

Hornsea Project Three
Offshore Wind Farm



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Environmental Statement:
Volume 6, Annex 2.4 – Hydrological Characterisation Report

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Hornsea 3
Offshore Wind Farm

Orsted

Environmental Impact Assessment

Environmental Statement

Volume 3

Annex 2.4 – Hydrological Characterisation Report

Liability

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Glossary

Term	Definition
Aquifer	A body of permeable rock which can contain or transmit groundwater.
Catchments	An area that serves a watercourse with rainwater. Every part of land where the rainfall drains to a single watercourse is in the same catchment.
Discharge consents	Consent granted by the Environment Agency to discharge into watercourses, subject to conditions.
European conservation site	A Special Area of Conservation (SAC) or candidate SAC, a Special Protection Area (SPA) or potential SPA, a site listed as a site of community importance or a Ramsar site.
Environmental Stewardship	An agri-environment scheme, which provides funding to farmers and other land managers in England who deliver effective environmental management of their land.
Entry Level Stewardship	Basic level of entry into the Environmental Stewardship Scheme. As described under Environmental Stewardship above.
Field drainage	Limiting the effect of flooding by maintaining surface water and land drainage systems.
Flood Defences	A structure that is used to reduce the probability of floodwater affecting a particular area.
Geology	The scientific study of the origin, history and structure of the earth.
Ground Conditions	An assessment of the history and chemical and physical characteristics of the soil conditions at a site.
Groundwater	All water which is below the surface of the ground in the saturated zone and in direct contact with the ground or subsoil.
High Level Stewardship	A more demanding level of Environmental Stewardship (than Entry Level) designed to build on the Entry Level Stewardship agreement.
Hydrology	The study of the movement, distribution, and quality of water.
Internal Drainage Board	Drainage Boards are an integral part of water level management in the UK. Each IDB is a local public authority established in areas of special drainage need in England and Wales. They have permissive powers to manage water levels within their respective drainage districts. They undertake works to reduce flood risk to people and property and manage water levels to meet local needs.
Main rivers	The term used to describe a water course in respect of which the Environment Agency has permissive powers in relation to its management.
Minor watercourses	The term used to describe a water course owned and operated by a local Drainage Board, a Lead Local Flood Authority or a private land owner.
Non-statutory designated sites	Non-statutory designated sites are sites which have been designated due to their nature conservation interest, typically through the local planning process, which are usually protected by planning policies but not legally protected.
Onshore Ecology Expert Working Group	Onshore Ecology Expert Working Group comprises local planning authorities, Natural England, the Environment Agency, the RPSB and Norfolk Wildlife Trust. The aim of the group is to discuss and agree (where possible) key elements of the EIA and HRA during the pre-application period.
Onshore elements of Hornsea Three	Hornsea Three landfall area, onshore cable corridor, the onshore HVAC booster station, the onshore HVDC converter/HVAC substation and the interconnection with the Norwich Main National Grid substation.

Term	Definition
Ordinary watercourses	A river, stream, ditch, cut, sluice, dyke or non-public sewer that is not a designated Main river, and for which the local authority has flood risk management responsibilities and powers.
Sites of Special Scientific Interest	Sites designated by Natural England under the Wildlife and Countryside Act 1981 (as amended) as areas of land of special interest by reason of any of their flora, fauna, or geological or physiographical features.
Special Area of Conservation	A site designation specified in the Habitats Directive (Council Directive 92/43/EEC). Each site is designated for one or more of the habitats and species listed in the Directive. The Directive requires a management plan to be prepared and implemented for each SAC to ensure the favourable conservation status of the habitats or species for which it was designated. In combination with Special Protection Areas, these sites contribute to the Natura 2000 Sites network.
Water Framework Directive	Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.
Water Quality	The physical, chemical and biological characteristics of water.

Acronyms

Acronyms	Description
BT	British Telecom
CWS	County Wildlife Site
EA	Environment Agency
EWG	Onshore Ecology Expert Working Group
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IDB	Internal Drainage Board
OS	Ordnance Survey
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive

Units

Unit	Description
ha	Hectares (area)
m	Metres (distance)
km	Kilometres (distance)

1. Introduction

1.1 Background

1.1.1.1 This annex has been prepared in response to statutory consultation comments raised by Natural England and the Environment Agency (EA) in their review of the Hornsea Three Scoping Report (see Table 2.4 of volume 3, chapter 2: Hydrology and Flood Risk). The comments highlighted concerns that the onshore cable corridor may directly affect the hydrological processes and the habitats present within the River Wensum Special Area of Conservation (SAC) and potentially other crossings of main rivers.

1.1.1.2 This annex therefore sets out the hydrological characterisation of key watercourse crossing points along the Hornsea Three onshore cable corridor.

1.2 Objectives

1.2.1.1 The consultation with Natural England and the EA identified a need to:

- Better understand the hydrological regime and ecological environment at the crossing of the River Wensum and other crossings of main rivers along the onshore cable corridor;
- Support the baseline characterisation presented in volume 3, chapter 2: Hydrology and Flood Risk of the Environmental Statement;
- Facilitate future engagement with relevant stakeholders;
- Identify ecological and hydrological constraints to inform engineering site visits and investigations of potential crossing locations and site-specific issues; and
- Develop the basis for appropriate post-consent control mechanisms for agreeing final cable crossing installation methodologies with the relevant regulators/asset owners.

1.3 Scope

1.3.1.1 This annex focuses on the following characteristics of the hydrological regime:

- Physical location of tributaries and streams;
- Flood risk data and records of flooding events;
- Water Framework Directive (WFD) objectives;
- Current abstractions (private and licensed) and discharge consents (and environmental permits) which may influence water quality and flow;
- Geology and hydrogeology;
- Ecology (particularly hydrologically/hydrogeologically dependent habitats/species); and
- Inter-relationships of the above.

1.3.1.2 The purpose and objectives of this annex were discussed with the Onshore Ecology Expert Working Group (including representatives from Natural England as well as the EA, Norfolk County Council, the Royal Society for the Protection of Birds (RSPB) and Norfolk Wildlife Trust). The Onshore Ecology Expert Working Group was also consulted on the scope and proposed sources of data and information and feedback has been incorporated into the report where relevant (for example, the inclusion of Source Protection Zones (SPZs)). The overall message from the Onshore Ecology Expert Working Group was that presenting ecological, hydrological and hydrogeological baseline information in this report would provide useful information for assessing the interactions between ecology, hydrology and hydrogeology, whilst also incorporating constraints into the design of the crossing methodologies.

1.3.1.3 Since the scope of the hydrological characterisation report was agreed, the design of Hornsea Three has been refined and the methods that will be used to cross the watercourses listed in Table 2.1 has been confirmed as Horizontal Directional Drilling (HDD) techniques. The proposed extent of the HDD for each crossing point is shown in Appendix C.

2. Methodology

2.1 Hornsea Three hydrological characterisation study areas

- 2.1.1.1 The annex focuses on the locations where the Hornsea Three onshore cable corridor will cross main rivers (as designated by the EA), and also includes locations where the corridor will cross ordinary watercourses managed by the Norfolk Rivers Internal Drainage Board (IDB) linked to the designated ecological habitats.
- 2.1.1.2 The Hornsea Three hydrological characterisation study areas comprise a 500 m buffer around these crossing locations. The size of the buffer is considered adequate to identify the key ecological, hydrological and hydrogeological receptors which may be impacted by the construction of Hornsea Three. The annex focuses on the construction phase of Hornsea Three, as this is the phase in which the greatest magnitude impacts to watercourses are predicted to occur.
- 2.1.1.3 The study areas are listed below in Table 2.1 and are shown on Figure 2.1. The study areas were agreed with the Onshore Ecology Expert Working Group.

Table 2.1: Watercourses in the Hornsea Three hydrological study areas.

Name	Watercourse name	EA main river or IDB watercourse
Study area 1	River Bure	EA main river
Study area 2	Blackwater Drain	IDB watercourse
Study area 3	Swannington Beck	IDB watercourse
Study area 4	River Wensum	EA main river
Study area 5	River Tud	EA main river
Study area 6	River Yare	EA main river
Study area 7	Intwood Stream	IDB watercourse

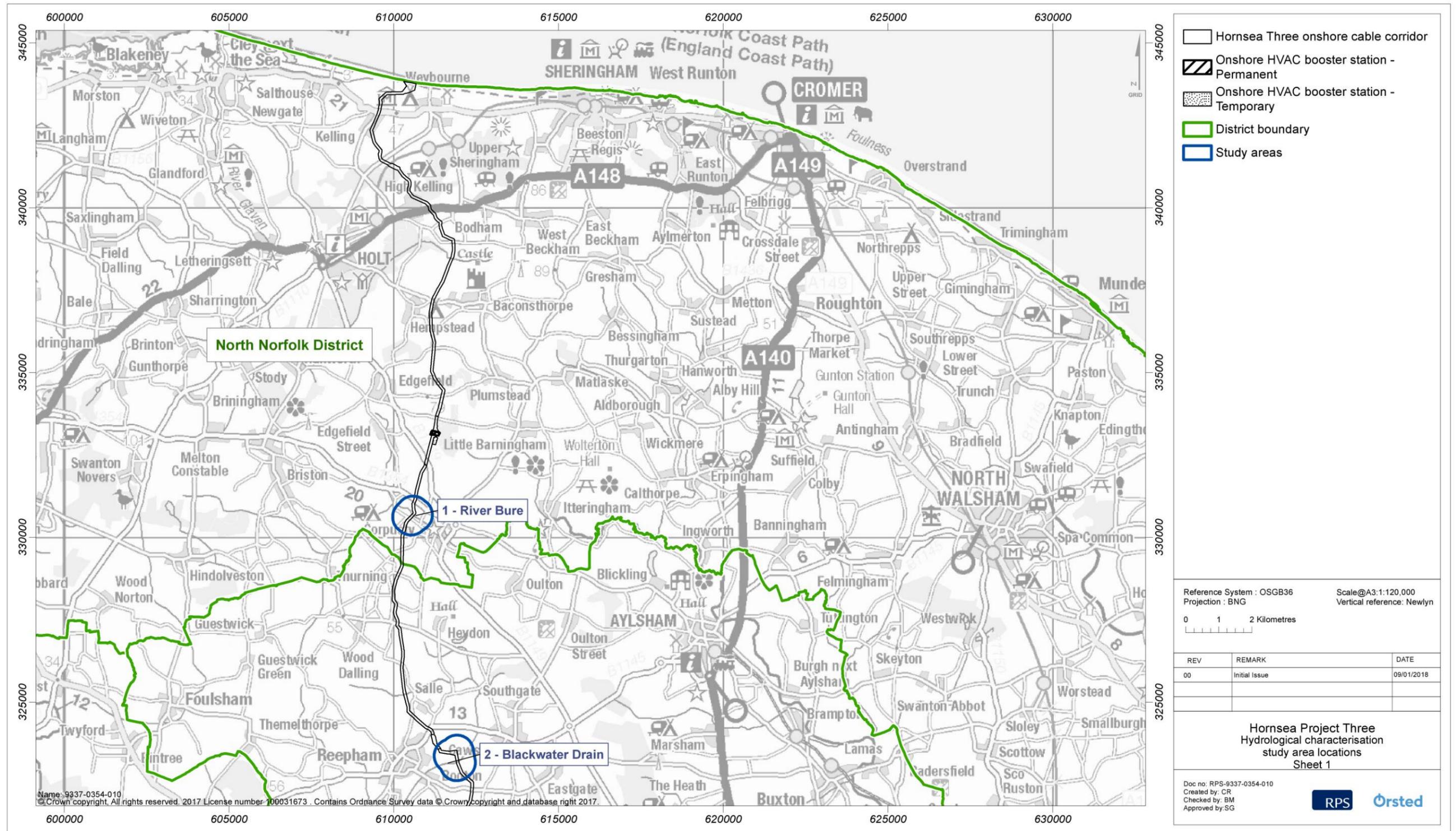


Figure 2.1: Hydrological characterisation study area locations

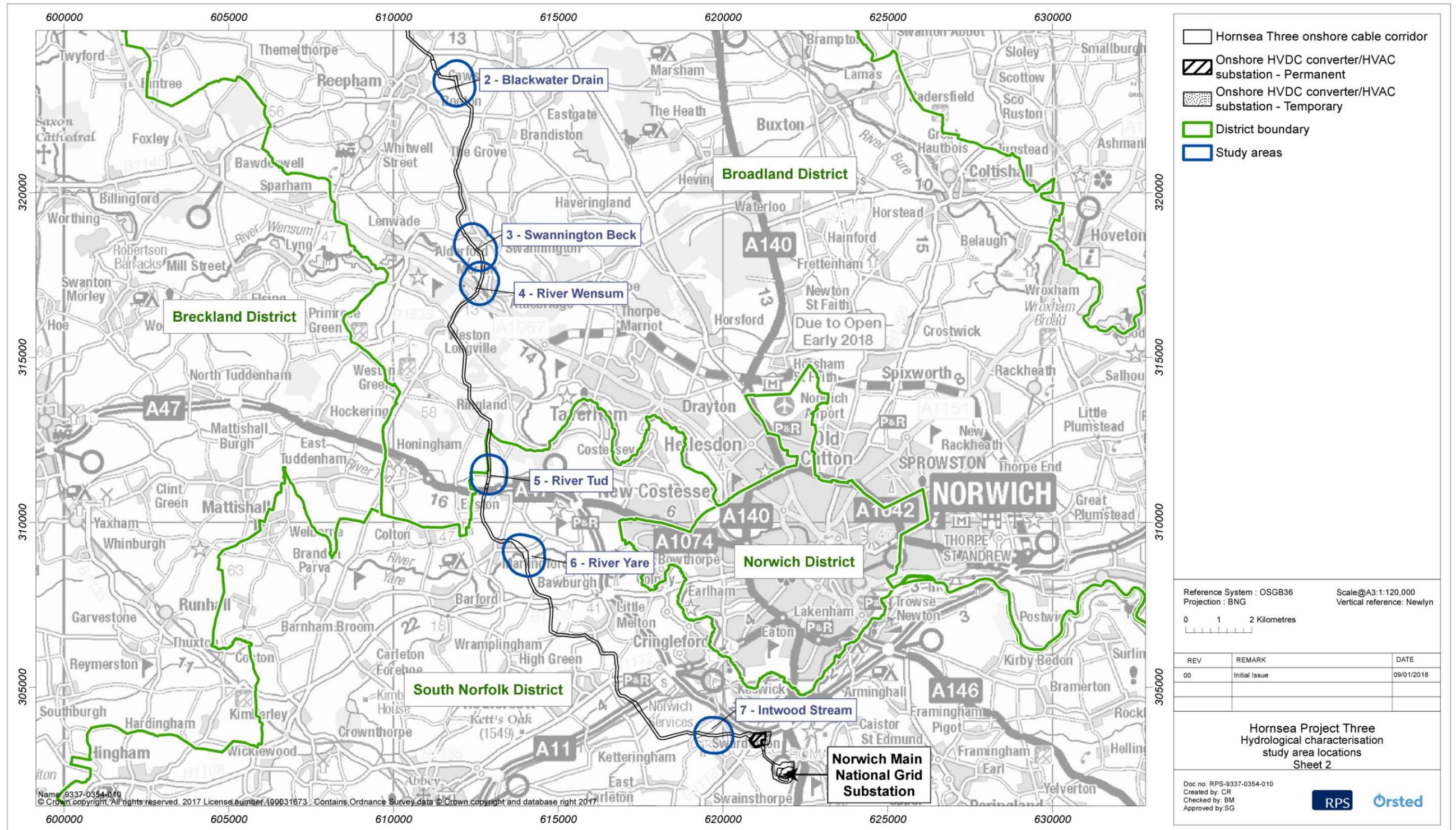


Figure 2.1: Hydrological characterisation study area locations.

2.2 Desk study

2.2.1 Data sources

2.2.1.1 This annex has been prepared based on information gathered from a desk study (see section 2.3) and observations made during a site visit in March 2017 (see section 2.4).

2.2.1.2 The types and sources of data used to inform this annex are set out in Table 2.2 below.

Table 2.2: Data Sources.

Data type	Source	Year
Designated sites citations	Natural England	2017
Private groundwater abstractions	Local Planning Authorities	2017
Licensed groundwater abstractions	Environment Agency	2017
Discharge consents/environmental permits	Environment Agency	2017
Groundwater Monitoring data	Environment Agency	2018
Borehole records	BGS Website http://mapapps2.bgs.ac.uk/geoindex/home.html	2016
Ground conditions report	Ørsted	2017
WFD objectives	Environment Agency	2015
Flood Risk information and records of flooding events	Environment Agency, Norfolk County Council (as Lead Local Flood Authority)	2017
BGS 1:50,000 and 1:10,000 digital geological mapping	BGS via Groundsure GeoInsight Report	2017
Location of seepages and springs	OS maps, British Geological Survey, Environment Agency Questions to landowners	2017
River corridor habitats	Phase 1 Habitat Survey results (annex 3.1: Extended Phase 1 Habitat Survey), Google Maps	2017

2.2.1.3 A WFD assessment has been undertaken for groundwater and surface water (see annex 1.4: Water Framework Directive Groundwater Assessment and annex 2.5: Water Framework Directive Surface Water Assessment). These annexes have been used to provide information on the quality of the water bodies at each crossing point.

2.2.1.4 Land owners were also interviewed about their land/property within the study areas. The information they provided was appraised for anything warranting further investigation.

2.2.2 Review of data

2.2.2.1 Information from the desk study was reviewed and compiled describing the key hydrological/hydrogeological/ecological features of each study area. Observations from the site visit were also collated.

2.3 Site visit

2.3.1.1 A site visit to each of the study areas outlined in Table 2.1 was undertaken during March 2017 by a multi-disciplinary team from RPS and a survey team of site engineers. The RPS team comprised a qualified ecologist and hydrologist.

2.3.1.2 The surveyors were given a copy of the maps and desk study information to provide background information of each study area.

2.3.1.3 Photographs were taken and observations were made at each study area. The observations focused on ground truthing the information gathered from the desk study as well as identifying site specific features such as:

- Location of wet/boggy ground;
- Width/depth/flow of rivers and tributaries;
- Surrounding land uses (e.g. agricultural (arable/grassland), residential, woodland, commercial);
- Habitats associated with wet ground;
- Topography; and
- Local flood defences/improvements.

2.3.1.4 Whilst on site, the environmental and engineering teams discussed how the ecological, hydrological or hydrogeological features identified during the desk study and site visit would be taken into account in the design of the proposed crossings in each study area. As mentioned in paragraph 1.3.1.3, the design of Hornsea Three has been refined and, in all of the hydrological characterisation study areas, the use of HDD crossing techniques has been confirmed (see volume 1, chapter 3: Project Description).

2.3.1.5 These discussions are captured at the end of the description of each study area and illustrated in Appendix A, together with an update on the features from the Phase 1 Habitat Survey (see annex 3.1: Extended Phase 1 Habitat Survey). Target notes for the updated Phase 1 Habitat Survey are contained in Appendix B.

2.3.1.6 Specific details and locations of some ecological features (e.g. badger setts) have been omitted from this annex due to their sensitive nature. This information will be contained within confidential annexes.

3. Study Area 1 – River Bure

3.1.1.1 Study area 1 focuses on where the Hornsea Three onshore cable corridor crosses the River Bure and is located approximately west of Corpusty (Figure 3.2). Baseline information from the desk study and observations from the site visit are presented below.

3.2 Hydrological aspects

River Bure

3.2.1.1 The River Bure flows west to east in an open channel across the onshore cable corridor (Figure 3.1). During the site visit the channel was observed to have a constant flow of water across the whole section. A pond feature is also present south of the River Bure within the study area.



Figure 3.1: River Bure.

3.2.1.2 Land between the River Bure and field drains to the north of the river comprises marshy grassland, with limited potential for infiltration. Further afield, agricultural land to the north and semi-improved grassland to the south would allow for infiltration of surface water. The site is a flat river valley with sloping sides, the sides rising steeply to the south, with a gradual incline to the north. The Hornsea Three onshore cable corridor passes below a large pond and wooded area on the southern bank of the river.

3.2.1.3 An established hedgerow exists towards the north eastern end of the HDD location running parallel to a ditch and forming a field boundary.

Other watercourses

- 3.2.1.4 Field drains within the onshore cable corridor have a constant volume of water within the channel (Figure 3.3). During the site visit, the flow was slow/stagnant with algae growing on the surface.



Figure 3.3: Field drain within the study area 1.

Licensed surface water abstractions

- 3.2.1.5 In the study area, there is one licensed surface water abstraction from the River Bure. It is located just east of where the road between Little London and Saxthorpe crosses the river (E 610760, N 330490). This abstraction relates to the storage for use as spray irrigation.

Private surface water abstractions

- 3.2.1.6 No private surface water abstractions were identified in the study area.

Discharge consents/environmental permits

- 3.2.1.7 There is a discharge consent for the River Bure at the centre of the study area, east of the Timber Yard in Town Close (E 610500, N 330700). There is also a miscellaneous ground discharge consent south of Town Close (E 610300, N 330600). Both of these discharge consents are for domestic properties.



Figure 3.4: Pond feature south of the River Bure.

Water Framework Directive Objectives

- 3.2.1.8 The WFD water quality classifications for the River Bure are as follows:

- Overall water body – Poor;
- Ecological – Poor; and
- Chemical – Good.

Flood risk

- 3.2.1.9 The land close to the River Bure, inside the IDB boundary, is for the most part in Flood Zone 3 with some areas of Flood Zone 2.

3.3 Ecological aspects

Designated sites

Dismantled Railway County Wildlife Site

- 3.3.1.1 The County Wildlife Site (CWS) crosses the onshore cable corridor and extends from the west of the study area, parallel to the Heath Road, to south of Little London.

3.3.1.2 The CWS comprises a length of disused railway where the habitats vary from woodland through to scattered trees and scrub over a fairly species-rich re-colonised grassland. Part of the line is a footpath. During the site visit, there were no discernible signs of management and a very large rabbit population. To the east of the CWS there are wooded areas on a steep-sided embankment, lined by dense birch and alder sapling with more mature woodland behind. This area grades into mature oak dominated woodland. Further east is grassland with a variety of grasses and herbs. Past Heath Road Bridge oak woodland develops again which terminates in a scrub patch.

Corpusty Fen CWS

3.3.1.3 This CWS is located on the north bank of the River Bure, north of Town Close. This site is an area of tall fen vegetation. East and west boundaries are formed by mature poplar plantations, the northern boundary by arable land.

Agri-environment Schemes

Environmental Stewardship Agreements

3.3.1.4 The majority of the fields in the study area are managed to Entry Level and Higher Level Stewardship standard with the exception of the fields in the south of the study area (Figure 3.2).

Habitats

Aquatic Features

3.3.1.5 During site visit, the River Bure had a good clear flow over a mixed gravel and sandy bed. There were some submerged and emergent plant species and in places riffle sections.

3.3.1.6 There are a number of drains leading to, or running parallel to, the River Bure which were observed to support a range of aquatic plant species.

Wetland

3.3.1.7 To the north of the River Bure, adjacent to Corpusty Fen, is a marshy area which drains into the River Bure. Within the onshore cable corridor, the field to the north of the River Bure is marshy grassland. Toads, frogs and snipe are recorded in this area (see target notes 1, 5, 2 and 6 respectively in Appendix B).

Grassland

3.3.1.8 The Phase 1 Habitat Survey identifies the field north of the River Bure as marshy grassland and the fields to the south improved and species-poor semi-improved grassland. The majority of the rest of the fields are arable land.

Woodland

3.3.1.9 The land north of Town Close, on the banks of the River Bure, including Corpusty Fen, is categorised as Deciduous Woodland in the Priority Habitat Inventory.

3.4 Hydrogeological aspects

Superficial deposits

3.4.1.1 The study area includes:

- Alluvium – clay, silt, sand and gravel;
- Briton's Lane Sand and Gravel Member – sand and gravel;
- Head – Diamicton; and
- Lowestoft Formation – Diamicton

Aquifer status

3.4.1.2 All superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated aquifer.

Bedrock

3.4.1.3 The study area is underlain by the Lewes Nodular Chalk of the White Chalk Subgroup.

Aquifer status

3.4.1.4 The Chalk is classified as a Principle aquifer.

Expected ground conditions

3.4.1.5 Alluvium follows the northeast southwest direction of the river. It is underlain by Pleistocene Glaciofluvial and Till deposits. From the descriptions of boreholes located approximately 1 km east of the crossing, it appears that approximately 0-10 m thick of the Pleistocene Glaciofluvial deposits are overlaying clayey till deposits which are between 3 and 20 m thick. Considerable variability was observed within the small area in which these boreholes are located. Underlying the till deposits was a 10-12 m thick sand layer identified as Crag. Soft chalk and chalk with flints was observed below the Crag at depths varying from 30- 40 m below ground level.

Licensed groundwater abstractions

3.4.1.6 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

3.4.1.7 No private groundwater abstractions are identified within the study area.

Water Framework Directive

3.4.1.8 The WFD unit underlying study area 1 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and

- Impact on surface waters – Good.

Source Protection Zone

3.4.1.9 The study area is not located within a SPZ.

3.5 Information from landowners

Field View

Location

3.5.1.1 The field immediately adjacent to, and to the north of, the dismantled railway, south of Town Close in the west of the study area.

Agri-environment and single payment schemes

3.5.1.2 The landowner indicates that the land is not included in agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.3 The landowner indicates that there are no additional hydrological features and that the land is not susceptible to flooding or waterlogging.

Abstractions/discharge consents

3.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land Use

3.5.1.5 The land is currently kept as woodland.

Great Farm, Saxthorpe

Location

3.5.1.6 The fields and farm buildings in the centre and east of the study area, to the east and west of Croft Lane.

Agri-environment and single payment schemes

3.5.1.7 The area is managed under Entry Level Stewardship and Higher Level Stewardship. Standard Level Stewardship is also claimed by the landowner.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.8 There are no additional hydrological features apart from the River Bure. The land holds water most of the year. The land is susceptible to flooding in very wet years. The last flood was in 2016.

Abstractions/discharge consents

3.5.1.9 The landowner holds a consent to abstract water from the River Bure.

Land use

3.5.1.10 The land is used as pasture for grazing livestock.

The Sawmill, Town Close

Location

3.5.1.11 In the centre of the study area, east of the T-junction on Heath Road, the land in between the road and the River Bure.

Agri-environment and single payment schemes

3.5.1.12 The landowner indicates that the land is not included in Agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.13 There are streams and drains adjoining the river. There is also possibly a spring in a pond on the land. The land is not prone to waterlogging and does not flood.

Abstractions/discharge consents

3.5.1.14 The landowner is not aware of any abstractions or discharge consents on their land in the study area.

Land use

3.5.1.15 At the time of the survey, the land was used as pasture however, the landowner indicated that it may also be used as a caravan park.

No. 2a, New Street

Location

3.5.1.16 In the centre of the study area, the field between Heath Road and the dismantled railway, to the east of the T-junction on Heath Road.

Agri-environment and single payment schemes

3.5.1.17 The landowner indicates that the land is not included in Agri-environment and single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.18 The landowner indicates that there are no additional hydrological features and that the land is not susceptible to flooding or waterlogging.

Abstractions/discharge consents

3.5.1.19 The landowner is not aware of any abstractions or discharge consents on their land in the study area.

Land use

3.5.1.20 The land is used for grazing horses.

Town Close, Corpusty

Location

3.5.1.21 In the west of the study area, the third property north west of the T-junction on Heath Road. This area extends from Heath Road to the River Bure.

Agri-environment and single payment schemes

3.5.1.22 The landowner indicates that the land is not included in Agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.23 No other features apart from the River Bure which abuts the north east of the property. The land is wet adjacent to the river and the same area is susceptible to flooding. The last flood was in December 2016.

Abstractions/discharge consents

3.5.1.24 The landowner is not aware of any abstractions or discharge consents.

Land use

3.5.1.25 The uses are grazing horse and sheep, residential and garden.

Prospect Point

Location

3.5.1.26 This property is the north west of the study area, on the north bank of the River Bure, and includes the Corpusty Fen CWS.

Agri-environment and single payment schemes

3.5.1.27 The landowner indicates that the land is not included in agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

3.5.1.28 No hydrological features apart from the River Bure which runs through the land. Parts of the land remain wet in patches most of the year. The land is not susceptible to flooding.

Abstractions/discharge consents

3.5.1.29 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

3.5.1.30 The land is used as pasture, hay production and woodland.

3.6 Engineering considerations

Access

3.6.1.1 Limited access points are available for this crossing location.

Local utilities

3.6.1.2 A wood pole low voltage over-head line crosses the study area 1 near the centre, running approximately in a north east to south east direction.

3.6.1.3 A major National Grid gas pipeline runs parallel to the onshore cable corridor at a distance of approximately 60 m to the east of where the Hornsea Three onshore cable corridor crosses the River Bure.

3.6.1.4 British Telecom (BT) and water utilities serving the local village extend either side of the access road crossing the onshore cable corridor.

Local drainage

3.6.1.5 There is a 1 m deep ditch running across the Hornsea Three onshore cable corridor north east of the River Bure. There is no evidence of public drainage services in the immediate vicinity of the HDD locations. At the time of the site visit, the surfaces of the fields were firm on the higher ground, but boggy to the north east of the valley floor.

Areas for further consideration

3.6.1.6 The above noted natural gas pipeline crosses the onshore cable corridor approximately 150 m south of the proposed drill reception pit for the River Bure crossing. The gas pipeline will also be crossed by HDD (see the southern HDD area in Figure C.).

3.7 Initial environmental/engineering observations on design of the HDD crossing

3.7.1.1 The valley within the onshore cable corridor is wet in the bottom, particularly to the north of the River Bure.

3.7.1.2 The arable fields on the north and south sides of the river valley were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 1 of 7).

3.7.1.3 Where possible, HDD compounds will be located outside Flood Zones 2 and 3. Storage areas and secondary construction compounds have been sited outside Flood Zone 3 (and where possible, Flood Zone 2). Measures from the Outline Code of Construction Practice (CoCP) (document reference A8.5) will be implemented to control the use of these areas and to minimise the risk of surface water runoff.

- 3.7.1.4 In consideration of areas suitable for HDD activities. It is likely that the drill would start from the north eastern side of the crossing. The drill and supporting equipment would be contained within a compound and it is likely that the drill pits will be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the south western end of the drill would be contained in a compound.
- 3.7.1.5 In consideration of the presence of existing features such as the railway, road, hedgerow, ponds, potential flood risk, wooded areas, ditches and local services, it is likely that the drill would span from a point in the grassed field to the south of the railway and end to the north of the ditch in the ploughed field to the north east of the river and overhead line.
- 3.7.1.6 A drill length of approximately 350 m would be required to achieve the above. The maximum drill depth through this area is expected to be around 10 m.
- 3.7.1.7 No other hydrological constraints were observed during the site visit.

4. Study Area 2 – Blackwater Drain

4.1.1.1 Study area 2 focuses on where the Hornsea Three onshore cable corridor crosses Blackwater Drain and is located approximately 1.5 km east of Reepham (Figure 4.2). Baseline information from the desk study and observations from the site visit are presented below.

4.2 Hydrological aspects

Blackwater Drain

4.2.1.1 The Blackwater Drain flows in a westerly direction in an open channel across the onshore cable corridor (Figure 4.1). The drain flows along the boundary of Booton Common with a constant flow of water within the channel at the time of the site visit.



Figure 4.1: Blackwater Drain.

4.2.1.2 The site is flat around the drain and sloping gently to the south towards arable land and to the north towards a dense woodland area.

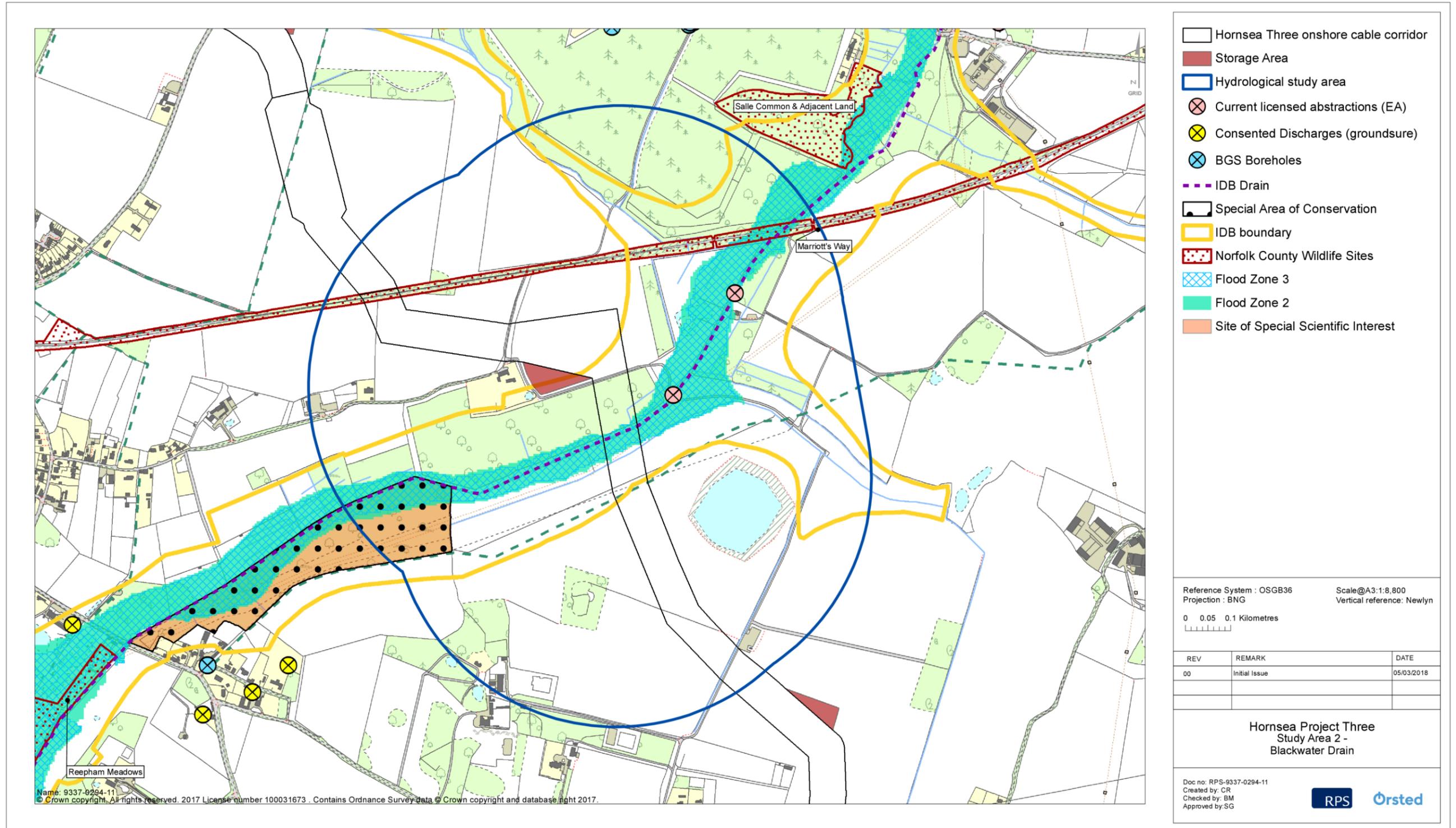


Figure 4.2: Study area 2 - Blackwater Drain.

Feeder channel

4.2.1.3 The feeder drain (Figure 4.3) flows in an open channel and discharges into the Blackwater Drain on the edge of Booton Common (Figure 4.4). No discharge from the Blackwater Drain or its feeder drain flow into Booton Common.

Surface water flows

4.2.1.4 There is an important break in slope within the Hornsea Three onshore cable corridor providing an indication of the likely direction of surface water flow routes. This suggests that within the onshore cable corridor, the surface water running into the valley flows direct to the feeder channel south of the Drain and then into the Blackwater Drain at the perimeter of Booton Common.

Licensed surface water abstractions

4.2.1.5 There is one licensed surface water abstraction in the study area. It is located in the east of the study area, where the track from Moor Farm to Booton Manor crosses the Blackwater Drain (E 612036, N 323361). This abstraction is operated by Ollands Farm and is used extract water for storage for later use in spray irrigation.

Private surface water abstractions

4.2.1.6 No private surface water abstractions have been identified in the study area.

Other watercourses

4.2.1.7 Field drain/drainage ditches within the onshore cable corridor and the wider study area flow around Booton Common.

Discharge consents/environmental permits

4.2.1.8 No discharge consents were identified within the study area.

Water Framework Directive Objectives

4.2.1.9 The WFD water quality classifications for Blackwater Drain are as follows:

- Overall water body – Moderate;
- Ecological – Moderate; and
- Chemical – Good.

Flood risk

4.2.1.10 A small amount of land approximately 30 m either side of the Blackwater Drain is susceptible to flooding. The majority of this land is classified as Flood Zone 3, with small areas further away from the stream classified as Flood Zone 2.



Figure 4.3: Feeder channel to Blackwater Drain.



Figure 4.4: Feeder drain discharges to Blackwater Drain.

4.3 Ecological aspects

Designated Sites

Booton Common Site of Special Scientific Interest and Norfolk Valley Fens SAC

- 4.3.1.1 The Booton Common Site of Special Scientific Interest (SSSI) (Figure 4.5) totals approximately 8.1 ha, with approximately 3.20 ha located in the study area. The Booton Common SSSI runs parallel to Blackwater Drain in the east of the study area. Booton Common SSSI is one of the component sites making up Norfolk Valley Fens SAC.



Figure 4.5: Booton Common SSSI and Norfolk Valley Fens SAC.

- 4.3.1.2 The reasons for the citation of Booton Common as a SSSI are as follows. The species-rich fen and wet heathland contain several rare plants. The principal interest of the site is associated with a mosaic of wet calcareous fen grassland and acid heath communities which have developed due to the naturally undulating ground. Areas of tall fen and a strip of valley alder woodland occupy the lower ground adjacent to the stream. A variety of breeding birds are present including snipe, woodcock, grasshopper warbler and lesser whitethroat.
- 4.3.1.3 The reasons for the citation of Norfolk Valley Fens as a SAC are as follows. The Annex I habitat that is the primary reason for the selection of this site is a series of valley-head spring-fed Alkaline fens.

- 4.3.1.4 The Annex I habitats present as a qualifying features, but not a primary reason for selection of this site are as follows: northern Atlantic wet heaths with *Erica tetralix*; European dry heaths; semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*); Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinia caeruleae*); calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* (Priority feature); alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) (Priority feature).

- 4.3.1.5 There are also Annex II species that are a primary reason for selection of this site: narrow-mouthed whorl snail (*Vertigo angustior*), Desmoulin's whorl snail (*Vertigo moulinsiana*).

Agri-environment Schemes

Environmental Stewardship Agreements

- 4.3.1.6 The woodland south of Moor Farm and all the fields in the study area are managed to Entry Level and Higher Level Stewardship standard. Booton Common SSSI is managed to Higher Level Stewardship standard.

Habitats

Aquatic Features

- 4.3.1.7 The Blackwater Drain is tree-lined and shaded in parts. Where it is more open there is some submerged aquatic plant growth at the time of the site visit and the channel bed was noted as being a mix of silty mud and more sandy, with areas of gravels also. There are a number of springs and flushes on both sides of the shallow valley.

- 4.3.1.8 There are also further drains leading to Blackwater Drain, including a feeder channel that runs to the south of the Blackwater Drain which was observed to provide additional aquatic habitats. The flow in this feeder ditch cuts down to the Drain before reaching the Booton Common designated site (see target note 7 Appendix B and sheet 2 of 7 in Appendix A).

- 4.3.1.9 There is an important break in slope (see target note 3) providing an indication of likely direction of groundwater flows downslope. This suggests that within the onshore cable corridor the groundwater running into the valley flows direct to the Blackwater Drain and the feeder channel rather than to the designated site to the west.

- 4.3.1.10 There are three ponds located within private land associated with houses in the study area. To the east of the study area there is a reservoir fed by abstraction from the watercourse.

Wetland

- 4.3.1.11 The area under where the telephone lines pass through Booton Common SSSI is characterized by Lowland Fens in the Priority Habitat Inventory. To the east of the designated wetland are other areas of marshy grassland, sedge beds, springs and flushes on both the north and to the south of the Blackwater Drain (see target notes 3, 5 and 6 and on sheet 6 of 7 in Appendix A).

Grassland

- 4.3.1.12 In the Phase 1 Habitat Survey the fields south and east of Booton Common SSSI and close to Blackwater Drain are classified as a mix of marshy grassland and drier semi-improved grassland. The field north of Booton Common SSSI and the field around Manor Farm are also classified as semi-improved; and the rest of the land further afield is classified as arable.

Woodland

- 4.3.1.13 Booton Common SSSI, the woodland surrounding Wood Cottage, and the woodland south of Moor Farm, is characterized as Deciduous Woodland in the Priority Habitat Inventory. The latter is also interspersed with areas of conifers to the north.

4.4 Hydrogeological aspects

Superficial deposits

- 4.4.1.1 The study area includes:
- Alluvium – clay, silt, sand and gravel;
 - Brickearth – clay, silt and sand;
 - Glaciofluvial Deposits, Mid Pleistocene – sand and gravel; and
 - Till, Mid Pleistocene – Diamicton.

Aquifer status

- 4.4.1.2 The Brickearth is classified as Secondary B. All the other superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated aquifer.

Bedrock

- 4.4.1.3 The bedrock consists of the Wroxham Crag formation (sand and gravel).

Aquifer status

- 4.4.1.4 Wroxham Crag Formation is classified as a Principle aquifer.

Expected ground conditions

- 4.4.1.5 Alluvium extends in a south west to north east direction following the course of the river and is surrounded by the Brickearth formation. There are no boreholes in close proximity to the crossing, however boreholes to the south and west indicate that the chalk is between 18-24 m below ground level and is overlain by the Wroxham Crag Formation which is up to 7.5 m thick. Superficial deposits glacial clayey and sandy deposits are between 10 and 20 m deep, however the thickness is expected to be reduced closer to the river.

Licensed groundwater abstractions

- 4.4.1.6 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

- 4.4.1.7 No private groundwater abstractions have been identified within the study area.

Water Framework Directive

- 4.4.1.8 The WFD unit underlying study area 2 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

- 4.4.1.9 The study area is not located in a SPZ.

4.5 Information from landowners

Town Farm, Church Road

Location

- 4.5.1.1 The fields south of Booton Common SSSI in the south west of the study area.

Agri-environment and single payment schemes

- 4.5.1.2 The land is managed under Higher Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

- 4.5.1.3 The ditch in the north of the field, between the field and Booton Common, holds water a lot of the year. The land is not waterlogged or susceptible to flooding.

Abstractions/discharge consents

- 4.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

- 4.5.1.5 The site is left to grassland.

Moor Farm, The Moor

Location

- 4.5.1.6 Moor Farm north of the centre of the study area.

Agri-environment and single payment schemes

4.5.1.7 The land is managed under Higher Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

4.5.1.8 On the land there is a spring which forms a large pond. The lower part of the land is a damper, marshy valley. The land is not susceptible to flooding.

Abstractions/discharge consents

4.5.1.9 According to the landowner, there is a discharge from house that drains into Eyn Beck.

Land use

4.5.1.10 The land is a large garden.

Booton Common Trust

Location

4.5.1.11 Booton Common SSSI in the west of the study area.

Agri-environment and single payment schemes

4.5.1.12 The area is managed under Higher Level Stewardship and is also a SSSI.

Hydrological/hydrogeological aspects, groundwater and flooding

4.5.1.13 There are a lot of springs/ditches throughout (fenland). The land is very wet during the year and is susceptible to flooding. The last flooding event was in 2015.

Abstractions/discharge consents

4.5.1.14 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

4.5.1.15 The land is used as a Nature Reserve which is sometimes grazed with ponies.

Ollands Farm, Heydon

Location

4.5.1.16 The land includes the majority of the farm land (fields) in the study area.

Agri-environment and single payment schemes

4.5.1.17 The area is managed under Entry Level Stewardship and Higher Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

4.5.1.18 There are streams, springs and drainages ditches which hold water. The land is marshy and the woodland is very wet. In winter, there is minor flooding and it gets very wet. There has not been a flooding event in a 'long time'.

Land use

4.5.1.19 The land is used for grazing, cattle and woodland.

4.6 Engineering considerations

Access

4.6.1.1 There are existing access points which would be investigated further, however, it is likely that access to both ends of the HDD drill would be through the onshore cable corridor.

Local utilities

4.6.1.2 Numerous wood pole over-head lines cross the onshore cable corridor and the southern end of the HDD location.

4.6.1.3 There are BT and local potable water supply lines running across the onshore cable corridor along the narrow farm track at the northern end of the HDD location.

Local drainage

4.6.1.4 No public drainage services were identified in the immediate vicinity of the drill sites. The proposed drill sites are on firm ground. However, much of the onshore cable corridor at this location will be in very wet saturated ground.

Areas for further consideration

4.6.1.5 Further considerations are as follows:

- No good local access tracks to the drill sites;
- General area is very wet; and
- Given the extent of the dense wooded area, which is known to be very wet, any frack-out occurrences within these areas would be difficult to locate and rectify.

4.7 Initial environmental/engineering observations on design of the HDD crossing

- 4.7.1.1 The valley within study area 2 (Figure 4.2), which contains Blackwater Drain, is waterlogged, particularly within the Booton Common SSSI. To the east the marshy grassland and springs/flushes occur on both sides of the Blackwater Drain. Groundwater flows feed into the valley on both slopes. There is a break of slope on the southern side of the valley within the refined onshore route corridor that suggests that groundwater flows within the corridor do not feed directly into the SAC/SSSI but run downslope to the Blackwater Drain. The HDD crossing is upstream of the SAC/SSSI but there are no direct surface water flows from the cable corridor into the valley fen, except for the Blackwater Drain itself. The Blackwater Drain forms the northern boundary of the Booton Common designated site and it is probable that the drain and the fen are hydraulically linked.
- 4.7.1.2 The arable fields on north and south sides of the river valley were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 2 of 7). In consideration of areas suitable for pipe welding it is likely that the drill would start from the northern side of the crossing. The drill and supporting equipment would be contained within a compound and the drill pits are likely to be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the southern end of the drill would be contained in a compound.
- 4.7.1.3 In study area 2 there are a number existing features such as the drain, dense wooded areas, local above ground and underground services. Therefore, the HDD would need to span from a point in the grassed field to the south of the drain end to the north of small access track, north of the dense wooded area. A drill length of approximately 196 m would be required to achieve the above. The maximum drill depth through this area is expected to be approximately 6 m. Drill depth below the wooded area is expected to be in excess of 4 m.
- 4.7.1.4 Where possible, HDD compounds will be located outside Flood Zones 2 and 3. All construction activities and access will avoid the Flood Zones 2 and 3 and associated wet habitats and in particular, an appropriate buffer strip between the route corridor and the SAC will be defined and observed. No other hydrological constraints were identified during the site visit in relation to HDD crossing techniques.

5. Study Area 3 – Swannington Beck

5.1.1.1 Study area 3 focuses on where the Hornsea Three onshore cable corridor crosses Swannington Beck and is located approximately 1 km north of Attlebridge and 1 km south of Swannington (Figure 5.2). Baseline information from the desk study and observations from the site visit are presented below.

5.2 Hydrological aspects

Swannington Beck

5.2.1.1 The Beck flows in an open channel across the onshore cable corridor (Figure 5.1). At the time of the site visit the Beck had a reasonable volume of water within the channel. The site is generally flat around the drain sloping gently towards a narrow but densely wooded strip crossing the onshore cable corridor towards the northern end of the crossing.



Figure 5.1: Swannington Beck.

Other watercourses

5.2.1.2 The field drain to the north of the Beck flows in an open channel with a constant volume of water flowing within the channel.

Licensed surface water abstractions

5.2.1.3 There is one licensed surface water abstraction from the River Wensum, on the south western edge of the study area (E 612260, N 317800). This abstraction license is owed by Harold Jones Farms Ltd and is used for direct spray irrigation.

Private surface water abstractions

5.2.1.4 No private surface water abstractions have been identified within the study area from the data received.

Discharge consents/environmental permits

5.2.1.5 There is one sewage discharge consent point outside of the study area, but upstream. This is a sewage disposal works at 4 Broad Lane (E 613440, N 318880).

Water Framework Directive Objectives

5.2.1.6 The WFD water quality classifications for the Swannington Beck are as follows:

- Overall water body – Good;
- Ecological – Good; and
- Chemical – Good.

Flood risk

5.2.1.7 The land close to the Swannington Beck, inside the IDB boundary, is generally in Flood Zone 3 with some areas of Flood Zone 2.

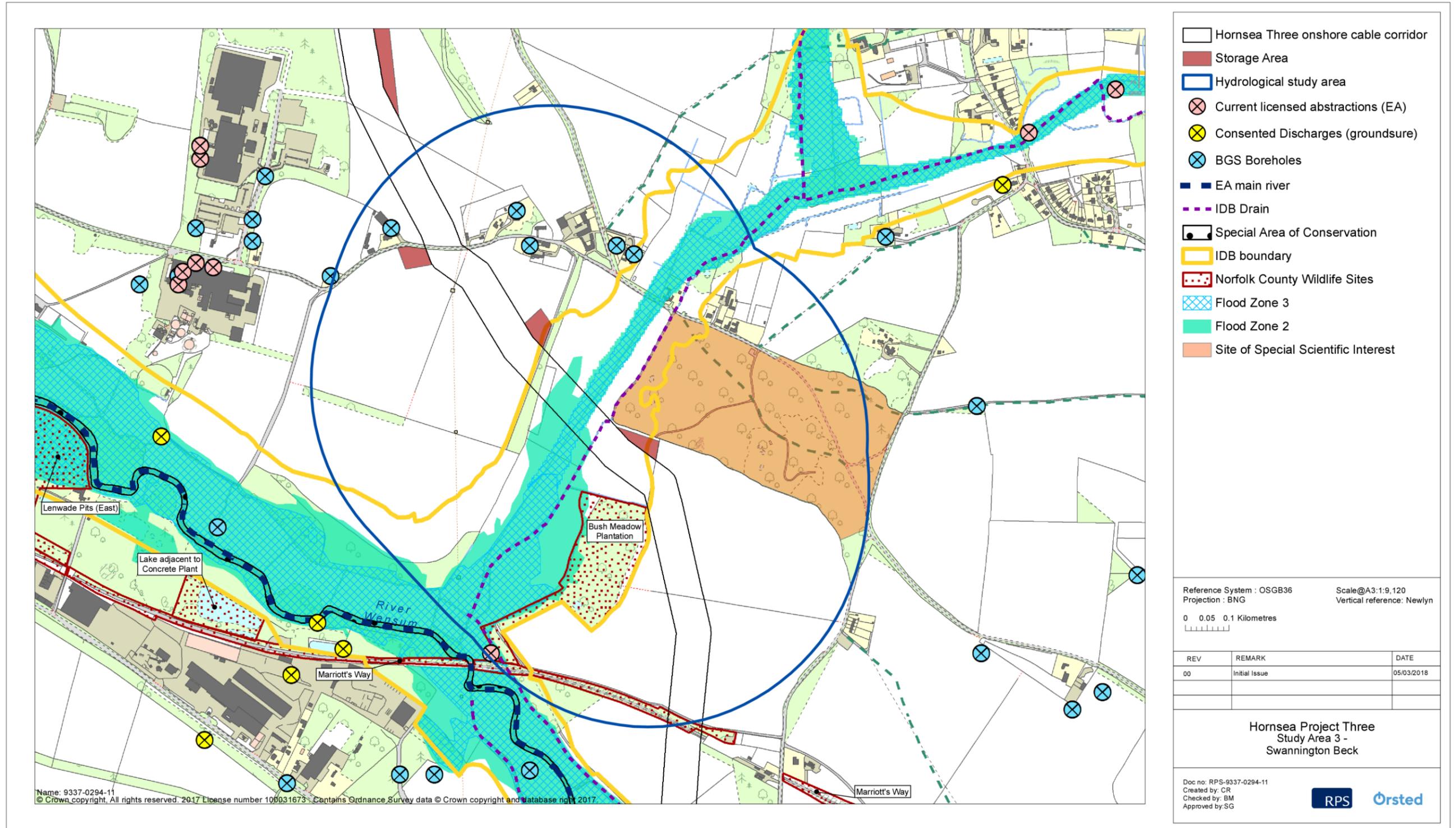


Figure 5.2: Study area 3 - Swannington Beck.

5.3 Ecological Aspects

Designated sites

Alderford Common SSSI

- 5.3.1.1 The SSSI is located adjacent to Swannington Beck in the centre of the study area and extends east and is bisected by the study area boundary. The site is roughly 17.5 ha, of which approximately 16.4 ha are in the study area. This SSSI is divided by Reepham Road.
- 5.3.1.2 Alderford Common includes a drainage ditch around the perimeter of the area, which would intercept any surface water runoff from the surrounding fields.
- 5.3.1.3 Alderford Common has gained a SSSI citation because of the following. The Common is situated on gently undulating ground and supports a wide range of habitats developed in response to variations in soils and topography. A thin layer of glacial sands and gravels cover the underlying chalk which is exposed in abandoned marl workings. A diverse chalk flora has developed in the old pits and the site forms the only remaining example of species-rich chalk grassland in East Norfolk. A bat roost and an outstanding assemblage of breeding birds provide additional interest. The habitats include scrub, woodland, bracken heath, marshy grassland and ponds. Chalk grassland occurs in the bottom of the marl-pits and many herb-species associated with the grassland are present. Damp hollows, on low-lying ground, have characteristic flora. Secondary woodland, open bracken heath and dense scrub surround the marl workings. Ponds are used as breeding sites by several species of amphibians including a small population of great crested newt (*Triturus cristatus*) and a small marshy area has developed around one of the ponds. The thick scrub provides suitable nesting sites for a wide range of breeding birds including the largest population of nightingales in East Norfolk. An old lime-kiln is used by bats both as a winter hibernating site and as a daytime roost during the summer.

Bush Meadow Plantation CWS

- 5.3.1.4 The CWS covers an area to the south of the study area and extends to approximately 4.8 ha.
- 5.3.1.5 This site is mature semi-natural woodland and with a small shaded pond with marginal vegetation. The woodland is predominantly oak and some field maple, some of which are coppiced along with hazel and occasional spindle.

Marriott's Way CWS

- 5.3.1.6 Approximately 0.3 ha of the CWS falls within the study area. The site is adjacent to the southern tip of Bush Meadow Plantation CWS.

Agri-environment Schemes

Environmental Stewardship Agreements

- 5.3.1.7 Alderford Common SSSI is managed in accordance with Higher Level Stewardship.

Habitats

Aquatic features

- 5.3.1.8 Swannington Beck is a small stream with a clean sandy/gravel bed and where it is not shaded, a range of marginal and aquatic plant species were present. Within the onshore cable corridor, it is more shaded to the north and more open and vegetated to the south.
- 5.3.1.9 There are a number of ponds in the study area, notably within Alderford Common SSSI and another in Bush Meadow Plantation CWS (target notes 1 and 7 respectively in Appendix B and sheet 3 of 8 in Appendix A). There are also a number of drains running parallel to and adjoining Swannington Beck, including a feeder ditch to the west of the Beck in a field where no access was possible.

Wetland

- 5.3.1.10 The very shallow river valley has marshy grassland between the Beck and feeder ditch and these became progressively wetter to the south west.

Grassland

- 5.3.1.11 The fields immediately adjacent to Swannington Beck are classified Floodplain Grazing Marsh in the Priority Habitat Inventory and the one field between the Beck and feeder channel is recorded as marshy grassland. The updated Phase 1 Habitat Survey notes the other grassland fields adjacent to Swannington Beck range from semi-improved grassland to improved. Land to the west of the Beck was not accessible but observed as probably being semi-improved grassland (see target note 5 Appendix B and sheet 3 of 7 Appendix A). Fields further from Swannington Beck are arable.

Woodland

- 5.3.1.12 Ploughed Meadow Plantation in the west of the study area, in addition to Alderford Common SSSI and Bush Meadow Plantation, are classified as areas of Deciduous Woodland in the Priority Habitat Inventory. This is confirmed in the Phase 1 Habitat Survey.

5.4 Hydrogeological aspects

Superficial deposits

- 5.4.1.1 The study area includes:
- Alluvium – clay, silt, sand and gravel;
 - Brickearth – clay, silt and sand;
 - Glaciofluvial Deposits, Mid Pleistocene – sand and gravel; and
 - Undifferentiated River Terrace Deposits – sand and gravel.

Aquifer status

5.4.1.2 The Brickearth is classified as Secondary B. All the other superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated aquifer.

Bedrock

5.4.1.3 The majority of the study area is underlain by Lewes Nodular Chalk with Wroxham Crag Formation at the peripheries, furthest from the Swannington Beck.

Aquifer status

5.4.1.4 The Chalk and Wroxham Crag Formation are classified as the Principle aquifers.

Expected ground conditions

5.4.1.5 Alluvium follows the direction of the river in a northeast southwest direction. River Terrace Deposits surround the alluvium on both sides of the river. Outcropping bedrock (described as chalk) surrounds the alluvium to the eastern part of the study area. Extending out from the crossing, outcrops of Wroxham Crag Formation and the Brickearth formation are seen on both flanks of the river.

5.4.1.6 A borehole 400 m north of the crossing indicates a very shallow extent of alluvium of only 0.6 m thick. This is followed by thin interbedded sand and gravel layers from the River Terrace Deposits extending to 2.7 m thick. Below these deposits is an interglacial clayey layer approximately with the chalk found at 17 m depth.

Licensed groundwater abstractions

5.4.1.7 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

5.4.1.8 No private groundwater abstractions were identified within the study area.

Water Framework Directive

5.4.1.9 The WFD unit underlying study area 3 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300).

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

5.4.1.10 The study area is not located within a SPZ.

5.5 Information from landowners

Swannington with Alderford and Little Witchingham Parish Councils

Location

5.5.1.1 Alderford Common is in the north east of the study area.

Agri-environment and single payment schemes

5.5.1.2 The land is managed under Higher Level Stewardship and is also a SSSI.

Hydrological/hydrogeological aspects, groundwater and flooding

5.5.1.3 There are four ponds in this area. The land is not waterlogged and is not susceptible to flooding.

Abstractions/discharge consents

5.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

5.5.1.5 The area comprises woodland and grassland.

5.6 Engineering considerations

Access

5.6.1.1 There are some existing access points to investigate further to support this HDD location. It is likely however, that access to both ends of the HDD drill would be through the onshore cable corridor.

Local utilities

5.6.1.2 A single low voltage wood pole over-head line crosses the onshore cable corridor just to the north of a land drain running parallel and to the north of the Beck.

Local drainage

5.6.1.3 The following are the drainage considerations for the Swannington Beck study area:

- There does not appear to be any public drainage services in the immediate vicinity of the crossing;
- There is a local ditch of similar size to the Swannington Beck located 60 m to the north of the Beck;
- The area to the north of the Beck appears to be a flood plain; and
- The proposed drill sites would be on firm ground.

Areas for further consideration

5.6.1.4 There are no existing local access tracks to the drill sites.

5.7 Initial environmental/engineering observations on design of the HDD crossing

- 5.7.1.1 The shallow valley within the onshore cable corridor is apparently only wet in a narrow strip between the Beck and the feeder channel to the west, although full access was not available.
- 5.7.1.2 The species-poor semi-improved grassland to the east of Swannington Beck and the arable field on west side of the river valley, were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound, other associated works and access (see Appendix A, Sheet 3 of 7). Note that the arable field further to the east of the Beck would also be a suitable location but would require a longer drill length. The Flood Zone along the bank of Swannington Beck will affect the position of the HDD construction compound. The compound areas will be positioned outside areas designated within Flood Zone 2 and 3. Where possible, construction activities and access would avoid the floodplain and associated wet habitats.
- 5.7.1.3 In consideration of areas suitable for HDD activities etc, the drill is likely to start from the northern side of the crossing. The drill and supporting equipment would be contained within a compound and the drill pits are likely to be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the southern end of the drill would be contained in a compound.
- 5.7.1.4 In consideration of the presence and proximity of existing features such as the ditch, Beck, flood plain, dense wooded area and access track, the drill is likely to span from a point in the grassed field to the south of the Beck and end to the north of the small access track beyond the tree boundary. A drill length of 280 m would be required to achieve the above. The maximum drill depth through this area is expected to be around 6 m. Drill depth below the wooded area is expected to be in excess of 4 m.
- 5.7.1.5 The potential crossing point of the beck is downstream of Alderford Common, reducing the potential for any surface runoff from the compound area to adversely affect the IDB drains. Measures to control surface runoff from compounds and work areas will be implemented (see section 10)
- 5.7.1.6 The species-poor grassland to the east of the Beck is positioned between the ponds within the SSSI and the CWS and is likely to be used as terrestrial habitat for foraging and commuting by great crested newts which are recorded as breeding in the SSSI. Appropriate pre-commencement precautions under licence will be required to temporarily clear this ground.

6. Study Area 4 – River Wensum

6.1.1.1 Study area 4 focuses on where the Hornsea Three onshore cable corridor crosses the River Wensum and is located just west of Attlebridge (Figure 6.3). Baseline information from the desk study and observations from the site visit are presented below.

6.2 Hydrological aspects

River Wensum

6.2.1.1 The River Wensum flows in a wide, open channel across the onshore cable corridor in a north west to south direction (Figure 6.1). The river was reasonably fast flowing at the time of the site visit, with a large volume of water within the channel. A number of field drains are located within the onshore cable corridor and discharge into the river. These field drains were slow flowing/stagnant at the time of the site visit and heavily vegetated.

6.2.1.2 The site is a flat river valley with a steeply sloping rise to the south of the river plain and gently rising to the northern end of the river plain. The ground is soft with areas of slightly boggy ground. Established hedgerows and trees line the banks of the local ditches.



Figure 6.1: River Wensum.

Other watercourses

6.2.1.3 No additional streams were identified during the site visit. A pond area is present immediately to the west of the onshore cable corridor (Figure 6.2). The area around the pond is boggy. Limited potential for infiltration within this area.



Figure 6.2: Pond to the west of the onshore cable.

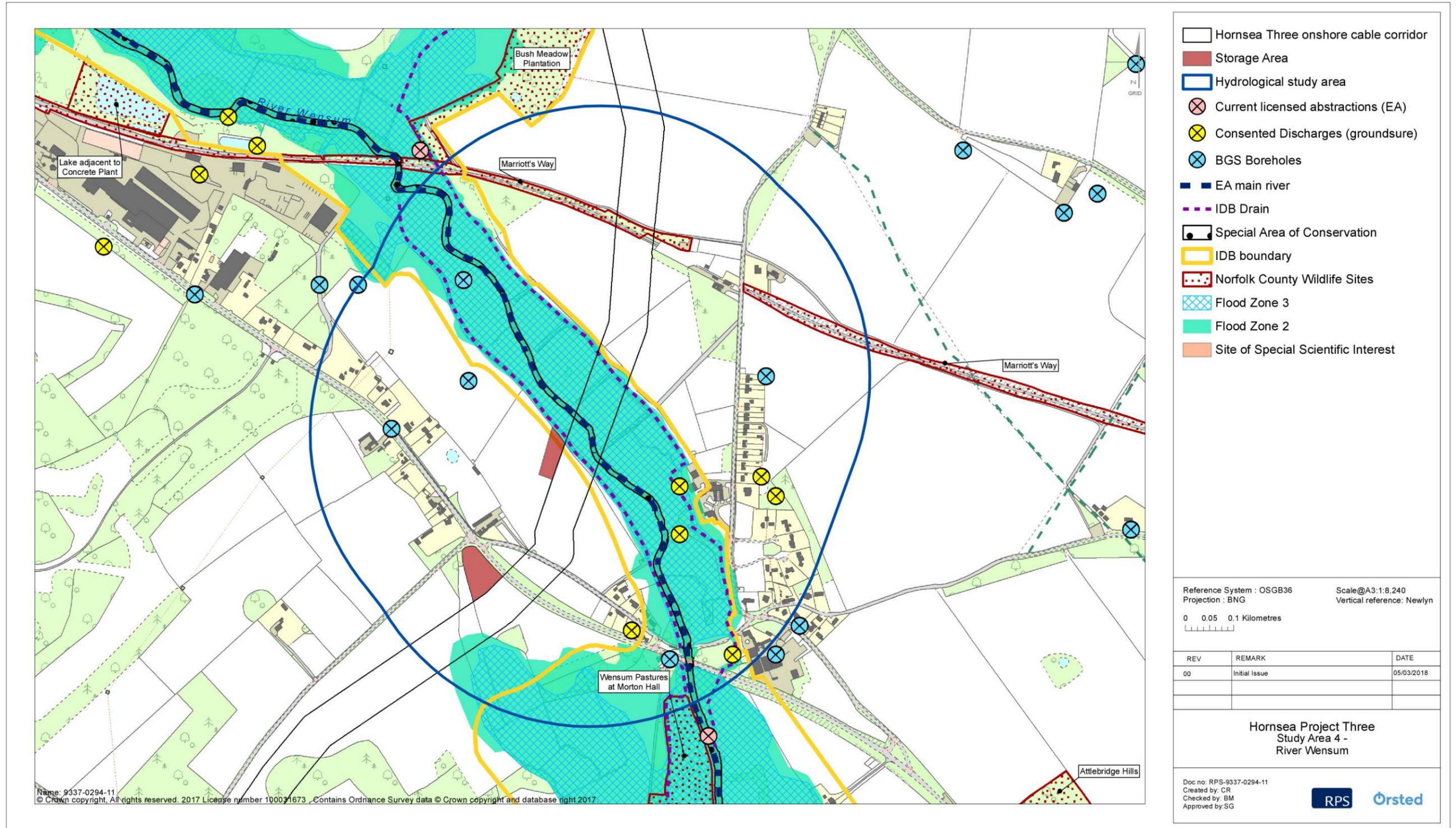


Figure 6.3: Study area 4 - River Wensum.

IDB drains

6.2.1.4 The IDB drain to the north of the River Wensum is an open cut channel and was slow moving at the time of the site visit (Figure 6.4). The IDB drain is a tributary of the River Wensum.



Figure 6.4: IDB drain tributary of the River Wensum.

Licensed surface water abstractions

6.2.1.5 There is one licensed surface water abstraction from the River Wensum, on the southern edge of the study area, where it crosses the River (E 612860, N 316580). This abstraction license is owned by Harold Jones Farms Ltd and is used for direct spray irrigation.

Private surface water abstractions

6.2.1.6 No private surface water abstractions were identified in the study area from the data received.

Discharge consents/environmental permits

6.2.1.7 There are a number of sewage discharge consents around the town of Attlebridge. Three of the consents relate to sewage disposal at Church Field (E 612800, N 317000), Ashtree Farm (N 612800, E 317100) and Church Farm House (N 612910, E 316750). Two of the consents discharge into the River Wensum and the latter into the tributary of the river. There are two domestic discharge consents at Meadow View (E 612700, N 316800), west of the River Wensum, for sewage and miscellaneous discharge to soakaways. There are also two domestic sewage discharge points (E 612970, N 317120) relating to land to the east of Attlebridge. In addition, upstream of the study area there are two consented discharge points associated with Atlas Works. One relates to a sewage disposal works (E 611800, N 317750) and the other for metal recycling sites (E 611860, N 317870).

6.2.1.8 A discharge pipe from a field drain immediately west of the onshore cable corridor was seen during the site visit however, no water was discharging at the time of the site visit (Figure 6.5).



Figure 6.5: Field drain west of the onshore cable corridor.

Water Framework Directive Objectives

6.2.1.9 The WFD water quality classifications for the River Wensum are as follows:

- Overall water body – Moderate;
- Ecological – Moderate; and
- Chemical – Good.

Flood risk

6.2.1.10 The land close to the River Wensum, inside the IDB boundary is generally in Flood Zone 3 with some areas of Flood Zone 2. To the south west of the study area, outside of the IDB boundary, the area around the drainage dykes is also classified as in Flood Zones 3 and 2.

Possible flood mitigation

6.2.1.11 The property immediately north east of the IDB drain may have flood mitigation built into the building design. A brick base has been built into the barns allowing around 1 m extra protection from flooding (Figure 6.6).



Figure 6.6: Flood defences built into barns.

6.3 Ecological aspects

Designated sites

River Wensum Special Area of Conservation and River Wensum Site of Special Scientific Interest

- 6.3.1.1 The river meanders from the north west to south east of the study area, through the onshore cable corridor.
- 6.3.1.2 In terms of the SSSI citation, the Wensum has been selected as one of a national series of rivers of special interest as probably the best example of an enriched, calcareous lowland river. The River Wensum is an enriched, calcareous lowland river with over one hundred species of plants, a rich invertebrate fauna and a relatively natural corridor. The upper reaches are fed by springs that rise from the chalk and by runoff from calcareous soils rich in plant nutrients, giving rise to dense beds of submerged and emergent vegetation. Much of the adjacent land is still traditionally managed for hay crops and by grazing, giving a wide spectrum of grassland habitats some of which are seasonally inundated. The mosaic of meadow and marsh habitats provides niches for a wide variety of specialised plants and animals.
- 6.3.1.3 The SAC citation is due to the Annex I habitats of water courses of plain to montane levels with the *Ranunculus fluitantis* and *Callitriche-Batrachion* vegetation.
- 6.3.1.4 In addition, Annex II species that are a primary reason for selection of this site is the White-clawed crayfish (*Austropotamobius pallipes*). Annex II species which present as a qualifying feature, but not a primary reason for site selection, are Desmoulin's whorl snail (*Vertigo moulinsiana*), Brook lamprey (*Lampetra planeri*), Bullhead (*Cottus gobio*).

Wensum Pastures at Morton Hall CWS

- 6.3.1.5 From the south, the CWS extends approximately 0.5 ha into the study area adjacent to the east bank of the River Wensum.
- 6.3.1.6 Predominately improved cattle-grazed pasture is adjacent to the River Wensum SSSI, and crossed by a network of drains supporting a species-rich flora associated with aquatic habitats. The site lies within the Broads Environmentally Sensitive Area and constitutes part of the Morton Estate. It lies on the flat Wensum floodplain and is subject to periodic flooding. Parts of the site are undulating in relief and ephemeral ponds form in some of the hollows. Low lying neutral grassland is dominated by coarse grasses to a short sward. At the peripheries, the vegetation is frequently taller and less intensively grazed and there are patches of damper grassland where finer herbs are frequent. The grassland is wetter towards the south eastern end of the site and there are tree lines and occasional trees and scrub scattered across the site. A low-lying loop adjacent to the river holds standing surface water and a flowing, tributary drain bisects the site, running parallel with the river, from which stems a network of lateral and sub-lateral drains. The drains hold standing surface water and support a species-rich marginal aquatic flora.

Marriott's Way CWS

- 6.3.1.7 The Marriott's Way CWS is a footpath which runs across the north of the study area, crossing the onshore cable corridor.
- 6.3.1.8 The CWS follows the alignment of a former railway. Much of the CWS is on acidic ground with light, sandy soil but plants also found in neutral and basic soils seem to occur alongside one another. Aspects vary along the path, with cuttings and embankments, different soils and the influence of water on the vegetation. Cuttings and embankments often have a more diverse flora or wetland plants and trees which may grow in damp or wet ground, often at the base of an embankment. Often loose stones, cinders and coal lie on embankment slopes, and, in places, fallen trees and shrubs help in the diversification of woodland habitats. Badger setts occur and bats are known to roost beneath bridges and use the route for commuting and foraging.

Agri-environment Schemes

- 6.3.1.9 There are no agri-environment schemes associated to land within the study area.

Habitats

Aquatic features

- 6.3.1.10 The section of the River Wensum within the onshore cable corridor has a series of in-channel and bank-side features, aquatic and marginal vegetation, vertical earth banks and gravel bars. The clean gravel bed supports swan mussel, with pool, riffle and glide sequences.

Wetland

- 6.3.1.11 The river valley has two slightly higher feeder channels and a series of wet ditches running through marshy grassland that is in places very wet, particularly to the south of the onshore cable corridor. Snipe were noted in two locations and also woodcock (target notes 2, 9 and 11 in Appendix B).

Grassland

- 6.3.1.12 The area of Wensum Pastures at Morton Hall CWS in the study area, and the land between drainage dykes running parallel to the River Wensum, is classified as Floodplain Grazing Marsh in the Priority Habitat Inventory. In the updated Phase 1 Habitat Survey the majority of higher fields of permanent grassland in between Fakenham Road and Marriott's Way are improved, with the lower valley grassland marshy. Fields outside of this area are generally in arable use.

Woodland

- 6.3.1.13 There are pockets of woodland categorised as Deciduous Woodland in the Priority Habitat Inventory where Fakenham Road crosses the River Wensum to the south east of the site. To the north of the study area is mixed deciduous and coniferous woodland surrounding the Marriott's Way, some of which is categorized as Deciduous Woodland in the Priority Habitat Inventory.

6.4 Hydrogeological aspects

Superficial deposits

6.4.1.1 The study area includes:

- Alluvium – clay, silt, sand and gravel;
- Brickearth – clay, silt and sand;
- Glaciofluvial Deposits, Mid Pleistocene – sand and gravel; and
- Undifferentiated River Terrace Deposits – sand and gravel.

Aquifer status

6.4.1.2 The Brickearth is classified as Secondary B. All the other superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated aquifer.

Bedrock

6.4.1.3 The study area is split between the Lewes Nodular Chalk of the White Chalk Subgroup and the Wroxham Crag Formation. The majority of the study area is Lewes Nodular Chalk with Wroxham Crag Formation at the peripheries, furthest from the River Wensum.

Aquifer status

6.4.1.4 The Chalk and Wroxham Crag Formation are classified as Principle aquifers.

Licensed groundwater abstractions

6.4.1.5 There are no licensed abstractions within the study area.

Private groundwater abstractions

6.4.1.6 No private groundwater abstractions have been identified within the study area.

Water Framework Directive

6.4.1.7 The WFD unit underlying study area 4 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

6.4.1.8 The study area is not located within a SPZ.

6.5 Information from landowners

Ash Tree Farm, Station Road

Location

6.5.1.1 The fields between the River Wensum and Station Road, around Ashtree Farm, in the centre of the study area.

Agri-environment and single payment schemes

6.5.1.2 The land is not managed under any schemes. However, a SSSI management plan will be in place for the river.

Hydrological/hydrogeological aspects, groundwater and flooding

6.5.1.3 All of the stream, drains, etc. hold water all year round. The land can be wet depending on the weather. The land near the river is susceptible to flooding, and last flooded in 2015.

Abstractions/discharge consents

6.5.1.4 There is an abstraction point at Marriot's Way in the north of the study area.

Land use

6.5.1.5 The land is used as arable farmland and pasture.

6.6 Engineering considerations

Access

6.6.1.1 Good access roads exist to the south of the river crossing site, both of which cross the Hornsea Three onshore cable corridor and could be used for access to the drill site. Access to the north side of the river and drill site would be from the onshore cable corridor.

Local utilities

6.6.1.2 To the south of the river crossing there are wood pole overhead lines and also an underground low voltage cable crossing the river within the onshore cable corridor heading in a north easterly direction.

6.6.1.3 BT and water utilities serving the local village run on either side of the local roads to the south of the river crossing.

Local drainage

6.6.1.4 Apart from the river crossing, there are three established ditches that cross the onshore cable corridor each having established hedgerows/trees along their length. There does not appear to be any public drainage services in the immediate vicinity of the drill sites.

6.6.1.5 The surfaces of fields beyond the flood plain were firm. However, the ground within the flood plain was found to be soft.

Areas for further consideration

6.6.1.6 Unknown depth of the low voltage cable crossing below the river and within the onshore cable corridor.

6.7 Initial environmental/engineering observations on design of the HDD crossing

6.7.1.1 The river valley within the onshore cable corridor is wet, particularly to the south near the road crossing. The river, the feeder channels, ditches and marshy grassland are ecologically sensitive and hydrologically linked.

6.7.1.2 The slightly higher improved grassland to the south west and north east of the valley bottom is of much less ecological interest and drier and relatively level. These improved grassland fields on either side of the river valley were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 4 of 7). In consideration of areas suitable for HDD activities, the HDD drill is likely to start at the southern end. The drill and supporting equipment would be contained within a compound and the drill pits are likely to be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the northern end of the drill would be contained in a compound.

6.7.1.3 Where possible, HDD compounds will be located outside Flood Zones 2 and 3. Storage areas and secondary construction compounds have been sited outside Flood Zone 3 (and where possible, Flood Zone 2). Measures from the Outline CoCP (document reference A8.5) will be implemented to control the use of these areas and to minimise the risk of surface water runoff.

6.7.1.4 All construction activities and access would avoid Flood Zones 2 and 3 wherever possible and the associated wet habitats and in particular, an appropriate buffer strip between the route corridor and the SAC should be observed. In consideration of the presence of the above features the HDD drill is likely to span from a point in the grassed field to the south of the river (near to the existing overhead wood pole lines) to a grassed field north of the flood plain. A drill length of approximately 420 m would be required to achieve the above. The maximum drill depth through this area is expected to be around 12 m.

7. Study Area 5 – River Tud

7.1.1.1 Study area 5 focuses on where the Hornsea Three onshore cable corridor crosses the River Tud and is located just north of Easton (Figure 7.2). Baseline information from the desk study and observations from the site visit are presented below.

7.2 Hydrological aspects

River Tud

7.2.1.1 The River Tud flows in an open channel across the onshore cable corridor in an east west direction (Figure 7.1). The width of the channel is between 1.5 m and 2 m and at the time of the site visit it was relatively fast flowing.

7.2.1.2 The topography at the crossing site is flat across the river plain but rises steeply to the north of the river. South of the river plain the ground rises steeply for a short distance before levelling off to arable land.



Figure 7.1: River Tud.

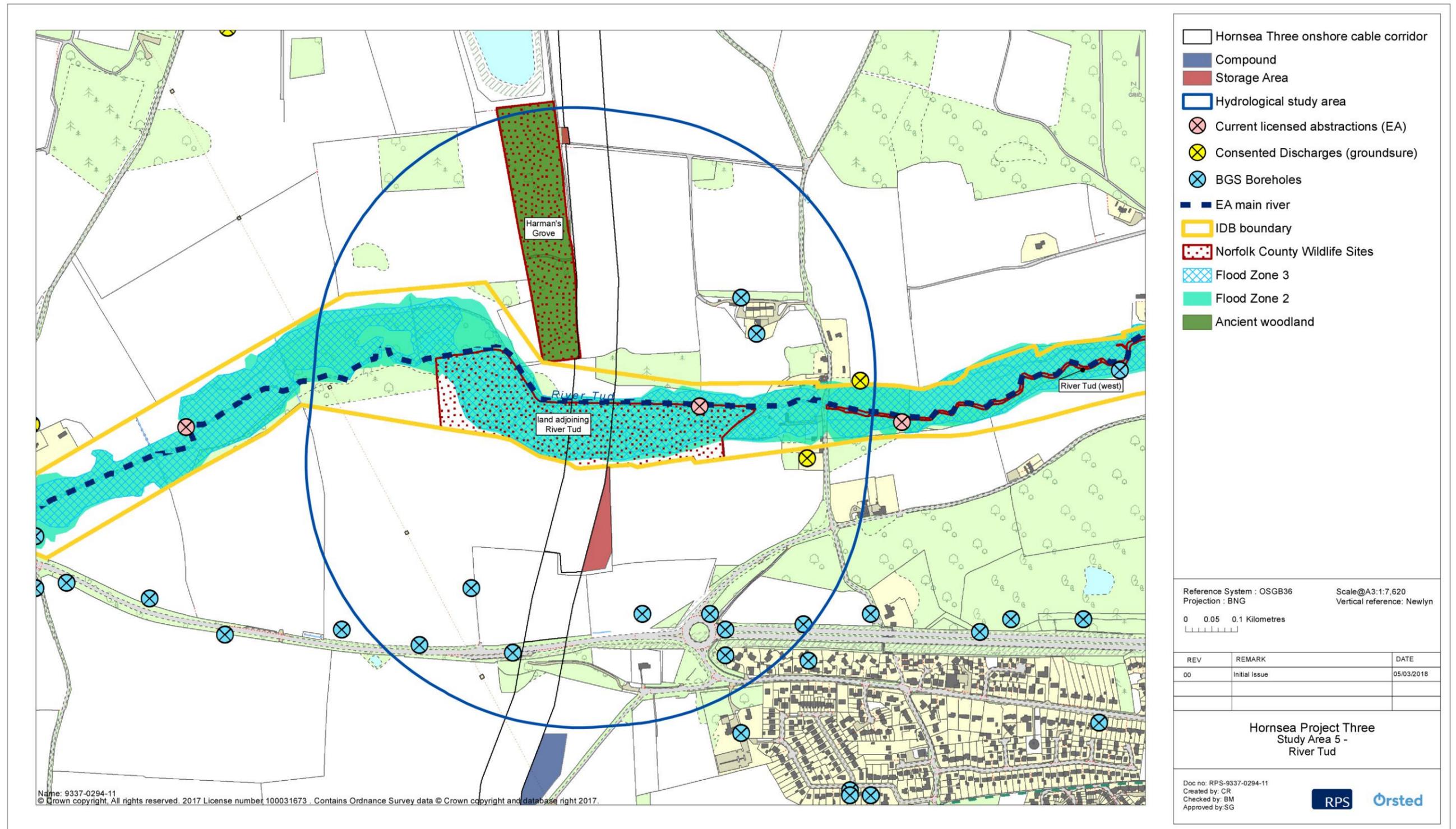


Figure 7.2: Study area 5 - River Tud.

Other watercourses

7.2.1.3 To the south of the River Tud, there is a network of field drains which intercept surface water from the agricultural land (see Figure 7.3). The field drains were slow flowing/still at the time of the site visit.



Figure 7.3: Field drains in the study area 5.

Licensed surface water abstractions

7.2.1.4 In the study area, there are two licensed abstractions from the River Tud, which are operated by Honingham Aktieselskab (Easton Estates). Both are located in between the onshore cable corridor and Ringland Road (E 613110, N 311470) (see Figure 7.4). One is used for direct spray irrigation and one is used extracting water to storage prior to spray irrigation.



Figure 7.4: Licensed abstractions from the River Tud.

Private surface water abstractions

7.2.1.5 No private surface water abstractions have been identified from the data received.

Discharge consents/environmental permits

7.2.1.6 There are two discharge consents in this study area (see Figure 7.2). One at Ford Cottage (N 613317, E 311370), south of the River Tud, and grants consent to discharge to a tributary of the river. The other at Riverside Farm (N 613420, E 311520), north of the River Tud, grants consent to discharge to the river. Both relate to domestic sewage.

Water Framework Directive Objectives

7.2.1.7 The WFD water quality classifications for the River Tud are as follows:

- Overall water body – Moderate;

- Ecological – Moderate; and
- Chemical – Good;

Flood risk

7.2.1.8 The majority of land inside the IDB boundary around the River Tud is in Flood Zones 2 and 3. Most is Flood Zone 3 with some small areas of Flood Zone 2.

7.3 Ecological aspects

Designated sites

Adjacent to River Tud CWS

7.3.1.1 The CWS is located immediately to the south of the river. The site consists of rough pasture and a large area of wet meadow overgrown with greater pond sedge. Several drainage ditches traverse the CWS and these hold the main botanical interest. The rough pasture lies mainly to the south of the main ditch and at the west end of the site. Some lengths of ditch have become overgrown but elsewhere the vegetation in the ditches and along the banks is generally species-rich.

Harman's Grove CWS

7.3.1.2 The CWS is located to the north of the River Tud, with the majority within the study area. The total area is approximately 4.5 ha, of which 3.9 ha are located in the study area.

7.3.1.3 The site is described as semi-natural ancient woodland. Species present include a range of broad-leaved species and the occasional conifer. The understory comprises dense tall ruderals and bramble. Access was not permitted at the time of the site visit and it had to be viewed from Weston Road.

Agri-environment Schemes

Environmental Stewardship Agreements

7.3.1.4 Almost the entire study area is included in Entry Level Stewardship. Church Plantation to the south east of the study area is included in Higher Level Stewardship.

Habitats

Aquatic features

7.3.1.5 The River Tud is a fast-flowing river with a clean gravel bed. It has a range of emergent and submerged aquatic plant species, including crowfoot and bur-reed, amongst others. It is a good quality watercourse with a calcareous influence.

7.3.1.6 There are two ponds in the study area: one to the west of the Adjacent to River Tud CWS, the other is to the west of Lower Easton. Both are close to the River Tud. There are also a number of drains in the Adjacent to River Tud CWS which may provide diverse aquatic habitat.

Wetland

7.3.1.7 There are small but notable areas of wetland to the north of the river outside of the CWS including areas of sedge bed close to the river and larger areas to the west and eastern edges of the onshore cable corridor. Frog spawn was noted in two locations (target notes 1 and 3 in Appendix B).

Grassland

7.3.1.8 The whole of the Adjacent to River Tud CWS is categorized as Floodplain Grazing Marsh in the Priority Habitat Inventory and recorded in the updated Phase 1 as marshy grassland. As noted above, this marshy grassland also extends in places to the north bank of the river.

Woodland

7.3.1.9 There are four main areas of woodland habitat in the study area categorised as Deciduous Woodland in the Priority Habitat Inventory. Including Harmon's Grove, which is also classified as Ancient Replanted Woodland.

7.4 Hydrogeological aspects

Superficial deposits

7.4.1.1 The study area includes:

- Alluvium – clay, silt, sand and gravel;
- Alluvial fan deposits – clay and silt;
- Undifferentiated Happisburgh Glaciogenic Formation and Lowestoft Formation – sand and gravel; and
- Lowestoft Formation – Diamicton.

Aquifer status

7.4.1.2 All the superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated.

Bedrock

7.4.1.3 The study area includes:

- Undifferentiated Lewes Nodular Chalk Formation;
- Seaford Chalk Formation;
- Newhaven Chalk Formation;
- Culver Chalk Formation; and
- Portsdown Chalk Formation.

Aquifer status

7.4.1.4 The chalk bedrock is classified as a Principle aquifer.

Expected ground conditions

7.4.1.5 Alluvium follows the direction of the river (east-west) through the centre of the site. From a borehole record, approximately 1 km to the east of the crossing, the thickness of the alluvium is less than 1 m overlying a gravel layer of the Leet Hill Sand and Gravel Member which is approximately 7 m thick. Below these superficial deposits is the Upper Chalk. Boreholes to north-north-east of the study area Upper Chalk was found to be 7-17 m deep overlain by clayey sandy till. To the south, bedrock was not encountered in any of the boreholes.

Licensed groundwater abstractions

7.4.1.6 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

7.4.1.7 No private groundwater abstractions were identified within the study area from the data received.

Water Framework Directive

7.4.1.8 The WFD unit underlying study area 5 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

7.4.1.9 Land in the western and northern parts of the study area are located within zone III (total catchment) of a SPZ. The remainder of the study area and the crossing point of the River Tud are not located within an SPZ.

7.5 Information from landowners

Hall Farm, Kenningham

Location

7.5.1.1 A small area of the land is on the most westerly edge of the study area.

Agri-environment and single payment schemes

7.5.1.2 The land is managed under Higher Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

7.5.1.3 No additional hydrological features. Adjacent to the river is wet most of the year and is susceptible to flooding. The last flood was February 2017.

Abstractions/discharge consents

7.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land in the study area.

Land use

7.5.1.5 Land close to the River Tud is used for grazing and land further from the river is used as arable land.

Easton Estates

Location

7.5.1.6 Easton Estates owns the majority of the land in the study area, excluding those areas mentioned above and other residential locations.

Agri-environment and single payment schemes

7.5.1.7 The land is managed under Entry Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

7.5.1.8 The ditches in the meadows next to river hold water most of the year. The land in the marshes adjacent to river is wet most of the year and the same area floods most winters.

Abstractions/discharge consents

7.5.1.9 The landowner has two abstractions consents from the River Tud.

Land use

7.5.1.10 The land is used for grazing (grassland adjacent to river) and is arable on surrounding fields.

7.6 Engineering considerations

Access

7.6.1.1 Access to both sides of the crossing drill would be through the onshore cable corridor. There are no local farm tracks or roads in the near vicinity of the crossing.

Local utilities

7.6.1.2 There are no utility services within the study area.

Local drainage

7.6.1.3 No public drainage services were identified in the immediate vicinity of the drill sites. The proposed drill sites are on firm ground. Much of the onshore cable corridor in this area is very wet saturated ground.

Areas for further consideration

7.6.1.4 Points to consider:

- No local access tracks to the drill sites; and
- The general area of the flood plain is very wet.

7.7 Initial environmental/engineering observations on design of the HDD crossing

7.7.1.1 The river valley within the study area 5 (Figure 7.2) is waterlogged, particularly south of the River Tud in the CWS, with marshy grassland and associated ditches, which are ecologically sensitive and hydrologically linked to the river.

7.7.1.2 The slightly higher improved and semi-improved grassland to the north of the valley bottom are of less botanical interest but may require further botanical survey later in the survey season, if the scheme may affect them.

7.7.1.3 The arable fields on either side of the river valley were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 5 of 7). In consideration of areas suitable for HDD activities, the HDD drill would start from the southern side of the river. The drill and supporting equipment would be contained within a compound and the drill pits would be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the northern end of the drill would be contained in a compound.

7.7.1.4 Where possible, HDD compounds will be located outside Flood Zones 2 and 3. (primarily to the south of the river) and its associated habitats. In consideration of the presence and proximity of existing features such as the flood plain and dense wooded area, it is likely that the HDD drill would span from a point in arable land to the south of the flood plain to arable land located north of the dense wooded area. A drill length of indicatively 250 m would be required to achieve the above. The maximum drill depth through this area would be approximately 6 m. Drill depth below the wooded area would be approximately 3 m.

7.7.1.5 The botany of the ditches within the CWS may also require further survey if directly affected, as a wide range of aquatic plant species were noted in the walkover.

8. Study Area 6 – River Yare

8.1.1.1 Study area 6 focuses on where the Hornsea Three onshore cable corridor crosses the River Yare and is located approximately 1 km east of Marlingford and 1 km west of Bawburgh (Figure 8.3). Baseline information from the desk study and observations from the site visit are presented below.

8.2 Hydrological aspects

River Yare

8.2.1.1 The River Yare flows in a wide, open channel across the onshore cable corridor (Figure 8.1). The river is relatively fast flowing with a large volume of water within the channel. The study area contains a number of field drains which discharge into the River Yare. At the time of the site visit the field drains within the onshore cable corridor were slow flowing/stagnant and heavily vegetated.

8.2.1.2 The topography surrounding the river banks is gently sloping and the terrain starts to rise approximately 20 m from the bank. To the north of the river the terrain slopes gently towards the Bawburgh Road. The ground is soft to firm grassland.

8.2.1.3 To the south of the river the onshore cable corridor passes a steep sided hill which forms an obstacle around which the onshore export cable corridor would be routed.

8.2.1.4 There are established hedgerows and trees to the edges of the access track.



Figure 8.1: River Yare.

Other watercourses

8.2.1.5 A number of field drains are present within the onshore cable corridor including a stream which runs parallel to river to the north. At the time of the site visit, the field drains were relatively slow flowing with vegetation across the banks (see Figure 8.2).



Figure 8.2: Field drain in study area 6.

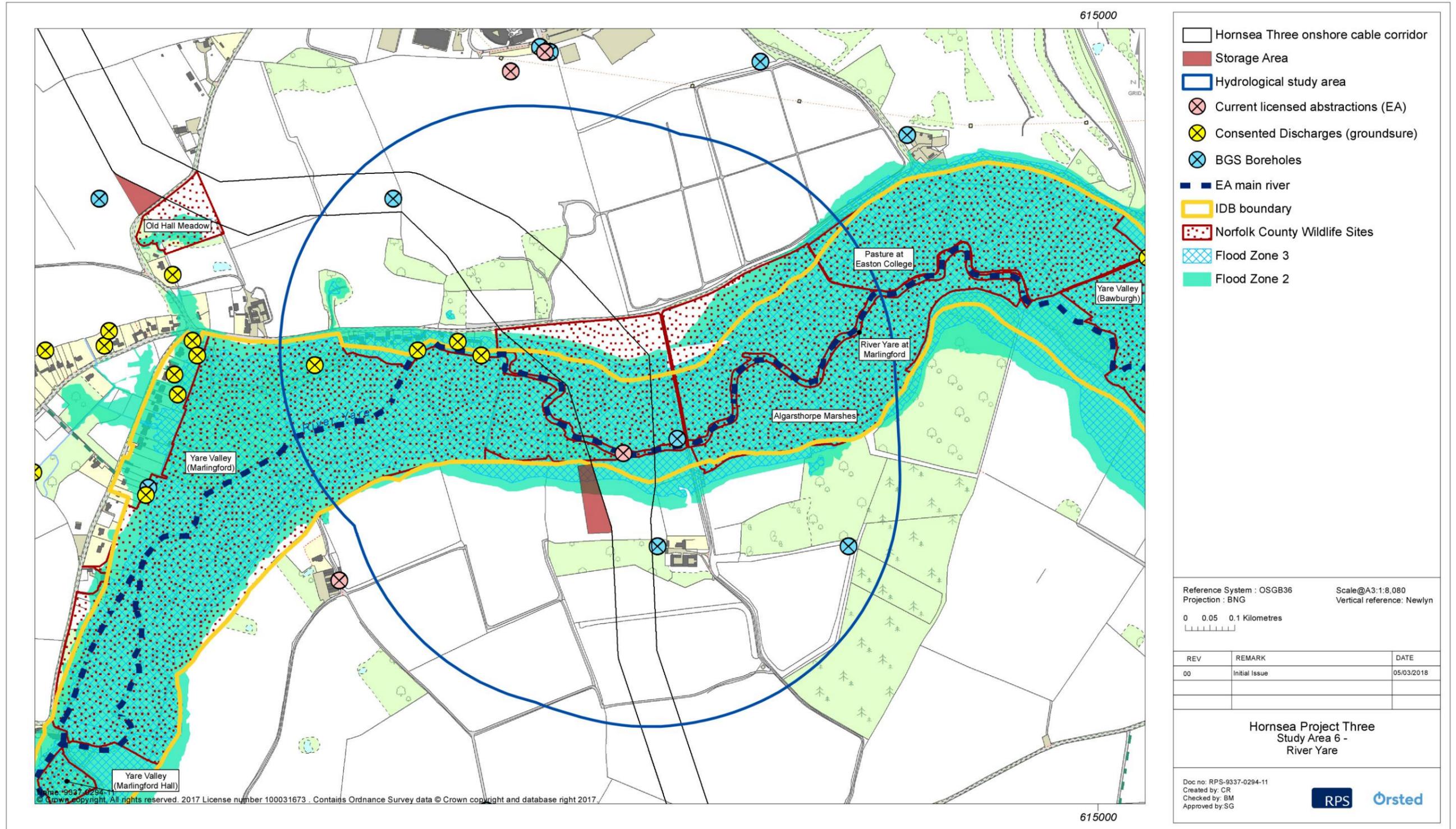


Figure 8.3: Study area 6 - River Yare.

Licensed surface water abstractions

- 8.2.1.6 There is one licensed surface water abstraction from the River Yare (Figure 8.4). It is located at the centre of the study area, west of the bridge across the River Yare, within the onshore cable corridor (E 614030, N 308920). This abstraction point is owned by Great Melton Farms Ltd and is used for direct spray irrigation.



Figure 8.4: Licensed surface water abstraction at the River Yare.

Private surface water abstractions

- 8.2.1.7 The data received did not identify any private surface water abstractions in the study area.

Discharge consents/environmental permits

- 8.2.1.8 Within the boundary of the study area are two domestic discharge consent points to the River Yare (E 613740, N 309120 and E 613692, N 309148) and one to a tributary of the river further upstream, outside of the study area (E 613400, N 309100).

Water Framework Directive Objectives

- 8.2.1.9 The WFD water quality classifications for the River Yare are as follows:
- Overall water body – Moderate;
 - Ecological – Moderate; and
 - Chemical – Good.

Flood risk

- 8.2.1.10 Close to the River Yare there are areas in Flood Zone 3 and 2. The area at risk of flooding extends approximately 30 m further from the river and generally mirrors the area of the IDB boundary. The majority of the areas at risk of flooding are in Flood Zone 3, with only isolated areas of Flood Zone 2. Available information indicates that a flood in this area affected the land which is currently classified as Flood Zone 3.

8.3 Ecological aspects

Designated sites

Yare Valley (Marlingford) CWS

- 8.3.1.1 The CWS extends into the study area to within the onshore cable corridor from the east and includes the River Yare, surrounding drainage dykes and grassland. The total area of the CWS is approximately 36 ha, with 6 ha in the study area.
- 8.3.1.2 This site comprises a diverse range of habitats situated on flat land either side of the River Yare. Much of the grassland within the site is grazed but the woodland areas, marsh and tall fen all appear unmanaged. Areas of marshy grassland are generally found close to the river. Several drains cross through the grassland and where the grassland areas are grazed a more varied flora has developed, particularly close to the drains. Further from the river are areas of grassland which have been improved. Fen vegetation is found to the north of the site and there are a number of ponds in the CWS within the onshore cable corridor.

Easton College Water Meadows CWS

- 8.3.1.3 The site occupies the land between the River Yare and Bawburgh Road in the north east of the study area. The site is approximately 11.5 ha, including 1.7 ha within the study area.
- 8.3.1.4 This is a large area of water meadows with wet ditches. The soils are dark and silty. The site varies though is generally damp or wet. The two westernmost parts of the CWS are the most botanically diverse. North of the east-west ditch vegetation grows in variable patches. The area between the two east-west ditches has an area of tall vegetation. The most easterly part is a very wet, wide area, with much standing water. The northern edge bordering the road is relatively dry and species-poor. There is a network of wet ditches across the CWS, some more botanically diverse than others. Most of the ditches are fringed with a wide border of tall vegetation, often two or three plants. The River Yare is a broad and high watercourse within the CWS, bordered with a wide band of grey willow. Some of the ground is very wet, though drier parts also occur. Some of the trees have blown over, with a clump of five joined fallen poplars in the centre of the CWS. A long hedge borders the road as well as tall shrubs. Frequent signs of otter have been reported and signs of water vole have been found in the past.

Algarsthorpe Marshes CWS

- 8.3.1.5 The site occupies three parcels of land west of Marlingford adjacent to the River Yare either side on of the track section of Bawburgh Road, which runs north to south in the centre of the study area. The site is approximately 23.6 ha, of which 21.6 ha are within the study area.
- 8.3.1.6 In the northern area of the site, the land rises up to the road and here the soils are sandy and the grassland semi-improved and relatively species poor. In the southern area of the site, there are areas of grazing marsh with damp peaty soils. West of the track, the most dominant grass species is perennial rye-grass which is abundant. East of the track and south of the river the diversity is in general similar to west of the track with a similar assemblage and in its eastern half the ground conditions are slightly damper. Both ditches and scrapes occur across the grazing marsh, which may seasonally contain areas on standing water. Some ditches are also spring fed. Adjacent to the ditches and scrapes, more localized areas of more diverse flora occur due to the damper soil conditions. A small pond is present east of the road and south of the river. Its banks are dominated by reed species. Stretches of hedgerows occur either side of the central track, along the northern boundary adjacent to the road and along the southern boundary east of the track. The River Yare flows west-east through the site and in general its bed is silty/sandy although gravel sections occur frequently along its length.

River Yare at Marlingford CWS

- 8.3.1.7 The site consists of a section of the River Yare. The site runs from just west of where the River Yare crosses the track section of Bawburgh Road, which runs north to south in the centre of the study area, to the Bawburgh parish boundary, just east of the study area. The site is approximately 1.5 ha, of which 0.9 ha are within the study area.
- 8.3.1.8 It is listed for its species-rich marginal and riverine flora, presence of 10 species of fish, including eel and relatively natural physical features. The river has a fairly natural appearance, meandering through grazing marshes. Trees and scrub stand in the eastern third and at the western end. The flow is generally steady, but speeds up occasionally where stones break the surface and divert the water around them. The depth varies across the channel and also along its length. Several berms/beaches occur, some are small and sandy while others are wider and muddier, the result of cattle accessing the river. Bankside trees overhang the river to the east creating a shadier section of the site. Several species of aquatic vegetation throughout the site, as well as assemblages of terrestrial plants along the banks. Trees edge the river in the eastern third of the site.

Agri-environment Schemes

Environmental Stewardship Agreements

- 8.3.1.9 The whole of the study area is included in Entry Level and Higher Level Stewardship.

Habitats

Aquatic features

- 8.3.1.10 The River Yare is a wide clear watercourse with a fast flow and strongly vegetated margins and a range of submerged and emergent in-channel vegetation. A good range of watercourse features, including vertical earth banks and gravel bars, riffle and glide sections.
- 8.3.1.11 Close to the River Yare, to the east of the study area, there are a number of ponds which are likely to be seasonal in nature and/or weather dependent. There is also a seasonal pond to the west within the onshore cable corridor (see target note 3 sheet 6 of 7 Appendix A). Drains leading to, or running parallel to the River Yare also provide aquatic habitats and are generally overgrown with a range of aquatic plant species.

Wetland

- 8.3.1.12 The designated wetlands upstream and downstream of the River Yare crossing are noted as being of higher quality mosaics of wetland habitats. Within the onshore cable corridor there are wetter areas of grassland along the valley floor. Snipe were observed in two locations (target note 6 and 8 Appendix B).

Grassland

- 8.3.1.13 In the study area the fields north of Algarsthorpe Farm and all the fields between the River Yare and the parallel drains are classified as Floodplain Grazing Marsh in the Priority Habitat Inventory. The updated Phase 1 Habitat Survey records these valley bottom fields as marshy grassland, with the higher level grassland mostly as improved.

Woodland

- 8.3.1.14 There are four main areas of woodland within the study area: Cobb's Grove Plantation in the north; The Glade abutting the River Yare in the centre of the study area; the Yare Valley (Marlingford) CWS; and Beech Grove in the south. All are broadleaved woodland classified in the Priority Habitat Inventory as Deciduous Woodland.

8.4 Hydrogeological aspects

Superficial deposits

- 8.4.1.1 The study area includes:
- Alluvium – clayey, silty sand with some evidence of peat;
 - River Terrace Deposits – sand and gravel deposits;
 - Sheringham Formation – interbedded sand and gravel layers;
 - Lowestoft Formation – sand and gravel; and
 - A small area of Lowestoft Formation – Diamicton.

Aquifer status

8.4.1.2 All the superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated.

Bedrock

8.4.1.3 The study area includes:

- Undifferentiated Lewes Nodular Chalk Formation;
- Seaford Chalk Formation;
- Newhaven Chalk Formation;
- Culver Chalk Formation; and
- Portsdown Chalk Formation.

Aquifer status

8.4.1.4 The chalk bedrock is classified as a Principle aquifer.

Expected ground conditions

8.4.1.5 Alluvium follows the direction of the river (east west) through the centre of the site. Peat is evident along the course of the river but is unlikely to present a significant resource due to its limited thickness (approximately 2.4 m thick at a nearby borehole location). Surrounding this is the Sheringham formation except to the west where the river terrace deposits are seen. There are outcrops of the Lowestoft Formation and the Lewes Nodular Chalk Formation. The Sheringham formation was found to have a thickness of 6.4 m and the upper chalk was underlying the superficial deposits at 9 m depth (at a nearby borehole).

Licensed groundwater abstractions

8.4.1.6 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

8.4.1.7 The data received to date does not identify any private groundwater abstractions in the study area.

Water Framework Directive

8.4.1.8 The WFD unit underlying study area 6 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

8.4.1.9 Land within the study area to the north of the River Yare is located within zone I (inner protection zone) of a SPZ. Land to the south of the river is not within a SPZ.

8.5 Information from landowners

Great Melton Farms

Location

8.5.1.1 This land consists of the majority of the study area south of Bawburgh Road apart from Easton College Water Meadows CWS in the north east.

Agri-environment and single payment schemes

8.5.1.2 The land is managed under Entry Level plus Higher Level Stewardship.

Hydrological/hydrogeological aspects, groundwater and flooding

8.5.1.3 Other than the river there are no hydrological features of note. The flood plains near the river are susceptible to flooding and do so most winters. The same area is wet for the majority of the year.

Abstractions/discharge consents

8.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

8.5.1.5 The land is pasture used for grazing.

8.6 Engineering considerations

Access

8.6.1.1 Access is limited, but there are existing access points which would be considered.

Local utilities

8.6.1.2 A BT/telecom service exists on a wood pole line connecting to the local farm.

8.6.1.3 Anglian Water has two services in the vicinity of the onshore cable corridor. One of these outfalls into the river on its northern bank. The other crosses below the river and eventually crosses into the onshore cable corridor in the area of the proposed crossing before continuing in a southerly direction.

Local drainage

- 8.6.1.4 There is a 1 m deep ditch running across the onshore cable corridor to the north of the river and crossing location. There are local ponds adjacent to the onshore cable corridor. Other ditches exist to the south of the river within the study area. On the higher ground, the ground was firm, but wet and soft in places close to the river.

Areas for further consideration

- 8.6.1.5 The size and depth of the Anglian Water service is unknown and could have an impact on the depth and width of the proposed crossing.

8.7 Initial environmental/engineering observations on design of the HDD crossing

- 8.7.1.1 The river valley within the study area 6 (Figure 8.3) features marshy grassland and associated ditches habitats, which are ecologically sensitive and hydrologically linked to the two CWSs upstream and downstream of the crossing point.
- 8.7.1.2 The slightly higher improved grassland fields on either side of the shallow valley were identified by the environmental/engineering team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 6 of 7). In consideration of areas suitable for pipe welding etc, it is likely that the drill would start from the southern side of the crossing. The drill and supporting equipment would be contained within a compound and drill pits would be contiguous across approximately 60 m of the Hornsea Three onshore cable corridor. The reception pit at the northern end of the crossing would be contained in a compound.
- 8.7.1.3 Where possible, HDD compounds, will be located outside Flood Zones 2 and 3. Storage areas and secondary construction compounds have been sited outside Flood Zone 3 (and where possible, Flood Zone 2). Measures from the Outline CoCP (document reference A8.5) will be implemented to control the use of these areas and to minimise the risk of surface water runoff
- 8.7.1.4 A drill length of indicatively 400 m would be required to achieve the above. The maximum drill depth through this area would be approximately 6 m.

9. Study Area 7 – Intwood Stream

9.1.1.1 Study area 7 focuses on where the Hornsea Three onshore cable corridor crosses the Intwood Stream and extends from Small Wood to the Norwich Main Substation (Figure 9.3). Baseline information from the desk study and observations from the site visit are presented below.

9.2 Hydrological aspects

Intwood Stream

9.2.1.1 Intwood Stream flows northwards in a small channel varying in depth (pictured in Figure 9.1). The channel had a constant flow during the site visit. A number of field drains discharge into the Intwood Stream, however most are located within the study area rather than the onshore cable corridor.

9.2.1.2 The land is generally flat around the stream and associated flood plain rising to the east and west beyond the flood plain. Land on the bank of the stream comprises firm grassland used for grazing of cattle.



Figure 9.1: Intwood Stream.

Location of tributary

9.2.1.3 There is a stream which flows from the west of the study area, inside the onshore cable corridor, through Spruce's Plantation, until it joins Intwood Stream in the north of the study area (pictured in Figure 9.2). The stream is open cut with a constant flow of water within the channel. The topography from the banks is flat lying grassland.



Figure 9.2: Tributary of Intwood Stream.

Licensed surface water abstractions

9.2.1.4 The data received to date did not identify any licensed or private surface water abstractions in the study area.

Discharge consents/environmental permits

9.2.1.5 There are two sewage network pumping stations owned by Anglian Water Services which have discharge consents located at Intwood Stream (E 619676, N 303055 and E 619700, N 303100), west of Swardeston Common, upstream of the onshore cable corridor. There are a further two discharge consents at Keswick Barn, downstream of the onshore cable corridor - one for sewage works (E 619910, N 304080) and one for other discharges (E 619900, N 304000).

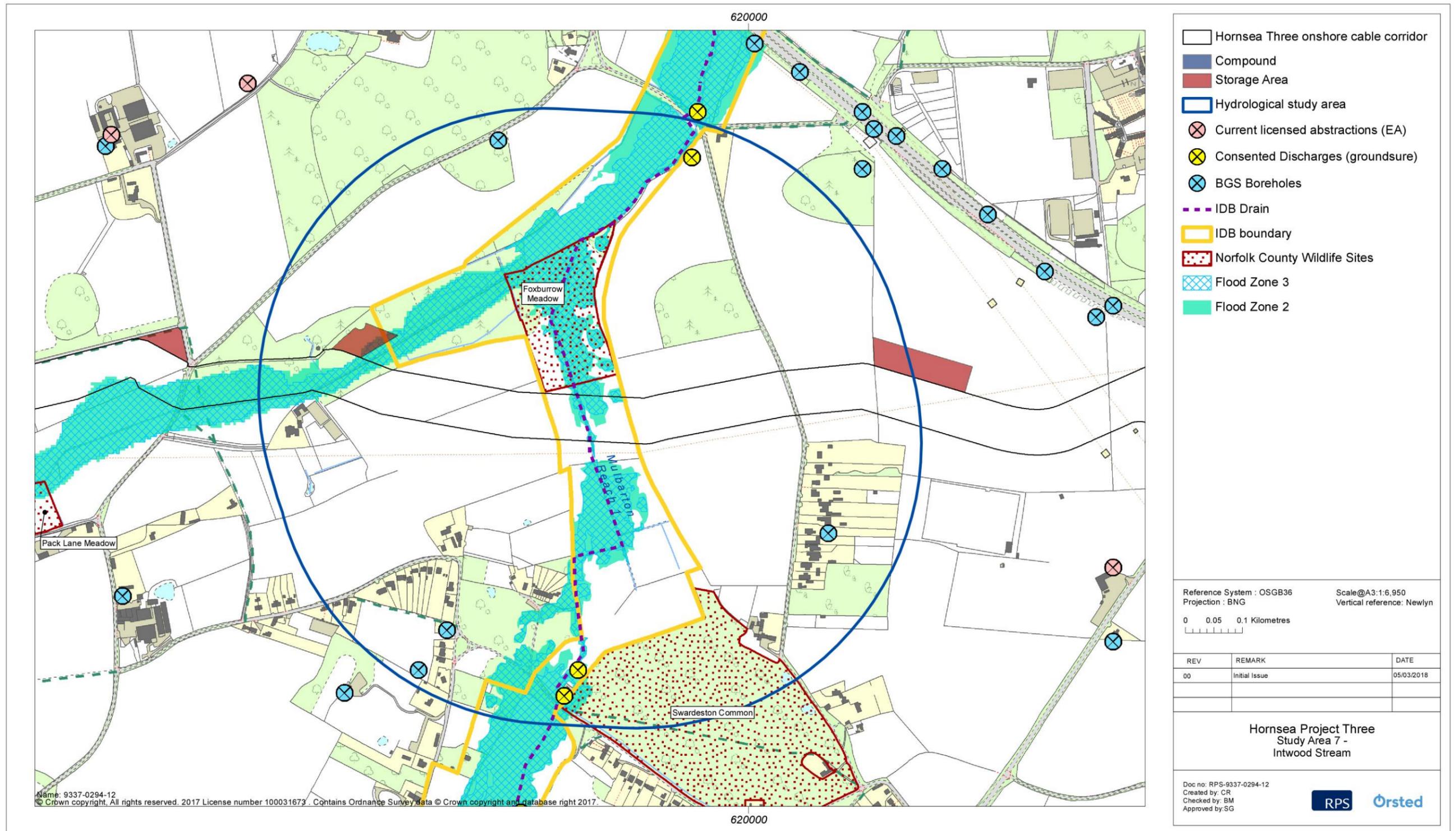


Figure 9.3: Study area 7 - Intwood Stream.

Water Framework Directive Objectives

9.2.1.6 The WFD water quality classifications for Intwood Stream are as follows:

- Overall water body – Moderate;
- Ecological – Moderate; and
- Chemical – Good.

Flood risk

9.2.1.7 Land close to Intwood Stream primarily falls within Flood Zone 3 with isolated areas of Flood Zone 2. Most of the flood risk areas associated with Intwood Stream fall inside of the IDB boundary (see Figure 9.3).

9.3 Ecological aspects

Designated sites

Foxburrow Meadow County Wildlife Site (CWS)

9.3.1.1 The meadow extends north from outside the boundary of onshore cable corridor into the wider study area. The total area of Foxburrow Meadow is approximately 3.4 ha.

9.3.1.2 Foxburrow Meadow is a small area of marshy grassland, patches of tall herb fen, scrub and scattered trees. The CWS is bisected by Intwood Stream which flows into another watercourse along the northern boundary.

Swardeston Common CWS

9.3.1.3 Swardeston Common CWS falls outside the onshore cable corridor but is located within the study area. The total area of Swardeston Common is approximately 11 ha with approximately 5.8 ha located in the south of the study area.

9.3.1.4 The CWS is an area of common land that has been left relatively unmanaged resulting in the development of coarse grassland and dense scrub. Recent clearance work has left a mosaic of these habitats together with areas of disturbed ground and tall ruderal vegetation.

Agri-environment Schemes

Countryside Stewardship Agreement

9.3.1.5 The field in the north east of the study area, south of Swardeston Lane, is managed in accordance with Countryside Stewardship Mid-Tier.

Environmental Stewardship Agreements

9.3.1.6 The field surrounding Foxburrow Plantation, the field to the south of Intwood Lane (in the north of the study area) and Foxburrow Meadow CWS are managed in accordance with Entry Level and Higher Level Stewardship. Swardeston Common CWS are managed in accordance Higher Level Stewardship.

Habitats

Aquatic features

9.3.1.7 The section of the Intwood Stream has a good range of in-channel vegetation and a clean gravelly channel bottom with sandy patches (see Figure 9.4 below).



Figure 9.4: Aquatic features of Intwood Stream.

9.3.1.8 There are several small ponds in the study area. One pond is located in the north east corner of Foxburrow Meadow and three further ponds are located south of the onshore cable corridor, between Intwood Stream and Lower East Carleton. The Intwood Stream also has several drains discharging into it.

Wetland

9.3.1.9 The west of Swardeston Common and the northern half of Foxburrow Meadow are classified in the Priority Habitat Inventory as Lowland Fens. The Foxburrow Meadow CWS and the low-lying fields within the onshore cable corridor are recorded as marshy grassland in the updated Phase 1 Habitat Survey (see Appendix A, Sheet 7 of 7).

Grassland

9.3.1.10 The fields to the north of Swardeston Common containing tributary drains to Intwood Stream, together with fields abutting Intwood Stream (in the north of the study area), and the south of Foxburrow Meadow are classified in the Priority Habitat Inventory as Floodplain Grazing Marsh. These areas are reported as a mix of marshy grassland and drier semi-improved grassland in the updated Phase 1 Habitat Survey. The adjoining fields on higher ground are in arable use.

Woodland

9.3.1.11 The study area includes zones of woodland classified in the Priority Habitat Inventory as Deciduous Woodland. The Phase 1 Habitat Survey adds more information indicating that Foxburrow and Spruce's plantations are dense mixed woodland and pine plantation, respectively.

9.4 Hydrogeological aspects

Superficial deposits

9.4.1.1 The study area includes:

- Alluvium – clayey silt, sand;
- Sheringham Cliffs Formation – gravelly sand to sandy gravel which appears to have limited vertical extent; and
- Lowestoft Formation – chalky till.

Aquifer status

9.4.1.2 All the superficial deposits are classified as either Secondary A aquifer or Secondary Undifferentiated aquifer.

Bedrock

9.4.1.3 The study area includes:

- Undifferentiated Lewes Nodular Chalk Formation;
- Seaford Chalk Formation;
- Newhaven Chalk Formation;
- Culver Chalk Formation; and
- Portsdown Chalk Formation.

Aquifer status

9.4.1.4 The Chalk and Wroxham Crag bedrock is classified as a Principal aquifer.

Expected ground conditions

9.4.1.5 Shallow ground conditions are likely to comprise highly variable layers of sand and clay with varying amounts of interbedded gravels. Deeper materials consist of poorly sorted sands and gravels overlying deeper chalks and possibly flints.

Licensed groundwater abstractions

9.4.1.6 There are no licensed groundwater abstractions within the study area.

Private groundwater abstractions

9.4.1.7 No private groundwater abstractions were identified in the study area.

Water Framework Directive

9.4.1.8 The WFD unit underlying study area 7 is the Broadland Rivers Chalk and Crag Unit (GB40501G400300). The classifications are as follows:

- Current quantitative quality – Poor;
- Groundwater dependent terrestrial ecosystems – Poor; and
- Impact on surface waters – Good.

Source Protection Zone

9.4.1.9 The study area is not located within a SPZ.

9.5 Information from landowners

Dairy Farmhouse, Low Common

Location

9.5.1.1 Dairy Farm and the associated field to the east.

Agri-environment and single payment schemes

9.5.1.2 The landowner indicates that the land is not included in agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

9.5.1.3 There are no hydrological or hydrogeological features (e.g. streams or springs) on their land within the study area. The land is not wet for most of the year and is not susceptible to flooding.

Abstractions/discharge consents

9.5.1.4 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

9.5.1.5 The land is used for grazing horses.

Gowthorpe Manor, Gowthorpe Lane

Location

9.5.1.6 Swardeston Common and the land south of Dairy Farm and north of Low Common.

Agri-environment and single payment schemes

9.5.1.7 According to the landowner (contrary to what is indicated by www.MAGIC.gov.uk), the land is not managed under any agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

9.5.1.8 There are ponds on Swardeston Common. The land is wet for most of the year and can become very marshy in places.

Abstractions/discharge consents

9.5.1.9 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

9.5.1.10 The land is used for recreational use including pitches/playing fields.

Blackthorn Farm, The Common

Location

9.5.1.11 Blackthorn Farm and two associated fields to the north.

Agri-environment and single payment schemes

9.5.1.12 The landowner indicates that the land is not included in agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

9.5.1.13 No streams, springs or drainage ditches. The land is not susceptible to flooding although it is muddy during the winter.

Abstractions/discharge consents

9.5.1.14 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

9.5.1.15 The land is used as pasture for grazing horses.

Address unknown

Location

9.5.1.16 The triangular strip of land with Intwood Stream to the east, The Drift (road) to the west, and Low Common (road), to the north.

Agri-environment and single payment schemes

9.5.1.17 The landowner indicates that the land is not included in agri-environment or single payment schemes.

Hydrological/hydrogeological aspects, groundwater and flooding

9.5.1.18 Intwood Stream extends the full length of the land. There is also a pond which dries out during summer. According to the landowner, the land is not susceptible to flooding and is generally not wet throughout the year.

Abstractions/discharge consents

9.5.1.19 The landowner is not aware of any abstractions or discharge consents on their land within the study area.

Land use

9.5.1.20 The land is grassland which is not currently used for anything.

9.6 Engineering considerations

Access

9.6.1.1 Access to both ends of the HDD drill would likely be through the onshore cable corridor. It is likely that the stream will have to be culverted (or similar) to allow plant and personnel to cross between the ends of the drill.

Local utilities

9.6.1.2 A single low voltage wood pole over-head line exists to the south and extends parallel to the onshore cable corridor. A natural gas line also runs south of the over-head line and parallel to the onshore cable corridor.

Local drainage

9.6.1.3 No public drainage services were observed in the immediate vicinity of the drill sites. The flood plain area is very soft and wet. The proposed drill sites would be on firm ground beyond the flood plain.

Areas for further consideration

9.6.1.4 There are no existing local access tracks to the drill sites.

9.7 Initial environmental/engineering observations on design of the HDD crossing

9.7.1.1 The stream valley within the onshore cable corridor is wet and includes a number of ecologically sensitive and hydrologically-linked habitats (i.e. Foxburrow Meadow CWS, Intwood Stream and its associated ditches, ponds and marshy grassland).

9.7.1.2 The arable fields on either side of the shallow valley were identified by the team as suitable and appropriate locations to be considered for the HDD compound and other associated works and access (see Appendix A, Sheet 7 of 7). In consideration of areas suitable for pipe welding etc, it is likely that the HDD drill would start from the eastern side. The drill and supporting equipment would be contained within a compound and the drill pits would be contiguous across approximately 60 m of the onshore cable corridor. The reception pit at the western end of the drill would be contained in a compound.

9.7.1.3 Where possible, HDD compounds will be located outside Flood Zones 2 and 3. Storage areas and secondary construction compounds have been sited outside Flood Zone 3 (and where possible, Flood Zone 2). Measures from the Outline CoCP (document reference A8.5) will be implemented to control the use of these areas and to minimise the risk of surface water runoff

9.7.1.4 Due to the extent and condition of the flood plain it is proposed that the HDD include both the stream and associated flood plain. This would result in a drill length of approximately 160 m, with a depth of approximately 6 m.

9.7.1.5 The work undertaken to date has not identified any hydrological constraints within the onshore cable corridor that would affect HDD crossing techniques being used for the Intwood Stream and its tributaries.

9.7.1.6 A drill length of indicatively 400 m would be required to achieve the above. The maximum drill depth through this area would be approximately 6 m.

10. Summary

- 10.1.1.1 This annex was prepared in response to comments from the Environment Agency and Natural England which indicated that further consideration should be given to the hydrological processes of the River Wensum and the potential impacts from the construction of the Hornsea Three onshore cable corridor. The scope of the report was expanded to include other crossing locations of Environment Agency designated main rivers and watercourses managed by Norfolk Rivers IDB that were located close to ecologically designated sites. A buffer of 500 m was delineated around these crossing locations and they formed the study areas.
- 10.1.1.2 The scope of this annex was agreed with the Onshore Ecology Expert Working Group which included representatives from the Environment Agency, Natural England, Norfolk County Council, Norfolk Wildlife Trust, North Norfolk District Council, Broadland District Council, South Norfolk District Council and the RSPB.
- 10.1.1.3 A review of desk based information was undertaken of the study areas to identify the location of designated sites and hydrological and hydrogeological receptors. This was supplemented by a Phase 1 habitat survey and a site visit involving an experienced ecologist, hydrologist and engineers to identify any site specific constraints that needed to be taken into account in the design of the crossing methodologies.
- 10.1.1.4 The report has identified a number of ecologically important sites within the study areas that are closely linked to watercourses and underlying groundwater. Hydrologically dependant habitats and in some cases (groundwater dependent habitats) have evolved and many provide habitats for protected species. These ecological sites are sensitive to the quality and available resource of the rivers and streams identified in the report and the underlying groundwater.
- 10.1.1.5 The design of the Hornsea Three onshore cable corridor has been refined since the original scope of the Hydrological Characterisation Note was agreed with the Onshore Ecology Expert Working Group. A key influence in the design decisions has been to avoid or reduce potential impacts of construction on ecologically designated sites and hydrological receptors. As a result, all of the crossing locations identified in this report will be constructed using HDD techniques. The location and extent of the HDDs have been designed to avoid the main channel of the watercourses and also key tributaries and streams and designated ecology habitats. Where possible, areas in the Flood Zone 2 and 3 have also been avoided. The proposed HDD crossing for each of the study areas is provided in Appendix C.
- 10.1.1.6 Mitigation measures to manage potential impacts of the HDD are set out in the Outline CoCP (document reference A8.5). It includes commitments to undertake investigations at each HDD crossing location to confirm the local ground conditions and to identify an appropriate stand-off between the hard bed of the watercourse and the upper layers of the chalk aquifer. Sediment and pollution control measures will be implemented for compounds, storage areas and work areas to minimise potential impacts to watercourses. A bentonite break-out plan and crossing-specific method statements will be prepared for each of the watercourse crossing locations identified in this report. These method statements will take into account site-specific conditions (e.g., adaptations to the bentonite break-out plan for crossings in wet woodland areas where break-out may be difficult to locate). Other watercourse crossings will be undertaken in accordance with a general crossing method statement. Outline versions of these documents accompany the Outline CoCP (document reference A8.6) and will be developed further during the detailed design stage.

Appendix A Updated Phase 1 Habitat Survey

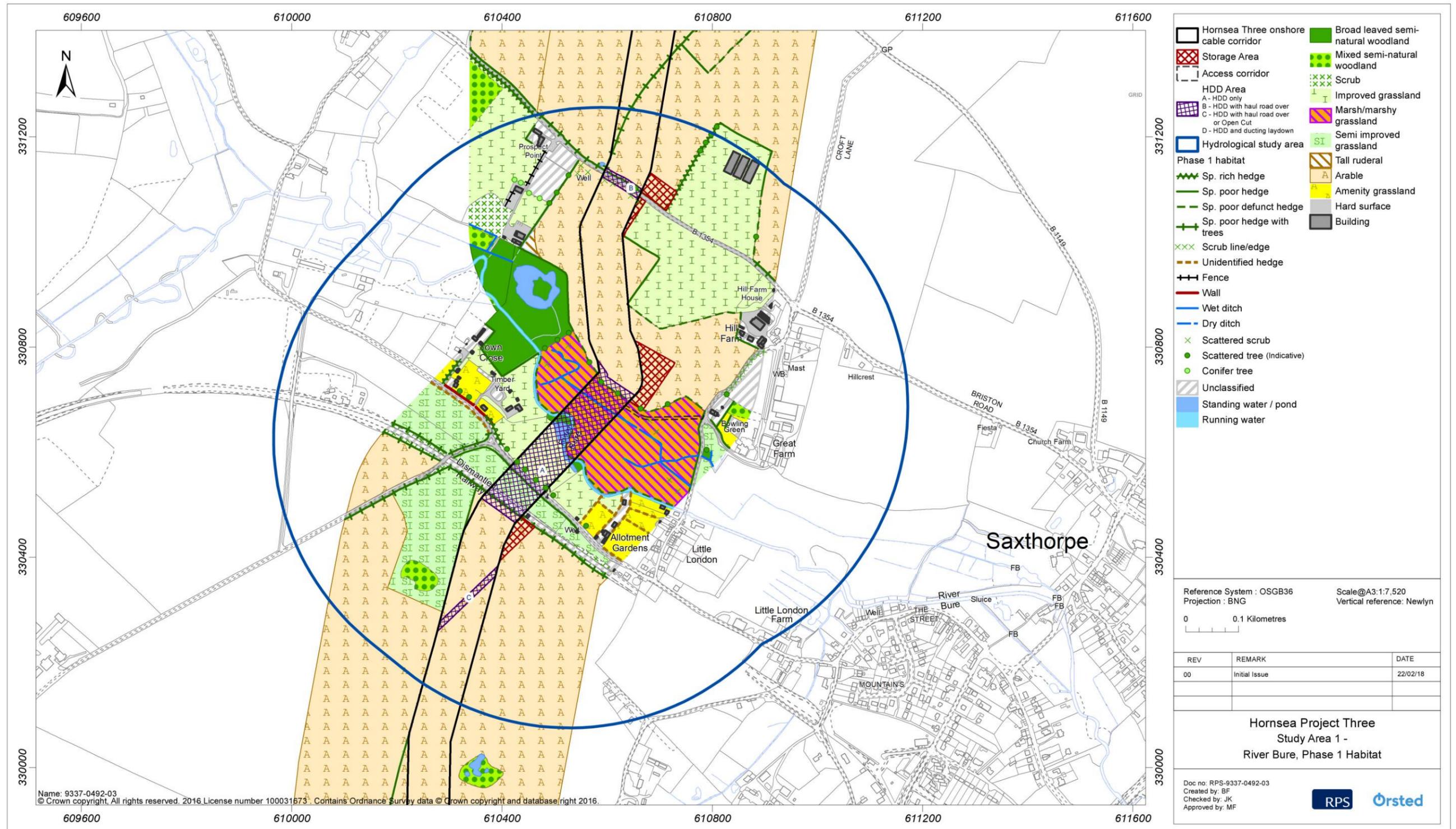


Figure A.10.1: Hydrological study area 1 - River Bure, Phase 1 habitat.

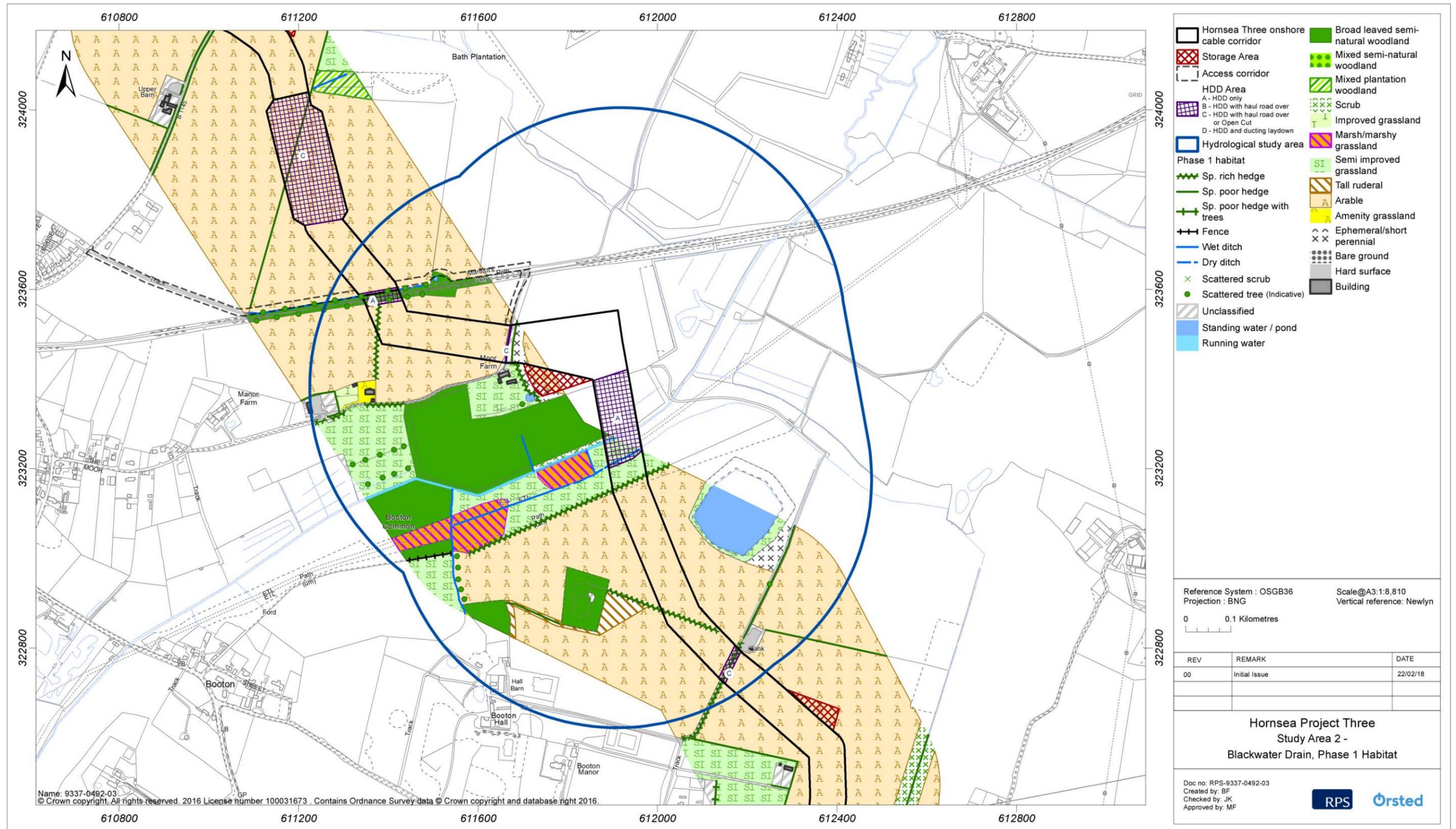


Figure A.10.2: Hydrological study area 2 – Blackwater Drain, Phase 1 habitat.



Figure A.10.3: Hydrological study area 3 – Swannington Beck, Phase 1 habitat.

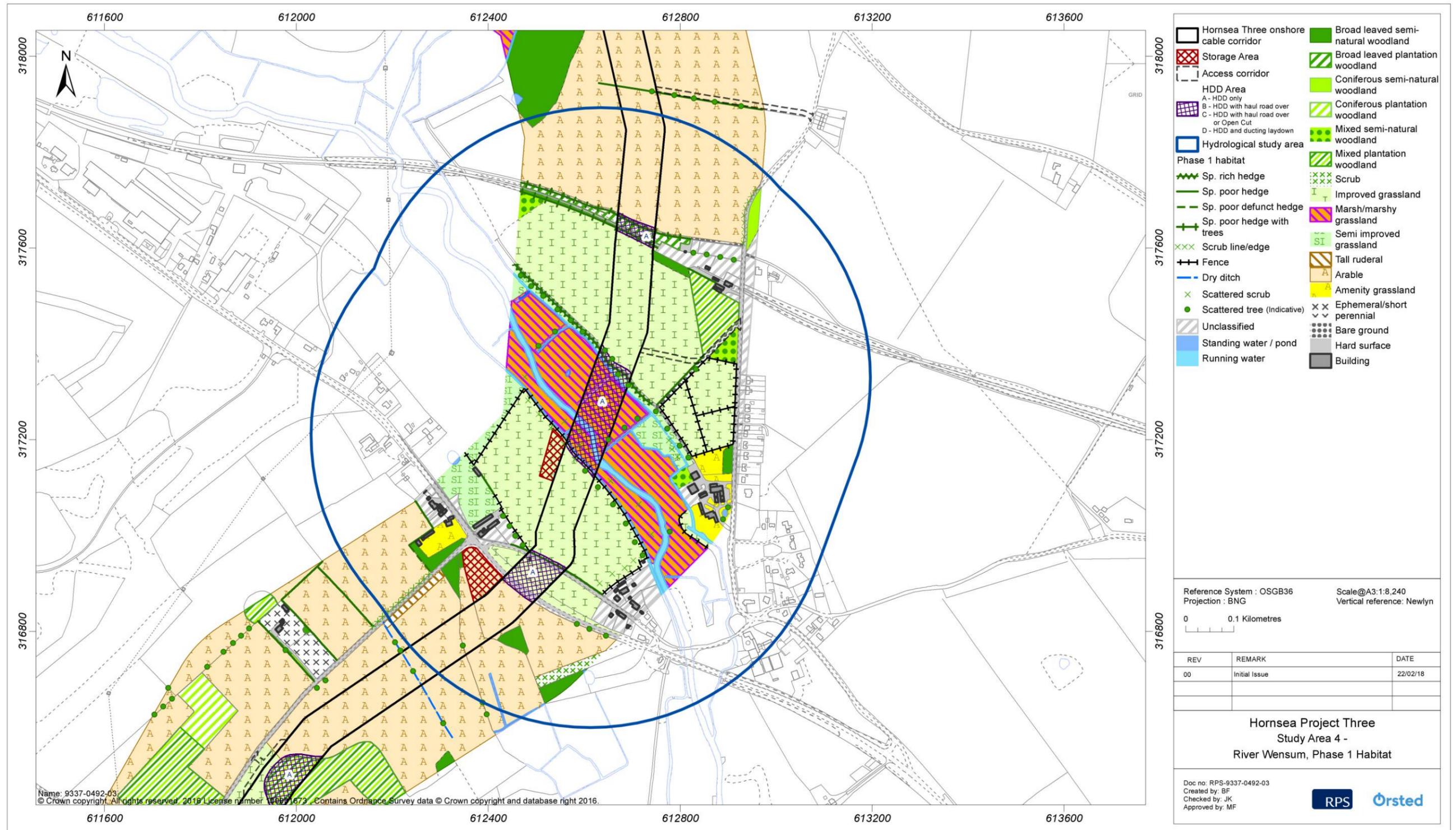


Figure A.10.4: Hydrological study area 4 – River Wensum, Phase 1 habitat.

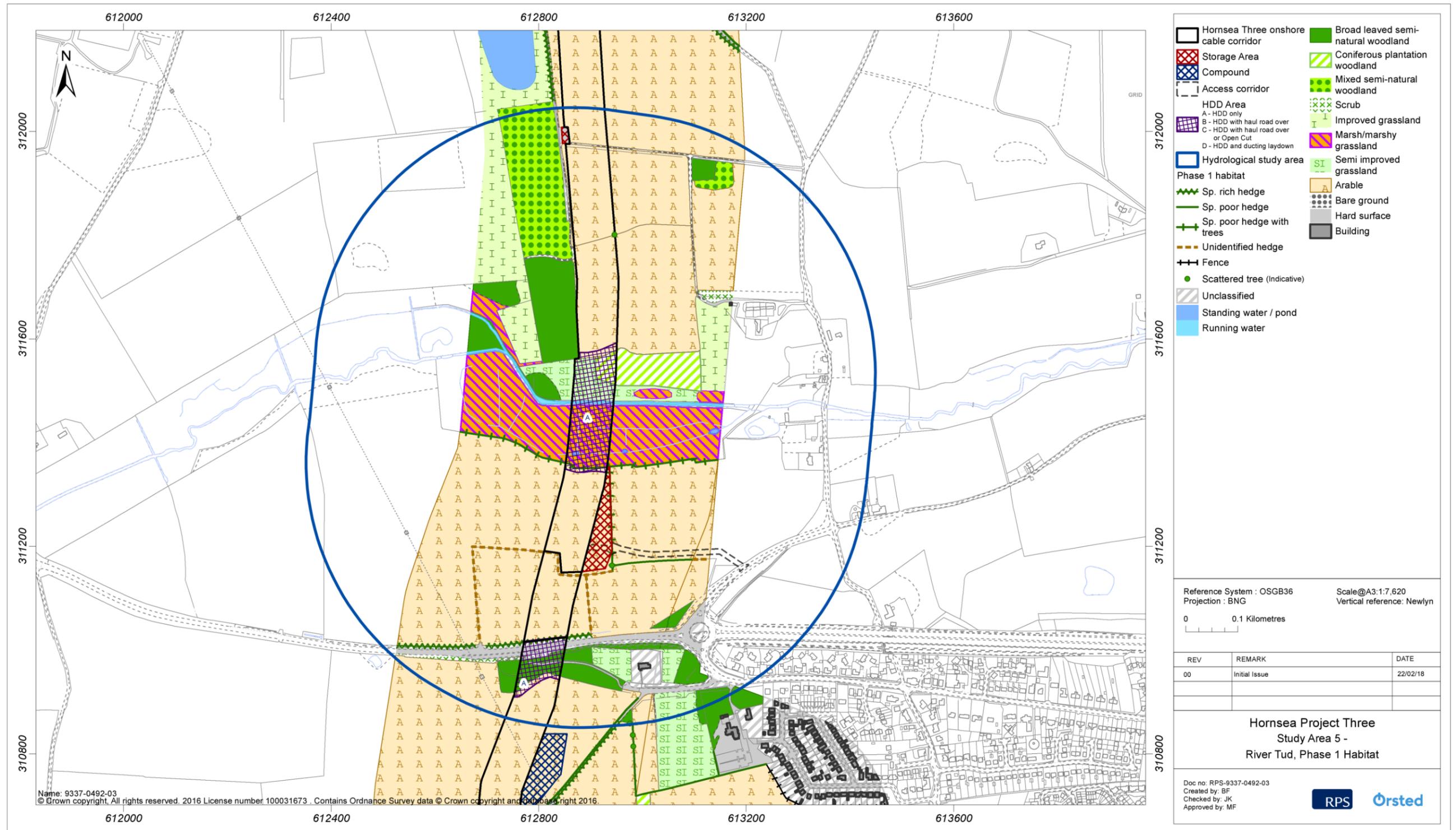


Figure A.10.5: Hydrological study area 5 – River Tud, Phase 1 habitat.

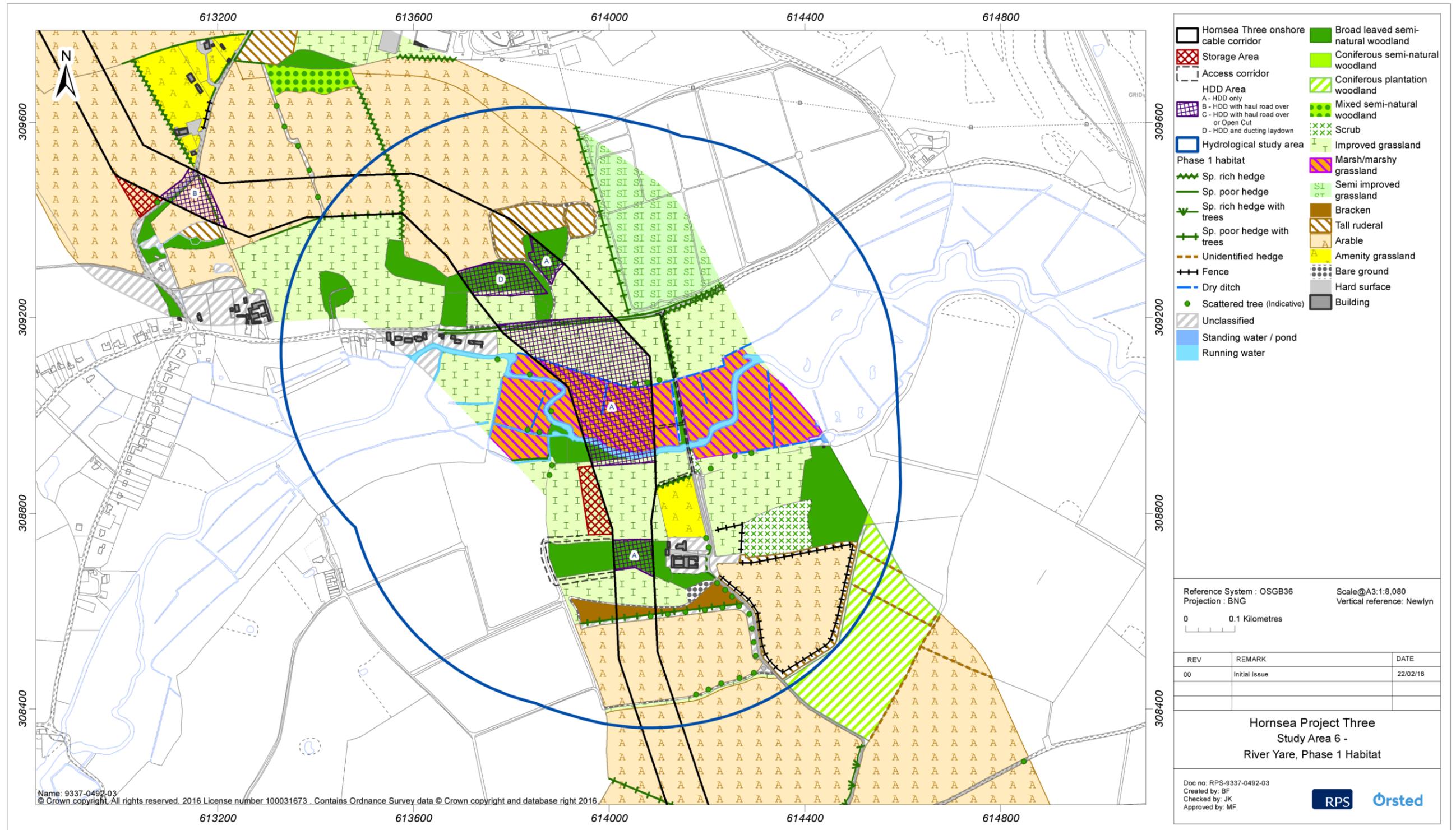


Figure A.10.6: Hydrological study area 6 – River Yare, Phase 1 habitat.

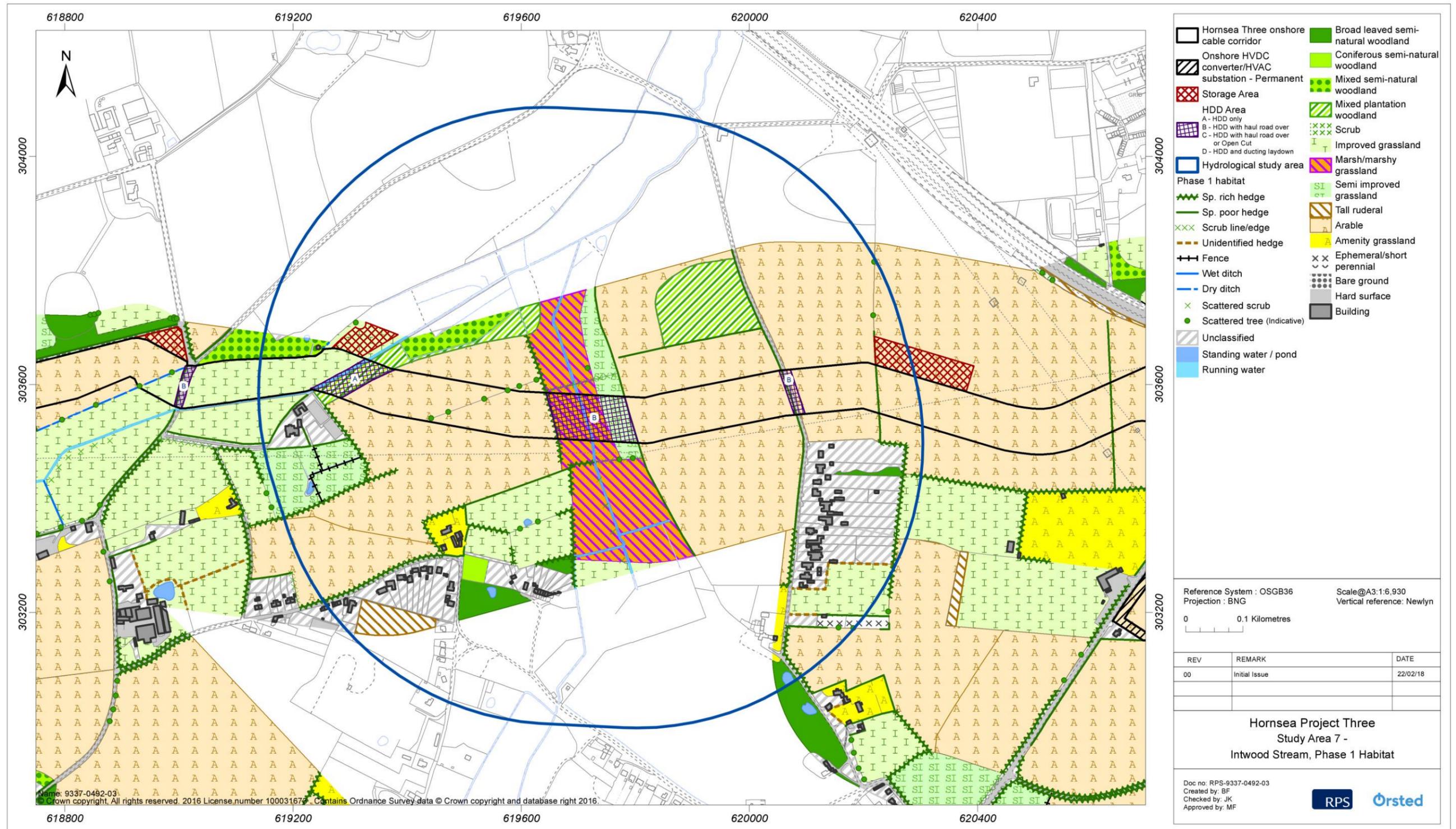


Figure A.10.7: Hydrological study area 7 – Intwood Stream, Phase 1 habitat.

Appendix B Updated Phase 1 Habitat Plan Target Notes

B.1 Study Area 1 – River Bure Target Notes (accompanies updated Phase 1 sheet 1 of 7)

Target Note	Description
1.	Top feeder channel at top of marshy grassland field only holds water to the west. Above ditch is a line of old alder and other coppice. Toad noted.
2.	Wet ditches within marshy grassland are well vegetated with reed sweet grass, sedges and rush, although still some open water.
3.	The marshy grassland is wet with occasional standing water and a tussocky sward with frequent rush clumps. Not particularly diverse but of interest.
4.	The River Bure has a good clear flow over a mixed gravel and sandy bed. There is some submerged and emergent plant species and in places riffle sections. There are a number of drains leading to, or running parallel to, the River Bure which support a range of aquatic plant species.
5.	Snipe flushed from the marginal vegetation by the ditch.
6.	Toad under reptile mat.
7.	South of the river as the ground rises the field is much drier and improved grassland with a line of mature ash along the field edge.
8.	The dismantled railway has a mix of semi-improved grassland, scrub and scattered mature trees.

B.2 Study Area 2 – Blackwater Drain Target Notes (accompanies updated Phase 1 sheet 2 of 7)

Target Note	Description	Site Photos
1.	Booton Common SSSI/SAC – valley fen and birch/willow wet woodland. Evidence of flushes feeding wetland habitats as well as surface waters from upslope. These appear to be physically separated from the upstream refined cable route corridor by a break in slope (at target note 3) and by the boundary ditches at the edge of the common. Further investigation of ground and surface water flows and interaction is probably required here.	
2.	Valley edge and bottom fields are a mix of semi-improved grassland with some rush and in places wetter marshy grassland. Some of this marshy ground is perched upslope and must be groundwater fed.	

3.	At point 3 there is a slight break in slope which may indicate that to the west of the point groundwater flows to the boundary ditch of the common or directly down to the Blackwater Drain, while to the east the flow is likely to be more directly down straight to the Blackwater Drain.	
4.	The Blackwater Drain is tree-lined and shaded in parts. Where is more open there is some submerged aquatic plant growth and the channel bed is noted as being a mix of silty mud and more sandy, with areas of gravels also. There are a number of springs and flushes noted on both sides of the shallow valley.	
5.	Perched sedge bed in a valley side flush within the young woodland. Very wet conditions but drier quickly away from the flush both upslope and downslope.	
6.	Another very wet sedge bed and the bottom of the wooded valley slope.	
7.	The higher feeder channel turns and runs down slope to the Blackwater Drain at this point – so flows do not run directly west between the two fields of grassland. To the west of the ditch is a much wetter marshy grassland that could be influenced by the flows in the feeder channel.	
8.	A pair of oystercatcher and also lapwing noted – possible breeding behaviour.	

B.3 Study Area 3 – Swannington Beck Target Notes (accompanies updated Phase 1 sheet 3 of 7)

Target Note	Description
1.	Ponds close to edge of Alderford Common SSSI with potential for breeding Great Crested Newt.
2.	Swannington Beck is a small stream with a clean sandy/gravel bed and where it is not shaded, a range of marginal and aquatic plant species present. It is more shaded to the north and more open and therefore vegetated to the south.

3.	Rather species-poor semi-improved grassland but likely to be Great Crested Newt terrestrial habitat. Might be worth a botanical survey later in season if the HDD is in the field (or it is open cut).
4.	Western feeder channel – no direct access at crossing point. Where accessed in the south it is deeper and with less flow than the beck.
5.	No direct site access – could be wet but otherwise appears to be species-poor semi-improved grassland. Should be surveyed later in season if access allows.
6.	Further south sward gets more tussocky and with much more rush and other species, evidently wetter with some standing water.
7.	Woodland pond, completely shaded in the spring and summer, no evident aquatic vegetation but could still be a Great Crested Newt breeding pond (or a sink pond).

4.	At gravel side bar near willow island the river bed is cleaned by particularly fast riffle flows and swan mussels and other benthic invertebrates were observed in the shallows (not actively sampled).	
6.	Alder and willow tree line next to a sedge dominated water-filled ditch.	
7.	Eastern feeder channel also with slow flow and abundant marginal and emergent vegetation.	
8.	Very shallow muddy pond where surface water has collected. No evident aquatic vegetation.	
9.	Snipe flushed from marginal vegetation of river.	
10.	Improved grassland on the raised fields above the flood plain.	
11.	Woodcock flushed from Marriots Way CWS.	

B.4 Study Area 4 – River Wensum Target Notes (accompanies updated Phase 1 sheet 4 of 7)

Target Note	Description	Site Photos
1.	River Wensum valley floor marshy grassland is wettest to the south with standing water. Sward is tussocky with abundant rush and some sedge and reed sweet grass stands. Diversity of sward species is apparently limited though with abundant buttercup spp.	
2.	Snipe flushed from marginal vegetation of river.	
3.	Western feeder channel is quite shaded by alder and willows, little flow and very silty/muddy in places. Where the channel narrows and flow increases the bed is sandy gravels. Channel is nearly bankfull in places and groundwater levels in fields is at or near the surface.	
4.	The River Wensum is a high quality, diverse gravel bed watercourse with a good range of riverine features including an in-channel willow island. A good range of submerged, emergent and marginal vegetation including reed sweet grass, pond sedge, rushes and others.	

B.5 Study Area 5 – River Tud Target Notes (accompanies updated Phase 1 sheet 5 of 7)

Target Note	Description	Site Photos
1.	River Tud valley floor marshy grassland south of the river is CWS. Sward is tussocky and wet with abundant rush and some sedge and reed sweet grass stands. Good diversity of sward species with meadowsweet, buttercup spp. And others likely later in season. Frog spawn noted – 20+ clumps.	
2.	River Tud is a high quality, diverse gravel bed watercourse with a good range of submerged, emergent and marginal vegetation including water-crowfoot, bur-reed and others within the channel.	
2.	Note the good range of submerged, emergent and marginal vegetation including water-crowfoot, bur-reed and others within the channel.	
3.	7-10 clumps of frog spawn noted in one of the valley bottom ditches.	

Target Note	Description	Site Photos
4.	In one of the valley bottom ditches possible water violet recorded, as well as water plantain and aquatics – ditch system is good quality too.	
5.	On north bank the topography rises quickly. The grassland is much drier and appears to be species-poor semi-improved but should be re-checked later in season if the field is to be directly affected. In valley bottom by the river there are remnant sedgebeds where there ground is wettest.	
6.	CWS is an oak, beech and ash bluebell wood, although game management is strongly evident the quality of the woodland is still apparent.	

B.6 Study Area 6 – River Yare Target Notes (accompanies updated Phase 1 sheet 6 of 7)

Target Note	Description	Site Photos
1.	River Yare is a larger river with a good clear fast flow with a sandy/gravel bed and a good range of riverine features as it meanders across the valley floor flood plain.	

Target Note	Description	Site Photos
2.	Valley bottom grassland has characteristics of marshy grassland and is wet in places with rushy patches, although not a diverse sward suggesting it has been improved in the past.	
3.	Very shallow muddy pond of standing water with little or no aquatic vegetation, depth <10cm.	
4.	Locations of possible water vole burrows.	
5.	Within adjacent CWS a series of ponds and apparently wetter more diverse marshy grassland and reed habitat mosaic.	
6.	Snipe flushed.	
7.	Feeder ditches fully vegetated with reed sweet grass, pond sedge, rushes and other emergent species – grassland wetter east of the farm access road. Very little open water remaining.	
8.	A pair of snipe flushed.	

Target Note	Description	Site Photos
2.	Intwood Stream at this point is a narrow quite fast flowing small stream and in places a clean gravel bed, fringed with good growth of marginal vegetation and submerged aquatics such as starwort, sweet grass and fools water-cress.	
3.	Towards the eastern edge of the valley the fields rise and become drier, species-poor semi-improved grassland.	
4.	Channel of stream shaded by mixed plantation, wider and shallower so flow is slower and bed is silty sand with only occasional gravel beds at riffle sections at obstructions such as fallen trees.	
5.	Upstream is in the open again and flow faster in narrow vegetated channel with fool's water-cress, brooklime, sweet grass and others.	

B.7 Study Area 7 – Intwood Stream Target Notes (accompanies updated Phase 1 sheet 7 of 7)

Target Note	Description	Site Photos
1.	Valley bottom consists of a number of very wet marshy grassland with clumps of rush and sedges within diverse sward of sweet grass and other grasses. Hard to differentiate the quality of the marshy grassland in and out of the CWS.	 Photo – veteran willow multi-stem clump in NW corner of top CWS field

Appendix C Proposed Location and Extent of HDDs

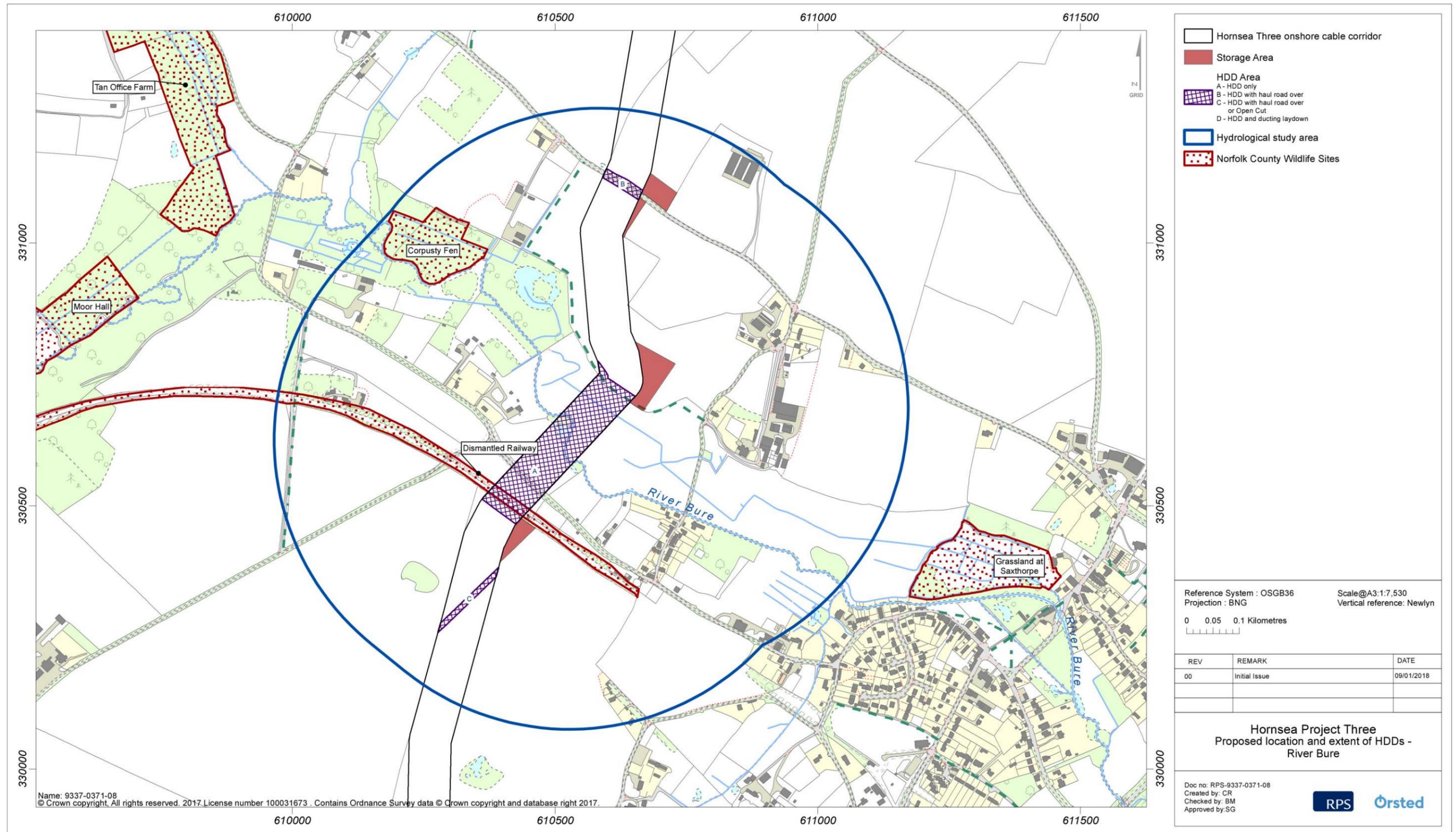


Figure C.10.8: Proposed location and extent of HDDs – River Bure.

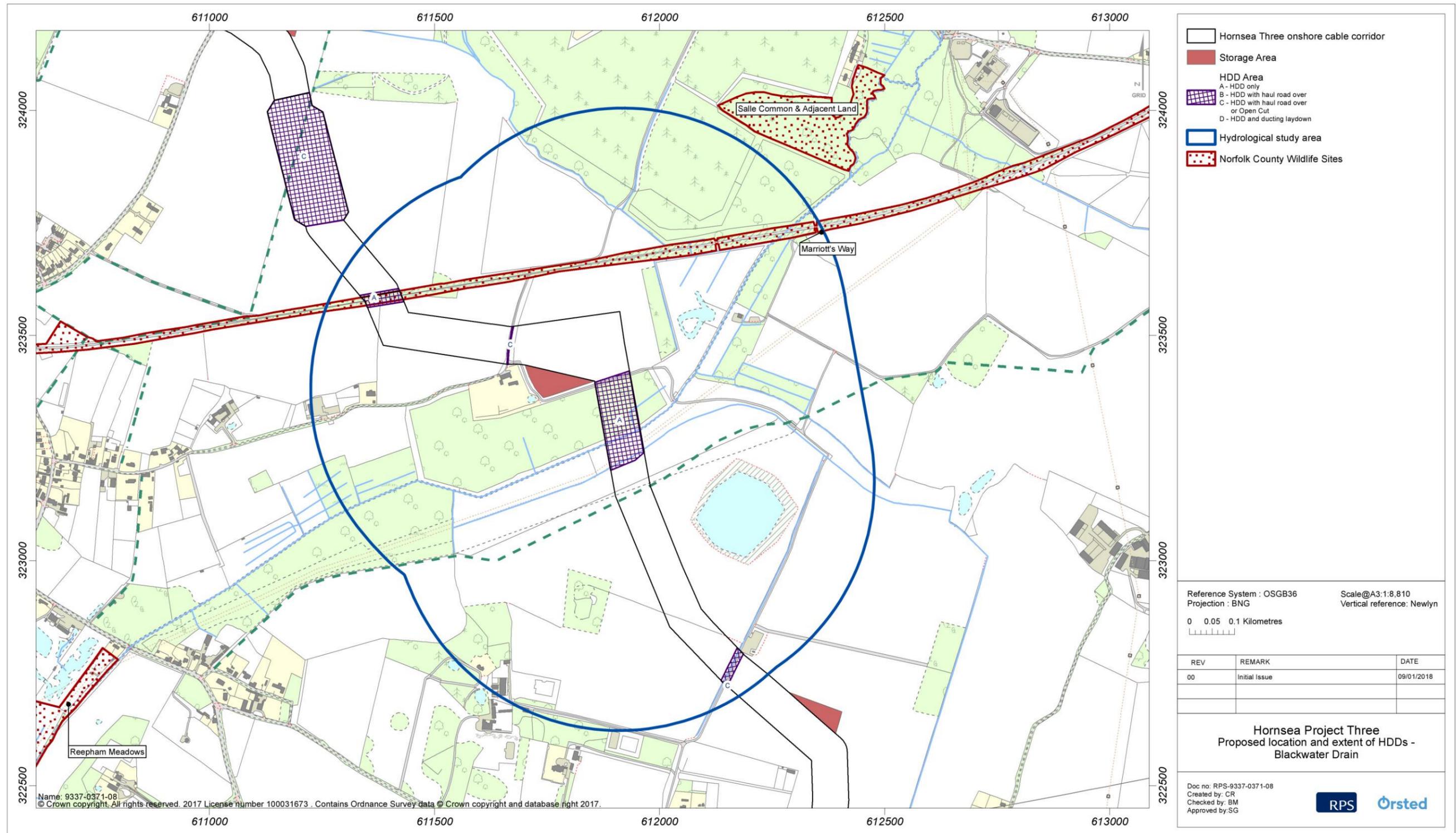


Figure C.10.9: Proposed location and extent of HDDs – Blackwater Drain.

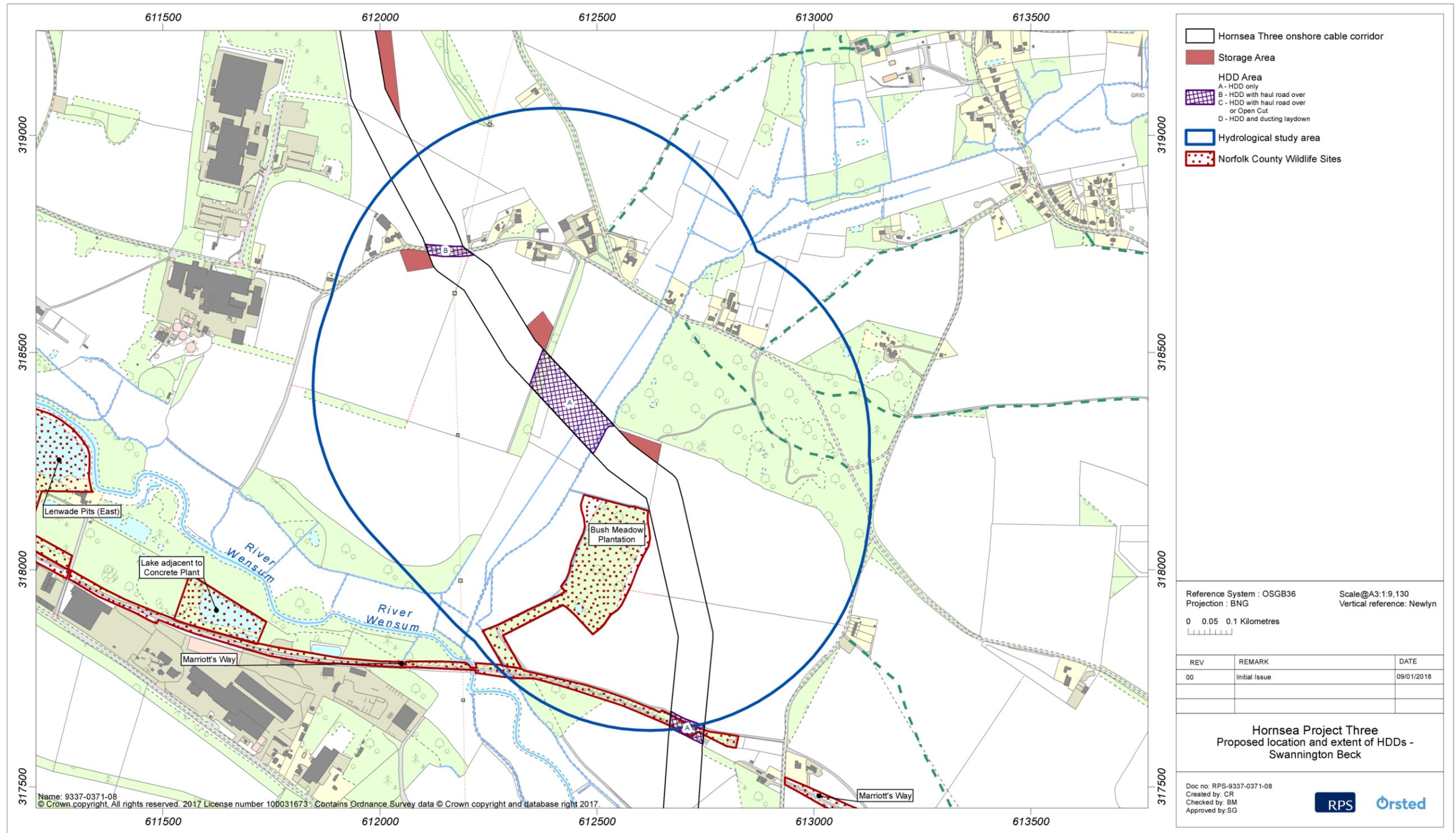


Figure C.10.10: Proposed location and extent of HDDs – Swannington Beck.

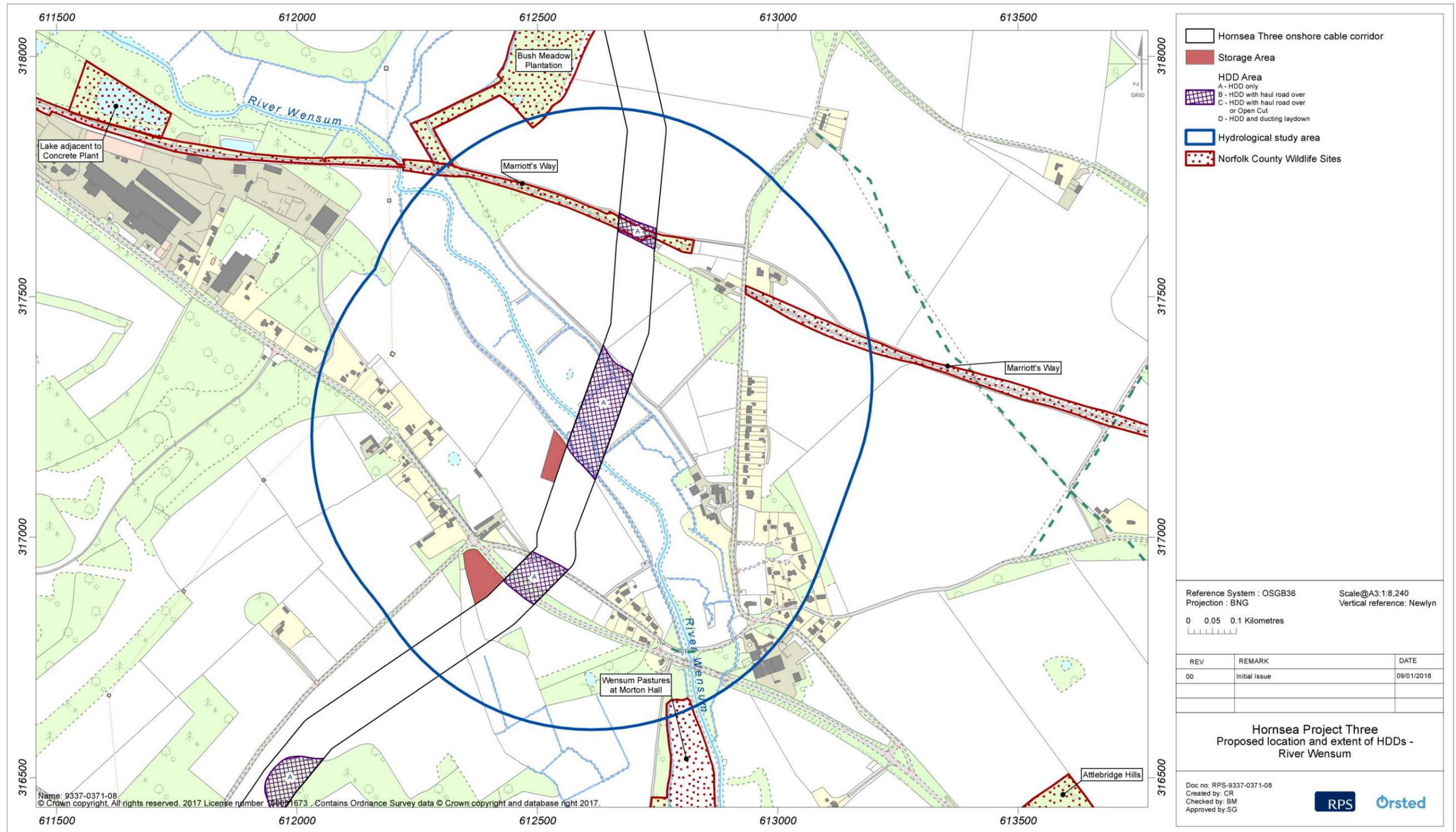


Figure C.10.11: Proposed location and extent of HDDs – River Wensum.

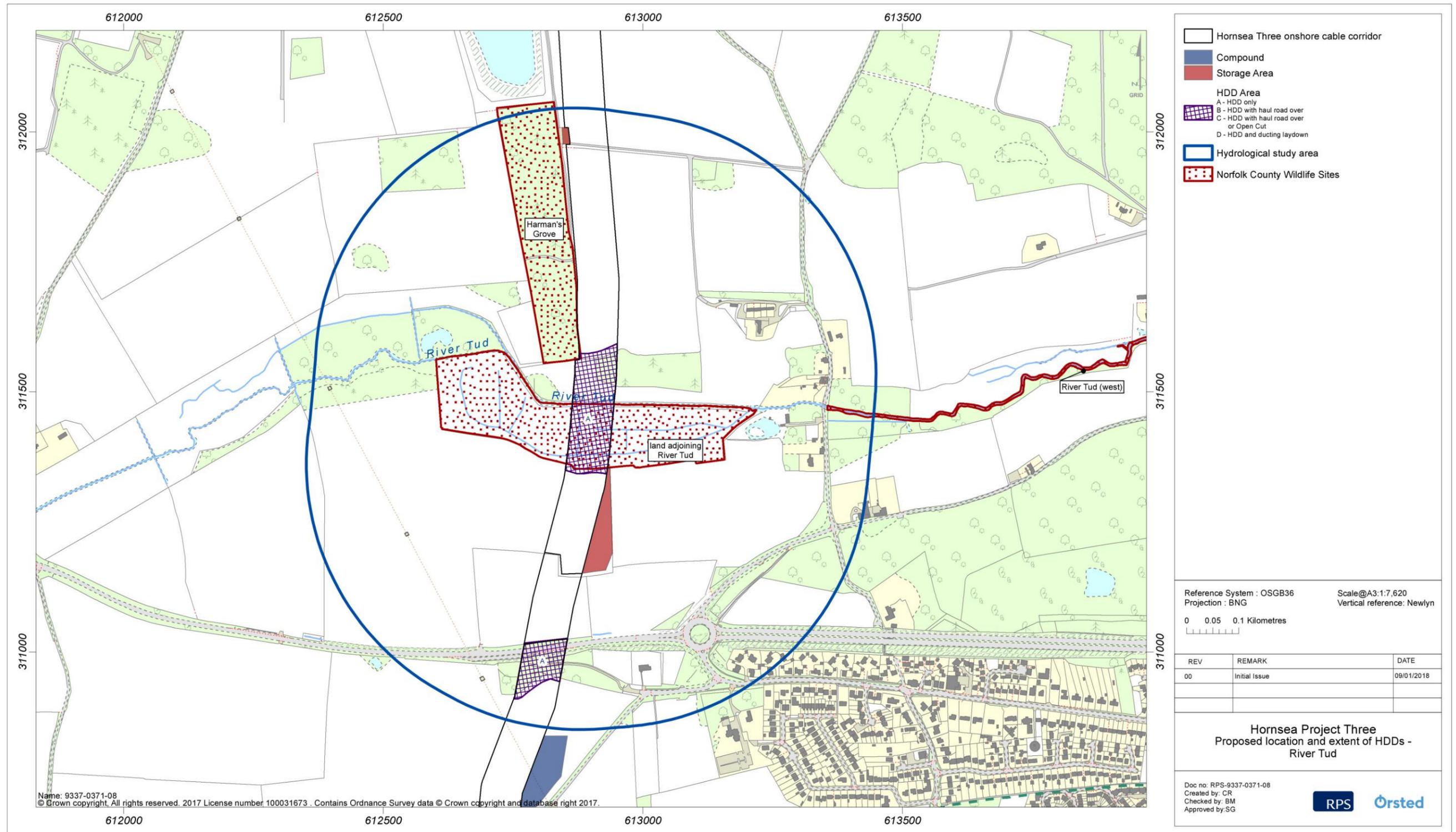


Figure C.10.12: Proposed location and extent of HDDs – River Tud.

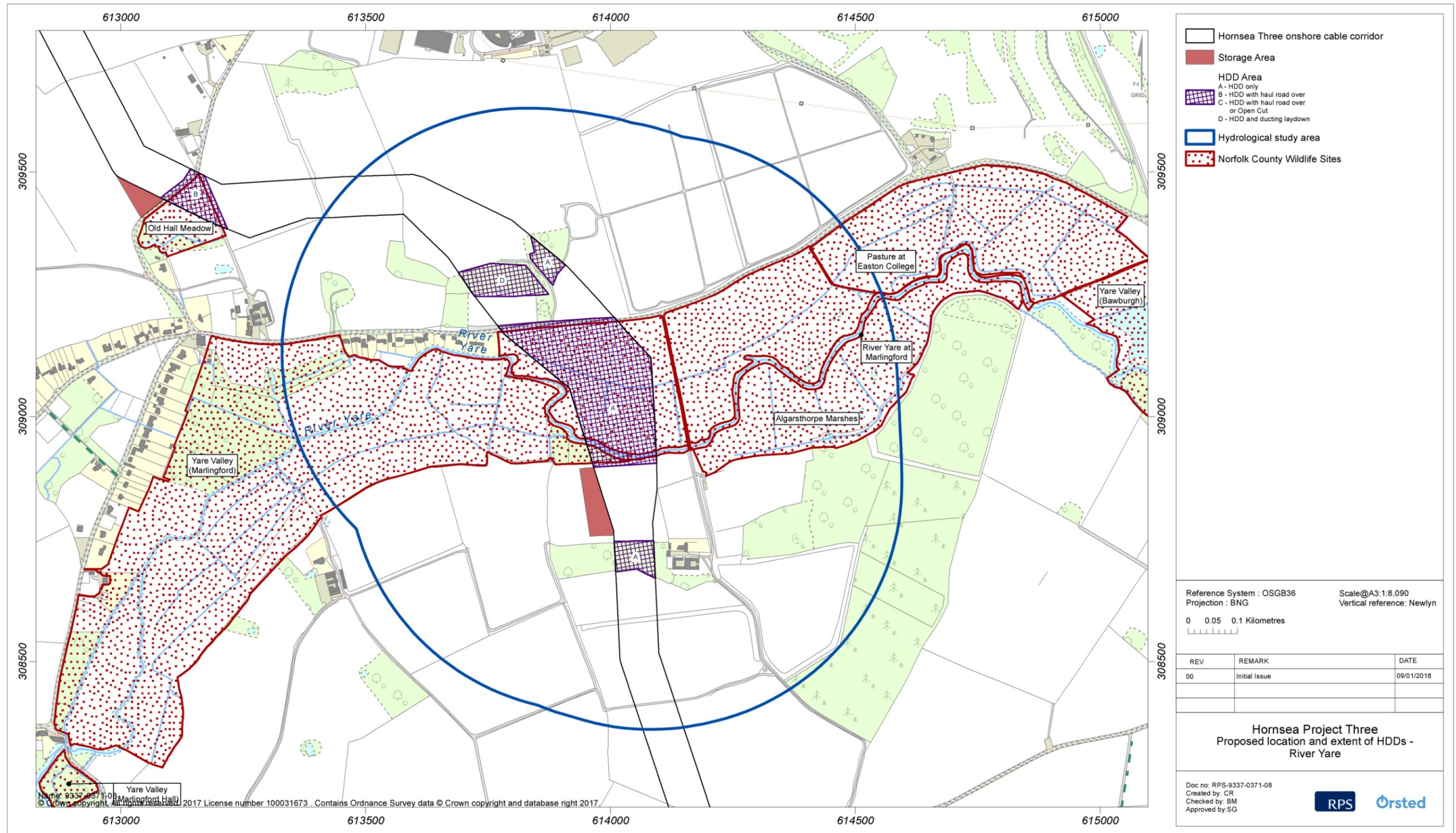


Figure C.10.13: Proposed location and extent of HDDs – River Yare.

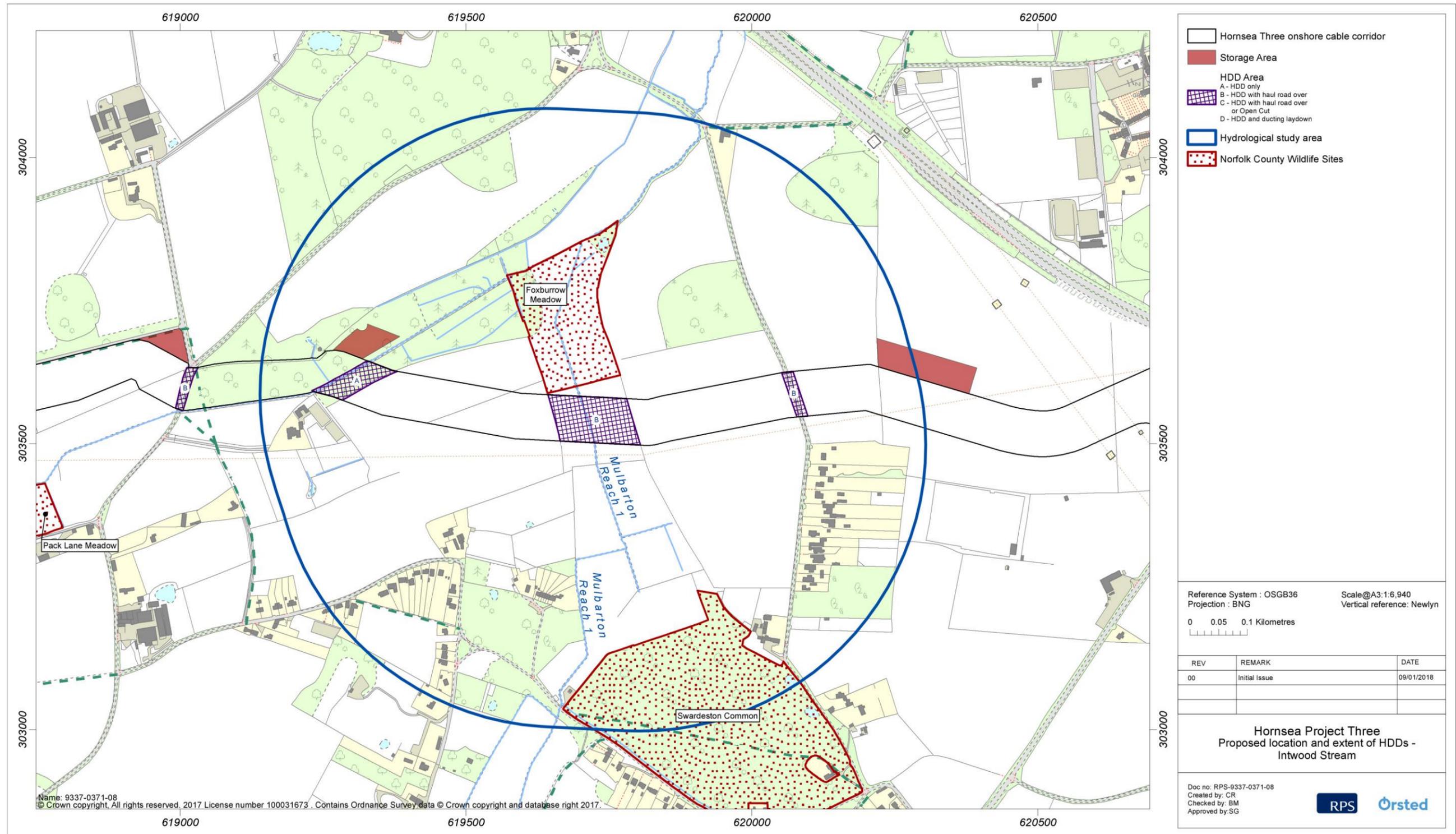


Figure C.10.14: Proposed location and extent of HDDs – Intwood Stream.