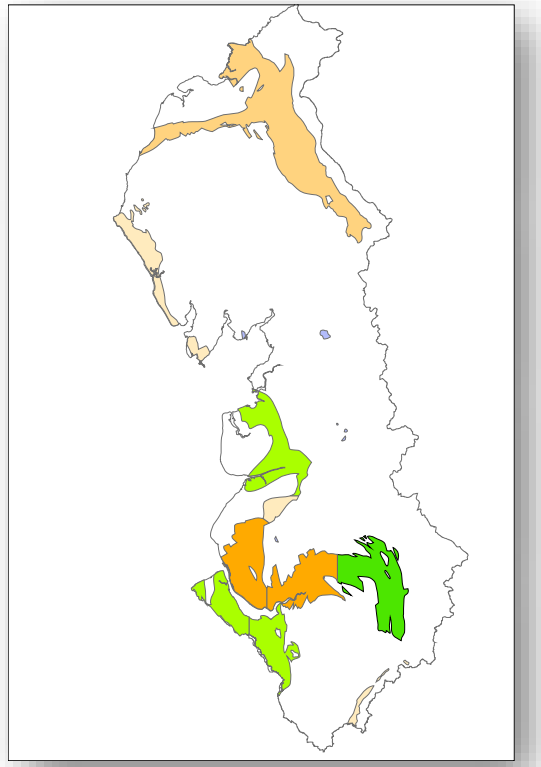
Reflections of a retired hydrogeologist on…

…the use, management and understanding of the Permo-Triassic sandstones of north west England.

Keith Seymour *(vice president for regional groups)*



Reflections of a retired hydrogeologist on

the use, management and understanding of the Permo-Triassic sandstones of north west England.

- Introduction – *my credentials*
- Setting the scene – geology and hydrogeology of NW
- History of abstraction
- History of regulation
- Key insights
  - Compartmentalisation
  - Saline intrusion
  - Recharge
- Chalk and cheese: drought and flood responses

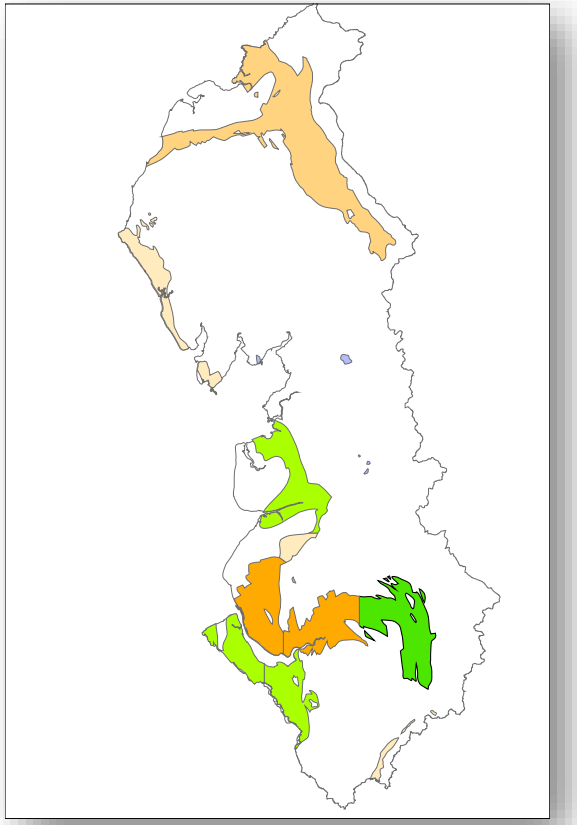
Introduction

1976

North West Water

1989

NRA

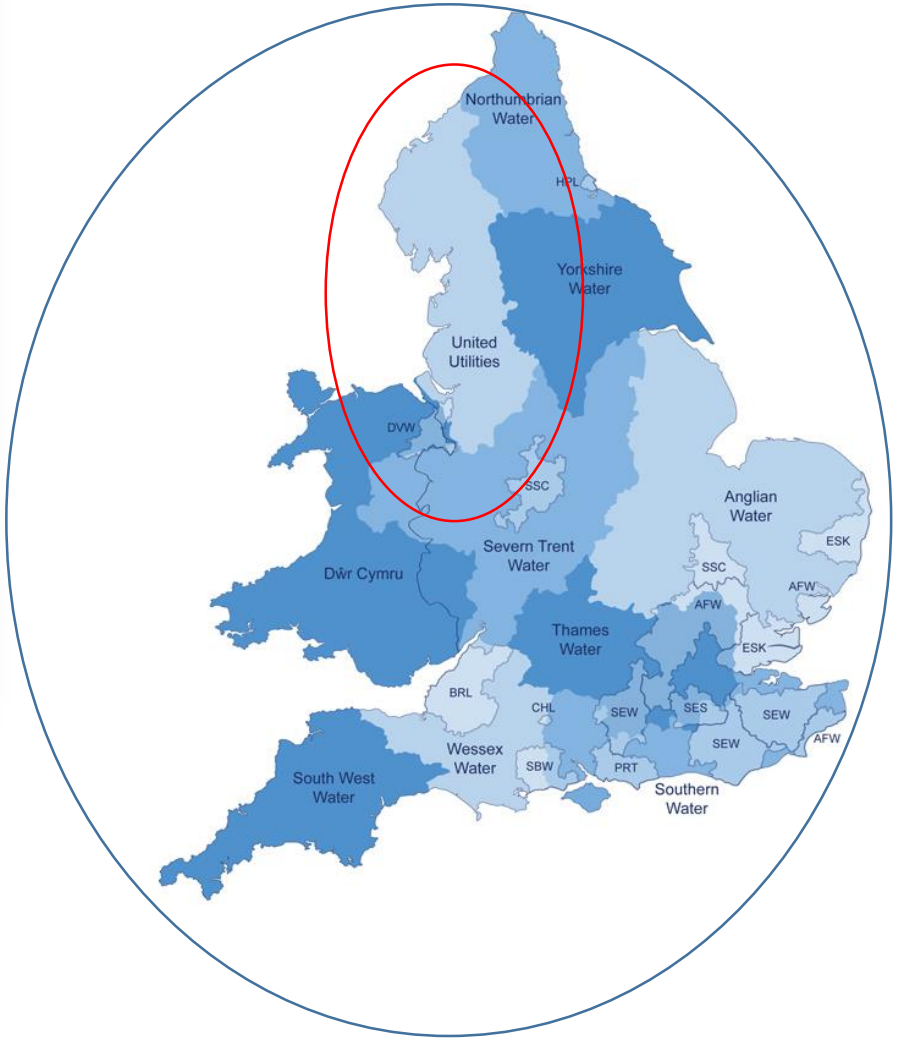


1996

Environment Agency

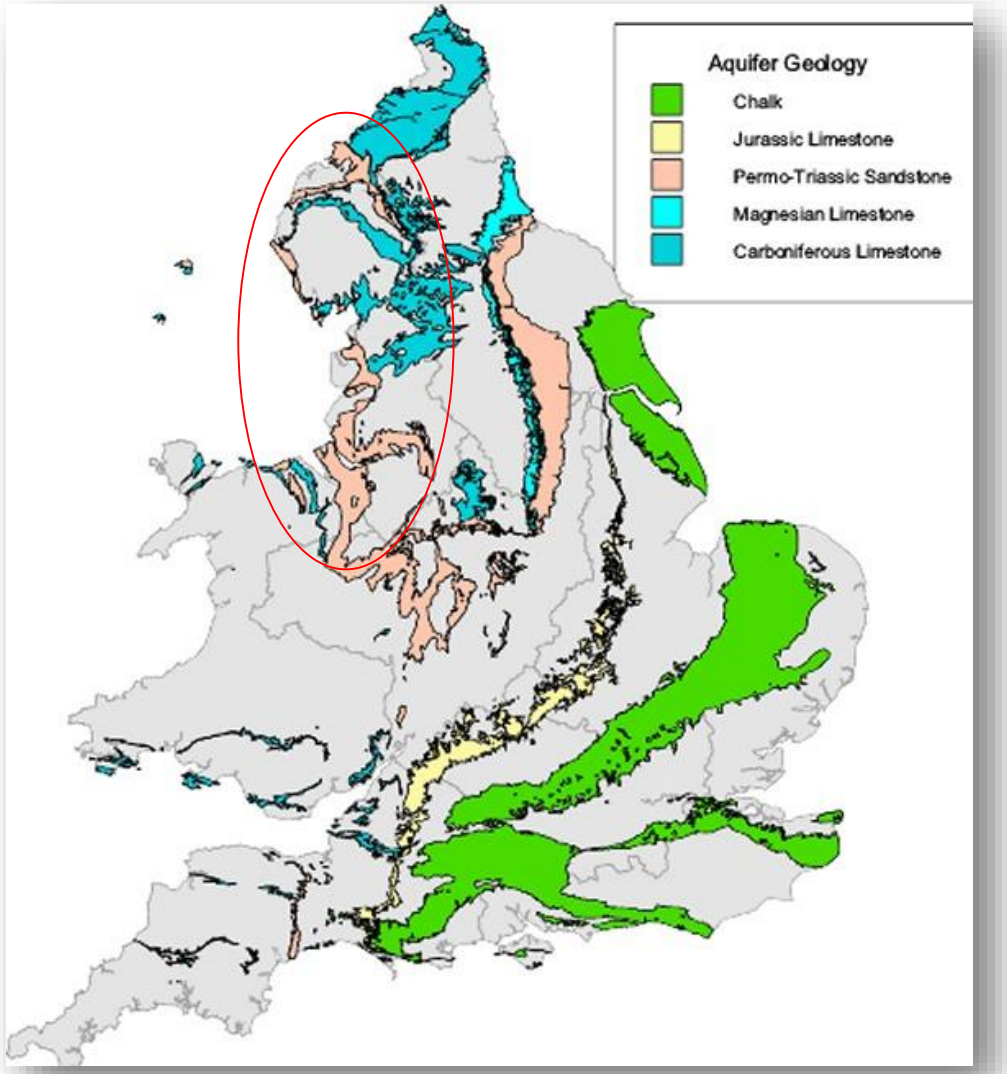
2008/14

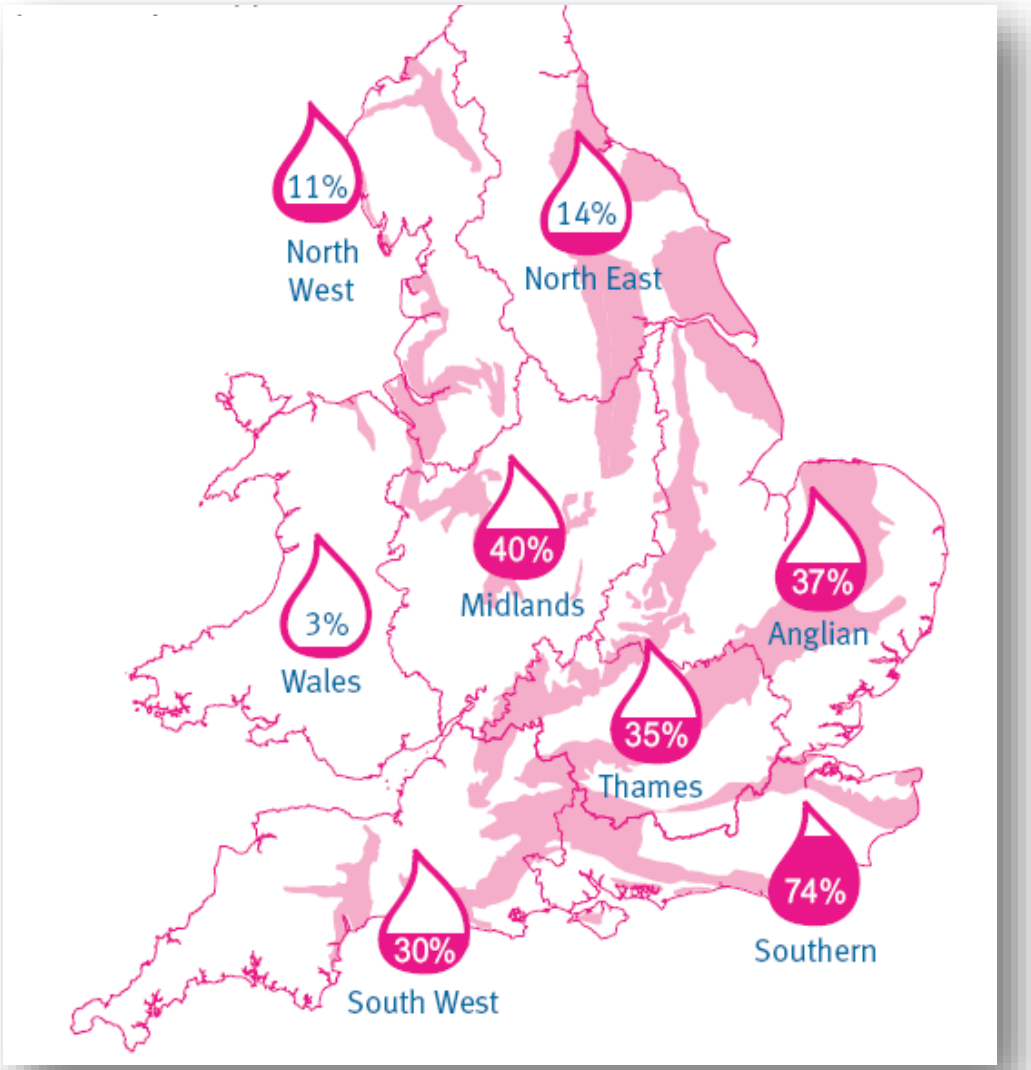
The Geological Society



‘Credentials’

Our principal aquifers





~importance for public water supply

Why is groundwater only 11% of PWS in the NW?

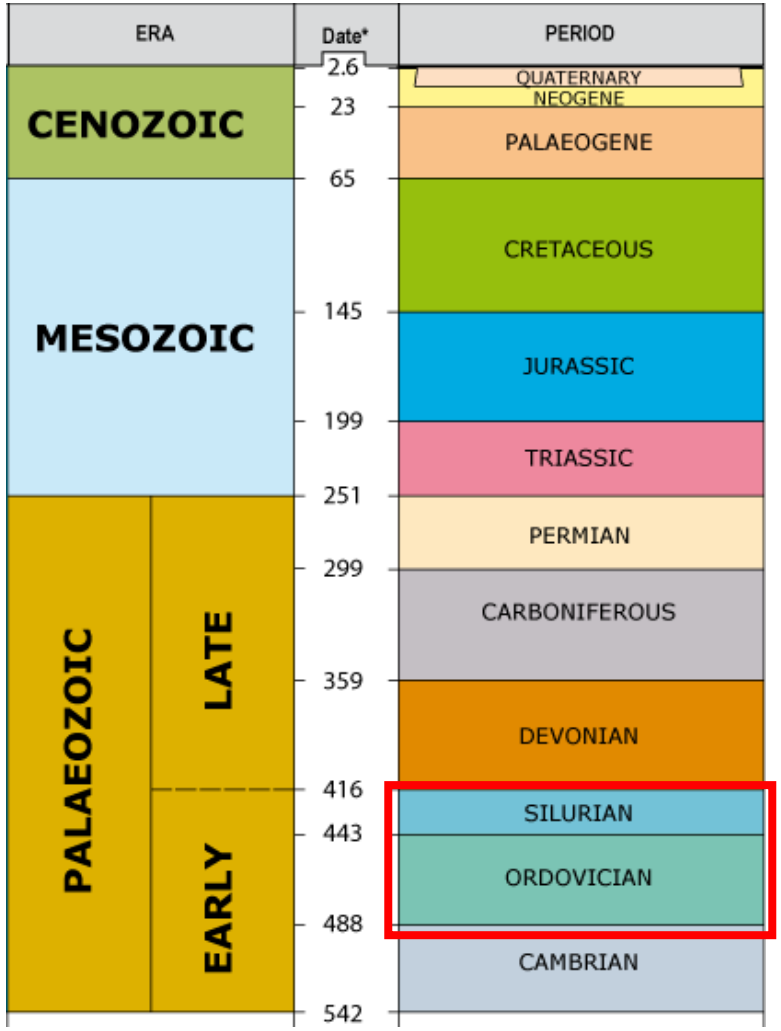
Weather or not,

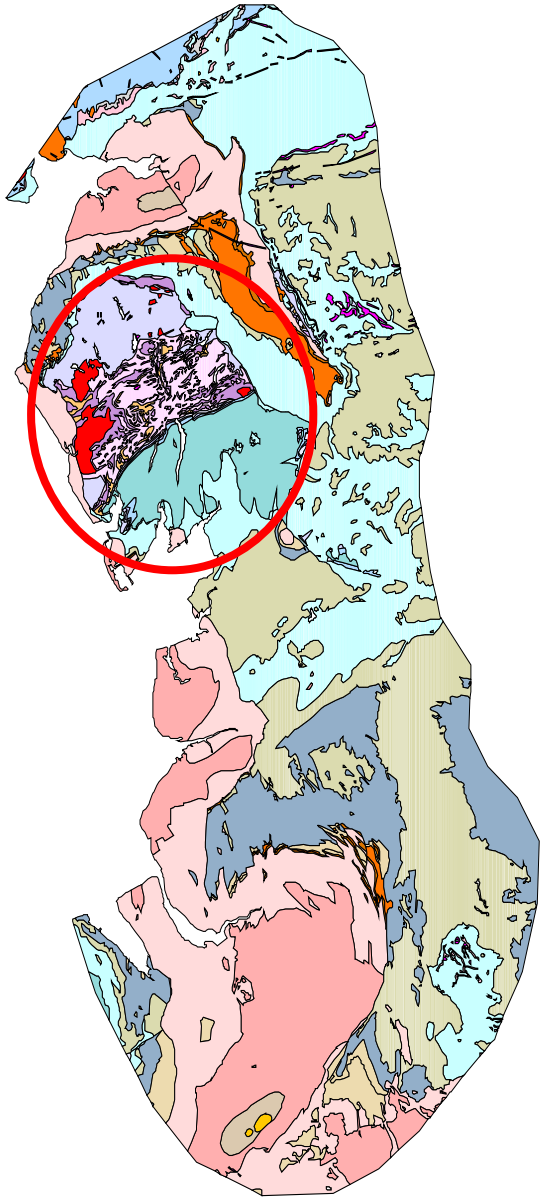
is it a ‘geology thing’?

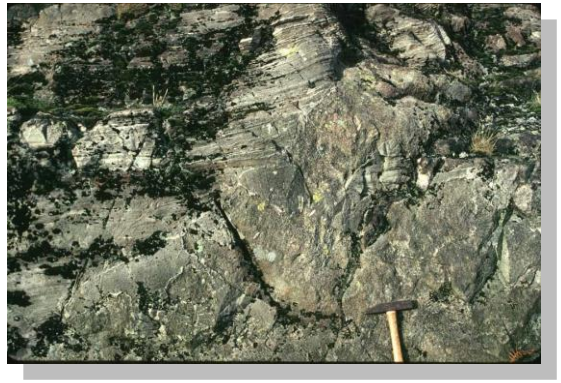
Setting the scene:

– Geology and hydrogeology of NW

Geology of NW

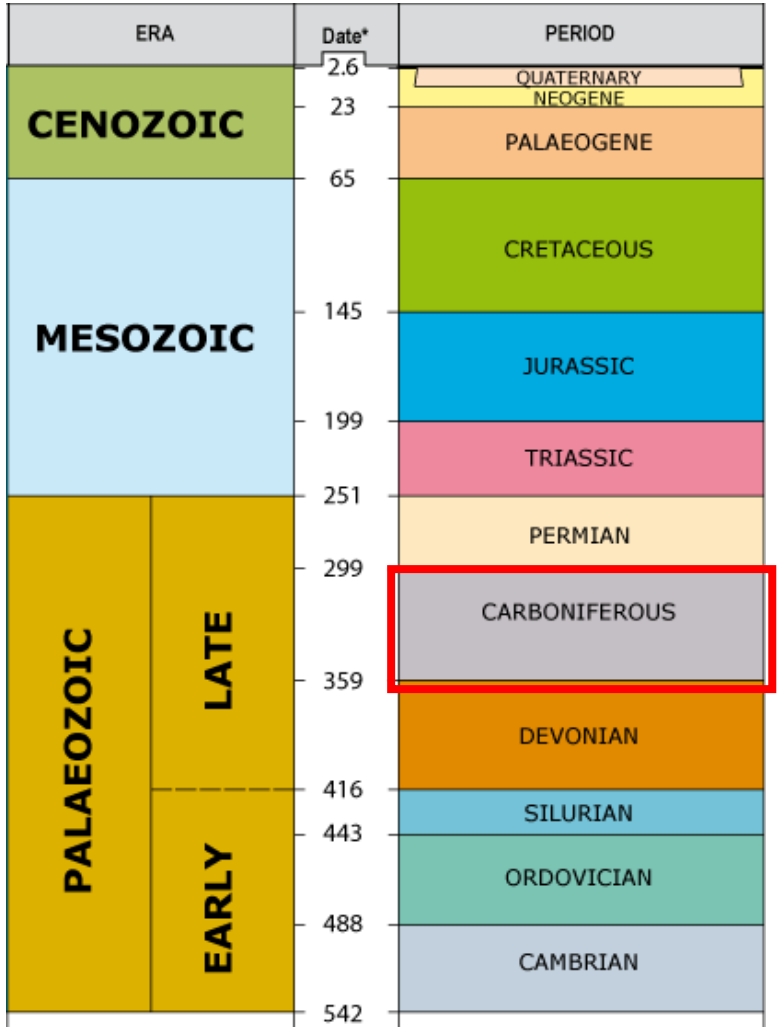


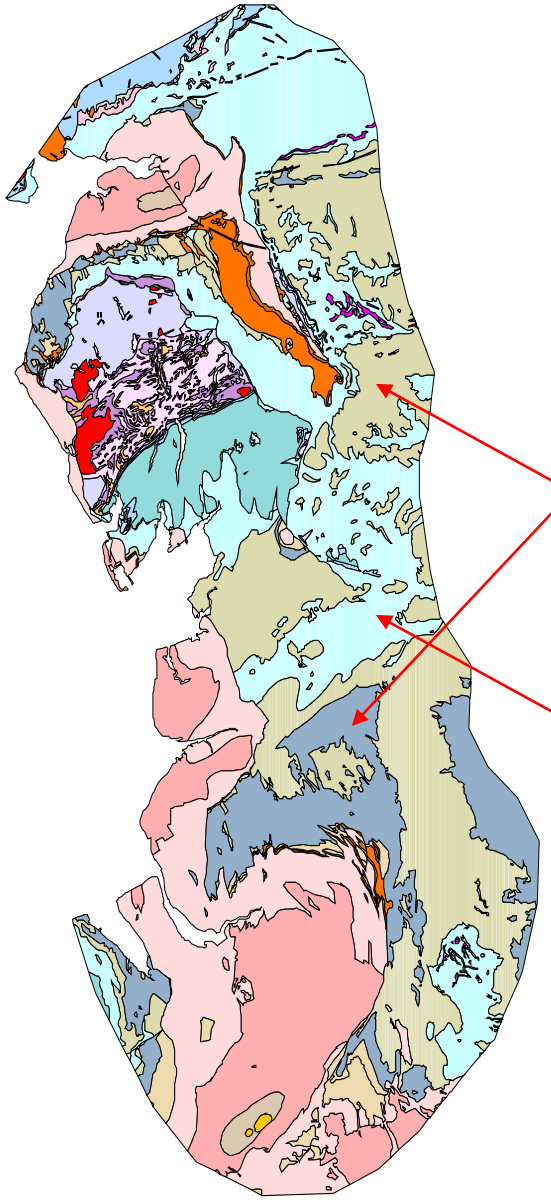




Lower Palaeozoic

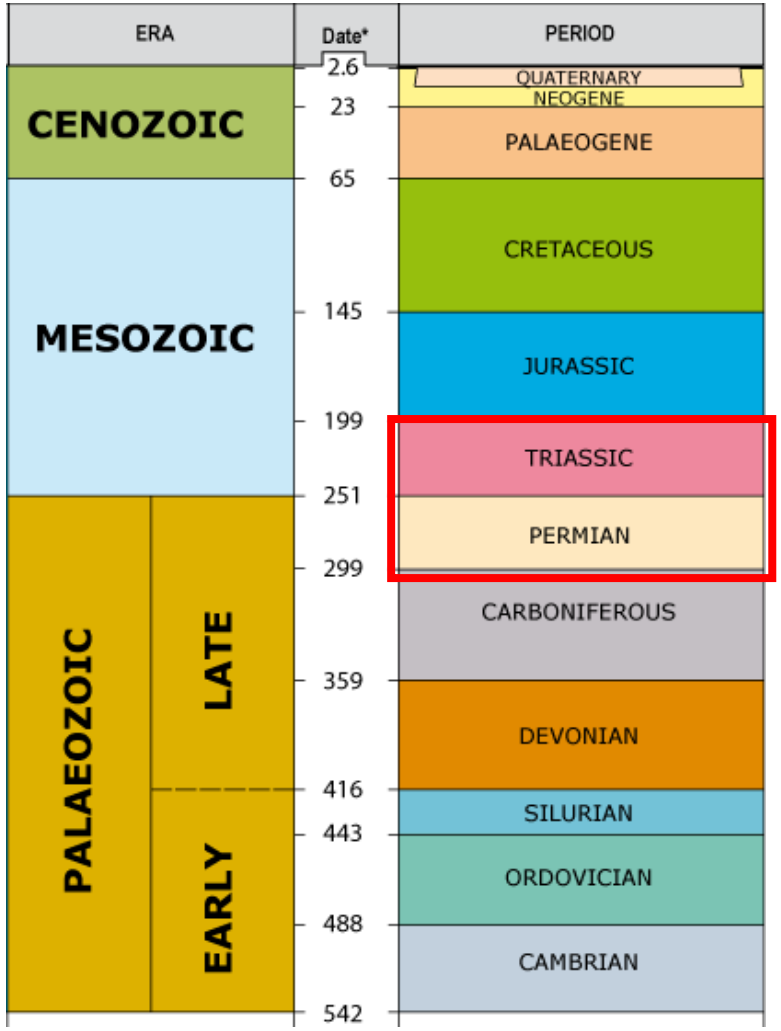
Geology of NW

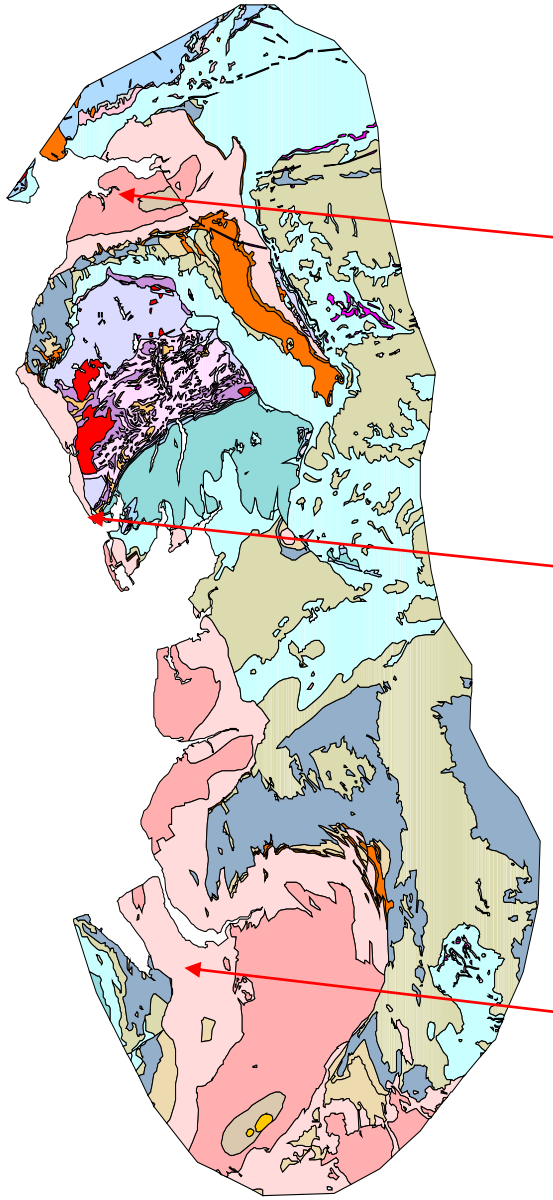


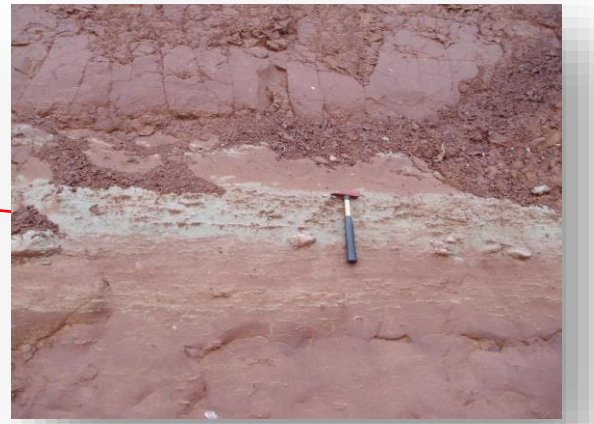


Carboniferous

Geology of NW

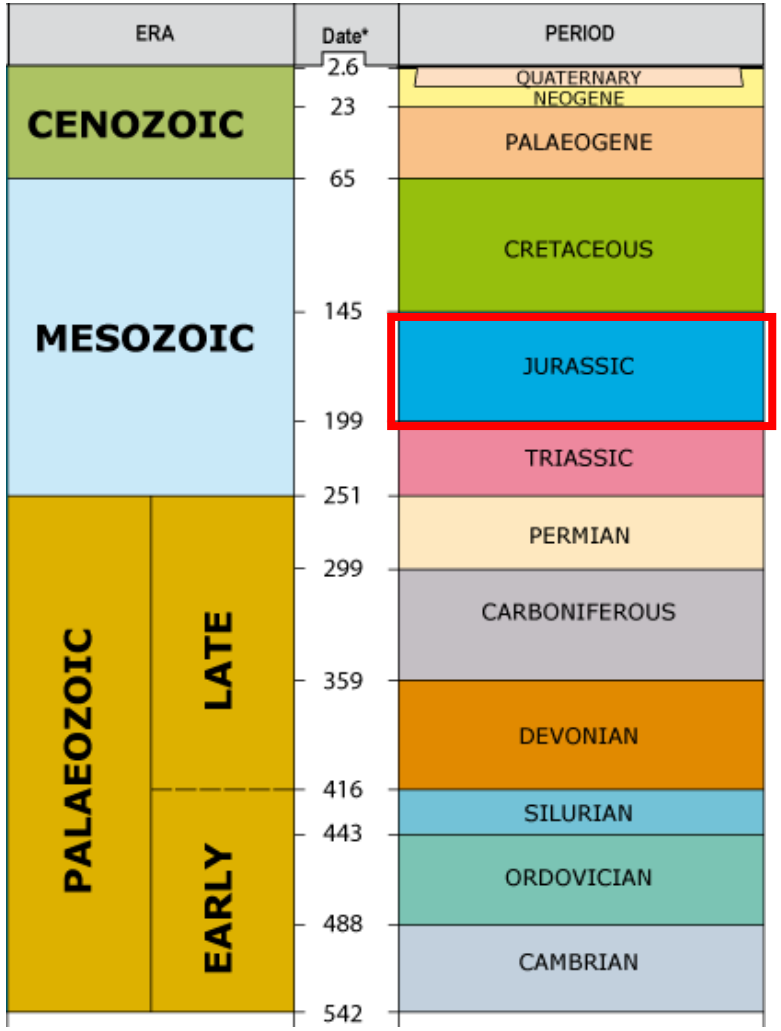


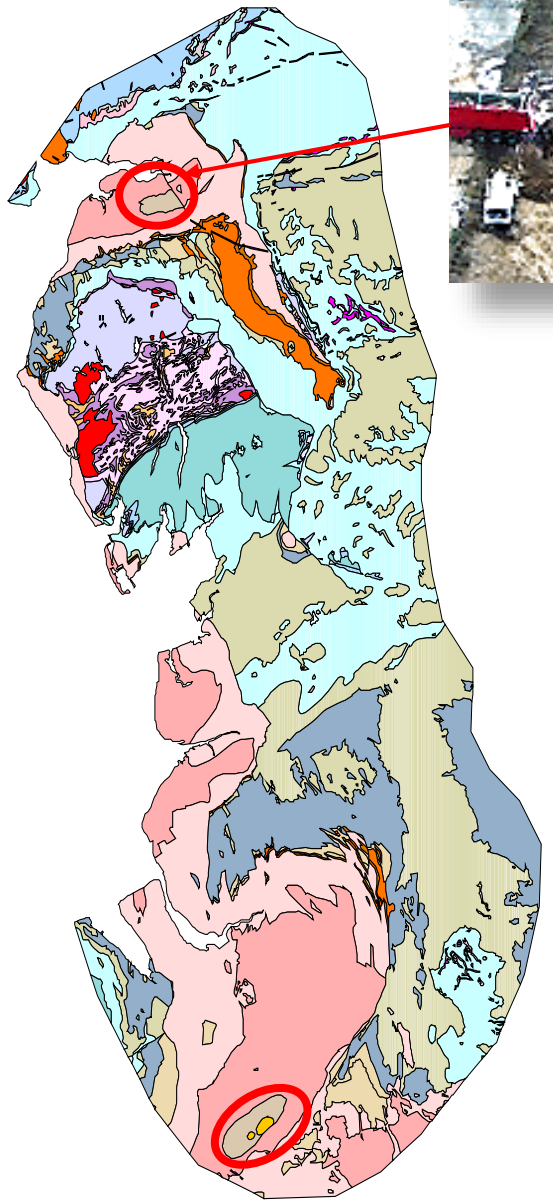




Permo- Triassic

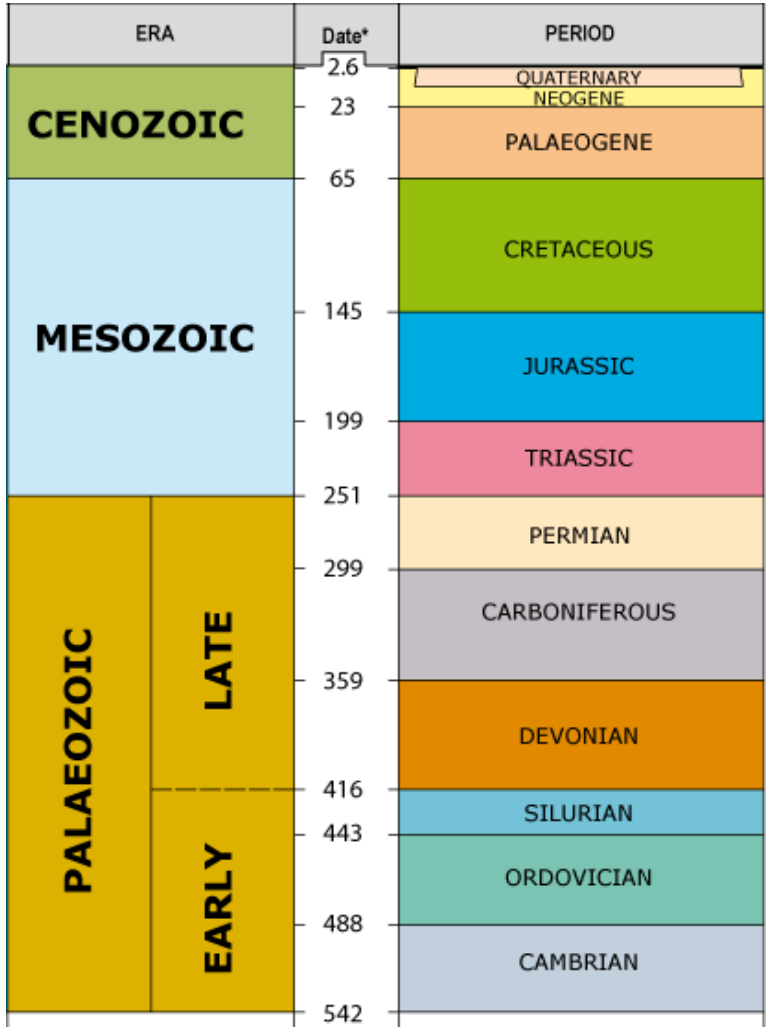
Geology of NW

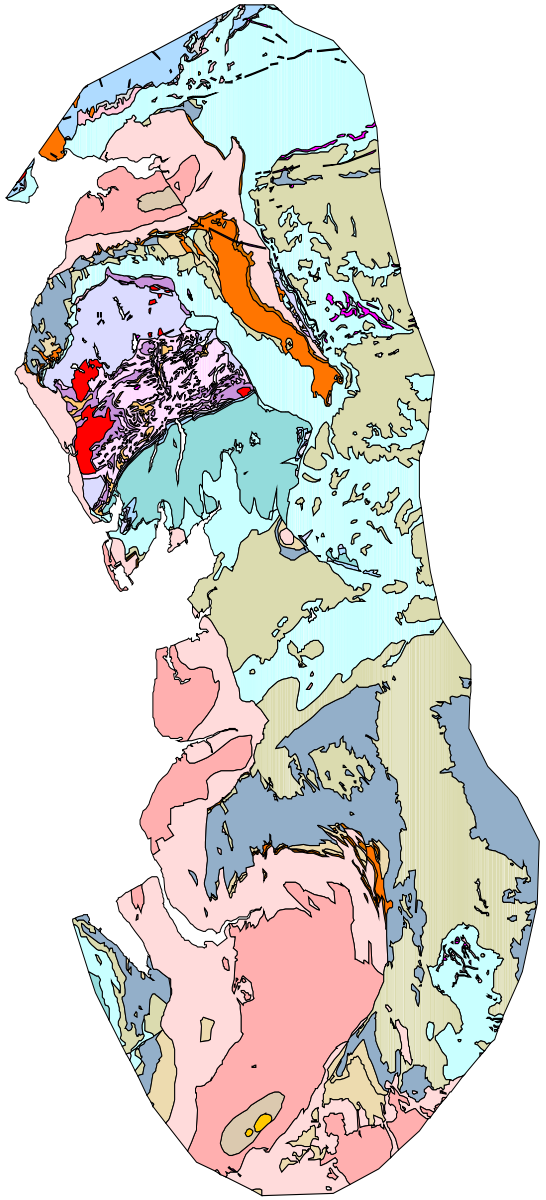




Jurassic (Lias)

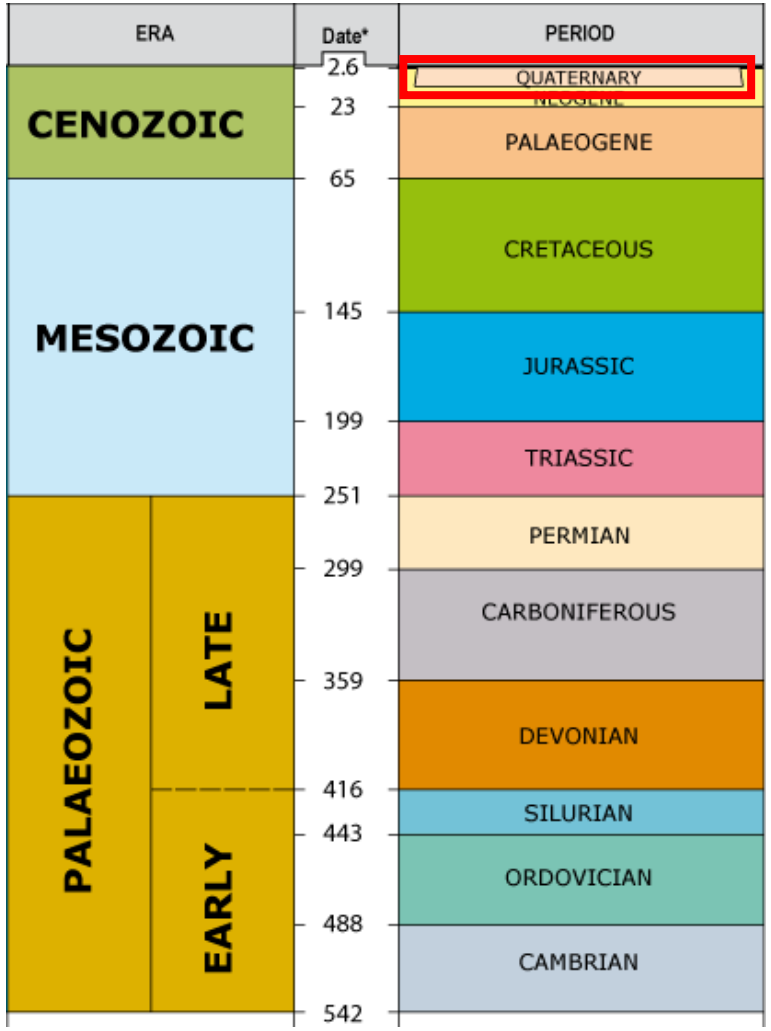
Geology of NW

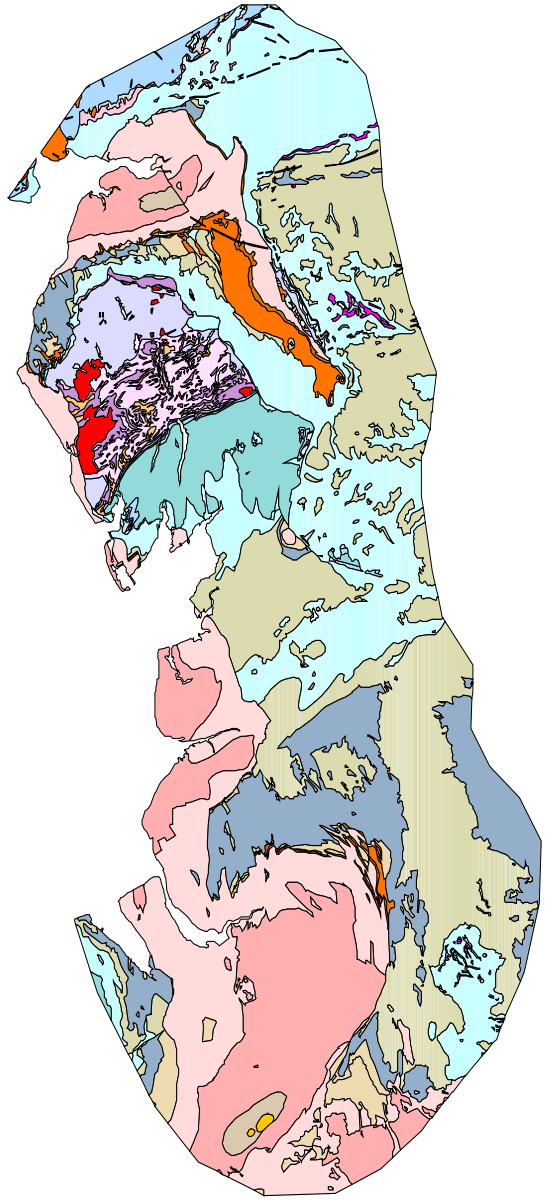




Cretaceous??

Geology of NW

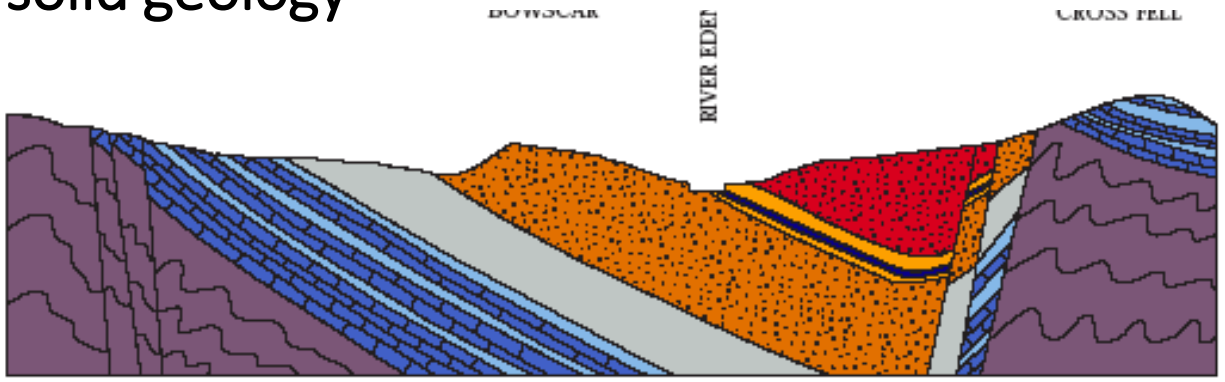




Quaternary (Superficial/Drift)

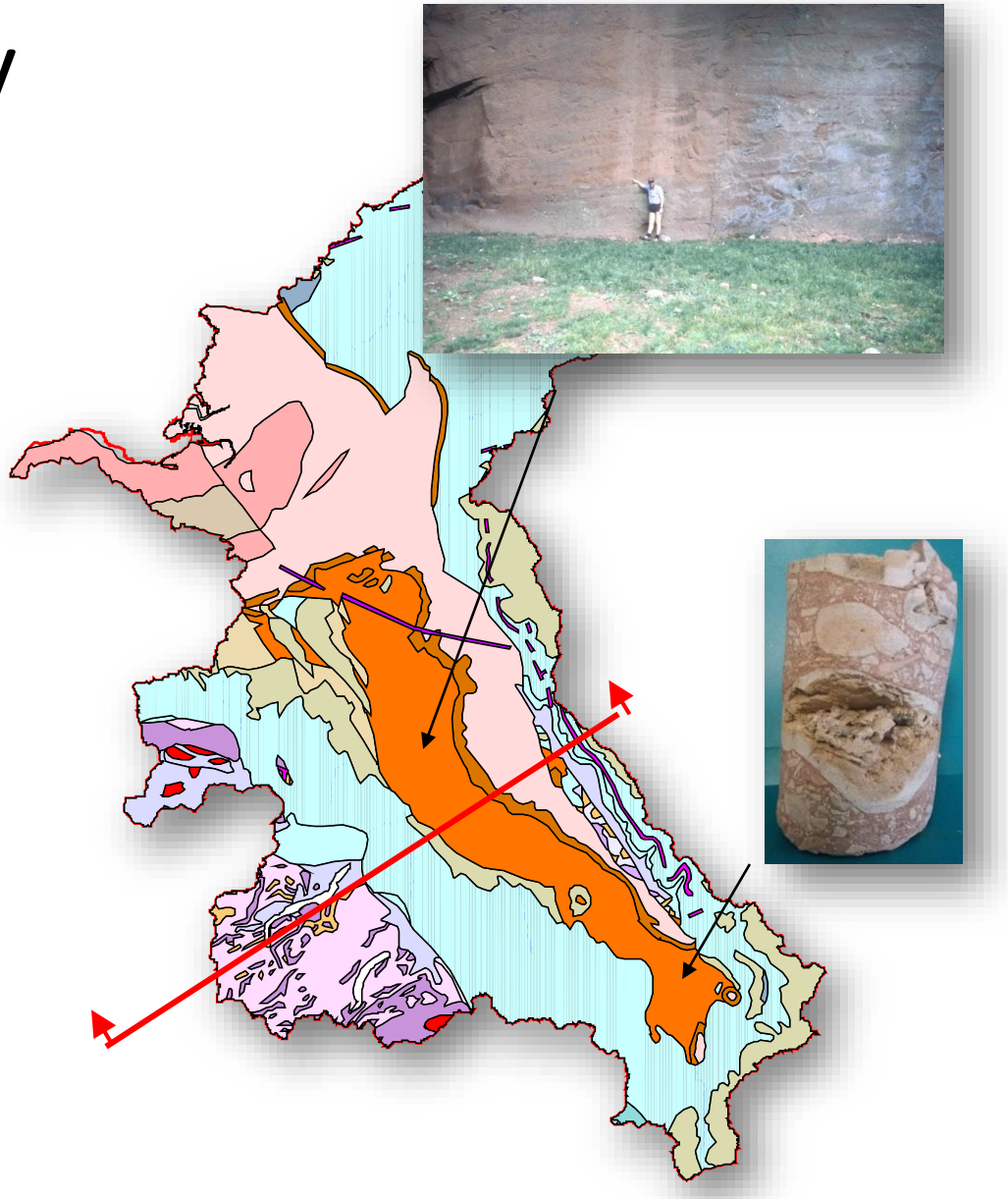
Basin deposition : The Eden Valley

solid geology



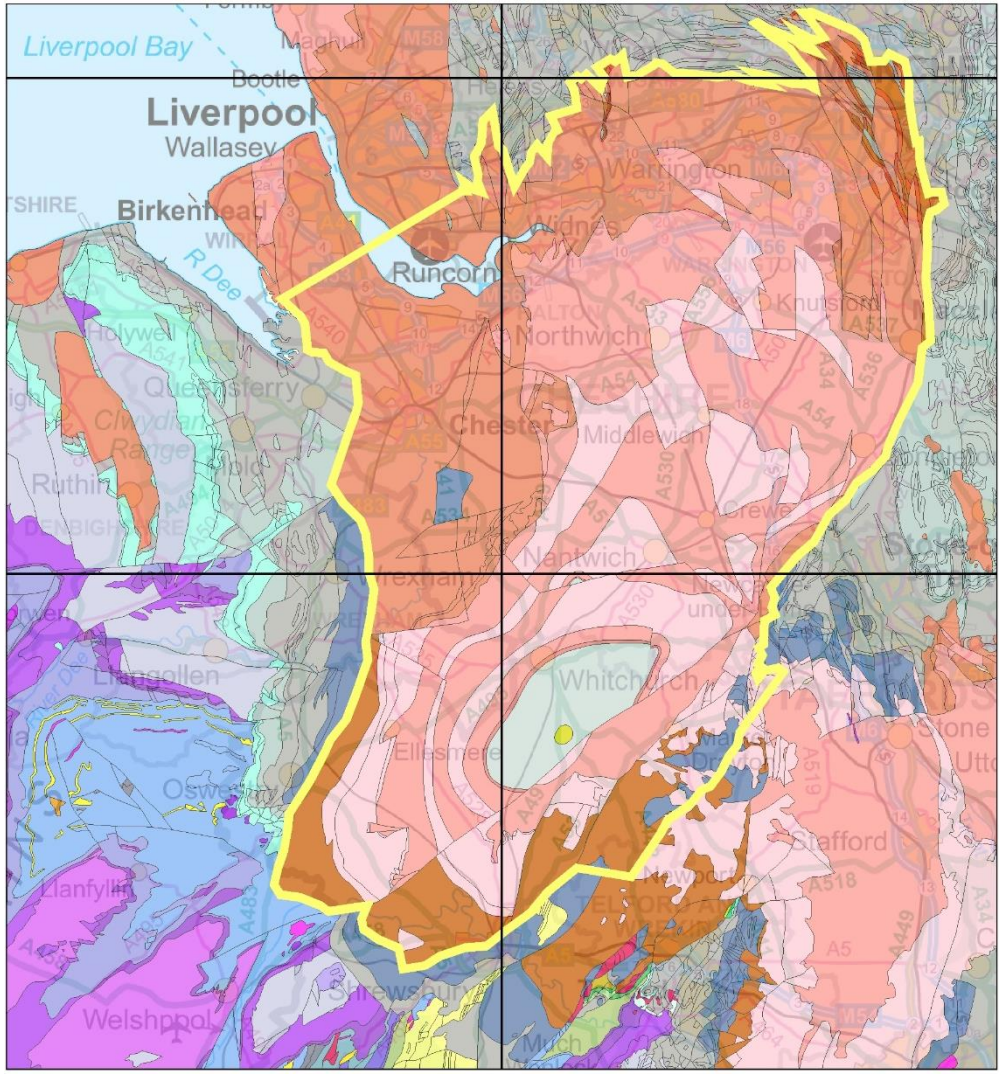
Legend

St Bees Sandstone	- Triassic	
Eden Shales	)	
	)- Permian	
Penrith Sandstone	)	
Millstone Grit Series	)	
	) - Carboniferous	
Limestone Series	)	
Borrowdale Volcanic Series	- Ordovician	



The Cheshire Basin

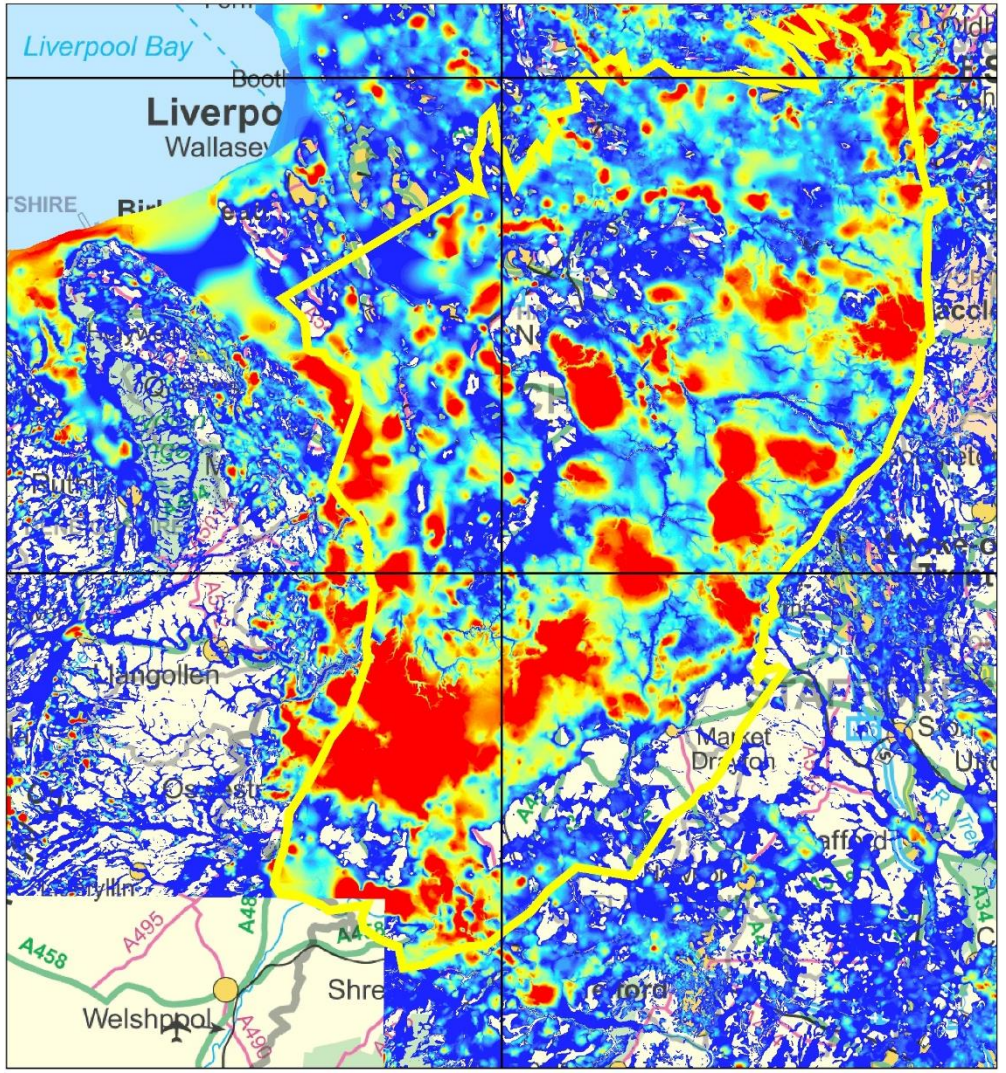
- Up to 5km of Permo-Triassic rocks
- Defined by a series of prominent geological faults that displace the rocks in places by over 3km
- Rocks are deepest in the east -asymmetrical (half graben)



Geology extract from DiGMapGB 50

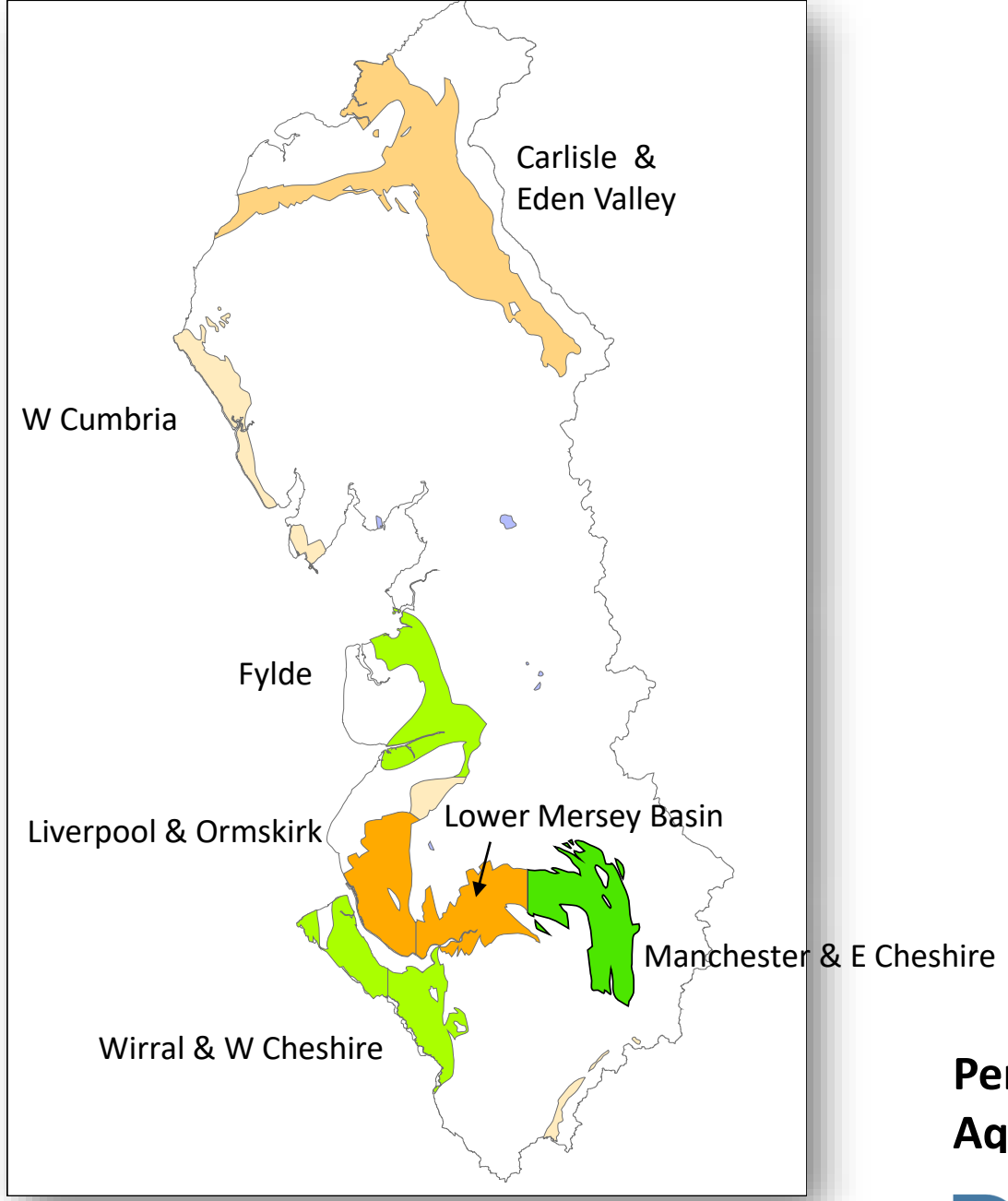
Ice Age

- Deposits range from Till (sandy gravelly clay) to sand and gravel
- Thickness of superficial deposits very variable from less than 2m (BLUE) to over 100m thick (RED)



Now back to groundwatery stuff

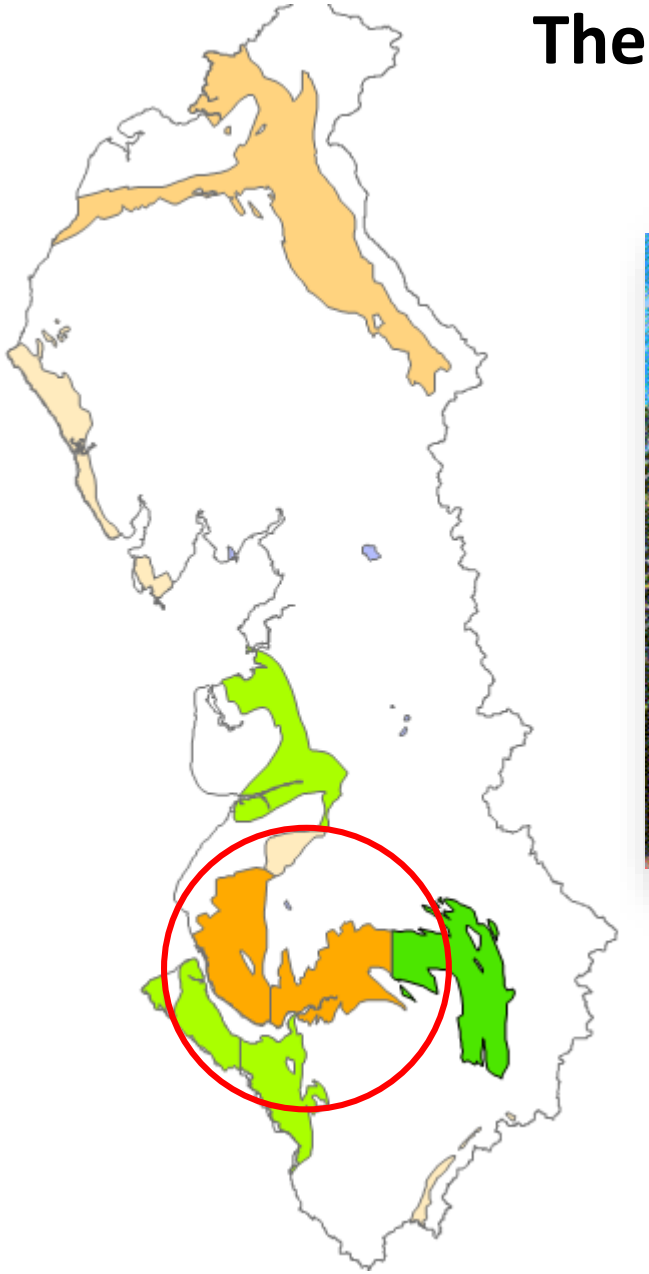
……and the why only 11%



Permo-Triassic (Principal) Aquifer Management Units

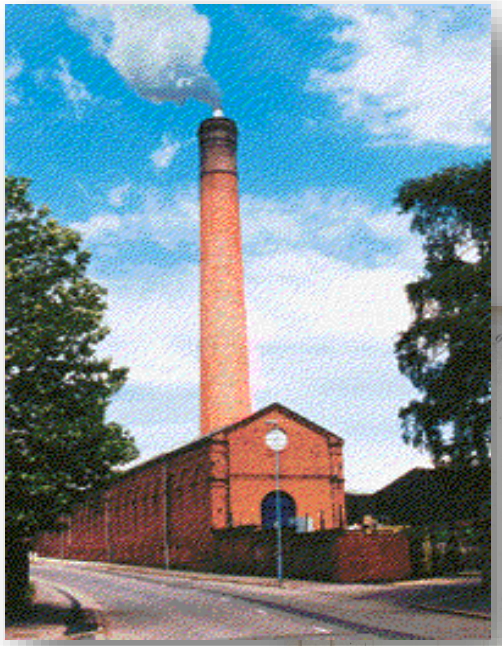
North West Water
NRA
Environment Agency

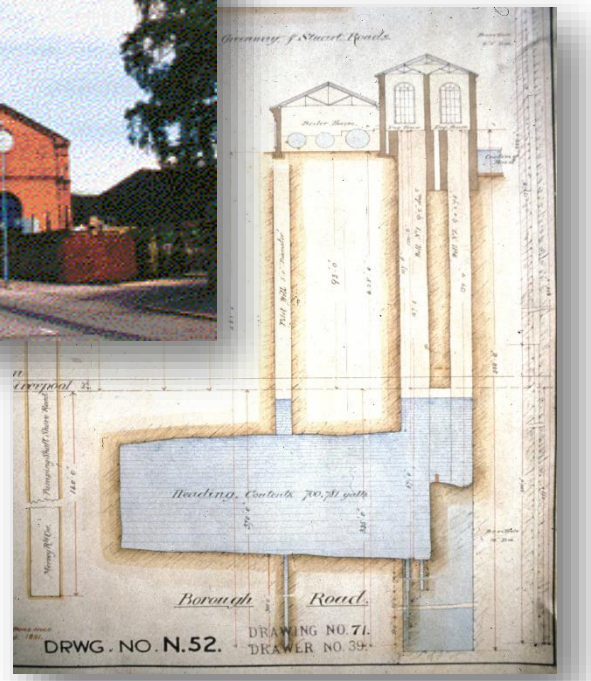
Abstraction history and water supply in the NW

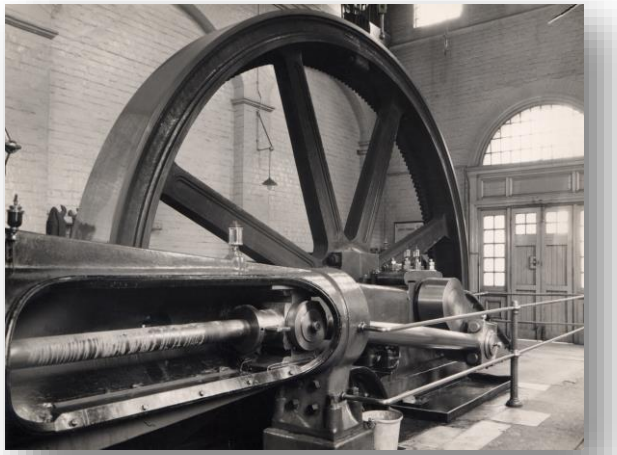


The Mersey Basin

~ long history of groundwater abstraction





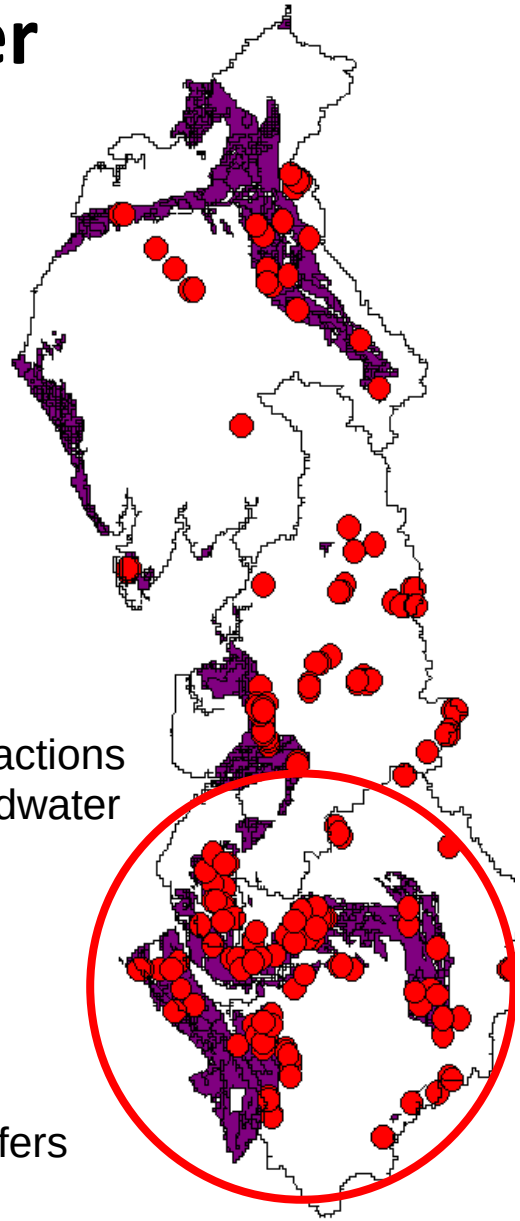


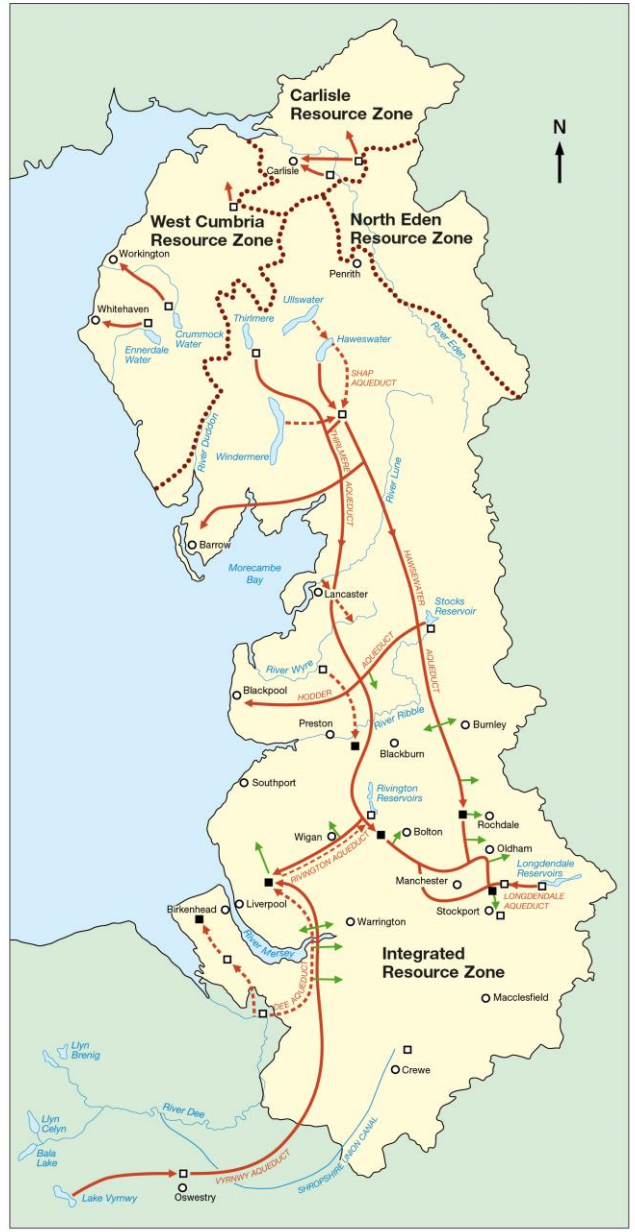
Public water supply in the NW:
~ the importance of Groundwater

- The old days *(local 'water boards')*
  - local sources – baseload pumping
  - then remote bulk supplies

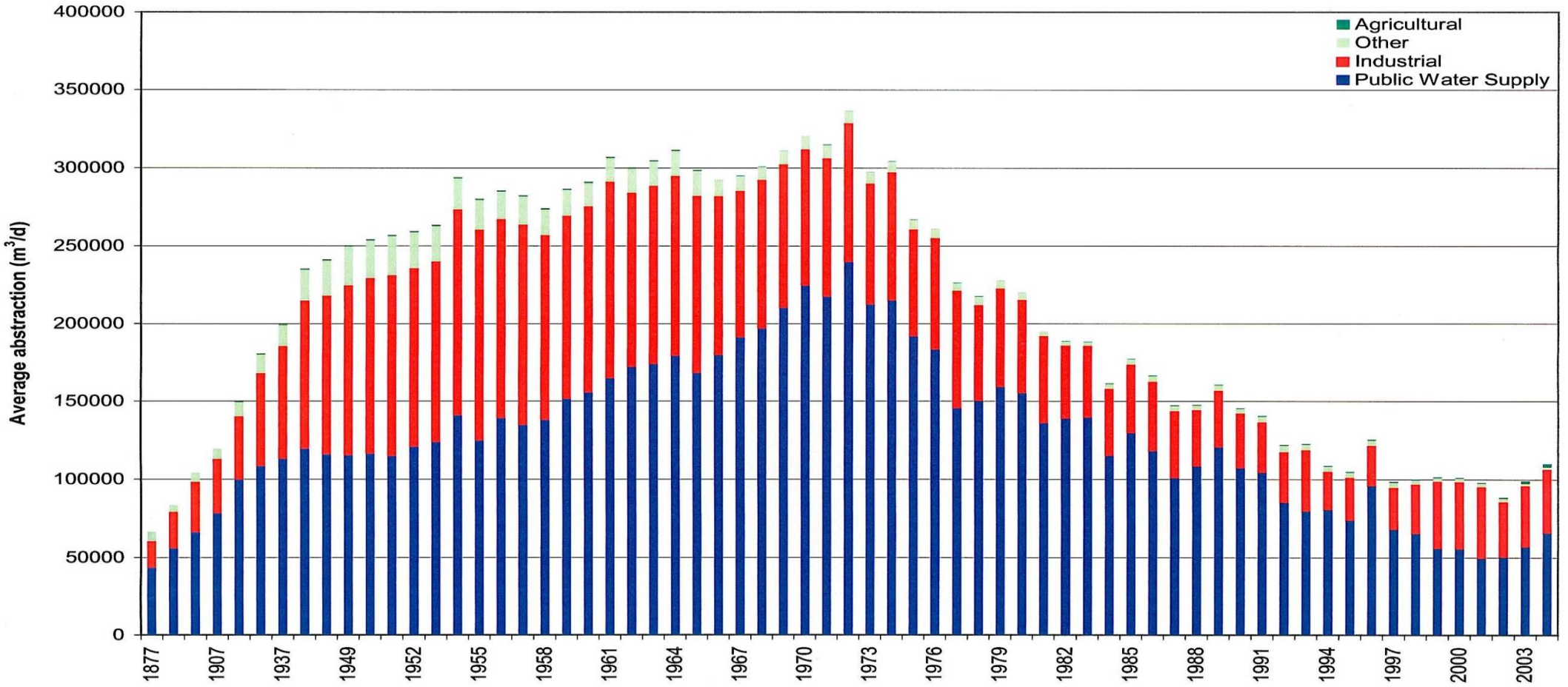
  e.g Manchester (Lakes)

  Liverpool (Wales)
- Now
  - integrated zones
  - conjunctive use

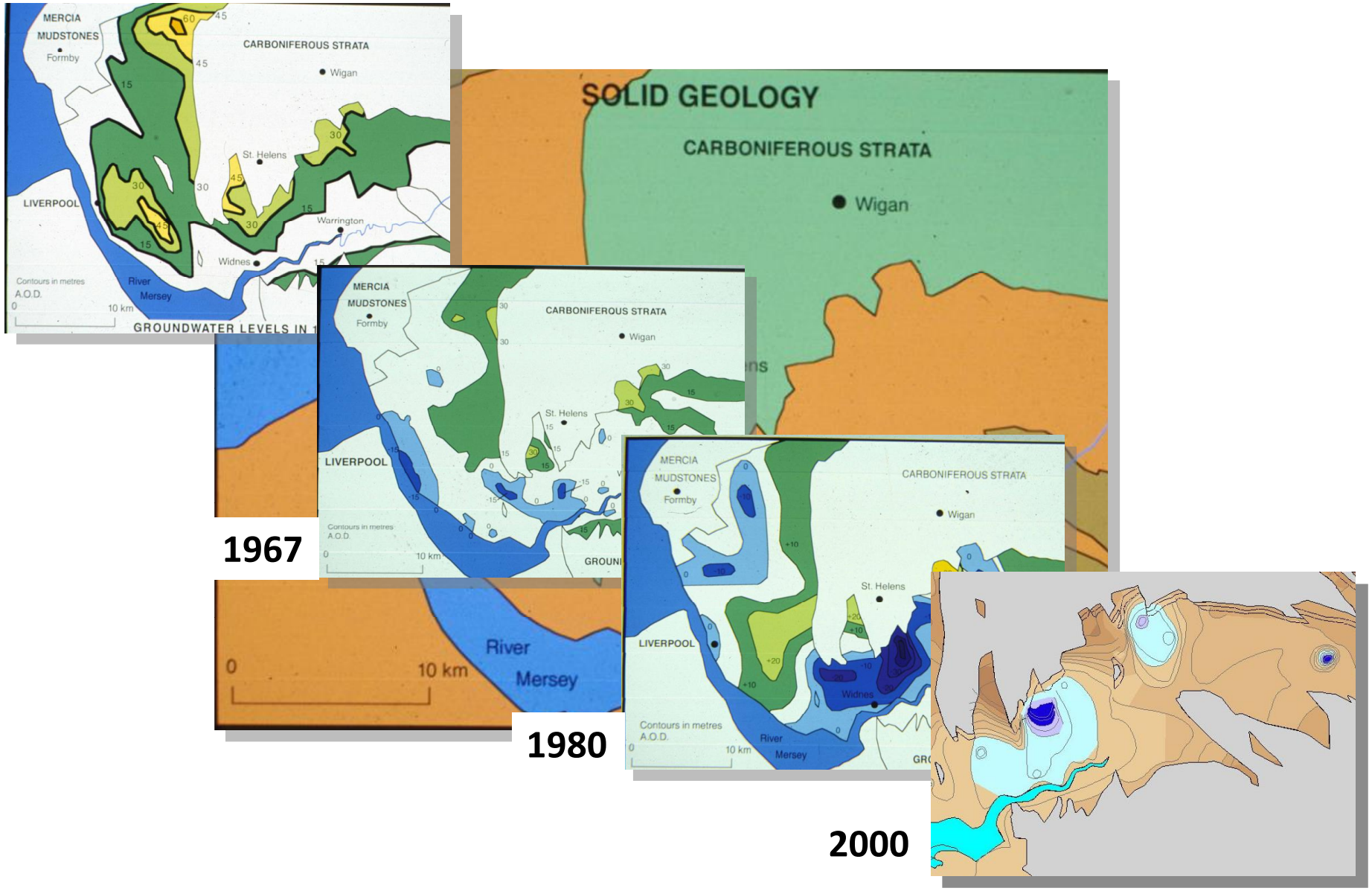




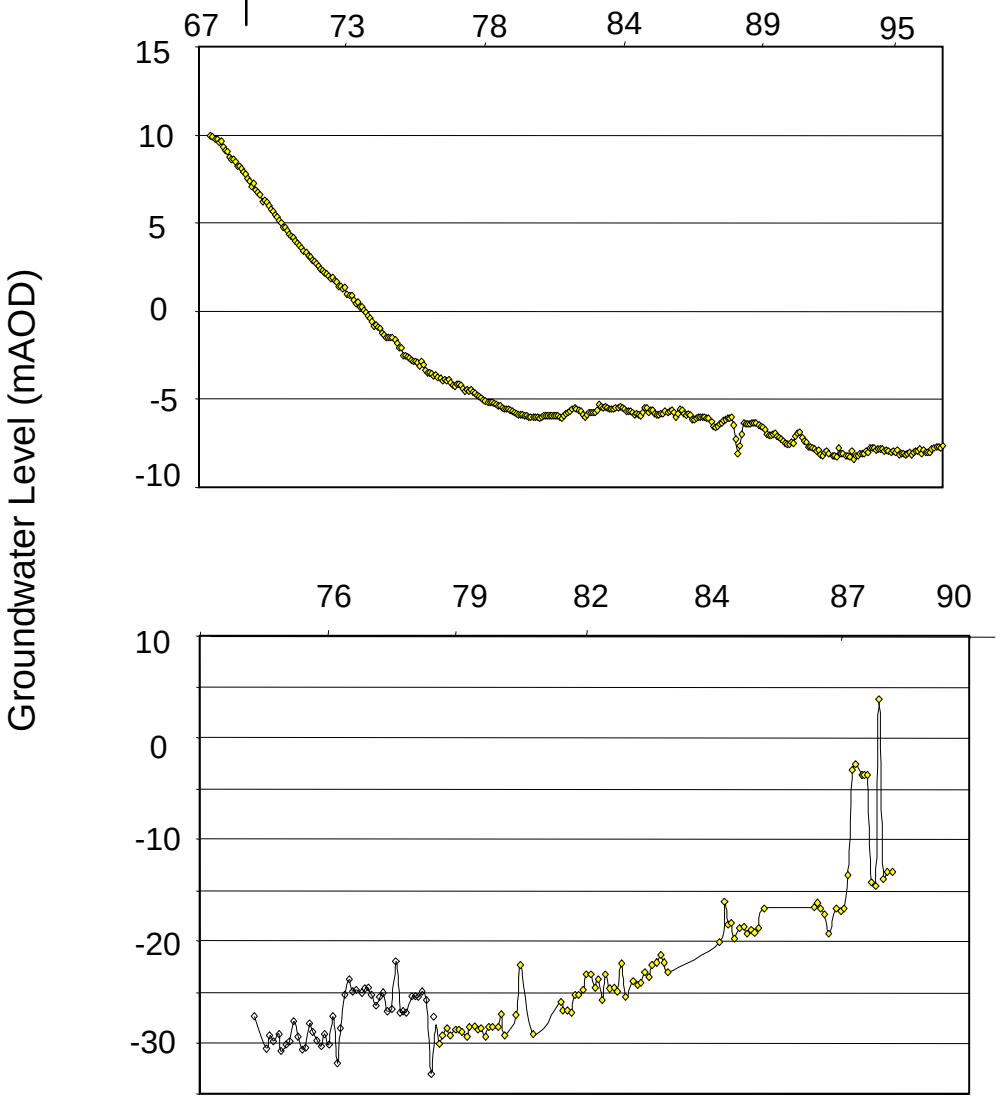
Mersey Basin groundwater abstractions



Mersey Basin - Groundwater Levels



Groundwater Hydrographs
Mersey Basin



Kenyon Lane

Observation Borehole

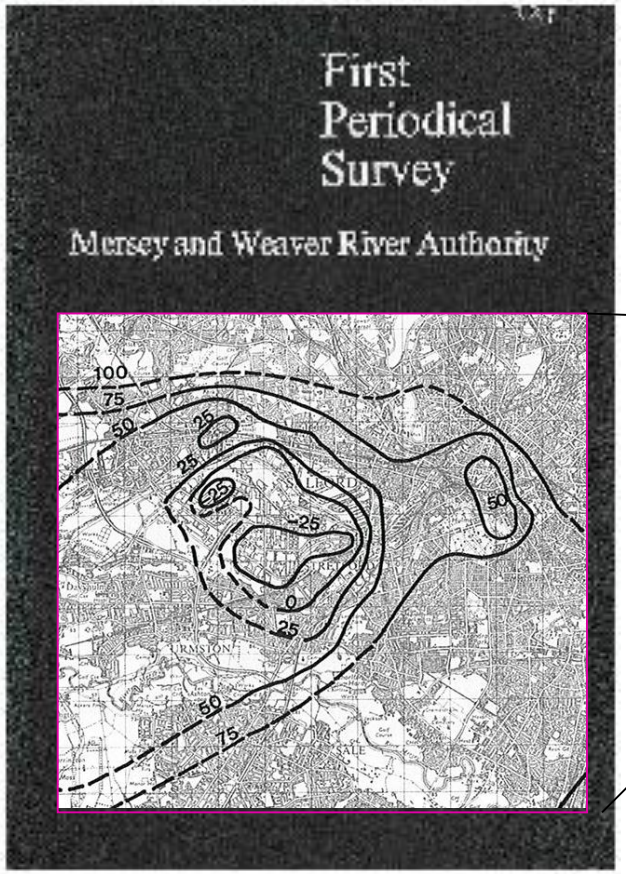
Public Water Supply

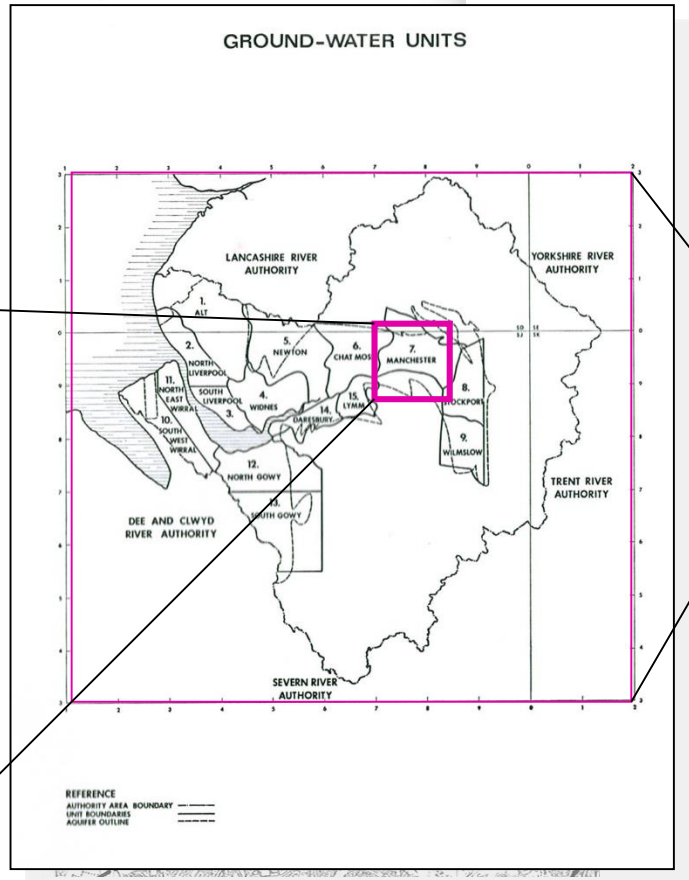
Abstraction Borehole

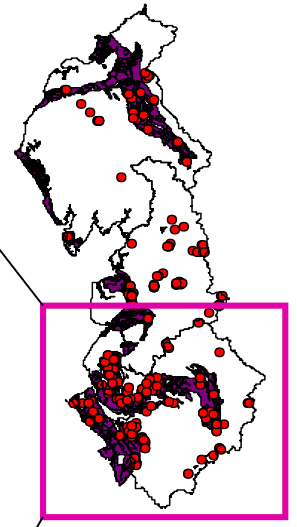
Groundwater Lake - Winwick

Regulation history

In the beginning… Water Resources Act 1963



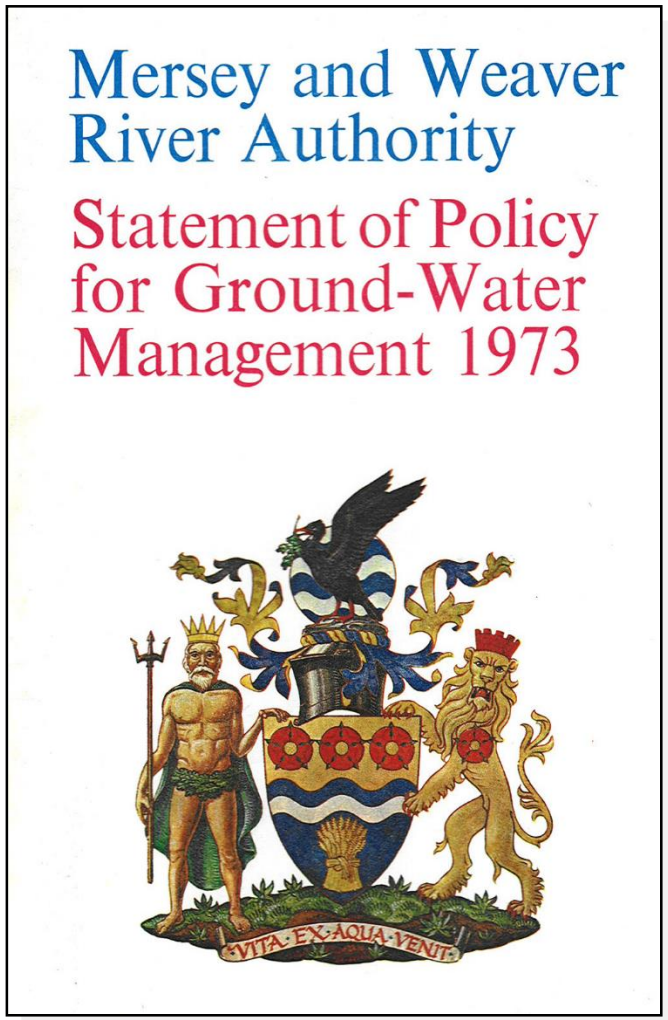


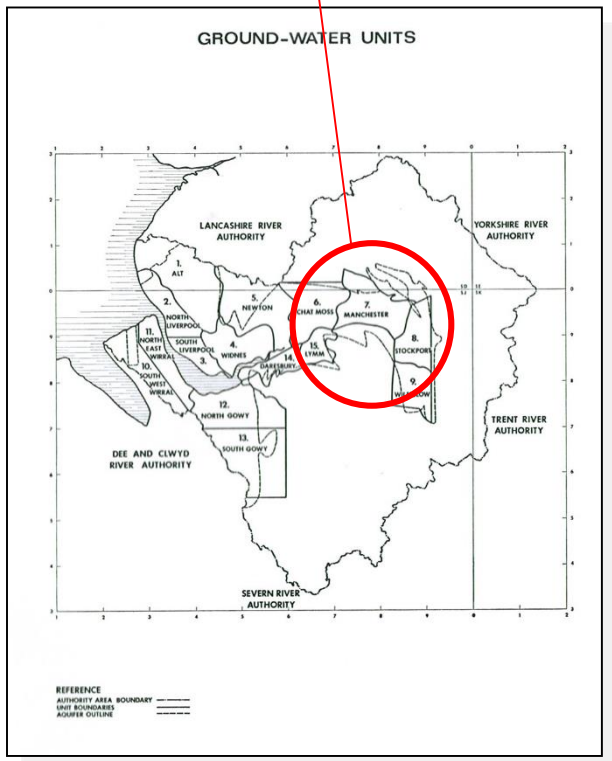


Duty to **assess** WR availability

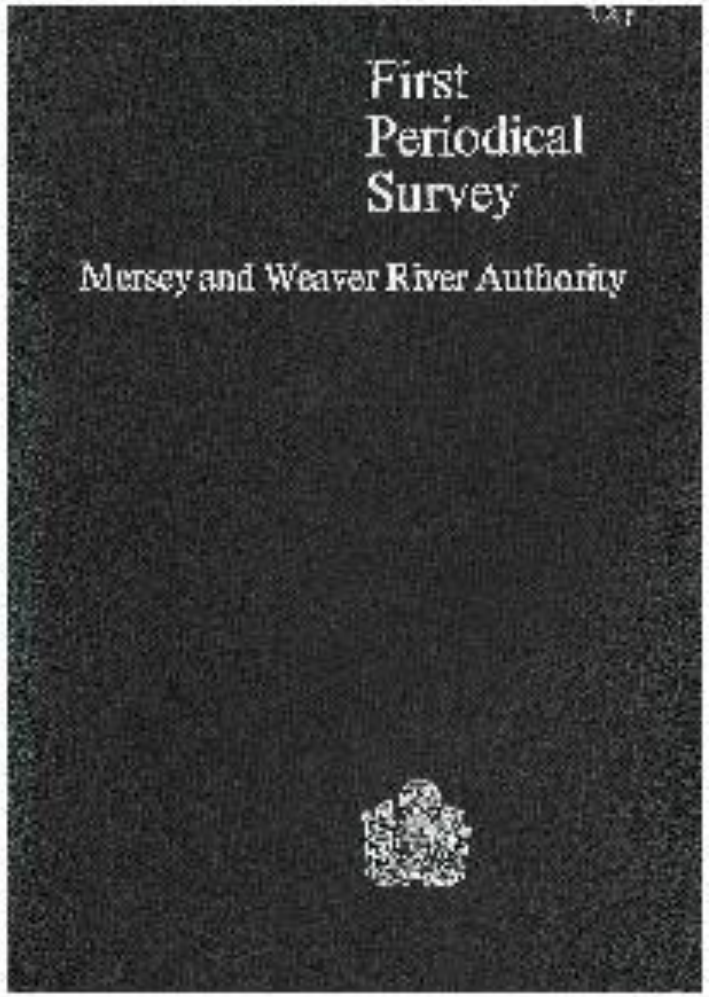
… and manage groundwater

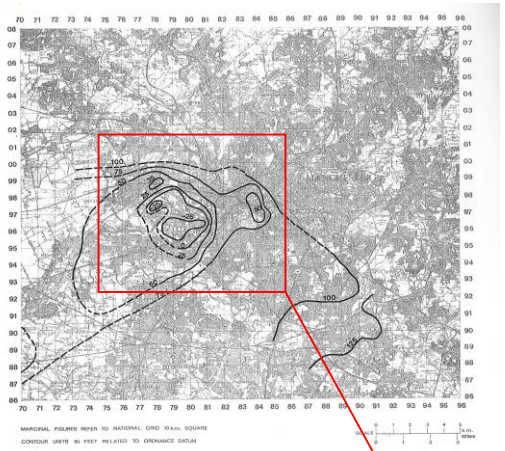
9.9 Within the **Manchester Ground-Water Unit,** there are some signs of slight improvement in ground-water level and the main aim must be not to exceed the present rates of abstractions. Some temporary increases could be considered so long as these were spaced well away from the area within Trafford Park where abstractions are at present concentrated.



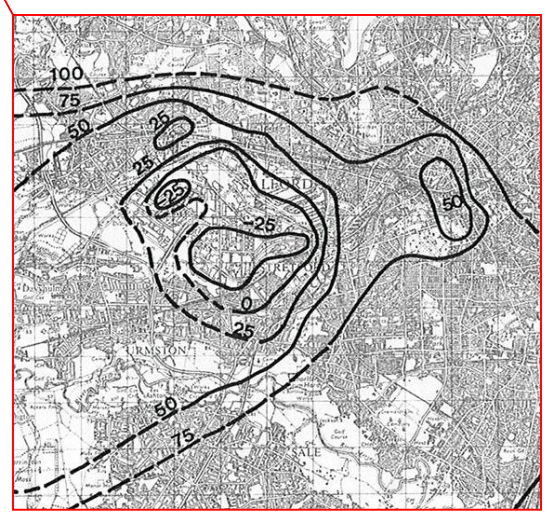


Resources Assessment - *the old days*

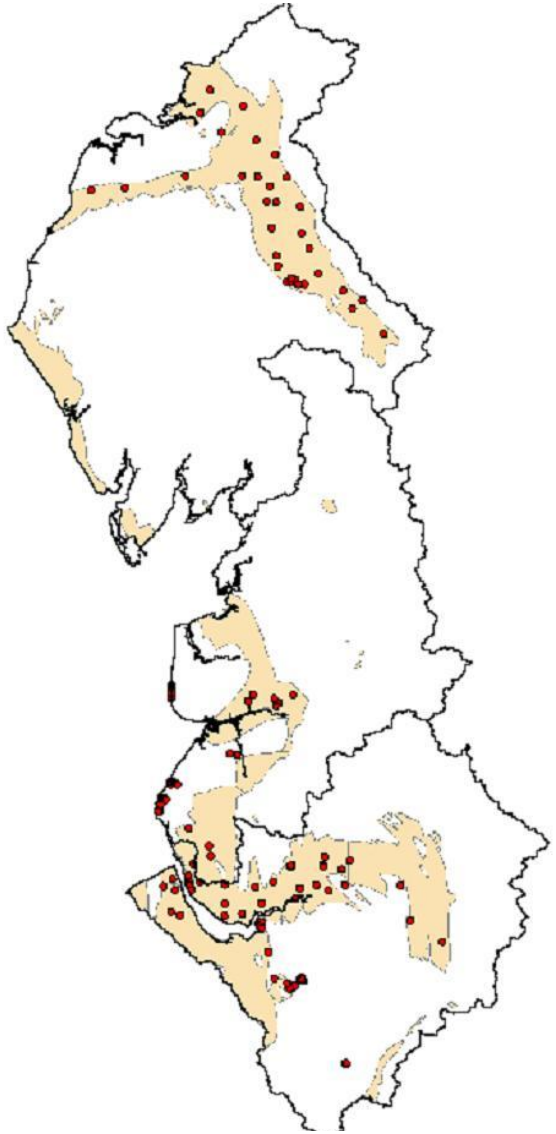


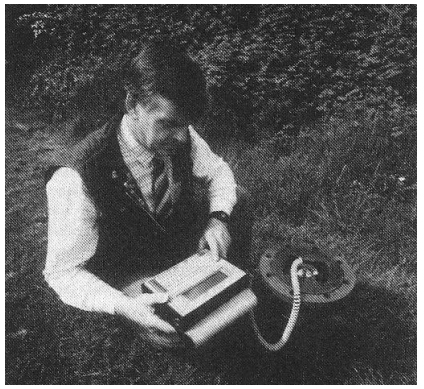


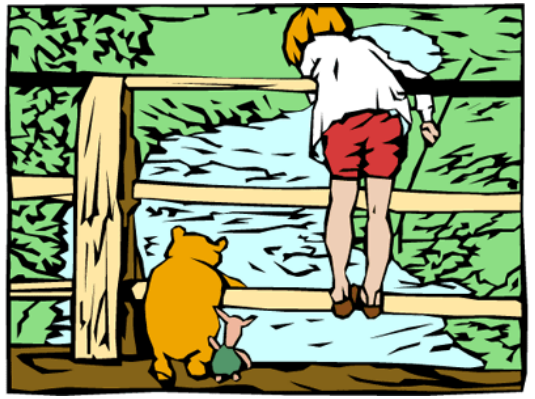
MANCHESTER GROUND WATER DISTRICT
GROUND WATER CONTOURS
1965



Resources Assessment - *the start of monitoring*



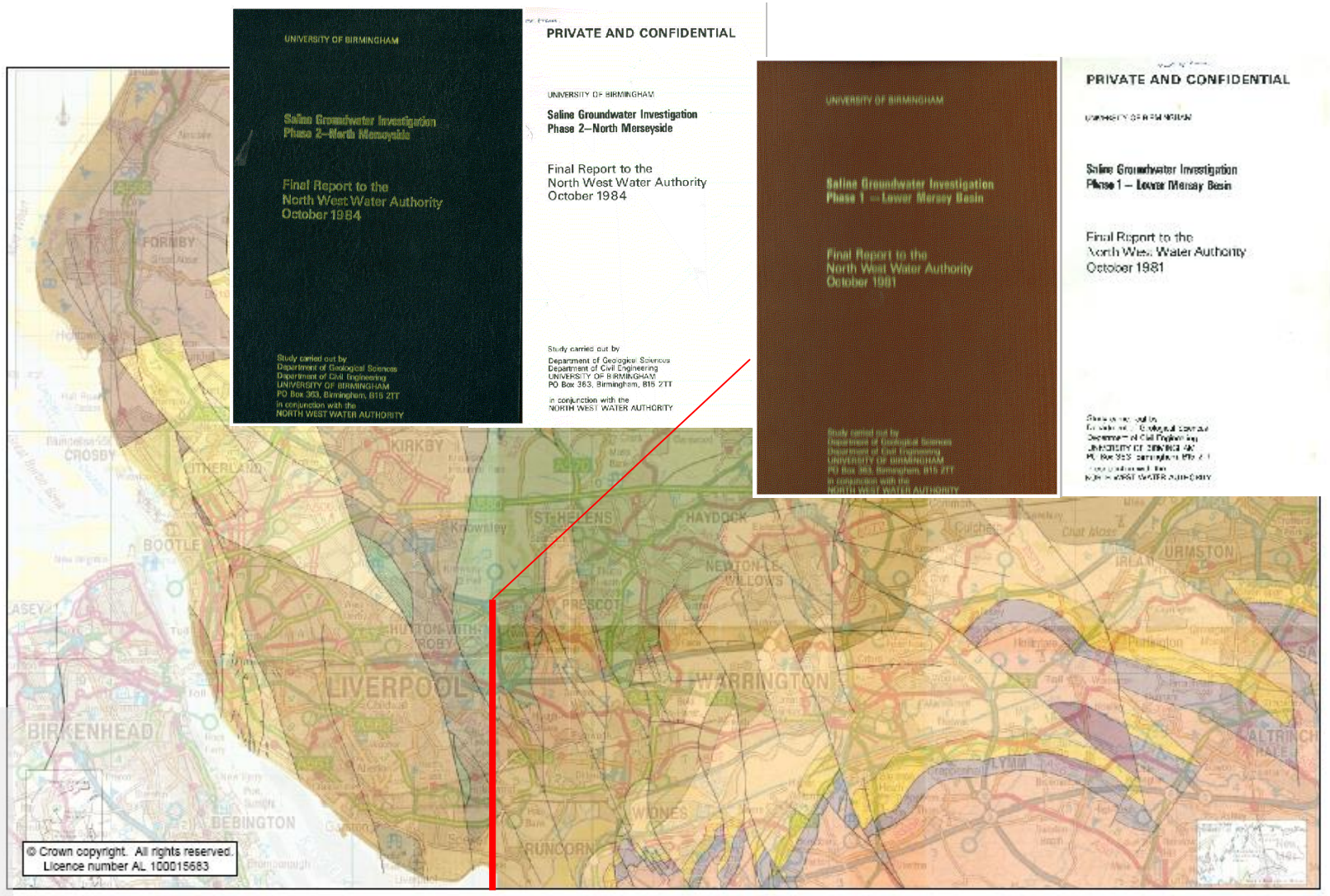




Development **NW Observation borehole network** ***Monitoring***

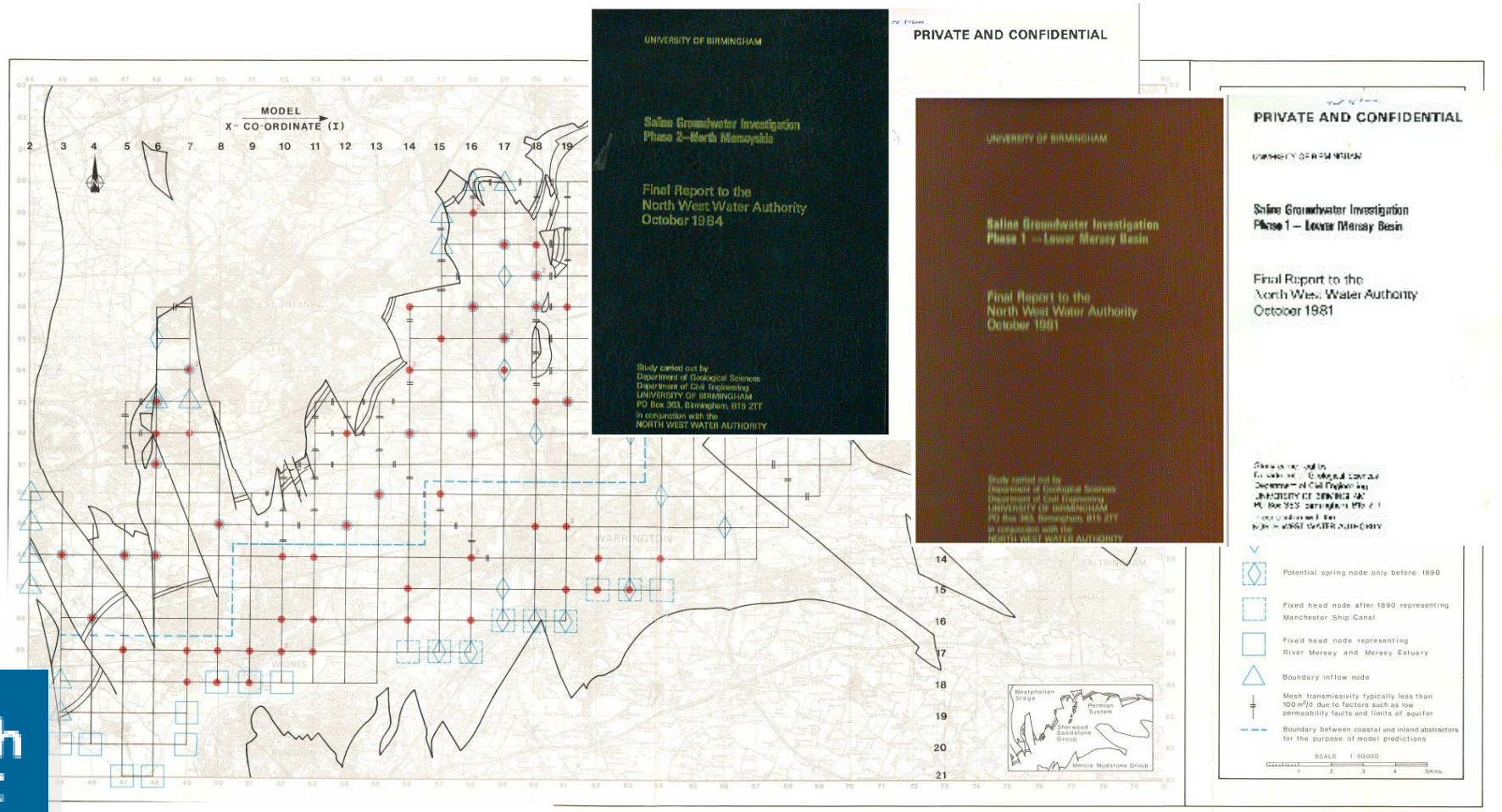
Resources Assessment - *the early days*

~ 1980's Mersey Basin Saline Groundwater Study



North West Water

Groundwater development history & previous studies



North West Water

What's changed?

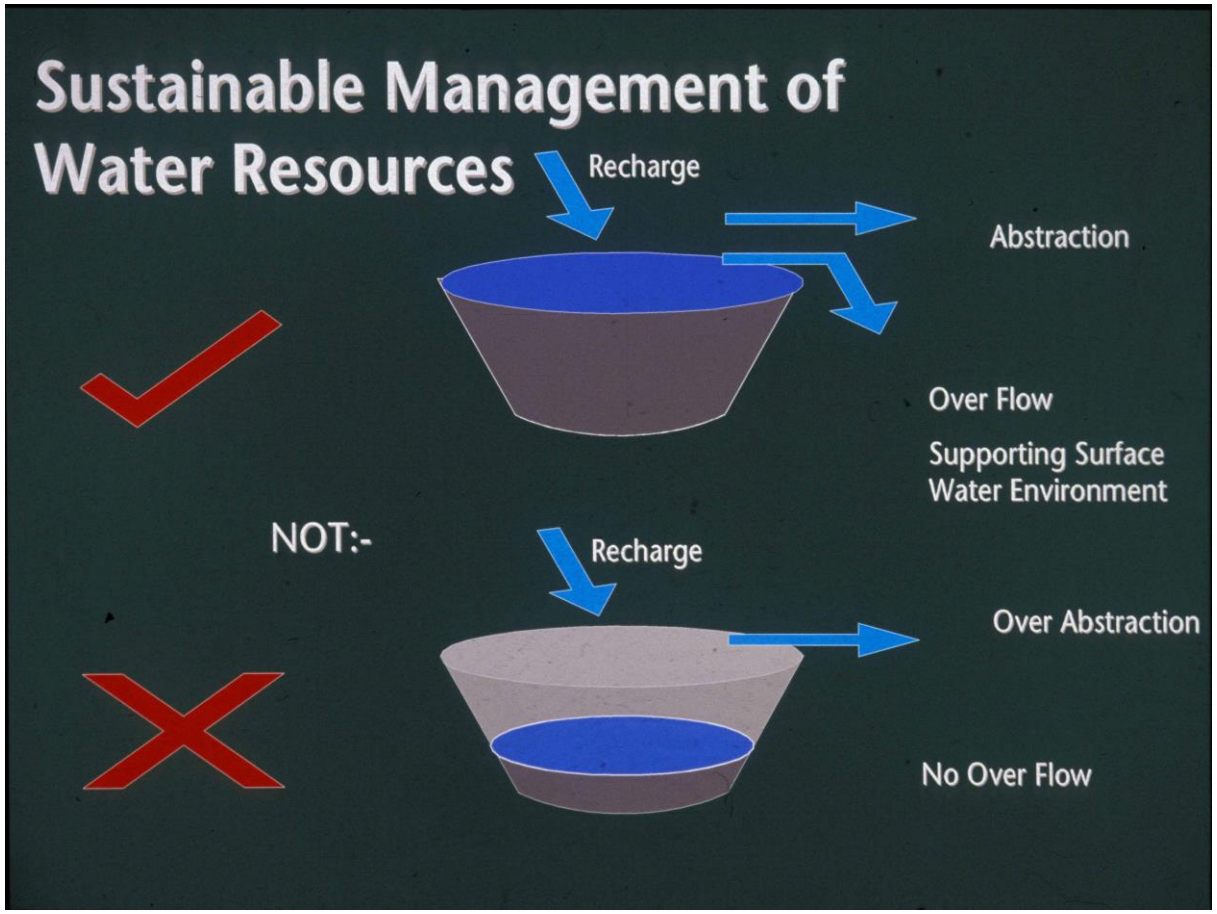
How do 'we' manage (ground) water resources now on a regional scale?

CAMS & WfD

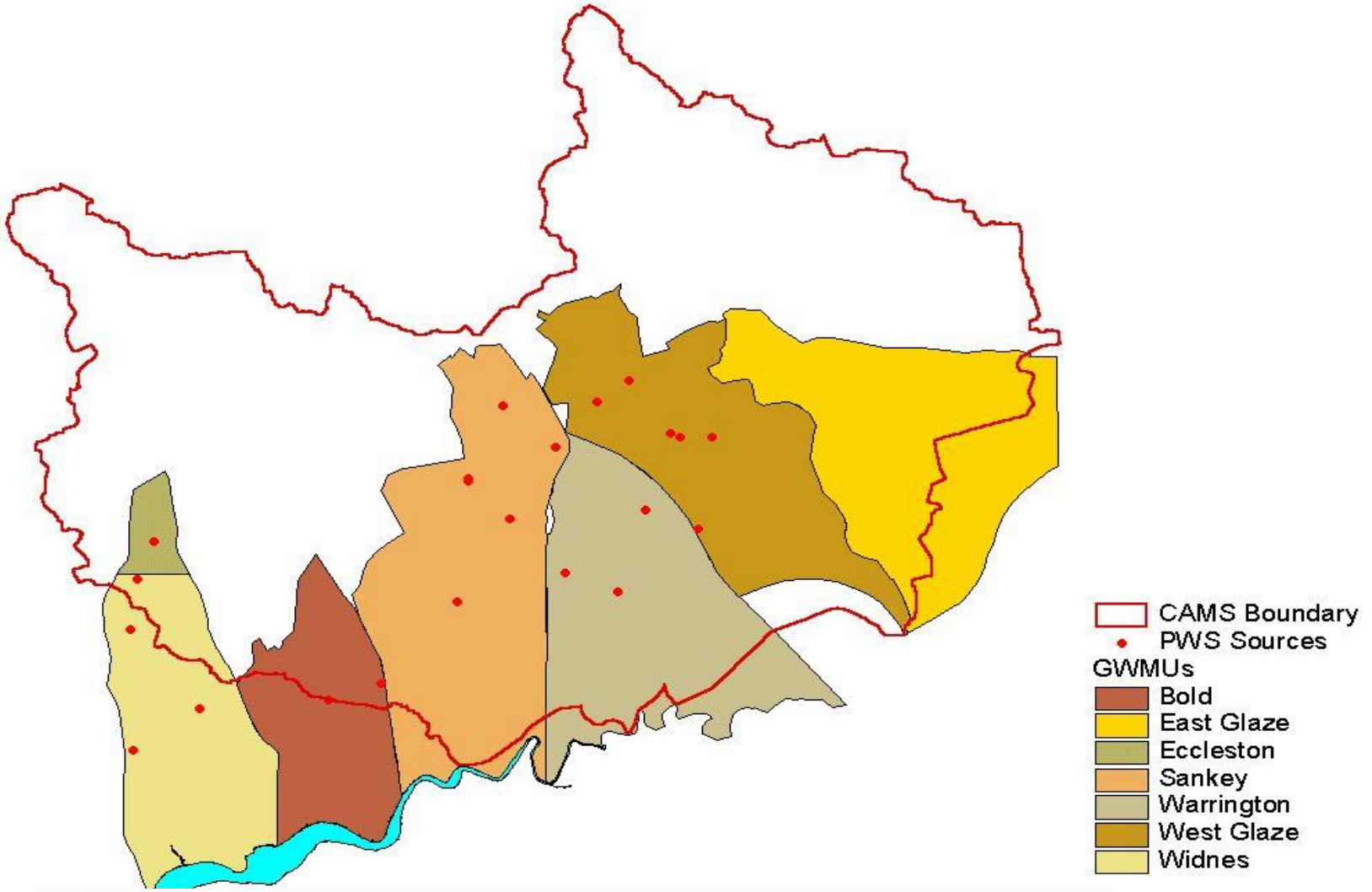
Catchment Abstraction

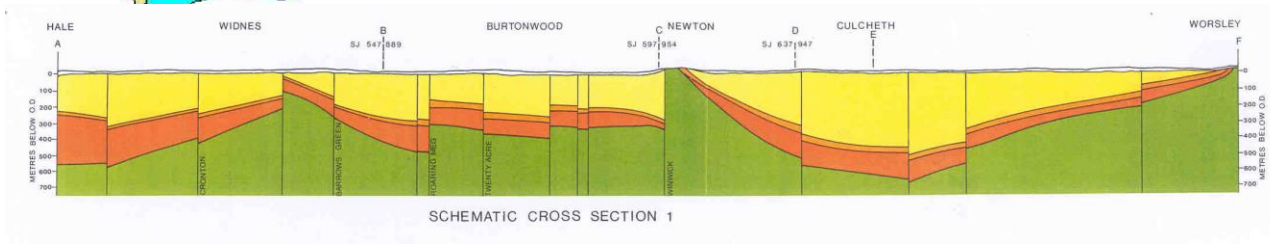
Management Strategies-

- Integrated SW/GW
- ecology
- environmental needs
- defines water resource availability



CAMS still use groundwater management units





SCHEMATIC CROSS SECTION 1

Key insights:

- Compartmentalisation/structural controls
- Salinity
- Limited recharge

from

- Operational testing (groundwater investigation consents)
- Groundwater level monitoring data
- Groundwater resources (modelling) studies

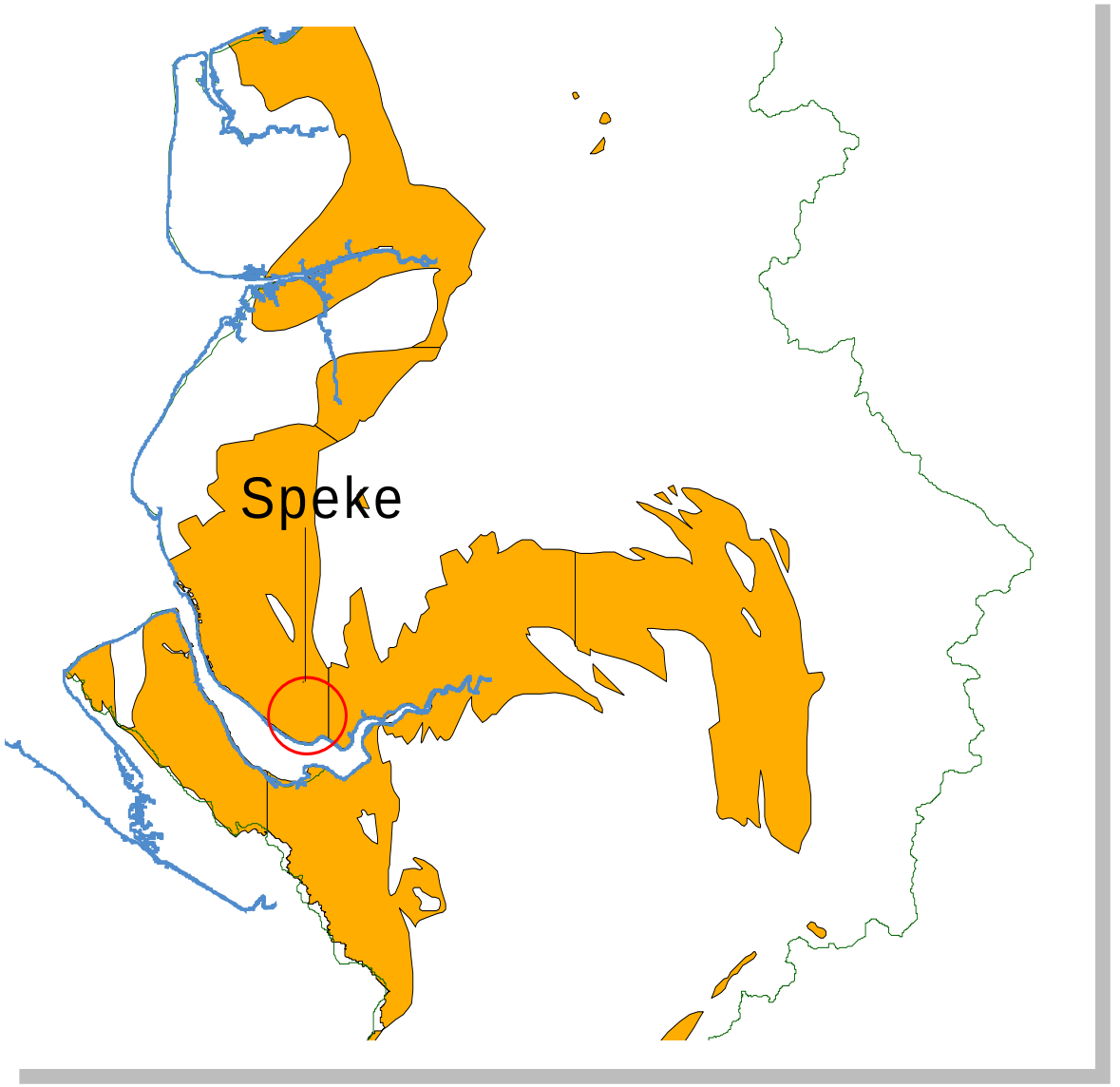
Key insights:

- Compartmentalisation/structural controls

Operational

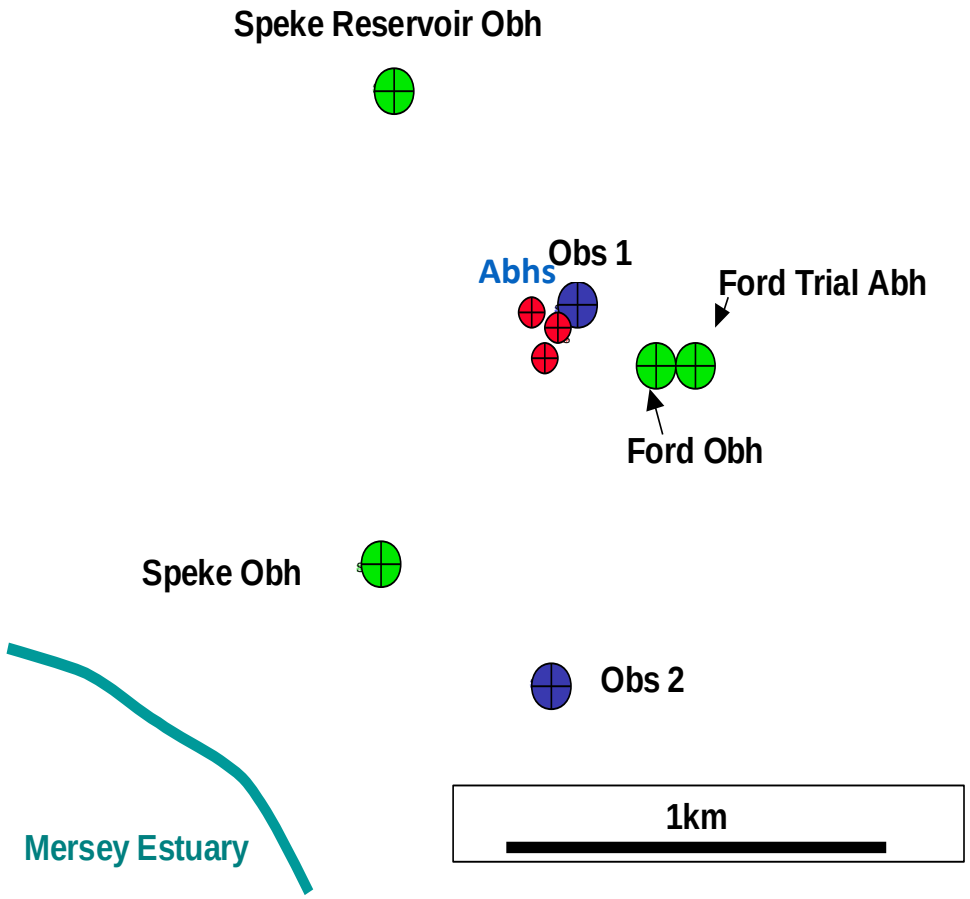
Test pumping

Speke

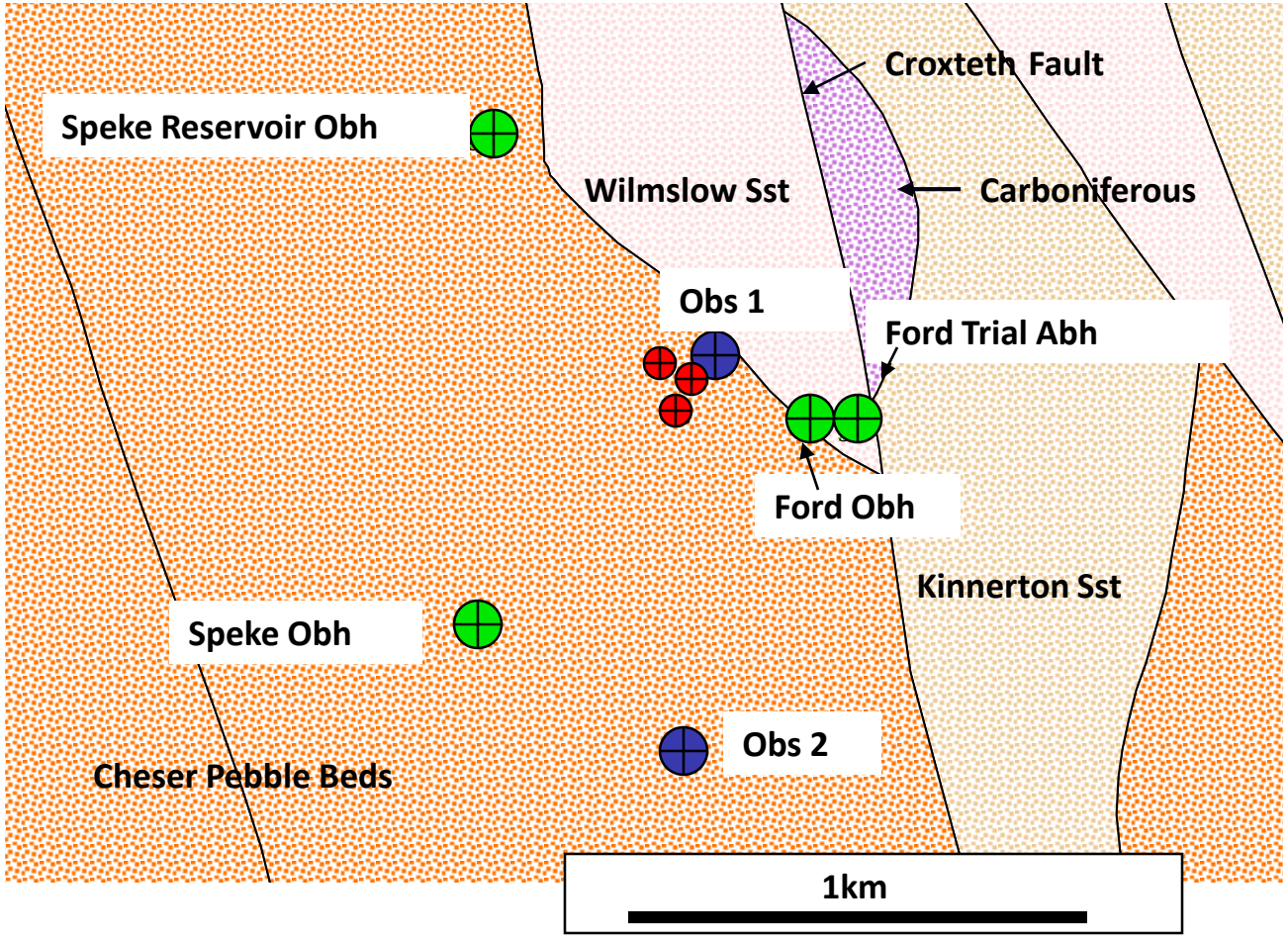


Speke

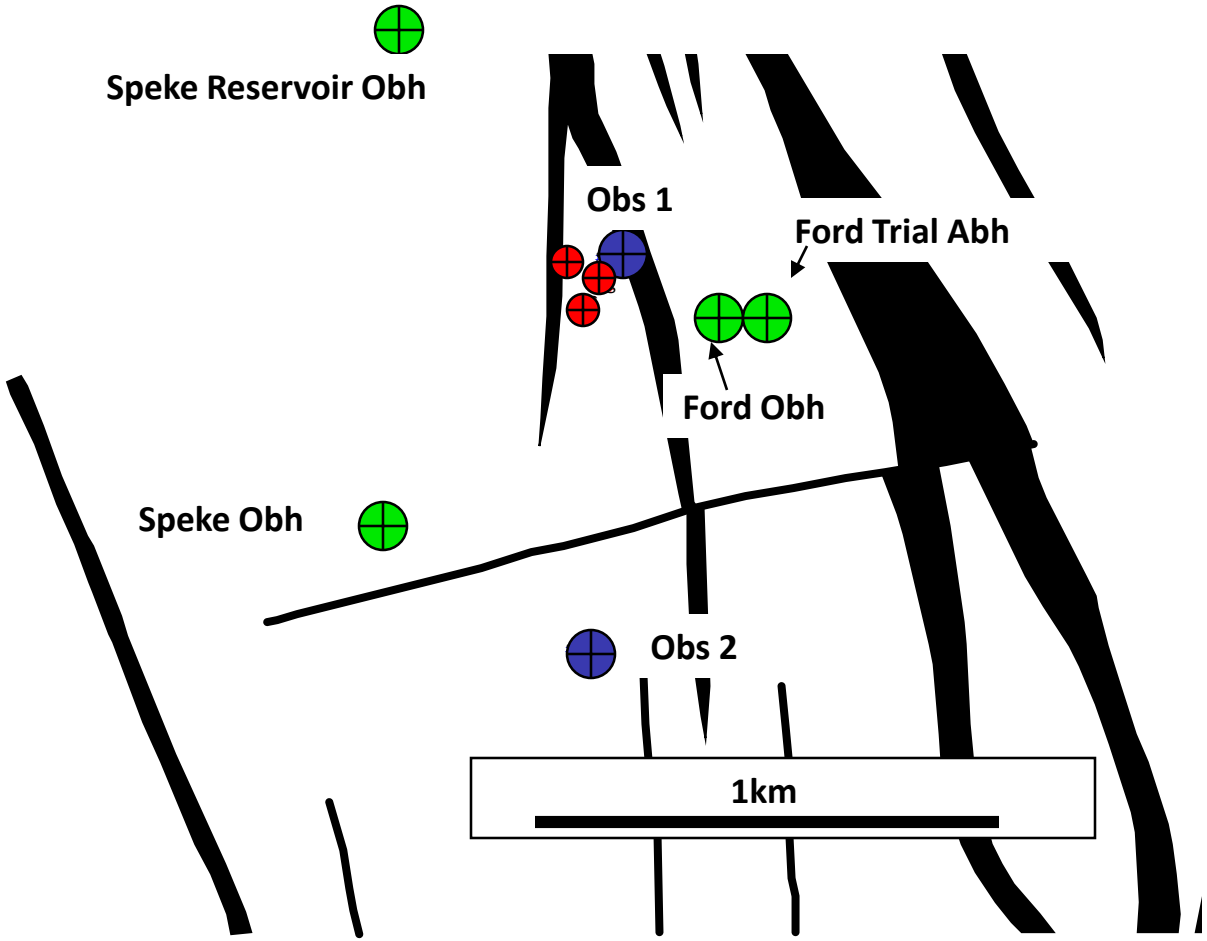
- Industrial Abstn
  - licence increase
- Saline intrusion?
- Sustainability?

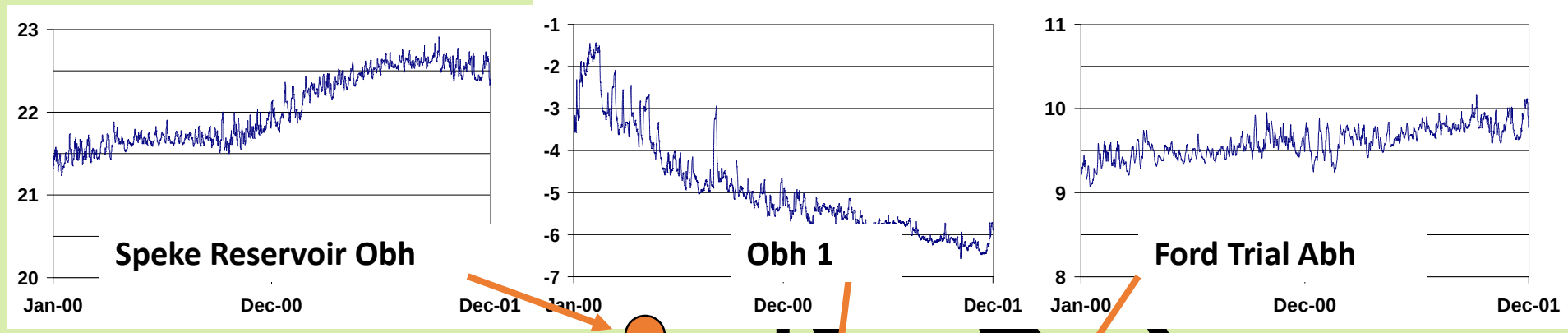


Speke - Solid Geology

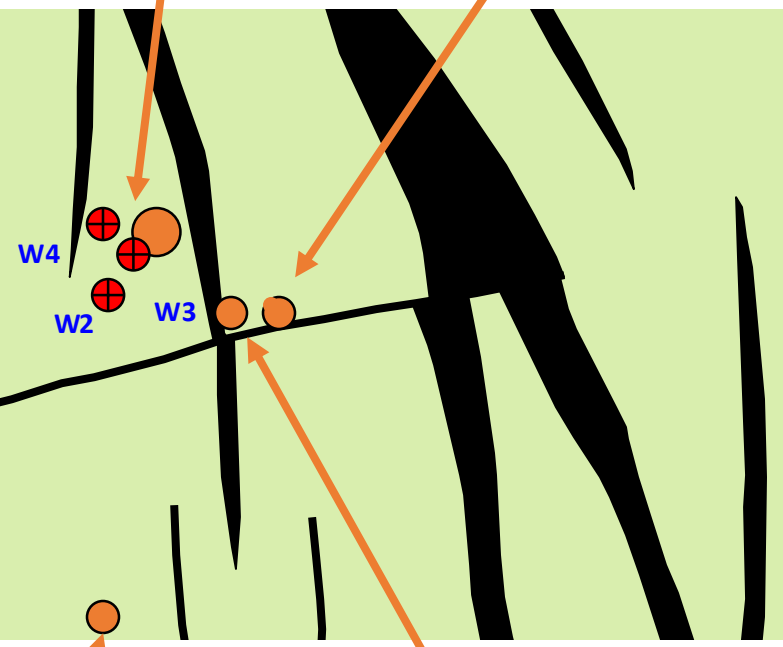


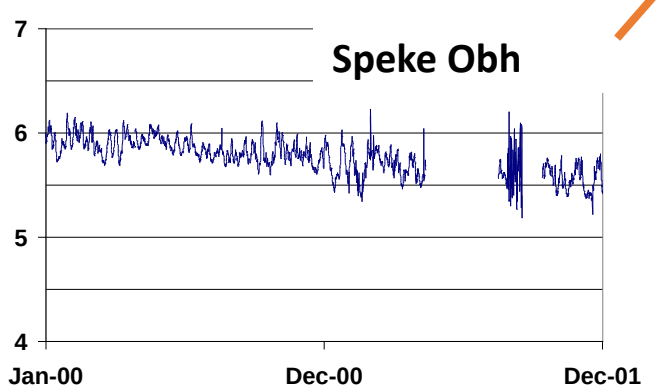
Speke - faults *(from seismic)*

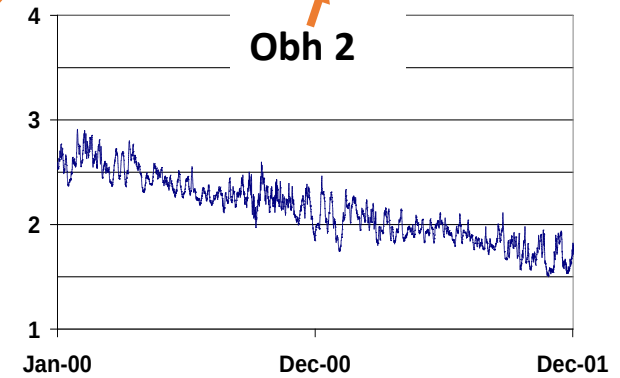


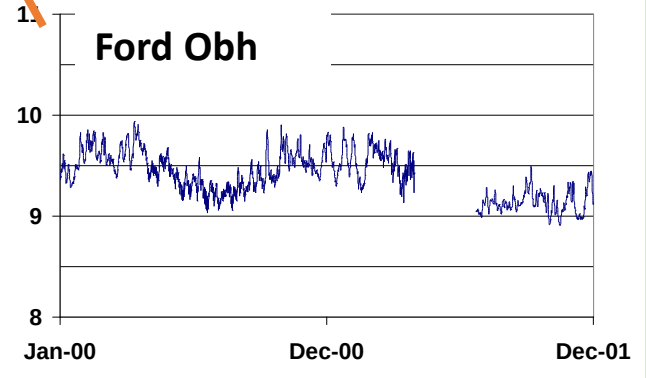


2 year Operational Pumping Test (under TLL)

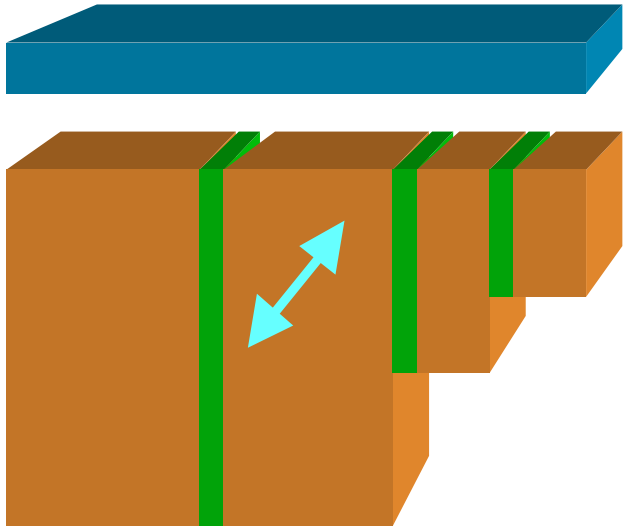


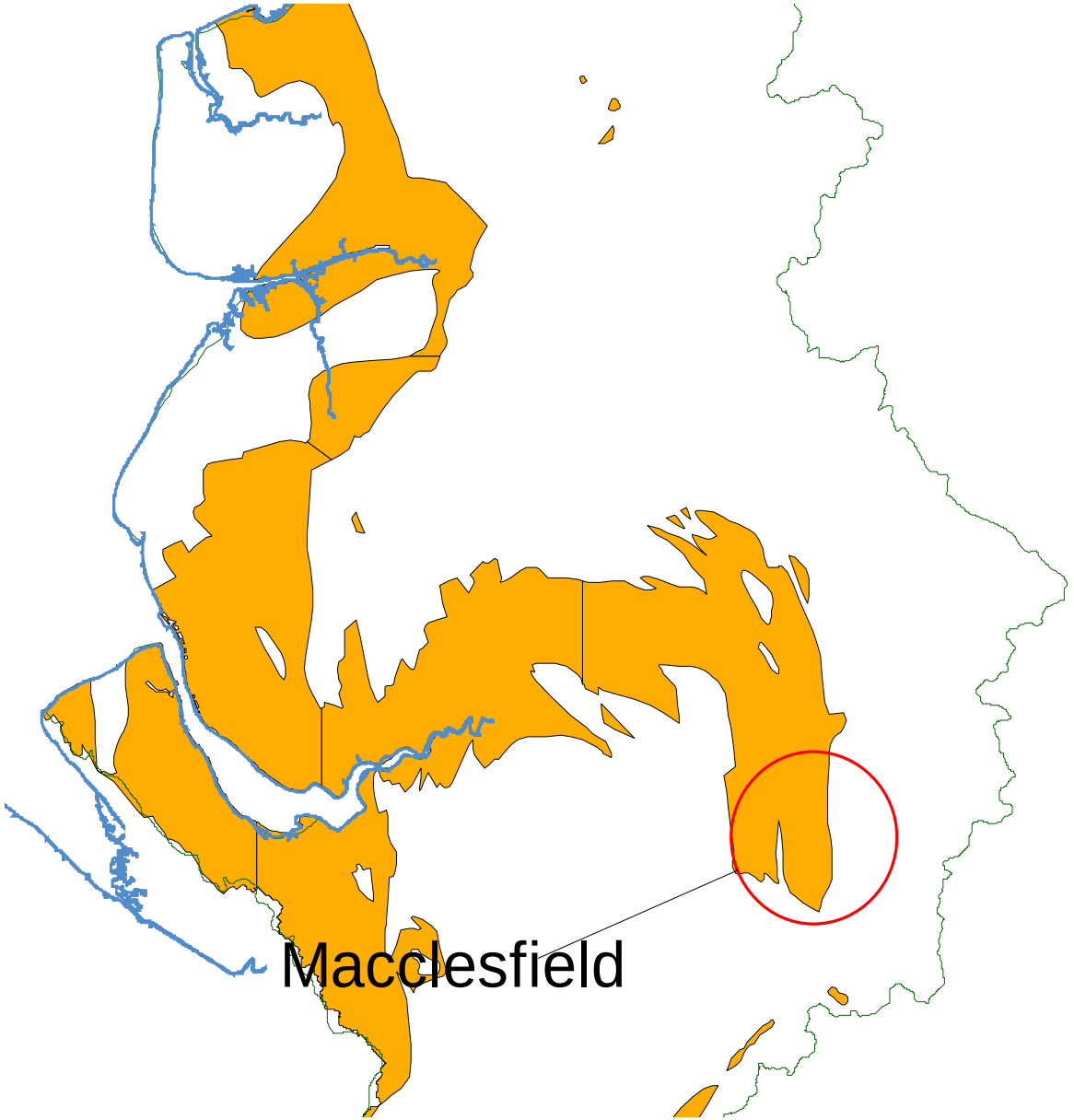






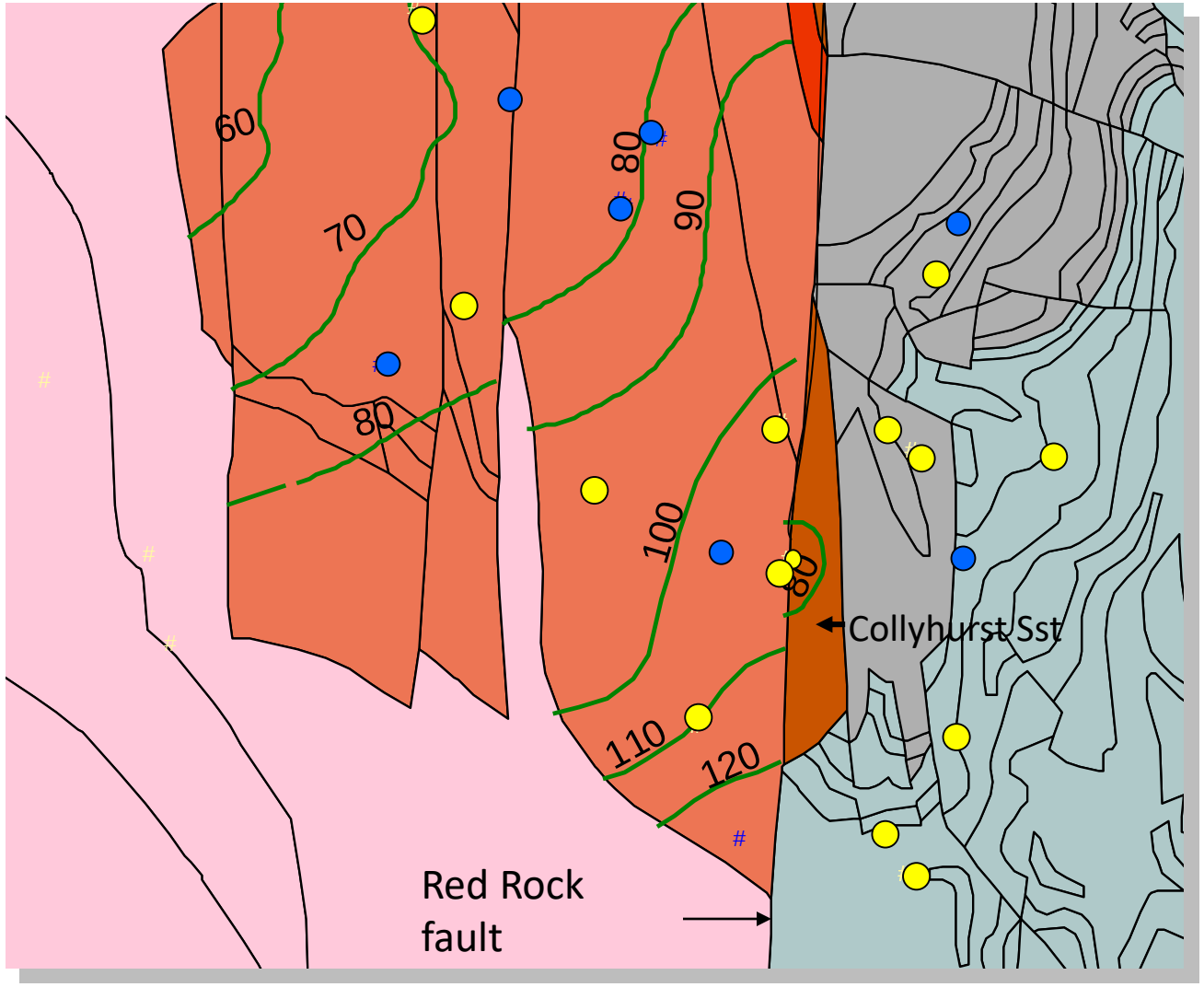
Speke - Summary





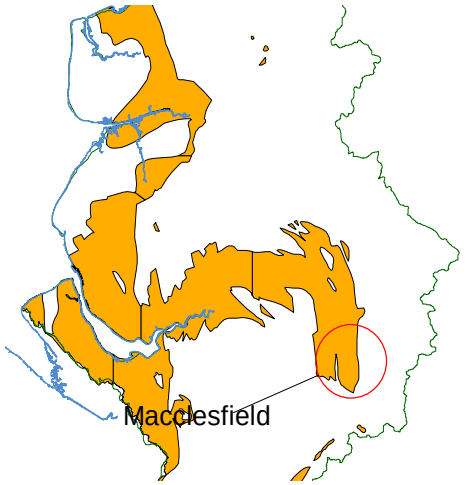
Macclesfield

Macclesfield
Geology & GW levels (2000)

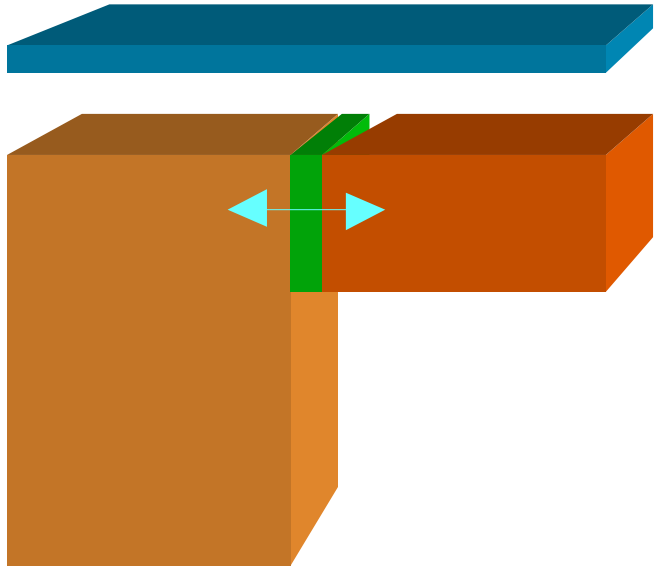


PWS Abhs

Industrial Abhs

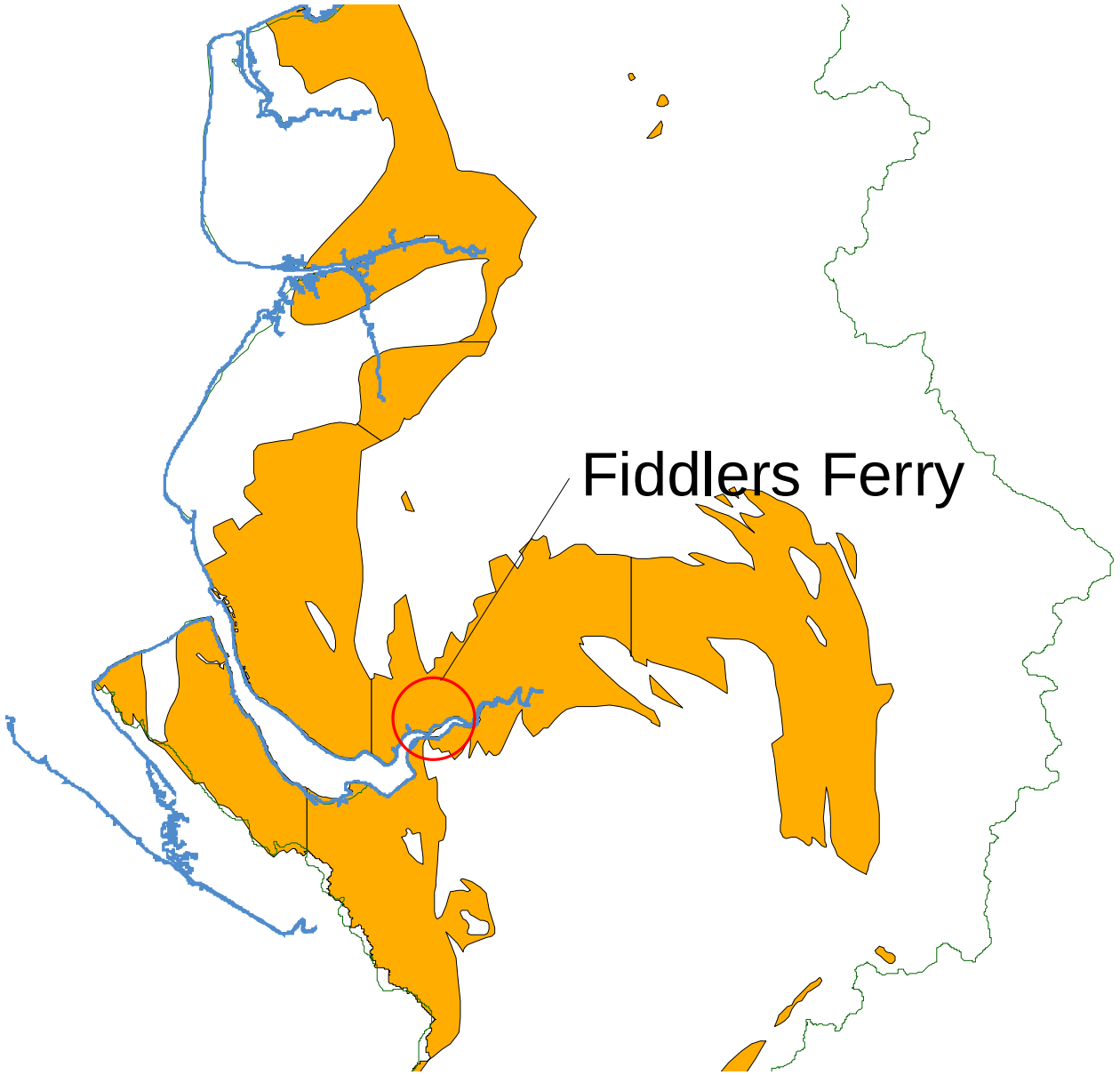


Macclesfield - Summary



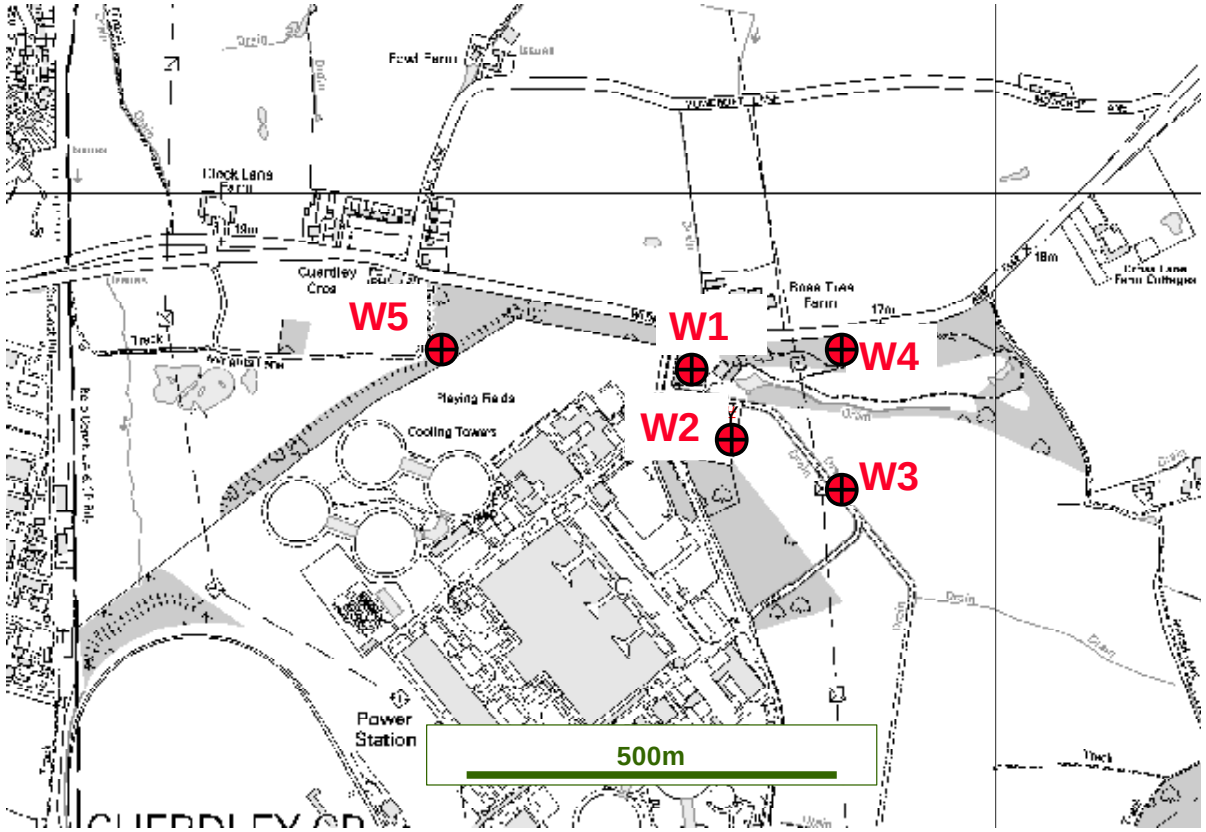
Fiddlers Ferry

Power Station



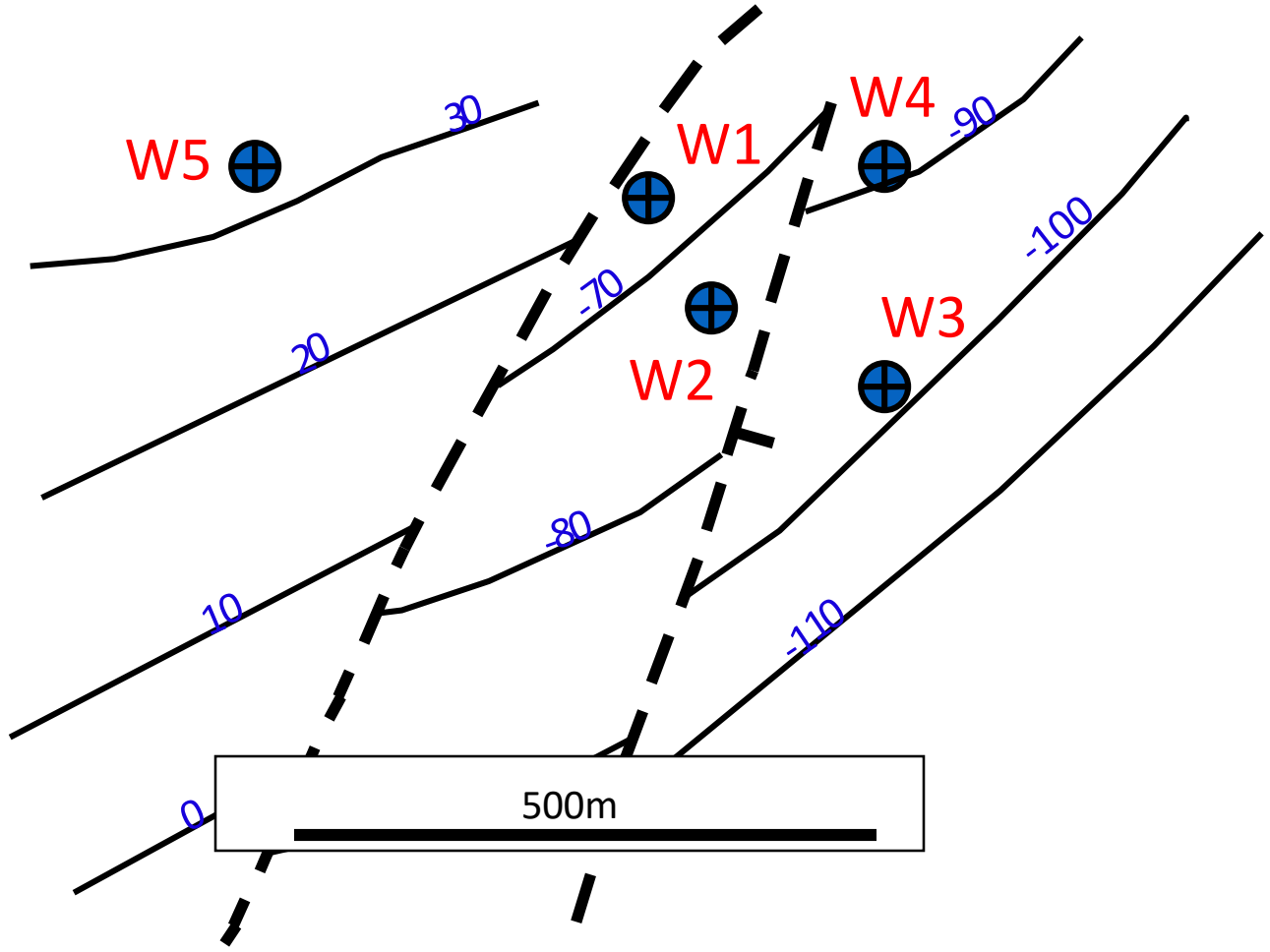
Fiddlers Ferry

- Power station
- Independent water supply
- Investigations 1984
- 5 trial bhs

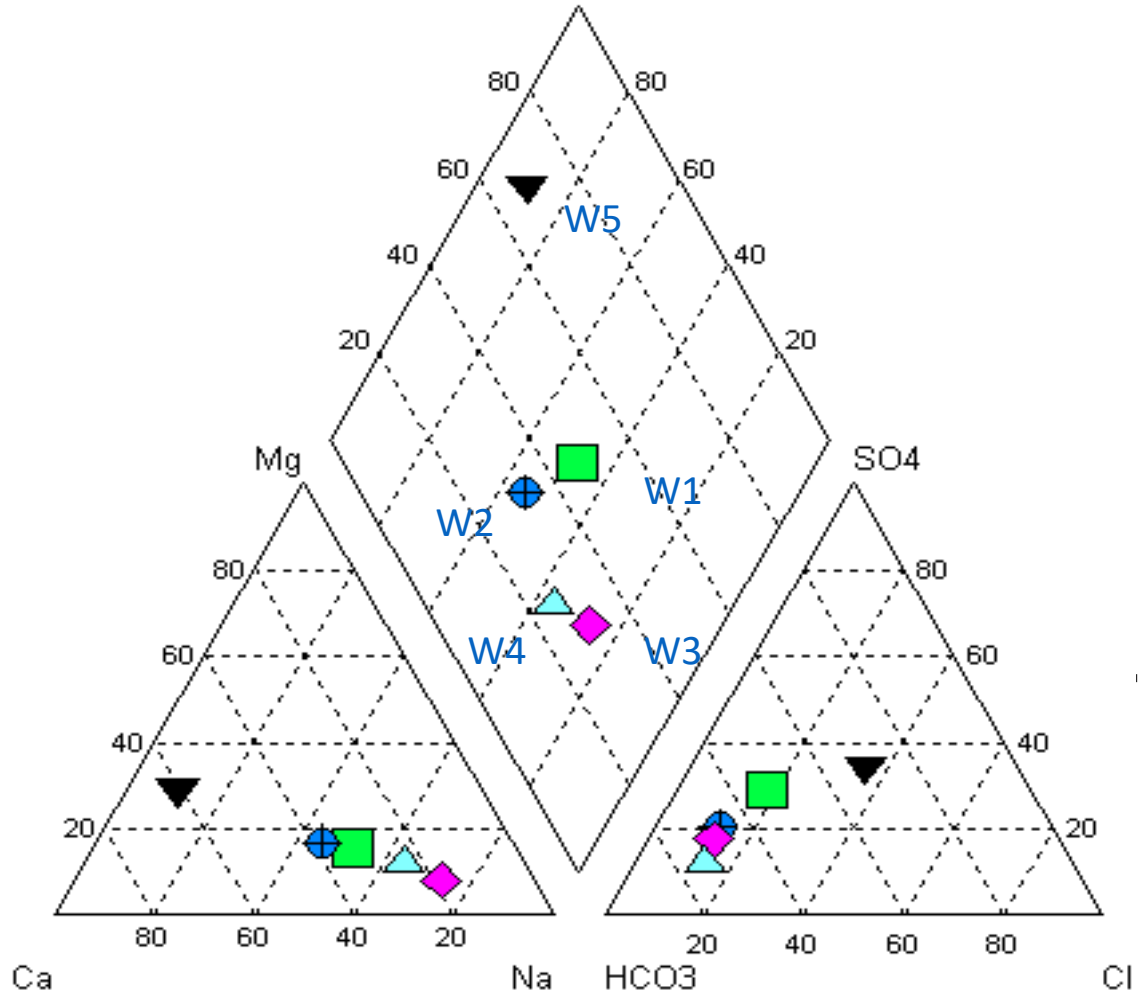


Fiddlers Ferry - Water Levels mAOD (1984)

Fiddlers Ferry - Transmissivity (m2/d)

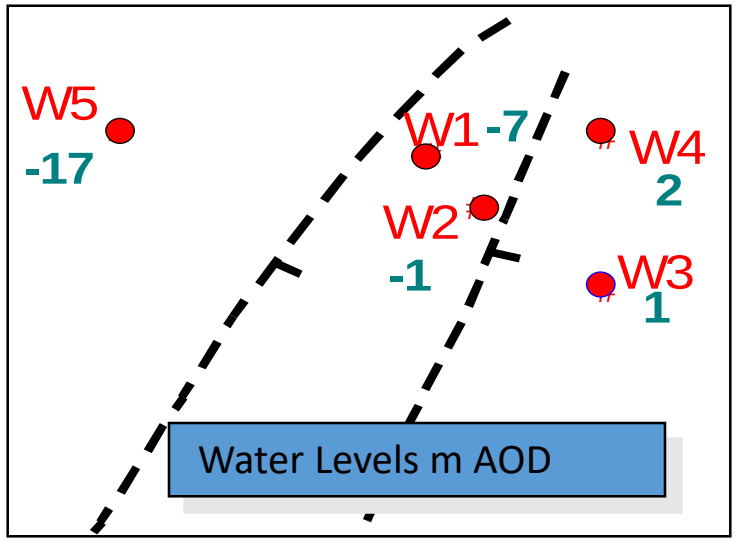


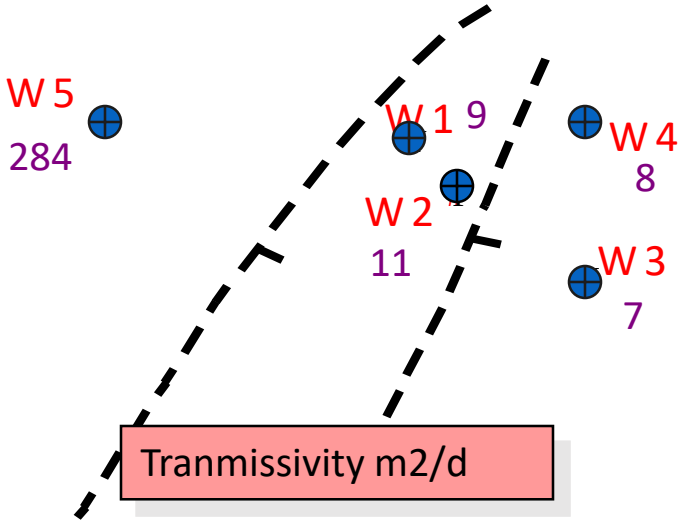
Fiddlers Ferry - Structure (base Wilmslow Sst)

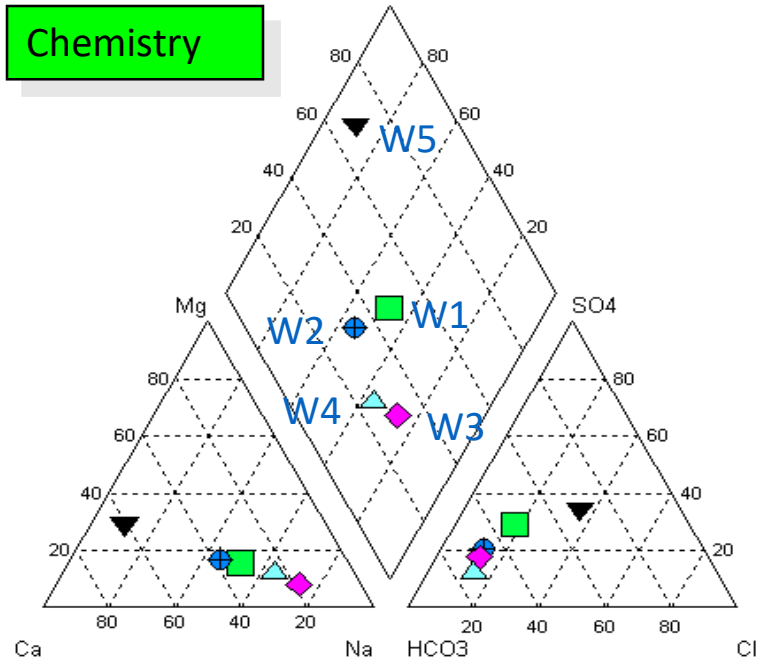


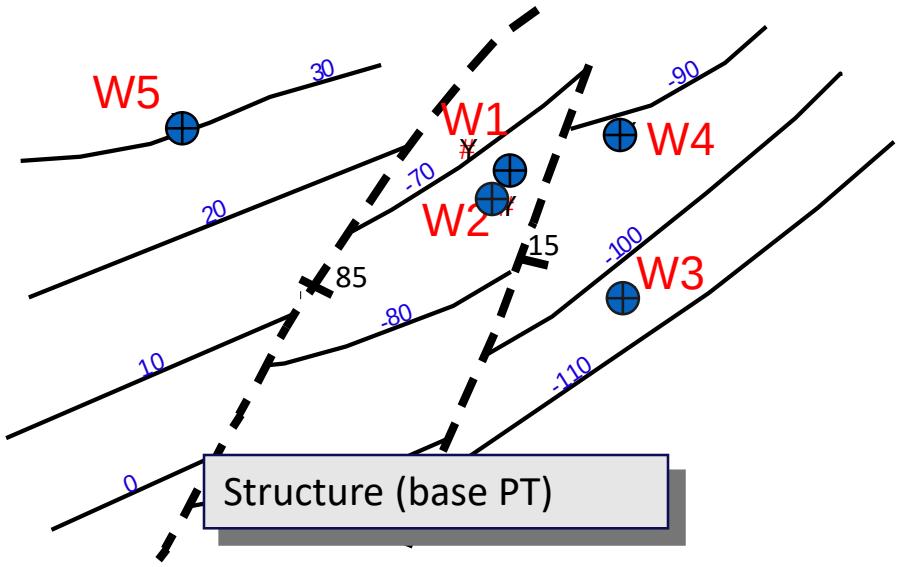
Fiddlers Ferry -

Major Ion Chemistry

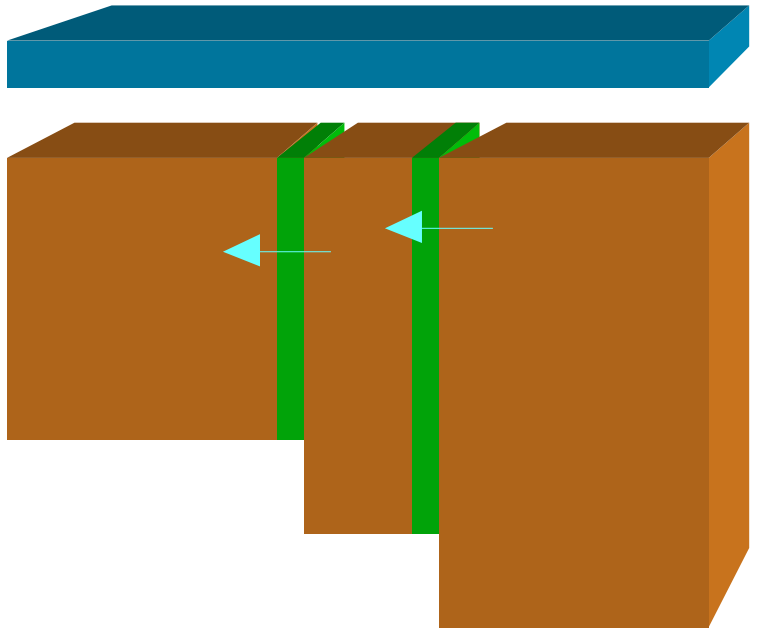

W5
-17
W1 -7
W4
2
W2
-1
W3
1
Water Levels m AOD


W 5
284
W 1 9
W 4
8
W 2
11
W 3
7
Tranmissivity m2/d


Chemistry
W5
W1
W2
W4
W3
Mg
SO4
Ca
Na
HCO3
Cl
80
60
40
20


W5
W1
W4
W2
W3
30
20
10
0
-70
-80
-90
-100
-110
85
15
Structure (base PT)

Fiddlers Ferry - summary

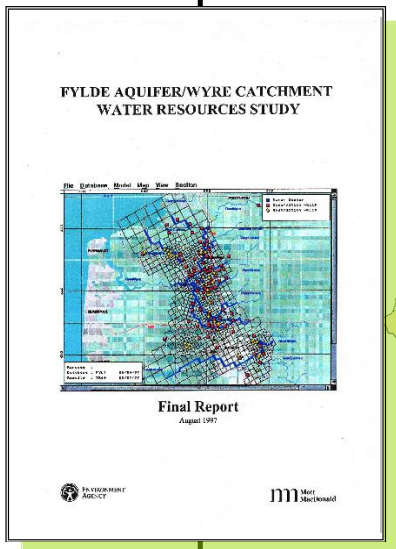


Recent groundwater resources investigations (modelling studies)

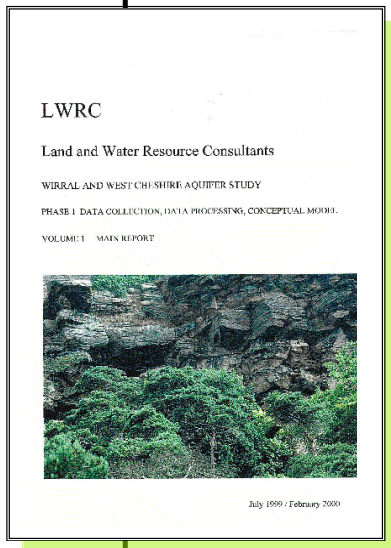
NW Region

Groundwater Resource Investigations

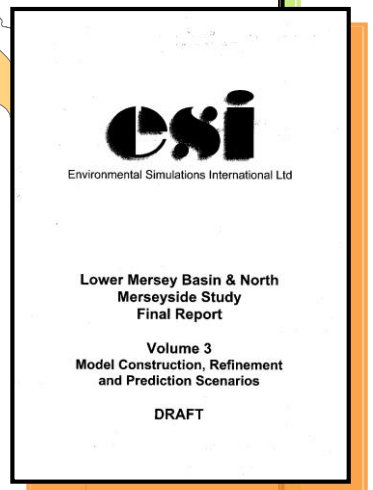
1997



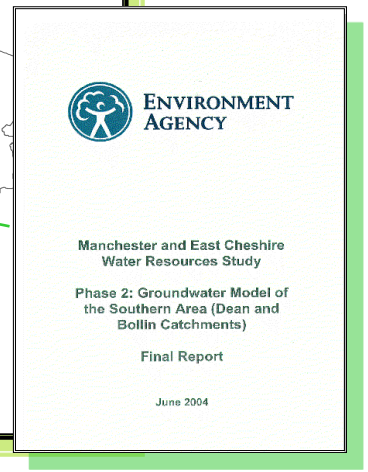
2000



2007

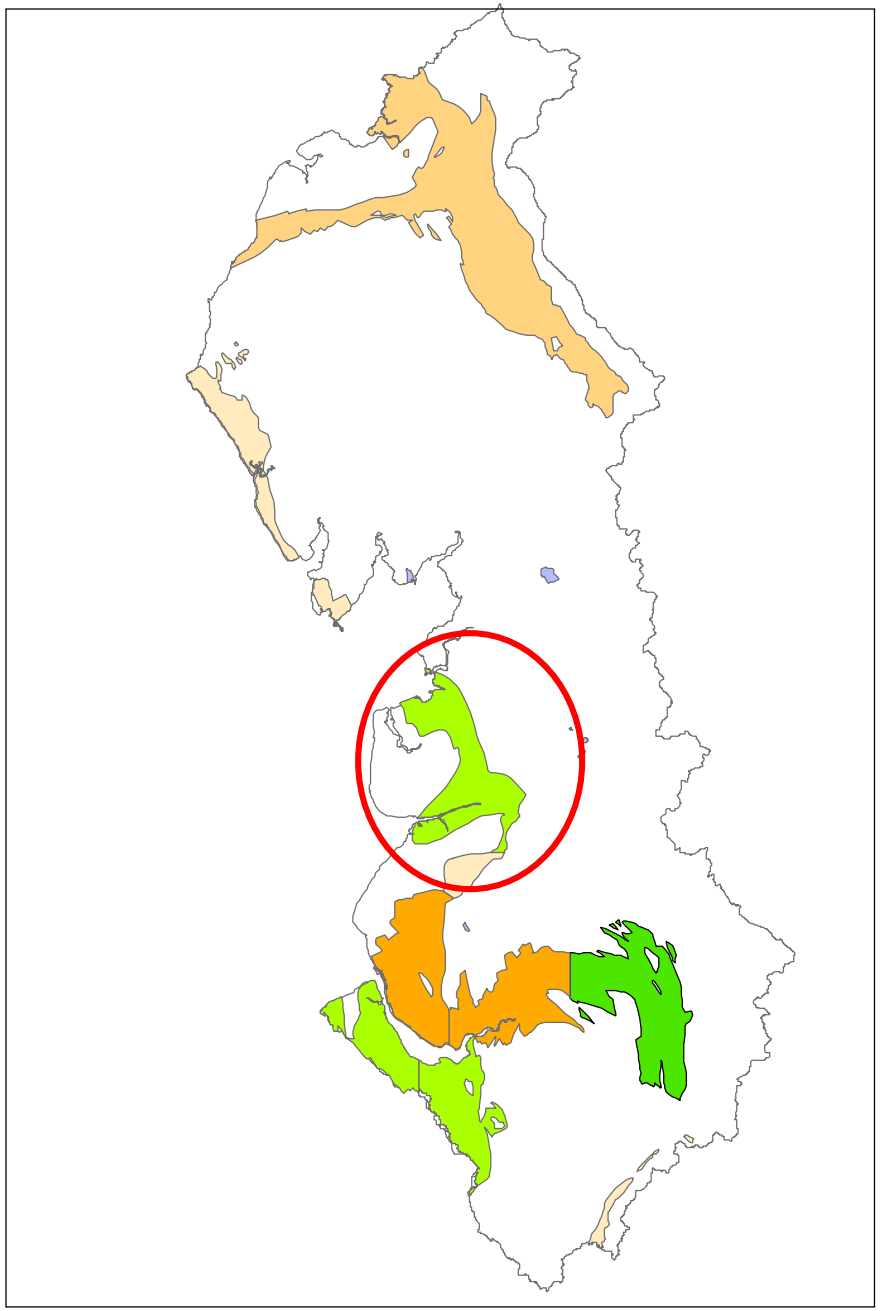


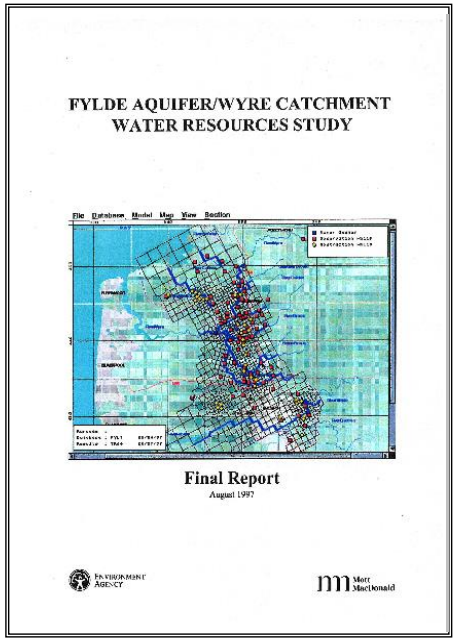
2004



Fylde

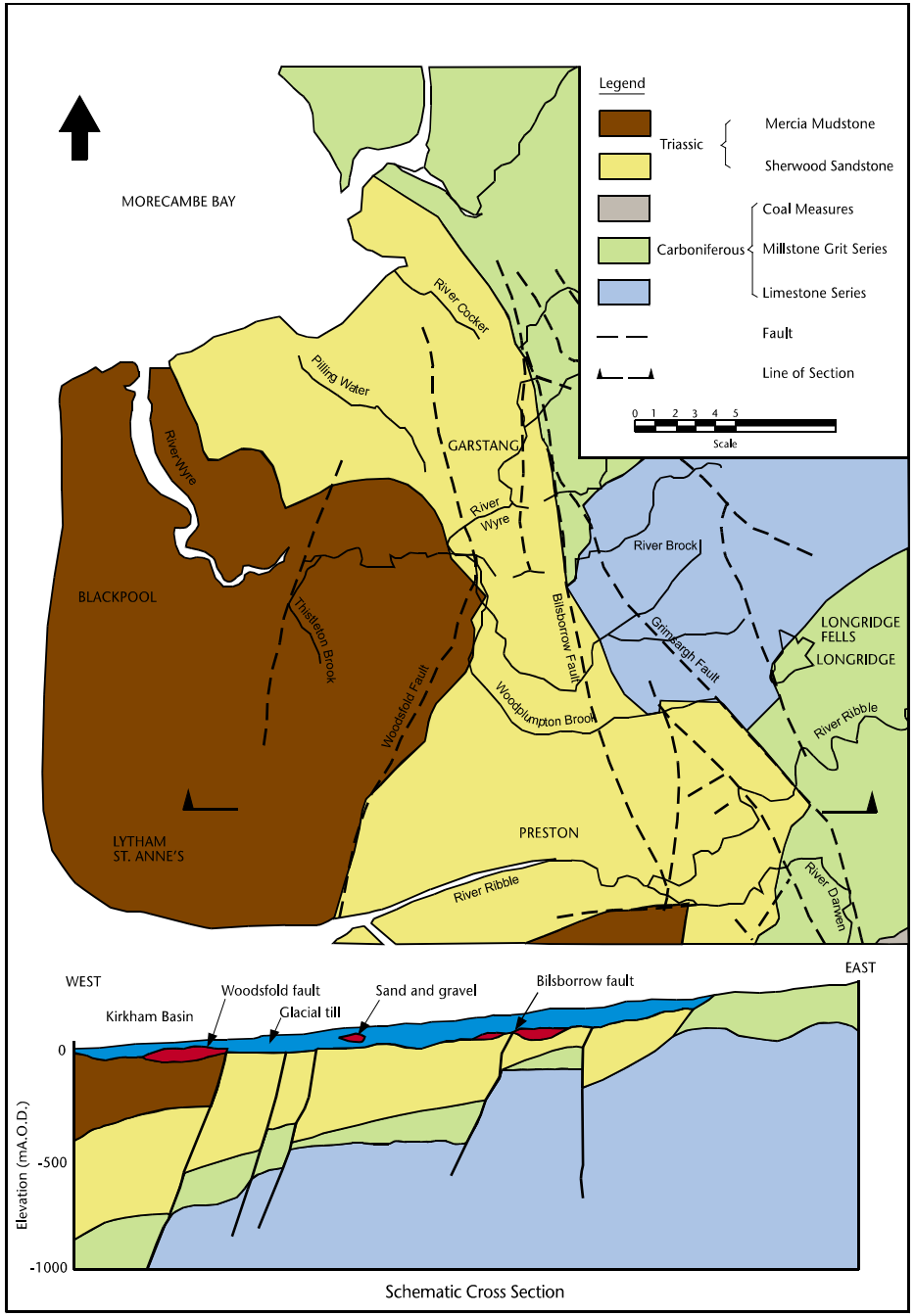
Aquifer





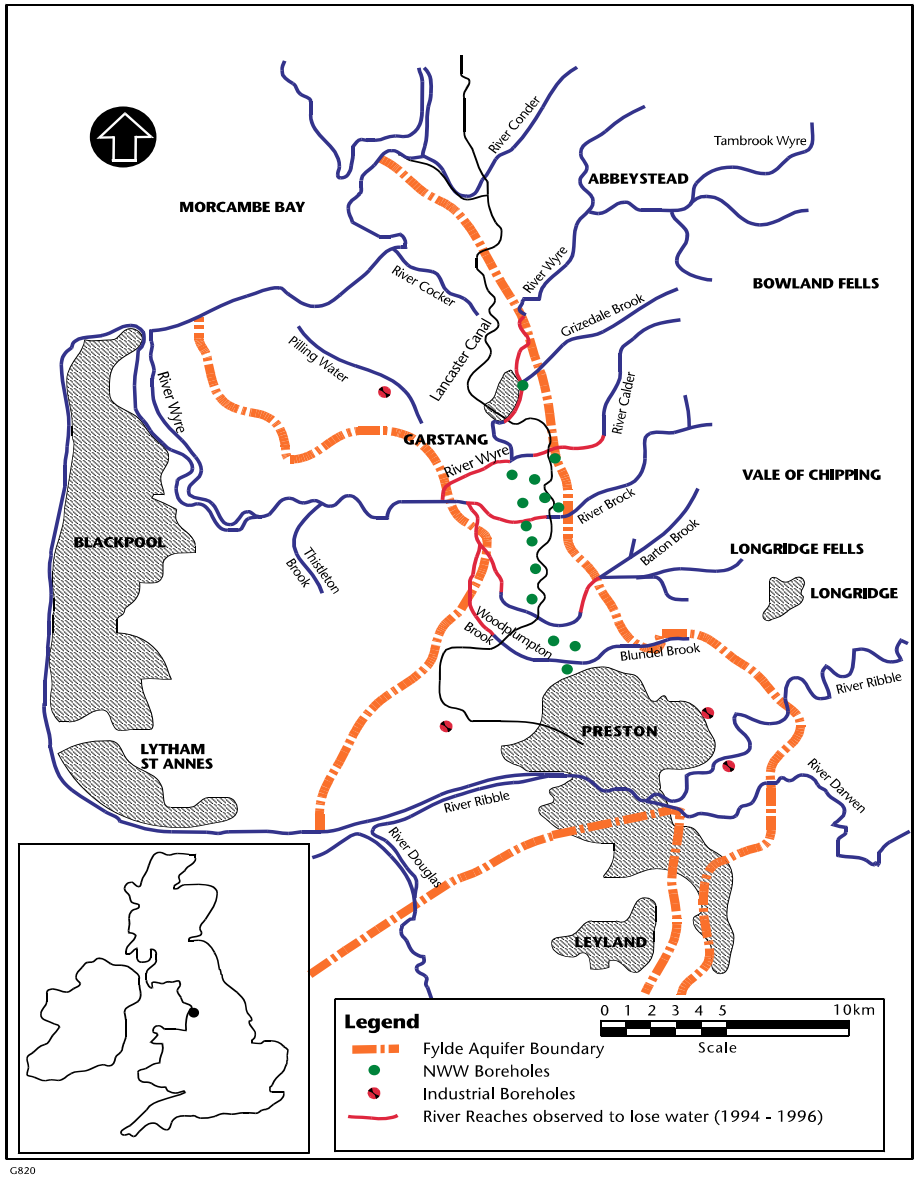
Fylde Aquifer

Geology

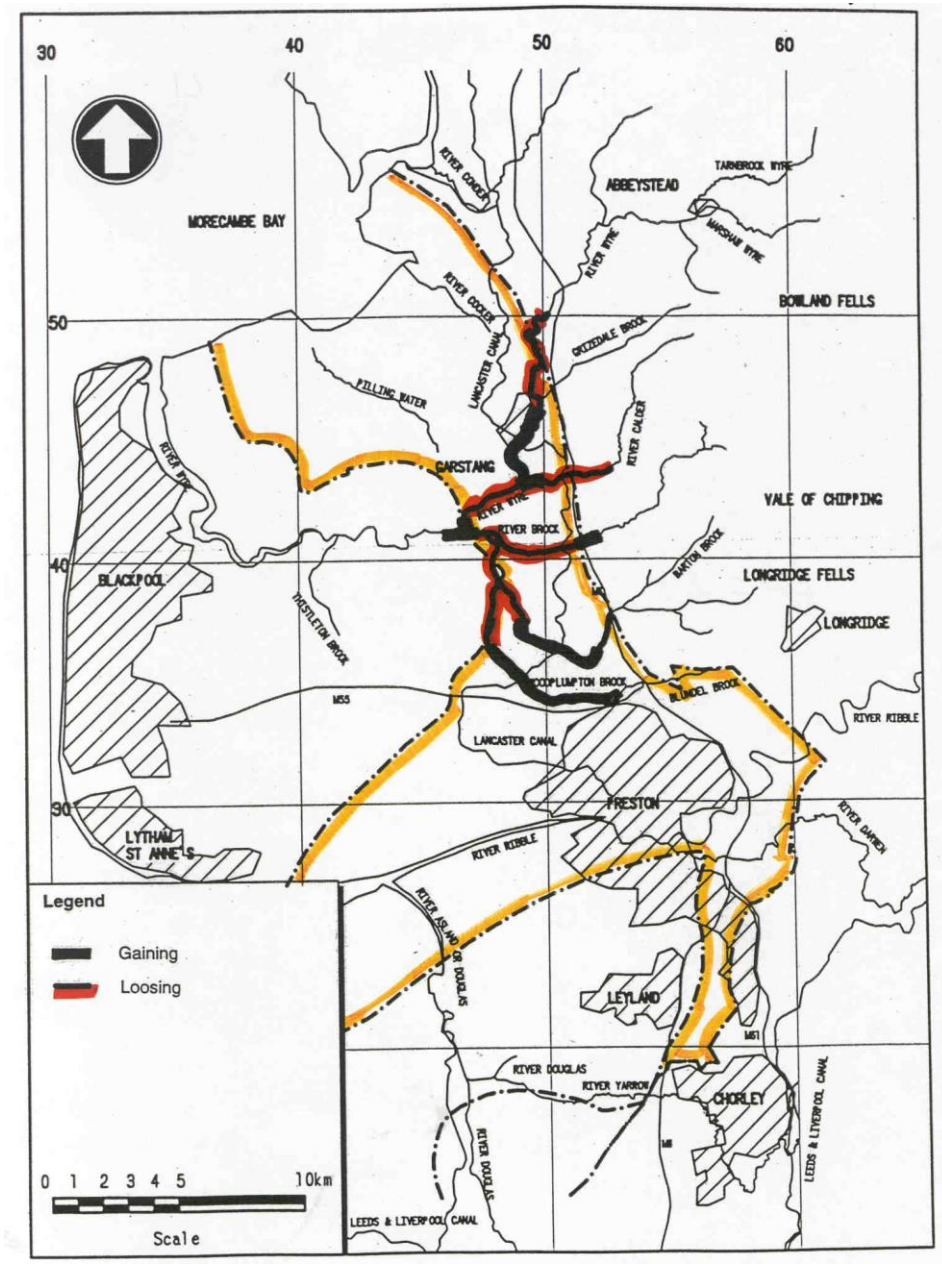


Fylde Aquifer

- Abstractions
  - Industrial
  - PWS
- LCUS
  - seasonal abstraction
  - detailed investigations
  - 30 years operation



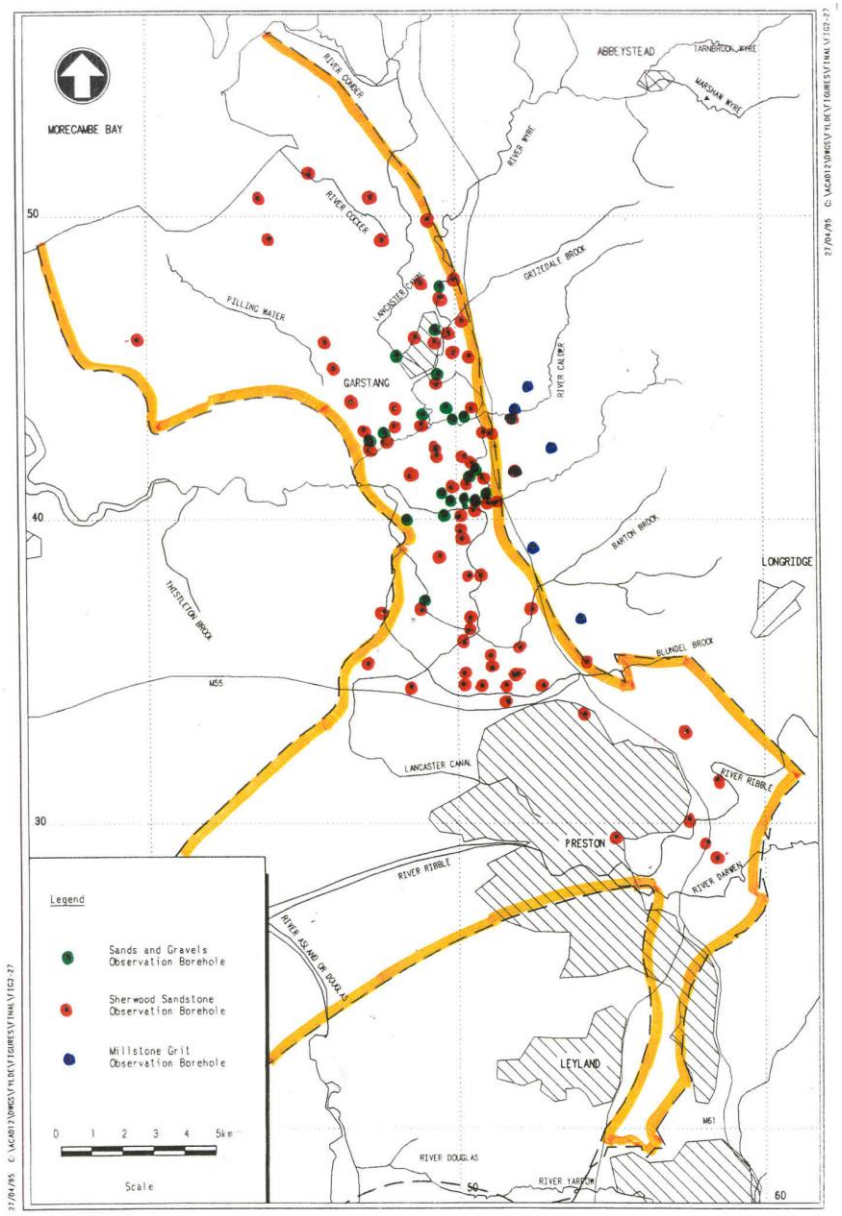
Gaining/Losing River Reaches - July 1994



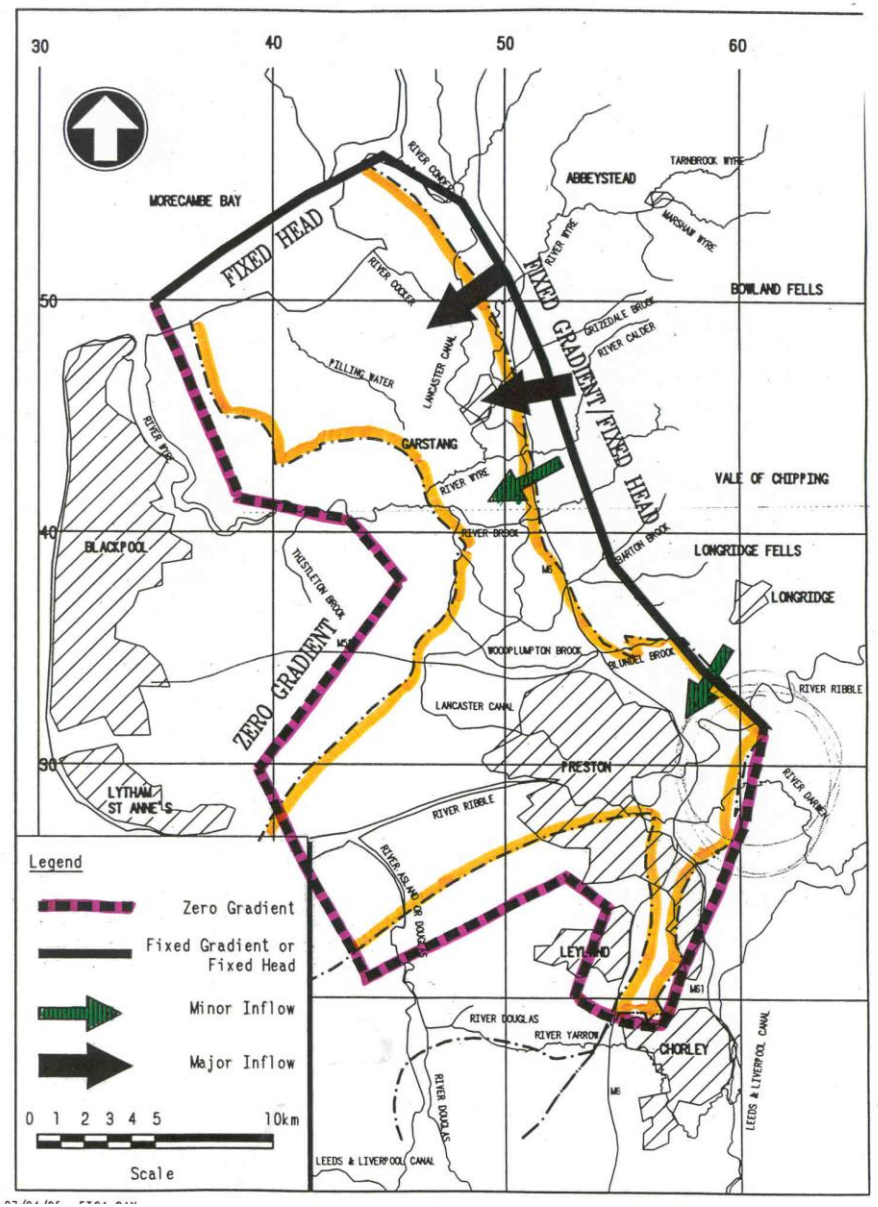
Fylde Aquifer/Wyre Catchment Water Resources Study

- Why?
  - sustainability of licence
  - impact on rivers
- How:
  - data review,conceptual & numerical model
- Who?
  - EA, United Utilities, Mott MacDonald, Ken Rushton

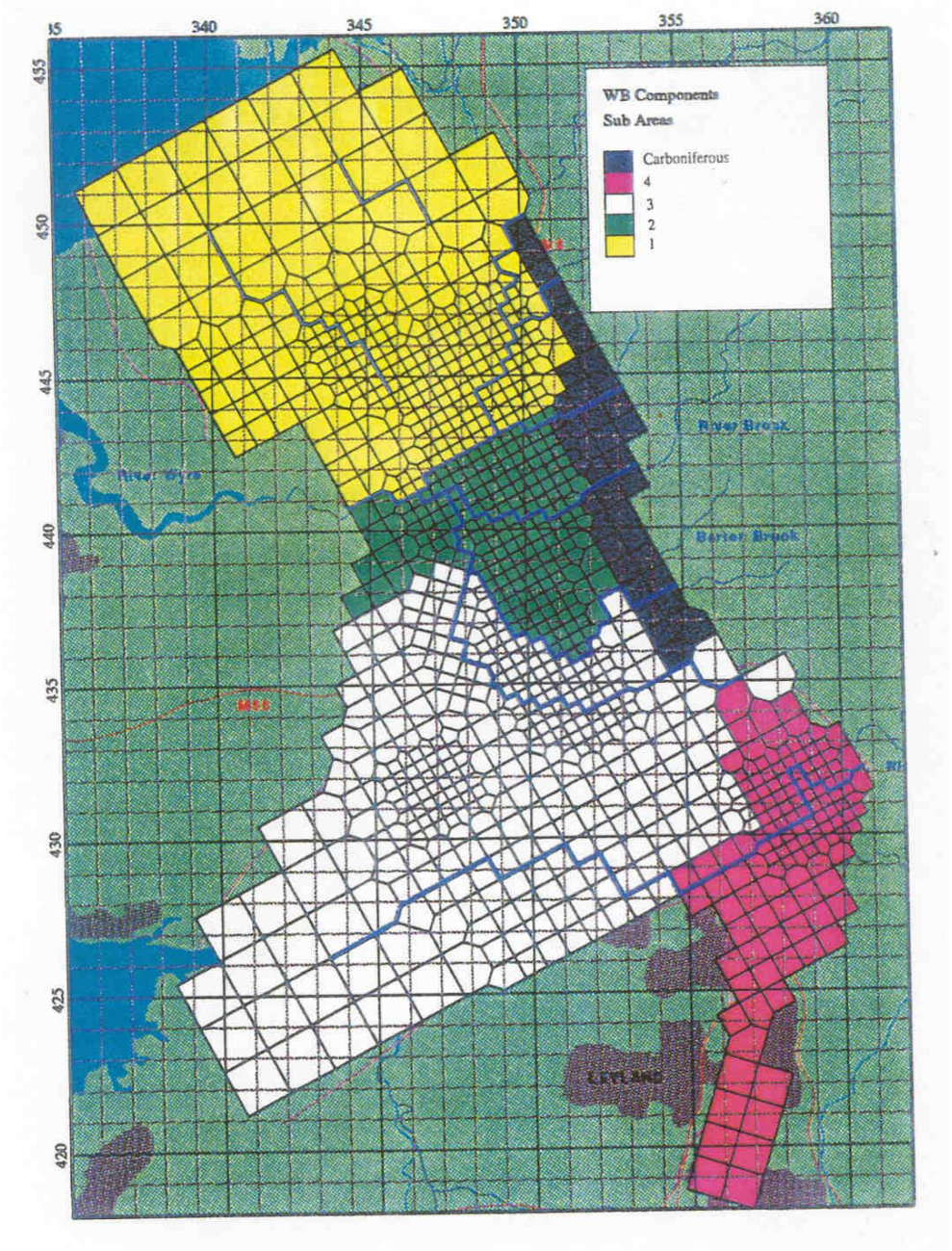
Location of Observation Boreholes



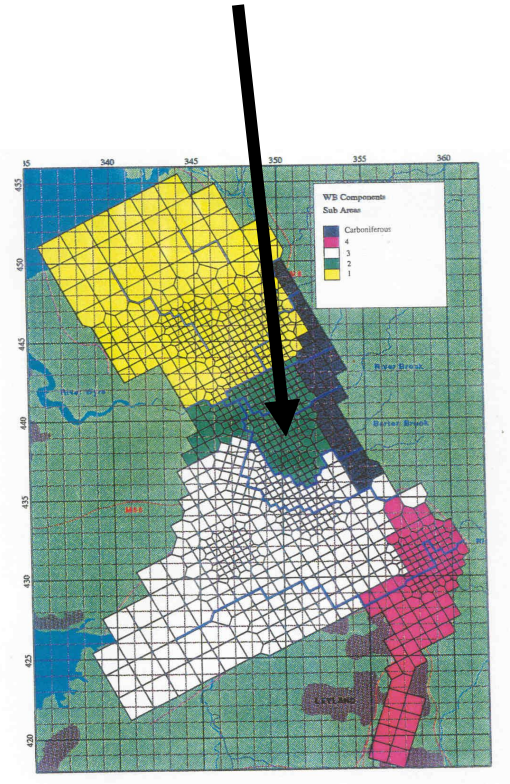
Model Extent
and
Boundary Conditions

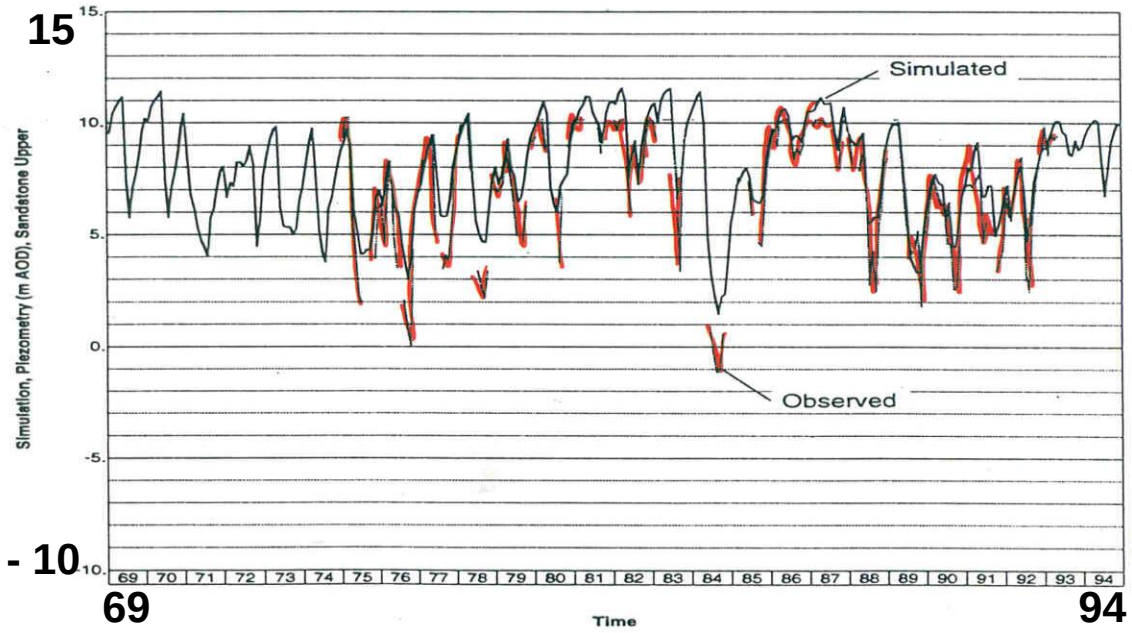


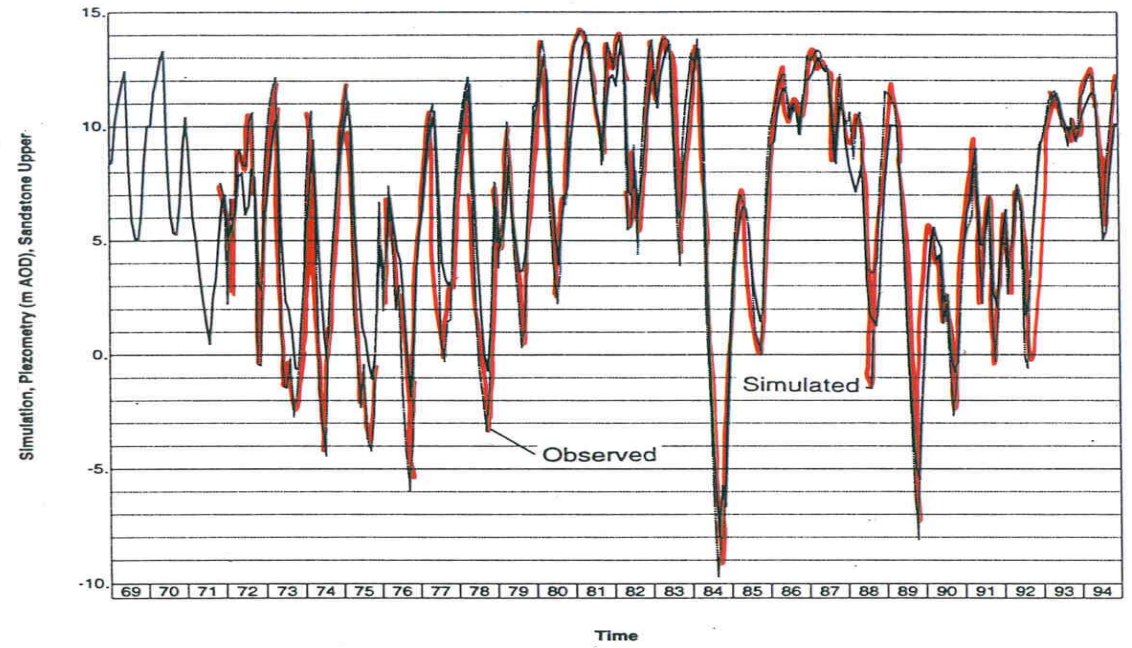
Sub Areas of the Model



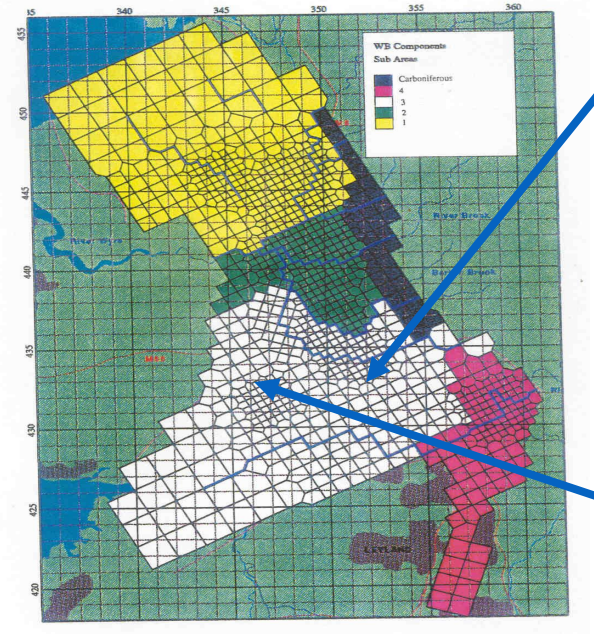
Calibration: Simulated Groundwater Levels in the Central Area

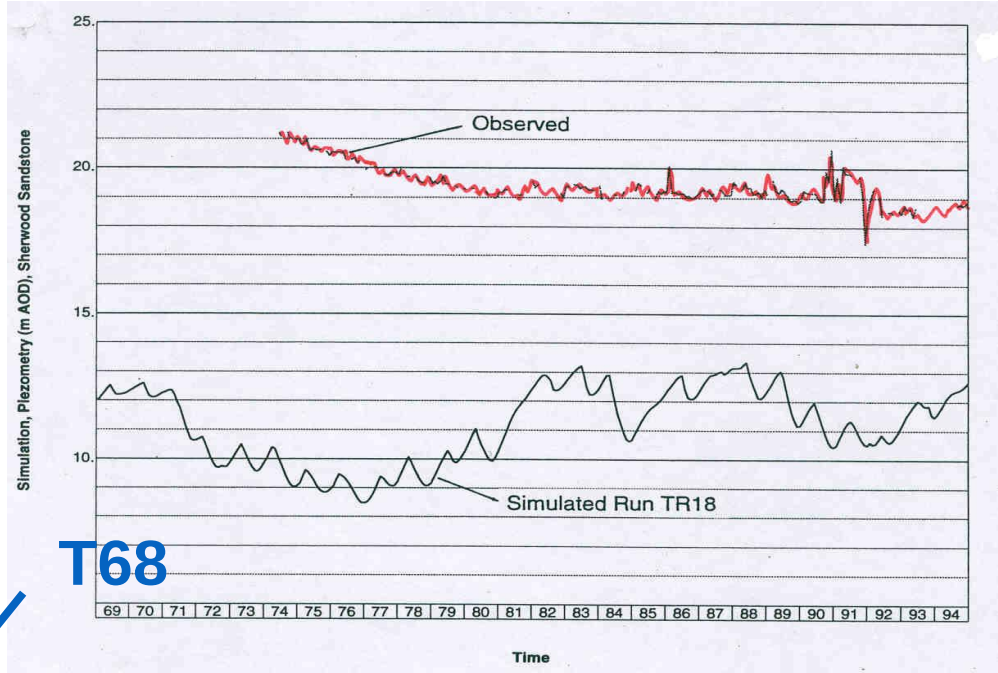


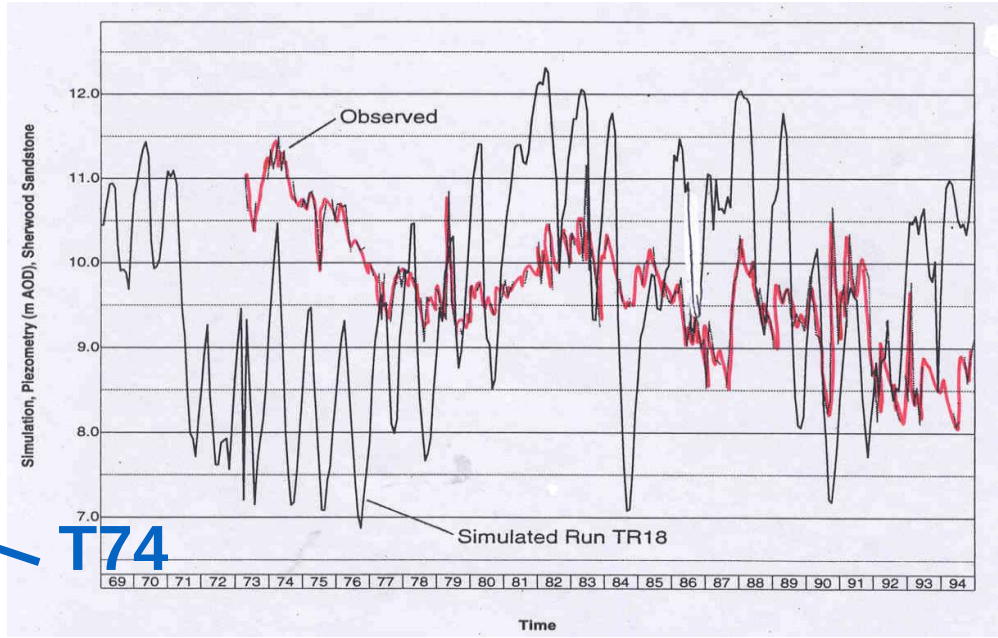




Early Simulations - Southern area

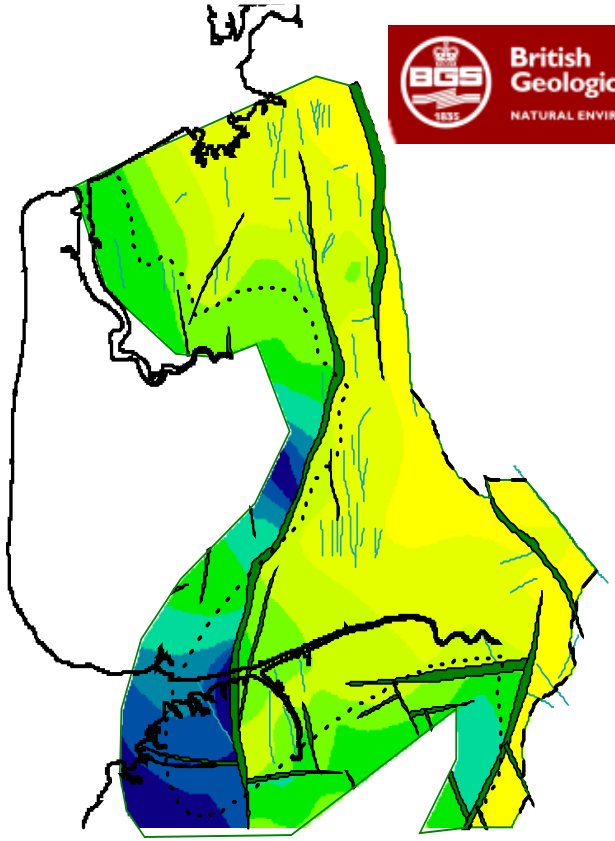




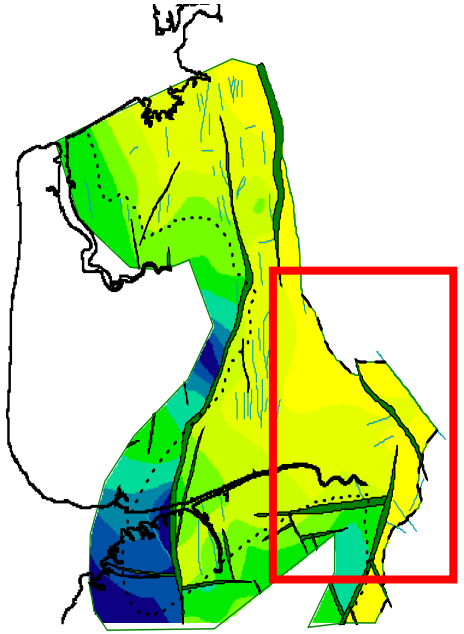


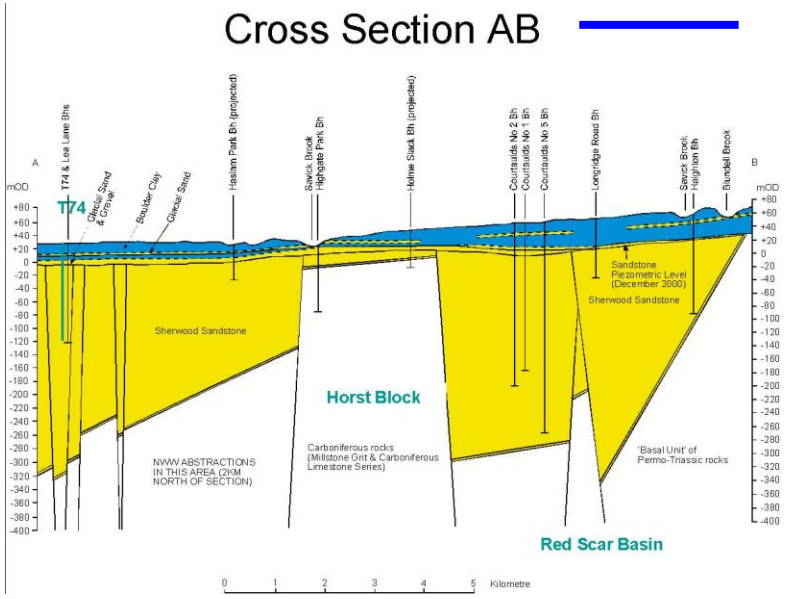
Fylde Aquifer/Wyre Catchment Water Resources Study

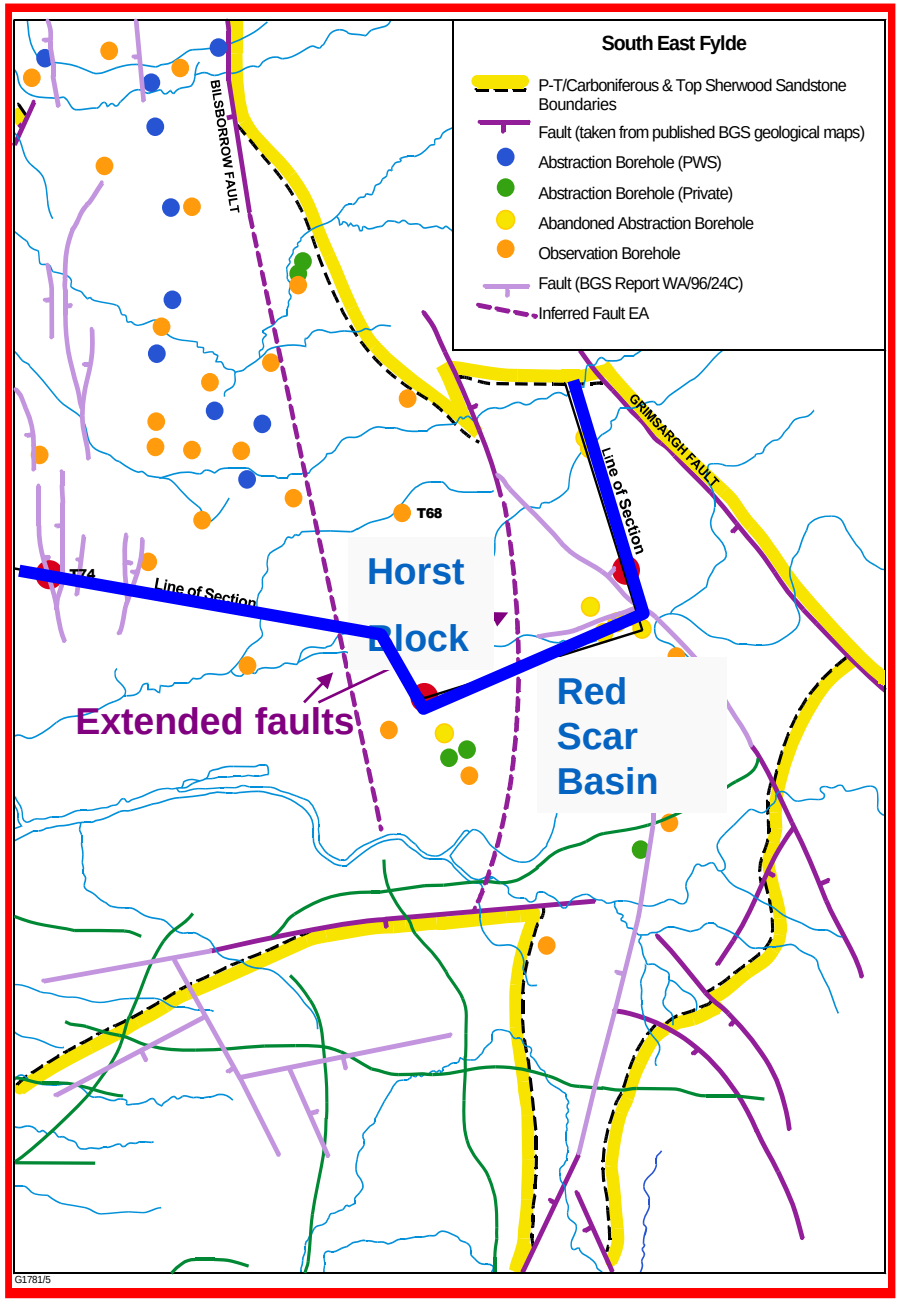
- Reconceptualisation
  - time for a rethink!:
- Structural controls?



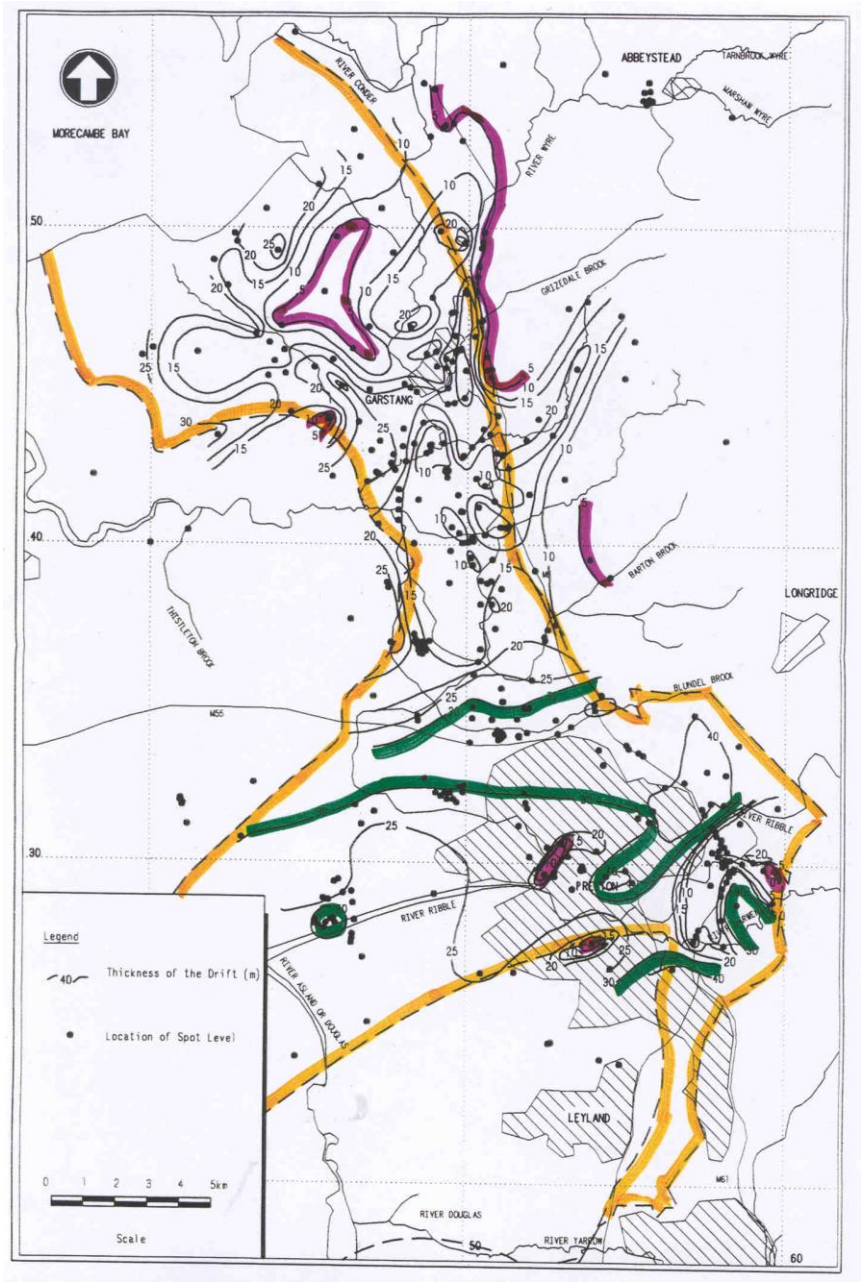
British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL



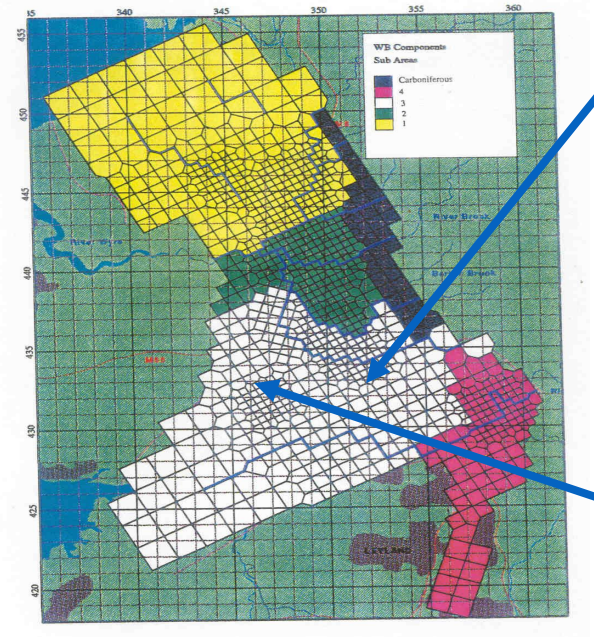

Cross Section AB
A
B
mOD
T74
Sherwood Sandstone
Horst Block
Red Scar Basin
Carboniferous rocks (Millstone Grit & Carboniferous Limestone Series)
'Basal Unit' of Permo-Triassic rocks
Sandstone Piezometric Level (December 2000)
NWW ABSTRACTIONS IN THIS AREA (2KM NORTH OF SECTION)
Kilometre

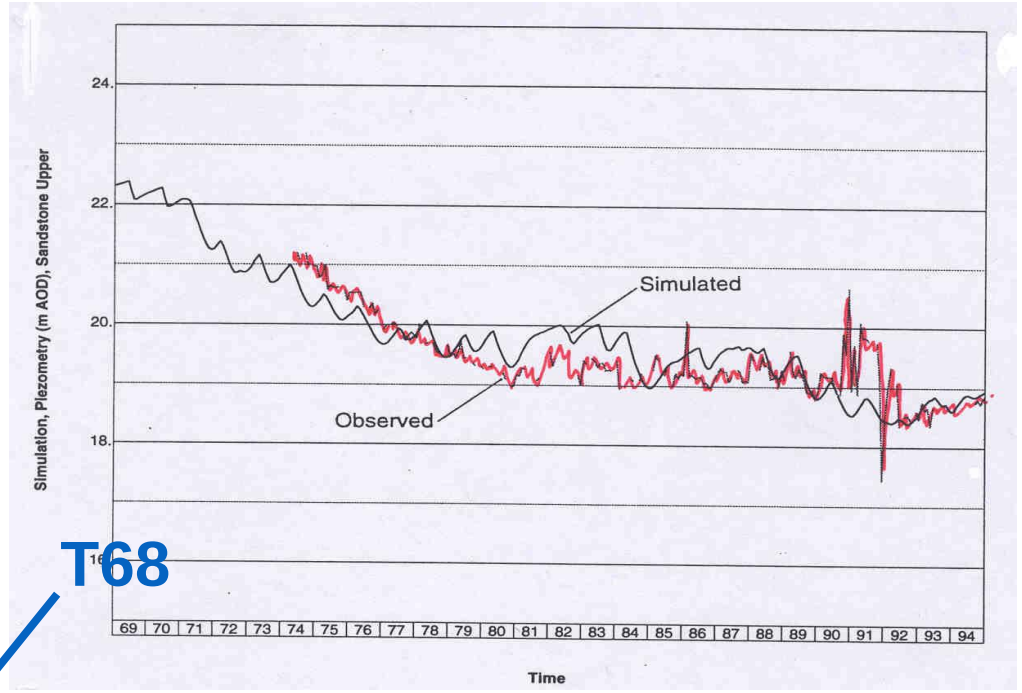

South East Fylde
P-T/Carboniferous & Top Sherwood Sandstone Boundaries
Fault (taken from published BGS geological maps)
Abstraction Borehole (PWS)
Abstraction Borehole (Private)
Abandoned Abstraction Borehole
Observation Borehole
Fault (BGS Report WA/96/24C)
Inferred Fault EA
BILSBORROW FAULT
GRIMSARGH FAULT
Line of Section
T68
T74
Horst Block
Red Scar Basin
Extended faults
G1781/5

Thickness of Drift

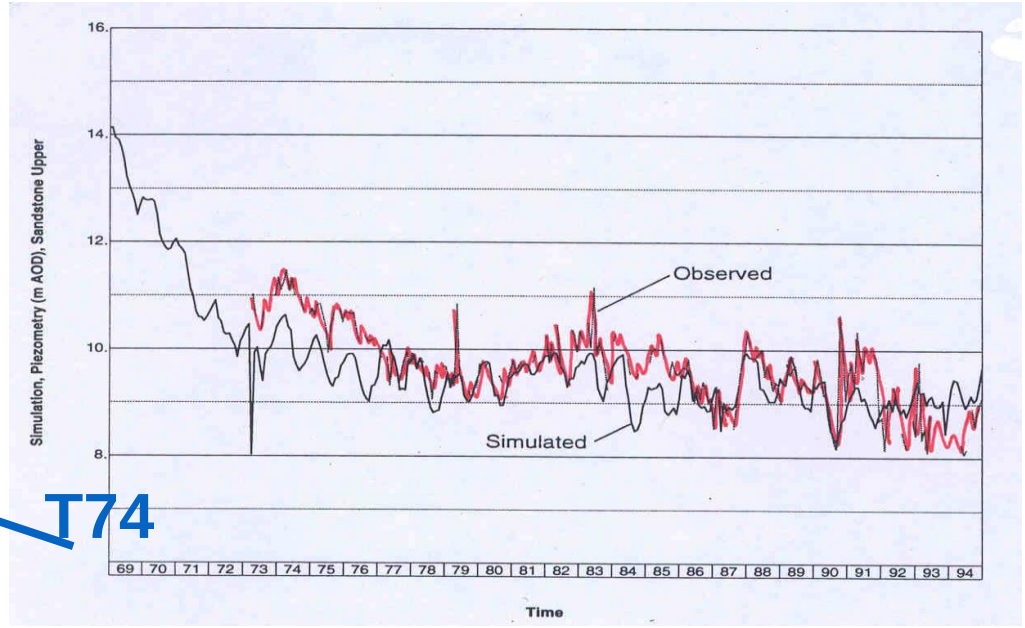


Final Calibration: - Southern area



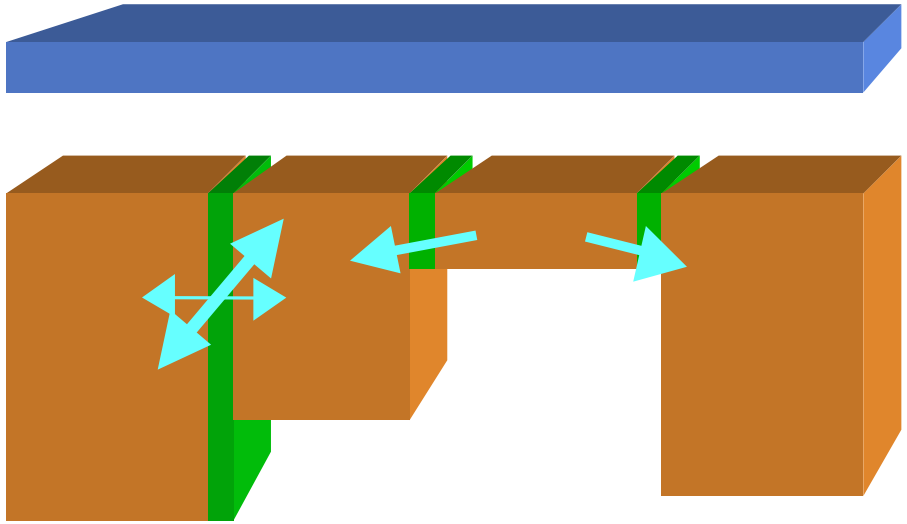


T68



T74

Fylde - Summary:



the importance of the conceptual model

the Fylde