

Nitrex Wastewater Nitrogen Removal System



Western Massachusetts Public Health Association

October 24, 2023

Environmental Engineers/ Consultants

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***Operating Projects of Nitrex technology for Nitrogen removal in MA, CT, NY, RI, MD, VA, NC, FL, AZ, CA, OR, UT & MT—since 2001**

***Use of Permeable Reactive Barriers (PRB) for Nitrogen Removal with operating systems in Canada, CT, NY & FL since 1995**

***Engineer for \$250 million wastewater projects throughout US – receiving number of Engineering Excellence Awards**

Wastewater Quality

Total Nitrogen

~ 65 mg/L - Residential

15 g/day – person

12 lbs/year -person

~ 150 mg/L – Schools/Office/Retail

~ 80 mg/L – Restaurants

Nitrogen Removal Mechanisms

Organic Nitrogen → Ammonia - NH_4^+

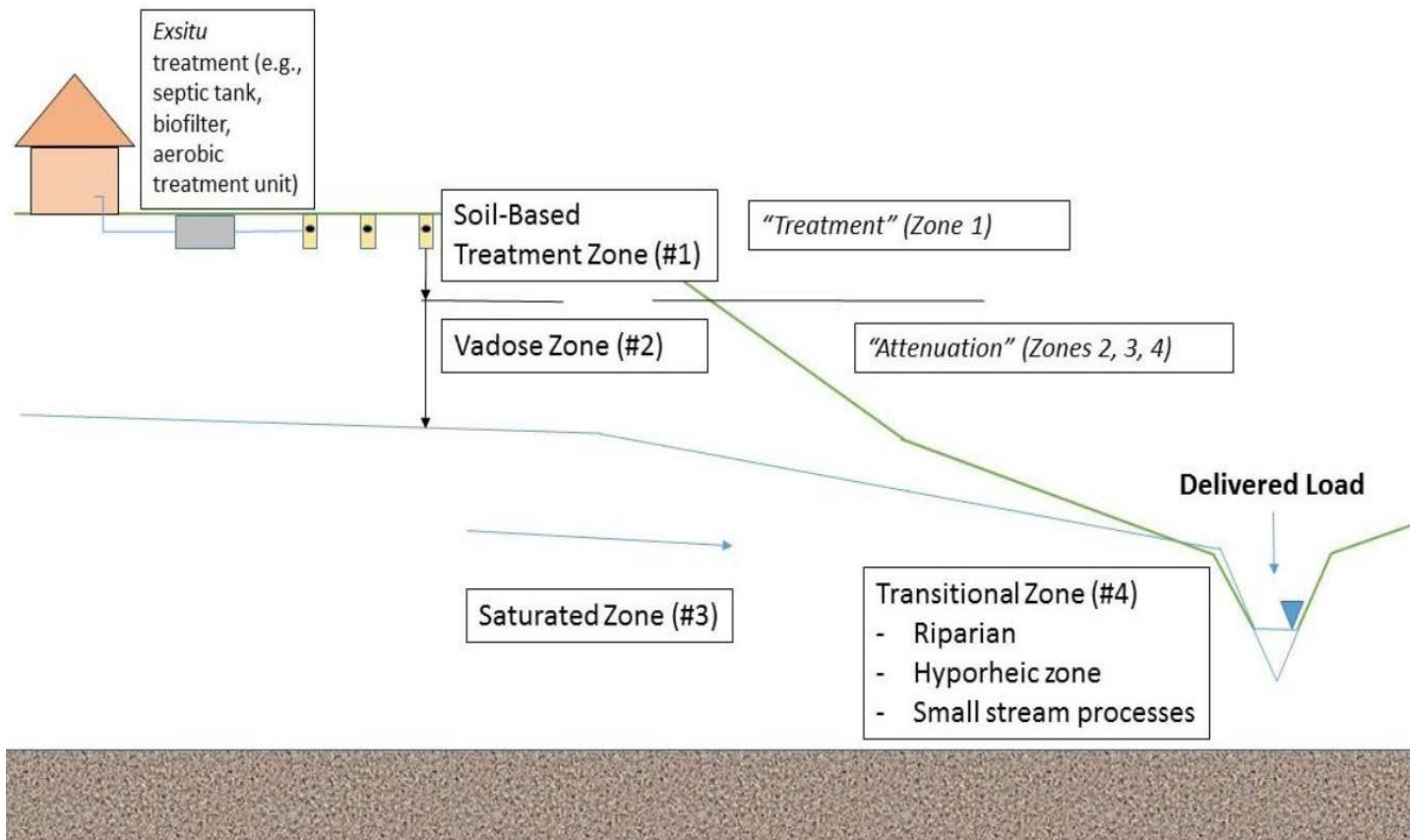
Ammonia NH_4^+ → Nitrite -NO_2^- + H^+ → Nitrate NO_3^-

Nitrate NO_3^- → *Nitrogen Gas (N_2)*

Nitrogen Removal by Soils / Watershed Processes

Four Transformation Zones

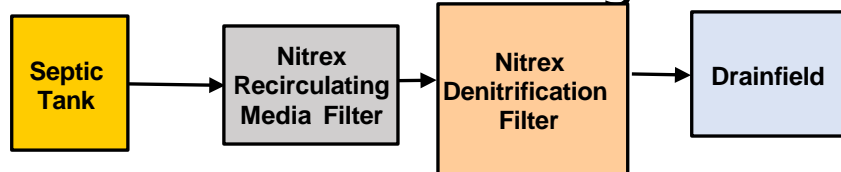
Methodology developed and used by the US EPA Chesapeake Bay Program





for Nitrogen Removal

Process Flow Diagram



- **Very low energy use. No aeration. Treatment system cannot be shut off. Oxygen provided by spraying water over media.**
- **Can be completely gravity at sites with sufficient slope**
- **Sludge – very small, no need for removal for 20+ years**
- **Electricity solely for periodic pump use**
- **Professional Engineer Guaranteed to achieve TN < 10 mg/L, Averaging 3 mg/L**
- **Performance comparable / better than sewer systems for N Removal**



- ✓ Nitrex has had MassDEP Pilot Approval since 2001 & Provisional use approval since 2006
- ✓ Nitrex has received site specific MassDEP Piloting Permit to achieve TN < 10 mg/L
- ✓ Permitted to Achieve TN < 10 mg/L in many states since 2007
- ✓ Permitted to Achieve TN < 2.5 mg/L in Utah
- ✓ Permitted to Achieve CA Title 22 unrestricted nonpotable reuse
- ✓ US EPA & MASSTC recognized to achieve TN 2.4 mg/L
- ✓ 22 + years of proven performance - field validated by MASSTC, US EPA, States of Oregon, Montana & Florida and Suffolk County NY



Guidance for Federal Land Management in the Chesapeake Bay Watershed

Chapter 6. Decentralized Wastewater Treatment Systems

Guidance for Federal Land Management in the Chesapeake Bay Watershed

Table 6-2. Examples of biological N removal performance from the literature

Technology examples	TN removal efficiency (%)	Effluent TN (mg/L)
Suspended growth		
Aerobic units w/ pulse aeration	25%–61% ^a	37–60 ^a
Sequencing batch reactor	60% ^b	15.5 ^b
Attached growth		
Single-Pass Sand Filters (SPSF)	8%–50% ^c	30–60 ^c
Recirculating Sand/Gravel Filters (RSF)	15%–84% ^d	10–47 ^d
Multi-Pass Textile Filters (AdvanTex AX20)	64%–70% ^e	3–55 ^e
RSF w/ Anoxic Filter	40%–90% ^f	7–23 ^f
RSF w/ Anoxic Filter & external carbon source	74%–80% ^g	10–13 ^g
RUCK system	29%–54% ^h	18–53 ^h
NITREX	96% ⁱ	2.2 ⁱ



**SUFFOLK COUNTY, NEW YORK
DEPARTMENT OF HEALTH SERVICES
OFFICE OF WASTEWATER MANAGEMENT**

**ALTERNATIVE ON-SITE SEWAGE DISPOSAL SYSTEMS
TASK IX-SUMMARY REPORT**

H2M Project No.: SCHS 09-01

Draft: August 2012

Final Draft: February 2013

Final: June 2013

Prepared by:
Holzmacher, McLendon & Murrell, P.C.
Division of Wastewater Engineering
175 Pinelawn Road, Suite 308
Melville, New York 11747



architects + engineers

No.	Site Name	Nitrex™ EFFLUENT TN (mg/l) Sampled by H2M - CDM		
		1st sampling	2nd sampling	Average
1	Eastham MA 40 unit subdivision	1.33	1.37	1.35
2	Mashpee MA 24 unit subdivision with 5,200 sf commercial	0.54	1.57	1.055
3	Harvard MA 2 family installation	0.63	1.4	1.015
4	Malibu CA 16,000 gpd Shopping Center restaurants & retail	1.58	1.28	1.43
5	St. Leonard, MD MA single family installation	2.3	3.68	2.99
Average all sites		1.28	1.86	1.57



O&M Requirements & Costs

- ✓ **Consistent performance even with seasonal use – tested at MASSTC**
- ✓ **Min. Operator visits - 1 year**

- ✓ **Costs – Single family, 3-4 bedroom**
 - **Equipment costs \$22,000 - \$25,000**
 - **Installed costs – site specific**
 - **O&M**
 - **Electricity** **\$ 50/yr**
 - **Total O&M Costs w/o sampling \$250/yr**

 - **Mass DEP required O&M sampling**
 - ✓ **Years 1 – 3** **\$1,950**
 - ✓ **Year 4+** **\$ 850**

Sampling Requirements - <2,000-gpd - Year Round Occupancy - Effluent Only					
Constituents	pH	BOD ₅	TSS	Total Nitrogen (TN)	Flow
Performance Evaluation Period - Quarterly Sampling for 36 months					
After Performance Evaluation Period & Approval by MADEP					
2x/year, 5-months min. apart, one between December 1 & March 1. Effluent TN only					
Sampling Requirements - <2,000-gpd - Seasonal Occupancy - Effluent Only					
Constituents	pH	BOD ₅	TSS	Total Nitrogen (TN)	Flow
2x/year, 1st 30-60 days after occupancy, 2nd min. 2 months after 1st					
After 12 rounds of sampling, can be reduced to TN only Quarterly					
After Performance Evaluation Period & Approval by MADEP					
2x/year, 1st 30-60 days after occupancy, next one min. 2 months after 1st. Effluent TN only					

Maintenance & Sampling Costs- SFR

Quarterly/yr. for 3 years	\$1,950
2 / Year after 3 years	\$ 870

Sampling Requirements >2,000-gpd - Year Round Occupancy						
Constituents	pH	BOD ₅	TSS	TN	Flow	
Location	Sampling Frequency - Performance Evaluation Period, 36-months					
Non NSA ⁽¹⁾	Monthly for 36 months, quarterly TN only thereafter - Effluent Only					
NSA ⁽¹⁾	Monthly for 36 months, quarterly thereafter, no reduction in constituents. Influent monitoring required for 12 quarters.					
⁽¹⁾ NSA = Nitrogen Sensitive Areas						
Occupancy	After Performance Evaluation Period & Approval by MADEP					
Non NSA ⁽¹⁾	Quarterly, min. 2 months apart -TN of Effluent only					
NSA ⁽¹⁾						
Sampling Requirements >2,000-gpd - Seasonal Occupancy						
2x/year, 1st 30-60 days after occupancy, 2nd min. 2 months after 1st						
After Performance Evaluation Period & Approval by MADEP						
2x/year, 1st 30-60 days after occupancy, next one min. 2 months after 1st						





Nitrogen Removal for larger Title 5 and Groundwater Discharge Systems

- **SCADA - Treatment system managed by a Programmable Logic Controller (PLC) with internet connection to Engineer + Operator**
- **Daily reports electronically issued on system wastewater flows and process unit status.**
- **Alarm conditions are instantaneously sent to the facility operator and engineer with identification of alarm cause**

PS-FE1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-1	105.03	36.0	84	3780.97	1.25
P-2	105.00	36.0	84	3779.84	1.25
TOTALS	210.02		168	7560.85	

PS-AX1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-5	360.43	56.0	99	20184.11	3.64
P-6	359.33	56.0	98	20122.38	3.67
TOTALS	719.76		197	40306.50	

PS-NF1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-7	272.30	28.0	21	7624.27	12.97
P-8	278.25	28.0	20	7790.89	13.91
TOTALS	550.54		41	15415.16	

PS-AX2

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-3	205.99	62.0	103	12771.67	2.00
P-4	205.26	62.0	102	12725.88	2.01
TOTALS	411.25		205	25497.70	

PS-NF2

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-9	289.24	28.0	23	8098.81	12.58
P-10	244.26	28.0	22	6839.33	11.10
TOTALS	533.51		45	14938.14	

PS-DF1

PUMP #	RUN (MINS)	FLOW RATE (GPM)	# OF CYCLES	CALC FLOW (GPD)	TIME/CYC
P-11	62.31	66.0	6	4112.47	10.39
P-12	66.44	66.0	6	4384.73	11.07
TOTALS	128.75		7	8497.20	

NITREX STAGE 1 DAILY FLOW

SV #	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-NX1	7431.2	191.30	0.0	304	0.00
SV-NX2	7630.7	192.03	0.0	305	0.00
SV-NX3	7607.1	179.63	0.0	307	0.00
SV-NX4	0.0	0.00	0.0	0	0.00
SV-NX5	0.0	0.00	0.0	0	0.00
TOTALS	22668.9	562.96		916	0.00

NITREX STAGE 2 DAILY FLOW

SV#	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-NX6	26.8	273.99	0.0	423	0.00
SV-NX7	26.7	273.44	0.0	417	0.00
TOTALS	53.5	547.43		840	0.00

ADVANTEK STAGE 1 TOTALS

SV#	FLOW (GPD)	SV OPEN (MIN)	SV RATE (SEC)	# OF CYCLES	CALC OPEN TIME
SV-AX1	24035.6	362.57	0.0	196	0.00
SV-AX2	23840.2	363.71	0.0	197	0.00
TOTALS	47875.9	726.27		393	0.00

ADVANTEK 2 AND EFFLUENT

FM-AX2 TOTAL GPD	112732.5 GAL	EFFLUENT TOTAL GPD	7699.2 GAL
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Representative Installations - Single Family





PROJECT DESCRIPTION – WESTFIELD, MA

Wellfleet, MA

Residential System

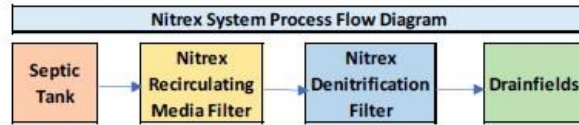
Design Flow: 2 bedroom, 220 gpd

Wastewater Engineer: Pio Lombardo, P.E.
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 Boston, MA
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www.LombardoAssociates.com

Lombardo Associates, Inc. (LAI) engineered a residential Nitrex™ wastewater nitrogen removal system to serve a seasonal residence in Westfield. The Nitrex™ system is virtually maintenance free. The process flow diagram is shown below. The system became operational in 2023. The water quality data is presented below:

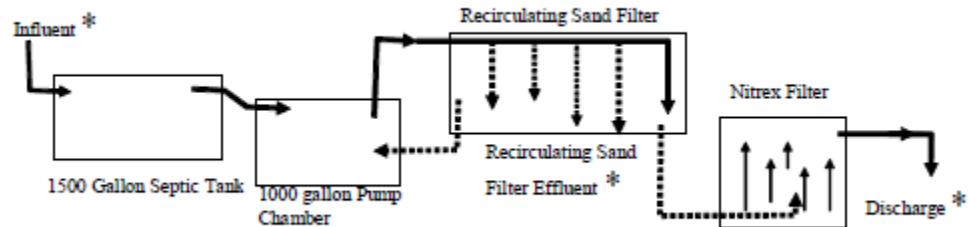


Date	Influent Effluent	
	TKN	TN
27-Jul-23	93.6	7.58
26-Sep-23	121	2.99



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“The Nitrex™ Filter effluent exhibited a mean TN of 5.4 mg/L (median=4.2 mg/L)”.

FINAL

Onsite Wastewater Technology Testing Report
Nitrogen Removal Performance



Massachusetts Alternative Septic System Test Center
Air Station Cape Cod, Massachusetts 02542
Telephone: 508-563-6757
MASSTC@cape.com

Massachusetts
Alternative
Septic
System
Test
Center

-- April 2008 --

Nitrex™ Filter

Technology Vendor

Lombardo Associates, Inc.



Larger Flows Representative Installations





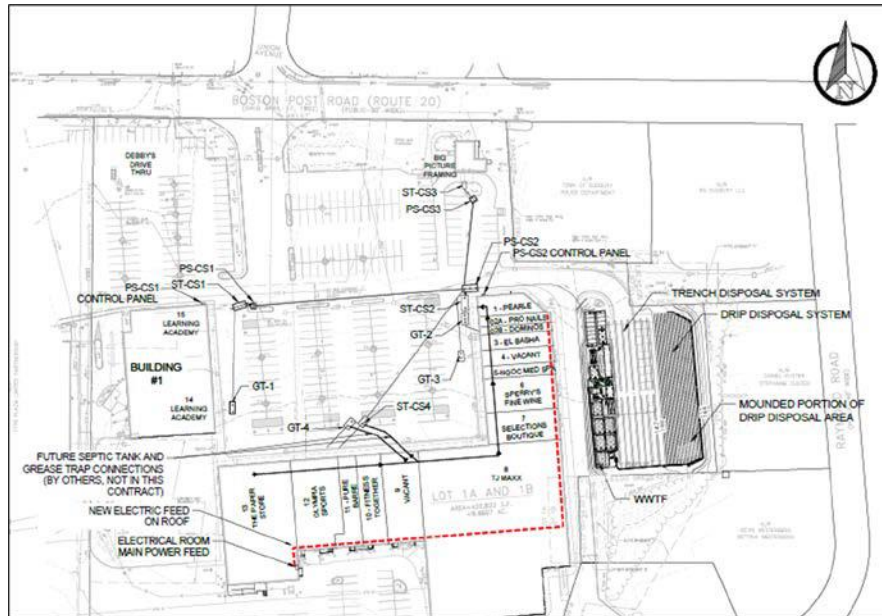
Representative Installations





Sudbury Crossing Shopping Center – 9,600 gpd TN < 2 mg/L

SCSC - Sudbury MA Nitrex Wastewater Treatment System Performance			
Date	Effluent TN (mg/L)	GW MW-2 Fecal Col (#/100)	GW MW-1 Fecal Col (#/100 mL)
Permit Req'd	5	200	200
6/9/23	4.98	< 2	< 2
6/14/23	3.07		
6/21/23	1.10		
6/26/23	2.42		
7/5/23	1.70		
7/12/23	1.69		
7/19/23	1.53	< 2	< 2
7/26/23	1.41		
8/2/23	1.15		
8/9/23	1.58		
8/14/23	3.12		
8/24/23	1.89	52.00	2.00
8/29/23	1.63		
9/6/23	1.47		
9/12/23	1.95		
9/20/23	1.41	64.00	< 2
9/27/23	1.57		
Geomean	1.8	< 2	< 2
Average	2.0	< 2	< 2



- **Mashpee MA (Cape Cod) – Residential and Commercial 5,600 gpd since 2006 - Under parking area**
 - ✓ **Geomean Effluent TN = 3.6 mg/L quarterly Operator visit**



- **Eastham MA (Cape Cod) - Residential 5,600 gpd since 2006**
 - ✓ **Geomean Effluent TN = 3.6 mg/L quarterly Operator visit**

■ **Captree State Park, Long Island NY Restrooms for Sports /Commercial Fishing Location 6,000 gpd design flow since April 2020**

- **Influent TN = 170 mg/L, Effluent TN = 4 mg/L 1/month Operator visit**
- **Cross Creek Shopping Center Malibu CA 24,500 gpd, predominately restaurants, 2006- 2018 Effluent TN = 2.66 mg/L**
 - **Complied with CA Title 22 Unrestricted Non-Potable Water Reuse Standards - 2/month Operator visit.**
 - **Under parking lot**

Wastewater Treatment system below parking lot and inside fence. Small building for electrical and disinfection equipment

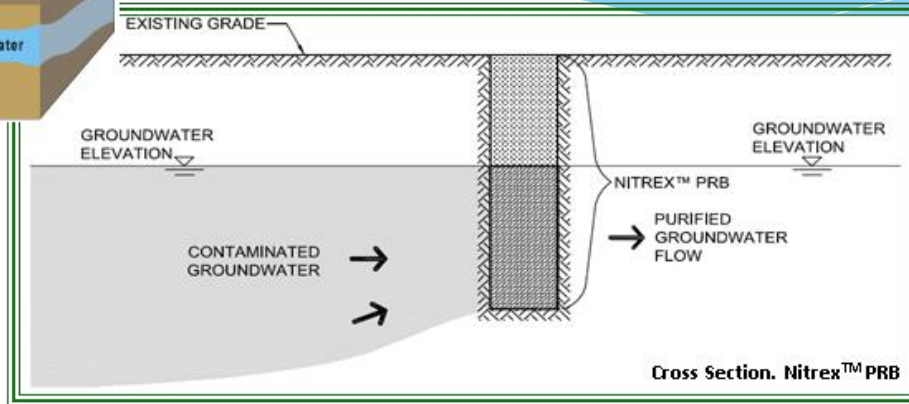
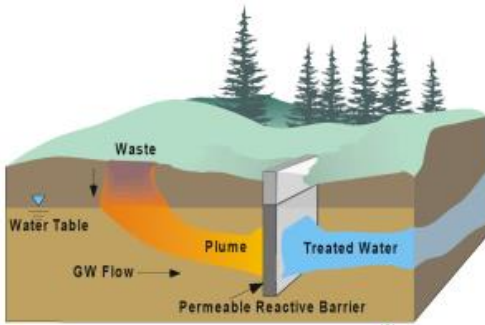


■ **Croatan High School and Bogue Sound Elementary School, Newport, NC –12,000 gpd high TN strength 150 mg/L since January 2010**

- **Geomean Effluent TN = 2.5 mg/L**

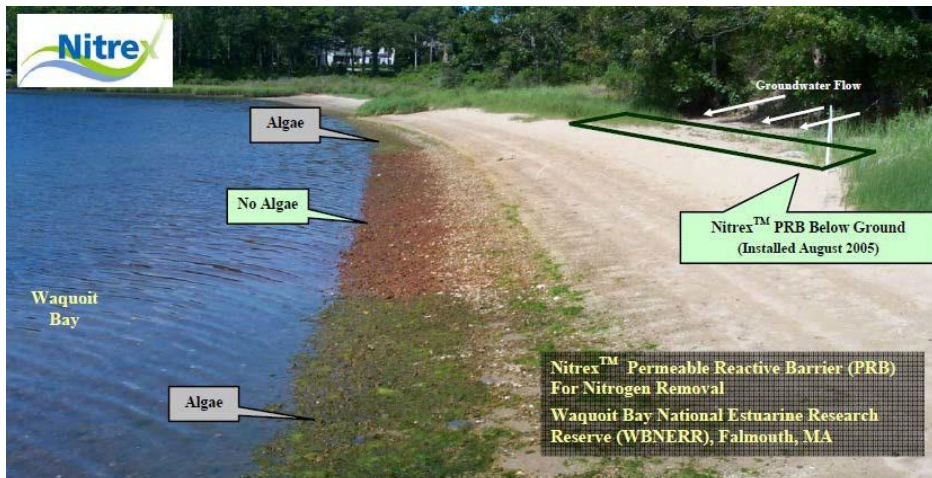


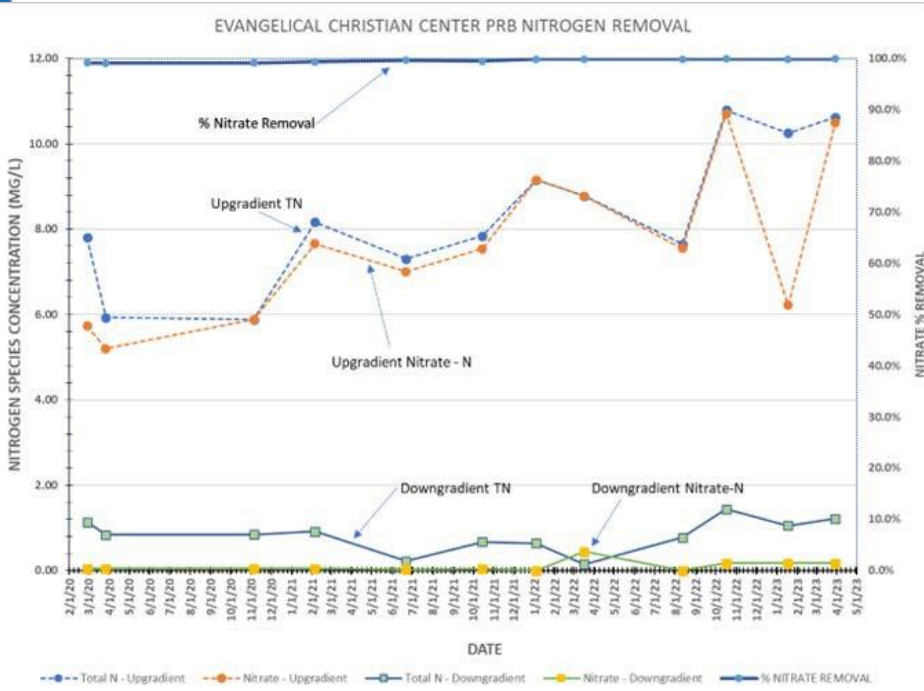
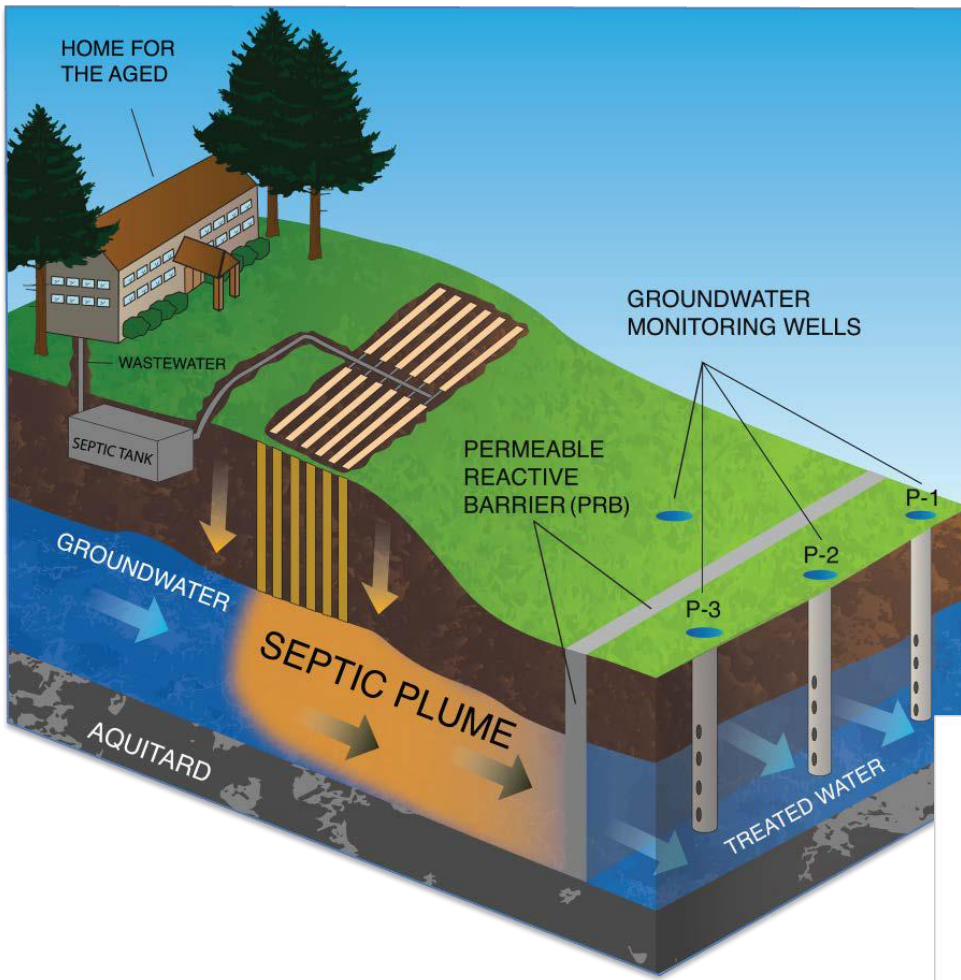
Permeable Reactive Barrier



**2005 - Selected by
Woods Hole Marine
Biological Lab, Cape
Cod**

Site	Influent Nitrate - N (mg/l)	Effluent Nitrate - N (mg/l)
Waquoit Bay	6.74	0.007
Childs River	7.19	0.568







During PRB Installation



PRB after construction completion

Permeable Reactive Barrier Projects

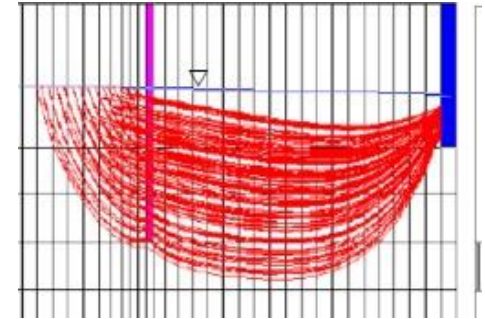
Southampton, NY

Part of 11,000 gpd wastewater system achieving 150% nitrogen removal for project – as groundwater has nitrogen contamination from other sources

Sarasota FL –
1,000,000 gpd effluent nitrogen removal –



Wastewater-groundwater flow thru PRB





Questions / Discussion

Thank you for your attention

Pio Lombardo, P.E.

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