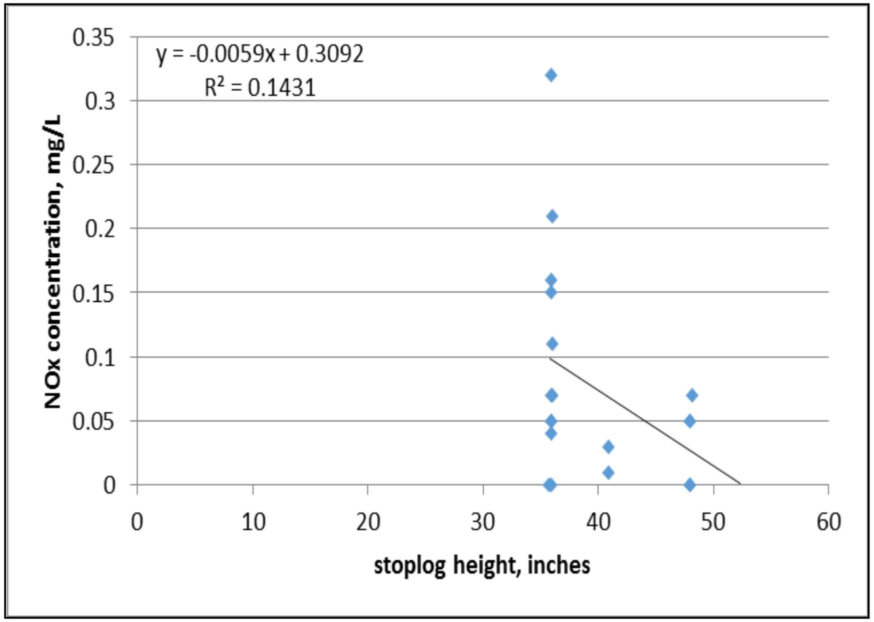
- “open”, “free drain”, “uncontrolled” tile systems in the Midwest have resulted in significant nitrogen losses and impacts to downstream systems.
- “Controlled” tile drainage can significantly reduce the movement of nitrogen by reducing water movement and creating conditions where nitrate nitrogen can be transformed to nitrogen gas (denitrified).
- Denitrification requires an absence of oxygen, a carbon source and sufficient time for microbes to break the nitrate down.
- Creating a pool of water in the soil to intercept nitrate before it gets into the IDT system provides an opportunity to remove it before the water is discharged downstream.

Board Height vs. Nitrate-Nitrogen Concentration





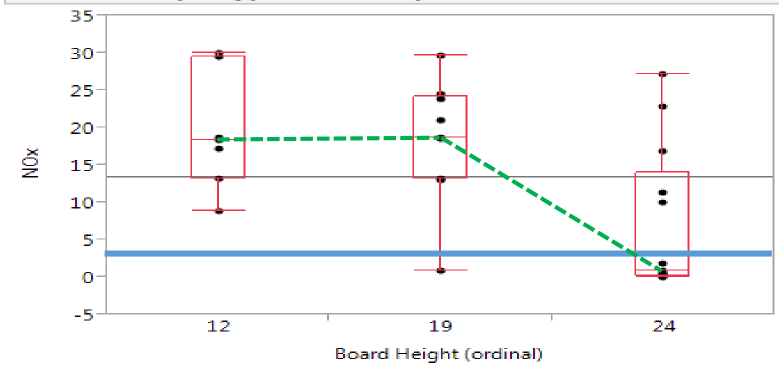




Nitrate Concentration at Different Board Heights

control 2.91 ± 4.33 mg/L

Oneway Analysis of NOx By Board Height (ordinal) Sample Type=AutoSampler, site ID=BIG



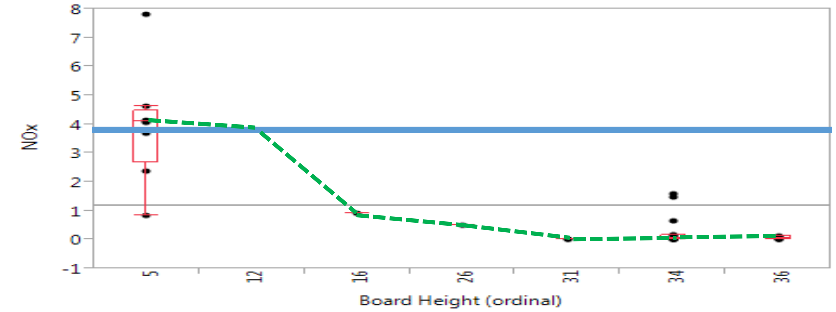
Missing Rows 10

Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
12	8.91	8.91	13.24	18.35	29.52	29.98	29.98
19	0.88	0.88	13.115	18.64	24.17	29.6	29.6
24	0	0.02	0.24	0.9	14.055	25.48	27.2

control 3.95 ± 2.97 mg/L

Oneway Analysis of NOx By Board Height (ordinal) Sample Type=AutoSampler, site ID=MIG



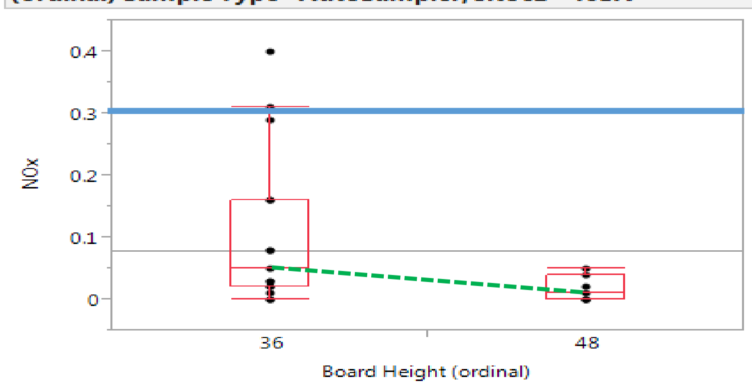
Missing Rows 18

Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
5	0.84	0.84	2.6875	4.085	4.4925	7.82	7.82
12	3.85	3.85	3.85	3.85	3.85	3.85	3.85
16	0.93	0.93	0.93	0.93	0.93	0.93	0.93
26	0.51	0.51	0.51	0.51	0.51	0.51	0.51
31	0.03	0.03	0.03	0.03	0.03	0.03	0.03
34	0	0	0	0.05	0.18	1.528	1.6
36	0	0	0	0.055	0.1075	0.13	0.13

control 0.302 ± 0.433 mg/L

Oneway Analysis of NOx By Board Height (ordinal) Sample Type=AutoSampler, site ID=TIGN

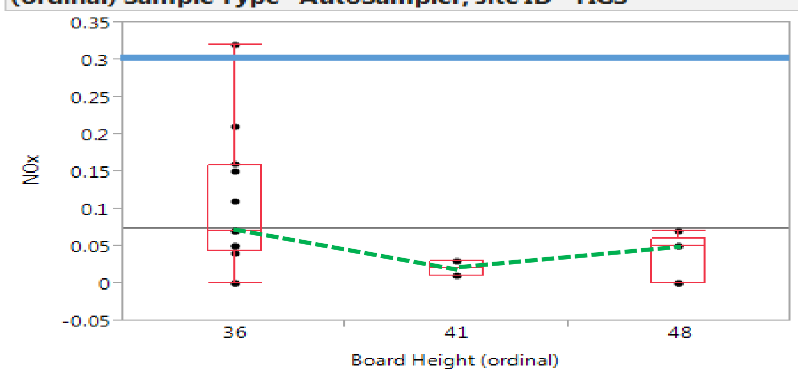


Missing Rows 17

Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
36	0	0	0.02	0.05	0.16	0.346	0.4
48	0	0	0	0.01	0.04	0.05	0.05

Oneway Analysis of NOx By Board Height (ordinal) Sample Type=AutoSampler, site ID=TIGS



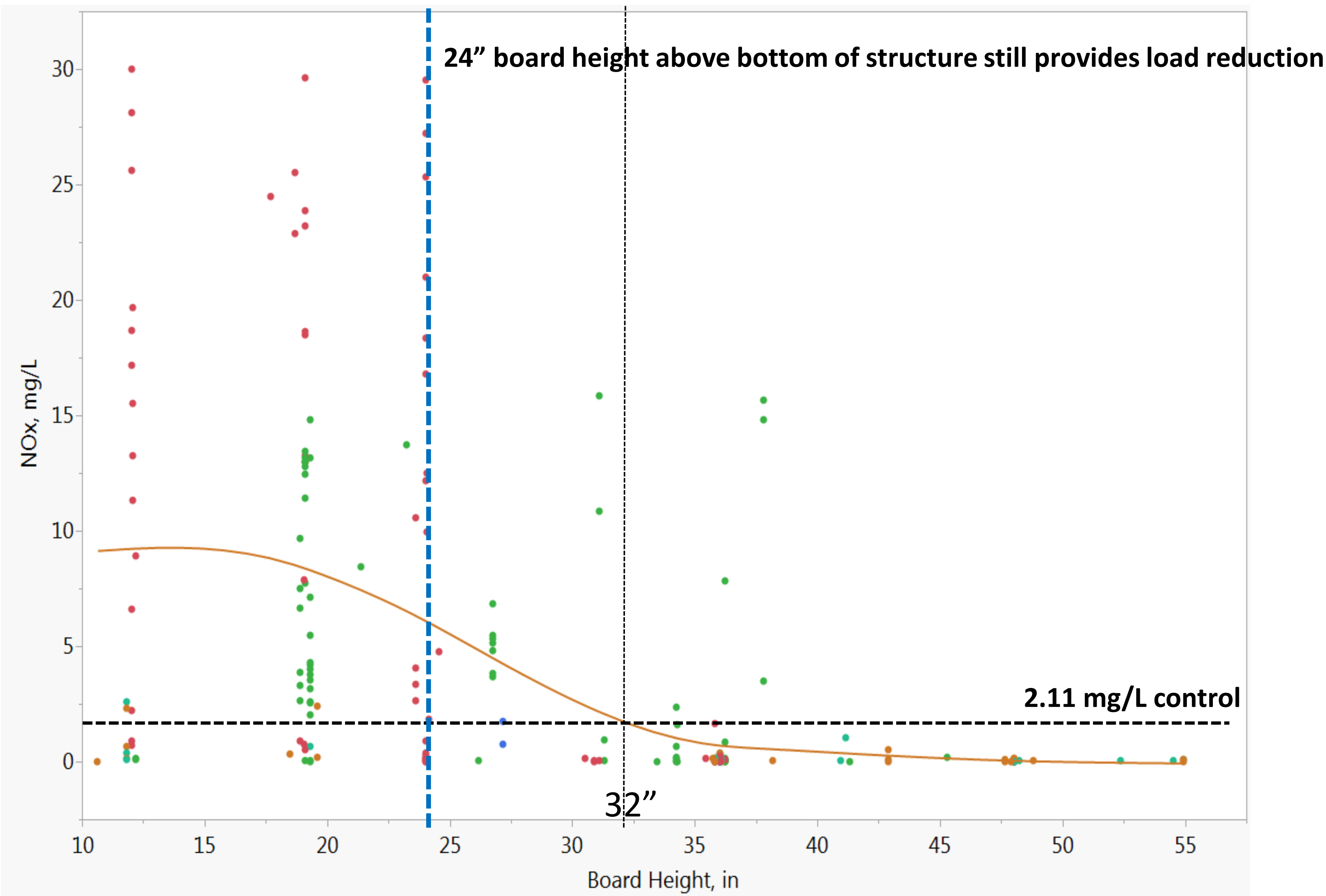
Missing Rows 13

Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
36	0	0	0.0425	0.07	0.1575	0.287	0.32
41	0.01	0.01	0.01	0.02	0.03	0.03	0.03
48	0	0	0	0.05	0.06	0.07	0.07

Nitrate Concentration vs. Board Height

All fields and 1.5 years monitoring combined



Board Height Recommendation to Reduce Nitrogen Concentration in Runoff

- Attempt to maintain a minimum board height of 24”
- If boards are pulled below 24”, minimize duration of time boards are below 24”
- Boards should only be pulled below 24” if crop is threatened.

- Rationale
  - A strong relationship exist between the height of boards and the concentration of nitrogen being discharged at the edge of the field.
  - It is believed that maintaining a minimum saturated zone before water is discharged results in anaerobic conditions and denitrification of nitrate as it flows to the tile drain.
  - A minimum board height of 24” results in nitrogen concentrations similar to, or less than, that of conventional seepage fields.

Simple IDT Management Guideline

*Maintain **high boards** and "**freeboard**" whenever possible.*

- Low boards decrease rainfall capture
- Low boards reduce stored water in field
- Available freeboard captures rainfall and reduces irrigation
- Low boards leach nutrients
- Low boards increase nutrient loads

Summary of Irrigation Drainage Tile

- Significant potential to reduce water use and runoff.
- Nitrogen reductions dependent on board height management to provide denitrification zone and reduce runoff volume.
  - Recent guidance provided to hold boards at 24”
- Phosphorus reductions are significant due to reduction in surface particulate runoff and likely sorption in deeper soil profile.
  - Soil sorption potential is finite and being investigated to determine longevity and possible amendments to enhance.

Ranking of TCAA-WMP projects

- Semi-annual call for projects
- Multiple practices for growers to choose from or propose alternative.

B.	Proposed Project/Practice (all applicants)
B-1	**Check the project(s) and/or practice(s) you are proposing.** ☐ Farm Surface Drip Irrigation ☐ Farm Subsurface Drip Irrigation ☐ Irrigation Tailwater Recovery and Reuse ☐ Stormwater Runoff Recovery and Reuse ☐ Banding equipment on ____ acres ☐ Other Project or Practice: ☐ Farm Overhead Irrigation X Subsurface Irrigation/drain tile ☐ Wet Detention ☐ Regional Water Reuse ☐ Soil moisture sensors

- After grower application submitted, technical support team visits with grower to better understand proposed project.
- Projects are then ranked.

Ranking Spreadsheet

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA
1								**Program Objectives**				**Reduction Potential**											**Cost Effectiveness points (based on TCAA-WMP cost relative to this application round only)**			**Final score and ranking**	
2							**Administrative**	Addresses Water Quality	Addresses Water Quantity	First time or years since last applicat	Novel/Innovative project	TP Reduction	TN Reduction	Water Conservation	**Distance from river or Crescent Lake**		**Estimated mass load reduction**			**Cost Effectiveness (based on TCAA-WMP cost)**			$/lb TP removed	$/lb TN removed	$ gal water saved		
3	Applicant	Practice	Acreage	Total Project Cost	Amount Requested	Ratio requested/total	possible points 0 or 5	possible points 0 or 5	possible points 0 or 5	possible points 0 or 5	possible points 0 or 5	possible points 0-20	possible points 0-20	possible points 0-20	miles	Possible Points 0-5	**lb TP / acre removed**	**lb TN / acre removed**	**1000gal/ acre water saved**	$/lb TP removed	$/lb TN removed	$ 1000gal water saved	possible points 0-10	possible points 0-10	possible points 0-10	Overall score (0-120)	Ranking
4	Marineland Aquaponics[6]	System	5	$ 500,000.00	#########	$ 0.50	5	5	5	5	5	20	20	20	0.1 SJR	5	910	6491	101785	$ 1.8	$ 0.3	$ 0.02	10	10	10	120	**1**
5	Greene's Farm[3]	Wet detentionpon-filtered	99	$ 357,000.00	#########	$ 0.70	5	5	5	0	5	20	20	20	4.2 to Crescent Lake	1	2.55	7.68	192	$ 16.5	$ 5.5	$ 0.2	6	8	8	103	**2**
6	Tree Town USA[1]	Retrofit Irrigation	50	$ 110,086.00	$ 82,564.50	$ 0.75	5	0	5	5	0	20	20	10	9 to Crescent Lake	0	2.5	8.5	151	$ 22.0	$ 6.5	$ 0.4	4	8	6	83	**3**
7	Lawrence Downes[5]	Fencing/well retrofit	200	$ 123,371.01	$ 95,528.25	$ 0.77	5	5	5	5	0	14	14	0	<1 mile to Crescent Lake	5	1.05	3.15	0	$ 15.2	$ 5.1	N/A	6	8	0	67	**4**
8	Boardwalk Farms	IDT	70	$ 245,000.00	#########	$ 0.75	5	5	5	5	0	14	6	8	2.4 SJR	3	1.6	2.46	68.4	$ 27.3	$ 17.8	$ 0.64	3	3	3	60	**5**
9	John Seay Farm[2]	GPS for Land Leveling	377	$ 34,097.73	$ 25,573.30	$ 0.75	5	5	5	5	0	2	2	2	6.5 to Crescent Lake	0	0.28	0.72	21.4	$ 4.0	$ 1.6	$ 0.1	9	10	10	55	**6**
10	Riverdale Potato Farms	IDT	58	$ 254,242.45	#########	$ 0.75	5	5	5	0	0	14	6	8	~1 SJR	4	1.6	2.46	68.4	$ 34.2	$ 22.3	$ 0.80	1	1	1	50	**7**
11	C.P. Wesley Smith Inc.	IDT	74	$ 334,236.78	#########	$ 0.75	5	5	5	0	0	14	6	8	7.9 SJR	0	1.6	2.46	68.4	$ 35.2	$ 22.9	$ 0.82	1	1	1	46	**8**
12	Crescent Lake fernery[4]	Irrigation Retrofit	10	$ 32,412.86	$ 24,309.65	$ 0.75	5	5	5	5	0	0	0	4	3.7 miles to Crescent Lake	2	0.00	0.00	1.2	N/A	N/A	$ 207.8	0	0	1	27	**9**
13																											
14																											
15																											

16 [1] Used same data as previous application except for updated costs

17 [2] Applied a 10% improvement in TN, TP and water conservation. I could not locate any specific nutrient load or water savings values for land leveling practices. Therefore, 10% of conventional seepage TN and TP values used were 2.8 lbs/acre/yr and 7.17 lbs/acre/yr, and 215,000 gal/acre/yr, respectively.

18 [3] Assumed 90% reduction in TN, TP and Water consumption based on tailwater pond and reuse. Conventional seepage TN and TP values used were 2.8 lbs/acre/yr and 7.17 lbs/acre/yr, respectively.

19 [4] Mr. Revels indicated a 20% improvement in water consumption, CUP total from two wellsreported in application = 58328 gpd, or 11663 savings/day, 1166g/acre/day. He also indicated there was no surface runoff from site so no credit was given for WQ improvement and full project cost applied to water cons

20 [5] Well repair will increase overall groundwater consumption from present condition so no credit for water conservation. Fencing, if allowing at least 10 meter vegetated buffer from top of bank should provide 70-72% reduction in TN and TP load or 1.05 lb TP/acre and 3.15 lb TN/acre. Cost amortized for TN and

21 [6] Longevity of filtration system assumed to be 10 years

Inputs to Ranking Criteria

General information (used in determining some of the point values in the ranking process)

- Applicant name
- Proposed Enhanced BMP Practice
- Acreage of proposed Enhanced BMP practice
- Total Project Cost
- Total Amount requested from partnership

Administrative (0-5 points)

- Completed application/detailed cost-estimated submitted by deadline (0 or 5 points)

TCAA-WMP Objectives (0-20 points)

- Addresses water quality (0 or 5 points)
- Addresses Water Quantity (0 or 5 points)
- First-time applicant (0 or5 points)
- Novel/innovative project (0 or 5 points)

Reduction potential (0-65 points)

- TP reduction (0-20 possible points)
- TN reduction (0-20 possible points)
- Water conservation (0-20 possible points)
- Distance from river or Crescent Lake (0-5 points)

Cost Effectiveness (0-30 points)

- Dollars per pound of total phosphorus removed. (0-10 possible points)
- Dollars per pound of total nitrogen removed. (0-10 possible points)
- Dollars per thousand gallons of water saved. (0-10 possible points)

Reduction Potential

- Points awarded based on relative nutrient reduction efficiency or water savings compared to conventional seepage irrigated field.
- Some reduction efficiencies come from previous study, some provided by SRWMD.

Measured P reduction potential

	Total Phosphours lbs/acre/yr		
	Conventional	IDT Field	Difference
Picolata	1.20	1.07	0.12
Sykes and Cooper	3.85	2.27	1.59
Tater Farms	3.46	0.37	3.09
average	2.84	1.24	1.60

Points allocated for P reduction potential of practice

Practice	**TP lbs/acre/yr**	**% of max reduction potential**	**Points awarded out of 20 possible**
Fertilizer banding	0.91	36%	7
Overhead linear	1.27	50%	10
Center Pivot	1.28	50%	10
Irrigation Drain Tile	1.60	63%	13
Enhanced Seepage	1.93	76%	15
Surface Drip	2.31	90%	18
Tailwater w/ reuse	2.55	100%	20

Points allocated for P, N and water reduction potential by practice

Practice	Phosphorus Reduction	Nitrogen Reduction	Water Conservation
Fertilizer banding	7	5	0
Overhead Irrigation	10	11	11
Center Pivot	10	11	11
Irrigation Drain Tile	13	6	8
Enhanced Seepage	15	17	16
Surface Drip	18	20	18
Tailwater w/ reuse	20	18	20

Points allocated for distance from river / C. Lake

- 0-1 mile from impaired water body = 5 points
- 1-2 miles from impaired water body = 4 points
- 2-3 miles from impaired water body = 3 points
- 3-4 miles from impaired water body = 2 points
- 4-5 miles from impaired water body = 1 point
- >5 miles from impaired water body = 0 points

Cost Effectiveness

- Cost-share ask $ / # of objectives met / project acreage / load reduction potential (lbs per acre)
- Range in cost effectiveness for that round is distributed across 10 categories to allocate points

Phosphorus Reduction Cost $/lb TP/acre/yr	Points	Nitrogen Reduction Cost $/lb TN/acre/yr	points	Water Conservation Cost $/1000gal/acre/yr	points
$0-$50	10	$0-$30	10	$0.0-$1.0	10
$51-$100	9	$31-$60	9	$1.1-$2.0	9
$101-$150	8	$61-$90	8	$2.1-$3.0	8
$151-$200	7	$91-$120	7	$3.1-$4.0	7
$201-$250	6	$121-$150	6	$4.1-$5.0	6
$251-$300	5	$151-$180	5	$5.1-$6.0	5
$301-$350	4	$181-$210	4	$6.1-$7.0	4
$401-$450	3	$211-$240	3	$7.1-$8.0	3
$451-$500	2	$241-$270	2	$8.1-$9.0	2
$501-$550	1	$271-$300	1	$9.1-$10.0	1

TCAA-WMP Program

- **Program has been very successful in increasing implementation of enhanced BMP's within TCAA**
- **Program has also helped in collaboration among growers and agencies.**
- **Irrigation Drainage Tile has been beneficial for both growers' management and nutrient load reductions**
- **Need to develop follow up programs for management and identify limits to IDT.**
- **Need to promote tailwater recovery and reuse, food safety is perceived barrier.**

Water Quality Monitoring of Fertilization Best Management Practices for Commercial Potato Production in Northeast Florida
(preliminary 2019 water quality results)

Mark Clark[1],
Guodong Liu[2]
and Kelly Morgan[3]
[1] Soil and Water sciences Department, UF Gainesville
[2] Department of Horticultural Sciences, UF/IFAS Gainesville
[3] Soil and Water Sciences Department, UF/IFAS SWFREC

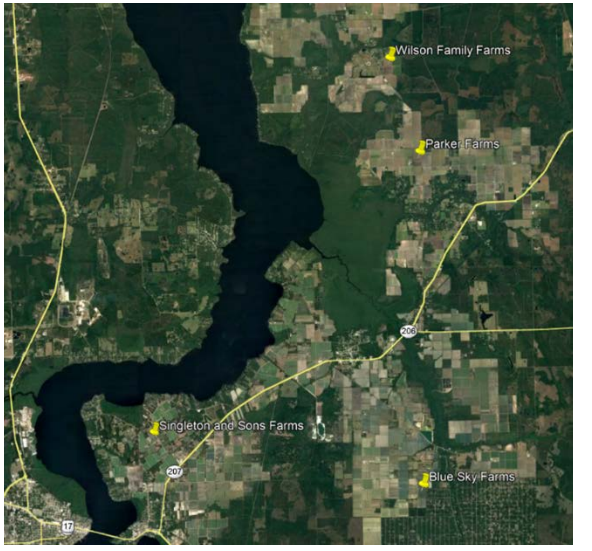
The real work done by > **Lindsey Kelly**, **Haley Cox**, Niamh Hays and Mary Szoka,

Study Objective

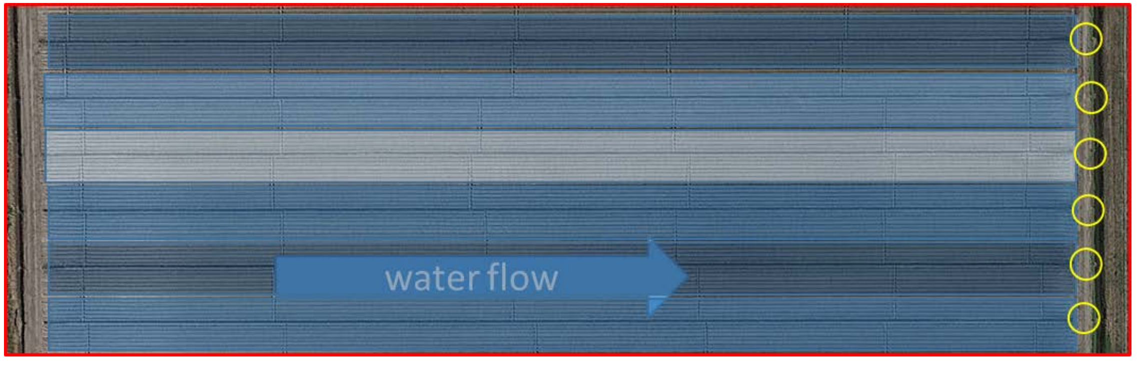
- Issue
  - BMPs require soil testing and following IFAS recommended P fertilizer application for presumption of compliance.
  - Uncertainty regarding accuracy of soil test to predict available P especially under cool season growing conditions.
  - Large scale disregard of UF/IFAS P fertilizer recommendations.

- Resolution
  - Conduct P fertilizer trial at farm scale evaluating soil test prediction along with UF/IFAS P fertilizer recommendation.
  - Evaluate crop yield response to various P treatments and assess runoff water quality.

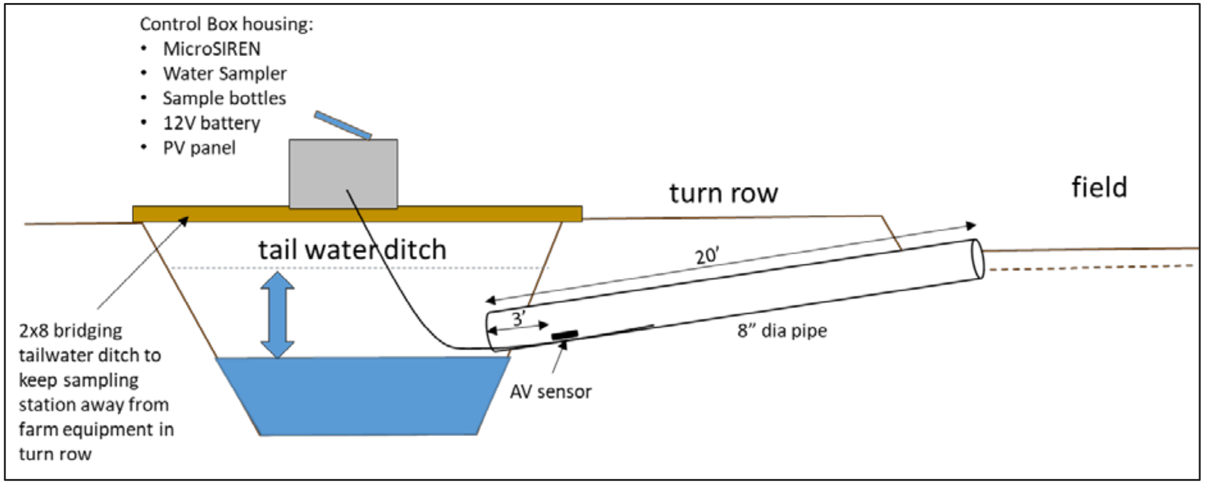
Design of Water Quality Monitoring Component



- Four farms
  - Blue Sky, Parker, Singleton and Wilson
- P treatments
  - 25 lb banded at seed plant or emergence($\underline{+}$)
    - + 0 lbs P/acre (0 P treatment)
    - + 25 lbs P/acre (50 P Treatment)
    - + 75 lb P/acre (100 P Treatment)
- Treatment applied on 8 rows (half bed) either side of water furrow.



Monitoring Station Set Up



Two Sampling Types

Automated -flow weighted composite sample

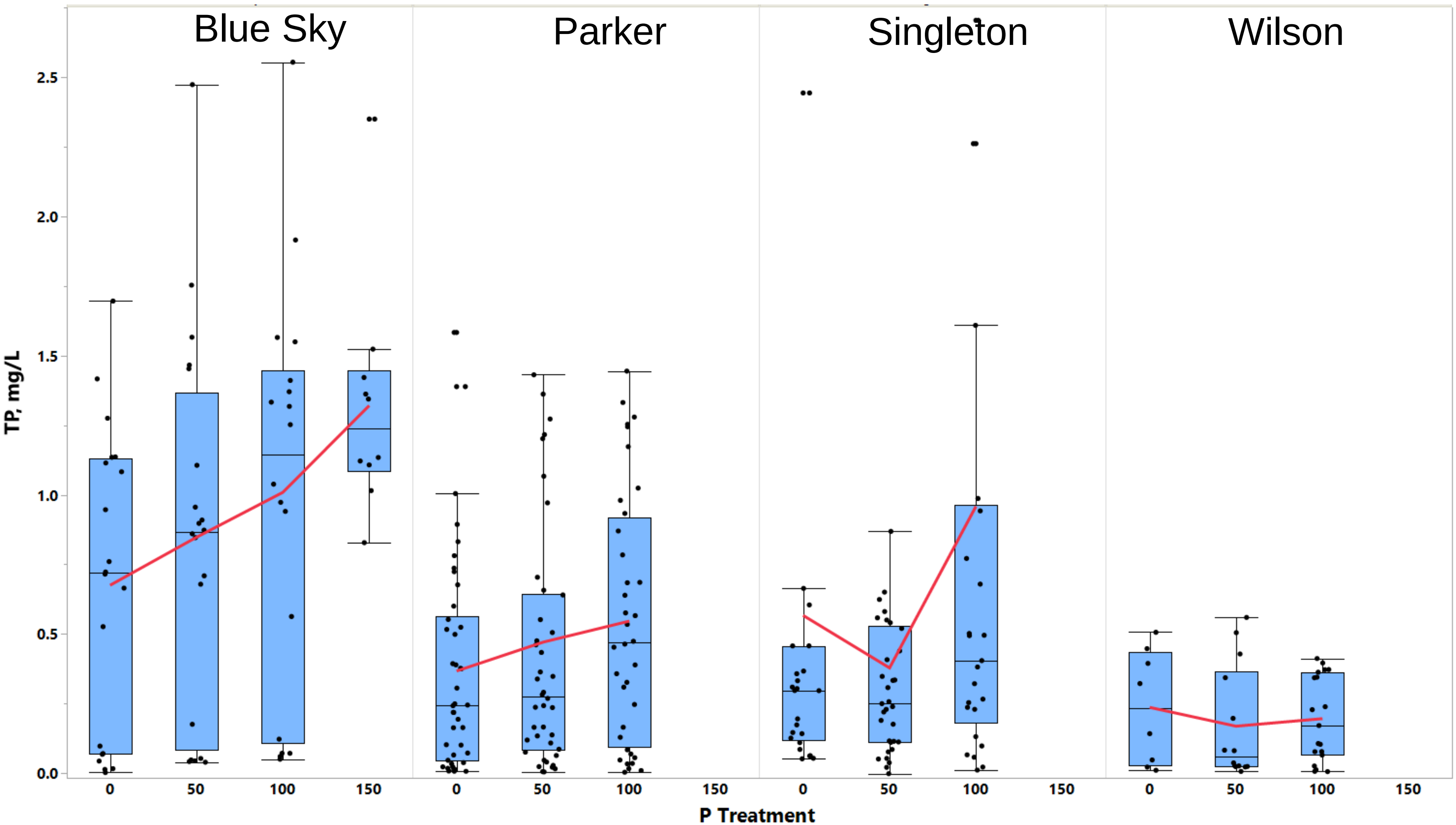
Grab sample

- *Grab samples often associated with runoff from irrigation and post storm event.*
- *When available grab samples were also collected at Blue Sky 150 lb/acre treatment.*

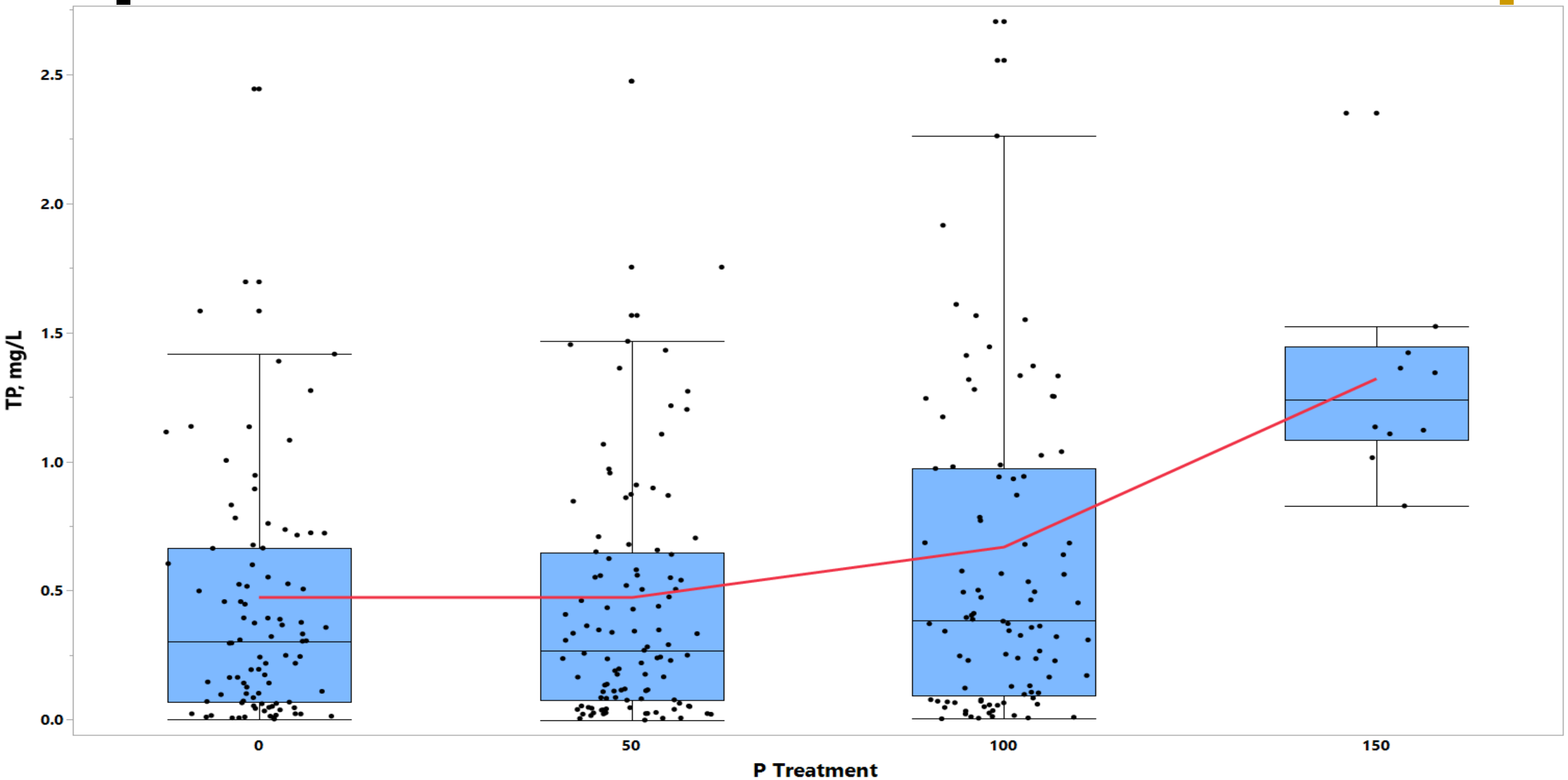
Conditional Results

- Concentration data only, does not include later part of June sampling.
- No load data yet, although flow weighted samples essentially proportion concentration within composite sample.
- No relationships between soil test P or yield have been developed yet.
- No nitrogen data being presented.
- Statistical comparisons are based on $\alpha = 0.10$ (i.e. 90% confident that there is a differences between mean values, only 10% chance of Type I error (really not different)). However, "power analysis" of statistical comparisons often indicate values <0.6 (i.e less than 60% certain there is not a Type II error. A Type II error occurs when you say results are not different, but they really are).

Total Phosphorus Concentration by Treatment and by Farm (Sample Type Combined)



Total Phosphorus Concentration by Treatment (All Farms and Sample Type Combined)



Treatment	aveage TP, mg/L	% greater than zero treatment	stat. sig. (α = 0.1)	stat. sig. (α = 0.2)
0	0.474 ± 0.587	0.0%	b	c
50	0.473 ± 0.577	-0.1%	b	c
100	0.669 ± 0.863	41.1%	b	b
150	1.321 ± 0.417	178.7%	a	a

Preliminary Summary

- Phosphorus fertilizer treatment level effect on Total Phosphorus runoff concentration was rarely statistically significant even at $\alpha = 0.10$. This is likely due to high variability in TP concentration and or low treatment replication.
- Average TP runoff concentrations generally increased with higher P fertilizer treatment (Blue Sky, Parker, Singleton); however, this trend did not occur at all farms (Wilson).
- Increased P application often resulted in increased potato yield, even with soil test P concentrations above UF/IFAS recommended rates.

- Addition monitoring during growing 2020 growing season