Introduction to Onsite Wastewater Treatment

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Introduction

- What is an On Site Sewage Facility (OSSF)?
- Why are we concerned about wastewater?
- Evolution of onsite wastewater treatment
- Function of a septic system
- Evaluation of septic tank operation
- When should a septic tank should be pumped?
- How to live with a septic 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.

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

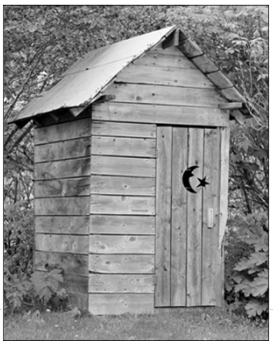
- sewage, human excreta, or other organic waste discharged or exposed in a manner that makes it a potential instrument or medium in the transmission of disease to or between persons
- an overflow from a septic tank or similar device, including surface discharge from or groundwater contamination by a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

Evolution of wastewater management

- 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

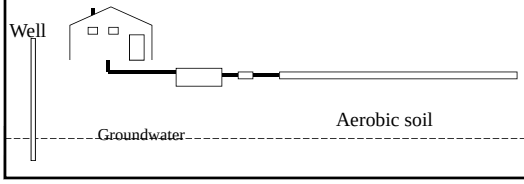
- Convenience
- Water carrier to convey waste out of facility
- 'Collection system'
- Public health and pathogens
- Management: keep pipe flowing

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

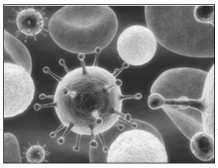
Septic tank & soil treatment area

- Evolving goal:
  - Disposal: effluent goes away versus treatment
  - Dispersal: TREATMENT
- Public health AND environmental issues addressed
- Management:
  - Disposal: often no management at all
  - Dispersal: system management is critical



Public health

- Wastewater can contain disease causing pathogens
  - Bacteria
    - E-coli
    - Salmonella
  - Viruses
    - Hepatitis A
  - Parasites
    - Giardia
    - Cryptosporidium
    - Roundworms



Environmental protection

- Treat contaminants before they reach surface water or groundwater
- Nutrients
  - Phosphorus
  - Nitrogen
- Organic loading
- Pathogens

Goal: TREATMENT AND DISPERSAL

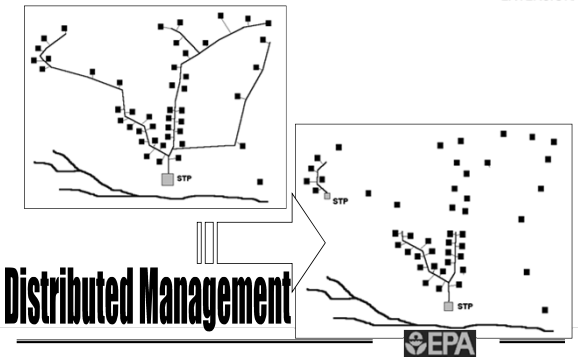
- Starting to address both environmental concerns in addition to public health concerns
- Technological advancements now allow removal of:
  - Bacteria - Pathogens
  - Solids – Organic matter
  - Nutrients
- System management is vital to treatment
- Goal is now DISPERSAL
  - Hydrologic cycle

Changes in goals means:

- Approach must also change
  - Siting requirements
  - Choice of components and systems
  - System O&M
  - Management program
  - Industry needs

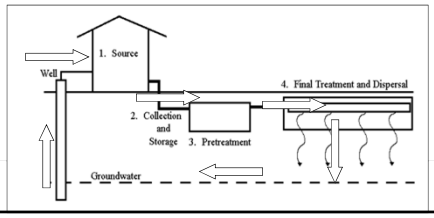
Education

Decentralized Approach



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

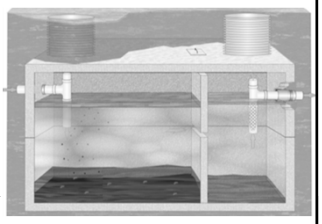
- Facility type
  - Domestic
  - Commercial
- User
  - Owner/family
  - Employees

Collection

- Piping from facility with cleanout
  - Blackwater
  - Graywater
- Collection Options
  - Holding tanks
  - Composting toilets
  - Incinerating toilets

Pretreatment

- Pre-treating waste before it reaches the soil
  - Septic tanks
  - Aerobic treatment units
  - Media filters
  - Constructed wetlands
  - Disinfection



Final treatment and dispersal

- Final treatment occurs in the soil
  - Conventional trench or bed distribution
  - Low pressure distribution
  - Drip field
  - Spray field
  - Evapotranspiration beds

How do we make the OSSF work?

- Evaluate the wastewater source:
  - Hydraulic and organic loading
- Evaluate site
  - Wastewater treatment
  - Wastewater acceptance
- Choose a final treatment and dispersal component
- Choose the appropriate pretreatment system
- Operation and maintenance

Choices of distribution for various soil types

Soil conditions		Distribution systems: Standard drain field[a]	Low-pressure distribution	Subsurface drip distribution	Spray distribution[e]	Mound system	ET bed[f]	Soil substitution drain field	Pumped effluent drain field
Soil type[b]	Ia	No	No[d]	No[d]	Yes	Yes	Yes (lined only)	Yes	No
	Ib	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	II	Yes[c]	Yes[c]	Yes[c]	Yes	Yes[d]	Yes	Yes[c]	Yes[c]
	III	Yes[c]	Yes[c]	Yes[c]	Yes	Yes[d]	Yes	Yes[c]	Yes[c]
	IV	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Depth of good soil (type Ia, II, III) below application depth	2 or more feet	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1 foot	No	Yes	Yes	Yes	Yes[d]	Yes (lined only)	Yes[d]	Yes
	Less than 1 foot	No	No	Yes[d] (6 inches)	Yes (must support vegetation)	Yes[d]	Yes (lined only)	Yes[d]	No
Groundwater depth below application depth	2 feet or more	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	1 foot	No	No	Yes[d]	Yes	Yes[d]	Yes (lined only)	No	No
	Less than 1 foot	No	No	No	Yes	Yes[d]	Yes (lined only)	No	No
Soil surface slope	0-30%	Yes[g] < 30%	Yes	Yes	Yes[h]	≤10%	Yes	Yes	≤ 2%
	Over 30% or complex slopes	No	Yes	Yes	Yes[h]	No	No	No	No

[a] This option includes conventional gravel-filled trench, leaching chambers and gravelless pipe.
[b] This option is available with a pretreatment system giving a secondary-quality effluent and disinfection. 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.
[c] ET= Evapotranspiration
[d] Soil types: Ia - sandy soil with more than 30% gravel; Ib - sand and loamy sand; II - sandy loam and loam; III - 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.
[e] 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 type IV soil.
[f] 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.
[g] 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.
[h] May require gravel analysis for determining further suitability.
- Sites with a slope of less than 2% need a drainage plan for removing rainfall runoff.

Minimum required separation distances

From	To: Sewage treatment tanks or holding tanks	Soil absorption systems and unlined ET beds	Lined evapotranspiration beds	Sewer pipe with watertight joints	Surface distribution (spray area)	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	20	100	100
Private water line	10	10	5	10 except at connection to structure	0	10
Private water well (pressure cemented or grouted to 100 ft. or cemented or grouted to water table if water table is less that 100 ft. deep	50	50	50	20	50	50
Streams, ponds, lakes, rivers (measured from normal pool elevation (with and water level); saltwater bodies (high tide only)	50	75, LPD (Secondary treatment and disinfection) - 50	50	20	50	25 when R_a≤0.1[d] 75 when R_a >0.1 secondary treatment and disinfection) - 50
Foundations, buildings, surface improvements, property lines easements, swimming pools and other structures	5	5	5	5	No separation distances except property lines - 10[d] swimming pools - 25	No separation distances except[d] property lines - 5
Sharp slopes, breaks	0 Special support may be required for zero separation distances	25	5	10	25	10 when R_a≤0.1[e] 25 when R_a >0.1[e]
Edwards Aquifer recharge features[f]	50	150	50	50	150	100 when R_a ≤0.1[e] 150 when R_a >0.1[e]

[a] All distances measured in feet.
[b] R_a 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, Ib, II, III and IV have the corresponding Ra values 0.5, 0.38, 0.25, 0.20 and 0.1, respectively.
[c] Drip distribution lines may not be placed under foundations.
[d] No on-site sewage facility may be installed closer than 75 feet from the banks of the Nueces, Dry Frio, Frio or Sabinal rivers downstream from the northern Uvalde County line to the recharge zone.
[e] 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.

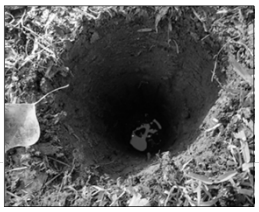
Roles with septic system management

- Site evaluation
- Design
- Installation
- Startup
- Inspection
- Operation
- Maintenance
- Monitoring
- Pumping

Site evaluation

- Comprehensive evaluation of soil and site conditions for a given land use.
  - Wastewater treatment
  - Wastewater acceptance

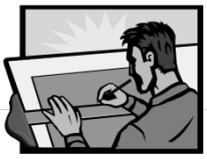
Licensed OSSF Site Evaluator,
Professional Engineer



Design

- The process of selecting, sizing, locating, specifying and configuring treatment train components that match site characteristics and facility use, as well as creating the associated written documentation.
- A design is also the written documentation of size, location, specification, and configuration.

Professional Engineer,
Registered Sanitarian



Installation

- The assembly and placement of components of a system, including final grading and establishment of an appropriate cover
- Startup

Licensed OSSF Installer I
or
OSSF Installer II

Inspection

- The evaluation of and reporting on the status of a wastewater treatment system

Designated Representative

Operation and maintenance

- Operation
  - Assessing whether <u>each</u> component of the system is functioning properly
- Maintenance
  - taking care of the pieces
- Monitoring
  - verifying performance for a regulatory authority or a manufacturer

Licensed OSSF Maintenance Provider

Pumping

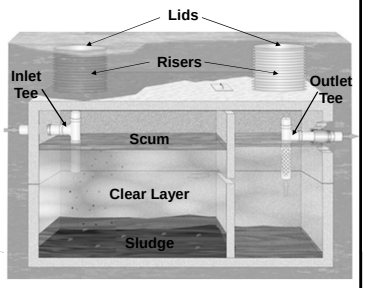
- The action of removing septage from a wastewater treatment system component
- Necessary to prevent accumulated solids from moving into downstream components
  - Drain fields
  - Pumps
- TCEQ Registered Sludge Transporter

Pumper

What is a conventional septic system?

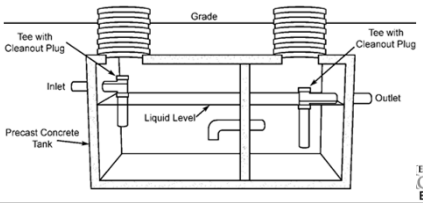
What is a septic tank?

- Water tight containers
  - Concrete
  - Plastic / Fiberglass
  - NOT Metal
- Detention time
  - Typically 2-3 days
  - Calm conditions
- Gravity separation
  - Heavy sinks
  - Lighter floats
- Anaerobic digestion

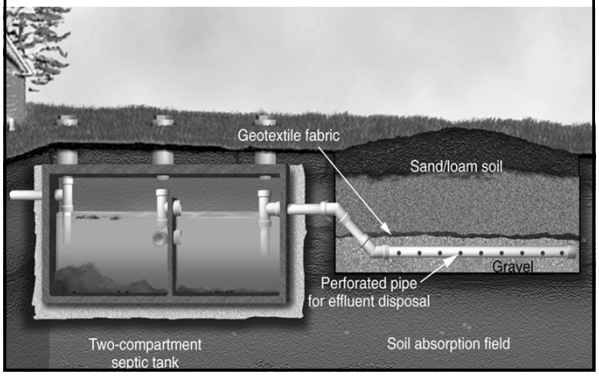


What is a Grease Tank?

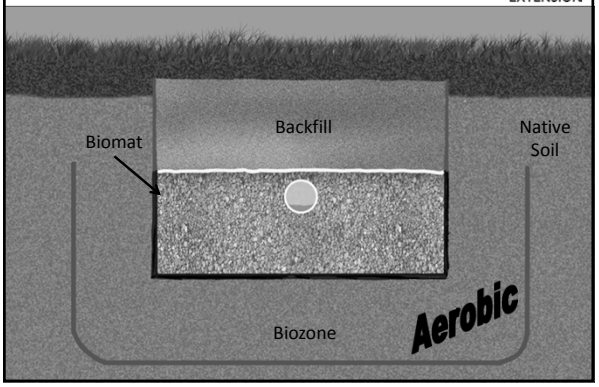
- Baffles extend lower in the tank to help retain grease and oil
- Typically not needed in most residential systems
- Necessary for restaurants



Conventional septic tank system



Soil Treatment Area

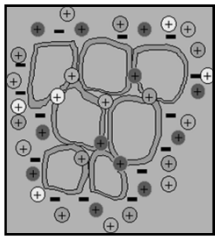


Physical treatment processes

- Sedimentation
  - Settling of the solids
- Filtration
  - Aerobic conditions required, wastewater flows through smaller pores
  - Removes large - particles, bacteria, suspended solids
- Dispersion and dilution
  - Wastewater mixes with groundwater
  - Less concentrated, lower hazard
  - But dilution doesn't remove pollutants

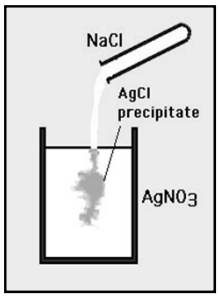
Chemical treatment processes

- Cation exchange and adsorption
  - Positively charged waste constituents bond with soil particles
  - Slows rate of movement through soil
  - Allows use by plants and microorganisms
  - Typically occurs in soils



Chemical treatment processes

- Precipitation
  - Solids that form due to reactions of solutions and/or solids
  - Important for phosphorus removal in soils, where P reacts with calcium carbonate, iron and aluminum in soils
- Chemical oxidation
  - Chlorination

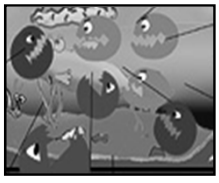


Biological treatment processes

- Natural die-off
  - Occurs when pathogens are held in nutrient poor aerobic conditions
- Predation
  - Natural soil organisms attack and destroy pathogenic bacteria and viruses

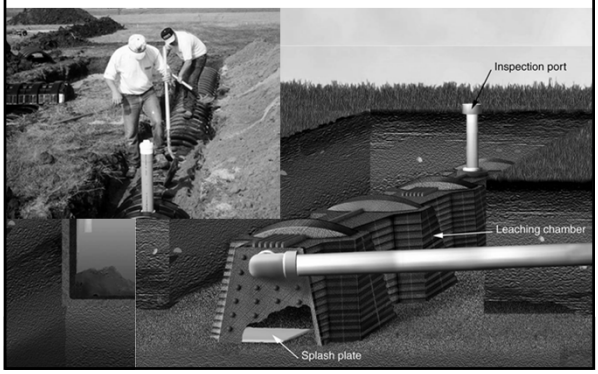
Biological treatment processes (cont.)

- Biological oxidation
  - Bacteria break down organic matter into water and CO_2
  - Reduces BOD, removes pathogens
  - Works best in aerobic conditions

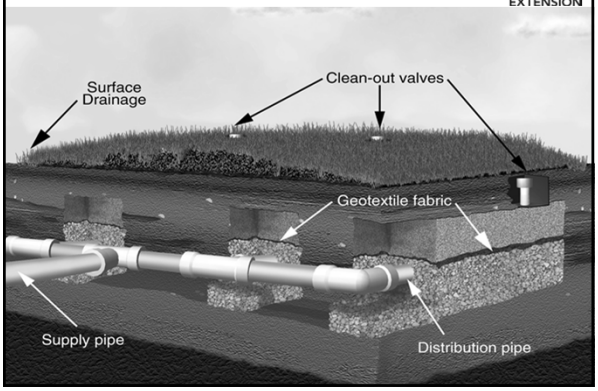


Gravel-less pipe distribution

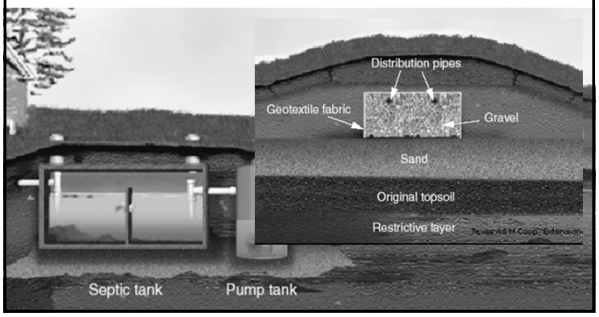
Leaching chambers



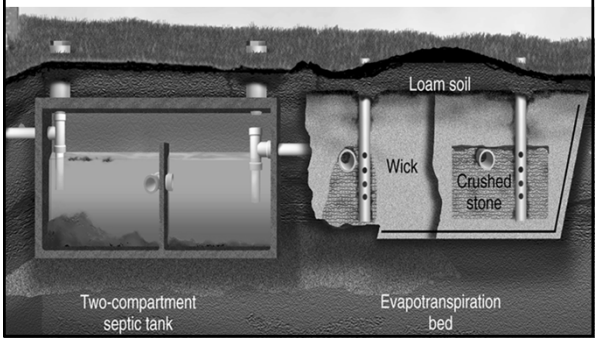
Low-Pressure Distribution



Mound distribution field



Evapotranspiration Bed

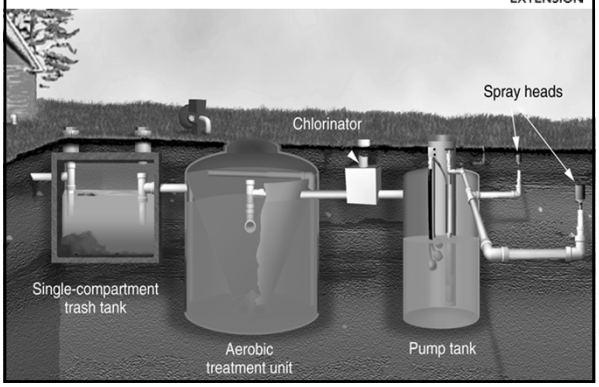


Role of vegetative cover in treatment system

- A healthy cover crop is essential for the system to function properly.
- Plants will:
  - Take up water and nutrients
  - Stabilize the soil & prevent erosion
  - Support beneficial soil organisms
- Do NOT park vehicles on drainfield
- Do NOT construct decks, driveways or buildings over drainfield
- NO woody vegetation over drainfield

What is an aerobic treatment unit?

What is an Aerobic Treatment Unit?



Aerobic vs. Anaerobic Processes (???)

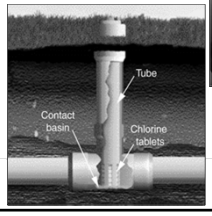
- Aerobic
  - Aerobic bacteria require O_2 to live and grow
  - Aerobic treatment processes require O_2 to proceed
  - Common condition in soil treatment, media filters, MATUs
- Anaerobic
  - Anaerobic bacteria grow in absence of free oxygen,O_2
  - Anaerobic treatment processes do not use oxygen, but consumption of items, breaks oxygen bonds Ex. SO_4, NO_3
  - Common condition in septic tanks, processing tanks, and usually any saturated environment

Aerobic treatment unit

- Aerobic Microbes
  - Require Oxygen to live and grow
  - Consume waste and bacteria
- Air supply
  - Compressor / Aerator
  - Diffusers
  - Oxygen transfer to wastewater
  - Mixing of food and organisms
- Clarifier

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 microbes are the final treatment!
- This is effluent – ***NOT DRINKING WATER!!!!***

Spray Field Vegetation

- A healthy cover crop is essential for the system to function properly.
  - Take up water and nutrients
  - Stabilize the soil and prevent erosion
  - Provide food and habitat for beneficial soil organisms
- Clear area around spray head – 10 feet in the direction of spray from the head.
- Dead vegetation should be reseeded to establish vegetation.

Subsurface drip distribution

Feeding the System

Conventional and Aerobic Systems

Sewage composition

- Hydraulic Loading - water carrying waste
- Organic Loading
  - BOD
  - TSS
- Pathogens
- Nutrients
  - Phosphorus
  - Nitrogen
- Chemicals
- Fats, oils, grease

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

In-Home Businesses/Hobbies

- Add stronger waste
- Add chemicals
- Increase flow

- Examples of Businesses:
  - Barber shops
  - Day care
  - Bakery
  - Dog grooming
  - Taxidermy
  - Artist
  - Home photography developing lab

Prescription drugs & antibiotics

- Can kill microbes living in system
  - Won't discriminate against organisms living in the system
- Additional treatment components may be necessary
- Increase maintenance
- Do not pour unused medicines down the drain

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

- Use should be spread out
  - Returning from vacation
- Liquid soap is recommended
  - Use less
  - Remove risk of fillers in powders
- Install High Efficiency appliances

Bathroom fixtures

- 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

Hand Washing Soap

- Antibacterial soap affects biology of tank
- Liquid soaps tend to be overused

Toilet

- 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

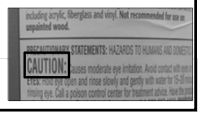
Septic Safe?

Toilet paper

- Excessive use results in faster sludge build up
- Treated toilet paper (with lotions) prevents paper from settling
- Wet wipe disposal is discouraged

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.



Drain cleaner

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

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

Operation & Maintenance of Septic Systems

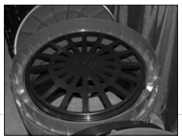
Gases and chemicals of concern

- Hydrogen Sulfide
- Sulfuric Acid (converted from H_2S)
- Chlorine Gas
- $CO_{(X)}$'s
  - Carbon Dioxide
  - Carbon Monoxide
- Methane

Common biological hazards around the site

- Kids
- Pets
- Insects
- Snakes
- Vegetation






Restricting access

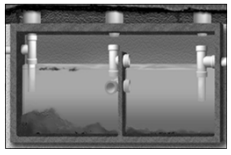

Conditions at the tank




Odors?

Tank Material


Tank Configurations



Tank Access

Access Location:

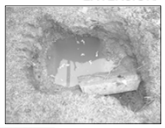
- Inlet
- Outlet
- Center

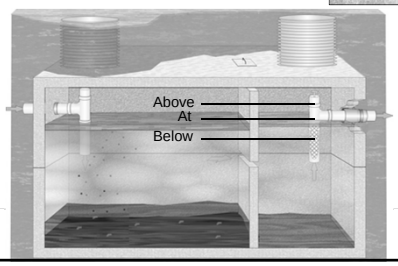
Accessibility issues

- Accessibility = ease of maintenance
  - Depth of installation
  - Inspection ports & risers
  - Encroachment

Operating condition

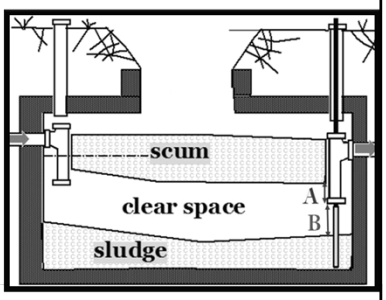
- Liquid level in respect to outlet (inches):
  - At
  - Above
  - Below



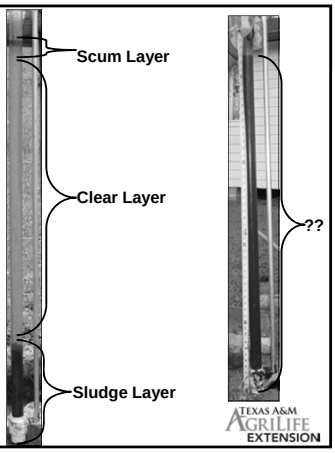


Septic tank pumping recommended?

- Should be pumped when total solids reach 25-33% of tank capacity
  - If 'A' is less than 3"
  - If 'B' is less than 12"
- Typically required every 3 to 5 years
- Pump during dry seasons to reduce the risk of tank floatation



Measuring solids



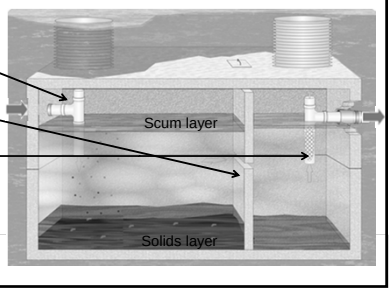
Septic tank pumping recommended?

Tank Size	Household Size (Number of People)									
(gals)	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.

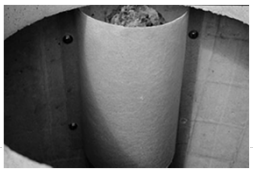
Baffles

- Critical to retention of solids in the septic tank
- Determine if baffles are in place



Baffles

- Concrete
- Plastic
- Fiberglass
- PVC tee

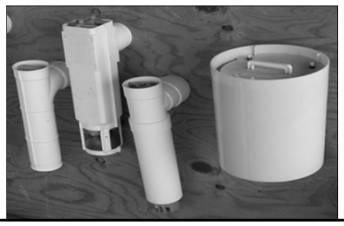




Tees



Effluent screens

- Installed at the septic tank outlet
- Trap solids trying to leave the septic tank
- Protect the drainfield

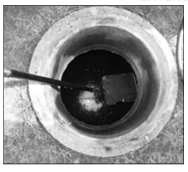
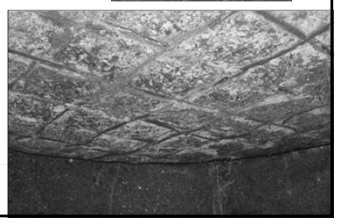
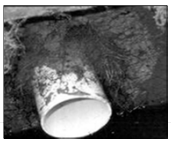



Effluent Screen Cleaning

- 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

Site conditions

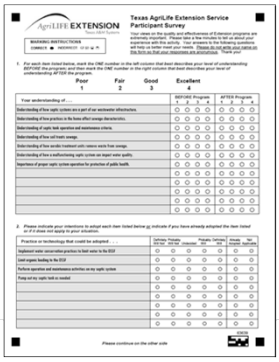
- Divert rainwater from system components
- Trees in distribution field
- Excessive vegetation
- Uneven vegetation
- Poor vegetation
- Saturated soils
- Odors

Why perform maintenance?

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

Early plumbers

Participant survey


Texas AgriLife Extension Service
Participant Survey

Thank you

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