PORT OF
TILBURY
LONDON

PLANNING ACT 2008
INFRASTRUCTURE PLANNING
(APPLICATIONS: PRESCRIBED FORMS AND PROCEDURE) REGULATIONS 2009
REGULATION 5 (2) (a)

PROPOSED PORT TERMINAL AT FORMER TILBURY POWER STATION

TILBURY2

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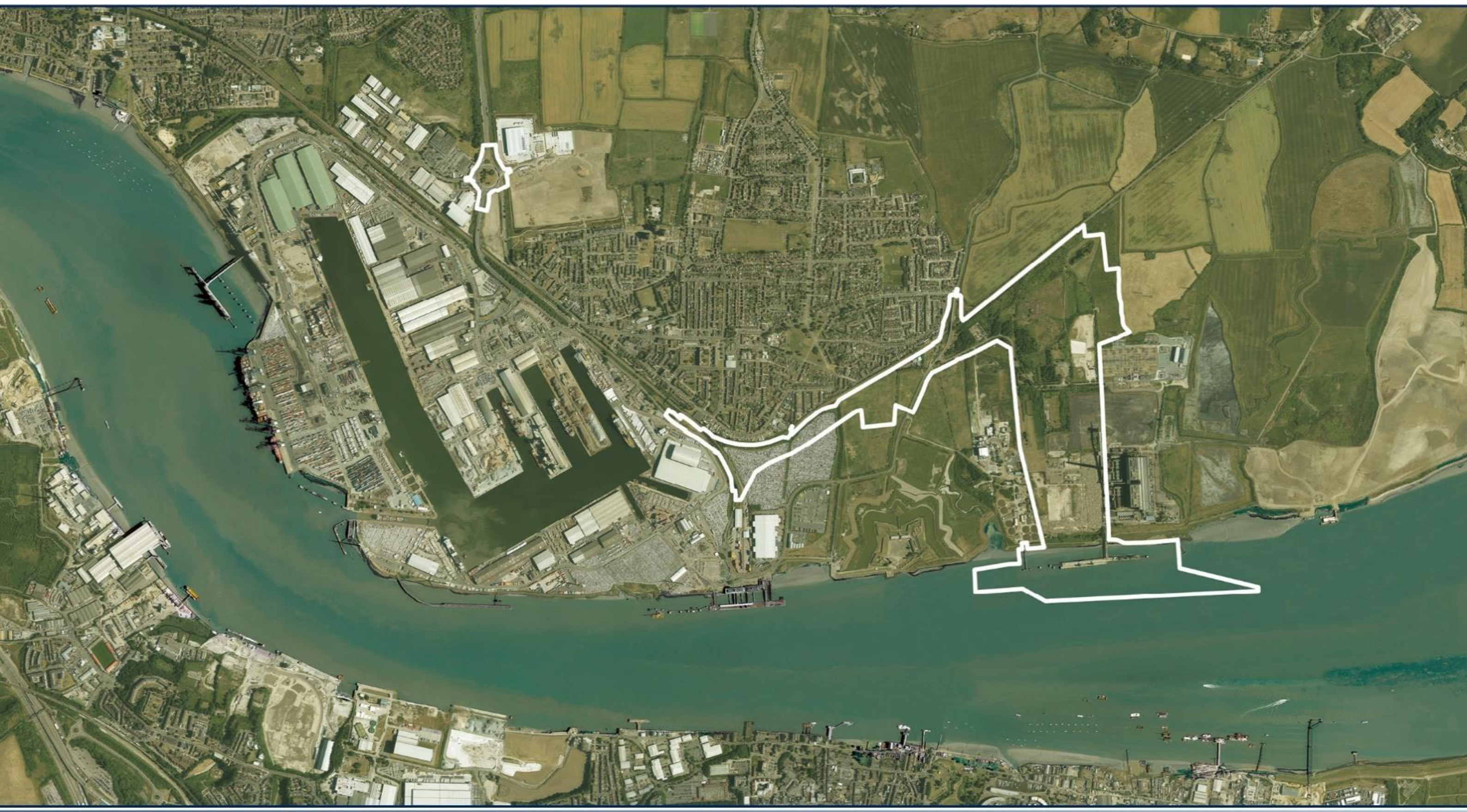

TILBURY2

Tilbury 2
Land at the former RWE Power Station
Tilbury, Essex

Stage 1 Marine Geoarchaeological Assessment

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Stage 1 Marine Geoarchaeological Assessment

Summary

Wessex Archaeology was commissioned by CgMS Consulting Ltd on behalf of Port of Tilbury London Ltd to prepare a Geoarchaeological Assessment for the forthcoming Site Investigation works for the proposed development of land at the former RWE power station at Tilbury, Essex centred on National Grid Reference (NGR) 565700, 175951.

Eight borehole records and eight riverbed samples were reviewed by specialist geoarchaeologists. The geotechnical boreholes reveal a relatively simple sequence of early Holocene alluvium overlying Pleistocene sands and gravels (River Terrace Deposits) of the Shepperton Gravel Formation. The surface of the Shepperton Gravels ranges from -16.5 to -12.5mOD, overlain by between 1.5 to 6.5m of alluvium. The alluvium contains pockets of peat <20-40mm that are considered to represent eroded and redeposited organic material.

No distinct peat horizons were recorded in any of the boreholes. The lack of securely datable horizons severely limits the geoarchaeological potential of the recorded deposits, and no further geoarchaeological work is recommended on any of the samples.

Tilbury 2
Land at the former RWE Power Station
Tilbury, Essex

Stage 1 Marine Geoarchaeological Assessment

1 INTRODUCTION

1.1 Project background

1.1.1 Wessex Archaeology (WA) was commissioned by CgMS Consulting Ltd (the Client) on behalf of Port of Tilbury London Ltd (PoTLL) to prepare a **Stage 1** Geoarchaeological Assessment for the proposed development of land at the former RWE power station at Tilbury, Essex, (**Figure 1**) centred on National Grid Reference (NGR) 565700, 175951.

1.1.2 The proposed development involves the re-development of the location as a new port terminal, upgrading the present jetty with new berthing dolphins, a link bridge and additional hopper and conveyor belt and a new berth for Roll-on/roll-off (Ro-Ro) ships. The raised pipeline to the Anglian Water Services sewage treatment plant to the west of the site will be removed.

1.2 Scope of report

1.2.1 To help frame geoarchaeological investigations of this nature, WA has developed a five-stage approach, encompassing different levels of investigation appropriate to the results obtained, accompanied by formal reporting of the results at the level achieved. The stages are summarised below (**Table 1**).

1.2.2 This document sets out the results of the **Stage 1** geoarchaeological assessment comprising a review of geotechnical logs, and, deposit modelling of the interpreted stratigraphy. The results will inform an assessment of the archaeological potential of the sedimentary sequences and recommendations for any further work.

Table 1: Staged approach to geoarchaeological investigations

Stage 1: Geoarchaeological desk-based assessment	Review of sub-surface data, generally borehole and/ or test-pit logs generated by geotechnical contractors, and including other available data such as BGS online logs. Establish the probable location of any deposits with likely archaeological and/ or palaeoenvironmental potential. This may be simply in the form of a scoping for a WSI, or be reported on as a discrete phase of Stage 1 work. Outline any fieldwork recommended to investigate deposits according to the project aims. The recommended number, location, type and depth of any boreholes, test pits or other works proposed will be specified, although this may be adjusted due to external factors such as service locations.
Stage 2: Geoarchaeological field assessment (sample collection, description & interpretation)	If fieldwork has been agreed at Stage 1, this is carried out now. The cores are described by a geoarchaeologist, and interpretations made regarding formation processes and depositional environments, and their likely archaeological and palaeoenvironmental potential. A deposit model may be constructed at this stage if appropriate, which will also incorporate any other available data. The Stage 2 report will set out the nature and scope of any Stage 3 (palaeoenvironmental assessment) work which may be recommended to assess the potential of the deposits, and to further characterise and interpret them. If further work is recommended, then the number, type and location of recommended sub-samples will be specified, which may include radiocarbon samples. Should no further works be required, a Stage 2 report outlining the results in the archaeological and palaeoenvironmental context of the local or wider area will be prepared, and will form the final reporting stage unless publication is required.
Stage 3: Palaeoenvironmental assessment	Sub-sampling and assessment of samples agreed in Stage 2 (for a range of micro-and macro-fossil palaeoenvironmental indicators such as pollen, diatoms, plant macrofossils, molluscs, ostracods and foraminifera as appropriate). Samples for radiocarbon dating may also be taken and submitted at this stage if this has been agreed at Stage 2. The relevant ecofacts will be identified to at least main Taxon, with quality of preservation and approximate quantification. This enables the value of the palaeoenvironmental material surviving within the samples to be assessed. The Stage 3 report will set out the results of each laboratory assessment, and summarise the results and their potential in the archaeological and palaeoenvironmental context of the local or wider area. Recommendations will be made as to whether any Stage 4 work is warranted. If Stage 4 work is recommended, then the number, type and location of sub-samples will be given, along with those for radiocarbon dating. Should no further works be required, the Stage 3 report may form the final reporting stage unless publication is required.
Stage 4: Analysis	Full analysis of samples specified in Stage 3. Typically, Stage 4 will be supported by radiocarbon dating of suitable sub-samples. The Stage 4 report will provide a detailed synthesis of the results, and place them in their local, regional and wider archaeological and palaeoenvironmental context as appropriate. Publication of the results will usually follow from the Stage 4 report.
Final Reporting	The scope and location of the final publication report will be agreed in consultation with the client and LPA advisor. The publication report may comprise a note in a local journal or a larger publication article or monograph, dependant on the significance of the archaeological work.

1.3 Geology and topography

1.3.1 The underlying bedrock geology in the local area forms part of the Sussex White Chalk Formation of Upper Cretaceous date (100.5 to 66 million years ago). The bedrock is in turn overlain by a sequence of superficial sediments of Late Pleistocene and Holocene age, consisting of alluvial clays, silts, sands and gravels. The sands and gravels correspond to the Shepperton Gravel Formation, in places measuring over 5 m in depth. The Shepperton Gravels are the youngest of the Thames gravels and were deposits between 18,000 and 15,000 years ago after the last glacial maximum (Larminie, 1989; Bridgland 1994).

1.3.2 During the Holocene, alluvial clays and silts were deposited under the influence rising post-glacial sea-levels, representing mudflat and saltmarsh environments, with the interbedded peats representing phases of marine regression when peat-forming semi-terrestrial plant communities developed (Devoy 1979).

1.4 Geoarchaeological background

1.4.1 The geoarchaeological background and associated archaeological potential for the area is outlined in detail in the Marine Desk Based Assessment (Wessex Archaeology, 2017), summarised below in the context of previous geoarchaeological work in the Tilbury area.

1.4.2 Initial work by Devoy (1979, 1982) characterised the Pleistocene and Holocene deposits within the lower Thames Estuary, describing a series of interbedded alluvial clays and silts and peat deposits occurring between -12 to 0 mOD and up to 12 m thick. The peats were referred to as Tilbury I to IV, forming under periods of falling (or stable) river levels during marine regressive episodes, with the earliest peats forming on gravel dating the Mesolithic (c. 9400-7500 cal. BP). The minerogenic deposits of clays and silts are alternatively referred to as Thames I to IV, forming under rising sea-levels during marine transgressive episodes.

1.4.3 A full geoarchaeological survey of the onshore Development Area, including a N-S transect across the inter-tidal zone into the marine zone and an E-W transect across the south side of the existing jetty (Wessex Archaeology, 2008) demonstrated the presence of buried peat deposits within the terrestrial and inter-tidal zones in the upper ‘Unit 3’ deposit of alluvium, but these were not present in the marine boreholes. This may be due to fluvial erosion of the upper layers of alluvium, suggesting that there may well be exposed edges of peat along the High-Water Mark and within the inter-tidal deposits.

1.4.4 Previous work by Wessex Archaeology (2015) in the western part of the Tilbury Docks identified a series of alternating organic clays, silts and peat deposits between -5.1 m and -12.77 mOD, overlying gravels of the Shepperton Gravel Formation. The overlying peats were dated to the late Mesolithic, early and mid-late Neolithic and Iron Age, representing a series of bog, fen and alder carr woodland habitats interspersed with mudflats and saltmarshes formed during marine transgressive episodes.

1.4.5 A more recent report into the geoarchaeological potential by Quest (2016) also noted the presence of three bands of peat (Lower, Middle and Upper), dating to the middle-late Mesolithic, late Mesolithic to early Bronze Age and Iron Age respectively. Quest highlight the regional and potentially national potential of all three layers of peat for containing palaeoenvironmental evidence for occupation, environment and sea-level rise, and their potential for containing associated artefacts. The report also notes the recent analysis of human remains (Schulting, 2013) found within the Lower Peat during the construction of Tilbury Docks in the 1880s, which date these remains to the Late Mesolithic, a period for which minimal human remains have been found in the UK (Quest, 2016).

2 AIMS AND OBJECTIVES

2.1.1 The overall aim of this Stage 1 report is to assess the geoarchaeological potential and significance of the sedimentary sequences, and to make suitable recommendations for Stage 2 geoarchaeological recording if appropriate. Specific aims are;

- review, model and describe the geotechnical borehole logs;
- identify the presence of geoarchaeological significant deposits (e.g. peat) that have the potential to provide data on the relationships between past climate, vegetation change and human activity; and,
- make detailed recommendations for any further Stage 2 work where appropriate.

3 METHODOLOGY

3.1 Borehole review

3.1.1 The Stage 1 review was based on geotechnical logs produced by the geotechnical contractor. Interpretation of the geotechnical logs will be undertaken by an experienced and qualified geoarchaeologist with reference to previous investigations in the area. Advice will be communicated to the geotechnical contractor regarding retention of undisturbed core samples if further (Stage 2) work is warranted. The assessment was undertaken with reference Historic England guides to Environmental Archaeology (2011) and Geoarchaeology (2015).

3.2 Deposit modelling

3.2.1 Deposit modelling is undertaken to map the lateral extent and depth of deposits within the development area. Eight deposit records (**MO-BH01** to **MO-BH08**) were entered into an industry standard software package (Rockworks^{TM} v17.0). Each interpreted stratigraphic unit (e.g. peat, alluvium, bedrock) was assigned a colour and pattern allowing correlation and grouping of the different sediment and soil types between borehole locations. The grouping of these deposits is based on the lithological descriptions in the original logs, which define distinct depositional environments referred to as 'stratigraphic units'.

3.2.2 Where suitable contexts are present, stratigraphic units are reconstructed laterally and displayed in the form of Digital Elevation Models (DEMs), thickness plots and transects (**Figures 2-6**). For the creation of thickness plots, only those boreholes containing the full stratigraphic unit, and penetrating into the underlying deposit, have been used to model thickness of sediment across the proposed development area.

4 RESULTS

4.1.1 Eight borehole records were reviewed and modelled (**MO-BH01** to **MO-BH08**), a transect reporting the key deposits is shown on **Figure 6**). Riverbed sediments were also sampled at eight locations (**MO-RBS01** to **MO-RBS08**) close to the borehole locations, in all cases to a shallow depth of 0.30 m.

4.1.2 Digital Elevation Models and Thickness were created for alluvium (**Figures 3** and **4**) and river terrace deposits (**Figures 5** and **6**).

Alluvium

4.1.3 Alluvium is present in all eight boreholes and eight riverbed samples, predominantly consisting of slightly sandy clay, containing occasional pockets of organic matter, wood fragments and rootlets. The alluvium grades into gravelly sand in borehole **MO-BH01**.

4.1.4 The alluvium is penetrated in five boreholes (**MO-BH01**, **MO-BH03** to **MO-BH06**) where it ranges in thickness from 1.5m (**MO-BH06**) to 6.5m (**MO-BH01**), and displays a gradual east to west thinning. The elevation of the surface of the alluvium ranges from -8.95 to -13.6 mOD (**Figures 2, 3** and **4**). The geotechnical descriptions of organic inclusions in the alluvium suggest the organic matter may be largely eroded and redeposited, rather than forming discrete organic layers or laminae. No peat deposits were recorded in any of the boreholes.

Pleistocene river terrace deposits

4.1.5 Pleistocene deposits are recorded in five of the eight boreholes (**MO-BH01**, **MO-BH03** to **MO-BH06**), consisting of brown, sands and gravels with some finer components grading with depth into coarser sands and gravels.

4.1.6 The gravels comprise angular to rounded flint. No organic lenses were recorded within the Pleistocene deposits. Two boreholes penetrated into the underlying bedrock (**MO-BH01** and **MO-BH05**) with 4.85 and 7.6m of sands and gravels recorded, respectively (**Figure 2**).

4.1.7 The river terrace deposit DEM and unit thickness (**Figures 5** and **6**) suggest the height of the surface of these sands and gravels dip from east to west (-12.6 to -16.5mOD), with increasing thickness in deposits to the west.

Bedrock

4.1.8 Pleistocene river terrace deposits are underlain by chalk bedrock, identified in boreholes **MO-BH01** and **MO-BH05** at -20mOD.

5 DISCUSSION AND RECOMMENDATIONS

Discussion

5.1.1 The boreholes logs record a relatively simple sequence of Holocene alluvium overlying Pleistocene sands and gravels of the Shepperton Gravel Formation. The surface of the Shepperton sands and gravel dip from east to west (-16.5 to -12.5mOD), overlain by between 1.5 to 6.5m of alluvium, thickening to the west as the sands and gravels decrease in OD height (**Figure 6**).

5.1.2 No distinct peat deposits were recorded in the borehole logs. Pockets of peat (<20-40mm) are described for most boreholes, but are interpreted to represent eroded and redeposited organic matter rather than *in-situ* peat layers.

5.1.3 Peat deposits have previously been recorded from sites around Tilbury at heights from -13.5 to -7.37mOD (Devoy, 1979; Wessex Archaeology, 2015), with the basal peat formed on sands and gravels. These peats are within the elevation range of the alluvium recorded from the former RWE Power Station, although hydrological conditions at the Site appear to have been unsuitable for peat formation.

5.1.4 The alluvium at the site is thought to date to the early Holocene and Mesolithic period based on radiocarbon dated peats from other sites in the Tilbury area at similar elevations (-13.5 to 10 mOD) that range between 9400 and 7500 cal. BP (Devoy, 1979; Wessex Archaeology, 2015).

Recommendations

5.1.5 The eight boreholes all have limited potential for Stage 2 geoarchaeological borehole recording, primarily due to the lack of suitable peat horizons likely to contain palaeoenvironmental remains (e.g. pollen, plant macrofossils) and *in-situ* organic material to support radiocarbon dating.

5.1.6 Palaeoenvironmental remains are likely to be present in alluvium, particularly diatoms, foraminifera and ostracods reflecting changes in sea level and freshwater-estuarine environments. However, in the case of pollen, the grains are generally more poorly preserved than in peat, and can be transported over longer distances suspended in the water column and therefore of uncertain source area.

5.1.7 The key limiting factor is the absence of terrestrial plant macrofossils and other organic material in alluvium suitable for radiocarbon dating; any palaeoenvironmental data will therefore lack a secure chronological context, and will be coarsely dated at best, if at all, precluding reliable interpretations to any archaeology from the adjacent dry ground.

5.1.8 Consequently, no further geoarchaeological work is recommended on these samples.

6 REFERENCES

Bridgland, D.R., 1994, *Quaternary of the Thames. Geological Conservation Reviews No. 7.* London, Chapman and Hall.

Devoy, R.J.N., 1979, Flandrian sea level changes and vegetation history of the Lower Thames' in *Philosophical Transactions of the Royal Society of London*. Series B: Biological Sciences. 285 (1010), 355-407.

Devoy, R.J.N., 1982, Analysis of the geological evidence for Holocene sea-level movements in southeast England. Proceedings of the Geologists' Association 93, 65-90.

Historic England, 2011, *Environmental Archaeology: A guide to the theory and practice of methods, from sampling and recovery to post-excavation*, Swindon, Historic England.

Historic England, 2015, *Geoarchaeology: Using Earth Sciences to Understand the Archaeological Record*, Swindon, Historic England.

Larminie, G., 1989, *Thames Estuary Sheet 51° N-00°. British Geological Survey 1:250,000 Series, Solid Geology*. HMSO, London.

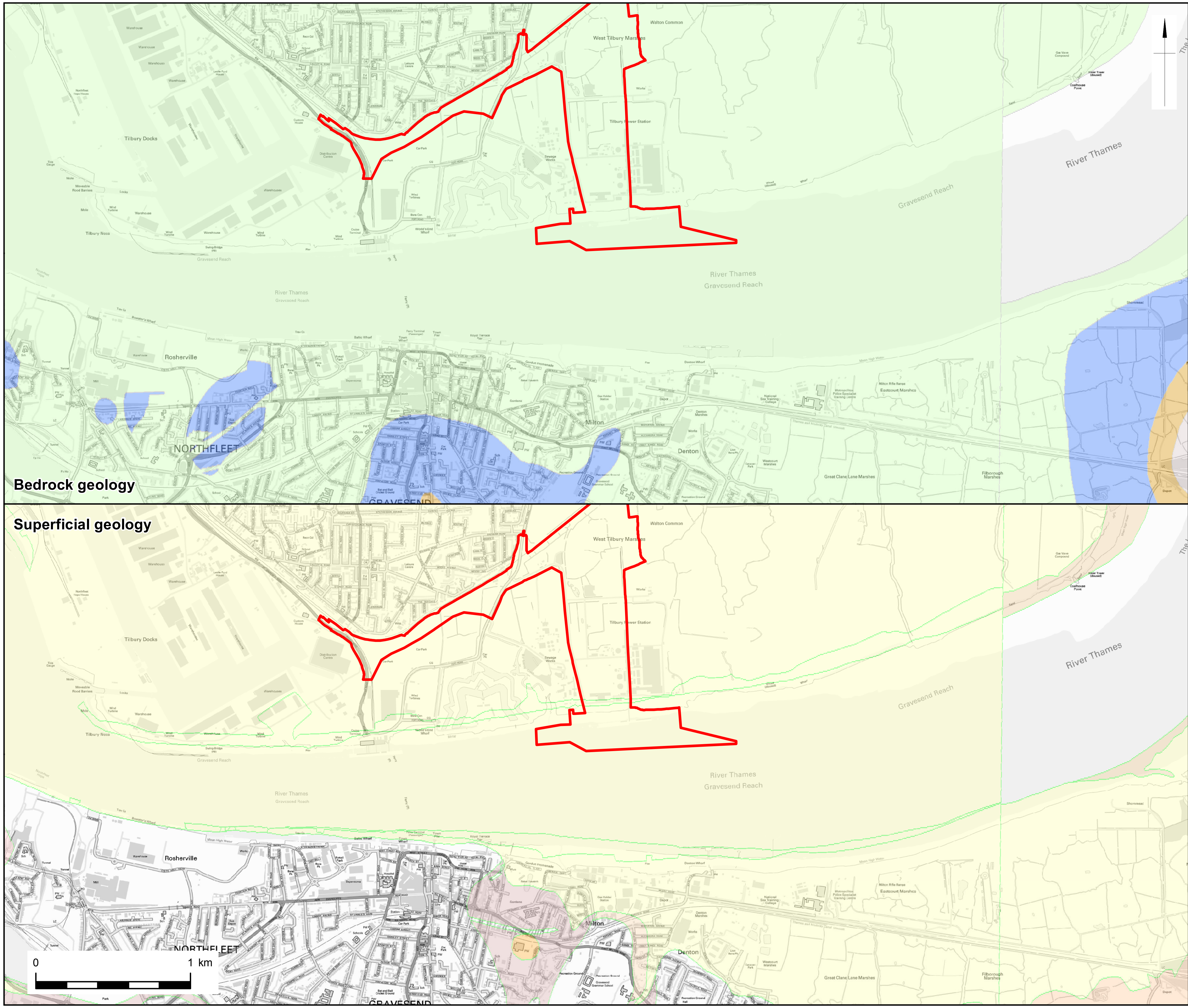
Quest, 2016, *Tilbury 2, the former RWE Power Station, Tilbury, South Essex. Geoarchaeological Deposit Model Report,* Ref 140/16.

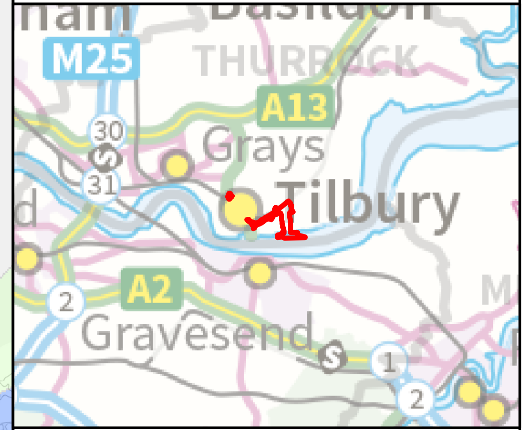
Schulting, R., 2013, 'Tilbury Man': A Mesolithic Skeleton from the Lower Thames. *Proceedings of the Prehistoric Society* 79: 19–37.

Wessex Archaeology, 2008, *Tilbury C Power Station. Geaorchaeological recording of borehole samples*. Report Ref: 67690.03.

Wessex Archaeology, 2015, Tilbury Docks, Tilbury, Essex. Borehole survey, palaeoenvironmental assessment report. Report Ref: 104540.03.

Wessex Archaeology 2017, Tilbury 2. Land at the former RWE Power Station, Tilbury, Essex. Marine Desk Based Assessment. Report Ref: 116220.01.





Site boundary

Bedrock geology

Chalk

Lambeth Group

Thanet Sand

Superficial geology

Alluvium

Head

Lynch Hill Gravel

Tidal River or Creek Deposits

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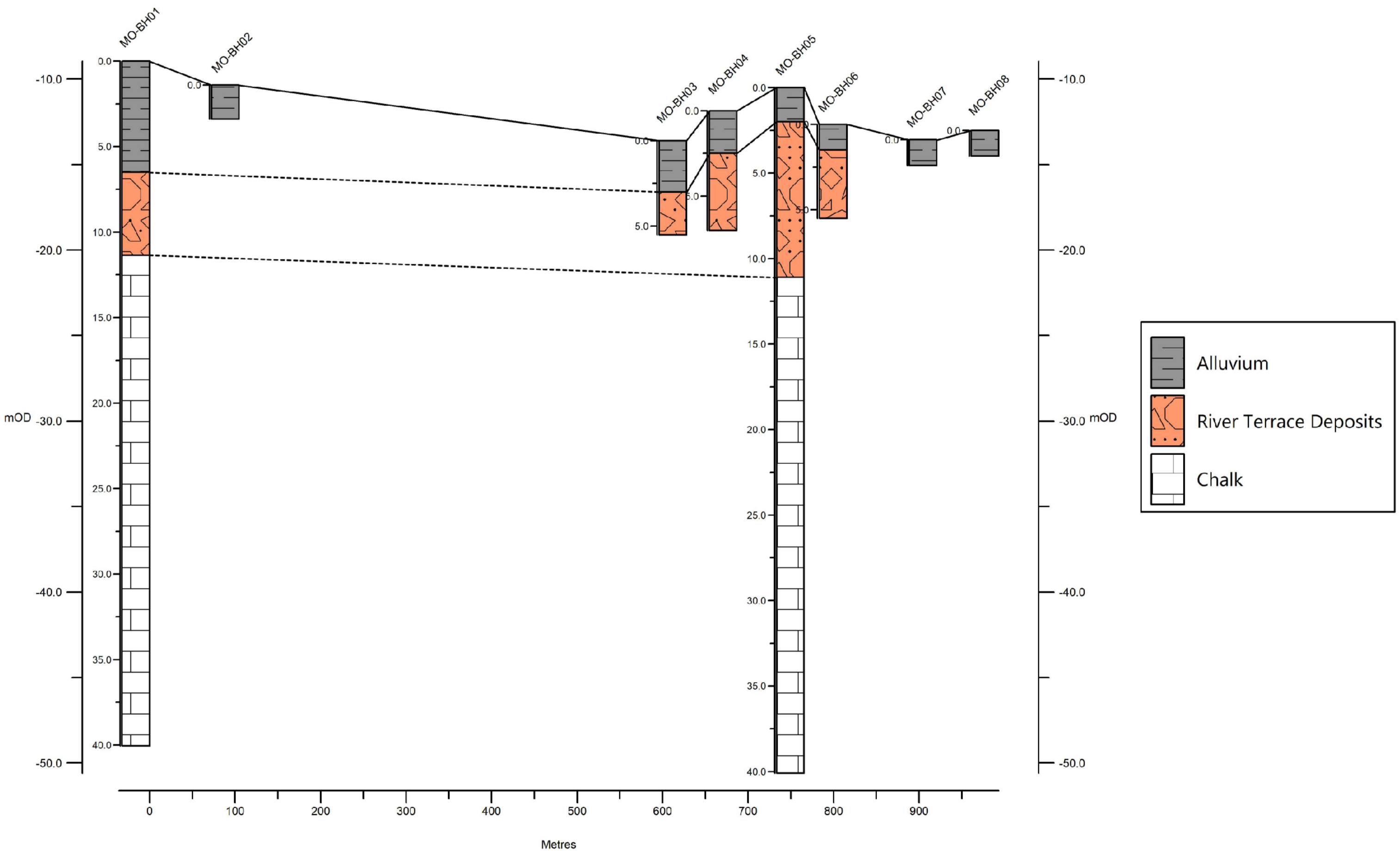
Site location

Figure 1



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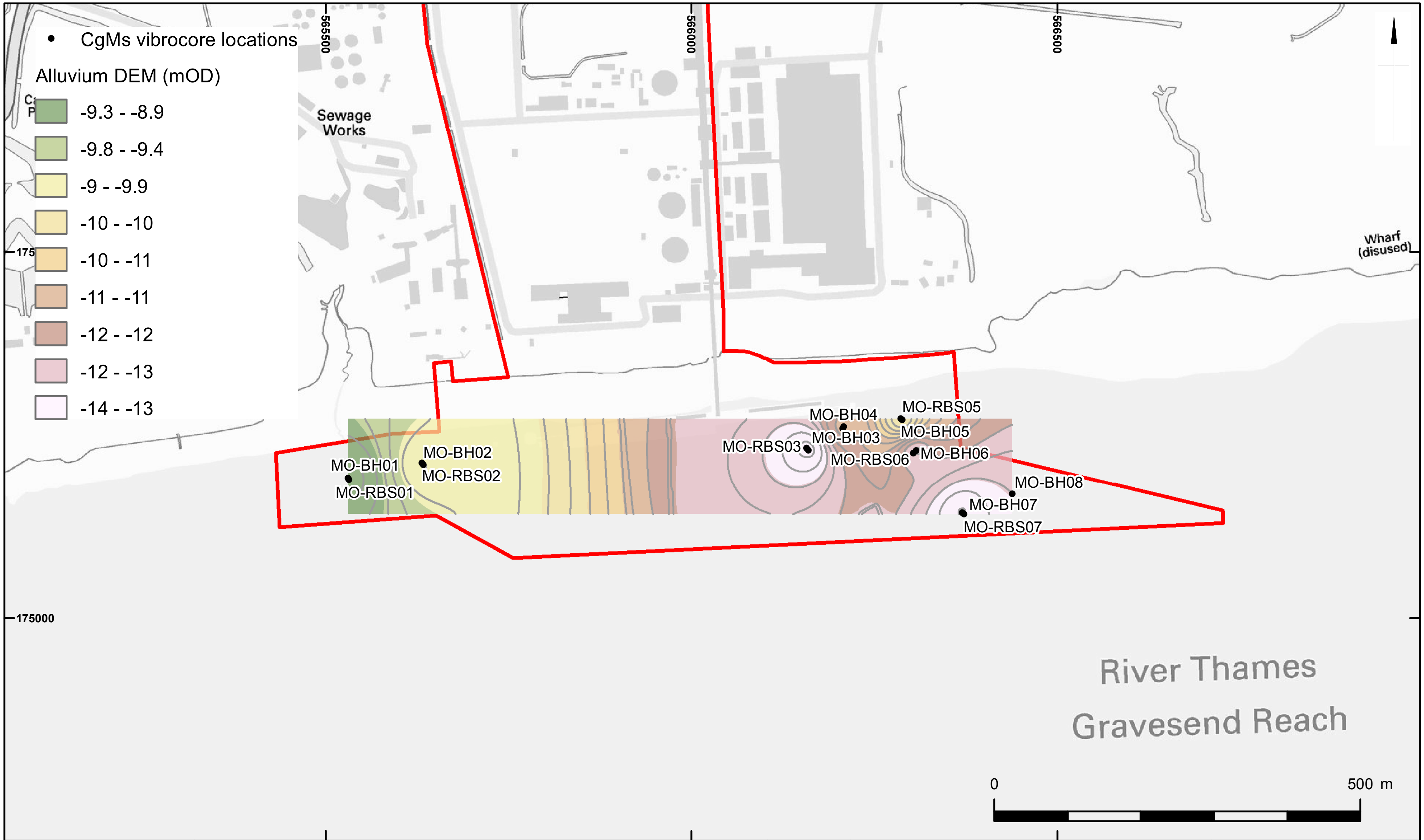
Transect across vibrocores

Figure 2



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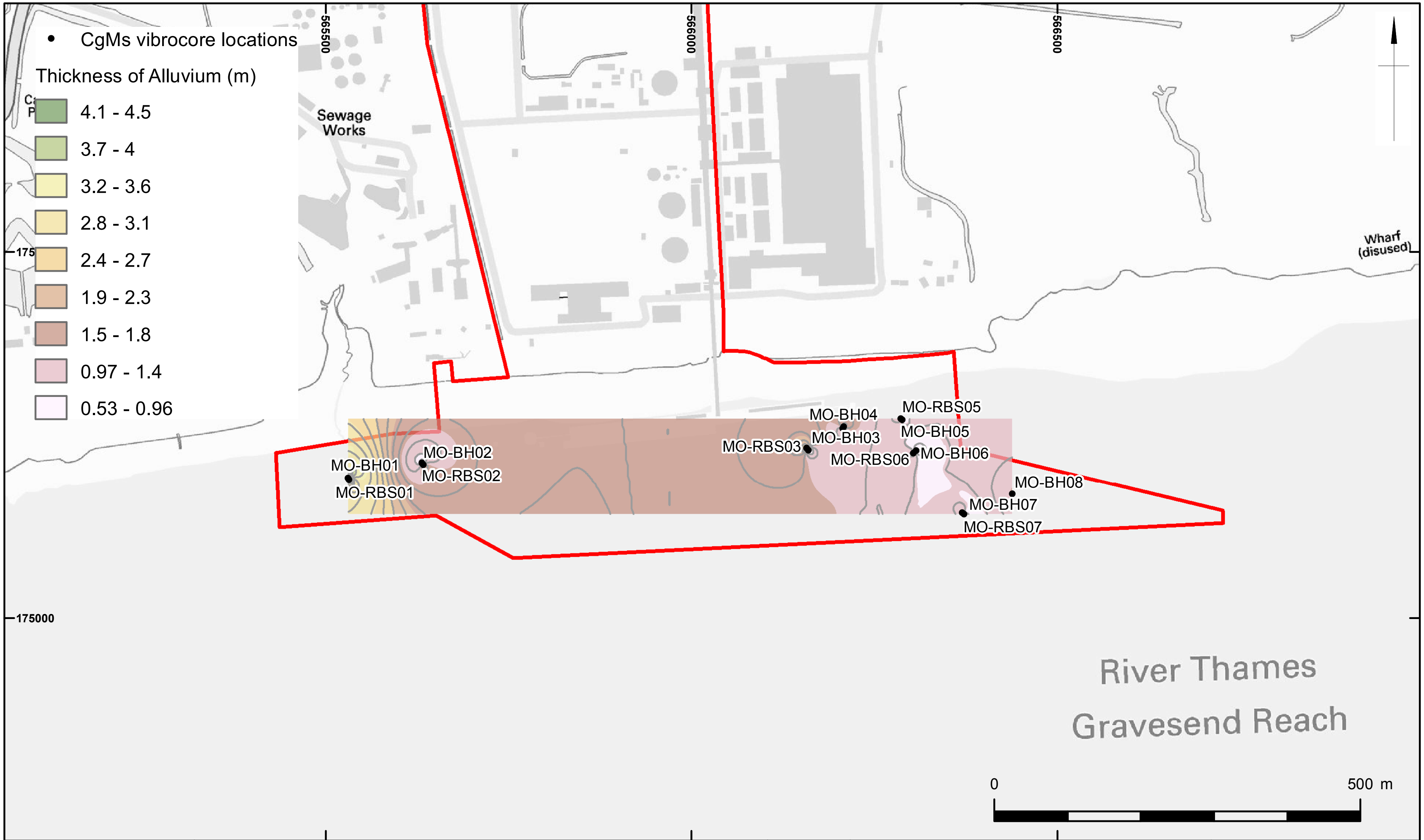
Alluvium DEM

Figure 3



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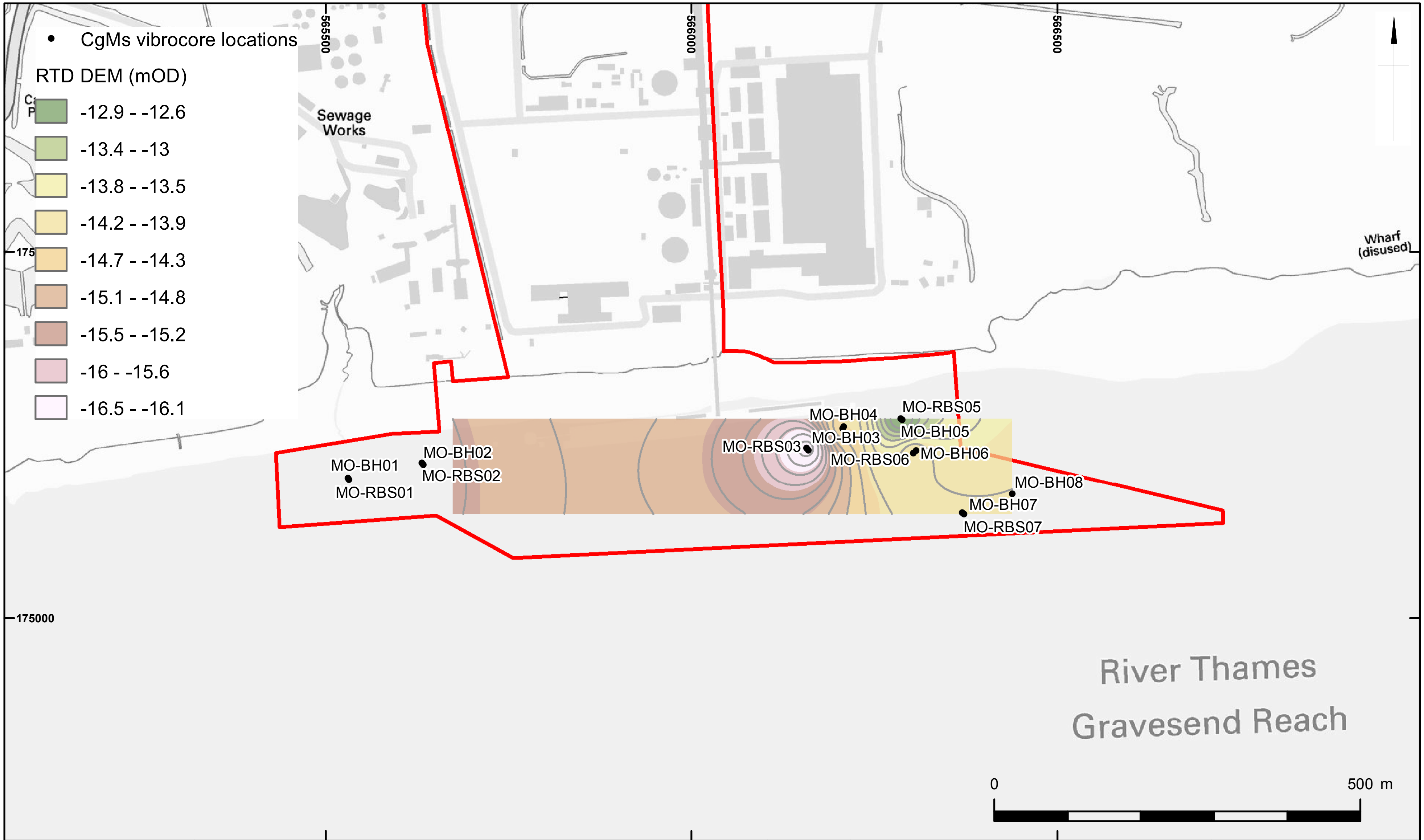
Thickness of Alluvium

Figure 4



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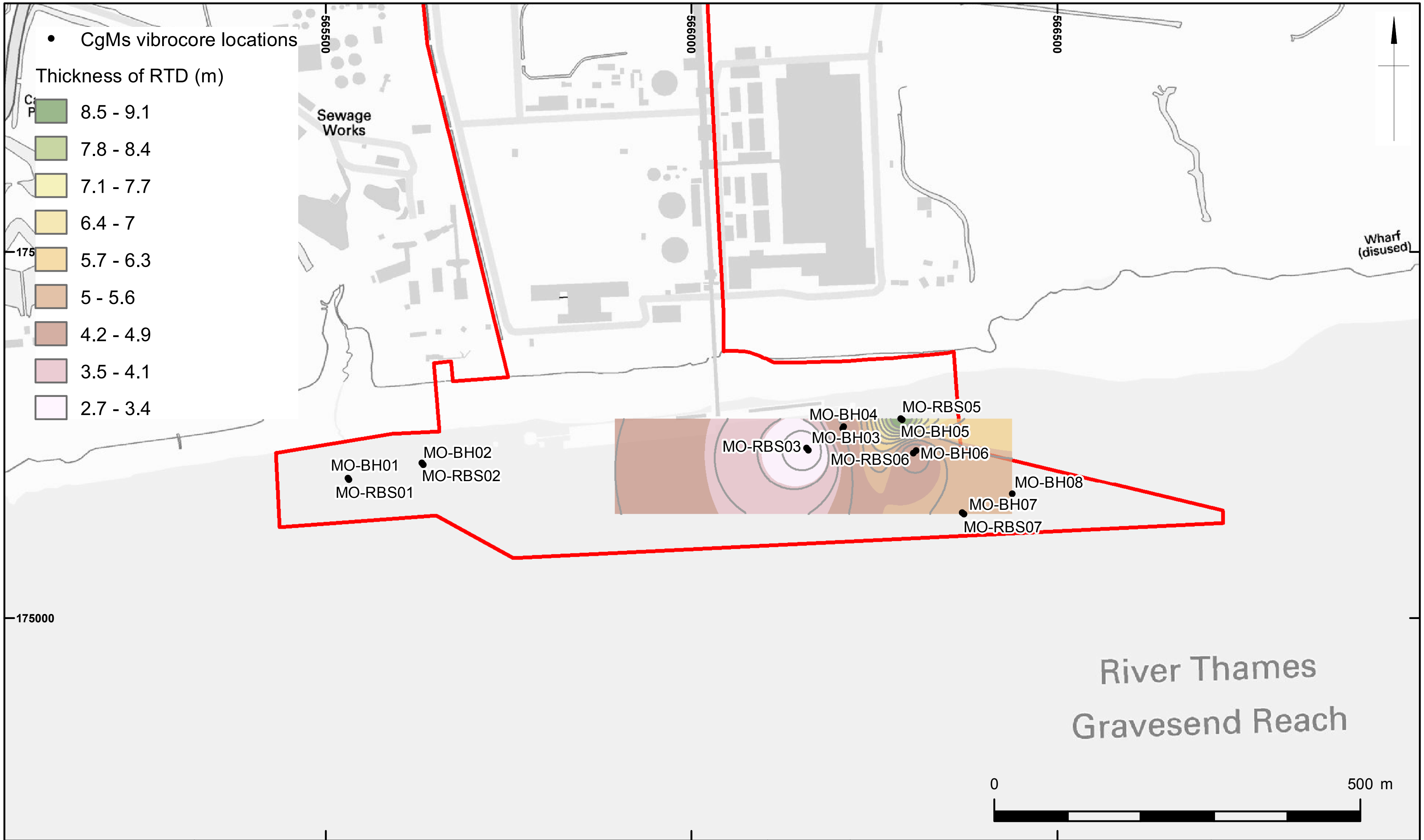
RTD DEM

Figure 5



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Thickness of RTD

Figure 6