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Sediment Management in the Humber Estuary: Dredging and Disposal Strategies

– Study in the framework of the Interreg IVB project TIDE

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1 Overview on the estuary and its ports

The Humber is one of the largest estuaries in the UK, measuring some 280km². It is approximately 6.5km wide at its entrance, opening to 9.5km wide immediately past its entrance at Spurn Point, with its upper reaches (some 48km upriver) at 2.5km wide. Major tributaries include the Trent, Ouse, Don and Aire (National Rivers Authority, 1991). The Estuary has a number of significant conurbations including on the north bank Kingston-upon-Hull, Hessle and North Ferriby; and on the south bank Cleethorpes, Barton-upon-Humber, Grimsby, Immingham, plus North and South Killingholme, see Figure 1.1 for locations.

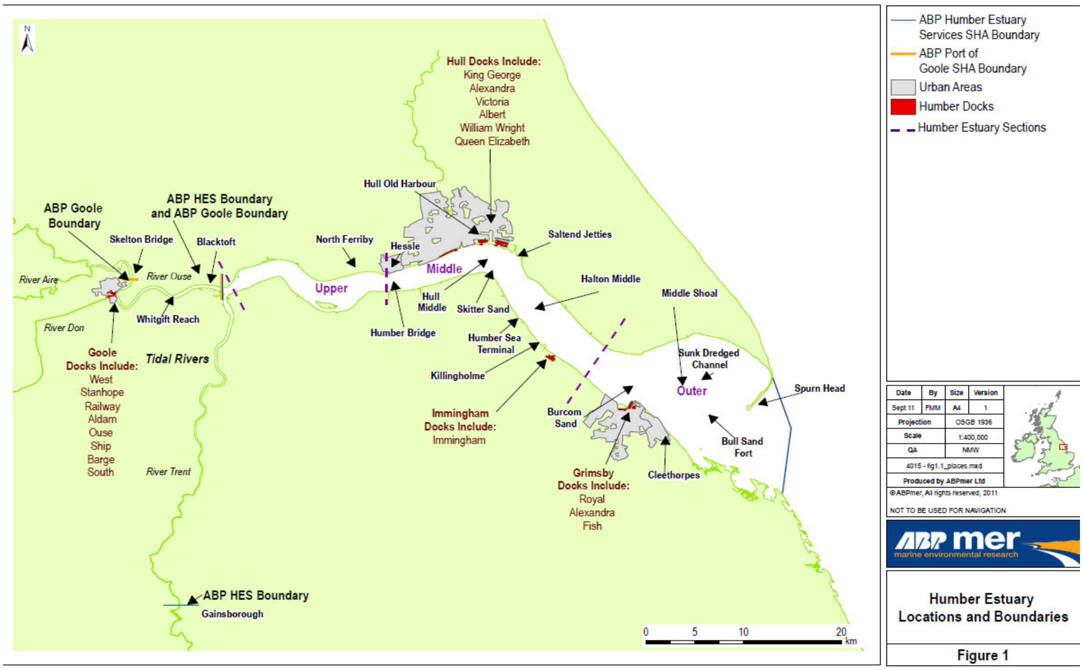

Figure 1.1: Location of the ports, disposal sites and zones of the Humber Estuary (HES, 2012).

The Humber Estuary is one of the busiest waterways in the United Kingdom, with around 29,500 commercial shipping movements in 2010, bound for 27 principal dock, jetty and river locations (including anchorages). The vast majority of the Humber Estuary is open water, buoys and light floats mark the main navigational channels. The channel chosen by vessels and the track followed will vary from tide to tide, depending on the tidal height and draught of the transiting vessel.

The major Humber ports of Hull, Goole and Grimsby, and Immingham account for 86% of all shipping tonnage. These ports handled 9.8 million tonnes, 1.6 million tonnes and 54.7 million tonnes of cargo respectively in 2009 (Department for Transport (DfT, 2011)). The principal commercial dock operations of Hull, Goole, Grimsby and Immingham are owned, managed and operated by Associated British Ports (ABP). In addition to these dock and jetty facilities, a number of other facilities are offered at terminals such as Salt End Jetties (owned by ABP), Immingham Oil Terminal (owned by ABP), North and South Killingholme, New Holland, Humber Sea Terminal and various smaller wharf operators above the Humber Bridge in the Upper Humber and the River Trent.

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In addition to commercial activity, the Estuary is also used by recreational clubs and individuals for leisure activities. A large proportion of recreational vessel movements are composed of vessels transiting between the network of rivers and canals connecting the Humber with inland waterways. Larger marina facilities exist at Grimsby, Hull and Goole, with smaller moorings available in creeks around the Estuary.

Maintaining safe port access for commercial and recreational maritime transport is an important function for Harbour Authorities. This necessitates the maintenance dredging of access channels and berth pockets to remove recently deposited sediment. Most of the dredging occurs in the lower and middle estuary (down estuary of the Humber Bridge) to maintain access to berth pockets and enclosed dock systems. In addition to the port facilities, the Sunk Dredged Channel provides access for larger vessels using the Humber Ports. The Channel was created in 1969 and has required regular dredging to maintain its depth against ongoing siltation events.

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2 Traffic

The Humber is one of the busiest and fastest-growing trading areas in Europe. Almost one quarter of the UK's seaborne trade passes through the Humber; this includes 25 per cent of the country's natural gas and 25 per cent of its refined petroleum products. Consequently, the Humber is a vital component of the country's wellbeing and is a major contributor to the UK's economy.
The Humber Ports owned by ABP are the Ports of Hull on the North Bank of the estuary; Grimsby and Immingham on the south bank and the Port of Goole located on the River Ouse (see Figure 1.1). Together they handle 60 million tonnes of cargo a year and 20,000 ship movements.

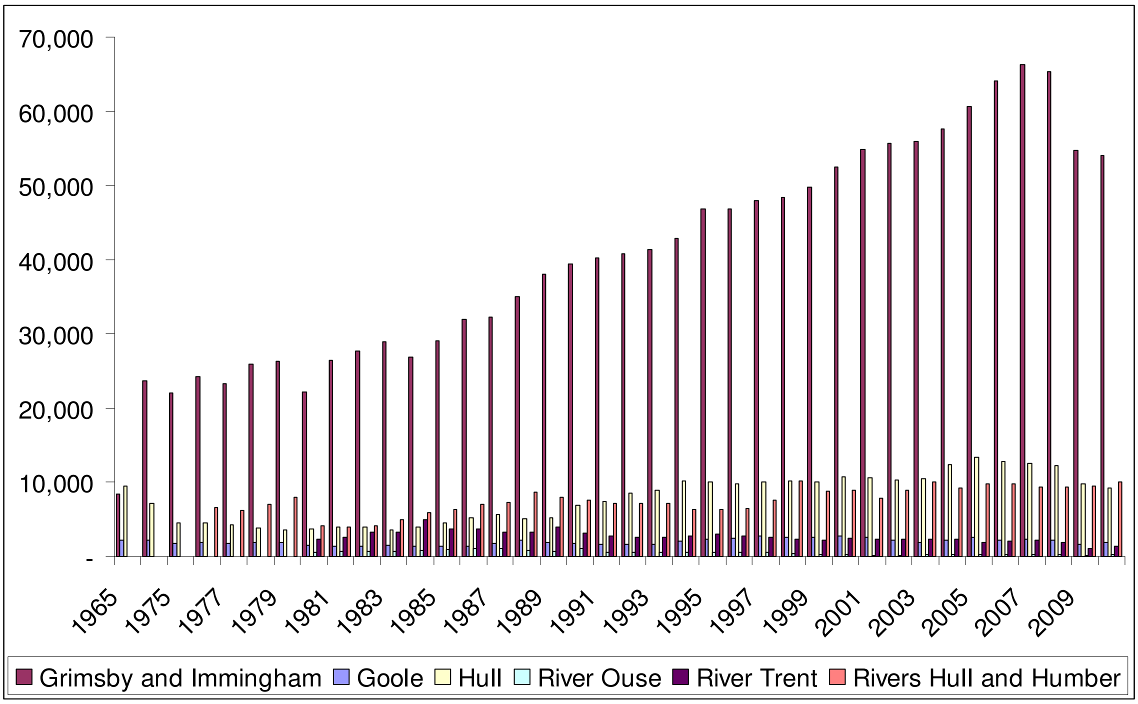

Figure 2.1: The volume of cargo that has come through the Humber from 1965 until 2010 (thousand tonnes) based on port.

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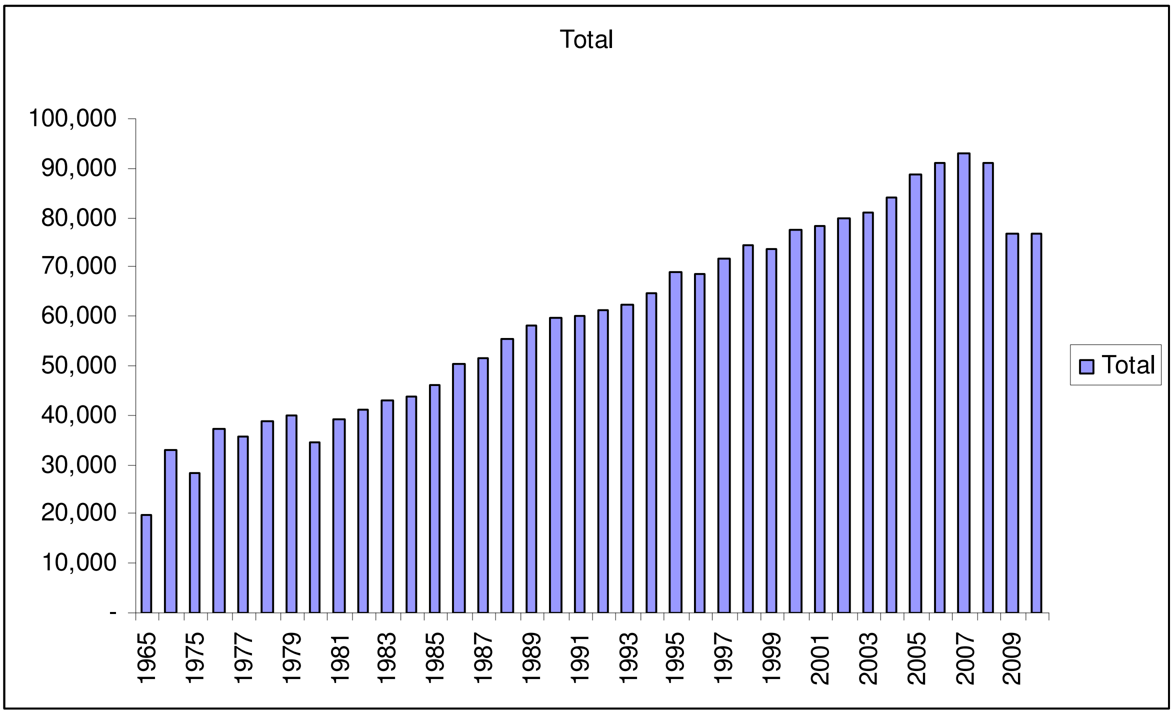

Figure 2.2: The total volume of cargo that has come through the Humber from 1965 until 2010 (thousand tonnes).

Port of Hull

The Port of Hull is situated on the North Bank and covers an area of 3,000 acres. Annually, the port handles approximately 10 million tonnes in containers, dry bulks, paper and forest products, fresh produce and perishables, general cargo, liquid bulks and is where the ferries for Zeebrugge and Rotterdam berth handling Ro-Ro and passengers. The port is capable of handling cruise ships and is currently in the process of applying to refigure Alexandra Dock as a wind turbine manufacturing and export facility (ABP, 2012).

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Table 2.1: Dimensions for the Port of Hull

Dock, Jetty or Quay	Quay length	Depth of Water	Length	Beam	Draught	Approx. dwt
Saltend Jetty No.1		9.8 m (tidal)	214.0 m	40.2 m	10.4 m	37,000
Saltend Jetty No.3		9.8 m (tidal)	214.0 m	40.2 m	10.4 m	37,000
King George & Queen Elizabeth Docks	5,069 m	11.3 m (impounded)	199.0 m	25.5 m	10.4 m	34,000
River Terminal 1		7.0 m	215.0 m	32.0 m	6.5 m	12,000
Alexandra Dock	4,082 m	8.3 m	153.0 m	23.7 m	7.9 m*	9,000
Alexandra Dock extension		8.3 m	122.0 m	19.7 m	7.9 m*	6,000
Riverside Quay	325 m	4.8 m (tidal)		30.0 m	4.5 m	4,500
Albert & William Wright Docks	3,453 m	6.5 m	122.0 m	22.0 m	7.0 m	5,000
Dry dock facilities	Net length	Width of dock at cope	Width of entrance	Depth of water on sill		
				At MHWS	At MHW	
Alexandra Dock No.1	139 m	24.6 m	17.2 m	5.4 m	3.9 m	
Alexandra Dock No.2	153 m	27.1 m	18.6 m	6.1 m	4.6 m	
William Wright Dock	137 m	25.9 m	15.2 m	6.5 m	5.0 m	

Port of Goole

The Port of Goole is the UK's most inland port, situated on the River Ouse. It covers 150 acres and handles approximately 2 million tonnes in containers, dry bulks, forest products, liquid bulks, steel and other cargo, rail traffic and project cargoes (ABP, 2012).

Table 2.2: Dimensions for the Port of Goole

	Normal acceptance dimensions of vessels			
Dock, Jetty or Quay	**Length**	**Beam**	**Draught**	**Approx. dwt**
Any	100.0 m	24.0 m	5.5 m	4,500

Port of Immingham

The Port of Immingham handles approximately 50 million tonnes annually and covers 1,230 acres of land. The port handles cargoes such as dry bulk, containers, Ro-Ro, forest products, general cargo, liquid bulks, steel and offers over 100 acres for offshore wind activities (ABP, 2012)

Table 2.3: Dimensions for the Port of Immingham

Normal acceptance dimensions of vessels				
Dock or Quay	**Length**	**Beam**	**Draught**	**Approx. dwt**
Enclosed dock	198.0 m?	26.2 m?	10.36 m	38,000
Eastern & Western Jetties	213.0 m	No restriction	10.40 m	50,000
Immingham Oil Terminal	366.0 m	No restriction	13.10 m	290,000?
Immingham Bulk Terminal	303.0 m	45.0 m	14.00 m	200,000?
Immingham Gas Jetty	280.0 m	No restriction	11.00 m	50,000
Humber International Terminal	289.0 m	45.0 m	12.80-14.20 m•	200,000?
Immingham Outer Harbour	240.0 m	35.0 m	11.00 m	18,500

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Port of Grimsby

The Port of Grimsby is the most easterly ABP port on the Humber Estuary and covers 550 acres of land. The port handles Ro-Ro cargo (cars), fresh produce and perishables (fish), dry bulks, forest products, general cargo, minerals and ores, steel and other metals and is home to an established centre of excellence for operations and maintenance activities for wind farms in the North Sea (ABP, 2012).

Table 2.4: Dimensions for the Port of Grimsby

	Normal acceptance dimensions of vessels			
Dock, Jetty or Quay	**Length**	**Beam**	**Draught**	**Approx. dwt**
Commercial Docks	145.0 m*	20.5 m	5.8 m	6,000
Fish Docks	73.0 m	12.8 m	5.8 m	

3 Shipping channels

The Sunk Dredged Channel is the deep water channel through the outer Humber that allows access to the ports. It is maintained at a depth of 8.8m below Chart Datum. Further information on this is provided in Table 5 and Figure 1 (both Annex).

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4 General aspects of dredging and disposalQuantities of dredged material

4.1.1 Dredging sites and sediment quality in the Port of the Humber Estuary

The Harbour Authorities within the Humber Estuary and tidal Rivers of Trent and Ouse have a statutory duty to maintain advertised depths of water in navigable channels, along riverside berths and within enclosed docks. This is achieved through regular, carefully planned maintenance dredge campaigns and additional capital dredge campaigns when required. The following sections describe historic and current known dredge activities, outlining dredge quantities, dredge techniques and identifying open, closed and disused dredge disposal sites. In addition to dredging carried out by established Harbour Authorities, it is known that *circa* 12 other organisations carry out, or have carried out maintenance dredging within the last 10 years. Where information on dredge methods, volumes and times are known, this has been included.

The total volume of maintenance dredging which has taken place by ABP per year between 2004 and 2010 ranges from 2,588,524 to 4,133,536m³; the equivalent of approximately 3,365,100 to 5,373,600 wet tonnes (Table 4.1). Specific details relating to dredge locations, quantities and dredge methodology are provided within this Section (4.3.1).

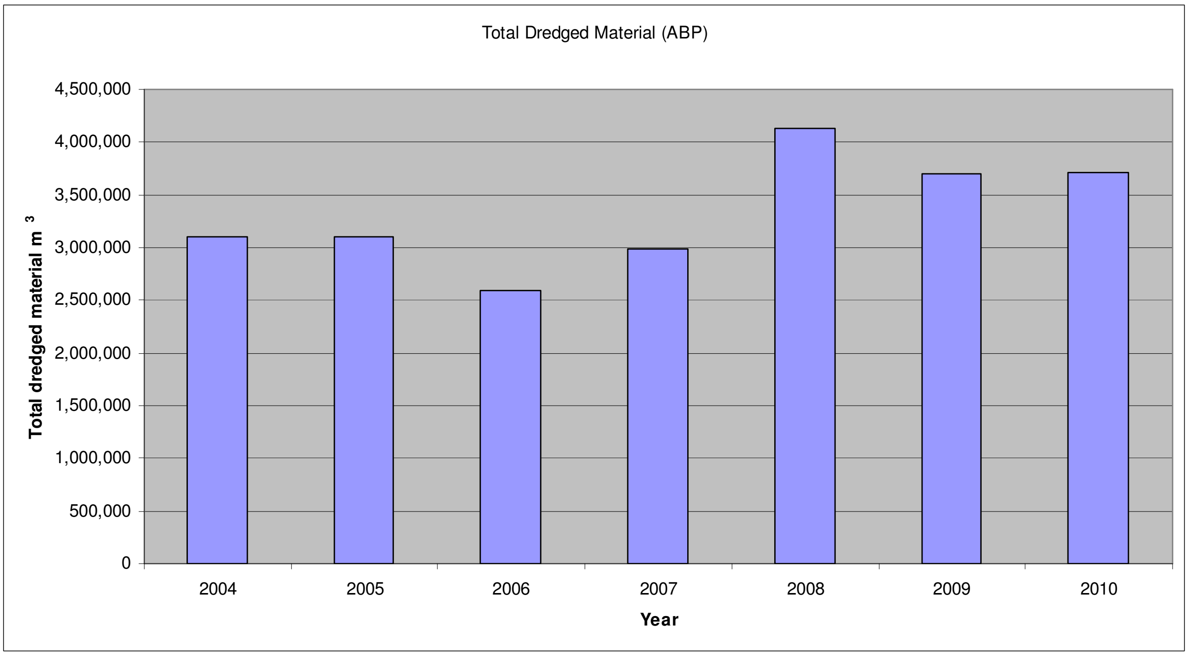

Figure 4.1: Total dredge volumes for the Humber between 2004-2010

1. Dredging volumes per estuary zone (+/- TIDE zones) (graph)

Based on the zones as shown in figure 1.1 the dredging volumes have been separated by zone and are shown in figure 4.2.

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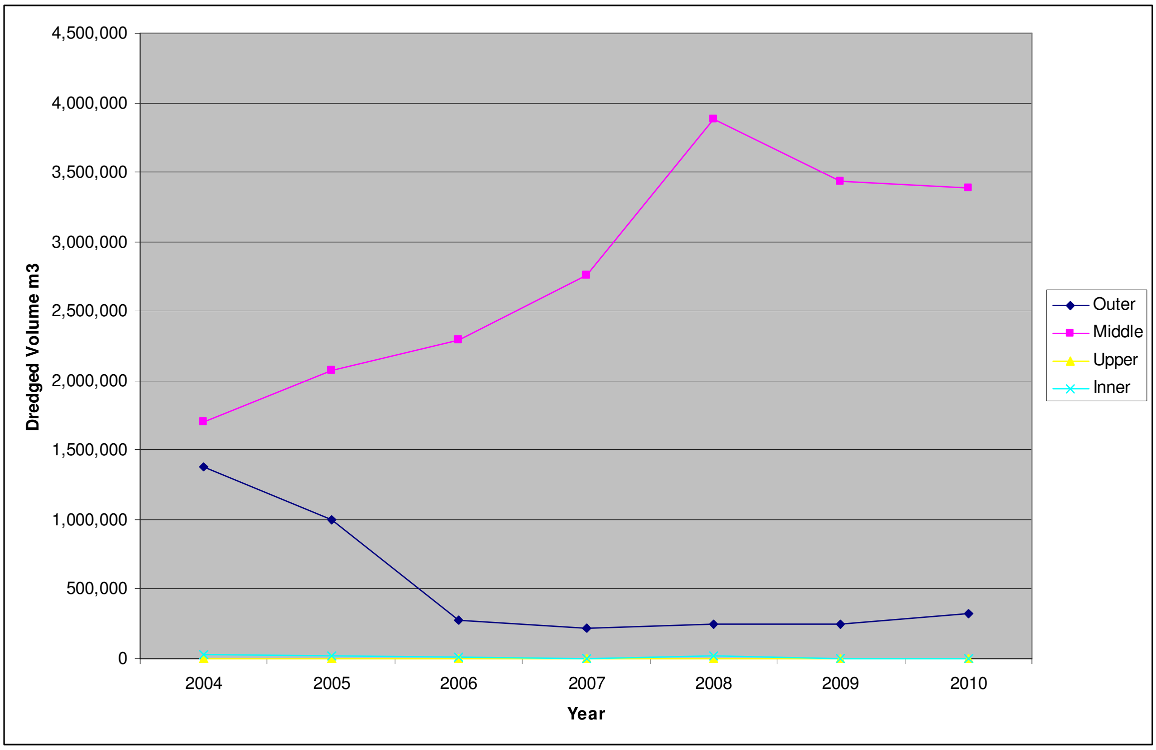

Figure 4.2: The dredge volumes per estuary zone for 2004-2010.

The Grimsby Ro-Ro project is currently still under construction and therefore no accurate dredge volume can be ascertained.

There has been no sand winning during the study period.

In the context of the Humber Estuary, the only “fairway” that ABP maintain is the SDC. Therefore Figure 4.3 shows the relevant dredge volumes.

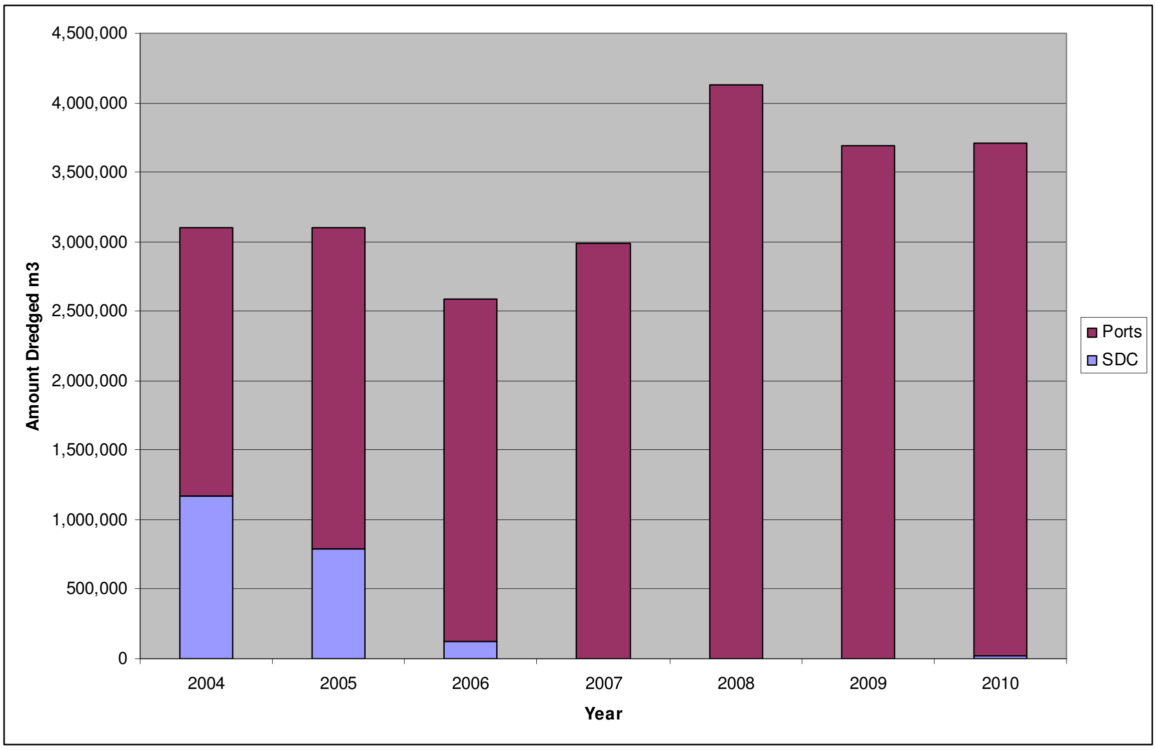

Figure 4.3: The total dredge volumes for the SDC and ports (cumulative) for 2004-2010.

ABP have recently installed a Water Injection system at the Immingham Outer Harbour however, due to the short amount of time it has been operating ABP currently have no results to share. ABP are however, looking at alternative locations for additional water injection activities.

Based on the zones as shown in Figure 1.1 the disposal volumes have been separated by zone and are shown in figure 4.4.

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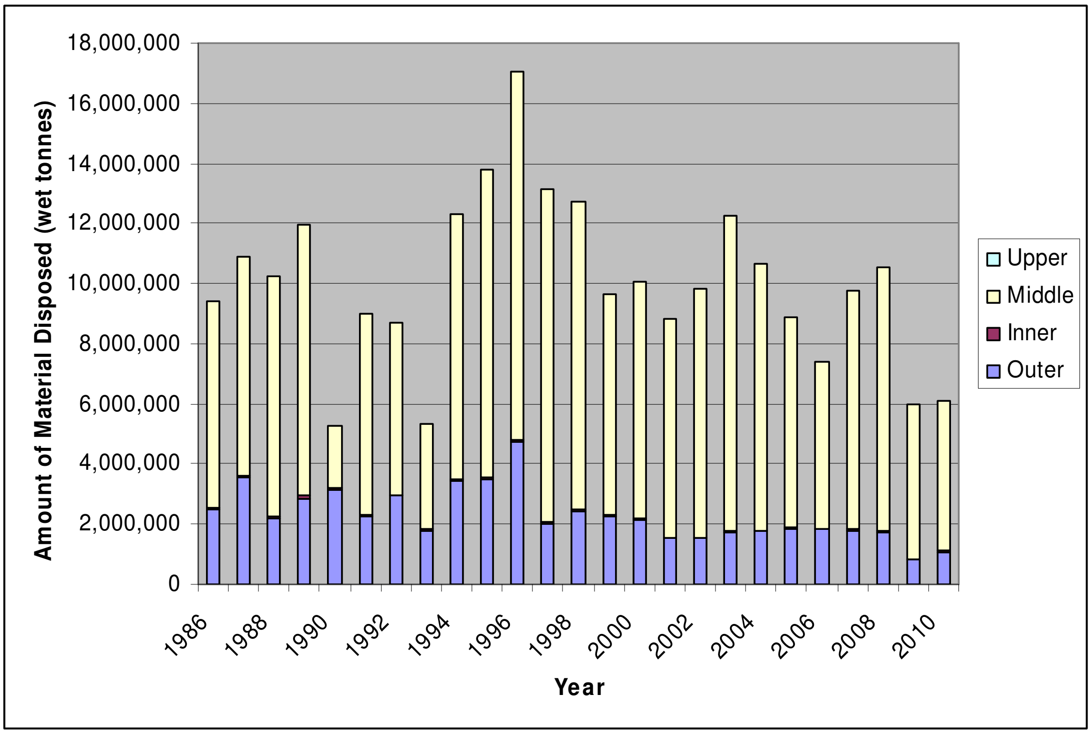

Figure 4.4: The disposal volumes per estuary zone between 1986-2010.

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Table 4.1: Dredge material volume (m³) handled by UKD from 2004 to 2010 for ABP operations only

Location		2004	2005	2006	2007	2008	2009	2010	2011
Sunk Dredged Channel	Sunk Dredged Channel	1,172,718	791,829	124,467	0	0	0	23,489	
Grimsby Docks	Grimsby Entrances	0	0	0	7,294	104,885	109,167	186,561	
	Grimsby No.2 Fish Dock & Marina	0	0	0	36,198	17,381	6,828	12,324	
	Grimsby Alexandra Dock	46,772	3,345	13,964	21,357	2,276	10,098	25,491	
	Grimsby Royal Basin	97,975	36,309	14,778	35,300	14,760	5,997	946	
	Grimsby Royal Dock	63,158	165,188	119,232	114,218	106,354	111,615	73,570	
Immingham Docks and Waterfront Berths	Humber International Terminal	130,162	290,098	392,802	370,222	537,686	339,683	284,900	
	Immingham Bellmouth (inc East Jetty)	207,634	215,962	110,038	184,249	260,609	187,288	184,401	
	Immingham Dock	298,191	260,692	229,980	148,660	257,418	196,994	146,032	
	Immingham Gas Terminal	31,780	84,475	51,138	54,276	85,207	40,654	32,061	
	Immingham West Jetty Ext	278,614	479,710	41,893	65,933	87,433	24,495	63,011	
	Immingham Outer Harbour	0	0	724,488	1,344,167	2,076,000	2,014,179	1,948,117	
	South Killingholme Oil Jetty	0	0	0	0	0	13,784	10,315	
Saltend Jetty	Saltend Jetty	40,026	155,983	234,517	164,090	62,326	38,168	177,054	
Hull Docks and Waterfront Berths	King George Dock	155,051	196,348	189,922	140,295	137,854	129,666	85,094	
	King George Dock Entrance	159,416	113,885	68,171	139,347	199,257	247,616	221,519	
	Queen Elizabeth (QE) Docks	0	0	0	1,115	0	0	0	
	Albert Dock Entrance	47,730	16,725	23,300	4,255	2,230	9,435	19,480	
	Albert Dock	128,540	101,894	78,202	33,277	52,530	26,238	9,757	
	William Wright Dock	0	0	0	0	0	0	0	
	Alexandra Dock Entrance	70,512	42,755	49,141	14,909	2,292	80,676	84,780	
	Alexandra Dock	153,478	113,306	100,491	84,177	69,469	19,398	47,365	
	River Terminal 1	0	0	0	12,346	53,314	69,048	74,266	
Goole Docks	Goole Docks	22,300	33,020	22,300	9,663	4,255	14,581	4,288	
	Total	**3,104,057**	**3,101,524**	**2,588,824**	**2,985,348**	**4,133,536**	**3,695,608**	**3,714,821**	

Note: All values given in the table are in m³. For in-situ density (tonnes) all values are subject to a 1.3 multiplier (i.e. 1,000m³ = 1,300 tonnes). William Wright Dock is excluded from dredging/disposal due to contamination issues.

(1) Sunk Dredged Channel

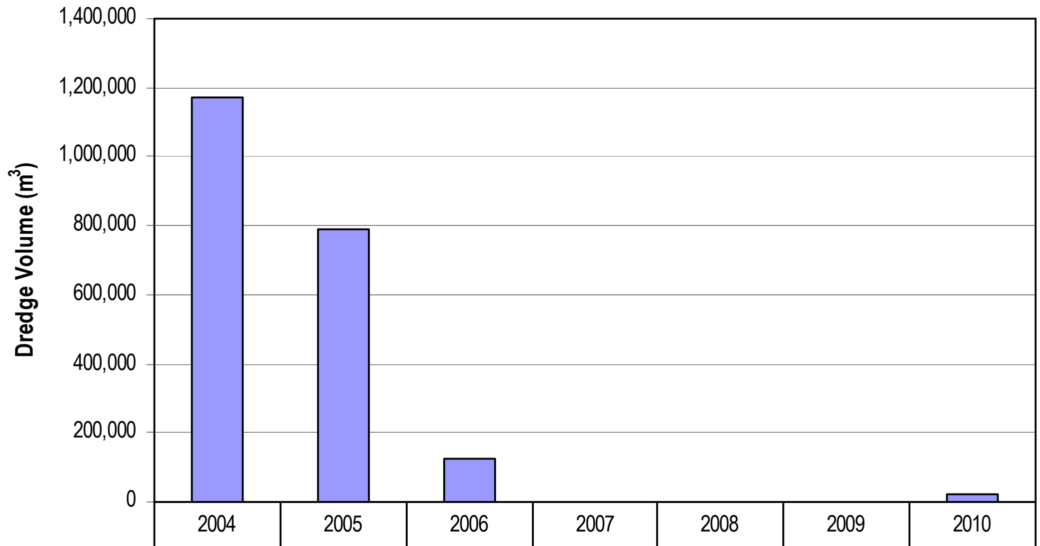
The SDC (references to this channel also include the Hawke Channel) was originally dredged to enable deep-draughted vessels to use the deep-water terminals of the Immingham Oil Terminal and the Immingham Bulk Terminal. The Harbour Master is responsible for determining the safe navigable depth for the SDC, the position of which is shown in the Annex, Figures 1.1 and 4.5. In this role, they are responsible for initiating dredging of the channel to maintain a least available advertised depth over the minimum controlling width of 150m. The present buoy line gives a channel width of 180m.

Siltation Regime

Material tends to accumulate on the south side of the western two-thirds of the channel. Siltation in the channel tends to be variable with average siltation rates being at a maximum during the summer months, although rapid siltation can occur at any time. Historical records indicate a cyclic pattern with a period of circa 14-15 years, although this has modified during most recent years. Figure 4.5 summarises the dredge volumes for the SDC for the period 2004 to 2010.

Current Dredging Operations

The SDC is dredged as often as necessary in order to maintain the advertised depth. Due to the dynamic nature of the channel, whereby sand migrating into the channel is highly variable from day to day, seasonally and over long period of many years, there is not an established consistent regime for dredging frequency; the necessity for dredging is determined by frequent bathymetric surveys. Figure 4.5 identifies that no maintenance dredging was undertaken along the SDC from 2007 to 2009, with only a small campaign taking place during 2010. However, it is quite possible that the channel will need more substantial dredging in the near future; i.e. similar to those seen historically as part of the cyclic pattern.



	2004	2005	2006	2007	2008	2009	2010
Sunk Dredged Channel	1,172,718	791,829	124,467	0	0	0	23,489

Figure 4.5: ABP Maintenance Dredging Volumes for the SDC (2004 to 2010)

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When maintenance dredging is undertaken along the SDC, this is generally carried out by a TSHD. To maintain the levels of the navigable width, the majority of dredging is required within a buffer zone of approximately 63m width on the southern edge of the channel. The channel in the past has been maintained to provide a Least Available Depth of 8.8-9.4m below CD, however from 2007-2010 it has been self maintained at in excess of 9.8m CD. This provides a depth of around 14 to 16m at high water. This variation in depth reflects the dynamic nature of the channel, and is the reason for the fortnightly surveys (weather permitting) and continual notification of the changing depth.

Material Type

The material dredged from the SDC in the years before the period of self maintenance was predominantly sand with a mean/medium grain size of 100-200 microns. In the early years of the channel, silt with a median particle size of <63 microns was mainly dredged. This material is still from time to time present, but less frequently than seen in the past. The average bed density for the sand has been established as approximately 1,550kg/m^3, although material deposited from the dredger at the Humber 1A/Middle Shoal (HU080) disposal site can range in density from under 1,200kg/m^3 to in excess of 1,400kg/m^3.

(2) Grimsby Docks

In order to maintain vessel access and ABP operations at Grimsby Docks, maintenance dredging is undertaken at five locations. The locations of these dredged areas are as follows (see Annex, Figure 4.6):

- Grimsby Entrances;
- Grimsby No.2 Fish Dock & Marina;
- Grimsby Alexandra Dock;
- Grimsby Royal Basin; and
- Grimsby Royal Dock.

Additional third party maintenance dredging is also undertaken within the Grimsby Fish Docks (No.1 and No.3) and within the outer Fish Dock Entrance by GFDE.

Siltation Regime

The commercial docks at Grimsby are not impounded. The sediment therefore enters the dock system due to density interchange during the lock penning process and at times of levelling, i.e. the dock level is allowed to rise at the same rate as the tide towards high water. Siltation within the main dock therefore occurs due to the operation of the lock gates. Given that the lock gates are located in Royal Dock it is understandable that the majority of the deposits occur there. The movement of water within the dock forms a circulatory pattern entering via the lock gate, progressing down the West Quay under and through the coal berth extension at the south end of the dock and finally back up the dock following the East Quay. This circulatory effect assists deposition at number 1 quay (the northernmost berth on the east side). Some material also deposits in the corners of the dock and under the Coal Jetty in addition to along the quay walls.

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Transit of vessels restricts the formation of large amounts of material in the centre of the dock. The only other area to experience a build up of material is the entrance to the Union Dock cutting.

Within Alexandra Dock the majority of accumulated material is at the end of the Union Dock cutting and around the edges of the Union Dock due to the wash of vessels swinging in the turning area. Alexandra Dock experiences accretion but at a reduced rate compared to Royal Dock. This is partly due to sluicing and the distance from the lock gates together with the turning action of vessel traffic.

The tidal basin in the dock entrance requires regular work to keep access clear. The accumulation of material is concentrated within the area protected by the piers. The material that settles on the intertidal areas is drawn down with the tide or slumps into the navigable channel. Deposits in this area are dominated by the tidal and wave regime, thus providing a constant maintenance dredge requirement.

Current Dredging Operations

The present in-dock and basin maintenance dredging operations at Grimsby Docks are tidally restricted since the dredger must pass through the lock gates to deposit the dock sediments at the Humber 2/Burcom Sand (HU090) disposal site (situated approximately 2km to the north), or can only work in the basin over the higher water periods.

Dredging is typically achieved by a GHD for about 13 days a year in total, but these days are distributed fairly evenly over approximately 6 months of the year. TSHD is undertaken for approximately 17 days over the year, principally in a spring and autumn campaign of 5 days each with the remaining days used as required. A plough (bed-leveller) works for around 20 days a year, with its role split between pulling material out to a reachable position for the TSHD, and smoothing off the dock bottom after the GHD. Figure 4.6 summarises ABP maintenance dredging volumes across the Grimsby Dock for the period 2004 to 2010.

The Royal Dock entrance is dredged to a depth of 1.2m below CD, which means that at high water the entrances are generally deep enough to allow access to those vessels with the necessary beam to pass through the locks. Royal Dock is dredged to maintain a depth of 6.8m and Alexandra Dock a depth of 6.6m as measured on the inner sill of the dock. This allows access to vessels with a draught of 5.8m, assuming the height of the tide is sufficient for them to navigate the entrances, although larger vessels can be admitted with the Dock Master's approval and a sufficient tide.

The Fish Docks (in its entirety) was originally dredged to maintain a depth of 6.7m on the inner sill at mean high water springs, although in recent years, the change of operation and usage has resulted in the maintenance of shallower depths. However, increased sedimentation in the vicinity of the No.2 Fish Dock, site of the Humber Cruising Association (HCA), meant that dredging was needed to meet operational requirements. As such the HCA (with ABP's assistance) contacted the Marine and Fisheries Agency (MFA) with a view to carry out a small dredging campaign. As the area had not been dredged for some 14 years, Cefas advised that sampling of the sediments must take place first; on the basis that no anomalies were detected, the dredge was undertaken by a small independent operator (mv Coquetmouth). Dredging has now been undertaken within the No.2 Fish Dock & Marina since 2007 through UKD.

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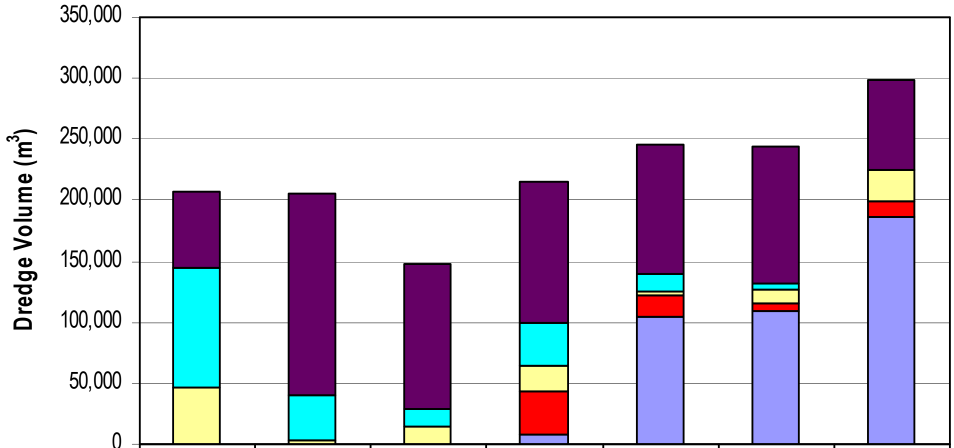

	2004	2005	2006	2007	2008	2009	2010
Grimsby Royal Dock	63,158	165,188	119,232	114,218	106,354	111,615	73,570
Grimsby Royal Basin	97,975	36,309	14,778	35,300	14,760	5,997	946
Grimsby Alexandra Dock	46,772	3,345	13,964	21,357	2,276	10,098	25,491
Grimsby No.2 Fish Dock & Marina	0	0	0	36,198	17,381	6,828	12,324
Grimsby Entrances	0	0	0	7,294	104,885	109,167	186,561

Figure 4.6: ABP Maintenance Dredging Volumes for Grimsby Docks (2004 to 2010)

Material Type

The material dredged from the Grimsby Docks is composed predominantly of fine silts, clay and some sand. The *in-situ* bed density is generally of the order of 1,300-1,400kg/m³. The GHD removes the material at approximately *in-situ* density, whereas the average density at the point of disposal from the TSHD will generally be between 1,150-1,250kg/m³, depending on material type, when last dredged and amount of material to be dredged.

(3) Immingham Docks and Waterfront Berths

In order to maintain vessel access and ABP operations at Immingham Docks, within the entrance and along the waterfront (river) berths, maintenance dredging is undertaken at eight locations. The locations of these dredged areas are as follows (see Figure 4.7):

- Immingham Bellmouth (including East Jetty);
- Immingham Dock;
- Immingham West Jetty Ext;
- Immingham Outer Harbour;
- Humber International Terminal;
- Immingham Gas Terminal; and
- South Killingholme Oil Jetty.

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Additional third party maintenance dredging is also undertaken locally at the Immingham Bulk Terminal (IBT) for Tata Steel, and at the Humber Sea Terminal (Berths 1 to 6) at North Killingholme Jetty by Humber Sea Terminal Ltd (Simon Group plc).

Siltation Regime

Siltation within the dock occurs primarily along the quay walls, with a large depression forming in front of the lock entrance due to the turning action of dock traffic. This turning action causes the expulsion of fine material towards the two dock arms. Material does not accrete at the end of the Ro/Ro berth dock arm, (southwest arm), due to the ferries berthing action. The ingress of suspended material is via the impounding pumps and lock gates. Studies have been carried out to determine the most appropriate times for operating the pumps in order to minimise ingress of material. However, the vessel traffic through the lock necessitates the use of the pumps at all times irrespective of the 'most favourable' operational periods.

Current Dredging Operations

Immingham is similar to Grimsby in that there is a programme of maintenance dredging of the main dock in order to maintain a constant depth for vessels. However, there is a far larger waterfront berth dredging programme at Immingham which has riverside terminals providing berthing facilities for larger vessels requiring deeper water.

A TSHD and GHD operate at Immingham for approximately 28 and 30 days per year in total respectively, working Immingham Dock, the entrances and the waterfront berths. A plough (bed-leveller) works for about 34 days per year, pulling material out to be reached by the TSHD, and smoothing off the dock bottom after the GHD. This is normally programmed to be fairly evenly spread throughout the year by arranging a dredging presence in the Grimsby and Immingham area every 3 to 4 weeks, for periods of up to a week at a time. The established dredging commitment to the port is based on the number of days worked the previous year. The dredger is booked and carries out work based on the Dock Master's requirements combined with available survey information, meaning that the dock system may not be maintained to the same levels at all times. Further variations may occur depending on the commercial requirements within the dock.

In addition to these requirements, the recently completed Immingham Outer Harbour (IOH) provides a workload of around 72 days per year for both a TSHD and plough.

Figure 4.7 summarises dredging volumes undertaken by ABP across the Immingham Docks and waterfront berths for the period 2004 to 2010. At the present time, all maintenance dredge material arising from Immingham Dock, its entrance and waterfront berths, and from the terminals at Immingham and South Killingholme is deposited at the Humber 3A/Clay Huts (HU060) disposal site.

The main Immingham Dock is dredged by a TSHD to remove fine silts, and to maintain a depth of 11m as shown on the dock sill gauge at the normal impounded water level. It is difficult to reach some areas, such as adjacent to the dock walls, so a GHD is used to remove the build up of sediment and a plough is employed to pull material to a reachable position for the TSHD. The plough is also used to smooth off the dock bottom after the GHD. An area two to three times the width of the berth needs to be dredged in front of the East and West Jetties as well as in the Bellmouth. Fine silt deposits in the immediate lock entrance within the dock Bellmouth tend to

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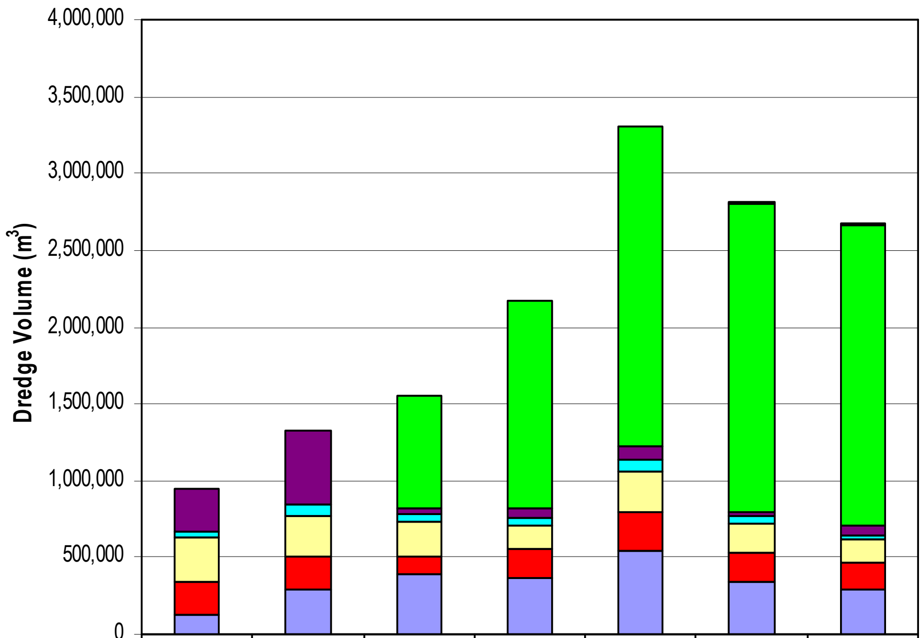
be removed using the GHD due to lack of manoeuvring space. The Bellmouth is dredged to a depth of 7.6m below CD, therefore allowing vessels with a draught of 10.36m being admitted to the docks at Immingham. The two jetties either side of the lock entrance known as the Eastern and Western jetties are dredged to an advertised depth of 9.8m below CD although in reality this depth may vary. Should the current trade at the jetties and berths not require these depths then dredging is postponed in order to reduce the dredging requirement. Deepening back to the original depth may however be required at any time and will be carried out as and when appropriate.



	2004	2005	2006	2007	2008	2009	2010
South Killingholme Oil Jetty	0	0	0	0	0	13,784	10,315
Immingham Outer Harbour	0	0	724,488	1,344,167	2,076,000	2,014,179	1,948,117
Immingham West Jetty Ext	278,614	479,710	41,893	65,933	87,433	24,495	63,011
Immingham Gas Terminal	31,780	84,475	51,138	54,276	85,207	40,654	32,061
Immingham Dock	298,191	260,692	229,980	148,660	257,418	196,994	146,032
Immingham Bellmouth	207,634	215,962	110,038	184,249	260,609	187,288	184,401
Humber International Terminal	130,162	290,098	392,802	370,222	537,686	339,683	284,900

Figure 4.7: ABP Maintenance Dredging Volumes for Immingham Docks and Waterfront Berths (2004 to 2010)

Up-estuary of from the Western Jetty, the waterfront berths at Immingham are dredged using a TSHD, with the principle dredging commitment being required at Humber International Terminal (HIT 1 & 2) and IOH. These jetties require dredging in order to remove sediment that accumulates within the deep berthing pockets. The HIT berths are designed to handle much larger vessels, and are dredged to 14.7m below CD for vessels of 14.2m draught. The IOH is dredged to 10m below CD. In addition to the TSHD used within IOH, a jetting system has recently been installed (during 2011) below the IOH pontoon. By maintaining a constant flow rate beneath the pontoon,

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sediment deposition is being prevented, which has in the past lead to the grounding of the pontoon structure at low water on a spring tide. The use of this jetting system should hopefully lead to the long-term reduction in maintenance dredging around the IOH pontoon.

Again further up-estuary, a TSHD is also used to maintain the berthing pocket of the Immingham Gas Jetty (IGJ) at a depth of approximately 10m below CD, although it was constructed with the capacity to be deepened to 14.8m below CD; if and when this is required, the necessary deepening work will be undertaken. The South Killingholme Jetty, run by the Oil and Pipelines Agency, is dredged to 11m below CD.

The Immingham Oil Terminal (IOT) does not currently require any dredging as it is located on the main deep water channel in the river and the depth is maintained naturally.

The future dredging requirements at ABP Immingham may be subject to change depending on a variety of factors including natural sedimentation rates, commercial pressures, and new developments and developing dredging technology. Indeed, it has become apparent in recent times that sedimentation rates on the new IOH development have been in excess of that indicated by the numerical modelling; leading to a request in 2007 for an extension to the deposit amount in the Humber 3A/Clay Huts (HU060) disposal site. At the time, this was considered to be a temporary aberration, caused by excessive flood waters draining out of the Humber, although as a precautionary action, a high dredge tonnage has subsequently been assumed for the berths.

Material Type
The bed material in Immingham Dock and the Bellmouth consists mainly of silt with some clay and sand, with finer sediments in-dock compared to the waterfront berths. There is a bed density of up to 1,300kg/m^{3}in the dock (varies from 1,200-1,250kg/m^{3}in the dock arms). In most areas, this material is constantly re-distributed by shipping movements, currents or discharge from the impounding pumps and by the action of dredging. Such activities prevent consolidation of the bed particularly in areas where more than one of these processes occurs. Average densities deposited at the disposal ground will be of the order of 1,200kg/m^3 or less.

(4) Saltend Jetty
The Saltend Jetty comprises two berths owned and operated by ABP which are currently used mainly for the discharge and loading of Chemical Tankers. There is one berthing pocket that is dredged to provide an adequate depth across both berths, see Annex, Figure 4.8.

Siltation Regime
Occasional dredging is required to remove material that slips into the vessel berthing areas from the bank to the landward side and bed material that accumulates between the jetty piles.

Current Dredging Operations
The dredging requirement for the two berths at Saltend is relatively low with the frequency of the vessels themselves maintaining depths in the relatively strong estuary flows. On average the berths are dredged by a TSHD for a total of about 2 days per year, with a GHD to remove material from along the jetty face for 1-2 days a year (if at all). This total dredging commitment tends to be split over a number of more frequent operations (lasting a few hours each). Both berths at

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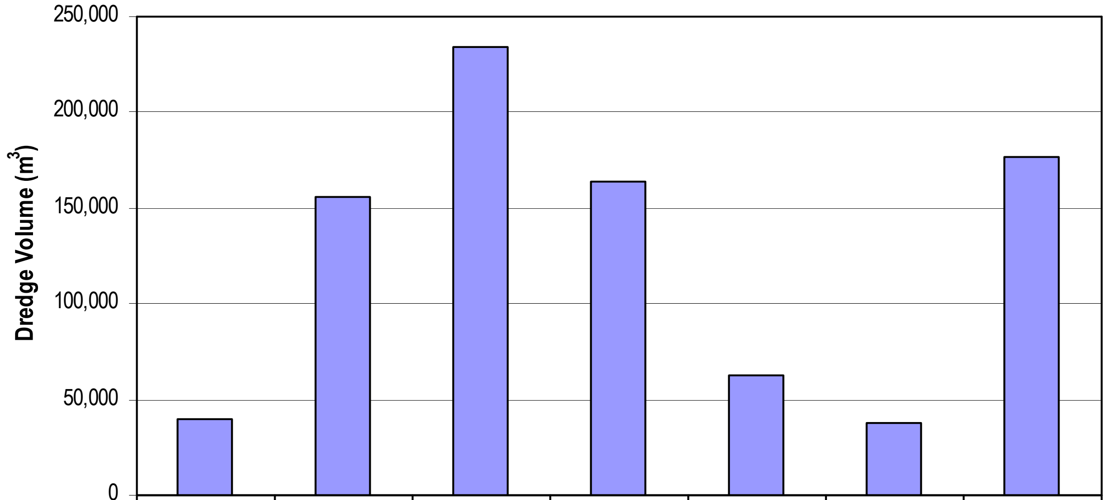
Saltend are dredged to 9.8m below CD, which enables, depending on the state of the tide, berthing of vessels with a draught of 10.4m. Figure 4.8 summarises ABP maintenance dredging volumes across at the Saltend Jetty for the period 2004 to 2010.



	2004	2005	2006	2007	2008	2009	2010
Saltend Jetty	40,026	155,983	234,517	164,090	62,326	38,168	177,054

Figure 4.8: ABP Maintenance Dredging Volumes for the Saltend Jetty (2004 to 2010)

(5) Hull Docks and Waterfront Berths

In order to maintain vessel access and ABP operations at Hull Docks, within the entrances and along the waterfront (river) berths, maintenance dredging is undertaken at eleven locations. The locations of these dredged areas are as follows (see Annex, Figures 4.9 and 4.10):

- King George Dock;
- King George Dock Entrance;
- Queen Elizabeth Dock;
- River Terminal 1;
- East Middle;
- Alexandra Dock;
- Alexandra Dock Entrance;
- Victoria Dock Basin;
- Albert Dock;
- Albert Dock Entrance; and
- William Wright Dock (currently excluded from the FEPA Licence)

Additional third party maintenance dredging is also undertaken locally at the Old Harbour (River Hull) and for the Hull Marina Dock & Basin Area.

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Siltation Regime

Siltation at the King George and Queen Elizabeth Docks is caused by river water entering the dock through the lock and the impounding pumps, carrying suspended sediment which falls out along the dock wall opposite the lock entrance. The remaining sediment is dispersed around the dock by vessel activity. Deposition is noticeable along the boundary of an old dock retaining wall and also at the ends of the docks. A two metre depression tends to form in the centre of the dock towards the location of the ferry Ro/Ro terminal. This is due to the turning actions of the ferries located in this area and other vessels entering the dock. Material deposition is also found at the seaward entrance to the lock to the east of the lock entrance.

River Terminal 1 (RT1) is comprised of a 'T' shaped boarding jetty with a link span to a Ro/Ro Ferry moored against breasting dolphins. For the purpose of keeping the vessel afloat at all states of the tide, a dredged box has been created beginning at the link span location and extending to a point well clear of the bows. The main sedimentation at RT1 is next to the link span. The action of the ship's main engines causes slippage from the steep bank of bed material around the jetty. To a lesser degree, similar action causes slippage at the location that corresponds to the vessel's bow thrusters. The remainder of the deposited material is evenly distributed along the length of the box by the river's natural siltation process

Sediment enters Alexandra Dock through the lock gates and drops out of suspension. There are no impounding pumps in this dock and the lock gates are the only source of ingress of suspended material. Additionally, sediment also enters the Victoria Dock Basin from the estuary culminating in a requirement for dredging.

Finally, sediment enters Albert Dock through the lock gates and accretes in the lock entrance. Further hydrodynamic effects move finer particulates along the dock through the open entrance into William Wright Dock. Due to low level dock usage the lock itself sometimes requires small quantities removing. Another area where sediment accumulates is the lock approaches which is angled towards the flood tide. A back water is formed which causes material to be deposited. There are no impounding pumps in either dock therefore the lock gates are the only source of ingress of suspended material.

Current Dredging Operations

At the King George and Queen Elizabeth Docks, a TSHD presently works in conjunction with a GHD, with the GHD able to access close to the dock walls and in-dock recesses; the two dredgers do not necessarily work together simultaneously. Based on recent figures (see Figure 4.9), a TSHD is required on average to dredge King George and Queen Elizabeth Docks and the approaches for about 16 days in a year, whilst a GHD is generally used for around 20 days. This dredging commitment is spread fairly evenly over the year. Dredging is not affected by tidal constraints as the dredger can be penned out under most states of tide (extreme springs being the exception), although significant delays can result from a high volume of dock traffic. In addition to the TSHD and GHD, there has been an occasional use of a bed leveller in the docks to maximise the dredge efficiency. The King George and Queen Elizabeth Docks are both maintained to a sill depth of 11.5m at the impounded water level to allow vessels of up to 10.4m draught to navigate safely in the dock, thereby meaning that the docks are dredged to 5.5m below CD.

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Historically at RT1, a combination of a TSHD and a GHD has been used for maintenance dredging. More recently, a bed leveller has been deployed to maintain the dredge box, achieved through 5-6 hours of dredging every month. The bed leveller relies on the principle that the operation keeps the material in a fluid state and the agitation action of the leveller drags the material out of the box into the tidal stream. This operation is usually carried out on an ebb tide for maximum efficiency. The dredged box has been maintained to such effect using the bed leveller that it is not envisaged that either a TSHD or a GHD will be required in the foreseeable future. RT1 is currently dredged (if necessary) to maintain a depth of 7.0m below CD, although the frequent vessel usage at the terminal tends to assist the maintenance of the berth. The surrounding area is typically maintained by a TSHD or GHD (with some bed levelling if required), whereby the dredge volumes are shown in Figure 4.9. However, natural self-scouring in this part of the estuary generally keeps the dredging requirement low. The future dredging method and frequency will be whatever is required to keep the berth operational and safe for vessels.

Dredging occurs at East Middle where the bank encroaches into the main navigation channel on the approaches to Hull's Docks. This area is dredged on an ad hoc basis in response to navigational safety concerns and the requirement to maintain navigable width and depths. A TSHD is used when necessary to maintain this area.

The Alexandra Dock and its entrance are dredged using a TSHD and a GHD for around 7 days and 10 days per year respectively. The dredging tends to be concentrated into 4 main campaigns over the course of the year. The dock shape lends itself well to the deployment of a TSHD with the exception of the pencil jetties and enclosed dock extension which to date have been worked by the GHD, which is far more manoeuvrable and capable of getting into restricted areas where sediment may accumulate. Alexandra Dock is dredged to maintain a sill depth of 8.2m, allowing access to vessels of up to 7.9m draught. The dock entrance is dredged to 3m below CD. The Victoria Dock Basin and its entrance (slightly further up-estuary from Alexandra Dock) are currently plough dredged once or twice a year, although this may vary depending on siltation rates.

Albert Dock and its approaches are currently dredged for approximately 5 days and 8 days per year by a TSHD and GHD respectively. This dredging is generally distributed evenly over the year but is also tidally restricted due to the relatively shallow maintained depths in the entrance. The long pencil shape of the dock does not suit vessels needing space to manoeuvre, especially if vessels are berthed along the quay. A plough (bed leveller) is used in the entrance around 3 to 4 times annually. The Albert Dock is dredged to maintain a sill depth of 7m, while the dock entrance is dredged to 1.3m below CD. The dock can cater for vessels of up to a 7m draught. Due to sediment contamination issues within the William Wright Dock, adjacent to Albert Dock, no dredging or disposal activities are currently being undertaken (as shown in Figure 4.9).

ABP will continue to dredge as frequently as required at Hull in order to ensure advertised depths are maintained, with the Humber 4B/Hook (HU020), Humber 4B/Hook Extension (HU021) and Humber 4 (HU030) disposal sites receiving dredged material originating from Hull (docks and waterfront berths) and the Saltend Jetty. However, the future dredging commitment may change depending on the sedimentation regime both within the docks and the river, and the nature of the dredging operation undertook. If more cost efficient dredging methods can be adopted at the

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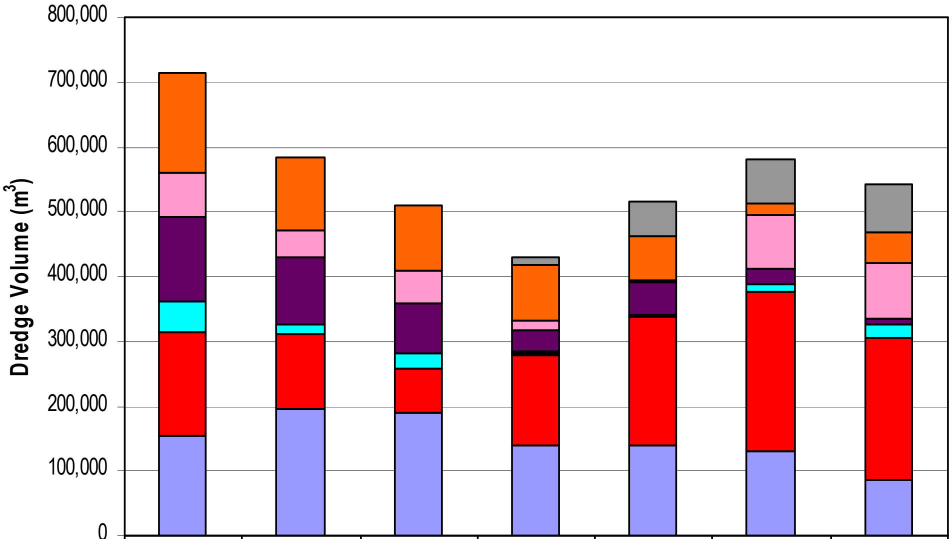
port to minimise the annual dredging commitment then such measures will be adopted wherever possible.



	2004	2005	2006	2007	2008	2009	2010
River Terminal 1	0	0	0	12,346	53,314	69,048	74,266
Alexandra Dock	153,478	113,306	100,491	84,177	69,469	19,398	47,365
Alexandra Entrance	70,512	42,755	49,141	14,909	2,292	80,676	84,780
William Wright Dock	0	0	0	0	0	0	0
Albert Dock	128,540	101,894	78,202	33,277	52,530	26,238	9,757
Albert Entrance	47,730	16,725	23,300	4,255	2,230	9,435	19,480
QE Docks	0	0	0	1,115	0	0	0
King George Entrance	159,416	113,885	68,171	139,347	199,257	247,616	221,519
King George Dock	155,051	196,348	189,922	140,295	137,854	129,666	85,094

Figure 4.9: ABP Maintenance Dredging Volumes for Hull Docks and Waterfront Berths (2004 to 2010)

Material Type

The material removed from within King George and Queen Elizabeth Dock is comprised of fine silt and clays with an approximate bed density of 1,300kg/m³. The density is controlled by allowing consolidation to occur. At RT1, Albert and Alexandra Dock, the material removed is comprised of silt, sand and clay with bed densities of approximately 1,200kg/m³, 1,275kg/m³ and 1,250kg/m³ respectively.

(6) Goole Docks

The Port of Goole and its associated docks are located on the River Ouse, approximately 80km from the mouth of the Humber. The location of dredging undertaken within the Goole Dock system (including the dock entrances) is shown in the Annex, Figure 4.11.

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Siltation Regime

Sediment enters the Goole Dock system through Ocean Lock (main lock), via Victoria Lock or directly from the canal; although it is accepted that the canal water does not contain significant amounts of sediment. The main ingress of suspended sediment is that which enters through the operation of the lock gates. The accumulation of this sediment is centred in and around Ship and Barge Docks which are the first two docks adjacent to the main lock. Sediment is also deposited in Ouse Dock and under the road bridge spanning the dock exit. The accumulation in this area is due to material entering through Victoria Lock.

The fairway between Ocean Lock, running through Ship Dock into Aldam and Railway Dock, is kept clear by vessel movements. The recess of Aldam Dock accretes slowly whilst the corner of Railway Dock has a more significant build up. Deposition in these areas can be attributed to vessels turning action in order to transit the docks. Stanhope, South and West Docks currently have no siltation issues, although localised ridges may form along the berths due to ships lying along the quays (also seen in the other docks). A significant siltation problem occurs in the mouth of the recessed Ocean lock due to the angle of the lock entrance to the river, where flood tide material is deposited at this location; less significant siltation occurs on the ebb tide in the mouth of Victoria Dock.

Goole also has fresh water entering from the canal, whereby the flow is unpredictable as the amount can change from a sizeable influx to a minimal flow in times of little or no rainfall. During 1999 the freshwater input was considerable, allowing the docks to be flushed out. This process can clear fluid mud and keep South Dock, Barge Dock and Ocean Lock clear. However the biggest differences are noted in the Bellmouth area, where the dredging requirement was much reduced in 1999. When there has been limited rainfall, the sluicing facility is not available and the dredging requirement is increased. This makes prediction for maintenance dredging difficult.

Current Dredging Operations

Historically, Goole Docks has been dredged by the GHD "Goole Bight", operated by the Port of Goole, which extracted small amounts of material almost daily. Since the beginning of 1999, UK Dredging took over the dredging requirement with a GHD which is used for up to three campaigns annually of 6 to 10 days each in conjunction with a plough (bed leveller). As Goole has a tidal restriction, the GHD can only take a single dredge load per tide to either the Whitgift Bight (HU040) or Goole Reach (HU041) disposal sites. It should also be noted that West Dock is currently excluded from the FEPA Licence due to contamination issues. The annual dredge volumes for Goole Docks can be seen in Figure 4.10. The docks at Goole are dredged in order to maintain a generally uniform 6.2m water level on the River Gauge throughout the dock system, however, this may in reality vary between individual docks depending on the movement of shipping and natural sedimentation rates. The lock entrances are dredged to 2.4m below CD, typically allowing vessels with a draught of up to 6m to enter the dock system.

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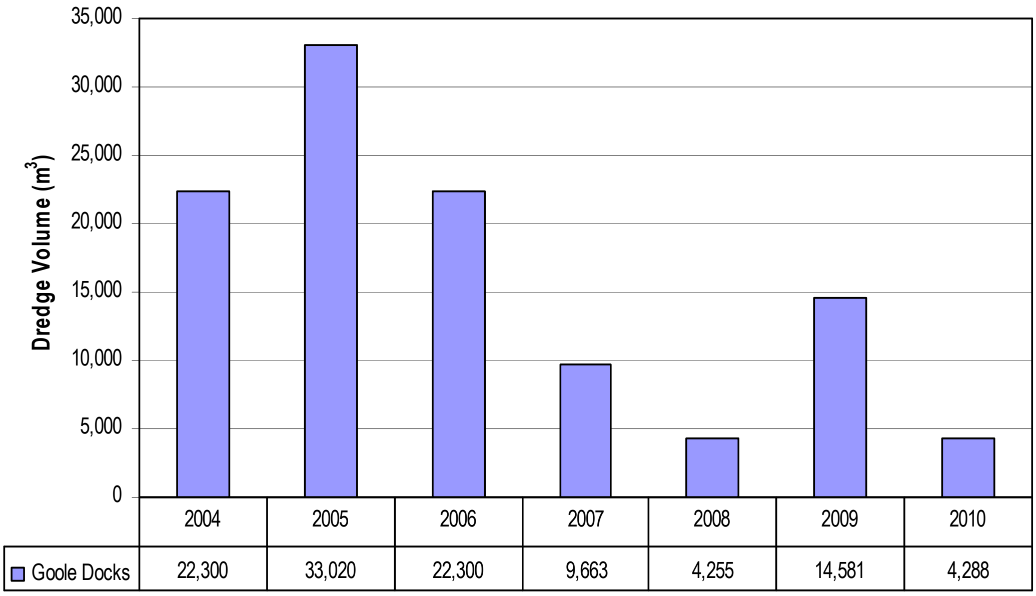

Figure 4.10: ABP Maintenance Dredging Volumes for Goole Docks (2004 to 2010)

Material Type

The sediment in Goole dock is composed of medium to fine silt and clay with an *in-situ* density of approximately 1,300kg/m³in the inner docks and about 1,450-1,500kg/m³ where sediments have been allowed to accumulate in the corners of the outer docks.

Non-ABP (Third Party) Dredging

ABP is the navigation and conservancy authority for the river and has extensive powers over the control of dredging in the river. A third party must seek the permission of the Harbour Master to undertake dredging works as well as secure their own FEPA/Marine licence from the MMO. Certain Acts of Parliament, Harbour Revision Orders etc. may also convey certain powers to dredge but only with the written consent of the Harbour Master (which shall not be unreasonably withheld). Any consents to dredge are accompanied by certain conditions which must be strictly adhered to. Part of these conditions is an assurance, supported by an assessment, that the proposed works will not have a detrimental effect on the river regime and adjacent facilities. They will also include a requirement to forward records to the Harbour Master's office of the location from which material is being dredged as well as the quantities involved. Dredgers are also monitored on radar through the VTS control centre.

Therefore, although ABP has no direct responsibility for the dredging operations of other organisations it is through these existing controls associated with the consents mechanism that ABP seek to ensure that consents issued to third parties to dredge in the Humber are consistent with its own operations. Operators of non-ABP facilities contributed advice and data to this baseline document and have actively commented on the end document. This baseline is a joint exercise between all the operators on the Estuary, and it is envisaged that all contributory companies and facility operators will continue to work together to achieve updates when requested by the lead authority. An overview of the non-ABP (third party) maintenance dredge operators on the Humber Estuary is detailed in the following sections.

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(7) Grimsby Fish Docks

Grimsby Fish Dock Enterprises employ Van Oord to carry out their dredging requirement for the Grimsby No. 1 and 3 Fish Docks and the external entrance channel (up to the main navigation channel), as shown in Figure 4.6. Prior to 2009, dredging in the Fish Docks was undertaken by TSHD and a plough once or twice per year, with each campaign lasting around 4 to 6 weeks. This material was disposed at the licensed Humber 2/Burcom Sand (HU090) disposal site, approximately 2km to the north. Since 2009, WID has been taking place for approximately 3 weeks per year, and has proved to be a more efficient and cost productive process compared to using a TSHD. The Fish Dock entrance channel is currently dredged to a depth of 1.2m below CD, whilst the No.1 and No.3 Fish Docks are dredged to maintain a depth of 6.7m on the inner sill at high water springs. The volume of material dredged by Grimsby Fish Dock Enterprises is summarised in Table 4.2 for the period 2002-2010.

Table 4.2: Maintenance dredging volumes (m³) for Grimsby Fish Docks (No.1 and 3) and the external entrance channel

Location	2002	2003	2004	2005	2006
Grimsby Fish Docks (No. 1 & 3 Docks and the External Entrance Channel)	94,518	109,934	50,000	27,000	80,380
	2007	**2008**	**2009**	**2010**	~~**2011**~~
	126,079	81,900	46,800	85,000	
Note: All values given in the table are in m³. For *in-situ* density (tonnes), values are subject to a 1.4 multiplier.					

(8) Immingham Bulk Terminal

The Immingham Bulk Terminal (IBT) is currently operated by Tata Steel (formerly Corus), and has a FEPA licence to dispose of maintenance dredge material originating from the berths (see Annex, Figure 4.7) at the licensed Humber 3A/Clay Huts (HU060) disposal site. The maintenance dredge commitment for IBT is approximately 18 days each year using a TSHD and GHD, whereby the berths are dredged to 14.5m below CD for vessels of 14m draught. Dredging is also required behind the IBT to remove material that may slump through the jetty to the berthing pocket, which would compromise the depth; however, this dredging is undertaken by ABP. The volume of material dredged from the IBT berths for the period 2004 to 2010 is shown in Table 4.3.

Table 4.3: Maintenance dredging volumes (m³) for the Immingham Bulk Terminal

Location	2004	2005	2006	2007
Immingham Bulk Terminal	298,163	635,339	430,916	485,177
	2008	**2009**	**2010**	~~**2011**~~
	606,748	484,810	304,218	
Note: All values given in the table are in m³. For *in-situ* density (tonnes), values are subject to a 1.3 multiplier.				

(9) Humber Sea Terminal

The Humber Sea Terminal (HST) at North Killingholme (Immingham) is currently operated by Humber Sea Terminal Ltd (Simon Ports plc), and has three separate FEPA licenses for the disposal of dredge material originating from its approaches and six berths (Annex, Figure 4.12). All maintenance dredging at the HST is carried out by UK Dredging using a TSHD, where there is on average one dredge campaign a month which lasts around 3 days, with this material being disposed at the licensed Humber 3A/Clay Huts (HU060) disposal site. The volume of material

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dredged for the HST is summarised in Table 4.4 for the period 2004-2010; earlier dredge volumes for the HST are not known. Dredging is undertaken to try and maintain a depth of 6.3m below CD in the approaches to the terminal and berths (although the design depth is 7.2m below CD), however, the berths themselves generally maintain their own depth without any dredging. This being said, berth 6 has been neglected since its construction in 2007 (where approximately 19,405 wet tonnes of material was dredged as part of a capital works scheme for berths 5 and 6) and would therefore require some work before it could be used. At the time of writing (September 2011), berth 4 had not been dredged since November 2010 and can only be approached at certain states of the tide, although the depth of this berth is still sufficient. Capital dredge works were undertaken at berths 1-4 during 2000 using a TSHD and a GHD for close work around the jetty face, but dredge volumes for this are not known.

Table 4.4: Maintenance dredging volumes (m^3) for the Humber Sea Terminal

Location	2004	2005	2006	2007
Humber Sea Terminal (Approaches and Berths 1-6)	152,472	210,476	390,850	539,424
	2008	**2009**	**2010**	~~**2011**~~
	1,435,339	773,785	702,806	
Note: All values given in the table are in m^3. For *in-situ* density (tonnes), values are subject to a 1.3 multiplier.				

(10) Old Harbour and River Hull

Dredging of the Old Harbour and River Hull is under the jurisdiction of the River Hull Harbour Master (Mike Monday, Hull City Council). Dredging of the Old Harbour occurs approximately once a year (maybe more often if required), and is typically achieved using a plough or a cutter suction dredger (where the dredge material is dispersed back into the water column) to a depth of around 0.5m below the lowest tide level. The location of this dredge area is shown in the Annex, Figure 4.10. Dredging may also be carried out along the River Hull, where there is a potential for dredging within the vessel turning area below Drypool Bridge (Annex, Figure 4.10). This dredging is undertaken when required, generally on an annual basis, and is also achieved through a plough or cutter suction dredger. Prior to 2009, dredging in the Old Harbour and River Hull was achieved by a small GHD with bottom opening doors over high water, with the dredged material being deposited at a licensed sea disposal site.

(11) Hull Marina Dock ('Humber' Dock) and Dock Basin

Dredging of the Hull Marina Dock (Annex, Figure 4.10) is under the jurisdiction of British Waterways, who lease the Dock from Hull County Council. Hull Marina Dock requires major maintenance dredging on average once every 20 years, and is dependant on lock usage and rainfall. No dredging has been undertaken in recent years (i.e. the last 5-10 years). Material from the Dock can also be removed (to a degree) on a regular basis by sluicing and other hydrodynamic techniques (i.e. via flexi-hose into the main flow).

The entrance to Hull Marina Dock is termed 'Dock Basin' and requires maintenance dredging to remove the slow accumulation of material. The Dock Basin was last dredged in 2009 by Hull City Council for a clipper event, where ploughing was undertaken through side-casting using the 'Pelagic II' vessel owned by Barry Hughes Marine. Prior to this, it is believed that the Dock Basin was plough dredged on average once or twice a year, although this may have varied depending on usage, finance and siltation rates.

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(12) Winteringham and Brough Havens

Every year, for the last 10-12 years, the Humber Yawl Club have washed off the berths at Winteringham Haven (Annex, Figure 4.13) using a 4 inch diesel displacement pump, in which the mud is then dispersed into the estuary using an outboard motor. This work is undertaken between December and March, and takes approximately 170 man hours annually to complete. The same technique is also undertaken at Brough Haven (Annex, Figure 4.13), although the volume of work is approximately half of that at Winteringham Haven.

(13) River Trent

A number of independent operators carry out periodic maintenance dredging on the River Trent, the locations of which are shown in the Annex, Figure 4.13. These activities are carried out in order to maintain operational depths at individual berths and approaches, the details of which are discussed separately below.

The berths at Flixborough Wharf and Top Gunness Wharves (Keadby Bridge) are currently maintained by RMS Group Holdings Ltd., who utilise a shore-side crane to grab mud, which is side-cast through the water and re-deposited on the river bed 10-15m from the jetty. This dredging is required to 'level' the build up of mud against the jetty face(s), and takes approximately 1.5 man hours every month to achieve, generally undertaken during quiet periods or as and when is required. Maintenance dredging is essential to the operation of these wharves, but is kept to a minimum to reduce disturbance to the river bed. A plough dredger trial was previously undertaken at Flixborough Wharf, which was along the length of the quay (to the width of the plough), however this process did not achieve any better results than the current methodology and was subsequently discontinued.

At the Neap House and Grove Wharves, maintenance dredging is undertaken by Grove Wharf Ltd. using a shore-side crane, which removes mud from against the jetty face approximately 3 times per year during low tide. This mud is then dumped around the wharf site or nearby into the river.

The berths at Keadby Lock Wharf, which are operated by PD Port Services, are maintenance dredged by shore-side cranes approximately five or six times a year and for a period of around four hours on an ebb tide. Material is grabbed with shore-side equipment and dragged into the outgoing tidal flow as a form of agitation dredging.

Keadby Lock and the navigation channel allowing entry to the lock are maintained on a regular basis through hydrodynamic techniques, which is controlled by British Waterways. No further information is available on timings or methodology. The lock is maintained to the sill level to allow access and lock operation.

(14) Drainage Channels

As a result of flooding, due to the apparent inability of certain drainage channels (ditches) to cope with the volume of water from abnormal amounts of rainfall, the Environment Agency embarked on a campaign of dredging in early 2008. Two drainage ditches on the north side of the estuary were targeted, and sediment build-up was removed with the use of a small cutter suction dredger mounted on a 'jack-up' rig, which disposed of sediment into the flow of the estuary through flexi-hoses. Around 17,000m³ of material was removed from Hedon Haven at the Burstwick Drain

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Outfall during January 2008, and about 19,500m³ of material was removed from Stone Creek at the Keyingham Drain Outfall during February 2008.

In addition to these campaigns, some localised dredging at the Stone Creek outfall structure has been done in the past using a long reach excavator. The removed material was placed and spread on the adjacent foreshore. This dredging was carried out to ensure the tidal gates continued to function properly. No dredging has been undertaken at the Holderness Drain to date, however, ABP have been asked to dredge between the Hedon Road Doors and their tidal doors (for which a land Drainage Consent has been granted by the Environment Agency), with works due to start once site access difficulties have been overcome. No previous dredging operations have been undertaken at Fleet Drain (Hessle), however, there are outline proposals to dredge the A63 culvert downstream at Hessle Clough.

b) Sediment Quality within the Study Area

Sediment quality data for a number of locations within the Humber Estuary for the period 2008 to 2010 are presented in ABP 2012, with a summary provided below. The most recent data for each location is considered first, with the appropriate tables listed in succession from old to new (allowing the document to be updated efficiently).

Metals

Data from the 2008 to 2010 sampling exercises indicate that metal concentrations within the Humber Estuary sediments are typically below Cefas ALs or slightly above Cefas AL 1. However, there were a few sediment samples that exceeded Cefas AL 2, these are for Zinc at West Dock, Goole (2008, Table A3) and William Wright Dock, Hull (2008, Table A6), and for Copper at South Dock, Goole (2008, Table A3).

Organotins

Levels of Tributyltin (TBT) are generally below Cefas ALs for all sediment samples. However, once again there were a few tested samples that exceeded Cefas AL 2. These samples originated from West Dock, Ouse Dock and South Dock at Goole (2008, Table A3) and William Wright Dock, Hull (2008, Table A6). No sampling results have been provided by Cefas for Dibutyltin (DBT) for the period 2008 to 2010, and therefore it is assumed no analysis was undertook.

Polychlorinated Biphenyls (PCBs)

Historically, PCB contamination levels within the Humber Estuary and dock systems are relatively low, and as such, there has been little sampling undertaken in recent years. However, sampling was undertaken within Goole Docks during 2009, as shown in Table A16. Analysis of the sediment samples show that Cefas AL 2 was exceeded at South Dock, Ship Dock, Stanhope Dock and Ouse Dock for CB no.47 (2,2',4,4'-Tetrachlorobiphenyl) and g-HCH (Lindane), whilst Ouse Dock also exceeded Cefas AL 2 for CB no. 156 (2,3,3',4,4',5-Hexachlorobiphenyl) and CB no. 158 (2,3,3',4,4',6-Hexachlorobiphenyl).

Polyaromatic Hydrocarbons (PAHs)

Within the Humber Estuary, many locations exceed Cefas AL 1 for a range of PAH substances, although the Total Hydrocarbons (THC) range largely from 164ppm to 1755ppm. As such, THC exceeds Cefas AL 1 for all sampled locations between 2008 and 2010.

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c) Summary of Sediment Quality

The sediment quality of material licensed for maintenance dredging on the Humber Estuary has been routinely monitored by Cefas. Prior to 2005, it had not been necessary to place licence restrictions on any applicants on the Humber in relation to the sediment quality of maintenance dredge material. However, in December 2005, it was necessary to place a restriction on dredging activities both within Alexandra Dock and William Wright Dock (Hull), due to unacceptably high TBT levels in sediment samples. TBT contamination in Alexandra Dock was subsequently found to have reduced to acceptable levels, and this restriction was lifted; although the restriction on William Wright Dock has remained. In addition to these, West Dock (Goole) has also been excluded from FEPA licenses since 2006, due to high levels of Zinc within the dock. These issues are further noted in ABP 2012.

In more recent times (i.e. since 2008), the docks at Goole have also been the subject of further investigation, primarily with relation to Zinc, Copper, PAH and DDT (g-HCH) contamination. Further details are provided in ABP 2012, whereby monitoring and subsequent analysis was undertook to satisfy licence conditions on the present FEPA licence.

However, although there have been contamination issues at select locations in recent years, contamination levels within sediment samples across the Humber Estuary are typically below Cefas ALs or slightly above AL 1. In general, contaminant levels in dredged material below AL 1 are of no concern with respect to their potential to cause pollution, and are unlikely to influence the decision to issue a licence. These action levels are not absolute 'pass/fail' levels, but are used as guidance in conjunction with other assessment criteria. Where contamination levels in sediment samples exceeded Cefas AL 1, these concentrations would have been taken into account by the licensing authority, and have nonetheless been deemed acceptable for disposal to sea.

4.2 Placement sites

4.2.1 Relocation within the aquatic environment

Disposal Sites

Within the Humber Estuary there are a number of disposal sites which can be used under FEPA licence for the disposal of maintenance and capital dredge material. Table 4.5 lists these sites along with their current status, i.e. open, closed or disused, and their locations can be seen in Figures 4.1 to 4.4 (all Annex).

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Table 4.5: Sea disposal sites within the study area

Disposal Site		Status
Site No.	Site Name	
HU020	Humber 4B / Hook	Open
HU021	Humber 4B / Hook Extension	Open
HU025	Alexandra Dock (Pipeline)	Closed
HU030	Humber 4	Open
HU040	WhitgiftBight (River Ouse)	Open
HU041	GooleReach	Open
HU045	Redcliffe	Disused
HU046	Hull Marina	Open
HU050	Humber 3	Closed
HU055	Foul Holme Deposit	Closed
HU056	Holme Channel Deep	Open
HU057	Foul Holme (Circular)	Closed
HU060	Humber 3A / Clay Huts / Buoy 11A	Open
HU080	Humber 1A / MiddleShoal	Open
HU081	North Sunk / SDC Window Site 'B'	Open
HU082	SDC Window Site 'C'	Open
HU083	SDC Window Site 'A'	Open
HU090	Humber 2 / Burcom Sand / Burcom Middle	Open
HU091	Humber 2 Extension A	Disused
HU092	Humber 2 Extension B	Closed
HU093	Humber 2 Extension C	Closed
HU109	Bull Sand Fort Extension	Open
HU110	Humber 1 / Haile Channel	Closed
HU111	Bull Sand Fort	Open
HU112	Pyewipe Channel	Open
HU162	North Killingholme Cargo Haven	Open
HU201	Conoco Pipeline Trench	Open
-	Foul Holme Spit - Capital Works Beneficial Use Site (IOH)	Closed
-	Clay Huts Capital Site - Capital Works Beneficial Use Site (IOH)	Open
-	Albert Dock Pipeline (Hull)	Open
-	Holme RidgeBuoy	Proposed

Of the disposal locations detailed in Table 4.5, only a small proportion are currently used for maintenance dredging purposes by ABP and non-ABP (third party) organisations within the Humber, for which a FEPA/Marine licence is required for the disposal of material at these sites. Details of these disposal sites are given in the subsequent sections, along with the disposal returns for maintenance dredging as recorded in the Disposal at Sea (DAS) database (available from Cefas), shown in Table 4.6.

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(1) Humber 1A / Middle Shoal (HU080)

The Humber 1A/Middle Shoal (HU080) disposal site is located immediately to the south of the SDC in the Outer Humber Estuary (seen in the Annex, Figure 4.1). This deposit site was licensed for the first time in the early 1970s and has received nearly all of the maintenance material dredged from SDC, except for some of the early years of the channel.

The proximity of the deposit site improves the efficiency of dredging despite the greater potential for sediment directly returning to the channel than disposal further from the site. In effect, the sediment is displaced laterally by the dredging processes and thereby minimising any impact on the sediment dynamics of the estuary. Occasionally cargoes from Immingham and Grimsby will be deposited at the Humber 1A disposal site when in transit between the various dredge locations.

Table 4.6 indentifies the disposal records for Humber 1A, as taken from the DAS database, for the period 1986 to 2010. The peak amount being disposed at this site occurred in 1997, when around 8.95 million wet tonnes of material was disposed. The average yearly amount of material being disposed at this site for this 25-year period is approximately 3.87 million wet tonnes, of which the majority has originated from the SDC.

(2) Humber 2 / Burcom Sand (HU090)

The Humber 2/Burcom Sand (HU090) disposal site is situated on the edge of Burcom Sand, approximately 1nm (nautical mile) north of Grimsby Docks (seen in the Annex, Figure 4.1). The site has been used for in excess of 100 years, predominantly receiving material dredged from the Grimsby Docks system. The peak amount of material disposed at the site for a 25-year period (between 1986 and 2010) occurred in 1996, when some 917,795 wet tonnes of material was disposed (see Table 4.6). Over this same period, the average annual disposal amount was approximately 633,615 wet tonnes.

(3) Humber 3A / Clay Huts (HU060)

The Humber 3A/Clay Huts (HU060) disposal site is situated just off Immingham Dock, adjacent to Clay Huts and Holme Ridge in the river (see in the Annex, Figure 4.2). This site is mainly used for material arising from the dredging of the enclosed Immingham Dock, plus its entrance and riverside berths, from the terminals at Immingham and South Killingholme and any requirement from the Humber Sea Terminal at North Killingholme. Occasionally, dredged material from Saltend will also be deposited at the site if dredging is required on neap tides when the Hull disposal sites (HU030 and HU020) are inaccessible, or where the dredger is in transit between dredge locations.

Table 4.6 indentifies the disposal records for Humber 3A, as taken from the DAS database, for the period 1986 to 2010. The peak amount being disposed at this site occurred in 2008, when around 8.21 million wet tonnes of material was disposed. The average yearly amount of material being disposed at this site for this 25-year period is approximately 3.15 million wet tonnes.

(4) Humber 4B / Hook and Extension (HU020 & HU021) and Humber 4 (HU030)

The Humber 4B/Hook (HU020), Humber 4B/Hook Extension (HU021) and Humber 4 (HU030) disposal sites are located adjacent to Hull Docks, as shown in the Annex, Figure 4.3. The majority of material deposited at these three sites comes predominantly from the various docks and dock entrances at Hull, River Terminal 1 and the berths at Saltend. The same sites are used should any dredging be required from non-ABP (third party) jetties and wharves in the area of Hull. It should be noted that the Humber 4B Extension disposal site was both characterised and used for dredge disposal for the first time during 2010.

The peak amount of material disposed at the Humber 4B and Humber 4 sites for a 25-year period (between 1986 and 2010) occurred in 1996 and 1999, respectively, when some 3.74 and 2.01 million wet tonnes of material was disposed (see Table 4.6). Over this same period, the average annual disposal amount at each site was approximately 1.22 and 1.07 million wet tonnes respectively. With regards to the recently opened Humber 4B Extension disposal site, circa 30,000 tonnes of material was disposed during 2010. It is also worth highlighting that there has been a marked decline in the dredge and disposal requirement at Hull since 1996.

Table 4.6: Summary of DAS records for maintenance dredging returns at relevant Humber disposal sites (wet tonnes)

Disposal Site	1986	1987	1988	1989	1990	1991	1992	1993	1994
HU020	1,241,897	2,003,313	1,983,780	2,673,175	2,871,865	2,154,130	2,907,866	1,784,060	1,569,023
HU021	-	-	-	-	-	-	-	-	-
HU030	1,222,536	1,536,421	205,360	196,990	249,730	99,580	24,000	20,930	1,866,497
HU040	74,210	63,035	54,420	78,890	52,240	49,715	41,010	45,890	43,620
HU041	-	-	-	-	19,345	13,880	7,855	6,945	5,740
HU046	-	-	-	-	-	-	-	-	-
HU060	3,016,875	3,432,605	2,047,285	1,798,265	1,407,085	1,347,612	1,764,605	1,245,246	2,326,894
HU080	3,057,600	2,995,200	5,293,600	6,592,300	0	4,811,300	3,190,200	1,758,640	5,651,604
HU090	776,870	864,350	632,235	612,330	670,455	519,925	740,310	482,740	837,926

Disposal Site	1995	1996	1997	1998	1999	2000	2001	2002	2003
HU020	2,344,045	3,735,181	1,353,613	1,576,273	235,314	331,415	252,833	166,580	141,965
HU021	-	-	-	-	-	-	-	-	-
HU030	1,146,331	985,788	649,011	848,355	2,009,174	1,828,187	1,289,602	1,343,826	1,543,189
HU040	50,455	55,576	32,425	43,310	38,180	6,575	5,575	0	1,115
HU041	19,255	31,310	17,480	17,385	42,040	6,690	9,720	10,220	33,451
HU046	-	-	-	-	-	-	-	-	44,400
HU060	2,030,341	3,010,452	1,697,240	2,371,148	2,993,101	2,547,476	2,388,177	3,336,997	2,768,711
HU080	7,729,597	8,332,745	8,945,818	7,170,342	3,506,220	4,719,030	4,190,217	4,241,355	7,307,587
HU090	483,480	917,795	462,266	676,375	809,118	639,142	713,975	708,221	423,099

Disposal Site	2004	2005	2006	2007	2008	2009	2010	2011	2012
HU020	264,945	197,235	216,905	156,460	114,390	127,685	84,851		
HU021	-	-	-	-	-	-	30,076		
HU030	1,472,404	1,635,917	1,594,512	1,620,639	1,624,536	679,197	980,214		
HU040	3,345	15,565	10,035	10,105	3,380	5,765	2,230		
HU041	18,500	21,855	14,565	28,125	8,305	17,010	5,725		
HU046	29,600	0	0	0	0	0	-		
HU060	3,799,975	3,935,056	4,483,622	7,298,446	8,213,693	4,851,564	4,566,517		
HU080	4,366,425	2,485,842	448,446	0	0	0	30,536		
HU090	681,309	610,857	626,677	682,177	559,482	316,251	393,019		

(5) Whitgift Bight (HU040) and Goole Reach (HU041)

The Whitgift Bight (HU040) and Goole Reach (HU041) disposal sites are located in the River Ouse (see Annex, Figure 4.4), on the approaches to Goole, and are used solely for the disposal of material dredged from the Goole Docks and lock entrances. Disposal of material dredged from Goole Docks is permitted anywhere within the designated boundaries of the two disposal sites.

The peak amount of material disposed at the Whitgift Bight site for a 25-year period (between 1986 and 2010) occurred in 1989, when some 78,890 wet tonnes of material was disposed (see Table 4.6). Over this same period, the average annual disposal amount was approximately 31,467 wet tonnes. In comparison, the peak amount of material disposed at the Goole Reach site between 1990 and 2010 occurred in 1999, a value of 42,040 wet tonnes. Over this 21-year period, the annual disposal amount was around 14,216 wet tonnes. The combination of these values would therefore suggest that the long-term average yearly dredge/disposal amount for the Goole Dock system is in the region of 45,683 wet tonnes.

(6) Pipeline disposal Hull

In addition to the disposal sites mentioned above, there are two disposal pipelines located within the Humber; one is located in Alexandra Dock (HU025) and the other in Albert Dock, Hull. The exact locations of these pipelines are shown in the Annex, Figure 4.3.

The pipelines were installed in both docks in order to improve the efficiency of the dredging operation. Due to the fact that the docks are not impounded, the fixed pipelines reduce dredger transits, which assist in maintaining the dock water level and reduce the ingress of sediment. By using the pipelines, a TSHD dredger can undertake dredging within the docks, then as opposed to negotiating the lock, they can simply hook up the pipeline and pump the dredged material out into the estuary over the dock wall (into the strong tidal flows). However, although the Albert Dock pipeline is still currently being used, the pipeline at Alexandra Dock is now closed.

Dredging Methods

Trailer Suction Hopper Dredging: TSHD uses suction to raise loosened material from the bed through a pipe connected to a centrifugal pump. Suction alone is normally sufficient for naturally loose material, such as recently deposed material within deepened areas such as the approach channel or berthing areas. TSHD is most efficient when working with fine substrates such as mud, silt, sand and loose gravel as the material can be easily held in suspension. Coarser materials can also be dredged using this method, but with a greater demand on pump power and with greater wear on pumps and pipes. Material dredged by TSHD then requires depositing either within a licensed sea or land disposal site usually by direct bottom dumping (at sea) or through pumped discharge (to a land disposal or beneficial use site).

Grab Hopper Dredging: A GHD is a vessel which has one or more dredging cranes mounted around a receiving hopper. The cranes are fitted with grabs that pick up material from the seabed, and discharge the material into the hopper. GHD are usually held in position while working by anchors and moorings but a few are fitted with a spuds, or piles, which can be dropped onto the seabed whilst the dredger is operating. Once loaded, the vessel moves to a disposal site to discharge material, which is normally achieved through direct placement at the site by direct bottom dumping.

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Water Injection Dredging: WID consists of injecting large amounts of water at low pressure into surface sediments on the seabed. This generates a high density layer on the seabed, normally being a maximum of 1.0m deep, with the highest density part of the cloud being 0.5m above the bed. The density cloud acts as a fluid layer and flows over the bed through the action of gravity along the seabed contours. The aim of this form of dredging is not to suspend sediments within the water column, but rather to move sediments from one area to another, and thus keep the sediment within the system. Some re-suspension of fine sediment fractions often occurs locally to the WID site, or where tidal flows are higher thereby mobilising material. If the density cloud flows over a pronounced change in bed gradient, material also has the potential to be re-suspended.

Plough Dredging (Bed Levelling): Plough dredging utilises a tug equipped with a plough unit. The plough is lowered to a predetermined depth and is used to drag sediment along the seabed. Ploughing is typically used in confined areas due to the small size and manoeuvrability of the vessel, moving material from inaccessible areas such as dock entrances, corners or complicated areas of bathymetry to areas accessible by TSHD or WID vessels, or is used for bed-levelling purposes only. As with WID, ploughing should not typically lead to significant re-suspension of sediment in to the upper water column, but if the sediment ploughed is soft it may be sufficiently disturbed to raise smaller sediment fractions into suspension.

4.2.2 Deposition of sediments at the North Sea

This practice is not carried out on the Humber Estuary.

4.3 Land Treatment of Sediments

This practice is not carried out on the Humber Estuary.

5 Strategies for dredging

5.1 General aspects

Few cost effective beneficial uses have been identified to date due to the nature of much of the material arising from maintenance dredging in the Humber Estuary, which predominantly consist of coarse to fine silts, of which the remainder is mostly fine sand mixed with silt. When there is a maintenance requirement in the SDC (see Table 4.1), well sorted sand of 120-180 microns is dredged from the south side of SDC.

In the past some sand has been used as general fill for reclamation or foundation material for construction works within the river, even though not of ideal quality. It is considered that when dredging of this material is required, this could represent a resource for general fill material that could be used within the estuary. In general, the material is too fine for beach nourishment purposes. ABP will continually look to use a proportion of this material wherever possible to reduce the need of using a more valuable natural resource, therefore minimising any environmental impacts when considered on a wider, more holistic basis, whilst also taking account of maintaining the sediment budget of the estuary.

One of the main concerns relating to maintenance dredging is the loss of fine material (predominantly silts) from estuaries due to disposal sites outside of the system, therefore depleting material that could potentially contribute to accretion of the intertidal areas within the estuary. In the case of the Humber Estuary, fine maintenance dredge material is deposited within the estuary system which prevents direct material loss. The disposal of material from the docks nearby in the estuary returns the material which has become cut off from the dynamics of the sedimentary system. The disposal of material from SDC is relocated adjacent to the channel in a similar flow environment, thus minimising any additional indirect loss from the estuary that may occur.

Deposit grounds within the Humber Estuary are all located as near as practically possible to the areas where dredging takes place; thus relocation in terms of distance is minimised. The deposited sediments are rapidly dispersed into the tidal flow joining the fine sediments that are already in suspension and pass in and out of the estuary on every tide. Modelling by both Delft Hydraulics (2004) and ABPmer (2004b) indicates that a proportion of the relocated sediments move out of the estuary and therefore could represent a small risk of loss. However, these models do not take into account:

- Recirculation back to the estuary, which almost certainly occurs;
- Background concentrations which will influence the transport and settling of material; and
- If the material did not settle in the docks or channel it would pass through the estuary, the same as the relocated sediment. This suggests that considerable care is required in analysing the results of modelling and in general, modelling will lead to an overestimation of the loss of sediment. Also, the total annual maintenance dredging is approximately equivalent to the amount of sediment in the estuary on a spring tide, therefore the sediment relocated represents less than 0.2% of the suspended sediment in the estuary over a year.

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Surveys of the deposit grounds over the last century indicate that most (if not all) of the deposited fine silts have been dispersed throughout the system. Modelling of the dispersal from the deposit grounds indicates that the material relocated in these areas contributes to the sediment supply of the intertidal areas throughout the estuary. Also as no significant change in the bathymetry has occurred, the disposals have not changed the local hydrodynamics. This type of disposal of fine material has been called sediment cell maintenance (sustainable relocation), which is considered to be beneficial to the system compared to removal of fine silt sized sediment to land or taken out to sea into a different sediment system.

Modelling the size distribution of sediments throughout the estuary indicates that the removal of coarser, sand material from the outer estuary for beneficial use, as described above, is unlikely to significantly affect the estuary system. This is due to the volumes involved being small compared with the large volumes of change that occur annually within the outer estuary and the fact that the size of the material makes little overall contribution to the build up of the intertidal areas within the estuary.

The existing maintenance dredging is long established and the estuary morphology is working towards a dynamic equilibrium with this process. Work on the entropy of the system suggests that any changes could be in the order of 350 years to come to equilibrium. If this is correct, then the estuary is still changing from the significant reclamation and other work in previous centuries. The system is therefore not in a stationary state. In this respect the dredging is so small in context to the scale of the estuary system that any response signal will be difficult to detect. At present there is no evidence that any part of the estuary is starved of sediment or that continuation of the current disposal practices or the associated small scale beneficial use of a proportion of the coarser sediment are likely to significantly modify the existing morphology of the estuary, which has adapted to these activities over many decades.

As part of the licensing process, ABP also actively seek, by consultation wherever possible, to find a beneficial use for the maintenance dredged material taken from the Humber. The bodies consulted include:

- Environment Agency;
- East Riding District Council;
- East Lindsey District Council;
- North Lincolnshire Council; and
- North East Lincolnshire Council.

5.2 Capital dredging of fairways

In the context of the Humber Estuary, the only “fairway” that ABP maintain is the SDC. This was capital dredged in 1969 and has been maintained at its current depth of 8.8m chart datum since. Maintenance dredging is carried out on an Ad Hoc basis. It is hard to say whether any avoidance of maintenance dredging was considered in the process but even at present, it is almost impossible to predict how much maintenance dredging will be required. This is because of the Humber Estuary’s dynamics and high turbidity content.

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5.3 Maintenance dredging of fairways

Maintenance dredging is carried out on an Ad Hoc basis. ABP place the clay dredged material at the SDC windows to primarily fill natural depressions and level out the estuary bed, but it can also act as a training wall to the SDC and encourage scour.

Maintenance dredging of the SDC is not constrained by tide. The only constraint is that the dredging activities must avoid commercial vessels who need to use the channel to reach the ports.

With regards to special features, ABP have to take into consideration the designated species and features, which is the purpose of the Maintenance Dredge Baseline Document. This is to be reviewed when a new project is consented and constructed. This document take assesses the baseline activity against all of the designations.

5.4 Maintenance dredging of harbours (open)

In the context of the Humber Estuary, the term “harbour” has been understood to mean “port”.

The general strategy of maintenance dredging is outlined in the Baseline Document (ABP 2012), and the primary reasons are given here in section 5.1. Again, maintenance dredging is carried out on an ad hoc basis and it is impossible to design out future maintenance dredging activities due to the high turbidity of the Humber, however, on the rare occasion that shipping activity is greatly reduced, ABP have not opened the lock gates so as to prevent further sediment laden water entering the docks.

Maintenance dredging is not constrained by tide. The only constraint is that the dredging activities must avoid commercial vessels which need to reach the ports

With regards to special features, ABP have to take into consideration the designated species and features, which is the purpose of the Maintenance Dredge Baseline Document (ABP 2012). This has to be reviewed when a new project is consented and constructed. This document take assesses the baseline activity against all of the designations

5.5 Placement in open water

General approach
The main reasons why dredged material is disposed of within the estuary being:

1. for sedimentary budget reasons. Humber Estuary Services (HES) aim to deposit the sediment back to it’s place of origin.
2. sites are based on a like for like basis i.e. sandy dredged material is placed in a location that is predominantly sand

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3. for economic and resource reasons. Aim is to keep sediment away from the dredged areas but not too far away so as to mean that there is more time spent steaming than dredging/ dumping of the material.
4. aid to intertidal
5. minimal change to the estuary bed levels
6. minimal change to designated features; and
7. to dispose of the material evenly over an area to avoid smothering of benthic organisms.

Use of dredged sediments for re-establishing habitats or hydro-engineering

The sediment is primarily deposited based on the criteria given above, namely sediment budget, like for like basis and economic reasons. Dredged material has not been used for the re-establishment of habitats at an intertidal level due to the high accretion levels from the Humber's high turbidity. Placing dredged material on these areas would potentially facilitate the development of the mudflats to saltmarsh and eventually terrestrial habitat.

The placement of dredged material has been used for hydro-engineering purposes but not extensively. The SDC windows for example were identified because they were natural depressions and by depositing material here it would level out the estuary bed. The deposition of material here would have a secondary beneficial effect of acting as a training wall to direct the SDC.

The Bull Sand Fort disposal sites were temporary disposal sites for clay to reduce natural scour that occurred around the base. The material for this was taken from primarily SDC dredging but also others.

Placement time, e.g. dependant on tidal phase, current velocities and/or season

This practice is not carried out for maintenance dredge disposal due to operational restriction.

Special aspects referring to ecology/water quality/habitats and species protection

The focus of protecting the estuarine habitat is to ensure that the sediment budget remains within the estuary to protect the estuarine ecosystem by not altering the dynamics etc and therefore ensuring the other designated features are not affected. The assessment of maintenance dredging on the designated features is given in the Baseline Document.

Water quality of the Humber Estuary is monitored by Cefas. When a new application is submitted, the sediment must be tested for contaminants etc to determine if consent should be granted and the best course of action. Additional sampling and testing may be required if the Marine Licenses have special conditions requiring sampling at more often intervals if there is a concern over an area.

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5.6 Land treatments, Confined disposal facility (CDF), alternative utilization

This practice is not carried out on Humber.

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6 References

ABP Humber Estuary Services. 2012. "Humber Estuary: Maintenance Dredge Protocol and Water Framework Directive Compliance Baseline Document. R1872.

ABP. 2011. Green Port Hull. D136322. **Environmental Statement**: Non Technical Summary. November 2011. URS

Humber Estuary Services. 2012. http://www.humber.com/

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Annex

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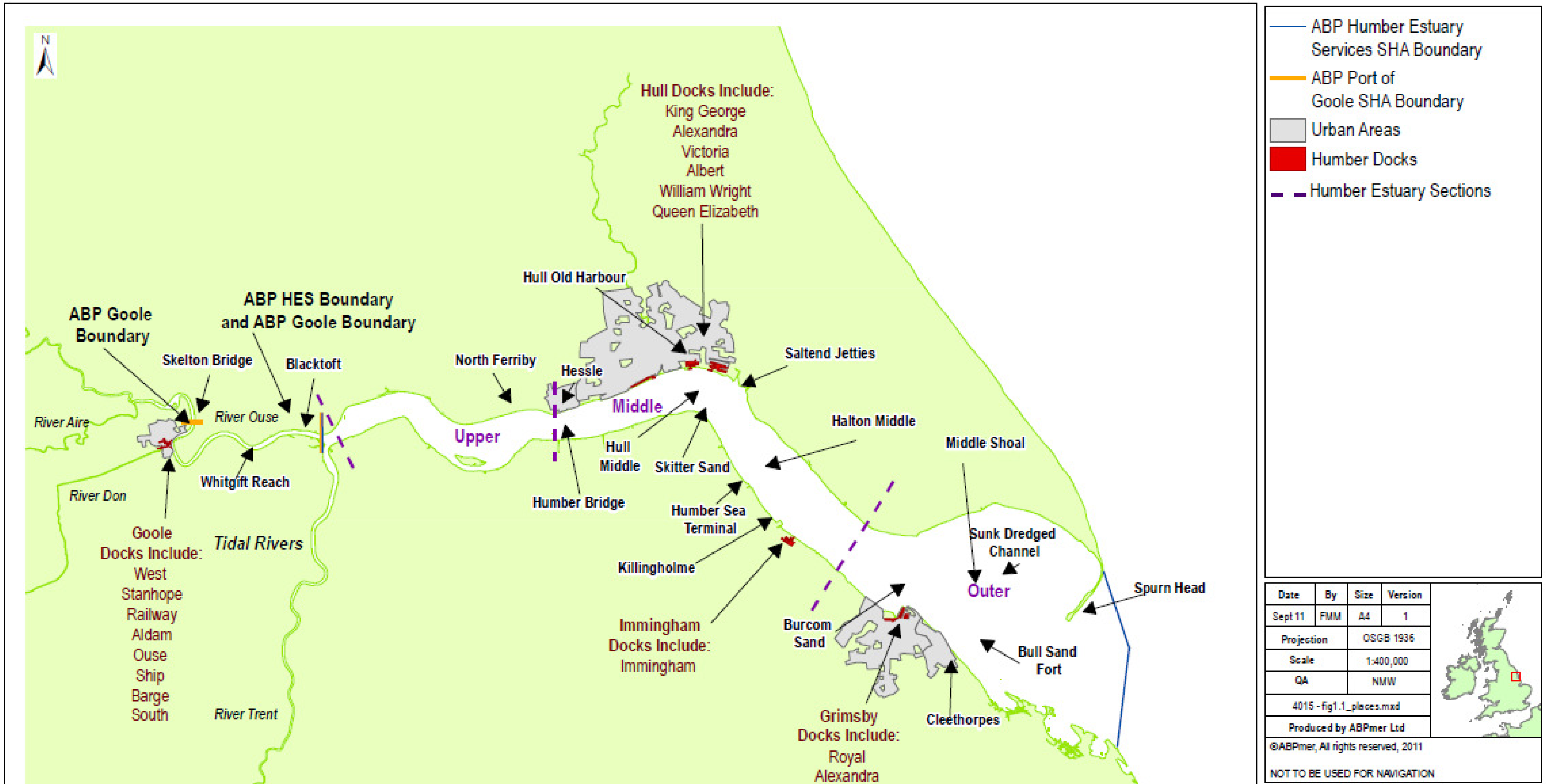
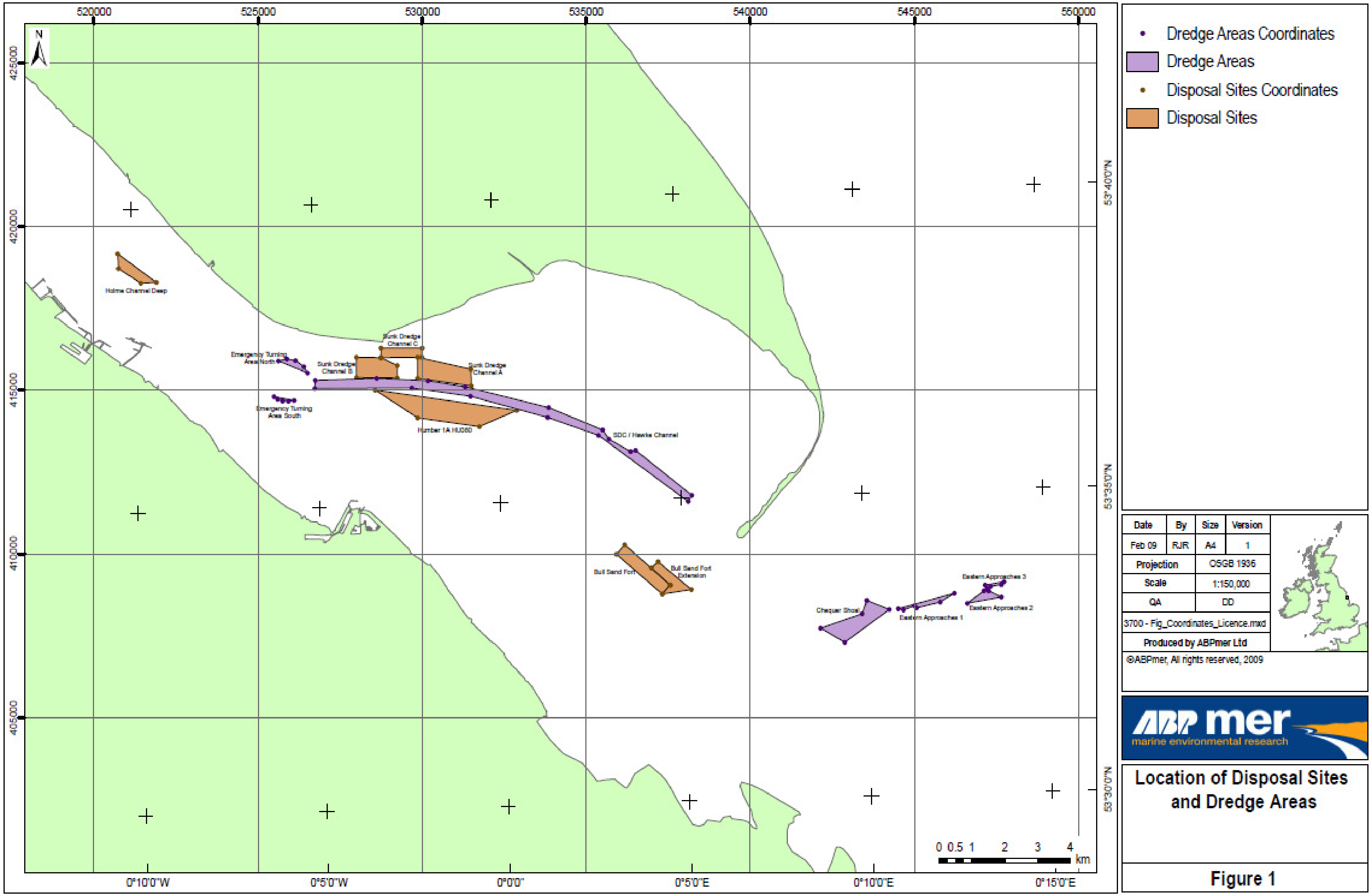


Humber Estuary Locations and Boundaries

Figure 1.1



Location of Disposal Sites and Dredge Areas

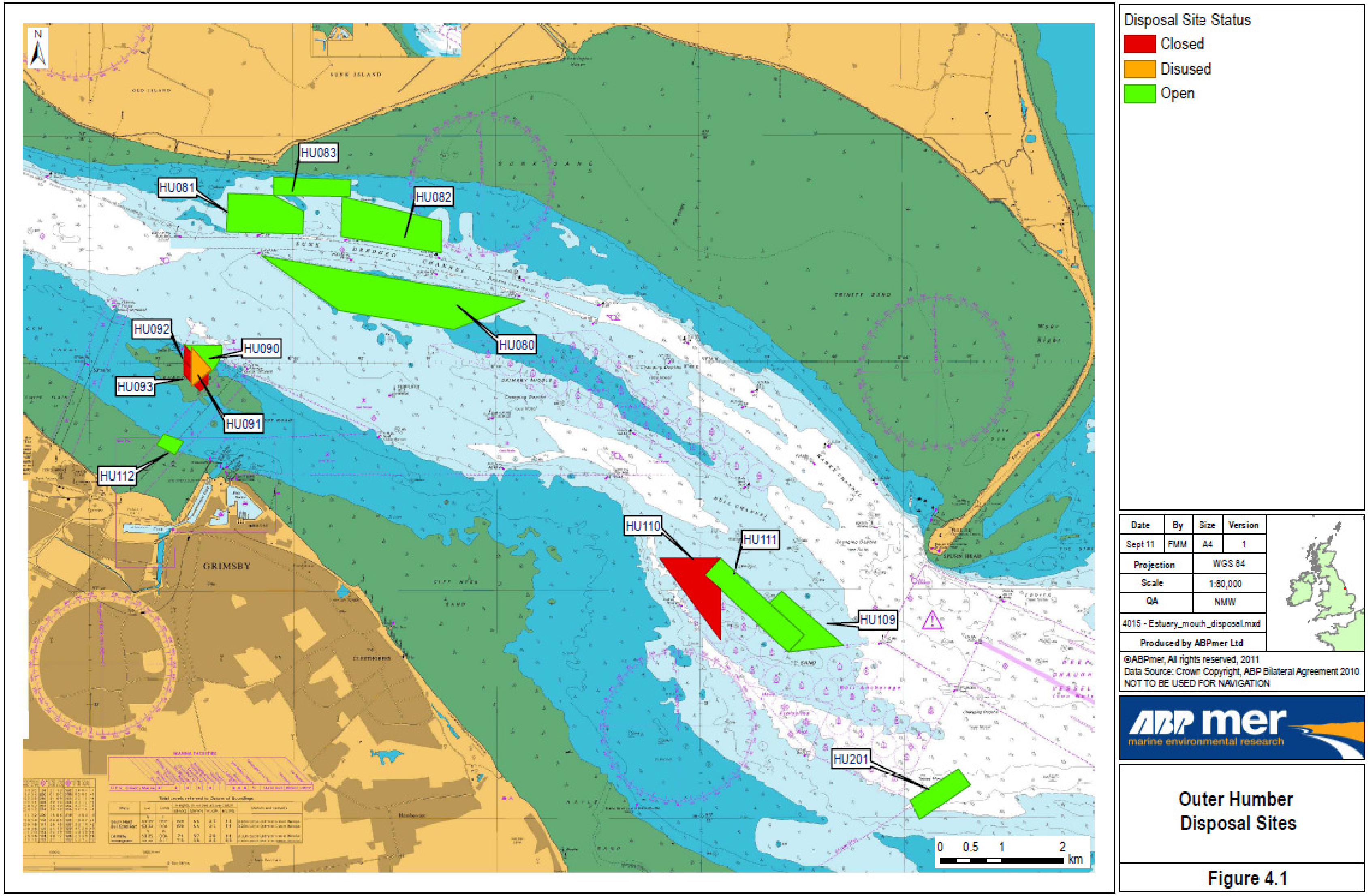
Figure 1

Table 5. Summary of Immingham Oil Terminal approach channel deepening dredge and disposal strategy including beneficial use as infill for Green Port Hull

Dredge Location	Dredge Material Volume	Proposed Capital Dredge Depth	Dredge Material Type	Dredge Method	Controlling Depth at Dredge Location	Deposit Location	Deposit Volume	Deposit Site Distance From Dredge Location	Deposit Site Controlling Depth	Deposit Site Approaches - Controlling Depth	Approximate Deposit Site Accessibility (Basis 6.5 m Draught)
Stallingborough Emergency Turning Area	65,000 m^3	11.6 m below CD	Soft clay, silt and sand	TSHD	10.3 m - 10.5 m below CD	Holme Channel Deep (new site) *	22,000 m^3	6.5 km	5 m below CD	4 m below CD	1.75 hours ± HW on spring tides
						Middle Shoal (Humber 1A/HU080)	43,000 m^3	3.5 - 6 km	4 - 5 m below CD	5 m below CD	4 hours ±HW on spring tides
Sunk Dredged Channel - north side	970,000 m^3	11.6 m below CD	Soft clays and silt	TSHD	9 m below CD	Holme Channel Deep (new site) *	311,000 m^3	6 - 14 km	5 m below CD	4 m below CD	1.75 hours ± HW on spring tides
						Middle Shoal on flood tide	659,000 m^3	2.5 - 6 km	4 - 5 m below CD	5 m below CD	4 hours ±HW on spring tides
Sunk Dredged Channel - south side	895,000 m^3	11.6 m below CD	Fine sand	TSHD	9 m below CD	Middle Shoal on ebb tide	895,000 m^3	2.5 - 6 km	4 - 5 m below CD	5 m below CD	4 hours ±HW on spring tides
Sunk Dredged Channel - full area	120,000 m^3	11.6 m below CD	Firm glacial clay	Cutter Suction Dredger **	9 m below CD	SDC area 'C'	120,000 m^3	3 - 4.5 km	5 - 7 m below CD	9 m below CD	Barge or pipe and booster station. No restriction for barges
Hawke Channel	565,000 m^3	11.8 m below CD	Soft clays and silt	TSHD	9.7 - 10.8 m below CD	Bull Sand Fort (disused deposit site HU111)	565,000 m^3	2.5 - 7 km	4 - 16 m below CD, ave 7 m below CD	9 m below CD	No restriction
Chequer Shoal	865,000 m^3	13 m below CD	Fine to medium compacted sand	TSHD	10.4 m below CD	To GPH infill	865,000 m^3	37 - 38km	No restriction	No restriction	No restriction
Eastern Approaches	170,000m^3	13.1m below CD	Fine to medium sand	TSHD	10.5 m below CD	To GPH infill	112,600 m^3	40 - 43km	No restriction	No restriction	No restriction
		13.1m below CD	Fine to medium sand	TSHD	10.5 m below CD	Bull Sand Fort (slight increase in area to NE)	57,340m^3	7.5 - 10 km	4 - 16 m below CD, ave 7 m below CD	9 m below CD	No restriction
	255,000 m^3	13.1 m below CD	Stiff glacial clay	Backhoe and barges	10.5 m below CD	Bull Sand Fort and SDC areas 'A' and 'B'	255,000 m^3 in clay 'lumps'	20 km	5 - 6 m below CD	5 - 6 m below CD	No restriction for barges

* When tide allows access, otherwise middle shoal

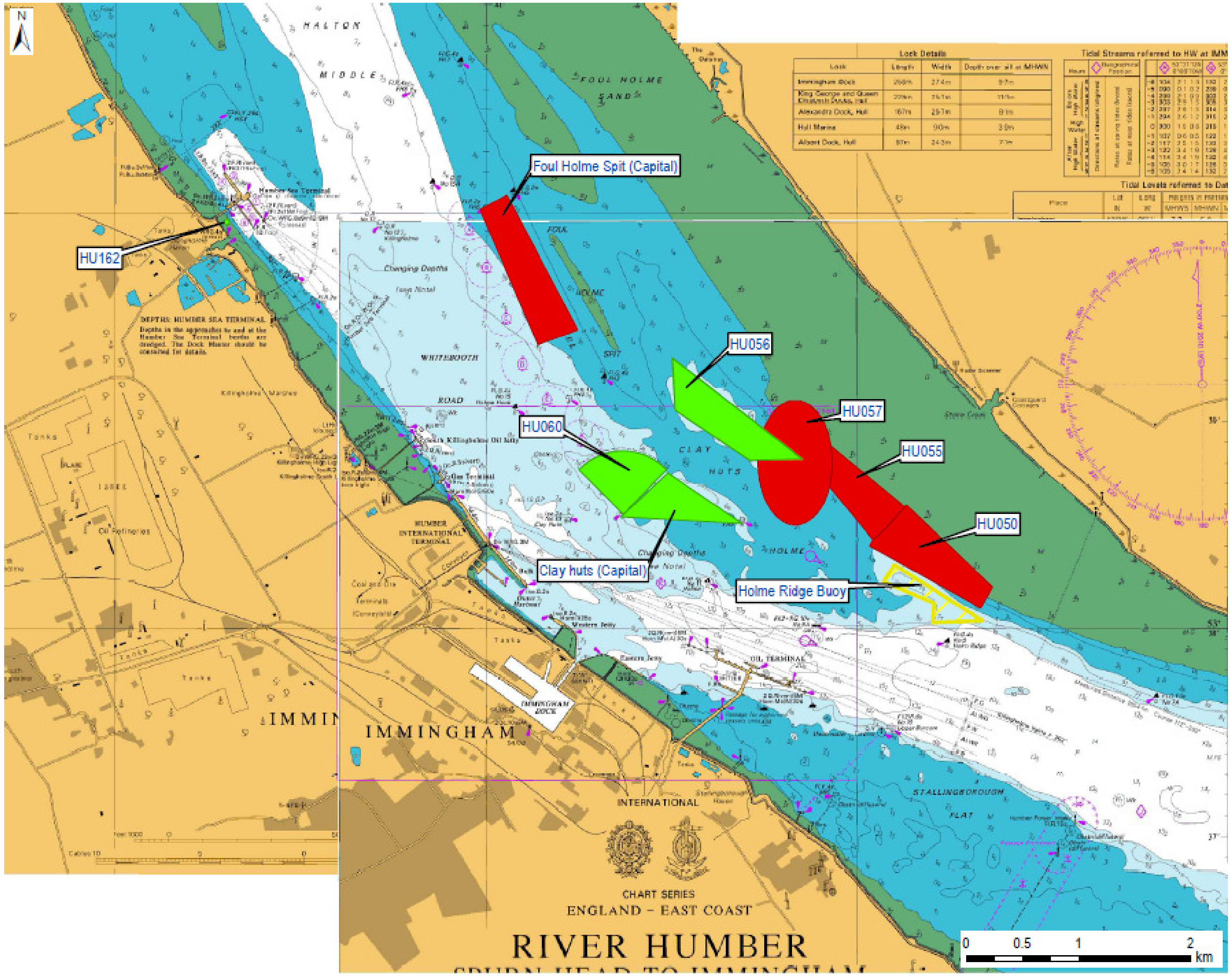
** If Backhoe used then SDC 'A' and 'B' must be used



Outer Humber Disposal Sites

Figure 4.1

Tidal River Development



Disposal Site Status
- Closed
- Disused
- Open
- Proposed

Date	By	Size	Version
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Projection		WGS 84	
Scale		1:50,000	
QA		NMW	
4015 - Grimsby_disposal.mxd			
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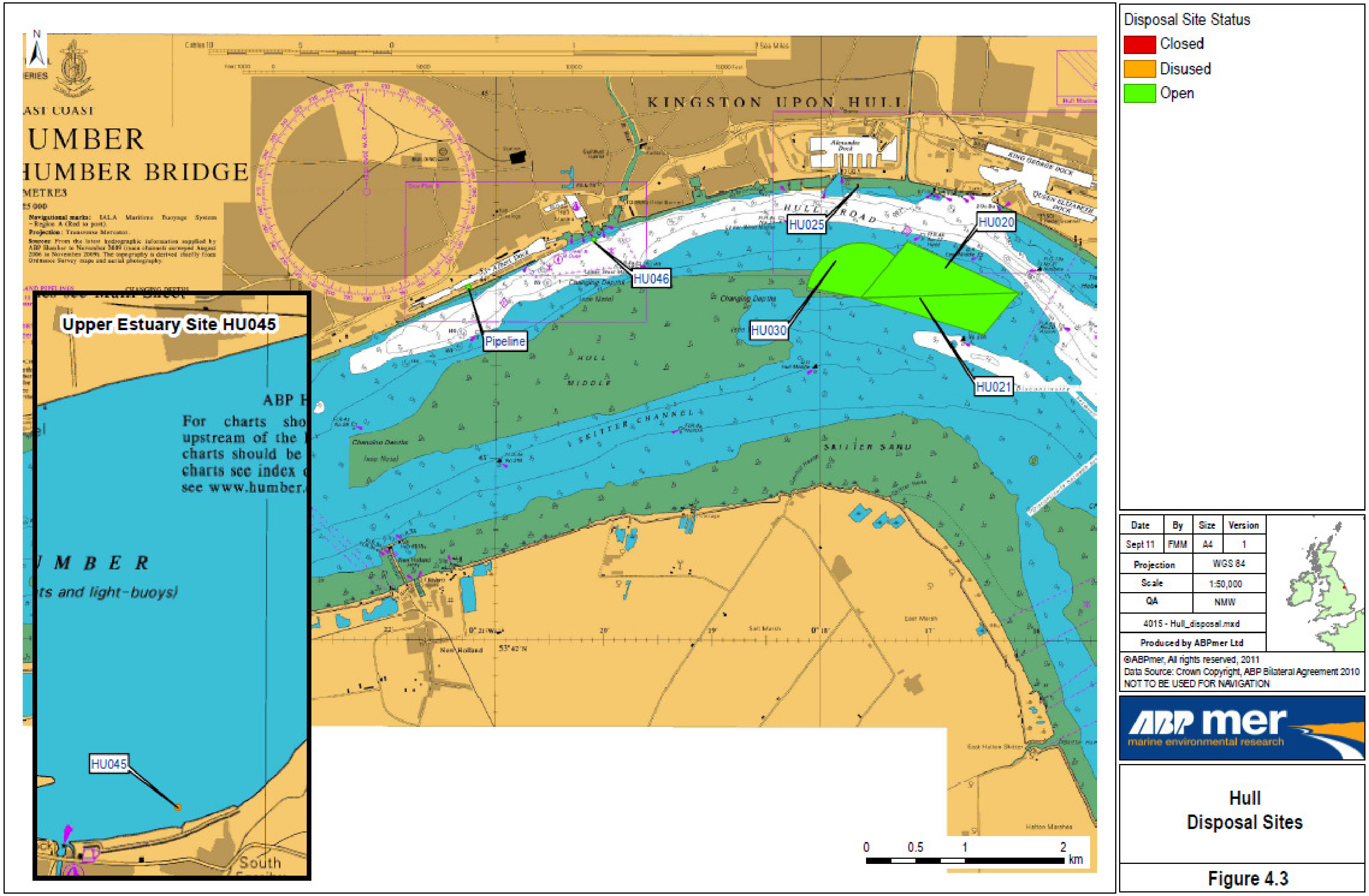
Middle Humber Disposal Sites

Figure 4.2


KINGSTON UPON HULL
HUMBER BRIDGE
Upper Estuary Site HU045
HU045
HU046
HU025
HU020
HU030
HU021
Pipeline
HULL ROAD
SKITTER CHANNEL
MIDDLE
0
0.5
1
2
km
Disposal Site Status
Closed
Disused
Open
Date
By
Size
Version
Sept 11
FMM
A4
1
Projection
WGS 84
Scale
1:50,000
QA
NMW
4015 - Hull_disposal.mxd
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Data Source: Crown Copyright, ABP Bilateral Agreement 2010
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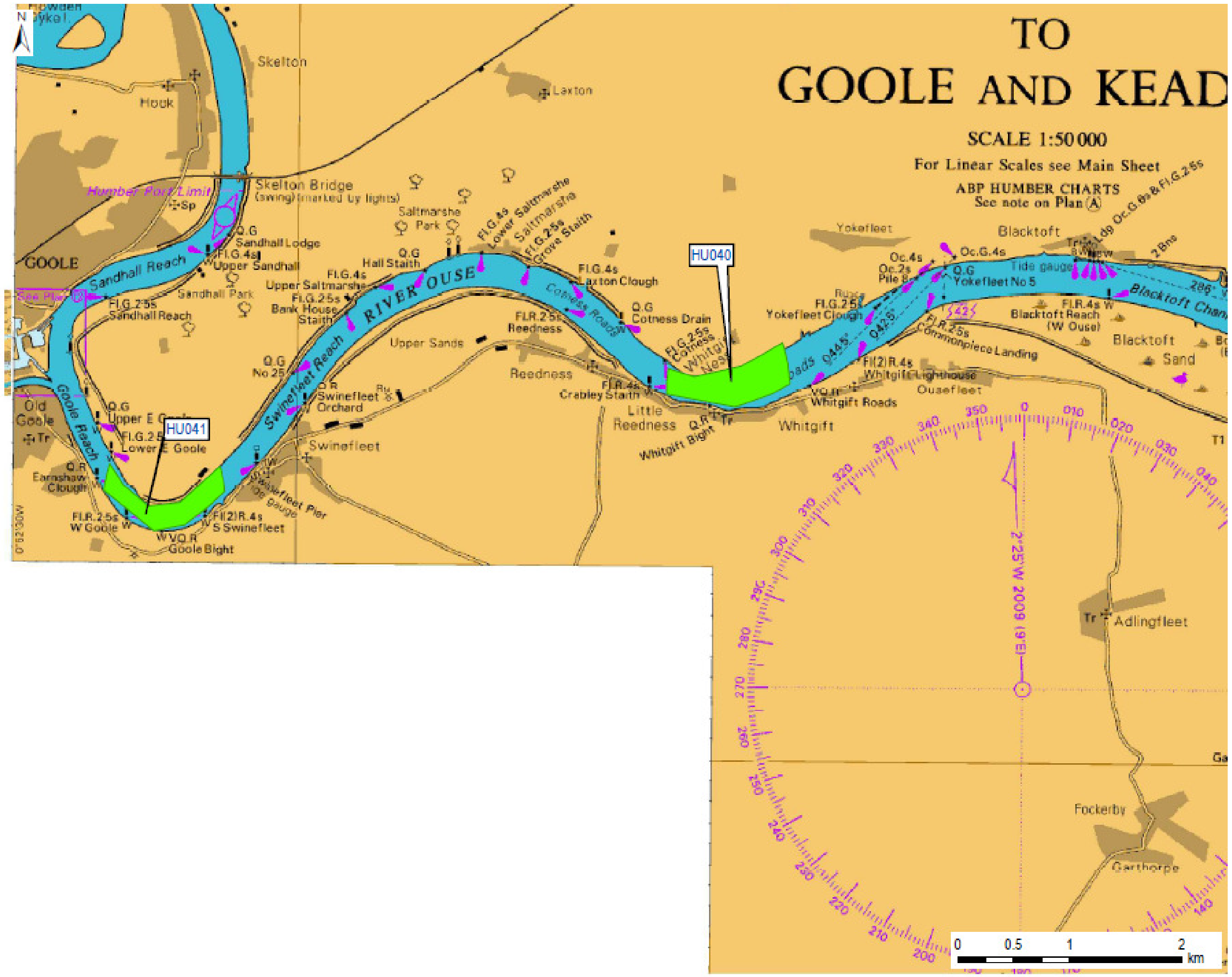
Hull
Disposal Sites
Figure 4.3



Disposal Site Status

- Closed
- Disused
- Open

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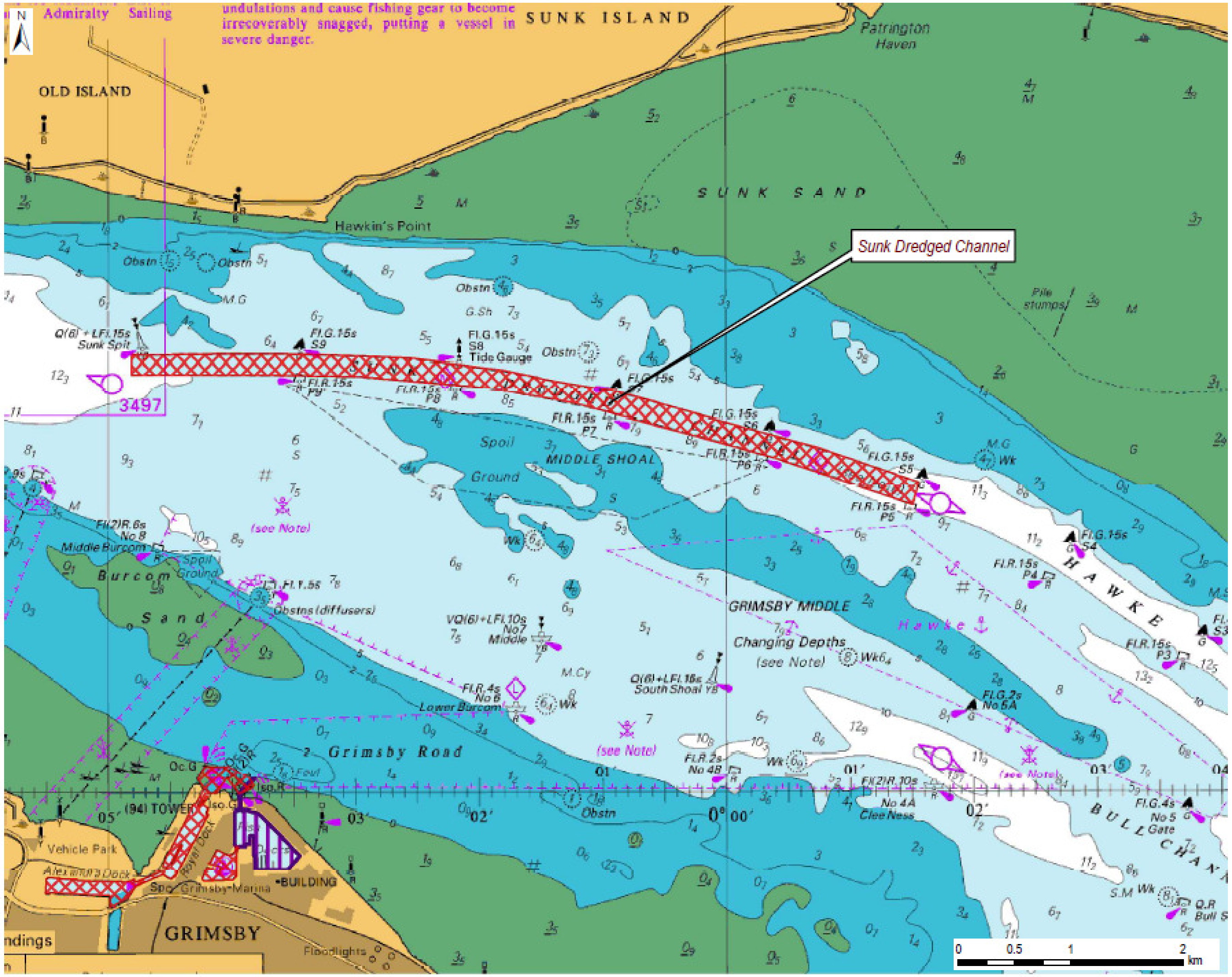
River Ouse Disposal Sites

Figure 4.4



ABP Dredge Sites
Third Party Operators

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Scale		1:50,000	
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4015 - fig_SDC_dredge.mxd

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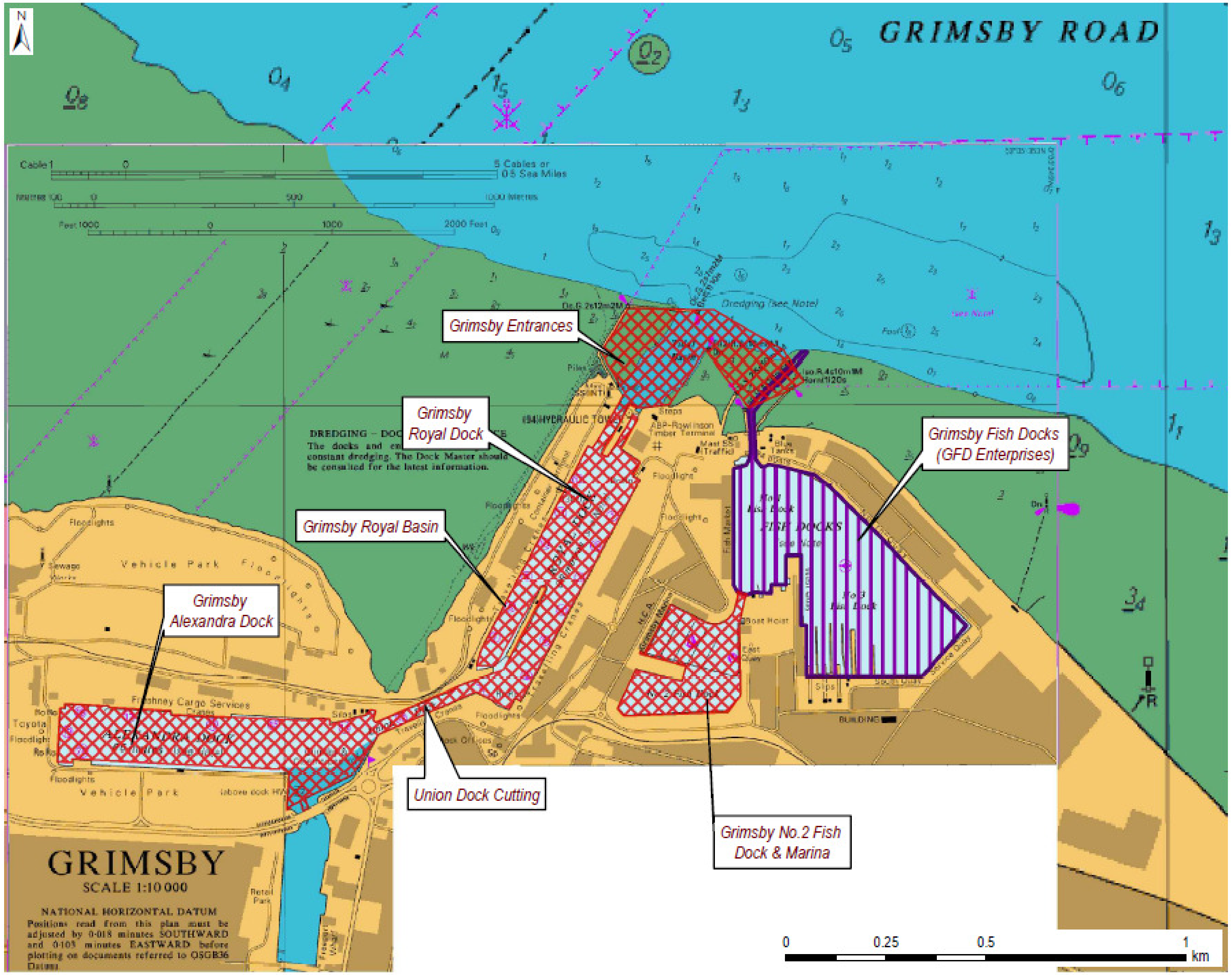
Outer Humber Dredge Locations

Figure 4.5



ABP Dredge Sites
Third Party Operators

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Scale		1:14,000	
QA		NMW	

4015 - fig_grimsby_dredge.mxd

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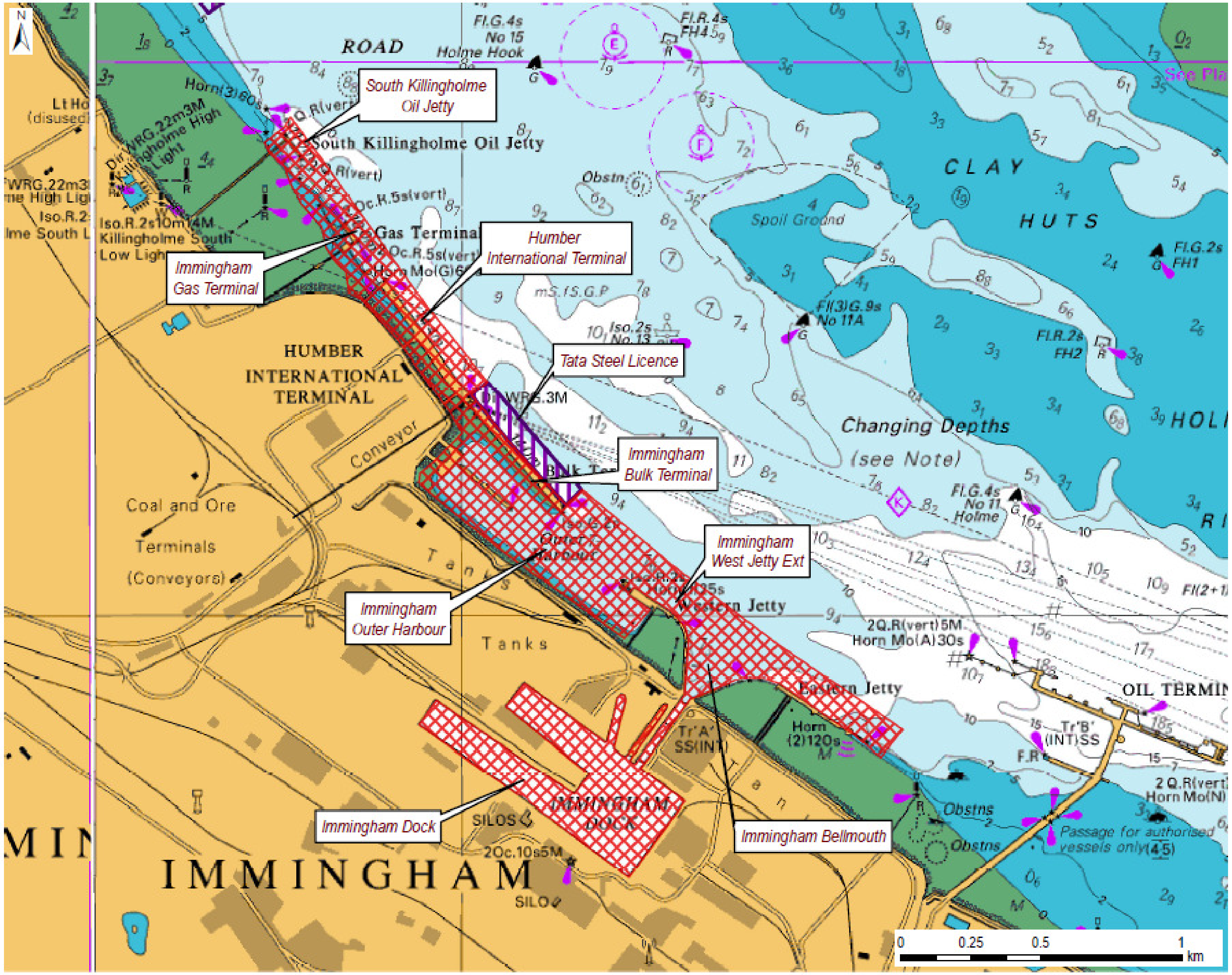
Grimsby Dredge Locations

Figure 4.6

TIDE
Tidal River Development



ABP Dredge Sites
Third Party Operators

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4015 - fig_immingham_dredge.mxd

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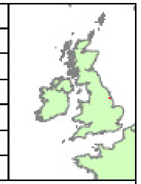
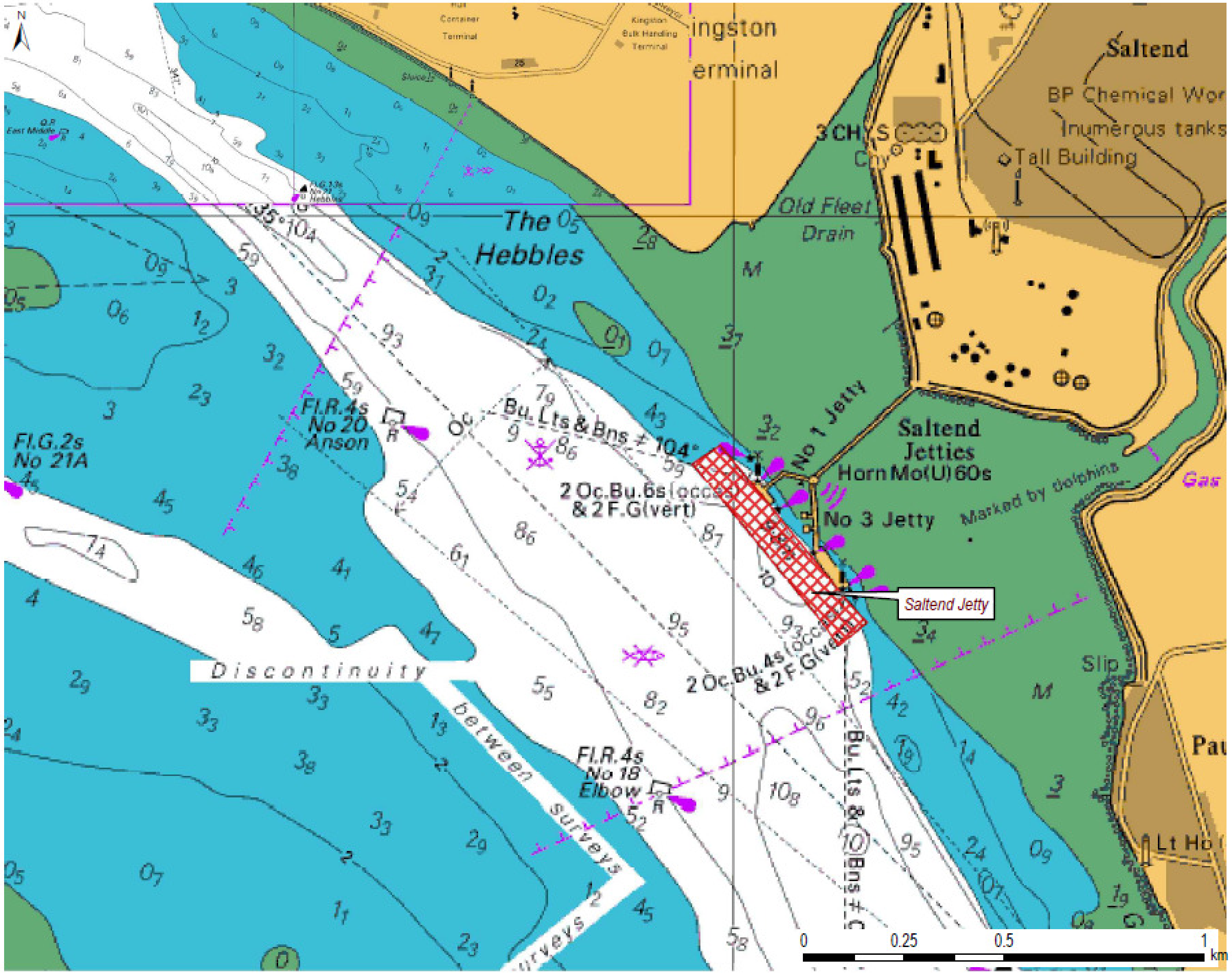


Immingham Dredge Locations

Figure 4.7



ABP Dredge Sites

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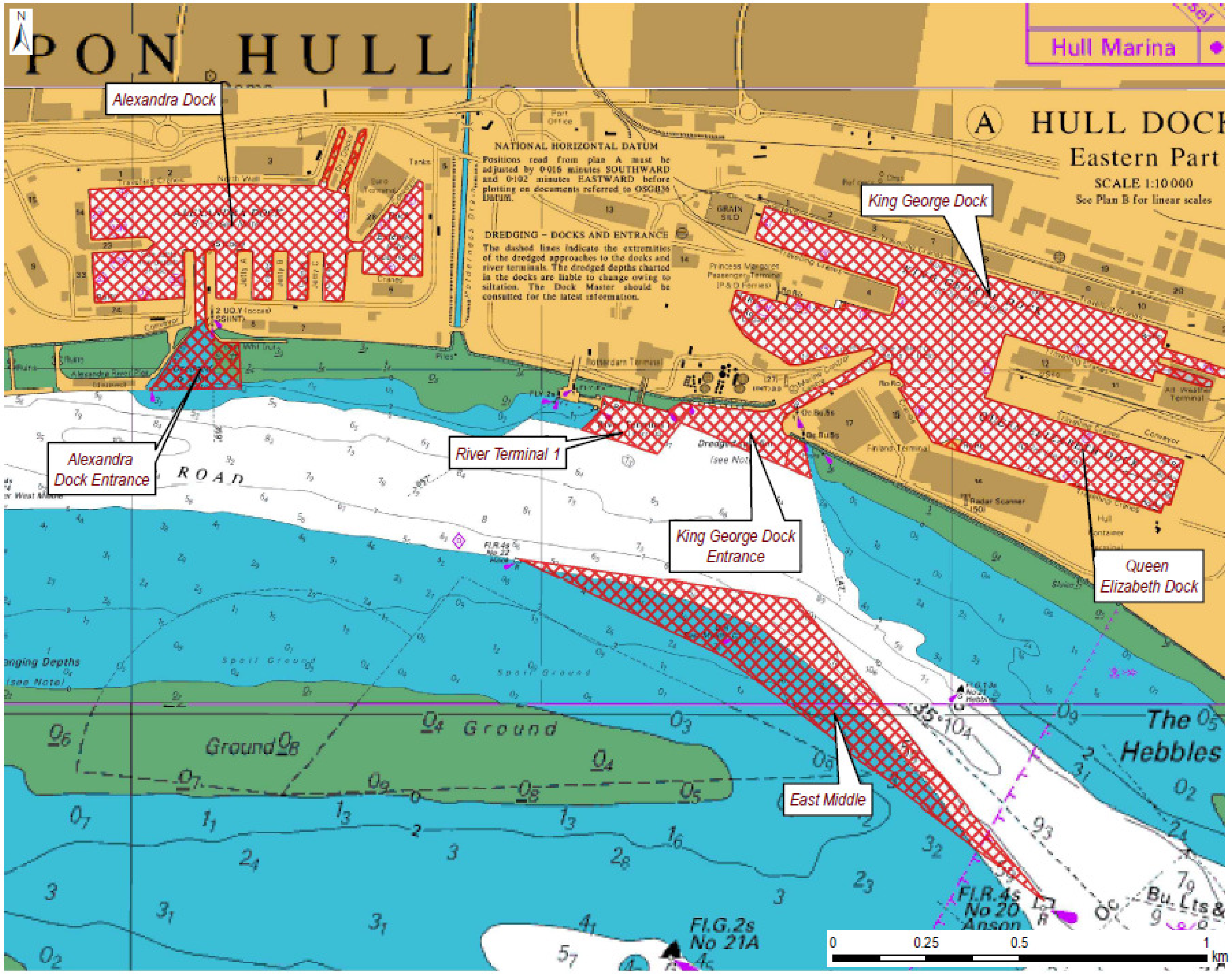
Saltend Jetty Dredge Location

Figure 4.8



ABP Dredge Sites

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QA		NMW	

4015 - fig_King_george_dredge.mxd

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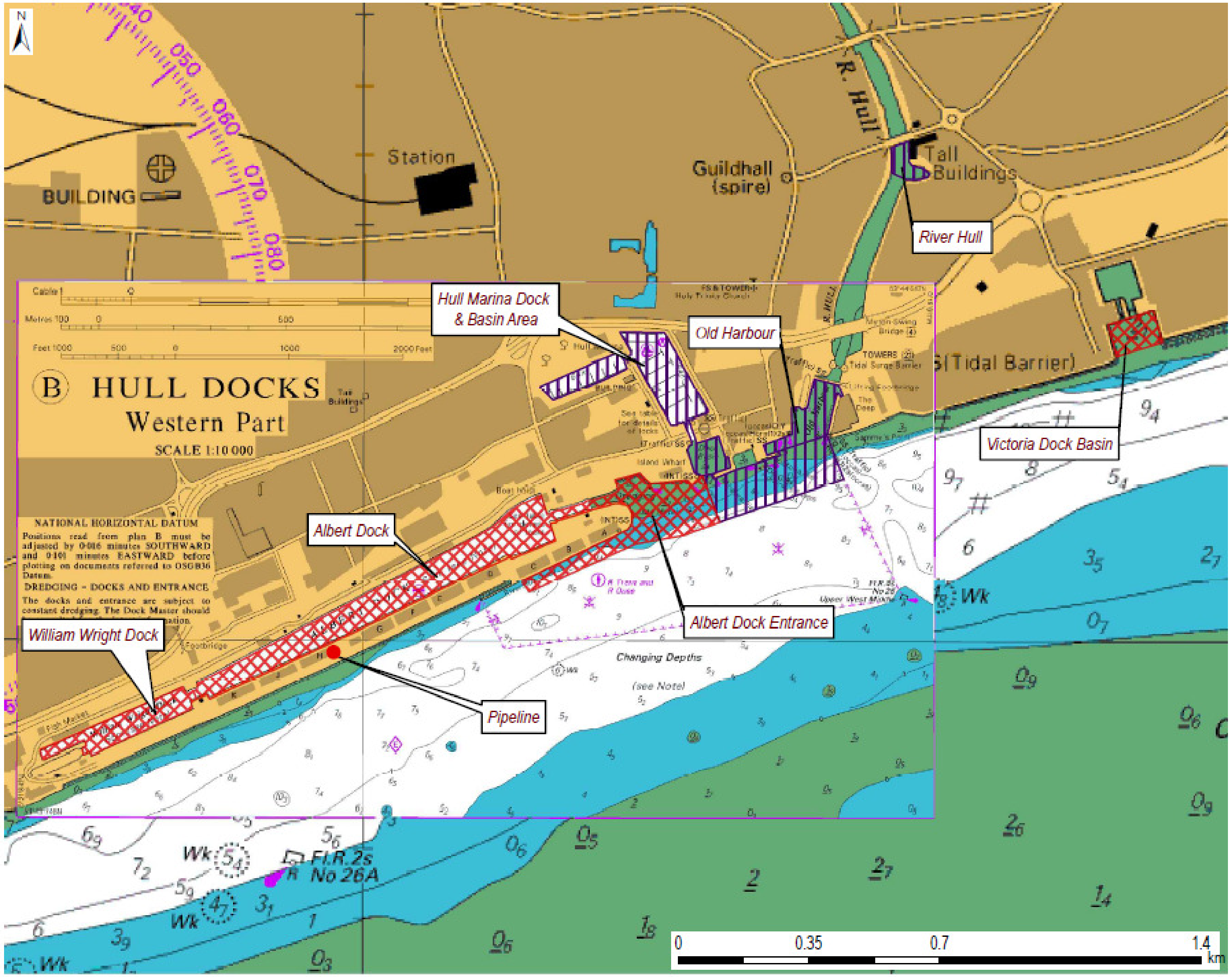
Hull Alexandra & King George Docks Dredge Locations

Figure 4.9



ABP Dredge Sites
Third Party Operators

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4015 - fig_Albert_dock_dredge.mxd

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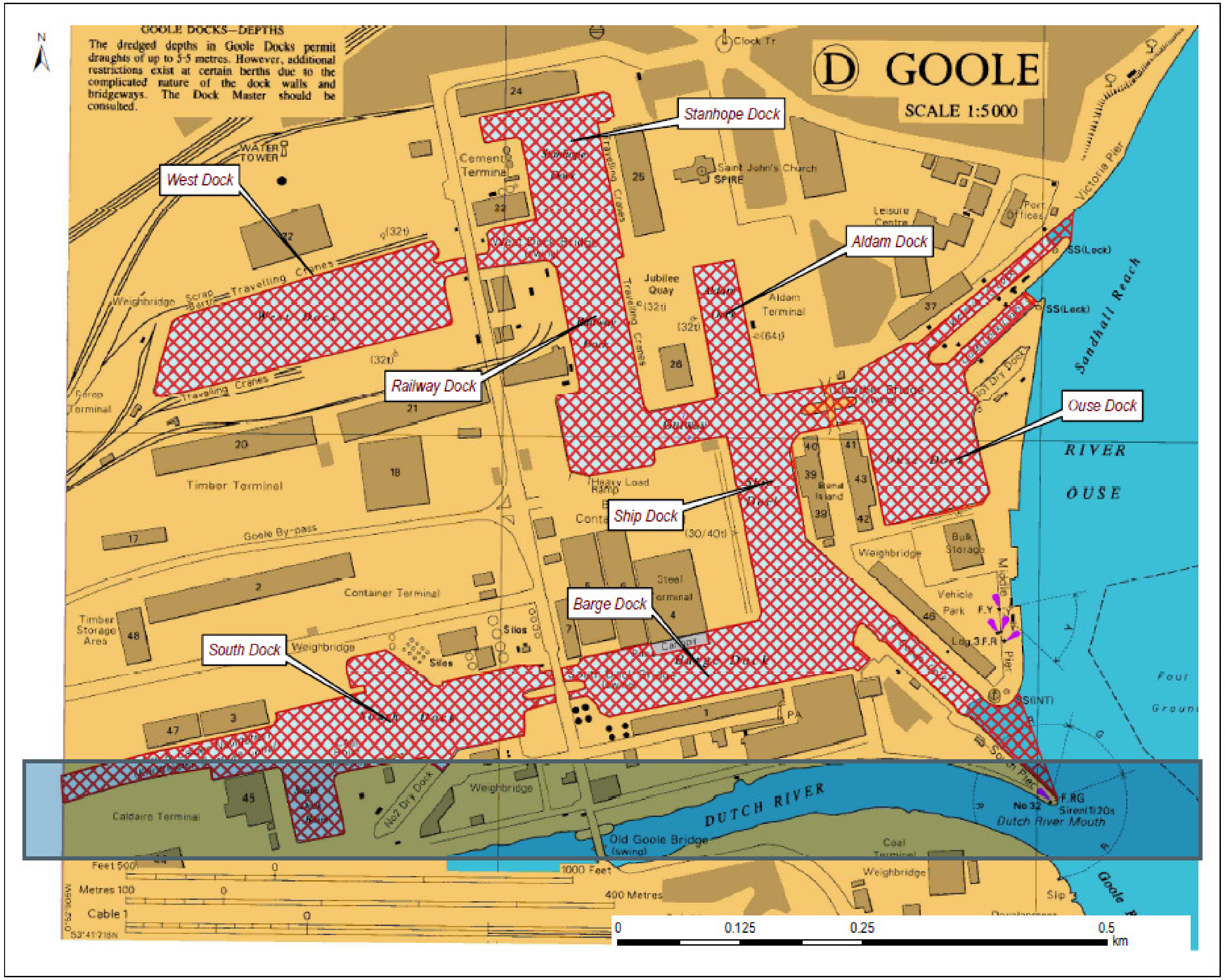
Humber Albert Dock Dredge Sites

Figure 4.10



ABP Dredge Sites

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Scale		1:5,500	
QA		Draft	

4015 - fig_Goole_docks_dredge.mxd

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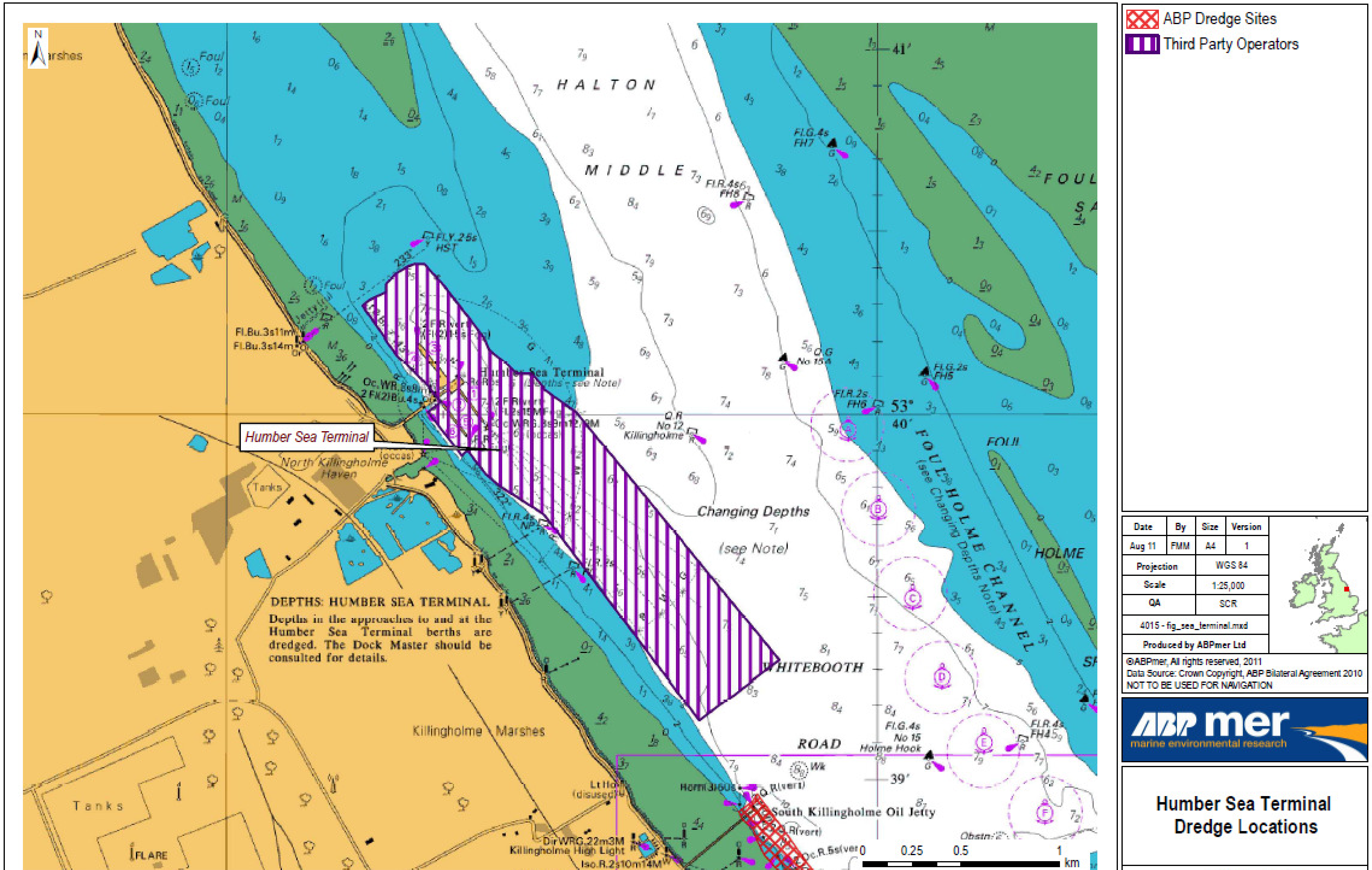
Goole Docks Dredge Locations

Figure 4.11


ABP Dredge Sites
Third Party Operators
Humber Sea Terminal
HALTON
MIDDLE
Changing Depths
(see Note)
FOUL HOLME CHANNEL
WHITEBOOTH
ROAD
South Killingholme Oil Jetty
Killingholme Marshes
North Killingholme Haven
DEPTHS: HUMBER SEA TERMINAL
Depths in the approaches to and at the Humber Sea Terminal berths are dredged. The Dock Master should be consulted for details.
0 0.25 0.5 1 km
Date | By | Size | Version
Aug 11 | FMM | A4 | 1
Projection WGS 84
Scale 1:25,000
QA SCR
4015 - fig_sea_terminal.mxd
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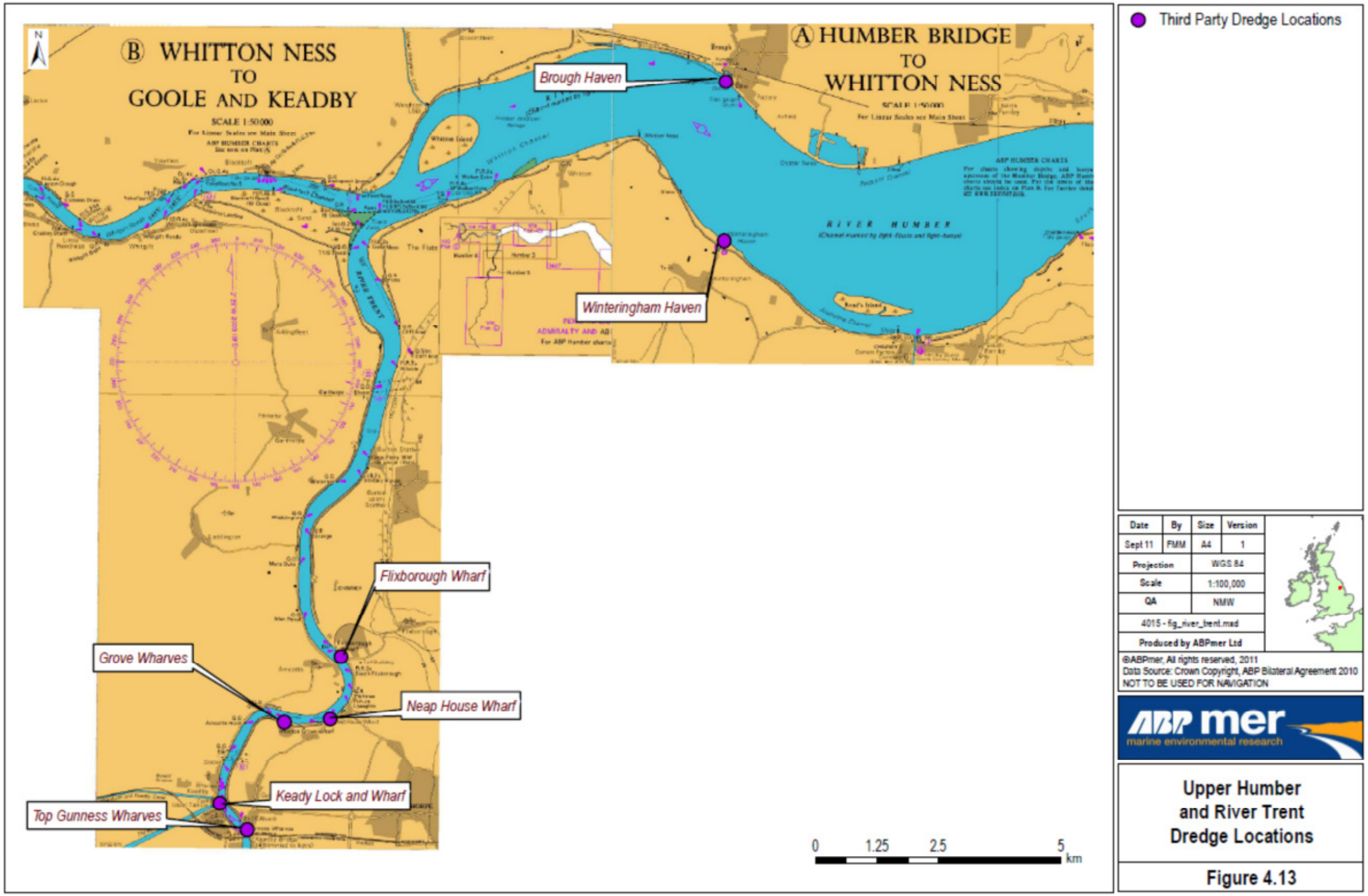
Humber Sea Terminal Dredge Locations

Figure 4.12



Upper Humber and River Trent Dredge Locations

Figure 4.13