Decentralized Wastewater Treatment Systems:

Processes, Design, Management, and Use

Sponsored by the Watershed Management Program at Purdue University, the Conservation Technology Information Center, and US EPA

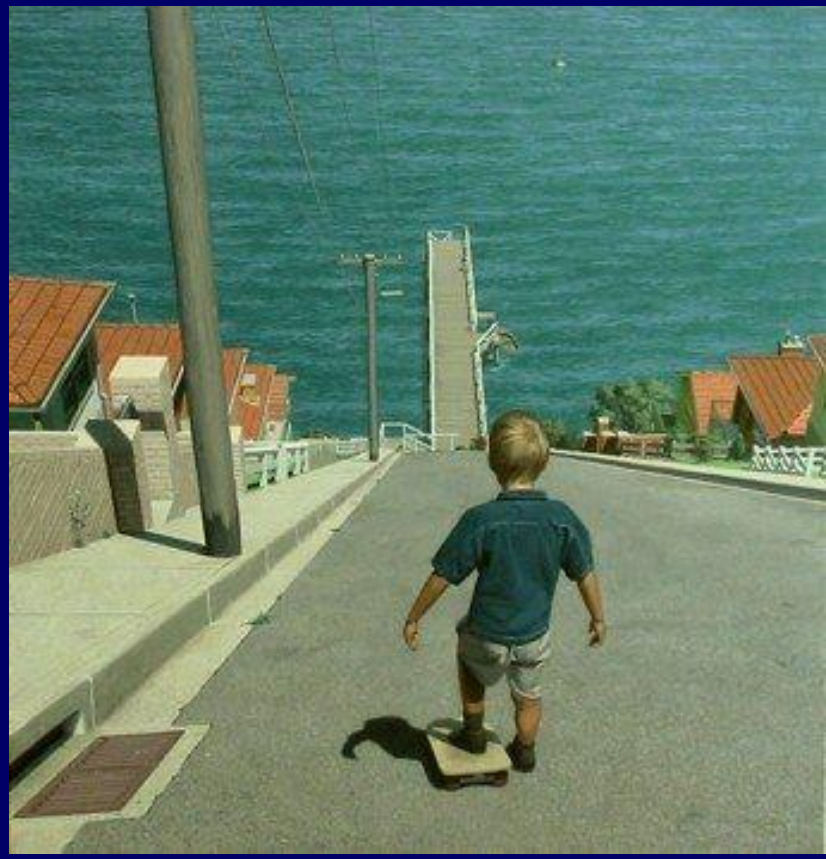
Session 1

Overview of Decentralized Wastewater Treatment

Barry Tonning, Tetra Tech

Overview of Decentralized Wastewater Management Issues

- Summary of wastewater management issues
- Treatment approaches
- Management considerations
- Water resource management context



Wastewater Management Issues

Condition of U.S. surface waters

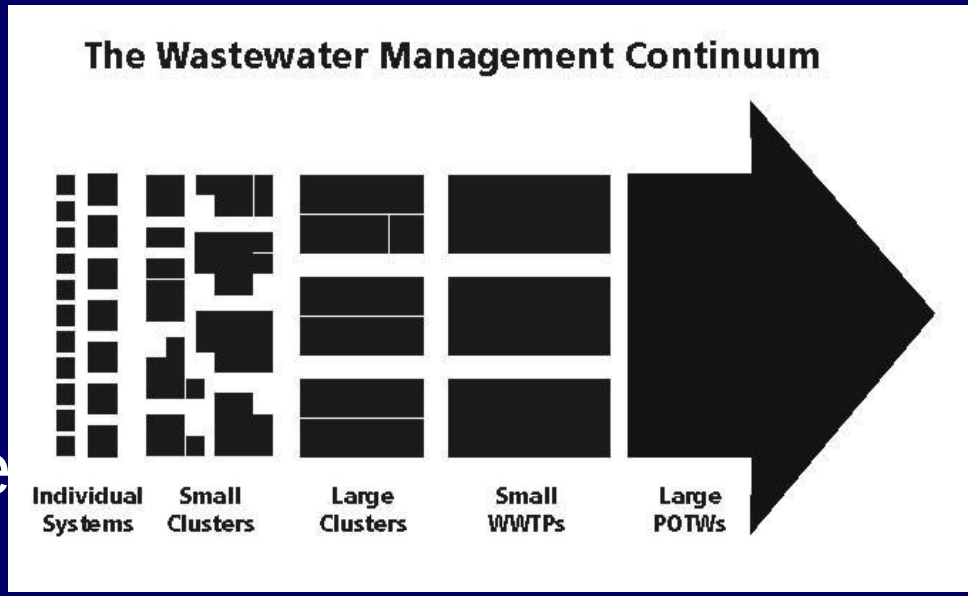
- Pollutant-impaired waters include :
  - 45% of assessed rivers and streams
  - 47% of assessed lake acres
  - 32% of assessed bay and estuarine square miles
- Polluted (nonpoint) runoff is mostly to blame
- Chief causes are nutrients, pathogens, and sediment

Wastewater pollutants of concern

- Pathogens – bacteria & viruses mainly; plus protozoa, worm eggs
- Nitrogen – causes algal growth in nitrogen-limited (mostly coastal) waters; nitrate can cause “blue baby” syndrome
- Phosphorus – causes algal growth in P-limited (mostly inland fresh) waters
- Others – pharmaceuticals, cleaners, solvents, & other toxics (most of which affect treatment processes)

Wastewater treatment

- What are the options?
  - Individual onsite (“septic”) or advanced wastewater treatment systems
  - Clustered systems with soil infiltration or effluent re-use
  - “Package” plants with ditch/stream discharge
  - Centralized plant with lake/river/ocean discharge



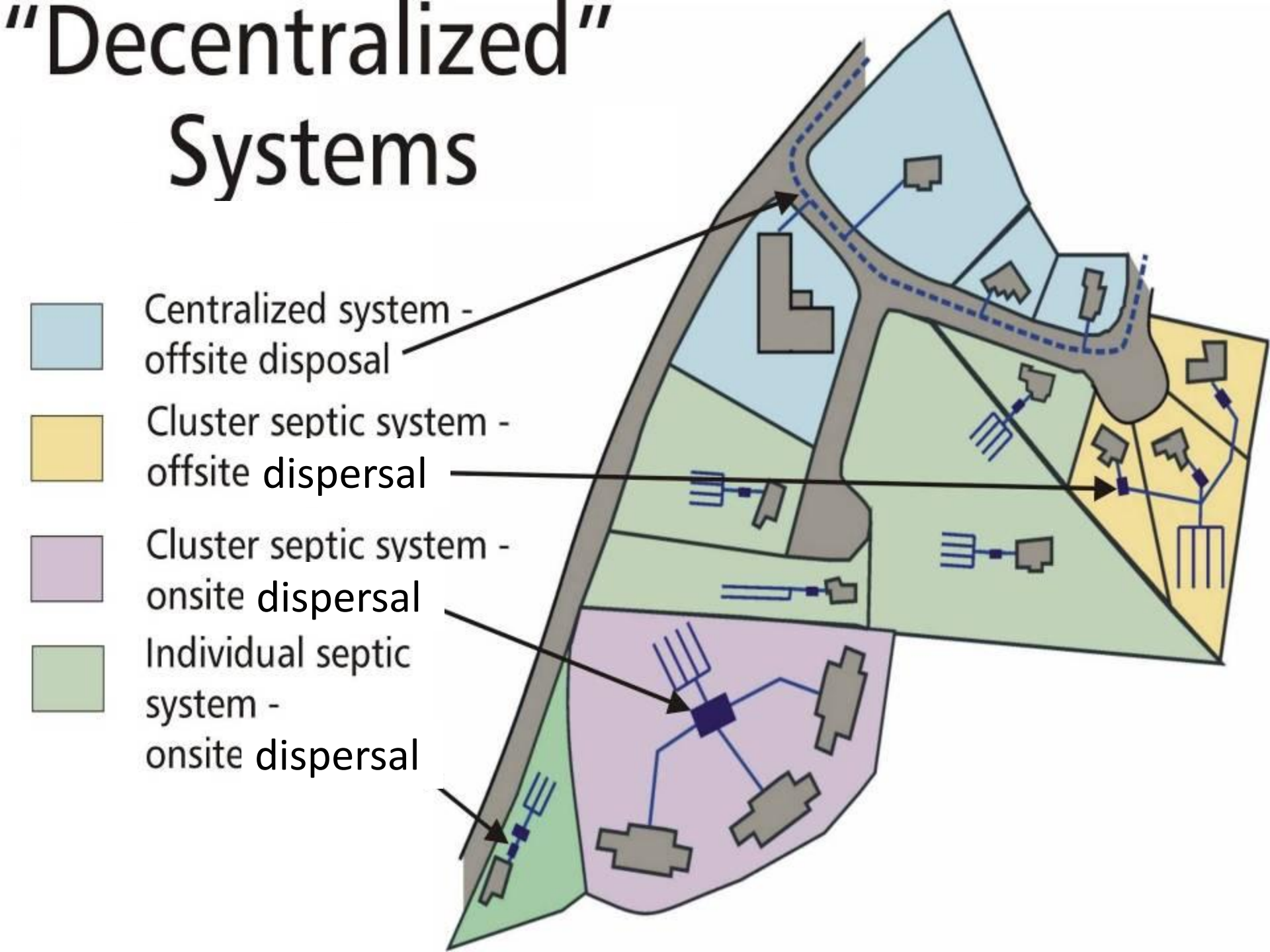
Centralized treatment plants

- Most discharge to rivers, lakes, streams, ocean, & need state/federal NPDES permit
- Centralized treatment can result in better operator attention and mgmt
- Good option for high-density development
- Efficiencies related to economy-of-scale

Centralized treatment plants

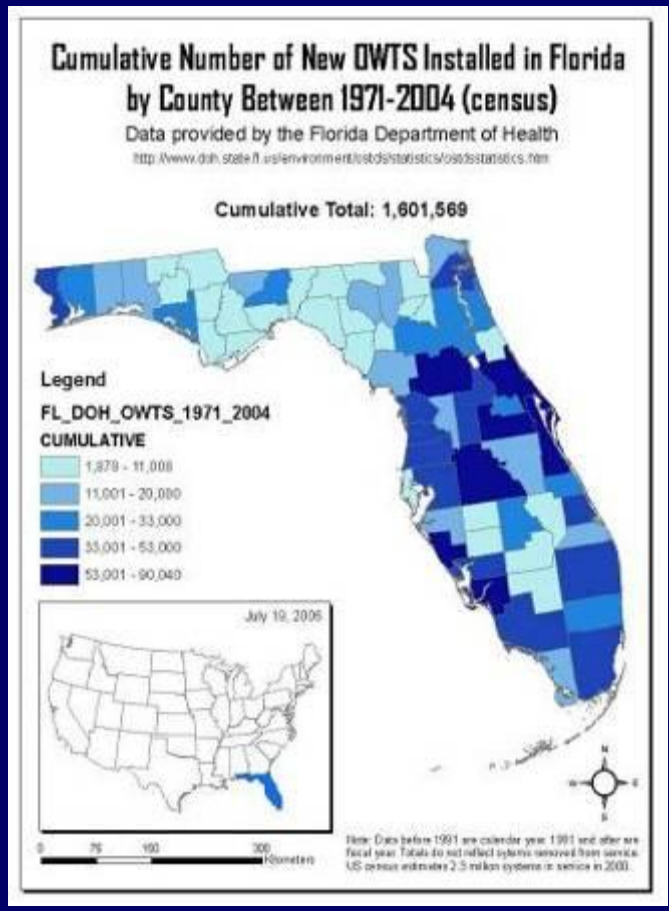
- Some older plants have CSOs or SSOs
- Collection systems have infiltration/inflow & leaks
- New regulations forcing higher treatment levels
- Upgrades & expanded collection systems are costly
- Local opposition to siting some new plants

"Decentralized" Systems



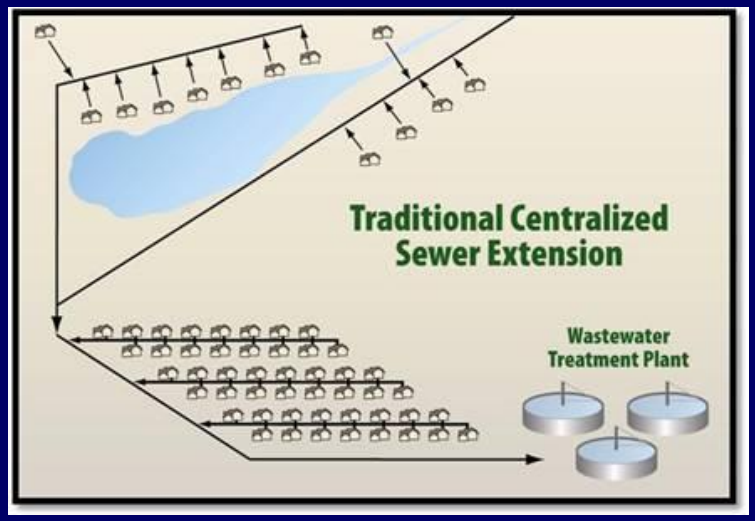
Decentralized soil-discharging systems

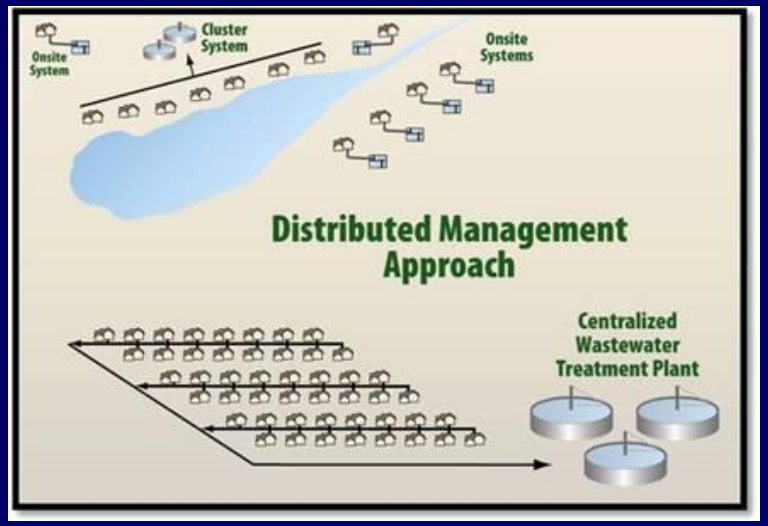
- Good for high or low density areas
  - Need space for soil dispersal field
- Excellent treatment performance
- Individual systems
  - Septic tank with gravity flow
  - Tank with pressure dosing
  - Advanced systems with dosing
- Clustered systems
  - Each home usually has a tank
  - Effluent collected via gravity or pumped
  - Multiple options for treatment facilities
  - Dosed or gravity flow dispersal to the soil



Advantages of decentralized wastewater treatment

- Extent of sewers limited
- Multiple, small discharges for enhanced assimilation
- Conserves water within watershed through groundwater recharge
- Avoids large mass loadings at outfalls
- Risks from malfunctions small and easier to manage
- Can match implementation with capacity needs





Decentralized treatment technologies

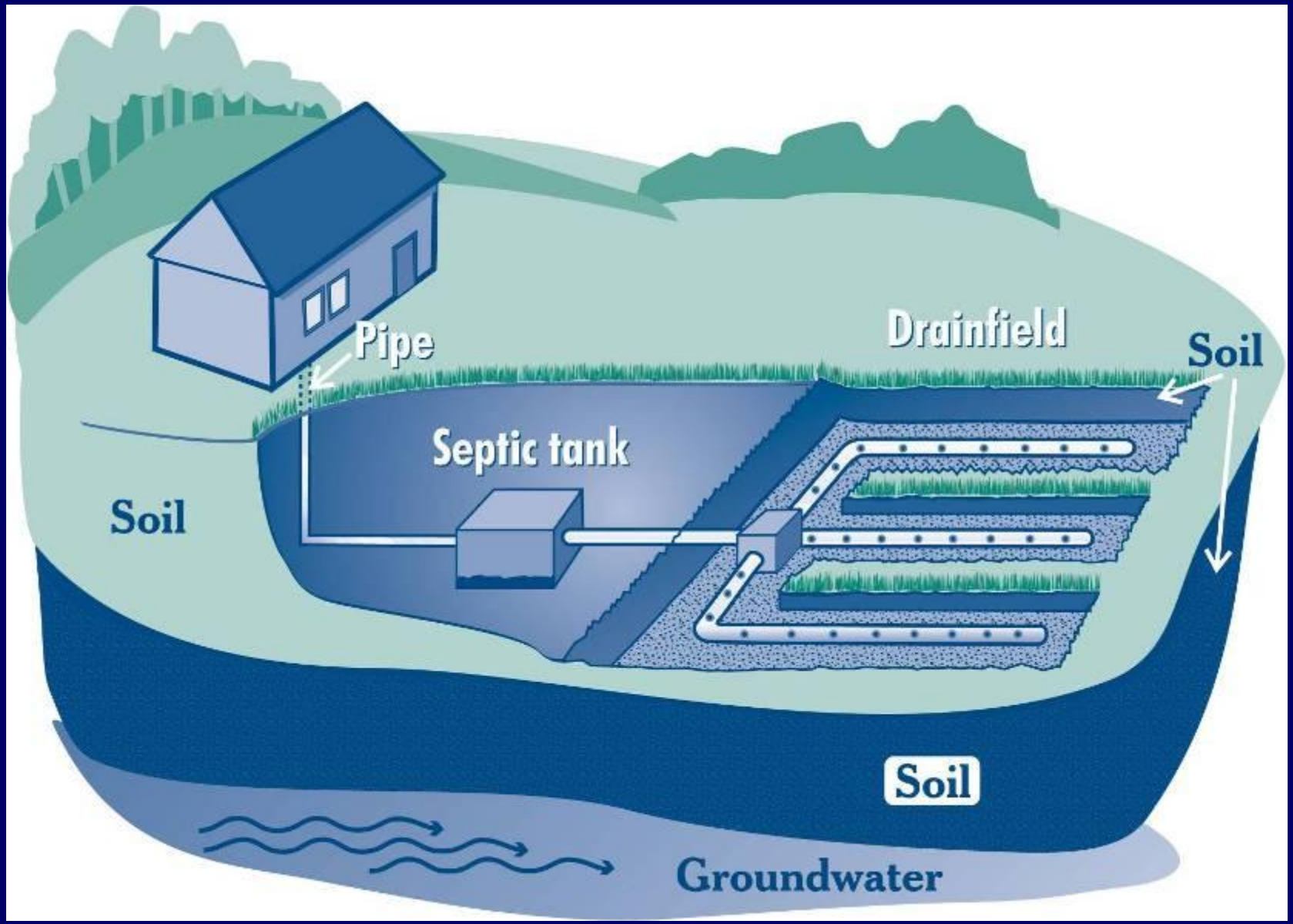
Treatment process units

- Conventional systems
  - Septic tank
  - Trenches, chambers, or oth dispersal
- Advanced systems
  - Tank or treatment unit
  - Fixed film or suspended growth unit(s)
  - Gravity, pumped, pressure drip (dosed) effluent dispersal

Overview of treatment processes

- Bacteria & other pathogens
  - Biological death, predation, & decomposition outside host (i.e., in soil)
- Phosphorus
  - Some retention in tank, soil adsorption
- Nitrogen
  - Ammonia nitrified in treatment unit or soil; poor denitrification of nitrate w/o anaerobic step
- Suspended solids
  - Settling out in tank & in treatment unit sludge; filtration by soil
- Other pollutants
  - Soil treatment removes a variety of pollutants by chemical, physical, & biological processes

Conventional gravity-flow “septic” system



Soil dispersal options

Questions?

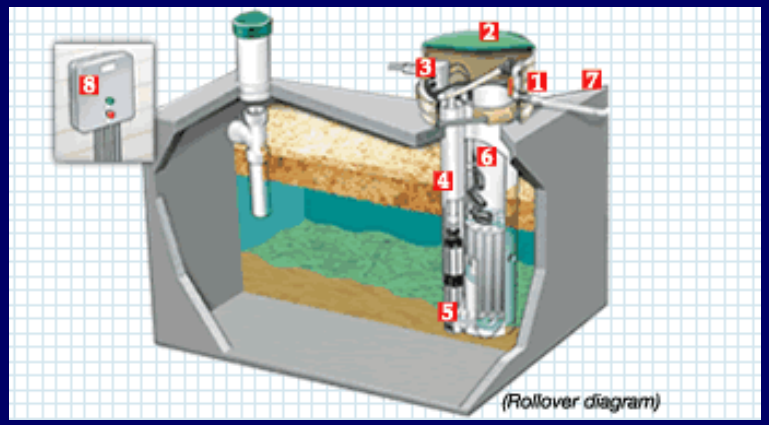
Advanced Wastewater Treatment Technologies

Beyond the “box & rocks” systems

- Package & site-built units provide additional treatment for septic tank effluent
  - Usually requires tank
  - Can discharge to soil or surface waters
- Treatment processes include:
  - Suspended growth biological treatment, followed by settling tank & disinfection
  - Fixed film biological treatment, followed by filtration & drip irrigation to soil
  - Includes use of various media

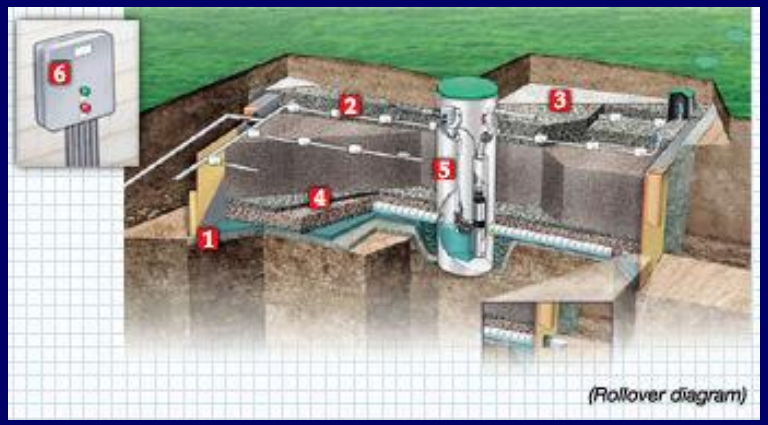
- *All treatment systems require professional management!*

Advanced treatment options . . .

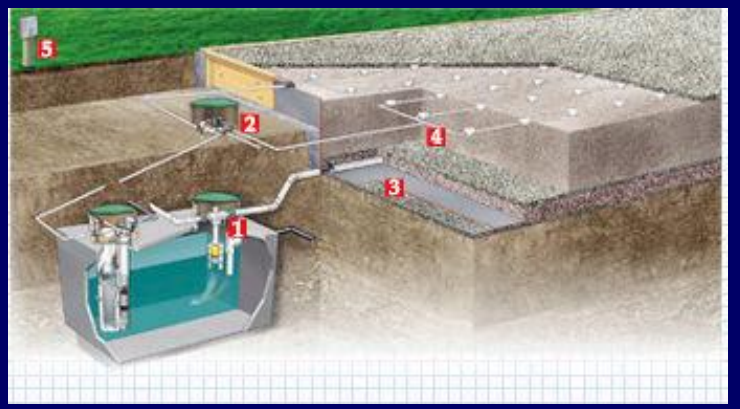


Effluent Pumping

Textile Filter

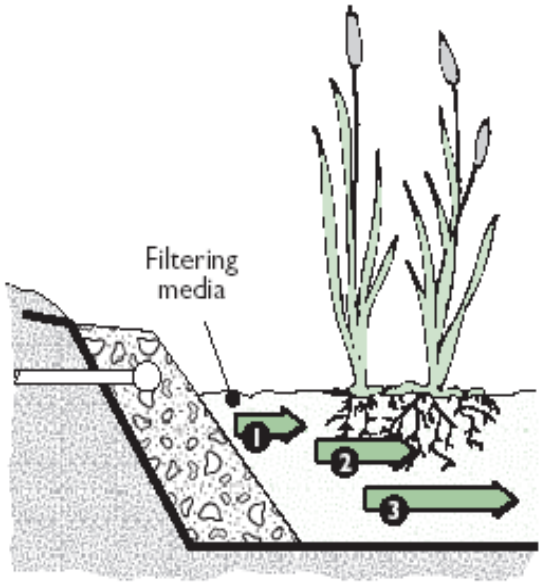


Intermittent Sand Filter



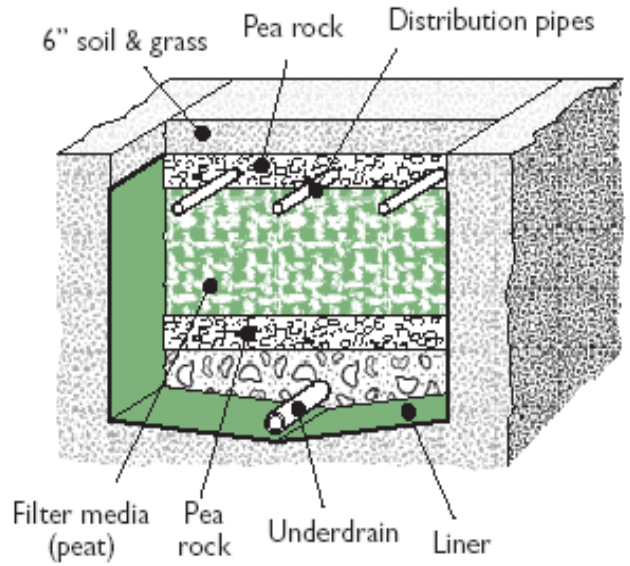
Recirculating Sand Filter

Some other treatment approaches

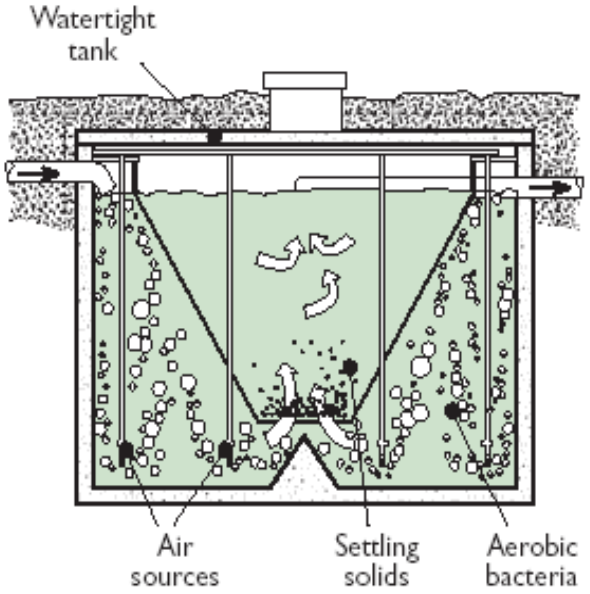


1. Physical filtering
2. Aerobic breakdown at plant roots
3. Anaerobic breakdown in media

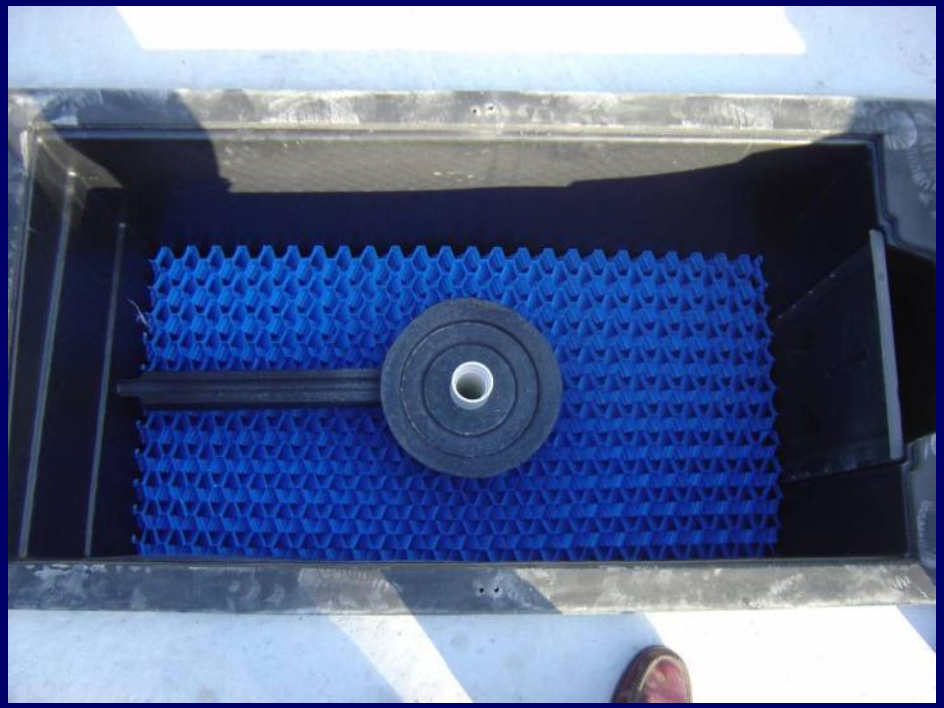
Constructed wetland



Peat filter

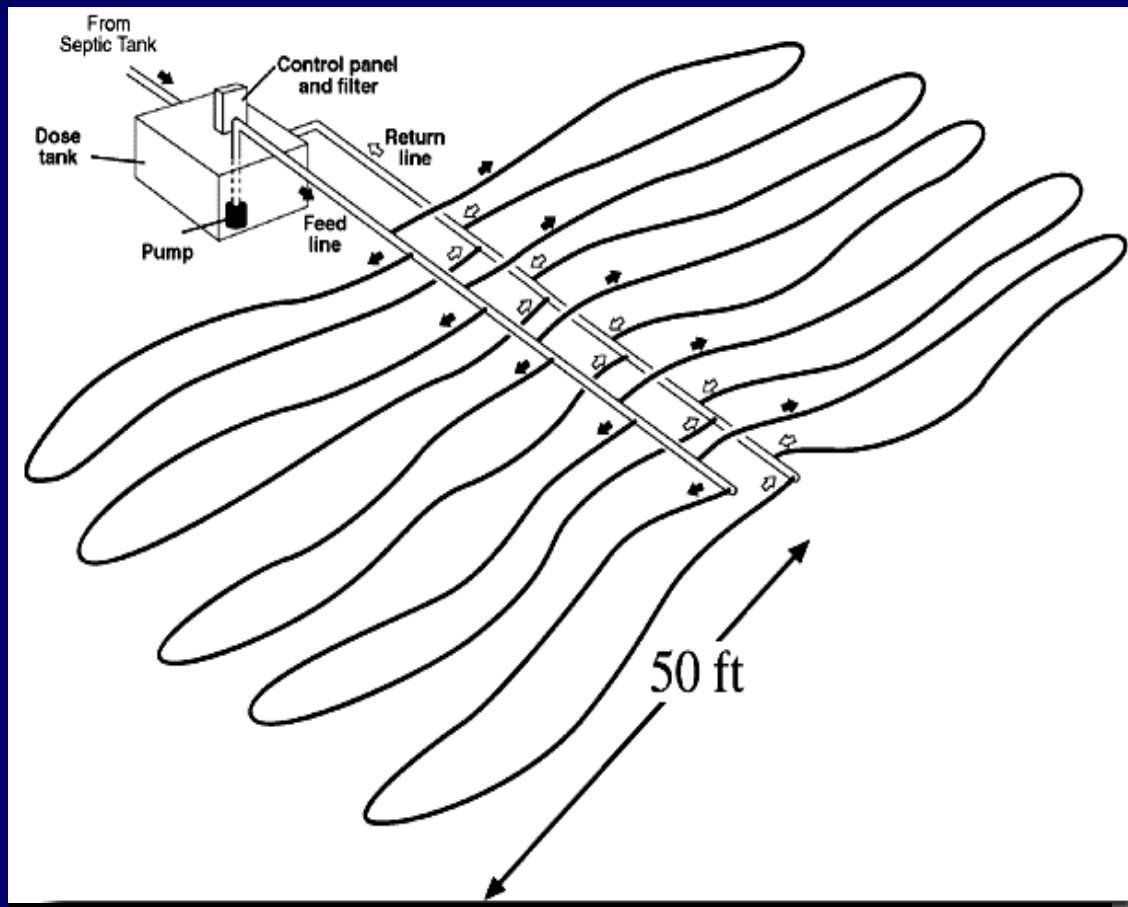


Aerobic treatment unit (suspended growth type)



Drip irrigation: new technology from the agricultural sector

- Drip lines high in the soil profile enhance treatment
- Good for sites with high water tables
- Can be used on sloping sites with trees, etc.
- Excellent dosed dispersal approach



Source: University of Minnesota Extension

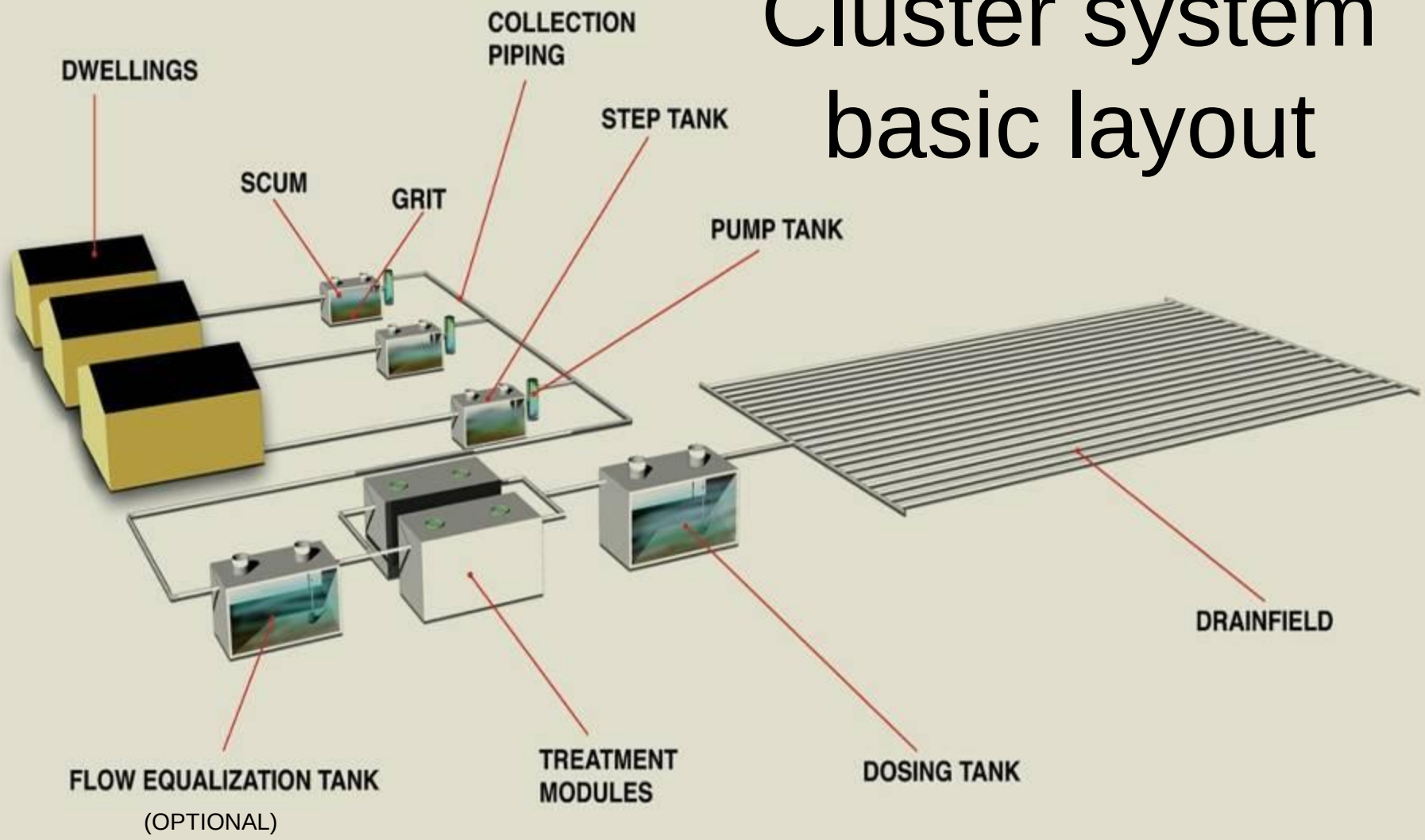
Clustered treatment systems

- Existing development
  - Can economically serve dense areas with small lots*
  - Improves treatment levels over septic system units
  - Increases groundwater recharge & reuse options

- New development
  - Facilitates development that fits local landscapes and meets wastewater treatment requirements*
  - Very friendly to smart growth, green infrastructure, and low-impact development approaches
  - Promotes clustering of homes & businesses, preservation of woodlands & open space

** Need space for soil dispersal area*

Cluster system basic layout



Treatment system effectiveness

Pollutant Parameter	Septic Tank Effluent (mg/L)	Aerobic Treatment Unit (FIXED OR SUSP) (mg/L)	Media Filter Treatment (SINGLE-PASS) (mg/L)	Coarse Media, Foam or Textile Unit (RECIRC FILTER) (mg/L)	Removal Rate (%): ~3' of Soil
BOD (mg/l)	100-150	30-50	2-15	5-15	>90%
TN (mg/l)	40-70	30-50	30-50	20-30	15-20%
TP (mg/l)	5-10	4-8	4-8	4-8	90-100%
Bacteria	10^6-10^8	10^4-10^6	10^1-10^2	10^2-10^3	>99.99%

Average costs of decentralized treatment systems

Treatment Method	Technology	Capital Cost
Conventional	Septic Tank and Gravity Soil System	$5,000 to $6,000
Suspended Growth	Suspended Growth Aerobic Treatment	$6,000 to $8,000
	Attached Growth Aerobic Treatment	$9,000 to $13,000
Attached Growth	Intermittent Media Filter	$6,500 to 11,500
	Recirculating Media Filter	$8,000 to $11,500
	Vegetative Submerged Bed	$7,500 to $10,500
Pressure Dispersal	Pressure Distribution	$7,000
	Drip Dispersal	$7,800 to $9,300
Cluster Systems	Conventional sewer	$14,000**
	STEG	$7,500**
	STEP	$10,000**
	Vacuum	$10,000**
	Grinder Pump	$9,500**

*NOTE: Costs vary with labor, materials, other factors; **cost per EDU in clusters > 100 EDUs*

Rocky Mountain Institute Cost/Benefit Analysis of Centralized and Decentralized Wastewater Options

www.rmi.org

Valuing Decentralized Wastewater Technologies

A Catalog of Benefits, Costs, and Economic Analysis Techniques

Prepared by Rocky Mountain Institute
For the U.S. Environmental Protection Agency
November, 2004

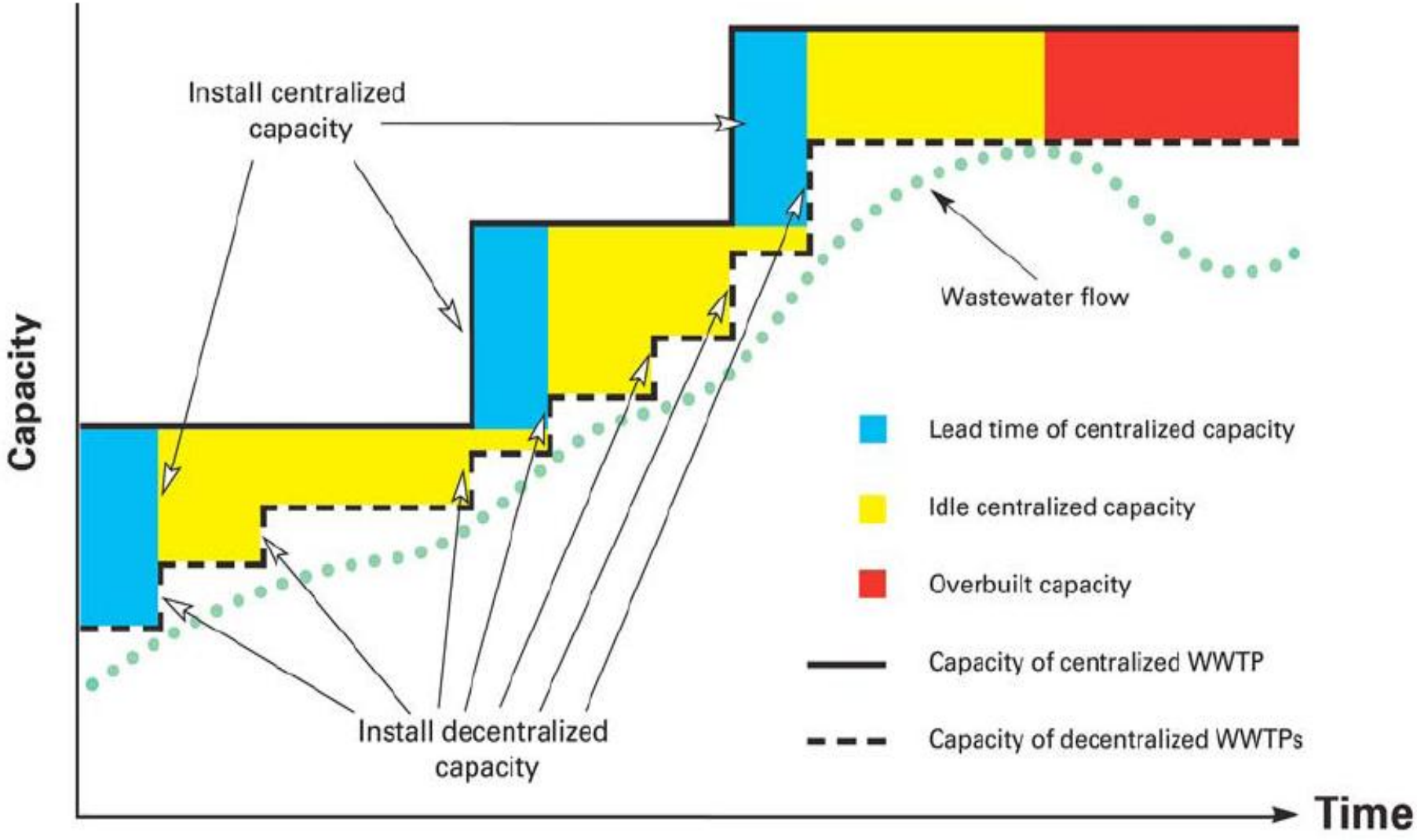
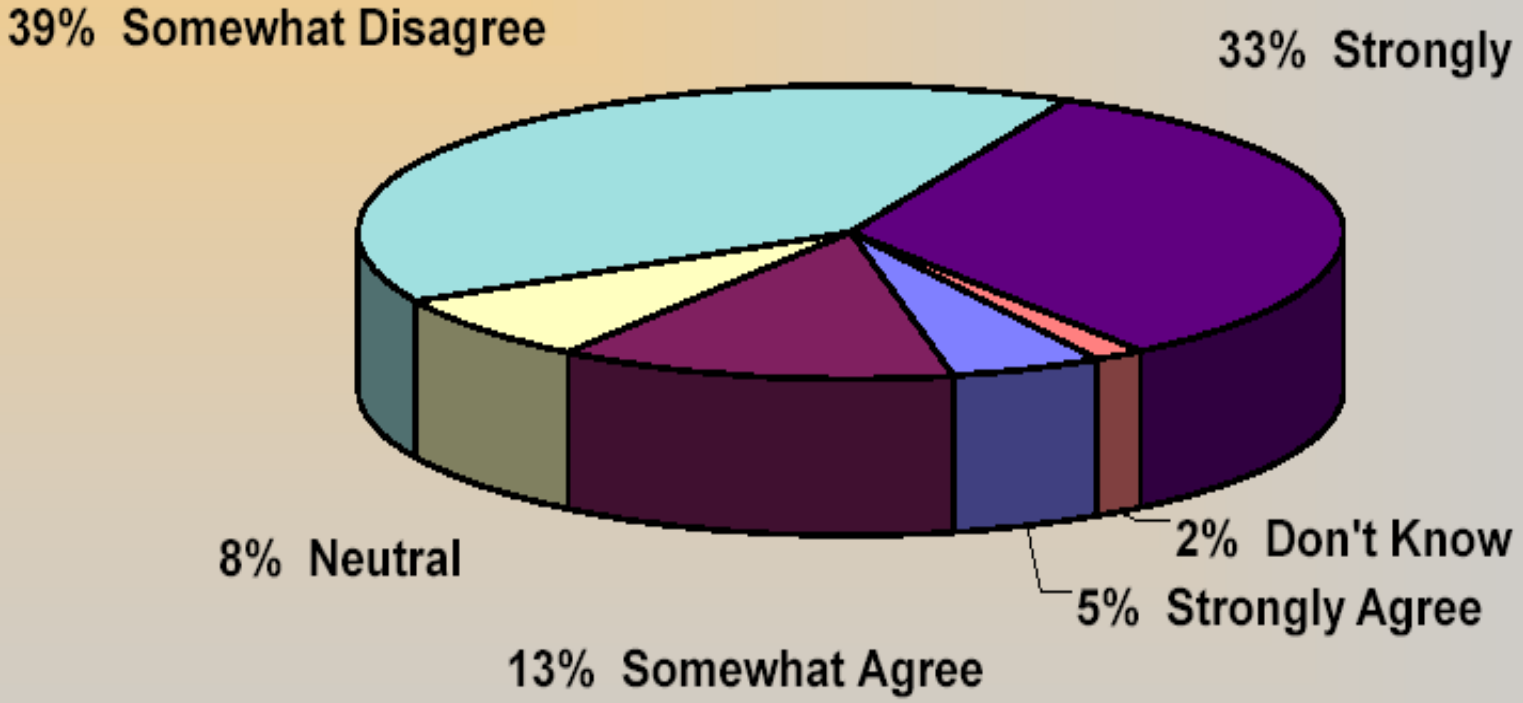


Figure 8-1: Flow Versus Capacity for Centralized and Decentralized Wastewater Systems. WWTP stands for Wastewater Treatment Plant.

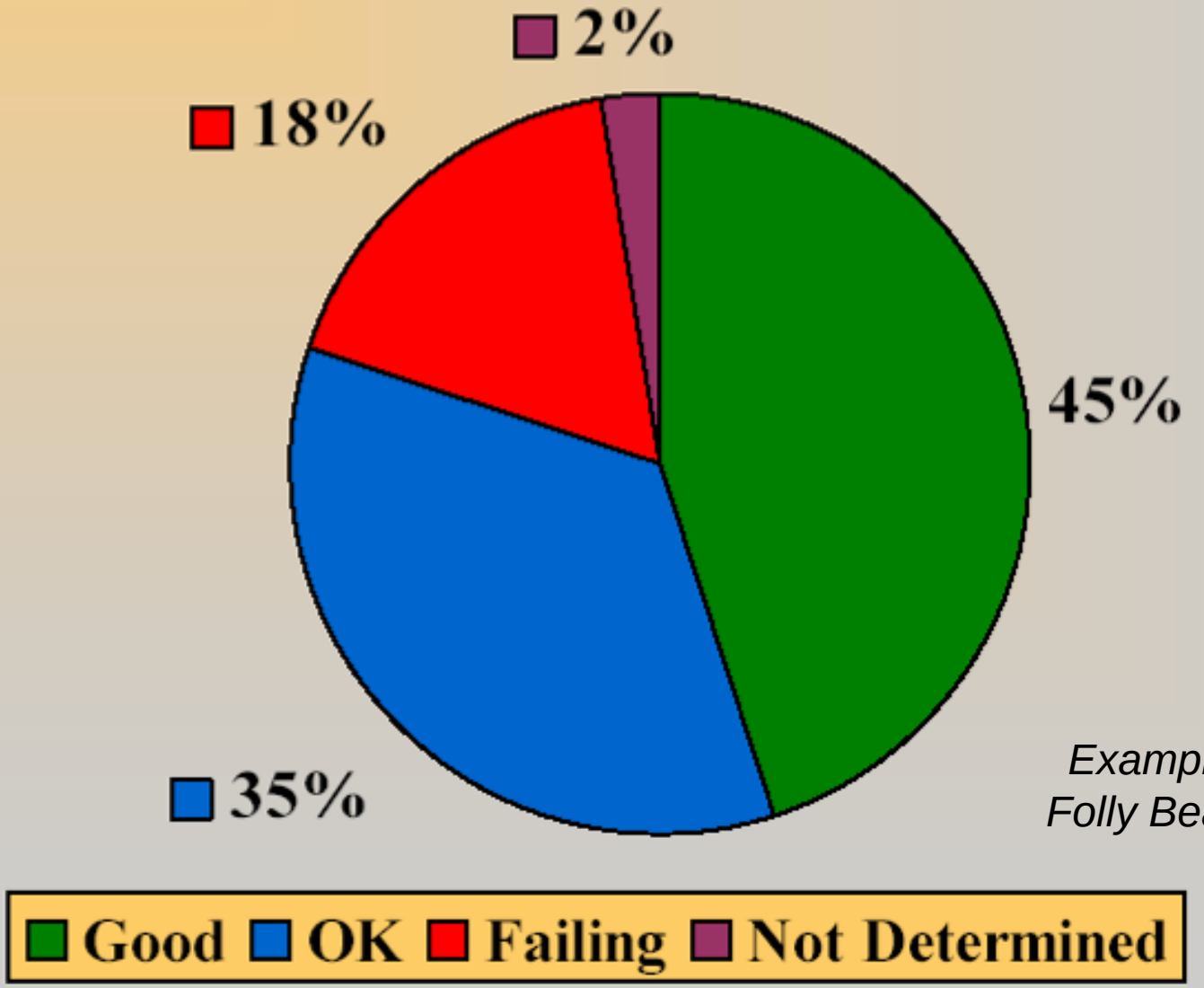
Questions?

Individual/Cluster System Management

Most Homeowners with Septic Systems are Knowledgeable about Septic System Operation and Maintenance



Performance Status of Inspected Systems



Example from Folly Beach, SC

General management approach

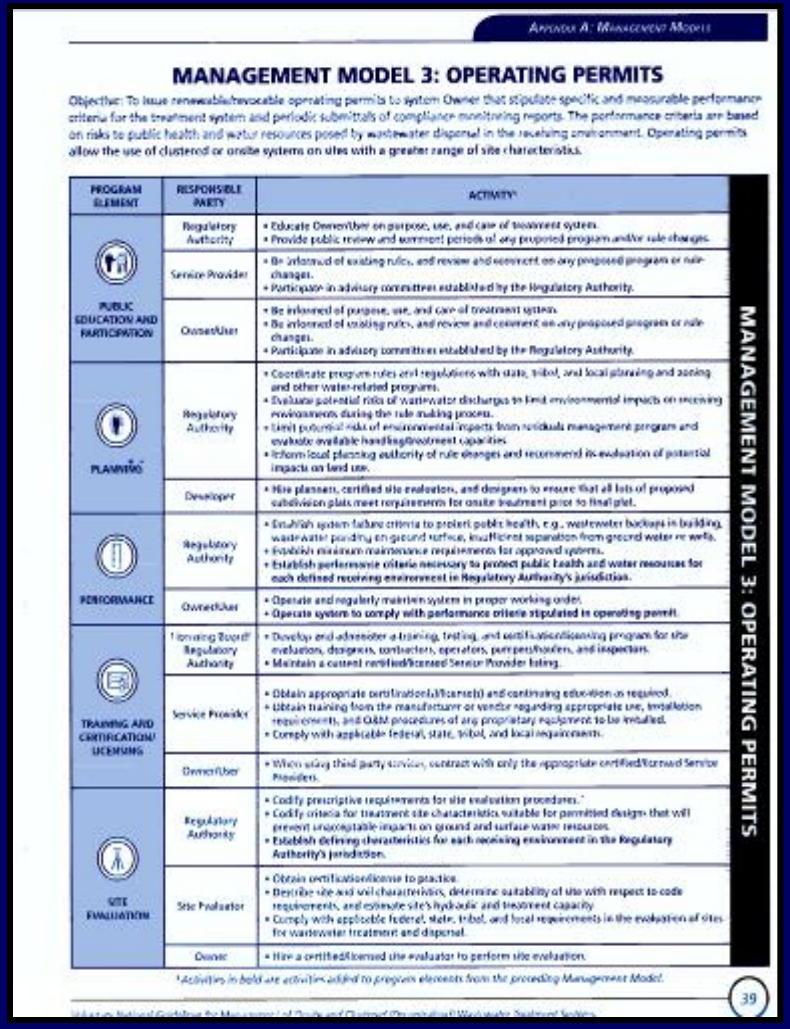
- Management intensity is tied to risk
  - Sensitivity of receiving water, local setting
  - Complexity & density of treatment systems
- Public or private mgmt entity is necessary!
  - Sanitation districts
  - Public utility
  - Special district
  - Profit/nonprofit corporation
- Public agencies provide regulatory oversight

Managing onsite/clustered systems

- Management for existing systems
  - Assess surface & groundwater quality
  - Assess treatment systems & related risks
  - Find & fix problems
- New system mgmt
  - Planning & design
  - Construction
  - O&M
- System inventories are needed!

Elements of a Comprehensive Management Program

- Public Involvement
- Planning
- Performance Requirements
- Training & Certification/ Licensing
- Site Evaluation
- Design
- Construction



Appendix A: Management Models

MANAGEMENT MODEL 3: OPERATING PERMITS

Objective: To issue renewable/revocable operating permits to system Owner that stipulate specific and measurable performance criteria for the treatment system and periodic submittals of compliance monitoring reports. The performance criteria are based on risks to public health and water resources posed by wastewater disposal in the receiving environment. Operating permits allow the use of clustered or onsite systems on sites with a greater range of site characteristics.

PROGRAM ELEMENT	RESPONSIBLE PARTY	ACTIVITY*
PUBLIC EDUCATION AND PARTICIPATION	Regulatory Authority	• Educate Owner/User on purpose, use, and care of treatment system. • Provide public review and comment periods of any proposed program and/or rule changes.
	Service Provider	• Be informed of existing rules, and review and comment on any proposed programs or rule changes. • Participate in advisory committees established by the Regulatory Authority.
	Owner/User	• Be informed of purpose, use, and care of treatment system. • Be informed of existing rules, and review and comment on any proposed programs or rule changes. • Participate in advisory committees established by the Regulatory Authority.
PLANNING	Regulatory Authority	• Coordinate program rules and regulations with state, tribal, and local planning and zoning and other water-related programs. • Evaluate potential risks of wastewater discharges to limit environmental impacts on receiving environments during the rule making process. • Limit potential risks of environmental impacts from residuals management program and evaluate available handling/treatment capacities. • Inform local planning authority of rule changes and recommend its evaluation of potential impacts on land use.
	Developer	• Hire planners, certified site evaluators, and designers to ensure that all lots of proposed subdivision plats meet requirements for onsite treatment prior to final plat.
PERFORMANCE	Regulatory Authority	• Establish system failure criteria to protect public health, e.g., wastewater backups in building, wastewater ponding on ground surface, insufficient separation from ground water or wells. • Establish minimum maintenance requirements for approved systems. • Establish performance criteria necessary to protect public health and water resources for each defined receiving environment in Regulatory Authority's jurisdiction.
	Owner/User	• Operate and regularly maintain system in proper working order. • Operate system to comply with performance criteria stipulated in operating permit.
TRAINING AND CERTIFICATION/ LICENSING	Licensing Board/ Regulatory Authority	• Develop and administer a training, testing, and certification/licensing program for site evaluators, designers, contractors, operators, pumpers/haulers, and inspectors. • Maintain a current certified/licensed Service Provider listing.
	Service Provider	• Obtain appropriate certification/license(s) and continuing education as required. • Obtain training from the manufacturer or vendor regarding appropriate use, installation requirements, and O&M procedures of any proprietary equipment to be installed. • Comply with applicable federal, state, tribal, and local requirements.
	Owner/User	• When using third party services, contract with only the appropriate certified/licensed Service Providers.
SITE EVALUATION	Regulatory Authority	• Codify prescriptive requirements for site evaluation procedures.* • Codify criteria for treatment site characteristics suitable for permitted designs that will prevent unacceptable impacts on ground and surface water resources. • Establish defining characteristics for each receiving environment in the Regulatory Authority's jurisdiction.
	Site Evaluator	• Obtain certification/license to practice. • Describe site and soil characteristics, determine suitability of site with respect to code requirements, and estimate site's hydraulic and treatment capacity. • Comply with applicable federal, state, tribal, and local requirements in the evaluation of sites for wastewater treatment and disposal.
	Owner	• Hire a certified/licensed site evaluator to perform site evaluation.

*Activities in bold are activities added to program elements from the preceding Management Model.

MANAGEMENT MODEL 3: OPERATING PERMITS

39

- O&M
- Residuals Management
- Inspections/ Monitoring
- Corrective Actions
- Record-Keeping/ Reporting
- Financing

Questions?

Wastewater Treatment in Context:

Watershed Management, Stormwater Permits, and TMDLs

Where is wastewater headed?

- Watershed management plans are integrating wastewater, stormwater, nonpoint source (runoff) pollution control etc.
- Decentralized wastewater facilities are generating more interest and attention
  - Subsurface soil discharge systems
  - Water re-use systems
- Stormwater infiltration and wastewater dispersal is driving site planning
  - Avoidance of new/expanded NPDES discharges
  - Greater emphasis on green space use
  - Lower energy requirements

Low Impact Development / Green Infrastructure

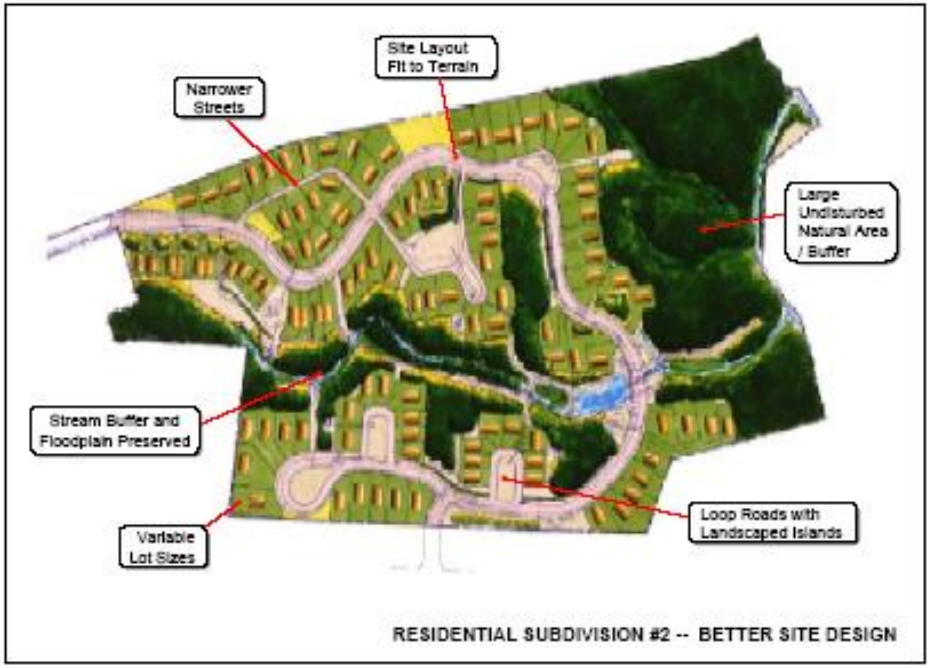
Fit the project to the site

Work with site soils & slopes as much as possible

Preserve the natural drainage system

Keep green space and large trees

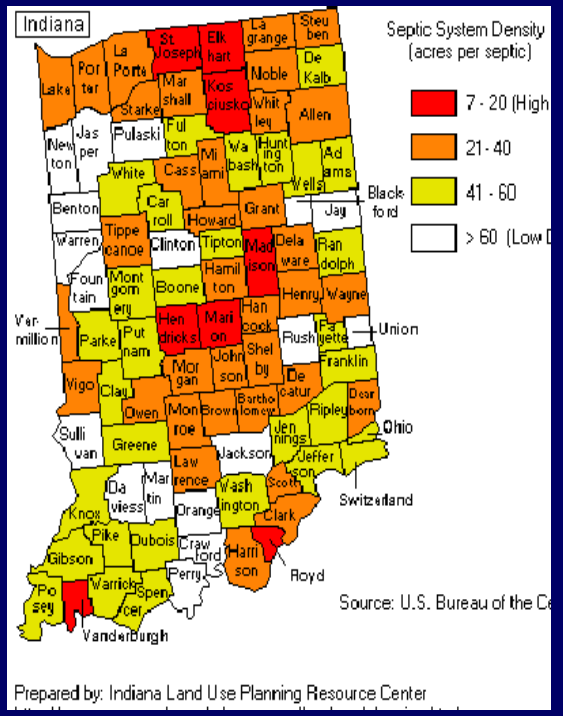
Figure 1.4.3-2 Comparison of a Traditional Residential Subdivision Design (above) with an Innovative Site Plan Developed Using Better Site Design Practices (below).



TMDLs with Wastewater Loads

- Centralized WWTPs are part of the wasteload allocation
- Subsurface discharging systems get a load allocation (nonpoint source)
- Individual/cluster impacts vary:
  - Older, densely installed, poorly managed, near water =

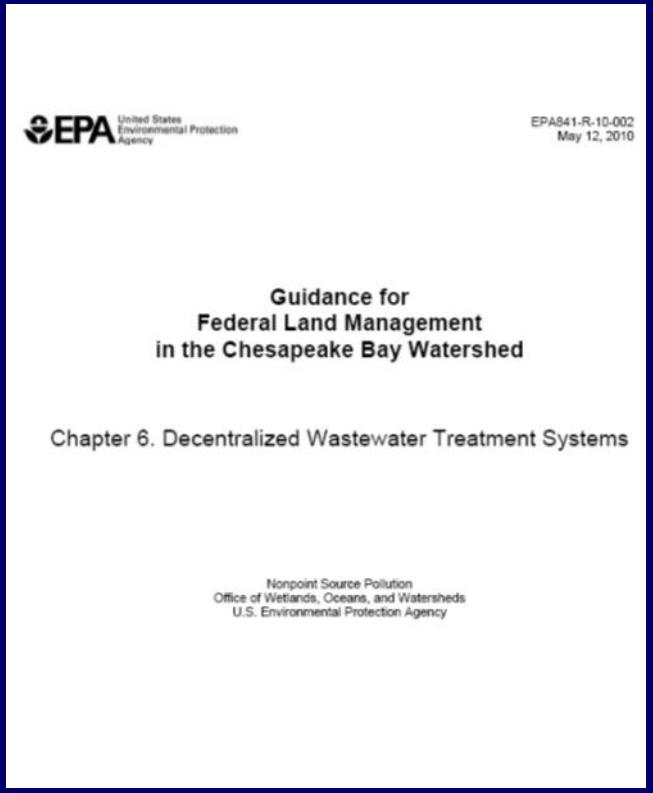
    high impact



But as scale increases, relative impacts from onsite systems diminish

Ches Bay Federal Facilities Guide

- 100 ft setback from surface waters, open channel MS4s
- 5 mg/L TN from 100 – 200 ft
- 10 mg/L from 200 – 1000 ft
- 20 mg/L bay-wide for subdivisions, commercial development
- Inventories, inspections, repairs


EPA United States Environmental Protection Agency

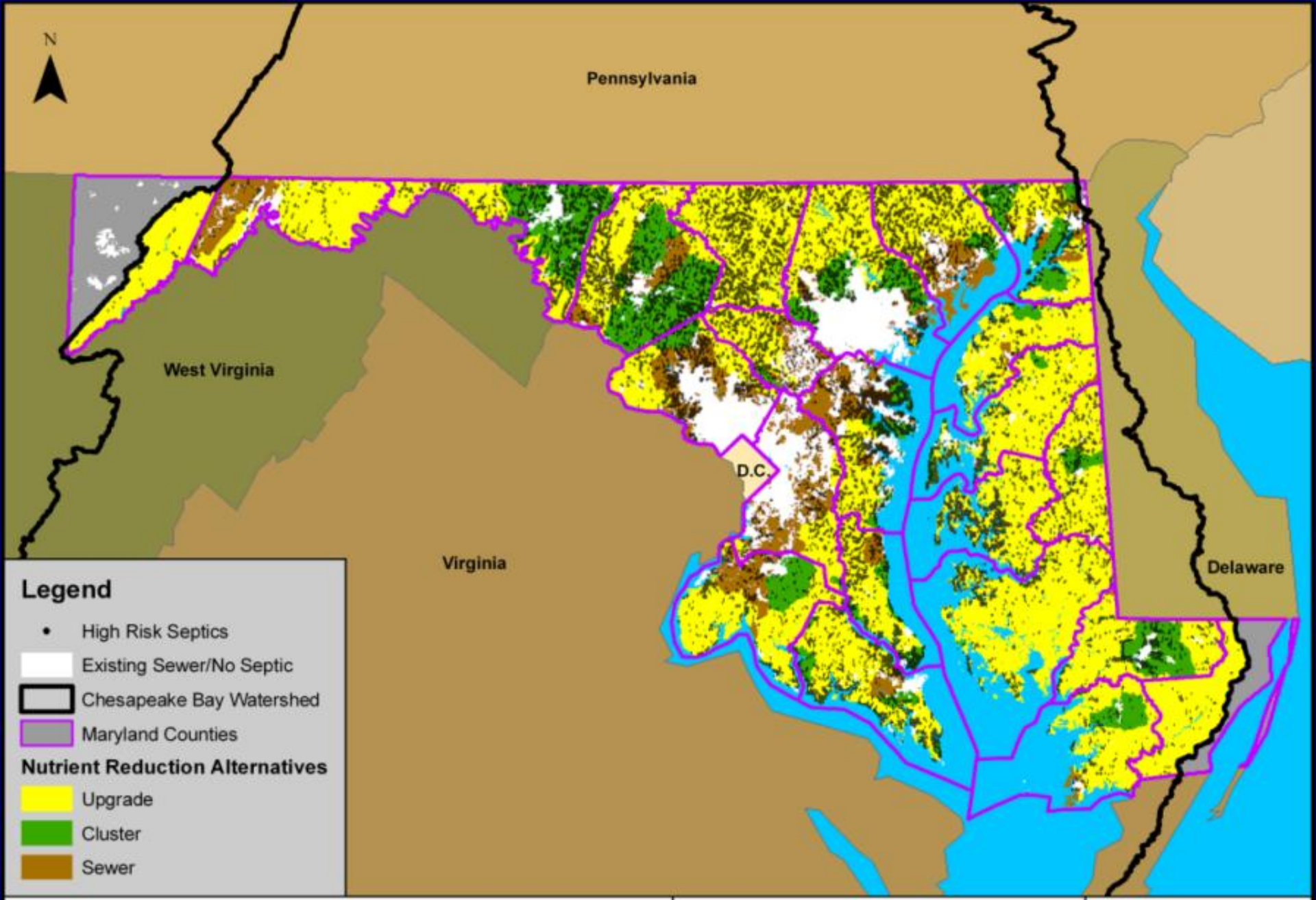
EPA841-R-10-002
May 12, 2010

Guidance for Federal Land Management in the Chesapeake Bay Watershed

Chapter 6. Decentralized Wastewater Treatment Systems

Nonpoint Source Pollution
Office of Wetlands, Oceans, and Watersheds
U.S. Environmental Protection Agency

http://www.epa.gov/owow_keep/NPS/chesbay502/index.html



Chesapeak Bay TMDL - Select Septics with Proposed Nutrient Reduction Alternatives

NAD_1983_StatePlane_Maryland_FSPS 1900
Map produced 08-20-2010 - P. Cada

0 15 30 60 Kilometers

0 15 30 60 Miles

TETRA TECH

Federal antideg reg @ CFR 131.12

- States must have an “antidegradation policy” & “methods for implementing” the policy
- Tier I: Existing uses and water quality necessary to protect them shall be maintained and protected
- Tier II: Where water quality exceeds that necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water, that quality shall be maintained and protected unless the State finds . . . that allowing lower water quality **is necessary** to accommodate important economic or social development
- Tier III: No degradation of ONRWs allowed

What does all that mean?

- Proposed new and expanded point source discharges must analyze (and use) cost-effective alternatives, if surface water quality will be degraded
- Some states explicitly require that soil discharge options be examined

Decentralized system drivers

- TMDL-driven WWTP upgrades
- New effluent limits on phosphorus (~ 0.1 mg/L) and nitrogen (3 mg/L)
- Antidegradation lawsuits
- Aging, complex infrastructure
- Infiltration/inflow challenges
- Higher collection and treatment costs
- Interest in water re-use

NEIGHBORHOOD NOTES

Déjá Vu? We've Been Here Before with Sewers and Storm Water Problems

by Walt Gaffield

The Fayette County Neighborhood Council (FCNC) is a consortium of over 130 neighborhood associations in Lexington. If you belong to a neighborhood association, it probably belongs to the FCNC. The article below should be entitled Déjà Vu (we've been here before). It describes the efforts of the FCNC on behalf of neighborhoods regarding flooding and storm water management, water quality, and Fayette County's inadequate sewer system.

In October of 1998 the FCNC published a Sanitary Sewer Study that was the result of two years of data collection and compilation. The study found massive systemic failures. Written comments from the public included, "citizens there have reported regularly their problems with raw sewage," "had toilet paper hanging in trees," "homes have had sewer backup into sinks," "basements have sanitary sewer backup into them," and "a man must park his truck on the manhole cover to keep it from lifting during heavy rains." The study contained as much documentation of storm water problems as sanitary sewer problems since one exacerbates the other and both impact water quality. Shortly thereafter, the Neighborhood Council made it clear to the Lexington-Fayette Urban County Government (LFUCG) that unless it began a concentrated sanitary sewer rehabilitation program, the FCNC would institute a "citizens' suit" under the provisions of the U.S. Clean Water Act. We already had retained counsel and received advice that we had a strong cause of action.

The mayor, chief administrative office, and other government officials met with us and indicated that they would use the FCNC study to take steps to improve the sanitary sewer system and do something about the city's terrible storm water problems. We took them at their word and have carefully watched what has been done since 1998. The sanitary sewer rehabilitation work has been effective in some areas and less so in others, but an overwhelming amount of work remains to be done.

In addition to the sanitary sewer system, Fayette County's storm water system also presents severe problems. An engineering firm developed a list of needed storm water projects in the 1990s estimated to cost in excess of $100 million. The LFUCG has not made adequate progress on the list nor has it been anxious to acknowledge that problems are widespread and serious. Hickman Creek, for example, has a high fecal coliform count near a public school. When the FCNC requested that the LFUCG post warning signs about the health risk, the response from a former official was, "That would send the wrong message."

Well, here we are, eight years later facing the exact same problems only in greater numbers because of the city's rapid growth. However, now the United States Environmental Protection Agency has taken an interest in Lexington's problems. The city is now in negotiations with the EPA to try to reach a consent decree regarding fines and penalties. The estimated cost of similar settlements in Louisville and Northern Kentucky are both estimated to be in excess of $500 million. The estimated cost in Cincinnati is in excess of $1 billion.

"...the United States Environmental Protection Agency has taken an interest in Lexington's problems. The city is now in negotiations with the EPA to try to reach a consent decree regarding fines and penalties."

The FCNC does not intend to "point fingers" or assign blame. Literally decades of neglect contributed to create these serious problems. It would seem that maintenance and repair in existing neighborhoods are not as politically glamorous as say, asphalt, new development, or new facilities. Ironically, the FCNC has reason to believe that storm water violations exist in Lexington's new expansion area created when the local Planning Commission last approved a large expansion of Lexington's urban services area boundary. We once again have retained counsel and will pursue our legal rights to file a "citizen's suit." Only this time, we expect to have a seat at the table.

As part of this effort, FCNC is looking for factual data to report to local government and the EPA and is especially interested in any pictures or video evidence. Anyone wishing to advise the FCNC of a water quality problem, flooding, or sewage overflow issues, should contact the FCNC at 373-0793 and leave their name, telephone number, address, and if applicable, e-mail address. Contact us to try to make sure that your problem becomes part of the consent decree between the city and the EPA.

Walt Gaffield, President
Fayette County Neighborhood Council, Inc.

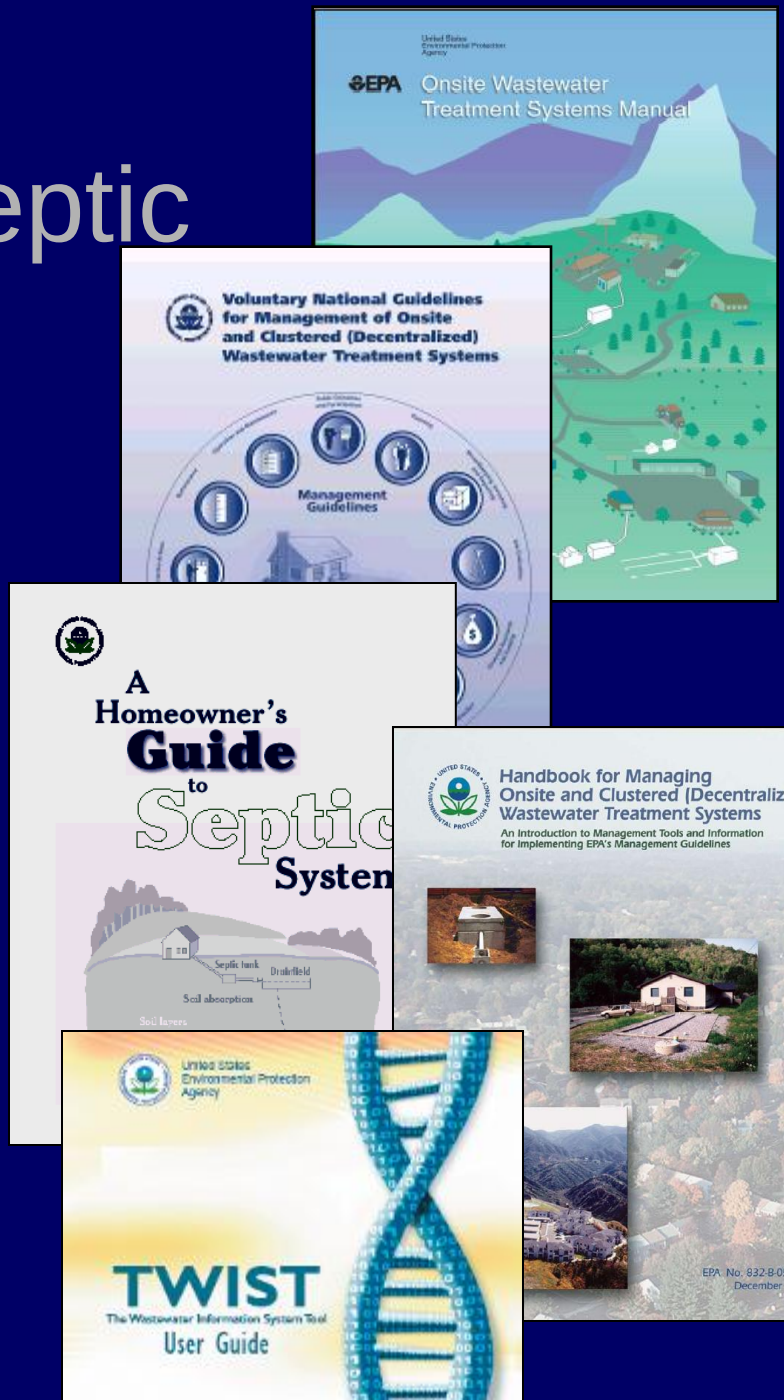
September2006

Summary and final perspectives

- Soil-discharging systems fit well with LID
  - Deters sprawl while accommodating growth
- Individual and clustered soil-discharging systems are not a big problem in most places
  - Agriculture, CSO/SSOs, old/underperforming treatment systems, construction/development, urban runoff, are greater
  - Exceptions exist, with high attention & interest in solutions
- Decentralized systems are dependable & performing well, for the most part
  - Greater acceptance of new technologies in more places
  - Greater willingness to pay to protect water resources
- Combined sewer overflow and sanitary sewer overflow problems are increasing interest in other approaches
  - Soil-discharging systems are becoming more popular

US EPA resources at www.epa.gov/owm/septic

- Design guidance
- Management guidelines
- Case studies
- Technology fact sheets
- State and local examples
- Research, demonstration projects, and other tools



Other Resources on the Web

- Water Environment Research Foundation (WERF.org)
- Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT – OnsiteConsortium.org)
- National Decentralized Water Resources Capacity Development Project (DecentralizedWater.org)
  National Onsite Wastewater Recycling Assn (NOWRA.org)
- National Assn of Wastewater Transporters (NAWT.org)
- National Environmental Health Assn (NEHA.org)
- Coalition of Alternative Wastewater Treatment
  (CAWT – SustainableWaterForum.org)
- National Rural Electric Cooperation Assn (NRECA.org)
- Electric Power Research Institute (EPRI.com)

Upcoming webinar sessions

Tuesdays at Noon Eastern til December 14th

Date	Topics	Presenter
November 9	*Overview of Centralized and Decentralized Treatment*	*Barry Tonning*
November 16	*Decentralized Treatment: Processes & Technologies*	*Jim Kreissl*
November 23	*Decentralized Wastewater System Design: Part 1*	*Vic D'Amato*
November 30	*Decentralized Wastewater System Design: Part 2*	*Vic D'Amato*
December 7	*Management Approaches for Decentralized Systems*	*Khalid Alvi*
December 14	*Integrated Water Resource Management*	*Vic D'Amato*