Outer Dowsing Offshore Wind

Environmental Statement

Chapter 24 Hydrology and Flood Risk

Volume 3 Appendices

Appendix 24.1 Groundwater Risk Assessment

Date: February 2025

Document Reference: 6.3.24.1
Pursuant to APFP Regulation: 5(2)(a)
Revision: 2.0

Company:	**Outer Dowsing Offshore Wind**			Asset:	**Whole Asset**	
Project:	**Whole Wind Farm**			Sub Project/Package:	Whole Asset	
Document Title or Description:	6.3.24.1 Groundwater Risk Assessment					
Internal Document Number:	PP1-ODOW-DEV-CS-REP-0194_02			3rd Party Doc No (If applicable):	N/A	
Rev No.	**Date**	**Status / Reason for Issue**	**Author**	**Checked by**	**Reviewed by**	**Approved by**
1.0	March 2024	DCO Application	SLR	SLR	Shepherd & Wedderburn	Outer Dowsing
2.0	February 2025	Examination Update: updates to reflect, where relevant: clarifications to date in Examination; correcting errata; additional commitments made through Examination; and changes to status of or addition of cumulative projects.	SLR	SLR	Shepherd & Wedderburn	Outer Dowsing

Volume 3, Appendix 24.1 Groundwater Risk Assessment

Outer Dowsing Offshore Wind Environmental Statement

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SLR Project No.: 410.V05356.00013
Client Reference No: 05356

26 February 2025

Revision: V2.0

Revision Record

Revision	Date	Prepared By	Checked By	Authorised By
V1.0	1 March 2024	SLR	GoBe	ODOW
V2.0	26 February 2025	SLR	SLR	ODOW

Basis of Report

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Acronyms and Abbreviations

AOD	Above Ordnance Datum
BGL	Below Ground Level
BGS	British Geological Society
CIC	Cable Installation Compound
CSM	Conceptual Site Model
DEFRA	Department for Environment, Food and Rural Affairs
DC	Document Controller
DCO	Development Consent Order
DEFFRA	Department for Environment, Food and Rural Affairs
ECC	Export Cable Corridor
EDMS	Electronic Document Management System
EA	Environment Agency
EIA	Environmental Impact Assessment
ES	Environmental Statement
Fm	Formation
GPP	Guidance for Pollution Prevention
GWRA	Groundwater Risk Assessment
GW SPZ	Groundwater Source Protection Zone
GT R4 Limited	GT R4 or GT R4 Limited, the incorporated joint venture development Co.
HDD	Horizontal Directional Drilling
HIA	Hydrogeological Impact Appraisals
HVAC	High Voltage Alternating Current
IDB	Internal Drainage Board
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
NGR	National Grid Reference
ODOW	Outer Dowsing Offshore Wind (The Project)
OFTO	Offshore Transmission Owner
OnSS	Onshore Substation
OSS	Offshore Substation
PEIR	Preliminary Environmental Information Report
PLE	Project Planning Engineer
PPG	Pollution Prevention Guideline
PWS	Private Water Supply

SAC	Special Area Conservation
SPA	Special Protection Area
SPZ	Source Protection Zones
SSSI	Site of Specific Scientific Interest
TC	Trenchless Crossing
TCE	The Crown Estate
TE	TotalEnergies

Terminology

400kV cables	High-voltage cables linking the OnSS to the NGSS.
Baseline	The status of the environment at the time of assessment without the development in place.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for a Nationally Significant Infrastructure Project (NSIP) from the Secretary of State (SoS) for Department for Energy Security and Net Zero (DESNZ).
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the sensitivity of the receptor, in accordance with defined significance criteria.
Environmental Statement (ES)	The suite of documents that detail the processes and results of the EIA.
Export cables	High voltage cables which transmit power from the Offshore Substations (OSS) to the Onshore Substation (OnSS) via an Offshore Reactive Compensation Platform (ORCP) if required, which may include one or more auxiliary cables (normally fibre optic cables).
Intertidal	The area between Mean High-Water Springs (MHWS) and Mean Low Water Springs (MLWS).
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Impact	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Intertidal	Area where the ocean meets the land between high and low tides.
Landfall	The location at the land-sea interface where the offshore export cables and fibre optic cables will come ashore.
Link boxes	Underground metal chamber placed within a plastic and/or concrete pit where the metal sheaths between adjacent export cable sections are connected and earthed.
Mitigation	Mitigation measures are commitments made by the Project to reduce and/or eliminate the potential for significant effects to arise as a result of the Project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of potentially significant effects.

Onshore Export Cable Corridor (ECC)	The Onshore Export Cable Corridor (Onshore ECC) is the area within which the export cables running from the landfall to the onshore substation will be situated.
Onshore Substation (OnSS)	The Project's onshore HVAC substation, containing electrical equipment, control buildings, lightning protection masts, communications masts, access, fencing and other associated equipment, structures or buildings; to enable connection to the National Grid.
Onshore Infrastructure	The combined name for all onshore infrastructure associated with the Project from landfall to grid connection.
Outer Dowsing Offshore Wind (ODOW)	The Project.
Order Limits	The area subject to the application for development consent, the limits shown on the works plans within which the Project may be carried out.
Preliminary Environmental Information Report (PEIR)	The PEIR was written in the style of a draft Environmental Statement (ES) and provided information to support and inform the statutory consultation process during the pre-application phase.
Receptor	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of receptors include species (or groups) of animals or plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
Study Area	Area(s) within which environmental impact may occur – to be defined on a receptor-by-receptor basis by the relevant technical specialist.
The Project	Outer Dowsing Offshore Wind, an offshore wind generating station together with associated onshore and offshore infrastructure.
Transition Joint Bay (TJBs)	The offshore and onshore cable circuits are jointed on the landward side of the sea defences/beach in a Transition Joint Bay (TJB). The TJB is an underground chamber constructed of reinforced concrete which provides a secure and stable environment for the cable.

24.0 Groundwater Risk Assessment

24.1 Introduction

1. A Groundwater Risk Assessment (GWRA) has been prepared for the proposed works to be undertaken during the construction and operation of the onshore elements for Outer Dowsing Offshore Wind (ODOW) ("the Project").

24.2 Project Overview and Development History

2. A detailed description of the proposed development is provided in Volume 1, Chapter 3: Project Description (document reference 6.1.3), as part of this Environmental Statement (ES).

24.3 Purpose and Scope

3. This Groundwater Risk Assessment has been prepared as an Appendix to ES Volume 1, Chapter 24: Onshore Hydrology, Hydrogeology and Flood Risk (document reference 6.1.24) to address and respond to advice received through Section 42 consultation.
4. The assessment includes a desktop review of the Order Limits baseline geology, hydrogeology, and hydrology to develop a conceptual site model (CSM). This CSM is then used to assess the potential impact of the works on identified hydrogeological or hydrological receptors within the 2km study area and to outline any mitigation which would be required to prevent the works from adversely impacting upon identified receptors.
5. This assessment has been prepared in response to concerns raised by Natural England in its Section 42 response to the Preliminary Environmental Information Report (PEIR) which was published in June 2023. Natural England highlighted the presence of the Sea Bank Clay Pits Site of Specific Scientific Interest (SSSI) near to the route. The comment was as follows:

   "Natural England note that, where the project makes landfall, it will cross under the Sea Bank Clay Pits SSSI via HDD. This SSSI is predominantly designated for hydrological features which can be susceptible to changes in the water table caused by trenchless crossing. The main risk to this site from the proposed development is considered to be the impacts or changes to the hydrology, specifically quantity and quality of the water that currently feeds the site. This includes changes to ditches and waterbodies in the immediate vicinity."
6. The design of the landfall has been refined so that the landfall horizontal directional drilling (HDD) works do not cross underneath the SSSI. This GWRA has been prepared to assess the outstanding risk to the SSSI, as well as any other identified receptors which have been identified within the Order Limits.
7. This GWRA will be updated post consent and used to inform the preparation of a Water Quality Management and Mitigation Plan and be appended to it. This commitment is contained in the outline Code of Construction Practice (oCOCP) (document 8.1), which is secured through the Development Consent Order (DOO) Requirement 18.

24.4 Methodology

8. This GWRA has been developed in accordance with relevant Environment Agency guidance on the completion of groundwater risk assessments and Hydrogeological Impact Appraisals (HIA) (Environment Agency, 2016) and uses the following structure:
    - Section 24.6 provides a baseline assessment of the Order Limits, including a summary of the geology and hydrogeology including information on ground conditions, groundwater levels and flows, groundwater quality and the location of potential receptors which have the potential be impacted as a result of construction activities within the Order Limits. A CSM of the current hydrogeological regime is provided.
    - Section 24.7 provides an assessment of the potential impact that the construction works could have upon the identified receptors and regional hydrogeology and hydrology. Appropriate mitigation measures are outlined where required.
    - Section 24.8 provides a summary of the overall impact that the works could have upon the local hydrogeology and any identified receptors.
9. 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.
10. This approach provides a mechanism for identifying where additional mitigation measures could be required to reduce the risk to groundwater or surface water receptors.
11. The determination of a receptor's sensitivity has been made by considering its relative importance (whether it be on a local, regional, national or international scale), its rarity, its potential for substitution/ replacement, and/or its quality as provided in Table 24.1 below:

Table 24.1: Sensitivity Definition

Sensitivity	Definition
Very High	• International importance. • Receptor with a high quality and rarity, international or national scale and limited potential for substitution / replacement.
High	• National importance. • Receptor with a high quality, local scale and limited potential for substitution / replacement; or • Receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement.
Medium	• Regional importance. • Receptor with a medium quality and rarity, local scale and limited potential for substitution / replacement; or • Receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement.

Sensitivity	Definition
Low	• Local importance. • Receptor with a low quality and rarity, local scale. • Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.

12. The magnitude of impact has been assessed based on the perceived impact on the attribute, as summarised in Table 24.2 below:

Table 24.2: Magnitude of Impact Definition

Magnitude	Criteria	Definition
Major	Results in loss of attribute	Fundamental (long term or permanent) changes to hydrology, hydrogeology and water quality, such as: • Wholesale changes to watercourse channel, route, hydrology or hydrodynamics. • Changes to the application site resulting in an increase in runoff with flood potential and also significant changes to erosion and sedimentation patterns. • Major changes to the water chemistry or hydro-ecology. • Major changes to groundwater levels, flow regime and risk of groundwater flooding.
Moderate	Results in impact on integrity of attribute or loss of part of attribute	Material but non-fundamental and short to medium term changes to hydrology, hydrogeology and water quality, such as: • Some fundamental changes to watercourses, hydrology or hydrodynamics. Changes to application site resulting in an increase in runoff within system capacity. • Moderate changes to erosion and sedimentation patterns. • Moderate changes to the water chemistry of surface runoff and groundwater. • Moderate changes to groundwater levels, flow regime and risk of groundwater flooding.
Minor	Results in minor impact on attribute	Detectable but non-material and transitory changes to hydrology, hydrogeology and water quality, such as: • Minor or slight changes to the watercourse, hydrology or hydrodynamics. • Changes to application site resulting in slight increase in runoff well within the drainage system capacity. • Minor changes to erosion and sedimentation patterns. • Minor changes to the water chemistry of surface runoff and groundwater. • Minor changes to groundwater levels, flow regime and risk of groundwater flooding.
Negligible	Results in no impact or an impact on attribute of insufficient magnitude to	No perceptible changes to geology, hydrology, hydrogeology and water quality, such as: • No impact or alteration to existing important geological environs. • No alteration or very minor changes with no impact to watercourses, hydrology, hydrodynamics, erosion and sedimentation patterns.

Magnitude	Criteria	Definition
	affect use / integrity	• No pollution or change in water chemistry to either groundwater or surface water. • No alteration to groundwater recharge or flow mechanisms.

13. The sensitivity of the receiving environment together with the magnitude of the impact defines the significance of the potential effect, as identified within Table 24.2.

Table 24.3: Significance of Potential Effect

Magnitude of Impact	Sensitivity			
	Very High	High	Medium	Low
Major	Major	Major	Moderate	Minor
Moderate	Moderate	Moderate	Moderate	Minor
Minor	Minor	Minor	Minor	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

24.5 Sources of Information

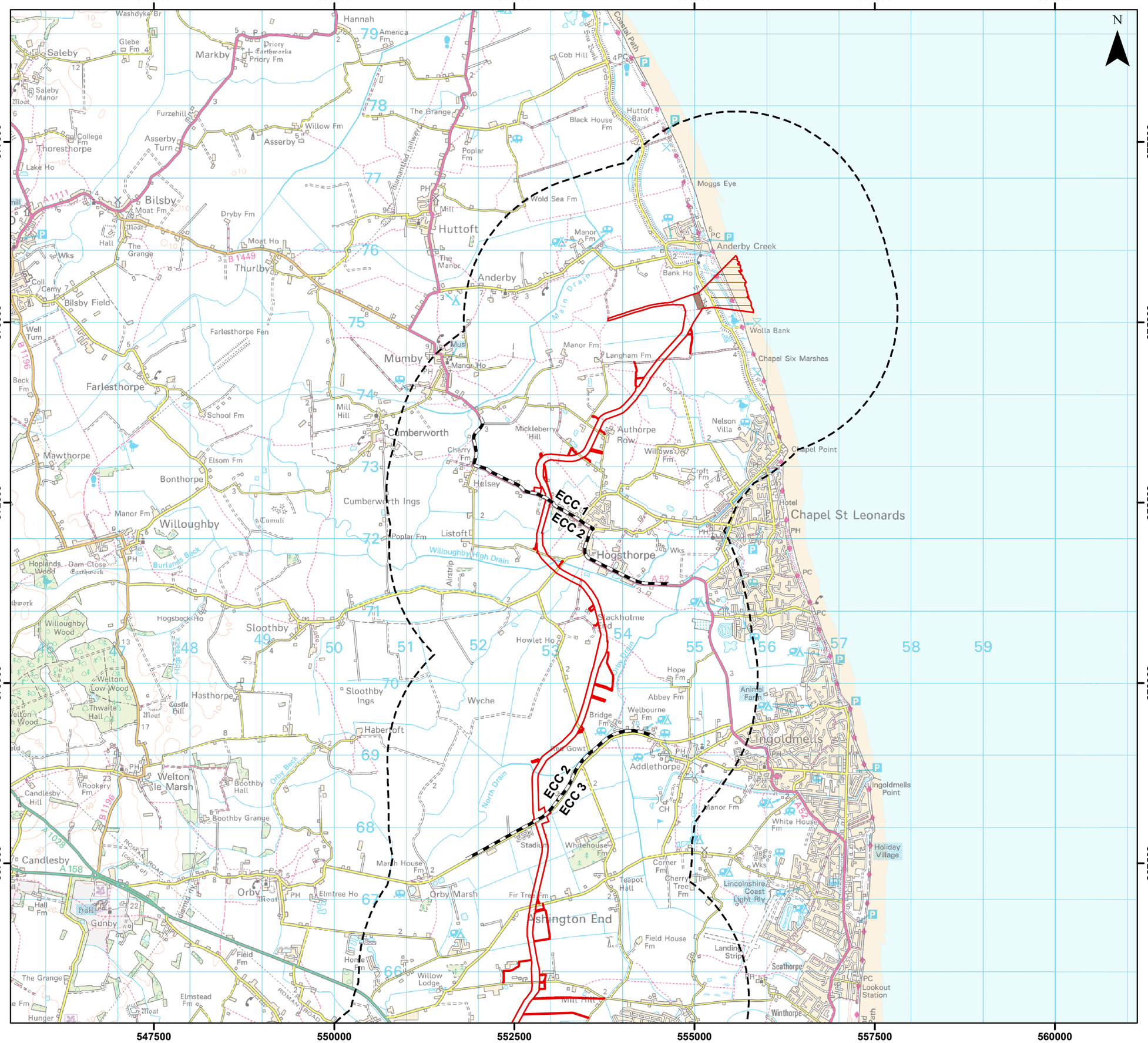
14. The following sources of information have been consulted to characterise the geology, hydrogeology and hydrology of the area within and surrounding the Order Limits:
    - Outer Dowsing Offshore Wind (2022), Scoping Report;
    - Outer Dowsing Offshore Wind (2023), Preliminary Environmental Information Report (PEIR) and associated consultee responses;
    - Outer Dowsing Offshore Wind (2023), Environmental Statement - Chapter 23: Geology and Ground Conditions;
    - Outer Dowsing Offshore Wind (2023), Environmental Statement – Chapter 24: Hydrology and Flood Risk;
    - British Geological Survey (BGS) online maps (https://www.bgs.ac.uk/map-viewers/geoindex-onshore/) for details of geology and borehole logs;
    - Hydrogeological map of North and East Anglia, sourced from the BGS website (https://largeimages.bgs.ac.uk/iip/hydromaps.html?id=north-east-lincolnshire.jp2);
    - National Soils Resource Institute Website for details on soils (https://www.landis.org.uk/soilscapes/);
    - Defra Magic Map Website (https://magic.defra.gov.uk/) for details on groundwater classifications, source protection zones and groundwater and surface water dependent designated ecological sites;
    - Groundwater and surface water quality and status as presented in the Environment Agency catchment planning datasets (https://environment.data.gov.uk/catchment-planning/); and
    - Details of the Order Limits, proposed development, and other site details provided by the client.

24.6 Baseline

15. The geological and hydrogeological regime within the Order Limits 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 in Section 24.7.

24.6.1 Location and Topography

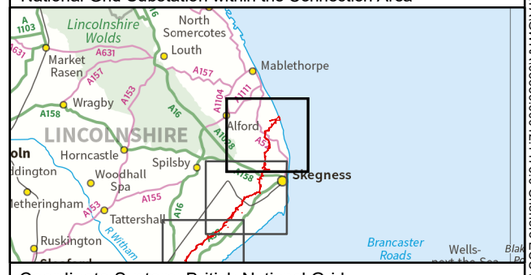
16. The onshore ECC extends for approximately 70 km from the Project's landfall at Wolla Bank, to the Onshore Substation (OnSS) at Surfleet Marsh. 400kv cables then connect the OnSS to the National Grid Substation Connection Area located at Weston Marsh. The onshore ECC runs through an area of coastal low-lying marshland, Lindsey Marsh, moving inland through a largely agricultural setting. The Project is located to the south-east of the south-eastern extent of the Lincolnshire Wolds, with the topography varying between 2 and 10m AOD across the entirety of the Order Limits.
17. The onshore study area for the GWRA is defined by the Order Limits with a 2km buffer. This has been split into a number of segments which describe the significant local features along the ECC. A plan showing the onshore ECC and the associated study area is presented as Figure 24.1.1



Legend

- Order Limits
- Onshore Segment Break
- Landfall Trenchless Works Area
- Transition Joint Bay Area
- Order Limits 2 km Buffer

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area



Coordinate System: British National Grid

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Scale: 1:50,000

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Onshore Export Cable Corridor (ECC)
Route and Study Area
Figure 24.1.1.1

OUTER DOWSING OFFSHORE WIND

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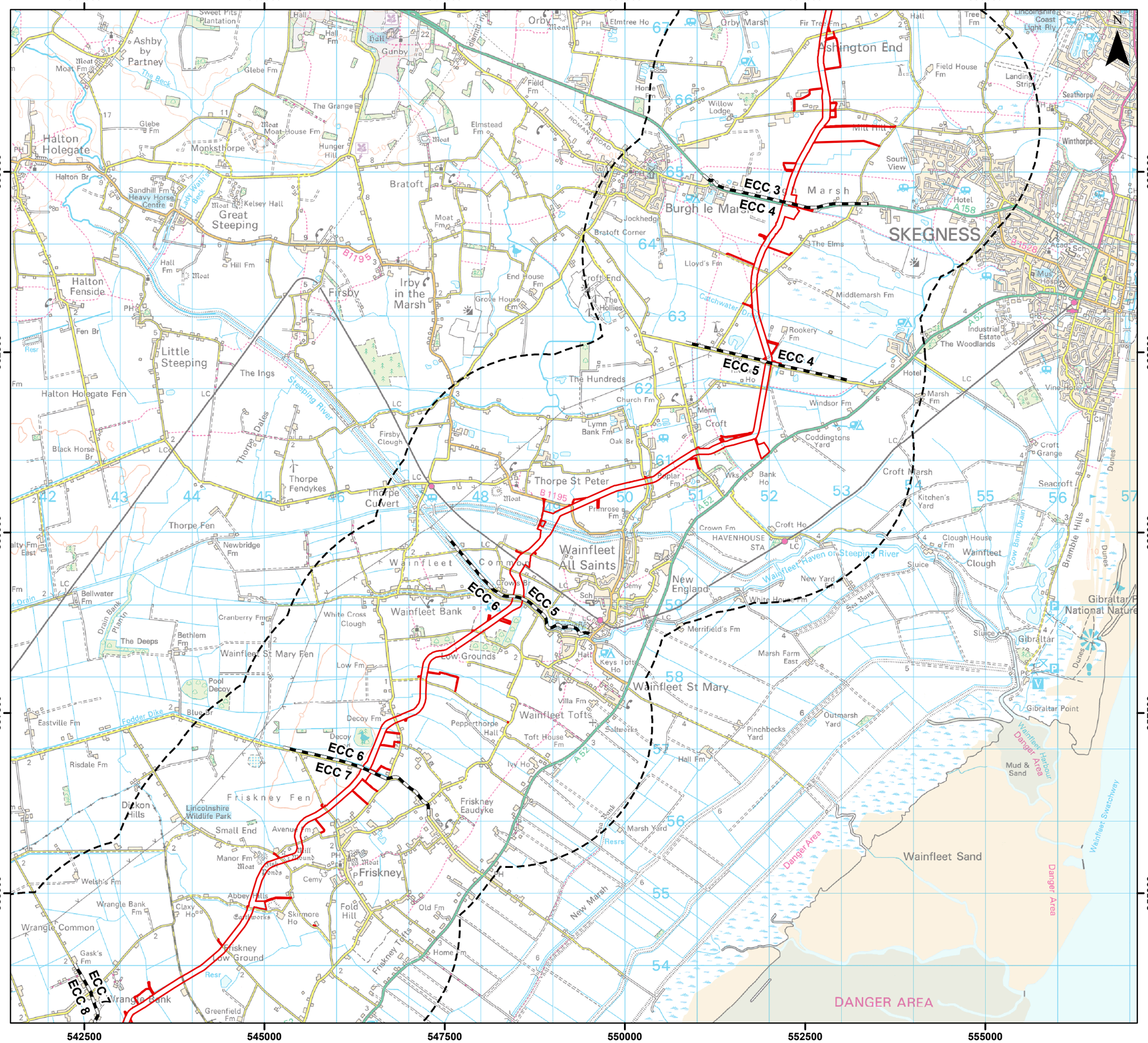

Legend

- Order Limits
- Onshore Segment Break
- Order Limits 2 km Buffer

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

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Onshore Export Cable Corridor (ECC)
Route and Study Area
Figure 24.1.1.2

OUTER DOWSING OFFSHORE WIND

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535000 537500 540000 542500 545000 547500

355000 352500 350000 347500 345000 342500

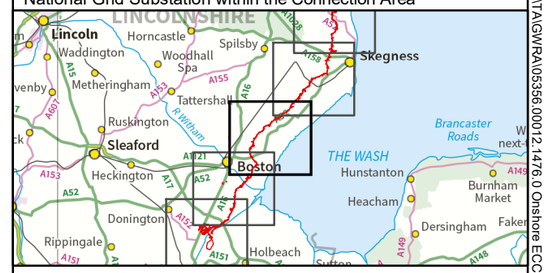
ECC 8 ECC 7 ECC 8 ECC 9 ECC 9 ECC 10

Wrangle Flats Mud & Sand Butterwick Low Bar Sand Roger Sand Mud & Sand Danger Area Danger Area

Legend

- Order Limits
- Onshore Segment Break
- Order Limits 2 km Buffer

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area



Coordinate System: British National Grid

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Onshore Export Cable Corridor (ECC)
Route and Study Area
Figure 24.1.1.3

OUTER DOWSING OFFSHORE WIND

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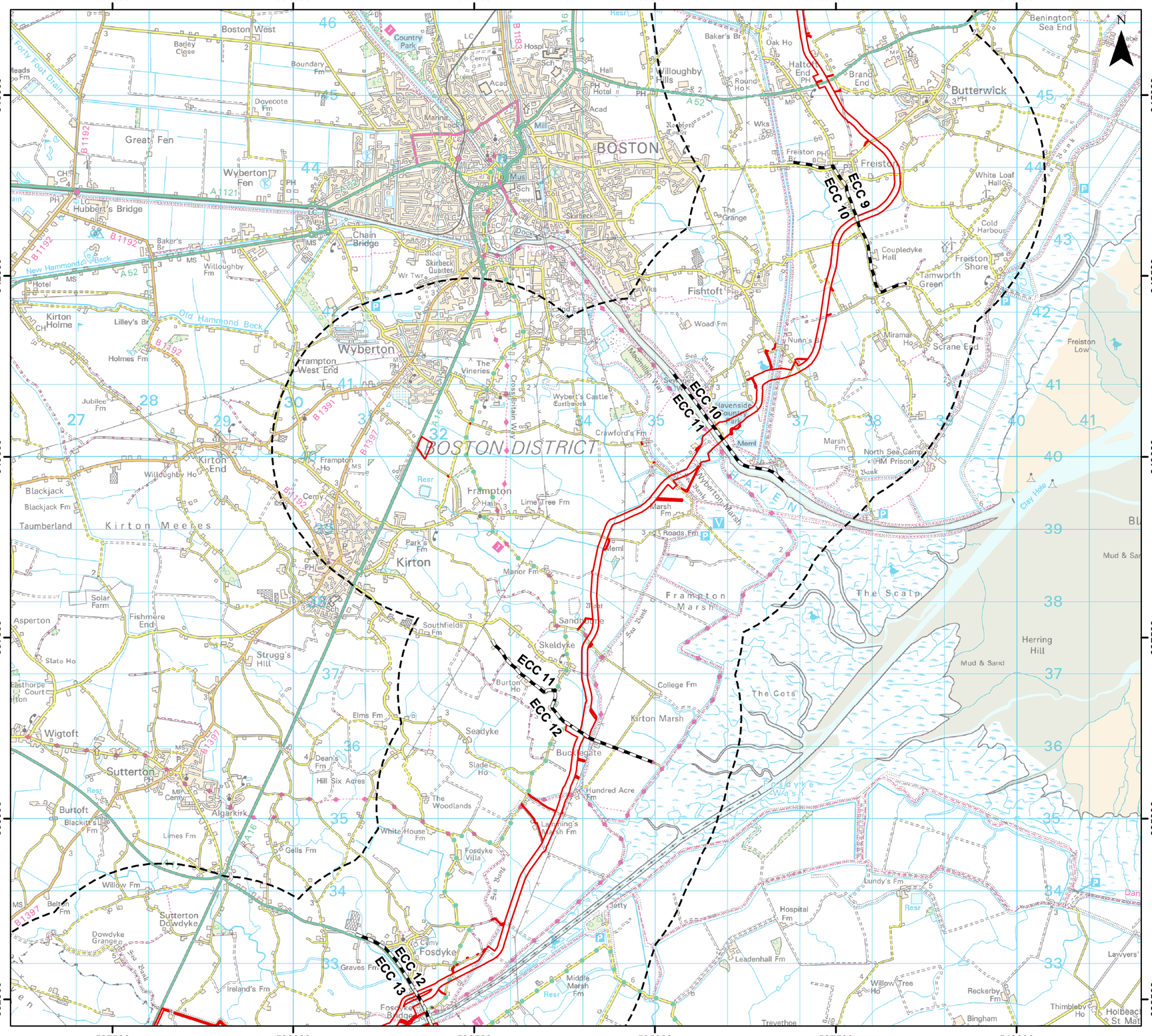

Legend

- Order Limits
- Onshore Segment Break
- Order Limits 2 km Buffer

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Coordinate System: British National Grid

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Scale: 1:50,000

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Onshore Export Cable Corridor (ECC)
Route and Study Area
Figure 24.1.1.4

OUTER DOWSING OFFSHORE WIND

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522500 525000 527500 530000 532500 535000

335000 332500 330000 327500 325000

Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Connection Area
- Order Limits 2 km Buffer

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Coordinate System: British National Grid

0 1 2 km

Scale: 1:50,000 A3 Page Size

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Onshore Export Cable Corridor (ECC)
Route and Study Area
Figure 24.1.1.5

OUTER DOWSING OFFSHORE WIND

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18. The study area segments from landfall to Weston Marsh are listed below:
    - ECC 1: Landfall to A52 - Hogsthorpe;
    - ECC 2: A52 - Hogsthorpe to Marsh Lane;
    - ECC 3: Marsh Lane to A158 - Skegness Road;
    - ECC 4: A158 - Skegness Road to Low Road;
    - ECC 5: Low Road to Steeping River;
    - ECC 6: Steeping River to Fodder Dike Bank/Fen Bank;
    - ECC 7: Fodder Dike Bank/Fen Bank to Broadgate;
    - ECC 8: Broadgate to Ings Drove;
    - ECC 9: Ings Drove to Church End Lane;
    - ECC 10: Church End Lane to The Haven;
    - ECC 11: The Haven to Marsh Road;
    - ECC 12: Marsh Road to Fosdyke Bridge;
    - ECC 13: Fosdyke Bridge to Surfleet Marsh OnSS/Marsh Drove; and
    - ECC 14: Surfleet Marsh OnSS/Marsh Drove to the Connection Area

24.6.2 Geology

19. The geological and hydrogeological setting of the project study area are described in detail within ES Volume 1, Chapter 23: Geology and Ground Conditions (document reference 6.1.23) and Chapter 24 (document reference 6.1.24). A summary is provided in the subsections below.
20. During 2023, the applicant carried out the first phase of its ground investigations at locations where the landfall, major crossings, the onshore substation (OnSS) and other works are required. Further investigations are proposed for 2024 in order to support the detailed design process.

24.6.2.1 Soil Types

21. The Cranfield Soilscapes online soil map viewer indicates that Order Limits are primarily underlain by *"Loamy and clayey soils of coastal flats, with naturally high groundwater*". As the route runs to the north-west of the village of Friskney, it overlies c.2.3km soils described as "*Loamy and sandy soils with naturally high groundwater and a peaty surface*".
22. Both soil-types are described as being naturally wet and primarily draining to groundwater.

24.6.2.2 Superficial Geology

A geological map showing the regional superficial geology, as plotted on the BGS online mapping service Geoindex, is provided as Figure 24.1.2**Error! Reference source not found.**

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375000 370000 365000 360000 355000

N

Ruckland Swaby Aby Thoresthorpe White Pit South Thoresby ALFORD Asserby Bilsby Thurlby Manor House Farlesthorpe Hutoft Anderby Creek Anderby Mumby Cumberworth Willoughby Hogsthorpe Chapel St Leonards Sloothby Ingoldmells Ingoldmells Point Holiday Village Inner Dowsing Wind Farm Welton le Marsh Orby Orby Marsh Winthorpe Seathorne SKEGNESS Lynn Wind Farm Seacroft Croft Marsh Gibraltar Wainfleet All Saints Wainfleet St Mary Wainfleet Tofts Wainfleet Sand Friskney Eaudyke Friskney Flats Fold Hill Wrangle Bank Jade Bank Leake Commonside Wrangle Lowgate Eastville East Fen Midville New Leake Stickford Thorpe Fendykes Thorp St Peter Thorpe Culvert Firsby Little Steeping Toynton St Peter Toynton Fen Side East Keal Toynton All Saints West Keal Keal Cotes Old Bolingbroke Hundleby SPILSBY Halton Holegate Candlesby Ashby by Partney Great Steeping Irby in the Marsh Burgh le Marsh Gunby Hall Bratoft Raithby by Spilsby Mavis Enderby Partney Scremby Skendleby Dalby Fordington Harrington Aswardby Langton Sausthorpe Somersby Bag Enderby Brinkhill Driby Ulceby Cross Ulceby Well Mawthorpe Claxby A16 A1104 A1028 A158 A52 B1195 B1184

ECC 1 ECC 2 ECC 3 ECC 4 ECC 5 ECC 6 ECC 7 ECC 8

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Legend

- Order Limits
- Onshore Segment Break
- Landfall Trenchless Works Area
- Transition Joint Bay Area
- Order Limits 2 km Buffer

Superficial Deposits

- Bank Deposits – Sand
- Beach And Tidal Flat Deposits - Clay, Silt And Sand
- Bedrock at or Near Surface
- Blown Sand – Sand
- Glaciofluvial Deposits, Devensian - Sand And Gravel
- Peat – Peat
- Storm Beach Deposits - Sand And Gravel
- Storm Beach Deposits - Sand And Silt
- Tidal Flat Deposits - Clay And Silt
- Till, Devensian – Diamicton

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Coordinate System: British National Grid

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Scale: 1:100,000

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Superficial Geology

Figure 24.1.2.1

OUTER DOWSING OFFSHORE WIND

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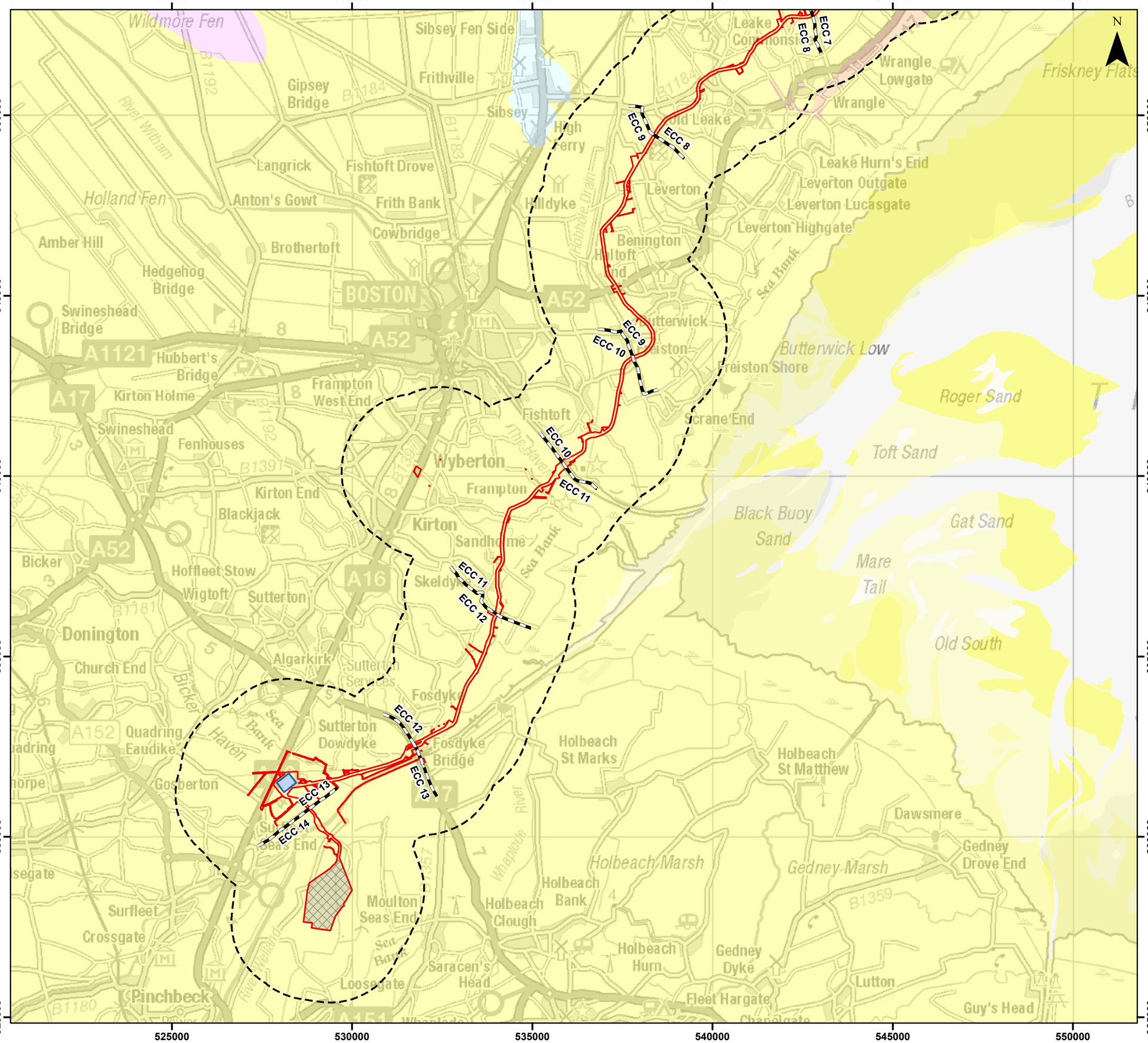

Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Connection Area
- Order Limits 2 km Buffer

Superficial Deposits

- Bank Deposits – Sand
- Beach And Tidal Flat Deposits - Clay, Silt And Sand
- Bedrock at or Near Surface
- Blown Sand – Sand
- Glaciofluvial Deposits, Devensian - Sand And Gravel
- Peat – Peat
- Storm Beach Deposits - Sand And Gravel
- Storm Beach Deposits - Sand And Silt
- Tidal Flat Deposits - Clay And Silt
- Till, Devensian – Diamicton

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Coordinate System: British National Grid

0 2.5 5 km

Scale: 1:100,000

A3 Page Size

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Superficial Geology

Figure 24.1.2.2

OUTER DOWSING OFFSHORE WIND

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23. The regional superficial geology is heavily influenced by the Project's proximity to the sea, with BGS Geoindex confirming that the Project is entirely underlain by superficial deposits comprising Tidal Flat Deposits (Clay and Silt). Historic borehole logs published by the BGS confirm that these deposits typically comprise beds of low permeability silty clays and clayey silts up to a thickness of 15m Below Ground Level (BGL). Sand horizons were typically observed at depths of between 5 and 12m BGL, although these are considered to be laterally discontinuous.
24. BGS mapping indicates Storm Beach Deposits (Sand and Silt) are located c.1km to the south-east of the project, between the segments of ECC 6: Steeping River to Fodder Dike Bank/Fen Bank and ECC 8: Broadgate to Ings Drove.
25. BGS mapping identifies till deposits and glaciofluvial deposits in the study area surrounding ECC 1 Landfall to A52 – Hogsthorpe. These superficial deposits comprise diamicton (poorly sorted soft brown clays, silts and sands), interbedded with higher permeability, sand and gravel deposits. No infrastructure is observed to be underlain by glaciofluvial sands and gravels, however till deposits directly underlie the ECC in the vicinity of a limited number of Cable Installation Compounds (CIC), which will be used for trenchless cable installation activities; these are: CIC18, CIC19, CIC20, CIC31, CIC32[1].
26. All remaining construction activities are underlain by Tidal Flat deposits.

24.6.2.3 Bedrock Geology

27. A review of 1:50,000 BGS bedrock geology mapping, as provided on Geoindex, indicates that the geological sequence in the area consists of the following sequence as outlined in Table 24.4.

Table 24.4: Regional Geological Sequence

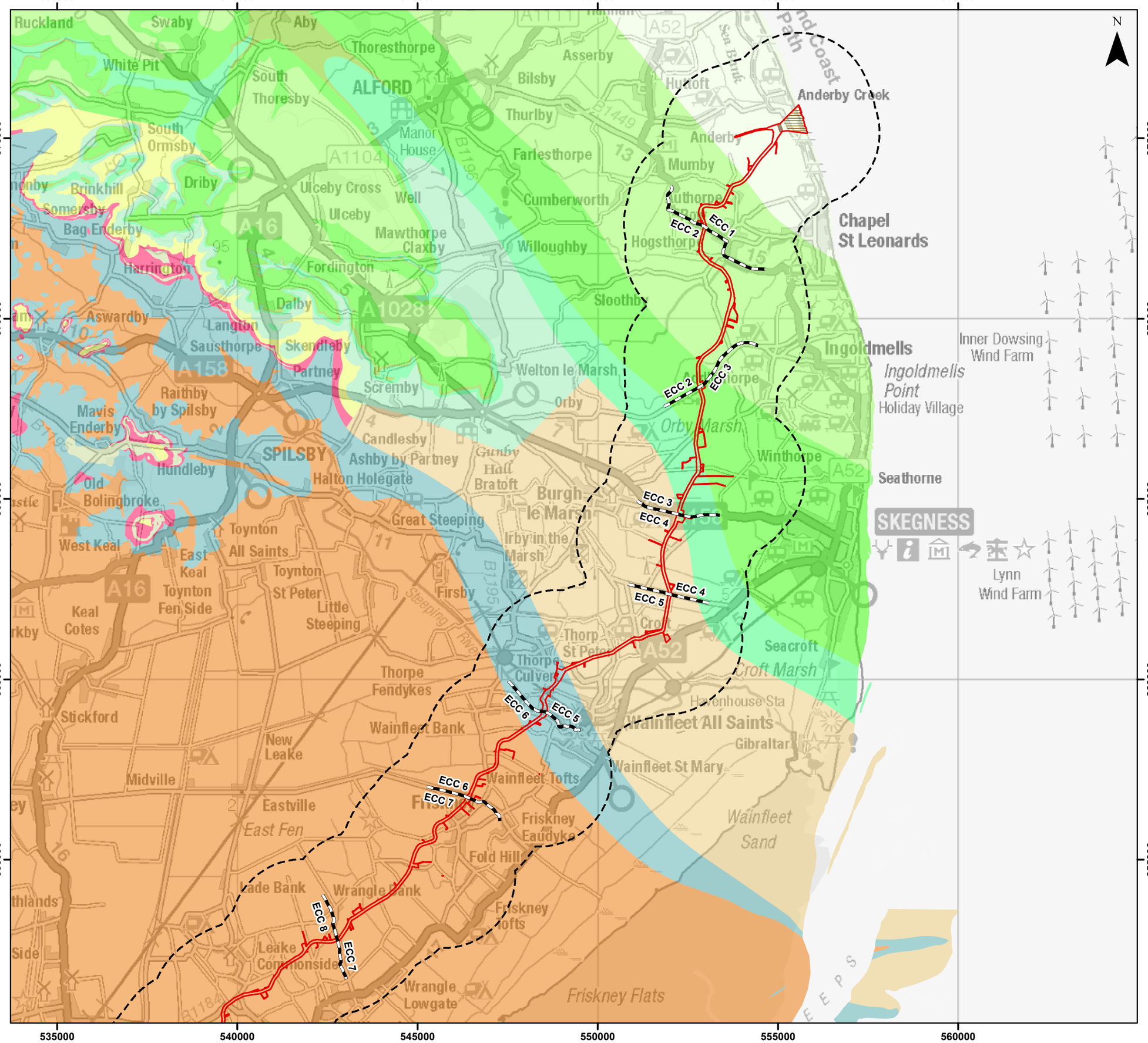
Parent Unit	Formation (Fm)	Description	Thickness (m)
White Chalk Subgroup	Welton Chalk Fm.	White, massive or thickly bedded chalk with common flint nodules.	53
Grey Chalk Subgroup	Ferriby Chalk Fm.	Grey, soft, marly, flint-free chalk, typically weathering buff in exposures.	20 - 25
Lower Greensand Group	Carstone Fm.	Greenish-brown (rusty when weathered), thick-bedded, cross-bedded, oolitic ferruginous sandstone.	5
Wealden Group	Claxby Ironstone Fm., Tealby Fm. and Roach Fm. (undifferentiated)	Mudstone and siliciclastic argillaceous rock with subsidiary ironstone.	65
	Spilsby Sandstone Fm.	Upper Spilsby Sandstone Member: Thin, coarse-grained, grey or brown pebble sandstone with iron ooliths. Lower Spilsby Sandstone Member: Coarse-grained, pebbly, glauconitic	10 – 20

[1] Cable Installation Compound (CIC) locations are shown in Volume 2, Chapter 3, Figure 3.4: Indicatve Onshore Infrastructure (Detailed) Basis of Assessment

		sands and sandstones with calcareous "doggers" and sporadic phosphatic nodules towards the top.	
Ancholme Group	Kimmeridge Clay Fm.	Mudstones (calcareous or kerogen-rich or silty or sandy); thin siltstone and cementstone beds; locally sands and silts.	90
	Ampthill Clay Fm.	Mudstone, mainly smooth or slightly silty, pale to medium grey with argillaceous limestone (cementstone) nodules.	N/A See footnote[2]
	West Walton Fm.	Calcareous mudstone, silty mudstone and siltstone, with subordinate fine-grained sandstones and argillaceous limestone (cementstone) or siltstone nodules.	
	Oxford Clay Fm.	Silicate-mudstone, grey, generally smooth to slightly silty, with sporadic beds of argillaceous limestone nodules.	

28. Bedrock geology, based on BGS Geoindex mapping, is provided in map format in **Figure 24.1.3.**

[2] The total thicknesses of these horizons have not been proven within the Order Limits. They are assumed to be broadly comparable to outcrop spread and therefore greater than 100 metres in thickness.



Legend

- Order Limits
- Onshore Segment Break
- Landfall Trenchless Works Area
- Transition Joint Bay Area
- Order Limits 2 km Buffer

Sedimentary Bedrock (Onshore ECC)

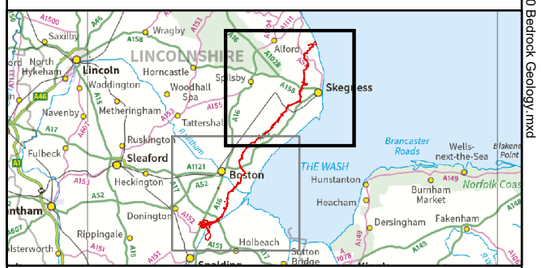
- Burnham Chalk Formation – Chalk
- Welton Chalk Formation – Chalk
- Ferriby Chalk Formation – Chalk
- Hunstanton Formation – Chalk
- Carstone Formation – Sandstone
- Roach Formation - Mudstone And Limestone, Interbedded
- Claxby Ironstone Formation, Tealby Formation And Roach Formation - Mudstone And Limestone, Interbedded
- Spilsby Sandstone Formation – Sandstone
- Kimmeridge Clay Formation – Mudstone
- Ampthill Clay Formation – Mudstone
- West Walton Formation - Mudstone And Siltstone
- Oxford Clay Formation – Mudstone

Cretaceous

Jurassic

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Sources:
Bedrock Geology data obtained via BGS WMS. British Geological Survey © NERC. All Rights Reserved.



Coordinate System: British National Grid

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Scale: 1:100,000

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Environmental Statement Version 2
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Bedrock Geology

Figure 24.1.3.1

OUTER DOWSING OFFSHORE WIND

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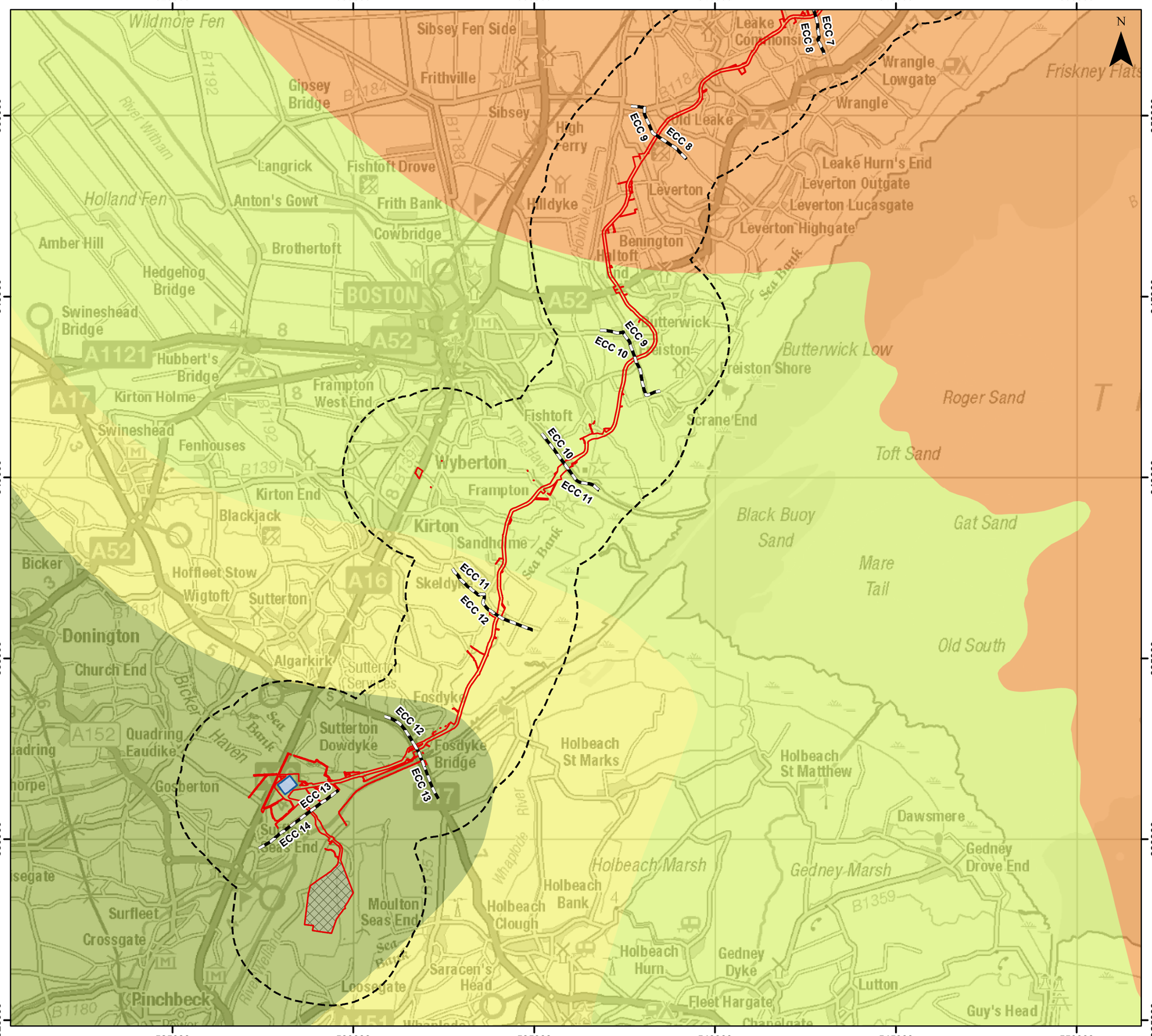


Legend

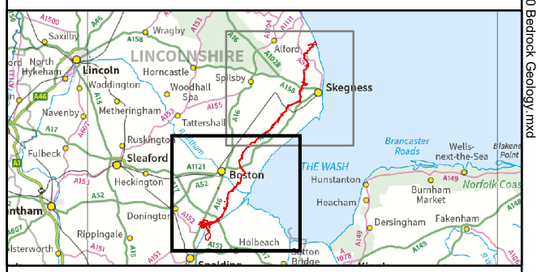
- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Connection Area
- Order Limits 2 km Buffer

Sedimentary Bedrock (Onshore ECC)

Cretaceous
- Burnham Chalk Formation – Chalk
- Welton Chalk Formation – Chalk
- Ferriby Chalk Formation – Chalk
- Hunstanton Formation – Chalk
- Carstone Formation – Sandstone
- Roach Formation - Mudstone And Limestone, Interbedded
- Claxby Ironstone Formation, Tealby Formation And Roach Formation - Mudstone And Limestone, Interbedded
- Spilsby Sandstone Formation – Sandstone

Jurassic
- Kimmeridge Clay Formation – Mudstone
- Ampthill Clay Formation – Mudstone
- West Walton Formation - Mudstone And Siltstone
- Oxford Clay Formation – Mudstone

Note:
GWRA does not include an assessment of the National Grid Substation within the Connection Area



Coordinate System: British National Grid

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Scale: 1:100,000

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Environmental Statement Version 2
Examination Update

Bedrock Geology

Figure 24.1.3.2

OUTER DOWSING OFFSHORE WIND

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29. At landfall, the cable route is located upon the youngest bedrock observed regionally, the Welton Chalk Formation. As the cable route then progresses westwards and inland, it progresses down through the stratigraphic sequence to clay/mudstone members of the Ancholme Group.
30. Chalk bedrock (*Welton and Ferriby Chalk Formations*) is observed between the route segments of ECC 1: Landfall to A52 – Hogsthorpe and ECC 3: Marsh Lane to A158 - Skegness Road. Unconformably underlying the chalk bedrock are sedimentary members of the Lower Greensand and Wealdon Groups (*Carstone Fm., Claxby Ironstone Fm., Tealby Fm. and Roach Fm. (undifferentiated) and the Spilsby Sandstone Fm.*) which extend between ECC 3 and ECC 6: Steeping River to Fodder Dike Bank/Fen Bank. From the boundary of ECC6/7 westwards to the substation, the cable route overlies clay-rich members of the Ancholme Group.
31. Regionally the bedrock is observed to dip uniformly and gently to the north-east with very limited faulting. A conceptual schematic of the regional geology is presented in the BGS technical report for the Minor Aquifers of England and Wales, provided below as Plate 24.1.
32. As outlined in section 24.6.2.2 above all bedrock is overlain by an extensive thickness of Tidal Flat Deposits.

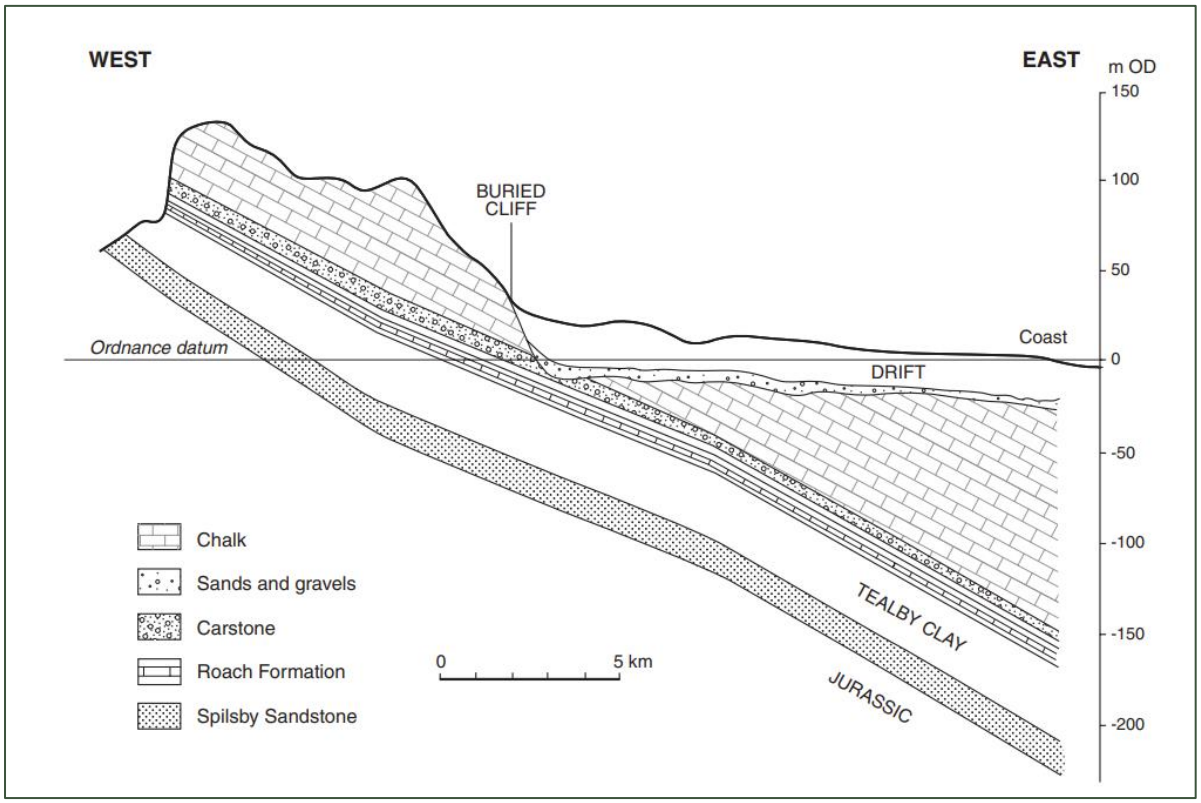


Plate 24.1: Conceptual cross section showing regional geology in Lincolnshire Wolds

24.6.3 Hydrogeology

24.6.3.1 Recharge Mechanisms

33. The Met Office climate summary (1991 – 2020) for Wainfleet (Lat.: 53.088, Long.: 0.274), located c.4.4km to the south-east of the ECC 5: Low Road to Steeping River boundary, indicates that the average annual rainfall for the study area is 625.77mm.
34. Climate averages for Wainfleet is presented below as Table 24.5.

Table 24.5: Climate Averages (1991 to 2021) for Wainfleet Meteorological Station

Month	Rainfall (mm)	Max. Temp. (oc)	Min. Temp. (oc)
January	50.67	6.99	1.87
February	40.92	7.6	1.78
March	38.09	9.95	2.95
April	38.91	12.61	4.71
May	48.40	15.62	7.38
June	56.58	18.52	10.25
July	58.07	20.95	12.17
August	62.72	21.26	12.3
September	52.05	18.39	10.32
October	65.27	14.32	7.96
November	59.53	10.13	4.44
December	54.56	7.27	2.1
Annual	625.77	13.67	6.54

35. Recharge regionally will be dependent on the permeability of the overlying superficial deposits. Borehole logs, published by the BGS, has confirmed that the Tidal Flat deposits are predominantly clay and silt based and therefore would allow only limited recharge to the underlying bedrock. However, to the north-west of the Order Limits is the Lincolnshire Wolds, a range of chalk hills where the bedrock is observed to outcrop at surface. This area is therefore considered the principal area of recharge.
36. Direct recharge to the Spilsby Sandstone has been estimated to average approximately 240 mm/yr, indicating that up to 62% of rainfall does not infiltrate the ground, instead running off to local waterways[3]. This will likely be higher where the bedrock is overlain by Tidal Flat deposits.

24.6.3.2 Aquifer Characteristics and Groundwater Vulnerability

37. The aquifer characteristics and Environment Agency aquifer designation of the strata within the Order Limits are summarised in Table 24.6.

[3] Environment Agency Technical Report WD/00/04, The Physical Properties of Minor Aquifers in England and Wales, 2000.

Table 24.6: Regional Aquifer Status

Rock Type	Parent Unit	Formation	Aquifer Designation
Superficial	Storm Beach Deposits		Secondary A Aquifer
	Till Deposits		Secondary B Aquifer
	Tidal Flat Deposits		Unproductive Strata
Bedrock	White Chalk Subgroup	Welton Chalk Fm.	Principal Aquifer
	Grey Chalk Subgroup	Ferriby Chalk Fm.	Principal Aquifer
	N/A	Carstone Fm.	Principal Aquifer
	N/A	Claxby Ironstone Fm., Tealby Fm. and Roach Fm. (undifferentiated)	Secondary B Aquifer
	Cromer Knoff Group	Spilsby Sandstone Fm.	Principal Aquifer
	Ancholme Group	Kimmeridge Clay Fm.	Unproductive Strata
		Ampthill Clay Fm.	Unproductive Strata
		West Walton Fm.	Unproductive Strata
		Oxford Clay Fm.	Unproductive Strata

38. The various classifications are described by the Environment Agency 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.

39. Potential aquifer units (formed by the chalk and sandstone bedrock) are only observable in the north-eastern areas of the Order Limits. A summary of the aquifer system is as follows:

- Tidal Flats deposits, Aquitard – local ground investigation has confirmed that the Tidal Flats deposits are rich in low permeability clays and silts of between 10 and 15 metres thickness, significantly limiting the potential for recharge and groundwater flow. They would therefore act as an aquitard, confining the underlying bedrock aquifer.
- Bedrock Chalk, Aquifer – the Welton and Ferriby Chalk formations are likely to act as a singular aquifer unit with fracture flow acting as the primary mechanism for

groundwater flow. Field values of transmissivity range from 500 to 3000 m^2/day are attributed to the chalk aquifer[4].

- Carstone Sandstone Fm., Aquifer – whilst juxtaposed against the younger Chalk aquifer, the Carstone Sandstone Formation should be considered a singular aquifer unit due to its contrasting aquifer properties. Groundwater flow within this unit is predominantly intergranular, and via fractures where present.
- Claxby Ironstone Fm., Tealby Fm. and Roach Fm. (undifferentiated), Leaky aquitard – whilst classified by the Environment Agency as a Secondary B aquifer, local ground investigation and published borehole logs confirm that the Tealby and Roach formations comprise sandstones interbedded with beds of clay (in particular, the Tealby Clay). The clay units would significantly limit flow within this aquifer, with groundwater only flowing where sandstone beds are not isolated.
- Spilsby Sandstone Fm. Aquifer – groundwater flow within this unit is predominantly intergranular, with a mean transmissivity of 141 m^2/d attributed to the aquifer[2].

24.6.3.3 Groundwater Levels and Flow

40. Groundwater flow within the bedrock is expected to follow the regional geological dip, with levels broadly falling in a north-easterly direction towards the coastline. Available groundwater information provided by published borehole records on the BGS GeoIndex indicate that the sandstone and chalk aquifers are likely to be confined by the overlying clay-rich superficial units, with resting water levels typically recorded above the upper horizon of the bedrock and near to ground level.
41. Seasonal groundwater levels within the confined chalk aquifer are expected to vary by 1 to 1.5 metres[2].

24.6.3.4 Groundwater Abstractions and Source Protection Zone

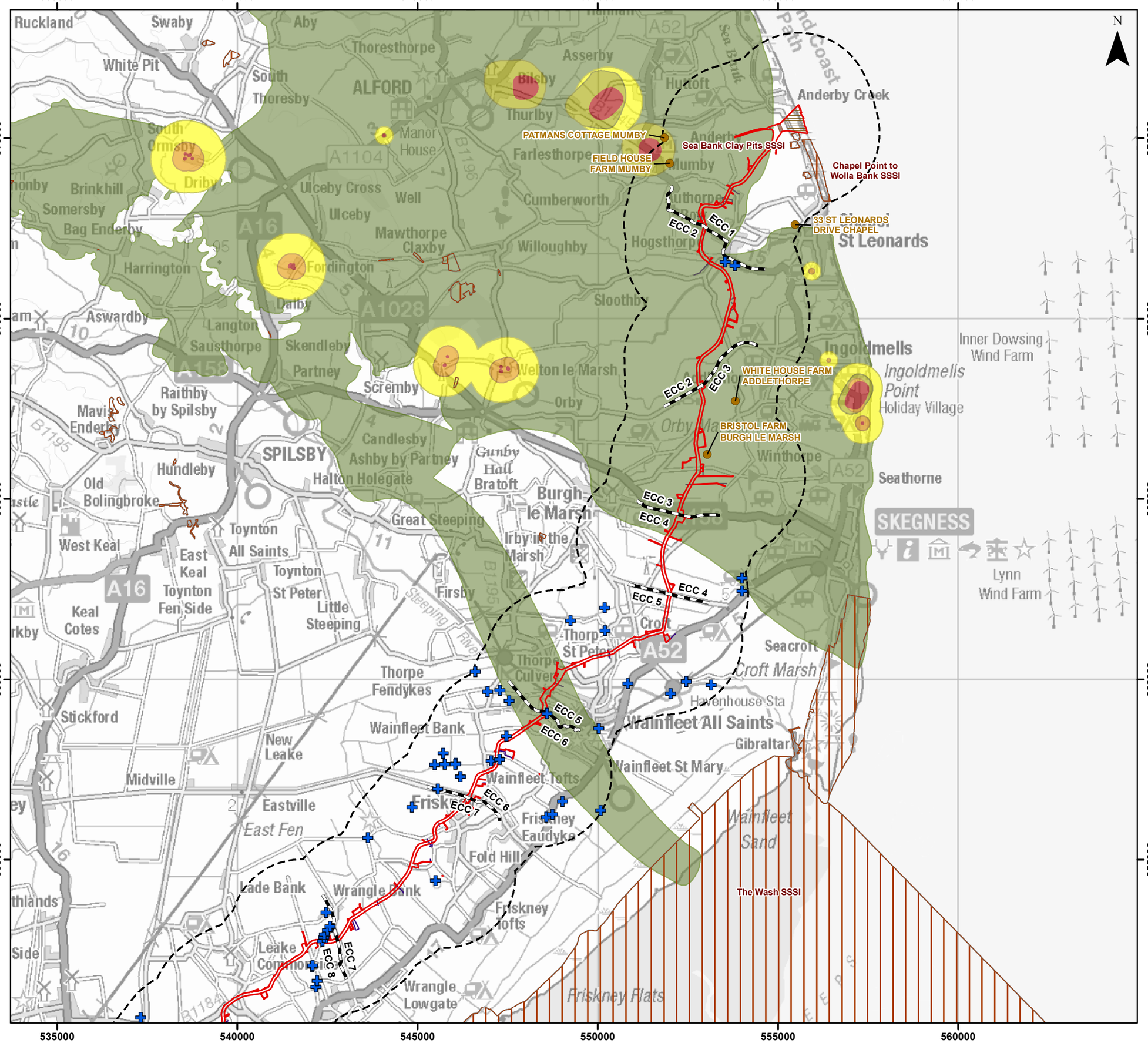
42. Defra's Magic Map website indicates that eastern areas of the route are located within Zone III of a groundwater Source Protection Zone (SPZ), which is likely associated with the underlying chalk and sandstone aquifers. No section of the route is located within Zone I or Zone II, nor are these zones located within a 2km radius of the site.
43. A summary of the SPZ mapping per route segment is provided in Table 24.7 below and shown in Figure 24.1.4.

Table 24.7: Source Protection Zone relative to ECC

ECC	Source Protection Zone
1	The majority of the segment lies within an area designated as a Zone III of GW SPZ. The landfall site and a small area of the segment to the east does not lie within a SPZ.
2	The segment lies within an area designated as Zone III of a GW SPZ.
3	The segment lies within an area designated as Zone III of GW SPZ.
4	The majority of the segment is not designated as a SPZ. A small area to the north of the segment lies within an area designated as Zone III of a GW SPZ.
5	The majority of the segment is not designated as a SPZ. A small area to the north of the segment lies within an area designated as Zone III of a GW SPZ.

[4] British Geological Society, Research Report RR/06/03: The Chalk Aquifer system of Lincolnshire, 2006.

6	The southern part of the segment is not designated as a SPZ. To the north of the segment, the area is designated as Zone III of GW SPZ associated with the Principal aquifer.
7	The segment is not in an area identified as a SPZ.
8	The segment is not in an area identified as a SPZ.
9	The segment is not in an area identified as a SPZ.
10	The segment is not in an area identified as a SPZ.
11	The segment is not in an area identified as a SPZ.
12	The segment is not in an area identified as a SPZ.
13	The segment is not in an area identified as a SPZ.
14	The segment is not in an area identified as a SPZ.



Legend

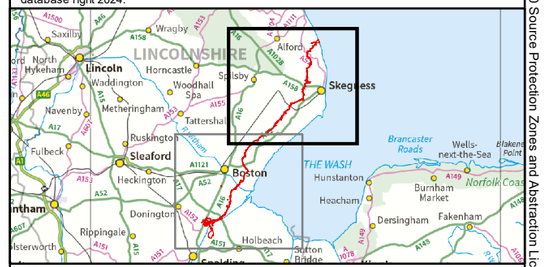
- Order Limits
- Onshore Segment Break
- Landfall Trenchless Works Area
- Transition Joint Bay Area
- Order Limits 2 km Buffer
- Abstration Licence Location
- Private Water Supply Location
- Site of Special Scientific Interest (SSSI)

Source Protection Zone

- 1
- 1c
- 2
- 2c
- 3

Notes:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Only Sites of Special Scientific Interest within 2 km of the Order Limits are labelled



Coordinate System: British National Grid

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Scale: 1:100,000

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Source Protection Zones, Abstraction Licences and Sites of Special Scientific Interest
Figure 24.1.4.1

OUTER DOWSING OFFSHORE WIND

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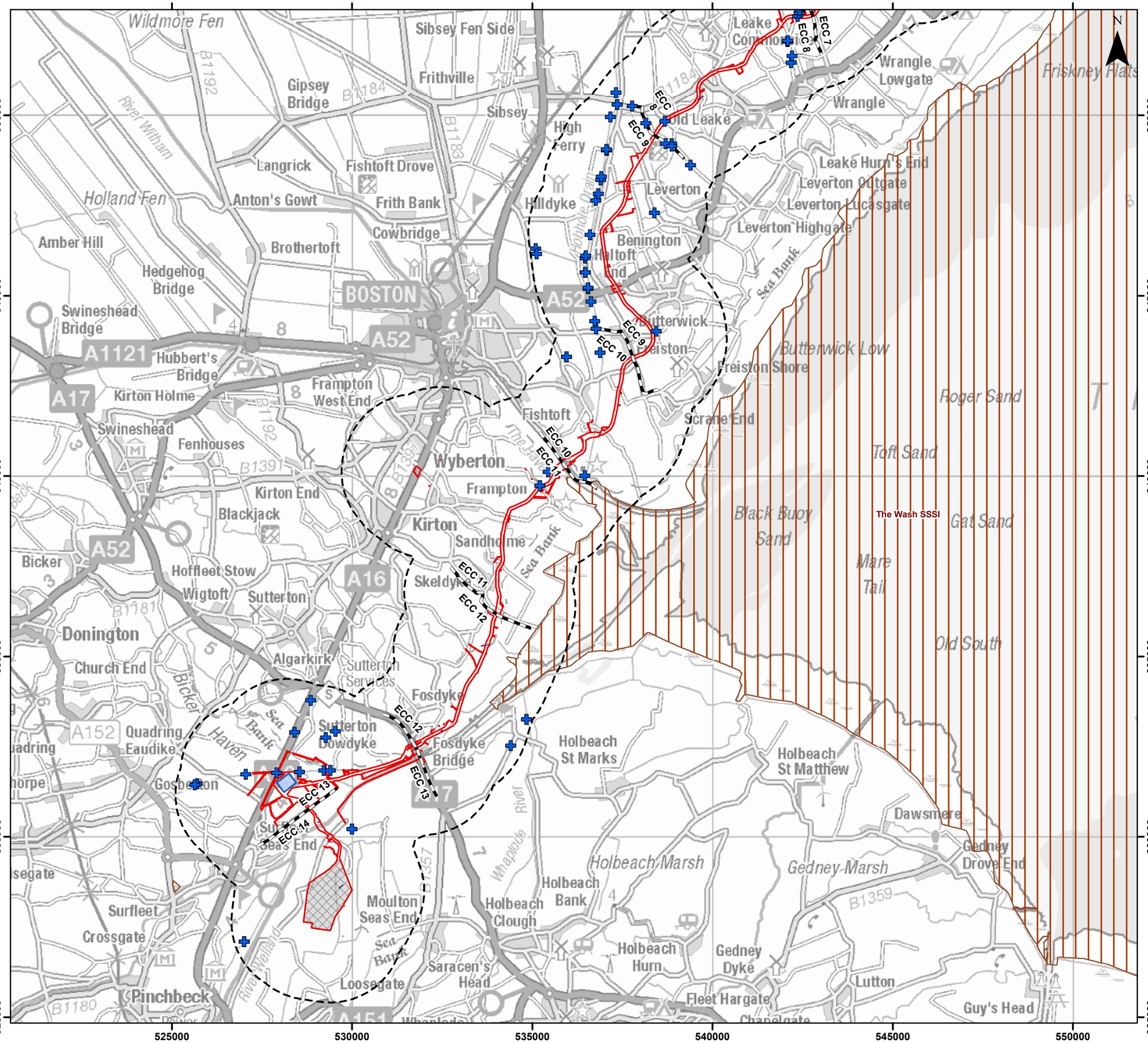
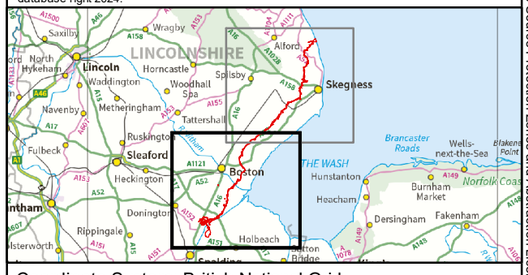


Legend

- Order Limits
- Onshore Segment Break
- Onshore Substation (OnSS) Footprint
- Connection Area
- Order Limits 2 km Buffer
- Abstration Licence Location
- Site of Special Scientific Interest (SSSI)

Notes:
GWRA does not include an assessment of the National Grid Substation within the Connection Area

Only Sites of Special Scientific Interest within 2 km of the Order Limits are labelled



Coordinate System: British National Grid

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Scale: 1:100,000

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Environmental Statement Version 2
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Source Protection Zones, Abstraction Licences and Sites of Special Scientific Interest
Figure 24.1.4.2

OUTER DOWSING OFFSHORE WIND

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44. There are no licenced groundwater abstractions within the 2km study area surrounding the Order Limits. Four private water supplies have been identified within 2km of the Order Limits which source groundwater from the underlying bedrock aquifers. Of these, only one is located within a 500m radius of the route as shown on Table 24.8.

Table 24.8: Private Water Supplies located within a 2km radius of the Order Limits

Registered User	Location & Approx. Dist. from Order Limits	Source	Use	Geological Setting
Field House Farm (Mumby)	TF 51998 74305 1,670m NW	Borehole	Domestic	Tidal Flat Deposits Chalk Aquifer
33 St Leonards Drive (Chapel St Leonards)	TF 55471 72603 1,810m SE	Borehole	Domestic	Tidal Flat Deposits Chalk Aquifer
White House Farm (Addlethorpe)	TF 53817 67713 870m E	Borehole	Domestic	Tidal Flat Deposits Chalk Aquifer
Bristol Farm (Burgh Le Marsh)	TF 53040 66237 220m E	Unknown	Domestic	Tidal Flat Deposits Chalk Aquifer

45. The locations of all abstractions, private water supplies and SPZ mapping is presented on Figure 24.1.4.

24.6.4 Hydrology

46. Chapter 24 (document reference 6.1.24) provides a technical discussion of the hydrological setting within 2km of the Order Limits.
47. Numerous Environment Agency Main Rivers (Environment Agency, 2023c) are present across or around the Order Limits along with several ordinary watercourses flowing across the onshore ECC and 400kv cables serving as tributaries to the Main Rivers. There are also numerous Internal Drainage Board (IDB) maintained drains within the Order Limits.
48. With consideration for the clay-rich superficial geology, it is considered that the groundwater does not provide significant baseflow to the local river system in the south of the Lincolnshire Wolds. A study of the interaction between groundwater and river systems in Lincolnshire Wolds identified no surface water receptors in the south (and in area of the proposed cable route) which were supported by baseflow from the aquifer system[5].
49. The route crosses four Surface Water Operational Catchments, these are:

- **Steeping and Eaus**
    - The Steeping and Eaus operational catchment is a predominately rural catchment with small settlements. The catchment is predominately underlain by chalk bedrock geology, from which chalk streams rise. The operational catchment covers the northernmost part of the onshore ECC, north of the A52 up to

[5] British Geological Society, Research Report RR/06/03: The Chalk Aquifer system of Lincolnshire, 2006

Steeping River, and approximately up to Ivy House Farm along Weston Marsh, south of the A52.

- The Main Rivers within this operational catchment that cross the Order Limits are:
  - Willoughby High Drain;
  - Wainfleet Haven;
  - Steeping River; and
  - The Lymn.

- **Fens East and West**
  - The Fens East and West operational catchment includes the significant ordinary watercourses of West Fen Catchwater, Maud Foster Drain and the Witham Drains. There are no Main Rivers within this operational catchment. The north of the catchment uses the East and West Fen Catchment Drains, which intercept water from higher ground before discharging into the Haven at Boston. The Witham Drains collect waters from the low-lying fenland areas and supply irrigation in summer months; this is managed by Witham Fourth IDB.
  - The operational catchment covers the area south of Steeping River along the ECC, north of the A52.
- **South Forty Foot Drain**
  - The South Forty Foot Drain operational catchment is predominately agricultural, with small settlements and drains the fenland areas of South Lincolnshire to the southwest of Boston. The South Forty Foot Drain is an ordinary watercourse which discharges into the Witham Haven in Boston via the Black Sluice pumping station. There are no Main Rivers within this operational catchment.
  - This operational catchment covers the area south of the Haven along ECC, south of the A52, to approximately Kirton Drain/Low Mill Lane area.
- **Lower Welland**
  - The Lower Welland operational catchment starts below Stamford, collecting urban run-off from Peterborough before becoming the embanked wide River Welland across the Fens to Spalding, where the watercourse becomes tidal, before discharging into the Wash. It is an important source of water for agricultural use and is used to feed IDB drains, which supply agricultural water to the arable and horticultural industries. The River Welland is the only Main River within this catchment.
  - This operational catchment covers the area south of Kirton Drain/Low Mill Lane area to the OnSS and National Grid substation connection area.

24.6.5 Designated Sites

50. Three statutory designated sites have been identified within the study area, these are provided in Table 24.9.

Table 24.9: Designated Sites within a 2km radius of the Order Limits

Site	Location and Dist. from Site	Justification	Potentially groundwater influenced?
Sea Bank Clay Pits SSSI	E: 555,544 N: 375,161 Immediate to the south of landfall area, inland from coast.	A series of isolated clay workings of varying size, depth and topography occupying a total of 17 ha between Sutton-on-Sea and Chapel St Leonards. The pits support uncommon aquatic plant communities' characteristic of the slightly brackish, eutrophic water, in addition to extensive reedbeds and a rich marginal wetland flora. They are known to support a rich aquatic invertebrate fauna, notably beetles, including several nationally scarce species. The pits are owned or leased by Lincolnshire Wildlife Trust and managed as five nature reserves, namely: Sandilands Pit; Huttoft Bank Pit; Wolla Bank Reedbed; Wolla Bank Pit; and Chapel Pit.	Yes – No public information found on clay pit construction and the thickness of in-situ low-permeability material. Elevated groundwater levels may result in basal heave/inflows to pits.
Chapel Point to Wolla Bank SSSI	E: 556,083 N: 374,135 170m to south of landfall on coastline.	This site extends for 1.5 km along the Lincolnshire coastline between the car park at Wolla Bank and the coastguard lookout at Chapel Point. The area was designated as a geological SSSI for its nationally important geological features.	No – designation made on coastal exposure of geological features.
The Wash SPA, Ramsar, SSSI, SAC	E: 566886 N: 344515 200m to SE of ECC 8 area.	Covering an area of c.62,212 ha, this site is of exceptional biological interest. The intertidal mudflats and saltmarshes represent one of Britain's most important winter-feeding areas for waders and wildfowl outside of the breeding season.	No – ecological sites are predominantly freshwater and tidally influenced.

51. Of the three identified above, only the Sea Banks Clay Pit SSSI is considered to be potentially influenced by groundwater. The SSSI was formed through the extraction of clay material from the Tidal Flat deposits for the purpose of constructing local sea defences. The thickness and type of material remaining beneath the SSSI is not known.

24.6.6 Conceptual Site Model

52. The assessment of the baseline conditions of the cable route indicates that the route is underlain by several aquifer systems in the central and eastern areas, these are identified as the bedrock chalk aquifer, the Carstone sandstone Aquifer and the Spilsby

sandstone aquifer. The two sandstone aquifers are separated by a leaky aquitard comprising undifferentiated beds of the Claxby Ironstone Formation, Tealby Formation and Roach Formation.

53. A schematic model of the site conceptual model is presented as Plate 24.2 below.
54. All bedrock units are overlain by superficial geology comprising Tidal Flat and Till deposits; these are identified as being clay-rich and present in thicknesses of between 10 and 15 metres. The deposits are expected to significantly impede recharge to the bedrock aquifers, whilst confining groundwaters present in the underlying bedrock.
55. The prevalence of clay-rich superficial deposits within the study area, has resulted in limited private exploitation of the underlying bedrock aquifer systems for groundwater abstraction. Across the c.70km length study area, five private water supplies and no licenced groundwater abstractions were identified. Of the four private water supplies, only one was located within a 500m radius of the Order Limits, the potential radius of influence for any dewatering.
56. The Order Limits cross four Surface Water Operational Catchments, several Environment Agency Main Rivers and numerous ordinary watercourses managed by the local Drainage Boards. Due to the prevalence and thickness of clay-rich superficial deposits, it is considered that the interaction between these watercourses and the underlying aquifer system is negligible. The surface water catchments have therefore been screened out as potential receptors.
57. Three statutory designated sites have been identified within the study area. Of these only the Sea Bank Clay Pits SSSI has been identified as being potentially groundwater-fed.
58. The only potential receptors which require further assessment are therefore considered to be the Sea Bank Clay Pits SSSI, which is located +50 metres to the south of the landfall, and Bristol Farm Private Water Supply, which is located c.270 metres to the east of the Order Limits.

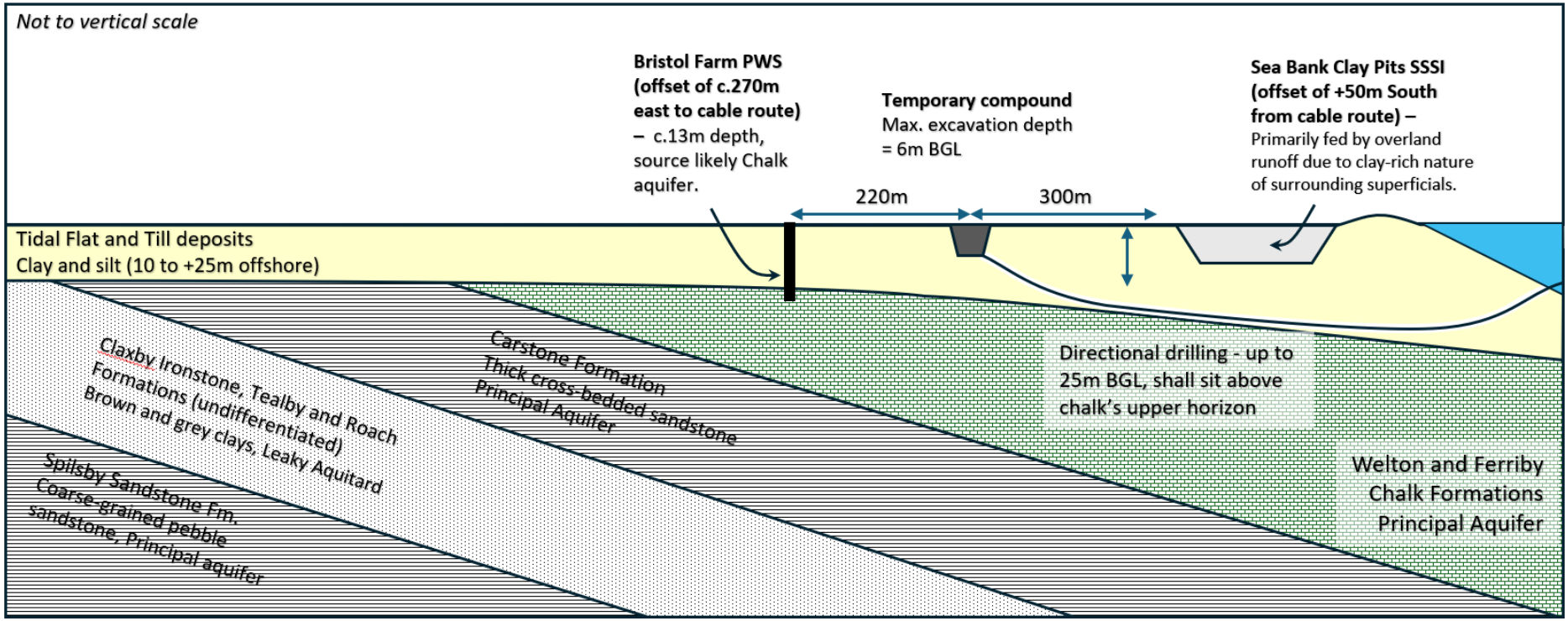

Plate 24.2: Schematic Model of the Site Conceptual Model

24.7 Hydrogeological & Hydrological Impact Assessment

24.7.1 Proposed Development

59. The onshore Order Limits will include the following works which could influence groundwater:
    - Up to 680 joint bays and link boxes – buried so that the base is 2.5m below ground level with temporary sheet piling being used during the construction to support the excavation, typically to a depth of 6m BGL;
    - Track matting to cable installation compounds – placed on ground surface, following vegetation removal;
    - Up to 27 construction compounds (primary and secondary);
    - 324 Cable Installation Compounds (CICs),
    - Open cut trenching with burial depth of 1.2m to 3m;
    - Trenchless cable installation – with a maximum dig depth of 6m below ground level, a proposed temporary sheet-piling depth of 10m BGL and a trenchless cable installation depth of up to 25m BGL; and
    - One onshore substation located at Surfleet Marsh; with piled foundations, typically up to 14m in depth.
60. Only the TJBs, link boxes, onshore substation, launch pits within cable installation compounds, and the cable trenches extend below 1m BGL and have therefore been reviewed to determine which required further assessment.
61. All construction activities located west of NGR TF 47967 58618 (namely cable installation compounds CIC121 to CIC324[1] are located on low permeability superficial geology (Tidal Flat deposits) underlain by bedrock mudstones identified as unproductive strata. These elements have therefore been screened out of the assessment.
62. Available BGS logs indicate that the tidal flats are universally 10-15m in thickness. These are very low permeability and are not considered as a potential pathway or receptor. Risk from the jointing bays, temporary construction compounds and open cut corridor can also be screened out of the assessment.
63. The trenchless installation works caried out from the cable instillation compounds have a maximum excavation depth of 6m below ground level and a maximum depth of 25m below ground level Whilst these are highly likely to be within low permeability clays and silts of the tidal flat deposits, it is noted that layers of sands and gravels have been recorded at depths of between 5-7m in certain BGS logs and there is uncertainty as to the exact thickness of the Tidal Flat deposits, therefore where a cable installation compound is present within proximity to either the SSSI or the Bristol Farm Private Water Supply further assessment of the risk of impacting groundwater is required.
64. Potential construction activities requiring further assessment include CIC1[1], located within 300m of the Sea Bank Clay Pits SSSI and CIC58 and CIC59[1], located within 220m of Bristol Farm Private Water Supply.

24.7.2 Location-Specific CSM

24.7.2.1 Sea Bank Clay Pits SSSI

65. As identified within Section 24.6.5, one ecological site, the Sea Bank Clay Pits SSSI, has been identified as having a potential groundwater link and being within 300m of the closest construction works (HDD works at the landfall) . The SSSI is a series of marshland ponds formed within flooded historic clay pits. BGS published mapping identifies the SSSI as being entirely situated upon Tidal Flats superficial deposits from which the clay was won. Underlying the superficial deposits at depth is a bedrock consisting of the Welton Chalk Formation.
66. The nearest published borehole log, TF57NW12 (located c.0.68km to the north of landfall), confirms the underlying geology as “buttery” clay to 6.1m depth, followed by a 1.22m thick sand and gravel band, with a hard marl (Boulder Clay) of 15.85m thickness at depth. A similar geology was also recorded in published borehole log TF57SW3 (located c.1.01km to the south-west), which identified interbedded clay and silt bands to a depth of 19.20m BGL.
67. Based on the recorded geology, it is conceptualised, as shown on Plate 24.2, that the clay pits are fed by rainfall as opposed to being groundwater fed, however, some inflows from the sand and gravel band cannot be ruled out.

24.7.2.2 Bristol Farm Private Water Supply

68. One private water supply, located at Bristol Farm (NGR TF 53040 66237) was identified as being within approximately 220m of the Order Limits and the trenchless works between CIC58 and CIC59[1]. The private water supply is located at an elevation of c.2.3 mAOD. BGS mapping identifies the local superficial geology as Tidal Flat deposits, underlain by a bedrock consisting of the Ferriby Chalk Formation. Whilst public records do not confirm the source of water supply, a conservative approach would suggest that the Chalk aquifer is the likely source.
69. The nearest published borehole log to this private water supply, TF56NW14 (located 1.04km to the north-east), confirms the near-surface geology as clay-rich superficial deposits to a depth of 6m BGL, followed by 4m of very silty, fine sand and gravel, and then boulder clay to a basal depth of 13m BGL.
70. Given the nature of the geology it is considered highly unlikely that the trenchless works will encounter the underlying Chalk aquifer and therefore the potential for a hydraulic connection between the trenchless works and the water supply is assessed as very low. However, it is acknowledged that there is uncertainty as to the source of supply, if from the silty, sandy horizon identified within the superficial deposits there is the potential for a hydraulic connection to exist.

24.7.3 Impact Assessment

24.7.3.1 Potential Effects

71. Without appropriate design and controls, construction of the works has the potential to impair local hydrology (water quality) and hydrogeology (groundwater levels, flow and quality), such as:

- 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;
- Existing groundwater flow paths could be disturbed or altered, impacting on nearby groundwater abstractions.

72. Standard construction techniques and best practices are to be used to avoid or reduce these potential impacts. Details are given in the following section.

24.7.3.2 Embedded Mitigation

73. Best practice construction techniques and procedures that have been developed through a series of outline management plans for approval by the Environment Agency, Lincolnshire County Council, and relevant Planning Authority, in accordance with the requirements of the Development Consent Order (DCO). These include:

- Outline Code of Construction Practice (document reference: 8.1) including:
  - Outline Soil Management Plan (document reference 8.1.3);
  - Outline Pollution Prevention and Emergency Incident Response Plan (document reference: 8.1.4); and
  - Outline Surface Water Drainage Strategy (document reference: 8.1.5).

74. A final CoCP, and associated documents, will be submitted post-consent with further details on construction techniques and procedures.

75. 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 C502 Environmental Good Practice on Site C741, CIRIA 2015;

76. The Pollution Prevention Guidelines (PPGs) (which are progressively being replaced with Guidance for Pollution Prevention (GPPs)[6]) provide environmental good practice for the devolved administrations of the UK, Whilst not endorsed by the Environment Agency, the GPPs provide a strong platform for informing best practice and environmental management in areas where there are no direct regulations. and relevant PPGs/GPPs will be followed, including:

- GPP01: Understanding your environmental responsibilities – good environmental practices (Oct 2020)
- GPP02: Above Ground Oil Storage Tanks (Jan 2018);
- GPP04: Treatment and Disposal of wastewater where there is no connection to the public sewer (Nov 2017);
- PPG6: Working at construction and demolition sites (2012);

[6] Guidance for Pollution Prevention (GPP), available at: [redacted]

- GPP08: Safe storage and disposal of used oils (July 2017);
- GPP13: Vehicle Washing and Cleansing (April 2017);
- PPG18: Managing fire water and major spillages (June 2000);
- GPP21: Pollution incident response planning (June 2021);
- GPP22: Dealing with Spills (Oct 2018).

77. Further environmental guidance for English businesses is provided by Gov.uk Pollution prevention for Businesses[7].

24.7.3.3 Impact upon Groundwater Levels and Flow Regime

78. The maximum depth of excavation associated with the construction activities is up to 6 metres below ground level, associated with entry pits for the trenchless works. An assessment of the superficial geology has confirmed that the construction activities are located upon clay-rich, low permeability materials, which are present in thicknesses of between 10 and 15m. The groundwater within these deposits is considered therefore to have **low** sensitivity. It is therefore likely that any groundwater encountered would be incidental, and not representative of a laterally continuous water table.
79. Sheet piling, associated with the construction of the launch pits and joint bays would be installed to a maximum depth of 10 metres below ground level, to support the excavation. The piling around the pits would not materially impact the local groundwater flow regime and would typically be removed within 6-8 weeks.
80. The trenchless cable installation, which may reach a maximum depth of 25m BGL, is also considered to have a negligible impact on the local groundwater regime. A very limited preferential flow path would form in the geology immediately adjacent to the annulus space, however this would not be expected to impact the wider flow regime of the aquifer. Further, it is proposed that the trenchless works would not reach a depth below that of the Chalk's upper horizon, and therefore the chalk aquifer would not be encountered.
81. In the event that groundwater is encountered within the excavations, there is the potential need for dewatering of the excavations. These would be dewatered and discharged back to ground, following treatment if necessary. As the excavations will be small and only open for a short period of time the potential volume of water encountered will be small and negligible in relation to the overall size of the aquifer. The magnitude of impact is therefore considered to be **minor**, and therefore the potential significance of impact is considered to be **negligible**. Nonetheless appropriate monitoring and mitigation (if required) is outlined below.

24.7.3.4 Impact upon Groundwater Quality

82. The construction works have the potential to mobilise sediments / particles that could be washed into surface waters, contributing to surface and groundwater pollution. 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.

[7] DEFRA and Environment Agency guidance on Pollution Prevention for Business (Accessed online at: https://www.gov.uk/guidance/pollution-prevention-for-businesses))

83. The onshore construction works will be undertaken in accordance with the management plans outlined in Section 24.7.3.2, which provide details of how construction will be completed in an environmentally safe manner and minimise the potential for spillages.
84. Best practice techniques will be incorporated within the management procedures for construction activities onsite in order to protect the water environment from pollution incidents. Key mitigation measures, as set out in the management plans, can be summarised as follows:
    - during construction 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 Environment Agency's Guidance for Pollution Prevention (GPP1) and Gov.UK's pollution prevention for business;
    - 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;
    - in accordance with GPP5 the amount of time stripped ground and soil stockpiles being exposed will be minimised and vegetation will only be removed from the area that needs to be exposed in the near future.
    - plant and wheel washing will be carried out in a designated area of hard standing at least 10 metres from any watercourse or surface water drain or rock outcrop (hard rock at surface).
85. Any groundwater within the superficial deposits is considered to have **low** sensitivity. Given the embedded mitigation in place, the potential impact during construction to groundwater quality and subsequently surface water quality of any down-stream watercourses in hydraulic continuity with the Chalk is assessed as **negligible** to **minor.** Consequently, the significance of potential effect is considered to be **negligible.**

24.7.3.5 Impact upon Private Water Supplies

86. One private water supply has been identified within a 500m radius of the Order Limits as shown on Figure 24.1.4. The supply at Bristol Farm is located approximately 220m to the east of CIC57, CIC58 and TC40[1]. The Bristol Farm PWS is considered to have **medium** sensitivity.
87. Published borehole logs confirm that the local superficial geology is predominantly clay-rich and therefore of low permeability, and present to a depth of at least 13m. Whilst not confirmed, it is conservative to assume that the Bristol Farm PWS sources groundwater from the underlying chalk bedrock aquifer which is likely present from a depth of +15 mBGL.
88. It is however noted that the exact source of supply is unknown, a survey will therefore be undertaken prior to commencement of any works to confirm the source of supply as from the Chalk. If identified as being from the superficial deposits, additional monitoring and

mitigation may be adopted. The assets identified above shall be entirely constructed within the superficial clay-rich deposits. Any associated excavations would not be expected to encounter significant groundwater inflows from the superficial deposits, nor from the chalk bedrock.

89. It is therefore considered that the construction of these assets would pose a **negligible** magnitude of impact upon the Bristol Farm PWS, with the resulting significance of potential effect considered to be **negligible**. As a highly conservative approach appropriate monitoring and mitigation (if required) are outlined.

24.7.3.6 Impact upon Ecological Sites

90. As identified within Section 24.6.5, one ecological site, the Sea Bank Clay Pits SSSI, has been identified as having a potential groundwater link and being within 300 metres of the trenchless works at landfall. The SSSI is considered to have **high** sensitivity relating to its importance at both a regional and national scale.
91. Published borehole logs indicate that the excavations, proposed to a maximum depth of 6m BGL, would be solely within low permeability, clay-rich superficial material. This is shown conceptually on Plate 24.2. Consequently, any dewatering associated with the asset's construction is predicted to be very limited and largely incidental. No consistent groundwater inflow is expected. If dewatering were to take place, any associated radius of influence would likely be of limited areal extent (<50m from any abstraction point) and less than the distance to the SSSI.
92. The trenchless installation works, proposed to a depth of 25m BGL, would not require dewatering and would only create a very localised preferential flow route in the geology. These works are not expected to impact the wider flow regime of the aquifer and therefore should not be expected to impact groundwater flow to the SSSI.
93. These works are not expected to encounter areas of known contamination within the superficial geology, and therefore the activity would not mobilise pollutants to the underlying bedrock aquifer.
94. The only potential pathway between the Project and Bank Clay Pits SSSI is considered to be in the event that the clay pits encountered the sand and gravel horizon identified in nearby BGS logs and that they also extend to the HDD location. Any such connection is unknown, however as a highly precautionary approach, in the event the HDD works encounter groundwater and require dewatering, then additional monitoring has been outlined.
95. Based on the above, the magnitude of impact on the local groundwater flow regime, from the construction of the landfall is considered to be **minor**. The potential significance of effect to the Sea Banks Clay Pits SSSI is therefore assessed as **minor**, however as a highly precautionary approach appropriate monitoring and mitigation are outlined.

24.7.4 Monitoring and Mitigation

24.7.4.1 Monitoring

96. Prior to commencement of any excavations a survey of the Bristol Farm PWS will be undertaken to confirm its source, use and construction and confirm that it is still utilised. If this confirms that the abstraction is from either the Chalk groundwater or surface water, no further monitoring or mitigation would be required. If indicated that abstraction is from the Tidal Flat deposits and deemed necessary to dewater the superficial deposits from

either of the trenchless works locations it is proposed that this location be monitored (subject to agreement with the landowner) throughout the construction period to ensure no adverse impact on levels or flow.

97. If it is deemed necessary to dewater the superficial deposits local to landfall, it is recommended that monitoring of Sea Bank Clay Pits SSSI is undertaken throughout the construction period to ensure no adverse impacts to the ecological site. This would include monitoring of water levels and visual inspection of any pond features situated within the boundaries of the ecological site (such as the pond situated at TF 55424 75093, for example). In the unlikely event that a notable drop in water levels or flows is recorded the dewatering would be ceased until appropriate assessment of impact or suitable mitigation can be put into place.

24.7.4.2 Mitigation

98. In the highly unlikely event that mitigation is required in response to the monitoring, this would likely involve either changing the method of working to avoid the need for dewatering or providing a replacement water supply to ensure that continuity of supply is available throughout the works.

24.7.4.3 Water Quality Management and Mitigation Plan

99. A Water Quality Management and Mitigation Plan will be prepared and submitted for approval prior to construction which will set out the methods to monitor and control changes to the quality and quantity of groundwater and surface water which could be impacted during the construction phase of the Project.

100. Prior to producing the plan, the Groundwater Risk Assessment will be updated in the pre-construction phase and used to inform the scope of the plan and will be appended to it and be submitted for approval as part of the plan.

101. The plan will detail the monitoring that will be undertaken, including the methods, locations, and frequency to be adopted. It is anticipated that monitoring will include the installation of groundwater boreholes which can be used to monitor both water depth and water quality on a regular, agreed basis, at sites agreed with the appropriate statutory bodies.

102. The plan will include:

- baseline monitoring to be undertaken prior to construction;
- construction phase monitoring and reporting; and
- post construction monitoring and reporting.

103. Monitoring of water quality will include regular extractive sampling of water at monitoring locations for laboratory analysis and more frequent field checks by the ECoW during the construction phase.

104. The water quality monitoring will:

- Build an understanding of the existing baseline conditions in surface water and groundwater features within and/or downstream of the onshore order limits;
- Inform the specification for monitoring during construction and post construction;
- Provide a record of water quality across the site that can be compared to rainfall and site activities; and

- Provide reassurance of the performance of the pollution prevention procedures installed to prevent contamination of surface water and groundwater throughout the construction period.

105. The Water Quality Management and Mitigation Plan will provide the information required to recognise a pollution incident, should one occur and will also detail the mitigation measures that should be followed in the event that monitoring identifies any impacts during construction.

106. The Water Quality Management and Mitigation Plan will be included as part of the final CoCP and this commitment is secured within the DCO by Requirement 18 (Code of Construction Practice).

24.8 Conclusions

107. A hydrogeological and hydrological impact assessment has been undertaken to assess the potential impact upon the local hydrogeological and hydrological regime of the proposed onshore construction works.

108. The assessment has identified two receptors with the potential to be impacted by the onshore construction works, these are the Sea Banks Clay Pit SSSI, and the private water supply at Bristol Farm. Both are located on Tidal Flat deposits which are identified as being clay-rich and of significant thickness; this significantly limits the potential hydraulic connection between the assets and the potential receptors. The onshore construction works will involve excavations which are relatively shallow and of limited area. Therefore, the potential impact on the private water supply and/or the SSSI is considered to be low, and even if localised dewatering is required, the low volumes are unlikely to impact the receptors. Nonetheless, a Water Quality Management and Mitigation Plan will be prepared and submitted for approval prior to construction, to ensure that the works do not result in an adverse impact on these features.

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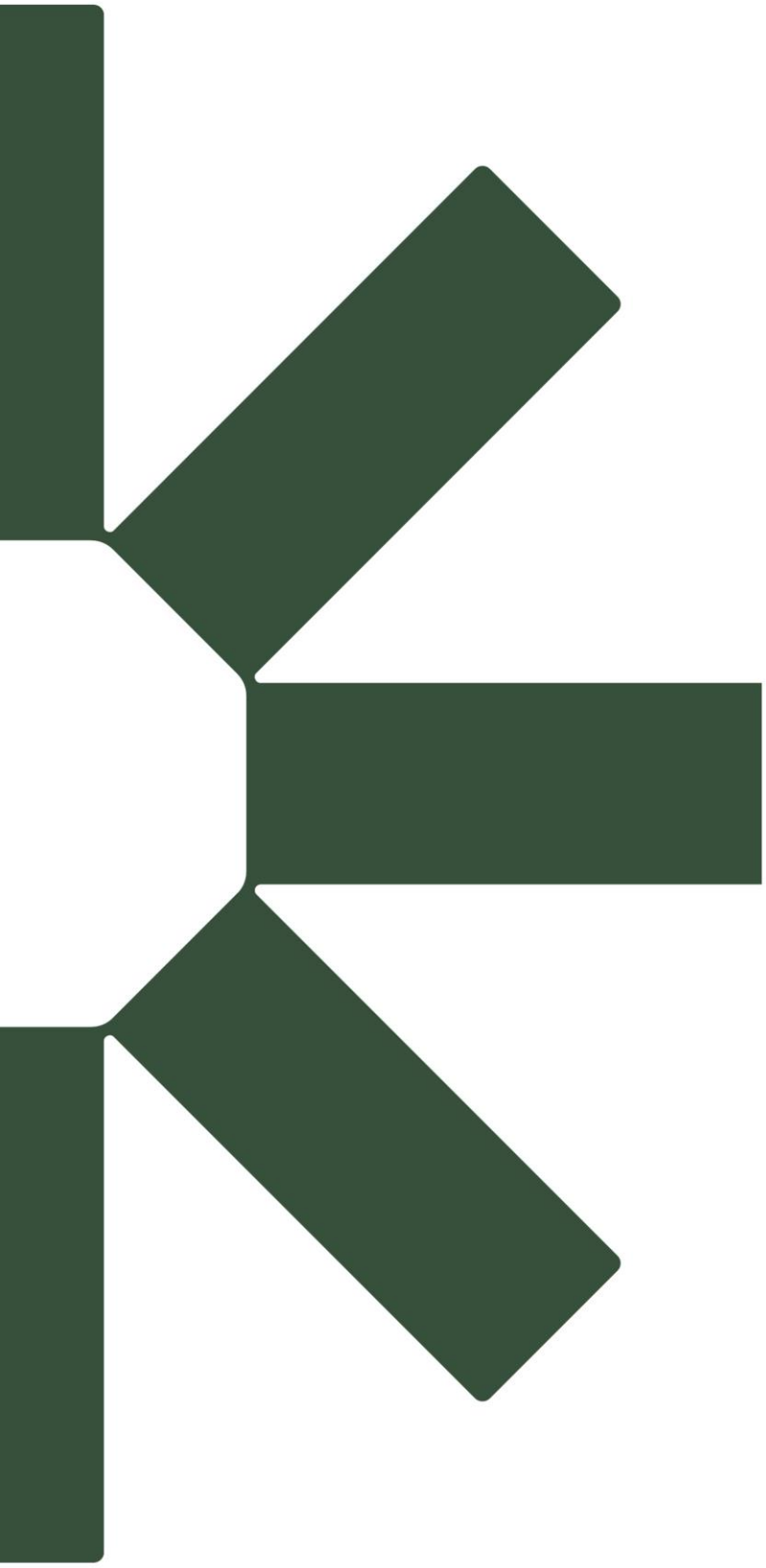

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