Florida Department of Environmental Protection

Update on DEP Septic Tank Research Activities

October 20, 2017



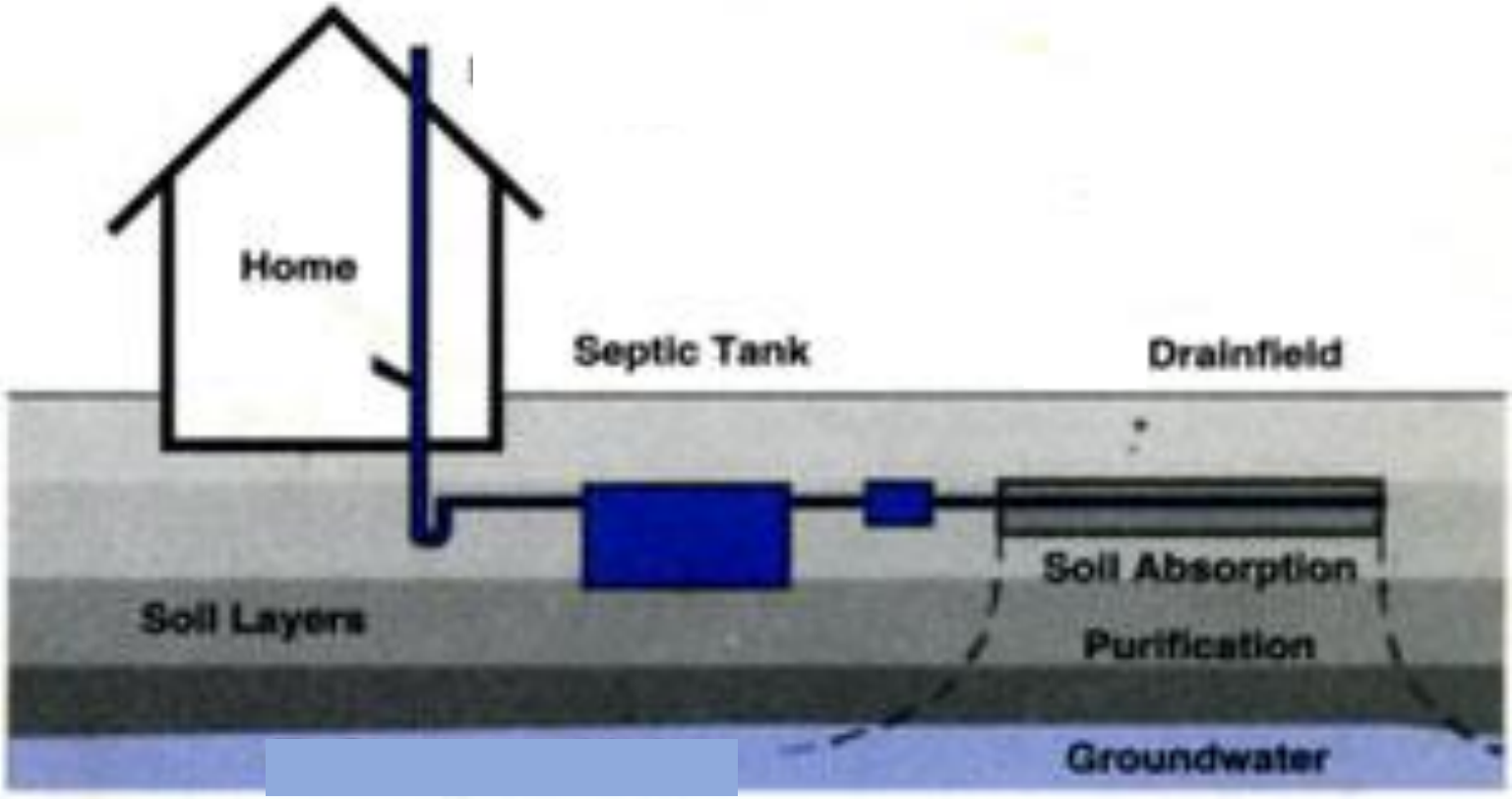


Info Covered

- Wekiva area homeowner's septic tank study
- Ichetucknee experimental drainfield
- Apopka experimental drainfield

Wekiva Study

-typical gravity system



Key Activities

- Homeowner septic tank study
  - Homeowner meeting (March 2015)
  - Screening and selection of 11 study sites (June 2015)
  - Site instrumentation (July-August 2015)
  - Monitoring period, bi-monthly sampling (September 2015-October 2016)

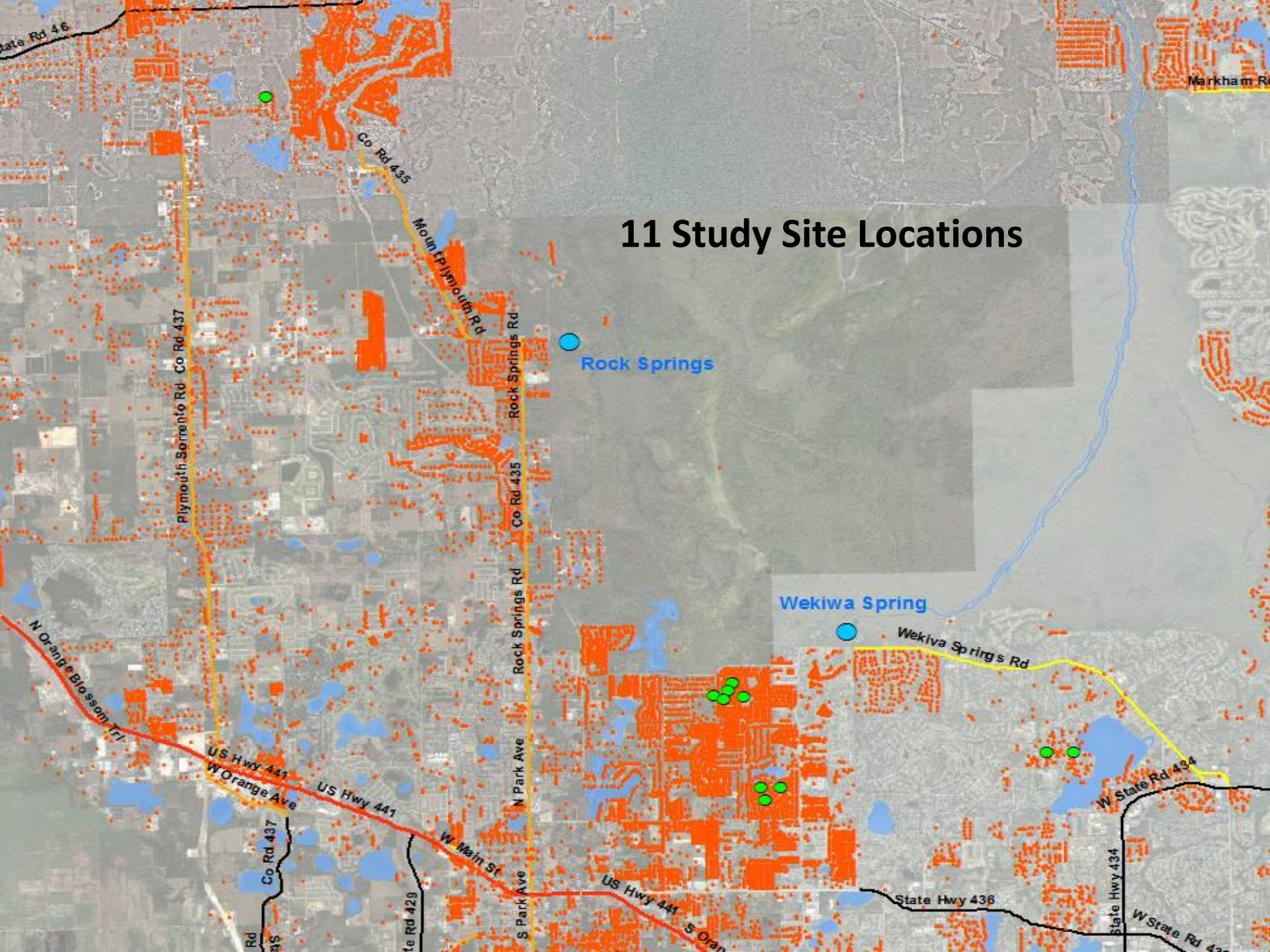
Wekiva Homeowner Study Objectives

The results of the study help us better understand:

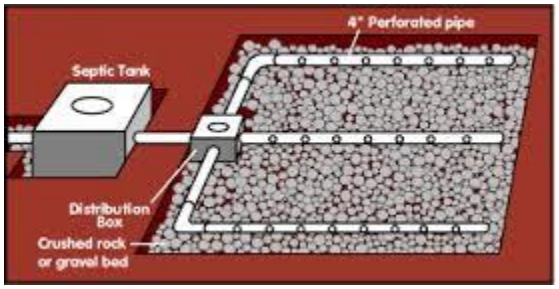
- Attenuation and leaching of nitrogen from existing septic systems into the soil and potentially to ground water
- Other sources of nitrogen in residential areas
- Conditions that may influence nitrogen attenuation in the Wekiva area
- Influence of septic tank pumping on treatment

Information on Study Sites

Site ID	City	No. residents	Drainfield repair/replacement history	Maintenance info	Fertilizer use	Soil
A	Sorrento	2	infiltrators (original)	pumped regularly	yes, self applied	Candler fine sand
B	Apopka	3	infiltrators (2009)	pumped in 2013	yes, self applied	Candler fine sand
C	Apopka	3	infiltrators (2010)	septic tank pumped in 2013	yes, self applied	Candler fine sand
D	Apopka	2	pipe in gravel (original)	not pumped out lately	yes, commercial service	Candler fine sand
E	Apopka	2	pipe in gravel (1989)	not pumped	yard mostly mulched beds	Candler fine sand
F	Apopka	4	infiltrators (2010)	pumped in 2014	not lately	Candler fine sand
G	Apopka	3	pipe in gravel (original)	pumped in 2014	yard mostly mulched beds	Candler fine sand
H	Apopka	2	pipe in gravel (original)	not pumped	yes, commercial service	Candler fine sand
I	Longwood	1-2	infiltrators (1989)	pumped in 2015	yes, commercial service	Urban land
J	Longwood	2	mounded pipe in gravel bed	pumped regularly	yes, commercial service	Urban land
K	Apopka	2	pipe in gravel (original)	pumped in 2015	yard mostly mulched beds	Candler fine sand


11 Study Site Locations
Rock Springs
Wekiwa Spring
Wekiva Springs Rd
Rock Springs Rd
Co Rd 435
Mount Plymouth Rd
Plymouth Sorrento Rd
Co Rd 437
N Orange Blossom Trl
US Hwy 441
W Orange Ave
W Main St
N Park Ave
S Park Ave
State Hwy 436
W State Rd 434
State Hwy 434
Markham Rd

Types of drainfields in study



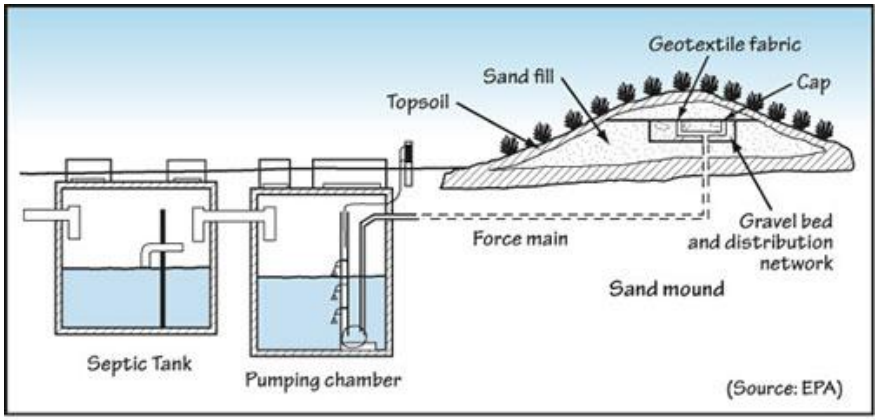


Figure 4 - Schematic of a Sand Mound System

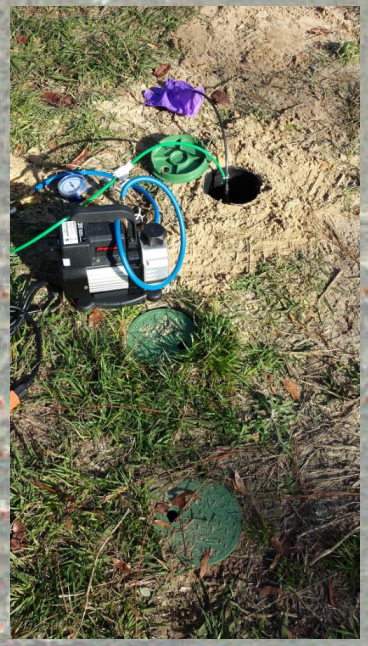
Scope

- Install and sample lysimeters to monitor soil pore water below drainfields and at background locations
- Install risers for septic tank effluent monitoring
- Install and sample monitoring wells at two locations
- Attempt to collect data on water use to estimate loading

Soil Pore Water Monitoring

Site	Lysimeters Installed	Total Depth (ft below land surface)	Location
A	AL1S-AL4S	5	Drainfield
	AL5S	5	Background
	AL2D	10	Drainfield adjacent to AL2S
B	BL1S-BL4S	5	Drainfield
	BL5S	5	Background
	BL3D	10	Drainfield, adjacent to BL3S
	BL3E	15	Drainfield, adjacent to BL3S
C	CL1S-CL3S	5	Drainfield
	CL4S	5	Background
D	DL1S-DL2S	5	Drainfield
	DL3S	5	Background
E	EL1S-EL3S	5	Drainfield
	EL4S	5	Background
F	FL1S-FL3S	5	Drainfield
	FL4S	5	Background
	FL2D	10	Drainfield, adjacent to FL2S
G	GL1S-GL2S	5	Drainfield
	GL3S	5	Background
	GL1D	10	Drainfield, adjacent to GL1S
	GL1E	15	Drainfield, adjacent to GL1S
H	HL1S-HL2S	5	Drainfield
	HL3S	5	Background
I	IL1S-IL3S	5	Drainfield
	IL4S	5	Background
J	JL1S-JL3S	5	Drainfield
	JL4S	5	Background
K	KL1S-KL4S	5	Drainfield
	KL5S	5	Background

Lysimeter Installation

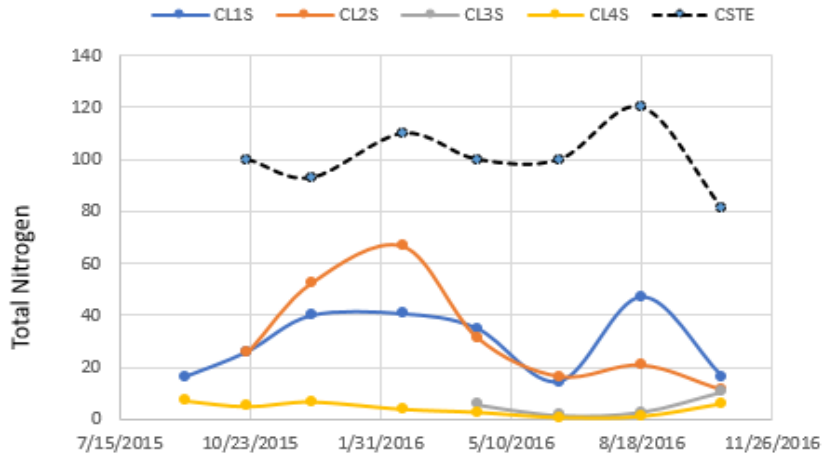


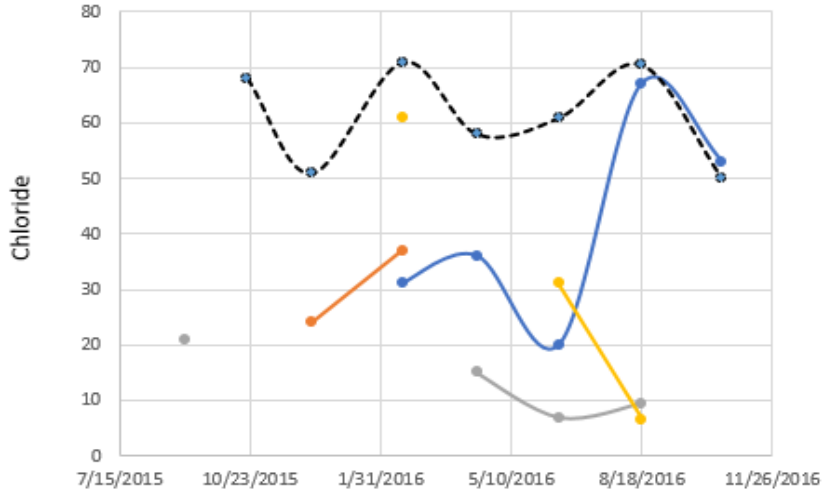
Septic Tank Effluent Sampling

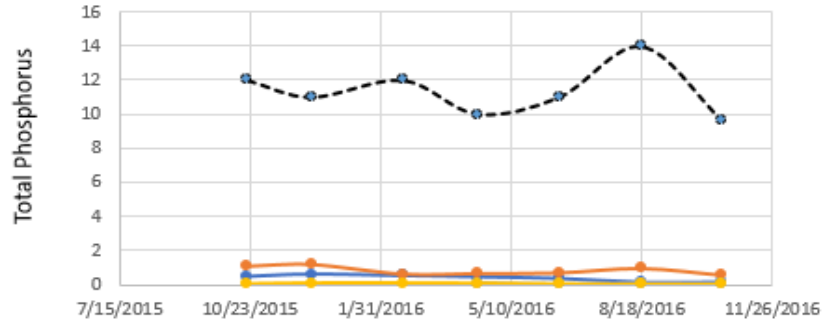
Septic tank effluent samples collected bimonthly at 8 sites. Results in mg/L.

Site	Average Total Nitrogen	Average Chloride	TN/Chloride Ratio	Average Total Phosphorus
A	61	32	1.91	7.8
B	93	43	2.16	9.3
C	101	63	1.60	12
E	57	47	1.21	6.8
F	57	45	1.27	6.8
G	75	42	1.79	7.5
I	140	87	1.61	16
J	93	74	1.26	9.3
All Sites	**85**	**54**	**1.57**	**9.4**


Septic Tank
L3S
L1S
L4S
L2S
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: C
Feet
0 5 10 20 30
Map prepared 4/12/2017 by the Division of Environmental Assessment and Restoration. This map is not for legal decision making purposes. For more information or copies, contact David.Huggins@dep.state.fl.us
L = Lysimeter
S = Shallow
D = Deep
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


CL1S
CL2S
CL3S
CL4S
CSTE
Total Nitrogen
140
120
100
80
60
40
20
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Chloride
80
70
60
50
40
30
20
10
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Total Phosphorus
16
14
12
10
8
6
4
2
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


L1S
L2S
L1D
Septic Tank
L3S
L4S
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: E
Feet
0 5 10 20 30
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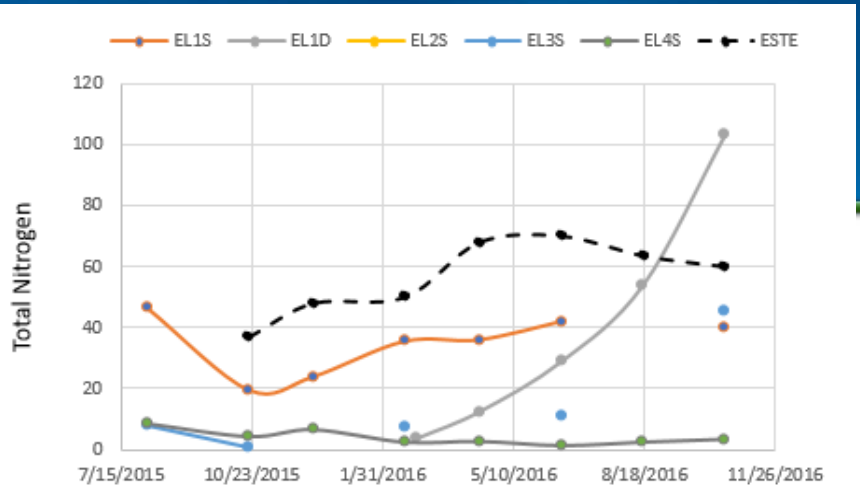
Septic Tanks
Sampling Site
Drainfield
N


EL1S
EL1D
EL2S
EL3S
EL4S
ESTE
Total Nitrogen
120
100
80
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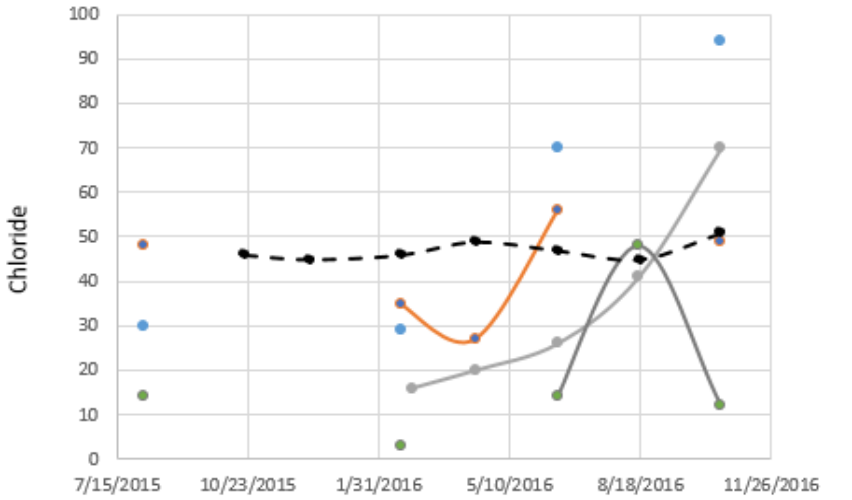
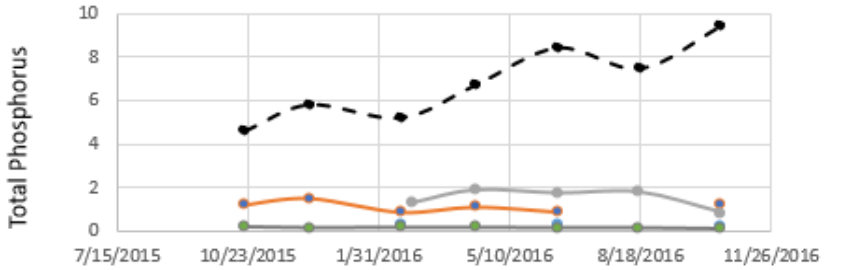
40
20
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Chloride
100
90
80
70
60
50
40
30
20
10
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Total Phosphorus
10
8
6
4
2
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


L5S
L1S
L3S
Septic
Tank
L4S
L2S
L2D
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: A
Feet
0 5 10 20 30
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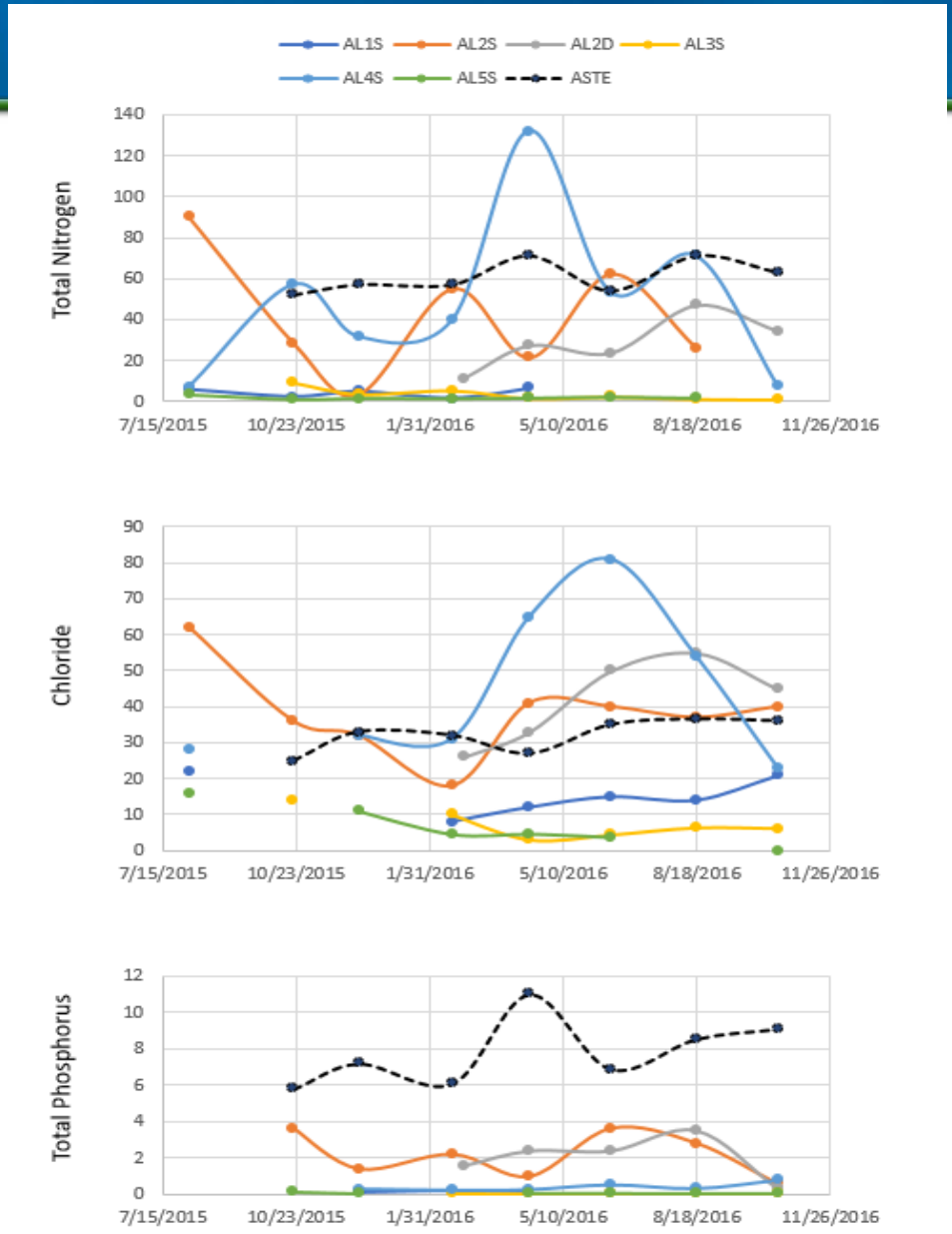
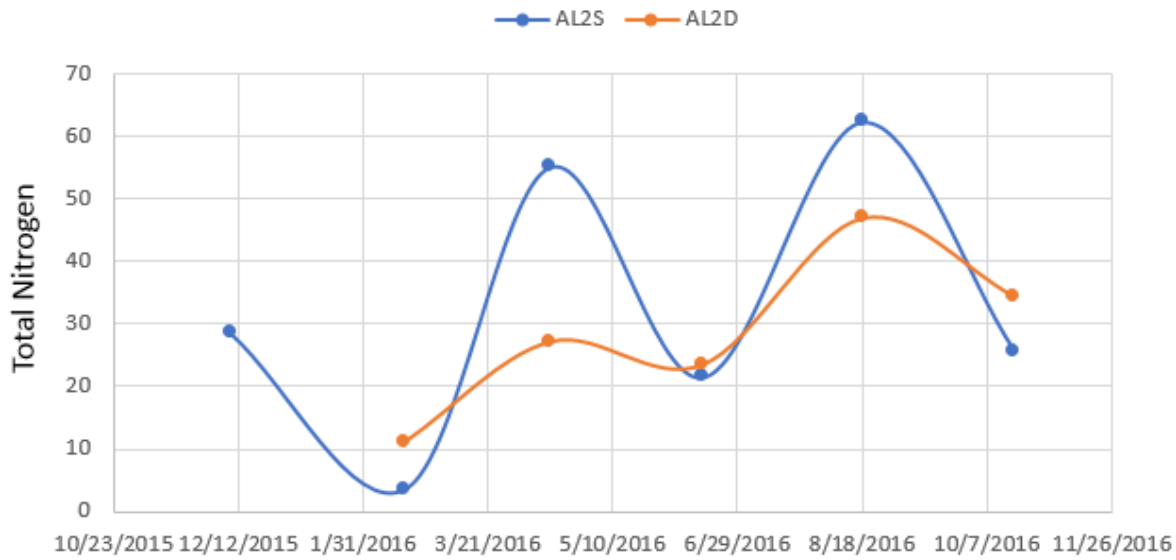
L = Lysimeter
S = Shallow
D = Deep
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


AL1S
AL2S
AL2D
AL3S
AL4S
AL5S
ASTE
Total Nitrogen
140
120
100
80
60
40
20
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
Chloride
90
80
70
60
50
40
30
20
10
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
Total Phosphorus
12
10
8
6
4
2
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


AL2S
AL2D
Total Nitrogen
70
60
50
40
30
20
10
0
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016


L5S
L1S
L2D
Septic
Tank
L2S
L3S
L4S
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: F
Feet
0 5 10 20 30
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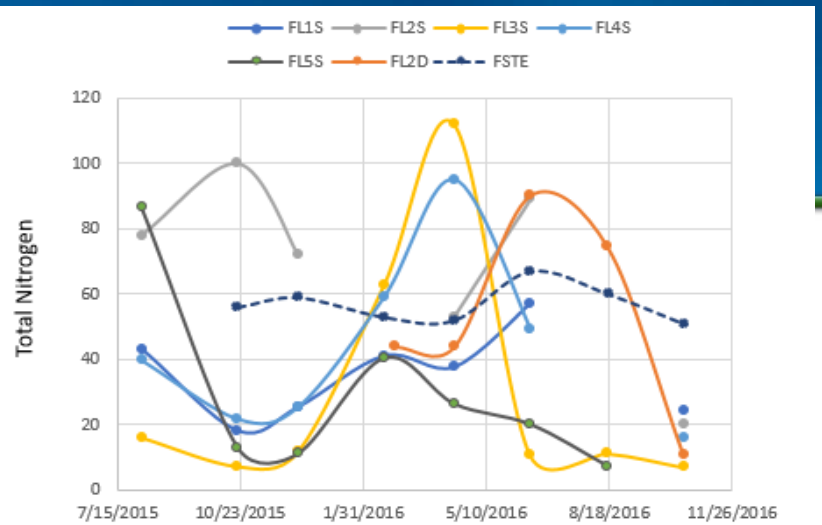
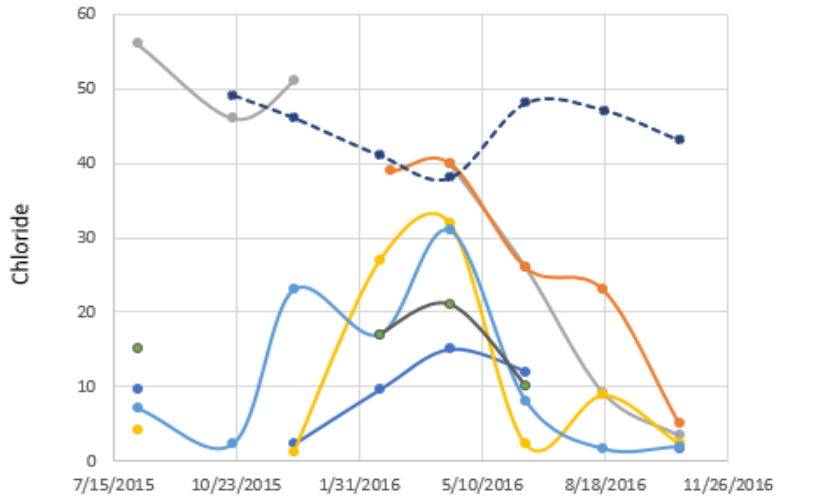
Drainfield
N


FL1S
FL2S
FL3S
FL4S
FL5S
FL2D
FSTE
Total Nitrogen
120
100
80
60
40
20
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Chloride
60
50
40
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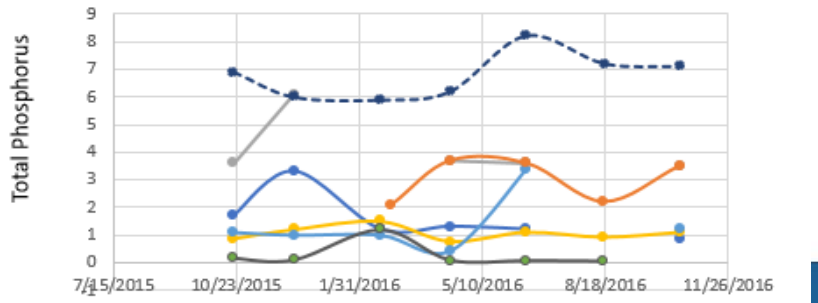
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Total Phosphorus
9
8
7
6
5
4
3
2
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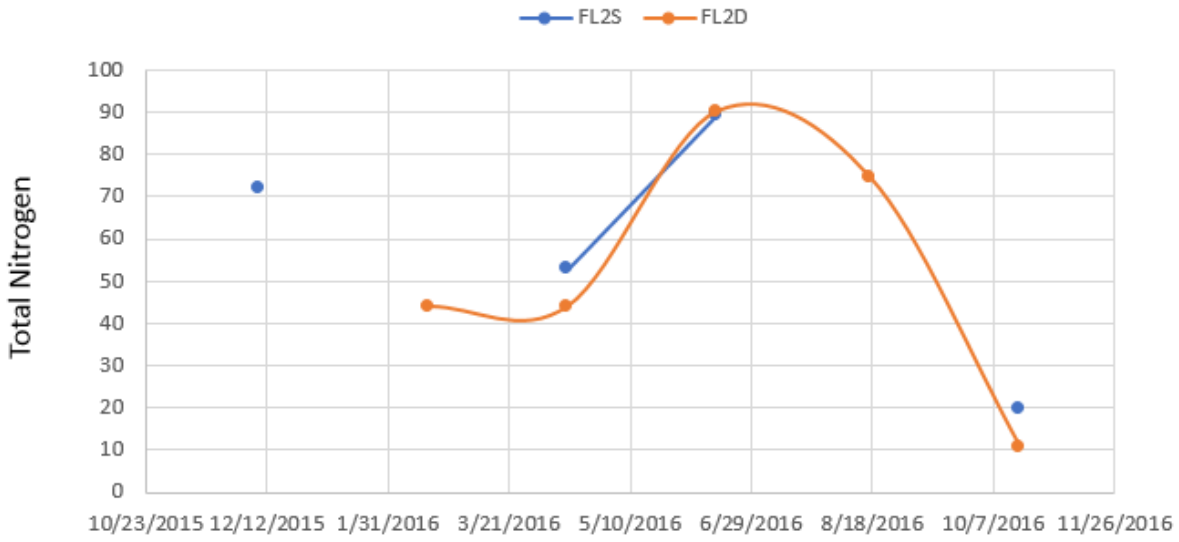
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


FL2S
FL2D
Total Nitrogen
100
90
80
70
60
50
40
30
20
10
0
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016

Summary Findings for Lysimeter Samples

Site	Max TN	Min TN	Avg TN	Max Chloride	Min Chloride	Avg Chloride	Max TP	Min TP	Avg TP
A	132	0.96	37	81	0.04	26	3.6	0.034	0.89
B	254	1.5	49	180	1.6	33	3.6	0.008	0.32
C	67	0.83	19	67	6.5	30	1.2	0.033	0.38
D	22	1.3	6.0	28	2.7	13	2.1	0.053	1.2
E	103	0.74	22	94	2.9	37	1.9	0.11	0.77
F	112	7	42	56	1.3	18	6.1	0.047	1.8
G	152	2.2	49	2600	5.8	234	7.9	0.04	1.8
H	10	1.5	6.3	92	1.9	24	0.12	0.021	0.07
I	69	0.6	8.5	120	3.9	21	2.3	0.048	0.80
J	56	0.56	4.0	96	2.2	24	0.12	0.015	0.038
K	192	0.43	31	260	1.3	55	8.2	0.32	3.0

Information about drainfield-related N attenuation

Results from some of the sites where TN was mostly from drainfields during some portion of the monitoring period are summarized below.

- At Site E, 39 % of nitrogen was reduced with 10% due to dilution.
- At Site G, 42 to 46 % of nitrogen was reduced in shallow and deep lysimeters with no dilution.
- At Site J where there is a shallow water table, 35 % of the nitrogen was reduced in a shallow well with no dilution.
- At Site K, 44 % of nitrogen was reduced with no dilution.

Using data from multiple sites, it appears that attenuation of N by means other than dilution is about 42 % (based on assumed TN/Cl relationship)

Soil Attenuation Modeling

Soil Science Society of America

SSSA Onsite Wastewater Conference
April 7-8, 2014

The Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project

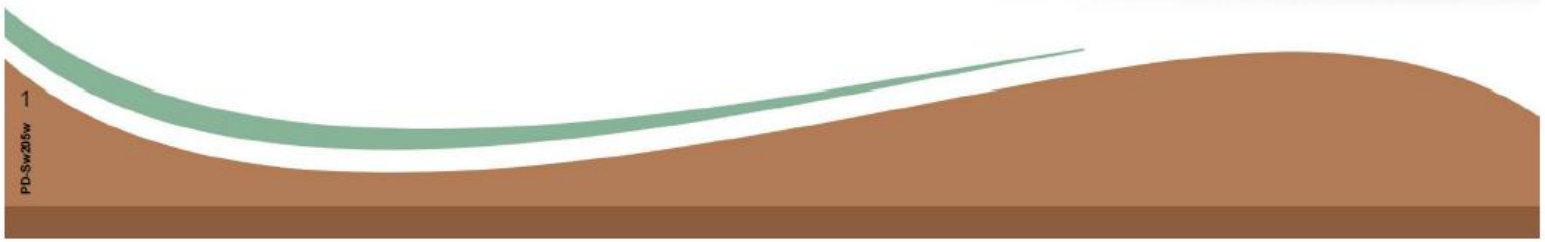
FOSNRS 6: STUMOD-FL - A Tool for Predicting Fate and Transport of Nitrogen in Soil Treatment Units in Florida

April 7, 2014

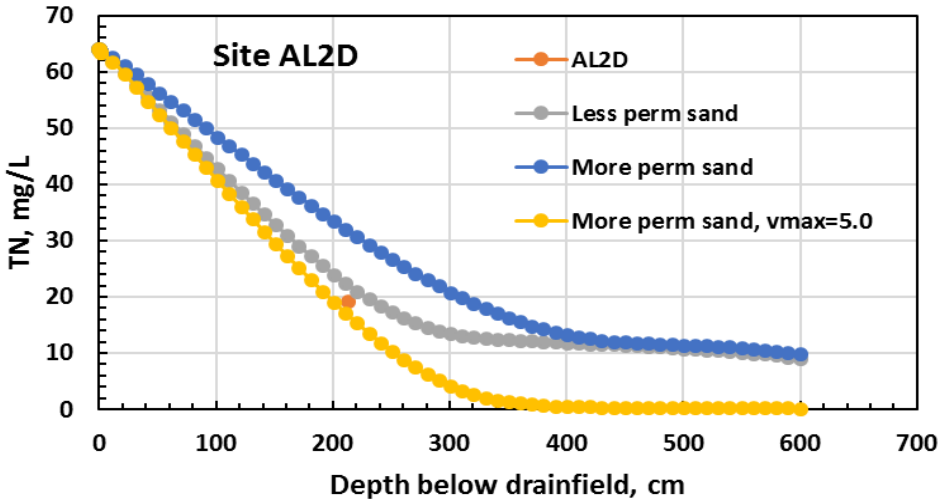
Mengistu Geza[1], Kathryn S Lowe[1], Cliff Tonsberg[1], John McCray[1] and Eberhard Roeder[2]

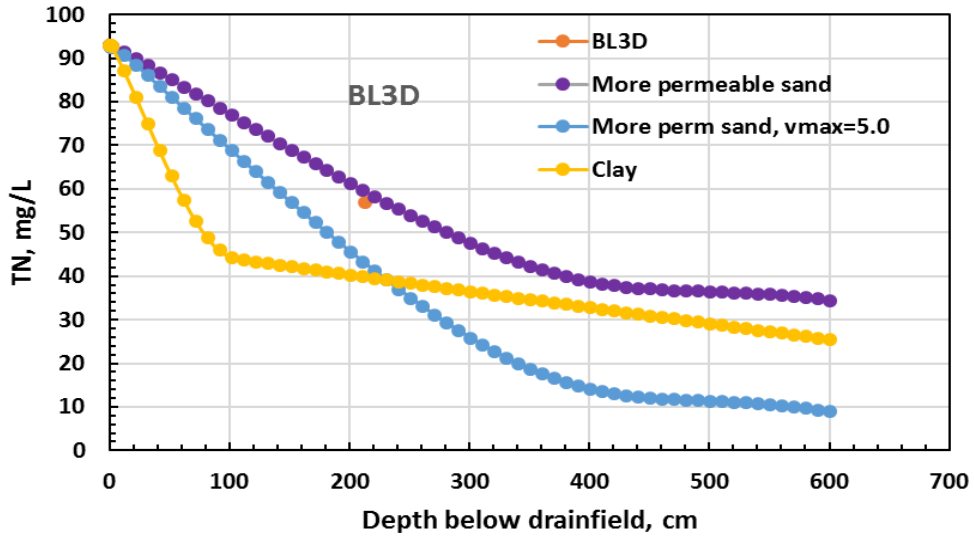
[1]Civil and Environmental Engineering, Colorado School of Mines, Golden, CO

[2]Division of Disease Control and Health Protection Bureau of Environmental Health, Florida Department of Health, Tallahassee, FL

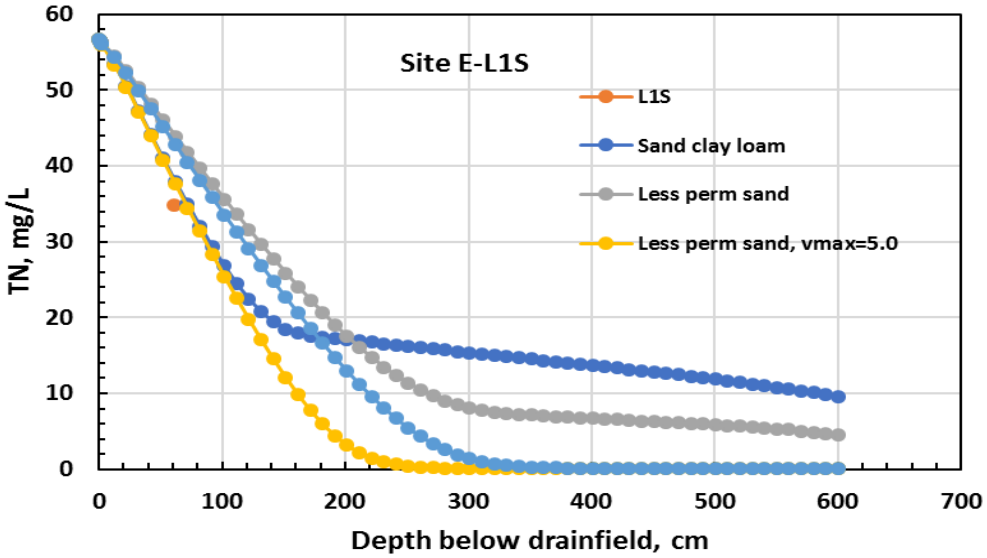


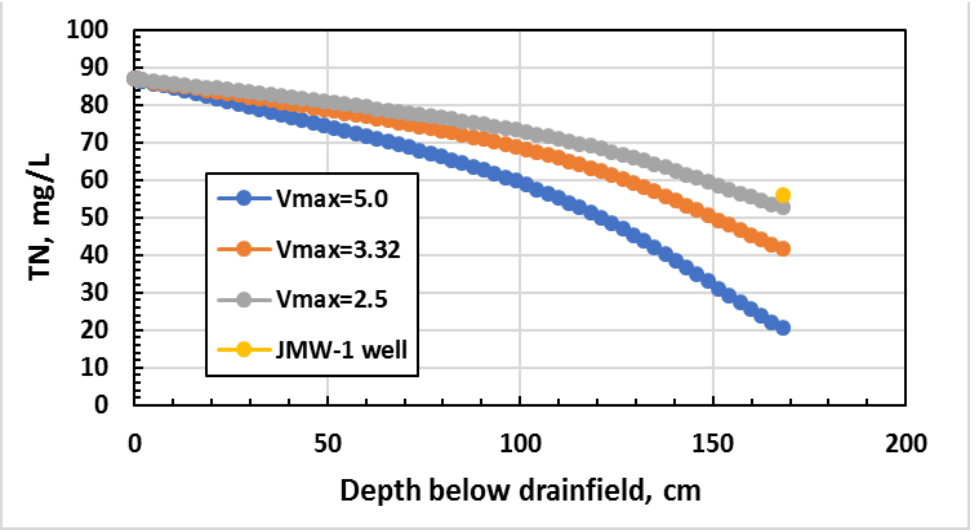
STUMOD runs for study sites



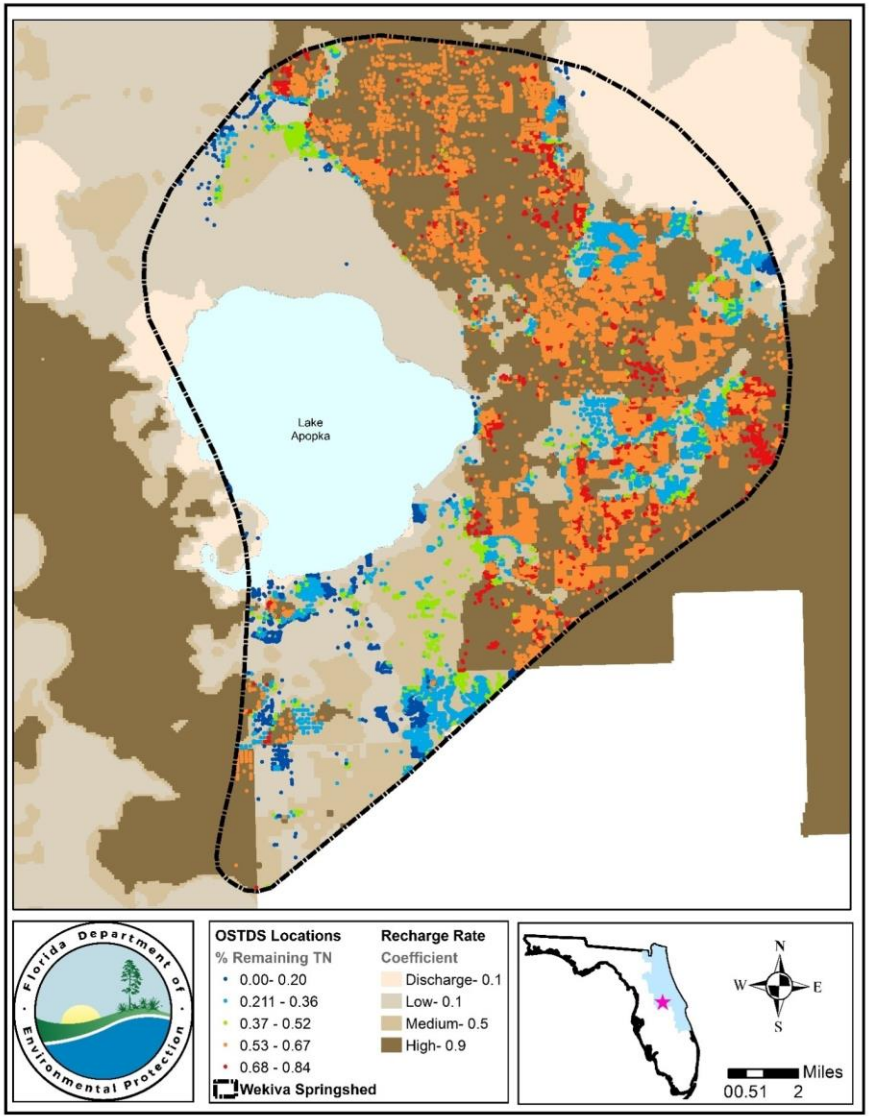


STUMOD runs for study sites



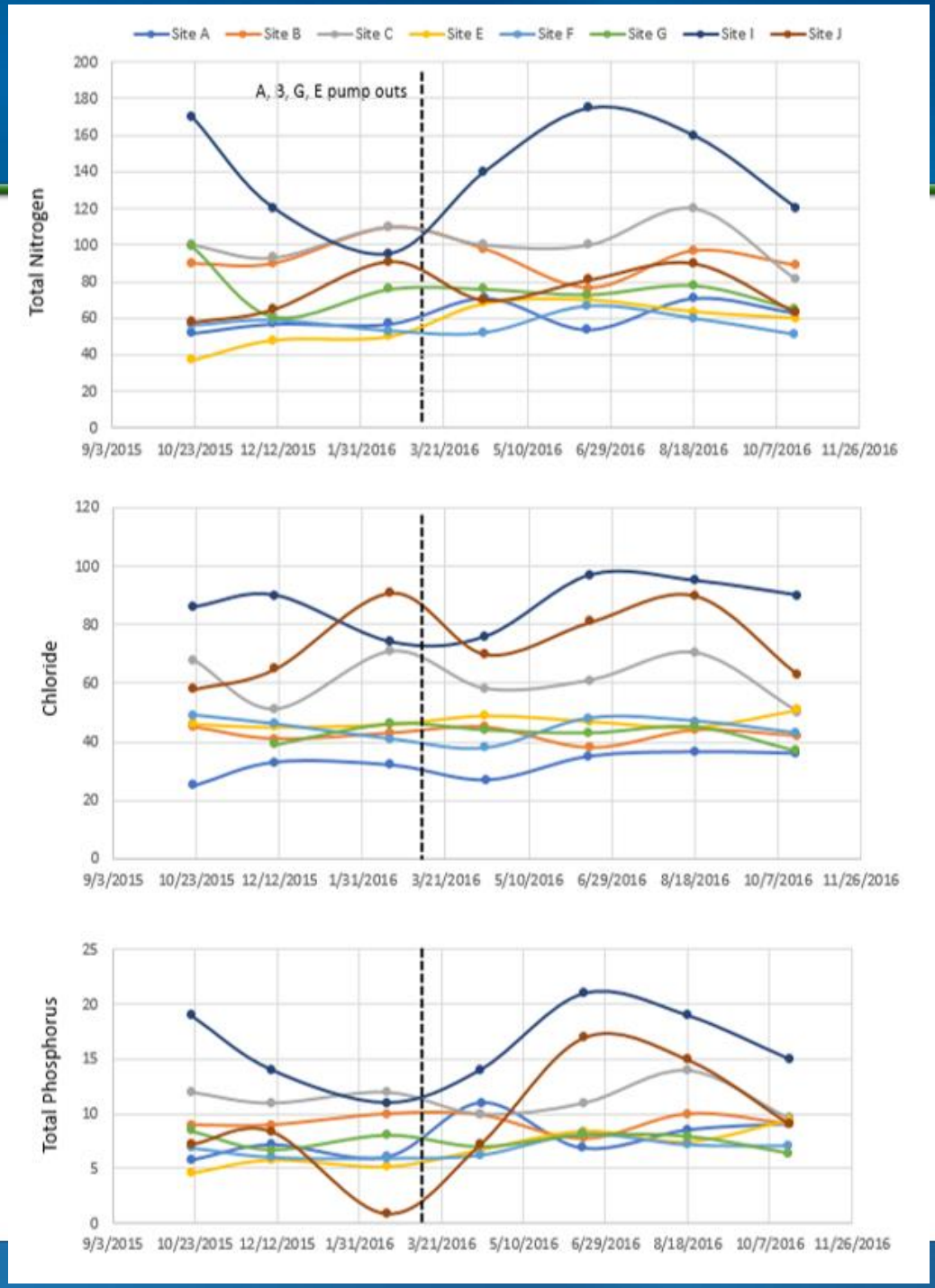


Potential application of STUMOD on regional scale



Septic Tank Effluent and Influence of Pumping

- Midway through the study, 4 septic tanks were pumped. Others left as control.
- Septic tanks at sites A, B, E and G were pumped in March 2016, between February and April monitoring events

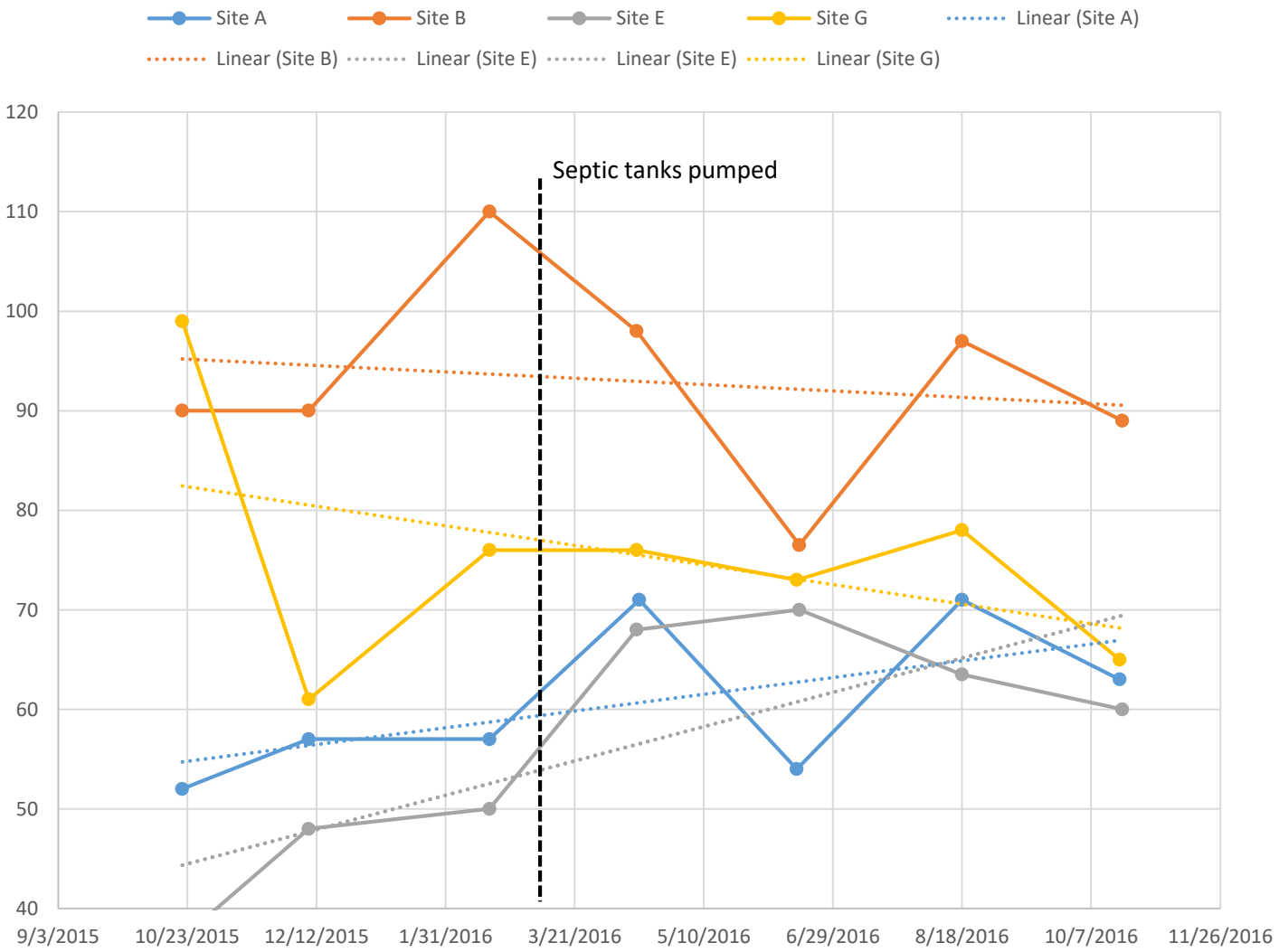

Site A
Site B
Site C
Site E
Site F
Site G
Site I
Site J
A, 3, G, E pump outs
Total Nitrogen
Chloride
Total Phosphorus
9/3/2015
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016

General statistics for all sites

Site	TN Before	TN After	% Chg	Chloride Before	Chloride After	% Chg	TP Before	TP After	% Chg
A[1]	55	65	+18	30	34	+13	6	9	+5
B[1]	97	90	-7	43	42	-2	9	9	0
C	101	100	-1	63	60	-5	12	11	-8
E[1]	45	65	+44	46	48	+4	5	8	+60
F	56	65	+18	45	48	+7	6	8	+33
G[1]	79	73	-8	43	42	-2	8	7	-13
I	128	149	+16	83	90	+8	15	17	+13
J	77	106	+38	71	76	+7	5	12	+140

Notes: [1]- septic tank pumped in March 2016. Other sites are controls.

TN Trends after pumping



Ichetucknee Drainfield Study

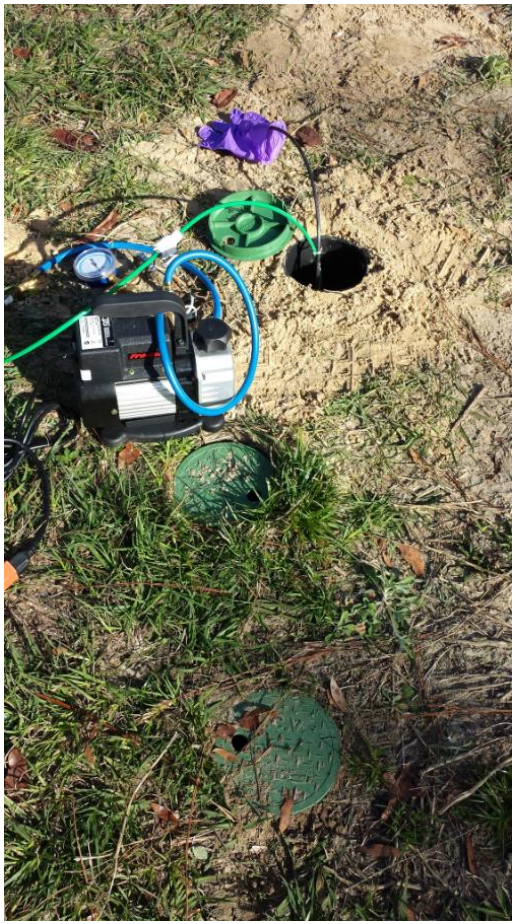
- Intentionally low-tech, low cost design (added approximately $300 to the cost of a new drainfield)
- Ichetucknee Springs State Park manager's house
- With DOH construction and operating permits, and under a Memorandum of Understanding
- Installed a second drainfield underlain by wood chips
- Installed monitoring system and monitored
- Put in the ground in March 2014 and septic tank effluent diverted to new system

Figure 1. View East: First phase of lignocellulosic layer installation. ~11:20 am

Figure 6. Installation of deep lysimeters (buckets contain silica mix), ~1:55 pm

Figure 10. Installation of three rows of chambers at a slight angle to the length axis of the mulch bed. ~4:36 pm

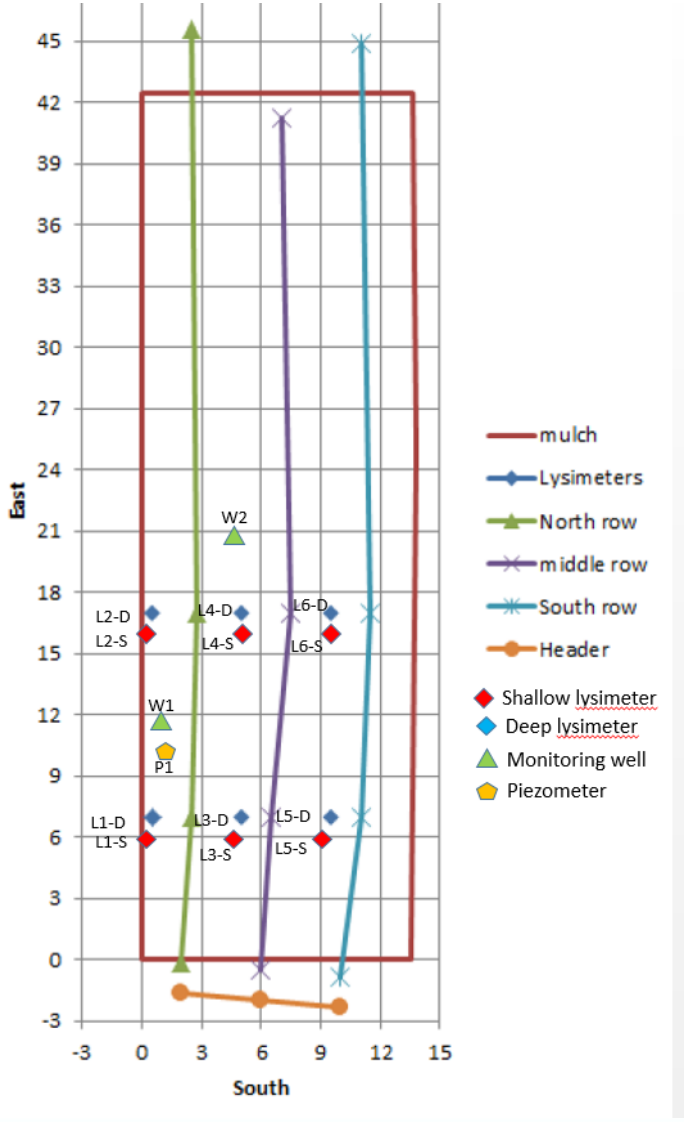
Soil pore water sampling using lysimeters



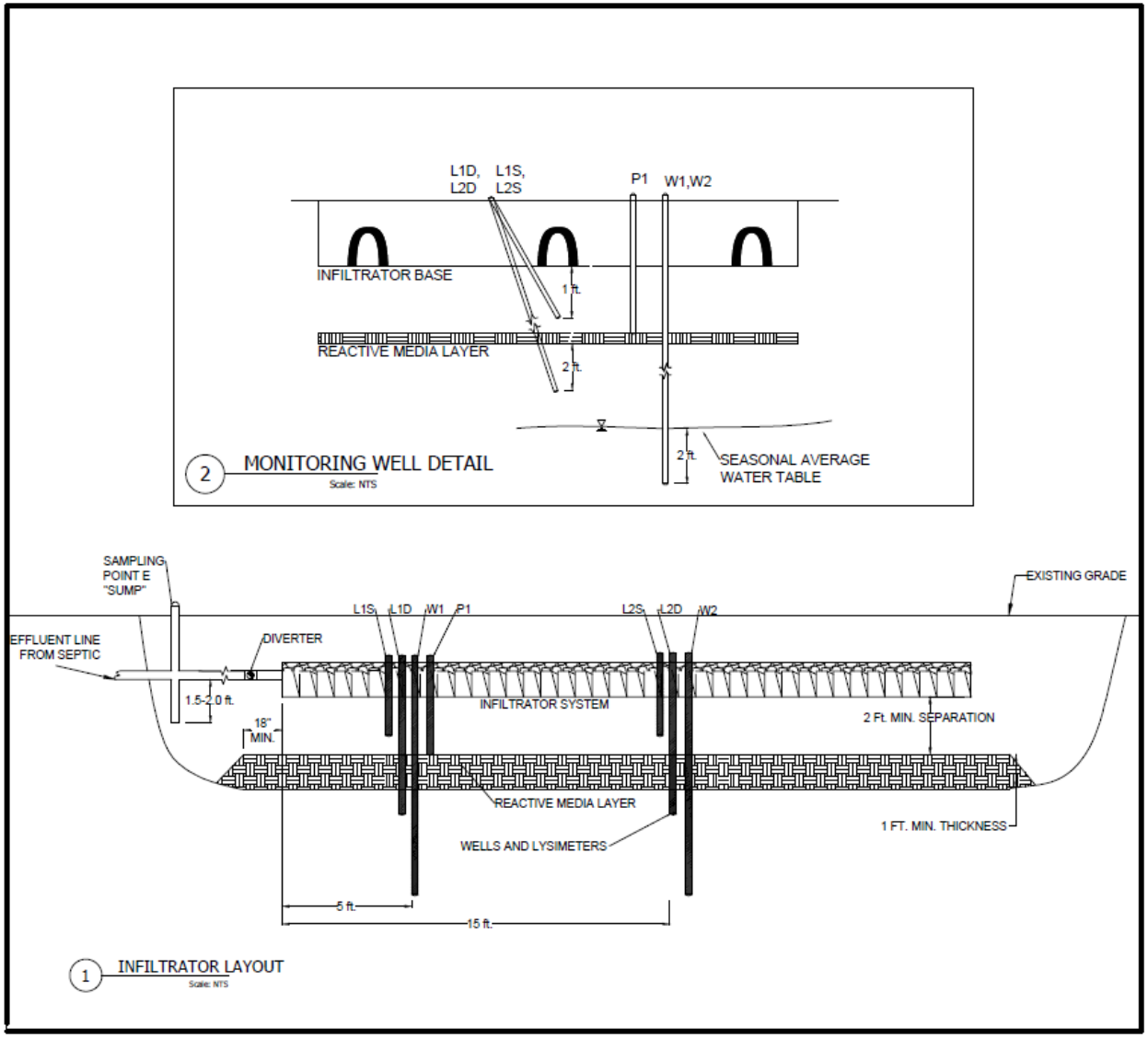
Monitoring includes

- Pore water from lysimeters set above and below the mulch layer
- Shallow ground water from beneath the drainfield
- Septic tank effluent
- Water level in a shallow piezometer to measure mounding

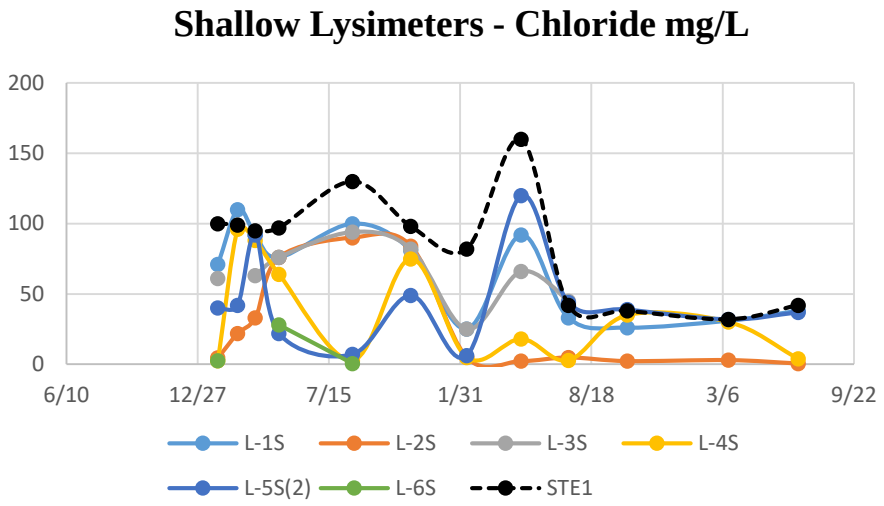
Plan view

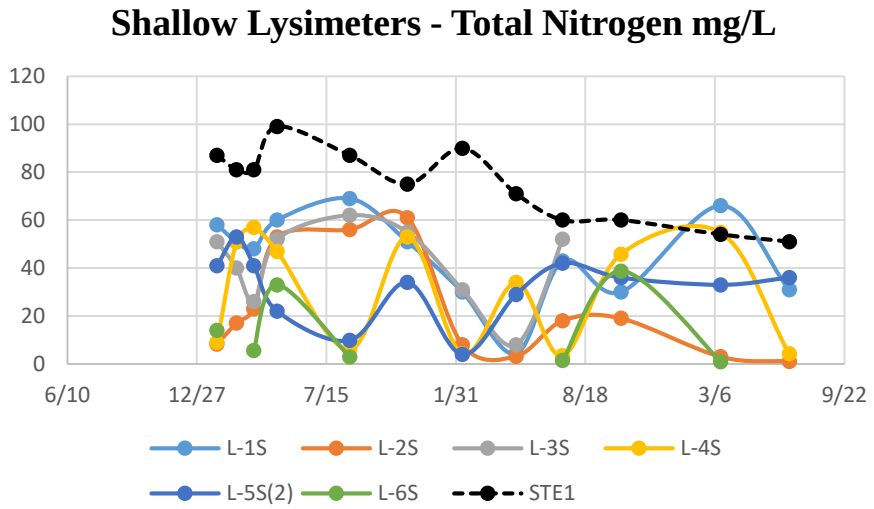

45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
0
-3
East
-3
0
3
6
9
12
15
South
W2
L2-D
L2-S
L4-D
L4-S
L6-D
L6-S
W1
P1
L1-D
L1-S
L3-D
L3-S
L5-D
L5-S
mulch
Lysimeters
North row
middle row
South row
Header
Shallow lysimeter
Deep lysimeter
Monitoring well
Piezometer

Cross section

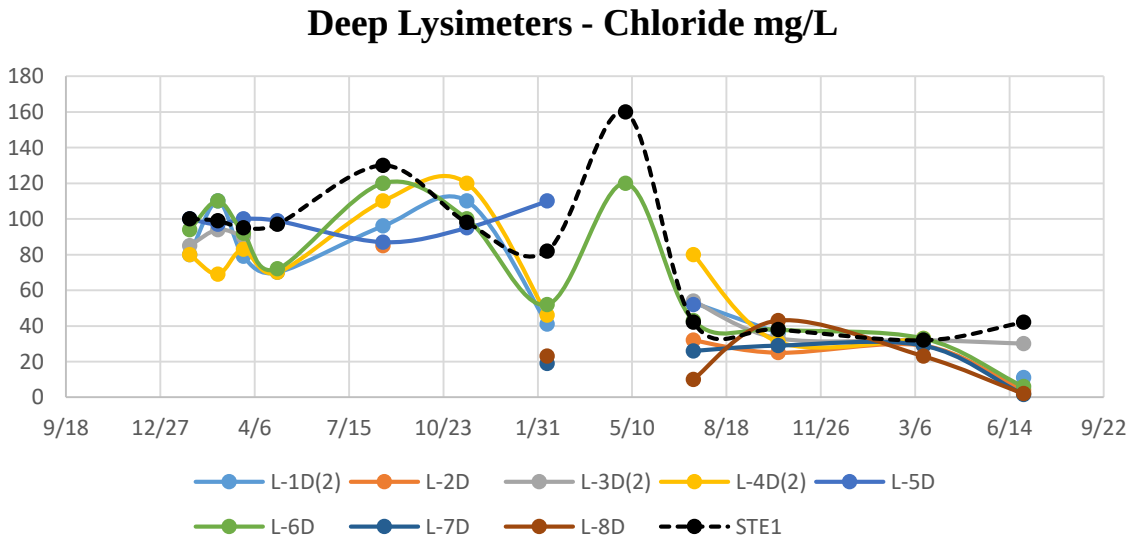


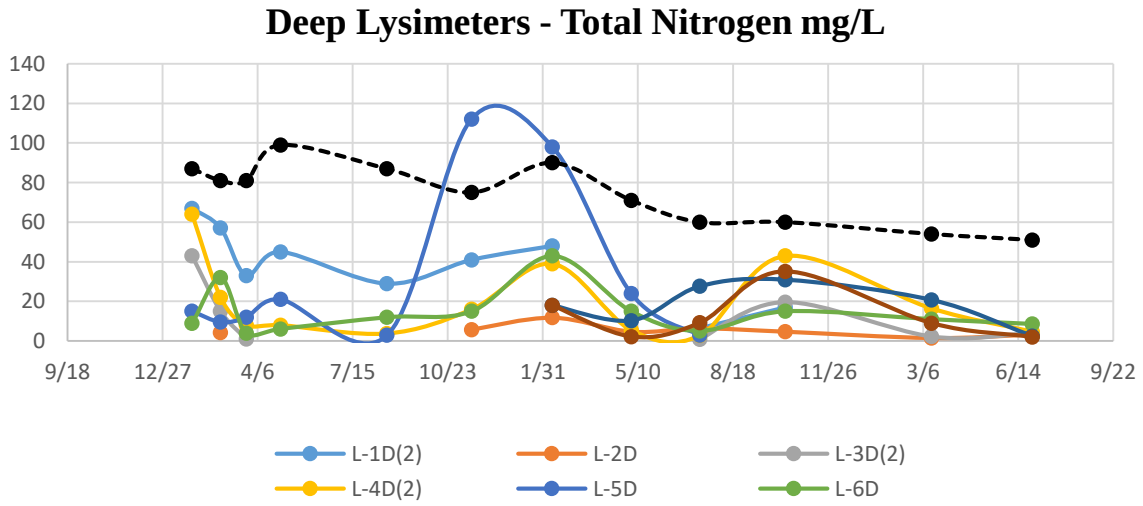
Shallow Lysimeter Data





Deep lysimeter data

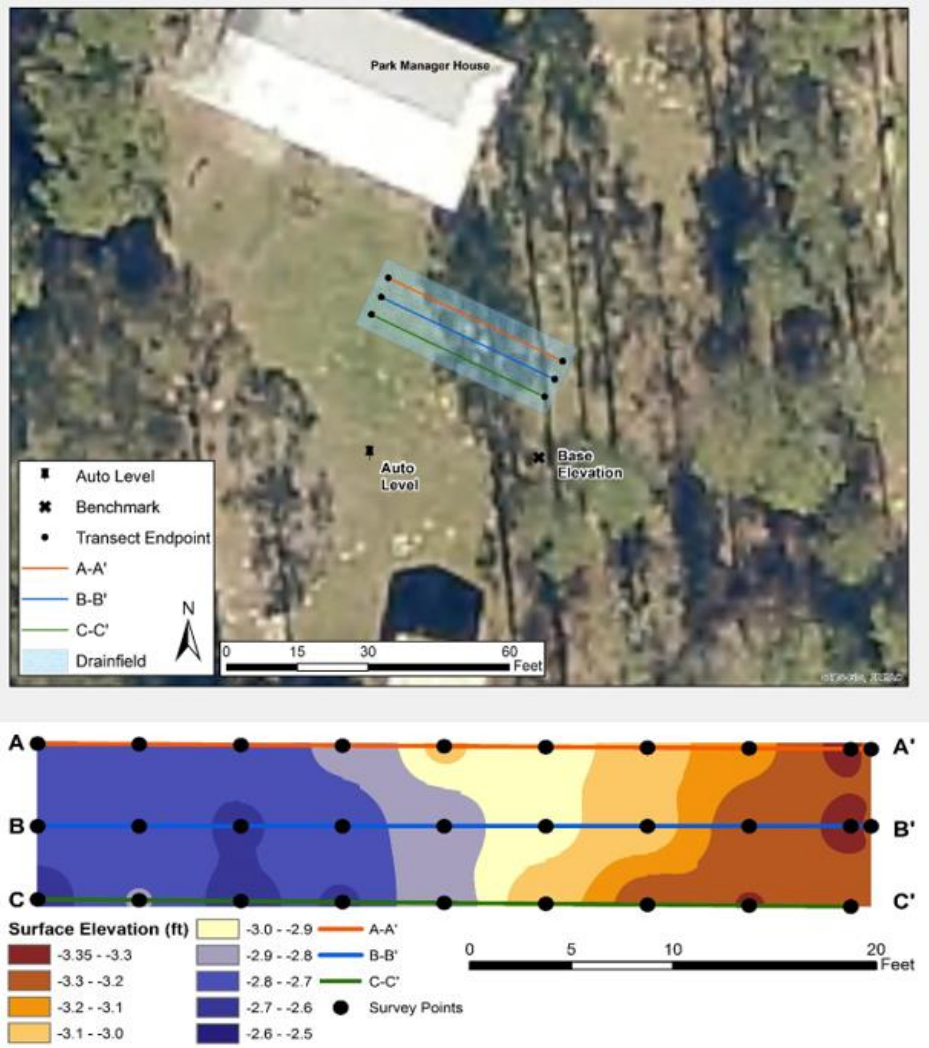




Groundwater monitoring

- Water table at about 20-24 ft below land surface
- Two wells installed between infiltrator rows
- Beneath active drainfield nitrate ranged from 18 to 26 mg/L over the past year, increasing from original background concentration of 3.3 mg/L

Evaluating subsidence



Figure·13.·Land·Surface·Elevation·(LSE)·Survey·of·Drainfield·July·2017¶

Evaluating mulch condition

March·2014¶

¶

January·2015¶

¶

July2017¶

¶

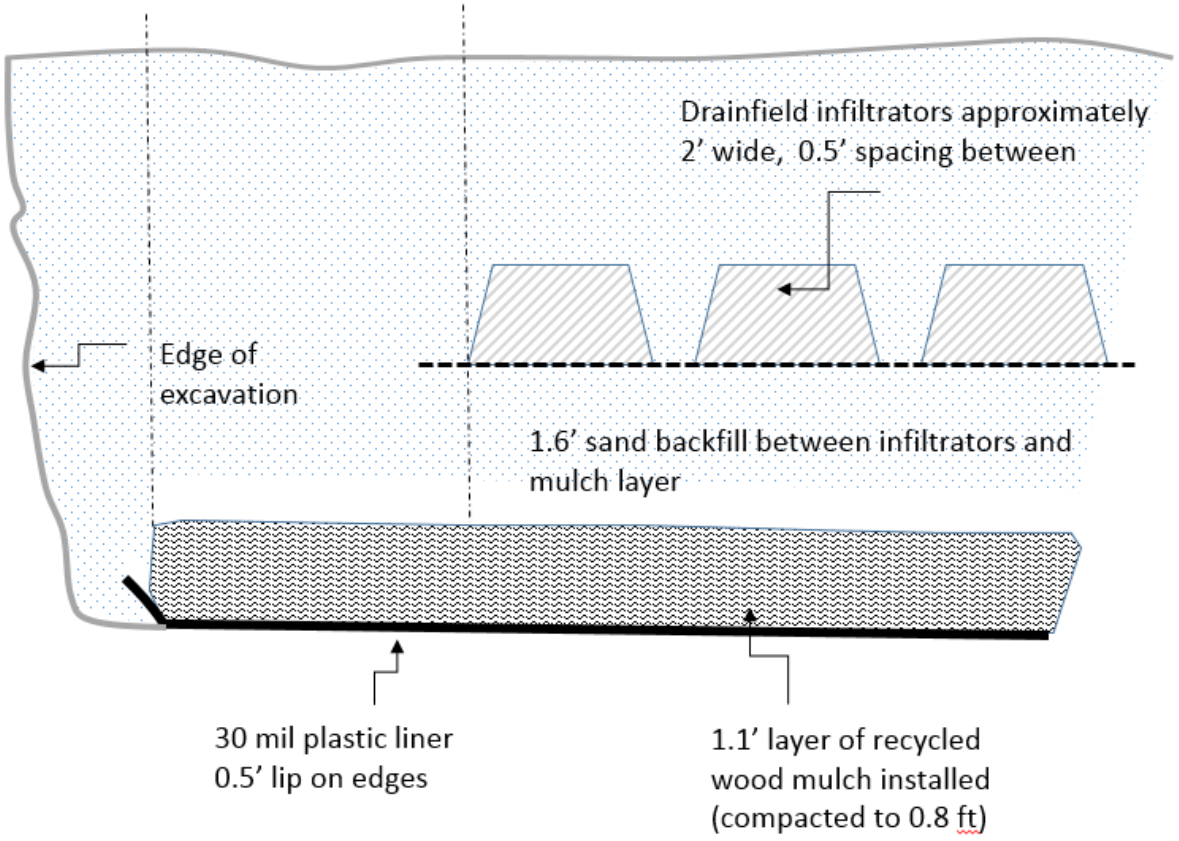
Figure·15.·Photographs·of·mulch·from·March·2014(at·installation),·January·2015·and·July·2017¶

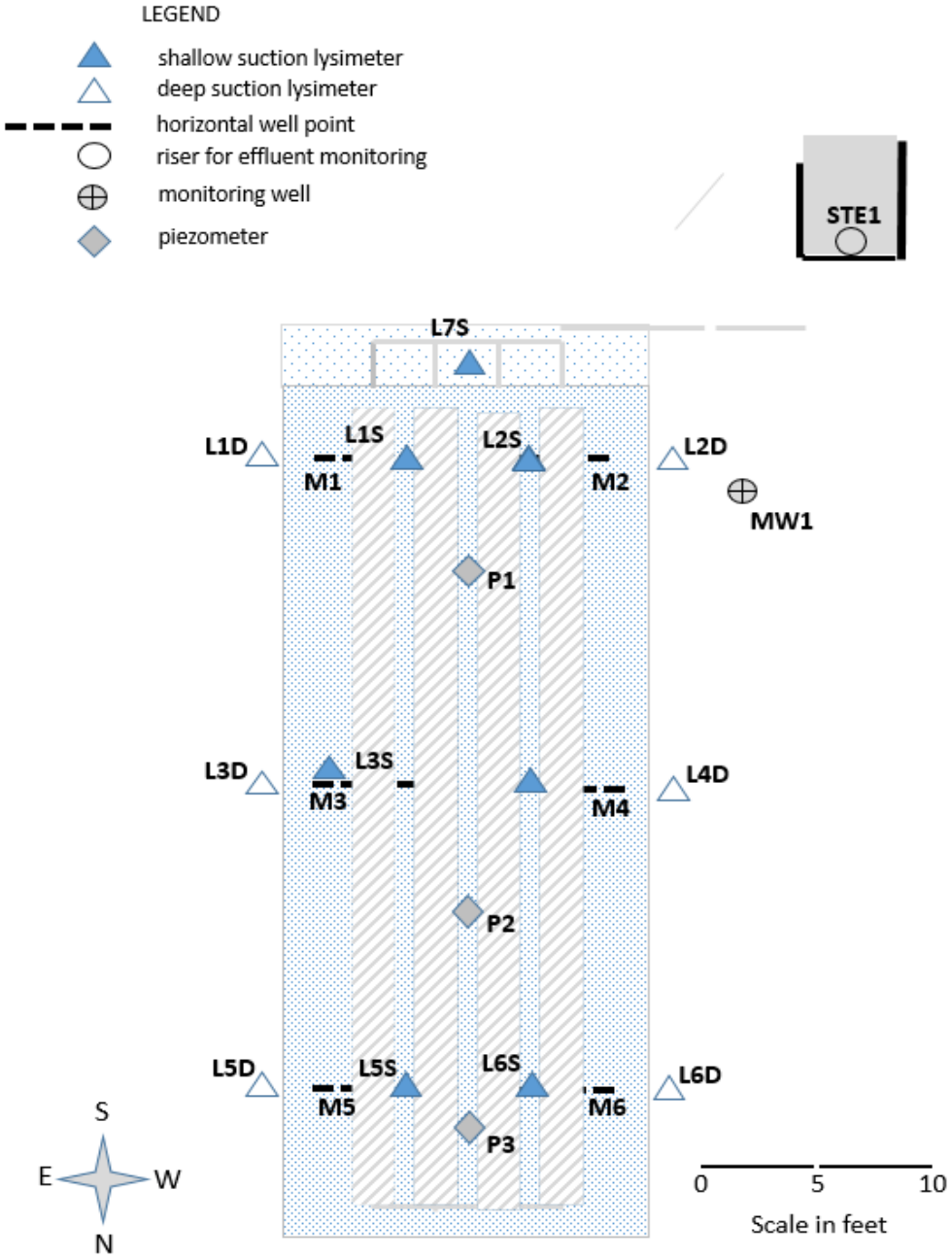
Apopka Lined Drainfield Site

- Experimental drainfield
  - Passive drainfield with mulch on liner
  - Recycled wood mulch
  - No pump
  - Installed August 2016
  - Monthly monitoring for 1 year followed by quarterly monitoring


Power line
Driveway
Experimental drainfield
Pre-existing drainfields
Septic tank
Water well
0
12.5
25
50 Feet

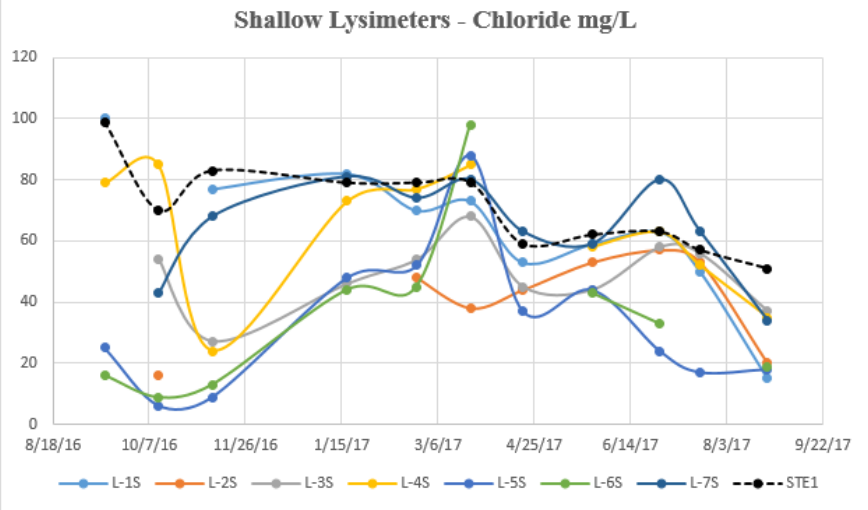
Wood mulch and liner extend
3-5’ beyond edge of drainfield



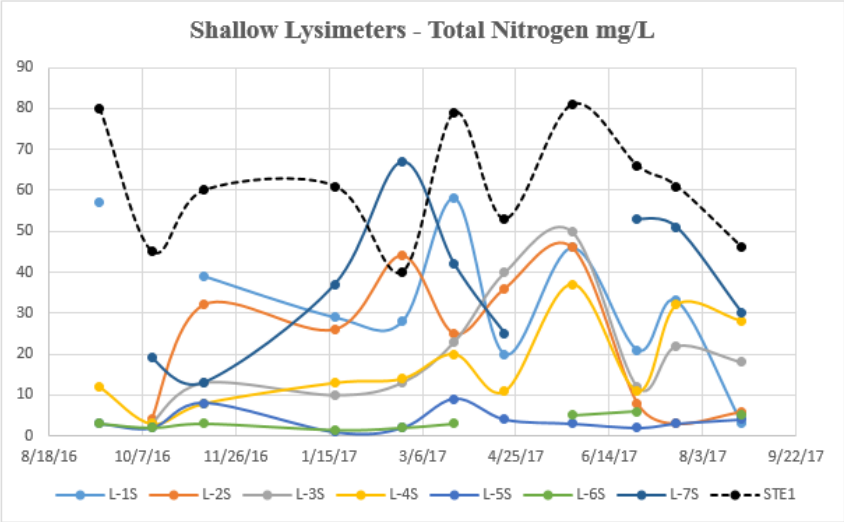

LEGEND
shallow suction lysimeter
deep suction lysimeter
horizontal well point
riser for effluent monitoring
monitoring well
piezometer
STE1
L7S
L1D
L1S
M1
L2S
M2
L2D
MW1
P1
L3D
L3S
M3
M4
L4D
P2
L5D
L5S
M5
L6S
M6
L6D
P3
S
E
W
N
0
5
10
Scale in feet


CASE

Shallow Lysimeter Results for First Year

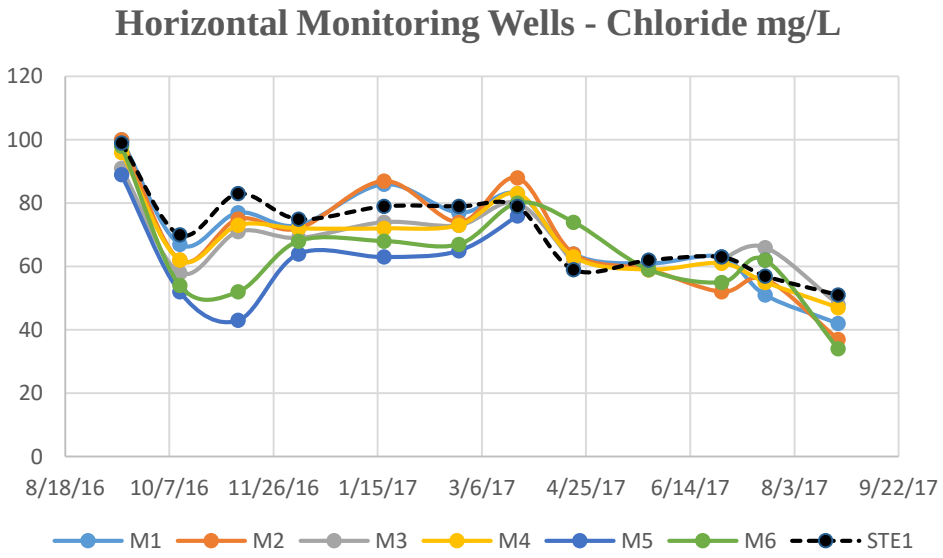


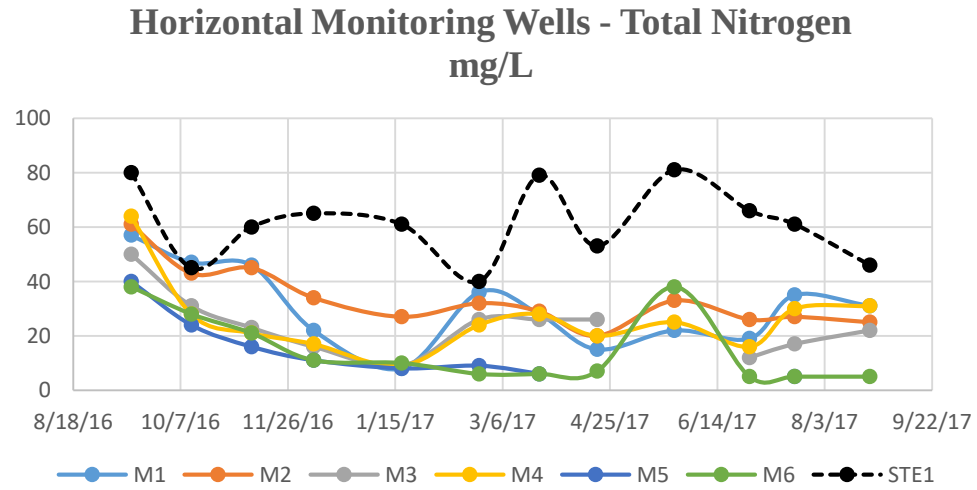
Figure·4.··Shallow·Lysimeters·–·Chloride·mg/L¶



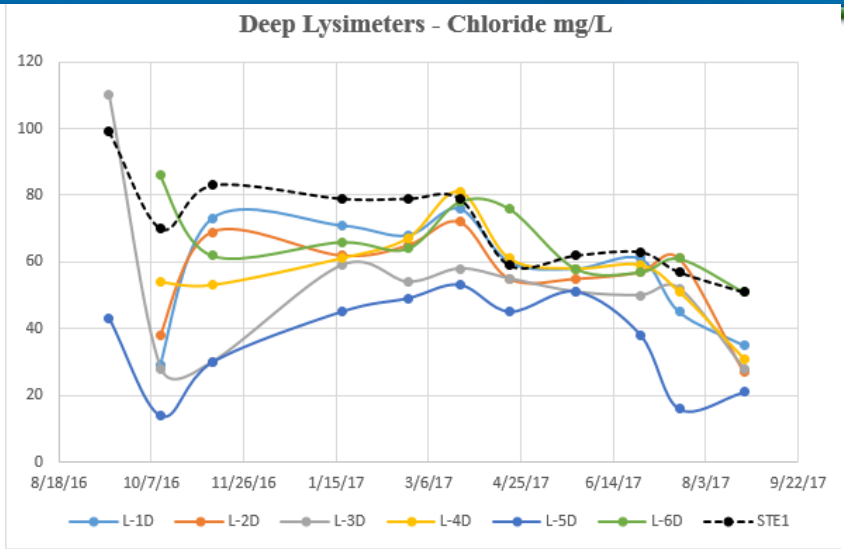
Figure·5.··Shallow·Lysimeters·–·Total·Nitrogen·mg/L¶

Horizontal Well Results for First Year

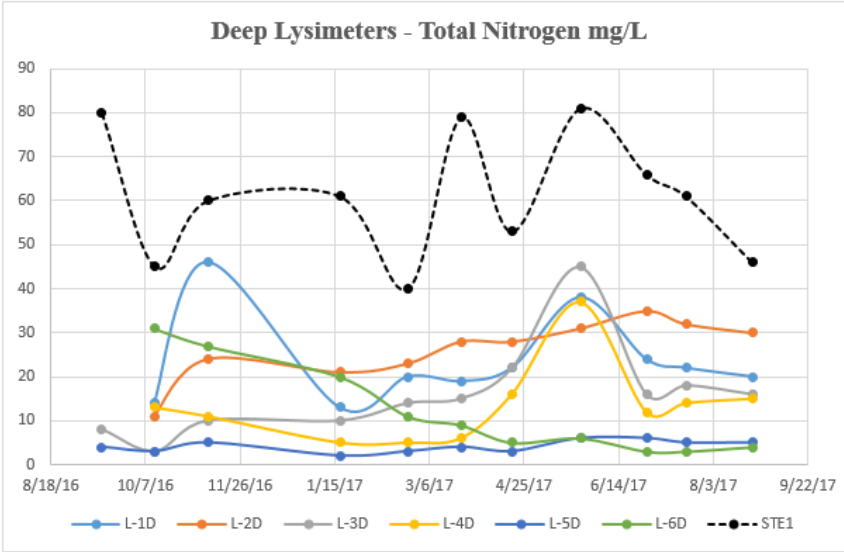




Deep Lysimeter Results for First Year



Figure·10.··Deep·Lysimeters·–·Chloride·mg/L¶



Figure·11.··Deep·Lysimeters·–·Total·Nitrogen·mg/L¶

Groundwater Monitoring

- One well adjacent to active end of drainfield
- Nitrate increased from 3.5 mg/L pre-installation to 6.0 mg/L one year later
- Depth to groundwater about 30 feet below land surface

Questions?