

FOSNRS 3: The Performance of a Full-scale 2 Stage Passive Biofilter System

Damann Anderson, P.E.
Hazen and Sawyer, P.C.

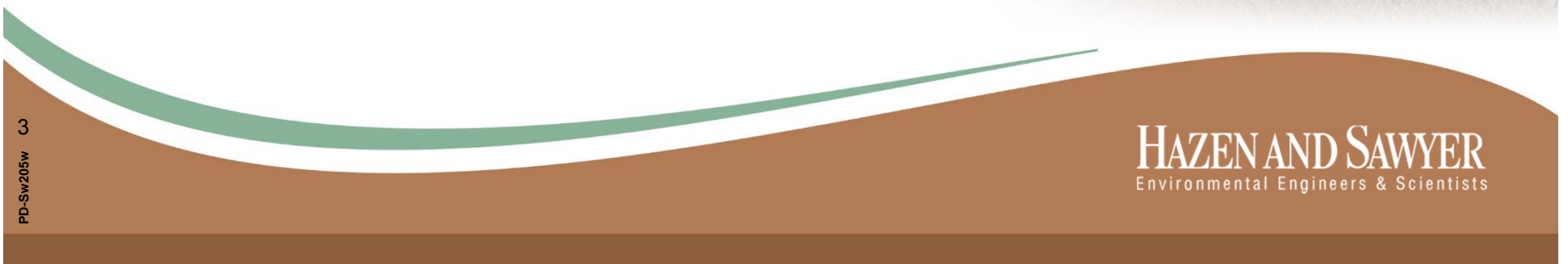
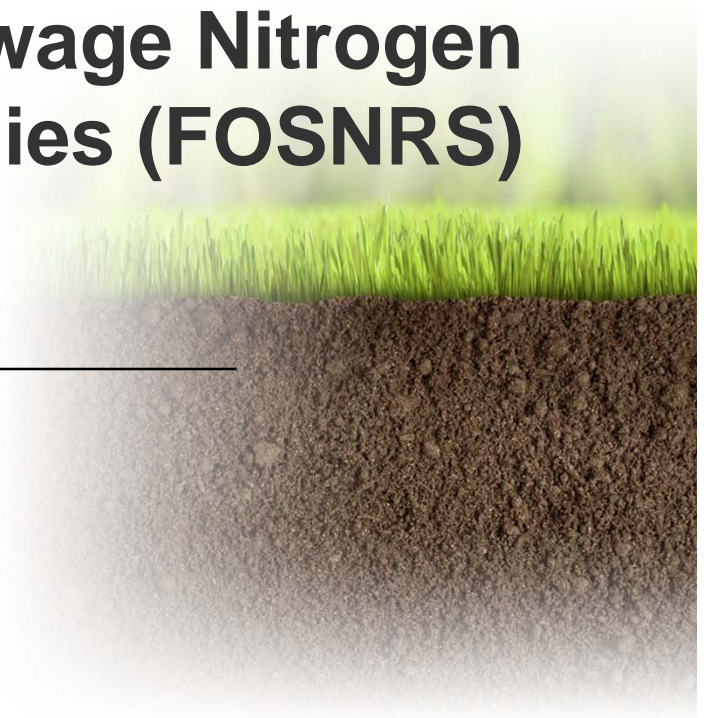
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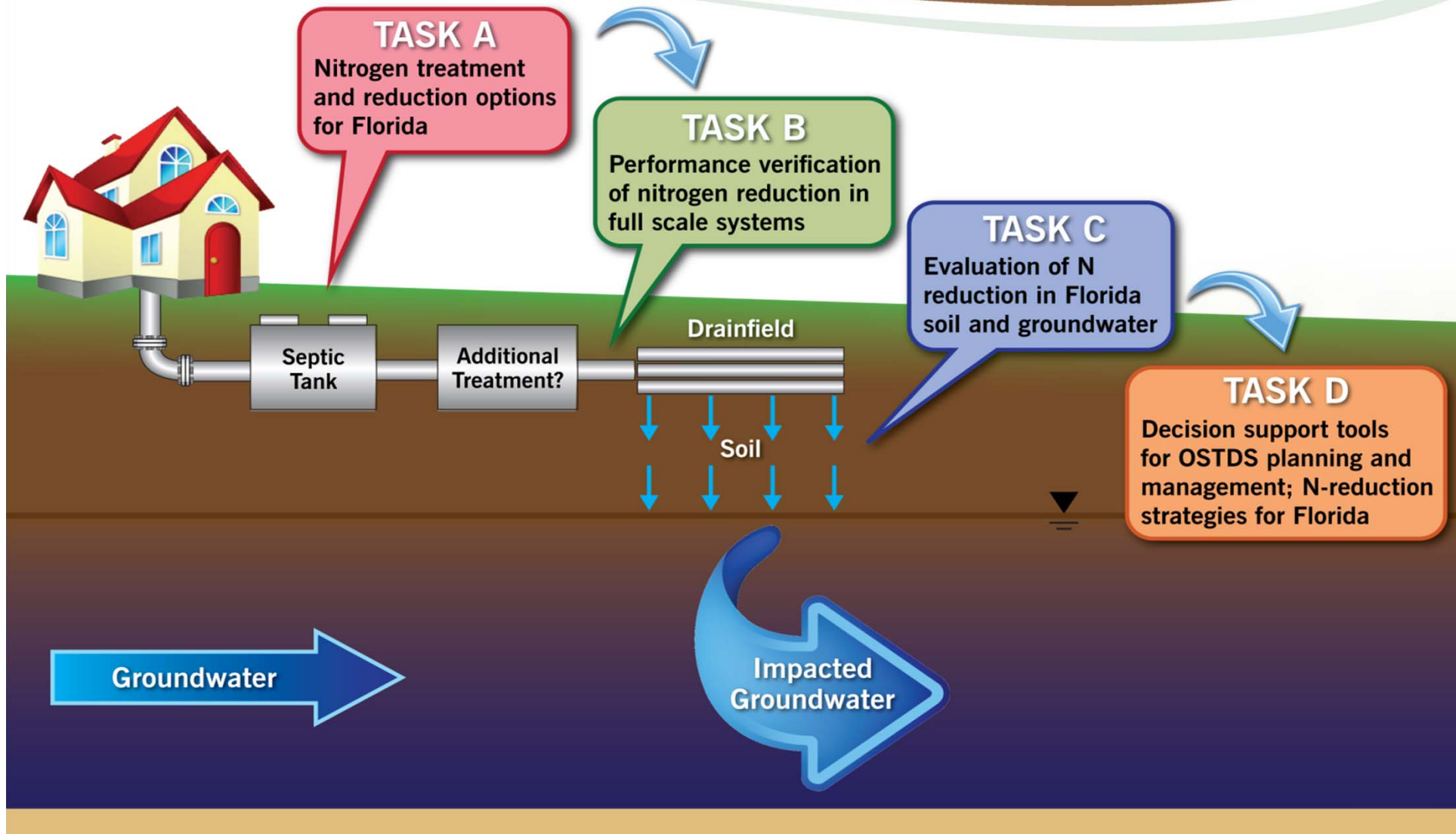
Presentation overview

- The Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project
- Brief Recap of pilot-scale studies of passive nitrogen reduction systems (PNRS)
- FOSNRS Task B: Full-scale testing of PNRS systems
- Questions and answers

Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project



Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Study



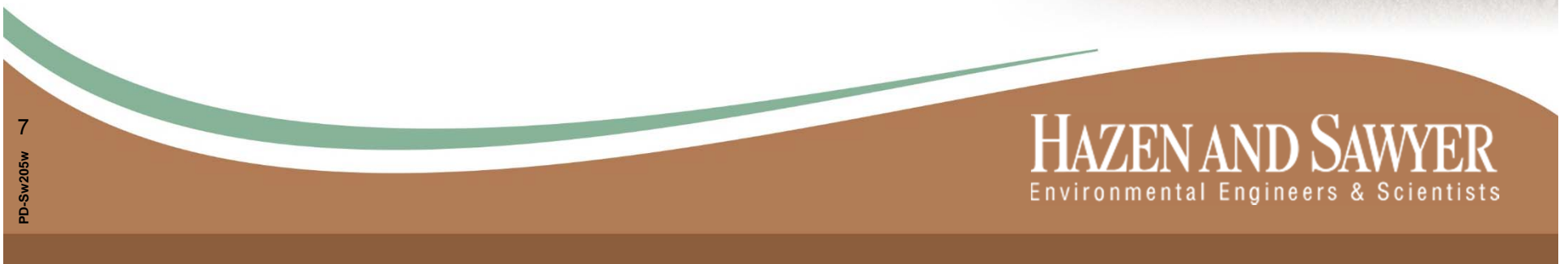
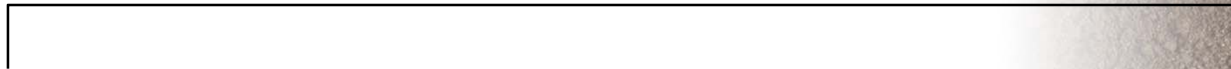
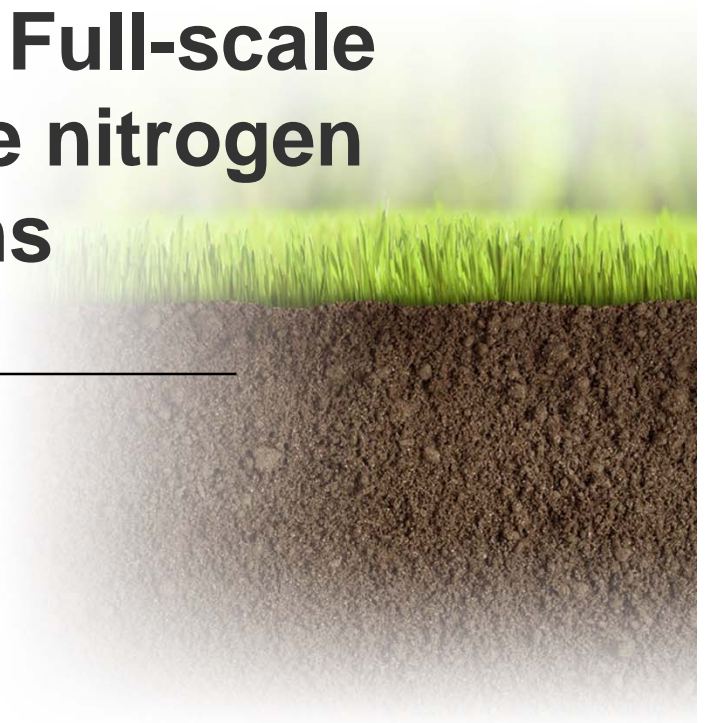
What are “Passive” nitrogen reduction systems (PNRS)?

- Most current N-reducing onsite systems are mechanical treatment units: blowers, pumps, controls, etc.
- “Passive” nitrogen reducing OSTDS: more similar to conventional onsite systems in their operation and maintenance
- Passive definition for this project: Passive nitrogen reduction systems (PNRS) are OSTDS that reduce effluent N using reactive media for denitrification and a single liquid pump as energy input, if necessary.

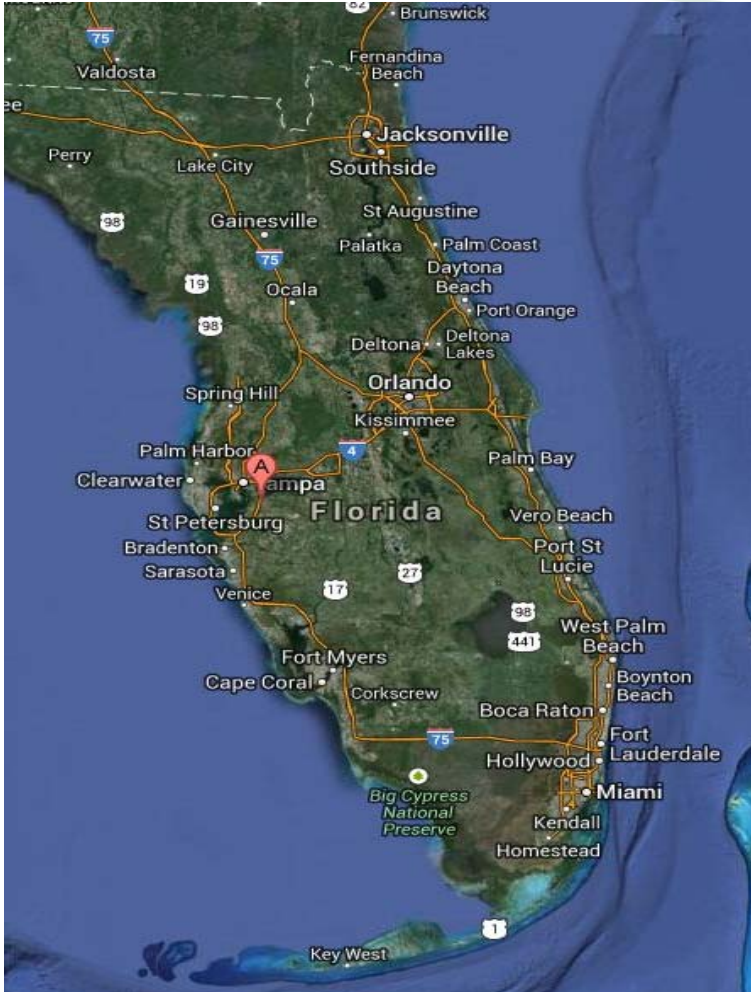
Lessons learned from pilot test

- Encouraging results from pilot PNRS; several system configurations capable of $\geq 95\%$ N reduction
- Highly reactive elemental sulfur media
- Sulfate production vs nitrate reduction
- Lignocellulosic retention time issues
- Recommended evaluation of combination lignocellulosic and elemental sulfur denitrification systems for full-scale treatment units

FOSNRS Task B: Full-scale testing of passive nitrogen reduction systems

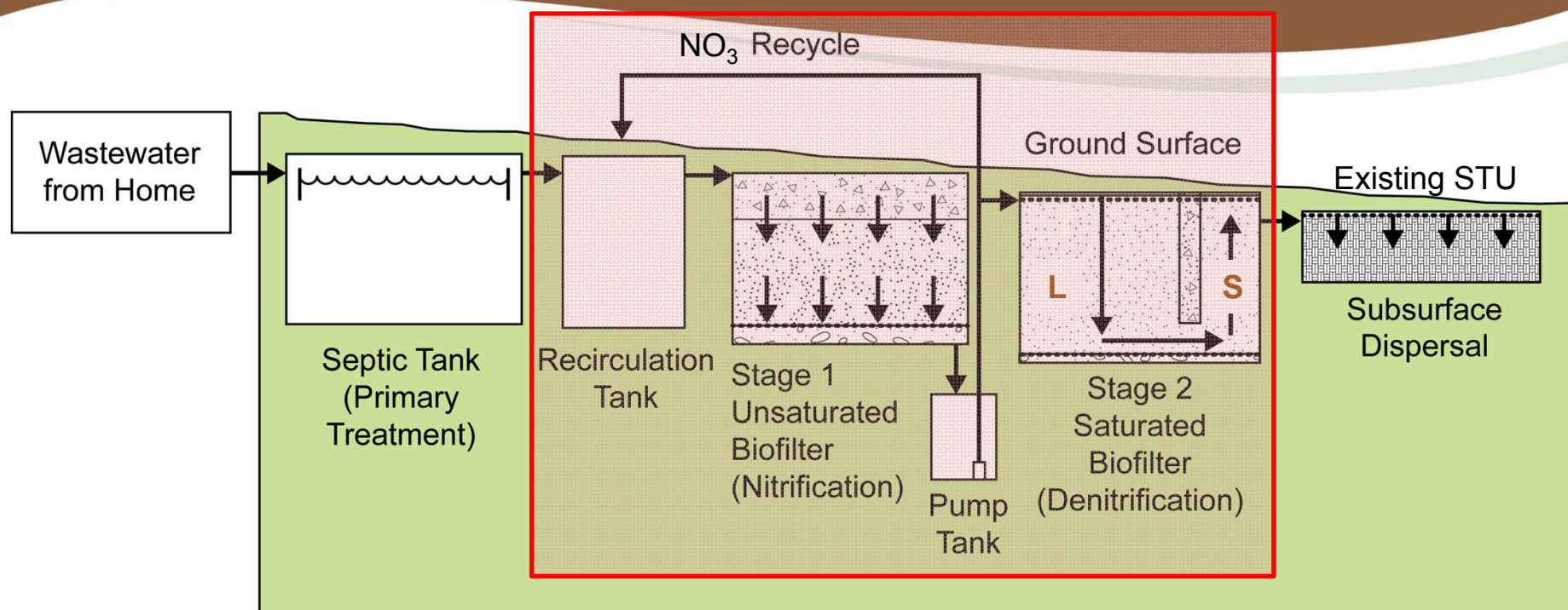


Hillsborough County PNRS Location



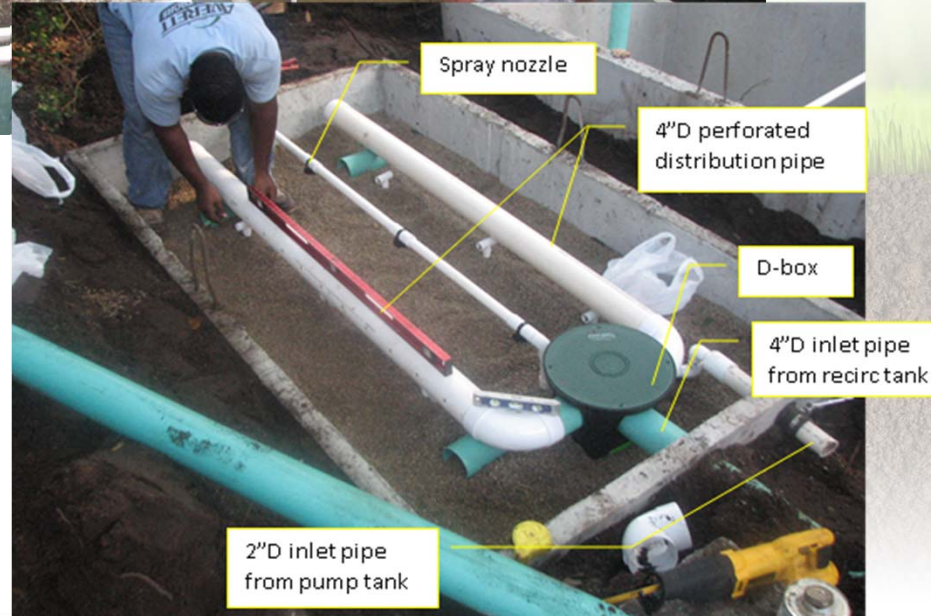
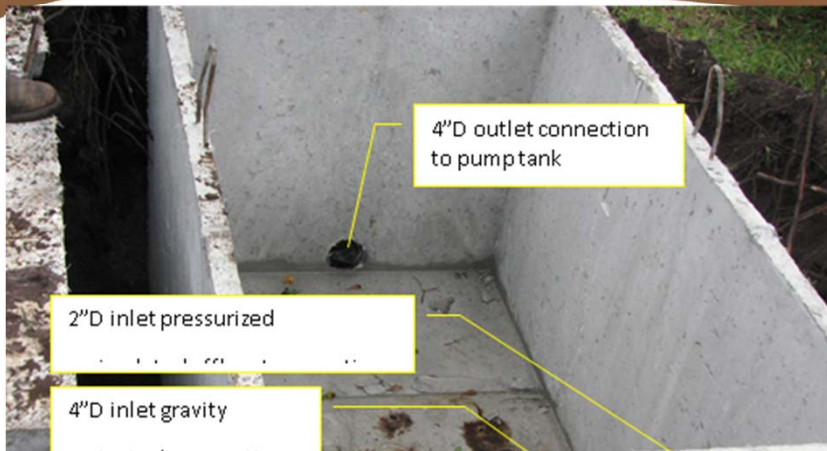
- Single family home
- 3 bedroom
- 2 residents
- Flow of 112.5 gpd

PNRS Flow Schematic and Basic Design Criteria



ID	HLR	Flow
Stage 1	3 gal/ft ² -d forward flow	112.5 gpd forward flow 508.1 gpd total w recycle (3.52:1 recycle ratio R/Q)
Stage 2, lignocellulosic	3.1 gal/ft ² -d	112.5 gpd
Stage 2, sulfur	6.2 gal/ft ² -d	112.5 gpd

Stage 1 Recirculating Biofilter Construction



Stage 2 Denite Biofilter Construction



Completed Two-stage PNRS



Hillsborough County PNRS Installation, September 2012

PNRS components installed between septic tank and drainfield:

- 300 gallon recirculation tank
- 900 gallon Stage 1 biofilter
- 300 gallon pump tank
- 1,500 gallon Stage 2 biofilter



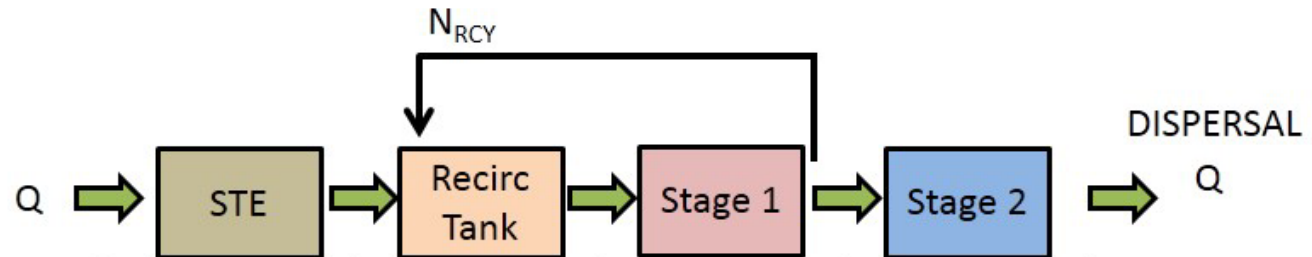
Stage 1 Biofilter



Stage 2 Biofilter



Hillsborough County PNRS Results, ~1 year operation

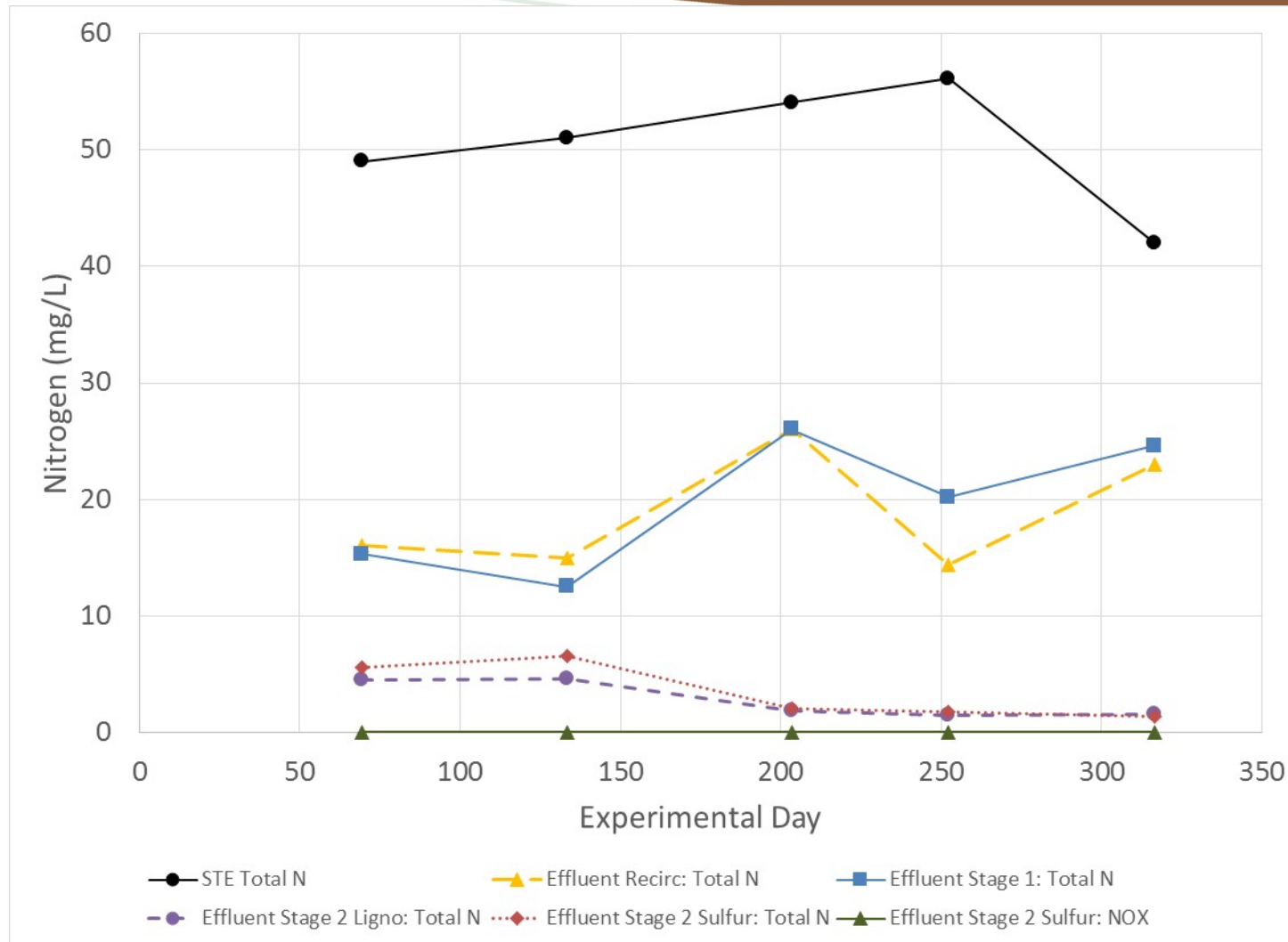


		Septic tank effluent	Recirc tank effluent	Stage 1 effluent	Stage 2 effluent
n		5	5	5	5
CBOD ₅ mg/L	mean	105.6	25.2	15.2	67.6
TKN mg N/L	mean	50.4	12.8	3.1	3.4
NH ₃ mg N/L	mean	41.6	9.0	0.9	2.2
NO _x mg N/L	mean	0.05	6.1	16.7	0.02
TN mg N/L	mean	50.5	18.9	19.7	3.5
Sulfate mg/L	mean	83.4	not analyzed	not analyzed	192
Fecal Coliform (Ct/100 MI)	geomean	115,416	38,350	166	53

***TN Reduction
Stage 1, 61%
Stage 2, 93%
prior to
STU/drainfield***

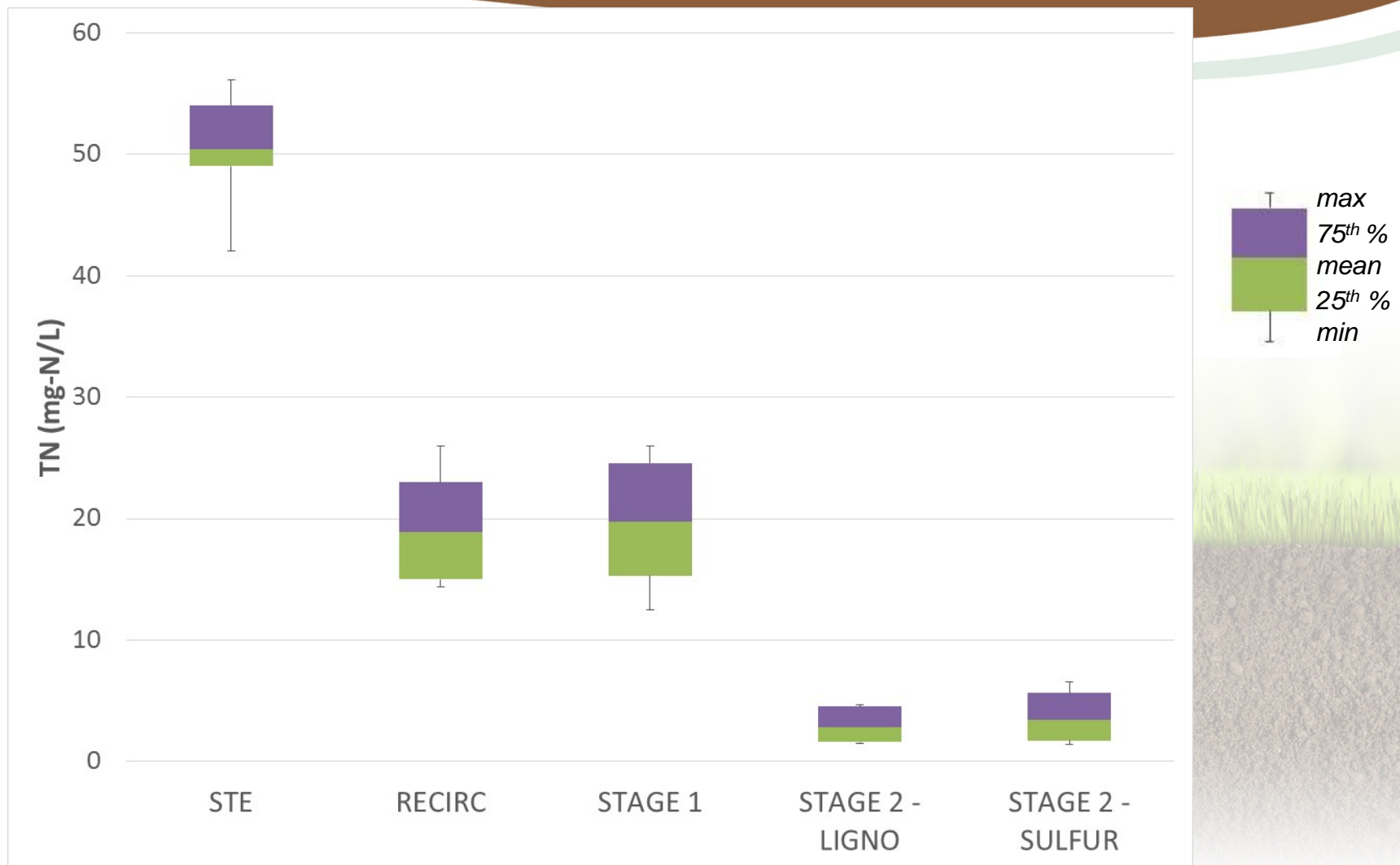
Hillsborough County PNRS

Time series of nitrogen data



Hillsborough County PNRS

Total nitrogen results



Hillsborough County PNRS

Stage 2 biofilter profile results, Day 316

FROM PUMP	TKN	NH3-N	NOX-N			TKN	NH3-N	NOX-N
Influent	1.6	0.28	23.0		Effluent	1.4	0.41	0.02
LIGNO-36	1.9	0.46	3.9					
LIGNO-30	1.8	0.34	4.6					
LIGNO-24	1.6	0.13	1.4					
LIGNO-18	1.2	0.095	0.02		SULFUR-18	1.6	0.41	0.02
LIGNO-12	1.4	0.19	0.02		SULFUR-12	1.8	0.41	0.02
LIGNO-6	0.99	0.095	0.06		SULFUR-7	1.5	0.44	0.02
LIGNO-0	1.6	0.42	0.02		SULFUR-3	1.7	0.40	0.02

42" Lignocellulosic

24" Elemental Sulfur

Hillsborough County PNRS Operation and maintenance

- Average energy consumption of 0.31 kWh/day or 2.7 kWh/1000 gal treated
- Stage 1 biofilter – no surficial biomat or clogging present
- Stage 2 biofilter – reactive media shows very little reduction in volume

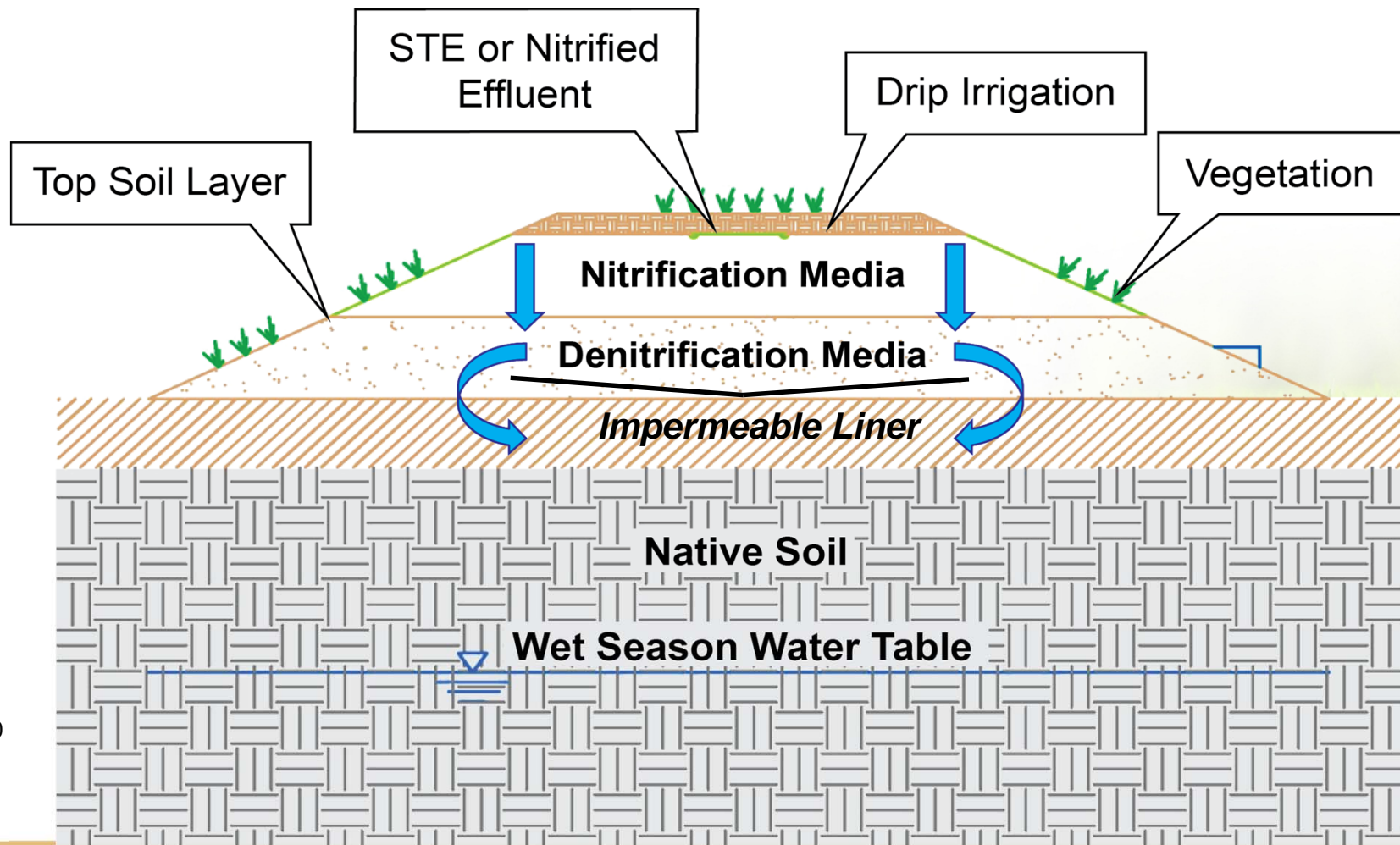


Hillsborough County PNRS Summary

- The influent total nitrogen average concentration of 50.5 mg/L is within the range of values typically reported for Florida single family residence STE.
- The Stage 1 biofilter converted most of the ammonia N to oxidized nitrogen; average effluent contained 3.1 mg/L TKN, of which 0.9 mg/L was ammonia.
- The Stage 2 biofilter produced a reducing environment and effluent $\text{NO}_x\text{-N}$ was below the method detection limit of 0.02 mg N/L.
- The average total nitrogen concentration in the final effluent from the total treatment system was 3.5 mg/L, an approximately 93% reduction from STE, prior to discharge to the soil treatment unit (drainfield)
- Energy consumption was 0.31 kWh/day or 2.7 kWh/1000 gal treated

Also investigating *in-situ* stacked biofilters

Vertically Stacked In-situ Biofilter Concept

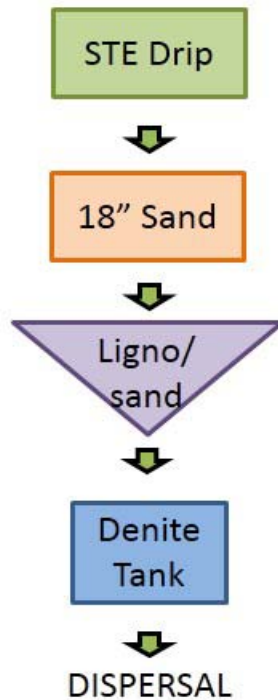


In situ Stacked Biofilter Construction



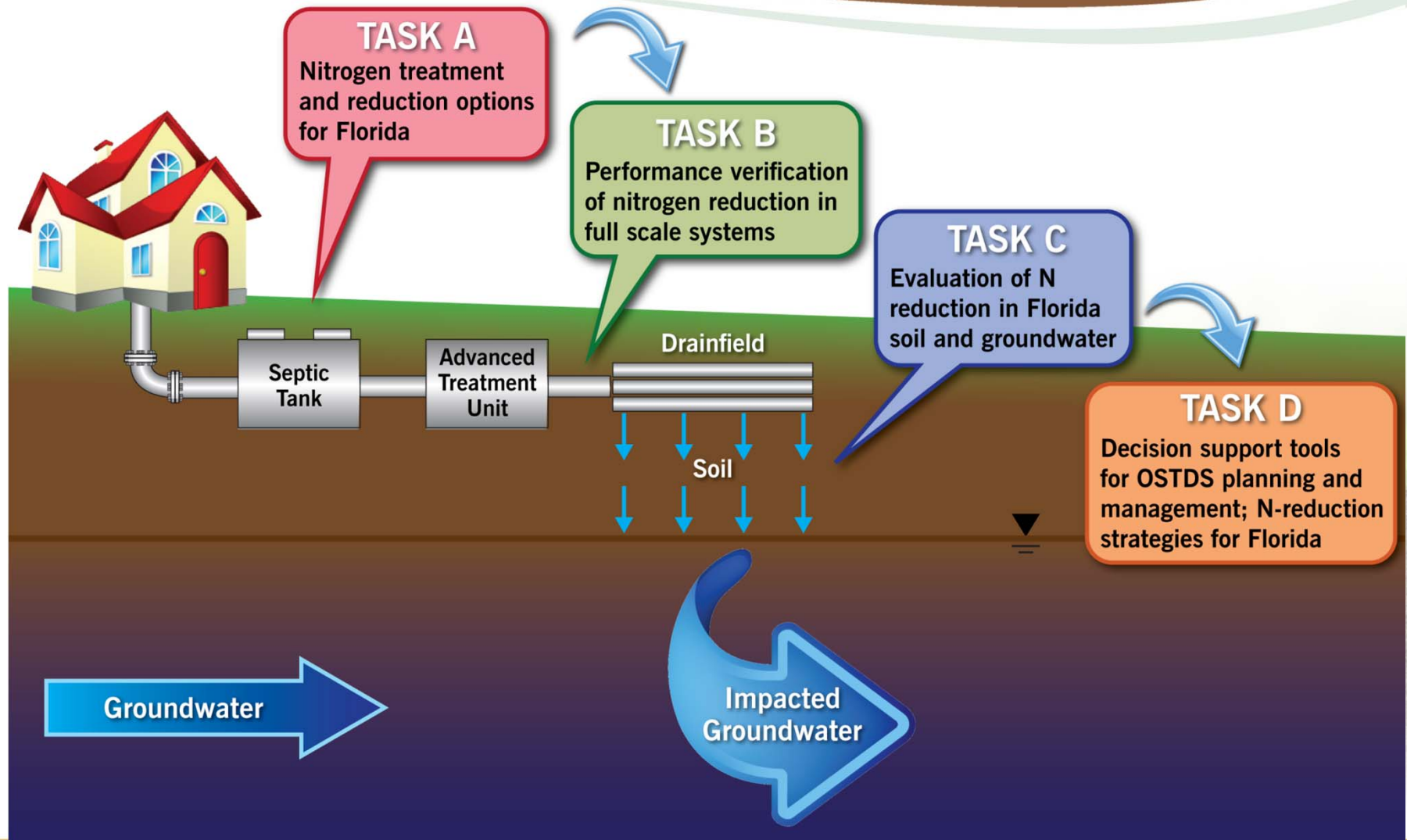
Pilot *in situ* stacked biofilter system performance

Mean results over 8 sample events, 523 days of operation



n	TKN mg N/L	NH ₃ mg N/L	NO _x mg N/L	TN mg N/L	Sulfate mg/L	Fecal Coliform (Ct/100 mL)	% TN Reduction
mean	mean	mean	mean	mean	mean	geomean	
8	65.1	55.60	0.29	65.4	40.6	13,273	
8	3.2	0.03	33.13	36.3	49.4	Non-detect	44%
9	3.0	0.36	3.55	6.5	115.7	2.3	90%
8	3.4	0.95	0.06	3.5	292.9	6.5	94%

Development of N-reduction strategies



Questions?

Damann L. Anderson
Hazen and Sawyer, P.C.
Phone: 813.630.4498
e-mail: danderson@hazenandsawyer.com

