Compaction: The Enemy of System Longevity

GRANITE STATE DESIGNERS & INSTALLERS
New Hampshires Association of Septic System Professionals

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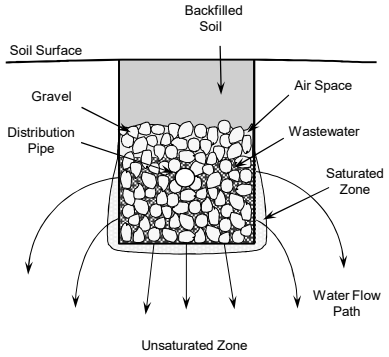
Presentation overview

- Keys to effective soil treatment
- Methods to limit compaction
  - During installation
- When to compact
- Ideas for compacted sites
- Methods to limit compaction
  - After installation

Keys to Effective Soil Treatment



NOT TO SCALE

Keys to effective soil treatment

- **Unsaturated soil**
- **Natural soil**
  - **Not:**
    - **Smeared**
    - **Compacted**

- **Shallow dispersal**
  - **Microbial activity**
  - **Root activity**
  - **Oxygen transfer**

Unsaturated vs. saturated flow

Unsaturated	Saturated
Pores: Air available	Pores: Volume filled with water
Slower: Next to particles	Faster: In large pores
Aerobic	Non aerobic
Bacteria & virus removal	Pathogens travel with water flow

Maintaining natural soil conditions

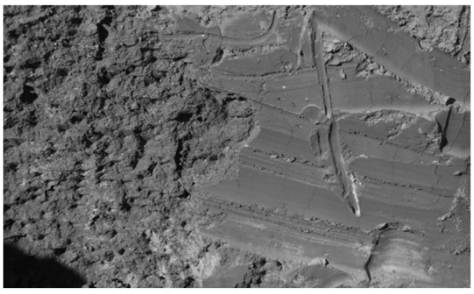
- Soil located at or near the soil surface is generally the best for:
  - Treatment
  - Dispersal
  - Oxygen-transfer
  - Evapotranspiration
  - Natural biological activity

Soil 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

Soil smearing continued

- Soil smearing can be raked out
  - Sidewalls and bottom of soil treatment area
- If not soil infiltration rate will be reduced
- Longevity affected

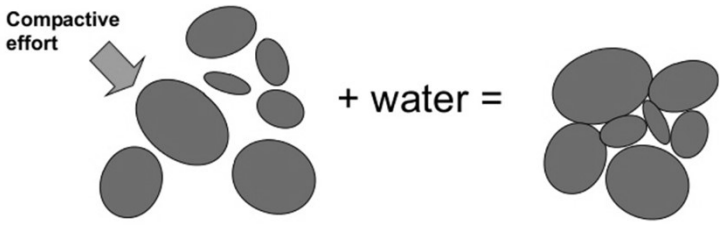


Soil compaction
3 different things

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

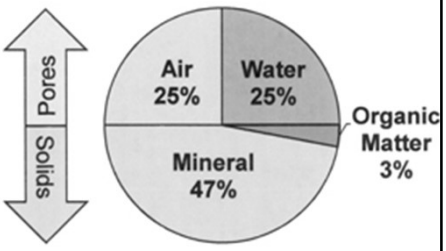
3. Consolidation

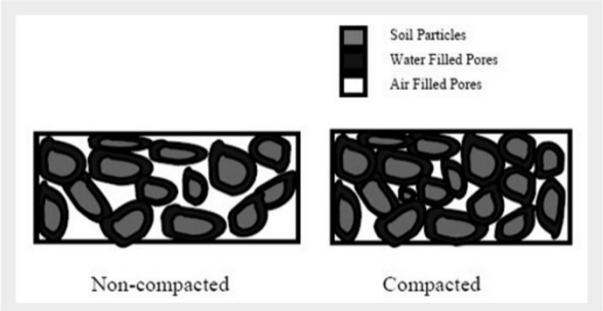
- Deformation of the soil destroying any pore space and structure
  - Water is squeezed from the soil
  - Process leads to increased internal bonding and soil strength as more particle to particle contacts are made and pore space is eliminated



Maintain pore space

- **Pore space is essential for:**
  - **Oxygen transfer**
  - **Water movement**

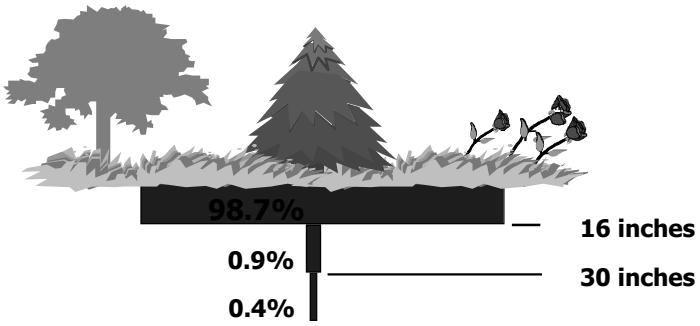




Shallow dispersal - topsoil benefits

- **Typically best soil for treatment and dispersal**
- **Removing increases likelihood of damaging soil**
- **May assist with nitrogen & other contaminant removal process**

SOIL BIOTA POPULATION VS SOIL DEPTH



Contaminants of Emerging Concern Treatment in Shallow Soil-Based Septic Systems

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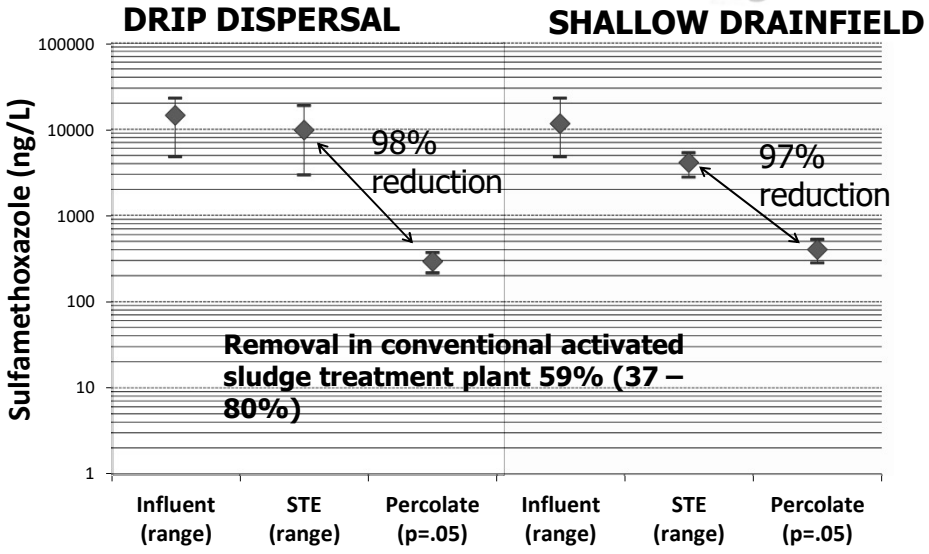
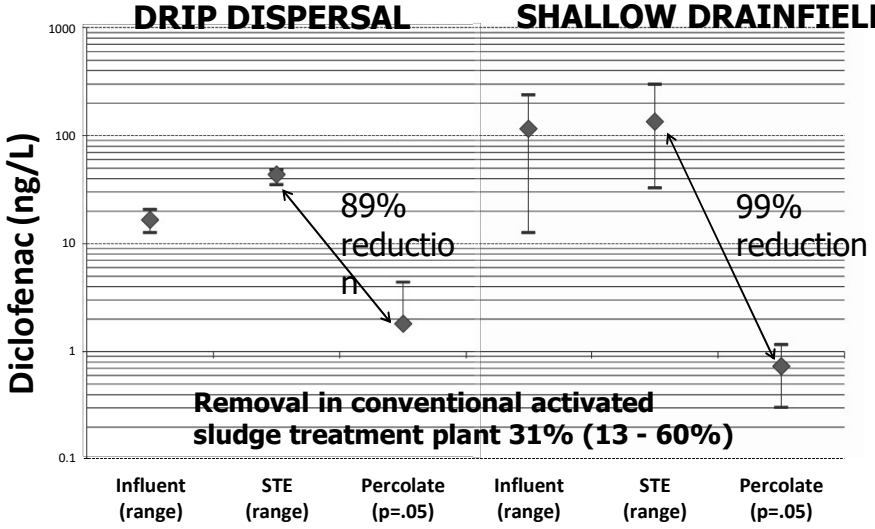
Antibiotics

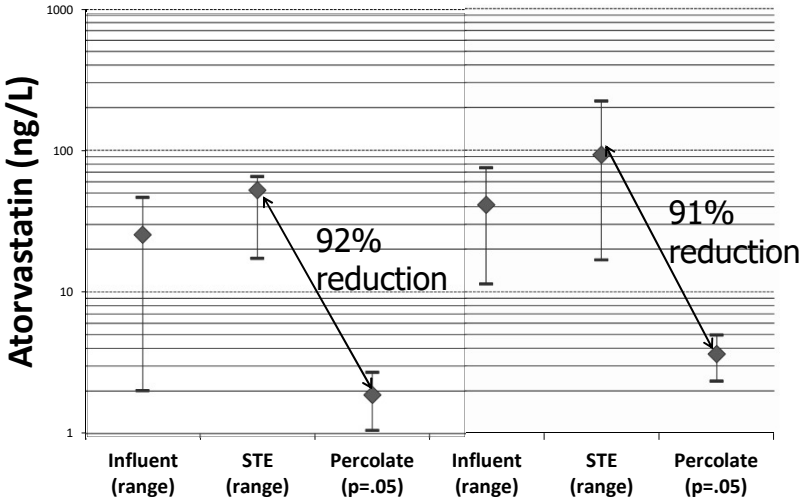


Nonsteroidal Anti Inflammatory Drugs

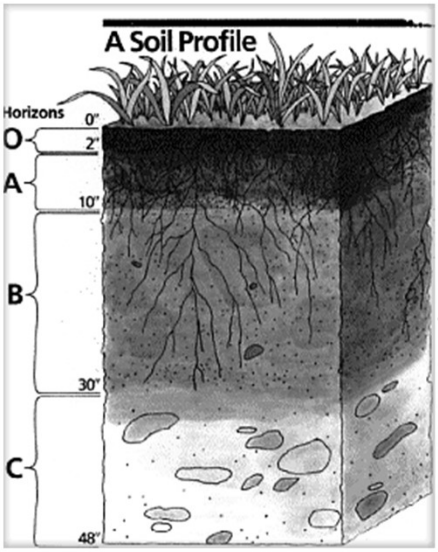


Lipid regulating drugs

DRIP DISPERSAL **SHALLOW DRAINFIELD**



Bacteria (and other microbes) – the real workhorses of the terrestrial ecosystems



Bacteria/gram of soil

Billions

7-8 million

1- 2 million

400 – 500 thousand

~ 10 thousand

one thousand

hundreds

Attenuation **VS** Removal

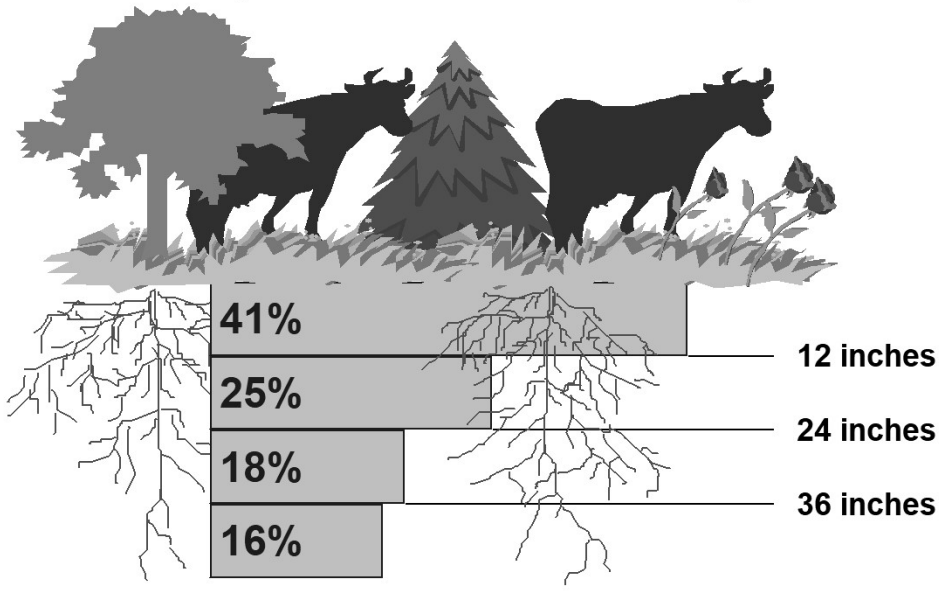
- Adsorption
- Conjugation (with possibility of deconjugation)

- Chemical breakdown
- Biodegradation

An important distinction

WATER USE

(WHERE ROOTS DRINK AND EAT)



Oxygen levels with depth case study

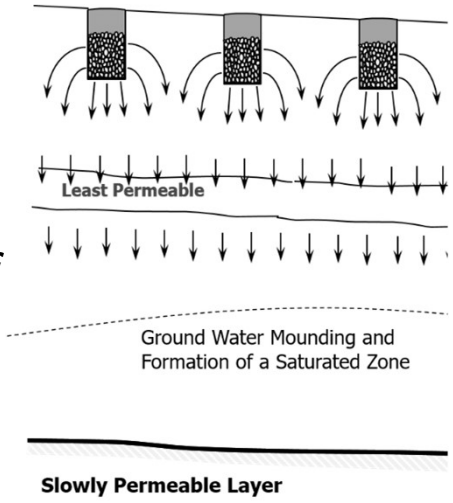
Depth Inches	Wet Time Periods (mg/L)	Dry Time Period (mg/L)
3.9	13.7	20.6
9.8	12.7	19.8
17.7	12.2	18.8
35.4	7.6	17.3
47.2	7.8	16.4

Nitrogen removal in the soil

1. $NH_4+ \rightarrow NO_3^-$

If carbon source, microbes & anaerobic conditions exist

2. $NO_3- \rightarrow N_2$



Compaction is the enemy of our STA

- Prior actives
- During construction
- After construction
- Decreased:
  - Aeration into STA
  - Evaporation
  - Pores for water movement
  - Lesser quality vegetative

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

Methods to limit compaction during installation

- Proper moisture conditions
- Reduce tire pressure to minimal allowable pressures
- Use tracks or duals to replace singles or larger diameter tires

Protecting exposed natural soil

- If soil treatment area (STA) infiltrative surface has been exposed must be covered otherwise:
  - Damage
  - Contamination
- Raindrop impact – research shows a soil crust develops
  - Usually less than 1/2 inch thick at the soil surface

- Don't expose it unless media to over is available
- When you can't cover exposed soil immediately, protect area with tarp

Strategies to limit compaction

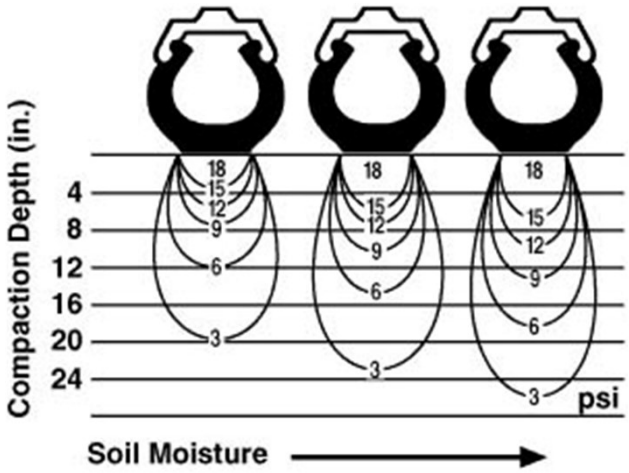
- Work from upslope of soil treatment system whenever possible
- Use smaller equipment - avoid oversized
- Combine field operations

Strategies to limit compaction – wet sites

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

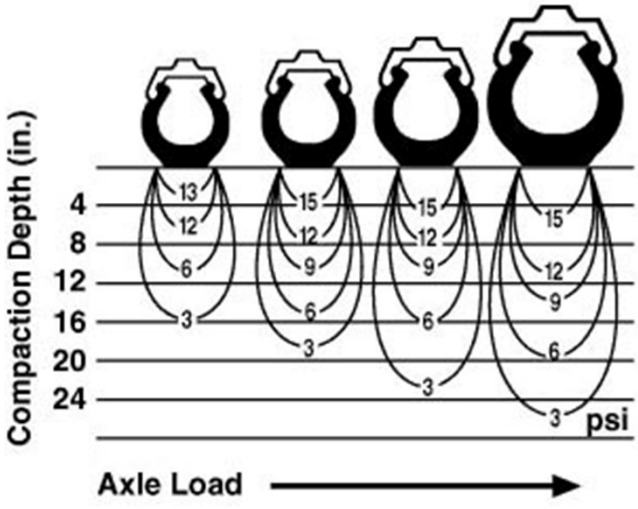
Too wet!

Compaction with: axle load versus soil moisture



Tire pressure remained at 12 psi for all tire sizes.

Depth of compaction as soil moisture increases



Tire size 11x28, load 1,650 lbs., pressure 12 psi.

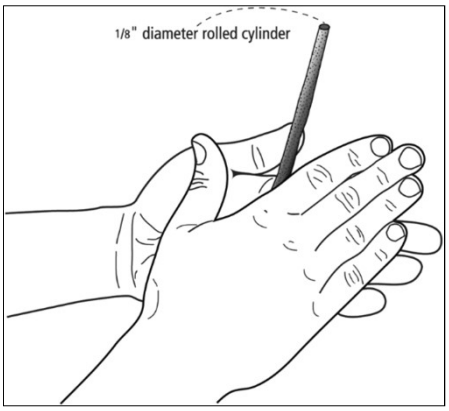
Compaction under dual tires

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

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**

Mark off areas where traffic needs to be voided

Keep traffic off

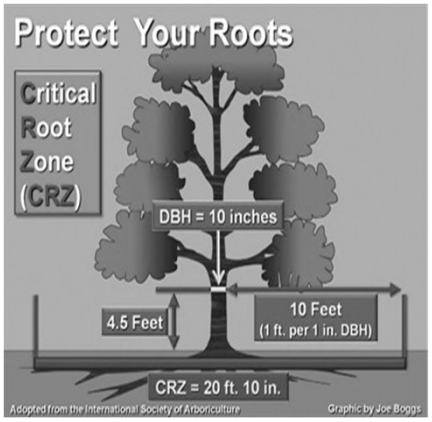
Compaction impacts due to traffic

Reserve area ?

Vegetation removal

- Who is removing?
- Trees – to avoid damaging soil, cut as short as possible and leave stumps in place to decompose
- Consult an arborist if construction is occurring close to trees
- For above-grade systems
  - Vegetation – cut to 2 inches or less and remove
  - Purpose - no barrier to movement of effluent

Mark off areas where vegetation is to stay



Tree removal

- Not recommended
- Large diameter trees - may need to be removed so the system can be installed
- When deciding of trees should be removed:
  - Consider
    - Type of tree and corresponding root system
    - Site and soil characteristics
    - System being installed
    - Local regulations

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

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

Compaction study

- **A piece of equipment ran over a field 10 consecutive times**
- Native soils with intact topsoil
- **Measured soil density after each pass & found:**
  - **70% of total compaction of all 10 passes occur with 1st pass**
  - **10% of total compaction of all 10 passes with the 2nd pass**
  - **5% of total compaction of all 10 passes with the 3rd pass**

Compaction studies continued

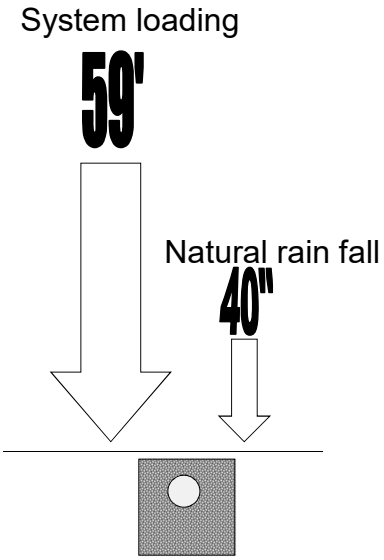
- Other studies have shown up to 90% on the first trip across the field
- These results will be consistent across soil types
  - Other soil condition (removed topsoil, fill, etc. will make this compaction worse
- By controlling traffic, the travelled area will have a slightly deeper compaction
- **Have dedicated construction paths on sites to protect the STA**

Who is landscaping?

- **Identify in the contract**
- **Not you?**
- **Potential negatives**
  - **Tillage**
  - **Traffic**
  - **Irrigation**
  - **Edible plants**
  - **Unacceptable plants**

Watering - irrigation

- **Light watering may be needed to establish vegetation**
- **In an average year 44" of rain water is added to the system**
- **Typical household with 3-4 people puts out 75,000 gallon per year**
- **In a sandy soil 59' of water is being added per year**
- **In a clay loam soil 22' of water is being added per year**
- **No irrigation!**



Signs of compaction, topsoil and vegetation problems

When to Compact

Compaction applications

- Pipe bedding
- Distribution boxes
- Tank excavation area
- Around media filter or ATUs
- Be careful
- Not for use in a mounds, sand filters or sand lined systems because the vibratory action will potentially cause layering with the material as the fines migrate to the surface and reduced pore space

Compaction Applications & Equipment

- **Compaction equipment**
  - **A compactor is a machine or mechanism used to reduce the size soil through compaction**
  - **In system construction, there are two main types of compactors:**
    - **the plate compactor**
    - **the "jumping jack"**

Compactable Backfill Material

Term	Typical Size	Description	Application
Backfill, compactable	3/8 – 1 inch minus	• Compactable material with no rocks larger than 2.5 inches in diameter • Free of organic material, debris, clods, or frozen soil • Not washed, fines present	• Backfill around tanks and advance treatment units where ground and surface water is an issue

Sand media installation

- Mounds and media filters
- Sand installed in layers/lifts of 6-8 inches
- Foot compaction and light watering to reduce volume of pore spaces
- Compaction equipment should not be used

Densifying the Sand Fill Area

"Track-in" the fill the width of the tracks to take the "fluff out"

Rock as the distribution media

- Carefully place drainfield rock into the excavation by minimizing drop distance into the excavation

Compacted site – What to Do?

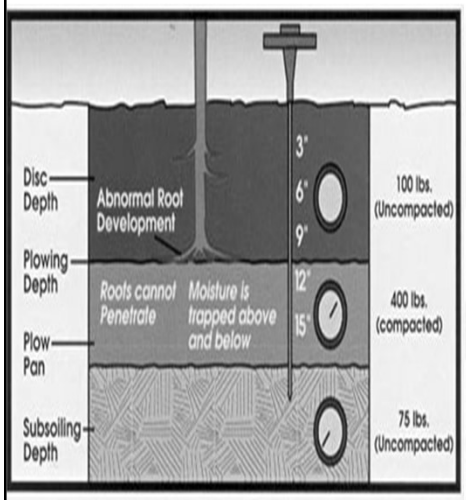
Methods and options

- 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!

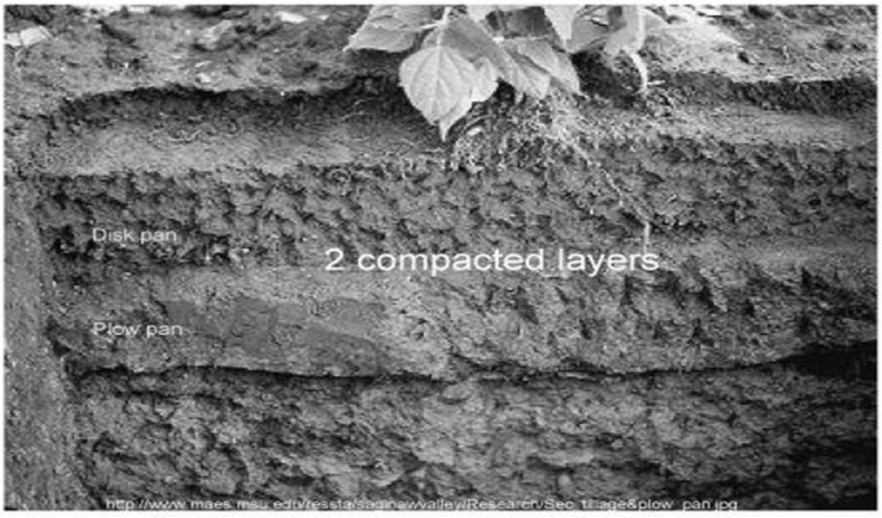
Tillage techniques to shatter compacted layers



Typical Compaction Situation

57

Must shatter completely through all compacted zones



http://www.maes.msu.edu/ressta/saginawvalley/Research/Sec_tillage&plow_pan.jpg

Methods to Limit Compaction Post - Installation

After install - maintenance

- First visit should be within the first few weeks/months of use
  - To catch construction damage or errors
  - To be sure controls/alarms are set correctly for the use pattern
  - To check for leaks, including leaky tanks
  - To advise owner/resident on filter use
  - To be sure landscaping does not add depth, compact or cause other damage

Homeowner stupidity

- When the driveway is crowded, they park cars over the septic system
- They construct a wooden deck over the septic tank, hindering access
- They invite:
  - soil compaction, and
  - broken and damaged drainlines, and then
  - wonder why they're having problems with their septic system

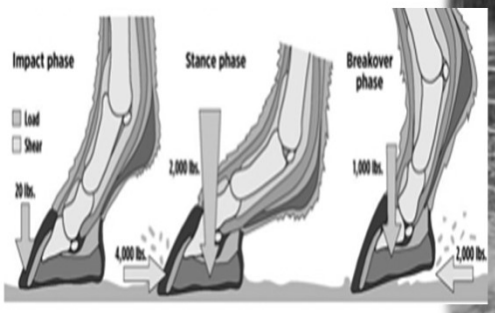
Homeowner landscaping dos and don'ts

- Minimize traffic on the soil system, both human and animal, to avoid soil compaction
  - Do not exercise pets or allow them to play on septic system
  - Never drive a car or other vehicle across the system, and do not mow when the soil is wet
  - Compacted soil can lead to soil erosion and impedes the flow of air around the systems

Compaction actives

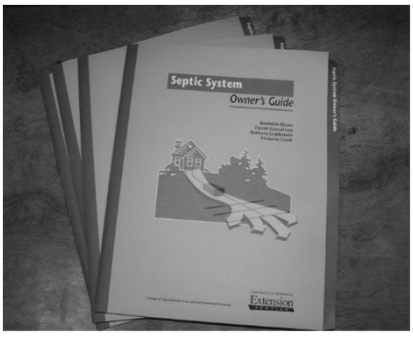
- Horses exert 23.0 psi/hoof
  - Cattle would be similar
- Typical vehicles ~ 30 psi
- Mowing

Horse caused compaction



Educational materials

Generic



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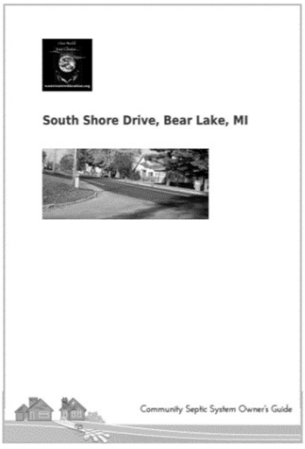

Questions & more information

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