



Managing Soil Drainage and Compaction in Pasture



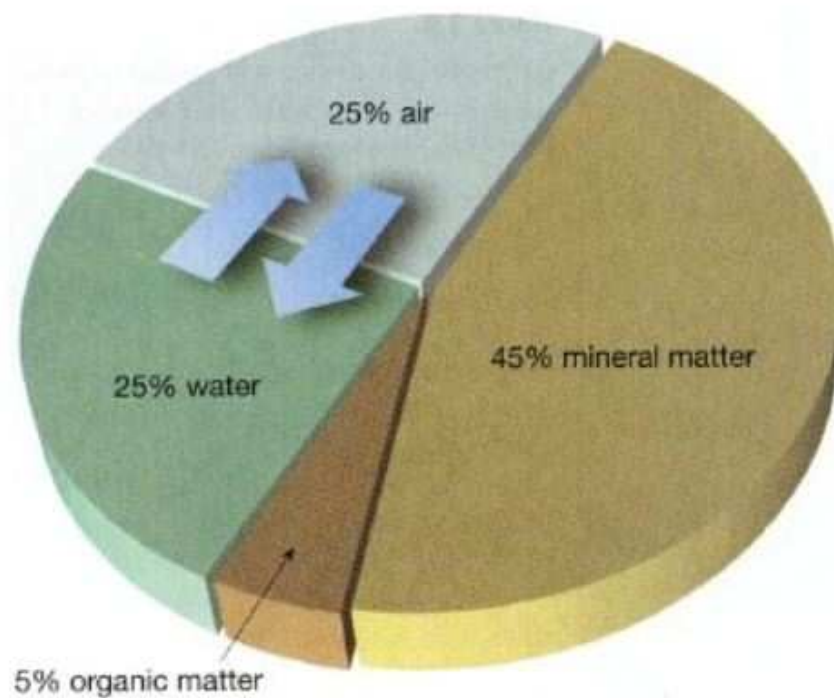
Key factors for movement of water in the soil

- Soil Texture
- Soil Structure
- Soil Compaction
- Soil drainage – Natural and Installed

Soil Texture

What is Soil?

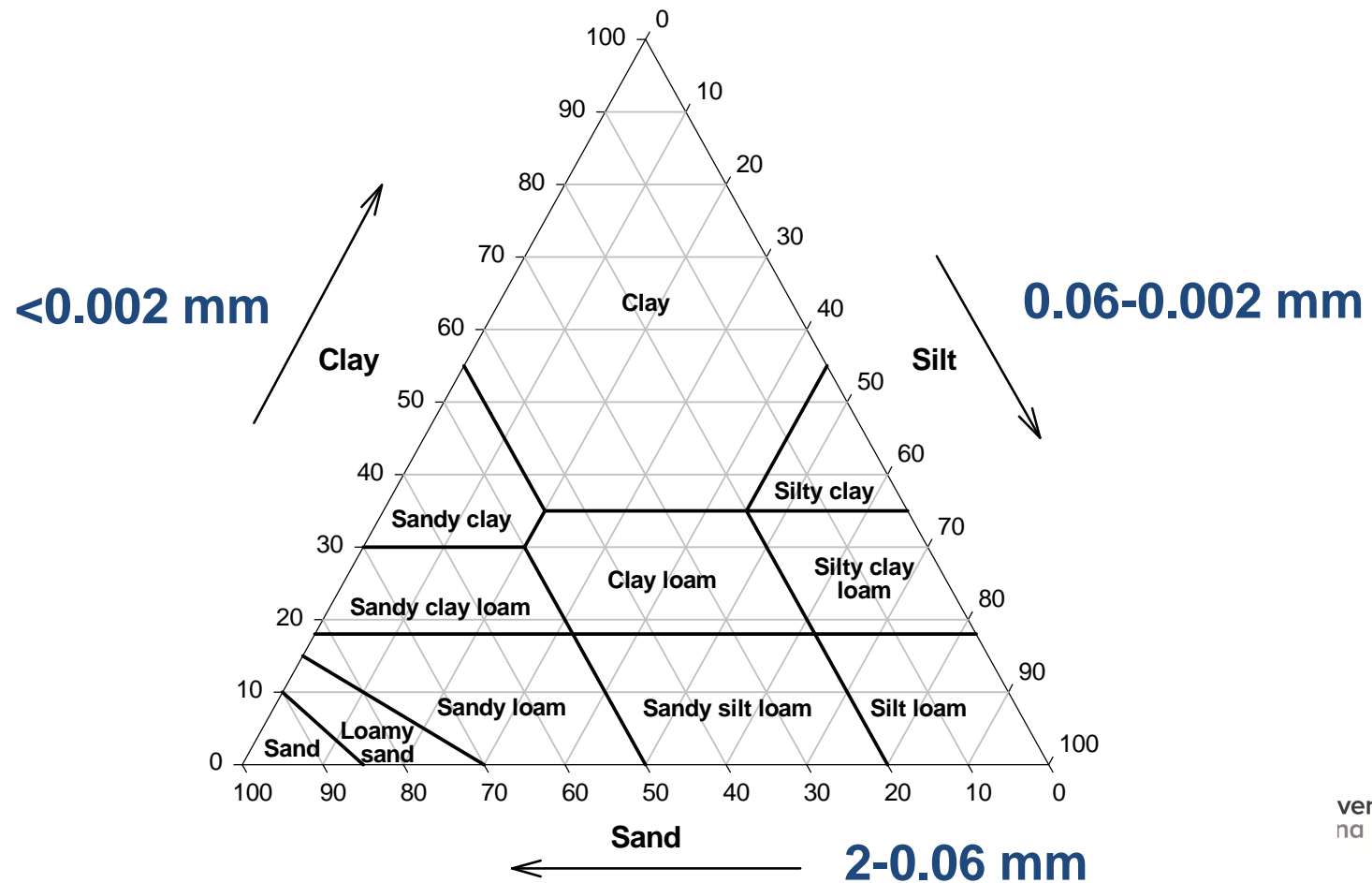
Typical soil make-up



Soil Texture

- It describes the physical composition of the soil
 - % of sand, silt and clay
- Refers to the mineral fragments of the soil only
 - water and organic material are not considered
 - only considers particles <2mm
- Texture is a stable soil property - does not change measurably over a long period of years

Soil texture classes



Soil texture & water



- The sizes of pores in a soil are related to its texture
 - Sands have large pores
 - Clays have small pores
- Large pores allow free drainage
 - Sandy soils drain more easily than clays
- Small pores store water
 - Clay soils have a bigger water holding capacity than sandy soils

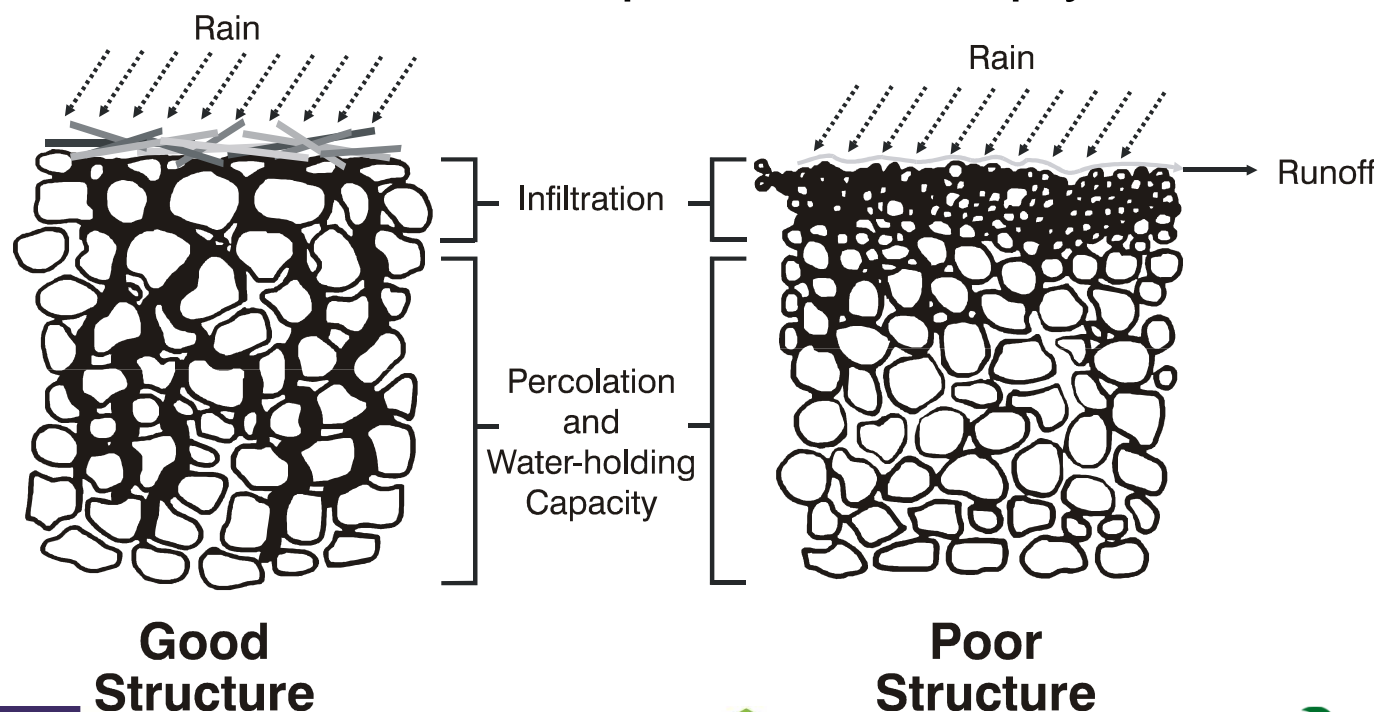
Water in soil

- **Gravitational water**
 - drains freely from large pores
 - only available to plants for a short time
- **Capillary water**
 - held in small pores
 - available for plants
- **Hygroscopic water**
 - held tightly around small particles
 - not available to plants

Soil Structure

Soil structure: the importance of macropores

- Macropores and cracks : allow water infiltration and drainage, keep the soil aerated reducing nitrous loss and increase water uptake and crop yield.



Benefits of Good Soil Structure



- **Good structure improves aeration & reduces waterlogging**
 - easier for roots to access nutrients
 - leaching of nutrients less likely
- **Good structure reduces compaction**
 - more extensive root system
 - better water & nutrient uptake
- **Good structure reduces droughtiness**
 - improves nutrient uptake

Structure-forming processes

- **Activity of roots and soil organisms especially earthworms**
 - mixing, cementing, transforming
 - needs organic matter
- **Wetting & drying**
 - swelling & shrinkage
- **Freezing & thawing**
- ***Organic matter is key to structure formation and maintenance***

Soil Compaction

Main causes of compaction

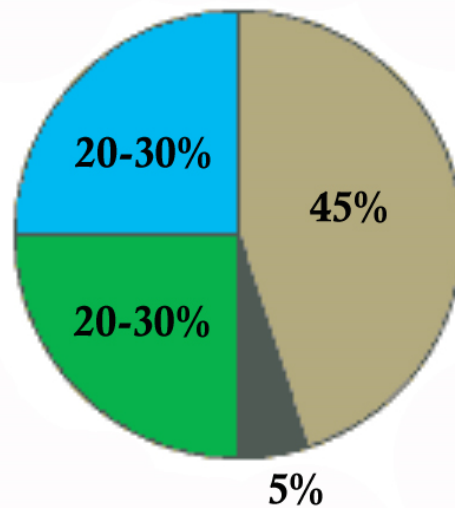
- **Working / Cultivating / Grazing in wet conditions**
- **Over-cultivation**
- **Continuous cultivation**
- **Heavy machinery**
- **Over-grazing**

Effects of Compaction

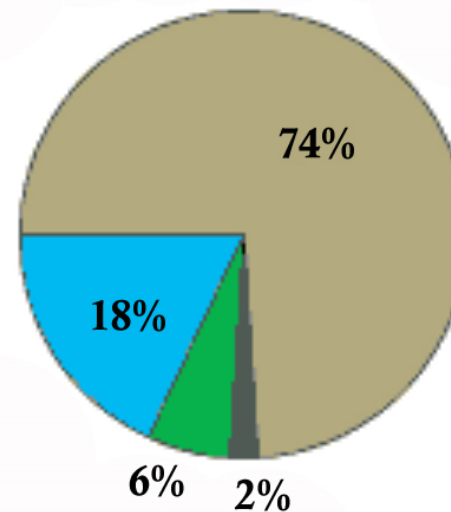


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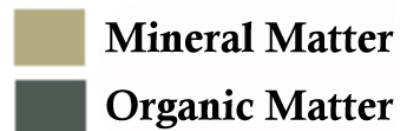
**UNDISTURBED
SOIL**



**COMPACTED
SOIL**



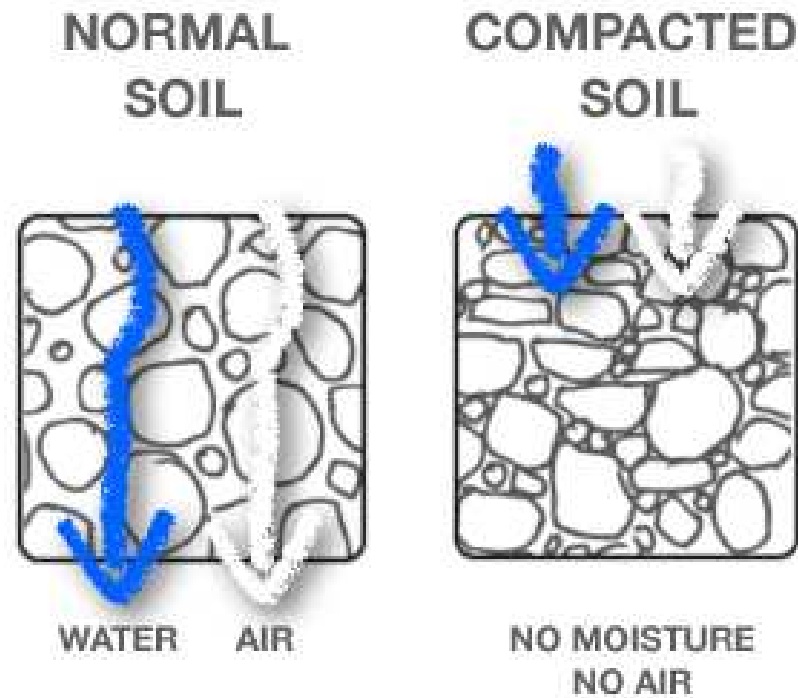
Soil Solid Space



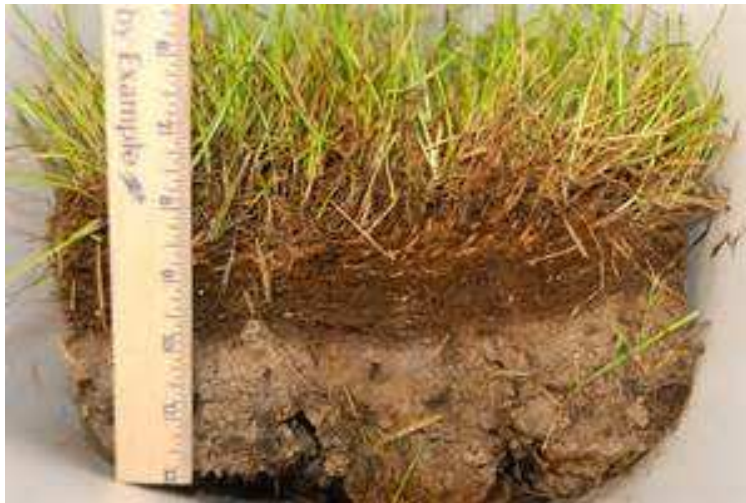
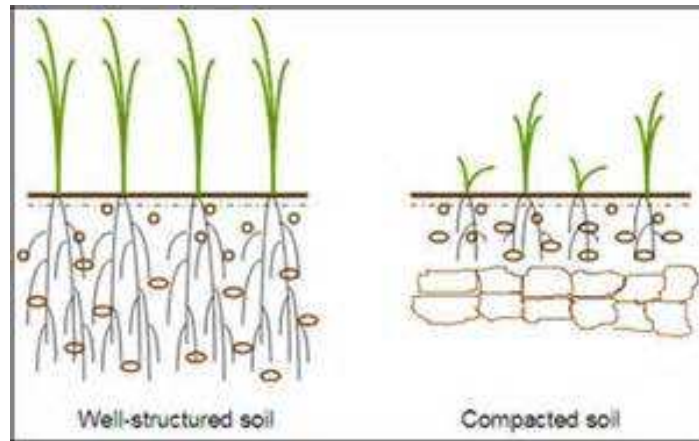
Soil Pore Space



Compaction Reduces infiltration and Increases surface run-off



Rooting in compacted soils



Soil structure is affected by management

- **Compaction**



- **Poaching**

Image: Farmers Weekly



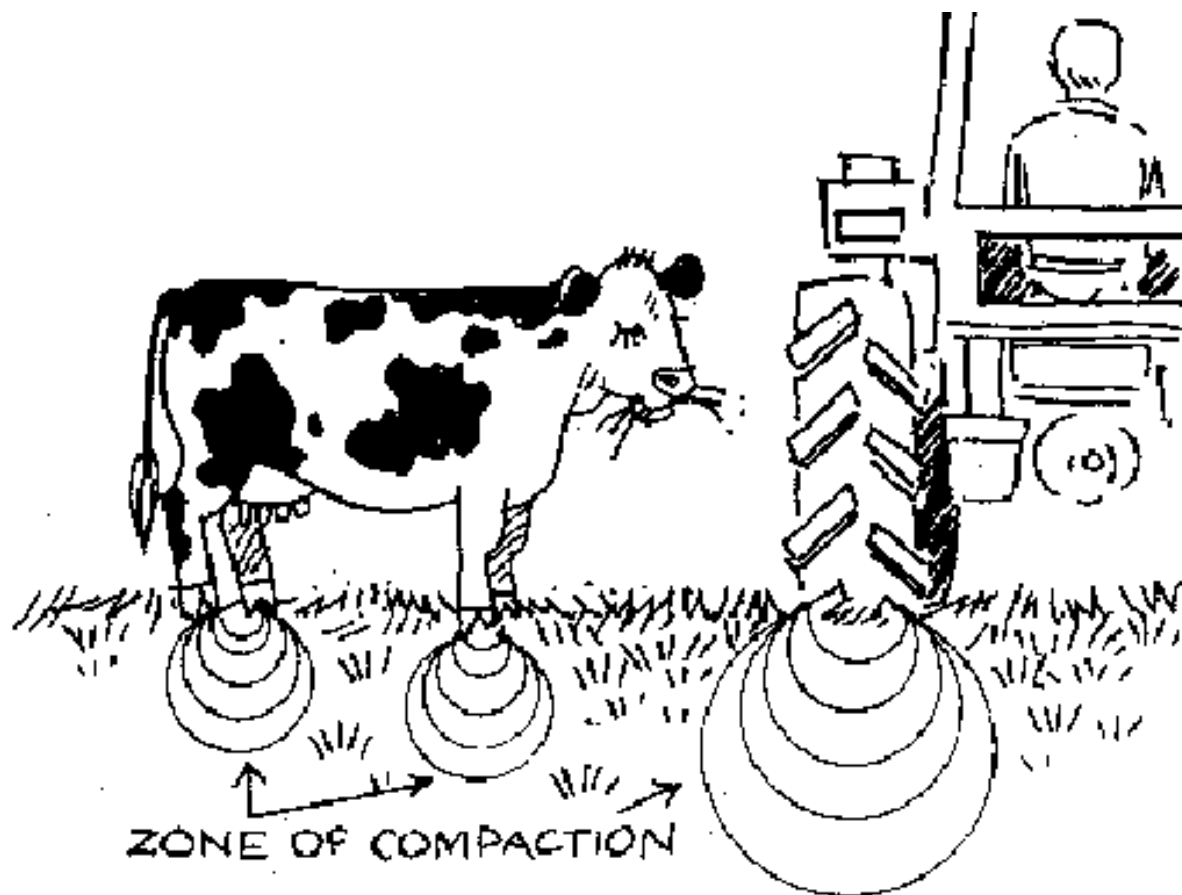
- **Waterlogging**



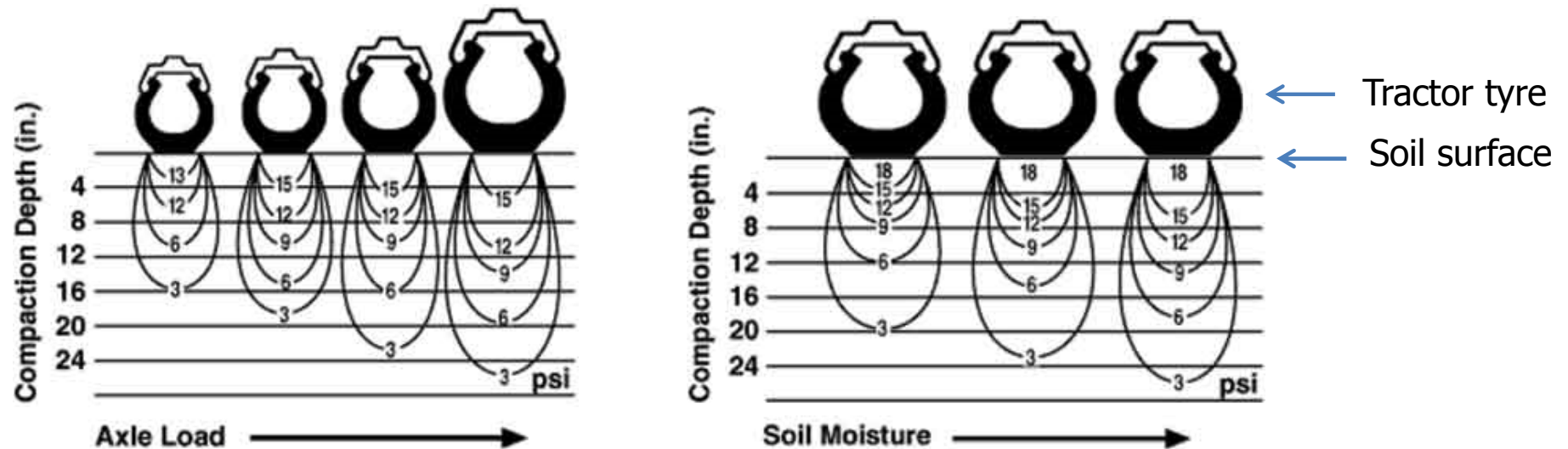
Zone of Compaction



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Compaction and soil moisture



Wheel traffic compaction. The depth of compaction increases with increasing equipment weight (axle load) or increasing moisture condition.
(Adapted from Soehne, 1958. Journ. of Agr. Eng.)

Source: University of Minnesota Extension Publication WW-03115; Available on-line at:
<http://www.extension.umn.edu/distribution/cropsystems/components/3115s01.html#section1>

Tyres and Compaction



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**Spot the difference: Trailer with 11 tonne
payload running on
500/60R22.5 (left)
385/65R22.5 (right)**

Tyres and Compaction (2)



Tyres and Compaction (3)



Extreme problems



Dealing with compaction



- Avoid compacting the soil in the first place (Prevention)
- Change management systems to protect soil
- Make the soil more resistant to compaction
- Protect the soil against raindrop impact - protects soil structure
- Eradicate the compaction (Cure)

Remediation of poaching, shallow compaction



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Shallow Compaction



Pasture Harrow with Grass Seeder



Pasture Harrow



Grassland Surface Spikers



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Grassland spiker



Effect of surface spiking



Roller spiker with grass seeder
and frame for extra weight



Spiker with water tank for extra weight

Grassland Sward lifters



Pre-cutting Disc and Closer leg spacing



Roller for depth control and break back legs
to reduce bringing stones to the surface



Spiked roller to help aerate surface



Roller to level surface following treatment

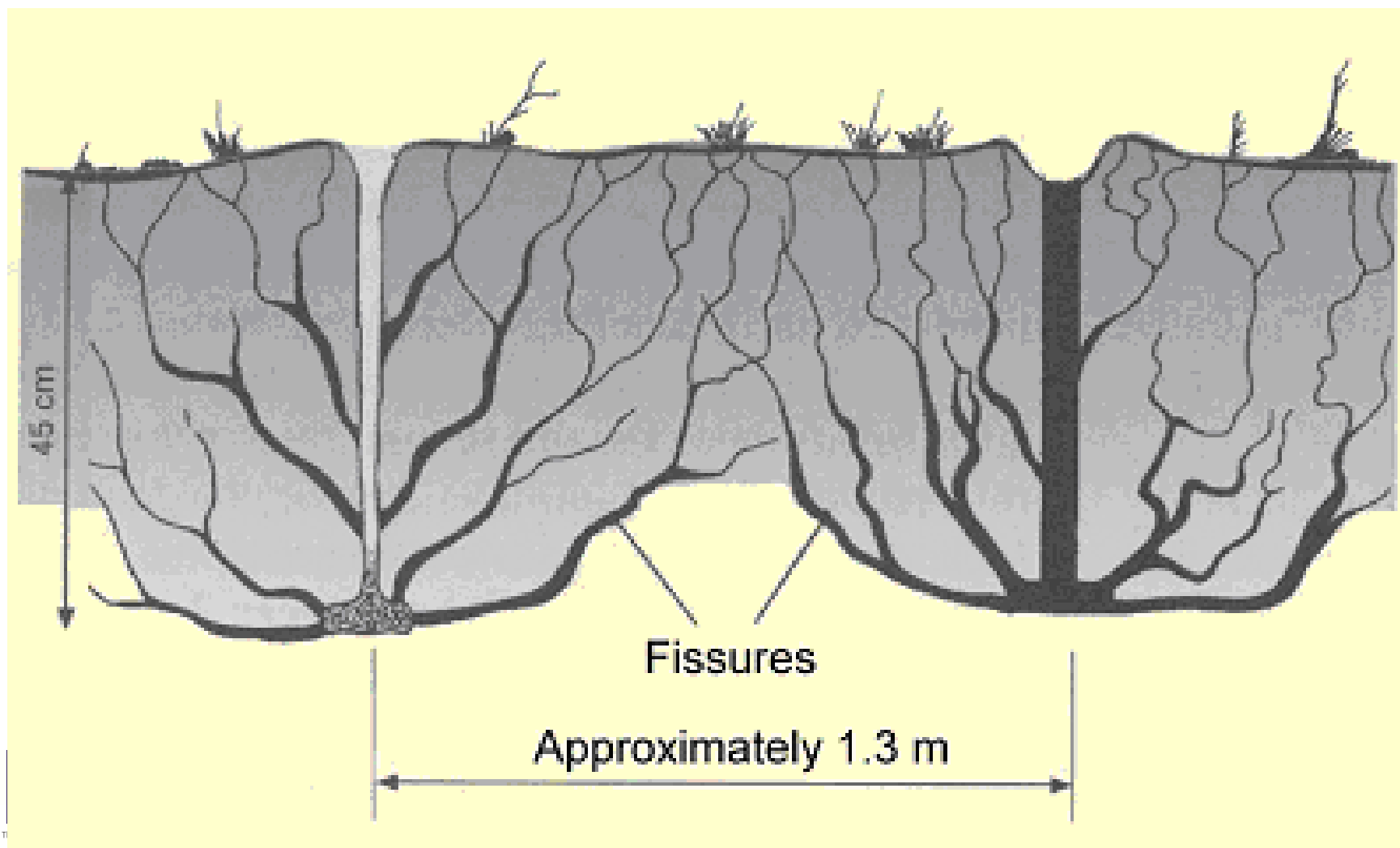
Sub Soilers



Subsoiling

- Some soils benefit from subsoiling
- Subsoiling aims to loosen the soil and allow water to flow more freely through it
- Can be effective in soils of low clay content or stony soils where mole drains would not work

Subsoil shatter



Remediation of subsoil compaction and pans



- Make fissures through the layer with minimal soil break up and mixing.
- This creates paths for drainage and root movement while keeping the support capacity of the compacted layer



When to subsoil



- Only when necessary - check the subsoil for compaction
- When the subsoil is brittle i.e. not too dry or too wet
- Late summer subsoiling is generally best in terms of land access and soil suitability
- Spring subsoiling gives the longest benefit if done in the correct conditions

Land Drainage

Benefits of Good Drainage

- **Less surface run-off**
- Improved root growth
- Greater soil biology
- Better crop and grass yields
- Better animal health – reduces risk of some parasites and diseases
- Less soil damage
- Longer utilisation of fields

How do you know when a soil has poor drainage?

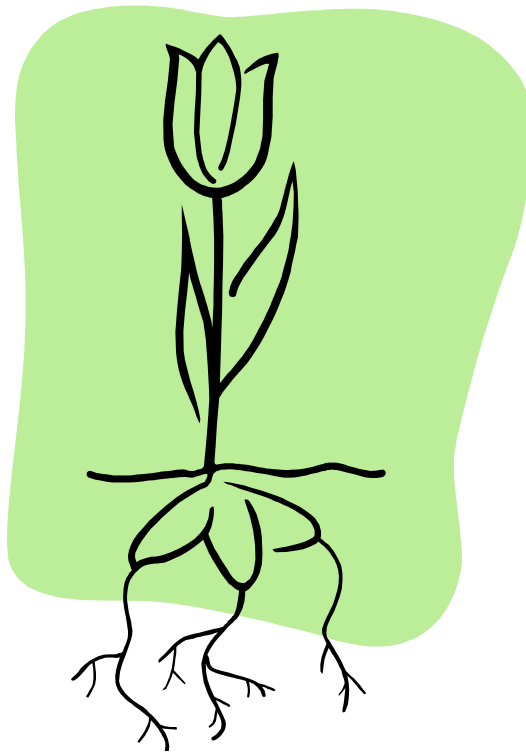


- Water lies on the surface
- Water can be seen in a soil pit
- Roots are brown and shallow
- Dull grey colours (rusty or multi-coloured)
- Mottled colours in subsoil
- “Sour” smell
- Unrotted manure or crop residues

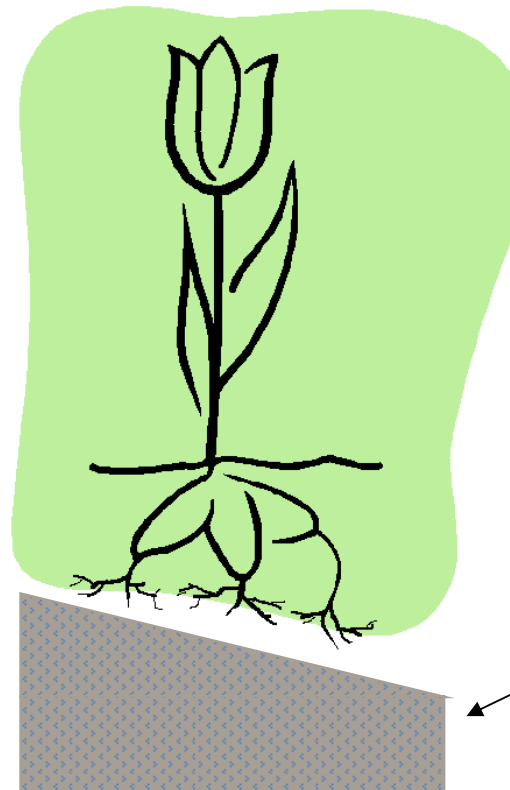
Effect of drains on root growth



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With drains



**Waterlogged
soil**

Without drains

Where do you start?



Investigate the existing drainage scheme

Carry out Maintenance where needed

- Clean ditches
- Mark drain outlets
- Exclude livestock where possible
- Clear pipe outfalls and culverts
- Repair burst pipes

Drainage Maintenance (2)



- Mark outfalls clearly.
- Clear outfalls on a regular basis (annual / bi annual).
- Clear ditches on a regular basis Clay soils every 3 to 5 years,
Peat soils every 2 to 3 years sandy soils every 1 to 2 years.
- Keep trees, shrubs and bushes on the banks cut back every 3
to 5 years **(Especially important on flood banks).**

Drainage Maintenance (3)



- Check and clear culverts on an annually in late summer / early autumn in preparation for winter rainfall.
- Check flood banks every summer and after flood event for damage.
- Every 3 to 5 years check and repair culvert banks and crossing surface.
- Where flap valves are installed check on an annual basis that they are free to open and close before winter rains.
- Annually mark unusual wet areas on a plan and compare with drainage plans to identify areas that may need existing systems repaired or new drains installed.

Main Drainage Problems



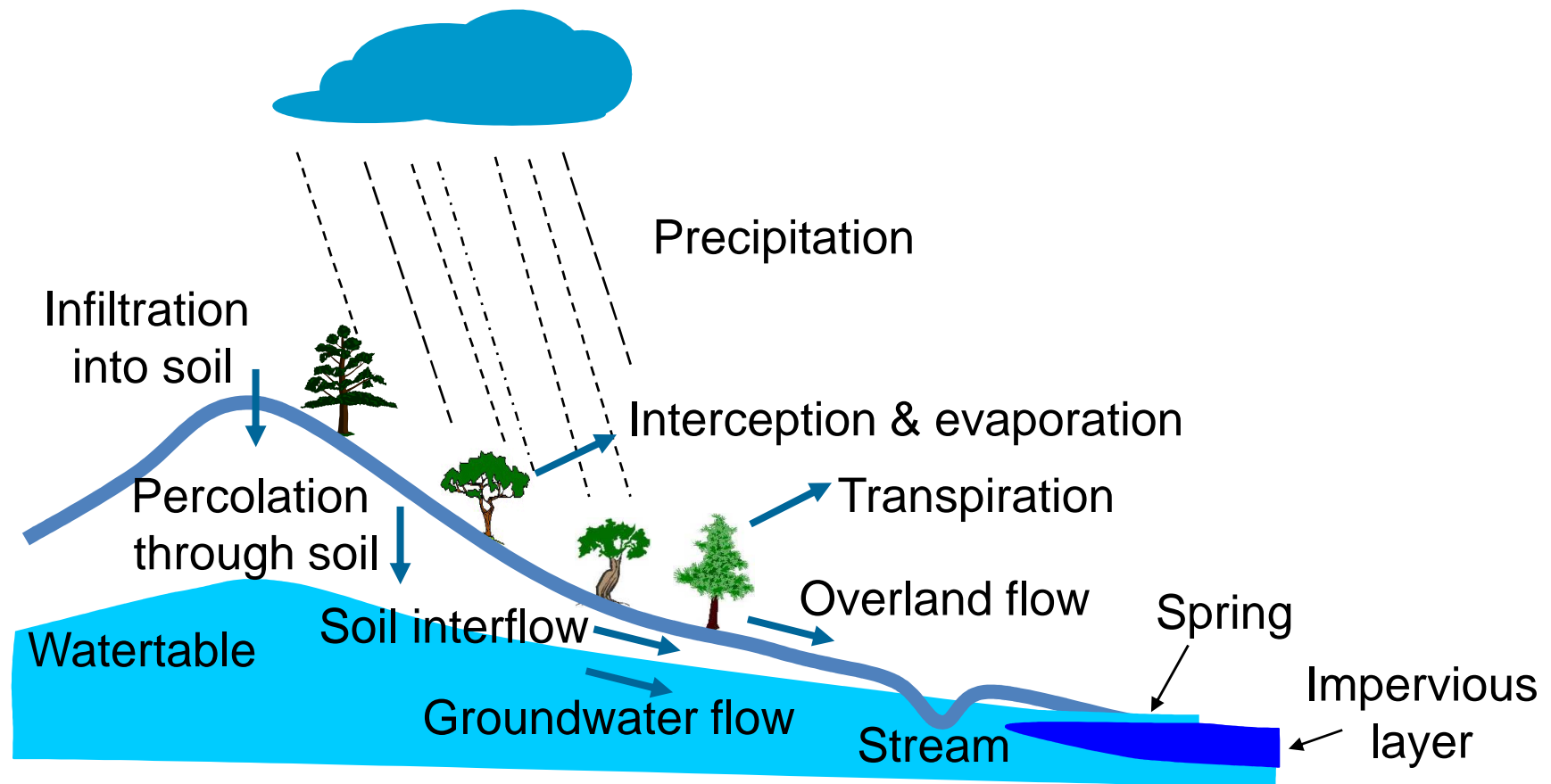
- **Surface water**
- **Ground water**
- **Springs**

Problem type and occurrence

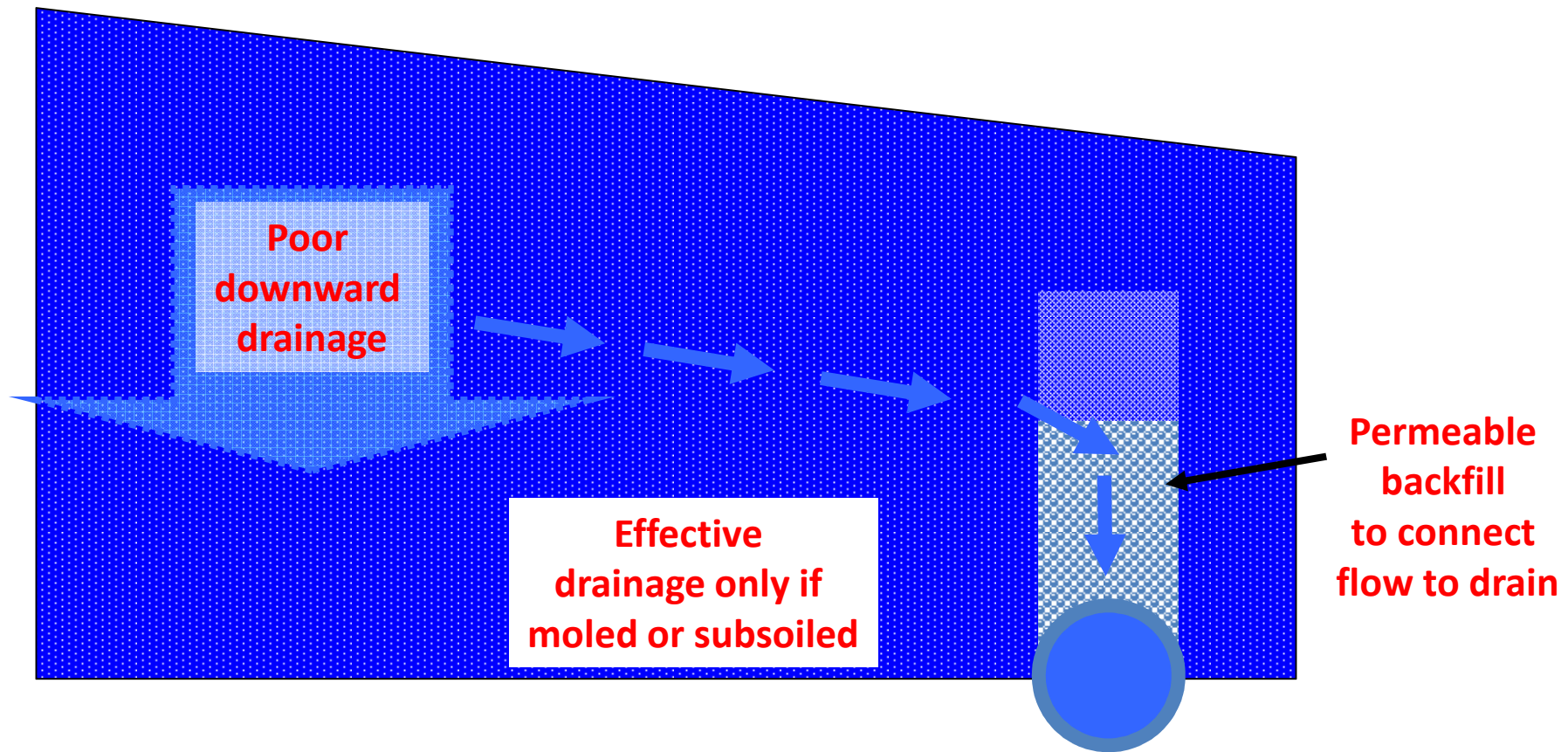
- During the late 1970s the various drainage problems were broken down into the following types,

Drainage Problem	Scotland as a Whole % of problems
Water Table	25
Impermeable Subsoil	20
Springs	12
Failure of Old Drains	39
Other	4

Water Pathways

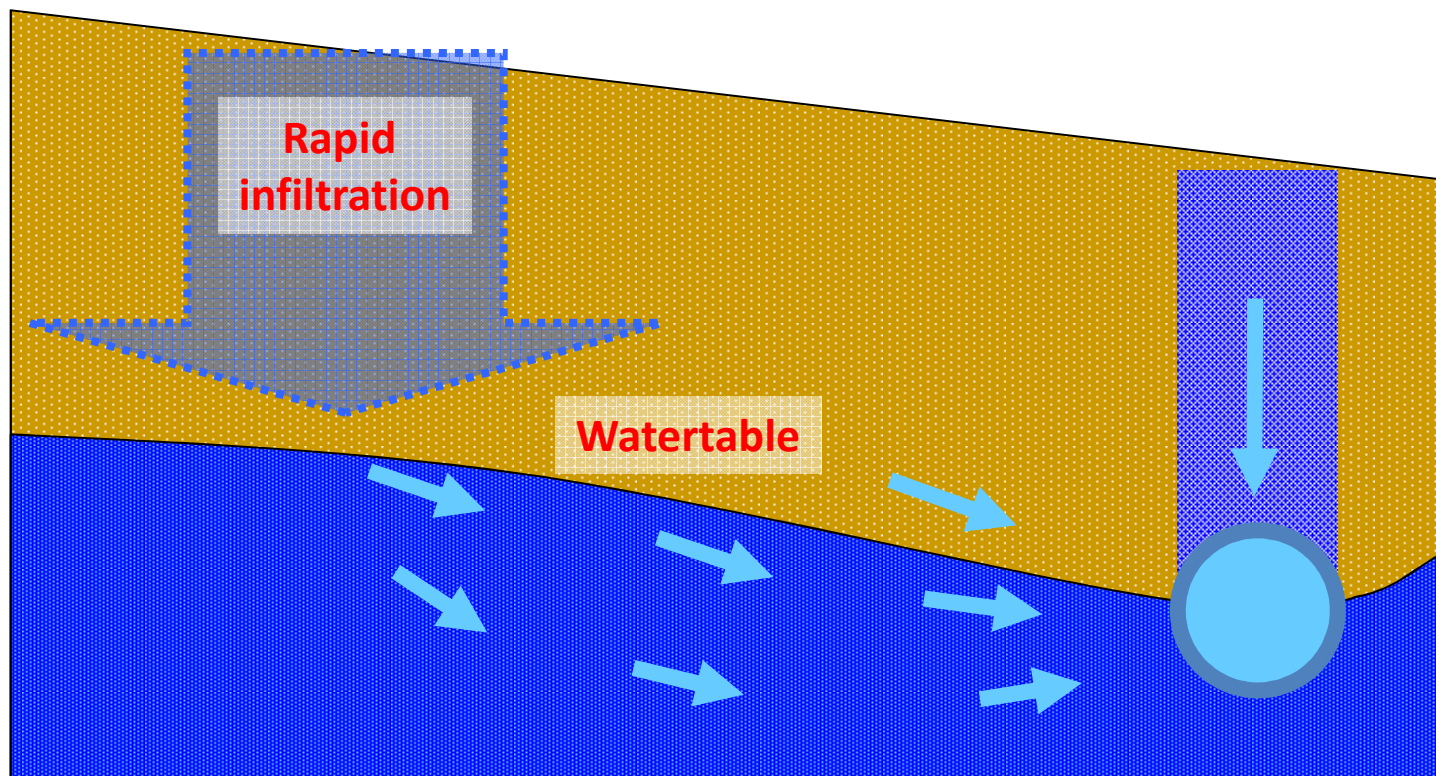


Drainage of impermeable soils - surface water problem



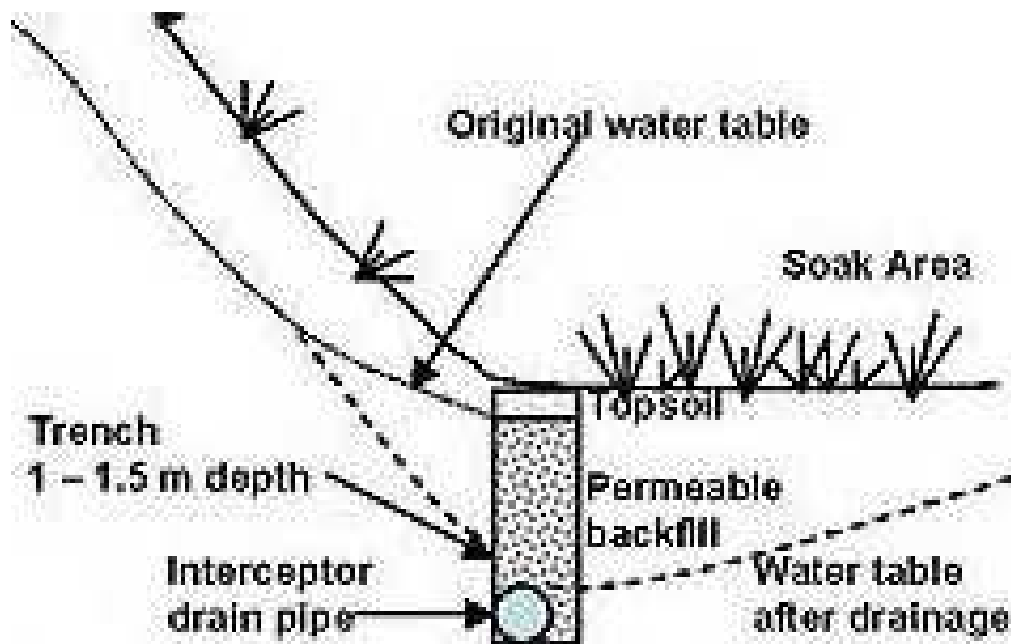
Must have gravel backfill to connect to drains

Drainage of permeable soils - ground water problem



Drainage of soils

- seepage water problem



How do you Improve Drainage ?



- Investigate the site
- Identify the problems
- Prepare a plan
- Budget the plan
- Prioritise the solutions
- Carry out the work
- Record the work carried out

New Drainage



- Drainage is expensive – prioritise areas to be drained
- Collaborate with neighbours where possible to maximise benefits
- Ditches lowest cost but take up land
- Pipes with gravel most expensive but take up least land

Drainage Design

- Design for required outcome – allow for expansion at a later date
- Design from the outfall back
- Install ditches on boundaries where possible
- Minimise requirement for culverts – potential for blockage in the future.
- Install correctly sized pipes where required – use gravel if necessary
- If there are problems with ochre or running sand – install a bigger diameter pipe if practical

Any Questions?

