CONTENTS

2 PROJECT DETAILS

2.1 Introduction

This section describes in detail the Thanet Offshore Wind Farm (Thanet) project that is:

- The offshore elements comprising the turbines and foundations;
- Interconnecting cables;
- Offshore substation and export cables;
- Anemometry mast; and
- The landside elements, including the landfall, buried onshore cable route and substation works.

A description of each of these elements is provided along with, where relevant, a description of the options being considered. The method of construction is described, as well as details on operation and maintenance and subsequent decommissioning.

A main Construction Contractor has yet to be appointed and therefore the construction details represent the current understanding of the way in which the project would be built, based on similar projects. The actual method of construction to be employed may vary, but Thanet Offshore Wind Limited (TOW) would ensure, through consultation with the appropriate authorities, that any variation does not result in environmental impacts that differ significantly from those reported in this Environmental Statement (ES). It is considered that the Environmental Impact Assessment (EIA) has covered all likely permutations and options.

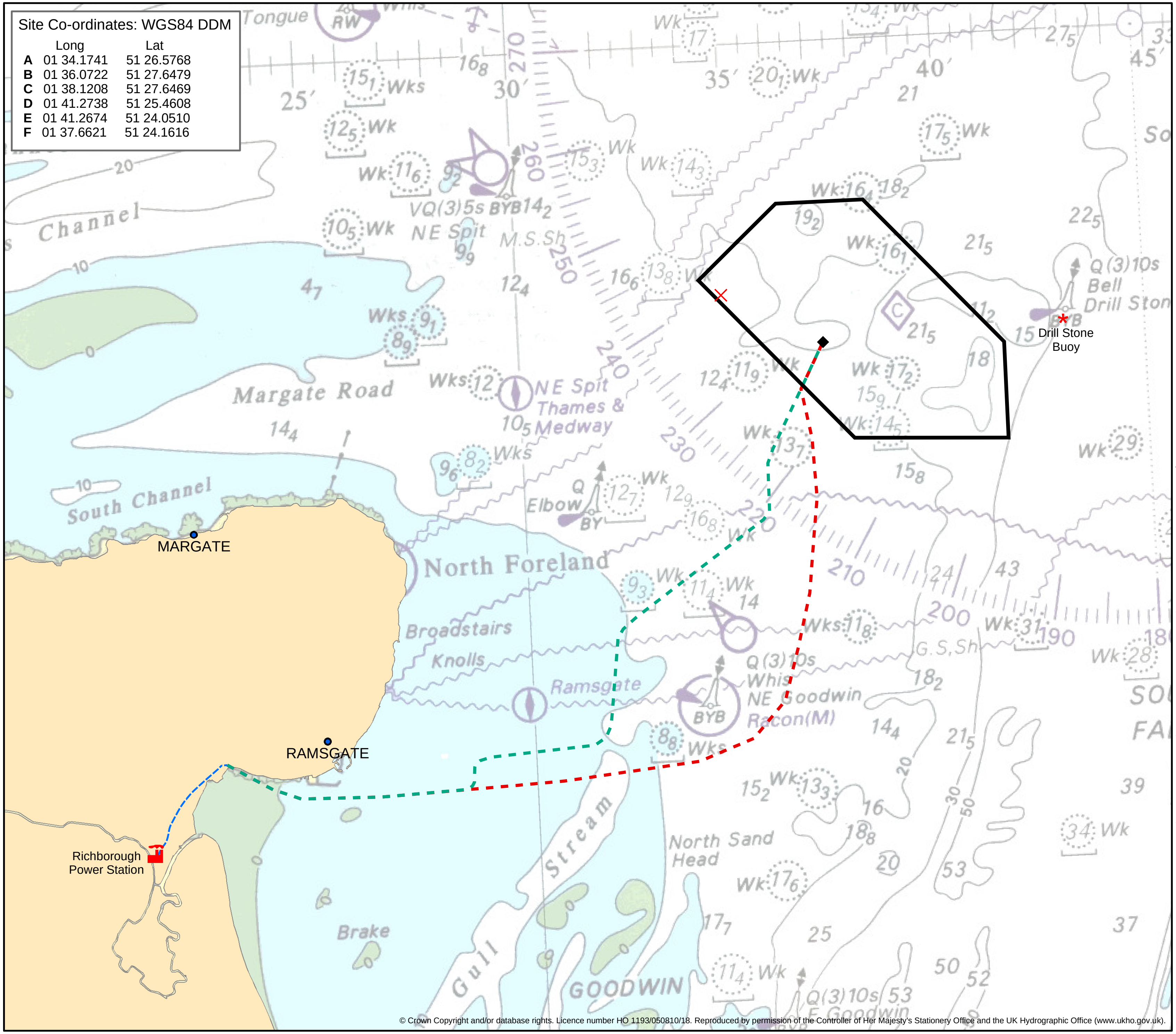
2.2 Site Location, Key Project Characteristics and Wind Farm Layout Options

2.2.1 Site location

The Thanet site is nominally bounded by existing in-service and out-of-service telecommunications cables to the north and south, the Drill Stone cardinal navigational buoy to the east, navigation routes to the north, east, south and south west, and a need for a maximum separation in visual terms with the Thanet coastline to the west (see **Figure 2.1**). The shape of the site to the north has been chosen so as to avoid a ‘corner’ of the wind farm being used as a navigational waypoint.

Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616



Legend:

- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2
- Terrestrial Cable Route
- Offshore Substation
- Anemometry Mast

Title:

THANET OFFSHORE WIND FARM SITE

Project:

THANET OFFSHORE WIND FARM

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Date:	Figure:
31/10/2005	2.1

Scale:	Revision No:
0 0.5 1 1.5 2 Kilometres	003

ROYAL HASKONING

2.2.2 Key project characteristics

A summary of the key project characteristics is provided in **Table 2.1** below.

Table 2.1 Summary of the key project characteristics

Key project characteristics	
Hub height and blade length (maximum)	90m hub height, 60m blade length, 150m total above mean sea level
Minimum clearance above sea level	22m above mean high water springs level (MHWS)
Nominal output of each wind turbine	3.0 - 5.0MW_e
Nominal maximum output of the wind farm	300MW_e
Separation between turbines	450 - 600m within rows 675 - 900m between rows
Total wind farm area	35km^2
Minimum distance to shore	11.1 to 11.4km
Minimum distance to nearest residence	11.3 to 11.6km
Location of offshore substation	Towards the south west area of the site
Location of anemometry mast	Towards the north west area of the site
Location of export cable landfall	North of the disused hoverport in Pegwell Bay
Electrical connection	Existing substation at Richborough Power Station

2.2.3 Wind farm layout options

Four wind farm layout options have been considered as part of the EIA, where the number of turbines varies depending upon the rating of the machine chosen, as shown in **Table 2.2**. The maximum electricity output of the Thanet project is 300MW, therefore, the higher the rating of the turbine, the fewer turbines would be required in order to meet the 300MW limit and vice versa. Given a range of turbines between 3.0MW and 5.0MW, the number of turbines would range from 100 to 60 respectively. **Figures 2.2** to **2.5** show the provisional layouts for the Thanet project based on 3.0MW, 3.6MW, 4.2MW and 5.0MW turbine types respectively.

Table 2.2 Four layout options for the potential turbine configurations

Turbine Rating	No. of Turbines	Min. Separation in Rows	Min. Separation Between Rows
3.0MW	100	450m	675m
3.6MW	83	520m	780m
4.2MW	71	575m	860m
5.0MW	60	600m	900m

Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

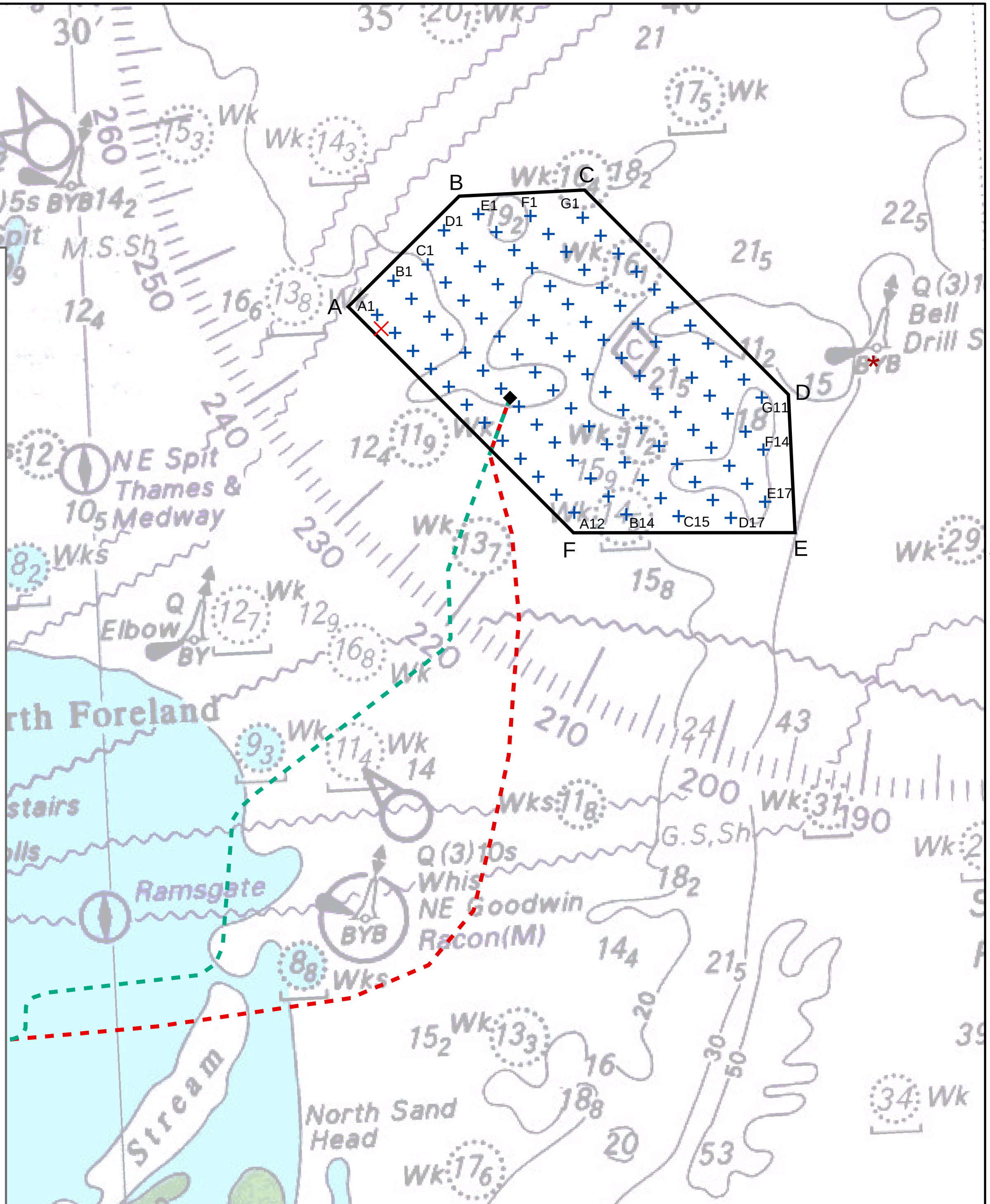
Distance from shore to nearest turbine = 11.1 km

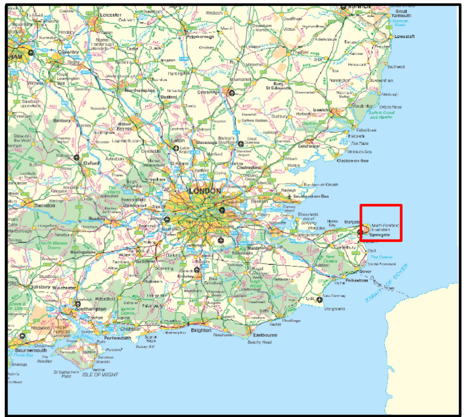
Distance from Drill Stone buoy to nearest turbine = 2.22 km

Turbine Co-ordinates: WGS84 DDM

	Long	Lat
A1	01 34.6419	51 26.4788
A2	01 34.9194	51 26.2868
A3	01 35.1969	51 26.0947
A4	01 35.4743	51 25.9027
A5	01 35.7518	51 25.7106
A6	01 36.0292	51 25.5186
A7	01 36.3066	51 25.3266
A8	01 36.5838	51 25.1345
A9	01 36.8612	51 24.9424
A10	01 37.1384	51 24.7502
A11	01 37.4156	51 24.5582
A12	01 37.6928	51 24.3660
B1	01 34.9352	51 26.8187
B2	01 35.2128	51 26.6267
B3	01 35.4903	51 26.4347
B4	01 35.7677	51 26.2426
B5	01 36.0452	51 26.0506
B6	01 36.3226	51 25.8585
B7	01 36.5999	51 25.6664
B8	01 36.8773	51 25.4743
B9	01 37.1545	51 25.2822
B10	01 37.4318	51 25.0901
B11	01 37.7090	51 24.8980
B12	01 37.9862	51 24.7059
B13	01 38.2633	51 24.5137
B14	01 38.5404	51 24.3215
C1	01 35.5062	51 26.9666
C2	01 35.7836	51 26.7746
C3	01 36.0611	51 26.5825
C4	01 36.3386	51 26.3904
C5	01 36.6161	51 26.1983
C6	01 36.8935	51 26.0062
C7	01 37.1708	51 25.8142
C8	01 37.4480	51 25.6220
C9	01 37.7253	51 25.4299
C10	01 38.0026	51 25.2378
C11	01 38.2797	51 25.0456
C12	01 38.5568	51 24.8535
C13	01 38.8340	51 24.6613
C14	01 39.1111	51 24.4691
C15	01 39.3881	51 24.2769
D1	01 35.7997	51 27.3065
D2	01 36.0771	51 27.1145
D3	01 36.3547	51 26.9224
D4	01 36.6321	51 26.7303
D5	01 36.9096	51 26.5382
D6	01 37.1870	51 26.3461
D7	01 37.4643	51 26.1540
D8	01 37.7416	51 25.9619
D9	01 38.0189	51 25.7697
D10	01 38.2962	51 25.5776
D11	01 38.5733	51 25.3854
D12	01 38.8506	51 25.1932
D13	01 39.1276	51 25.0010
D14	01 39.4047	51 24.8089
D15	01 39.6818	51 24.6167
D16	01 39.9587	51 24.4245
D17	01 40.2357	51 24.2323

	Long	Lat
E1	01 36.3708	51 27.4543
E2	01 36.6482	51 27.2622
E3	01 36.9257	51 27.0702
E4	01 37.2032	51 26.8780
E5	01 37.4806	51 26.6859
E6	01 37.7579	51 26.4938
E7	01 38.0353	51 26.3017
E8	01 38.3126	51 26.1095
E9	01 38.5897	51 25.9173
E10	01 38.8671	51 25.7252
E11	01 39.1442	51 25.5330
E12	01 39.4213	51 25.3408
E13	01 39.6984	51 25.1486
E14	01 39.9755	51 24.9564
E15	01 40.2524	51 24.7641
E16	01 40.5294	51 24.5719
E17	01 40.8064	51 24.3797
F1	01 37.2194	51 27.4100
F2	01 37.4969	51 27.2178
F3	01 37.7742	51 27.0257
F4	01 38.0516	51 26.8336
F5	01 38.3290	51 26.6414
F6	01 38.6063	51 26.4493
F7	01 38.8836	51 26.2571
F8	01 39.1608	51 26.0649
F9	01 39.4379	51 25.8727
F10	01 39.7151	51 25.6805
F11	01 39.9922	51 25.4883
F12	01 40.2692	51 25.2961
F13	01 40.5463	51 25.1039
F14	01 40.8233	51 24.9116
G1	01 38.0680	51 27.3655
G2	01 38.3454	51 27.1734
G3	01 38.6228	51 26.9812
G4	01 38.9001	51 26.7890
G5	01 39.1774	51 26.5969
G6	01 39.4546	51 26.4047
G7	01 39.7318	51 26.2125
G8	01 40.0089	51 26.0202
G9	01 40.2861	51 25.8280
G10	01 40.5631	51 25.6358
G11	01 40.8402	51 25.4435





Legend:

- Thanet Wind Farm Site Location
- Turbines x 100
- Anemometry Mast
- Offshore Substation
- Drill Stone Buoy
- Proposed Cable Route 1
- Proposed Cable Route 2

Title:

THANET OFFSHORE WIND FARM
LAYOUT FOR 100 x 3.0MW TURBINES

Project:

THANET OFFSHORE WIND FARM

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Date:	Figure:
25/10/2005	2.2

Scale: 0 0.5 1 1.5 2 Kilometres

Revision No: 016

ROYAL HASKONING

Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

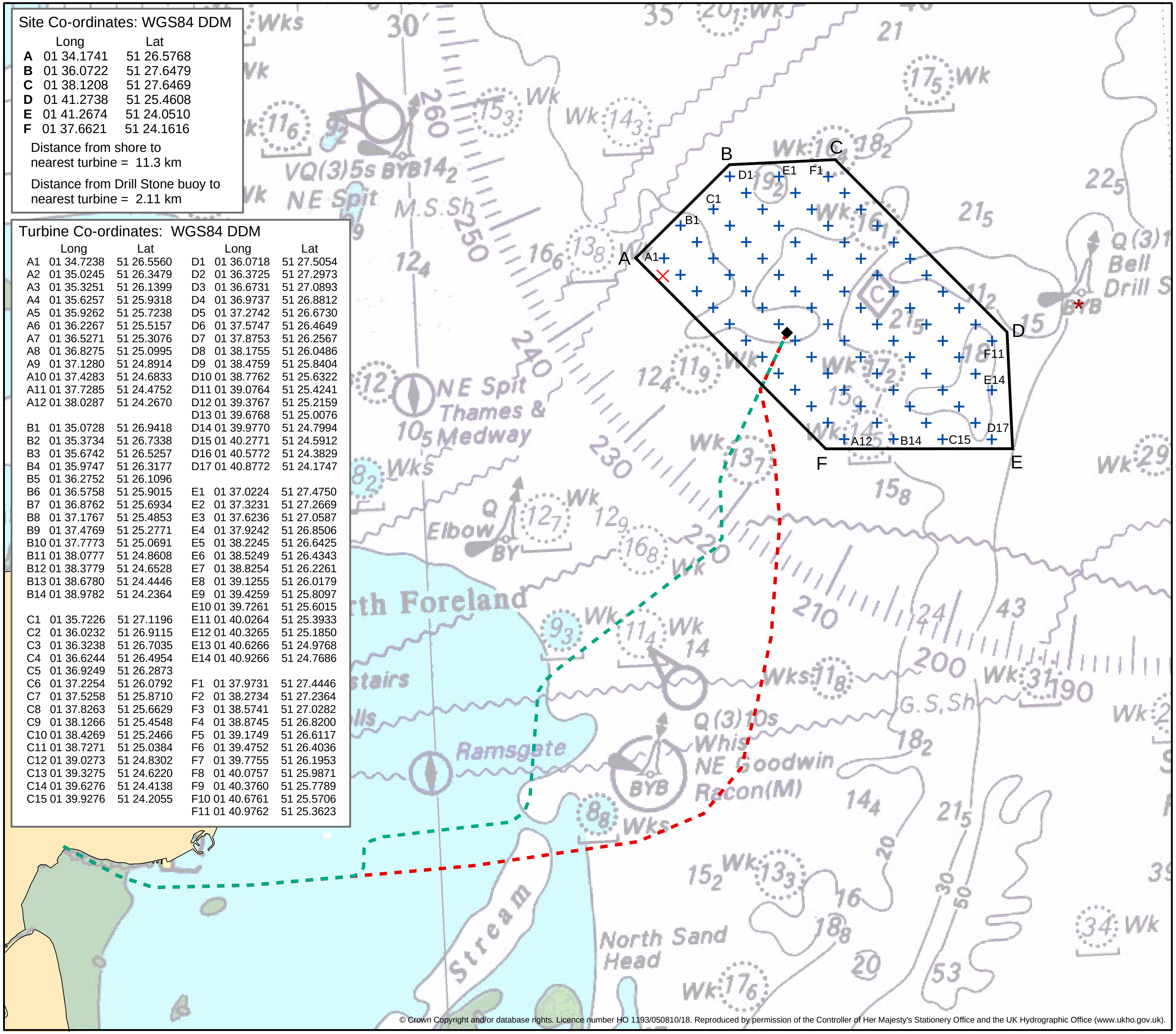
Distance from shore to nearest turbine = 11.3 km

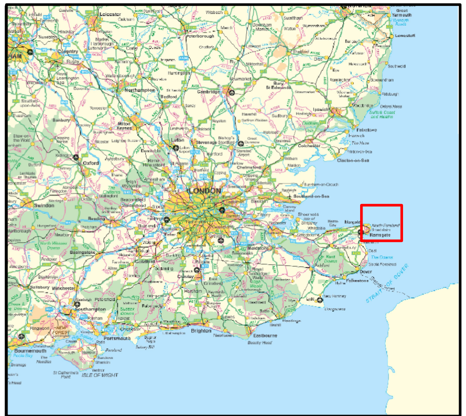
Distance from Drill Stone buoy to nearest turbine = 2.11 km

Turbine Co-ordinates: WGS84 DDM

	Long	Lat
A1	01 34.7238	51 26.5560
A2	01 35.0245	51 26.3479
A3	01 35.3251	51 26.1399
A4	01 35.6257	51 25.9318
A5	01 35.9262	51 25.7238
A6	01 36.2267	51 25.5157
A7	01 36.5271	51 25.3076
A8	01 36.8275	51 25.0995
A9	01 37.1280	51 24.8914
A10	01 37.4283	51 24.6833
A11	01 37.7285	51 24.4752
A12	01 38.0287	51 24.2670
B1	01 35.0728	51 26.9418
B2	01 35.3734	51 26.7338
B3	01 35.6742	51 26.5257
B4	01 35.9747	51 26.3177
B5	01 36.2752	51 26.1096
B6	01 36.5758	51 25.9015
B7	01 36.8762	51 25.6934
B8	01 37.1767	51 25.4853
B9	01 37.4769	51 25.2771
B10	01 37.7773	51 25.0691
B11	01 38.0777	51 24.8608
B12	01 38.3779	51 24.6528
B13	01 38.6780	51 24.4446
B14	01 38.9782	51 24.2364
C1	01 35.7226	51 27.1196
C2	01 36.0232	51 26.9115
C3	01 36.3238	51 26.7035
C4	01 36.6244	51 26.4954
C5	01 36.9249	51 26.2873
C6	01 37.2254	51 26.0792
C7	01 37.5258	51 25.8710
C8	01 37.8263	51 25.6629
C9	01 38.1266	51 25.4548
C10	01 38.4269	51 25.2466
C11	01 38.7271	51 25.0384
C12	01 39.0273	51 24.8302
C13	01 39.3275	51 24.6220
C14	01 39.6276	51 24.4138
C15	01 39.9276	51 24.2055

	Long	Lat
D1	01 36.0718	51 27.5054
D2	01 36.3725	51 27.2973
D3	01 36.6731	51 27.0893
D4	01 36.9737	51 26.8812
D5	01 37.2742	51 26.6730
D6	01 37.5747	51 26.4649
D7	01 37.8753	51 26.2567
D8	01 38.1755	51 26.0486
D9	01 38.4759	51 25.8404
D10	01 38.7762	51 25.6322
D11	01 39.0764	51 25.4241
D12	01 39.3767	51 25.2159
D13	01 39.6768	51 25.0076
D14	01 39.9770	51 24.7994
D15	01 40.2771	51 24.5912
D16	01 40.5772	51 24.3829
D17	01 40.8772	51 24.1747
E1	01 37.0224	51 27.4750
E2	01 37.3231	51 27.2669
E3	01 37.6236	51 27.0587
E4	01 37.9242	51 26.8506
E5	01 38.2245	51 26.6425
E6	01 38.5249	51 26.4343
E7	01 38.8254	51 26.2261
E8	01 39.1255	51 26.0179
E9	01 39.4259	51 25.8097
E10	01 39.7261	51 25.6015
E11	01 40.0264	51 25.3933
E12	01 40.3265	51 25.1850
E13	01 40.6266	51 24.9768
E14	01 40.9266	51 24.7686
F1	01 37.9731	51 27.4446
F2	01 38.2734	51 27.2364
F3	01 38.5741	51 27.0282
F4	01 38.8745	51 26.8200
F5	01 39.1749	51 26.6117
F6	01 39.4752	51 26.4036
F7	01 39.7755	51 26.1953
F8	01 40.0757	51 25.9871
F9	01 40.3760	51 25.7789
F10	01 40.6761	51 25.5706
F11	01 40.9762	51 25.3623





Legend:

- Thanet Wind Farm Site Location
- Turbines x 83
- Anemometry Mast
- Offshore Substation
- Drill Stone Buoy
- Proposed Cable Route 1
- Proposed Cable Route 2

Title:

THANET OFFSHORE WIND FARM
LAYOUT FOR 83 x 3.6MW TURBINES

Project:

THANET OFFSHORE WIND FARM

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Date:	Figure:
25/10/2005	2.3

Scale:	Revision No:
0 0.5 1 1.5 2 Kilometres	016

ROYAL HASKONING

Site Co-ordinates: WGS84 DDM

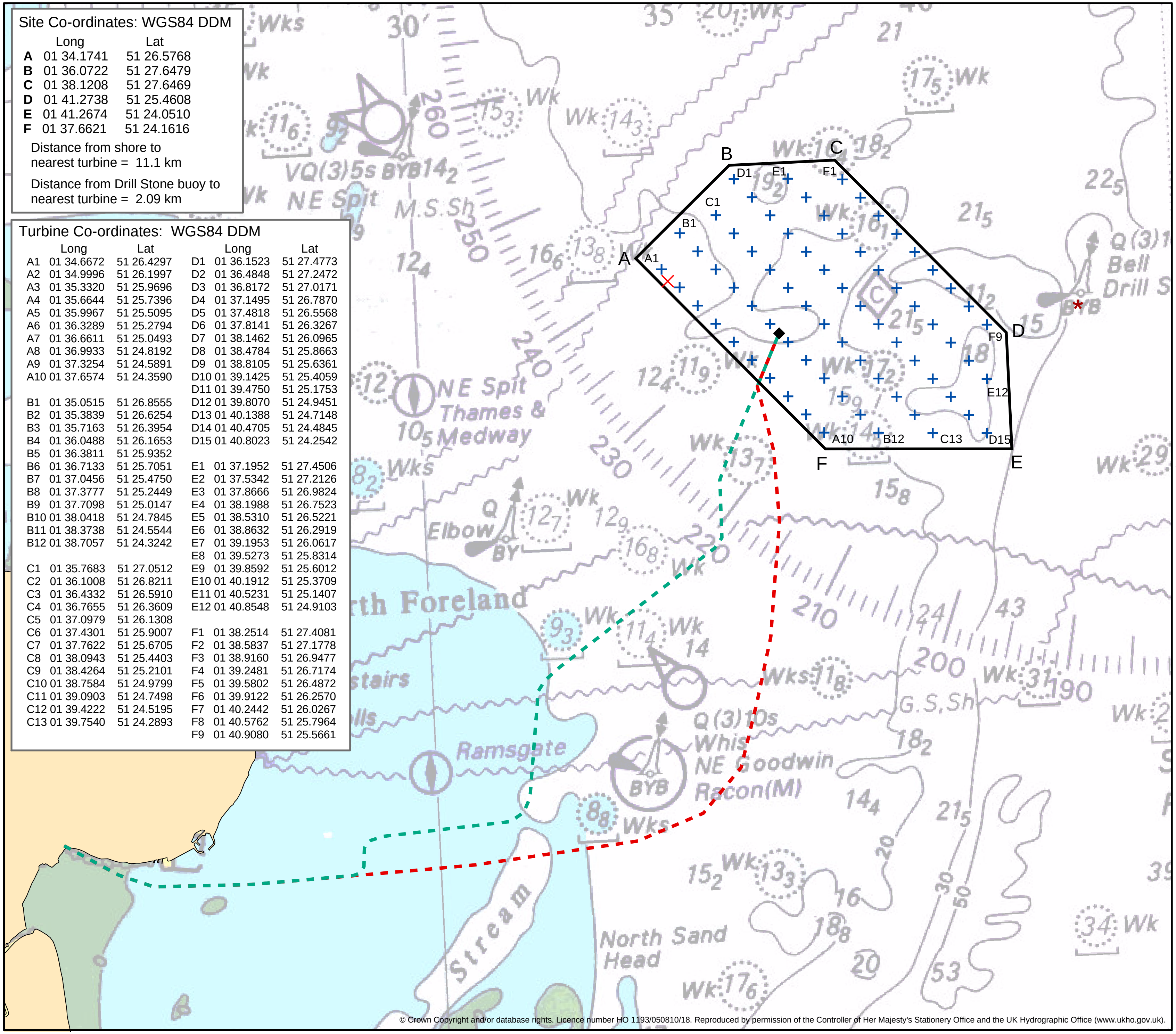
	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

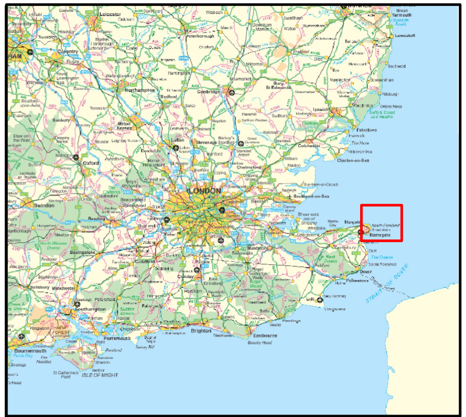
Distance from shore to nearest turbine = 11.1 km

Distance from Drill Stone buoy to nearest turbine = 2.09 km

Turbine Co-ordinates: WGS84 DDM

	Long	Lat		Long	Lat
A1	01 34.6672	51 26.4297	D1	01 36.1523	51 27.4773
A2	01 34.9996	51 26.1997	D2	01 36.4848	51 27.2472
A3	01 35.3320	51 25.9696	D3	01 36.8172	51 27.0171
A4	01 35.6644	51 25.7396	D4	01 37.1495	51 26.7870
A5	01 35.9967	51 25.5095	D5	01 37.4818	51 26.5568
A6	01 36.3289	51 25.2794	D6	01 37.8141	51 26.3267
A7	01 36.6611	51 25.0493	D7	01 38.1462	51 26.0965
A8	01 36.9933	51 24.8192	D8	01 38.4784	51 25.8663
A9	01 37.3254	51 24.5891	D9	01 38.8105	51 25.6361
A10	01 37.6574	51 24.3590	D10	01 39.1425	51 25.4059
			D11	01 39.4750	51 25.1753
B1	01 35.0515	51 26.8555	D12	01 39.8070	51 24.9451
B2	01 35.3839	51 26.6254	D13	01 40.1388	51 24.7148
B3	01 35.7163	51 26.3954	D14	01 40.4705	51 24.4845
B4	01 36.0488	51 26.1653	D15	01 40.8023	51 24.2542
B5	01 36.3811	51 25.9352			
B6	01 36.7133	51 25.7051	E1	01 37.1952	51 27.4506
B7	01 37.0456	51 25.4750	E2	01 37.5342	51 27.2126
B8	01 37.3777	51 25.2449	E3	01 37.8666	51 26.9824
B9	01 37.7098	51 25.0147	E4	01 38.1988	51 26.7523
B10	01 38.0418	51 24.7845	E5	01 38.5310	51 26.5221
B11	01 38.3738	51 24.5544	E6	01 38.8632	51 26.2919
B12	01 38.7057	51 24.3242	E7	01 39.1953	51 26.0617
			E8	01 39.5273	51 25.8314
C1	01 35.7683	51 27.0512	E9	01 39.8592	51 25.6012
C2	01 36.1008	51 26.8211	E10	01 40.1912	51 25.3709
C3	01 36.4332	51 26.5910	E11	01 40.5231	51 25.1407
C4	01 36.7655	51 26.3609	E12	01 40.8548	51 24.9103
C5	01 37.0979	51 26.1308			
C6	01 37.4301	51 25.9007	F1	01 38.2514	51 27.4081
C7	01 37.7622	51 25.6705	F2	01 38.5837	51 27.1778
C8	01 38.0943	51 25.4403	F3	01 38.9160	51 26.9477
C9	01 38.4264	51 25.2101	F4	01 39.2481	51 26.7174
C10	01 38.7584	51 24.9799	F5	01 39.5802	51 26.4872
C11	01 39.0903	51 24.7498	F6	01 39.9122	51 26.2570
C12	01 39.4222	51 24.5195	F7	01 40.2442	51 26.0267
C13	01 39.7540	51 24.2893	F8	01 40.5762	51 25.7964
			F9	01 40.9080	51 25.5661





Legend:

- Thanet Wind Farm Site Location
- Turbines x 71
- Anemometry Mast
- Offshore Substation
- Drill Stone Buoy
- Proposed Cable Route 1
- Proposed Cable Route 2

Title:

THANET OFFSHORE WIND FARM
LAYOUT FOR 71 x 4.2MW TURBINES

Project:

THANET OFFSHORE WIND FARM

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SMG	SDG	9P5164/04/104

Date:	Figure:
25/10/2005	2.4

Scale:	Revision No:
0 0.5 1 1.5 2 Kilometres	016

ROYAL HASKONING

Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

Distance from shore to nearest turbine = 11.4 km

Distance from Drill Stone buoy to nearest turbine = 2.28 km

Turbine Co-ordinates: WGS84 DDM

	Long	Lat		Long	Lat
A1	01 34.7161	51 26.6819	D1	01 36.6187	51 27.5373
A2	01 35.0631	51 26.4418	D2	01 36.9656	51 27.2971
A3	01 35.4100	51 26.2017	D3	01 37.3124	51 27.0570
A4	01 35.7568	51 25.9617	D4	01 37.6591	51 26.8169
A5	01 36.1036	51 25.7216	D5	01 38.0058	51 26.5767
A6	01 36.4503	51 25.4815	D6	01 38.3525	51 26.3365
A7	01 36.7969	51 25.2414	D7	01 38.6990	51 26.0963
A8	01 37.1435	51 25.0013	D8	01 39.0455	51 25.8561
A9	01 37.4900	51 24.7611	D9	01 39.3920	51 25.6158
A10	01 37.8365	51 24.5210	D10	01 39.7384	51 25.3756
A11	01 38.1829	51 24.2808	D11	01 40.0847	51 25.1353
			D12	01 40.4310	51 24.8951
B1	01 35.4658	51 26.8870	D13	01 40.7772	51 24.6547
B2	01 35.8127	51 26.6470			
B3	01 36.1596	51 26.4068	E1	01 37.7156	51 27.5021
B4	01 36.5064	51 26.1668	E2	01 38.0623	51 27.2619
B5	01 36.8531	51 25.9266	E3	01 38.4091	51 27.0217
B6	01 37.1997	51 25.6865	E4	01 38.7557	51 26.7815
B7	01 37.5464	51 25.4464	E5	01 39.1023	51 26.5413
B8	01 37.8929	51 25.2062	E6	01 39.4489	51 26.3010
B9	01 38.2394	51 24.9660	E7	01 39.7954	51 26.0608
B10	01 38.5858	51 24.7259	E8	01 40.1417	51 25.8205
B11	01 38.9322	51 24.4856	E9	01 40.4881	51 25.5803
B12	01 39.2785	51 24.2454	E10	01 40.8344	51 25.3399
C1	01 35.8687	51 27.3322			
C2	01 36.2157	51 27.0921			
C3	01 36.5625	51 26.8520			
C4	01 36.9093	51 26.6119			
C5	01 37.2561	51 26.3718			
C6	01 37.6028	51 26.1316			
C7	01 37.9493	51 25.8915			
C8	01 38.2959	51 25.6513			
C9	01 38.6424	51 25.4111			
C10	01 38.9889	51 25.1709			
C11	01 39.3352	51 24.9306			
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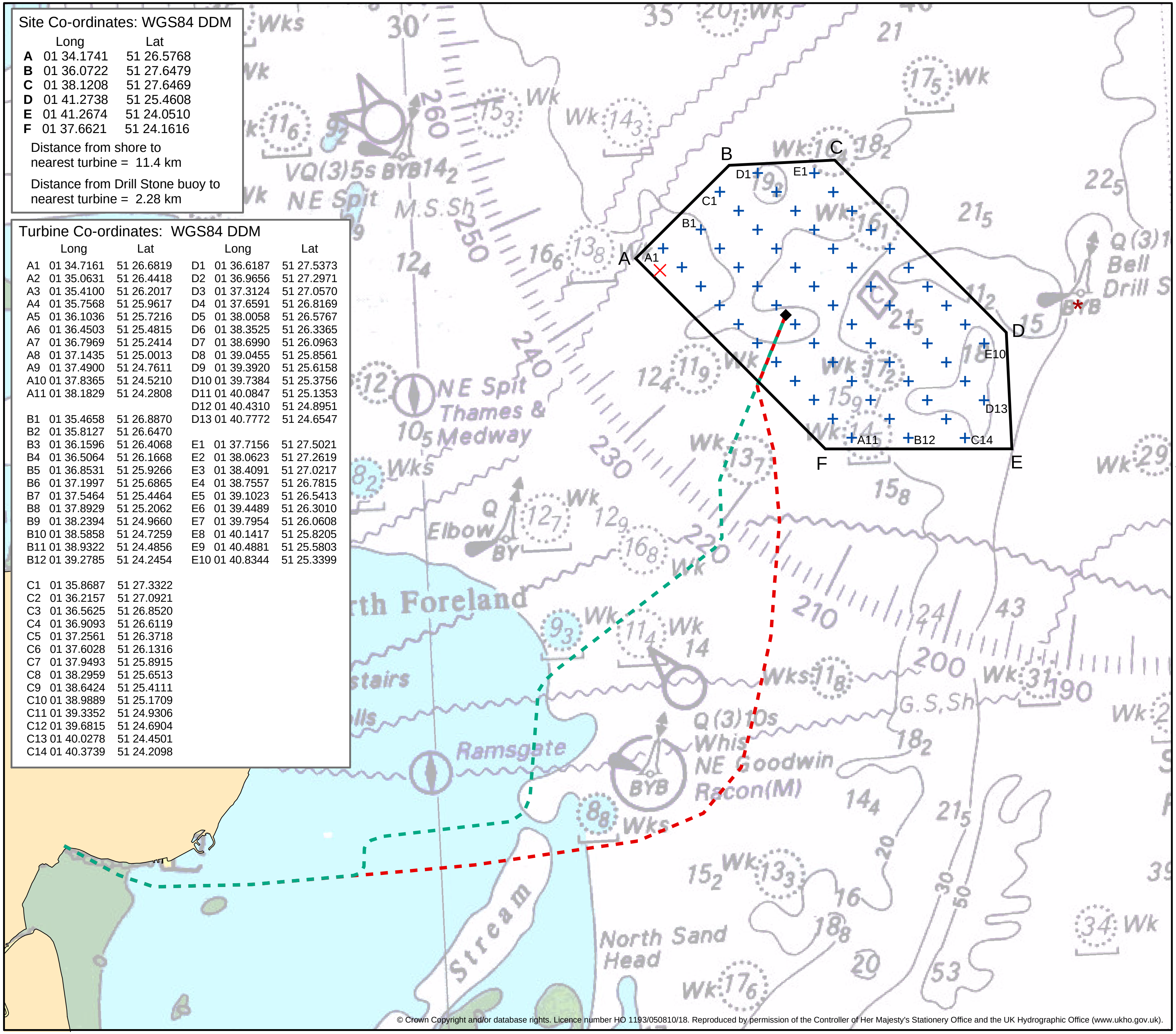
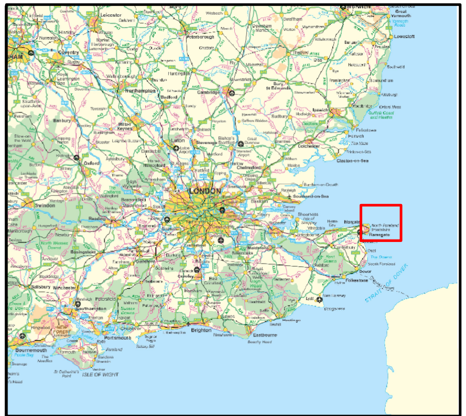
C13	01 40.0278	51 24.4501			
C14	01 40.3739	51 24.2098			





Legend:

- Thanet Wind Farm Site Location
- Turbines x 60
- Anemometry Mast
- Offshore Substation
- Drill Stone Buoy
- Proposed Cable Route 1
- Proposed Cable Route 2

Title:

THANET OFFSHORE WIND FARM
LAYOUT FOR 60 x 5.0MW TURBINES

Project:

THANET OFFSHORE WIND FARM

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Client:

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Drawn by:	Checked:	Drawing No:
SMG	SDG	9P5164/04/103

Date:	Figure:
25/10/2005	2.5

Scale:	Revision No:
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2.3 Foundation Systems and Scour Protection

A number of different foundation types were considered and evaluated for the Thanet project including monopiles, braced monopods, suction caisson/pile and gravity base structures (GBS). The evaluation concluded that the monopile and GBS foundations are the most likely foundation types to be used for the Thanet project. This assessment was based on the geotechnical conditions, water depth and environment conditions which prevail at the site.

The monopile foundation system is technically feasible for all foundation locations across the complete site. However, for a large section of the southern part of the site, it is possible that GBS foundations could be used. **Figures 2.6a** to **2.6d** shows three zones where it is possible that different foundation types could be used. The final type of foundation used for the Thanet project would only be determined following a full geotechnical investigation and subsequent detailed foundation engineering. Therefore, the demarcation lines shown in **Figures 2.6a** to **2.6d** are indicative at this stage and subject to possible change at a later date.

These two foundation types are described in detail within this section of the ES together with the anticipated installation methodology. In addition, scour protection methods for both foundation types are also presented.

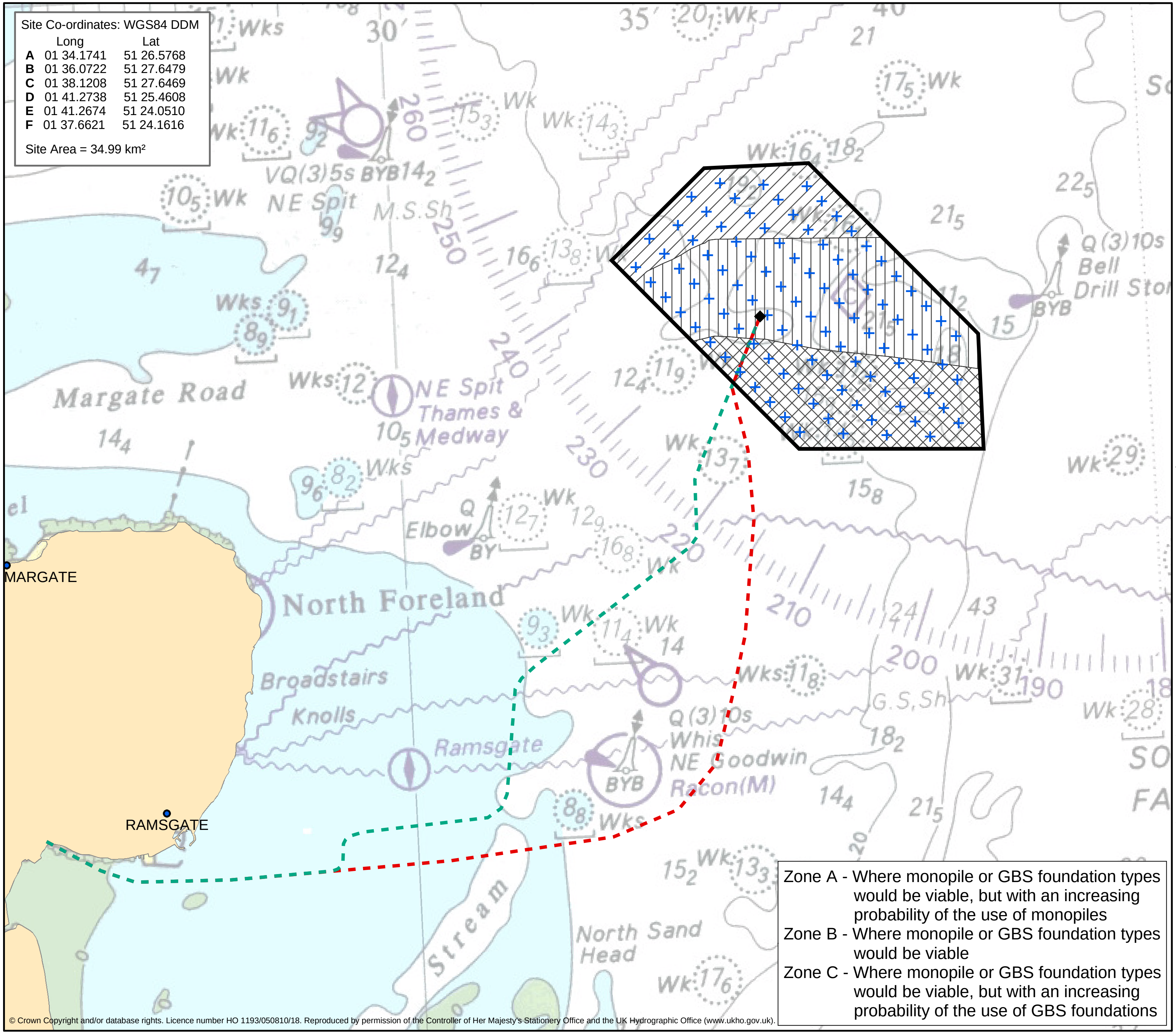
There would be excavations into the chalk strata either if drilling is used as part of the installation process for monopile foundations or, if a degree of seabed preparation is required in advance of the installation of a GBS foundation. TOW would propose to remove the bulk of such excavations from the site and then dispose of the chalk either at sea in an approved spoil ground, or alternatively they would be brought onshore for disposal on land. It is anticipated that up to 5% of the excavations would be dispersed locally at the site. Precedents for this level for local disposal of chalk deposits exist in European waters. An example is the Oresund Link Crossing in Denmark where the tunnel excavation contractor (Per Aasleff) was permitted to dispose of up to 5% of the excavated chalk into the sea. This was undertaken in a recognised environmentally sensitive area, but all stakeholders agreed that the environment could tolerate this level of chalk dispersal.

2.4 Monopile Foundation

2.4.1 Overview

The monopile configuration has been used exclusively for founding offshore wind farm structures in the UK to date. A monopile consists of a single, large diameter, steel foundation pile. There are three potential methods of installation to ensure the monopile achieves the required depth of penetration into the seabed:

- Driven to full penetration;
- Drive/Drill/Drive; and
- Drilled and then grouted into position.



Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

Site Area = 34.99 km²

Zone A - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of monopiles

Zone B - Where monopile or GBS foundation types would be viable

Zone C - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of GBS foundations

Legend:
- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2
- Turbines x 100
- Offshore Substation
- Zone A
- Zone B
- Zone C

Title:

FOUNDATION TYPE OPTIONS ACROSS THE THANET OFFSHORE WIND FARM SITE

Project:

THANET OFFSHORE WIND FARM

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Date:	Figure:
25/10/2005	2.6a

Scale:	Revision No:
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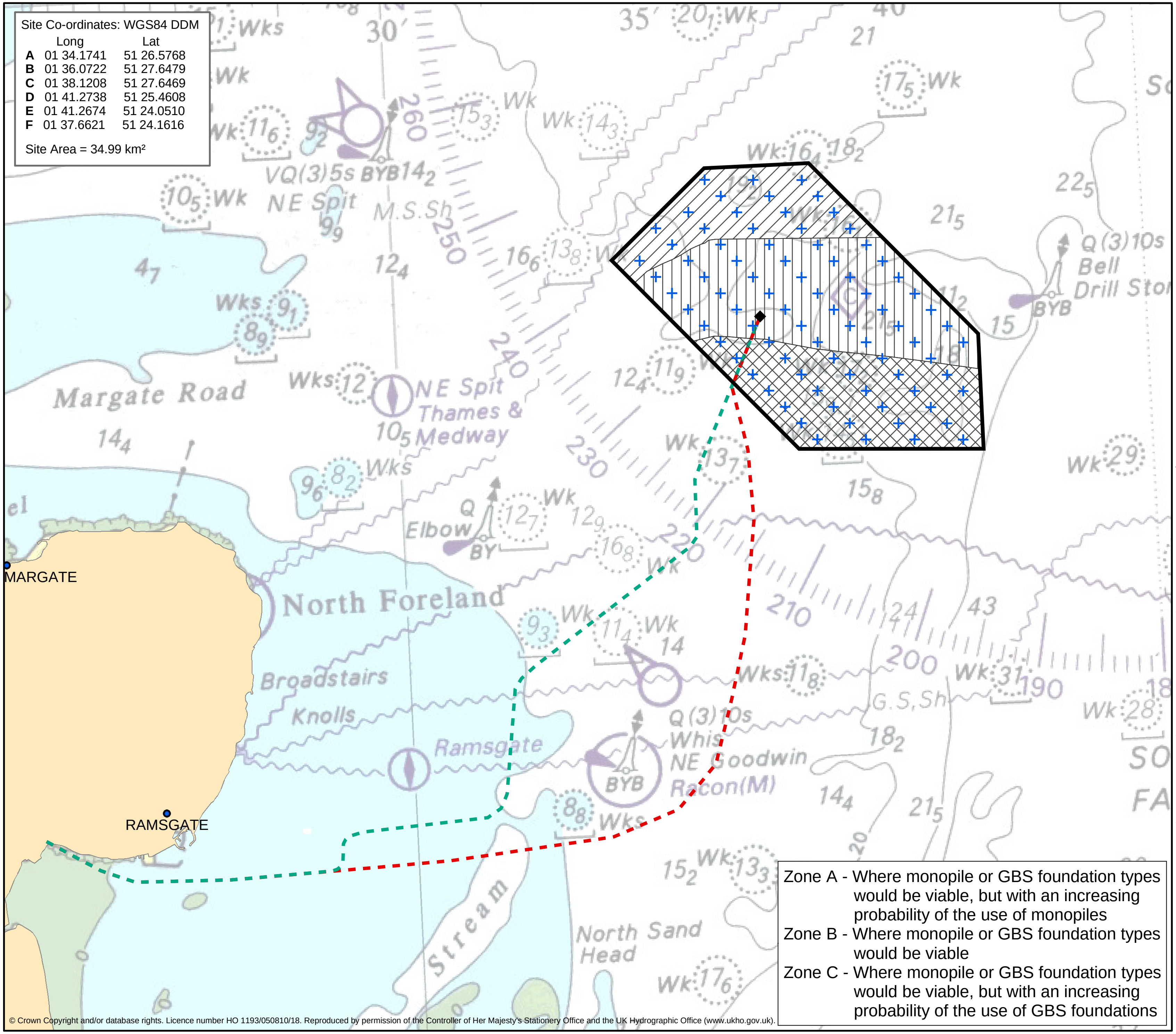
ROYAL HASKONING



Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
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Zone B - Where monopile or GBS foundation types would be viable

Zone C - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of GBS foundations

Legend:
- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2
- Turbines x 83
- Offshore Substation
- Zone A
- Zone B
- Zone C

Title:
FOUNDATION TYPE OPTIONS ACROSS THE THANET OFFSHORE WIND FARM SITE

Project:
THANET OFFSHORE WIND FARM

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Date: 25/10/2005

Figure: 2.6b

Scale: 0 0.5 1 1.5 2 Kilometres

Revision No: 003

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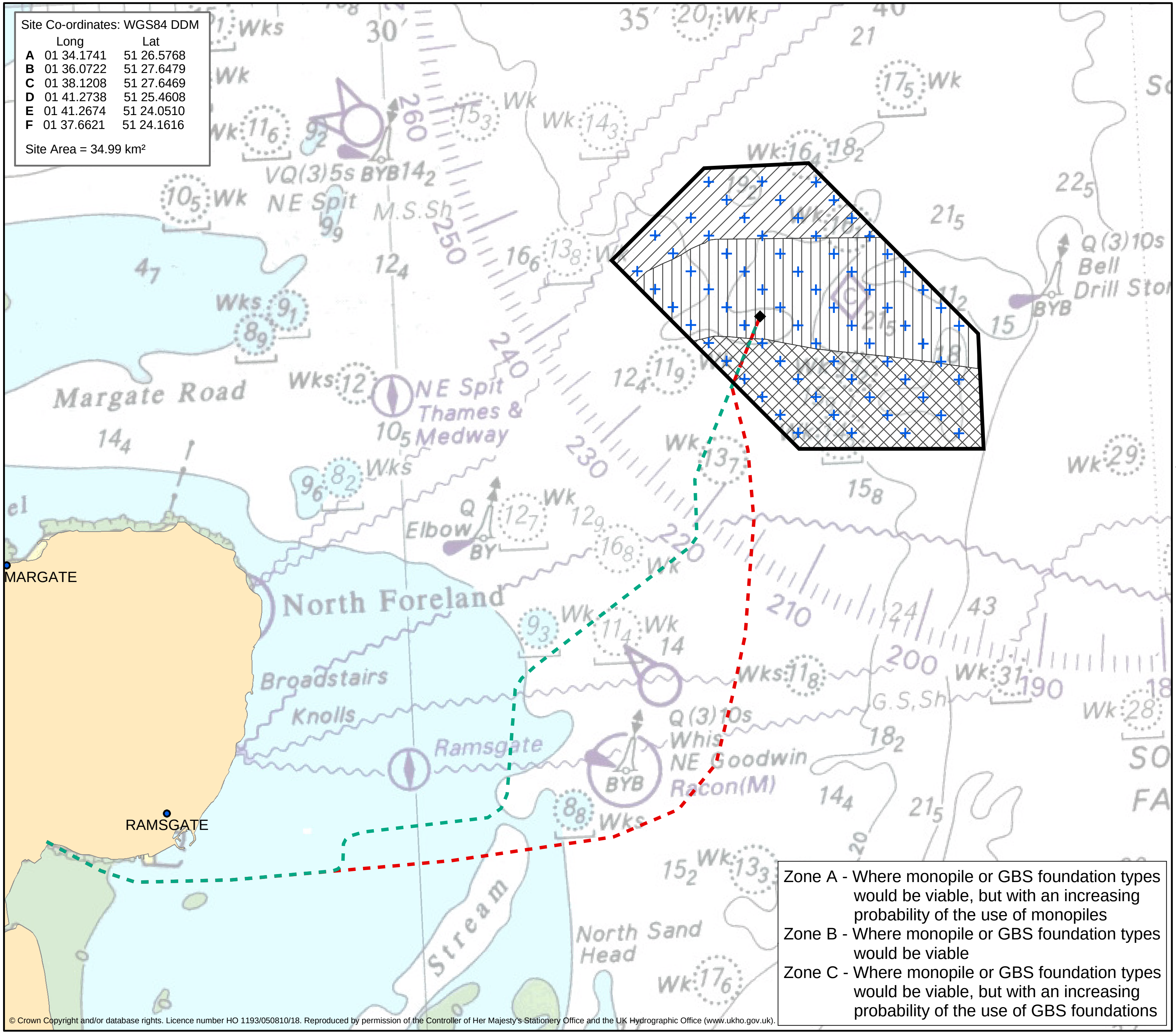

Site Co-ordinates: WGS84 DDM

	Long	Lat
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B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

Site Area = 34.99 km²

Zone A - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of monopiles

Zone B - Where monopile or GBS foundation types would be viable

Zone C - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of GBS foundations

Legend:

- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2
- Turbines x 71
- Offshore Substation
- Zone A
- Zone B
- Zone C

Title:

FOUNDATION TYPE OPTIONS ACROSS THE THANET OFFSHORE WIND FARM SITE

Project:

THANET OFFSHORE WIND FARM

Source: Main Chart - Not to be used for navigation.

Client:

THANET OFFSHORE WIND LTD

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SMG	SDG	9P5164/06/700

Date:	Figure:
25/10/2005	2.6c

Scale:	Revision No:
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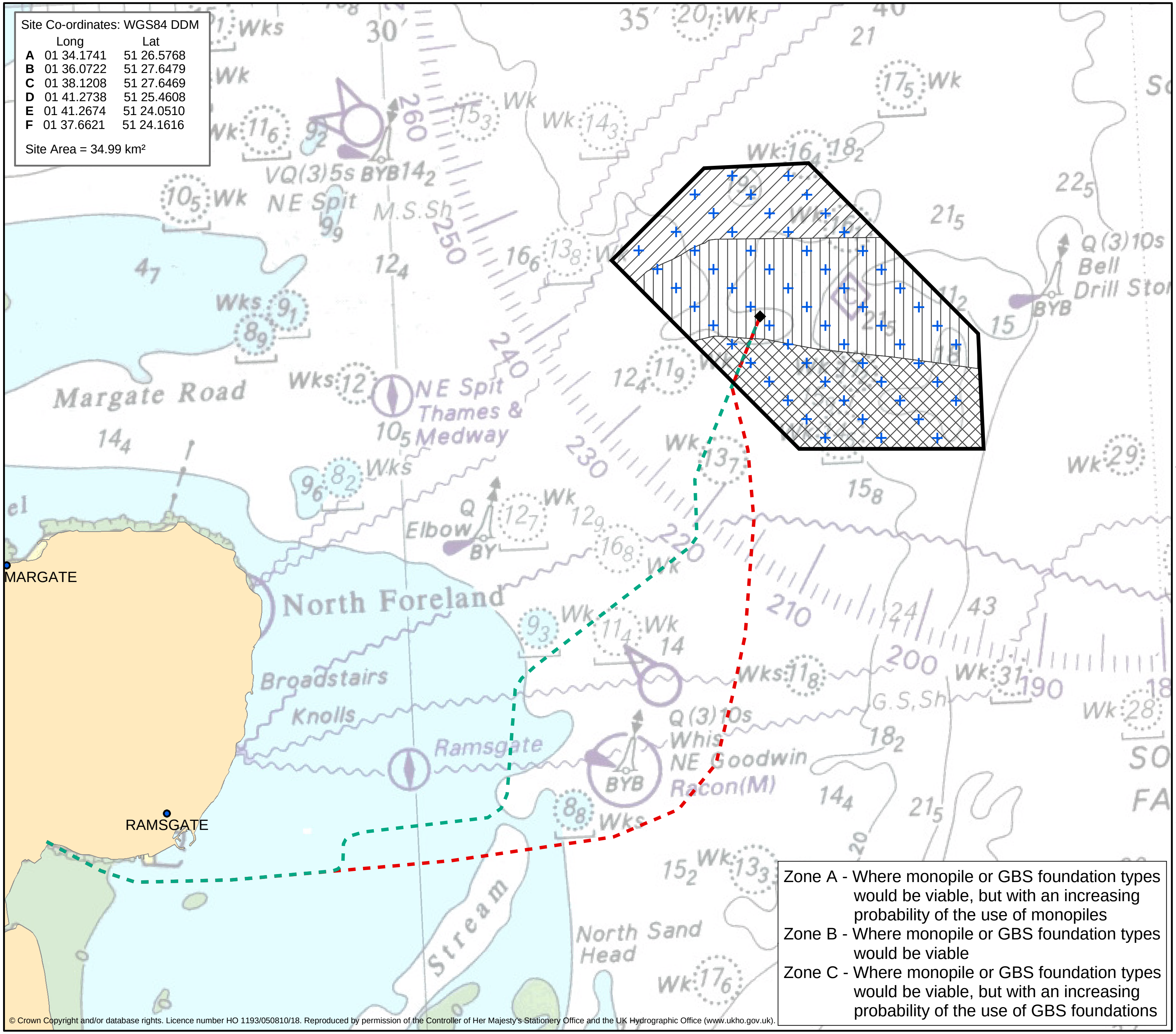
ROYAL HASKONING



Site Co-ordinates: WGS84 DDM

	Long	Lat
A	01 34.1741	51 26.5768
B	01 36.0722	51 27.6479
C	01 38.1208	51 27.6469
D	01 41.2738	51 25.4608
E	01 41.2674	51 24.0510
F	01 37.6621	51 24.1616

Site Area = 34.99 km²

Zone A - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of monopiles

Zone B - Where monopile or GBS foundation types would be viable

Zone C - Where monopile or GBS foundation types would be viable, but with an increasing probability of the use of GBS foundations

Legend:
- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2
- Turbines x 60
- Offshore Substation
- Zone A
- Zone B
- Zone C

Title:

FOUNDATION TYPE OPTIONS ACROSS THE THANET OFFSHORE WIND FARM SITE

Project:

THANET OFFSHORE WIND FARM

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Client:

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Drawn by:	Checked:	Drawing No:
SMG	SDG	9P5164/06/700

Date:	Figure:
25/10/2005	2.6d

Scale:	Revision No:
0 0.5 1 1.5 2 Kilometres	003

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The tower section supporting the turbine nacelle and the rotor is then attached to the monopile. The tower can be connected directly to the monopile via a bolted flange or more commonly, a transition piece is grouted onto the monopile to accommodate any out-of-vertical tolerances. The tower is then bolted to the top of the transition piece. If used, the transition piece would also normally carry the access platform and other ancillary equipment.

Monopiles are welded steel tubular sections, which rely on the sub-strata below the seabed to provide lateral resistance to horizontal forces generated by the environmental loading and to also support the dead and live loads, which the tower and wind turbine generate. The resistance for axial loading is gained from lateral skin friction between pile and sub-strata and the end bearing at the base of the pile and for lateral loading the resistance is gained by horizontal earth pressures acting on the vertical sides of the monopile.

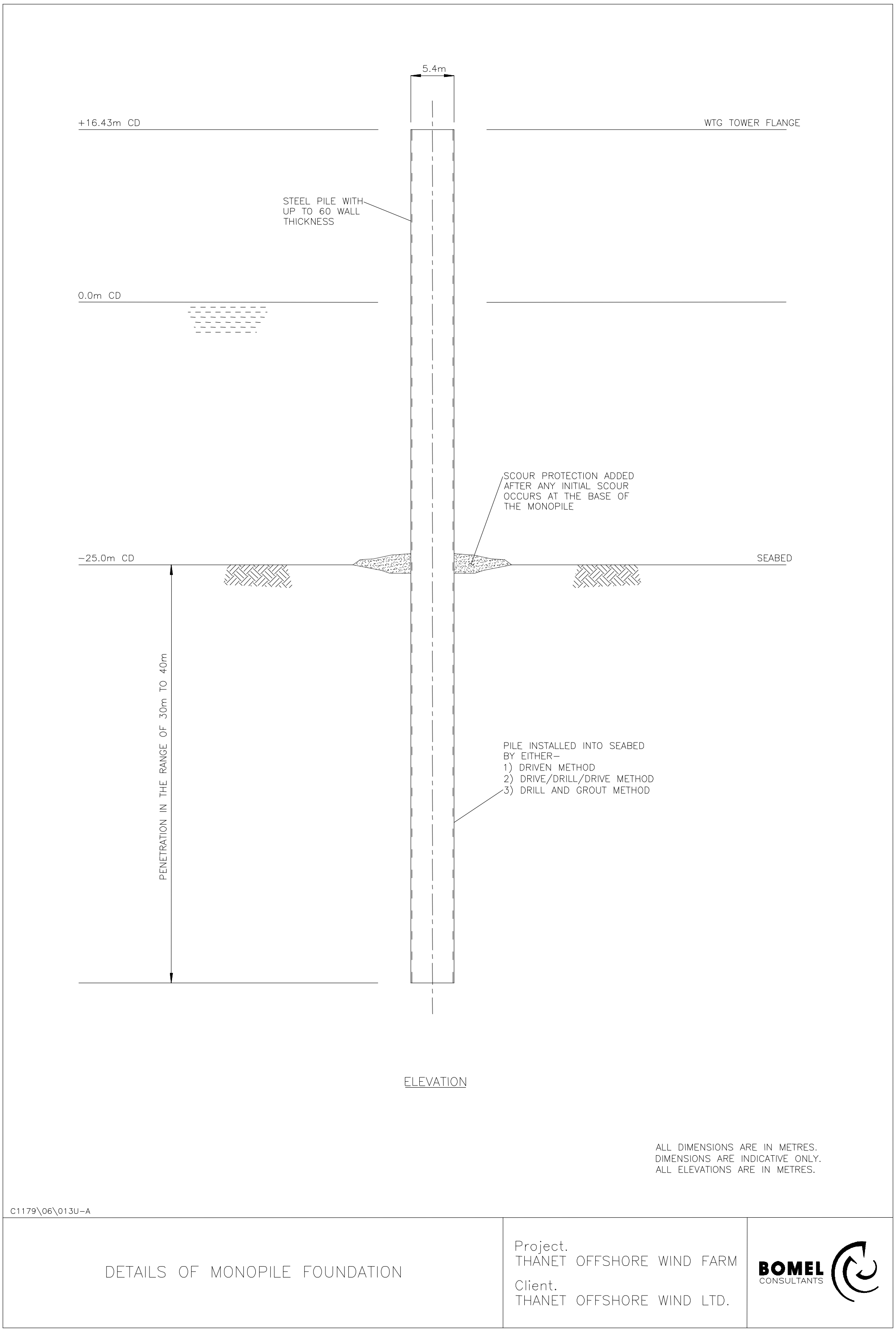
Figure 2.7 details an example schematic for a monopile foundation that would be used for the Thanet project. All dimensions are indicative at this stage and subject to confirmation following the detailed design. **Table 2.3** below also provides indicative monopile dimensions for varying water depth and different turbine ratings.

Table 2.3 Indicative monopile dimensions

Water Depth (-m CD)	Turbine Rating	Pile Diameter (m)	Pile Wall Thickness (mm)	Depth of Seabed Penetration (m)
15	3.0MW	3.5 to 4.0	45 to 50	25.0
15	3.6MW	4.0	55 to 60	30.0
15	5.0MW	5.0	55 to 60	37.0
25	3.0MW	3.5 to 4.0	50 to 55	27.0
25	3.6MW	4.3	55 to 60	32.1
25	5.0MW	5.4	55 to 60	39.8

The monopile foundations would be fabricated and coated with a corrosion protection system, to be agreed with the regulators, at a fabrication facility, which would have large pipe rolling and welding facilities. The completed monopiles would then be transported by sea to the nominated construction port for the Thanet project. Alternatively, the completed monopiles may be transported directly to site on a transportation barge or directly by the main installation vessel.

Figure 2.7 Details of monopile foundation



2.4.2 Monopile foundation – installation methodology

There are two methods, which would be employed to transport the monopiles to the Thanet site, namely:

- Floating transportation procedure; and
- Direct lift procedure.

Transportation method – floating transportation procedure

The monopiles are made buoyant for the floating transportation procedure. An inflatable seal is used at the toe of the pile and the top of the pile is sealed by the lifting head, which also acts as a tow head for the tow phase. The monopile is then towed to site using a tug, after having been lifted into the water using a quayside crane.

On arrival at the installation site, a lifting line is attached to the lifting head at the top of the monopile and the monopile is prepared for lifting. The tug that towed the monopile to site would assist in keeping the monopile on station (see **Plate 2.1**).

Plate 2.1 Monopile immediately prior to upending

The monopile is then upended using a combination of controlled ballasting and lifting to ensure stability and positioned in a pile guiding or pile gripper system. These systems are used to guide the monopile to the pre-defined location on the seabed whilst maintaining verticality. **Plate 2.2** shows a monopile held in place vertically by a set of pile grippers on the installation vessel.

Transportation method – direct lift procedure

An alternative procedure to that outlined above is for the monopiles to be lifted from the quayside onto a transportation barge, which is used to transport the piles to the offshore site. The monopiles are then lifted from the transportation barge by the crane on the installation vessel and pitched into the pile guiding system. It is also possible that instead of using a separate transportation barge, the installation vessel itself could collect the piles from the quayside of the nominated construction port and take them directly to site. A number of the larger installation vessels currently working in the offshore wind farm industry would be able to transport a number of piles in a single trip.

Plate 2.2 Monopile held in pile grippers

Installation method – drive/drill/drive method

The geotechnical conditions, which exist at the Thanet site, would make the drive/drill/drive installation method a viable option across the whole site for the offshore installation contractor.

Initially, the pile is allowed to sink under its own self weight and then it is driven into the seabed using a hydraulic hammer until a pre-determined refusal point is reached. The first refusal is gauged by the blow count and travel of the pile. The pile hammer is then removed and a drilling rig system is installed within the diameter of the monopile. Internal material is removed by the drilling process, therefore reducing skin friction on one face of the monopile, and a 'socket' is drilled down to a location 0.5m above the final design elevation of the monopile's toe. The drilling rig is then removed and the pile hammer placed on the monopile once again.

The cutting action of the drill bits would create cuttings or arisings during any drilling operation. These arisings are lifted from inside the monopile by the use of a suction pump unit. The arisings would probably be deposited into a cargo barge, moored close to the main pile installation vessel, ready for disposal. The monopile is then driven into the 'socket' until the required penetration is obtained.

Plate 2.3 shows a typical monopole drill rig.

Plate 2.3 Monopile drill rig

Installation method – drive only method

The geotechnical conditions, which exist at the Thanet site, would potentially make this installation method viable in the northern section of the site where the Woolwich and Thanet formations overlay the chalk strata. However, it is less likely that the monopiles could be driven directly into the chalk to the required penetration in the southern section of the site where the chalk is close to or at the seabed surface.

Driving is achieved by installing a hydraulically driven hammer on top of the monopile and then driving the monopile to the required depth of penetration in the seabed. The Installation Contractor would need to undertake detailed pile driveability analyses to ensure that the monopiles are driveable with the nominated pile driving hammer. The Installation Contractor may also elect to mobilise a drilling rig, as a contingency, so that if a monopile was to refuse prematurely, it could be drilled out.

Plate 2.4 shows a hammer being lifted onto a monopile ready to commence driving operation.

Plate 2.4 Pile driving hammer being installed on a monopile

Installation method – drill and grout method

A third installation option, which would be available to the Installation Contractor, would be the drill and grout method. In this scenario, an oversized socket is pre-drilled to the full depth of the pile. The amount of material removed would likely be in the range of $250m^3$ to $600m^3$ per monopile. The drilling arisings would be handled as per the same procedure noted for the drive/drill/drive method.

The monopile is then upended and lowered into the socket. The pile gripper system on the installation vessel then accurately holds the monopile vertical, whilst the annulus between the outer face of the pile and the socket is grouted using a structural cementitious grout, securing the monopile in place.

The grout would be a high strength structural grout, as typically used by the offshore oil and gas industry on a regular basis (Characteristic Compressive Strength @ 28 days ≈ $50N/mm^2$). The volume of grout typically required per monopile would vary between $60m^3$ and $120m^3$ depending on the final design size of the monopile.

2.5 Gravity Based Structures

2.5.1 Overview

A GBS would be constructed in steel or concrete and would sit directly on the seabed and relies on its mass and weight to resist the applied environmental and gravity loads. Sliding is resisted by friction, which is often enhanced by the provision of skirts around the structure's perimeter. These skirts move the friction plane downwards from the relatively weak mudline into a stronger undisturbed soil layer. The skirts also serve to ensure that any scour that may occur around the perimeter does not undermine the structure's foundation. GBS foundations have been used at the Nysted wind farm in Denmark. **Figure 2.8** shows a typical layout for a GBS, which would be used at the Thanet site. All dimensions are indicative at this stage.

Table 2.4 provides indicative dimensions for a GBS concept for the Thanet project, based on a preliminary engineering assessment.

Table 2.4 Indicative dimensions for the GBS concept

Water Depth	Required GBS Diameter for Turbine Size		
	3.0 MW	3.6 MW	5.0 MW
15m	25m	31m	36m
25m	27m	37m	41m

2.5.2 Gravity base foundation – installation methodology

A degree of seabed levelling may be required prior to the arrival of the GBS and this would be undertaken using dredging equipment with high resolution sonar to scan that the seabed is level after the intervention works and prior to the installation of the GBS. The volume of spoil would increase in proportion to the depth if a shallow pit were required. The volume of spoil removed could vary from 0 to 1,250m^3 per turbine depending on local conditions.

There are two installation methodologies, which would be used for the installation of a GBS foundation at Thanet:

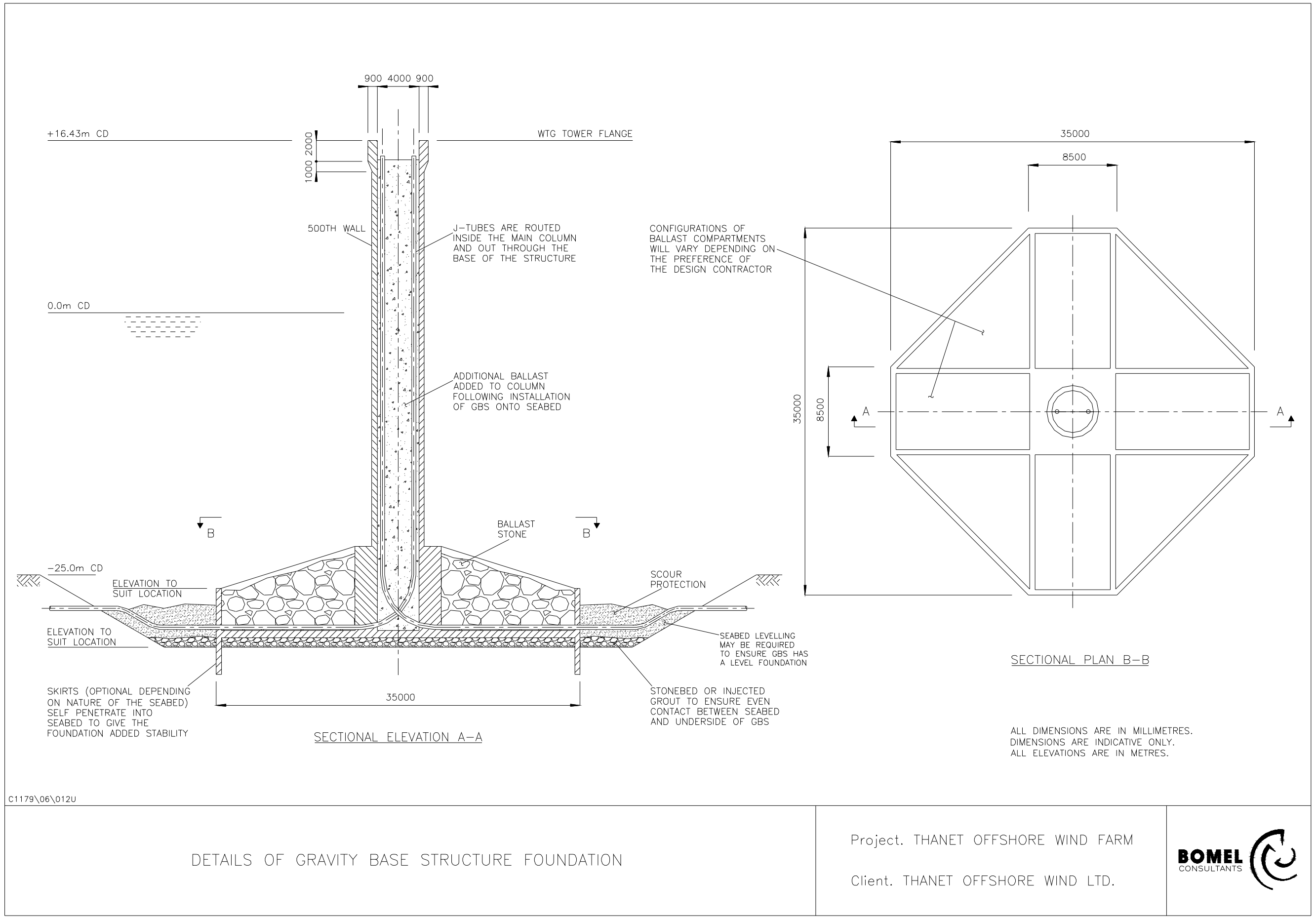
- Transported by barge; and
- Self floating tow.

Both methodologies are outlined in this section of the ES.

Installation method – barge transport

The GBS is loaded onto a cargo barge at the construction yard either by skidding or by using a quayside crane. The cargo barge would either have to be continually ballasted during a skidded loadout to maintain a constant horizontal trim, or the barge would be grounded on a temporary sandbank. It may be possible to load more than one GBS on the barge at a time, depending on the barge capacity. The GBS is then seafastened to the barge, prior to the barge being towed to the offshore work site.

Figure 2.8 Details of gravity base structure foundation



On arrival at the Thanet site, the GBS would be lifted by a crane on a heavy lift vessel (HLV). The HLV is likely to be either a specialist floating lift vessel or a large multi-leg jack-up barge. Both types of vessel would be equipped with suitable craneage to complete heavy offshore lifts. The GBS is then lowered to the seabed by the HLV. Once in position, and the GBS is confirmed as being stable, the rock ballast is placed in the base compartments of the GBS to give the foundation the required stability for the in-service condition. The ballast would be placed in the compartments by either a pumped or dumping procedure from a specialist rock placement vessel.

The amount of rock ballast required would vary depending on the size of turbine, water depth and density of rock material. **Table 2.5** provides indicative volumes:

Table 2.5 Indicative ballast volumes by turbine size

Turbine Size	Estimate of Ballast Volume (m^3)
3.0 MW	2,000
3.6 MW	3,500
5.0 MW	4,000

The rock is likely to be sourced from local quarries, if the density is not critical in the design of the ballast requirements. However, it is possible that heavier, more dense material, would be transported by barge from overseas for placement at the Thanet site.

It may be necessary to either pump grout or to use a gravel or shingle bed under the base, depending on the soil conditions encountered, to ensure an even and positive contact between the GBS and the seabed. The typical volume of material required to complete this procedure would be in the range $50m^3$ to $150m^3$ per GBS.

Installation method – self floating tow

The GBS would either be constructed in a dry dock, which is then flooded, or would be lifted from the quayside of the nominated construction base into the sea. The GBS would have adequate buoyancy tanks to ensure that it remained buoyant throughout the tow. The tanks may subsequently be filled with ballast after installation or removed.

On arrival at the Thanet site, the GBS structures would be positioned as described above.

It is possible that the self floating GBS would be transported and installed complete with tower, nacelle and rotors. However, the stability of the system would have to be carefully evaluated and monitored during the transportation and installation phases as the concentration of loading at a height above sea level on the end of a long slender structural element i.e. the tower, provides significant technical problems.

2.5.3 Scour protection

Scour would occur at the Thanet site, depending on the availability of mobile material on the seabed, as a consequence of strong seabed currents moving sediments adjacent to the foundations. The installed structures would interfere at a local level with the normal flow of the current, causing turbulent effects, which can then wash out sediments leaving depressions around the structures. Scour protection would therefore need providing for any of the foundation types following installation.

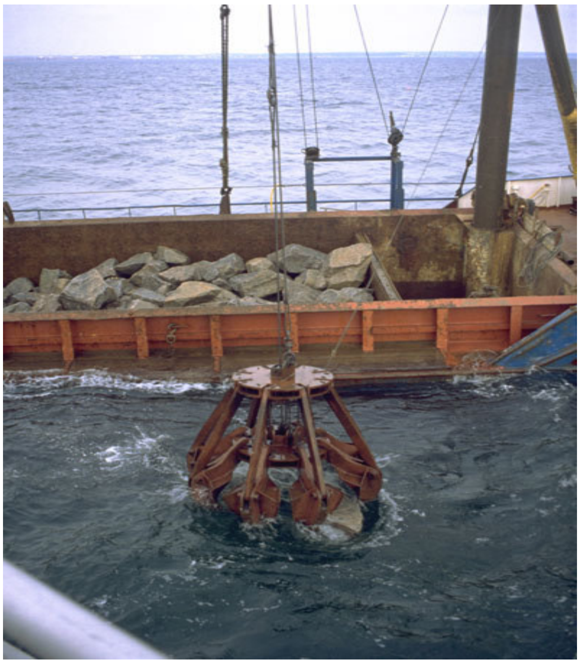
A preliminary assessment of the Thanet site has indicated that scour protection would be required at the locations across the site where recent marine sediments are found. According to the most recent geophysical survey, the recent marine sediments only partially cover the site. Where they are present, they are typically 1-2m in thickness with some localised pockets up to 5-6m in thickness.

The design of the foundations for the Thanet project would make provision for scour. However, it is often good practice to place scour protection material where scour has occurred to ensure the ongoing structural integrity of the foundation system is not compromised.

The following procedure would typically be adopted to install adequate scour protection at Thanet, should scour protection be deemed necessary:

- A bathymetric survey would confirm the seabed profile adjacent to the foundation structure immediately following the installation of the structures.
- The base of the structures would be resurveyed after a period of two to three months to ascertain the degree of scour that has occurred. The scour is assessed and a decision taken on whether scour protection is required.
- Rock or slate would be deposited at the base of the foundation structures. The rock placement would infill any scour pit, which may have developed, as well as building a profile above the seabed, referred to as a rock berm. The rock berm would be designed to remain stable for the full life of the structure under all forms of predicted environmental loading.
- The rock or slate would be placed by a vessel using a side tipping system or placed using a grab device as illustrated in **Plate 2.5**.
- The rock or slate would be resurveyed at the base of the structure to confirm that the required coverage and rock profile has been achieved.

Plate 2.5 Placement of rock for scour protection



2.6 Turbine Support Structures

2.6.1 Introduction

This section of the ES addresses the component of the offshore wind turbine structure, which connects the foundation unit to the tower supporting the wind turbine. There are two options, which could be used:

- Flanged Connection Option; and
- Transition Piece Option.

2.6.2 Flange connection option

The flange connection option allows the tower section of the offshore structure to be connected directly onto the top of the foundation unit. If the foundation is a driven monopile, the flanged connection at the top of the monopile is protected during the pile driving operation by the use of a temporary insert piece.

The flanged connection would have a number of locator units, which would be fitted upon completion of the installation of the foundation unit. These would assist in aligning the tower section when it is lifted into place. Once all the connection bolts are installed, hydraulic bolt tensioning equipment would be used to ensure an even distribution of bolt load around the circumferential flange connection. Spherical washer sets would also be used to minimise any long term losses in bolt tension.

Auxiliary equipment, such as boat fenders, J-tubes and anodes, would normally be fitted to the substructure below the elevation of the connection flange before the tower is installed.

2.6.3 Transition Piece Option

A transition piece is a steel tubular section, which has a larger internal diameter than the outside central tubular diameter of the foundation, allowing the transition piece to be installed over the central tubular with an annular gap between the two. The transition piece is then connected to the central tubular by means of a structural grouted connection. The grout would be a high strength structural grout as typically used by the offshore oil and gas industry on a regular basis (Characteristic Compressive Strength @ 28 days ≈ $50N/mm^2$). The volume of grout typically required would vary between $3m^3$ and $10m^3$ per monopile. A flange is provided at the top of the transition piece to enable the tower section to be bolted into place.

The use of a transition piece allows for adjustment in the verticality of the tower section. It also has the added benefit of incorporating various auxiliary items such as boat fenders, J-tubes and access platforms. Additionally, in the case of the driven monopile, this approach ensures that the flange connection to the tower is not damaged during pile driving operations.

Transition pieces can be designed to have varying elevations in relation to the upper elevation of the foundation structure. However, commonly their upper elevation is at least 15m above mean sea level so that the platform, which provides access into the base of the turbine tower and needs to be above the highest wave crest, can be fabricated as an integral part of the transition piece.

Plate 2.6 shows two transition pieces being transported to the construction site at an offshore wind farm site.

Plate 2.6 Transition pieces in transit to the offshore work site

Plate 2.7 shows a transition being lifted into position over a monopile foundation.

Plate 2.7 Transition piece installation

2.7 Turbine Support Structure Ancillary Equipment

2.7.1 Introduction

This section details the ancillary equipment or appurtenances, which would be located on the turbine support structure. This structure consists of the foundation and the transition piece. The ancillary equipment is defined as:

- J-tubes;
- Access platform;
- Access ladders;
- Access system; and
- Corrosion protection systems.

2.7.2 J-tubes

The J-tubes are steel tubes that facilitate the installation of cables by providing a conduit through which the cables can be hauled. The J-tubes run from the cable termination points at the base of the tower, down the support structure and bend outwards in a 'J' shape terminating in a wide bellmouth at the seabed. A pull-wire is pre-installed through the J-tube, which is connected to the incoming cable during cable installation. This wire enables the cable to be pulled through the bellmouth, which prevents snagging, up through the J-tube to the cable termination points.

The number of J-tubes required at any given turbine support structure depends on its location within the array of wind turbines. Most structures would require two, whilst others require one or three.

J-tubes would either be located inside the support column, as illustrated in **Figure 2.8** for a GBS, or externally to the structure. Monopiles would usually have J-tubes external to the steel structure, as it is impractical to pre-install them either because of pile driving vibration causing damage or allowing free access to drill out the monopile if so required.

In all cases, the lower horizontal end of the J-tube may be extended to bridge over any area that may be susceptible to scour. This extended horizontal section may be hinged back vertically during installation to minimise the risk of construction damage. External J-tubes can also be configured so that in addition to acting as J-tubes, they also act as support structures for either boat fenders or ladder supports, although a final decision on this would not be made until the detailed design phase.

2.7.3 Access platform

Access platforms would be located at the interface between the bottom of the tower and the top of the support structure and may be used as a refuge by mariners in an emergency situation. These platforms provide access to the tower, a limited laydown area and may incorporate maintenance equipment, such as a winch. The platform is likely to be a minimum of 3m wide. This would increase to approximately 5m at the laydown area. Access to and from the platform is provided by vertical access ladders.

2.7.4 Access ladders

Between one and three vertical access ladders would be provided up to an intermediate landing above the splash zone. One or two further vertical ladders would then provide access upwards from the intermediate landing to the access platform. The ladders would be approximately 600mm wide with rungs at approximately 300mm centres.

The access ladders would extend downwards to below lowest astronomical tide (LAT) to provide access at all states of the tide.

2.7.5 Boat access system

Access for inspection, maintenance and repair works would most likely be by boat. The boat access system would be located such that it is on the lee side of the prevailing wind and waves. This is to minimise the periods during which it is not feasible to access the turbine structure due to bad weather.

The boat access system would either be a 'boat alongside' or 'boat bow on' access arrangement. The access system is likely to consist of two vertical boat fenders. For a ‘boat alongside’ system, the boat berths against the fenders side on allowing personnel to step onto the ladder, or for ‘boat bow on’, the boat gently pushes the bow into the gap between fenders again allowing personnel to step onto the access ladder.

Other more sophisticated systems may be considered during the detail design process, such as inflatable bridges, known as water bridges, or heave compensated systems. If these systems are used, some modifications to the appurtenances may be necessary.

2.7.6 Corrosion protection system

Two corrosion protection systems would be used on steel turbine support columns. Where a steel column is, or may be, exposed to air, a paint system would be used, the specification of which would be agreed with the regulators. Below the paint system, where the column remains continually immersed, a cathodic protection system would be specified.

It is probable that no corrosion protection system would be required for a concrete GBS.

2.8 Offshore Wind Turbines

2.8.1 Overview

A number of turbine models at varying ratings would be considered for the Thanet project. It is envisaged that the wind farm would consist of up to 100 wind turbines giving a maximum output of up to 300MW. The turbines being considered would be in the range of 3.0MW to 5.0MW units. Additionally, the turbines would operate within a range of wind speeds, typically starting at 3m/s and producing maximum power at about 15m/s. The turbines would normally stop rotating at wind speeds greater than 25m/s in order to avoid damage.

The projected life of the wind farm is 40 years of operation, after which time the site lease grants two years to complete decommissioning. It is likely that the wind turbines would be replaced after 20 years, although this would be subject to a further consents application at the appropriate time.

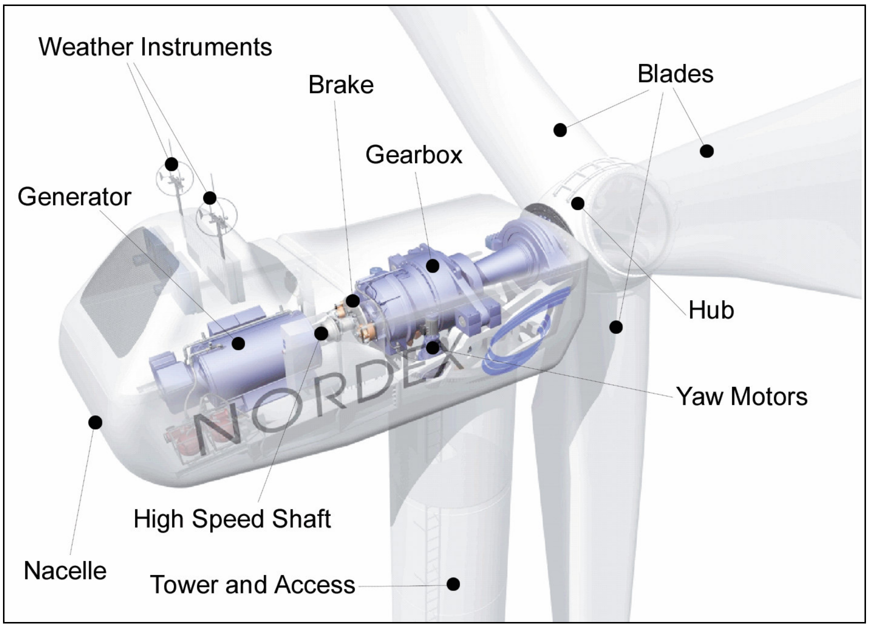
The turbines would consist of three primary components:

- The tower;
- The nacelle; and
- The rotor.

Figure 2.9 shows the typical components of a wind turbine.

These components would be delivered by water from the various manufacturers to either a nominated construction port close to the Thanet site, or the Offshore Installation Contractor may elect to collect the components directly from a quayside close to the manufacturing facility and then transport the components directly to the Thanet site. The latter option would only be feasible if a large construction vessel is used on the project.

Figure 2.9 Components of a typical wind turbine



(source: www.nordex.dk)

Any requirements for temporary or permanent works at the onshore construction base would be subject to a local planning application at the time, should this be necessary.

2.8.2 Turbine tower

The tower structure is the section of the structure, which connects the flanged connection at the top of the foundation unit or transition piece to the wind turbine nacelle. The tower structure is likely to consist of up to three tapering steel tubular sections, which are lifted into place and bolted together.

Plates 2.8 and **2.9** illustrate a typical installation sequence for the tower sections.

Plate 2.8 Tower section being lifted into position

Plate 2.9 Lower tower section connected to transition piece

2.8.3 Nacelle and rotor

The nacelle hatches would be capable of being opened from the outside to allow Search and Rescue personnel, such as a helicopter winch man to gain access to the nacelle if the occupants are unable to assist and when seaborne approach is not possible.

The installation of the nacelle and rotor requires the use of a heavy lift vessel because of the weight and the size of the items e.g. the nacelle and the rotor. In addition, the hook height for the crane to enable the items to be installed demands a high rated offshore crane. To achieve the required heavy lift at the required hook height, there are a number of specialist installation vessels working in the market, which could potentially be used, for example:

- Jack-up barges with heavy lift capacity;
- Resolution (MPI, Middlesbrough, England);
- Excalibur (Seacore, Helston, England);
- Jumping Jack (Mammoet Van Oord, Schiedam, Netherlands);
- Flat bottom vessels with heavy lift capacity;
- Rambiz (Scaldis, Antwerp, Belgium);
- Taklift 1 (Smit, Rotterdam, Netherlands); and
- Taklift 4 (Smit, Rotterdam, Netherlands).

There are two methods of installing the nacelle and rotor:

- The ‘Bunny Ears’ method; and
- Turbine blades installed individually.

'Bunny ears' installation method

Two of the three turbine blades are connected to the nacelle hub in the construction laydown yard, either at the nominated construction port or the manufacturing facility. The result looks like 'bunny ears', hence the method's name.

The nacelle, complete with two turbine blades, is then loaded out onto a cargo barge or the installation vessel and seafastened into position. The third turbine blade is separately loaded.

On arrival at the site, the nacelle complete with two turbine blades is lifted into place and bolted into position (see **Plate 2.10**). The third turbine blade is then lifted into position, pointing vertically downwards, and connected to the nacelle's hub.

Plate 2.10 Installing two turbine blades as 'bunny ears'

Turbine blades installed individually

The nacelle and the three turbine blades are loaded out as four individual components onto a cargo barge or the installation vessel and seafastened into position. On arrival at the site, the nacelle is lifted into place and bolted into position. The three turbine blades are then individually lifted into position and connected to the nacelle's hub.

2.9 Offshore Substation

An offshore substation would be located towards in the south west side of the Thanet site and would accommodate the transformers required to increase the distribution voltage (33kV) of the interturbine array cables to a transmission voltage of 132kV. Two 132kV export cables would then carry the power to the landfall location.

The offshore substation would have a topside structure, which would typically accommodate the following:

- Power transformers;
- Switchgear;
- Instrumentation systems;
- Uninterruptible power supply systems;
- Emergency shelter;
- Craneage;
- Anemometry equipment; and
- Utility and control systems.

The topside structure would be configured either as an open deck with modular equipment or as a fully enclosed structure. All weather sensitive equipment would be placed in environmentally controlled areas.

The support structure and its foundation are likely to be either a large monopile structure, or a small jacket structure. The small jacket structure is currently favoured, as it would allow the J-tubes, which contain various cables, including the export cables and link cables to the turbine arrays, to be 'shielded' and hence less vulnerable from any vessel impact throughout the lifetime of the wind farm.

Figure 2.10 shows typical configurations for offshore substations, which includes a monopile and the more likely option of a small jacket structure.

2.10 Anemometry Mast

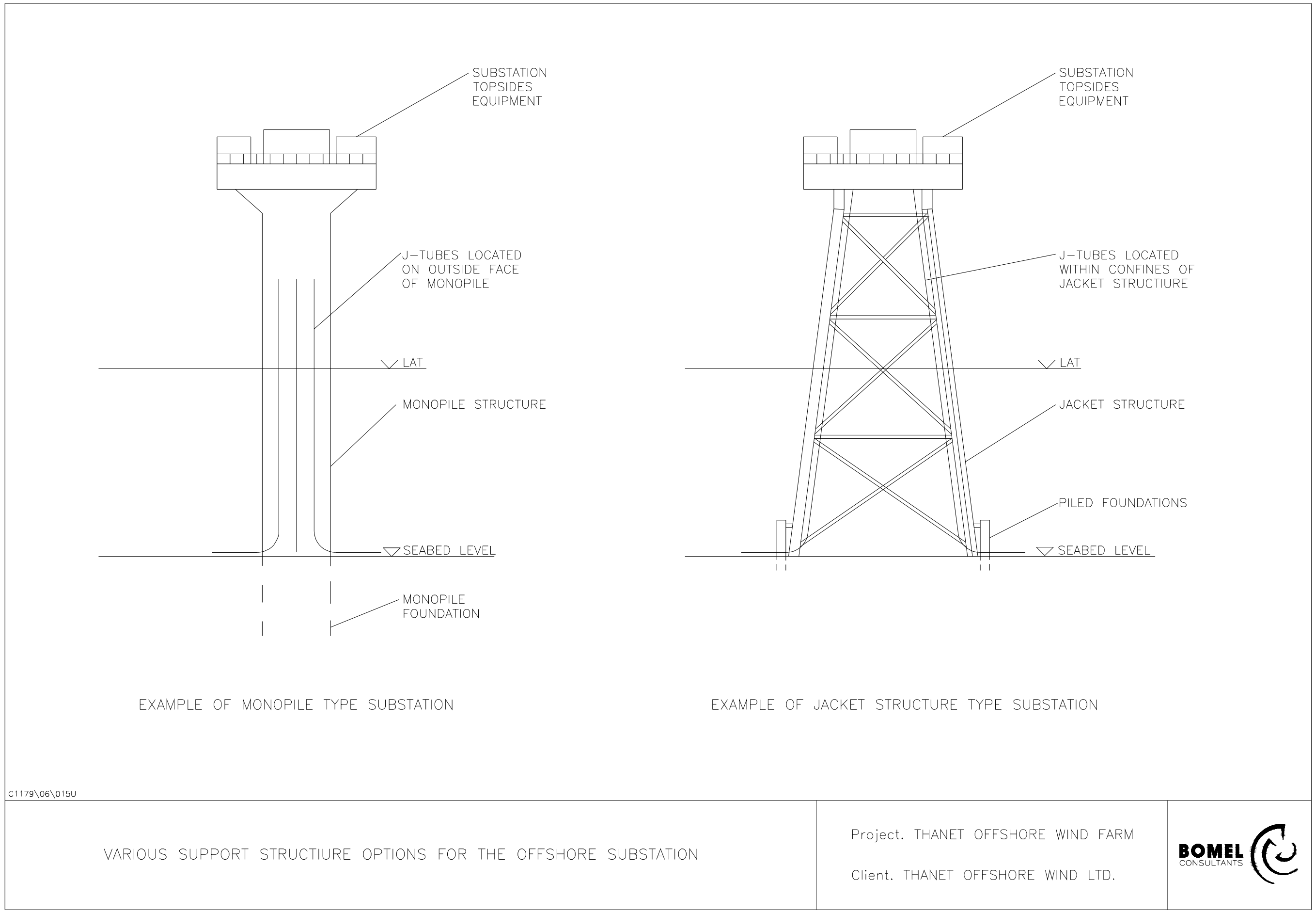
A single anemometry mast would be installed at the Thanet site to gather meteorological and oceanographic data, which is often referred to as metocean data. This data is used in the project design process to assess wind resource, to predict wind loading on turbines and other offshore structures, and to predict hydrodynamic loading from waves and currents on support structures. The data is also used during the operational phase, as the mast is an integral part of the wind farm's SCADA system. This is used to monitor and control the wind turbines remotely, and to enable operations and maintenance teams to predict weather conditions at the site.

The mast would consist of a lattice tower up to 100m above mean sea level, supported by a foundation, which is likely to very similar to one of the turbine foundations but of a smaller scale. Foundation weights, sizes, spoil and scour protection quantities are likely to be up to 75% of those for a turbine foundation.

The tower would be lifted into place using a crane on the installation vessel, and secured to the foundation using a bolted connection. The monitoring equipment would then be commissioned.

The location of the anemometry mast is shown towards the northwest side of the site, in order to receive a clean flow of air from the prevailing southwesterly winds, however, this would be subject to confirmation during the detailed design phase.

Figure 2.10 Typical configurations for offshore substations



Equipment on the anemometry mast is expected to consist of:

- Anemometers, wind vanes and other meteorological sensors at regular intervals up the mast, mounted on long booms;
- An integrated wave and tide monitoring system;
- A standalone solar charged power supply;
- An integrated data processing and logging system connected to a modem;
- A cage on the main platform to protect personnel and equipment;
- Twin access ladders; and
- Fall arrest safety systems throughout.

2.11 Interturbine Array and Substation Cables

2.11.1 Overview

The interturbine array cables connect the turbines into arrays and then connect the arrays together. These cables also connect the offshore substation to the turbine array. The cables between adjacent turbines are relatively short in length, typically in the range of 750m to 950m. However, the cables between the substation and the turbine arrays would be longer and possibly up to 3.0km long.

The interturbine array cables would typically be 33kV, 3-core copper conductors, insulation/conductor screening and steel wire armoured. The insulation would be either dry type XLPE, wet type XLPE or a combination of both. All cables would contain optical fibres embedded between the cores. A number of conductor sizes would be used, depending on the load current that the cable is required to carry. The range of indicative cable conductor sizes and overall diameters that may be used are shown in the **Table 2.6**.

Table 2.6 Interturbine array cable details

Details	33kV Cable Type				
	95 mm²	240 mm²	400 mm²	630 mm²	800 mm²
Overall Diameter (mm)	89	104	127	143	153
Weight (kg/m)	12.2	18.6	38	49	59
MVA (approx)	18	29	36	44	48

An indicative total accumulative length for interturbine array cables is currently calculated to be between 40km and 80km. Target depth of burial for these cables would be 1m.

2.12 Installation Method Statements

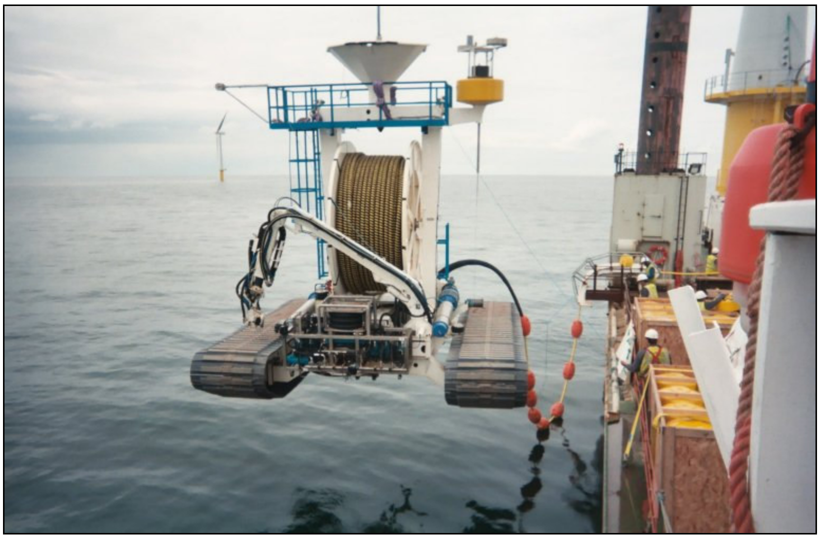
The following Method Statements set out the likely sequence of installation for the interturbine array cables:

- A cable barge or a specialist cable installation vessel would be mobilised to the Thanet site. The cables are likely to be supplied on cable reels because of the relatively short individual lengths of cable involved in the interturbine array installation work.
- The vessel transits to site and takes up station adjacent to a turbine structure and either holds station on dynamic positioning (DP) or sets out a mooring pattern using anchors. A cable end is then floated off from the cable reel on the vessel towards the wind turbine structure and connected to a pre-installed messenger line in the J-tube. The messenger line allows the cable to be pulled up the J-tube.
- The cable is then pulled up the J–tube in a controlled manner with careful monitoring. When the cable reaches the cable termination point, the pulling operation ceases and the cable joint is then made.
- The cable is then laid away from the J-tube towards the J-tube on the second wind turbine structure. The cable installation vessel would either move under DP control or by hauling on its anchors, redeploying the anchor pattern as required.
- If the cable is being buried simultaneously with the lay of the cable, this would be achieved with the use of a subsea cable plough. The mode of operation of a subsea cable plough is fully outlined in **Section 2.13**, which provides Method Statements for the installation of the export cables. Alternatively, the cable would be laid onto the seabed and buried later using a remotely operated vehicle (ROV) which is purpose built for cable burial.
- When the cable installation vessel nears the J-tube on the second wind turbine structure, the cable end is taken from the reel, ready for pulling up the second J-tube.
- The cable end is attached to the messenger line from the bellmouth of the second J-tube. A tow wire is taken from the cable installation vessel and connected to the messenger line at the top of the J–tube and the pulling operation is repeated in the same manner as was employed at the first J-tube.
- It is probable that a 'lay loop' of cable would be laid on the seabed close to the second J-tube to accommodate the slack, or overlength allowance, in the overall length of the cable as the final cable end is released from the cable drum.
- If the cables have been prelaid on the seabed they would then be buried using a specialist cable burial (Remotely Operated Vehicle). **Plate 2.11** shows the Global Marine 'Eureka' ROV, which is an example of this type.

Plate 2.11 Typical specialist cable burial ROV

- The cable burial ROV is launched and then positions itself over the cable to be buried. The ROV is likely to be a tracked vehicle and the ROV may have to deploy ramps temporarily onto the cable to allow the ROV to safely track over the cables without damaging the cable. Once in position over the cable, the burial process can commence.
- The target burial depth is likely to be 1m. Burial would be achieved using specialist burial tools, which are fitted to the ROV. Certain ROVs load the cable into a cable pathway within the vehicle to protect the cable during burial and have a failsafe cable ejection system should a power failure to the ROV occur. The ROV would continue to bury the cable from J-tube to J-tube.
- There is a further option to the above procedure, which involves using an ROV, which is fitted with a cable reel, which lays and buries the cable as it progresses. **Plate 2.12** shows an example of this type of ROV.

Plate 2.12 Example of a tracked ROV with dedicated cable reel for simultaneous cable lay and burial operations



- When the main burial operation of each interturbine array cable has been completed, it would be necessary to revisit the exposed ends of the cable lying on the seabed surface close to each of the J-tube bellmouth exit points.

Typically, these exposed sections are up to 20m long. There are four recognised techniques to protect these end sections of cable, which are outlined below:

- Option 1: Continue the rock dumping for scour protection or covering of J-tube exit point and rock dump an extended 'tail' for the 20m of cable on the seabed.
- Option 2: Use diver intervention with hand-held jetting lances and air lift devices to manually excavate trenches close to the J-tube ends of the cable.
- Option 3: Use concrete mattresses, which are lifted and placed over the cable sections to protect the cables. This methodology is sometimes supplemented with the use of sandbags to stabilise the edges of the mattresses.
- Option 4: Use grout bags, which are placed empty over the lengths of cable and then inflated with structural grout. The grout then cures to provide an effective over cover protection system for the cables. This approach requires diver assistance.

2.13 Export Cables

2.13.1 Overview

The export cables transmit the electricity, which would be up to 300MW, from the offshore substation to the designated onshore landing point. The cable would be rated for a 132kV voltage. The cable is likely to be constructed with 3-core copper conductors, insulation and conductor screening, steel wire armour and XLPE insulated with a lead sheath. The copper conductor size is currently estimated at between 300mm^2 and 1,200mm^2. The cables would contain optical fibres embedded between the cores. The range of indicative cable conductor sizes and overall dimensions, which could be used, are shown in **Table 2.7**.

Table 2.7 Export cable details

Details	132kV Cable Type				
	300 mm²	500 mm²	800 mm²	1,000 mm²	1,200 mm²
Overall Diameter (mm)	185	193	214	227	232
Weight (kg/m)	58	68	88	100	108
MVA (approx)	127	157	187	200	233

It is anticipated that the Thanet project would have two export cables, which would connect the offshore substation towards the south west side of the wind farm site to the onshore landing point or landfall. The estimated length of each cable is approximately 24 to 26.5km, depending on the final route chosen, giving an estimate total length of offshore cabling of up to 53km. The target depth of burial for these cables would be 1m to 3m depending on localised seabed conditions.

The separation between each export cable is likely to be in the range of 10m to 50m. However, the cables would come together at the landfall in a fan shape in order to enter the onshore transition joint chamber, where the cables would be jointed to the onshore cable sections.

It is anticipated that each export cable could be installed in a seven to ten day period, assuming 24 hour working. Therefore, the total programme for the export cable installation would be of the order 14 to 20 days.

2.13.2 Export cable installation methodology

There are two methods by which the export cables would be installed for the Thanet project:

- Installing the cables from the wind farm to shore; or
- Installing the cables from shore to the wind farm.

Due to the lengths of cable involved, it is envisaged that the cables would be installed using a subsea cable plough, which would bury the cables simultaneously with the laying of the cable from the main cable installation vessel.

Burial for the export cables would be required in chalk strata for a significant proportion of the route. There are some overlying sediments along the route but these are typically only less than 0.5m thick. Therefore, to achieve burial to a target depth of 1m, burial into the chalk of approximately 0.5m would be required. The cable plough would be a 'rock ripping' type of plough in order to cut through the hard seabed substrate of chalk with flint. High tow tensions would be anticipated for the operation, but this method is preferred to a rock wheel cutter, which would only be used as a contingency, in the event that the chalk was too hard to be cut by a rock cutting plough. The added advantage of using a cable plough is that only minimal disturbance of the seabed occurs.

The cable would be stored in either a static cable tank or a powered cable carousel. The cable installation vessel would also be equipped with cable handling equipment to control the tension during the cable lay and to provide holdback to control the rate of cable payout. The cable installation vessel would also be the host vessel for the cable subsea plough with its own dedicated control system and launch and recovery system (LARS).

The cable installation vessel is likely to be a dynamic positioned (DP) vessel or a barge using a mooring pattern of anchors. The DP vessel would be self positioning, however, a barge would use up to eight anchors in a mooring pattern to control position and would haul against these anchors to move along the export cable route. The cable installation barge would also have to utilise pre-installed ground anchors at the shore for cable handling operations close to the shore. These barges are typically flat bottomed, which allows them to operate in very shallow waters and also to safely 'ground' on a receding tide.

The following procedure describes the typical methodology for a cable installation from the wind farm to the shore:

- The cable installation vessel with loaded cable transits to the Thanet site.
- The cable end is floated from the cable installation vessel towards the offshore substation structure.
- The cable is then pulled up the J-tube in a controlled manner with careful monitoring of cable tension. When the cable reaches the cable termination point, the pulling operation ceases and a strain restraint is connected to the cable end.
- The subsea cable plough is then launched from the cable installation vessel using the LARS and the simultaneous lay and burial of the cable commences with the vessel moving away from the wind farm.
- The plough cuts a narrow trench in the seabed, typically 250mm wide, and buries the cable to a target depth of 1m. The action of the plough lifts a wedge of soil, deposits the cable at the base of the trench, the lifted wedge then falls back onto the buried cable. This procedure results in minimum disturbance of the seabed, leaving a small 'scour' with no removal of any material from the seabed.
- The cable installation vessel stops as close as is practical to the shoreline and turns through at least 90 degrees to allow an easy exit for the end of the export cable to be pulled up the beach.
- The free end of the cable is then passed from the cable installation vessel and floated to shore where it is attached to an onshore winch. The onshore winch then pulls the cable up the shore to the onshore jointing chamber. Portable roller sets are often used to reduce friction on the cable as it is dragged over the sandy or pebbly beach.
- The subsea plough remains on the seabed during the cable pulling operation with the cable passing through it. Once the cable pull operation has been completed, divers enter the water and disconnect the tow line wire from the cable installation vessel and reconnect the towing cable to an onshore winch.
- The subsea cable plough is then pulled up the beach to the low water mark using the onshore winch, burying the cable in the process.
- When past the low water mark, the subsea cable plough ceases burial operations, the towing cable is released manually from the plough and the plough is pulled back towards the cable installation vessel where it is then recovered and made ready for the next cable burial operation.
- Any further burial of the export cable, which is required on the beach or shore section, is then completed by land based excavating equipment.
- With all installation and burial operations completed the cable joint is then made at the jointing chamber. This connection would have both a strain termination, in the event that any tension is introduced into the beach section of cable, as well as electrical and data transmission connectivity.
- A short section of cable would remain unburied from the J-tube on the offshore substation to the grading in point for the subsea plough burial. This section of

cable is usually protected at a later date using a ROV or by placing mattresses or rock over the cable section.

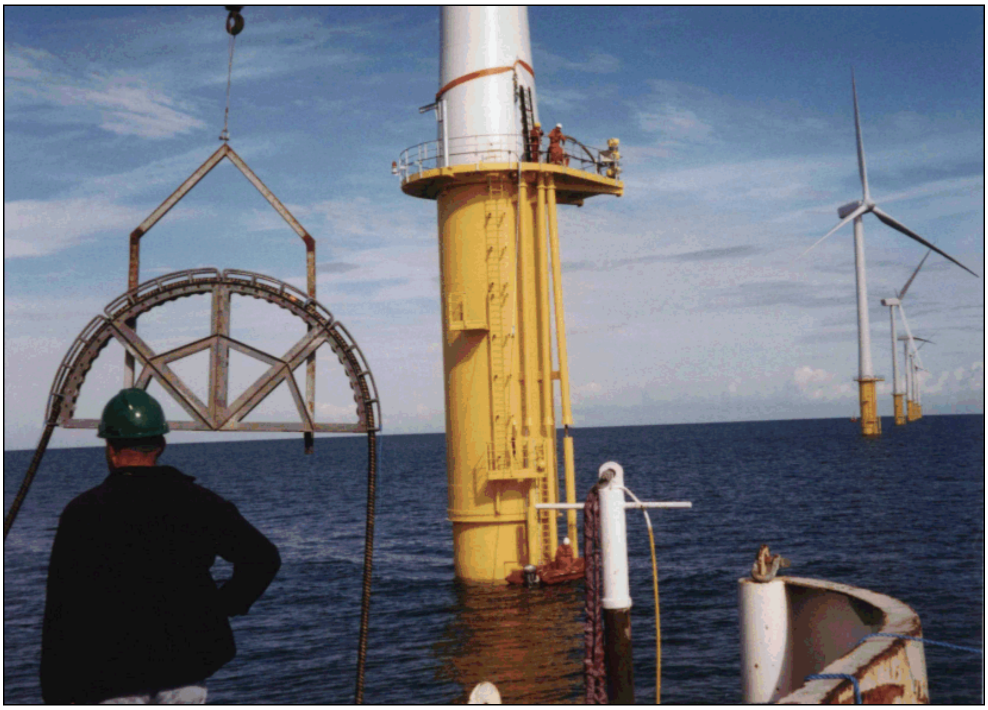
The alternative to the above procedure is to install the export cables from the shore landing point to the offshore wind farm and this alternative procedure is described below:

- The cable installation vessel arrives at a location close to the shore landing point approaching the shore at high water.
- The cable end is passed from the cable installation vessel and connected to a tow wire from an onshore winch. The cable end is then floated off from the vessel and towed towards the shore. When the cable end reaches the beach a series of portable roller sets are laid on the beach to reduce friction and allow the cable end to be pulled up to the cable onshore jointing chamber.
- The cable end is then secured with a strain termination at the joint transition pit.
- The subsea cable plough is then carefully deployed to the seabed using the LARS on the cable installation vessel. The cable installation vessel slowly moves away from the shore, establishing catenaries for both the tow wire to the subsea plough and the export cable.
- The subsea cable plough is then launched from the cable installation vessel using the LARS and the simultaneous lay and burial of the cable commences with the vessel moving away from the shore.
- **Plate 2.13** shows a cable plough burying cables at the shore being pulled towards the host barge, which has been deliberately grounded on the beach before re-floating at high tide and moving away to the wind farm, simultaneously laying and burying the subsea cable.

Plate 2.13 Subsea cable plough burying cable at the shore

- The plough cuts a narrow trench in the seabed, typically 250mm wide, and would bury the cable to a target depth of 1m.
- With the cable installation vessel at its closest acceptable position to the offshore substation, typically 50m to 70m away, the cable installation vessel recovers the subsea cable plough onto the deck of the cable installation vessel using the LARS.
- With the plough recovered on deck, the cable is then released from the cable pathway in the plough and the cable end is then floated off from the vessel towards the substation structure. A roller quadrant is often suspended from the crane on the cable installation vessel during this cable handling operation to facilitate safe and careful handing (see **Plate 2.14**).

Plate 2.14 Cable installation adjacent to an offshore wind farm structure



- At the substation, the cable is connected to the end of the messenger line exiting the J-tube's bellmouth.
- The cable is then pulled up the J-tube in a controlled manner with careful monitoring of cable tension and the complete operation.
- When the cable reaches the cable termination point, the pulling operation ceases and a strain restraint is connected to the cable end.
- This installation procedure would leave a section of cable unburied from the point of subsea plough recovery to the J-tube bellmouth. This section of cable is then buried at a later date using a post lay burial ROV, usually as part of the scope of work for the interturbine array cables.

2.14 Cable Crossings

A number of telecommunications cables to the south of the Thanet site would require crossing by the export cables, namely:

- UK to Belgium 5 (out-of-service);
- Pan European Crossing (PEC); and
- Tangerine.

The procedure for the out-of-service cable would require the section of cable to be located and a length removed to provide an adequate corridor for the crossing export cables. This procedure would be undertaken in accordance with guidelines set out by the International Cable Protection Committee (ICPC, 2004).

For the in-service cables, the following cable crossing procedure would be used:

- The optimum position to cross existing telecommunications cables would be confirmed following a localised survey of the potential crossing zone. The survey would also confirm the exact location of the cables, including the separation between them, the relative orientation of each cable and the degree of burial. A crossing area would be selected where the seabed is level and there is a reasonable degree of cover over the existing cables.
- Concrete mattresses would be laid across the telecommunications cables by a bespoke vessel, and divers would be deployed to ensure accurate placement. The mattresses could each weigh typically 10 tons in air and measure 5m x 3m x 300mm thickness. These would be foundation mattresses and their design would ensure stability under current loading and scour effects and guaranteed integrity for the design life of the wind farm.
- The export cables would then be laid over the mattresses, which would be followed by the laying of top protection mattresses. These mattresses would be laid along the line of the cable for at least a length of 50m. The top protection mattresses would typically weigh approximately 5 tons in air and would be 5m x 3m x 150mm thick.
- As the subsea cable plough would have to be recovered and then redeployed either side of the telecommunications cable crossing, there would be sections of cable left on the seabed that remain unburied either side of the end points of the top protection mattresses. These sections of cables require protection and the methods available include:
    - Burial using a cable burial ROV;
    - Extending the top mattress cover over the cable;
    - Using rock or slate dump over the cable sections; or
    - Using divers employing hand held jetting lances and air lift equipment.
- When all construction works have been completed, the crossing points would be resurveyed and the as-built condition forwarded to the telecommunications cable operator.

A detailed technical specification would be prepared as part of the legal agreement between TOW and the telecommunications cable operator. This specification would contain details of anchor zone exclusions together with a technical specification for the crossing detail. The technical specification would include as a minimum, stability calculations to show that any mattresses or rock used at the crossing point would maintain their integrity for the anticipated lifetime of both the telecommunications and offshore wind farm export cables.

2.14.1 Crossing the navigation approach channel

This section provides outline procedures for the installation of the Thanet export cables across the navigation approach channel into the Port of Ramsgate. The current navigation approach channel is understood to have a reference elevation of -7.5m CD (Chart Datum) and it is a requirement that the installed export cables have a reference elevation of -11.0m CD. By installing the cables to this reference elevation they would be protected from any future planned dredging operations along the approach channel.

It is understood that the current navigation approach channel from the Port of Ramsgate is approximately 110m wide with a nominal depth of 2m below current seabed levels. The channel also has side slopes, which increase the overall width of the channel to approximately 250m wide. **Figure 2.11** shows details of the navigation approach channel together with the line of crossing for the export cables.

Two options are presented to ensure that both of the planned export cables would be installed to a reference elevation of -11.0m CD.

Option 1 - pre-excavation method

This method requires an initial pre-excavation across the navigation approach channel before the export cables are installed. The two export cables would be buried using a subsea cable plough, or possibly a trenching vehicle, which would pass over the channel, simultaneously burying the export cables during the cable lay procedure. It is anticipated that the cable crossing corridor across the channel would be up to 50m wide and this section of the channel would be the only area subject to local excavation.

Excavation would either be achieved by use of conventional grab dredging equipment or by using specialised remotely controlled underwater excavation devices, which are used for localised excavation. **Figure 2.12** (Option 1) shows the profile of the anticipated locally excavated section. The local excavation would have the objective of lowering the seabed level from a reference elevation of -7.5m CD down to a reference elevation of -10.0m CD.

Following the completion of the local excavation, a subsea cable plough or trenching vehicle would then traverse across the locally excavated section cutting the 1m depth of trench and simultaneously burying the cable to this target depth during the cable lay procedure. This would then ensure a target cable installation to a reference elevation of -11.0m CD.

Figure 2.11 Details of export cable crossing point over navigation approach channel

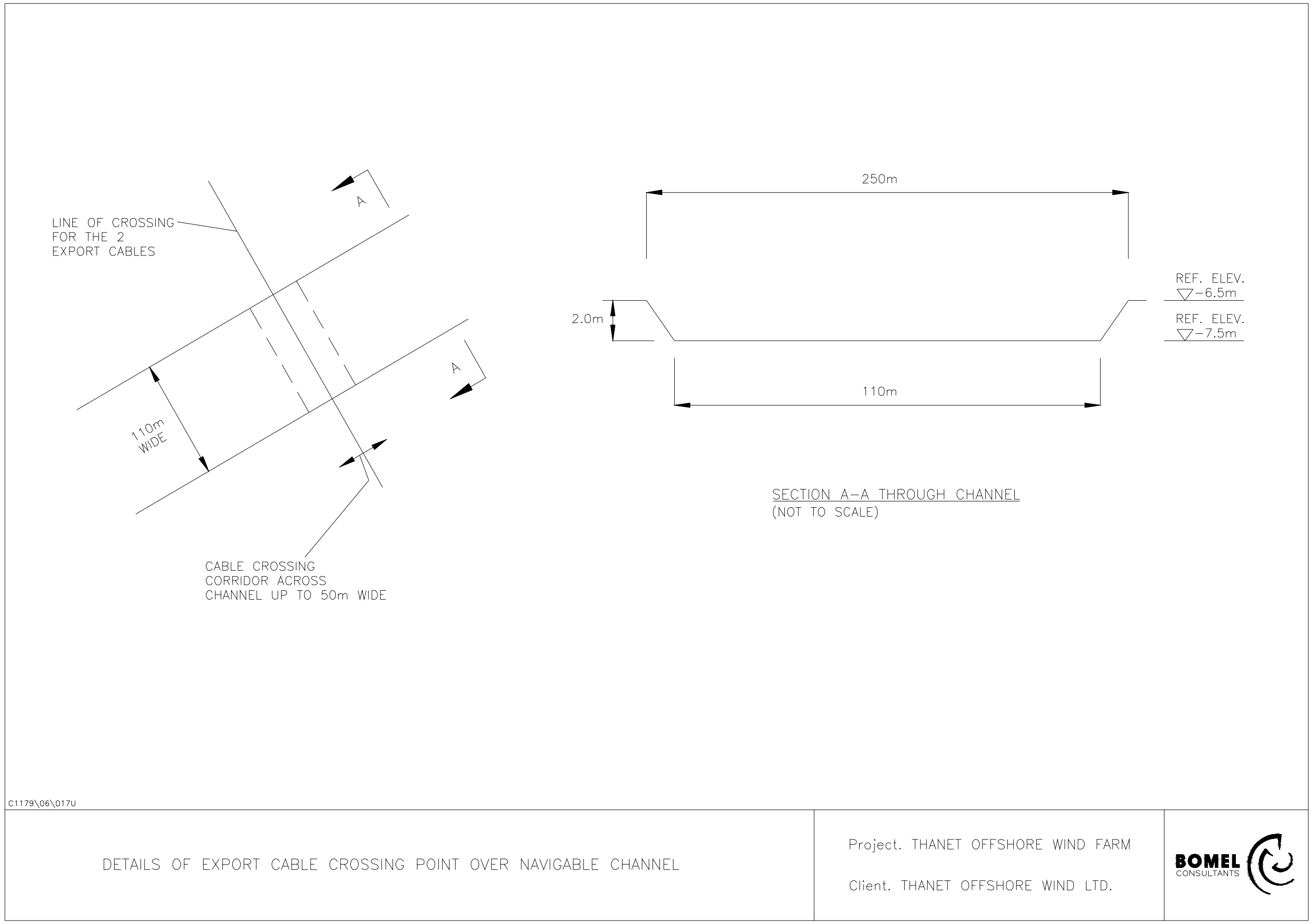
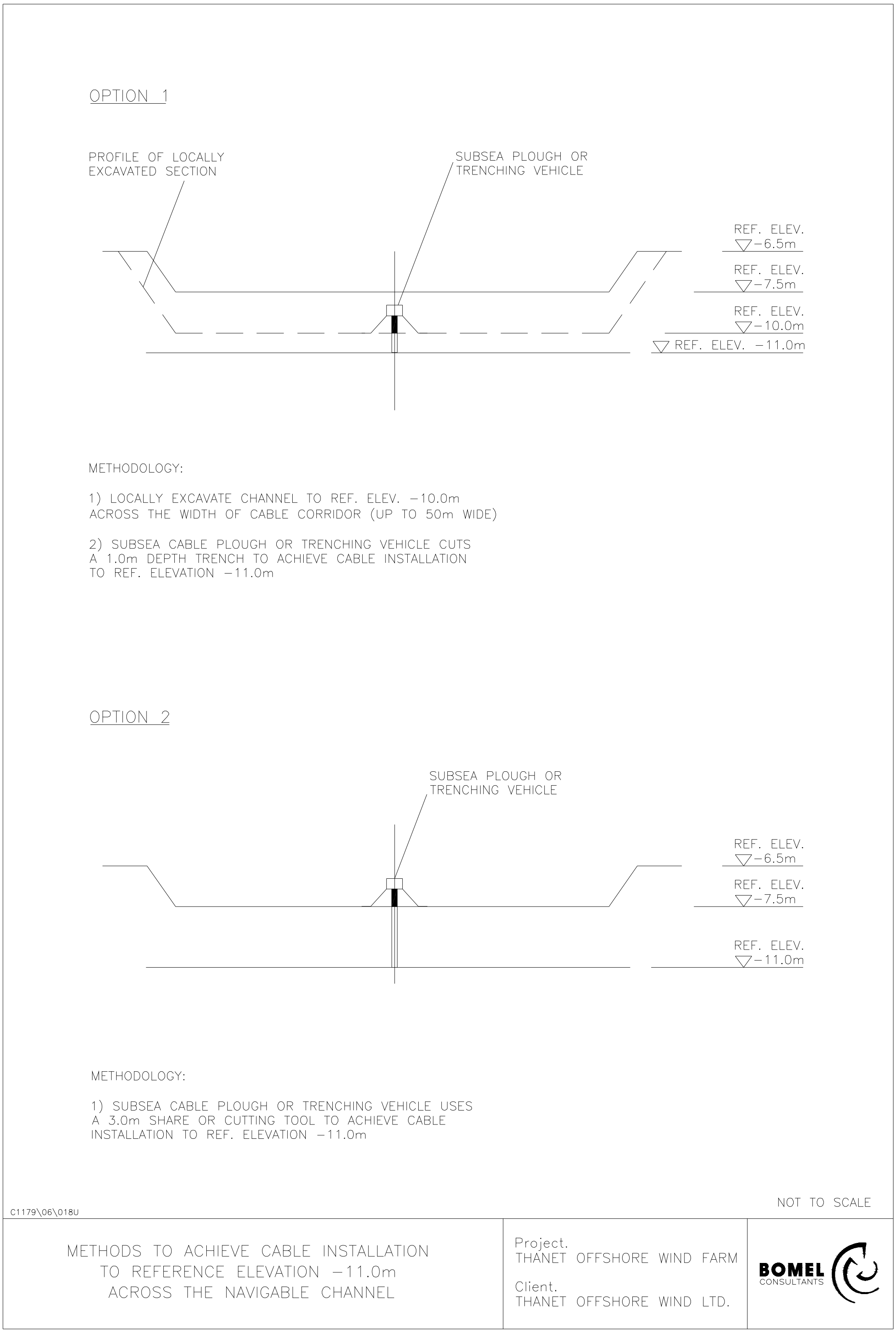


Figure 2.12 Methods to achieve cable installation to reference elevation -11m CD across the navigation approach channel



Option 2 – deep burial with subsea plough or trenching vehicle

It may be possible to utilise a subsea plough or trenching vehicle fitted with either a 3m depth of burial plough share or cutting tool in order to avoid any pre-excavation across the navigation approach channel. The burial device would be deployed to the full penetration depth of 3m when the plough or trenching unit traverses across the navigation approach channel, but would then revert to a target depth of burial of 1m for all other sections of the export cable route.

Figure 2.12 (Option 2) shows the concept of deeper burial either using the subsea plough or the trenching vehicle.

The likelihood of success of this methodology would be dependent upon the local geotechnical conditions. These conditions would be verified by local site investigation prior to any installation activities commencing.

2.15 Landfall Connection and Onshore Route

The proposed landfall connection for the two offshore export cables to the six onshore cables would be made at a joint transition pit located in an arable field above the former hoverport facility at the northern end of Pegwell Bay. The following options are under consideration for the landfall connection and are illustrated in **Figure 2.13**.

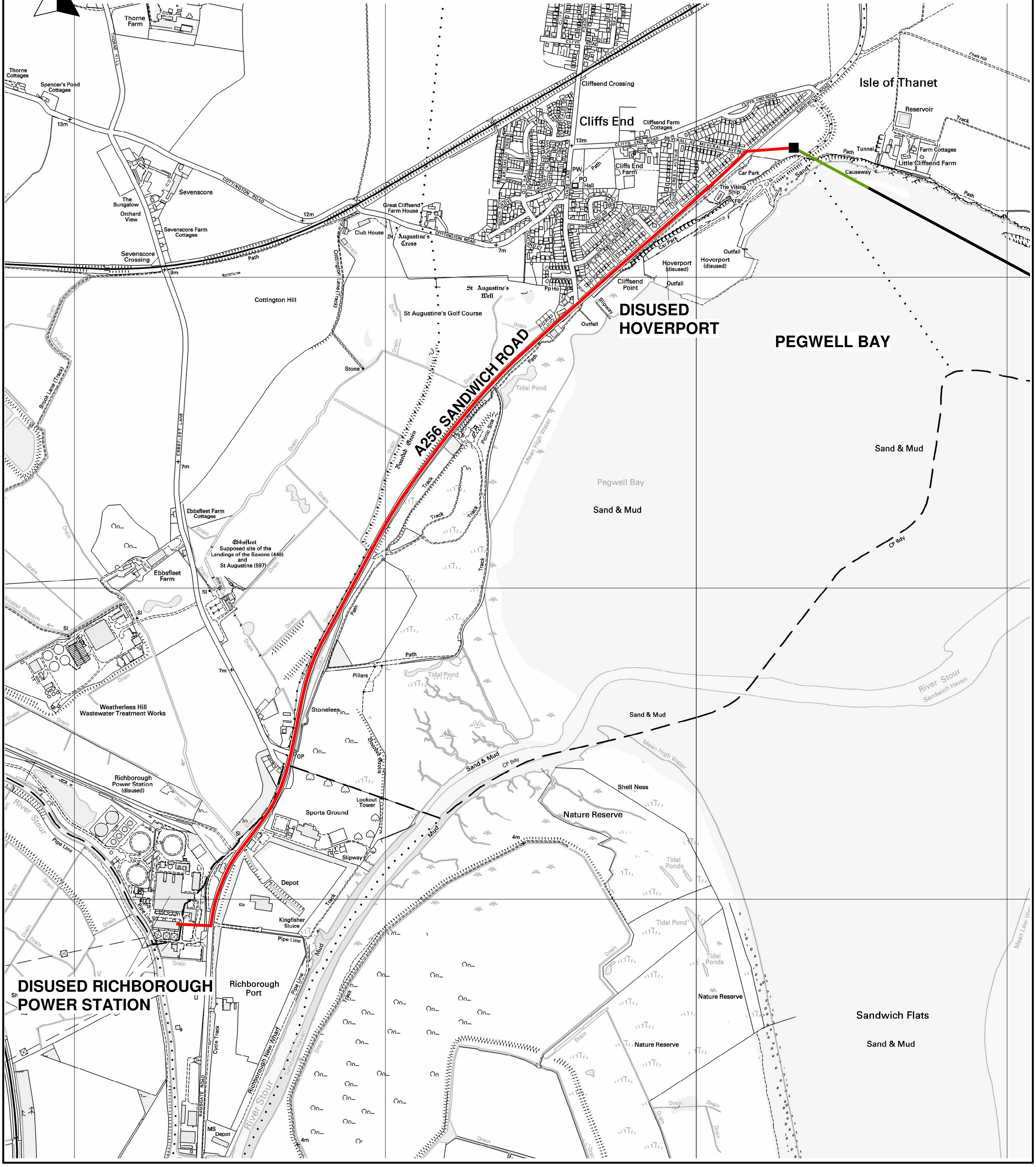
- The preferred option would be to route the cables via open cut installation across the beach and a short section of shoreline, along the bank and then routed into the joint transition pit at the top of the cliffs in a corner of the arable field.

- The alternative would involve directional drilling from the joint transition pit to a suitable exit point on the beach. Ducts would be installed along the line of the directional drill to allow the export cables to be pulled through and the joint made in the joint transition pit.

The joint transition pit would comprise an underground vault, approximately 7m x 6m in dimensions. Two locked manhole chambers would provide permanent access to the joint transition pit.

The onshore cable route would run from the transition pit up to the A256 Sandwich Road and along the carriageway to the existing EDF Energy substation at the disused Richborough Power Station. The six onshore single phase cables would be installed via an open cut method and be buried to a minimum depth of 1.1m. The total length of the onshore cable route is approximately 3,360m.

Landfall connection works in the area of the beach and joint transition pit are estimated to take approximately ten days.



Legend:	Title: CABLE LANDFALL AND ONSHORE ROUTE	Drawn by: MJM	Checked: CO	Drawing No:
Terrestrial Cable Route		Date: SEPT 05		Figure: 2.13
Joint Transition Pit	Project: THANET OFFSHORE WIND FARM	Scale: 1:12,000		Revision No:
Landfall Route				
Marine Cable Route				

Source:
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Client:
THANET OFFSHORE WIND LTD

ROYAL HASKONING

2.15.1 Installation of onshore cables

All activities other than access and cable storage during construction would be confined to a defined and demarcated working width. This would generally be up to 5m wide, although additional land may be required at certain locations such as road crossings and in the vicinity of the landfall to facilitate safe construction practices.

Following a detailed survey of the cable route and a full existing utilities and services search, a trench would be constructed using a conventional excavator. Rollers would be laid at the base of the trench and the cable pulled. Top and subsoil removed from the trench would be stored separately. Topsoil would be stored in such a way that it is not trafficked over by any machinery operating in the working area. The amount of vehicular traffic along the working width would be kept to a minimum to reduce compaction of the vegetation and underlying soil. In some areas, where ground conditions dictate, it may be necessary to provide additional protection, either through temporarily stripping the topsoil, or by the use of wooden 'bog-mats', which spread the weight of construction plant.

In some conditions, the cable may be laid onto sand or suitable backfill material to provide a degree of protection immediately around the cable. Cable tiles and tape would be placed above the cable before the sub and topsoil are replaced to provide protection and a warning against any third-party excavations. There may be surplus subsoil following the backfill of the trench and replacement of topsoil due to the presence of the cable itself, protective backfill and bulking of trench material. Surplus material would be disposed of at an appropriate licensed facility. The final stage is the restoration of the working area and the restoration of the ground in accordance with the landowner's and other consultees' requirements.

The working width would be fenced off in advance of construction where the cable route crosses agricultural or open land. Temporary access routes agreed in advance with the landowner would be established where required. In the case of the section along the public highway, agreement would be reached with the Highways Authority regarding the length of road that can be worked at any one time and traffic management would be established and rolled along as construction proceeds. All work in the highways would be carried out in accordance with the New Roads and Street Works Act (1991).

The onshore cable would most likely be delivered to site by road on cable drums, in 500m lengths. This would require up to 42 lorry loads to the laydown area over a period of four to six weeks. The possibility of delivery by sea is also being assessed and a final decision would be made during detailed design.

A temporary construction area to accommodate site offices, storage facilities, canteen, toilets and car parking would be required. The location would be chosen by the Cable Contractor and would be subject to a separate local planning application at the time.

2.15.2 Substation connection

The Thanet project is rated at 300MW, which enables connection to the network at Richborough Power Station with minimal work required. A 132kV Connection Feasibility Study has been undertaken by EDF Energy, which has identified two options for connection to the existing substation (ABB, 2005):

- Single circuit generator infeed via overhead busbar interface: This would require a small extension to the existing substation compound to accommodate the new equipment, the relocation of the existing internal site road, and the demolition of some minor structures associated with the disused power station (see **Drawing ABB/A178/M/001**); and
- Double circuit - Thanet tee: This would require the diversion of buried 33kV cables within the existing substation compound and the new equipment located adjacent to the existing overhead towers (see **Drawing ABB/A178/M/002**).

The existing 132kV control and relay room has sufficient space for both options but some civil works would be required adjacent to the existing substation on the existing hardstanding areas.

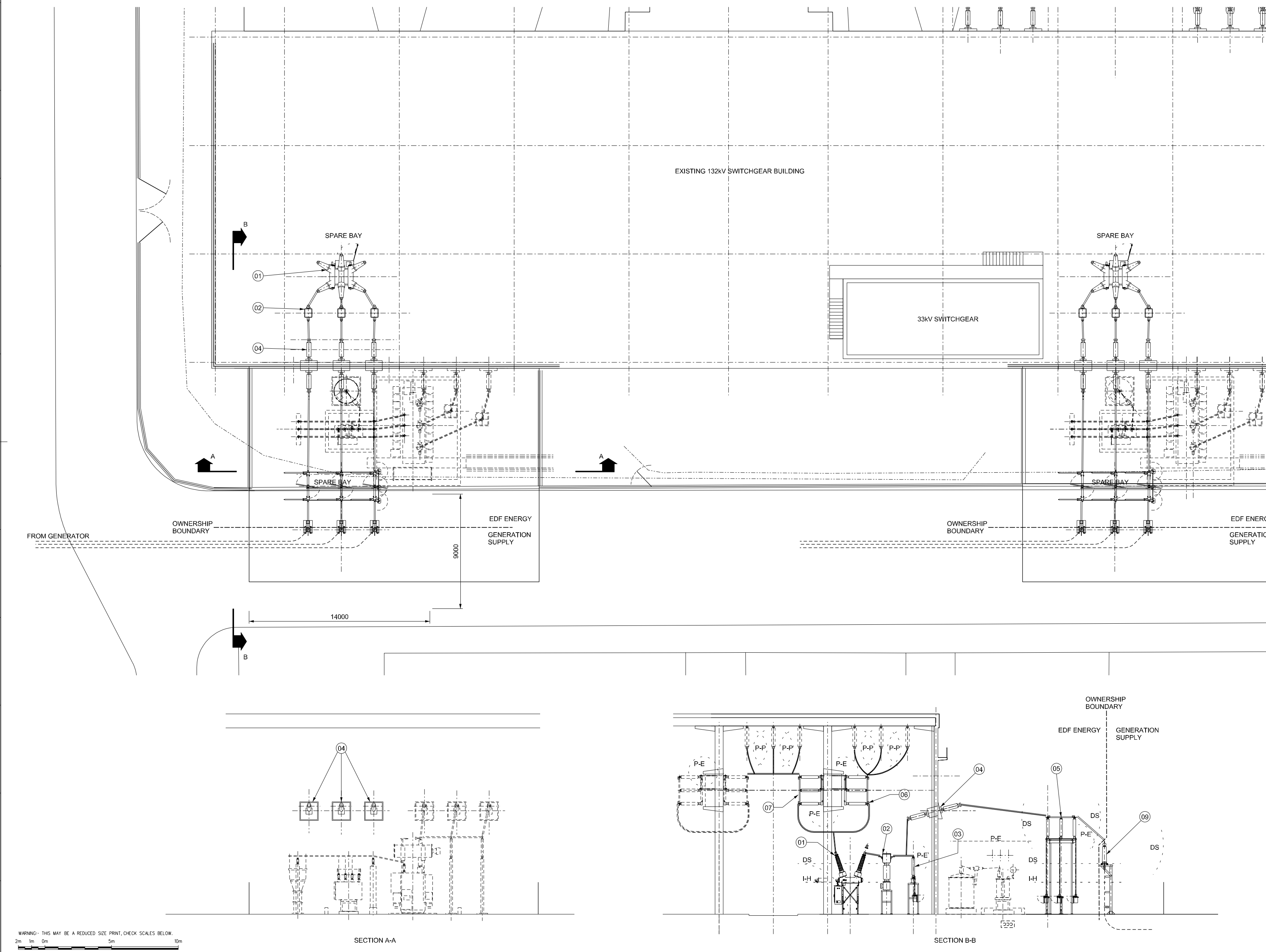
2.16 Commissioning

Following turbine installation and connection to the electrical and control systems, a process of testing and commissioning would be undertaken prior to the turbines being put into full active service. The responsibility for completing the full commissioning and testing schedule would be the responsibility of the Installation Contractor. The plan as developed by the Installation Contractor would include online commissioning / performance testing / reliability assessments of each wind turbine. In addition, the same plan would include the procedure for identification and rectification of any faults, scope and duration of testing, and an energisation plan for all of the turbines/arrays.

Wherever possible, onshore testing would be employed to minimise offshore commissioning activities and this would specifically apply to switchgear and transformers prior to them being shipped to the offshore site. The final commissioning activities would include the commissioning of the following system components of the Thanet project:

- Offshore substation;
- Interfaces with EDF Energy at point of grid connection;
- Offshore cable connections;
- Communications and SCADA systems;
- Electrical network;
- Protection systems;
- All associated equipment and components;
- Ancillary systems, such as navigation aids etc;
- Phased connections of turbine arrays; and
- Final energisation.

132kV SUBSTATION ELECTRICAL CLEARANCES AS TO NGTS 2.1		
I-H	INSULATION HEIGHT (PEDESTRIAN ACCESS)	2400mm
P-E	PHASE TO EARTH	1100mm
P-P	PHASE TO PHASE	1400mm
DS	DESIGN CLEARANCE FOR SAFETY (VERTICAL)	3800mm
DSH	DESIGN CLEARANCE FOR SAFETY (HORIZONTAL)	2900mm
IN GENERAL THE VERTICAL DESIGN CLEARANCE SHOULD BE APPLIED IN ALL DIRECTIONS UNLESS OTHERWISE AGREED BY NGC.		

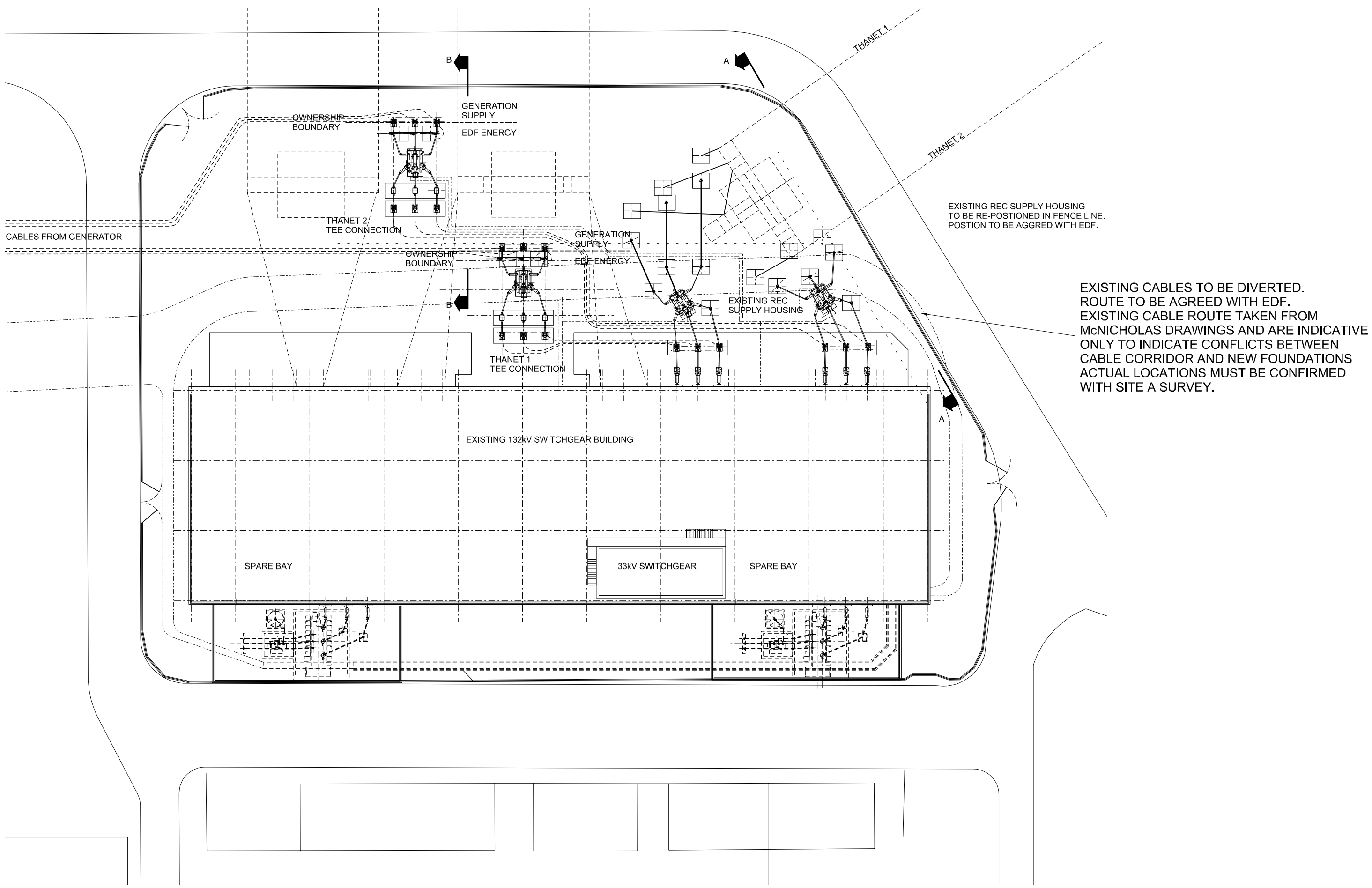


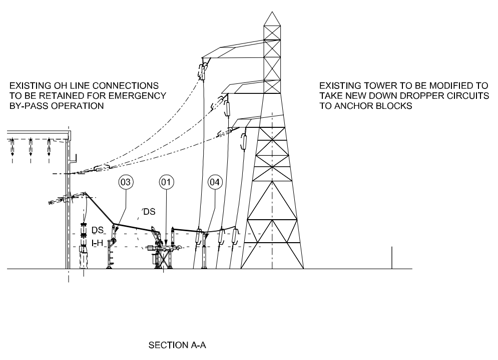
EQUIPMENT LIST	
REF	EQUIPMENT
01	132kV DEAD TANK CIRCUIT BREAKER
02	132kV METERING UNIT (HAM CT/VT)
03	132kV EARTH SWITCH (3 PHASE)
04	132kV THROUGH WALL BUSHING
05	132kV RCP DISCONNECTOR WITH 2 EARTH SWITCH
06	132kV RCP DISCONNECTOR WITH 1 EARTH SWITCH (HORIZONTAL MTD.)
07	132kV RCP DISCONNECTOR (HORIZONTAL MTD.)
08	
09	132kV CSE NOT EDF SUPPLY
10	

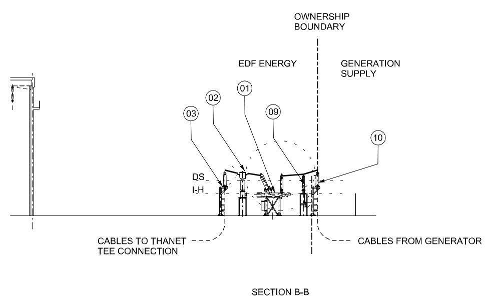
- ·-·-·-·- INDICATES EXISTING CABLE ROUTES
- - - - - - INDICATES EXISTING EQUIPMENT
- ——— INDICATES NEW EQUIPMENT

Rev.	Revision	Drawn	Chkd	Appd	Date
01	E/SW ADDED TO DISCONNECTOR COMPOUND SIZE REVISED FOR FUTURE TX INSTALLATION	TWB	SK	AW	20 AUG 05

Client Doc No: N/A				
Client: EDF ENERGY NETWORKS LTD			Client Ref:	
Project: RICHBOROUGH 132kV CONNECTION FEASIBILITY STUDY			ABB Ref: A178	
Site / Circuit: RICHBOROUGH 132kV SUBSTATION				
Prepared: TWB	Checked: SK	Approved: AW	Title: TENDER DRAWING PROPOSED GENERATION CONNECTION OPTION 1C-01 (LTB/DTB CB.)	Rev: 01
Date Approved: 18 JUL 05	Department: PTPS	Scale: 1:200 / Format: A0		Sheet: 01
ABB	ABB Limited		Drg No: ABB/A178/M/001	Cont: 00







132kV SUBSTATION ELECTRICAL CLEARANCES AS TO NGTS 2.1		
I-H	INSULATION HEIGHT (PEDESTRIAN ACCESS)	2400mm
P-E	PHASE TO EARTH	1100mm
P-P	PHASE TO PHASE	1400mm
DS	DESIGN CLEARANCE FOR SAFETY (VERTICAL)	3800mm
DSH	DESIGN CLEARANCE FOR SAFETY (HORIZONTAL)	2900mm

IN GENERAL THE VERTICAL DESIGN CLEARANCE SHOULD BE APPLIED IN ALL DIRECTIONS UNLESS OTHERWISE AGREED BY NGC.

EQUIPMENT LIST

REF	EQUIPMENT
01	132kV PASS MO CIRCUIT BREAKER WITH CT/DICONNECTOR/E-SW
02	132kV METERING UNIT (HAM CT/VT)
03	132kV CABLE SEALING END
04	132kV POST INSULATOR
05	.
06	.
07	.
08	
09	132kV 3 PHASE EARTH SWITCH
10	132kV CSE NOT EDF SUPPLY

INDICATES EXISTING CABLE ROUTES
INDICATES EXISTING EQUIPMENT
INDICATES NEW EQUIPMENT

Rev.	Revision	Drawn	Chkd	Appd	Date
01	OWNERSHIP BOUNDARY REDIFINED EXISTING CABLE ROUTES INDICATED	TWB	SK	BJ	20 AUG 05

Client Doc No	N/A
Client	EDF ENERGY NETWORKS LTD
Client Ref	
Project	RICHBOROUGH 132kV CONNECTION FEASIBILITY STUDY
ABB Ref	A178
Site / Circuit	RICHBOROUGH 132kV SUBSTATION
Prepared	TWB
Checked	SK
Approved	BJ
Date Approved	25 JUL 05
Department	PTPS
Scale	1:200
Format	A0
Title	TENDER DRAWING PROPOSED GENERATION CONNECTION OPTION 2A-01 (PASS-MO CB.)
Rev	01
Sheet	00
Dwg No	ABB/A178/M/002
Cont	00

ABB Limited

Suitable spares and consumables would be made available to the commissioning teams during the commissioning process to minimise the overall schedule for the works and any modifications that are made to the turbines during the commissioning process would be logged and recorded.

All commissioning activities would be completed with full regard to safety of personnel and equipment in support of protection to the environment.

2.17 Decommissioning

A full Decommissioning Plan for the project would be drawn up before construction commences. The Decommissioning Plan would take into account the legislation and best practice guidelines that are available at that time in connection with the type of facilities that are to be deployed.

The Decommissioning Plan would describe the methodologies to be used, any expected environmental impacts and would also describe what pre- and post-decommissioning surveying activities are being proposed.

The Decommissioning Plan would be submitted to The Crown Estate and relevant Government departments, including the Department for Trade and Industry, for comment and approval.

It is currently expected that the Decommissioning Plan would include for the complete removal of all offshore structures deployed in the wind farm above the seabed to ensure that no obstruction is left following decommissioning. This would include all turbines, the offshore substation and the anemometry mast.

The Decommissioning Plan would include for the complete removal of any gravity base structures that may have been used and the cutting of any monopile foundations to 2m beneath the seabed. It is expected that buried cables would be left in place in line with current practice.

The Decommissioning Plan would be regularly updated in light of any changes to legislation or best practice and in particular would be thoroughly reviewed as the wind farm approaches the end of its operational life. This review would probably include a full Environmental Impact Assessment.

2.18 Programme

Construction of the offshore wind farm would be completed in six stages, as follows:

- Prefabrication (structures constructed onshore);
- Transportation (structures floated or transported by barges);
- Offshore foundation installation;
- Interturbine cabling;
- Tower and turbine installation; and
- Export cables.

Construction of the landside infrastructure would be completed in three stages, as follows:

- Landfall connection works;
- Buried cable installation; and
- Substation extension works.

Construction of the offshore works is likely to take place primarily outside of the winter months due to the potential adverse weather conditions being outside of the safe operating envelope of the construction vessels. The offshore construction season may now extend from March to November each year depending on the vessels chosen by the Installation Contractor, when appointed for this project. Offshore construction works would be carried out on a 24 hour operations basis.

The construction of the onshore elements of the project can generally be undertaken at any time within the programme, however, due to the need to avoid the key season for overwintering birds; this is also likely to take place during the summer months. Onshore construction works would be carried out within normal daily working hours.

Whilst it is targeted that the Thanet project be constructed during a single season, it is acknowledged that this may extend to two seasons depending on a number of factors, including timing of consent award. The final decision on this would be taken once a contractor, or contractors, has been chosen and when further detailed engineering studies have been completed. Whichever programme is adopted; the project timetable will ensure that any seasonal restrictions on certain activities identified during the consenting process will be adhered to.

If a two season programme is adopted, the activities carried out in the first season are likely to include the installation of all foundations and transition pieces at the wind farm site and the installation of the anemometry mast. These structures will include all of the navigational aids required to ensure navigational safety, as laid down in the appropriate guidelines. The remaining construction activities and the full commissioning programme would then take place during the construction season in the following year.

Subject to the consents being received during the first half of 2006, it is currently intended that the Thanet project would be deployed in the following construction season or seasons, with electrical generation commencing either in late 2007 or late 2008, depending on a single or two season build programme.

It is proposed that for both programmes, the landside works would be completed in a single season.

2.19 Operations and Maintenance

2.19.1 Introduction

The wind turbines would be designed to operate unmanned and are expected to be available to produce electricity for at least 95% of the time. Deliberate outages for a turbine would be triggered mainly by routine maintenance requirements, but also occasionally at the request of Maritime Rescue Co-ordination Centre (MRCC) in support of Search and Rescue (SAR) activities in the area. The turbines are also normally shut down due to severe weather conditions, when wind speeds exceed 25m/s, to avoid damage to the generators.

2.19.2 Operation and maintenance activities

Operation and maintenance (O&M) of the wind farm after commissioning would largely comprise of routine minor maintenance and inspection visits to each turbine plus scheduled maintenance, normally expected once per year and timetabled for the summer months. Larger, unscheduled repair activities may also be required, especially in the early years of operation when any significant faults are likely to be detected.

The wind industry has seen steady improvements in turbine reliability and the ability to remotely monitor and control the operation of key equipment. This trend is expected to continue and would help minimise the number of visits needed to each installation, however, minor interventions and inspections are still expected to be more frequent in the early years of the operation, as minor faults are detected and remedied.

Access to each installation would be by boat with at least two service personnel being on each structure at any one time for safety reasons. In order to achieve the maintenance programme, it is anticipated that teams would be working simultaneously on several turbines, and it is therefore expected that at least two vessels would be on-station within the wind farm site when maintenance is being carried out, again for safety reasons.

The O&M Contractor, when selected, would decide in due course on the exact numbers of full time service personnel that would be required, their base location and the number and type of service vessels that are required to fulfil their obligations to TOW. Additional personnel would be brought in to cover major maintenance and repair operations as and when required. Any larger unscheduled maintenance or repairs, such as the replacement of a generator, is also likely to require additional service personnel and also specialist vessels.

All planned maintenance visits to installations in the wind farm would be carried out as day visits to the site. No facilities for overnight accommodation would be included at the wind farm, although emergency accommodation would be included on the offshore substation and emergency packs, containing bedding, food and water, would be included on each wind turbine and on the offshore substation in case crews are stranded at any time by unexpected weather conditions.

2.19.3 Operation and maintenance port and facilities

The O&M base should be located as close as possible to the wind farm site to minimise the time spent travelling to and from the site. This is particularly important as it is proposed that all visits would be completed as day visits. The port would need space for buildings, to house stores, a workshop and accommodate administrative functions, and alongside quay areas for the service vessels. Where necessary, a separate local planning permission would be sought for these onshore facilities.

The final choice for the location of the O&M port facilities would be made by the O&M Contractor, when selected, but it is currently expected that these activities would be based in Ramsgate.

The local O&M facility would be equipped with a chart indicating the Global Positioning System (GPS) position and unique identification number of each turbine within the wind farm, as required by the Maritime and Coastguard Agency (MCA)

It would be possible for each individual turbine to be remotely controlled from the O&M facility. This would enable turbines to be closed down in a pre-agreed orientation at the request of the MRCC in support of SAR activities in the area. These procedures would be tested on a regular basis, as required by the MCA.

Whilst the local O&M facility may not necessarily be manned on a 24 hour basis, procedures would be agreed with the MCA for shutdown in the event of an 'out of hours' incident. Furthermore, the wind turbines would also be remotely monitored on a 24 hour basis from the wind turbine manufacturer's control room.

2.20 Alternatives

Site location is invariably a compromise between a number of often competing issues. At the proposed Thanet site these include those relating to distance from the coast, and therefore visual impact, with the interests of maritime safety and the constraints of existing cable routes. All interests have been considered carefully and taken into account with due discussion with the relevant stakeholders at the scoping stage.

The wind farm site has undergone minor repositioning as a consequence of the investigations and consultations undertaken place as part of the EIA process. This was primarily to accommodate maritime safety requirements and proximity to existing cables, particularly those located to the north of the site.

In addition, the route of the offshore export cables has been relocated due to geophysical conditions along the route, cable crossings, and navigation requirements in terms of the navigation approach channel into the Port of Ramsgate. This relocation took place after the site specific surveys were largely completed, however, in most cases sufficient information had been already collected to evaluate impacts (see each relevant section for further details).

The location of the cable landfall has altered during the scoping and EIA process. The original route was proposed to pass along the bed of the River Stour, however, following discussions with the Environment Agency this option was discounted due to the likely unacceptable impacts to the river bed and its functioning. A second route, which took the cable landfall across the disused hoverport apron at Pegwell Bay, was also discounted due to the area comprising made ground, which is known to be contaminated.

An alternative export cable route was considered to the north, suggested because of the closeness to the landfall for existing telecommunications cables at Joss Bay, near North Foreland. This was intended to tie in to the existing electrical substation at Margate, however, a feasibility study undertaken by the local Distribution Network Operator

(DNO), EDF Energy, resulted in the preferred point of connection to the electrical network being the disused Richborough Power Station in Pegwell Bay.

Other potential sites for the wind farm were not available due to the constraints of the pre-determined strategic areas allocated by the Department of Trade and Industry (DTI) as part of their Strategic Environmental Assessment, and The Crown Estate as part of the tendering process for the Round Two offshore wind farm sites.