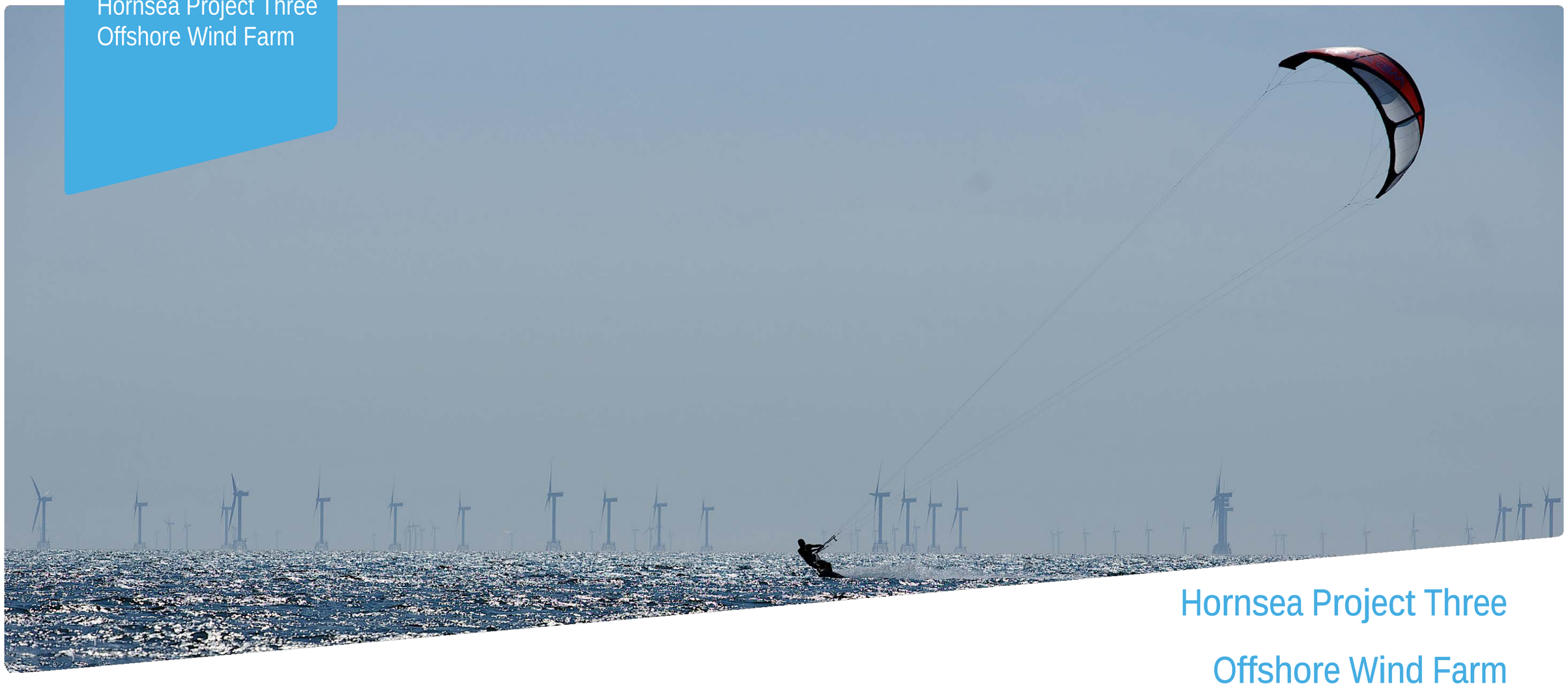
Hornsea Project Three
Offshore Wind Farm



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Offshore Wind Farm

Environmental Statement:
Volume 4, Annex 4.3 – Refinement of the Onshore Cable Corridor and Associated Infrastructure (Stages 5-7 Scoping to PEIR)

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Hornsea 3
Offshore Wind Farm

Ørsted

Environmental Impact Assessment

Environmental Statement

Volume 4

Annex 4.3 – Refinement of the Onshore Cable Corridor and Associated Infrastructure (Stages 5-7 Scoping to PEIR)

Report Number: A6.4.4.3

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This report is also downloadable from the Hornsea Project Three offshore wind farm website at:

www. hornseaproject3.co.uk

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Front cover picture: Kite surfer near a UK offshore wind farm © Orsted Hornsea Project Three (UK) Ltd, 2018.

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Acronyms

Acronym	Description
ALC	Agricultural Land Classification
ECR	Export Cable Route
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
MOD	Ministry of Defence
PEIR	Preliminary Environmental Information Report
SAC	Special Area of Conservation
SoCC	Statement of Community Consultation
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate

Units

Unit	Description
km	Kilometre (length)
kV	Kilovolts
m	Metre (length)

1. Introduction

1.1 Introduction

1.1.1.1 Orsted Hornsea Project Three (UK) Ltd (hereafter referred to as Orsted) is promoting the development of the Hornsea Project Three Offshore Wind Farm (hereafter referred to as Hornsea Three).

1.1.1.2 Located in the southern North Sea, Hornsea Three's array area (i.e. the area in which the turbines are located) is approximately 696 km^2, and is situated approximately 121 km northeast off the Norfolk coast and 160 km east of the Yorkshire coast.

1.1.1.3 Hornsea Three will comprise a maximum of 300 turbines and all infrastructure required to transmit the power generated by the turbines to the existing Norwich Main National Grid substation.

1.2 Purpose of the Report

1.2.1.1 This Annex has been produced by SLR Consulting Limited on behalf of Orsted to document the decision making behind the refinement of the following onshore infrastructure up to submission of the Preliminary Environmental Information Report (PEIR) in July 2017:

- Landfall;
- HVDC Converter/HVAC Substation;
- Onshore Export Cable Route (ECR) Corridor;
- Booster Station (and Route Refinement); and
- Construction Compounds.

1.2.1.2 Prior to PEIR submission the project had engaged with a range of stakeholders with regards to the progress of the project and emerging project design matters. Stakeholders that were consulted up to Stage 7 (pre-PEIR) included:

- The Planning Inspectorate;
- North Norfolk District Council;
- Broadland District Council;
- South Norfolk District Council;
- Norfolk County Council;
- Norwich City Council;
- Norfolk Broads National Park Authority;
- The Environment Agency;
- Natural England;
- The Marine Management Organisation;
- Highways England
- The Wildlife Trust;
- Cefas;
- Trinity House;
- Oil and Gas Operators;
- Utility Providers;
- Landowners;
- Parish Councils; and
- Members of the public through the Phase 1A (October/November 2016) and 1B consultation (March 2017) events and during formal scoping of the project.

1.2.1.3 For further background information on project elements, site selection and alternatives this annex should be read in conjunction with the following documents:

- Volume 1, chapter 3;
- Volume 1, chapter 4;
- Volume 4, annex 4.1 – Grid Connection and Refinement of the Cable Landfall (Stages 3-4);
- Volume 4, annex 4.2 – Selection and Refinement of the Offshore ECR and HVAC Booster Station (Stages 4-9); and
- Volume 4, annex 4.4 – Post PEIR changes (Stages 8-9).

1.3 Structure of the Report

1.3.1.1 Following this Section, the remainder of this report is structured as follows:

- Section 2 – presents a background to the site selection;
- Section 3 – provides detail of the site selection criteria for each element of the project's onshore infrastructure along with an appraisal of options to determine a preferred option of each where applicable; and
- Section 4 – concludes by summarising the components of the project up to PEIR submission and next steps.

2. Background

2.1 Introduction to Scoping (Stage 5)

2.1.1.1 Following the identification of Zone 2 as the preferred landfall zone and initial consideration of onshore (and offshore) constraints (See Annex 4.1 for further information), defined search areas for each project component were established for the purposes of informal consultation with the public and relevant statutory and non-statutory stakeholders.

2.1.1.2 A search area was established from the landfall to the Norwich Main Substation with the intention of providing areas within which the most direct onshore route possible could be identified, with opportunities to avoid sensitive sites, environmental constraints, and major crossings. This search area was developed on the basis of a desktop assessment using the preferred landfall zone identified above and commencing with a straight line approach to Norwich Main Substation.

2.1.1.3 This saw the identification of a 5 km wide corridor which widened slightly near Norwich to provide enhanced routeing flexibility in light of the concentration of infrastructure and built development present.

2.1.1.4 At this stage, no specific areas were identified for the onshore HVAC booster station or the onshore HVDC converter/HVAC substation within the onshore ECR search area, however it was established for electrical efficiency reasons that the former would need to be as close to the coast as possible (although could be up to approximately 10 km from the coast) in order to minimise electrical losses and the latter sited as close to the existing National Grid substation as possible.

2.1.1.5 The boundaries which were defined were considered to contain sufficient buffers to enable an iterative process for the evaluation of specific routes and infrastructure locations as the Project progressed through the pre-application phase.

2.1.1.6 The onshore (and offshore) search areas are shown in Figure 2.1, and represent the culmination of the site selection process up to Q3 2016 at which point a Project boundary was defined for the purposes of EIA Scoping. The scoping corridor was drawn to encompass an area within which all the required project components could potentially be accommodated, based on the status of the project design at that point, known infrastructure and environmental assets/constraints, and providing a spatial extent sufficient to accommodate potentially viable terrestrial (and marine) cable options, and providing space for further cable route development and refinement work, as the project design progressed and feedback from consultation was digested.

2.1.1.7 The final onshore scoping boundary was considered to include all realistic options for the development of the required onshore cable route corridor, onshore HVAC booster station and onshore HVDC converter/HVAC substation, along with the grid connection point at Norwich Main Substation.

2.1.1.8 These areas were consulted on between September 2016 October and November 2016 (Phase 1.A consultation with the public) and December 2016 (as part of formal Scoping of the Project).

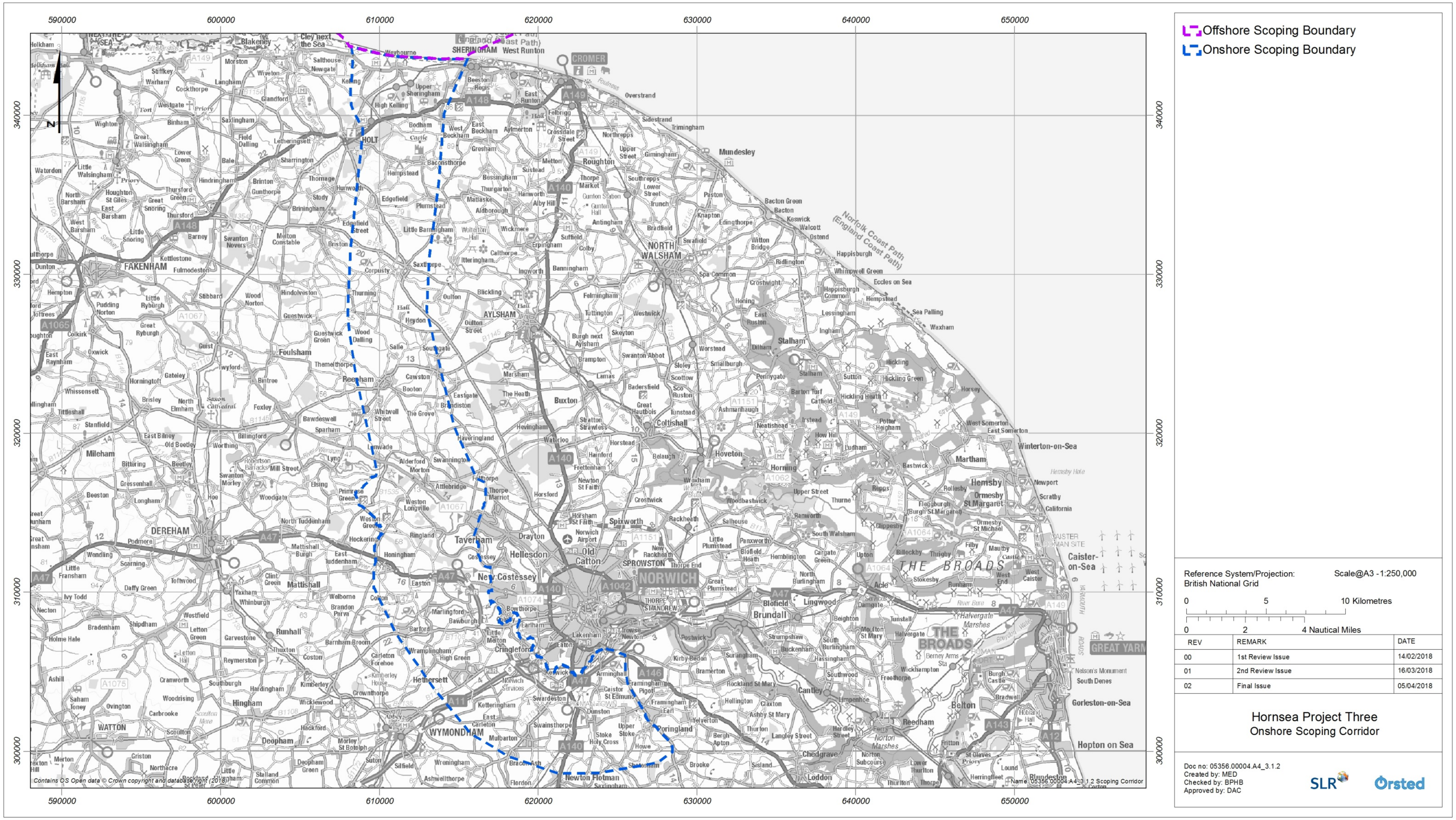

Figure 2.1: Onshore ECR Scoping Boundary.

3. Detailed Routeing and Siting (Stages 6 and 7)

3.1 Landfall Zone

3.1.1 Description

3.1.1.1 Volume 4, annex 4.1 identified that in combination with onshore and offshore ECRs, landfall Zone 2 was the preferred option to be taken forward. The landfall area within Zone 2 was further refined to identify a narrower and viable landfall area as described below.

3.1.1.2 The full stretch of coastline between the east of Salthouse and west of Sheringham was considered in the siting of landfall Zone 2.

3.1.1.3 A landfall area requires a suitable working area to allow for drilling operations (if required), feasibility to install jointing bays and cable pull-in and suitable access for inspection and maintenance. Other commercial considerations include:

- Cost implications of future proximity and crossing options arrangements for existing offshore wind farm infrastructure;
- proximity of (offshore/onshore) telecoms or power cables;
- the need to cross any cables or sea defences at an angle as close to 90 degrees as possible; and
- land ownership where the land might be publically owned e.g. National Trust, Ministry of Defence (MOD), Common Land; Forestry Commission; Historic Parks and Gardens; and TCE land.

3.1.2 Selection Criteria

3.1.2.1 Selection gave consideration to a range of technical, commercial and consenting constraints which were informed by GIS mapping and site visits conducted in Summer 2016. The following presents a list of those considerations required for a successful cable landing or to minimise project risk/complexity:

3.1.2.2 Avoidance of:

- Residential property and heritage assets (if/wherever possible);
- Registered Common Land;
- Land designated for nature conservation where possible (e.g. SPA, SAC, SSSI etc.);
- Land in active use for militarypurposes;
- Routeing adjacent to railway lines;
- Excessive take of Class 1 Agricultural Land (noting that following cable installation and restoration, continued agricultural use can occur);
- Steep gradients/banked verges (e.g. cliffs) which could affect the project's efficiency;
- Standing water and saltmarsh; and
- Areas of ancient woodland habitats or other areas of woodland likely to have nature conservation interest.

3.1.2.3 Minimisation of:

- Minimise crossings of linear natural features and infrastructure, e.g. rail, road, water and oil and gas utilities and where possible, aim to cross these at 90°;
- The amount of private land required;
- Third Party interaction in terms of cable burial requirements; and
- Length of HDD (or similar technology) required to cross the sea defences and or rivers, railways and main roads.

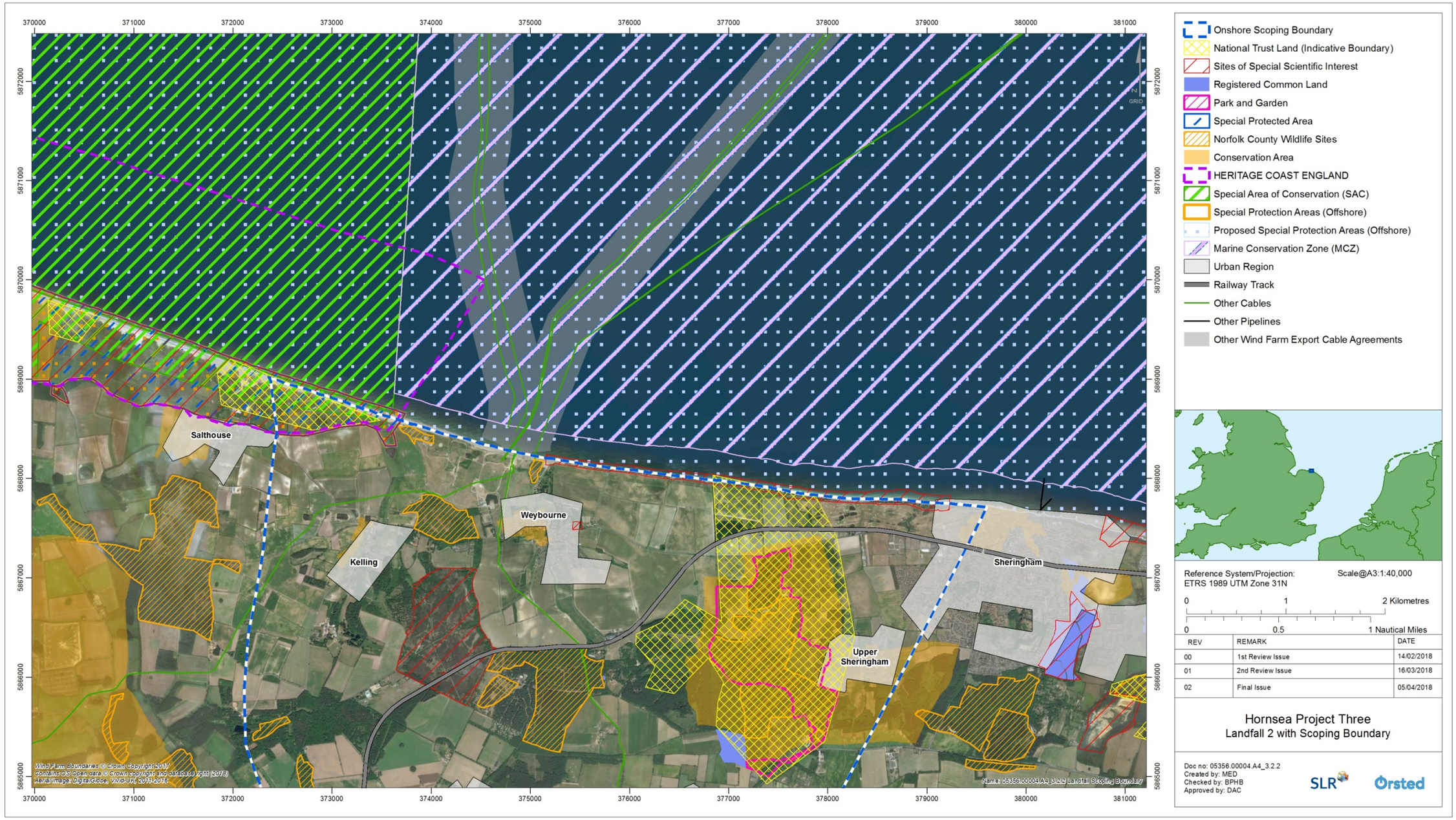

Figure 3.1: Landfall Zone 2 with scoping boundary.

3.1.3 Appraisal

3.1.3.1 The coastline within the scoping boundary benefits from a lack of residential properties and urban areas, with only the western edge of Sheringham and to a lesser extent Weybourne limiting the potential for landfall. Agricultural Land Classification (ALC) along the coastline within the scoping corridor is predominantly Grade 3. Individual heritage assets (Pill Boxes etc) are present but it would be expected that it would be possible to route around these at more detailed stages of the routeing study, therefore only designated areas (e.g. conservation areas) have been considered at this stage due to the increased concentration of assets they imply, which pose a greater challenge to routeing.

3.1.3.2 From a technical perspective approximately 4.15 km of coastline to the west of Sheringham is is characterised by narrow beaches backed by active cliffs (See Figure 3.2). These features form part of the Weybourne Cliffs SSSI, decreasing in height from Sheringham westward towards Weybourne.

Figure 3.2: Illustrative photo of Zone 2, Land east of Weybourne.

3.1.3.3 The drill profile and height of the cliffs along this stretch of coastline means that the cables may be at significant depth for some sections. This presents an engineering complexity in that it could affect the cable design, potentially limiting the amount of power that can be transferred down a single cable, which in turn could affect the efficiency of the Wind Farm design.

3.1.3.4 The western part of the scoping boundary (east of Salthouse) is technically constrained by a migrating barrier beach (See Figure 3.3). This barrier forms part of the landward extents of The Wash SAC and the North Norfolk Coast Heritage Coast/Ramsar/SAC/SPA/SSSI which the site selection process sought to avoid. Notwithstanding this, the barrier, along with the marshland it helps maintain was also considered to present additional technical complexity in terms of both cable installation and operation.

Figure 3.3: Illustrative photo of Zone 2, Land east of Salthouse.

3.1.3.5 Following the coastline to the east, the beach barrier comes to an end, where, in close proximity to the North Norfolk Coast SSSI, lies Kelling Hard CWS, a wetland area with shingle ridge. In light of the extent of wetland areas and length of HDD required and ecological sensitivity this too was excluded from the site search.

3.1.3.6 In terms of land ownership along the coastline there are areas owned by the National Trust (Sheringham, Blakeney) and there is a private active airfield/museum at Weybourne Military Camp. These were identified as potentially presenting additional complexities and challenges to successful routeing and so were avoided at this stage as alternatives appeared to be available.

3.1.3.7 The aforementioned constraints naturally concentrated the landfall search towards the centre of the scoping corridor, closer to Weybourne. While this brought with it commercial considerations such as the interaction with residential properties and other infrastructure such as the export cables associated with Sheringham Shoal and Dudgeon Offshore Wind Farms, the lowlying nature of the beach combined with existing access points offers the potential for successful construction.

3.1.3.8 While it is acknowledged that there is the potential for conflict with existing windfarm infrastructure in the area, it is considered that this risk can be effectively managed through proximity agreements, consideration of future proximity and designing crossing options at an angle as close to 90 degrees as possible.

3.1.4 Conclusion

3.1.4.1 A 1.2 km wide stretch of coastline (See Figure 3.4) towards the centre of the scoping boundary presented a location which offered the onshore ECR an appropriate landfall zone that minimised any impact on environmental designations whilst potentially limiting engineering complexity through the potential to use open cut construction rather than just HDD which may be the only option in some instances. This area also offered a degree of flexibility to the onshore ECR corridor in being able to route either side of Weybourne.

3.2 Onshore HVDC Converter/HVAC Substation

3.2.1 Description

3.2.1.1 The onshore HVDC converter/HVAC substation will contain the electrical components for transforming the power supplied from the offshore Wind Farm to 400 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid.

3.2.1.2 A staged approach was applied to site selection. Firstly a search area was established before selection criteria (see paragraph 3.2.3.1) were used to identify potentially suitable sites within the search area for further investigation.

3.2.2 Search Area Identification

3.2.2.1 A search area was established within an approximate 3 km radius of Norwich Main Substation in order to minimise the distance of the 400kV AC connection between the new substation and the grid connection point. Minimising this distance was necessary to reduce cable reactive power issues, mitigate transmission losses, and minimise adverse effects on economic efficiency. The 3 km radius was selected on the basis that it would minimise the distance and was expected to include a number of viable and acceptable site options. This search area would have been extended if this proved not to be the case.

3.2.2.2 Figure 3.5 presents the search area within which options for an onshore HVDC converter/HVAC substation were considered. Small areas to the north at the outer extent of the study area were removed due to a combination of designations, former landfill and watercourse.

3.2.3 Selection Criteria

Heat Mapping Exercise

3.2.3.1 After establishing the search area an initial constraints based heat mapping exercise utilised the following datasets to identify areas that could be excluded from consideration and/or indicate the least environmentally constrained locations within the search area:

- Areas designated for landscape importance (National Park/AONB);
- Environmentally designated sites (SAC/SPA/SSSI/Ramsar/NNR/LNR/CWS/RSPB Reserves);
- Flood Risk Zone 3 areas;
- Settlements and clusters/individual residential properties;
- Historic Parks and Gardens;
- Sites allocated for development in the relevant Development Plans;
- Scheduled Ancient Monuments and Listed Buildings;
- Substantial Wooded Areas;
- Ancient Woodland Inventory;
- Conservation Areas;
- Active landfill areas;
- Surface water features;
- National Trust and Forestry Commission Land;
- Registered Common Land;
- Operational airfields; and
- Designated open space.

Desk Based Search

3.2.3.2 A more detailed desk based search was then undertaken to identify potential specific site locations for further investigation. As well as consideration of the Horlock Rules (this is guidance developed by National Grid to assist in site selection and design for substations – See Environmental Statement Chapter 4 for further detail) the following criteria was applied in order to establish suitable sites:

- Where possible the site should be located within the onshore ECR corridor search area in order to minimise deviations/cable route length between the corridor, the new onshore HVDC converter/HVAC substation, and onward connection to the National Grid;
- Able to accommodate 12.8 ha of permanent land take, associated working areas and land for visual mitigation; and
- Generally flat;
- Benefitting from some existing landscape screening/landscape framework;
- Unconstrained by existing services and utilities; and
- Accessible for construction/delivery of abnormal loads.

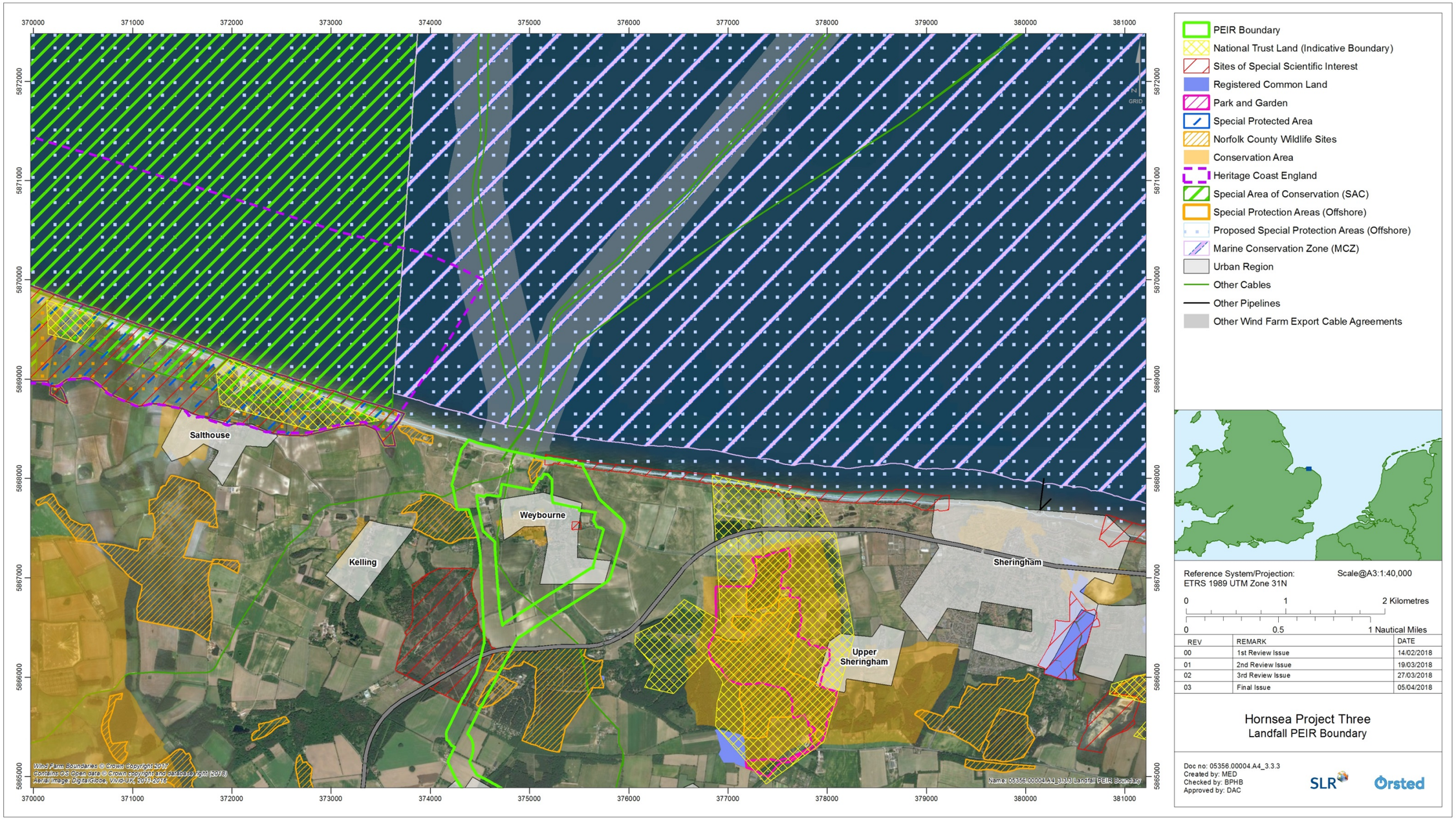

Figure 3.4: Landfall PEIR Boundary.

Figure 3.5: HVDC Converter/HVAC Substation 3 km Search Area around Norwich Main Substation.

3.2.4 Appraisal

3.2.4.1 Figure 3.6 presents a heat map which was presented at the Phase 1B consultation event (March 2017) showcasing a range of constraint factors considered including:

- Quarried land;
- Listed Buildings and Scheduled Monuments;
- Distance to Substation
- Watercourses;
- Distance to Residential Properties;
- Cable Direction Preference;
- Protected Areas; and
- Woodland (including Ancient Woodland).

3.2.4.2 The image in blue provides a combined output and shows at a high level that the least constrained area within the search area appeared to be within close proximity to the Norwich Main Connection Point.

3.2.4.3 Following the selection of landfall Zone 2, a decision was made to limit the search area for the HVDC converter/HVAC substation. With the ECR corridor coming from the west, it was clear that routeing beyond the connection point at Norwich Main to then have to divert back on itself would not be economically efficient and would introduce further engineering, commercial and potentially programme complexities because of the need to cross and re-cross a railway line and river crossing. In general terms this reduced the search area to land west of the railway line. Not only did this help focus on the most direct potentially feasible onshore ECR corridor options to the west of Norwich, but it negated conflict with the Norfolk Broads National Park which is present to the east of Norwich.

Options

3.2.4.4 Figure 3.7 presents four options within the search area that were identified following the heat mapping exercise. Due to the constraints imposed by road and rail infrastructure, (and responding to the route of the onshore ECR being around the west of Norwich) options were limited to sites west of the railway line in close proximity to the Norwich Main Substation connection point.

3.2.4.5 Taking the Horlock Rules into consideration, all four sites were considered to be suitable in terms of providing an appropriate separation from sites of amenity, cultural and scientific value. Due to its proximity to Swardeston, Option C was considered to have the potential for a greater adverse impact from a visual amenity perspective than the other options, whereas Option A was seen to benefit from the most remote location of the four, with greater opportunity to utilise and reinforce existing vegetation such as screening. From an engineering perspective, Option D was the least preferred due to the need for a greater length of cable, the increased complexity of having to cross the railway line twice and also the issue of having to negotiate a more constrained route past a working quarry in order to reach the connection point.

Shortlist

3.2.4.6 Following the initial constraints mapping exercise, as well as consideration of technical constraints, two sites were shortlisted for further investigation. The sites are presented on Figure 3.8, Figure 3.9 and Figure 3.10 below.

3.2.4.7 Due to the early stage of technical investigation at the point of the Phase 1.B consultation events, the two sites above were not shown at the consultation events as work was ongoing to determine whether each was considered to be technically feasible. However, the heat mapping exercise was presented to demonstrate the process that Hornsea Three was using to try to identify potential sites.

3.2.4.8 Supported by information gathered during site visits to the wider area in the summer of 2016 the two shortlisted sites were considered relative to one another, through site inspections, to determine a preferred option. At this stage further consideration was given to matters such as topography, access, landscape framework/screening, hydrology and ground conditions, to supplement the desk top work that was carried out. Furthermore, both sites were subjected to a desk top heritage assessment and phase 1 ecology survey.

3.2.4.9 Both options were seen to be positioned positively in relation to the onshore ECR corridor search area however it was established that Option A's proximity to the railway line directly to the east and the Norwich Main National Grid substation to the north made it physically more constrained than Option B. Furthermore, Option B was significantly less constrained in terms of both access and existing services and utilities, as well as possessing a greater availability of land for potential mitigation to be implemented.

3.2.5 Conclusion

3.2.5.1 Based on the appraisal of options, taking into consideration various constraints and application of the Horlock Rules, Onshore HVDC converter/HVAC substation Option B was selected as the preferred option. This is subject to further on site investigation, technical design work, and feedback from public consultation at the PEIR stage.

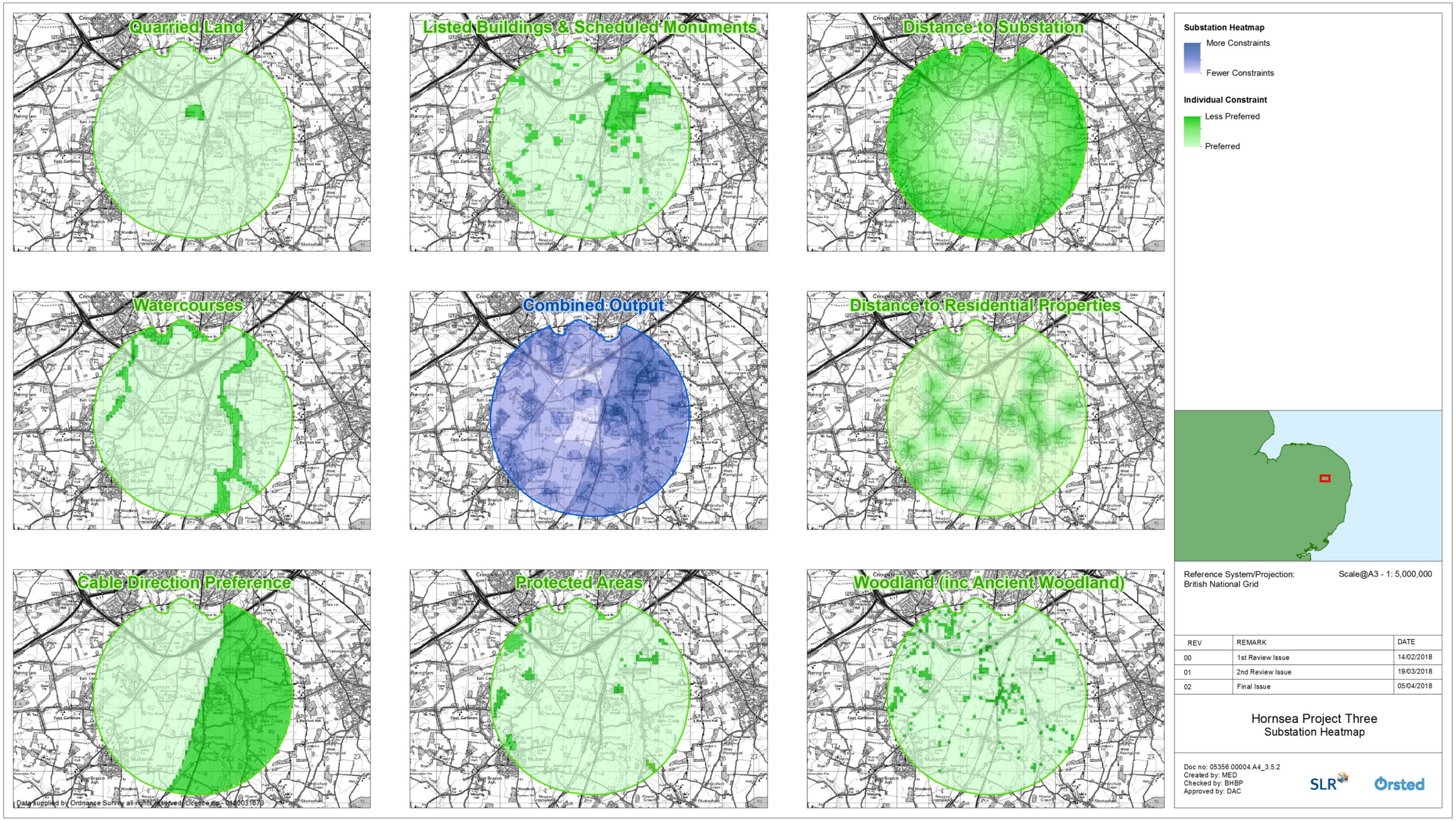

Figure 3.6: Substation Heat Mapping.

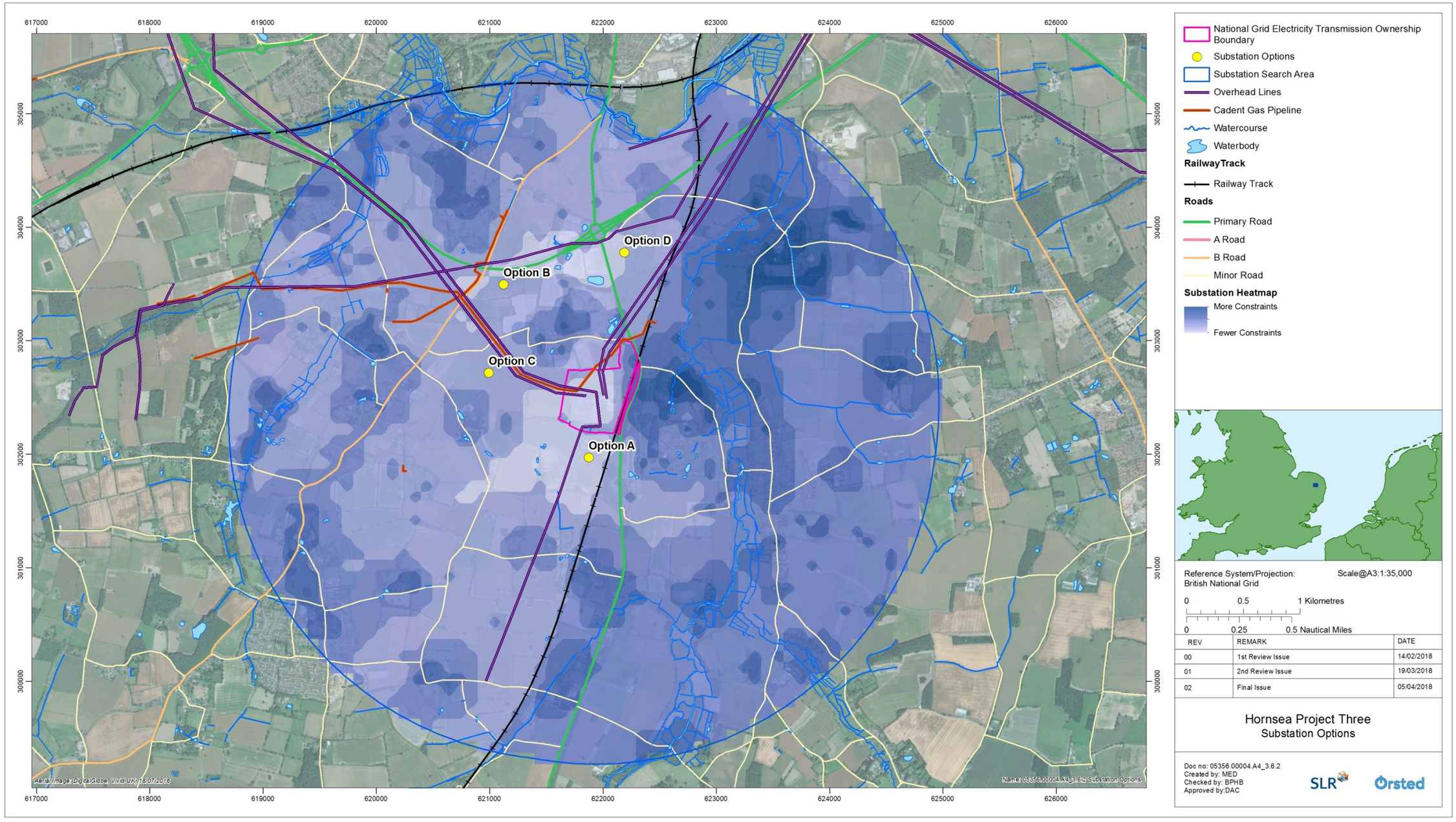

Figure 3.7: Substation Options.

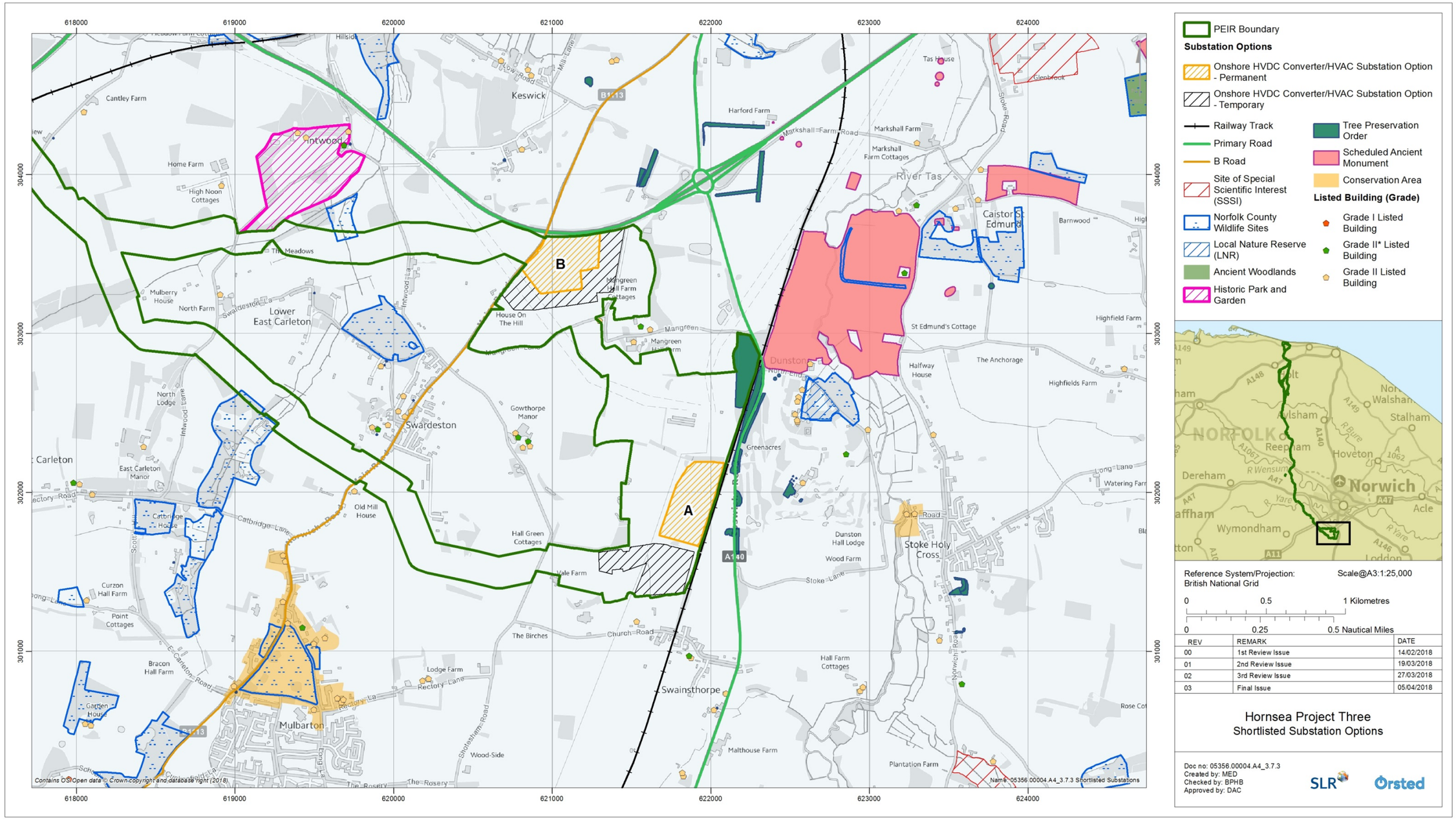

Figure 3.8: Shortlisted Substation Options.

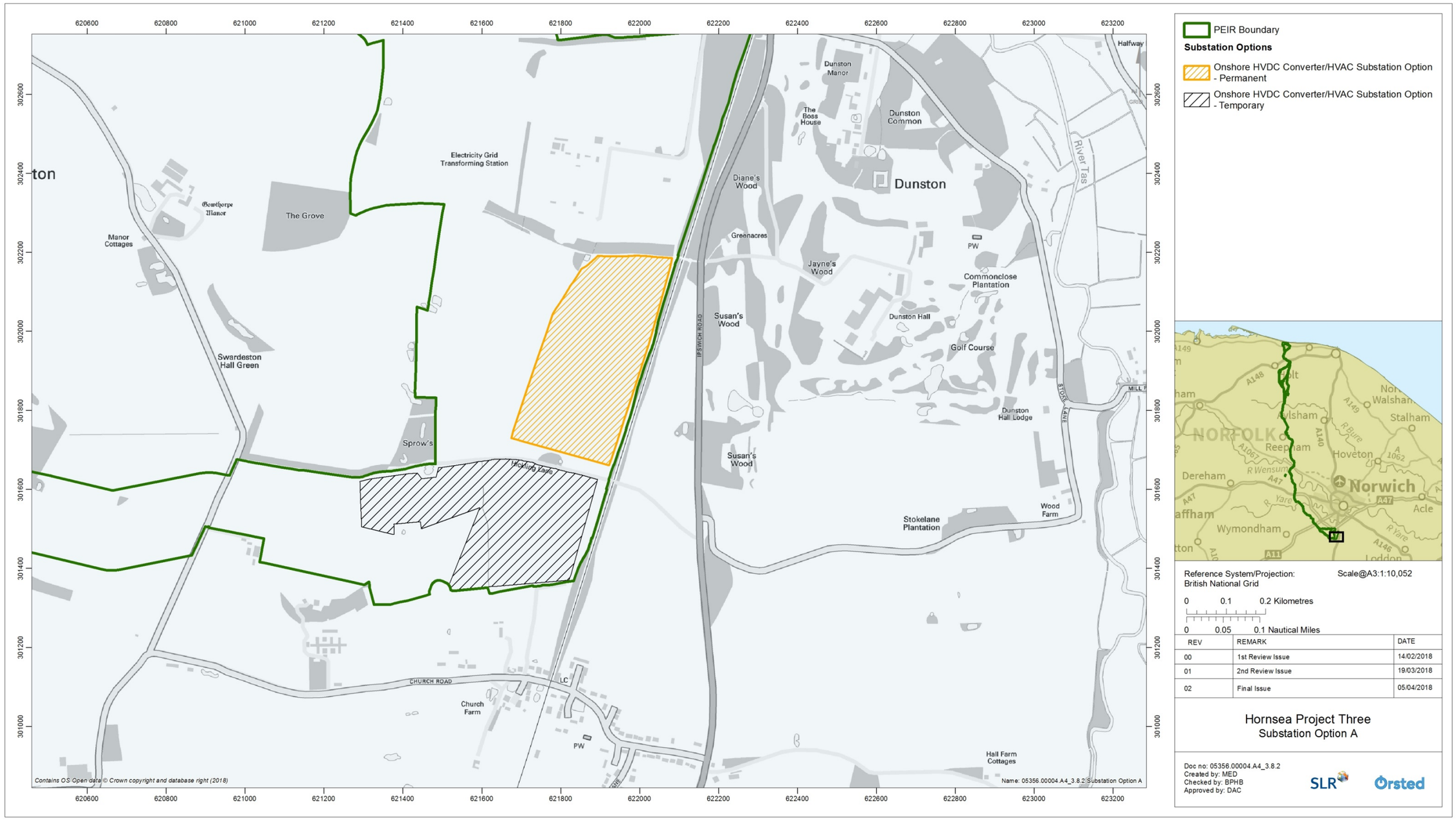

Figure 3.9: Substation A.

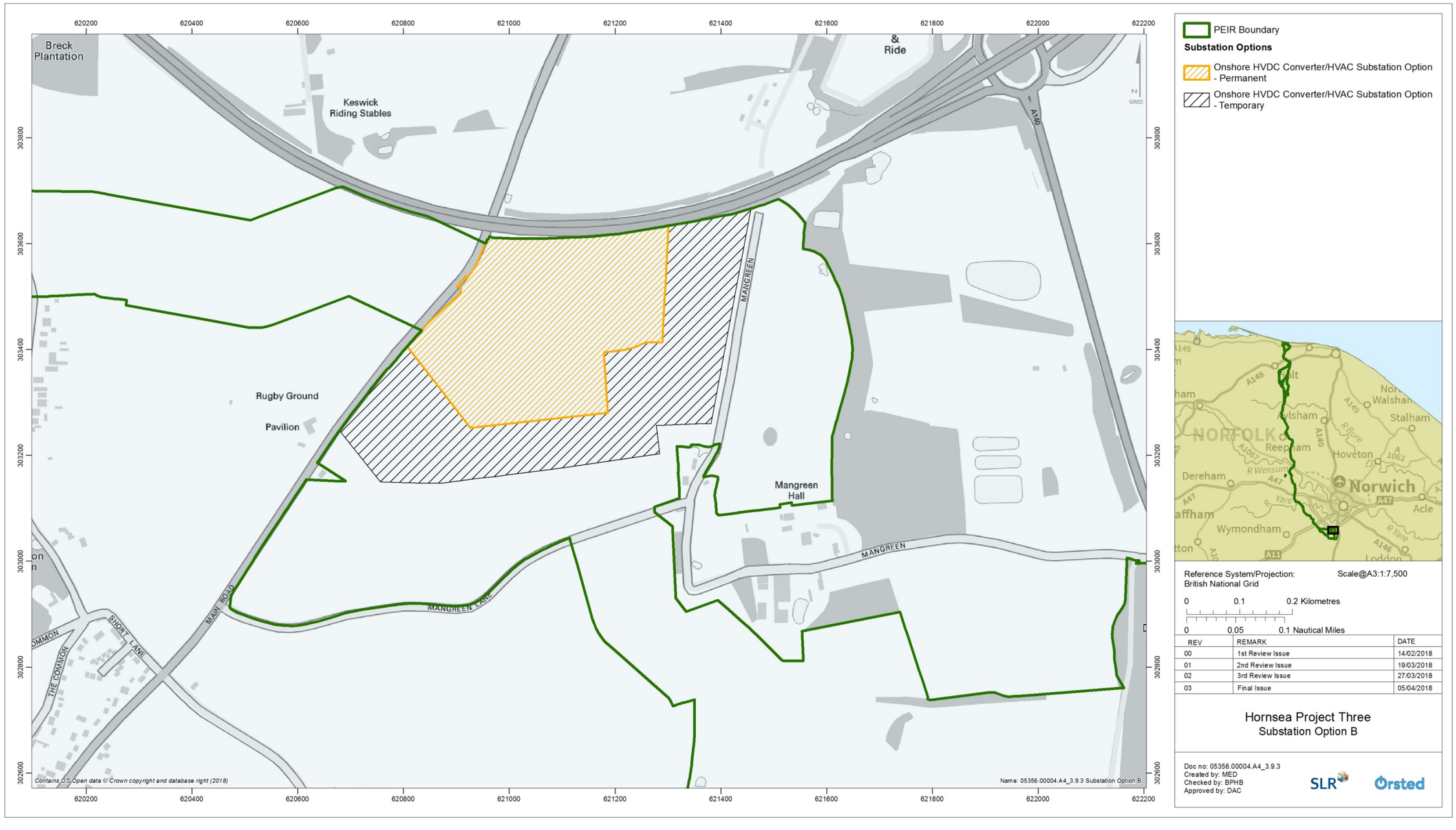

Figure 3.10: Substation B.

3.3 Onshore Export Cable Route (ECR) Corridor

3.3.1 Description

3.3.1.1 Onshore export cables will connect to the offshore export cables at the landfall point (see section 3.1) and transfer the power onwards to the onshore HVDC converter/HVAC substation (potentially via an onshore HVAC booster station in the case of HVAC) (see section 1.1). The onshore export cables will be buried for the entirety of the route.

3.3.1.2 At Phase 1.B Consultation the onshore ECR search area was reduced from a 5 km wide scoping boundary (See Figure 3.1) to a 200 m wide ECR corridor with a 100 m buffer on either side. For PEIR submission (Stage 7) this was refined further to a 200 m wide corridor.

3.3.2 Principles

3.3.2.1 The following principles were applied to route refinement:

- Select the most direct route possible;
- Deviate from the straight line to avoid hard constraints (housing, commercial, allocated land), focusing routeing on open countryside as far as possible;
- Avoid installation within transport infrastructure (roads/railway) due to the individual, and combined, width of cable trenches that would be required as well as impacts on transport networks locally;
- Keep cable turns under 90 degrees;
- Minimise major asset crossings and close proximities to other assets - for all major crossings allow for a HDD working area, measuring approx 70m x 70m, at each end of the crossing;
- HDD for A roads and main rivers. Seek to minimise the number of major crossings overall; and
- Avoid environmental constraints and identify consequent buffers where feasible.

3.3.3 Routeing Considerations

3.3.3.1 Where feasible the objective was to avoid these features along with other land uses such as settlements, commercial development, housing, surface water bodies, and woodland. This enabled the exclusion of the following features from the original search area as far as possible (noting there may be some circumstances where they could not be completely avoided):

- Sites of Nature Conservation Interest (SNCI)/designated sites (Special Area of Conservation (SAC)/Special Protection Area (SPA)/Site of Special Scientific Interest (SSSI)/Ramsar/National Nature Reserve (NNR)/Local Nature Reserve (LNR)/County Wildlife Site (CWS)/Royal Society for the Protection of Birds (RSPB) Reserves);
- Settlements and residential development;
- Historic Parks and Gardens;
- Sites allocated for development in the relevant Development Plans;
- Scheduled Ancient Monuments and Listed Buildings;
- Substantial Wooded Areas;
- Ancient Woodland;
- Active landfill areas;
- Surface water features;
- Airfield locations;
- Designated open space; and
- National Trust and Forestry Commission Land.

3.3.3.2 Not all of the above features were determining factors in routeing decisions, as such the following appraisal text discusses those that are the main factors in the decision making.

3.3.4 Appraisal

3.3.4.1 Route definition of the ECR corridor for PEIR submission took into account the routeing principles and the routeing considerations referred to above. The route is described from north to south in the following text. In many locations the route identified was influenced by decision making in locations in the adjacent sections of cable and as the route was defined a back check against the principles forms an ongoing part of the route development process.In many locations the application of the principles and routeing considerations leds to the identification of a single corridor with no consideration of alternatives necessary. In a number of locations the combination of constraints or need to interact with the location of other elements of the connection infrastructure (HVAC booster station or HVDC converter station/HVAC substation) led to the consideration of alternative ECR corridor alignments. These alternatives and the main reasons for their definition and/ or exclusion are described below.

Weybourne to High Kelling

3.3.4.2 From the landfall area the scoping corridor immediately splits into two alternative ECR options to provide flexibility in navigating around the residential area of Weybourne (Figure 3.11). The more direct western route passes close to Muckleburgh Hill CWS (though this in itself is not a constraint to this option) with the eastern ECR corridor being the less direct route of the two.

3.3.4.3 To the south of Weybourne the scoping corridor then becomes more constrained with woodland and various environmental designations. In this location the preferred scoping ECR corridor was able to route through a caravan park whilst marginally encroaching onto Kelling Heath Park & Hundred Acre Wood CWS and Kelling Heath SSSI. Other alternative routes in this area would require a substantial deviation to the route alignment in order to avoid these features.

3.3.4.4 The ECR corridor then routes in a south east direction avoiding the village of High Kelling and Old Decoy, Selbrigg Pond, The Lows CWS.

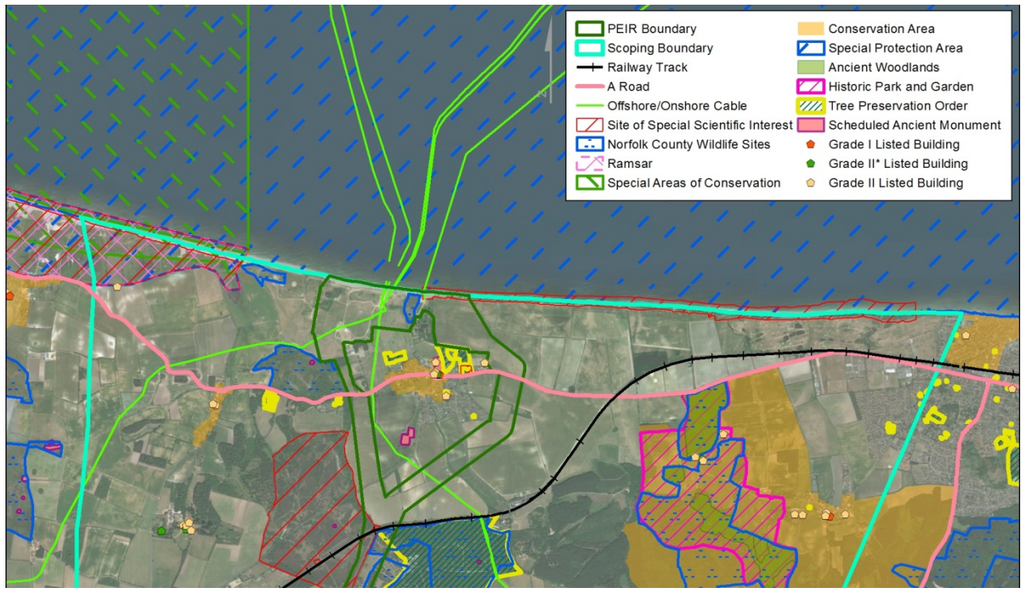

Figure 3.11: Weybourne to High Kelling.

Hempstead, Baconsthorpe and Edgefield

3.3.4.5 Following the development of the initial route, a number of alternative sites for a HVAC booster station were identified in line with the relevant criteria and alternative cable routes to get to those were developed to allow consideration of the combination of HVAC booster and cable corridor (Figure 3.12).

3.3.4.6 A preferred onshore ECR was initially chosen, subsequently consideration was given to HVAC Booster Station locations and having identified two further alternatives away from the ECR corridor further consideration was given to presenting revised route alignments. These alternative route alignments were considered in combination with HVAC booster station locations in order to reach a balanced decision. Further detail on the consideration of booster station options is provided within section 3.4.

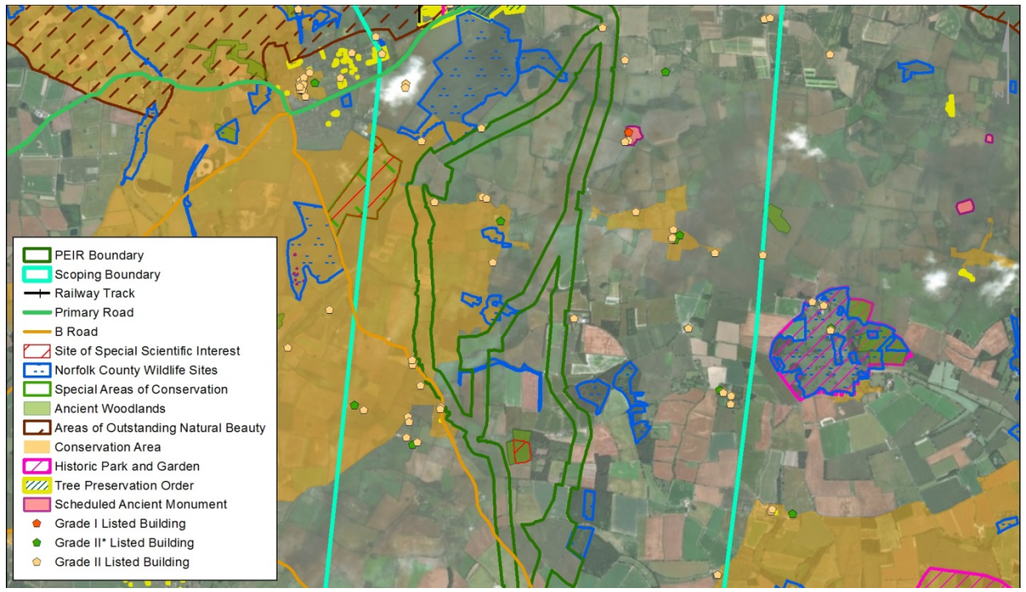

Figure 3.12: Hempstead, Baconsthorpe and Edgefield.

River Wensum

3.3.4.7 Near Morton on the Hill the scoping corridor is heavily constrained with the A1607, numerous villages, multiple river crossings, drainage ditches, woodland areas, CWSs and a SSSI. The ECR corridor deviates from the straight line approach in order to avoid/minimise interaction with these constraints (Figure 3.13).

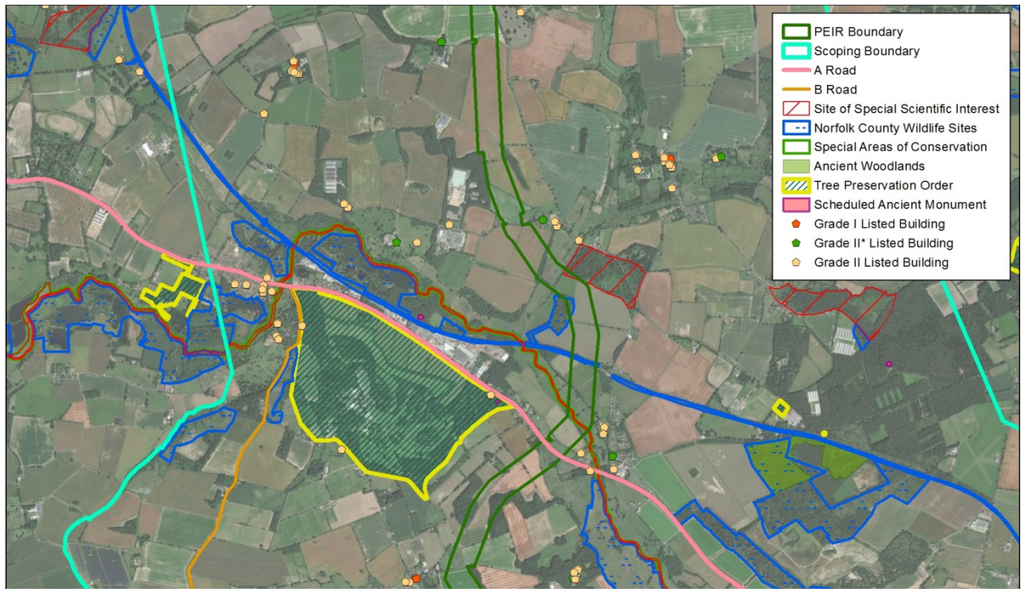

Figure 3.13: River Wensum.

The River Tud and A47

3.3.4.8 In this location the scoping corridor is heavily constrained by the built up areas of Easton and Norwich limiting the possibility of an ECR corridor further to the east. Alignments for the ECR corridor to avoid the CWS to the east or west were considered but were ultimately discounted. Such diversions would have led to increased effects on existing woodland or required long diversions thus increasing the overall level of environmental effects. It was also noted that the need for HDD to cross the River Tud and the A47 could also allow for crossing of the CWS (a combined 700 m HDD) and would mitigate the potential effects on the CWS by avoidance. This route and installation techniques was therefore selected. (Figure 3.14 opposite).

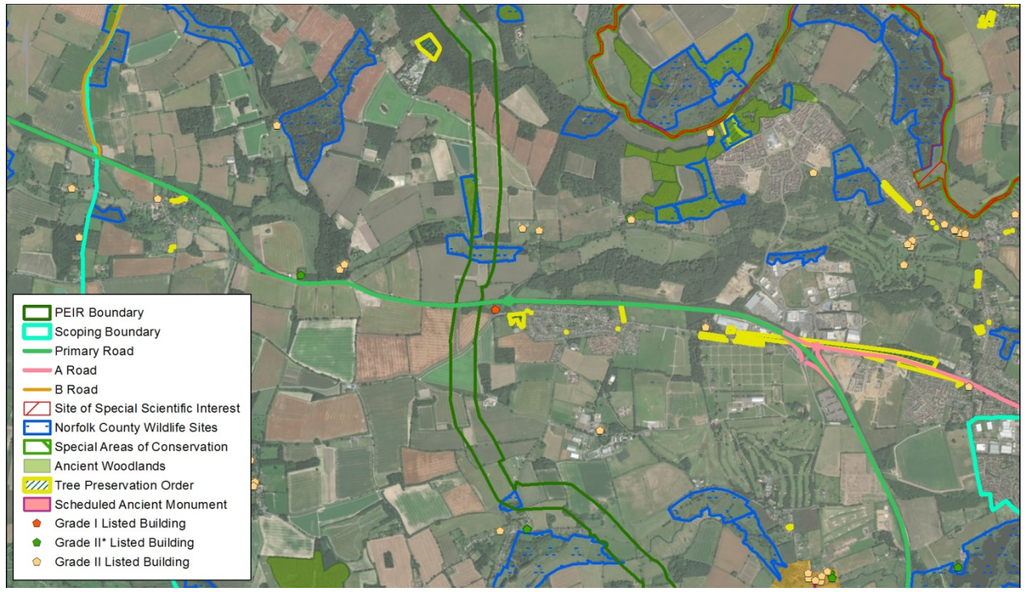

Figure 3.14: River Tud and A47.

River Yare and River Tiffey

3.3.4.9 Between Barford and Bawburgh the scoping corridor is constrained by woodland plantations and CWSs (Figure 3.15 below). Near Marlingford the ECR corridor will use HDD to cross the River Yare and a ditch complex rather than having to deviate and potentially interact with the Yare Valley CWS and Pasture at Easton College CWS nearby. Further south the ECR corridor does similar in crossing the River Tiffey and a B road within a short distance of each other. Routeing to the east of Beckhithe rather than the west minimises any potential conflict with the urban expansion of Hethersett.

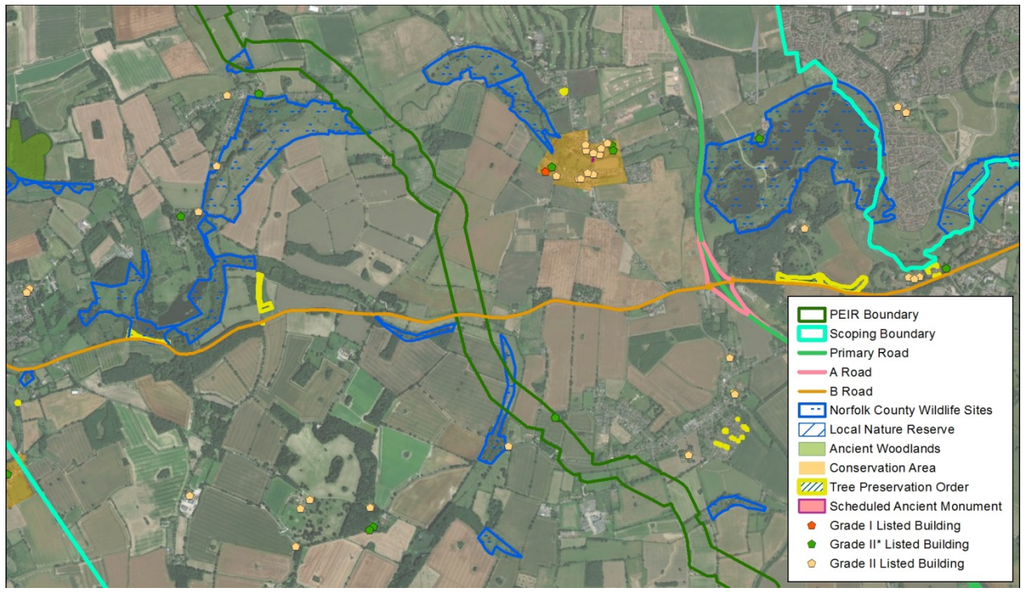

Figure 3.15: River crossings and the Beckhithe urban expansion.

Ketteringham, the A11 and Swardeston

3.3.4.10 Between Hethersett and Ketteringham the scoping corridor is traversed by a railway line in close proximity to the A11 which require HDD. To the east of Ketteringham the ECR corridor splits in two for the final 4 km to the Norwich Main grid connection to allow for the flexible consideration of alternative sites for an onshore HVDC converter/HVAC substation as there wasn't a single corridor that would be suitable to serve both options. (Figure 3.16 opposite).

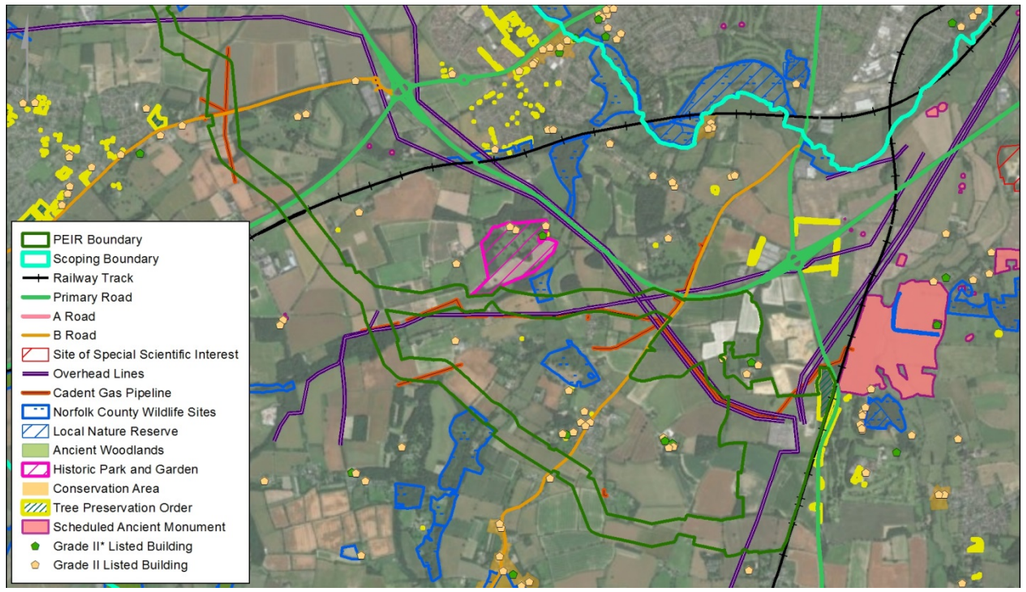

Figure 3.16: Ketteringham, the A11 and Swardeston.

3.4 HVAC Booster Station (and route refinement)

3.4.1 Description

3.4.1.1 An onshore HVAC booster station would potentially be required if an AC electrical system is developed, in order to mitigate transmission losses and meet National Grid system requirements.

3.4.2 Search Area Identification

3.4.2.1 In order to maximise the electrical efficiency/minimise electrical losses of the Project a search area within approximately 10 km of the preferred landfall zone was identified. This search area was restricted to within the onshore ECR corridor where possible in order to minimise deviations/cable route length between onshore cable corridor options identified and the HVAC booster station.

3.4.3 Selection Criteria

Desk Based Search

3.4.3.1 The following principles were applied in order to establish suitable sites:

- Seek close proximity to the identified ECR corridor in order to minimise deviation;
- Suitable to accommodate a 2.5 ha HVAC Booster Station and associated working areas;
- Generally flat;
- Benefitting from some existing landscape screening/landscape framework;
- Unconstrained by existing services and utilities;
- Avoid flood zone 3; and
- Accessible for construction/delivery of abnormal loads.

Heat Mapping Exercise

3.4.3.2 After establishing the search area an initial constraints based heat mapping exercise utilised the following datasets to identify areas that could be excluded from consideration and/or indicate the least environmentally constrained locations within the search area:

- Areas designated for landscape importance (AONB);
- SNCI/designated sites (SAC/SPA/SSSI/Ramsar/NNR/LNR/CWS/RSPB Reserves);
- Flood Risk Zone 3 areas;
- Settlements and residential development;
- Historic Parks and Gardens;
- Sites allocated for development in the relevant Development Plans;
- Scheduled Ancient Monuments and Listed Buildings;
- Substantial Wooded Areas;
- Ancient Woodland;
- Conservation Areas;
- Active landfill areas;
- Surface water features;
- National Trust and Forestry Commission Land;
- Registered Common Land;
- Approximate airfield locations; and
- Designated open space.

3.4.4 Appraisal

3.4.4.1 The site selection process resulted in the identification of three potential sites for further investigation:

- Option A (Pond Hills);
- Option B (Holt Farm); and
- Option C (Little Barningham).

3.4.4.2 The onshore ECR was split into three to provide an ECR option to each potential onshore HVAC booster station option, taking account of the same siting constraints as outlined above. These ECR options then all re-joined the main onshore ECR to the south of Option C. Figure 3.17 provides an overview of these sites and their associated ECR corridor options.

3.4.4.3 An assessment of the three shortlisted sites and their associated ECR corridors was undertaken to determine a preferred option. This was supported by previous site visits of the wider area conducted in the Summer of 2016. During these site inspections further consideration was given to matters such as topography, access, landscape framework/screening, hydrology and ground conditions in order to supplement the desk top work that was carried out. As part of the wider scoping boundary, the sites had been the subject of desk top heritage assessment and phase 1 ecology surveys, information that was also considered.

3.4.4.4 Option C (Figure 3.20) was considered to be the least constrained from a commercial perspective due to its availability, existing access arrangements and land available to implement landscape mitigation in the form of screening. Option A (Figure 3.18) was considered to have the greatest impact on the landscape due to the need for its associated ECR corridor to remove woodland vegetation. Option C was also considered more favourable in terms of its relationship to the ECR corridor, compared with Options A and B where the corridor is less direct and routes in closer proximity to the village of Edgefield.

3.4.4.5 Feedback from the Phase 1.B Community Consultation process expressed strong concerns regarding Option A on the basis that this particular site is valued by local communities and visitors to the area. The proximity of Options A and B (Figure 3.19) to areas of conservation including the Glaven Conservation Area and listed buildings meant Option C was seen more favourably. Furthermore it was noted that of the three options, Option C has the most direct ECR corridor and was furthest from public footpaths.

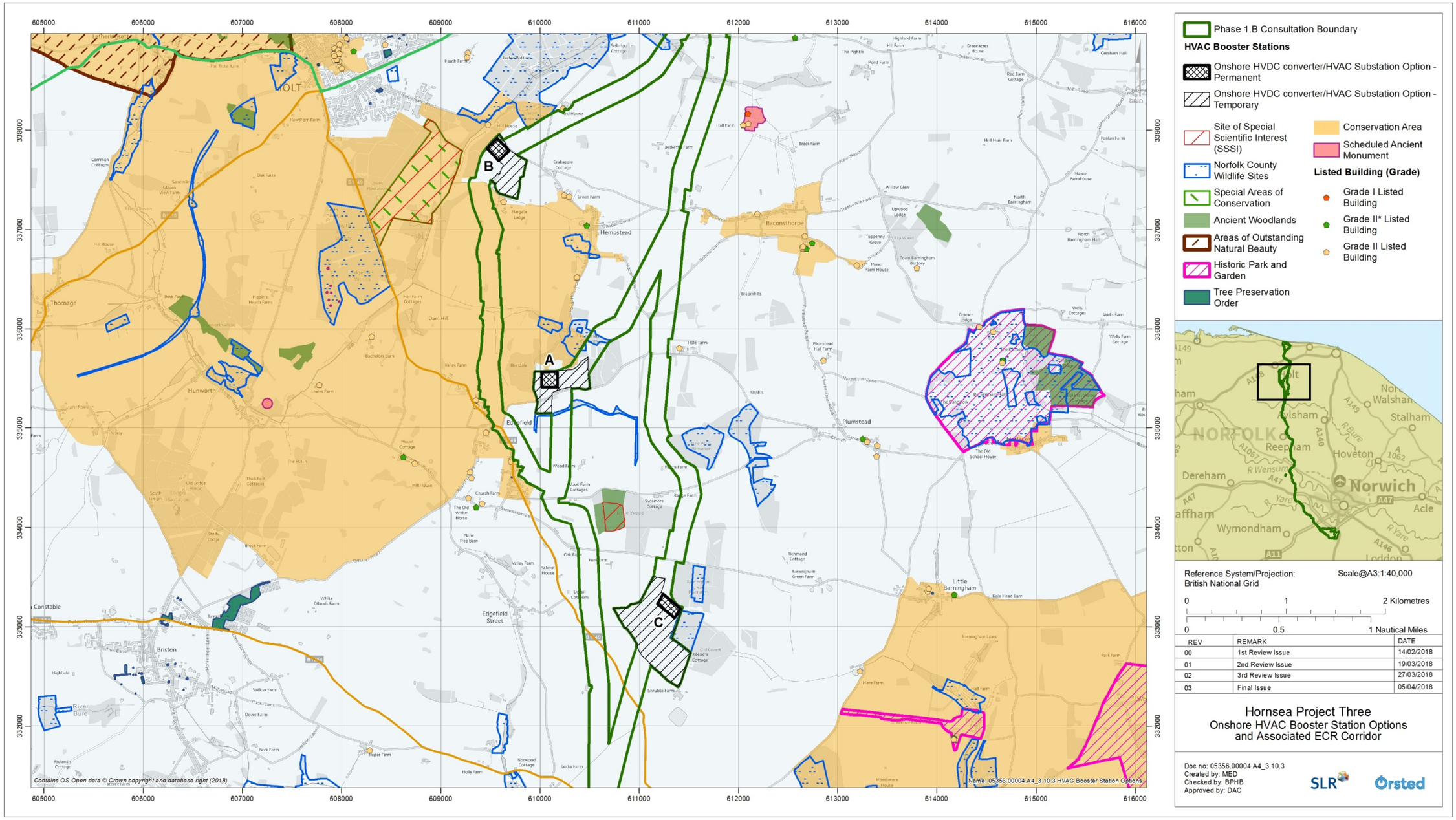

Figure 3.17: Onshore HVAC Booster Station options and associated ECR corridors.

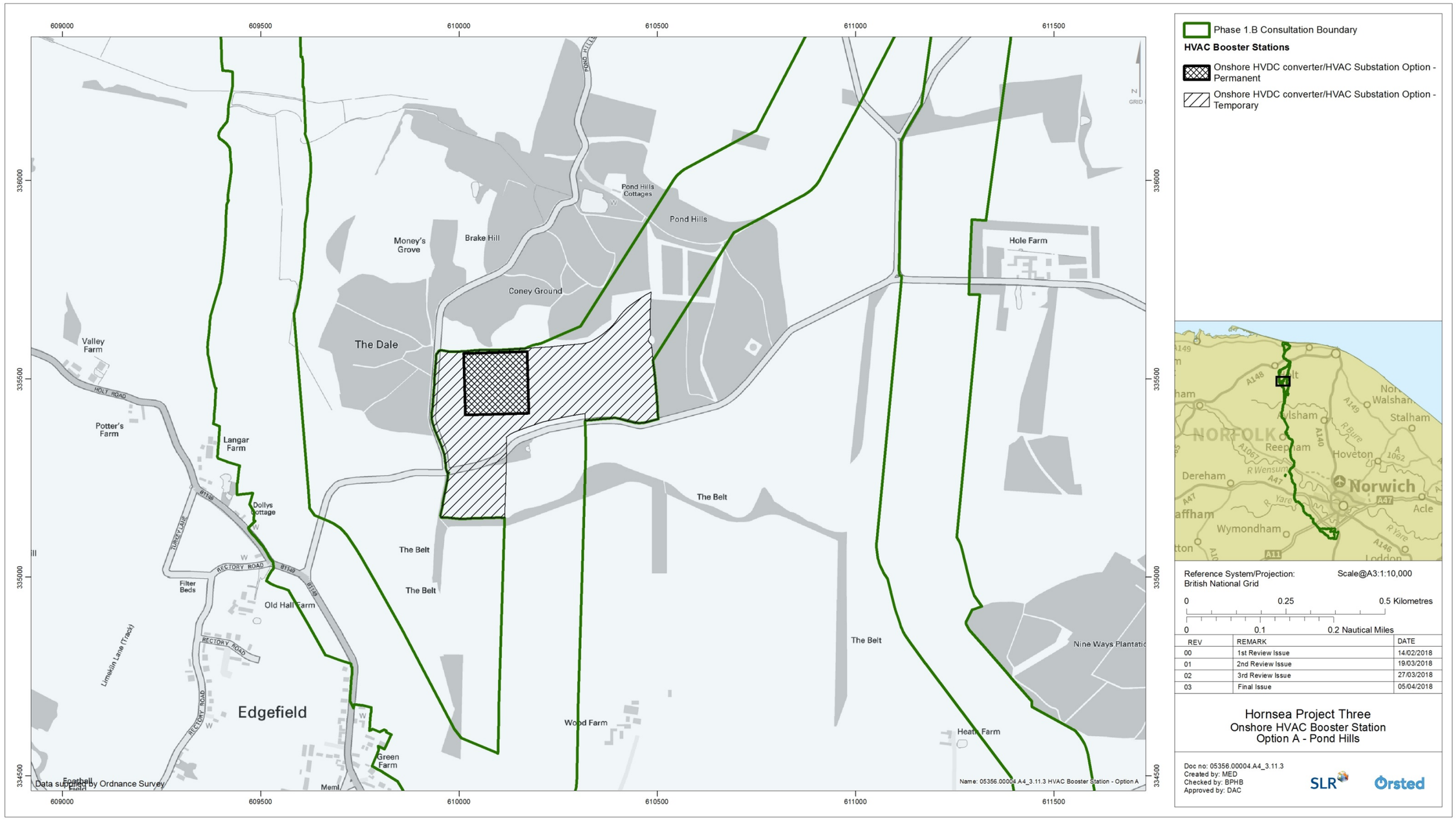

Figure 3.18: Onshore HVAC Booster Station Option A – Pond Hills.

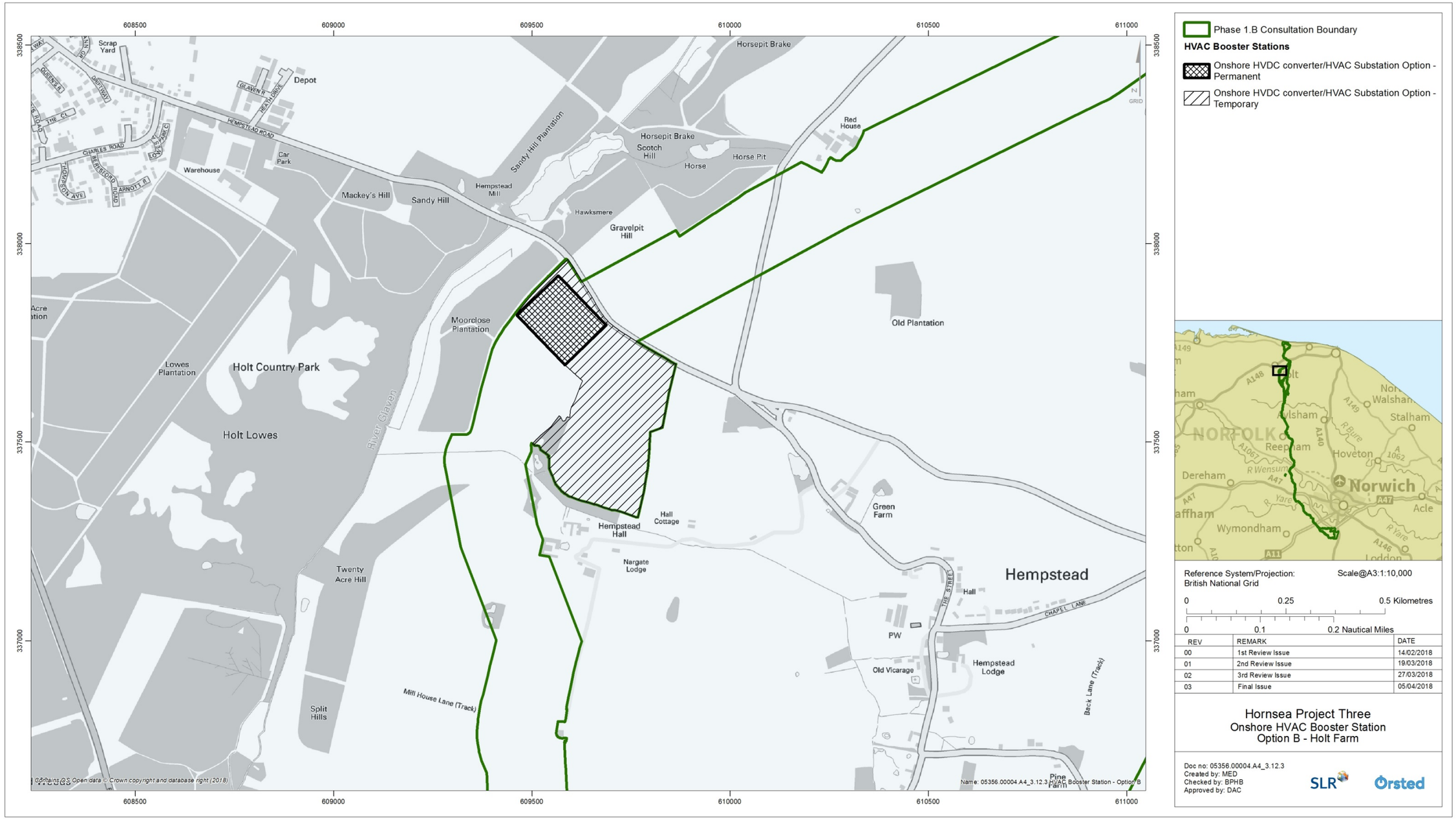

Figure 3.19: Onshore HVAC Booster Station Option B – Holt Farm.

Figure 3.20: Onshore HVAC Booster Station Option C – Little Barningham.

3.4.5 Conclusion

3.4.5.1 Based on the appraisal of commercial, environmental and technical constraints alongside the Horlock Rules, and taking account of consultation with both Statutory Stakeholders and the local community, it was concluded that onshore HVAC booster station Option C "Little Barningham" was selected as the preferred option to be taken forwards for assessment at PEIR. The ECR corridors associated with onshore HVAC booster station options A and B were therefore removed from the PEIR boundary.

3.5 Construction Compounds

3.5.1 Description

3.5.1.1 Construction compounds of various sizes will be required along the onshore ECR corridor for:

- the laydown and storage of materials and plant, as well as space for small temporary offices, welfare facilities, security and vehicle parking for staff;
- crossings of other infrastructure to house operations such as drilling works;
- joint bay and link box construction; and
- a central base (main compound) for the onshore construction works and would house the central offices, welfare facilities, and stores, as well as acting as a staging post and secure storage for equipment and component deliveries.

3.5.1.2 Compounds storage would be identified at a later stage once the ECR route was more defined.

3.5.2 Principles

3.5.2.1 The main construction compound does not need to be located on the route itself but on a suitable site in a central location in close proximity to the ECR, taking account of the siting constraints considered in appraisal of the substation and HVAC booster station options.

3.5.3 Options Considered

3.5.3.1 Three potential locations for a main compound (of up to 4.5 ha in area) were identified within the jurisdiction of Broadland District Council (See Figure 3.21). In addition, a fourth potential compound was identified that was not assessed within the PEIR, at Oulton airfield (See Figure 3.21). This was as a result of further design refinements and design optimisation following consultation with landowners, responding to emerging findings from ongoing environmental assessments and also to further reduce and offset the potential environmental effects. It is nonetheless noted that compound options continued to be reviewed as the compound strategy developed post PEIR.

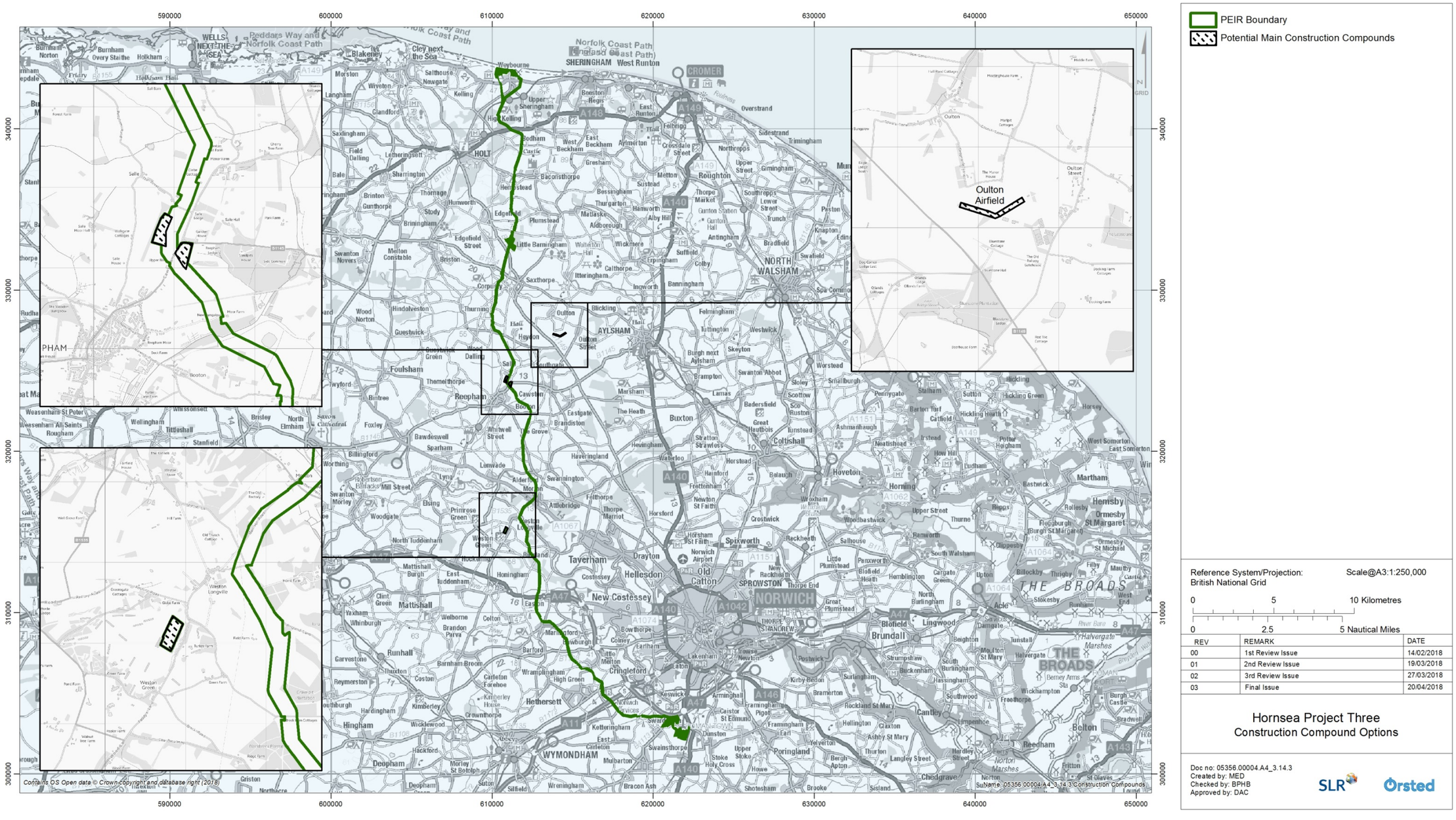

Figure 3.21 Construction Compound Options.

3.5.4 Consideration of alternative route options

3.5.4.1 Prior to Phase 2.A Statutory Consultation, a number of modifications (See Figure 3.22) were made to the onshore ECR and associated infrastructure that were not assessed within the PEIR. This was as a result of further design refinements and design optimisation following consultation with landowners, responding to emerging findings from ongoing environmental assessments and also to further reduce and offset the potential environmental effects. These alternative options were identified by using the same routing criteria that had previously been applied to define the original ECR boundary for the PEIR. These were to:

- Take the most direct route possible;
- Avoid developed areas (housing, commercial, land allocated) where possible;
- Keep cable turns under 90 degrees;
- Minimise major asset crossings (roads, rail lines, rivers) and close proximities to other assets (utilities, drainage networks, etc.); and
- Ensure that opportunities for Horizontal Directional Drilling (HDD) compounds would be present at both ends of any crossing potentially requiring HDD to ensure that the option would be technically feasible.

3.5.4.2 Additionally the route also aimed to avoid the following areas as far as possible (noting that there may be some circumstances where these could not be completely avoided or where it was considered that the required cable corridor could be routed to avoid or reduce interactions to an acceptable level):

- Sites of Nature Conservation Interest (SNCI)/designated sites (Special Area of Conservation (SAC)/Special Protection Area (SPA)/Site of Special Scientific Interest (SSSI)/Ramsar/National Nature Reserve (NNR)/Local Nature Reserve (LNR)/County Wildlife Site (CWS)/Royal Society for the Protection of Birds (RSPB) Reserves);
- Settlements and residential development;
- Historic Parks and Gardens;
- Sites allocated for development in the relevant Development Plans;
- Scheduled Ancient Monuments and Listed Buildings;
- Substantial Wooded Areas;
- Ancient Woodland;
- Active landfill areas;
- Surface water features;
- Active Airfield locations;
- Designated open space; and
- National Trust and Forestry Commission Land.

3.5.4.3 The principal alternative routes/modifications that were identified (as shown by the insets in Figure 3.22) are listed below from north to south:

- Inset 1 shows a proposed alternative re-route at Kelling. The re-route addresses a number of technical and environmental impacts;
- Inset 2 illustrates the access routes to the chosen HVAC booster station. There was no proposed change to the ECR in order to reach the HVAC location;
- Inset 3 shows an alternative route proposed around the Salle Estate. This was identified as a result of feedback from the landowner and also for historic environment reasons;
- Inset 4 relates to minor moves to the ECR, to simplify the design and technical implementation of the HDD of the cables under the River Wensum. The refinements were identified following the results of site specific hydrology surveys with the HDD involving the crossing of a complex of rivers, drainage ditches, the A1067, as well as woodland and wildlife sites;
- Inset 5 shows two minor re-routes in the vicinity of Bawburgh and Little Melton which arose as a result of landowner feedback;
- Inset 6 shows the widening of a bend near Mulberry House. These changes were proposed in order to avoid a band of trees; and
- Inset 7 shows the final choice for the substation location at a larger scale.

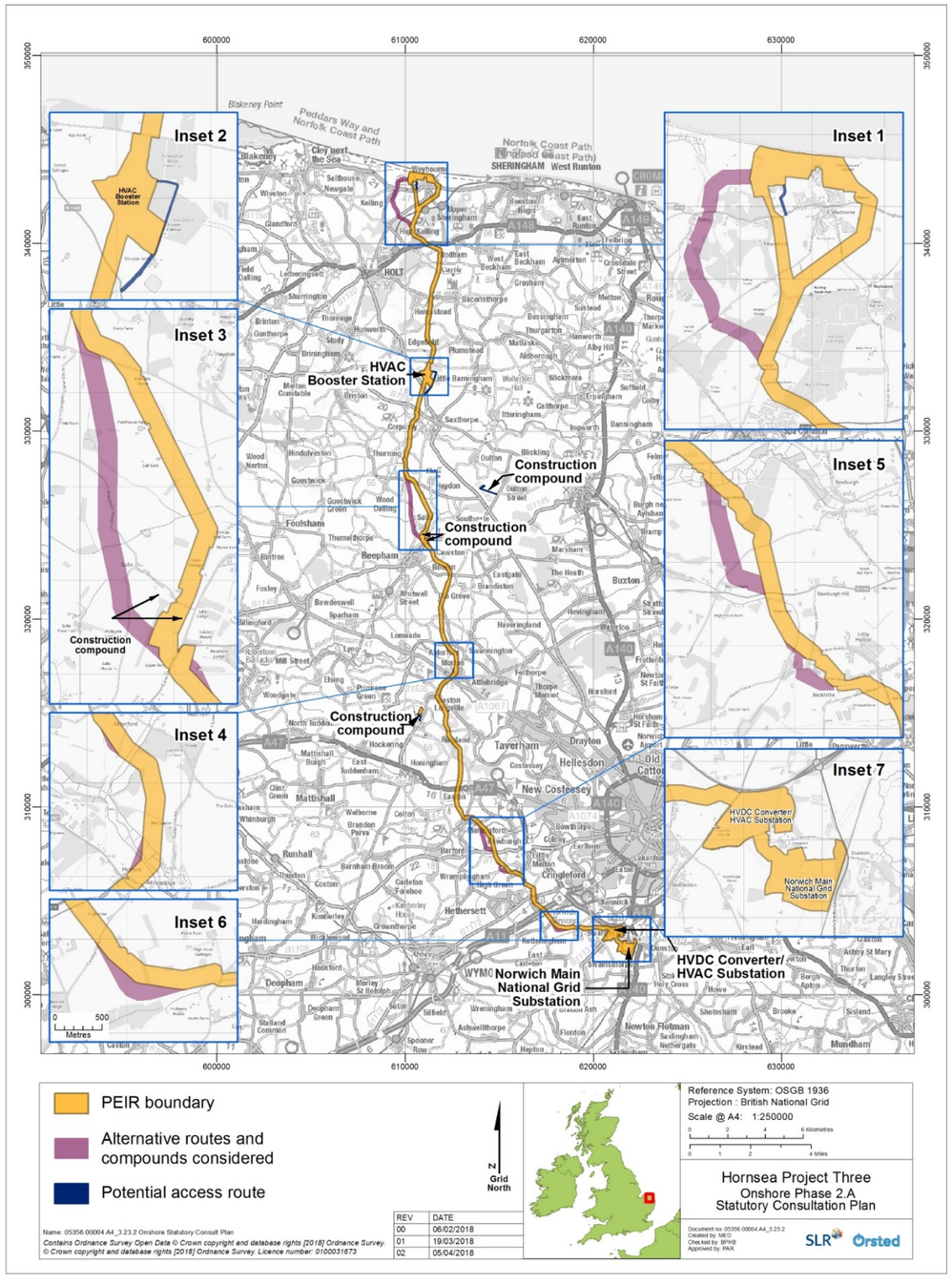

Figure 3.22: Onshore Phase 2.A Statutory Consultation Plan.

3.5.5 Examples of alternative onshore cable route options

3.5.5.1 The following presents an overview of two example options (Figure 3.22: Insets 1 and 3) along with the rationale supporting the decision making process for each refinement.

3.5.5.2 Figure 3.23 and Figure 3.24 show the location of these alternative options along the ECR in greater detail. The first relates to the landfall and routeing near Weybourne and the second relates to a proposed reroute around the village of Salle.

Refined landfall and western re-route

3.5.5.3 From the route options presented in the PEIR documentation, the extent of the landfall area and its routing was further refined following receipt of s42 feedback. These refinements (in no particular order) primarily related to:

- The avoidance of cliffs and coastal geomorphological SSSIs in the landfall search zone which directed the landfall further to the west;
- The requirement to cross a heritage railway in the vicinity of Kelling Heath, where following further consideration the topography of the steep railway embankment in combination with the length of HDD was considered to make this technology unviable;
- Avoidance of the Kelling Heath SSSI and CWS which are designated for their rare habitats of European dry heath, and contain an range of protected/rare insects, reptile and faunal species; and
- Feedback received from local community and landowners in the areas of Kelling and Weybourne.

3.5.5.4 Figure 3.23 illustrates that the PEIR consulted on a fairly wide landfall zone in the order of 1.2 km in lateral extent, just to the north of Weybourne. The viable landfall area was further refined post PEIR, down to the very western side of the PEIR boundary, (shown as the purple alternative route on Figure 3.23). This was due to the presence of cliffs on the eastern side of the search corridor which raised technical design concerns in relation to the feasibility of HDD through the cliffs, in combination with the thermal design requirements for the cables. Both these elements together increased the technical risk of landfall on the eastern side of the search area compared to the other available choices to the west. Additionally, concentrating on the western side of the landfall area would also enable the avoidance of a beach car park, which would help to reduce any social impacts and construction disturbance. This refinement of the landfall area also took into consideration the likely route of the offshore cable and where, or how it was likely to come ashore. At the time of the further statutory (Phase 2.B) consultation that took place in November 2017, a marine cable route approaching the Weybourne coastal zone from the west, was also under consideration.

3.5.5.5 Just south of Weybourne, the presence of a historic railway also provided another good reason to re-route the ECR that was presented in the PEIR, due to the difficulty of implementing HDD under the steep railway embankment. Even if a technical solution to the HDD could be identified, the combination of the required depth of the HDD, the varied topography of the area, the required length of the HDD, and the difficulty of access, in combination with stakeholder concerns, all combined together to create very significant risks to the project.

3.5.5.6 In general most design choices are not considered technically insurmountable, as most options are usually technically feasible in some way. However increasingly difficult tasks and complex design can quickly escalate the risk of a project. This logically means that the less difficult alternative, subject to being acceptable and not impacting on other environmental constraints such as designated sites, is more preferable and the option that is taken forward.

3.5.5.7 Finally, the presence of the CWS and the Kelling Heath SSSI to the south-east and south-west of Weybourne respectively, would also create a very constrained working area for the cable routing, if it were to completely avoid any ecological effects on the designated ecological receptors.

3.5.5.8 In summary, a combination of the presence of cliffs on eastern side of the landfall search area, the technical complexity of the historic railway crossing near Kelling Heath, the presence of the SSSI and CWS and stakeholder feedback meant that the logical project decision would be to re-direct the ECR to the west of Weybourne, circumnavigating around the SSSI before continuing south along the PEIR route corridor.

3.5.5.9 This alternative route was later chosen as the preferred route for the ECR as presented in this Environmental Statement.

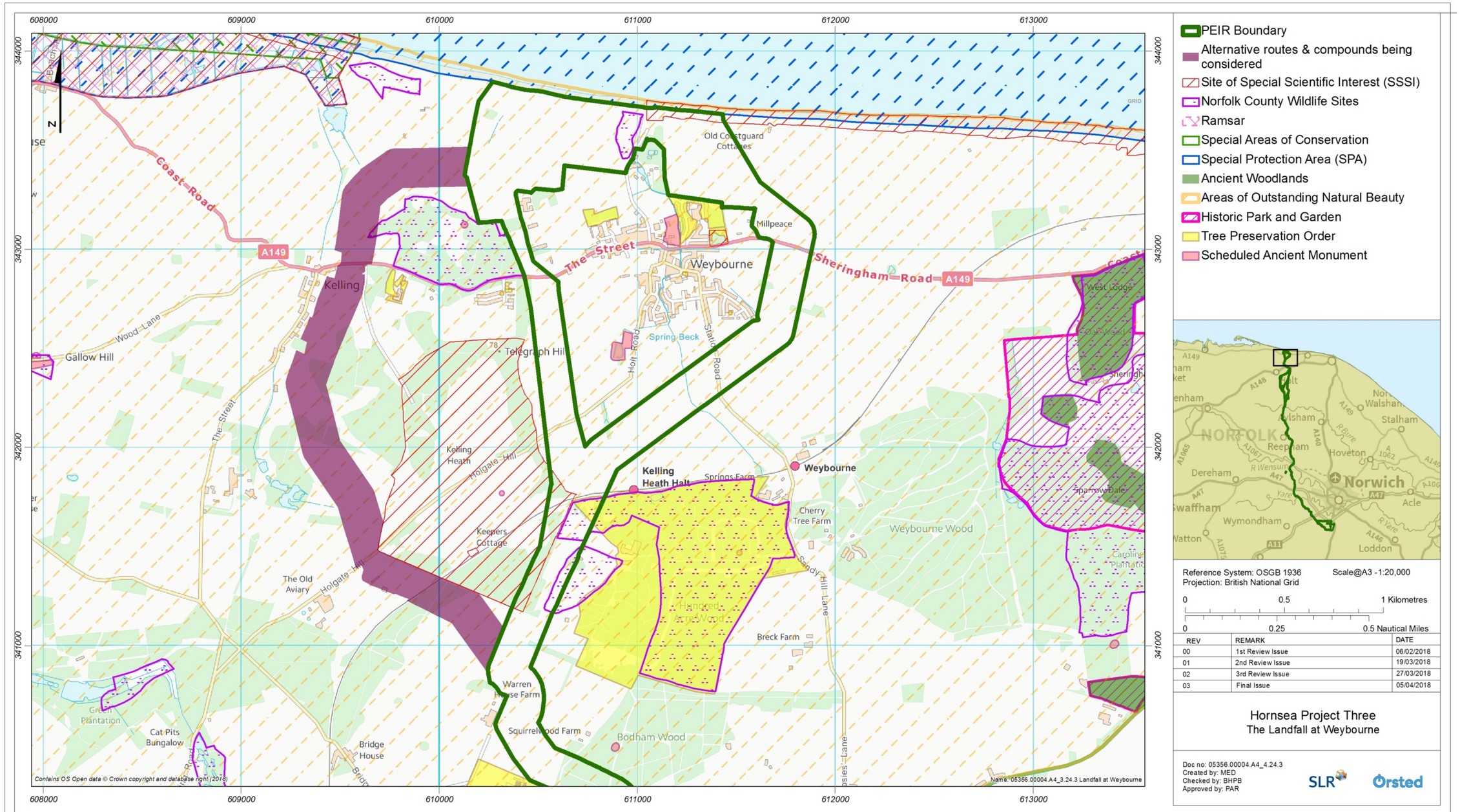

Figure 3.23: The Landfall at Weybourne.

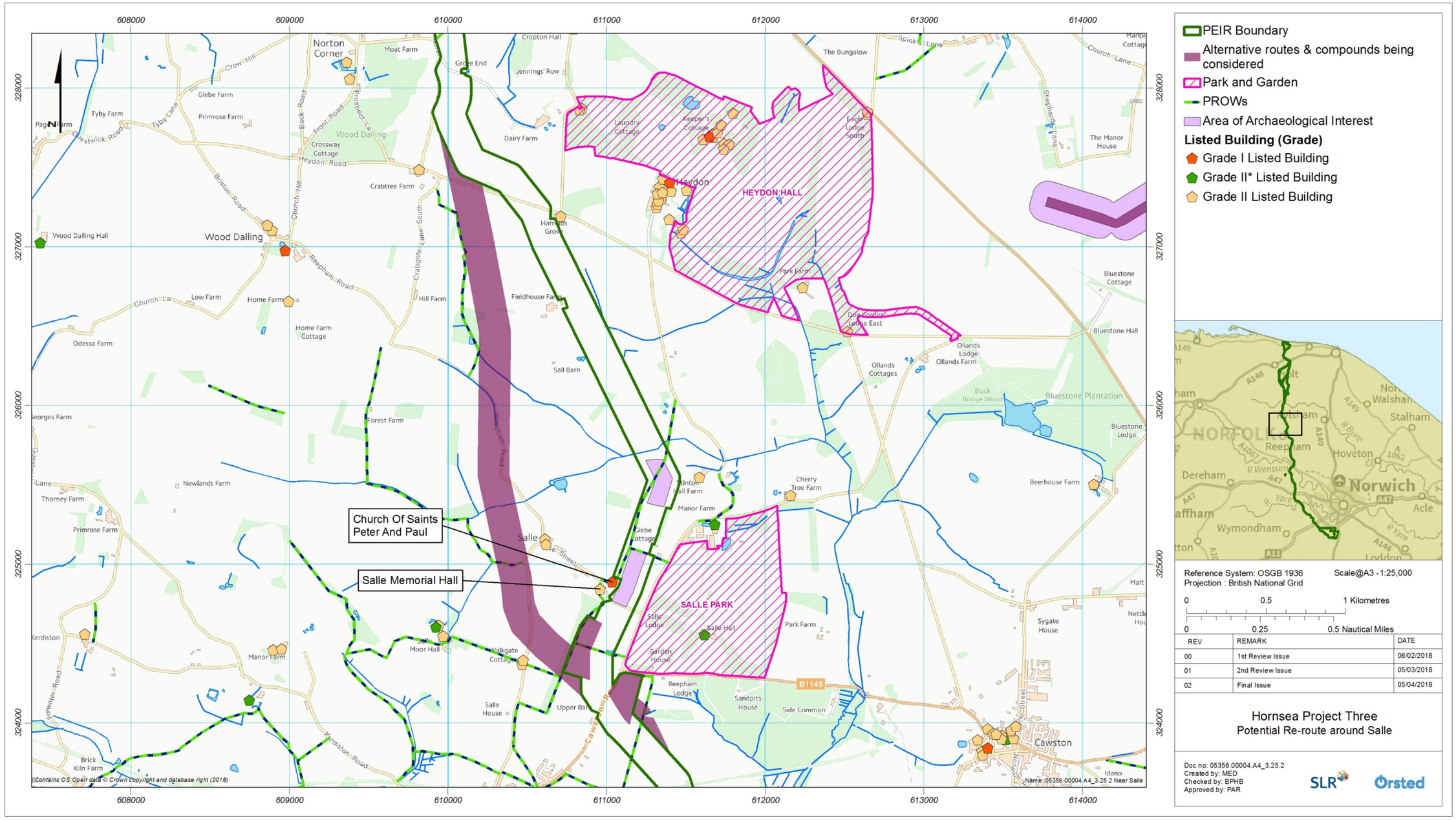

Figure 3.24: Potential Re-route around Salle.

Listening to consultation feedback – a re-route around Salle

3.5.5.10 Pre-PEIR informal landowner consultation sought feedback on the ECR corridor and the landowner suggested a change to the route near the village of Salle, north of Reepham, see Figure 3.24. This alternative route, which did not have time to be assessed was presented in the PEIR, as one of the potential additional routes.

3.5.5.11 The landowner requested a change to the route of the ECR in order to relocate it to an area of lower quality soil and drainage in order to minimise good quality land take. The requested change also allowed the cable route to:

- Be located further from the Salle Hall Estate (Salle Park) and Salle Church Grade I Listed Building and Grade II Listed Salle Memorial Hall;
- Avoid a small number of ecological ponds;
- Avoided some potential archaeological remains which had been identified during archaeological walkover surveys of the preferred route;
- Avoid a wider section of a tributary of the River Wensum; and
- Reduce the requirement to cross public right of ways (PRoWs).

3.5.5.12 This solution, which also addressed a number of other landowner requests, provided a serviceable but less direct route that was potentially less constrained than the pre-PEIR route. It was also viable from a technical and engineering perspective, and additionally, it did not unnecessarily prolong the route compared to the previous option.

4. Conclusion and Next Steps

4.1.1.1 The onshore site selection and refinement work within this Annex took account of design refinements and optimisation, consultation with landowners and emerging findings from ongoing environmental assessments (section 3.6 above) and incorporated it into the information presented at Phase 2.A Statutory Consultation. This included the following onshore project components that were subject to an assessment of the likely environmental impacts:

- Landfall Zone refinement and ECR route options in the vicinity of Weybourne;
- A preferred onshore HVDC converter/ HVAC substation;
- A preferred onshore ECR search area including consideration of alternative route options;
- A preferred onshore HVAC booster station; and
- Four potential locations for construction compounds.

4.1.1.2 While not assessed as part of the PEIR submission, the route modifications identified in section 3.5.4 were also included within the package of documents consulted upon at Phase 2.A Statutory Consultation.

4.1.1.3 The Project considered that these options and refinements were sufficiently justified and narrowed down to enable stakeholders to meaningfully comment on the proposed scheme and its potential effects on the receiving environment.

4.1.1.4 Feedback on this consultation as well as Phase 2.B (Further Statutory Consultation) and Phase 2.C (Focussed Statutory Consultation) is documented within Annex 4.4, Post PEIR changes to Hornsea Project Three (stages 8-9).