

GRANITE STATE DESIGNERS & INSTALLERS
New Hampshire's Association of Septic System Professionals

Installation Keys – Cold Weather Focus

UNIVERSITY OF MINNESOTA
ON-SITE SEWAGE TREATMENT PROGRAM

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March 13, 2017

Installation keys overview

- ◆ Material issues
- ◆ Keeping soil conditions natural
 - Keeping soil nature at infiltrative surface
 - Compaction and smearing
- ◆ Cold climate considerations



Proper installation is REALLY important!

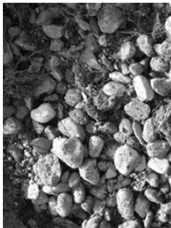
- ◆ Using good material and techniques are critical for long term system performance
- ◆ If site or soils are negatively impacted the ability for site to treat and accept wastewater long term will be decreased



Media specifications

Media specifications

- ◆ Installer must make sure media available meets specifications of system designer and codes!
 - Know what material to ask for
 - Get documentation that material is what you ordered
 - Know what it should look like
 - Know how to double check if needed
 - Document with pictures




Treatment media - sand

- ◆ Treatment media in:
 - Filters
 - Mounds
- ◆ Washed to be free of silt and clay particles (fines <5%) to prevent system failure
- ◆ Check design & local code for allowable amount



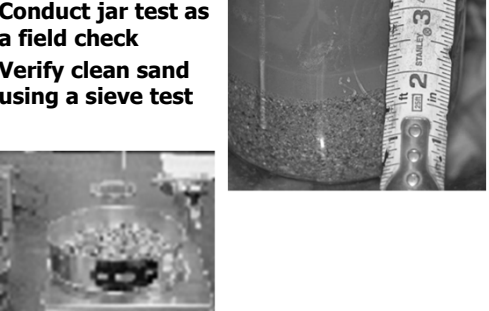
Fines reduce treatment performance

- ◆ Fines migrate to bottom and form a restrictive layer
 - Holds effluent and water in pore space
 - Effluent and water wicked upwards into media due to capillary action
 - Reduced pore space
 - Less air transfer
 - Less space for sloughing of biomass to move through media



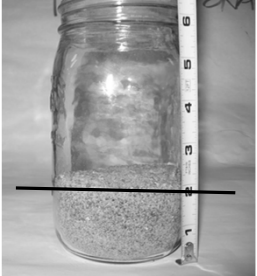
Sand quality tests

- ◆ Conduct jar test as a field check
- ◆ Verify clean sand using a sieve test




Jar test – field procedure - I

- ◆ Place two inches of sand in the bottom of a quart jar



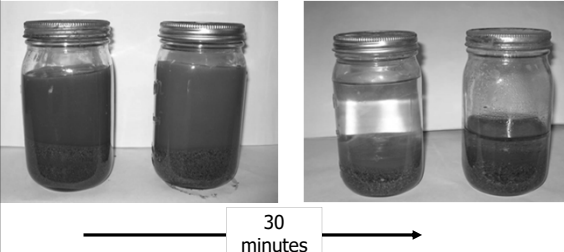
Jar test – field procedure - II

- Fill the jar 3/4 full of water
- Cover
- Shake for 1 – 2 minutes



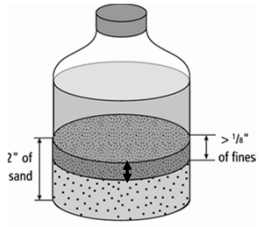
Jar test - field procedure - III

- ◆ Allow jar to stand for 30 minutes

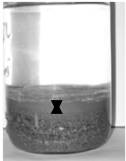


Jar test - field procedure - IV

- ◆ Measure layer of fines on top of sand
- ◆ Layer should measure less than 1/8"




If the fines that settle out in 30 minutes accumulate to a depth of greater than 1/8", then the percentage of fines is too great and the sand should not be used for mound or sand filter construction.



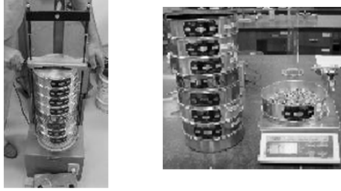
Sand size characteristics

- ◆ Specific size
- ◆ Uniformity coefficient
- ◆ Effective size
- ◆ Sieve test is a method to characterize the size of the sand



Sieve analysis

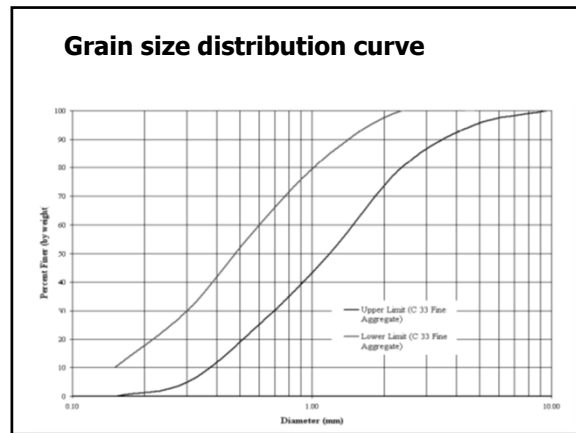
- ◆ Soil sample is placed on top sieve and run through a shaker to separate different size grains



- ◆ Material collected from each sieve is weighed and the point data plotted


Example sieve analysis

Size Number	mm	Individual Retained Weight (grams)	Cumulative Percent Retained	Cumulative Percent Passing
8	2.36	127.0	18.7	81.3
16	1.18	189.5	46.5	53.5
30	0.60	140.0	67.1	32.9
50	0.30	105.0	82.5	17.5
100	0.15	93.0	96.2	3.8
200 FINES	0.075	25.5	99.9	0.1
Pan		1.00		




Sand media installation

- ◆ Mounds and media filters
- ◆ Sand installed in lifts of 6-8 inches
- ◆ Foot compaction and light watering to reduce volume of pore spaces
- ◆ In mounds, after 6-12 inches of media has been installed tracked equipment maybe allowed across area
- ◆ Compaction equipment should not be used




Rock characteristics - "clean"

- ◆ The rock must be "clean" as dirty rock has fines (silt and clay particles)
- ◆ These fines can cause system failure because they will reduce the long term acceptance rate of the underlying soil or media



Dirty Rock



Keeping soil conditions natural


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




Roughing

- ◆ Scarification - process of scratching the absorption area
 - Stake first
 - Proper elevations
 - Green side down
- ◆ Backhoe
 - Never drive on loosened soil
- ◆ Do not smear or compact soil
- ◆ Check if soil is too dry or wet prior




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




Can the soil be too dry?

- ◆ Yes! Soils which are too dry when worked are smeared by the bucket
- ◆ Fine soil particles separated and stratified into layers
- ◆ Stratification impairs the movement of wastewater due to silty layer formation




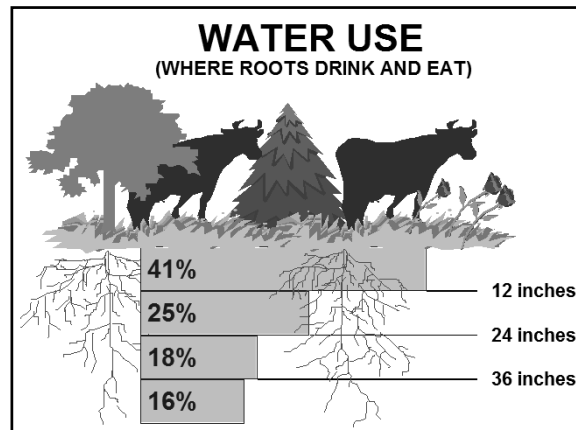
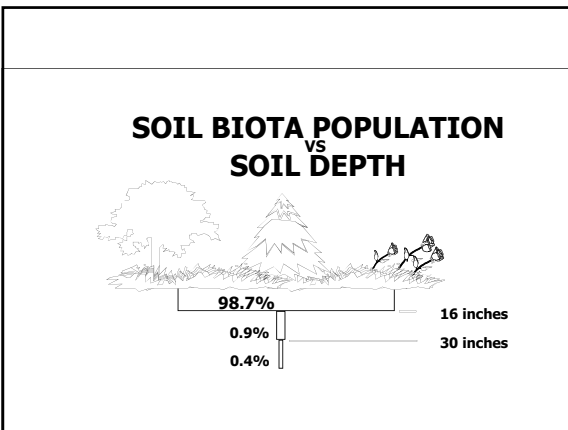
Topsoil benefits

- ◆ Typically soil for treatment and dispersal
- ◆ Removing increases likelihood of damaging soil
- ◆ May assist with nitrogen removal process
- ◆ Topsoil has been shown to be effective at removing chemicals of emerging concern



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

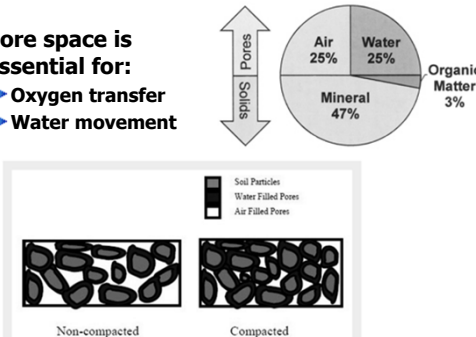
Protecting exposed natural soil

- ◆ 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



Maintain pore space

- ◆ Pore space is essential for:
 - > Oxygen transfer
 - > Water movement




Component	Percentage
Air	25%
Water	25%
Mineral	47%
Organic Matter	3%

Oxygen levels with depth case study

Depth	Wet Time Periods	Dry Time Period
<u>Inches</u>	<u>(mg/L)</u>	<u>(mg/L)</u>
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





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

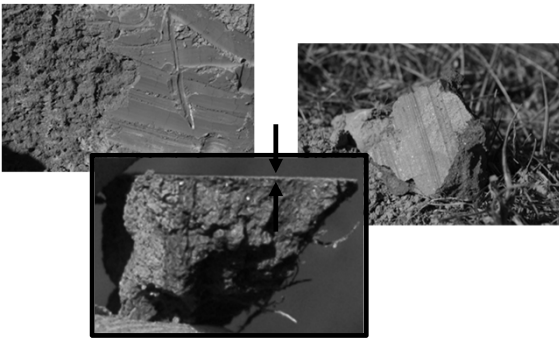


Soil smearing

- ◆ 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

1. **Compression** is loss of soil volume
2. **Compaction**
 - Translocation and resorting sand, silt, and clay particles
 - Destruction of soil aggregates
 - Collapse of aeration pores



3. Consolidation

- ◆ 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

Compaction

- ◆ If a piece of equipment could run over an area 10 consecutive times and one could measure soil density after each pass one would find the following:
 - 70% of total compaction of all 10 passes occur with first pass
 - 10% of total compaction of all 10 passes with the second pass
 - 5% of total compaction of all 10 passes with the third pass

Compaction under dual tires

17 psi 30 psi

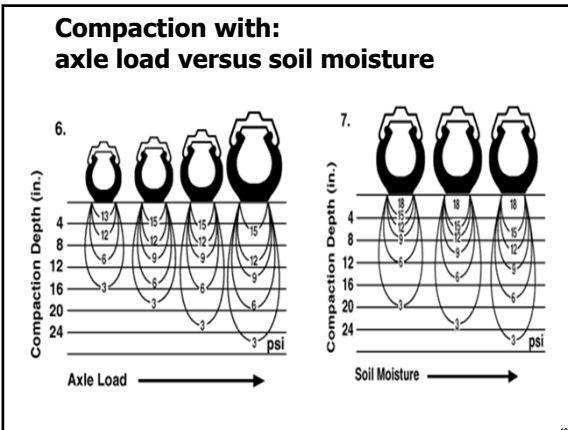
Compaction under different tire design

Large PSI per surface contact

Soil compaction by weight of machine and oxygen diffusion rates

Figure 12: Relative oxygen (O₂) diffusion rates with increasing soil compaction. (after Kelsey 1994)

10 cm = ~ 4 inches



- ### Strategies to reduce compaction
- ◆ Reduce tire pressure to minimal allowable pressures
 - ◆ Use tracks or duals to replace singles
 - ◆ Install larger diameter tires to increase length of footprint
 - ◆ Work from upslope of soil treatment system whenever possible
 - ◆ Use smaller equipment - Avoid oversized
 - ◆ Combine field operations
 - ◆ Protect the soil treatment area




Soil compaction

Person walking	8-12 psi
Bulldozer - D5 Cat.	7- 9 psi
- D7 Cat.	8-10 psi
- D8 Cat.	10-13 psi
Ag. Tractor - Rear	15-20 psi
- Front	35-45 psi
Rubber-tire Scraper	40-60 psi
Sheepsfoot Roller	> 300 psi
Person in high heels	> 860 psi

Compacted site – what to do?

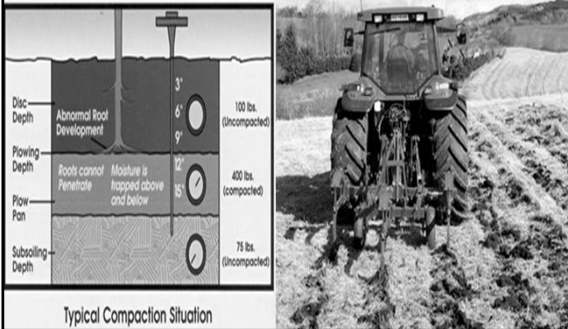
- ◆ Avoid compaction
- ◆ Discuss options with Designer/Local unit of government
- ◆ Determine severity
- ◆ Move system location
- ◆ Time will help
 - Freeze/thaw
 - Root activity
 - Weathering
- ◆ Experimental methods
 - Lower loading rates
 - Mechanical soil fracturing
 - Deep plowing/ripping – shank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



Overcoming compaction

- ◆ Can never return to natural
- ◆ Till/Rip/Bust when DRY!
- ◆ Till/Rip/Bust through the whole restrictive zone!
- ◆ Addition of organic matter will assist in the long term to provide structural stability!

Tillage techniques to shatter compacted layers



Disc Depth	Abnormal Root Development	3"	100 lbs. (Uncompacted)
Plowing Depth	Roots cannot Penetrate	6"	400 lbs. (compacted)
Plow Pan	Moisture is trapped above and below	9"	75 lbs. (Uncompacted)
Subsoiling Depth		15"	

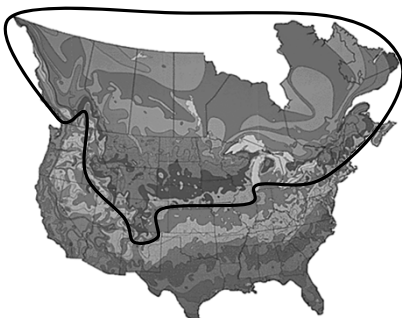
Typical Compaction Situation

Must shatter completely through all compacted zones




Cold climate considerations

Where is freezing a concern?



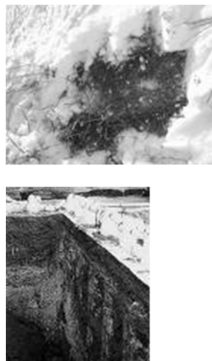
Extreme winters

- ◆ No snow = no insulation
- ◆ Frost recorded at depths greater than usual
- ◆ Municipal sewage and water lines freeze too!



Can I install in frozen soils?

- ◆ Any frost is too much 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?

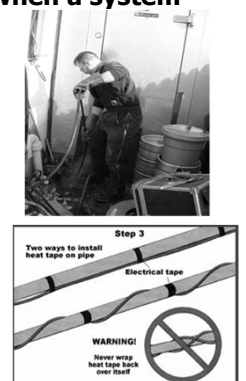
- ◆ Stock piles of sandy/loamy soil material (cover) or topsoil should not be allowed to freeze
- ◆ Attempting to use this material for cover will result in:
 - > Uneven cover thicknesses
 - > Increased erosion potential
 - > Difficulties in establishing vegetative cover
 - > Poor frost protection

Why do systems freeze?

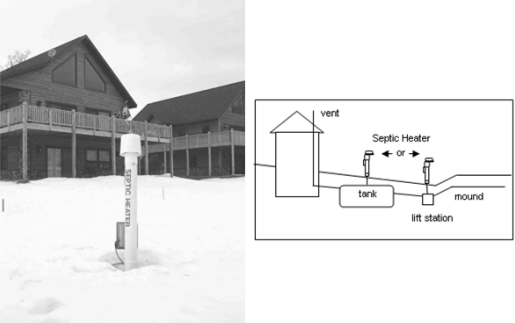
- ◆ Lack of snow cover, cold temps = frozen soil
- ◆ Compacted snow or soil
- ◆ No plant cover
- ◆ Low or no water use (including leaking fixtures, high efficiency furnaces)
- ◆ Pipes not draining = saturated flow of water
- ◆ Cold air entering the system
- ◆ Water logged system = saturated flow of water
- ◆ Enough contact time to freeze

Immediate tasks when a system freezes

- ◆ Tell homeowner to shut pump off if part of the system
- ◆ If soil treatment system is not frozen
 - > Jet or steam out the lines
 - > Heat tape or thermostatically-controlled heat cables can be used to wrap pipes.
 - > Heat tape for inside pipe exists too



Septic heater?




Immediate Tasks when System Freezes Cont'd

- > Add a heater
 - STEP-HEAT - low voltage heating of small or large storage tanks
 - Stock tank heaters
 - Septic heater
- > Send camera down line to see if pipe has fall and where blockage is
- > Thaw system –heat blankets
- > Use tanks as holding tanks until spring
 - Minimize water use
- > Do NOT
 - add antifreeze, salt or an additive
 - pump out sewage onto the ground surface
 - start a fire over the system
 - run water continually to try to unfreeze system.

1. Pipe From House to Tank

- ◆ Check for leaking fixtures and low water using devices such as high efficiency furnaces
- ◆ Verify that pipe has proper fall
 - > 1 inch in 8 feet –2 inches in 8 ft
 - > Laser, camera or backhoe




2. Septic or Pump Tank Froze

- ◆ Verify baffles are still in place and have not been damaged
- ◆ Verify that tank has not cracked
- ◆ Add Styrofoam over tank
- ◆ Notify homeowners that if emergency pumping was done not through the manhole = no maintenance
- ◆ Verify pump and floats working properly
- ◆ Bring manhole with pump to the surface, add Styrofoam under lid or add mulch over the top in fall.
- ◆ Insulate!


3. Pipe to Soil Treatment Area

- ◆ Verify proper fall and leaky fixtures
- ◆ Make sure drain back is set up right
- ◆ Replace all check valves and systems set up with effluent draining through the pump
- ◆ ¼ inch weep hole located in the lowest portion of piping in manhole (typically elbow)




4. Frozen Soil Treatment Area

- ◆ If wet or soggy in fall the system was a problem waiting to happen
- ◆ If froze during the winter and sewage came to the surface
 - > Future pathway for sewage
 - > Add topsoil or rework area
- ◆ Check distribution
 - > Drop and distribution boxes
 - > Pressure distribution system



Freeze Prevention Techniques for New Systems

- ◆ Use insulated pipe whenever appropriate
 - High traffic
 - Shallow
- ◆ Add insulation over tanks and manhole risers that come to the surface




Thermal Conductivity for Various Materials

- ◆ Thermal conductivity is a measure of how much energy/heat is being transferred through an area

Material	Thermal Conductivity (MJ/m ² · d · °C)
Polystyrene	0.0026
Snow	0.0056
Straw	0.0078
Soil	0.0449
Sand	0.0302
Clay	0.1123

Soil, Straw or Insulation?

- ◆ Make sure system has minimum cover
 - 12" minimum recommended
- ◆ 2 inches of polystyrene = 35 inches of soil
- ◆ 6 inches of straw = 35 inches of soil



Insulation blankets

- ◆ If installed prior to freezing conditions trap the heat of the soil and reduce freezing problems
- ◆ Waterproof, it sheds late fall rain and holds snow for added insulation




Construction techniques for cold climates

- ◆ Key techniques
 - Keep proper slope on pipes
 - Insulate where appropriate
 - Bed pipes properly to prevent dips




Pipe sleeving

- ◆ Use in areas where pipe needs additional support
 - Under driveways, roads, structures
 - Wastewater pipe close to water lines or crosses water lines.
 - Underlying soil is disturbed




Pipe sleeving methods

- ◆ Place a larger *and* stronger pipe around smaller pipe:
 - Helps support pipe
 - Prevents bowing
 - Where debris gets caught
 - Spray insulation:
 - Prevents soil backfill from filling pipe



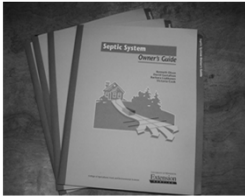
Construction techniques for cold climates

- ◆ 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





Educational materials

Generic



Customized





Questions & more information

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