Hornsea Project Four: Reports

PINS Document Reference: B2.2
APFP Regulation: 5(2)(g)

B2.2: Report to Inform Appropriate Assessment Part 9: Appendix F: Maximum Design Scenario

Prepared GoBe Consultants Ltd, September 2021
Checked Sarah Randall, September 2021
Accepted Francesca De Vita, Orsted, September 2021
Approved Julian Carolan, Orsted, September 2021

Doc. no. B2.2.F
Version A

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Construction			
Temporary habitat disturbance in the Hornsea Four array area and offshore Export Cable Corridor (ECC) from construction activities.	Benthic and Intertidal Ecology	**Temporary habitat disturbance of 75,895,509 m²** **Array Area:** **Foundation seabed preparation = 779,106 m²** • 110 GBS (Wind Turbine Generator (WTG) type) foundations for WTGs = 411,321 m²; • 70 suction caisson jacket (WTG type) foundations for WTGs = 198,870 m². Six small Offshore Substations (OSS) on suction caisson jacket (small OSS) foundations and three large OSS on GBS (large OSS) foundations = 156,594 m²; and • One accommodation platform on a suction caisson jacket (small OSS) foundation = 12,321 m². **Jack up and anchoring operations = 1,063,200 m²** • WTG installation jack up vessel (JUV) footprint (six legs, 170 m² per foot, four jack-up operations per turbine) = 734,400 m²; • WTG installation vessel anchor footprints (100 m² per anchor, eight anchors per vessel, two anchored vessels per turbine) = 288,000 m²; and • OSS and accommodation platform installation JUV footprint (six legs, 170 m² per foot, four jack-up operations per structure) = 40,800 m². **Cable seabed preparation and installation in the array area = 37,950,000 m²** • Boulder and sandwave clearance in array area (690 km length, 40 m width) = 27,600,000 m²; • Burial of array cables (600 km length, 15 m width) = 9,000,000 m²; and • Burial of inter-connector cables (90 km length, 15 m width) = 1,350,000 m². Note the 15 m cable width is located within the boulder and sandwave clearance 40 m width. **Offshore ECC:** • Foundation seabed preparation for three suction caisson jacket (small OSS) foundations = 36,963 m²; and • OSS installation JUV footprint (six legs, 170 m² per foot, four jack-up operations per structure) = 12,240 m². **Export cable seabed preparation and installation = 36,054,000 m²** • -Boulder and sandwave clearance in offshore ECC (654 km length, 40 m width) = 26,160,000 m²; • -Burial of export cables (654 km length, 15 m width) = 9,810,000 m²; and • Cable jointing (four joints per cable, six cables, 3,500 m² per joint) = 84,000 m².	The temporary disturbance relates to seabed preparation for foundations and cables, jack up and anchoring operations, and cable installation. It should be noted that the seabed preparation area for foundations is less than the footprint of the foundation scour protection and the footprint of infrastructure is assessed as a permanent impact in the operations and maintenance phase. It should be noted that the MDS presents a precautionary approach to temporary habitat disturbance because it counts both the total footprint of seabed clearance as well as cable burial across both the array and offshore ECC. This approach effectively counts the footprint of seabed habitat to be impacted by construction in the same area twice. However, this precautionary approach has been taken because there is some potential for recovery of habitats between the activities due to project timescales.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Note the 15 m cable width is located within the boulder and sandwave clearance 40 m width.	
Temporary increase in SSC and sediment deposition in the Hornsea Four array area and offshore ECC.	Benthic and Intertidal Ecology	**Total volume 12,192,331 m^3.** **WTG Foundations:** • 110 turbines on GBS (WTG type) foundations requiring seabed preparation, resulting in the suspension of 685,794 m^3 of sediment. • 70 Suction Caisson Jacket (WTG type) foundations requiring seabed preparation, resulting in the suspension of 359,427 m^3 of sediment. **OSS Foundations (array):** • Six OSS on suction caisson jacket (small OSS) foundations and three OSS on GBS (large OSS) foundations requiring seabed preparation, resulting in the suspension of 737,130 m^3 of sediment. **Offshore Accommodation Platform Foundations:** • One suction caisson jacket (small OSS) foundation requiring seabed preparation, resulting in the suspension of 57,245 m^3 of sediment. **High Voltage Alternating Current (HVAC) Booster Station Foundations:** • Three suction caisson jacket (small OSS) foundations requiring seabed preparation, resulting in the suspension of 171,735 m^3 of sediment. **Sandwave Clearance:** • Sandwave clearance for 600 km of array cables resulting in the suspension of 769,000 m^3 of sediment; • Sandwave clearance for 90 km of interconnector cables resulting in the suspension of 115,000 m^3 of sediment; and • Sandwave clearance for 654 km of export cables resulting in the suspension of 834,000 m^3 of sediment. **Cable Trenching:** • Installation of 600 km of array cables by Controlled Flow Excavation (CFE) resulting in the suspension of 3,600,000 m^3 of sediment; • Installation of 90 km of interconnector cables resulting in the suspension of 540,000 m^3 of sediment; • Installation of six export cables by CFE resulting in the suspension of 3,903,000 m^3 of sediment (excluding the part of the export cable within the array); and • Up to 420,000 m^3 of sediment from up to four cable joints per export cable in the	The MDS for foundation installation results from the largest volume suspended from seabed preparation (GBS and suction caisson jacket foundations). For cable installation, the MDS results from the greatest volume from sandwave clearance and installation using energetic means (CFE). This also assumes the largest number of cables and the greatest burial depth.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		ECC.	
Temporary increase in SSC and sediment deposition in the intertidal area.	Benthic and Intertidal Ecology	Eight offshore cofferdam HDD exit pits require excavation of 20,000 m^3 (8 x 2,500 m^3) which will be side-cast onto the adjacent seabed. Backfilling of exit pits will recover a similar amount to be from the surrounding seabed, as required. HDD exit pits will come out below MLWS, so will not directly impact the intertidal. HDD Bentonite drilling fluid loss per cable 265 m^3.	The MDS for temporary habitat disturbance in the intertidal area from the HDD works is included. It is important to note that HDD exit pits will be located below MLWS.
Direct and indirect seabed disturbances leading to the release of sediment contaminants.	Benthic and Intertidal Ecology	The MDS for seabed disturbance is presented above (Temporary increase in SSC and sediment deposition in the Hornsea Four array area and offshore ECC).	The MDS for foundation installation results from the largest volume suspended from seabed preparation (GBS and suction caisson jacket foundations). For cable installation, the MDS results from the greatest volume from sandwave clearance and installation using energetic means (CFE). This also assumes the largest number of cables and the greatest burial depth.
Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) from piling noise	Marine Mammals	**Spatial MDS:** • 180 Wind Turbine Generators (WTGs) on monopile foundations; • Six small and three large Offshore Substations (OSS) on monopile foundations; • One accommodation platform on a monopile foundation; • Three High Voltage Alternating Current (HVAC) Booster Stations (small OSS) on monopile foundations; • Maximum design: *5,000 kJ hammer energy,* 4.4 hours piling duration including a 30 min soft start and 22.5 min ramp up; • Most likely: 4,000 kJ hammer energy, 2.1 hours piling duration including a 30 min soft start and 22.5 min ramp up; • Total WTG piling days: 216 assuming 1.2 days per monopile over a 12 month piling period; • Total non-WTG piling days: 16 assuming 1.2 days per monopile over a 12 month piling period; and	The piling scenario with the largest PTS impact ranges represent the maximum design scenario. This differs between species depending on the frequency characteristics emitted during installation of each pile type and the hearing of the species (e.g. for high frequency cetaceans such as harbour porpoise, pin piles have a larger PTS impact range whereas for low frequency cetaceans, monopiles have a larger PTS impact range). The maximum number of piled foundations would represent the temporal maximum
Behavioural disturbance from piling noise	Marine Mammals		

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Simultaneous piling: only two piles will be piled simultaneously within the Hornsea Four array area. **Temporal MDS:** • 180 WTGs on piled jacket (WTG-type) foundations, three piles per jacket (540 total); • Six small OSS on piled jacket (small OSS) foundations and three large OSS on piled jacket (large OSS) foundations (144 total piles); • One accommodation platform on a piled jacket (small OSS) foundation (16 total piles); • Three HVAC Booster Stations on piled jacket (small OSS) foundations (48 total piles); • Maximum design: 3,000 kJ hammer energy, 4.4 hours piling duration including a 30 min soft start and 22.5 min ramp up; • Most likely: 1,750 kJ hammer energy, 2.1 hours piling duration including a 30 min soft start and 22.5 min ramp up; • Total WTG piling days: 270 assuming 1.5 days per jacket foundation over a 12 month piling period; • Total non-WTG piling days: 39 assuming 3 days per jacket foundation over a 12 month piling period; and • Simultaneous piling: only two piles will be piled simultaneously within the Hornsea Four array area.	design scenario for disturbance. The maximum predicted impact range for underwater noise for piled foundations would represent the spatial maximum design scenario for disturbance.
Vessel collision risk	Marine Mammals	**Wind Turbine Foundation Installation:** • Up to 2,880 return trips over a 12-month period. **Wind Turbine Installation:** • Up to 900 return trips over a 24-month period. **OSS Installation (all OSSs and the accommodation platform):** • Up to 270 return trips over a two-month period. **OSS Foundation Installation (all OSSs and the accommodation platform):** • Up to 180 return trips over a two-month period. **Inter-Array and Interconnector Cable Installation:** • Up to 1,488 return trips over a 24-month period.	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Disturbance from vessels	Marine Mammals		

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		Offshore Export Cable Installation: • Up to 408 return trips over a 24-month period. **Total:** • Up to eight vessels in any given 5 km^2 at any one time.	
Non-piling noise (e.g. cable laying, dredging)	Marine Mammals	• Surface lay, mechanical trenching, dredging, jetting, ploughing, controlled flow excavation, vertical injection, rock cutting. • Total length of array cables: 600 km; • Total length of interconnector cables: 90 km; • Where possible, the export cables will be buried below the seabed through to landfall.; • Total length of export cables: 654 km (6 cables x 109 km cable length); and • Total duration of cable installation: 36 months.	Maximum potential for underwater noise impacts.
PTS from Unexploded Ordnance (UXO) clearance	Marine Mammals	**UXO Clearance:** • Estimated 2,263 targets; • 86 UXOs may require clearance; • up to 5 UXO could be detonated per day.	Estimated maximum design based on data from other projects in the Hornsea Zone. A detailed UXO survey would be completed prior to construction. The type, size (net explosive quantities (NEQ)) and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.
Disturbance from UXO clearance	Marine Mammals		
Reduction in prey availability	Marine Mammals	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**).	
Reduction in foraging ability	Marine Mammals	**Total volume 12,192,331 m^3** **WTG Foundations:** • 110 turbines on Gravity Base Structure (GBS) (WTG type) foundations requiring seabed preparation, resulting in the suspension of 685,794 m^3 of sediment; and • 70 Suction Caisson Jacket (WTG type) foundations requiring seabed preparation, resulting in the suspension of 359,427 m^3 of sediment. **OSS Foundations (array):**	The maximum impacts from remedial cable burial and cable repairs of array, interconnector and export cables result from the use of CFE. This assumes the largest number of cables, repair events, the greatest burial depth and greatest length/area of maintenance. This results in the maximum sediment volume disturbance.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Six OSS on suction caisson jacket (small OSS) foundations and three OSS on GBS (large OSS) foundations requiring seabed preparation, resulting in the suspension of 737,130 m^3 of sediment. **Offshore Accommodation Platform Foundations:** • One suction caisson jacket (small OSS) foundation requiring seabed preparation, resulting in the suspension of 57,245 m^3 of sediment. **High Voltage Alternating Current (HVAC) Booster Station Foundations:** • Three suction caisson jacket (small OSS) foundations requiring seabed preparation, resulting in the suspension of 171,735 m^3 of sediment. **Sandwave Clearance:** • Sandwave clearance for 600 km of array cables resulting in the suspension of 769,000 m^3 of sediment; • Sandwave clearance for 90 km of interconnector cables resulting in the suspension of 115,000 m^3 of sediment; and • Sandwave clearance for 654 km of export cables resulting in the suspension of 834,000 m^3 of sediment. **Cable Trenching:** • Installation of 600 km of array cables by Controlled Flow Excavation (CFE) resulting in the suspension of 3,600,000 m^3 of sediment; • Installation of 90 km of interconnector cables resulting in the suspension of 540,000 m^3 of sediment; • Installation of six export cables by CFE resulting in the suspension of 3,903,000 m^3 of sediment (excluding the part of the export cable within the array); and • Up to 420,000 m^3 of sediment from up to four cable joints per export cable in the ECC.	
Disturbance and displacement from increased vessel activity and	Offshore and Intertidal Ornithology	**Construction Vessels / Helicopters within Array Area:** • Up to eight construction vessels in a given 5 km^2 area with approximately three or four 5 km^2 areas at any one time. • Single phase of offshore construction over approximately 3 years.	The maximum estimated number of development areas within the array area with vessels operating concurrently would

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
helicopters within the array area		**WTG Installation:** • -Up to two installation vessels (Jack Up Vessels (JUV) or anchored) (90 return trips); • Up to 12 support vessels (270 return trips); • Up to 24 transport vessels (540 return trips); and • Up to 135 helicopter return trips. **WTG Foundation Installation:** • 6 installation vessels (2 anchored or 4DP2 or 6 x Tugs) (90 return trips if anchored or DP2. 540 return trips if Tugs); • 19 support vessels (900 return trips); • 40 transport/feeder vessels (including tugs) (720 return trips); • 12 dredging vessels (720 return trips); and • 180 helicopter return trips. **OSS and Accommodation Platform Installation:** • 2 installation vessels (36 return trips); • 12 support vessels (162 return trips); • 4 transport/feeder vessels (72 return trips); and • 63 helicopter return trips. **OSS and Accommodation Platform Foundation Installation:** • 2 installation vessels (24 return trips); • 12 support vessels (108 return trips); • 4 transport/feeder vessels (48 return trips); and • 42 helicopter return trips. **Array and Interconnector Cable Installation:** • 3 main cable laying vessels (204 return trips); • 3 main cable burial vessels (204 return trips); • 12 support vessels (1,080 return trips); and	cause the greatest disturbance to birds on site.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• 396 helicopter return trips.	
Indirect impacts during the construction phase within the array area through effects on habitats and prey species	Offshore and Intertidal Ornithology	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**) and for the Benthic and Intertidal Ecology assessment (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**).	
Disturbance and displacement from vessel activity within the ECC area	Offshore and Intertidal Ornithology	**Construction Vessels within ECC:** • 3 cable laying vessels (96 return trips) • 3 cable jointing vessels (72 return trips) • 3 cable burial vessels (96 return tips) • 15 support vessels (144 return trips) • 800 helicopter return trips • Single phase of offshore construction over approximately 3 years.	The assumption is that vessels would be *in situ* from start to finish, so any disturbance events would be throughout entire period.
Disturbance and displacement from presence and operation of construction machinery/vehicles within the cable landfall area	Offshore and Intertidal Ornithology	**Horizontal Directional Drilling (HDD) Installation:** • Eight offshore HDD exits pits; • Minimum 6 m entry pit and 5m exit pit depth; • Small 4x4 vehicles related to emergency response on the beach; and • Small 4x4 on beach to monitor the drill head using handheld equipment. **Cable Laying:** • Maximum duration of cable laying via HDD is 24 months within a 32 month period.	The assumption is that the process would be undertaken by HDD methods, so no open trenching, cable laying and burial of the export cable would be required. Therefore, MDS activities to be assess are limited, though they are to take place over a maximum of 24 months within a 32 month period (allowing for up to six months of weather-related downtime).
Direct impacts on designated sites: Temporary construction areas could occupy areas leading to loss and/or degradation of designated sites	Ecology and Nature Conservation	**Onshore Export Cable Corridor:** • Construction duration: 30 months; • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months; • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m2; • Haul Road: Number: 1, Width: 6 m (with 7 m passing places), Length: 39 km, Maximum Depth: 1 m, Average Depth: 0.4 m;	These parameters represent maximum ground disturbance conditions both in terms of potential size of area affected and in terms of duration of expected disturbance.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1 m, Average Depth: 0.4 m; • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m^2 per Joint Bay, Joint Bay compounds: 240 40x40 m compounds; • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m^2 per Link Box; and • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20% of all HDD locations). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m; • Approximate Length: 1 km; and • Width: 60 m.	
Impacts on bat species: Construction activities will temporarily occupy areas leading to loss and/or degradation of habitat and loss of habitat connectivity used by bats for roosting, commuting and/or foraging	Ecology and Nature Conservation	**Landfall:** • Construction duration: 32 months; • Landfall compound: Number: 1, Total Area: 40,000 m^2, Duration: 32 months; and • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth: 6 m. **Onshore Export Cable Corridor:** • Construction duration: 30 months; • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months; • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m^2; • Number of cable circuits (HVAC system): 6 • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m; • Haul Road: Number: 1, Width: 6 m (with 7 m passing places), Length: 39 km,	These parameters represent the maximum number of crossings, construction duration and building design parameters that could potentially disrupt bat commuting/foraging habitat and/or bat roosts. For further detail, see **Volume A4, Annex 4.2: Onshore Crossing Schedule**.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		Maximum Depth: 1 m, Average Depth: 0.4 m; • Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1 m, Average Depth: 0.4 m; • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m^2 per Joint Bay, Joint Bay compounds: 240 40x40 m compounds; • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m^2 per Link Box; and • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20 % of all HDD locations). **Onshore Substation and Energy Balancing Infrastructure:** • Construction duration: 43 months; • Permanent infrastructure area: 164,000 m^2; • Temporary works area: 130,000 m^2; • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8 m soil storage); and • Permanent access road: Number 1. Length 1, 800 m, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m; • Approximate Length: 1 km; and • Width: 60 m.	
Impacts on breeding and/or wintering bird species: Construction activities will temporarily occupy areas leading to loss and/or degradation of	Ecology and Nature Conservation	**Landfall:** • Construction duration: 32 months; • Landfall compound: Number: 1, Total Area: 40,000 m^2, Duration: 32 months; and • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth: 6 m.	These parameters represent maximum ground disturbance conditions both in terms of potential size of area affected and in terms of duration of expected disturbance.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
habitat used by breeding and/or wintering birds		**Onshore Export Cable Corridor:** • Construction duration: 30 months; • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months; • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m^2; • Number of cable circuits (HVAC system): 6; • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m; • Haul Road: Number: 1, Width: 6 m (with 7 m passing places), Length: 39 km, Maximum Depth: 1 m, Average Depth: 0.4 m; • Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1 m, Average Depth: 0.4 m • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m^2 per Joint Bay, Joint Bay compounds: 240 40x40 m compounds; • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m^2 per Link Box; and • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20 % of all HDD locations). **Onshore Substation and Energy Balancing Infrastructure:** • Construction duration: 43 months; • Permanent infrastructure area: 164,000 m^2; • Temporary works area: 130,000 m^2; • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8 m soil storage); and • Permanent access road: Number 1. Length 1.8 km, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m;	

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Approximate Length: 1 km; and • Width: 60 m.	
Impacts on otter and / or water vole: Open cut trenching and HDD used to cross watercourses with otter and / or water vole potential could lead to loss of habitat, disturbance and / or connectivity severance	Ecology and Nature Conservation	**Landfall:** • Construction duration: 32 months; • Landfall compound: Number: 1, Total Area: 40,000 m^2, Duration: 32 months; and • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth: 6 m. **Onshore Export Cable Corridor:** • Construction duration: 30 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m^2; • Number of cable circuits (HVAC system): 6; • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m; • Temporary watercourse crossings: Number: 31, Width: 6 m, Length: 10 m; and • Crossings: Number: 58. **Onshore Substation and Energy Balancing Infrastructure:** • Construction duration: 43 months; • Permanent infrastructure area: 164,000 m^2; • Temporary works area: 130,000 m^2; • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8 m soil storage); and • Permanent access road: Number 1. Length 1.8 km, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m; • Approximate Length: 1 km; and • Width: 60 m.	These parameters represent the maximum numbers of crossings that could potentially affect water vole and/or otter habitat.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Impacts on great crested newt populations: Works in or within 250 m of water bodies with great crested newt potential could cause habitat loss, degradation, habitat severance and harm or kill individual animals	Ecology and Nature Conservation	**Landfall:** • Construction duration: 32 months; • Landfall compound: Number: 1, Total Area: 40,000 m^2, Duration: 32 months; • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth: 6 m; **Onshore Export Cable Corridor:** • Construction duration: 30 months; • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months; • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m^2; • Number of cable circuits (HVAC system): 6; • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m; • Haul Road: Number: 1, Width: 6 m (with 7 m passing places), Length: 39 km, Maximum Depth: 1 m, Average Depth: 0.4 m; • Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1m, Average Depth: 0.4 m; • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m2 per Joint Bay, Joint Bay compounds: 240 40x40 m compounds; • Link Boxes: Number: 240, Depth: 2 m, Area: 9 m2 per Link Box; and • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20 % of all HDD locations). **Onshore Substation and Energy Balancing Infrastructure:** • Construction duration: 43 months; • Permanent infrastructure area: 164,000 $m^{2;}$ • Temporary works area: 130,000 $m^{2;}$ • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8	These parameters represent maximum ground disturbance conditions both in terms of potential size of area affected and in terms of duration of expected disturbance.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		m soil storage); and • Permanent access road: Number 1. Length 1.8 km, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m; • Approximate Length: 1 km; and • Width: 60 m.	
Impacts on badgers: Construction activities could disturb badger setts and / or lead to temporary severance of territories.	Ecology and Nature Conservation	**Landfall:** • Construction duration: 32 months; • Landfall compound: Number: 1, Total Area: 40,000 m^2, Duration: 32 months; and • Transition Joint Bays (located within Landfall compound area): Number: 8, Depth: 6 m. **Onshore Export Cable Corridor:** • Construction duration: 30 months; • Primary logistics compounds: Number: 1, Size: 140x140 m, Duration: 36 months; • Secondary Logistics compounds: Number: 7, Size: 90x90 m, Duration: 36 months; • ECC: Length: 39 km (approximate), Width: 80 m, Area: 3,120,000 m^2; • Number of cable circuits (HVAC system): 6; • Cable trench: Depth: 1.5 m, Width at base: 1.5 m, Width at surface: 5 m; • Haul Road: Number: 1, Width: 6 m (with 7 m passing places), Length: 39 km, Maximum Depth: 1 m, Average Depth: 0.4 m; • Temporary access roads: Number: 36, Width: 6 m (with 7 m passing places), Maximum Depth: 1 m, Average Depth: 0.4 m; • Joint Bays: Number: 240, Depth 2.5 m, Area: 225 m^2 per Joint Bay, Joint Bay compounds: 240 40x40 m compounds;	These parameters represent maximum ground disturbance conditions both in terms of potential size of area affected and in terms of duration of expected disturbance.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Link Boxes: Number: 240, Depth: 2 m, Area: 9 m^2 per Link Box; and • HDDs: Number: 112, HDD compounds (entry and exit):224 70x70 m compounds, HDD compounds hardstanding: 46 50x50 m (at approximately 20 % of all HDD locations). **Onshore Substation and Energy Balancing Infrastructure:** • Construction duration: 43 months; • Permanent infrastructure area: 164,000 m^2; • Temporary works area: 130,000 m^2; • Temporary access road: Number: 1, Length: 1,800 m, Width: 15 m (7 m road, 8 m soil storage); and • Permanent access road: Number 1. Length 1.8 km, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities). **400 kV ECC:** • Number of cable circuits: 4; • Cable trench depth: 1.5 m; • Approximate Length: 1 km; and • Width: 60 m.	
Temporary localised increases in SSC and smothering.	Fish and Shellfish Ecology	**Total volume 12,214,451 m^3** **WTG Foundations:** • 110 turbines on GBS foundations (WTG-type) requiring seabed preparation, resulting in the suspension of 685,794 m^3 of sediment; and • 70 Suction Caisson Jacket (WTG type) foundations requiring seabed preparation, resulting in the suspension of 359,427 m^3 of sediment. **OSS Foundations:** • Six small OSS on suction caisson jacket (small OSS) foundations and three large OSS on GBS (large OSS) foundations requiring seabed preparation, resulting in the suspension of 737,130 m^3 of sediment.	The MDS for foundation installation results from the largest volume suspended from seabed preparation (GBS foundations and suction caisson foundations) with the maximum number of foundations (180) and associated offshore platform infrastructure. For cable installation, the MDS results from the greatest volume from sandwave clearance and installation using energetic means (CFE). This also assumes the largest
Direct and indirect seabed disturbances leading to the release of sediment contaminants.	Fish and Shellfish Ecology		

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		Offshore Accommodation Platform Foundations: • One suction caisson jacket (small OSS) foundation requiring seabed preparation, resulting in the suspension of 57,245 m^3 of sediment. **HVAC Booster Station Foundations:** • Three suction caisson jacket (small OSS) foundations requiring seabed preparation, resulting in the suspension of 171,735 m^3 of sediment. **Sandwave Clearance:** • Sandwave clearance for 600 km of array cables resulting in the suspension of 769,000 m^3 of sediment; • Sandwave clearance for 90 km of interconnector cables resulting in the suspension of 115,000 m^3 of sediment; and • Sandwave clearance for 654 km of export cables resulting in the suspension of 834,000 m^3 of sediment. **Cable Trenching:** • Installation of 600 km of array cables by Controlled Flow Excavation (CFE) resulting in the suspension of 3,600,000 m^3 of sediment; • Installation of 90 km of interconnector cables resulting in the suspension of 540,000 m^3 of sediment; • Installation of 654 km of export cables resulting in the suspension of 3,903,000 m^3 of sediment (excluding the part of the export cable within the array); and • Up to 420,000 m^3 of sediment from up to four cable joints per export cable (six) in the ECC. **Landfall Area:** Eight offshore cofferdam Horizontal Directional Drilling (HDD) exit pits require excavation of 2,500 m^3 each which will be side-cast onto the adjacent seabed. Backfilling of exit pits will recover a similar amount to be from the surrounding seabed, as required. Total excavated = 20,000 m^3.	number of cables and the greatest burial depth.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		HDD Bentonite drilling fluid loss per cable 265 m^3. Total drilling fluid loss = 2,120 m^3	
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration.	Fish and Shellfish Ecology	**Array Area (spatial MDS):** • 180 monopile WTG foundations (15 m diameter) with a maximum of two foundations installed concurrently; • Six small OSS (15 m diameter monopiles); • Three large OSS (15 m diameter monopiles); • One offshore accommodation platform (15 m diameter monopiles); • Maximum hammer energy 5,000 kJ; • Four-hour piling duration; • 1.2 days per monopile; • 216 piling days (single vessel); • 106 piling days (two vessels); and • Maximum separation distance between piling events will be the maximum extent of the array area. **Array Area (temporal MDS):** • 180 WTGs on piled jacket (WTG-type) foundations (three 4 m diameter pin piles per jacket) – 540 pin piles; • Six OSS on piled jacket (small OSS) foundations (six legs per jacket and four 3.5 m pin piles per leg) – 144 pin piles; • Three OSS on piled jacket (large OSS) foundations (eight legs per jacket and two piles per leg) – 48 pin piles; • One offshore accommodation platform on a piled jacket (small OSS) foundation (six legs and four 3.5 m pin piles per leg – 24 pin piles; • Total of 756 pin piles in the array; • Maximum hammer energy 3,000 kJ; • 1.5 days per foundation; • 270 piling days (single vessel); and • 135 days (two vessels). **HVAC Booster Area of Search (spatial MDS):**	Piling: For the array area, the spatial MDS results from the concurrent installation of monopile foundations for 180 WTGs in the NW and E corners of the array, and the sequential installation of monopile foundations for nine OSS and an offshore accommodation platform using 5,000 kJ hammer energy. This would result in the largest spatial noise impact at any given time. The temporal MDS for the array area would be associated with the installation of the maximum number of piles; the MDS would be the installation of 180 WTGs using piled jacket (WTG-type) foundations, and seven structures (OSS and an accommodation platform) on piled jackets (small OSS) and three OSS on piled jackets (large OSS). For HVAC booster stations, the spatial MDS is based on three OSS monopiles, and the temporal MDS is based on three OSS on piled jacket (small OSS) foundations. UXO clearance: Estimated MDS based on the recent internal analysis report for Hornsea Three, the number of UXO requiring inspection and detonation has been scaled for Hornsea Four. A detailed

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		• Three HVAC booster stations on 15 m diameter monopile foundations; • Maximum hammer energy 5,000 kJ; • Four-hour piling duration; and • 1.2 days per monopile. **HVAC Booster Area of Search (temporal MDS):** • Three HVAC booster stations on piled jacket (small OSS) foundations (six legs per jacket and four 3.5 m diameter pin piles per leg) – 72 pin piles. **UXO Clearance:** • Estimated 2,263 targets; • 86 UXOs may require clearance; • Up to five UXO will be cleared every 24 hours; and • Up to 86 detonations in 86 days.	UXO survey will be completed prior to construction. The type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage. Seabed clearance and installation activities such as cable laying, dredging and vessel movements may introduce an effect-receptor pathway for underwater noise, however these activities are established as producing low levels of noise, in the case of vessel movement no greater than the existing baseline of regional vessel noise, affecting a relatively small area in the immediate vicinity of activities. These general activities are therefore considered to fall within the impacts associated with piling and as such are not considered separately.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Operation and Maintenance			
Long-term habitat loss/ change from the presence of foundations, scour protection and cable protection	Benthic and Intertidal Ecology	**Habitat change of 3,730,671 m²**. **Array Area**: • Turbine footprint with scour protection, based on 110 GBS (WTG-type) foundations = 504,540 m²; • Turbine footprint with scour protection, based on 70 suction caisson Jacket (WTG type) foundations = 296,881 m². • OSS foundations footprint and scour protection, based on six small (GBS (Box-type)) and three large OSS (GBS (Large OSS)) = 371,250 m²; • Accommodation platform foundation footprint and scour protection, based on one small OSS foundation (GBS (Box-type)) = 30,625 m²; • Maximum rock protection area for array cable = 624,000 m²; • 25% replenishment of scour protection during operation and maintenance phase = 156,000 m². • Maximum rock protection area for interconnector cable = 94,000 m²; • 25% replenishment of scour protection during operation and maintenance phase = 23,500 m²; and • Pre- and post-lay rock berm area within array area (32 cable crossings) = 204,000 m². **Offshore ECC:** • HVAC booster station foundations footprint and scour protection, based on three small OSS foundations (GBS (Box-type)) = 91,875 m²; • Maximum rock protection area for the export cable = 792,000 m²; • 25% replenishment of scour protection during operation and maintenance phase = 198,000 m²; and • Pre- and post-lay rock berm area, based on 54 cable crossings within the export ECC area = 344,000 m².	The MDS is defined by the maximum area of seabed lost as a result of the placement of structures, scour protection, cable protection and cable crossings. Habitat loss from drilling and drill arisings is of a smaller magnitude than presence of project infrastructure.
Colonisation of the WTGs and scour/ cable protection may affect benthic ecology and biodiversity.	Benthic and Intertidal Ecology	**Total surface area of introduced hard substrate in the water column = 4,759,171 m²** **Total area of introduced hard substrate at seabed level = 3,730,671 m² (see BIE-O-8).** **Total surface area of subsea portions of foundations in contact with the water column: 1,028,500 m²**. • 110 WTGs on GBS (WTG-type) foundations, assuming 15 m diameter cylinder atop a conical/frustum base which tapers at 35 m above seabed level, with a base	The MDS is defined by the maximum area of structures, scour protection, cable protection and cable crossings introduced to the water column, including surface area of vertical structures.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		diameter of 53 m. Average water depth of 47.5 m, giving a per-foundation surface area of 5,650 m^2, with a total area of 621,500 m^2; • 70 WTGs on suction bucket jacket (WTG type) foundations, which has a base diameter of up to 40 m (extending 10 m above the seabed). Average water depth of 47.5 m, giving a per foundation surface area of 2,512 m^2, with a total area of 175,850 m^2. • Six small OSS on GBS (Box-type) foundations, each with a length and width of 75 m at seabed level and at Lowest Astronomical Tide (LAT). Average water depth of 47.5 m, giving a per-foundation surface area of 14,250 m^2, with a total area of 85,500 m^2; • Three large OSS on GBS (Box-type) foundations, each with a length and width of 150 m at seabed level and at LAT. Average water depth of 47.5 m, giving a per-foundation surface area of 28,500 m^2, with a total area of 85,500 m^2; • One accommodation platform on a GBS (Box-type) foundation (small OSS), with a length and width of 75 m at seabed level and at LAT. Average water depth of 47.5 m, giving a total surface area of 14,250 m^2; and • Three HVAC booster stations on GBS (Box-type) foundations (small OSS), each with a length and width of 75 m at seabed level and at LAT. Average water depth of 51 m in the HVAC Booster Station Search Area, giving a per-foundation surface area of 15,300 m^2, with a total area of 45,900 m^2.	
Increased risk of introduction or spread of Marine Invasive Non-Native Species (MINNS) due to presence of subsea infrastructure and vessel movements (e.g. ballast water) may affect benthic ecology and biodiversity.	Benthic and Intertidal Ecology	**Total surface area of introduced hard substrate in the water column = 4,543,694 m^2 (see BIE-O-9).** **Total of 1,693 vessel return trips per year:** • 260 crew shift transfer visits; • 124 JUV visits; • 1,205 crew vessels wind turbine visits; and • 104 supply vessel accommodation platform visits.	Defined by the maximum surface area introduced into the water column as described in 'Colonisation of the WTGs and scour/ cable protection may affect benthic ecology and biodiversity'. MDS with regards to maximum number of vessel movements during operation and maintenance activities.
Direct disturbance to seabed from jack-up vessels and cable	Benthic and Intertidal Ecology	**Direct disturbance to seabed from jack-up vessels and cable maintenance activities = 8,579,812 m^2.** **WTG O&M activities**:	Defined by the maximum number of jack-up vessel operations and maintenance activities that could have an interaction

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
maintenance activities.		• Component replacement = 378,000 m^2; • Access ladder replacement = 378,000 m^2; • Foundation anode replacement = 378,000 m^2; and • J-Tube repair/ replacement = 108,000 m^2. **Array cable activities:** • Remedial burial of array cables (42 km total length reburied) = 4,200,000 m^2; • Array cable repairs = 363,736 m^2; and • Cable protection replacement = 156,000 m^2. **Offshore substations and accommodation platform activities:** • Offshore substation component replacement = 6,000 m^2; • Access ladder replacement = 90,000 m^2; • Foundation anode replacement = 21,000 m^2; and • J-Tube repair/ replacement = 6,000 m^2. **ECC activities:** • Remedial burial of export cables (14 km total length reburied) = 1,400,000 m^2; • Export cable repairs = 153,548 m^2; and • Cable protection replacement = 198,000 m^2. **Interconnector cable activities:** • Remedial burial of interconnector cables (7 km total length reburied) = 700,000 m^2; • Interconnector cable repairs = 20,028 m^2; and • Cable protection replacement = 23,500 m^2.	with the seabed anticipated during operation.
Changes to seabed habitats arising from effects on physical processes, including scour effects and changes in the sediment transport and wave regimes resulting in potential effects on benthic communities.	Benthic and Intertidal Ecology	See MDS presented in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes.**	This impact is defined by any anticipated changes to physical processes as defined in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Operational noise	Marine Mammals	180 WTG (maximum rotor diameter 305 m)	The largest turbine will result in the highest levels of operational noise transmission.
Vessel collision risk	Marine Mammals	• Up to 1,205 crew vessel return trips per year • Up to 124 jack-up vessel return trips per year • Up to 104 supply vessel return trips per year **Total Trips:** Up to 1,433 return trips per year	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk.
Disturbance from vessels	Marine Mammals		
Reduction in prey availability	Marine Mammals	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**).	
Reduction in foraging ability	Marine Mammals	**Array Cable Activities:** • Remedial burial of array cable (42 km total length reburied) by CFE – 252,000 m^3; and • Array cable repairs = 218,258 m^3. **Interconnector Cable Activities:** • Remedial burial of interconnector cables (7 km total length reburied) by CFE = 42,000 m^3; and • Interconnector cable repairs = 11,153 m^3. **Export Cable Activities:** • Remedial burial of export cables (14 km total length reburied) by CFE = 84,000 m^3; and • Export cable repairs = 85,505 m^3. **Total volume: 692,916 m^3**	The maximum impacts from remedial cable burial and cable repairs of array, interconnector and export cables result from the use of CFE. This assumes the largest number of cables, repair events, the greatest burial depth and greatest length/area of maintenance. This results in the maximum sediment volume disturbance.
Disturbance and displacement from Operational activities associated with moving turbines and maintenance vessels.	Offshore and Intertidal Ornithology	**Array Area:** • WTG deployment across the full array area (468 km^2). **WTGs:** • Up to 180 WTGs; • Minimum height of lowest blade tip above MSL: 40 m; and	Displacement would be assumed from the entire array area that contains WTGs and other associated structures, which maximises the potential for disturbance and displacement.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
may lead to disturbance and displacement of species within the array area and different degrees of buffers surrounding it.		• Maximum rotor blade radius: 152.5 m. **Operation and Maintenance:** • 2,580 return visits to wind turbines per year; • 780 return visits to wind turbine foundations per year; • 65 return visits to offshore platforms (structural scope) per year; • 100 return visits to offshore platforms (electrical scope) per year; • A total of 3,525 total trips per year completed by helicopter and / or vessels; and • Vessels include: CTVs, service operation vessels, supply vessels, cable and remedial protection vessels, and JUVs.	Assessment of extent / varying displacement from array area and a buffer is species specific due to their sensitivity levels.
Collision risk to seabirds	Offshore and Intertidal Ornithology	**Array Area:** • WTG deployment across the full array area (468 km^2) area. **WTGs:** • Up to 180 WTGs; • Minimum height of lowest blade tip above MSL:40 m; and • Maximum rotor blade radius: 152.5 m.	This represents the maximum number of the largest WTGs, which represents the greatest total swept area to be considered for collision risk.
Collision risk to migrant non-seabirds	Offshore and Intertidal Ornithology		
Indirect impacts within the array area during the operational phase through effects on habitats and prey species	Offshore and Intertidal Ornithology	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**) and for the Benthic and Intertidal Ecology assessment (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**).	Indirect effects on birds could occur through changes to any of the species and habitats considered within the Fish and Shellfish Ecology or Benthic and Intertidal Ecology assessments. The maximum indirect impact on birds would result from the maximum direct impact on fish, shellfish and benthic species and habitats. The maximum design scenario is therefore as per justifications in **Volume A2, Chapter 3: Fish and Shellfish Ecology** and **Volume**

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
			A2, Chapter 2: Benthic and Intertidal Ecology.
Barrier effect to the migratory or regular foraging movements of seabirds	Offshore and Intertidal Ornithology	**Array Area:** • WTG deployment across the full array area (468 km^2) area; and • Up to 25.6 km north-south extent between the northernmost point of the array area and the southernmost point. **WTGs:** • Up to 180 WTGs.	The measurement would be North to South to define the additional effort required for birds to fly around the array area to the North or South from FFC colony during the breeding if assumed to be commuting to foraging areas beyond array area to the East.
Impacts on habitats or species: Operation of the Onshore Substation (OnSS) will cause long-term	Ecology and Nature Conservation	**Onshore Substation and Energy Balancing Infrastructure:** • Permanent infrastructure area: 164,000 m^2; • Temporary works area: 130,000 m^2; • Permanent access road: Number 1. Length 1.8 km, Width: 10 m (7 m road, 3 m soil stabilisation and below ground utilities); • Noise levels during operation (Power Convertors): 85 dB per unit; and • Power convertors: Number: 100.	These parameters represent maximum land take and operational activities relevant to the OnSS.
Impacts on protected species: Operation and maintenance activities of the OnSS could cause disturbance to protected species	Ecology and Nature Conservation		
Long-term loss of habitat due to the presence of turbine foundations, scour protection and cable protection.	Fish and Shellfish Ecology	**Total Habitat Loss/Change: 3,730,671 m^2** **WTGs:** • Turbine footprint with scour protection, based on 110 GBS (WTG-type) foundations = 504,540 m^2; and • Turbine footprint with scour protection, based on 70 suction caisson Jacket (WTG type) foundations = 296,881 m^2.	The maximum design scenario is defined by the maximum area of seabed lost by the footprint of structures on the seabed, scour protection, cable protection and cable crossings.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
		OSS foundations: • Offshore OSS foundation footprint and scour protection based on six small OSS on GBS (Box-type) foundations and three large OSS (on GBS (large OSS) foundations = 371,250 m^2. **HVAC Booster Station Foundations:** • Offshore HVAC booster substations and associated scour protection based on three GBS (Box-type) foundation = 91,875 m^2. **Offshore Accommodation Platform Foundations:** • Offshore accommodation platform and associated scour protection based on one GBS (Box-type) foundation = 30,625 m^2. **Array Cables:** • Maximum rock protection area = 624,000 m^2; • Pre- and post-lay rock berm area, based on 32 cable crossings = 204,000 m^2; and • 25% replenishment of scour protection during operation and maintenance phase = 156,000 m^2. **Interconnector Cable Protection:** • Maximum rock protection area = 94,000 m^2; and • 25% replenishment of scour protection during operation and maintenance phase = 23,500 m^2. **Offshore ECC:** • Maximum rock protection area = 792,000 m^2; • Pre- and post-lay rock berm area, based on 54 cable crossings = 344,000 m^2; and • 25% replenishment of scour protection during operation and maintenance phase = 198,000 m^2.	

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Increased hard substrate and structural complexity as a result of the introduction of turbine foundations, scour protection and cable protection.	Fish and Shellfish Ecology	**Total surface area of introduced hard substrate in the water column = 4,759,171 m² .** **Total area of introduced hard substrate at seabed level = 3,730,671 m² (see FSE-O-6).** **Total surface area of subsea portions of foundations in contact with the water column: 1,028,500 m².** • 110 WTGs on GBS (WTG-type) foundations, assuming 15 m diameter cylinder atop a conical/frustum base which tapers at 35 m above seabed level, with a base diameter of 53 m. Average water depth of 47.5 m, giving a per-foundation surface area of 5,650 m², with a total area of 621,500 m²; • 70 WTGs on suction caisson jacket (WTG type) foundations, which has a base diameter of up to 40 m (extending 10 m above the seabed). Average water depth of 47.5 m, giving a per foundation surface area of 2,512 m², with a total area of 175,850 m². • Six small OSS on GBS (Box-type) foundations, each with a length and width of 75 m at seabed level and at Lowest Astronomical Tide (LAT). Average water depth of 47.5 m, giving a per-foundation surface area of 14,250 m², with a total area of 85,500 m²; • Three large OSS on GBS (Box-type) foundations, each with a length and width of 150 m at seabed level and at LAT. Average water depth of 47.5 m, giving a per-foundation surface area of 28,500 m², with a total area of 85,500 m²; • One accommodation platform on a GBS (Box-type) foundation (small OSS), with a length and width of 75 m at seabed level and at LAT. Average water depth of 47.5 m, giving a total surface area of 14,250 m²; and • Three HVAC booster stations on GBS (Box-type) foundations (small OSS), each with a length and width of 75 m at seabed level and at LAT. Average water depth of 51 m in the HVAC Booster Station Search Area, giving a per-foundation surface area of 15,300 m², with a total area of 45,900 m².	Defined by the maximum area of structures, scour protection, cable protection and cable crossings introduced to the water column, including surface area of vertical structures.

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
Temporary localised increases in SSC and smothering	Fish and Shellfish Ecology	**Total volume: 692,916 m³** **Array Cable Activities:** • Remedial burial of array cable (42 km total length reburied) by CFE – 252,000 m³; and • Array cable repairs = 218,258 m³. **Interconnector Cable Activities:** • Remedial burial of interconnector cables (7 km total length reburied) by CFE = 42,000 m³; and • Interconnector cable repairs = 11,153 m³. **Export Cable Activities:** • Remedial burial of export cables (14 km total length reburied) by CFE = 84,000 m³; and • Export cable repairs = 85,505 m³.	The maximum impacts from remedial cable burial and cable repairs of array, interconnector and export cables result from the use of CFE. This assumes the largest number of cables, repair events, the greatest burial depth and greatest length/area of maintenance. This results in the maximum sediment volume disturbance.
Decommissioning			
Temporary habitat disturbance from decommissioning of foundation substructures and cables	Benthic and Intertidal Ecology	**Removal of all foundations, cables and rock protection leading to a temporary loss/change of 3,730,671 m² (see BIE-O-8).**	MDS is assumed to be similar to the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables and rock protection is considered the MDS, however the necessity to remove cables and rock protection will be reviewed at the time of decommissioning.
Increased SSC and sediment deposition from removal of foundations and cables.	Benthic and Intertidal Ecology	This impact is a subset of MP-C-2 for structures that are removed from the seabed. The impacts are expected to be equivalent to MP-C-2 apart from the structures that may remain (e.g. cables to be removed but not cable protection measures). See MDS presented in **Chapter 1: Marine Geology, Oceanography and Physical Processes**.	MDS is assumed to be as per the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables is considered the MDS, however the necessity to remove

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
			cables will be reviewed at the time of decommissioning.
Loss of introduced habitat from the removal of foundations.	Benthic and Intertidal Ecology	**Total area of introduced hard substrate to be lost = 4,543,694 m² (see BIE-O-9).**	Defined by the maximum surface area introduced as above. Some materials may be left *in situ* and this will be reviewed closer to the time of decommissioning. As such, the MDS assumes the removal of all infrastructure.
Reduction in prey availability	Marine Mammals	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**).	
Reduction in foraging ability	Marine Mammals	MDS is identical (or less) to that of the construction phase (MM-C-7). **Total volume = 12,192,331 m³**	MDS is assumed to be as per the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables is considered the MDS, however the necessity to remove cables will be reviewed at the time of decommissioning.
Indirect impacts during the decommissioning phase within the offshore export cable corridor and landfall through effects on habitats and prey species.	Offshore and Intertidal Ornithology	See MDS for Fish and Shellfish Ecology assessment (**Volume A2, Chapter 3: Fish and Shellfish Ecology**) and for the Benthic and Intertidal Ecology assessment (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**).	Indirect effects on birds could occur through changes to any of the species and habitats considered within the Fish and Shellfish Ecology or Benthic and Intertidal Ecology assessments. The maximum indirect impact on birds would result from the maximum direct impact on fish, shellfish and benthic species and habitats. The maximum design scenario is therefore as per justifications in **Volume A2, Chapter 3: Fish and Shellfish Ecology** and **Volume**

Impact	Receptor Group	Maximum Design Scenario (MDS) Assessed	Justification
			A2, Chapter 2: Benthic and Intertidal Ecology.
Temporary localised increases in SSC and smothering.	Fish and Shellfish Ecology	MDS is identical (or less) to that of the construction phase (FSE-C-2). **Total volume = 12,213,921 m^3**	MDS is assumed to be as per the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables is considered the MDS, however the necessity to remove cables will be reviewed at the time of decommissioning.
Direct and indirect seabed disturbances leading to the release of sediment contaminants	Fish and Shellfish Ecology	MDS is identical (or less) to that of the construction phase (FSE-C-2). **Total volume = 12,213,921 m^3**	MDS is assumed to be as per the construction phase, with all infrastructure removed in reverse-construction order. The removal of cables is considered the MDS, however the necessity to remove cables will be reviewed at the time of decommissioning.
Mortality, injury, behavioural changes and auditory masking arising from noise and vibration.	Fish and Shellfish Ecology	Maximum levels of underwater noise during decommissioning would be from underwater cutting required to remove structures. This is much less than pile driving and therefore impacts would be less than as assessed during the construction phase/ piled foundations would likely be cut approximately 1 m below the seabed.	This would result in the maximum potential disturbance associated with noise associated with decommissioning activities including foundation decommissioning.