



Investigation of Diffuse Groundwater Chemical Impacts on Groundwater-Dependent Terrestrial Ecosystems in England and Wales: Implications for WFD Groundwater Body Classification and Programmes of Measures

HydroEco 2011, May 2-5 2011

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Outline

- ➔ **Groundwater-Dependent Terrestrial Ecosystems (GWDTE)**
- ➔ **WFD requirements**
 - ➔ Groundwater status tests
 - ➔ Risk assessment
- ➔ **Case study**
- ➔ **Lessons learned**
- ➔ **Conclusions**

GWDTEs and WFD Groundwater Status Tests ('significant damage')

➔ Definition

- ➔ GWDTE are wetlands that are directly dependent upon water from a groundwater body to maintain their form and function
- ➔ Groundwater provides critical quantities (flow or level) or quality needed to sustain the wetland for at least part of the year
- ➔ GWDTE are a component of the groundwater body classification (Groundwater status test 3).
- ➔ 'Significant damage' to these ecosystems caused by a pressure (gw quantity or gw quality) derived from the groundwater body can result in a status failure of the groundwater body
- ➔ 'significant damage' is based upon:
 - ➔ the magnitude of the damage and
 - ➔ the ecological or socio-economic significance of the terrestrial ecosystem.

A tiered approach to GWDTE assessment (CIS Guidance No.26)

➔ Tier 1 – Pre-assessment

- ➔ Qualitative risk screening for GW bodies i.e. initial characterisation (high, medium, low or no risk)
See Whiteman and Skinner, HydroEco2009

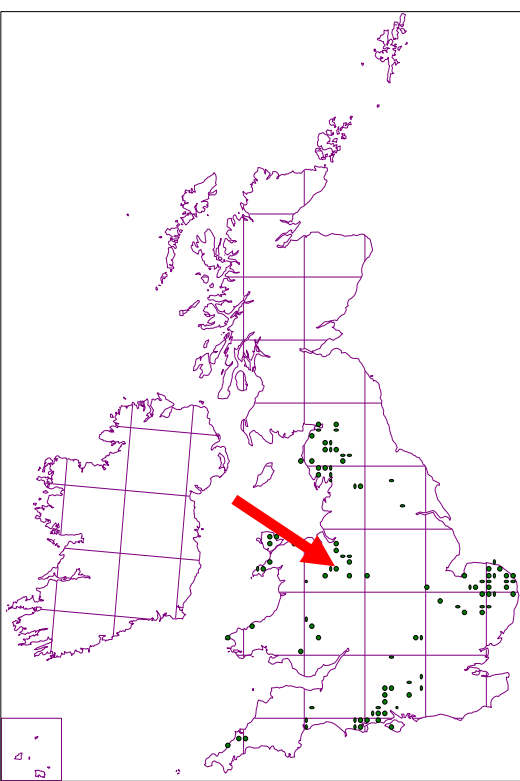
➔ Tier 2 – Appraisal

- ➔ Semi-quantitative assessment i.e. further characterisation and initial classification
 - Translating potential risk into actual damage
 - Evidence of actual ecological damage
 - Classified each groundwater body in England and Wales at either good or poor status according to whether GWDTEs are significantly damaged

➔ Tier 3 – Characterisation and evaluation

- Investigation and site specific data collection to address uncertainty

Case Study - Wybunbury Moss



Case Study - Wybunbury Moss

➔ Tier 1 – Pre-assessment

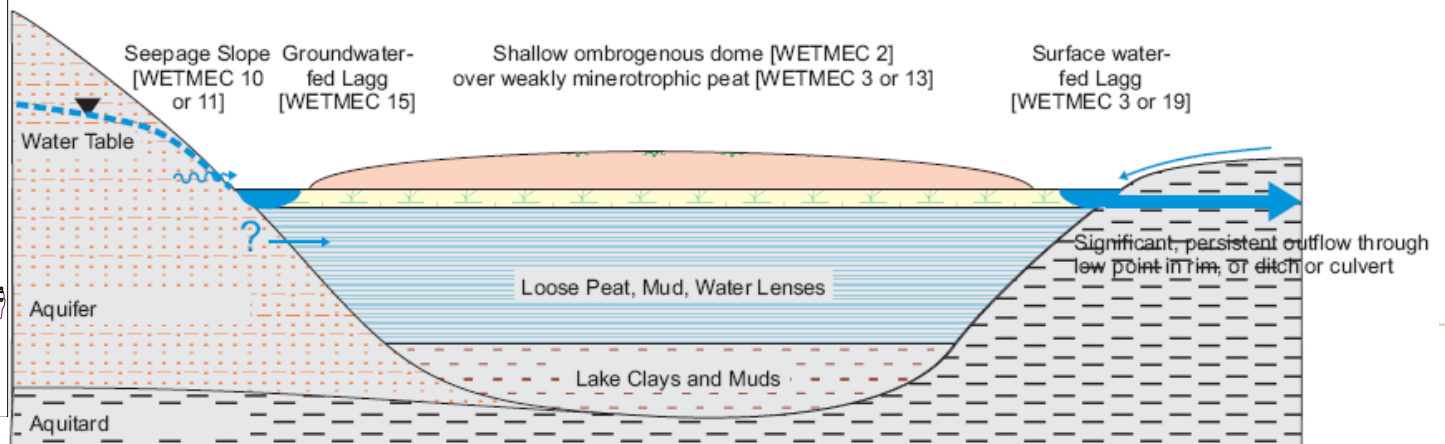
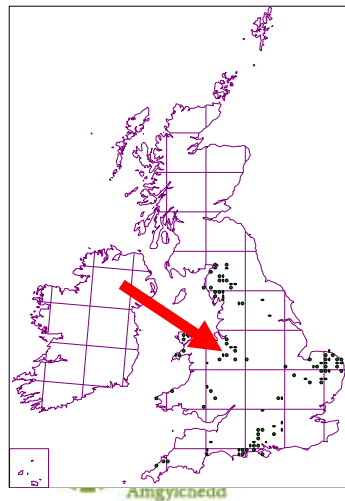
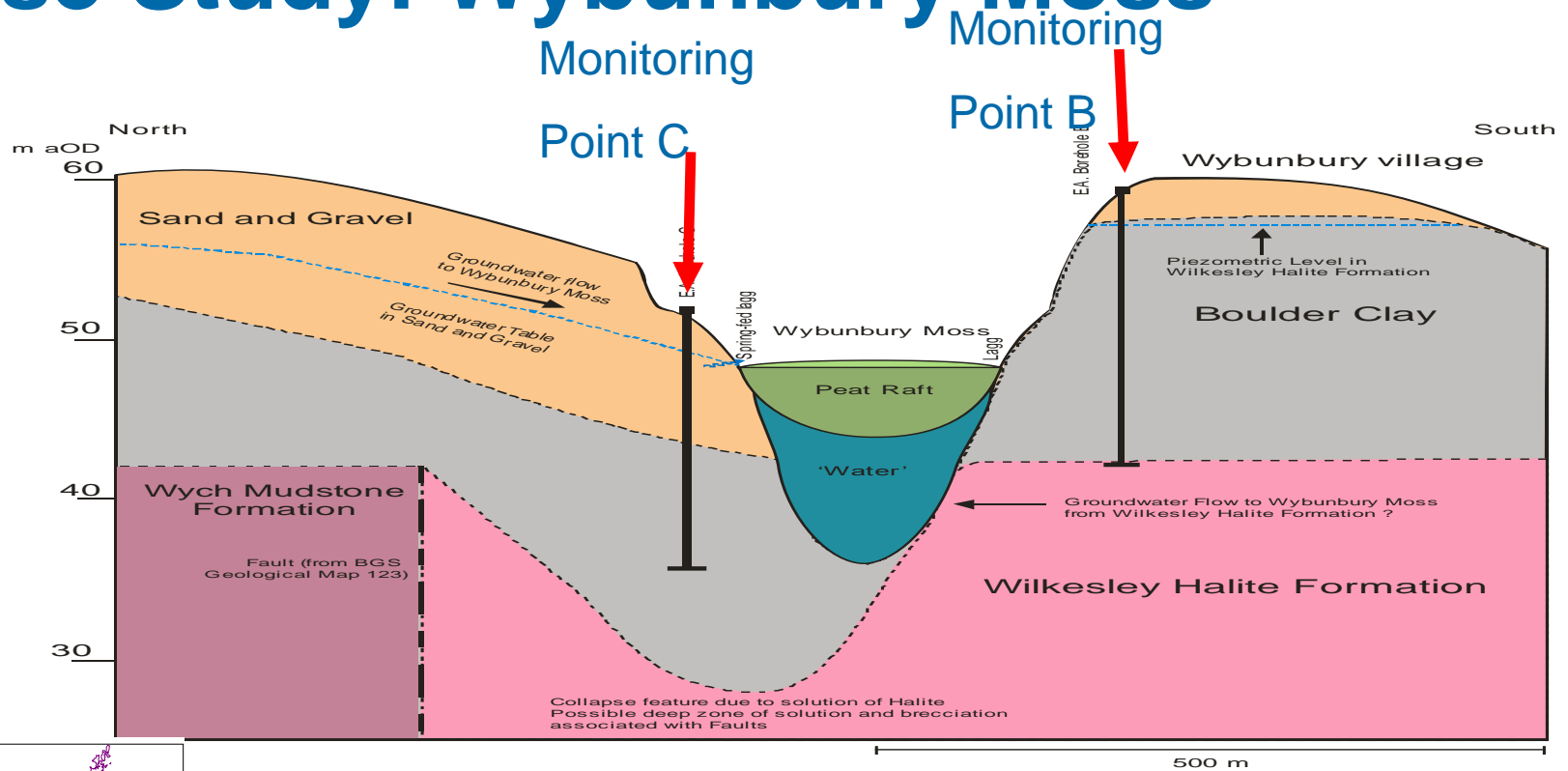
- ➔ At high risk from chemical pressure
 - As a result of elevated nitrate concentrations in the nearby groundwater monitoring point
- ➔ At no risk from quantitative pressure

➔ Tier 2 – Appraisal

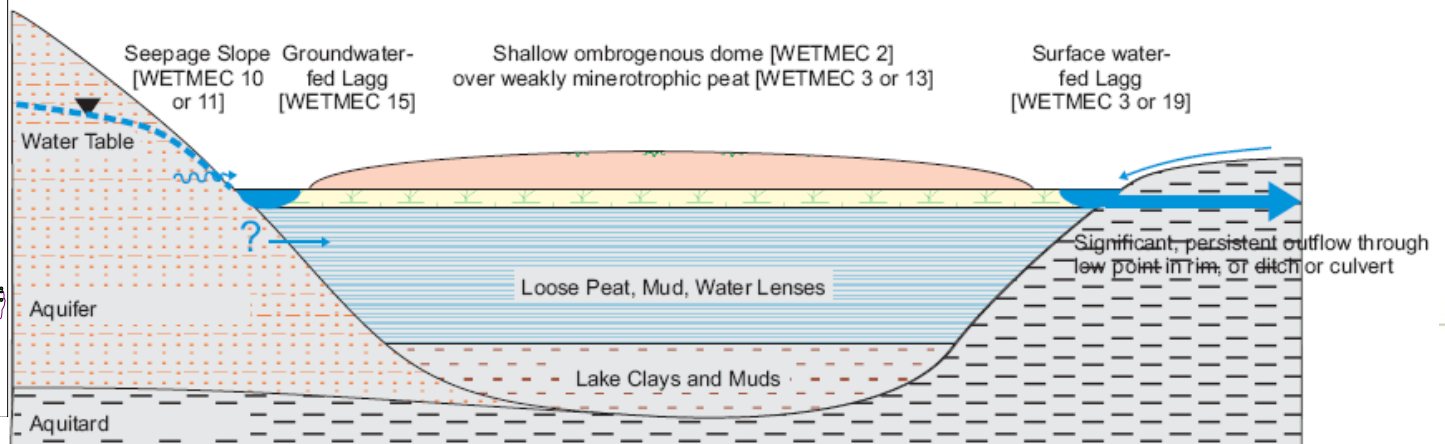
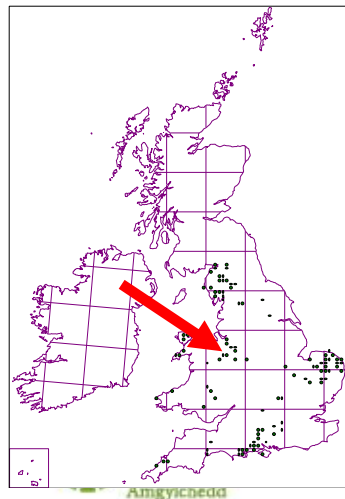
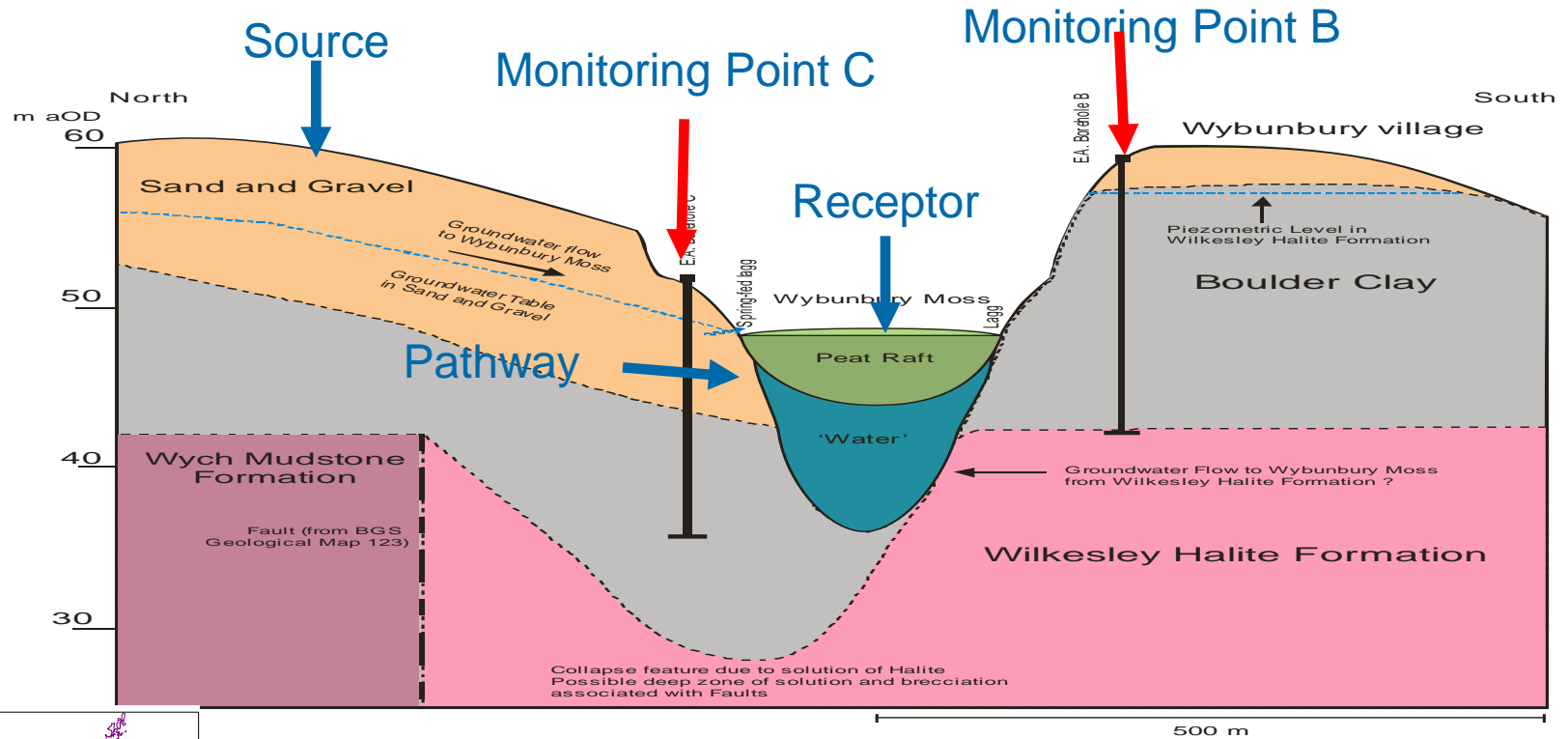
- ➔ Site was damaged as a result of water quality problems – therefore assessed as ‘significantly damaged’ and waterbody assigned Poor status.

➔ Tier 3 – Characterisation and evaluation

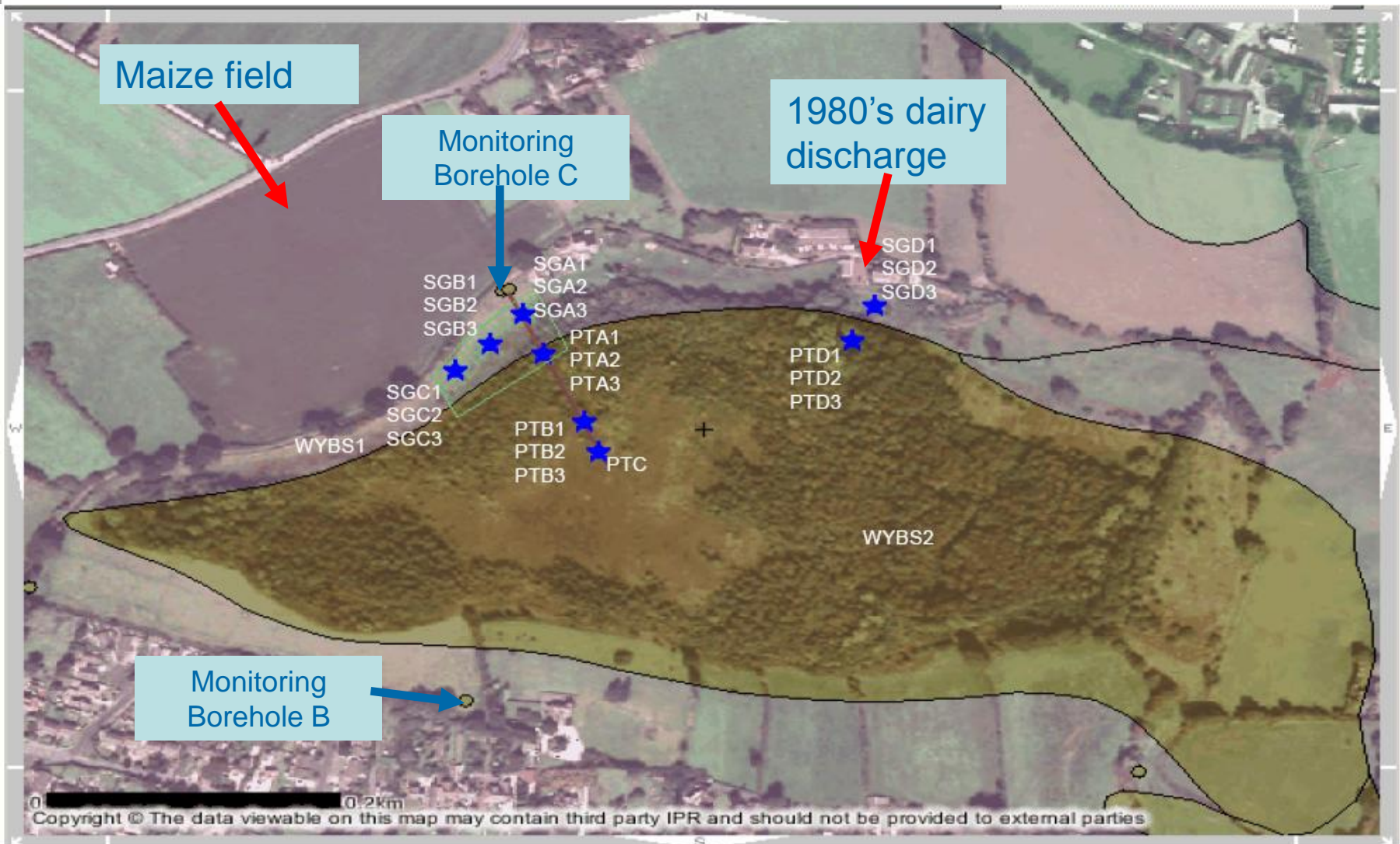
Case Study: Wybunbury Moss



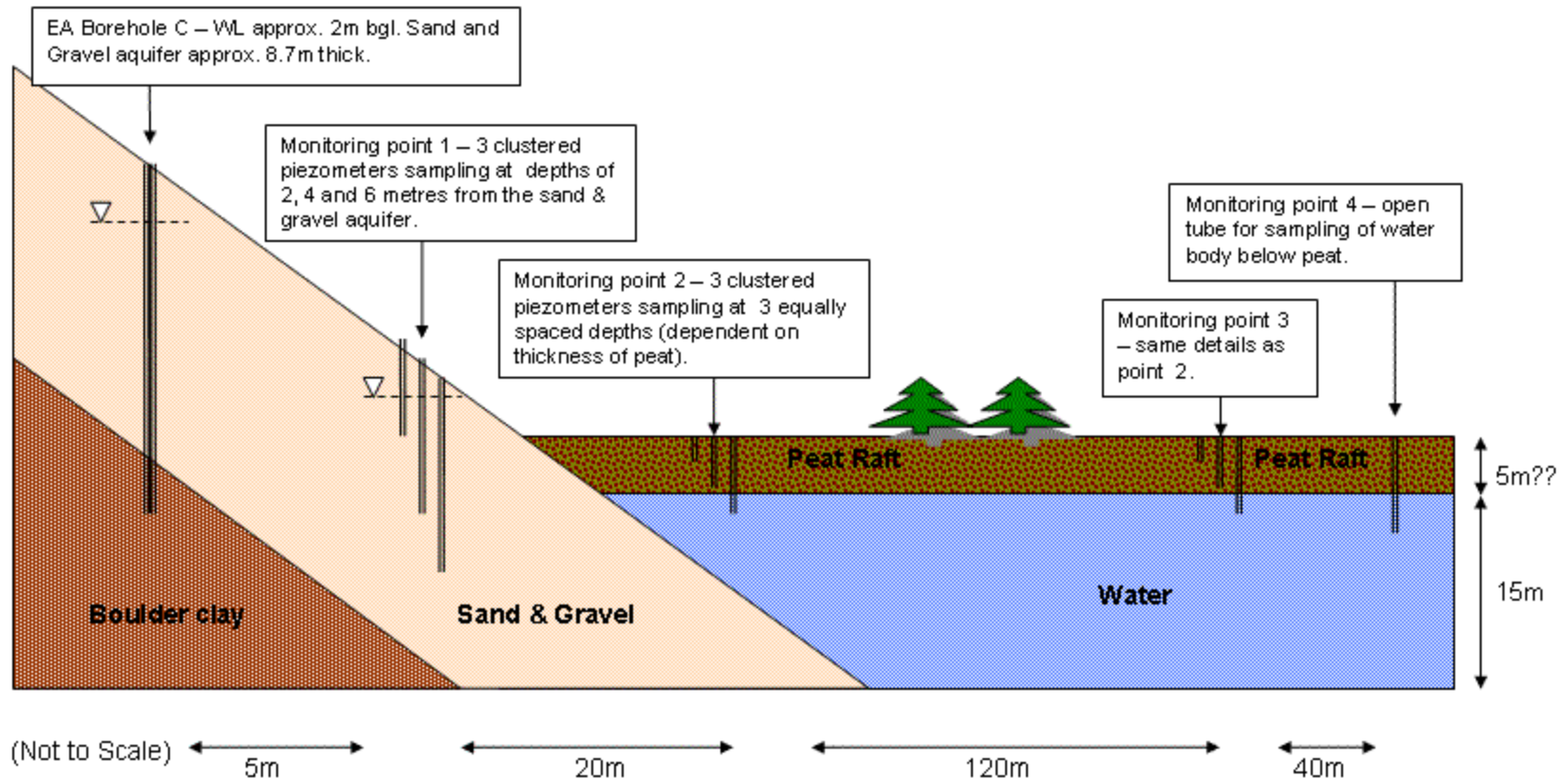
Case Study: Wybunbury Moss



Wybunbury – Investigation



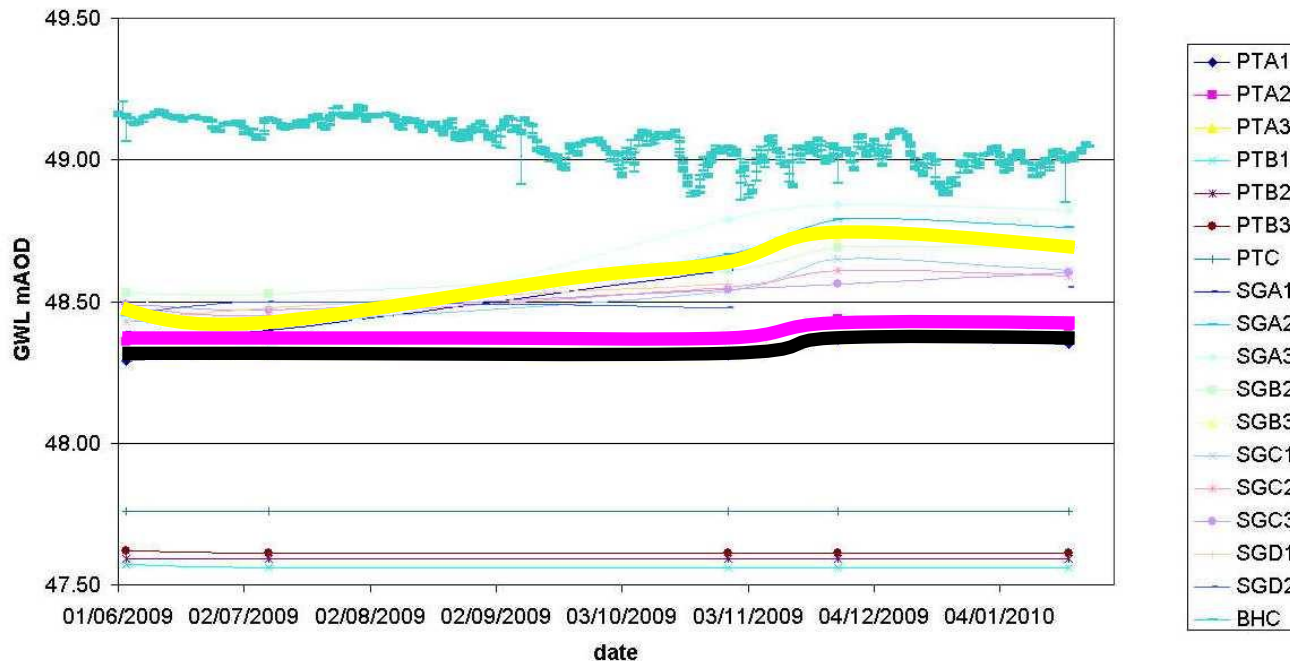
Nested piezometers



Wybunbury Moss

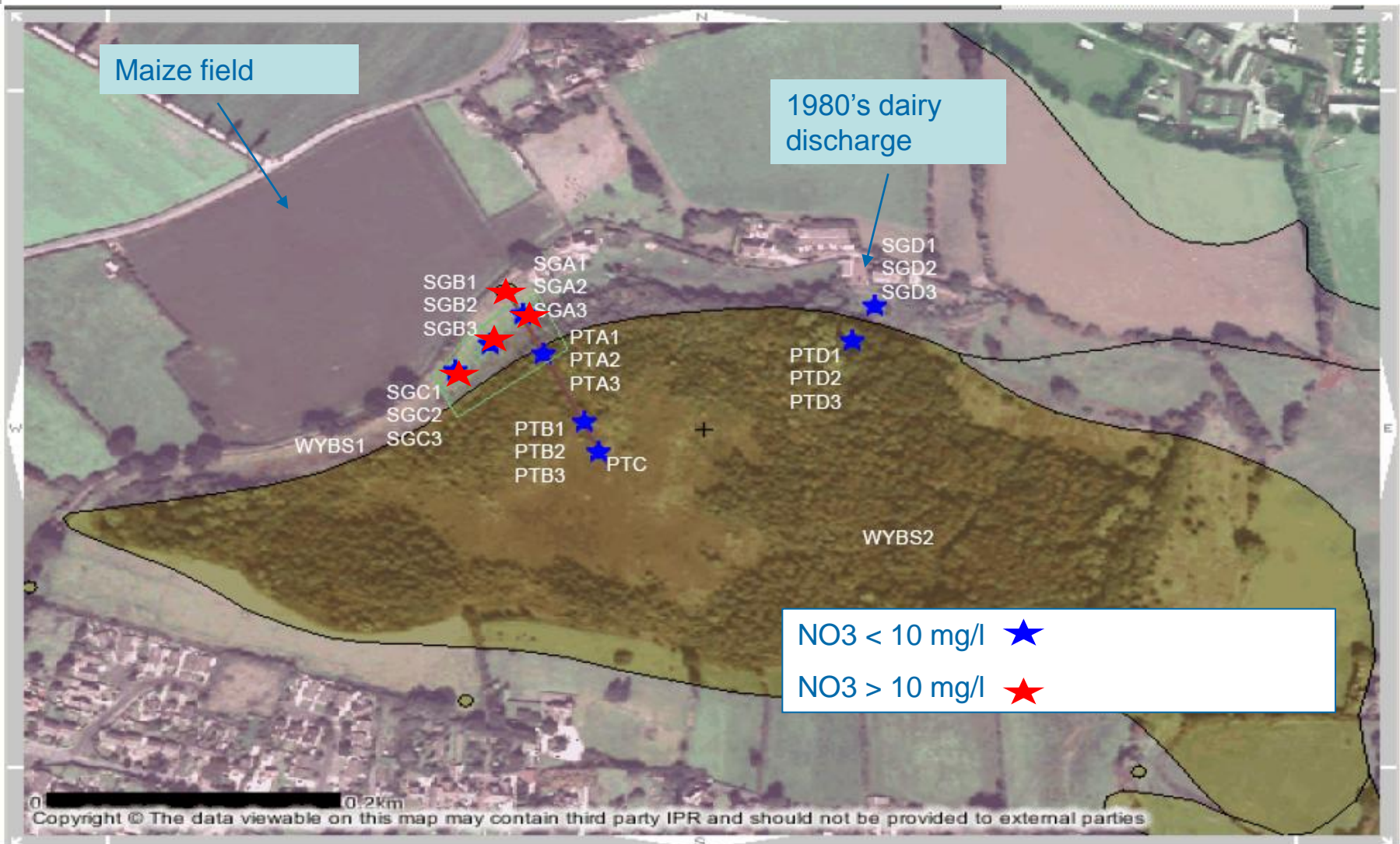
Groundwater heads in shallow piezometers

Figure 4.1 Shallow Groundwater Levels at Wybunbury Moss

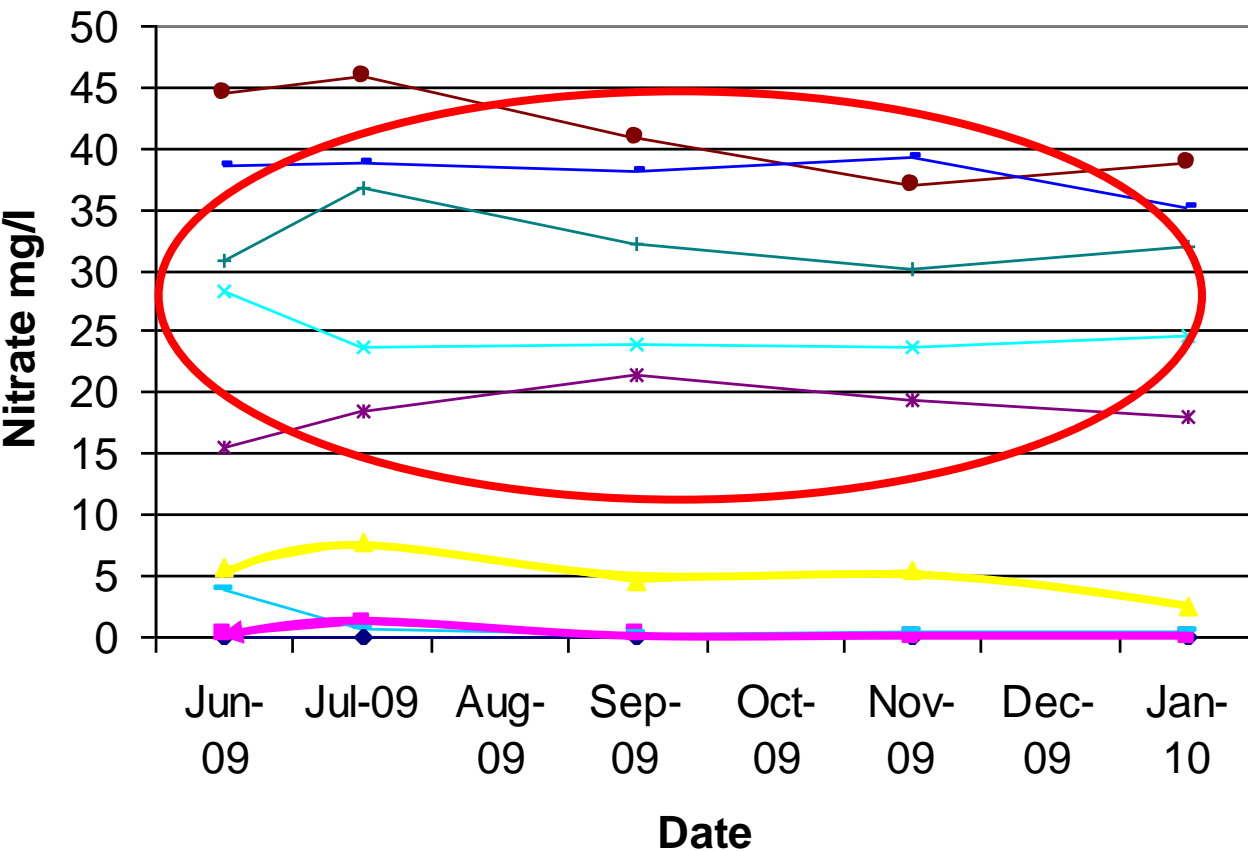


PTA1 = shallow
PTA2 = intermediate
PTA3 = deep

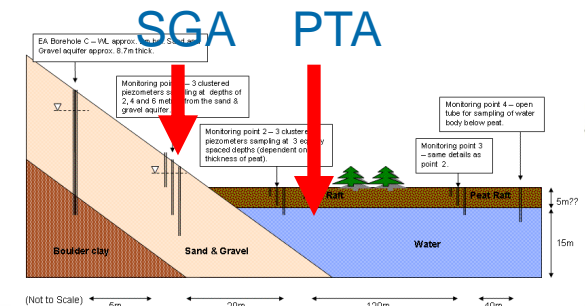
Chemical sampling



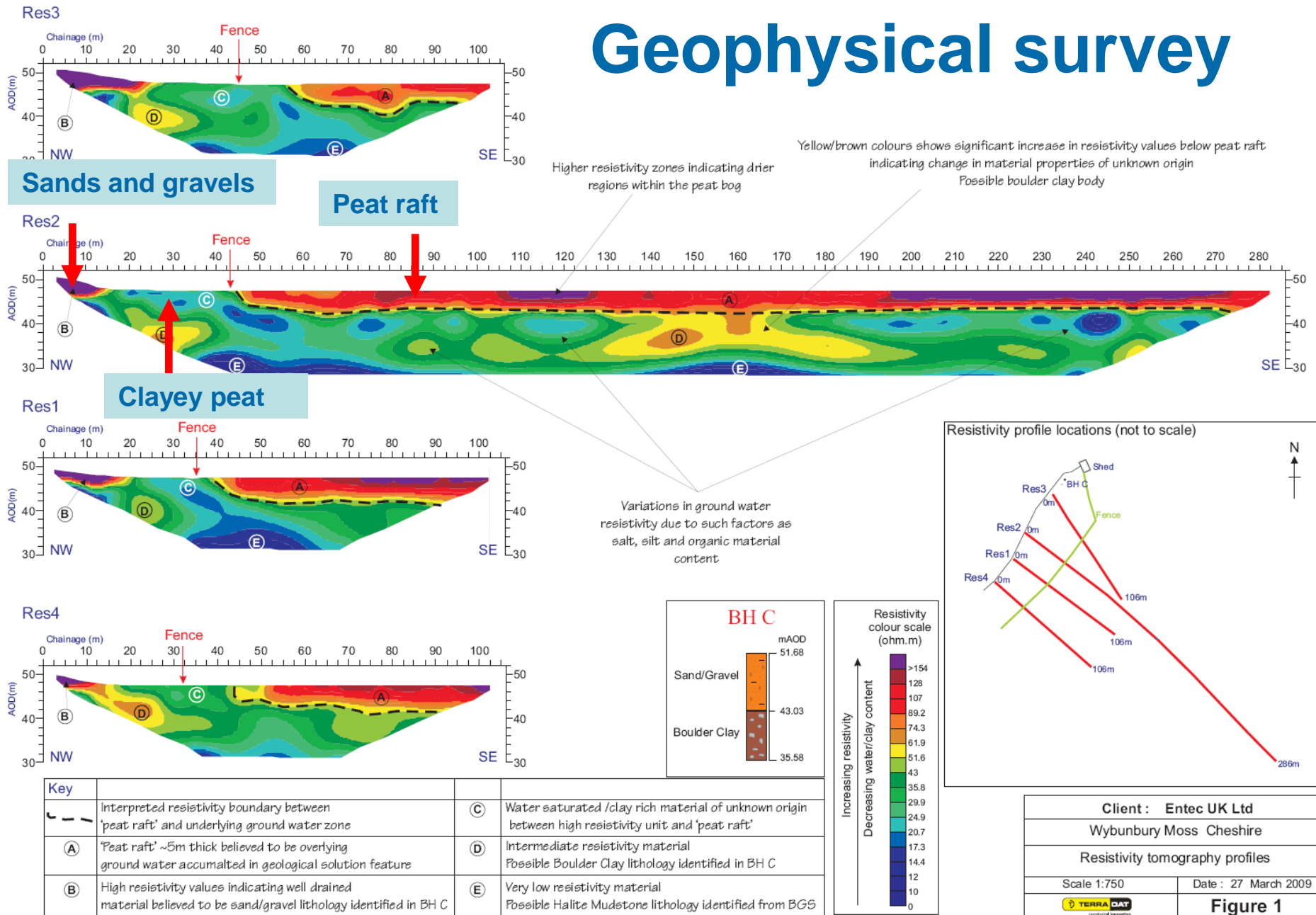
Nitrate Concentrations at Wybunbury Moss in Piezometers



PTA1	Shallow
PTA2	Intermediate
PTA3	Deep
SGA2	Intermediate
SGA3	Deep
SGB2	Intermediate
SGB3	Deep
SGC2	Intermediate
SGC3	Deep



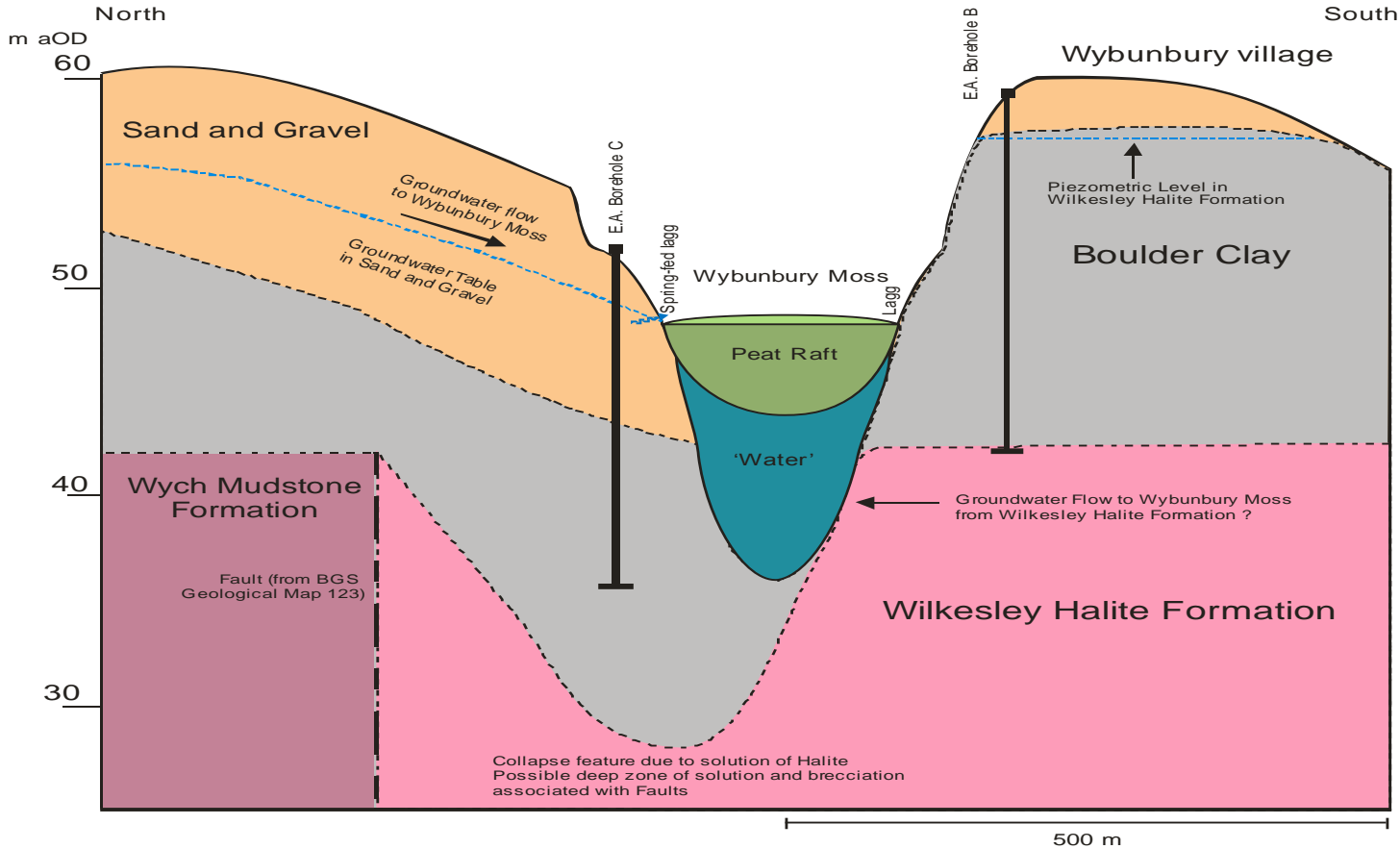
Geophysical survey



Targeted ecological survey



Initial conceptual model



Environment
Agency

Entec



Schlumberger
WATER SERVICES



Cyngor Cefn Gwlad Cymru
Countryside Council for Wales

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Revised conceptual model

Figure 5.1 Wybunbury Moss Revised Conceptual Diagram

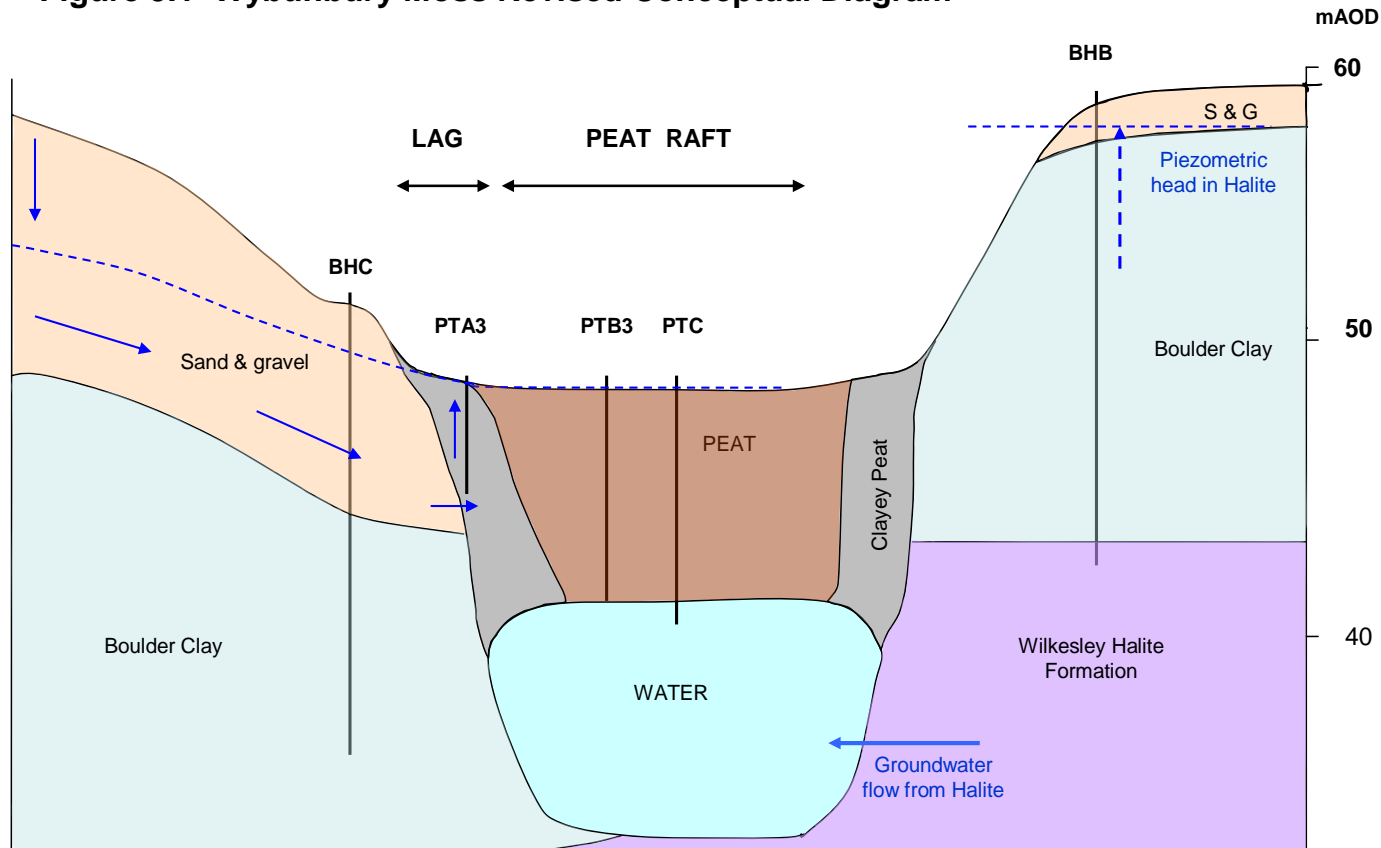
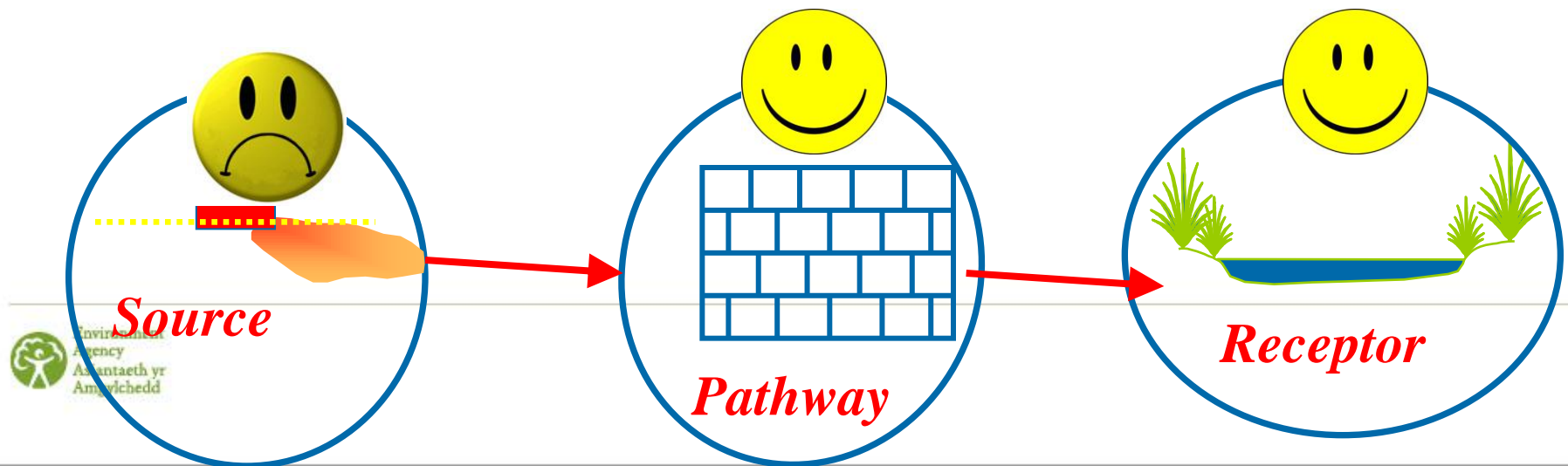


Figure drawn by Sarah Scott

Conclusions for Wybunbury (1)

- ➡ The sand and gravel aquifer is not in direct connectivity with the water beneath the peat raft
- ➡ There is no evidence that the site is being damaged as a result of a chemical pressure acting through the groundwater body. Hence the site is not significantly damaged...

So, the site is OK for now, BUT...



Conclusions for Wybunbury (2)

- ⇒ **Continued risk from ongoing application of chemical fertilisers**
 - ⇒ of causing an increasing trend in groundwater nutrient concentrations and subsequent damage to the site
- ⇒ **Important to take positive measures early**
 - ⇒ to reduce diffuse groundwater pollution (e.g. nutrient management plans)
- ⇒ **Investigations help target individual farms**
 - ⇒ Identify source areas for chemical pressures
 - ⇒ Agriculture teams working with farmers and nature conservation officers

Lessons Learned – chemical pressures

- ➔ Studies here and on other sites in England and Wales have indicated the key issues to consider
 - ➔ Not sure what levels of nitrate have a negative effect on different wetlands (thresholds?)
 - ➔ Can't rely on low P preventing damage (e.g. Cors Bodelio, Anglesey)
 - ➔ 'In-combination' effects may be important in causing actual ecological damage to GWDTEs
 - e.g. aerial deposition of nitrates as well as nitrates from groundwater sources (dunes at Merthyr Mawr, South Wales and fens at Cors Errdreinniog, Anglesey)

Study Conclusions

- Desk-based risk screening is inadequate on its own to predict the likelihood of significant damage
 - Risk screening **and** site-based data are needed to ensure good status of WFD gw bodies in the future (2nd cycle)
 - Existing gw monitoring networks do not provide the required site-specific data
 - Multiple sources and pathways may contribute **in combination** to the eutrophication of sites
 - Conceptual model is very important. If either the source or the pathway to the receptor are absent then there cannot be a groundwater-caused problem.
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- We need to act on these findings to refine our approach in the 2nd river basin planning cycle to reach improved conclusions on groundwater body status and in defining programmes of measures

Thank You

