FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES (FOSNRS) STUDY

Onsite Nitrogen Reduction Technology Classification, Ranking and Prioritization Workshop

Research Review, and Advisory Committee (RRAC) Meeting
May 28, 2009

AGENDA

I. **Introduction and Background**

II. **Objectives:** To review the Project Team's proposed onsite nitrogen reduction technology classifications, evaluation criteria, criteria weighting, and ranking methodology. To develop consensus on the procedures which will be used to identify and prioritize the technology list for future testing.

III. **Onsite nitrogen reduction technology classifications**

IV. **Onsite nitrogen reduction systems identified to date**

V. **Nitrogen reduction technology evaluation methods**

   a. **Criteria**
   b. **Weights**
   c. **Ranking**

VI. **Nitrogen reduction technology testing priority**

VII. **Summary**

VIII. **Next Steps**

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FLORIDA ONSITE SEWAGE NITROGEN REDUCTION STRATEGIES (FOSNRS) STUDY

Technology Classification, Ranking and Prioritization Workshop

May 28, 2009

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AET Applied Environmental Technology

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Agenda

- Introduction and background
  - FOSNRS Study Overview
  - Task A – This task
- Objectives
- Onsite Nitrogen Reduction Technology Classifications
  - Review of Wastewater Characteristics & Treatment
  - Nitrogen Cycle
- Onsite Nitrogen Reduction Systems Identified to Date
- Nitrogen Reduction Technology Evaluation Methods
- Nitrogen Reduction Technology Testing Priority
- Summary
- Next Steps

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Introduction and Background

FOSNRS Study Background

- Quality of Florida's surface and groundwater resources are impacted by excess nitrogen
- Onsite sewage treatment and disposal systems (OSTDS) one source of nitrogen
- Laws of Florida, 2008-152, Specific Appropriation 1682 directed FDOH to conduct a study to further develop cost-effective nitrogen reduction strategies for OSTDS
- FDOH ITN No. DOH08-026 identified four primary tasks for the study; to be controlled by RRAC
- The 2008 Florida legislature appropriated $900,000 for Phase I of a multi-year project

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FOSNRS Study Overview

- **Task A:** Technology Evaluation for Field Testing: Review, Prioritization, and Development
- **Task B:** Field Testing of Technologies and Cost Documentation
- **Task C:** Evaluation of Nitrogen Reduction Provided by Soils and Shallow Groundwater
- **Task D:** Nitrogen Fate and Transport Modeling
- **Task E:** Project Management, Coordination and Meetings

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Florida Onsite Sewage Nitrogen Reduction Strategies (FOSNRS) Project Team

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Bureau of Onsite Sewage Programs

FDOH Research Review and Advisory Committee (RRAC)

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(3) Colorado School of Mines (CSM)
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(7) Water Research Consulting, LLC (WRC)

Project Advisory Committee:
(8) University of Florida
(9) University of Rhode Island
(10) Barnstable County Health Department

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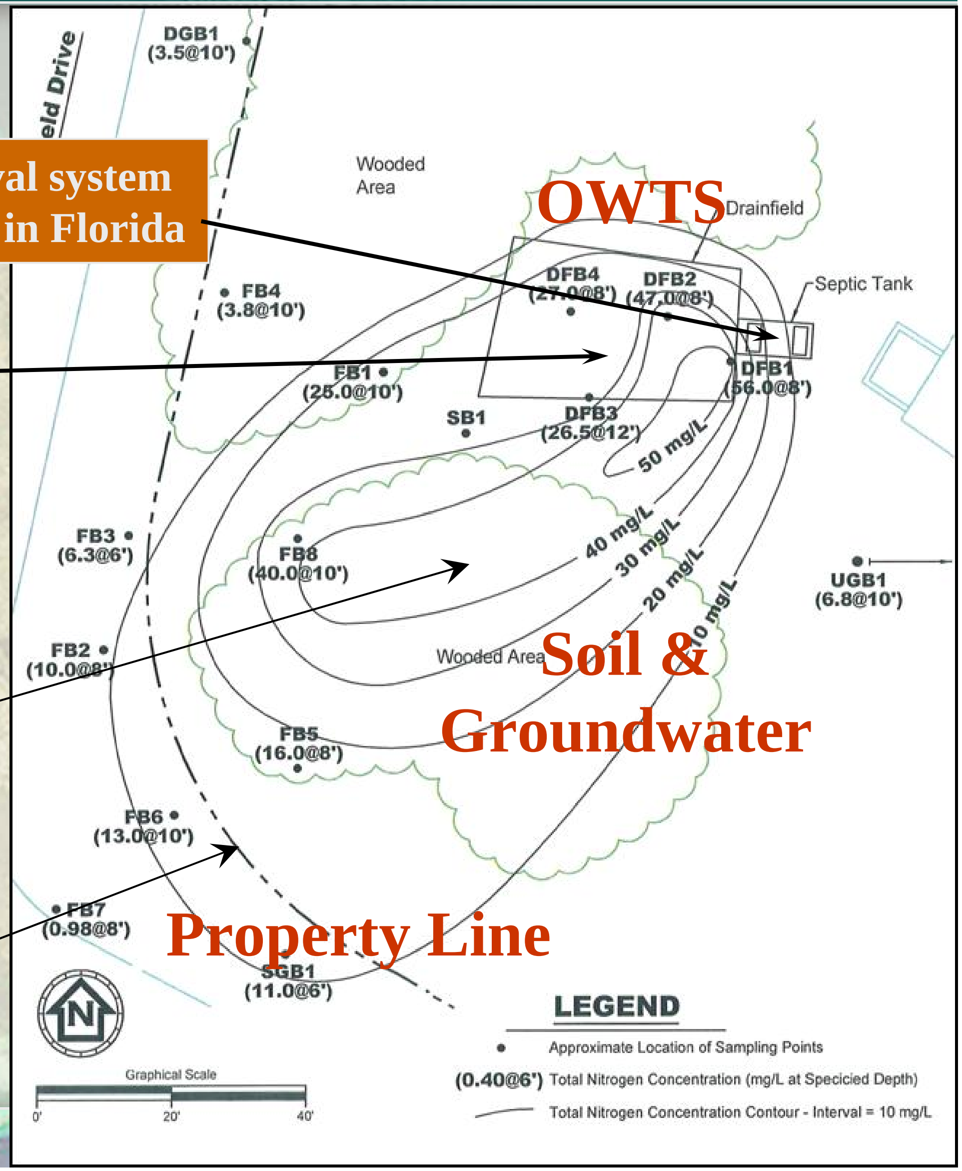
How do tasks relate to N-removal strategies?

Task A – N-removal system options for OWTS in Florida

Task B – OWTS N-removal performance verification

Task C – Evaluation of N reduction in soil & GW in Florida

Task D – Decision tools for setting N-removal goals for OWTS



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Focus of this workshop: Task A

- Task A Objectives
  - Evaluate and prioritize technologies for field testing and further development
- Task A Subtasks
  1. Perform literature review to evaluate available onsite nitrogen reduction technologies
  2. Develop technology classification scheme
  3. Formulate criteria for ranking of nitrogen reducing technologies
  4. Rank and prioritize nitrogen reduction technologies for field testing
  5. Test facility design and implementation
  6. Technology Development PNRS II

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Workshop Objectives

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9

Objectives

- Review the Project Team’s proposed onsite nitrogen reduction technology classifications, evaluation criteria, criteria weighting, and ranking methodology.
- Develop consensus on the procedures which will be used to identify and prioritize the technology list for future field testing.

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Review of Wastewater Treatment Fundamentals

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11

Nitrogen Cycle and N Chemistry Review: Nitrogen Species

- Organic Nitrogen
- Ammonia – NH_4

Total Kjeldahl Nitrogen (TKN)

- Nitrite – NO_2
- Nitrate – NO_3

Total Oxidized Nitrogen

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Onsite N Reduction Technology Classification Nitrogen Cycle and N Chemistry Review

Nitrogen in the Wastewater:

- EPA estimates we discharge ~11.2 grams of nitrogen per person into WW each day
  - 70 - 80% as toilet wastes
  - 10 - 15% is food preparation
  - Household products

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Onsite Wastewater Constituents (WERF, 2008)

	Raw Wastewater	Septic Tank Effluent
$cBOD_5$	337	153
COD	905	324
TN (as N)	63	54
NH_3 (as N)	47	36
TP (as P)	19	10
Alkalinity	-	503
TS	996	855
TSS	405	79

All units in mg/L

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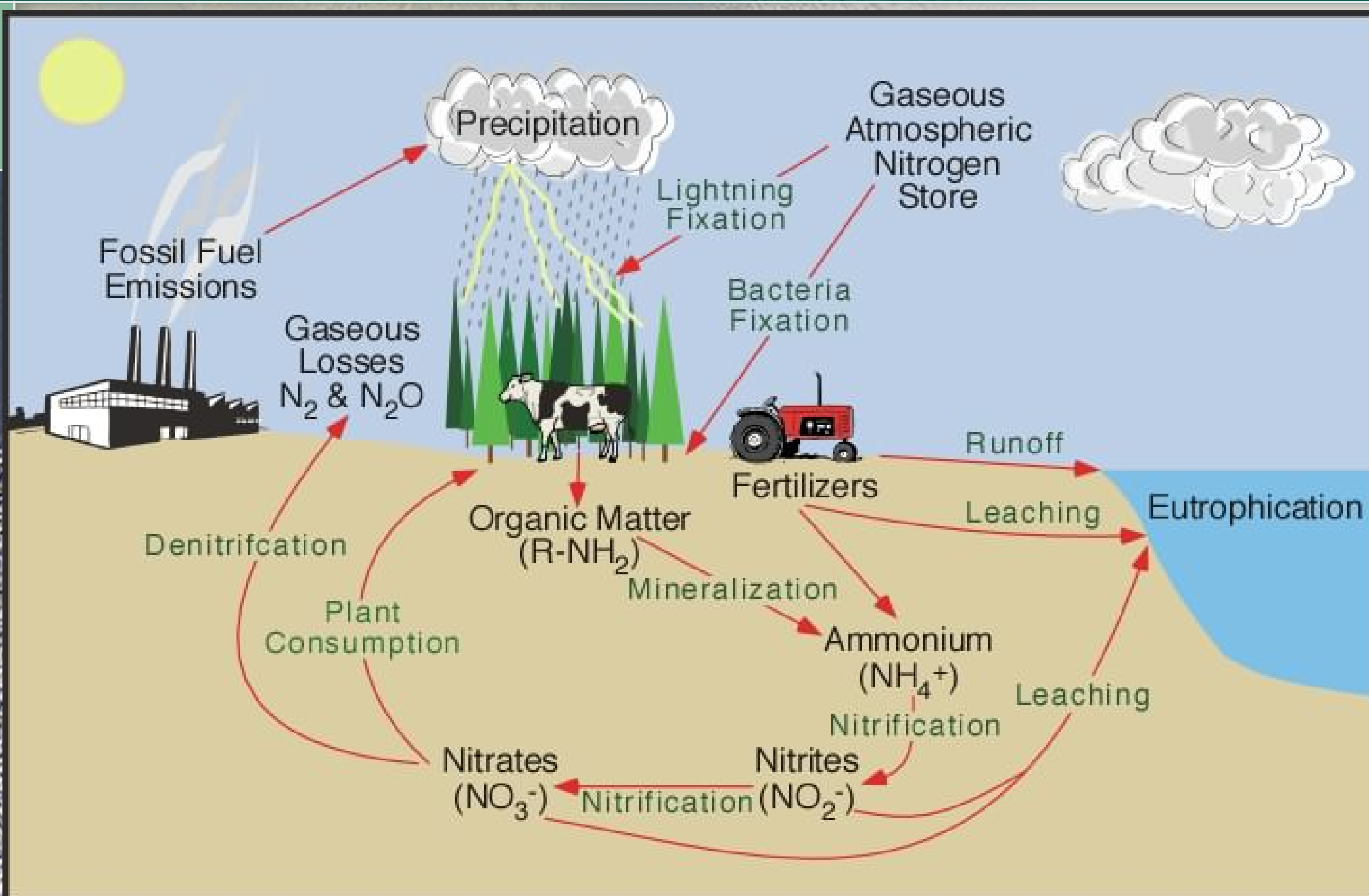
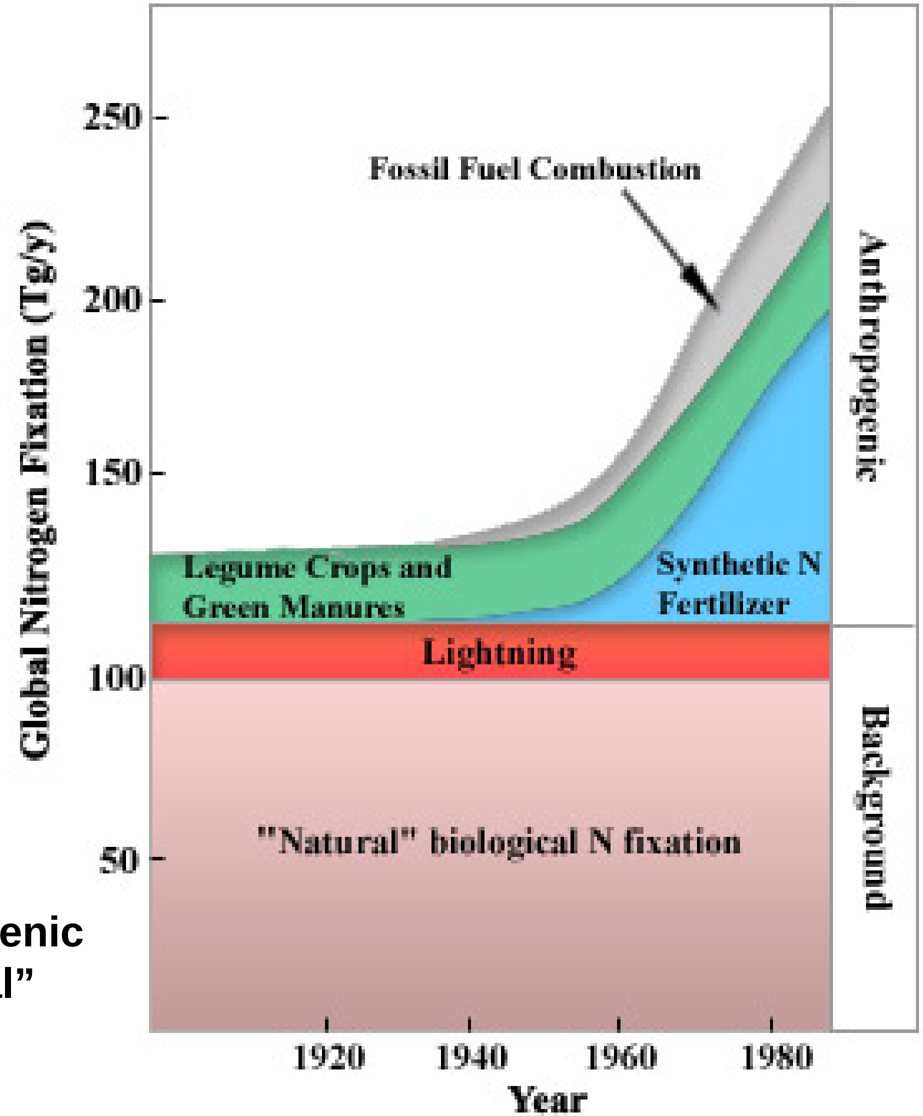
All units in mg/L

Nitrogen Cycle and N Chemistry Review



Nitrogen Cycle and N Chemistry Review: Man's Impact on Global N

Anthropogenic Activities Impact



Recent increases in anthropogenic N fixation in relation to "natural" N fixation (Harrison 2003)

Biochemical Transformations

Organic N → NH_4^+ → NO_2^- → NO_3^- → N_2

Ammonification

Nitrification (Aerobic)

Denitrification (Anoxic)

Nitrogen Cycle and N Chemistry Review

Nitrogen Mineralization (Ammonification):

- Nitrogen incorporated into organic matter can be converted back into organic nitrogen by nitrogen mineralization (decomposition of dead organisms)

organic N ➡ NH_4^+

- Ammonification converts the organic nitrogen back into ammonium
- Ammonification makes the nitrogen available for use by plants or for further transformation into nitrate (NO_3^-) through nitrification

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Nitrogen Cycle and N Chemistry Review

Nitrification:

- Nitrification is a biological process that converts ammonium into nitrate
- Chemoautotrophic bacteria use the energy released by conversion using inorganic rather than organic carbon compounds to sustain growth
  - Oxygen required
  - Sufficient alkalinity required
  - Sensitive to cold temperatures

$$NH_4^+ \rightarrow NO_3^-$$

- Nitrate produced (- charged) and in soils, not adsorbed but travels with the soil water until captured or taken up by plant roots

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Nitrogen Cycle and N Chemistry Review

Denitrification:

- Denitrification is a biological process that ultimately breaks nitrate down to nitrogen gas
- Process is used by facultative heterotrophic bacteria to obtain their energy for growth
- Under anoxic conditions, heterotrophs, which use organic carbon for energy, use the oxygen from the nitrate molecule to accept the electron received during the degradation of organic carbon

$$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$$

- Only nitrogen transformation that removes nitrogen from ecosystems

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Wastewater Treatment: Biological N Removal

Biological Nitrogen Removal

Nitrification: conversion of ammonia to nitrate:

$$NH_4^+ + 2\,O_2 \rightarrow 0.038\,C_5H_7O_2N + 0.96\,NO_3^- + 1.92\,H^+$$

Denitrification: reduction of nitrate to N_2 gas:

Heterotrophic

$$NO_3^- + 0.94\,CH_3OH + 0.94\,H^+$$

$$\rightarrow 0.057\,C_5H_7O_2N + 0.44\,N_2 + 2.27\,H_20 + 0.71\,CO_2$$

Autotrophic

$$NO_3^- + S^o + 0.22\,CO_2 + 0.66\,H_2O$$

$$\rightarrow 0.044\,C_5H_7O_2N + SO_4^{-2} + 0.48\,N_2 + H^+$$

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Wastewater Treatment: Biological N Removal

Primary Treatment

Mineralization of organic N to TKN (mostly ammonia – NH_4)

↓

Nitrification

TKN (Ammonia and organic N) oxidized to nitrate (NO_3) by nitrifying bacteria, requires oxygen

→

Denitrification

Nitrate converted to N_2 in anoxic environment; requires supply of electron donor

↑

Dispersal

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Onsite Nitrogen Reduction Technology Classifications

Unit Process Basis for Technology Classifications

- Followed typical wastewater engineering evaluation
- Based on unit operations and processes
  - Physical, Chemical, and Biological processes
  - Source Separation was included due to high nitrogen content of toilet waste stream
  - Natural systems used to classify systems utilizing the assimilative capacity of the receiving environment

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Onsite N Reduction Technology Classifications

- ONSITE NITROGEN REDUCTION TECHNOLOGIES CLASSIFICATION
  - SOURCE SEPARATION
  - BIOLOGICAL NITRIFICATION / DENITRIFICATION PROCESSES
  - PHYSICAL / CHEMICAL PROCESSES
  - NATURAL SYSTEMS

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Major Classification Examples

- Source Separation
  - Urine separating toilets; waterless urinals, composting toilets
- Biological Systems
  - Suspended growth; submerged attached growth; attached growth biofilters
- Physical/Chemical Systems
  - Chemical precipitation; adsorption; ion exchange
- Natural Systems
  - Conventional and fill OWTS; landscape irrigation systems; constructed wetlands systems

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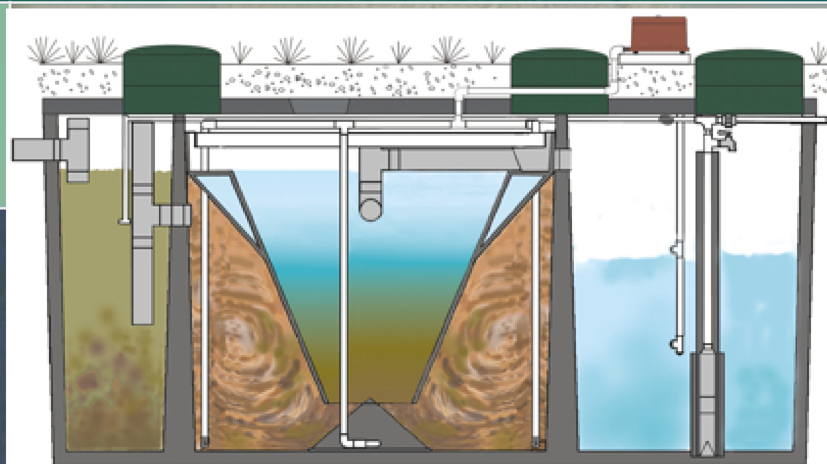
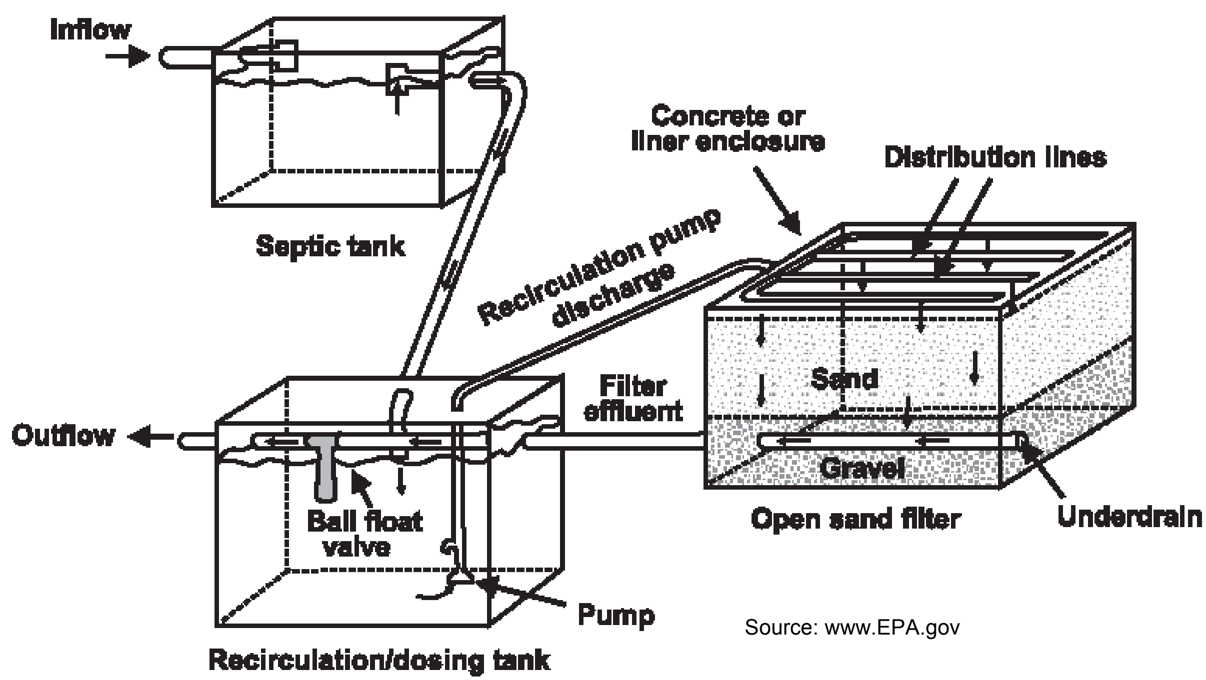
Onsite N Reduction Technology Classification by Process



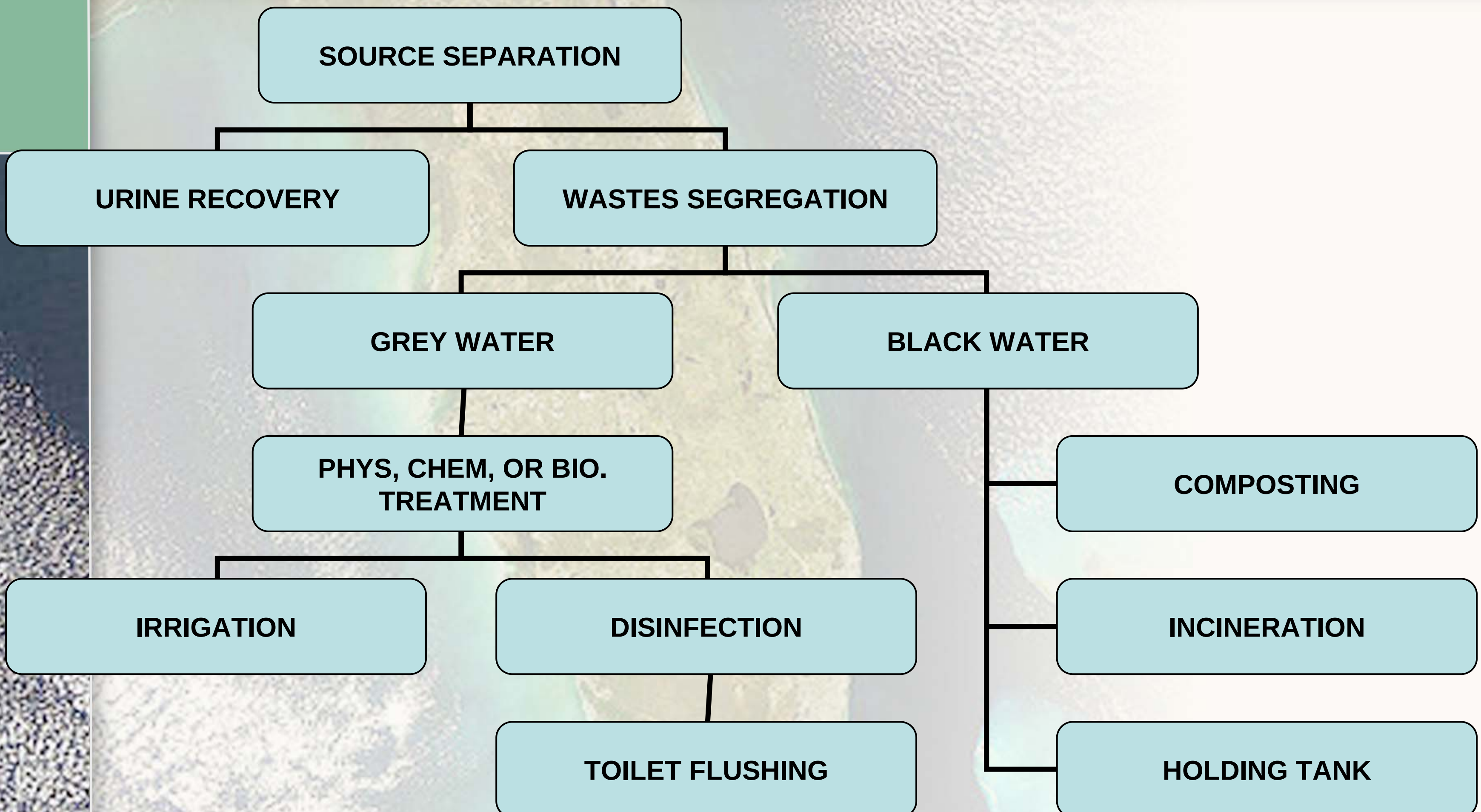


Source: www.EPA.gov

Technology Classification by Process

- ONSITE NITROGEN REDUCTION TECHNOLOGIES CLASSIFICATION
  - SOURCE SEPARATION
    - URINE RECOVERY
    - WASTES SEGREGATION
  - BIOLOGICAL NITRIFICATION / DENITRIFICATION PROCESSES
    - MIXED BIOMASS
    - TWO STAGE SEGREGATED BIOMASS
  - PHYSICAL / CHEMICAL PROCESSES
    - MEMBRANE SEPARATION
    - ION EXCHANGE
    - EVAPORATION
  - NATURAL SYSTEMS
    - SOIL INFILTRATION
    - VEGETATIVE UPTAKE
    - CONSTRUCTED WETLANDS

Onsite N Reduction Technology Classification
Source Separation Processes



Onsite N Reduction Technology Classification
Wastewater Characteristics

- The domestic sewage from individual households can be divided into 4 individual wastestreams (A, B, C & D)

Source Designation	Wastestream	Daily Volume (gpcd)	Gram / person-day			
			$CBOD_5$	TSS	Total N (as N)	Total P (as P)
A	Non-kitchen sinks, clothes washer, shower, bathtubs	32	11.4	5.2	0.8	0.2
B	Kitchen sinks, dishwasher, garbage grinder	10.3	35.1	38.5	1.7	0.3
C	Toilet: urine separated	17.5	12.5	80	1.1	0.4
D	Toilet: urine	0.6	4.2	0.1	10.9	1.2
Sum		60.4	63.2	124	14.5	2.0

Source: Benetto et al. 2009; Makropoulos et al.,2008; Magid et al., 2006; Memon and Butler, 2006; Tchobanoglous, et al., 2003; EPA, 2002; Lens and Lettinga, 2001; Gunther, 2000; Mayer et al., 1999

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Urine Separating Toilets

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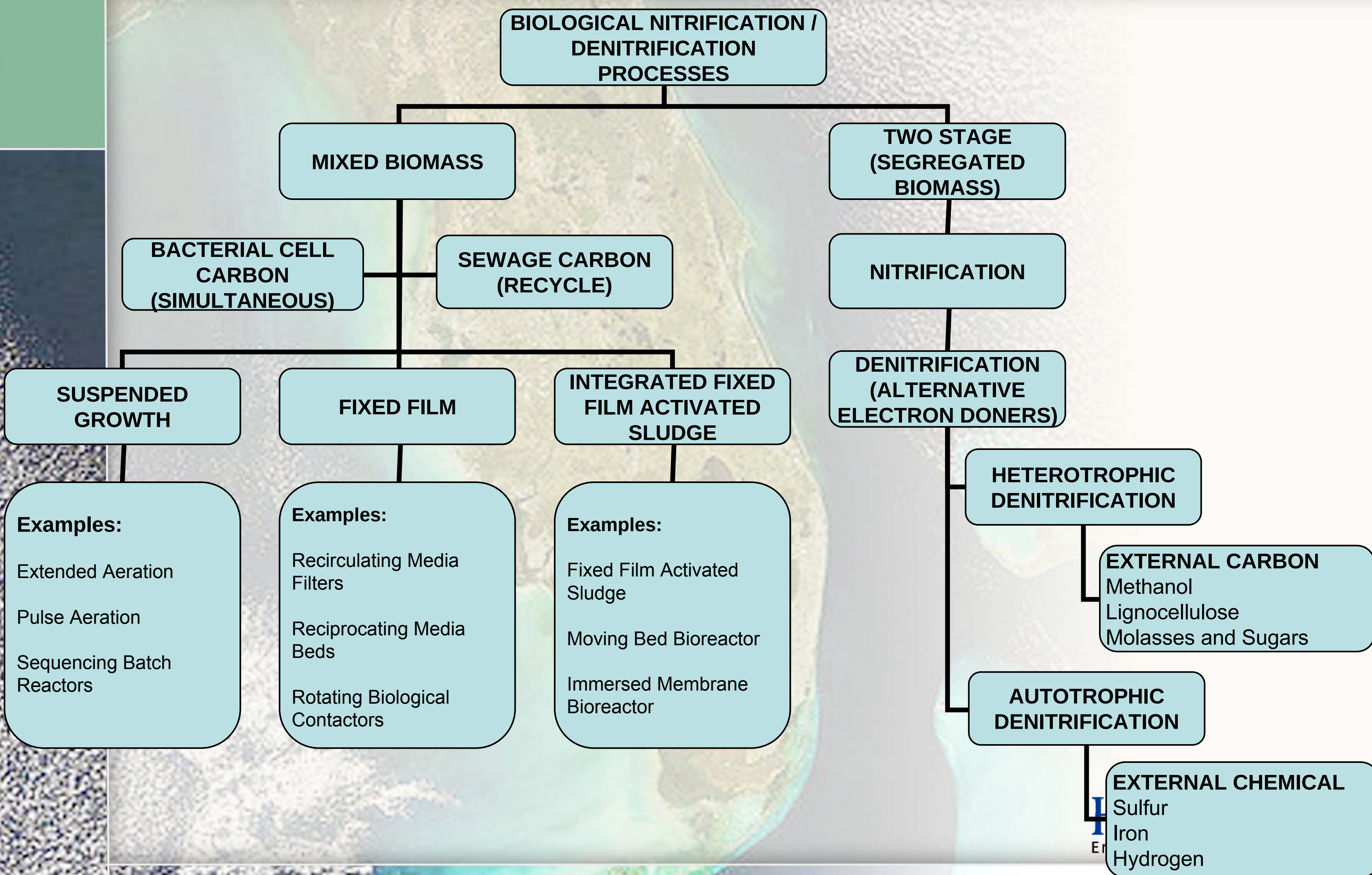
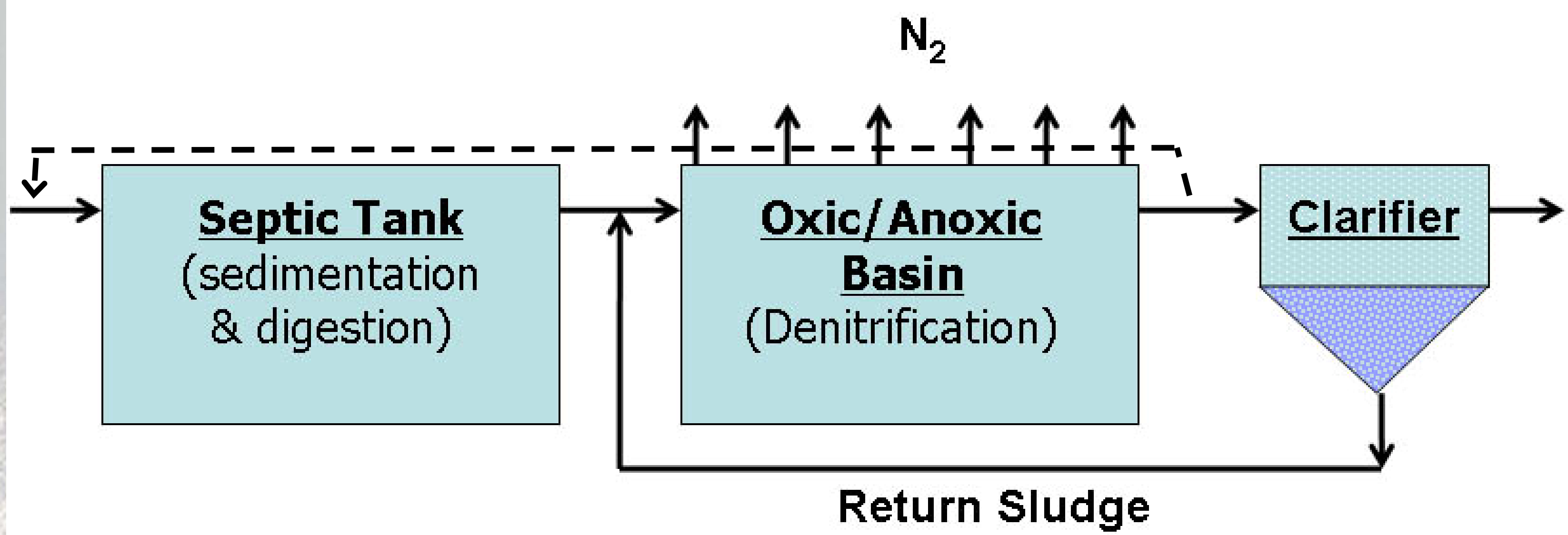
Onsite N Reduction Technology Classification
Biological Treatment



Mixed Biomass



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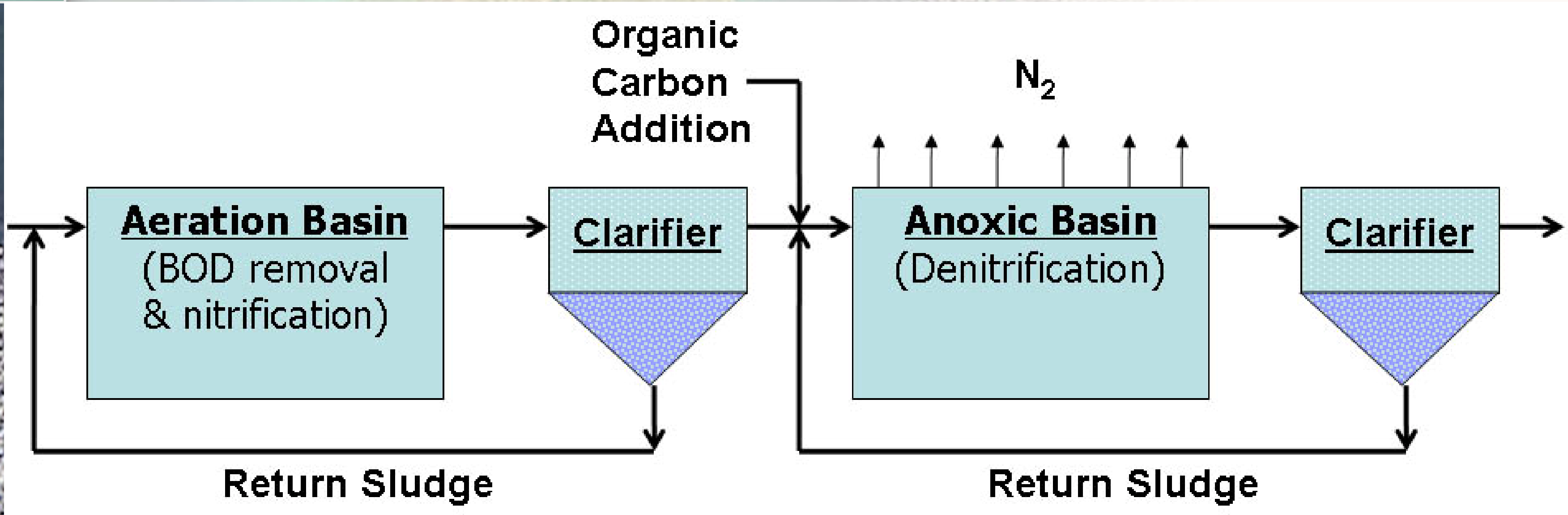
Two-Stage (Segregated Biomass)



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Biological Nitrogen Reduction: System Complexity

Nitrification

System Complexity (Low → High)

- Aerated Suspended Growth
- Aerated Fixed Film
- Recirculating Media Filter
- Single Pass Media Filter

Denitrification

System Complexity (Low → High)

	TN Reduction
Segregated Biomass - Liquid Electron Donor	80-96%
Segregated Biomass - Reactive Media	
Mixed Biomass - Recycle (Sewage Carbon)	60-80%
Mixed Biomass - Microbial Cell Carbon	40-60%

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Biological Nitrification Removal Processes

Process	Simultaneous (Mixed Biomass)	Recycle (Mixed Biomass)	External Donor (Two Stage)
Electron Donor	Organic carbon from bacterial cells	Organic carbon from influent wastewater	Cellulose, Sulfur, Iron, Other
Typical Removal	40 - 60%	60 - 80%	70 – 96%
Technologies	o Recirculating media filters w/o recycle o Reciprocating media beds o Extended aeration o Pulse aeration o Moving bed bioreactor o Sequencing batch reactors o Membrane bioreactor	o Recirculating media filters with recycle o Extended aeration with recycle o Moving bed bioreactor o Rotating Biological Contactors	o Heterotrophic suspended growth o Heterotrophic packed bed reactive media o Autotrophic packed bed reactive media

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Onsite N Reduction Technology Classification
Physical / Chemical Processes

- **PHYSICAL / CHEMICAL NITROGEN REDUCTION PROCESSES**
  - **MEMBRANE PROCESSES**
    - **Examples:** Reverse Osmosis, Nano Filtration
  - **ION EXCHANGE**
    - **CATION EXCHANGE (AMMONIUM)**
    - **ANION EXCHANGE (NITRATE)**
  - **EVAPORATION**
    - **EVAPO-TRANSPIRATION**
    - **SOLAR**
    - **DISTILLATION**

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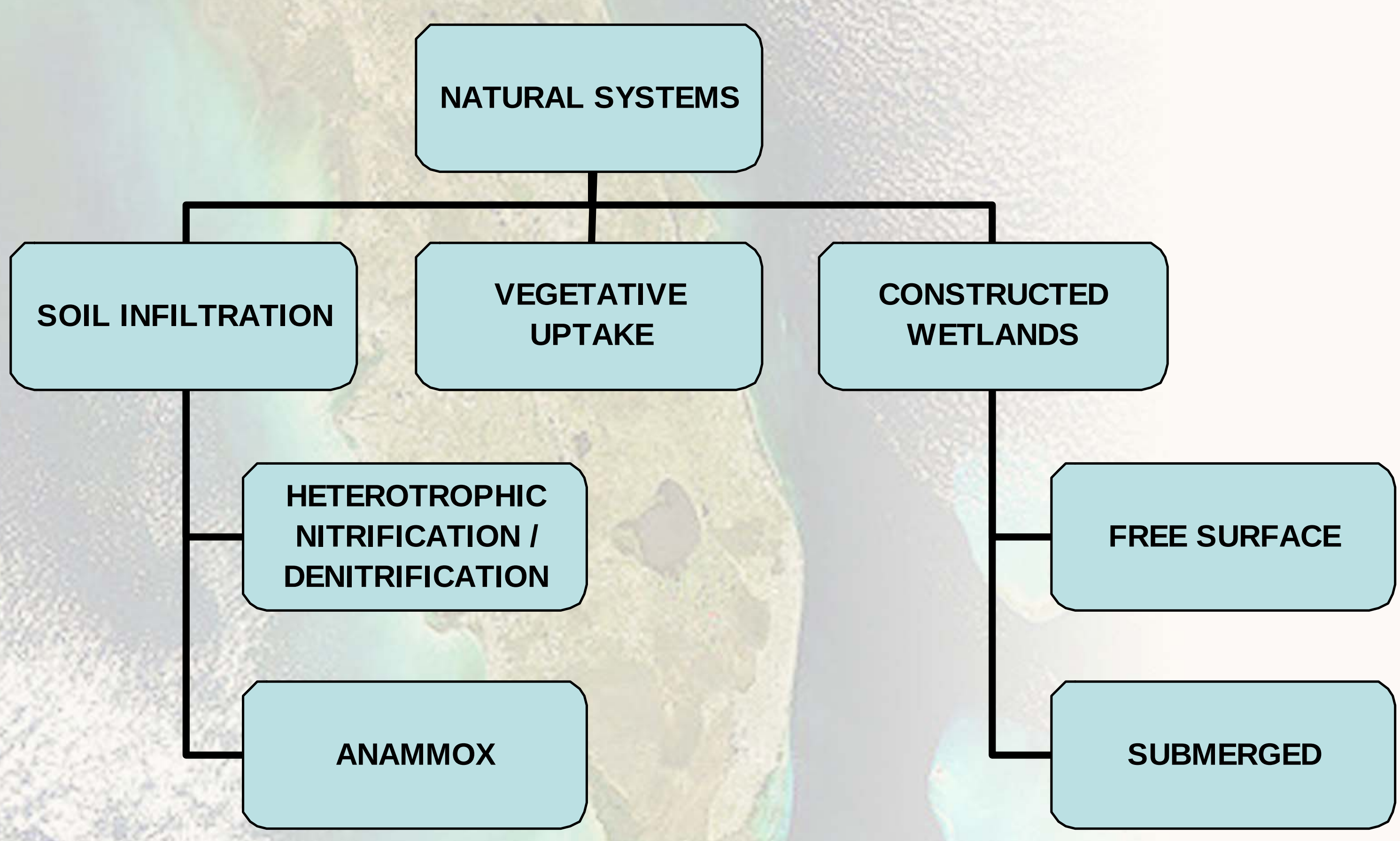
Onsite N Reduction Technology Classification
Natural Systems



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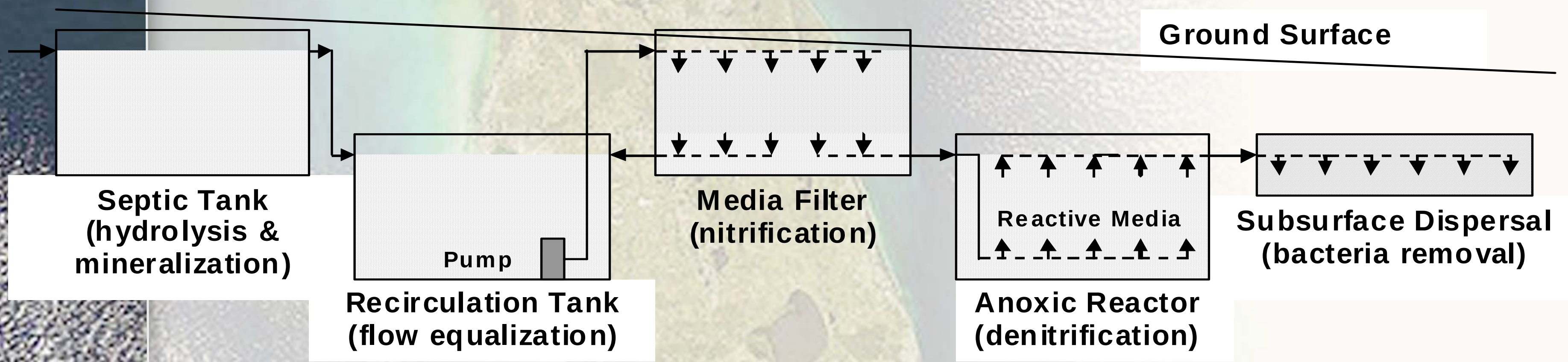
Passive two-stage denitrification system



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Onsite N Reduction Technology Classification
Nitrogen Reduction Technologies Matrix

Description	Components	Daily Volume (gal)	Primary Treatment (septic tank)	Mixed Biomass Nitrification/ Denitrification	Two-Stage Nitrification/ Denitrification	Second Stage Denitrification Biofilter	Natural Systems	Aerobic Biological Treatment	Disinfection	Struvite Precipitation	Final Liquid Application
Domestic wastewater	A+B+C+D	241									Irrigation or Soil Dispersal
											Indoor Reuse
Domestic wastewater minus urine	A+B+C	239									Irrigation or Soil Dispersal
											Indoor Reuse
Blackwater	B+C+D	113									Irrigation or Soil Dispersal
											Indoor Reuse
Black water minus urine	B+C	111									Irrigation or Soil Dispersal
Greywater	A	128									Irrigation or Soil Dispersal
											Indoor Reuse
Urine	D	1.6									Concentrated nutrient solution for crop production

Onsite Nitrogen Reduction Systems Identified to Date

41

Onsite Nitrogen Reduction Studies/Tests/Systems Identified

- How many are there? Many!

Biological

- ABJ ICEAS
- Activated Carbon
- Advantex 20x
- Advantex ISF
- Advantex RSF
- Aerated Fixed Film
- Aerated Suspended Growth
- Aerocell
- AeroDiffuser
- Aero-Stream
- AES BESTEP- IDEA
- Agricultural Residues
- AIRR
- Alliance
- Amphidrome
- Anoxic Packed Bed Reactors
- Aqua Aire
- Aqua Safe

Biological (cont)

- AquaKlear
- Aquarobic
- Ashco-A RSF III
- Autotrophic Packed Bed Reactive Media
- Bacterial Polyesters
- BEST 1
- Bi-A-Robi
- Bioclere model 16/12
- Biocycle, Inc.
- Bio-Coir
- Biodisc
- Bio-fosse
- BioGreen
- Biokreisel
- Biomax
- Bionest
- Biorotor

Biological (cont)

- BioSorb
- Black & Gold
- Brooks
- BTX Biotreater
- Cajun Aire
- Cardboard
- Clearwater
- Clearstream
- CMS Rotordisk
- Coir
- Corn Cobs
- Cotton
- Cromaglass
- Crushed brick
- Crushed Glass
- Delta ECOPOD
- Delta Whitewater ATU
- EcoFlo

Biological (cont)

- Ecoflow ST-650
- EcoKasa
- Eco-kleen
- Ecological systems
- Eco-Pod
- EcoPure 300
- Eljen In-Drain
- Envirocycle
- EnviroFilter C
- Enviro-Guard .75
- EnviroSBR
- Enviroserver
- Eparco
- Expanded aggregate
- Expanded Clay
- Expanded Shale
- Extended Aeration
- FAST

Biological (cont)

- Fine Gravel
- Five Star KR505
- Glass (crushed)
- Glass (sintered)
- Glendon biofilter
- Gravel
- Heterotrophic Packed Bed Reactive Media
- Heterotrophic Suspended Growth
- HOOT
- Horizontal Flow Bioreactor
- Hydro-Action
- IDEA Bestep
- Immersed Membrane Bioreactors
- JET BAT
- Klargester Biodisc

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Onsite Nitrogen Reduction Studies/Tests/Systems Identified

Biological (cont)
- Klargester RBC
- Kubota
- Limestone
- Lotus
- Membrane Bioreactor
- MicroFast
- Mighty Mac
- Mixed Biomass Systems
- Modified Drainfields (Using Media)
- Modulair
- Modular Recirculating Peat Filters
- Moving Bed Bioreactor
- Mudbug
- Multi-flo
- Navadic
- Nayadic
- Nibbler

Biological (cont)
- NirtoRaptor
- Nitrex
- NoMound
- Onsite Wastewater Mgmt, Inc NITE-LESS
- Open Cell Foam
- Opoka
- Orenco RTF
- Paper
- Peat
- Pirana
- Plastic Media
- Polonite
- Poly (e-caprolactone)
- Polystyrene
- Pulse Aeration
- Puraflo Peat
- ReCip® RTS ~ 500 System
- Reciprocating Media Beds

Biological (cont)
- Recirculating Media Filters
- Recirculating Sand Filters
- Recirculating Textile Filters
- Retrofast
- RIGHT
- Rock Tank
- Rotofix
- Rotordisk
- Rubber, shredded
- RUCK
- Sand (stratified)
- Sand (uniform)
- Sawdust
- SCAT Biofilter
- Segregated Biomass Denitrification
- SeptiTech
- Sequencing Batch Reactors
- Single Pass Media Filter

Biological (cont)
- Singulair
- Slag
- Solar Air
- Stratified Sand Biofilters
- Sulfur/Limestone Column
- Sulfur/Oyster Shell Filter
- SYBR AER
- Thomas TRD
- Tire Chips
- UASB
- USBF
- Waterloo Biofilter
- Whitewater ATU
- Woodchip
- Zenon
- Zeolites
- ZeroImpact

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Onsite Nitrogen Reduction Studies/Tests/Systems Identified

Physical / Chemical

Biovac A/S

Columbio

Evapotranspiration

Magenetic Ion Exchange Resin

Nano Filtration

Reverse Osmosis

Ultra Filtration

Wallax

Natural Systems

American Manufacturing Inc.

Annamox

AZTEC Products

Denitrification in Soil

Ecological Systems

Geoflow, Inc.

Lagoons

Netafilm Irrigation, Inc.

SF Wetlands

SSF Wetlands

Wastewater Systems, Inc.

Source Separation

Aerobic MBR

Ammonia Stripping

Anaerobic MBR

Aquatron

Clinoptilolite

Complete Mix Reactors

Constructed Wetlands

EcoSan

Electrochemical Treatment

Electrodialysis/Ozonation

Evaporation

Fluidized Bed Reactors

Freeze-Thaw

Internal Recycle Seeding Reactor

Ion Exchange

Low Intensity Aerobic Treatment

Membrane Bioreactor

Membrane Chemical Reactor

Source Separation (cont)

Microfiltration/Oxidation

Nanofiltration

Novaquatis

Packed Column Nitrification

Passive Anaerobic Digestion (Septic Tanks)

Pellet Reactors

Polymeric Ion Exchange Resins

Precipitation

Reverse Osmosis

Rotating Biological Contactor

Sand Filtration

Shallow Ponds with Riparian Zones

UASB followed by Membrane Filtration

Upflow Anaerobic Sludge Blanket Reactor

Urine Separating Toilets

Waterless Urinals

Wollastonite

Zeolites

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Nitrogen Reduction Technology Evaluation Methods

45

N Reduction Technology Evaluation Criteria

- Effluent total nitrogen concentration
- Performance consistency
- Performance reliability
- Construction costs
- Operation and maintenance cost
- Land area requirements
- Energy requirements
- Homeowner acceptance
- BOD/TSS effluent concentration
- Restoration of performance
- Stage of technology development

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N Reduction Technology Evaluation Methods

- **Evaluation Criteria**
  - Each criterion is scored against its particular attribute using a scale ranging from 1 to 5
- **Criteria Weighting**
  - To account for relative differences in significance between criteria, weighting factors ranging from 1 to 10 are assigned
- **Technology Scoring**
  - The total score is the sum of the products of the individual criterion scores times the weighting factors for each criterion
- **Technology Ranking**
  - The priority ranking for a technology is determined by its total score. The highest score represents the highest priority ranking.

N Reduction Technology Evaluation Methods
Ranking Criteria & Weighting Factors

Criterion Description	Maximum Score (S)	Level of Significance	Weighting Factor (W)	Total Possible Score (S x W)
Effluent total nitrogen concentration	5	Very High	10	50
Performance consistency	5	Very high	10	50
Performance reliability	5	Very high	10	50
Construction costs	5	High	7	35
Operation and maintenance cost	5	High	7	35
Land area requirements	5	High	7	35
Energy requirements	5	Medium	4	20
Homeowner acceptance	5	Medium	4	20
BOD/TSS effluent concentration	5	Low	2	10
Restoration of performance	5	Low	2	10
Stage of technology development	5	Low	2	10
				325

N Reduction Technology Evaluation Methods
How We Determined Criteria Weighting

	Effluent Total Nitrogen Concentration	Performance Consistancy	Performance Reliability	Restoration of Performance	Construction Costs	Operation and Maintenance Costs	cBOD/TSS Effluent Concentrations	Homeowner Acceptance	Energy Requirements	Land Area Requirements	Stage of Technology Development	Relative Rank Score	Criterion Rank
Effluent Total Nitrogen Concentration		1	1	1	1	1	1	1	1	1	1	10	Very High
Performannce Consistancy	0		0	1	1	1	1	1	1	1	1	8	Very High
Performance Reliability	0	1		1	1	1	1	1	1	1	1	9	Very High
Restoration of Performance	0	0	0		0	0	0	0	0	0	1	1	Low
Construction Costs	0	0	0	1		1	1	1	1	0	1	6	High
Operation and Maintenance Costs	0	0	0	1	0		1	1	1	1	1	6	High
cBOD/TSS Effluent Concentrations	0	0	0	1	0	0		0	0	0	0	1	Low
Homeowner Acceptance	0	0	0	1	0	0	1		0	0	1	3	Med
Energy Requirements	0	0	0	1	0	0	1	1		0	1	4	Med
Land Area Requirements	0	0	0	1	1	0	1	1	1		1	6	High
Stage of Technology Development	0	0	0	0	0	0	1	0	0	0		1	Low
	0	2	1	9	4	4	9	7	6	4	9		

N Reduction Technology Evaluation Methods
Criterion: Effluent Total N Concentration

Effluent TN (mg/L)	Score
< 3	5
3 – 10	4
11 – 15	3
16 – 30	2
> 30	1

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N Reduction Technology Evaluation Methods
Criterion: Performance Consistency

Variation in Onsite Nitrogen Removal Performance	Score
Physical/Chemical & Source Separation	5
MBR / IMB*	4
Fixed Film	3
IFAS**	2
Activated Sludge Nite/Denite	1

*MBR/IMB: Membrane Bioreactor / Immersed Membrane Bioreactor

**IFAS: Integrated Fixed Film Activated Sludge

N Reduction Technology Evaluation Methods
Criterion: Performance Reliability

Mean Time Between Service Calls	Score
annually	5
semi-annually	4
quarterly	3
monthly	1

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N Reduction Technology Evaluation Methods
Criterion: Construction Cost

Construction Cost ($1000)	Score
< 5	5
5 - 10	4
10 – 15	3
15 – 20	2
> 20	1

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N Reduction Technology Evaluation Methods
Criterion: Operation & Maintenance Cost

O&M Annual Cost ($/year)	Score
100 - 200	5
200 - 300	4
300 - 400	3
400 - 500	2
> 500	1

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N Reduction Technology Evaluation Methods
Criterion: Land Area Requirements

Land Area Required (ft^2)	Score
< 250	5
251-500	4
501-1000	3
1001-2000	2
> 2000	1

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N Reduction Technology Evaluation Methods
Criterion: Energy Requirements

Energy Use (kW-hour/year)	Score
< 500	5
500 – 1,000	4
1,000 – 1,500	3
1,500 – 2,500	2
> 2,500	1

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N Reduction Technology Evaluation Methods
Criterion: Homeowner Acceptance

Homeowner Acceptance	Score
Acceptable	5
Perceived nuisance	3
Aesthetically displeasing	1

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N Reduction Technology Evaluation Methods
Criterion: cBOD/TSS Effluent Concentration

Effluent cBOD/TSS (mg/L)	Score
10 / 10	5
20 / 20	4
30 / 30	2
> 50	1

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N Reduction Technology Evaluation Methods
Criterion: Performance Restoration

90% Performance Restoration Time (days)	Score
< 1	5
1 - 3	4
3 – 7	3
7 – 14	2
> 14	1

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N Reduction Technology Evaluation Methods
Criterion: State of Technology Development

Stage of Development	Score
National use	5
State use	4
Demonstration	3
Experimental	2
Conceptual	1

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Nitrogen Reduction Technology Testing Priority

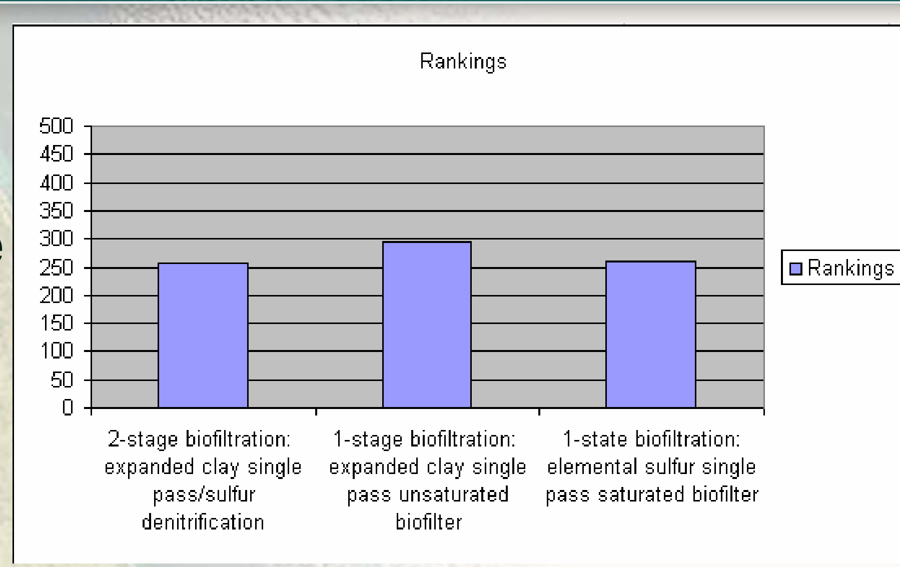
61

Nitrogen Reduction Technology Testing Priority

- Prioritization will be based on systematic application of the ranking criteria to individual technologies identified in the literature review
- Technologies will be grouped according to the classification scheme developed
  - Source Separation Technologies
  - Biological Treatment Technologies
  - Physical / Chemical Treatment Technologies
  - Natural Systems Technologies
- Each technology will receive individual scores for each evaluation criteria; the weighing criteria will then be used to generate a total score.
- For each classification, the technologies will be ranked according to their total score.

Nitrogen Reduction Technology Scoring and Priority Ranking

- Excel spreadsheet developed for real-time weight and score adjustment



	A	B	C	D	F	H
1	Criteria #	Ranking Criteria	Weighing Factor	2-stage biofiltration: expanded clay single pass/sulfur denitrification	1-stage biofiltration: expanded clay single pass unsaturated biofilter	1-state biofiltration: elemental sulfur single pass saturated biofilter
2	1	Effluent Nitrogen concentration	10	5	5	5
3	2	Performance consistency	10	3	3	3
4	3	Performance Reliability	10	5	5	5
5	4	Construction cost	7	4	5	5
6	5	Operation and maintenance cost	7	1	5	1
7	6	Land area required	7	5	5	5
8	7	Energy Requirement	4	3	3	3
9	8	Homeowner acceptance	4	5	5	5
10	9	BOD/TSS effluent concentration	2	5	5	5
11	10	Restoration of Performance	2	4	5	3
12	11	Stage of technology development	2	3	4	2
13			0			
14			0			
15				256	295	259

Biological Treatment Technologies Summary (Example)

Technology	Criteria										Total Score (out of 330)
	1	2	3	4	5	6	7	8	9	10	
	Nitrogen effluent concentration	Performance consistency	Reliability	Construction costs	Operation and maintenance cost	BOD/TSS effluent concentration	Homeowner acceptance	Energy requirement	Land area required	Stage of technology development	
	mg/L, Table 2,3,4	Table 5	Table 6,7	$, Table 8	$/year, Table 9	mg/L, Table 10	Table 11	kw-hr/ year, Table 12	1000 ft^2, Table 13	Table 14	
Two stage biofiltration: expanded clay single pass/sulfur denitrification	<3	5	5	7,187	1	5	5	1,209	200	3	285
One stage biofiltration: expanded clay single pass unsaturated biofilter	<1	5	5	3,770	5	5	5	1,209	120	4	315
One stage biofiltration: elemental sulfur single pass saturated biofilter	<1	5	5	3,417	1	5	5	1,209	80	2	278
MicroFAST								3,273			
Waterloo Biofilter								886			
Amphidrome								823			
Geoflow								565			
Recirculating sand filters	20	5	5	2,800	5	5	5	909	120	5	

Summary

65

Summary

- Questions?
- Let's review criteria, weights agreed on

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Review of Ranking Criteria & Weighting Factors

Criterion Description	Maximum Score (S)	Level of Significance	Weighting Factor (W)	Total Possible Score (S x W)
Effluent total nitrogen concentration	5	Very High	10	50
Performance consistency	5	Very high	10	50
Performance reliability	5	Very high	10	50
Construction costs	5	High	7	35
Operation and maintenance cost	5	High	7	35
Land area requirements	5	High	7	35
Energy requirements	5	Medium	4	20
Homeowner acceptance	5	Medium	4	20
BOD/TSS effluent concentration	5	Low	2	10
Restoration of performance	5	Low	2	10
Stage of technology development	5	Low	2	10
				325

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FLORIDA DEPARTMENT OF HEALTH

Next Steps

44237-001W-FN

68

Research Review and Advisory Committee for the Bureau of Onsite Sewage Programs

Approved Minutes of the Meeting held at the Florida Onsite Wastewater Training Center, Lake Alfred, FL
May 27, 2009 and May 28, 2009
Approved by RRAC July 1, 2009

May 27, 2009

In attendance May 27, 2009:

- **Committee Membership and Alternates**: David Carter (chairman, member, Home Building Industry); Anthony Gaudio (vice-chairman, member, Septic Tank Industry); Eanix Poole (alternate, Consumer); Patti Sanzone (member, Environmental Interest Group); Clay Tappan (member, Professional Engineer); and Pam Tucker (member, Real Estate Profession)
- **Not represented**: DOH-Environmental Health; Local Government; Restaurant Industry; and State University System
- **Visitors**: Dominique Buhot (Green's Environmental Services); Scott Carmody (Carmody); Blaine Carter (Carter Engineering); Stephen Clancy (GlobalMind); Chris Ferraro (FDEP – Central District); Roxanne Groover (FOWA) Pamela Hall (EarthSteps); Kathryn Lowe (Colorado School of Mines); Greg Mayfield (SWS); Linda Nelson (EarthSteps); Tresa Woodward (Representative Bryan Nelson's Office)
- **Department of Health (DOH), Bureau of Onsite Sewage Programs**: Paul Booher; Kara Loewe; Eberhard Roeder; and Elke Ursin

1. **Introductions:** Six out of ten groups were present, representing a quorum. Chairman Carter called the meeting to order at 1:10 p.m. Introductions were made and some housekeeping issues were discussed.

2. **Review of Previous Meeting Minutes**: Minutes were reviewed. **Motion by Eanix Poole and seconded by Patti Sanzone to approve the minutes as submitted. All were in favor with none opposed and the motion passed unanimously.**

3. **Election of Chair / Vice Chair**: David Carter is current chair, and there is no current vice-chair. About 5-years ago Patti Sanzone was vice-chair, but she has been off and then back on the committee since in that position. David Carter asked whether anyone has expressed an interest in being in these positions, and Elke Ursin indicated that Bill Melton had stated that he would be willing to serve as vice-chair. David Carter stated that his term as member for the Home Building Industry is up in January of 2010. He stated that he is willing to continue. Anthony Gaudio stated that he had offered to be chair several meetings ago, but the election has been moved forward so many times since then. Anthony Gaudio is still willing to do this, but if David Carter would like to run for chair he would be willing to run for vice-chair. **Motion by Pam Tucker and seconded by Clay Tappan to keep David Carter as the chairperson of the RRAC. All were in favor with none opposed and the motion passed unanimously.** David Carter, representing the Homebuilding Industry, was elected chair of the committee for the remainder of his term, which expires in January of 2010. **Motion by Eanix Poole and seconded by Patti Sanzone to appoint Anthony Gaudio as vice-chairman of the RRAC. All were in favor with none opposed and the motion passed unanimously.** There was a discussion about what to do about Bill Melton's interest and it was decided that since Anthony is here to have him as the nominee.

Anthony Gaudio, representing the Septic Tank Industry, was elected as vice chair of the committee.

4. **Presentation on Inventory of Onsite Sewage Treatment and Disposal Systems in Florida Study**: Elke Ursin gave a brief introduction to the project. The purpose of the study is to provide a comprehensive inventory of the approximate 2.5 million onsite sewage systems in the state. The inventory will help us understand the impacts of these systems on the environment as well as help with improving maintenance and management of septic systems to protect public health and the environment. A draft report was submitted. Pamela Hall with EarthSteps and Stephen Clancy with GlobalMind provided a presentation on the objectives and status of the inventory project. The work is still ongoing with an anticipated completion date of June 30, 2009. Out of 9-million parcels in Florida, 6.5-million are improved. All the Florida Department of Environmental Protection (FDEP) wastewater treatment facilities were contacted, and about 80% of the total permitted treatment capacity has been accounted for. Approximately two million parcels were specifically identified as being sewered, that is a dot could be placed on a map stating these particular parcels are NOT on septic. After contacting local county health departments and collecting information from the Department of Health's Environmental Health Database, about 0.5-million parcels have been specifically identified as being on onsite sewage systems, that a dot could be placed on a map indicating these particular parcels ARE on septic. There are 4-million unknown parcels (6.5-million developed – 2-million sewer – 0.5-million septic = 4-million). Now, they are in the process of developing models for each of the 67 county health departments, to estimate the probability of whether any particular remaining unknown parcel is on septic or not. Several possibilities for areas of future study were presented to the RRAC. The RRAC was interested in knowing what will be done with the information after the project is over, and Kara Loewe stated that at this point there is no additional money targeted for this project. [NOTE: See the budget discussion below for additional information on this project.]

5. **Brief updates on other projects**

   a) Ongoing projects

      - **Town of Suwannee Study** – The Quality Assurance Project Plan (QAPP) was approved by all parties on May 18, 2009. The project is behind schedule due to the delay in getting the QAPP approved with FDEP. Sampling began on Tuesday May 26th and will continue weekly until mid-July. The timeline for the data analysis and report writing will be shortened to meet the October 1, 2009 contract end date.
      - **Manatee Springs, Performance of Onsite Systems Phase II Karst Study** – The modifications to the systems have been completed and final approved by the County Health Department. Eberhard Roeder outlined what modifications were done on both of the systems. A background sampling event has been completed. An intensive 4-day performance sampling event will occur the first week of June. The project is to be completed in July.
      - **Monroe County Performance Based Treatment System Performance Assessment** – Quality control of existing data is ongoing. The Phase III Sampling will use the same procedures from Phase II and the sampling protocol document is nearing completion with the incorporation of final clarifications. One sampling event for systems studied during this phase has been completed and a second is nearing completion.

- **319 Project on Performance and Management of Advanced Onsite Systems** – Work will begin in the very near future on the database of advanced systems. The Florida State University Survey Research Laboratory was selected to perform the user-group perceptions survey task, and they are currently in the process of developing the surveys. A candidate for a contract staff position has been selected and is in the process of being hired to start working on this project.

6. **Research Budget** – A discussion was had on the research program budget. The research trust fund as of April 30, 2009 has a cash balance of $353,795. The committee voted to approve the following prioritized list of projects that will be completed as time and budget permits: Inventory Study: Maintenance of the Database, Town of Suwannee Study December-January Sampling Event, Columbia County River Front Survey, Wekiva Seasonal Variability Study, and the Alternative Drainfield Product Assessment. Department staffs were directed to research how much money will be required to conduct these projects effectively.

7. **Other Business** – None.

8. **Public Comment** - The public was allowed to comment throughout the meeting.

9. **Meeting Adjournment** – The meeting adjourned at 2:46 p.m.

May 28, 2009

In attendance May 28, 2009:

- **Committee Membership and Alternates**: David Carter (chairman, member, Home Building Industry); Kim Dove (member, DOH-Environmental Health); Anthony Gaudio (vice-chairman, member, Septic Tank Industry); Eanix Poole (alternate, Consumer); Patti Sanzone (member, Environmental Interest Group); John Schert (member, State University System); Clay Tappan (member, Professional Engineer); and Pam Tucker (member, Real Estate Profession)
- **Not represented**: Local Government and Restaurant Industry
- **Visitors**: Damann Anderson (Hazen and Sawyer); Rick Baird (Orange County Environmental Protection); Quentin Beitel (Markham Woods Association); Jonathan Blanchard (Hazen and Sawyer); Dominique Buhot (Green's Environmental Services); Blaine Carter (Carter Engineering); Scott Carmody (Carmody); Steve Danskine (Environmental Consulting & Technology); Josefin Edeback (Hazen and Sawyer); Doug Everson (PTI); Chris Ferraro (FDEP – Central District); Roxanne Groover (FOWA) Jack Hannahs (Markham Woods Association); John Higgins (Markham Woods Association); Mark Hooks (citizen); Justin Hubbard (Infiltrator); Ken Jones (Markham Woods Association); Kathryn Lowe (Colorado School of Mines); Dick Otis (Otis Environmental); Daniel Smith (AET); Charlie Stone (Marion County Commission); Tresa Woodward (Representative Bryan Nelson's Office)
- **Department of Health (DOH), Bureau of Onsite Sewage Programs**: Marcelo Blanco; Paul Booher; Kim Duffek; Bart Harriss; Kara Loewe; Eberhard Roeder; and Elke Ursin

1. **Introductions:** Eight out of ten groups were present, representing a quorum. Chairman Carter called the meeting to order at 10:08 a.m. Introductions were made and some housekeeping issues were discussed.

2. **Summary of Previous Days Meeting:** Elke Ursin provided a summary of some of the highlights that occurred at the meeting held the previous day (May 27, 2009).

3. **Nitrogen Reduction Strategies Study** – The objective of this meeting is to review the Project Team's proposed onsite nitrogen reduction technology classifications, evaluation criteria, criteria weighting, and ranking methodology. Another objective of this meeting is to develop a consensus on the procedures which will be used to identify and prioritize the technology list for future testing. Several presentations were made by Damann Anderson, Dick Otis, and Daniel Smith about the study background, an overview of the project, a review of nitrogen chemistry, and how to classify different technologies. The major classifications for technologies were source separation (e.g. urine separating toilets), biological systems with many sub-categories (e.g. suspended growth and fixed growth systems), physical/chemical systems (e.g. chemical precipitation), and natural systems (e.g. conventional and fill septic systems). There was a discussion on the definition of "passive". The current definition per the contract is: "a type of onsite sewage treatment and disposal system that excludes the use of aerator pumps and includes no more than one effluent dosing pump with mechanical and moving parts and uses a reactive media to assist in nitrogen removal".

   The committee was given stickers to perform a preliminary ranking of different onsite nitrogen reduction technology classification processes. There were five stickers for each member present to rank from 1 (highest ranking: most important) to 5 (lowest ranking: least important). Here are the results of this ranking:

System	Sticker(s) Ranking	Average Ranking
Autotrophic Denitrification	1	1
Soil Infiltration	1,2,2,3	2
Nitrification	2	2
Source Separation	2	2
External Carbon	2,3	2.5
Urine Recovery	1,2,1,5,4,3	2.67
Heterotrophic Denitrification	1,1,4,5	2.75
Vegetative Uptake	2,2,4,4	3
Denitrification (Alternative Electron Donors)	3	3
Two Stage (Segregated Biomass)	1,3,5	3
Sewage Carbon (Recycle)	1,3,5	3
External Chemical	3,4	3.5
Submerged	4	4
Suspended Growth	3,4,5,5	4.25
Anion Exchange (Nitrate)	5	5
Physical/Chemical	5	5

There was a discussion on what criteria are important to evaluate different systems. **Motion by Eanix Poole and seconded by Kim Dove to bring the weight for the Evaluation Criteria: 'Energy requirements' to match the Evaluation Criteria: 'Operation and maintenance cost'. All were in favor with none opposed and the motion passed unanimously.** After much discussion, the final prioritized list of criteria to be evaluated and their associated weights was as follows:

Evaluation Criteria	Weight
Effluent total nitrogen concentration	11
Performance reliability	10
Performance consistency	9
Construction costs	7.5
Operation and maintenance cost	7
Energy requirements	7
Construction complexity	5
Operation and maintenance	5
Land area requirements	4.5
BOD/TSS effluent concentration	3.5
Restoration of performance	3.5
System aesthetics	2
Stage of technology development	0.5

Results were presented on the preliminary evaluation of the University of South Florida's Lysimeter Station as well as the University of Florida's IFAS Gulf Coast Research and Education Center as possible locations for the test facilities. The Project Team recommended not using the Lysimeter Station because the cost to restore the site is more than the budget available. Instead, the Gulf Coast Center was a suitable location for both systems testing and groundwater monitoring. Conditions for denitrification are expected to be relatively good at this site. Having both components of the test facility conducted at one site also helps reduce some of the costs. **Motion by Anthony Gaudio and seconded by Eanix Poole to accept the recommendation to use the Gulf Coast Center as the only test facility location. All were in favor with none opposed and the motion passed unanimously.**

There was a discussion on the next steps for this project. The ranking criteria will be finalized based on the results of this workshop. The technologies will be scored and ranked based on the agreed upon criteria and weights. Draft reports will be finalized, after receipt of RRAC comments, and final reports will be distributed. The Project Team will meet to figure out what can be done by June 30th. A possible reorganization of the scope and budget may need to be done to meet the requirements in the approved 2009-2010 budget, which gave the Department spending authority for this project, did not add additional funds, and requires interim and final project reports to be due during the fiscal year. After the Project Team discusses this, this will be brought back to the RRAC and may be a focus for the next RRAC meeting.

4. **Other Business** – None.

5. **Public Comment** – The public were allowed to comment throughout the meeting. Mark Hooks mentioned a possible grant proposal that he may be working on to have a collaborative effort to take over the nitrogen project over where the contractor ends.

6. **Next Meeting**: The next meeting will be scheduled for the end of June or the beginning of July. The meeting location has not been determined, but may be held either at the University of Florida's Gulf Coast Research and Education Center or via teleconference. The focus of the next meeting will be to review draft documents and discuss the process forward for the Nitrogen Reduction Strategies Study as well as discuss current and proposed research projects.

7. **Meeting Adjournment** – The meeting adjourned at 5:30 p.m.

Next Steps…

- Consensus on technology classification criteria
- Finalize ranking criteria, attribute assignments, initial weighing factors based on today's workshop
- Complete scoring and ranking of technologies based on criteria and weights agreed upon
- Finalize draft report for Tasks A3 - A6, and deliver back to RRAC
- Finalize literature review and deliver to RRAC

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