



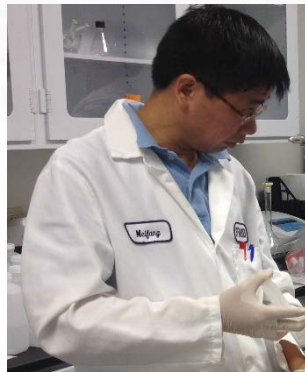
Infield Total Phosphorus Analyzer

Richard Walker, Laboratory Manager



Acknowledgments

- Dave Struve (Section Administrator)
- Meifang Zhou (Senior Chemist)
- Joel Nichols (Scientist 4)
- Manohardeep Josan (Scientist 4)



BACKGROUND

- Evaluation and monitoring of phosphorus concentrations throughout the environmentally sensitive areas of South Florida is a key concern of the District Deployments
- On average, Annually District's lab analyze phosphorus:
 - 40,000 Total Phosphorus Results
 - 11,000 Dissolved Total Phosphorus Results
 - 23,000 Ortho-Phosphate Results
- Deployed since 2007, the RPA instruments have generated more than 103,000 results for TP and TRP

Key Considerations for In Field (Remote) Analysis

- Reliability
- Accuracy and Precision
- Communication and Control
- Flexibility and Speed
- Maintenance
- Waste and the Environment

Benefits of Infield (Remote) Analysis

- Data generated 24/7, rain or shine
- Ability to observe short term trends
- No travel time (daily)
- No sample handling (preservation etc.)
- Minimal lab costs
- Higher Frequency of Analysis
- Event Driven

Design Parameters for Phosphorous Determinations

- Use a standard chemistry
- Results comparable to lab analyses
- Control analyzer temperature
- Determine:
 - Total Phosphorus (TP)
 - Total Reactive Phosphorus (TRP)
- Easy access to all data
- Fault detection
- Low maintenance
- Calibration standards “on board”

RPA Project Overview

- System developed by Greenspan Technology, Australia
- System uses standard Molybdate chemistry (SM4500PF)
- 3 month maintenance cycle
- Cell Phone Modem Technology

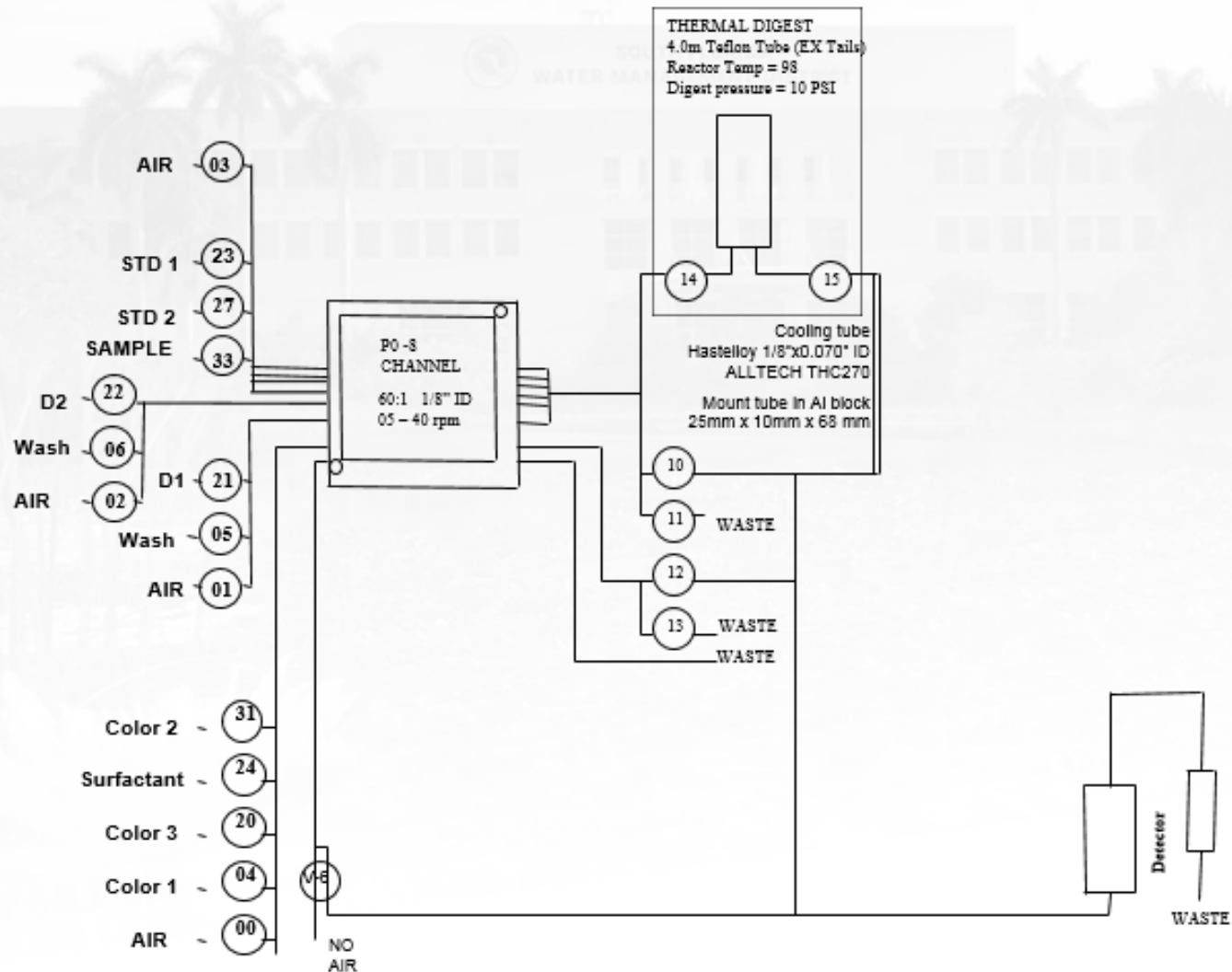
Analytical Conditions

- Sampling frequency-optimum 4 hour cycles
- Sample intake
- 3 point calibration, blank correction
- Determination of reactive phosphorous
- Sample digestion
- Determination of total phosphorous
- Monitoring of digester temperature, cabinet temperature, leak detectors, reagent volumes

RPA Setup



RPA Schematic



RPA Interior



Test Channel Info

Greenspan Aqualab

Area Name: SFWMD
Site Name: S390
Serial Number: TP001154
Log File: None
SCHEDULER ON

Monitor

Test Channels

Test	Unit	Current	Last Log	Time
Battery	Volts	+00013.9	+00013.9	14:00:07
TR Phosphate	ppb P		+000461.	12:29:32
Total Phos	ppb P		+000502.	12:58:27
TR Po4 chk	counts		+044312.	12:29:34
Total Phos chk	counts		+045160.	12:58:29
Base chk	counts		+009012.	14:07:15
Std1 chk	counts		+039362.	14:19:34
Std2 chk	counts		+060075.	14:33:04
TP Blank chk	counts		+008956.	12:15:01
TRP Blank chk	counts		+010424.	12:19:03
Cabinet Temp	deg C	+00025.7	+00025.0	14:55:55
Digester Temp	deg C	+00072.9	+00072.1	14:00:13
SamplePot Temp	deg C	+00029.3	+00028.7	14:55:58

Monitor

☒ Analyser Checks

Alarm

View System Status Close

System Status Info

 Greenspan Aqualab

Area Name: SFWMD
Site Name: S390

Serial Number: TP001154

Log File: None
SCHEDULER ON

Monitor

System Status

Solutions

Reagent	Level ml	Bottle ml	%Full
Standard 1 01	+001824.	+002000.	91%
Standard 2 02	+001824.	+002000.	91%
TP Wash 59	+018231.	+020000.	91%
TP Colour1 35	+004533.	+005000.	91%
TP Colour2 36	+000899.	+001000.	90%
TP Surf 56	+001000.	+001000.	100%
TP Colour3 52	+004431.	+005000.	89%
Acid Digest 27	+004490.	+005000.	90%
TP Digest2 38	+002217.	+002500.	89%

Battery (volts) +00013.9

Data Memory (bytes)

Available 491520

Used 224158

Tube Age (hours)

Pump 1 +000911.

Pump 2 +000000.

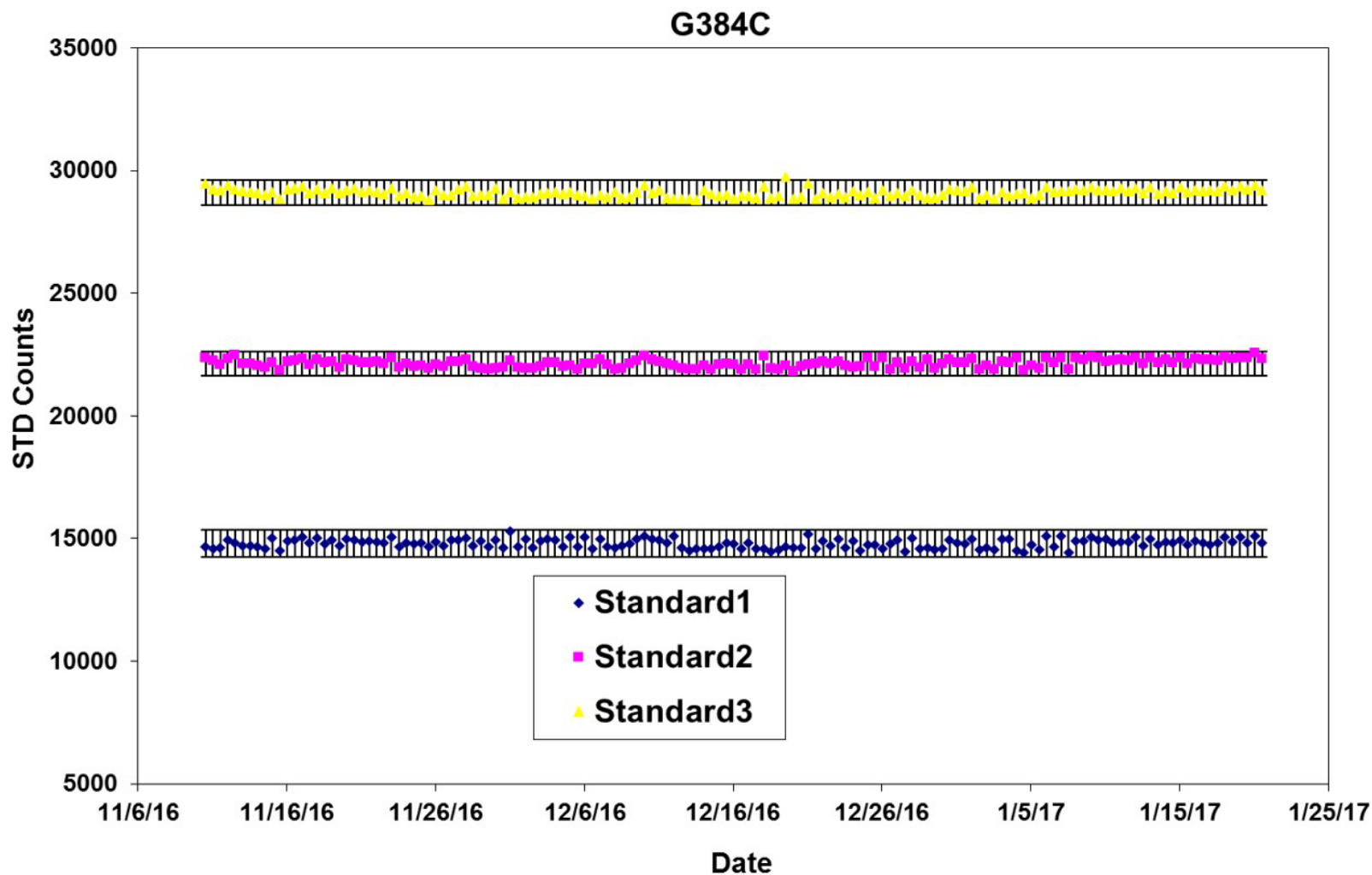
Alarm

[View Tests](#) [Close](#)

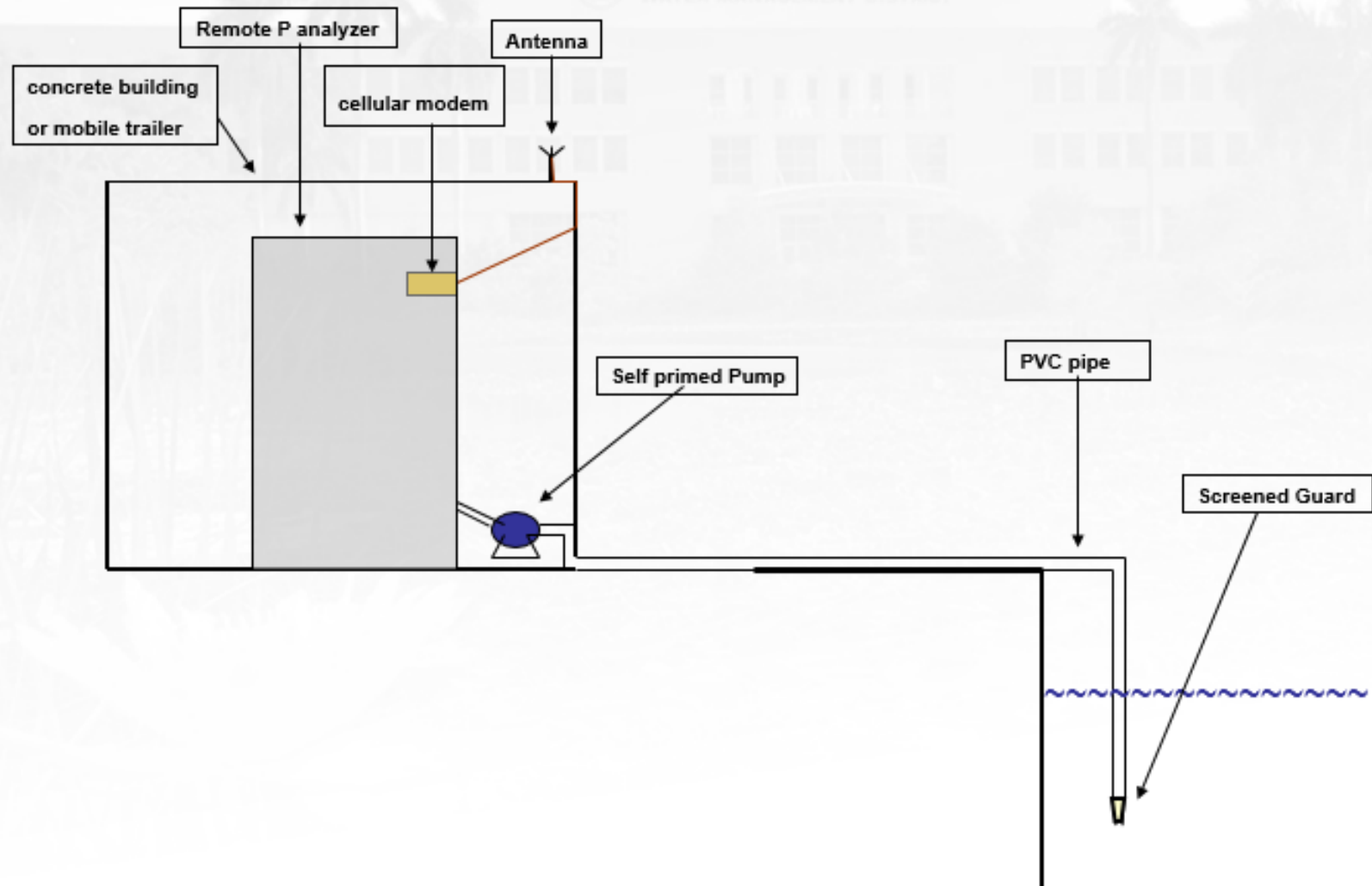
Standard Response Stability

- A single batch of standards/reagents is exhausted after about three months of deployment.
- The three standard deviation error bar is set as the control limit.
- For quality control purposes, if a standard count is above or below the control limit, this standard point fails.
- Long term--Almost all standard responses were within the limit and therefore the standard responses were considered stable.

Test of Standards



Field Setup Diagram



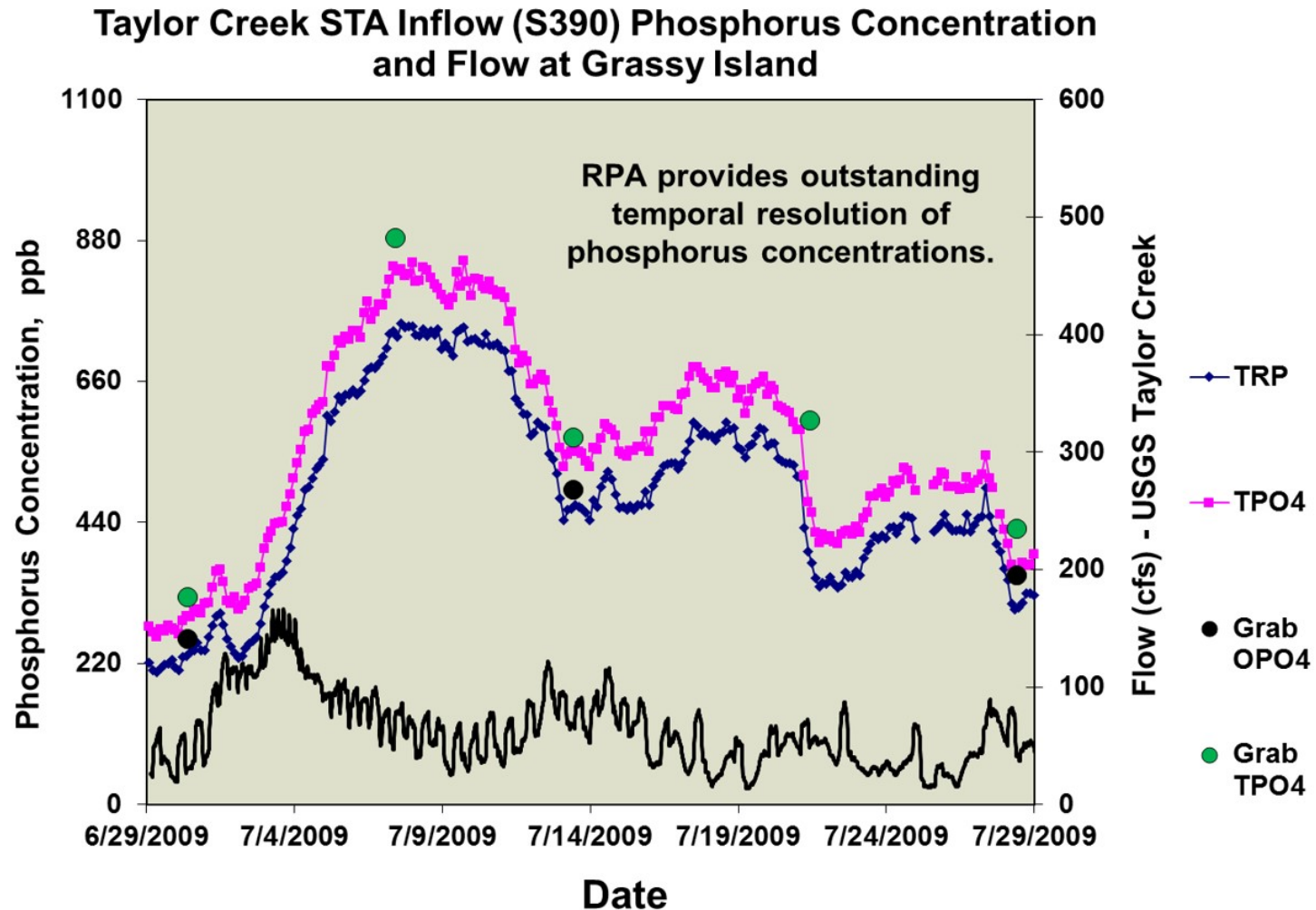
Deployment (1)



Deployment (2)

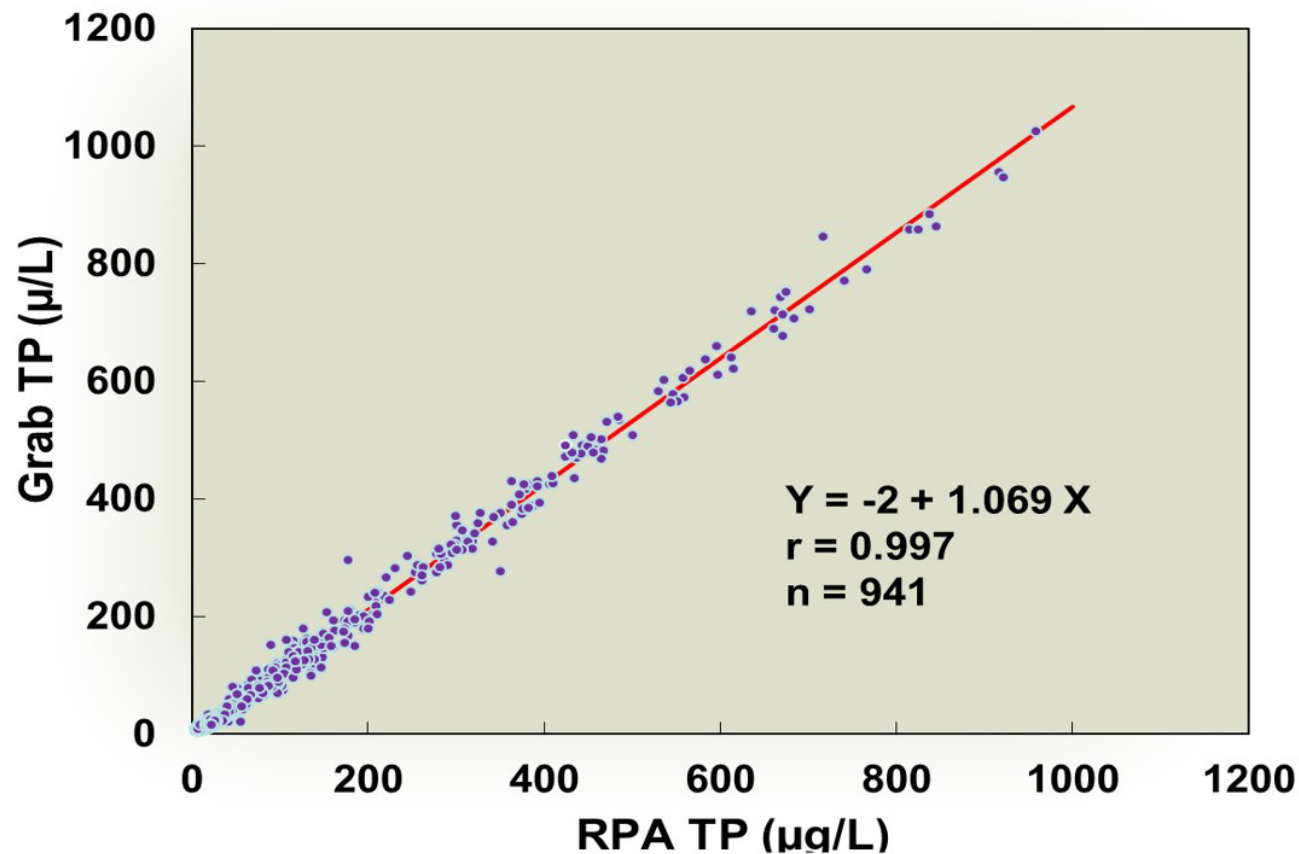


Quality Assurance (1)

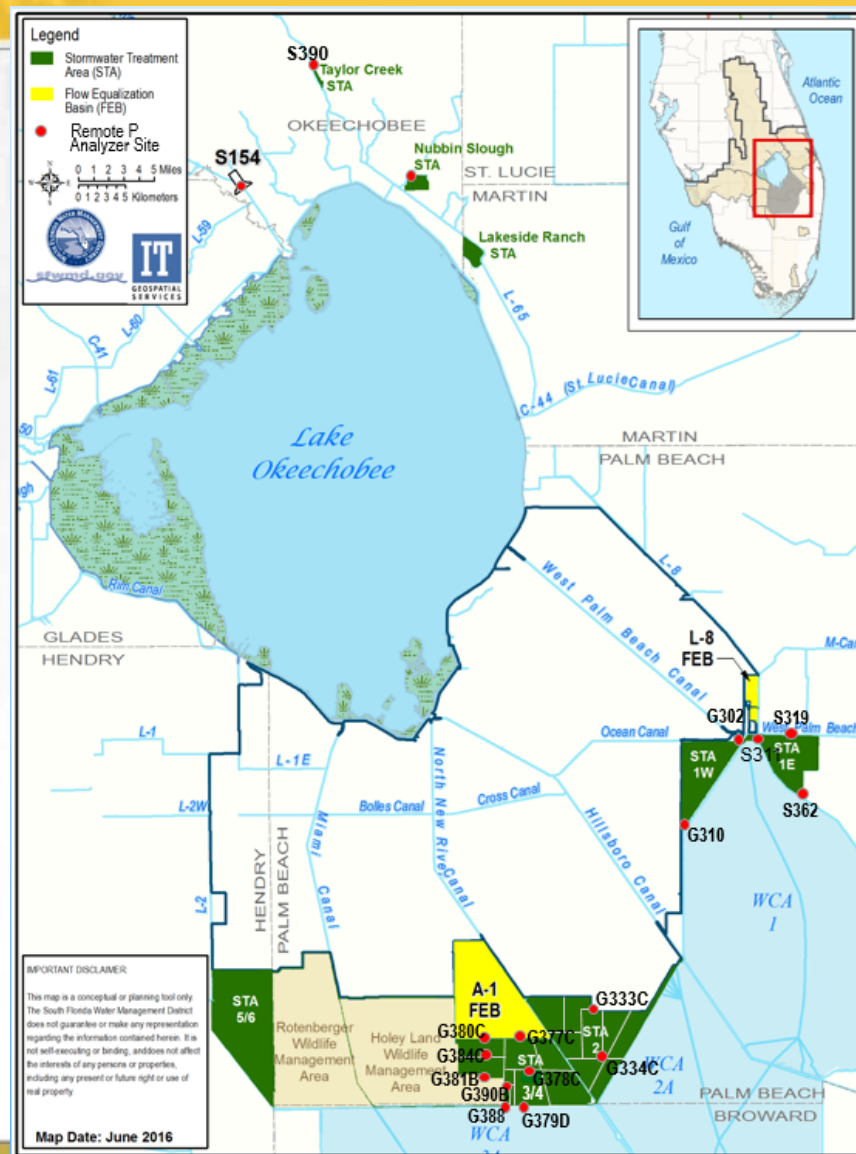


Quality Assurance (2)

Wilcoxon Signed Rank Test confirmed there is no significant difference between RPA and Grab TP results.



Lake 'O' Deployment



RPA Deployments – North and East of Lake ‘O’

Area	Station	Dates	# Samples	Mean TP (µg/L)
Taylor Creek STA Inlet	S390	9/19/07-9/15/13	12684	384±193
Nubbin Slough STA Inlet	N/A	8/14/08-9/15/12	10238	319±225
S154 basin Kissimmee River	S154	8/15/08-1/26/12	7156	290±193
STA 1W Inlet	G302	2/24/07-5/7/10	7214	108±61
STA1W Outlet	G310	2/4/07-8/4/10	10550	36±49
STA1E Inlet Central Flow-way	S319	8/16/10-3/7/12	4108	78±32
STA1E Inlet Western Flow-way	S311	6/19/10-12/21/11	3342	102±31
STA1E Outlet	S362	6/23/10-6/19/12	5656	25±6

RPA Deployments – South of Lake ‘O’

Area	Station	Dates	# Samples	Mean TP (µg/L)
STA2 Inlet Flow-way 3	G333C	6/3/13-10/10/13, 7/8/16- Present	1281	84±48
STA2 Outlet Flow-way 3	G334C	5/3/13-12/3/13, 5/24/16- Present	3954	22±7
STA3/4 Inlet Central Flow-way	G377C	5/19/14-1/9/15	2078	56±21
STA3/4 Mid-Levee, Central Flow-way	G378C	6/10/14-1/16/15	1880	16.3±3
STA3/4 PSTA Cell Inlet	G390B	4/5/12-9/30/15	8493	20±11
STA3/4 PSTA Cell Outlet	G388	3/30/12- Present	8968	13±5
STA3/4 Outlet Central Flow-way	G379D	7/2/12-11/11/12 2/24/14-1/26/15	3067	25±13
STA3/4 Inlet W. Flow-way	G380C	11/14/12-3/15/13, 1/23/15- Present	4646	57±28
STA3/4 Mid-Levee W. Flow-way	G384C	11/14/12-3/15/13, 1/23/15- Present	2729	24±7
STA3/4 Outlet W. Flow-way	G381B	7/5/12-8/4/15	5410	16±7

IMPACT of RPA DATA AVAILABILITY

- High resolution P results identify diurnal cycles and effects of pulse flow
- Comparison study with other sample collection techniques
- STA P removal efficiency
- On going study of P movement and trends in the system

Final Thoughts...

- By 2010, the concept of high quality, high frequency, near real-time remote P analysis had proven to be a valuable tool for evaluation of P variance in many District applications.
- The technology is now broadly accepted by District scientists and RPA deployments have been requested in support of several Science Plan Projects.
- Current RPA deployment capacity stands at five active units.

Questions?

Phosphorus Recoveries

Standard (STD) and QC recoveries

Sample Name	OPO ₄ recovery (%)	TP	n	MDL (µg/L)	MB (µg/L)
10 µg/L	98±4	115±5	32	1.2	-
25 µg/L	98±2	105±3	8	-	-
100 µg/L	99±2	101±2	51	-	-
150 µg/L	102±2	102±2	8	-	-
200 µg/L	103±1	103±1	7	-	-
Old STD 100 µg/L	98	100			
Old STD 200 µg/L	100	97			

TP Recoveries

TP recoveries of inorganic and organic phosphates

Phosphate	recovery (%)	n
Organic phosphate		
Phytic acid	101±0.6	9
Adenosine-5-triphosphate	91±4	6
β-glycerol phosphate	102±0.7	8
Inorganic phosphate		
KH ₂ PO ₄	101±1.6	51
Inorganic polyphosphates		
Tripolyphosphate	92±1.2	26
Trimetaphosphate	91±1.2	8
Average recovery	96	