

EMS717U/EMS717P

Renewable Energy Sources

Ground Source Energy

Prof. Hua Sheng Wang

Content

- Origin, characteristics & potential of geothermal energy
- How to extract geothermal energy?
- Direct use: open groundwater systems
- Direct use: closed loop systems
- Design and implementation of heat pump system
- Design and implementation of ground heat exchanger
- Assessment of the system performance
- Economic analysis

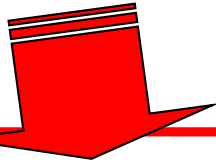
Geothermal Energy

**Geothermal resources can be divided into
3 distinct groups:-**

- High temperature (HT) $>150^{\circ}\text{C}$ for use in electrical power generation
- Intermediate temperature $30 < (\text{IT}) < 150^{\circ}\text{C}$ direct use for heating and hot water provision
- Low temperature (LT) $< 30^{\circ}\text{C}$, for cooling and for use with ground source heat pumps

Geothermal Energy

Most text books discuss these resources only

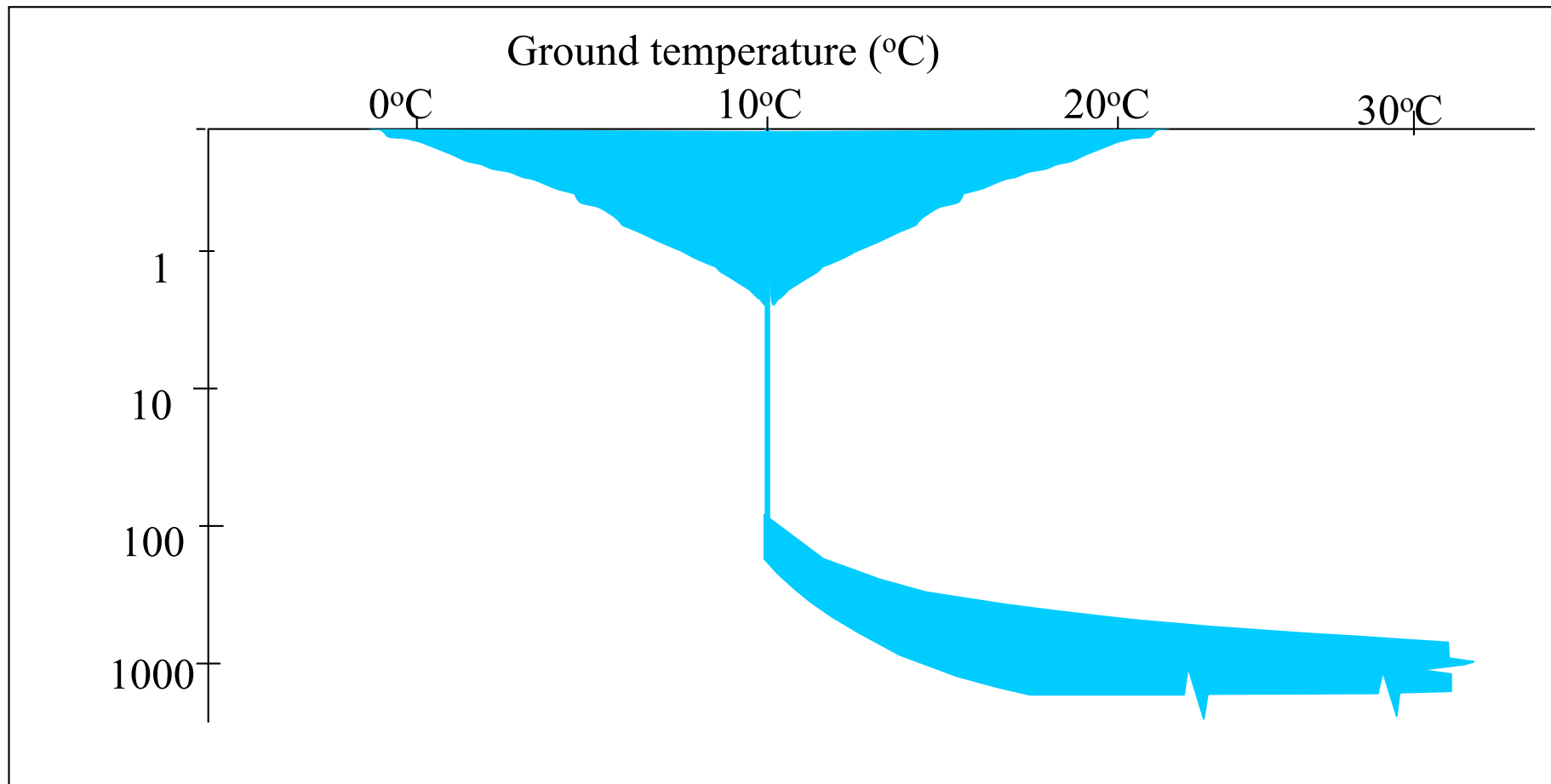


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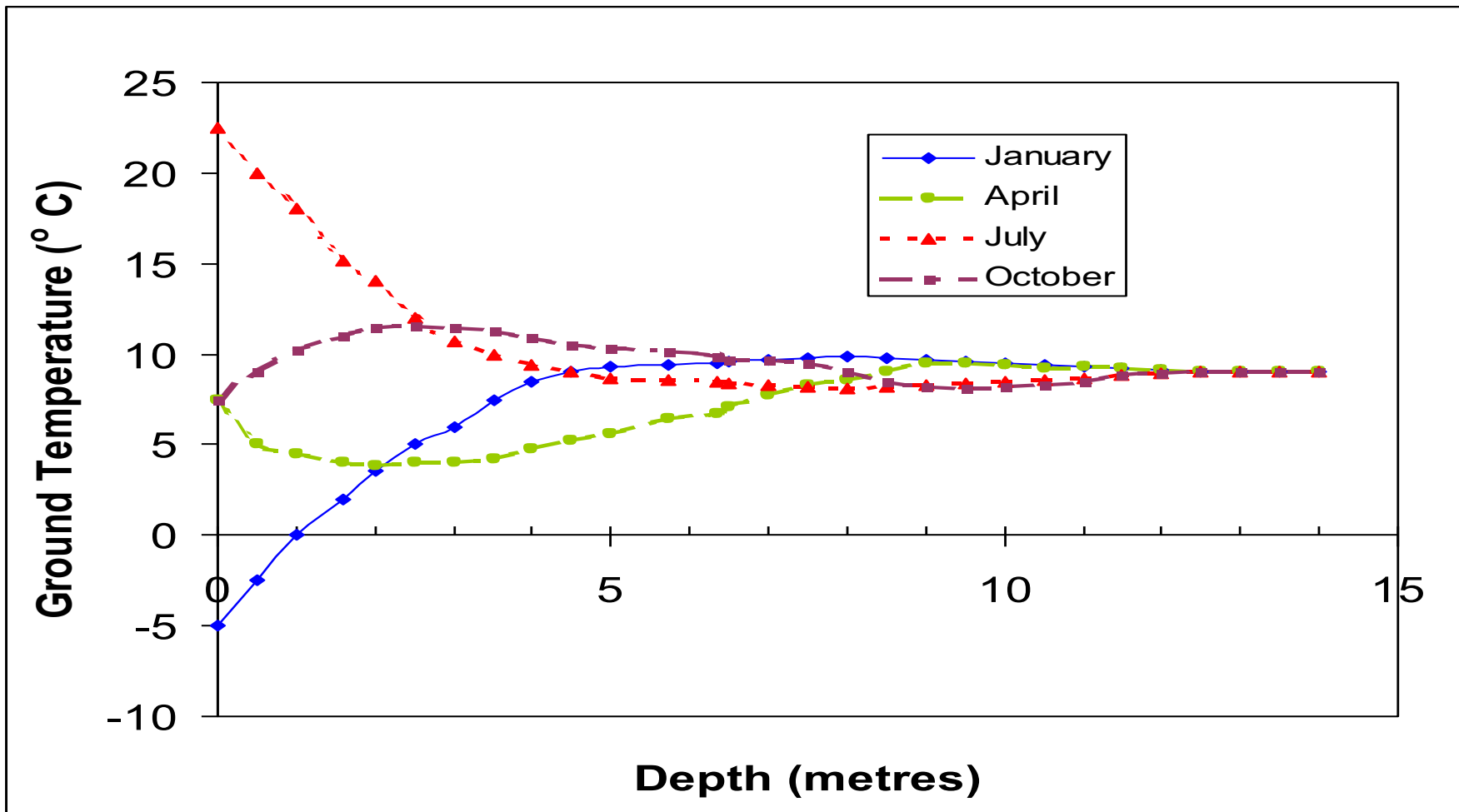
Much less on this

- Low temperature (LT) $< 30^{\circ}\text{C}$, for cooling and for use with ground source heat pumps

Ground temperature vs Depth

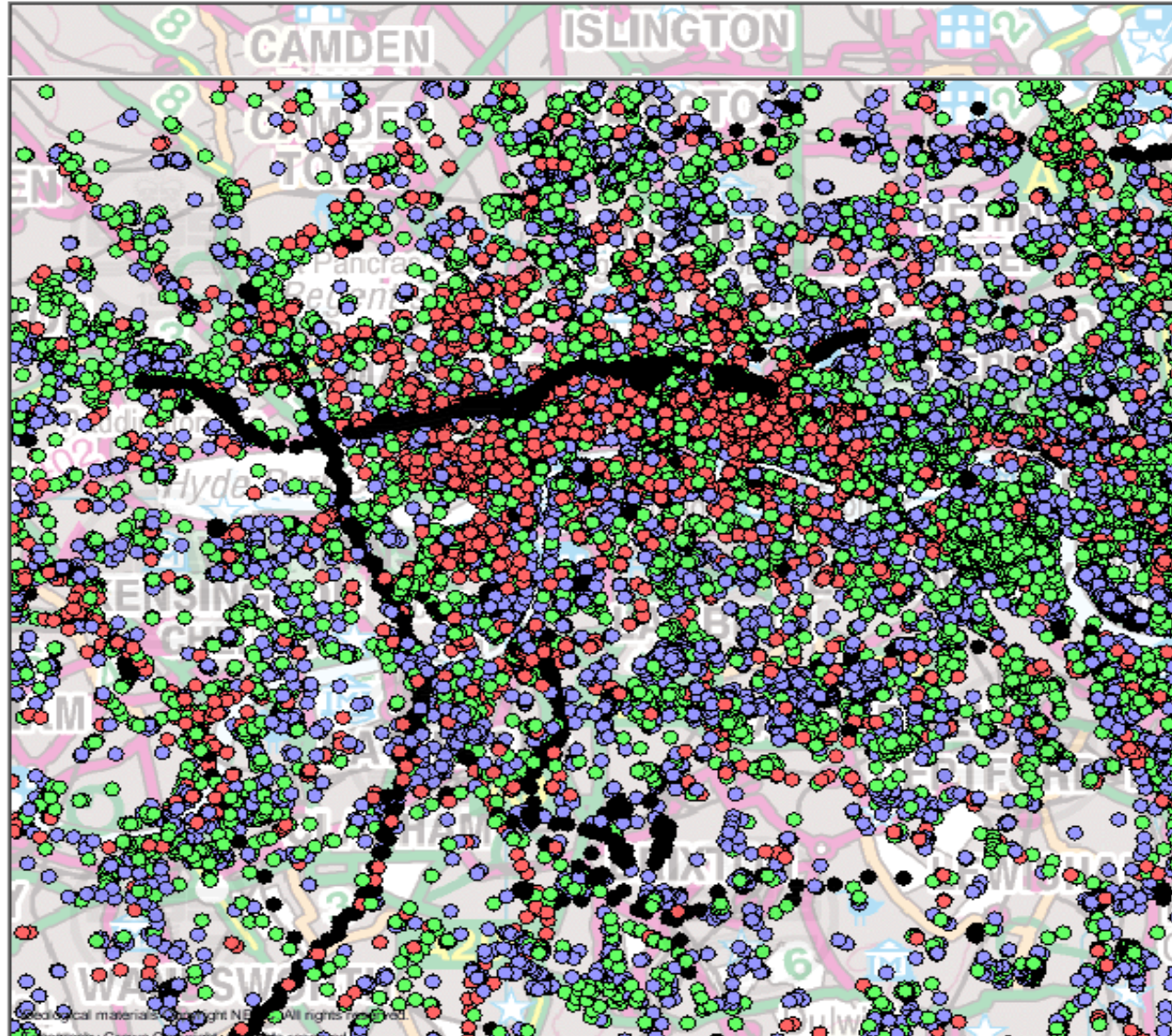


Ground temperature vs Local depth



Ground source data in the UK

- Secret
- <10m
- $10 < \text{depth} < 30 \text{ m}$
- >30m



Types of ground coupled cooling system

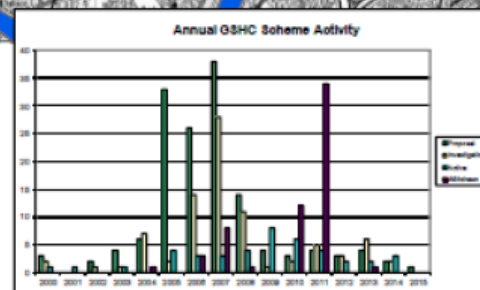
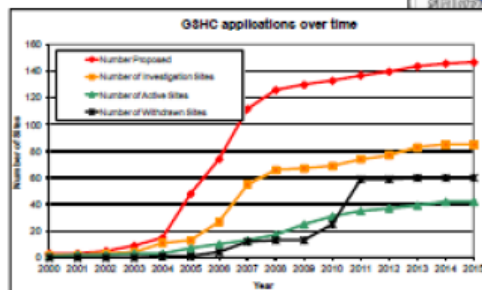
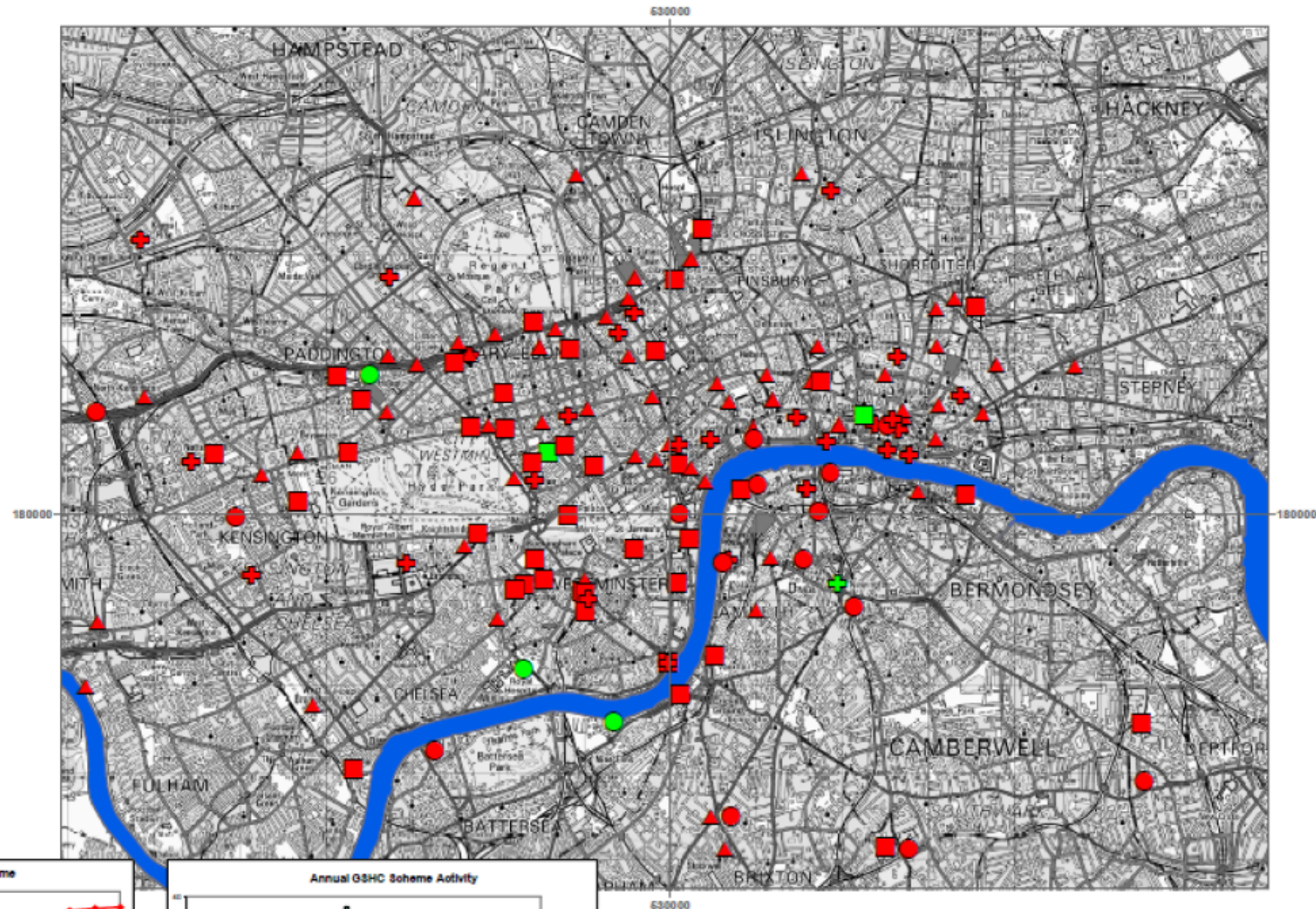
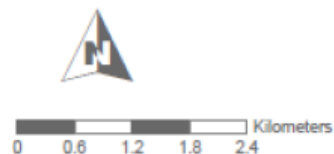
- **Open loop – normally direct use systems**
- **Closed loop**
 - **Direct use**
 - **Heat pump coupled**

Open Loop Systems

Location of Open Loop GSHC Schemes in Central London

Legend

- Active Site After 2015
- Active Site Before 2015
- Investigation Site After 2015
- Investigation Site Before 2015
- + Proposed Site After 2015
- + Proposed Site Before 2015
- ▲ Withdrawn Site Before 2015
- River Thames

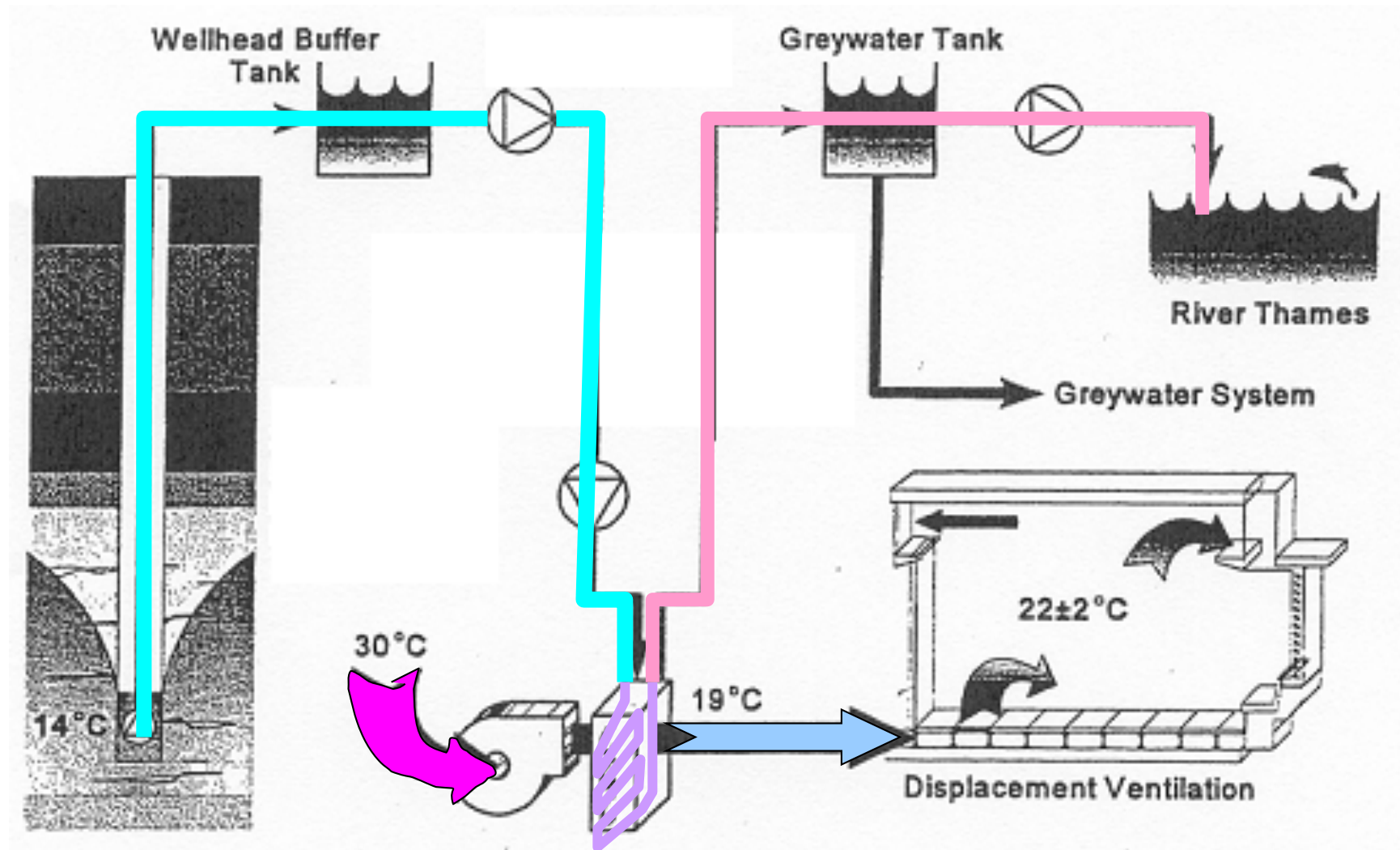


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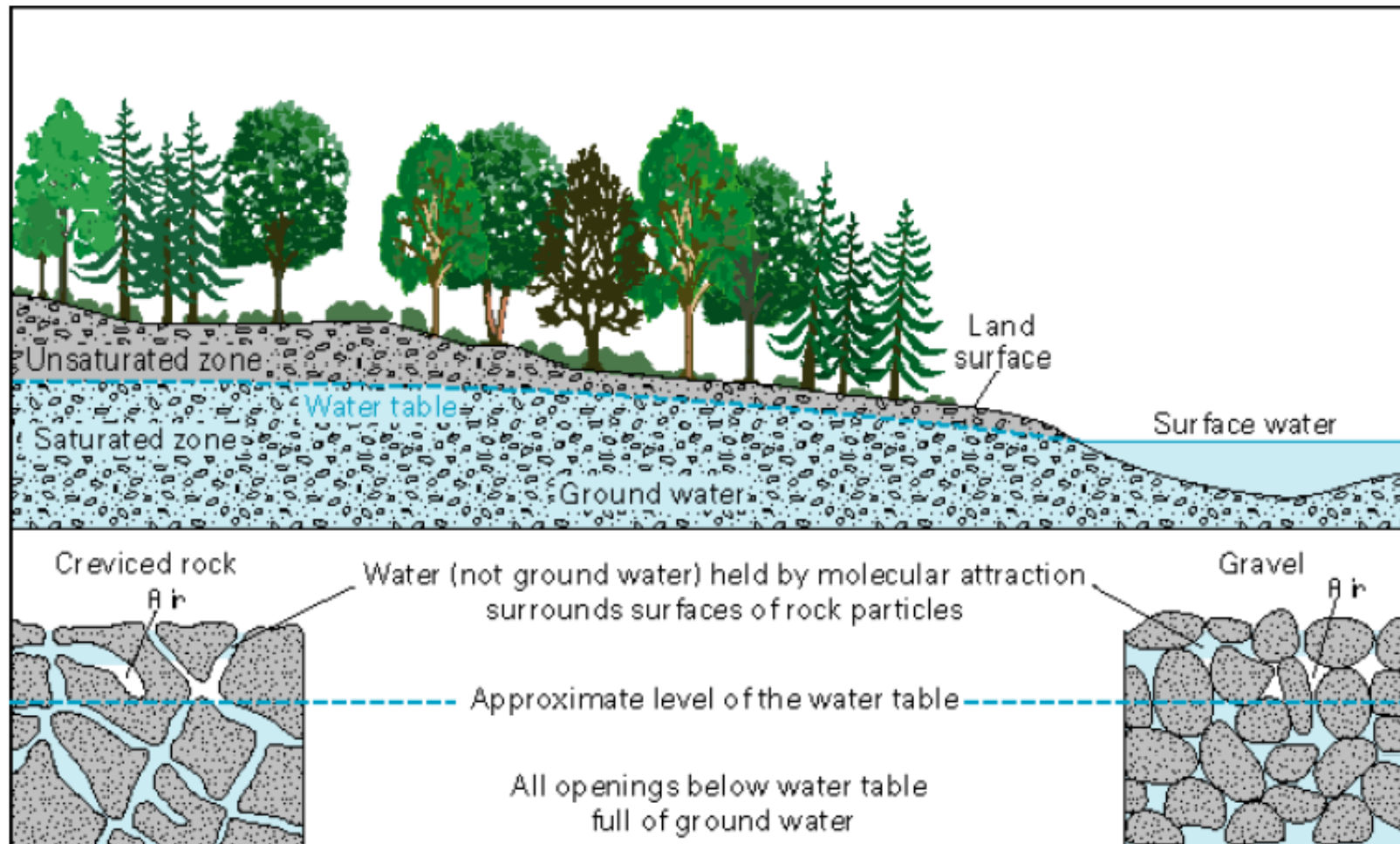
Groundwater cooling at Portcullis House



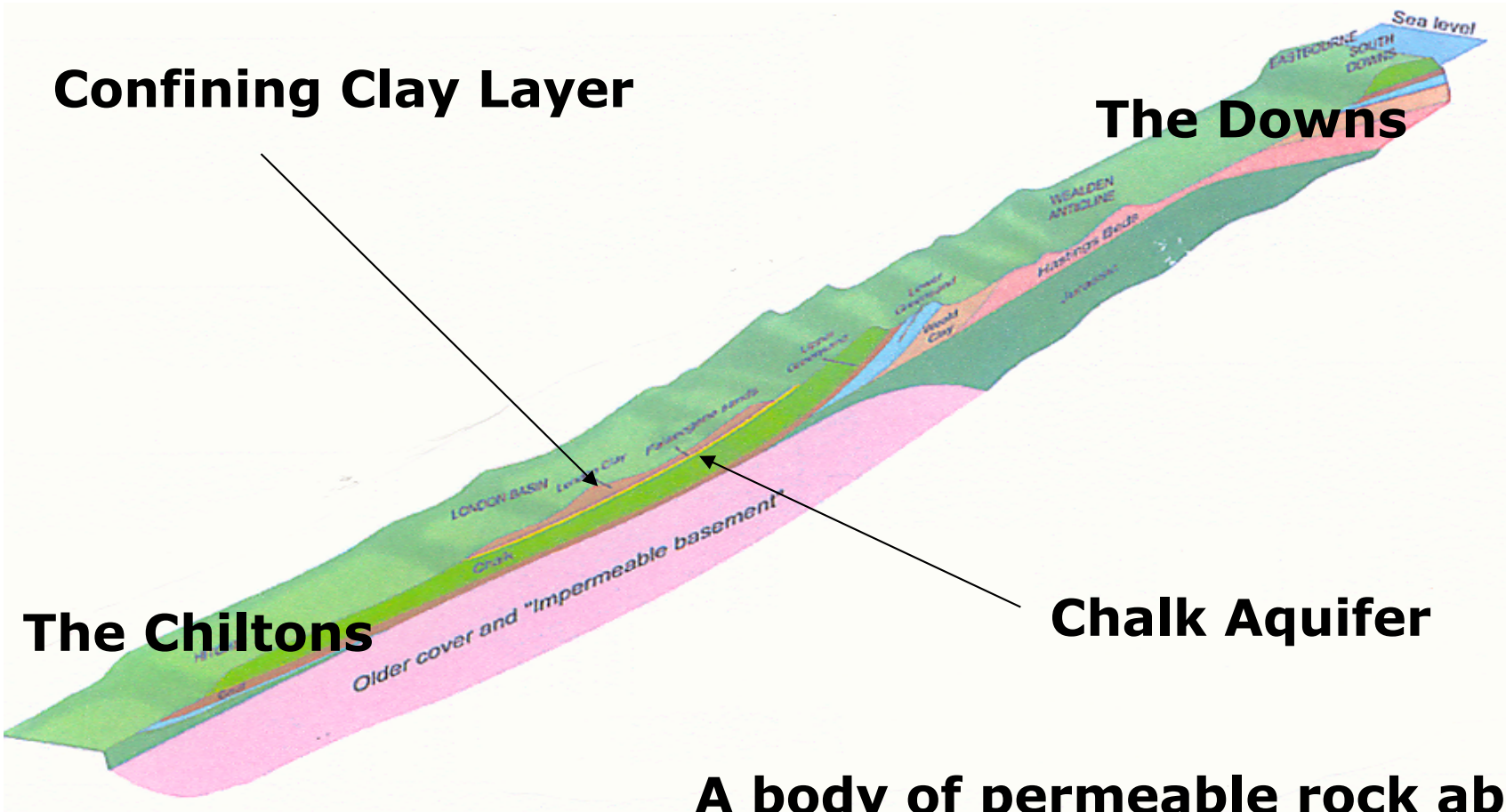
Groundwater cooling at Portcullis House



How groundwater occurs in rocks

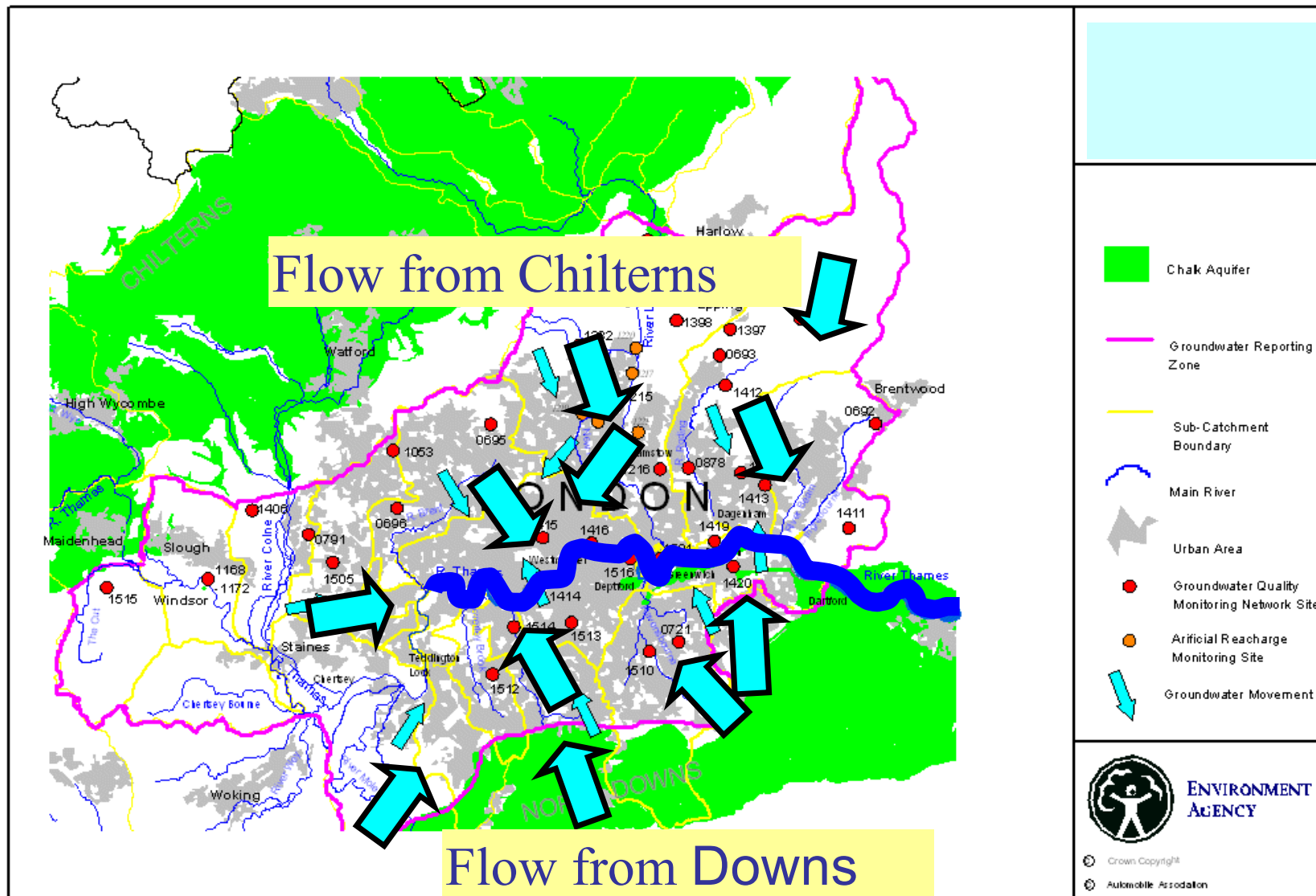


The London Aquifer



A body of permeable rock able to hold or transmit water

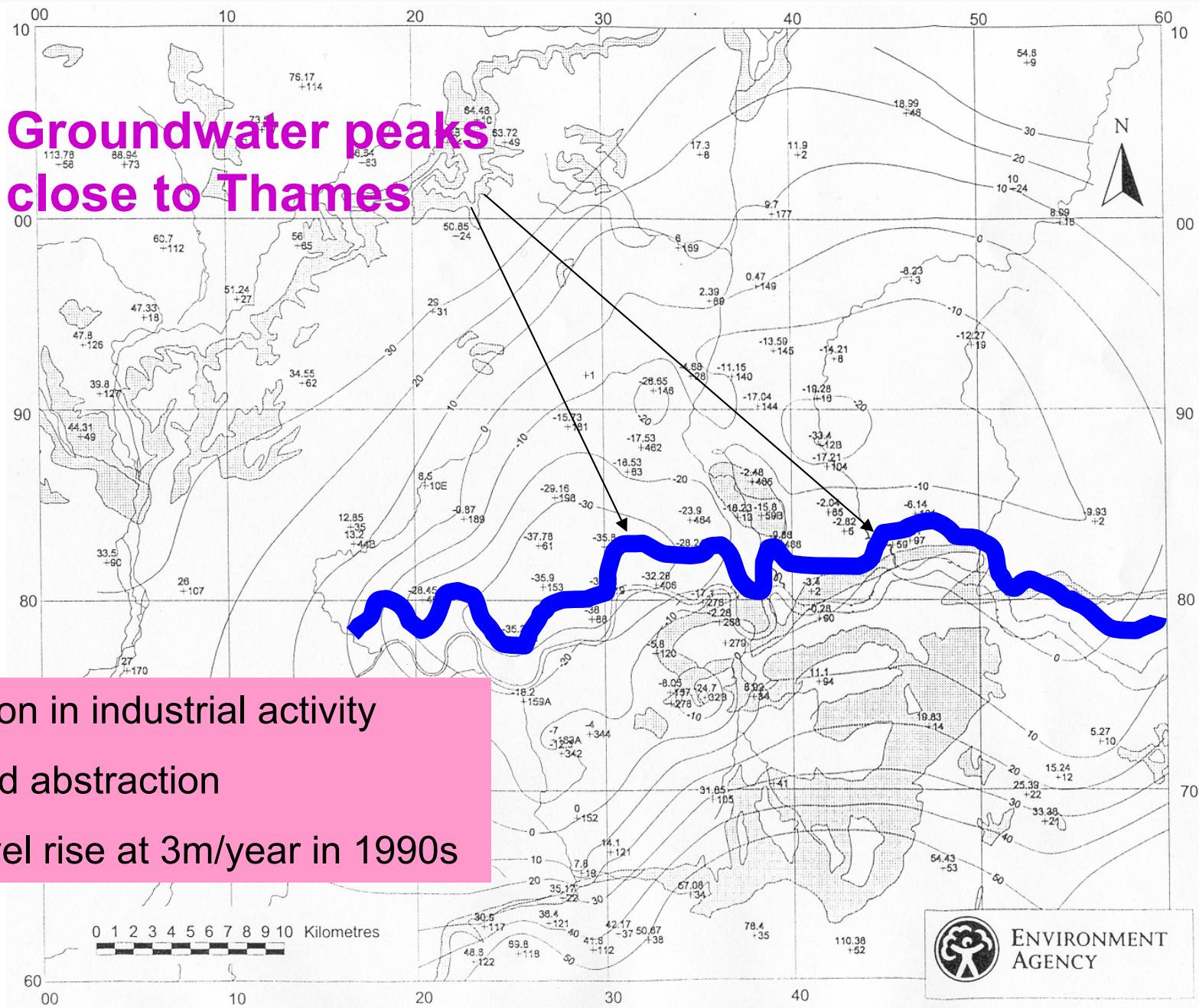
Groundwater flow in London



Groundwater levels in London

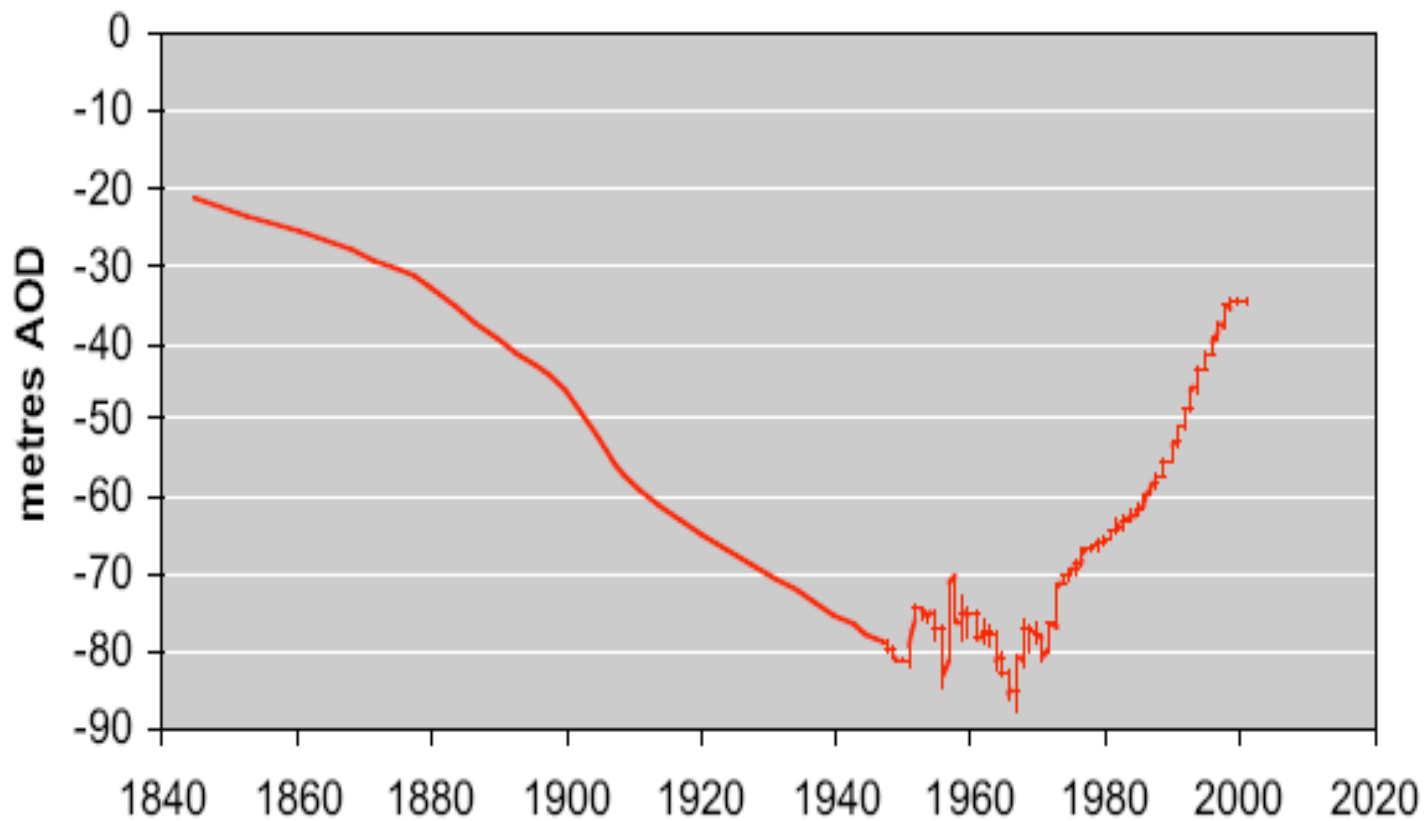
Groundwater peaks
close to Thames

- Reduction in industrial activity
- Reduced abstraction
- G/W level rise at 3m/year in 1990s



Groundwater levels in London

Groundwater levels at Trafalgar Square, 1845-2001

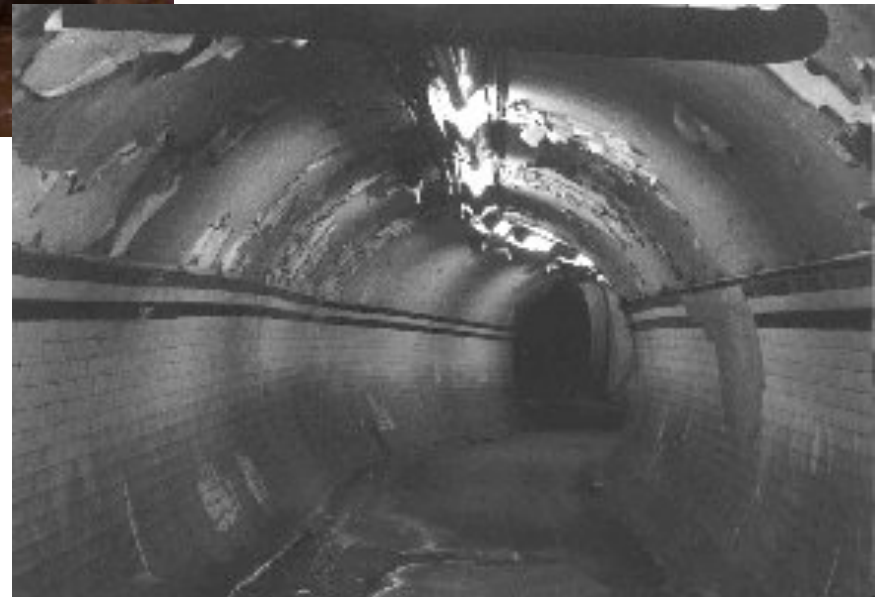


http://www.bgs.ac.uk/research/groundwater/datainfo/levels/levels_data.html

Groundwater levels in London



- Interference with buildings foundations and underground infrastructure



To abstract water

- **There needs to be water available!**
- **You may need a licence**
- **You may need to pay for the water you use**
- **You may need to pay to return the water to the sewers**
- **Is there an existing borehole?**
- **Speak to the Environment Agency**

Abstraction charges

Schedule 3 Water Abstraction Charges for the year commencing 1 April 2016

The rates of charge for the year commencing 1st April 2016 are as follows:

Regional charging area	2016/17 Standard Unit Charge (£/1000m ³)
Anglian	27.51
Midlands	14.95
Northumbria	29.64
North West	12.57
Southern	19.23
South West (incl. Wessex)	19.71
Thames	13.84
Yorkshire	11.63
Dee	13.58
Wye	13.58

<https://www.gov.uk/government/publications/abstraction-charges-scheme-april-2014-to-march-2015>

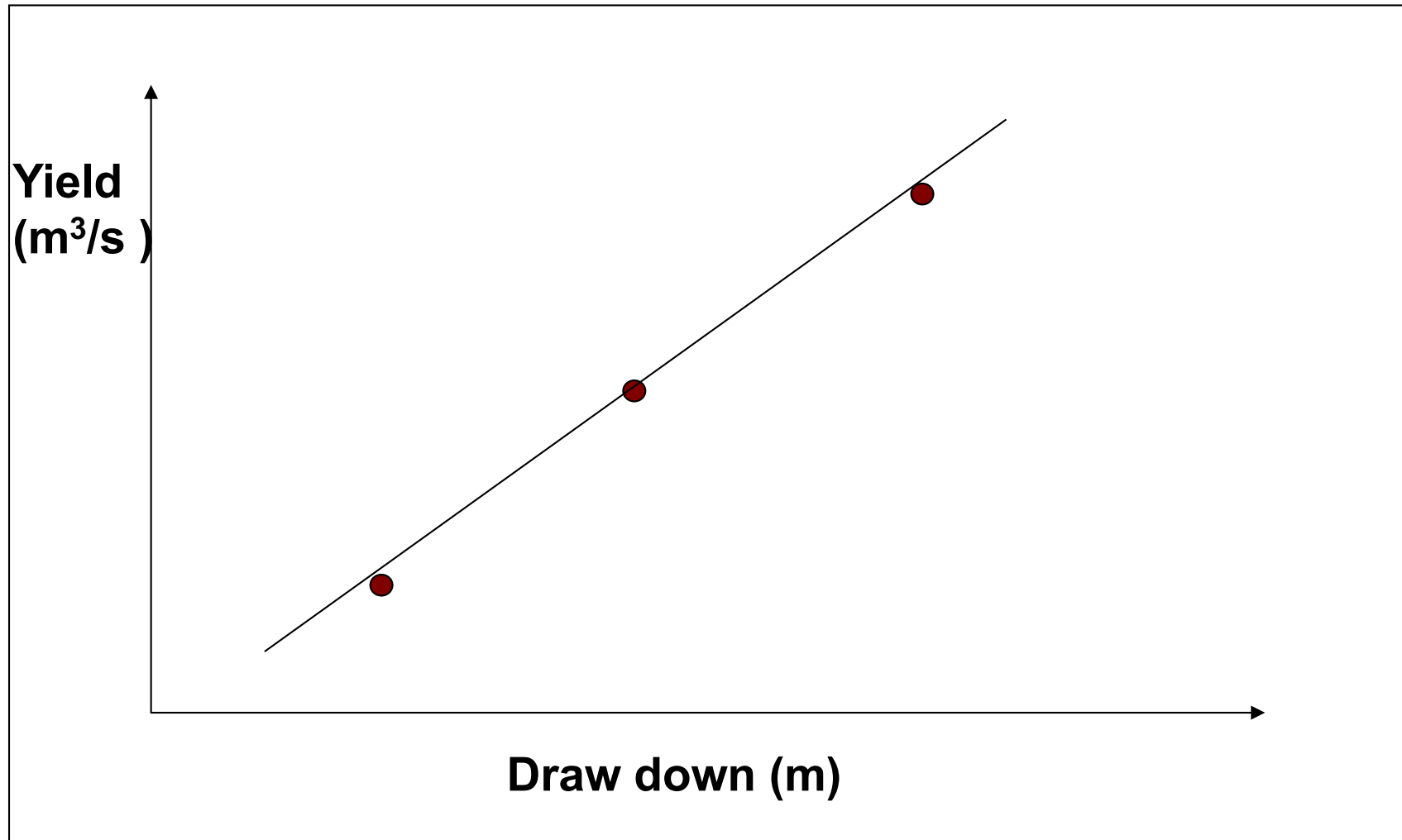
Factors affecting viability

- **Availability of resource: Depth of resource and ground material to be drilled.**
- **Confirm the resource quantity and well flow rate early**
- **Distance between resource and application site, most projects < 1500m**
- **Resource temperature (most approx. 12°C, London 14°C)**
- **Quality and composition of fluid**
 - **Particulates – fouling and erosion**
 - **Bacteria – fouling**
 - **Chemicals – corrosion and fouling**
- **Disposal, Resource life**

Before You Specify



Before You Specify



Closed loop systems

Outside Temp. 35 °C

House Temp. 20 °C

Summer application

