Installation Keys for Long Term System Performance

Sara Heger
sheger@umn.edu
septic.umn.edu

Installation challenges and solutions

- Wet sites
  - Keeping soil nature at infiltrative surface
  - Compaction and smearing
  - Dewatering
- Cold climate
- Proper elevation and grade
  - Bedding
  - Steep slopes
- Small lots
- System overloading

Concerns for installation on wet sites

- Dewatering may be needed
- Soil smearing and compaction more likely
  - Soil must be treated carefully
- Check weather before starting construction & be prepared

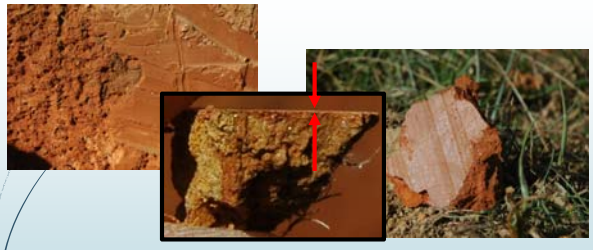
Soil considerations for installation on wet sites

- Excavation only when:
  - Soil is dry enough
  - Soil is below the plastic limit
    - Field check of moisture content
  - Soil is not frozen

Soil smearing

- Smearing: the spreading and smoothing of soil particles by sliding pressure
  - Any sandy loam or finer textured soil can be susceptible to smearing if enough water is present
  - This is why we test the plastic limit before construction

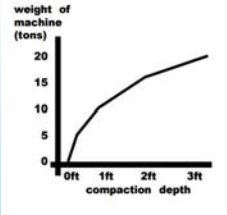
Smearing

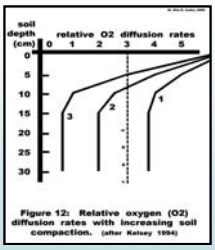


Soil Compaction – 3 different things

- *Compression* is the loss of soil volume
- *Compaction:*
  - Translocation and resorting sand, silt, and clay particles
  - Destruction of soil aggregates
  - Collapse of aeration pores
- *Consolidation* is the deformation of the soil destroying any pore space and structure
  - Water is squeezed from the soil
  - Process leads to increased internal bonding and soil strength as more particle to particle contacts are made and pore space is eliminated

Soil Compaction





10 cm = ~ 4 inches

Soil abuse

Smearing

- Reduces porosity
  - Textural
  - Structural
- Occurs as a thin zone (<1/8" thick)
- Caused by bucket or blade pressure
- May occur when soil is wet or dry
- Can be repaired

Compaction

- Reduces porosity
  - Textural
  - Structural
- Occurs over large area or thickness
- Caused by traffic, compression, storage of heavy materials
- More likely to occur when soil is wet
- Difficult to repair

Field testing of soil moisture

- Plastic limit procedure
  - Grab a ped/clump of soil from infiltrative surface
    - Do not add water
  - Try to roll into a wire/pencil

Field testing of soil moisture

- If wire/pencil is:
  - 1/8 inch in diameter and
  - 2 inches long without crumbling
    - Moisture content is above plastic limit
    - Construction should NOT proceed

Frozen soils

- Any frost is too much frost for an above- grade system
- For below grade trenches frost could be present, however cannot extend to the depth of the required sidewall or bottom area of the trench/bed
- Snow should be removed with caution

Frozen soil-why are they bad?

- No way to test the plastic limit
  - Wet fall
- Scarification will not work
  - Soil can be frozen solid
  - Large clumps instead of exposing natural soil structure
  - Shattering in dry frozen soils
- If scarified when frozen,
  - as the soil thaws it can "seal off" the scratched area
- The large frozen clumps will also hamper constructability

Frozen soil-why are they bad?

- Stock piles of sandy/loamy soil material (cover) or topsoil should not be allowed to freeze
- Attempting to use this material for cover will result in:
  - Uneven cover thicknesses
  - Increased erosion potential
  - Difficulties in establishing vegetative cover
  - Poor frost protection

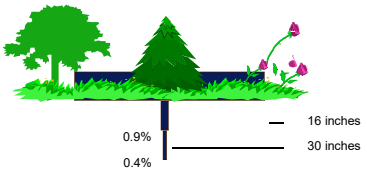
Protecting exposed natural soil

- If site has been scarified, immediately cover with media to prevent
  - Damage
  - Contamination
- When you can't cover exposed soil immediately, protect area with tarp

Maintaining natural soil conditions

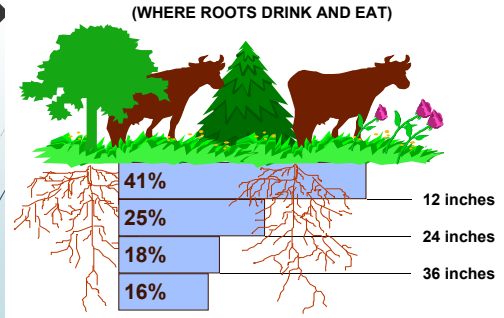
- Soil located at or near the soil surface is generally the best for:
  - Treatment
  - Dispersal
  - Oxygen-transfer
  - Evapotranspiration
  - Natural biological activity

SOIL BIOTA POPULATION VS SOIL DEPTH



WATER USE

(WHERE ROOTS DRINK AND EAT)



Oxygen levels with depth – case study

Depth	Wet Time Periods	Dry Time Period
Inches	(mg/L)	(mg/L)
3.9	13.7	20.6
9.8	12.7	19.8
17.7	12.2	18.8
35.4	7.6	17.3
47.2	7.8	16.4

Techniques to maintain natural soil conditions of infiltrative surface

- Do not drive excavation equipment or other vehicles over
- Limit foot traffic
- Rake sidewalls of trenches and beds
- Use low ground pressure equipment
- Position equipment upslope of system when placing media

During home construction

Post system installation

Compacted site – what to do?

- Avoid compaction
- Discuss options with Designer/Local unit of government
- Determine severity
- Move system location
- Time will help
  - Freeze/thaw
  - Root activity
  - Weathering
- Experimental methods
  - Lower loading rates
  - Mechanical soil fracturing
  - Deep plowing/ripping
  - Removing & backfilling

Construction techniques for cold climates

- Freezing may only be an issue 1 in 10 years, but better to prevent it
- Key techniques
  - Keep proper slope on pipes
  - Insulate where appropriate
  - Bed pipes properly to prevent dips

Construction techniques for cold climates

- Tanks and pretreatment units
  - Insulate when there is less than 2 feet of soil cover
- Soil treatment system
  - Limit traffic over system
  - Vegetation is a critical part of natural insulation
    - Vigorous growth in the fall is advantageous
    - Fall installations should have temporary insulation – place light mulch material

Techniques for installation at the proper elevation and grade

- Concern: Many components must be installed level and stable for the system to properly treat and disperse wastewater
  - Non-level and non-stabile installations can result in reduce retention times, hydraulic overload and component failure
- Critical to level components
  - Septic tanks
  - Advanced treatment

Proper elevation and grade

- Soil treatment area
  - Media/soil interface is critical
  - Distribution devices must be properly bedded to achieve even distribution
  - Pressure systems - laterals must be level

Over-excavation

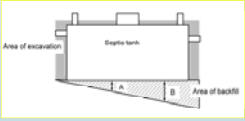
- Should be avoided whenever possible by the use of a laser
- Stability is essential

Why over-excavate?

- Some good reasons:
  - Rocks
  - Organic peat soils
  - Large diameter trees
  - Loose fill material
  - Soil substitution
- A bad reason - construction mistake
- Solution: proper backfilling/ bedding is critical to assure components are stable

Selecting bedding and backfilling materials

- Key issues are:
  - Can the material be effectively compacted?
  - Is there potential that water will collect in the area where material is being installed?
  - Note – areas with more bedding materials will settle more (B will settle more than A)



Proper backfill?

Compaction equipment

- Machine or mechanism used to reduce the volume of soil through compaction
- Two main types of compactors:
  - Plate
  - "Jumping jack"

Where do we use a compactor?

- Pipe bedding
- At bottom and along sides of tank excavation area
- Around modular media filters and ATUs

Where do we not use a compactor?

- In media filters
- Soil treatment areas
  - infiltrative surface
  - absorption area
- Around fragile components which could be damaged

Compaction in filters, mounds and areal fill systems

- Foot traffic
- Light watering
- Tracked equipment traffic after minimum base of material in place

Installation techniques for steep slopes

- Safety is #1
- Check your local codes for maximum slope
- Maintain the required vertical separation
- Hand installation needed in extreme situations

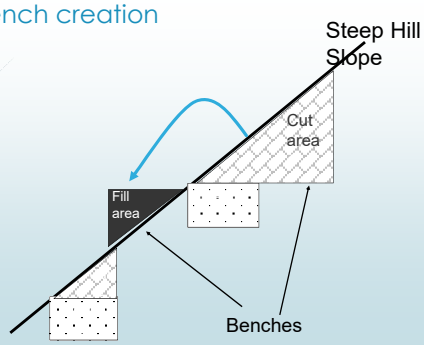
Installation techniques for steep slopes

- If tracked equipment is used a pad is needed to dig a level excavation
- Wheeled backhoes can self-level through the use of stabilizers

Installation techniques for steep slopes

- Construction techniques depend on the depth of soil available for excavation:
  - Deep soil
    - Create a bench by cutting out soil on the upslope of the first trench
    - Place the excavated material down slope to create a bench for the second trench excavation
  - Shallow system (less than 24" from grade)
    - Typically take soil from the first trench to create a bench for the second trench down slope

Bench creation



Small lots

- Too little space
  - Setbacks
  - Tough Soils
  - Short contour
  - Too much water
- High BOD

Small lot solutions

- Variances
  - Right Group
  - Deal with FIRST!
- Timer: Reduced flow design
  - Watch organic loading

Small lot~ high BOD

- I/A technology
  - Organic loading versus hydraulic
  - Organic design
- BOD/TSS/FOG
  - Be careful of FOG

System overloading

- System: Food
  - Hydraulic loading
  - Organic loading
- Site: Oxygen
  - Soil type
    - Texture
    - Structure
  - Separation
  - Depth
  - Geometry [Width]

Why does a biomat get too thick?

1. Physical processes:
   - Solids in wastewater
   - Fines in backfill or drainfield rock are trapped
   - Surface soil can be compacted during construction

Why too thick?

- Biological processes:
  - Masses of microorganisms collect at the infiltrative surface

Why too thick?

3. Chemical processes:
   - Waste products of microbiological metabolism accumulate

Hydraulic overload

- User
- System
  - Components
  - Surface water

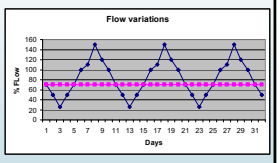
Solutions: lowering hydraulic loading

- Reduce usage
  - System owner uses less water, eliminate water softener, iron filter, add low flow fixtures and appliances, fix leaky toilets and faucets, etc.
- Time dosing with surge storage
- Holding tank for peak events

- Front loading machines
  - 65% less water
  - 12 – 20 gallons

Flow equalization systems

- Makes the flow introduced to the treatment system more consistent.
- Flow equalization is important if
  - The average flow is ≥ 70% of the design capacity
  - Water use habits or facility operations are variable - example church only open on Sun
  - Frequent peaks exceed system capacity
    - Wash day; cleaning service



Solutions - lowering organic loading

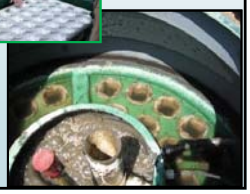
- BOD
  - Recoverable
  - Eliminate garbage disposal or other waste additive equipment or activities
  - Use composting toilets to provide hydraulic and organic discharge reductions
  - Add a treatment product to reduce organic loading

Lowering organic loading

- TSS
  - Organic – recoverable
  - In-organic
    - Difficult to recover
    - Lint, soil, others
  - Plugging of soil pores
  - Terra-lifting?

Technology applications

- Reduce organic levels
  - Cleaner effluent may be easier for soil to accept
- Residual oxygen in effluent
  - Can help reduce biomat
- Time dosing with some units to spread out loads



Other potential solutions

- Rest the system
  - Zone off a section of the soil treatment area
  - Pump the tank and system (i.e. operate as a holding tank)
- Add compressed air and 'beads' to open up the soil
- Re-build and replace the distribution media in the system
  - Typically a mound or sand filter

Thanks for having me!

sheger@umn.edu septic.umn.edu H2OandM.com