CLEVE HILL SOLAR PARK

ENVIRONMENTAL STATEMENT

VOLUME 1 - CHAPTERS

CHAPTER 5 – DEVELOPMENT DESCRIPTION

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5 DEVELOPMENT DESCRIPTION

5.1 Introduction

1. This chapter of the ES describes the Development. It provides a description of the existing Development site and the physical characteristics of the Development for the purpose of identifying and assessing the likely significant environmental effects resulting from the Development, more detail on which is provided in the other ES chapters. It also describes the proposed programme of site preparation, construction and decommissioning works for the Development and the key activities that would be undertaken during the works to inform the prediction of likely significant environmental effects set out in the technical chapters.

2. This chapter is supported by the following figures provided in Volume 2:

- Figure 5.1 Existing Site Areas;
- Figure 5.2 Development Site Layout - Overview;
- Figure 5.2a to d Development Site Layout - Detail;
- Figure 5.3 Flood Depths by Field;
- Figure 5.4a Solar PV Module Mounting Structure Elevation;
- Figure 5.4b Solar PV Module Mounting Structure Plan;
- Figure 5.5 Transformer elevations;
- Figure 5.6a to c Electrical Compound (Battery Pack);
- Figure 5.7a to c Electrical Compound (Containerised);
- Figure 5.8 Flood Protection Bund;
- Figure 5.9 400 kV Cable Connection;
- Figure 5.10 Site Access Options;
- Figure 5.11 Site Access Construction Detail; and
- Figure 5.12 Culvert Detail.

3. This chapter is also supported by the following technical appendices provided in Volume 4:

- Technical Appendix A5.1 Field Data;
- Technical Appendix A5.2 Outline Landscape and Biodiversity Management Plan;
- Technical Appendix A5.3 Microclimate and Vegetation Desk-Based Study;
- Technical Appendix A5.4 Outline Construction Environmental Management Plan; and
- Technical Appendix A5.5 Outline Decommissioning and Restoration Plan.

4. This chapter should be read in conjunction with the Outline Design Principles document which accompanies the DCO Application (DCO Document Reference 7.1).

5.2 Existing Development Site Description

5.2.1 Site Context

5. The Development site lies within the administrative districts of Swale Borough Council, Canterbury City Council and Kent County Council, 2 km north east of Faversham and 5 km west of Whitstable on the north Kent coast as shown on Figure 1.1. The Development site is coastal and the area is identified on Ordnance Survey maps as Nagden, Cleve and Graveney Marshes. The coastal nature of the Development site is in evidence where Faversham Creek forms the western site boundary and The Swale Channel forms the northern boundary.

5.2.2 Existing Development Site

6. The total area of the Development site is approximately 491.2 hectares (ha) and can be divided into four existing broad land use types:

- Arable Land;
- Freshwater Grazing Marsh;
- Flood Defences; and
- The Existing Cleve Hill Substation.

7. These areas are shown on Figure 5.1 and described in the following sections.

5.2.2.1 Arable Land

8. Arable land covers a total area of approximately 387.6 ha within the Development site as shown in Figure 5.1. Large fields are separated by drainage channels predominantly running south to north and a 400 kilovolt (kV) overhead line which traverses the Development site from west to east where it joins the existing Cleve Hill Substation. An 11 kV overhead line crosses the south of the Development site from Nagden in a straight-line westward towards Cleve Farm with a short spur south to Warm House.

9. Underground cables connecting London Array Offshore Wind Farm to the existing Cleve Hill Substation cross the arable land from north to south, from the flood defences to the existing Cleve Hill Substation.

10. Topographically, the majority of the arable land is flat and low lying with elevations above ordnance datum (AOD) typically ranging from 0 m to 3 m. The exception is the south east of the Development site where the land rises at a variable gradient of approximately 14% from south west to north east at Graveney Hill, reaching an elevation of approximately 15 m AOD.

Plate 5.1 Arable land

5.2.2.2 Freshwater Grazing Marsh

11. The area of freshwater grazing marsh shown on Figure 5.1 comprises approximately 35.1 ha of land in the east of the Development site, between the arable land to the west, Seasalter Road to the east and the existing coastal flood defences to the north. Similar to the arable land, the land is flat and low lying but with generally smaller fields also separated by drainage ditches.

12. This area of freshwater grazing marsh forms part of The Swale Special Protection Area, Site of Special Scientific Interest and Ramsar wetland designated sites.

Plate 5.2 Freshwater grazing marsh

5.2.2.3 Flood Defences

13. The land identified on Figure 5.1 as flood defences comprises the existing coastal flood defences that protect the Development site and the access to the flood defences from Seasalter Road at National Grid Reference (NGR) TR 06050 64418. The majority of the flood defences are within The Swale SSSI, SPA and Ramsar wetland designated site.

14. The flood defences vary in construction across their length from a lightly vegetated earth flood prevention embankment, to a concrete blockwork embankment with intermittent rock armour toe protection supporting a recurved concrete parapet wall intermittently fronted with intertidal vegetation and groynes.

15. The seaward side of the flood defences typically includes areas of shingle beach and saltmarsh leading to mudflats seaward of Mean High Water Springs (MHWS).

16. The landward side of the flood defences typically includes a strip of at least 50 m of freshwater grazing marsh between the crest of the flood defences and the edge of the arable land except in the southwest of the Development site where arable land abuts the flood defences.

17. A raised flood defence structure with a public right of way running along its crest forms the eastern Development site boundary, running parallel with and adjacent to Seasalter Road.

18. The area shown as flood defences in Figure 5.1 comprises an area of approximately 58.5 ha.

Plate 5.3 Flood Defences

5.2.2.4 Existing Cleve Hill Substation

19. The existing Cleve Hill Substation serves the London Array Offshore Wind Farm and includes the following infrastructure:

- Tarmacadam access road;
- London Array Offshore Wind Farm substation;
- Underground cables from London Array Offshore Wind Farm to the substation;

- National Grid Electricity Transmission (NGET) substation;
- 400 kV overhead lines which connect into the NGET substation via two gantries; and
- Landscaped grounds including fences, hedges, ponds and grassed areas.

20. The existing Cleve Hill Substation area as shown in Figure 5.1 comprises an area of approximately 10.0 ha within the Development site.

Plate 5.4 Aerial Photo of the existing Cleve Hill Substation[1]

5.3 The Rochdale Envelope

21. Due to the rapid pace of technological development in the solar photovoltaic (PV) and energy storage industry, it is necessary to provide flexibility in the Development Description chapter of this ES and the DCO, to allow for the most up to date technology possible to be utilised by the Development at the time of construction. In some cases, the Development could utilise technology which does not currently exist.

22. To address this, a Rochdale Envelope approach is used. The principles and justification for this approach are set out in section 2.1.1 of Chapter 2: EIA of this ES.

23. In order to establish parameters within the Rochdale Envelope for assessment, the Development Description chapter follows a two-tier approach by establishing:

- Rochdale Envelope design principles; and
- Candidate design - realistic worst-case design parameters within the Rochdale Envelope.

24. The design principles set out in the Outline Design Principles document (DCO Document Reference 7.1) form the Rochdale Envelope limits within which the Development can be built and operated.

25. The design principles are broad, allowing for flexibility in the Development design. Therefore, a set of realistic worst-case design parameters has also been developed as a candidate design which in all cases falls within the bounds of the design principles but is more specific to allow for robust assessment of likely significant effects to be undertaken within this ES.

26. An example of this is the angle of slope of the solar PV modules. The maximum height of the solar PV modules is the limiting design principle, but for the purposes of assessment, a parameter for the angle of slope is also required *e.g.*, to inform the three-dimensional model used to produce the photomontage visualisations. The height of the solar PV modules is partly governed by the angle of slope. This means that

[1] Image Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN and the GIS User Community.

although the angle of slope is not fixed, future adjustments to it are limited by the maximum height design principle.

27. The candidate design realistic worst-case design parameters do not always represent the maximum, as where maximum parameters can be set, these are established as design principles in the Outline Design Principles document (DCO Document Reference 7.1). For example, the number of solar PV modules is an indicative number rather than a maximum number as the maximum design principle parameter relates to the area of coverage of solar PV modules rather than the total number. This is appropriate because the size of an individual module and number of them doesn't have the potential to change the likely significant effects of the Development, whereas the maximum total area of all solar PV modules does. Over time, as technology advances, it is quite possible that modules could, say, reduce in size, meaning that more are required to cover the same area as currently predicted for the candidate design. However, it is the total area of module coverage that is relevant to LVIA and not the number of modules needed to achieve that, hence it is the area of coverage that is the relevant parameter for assessment.

28. Where alternative realistic worst-case scenarios are presented in the candidate design (*e.g.*, the alternative designs for the energy storage facility and the two alternative access routes), each technical assessor has determined which elements and construction methods represent the realistic worst-case in the context of their assessment. This is set out in each technical chapter and referred to as the 'Candidate Design' and the assessment of environmental effects is then based on that determination.

29. Following this approach will ensure that the findings of this ES will apply to the final design of the Development as-built and the effects will be no worse than predicted.

5.3.1 Defining the Detailed Design

30. Following consent and final detailed design, a final build plan will be submitted to Swale Borough Council for approval. The purpose of this submission will be to:

- Demonstrate compliance with the requirements included in the DCO; and
- Demonstrate that the final as-built design remains within the parameters of the Design Principles and therefore the Rochdale Envelope considered by this ES.

5.4 Development Description and Candidate Design

5.4.1 Solar Photovoltaic Arrays

Table 5.1 Solar PV Arrays Design Parameters

Solar PV Modules Candidate Design			**Applicable Design Principle**
Indicative Number of Solar PV Modules	884,388 See Technical Appendix A5.1, Field Data, for number of solar PV modules in each field.		The total area of solar PV modules in each field will not exceed the solar PV module areas set out in Technical Appendix A5.1 and a total area of 176.3399 ha.
Indicative Solar PV module capacity watt peak (Wp)	395		N/A
Indicative Solar PV Module Dimensions	Width (mm)	992	N/A
	Length (mm)	2010	
	Depth (mm)	40	

Solar PV Modules Candidate Design			Applicable Design Principle
	Area (m^2)	1.994	
Indicative Slope of Solar PV Modules from Horizontal	8 degrees		N/A
Minimum height of flood sensitive equipment above ground level (AGL)	1.2 m See Technical Appendix A5.1, Field Data, for the lowest heights in each field.		The minimum height of the lowest part of the solar PV modules will be 1.2 m AGL.
Maximum height of solar PV modules AGL	3.9 m See Technical Appendix A5.1, Field Data, for maximum heights in each field		The maximum height of highest part of the solar PV modules will be 3.9 m above ground level (AGL).
Indicative Solar PV Module Colour	Dark Blue (visualisations show RGB 37,61,109)		The solar PV modules will be dark blue, grey or black in colour.
Frame type	Anodized Aluminium Alloy		N/A
Indicative Number of Pyranometers	15		N/A
Solar PV Module Mounting Structures			
Indicative Table Width (incl. Ridge Break)	Width (east to west) (m)	24.3	The maximum height of highest part of the solar PV modules will be 3.9 m above ground level (AGL). The minimum height of the lowest part of the solar PV modules will be 1.2 m AGL.
Minimum Width of Ridge Break (mm)	300		The minimum separation at the central ridge of the array tables will be 300 mm.
Minimum East/West Distance Between Tables (no transformers)	2.5 m		The minimum east-west separation between the external parameters of array tables will be 2.5 m.
Indicative East/West Distance Between Tables (Transformer Rows)	10 m		N/A
Indicative Mounting Structure Material	Galvanised steel		N/A
Indicative Foundation Type	Driven-piles		N/A
Indicative Total number of piles	196,539 See Technical Appendix A5.1, Field Data, for number of piles per field		The total area of solar PV modules in each field will not exceed the solar PV module areas set out in Technical Appendix A5.1 and a total area of 176.3399 ha.
Depth of piles below ground level (m)	1 to 2		N/A
Inverters			
Indicative Number of	3,071		The total area of solar PV modules

Solar PV Modules Candidate Design			**Applicable Design Principle**
String Inverters			in each field will not exceed the solar PV module areas set out in Technical Appendix A5.1 and a total area of 176.3399 ha.
Indicative Inverter Dimensions	Height (mm)	1,075	String inverters will be used which will be mounted beneath the solar PV modules on the solar PV module mounting structures.
	Width (mm)	605	
	Depth (mm)	310	
Transformer			
Indicative Number of Transformers	80		The total area of solar PV modules in each field will not exceed the solar PV module areas set out in Technical Appendix A5.1 and a total area of 176.3399 ha.
Indicative Power Rating (MVA)	2.5 to 5		N/A
Indicative Transformer Dimensions	Length (mm)	8,200	The transformers will not exceed the maximum height AGL of the solar PV modules in the same solar PV array field as set out in Technical Appendix A5.1 (except during a flood event for floating transformers).
	Width (mm)	2,300	
	Height (mm)	3,000	
Indicative Transformer Foundation Dimensions (below ground level)	Length (mm)	10,700	N/A
	Width (mm)	5,100	
	Height (mm)	2,300	
Maximum ascent of platform base in flood scenario (m)	2.1		N/A
Indicative Transformer Colour	Grey (visualisations show RGB 128,128,128)		N/A
Electrical Cabling			
DC Cables from Solar PV Modules to Inverters and Combiners	Above ground, in racking secured to solar PV mounting structure.		All cable circuits within the solar PV array fields will be secured to the solar PV module mounting structures or will be underground. No new overhead lines will be constructed.
AC Cables from Inverters and Combiners to Transformers	Above ground, secured to solar PV mounting structure, and underground.		
AC Cables from Transformers to Development Substation	Underground		

5.4.1.1 Solar PV Array Fields

31. The large arable fields within the Development site have been sub-divided using existing physical features such as ditches and overhead powerlines into developable areas referred to as fields and labelled alphabetically, as shown in Figures 5.2 a to d.

The extent of these fields has been determined through consultation and application of constraints, such as minimum separation to ditches and required separations from existing overhead line towers (as set out in Chapter 17: Miscellaneous Issues of this ES).

32. The design changes described in Chapter 4 have resulted in 23 of the original 26 fields being used in the final design for development of solar PV arrays including fields labelled A to I and K to X (*i.e.*, fields J, Y and Z are no longer proposed to be developed as part of the solar PV array).

33. All of these fields are located within the arable land area described in section 5.2.2.1 and shown in Figure 5.1. None of the Development infrastructure described in this section (section 5.4.1) will be located on the freshwater grazing marsh, flood defences, or on existing Cleve Hill Substation land.

34. The minimum height of electrical equipment or connections across the solar PV array fields has been derived from flood modelling. The 1 in 1,000 year defended wave overtopping event in the year 2070 has been used to derive a maximum flood depth above ground level (AGL) in each field. Water-sensitive electrical equipment and connections will be placed above this height (plus 300 mm freeboard[2]) or above at least 1.2 m in each field. These heights are shown for each field in Figure 5.3 and in Technical Appendix A5.1, Field Data. This approach has been taken to reduce the risk of inundation of sensitive equipment as far as practicable should a catastrophic flood event, involving a major overtopping of the coastal flood defences occur during the Development's operational lifetime.

35. The 11 kV overhead powerline that resulted in the earlier subdivision of fields in the south of the Development site is proposed to be undergrounded (see ES Chapter 17: Miscellaneous Issues). However, the original field subdivisions formed by the overhead line have been broadly maintained to derive flood heights.

36. The design principles set out in the Outline Design Principles document (DCO Document Reference 7.1) limit the location and size of the solar PV arrays such that the candidate design parameters set out in Table 5.1 represent a realistic worst case design.

5.4.1.2 Solar PV Modules (Solar Panels)

37. Solar PV modules convert solar irradiance (light) into direct current (DC) electricity. They are designed to maximise the absorbency of the sun's rays and minimise solar glare. As a consequence, they are dark in hue and recessive in the landscape.

38. The individual solar PV modules within the Development will consist of dark blue, dark grey or black photovoltaic (PV) cells. A range of alternative PV technologies are developing rapidly and may be available at the time of construction therefore the solar PV modules are not limited to a particular type of PV cell.

39. Solar PV modules can be housed within an anodised aluminium frame or can be frameless. Solar PV modules will be fixed to mounting structures (section 5.4.1.3) using clamps and are connected together in strings which connect to the inverters (section 5.4.1.4) and combiners (if required).

40. Pyranometers will be located across the solar PV arrays to accurately measure solar irradiance and other weather conditions, to collect data to ensure the solar PV modules are performing as expected. It is expected there will be 10 to 15 pyranometers across the site, typically near the centre of the fields of solar PV modules.

41. The design principles in the Outline Design Principles document (DCO Document Reference 7.1) limit the location of solar PV modules to the fields described in section 5.4.1.1, but do not limit the scale or design of the individual solar PV modules in order

[2] Freeboard is an allowance applied to flood levels to account for residual uncertainty in flood modelling.

to maintain flexibility in that aspect of the Development design. However, the design principles set out a maximum surface area of all of the solar PV modules within each field. The realistic worst-case parameters reflect this in that the design shown in Figure 5.2 and set out in Technical Appendix A5.1, Field Data, represents the maximum surface area of solar PV modules within each field. This could result in an as built design made up of a greater number of smaller solar PV modules, or a smaller number of larger solar PV modules without exceeding the limits of the Rochdale Envelope.

42. Table 5.1 shows indicative details of the solar PV modules which form the realistic worst-case design parameters.

Plate 5.5a Indicative solar PV module design

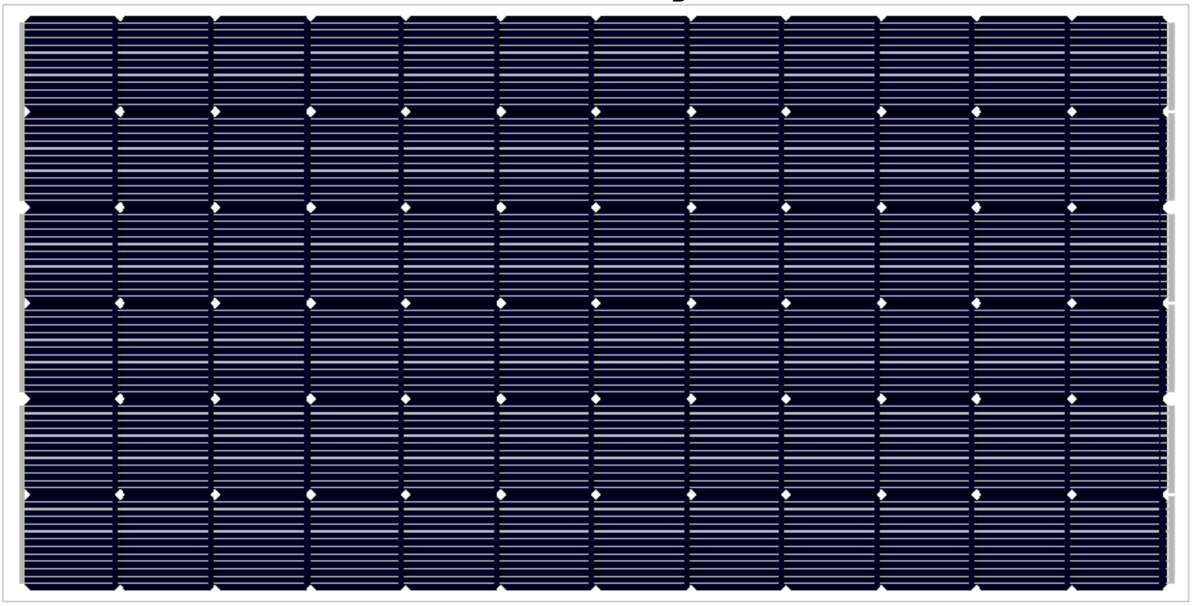


Plate 5.5b Typical pyranometer

Plate 5.5c Typical underside of solar PV modules

5.4.1.3 Solar PV Module Mounting Structures

43. The solar PV modules will be mounted on a metal (likely galvanised steel) rack supported by galvanised steel piles driven into the ground by an impact or vibratory pilling rig to a depth[3] of approximately 1.5 to 2 m. Typical mounting poles and an example east-west panel arrangement are shown in Plates 5.6a and b. The string inverters will also be mounted beneath the solar PV modules above the maximum identified flood height on the verticals of these structures.

44. Each east and west facing group of solar PV modules is referred to as a table, which includes the whole structure from the low point of the solar PV modules on one side to the ridge in the middle of the table and on to the low point on the other side.

45. Each half-table in the candidate design consists of 6 solar PV modules (in portrait) from east to west, so 12 modules from east to west across the full width of each table, and an unspecified number of solar PV modules long (in landscape) north to south. In the candidate design, tables will be located continuously from north to south without substantial gaps between them. Half tables (east half or west half) will be utilised where transformers are located within the solar PV array.

46. Each table is supported above the ground by driven piles, the candidate design assumes a realistic worst case ratio of 1 pile per 4.5 solar PV modules. An indicative table elevation is shown in Figure 5.4.

47. The design principles in the Outline Design Principles document (DCO Document Reference 7.1) do not limit the arrangement of solar PV modules within a table (including whether they are portrait or landscape), the angle of slope or the design of the mounting structures. However the maximum height of the solar PV modules (3.9 m) and the minimum (1.2 m) height of flood sensitive equipment AGL are limited as well as the orientation of the slope of the solar PV modules towards the east and west and the colour of the solar PV modules. The separation between solar PV modules both at the ridge at the highest point in the middle of each table (minimum 300 mm), and between the lowest solar PV modules in adjacent tables (minimum 2.5 m) is also limited. The realistic worst-case design parameters set out in Table 5.1 have been

[3] These depths are approximate and variable depending on localised ground conditions.

driven by the maxima in the design principles therefore representing the maximum coverage of solar PV modules placed at the greatest anticipated heights.

48. Technical Appendix A5.1, Field Data, provides more detail on the table characteristics across each field of the solar PV array.

Plate 5.6a Example PV module mounting structures (driven piles) during construction

Plate 5.6b Example east-west PV module mounting structure arrangement

5.4.1.4 Inverters

49. Inverters are required to convert the DC electricity generated by the PV modules into alternating current (AC) which allows the electricity to be exported to the National Grid. Inverters are sized to deal with the level of voltage which is output from the strings of solar PV modules.

50. String inverters will be utilised on the Development, *e.g.*, at a scale of one inverter for every 10 strings of approximately 27 solar PV modules (rather than fewer, larger, centralised inverters). String inverters are small enough to be mounted beneath the

solar PV modules on the verticals of the mounting structures (see example in Plate 5.7) and are therefore not shown on layout plans.

51. Figure 5.4 includes an indicative drawing of an inverter mounted on the structure.

52. Using the realistic worst-case number of the solar PV modules and the parameters set out in the previous paragraph results in a candidate number of 3,071 string inverters being required across the solar PV arrays.

53. Depending on the electrical design, combiners may also be required to rationalise cabling between the inverters and the transformers. If required, these would be similar in scale to the string inverters and also mounted on the support structure beneath the solar PV modules.

54. The design principles in the Outline Design Principles document (DCO Document Reference 7.1) limit the design of the inverters to the string type and the location to within the solar PV array fields, mounted to the solar PV mounting structures. The scale and design of the string inverters is not limited beyond these design principles as the inverters are inherently limited in scale through being secured to the mounting structure, and they are largely hidden from view beneath the solar PV modules within the solar PV array fields. The parameters set out in Table 5.1 therefore represent a realistic worst-case design for the inverters.

Plate 5.7 Example of string inverters mounted beneath solar PV modules

5.4.1.5 Transformers

55. Transformers are required to control and increase the voltage of the electricity generated across the solar PV arrays before it reaches the Development substation. Transformers will be located within the solar PV array fields, and are expected to be within the range 2.5 to 5 mega volt amps (MVA). Using the realistic worst-case parameters generated for the solar PV modules and inverters results in a candidate number of 80 transformers across all of the solar PV array fields as shown in Figure 5.2.

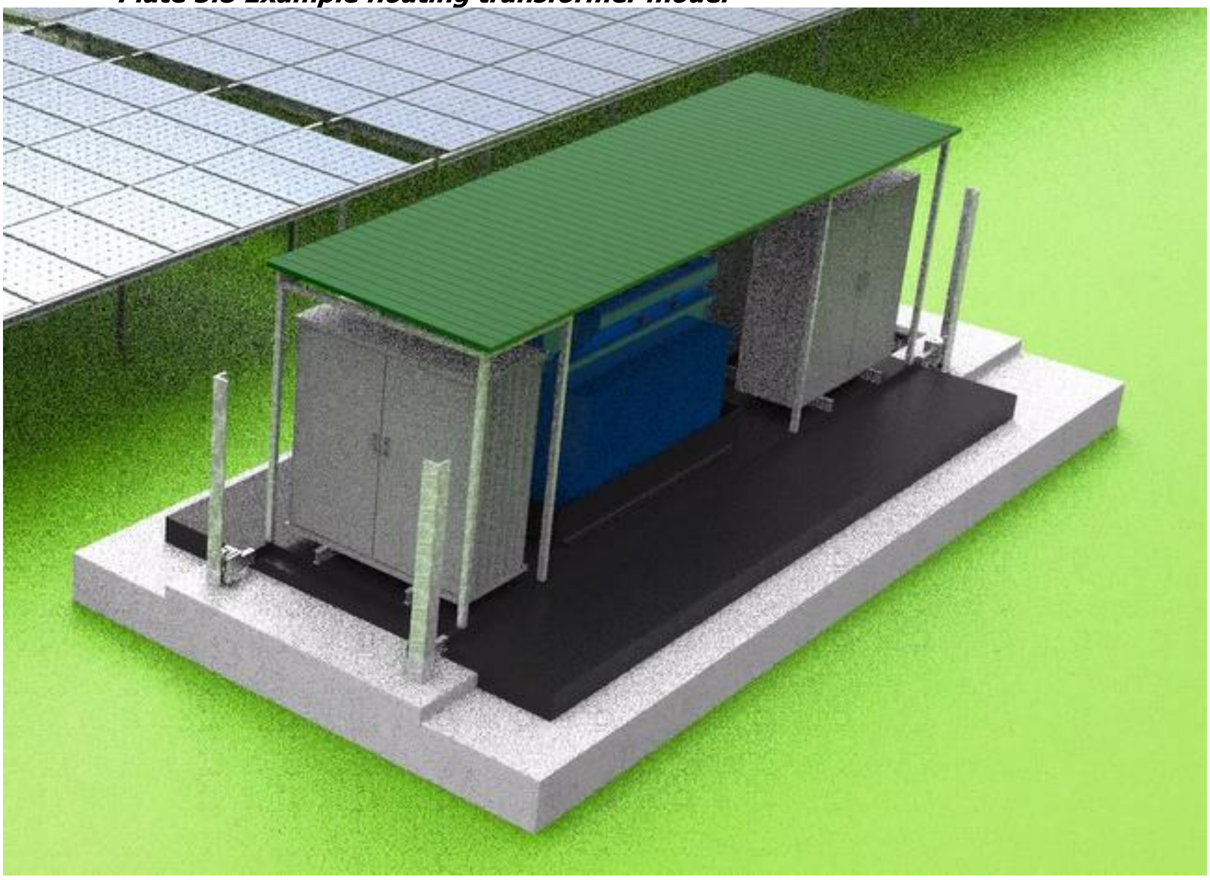
56. The variation in MVA capacity does not affect the dimensions of the transformers which are all anticipated to be the same approximate dimensions as the candidate design set out in Table 5.1.

57. The transformers will be of a design suitable to protect them against flooding either through resistance or resilience measures. The candidate design is a flood resistance solution; floating transformers. Each transformer station would be mounted on a floating platform housed within an underground tank. The cables entering and leaving the transformers would be coiled beneath the platform enabling it to rise and fall with flood waters. Four dolphins[4] at each corner of the transformer station would control the ascent and descent of the platform with flood waters. This design solution is considered to represent a realistic worst-case scenario in that the excavation for the base of the transformer would be required to a greater depth than for a standard foundation solution and there remains a likely requirement for structural concrete to form the base. An example design for this solution is shown in Plate 5.8 and Figure 5.5 which shows an indicative transformer plan and elevation.

58. Although Plate 5.8 shows a green roof, typically transformers are coloured grey to blend in with solar PV modules and other infrastructure forming part of the solar PV arrays.

59. The design principles in the Outline Design Principles document (DCO Document Reference 7.1) limit the location of the transformers to within the solar PV array fields and the scale of the transformers to not exceed 3 m in height AGL (except during a flood event). The design of the transformers must also incorporate some flood resistance or resilience measures as a design principle. The candidate design parameters set out in Table 5.1 therefore represent a realistic worst-case design for the transformers.

Plate 5.8 Example floating transformer model



[4] Vertical poles such as those used on tidal jetties to control the movement of a structure within a fixed location in relation to changes in water level.

5.4.1.6 Electrical Cabling

60. Onsite electrical cabling is required to connect the solar PV modules to the string inverters and combiners, and the string inverters and combiners to the transformers onsite. Higher rated cables are then required between the transformers and the Development substation within the electrical compound. The high voltage 400 kV connection to the National Grid is described in section 5.4.3.

61. DC cabling between solar PV modules and the string inverters will be above ground, fixed to the mounting structure.

62. All above ground cables will be routed through conduit and racking secured to the solar PV module mounting structures.

63. AC cables from the inverters to the transformers will be fixed to the solar PV module mounting structures before reaching ground level where they will be undergrounded or run in cable conduits above ground to reach the transformers.

64. AC cables between the transformers and the Development substation will be undergrounded.

65. Underground cables will be laid in trenches, typically of 0.5 to 1.1 m in depth and of varying width, depending on the number of cables and ground conditions. Cable trenches would generally run parallel to and between the tables and parallel and adjacent to or beneath the onsite spine road. Cable trenches may also carry earthing and communications cables and will be backfilled with fine sand and excavated materials to the original ground level. Where ditch crossings are required, the trenches will typically be located a minimum of 1 m below the bottom of the ditch and concrete markers will be placed on either side to clearly demarcate the location of the cable crossing.

66. Data cables will also be installed, typically alongside electrical cables in order to allow for the monitoring of data from the Development during operation, such as the collection of solar irradiance data from pyranometers. Cabling will also be required for power and data transfer associated with the CCTV system described in section 5.4.7.1.

5.4.1.7 Landscaping

67. Planting and management of grassland, hedgerows, trees and areas of scrub is proposed across the site for landscape, visual and biodiversity mitigation and enhancement. The landscaping proposals are described in detail in Technical Appendix A5.2: Landscape and Biodiversity Management Plan.

68. Technical Appendix A5.3: Microclimate and Vegetation Desk Study contains a desk-based study into the likely microclimate and vegetation responses to the design of solar PV mounting structures proposed. This study has been used to inform the Landscape and Biodiversity Management Plan.

5.4.1.8 Earthworks

69. Earthworks onsite (*e.g.*, transformer foundation excavations) may result in small surplus of material in areas of the Development site. This material will be reused in landscaping and restoration of the Development site during and after construction. If there remains a surplus post construction, small mounds of site won material of up to 3 m in height may be formed in vacant areas of the Development site to provide a range of habitats for certain species, to be agreed with habitat management consultees in advance, through implementation of Technical Appendix A5.2: Landscape and Biodiversity Management Plan.

5.4.2 *Electrical Compound*

Table 5.2a Electrical Compound Candidate Design Parameters

Flood Protection Bund Candidate Design		**Applicable Design Principle**
Bund height (m above ordnance datum)	5.316	The crest of the flood protection bund will be located at a height above ordnance datum (AOD) of 5.316 m to protect against the modelled 1 in 1,000 year flood event including a simulated breach of the existing coastal flood defences (the flood modelling is provided in ES Technical Appendix A10.1 (DCO Document Reference 6.4.10.1) and summarised in ES Chapter 10: Hydrology, Hydrogeology, Flood Risk and Ground Conditions) (DCO Document Reference 6.1.10).
Bund Width (m)	Varies - approximately 35	N/A
Bund Materials	Predominantly site won clay and topsoil	As much site won material from within the electrical compound area will be used to construct the bund as is reasonably practicable.
Bund Construction	Impervious foundation (likely imported) Core trench (suitable site won material) Impermeable core (suitable site won material) Topsoil (suitable site won material)	
Estimated volume of material required to create bund	75,000 m^3	
Estimated volume of material expected to be won onsite	63,750 m^3	
Estimated volume of material expected to be imported to form bund	11,250 m^3	

Table 5.2b Electrical Compound Candidate Design Parameters

Energy Storage Facility Candidate Design		**Battery Pack Solution**	**Containerised Solution**	**Applicable Design Principle**
Battery Pack Cabinets / Containers	Number of Cabinets	7,440	300	The energy storage facility will be located within the area marked as Work No. 2 & 3 on the Works Plan (DCO Document Reference: 2.2).
	Approximate total energy storage capacity	700 MWh	630 MWh	
	Cell Type	Lithium-ion	Lithium-ion	
	HVAC - Heating / Cooling System	Closed loop liquid	Climate Control -	

Energy Storage Facility Candidate Design			**Battery Pack Solution**	**Containerised Solution**	**Applicable Design Principle**
			thermal management	Chilled Water / Direct Expansion / Evaporator	
	Dimensions	Length (mm)	1,308	12,200	
		Width (mm)	822	2,438	
		Height (mm)	2,185	2,890	The components of the energy storage facility will not be higher than the top of the flood protection bund.
	Foundation Type		Concrete Pad	Concrete sleepers	N/A
Inverters	Number of Inverters		744	90	N/A
	Cooling System		Closed loop liquid thermal management with radiator and fans	Climate Control - Chilled Water / Direct Expansion / Evaporator	
	Dimensions	Length (mm)	1,014	12,200	
		Width (mm)	1,254	2,438	
		Height (mm)	2,192	12,200	The components of the energy storage facility will not be higher than the top of the flood protection bund.
	Foundation Type		Concrete Pad	Concrete sleepers	N/A
Controllers	Number of Controllers		744	N/A. The controllers are sited within the containers in the containerised solution.	N/A
	Dimensions	Length (mm)	229		
		Width (mm)	453		
		Height (mm)	499		The components of the energy storage facility will not be higher than the top of the flood protection bund.
	Foundation Type		Concrete pad / Rack		N/A

Energy Storage Facility Candidate Design			**Battery Pack Solution**	**Containerised Solution**	**Applicable Design Principle**
			Mounted		
33 kV / 415 V Transformers	Number of Transformers		124	130	N/A
	Dimensions	Length (mm)	4400	4400	
		Width (mm)	4100	4100	
		Height (mm)	2245	2245	The components of the energy storage facility will not be higher than the top of the flood protection bund.
	Foundation Type		Concrete pad	Concrete pad	N/A

Table 5.2c Electrical Compound Candidate Design Parameters

Development Substation Candidate Design				**Applicable Design Principle**
33 kV Equipment				
33 kV Zig Zag Transformer	Number	2		The Development substation will be located within the area marked as Work No. 2 & 3 on the Works Plan (DCO Document Reference: 2.2).
	Dimensions	Length (mm)	3700	
		Width (mm)	1100	
		Height (mm)	8850	The components of the Development substation will be a maximum of 12.8 m in height AGL.
33 kV Busbar Post	Number	6		N/A
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	8850	The components of the Development substation will be a maximum of 12.8 m in height AGL.
Transformer Plinth and Bund	Number	1		N/A
	Dimensions	Length (mm)	25300	
		Width (mm)	15075	
		Height (mm)	N/A	
400 kV Equipment				
Main Transformer, including radiators, fans, conservator and bushings	Number	1		The components of the Development substation will be a maximum of 12.8 m in height AGL.
	Dimensions	Length (mm)	14700	
		Width (mm)	7900	
		Height (mm)	11085	

Development Substation Candidate Design				**Applicable Design Principle**
Transformer Spare Phase	Number	1		
	Dimensions	Length (mm)	3500	
		Width (mm)	3000	
		Height (mm)	4800	
Post Insulators	Number	9		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	7800	
Tall Post Insulators	Number	24		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	12800	
Busbars, per m	Number	1,137		
	Dimensions	Length (mm)	1	
		Width (mm)	350	
		Height (mm)	350	
Isolating and Earthing Switch	Number	24		
	Dimensions	Length (mm)	5000	
		Width (mm)	500	
		Height (mm)	7800	
AIS Circuit Breaker	Number	12		
	Dimensions	Length (mm)	5000	
		Width (mm)	600	
		Height (mm)	7800	
Cable sealing end	Number	6		
	Dimensions	Length (mm)	1500	
		Width (mm)	1500	
		Height (mm)	7800	
CT	Number	9		
	Dimensions	Length (mm)	1200	
		Width (mm)	1200	
		Height (mm)	8600	
Pantograph disconnector	Number	6		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	12800	
STATCOM / Reactive Compensation				
Building	Number	4		

Development Substation Candidate Design				**Applicable Design Principle**
	Dimensions	Length (mm)	12300	
		Width (mm)	10300	
		Height (mm)	3000	
Reactor	Number	18		
	Dimensions	Length (mm)	2500	
		Width (mm)	2500	
		Height (mm)	8000	
Capacitor Rack	Number	6		
	Dimensions	Length (mm)	2000	
		Width (mm)	2000	
		Height (mm)	7500	
Post Insulator	Number	12		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	7800	
Tall Post Insulator	Number	6		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	12800	
Pantograph Disconnector	Number	12		
	Dimensions	Length (mm)	1000	
		Width (mm)	1000	
		Height (mm)	12800	
Cable sealing end	Number	6		
	Dimensions	Length (mm)	1500	
		Width (mm)	1500	
		Height (mm)	7800	
Harmonic Filter				
Capacitor Rack	Number	18		
	Dimensions	Length (mm)	2000	
		Width (mm)	2000	
		Height (mm)	7500	
Reactor	Number	18		
	Dimensions	Length (mm)	2000	
		Width (mm)	2000	
		Height (mm)	8000	
CT	Number	12		
	Dimensions	Length (mm)	1200	

Development Substation Candidate Design				**Applicable Design Principle**
		Width (mm)	1200	
		Height (mm)	8600	
Resistor	Number	6		
	Dimensions	Length (mm)	3500	
		Width (mm)	2000	
		Height (mm)	6500	
Surge Arrestor	Number	6		
	Dimensions	Length (mm)	1650	
		Width (mm)	1650	
		Height (mm)	7800	
Cable sealing end	Number	6		
	Dimensions	Length (mm)	1500	
		Width (mm)	1500	
		Height (mm)	7800	
Deluge System				
Pumphouse	Number	1		
	Dimensions	Length (mm)	9164	
		Width (mm)	2538	
		Height (mm)	2691	
Tank	Number	1		
	Dimensions	Length (mm)	8000	
		Width (mm)	8000	
		Height (mm)	3000	
Site Office, Storage and Welfare and Diesel Gensets				
Site Office, Storage and Welfare Building	Number	1		
	Dimensions	Length (mm)	20200	
		Width (mm)	19300	
		Height (mm)	4770	
Diesel Genset	Number	3		
	Dimensions	Length (mm)	3100	
		Width (mm)	1200	
		Height (mm)	1630	

70. Indicative plans, elevations and isometric drawings of the electrical compound are shown in Figures 5.6a to c and 5.7a to c. The electrical compound will comprise a flood protection bund, the Development substation and either an energy storage facility or an extension of the solar PV arrays. Should the energy storage facility be not, or only partially (compared to the candidate design), built, and/or should the substation be smaller than the candidate design, the overall electrical compound may be reduced in size. Should this occur, its eastern boundary will remain as shown on Figure 5.2, while its western and northern boundaries will be relocated further south east. The space left

by the relocation of these boundaries will be available for use by solar PV modules, as set out in section 5.4.2.4. This is reflected in Schedule 1 of the DCO and explains why the area of land in question may comprise energy storage or solar PV modules.

71. The candidate design is for the electrical compound to be built in full, as shown in Figure 5.2, and for it to contain one of the two candidate scenario energy storage solutions set out in Table 5.2b.

72. A steel palisade security fence will encircle the electrical compound within the bund at ground level.

73. The electrical compound, as shown on Figure 5.2, is located on land including an existing drainage ditch. This ditch will be filled in and replaced by a new drainage ditch that will be created along the length of the northern boundary of the electrical compound.

74. The electrical compound will contain a permeable road surface with an underdrain that flows to this new drainage ditch via a non-return valve (at the north end of the compound). The new into an existing drainage ditch draining north.

75. The short section of new ditch left at the southern end of the electrical compound will be diverted into the existing drainage ditch that runs along the northern boundary of the existing Cleve Hill Substation.

5.4.2.1 Flood Protection Bund

76. In order to protect the critical infrastructure within the electrical compound in the event of a breach of the coastal flood defences, a flood protection bund consisting of a vegetated earth bund with an impermeable core will be constructed which will encircle the electrical compound. The bund is expected to be formed predominantly of site won material, in particular clays, to form the core of the bund, and topsoil to provide a planting medium for the landscaping planting described in Technical Appendix A5.2. The crest of the bund which will be formed at approximately 5.316 m AOD, which is the worst case modelled flood level (including 300 mm freeboard) during a 1 in 1,000 year defended breach event in the year 2070 (*i.e.*, including for projections of sea level rise due to climate change). The existing ground level beneath the location of the bund is typically between 1 and 1.5 m AOD, therefore the bund height AGL will likely vary between approximately 3.8 and 4.3 m AGL.

77. Access into the electrical compound will be taken over the bund as shown in Figure 5.2.

78. Figure 5.8 shows a typical cross section of the flood protection bund.

5.4.2.2 Energy Storage Facility

79. Energy storage facilities currently utilise a range of technologies and built forms such as external 'battery packs', batteries housed within shipping containers or within larger bespoke buildings, and this range may expand to include new technologies and solutions in the future. Two example scenarios are included in the candidate design parameters to ensure that the operational scheme can provide the necessary electricity management services to the National Grid and will be commercially viable:

- Battery pack solution; and
- Containerised solution.

80. Neither of the scenarios presented would exceed the design principles in the Outline Design Principles document (DCO Document Reference 7.1).

Battery Pack Solution

81. The battery pack solution comprises an approximately 700 megawatt hour (MWh) battery array which would be located within the electrical compound. This battery

array has been designed using a modular, fully integrated, AC-coupled industrial energy storage system[5] which consists of three types of enclosure:

- Rechargeable lithium-ion battery pack cabinets;
- Inverter; and
- System controller.

82. Transformers are also required to step up the low voltage from each group of 60 battery cabinets to high voltage and supply it to the Development substation. These transformers are likely to have similar characteristics to the transformers within the solar PV arrays (although as they will be protected by the flood protection bund, they will not be required to float).

83. Typically, powerpacks are white in colour as shown in Plate 5.9.

Plate 5.9 Example Battery Storage Powerpack Arrangement[6]

84. The battery pack solution would require concrete pad style foundations.

85. An indicative layout for the battery pack solution is shown in Figures 5.7a to c.

Containerised Solution

86. The containerised solution comprises the same types of equipment as the battery pack solution but typically the batteries and the inverters are located within 'shipping container' type units. The containers shown on the indicative layout shown in Figures 5.7a to c are approximately 12 m in length and would be mounted on concrete sleeper supports.

87. Transformers are also shown on Figure 5.8a to c and are the same indicative dimensions as those presented for the battery pack solution.

5.4.2.3 Development Substation

88. The Development substation will consist of electrical infrastructure such as the transformers, switchgear and metering equipment required to facilitate the export of electricity from the Development to the National Grid.

89. The candidate design includes the following plant and equipment:

- 33 kV equipment;
- 400 kV equipment;
- STATCOM / reactive compensation yard;
- Harmonic Filter;
- Deluge System;
- Site office, storage and welfare building; and
- Diesel Gensets.

[5] Powerpack 2 System Site Design Manual, Tesla (2017)
[6] Powerpack 2 System Site Design Manual, Tesla (2017)

90. Welfare facilities would be provided in the site office, storage and welfare building. This would include telecommunication links, a connection to the public mains water supply and the local electricity distribution network, and either a connection to the foul sewer or a cess tank that would be periodically emptied and taken off site by a licensed operator.

91. The colour of the plant within the Development substation is yet to be determined, but typically substation equipment is bare metal or grey in colour. The applicable design principle is for the equipment and buildings to fit with other local infrastructure, such as the existing Cleve Hill Substation.

5.4.2.4 Extension to the Solar Park

92. As set out in section 5.3 of this chapter, the rapid pace of development in the energy storage sector necessitates that alternative scenarios are accounted for in the Development design. One of these scenarios is that the Development could be built without the energy storage facility, or comprising a smaller energy storage facility. If this were the case, the Applicant would wish to preserve the ability to maximise the capacity of the solar PV arrays by utilising the area vacated within the electrical compound area shown on Figure 5.2 to add additional solar PV modules to the Development and increase the electrical generation capacity.

93. If this were undertaken the design principles set out in the Outline Design Principles document (DCO Document Reference 7.1) would apply to the extension in order to ensure that the extension would appear as an integral part of the solar PV array design.

94. For all technical assessments, the realistic worst case is that the electrical compound is developed to its maximum extents, as set out above therefore the extension to the solar park is not assessed separately in this ES.

5.4.3 Grid Connection to the National Grid

Table 5.3 Grid Connection to the National Grid Candidate Design Parameters

Grid Connection to the National Grid		**Applicable Design Principles**
Indicative number of 400 kV circuits	1	N/A
Conducting cores forming the 400 kV circuit	3	N/A
Number of trenches	1	The cable between the electrical compound and the existing Cleve Hill Substation will be underground.
Approximate trench depth (m)	1.4	
Approximate trench width (m)	1.3	
Approximate length of cable system between edge of electrical compound and NGET substation building (m)	200	N/A

95. The electricity generated by the Development will be exported via an underground high voltage 400 kV cable system between the Development substation and the NGET substation located within the existing Cleve Hill Substation at NGR TR 04911 63997.

96. The 400 kV cable system will allow electricity to be exported and imported from the Development to facilitate the charging of the energy storage facility. The cable system is expected to comprise a single 400 kV circuit with 3 conducting cores placed in a single trench. Either ducting would be utilised or the cables would be directly buried.

97. The cable route is expected to run south from the Development substation into the existing Cleve Hill Substation compound passing between the drainage pond at NGR TR

04837 64008 and the western boundary of the NGET compound, within the area shown on Figure 5.2. The minimum distance between the NGET compound wall and the pond is 20 m and the cable will pass between the two. It is likely that the route will continue to the south side of the NGET compound before entering the compound itself and entering the NGET substation.

98. An indicative design for the 400 kV cable system trench is shown on Figure 5.10.

99. The NGET substation within the existing Cleve Hill Substation has available capacity for the Development to connect directly into the United Kingdom transmission network. It is not anticipated that any additional external plant or equipment requiring consents will be required to facilitate this connection. If this situation should change, responsibility for securing any necessary consents for upgrades to the existing NGET substation would remain with NGET under the terms of the grid connection agreement, which is explained in more detail in the Grid Connection Statement (DCO Document Reference 5.4).

5.4.4 Site Access

Table 5.4 Site Access Candidate Design Parameters

Site Access Candidate Design				**Applicable Design Principles**
Tarmacadam Access Road		**Northern Route**	**Southern Route**	
	Length of existing tarmac road utilised (m)	500	1,068	The site access road will be tarmacadam between the existing site entrance and the electrical compound marked as Work No. 2 & 3 on the Works Plan (DCO Document Reference: 2.2).
	Length of new tarmac road created (m)	1,002	503	
	Total length of finished tarmac road (m)	1,502	1,571	
	Width of new tarmac road (m)	4 to 7.25 (+ passing places)		
	Area of new tarmac road (m^2)	7,350	3,654	
	Estimated volume of road material required (m^3)	18,245	9,160	
Stone Spine Road	Length of new stone road created (m)	2,160		The site access road will be of permeable stone construction to the west of the first ditch crossing west of the electrical compound marked as Work No. 2 & 3 on the Works Plan (DCO Document Reference: 2.2).
	Width of new stone road (m)	4 (+ passing places)		N/A
	Area of new stone road	12,100		

Site Access Candidate Design			Applicable Design Principles
	(m^2)		
	Estimated volume of stone required (m^3)	6,713	

100. The site access will be taken from Seasalter Road via the existing bell mouth entrance to the existing Cleve Hill Substation at NGR TR 05729 63930.

101. A public footpath crosses the site access point from Seasalter Road and appropriate provision for pedestrian access will be maintained throughout construction and operation, with particular emphasis on the safety of users during the construction phase. Further information on this and other public rights of way within the Development site is included in Chapter 14: Access and Traffic, and Technical Appendix A14.1 Construction Traffic Management Plan, which includes a Public Rights of Way Management Plan.

102. The existing tarmac road which serves the existing Cleve Hill Substation will be utilised as far as NGR TR 05253 64066. From that point, two routes are included in the candidate design parameters:

- The northern route; and
- The southern route.

103. These two alternative routes are shown in Figure 5.10. The Applicant seeks consent for both routes, but it is only intended to create and use one of the access routes.

104. Both routes are also proposed to be tarmac surfaced as far as the electrical compound. An indicative tarmac road construction cross section drawing is provided in Figure 5.11.

The northern route

105. The northern route utilises the route of the existing gravel track which turns off the existing tarmac access road to the north towards the arable land at NGR TR 05257 64063 before turning west after exiting the existing Cleve Hill Substation boundary and running alongside the ditch which forms the northern boundary of the existing Cleve Hill Substation. The existing gravel road would be replaced with a tarmac surface as far as the entrance to the Development substation.

The southern route

106. Following comments received during consultation, a potential second route has been added to the Development Design. The southern route would utilise the existing tarmac road which runs to the south of the existing Cleve Hill Substation and exits into the arable land to the west. Where the tarmac currently ends, a new tarmac track would be constructed to connect to the electrical compound.

The spine road

107. Beyond the entrance to the electrical compound, a stone access track will be constructed as a spine road through the Development site as shown in Figure 5.3. The spine road will have a width of approximately 4 m with passing places and turning areas. The stone spine road will be an estimated 2.16 km in length.

108. The spine road will be formed either through:

- Excavation of approximately 0.5 m of material from the surface before using geotextile and clean stone to form the road at existing ground level; or through
- A 'floating road' construction where the track is formed in the same way but on top of the existing ground level without excavation.

109. The spine road will be constructed of crushed and graded stone giving a farm-track like appearance. The spine road will be of permeable construction but will also have adequate crown or cross-slope to allow rainwater to be shed. An indicative stone road construction cross section drawing is provided in Figure 5.11.

110. Access to the solar PV array during construction and operation will be taken from grassed tracks and existing farm tracks accessed from the spine road as described in section 5.5.4.

111. The spine road crosses public footpath ZR485 at approximate NGR TR033639. Whilst the main phase of construction activity is undertaken to construct the spine road and in Fields A, B, C, K and L to the west of this crossing, the public footpath will be constantly supervised during construction hours to ensure public safety. The construction of these fields is expected to last a total of approximately 18 to 20 weeks (not necessarily consecutive weeks). An alternative route to link the two ends of the footpath via the Saxon Shore Way will be signposted throughout the construction phase.

112. Further information on this and other public rights of way within the Development site is included in Chapter 14: Access and Traffic, and Technical Appendix A14.1 Construction Traffic Management Plan, which includes a Public Rights of Way Management Plan.

Culverts

113. New and upgraded existing culverts will be required to facilitate safe access to all of the Development site during construction and operation. There is an existing network of culverts across the Development site and this has been utilised where practicable. It has been assumed in the candidate design that where existing culverts provide access to fields, these will need to be upgraded, however at the start of construction each culvert proposed to be used will be surveyed and only culverts that require upgrading will be upgraded.

114. There are three different types of culvert, all of which could be new or upgraded depending on the location:

- Access road crossing;
- Perimeter fence crossing; and
- Field access.

115. Mammal-friendly box-section culverts will be utilised for new and upgraded culverts.

116. A watercourse crossing inventory is provided in ES Technical Appendix A5.4.

5.4.5 Habitat Management Areas

Table 5.5 Habitat Management Area Candidate Design Parameters

Habitat Management Areas Candidate Design			**Applicable Design Principles**
Arable Reversion (AR HMA)	Size (ha)	55.5	The arable reversion habitat management area will provide a minimum of 50.1 ha of functional habitat management land for brent geese, lapwing and golden plover. The functional habitat management land will be calculated by subtracting the total area of land within 50 m of the solar PV modules and/or transformers, crest of the flood protection bund, edge of a road surface, and not within an existing
	Primary Purpose	To mitigate for the loss of foraging and roosting habitat for overwintering birds on the arable land within the Development site by managing the land as a grassland habitat designed to consistently support overwintering birds.	
	Summary of	The management of	

Habitat Management Areas Candidate Design			Applicable Design Principles
	Management Prescriptions	the mitigation grassland has been agreed with Natural England to be focussed on provision of optimal foraging conditions for brent goose. This will involve summer grazing by cattle and/or sheep, application of organic fertiliser (e.g. farmyard manure) equivalent of up to 50 kg N per hectare and late summer/autumn cutting if required to provide a nutritious, short-sward grassland capable of supporting 2,097 goose-days per hectare through the winter. The establishment and effectiveness of the HMA will be monitored. It is agreed to continue ongoing consultation with the HMSG through the construction and operational phases of Development.	designation from the total area set aside for management to the north and east of the electrical compound marked as Work No. 2 & 3 on the Works Plan (DCO Document Reference: 2.2).
Freshwater Grazing Marsh (FGM HMA)	Size (ha)	36.6	N/A
	Primary Purpose	To provide support to the landowner for the ongoing management of the SSSI land to complement the management of the adjacent arable reversion land.	
	Summary of Management Prescriptions	Water, drainage and grazing management in consultation with the HMSG and the landowner.	
Graveney Hill Lowland Grassland Meadow (LGM HMA)	Size (ha)	13.3	N/A
	Primary Purpose	To provide a different range of biodiversity enhancements relating to ground nesting birds, small mammals, birds of prey, pollinators etc. in a publicly accessible area of the	

Habitat Management Areas Candidate Design			Applicable Design Principles
		Development site (crossed by public footpath ZV488).	
	Summary of Management Prescriptions	Establishment of a diverse grassland sward and managed grazing to encourage a lowland meadow habitat to establish.	
Existing Cleve Hill Substation complementary management (CHS HMA)	Size	2.0	N/A
	Primary Purpose	To influence the management of habitats adjacent to other habitat management areas to be complementary to the adjacent management.	
	Summary of Management Prescriptions	Unknown, likely related to mowing / grazing frequency and encouraging floristic diversity.	

117. Four distinct areas of specific habitat management are proposed within the Development site. These are:

- Arable reversion – land to be managed to be of specific benefit to dark-bellied brent goose, lapwing and golden plover;
- Freshwater grazing marsh – existing SSSI, SPA and Ramsar wetland which is proposed to be brought under the control of CHSPL to enable large scale complementary habitat management to be undertaken across a wider area.
- Lowland Meadow Creation – the slopes of fields Y and Z where solar PV modules were previously included in early conceptual design will be managed as a lowland meadow, a UK and local biodiversity action plan priority habitat[7,8]; and
- Existing Cleve Hill Substation – the management of an area of land between the existing site access and the arable reversion area and freshwater grazing marsh could be influenced for the benefit of biodiversity.

5.4.5.1 Arable Reversion

118. 55.5 ha of arable land in the east of the Development site is proposed to be kept free of infrastructure in order to mitigate for the loss of arable habitat currently used by overwintering birds associated with the Swale Special Protection Area (SPA), specifically lapwing, golden plover and dark-bellied brent goose.

119. Arable land in this habitat management area (HMA) will be reverted to grassland pasture. The arable reversion HMA (AR HMA) is designed to be managed to be of specific benefit to those overwintering species, but also to provide other biodiversity benefits to a range of other species, such as breeding waders and marsh harrier.

[7] Swale Green Grid Partnership (2016). Swale Biodiversity Action Plan. Available at: https://www.swale.gov.uk/assets/Strategies-plans-and-policies/Biodiversity-Action-Plan-2016.pdf [Accessed 20/10/2018]
[8] DEFRA (2008). UK Biodiversity Action Plan Priority Habitat Descriptions, Lowland Meadows. Available at: http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-29-Lowland%20Meadows.pdf [Accessed 20/10/2018]

120. The size, location and management of the area have been the subject of consultation with a Habitat Management Steering Group (HMSG), including Natural England, RSPB and Kent Wildlife Trust. Some of the measures that will be implemented in this area include:

- Sowing with a grass/clover seed mix;
- A revised water management regime;
- Application of organic matter to promote growth of a nutritious grass sward; and
- Controlled grazing (and/or cutting) to promote an appropriate sward length.

121. Further detail on the proposed management measures are provided in Technical Appendix A5.2: Landscape and Biodiversity Management Plan. The rationale for the size and location of this area is provided in Chapter 9: Ornithology.

5.4.5.2 Freshwater Grazing Marsh

122. 37.1 ha of existing freshwater grazing marsh (as shown in Figure 5.1) is also proposed to be included as a HMA – the FGM HMA. This land is within The Swale Site of Special Scientific Interest, Special Protection Area and Ramsar designated area, however following consultation, opportunities to improve the management of this area to bring additional benefits over and above the baseline for biodiversity and the designated interests of the Swale were identified and therefore this land has been included within the Development site boundary so that its management can be delivered and controlled via the DCO.

123. In particular, water management and controlled grazing are likely to be fundamental to achieving the desired outcomes for this area. The details of the management will be adaptive and subject to consultation and agreement with Natural England. In response to consultation responses, however, any benefits the Development may bring to this area are not considered to be mitigation of effects, because the current objectives for the area to be in favourable condition should be assumed to be successfully delivered in the future baseline scenario. Clarification on this is provided in Chapter 9: Ornithology.

124. Further detail on the proposed management measures are provided in Technical Appendix A5.2: Landscape and Biodiversity Management Plan.

5.4.5.3 Lowland Grassland Meadow Creation

125. The aim of the LGM HMA is to establish a grassland sward with greater ecological value than the existing arable land.

126. Arable agricultural land may be one of the most challenging types of habitat to convert/attempt sward enhancement due to its high soil fertility which promotes dominance by a limited diversity of competitive plant species which limits the establishment and success of less-competitive wildflowers and fine grasses. Consequently, grassland enhancement/ restoration is a complex process requiring monitoring and intervention over several years to ensure success, especially on sites with a long history of agricultural improvement.

127. Further detail on the proposed management measures are provided in Technical Appendix A5.2: Landscape and Biodiversity Management Plan.

5.4.5.4 Existing Cleve Hill Substation

128. The aim of the CHS HMA would be to establish a grassland sward with greater ecological value than the existing grassland to complement the management of neighbouring HMAs. This could include a more relaxed mowing regime, introduction of species to encourage pollinators etc. The CHS HMA is subject to agreement with London Array Ltd.

129. Further detail on the proposed management measures are provided in Technical Appendix A5.2: Landscape and Biodiversity Management Plan.

5.4.6 Flood Defences

Table 5.6 Flood Defence Maintenance Candidate Design Parameters

Flood Defences Candidate Design			**Applicable Design Principles**
Examples of Flood Defence Maintenance activities have been agreed with the Environment Agency and the Marine Management Organisation, and included within the design principles definition (non-exhaustive)	(i)	Inspection	Flood defence maintenance activities will include works that: • use the same materials as those present to date; • do not alter the plan form or cross section of the original defences; • do not provide an overall increase/reduction in flood level; and • do not require excavations of beach material deeper than 1.5 m. Examples of flood defence maintenance activities that satisfy the above criteria are provided in ES Chapter 5: Development Description (section 5.4.6). If maintenance works are required that exceed these design principles, separate consents will be sought.
	(ii)	Investigation (above MHWS, inclusive of trial pitting)	
	(iii)	Replacement of expansion joint material	
	(iv)	Concrete repair (to BS EN 1504)	
	(v)	Replacement of concrete toe beam	
	(vi)	Vegetation management (grass cutting, removal of larger vegetation)	
	(vii)	Replacement of loose and missing block work	
	(viii)	Repair of voids	
	(ix)	Fencing repair / replacement	
	(x)	Servicing outfalls	
	(xi)	Cleaning outfall ancillary structures	
	(xii)	Topping up of embankment crest levels at localised low spots	
	(xiii)	Vermin control	
	(xiv)	Repairs of rutting in crest	
	(xv)	Repointing of jointed structures	
	(xvi)	Replacing modular blocks	
	(xvii)	Replacement of toe armour as required	
	(xviii)	Reinstatement of timber toe piles (on river frontage)	
	(xix)	Timber groyne plank replacement	
	(xx)	Replacement of bolts on groyne	
	(xxi)	Placement of timber rubbing boards on groyne	
	(xxii)	Localised movements of beach material	
	(xxiii)	Cleaning/dredging of drainage ditch channels	

Flood Defences Candidate Design			Applicable Design Principles
	(xxiv)	Replacement of pitching where present	
	(xxv)	Replacement of access structures	
	(xxvi)	Painting	
	(xxvii)	Any other activities required to be undertaken within the four parameters set out in the Outline Design Principles document.	
Emergency Works			Flood defence works required in an emergency can be carried out without the requirement for additional consents, and are defined as activities carried out in response to any flood, or in response to the imminent risk to property (including the Development infrastructure) from flooding.

130. The Environment Agency (EA) has stated during consultation that CHSPL and other infrastructure owners who benefit from the protection afforded by the existing flood defences will be required to undertake future maintenance of the defences from the commencement of operation of the Development. The flood defences which protect the majority of the Development site from coastal flooding are therefore included within the Development site boundary to give CHSPL the powers and rights to enable it to access the flood defences and undertake the type of maintenance activities that the EA would have otherwise undertaken. The design principles guiding the definition of maintenance activities are set out in the Outline Design Principles document (DCO Document Reference 7.1). These design principles reflect those agreed with the EA and set out in a joint position statement which is appended to the Consultation Report (DCO Document Reference 5.1.1).

131. No specific flood defence works over and above those likely to be undertaken on an ongoing basis by the EA to maintain the current standard of protection are currently proposed. Therefore for the purposes of EIA, there is no change predicted to the future baseline. If more extensive works are required in future to maintain the current standard of protection, those works would be subject to the grant of appropriate future consents and EIA (if applicable), in the same way they would be in the absence of the Development.

132. The flood defence maintenance activities will be undertaken within the area marked as flood defences on Figure 5.2. This includes the flood defence structure and either a 15 m buffer seaward of the toe of the defences where they are visible (from the inferred location if they are not) or Mean High Water Springs (MHWS), whichever is further seaward.

5.4.7 Other Infrastructure

Table 5.7 Other Infrastructure Candidate Design Parameters

Other Development Candidate Design			**Applicable Design Principles**
Fencing	Length of Perimeter Fencing (km)	15	N/A
	Fence Type	Deer Fence Treated wooden poles Stock netting	
	Fence Height (m AGL)	2	Fencing and CCTV equipment will not exceed the maximum height AGL of the solar PV modules in the closest solar PV array field as set out in Technical Appendix A5.1.
CCTV	Number of CCTV Cameras	240	N/A
	Support Column Details	100 mm box section galvanised steel column or wooden pole	
	Camera Height (m AGL)	3	Fencing and CCTV equipment will not exceed the maximum height AGL of the solar PV modules in the closest solar PV array field as set out in Technical Appendix A5.1.
	Camera Position	1 m inside the fence boundary	
	CCTV Lighting	Infrared outside daylight hours (not visible light)	No lighting will be permanently operated.
Lighting	Solar PV Array transformers	Manually operated lighting PIR motion sensor activated security / emergency lighting.	
	Electrical Compound	Manually operated lighting Passive infra-red (PIR) motion sensor activated security / emergency lighting.	

5.4.7.1 Fencing, Security Measures and Lighting

Fencing

133. A perimeter fence will enclose the operational areas of the Development to prevent public access into the solar PV arrays. To achieve this, the fence must also separate the public right of way, and the permissive footpath from the solar PV array fields. This is expected to result in four perimeter fences being required.

134. The fence will be a 'deer fence' of approximately 2 m in height with wooden posts and stock netting to reflect the built form of other fencing in the local area. An example is shown in Plate 5.10.

135. Gates in the fencing will be placed in each field to facilitate access to the outer perimeter of the Development site for maintenance and security purposes.

136. The fence will incorporate mammal gates at regular (every 50 m) intervals to avoid the fence acting as a barrier to movement of mammals through the Development site.

137. A 1.2 m high post and wire stock fence will also be installed alongside Cleve Hill Road to prevent unauthorised access to the lowland grassland meadow habitat management area in the southeast of the Development site. Gates will be installed to ensure continued public access via the public footpath which crosses the area, and to allow vehicle access for land management.

138. Section 5.6.1 of this chapter provides more detail on the use of temporary and mobile stock fencing for livestock control.

CCTV

139. Pole mounted internal facing closed circuit television (CCTV) systems will be deployed within the perimeter fence of the operational areas of the Development. An example is shown in Plate 5.10.

140. The CCTV will be mounted at a maximum of 3 m AGL on either wooden or steel columns. The CCTV system will utilise infrared (invisible) lighting to capture images in low light conditions. Where the cameras are adjacent to publicly accessible locations or private property, the equipment will be sensitively located, and can also be "digitally blanked" in order to prevent privacy issues.

Lighting

141. Visible lighting, which will be manually controlled and switch on only when activated by passive infra-red (PIR) sensors for security/emergency purposes, will be deployed around the electrical compound and at the transformers within the fields of the solar PV arrays. The lighting will be fixed to the transformers themselves rather than being stand alone. No areas of the Development will be continuously lit during operation.

Plate 5.10 – Example fencing and CCTV camera

5.4.7.2 Permissive Footpath

142. Following suggestions made during consultation, a permissive footpath is proposed to be created and maintained during the operational phase of the Development to provide additional public access to the Development site over and above the existing public rights of way.

143. The permissive footpath uses the existing track though the Development site from the seawall at NGR TR 04265 64829 south past the Development electrical compound before following drainage ditches southeast to meet existing public footpath ZR 488 where it crosses over two drainage ditches on small footbridges at NGR TR 05008 63325.

144. Further detail is provided in Chapter 13: Socioeconomics, Tourism, Recreation and Land-use and the proposed permissive footpath is shown on Figure 13.1.

5.5 Construction

145. An indicative summary of the construction phasing is provided in Table 5.8.

Table 5.8 Candidate Construction Phasing

Construction Activity		**Month**																							
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
Phase One	Site Access Road	■	■	■																					
	Perimeter Fencing	■	■																						
	CCTV		■																						
	Temporary Compound	■	■	■	■	■	■																		
	Bund Construction		■	■	■	■	■	■	■													■	■		
	Spine Road			■	■	■	■																		
	Drainage			■	■	■	■	■	■																
	Compound Roads			■	■	■	■	■	■	■	■	■													
	Structural Concrete			■	■	■	■	■	■	■	■	■	■	■	■	■	■								
	Solar Array Construction						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■			
	Electrical Compound Installation									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Phase Two	Energy Storage Facility Concrete			■	■	■	■	■	■	■	■	■	■												
	Energy Storage Facility Installation													■	■	■	■	■	■	■	■	■	■	■	■
400 kV Cable																							■	■	■

5.5.1 Phasing

146. The construction period is likely to be undertaken in at least two phases:

- Phase one will include the construction of all aspects of the Development except the energy storage facility; and
- Phase two will include the construction of the energy storage facility (phase two in itself could be undertaken in multiple phases in order to deliver smaller amounts of energy storage capacity gradually).

147. Whilst the candidate design assumes that phase two will be undertaken during phase one, the design principles in the Outline Design Principles document (DCO Document Reference 7.1) allow for the flexibility to deliver the energy storage facility separately (and potentially via its own phased construction) at a later date if necessary to provide greater scope to exploit technological improvements.

148. The indicative phase one construction period is 24 months. The DCO includes for a phasing plan to be submitted to the LPA for approval prior to the commencement of development.

5.5.1.1 Phase One

149. Phase one of Development construction is currently anticipated to last 24 months.

150. Subject to achieving the necessary consents, the anticipated start date for construction is spring 2021.

151. To build the solar PV array, the field identification detailed in Technical Appendix A5.1, Field Data, will be utilised. A small temporary field compound will be established in an adjacent field to serve the field under construction.

152. The types of construction activities that may be required include during phase one (not necessarily in order):

- Site preparation and civil engineering works:
  - Preparation of arable land for construction (*e.g.*, seeding);
  - Establishment of the key habitat management areas;
  - Import of construction materials, plant and equipment to site;
  - Establishment of the perimeter fence;
  - The establishment of the main construction compound;
  - Construction of the spine road;
  - The upgrade or construction of crossing points (culverts) over drainage ditches; and
  - Marking out the location of the Development infrastructure.
- Construction of onsite electrical infrastructure to facilitate the export of generated electricity:
  - Construction of the flood protection bund;
  - Site preparation and civils for the Development substation and energy storage facility;
  - Trenching and installation of electric cabling;
  - Import of components to site; and
  - Installation of the Development substation.
- Solar PV array construction:
  - Import of components to site;
  - Piling of module mount verticals;
  - Erection of module mounting structures;
  - Mounting of modules and inverters;

    - Trenching and installation of electric cabling;
    - Transformer foundation excavation and construction; and
    - Installation of transformers.

- Testing and commissioning;
- Landscaping and habitat creation.

5.5.1.2 Phase Two

153. Construction phase two of the Development includes the establishment of the energy storage facility and is expected to last a total of up to 6 months but this could sub-phased.

154. Consideration would be given to the timing of works within the electrical compound in relation to potential disturbance impacts on the AR HMA if phase 2 occurred after phase one (rather than concurrently).

155. Regardless of whether it is to be delivered separately or concurrently, provision for the energy storage facility will be made during phase one of construction while the energy storage area is be used as a construction compound and therefore most of the site preparation will have already taken place. The types of construction activities that may be required include during phase two (not necessarily in order) are therefore likely to include:

- Energy storage facility construction:
    - Installation of electric cabling;
    - Foundation construction (if not already in situ);
    - Import of components to site; and
    - Installation of energy storage facility.

156. If the energy storage facility is installed concurrently with the rest of the Development during phase one, the work would be undertaken over a longer timescale to reduce traffic impacts. If phase two were delivered separately, it would be subject to the same design principle HGV traffic limitations set out in section 5.5.2.2 of this chapter and would also be subject to a design principle limiting phase two construction to 6 months.

5.5.2 Construction Control Mechanisms

5.5.2.1 Traffic Management

157. An Outline Construction Traffic Management Plan (CTMP) has been developed as part of the EIA which will guide the delivery of materials and staff onto the Development site during the construction phase. The Outline CTMP is provided as ES Technical Appendix A14.1.

158. Details of the traffic movements expected and staff numbers are given in Chapter 14: Access and Traffic. These include maximum expected numbers of vehicle movements per day, which have been used as the candidate scenario for assessment purposes.

159. A design principle has been established in respect of maximum HGV movements of 80 HGV vehicle movements per day (40 HGVs visiting site per day).

160. HGV delivery hours are restricted to avoid peak times at sensitive receptors on the delivery route.

5.5.2.2 Construction Environmental Management Plan

161. An Outline Construction Environmental Management Plan (CEMP) (ES Technical Appendix A5.4) has been developed as part of the EIA which will guide the construction process through environmental controls in order to promote good construction practice and avoid adverse impacts during the construction phase.

162. The Outline CEMP brings together control measures that are commonly included in documents such as working hours, Site Waste Management Plans, Pollution Prevention Plans and Codes of Construction Practice and includes a tabulated executive summary for easy reference during the construction phase.

163. Core working hours are proposed to be between 07.00 until 19.00, Monday to Friday and 07.00 until 13.00 on a Saturday (unless in exceptional circumstances where need arises to protect plant, personnel or the environment).

164. Depending on the time of year, some work lighting may be required to facilitate construction during these hours.

165. The Outline CEMP will be embedded in the Development design and the assessment of effects will assume that the measures contained within the CEMP are implemented in full.

5.5.3 Temporary Construction Compounds

166. The main temporary construction compound will be established within the electrical compound on the site of the energy storage facility prior to installation of the energy storage infrastructure. As outlined in section 5.5.1, the energy storage plant will be constructed either separately, or is likely to be one of the last elements of the project to be installed and therefore this area can be utilised for construction purposes for the majority of the construction phase. Smaller temporary compounds will be located across the Development site during construction, local to each phase of construction.

5.5.3.1 Main Temporary Construction Compound

167. The main temporary construction compound of approximately 10,000 m^2 (100 x 100 m) will be established on the energy storage facility area during the construction phase. This compound will likely include:

- Temporary portable buildings to be used for site offices, the monitoring of incoming vehicles and welfare facilities;
- Toilet facilities would be provided with a packaged treatment system to be designed in liaison with the EA;
- Containerised storage areas for tools, small plant and parts;
- Parking for construction vehicles and workers' vehicles;
- A receiving area for incoming vehicles;
- A concrete batching facility; and
- A bunded area for refuelling and storage of fuels and greases.

168. The construction compound will become the energy storage facility towards the end of the construction phase and therefore the initial establishment of the compound will be designed to facilitate the later installation of the energy storage infrastructure.

5.5.3.2 Temporary Field Compounds

169. A small unsurfaced temporary compound with welfare facilities and storage of tools and materials will be established adjacent to each field under construction. No fuel or oil will be stored in these areas, which will generally be located adjacent to the spine road (where it provides access directly to the field) and/or at least 10 m away from the nearest drainage ditch.

170. Flood defence maintenance activities during construction would be served by small temporary compounds within the perimeter fence.

5.5.4 Temporary Roadways

171. Depending on weather conditions during construction, temporary roadways (*e.g.*, plastic matting) may be utilised to access parts of the Development site during construction to avoid excessive soil disturbance or compaction.

5.5.5 Site Reinstatement and Habitat Creation

172. At the commencement of construction and following completion, a programme of landscaping and habitat creation will commence. A Landscape and Biodiversity Management Plan is provided in Technical Appendix A5.2, which sets out the proposals for how the land will be managed throughout the construction and operational phases, and how this will be implemented during construction, and following the completion of construction.

5.6 Operation

173. During the operational phase, activity on the Development site will be minimal and would be restricted principally to vegetation and livestock management (the Development site will be grazed by sheep), equipment/infrastructure maintenance and servicing including cleaning and replacement of any components that fail, and monitoring to ensure the continued effective operation of the Development.

174. Operational staff could require to access the Development 24 hours a day, seven days a week.

175. An indication of likely operational traffic requirements is provided in Chapter 14: Access and Traffic.

5.6.1 Flood Defence Maintenance

176. Flood defence maintenance activities during operation would be served by small temporary compounds within the solar PV arrays perimeter fence at locations where there is access to the flood defences. Flood defence works will remain subject to Environmental Permit applications within which temporary compound locations will be specified and agreed as part of the method statements for the maintenance works.

5.6.2 Sheep Grazing

177. During operation, vegetation within the Development site will be grazed by sheep. This has the benefit of continuing the agricultural use of the Development site whilst still giving scope for biodiversity enhancement through controlled grazing[9]. This land use is consistent with historic and present land use in the area such as grazing which takes place on adjacent land.

178. Temporary stock fencing will be utilised to keep sheep to areas around the solar PV arrays where vegetation control is required and separate them from areas where a more relaxed grazing regime may be desirable at certain times of year, for example around the ditch edge habitats. Stocking densities and breeds used will be chosen to fit the conditions onsite.

179. Further details on how grazing will be used to manage vegetation are set out in ES Technical Appendix A5.2, Outline Landscape and Biodiversity Management Plan.

5.6.3 Cleaning Panels

180. Cleaning would likely be undertaken by a vehicle travelling down the minimum 2.5 m gaps between the arrays with a cleaning boom attached. Technological advances could

[9] BRE (2014) Agricultural Good Practice Guidance for Solar Farms. Ed J Scurlock

result in automated cleaning equipment being used during the lifetime of the Development.

181. Solar PV modules are typically cleaned using distilled or deionized water. Detergents or abrasive products are not used as they have potential to damage the solar PV modules. The run-off from cleaning would therefore be clean water and would be dealt with in the same way as rainwater.

182. The need for cleaning would be appraised during the early stages of operation as it can be the case that cleaning is not worthwhile as the short-term benefit of cleaning the solar PV modules can be outweighed by the costs of cleaning.

5.6.4 Security

183. Security measures such as perimeter sensors, PIR lighting and alarms would be controlled from a central control room offsite. In the event of an emergency, security personnel would be despatched to the Development to respond.

184. Operational staff could require to access the Development 24 hours a day, seven days a week.

5.7 Decommissioning

185. When the operational phase ends, the Development will require decommissioning. All solar PV array infrastructure including solar PV modules, mounting structures, cabling, inverters and transformers would be removed from the Development site and recycled or disposed of in accordance with good practice and market conditions at that time.

186. A Decommissioning Plan, to include timescales and transportation methods, will be agreed in advance with the local planning authority and will be subject to environmental controls and legislation extant at the time. An Outline Decommissioning and Restoration Plan is provided as Technical Appendix A5.5 to give an indication of the likely activities to be undertaken. Decommissioning is expected to take between 6 and 12 months.

187. The effects of decommissioning are similar to, or often of a lesser magnitude than, construction effects and are considered as such in the relevant sections of this ES.