

INTRODUCTION TO WASTEWATER TREATMENT

Justin Mechell, EIT
 Extension Program Specialist
 Texas AgriLife Extension Service

Overview

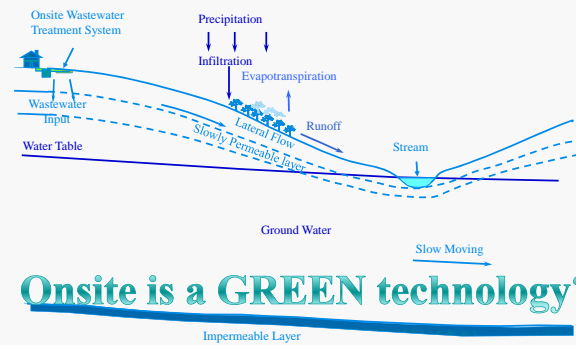
- What is wastewater?
- Why are we concerned about wastewater?
- The big picture.
- Goals for wastewater treatment are evolving
- How do we implement our infrastructure?
- Wastewater Treatment Processes – The end result is based upon your design
- Existing systems need upgrades to meet new requirements: onsite and centralized options

Wastewater infrastructure

- All facilities serving people generate wastewater
- How to meet these needs in an economical manner?
- Options:
 - On-site
 - Clustered
 - Centralized collection and treatment



Hydrologic cycle



Onsite is a GREEN technology?

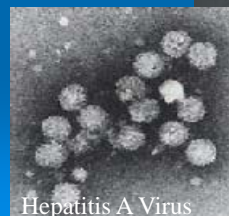
Wastewater constituents

- Organic matter – Biochemical Oxygen Demand – indicator
- Solids – TSS
- FOG – Fats, Oil & Grease
- Nutrients – Nitrogen, Phosphorous
- Pathogens
- Medications
- Chemicals
- Metals



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
 - BOD₅
- Bacteria - pathogens



The BIG picture

- In order to be an effective, long-term sustainable part of the wastewater infrastructure, onsite, cluster or centralized wastewater treatment systems must be properly sited, designed, installed, operated and maintained.
- We must have professionals who can provide system management services
- Trained professionals for all scales of infrastructure: onsite, cluster, & centralized.

Permitting dispersal systems

- Types: onsite, clustered, community/centralized
- On-site wastewater treatment system
 - Usually limited by maximum gallons per day (5,000 gpd)
 - TCEQ guidance: 30 TAC, Chapter 285
 - Prescriptive rules – local permitting, health departments
 - Identified as :
 - public – septic system; TCEQ – on-site sewage facilities (OSSF); nationally - On-site wastewater treatment system, (OWTS)
- Community systems (greater than 5000 gpd)
 - Performance based – State level permitting
 - TCEQ guidance: 30 TAC chapter 217
 - Potential groundwater impact due to water quality and mounding
 - Detailed soil analysis
 - Location of water wells within ½ mile
 - Uniformity of effluent distribution

Onsite wastewater treatment system



Centralized treatment system



Malfunctioning onsite system



Malfunctioning centralized system



Malfunction

- **Malfunctioning system** – A wastewater treatment system that is causing a nuisance or is not performing its intended function.

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 a wastewater treatment system.

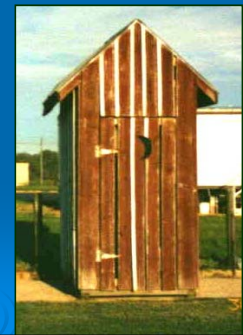
Evolution of wastewater management

Evolution of wastewater treatment goals

- From outdoor plumbing to water reuse

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



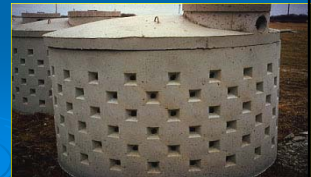
Indoor plumbing

- Convenience
- Water carrier to convey waste out of facility
- 'Collection system'
- Public health and pathogens
- Management: keep pipe flowing
- Where does it go?
 - Onsite
 - Sewer



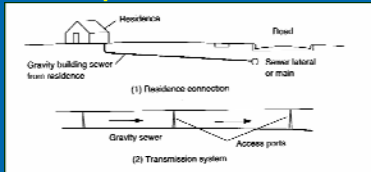
On-site disposal

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



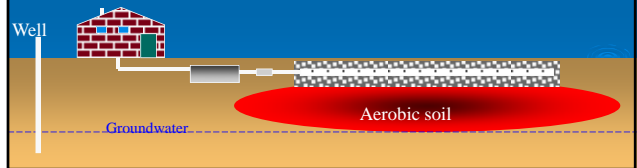
Off-site disposal

- Centralized sewer
 - Collection piping from houses
 - Cluster
 - Community
- Type of sewer
 - Gravity
 - Vacuum
 - Small diameter
 - STEP /STEG
- Treatment?



Septic tank and soil treatment area

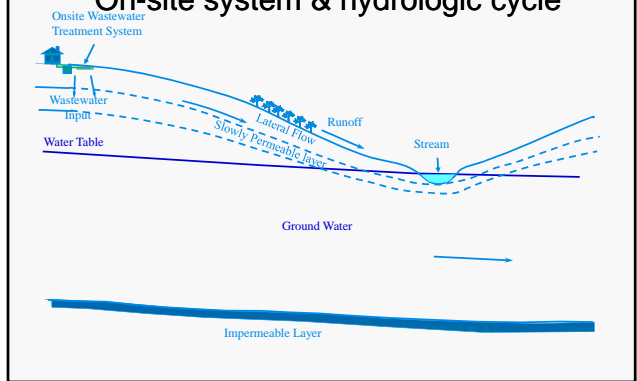
- Evolving goal:
 - Disposal: effluent goes away versus treatment
 - Dispersal: TREATMENT
- Public health AND environmental issues addressed
- Management:
 - Disposal: often no management at all;
 - Dispersal: system management is critical



Goal: TREATMENT AND DISPERSAL

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

On-site system & hydrologic cycle



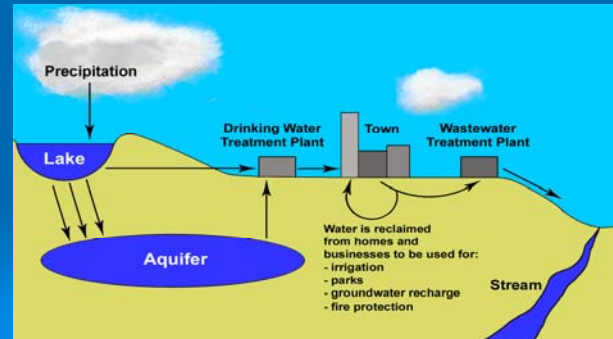
Off-site treatment and dispersal

- Convey wastewater to central point.
- Contaminants removed?
 - Primary
 - Secondary
 - Tertiary
- Treatment for removal of specific contaminants
- Discharge to surface water resources



Durham County North Carolina WWTP

Centralized system & hydrologic cycle



Water reuse

- Goal: careful use of a valuable resource
- Wastewater vs. water
- Potable vs. non-potable uses
 - Landscape reuse
 - Toilet flushing
 - Tough to meet potable quality
- Management: O&M is even more critical



Evolution of wastewater goals

- Outdoor plumbing
- Indoor plumbing - remove wastewater from the home.
- Disposal on-site - prevent wastewater from surfacing in the yard.
- Disposal off-site – prevent contact at facility and convey to stream.
- Treatment / dispersal on-site - provide effective treatment before effluent reaches surface or groundwater resources.
- Treatment / dispersal off-site – provide effective treatment before discharging to stream.
- Reuse - reclaim the water.

Varying rates of evolution

- Vary across the country
- Driving forces for change
 - Limited water resources
 - Environmental concerns
 - TMDL program
 - CZMP program
 - Source water protection
 - Watershed protection plans

TMDL defined

$$\text{TMDL} = \text{PS-LA} + \text{NPS-LA} + \text{MOS}$$

- TMDL = Total maximum daily load
- PS-LA = Waste load allocation (PS)
- NPS-LA = Load allocation
(Anthropogenic NPS + Natural Sources)
- MOS = Margin of safety
(plus Margin for Growth?)

Changes in goals means:

- Approach must also change
 - Siting requirements
 - Choice of treatment components and systems
 - System O&M
 - Management program
 - Industry needs
- Public acceptance of change
- Public willing to pay for additional service, \$\$\$
- Enforcement on participants not willing to change – public will to support enforcement

Education

Decentralized wastewater treatment system:

- Collection, treatment, and dispersal/reuse of wastewater from individual homes, clusters of homes, isolated communities, industries, or institutional facilities, at or near the point of waste generation.
- Onsite, cluster and centralized. Most cost effective for the site conditions.

Decentralized approach

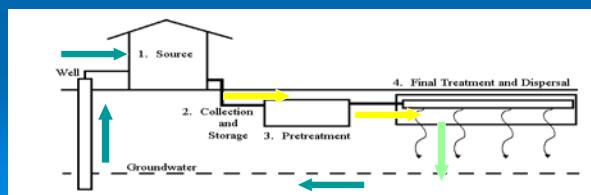


Distributed management:

- Method used to manage wastewater infrastructure where a responsible management entity (RME) combines onsite, cluster and centralized treatment in a cost effective and sustainable structure.

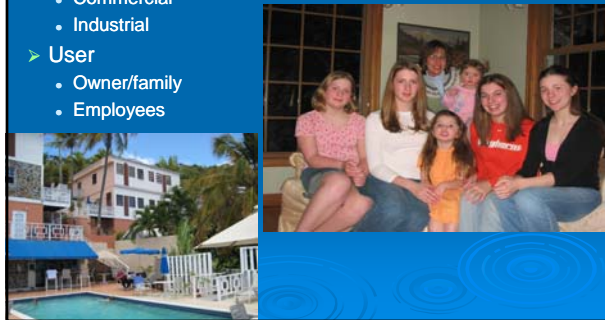
What is an onsite wastewater treatment system?

1. Wastewater source
2. Collection and storage
3. Pretreatment components
4. Final treatment and dispersal components



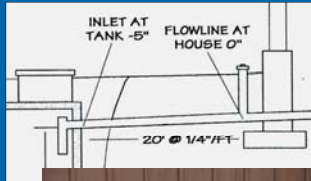
Wastewater source

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



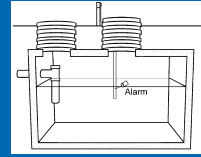
Collection

- Piping from facility with cleanout
 - Blackwater
 - Graywater



Collection Options

- Holding tanks
 - Total flow
 - Blackwater
 - Urine separation
 - Waste stream with microbial inhibitors
- Composting toilets
- Incinerating toilets



Courtesy of DIXON Mitrum

Pretreatment

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



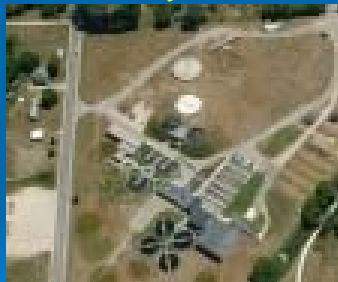
Final treatment and dispersal components



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

What is a central sewer system?

- Same components
 - Source
 - Collection
 - Pretreatment
 - Advanced treatment
 - Disinfection
 - Dispersal – mostly discharge
- Responsible management entity



City of Cadillac, Michigan

How do we make the on-site wastewater treatment system 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



Roles with septic system management

- Site evaluation
- Design
- Installation
- Startup
- Inspection
- Operation
- Maintenance
- Monitoring
- Pumping
- Point of Sale Inspection



Site evaluation

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



Site Evaluator

Design

Designer

- 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.

Installation

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



Installer

Startup

Installer

- The process of setting operational controls, verifying component function and documenting initial operating conditions of a system



Inspection

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



Designated Representative

Operation

What is it doing?

- The action of assessing whether each component of the system is functioning properly
- Each component must be operational if the system as a whole is to achieve the desired performance



Maintenance Provider/Technician

Maintenance

- The action of conducting required or routine planned performance checks, examinations, upkeep, cleaning, or mechanical adjustments to an onsite system.
- Includes Replacement of pumps, filters, aerator lines, valves or electrical components.

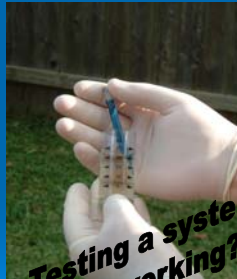


Taking care of the pieces

Maintenance Provider/Technician

Monitoring

- The action of verifying performance for a regulatory authority or a manufacturer



**Testing a system,
Is it working?**

Maintenance Provider/Technician

Pumping

- The action of removing septage from a wastewater treatment system component



Pumper

Point of sale inspection

- Inspect the treatment system at the time of property sale.
- Chance to upgrade the wastewater treatment system if needed.
- Must have trained professionals.
- No licensing in Texas for this person.



Good time to fix problems!!!

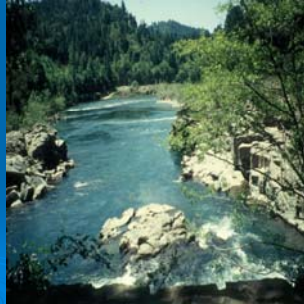
Repair

- Is the action of fixing substandard or damaged components.
 - Required repairs
 - Recommended repairs
 - Upgrades

Fixing a problem

Why perform operation and maintenance?

- Keep systems functioning properly
- Maintain effluent quality
- Early detection of problems
- Public Health
- Environmental Protection
- Public safety
- System Reliability
- Customer Satisfaction



What quality do you desire?

- Primary treatment
 - Gross solids removal
- Secondary treatment
 - BOD & TSS
- Disinfection
 - Pathogen removal
- Tertiary treatment
 - Nitrogen and phosphorous removal

King County Washington, Vashon



Primary treatment components

- Septic tank
- Bar screen
- Primary clarifier



Secondary treatment components

- Soil
- Aeration – aerobic treatment
- Secondary clarifier
- Sludge return to aeration
- Membrane bioreactors



Disinfection methods

- Soil
- Chlorine
- Ultraviolet Light
- Ozone



Tertiary treatment components

- Dilution
- Soil & plants
- Nitrogen removal
 - Denitrification
- Phosphorous removal
 - Chemical addition
 - Precipitation



Summary

- Wastewater management will play a vital role in our future infrastructure needs.
- Technologies are available for removing the constituents of concern.
- Environmental regulations will continue to be more stringent.
- Environmental health is ultimate form of public health protection.

Summary

- A site evaluation is critical to determining the potential for a site to treat wastewater.
- Advanced pretreatment and final treatment and dispersal technologies are available for most situations.
- Select the most appropriate technology and scale of system for your site.
- Operation and maintenance is critical for long-term function