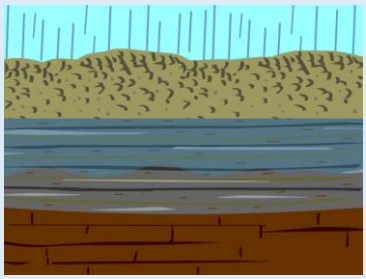
Aquifers and artesian basins

 # An aquifer is a body of porous and permeable rock capable of storing and yielding significant amounts of water.

#An Aquiclude is an impermeable rock that does not transmit water.

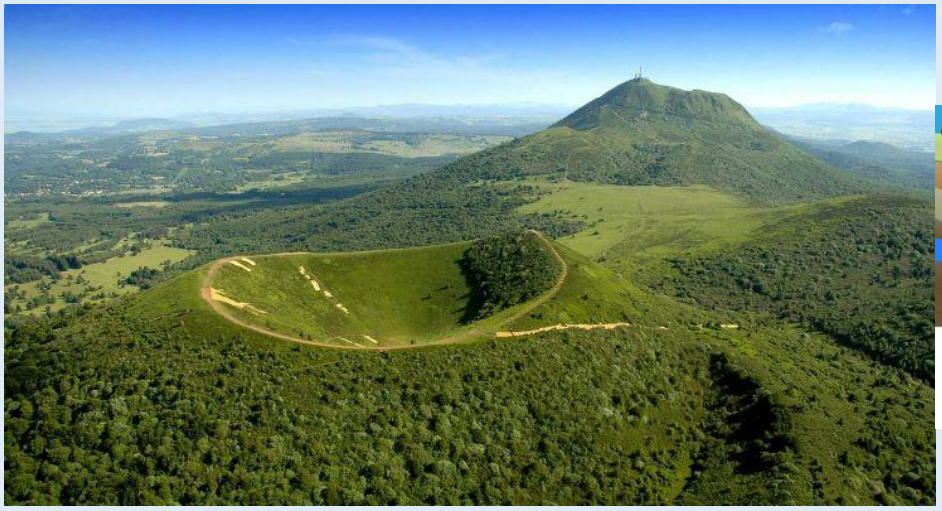
Aquifers and groundwater storage

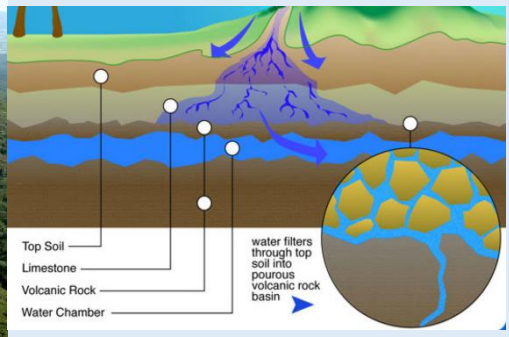
There is more water in the ground than in all of the Earth's lakes and rivers combined. It is the second largest store of water after the oceans.



Aquifers only occur when a large body of rock has a high porosity, this promotes the ability to store water within pore spaces; and a high permeability, so water can enter, flow through and be extracted from the aquifer.

Common rock that make suitable aquifers:
Sandstones (poorly cemented), most limestones, fractured chalk and in some cases, fractured volcanic rocks.





The Puy-de-Dome area of the Auvergne region of Central France has volcanic rocks which are fractured. The surface accumulations of scoriaceous material and the fractured rocks allow ground water to flow through.

The principal aquifers of the British Isles are the **Chalk, Permo-Triassic sandstones, Jurassic limestones** and the **Lower Greensand.**

#The recharge zone is the area of an aquifer open to the atmosphere allowing replenishment of water.

Aquifers with a recharge zone on the surface are replenished by rainwater and can provide constant supply of water provided that the rate of recharge equals the rate of extraction.

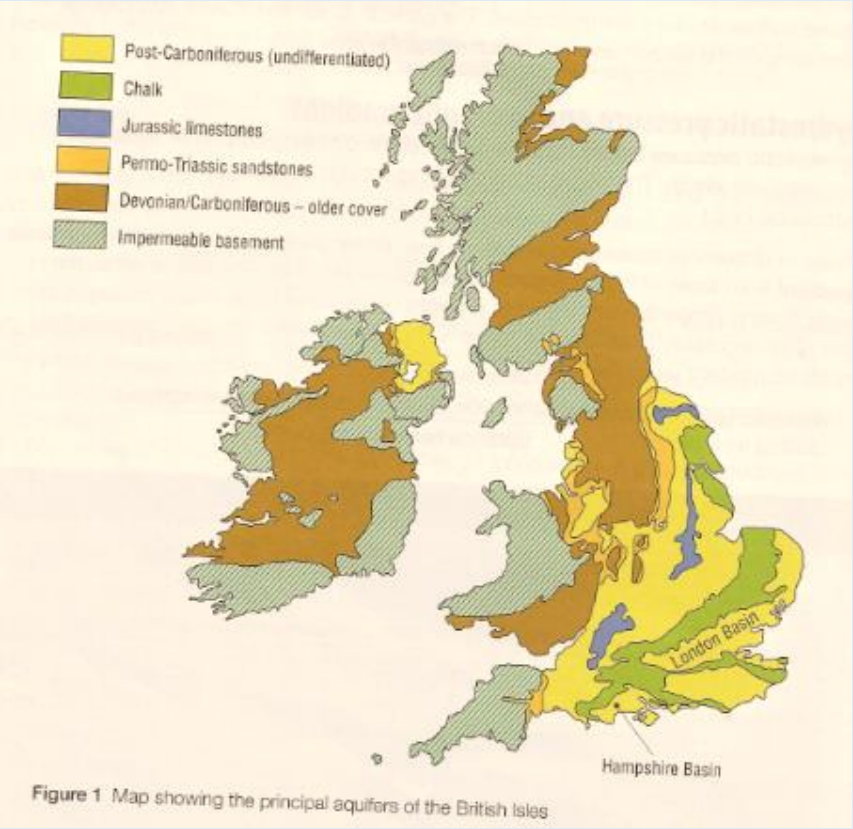


Figure 1 Map showing the principal aquifers of the British Isles

Types of Aquifer

There are two main types of aquifer, unconfined and confined:

An unconfined aquifer is open to the atmosphere, under atmospheric pressure, and is recharged by rainwater from directly above. Water will need to be pumped to the surface due to the lack of hydrostatic pressure. This is done through a borehole or well sunk into the unconfined aquifer.

A confined aquifer is overlain by impermeable rocks and the groundwater held within is under hydrostatic pressure. Groundwater can only be replenished in a confined aquifer if it has a recharge zone.

A perched aquifer sits above the regional water table and is underlain by a lens of impermeable rock which prevents the water from percolating further downwards.

Aquifers can also be classified by their replenishment activity:

Live aquifers are ones that are being currently replenished by rainwater via a recharge zone on the surface.

A Fossil aquifer is no longer being replenished and represents a relic of a past wetter climate.

Fossil aquifers can underlie present-day semi-arid environments, providing a key water source to regions where groundwater is otherwise scarce; they are a large underground reserve established in a past climatic environment.

Fossil aquifers are non-renewable supplies for water. They require careful management in order to sustain he area's water supply for as long as possible.

Important examples: Ogallala aquifer of central USA and those lying in Nubian Sandstones underlying the Sahara Desert, North Africa.

Isotopic dating of water from Great Artesian Basin of eastern Australia has shown that some of it is nearly 2 million years old.

Artesian basins and artesian wells

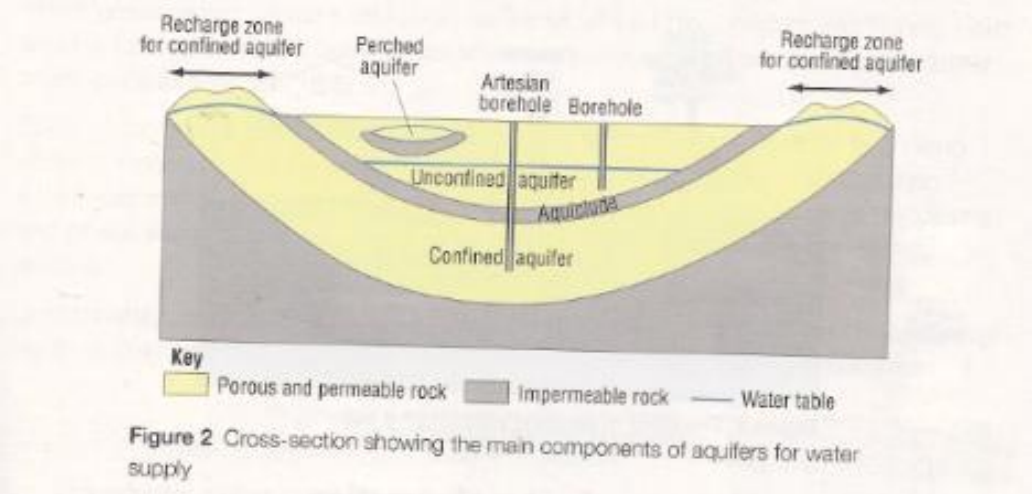


Figure 2 Cross-section showing the main components of aquifers for water supply

An artesian basin is a large synclinal confined aquifer under hydrostatic pressure.

Artesian wells hold water under hydrostatic pressure, which rises up the well on release.

In an artesian basin, the porous stone is sandwiched between a top and bottom layer of impermeable rock such as shale or clay. This causes positive (hydrostatic) pressure.

When a borehole is drilled into an artesian basin, water flows up to the surface and this is called an artesian well.

The fountains installed in Trafalgar Square in 1843 initially flowed naturally under hydrostatic pressure as they were in the centre of the London Basin. Once the hydrostatic pressure falls, the water has to be pumped to the surface.

The London Basin is the best example of an Artesian Basin in the British Isles. The main aquifer is the Chalk (180 – 245m thick), sandwiched between Gault Clay below and London Clay above. The main recharge zones for the London Basin are the Chiltern Hills and the North Downs.

Groundwater was first abstracted from beneath London in the eighteenth century and made a significant contribution to the economic and industrial development of the city. Many businesses, including the Savoy Hotel and the Bank of England, had their own boreholes into the aquifer.

In 1960s, water abstraction from the London basin peaked, with the water table falling 50m across and area of 200 km^2.

This caused poor water quality, reduced yield and surface subsidence.

Today, the majority of London's water supply is from reservoirs, rivers and springs on the surface. This has led to the recovery of groundwater levels below the city to such an extent that it is now a concern. Increased hydrostatic pressure within the chalk has led to the saturation of overlying London Clay. This is affecting the stability of some buildings and threatens flooding tunnels of London Underground and Cross Rail.

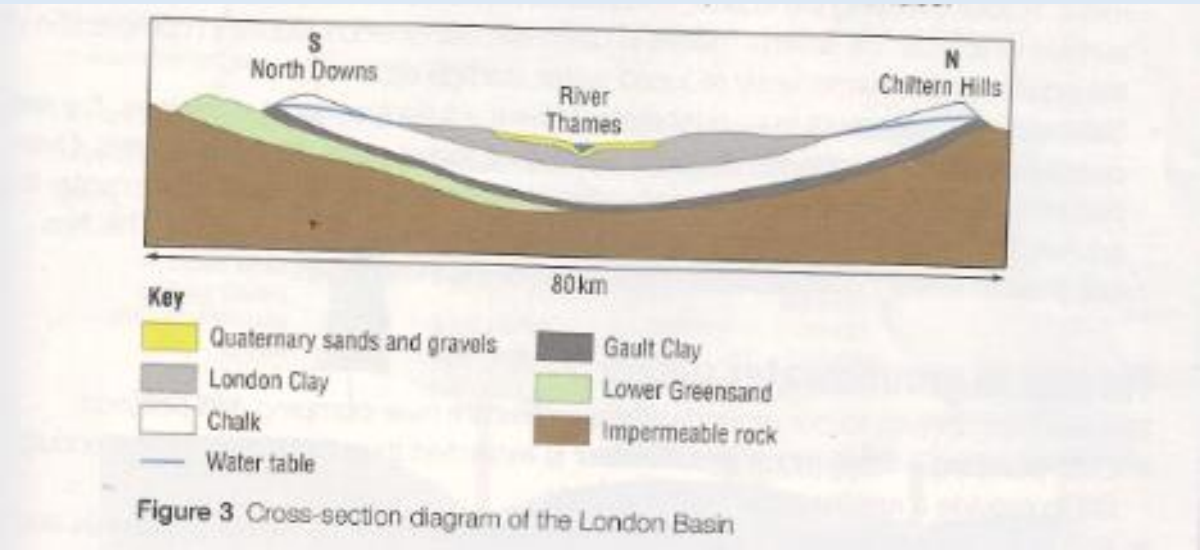


Figure 3 Cross-section diagram of the London Basin

The Environment Agency currently has 200 borholes in London for observation purposes; montioring groundwater elvels. Manageemnt of water elvels is mainly done through control of water abstraction licences.