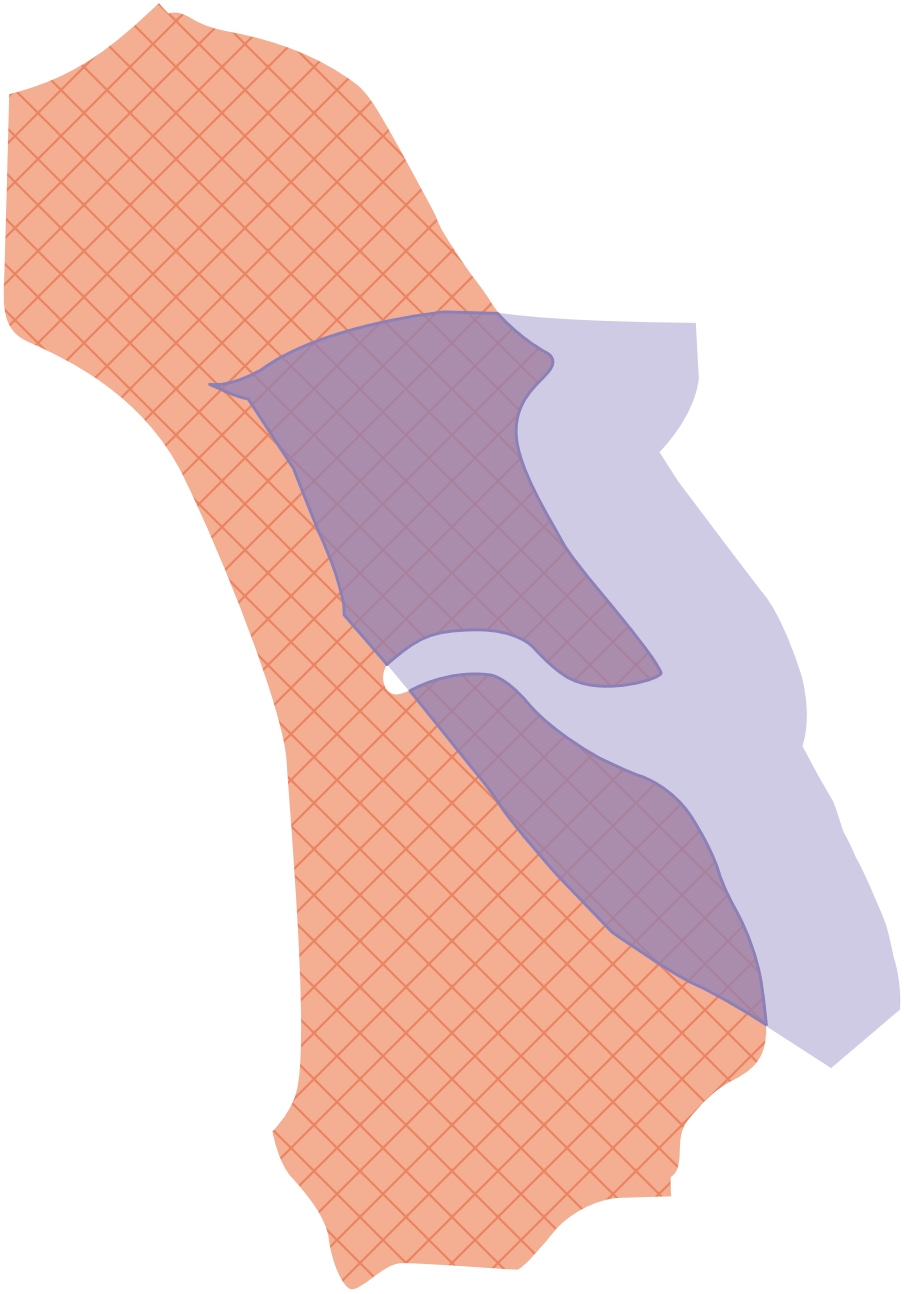
Radioactive Waste Management



# Eastern England

## 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 rocks cannot generally be seen at the surface in this subregion except in man-made excavations such as quarries or 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. There are also layers of rock salt west of Kingston upon Hull and Driffield and around Bridlington in which we may be able to site a facility. We would need to do more work to find out whether these rocks have suitable properties and thicknesses.

Even where individual clay-rich rock layers are found not to be thick enough to host a GDF they may contribute to the safety 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 known gas resources at Saltfleetby north of Mablethorpe. In this area the drilling is likely to have affected the way in which water moves through the rock. Also possible exploration in the future in this area means that it is more likely that future generations may disturb a facility.

Parts of this subregion have Petroleum Exploration & Development Licences to allow companies to explore for oil and gas. This exploration is currently at an early stage and it is not known whether oil or gas in these licence areas will be exploited. RWM will continue to monitor how this exploration programme progresses.

Parts of this area, immediately off the coast and in the Humber estuary, are Coal Authority Licence Areas allowing companies to explore for coal. It is not known whether coal in these licence areas will be exploited. RWM will also continue to monitor how this exploration programme progresses.

## Introduction

This subregion comprises the Yorkshire and Lincolnshire Wolds, the low-lying areas on either side of the River Humber between them and the adjacent inshore area which extends to 20km from the coast.

## Rock type

Figures 1a to 1c show where in the subregion there are likely to be Rock Types of Interest for the development of a GDF within the depth range of interest. The geology of this subregion comprises a reasonably well known and predictable sequence of younger sedimentary rocks throughout the depth range of interest. A number of Lower Strength Sedimentary Rock (LSSR) layers are present within this sedimentary sequence, including the Speeton, Kimmeridge and Oxford Clay Formations and Lias and Mercia Mudstone Groups (Figure 1b). The distribution, lithology and thickness of the Kimmeridge Clay Formation are well known from boreholes and brick pits. It is a consistently clay-rich sequence of mudstones, which reaches a thickness of 135m. The Speeton Clay Formation only occurs under the Yorkshire Wolds and the adjacent inshore, where a combination of boreholes and geophysical surveys show that it is mainly composed of mudstones up to 300m thick. The Oxford Clay Formation also comprises predominantly clay-rich mudstones up to 80m thick in central Lincolnshire. However, the Lias and Mercia Mudstone Groups are known to be more variable and contain non-clay lithologies.

There is also a potential Evaporite host rock present below the subregion (Figure 1c). The highest evaporite cycle in the Zechstein Group, the Sneaton Halite Formation, is likely to occur at the bottom of the depth range of interest under the subregion. However boreholes in the Selby, Goole and Market Weighton area have shown that the rock salt layer is only 11 to 17m thick and contains bands of mudstone and anhydrite. Further information would therefore be needed to determine its suitability as a host rock in this subregion. The Esk Halite Member of the Mercia Mudstone Group is reported to be only 10m thick to the south of Flamborough Head and is not present south of Withernsea. Therefore it is not considered to be a potential Evaporite host in this subregion.

A summary of the geological attributes of the Eastern England 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 no significant folding in this subregion but there are a few major faults in the very north of the area aligned east to west from Flamborough Head (see Figure 2). Faults may act as barriers to or pathways for groundwater movement, depending upon their characteristics, and these would need to be considered during the siting of a GDF[1].

### 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, present at or close to the surface across the whole of this subregion and widely used for public water supply, agriculture and industry. Several other principal aquifers are also present below the Chalk including the Spilsby Sandstone Formation and the Great and Inferior Oolite Groups. Groundwater is not extracted from these aquifers to any great extent in this subregion due to their depth and easier access to the overlying Chalk groundwater. However, due to overstepping of the Chalk onto the older rocks below, groundwater within them may be in hydraulic contact with the Chalk groundwater. The numerous layers of LSSR listed above are likely to provide hydraulic separation between deep and shallow groundwater even where they are not thick enough to host a GDF. This becomes more pronounced as the older layers dip eastwards away from their intersection with the overlying Chalk. The Sherwood Sandstone is widely used for public water supply, agriculture and industry to the west of the Eastern England region, but it occurs at considerable depth below this subregion, to the east and with evidence of increasingly saline water as it becomes deeper. Groundwater from depths greater than 400m is unlikely to be suitable as drinking water anywhere in the UK[2].

In some areas of the subregion, such as to the west of Grimsby, 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.

[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.

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

### Resources

There is a small gas field at Saltfleetby, just north of Mablethorpe (Figure 4a). It is less likely that this area would be suitable to host a GDF because borehole drilling associated with oil and gas exploration affects the way in which water moves through the rocks. It also presents a higher likelihood of inadvertent human intrusion in the future. These known resources would be taken into account in the siting of a GDF.

Petroleum Exploration and Development Licences[3] are currently held for much of the onshore part of this subregion and a small part of the inshore are (Figure 4a). There are also Coal Authority Licence Areas, in 2 inshore parts of this subregion off Hornsea and Mablethorpe (Figure 4b) and the Humber estuary between Kingston upon Hull and Grimsby. It is not known whether coal, oil or gas in these licence areas will be exploited, but they would need to be considered in the siting of a GDF.

### 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.

[3] This also includes other licences awarded by the Oil and Gas Authority to allow companies to explore for hydrocarbons.

**Figure 1a** The areas of the Eastern England subregion 2 where any of the 3 Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

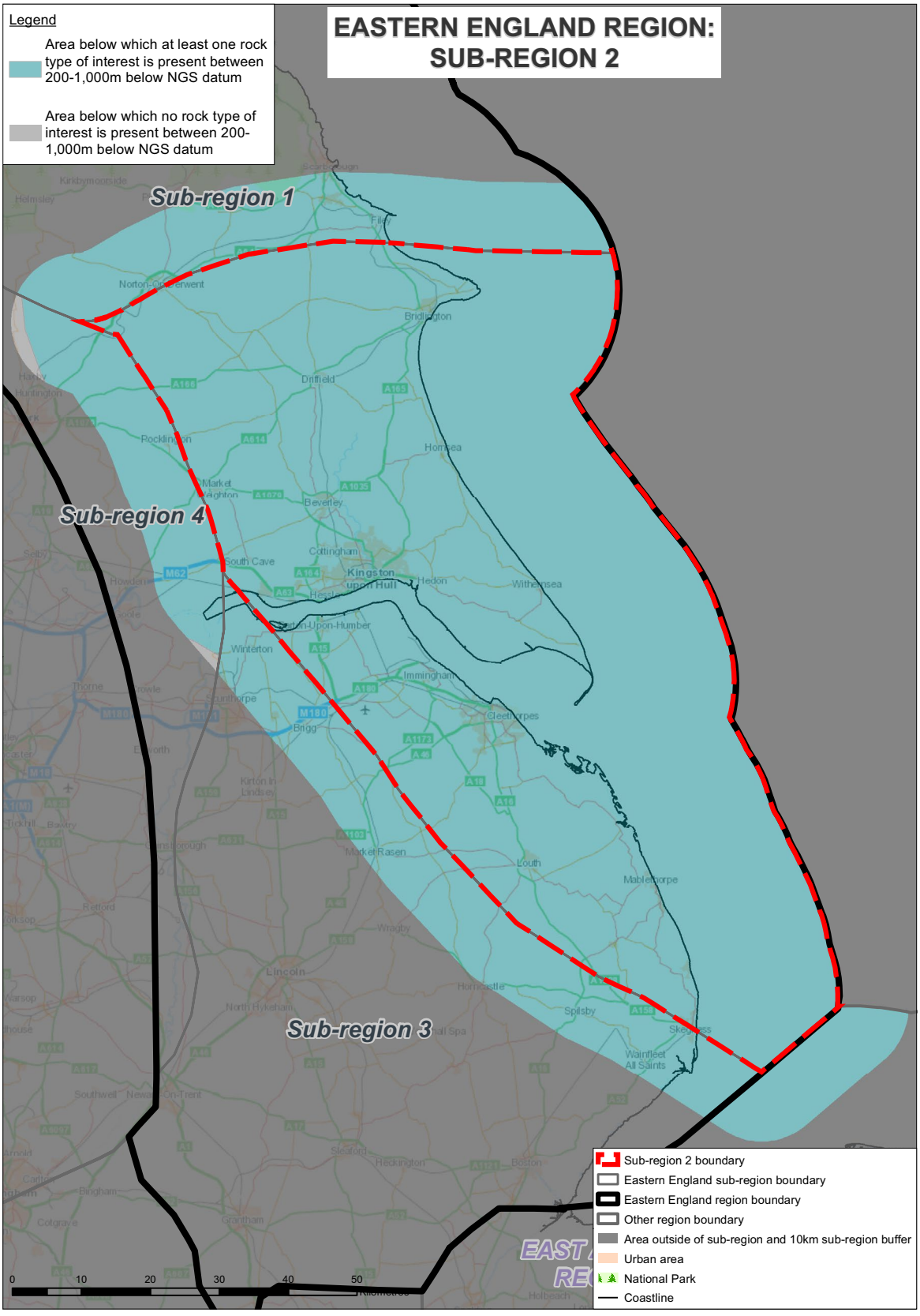


**Figure 1b** The areas of the Eastern England subregion 2 where Lower Strength Sedimentary Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

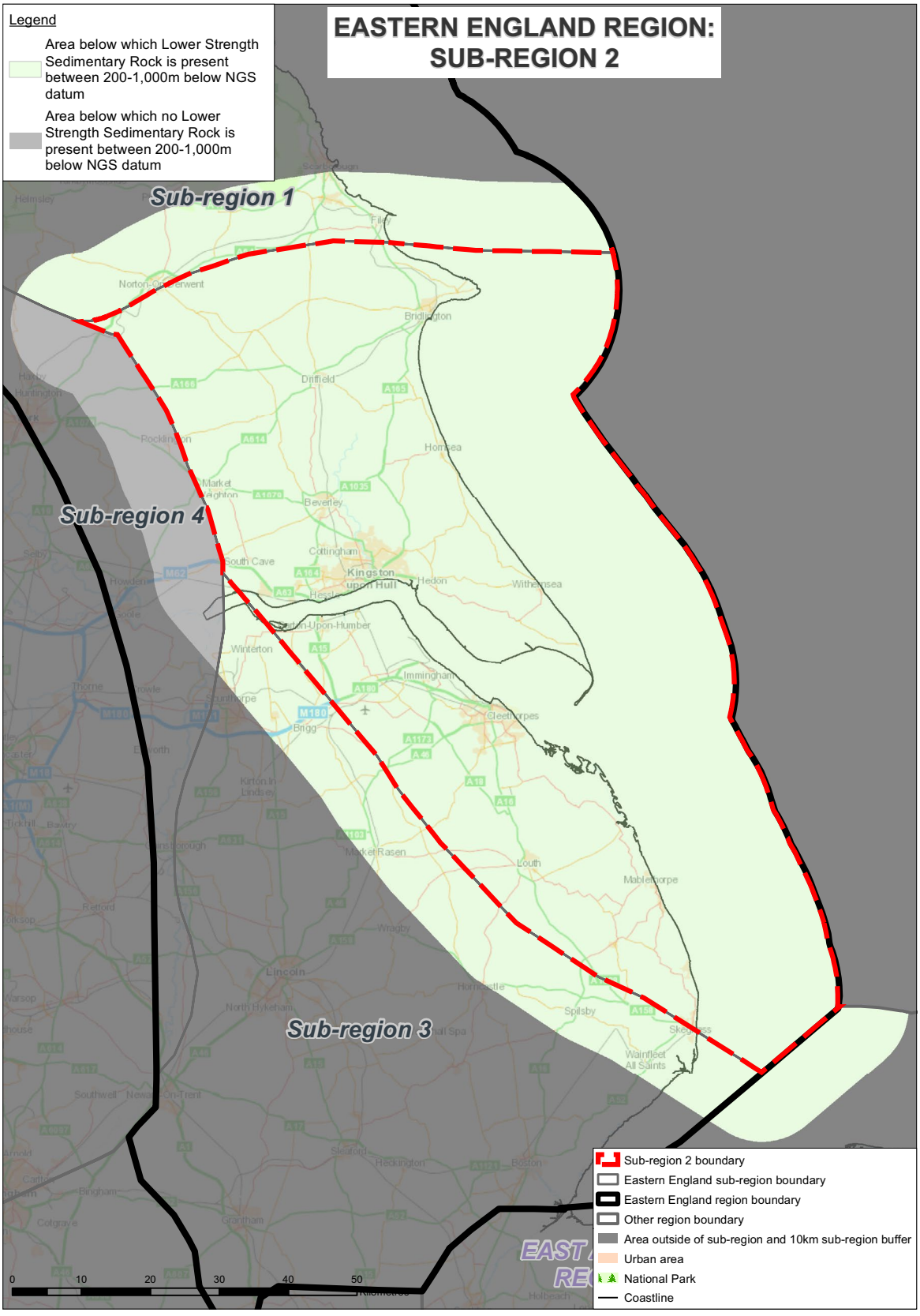


**Figure 1c** The areas of the Eastern England subregion 2 where Evaporite Rock Types of Interest are present between 200 and 1,000 m below NGS datum.

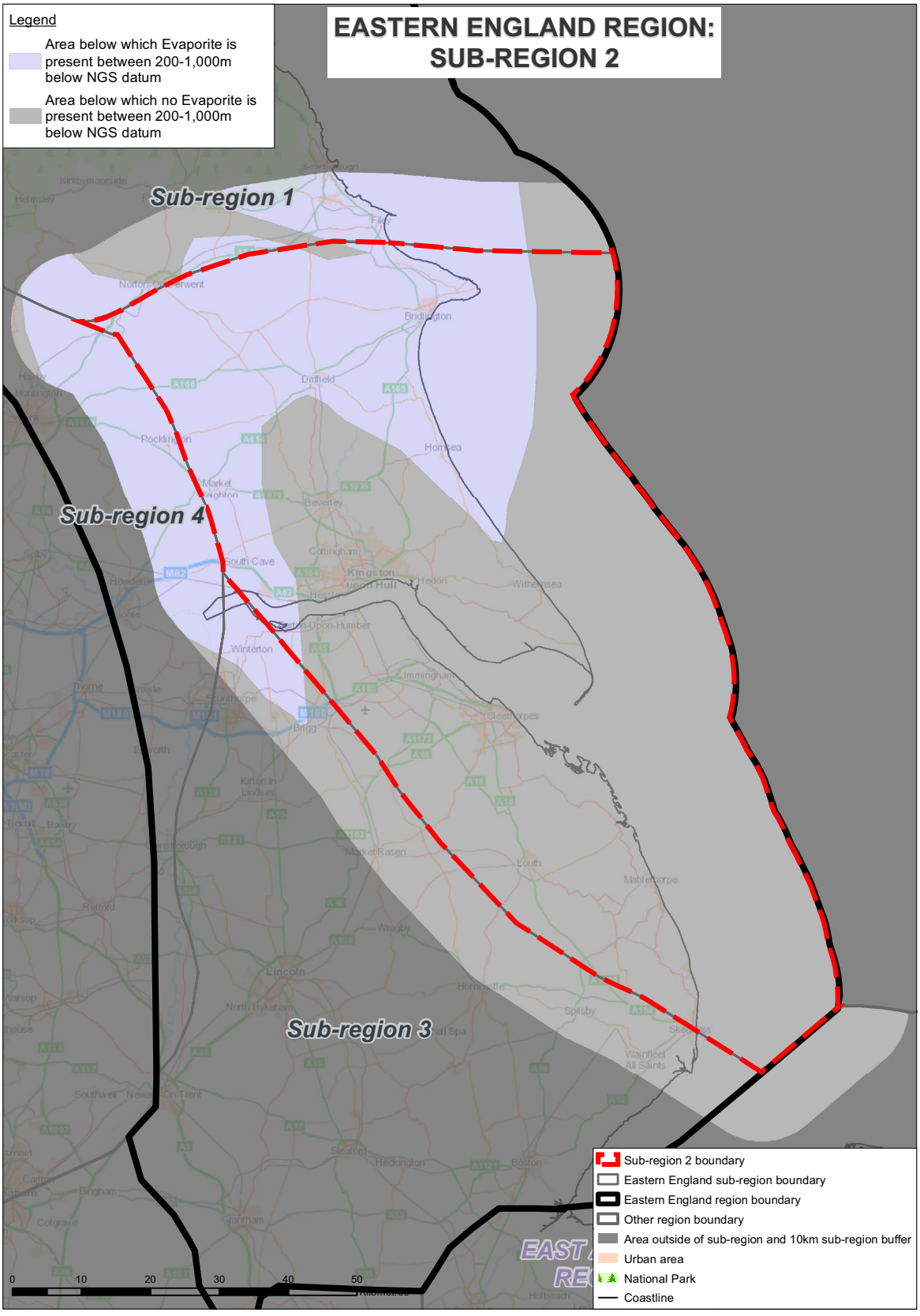


**Figure 2** Location of major faults in the Eastern England subregion 2.

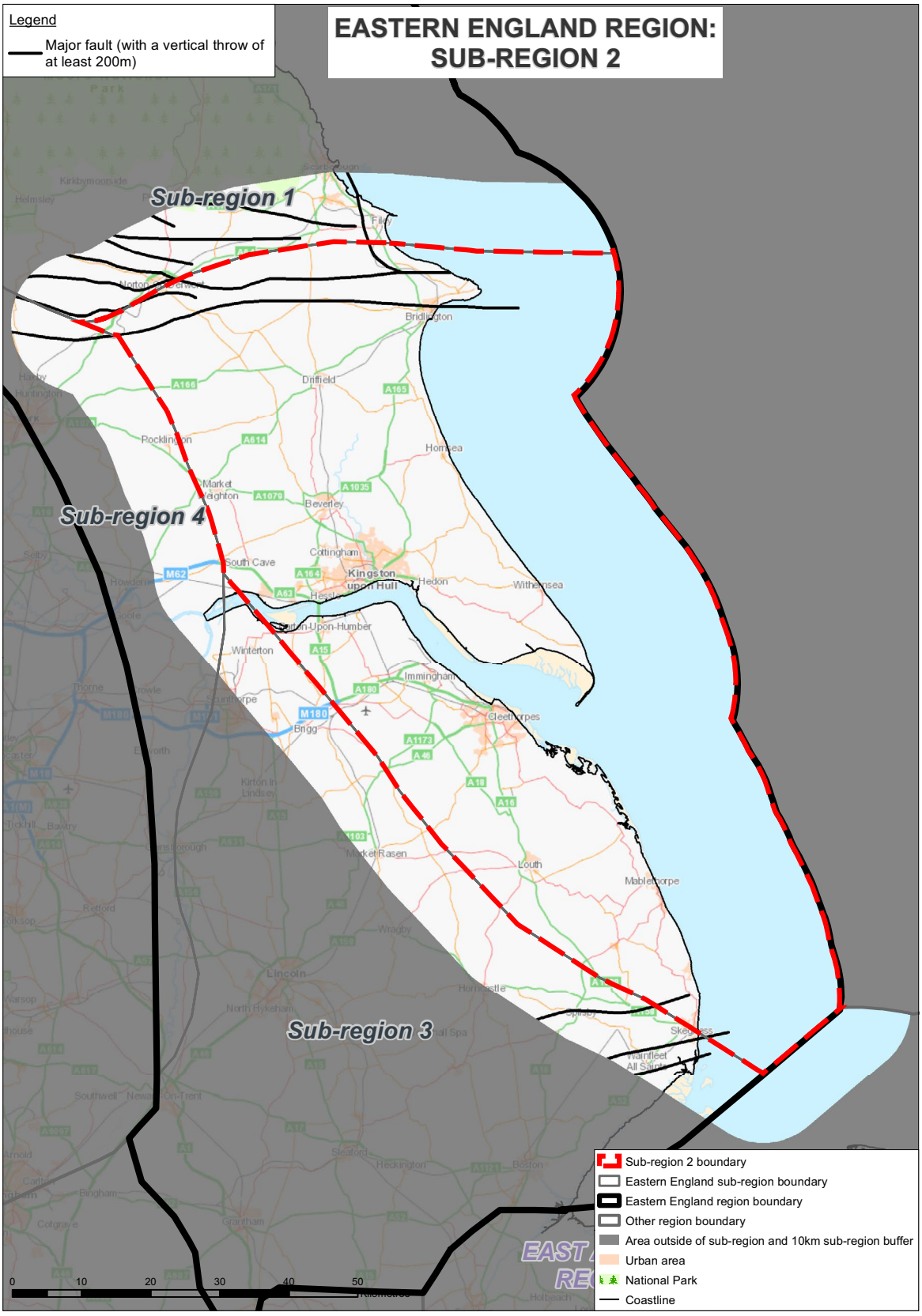


**Figure 3** Areas in the Eastern England subregion 2 with concentrations of deep exploration boreholes.

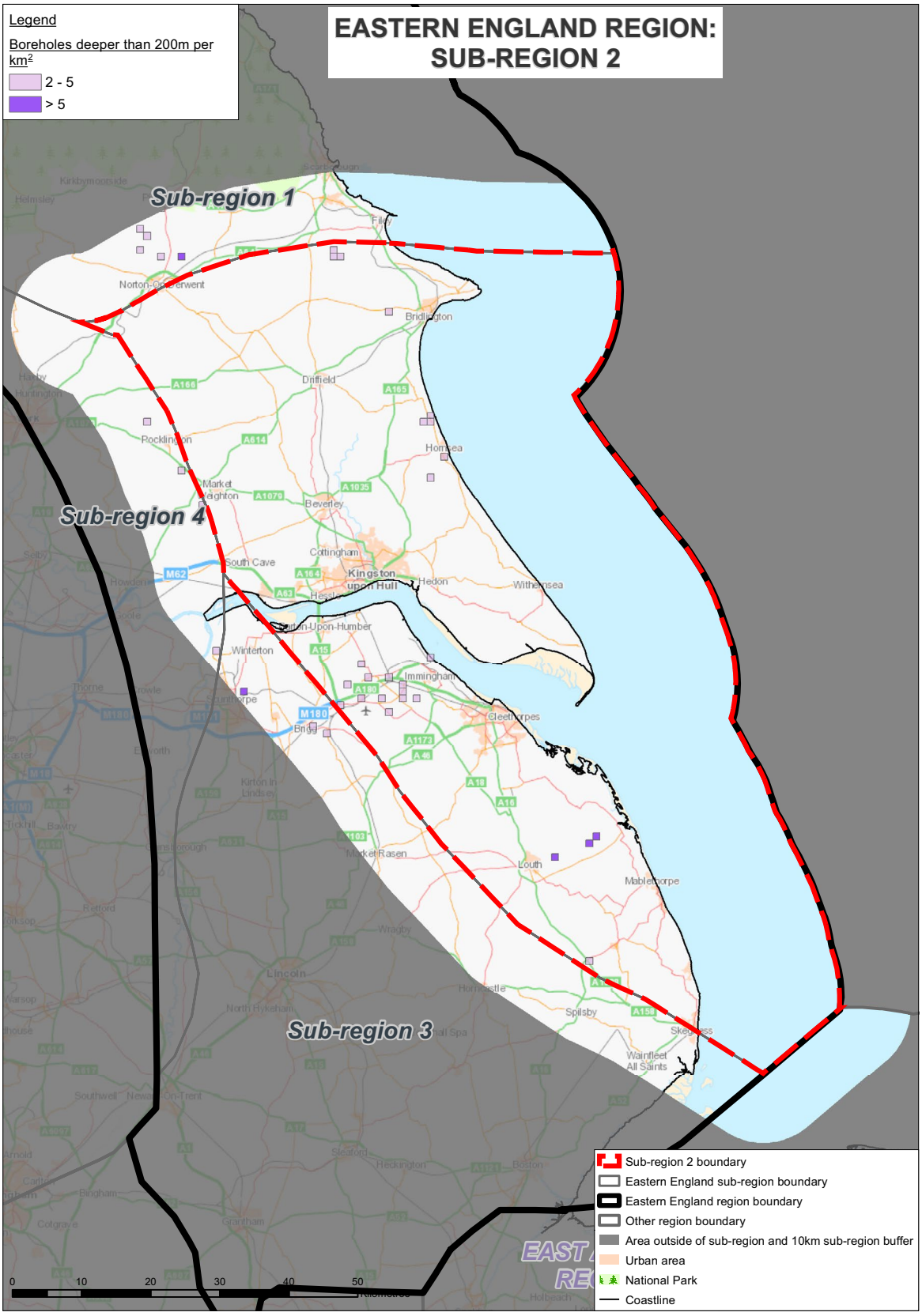


**Figure 4a** Areas of the Eastern England subregion 2 with oil and gas fields and Petroleum Exploration and Development Licences.

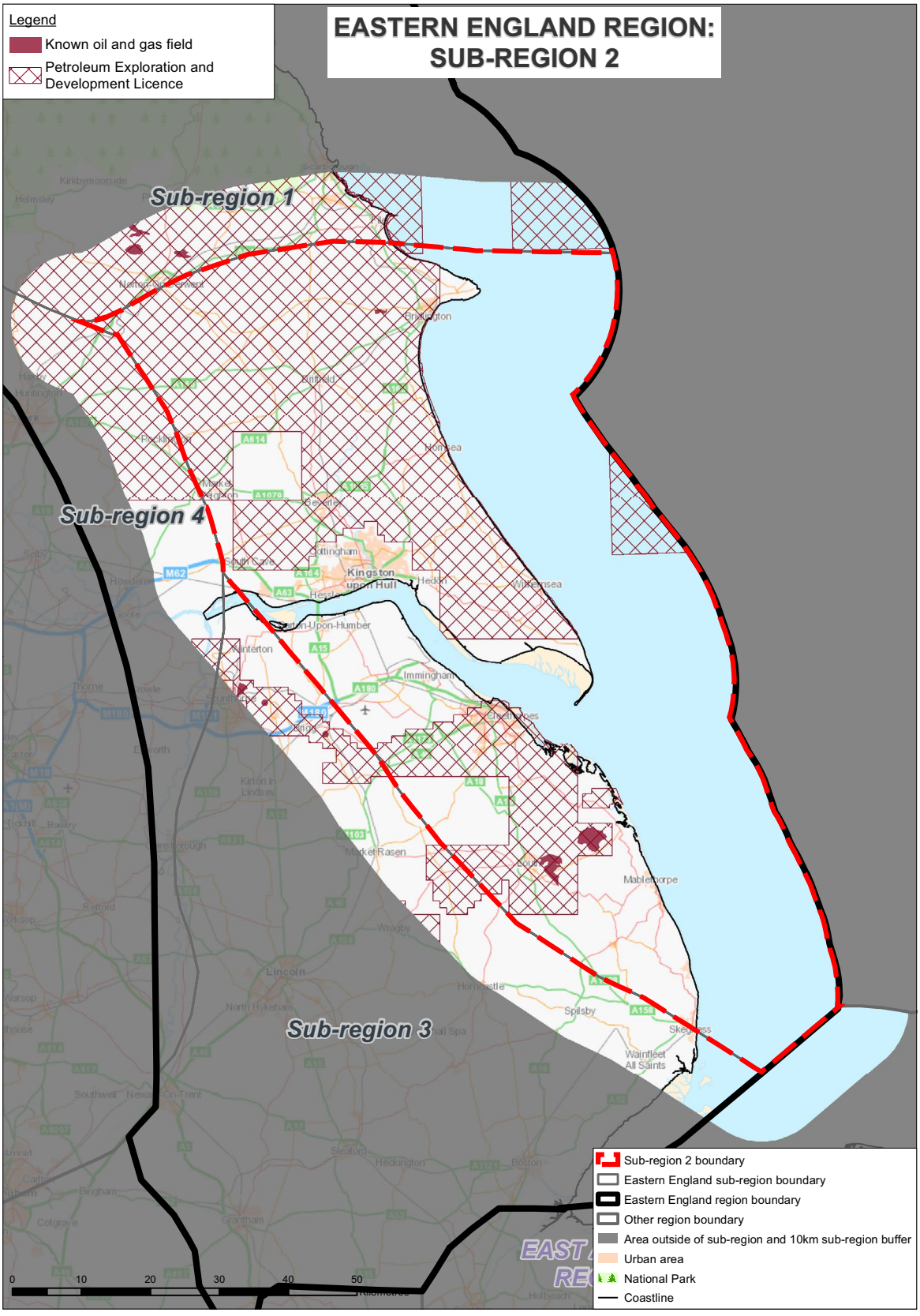
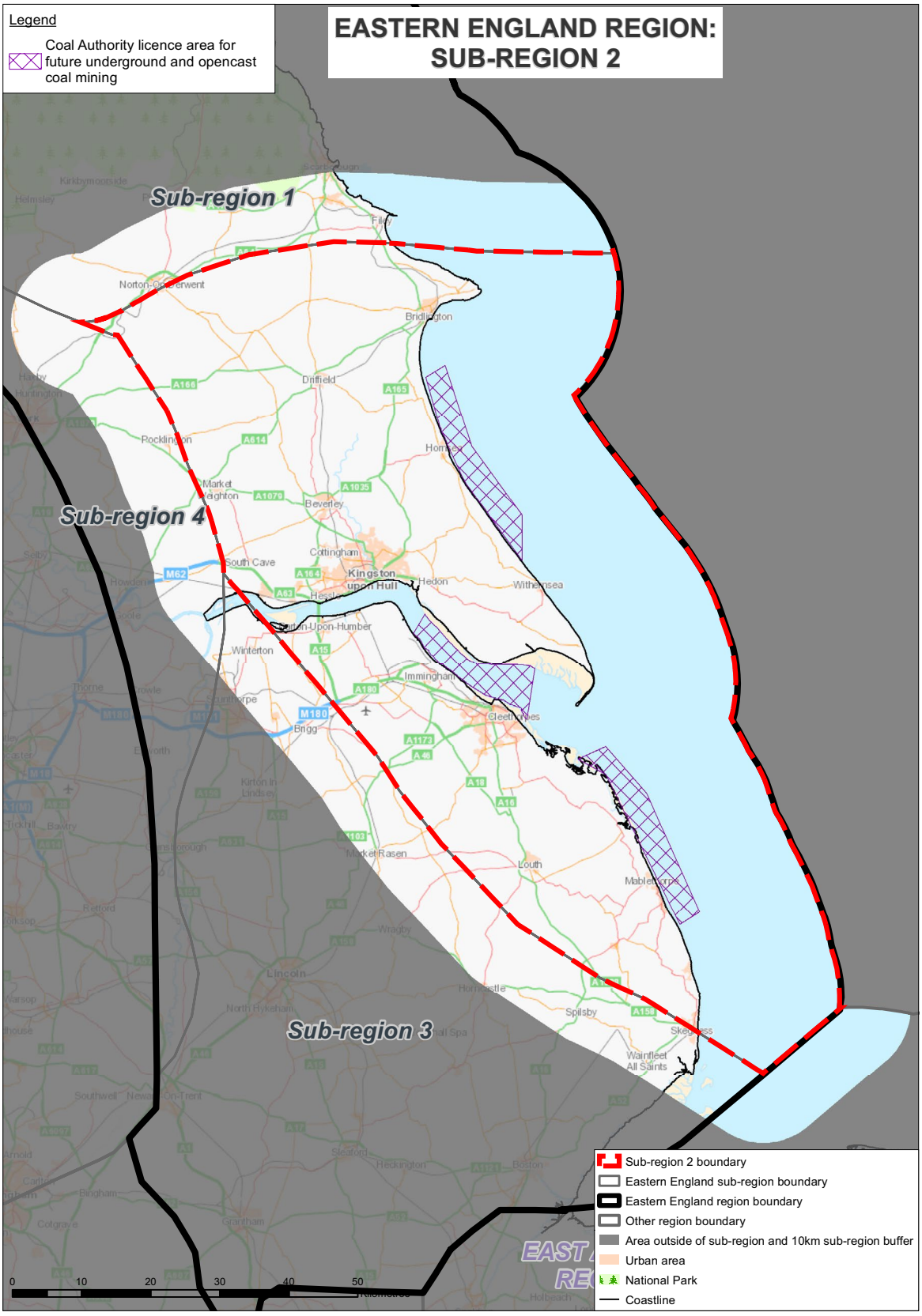


**Figure 4b** Areas of the Eastern England subregion 2 with Coal Authority Licence Areas.



# Glossary

### Anhydrite
A calcium sulphate mineral that forms from the evaporation of salty seas. It contains no water and occurs at greater depths and higher temperatures than gypsum.

### 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.

### Evaporite cycle
An evaporite cycle is a sequence of rocks left behind after a body of salty water has evaporated Often this cycle is repeated numerous times within a sequence.

### Halite
A sodium chloride evaporite mineral that forms when salty water dissolves. Also known as rock salt, or just 'salt'.

### Lithology
The physical properties of rock types.

### 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.

### Saline
Containing salt (e.g. seawater is saline).

### 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.

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