



Introduction to Onsite Wastewater Treatment Systems – Septic Systems
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Introduction

The introduction to septic systems program covers:

- Function of a septic system
- Evaluation of septic tank operation
- Determining if a septic tank should be pumped.
- How to live with a septic system




Onsite Wastewater Treatment System






Onsite wastewater treatment systems?



- Rural and Exurban wastewater infrastructure
- Water Quality Protection
- 25 - 40%, Wastewater Infrastructure



What is the system called?

- OWTS – Onsite Wastewater Treatment System; Nationally
- OSSF – On-Site Sewage Facility; Texas
- Septic System



Permitting Wastewater Treatment Systems in Texas

- Texas Commission on Environmental Quality (TCEQ), Chapter 285, 5000 gallons per day or less
 - Local Authorized Agent – Usually local Health Department
 - TCEQ Regional Office
- TCEQ, Chapter 217, Greater than 5000 gallons per day.

Malfunctioning Onsite System



Malfunction

- **Malfunctioning OSSF** – An on-site sewage facility that is causing a nuisance or is not operating in compliance with the 285 OSSF regulations.

Hard Malfunction
Soft Malfunction



Nuisance

- sewage, human excreta, or other organic waste discharged or exposed in a manner that makes it a potential instrument or medium in the transmission of disease to or between persons
- an overflow from a septic tank or similar device, including surface discharge from or groundwater contamination by a component of an on-site sewage facility; or
- a blatant discharge from an OSSF.



Evolution of wastewater treatment goals

- From outdoor plumbing to water reuse
- We need to review the history to understand the present

Outdoor plumbing: the pit privy

- Goal: designated place
- No carrier needed to convey waste
- Waste applied directly to the soil
- Public health concerns addressed
- Management: relocate



Indoor plumbing

- Convenience
- Water carrier to convey waste out of facility
- 'Collection system'
- Public health and pathogens
- Management: keep pipe flowing



Disposal

- Goal: limit human contact
- Keep wastewater below ground
- Disposal options
- Public health
 - "Disposing" of pathogens
 - Treatment?
- Environment: groundwater contamination
- Management: install, flush and forget



Septic tank and soil treatment area

- Changing goal:
 - Disposal: effluent goes away versus treatment
 - Dispersal: TREATMENT is essential to good systems
- Address both public health AND environmental concerns
- Management:
 - Disposal: often none at all;
 - Dispersal: System management is critical

Goal: TREATMENT AND DISPERSAL

- Changes in goals means:
 - Siting requirements
 - Technological advancements
 - Choice of components and systems
 - System O&M
 - Management program

Education

Decentralized Approach

Distributed Management

What is an Onsite Wastewater Treatment System?

1. Wastewater Source
2. Collection and Storage
3. Pretreatment components
4. Final Treatment and Dispersal components

Wastewater source

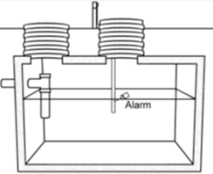
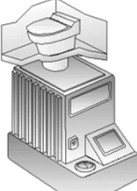

- Facility type
 - Domestic
 - Commercial
 - Industrial
- User
 - Owner/family
 - Employees

Collection

- Piping from facility with cleanout
 - Blackwater
 - Graywater

Collection options

- Holding tanks
- Composting toilets
- Incinerating toilets

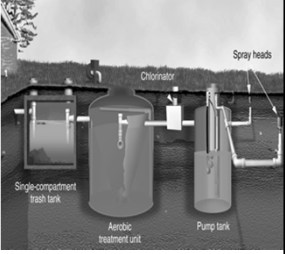




Courtesy of Dickus Martinum

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Pretreatment



- Septic tanks
- Aerobic treatment units
- Media filters
- Constructed wetlands
- Disinfection



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Final Treatment and Dispersal Components


- Trench and bed distribution
- Evapotranspiration beds
- Low pressure distribution trench
- Drip field
- Spray field

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How do we make the wastewater system work?

- Evaluate the wastewater source
 - Wastewater treatment
 - Wastewater acceptance
- Choose a final treatment and dispersal component
- Choose the appropriate pretreatment system
- Operation and Maintenance



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Minimum required separation distances

From	Sewage treatment tanks or holding tanks	Soil absorption systems and unlined ET beds	Lined evapotranspiration beds	Sewer pipe with watertight joints	Surface distribution (spray areas)	Drip distribution
Public water wells	50	150	150	50	150	150
Public water supply lines	10	10	10	10	10	10
Private water well	50	100	50	25	100	100
Private water line	10	10	5	10 except at connection to structure	0	10
Private water well (pressure controlled or grouted to 100 ft. or cemented or grouted to water table if water table is less than 100 ft. deep)	50	50	50	20	50	50
Streams, ponds, lakes, rivers (measured from normal pool elevation (with and water level); subsurface bodies (spr. only))	50	75 LPD (Secondary treatment and disinfection) - 50	50	20	50	25 when R ₁₀ < 1 [†] 75 when R ₁₀ > 1 [†] secondary treatment and disinfection - 50
Foundations, buildings, surface improvements, property line easements, swimming pools and other structures	5	5	5	5	No separation distance except property lines - 10 [†] swimming pools - 25	No separation distance except property lines - 5
Sharp slopes, breaks	0	25	5	10	25	10 when R ₁₀ < 1 [†] 25 when R ₁₀ > 1 [†]
Edwards Aquifer recharge features [‡]	50	150	50	50	150	100 when R ₁₀ < 1 [†] 150 when R ₁₀ > 1 [†]

[†] All distances measured in feet.
[‡] R₁₀ refers to the application rate for wastewater to the soil. This term is presented as gallons of wastewater applied per square foot of absorption area. Soil types Ia, B, II, III and IV have the corresponding R₁₀ values 0.5, 0.25, 0.20 and 0.1, respectively.
[§] Drip distribution lines may not be placed under foundations.
[¶] No on-site sewage facility may be installed closer than 75 feet from the banks of the Neuse, Dry Frio, Frio or Sabinal rivers downstream from the northern Uvalde County line to the recharge zone.
^{**} A separation distance of 10 feet is for spray systems controlled by a timer. A separation distance of 20 feet is required for uncontrolled spray systems, which spray effluent when the pump tank is full. This can occur at any time of the day.

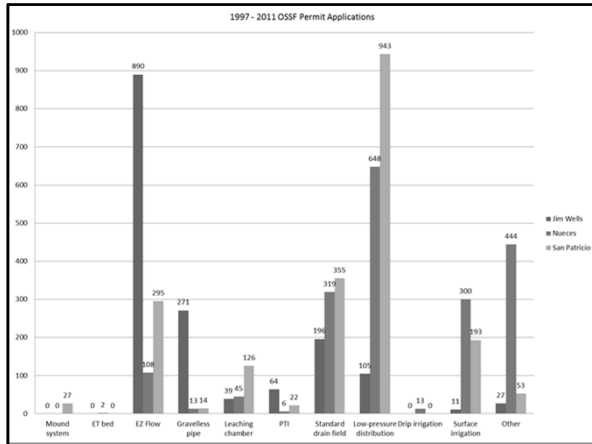
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Choices of distribution for various soil types

Soil conditions	Distribution systems								
	Standard drain field [†]	Low-pressure distribution	Subsurface drip distribution	Spray distribution [‡]	mound system	ET bed [§]	Soil substitution drain field	Pumped effluent drain field	
Soil type [¶]	Ia	No	No [¶]	No [¶]	Yes	Yes	Yes (lined only)	Yes	No
	II	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	III	Yes ^{**}	Yes ^{**}	Yes ^{**}	Yes	Yes ^{**}	Yes	Yes ^{**}	Yes ^{**}
	IV	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Depth of good soil type II, III, IV below application depth	2 or more feet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1 foot	No	Yes	Yes	Yes	Yes	Yes (lined only)	Yes [¶]	Yes
	Less than 1 foot	No	No	Yes [¶]	Yes (must support vegetation)	Yes [¶]	Yes (lined only)	Yes [¶]	No
Groundwater depth below application depth	2 feet or more	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1 foot	No	No	Yes [¶]	Yes	Yes [¶]	Yes (lined only)	No	No
	Less than 1 foot	No	No	Yes	Yes [¶]	Yes (lined only)	No	No	No
Soil surface slope	1 foot	Yes	Yes	Yes	Yes	Yes	Yes	Yes	±2%
	Over 30%	No	Yes	Yes	Yes ^{**}	No	No	No	No

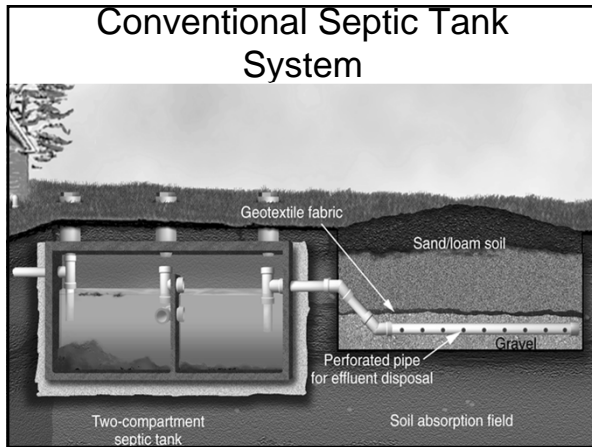
[†] This option includes conventional gravel-filled trench, leaching chambers and gravelless pipe.
[‡] This option is available with a pretreatment system giving a secondary-quality effluent and distribution. Class I aerobic units and sand filters are designed to give secondary-quality effluent. Other treatment systems need to be professionally designed to obtain the secondary-quality effluent.
[§] ET = Evapotranspiration
[¶] Soil types Ia - sandy soil with more than 30% gravel; Ib - sand and loamy sand; II - sandy loam and loam; III - silt, silt loam, silty clay loam, clay loam, sandy clay loam and sandy clay; and IV - silty clay and clay. A site evaluator determines these conditions.
^{**} The soil substitution drain field is built by removing the unsuitable soil and placing 2 feet of suitable soil around the absorption system. However, this system cannot be used in a slope IV soil.
^{††} The mound must be constructed to maintain 2 feet of good soil below the wastewater application level and above groundwater, 18 inches to restrictive horizon.
^{‡‡} Spray distribution of wastewater can be used on surface slopes of 0-15%. Land with steeper slopes needs to be landscaped and terraced to minimize runoff.
^{§§} May require gravel analysis for determining further suitability.
^{¶¶} Sites with a slope of less than 2% need a drainage plan for removing rainfall runoff.

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What is a conventional septic system?

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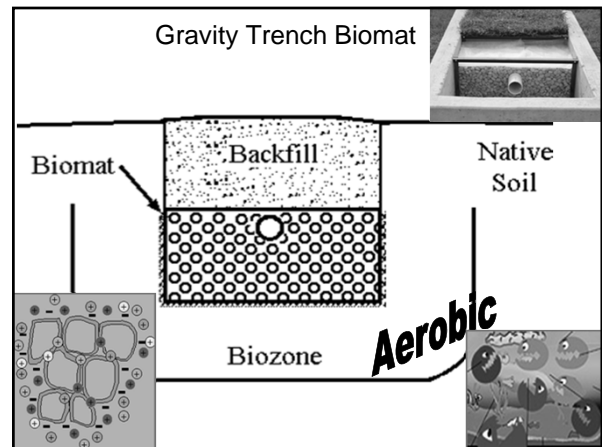
What is a Septic Tank?

- Water tight containers
 - Concrete
 - Plastic/ Fiberglass
- Gravity separation/ detention time
 - Typically 2-3 days
 - Heavy sinks
 - Lighter floats
- Calm conditions
- Screen assisted
- Anaerobic digestion

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What is a Grease Tank?

- Baffles extend lower in the tank to help retain grease and oil
- Typically not needed in most residential systems
- Necessary for restaurants



Wastewater distribution method

- Gravity
 - Sequential
 - Parallel
 - Manifolds
 - Beds
- Pressure dosed trench
- Pressure distribution in the Field

The diagram illustrates a gravity-based wastewater distribution system. It starts with a 'Source' house connected to a 'Septic tank'. From the septic tank, the effluent flows through 'Drop boxes' and is distributed into 'Trenches' that are laid out on a 'Slope'. The 'AgriLIFE EXTENSION' logo is at the bottom right.

Distribution media

- Rock
- Chambers
- Gravelless pipe
- Synthetic media

A photograph showing different types of distribution media used in septic systems. There are piles of rock, several large corrugated plastic chambers, and sections of white gravelless pipe. The 'AgriLIFE EXTENSION' logo is at the bottom right.

Gravity Distribution

This cross-section diagram shows a 'Two-compartment septic tank' on the left. A 'Perforated pipe for effluent disposal' leads from the tank to a 'Soil absorption field'. The pipe is covered with 'Geotextile fabric' and sits on a layer of 'Gravel'. Above the gravel is 'Sand/loam soil'. The 'AgriLIFE EXTENSION' logo is at the bottom right.

Gravel-less Pipe Distribution

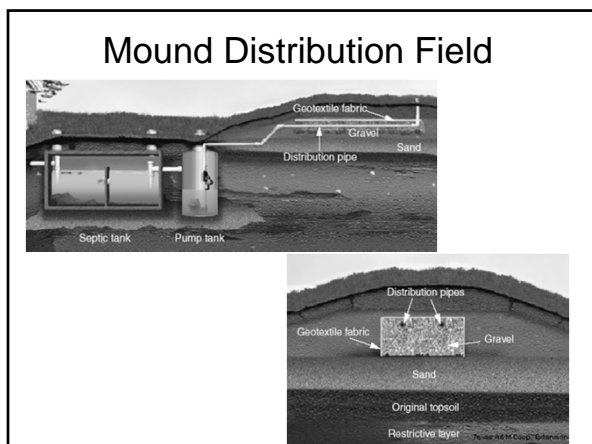
This cross-section diagram shows a 'Two-compartment septic tank' on the left. A 'Gravel-less pipe' leads from the tank to a 'Soil absorption field'. The pipe is covered with 'Geotextile fabric' and sits on a layer of 'Sand/loam soil'. The 'AgriLIFE EXTENSION' logo is at the bottom right.

Leaching Chambers

This cross-section diagram shows a 'Two-compartment septic tank' on the left. A pipe leads from the tank to a 'Leaching chamber' which is filled with gravel. Below the chamber is a 'Soil absorption field'. The 'AgriLIFE EXTENSION' logo is at the bottom right.

Low-Pressure Distribution System

This cross-section diagram shows a 'Two-compartment septic tank' on the left. A pipe leads from the tank to a 'Pump tank'. From the pump tank, a 'Low-pressure pipe system' leads to a 'Soil absorption field'. The 'AgriLIFE EXTENSION' logo is at the bottom right.

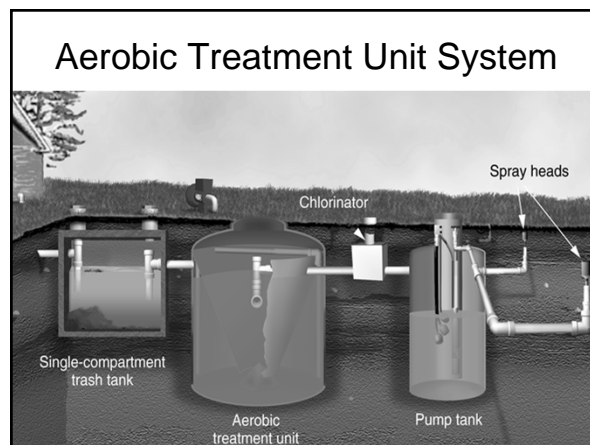


Role of vegetative cover in treatment system

➤ A healthy cover crop is essential for the system to function properly. Plants will:

- Take up nutrients
- Take up water
- Stabilize the soil and prevent erosion
- Provide food and habitat for beneficial soil organisms

What is an aerobic treatment unit?



Aerobic vs. Anaerobic Processes (???)

➤ **Aerobic**

- Aerobic bacteria require O₂ to live and grow
- Aerobic treatment processes require O₂ to proceed
- Common condition in soil treatment, media filters, ATUs

➤ **Anaerobic**

- Anaerobic bacteria grow in absence of free oxygen, O₂
- Anaerobic treatment processes do not use oxygen, but consumption of items, breaks oxygen bonds Ex. SO₄, NO₃
- Common condition in septic tanks, processing tanks, and usually any saturated environment

Aerobic Treatment Unit System

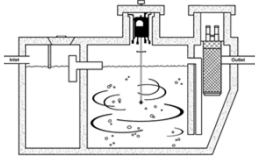
➤ **Trash Tank**

- Small septic tank
- 1 day retention time
- Physical separation
- Anaerobic digestion

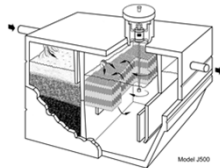
Aerobic tank

- Aerobic Microbes
 - Require Oxygen to live and grow
 - Consume waste and bacteria
- Configurations

Suspended growth:



Attached growth:



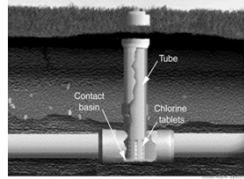
Aerobic Treatment Unit System

- Air supply
 - Compressor / Aerator
 - Diffusers
 - Oxygen transfer to wastewater
 - Mixing of food and organisms
- Clarifier
 - Process where the microbes, cell waste and biomass settle out of the water.



Aerobic Treatment Unit System

- Disinfection
 - Disinfection, not sterilization
 - Chlorinator
 - NOT SWIMMING POOL TABLETS!
 - UV light
- Distribution
 - Pump tank
 - Spray field



Water Quality – Spray Field

- High potential for human contact with water
- Secondary- Quality Effluent
- Remove 85-98% of solids and organic matter
- Remove pathogens?
- Soil for Final Treatment
- This is NOT drinking water!!



No Playing in Sprinklers!!

Spray Field

- Low angle spray head
 - < 15 degrees
- Clear area around spray head – 10 feet in the direction of spray from the head
- Vegetation growing for water and nutrient removal
- Reseed dead vegetation





Feeding the System

Conventional and Aerobic Systems



SEWAGE COMPOSITION

- Water carrying waste – Hydraulic Loading
- Organic Loading
 - BOD
 - TSS
- Pathogens
- Nutrients
 - Phosphorus
 - Nitrogen
- Chemicals





Fats, oils and grease

Constituent	State at room temperature	Comments
Fats	Solid	Non-toxic to the system, origin – animals, will separate in water
Oils	Liquid	Non-toxic to the system, origin – plants, trouble separating in water
Grease	Solid	Residual material on appliances; solid material on pans/equipment; petroleum products; moisturizers; bath oils; tanning oils; toxic to the wastewater system

Room temperature assumes 74 degrees F

A degreaser will move all components through a system



In-Home Businesses/Hobbies

- Add stronger waste
- Add chemicals
- Increase flow




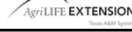
➤ Examples of Businesses:

- Home photography developing lab
- Barber shops
- Day care
- Bakery
- Dog grooming
- Taxidermy
- Artist





Prescription Drugs and Antibiotics

- Can kill microbes living in system
 - Won't discriminate against organisms living in the system
- Additional treatment components may be necessary
- Increase maintenance



Septic System Additives

- Not been proven to be beneficial to system performance
- Not recommended
- Break up particles that are settled at the bottom and make them suspended
- Potential solids loading to downstream components

Kitchen

- 20% of daily flow
- Dishwasher
- Garbage Disposal

Dishwasher



- Adds surges of wastewater
 - Hydraulically overload system
 - Homeowner should space out loads
- Organic load
 - Clean/scrape dishes



Garbage Disposal

- Increases scum by 20%
- System should be pumped 1-2 years sooner than without a garbage disposal
- Increases Organic Loading
 - Smaller particles will take longer to settle
 - Organic matter had not been digested, so it will take longer to break down
 - Potential for fats and oils
- More water is used to wash out sink



Laundry 20%

- Use should be spread out
- Liquid soap is recommended
 - Use less
 - Remove risk of fillers in powders



Bathroom Fixtures 60%



- Garden tubs
 - Use large volumes of water
 - Add hydraulic surges
 - How often it is used?
- Multi-head showers
- No every-use shower cleaner



Bath and body oils

- Increases Fats, Oils and Grease
- If usage is great, may need more maintenance



Bathroom

- Only urine, feces, soap, toilet paper and limited amounts of cleaner should be going down drain
- No feminine products, prophylactics, cigarette butts, etc
- No every-flush toilet bowl sanitizers



Septic Safe?

Toilet Paper

- Number of rolls used per week
- Results in faster sludge build up
- Treated toilet paper (with lotions) prevents paper from settling
- Wet wipe disposal is discouraged



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Cleaning Products

- Cumulative effects on system performance
- Look at Labels!
- **DANGER:** Means the chemical will kill the bacteria, and its use should be minimized or eliminated
- **WARNING:** Means limited use should have a minimal impact on the system.
- **CAUTION:** Typically means the product will have little effect.

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Drain Cleaner

- Toxic drain cleaners can impact ability to properly treat wastewater
- Affect bacteria activity



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Operation & Maintenance of Septic Systems

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Gases and Chemicals of Concern

- Hydrogen Sulfide
- Sulfuric Acid (converted from H₂S)
- Chlorine Gas
- CO_(X)'s
 - Carbon Dioxide
 - Carbon Monoxide
- Methane



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Common Biological Hazards around the Site

- Kids
- Dogs
- Cats
- Insects
- Snakes
- Vegetation



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Conditions at the tank

Odors?

Tank material

Concrete

Metal

Fiberglass

Plastic

Septic tank configurations

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Tank access

Access Location:

- Inlet
- Outlet
- Center

Current operating condition

Liquid level in respect to outlet (inches):

- At
- Above
- Below

In: _____

Above

At

Below

Septic tank pumping recommended?

If recommended, did it happen?

- Should be pumped when total solids reach 25-33% of tank capacity.
- If 'A' is less than 3"
- If 'B' is less than 12"

finished grade

4' min

Clean tank when A is 3" or less OR when B is 12" or less

scum

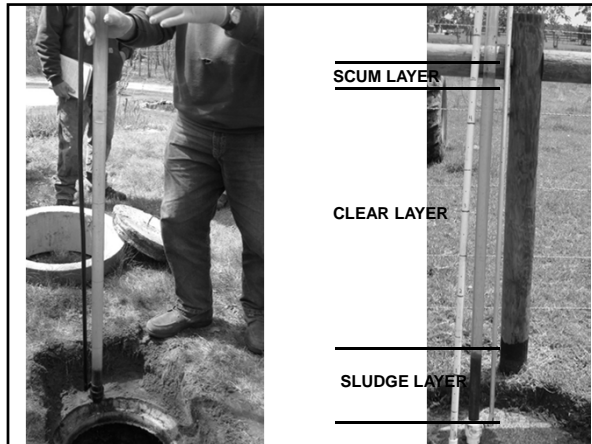
clear space

sludge

A

B

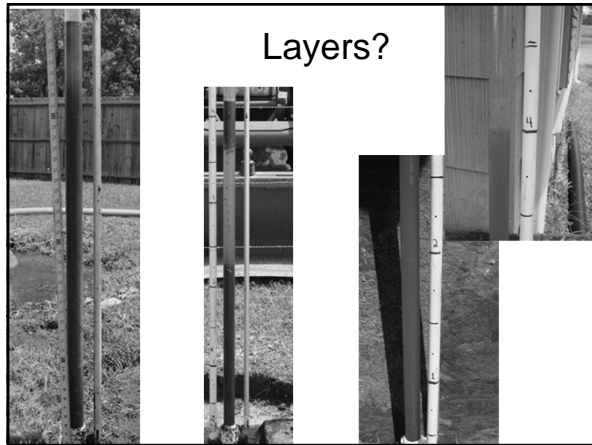
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Is It full?

- Measure solids in the tank
- 60" deep
- 6" of Scum
- 18" of Sludge

$[18'' + 6''] \div 60'' \times 100 = 40\%$



Septic tank pumping recommended?

Tank Size (gals)	Household Size (Number of People)									
	1	2	3	4	5	6	7	8	9	10
500	5.8	2.6	1.5	1.0	0.7	0.4	0.3	0.2	0.1	—
750	9.1	4.2	2.6	1.8	1.3	1.0	0.7	0.6	0.4	0.3
1,000	12.4	5.9	3.7	2.6	2.0	1.5	1.2	1.0	0.8	0.7
1,250		7.5	4.8	3.4	2.6	2.0	1.7	1.4	1.2	1.0
1,500		9.1	5.9	4.2	3.3	2.6	2.1	1.8	1.5	1.3
1,750			6.9	5.0	3.9	3.1	2.6	2.2	1.9	1.6
2,000			8.0	5.9	4.5	3.7	3.1	2.6	2.2	2.0
2,250				6.7	5.2	4.2	3.5	3.0	2.6	2.3
2,500					5.9	4.8	4.0	4.0	3.0	2.6

Note: More frequent pumping needed if a garbage disposal is used.

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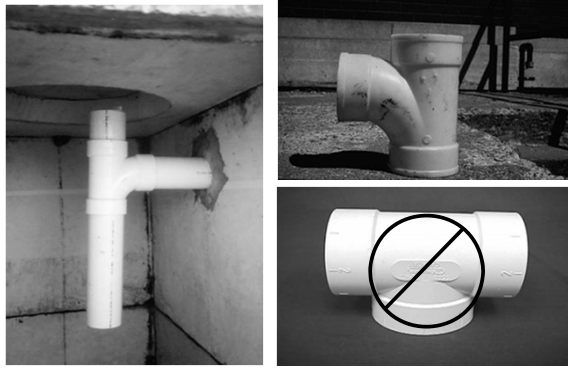
Baffles

- Inlet baffle in place
- Outlet baffle in place
- Compartment baffle in place

Baffles

- Concrete
- Plastic
- Fiberglass

Baffles - tees



Effluent screens



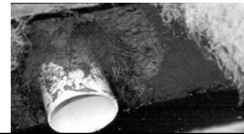
Effluent screen cleaning

- Screen is washed off directly into the septic tank
- This is being done at the inlet end of the tank to protect against cleanings going directly out the outlet
- Some units have protection against outflow or an extra screen that that operates during cleaning.



Tank structural condition

- Watertight (no visual leaks)
- Rebar exposed
- Root intrusion
- Corrosion or spalling present
- Cracks
- Flex



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Vegetation

- Trees in distribution field
- Excessive vegetation
- Uneven vegetation
- Poor vegetation



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Why perform maintenance?

- Keep systems functioning properly
- Maintain effluent quality
- Early detection of problems
- Public health
- Environmental Protection
- System reliability
- User satisfaction




Early plumbers


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Public health

- Wastewater can contain disease causing Pathogens
 - Bacteria
 - Viruses
 - Parasites
 - Protozoa



Hepatitis A Virus





Ascaris lumbricoides
(roundworm)

Environmental protection

Treat contaminants before they reach surface water or groundwater

- Nutrients
 - Phosphorus
 - Nitrogen
- Organic loading
- Pathogens
 - Fecal coliforms
 - E-coli





EPA water quality programs

- Onsite wastewater treatment systems
 - Non-point source of pollution
- Total Maximum Daily Loads
- Coastal Zone Management Program






System reliability

Performance of all system components must be functional to achieve full treatment

- Components require maintenance
- Service/maintenance should extend life of components



Thank you

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