Optimizing Nitrogen Removal in Advanced OWTS within the Greater Narragansett Bay Watershed

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Brittany Lancellotti, Graduate Student, Laboratory of Soil Ecology and Microbiology, University of Rhode Island

Anna Meyer, Environmental Analyst, NEIWPCC

NEIWPCC
New England Interstate Water Pollution Control Commission

NARRAGANSETT BAY ESTUARY PROGRAM

TODAY'S PRESENTER

Brittany Lancellotti

Master's Student,
Biological and Environmental Science

Laboratory of Soil Ecology and
Microbiology, University of Rhode Island

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Brittany Lancellotti

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THE UNIVERSITY OF RHODE ISLAND

Special Thanks to…

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Overview

1. Project description
2. Evaluation of rapid field tests
3. Evaluation of Performance of Advanced N removal OWTS in the Narragansett Bay Watershed
4. Predictors of effluent total nitrogen
5. Conclusions

Nitrogen Loading and Coastal Ecosystems: Rhode Island

Algal Bloom-
Narragansett Bay

Fish Kill-
Greenwich Bay

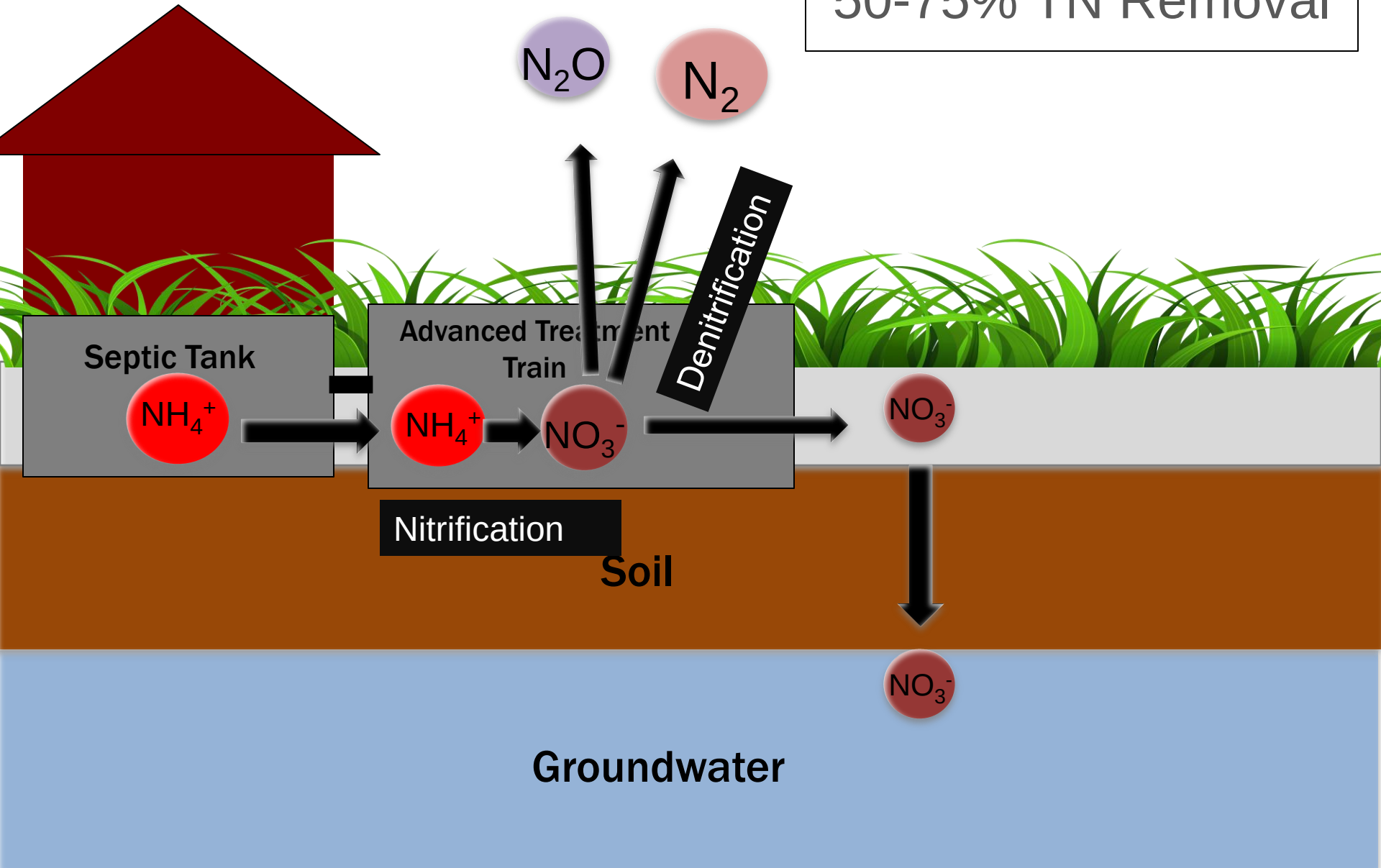
Addressing Eutrophication

Advanced Nitrogen Removal OWTS

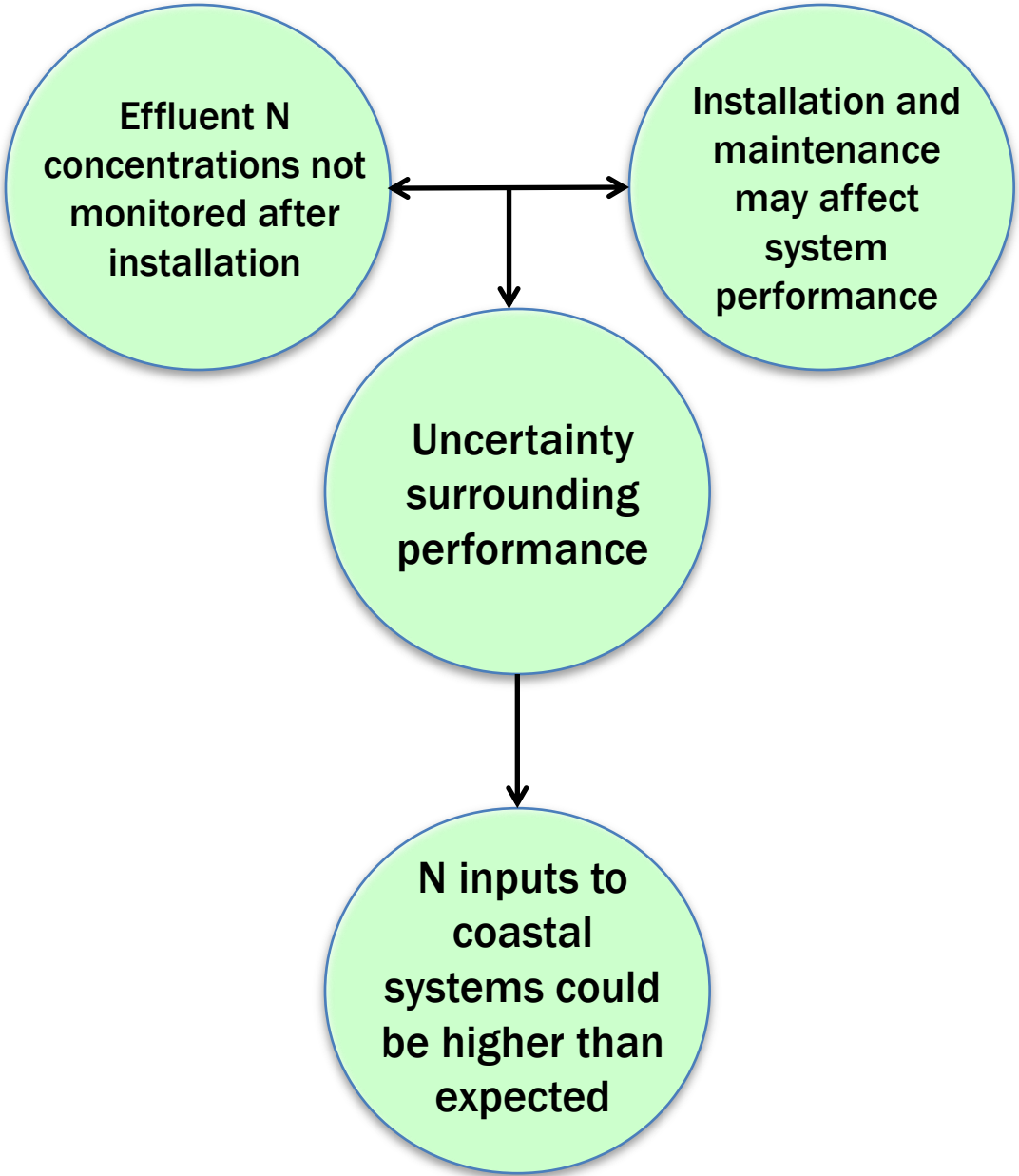
19 mg N/L Total Nitrogen Final Effluent Standard

Advanced N Removal OWTS

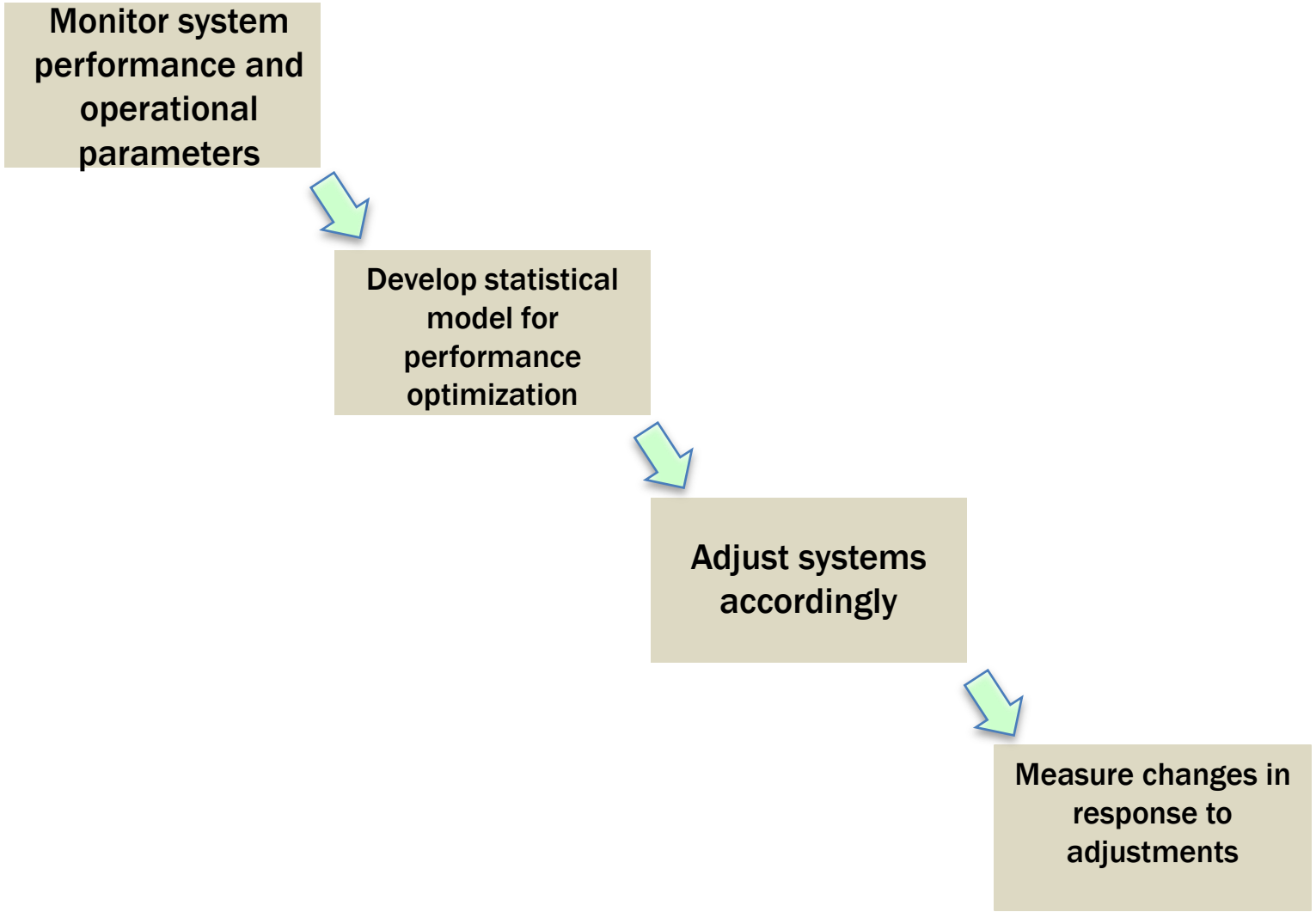
50-75% TN Removal



Advanced OWTS in Rhode Island: Considerations



Our Approach:



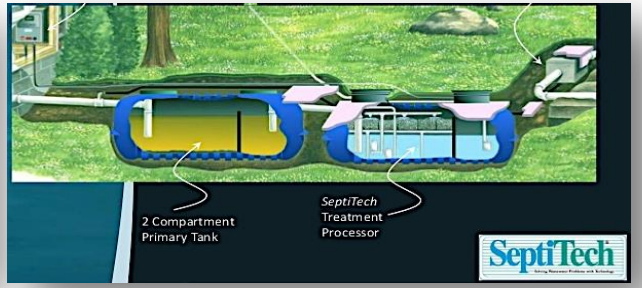
Sampling Design

We sample a total of 42 systems each month:

17 Systems	14 Systems	11 Systems
Orenco Advantex AX20®	BioMicrobics FAST®	SeptiTech D®

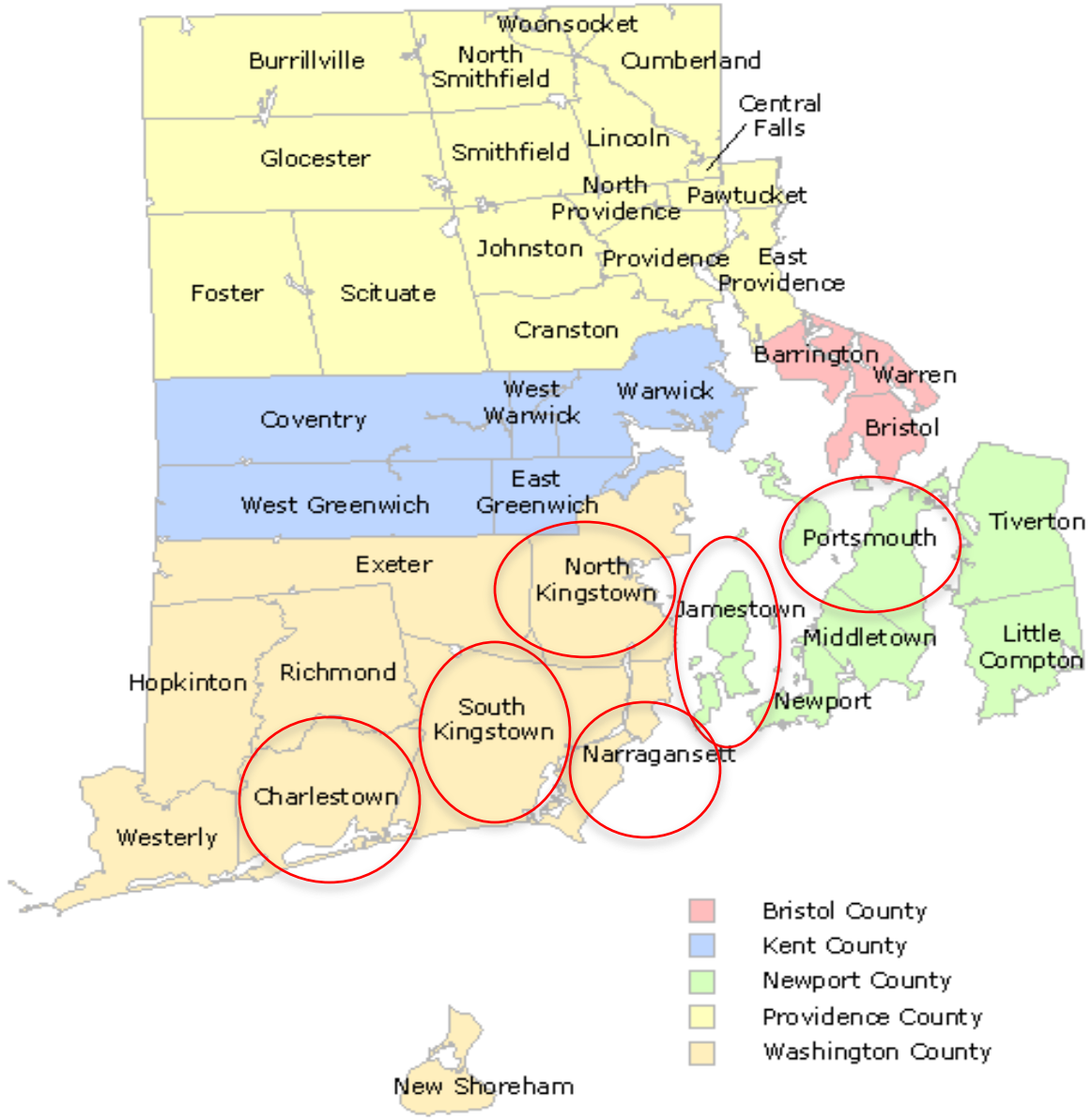
http://www.orenco.com/sales/choose_asystem/index.cfm

http://www.biomicrobics.com/products/fast-wastewater-treatment-systems/microfast/

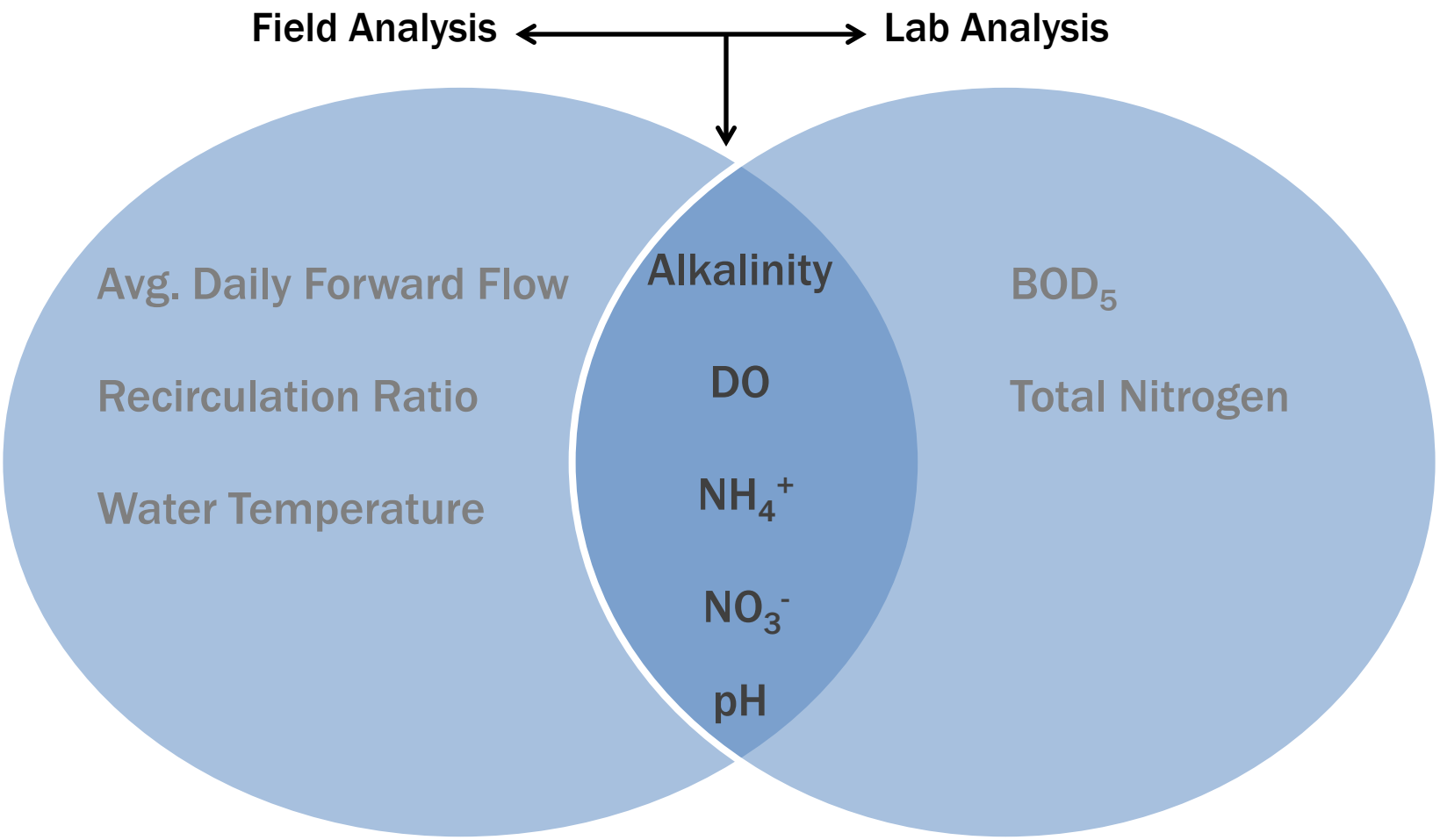


http://www.septitech.com/staar-residential/

Site Locations: Greater Narragansett Bay Watershed



Methodology: Operational Parameters



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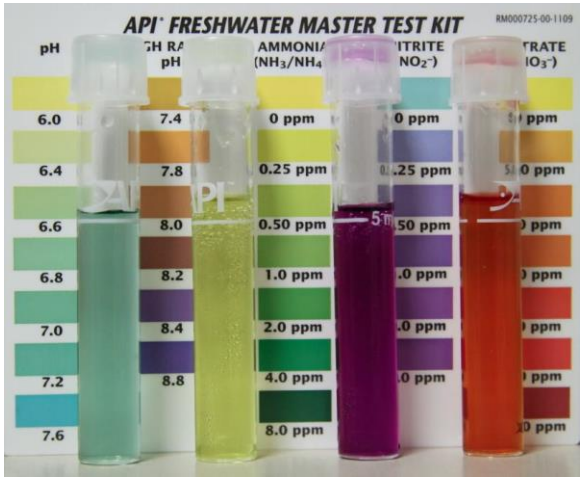
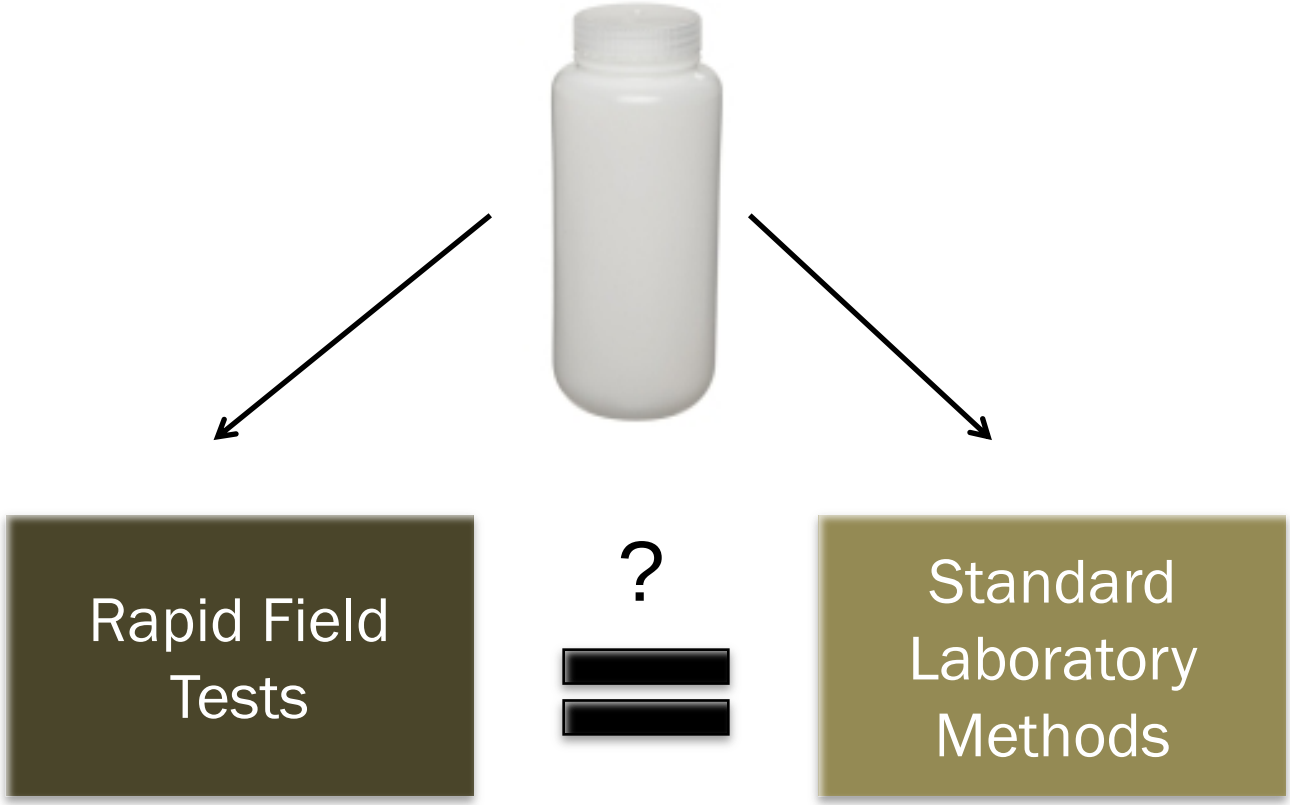
Evaluation of Rapid Field Tests

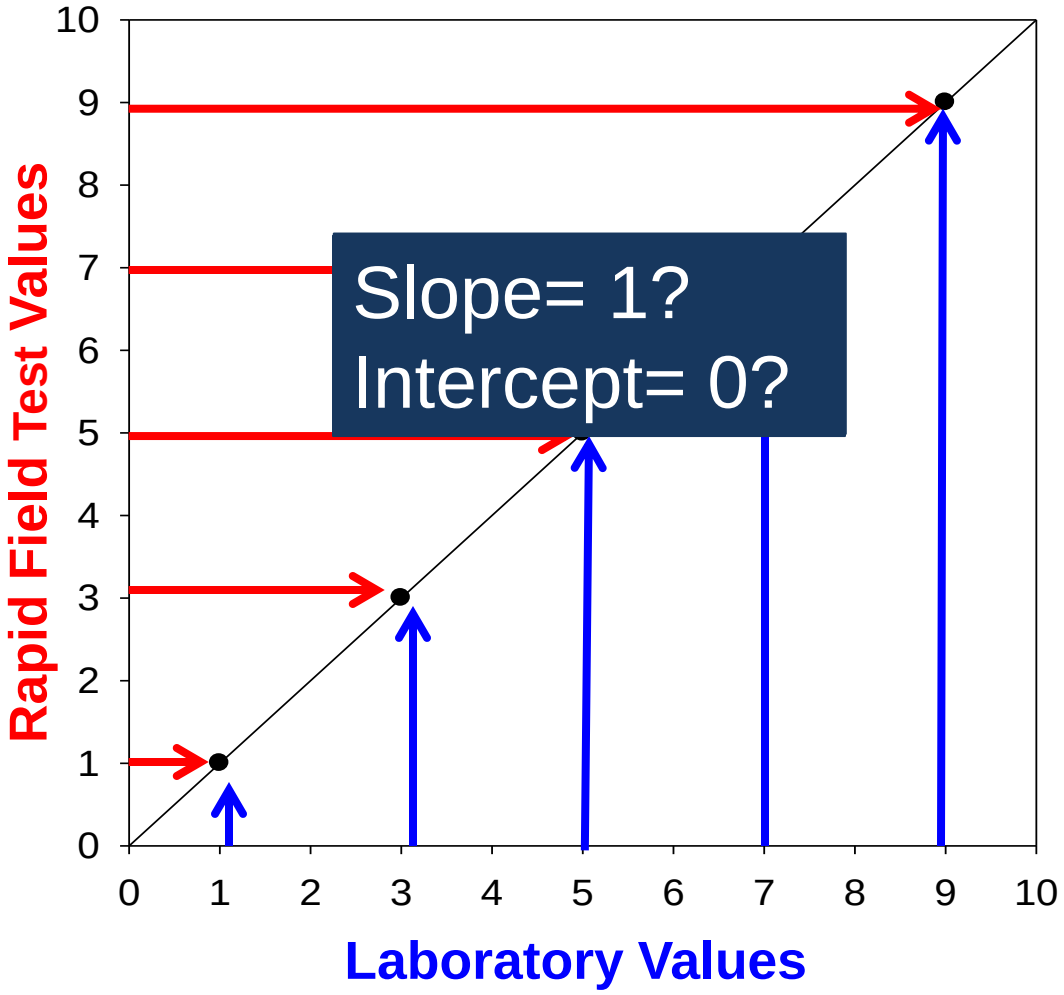
- Used by O&M service providers to evaluate system performance
- Provide quick results on-site
- Do they provide accurate results?



Evaluation of Rapid Field Tests: *Methods*



How is Accuracy Defined?



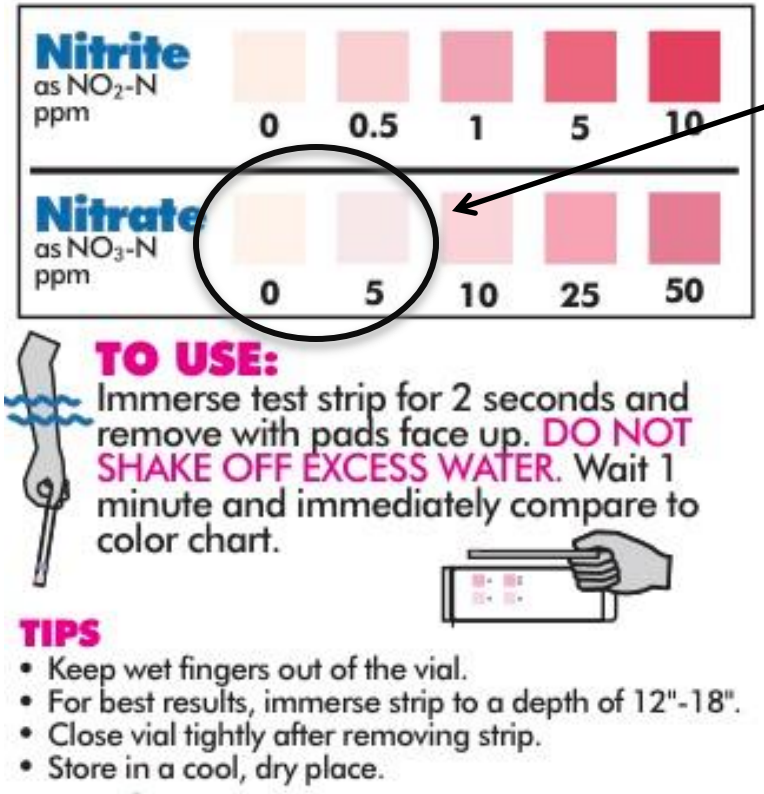
Rapid Field Test Methods

Property	Regression parameter: Intercept	Slope	R^2
Alkalinity	18.9*	0.9	0.4
Ammonium	4.5*	0.5*	0.8
Dissolved oxygen	2.4*	0.6*	0.5
Nitrate	1.5*	0.1*	0.1
pH – test strips	4.0*	0.1*	0.0
pH – pen	0.4	1.0	0.8

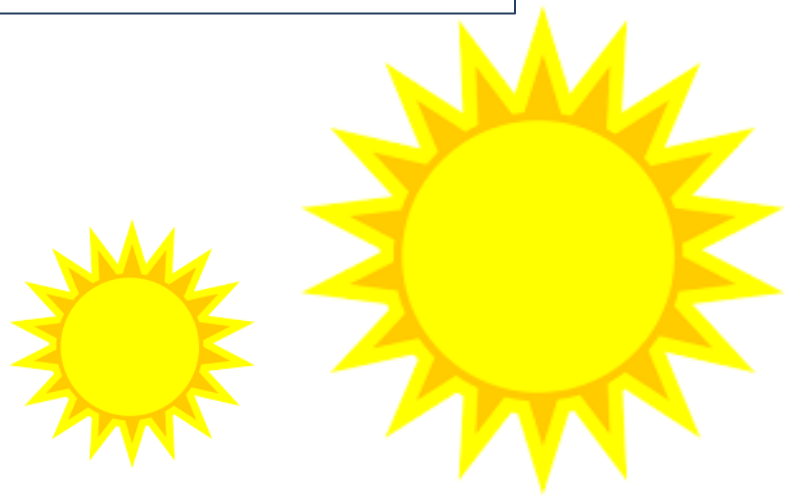
Rapid Field Test Methods : Used in the Laboratory

	Regression parameter:		
Property	**Intercept**	**Slope**	**R^2**
Alkalinity	19.8	1.6	0.2
Ammoniu			0.7
Nitrate			0.6
pH			0.4

Field Conditions and Error



Varying light conditions in the field complicate visual comparisons to color charts.



Accurate Rapid Field Test Methods

pH ✔

Nitrate ✔

Ammonium ✔

Ammonium
Nitrate
COD

Overview

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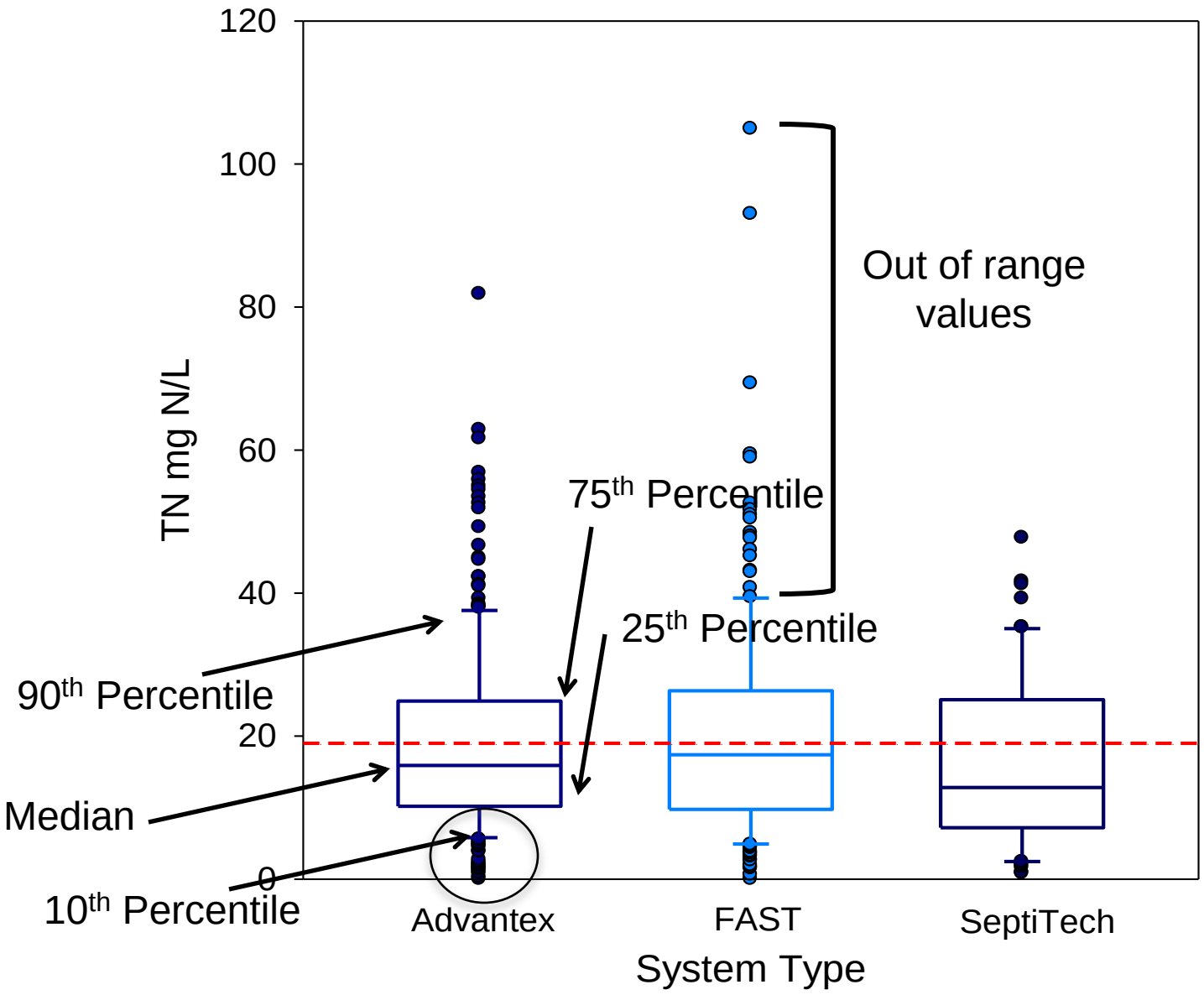
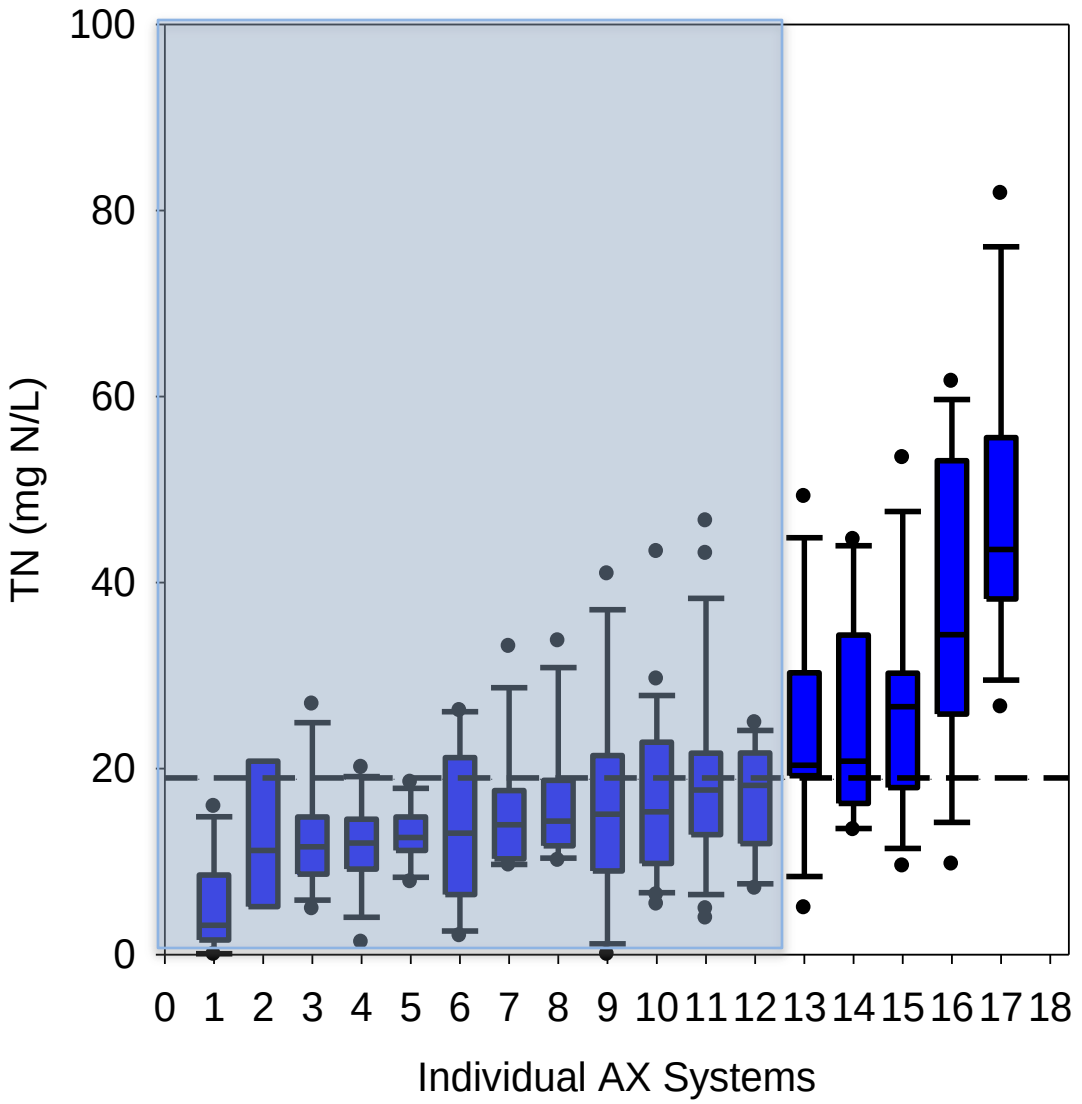
Evaluation of N Removal in Advanced OWTS

- Final effluent total nitrogen concentrations
- Collected from March 2015 to May 2016
- Standard laboratory values reported

Distribution of TN Concentrations: March 2015 - May 2016

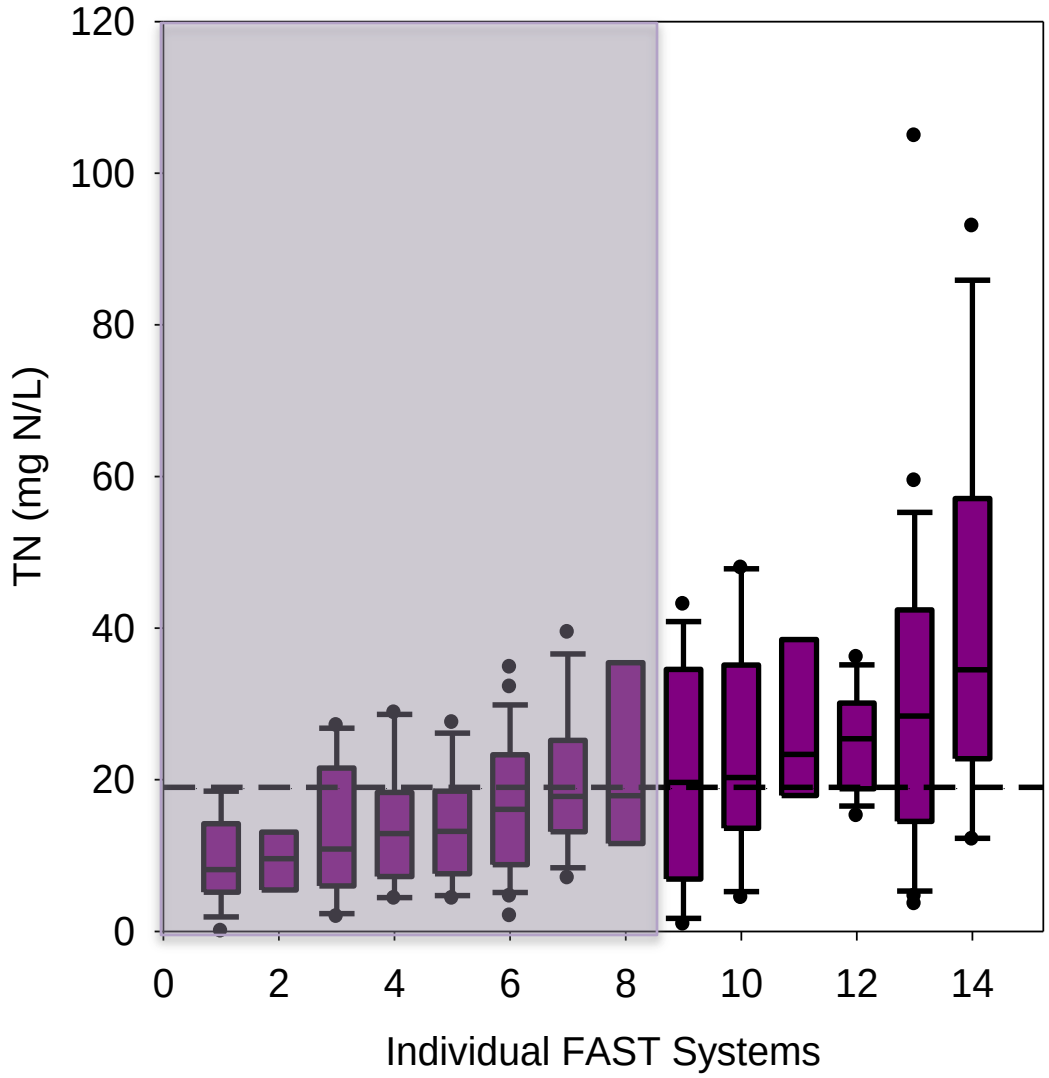


Advantex Systems: Distribution of TN Concentrations: March 2015 - May 2016



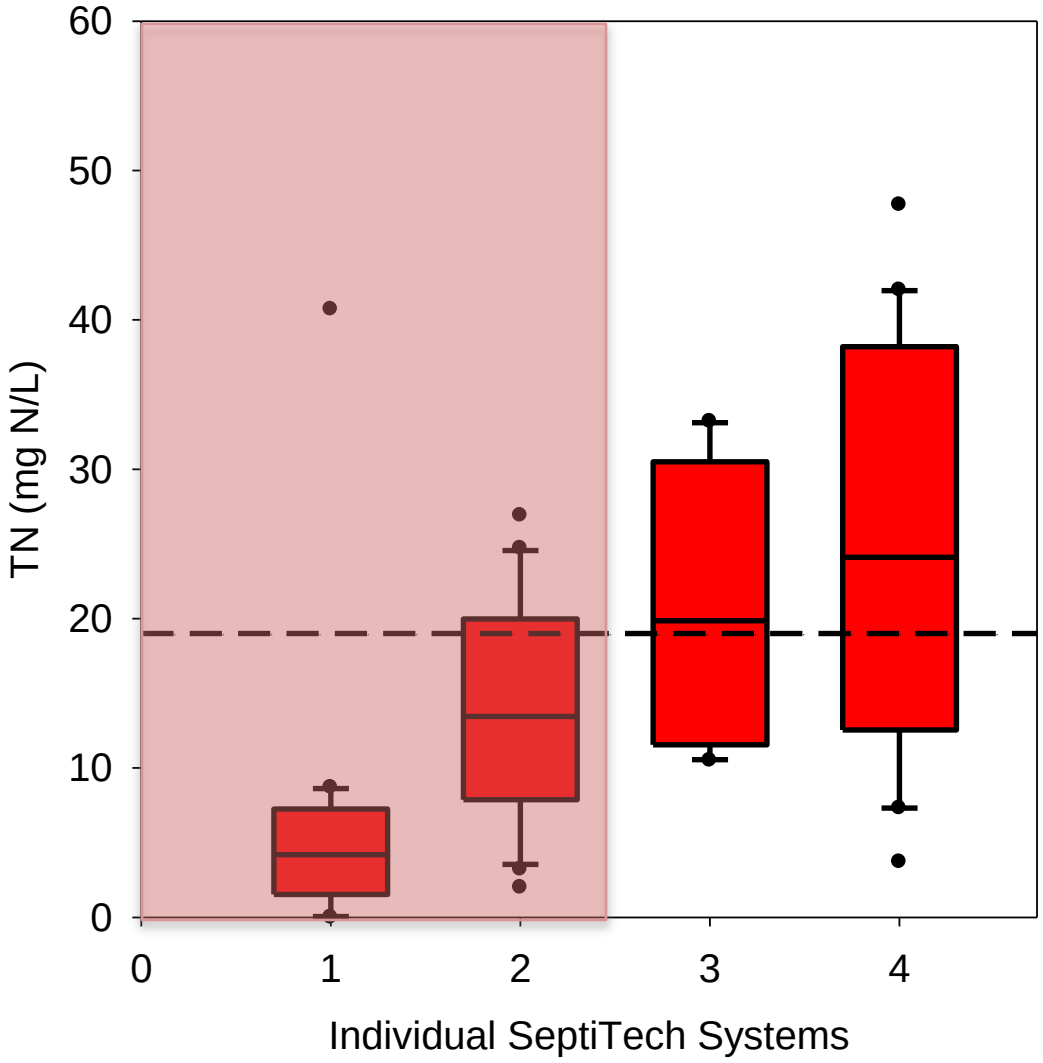
71% of systems meet the 19 mg N/L TN standard.

FAST Systems: Distribution of TN Concentrations: March 2015 - May 2016



57% of systems meet the 19 mg N/L TN standard.

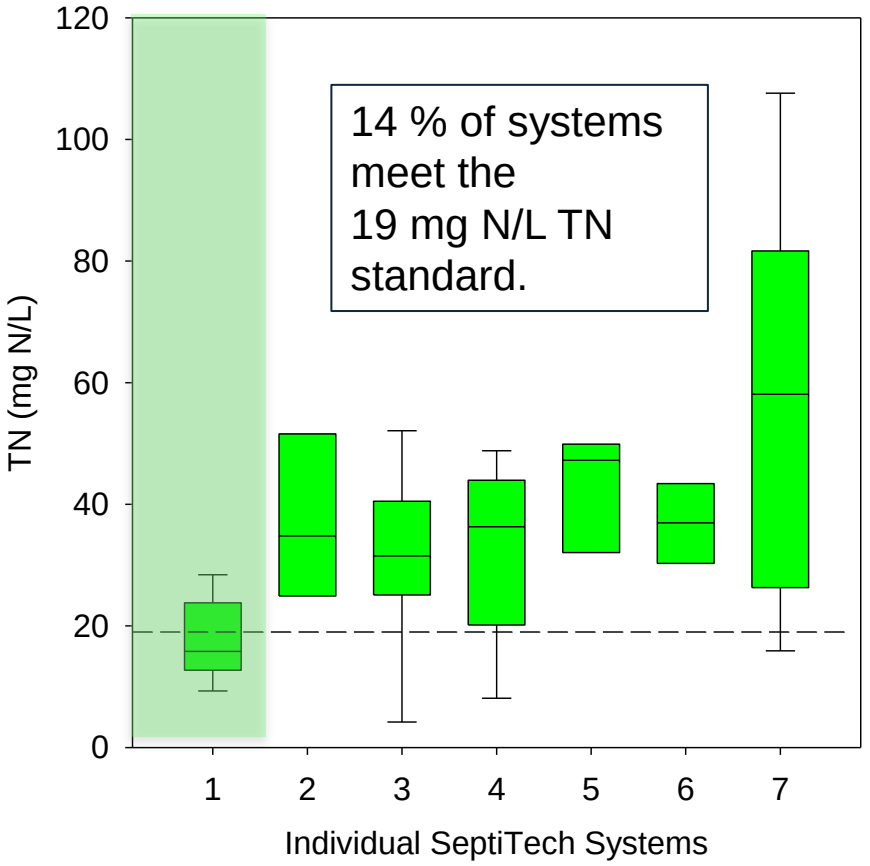
SeptiTech Systems: Distribution of TN Concentrations: March 2015 - May 2016



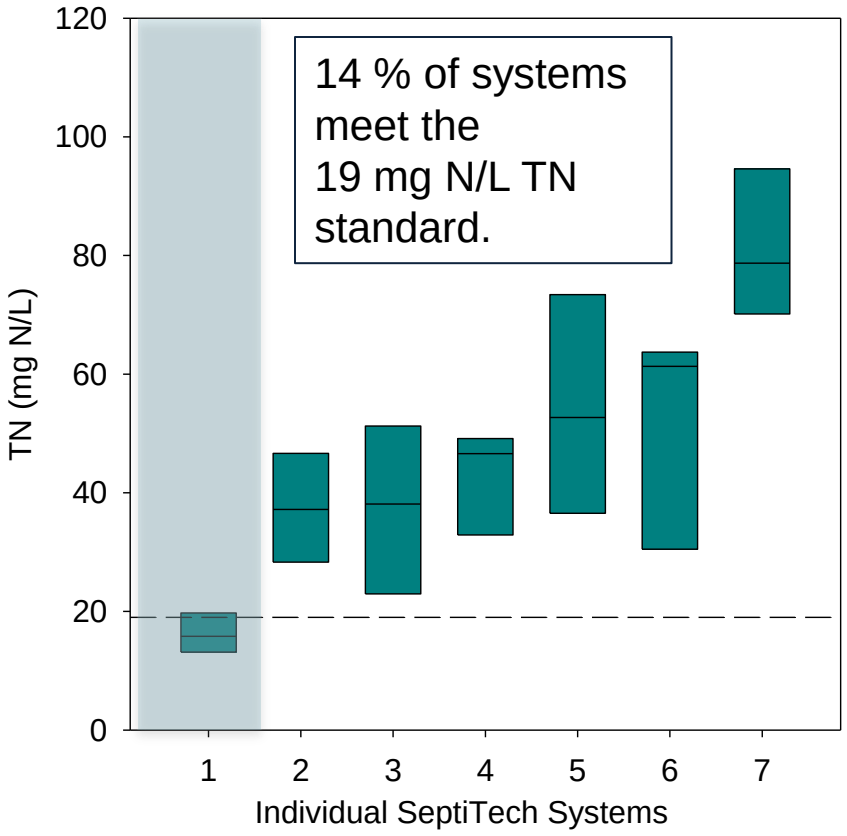
50% of systems meet the 19 mg N/L TN standard.

Individual SeptiTech Systems: Not turned on for Denitrification

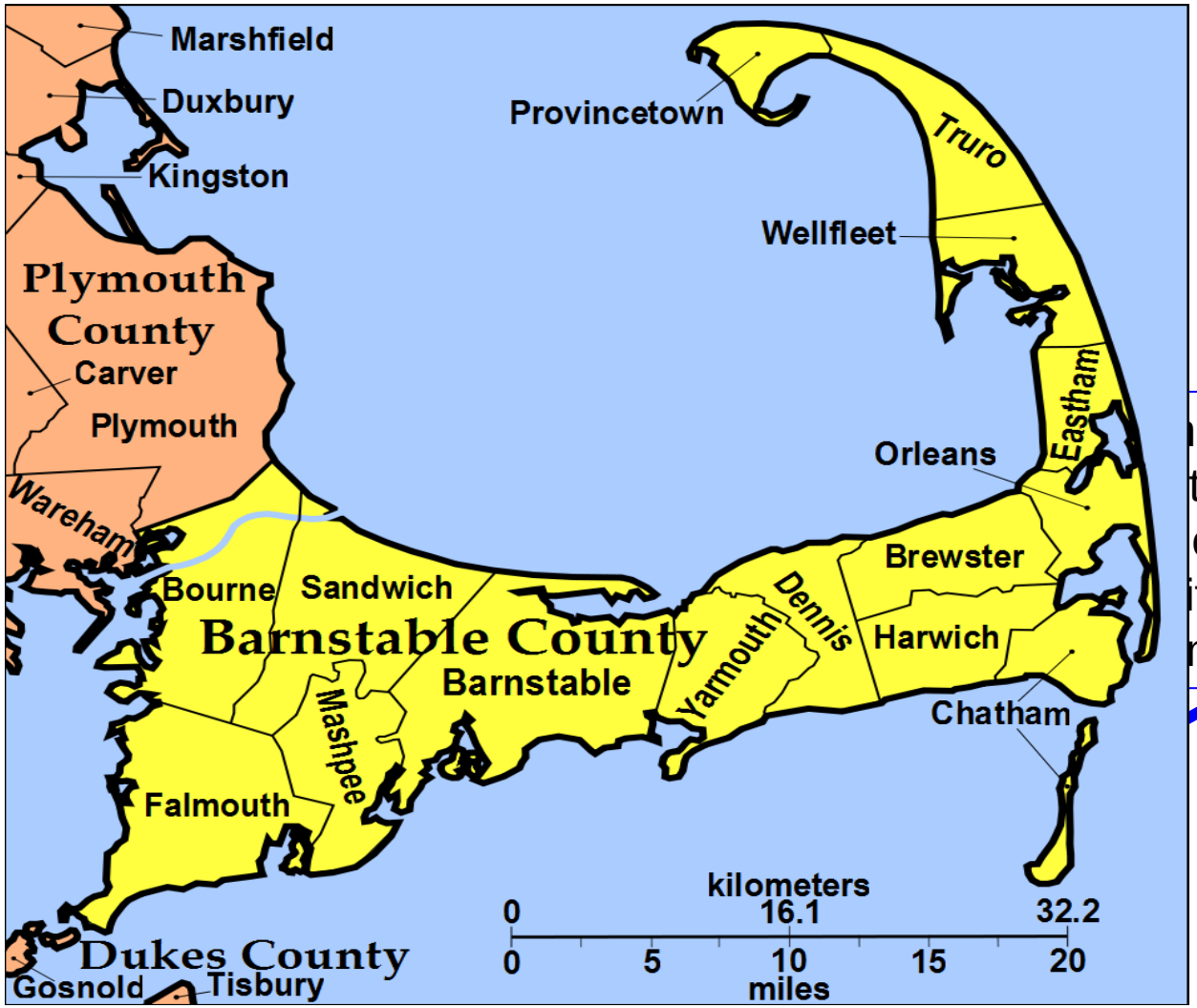
March 2015 - December 2015



January 2016 - May 2016



Median TN Concentration: Narragansett vs. Barnstable County Systems



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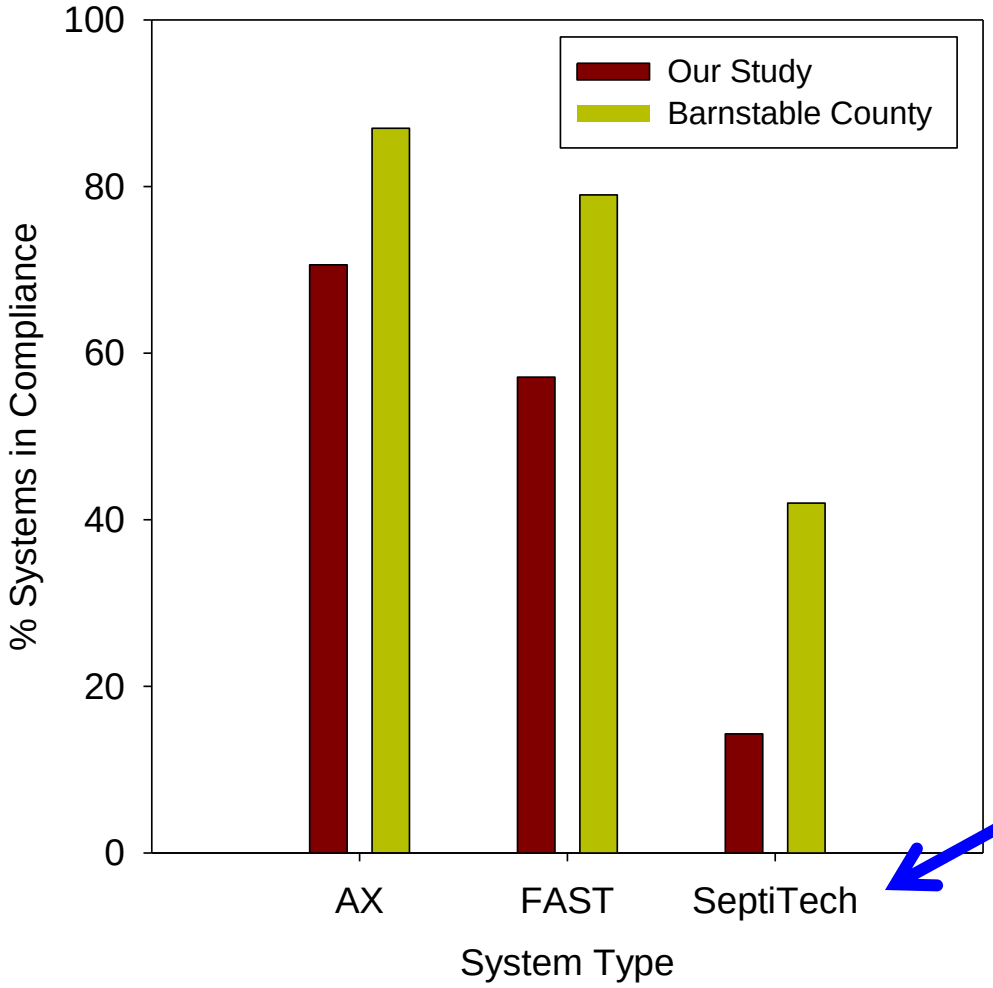
Percentage of Systems in Compliance: Narragansett vs. Cape Cod



Includes systems not turned on for denitrification mode

Differences in Regulations

Rhode Island

- 2 maintenance visits required per year
  - Focus on mechanical function
  - Do not include effluent sampling
  - 19 mg N/L TN standard

Barnstable County, Massachusetts

- 4 maintenance visits required per year
  - Effluent sampling required
  - 19 mg N/L TN standard
- Online management database
  - Tracks maintenance visits
  - Tracks effluent constituent levels
  - Alerts when effluent does not meet standards

Overview

Monitor system performance and operational parameters

2. Evaluation of rapid field tests

Develop statistical model for performance optimization

3. Perfo Advanced N removal OWTS in the Narragansett Bay Watershed

Adjust systems accordingly

4. Predictors of ef l nitrogen

5. Conclusions

Measure changes in response to adjustments

Which Parameters Best Predict Effluent Total Nitrogen Concentration?

How well do these parameters correlate with TN?

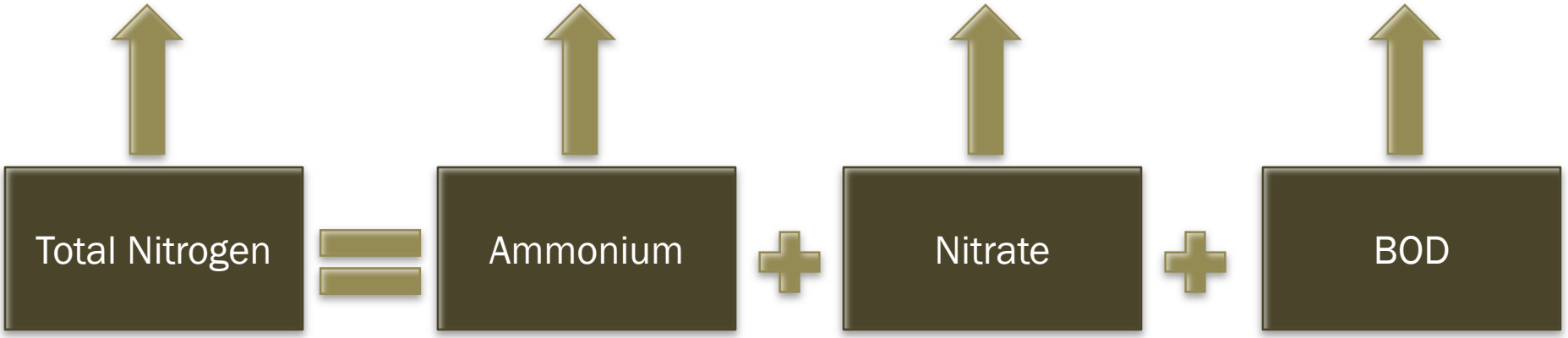
Which parameters can serve as indicators for effluent TN?

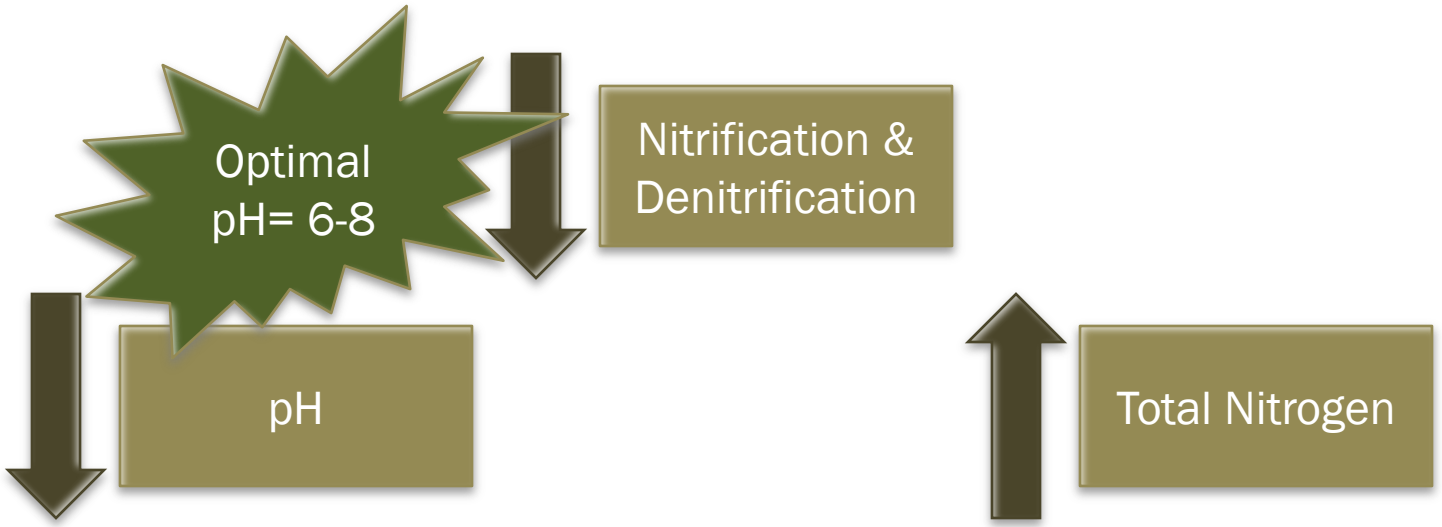
Ammonium
Nitrate
Alkalinity
pH
DO
Sample Temperature
Average Forward Flow
Recirculation Ratio
BOD

Total Nitrogen

System Type	Significant Predictors of Total Nitrogen
Orenco Advantex AX20®	+ Ammonium; + Nitrate
BioMicrobics FAST®	+ Ammonium; + Nitrate; + BOD
SeptiTech D®	− Nitrate; − pH; − Average Forward Flow

Best Predictors of Total Nitrogen





In conclusion…

- Accurate rapid field tests are available.
- Differences in regulatory requirements for monitoring influences management and may affect performance.
- Ammonium, nitrate, BOD, pH, and average forward flow are significant predictors of TN.

Where are we now?

- Continuing to collect and analyze final effluent wastewater samples
- Additional sampling in August
- Evaluating underperforming systems and working with service providers to make adjustments to improve N removal

We are hopeful!

- Monitored Massachusetts systems are performing better, but with the same level of management, RI systems can perform to standard.
- One town in RI is considering requiring effluent sampling during O&M visits.

CONTACT

Brittany Lancellotti

Master's Student

Laboratory of Soil Ecology and Microbiology,
University of Rhode Island

blancellotti@my.uri.edu

Anna Meyer

Environmental Analyst

NEIWPCC

ameyer@neiwpcc.org

QUESTIONS