

Phosphorus interaction in soils and water
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Overview

Phosphorus dynamics in soils

- Phosphorus forms soil & water
- Interactions with other elements and soil properties
- What this means for build-up and drawn-down of P?

Pinch-points for P loss on the farm

- Landscape processes & pathways
- Farm scale connectivity - what P measure and where?

Soluble ortho-phosphate (PO_4^-)

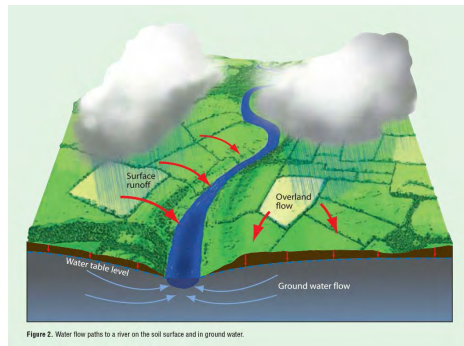
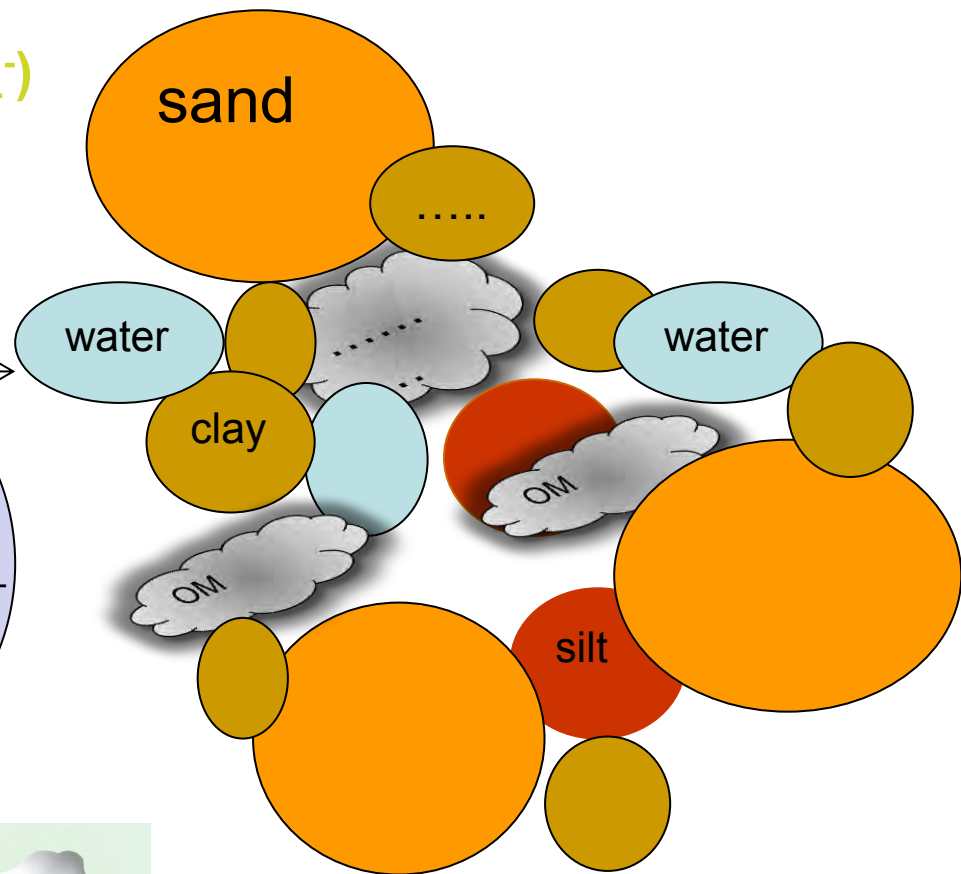
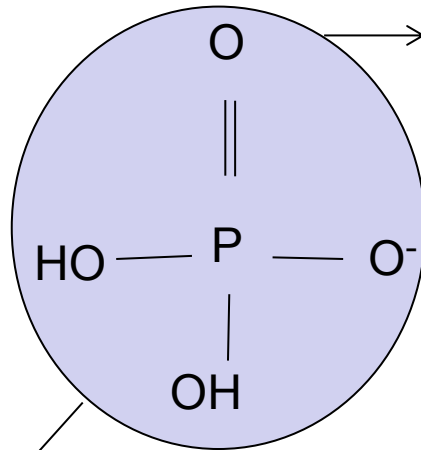
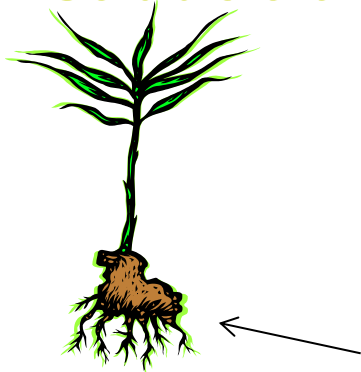
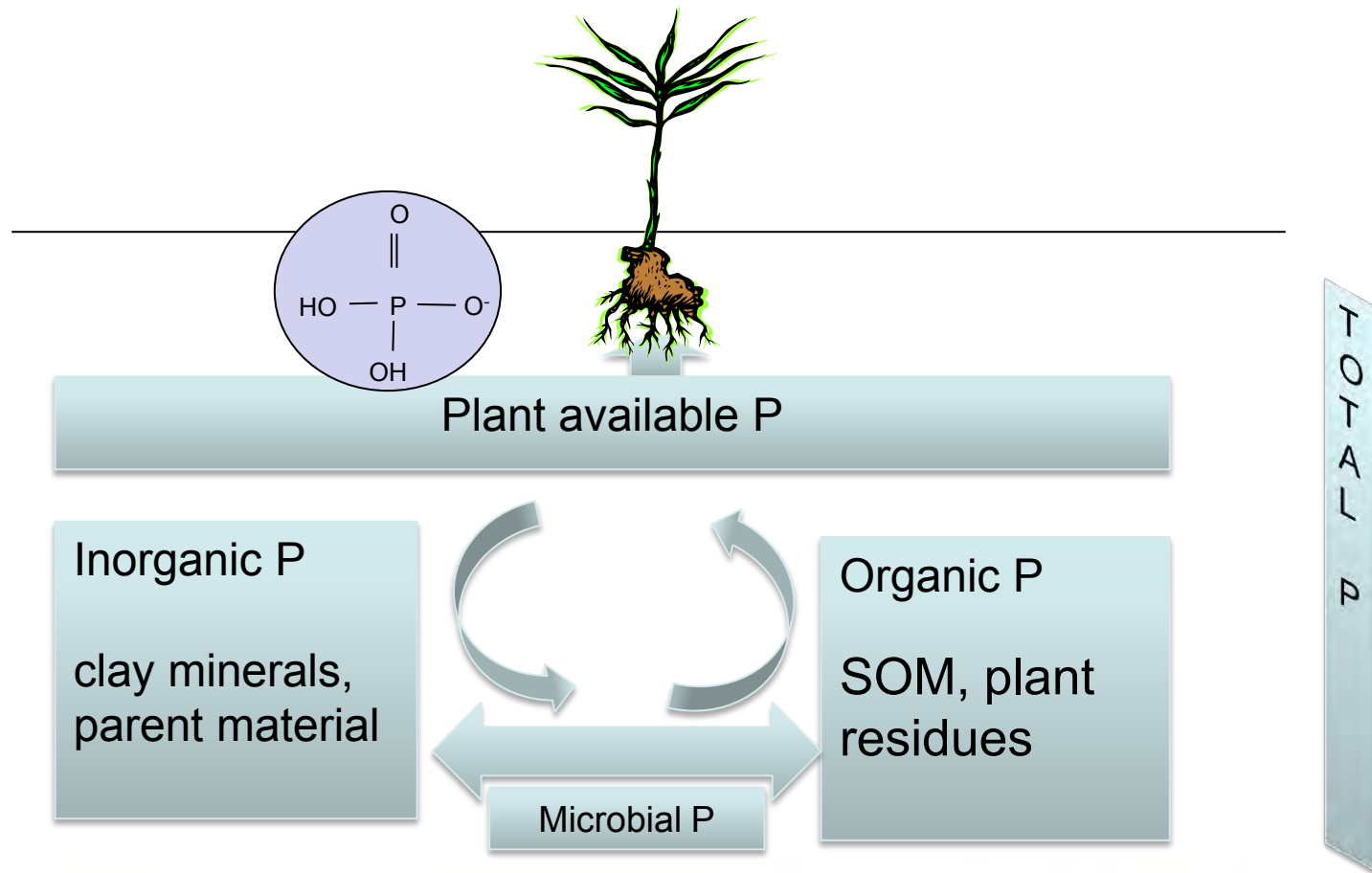
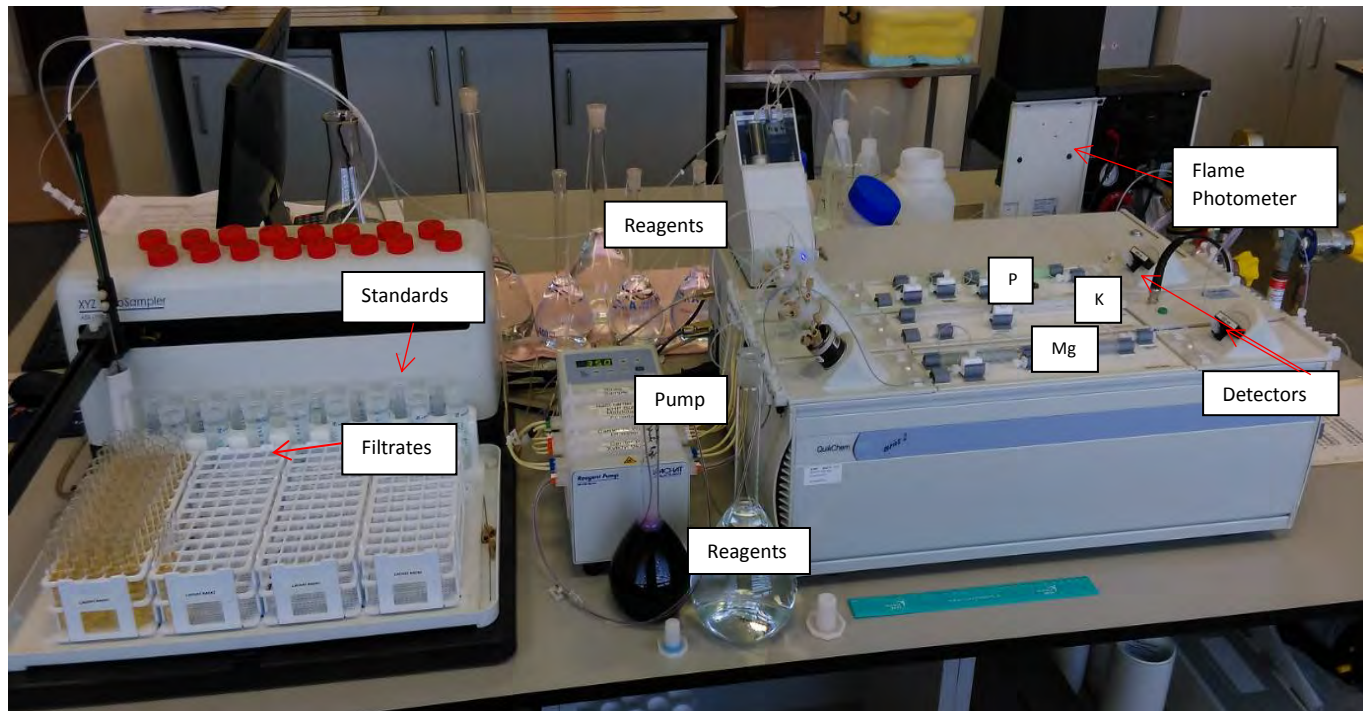
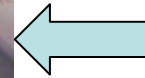
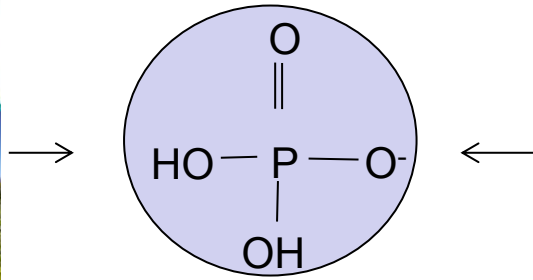


Figure 2. Water flow paths to a river on the soil surface and in ground water.

P in soil: A simple conceptual model of soil P cycle...unlike N!





We have
connected
STP with
WQ



Irish soils & P

Current methods:

Soil sampling typically every 2- 4 ha, once in 5 years.

Base decisions on few parameters

Should we correct for soil type?

P Index System

- 1: Deficient
- 2: Low
- 3: Optimum
- 4: Excessive

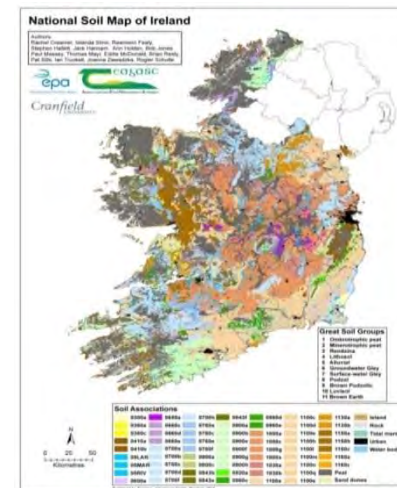
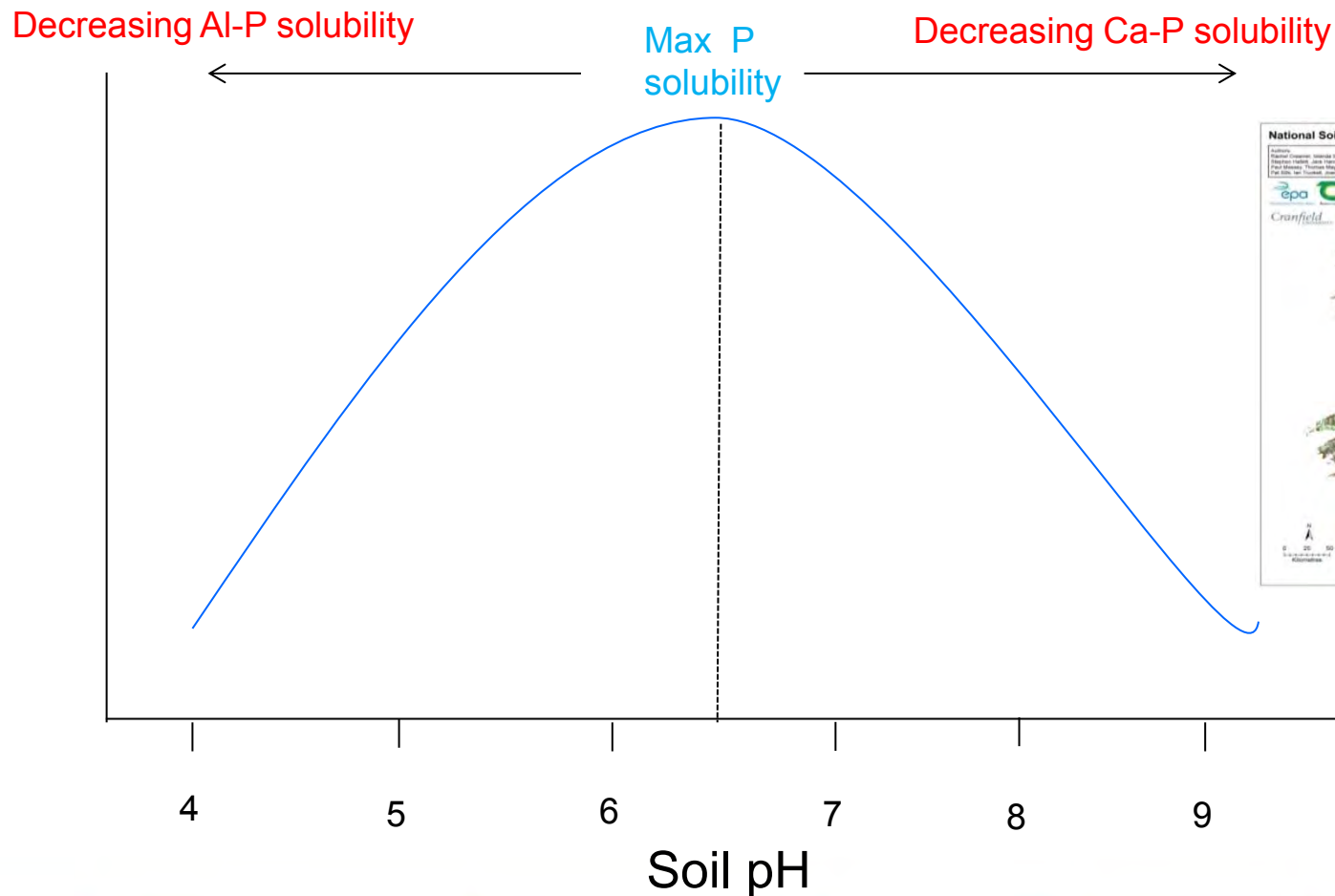


Texture?

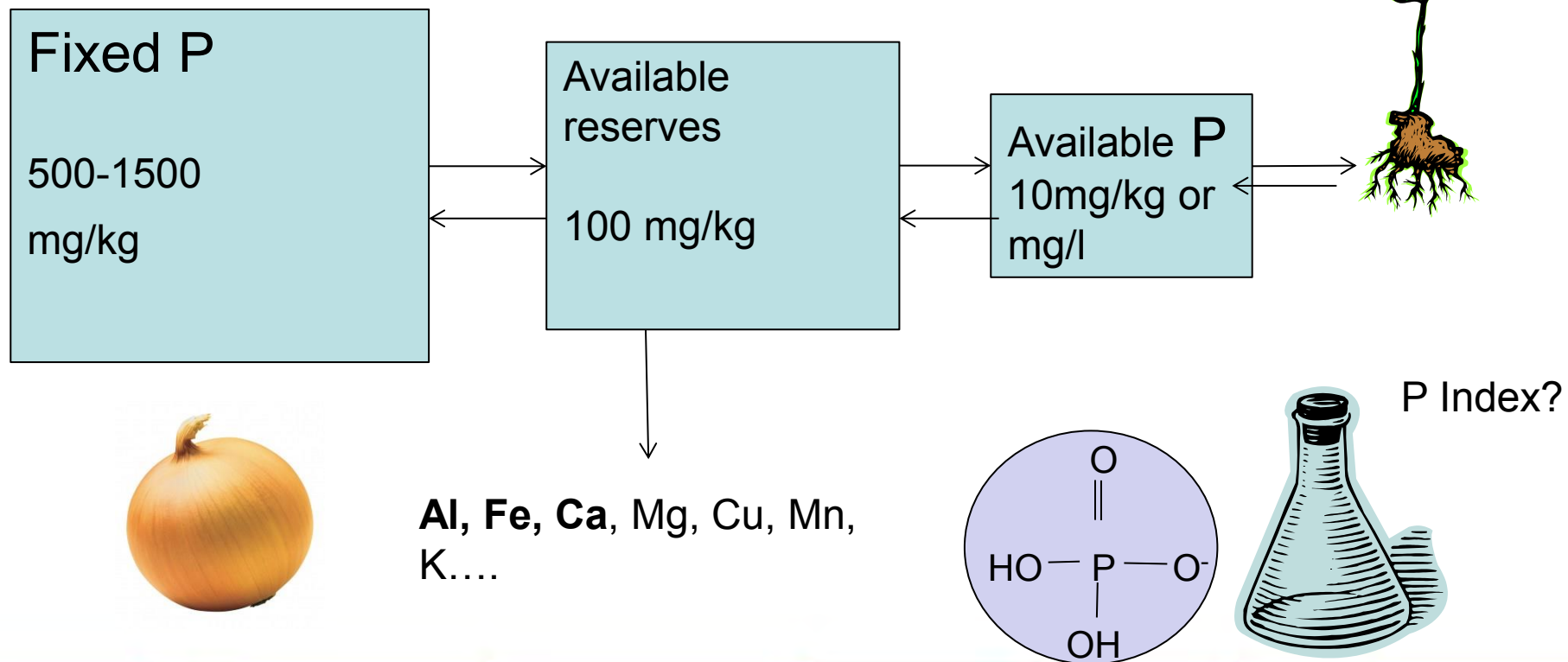
Al? Fe? Ca?



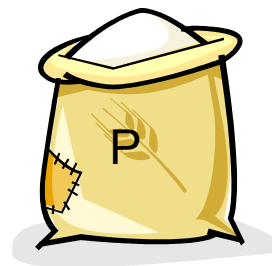
Soil controls on P solubility & availability



Inorganic phosphorus pools in soils

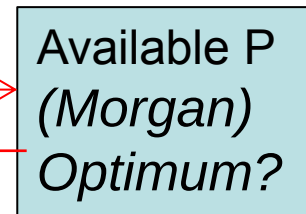
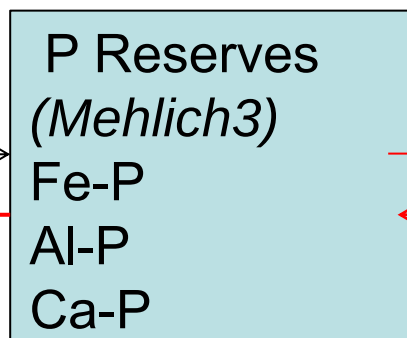
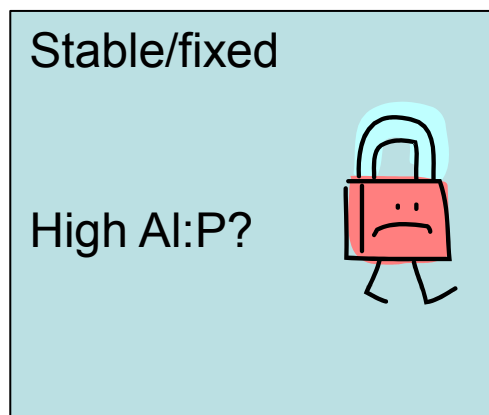
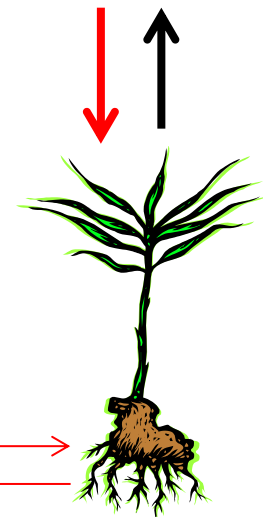


Build up



Fertiliser
inputs

Crop offtake



Check pH?

Slow reaction

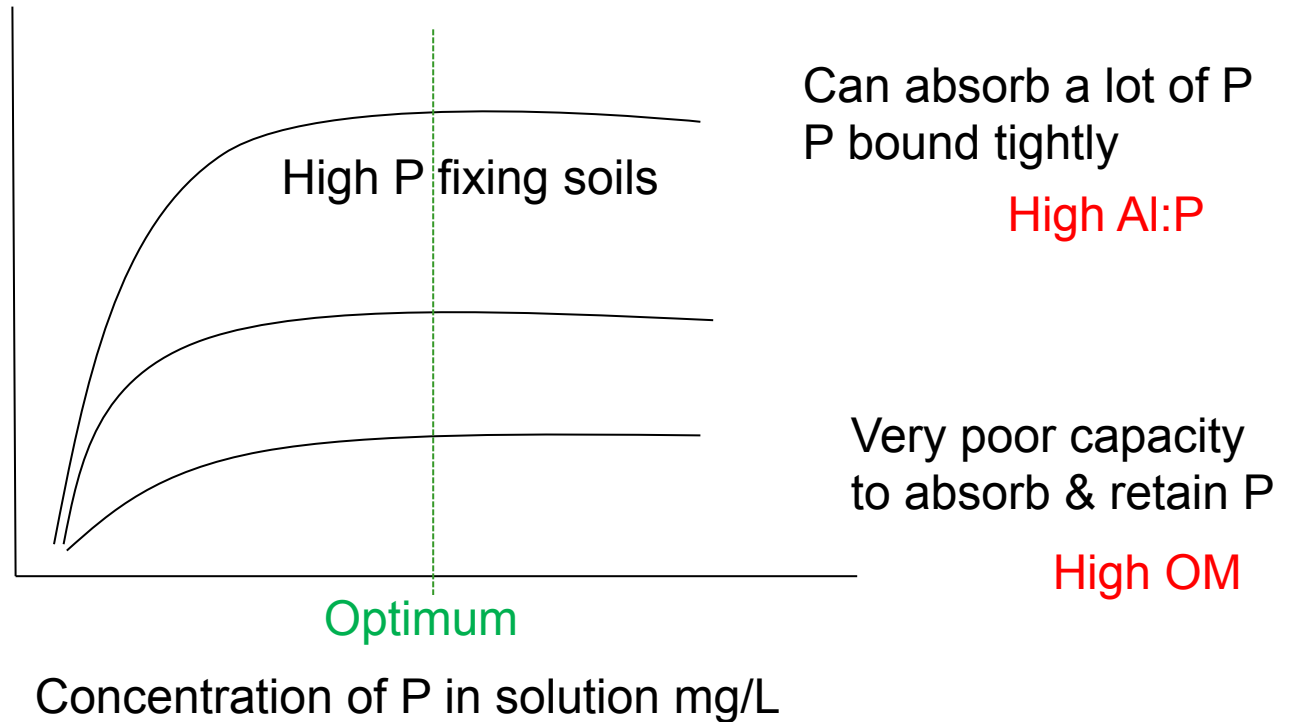
fast followed by slow
reaction

fast reaction

Phosphorus sorption: what happens when we add P to soil Build-up?



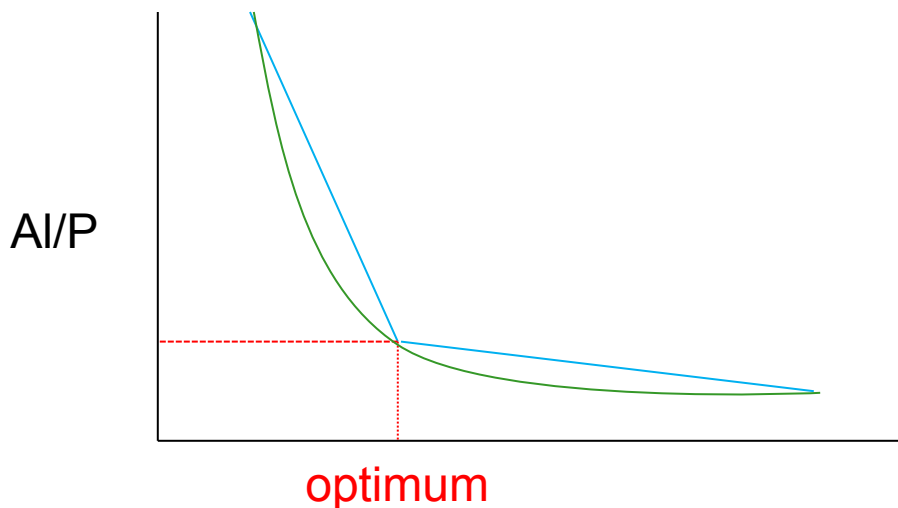
P sorbed onto soil
Mg/kg



Be patient with the high P fixers (takes time) & careful with poor P retainers

How do these things control P release into solution/water

In Irish soils, Al controls binding energies



How tight P is 'stuck' onto soil matrix

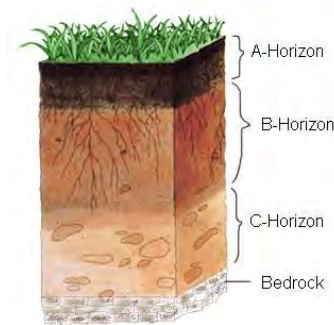
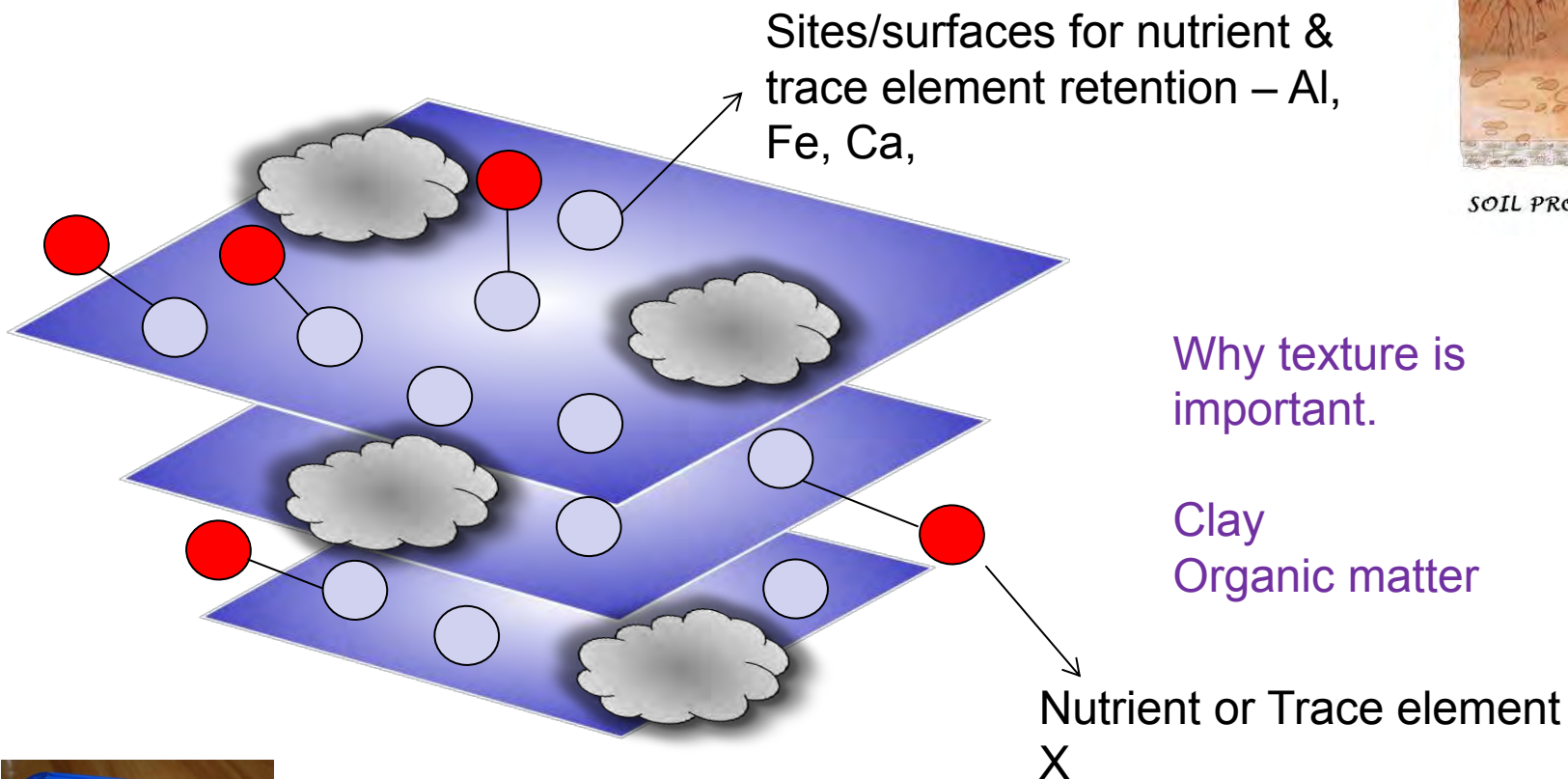
Al also is a sorption site...placeholder for P.

As P is added, some sorption sites need to fill up first before P can be released into solution

Draw-down, or decline from Index 4 to 3 will differ...again give it time.



What's happening on the soil matrix....

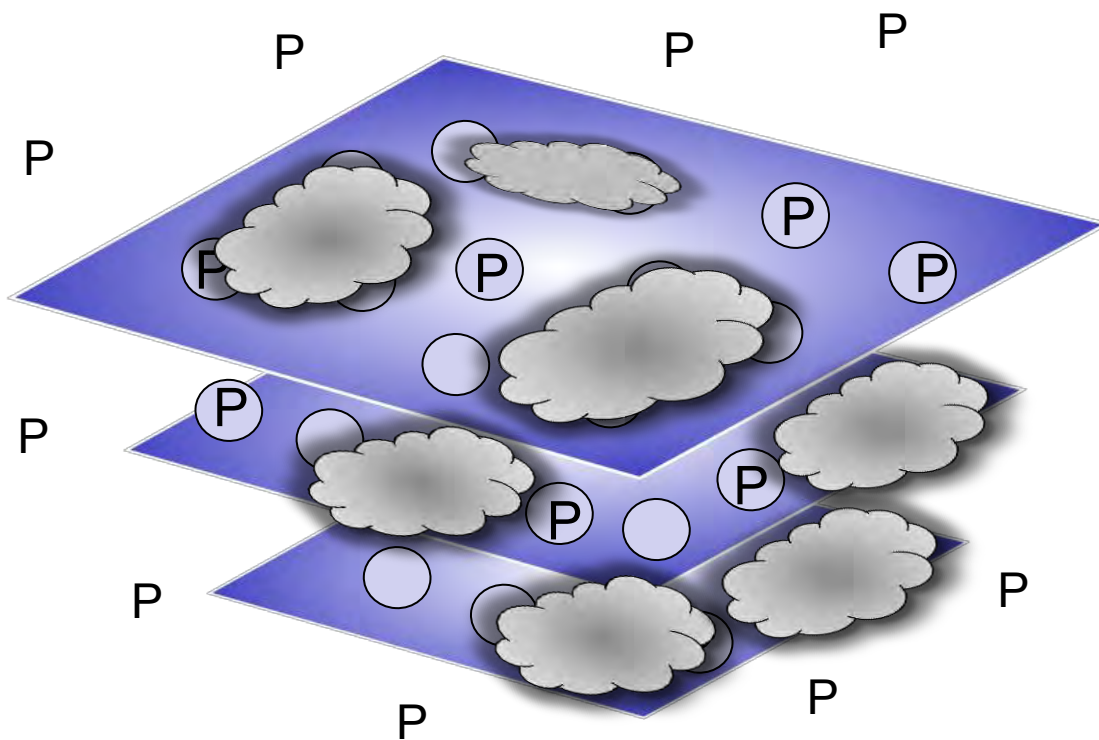


SOIL PROFILE



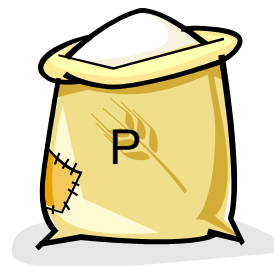
Organic Matter Influences on P (low P sorption).

Too much of a good thing?



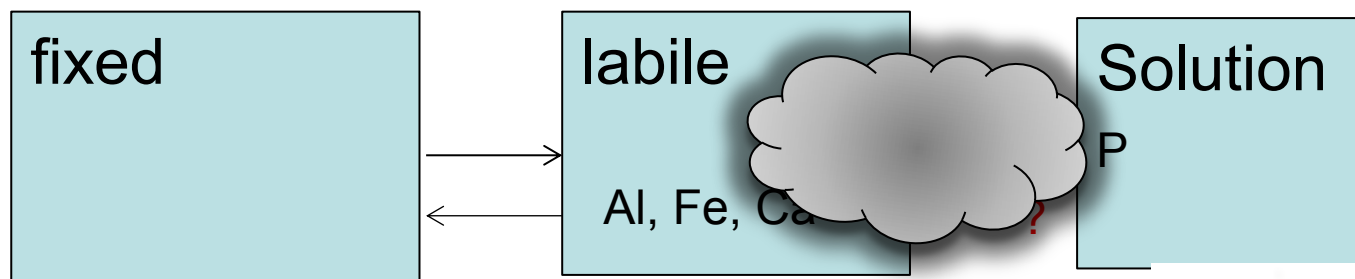
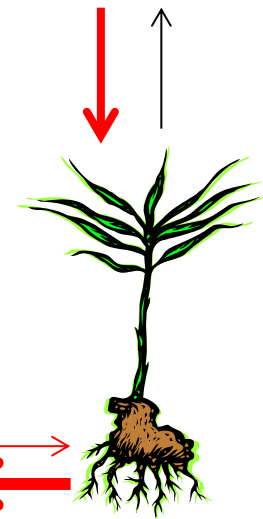
>20% OM in 10 cm depth

Soil naturally high in organic matter

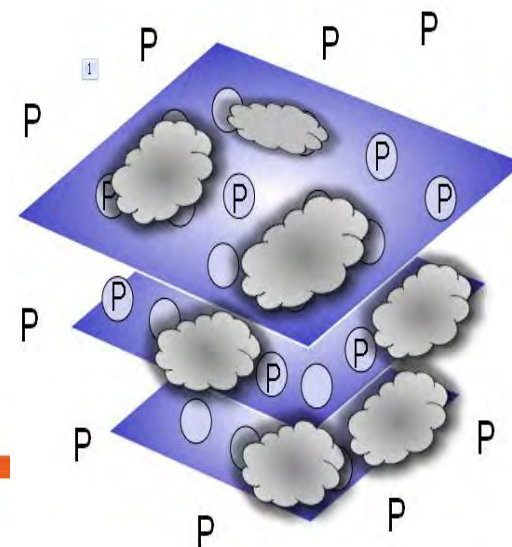


Fertiliser
inputs

Crop offtake



High risk of P loss if not taken up by
plant.
No build up!



High organic matter soils: Histics, humics and Peats



Ombrotrophic Peat



Histic Alluvial

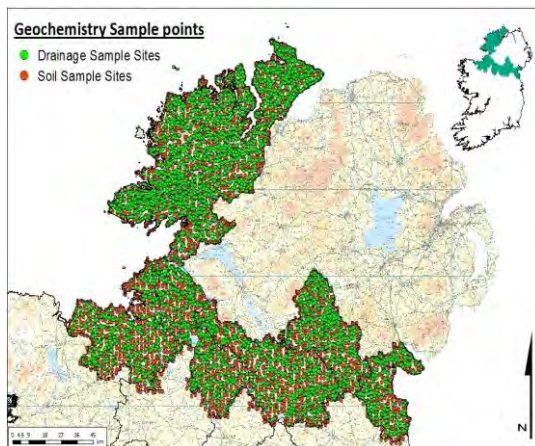
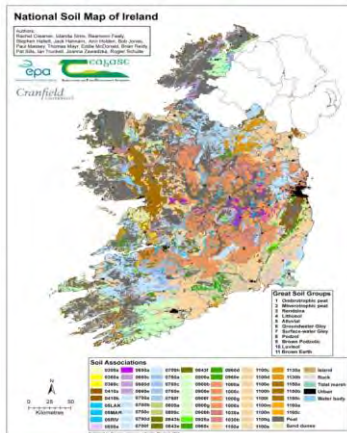


Humic Gley



Humic brown podzolic

Providing the data to 'know your soil' and understand P dynamics.



Agri-environmental Indicators for P in Irish soils

Morgan P, Al, Fe, Ca, texture, %OM/pH.
Agronomy & water quality models



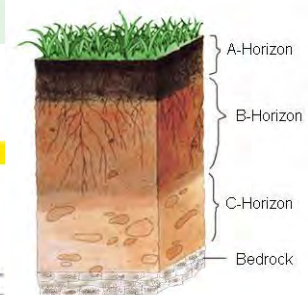
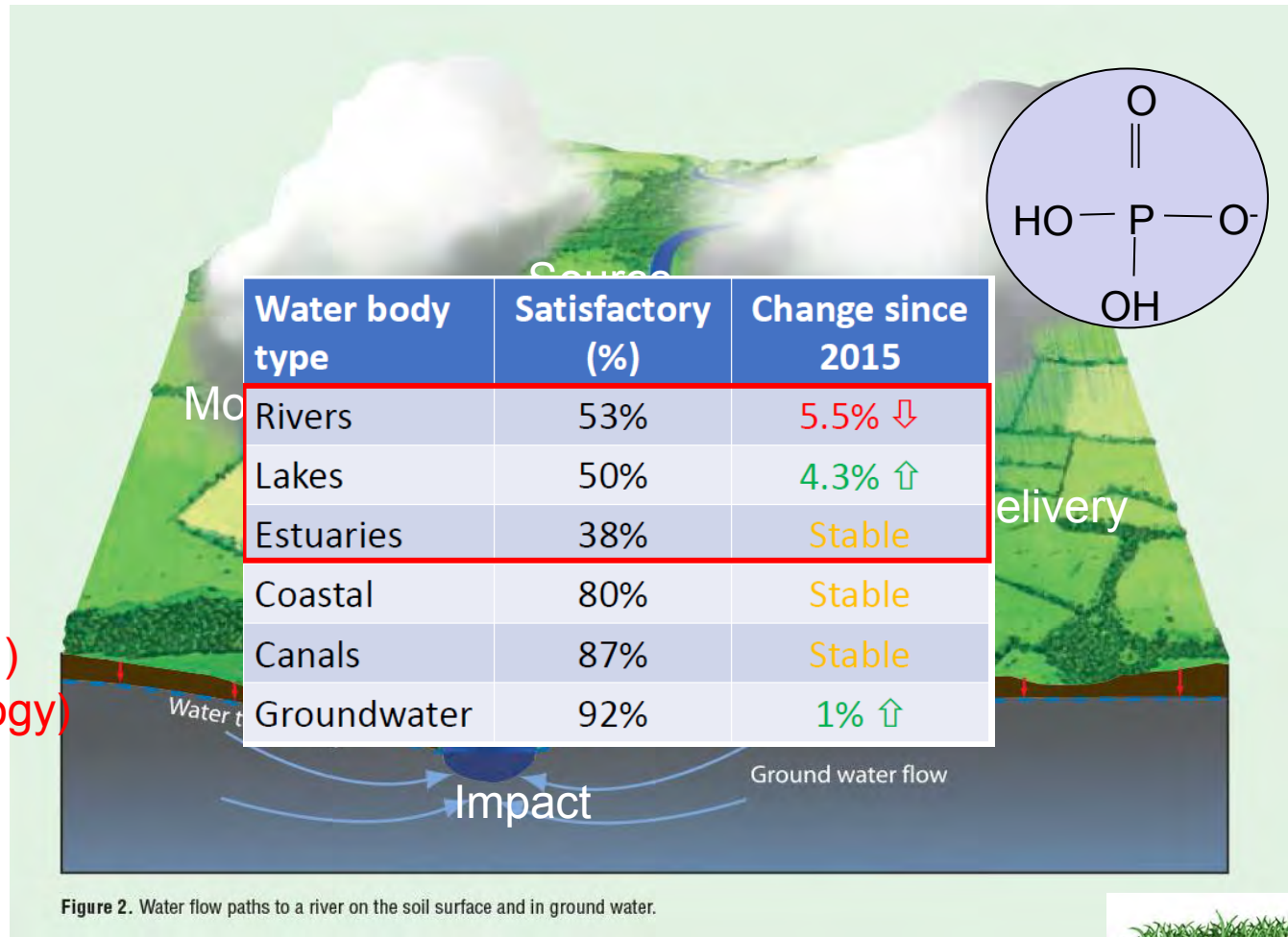
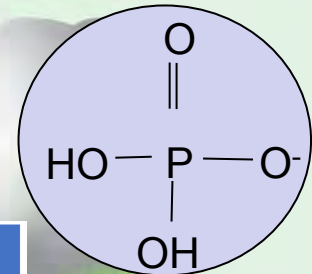
Landscape scales of diffuse P loss

Transport vector

Poorly drained soils

'flashy catchments'

Source (field)
Mobilisation (soil)
Delivery (hydrology)
Impact (river)

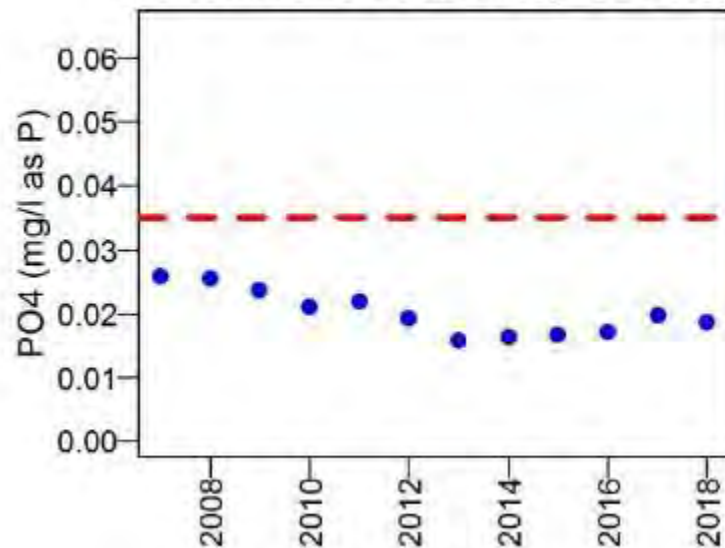


SOIL PROFILE

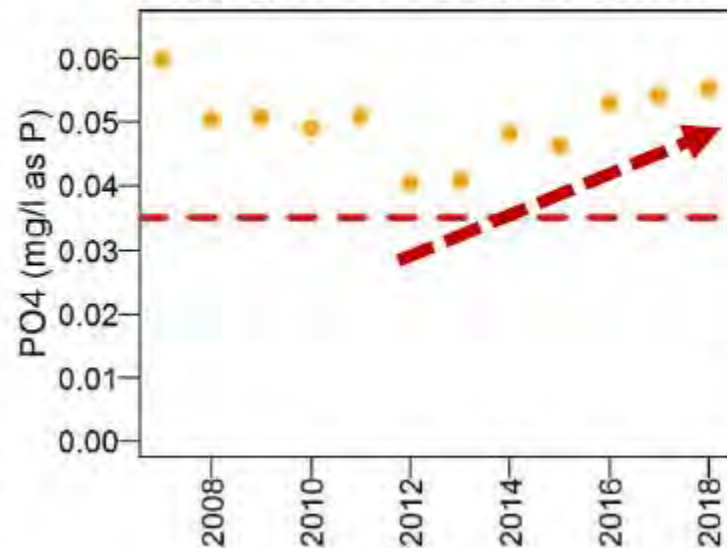
Why is P loss is a poorly drained soils issue?

P loss to water expressed as load kg/ha/yr

Sub-Catchments without Phosphorus issues



Sub-Catchments with Phosphorus issues where Agriculture is a significant pressure



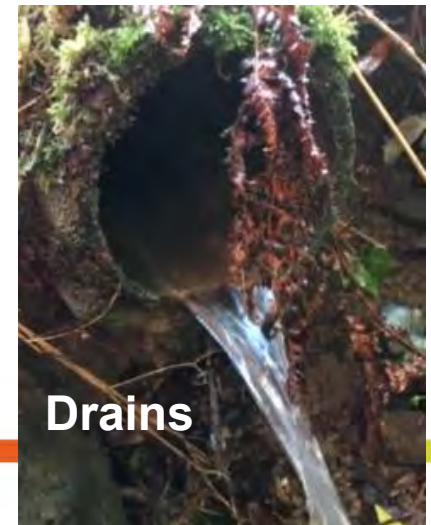
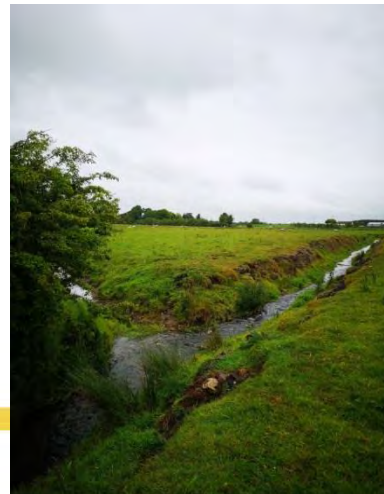
Flow rate is a function of soils' response to rainfall/water



Let's talk about farms on poorly drained soils...

**What are the critical source areas
(pinchpoints) for P at farm scale?**

Where are the pathways for P on the farm?



And runoff from roads & yards...into ditches!



Look out for Owen Fenton's webinar in July on soil hydrology!

@ROADRUN_Project



Connectivity: links the pathways up

Ditches, Drains, Gripes, Sheoughs, Marein Drain....??



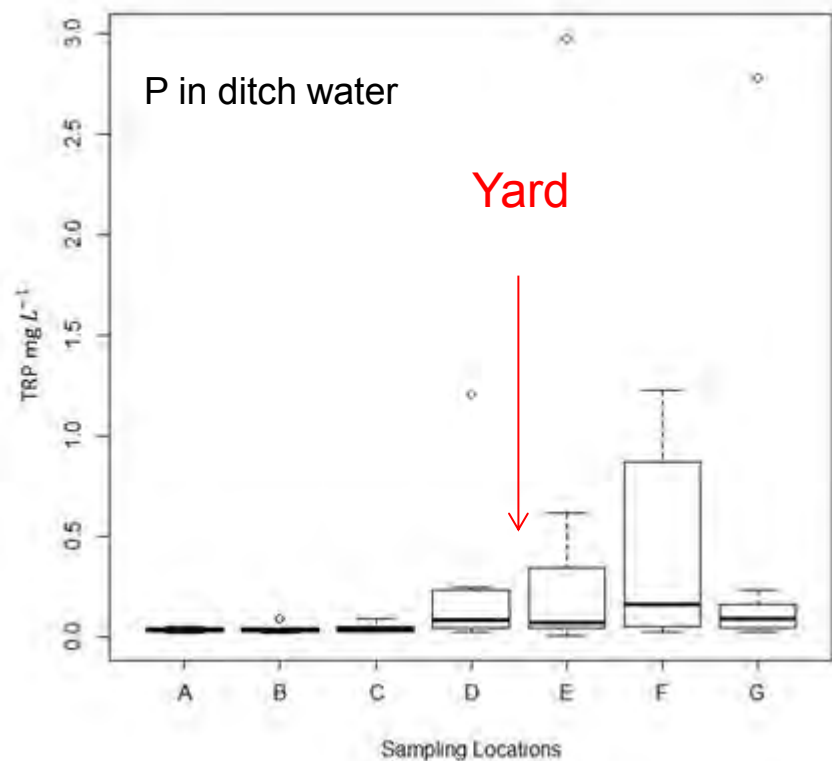
On-farm ditch connectivity to streams and outlets



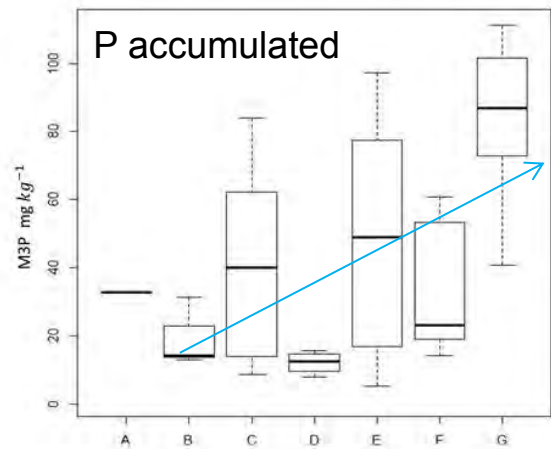
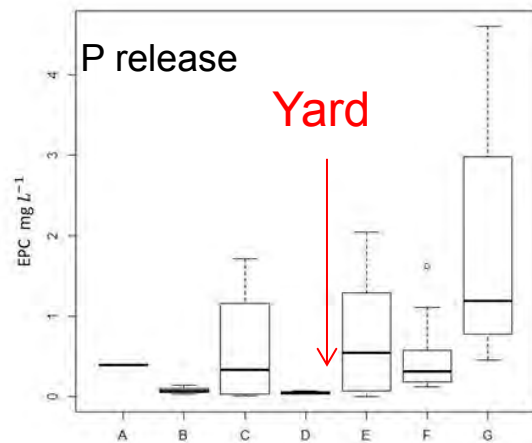
The most extensive connectivity feature on a farm?



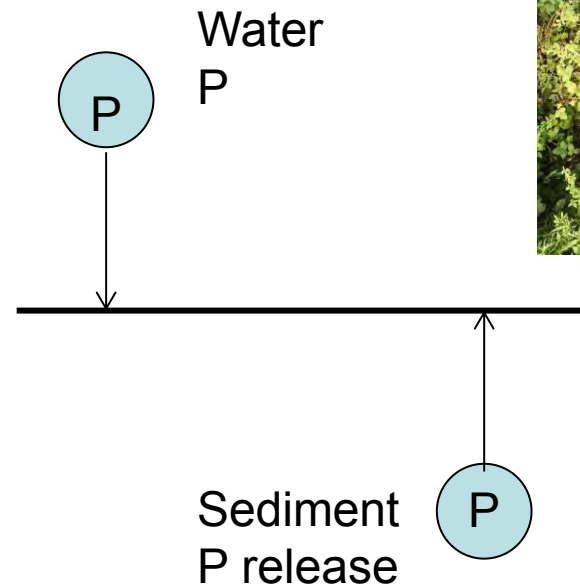
How ditch water is influenced by what it's connect to?



What's in sediment samples along length of ditch?



Direction of flow in ditch



Over time, sediment can accumulate P,
Sediment becomes a source of P...

For more on sediment: Daire O'Huallachain
Webinar (July).

Bringing it all together: pinchpoints for P on the farm?

Source



Pathway



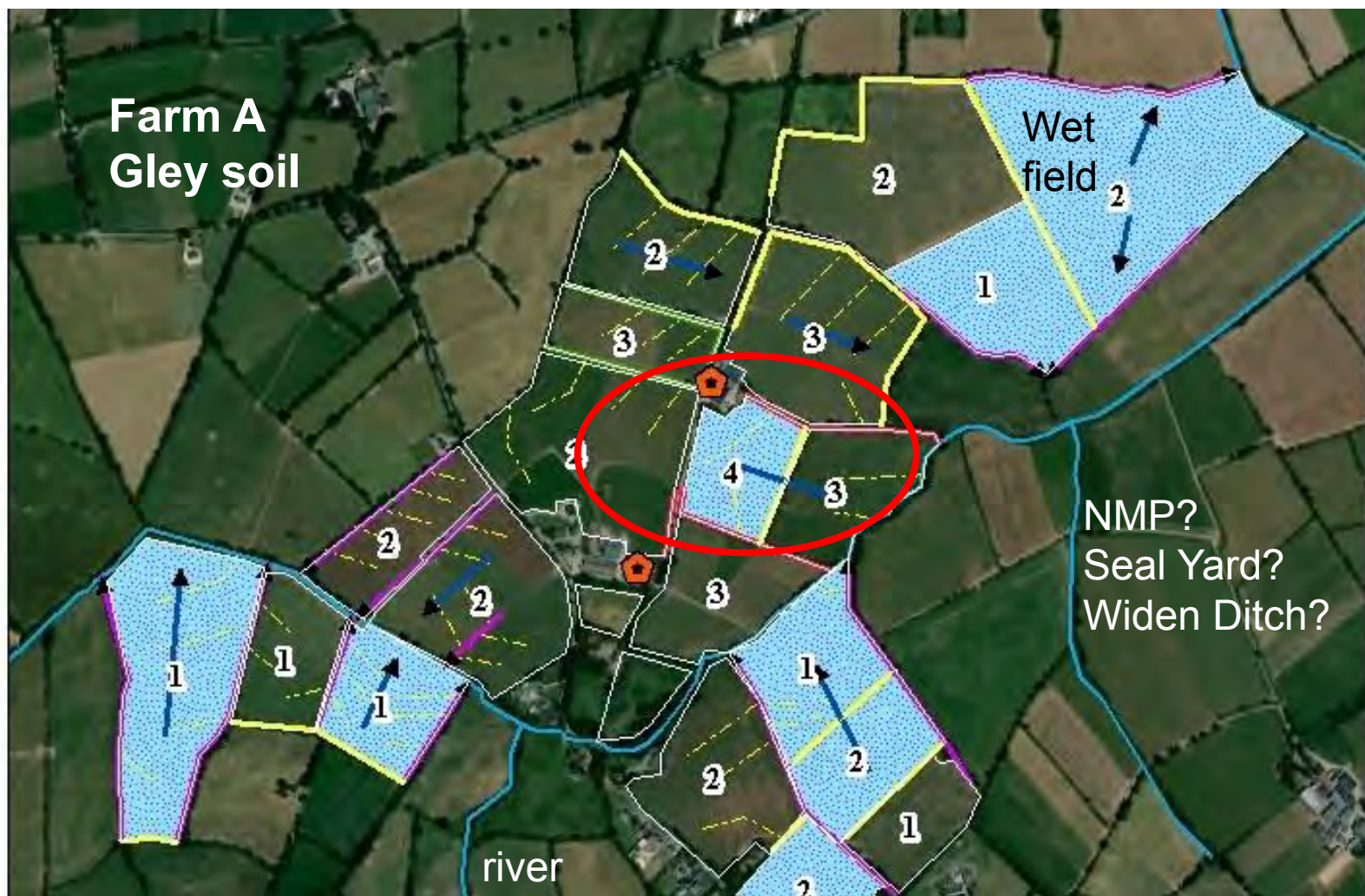
Connectivity



Receptor

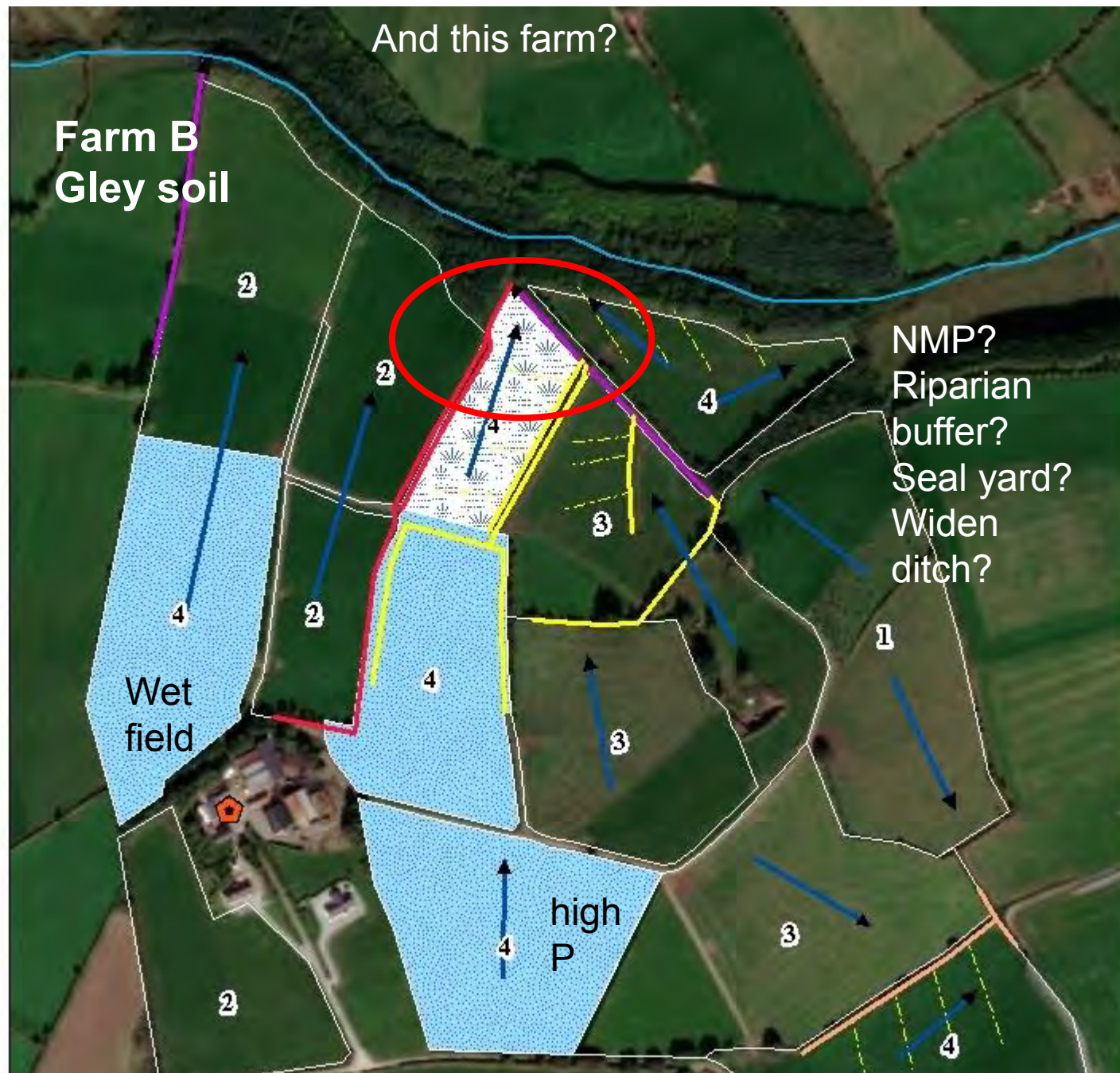


What P measure would you put on this farm & where?



And this farm?

Farm B
Gley soil

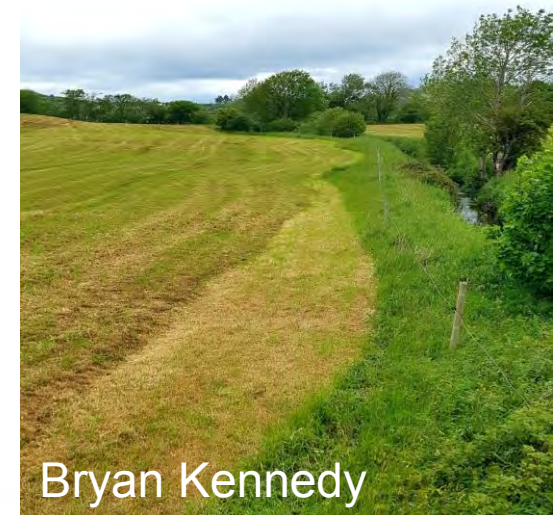
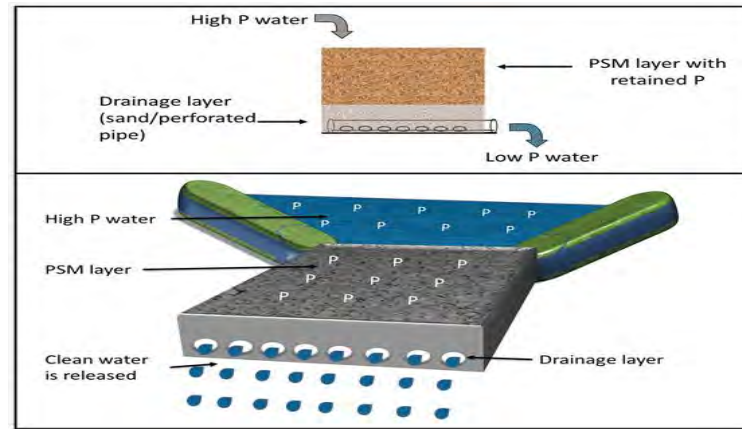


an

iority

Dis-connectivity or breaking the pathway...

Penn and Bowen (2018)



Take home messages

Know your soil

- soil pH
- high organic matter soils are (>20% OM in 10 cm)
- slow to respond to build-up/draw down? (high Al:P or high Ca)

Identify the critical source areas/pinchpoints for P on your farm?

- Look for connectivity - ditches, drains, wet fields
- Are they connected to a source? High soil P, farm yard
- Are they connected to a stream, river nearby.

Measure up?

- NMP – even distribution of P
- Seal leaks from yard
- Will a bufferstrip work?
- Trap sediment & widen a ditch?



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Thank you for listening!