NOWRA's Onsite A to Z

SEPTIC TANKS

Model Decentralized Wastewater Practitioner Curriculum

A Cooperative Effort

These materials were originally developed by the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT)

They have been adapted by members of CIDWT specifically for use in the National Onsite Wastewater Recycling Association (NOWRA) A to Z Training Program

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CIDWT
Consortium of Institutes for Decentralized Wastewater Treatment

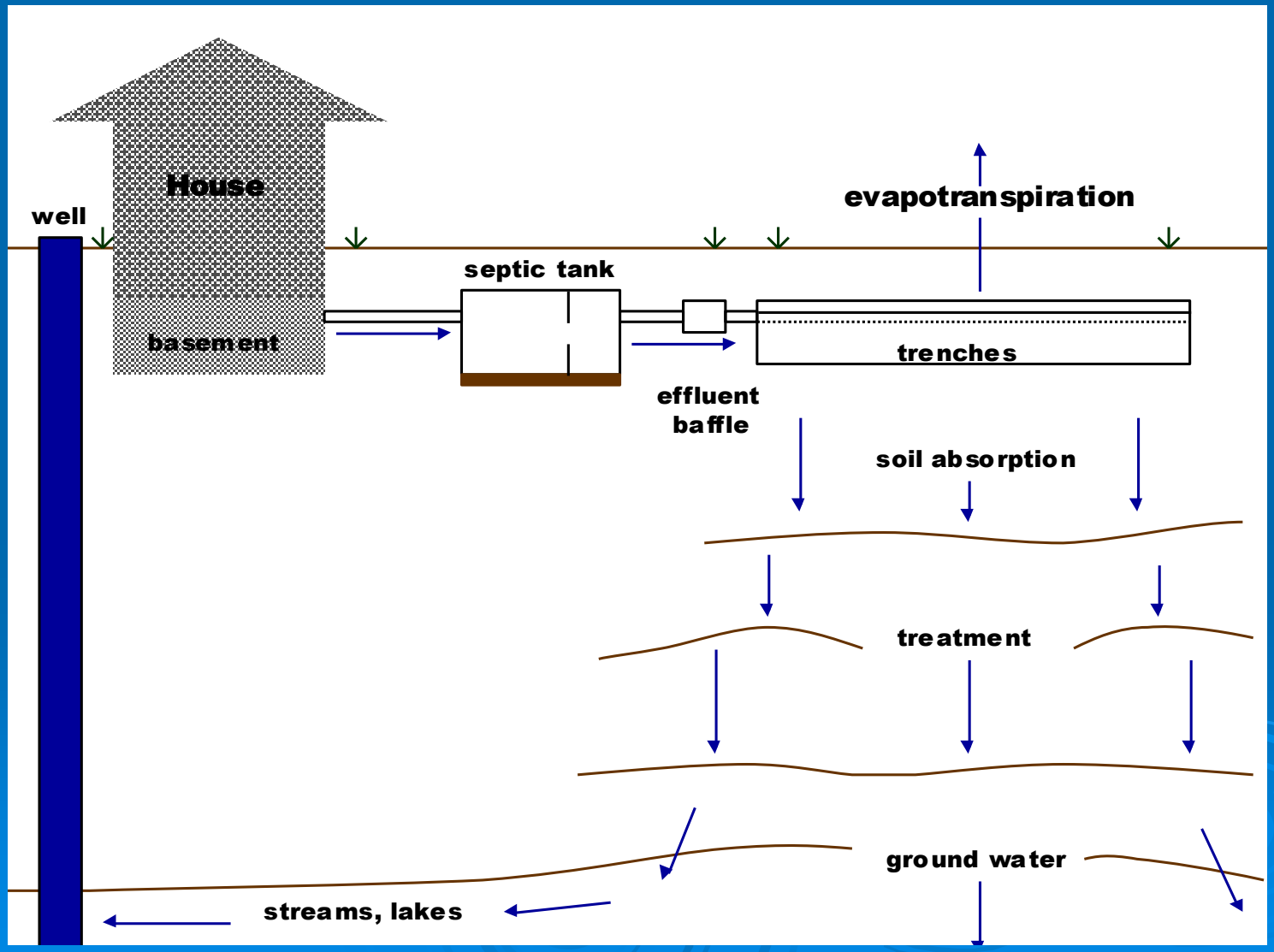
NC STATE UNIVERSITY

Citation

Loudon, T.L., T.R. Bounds, J.C. Converse, T. Konsler and C. Rock. 2005. Septic Tanks – PowerPoint Presentation. *in* (D.L. Lindbo and N.E. Deal eds.) Model Decentralized Wastewater Practitioner Curriculum. National Decentralized Water Resources Capacity Development Project. North Carolina State University, Raleigh, NC.

Overview

Typical Septic System



Tank Functions

- Solids removal by settling & floatation
  - 60-80% solids removal
- Anaerobic digestion
  - Can get 30% to 60% reduction in BOD
- Storage of solids

Average Removal of BOD, TSS, and Grease in Septic Tank

Parameter	Average Raw Sewage Influent	Average Septic Tank Effluent	% Removal
BOD (mg/L)	308	122	60
TSS (mg/L)	316	72	77
Grease (mg/L)	102	21	79

Seabloom, R.W., T.R. Bounds, and T.L. Loudon. 2005.

Treatment Classes

- Primary
  - Settling and floatation
  - Anaerobic digestion
- Secondary
  - Usually aerobic biological treatment
- Tertiary
  - Enhanced nutrient removal
  - Disinfection

What Happens in the Tank

Biological Activity in the Septic Tank

- Anaerobic (without Oxygen)
  - Incomplete
  - Cheap and easy
  - Reliable
- Gases produced are odoriferous
- Not all solids in tank are biodegradable

Factors that Influence Anaerobic Digestion

- pH
- Chemicals
- Highly variable flow patterns
- Pharmaceuticals
- Process wastewaters
- Lack of tank maintenance

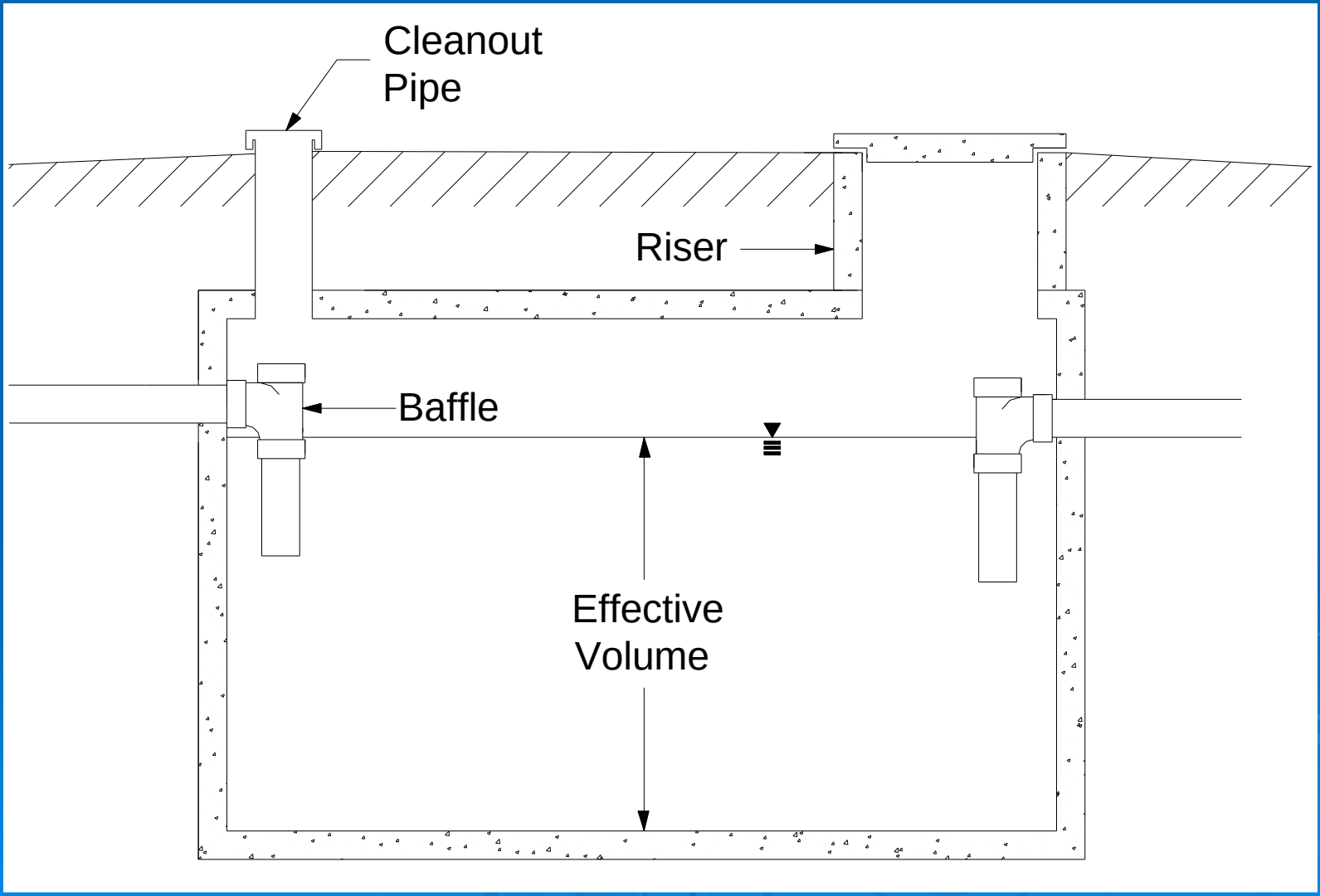
Factors that Influence Wastewater Strength

- FOGs
- Flow pattern
- Flow rates
- Nonbiodegradable items

Septic Tank Design

- Sizing
- Geometry
- Compartments
- Vehicular traffic
- Appurtenances

Effective Volume (new tank)



Tank Sizing

- Generally prescribed for individual homes based on home size
- Criteria: Hydraulic detention time plus solids storage
  - 1 to 2 days detention of design flow
  - Add solids storage volume equal to 1/3 – 1/2 of the above hydraulic detention

Septic Tank Sizing Example

- Consider a 3-bedroom home
- Design flow: 3 br, 2 people/br, 75 gpd/person
  - Flow = 3 x 2 x 75 gpd = 450 gpd
  - Provide for 2 day detention => 2 x 450 = 900 gal

Septic Tank Sizing Example

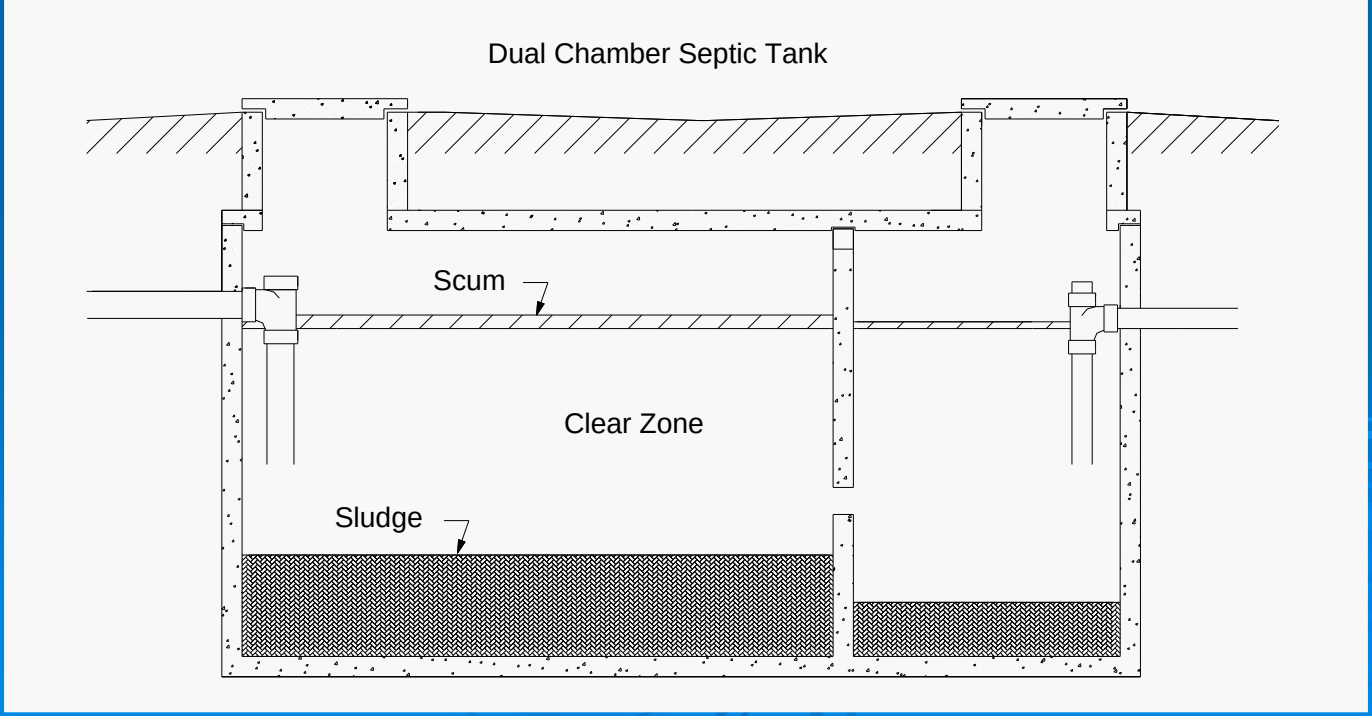
- Add solids storage
  - 1/3 of the above = 1/3 x 900 = 300 gal
- Total tank volume = 900 + 300 = 1200 gal

Septic Tank Sizing Example

- This is the minimum recommended tank size
  - The tank should have two compartments
- Many regulatory agencies now require 1,500 gal tank for a 3-br home, but sizing starts with a procedure like this.

Goal: Near Zero Velocity for Optimum Solids Removal

- Maximize distance between inlet and outlet
- Length:Width ratio at least 3:1
- Inlet to outlet drop ~ 2"



Other Factors that Affect Tank Size

- Garbage grinders
  - Add to solids accumulation rate and organic load
  - May add grease and oil
  - Increase hydraulic load some
- Though not recommended with septic systems
  - they will be used in many homes.

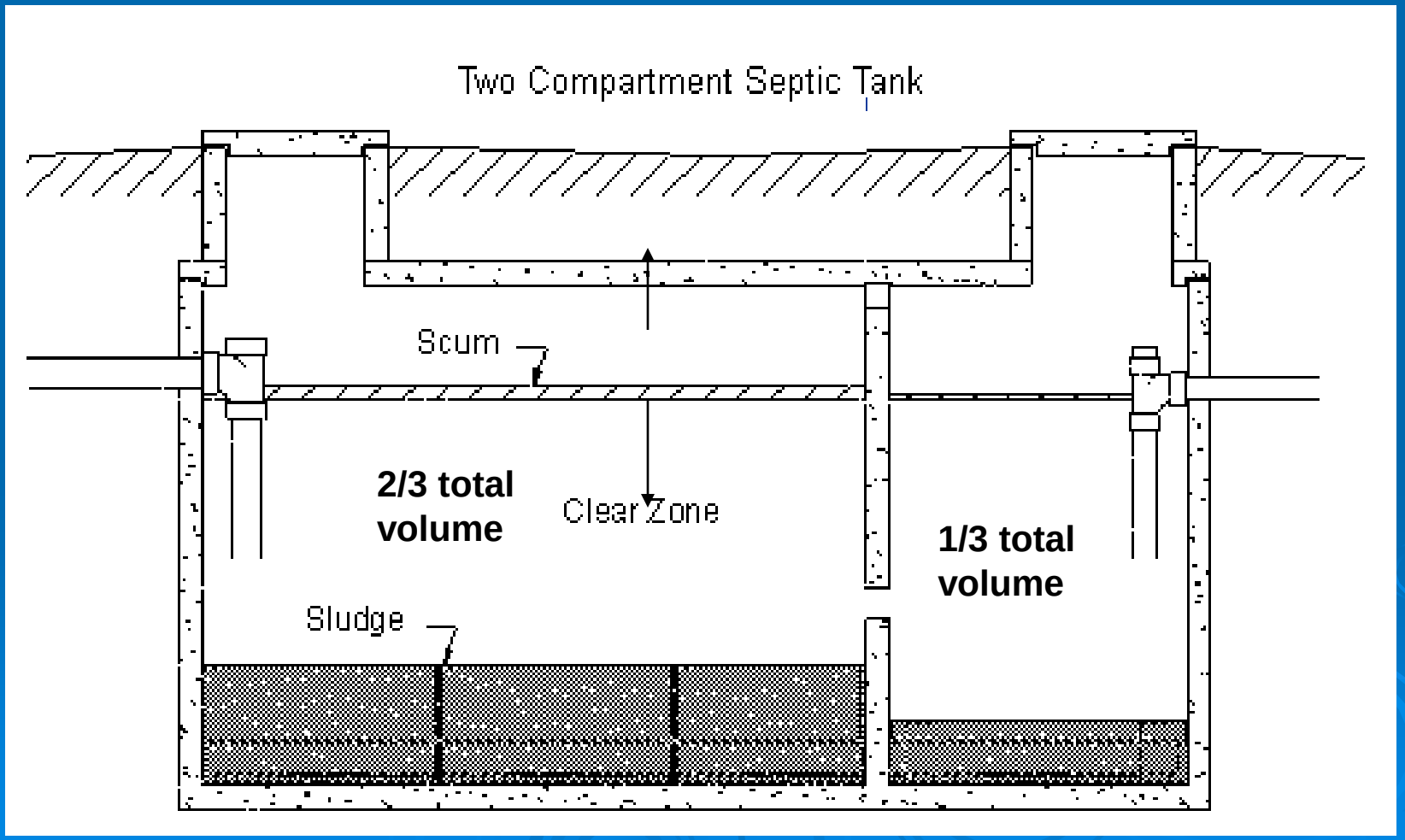
Other Factors that Affect Tank Size

- Sewage (grinder) lift pumps
  - Increase turbulence in the septic tank
  - Should discharge into sewer line – not directly to tank
  - Two compartment tanks highly recommended with pumps
  - Set pumps for minimum discharge volumes

Tank Compartments

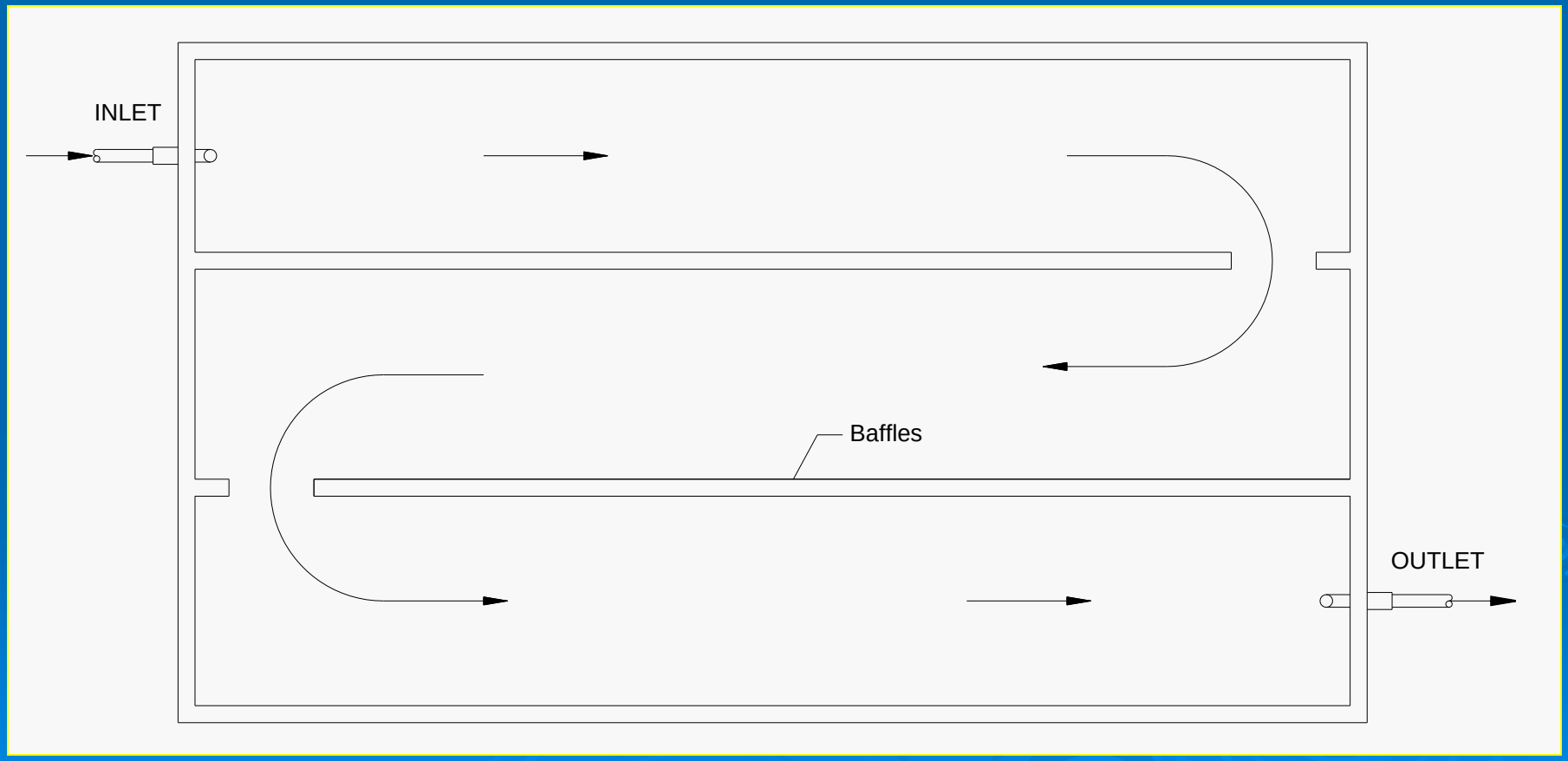
- Advantages of multiple compartments
  - More complete solids removal
  - Improved effluent quality
  - Protect against solids discharge due to lack of maintenance

Two Compartment Septic Tank



Tank Compartments

Meander Tank Design



Vehicular Traffic

- Standard concrete tanks are not designed to handle traffic loads
  - ASTM Standard C-857 provides information on these design issues
- Use other tanks in areas subject to traffic only with manufacturer guidance and engineer approval

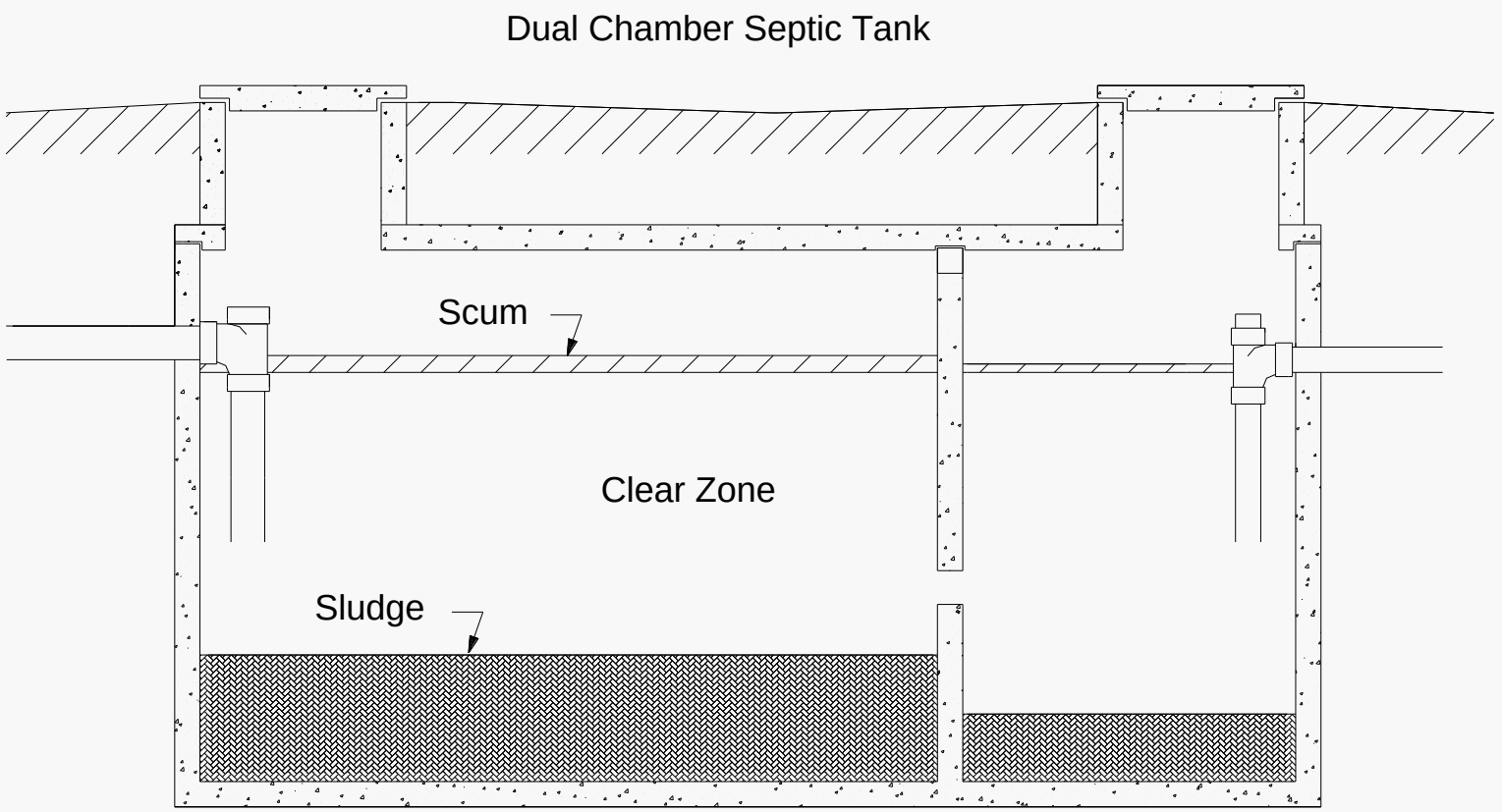
Tank Appurtenances

- Tees and baffles
- Effluent screens
- Access risers

Inlet and Outlet Baffles/Tees

- Inlet baffle
  - Directs flow
  - Minimizes turbulence and short circuiting
- Outlet baffle
  - Assures outflow comes from clear zone
  - Holds floating scum in tank

Inlet and Outlet Baffles/Tees

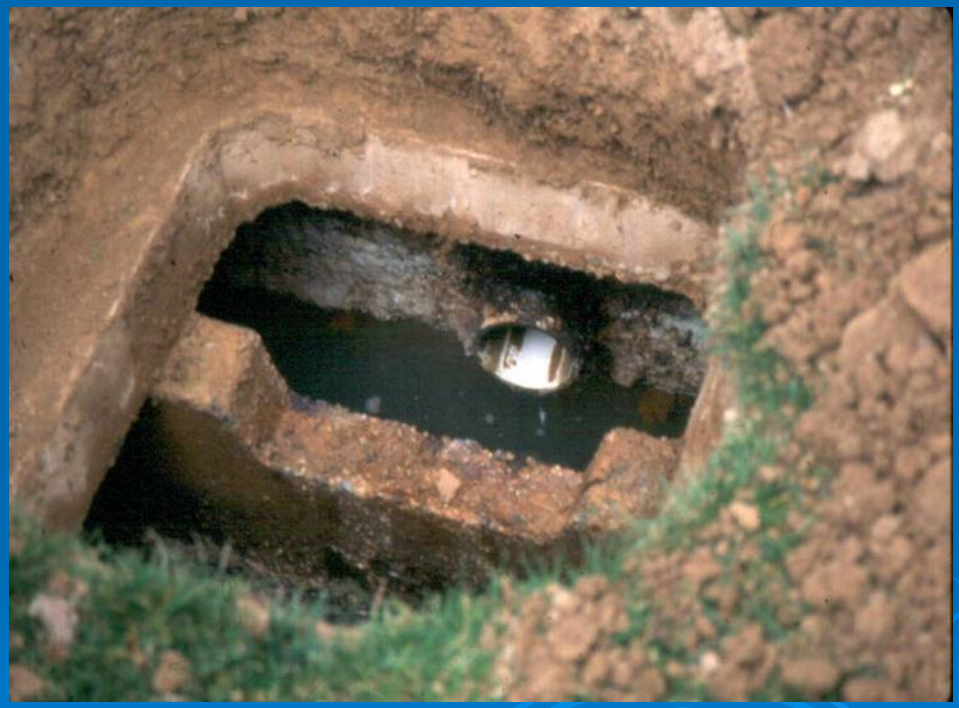


Tee-Type Outlet Baffle

- Baffle made from sanitary tee and 4-in pipe nipples
- Positioned directly under tank opening for access

Curtain Baffle

- Penetrates into clear zone
- Groove at top allows gas transfer across tank and up sewer to roof vent



Baffle Fastened to Tank Wall

Effluent Screens

- Designed to keep larger suspended solids in the tank
- Control outflow rate
- Protect downstream components
- Typically replace the outlet baffle
- Require riser to grade for access to screen

Effluent Screen Installation Issues

- Location
  - Tank
  - Sump
  - Pump vault
- Can be equipped with alarm
- Screen in second compartment of a two- compartment tank requires less service

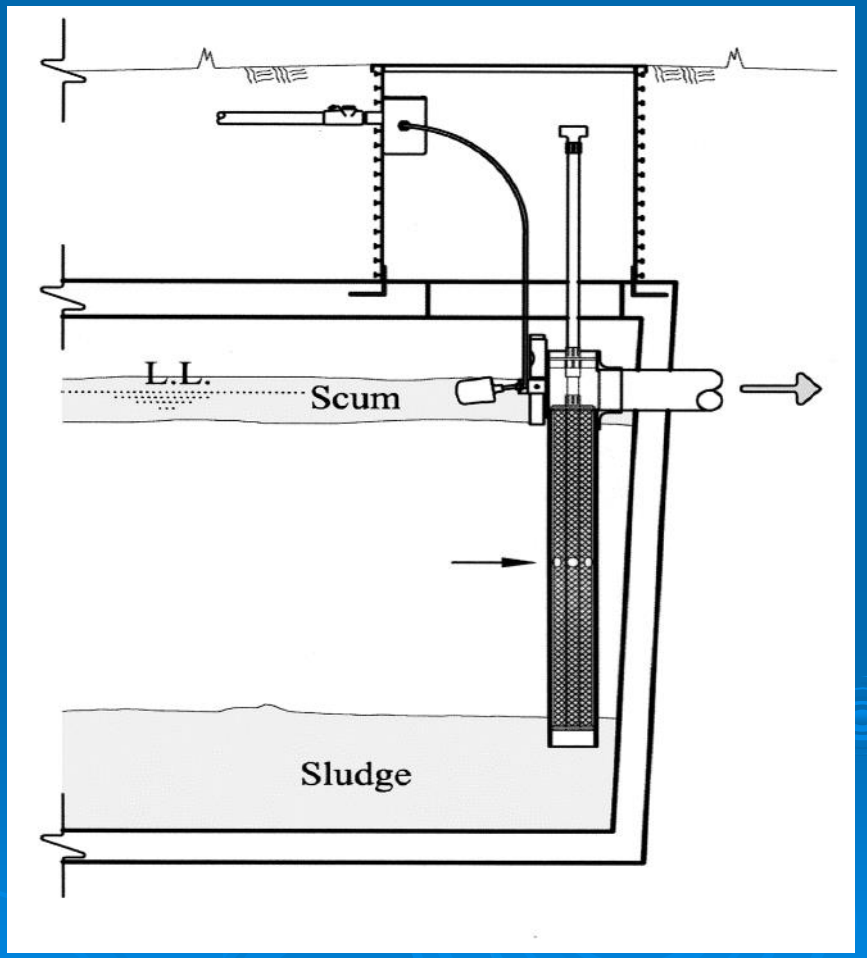
Effluent Screen Installation Issues

- Must be secure in place
- No bypass flow if clogging occurs
- Housing should not interfere with normal tank cleaning

Choosing an Effluent Screen

- Ease of serviceability
- Size appropriately for the flow
- Openings of 1/16 – 1/8 inch
- Designed to prevent solids bypass during cleaning
- Locate so that access for pumping is not hampered

Proprietary Effluent Screens



Location of Effluent Screen

Access Risers

- Provide easy access to tank & components
- A must for tanks with effluent screens or pumps
- Shallow tanks and short risers preferred

Riser Design

More Risers

Safety

Tank Construction

Tank Materials

Reinforced concrete

Fiberglass-reinforced plastic (FRP)

Polyethylene/Poly-propylene

Structural Soundness

- Withstand handling and transport
- Not susceptible to damage during installation
- Resist external and internal pressures
- Properly reinforced according to a standard
  - ASTM
  - NPCA

Seam Location for Concrete Tanks

Sealing Materials for Pre-Cast Tanks

- Blended sealant compounds
  - Butyl-rubber based
  - Asphalt-based (bituminous)

Mastic Sealant

- Rules of thumb
  - Does not compress much between thumb and forefinger
  - Cold-weather installations
  - Does not shred or snap when hand-stretched
  - Higher is better than wider
    - 50% compression is desirable
  - Knead joined ropes prior to placement

Achieving a Watertight Joint

- High quality mastics, seal gaskets
- Seams must be smooth, clean and dry
- Proper placement of mastic

Extra Measures

- Butyl rubber wrap around joint

Proof Testing Concrete Tanks for Structural Soundness

- Tanks should reach 4,000 psi before delivery to site
- Should comply with ASTM and NPCA standards
- Other engineering tests also available

Access Risers for Pre-cast Tanks

- Made from various materials
- Cast-in-place or added after tank construction

Cast-in-Place Concrete Risers

Cast-in-Place Poly Risers

Adding Concrete Risers

Mastic provides a better seal than mortar.

Adding Concrete Risers (cont.)

Adding Poly Risers to Concrete Tanks

- Adapter rings

Adding Poly Risers to Concrete Tanks

- Riser attached to adapter using adhesive and stainless bolts

Pipe Penetrations in Concrete Tanks

Pipe Seals and Risers for Poly Tanks

Pipe Seals for FRP Tanks

Access Risers for FRP Tanks

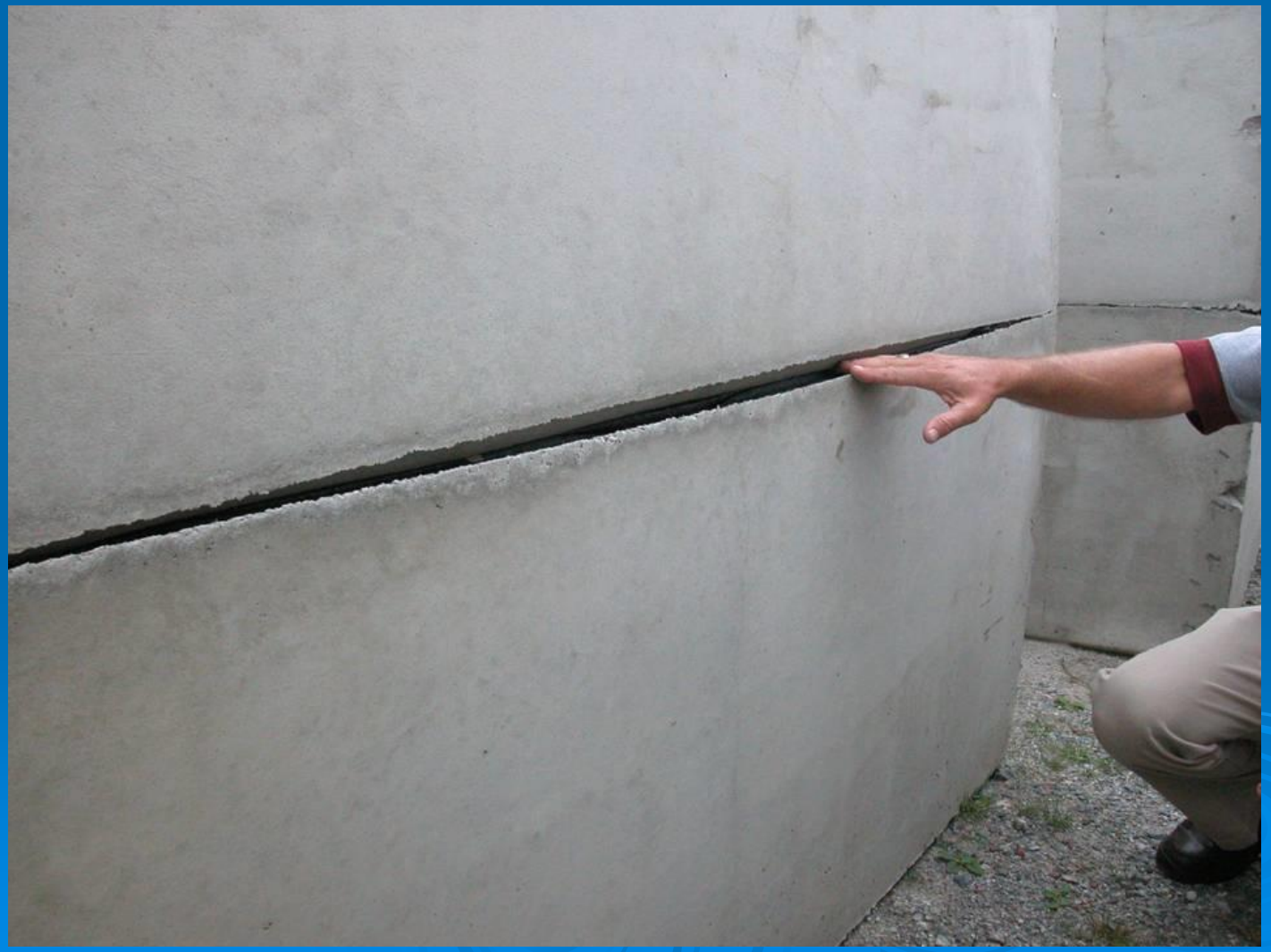
Overall Quality of Tanks: Looks are not Everything

- Cosmetic deficiencies may not affect performance
- Good-looking tanks may have structural deficiencies

Air Voids – Will they Leak?

Clean Connection between Halves

Will be Difficult to Seal

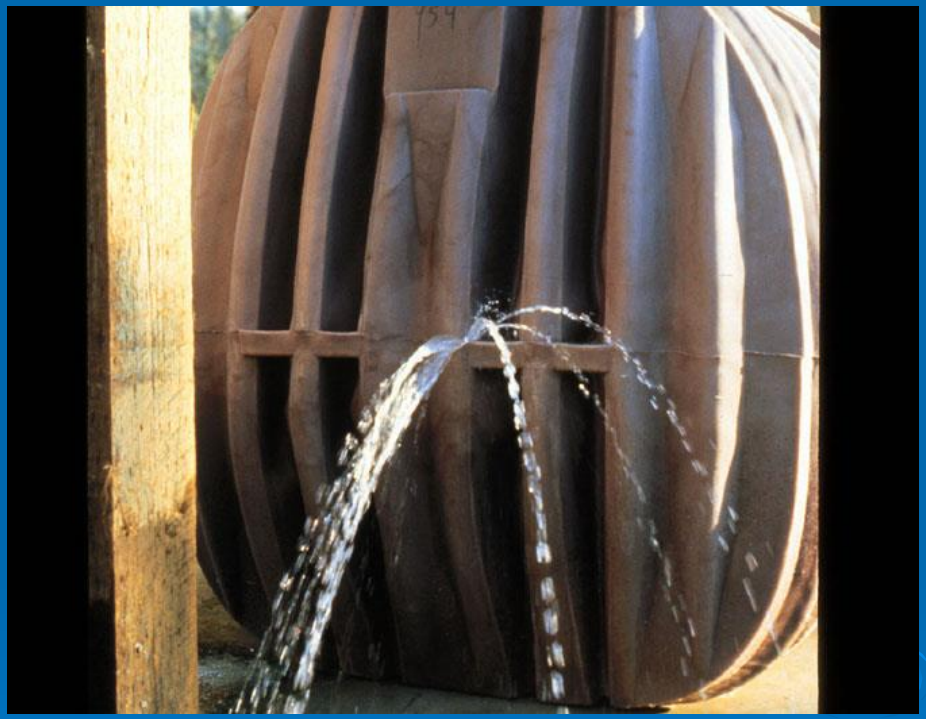


Honeycombing – Form Leak

Aggregate without Cement

Exposed Reinforcement Wire

Problems with Non-Concrete Tanks



What Makes a Good Concrete Tank?

- Reasonably smooth surface
  - No honeycombing or cracks
  - No exposed rebar or wire
- Smooth, well-made joint with mastic
  - Flexible, watertight pipe seals at all pipe penetrations
  - Cast-in-place or mechanically-attached riser with tight fitting lid

What Makes a Good Poly Tank?

- Even wall thickness – no thin areas or holes
- No deformation of riser openings
- Flexible pipe seals at all pipe penetrations
- Mechanically attached riser with tight fitting lid

What Makes a Good Fiberglass Tank?

- Properly sealed mid-seam
- No imperfections in lay-up
- No de-lamination
- No cracks or dings from handling
- Flexible pipe seals at all pipe penetrations
- Mechanically attached riser with tight fitting lid

Ultimately, it is Essential to TEST

- Investigate irregularities in tank of any material thoroughly
- If unsure, consult with manufacturer or engineer
- Testing will ensure quality, watertight installations.

Why do we Care?

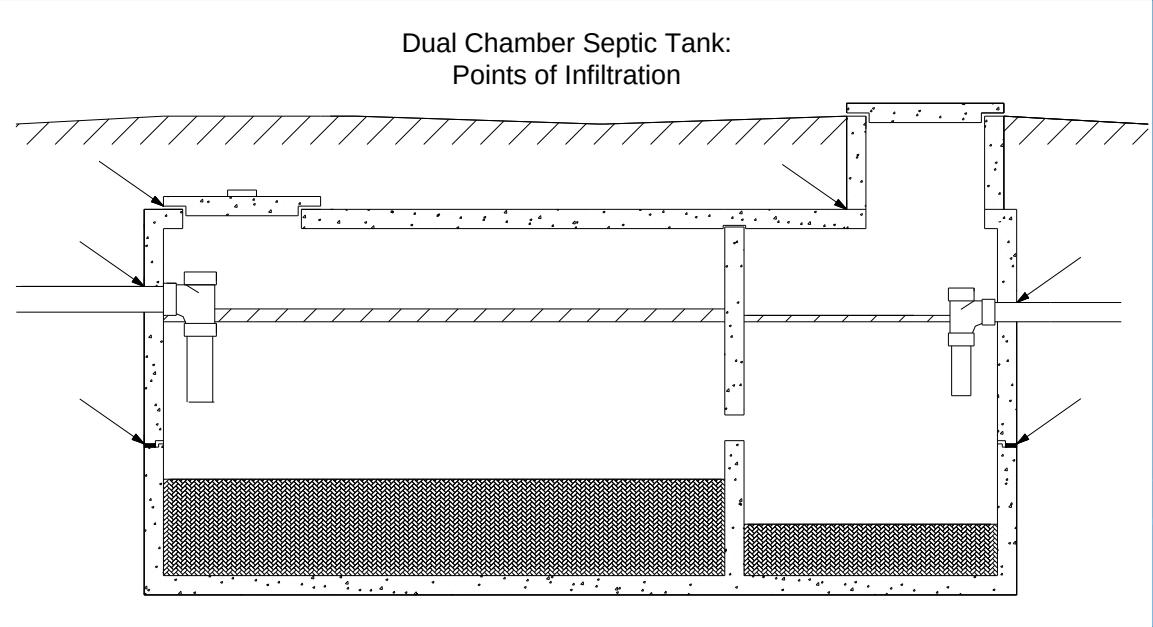
- Exfiltration could release untreated sewage deep in the soil
- Infiltration may occur
  - Disrupt settling processes in tanks
  - Overload drainfield or downstream components

Possible Points of Leakage

- Weep holes at the base of the tank
- Mid-seam or top seam joint
- Inlet/outlet pipe penetrations
- Tank top/access riser joint
- Access riser/lid joint
- Any damaged, improperly-formed location or area where material is too thin

Watertightness

- Watertight seals
  - All joints
  - Pipe penetrations
  - Riser and lid

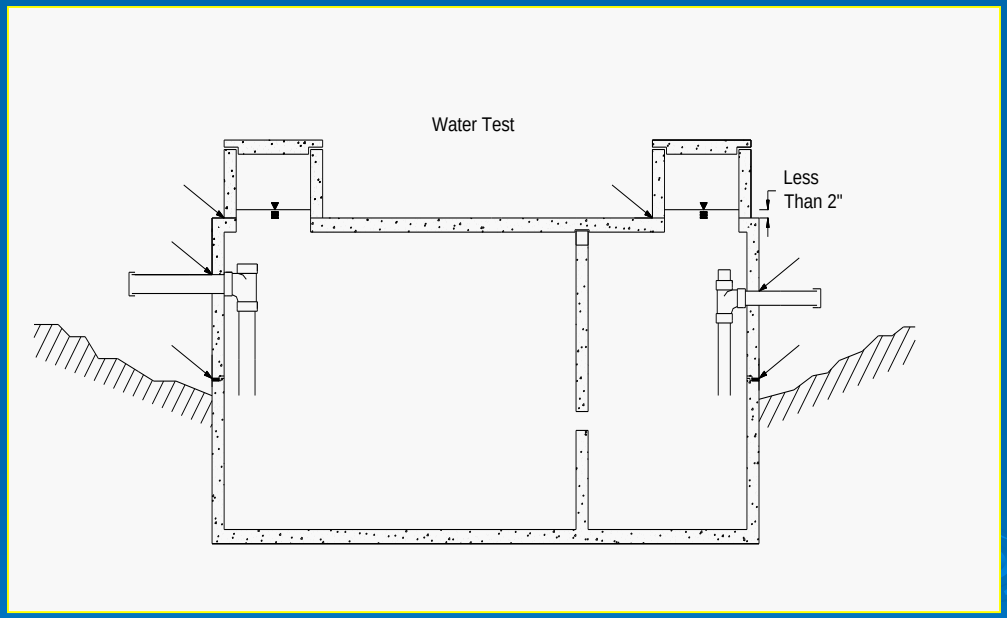


Testing for Watertightness

- Hydrostatic (water) testing
- Vacuum testing

Hydrostatic Testing New Tanks

- Prior to backfilling
  - Cap pipes
  - Fill 2" into riser
  - Soak for 24 hrs
  - Refill if concrete
  - Check in 24 hrs
  - Allowable loss is less than one gallon



Vacuum Testing Equipment

Watertightness Indicators

- Root intrusion
- High water table area:
  - Pump during wet season and look for infiltration
  - Outflow when there is no inflow
  - Beware of floatation
- Excavate outside of tank and look for evidence of exfiltration – blackness, odor, etc.

Recommendations to Homeowners

Myths and Additives

- Tanks typically do not require additives
  - No need to “start” a tank with a dead chicken (or possum)
  - Adding yeast, while harmless, is not needed
  - Commercial additives are normally not needed

Myths and Additives

- Beware of any additive that suggests it will reduce pumping frequency
  - Normal function means some accumulation
  - Solids may be washed out to next downstream treatment component
  - Independent research shows no benefit

Things that degrade slowly in the tank

…and accumulate as scum

- Toilet paper
- Hair
- Laundry lint
- OIL and GREASE

Things that do NOT Belong in the Tank

- Cigarette butts
- Coffee grounds
- Cooking fats
- Paints & chemicals
- Paper towels
- Female sanitary products
- Disposable diapers
- Condoms

‘Care and Feeding’ Recommendations

- Avoid simultaneous discharges
  - Showers, washing clothes and running the dishwasher all at once
- Spread laundry out – avoid consecutive loads,
  - Install a laundry lint filter

Care and Feeding' Recommendations

- Keep non-sewage water out of the system (clear water)
  - Water softener backwash (ongoing debate)
  - Footing drain sump pump discharge
  - Floor drains
  - Condensate from heating/cooling systems

Discussion and Questions?