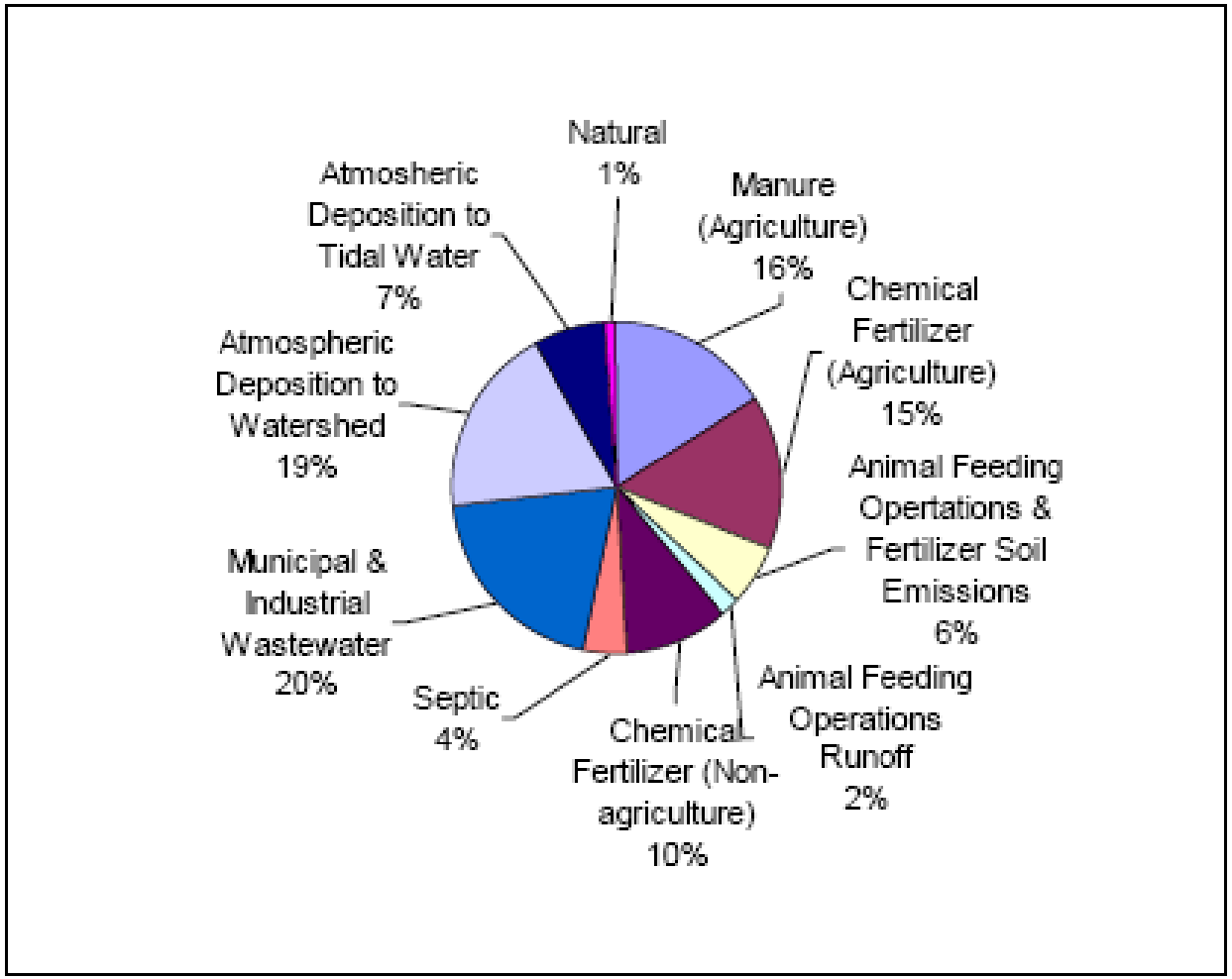
Overview of Best Available Technologies for Onsite Septic Systems and Management Considerations

Presentation to NAHB

A. R. Rubin, Professor Emeritus,
NCSU-BAE

2003 Sources of Nitrogen Loads to Chesapeake Bay Including Atmospheric Deposition to Tidal Water



http://www.chesapeakebay.net/pubs/statustrends/PowerPoint/i.ppt#276,8,Sources of Nitrogen Loads to the Bay Including Atmospheric Deposition to Tidal Water

Technical Wastewater Issues

Treatment

- Septic tank
- ATU
- Reuse

Dispersal

- Traditional SAS
- Alternative SAS
  - LPP
  - Drip

Nontechnical Wastewater Issues

O and M

- Competent Personnel
- Supplies and Equipment
- Monitoring, Measuring, Reporting
- Corrective action

Program Management

- Sustainability
- Finance
- Improvement/repair
- Infrastructure!

Science and Engineering

BOD

- Compounds containing organic Carbon
- Energy for microorganisms
- Oxygen required to degrade
- 1.5 Units O/Unit BOD
- Easily removed in properly managed systems
- Alkalinity necessary

Nitrogen

- Organic and inorganic forms of N in wastewater
- Both aerobic and anaerobic conditions necessary to degrade
- Oxygen converts R-NH to NO
- 4.6 Units O/unit R-NH
- Sensitive processes
- Alkalinity necessary

Onsite Wastewater Treatment

- Physical – solids removal
- Chemical – P removal
- Biological – BOD removal
- Aerobic/anaerobic

  systems necessary for N removal

* *<u>Soil systems remain vital part of the dispersal component</u>*

Design for Site and Soil Limitations

- Proper design addresses most limiting of the site and soil limitations and allows assimilation of all constituents on intended receiver site – Recommendations from Soils Consultants, agronomists, hydrogeologists, and farm/land manager
  - Hydraulic
  - Nutrient
  - Organic and Inorganic

Biochemical Oxygen Demand (BOD)

- Rate that organisms use oxygen to break down organic matter
- High BOD levels indicate high levels of organic matter which rob O2 from water
- Low DO undesirable and unhealthy for aquatic ecosystem

Nitrogen (N)

- Four forms of N occur in wastewater
  - Organic nitrogen
  - Ammonia (NH_3) / ammonium (NH_4^+)
  - Nitrite (NO_2^-)
  - Nitrate (NO_3^-)
- Organic N is converted to NH_4^+
- NH_4^+ is then converted to NO_2^- and NO_3^-
- In C rich environment under anaerobic conditions nitrate converted to N gas
- Reactions very dependent on temperature (low temperature retards reactions)

Phosphorous (P)

- Three forms occur in wastewater
  - orthophosphate
  - polyphosphate
  - organic phosphate
- Usually measured as total P

N and P

- In surface waters, these nutrients promote growth of algae and aquatic plants

NFS Program Overview

- Certification
  - Testing
  - Standards and Protocols
- Environmental Technology Verification (ETV)
- Research Services
- Professional Accreditation
- Field Effluent Monitoring:
  - PA DEP Program
  - National Standard
- Field Service and Maintenance Monitoring

NSF-ANSI Wastewater Standards

- **NSF/ANSI 41 -2011 *Non-liquid saturated treatment systems* (1978)**
- **NSF/ANSI 46 -2010 *Evaluation of components and devices used in wastewater* (1997)**
- **NSF/ANSI 240 -2011 *Drainfield trench product sizing for gravity dispersal onsite wastewater treatment and dispersal systems* (2011)**
- **NSF/ANSI 40 -2010 *Residential wastewater treatment systems* (1970)**
- **NSF/ANSI 245 -2010 *Wastewater treatment systems – nitrogen reduction* (2007)**
- **NSF/ANSI 350 -2011 *Onsite residential and commercial water reuse treatment systems* (2011)**
- **NSF/ANSI 350-1 -2011 *Onsite residential and commercial graywater treatment systems for subsurface discharge* (2011)**
- **NSF/ANSI 360 -2010 *Wastewater treatment systems – field performance verification* (2010)**
- **More may be developed as needed**

Treatment System Verification

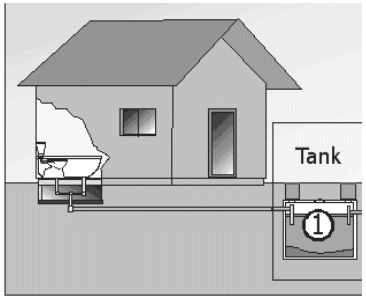
NSF

- Establishes standard – NSF/ANSI
- 40, 240, 245, 350
- Certifies technology to standard

Massachusetts Test Center

- Tests specific technology against NSF/ANSI standard
- Verifies performance through rigorous testing

Performance of Onsite Treatment Technologies



WASTEWATER FROM HOME

BOD: 110 - 400 mg/L

TSS: 100 - 350 mg/L

TN: 40 - 100 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^9 col/100 ML

SEPTIC TANK EFFLUENT

BOD: 110 - 200 mg/L

TSS: 50 - 100 mg/L

TN: 40 - 100 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^8 col/100 ML

SEPTIC TANK EFFLUENT, WITH RECYCLE

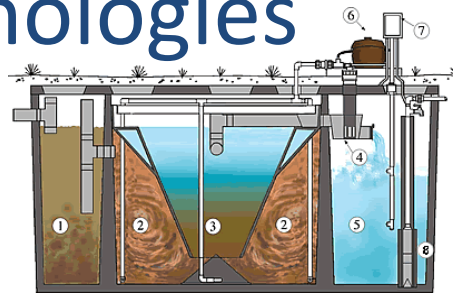
BOD: 80 - 120 mg/L

TSS: 50 - 80 mg/L

TN: 10 - 30 mg/L

TP: 5 - 15 mg/L

Fecal: 10^6 - 10^9 col/100 ML



AEROBIC UNIT EFFLUENT

BOD: 5 - 50 mg/L

TSS: 5 - 100 mg/L

TN: 25 - 60 mg/L

TP: 4 - 10 mg/L

Fecal: 10^3 - 10^4 col/100 ML

SAND FILTER EFFLUENT

BOD: 2 - 15 mg/L

TSS: 5 - 20 mg/L

TN: 10 - 50 mg/L

TP: <1 - 10 mg/L

Fecal: 10^1 - 10^3 col/100 ML

FOAM/TEXTILE FILTER EFFLUENT

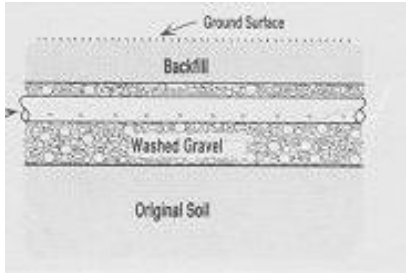
BOD: 5 - 15 mg/L

TSS: 5 - 10 mg/L

TN: 3 - 60 mg/L

TP: 5 - 15 mg/L

Fecal: 10^1 - 10^3 col/100 ML



FURTHER ATTENUATION BY SOIL

BOD: >90%

TSS: >90%

TN: 10 TO 20%

TP: 0 - 100%

Fecal: >99.99%

Pretreatment

- **THE “TANK”**

Pretreatment

- **THE "TANK"….. Improving function**
  - **Effluent screens (filters)**

The Septic Tank provides

- 40% reduction of BOD
- 50% reduction of solids
- Typical residential effluent
  - 150 mg/l BOD
  - 80 mg/l TSS
  - 60 mg/l TN (most ammonia)
  - <10 mg/l TP
  - <10 mg/l FOG
  - >1,000,000 FC organisms/ 100ml

Advanced treatment

- In general, advanced treatment systems describes various technologies/designs to further reduce BOD and solids in effluent
- How?????
  - By providing an “aerobic” environment

Advanced treatment

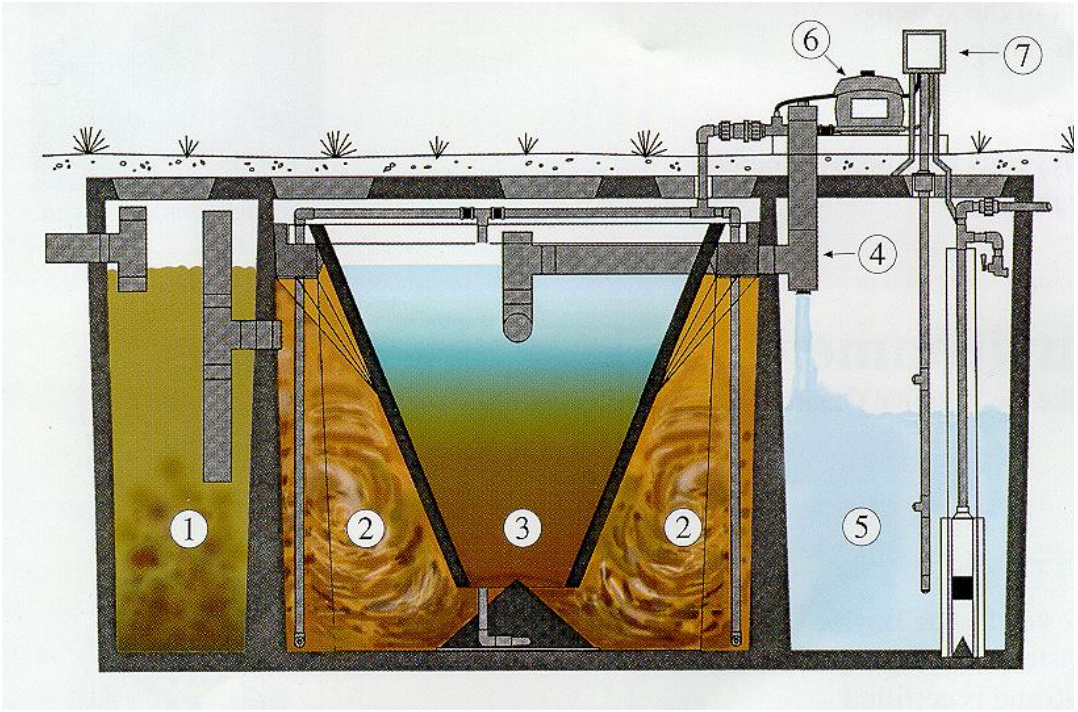
- Aerobic Treatment Units (ATU's)
  - Suspended growth
  - Fixed growth

Advanced treatment

- Aerobic Treatment Units (ATU's)
  - Use air compressor and air diffusers to "inject" oxygen into the effluent mix
    - More oxygen = more rapid digestion of "organic" material= less time and space
    - Suspended growth…..organisms floating in liquid
      - Air required as O2 supply and to maintain suspension,
      - energy required to supply air and suspend organisms
    - Fixed (attached) growth…structure provided for organisms to attach
      - Air supplied as liquid migrates into media,
      - energy necessary only to pump

Advanced treatment

- Aerobic Treatment Units (ATU's)
  - Suspended growth unit



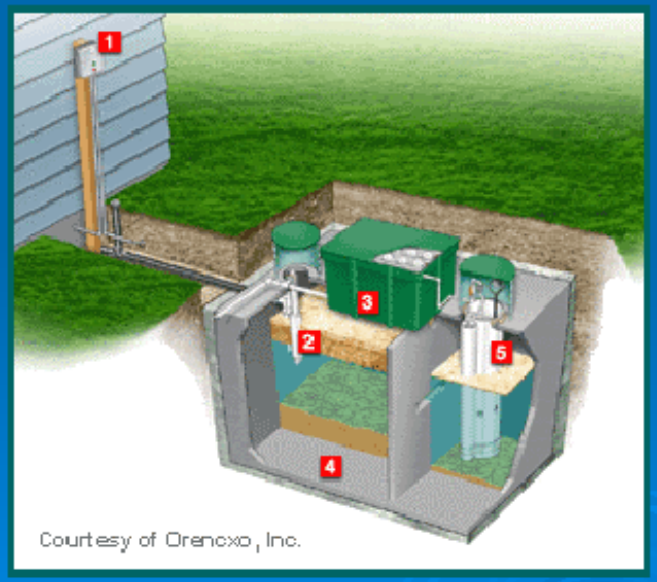
Advanced treatment

- Media/ packed bed filters
  - Generally introduction of oxygen is “passive”
  - Often use pumps to “dose” media
  - Sand…gravel…..peat….fabric……plastic…foam…..coconut husks
  - Sometimes effluent recycled back through filter

Advanced treatment

Media Filter

- **Textile sheets/chips**



Advanced treatment

- Aerobic Treatment Units (ATU's)
  - Fixed (attached) growth and Suspended Media hybrid unit

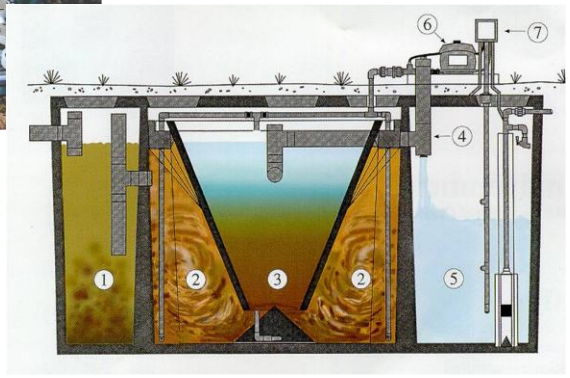
Advanced Wastewater Treatment

Processes

- Process capabilities (BOD, TSS, Nutrients, Biologicals)
  - NSF
  - State Rules

Pretreatment

Fixed Media



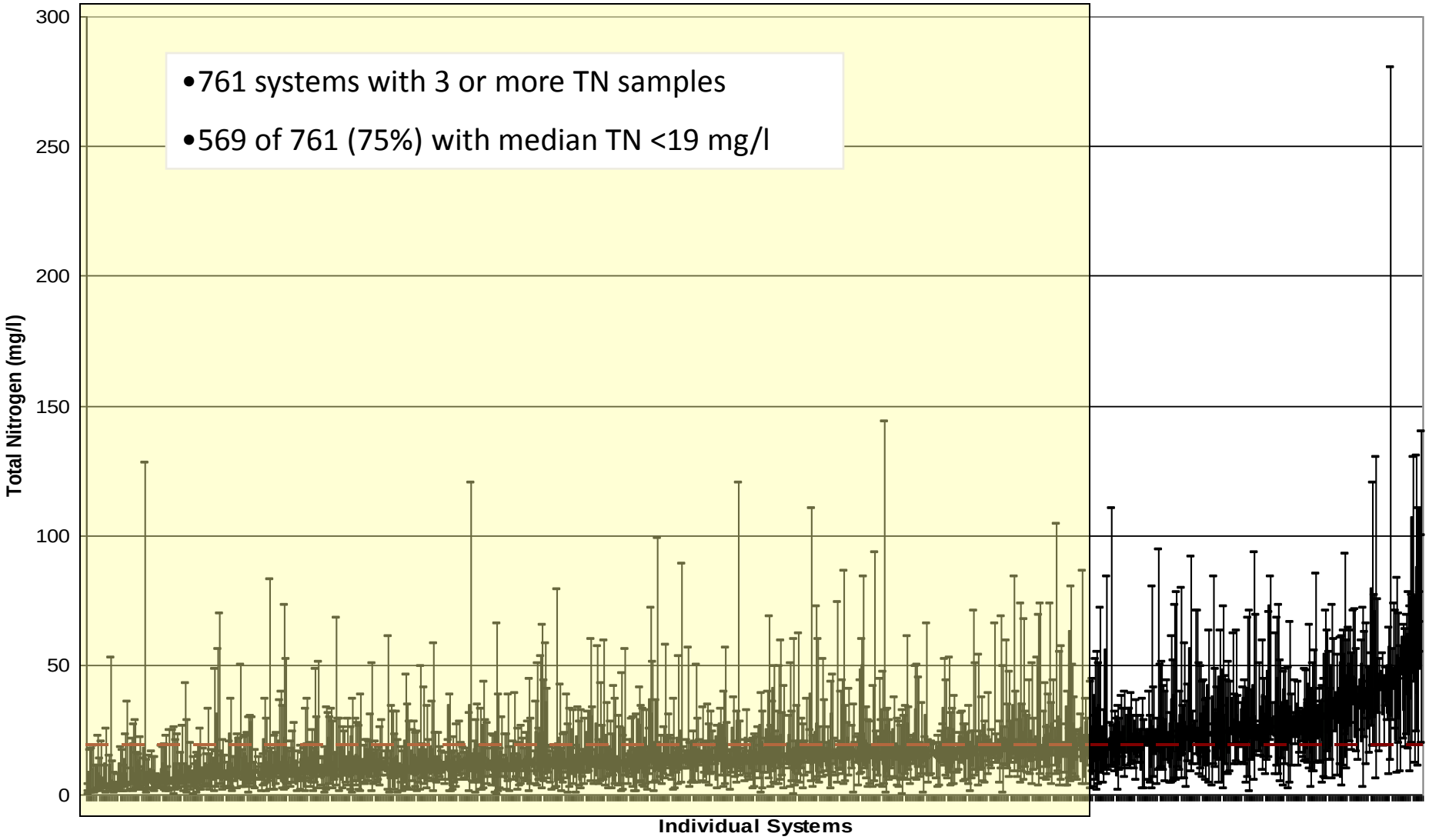
Suspended media

Parameter	BOD	TSS	Coliform	N
TS1	15 mg/l	15 mg/l	10000	10 NH4
TS2	10 mg/l	10 mg/l	1000	20 TN
Reuse	5 mg/l	5 mg/l	14	20 TN

High level of N and P possible w/added Carbon and Anaerobic conditions

Single Family all Types by Individual System

Three or More Samples with Full Nitrogen Series (Barnstable County)



Single Family all Types by System Type

Three or More Samples with Full Nitrogen Series (Barnstable Co)

System Type	Total with 3+ Samples	Total below 19mg/l	Percentage
All Types	761	569	75%
Advantex	27	21	78%
Amphidrome	4	3	75%
Bioclere	43	32	74%
FAST	442	355	80%
OMNI RSF	51	30	51%
RSF (Generic)	16	9	56%
RUCK	22	11	50%
Septitech	45	15	33%
Singulair	90	81	90%
Waterloo	11	7	64%

Approved Options

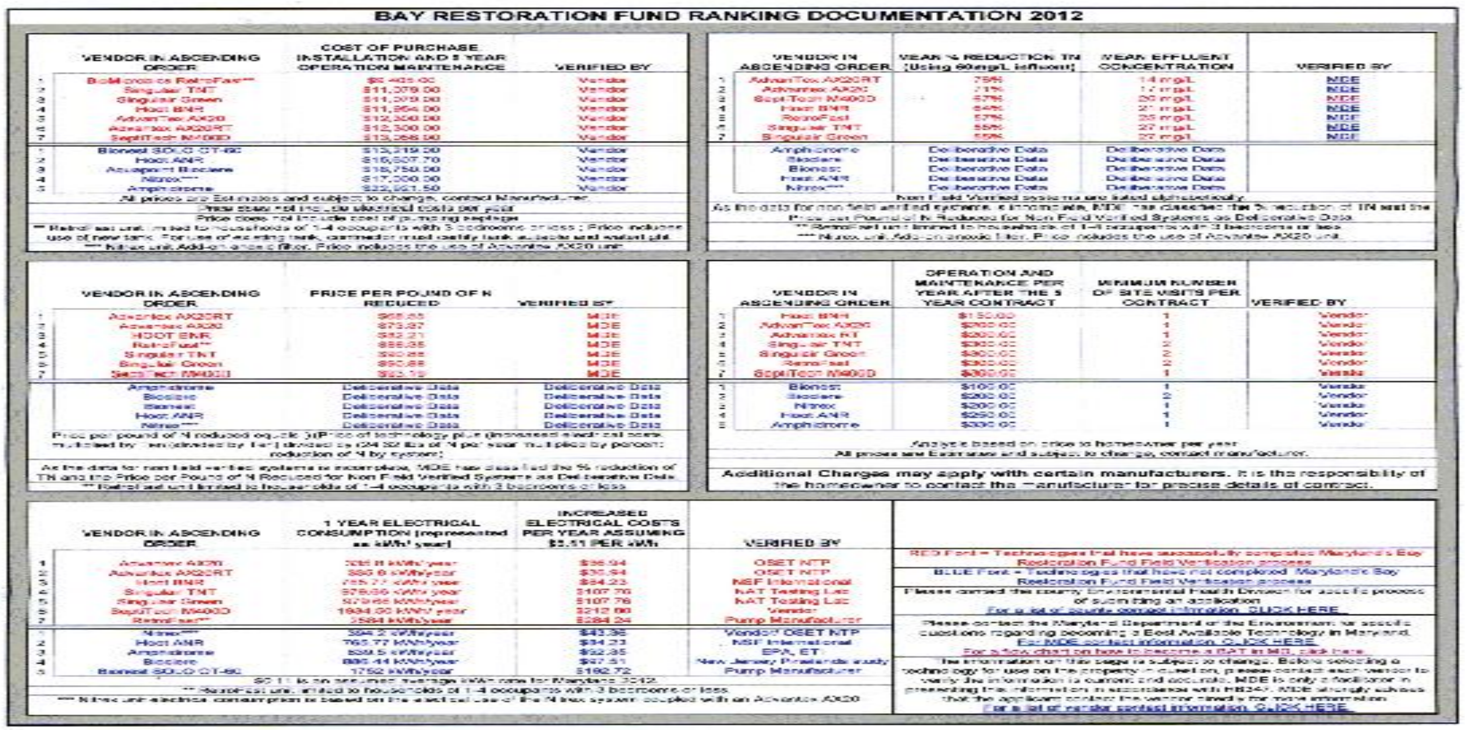
BAT System	Standard	Removal (%)	Concentration PPM
Advantex RT	3 rd party	76	14
Advantex AX 20	3rd party	71	17
SeptiTech	ETV/245	67	20
HOOT BNR	3 rd party	64	21
Retrofast	ETV	57	25
Singulair(Norweco)	245	55	27
NSF Data (reuse)*			
Biomicrobics MBR	350	80+	<10

* 350 is reuse standard through NSF, Not currently listed in MD.

Field Verification

HOOT ANR	Nitrix (add on)	Bionset	Microfast	Aqua Klear	Ecopod EN1	Hydro-Action	Clear Rx
245	3 rd party	245	ETV	245	245	245	245

Significant Effort



BAY RESTORATION FUND RANKING DOCUMENTATION 2012

	VENDOR IN ASCENDING ORDER	COST OF PURCHASE INSTALLATION AND 5 YEAR OPERATION MAINTENANCE	VERIFIED BY
1	BioMicrobics RetroFast**	$9,405.00	Vendor
2	Singulair TNT	$11,079.00	Vendor
3	Singulair Green	$11,079.00	Vendor
4	Hoot BNR	$11,264.00	Vendor
5	AdvanTex AX20	$12,300.00	Vendor
6	Advantex AX20RT	$12,300.00	Vendor
7	SeptiTech M400D	$13,066.00	Vendor
1	Bionest SOLO CT-60	$13,219.00	Vendor
2	Hoot ANR	$16,607.70	Vendor
3	Aquapoint Bioclere	$16,750.00	Vendor
4	Nitrex***	$17,000.00	Vendor
5	Amphidrome	$22,921.50	Vendor

All prices are Estimates and subject to change, contact Manufacturer.
Price does not include electrical costs per year
Price does not include cost of pumping septage
** RetroFast unit limited to households of 1-4 occupants with 3 bedrooms or less ; Price includes use of new tank. For use of existing tank, contractor must certify tank suitable and watertight.
*** Nitrex unit Add-on anoxic filter. Price includes the use of Advantex AX20 unit.

	VENDOR IN ASCENDING ORDER	MEAN % REDUCTION TN (Using 60mg/L influent)	MEAN EFFLUENT CONCENTRATION	VERIFIED BY
1	AdvanTex AX20RT	75%	14 mg/L	MDE
2	Advantex AX20	71%	17 mg/L	MDE
3	Septi-Tech M400D	67%	20 mg/L	MDE
4	Hoot BNR	64%	21 mg/L	MDE
5	RetroFast	57%	25 mg/L	MDE
6	Singulair TNT	55%	27 mg/L	MDE
7	Singulair Green	55%	27 mg/L	MDE
	Amphidrome	Deliberative Data	Deliberative Data	
	Bioclere	Deliberative Data	Deliberative Data	
	Bionest	Deliberative Data	Deliberative Data	
	Hoot ANR	Deliberative Data	Deliberative Data	
	Nitrex***	Deliberative Data	Deliberative Data	

Non Field Verified systems are listed alphabetically.
As the data for non field verified systems is incomplete, MDE has classified the % reduction of TN and the Price per Pound of N Reduced for Non Field Verified Systems as Deliberative Data.
** RetroFast unit limited to households of 1-4 occupants with 3 bedrooms or less
*** Nitrex unit Add-on anoxic filter. Price includes the use of Advantex AX20 unit.

	VENDOR IN ASCENDING ORDER	PRICE PER POUND OF N REDUCED	VERIFIED BY
1	Advantex AX20RT	$65.65	MDE
2	Advantex AX20	$73.87	MDE
3	HOOT BNR	$82.21	MDE
4	RetroFast**	$86.35	MDE
5	Singulair TNT	$90.88	MDE
6	Singulair Green	$90.88	MDE
7	SeptiTech M400D	$93.19	MDE
	Amphidrome	Deliberative Data	Deliberative Data
	Bioclere	Deliberative Data	Deliberative Data
	Bionest	Deliberative Data	Deliberative Data
	Hoot ANR	Deliberative Data	Deliberative Data
	Nitrex***	Deliberative Data	Deliberative Data

Price per pound of N reduced equals ((Price of technology plus (increased electrical costs multiplied by ten)(divided by ten)) divided by (24.32 lbs of N per year multiplied by percent reduction of N by system))

As the data for non field verified systems is incomplete, MDE has classified the % reduction of TN and the Price per Pound of N Reduced for Non Field Verified Systems as Deliberative Data.
** RetroFast unit limited to households of 1-4 occupants with 3 bedrooms or less

	VENDOR IN ASCENDING ORDER	OPERATION AND MAINTENANCE PER YEAR AFTER THE 5 YEAR CONTRACT	MINIMUM NUMBER OF SITE VISITS PER CONTRACT	VERIFIED BY
1	Hoot BNR	$150.00	1	Vendor
2	AdvanTex AX20	$200.00	1	Vendor
3	Advantex RT	$200.00	1	Vendor
4	Singulair TNT	$300.00	2	Vendor
5	Singulair Green	$300.00	2	Vendor
6	RetroFast	$300.00	2	Vendor
7	SeptiTech M400D	$300.00	1	Vendor
1	Bionest	$100.00	1	Vendor
2	Bioclere	$200.00	2	Vendor
3	Nitrex	$200.00	1	Vendor
4	Hoot ANR	$250.00	1	Vendor
5	Amphidrome	$300.00	1	Vendor

Analysis based on price to homeowner per year.
All prices are Estimates and subject to change, contact manufacturer.

Additional Charges may apply with certain manufacturers. It is the responsibility of the homeowner to contact the manufacturer for precise details of contract.

	VENDOR IN ASCENDING ORDER	1 YEAR ELECTRICAL CONSUMPTION (represented as kWh/ year)	INCREASED ELECTRICAL COSTS PER YEAR ASSUMING $0.11 PER kWh	VERIFIED BY
1	Advantex AX20	335.8 kWh/year	$36.94	OSET NTP
2	Advantex AX20RT	335.8 kWh/year	$36.94	OSET NTP
3	Hoot BNR	765.77 kWh/year	$84.23	NSF International
4	Singulair TNT	979.86 kWh/year	$107.78	NAT Testing Lab
5	Singulair Green	979.86 kWh/year	$107.78	NAT Testing Lab
6	SeptiTech M400D	1934.00 kWh/year	$212.80	Vendor
7	RetroFast**	2584 kWh/year	$284.24	Pump Manufacturer
1	Nitrex***	394.2 kWh/year	$43.36	Vendor/ OSET NTP
2	Hoot ANR	765.77 kWh/year	$84.23	NSF International
3	Amphidrome	839.5 kWh/year	$92.35	EPA, ET
4	Bioclere	886.44 kWh/year	$97.51	New Jersey Pinelands study
5	Bionest SOLO CT-60	1752 kWh/year	$192.72	Pump Manufacturer

$0.11 is an assumed average kWh rate for Maryland 2012.
** RetroFast unit limited to households of 1-4 occupants with 3 bedrooms or less.
*** Nitrex unit electrical consumption is based on the electrical use of the Nitrex system coupled with an Advantex AX20

RED Font = Technologies that have successfully completed Maryland's Bay Restoration Fund Field Verification process

BLUE Font = Technologies that have not completed Maryland's Bay Restoration Fund Field Verification process

Please contact the county Environmental Health Division for specific process of submitting an application
For a list of county contact information, CLICK HERE

Please contact the Maryland Department of the Environment for specific questions regarding becoming a Best Available Technology in Maryland.
For MDE contact information, CLICK HERE
For a flow chart on how to become a BAT in MD, click here

The information on this page is subject to change. Before selecting a technology for use on the property in question, please contact each vendor to verify the information is current and accurate. MDE is only a facilitator in presenting this information in accordance with HB347. MDE strongly advises that the applicant contact the vendor directly for more information.
For a list of vendor contact information, CLICK HERE

Reduce N – Harvest Urine???

- 1.5 l/person/day
- 10 g urea (N)/person/d or about 12 lb/yr
- Family of 4: 48 lb – N/yr
- Who picks it up, who processes, use
- Solid waste companies, Ostara, Inc, fertilizer
  - Sustainable source for N, P and K
  - Yuck factor???

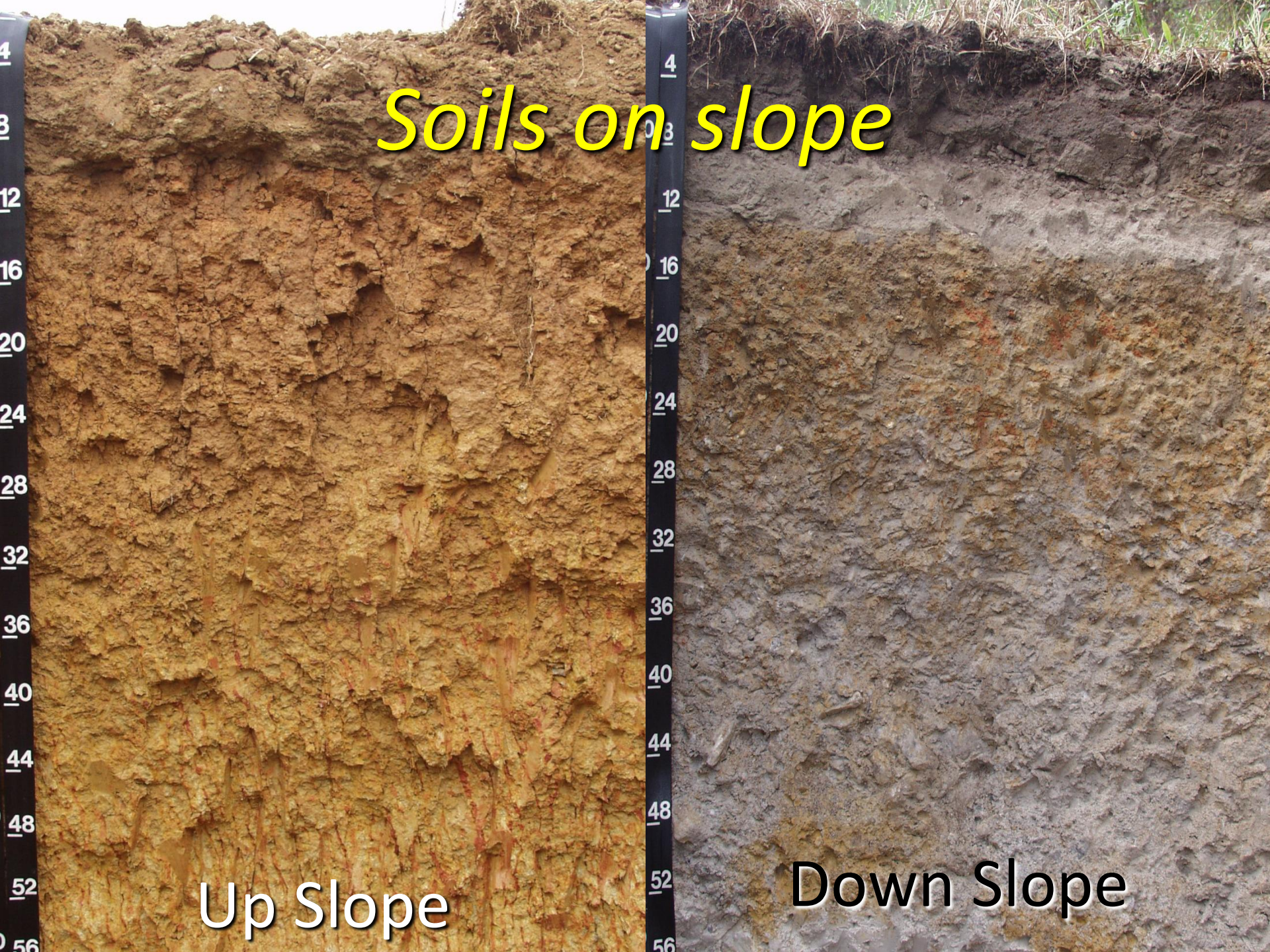
Soil – Initial receiver

Site

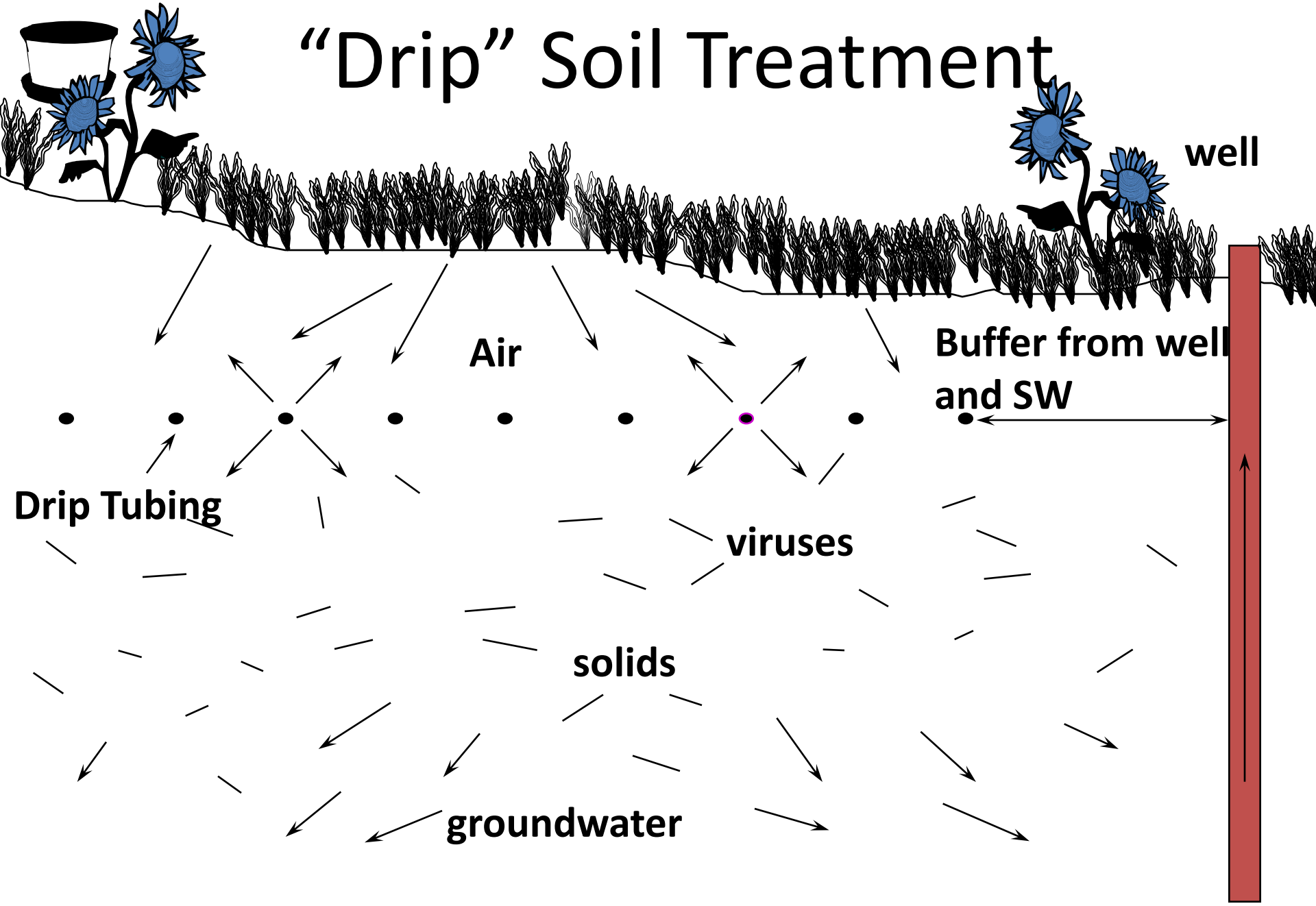
- Slope
- Distance to water
  - Groundwater
  - Surface water

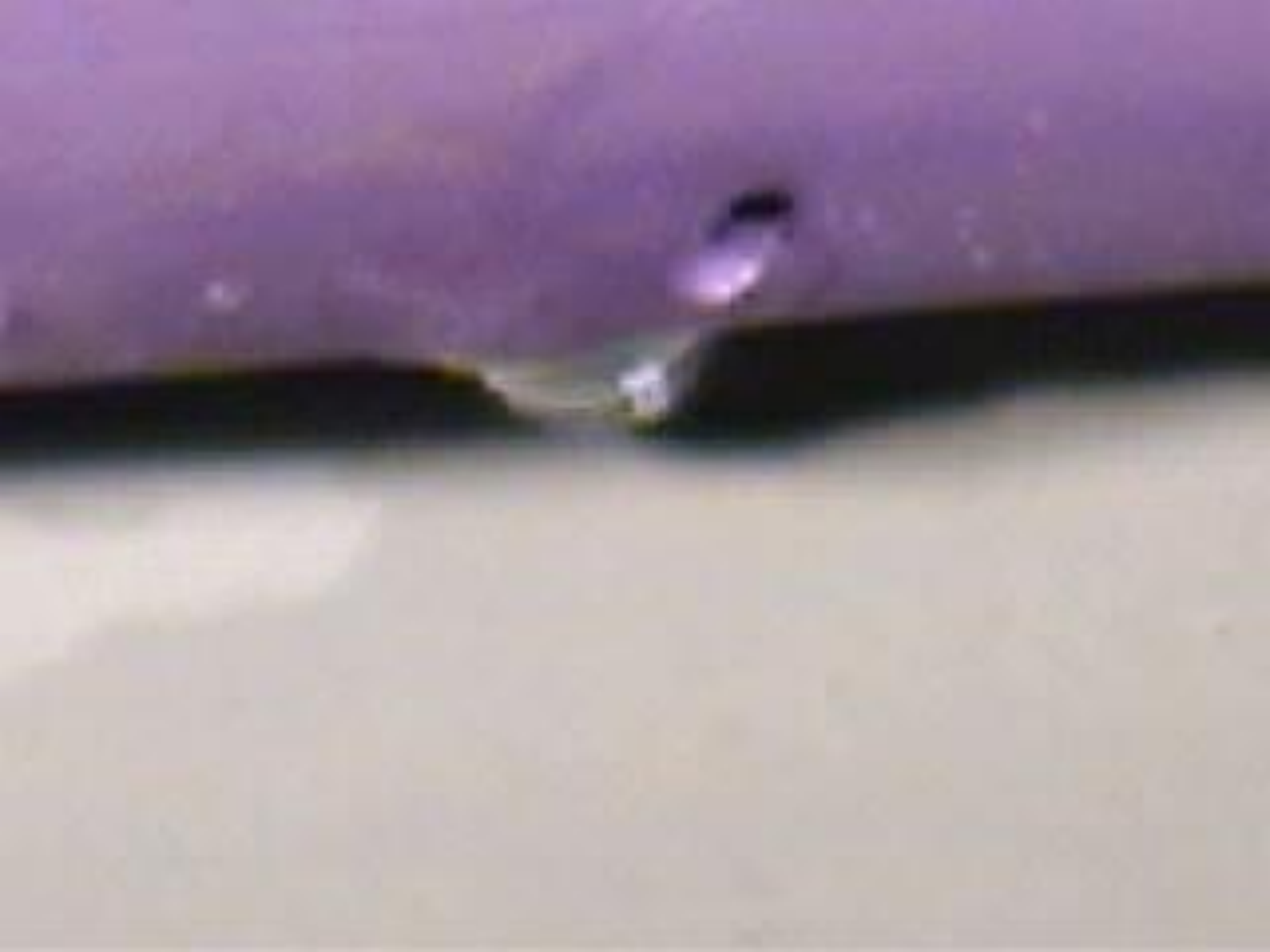
Soil

- Depth, Color, Texture, Structure, Consistence


Soils on slope
Up Slope
Down Slope

“Drip” Soil Treatment





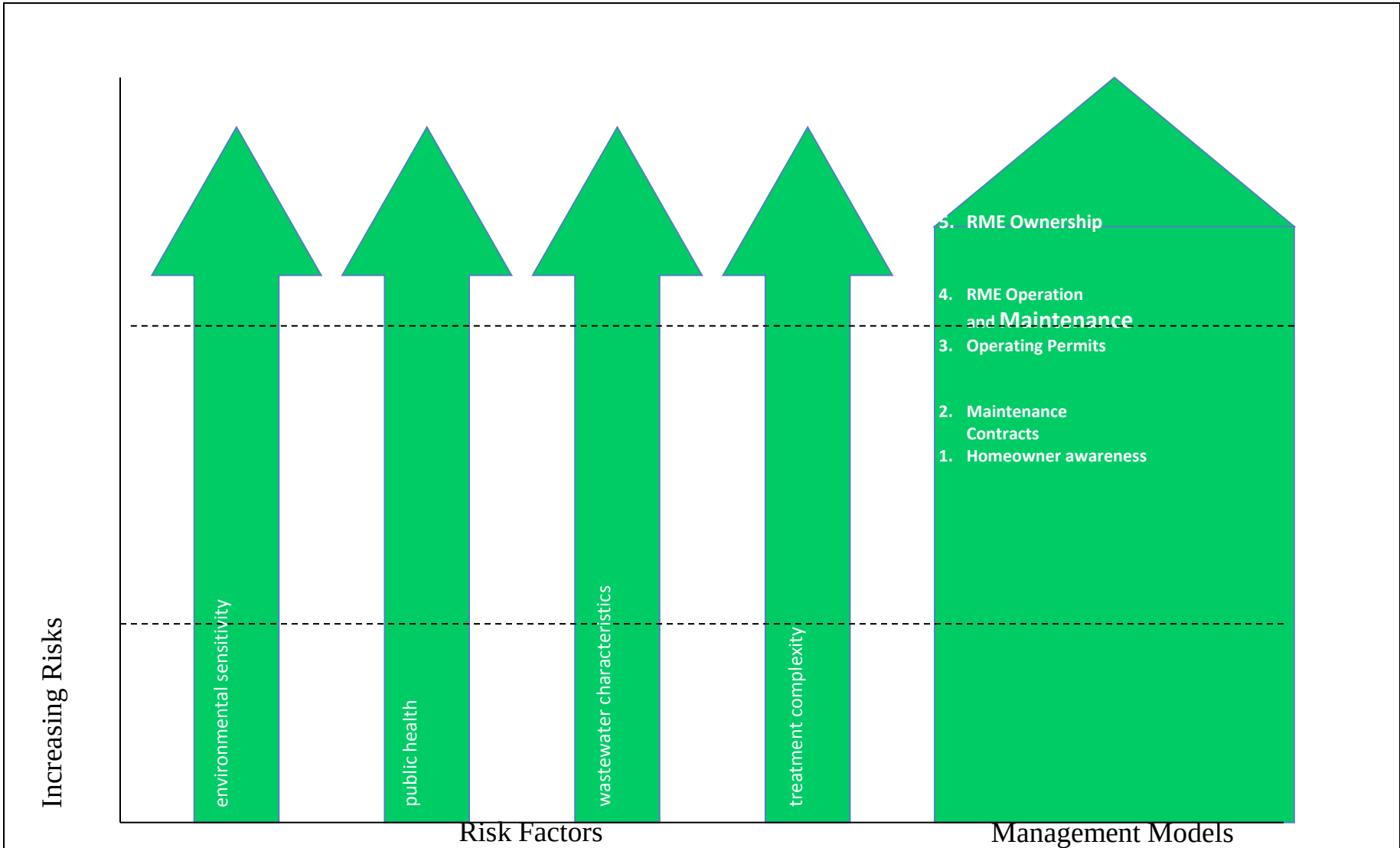
Management

- Operator
- Organization
- Long term sustainability of infrastructure
- Onsite is the Infrastructure for thousands of facilities
- EPA Management Guidelines

Management Programs

Program Level	Feature
1. Inventory/awareness	Traditional system, low risk environment
2. Contract	Mechanical systems, low risk environment
3. Performance	Performance base, moderate risk environment
4. RME Operation	Performance base, professional operation
5. RME Ownership	Performance base, professional operation, high risk

USEPA Management Guidelines



Management Need

I,OOO,OOO MGD Adv tmt/LT

- Serves 10000 homes, AS/Disinfection/Land Ap
- 16 FTE collection and Treatment (and utility director/city manager)
- 16FTEx8h/dx7d/wx52w/yr= 46590 h/y

Advanced Onsite

- 10,000 systems, ST/ATU/SAS
- 3 inspections/system/yr and 1.5 hr/inspection
- 10000x3x1.5=45000Hr/y

Advanced treatment

- Cost
  - Equipment
  - Energy
  - Maintenance
- Benefit
  - Significant Nutrient Removal Possible
  - Soil “friendly”
  - Recharge potential

Thank You

- Questions?

- A. R. Rubin, Professor Emeritus, NCSU-BAE
- rubin@ncsu.edu