Florida Department of Environmental Protection

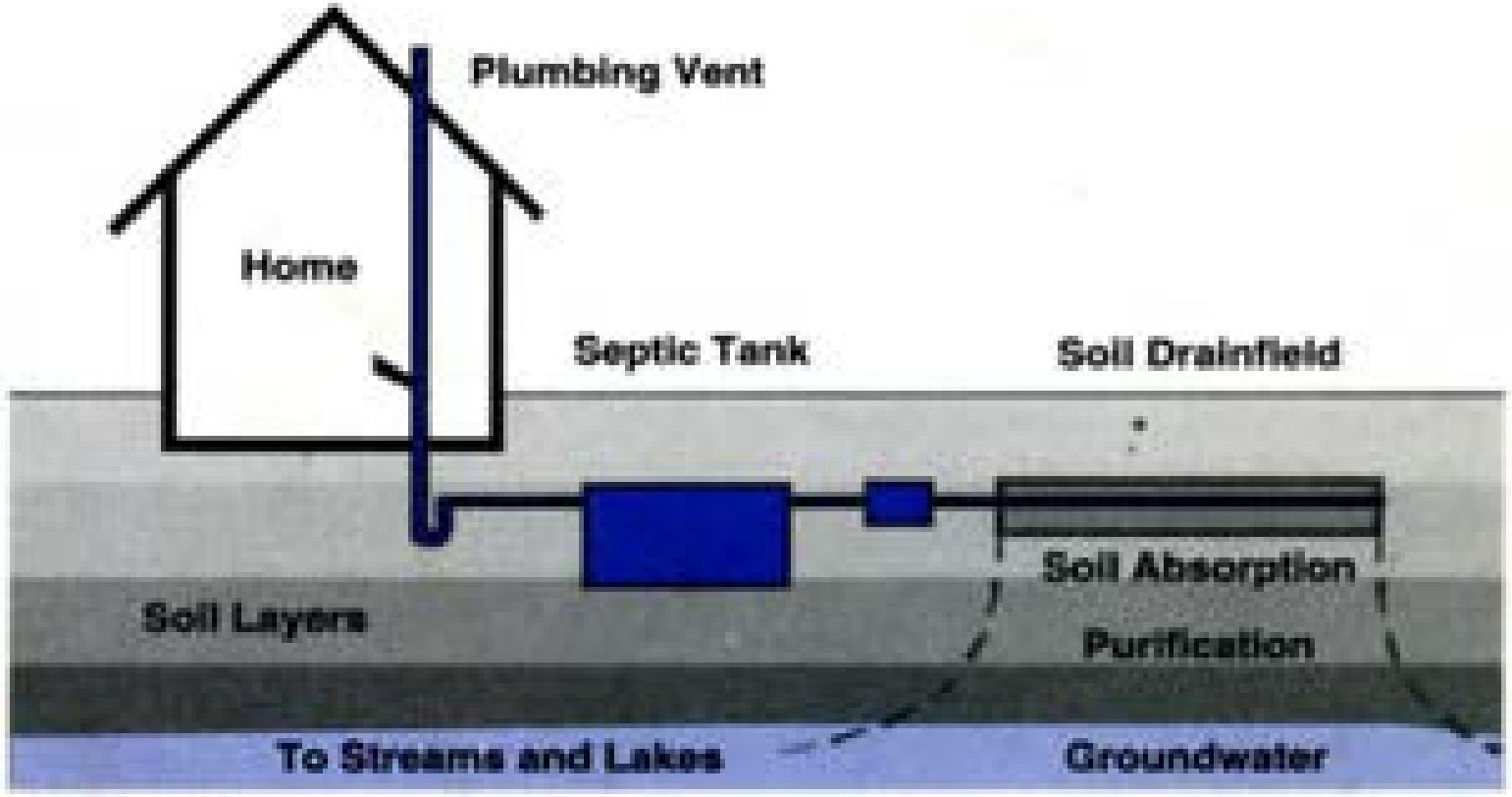
Update on Wekiva Septic Tank Research Activities

May 16, 2017





Typical Septic System



Study Objectives

The results of study helps us better understand:

- Attenuation and leaching of nitrogen from existing septic systems into the soil and ground water
- Other sources of nitrogen in residential areas
- Conditions that may influence nitrogen attenuation local to this area

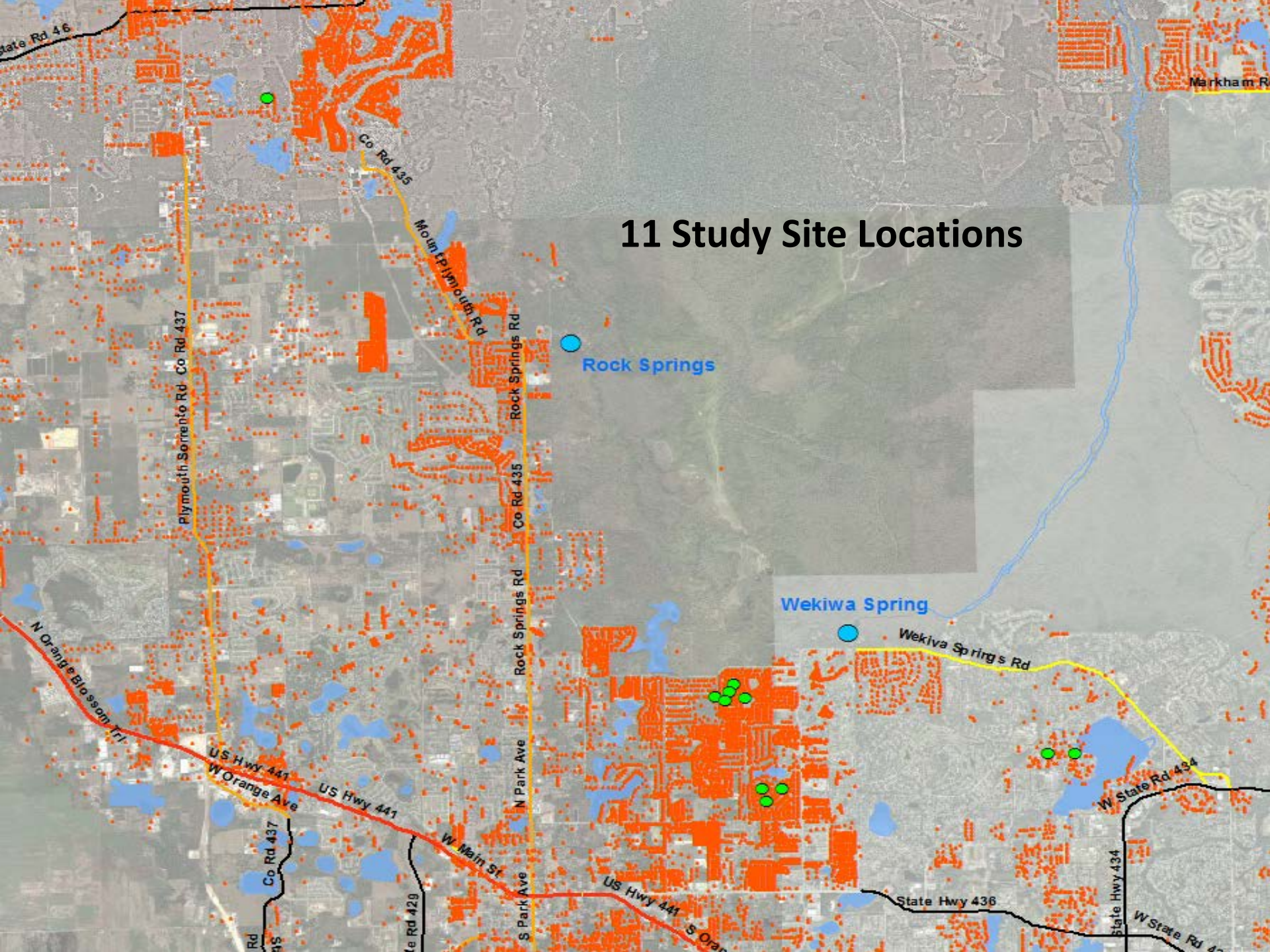
Chronology

Chronology of Activities

Date	Activity
December 2014	Study plan development and coordination with CPR
December 2014	SF6 injection, Rock Springs well
March 2015	Meeting with homeowners to discuss project and initial site visits
April-June 2015	Solicit septic tank contractor services
June 2015	Site inspections with contractor, select 12 study sites
July-August 2015	Install lysimeters at sites, install risers, initial sampling
September 2015	SF6 injection, Wekiwa Spring well
October 2015	Begin bi-monthly sampling
February 2016	Meeting with homeowners, interim findings
February 2016	Remove lysimeters Site H
February 2016	Install deep lysimeters at sites A, B, E,F, G,
March 2016	Pump septic tanks at 4 sites (A, B, E,G)
June 2016	Deep borings at A, J, K, Install monitoring wells at J,K
July 2016	Install deeper lysimeters at sites B and E
October 2016	Finish monitoring program
January 2017	Remove lysimeters from sites
April 2017	**Report findings**

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
Co Rd 435
Mount Plymouth Rd
Rock Springs 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

Scope

- Lysimeters to monitor soil pore water below drainfields and at background locations
- Riser installation and effluent monitoring
- Monitoring wells at some locations
- Collect data on water use to estimate loading

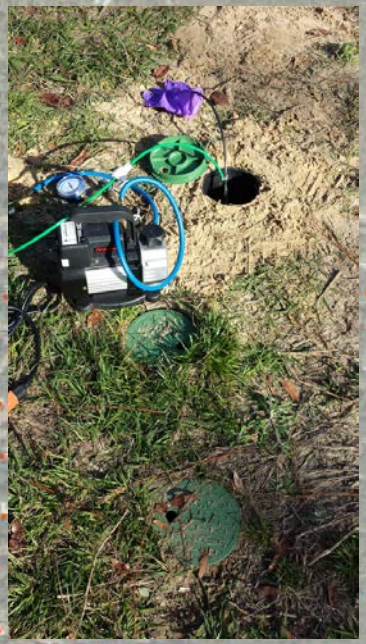
Other Activities

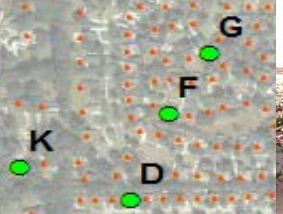
- Evaluate changes in septic tank treatment after pumping.
  - By selectively sampling septic tank effluent, pre and post pumping we hope to help provide some actual data on the potential benefit of tank pumping.
- Construct experimental alternative nitrogen reducing drainfield system(s).
  - Bold and Gold or other similar reactive media
  - Passive low-cost construction
  - Wekiwa Springs State Park location
  - Orchard Drive location
- Use data for modeling purposes, “STUMOD”

Nutrient Levels in Soil Pore Water

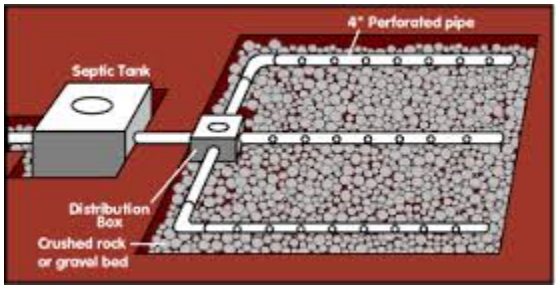
Site	Lysimeters Installed	Total Depth (ft below land surface)	Location
A	AL1S-AL4S	5	Drainfield
	AL5S	5	Background
	AL2D	10	Drainfield adjacent to AL2S
B	BL1S-BL4S	5	Drainfield
	BL5S	5	Background
	BL3D	10	Drainfield, adjacent to BL3S
	BL3E	15	Drainfield, adjacent to BL3S
C	CL1S-CL3S	5	Drainfield
	CL4S	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





Types of drainfields in study



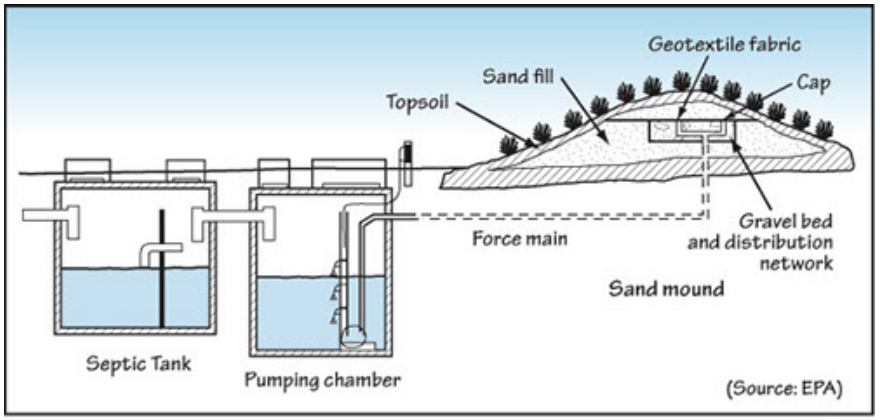


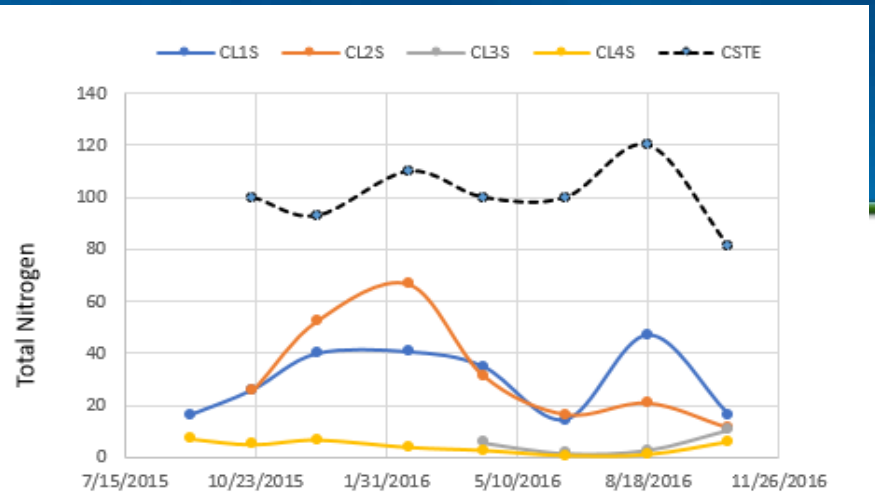
Figure 4 - Schematic of a Sand Mound System

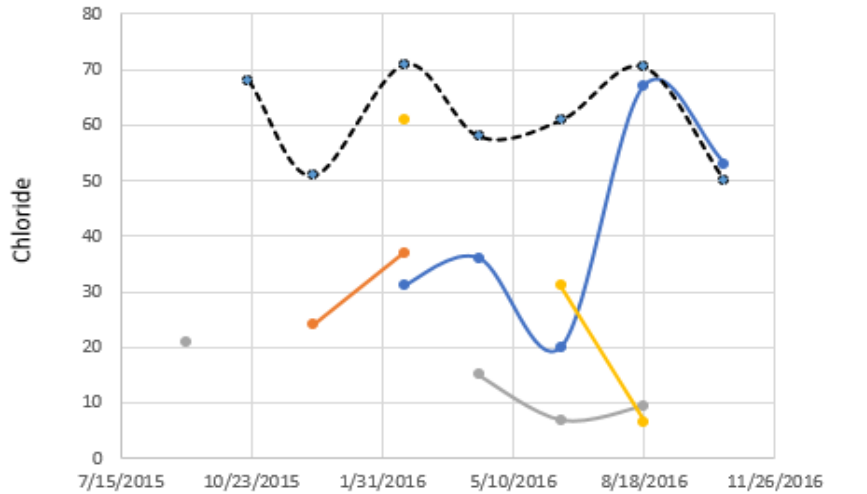
Septic Tank Effluent Sampling

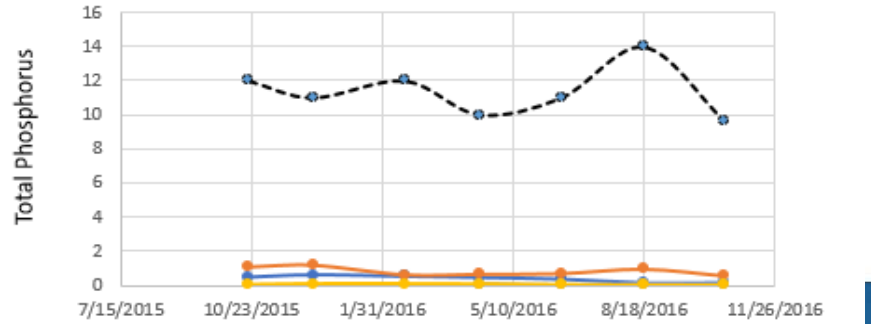
Septic tank effluent samples collected bimonthly at 8 sites

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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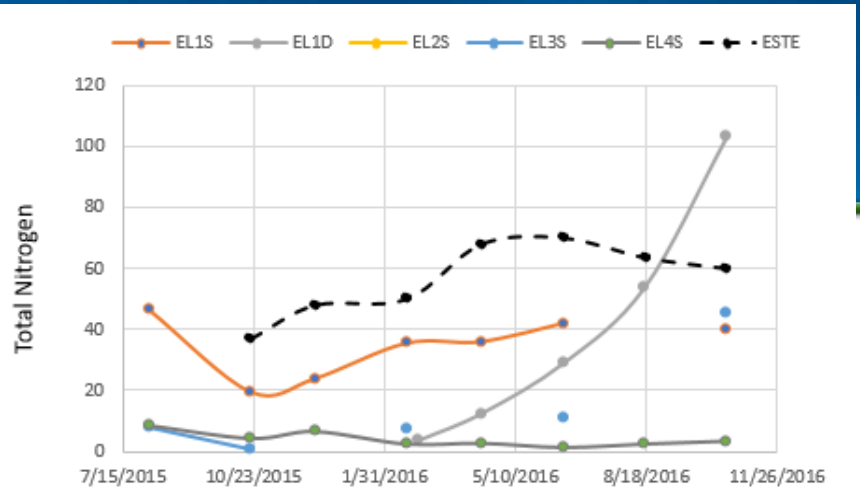
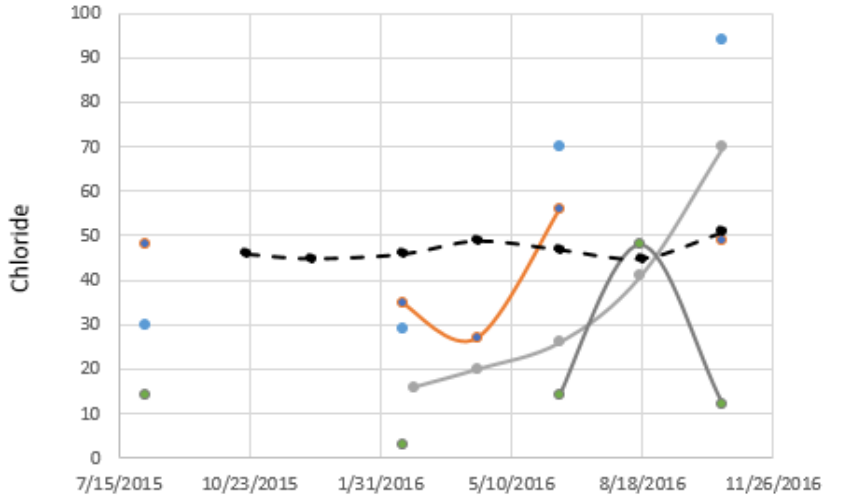
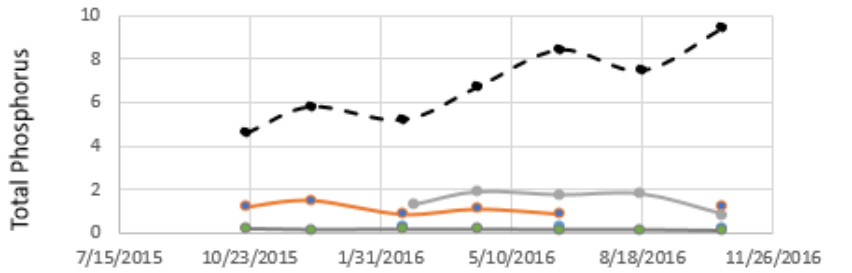
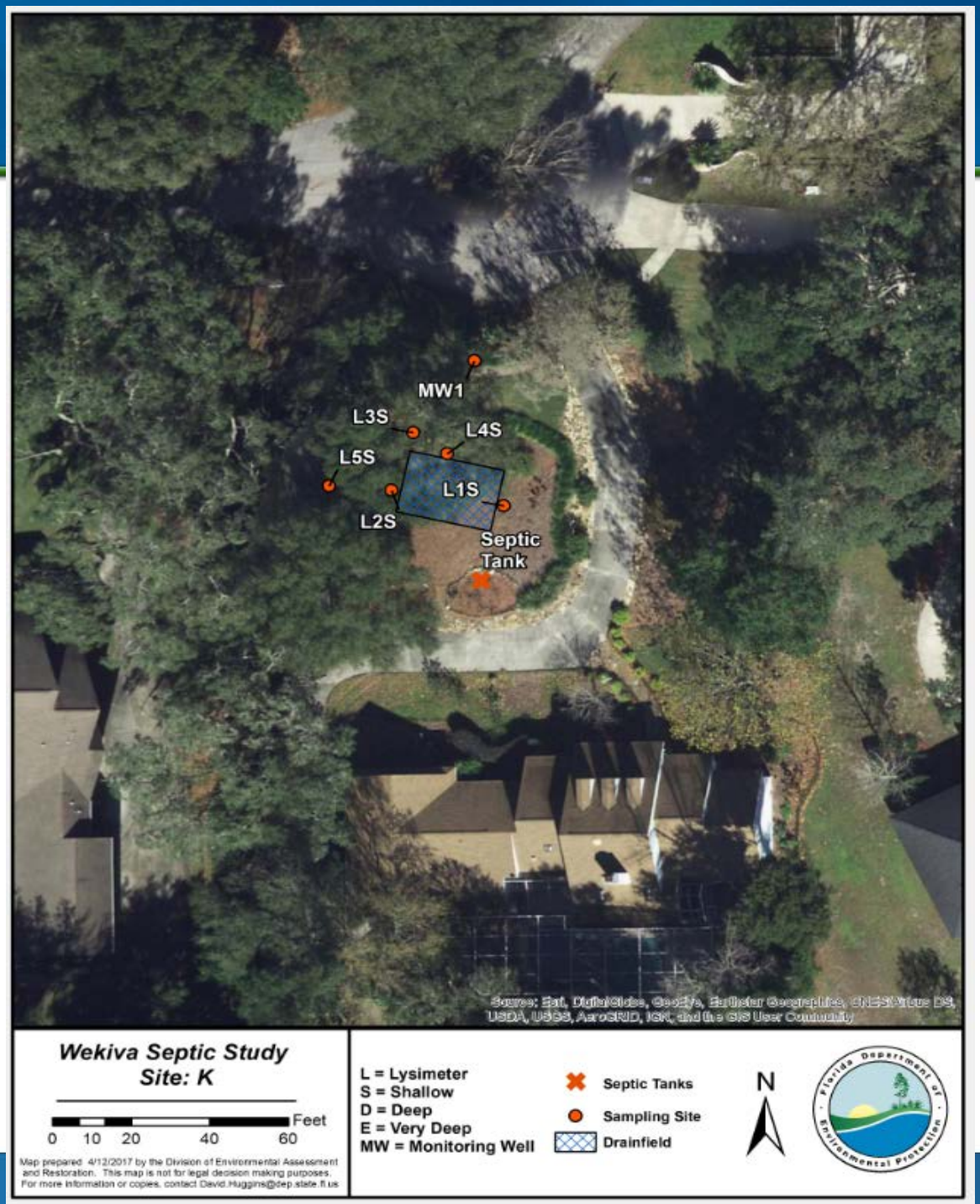
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


EL1S
EL1D
EL2S
EL3S
EL4S
ESTE
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
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


MW1
L3S
L4S
L5S
L1S
L2S
Septic Tank
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: K
0 10 20 40 60 Feet
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
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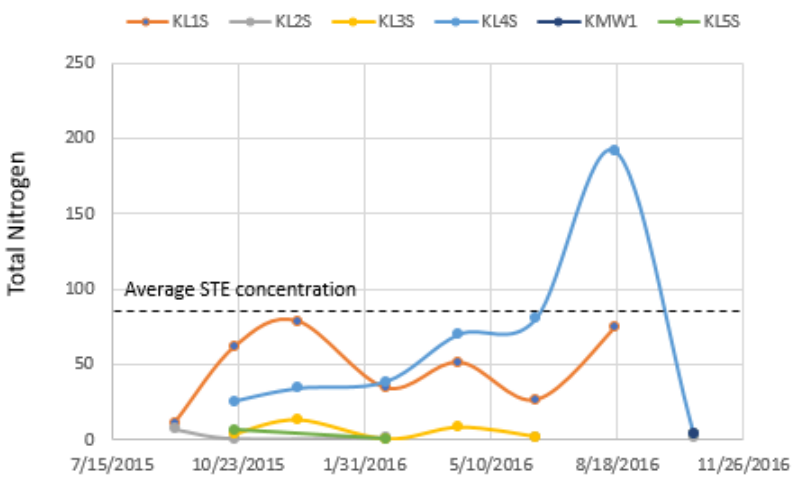
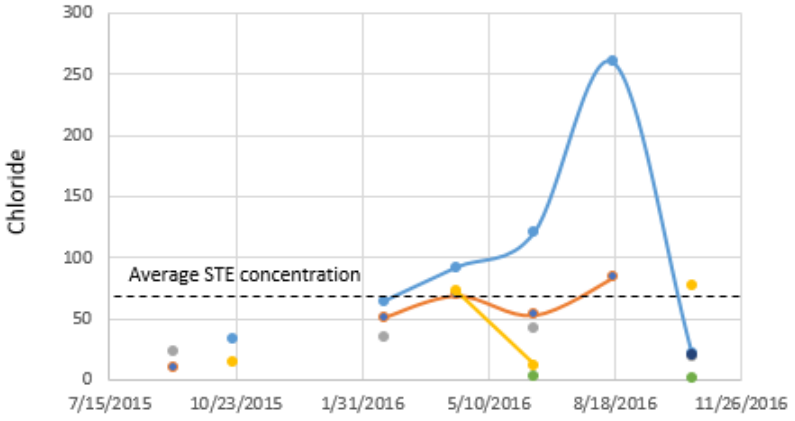
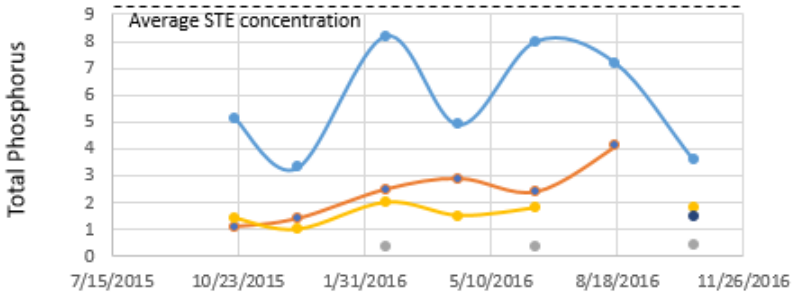
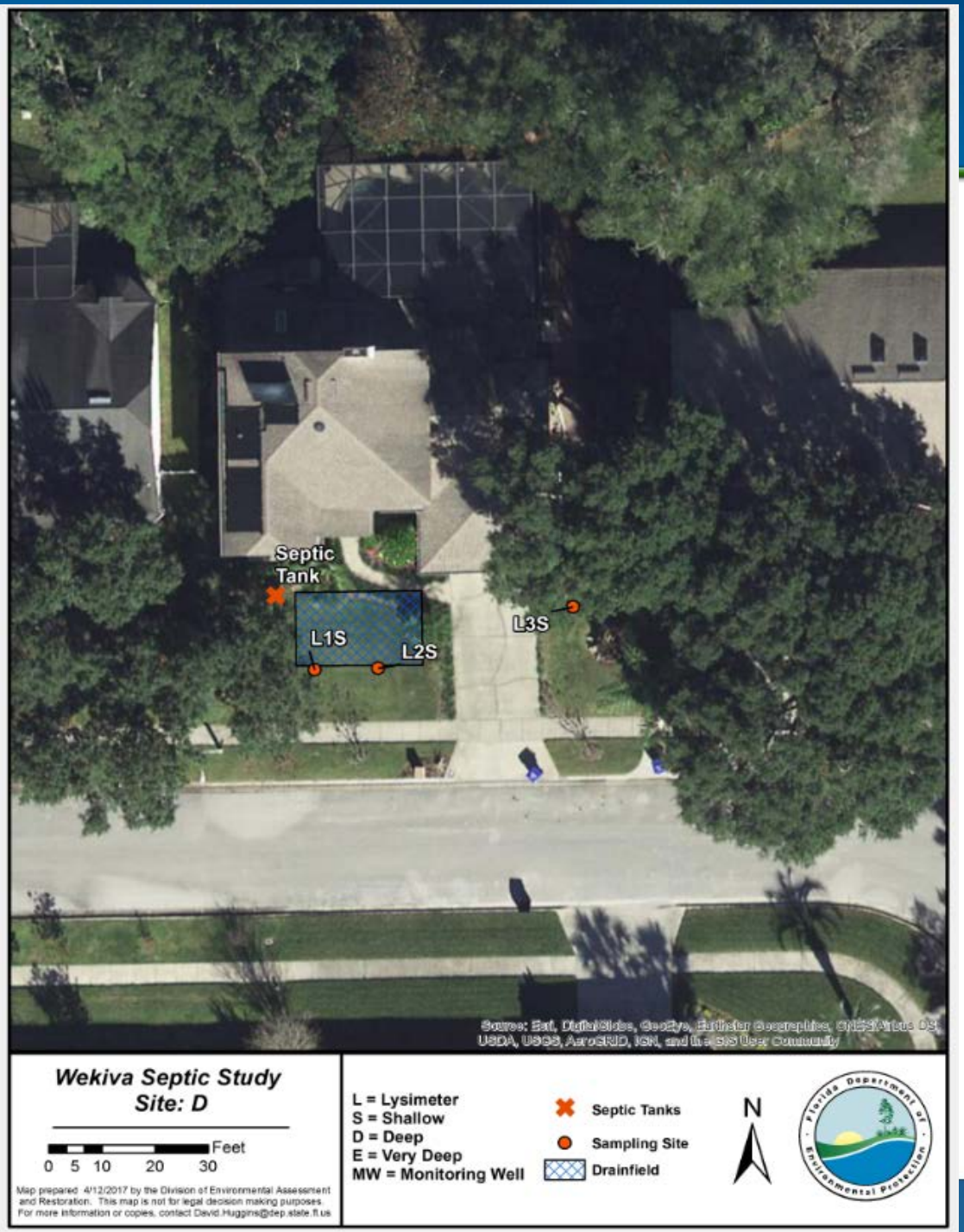
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


KL1S
KL2S
KL3S
KL4S
KMW1
KL5S
Total Nitrogen
250
200
150
100
50
0
Average STE concentration
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Chloride
300
250
200
150
100
50
0
Average STE concentration
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
1
0
Average STE concentration
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


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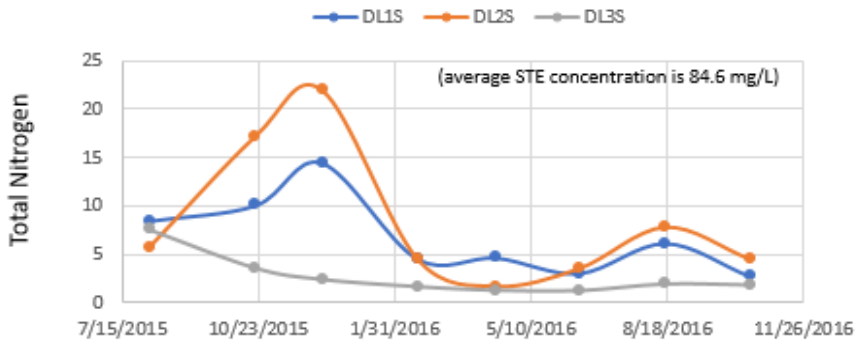
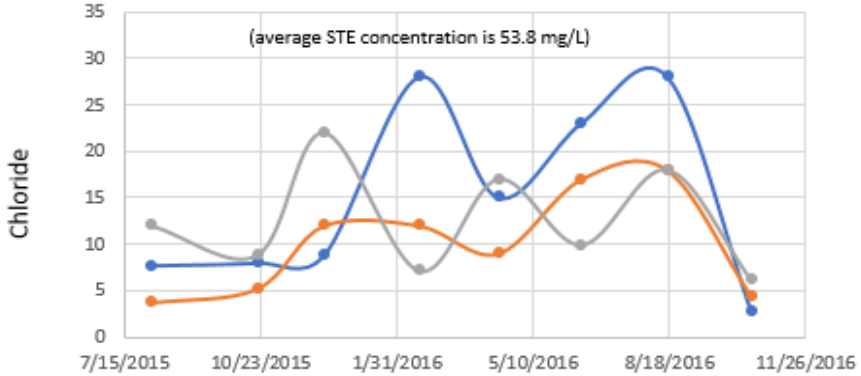
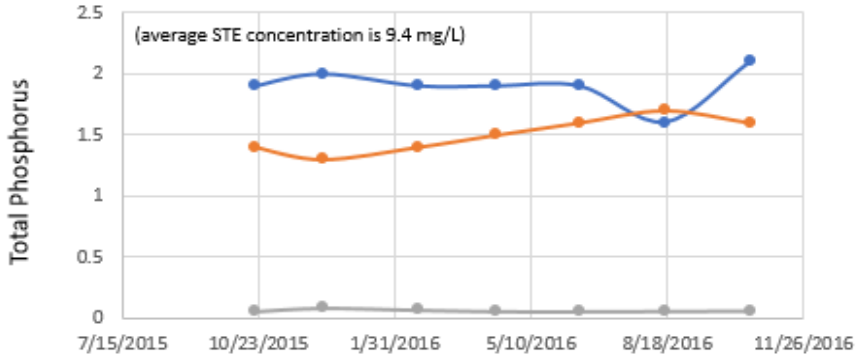
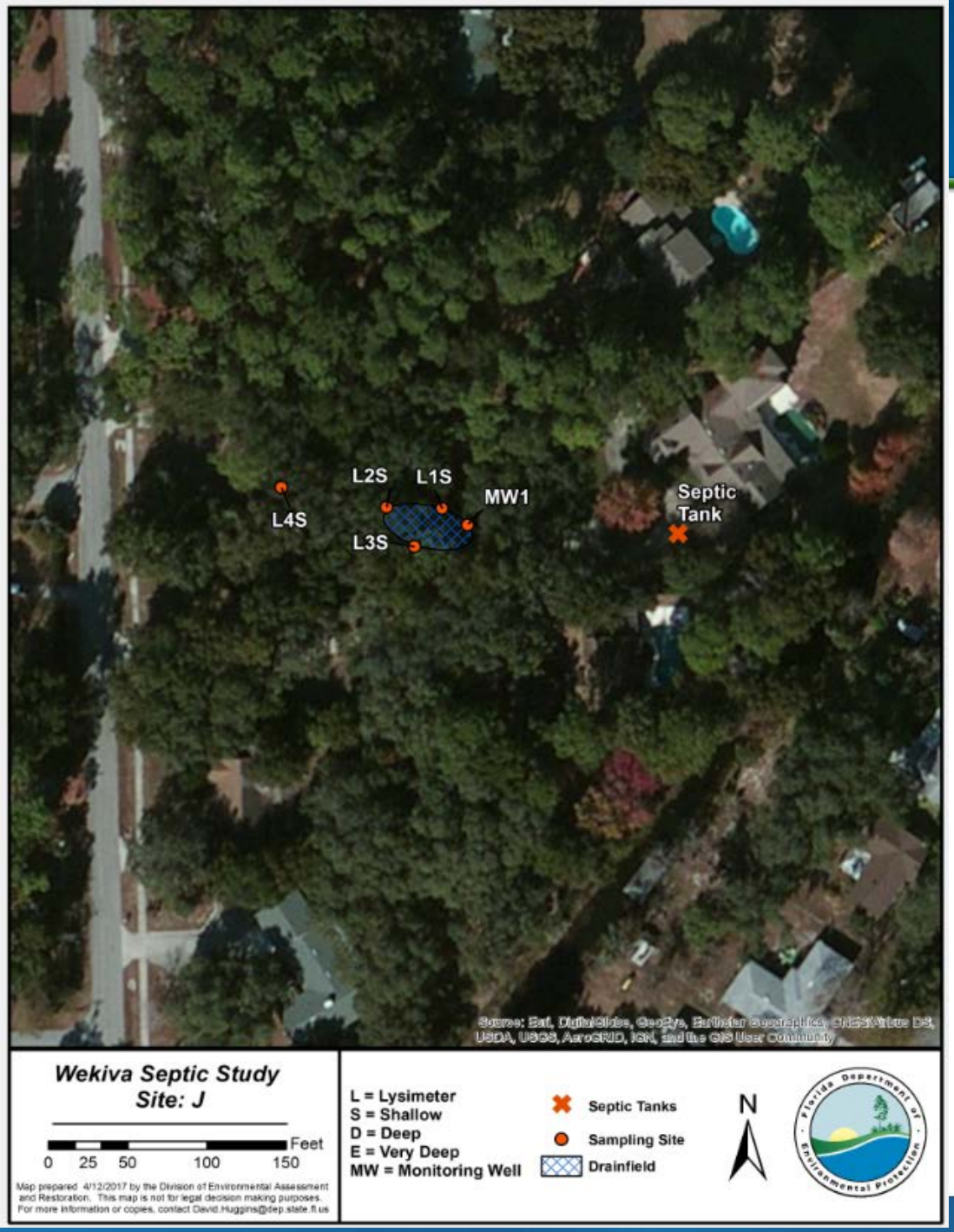
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


DL1S
DL2S
DL3S
Total Nitrogen
(average STE concentration is 84.6 mg/L)
25
20
15
10
5
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Chloride
(average STE concentration is 53.8 mg/L)
35
30
25
20
15
10
5
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


Total Phosphorus
(average STE concentration is 9.4 mg/L)
2.5
2
1.5
1
0.5
0
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016


L2S
L1S
MW1
L4S
L3S
Septic Tank
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Wekiva Septic Study
Site: J
Feet
0 25 50 100 150
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
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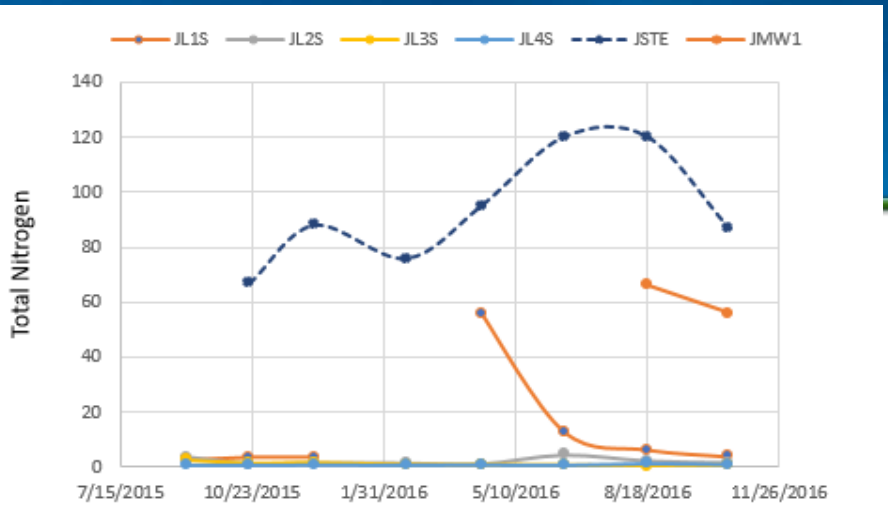
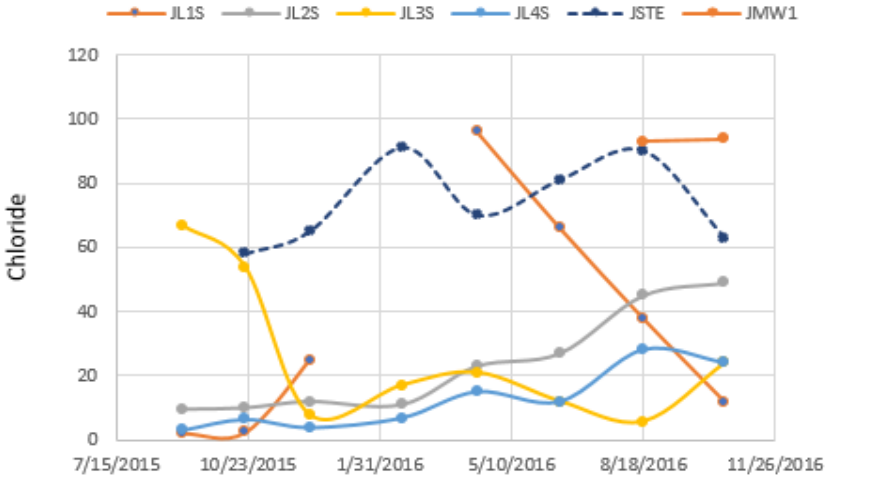
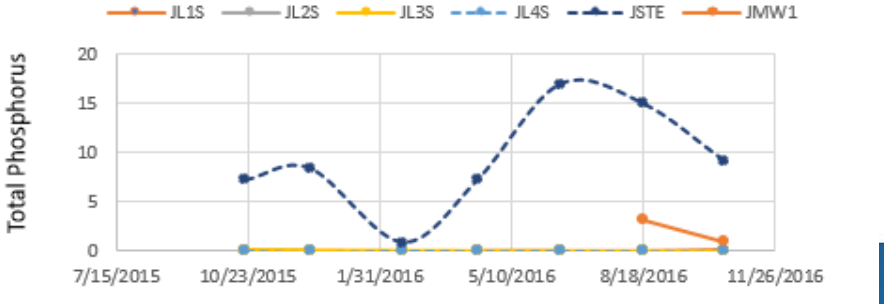
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


JL1S
JL2S
JL3S
JL4S
JSTE
JMW1
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


JL1S
JL2S
JL3S
JL4S
JSTE
JMW1
Chloride
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


JL1S
JL2S
JL3S
JL4S
JSTE
JMW1
Total Phosphorus
20
15
10
5
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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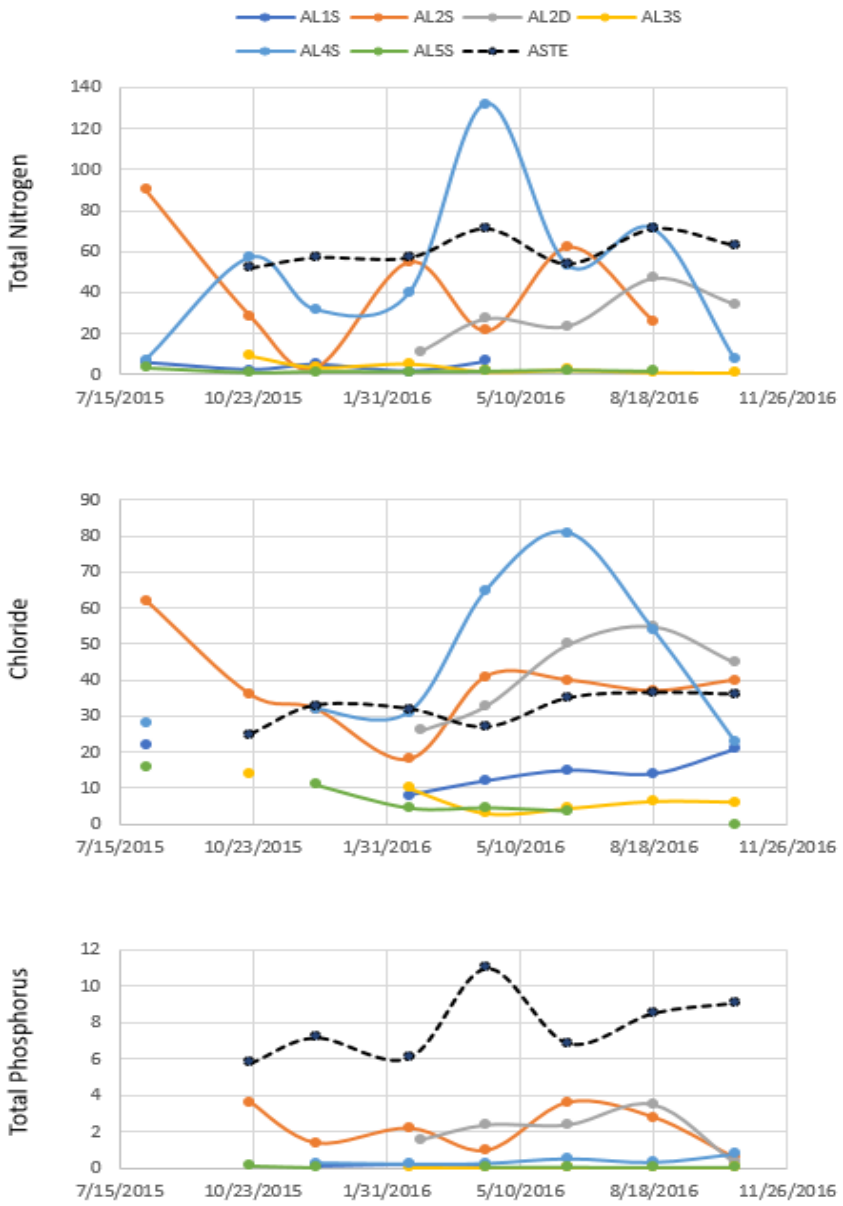
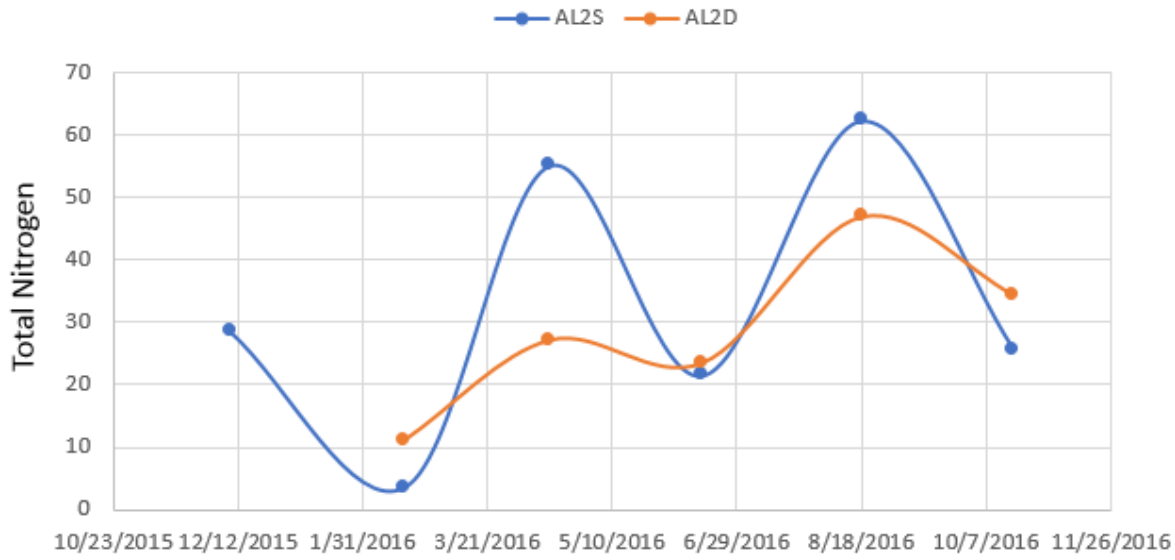
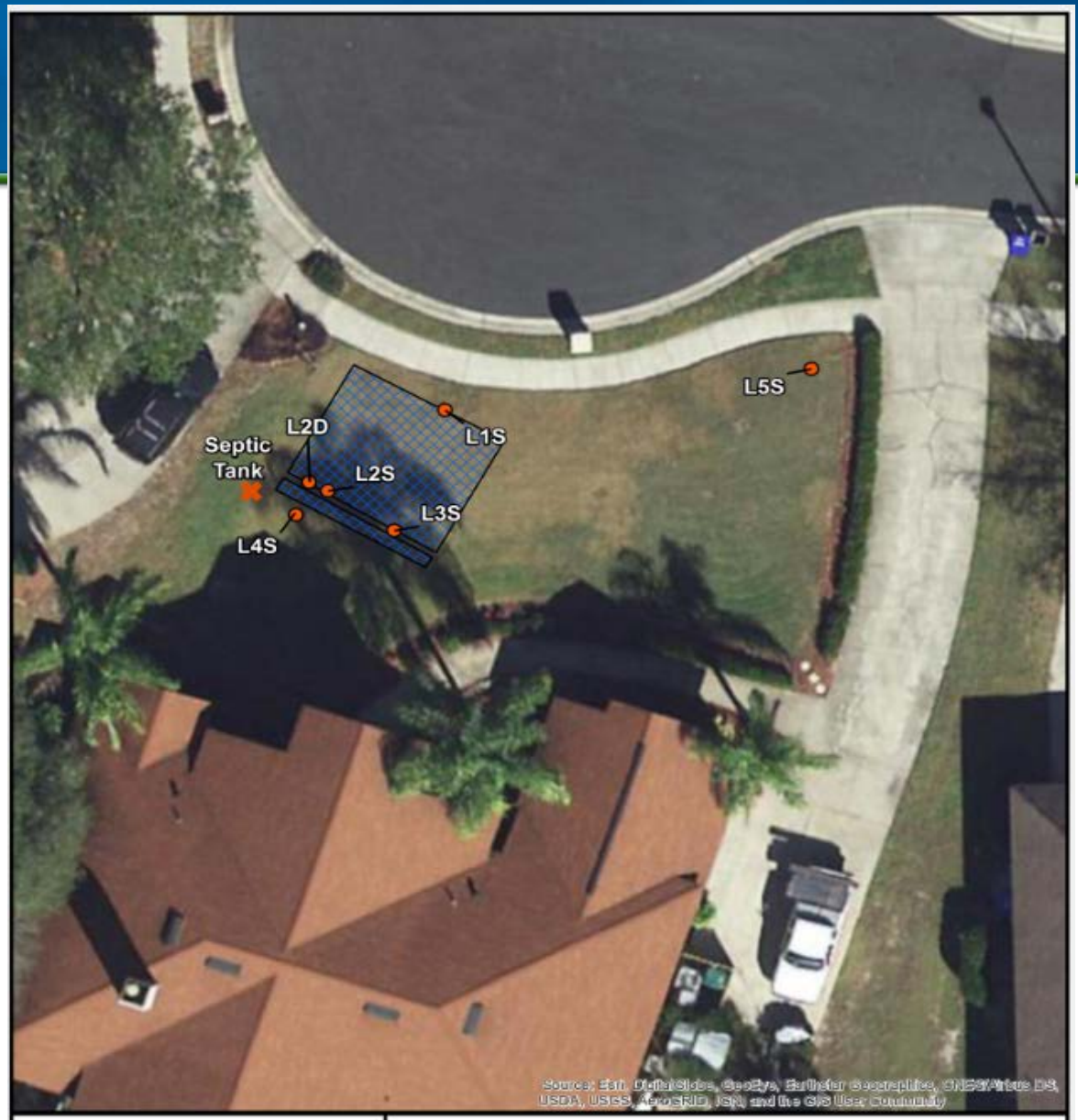
L = Lysimeter
S = Shallow
D = Deep
E = Very Deep
MW = Monitoring Well
Septic Tanks
Sampling Site
Drainfield
N


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



Wekiva Septic Study
Site: F

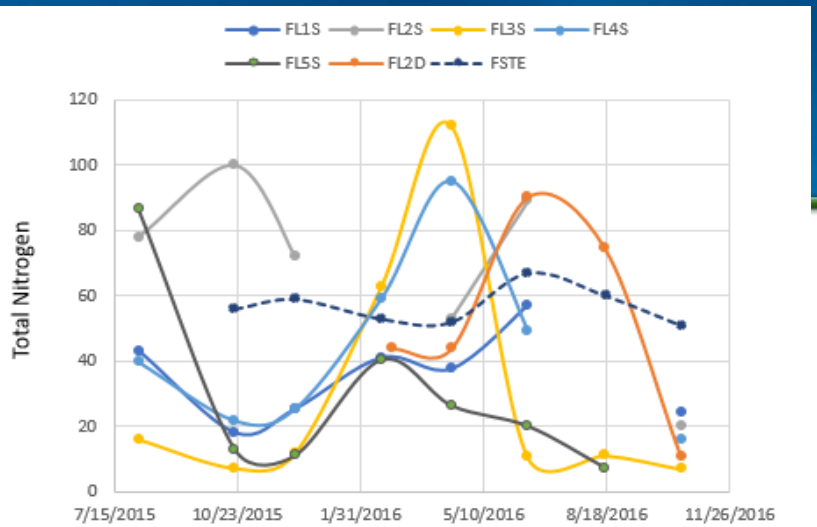
0 5 10 20 30 Feet

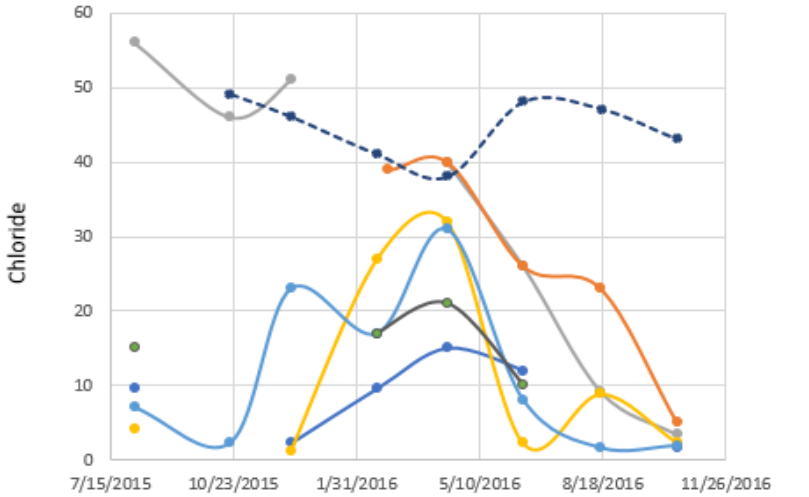
Map prepared 4/12/2017 by the Division of Environmental Assessment and Restoration. This map is not for legal decision making purposes. For more information or copies, contact David.Huggins@dep.state.fl.us

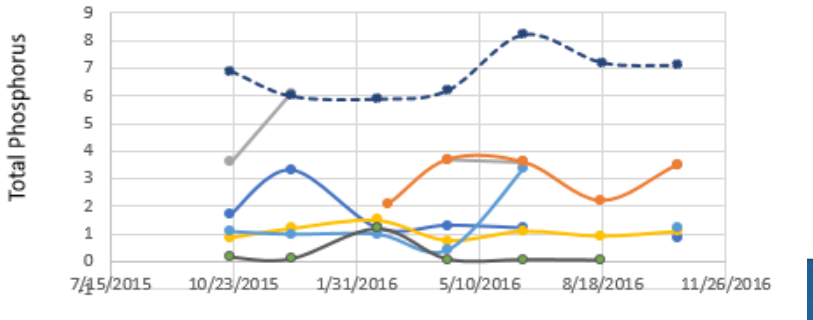
L = Lysimeter
S = Shallow
D = Deep
E = Very Deep
MW = Monitoring Well

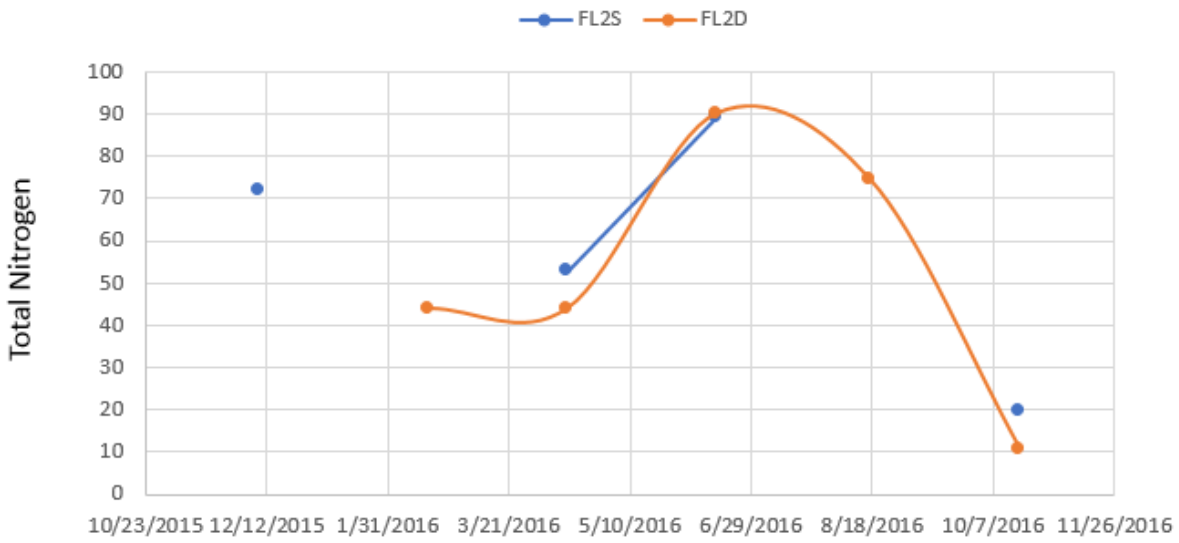
Septic Tanks
Sampling Site
Drainfield

N


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
30
20
10
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
1
0
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 40 % (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

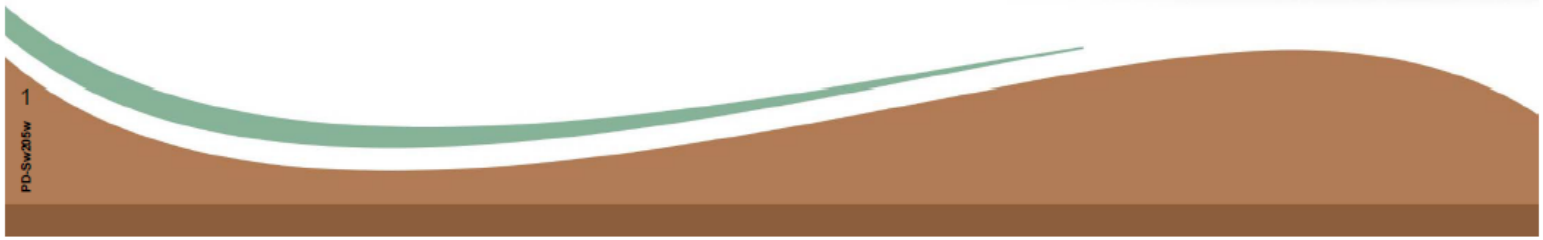
FOSNRS 6: STUMOD-FL - A Tool for Predicting Fate and Transport of Nitrogen in Soil Treatment Units in Florida

April 7, 2014

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

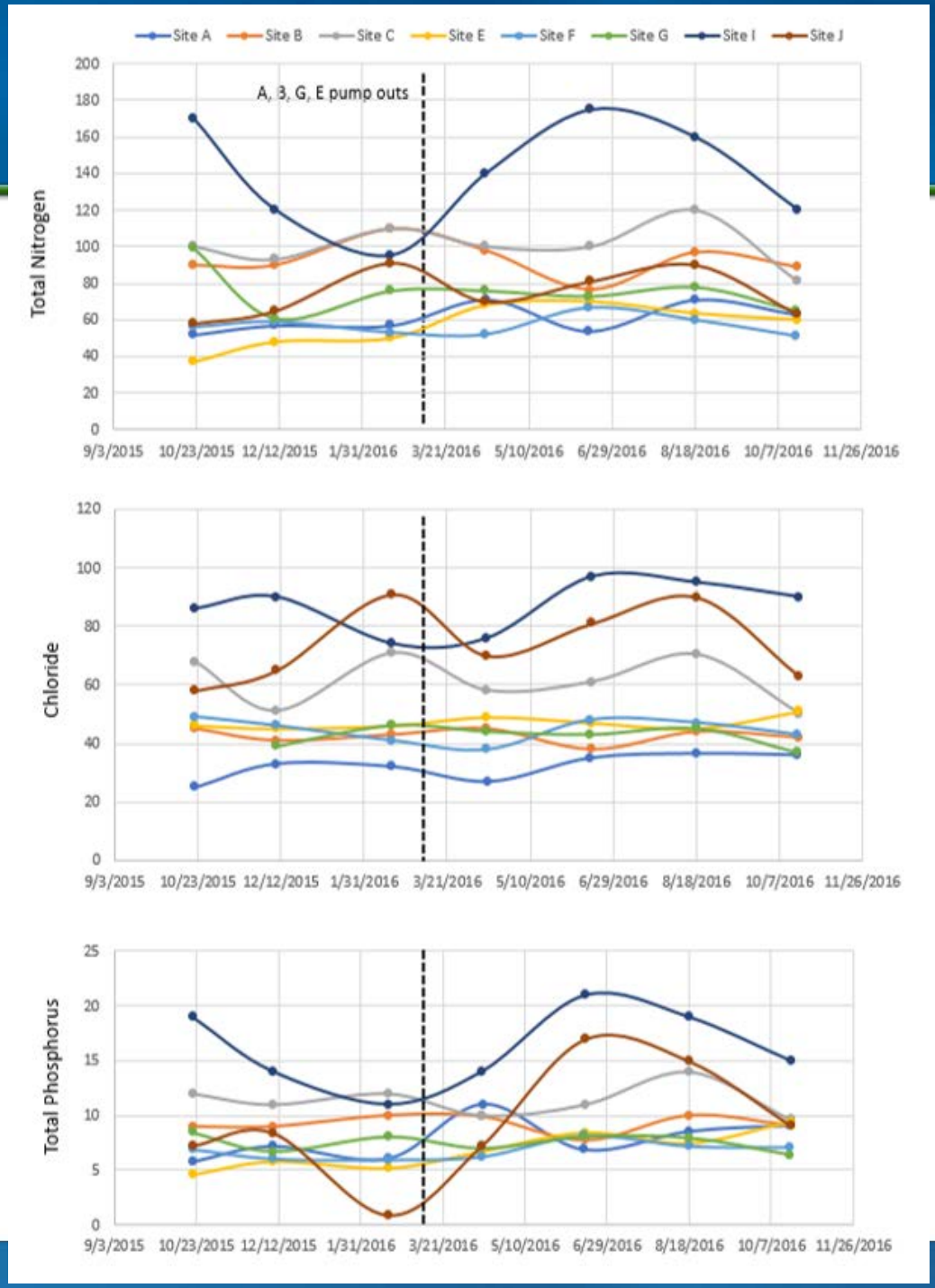
[1]Civil and Environmental Engineering, Colorado School of Mines, Golden, CO

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



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

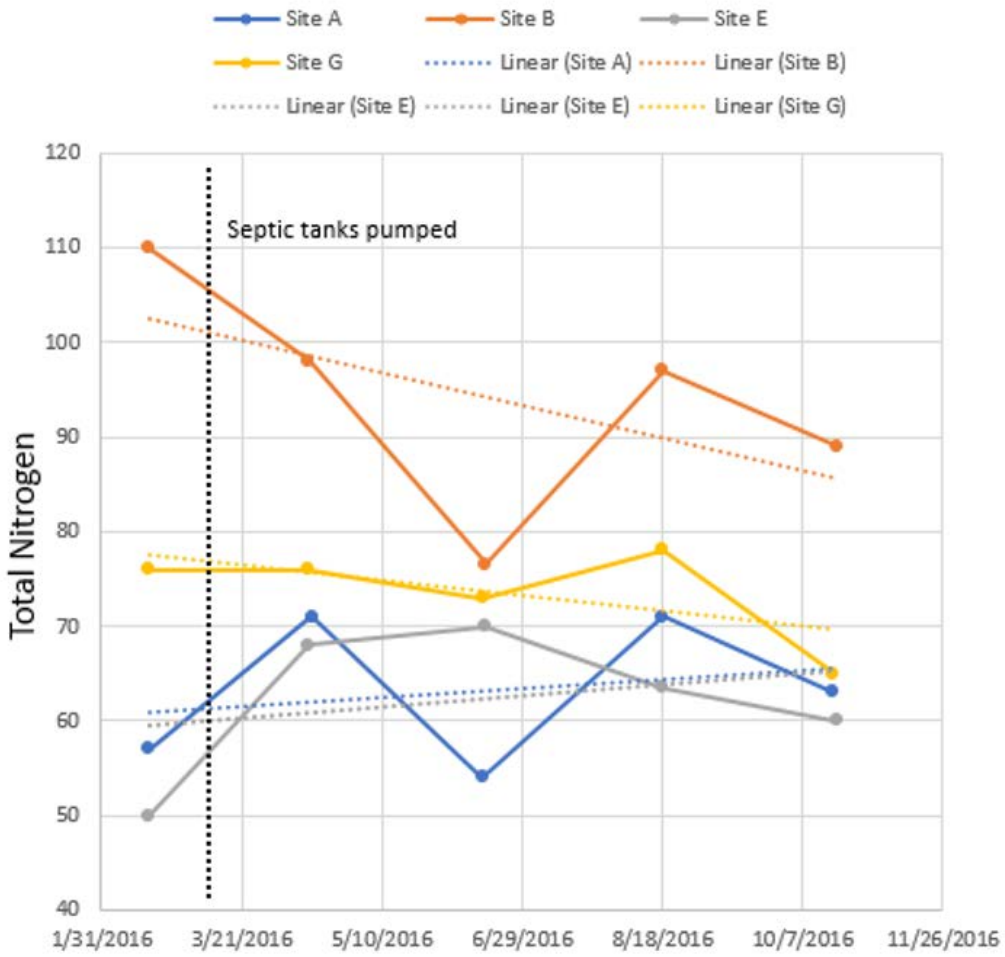

Site A
Site B
Site C
Site E
Site F
Site G
Site I
Site J
A, 3, G, E pump outs
Total Nitrogen
Chloride
Total Phosphorus
9/3/2015
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016

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



Alternative Drainfield Research

Construction Summary: Assessment of the Nitrogen Removal and Viability of a Reactive Layer with Liner under a Conventional Septic System Drainfield

Division of Environmental Assessment and Restoration

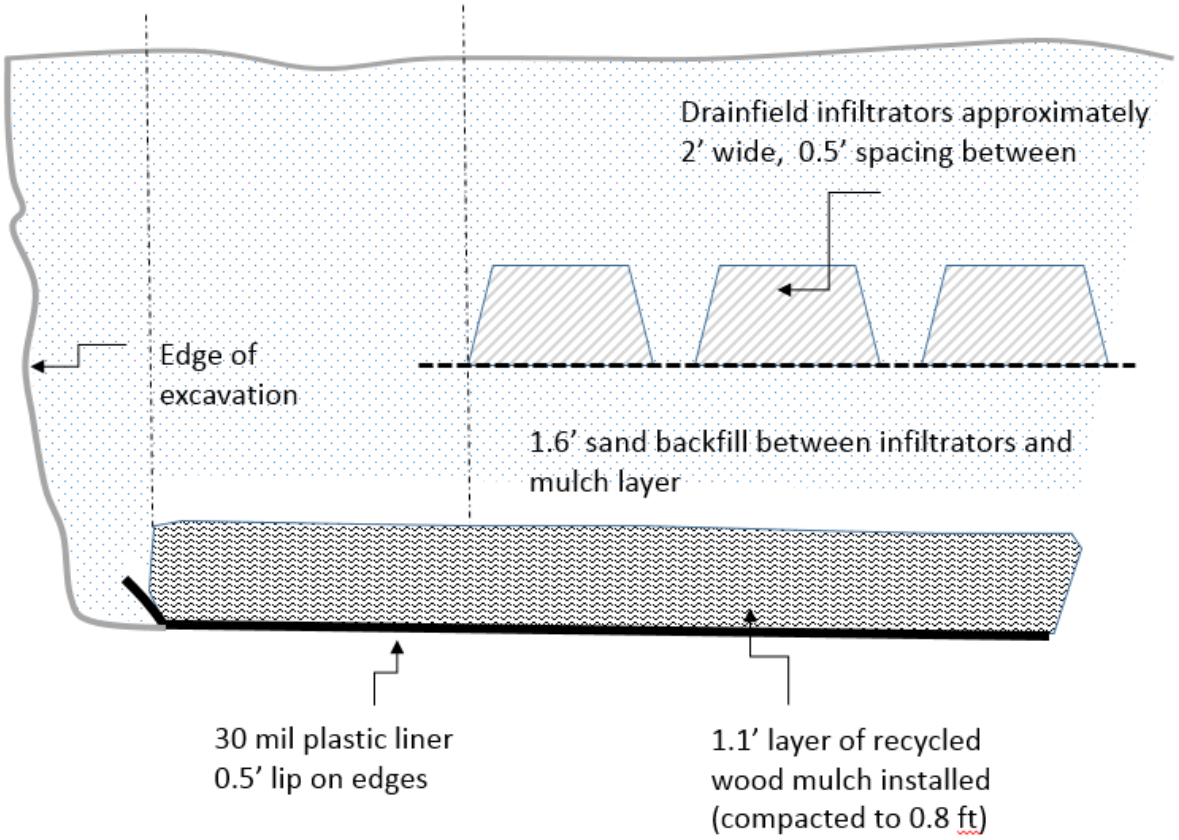
Florida Department of Environmental Protection

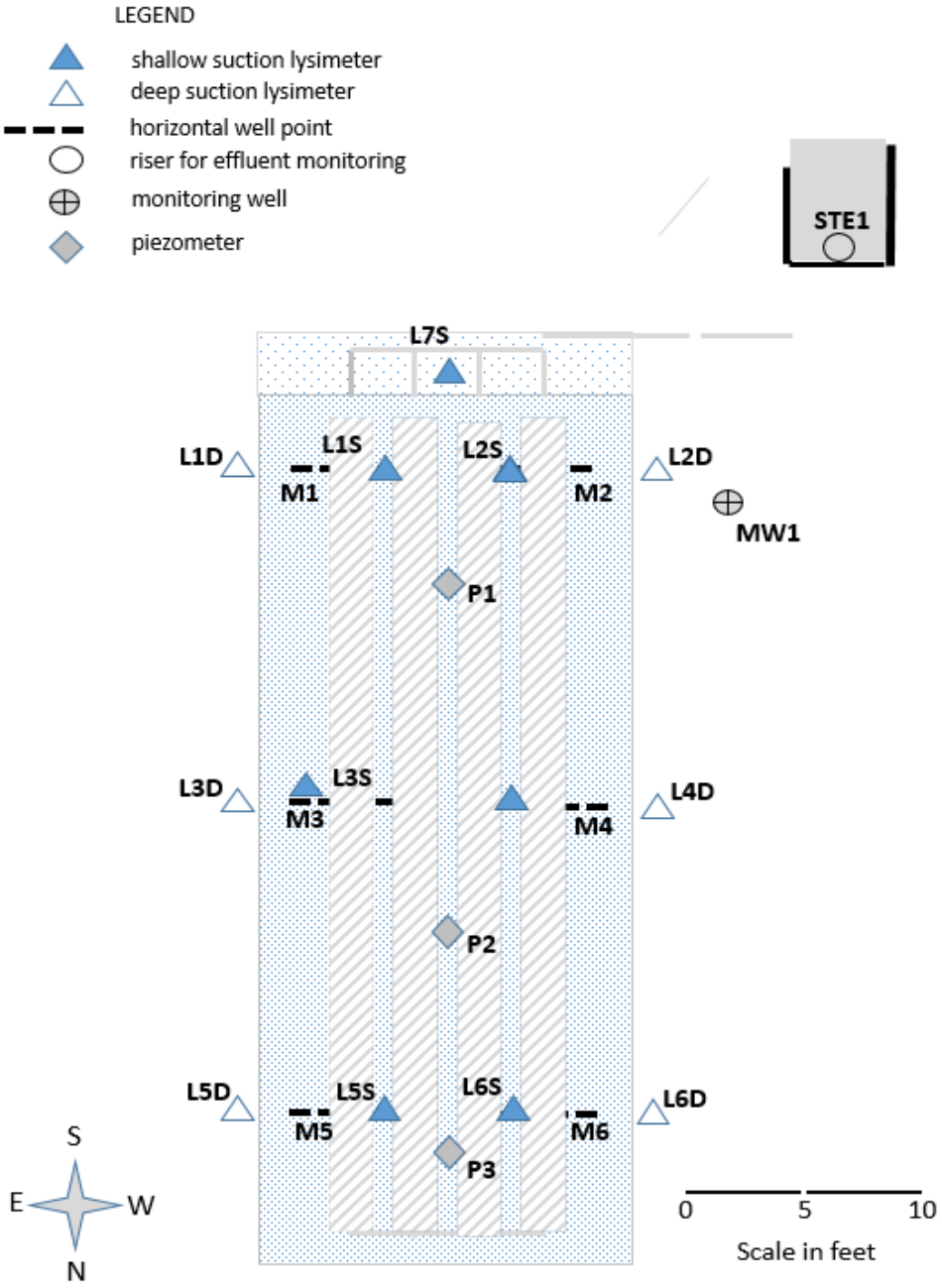
August 2016

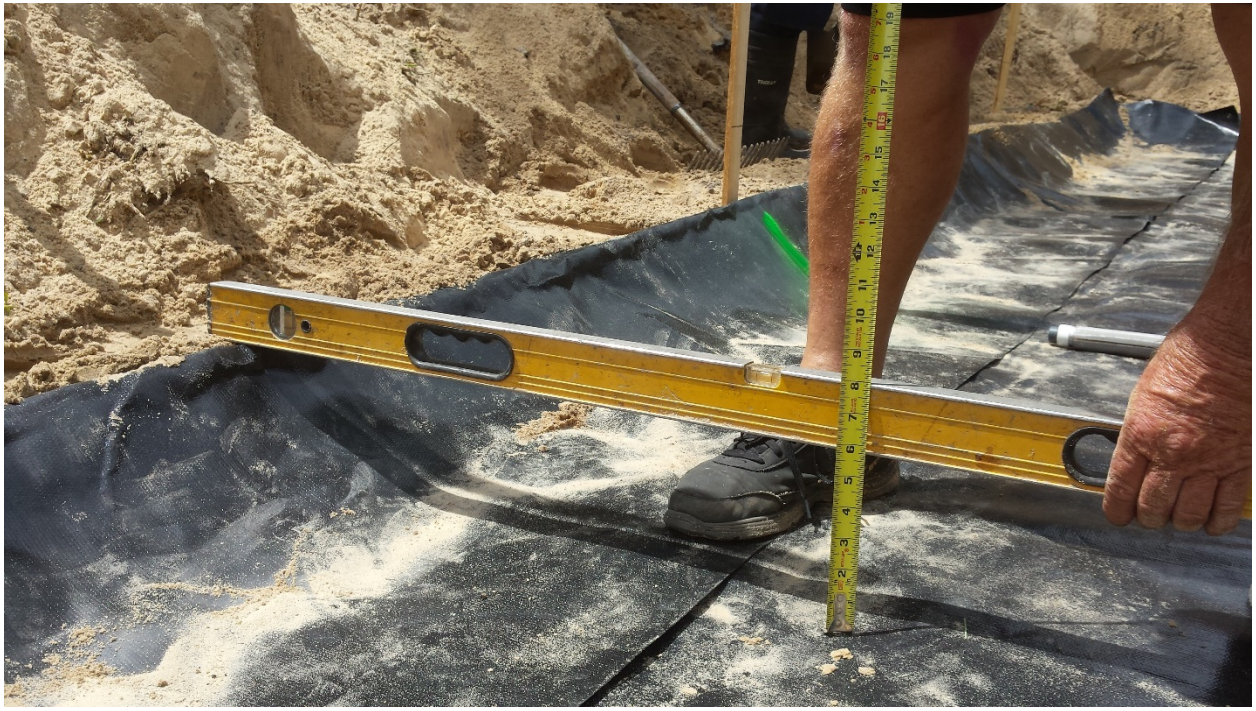
2600 Blair Stone Road, MS 3575
Tallahassee, Florida 32399-2400
www.dep.state.fl.us


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

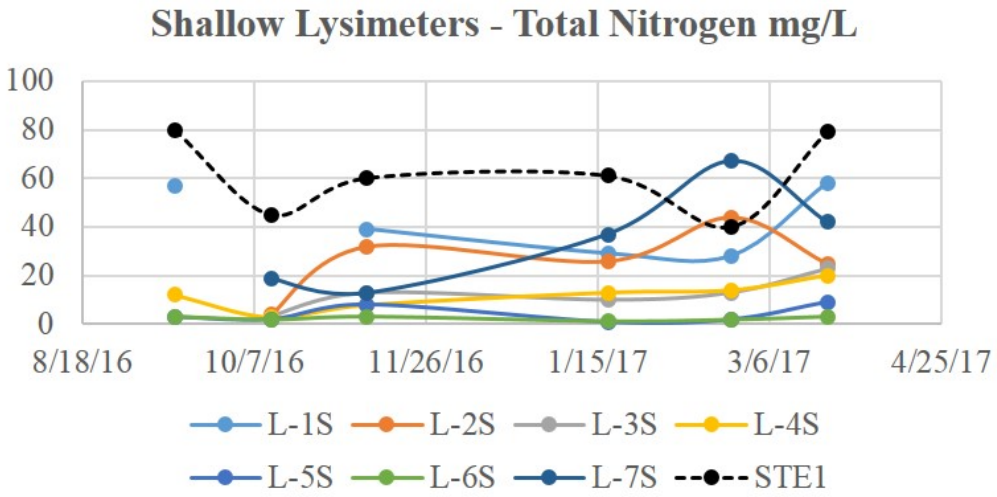


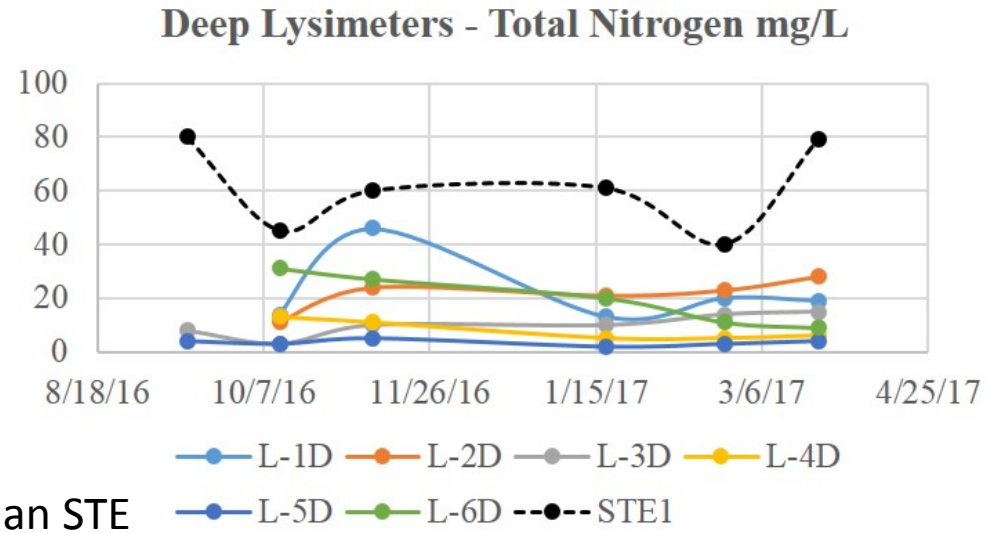

LEGEND
shallow suction lysimeter
deep suction lysimeter
horizontal well point
riser for effluent monitoring
monitoring well
piezometer
STE1
L7S
L1D
L1S
M1
L2S
M2
L2D
MW1
P1
L3D
L3S
M3
L4D
M4
P2
L5D
L5S
M5
L6S
M6
L6D
P3
S
E
W
N
0
5
10
Scale in feet




CASE

TN results through March





Deep lysimeter average 65-77 % lower than STE

Next Steps

- Complete modeling of soil attenuation (May 2017)
- Produce draft report (May 2017)
- Finalize report (June 2017)
- Continue monitoring at experimental site

Questions?