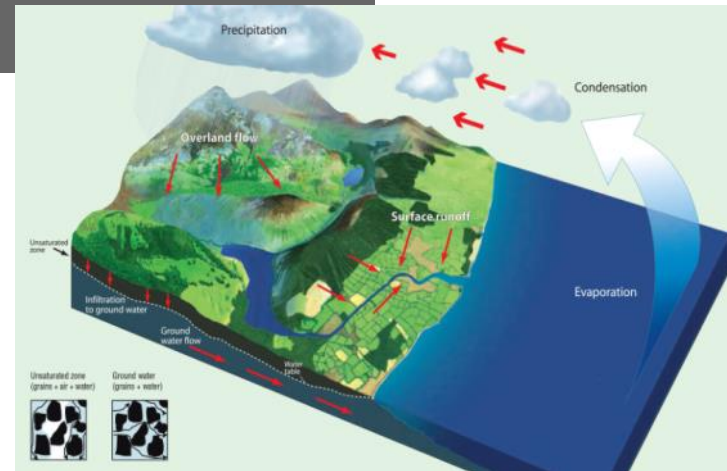
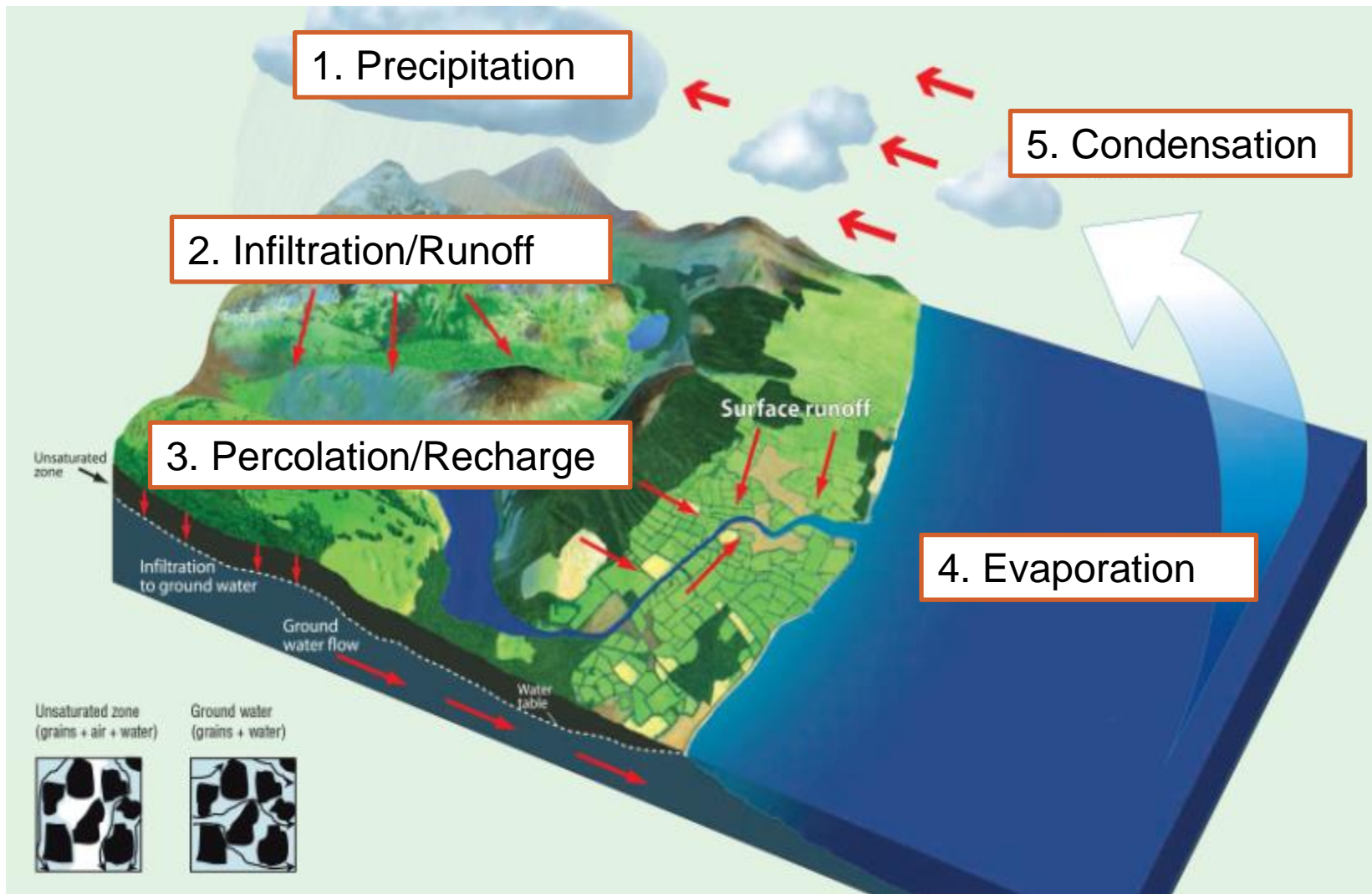


# The Water Cycle: Where does all the water go?

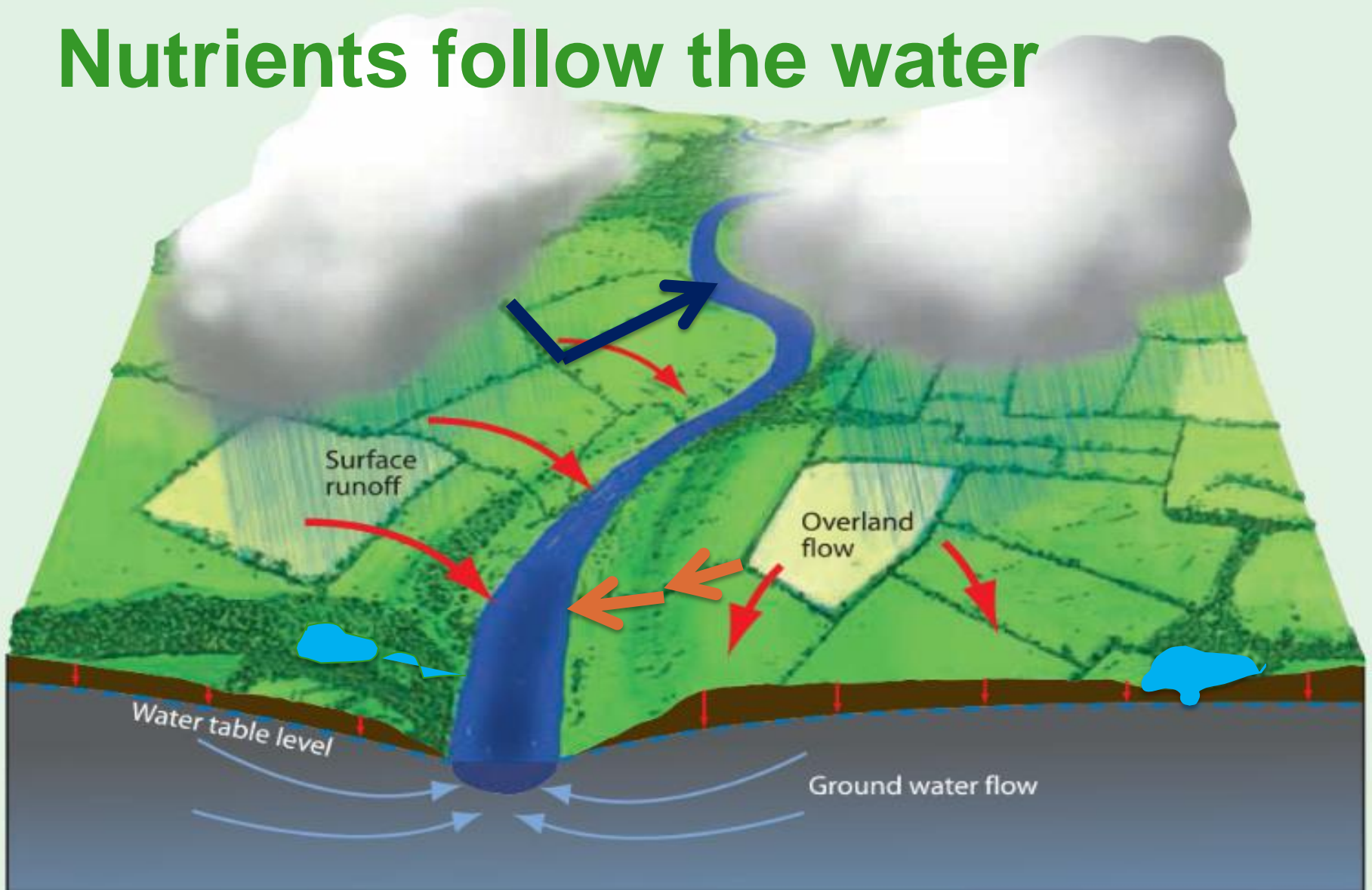
Owen Fenton  
Johnstown Castle  
owen.fenton@teagasc.ie  
@ofenton



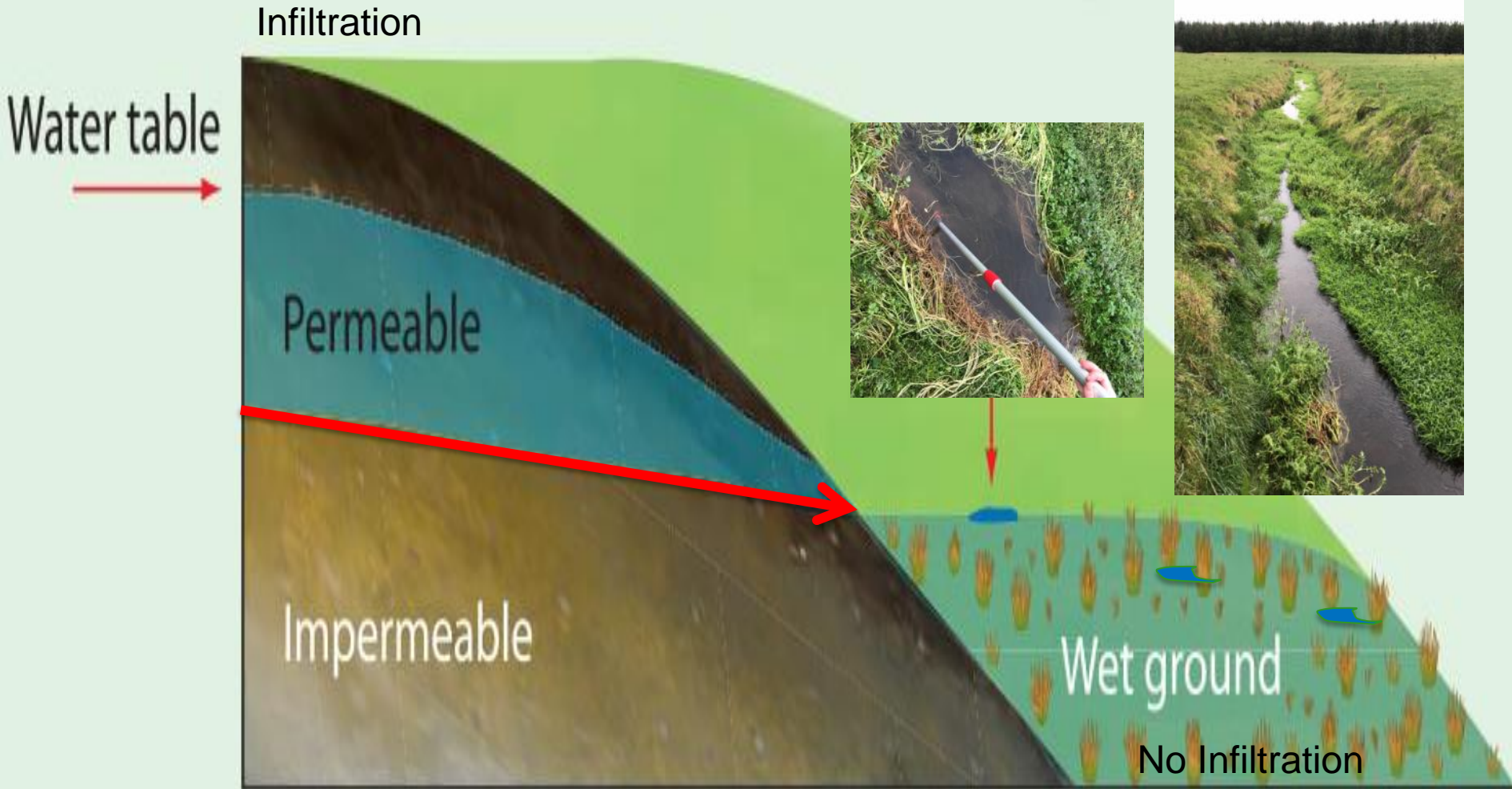
# The Water Cycle – flows & temporary stores



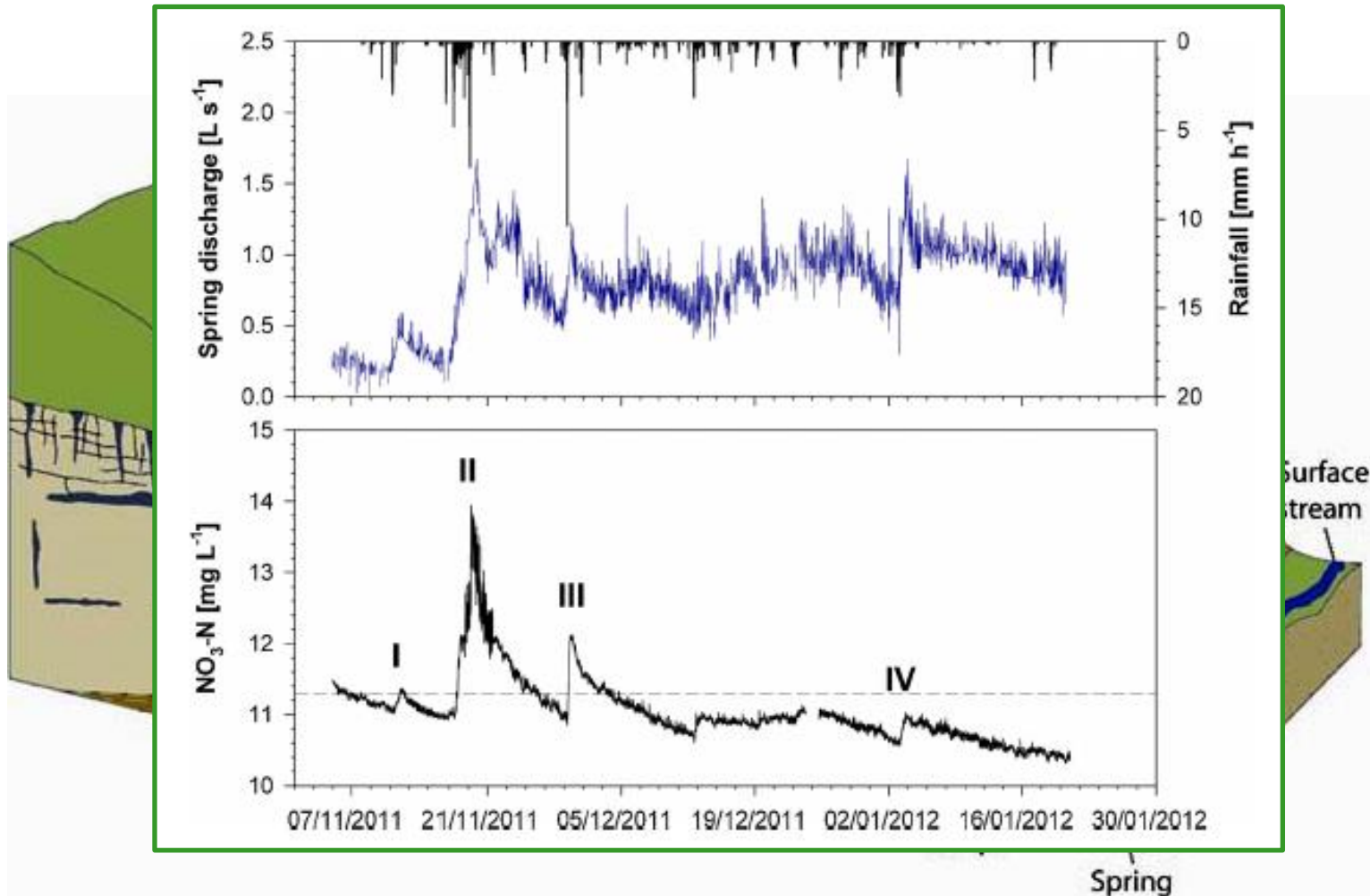
# Nutrients follow the water



# Springs:



# Sink hole, sinking stream

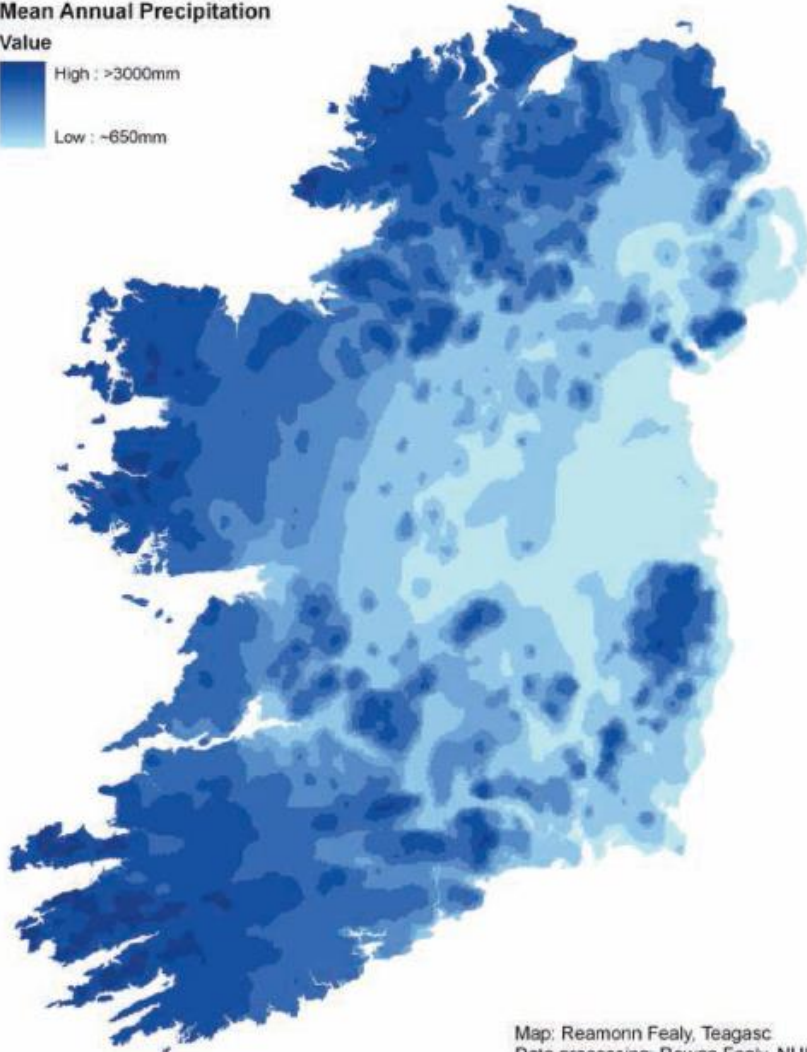


<https://www.pahasapagrotto.org/what-is-karst.html>

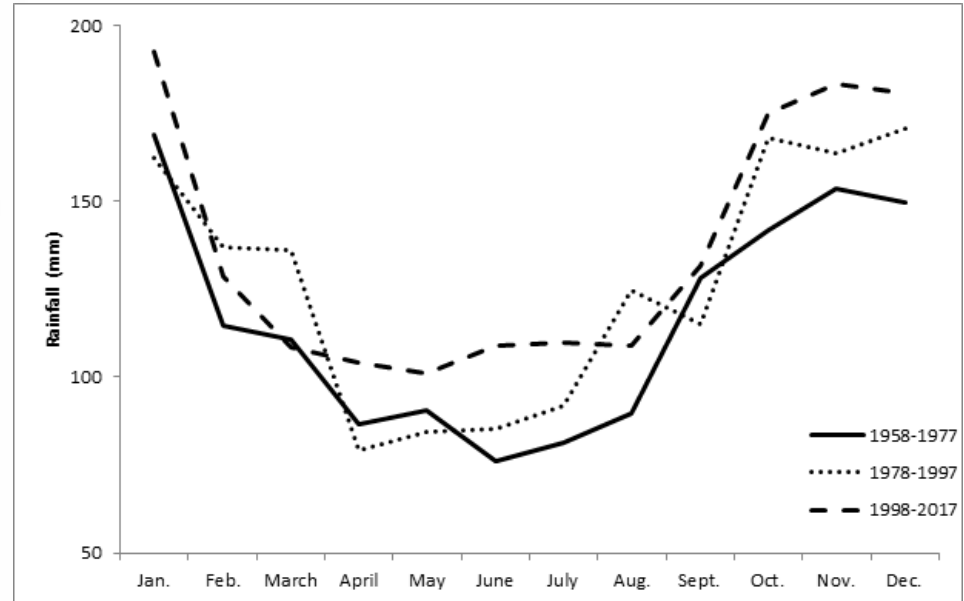
# Mean Annual Precipitation (mm)

Mean Annual Precipitation

Value



Map: Reamonn Fealy, Teagasc  
Data processing: Rowan Fealy, NUIM  
Data: Met Eireann



**More rainfall over time  
in summer months**

# Infiltration into soil

Gravel

Sand

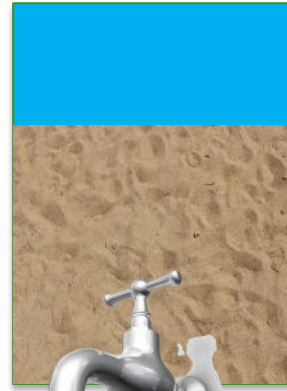
Silt

Clay

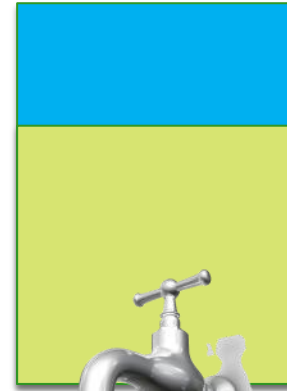
1 metre



2 minutes



2 hours



200 days

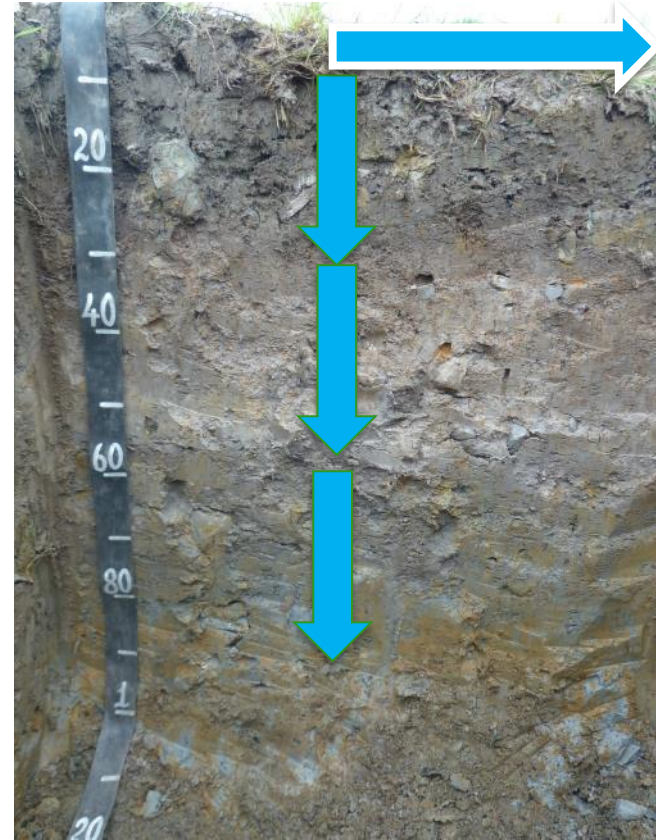


200 years

# Infiltration vs. Runoff



**Well drained**



**Poorly Drained**



# Fast Infiltration System?



## **Soil & Subsoil:**

Well drained

## **Rock:**

Karst Limestone or  
productive bedrock

**Runoff:** Low, no in-field drains, no ditches

**Dominant pathway:** Groundwater

**Roadway Network Density:** Low

**Nutrients Lost:** Nitrate, Phosphorus

## **Mitigation:**

Source and mobilisation control important

# Slow Infiltration System?



## **Soil & Subsoil:**

Poorly drained mineral or peaty soils

## **Rock:**

Underlain by a poorly productive bedrock

**Runoff:** High, in-field drains, ditches

**Dominant pathway:** surface

**Roadway Network Density:** High

**Surface Nutrient:** Phosphorus  
(particulate and dissolved)

**Subsurface nutrient:** Ammonium

## **Mitigation:**

Need to break the pathway

# Practice change and water quality response

How long does it take for the mitigation measures to have an effect on water quality?

At meso-catchment scale (up to 100 km<sup>2</sup>) – 25 studies found worldwide

- Positive effects were found in 17 of the 25 studies
- It took 1-10 years for positive response to show up in monitoring
- Longer times were connected with scale
- Response time increased as the transport pathway increased

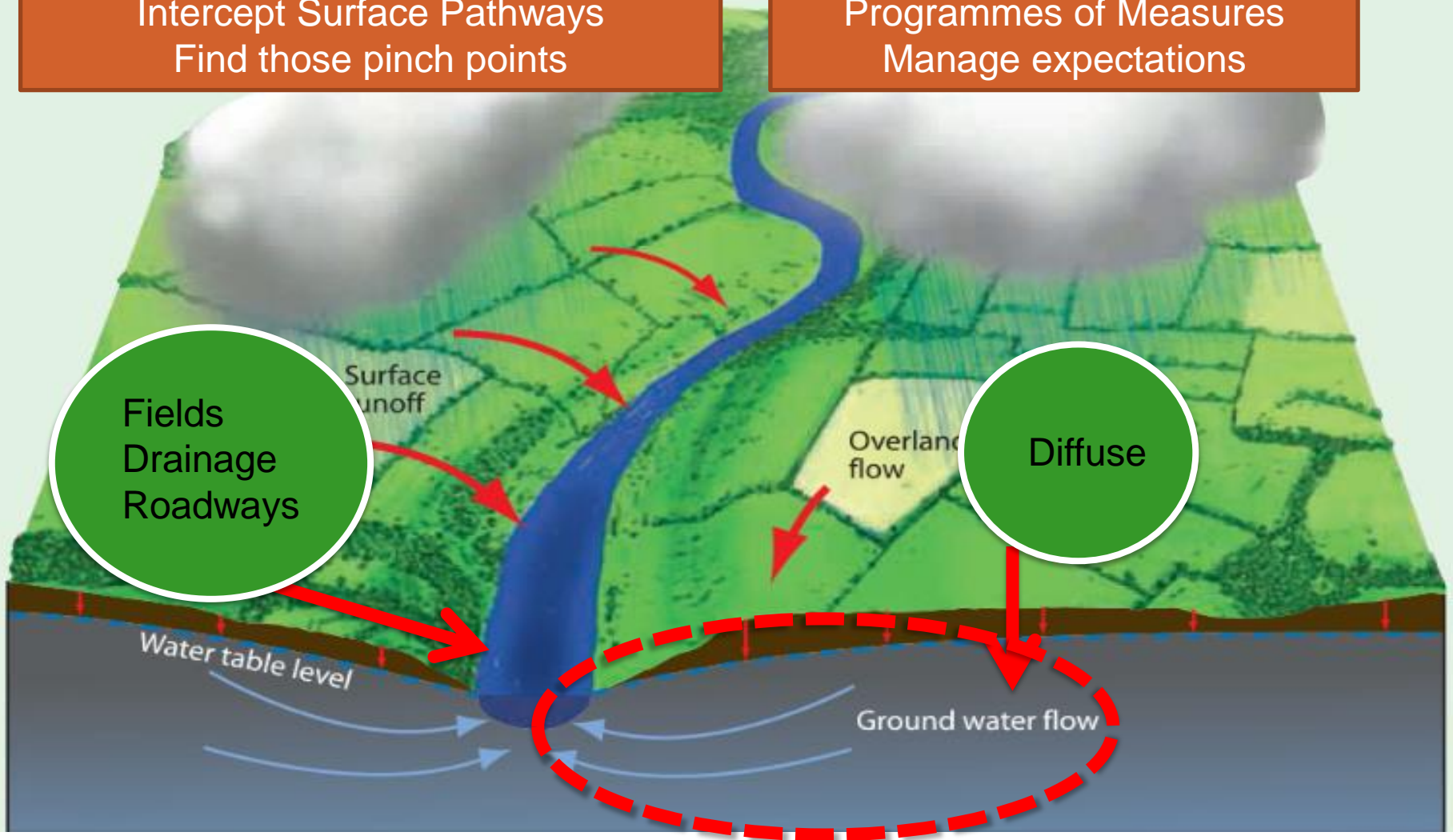
Also time lags associated with implementation of measures (0.5 – 14 years)

## SLOW INFILTRATION

Time Lag: weeks to months  
Intercept Surface Pathways  
Find those pinch points

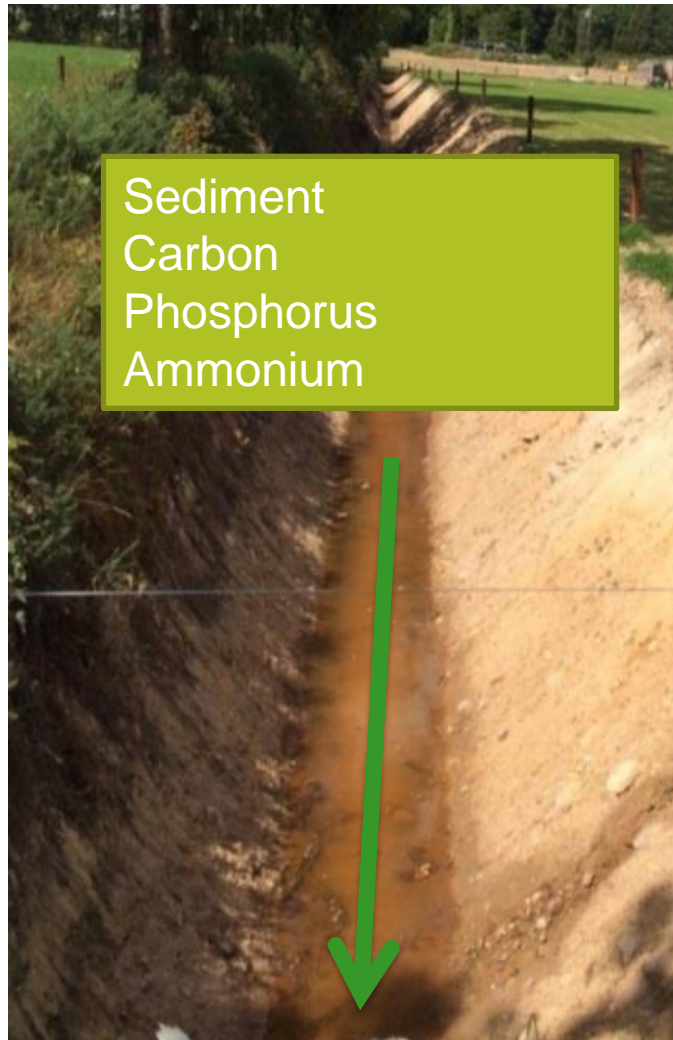
## FAST INFILTRATION:

Time Lag: months to decades  
Programmes of Measures  
Manage expectations

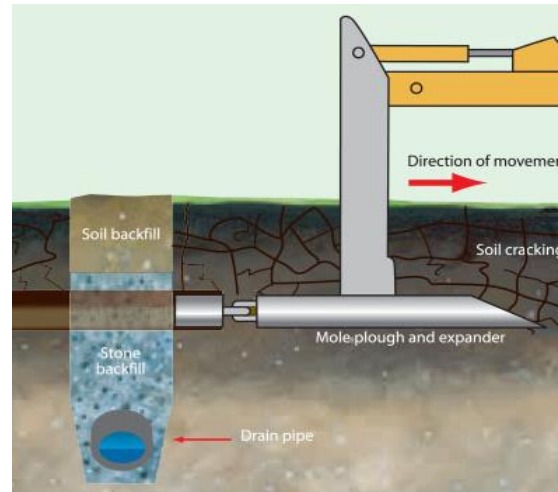


Biogeochemical  
time lags

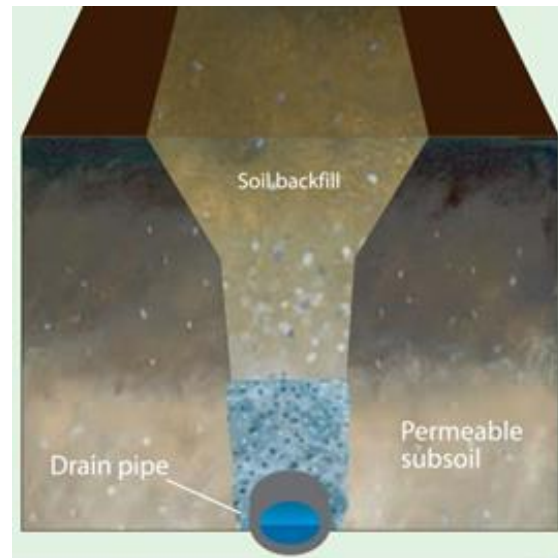
# On Farm Land Drainage -



Sediment  
Carbon  
Phosphorus  
Ammonium

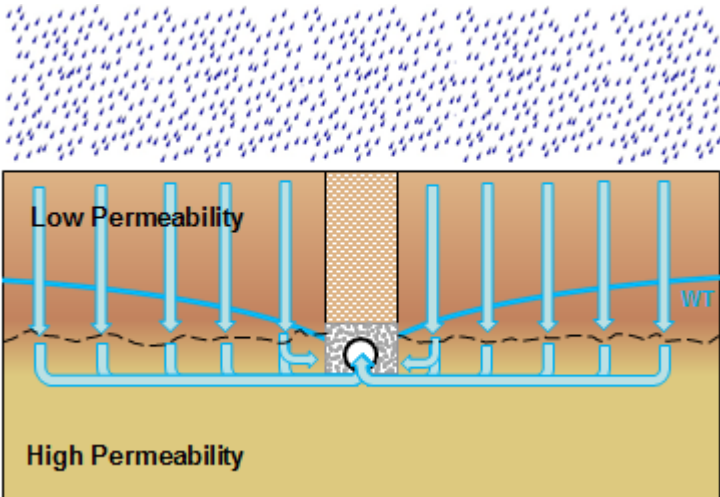
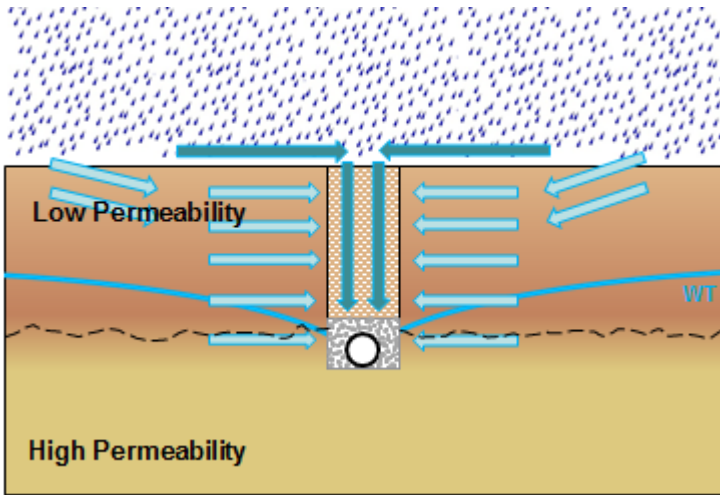


Shallow high intensity systems  
-target rainfall



Deep groundwater systems  
-target groundwater & rainfall

# We need to avoid land drainage mistakes..... Need to slow the flow



Going forward:

- Focus on mineral and not peat soils
- Avoid floodplains

Break connectivity of drainage network with:

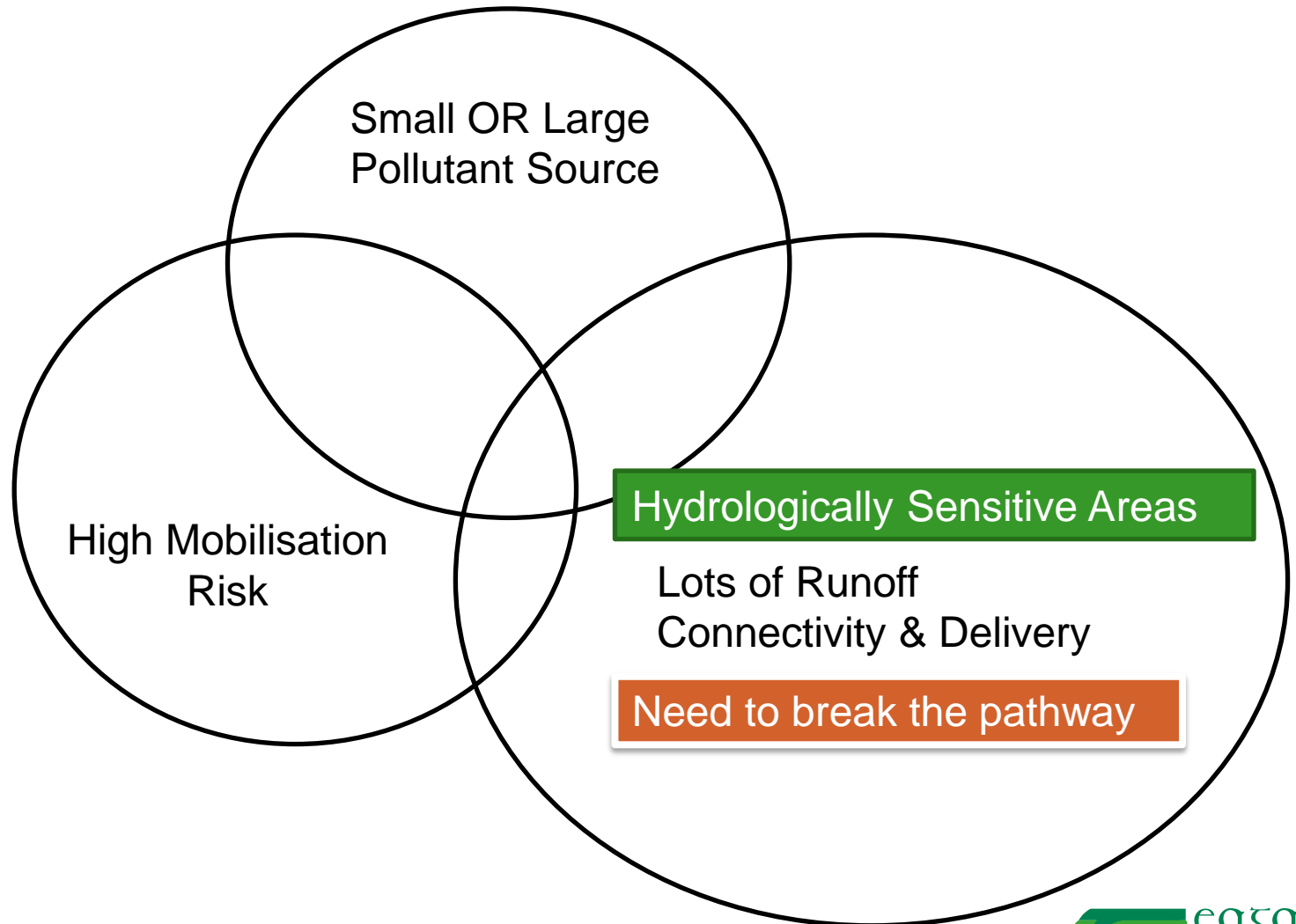
- Farmyards
- Roadways
- Surface Water

**Always back fill top soil on top of stone**



# Diffuse Critical Source Areas

## Slow Infiltration Systems



# New Pathway - Farm Roadways



ROADRUNNER

\*Research shows annual load of phosphorus and sediment are low:

Farm Scale: ~1% of all losses

Catchment Scale: ~10 % of all losses

**But, but, but.....**

Compared with field runoff, roadway runoff occurs all year round

**Reacts quicker (hard surfaces, less infiltration)**

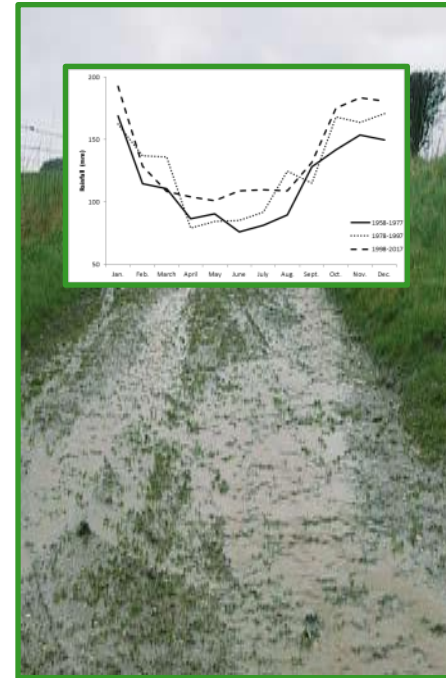
**Can connect directly to ditches and surface water**

**Especially in Summer months:**

Contributes much higher proportions to catchment load (**4-76%**)

**Find sections**

Intercept Pathway

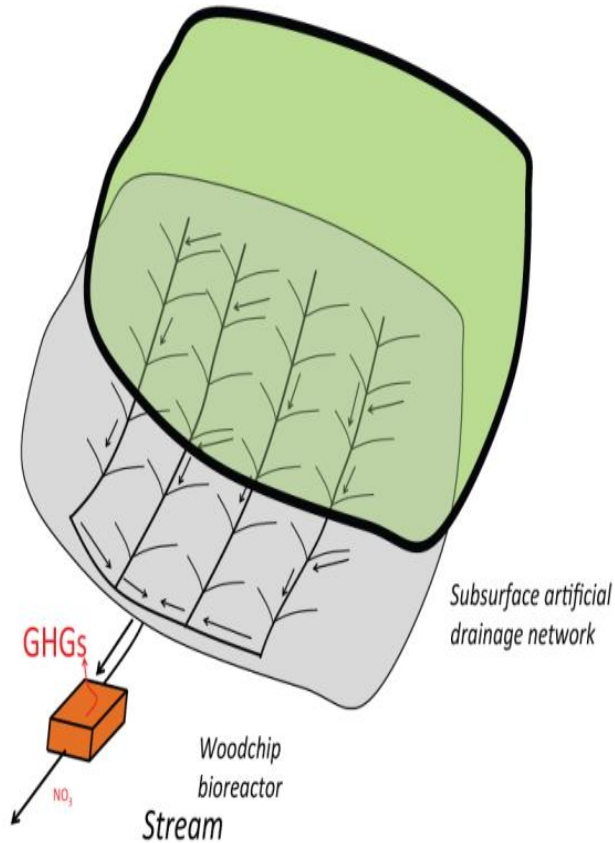


@ROADRUN\_project



# Break the pathway

Roadway, open ditch and in-field options must be explored . . . . .



(B)



(C)

