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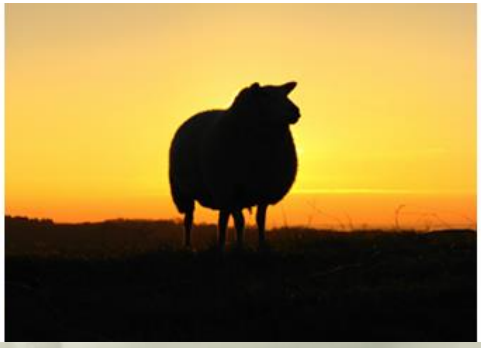

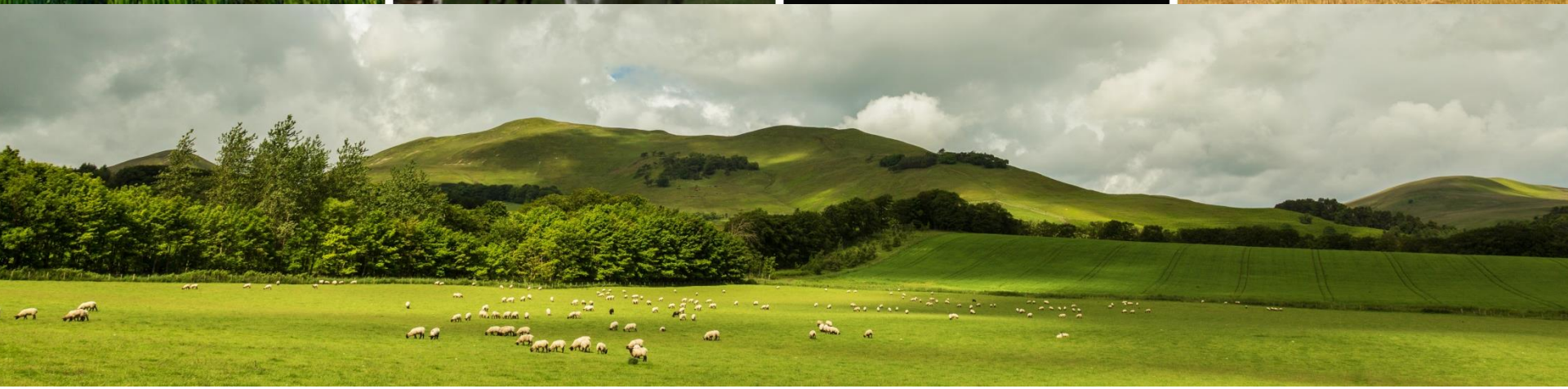

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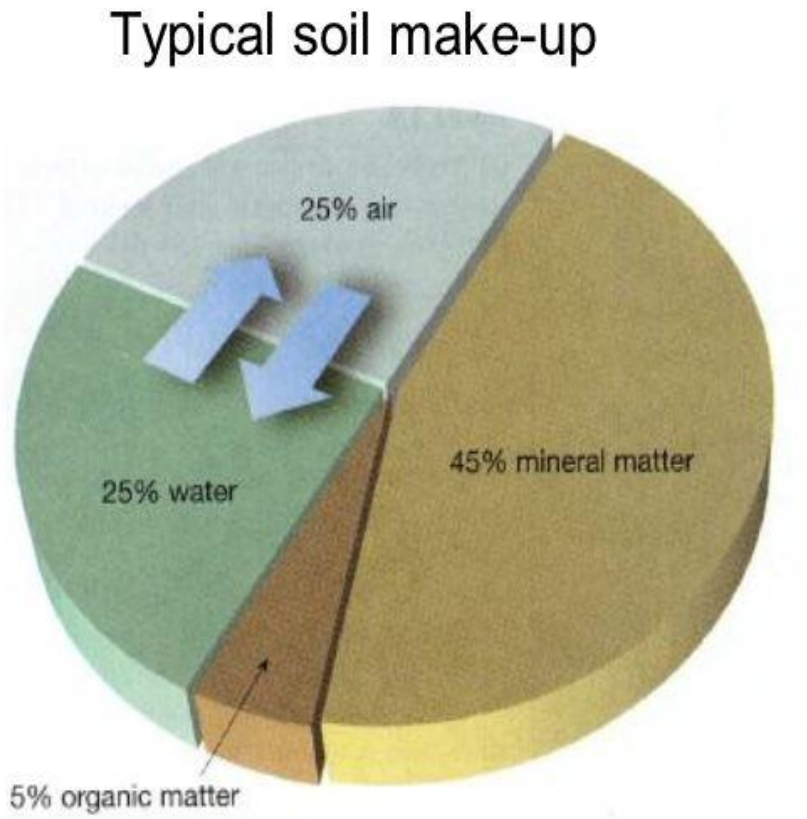
What is Soil?



A complex mixture of:

- **Inorganic matter**
- **Organic Matter**
- **Water**
- **Air**
- **Living organisms**

Managing Soil Drainage and Compaction in Pasture

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Key factors for movement of water in the soil

- Soil Texture
- Soil Structure
- Soil Compaction
- Underlying Soil Drainage Issues

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Soil Texture

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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

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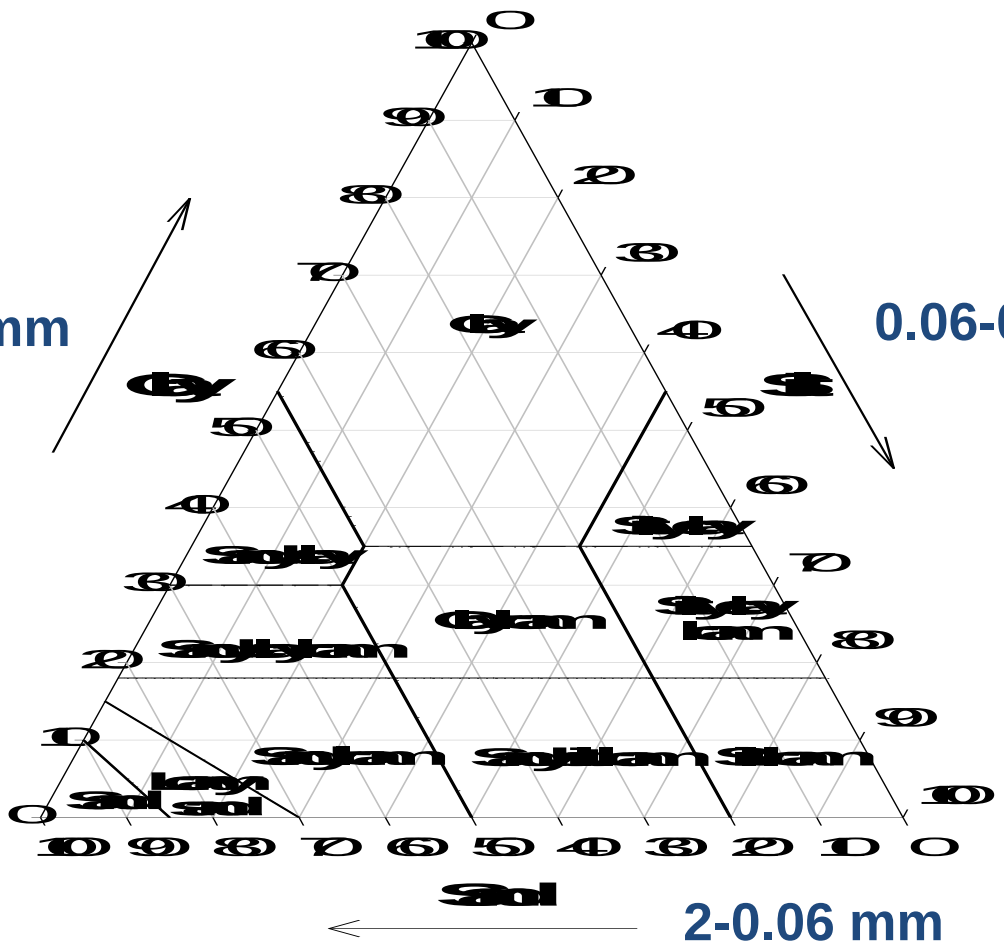

Texture Influences

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- **Drainage**
- **Cultivation ease**
- **Compaction risk**
- **Crop choice**
- **Available water holding**
- **Nutrient retention**
- **Nutrient content**
- **Liming**

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Soil texture & water movement

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- 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

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Soil Structure

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Soil structure: the importance of macropores

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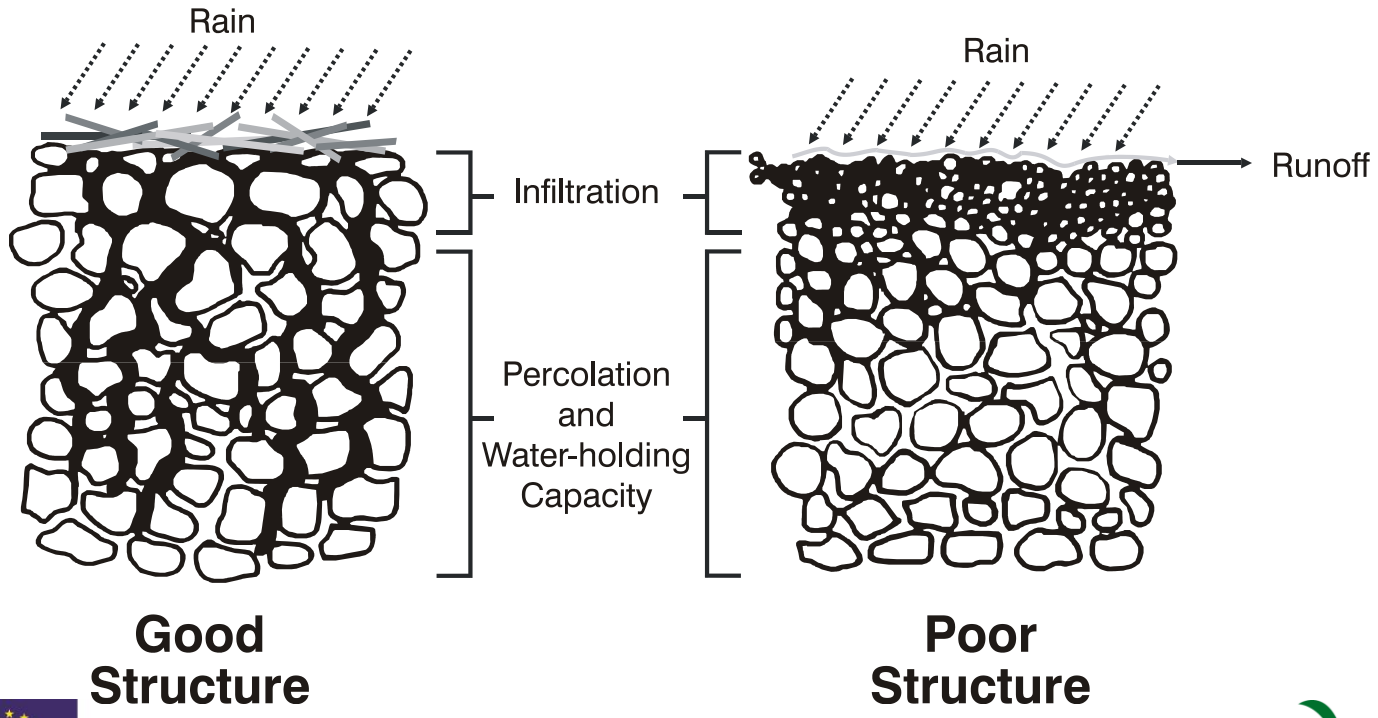
- Macropores and cracks : allow water infiltration and drainage, keep the soil aerated reducing nitrous loss and increase water uptake and crop yield.



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***

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Soil Compaction

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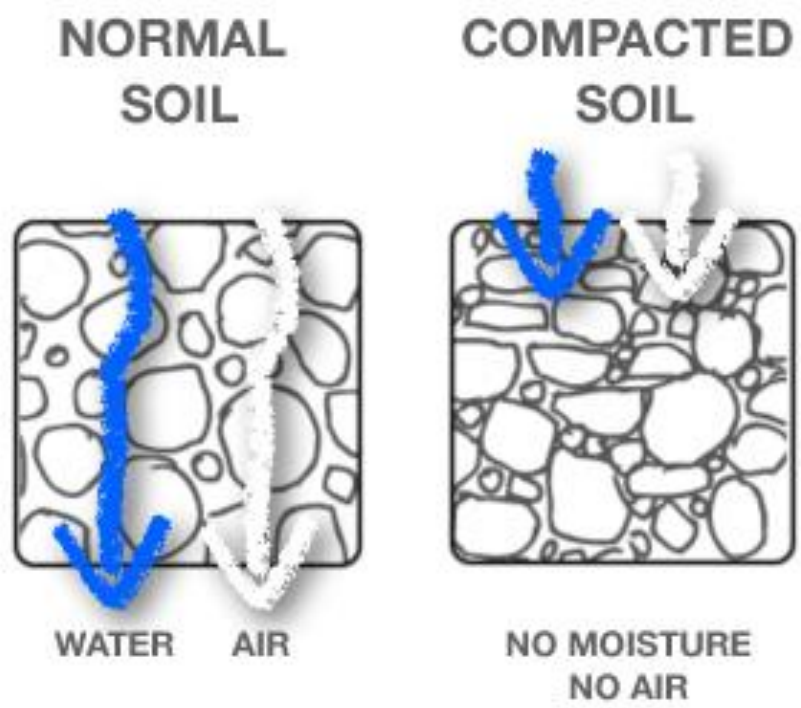
Main causes of compaction

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

Compaction Reduces infiltration and Increases surface run-off



Compacted soils reduce water flow to underlying natural and constructed drainage systems

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Rooting in compacted soils

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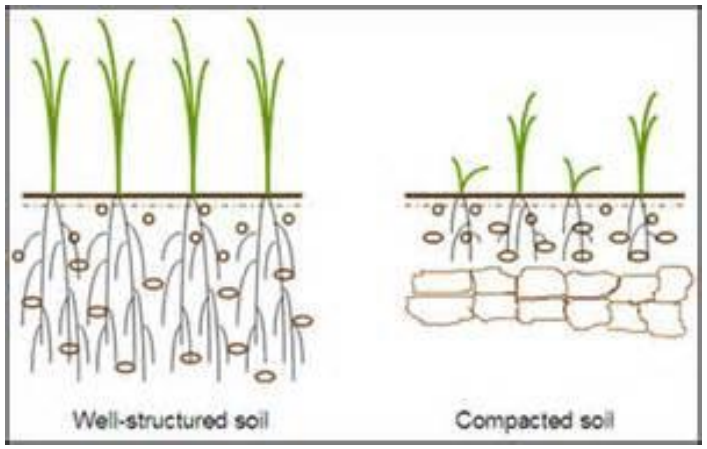

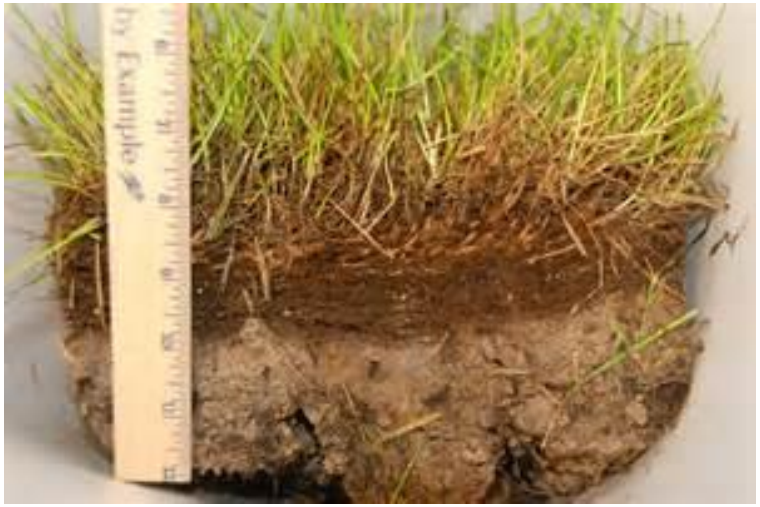

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Soil structure is affected by management

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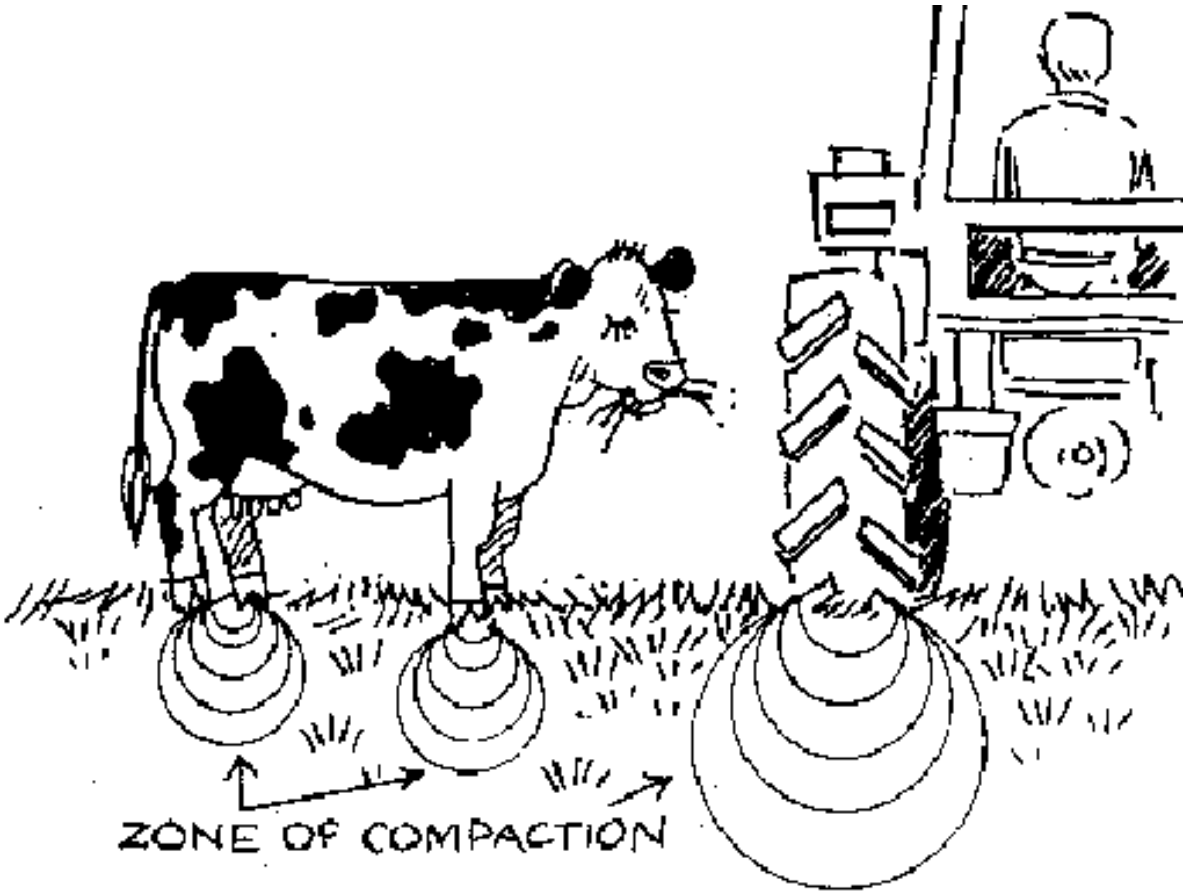

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Compaction and soil moisture

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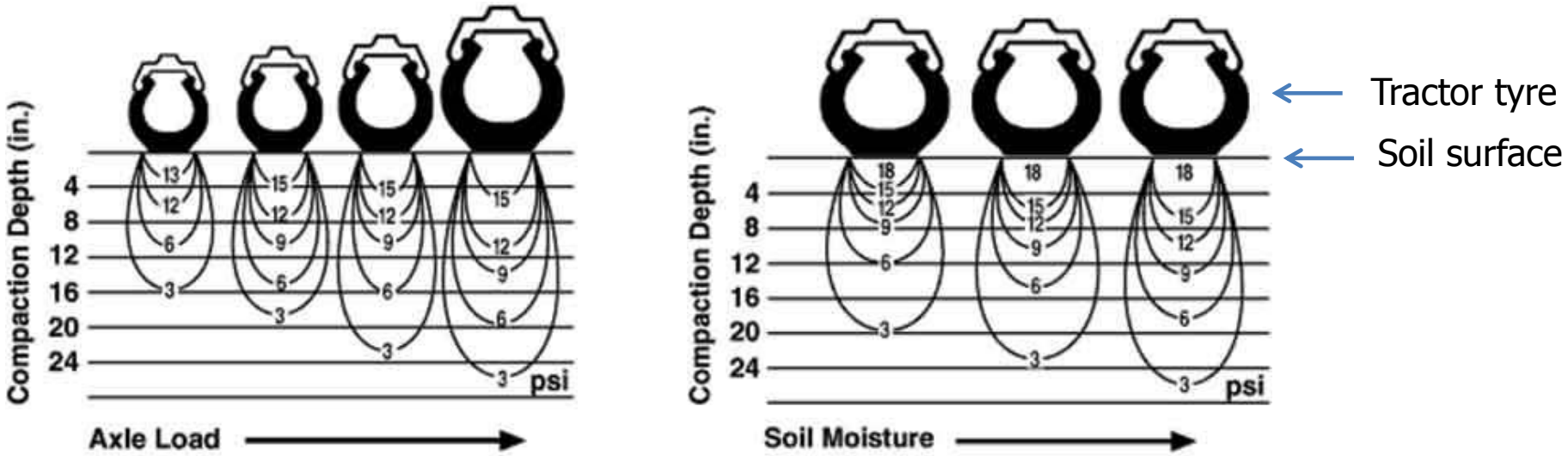

Wheel traffic compaction. The depth of compaction increases with increasing equipment weight (axle load) or increasing moisture condition. (Adapted from Soehne, 1958. Journ. of Agr. Eng.)

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

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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)

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

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Grassland Sward lifters

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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 aereate surface

Roller to level surface following treatment

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Sub Soilers

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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

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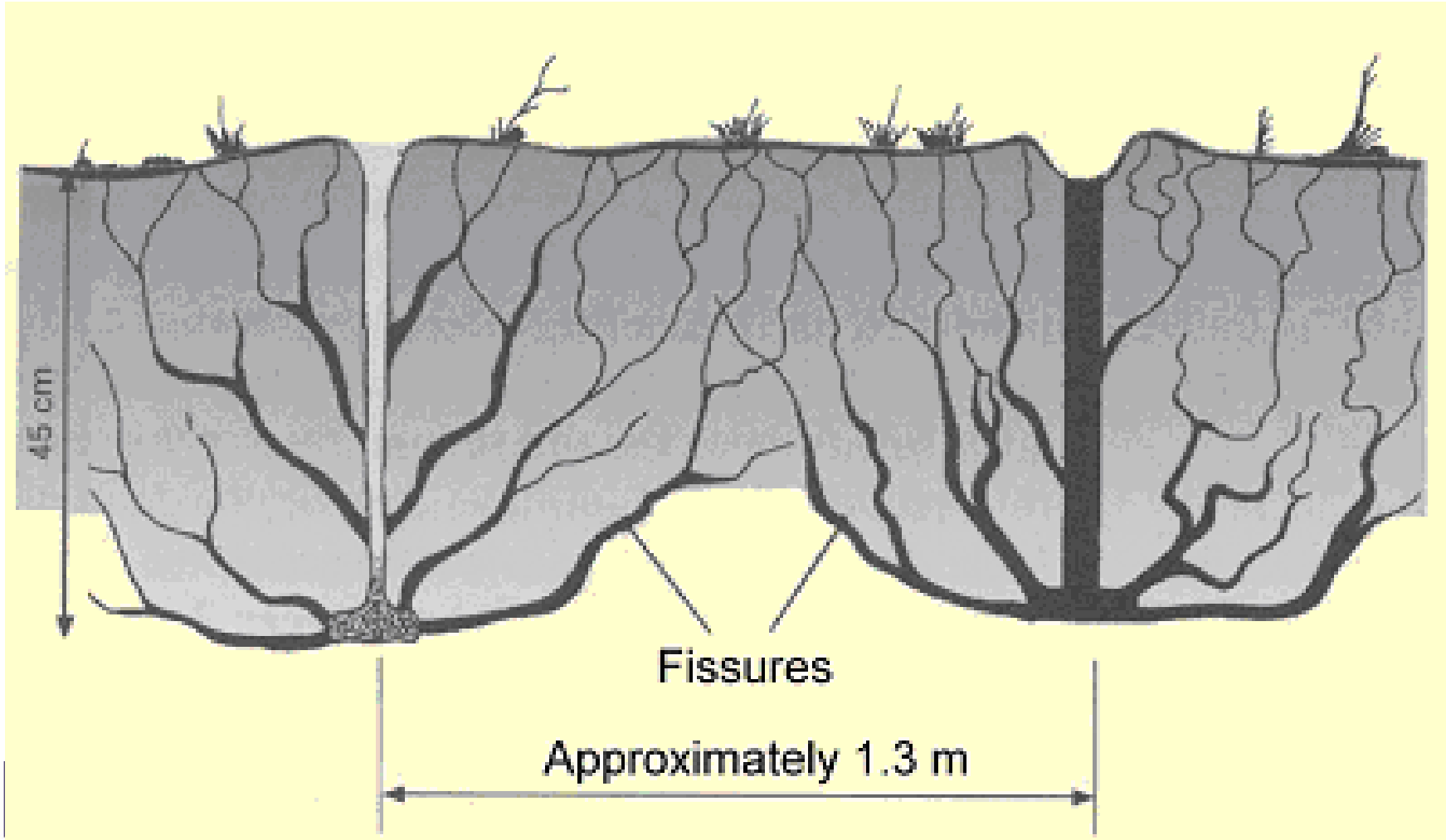

When to subsoil

- 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

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Soil Drainage

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Main Drainage Problems

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

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Problem type and occurrence

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

Drainage Problem	Scotland as a Whole % of problems	North East Scotland % of problems
Water Table	25	22
Impermeable Subsoil	20	13
Springs	12	39
Failure of Old Drains	39	25
Other	4	1

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Waterlogging

- Reduces crop yield
  - low nutrients, toxins, oxygen deficiency etc
- Affects soil management, e.g.
  - cultivation machinery choice
  - cultivation timing
  - cultivation energy input (number of passes required)
- Reduces access to the field
- Reduces optimum timing for harvest without causing compaction damage

Effect of drains on root growth

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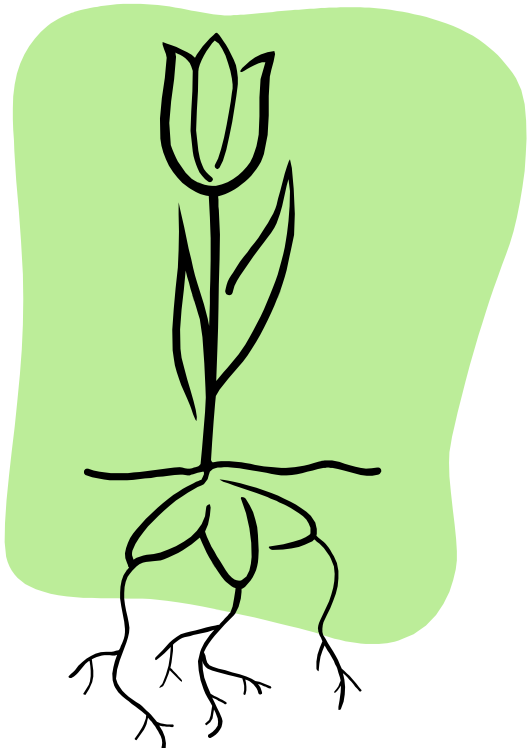
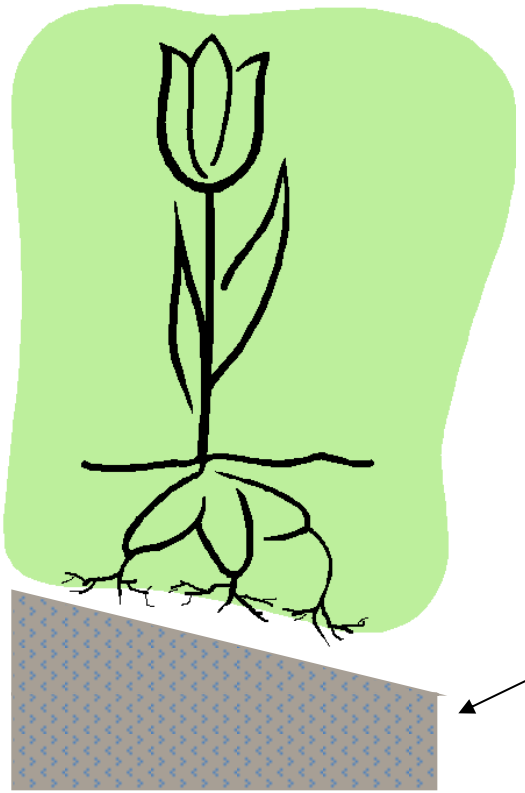
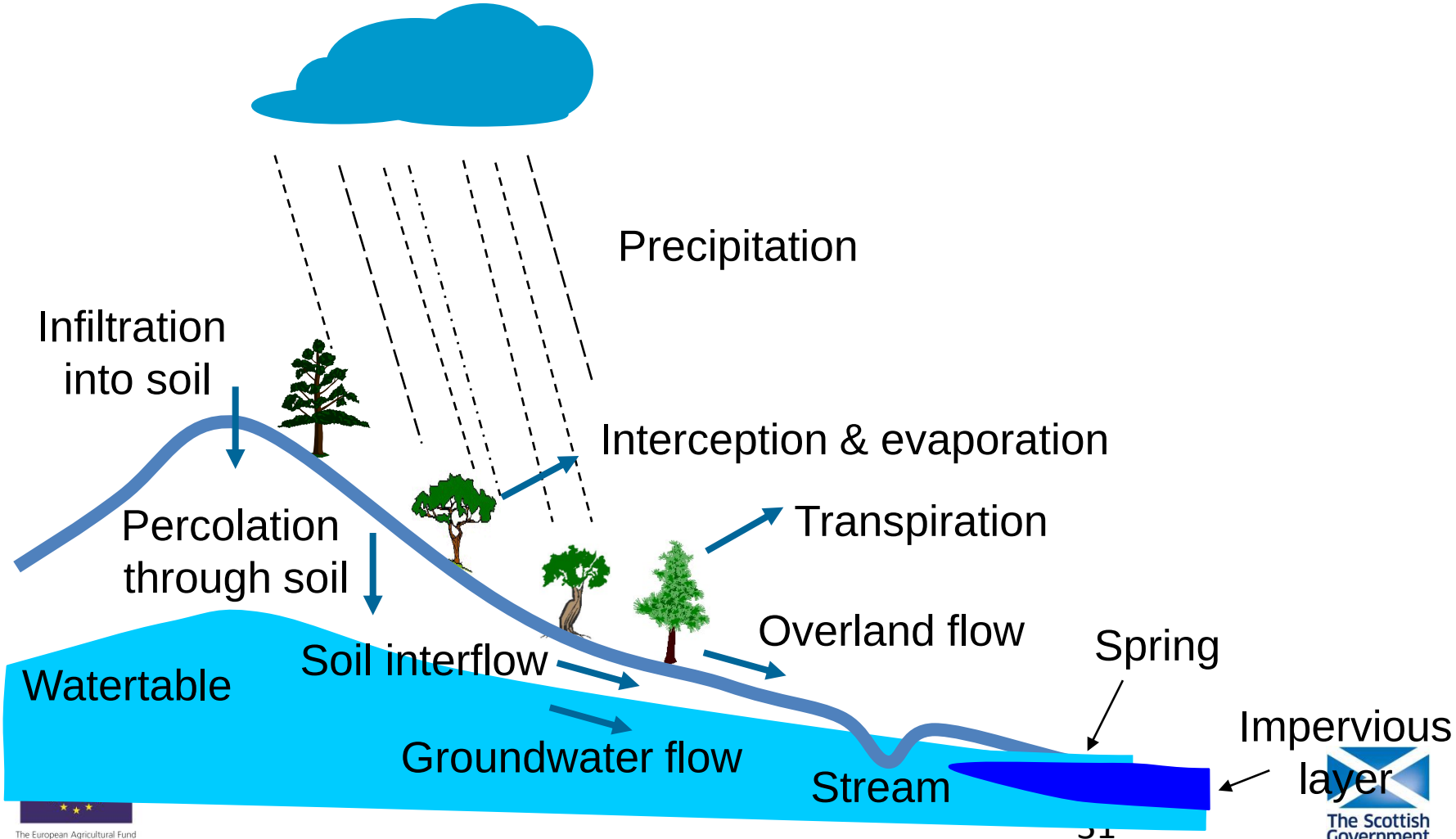


With drains



Without drains

Water pathways



Benefits of Good Drainage

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- Improved root growth
- Better crop and grass yields
- Better animal health – reduces risk of some parasites and diseases
- Less surface run-off (diffuse pollution)
- Less soil damage
- Longer utilisation of fields

Effect of poor drainage on yield (t/ha)

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	Freely drained	Poorly drained
Potato	40	15
Bean	10	2
Carrot	40	5

Drainage of impermeable soils - surface water problem

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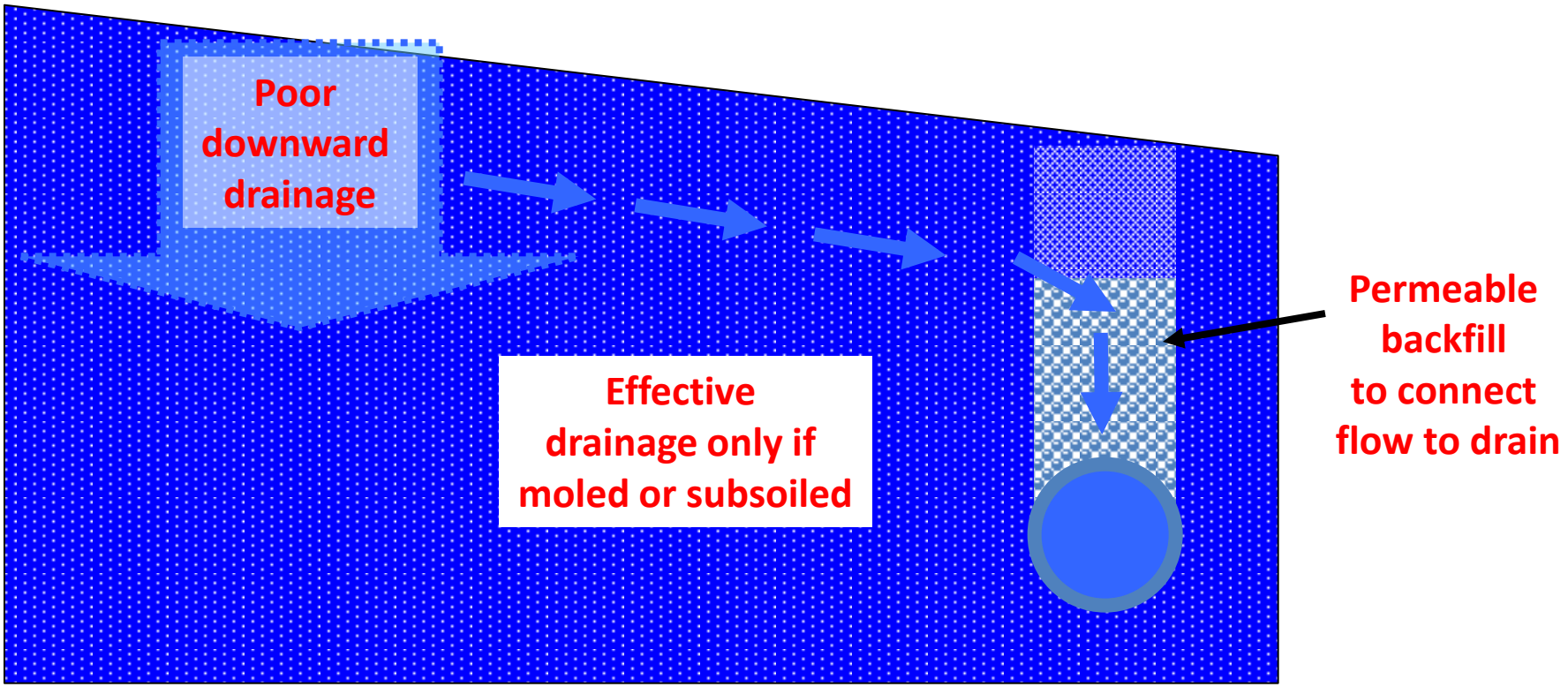

Must have gravel backfill to connect to drains

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Drainage of permeable soils - ground water problem

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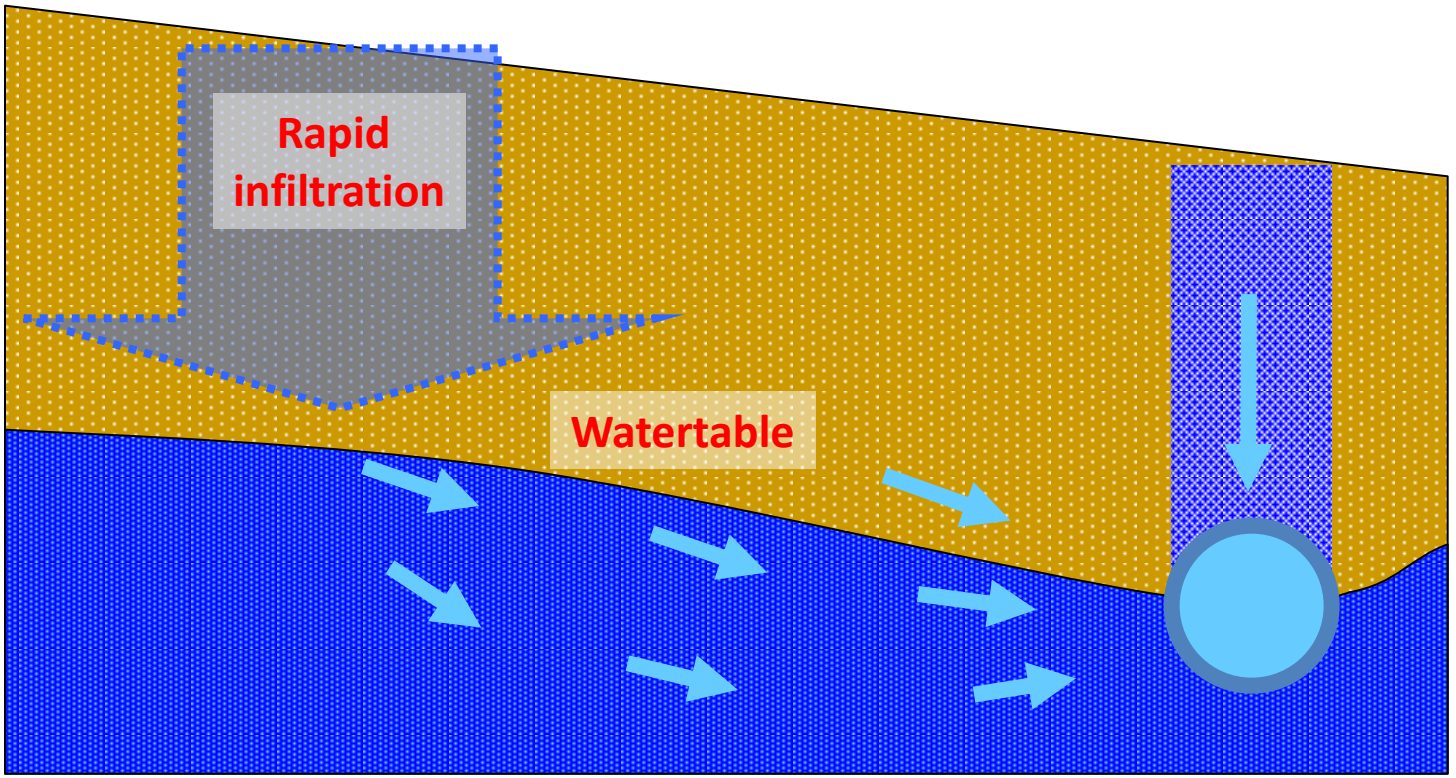

No permeable backfill Necessary ?

Drainage Design

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- 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