BCDHE

Barnstable County Department of Health and Environment

Promote - Protect - Support

90 Years of Service 1926 - 2016

Investigating Non-proprietary Means of Nitrogen Removal

A Brief Data Summary of Experiments Performed at
Massachusetts **A**lternative **S**eptic **S**ystem **T**est **C**enter

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Collaborative Effort

- Damann L. Anderson, P.E., a researcher of passive nitrogen removal systems for the State of Florida Onsite Sewage Nitrogen Reduction Study (FOSNRS);
- George Loomis, an onsite septic system specialist and published author from the University of Rhode Island;
- Dr. Will Robertson of the University of Waterloo;
- Jose Amador, a soil scientist at the University of Rhode Island;
- John Eliasson with the Wastewater Management Section of Washington State Department of Health's Division of Environmental Public Health
- More recently, researchers at Stony Brook University, NY

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To examine all elements of successful non-proprietary onsite denitrification projects and determine how to adjust the design features to work in our particular climatological and geological setting.

To determine whether the principles used in these projects will allow a design that is economical and feasible to install in Barnstable County.

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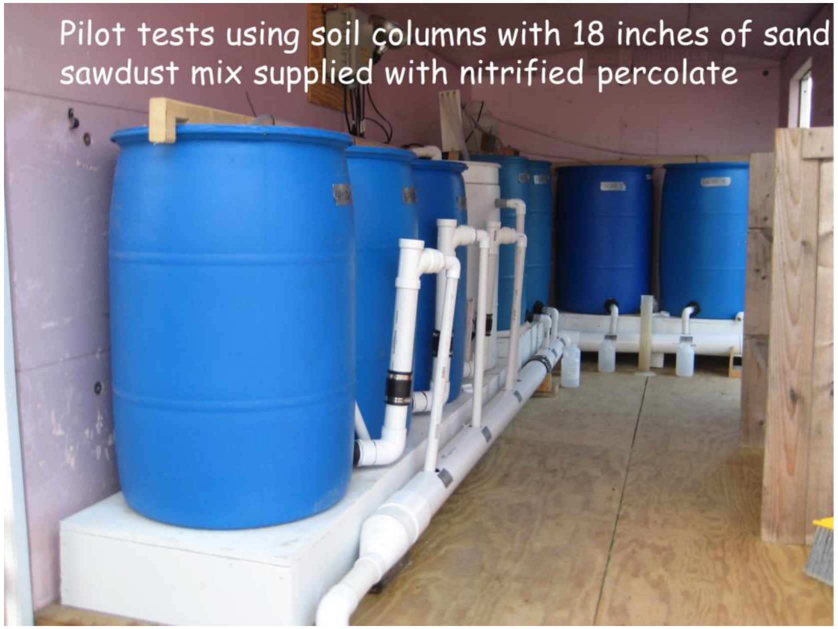
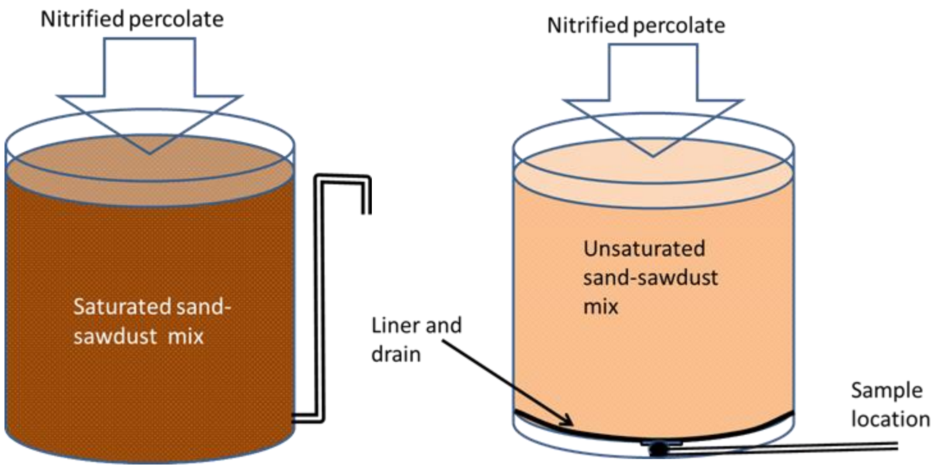
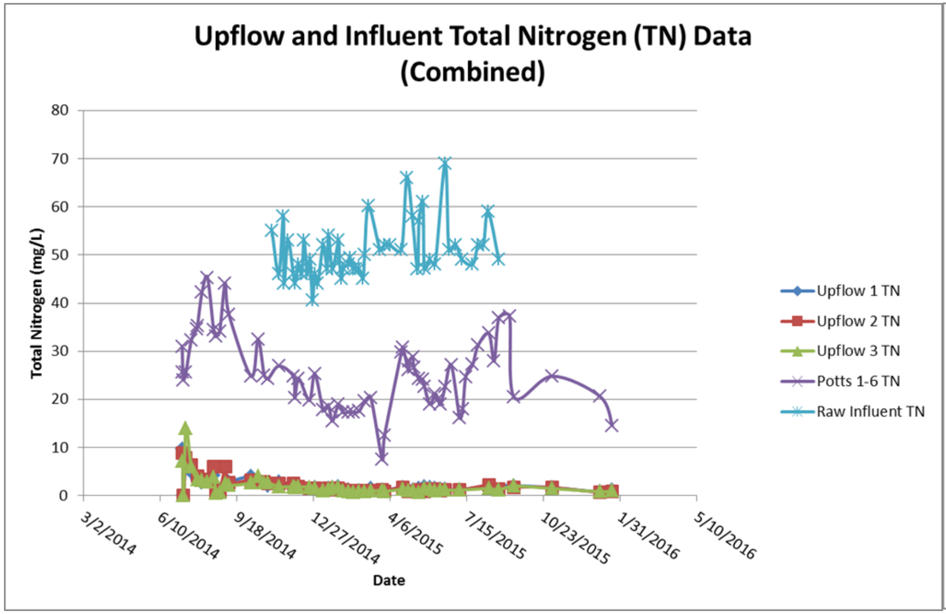
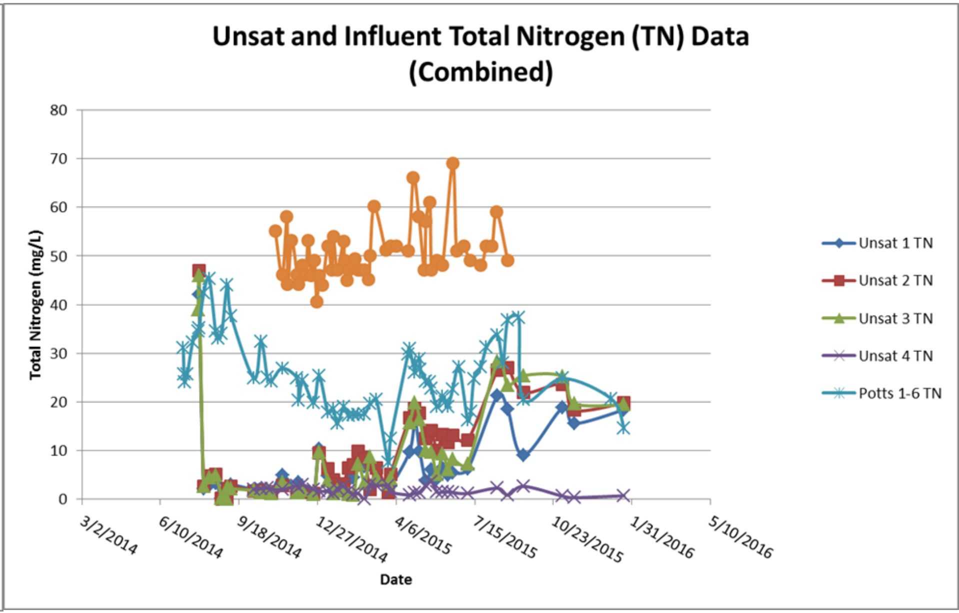
All projects investigated used ligno-cellulose (wood) or a byproduct as a carbon source to support denitrification

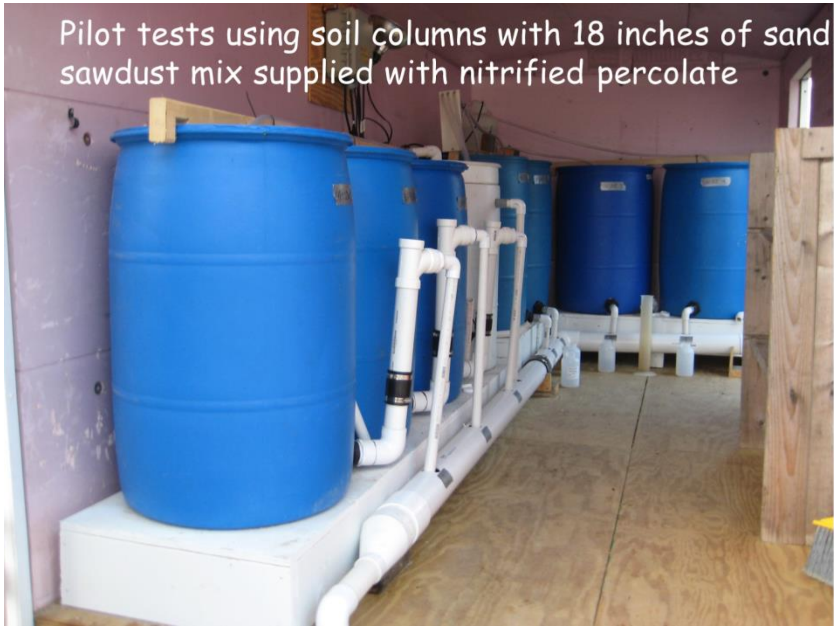
Initial investigations with soil columns suggested that sawdust could be incorporated into a soil profile following a layer for nitrification to achieve denitrification

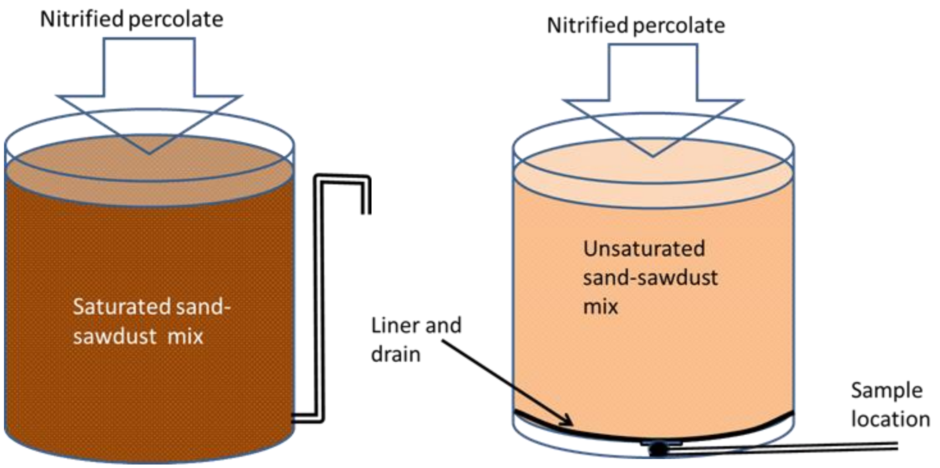

Pilot tests using soil columns with 18 inches of sand sawdust mix supplied with nitrified percolate


Nitrified percolate
Saturated sand-sawdust mix
Nitrified percolate
Unsaturated sand-sawdust mix
Liner and drain
Sample location


Upflow and Influent Total Nitrogen (TN) Data (Combined)
Total Nitrogen (mg/L)
Date
Upflow 1 TN
Upflow 2 TN
Upflow 3 TN
Potts 1-6 TN
Raw Influent TN


Unsat and Influent Total Nitrogen (TN) Data (Combined)
Total Nitrogen (mg/L)
Date
Unsat 1 TN
Unsat 2 TN
Unsat 3 TN
Unsat 4 TN
Potts 1-6 TN



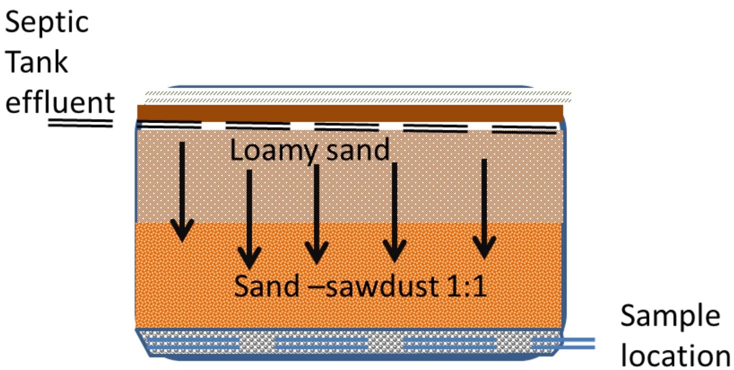


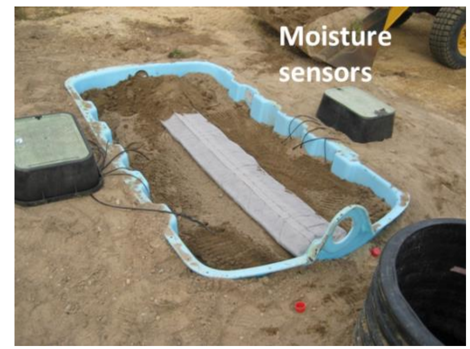
These small scale experiments suggested promise that ligno-cellulose could be used beneath a nitrifying soil layer to achieve denitrification

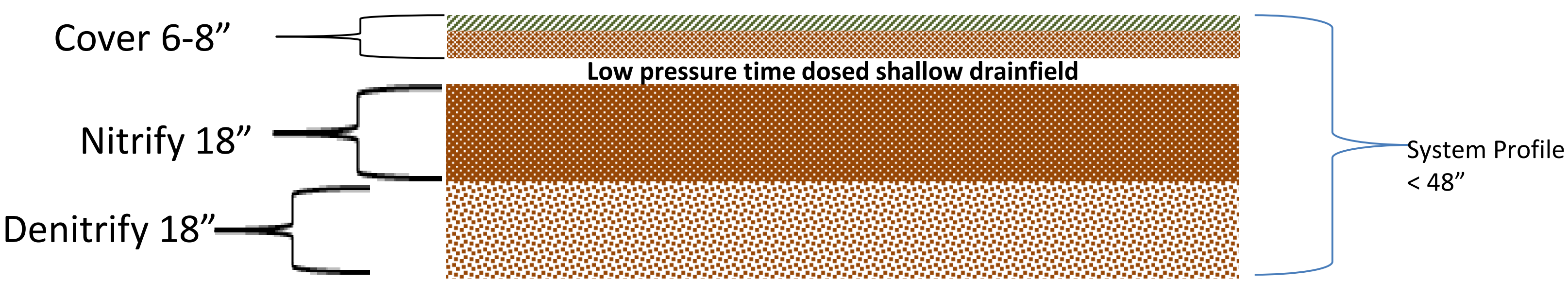
Larger scale installations

1. Small scale unsaturated flow system hydraulically loading at code-prescribed rate;
2. Large-scale saturated system
3. Large scale “permeable reactive barrier” system (Silt-sawdust layer)
4. Large Scale unsaturated flow system
5. Additional soil column experiments

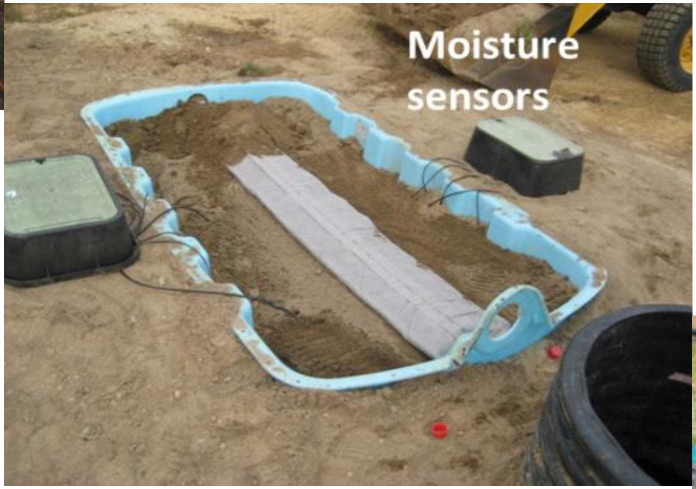
Small-scale unsaturated flow “layer cake”



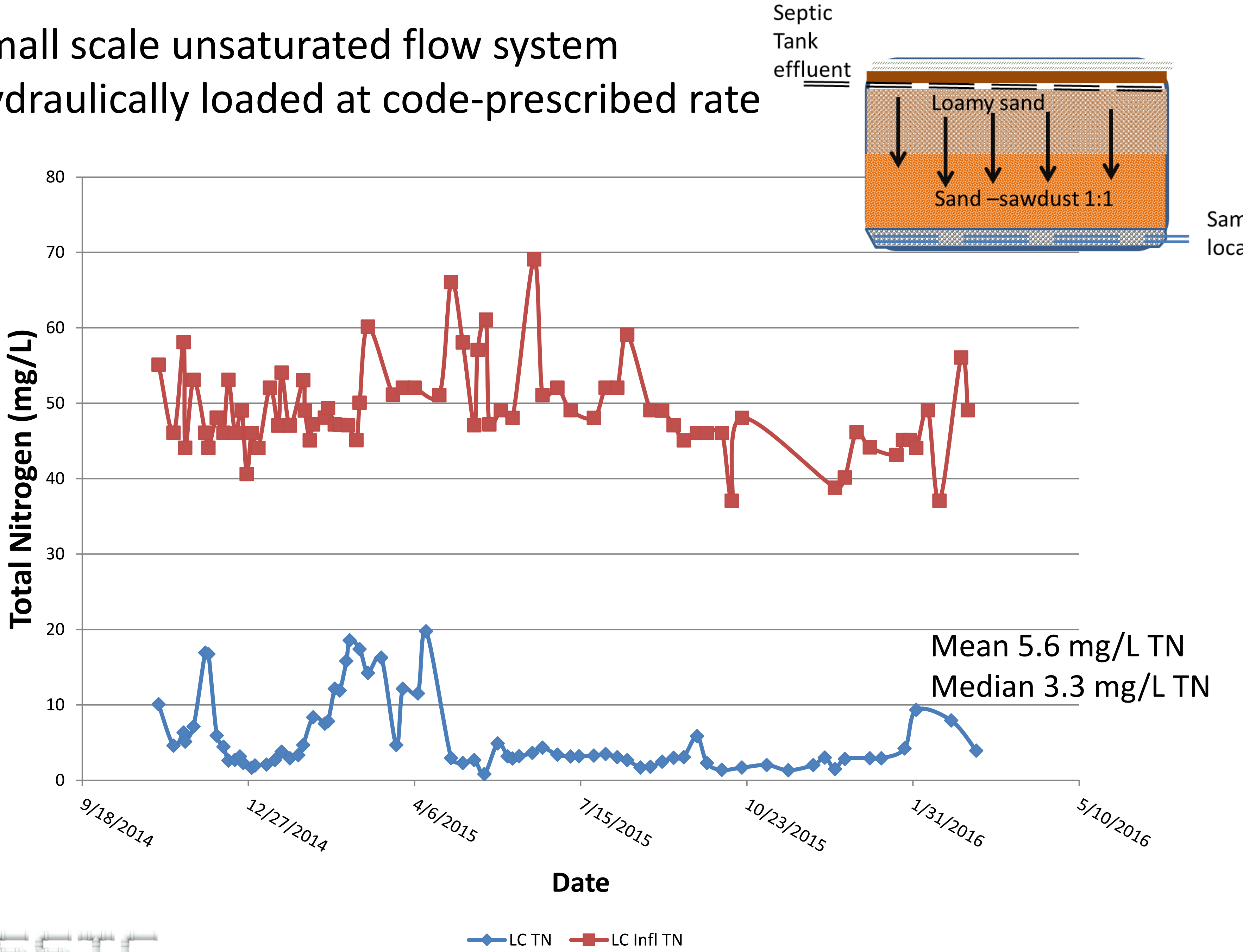




Small-scale unsaturated flow "layer cake"



Small scale unsaturated flow system hydraulically loaded at code-prescribed rate



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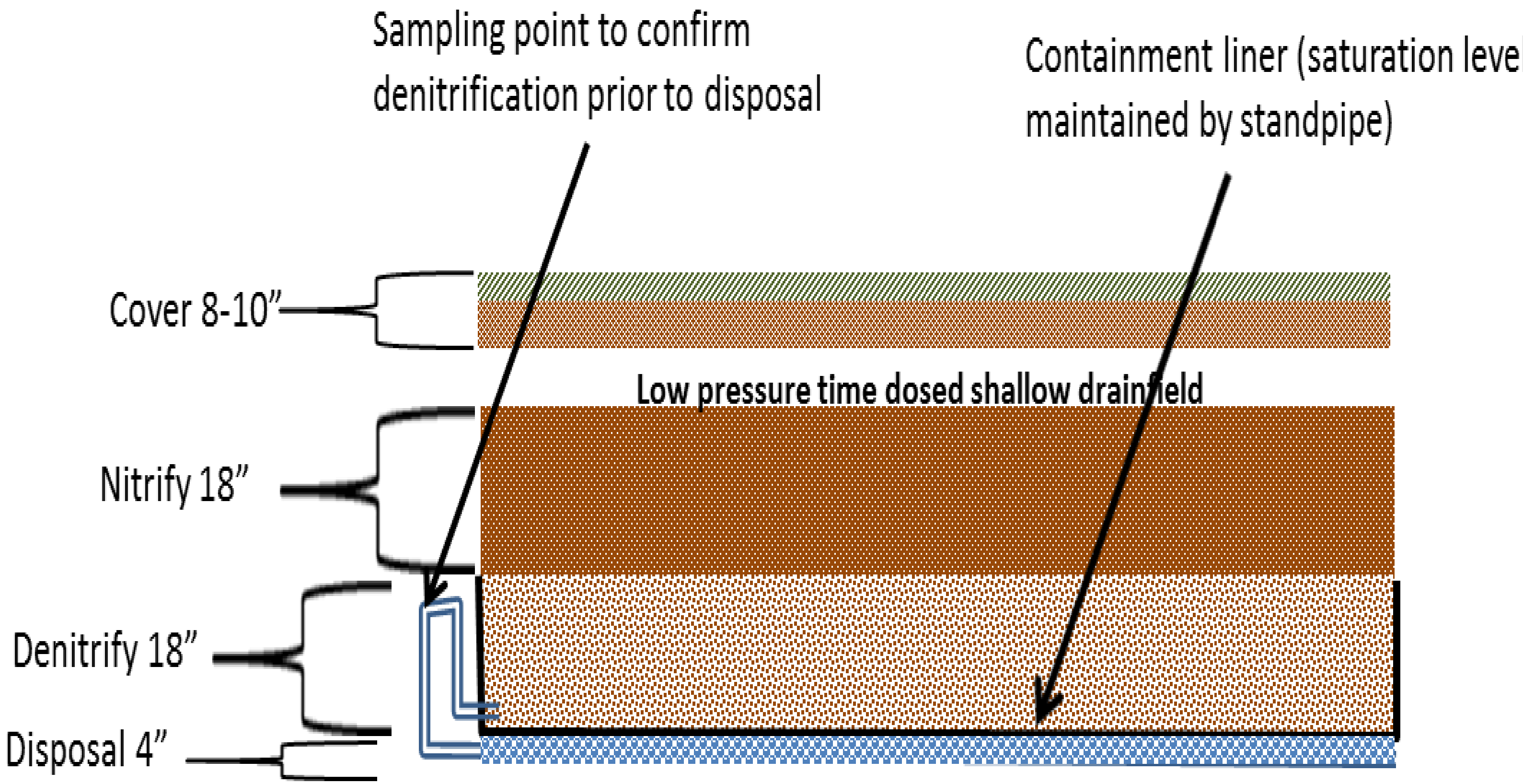
Large-scale saturated system



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Large-scale saturated system

Hydraulic Loading 0.6 gal/day/ sq. ft
(220 gallons/day)
Alternately dosed distribution laterals

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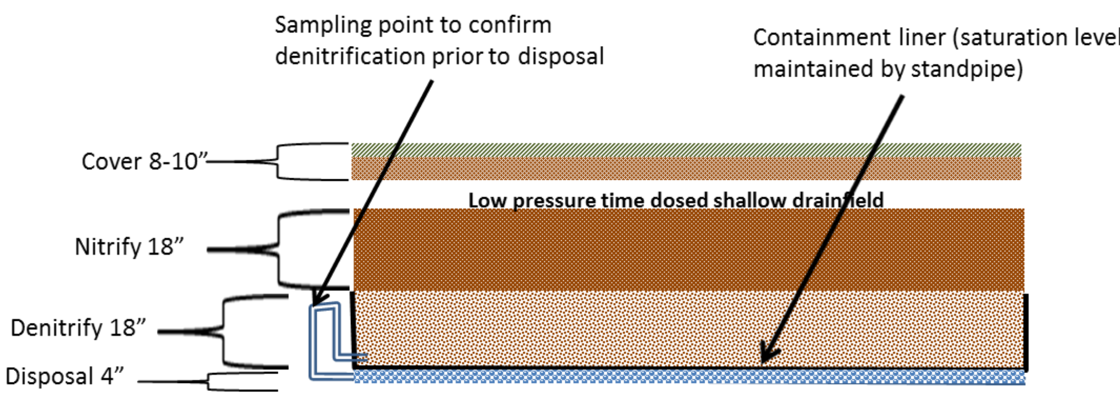
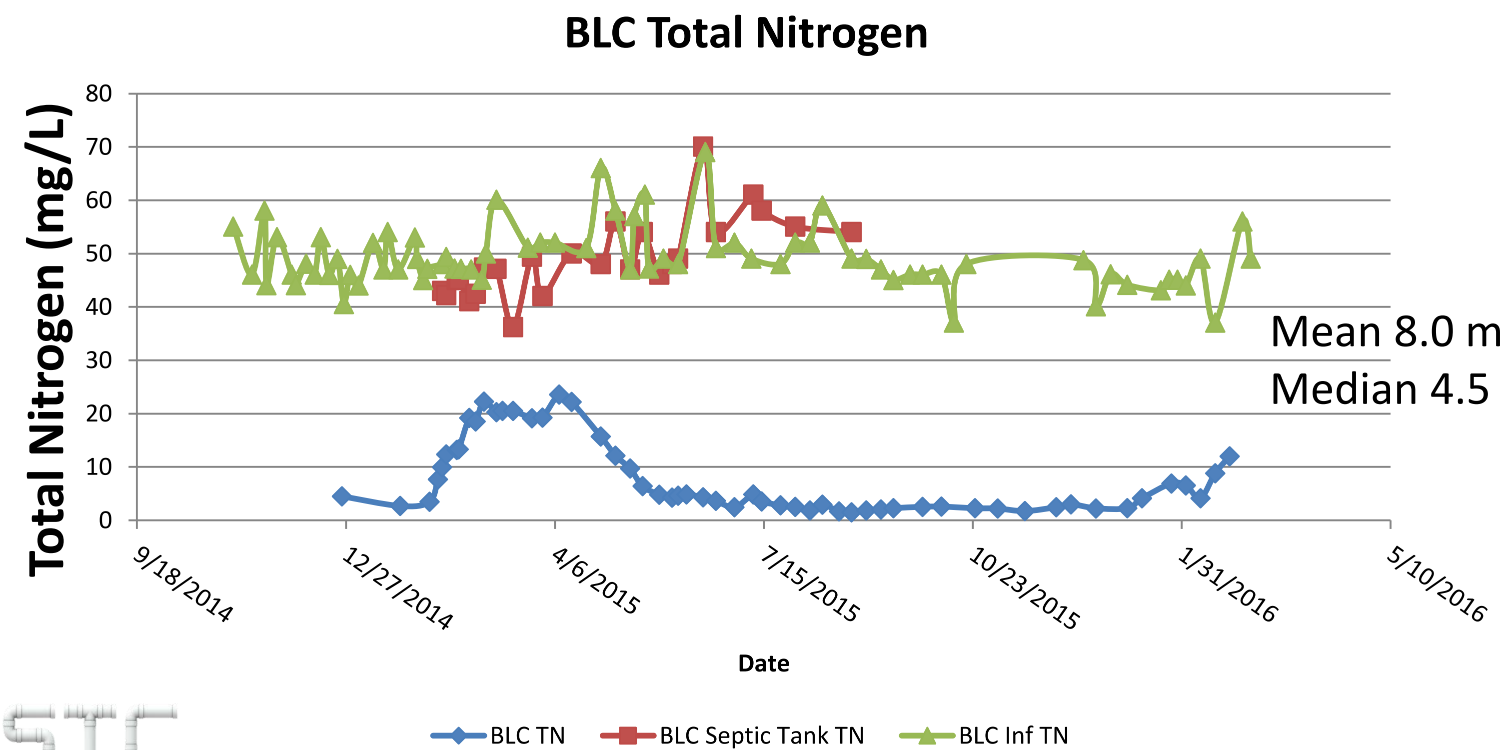
Large-scale saturated system





Mean 8.0 mg/L TN

Median 4.5 mg/L TN

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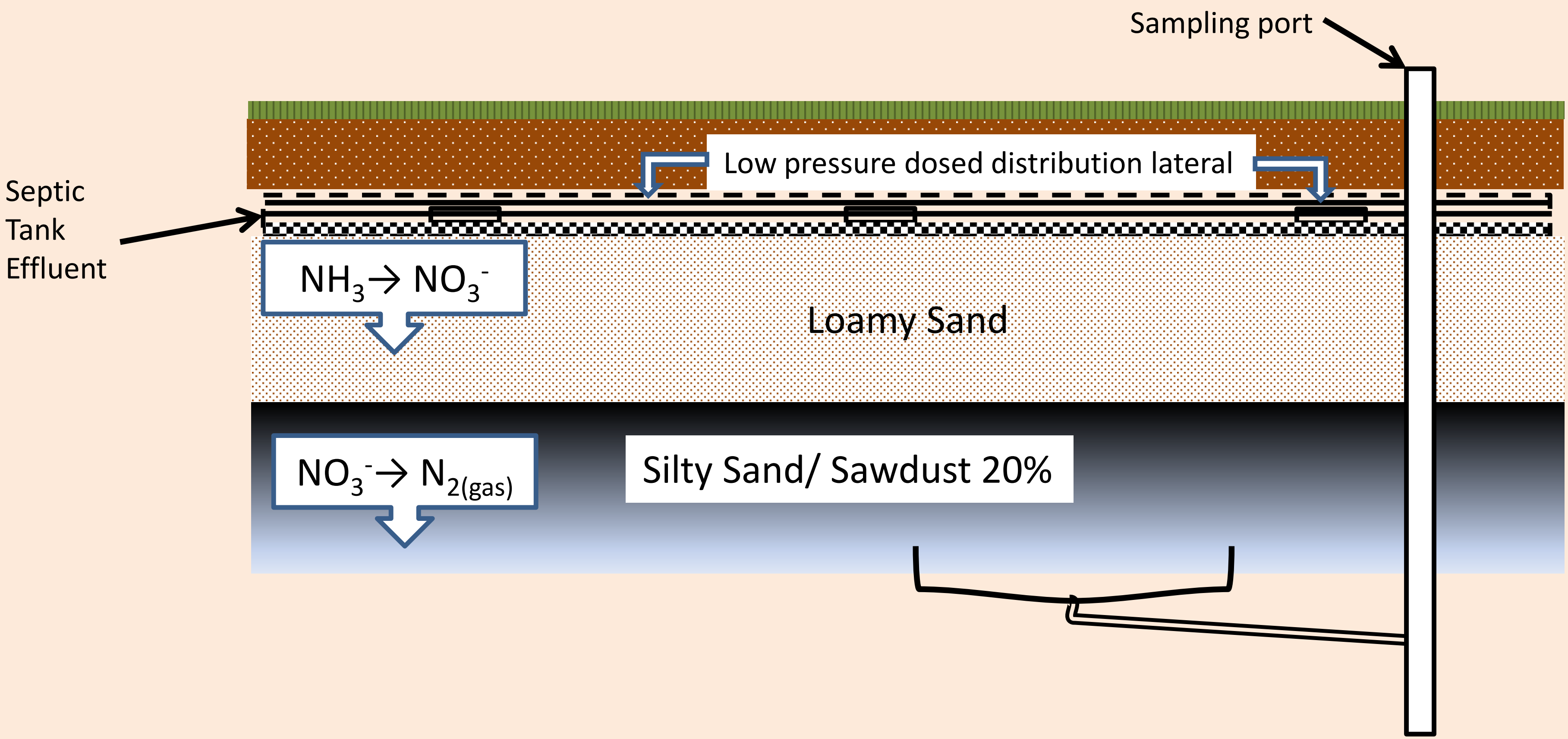
Large scale "permeable reactive barrier" system (Silt-sawdust layer)



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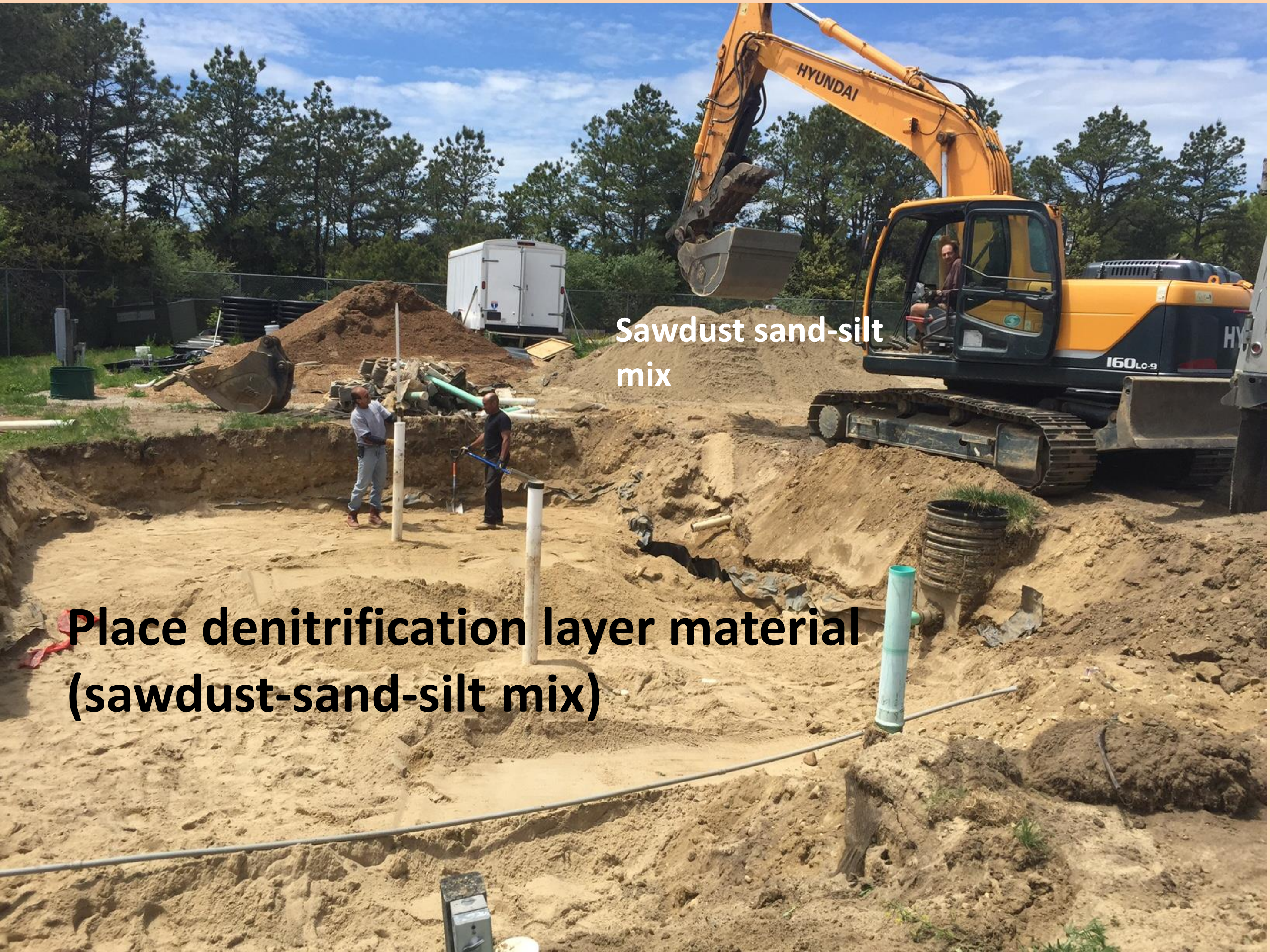


Large scale "permeable reactive barrier" system (Silt-sawdust layer)

"Marry" denitrification layer material to nitrification material layer

Large scale "permeable reactive barrier" system (Silt-sawdust layer)

Large scale "permeable reactive barrier" system (Silt-sawdust layer)

Field area levelled and made ready for distribution piping

Low-pressure distribution piping placed

Large scale "permeable reactive barrier" system (Silt-sawdust layer)

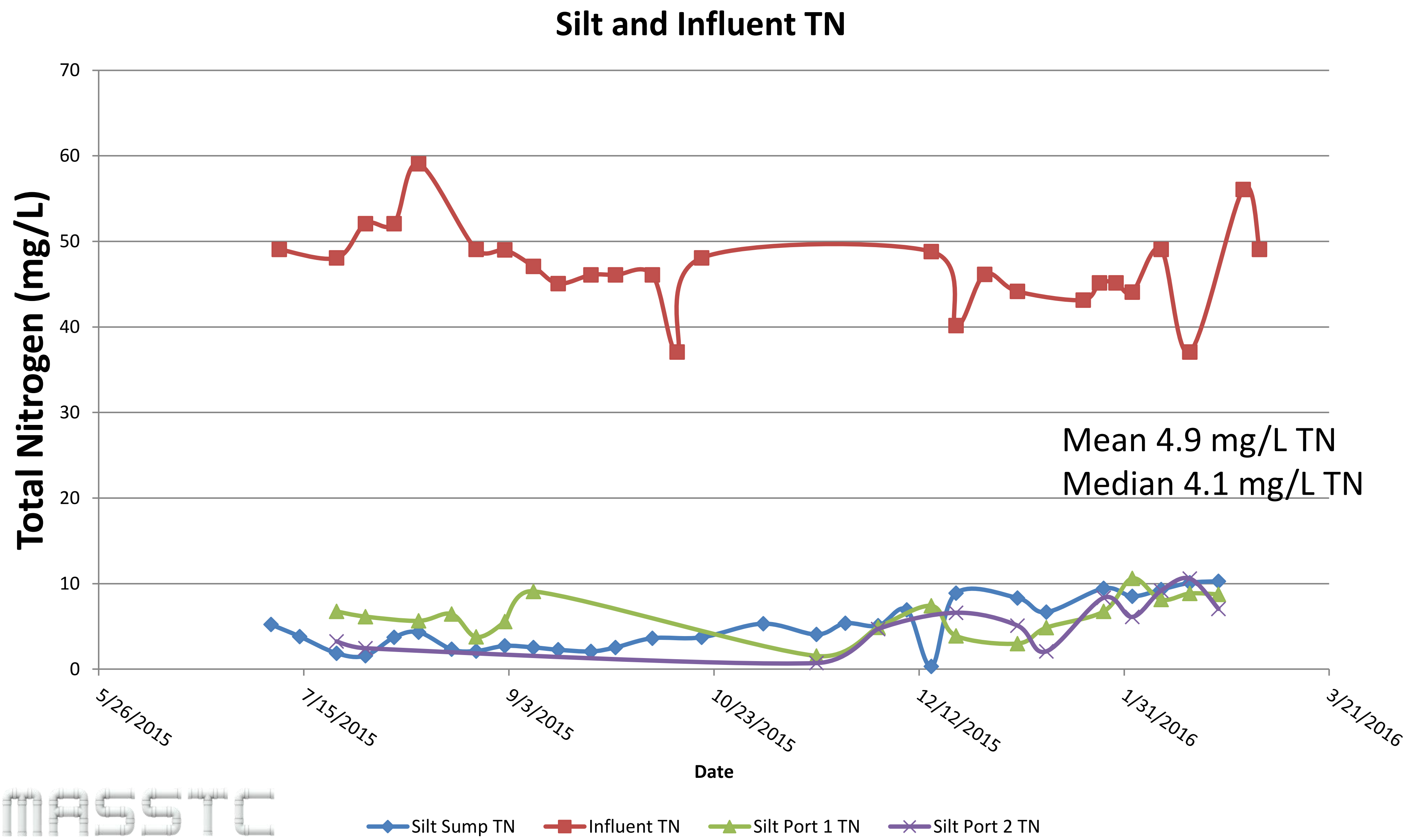
Final grade over soil treatment area

Grass planted over soil treatment area

Large scale "permeable reactive barrier" system (Silt-sawdust layer)

Grass planted over soil treatment area

Large scale "permeable reactive barrier" system (Silt-sawdust layer)



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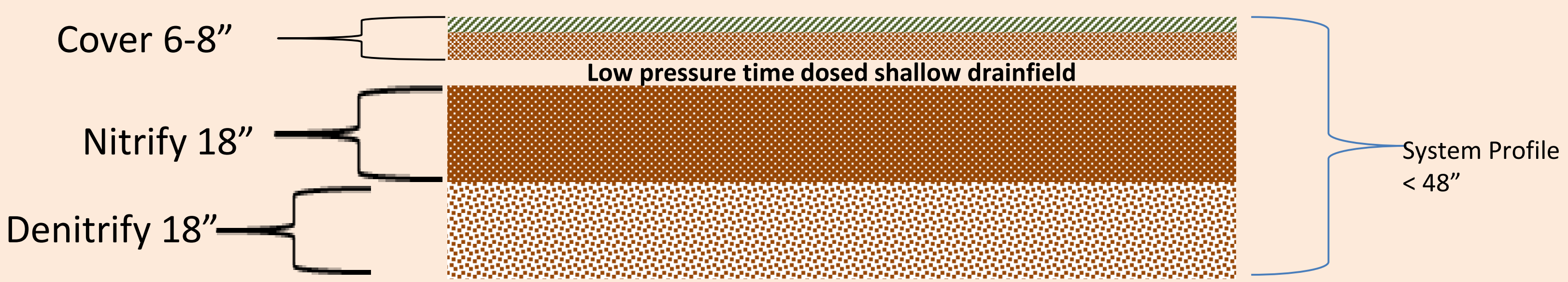
Large-scale unsaturated flow “layer cake”



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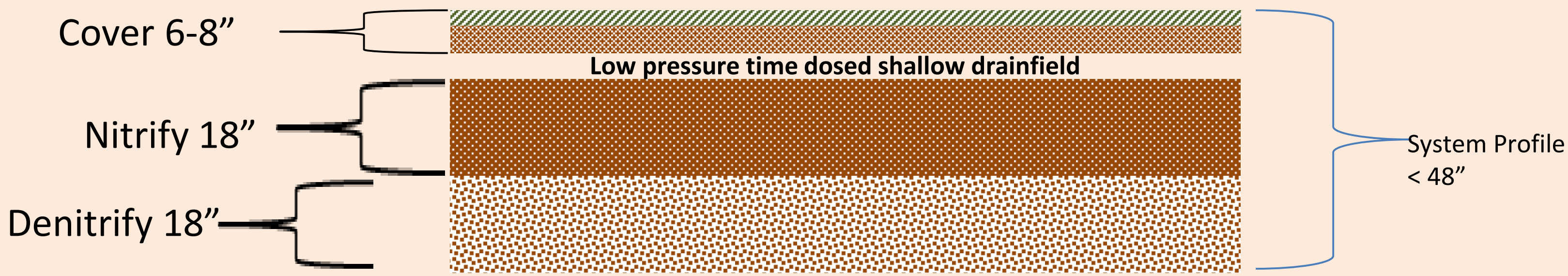
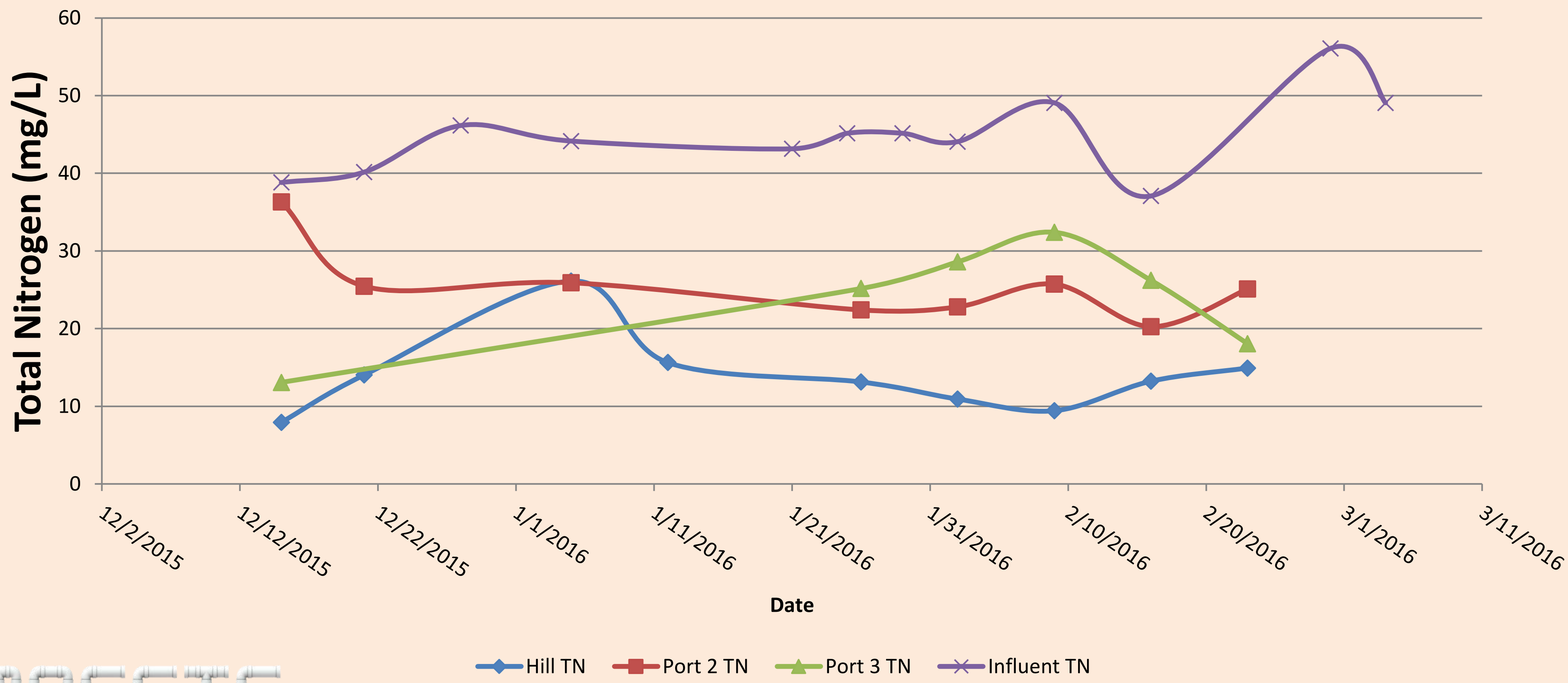
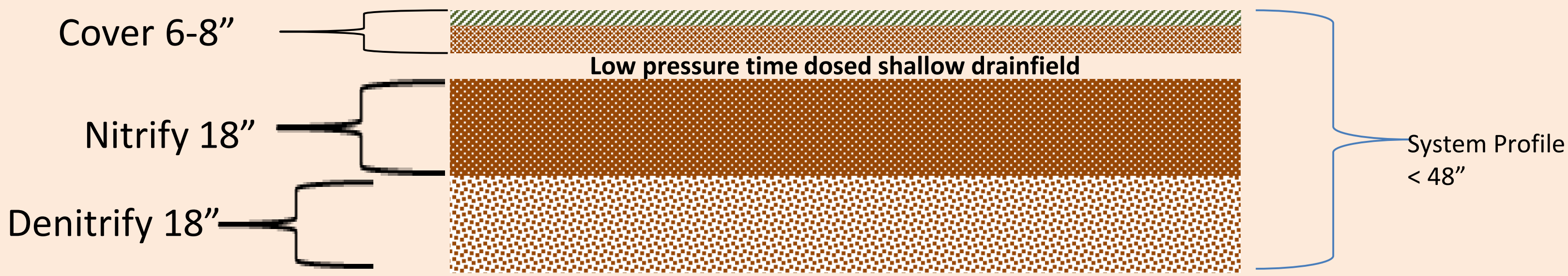
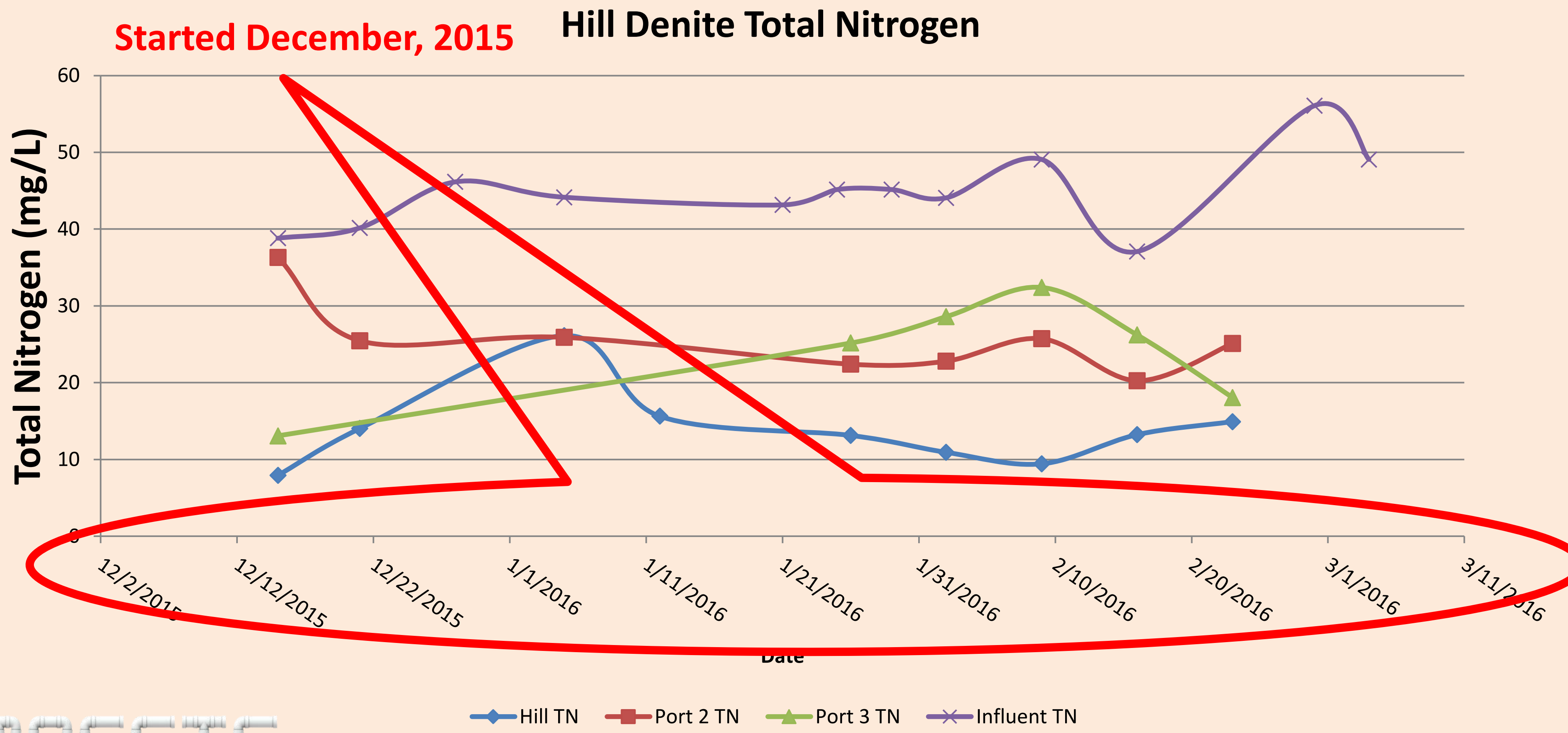


Hill Denite Total Nitrogen




Cover 6-8”
Low pressure time dosed shallow drainfield
Nitrify 18”
Denitrify 18”
System Profile
< 48”


Started December, 2015
Hill Denite Total Nitrogen
Total Nitrogen (mg/L)
60
50
40
30
20
10
0
12/2/2015
12/12/2015
12/22/2015
1/1/2016
1/11/2016
1/21/2016
1/31/2016
2/10/2016
2/20/2016
3/1/2016
3/11/2016
Date
Hill TN
Port 2 TN
Port 3 TN
Influent TN

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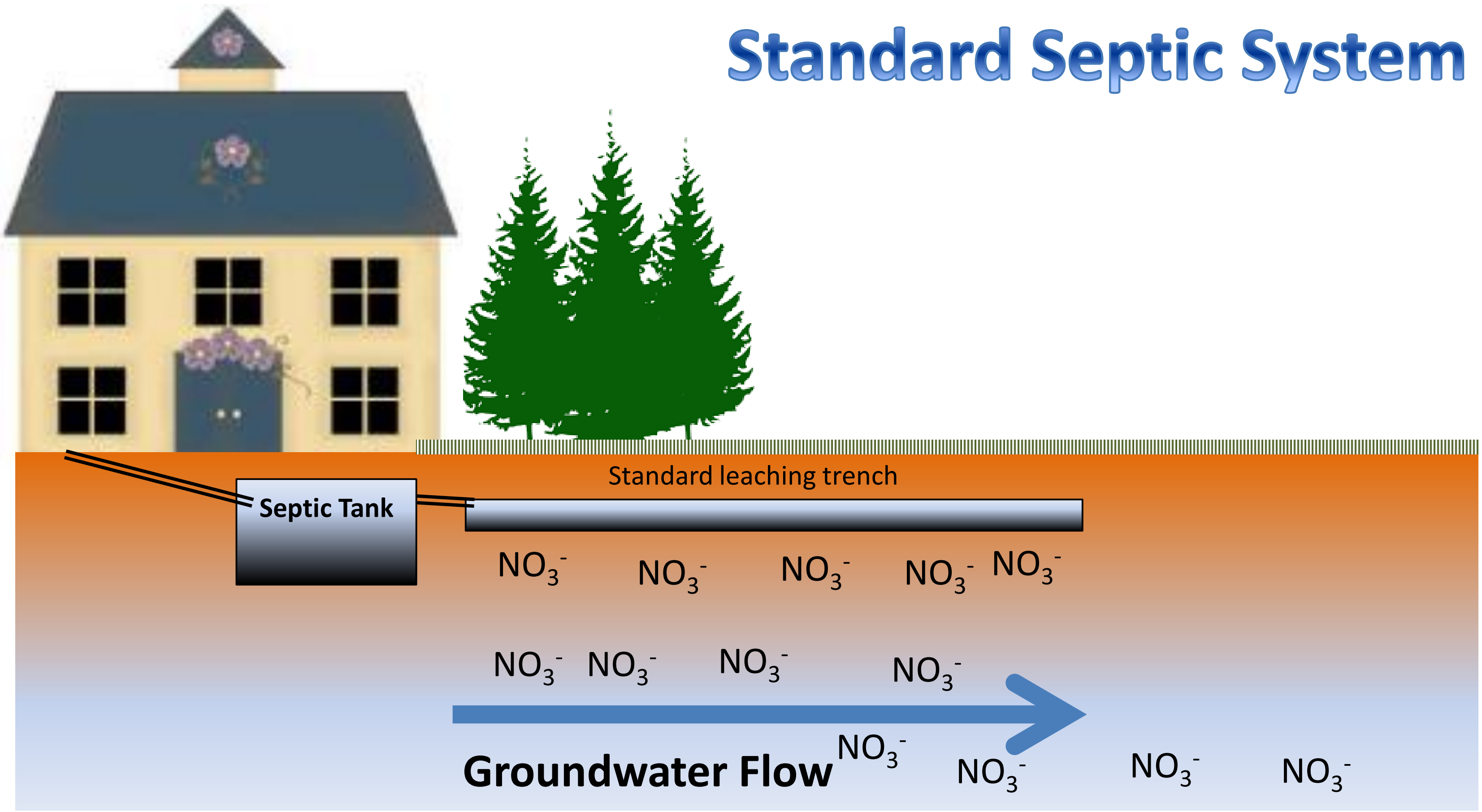
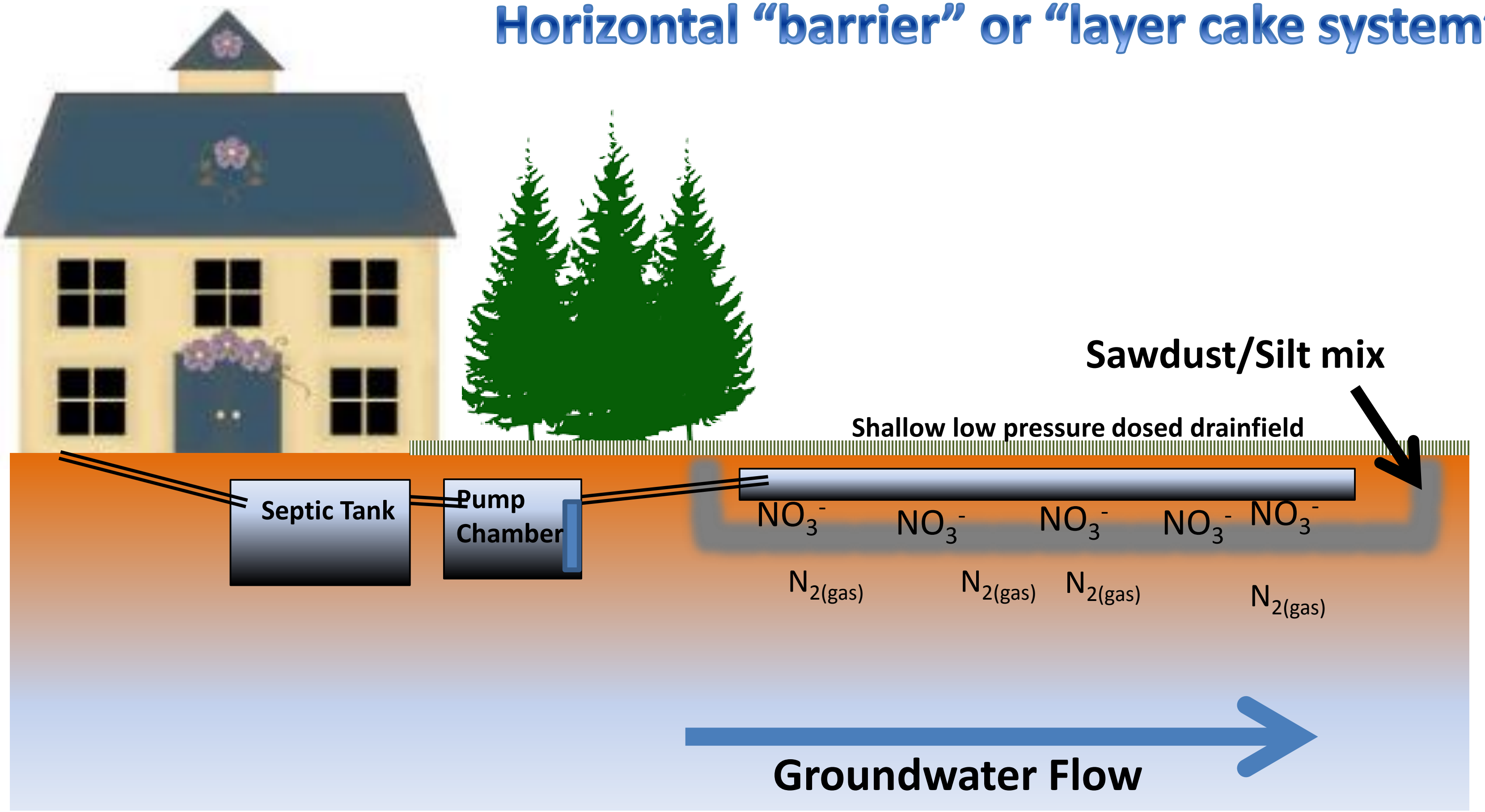
Main difference between layering and standard septic systems



Standard Septic System
Standard leaching trench
Septic Tank
NO_3^- NO_3^- NO_3^- NO_3^- NO_3^-
NO_3^- NO_3^- NO_3^- NO_3^-
Groundwater Flow
NO_3^- NO_3^- NO_3^- NO_3^-

Horizontal "barrier" or "layer cake system"



the BOTTOM LINE

- It appears that introducing ligno-cellulose into the soil profile can achieve reductions in total nitrogen from percolating wastewater

- Further study needs to be performed to determine the optimal design (saturated vs. unsaturated) that considers costs.

- Pilot systems at different-use households need to be installed and monitored to validate results found at the Test Center.

- Further beta testing with modifications of design that focus on how simple we can make it and still be effective.
- Work with soil scientists to bracket the soil characteristics necessary
- Put together the design manual for system installation.
- Identify and address the regulators' concerns

SNEP

EPA Proposal

- Install 12 systems in homes
- Six seasonal
- Three in outwash
- Three in moraine
- Monitor two years
- Create design manual
- Save the world


Questions?
Lawn atop saturated system January 1, 2016