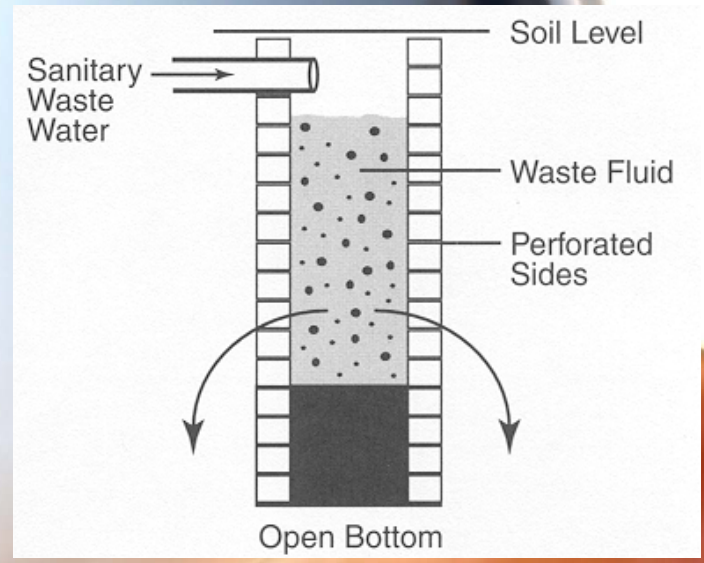
Nitrogen Reduction Technologies for Individual Wastewater Systems

Hawaii Dept. of Health – Wastewater Branch

Topics of Discussion

- Cesspools
- Nitrogen source in Wastewater
- Impacts to Public Health and Environment
- Priority Areas in Kauai
- Septic Tank Systems
- Biological Process for removing Nitrogen
- Aerobic Treatment Units
- Passive Wastewater Treatment
- Nitrogen Removing Biofilter

Cesspools



Cesspools are little more than holes in the ground;

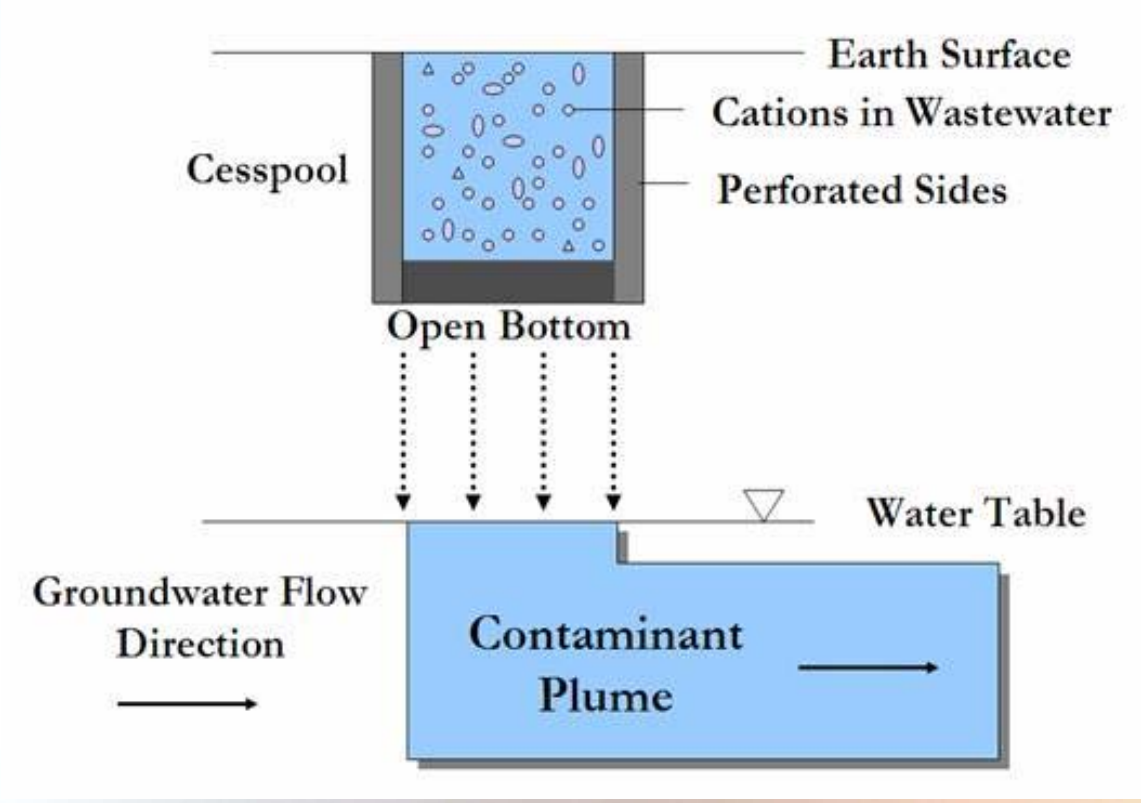
Cesspools discharge raw, untreated human waste into the subsoil;

Cesspools can contaminate ground water, drinking water sources and the ocean;

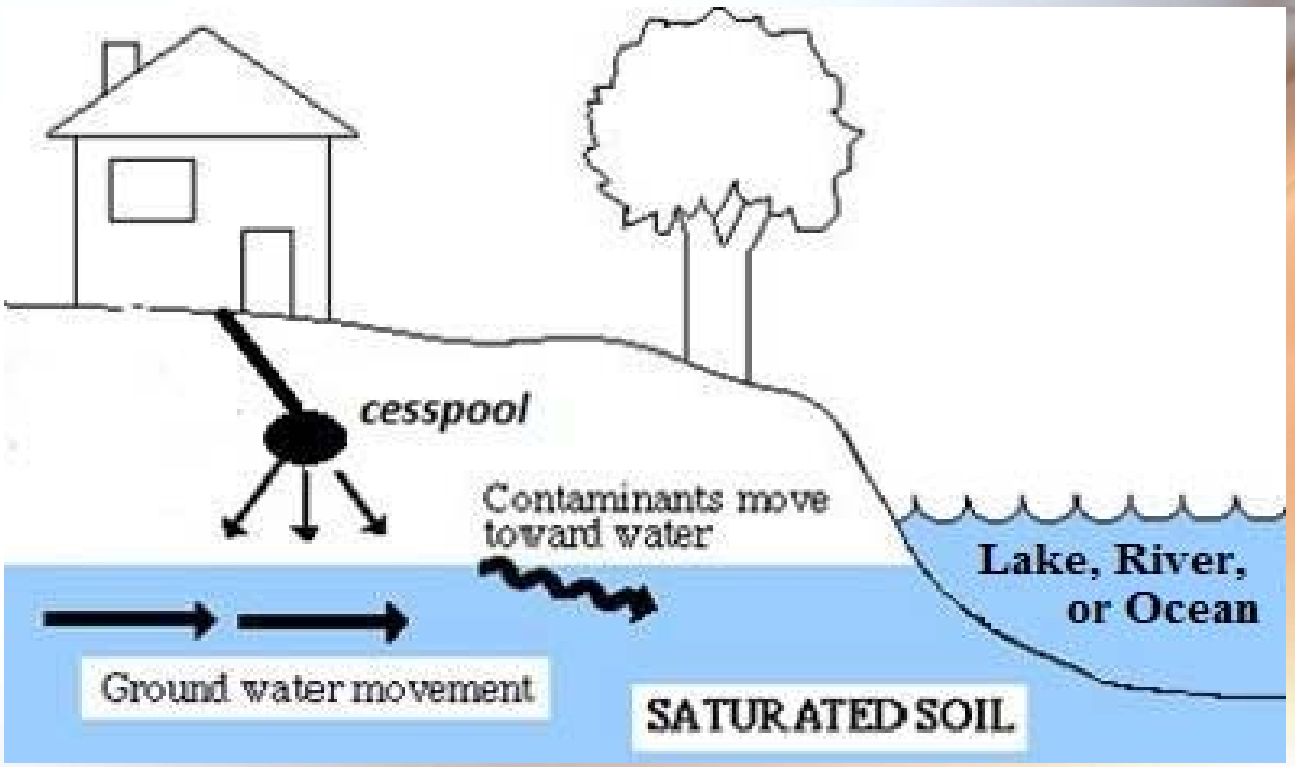
Presents risks to human health and the environment; and

Contains higher concentrations of nitrogen, phosphorus, and fecal coliform bacteria than septic tank systems.

Cesspools contaminate groundwater



Cesspools contaminate ground and surface waters



Nitrogen source in Wastewater

- Urine – greatest source
- Feces
- Garbage disposals
- Cleaning Products

Impacts to Public Health and Environment Due to Elevated Nitrogen Levels

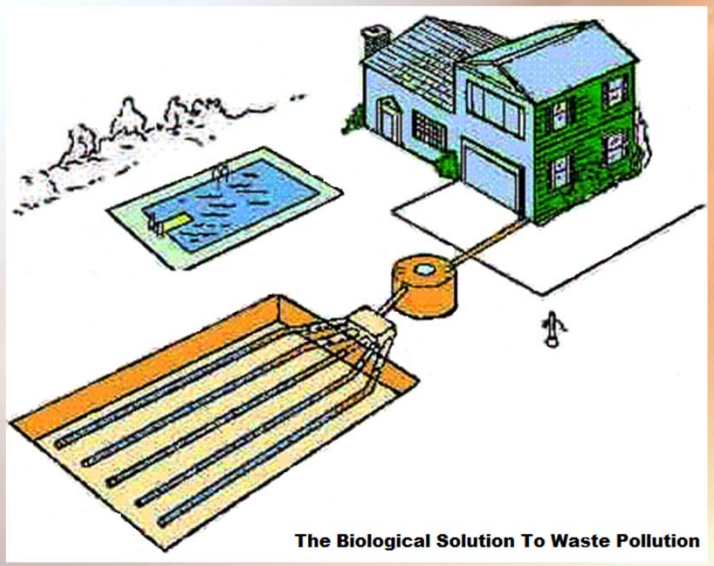
- Harmful algal blooms (HABs)
- Eutrophication
- Loss of native aquatic plant species and wetlands
- Fish kills
- Elevated nitrates in the drinking water can cause methemoglobinemia (“blue baby syndrome”)
  Maximum Contaminate Level is 10 mg/l. Decreases the ability of blood to carry oxygen.

Nitrogen Concentration in Sewage

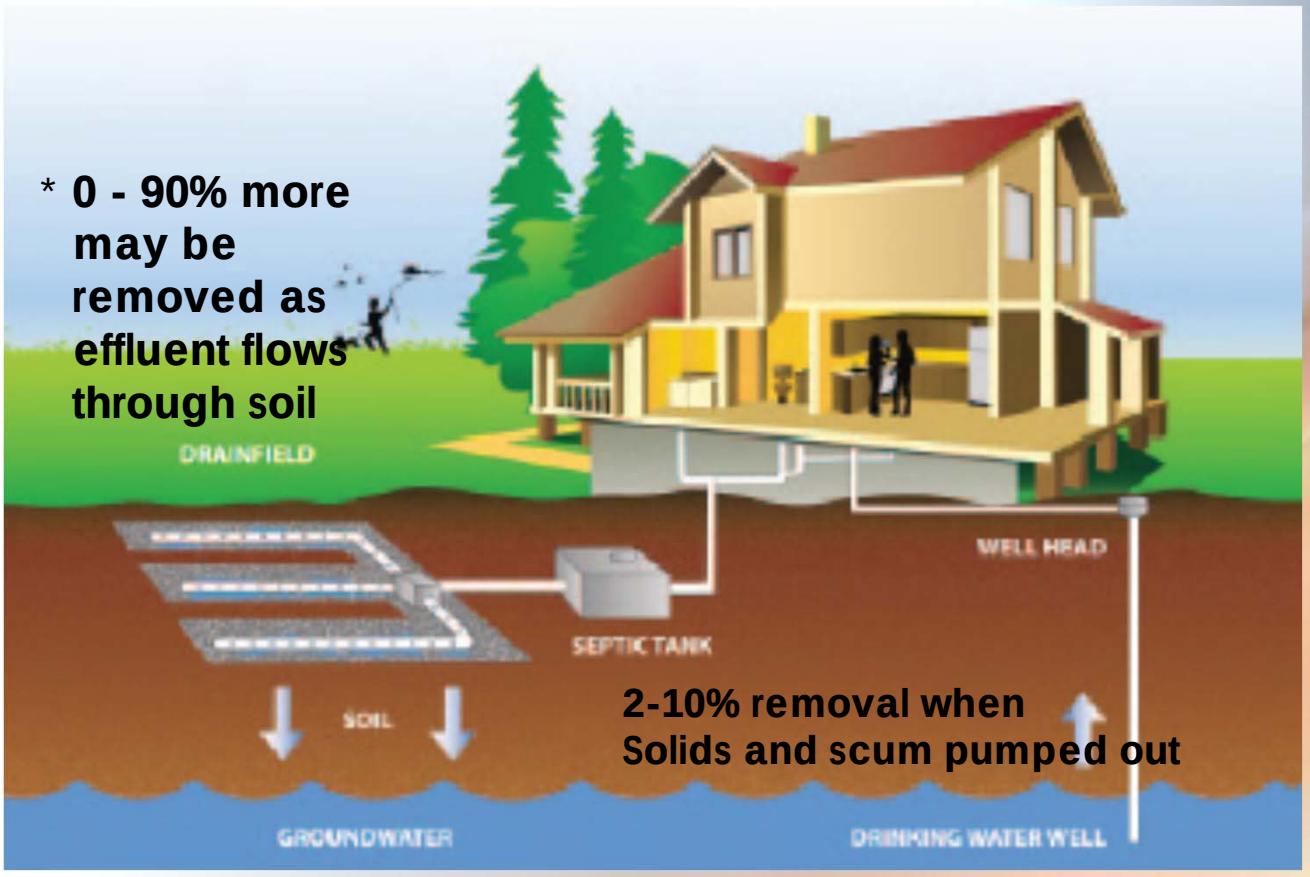
Between 50 – 60 mg/l

Septic Tanks & Soil Absorption Systems

- Septic Tanks & Soil Absorption Systems
  - Anaerobic digestion and settling provides primary treatment

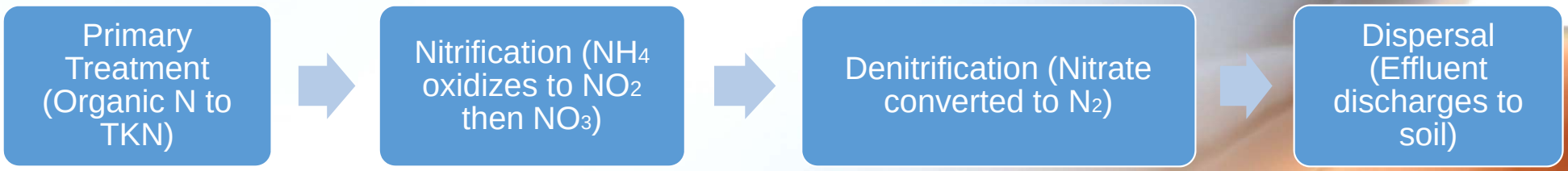


Nitrogen removal from septic systems



* The 90% reduction of nitrogen from the use of cellulosic enriched vegetated leachfields.

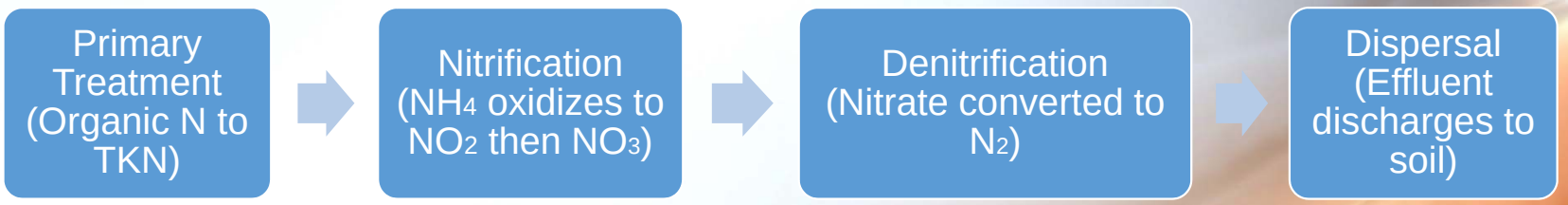
Biologically Removing Nitrogen in Wastewater



AMMONIFICATION

Ammonification of organic nitrogen in the human waste stream occurs primarily within the anaerobic conditions of septic tanks.

Biologically Removing Nitrogen in Wastewater

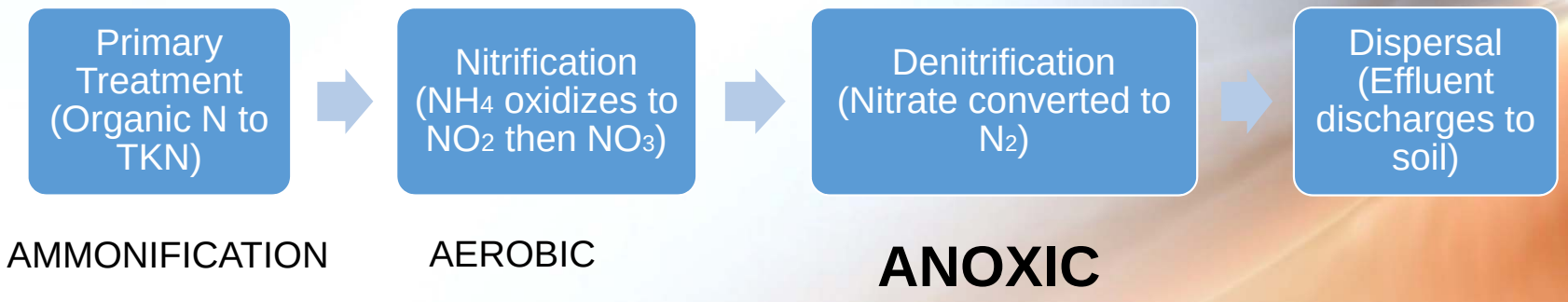


AMMONIFICATION

AEROBIC

Oxygen loving bacteria converts ammonium to nitrite and then to nitrate in the drain field. Process is called nitrification and effluent becomes "nitrified".

Biologically Removing Nitrogen in Wastewater



- **Systems that include oxygen-free (anoxic) conditions in part of the treatment process can remove over 90% of nitrogen through a process called denitrification.**

- **Denitrification converts nitrate to nitrogen gas which is released to the air.**

Nitrogen removal from a leach field

A properly designed leach field can also increase nitrogen removal.

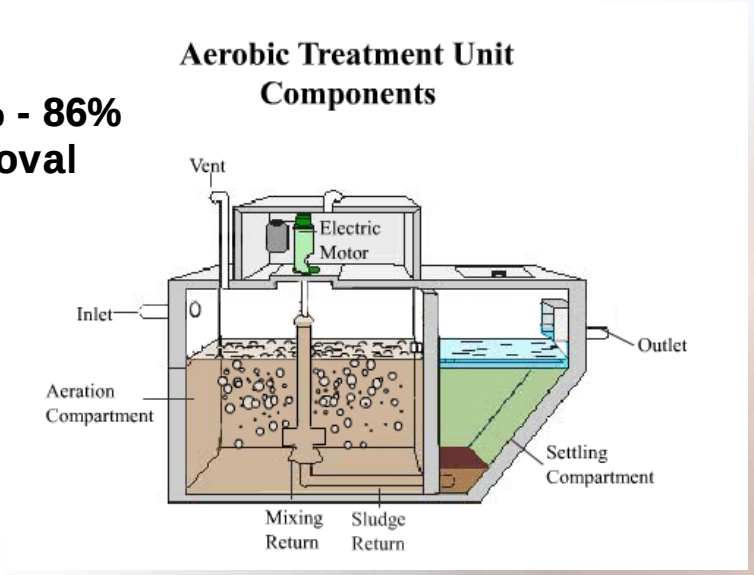
Characteristics such as:

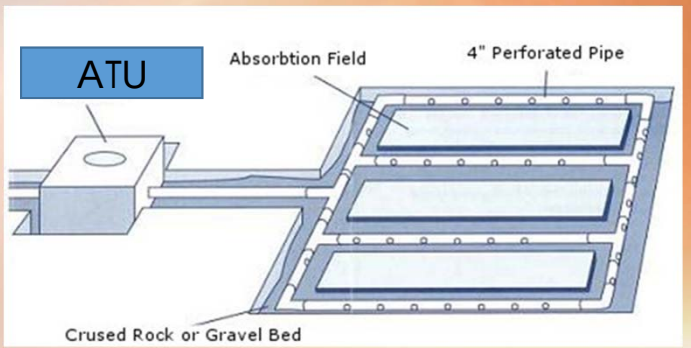
- **The size of the leach field;**
- **The rate wastewater is released to soil;**
- **The depth of soil;**
- **How the wastewater is applied and distributed (such as drip irrigation or trenches, gravity or pressure); and**
- **Vegetation management over the leach field can all influence what happens to the nitrogen once it enters and eventually leaves the leach field.**

Aerobic Treatment Unit (ATU)

- Aerobic Treatment Units and Soil Absorption Systems
  - Aerobic treatment provides secondary treatment
  - Mechanical unit that requires energy for aeration

Between 44% - 86% nitrogen removal





NSF/ANSI 245 Standards for ATUs

- Certifications require six months of testing
- Systems treating 400 to 1,500 gpd
- Achieve Total N of 50%
- Must also meet NSF/ANSI Standard 40

Evaluation Period

- 24-hour composite sampling
- 26 week minimum evaluation period
  - ✓ 16 weeks design loading
  - ✓ 7.5 weeks stress loading (wash-day, working-parent, vacation)
  - ✓ 2.5 weeks design loading

Total Nitrogen Removal Efficiency for Individual Waster Systems (IWS)

Vendor	Model	Total Nitrogen Removed
Orenco Systems	Advantex 20x Mode 1	64%
Orenco Systems	Advantex 20x Mode 3	66%
Quanics	Aerocell ATS SCAT-8-AC-C500	77%
Ecological Tanks, Inc.	Aqua Safe 500	52%
Clearstream Waste-water Systems, Inc	Clearstream 500 D	53%
Fuji Clean USA, LLC	Fuji Clean CE 5	67%
Fuji Clean USA, LLC	Fuji Clean CEN 5	74%
Eco-pure Wastewater Systems	EcoPure 300	44%
Consolidated Treatment Systems	Enviro-Guard 0.75	57%
Bio-Microbics	MicroFAST 0.5	71%
Hoot Aerobic Systems	HOOT H-500	63%
Norweco, Inc.	Hydro-Kinetic 600 FEU	76%
Lombardo Associates, Inc.	Nitrex[1]	72%
Norweco, Inc.	Singulair 960 w/Biokinetics	73%
Anua	Puraflo P150N*3B[2]	86%
Anua	added anoxic carbon addition Micro C-G[3]	67%
Septitech	Septitech Model 400	64%
WaiponoPure	WP-800	74%

[1] IWS unit placed after LAI-specified pretreatment

[2] Results based on single pass-through

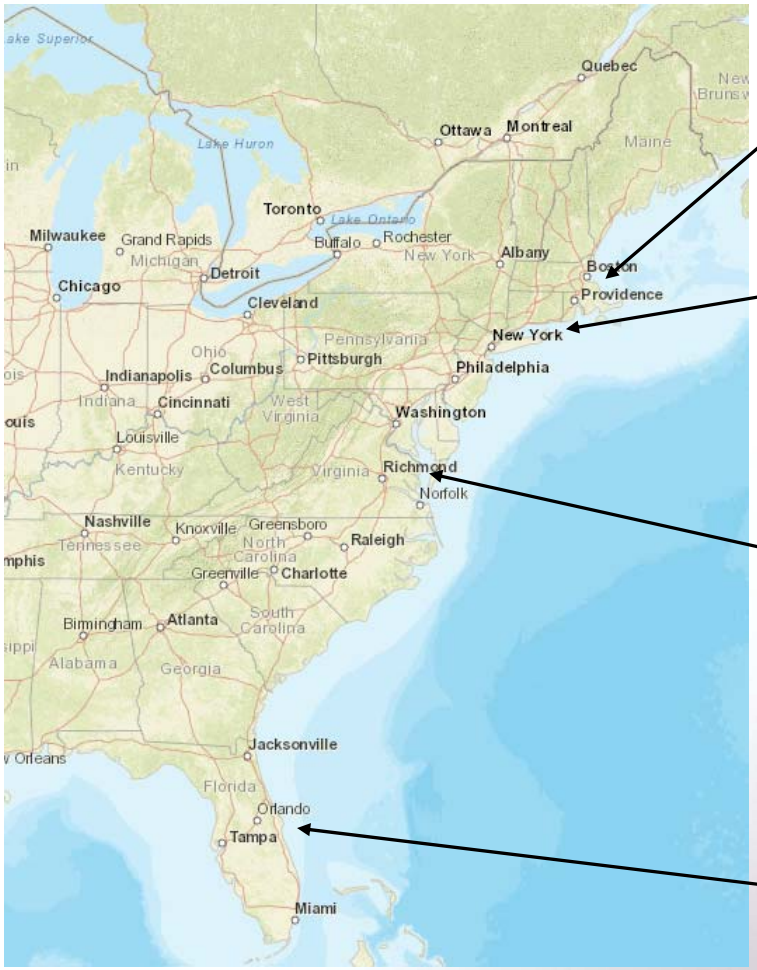
[3] Additional treatment after Anua Puraflo P150N*3B system

Source: http://www.floridahealth.gov/environmental-health/onsite-sewage/products/_documents/pbts-components.pdf

Other States dealing with Nitrogen issues with individual wastewater systems

- Chesapeake Bay Watershed (Washington DC, Maryland, Pennsylvania, Delaware, Virginia, W. Virginia, Parts of N.Y.)
- Florida
- Massachusetts (Cape Cod Bay)
- New York
- Connecticut
- Rhode Island
- New Jersey

NOW LET'S TAKE A LOOK AT WHAT IS BEING DONE…….



Cape Cod Bay, Massachusetts

- In 1999, Barnstable County's Dept. of Health and Environment started the Massachusetts Alternative Septic System Test Center.

Suffolk County, New York

- Stony Brook University founded the Center for Clean Water Technology in 2015 to test wastewater and drinking water treatment technology. For years, Suffolk county has had to deal with pollution from excessive nutrients.

Chesapeake Bay Watershed

- In 2009, President Obama issued executive order "Chesapeake Bay Protection and Restoration." Goal was to reduce nitrogen inputs into the bay. Most of which were attributed to onsite wastewater systems.

Florida

- Based on 2009 state legislation, engineering firm Hazen & Sawyer is tasked to test various passive nitrogen removal wastewater systems. The Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) study is started.

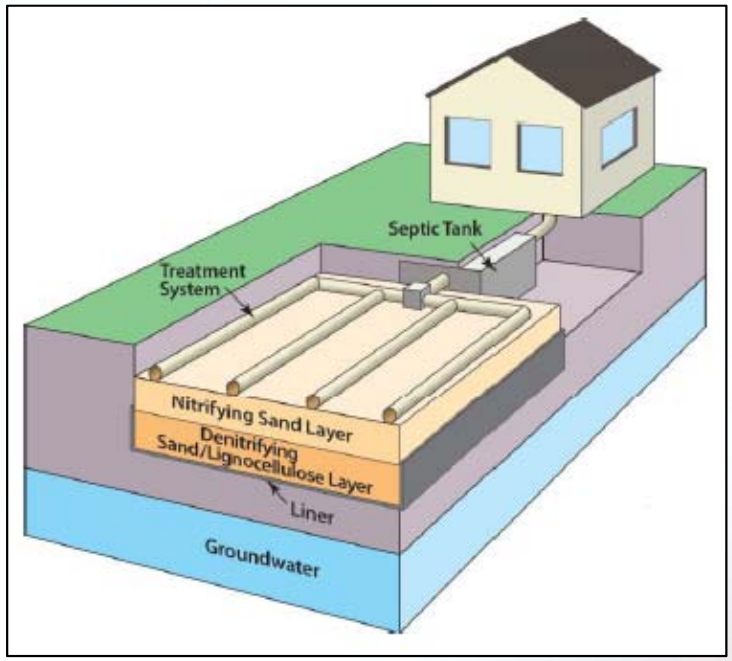
“Innovation rather than Re-invention”

- Several states in the eastern U.S. have taken a novel approach to wastewater treatment.
- Rather than attempting to “re-invent the wheel”, scientist and engineers have discovered a new way to reduce nitrogen…….

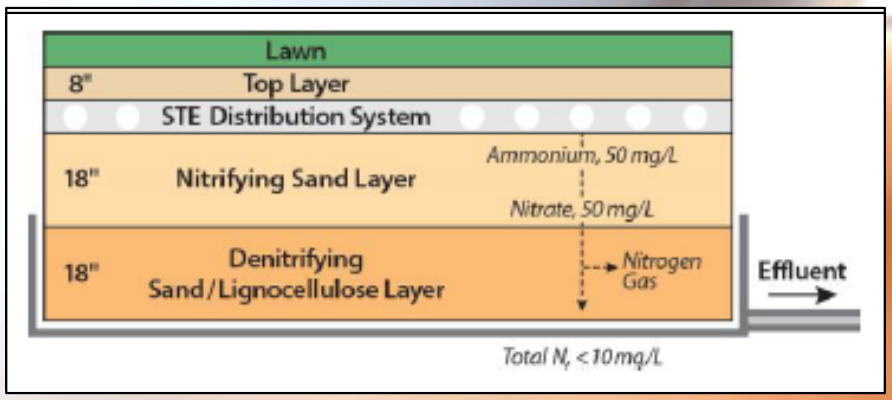
Passive Wastewater Treatment

- Systems that contain few moving parts
- Operate largely by gravity
- Low energy and low maintenance
- Low cost
- Sand-based “nitrification layer”
- Sand mixed with finely ground wood, “denitrification layer”
- Total nitrogen removal up to 90%
- Efficient removal rates for pathogens, pharmaceuticals and personal care products.

Nitrogen Removing Biofilter (NRB) Wastewater Passive System



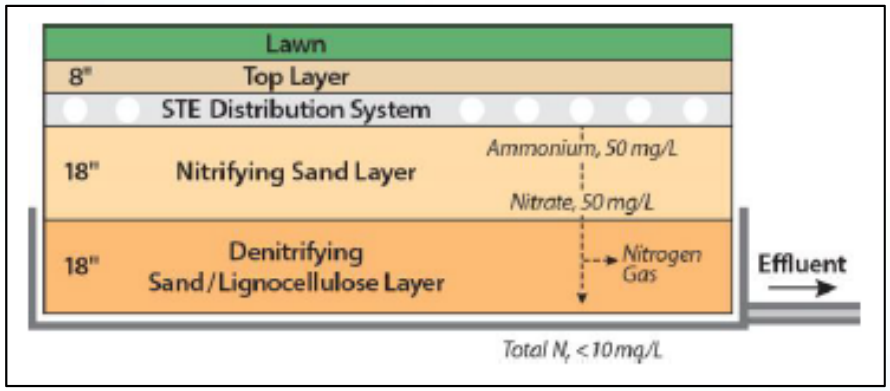
3-D schematic of Nitrogen Removing Biofilters



Cross-section view showing the details of each layer where nitrification and denitrification occurs

Up to 90% nitrogen removal

Nitrogen Removing Biofilter (NRB)
Wastewater Passive System



Effluent coming from septic system to the NRB through the **STE Distribution System** is ammonia and it is converted to nitrite and nitrate in the **18" Nitrifying Sand Layer**

Effluent converts from nitrate to nitrogen gas in the **18" Denitrifying Sand/Lignocellulose Layer**. Lignocellulose (wood chips or sawdust). This layer provides a carbon source for denitrification to occur

Challenges

- New technology needs further testing to determine life expectancy of ligno-cellulose. Theoretical calculations estimate media to last anywhere from 16.6 to 135.5 years.
- Specifications for design standards need to be established by regulatory agency.
- Slight learning curve for septic designers/installers. Technology transfer needs to be carefully done and well-thought out.
- Valuable insight can be gained through lessons learned from other states across the U.S. who are experiencing a similar situation.

What's next for Hawaii?

- Collaboration with the University of Hawaii to conduct a pilot study for passive nitrogen removal wastewater systems here in the islands.
- Location for test site needs to be determined. County or State facility on Oahu would be an ideal candidate.
- Economically and logistically beneficial for researchers, engineers, and scientist to be located on the same island as test site.
- Funding source for pilot study needs to be established.

QUESTIONS ?

Contact Us

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Mahalo!