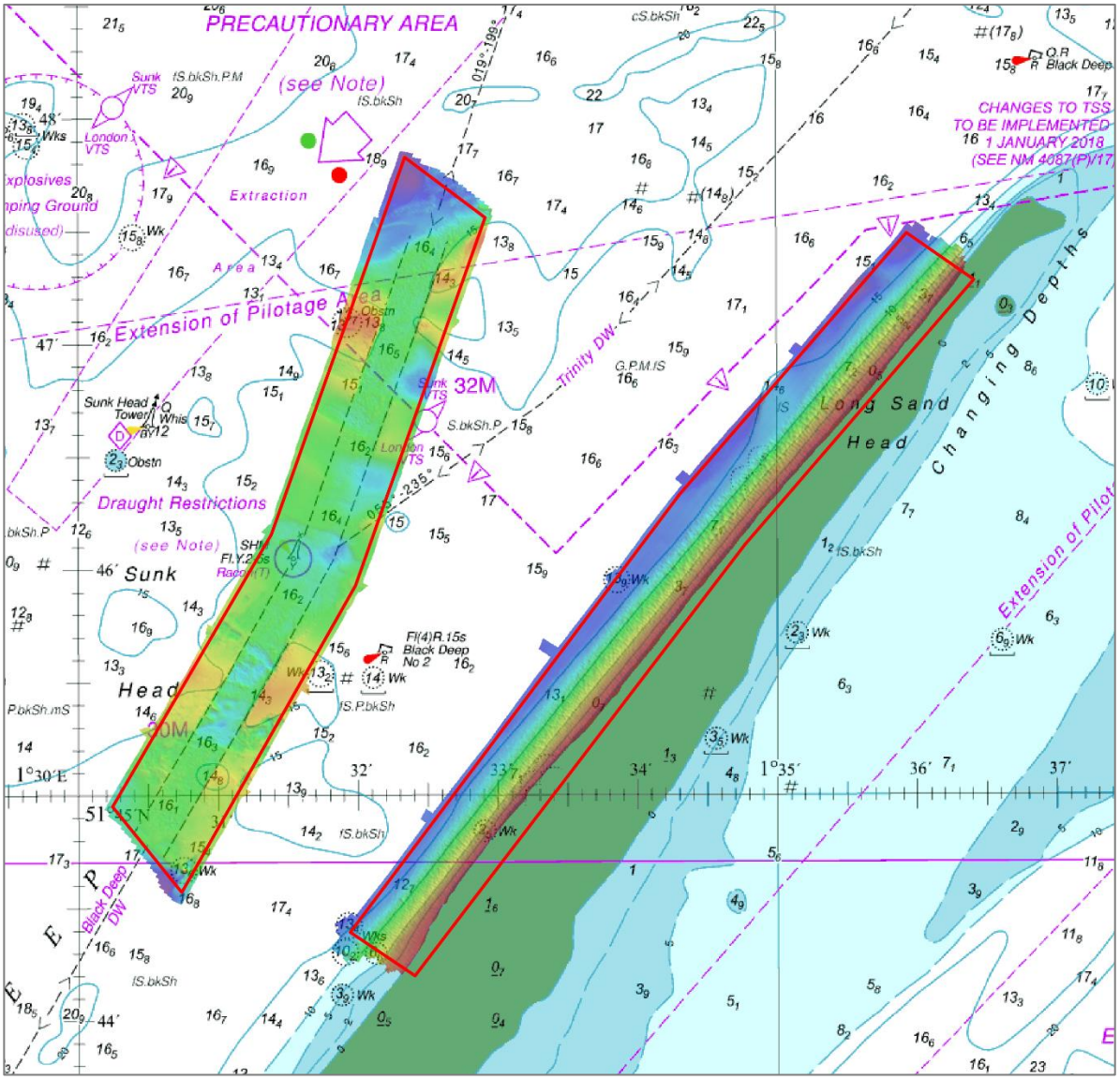
UK Hydrographic Office

Produced for: Maritime & Coastguard Agency

THAMES ESTAURY
BLACK DEEP (TE6A)
ASSESSMENT TE6A/2016-V3

An assessment of the 2016 hydrographic survey of the area TE6A: to monitor recent seabed movement; to identify any implications for shipping; and to make recommendations for future surveys.



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BLACK DEEP TE6A, 2016

1. EXECUTIVE SUMMARY

The Area and Recent Changes

1.1 The full area of TE6A is re-surveyed every 12 years, within which two focused areas are surveyed every 6 years. The 2016 focused survey for TE6A was originally programmed for 2017 but this was brought forward out of standard 6yr/12yr plan due to re-scheming.

1.2 TE6A lies at the entrance to Black Deep and is bounded by the banks of Long Sand to the east and Sunk Sand to the west. Sunk and Trinity Deep Water Routes (DWR) pass through TE6A and merge into Black Deep DWR. These form important approaches to the Thames Estuary and Medway for deep draught vessels.

1.3 The shoalest depths in TE6A are the drying heights along the top of Long Sand bank in Focused Area 1. The shoalest depth in Focused Area 2 is 13m, which is 0.3m shoaler than in 2012.

1.4 The western slope of Long Sand bank has migrated between 45 and 115m eastwards since 2011, and contains ripples up to 1m high (similar to that in 2011).

1.5 The vessel with the greatest registered draught transiting the Deep Water Routes was 16m, compared to a minimum depth of 13m close to Sunk DWR.

Reasons for Continuing to Resurvey the Area

1.6 To monitor the movement and extent of the dynamic Long Sand bank.

1.7 To monitor the minimum depth throughout the Sunk, Trinity and Black Deep routes, particularly areas which have become shallower since the last survey and are most critical to deep draught shipping.

Recommendations

1.8 Focused Area 1 covering the western slope of Long Sand Bank should be removed from the RRS Programme.

1.9 Focused Area 2 covering the Black Deep DWR should be retained with unchanged limits with the same resurvey interval.

1.10 Following the Full Area survey scheduled for FY2020-2021 there is a requirement to look at the long term changes in order to make a recommendation on survey limits and resurvey interval to the CHWG on both Full Area of TE6A and the remaining Focused Area covering Black Deep DWR

2. INTRODUCTION

2.1 This Assessment is produced by the United Kingdom Hydrographic Office (UKHO) for the Maritime and Coastguard Agency (MCA).

2.2 Analysis of the Routine Resurvey Areas forms part of the Civil Hydrography Programme and the reports are made available to all interested parties through the UKHO website and are

presented to the Civil Hydrography Working Group. When approved, the recommendations are incorporated into the Routine Resurvey Programme.

2.3 The Admiralty Chart extracts, other graphics and tables in this Report are included for illustrative purposes only and are NOT TO BE USED FOR NAVIGATION.

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3. AREA HISTORY

3.1 Summary of Surveys:

Year	Survey	Reference	Data	Year	Survey	File Ref.	Data
1983	K9341	H2040/82	s.	1997	M2815	HH090/743/01	s.d.
1985	K9723*	H2341/84	s.	1998	M3009	HH090/769/01	s.d.
1986	K9848*	H2342/85	s.	1999	M3235	HH090/852/01	s.d.
1987	M1116	H4026/86	s.t.	1999	M3293	HH090/852/01	s.d.
1988	M1229*	H6337/87	s.t.d.	2000	M3376	HH090/886/01	s.d.
1989	M1380*	H3935/88	s.d.	2001	M3558	HH090/936/01	s.d.
1990	M1596*	HH090/495/01	s.d.	2002	M3739	HH145/993/01	s.t.d.
1991	M1805*	HH090/516/01	s.d.	2003	M3924	HH090/1023/01	s.d.
1992	M1913	HH090/549/01	s.t.d.	2005	M4321	HH145/1118/01	s.d.
1993	M2134	HH090/574/01	s.t.d.	2008	HI1267	2008026412	m.
1994	M2269	HH090/627/01	s.d.	2011	HI1368	2011-112084	m
1995	M2496	HH090/655/01	s.t.d.	2012	HI1398	2012-117404	m
1996	M2671	HH090/690/01	s.d.	2016	HI1522	2016-181430	m

Key: s = sonar sweep, t = seabed texture tracing, d = digital data, m = multibeam digital data
Single-beam surveys (prior to 2004) conducted at 1:25,000 scale

3.2 Summary of historical recommendation enacted

Year	Remarks
1990	Old areas 6B and 6C included in area 6A.
1993	Area 6A established (H0423/85 - E1).
1999	Area extended to cover the Sunk DW Track (HA145/010/015/01).
2003	Survey frequency reduced to 3 years and limits revised, with areas requiring annual surveying transferred to TE5A.
2008	3 year focused and 12 year full re-survey frequencies retained. The next focussed survey will be due in 2011 and the next full survey due in 2020.
2011	Due to the stable nature of the Deep Water route area and receding or eastward migration of Long Sand Head, the survey frequency of the focused areas is extended from 3 to 6 years.

4. DESCRIPTION OF THE AREA

4.1 TE6A lies at the entrance to Black Deep and is bounded by the banks of Long Sand to the east and Sunk Sand to the west. Focused Area 1 is focused on the western slope of Long Sand bank and Focused Area 2 on the strip of water where Sunk DWR and Trinity DWR merge into Black Deep DWR. These form important approaches to the Thames Estuary and Medway for deep draught vessels.

4.2 The shoalest depths in TE6A are the drying heights along the top of Long Sand bank in Focused Area 1. The shoalest depth in Focused Area 2 is 13m, close to a charted obstruction 300m west of the Deep Water Route.

4.3 The western edge of Focused Area 1 is flat seabed until it reaches the western edge of Long Sand bank, where its slope contains ripples up to 1m high. Focused Area 2 is characterised by gentle undulations in the seabed with a dredged channel cutting through the centre of the Sunk and Black Deep routes. A ridge previously crossed Black Deep DWR with a controlling depth of 14.2m, but has been dredged deeper since the last survey in 2011.

4.4 Area Covered: 2.82 NM^2 (9.70 km^2) as shown in Figure 1 below.

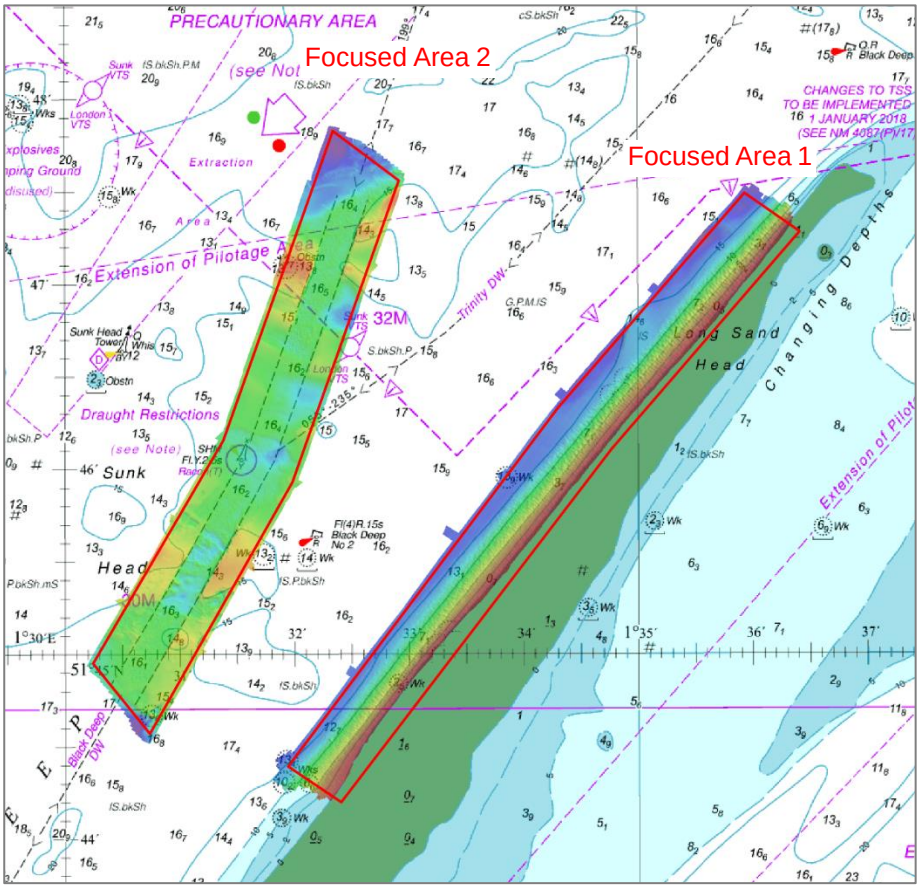

Figure 1 – HI1522 TE6A survey data sun-illuminated view overlaid on BA Chart 1975

4.5 The geographic limits at the time of resurvey are shown in the Tables 1 and 2 below and coordinates are in Decimal Degrees referenced to WGS84:

Table 1: Survey Limits for HI1522 TE6A Focussed Area 1

Point	Latitude (N)	Longitude (E)
01	51.0131331	1.0101150
02	51.0128075	1.0096583
03	51.0122778	1.0090000
04	51.0123317	1.0088717
05	51.0128686	1.0095275
06	51.0131908	1.0099817
07	51.0131331	1.0101150
08	51.0128075	1.0096583

Table 2: Survey Limits for HI1522 TE6A Focussed Area 2

Point	Latitude (N)	Longitude (E)
01	51.0124869	1.0084003
02	51.0128217	1.0087172
03	51.0132858	1.0089844
04	51.0132114	1.0091439
05	51.0127586	1.0088842
06	51.0123814	1.0085372
01	51.0124869	1.0084003

4.6 Survey interval at time of resurvey: 12 yr (full area) 6 yr (focused area)

4.7 Largest scale chart: BA1975 (Scale 1:50,000)

5. SHIPPING IN THE AREA

5.1 Black Deep forms one of the main approaches to the Thames Estuary. Shipping data from satellite AIS data for 2016 of vessels larger than 2000GT shows the maximum registered draught of vessel to transit through the TE6A area was 16m along the Deep Water Routes. Figure 2 illustrates the indicative shipping routes in the area in 2016.

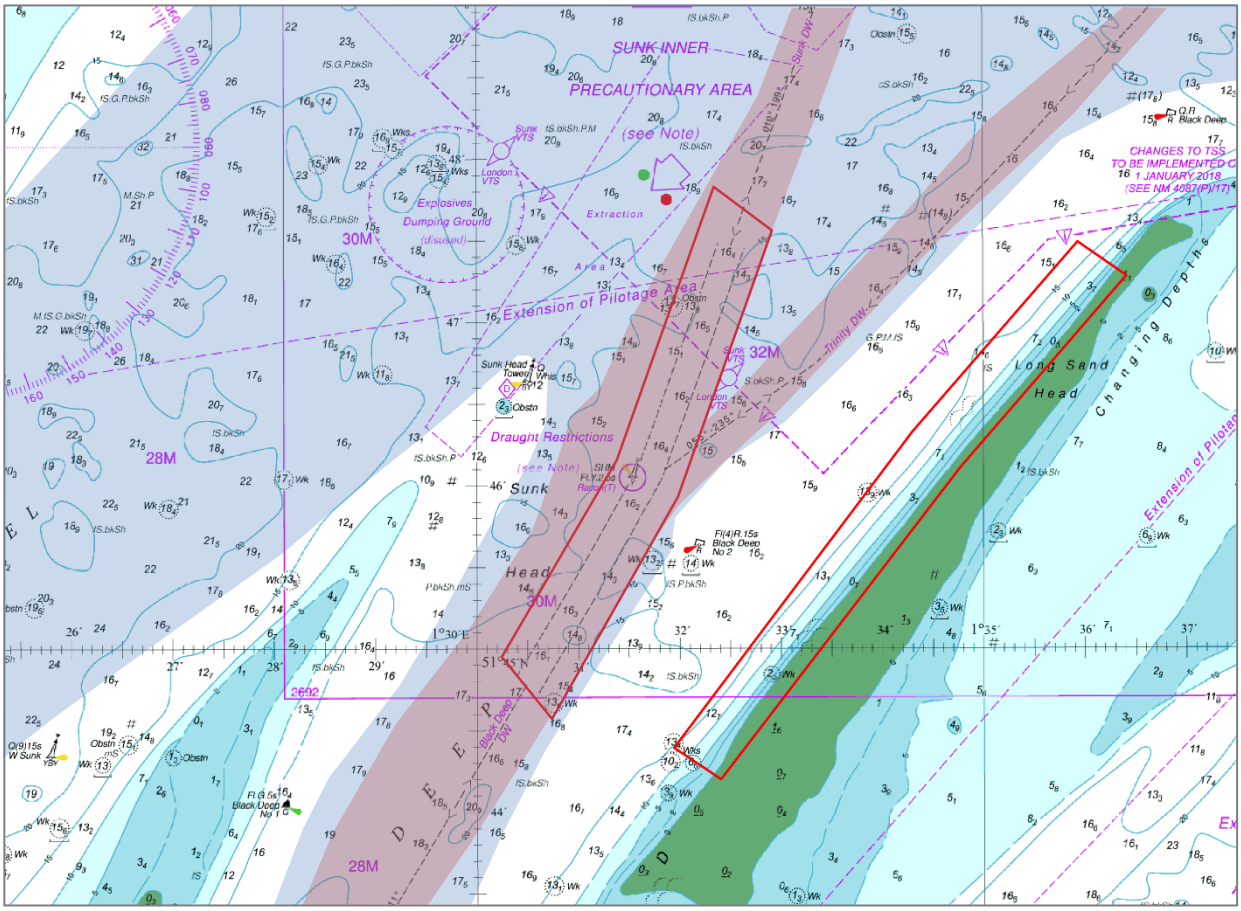

Figure 2 – Indicative shipping routes overlaid on BA Chart 1975

- - - - - -	Deep Water Track
	Limits of survey Area
	Indicative shipping routes of vessels with <10m draught
	Indicative shipping routes of vessels with 10-20m draught

6. REFERENCE SURVEY DETAIL

6.1 The historical Routine Resurveys gathered via the Civil Hydrography Programme (CHP) for area TE6A which have been used to compile this assessment are as follows:

- Hydrographic Instruction (HI) 1398 survey which was gathered from 6th to 9th October 2012
- HI1368 survey which was gathered on 5th and 28th July 2011. Sea states 1-3 (1 = smooth, 2 = slight, 3 = moderate) were experienced during this survey.

6.2 The survey data for both HIs given above was acquired using multibeam echosounder system. The primary reference position system used GNSS and was supplemented by a dynamic GNSS Precise Point measuring system. The surveys are referred to the European Terrestrial Reference Frame 1989 (ETRF89) datum.

6.3 Observations from GNSS 3D positioning were combined with the UKHO Vertical Offshore Reference Frame (VORF) to reduce depths to Chart Datum. The final deliverable was a 1m resolution CUBE (Combined Uncertainty and Bathymetry Estimator) surface.

6.4 The surveys were validated by UKHO and met IHO S44 (5th Edition) Order 1a standards.

6.5 The Report of Survey for these surveys is available upon request from the UKHO and the validated bathymetric surfaces are available to download from INSPIRE portal and MEDIN Bathymetry Data Archive Centre.

7. COMPARISON SURVEY DETAIL

7.1 The latest survey undertaken as part of the CHP Routine Resurvey Programme was in 2016 under HI1522. Area TE6A was surveyed between 3rd and 6th September was split into two Focused Areas 1 and 2 (see Figure 1). The vessel was on weather standby on 3rd and 4th September.

7.2 The survey data was acquired using a multibeam echosounder system. The primary reference position system used GNSS and was supplemented by a dynamic GNSS Precise Point measuring system. The survey is referred to the European Terrestrial Reference Frame 1989 (ETRF89) datum.

7.3 Observations from GNSS 3D positioning were combined with the UKHO Vertical Offshore Reference Frame (VORF) to reduce depths to Chart Datum. The final deliverable was a 1m resolution CUBE (Combined Uncertainty and Bathymetry Estimator) surface.

7.4 The survey was validated by UKHO and met IHO S44 (5th Edition) Order 1a standards.

7.5 The Report of Survey for this survey is available upon request from the UKHO and the validated bathymetric surfaces are available to download from INSPIRE portal and MEDIN Bathymetry Data Archive Centre.

8. DESCRIPTION OF RECENT BATHYMETRIC CHANGE

8.1 In Focused Area 1 the Variability Plots in Figure 3 and 5 show that between 2011, 2012 and 2016 Long Sand bank has continued a historical trend of migrating north-eastward. The Composite Diagram in Figure 4 shows that towards the north of Focused Area 1 the 10m contour has migrated up to 115m eastward between 2012 and 2016 (an average of 28.75m/year), and towards the south of Focused Area 1 the 10m has migrated 45m eastward between 2011 and 2016 (an average of 9m/year). Figures 3, 4 and 5 show that the further southeast in the area the slower the rate of sediment migration has been. Depths range from -0.36 (drying) to 19.8m in the area.

8.2 In the northern part of Focused Area 2 the Variability Plot in Figure 3 shows that between 2012 and 2016 the Sunk DWR has not seen much bathymetric change. In 2016 the minimum depth in Focused Area 2 was 13m, 300m west of the Deep Water Route, close to a charted obstruction. This has shoaled by 0.3m since 2012.

8.3 In the southern part of Focused Area 2 the Variability Plot in Figure 5 shows that between 2011 and 2016 the centre of the Black Deep DWR has deepened by up to 3.1m due to dredging activities. Depths along the centre of the route range between 15 and 18m, however the minimum depth close to the route is 14.3m (0.1m deeper than in 2011).

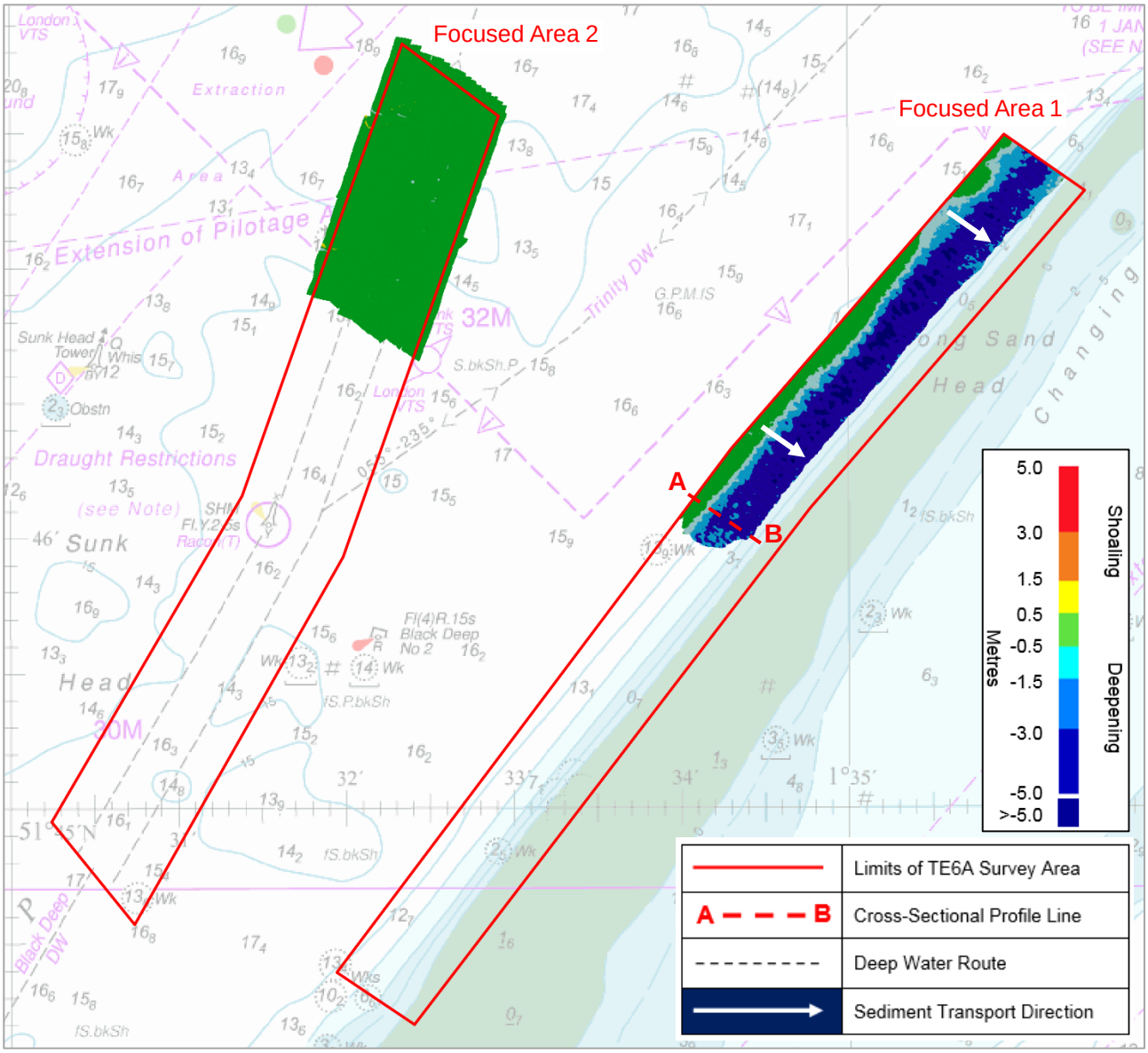

Figure 3 – Variability Plot showing Bathymetric changes between the 2012 and 2016 Surveys

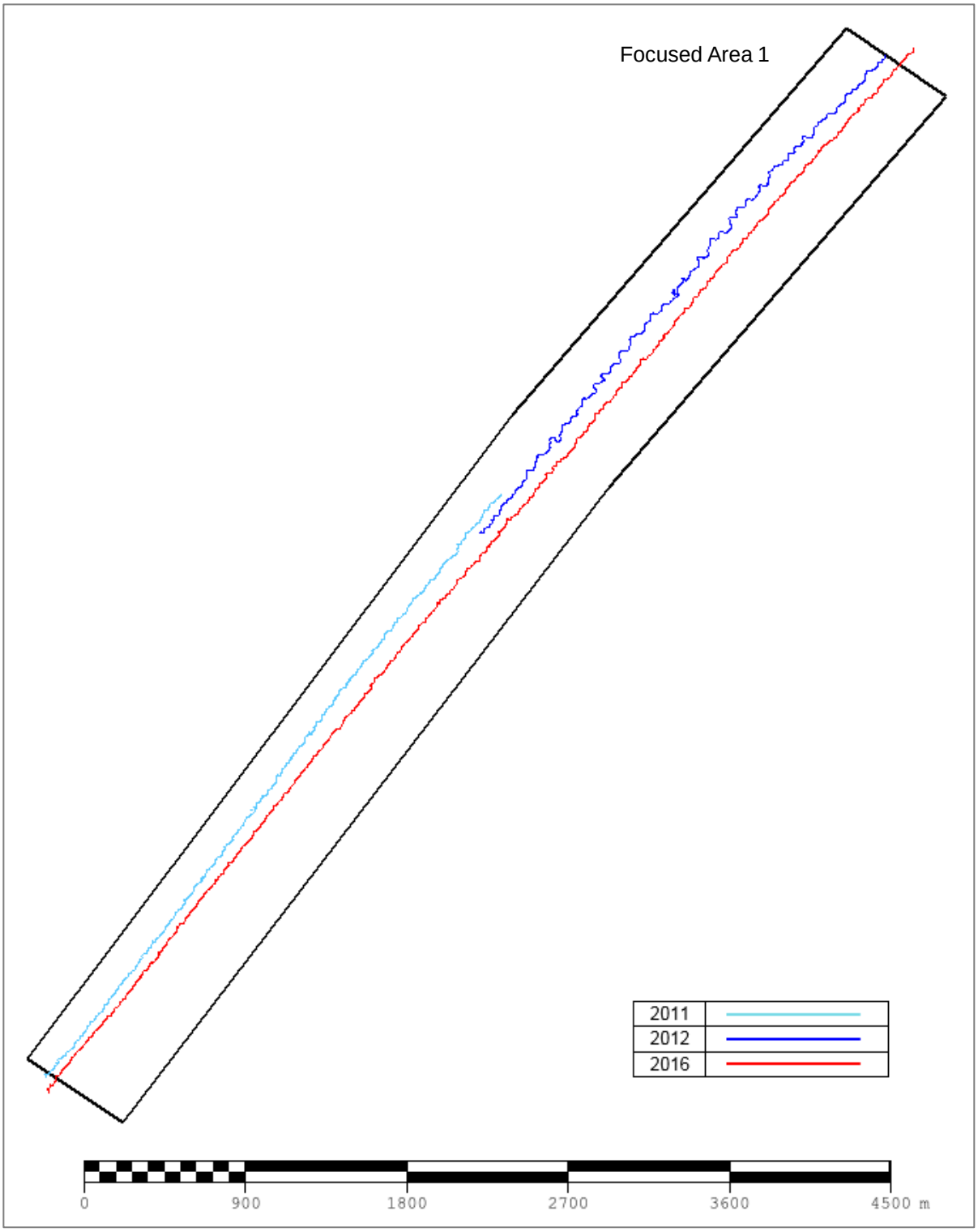

Figure 4 – Composite Diagram of the 10m Contour from the 2011, 2012 and 2016 surveys of Focused Area 1

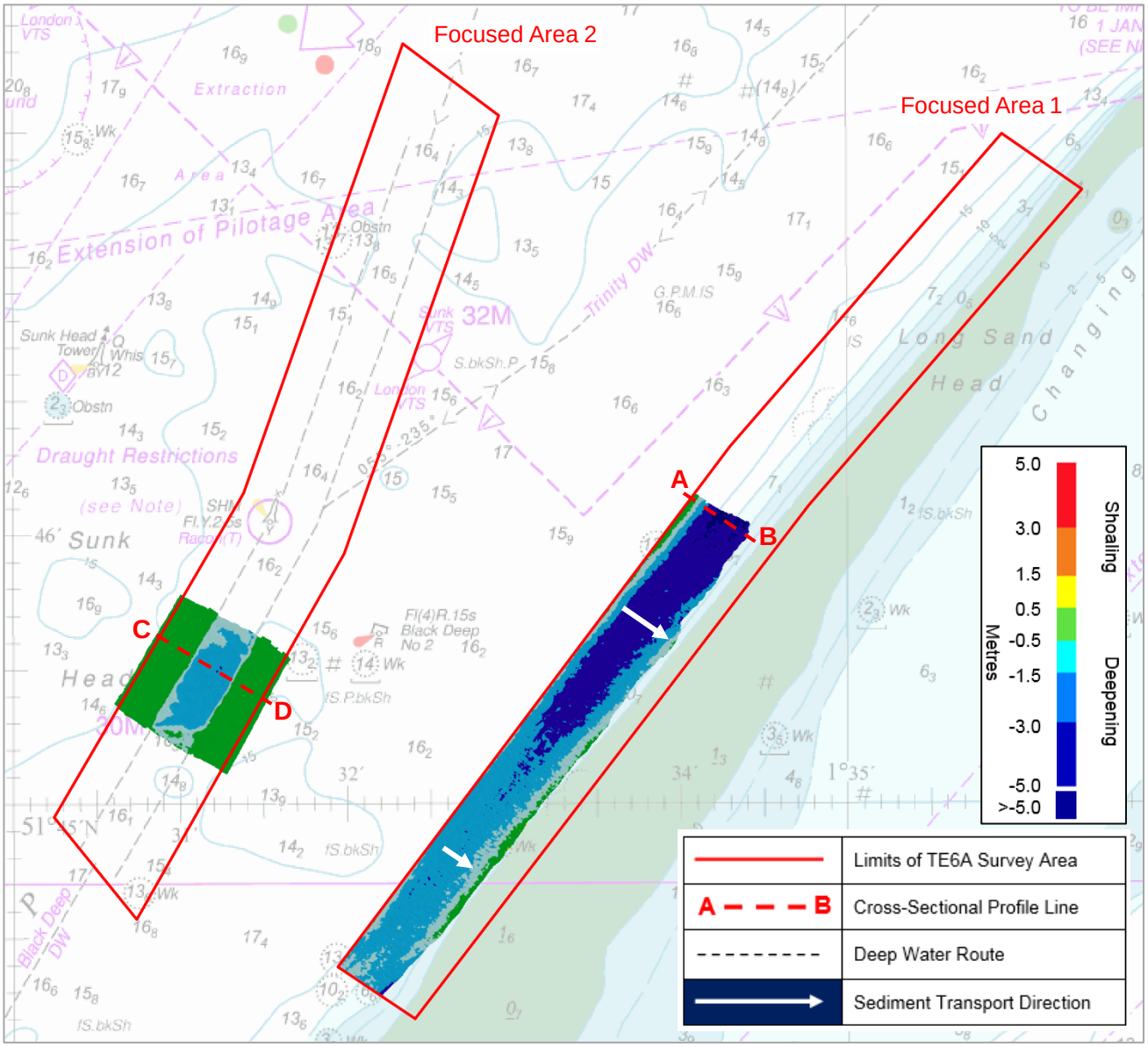

Figure 5 – Variability Plot showing Bathymetric changes between the 2011 and 2016 Surveys

8.4 Profile Comparison A-B in Figure 6 shows that between 2011, 2012 and 2016 Long Sand bank has continued the historical trend of migrating eastwards. Between 2011 and 2012 the bank migrated 50m eastward and between 2012 and 2016 it migrated 90m eastward. Therefore, annual migration has slowed from 50m/year between 2011 and 2012 to an average of 22.5m/year between 2012 and 2016.

8.5 Profile Comparison C-D in Figure 7 shows a cross-section of depth change along Black Deep DWR before and after dredging activities. The Depth Plot in Figure 8 shows that in 2011 the ridge crossing the route had a minimum depth of 14.2m. In 2016, after dredging up to the 15m contour, this part of the route is up to 2.3m deeper than 2011.

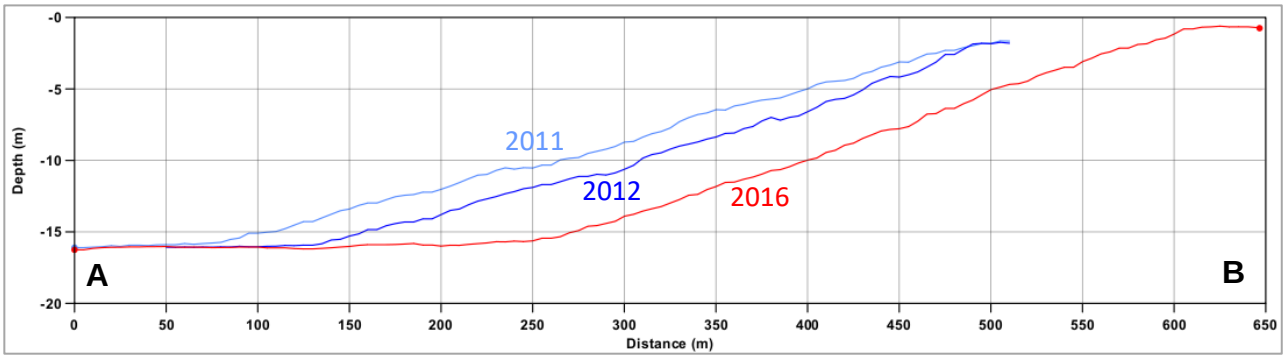

Figure 6 – Profile A-B comparison of bathymetric change between 2011, 2012 and 2016 surveys in Focused Area 1

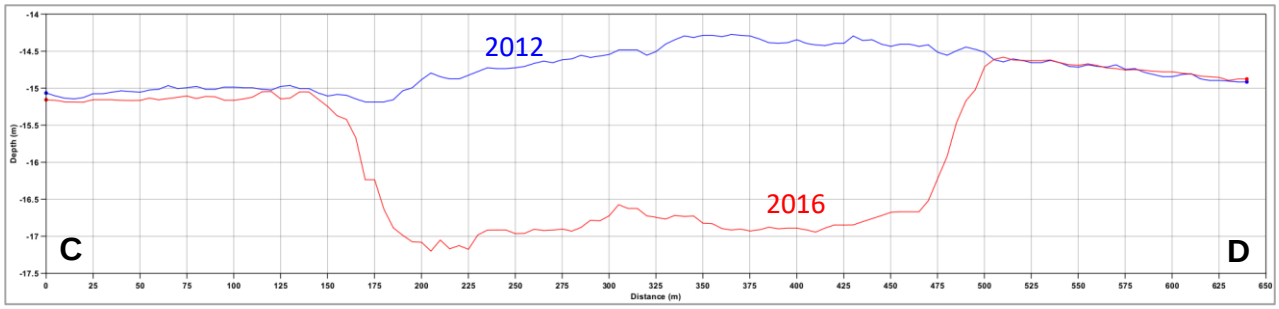

Figure 7 – Profile C-D comparison of bathymetric change between 2012 and 2016 surveys in Focused Area 2

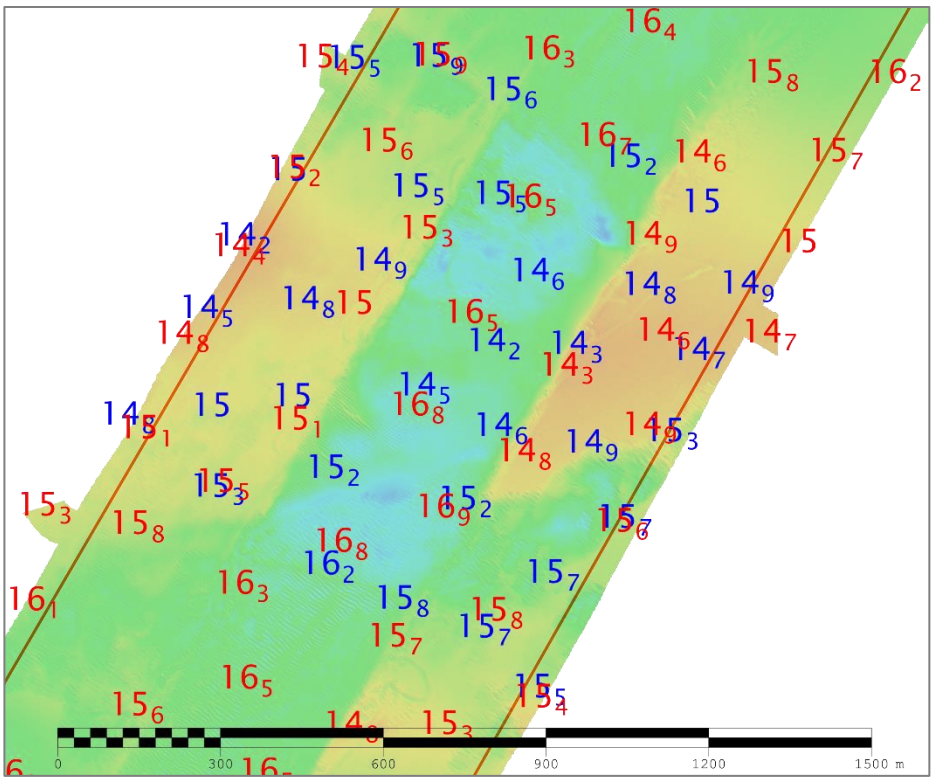

Figure 8 – Depth Plot of 2016 Survey (red) and 2011 Survey (blue) in the southern part of Focused Area 2 overlaid on HI1522 Survey Data

9. IMPLICATIONS FOR SHIPPING

9.1 In Focused Area 1 the western edge of Long Sand bank has continued to migrate eastwards away from the Trinity, Sunk and Black Deep routes, and is therefore not a concern to shipping transiting here. The eastward sediment migration is more of a concern to shipping transiting close to the most northerly tip of Long Sand Head to the northeast of the survey area.

9.2 Since 2012 depths along the Sunk DWR in the northern part of Focused Area 2 have generally stayed the same. The minimum depth of 13.3m in 2012 has shoaled to 13m in 2016. This is close to a charted obstruction, which shipping should take caution when transiting near, though AIS data indicates that vessels continue to transit close to.

9.3 In the southern part of Focused Area 2 dredging activities have taken place since 2012 over a ridge crossing Black Deep DWR. This part of the route is now 2.3m deeper, making it safer for vessels with large draughts to transit through. However, the minimum depth close to this route is 14.3m so vessels still need to transit with caution.

10. RECOMMENDATIONS FOR FUTURE SURVEYS

10.1 The eastward migration away from areas use by shipping of Long Sand Bank means the Focused Area 1 should be removed from the RRS Programme.

10.2 Due to the stable nature of the Deep Water Route In Focused Area 2 the survey area should be retained with unchanged limits (see Tables 1 and 2 in Section 4) and with the same resurvey interval.

10.3 Following the Full Area survey scheduled for FY2020-2021 there is a requirement to look at the long term changes in order to make a recommendation on survey limits and resurvey interval to the CHWG on both Full survey limits of TE6A and the remaining Focused Area covering Black Deep DWR.