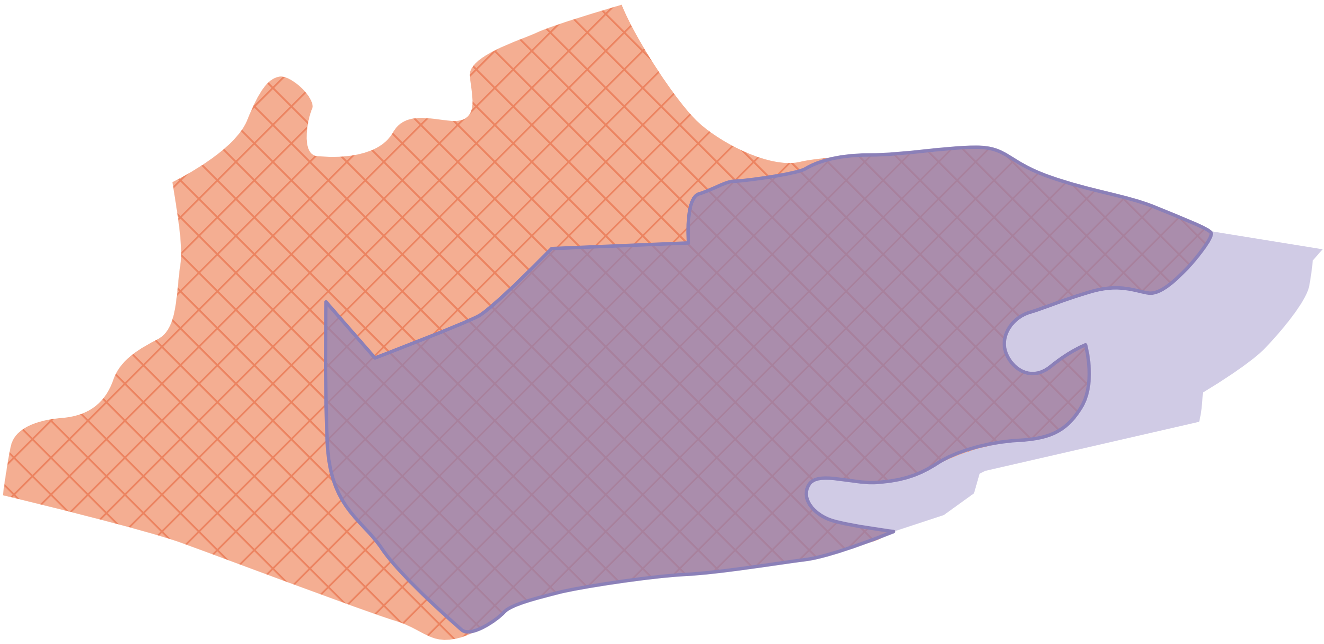
Radioactive Waste Management



London and the Thames Valley

SUBREGION 2

Contents

Clicking on words in green, such as sedimentary or lava will take the reader to a brief non-technical explanation of that word in the Glossary section. By clicking on the highlighted word in the Glossary, the reader will be taken back to the page they were on.

Clicking on words in blue, such as Higher Strength Rock or groundwater will take the reader to a brief talking head video or animation providing a non-technical explanation.

For the purposes of this work the BGS only used data which was publicly available at the end of February 2016. The one exception to this was the extent of Oil and Gas Authority licensing which was updated to include data to the end of June 2018.

Our work shows that we may find a suitable geological setting for a GDF in most of this subregion.

Although rock cannot generally be seen at the surface in this subregion except in man-made excavations such as quarries and road cuttings, numerous deep boreholes and geophysical investigations give us an understanding of the rocks present and their distribution.

There are clay-rich rock layers under the whole subregion in which we may be able to site a GDF. We would need to do more work to find out whether these rocks have suitable properties and thicknesses in the depth range of interest for a GDF.

Even where individual clay-rich rock layers are found not to be thick enough to host a GDF they may support the siting of a GDF in deeper rocks as they could act as a barrier to groundwater flow from depth. This is important because movement of groundwater is one of the ways in which radioactive material could be carried back to the surface.

There are no known coal, oil, gas or metal resources in this subregion which means that it is unlikely that future generations may disturb a facility.

Introduction

This subregion comprises the largest part of the London and the Thames Valley region east of Reading and Oxford and south of Thame, Luton, Stevenage and Royston. It includes London, Essex, parts of north-west Kent, the northern part of the Thames Estuary and the adjacent inshore area extending to 20km from the Essex coast. The extreme southern edge of this subregion, south of a line through Basingstoke, Woking and Croydon, has geological attributes similar to those of the Wealden District subregion 1.

Rock type

Figure 1 shows where in the subregion there are likely to be Lower Strength Sedimentary Rock (LSSR) within the depth range of interest, there are no Higher Strength Rocks (HSR) or Evaporites in the subregion. The depth range of interest in this subregion is occupied by a well-known sequence of sedimentary rocks, overlying basement rocks that are less known. The sedimentary rock sequence contains several LSSR layers including the Kimmeridge and Oxford Clay Formations in the west and south of the subregion, and the Gault Clay more or less throughout. The Gault, Kimmeridge and Oxford Clay Formations are well known both from outcrops and boreholes within the London and the Thames Valley region, and consist mainly of mudstone with some siltstone. These LSSR layers are thickest and most numerous in the west of the subregion, but gradually decrease in thickness and number eastwards. In the easternmost part of the subregion, the Gault Clay Formation is the only LSSR present and is a maximum of 10m thick. As a result, although these rocks may provide hydraulic separation between shallow and deep groundwater across the entire subregion, they may only be thick enough to host a GDF in the west of the subregion.

A range of mudstones, siltstones, sandstones and limestones were deposited across this subregion during Silurian to Cambrian times (approx. 420 to 540 million years ago). These sedimentary rocks may have been folded and metamorphosed such that, in places, the mudstones have become slaty with the potential to be a HSR host rock for a GDF. However, few deep boreholes have been drilled into the basement rocks beneath the sedimentary cover in this subregion and considerable further investigation would be required to establish their suitability as HSR host rocks for a GDF.

A summary of the geological attributes of the London and the Thames Valley region can be found here, including a simplified rock column showing the oldest and deepest rocks at the bottom, with progressively younger rock units towards the top.

Rock structure

There is little major folding or faulting in most of this subregion (Figure 2). However, the southern edge of this subregion lies within the northern edge of the Weald Anticline, and in a few places, particularly the Hog's Back ridge, major fault zones have tilted the strata such that they attain steep dips adjacent to the fault zones. Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and these would need to be considered during the sitintg of a GDF[1].

[1] Faults occur on a diverse range of scales, from centimetres to kilometres, and the subsurface is criss-crossed by networks of numerous individual faults. However our work includes only those faults identified by the BGS with throws (vertical offset) of 200m or more. This is because the data available to the BGS are not able to resolve all faults consistently, across all thirteen regions, with throws less than 200m. We recognize the potential importance of smaller scale faults to the integrity of a GDF and will need to survey them in detail as part of the site evaluation process.

Groundwater

There is very little information on groundwater in the depth range of interest for a GDF, 200 to 1,000m below NGS datum, although there is information on groundwater in aquifers above 200m. The Chalk Group is a principal aquifer across the whole subregion with its base reaching a maximum depth of about 400m north-west of Woking. Karstic conditions have developed in some places in the Chalk aquifer, such as beneath the Chilterns, where concentration of groundwater flow has enlarged fractures by dissolution to form a network of major fissures, resulting in fast movement of groundwater near the surface. The Upper and Lower Greensand and Portland Stone Formation aquifers are also present in the north-west of the subregion. Although there is no information in this subregion on groundwater in basement rocks, the Gault Clay Formation is likely to provide an effective barrier to flow between deep and shallow groundwater. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

There are some areas, such as around the Thames Estuary, where deep exploration boreholes may influence the connectivity between shallow and deep groundwater which would need to be considered during the siting process (see Figure 3). There are no thermal springs in this subregion to suggest rapid flow of deep groundwater to the surface.

Resources

There is an Oil and Gas Authority Licence for a small area at the extreme western limit of this subregion which is discussed further under the Hampshire Basin and adjoining areas region and a Coal Authority Licence Area in the Thames Estuary off Southend-On-Sea which is discussed further under the Wealden District region. The details of these licences are not publicly available but they would need to be ascertained during the siting process. There are no other known resources in this subregion and therefore the likelihood of future human intrusion is considered to be low.

Natural processes

Earthquakes and glaciations are unlikely to significantly affect the long-term safety of a GDF in the UK. Therefore, whilst a GDF would need to be sited and designed to take account of natural processes which may occur during its lifetime, they are not considered further as part of this screening exercise.

[2] Water Framework Directive UK TAG. Defining and reporting on groundwater bodies, 2012.

Figure 1 The areas of the London and the Thames Valley subregion 2 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

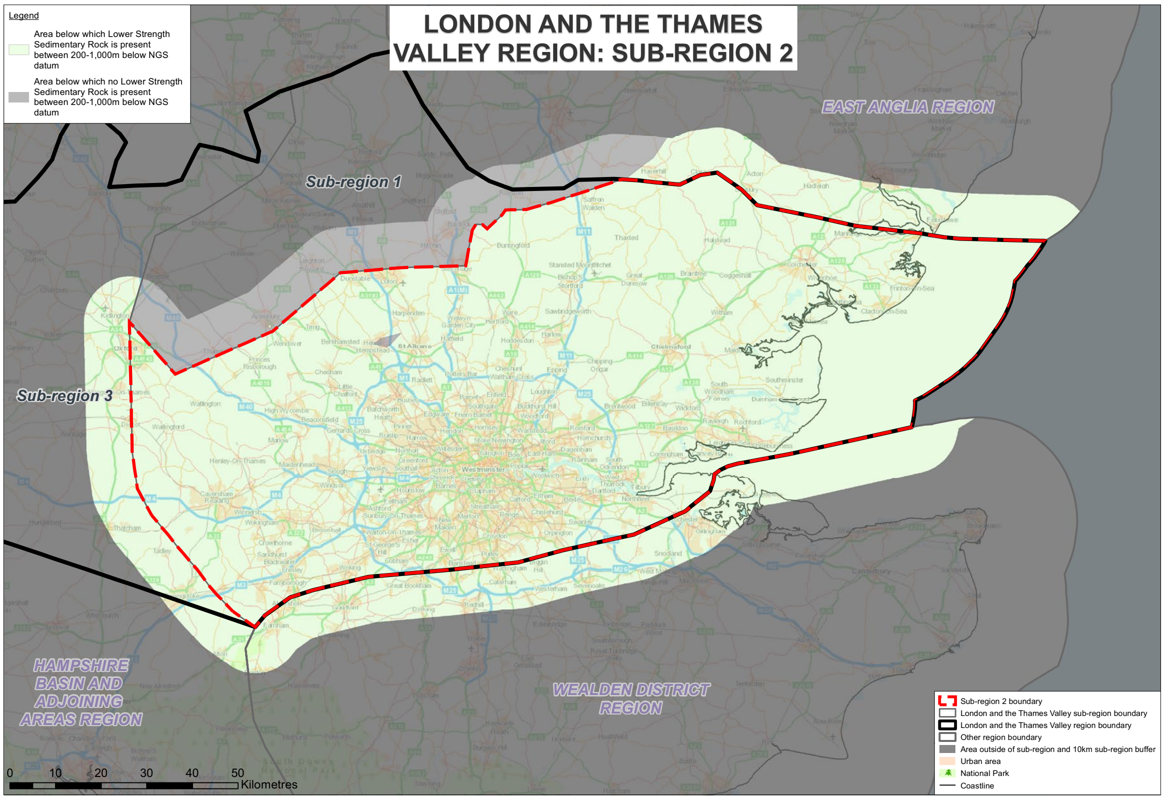


Figure 2 Location of major faults in the London and the Thames Valley subregion 2.

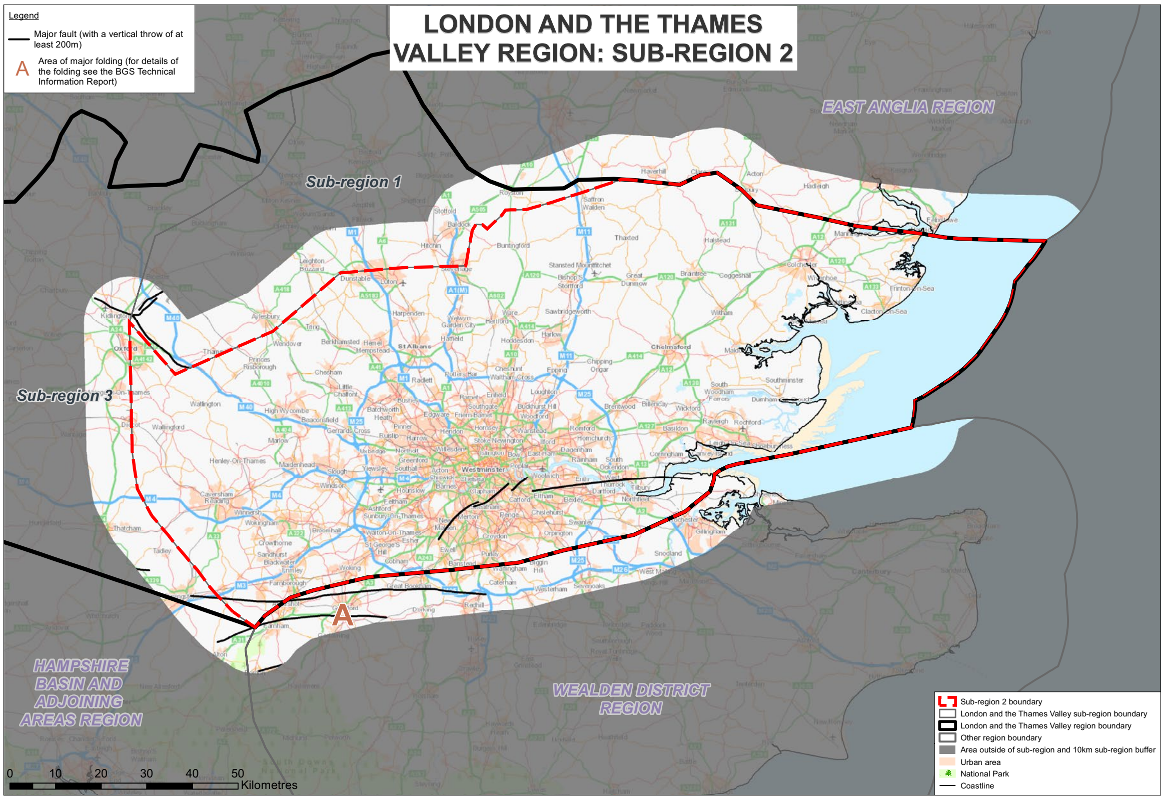
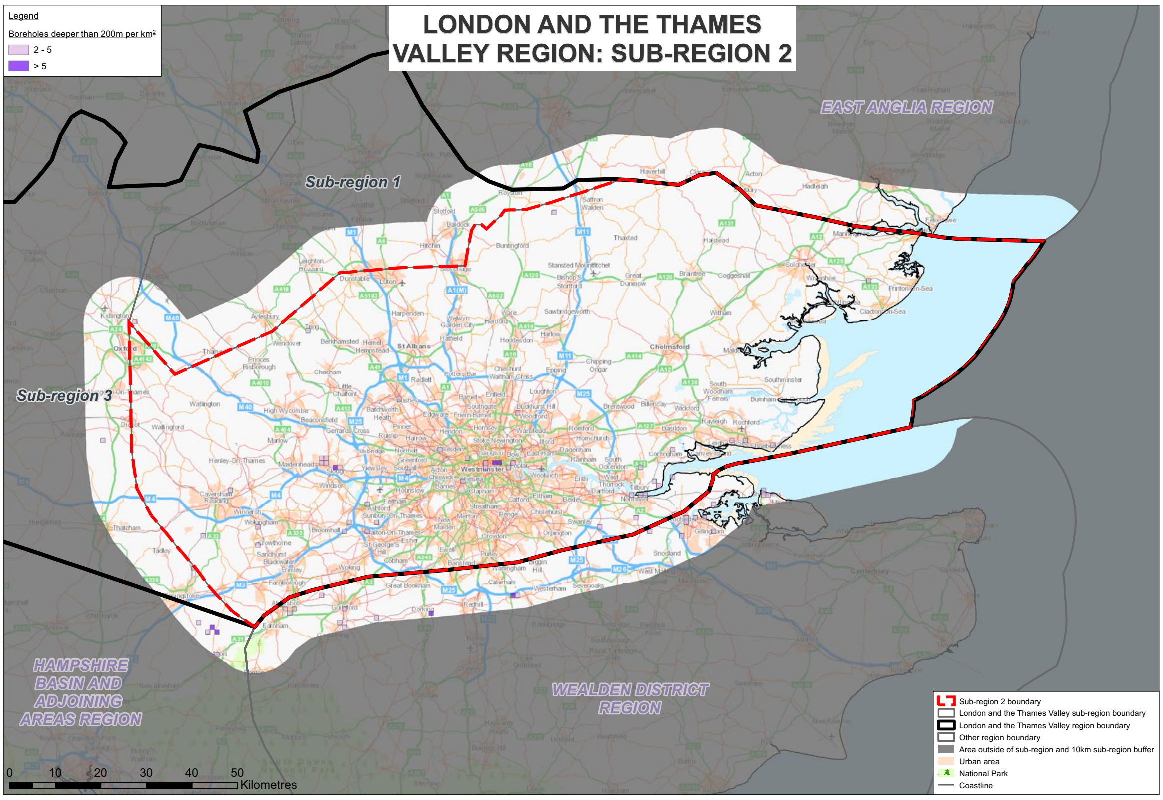


Figure 3 Areas in the London and the Thames Valley subregion 2 with concentrations of deep exploration boreholes.



Glossary

Aquifers
Aquifers are rocks that contain freshwater in pores and/or fractures and whose porosity and permeability are sufficiently high to make the extraction of groundwater possible.

Dip
The angle, or slope of a plane, such as sedimentary layering, measured relative to the horizontal.

Fracture
A crack in rock. Fractures can provide a pathway for fluids, such as groundwater or gas, to move in otherwise impermeable rock.

Karst
A distinctive type of landscape consisting of deep cracks and caves in limestones. Karst forms due to the action of mildly acidic groundwater dissolving the limestone.

Metamorphosed
A rock that has undergone change due to the action of temperature and pressure.

Outcrop
A visible exposure of bedrock on the surface

Principal aquifers
An aquifer classified by the Environment Agency as: "rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage." They represent the most important aquifers in terms of water supply or base flow.

Sedimentary
A type of rock resulting from the consolidation of material that has accumulated in layers to form gravel, sandstone, mudstone and limestone. The layers may be built up by movement from erosion (e.g. by rivers, the sea or wind) or by chemical precipitation. Generally, the material that accumulates has originated from the weathering of other rocks. Sedimentary rocks constitute one of the three main classes of rocks identified by geologists, the others being igneous and metamorphic.

Slaty
Distinctive way in which slate rocks split into very fine sheets.

Weald anticline
Large anticline in SE England that formed at the same time as the Alps, and which has now been deeply eroded. Tilted layers of Chalk around the edge of the Weald make up the North and South Downs.

Radioactive Waste Management

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