Advances in understanding the hydrogeology of the London Basin

Steve Buss¹ and Travis Kelly²

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Mike Jones, Rob Sage, Peter Isherwood, Vin Robinson, Rory Mortimore, Malcolm Anderson, Nigel Hoad, Jane Dottridge, Mike Streetly, Paul Daily, Victoria Price and Nancy Proudfoot

Background

The Chalk and Thanet Sands aquifer provides the main groundwater resource in the London area and supports significant abstraction for a variety of uses including public water supply. London’s underground water system is the mainstay of the Lambeth Group and London Clay. Outstanding analogies of the study area are mapped below.

Historical abstraction caused the development of a regional cone of depression beneath Central London, in the centre of which the Chalk aquifer developed an anastomosed zone. Since 1960 there has been a rise in groundwater levels over most of the Central London area as a response of the reduction in pumping. This recovery would potentially cause issues with structural integrity of infrastructure. To this has been a strategy of forming abstraction in the area GARDIT (General Aquifer Research Development and Investigation Team). Aquifer storage and recharge (ASR) schemes have been developed in the area where historical abstraction caused the development of an anastomosed zone in the Thanet Sands.

This poster presents some of the findings of an Environment Agency sponsored study into the hydrogeology of the London Basin aquifer. This Hallucinor model study provides a robust, quantitative foundation for a forthcoming numerical modeling project. The numerical model will be used in the Environment Agency to regulate the diverse abstraction pressures on the aquifers. The model allows the recovery of the historic cone of depression and the interaction of abstractions with the other aquifers and aquitards in the area. The model will be used to support the management of regional abstraction as part of the Environment Agency’s strategic approach to the aquifers in London.

Burial depth control of aquifer properties

The figure (right) compares the distribution of transmissivity from Down and Fotherby et al. (1972) with the current depth of the top of the Chalk aquifer. There is excellent correspondence between areas where the depth exceeds 80 m and the areas of identified low transmissivity. Transmissivity always decreases with increasing burial depth. The London Clay is a transition between the Thanet Sands and the Seaford Chalk, which respectively exhibit low and high transmissivity, respectively. The London Clay is a transition between the Thanet Sands and the Seaford Chalk, which respectively exhibit low and high transmissivity, respectively.

Sources of groundwater

The Tring Square Sylphid shows clearly that historically groundwater demand exceeded supply and that the abstraction considerably depleted aquifer storage. Having available the results of adjacent groundwater models, particularly the South West Chilterns, Vale of St Albans, Epsom and Ascot models, we have been able to determine inflows to the aquifer from other aquifer areas. The pie chart shows how abstraction impacts on, or results from, the confined London Basin since 1966. Abstraction from the confined aquifer is currently approximately balanced by inflows from the Chilterns and North Downs (which is an indication of the success of the GARDIT programme). Compare the total inflows below with the maximum historical abstraction of almost 500 Ml/day.

Structural controls on groundwater flow

Faulting often affects the hydraulic conductivity of chalk both to increase and reduce permeability. Along the flanks of some faults, high permeability zones may be more permeable than the aquifer. Simple numerical modelling of a pumping test in an otherwise homogeneous aquifer shows how:

1. Zones of low permeability are not observed in an anisotropic aquifer.
2. Drawdown does not propagate across the high permeability zones, resulting in steep hydraulic gradients. This is similar to what would be observed in an anisotropic aquifer.
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High or low permeability faults?

Despite the evidence that there are steep hydraulic gradients perpendicular to some fault zones, there appears to be less direct evidence that these are less permeable than the transverse stratigraphic units. However, several lines of field evidence that suggest some fault zones may be more permeable than the aquifer. Simple numerical modelling of a pumping test in an otherwise homogeneous aquifer shows:

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More details on the project and its outcomes can be obtained from the authors:
¹ Dr Steve Buss, ESI Ltd., 160 Abbey Foregate, Shrewsbury SY2 5HH (stevebuss@esinternational.com)
² Travis Kelly, Environment Agency, Red Kite House, Howbery Park, Wallingford OX10 8BD