



FIVE ESTUARIES OFFSHORE WIND FARM

6.6.6.1 GROUND WATER RISK ASSESSMENT (CLEAN)

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Five Estuaries Offshore Wind Farm

Groundwater Risk Assessment

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Table of Contents

Basis of Report	i
1.0 Introduction	A-1
1.1 Background & Project Overview	A-1
1.2 Scope of Works	A-1
1.3 Methodology.....	A-2
1.4 Scoping	A-2
2.0 Baseline Conditions	A-4
2.1 Location and Topography.....	A-4
2.2 Geology.....	A-4
2.2.1 Soils	A-4
2.2.2 Superficial Geology	A-5
2.2.3 Bedrock Geology.....	A-6
2.3 Hydrogeology	A-6
2.3.1 Recharge Mechanisms.....	A-6
2.3.2 Aquifer Characteristics and Groundwater Vulnerability	A-7
2.3.3 Groundwater Levels and Flow	A-8
2.3.4 Source Protection Zones	A-12
2.3.5 Groundwater Abstractions	A-12
2.3.6 Groundwater Quality	A-13
2.3.7 Hydrology	A-14
2.3.8 Springs.....	A-14
2.3.9 Groundwater Dependent Ecological Sites	A-14
3.0 Conceptual Site Model.....	A-16
4.0 Hydrogeological Impact Assessment	A-17
4.1 Proposed Development.....	A-17
4.2 Location Specific CSM	A-17
4.2.1 PWS 007 and PWS 008	A-17
4.2.2 PWS 002, PWS 003, PWS 004 and PWS 012	A-18
4.2.3 PWS 015.....	A-19
4.2.4 PWS 005, PWS 006 and PWS 009	A-19
4.2.5 PWS 001 and PWS 016	A-20
4.2.6 PWS 010, PWS 011, PWS 013 and PWS 014	A-20
4.2.7 Licenced Abstractions A9 and A10.....	A-21
4.3 Risk Assessment.....	A-21
4.3.1 Potential Effects	A-21



4.3.2 Embedded Mitigation.....	A-22
4.3.3 Impact on Groundwater Levels and Flows.....	A-23
4.3.4 Impact on Groundwater Quality.....	A-24
4.4 Monitoring and Mitigation	A-27
4.4.1 Survey.....	A-27
4.4.2 Monitoring	A-27
4.4.3 Mitigation.....	A-28
4.4.4 Permitting.....	A-28
5.0 Summary and Conclusions	A-28

Tables in Text

Table 2-1: Geological Sequence within vicinity of Onshore ECC Route	A-6
Table 2-2: Met-Office Climate Averages for Walton-on-the-Naze (1991 – 2020).....	A-6
Table 2-3: Aquifer Designations	A-7
Table 2-4: Estimated Hydraulic Conductivity of Superficial Sands and Gravels.....	A-11
Table 2-5: Licensed Abstraction Details	A-12
Table 2-6: Private Water Supply Details.....	A-13
Table 4-1: Summary of Groundwater Abstraction Points.....	A-23

Drawings

Drawing 1:	Site Location Plan
Drawing 2.1:	Superficial Deposits – North
Drawing 2.2:	Superficial Deposits – South
Drawing 3.1:	Bedrock Geology – North
Drawing 3.2:	Bedrock Geology – South
Drawing 4:	Source Protection Zones

Appendices

Appendix 01:	Abstraction Scoping
Appendix 02:	Groundwater Monitoring Plan



1.0 Introduction

SLR Consulting Ltd (SLR) has been appointed by GoBe Consultants Ltd (the client) to complete a groundwater risk assessment for the proposed Five Estuaries Offshore Wind farm (VE) onshore export cable corridor (ECC) and onshore substation (OnSS) area. The assessment also includes the North Falls Offshore Wind Farm (NF) OnSS area adjacent to the VE OnSS. VE and NF will share the same onshore ECC.

1.1 Background & Project Overview

Both VE and NF are developing cable routes running from a landfall between Frinton-on-Sea and Holland-on-Sea to connections points at the proposed National Grid (NG) substation between Ardleigh and Little Bromley.

Initial consultation with stakeholders including the local council and Environment Agency (EA) was undertaken in December 2023 to identify private water supplies (PWS) and licenced groundwater abstractions within a 250m radius of the onshore ECC and OnSS, this assessment as outlined within the preliminary groundwater risk assessment (GWRA)¹ submitted in February 2024.

The preliminary GWRA developed the conceptual site model (CSM), completed a preliminary impact assessment and outlined where additional monitoring was required.

Based on the preliminary GWRA a survey and monitoring of private water supplies was undertaken in September 2024 to inform this updated GWRA.

This updated Groundwater Risk Assessment is required to further refine assessment of the potential risk posed by the proposed construction works on the identified PWS and licenced abstractions.

1.2 Scope of Works

A Groundwater Risk Assessment has been completed to assess the potential risk posed by the proposed works on the fourteen identified PWS and two licenced abstractions located within or in close proximity to a 250m radius of the DCO Limits. The search radius was determined based on the worst case potential radius of influence, as outlined in the preliminary GWRA.

A baseline review of the geology, hydrogeology and hydrology has initially been undertaken and used to develop a Conceptual Site Model (CSM). This CSM is subsequently used to identify where a hydraulic connection exists between the proposed development and identified groundwater receptors.

A more detailed assessment of each receptor is subsequently completed to further refine the potential hydraulic linkages and a groundwater risk assessment completed based on the proposed construction works.

¹ SLR Consulting Ltd - 404.v05356.00010_Five Estuaries_GRA_V1



1.3 Methodology

This risk assessment has been developed in accordance with relevant EA guidance on completion of groundwater risk assessments² and Hydrogeological Impact Appraisals (HIA)³ and includes the following stages:

- Section 2 provides a baseline assessment of the onshore ECC and OnSS area. This includes a summary of the site geology and hydrogeology including information on ground conditions, groundwater levels and flows, groundwater quality and the location of potential receptors which could be impacted as a result of construction activities at the site. Finally, a CSM of the current hydrogeological regime is provided.
- Section 3 provides an assessment of the potential impact that the works could have upon the identified receptors and regional hydrogeology and hydrology. Appropriate mitigation measures and requirements for additional investigation and/or monitoring are outlined; and
- Section 4 provides a summary of the overall impact that the works could have upon the local hydrogeology and any identified receptors.

A qualitative risk assessment methodology has been used to assess the potential significance of impacts associated with the development works. Two factors are considered using this approach: the sensitivity of the receiving environment and the magnitude of any potential impact. This approach provides a mechanism for identifying where additional mitigation measures are potentially required to reduce the risk to groundwater receptors.

1.4 Scoping

Several stages of scoping has been undertaken to refine the locations of water supplies which need to be included within this assessment. The following processes have been followed to refine the scope of this assessment:

1. Freedom of information requests were submitted to the EA and local council in December 2023 to obtain the details of all licenced abstractions and Private Water Supplies (PWS) located within a 500m radius of the DCO Limits. This identified 33 licenced abstractions and 25 PWS;
2. A preliminary GWRA was completed in December 2023 which:
 - scoped out 20 of the licenced abstractions due to either abstracting from surface water or being in excess of 250m radius of the DCO Limits (as calculated as a worst case radius of influence from any potential dewatering). Six of the PWS were also scoped out for being in excess of 250m radius of the DCO.
 - The Preliminary GWRA was completed on the 13 remaining licenced abstractions and 19 remaining PWS. This further refined the number of locations in need of further assessment based on distance from any below ground development and hydraulic connection to the proposed works;
 - The finalised preliminary GWRA identified two licenced abstractions and 5 PWS which require further assessment and are included in this assessment

² Groundwater risk assessment for your environmental permit - GOV.UK (www.gov.uk), published Feb 2016, updated Apr 2018 [Accessed November 2023]

³ Hydrogeological Impact Appraisal for Dewatering Abstractions, Science Report – SC040020/SR1 Environment Agency, May 2007



3. Survey and monitoring of the abstractions outlined in the GWRA was undertaken in September 2024, this process also identified a further five PWS located either within or a little over 250m from the DCO Limits which have also been included in this assessment to ensure a conservative approach to assessment is maintained.
4. Further survey has been undertaken by Royal Haskoning DHV which has included discussions with the Land Agents identified two additional water supplies not presently registered with the local council within 250m radius of the DCO Limits which have also been included within this assessment

A plan showing the locations of all abstractions (licenced, PWS and unregistered) included within the preliminary GWRA and this updated GWRA is included on Drawings 1-4 and a summary of which licences have been previously scoped out of this assessment is presented in Appendix 01.

Based on the above process sixteen PWS or unregistered abstractions and two licenced abstractions have been included within this assessment, as summarised in further detail in Section 2.3.5.



2.0 Baseline Conditions

The geological and hydrogeological regime along the onshore ECC and the surrounding area is considered under the following headings: location and topography; geological setting; and hydrogeological setting, all of which have been used to develop a CSM. This provides an overview of the regional hydrogeology and is assessed further on a local scale, based on the location of identified infrastructure which could influence groundwater receptors.

2.1 Location and Topography

The onshore ECC route extends for approximately 22 km from landfall at National Grid Reference (NGR) TM 22681 18005, approximately 1.25 km to the south-west of the town of Frinton-on-Sea in the south-east, to the proposed NG East Anglian Connection Node (EACN) substation approximately 1.5 km west of the village of Little Bromley at NGR TM 08208 28709.

The route consists predominantly of agricultural land with several watercourse crossings, skirting towns, villages and some small woodlands. From landfall the route crosses several B-roads and the train line between Kirby Cross and Thorpe-le-Soken.

Ground levels begin at sea level rising to c.18m Above Ordnance Datum (AOD) within 300m of the coast. The route maintains a steady elevation of between 18m AOD and 25m AOD until a dog leg approximately 1 km north of Tendring. From there elevations rise to 30m AOD and then remain between 30m AOD and 35m AOD for the rest of the route except at the crossing of shallow valley north of Horsley Cross where it dips to a minimum of 25m AOD.

Whilst the entire onshore ECC route is approximately 22 km in length the preliminary GWRA and PWS survey indicate that all of the identified PWS are located in the north-western third of the route between Horsley Cross and the proposed substations (Sections 5-7 as defined in the Environmental Statement at Volume 6, Part 3, Chapter 1: Onshore Project Description) whilst the two licenced abstractions are located close the south-eastern (landfall) extent, within Section 1. The route layout is presented on Drawing 1.

The baseline conditions are therefore focused around Section 1 and Sections 5-7. Section 2 to Section 4b have been excluded from this assessment.

2.2 Geology

2.2.1 Soils

The Cranfield Soilscales online soil map viewer indicates that the soils across the route consist of:

- Soilscape 21: 'Loamy and clayey soils of coastal flats with natural high groundwater' present at landfall south of Frinton-on-Sea;
- Soilscape 18: 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' along the majority of the route; and
- Soilscape 8: 'Slightly acid loamy and clayey soils with impeded drainage' the predominate soil in the final third of the route.

Section 1 of the onshore ECC route, which includes the location of licenced abstractions A9 and A10, crosses each soil type but the abstraction points are in Soilscape 8. A recent



Socotec ground investigation⁴ has a borehole approximately 250m from A9 and reports topsoils as “*Soft locally firm brown slightly sandy silty CLAY with frequent rootlets, occasional plant debris (40x5x5mm) and rare angular medium gravel of flint.*”.

Sections 5 – 7 of the onshore ECC route, containing all of the noted PWS, predominately cross Soilscape 8 with a small section of Soilscape 18, c. 400m across, north-west of Horsley Cross, which does not infringe upon the PWS locations. A ground investigation⁵ around Section 7 completed trial pits c. 400m from the nearest PWS (008) and logged topsoils as “*Soft greyish brown slightly sandy CLAY with occasional rootlets. Sand is fine. Rare angular fine to medium gravel of flint.*”.

2.2.2 Superficial Geology

A geological map showing the regional superficial geology as plotted on the British Geological Survey (BGS) online mapping service Geoindex Onshore is provided as Drawing 2.1 and Drawing 2.2.

The BGS Geoindex indicates that superficial deposits crossed by the route consist mainly of cover sand underlain by the Kesgrave Catchment Subgroup. A band of alluvium, consisting of clay and silt, is crossed at landfall and twice along the course of the route, and is associated with major watercourses. The Kesgrave Catchments deposits typically comprise sands and gravels.

BGS logs indicate that the superficial sands and gravels typically range in thickness between 4m and 12m.

Section 1 predominantly crosses bedrock, but the two licenced abstractions scoped into this assessment are mapped as lying in the Kesgrave Catchment Subgroup. Nearby ground investigations⁴ log topsoils with possible head and possible cover sand to 1.9m with cover sand to 5.6m and bedrock below. BGS mapping shows the location of this borehole to be in a small pocket of cover sand and is likely not representative of geology at the abstraction locations.

Sections 5 – 7 are mapped as predominantly crossing cover sand with all PWS scoped into this assessment mapped as being within this lithology. However, trial pits⁵ c. 400m from PWS 008 log topsoils to 0.3m and the Kesgrave Catchment Subgroup to 2.5m(base of pit)..

Ground investigation completed across the proposed VE and NF substation areas^{5,6} included the completion of 18 trial pits (11 across the VE OnSS site and 7 across the NF OnSS site) to depth of between 2.40m and 3.30m below ground level (bgl). All trial pits recorded Kesgrave catchment sands and gravels at or close to the surface, with several of the more northerly trial pits recording a thin (0.30m – 0.50m) horizon of Head deposits overlying the sands and gravels at surface, described as “*slightly gravelly slightly clayey fine to coarse SAND*”. The Kesgrave Catchment deposits are typically described as a “*gravelly coarse SAND*”.

Kesgrave Catchment sands and gravels were recorded to the base of all trial pits. Nearby BGS logs indicate that the sands and gravels are around 8.5m in thickness locally.

⁴ Little Clacton Road, Frinton-On-Sea Ground Investigation: Ground Investigation Report (Factual Account of Fieldwork, Monitoring and Laboratory Testing), Report No. D3012-23, SOCOTEC, July 2023

⁵ Five Estuaries and North Falls Onshore Substations Trial Pits Phase 2: Ground Investigation Report (Factual Account of Fieldwork and Laboratory Testing), Report No: D3046-23, SOCOTEC, Nov 2023

⁶ Five Estuaries and North Falls Onshore Substations Trial Pits Phase 2: Ground Investigation Report (Factual Account of Fieldwork and Laboratory Testing), Report No: D3026-23, SOCOTEC, July 2023



2.2.3 Bedrock Geology

BGS Geoindex indicates that the geological sequence in the area consists of the following sequence as outlined in Table 2-1.

Table 2-1: Geological Sequence within vicinity of Onshore ECC Route

Age	Formation	Description	Thickness (m)
Neogene	Red Crag Group Formation	Coarse-grained, poorly sorted, cross-bedded shelly sands	0 – 28m
Paleogene	Thames Group	Mainly silty clays, some sandy or gravelly	30 – 60m
	Thanet Formation & Lambeth Group	Clay, sand and silt with subsidiary flint, mudstone and sandstone	10 – 20m
Cretaceous	Newhaven Chalk	Soft to medium hard, smooth white chalks with numerous marl seams	35 – 130m
	Culver Chalk	Soft white chalk, relatively marl free with flint seams	120m+

The Red Crag forms an extensive sheet across much of Suffolk but is largely absent along the onshore ECC, with the exception of one small outcrop approximately 500m to the north of the route. The Thames Group deposits are present across the entirety of the onshore ECC where it directly overlies the Thanet Formation and Chalks.

Bedrock geology, based on BGS Geoindex mapping, is provided in map format in Drawings 3.1 and 3.2.

Available BGS logs along the DCO⁷ indicate that the London Clay is between 30 – 40m in thickness along the route with the underlying Thanet Formation and Lambeth Group up to 20m in thickness. The underlying Chalk has been proven to depth of up to 135m below ground level.

2.3 Hydrogeology

2.3.1 Recharge Mechanisms

The Met Office climate summary (1991 – 2020) for Walton-on-the-Naze (Location: 51.854, 1.283), found c.19 km south-east of the substation areas and c.5 km from landfall, indicates that the average annual rainfall for the onshore ECC route is 556mm.

Climate averages for Walton-on-the-Naze are provided below in Table 2-2.

Table 2-2: Met-Office Climate Averages for Walton-on-the-Naze (1991 – 2020)

Month	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
January	6.98	2.08	48.2
February	7.89	2.62	45.94
March	10.07	3.76	35.26

⁷ BGS ID: 560541: BGS Reference: TM12SE1



Month	Max. Temp. (°C)	Min. Temp. (°C)	Rainfall (mm)
April	12.11	6.05	33.32
May	15.69	9.07	30.6
June	18.76	11.99	36.91
July	21.53	15.01	48.74
August	21.01	14.61	58.54
September	18.8	12.29	49.38
October	15.01	9.54	54.64
November	10.9	5.81	60.39
December	7.9	2.92	53.86
Annual	13.92	8.01	555.78

Recharge regionally will be variable depending upon the localised superficial geology. Where cover sand is present across the western and northern part of the route recharge will be significant due to the porous nature of the deposits, however in the east and south of the route where the Thames Group is present at or near the surface, infiltration rates are likely to be inconsequential relative to run-off.

2.3.2 Aquifer Characteristics and Groundwater Vulnerability

The aquifer characteristics and EA aquifer designation of the strata along the length of the route are summarised in Table 2-3.

Table 2-3: Aquifer Designations

Deposit Type	Age	Formation	Aquifer Designation
Superficial	Quaternary	Cover Sand – clay, silt and sand	Secondary B
		Kesgrave Catchment Sands and Gravels	Secondary A
		Alluvium	
Bedrock	Paleogene	Thames Group	Unproductive Strata
		Thanet Formation & Lambeth Group	Secondary A
	Cretaceous	Newhaven Chalk	Principal
		Culver Chalk	

The various classifications are described by the EA as follows:

- *Principal Aquifer: layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.*
- *Secondary A Aquifer: permeable layers that can support local water supplies, and may form an important source of base flow to rivers.*
- *Secondary B Aquifer: lower permeability layers that may store and yield limited amounts of groundwater through characteristics like thin fissures and opening or eroded layers.*



- *Secondary (undifferentiated): where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the rock type. These have only a minor value.*
- *Unproductive Strata: strata that are largely unable to provide usable water supplies and are unlikely to have surface water and wetlands ecosystems dependent on them.*

Given the variable geological conditions along the onshore ECC route the primary aquifers present beneath the onshore ECC route are considered to be:

- Shallow aquifers associated with the cover sand and underlying Kesgrave Catchment Subgroup, where these are underlain by Thames Group deposits these will form a perched aquifer, none are directly underlain by the Chalk. It is highly unlikely that the small outcrop of Red Crag Formation will be affected by temporary or permanent works;
- The Chalk aquifer present at depth beneath the Thames Group forms an extensive aquifer across south-east England, however it is considered that there will be no hydraulic continuity with the superficial deposits as the Thames Group clays running the length of the route will act as an aquitard between the shallow and deep aquifers. The presence of the extensive thickness of the Thames Group deposits mean that the Chalk aquifer can be scoped out as a potential receptor.

Section 1 and licensed abstractions A9 and A10 are mapped on the Defra mapping service⁸ as being within the superficial drift Secondary A aquifer of the Kesgrave Catchment Subgroup.

Sections 5 – 7 are all mapped as being within the Secondary B cover sand overlying the Secondary A Kesgrave Catchment Subgroup.

2.3.3 Groundwater Levels and Flow

2.3.3.1 Groundwater Levels

Examination of borehole records with water levels, available on the BGS website, indicate that groundwater levels within the superficial deposits are typically less than 5m bgl with a range of between 2m and 5m bgl.

Groundwater flow within the superficial deposits will largely follow the local topography and potentially be influenced by any watercourses present along the route.

The ground investigations (GI)^{5,6} indicate groundwater seepages in the base of most trial pits around the proposed OnSS locations, indicating that the trial pits were potentially excavated to a depth where groundwater was encountered. This GI data indicates groundwater levels typically between 2.3m and 3.3m below ground level (32m – 33m AOD), although it should be noted that the GI were completed in mid-May and mid-October respectively and therefore winter peak water levels will potentially be higher.

The PWS survey carried out on the 31st July and the 1st August 2024 also included water level monitoring, recording relatively shallow groundwater within the Superficial deposits at depths of between 1.45m and 3.44m below ground level. Groundwater levels at the majority of locations were recorded as being between 1.5m and 2m below ground level. It is again noted that this survey was undertaken in summer and therefore groundwater levels will potentially be closer to surface during winter peaks.

⁸ Defra Magic Map: <https://magic.defra.gov.uk/MagicMap.aspx> [Accessed December 2024].



A review of the EA hydrology data explorer⁹ indicates that there are no EA groundwater monitoring points along the DCO route itself, although there are two locations to the north of the proposed substation zone; Hungersdown Farm (at NGR: TM07216 29729 – approximately 245m to the north) and Lawford House Farm (NGR: TM 09261 30101 – approximately 1080m to the north-west). Locations are shown on Drawing 4.

Borehole logs for both of the EA groundwater monitoring locations (available on the BGS website) indicate that they are monitoring the superficials sands and gravels. Both of these boreholes record a similar seasonal variation, typically between 1m and 2m seasonally, although it is noted that greater range has been recorded following very wet winters; notably in 1988, 2001, 2003 and 2024.

Groundwater levels at Hungersdown Farm range between 2.45m and 6.1m bgl. Lawford House records elevations closer to surface, ranging between 0.25m and 4.3m bgl, with an average of 2.36m bgl.

The Lawford House reading for July 2024 (the time of the PWS survey) indicates a depth to water of 1.64m, this measurement of groundwater level is similar to groundwater levels recorded at other points in the PWS survey. The Lawford House groundwater level is therefore considered a good representation for likely conditions along the DCO route. Although the Lawford House data indicates that groundwater levels have on occasion risen close to surface, groundwater levels have only risen to within 1m of surface on five occasions since monitoring started in 1974 (in 1988, 2001, 2003, 2014 and 2024), these are therefore considered to be exceptional events and not reflective of typical conditions that would be anticipated during the construction period.

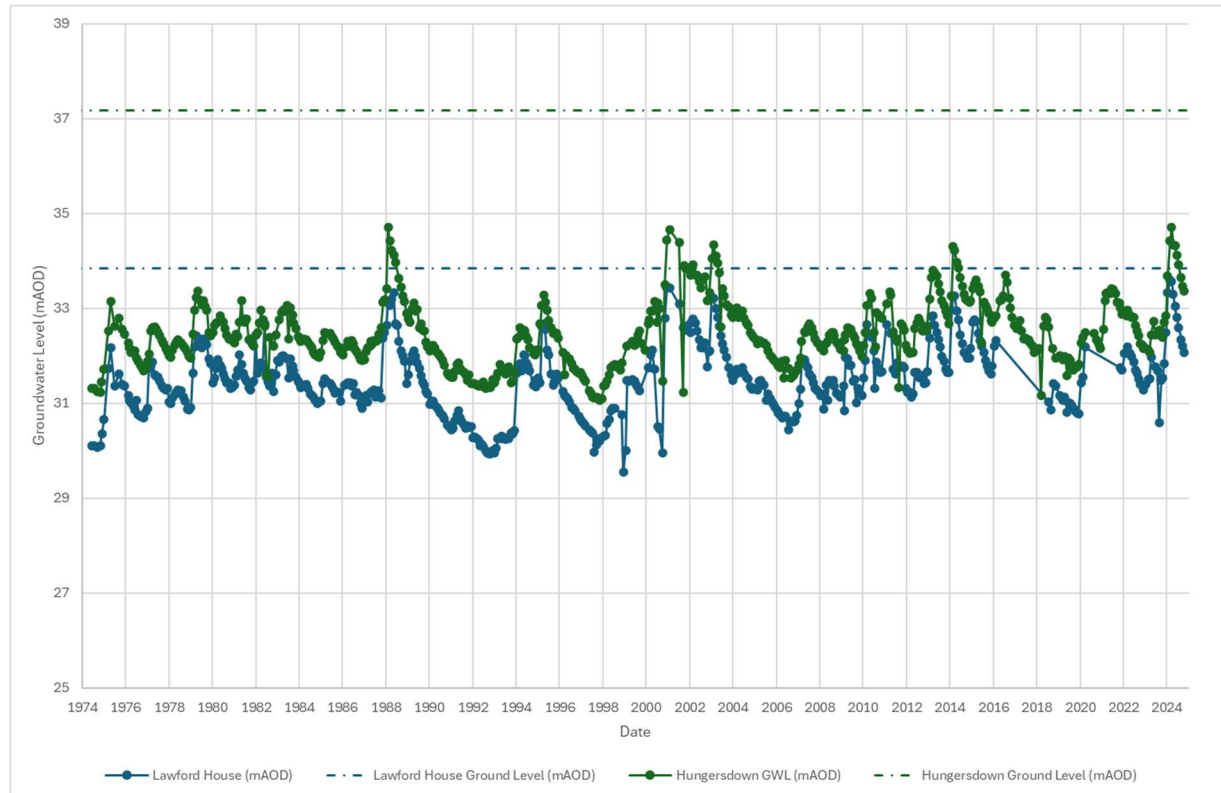
The PWS survey was undertaken on 31st July and 1st August 2024, and EA monitoring data indicates that groundwater levels towards the end of July (18th July) were 0.79m (Hungersdown) and 1.01m (Lawford House) below their respective winter peaks at this time, although it should be noted that groundwater levels in both boreholes remained in excess of 1m above the long-term average indicating that the water levels observed in the PWS are towards the upper end of likely levels to be observed during construction.

A hydrograph presenting groundwater levels recorded at the Hungersdown Farm and Lawford House monitoring boreholes over the last 50-years is provided below as Figure 2-1

⁹ Defra Hydrology Data Explorer: <https://environment.data.gov.uk/hydrology/explore> [Accessed December 2024].



Figure 2-1: Groundwater Levels - Lawford House Farm & Hungersdown Farm



2.3.3.2 Aquifer Parameters

Particle Size Distribution (PSD) analysis was completed as part of the GI, this data can be used to estimate the hydraulic conductivity of the sands and gravels. Data from the samples close to the base of trial pits (i.e. close to the saturated level of the deposit) has been used for the analysis. The Beyer formula had been used to assess the hydraulic conductivity where:

$$K_H = C_B \frac{g}{\nu} \ln \left(\frac{500}{\frac{D_{60}}{D_{10}}} \right) D_{10}^2$$

K_H = Hydraulic conductivity (m/sec)

C_B = empirical coefficient equal to 6×10^{-4}

g = gravitational acceleration (9.8 m/s^2)

ν = Kinematic viscosity of water ($1.2 \times 10^{-6} \text{ m}^2/\text{s}$)

D_{10} = grain diameter for which 10% passes (mm)

D_{60} = grain diameter for which 60% passes (mm)

The predicted hydraulic conductivities are summarised in Table 2-4 below which indicates hydraulic conductivity of the sands and gravels of between 7.09×10^{-4} and $2.95 \times 10^{-3} \text{ m/s}$.

It is noted that the Beyer formula is a laboratory-based technique for estimating permeability and might not be reflective of real-world hydraulic conductivity which would vary across strata, however this approach has been used to provide an initial high-level estimate of potential hydraulic conductivity for the purpose of the risk assessment. If an abstraction licence is ultimately required for dewatering, a more rigorous approach, such as completion of a pump test, would be undertaken to allow for more accurate assessment of dewatering volumes and potential impact.



Table 2-4: Estimated Hydraulic Conductivity of Superficial Sands and Gravels

Trial Pit ID	Sample Depth (mBGL)	D10 (mm)	D60 (mm)	Hydraulic Conductivity (m/sec)
TP01	3.0 – 3.1	0.170	0.570	7.09×10^{-4}
TP04	2.0 – 2.2	0.310	3.000	1.86×10^{-3}
TP05	2.9 – 3.0	0.371	2.337	2.95×10^{-3}
TP08	2.8 – 2.9	0.168	0.383	7.45×10^{-4}
TP10	2.0 – 2.2	0.327	1.122	2.61×10^{-3}
TP11	2.0 – 2.1	0.300	6.300	N/A*
TP16	2.0 – 2.2	0.181	1.000	7.23×10^{-4}
TP19	2.9 – 3.0	0.312	4.060	1.74×10^{-3}
TP22	2.0 – 2.2	0.300	1.875	1.93×10^{-3}
TP28	2.0 – 2.2	0.187	0.521	8.89×10^{-4}
Note: * Formula only appropriate where D10 between 0.06 and 0.6mm and D60 <6.0mm				

Based on the range of permeabilities for the sands and gravels of 7.09×10^{-4} m/sec to 2.95×10^{-3} m/sec from the above PSD analysis and a drawdown of up to 1.5m (based on a maximum excavation depth of 2.0m and minimum winter water level of 0.5m bgl) a worst-case radius of influence can be ascertained based using the Sichardt equation, whereby:

$$R_0 = Cs\sqrt{K}$$

Where:

R_0 : Radius of influence (m)

C = empirical factor (300)

s = drawdown (m)

k= Hydraulic Conductivity (m/s)

Assessed drawdowns of between 1m and 1.5m would result in a radius of influence of between 80m and 244m. As a conservative approach, the maximum area for assessment has been set at 250m from any potential below ground level development. This conservative approach also allows for the potentially fast travel times for any pollution incidents to impact abstraction points.

It is acknowledged that there are limitations and uncertainties with the use of the Sichardt formula, not least uncertainties as to the origin of the empirical calibrations factor 'C', however SLR experience indicates that this typically results in conservative estimate of the radius of influence. It is further noted that a highly conservative approach has been undertaken by using the maximum calculated hydraulic conductivity (with reference to the values presented in Table 2-4 above) and a conservative (worst-case) depth of required drawdown (dewatering). The search radius has been extended up to 250m to allow for inherent uncertainty.



2.3.4 Source Protection Zones

Defra's Magic Map website indicates that the majority of the northern half of the route (from the OnSS to Section 4B (which includes all of the PWS scoped into this assessment)), is located within a Zone III (total catchment) groundwater Source Protection Zone (SPZ). This SPZ is understood to be associated with the underlying Chalk aquifer.

No part of the route is located within either an SPZ 1 (inner) or an SPZ 2 (outer) zone. The nearest SPZ1 associated with major abstractions from the Chalk aquifer is approximately 3 km from the OnSS at the northwestern extent of the onshore ECC route.

There are no SPZ within the southern half of the route from the landward end of Section 4B to landfall, a length of c.12km.

The extent of groundwater SPZ is shown in Drawing 4.

2.3.5 Groundwater Abstractions

Freedom of Information (FOI) requests submitted to the EA and Tendring District Council identified a total of 33 licenced abstractions and 25 private water supplies (PWS) within a 500m radius of the DCO limits, however most of these points are located in excess of 250m from the DCO limit and were therefore excluded from further assessment within the preliminary GWRA¹, as summarised in Appendix 01.

Based on the findings of the preliminary GWRA, PWS monitoring and other surveys a total of 16 PWS and two licenced abstractions have been identified within or in close proximity to a 250m radius of the proposed works as outlined below.

2.3.5.1 Licenced Abstractions

There are two licenced abstractions recorded within a 250m radius of the DCO limits which could theoretically be impacted by construction works, as summarised in Table 2-5.

Table 2-5: Licensed Abstraction Details

Mapping ID	Licence No.	Holder	Address	Use	Source Type and Unit
A9	8/37/26/*G/0091	A H Brown Farms	Dairy House Farm, Great Holland, CO13 0EX	Spray Irrigation - Direct	Groundwater From Sands And Gravels
A10	8/37/26/*G/0091	A H Brown Farms	Dairy House Farm, Great Holland, CO13 0EX	Spray Irrigation - Direct	Groundwater From Sands And Gravels

2.3.5.2 Private Water Supplies

Private water supplies identified between FOI requests by SLR and from PWS surveying conducted by Wardell Armstrong and discussions with land agents (see Appendix 01) have revealed 16 PWS or unregistered abstractions of interest entirely located across Sections 5 – 7 of the onshore ECC route. These are summarised in Table 2-6 below.



Table 2-6: Private Water Supply Details

Mapping ID	SLR ID	WA ID	Type	Depth to Water (m)	Depth to Base (m)	Internal Diameter (m)	Source (Assumed)
001	Paynes Cottage	Paynes Cottage	Well	1.40	3.06	1.40	Superficial
002	Little Bromley Hall	Little Bromley Hall	Well	3.44	5.94	1.20	Superficial
003	N/A	Little Bromley Hall	Well	2.36	4.80	1.20	Superficial
004	The Coach House	Little Bromley Hall	Well	2.63	4.70	1.60	Superficial
005	Mulleys Farm	Mulleys Farm	Well	1.85	2.65	0.60	Superficial
006	Mulleys Farm	Mulleys Farm	Well	1.45	2.70	0.65 X 0.4	Superficial
007	Mulberry Lodge	Jennings Farm	Well	1.79	4.00	1.50	Superficial
008	N/A	Normans Farm	Well	1.40	3.30	0.62x0.46	Superficial
009	Crabtrees	Crabtrees	Well	2.14	3.88	0.6x0.4	Superficial
010	Welhams Farm	Welhams Farm	BH	-	c.90m ^A		Chalk
011	Oakwood	Oakwood	Well	1.45	3.28	1.15	Superficial
012	The Old Rectory	N/A	-	0.66	-	-	Superficial
013	Craigus	N/A	-				Superficial
014	Orchard Cottage	N/A	-				Superficial
015	Hiskeys Farm	N/A	-				Superficial
016	Richmond Cottage	N/A	-				Superficial
Note: ^A Information from owner, borehole has not been dipped.							

2.3.6 Groundwater Quality

A review of the EA water quality archive¹⁰ indicates that there is a single EA groundwater quality monitoring point along the DCO route, located at Welhams Farm. This location appears to correspond with PWS 010 (refer to Section 2.3.5) which is understood to monitor groundwater within the Chalk aquifer (although it is noted the EA has not directly stated which strata the borehole monitors). The monitoring data indicates elevated chloride, sodium, fluoride and some heavy metals which are considered to be reflective of saline influences on the Chalk aquifer. Similar elevated concentrations were also recorded in the monitoring of Welhams Farm PWS during the survey, confirming that this is likely to be abstracting from the Chalk.

Water quality monitoring has also been undertaken on ten of the PWS considered to be abstracting from the superficial aquifer. The monitoring indicates exceedances of microbiological parameters at all of the locations, most locations also recorded elevated nutrients with some elevated heavy metals, although these are less widespread. The monitoring data indicates that the water quality is likely influenced by agricultural activity, which is the predominant land use across the DCO route, as is reflected by the elevated nitrate concentrations and microbiological results.

¹⁰ Environment Agency: Open WIMS data [Accessed December 2024].



2.3.7 Hydrology

The onshore ECC route predominantly passes through the Colne Essex catchment, following the boundary with Stour operational catchment and crossing entirely for a length of approximately 6 km between Kirby Cross and Thorpe Green. This length of the route is not associated with any of the 21 water bodies within the Stour operational catchment. Two small sections of the northwest area of the onshore ECC route cross into the Stour operational catchment (into the area of Wrabness Brook), consisting of 190m of access road north off Tendring Heath and 490m of DCO Limits approximately 700m northeast of Horsley Cross.

The onshore ECC route crosses two major watercourses:

- The Holland Brook which flows in a broadly south-easterly direction, draining from the relative high ground to the north-west of the onshore ECC route. This watercourse is underlain by superficial deposits in the northwest of the route and likely to be supported by an element of groundwater baseflow. The onshore ECC route crosses the watercourse approximately 800m north-west of Horsley Cross. At this location the superficial sands and gravels are absent, and the watercourse is shown to be underlain by low permeability Alluvium and London Clay; and
- The Tendring brook, a tributary of the Holland Brook, arises to the north-east of the onshore ECC route. The watercourse is underlain by London Clay bedrock with a thin band of alluvium; clays and silts present immediately beneath the watercourse corridor. There are no superficial sands and gravels present beneath the watercourse, and baseflow is therefore considered to be negligible. There are a number of licenced surface water abstractions associated with this watercourse, however given the lack of hydraulic continuity with groundwater, any impact on these can be scoped out of further assessment.

There are also numerous smaller minor watercourses and drains along the route, although given that these are typically shallow, they are unlikely to be significant groundwater receptors. The Holland Brook is designated as a Nitrate Vulnerable Zone (NVZ).

2.3.8 Springs

A review of Ordnance Survey (OS) mapping has not identified any marked springs along or adjacent to the DCO Limits and none have been identified by surveys completed to date. It is noted that most of the watercourses in the area appear to originate at, or close to, the junction between superficial deposits and the underlying London Clay suggesting that these could potentially be fed by an element of spring flow. However, given that none are marked on OS mapping these are not likely to be significant features.

2.3.9 Groundwater Dependent Ecological Sites

A review of the Defra Magic Map webpage indicates that the only designated ecological sites within a 500m radius of the DCO limits is the Holland Haven Marshes Site of Special Scientific Interest (SSSI). The route crosses the SSSI at landfall. The SSSI is designated for its mixture of estuarine saltmarsh and freshwater marsh and grasslands, including an area of amenity grassland on Frinton golf course.

Although the first 300m – 700m of the onshore ECC route from landfall does cross the SSSI, the majority of that is across Frinton Golf Club and two parcels of agricultural land to the northwest. The area of marshland covered by the DCO Limits is equivalent to 0.05 km².



The SSSI is entirely underlain by alluvial silts and clays with little or no groundwater. The marshes will therefore be fed by surface run-off associated with poor drainage from the loamy, clayey soils and silty clay superfcials, where present.



3.0 Conceptual Site Model

The assessment of the baseline conditions of the onshore ECC route indicates that it is underlain by superficial aquifers in the Cover Sand and the Kesgrave Catchment Subgroup. The Thames Group underlying these superficial deposits is considered an aquitard providing no hydraulic continuity between them and the principal Chalk aquifer beneath. The southern half of the route crosses a total of 3 km of superficial deposits over 11.6 km of onshore ECC length. The northern half of the route crosses 8.5 km of superficial deposits over 9.5 km of onshore ECC length.

Available groundwater monitoring from BGS logs, PWS survey dips and EA monitoring data suggest groundwater levels are potentially in continuity with the Holland Brook in its headwaters, however there are no sands and gravels present beneath the majority of the watercourse length or beneath its associated significant tributaries. At the point of the watercourse crossings of the Holland Brook and Tendring Brook there are no sands and gravels present. Licenced surface water abstractions along these watercourses have therefore been scoped out of further assessment.

Based on available data from the BGS, EA and the PWS survey, groundwater within the superficial aquifers is typically shallow with groundwater levels typically present between 1m and 3m bgl. Long-term EA monitoring of two locations to the north of the DCO route indicates a typical seasonal variation of 1m-2m and indicates that groundwater could potentially rise to within 1m of surface following a wet season.

Given the recorded thickness of the superficial deposits (widely between 4m-12m) and the Thames Group (>30m) there is considered to be no potential for hydraulic connection between the superficial aquifer and deeper chalk aquifer.

The proposed works will comprise of either a shallow trenched cable route (up to 2m deep) or trenchless techniques, such as Horizontal Directional Drilling (HDD) which could potentially extend up to 20m bgl. In either instance there is considered to be no feasible potential for the activity to extend beyond the base of the Thames Group and therefore the Chalk aquifer has been excluded as a potential receptor from the proposed workings.

Recorded information on groundwater levels, quality and particle size distribution obtained from site investigations and a PWS survey completed along the DCO route has been used to assess the potential radius of influence for any dewatering required for the trenched cable works (and any other shallow excavations required). Based on this defined radius of influence (Section 2.3.3.2), a conservative search radius of 250m from the DCO route has been used within the assessment.

A total of sixteen PWS or unregistered supplies and two licenced abstractions have been identified within or in close proximity to a 250m radius of the DCO Limits, although one of these PWS (010) abstracts from the Chalk and another (007) is no longer located within 250m of the updated DCO Limits and can therefore be excluded from further assessment.

It is acknowledged that trenchless techniques, such as Horizontal Directional Drilling (HDD) is proposed at a number of locations where open trenching is not viable, this will generally extend to depths of between 5m-10m bgl, however these works do not require extended periods of dewatering. There will be some displacement or removal of water associated with the use of drilling fluids during this process however given the limited dewatering which would occur, it is considered that the 250m radius for assessment is applicable for the drilling locations. Similarly, any pollution risk would be limited to drilling fluids used within the process entering the aquifer system in the immediate vicinity of the drilling for which a 250m radius is considered to be a highly conservative assessment parameter.



4.0 Hydrogeological Impact Assessment

4.1 Proposed Development

The onshore project elements will include the following works:

- 1 up to 12 temporary construction compounds (TCC). Assumed to be no below ground development with the exception of shallow topsoil stripping;
- 2 49 No. Jointing bays per circuit – 15m x 4m with a depth of approximately 2m;
- 3 Trenched onshore ECC route to a maximum depth of 2m below ground level;
- 4 Trenchless or Horizontal Directional Drilling (HDD) points at typical depths of 5m to 10m;
- 5 Associated trenchless drilling compounds, assumed to be no below ground development with the exception of shallow topsoil stripping; and
- 6 An OnSS, with dimensions of approximately 250 x 180m. The piling solution for the OnSS will be determined post consent, following ground investigations.

4.2 Location Specific CSM

Based on the regional CSM the development area has been broken down into separate areas to allow for further assessment of local hydrogeological conditions and identification of the extent of any hydraulic connection between the onshore ECC and OnSS and the water supplies identified above in Section 3.0.

Where licenced abstractions or PWS are located in close proximity these have been grouped and assessed cumulatively. The identified locations have therefore been assessed as six separate areas.

4.2.1 PWS 007 and PWS 008

PWS 007 and 008 are both located adjacent to Ardleigh Road at the north-western extent of the DCO, they are located at the following locations:

- PWS 007 is located at Mulberry Lodge, Jennings Farm to the south-east of the proposed OnSS at an elevation of approximately 35m AOD. Although located less than 60m from the DCO Limits the abstraction is located approximately 400m to the north-west of the proposed HDD beneath Ardleigh Road and 450m south-east of the substation works area;
- PWS 008 is located a further 330m to the west of PWS 007 at Normans Farm at an elevation of approximately 34.5m AOD. The PWS is located approximately 60m to the east of the proposed HDD beneath Ardleigh Road.

BGS mapping confirms that both supplies are located on superficial sands and gravels, underlain by London Clay. Nearby historic BGS borehole log TM02NE15¹¹ located approximately immediately west of Norman Farm indicates that the local geology comprises 2.7m of loam (brown sandy clay) overlying 9.1m of sands and gravels with the London Clay recorded at 0.9m thickness. A ground investigation associated with the proposed substation location to the west of the PWS⁵ does not identify the loam, rather encountering Kesgrave

¹¹ BGS ID: 557827, BGS Reference: TM02NE15.



Catchment Sand and Gravel at a depth of 0.30m, extending to the base of the trial pits at between 2.5m and 3.0m below ground level.

The PWS survey indicates that both supplies are relatively shallow wells, extending to 4.0m (PWS 007) and 3.3m below ground level (PWS 008) with shallow groundwater levels of 1.79m bgl (PWS 007) and 1.40m bgl (PWS 008). Based on monitoring from a nearby EA borehole (Lawford House Farm) located approximately 1.5km to the north-east, there is the potential for groundwater levels to rise to less than 1m below ground level during winter peaks.

Given the shallow depth to groundwater and the shallow overall depths of the wells both PWSs are considered to be sensitive to changes in groundwater levels, it is however noted that PWS 007 is located beyond the maximum theoretical radius of influence from any dewatering which might be required. PWS 007 has therefore been excluded from further assessment.

Given the proximity of PWS 008 at just 60m from the proposed onshore ECC route there is considered to be a strong potential hydraulic connection to the proposed onshore ECC route trenching and potential impacts on this supply are assessed further in Section 5.0.

4.2.2 PWS 002, PWS 003, PWS 004 and PWS 012

PWS 002, PWS 003 and PWS 004 are all located at Little Bromley Hall towards the north-western extent of the route. All abstractions are located to the north of the DCO route at elevations of between located between 32.5m AOD and 33.5m AOD.

BGS log TM02NE21¹², located just west of PWS 002, indicates that the local geology comprises 1.2m of sandy clay overlying 4.3m sands and gravels and London Clay beneath. A water strike is recorded at 30.8m AOD, approximately 2.4m below ground level.

Details from the PWS survey indicates that the wells for PWS 002, PWS 003 and PWS 004 are between 4.7m and 5.94m in depth, abstracting from the superficial sands and gravels with resting water levels during the survey of between 2.36m BGL (PWS 003) and 3.44m BGL (PWS 002).

The water table at the time of survey was therefore below the likely maximum depth of working, although it is noted that groundwater levels will likely be higher during a winter peak. Based on the fall in water levels during 2024 seen within the EA monitoring boreholes of approximately 1m a conservative winter maximum water level of between 1.3m and 2.4m bgl can be assumed, suggesting that if worked in the winter there will be the potential need for dewatering in this area.

It is noted that no PWS was recorded at the Old Rectory (PWS 012) during the survey, however this has been retained in the assessment as worst case. Given the proximity of the PWS to the others in the area, located 350m to the east of PWS 002, similar ground conditions and water levels can reasonably be assumed.

All of the abstractions are located close to the edge of the 250m search radius around the DCO boundary, with PWS 002, PWS 004 and PWS 012 all located between 215m and 240m from potential excavations associated with the onshore ECC route (either trenching or trenchless crossings). The approximate distances from the onshore ECC route are:

- PWS 002: Located 240m to the north-east of the trenchless crossing of Church Road;

¹² BGS ID: 557833, BGS Reference: TM02NE21



- PWS 004: located 225m to the north-east of the trenchless crossing of Church Road; and
- PWS 012: Located 235m to the north of trenched onshore ECC route between Spratts Road and Church

Although located within 250m radius of the DCO boundary PWS 003 is located in excess of 350m from the onshore ECC route with the closest development comprising an access road which will have no or very limited below ground development. PWS 003 can therefore be excluded from further assessment.

Given the distance of PWS 002, PWS 004 and PWS 012 from the onshore ECC route the risk of dewatering activities impacting water levels within the PWS is also considered to be very low. Appropriate best practice and mitigation are however outlined with regards to potential impacts on water quality.

4.2.3 PWS 015

PWS 015 is an unregistered water supply located at Hiskeys Poultry Farm, adjacent to Spratts Lane to the south of the DCO boundary. The abstraction is located approximately 200m to the south of the proposed Trenchless crossing beneath Spratts Lane. The PWS is located at an elevation of approximately 32mAOD.

BGS log TM02NE22¹³, located approximately 400m to the south-east, indicates that the local geology comprises approximately 2.1m of loamy soils overlying 4.0m of glacial sands and gravels and London Clay present at base. A water strike was recorded at 4.9m below ground level, although it is noted that the borehole is located approximately 5m higher than the PWS so this is not directly relatable to the PWS.

The water supply has not been surveyed to date and therefore no information on its construction, use or water levels are available, however given the relatively shallow nature of the superfcials there is the potential for groundwater levels to be relatively shallow.

The geology at the PWS are consistent with the conditions along the ECC route and therefore there is the potential for a hydraulic connection between the two however given the distance of the PWS (>200m) from the trenchless crossing the potential impact on groundwater levels is considered to be very low and has been excluded from further assessment.

4.2.4 PWS 005, PWS 006 and PWS 009

PWS 005 and PWS 006 are both located at Mulleys Farm, off Bentley Road, to the north of the DCO boundary with PWS 009 located approximately 100m to the south at Crabtrees.

PWS 006 is located in excess of 250m from the DCO boundary. PWS 005 and PWS 009 whilst located within 250m of the DCO boundary, are between 335m (PWS 009) and 465m (PWS 005) from the onshore ECC route.

Both PWS 005 and PWS 009 only fall within the 250m search radius because the DCO boundary extends around road improvement works and a construction compound proposed adjacent to Bentley Road which have no below ground development, with the exception of shallow dewatering and are highly unlikely to require any dewatering.

The nearest BGS logs to these supplies are in excess of 750m to the south of these supplies, therefore detailed information on the local geology is unavailable. However, these

¹³ [BGS ID: 557834 : BGS Reference: TM02NE22](#)



logs indicate that the sands and gravels are in excess of 4m in thickness with water strike close to the base of the deposit (4.9m below ground level)¹⁴.

Survey of the PWS indicate that all three PWS are shallow wells between 2.65m and 3.88m deep with water levels between 1.45m bgl (PWS 006) and 2.14m bgl (PWS 009).

Given the distance of the PWS from any dewatering required, all three of these PWS have been excluded from further assessment.

4.2.5 PWS 001 and PWS 016

PWS 001 is located at Paynes Cottage, adjacent to Paynes Lane and c.30m to the north of the proposed trenchless crossing beneath Paynes Lane whilst PWS 016 is located at Richmond Cottage, approximately 140m further north from PWS 001

BGS mapping indicates that both PWSs are located on superficial cover sand overlying Kesgrave catchment Sand and Gravels and London Clay. There are no nearby BGS logs, and no ground investigations have been completed in this area, therefore localised geological detail is unavailable. However, conditions are likely to be similar to the surrounding areas with superficals likely to be between 4m and 6m in thickness.

The PWS survey indicates that PWS 001 is a relatively shallow well, extending to 3.06m bgl, with a shallow groundwater at 1.4m bgl which could potentially reduce to less than 1m below ground level in the winter.

Given the close proximity of PWS 001 abstraction to the onshore ECC route and the shallow depth to water it is considered that there is the potential for the construction works to impact this water supply. PWS 001 has therefore been included within the risk assessment.

PWS 016 is located in excess of 170m from any potential dewatering activity and therefore at the edge of any feasible radius of influence, the risk to this water supply is therefore considered to be low and has been excluded from further assessment.

4.2.6 PWS 010, PWS 011, PWS 013 and PWS 014

PWS 010, PWS 011, PWS 013 and PWS 014 are all located adjacent to Bentley Road to the south of the onshore ECC route. All four water supplies are located well in excess of 250m of the onshore ECC route, between 320m (PWS 011) and 560m (PWS 013) to the south.

PWS 010 and 013 are both recorded as being located at Welhams Farm. The PWS survey only identified one water supply at this location, and it is possible that the supply covers two properties (this will be confirmed during further survey and monitoring). As outlined in Section 2.3.5 PWS 010 is understood to abstract from the Chalk aquifer, and given the significant thickness of London Clay overlying the Chalk there is not considered to be a hydraulic connection between activity on the shallow superficals and the Chalk aquifer. No further assessment is therefore required on these PWS with regards to impact on water levels or flow.

PWS 011 and PWS 014 are located adjacent to each other at Oakwood and Orchard Cottage, and although it is noted that the survey did not identify a supply at Orchard Cottage this location has been included in the risk assessment as worst-case.

The closest BGS logs to PWS 011 and PWS 014, located approximately 500m to the south-west, indicate that the superficial deposits are approximately 2.8m in thickness¹⁵, this is

¹⁴ <https://api.bgs.ac.uk/sobi-scans/v1/borehole/scans/items/557834>

¹⁵ [BGS ID: 560381 : BGS Reference: TM12NW16](#)



consistent with the survey of PWS 011 which indicates a well base of 3.28m bgl and a resting water level of 1.45m bgl.

Whilst PWS 011 and PWS 014 are located remote from any potential impacts on water levels, given the proximity of these water supplies to the road improvements and associated drainage works there is a risk with regards to water quality, potential water quality impacts on these supplies are therefore included within the risk assessment with regards to water quality impacts but not to dewatering impacts.

4.2.7 Licenced Abstractions A9 and A10

Licenced abstractions A9 and A10 are located close to the southern extent of the proposed onshore ECC to the south-west of Great Holland. Both abstractions are located within 130m of the onshore ECC with A10 located within construction compound TCC2. The exact location will need to be confirmed prior to any development of this compound.

Both abstractions are located close to the southern edge of an isolated area of superficial sands and gravels. These are underlain by London Clay bedrock. A10 is shown to be located on the bedrock with no overlying superfcials, however the records provided by the EA indicate that the abstraction is from glacial sands and gravels.

Two site investigation boreholes drilled by Socotec in July 2023⁴ indicates that the local geology comprises between 4.5m and 5.6m of superficial deposits overlying London Clay bedrock. The London Clay was proven to a depth of at least 20m BGL. Groundwater was recorded at a relatively shallow depth of between 1.1m and 1.7m bgl, consistent with the situation in the wider area.

A survey of the two supplies undertaken in December 2024 reported that abstraction point A9 is capped and is understood to not currently be in use. A10 is located adjacent to this point and comprises a roughly 10m deep well with a water level which varies between 3.0m bgl and dry. The owner has confirmed that the well is used for agricultural purposes only and is only used intermittently, with abstraction using a diesel generator driven pump.

As abstraction point A10 is located within 50m of the proposed onshore ECC and within a construction compound, there is the potential for impact with regards to both water levels and water quality. Licenced abstraction A10 has therefore been included within the risk assessment.

4.3 Risk Assessment

4.3.1 Potential Effects

Without appropriate design and controls, construction of the works has the potential to impair the hydrogeological quality as well as levels and flows, such as:

- Existing groundwater flow paths could be disturbed or altered, impacting on nearby groundwater abstractions;
- The use of machinery and the movement of soils has the potential to generate suspended solids in run-off and/or introduce oils or hydrocarbons to the water environment;
- The use of drilling fluids in trenchless (HDD) crossings of roads and watercourses have the potential to result in release of drilling fluids to the environment
- The use of cement bound sand within the trenched onshore ECC route has the potential to impact water quality



As outlined within Section 2 and 3 of this report the significant hydrogeological receptors are considered to be water supplies from the shallow superficial aquifer where groundwater is relatively close to surface and therefore has a high groundwater vulnerability.

Based on the CSM the following locations are considered to be at risk from dewatering impacts (within 100m of potential dewatering activities) associated with the construction of the onshore ECC route:

- PWS 008 – Normans Farm;
- PWS 001 – Paynes Cottage
- A10 – Dairy House Farm

In addition, supplies located in close proximity to other above ground construction activity are at risk from adverse impacts on water quality, these include PWS 002 (Little Bromley Hall), PWS 004 (Little Bromley Hall), PWS 011 (Oakwood), PWS 013 (Craigus) and PWS 014 (Orchard Cottage).

4.3.2 Embedded Mitigation

Best practice construction techniques and procedures are outlined within the developed 9.21 Code of Construction Practice (CoCP) – Revision C REP5-033 which includes commitments on:

- Pollution Prevention;
- Soil Management;
- Emergency Response Procedures; and
- Temporary Site Drainage.

The construction works will also be undertaken in accordance with good practice guidance within the following documents:

- CIRIA SP156 Control of Water Pollution from Construction Sites - Guide to Good Practice, 2002;
- CIRIA C649D Control of water pollution from linear construction projects. Site guide, CIRIA 2006;
- CIRIA C753) The SuDS Manual, December 2015, and
- CIRIA C502 Environmental Good Practice on Site C741, CIRIA 2015.

The Guidance for Pollution Prevention (GPPs), although not forming current government guidance for England provide environmental good practice for the whole of the UK and relevant GPPs will be followed where appropriate, including:

- GPP01: Understanding your environmental responsibilities – good environmental practices (June 2021);
- GPP02: Above Ground Oil Storage Tanks (June 2021);
- GPP03: Use and design of oil separators in surface water drainage systems (March 2022);
- GPP04: Treatment and Disposal of wastewater where there is no connection to the public sewer (June 2021);
- GPP05: Works and maintenance in or near water (Feb 2018);



- GPP06: Working at construction and demolition sites (Apr 2023);
- GPP08: Safe storage and disposal of used oils (June 2021);
- GPP13: Vehicle Washing and Cleansing (June 2021);
- GPP20: Dewatering underground ducts and chambers (June 2021);
- GPP21: Pollution incident response planning (June 2021); and
- GPP22: Dealing with Spills (Oct 2018).

All work will be undertaken in accordance with regulatory guidance for England as outlined on the GOV.UK website including:

- Pollution prevention for businesses - [Pollution prevention for businesses - GOV.UK](#)
- Report an Environmental Incident - [Report an environmental incident - GOV.UK](#)
- Discharges to surface water and groundwater: environmental permits - [Discharges to surface water and groundwater: environmental permits - GOV.UK](#)
- Oil storage regulations for businesses - [Oil storage regulations for businesses - GOV.UK](#)
- Manage water on land: guidance for land managers - [Manage water on land: guidance for land managers - GOV.UK](#)

4.3.3 Impact on Groundwater Levels and Flows

The proposed onshore ECC route will include excavation of trenches up to a maximum of 2m bgl. The CSM developed in Section 2 and Section 3 confirms that much of the south-eastern extent of the onshore ECC route is underlain by Thames Group which is classified as unproductive strata where it is considered highly unlikely that groundwater will be encountered.

Pockets of superficial sands and gravels are however present across the length of the DCO and are most extensive in the north-west where there are a number of PWS within or in close proximity to a 250m radius of the DOC. Available monitoring data indicates that the water table is typically shallow and less than 2.0m bgl, potentially rising to less than 1.0m bgl during winter peaks. It is therefore envisaged that dewatering will be required at some locations to facilitate construction.

As outlined within Section 4.2, whilst a total of 14 PWS and two licenced abstractions are recorded within or in close proximity to a 250m radius of the onshore ECC route, all but three of these are in excess of 100m of the abstractions, at which distance the amount of drawdown will likely be negligible, based on the calculations outlined in Section 2.3.3.2. The potential impact on the three supplies which could potentially be impacted by dewatering are summarised below in Table 4-1.

Table 4-1: Summary of Groundwater Abstraction Points

Location ID	Location Name	Approx. Distance from Cable Route (m)	Well Details	
			Depth to base (m)	Depth to water (m)*
PWS 008	Normans Farm	60m	3.30	1.40
PWS 001	Paynes Cottage	35m	3.06	1.40



Location ID	Location Name	Approx. Distance from Cable Route (m)	Well Details	
			Depth to base (m)	Depth to water (m)*
A10	Dairy House Farm	43m	c.10m	3m – Dry

A review of the development plans indicates that all three locations are adjacent to trenchless crossing zones, although it is noted the exact positioning of these has not yet been confirmed and therefore it has been assumed that dewatering is possible at these locations when assessing the distance from the onshore ECC route.

The available data indicates that licenced abstraction A10 has a typical water level which is below the maximum depth of trenching and therefore any dewatering required is unlikely to adversely impact water supply. In the event that water levels have risen above the base of the trench (i.e. 2m bgl) there will remain up to 8m of well below any potential dewatering and therefore this is considered unlikely to significantly impact on the viability of the supply. The potential impact on abstraction A10 is therefore assessed a **'low'**.

PWS 008 at Normans Farm and PWS 001 at Paynes Cottage are both located within 60m from the onshore ECC route with a shallow water table which will potentially be less than 1.0m bgl during winter. The proposed trenching will extend up to 2m bgl indicating that although any dewatering will potentially impact water levels at the supply locations, there will remain in excess of 1.0m of water within the base of both wells (assuming as a worst case that the impact of dewatering lowers the water table at the supplies to 2.0m bgl).

Based on the range in water levels historically observed in EA boreholes, this is likely to be similar to water levels following dry summer periods and is not likely to result in the complete loss of supply. Nonetheless there is the potential for the works to impact water supply and appropriate monitoring is outlined within Appendix 02 to ensure that any significant impact is identified and mitigation measures in the form of alternative supply can be put into place if needed. The potential impact on groundwater levels and flows at PWS 008 and PWS 001 is therefore assessed as **'low'** to **'moderate'**.

4.3.4 Impact on Groundwater Quality

4.3.4.1 Construction works

The construction works along the route will inevitably give rise to suspended solids which if not managed could pollute surface waters and groundwaters. The construction works will also involve the use of mobile plant which could give rise to fuel spills which could potentially contaminate surface waters and groundwaters.

The onshore ECC route construction works will be undertaken in accordance with the management plans and guidance outlined in Section 4.3.2 which provide details of how construction will be completed in an environmentally safe manner and minimise the potential for spillages.

Best practice techniques will be incorporated within the management procedures for construction activities onsite to protect the water environment from pollution incidents. Key mitigation measures, as set out in the CoCP, can be summarised as follows:

- during operation there will be heavy machinery required onsite and, as a result, it is appropriate to adopt best working practices and measures to protect the water environment, including those set out in the Guidance for Pollution Prevention (GPP1);



- in accordance with GPP2 all above ground onsite fuel and chemical storage will be bunded;
- an emergency spill response kit will be maintained onsite;
- a vehicle management system will be put in place wherever necessary to reduce the potential conflicts between vehicles and thereby reduce the risk of collision;
- a speed limit will be imposed on site to reduce the likelihood and significance of any collisions;
- key infrastructure including entry and exit pits for trenchless crossing and site access points etc will be located at least 10 metres from any watercourse or surface water drain or rock outcrop (hard rock at surface) wherever possible.

Given the embedded mitigation in place, the potential risk during construction to groundwater quality assessed as '**negligible**' to '**low**'. However, given the high vulnerability of the superficial aquifer routine monitoring of all the water supplies outlined in 4.3.1 above is proposed to ensure that there is no deterioration in water quality during construction work.

4.3.4.2 Trenching – Cement Bound Sand

The trenched onshore ECC route will be backfilled using Cement Bound Sand (CBS to the base of the sub-soil layer (or appropriate depth required for effective heat management) which acts to conduct heat away from the cables, the trench will subsequently be backfilled using indigenous backfill to surface. This is normal best practice for high voltage cable routes. The exact specification of the CBS used on site has not yet been decided, although this most commonly used comprises 14 parts sand to 1 part cement.

The greatest risk with regard to this material is likely to occur to the surface water environment during the storage, preparation and mixing of the CBS, this risk will be controlled by the appropriate locating of these activities away from watercourses and through measures to ensure that there is no direct discharge of run-off, as outlined within the CoCP.

Once cables are placed, the risk to groundwater will be limited to the potential for leaching of contaminants and the migration of these contaminants through groundwater flow. Principal chemical concerns relate to the highly alkaline nature of the cement and the limited potential presence of heavy metals including chromium, particularly chromium VI which is a hazardous substance and commonly found within cement.

It is considered that the hydrogeological setting close to the trenching is relatively insensitive with the exception of nearby water supplies/abstractions. Given that cement forms only a minor constituent of the CBS to be emplaced, the overall risk to the water environment inclusive of surface water and shallow groundwater, is considered to be low.

Routine monitoring of pH and chromium will be undertaken at the water supplies located within a 100m radius of any CBS placed; i.e. PWS 008, PWS 001 and licenced abstraction A10. The proposed monitoring schedule is outlined in Appendix 02.

As the underlying Thames Group is considered an aquitard there is considered to be negligible risk from the use of cement for trench backfilling purposes to the Chalk aquifer at depth.

4.3.4.3 HDD – Drilling Fluids

The Trenchless crossings are likely to be constructed using Horizontal Directional Drilling (HDD), or similar techniques which will include the use of drilling fluids. All drilling will be



undertaken by an approved contractor and undertaken in accordance with relevant best practice including BS5930:2015¹⁶ BS EN 16228-3¹⁷.

The drilling mud typically used within HDD operations is inert and is not considered to pose a direct risk to groundwater quality, the primary environmental concerns would therefore be related to potential release of returned mud to the water environment, affecting suspended solids within a watercourse.

A secondary risk to water supplies could be associated with the potential for hydraulic fracture ('frac-out') to occur. When drilling is undertaken in close proximity to a water supply or beneath a watercourse this could result in drilling fluid entering a well if fracturing were to create a preferential pathway between the drill hole and the well. Assessment of the potential for hydraulic fracturing to occur will be undertaken and a method statement developed prior to any works being undertaken. Measures to ensure that the risk from frac-out is minimised is outlined within the CoCP and includes the following:

- Undertaking appropriate ground investigation/desk study to inform drilling parameters such as drilling pressures;
- Monitoring of drilling fluid properties (i.e. mud weight, viscosity, gel strength, volume and pressure) during drilling to prevent frac-outs;
- Stopping drilling if unexpected variations or trends are observed and investigating the cause;
- Having frac-out contingency plans and response equipment such as sand bags and clean-up equipment in place, and detailed in the activity Risk Assessments and Method Statement; and
- Regular inspections should also be conducted along the drill path during pilot hole drilling.

In the event that frac-out were to occur the impact is typically close to the drill location, however monitoring is proposed at water supplies PWS 008, PWS 001 and licenced abstraction A10 (which are all located within 60m of trenchless crossings) to ensure that there is no impact on water quality. The proposed monitoring schedule is outlined in Appendix 02.

4.3.4.4 Piling

As mentioned above in Section 4.1 the piling solution for the OnSS will be determined post consent, following ground investigations.

To minimise the potential risk to groundwater, in the event where a piled foundation solution is taken forward, a piling method statement will be developed outlining the methodology/ piling method and safety protocols, as outlined within the CoCP. It is expected that a selection of boreholes installed as part of ground investigation works will be retained for quality monitoring of the groundwater against pre-agreed criteria before, during and after any piling activity.

Any environmental incidents or elevated contaminant levels observed during piling operations would lead to a suspension of the works until the pathways identified or the piling methodology reviewed to allow the most appropriate response. Supervision of the works by

¹⁶ British Standard (BS) 5930:2015 *Code of Practice for Ground Investigations*

¹⁷ British Standard (BS EN) 16228-3 *Drilling and foundation equipment – safety – part 3: Horizontal directional drilling equipment*



a suitably qualified geologist/engineer will also ensure for a proactive comparison of actual ground conditions versus those expected, with proactive notification and work procedures should conditions differ. The exact requirements would be outlined within a piling risk assessment, if needed.

It is noted that there are no water supplies located within 150m of proposed works within the substation zone and therefore the risk from this activity on these supplies is considered to be very low.

Given the thickness of the London Clay (up to 30m) it is considered highly unlikely that any piling would extend below the base of the clay.

4.4 Monitoring and Mitigation

An outline groundwater monitoring and mitigation plan is included in Appendix 02 which outlines the proposed water monitoring which will be undertaken during the construction phase of development to ensure that there is no impact on the water supplies outlined in this assessment.

4.4.1 Survey

A survey has already been completed on eleven of the identified PWS however it is noted that no survey data was available for PWS013 or PWS014 therefore additional survey will be undertaken prior to finalisation of the monitoring plan.

In addition further discussion will be undertaken with the proposed locations to be monitored to confirm that the locations are in-use and that there will be an ongoing need for the supply during the construction phase. The monitoring plan will be updated prior to commencement of the construction phase.

4.4.2 Monitoring

Whilst the risk to both groundwater levels and quality is assessed as low to moderate an outline monitoring regime has been outlined within Appendix 02 to ensure that any impact on either water supply or water quality to the water supplies located in close proximity to the proposed onshore ECC route (namely PWS 008, PWS 001 and licenced abstraction A10) can be identified at the earliest opportunity and mitigation put into place. The need for monitoring of these locations would be confirmed prior to commencement of the construction phase through consultation with the supply owners, in the event that any of these locations do not require the supply during the construction period (i.e. due to lack of need or an existing alternate supply) then these will be removed from the monitoring schedule and confirmatory monitoring undertaken instead.

Confirmatory monitoring of other water supplies located within a 250m radius of the DCO and close to any construction activity which could impact water quality is also outlined to allow for collection of baseline pre-development water quality and post-completion water quality to ensure that there is no detrimental impact on these supplies. The following locations will be included within the confirmatory monitoring:

- PWS 002 – Little Bromley Hall
- PWS 004 – Little Bromley Hall
- PWS 011 – Oakwood
- PWS 013 – Welhams Farm



- PWS 014 – Orchard Cottage

Locations PWS 003, PWS 005, PWS 006, PWS 007, PWS 012, PWS 015 and PWS 016 have been excluded from confirmatory monitoring as they are either in excess of 250m from any potential dewatering and/or remote from any significant construction activity which could impact water quality. In addition PWS 010 has been excluded as it is abstracting from the Chalk bedrock which is not hydraulically connected to the proposed works. Location A10 has also been excluded as the survey confirmed this is not in use.

4.4.3 Mitigation

Appropriate mitigation in the event of an adverse impact on water supplies is outlined in Appendix 02. This will likely include the provision of an alternate supply during construction phase and rehabilitation or provision of a replacement supply if long-term impact is indicated.

4.4.4 Permitting

Based on the developed CSM it is likely that dewatering will be required along much of route that crosses the superficial aquifer, however given that the proposed trenching will be to less than 2m the dewatering depth will typically be less than 1m and potential abstraction volumes limited.

It is therefore anticipated that dewatering rates will likely remain below the licencing limit (20m³/day). In the event that the abstraction rate exceeds 20m³/day initially the abstraction would comply with the '*water abstraction and impounding (exemptions) regulations 2017*' regulations which allow for the abstraction of up to 100m³/day along much of the onshore ECC route, reducing to 50m³/day for any abstraction within 250m radius of a water supply, where discharging to a watercourse or at an unlimited rate where discharging back to ground.

Given the limited number of watercourses along the development route it is likely that any abstraction required will discharge back to ground, if a discharge to a watercourse is proposed this will be undertaken in accordance with the EA's regulatory position statement for *temporary dewatering from excavations to surface water* (RPS 261).

The EA has clarified that the '*water abstraction and impounding (exemptions) regulations 2017*' allow for abstraction for a maximum period of 6 month and that the entire site will be treated as a single operation and therefore if the regulations are triggered all subsequent abstraction would need to be completed within 6 months. In the event that dewatering volumes exceed the limits outlined above or are likely to exceed the six months in duration then an abstraction licence would need to be obtained from the EA.

5.0 Summary and Conclusions

A Groundwater Risk Assessment has been undertaken to assess the potential impact of the proposed Five Estuaries Offshore Wind farm (VE) onshore export cable corridor (ECC) and onshore substation (OnSS) construction on the local and regional hydrogeology and to specifically assess the potential impact on private water supplies and licenced groundwater abstractions.

A conceptual site model (CSM) for the route has been developed and confirms that the primary groundwater pathway along the route consists of a shallow superficial aquifer comprising cover sand underlain by sands and gravels of the Kesgrave Catchment Subgroup. Available monitoring data indicates that the superficial aquifer is typically between 4m and 12m in thickness with a shallow water table between 1m and 2m below ground level, occasionally rising to less than 1m during winter peaks. The underlying



bedrock (which is present at surface across much of the route) comprises of low permeability London Clay, which is not considered to be water bearing and which acts as an aquitard to the underlying Chalk aquifer (and therefore is not considered to be a potential receptor).

A FOI request and subsequent survey has identified a total of seven private water supplies and one licenced abstractions located within a 250m radius of the DCO which could feasibly be impacted by construction activities including dewatering and construction. There are no groundwater dependent ecological sites or springs recorded along the development route.

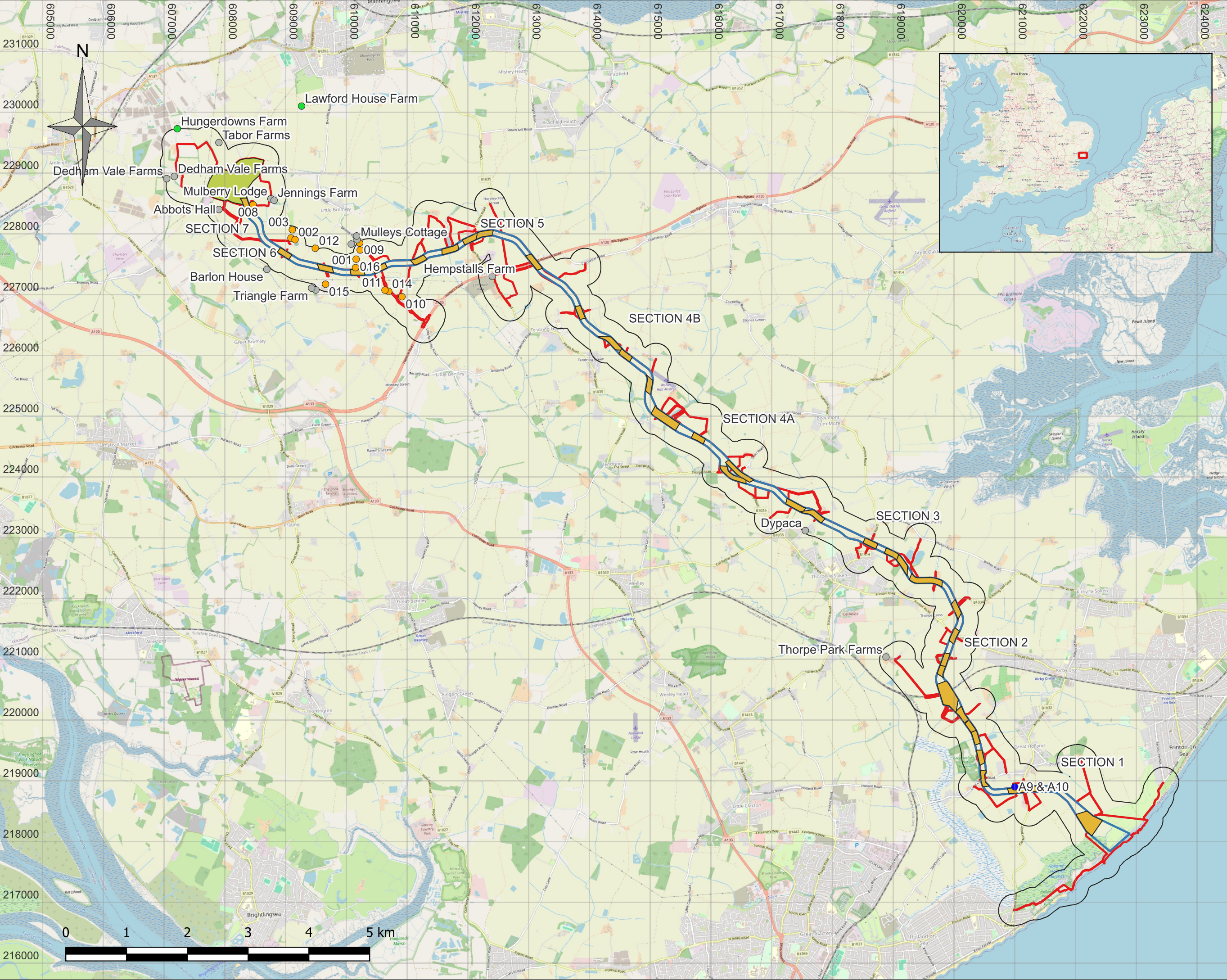
A qualitative impact assessment has been undertaken and confirms that subject to incorporation of appropriate best practice and the measures outlined within developed management plans the potential risk to the identified groundwater abstractions is low to moderate, nonetheless a groundwater monitoring plan has been developed to allow for ongoing monitoring of water supplies throughout the construction phase and ensure that there are no adverse impacts on water supplies.



Drawings

Drawing 1:	Site Location Plan
Drawing 2.1:	Superficial Deposits – North
Drawing 2.2:	Superficial Deposits – South
Drawing 3.1:	Bedrock Geology – North
Drawing 3.2:	Bedrock Geology – South
Drawing 4:	Source Protection Zones





Notes:

1.

Legend:

Legend

Abstraction Points

- EA Monitoring BH
- Licenced Abstraction
- Private Water Supplies
- Previously Scoped Out Abstraction

DCO Boundary

Section Boundaries

250m Buffer

Trenchless Crossings

Substation Works Area

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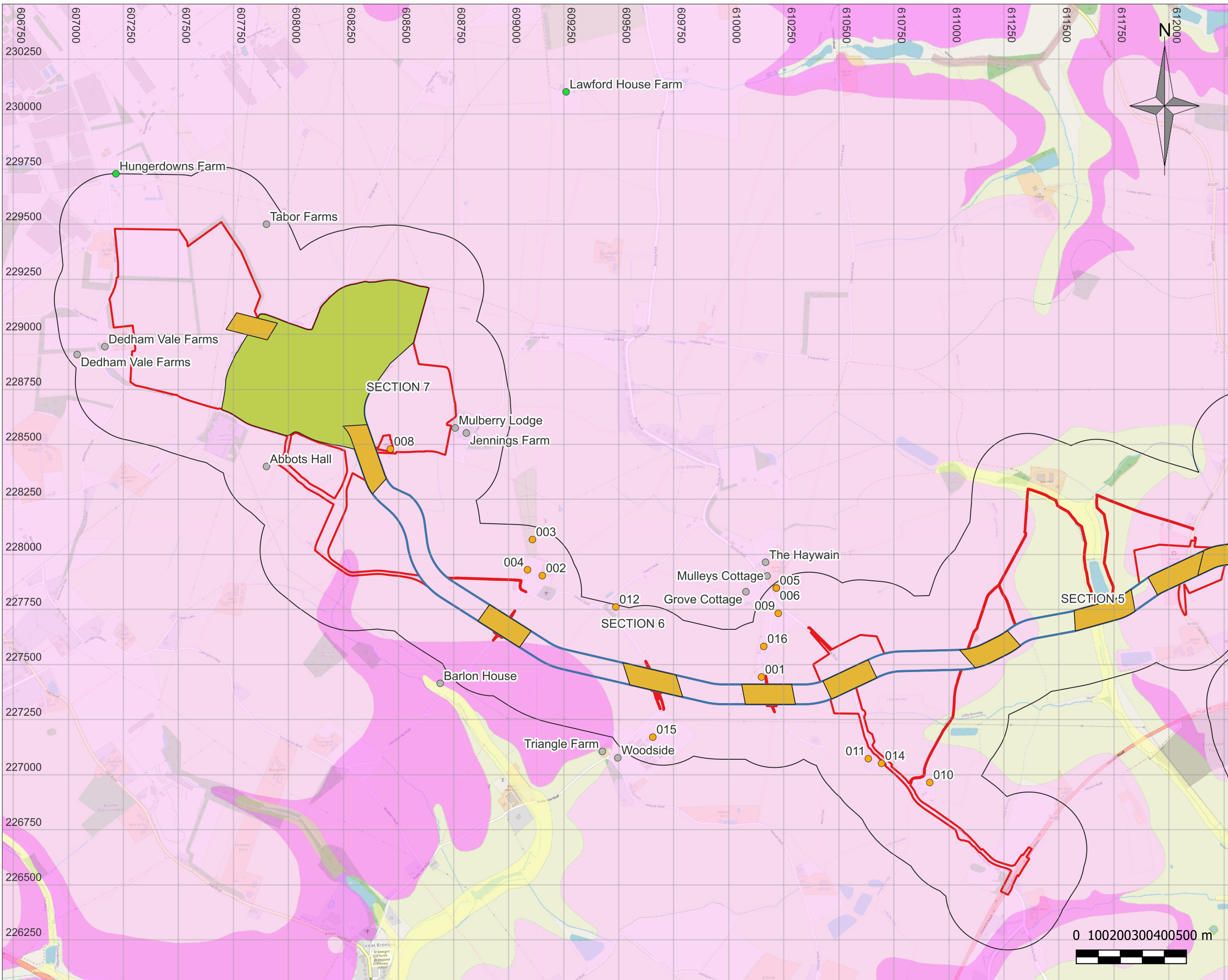
Project

Five Estuaries Offshore Windfarm: Groundwater Risk Assessment

Drawing Title

Site Location

Scale	1:125,000 @ A3	SLR Project No.	402.065339.00001
Designed	BC	Drawn	BC
Checked	SM	Authorised	SM
Date	Feb 2025	Date	Feb 2025
Drawing Number	1.1	Rev	1



Notes:

Legend:

Legend

Abstraction Points

- EA Monitoring BH
- Private Water Supplies
- Previously Scoped Out Abstraction

DCO Boundary

Section Boundaries

250m Buffer

Trenchless Crossings

Substation Works Area

Superficial Legend

- Cover sand - clay, silt and sand
- Kesgrave catchment subgroup - sand and gravel
- Alluvium - clay and silt

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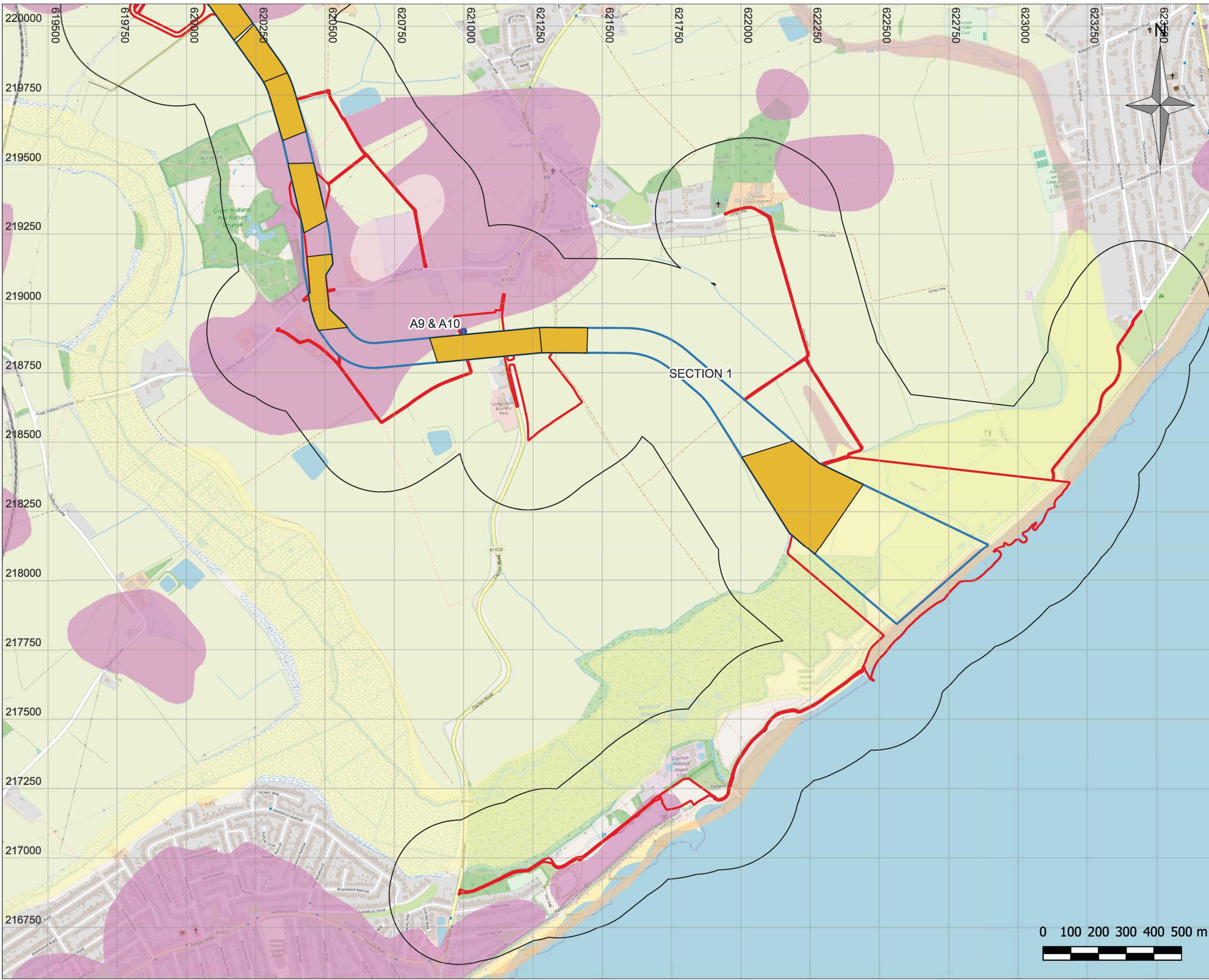
Project

Five Estuaries Offshore Windfarm: Groundwater Risk Assessment

Drawing Title

Superficial Deposits - North

Scale	1:26,000 @ A3	SLR Project No.	402.065339.00001					
Designed	BC	Drawn	BC	Checked	SM	Authorised	SM	
Date	Feb 2025	Date	Feb 2025	Date	Feb 2025	Date	Feb 2025	
Drawing Number	2.1						Rev	1



Notes:

1.

Legend:

Legend

- Licenced Abstractions
- DCO Boundary
- SectionBoundaries
- 250m Buffer
- Trenchless Crossings

Superficial Legend

- Cover sand - clay, silt and sand
- Kesgrave catchment subgroup - sand and gravel
- Alluvium - clay and silt
- Head - diamicton
- Storm beach deposits - sand and gravel

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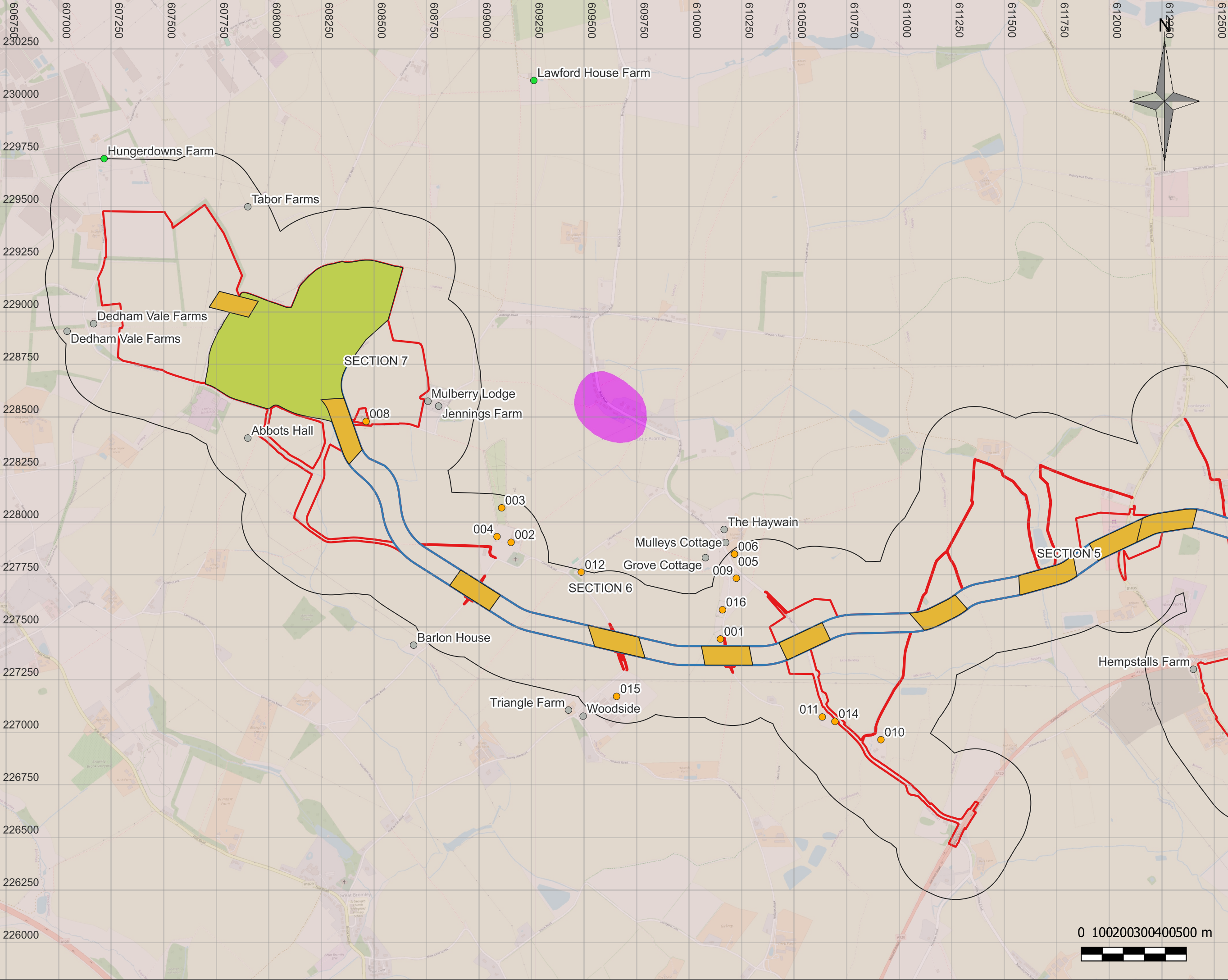
Project:

Five Estuaries Offshore Windfarm:
Groundwater Risk Assessment

Drawing Title:

Superficial Deposits - South

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				402.065339.00001	
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Date	Feb 2025	Date	Feb 2025	Date	Feb 2025
Drawing Number					2.2
					Rev 0



Notes:

1.

Legend

Abstraction Points

- EA Monitoring BH
- Private Water Supplies
- Previously Scoped Out Abstraction

DCO Boundary

SectionBoundaries

250m Buffer

Trenchless Crossings

Substation Works Area

Bedrock Legend

- Red Crag Formation - sand
- Thames Group - clay, silt and sand

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Project Five Estuaries Offshore Windfarm: Groundwater Risk Assessment					
Drawing Title Bedrock Geology - North					
Scale 1:26,000 @ A3			SLR Project No. 402.065339.00001		
Designed BC	Drawn BC	Checked SM	Authorised SM		
Date Feb 2025	Date Feb 2025	Date Feb 2025	Date Feb 2025		
Drawing Number 3.1					Rev 1



Notes:

Legend:

Licenced Abstractions

DCO Boundary

Section Boundaries

250m Buffer

Trenchless Crossings

Bedrock Legend

Thames Group - clay, silt and sand

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Five Estuaries Offshore Windfarm:
Groundwater Risk Assessment

Drawing Title

Bedrock Geology - South

Scale

1:16,000 @ A3

SLR Project No.

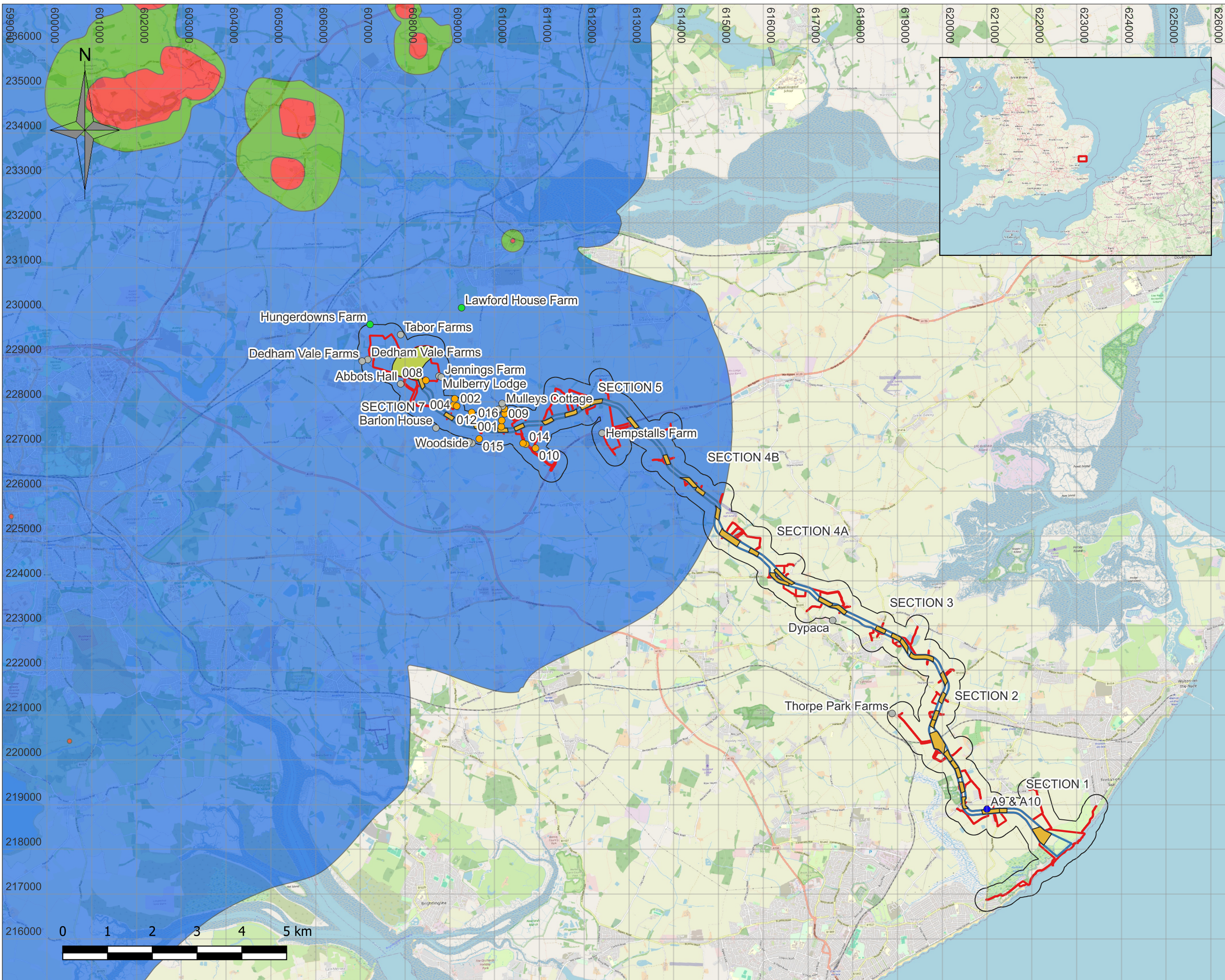
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Notes:

1.

Legend:

Abstraction Points

- EA Monitoring BH
- Licenced Abstraction
- Private Water Supplies
- Previously Scoped Out Abstraction

DCO Boundary

Section Boundaries

250m Buffer

Trenchless Crossings

Substation Works Area

Source Protection Zones

- Zone 1 - Inner Protection Zone
- Zone 2 - Outer Protection Zone
- Zone 3 - Total Catchment

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Five Estuaries Offshore Windfarm:
Groundwater Risk Assessment

Drawing Title

Source Protection Zones

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Date	Feb 2025	Date	Feb 2025	Date	Feb 2025	Date	Feb 2025	
Drawing Number	4.0						Rev	1

Appendix A Abstraction Scoping

Five Estuaries Offshore Wind Farm

Groundwater Risk Assessment

GoBe Consultants Ltd

SLR Project No.: 402.065339.00001.0006.012

6 February 2025



Appendix A Abstraction Licence Scoping

The table below outlines all water supplies identified within a 500m radius of the DCO Limits sorted by distance to provide information on where locations have been scoped into and out of the GWRA.

Location ID	Location Name	Abstraction Type	Licence No	Distance from DCO Limits at closest point (m)	Included in updated GWRA?	Reason for scoping out of assessment
A9 & A10	AH Brown Farms	Well (Superficial)	8/37/26/*G/0091	<0m	Yes	-
014	Orchard Cottage	Well (superficial)	Reg 10	10m	Yes	-
001	Paynes Cottage	Well (superficial)	Reg 10	10m	Yes	-
011	Oakwood	Well (Superficial)	Reg 10	30m	Yes	-
008	Normans Farm	Well (Superficial)	Unregulated	30m	Yes	-
A11	Hempstalls Farm	Unknown	8/36/19/*G/0092	30m	No	Excluded in Preliminary GWRA although adjacent to DCO Limits located 600m+ from any confirmed construction activity
A7 & A8	Abbots Hall	Unknown	8/37/25/*G/0172	40m	No	Excluded in Preliminary GWRA although adjacent to DCO Limits located 250m+ from any confirmed construction activity
010	Welhams Farm	Borehole (Chalk)	Reg 10	40m	Yes	-
015	Hiskeys Farm	Unknown	Unregulated	100m	Yes	-
004	The Coach House	Well (Superficial)	Reg 10	110m	Yes	-
016	Richmond Cottage	Unknown	Unregulated	120m	Yes	-



Location ID	Location Name	Abstraction Type	Licence No	Distance from DCO Limits at closest point (m)	Included in updated GWRA?	Reason for scoping out of assessment
A1 – A3	Dedham Vale Farms	Unknown	8/37/25/*G/0064	120m	No	Excluded in Preliminary GWRA although within 250m of DCO Limits located 250m+ from any confirmed construction activity
009	Crabtrees	Well (Superficial)	Reg 10	140m	Yes	-
002	Little Bromley Hall	Well (Superficial)	Reg 10	140m	Yes	-
003	Little Bromley Hall	Well (Superficial)	Reg 10	140m	Yes	-
PWS12-18	Thorpe Park Farms	Unknown	Reg 10 (shared)	160m	No	Scoped out during Preliminary GWRA although within 250m of DCO Limits located 250m+ from any below ground construction
PWS11	Dypaca	Unknown	Reg 10	220m	No	Scoped out during Preliminary GWRA although within 250m of DCO Limits located 250m+ from any below ground construction
005	Mulleys Farm	Well (Superficial)	Reg 10	230m	Yes	-
006	Mulleys Farm	Well (Superficial)	Reg 10	230m	Yes	-
012	Old Rectory	Well (Superficial)	Reg 10	230m	Yes	-
A5 & A6	Dedham Vale Farms	Unknown	8/37/25/*G/0191	250m	No	Scoped out during Preliminary GWRA although within 250m of DCO Limits abstraction located 250m+ from any below ground construction
A12, A13	Tabor Farms	Unknown	8/37/25/*G/0236	200m	No	Scoped out during Preliminary GWRA although within 250m of DCO Limits



Location ID	Location Name	Abstraction Type	Licence No	Distance from DCO Limits at closest point (m)	Included in updated GWRA?	Reason for scoping out of assessment
						abstraction located 250m+ from any below ground construction
N/A	Woodside	Unknown	Reg 10	280m	No	Scoped out within preliminary GWRA due to being >250m from DCO Limits
N/A	Mulleys Cottage	Unknown	Reg 10	290m	No	
N/A	Barlon House	unknown	Reg 10	300m	No	
N/A	Triangle Farm	unknown	Unregulated	320m	No	Not previously identified but excluded due to >250m from DCO Limits
N/A	Grove Cottage	unknown	Reg 10	330m	No	Scoped out within preliminary GWRA due to being >250m from DCO Limits
N/A	The Haywain	unknown	Reg 9	350m	No	
007	Mulberry Lodge	Unknown	Reg 10	360m	Yes	Scoped in as fell within 250m radius of a previous iteration of DCO Limits – reviewed and scoped out of assessment
N/A	Jennings Farm	Unknown	Reg 10	370m	No	Scoped out within preliminary GWRA due to being >250m from DCO Limits



Appendix B Groundwater Monitoring Plan

Five Estuaries Offshore Wind Farm

Groundwater Risk Assessment

GoBe Consultants Ltd

SLR Project No.: 402.065339.00001.0006.012

6 February 2025





Five Estuaries

Outline Groundwater Monitoring and Mitigation Plan

GoBe Consultants Ltd

Client Address

Prepared by:

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SLR Project No.: 402.065339.00001.012

7 February 2025

Revision: V2

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1	10 December 2024	BC	SM	MB
V2	7 February 2025	BC	SM	MB
	Click to enter a date.			
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Table of Contents

1.0 Background	1
2.0 Monitoring and Sampling Plan	1
2.1 Monitoring Locations	1
2.2 Duration of Monitoring	2
2.3 Methodology and Procedure.....	2
2.3.1 Level Monitoring	2
2.3.2 Sample Collection	2
2.3.3 Sample Preparation, Preservation and Transport.....	3
2.3.4 Testing	3
2.4 Proposed Monitoring Schedule.....	3
2.5 Record Keeping and Reporting	4
2.5.1 Monitoring and Sampling Records.....	4
2.5.2 Monitoring Database	5
2.5.3 Quality Assurance and Quality Control	5
2.6 Mitigation Planning	5
2.6.1 Water Quality	5
2.6.2 Water Levels	5
3.0 Mitigation	6

Drawings

Drawings 001 & 002:
Groundwater Monitoring Plan



1.0 Background

Based on the findings of the Groundwater Risk Assessment (GWRA) for the Five Estuaries Onshore export cable corridor (ECC) and onshore substation (OnSS) a groundwater monitoring and mitigation plan (GWMP) is required to ensure that there are no adverse impacts from the construction phase on water supplies.

The GWRA has identified two private water supplies (PWS) and one licenced abstraction which could potentially be impacted by the dewatering associated with the construction works during which regular monitoring will be required to ensure that there is no adverse impact on the supplies. A further 5 PWSs have also been recorded remote from dewatering activity but within close proximity to other construction activity which could impact water quality for which confirmatory monitoring is proposed to ensure that there is no adverse impact on the water quality.

This outline GWMP which will be confirmed following finalised design of the works, construction techniques and confirmation of need from the water users. The final GWMP, produced in accordance with this outline, will be submitted for approval to the relevant authorities and secured through a DCO requirement.

2.0 Monitoring and Sampling Plan

The proposed outline monitoring plan is based on the water quality testing requirements for private water supplies as outlined within *'The Private Water Supplies (England) Regulations, 2016)* and will be completed throughout the proposed construction phase of development.

Two monitoring suites are proposed;

1. All supplies within 100m of possible dewatering activity will monitor all parameters outlined in Part I and Part II of Schedule 1 of the regulations and will undertake frequent water level monitoring; and
2. All supplies between in excess of 100m from possible dewatering but in close proximity to construction activity which could impact water quality will monitor a reduced suite of indicator determinands, as outlined by Part II of Schedule 1 of the regulations

2.1 Monitoring Locations

Monitoring will be completed from the PWS and licenced abstraction locations outlined in Table 2--1, unless agreed with the landowner that monitoring is not required, for example if the abstractions are no longer in use. Locations are presented on Drawing 001.

Table 2--1: Proposed Groundwater Monitoring Locations

Location ID	Location Name	National Grid Reference (NGR)	Distance from Potential Dewatering
PWS008	Normans Farm	TM 08463 28479	<100m
PWS001	Paynes Cottage	TM 10147 27445	
A10	Dairy House Farm	TM 20981 18927	
PWS002	Little Bromley Hall	TM 09153 27904	100 – 250m
PWS004	Little Bromley Hall	TM 09086 27931	



Location ID	Location Name	National Grid Reference (NGR)	Distance from Potential Dewatering
PWS011	Oakwood	TM 10633 27067	
PWS013	Craigus	TM 10913 26945	
PWS014	Orchard Cottage	TM 10695 27054	

2.2 Duration of Monitoring

Monitoring would be undertaken during the construction phase, the exact timing of which will be determined by any on-site activities. Monitoring would commence a minimum of 1 month prior to any works within a 250m radius of the water supply and would continue for a period of up to 3 months following cessation of works. The frequency of monitoring is based on the sensitivity of the water supply and is presented in Section 2.4.

2.3 Methodology and Procedure

The requirement for monitoring will be agreed with the landowner prior to the commencement of the construction phase of development. Where it is agreed that there is no requirement for the groundwater supply during the construction phase (i.e. due to the availability of alternate supply or lack of need) then there will be no requirement for the extended monitoring suite and only pre-commencement and post-development confirmatory monitoring will be required.

2.3.1 Level Monitoring

Continuous monitoring of water levels has been proposed for the three supplies located within 100m of the cable route whilst any dewatering is being undertaken within the trenches, unless agreed otherwise with the land-owner. Monitoring should be completed using automated water level loggers and include barometric compensation. The monitoring frequency should be suitable to allow for recording of daily changes in water level.

Routine monitoring is also proposed for locations in excess of 100m of the cable route and during periods where no dewatering is being undertaken. Routine monitoring should be undertaken using a calibrated dip meter and the dip to water from both the top of well and ground level recorded in addition to the dip to base.

2.3.2 Sample Collection

The choice of sampling technique utilised will be at the discretion of the contractor used and the nature of the water supply. The water supply should be taken prior to any local treatment (i.e. from the well rather than the tap). Where the well has not been in regular use samples should be taken following either of the approaches below:

- pumping: boreholes are purged prior to sampling using either a submersible or surface mounted pump. Three (3) well volumes¹ should be purged where possible to remove stagnant water from the borehole and allow fresh water to be sampled; or
- bailing: the same approach should be used when using a bailer for sampling with three well volume purged using the bailer prior to sampling to allow fresh water to be sampled;

¹ Well volume should be calculated using $V = \pi r^2 \times L$



2.3.3 Sample Preparation, Preservation and Transport

In accordance with best practice filtration should take place in the field for dissolved heavy metals using a 0.45µm in-line filter, in order to prevent precipitation of metal species. Typically filtered water is placed in a 150ml plastic bottle containing nitric acid (to be confirmed with the chosen laboratory).

Samples should be filled to the top of the bottle neck until a meniscus forms. This ensures that all air has been excluded from the samples, which helps to prevent oxidation of the sample. It can also prevent removal of other dissolved gases from solution.

Samples should be delivered to the selected accredited laboratory with the relevant chain of custody form completed within 24 hours of sampling.

2.3.4 Testing

Testing should be completed by an ISO/17025 accredited laboratory.

2.4 Proposed Monitoring Schedule

The proposed monitoring schedule is outlined in Table 2-2 for supplies located within 100m of potential dewatering activity and in Table 2-2 for supplies located at risk from water quality impacts, as noted above the requirement for monitoring will be agreed with the supply owner prior to commencement of works and locations only monito.

Table 2-2: Groundwater Monitoring Schedule – Water Supplies within 100m of Potential Dewatering

Location ID	Frequency	Monitoring Parameter	Notes
PWS001 PWS008 A10	Continuous – during periods of dewatering only	Groundwater Level (m BGL)	To commence 1 week prior to commencement of dewatering until 1 week following cessation
	Weekly	<u>Field Measurements</u> pH, oxidation redox potential, dissolved oxygen, electrical conductivity, total dissolved solids, turbidity	
			To commence 1 month prior to commencement of any works within 100m radius of well until 3 months following cessation of working
	Monthly	<u>Field Measurements</u> pH, oxidation redox potential, dissolved oxygen, electrical conductivity, total dissolved solids, turbidity <u>Lab Measurements</u> Groundwater Level, Coliforms, E.Coli, colony counts, Enterococci	



Location ID	Frequency	Monitoring Parameter	Notes
		Ammonium, Chloride, electrical conductivity, pH, Sulphate, Total Organic Carbon, Turbidity Arclylamide, antimony, arsenic, benzene, benzo(a)pyrene, boron, bromate, cadmium, chromium VI Copper, cyanide, 1,2 dichloroethane, epichlorohydrin, fluoride, lead, mercury, nickel, nitrate, nitrite, Polycyclic aromatic hydrocarbons, selenium Aluminium, iron, manganese, sodium, tetrachloromethane	

Table 2-3: Groundwater Monitoring Schedule: Water Supplies at risk from water quality impacts

Location ID	Frequency	Monitoring Parameter	Notes
PWS002 PWS004 PWS011 PWS013 PWS014	Monthly	Groundwater Levels (mBGL), base of well <u>Field Measurements</u> pH, oxidation redox potential, dissolved oxygen, electrical conductivity, total dissolved solids, turbidity <u>Lab Measurements</u> Ammonium, Chloride, electrical conductivity, pH, Sulphate, Total Organic Carbon, Turbidity	To commence 1 month prior to commencement of any works within 250m radius of well until 3 months following cessation of working

2.5 Record Keeping and Reporting

2.5.1 Monitoring and Sampling Records

During each monitoring event, the sampling personnel should record the following information:

- date of sampling;
- on-site weather condition;
- name of sampling personnel;
- sampling equipment, serial number and method;
- time at which water level was recorded and at which sample was taken;



- volume of water purged from the groundwater monitoring well prior to sampling (if purging undertaken);
- response to pumping (pump rate, drawdown at end of pumping);
- observations including water colour, turbidity, odour²;
- observations of damage to installations;

2.5.2 Monitoring Database

The data collected from each monitoring visit should be inputted into a suitable, user-friendly database, for example Microsoft Excel.

2.5.3 Quality Assurance and Quality Control

Monitoring and sampling should be undertaken in accordance with the proposed monitoring procedures by suitably trained personnel.

Monitoring instruments and equipment should be serviced and maintained in accordance with the manufacturers' recommendations. Calibration records should be kept and filed accordingly.

A suitably accredited laboratory should carry out analysis of groundwater samples.

2.6 Mitigation Planning

2.6.1 Water Quality

To ensure that there is no adverse impact on the water supplies the water quality data should be reviewed following each monitoring round and assessed against baseline data and relevant UK Drinking Water Standards, as outlined in '*The Water Supply (Water Quality) Regulations 2016*'.

In the event of an exceedance of DWS the following measures would be undertaken:

- Request a re-test of the sample from the lab to ensure the results is correct;
- Review the latest monitoring against the baseline water quality data collected prior to commencement of working to determine if the exceedance is consistent with baseline data;
- If the monitoring indicates a deterioration in water quality since baseline monitoring temporarily increased to weekly to allow for further review;
- Provide a provision for temporary alternate supply;
- Meanwhile complete assessment of potential on-site sources of impact to water quality and outline appropriate mitigation (if needed);

2.6.2 Water Levels

It is not proposed to stipulate trigger levels for level monitoring as it is noted that natural seasonal variation will potentially result in water levels dropping below the base of proposed excavations and could result in shallow wells running dry.

² To allow for a comparison between sampling events. An increase in turbidity or a change in colour may indicate collapse of the borehole or damage to the screen intake



However in the event of a landowner reporting a lack of supply the following measures should be undertaken:

- Temporarily cease dewatering to review monitoring data;
- Review level monitoring and logger data to assess whether there has been a notable change in water levels since commencement of dewatering;
- If the review indicates a likely source then dewatering to be ceased until appropriate mitigation can be put into place;
- If the monitoring indicates natural seasonal trends or alternate course for loss of supply then dewatering to recommence.

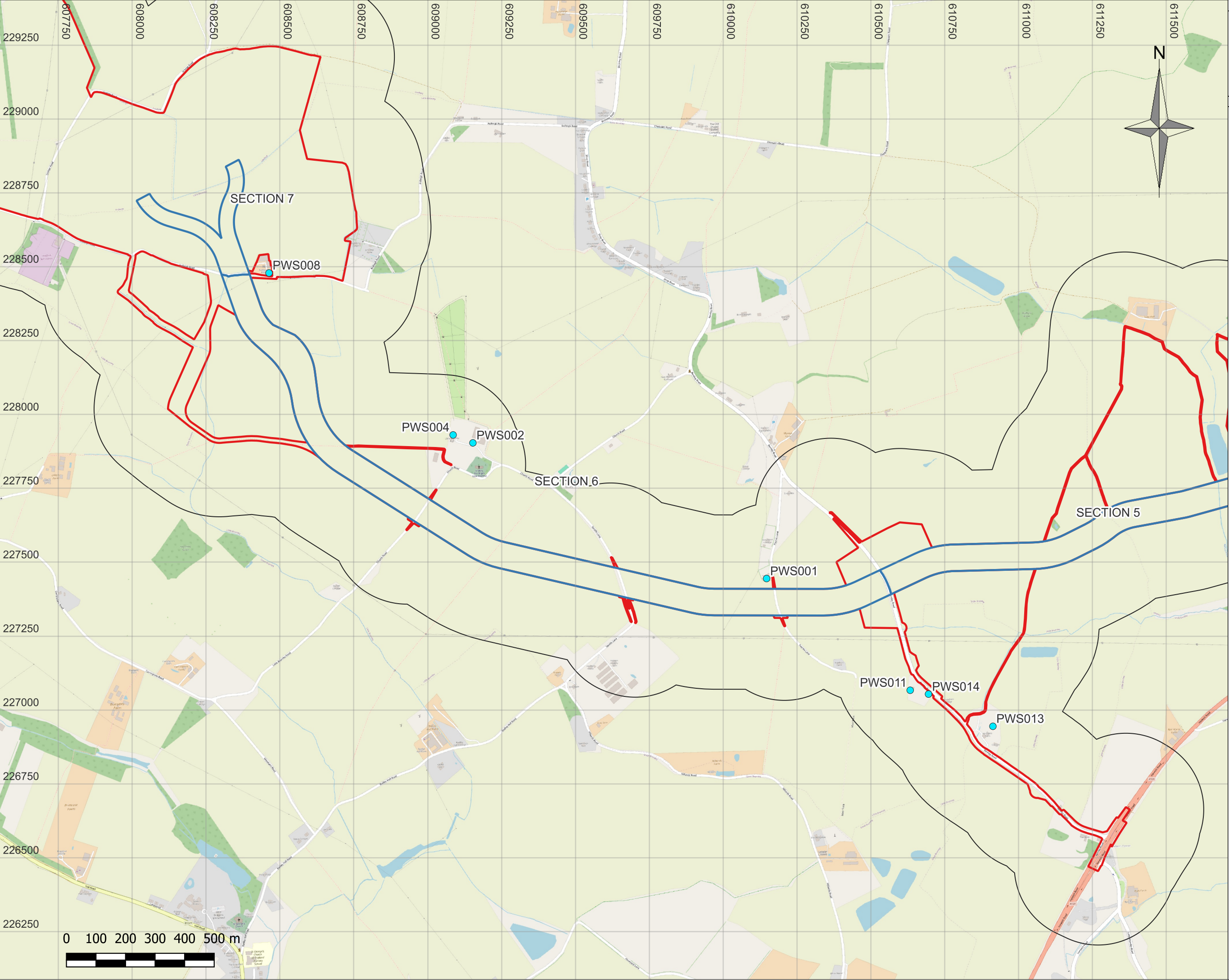
Any concerns raised from supply owners will be communicated through the community liaison officer, as outlined within the Code of Construction Practice (CoCP).

3.0 Mitigation

In the unlikely event of an adverse impact on water quality appropriate mitigation will be put into place to provide either a temporary or permanent replacement to supply. If a longer term impact this would potentially include the drilling of a replacement well away from the current location to remove any impact on water quality or availability of supply.

If the impact is assessed as short duration due to dewatering then a temporary water supply (such as tankering/water bowser) could potentially be provided, to be agreed with the PWS owner.





Notes:
1.

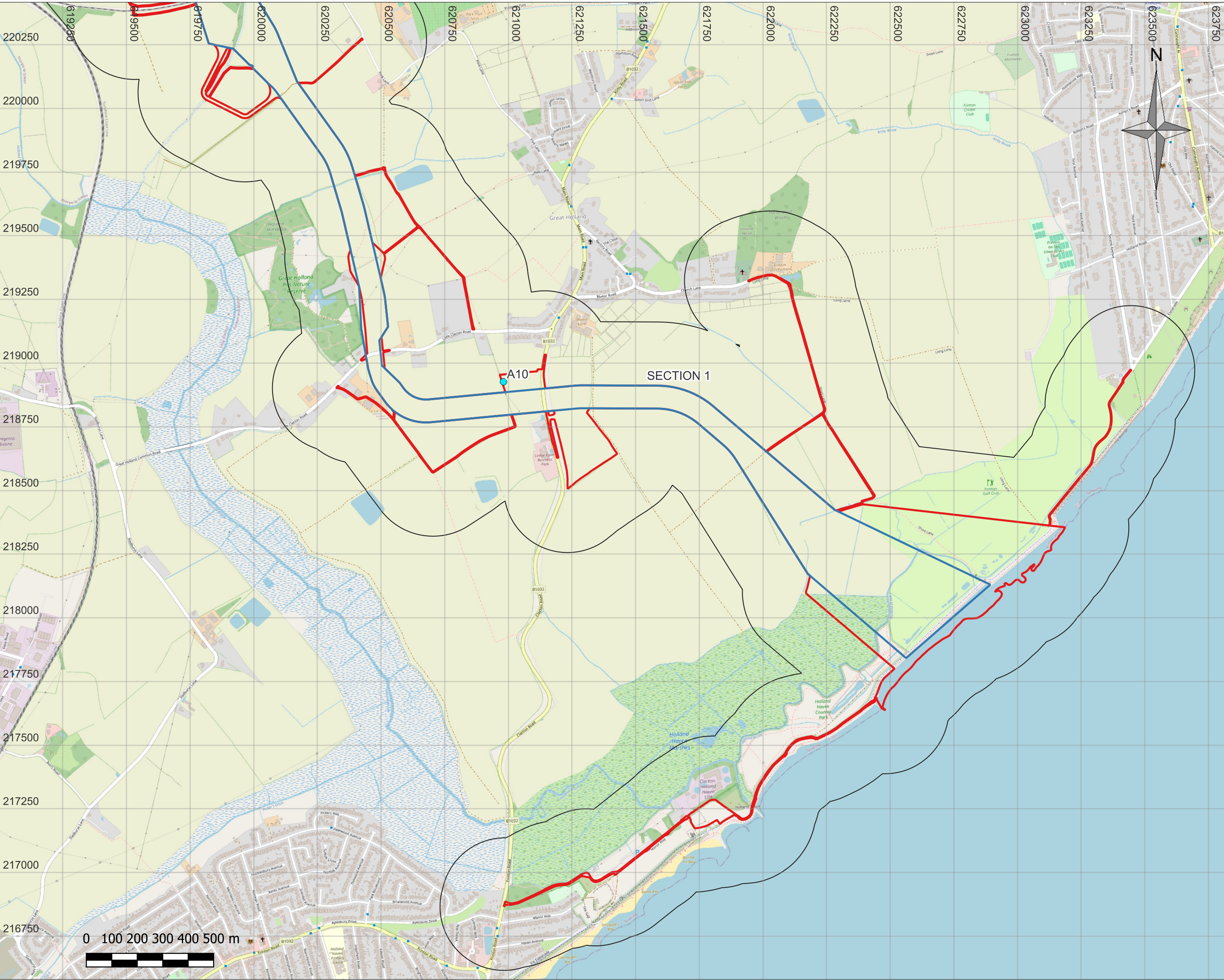
Legend

- Monitoring Locations
- DCO Boundary
- Section Boundaries
- 250m Buffer

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Rev	Amendments	Date	By	Chk	Auth
SLR www.slrconsulting.com					
Client GoBe Consultants Ltd					
Project Five Estuaries Offshore Windfarm: Groundwater Monitoring Plan					
Drawing Title Monitoring Locations					
Scale 1:16,000 @ A3		SLR Project No. 402.065339.00001			
Designed BC	Drawn BC	Checked SM	Authorised SM		
Date Feb 2025	Date Feb 2025	Date Feb 2025	Date Feb 2025		
Drawing Number 001				Rev 1	



Notes:

1.

Legend:

Monitoring Locations

DCO Boundary

Section Boundaries

250m Buffer

Environment Agency Reference (OGL data)

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Rev	Amendments	Date	By	Chk	Auth
SLR www.slrconsulting.com					
Client GoBe Consultants Ltd					
Project Five Estuaries Offshore Windfarm: Groundwater Monitoring Plan					
Drawing Title Monitoring Locations					
Scale 1:16,000 @ A3		SLR Project No. 402.065339.00001			
Designed BC	Drawn BC	Checked SM	Authorised SM		
Date Feb 2025	Date Feb 2025	Date Feb 2025	Date Feb 2025		
Drawing Number 002					Rev 1



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