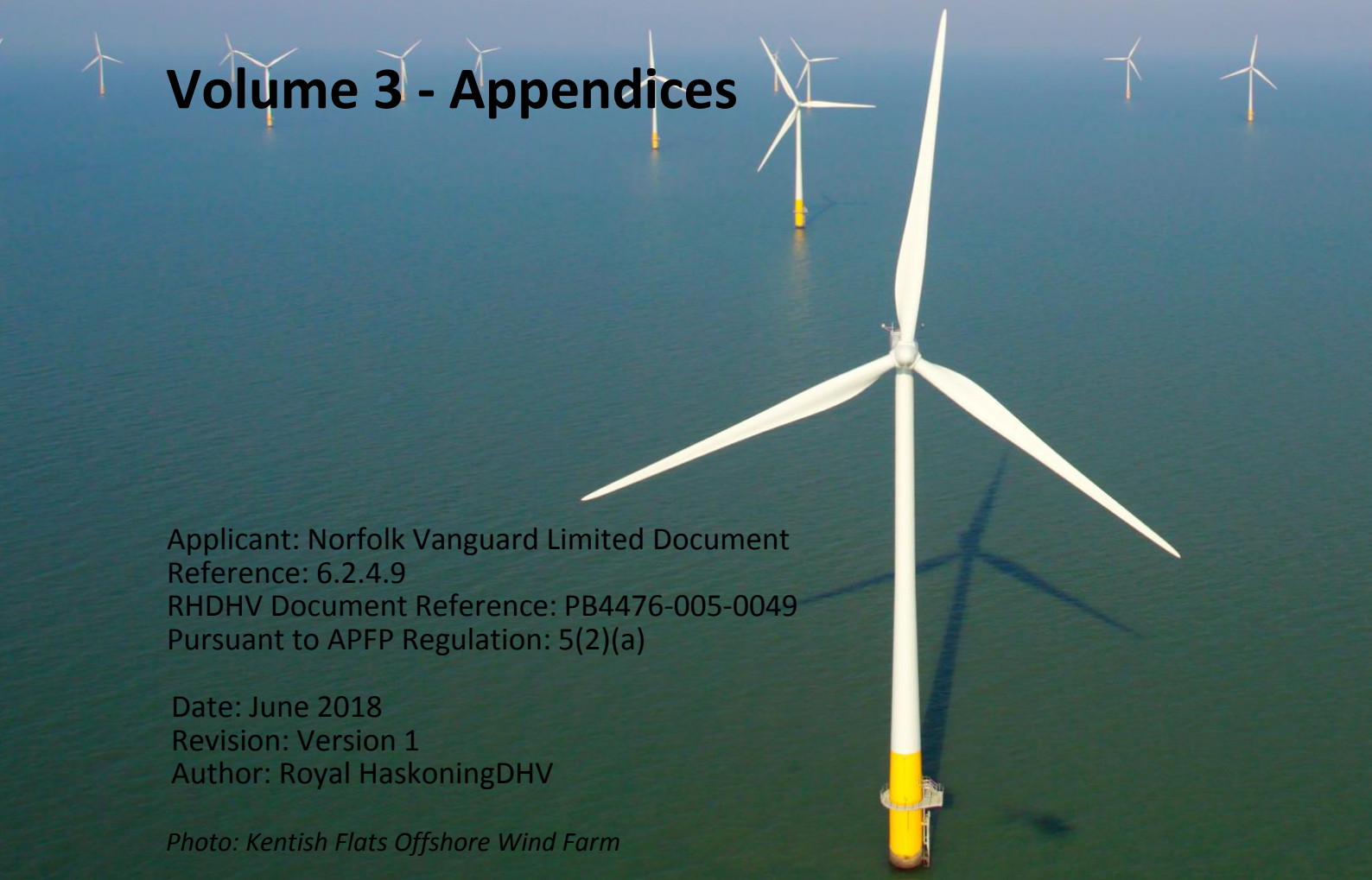
Norfolk Vanguard Offshore Wind Farm

Appendix 4.9

Onshore Project Substation Site Selection

Environmental Statement

Volume 3 - Appendices



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Environmental Impact Assessment
Environmental Statement

Document Reference: PB4476-005-0049

June 2018

For and on behalf of Norfolk Vanguard Limited

Approved by: Ruari Lean, Rebecca Sherwood

Signed: [redacted]

Date: 8th June 2018

REPORT

Onshore Project Substation Site Selection

Client: Norfolk Vanguard Limited

Reference: PB4476

Revision: 0.1/Final

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Classification
Project related

1 Introduction

The overall purpose of this report is to present the assessment undertaken to identify the most suitable site for locating the onshore project substation for Norfolk Vanguard, considering the environmental constraints.

2 Refining the Substation Search Area

The purpose of this report is to demonstrate how high-level environmental considerations and consultation were considered from an early stage of the site selection process, in order to identify the environmental risks and opportunities associated with the substation search area. This builds upon the previous substation site selection work, which characterised the 3km substation search area using high level environmental data sets.

2.1 Constraints Mapping

The substation search area was consulted upon as part of the Scoping Report (Royal HaskoningDHV, 2016), as well as during community drop in exhibitions, and face to face discussions with landowners, stakeholders and regulators. The search area was also presented widely through the project website and newsletters. Environmental constraints of the substation search area were also considered as part of the site selection in order to understand potential environmental risks and opportunities.

Key environmental constraints were considered individually, and then collated as part of an overall constraints mapping exercise, which looked at a range of environmental datasets currently held and this process is demonstrated in Plate 1 to Plate 5 below.

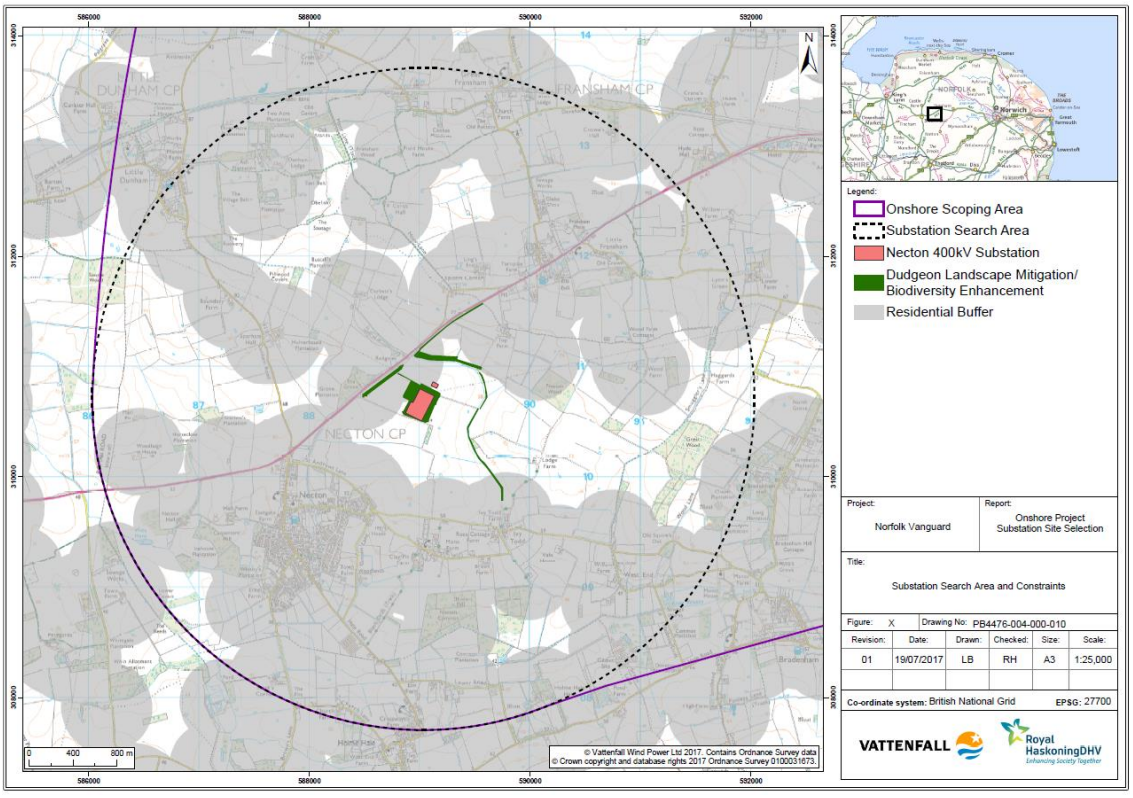

Plate 1 Residential buffer

Based on mitigated noise levels, an indicative buffer of 517m was applied to all residential properties within the onshore project substation search area to identify areas with increased separation distance in order to minimise potential impacts.

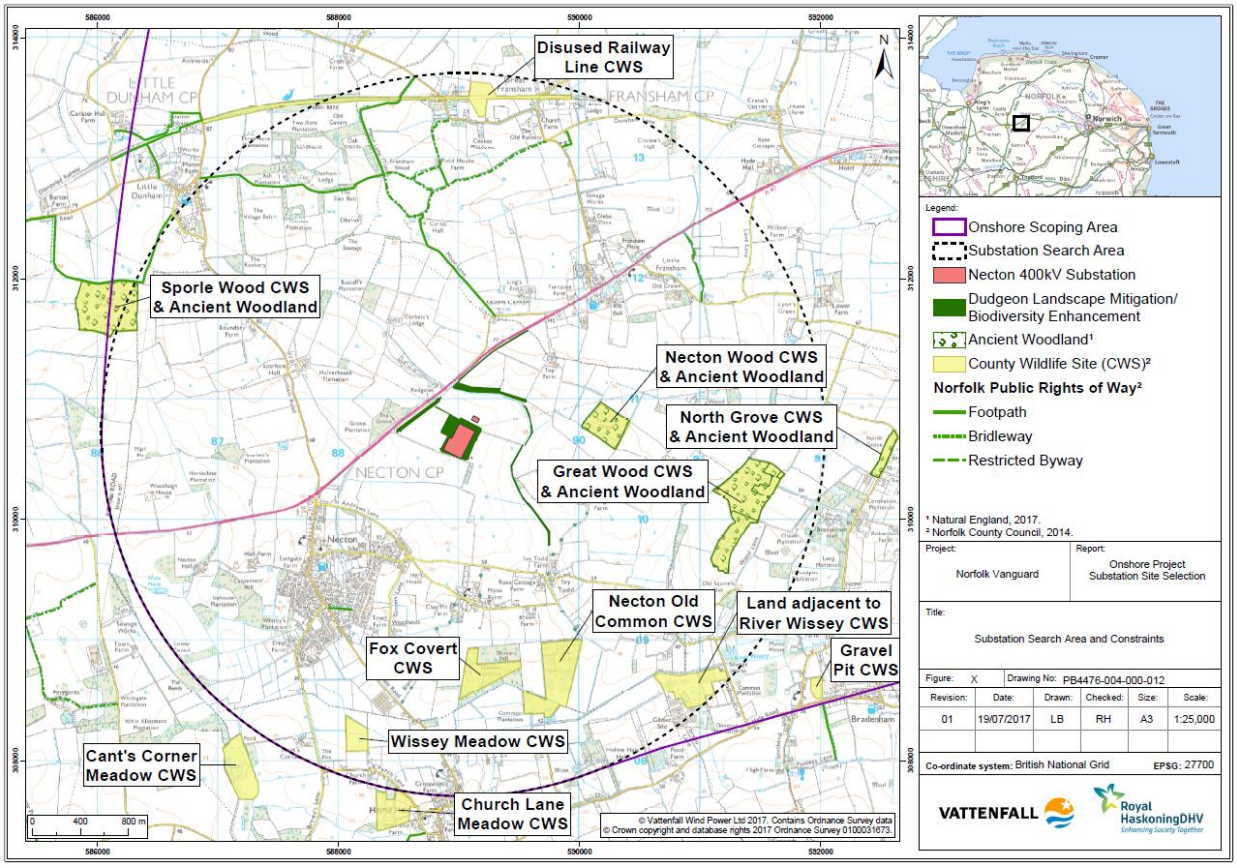

Plate 2 Ecological designations within the Substation Search Area

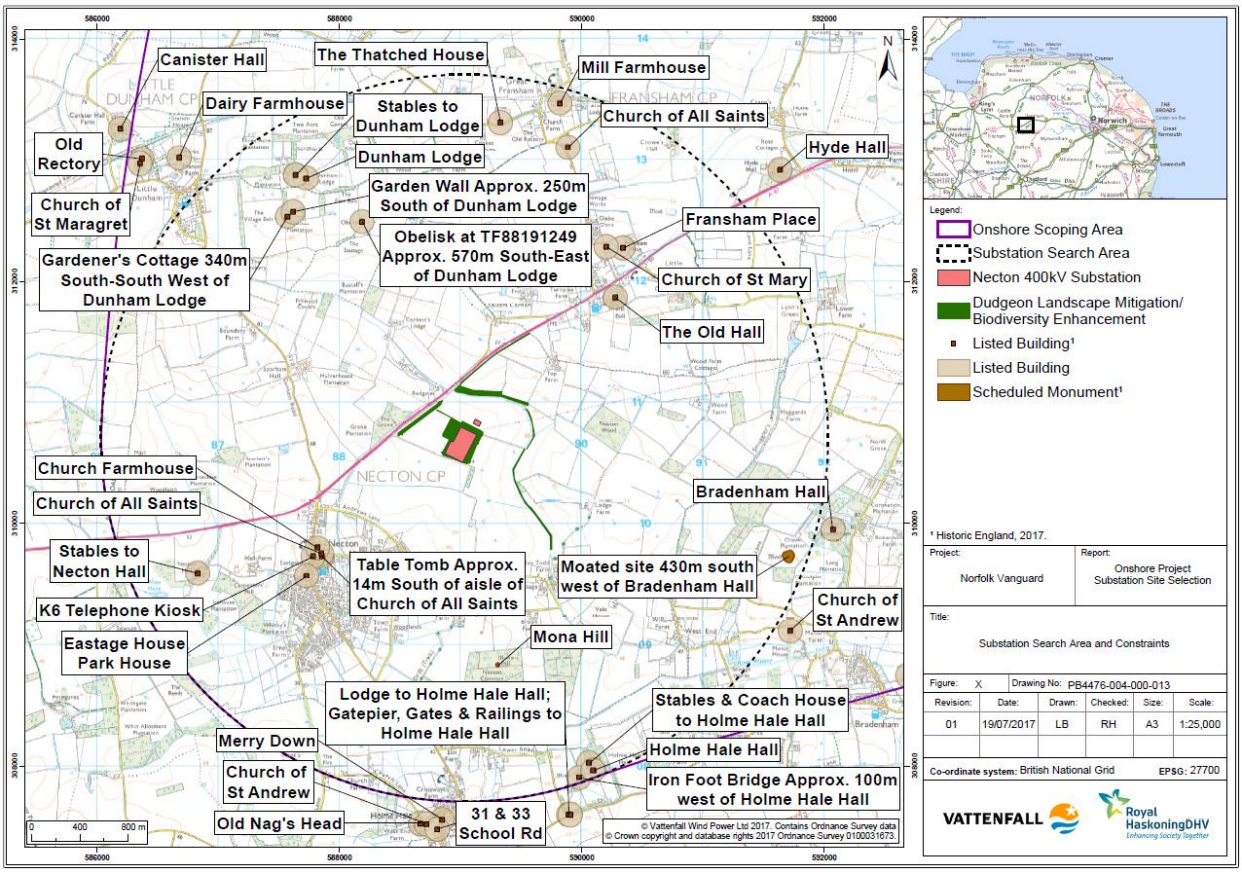

Plate 3 Heritage Assets within the Substation Search Area

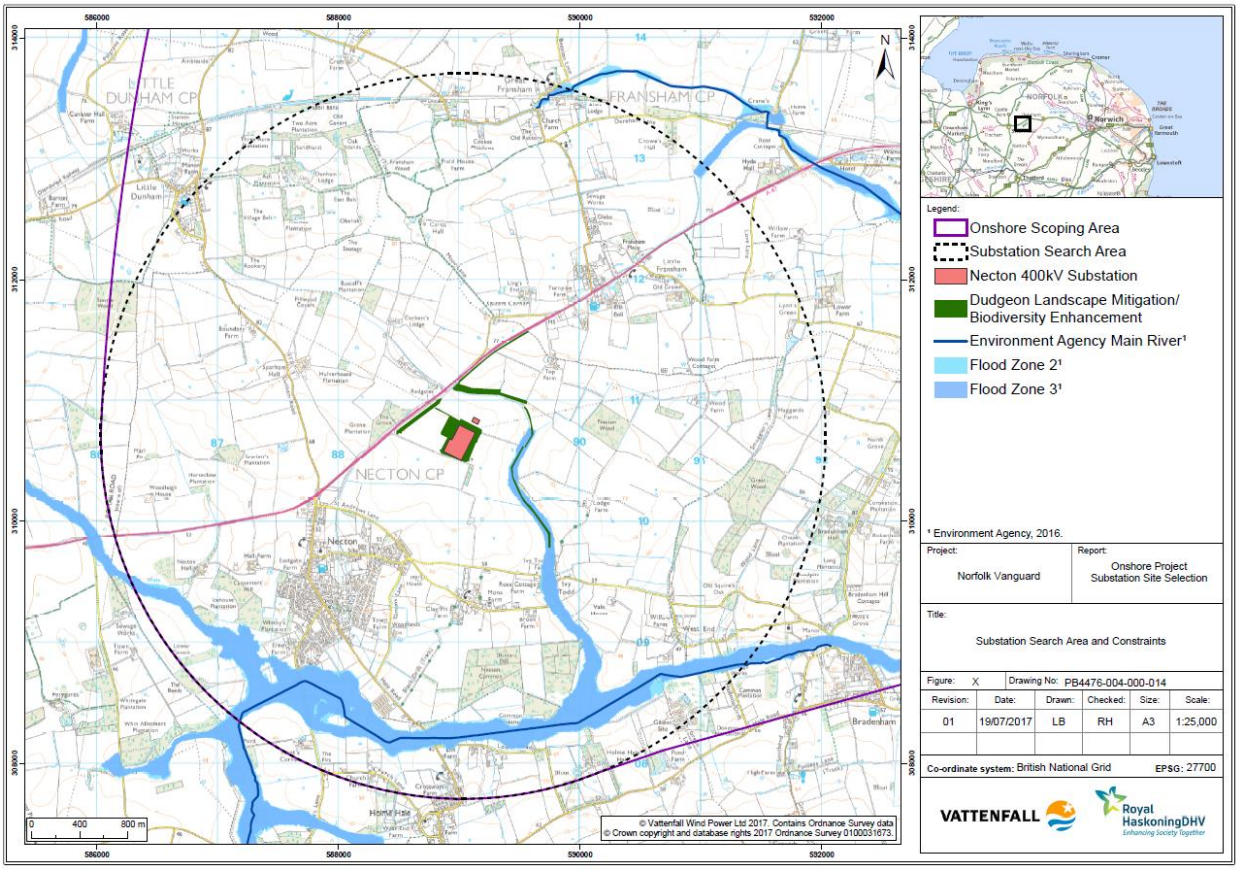

Plate 4 Flood Zones within the Substation Search Area

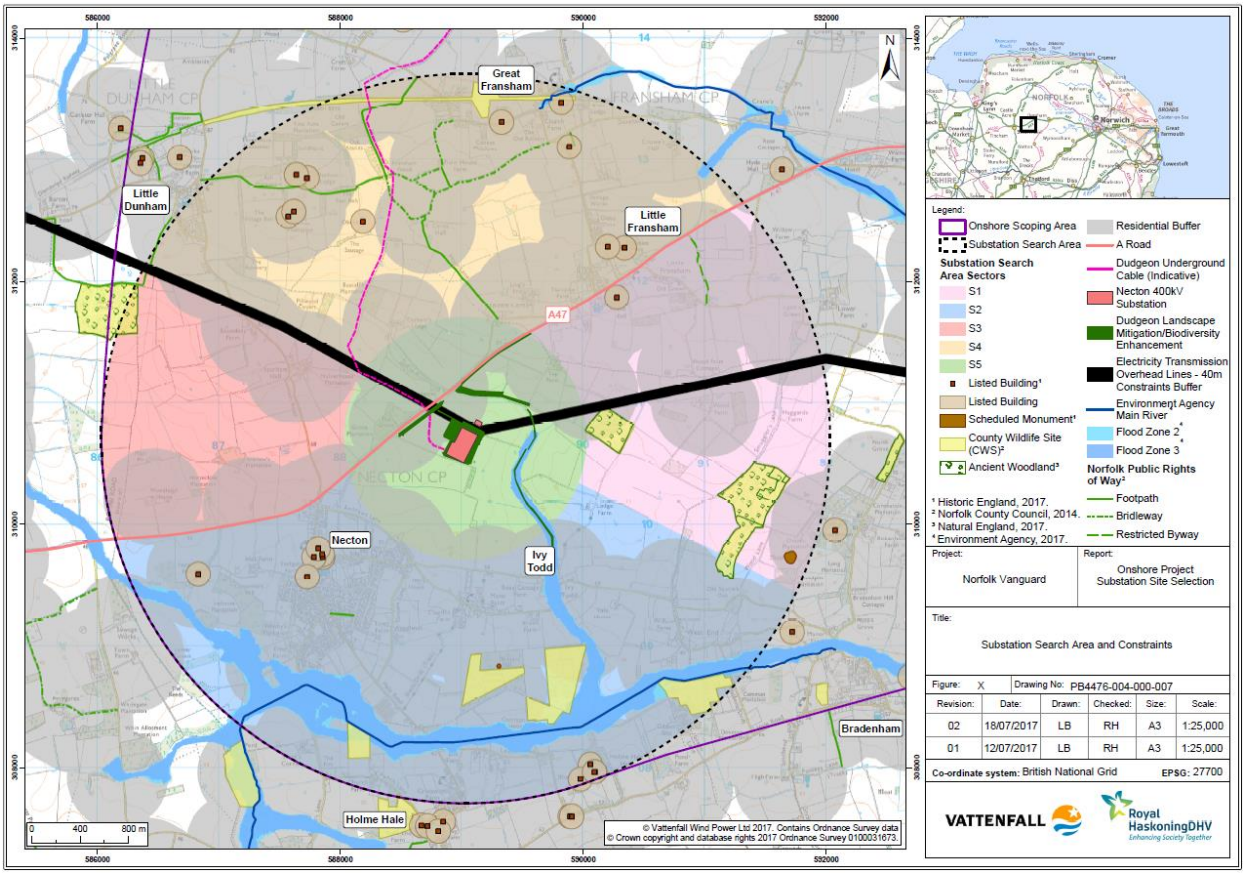

Plate 5 Substation Search Area Sectors and Constraints

Reviewing the collated constraints mapping results, as shown in Plate 5, the least constrained areas (and therefore the areas of least environmental risk) within the substation search area were sector 1 and sector 5 (the green and pink sectors respectively). These sectors had the least environmental risk, due to the absence of PRoWs and environmental designations e.g. ecological and archaeological features, as well as being less influenced by the residential buffer zones, compared to the other three remaining sectors. With the proposed cable corridor approaching from the east, sector 1 and 5 also represent areas which would allow the most direct cable route to reduce transmission losses.

The benefits of these least constrained areas, as shown in Plate 5, are that:

- Sector 1 (pink sector) contains existing natural screening (in accordance with the Horlock Rules) afforded by Great Wood, Necton Wood and a network of hedgerows in order to potentially reduce landscape and visual impacts; and
- Sector 5 has the advantage of aggregating electrical infrastructure in proximity to the existing National Grid substation which reduces transmission losses and also keeps intrusion of electrical infrastructure into surrounding areas to a reasonably practicable minimum. However, consideration also needs to be given to the substation extension requirements to be undertaken in this area which have additional land take requirements.

These sectors were therefore preferred for identifying a suitable location for the onshore project substation.

2.2 Identification of the 'Keyhole' Search Area

As a result of the above considerations, the onshore project substation search area was refined to a 'keyhole' shape as demonstrated in Plate 6.

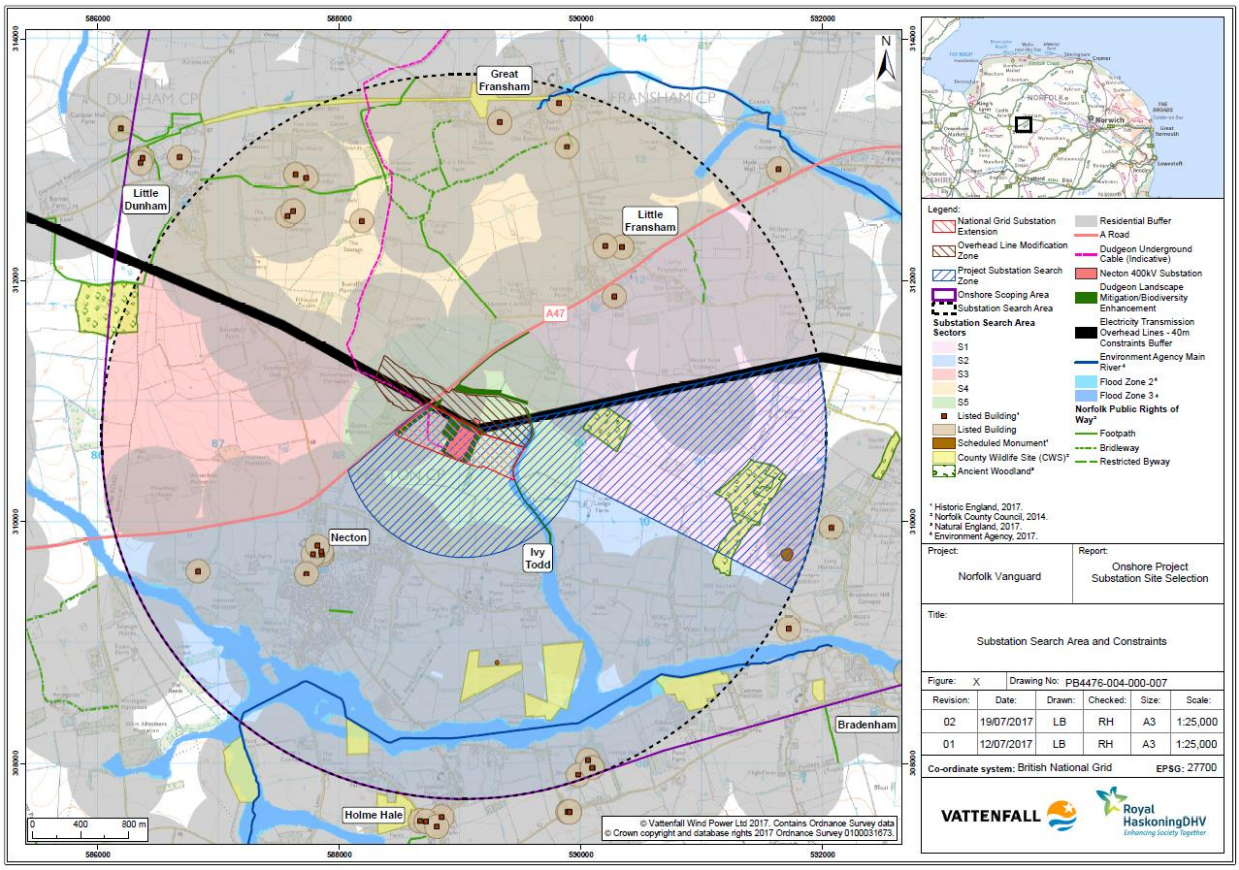

Plate 6 Keyhole Search Area in relation to Substation Search Area

This refined 'keyhole' area was presented as part of the March 2017 community events and stakeholder meetings, as well as being circulated through the project website and newsletter. Although there are some environmental constraints still present within this refined 'keyhole' search area, these are considered low risk/acceptable. In addition, there are micrositing opportunities available and sufficient land availability to accommodate the co-location of the onshore project substations for Norfolk Vanguard and Norfolk Boreas, the 'sister' project to Norfolk Vanguard. Co-location of both projects substations was a design principle taken forward into the site selection process.

2.3 Identification of the Refined Onshore Project Substation Zone

Since March 2017, the keyhole area was refined through more detailed consideration of constraints drawing on a range of engineering and environmental expertise and informed by further discussion with landowners and stakeholders to the 'refined onshore project substation zone' shown in Plate 7 below.

The main benefits of the refined onshore project substation include:

- Siting the substation as far away from the village of Necton as possible based upon other existing constraints within the refined area;
- Maintaining proximity to the Necton National Grid substation;
- Maximising opportunities associated with existing natural screening (in accordance with the Horlock Rules) afforded by Great Wood, Necton Wood and a network of hedgerows in order to potentially reduce landscape and visual impacts; and
- Located away from nearby residential receptors within the keyhole area.

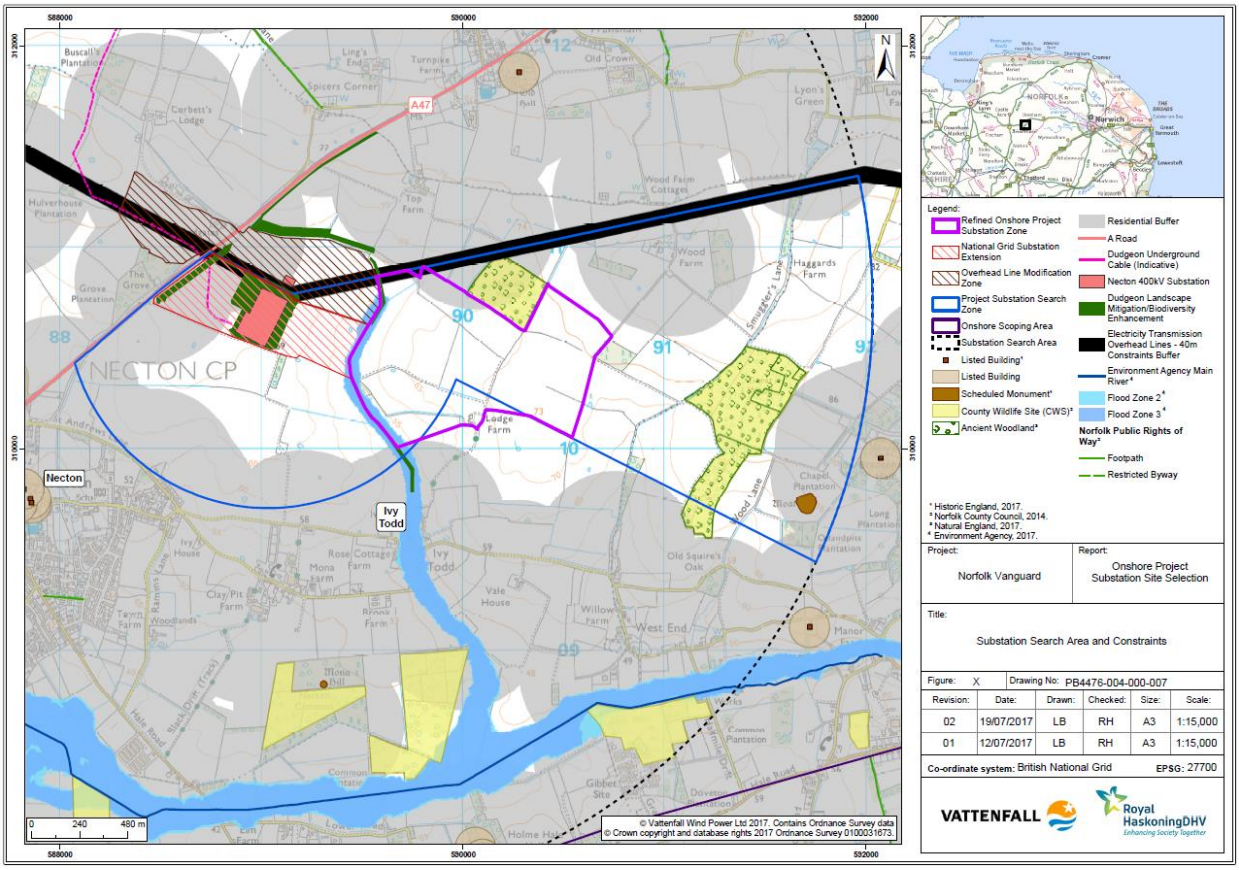

Plate 7 Refined Onshore Project Substation Zone

3 Footprint Options

The purpose of this section of the technical note is to identify the environmental risks associated with each of the proposed substation footprint locations.

3.1 Design Assumptions

Following the initial constraints mapping exercise, as well as consideration of technical constraints and information gathered at site visits and consultation events, four sites were identified for further investigation. The specific design principles / requirements used in identifying preferred location options for the onshore project substation locations included:

- An area of 250m x 300m for Norfolk Vanguard (see Chapter 5 Project Description for the onshore project substation dimensions) and requirements;

- An area of 200m x 100m for a temporary construction compound;
- Access from the A47 during construction and operation;
- Use of existing features present (woodland and topography) to aid screening;
- Avoid Public Rights of Way (PRoW);
- Avoid siting under overhead lines and other utilities;
- Avoid siting within Flood Zones 2 and 3;
- Avoid residential properties;
- Avoid where possible key archaeological assets; and
- Avoid where possible ecological habitats.

Due to the strategic nature of the development of Norfolk Vanguard and Norfolk Boreas, the potential to co-locate the onshore project substations for both projects was also a key consideration in identifying location options.

3.2 Footprint Options

Within the Project Design, the four co-located footprints considered for the substation site are shown on Plate 8.

- Option 1;
- Option 2;
- Option 3; and
- Option 4.

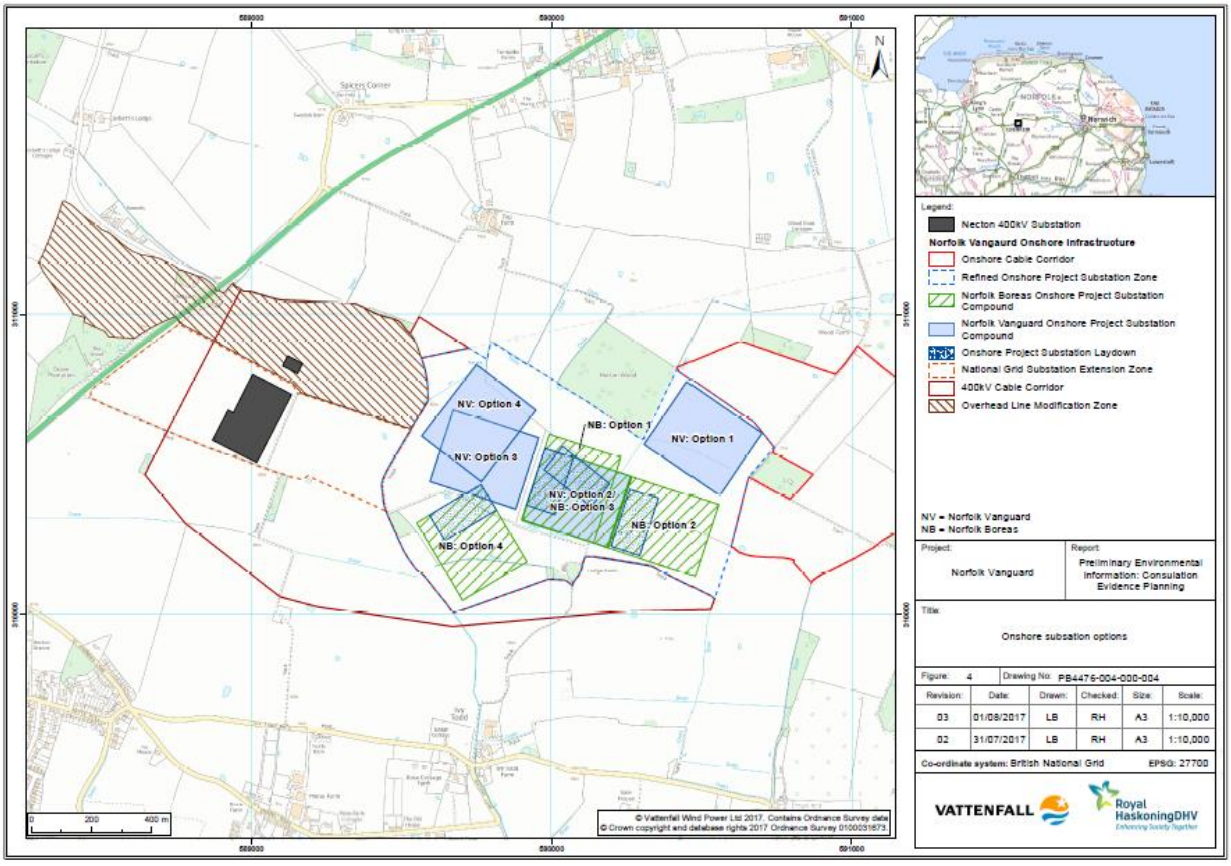

Plate 8 Substation Footprint Options

3.3 Background and Aim of the Environmental Assessment

The environmental risks associated with each footprint for the substation in relation to the following technical topics are presented:

- Water resources and flood risk;
- Ground conditions and contamination;
- Archaeology and cultural heritage;
- Noise and vibration;
- Traffic and transport;
- Land use and agriculture;
- Air quality;
- Ecology;
- Ornithology;
- Landscape and visual impacts;
- Socio-economics; and
- Tourism and recreation.

4 Methodology

For the locations identified, a risk classification matrix has been applied based on a qualitative assessment and expert judgement.

The classification system used to score these considerations is shown in Table 4.1.

Table 4.1 Classification for development considerations for the environment

Grey	Hard constraint / unacceptable risk to the environment
Red	Major risk to the environment
Amber	Minor risk to the environment
Green	Unlikely to pose risk to the environment

5 Assessment Results

5.1 Water Resources and Flood Risk

All options require temporary construction compounds that will impact upon field drains. There are no anticipated differences between the options presented in relation to flood risk.

The following compound locations will require the diversion/removal of drains:

- Norfolk Vanguard Option 2;
- Norfolk Vanguard Option 4.
- Norfolk Boreas Option 1;
- Norfolk Boreas Option 3; and
- Norfolk Boreas Option 4.

When considering the co-location of Norfolk Vanguard and Norfolk Boreas, Options 1, 2 and 3 would be preferred over Option 4, as Option 4 requires the diversion/removal of field drains for both the Norfolk Vanguard and Norfolk Boreas compounds.

All options are considered to be **amber** with regards to development considerations for water resources and flood risk.

Based on the information provided above, the substation option priority order with regards to water resources and flood risk would be as follows (in order from the most preferred to the least preferred):

- Option 1, 2 and 3; and
- Option 4.

5.2 Ground Conditions and Contamination

A desk-based assessment of contamination risks has identified no potential sources of contamination within the footprint of options 1, 2 and 4. Option 3 is located adjacent to a disused common clay and shale pit. Potentially contaminated Made Ground may be encountered when undertaking excavations in this area. All options are located within Source Protection Zone III.

No significant risks associated with ground contamination are anticipated for any of the footprint options. It is likely that short term risks associated with construction within any of the substation search area zones could be managed using personal protective equipment and appropriate working practices. However, protocols for dealing with unexpected contamination should be set in place prior to construction to ensure that procedures are known and agreed with the Regulators should contaminated materials be encountered.

Based on the precautionary principle, Options 1, 2 and 4 have been assigned as **green** with regards to development considerations for ground conditions and contamination. Based on the precautionary principle, Option 3 has been assigned as **amber** with regards to development considerations for ground conditions and contamination.

Based on the information provided above, the substation option priority order with regards to ground conditions and contamination would be as follows (in order from the most preferred to the least preferred):

- Option 1, 2 and 4; and
- Option 3.

5.3 Archaeology and Cultural Heritage

5.3.1 *Option 1 and 2*

Source material assessed to date (aerial photographic and LiDAR data and Norfolk Historic Environment Record) does not indicate the presence of buried archaeological remains within these footprints. Although the potential for remains to exist at these locations cannot be discounted, based on data assessed to date, this area has not been identified as an area of concern with regards to direct impact upon archaeology and cultural heritage. Indirect impacts may, however, occur on the setting of heritage assets. At this stage, no site visits have been undertaken within the substation zone to inform a settings assessment, although topography and vegetation surrounding heritage assets within this area has been taken into account as part of a preliminary settings assessment. The results of this assessment indicate that the majority of designated assets in the area surrounding the substation zone are potentially screened by existing vegetation and topography (although further site visits are required to verify this). The exception of this is the Grade II* Listed Building Old Hall (58) which has been proposed as a Landscape and Visual Impact Assessment (LVIA) heritage view point. Due to vegetation to the north-west of Option 1 and 2, it is possible that the Old Hall is screened from this option, although this would require further assessment.

Based on the precautionary principle, footprint options 1 and 2 have been assigned as **amber** with regards to development considerations for archaeology and cultural heritage.

5.3.2 *Option 3*

Source material assessed to date indicates the presence of buried archaeological remains within this footprint. The aerial photographic and LiDAR data assessment has identified a potential area of buried

archaeological remains intersecting the proposed onshore substation compound area for Option 3. This feature (AP 1) is recorded as an 'Undated moat set within an area of likely associated ditches and boundaries and a further enclosure to the immediate NW of the moat, of unknown date', possibly dating to the medieval period. This feature is part of an area of possible archaeological interest (group 1) assigned a precautionary and preliminary medium heritage significance. In the absence of mitigation, Option 3 has the potential to result in significant impacts upon the archaeological and cultural heritage resource. Indirect impacts may also occur to the setting of heritage assets. To date, no site visits have been undertaken within the substation zone to inform upon a settings assessment, although topography and vegetation surrounding heritage assets within this area has been taken into account as part of a preliminary settings assessment. The results of this assessment indicate that the majority of designated assets in the area surrounding the substation zone are potentially screened by existing vegetation and topography (although further site visits are required to verify this). There is the potential for visual interaction between the proposed onshore substation compound area for Option 3 and the Grade II* Listed Building Old Hall (58).

Plate 9 Aerial photographic and LiDAR data and Norfolk Historic Environment Records for Option 3

Based on the precautionary principle, footprint option 3 has been assigned as **red** with regards to development considerations for archaeology and cultural heritage.

5.3.3 *Option 4*

Source material assessed to date indicates the presence of buried archaeological remains within this footprint. The aerial photographic and LiDAR data assessment has identified a potential area of buried archaeological remains intersecting the proposed onshore substation compound area and laydown area for Option 4. The feature also intersects the proposed onshore substation compound area for Norfolk Boreas, and as such, there is the potential for cumulative impacts to occur. This feature (AP 1) is recorded as an 'Undated moat set within an area of likely associated ditches and boundaries and a further enclosure to the immediate NW of the moat, of unknown date', possibly dating to the medieval period. This feature is part of an area of possible archaeological interest (group 1) assigned a precautionary and preliminary medium heritage significance. In the absence of mitigation, Option 4 has the potential to result in significant impacts upon the archaeological and cultural heritage resource.

Indirect impacts may also occur to the setting of heritage assets. To date, no site visits have been undertaken within the substation zone to inform upon a settings assessment, although topography and vegetation surrounding heritage assets within this area has been taken into account as part of a preliminary settings assessment. The results of this assessment indicate that the majority of designated assets in the area surrounding the substation zone are potentially screened by existing vegetation and topography (although further site visits are required to verify this). There is the potential for visual interaction between the proposed onshore substation compound area for Option 4 and the Grade II* Listed Building Old Hall (58).

Plate 10 aerial photographic and LiDAR data and Norfolk Historic Environment Record for Option 4

Based on the precautionary principle, this area has been assigned as **red** with regards to development considerations for archaeology and cultural heritage.

Based on the information provided above, the substation option priority order with regards to onshore archaeology and cultural heritage would be as follows (in order from the most preferred to the least preferred):

- Option 2;
- Option 1;
- Option 3; and
- Option 4.

5.4 Noise and Vibration

All substation options have been subject to noise and vibration modelling, using a worst case scenario of 115.1dB(A) (sound power levels were calculated using source measurements obtained by Vattenfall Wind Power Ltd based on HVAC technology as a worst case). The results at this stage show that mitigation will be required for all options within the current search area, due to the proximity of sensitive receptors (residential housing). Recommendations are given based upon which option would be furthest from sensitive receptors and therefore require the least mitigation.

Noise modelling was carried out to assess the noise impact of the onshore project substations for the co-location of Norfolk Vanguard and Norfolk Boreas offshore wind farm installations. The assessment looked at the possibility of mitigating the noise levels following a standard mitigation procedure to present more robust information on the implications of such an installation on the acoustic environment.

Based on the precautionary principle, all options have been assigned (pre-mitigation) as **red** with regards to development considerations for noise and vibration, however it is assumed that noise reduction technology and proven mitigation options exist that, through the detailed design process, can be combined to create a design that will meet the required low noise emissions. Based on the information provided above, the substation option priority order with regards to noise and vibration was as follows (in order from the most preferred to the least preferred):

- Option 2;
- Option 4;
- Option 3; and
- Option 1.

Based on mitigated noise levels, an indicative buffer of (517m) was applied to all residential properties within the onshore project substation search zone to identify areas with increased separation distance in order to minimise potential impacts.

5.5 Traffic and Transport

A review of highway geometry demonstrates that the only suitable route to gain access to the substation sites would be via the A47.

At this stage, discussions are ongoing with Highways England (HE) regarding accessing the substation from the A47. A new access from the A47 may be acceptable with suitable accommodation works. Highways England have also identified that they would not object to the use of the existing Dudgeon access (for Norfolk Vanguard construction traffic) if it could be demonstrated that:

- There had not been an increase in accidents at the Dudgeon access; and
- Norfolk Vanguard would result in similar levels of traffic to Dudgeon.

Should it not be possible to demonstrate the above criteria could be met, HE would likely require further mitigation measures such as a right turn lane.

No significant issues with respect to sensitive receptors or road safety have been identified for traffic accessing from the A47.

Depending upon the onshore project substation location, the length of new access road from the A47 to the onshore project substation would vary between approximately 1.25km for option 4 to 2.2km for option 1.

From a Traffic and Access perspective, the length of the new access road is the only key differentiating factor between the sites and this is reflected in the ranked order.

Based on the precautionary principle, all options have been assigned as **amber** with regards to development considerations for traffic and transport.

Based on the information provided above, the substation option priority order with regards to traffic and access would be as follows (in order from the most preferred to the least preferred):

- Option 4;
- Option 3;
- Option 2; and
- Option 1.

It is important that new access roads are given due consideration with regard to indirect impacts e.g. landscape, ecology and archaeology to complete the access assessment.

5.6 Land Use and Agriculture

5.6.1 Option 1

Substation option 1 crosses a parcel of land that has been under the Entry Level plus Higher Level Stewardship scheme since 2008, on Bradenham Hall Farms land.

Based on the precautionary principle, this area has been assigned as **amber** with regards to development considerations for land use and agriculture.

5.6.2 Option 2, 3 and 4

There are limited receptors in the vicinity of Options 2, 3 and 4. These areas are all assigned **green** with regards to development considerations for land use and agriculture.

Based on the information provided above, the substation option priority order with regards to land use and agriculture would be as follows (in order from the most preferred to the least preferred):

- Option 2, 3 or 4; and
- Option 1.

5.7 Air Quality

There are very few receptors for air quality in the vicinity of all options. For construction dust, appropriate mitigation measures will be recommended, and the implementation of these will ensure impacts are not significant, in accordance with IAQM guidance. The location of the substation will not affect traffic flows; in any event, at present the air quality assessment shows a negligible impact at all receptors.

These areas are all assigned **green** with regards to development considerations for air quality.

Based on the information provided above, there is no priority order for substation options with regards to air quality.

5.8 Ecology

5.8.1 Option 1

There are two ancient woodlands within 2km of the onshore project substation option 1 location. These are Necton Wood (Ancient semi-natural) and Great Wood (Ancient semi-natural and ancient replanted) which are located adjacent to and approximately 600m east of the proposed onshore project substation option 1 respectively.

There are five non-statutory designated sites within 2km of the onshore project substation option 1, namely Necton Wood, Great Wood, Fox Covert, Necton old Common and Land Adjacent to River

Wissey. The latter four sites are located over 650m from the onshore project substation option 1, and as such there will be no change upon these non-statutory designated sites due to the proposed onshore project substation works for this option.

The onshore project substation option 1 works will result in a temporary loss of approximately 400m of species-rich hedgerow with trees for the duration of the construction phase (currently considered as approximately six years under a three phased approach). As a viable area of UKHPI and Norfolk BAP hedgerow habitat, the local resource is of high importance. The scale of the habitat loss is of low magnitude given the context of surrounding hedgerows. This hedgerow is also potentially an important feature for the local network of bat commuting and foraging populations.

One watercourse (a ditch) is located adjacent to the onshore project substation option 1 laydown area. A single potential water vole burrow was recorded along this watercourse (WV05) during the 2017 Water Vole Survey. This burrow is located approximately 150m west of the onshore project substation option 1 laydown area.

There are no standing water bodies within the onshore project substation option 1. There are 14 standing water bodies located within 500m of the onshore project substation option 1 permanent works. Presence of great crested newts has been confirmed in one of these water bodies, and there are a further seven water bodies where survey data has not been collected due to access restrictions. It is therefore assumed at this time that these water bodies do support great crested newts.

Based on the precautionary principle, this area has been assigned as **amber** with regards to development considerations for ecology.

5.8.2 Option 2

There are two ancient woodlands within 2km of the onshore project substation option 2 location, namely Necton Wood (Ancient semi-natural) and Great Wood (Ancient semi-natural and ancient replanted) which are located approximately 150m north and approximately 600m east of the proposed onshore project substation option 3 respectively.

There are five non-statutory designated sites within 2km of onshore project substation option 2, namely Necton Wood, Great Wood, Fox Covert, Necton old Common and Land Adjacent to River Wissey. The latter four sites are located over 650m from onshore project substation option 2, and as such there will be no change upon these non-statutory designated sites due to the proposed onshore project substation works for these options.

The onshore project substation option 2 works will result in a temporary loss of approximately 250m of species-poor hedgerow with trees for the duration of the construction phase (currently considered to be approximately six years under a three phased approach). As a viable area of UKHPI and Norfolk BAP hedgerow habitat, the local resource is of high importance. The scale of the habitat loss is of low magnitude given the context of surrounding hedgerows. This hedgerow is suitable commuting / foraging hedgerow with trees and watercourse habitat located within onshore project substation option 2.

One watercourse (a ditch) is located within the onshore project substation 2 compound area. A single potential water vole burrow was recorded along this watercourse (WV05) during the 2017 Water Vole Survey. This burrow is located approximately 450m west of the onshore project substation 2 compound area.

There are no standing water bodies within the cable route. There are nine standing water bodies located within 500m of the onshore project substation option 1 permanent works. Presence of great crested newts has been confirmed in one of these water bodies, and there are a further five water bodies for which no data has been collected to date due to access restrictions. It is therefore assumed at this time that these water bodies do support great crested newts.

Based on the precautionary principle, this area has been assigned as **amber** with regards to development considerations for ecology.

5.8.3 Option 3

There are two ancient woodlands within 2km of the onshore project substation option 3 location, namely Necton Wood (Ancient semi-natural) and Great Wood (Ancient semi-natural and ancient replanted). These are located approximately 150m north and approximately 1km east of the proposed onshore project substation option 3 respectively. There are no other terrestrial statutory designated sites located within 2km of the proposed onshore project substation option 3.

There are five non-statutory designated sites within 2km of onshore project substation option 3, namely Necton Wood, Great Wood, Fox Covert, Necton old Common and Land Adjacent to River Wissey. The latter four sites are located over 650m from onshore project substation option 3, and as such there will be no change upon these non-statutory designated sites due to the proposed onshore project substation works for these options.

There are no hedgerows located on onshore project substation option 3 and as such no change upon these habitats is anticipated as a result of the proposed works.

One watercourse (a ditch) is located adjacent to the onshore project substation 3 laydown area. A single potential water vole burrow was recorded along this watercourse (WV05) during the 2017 Water Vole Survey. This burrow is located approximately 150m west of the onshore project substation 3 laydown area. There are no standing water bodies within the cable route. There are seven standing water bodies located within 500m of the onshore project substation option 3 permanent works, and of these there are two for which no survey data has been collected to date due to access restrictions. It is therefore assumed at this time that these water bodies do support great crested newts.

Based on the precautionary principle, this area has been assigned as **amber** with regards to development considerations for ecology.

5.8.4 Option 4

There are two ancient woodlands within 2km of the onshore project substation option 4 location, namely Necton Wood (Ancient semi-natural) and Great Wood (Ancient semi-natural and ancient replanted). These are located approximately 100m north and approximately 1.3km east of the proposed onshore project substation option 4 respectively. There are no other terrestrial statutory designated sites located within 2km of the proposed onshore project substation option 4.

There are five non-statutory designated sites within 2km of onshore project substation option 4, namely Necton Wood, Great Wood, Fox Covert, Necton Old Common and Land Adjacent to River Wissey. The latter four sites are located over 650m from onshore project substation option 4, and as such there will be no change upon these non-statutory designated sites due to the proposed onshore project substation works for option 4

The onshore project substation option 4 works will result in a temporary loss of approximately 100m of species-poor hedgerow with trees for the duration of the construction phase (currently considered to be approximately six years under a three phased approach). As a viable area of UKHPI and Norfolk BAP hedgerow habitat, the local resource is of high importance. The scale of the habitat loss is of low magnitude given the context of surrounding hedgerows. There is approximately 100m of suitable commuting / foraging hedgerow with trees and watercourse habitat located within onshore project substation option 4.

One watercourse (a ditch) is located within the onshore project substation option 4 compound area. A single potential water vole burrow was recorded along this watercourse (WV05) during the 2017 Water Vole Survey. This burrow is located within the onshore project substation option 4 compound area.

There are no standing water bodies within the cable route. There are six standing water bodies located within 500m of the onshore project substation option 4 permanent works, of these there are seven water bodies for which no survey data has been collected to date due to access restrictions. It is therefore assumed at this time that these water bodies do support great crested newts.

Based on the precautionary principle, this area has been assigned as **amber** with regards to development consideration for ecology. Based on the information provided above, the substation option priority order with regards to ecology would be as follows (in order from the most preferred to the least preferred):

- Option 3;
- Option 4;
- Option 2; and
- Option 1.

5.9 Ornithology

No notable species have been recorded wintering / on passage within 300m of the onshore project substation for all options. As such there will be no change upon notable wintering / on passage bird species due to the proposed project onshore project substation works for all options.

Construction methodologies proposed for site vegetation clearance include the removal of nesting habitat for common breeding birds outside of the bird breeding season (which is typically between March and August inclusive, but is weather and temperature dependant). As such, risk of damaging, destroying or disturbing the nesting habitats of any common breeding bird (either during construction or operation) during the onshore project substation works (all options) has been removed.

Based on the precautionary principle, all options have been assigned as **green** with regards to development considerations for ornithology

5.10 Landscape and Visual Impacts

5.10.1 Option 1

The landform within footprint option 1 is gently undulating with a fall from north-east to south-west across the Norfolk Vanguard site and east to west across the Norfolk Boreas site. Norfolk Vanguard would be located on the edge of the Plateau Farmland LCT and Norfolk Boreas on the edge of the Settled Tributary Farmland LCT.

Option 1 would be partly enclosed by surrounding woodland with Necton Wood to the immediate west and smaller blocks to the north and east. The Norfolk Boreas site would be more exposed with limited enclosure from hedgerow and tree cover to the south.

There are no close range settlements or roads. The closest range receptors would be Ivy Todd Road and Ivy Todd hamlet at approx. 800m to the south, albeit largely screened by intervening tree cover. Wood Farm lies within 500m of Norfolk Vanguard and Top Farm within 700m of Norfolk Boreas.

Viewpoint 1: Ivy Todd Road. Both HVDC and HVAC options of Norfolk Vanguard and Norfolk Boreas (as currently being considered within the design envelope) would be readily visible owing to their location on the elevated plateau, with the HVDC option forming a notable feature owing to its larger scale halls. Norfolk Boreas substation would be more prominent owing to its location to the fore, such that it would screen Norfolk Vanguard. The right extent of Norfolk Vanguard and the left extent of Norfolk Boreas would be screened by tree cover, with the remainder mostly exposed.

Viewpoint 2: Lodge Lane South. Norfolk Vanguard HVAC option would be screened by landform and Norfolk Vanguard HVDC option would be mostly screened by landform, with only limited visibility of vertical components. Norfolk Boreas would be located to the fore and more visible, albeit with only a small proportion of the overall development visible, and the remainder screened by landform and vegetation.

Viewpoint 3: Lodge Lane North. Visual assessment not completed at this stage. The final visualisations will be compiled as part of the environmental impact assessment process and presented as part of the final Environmental Statement.

Viewpoint 4: A47 Necton substation. Both HVDC and HVAC options of Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform and Necton substation.

Viewpoint 5: A47 Spicer's Corner. Norfolk Vanguard HVDC and HVAC options would be screened by Necton Wood. Norfolk Boreas HVDC and HVAC options would be exposed and prominent on ridge of plateau; HVDC especially evident owing to the scale of the halls. HVAC option would be possible to mitigate through planting, while the HVDC option would take more time to mitigate.

Viewpoint 6: A47 Top Farm. Norfolk Vanguard HVDC and HVAC options would be screened by tree cover. Left extent of Norfolk Boreas HVDC and HVAC options would be screened by tree cover with remainder exposed albeit not as prominent as in VP 5. HVDC would be especially evident owing to the scale of the halls. HVAC option would be possible to mitigate through planting, while the HVDC option would take more time to mitigate.

Viewpoint 7: Ivy Todd Road East. Norfolk Vanguard and Norfolk Boreas HVAC options would be screened by intervening landform and tree cover. Norfolk Vanguard and Norfolk Boreas HVDC options would be largely screened by landform and tree cover, with partial visibility of halls occurring through trees.

Viewpoint 8: Chapel Road, Necton. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform, apart from tips of the lightning protection mast of Norfolk Boreas HVDC, which would be seen as a minor feature along the ridge
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Viewpoint 9: Crown Lane. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening vegetation and landform.

The separation of the Norfolk Vanguard and Norfolk Boreas onshore project substation sites would increase the cumulative effects by creating a more disparate appearance and increasing the horizontal extent of visual influence. As the proposed Norfolk Vanguard site would be well screened by existing woodland in certain views, this would reduce the potential cumulative effect.

Any movement of Norfolk Boreas towards the east would help to better consolidate the developments and optimise screening from existing woodland. Detailed design should allow for the retention of hedgerows currently on or just within boundary lines.

Planting along the northern boundary for the Norfolk Vanguard site and on the eastern, southern and western boundaries for the Norfolk Boreas site would work towards mitigating potential visual effects.

While the Norfolk Vanguard site would benefit from screening from existing woodland, the separation of the Norfolk Vanguard and Norfolk Boreas onshore project substation sites would increase the potential cumulative effects.

Option 1 is assigned **amber** with regards to development considerations for landscape and visual impacts.

5.10.2 Option 2

The landform within footprint option 2 is gently undulating with a gentle fall from north-east to south-west for Norfolk Boreas and east to west for Norfolk Vanguard. The sites are located on the edge of the Plateau Farmland LCT and Settled Tributary Farmland LCT.

Both sites have little benefit from vegetative enclosure, with hedgerows and tree cover providing limited enclosure to the south and west but not on the other aspects.

The sites would bring development marginally closer to visual receptors at Ivy Todd, although tucked to the east out of the main channel of views along the river valley to the north. The Norfolk Vanguard site would potentially be more visible where views occur through tree cover along Ivy Todd road and Ivy Todd hamlet.

Viewpoint 1: Ivy Todd Road. Both HVDC and HVAC options of Norfolk Vanguard and Norfolk Boreas would be readily visible owing to their location on an elevated plateau. The HVDC option would form a more notable feature owing to its larger scale halls. Norfolk Vanguard would appear more prominent owing to its location to the fore, such that it would largely screen Norfolk Boreas. Norfolk Boreas would be mostly screened by tree cover, especially the HVAC option. Norfolk Vanguard would be mostly exposed.

Viewpoint 2: Lodge Lane South. In the HVAC options, Norfolk Vanguard and Norfolk Boreas would be concealed apart from occasional components visible through trees. In the HVDC option, the halls of Norfolk Vanguard and Norfolk Boreas would be visible along the ridge, although partially screened by tree cover and benefitting from favourable scale comparison with trees.

Viewpoint 3: Lodge Lane North. Visual assessment not completed at this stage. The final visualisations will be compiled as part of the environmental impact assessment process and presented as part of the final Environmental Statement.

Viewpoint 4: A47 Necton substation. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform and Necton substation.

Viewpoint 5: A47 Spicer's Corner. Norfolk Vanguard HVDC and HVAC options would be exposed and prominent on ridge of plateau - HVDC especially evident owing to the scale of the halls. HVAC option would be possible to mitigate through planting in the medium term, while HVDC option would take the longer term to mitigate. Norfolk Boreas would be screened by Norfolk Vanguard, thus reducing cumulative effect.

Viewpoint 6: A47 Top Farm. Norfolk Boreas HVDC and HVAC options would be largely screened by tree cover. Left extent of Norfolk Vanguard HVDC and HVAC options would be screened by tree cover with remainder exposed albeit not as prominent as in VP 5. HVDC would be especially evident owing to the scale of the halls. HVAC option would be possible to mitigate through planting in the medium term, while HVDC option would take the longer term to mitigate.

Viewpoint 7: Ivy Todd Road East. Norfolk Vanguard and Norfolk Boreas HVAC options largely screened by intervening landform and tree cover with very limited visibility. Norfolk Vanguard and Norfolk Boreas HVDC options largely screened by landform and tree cover, with partial visibility of halls through trees.

Viewpoint 8: Chapel Road, Necton. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform, apart from tips of the lightning protection mast of Norfolk Vanguard HVDC which wold be seen as minor feature along the ridge.

Viewpoint 9: Crown Lane. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas are screened by intervening vegetation and landform.

While the close proximity of the Norfolk Vanguard and Norfolk Boreas sites would create a well consolidated appearance, their arrangement with long sides both facing south would maximise the horizontal extent that would be experienced from this direction. While this may add to the cumulative effect, existing mature tree cover around Lodge Farm would act to moderate this effect.

The Norfolk Vanguard site makes best use of the hedgerows to the west and south but movement north of both sites would make better use of screening effect of Necton Wood.

The elevated location of these sites on the edge of the Plateau Farmland LCT would mean mitigation through planting would require a longer term period, especially in respect of the HVDC option. Substantial planting would be needed, especially along the southern boundary closest to the visual receptors.

The closer proximity of the proposed development to the receptors at Ivy Todd could give rise to potential effects.

Option 2 is assigned **amber** with regards to development considerations for landscape and visual impacts.

5.10.3 Option 3

In the option 3 footprint, the landform of the Norfolk Boreas site falls gradually from east to west while the landform on the Norfolk Vanguard site falls steeply towards the river valley - a fall of approx. 8m. Being located at a lower elevation and in the fold of the valley would moderate the prominence of Norfolk

Vanguard in views especially from the south. Major earthworks would be required to form a level platform.

Both sites have little benefit from vegetative enclosure, with tree cover screening the end extents of the Norfolk Vanguard and Norfolk Boreas onshore project substations and hedgerows providing lower level enclosure but not on all aspects.
There are no close range settlements or roads. The closest range receptors are Ivy Todd Road and Ivy Todd hamlet and although mostly screened by intervening tree cover, would be close in range at approx. 600m to the south.

Viewpoint 1: Ivy Todd Road. Despite the closer range of Norfolk Vanguard, Norfolk Boreas would be more prominent owing to its more elevated position on the plateau. In the HVDC option, Norfolk Boreas would be readily apparent owing to the scale of the halls, Norfolk Vanguard would also be apparent, albeit partially screened by intervening landform. In the HVAC option, Norfolk Vanguard would be almost completely screened, while lesser vertical scale of Norfolk Boreas would fit with the scale of the wooded backdrop and adjacent tree cover.

Viewpoint 2: Lodge Lane South. Both long sides of the onshore project substations on to this viewpoint maximise the horizontal extent. The convex landform means only the southern edge of HVDC options for both Norfolk Vanguard and Norfolk Boreas would be visible, albeit set against open skyline. Norfolk Vanguard would be seen fully, while the right half of Norfolk Boreas would be screened by intervening tree cover. HVAC options would be largely screened by the intervening landform.

Viewpoint 3: Lodge Lane North. Visual assessment not completed at this stage. The final visualisations will be compiled as part of the environmental impact assessment process and presented as part of the final Environmental Statement.

Viewpoint 4: A47 Necton Substation. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas are screened by intervening landform and Necton National Grid substation.

Viewpoint 5: A47 Spicer's Corner. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be readily apparent owing to location on plateau. The prominence of the HVDC options would be accentuated by the scale of the halls and their vertical extension above skyline. HVAC would be better contained by background landscape although still prominent. Location of Norfolk Vanguard to the fore would partially screen Norfolk Boreas and reduce cumulative effect.

Viewpoint 6: A47 Top Farm. Norfolk Vanguard HVDC would appear prominent, albeit better contained by background than in VP5. Norfolk Boreas would be located to the rear with its left extent screened by tree cover, although also forming a prominent feature and notable influence on the cumulative effect. Norfolk Boreas HVAC would benefit better from screening from Norfolk Vanguard and tree cover, while Norfolk Vanguard HVAC would fit within the scale of surrounding and background tree cover and with potential to mitigate further through planting.

Viewpoint 7: Ivy Todd Road East. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform and tree cover, although outline of some HVDC options just visible through trees.

Viewpoint 8: Chapel Road, Necton. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform, apart from tips of the lightning protection mast of Norfolk Boreas HVDC, which would be seen as minor feature along the ridge.

Viewpoint 9: Crown Lane. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening vegetation and landform.

While the close proximity of Norfolk Vanguard and Norfolk Boreas would create a well consolidated appearance, their arrangement with long sides both facing south would maximise the horizontal extent that would be experienced from this direction and this would add to the cumulative effect.

Mitigation of effects from existing hedgerows and tree cover would be limited especially in relation to the Norfolk Vanguard site. Movement north of both sites would make better use of screening effect of Necton Wood.

Substantial planting would be needed, especially along the northern boundary where the proposed developments are exposed in views from the north and the south-western boundary where Norfolk Vanguard is exposed in views from the south. Substantial earthworks would be required to accommodate the Norfolk Vanguard site.

Option 3 is assigned **amber** with regards to development considerations for landscape and visual impacts.

5.10.4 Option 4

In the option 4 footprint, the Norfolk Vanguard and Norfolk Boreas sites occupy the eastern valley side of the unnamed water course with the land falling from south-west to north-east for Norfolk Vanguard and north-east to south-west for Norfolk Boreas, both over a range of approx. 8m. Location in the 'fold' of the valley will reduce the prominence of the proposed development from select viewpoints, although substantial earthworks will be required to form a level platform.

Vegetative enclosure is limited to the north and south, such that the proposed developments would be exposed in views from these directions. Tree cover and hedgerows to the south-west are more substantial and provide some screening.

The Norfolk Boreas site brings the proposed development to within 400m of Ivy Todd hamlet and minor road and although largely screened by vegetation around the hamlet and road, the proximity would impinge on the setting of the hamlet.

Viewpoint 1: Ivy Todd Road. Norfolk Vanguard and Norfolk Boreas HVAC options would be largely screened by intervening tree cover and hedgerows. HVDC options would be readily evident, with Norfolk Boreas appearing more prominent owing to its closer location. Norfolk Vanguard HVDC would increase the extent of development to the left, creating a cumulative effect in respect of the horizontal extent.

Viewpoint 2: Lodge Lane South. Both HVDC and HVAC options for Norfolk Vanguard would be screened by intervening landform and tree cover. Both HVDC and HVAC options for Norfolk Boreas would present a prominent feature, extending beyond the enclosing ridge and tree cover. Although Ivy Todd would be largely enclosed by tree cover, the proximity of Norfolk Boreas would impinge on the hamlet setting, especially the HVDC option owing to larger scale of the halls.

Viewpoint 3: Lodge Lane North. Visual assessment not completed at this stage. The final visualisations will be compiled as part of the environmental impact assessment process and presented as part of the final Environmental Statement.

Viewpoint 4: A47 Necton National Grid substation. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening landform and Necton National Grid substation.

Viewpoint 5: A47 Spicer's Corner. Norfolk Vanguard would be located to the fore and appear more prominent than Norfolk Boreas in both HVDC and HVAC options. Norfolk Boreas would add some extent to the right but would not lead to a notable cumulative effect. Without screening, Norfolk Vanguard would appear exposed. The HVAC option would appear contained below the background of the landform and tree cover, while the vertical scale of the HVDC halls would break the skyline.

Viewpoint 6: A47 Top Farm. Norfolk Vanguard would be located to the fore and appear more prominent than Norfolk Boreas in both HVDC and HVAC options. Norfolk Boreas would add some extent to the right but would not lead to a notable cumulative effect. Without screening, Norfolk Vanguard would appear exposed. The HVAC option would appear contained below the background of the landform and tree cover, while the vertical scale of the HVDC halls would break the skyline.

Viewpoint 7: Ivy Todd Road East. Both Norfolk Vanguard and Norfolk Boreas HVAC options would be screened by intervening landform and tree cover and the HVDC options would be largely screened with a limited proportion of the Norfolk Boreas HVDC option seen partially screened by trees, albeit in a sector where existing pylons are evident.

Viewpoint 8: Chapel Road, Necton. Both HVDC and HVAC options would be screened by intervening landform.

Viewpoint 9: Crown Lane. Both HVDC and HVAC options for Norfolk Vanguard and Norfolk Boreas would be screened by intervening vegetation and landform.

The containment of the developments within the valley would present a consolidated appearance and reduce the extent of visual influence across the wider area.

Norfolk Boreas would need to be relocated to the north - currently too close to Ivy Todd, and breaches containment of ridge and tree cover. Micro-siting may be required in respect of the extent of earthworks that would be required and the proximity of the site to the unnamed watercourse.

Mitigation planting around the site would help to reduce the visual effects of the earthworks and screen the proposed development in potential views from the north and south.

Option 4 is assigned **red** with regards to development considerations for landscape and visual impacts.

5.10.4.1 Summary for Landscape and Visual Impacts

In terms of the red, amber, green rating of the four options, options 1, 2 and 3 have been assigned an amber rating, while option 4 has been assigned a red rating – this is largely owing to its relative proximity to Ivy Todd hamlet. The three remaining options are broadly similar in terms of their advantages and disadvantages, albeit with option 3 extending into the valley landform where the formation of a level platform would give rise to major earthworks.
Based on the information provided above, the substation option priority order with regards to landscape and visual impacts would be as follows (in order from the most preferred to the least preferred):

- Option 1, 2 and 3; and
- Option 4.

5.11 Socio-Economics, Tourism and Recreation

There are no PRoWs in the vicinity of any of the options, and no community or tourism assets within the boundaries of any of the options. Option 1 is closest to a tourism asset, but this is still 1.36km away and so outside of a potential impact boundary.

From a tourism and socio-economic point of view, none of the options would create additional impacts and all of them are considered **green** with regards to development considerations for socio-economics, tourism and recreation. Therefore there is no priority order.

6 Assessment Summary

Below is a summary table for each option. Where there are multiple options ranked the same level of risk (red, amber or green), these have been broken down into a further rank by priority order. Where no priority is given, there are no numbers given.

Location option	Substation			
Topic	1	2	3	4
Water resources and flood risk	1	1	1	4
Ground conditions and contamination	1	1	4	1
Archaeology and cultural heritage	2	1	3	4
Noise and vibration	4	1	3	2
Traffic and transport	4	3	2	1
Land use and agriculture	4	1	1	1
Air quality	-	-	-	-
Ecology	4	3	1	2
Ornithology	-	-	-	-
LVIA	1	2	3	4
Socio-economics, tourism and recreation	-	-	-	-

Overall, based on the information presented to date, it is considered from an environmental perspective that substation footprint options 2 and 3 are ranked as the preferred options to be considered as part of the site selection considerations.

Where red risks have been identified for noise and archaeology for these footprints, it should be noted that:

- Noise reduction technology and design approach can be considered through the detailed design process to mitigate noise impacts.

- Any potential for indirect impacts to occur to the setting of heritage assets (visual interaction between the substation for Option 3 and the Grade II Listed Building Old Hall) will be considered as part of the Heritage settings assessment presented as Chapter 28 Onshore Archaeology and Cultural Heritage and Chapter 29 Landscape and Visual Impact Assessment. However, as part of a preliminary settings assessment, the results indicate that the majority of designated assets in the area are potentially screened by existing vegetation and topography.

The main benefits of substation footprints 2 and 3 include:

- Siting the substation away from the village of Necton;
- Maintaining proximity to the Necton National Grid substation;
- Maximising opportunities associated with existing natural screening (in accordance with the Horlock Rules) afforded by Great Wood, Necton Wood and a network of hedgerows in order to potentially reduce landscape and visual impacts;
- Distance from nearby residential receptors; and
- Opportunity to co-locate the onshore project substations for both projects (Norfolk Vanguard and Norfolk Boreas).

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