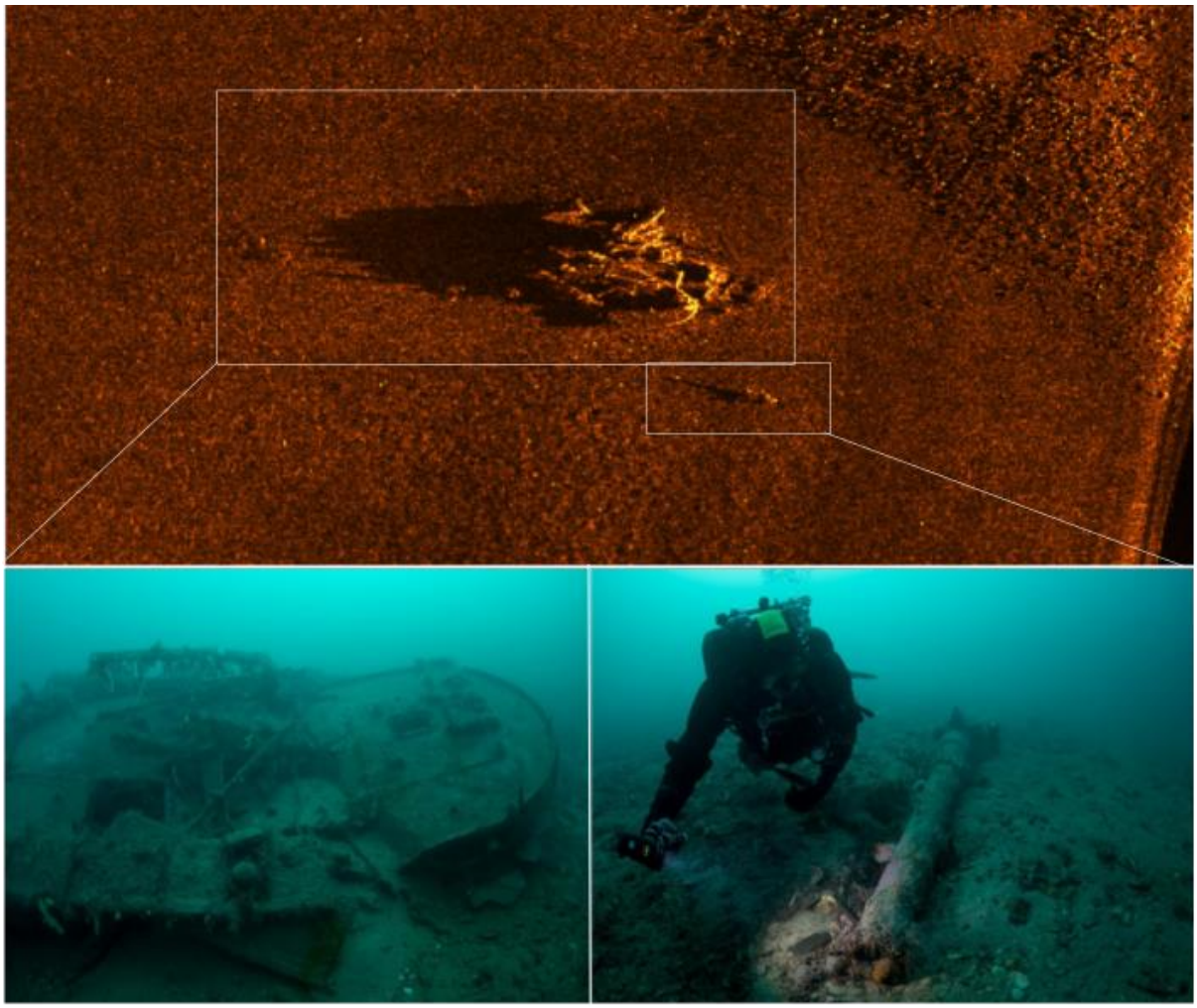
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

High Seas Fleet Salvage Sites Report



This report was compiled by ORCA Marine, University of the Highlands and Islands Archaeology Institute and SULA Diving on behalf of Historic Environment Scotland

4th April 2017

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Title:	High Seas Fleet Salvage Sites, Scapa Flow, Orkney
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Derivation:	
Origination Date:	15 February 2017
Reviser(s):	Sandra Henry, Paul Sharman
Date of last revision:	04/04/2017
Version:	V8
Status:	Final Report
Summary of Changes:	Minor changes in response to client review
Circulation:	Philip Robertson, Historic Environment Scotland, philip.robertson@hes.scot
Required Action:	
File Name / Location:	X:\MarineArchaeology\ORCAMarineProjects\697_Scapa_Flow_Scrap_Sitest\Report\Salvage_Sites_Report_V8(Final)
Approval:	

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Executive Summary

This report presents the outcomes of research, side scan sonar and diver survey on the salvage sites of the German High Seas Fleet in Scapa Flow, Orkney. Seventy-four vessels of the High Seas Fleet were interned in the British naval base when the scuttling occurred on the 21st June 1919. Forty-five of the fifty-two scuttled ships were successfully recovered, and evidence of this salvage activity remains on the seabed (Bowman, 1964; Friedman, 1992; George, 1973; Gröner, 1982; The Orcadian; UKHO). This project identified the locations of various components of the salvaged vessels structures, identifying the vessels represented by these wreck sites, furthering our understanding of the salvage activities and the submerged cultural heritage resource of the High Seas Fleet present on the seafloor in Scapa Flow.

At the primary sites, evidence of salvage activities can be seen in the form of superstructure fittings, along with large depressions on the seabed and lifting apparatus used by the salvors. The movement of the vessels after they were lifted is evident in the debris trails associated with their towing to Lyness or their secondary sites at Rysa Little and Cava. These debris trails were created as parts of the superstructure became trapped in the seabed and broke away or were cut and blasted off by the salvors. Secondary sites are the locations where cutting or blasting of superstructures was undertaken in shallower water to reduce the draught of the vessel before moving to Lyness or south to dry docks at Rosyth, Faslane or various other locations.

The surveys and evaluations established the identification, extent of survival, character and condition of the remains in support of *Scotland's Archaeology Strategy* (HES 2015; http://archaeologystrategy.scot/). The aims of this strategy are to help deliver archaeology, to enhance the understanding of our past, to help care for, value and protect our historic environment, to encourage greater engagement with our past, and to provide opportunities for innovation and development of skills.

While it is not within the remit of this survey project to address management issues, the evidence from this project (and the outcomes of previous surveys) should contribute to HES and stakeholders' formulation of appropriate management and monitoring strategies for heritage assets within Scapa Flow and at a national level. This project provides baseline data for long-term monitoring of the sites, aiding promotion and protection of this submerged cultural heritage resource.

Acknowledgements

Sandra Henry, Kevin Heath and Mark Littlewood authored this report. In addition, Malcolm Thomson, Bertrand Taylor, Barry Kenyon and Bob Anderson participated in data collection.

The authors are very grateful to Philip Robertson for his input throughout this project, and comments on earlier drafts of this report.

The authors would like to thank Marsden Samuel and Gary Staff for their input and contribution to this project.

Thanks are extended to members of the Orkney Maritime Archival Research Group: Edd Baxter, Jim Bright, Michael Ferguson, Laken-Louise Hives, Tom Hunter, Alette Kattenberg, Andrew Prentice, Jasmijn Sybenga and Tris Thorne.

1. Introduction

This project was undertaken by ORCA Marine, University of the Highlands and Islands (UHI) Archaeology Institute and SULA Diving on behalf of Historic Environment Scotland (HES). This report details the results of survey work undertaken on the salvage sites of the German High Seas Fleet located in Scapa Flow, Orkney. Previous marine archaeological surveys collected small amounts of data concerning the salvage sites indicating that this resource was far more substantial and intriguing than previously believed.

This project is based around the scuttling of the High Seas Fleet in 1919, and will feed into the centenary commemorations marking the event that resulted in the last loss of lives during the First World War. This project involved geophysical survey of all salvage sites of the High Seas Fleet using side scan sonar. Diver survey focused on battleship and battlecruiser wreck sites selected from a combination of geophysical survey and archival research work. Archival research studied and transcribed documents related to the High Seas Fleet salvage operations by Metal Industries Ltd held at Orkney Library Archives.

The scrap site assemblages include major components of ship superstructures. These wreck sites are at high risk from salvage activity and looting due to their deconstructed nature and lack of statutory protection. The surveys and evaluations established the identification, extent of survival, character and condition of the remains in support of Scotland's Archaeology Strategy (HES 2015, http://archaeologystrategy.scot/). The aims of this strategy are to help deliver archaeology, to enhance the understanding of our past, to help care for, value and protect our historic environment, to encourage greater engagement with our past, and to provide opportunities for innovation and development of skills.

This project aimed to examine, document and create a baseline record of primary scrap sites created during the salvage of the High Seas Fleet. The sites focused on in this report are *Friedrich der Grosse; Derfflinger; Hindenburg; Von der Tann; Grosser Kurfürst; König Albert* and *Kaiserin*. Secondary scrap sites were investigated as part of this project. A secondary site occurs in areas where salvaged ships were moored prior to towing to scrapping yards or where geological features and shallows on the seafloor prevented movement, for example at the islands of Hoy, Rysa Little and Cava. At these sites, blasting or cutting reduced the superstructure to ensure the ship was the correct draught for dry dock. In many instances, the superstructure never was salvaged and evidence of this activity remains on the seafloor.

2. Project Background

This project builds on and complements previous projects undertaken and conducted in Orkney. The *Scapa Map* project (2006) identified and recorded salvage sites, imaging the significant depressions and structural remains present at a number of the primary sites. The *Scapa Flow 2013 Marine Archaeology Survey* (2013) recorded the SMS *Bayern* and SMS *Seydlitz* primary salvage sites. The *Lost Aircraft of Scapa Flow* project (2016) highlighted the extent of the secondary salvage sites that are present on the seabed in Orkney, during the investigation of aircraft remains.

Previous projects have produced baseline and monitoring data for the submerged heritage resource, recording the extent and condition of submerged historic assets in the area. These

projects have cumulatively helped to map and record large extents of the cultural heritage resource situated on the seabed throughout Scapa Flow, and within the wider context of Orkney. Projects include:

- Lost Aircraft of Scapa Flow, Orkney by ORCA Marine and SULA Diving in 2016 funded by HES (http://www.scapaflowwrecks.com/projects/);
- Geophysical survey of the HMS *Hampshire* 2016, by ORCA Marine, Seatronics & Teledyne Reson;
- Roan Head Boom Buoy Vessel Project conducted by ORCA Marine and SULA Diving in 2015 as part of the HES funded project to undertake archaeological assessment of submerged wartime defences off Roan Head, Flotta (Christie et al. 2015) (http://www.scapaflowwrecks.com/resources/scapa-map/boom-buoy-barge-report-2015.pdf);
- Side scan sonar and diving surveys of the blockships at the Churchill Barriers and lesser known wartime wrecks around Scapa Flow conducted by ORCA Marine and SULA Diving in 2013 as part of the HES funded Scapa Flow 2013 Marine Archaeology Survey (Christie et al. 2014);
- HES-funded MBES surveys completed by Wessex Archaeology (WA) in 2011 to map the blockships in Burra Sound and other wartime wrecks (HMS *Strathgarry; UB116*; the *F2* and *YC21* barge; *S54*; *V83*; and *Dewey Eve*) (Dresch and McCarthy 2012);
- Desk-based assessment (DBA) work to improve the record of the marine historic environment conducted as part of HS and the Royal Commission for Ancient and Historic Monuments of Scotland (RCAHMS) Project Adair (Pollard et al. 2012);
- Multibeam Echosounder (MBES) surveys in 2001 and 2006 as part of the HES funded ScapaMap project to map the remains of the scuttled German High Seas Fleet and the area of the Royal Navy Anchorage including the dispersed remains of the HMS *Vanguard* (http://www.scapaflowwrecks.com/projects/scapa-map/); and
- Ministry of Defence (MoD) surveys of the HMS *Royal Oak*;

3. Aims and Objectives

This project aimed to:

- create a baseline database of the scrap sites of the High Seas Fleet in Scapa Flow, Orkney;
- establish the extent of the remains of individual scrap sites;
- locate, record and assess the condition of scrap sites in Scapa Flow, Orkney;
- provide information to aid HES in monitoring protected wartime heritage assets;
- create a dataset to inform the Pentland Firth and Orkney Waters Marine Spatial Plan; and
- ensure that the information collected is disseminated widely and made available for public study, appreciation and enjoyment.

4. Methodology

4.1 Desk Based Research

A number of sources were identified to collect historical data on the salvage operations of the scuttled High Seas Fleet, Scapa Flow, Orkney. This research informed on the vessels interned in Scapa Flow and the subsequent salvage operations along with the submerged cultural heritage assets that remain on the seabed today. The research focused on the use of primary sources, and was enhanced by using secondary sources.

Primary Sources:

- Cox, E. F., 1932, *Eight years of salvage at Scapa Flow*, Proceedings Fifth Thomas Gray lecture, The Institute of Mechanical Engineers
- Illustrated London News The British Newspaper Archive
- McKenzie, T., 1949, *Marine Salvage in Peace and War*, The Institute of Engineers and Shipbuilders in Scotland, Vol 93, Paper 1122
- Metal Industries Ltd Salvage Logbooks, D1/59 Orkney Library Archives
- Metal Industries Ltd records, D1/59 Orkney Library Archives
- The Orcadian, Orkney Library Archives
- Scotsman, The British Newspaper Archive
- Aberdeen Press and Journal, The British Newspaper Archive
- Dundee Courier, The British Newspaper Archive
- Portsmouth Evening News, The British Newspaper Archive
- United Kingdom Hydrographic Office (UKHO)

4.2 Geographical Information System (GIS)

A Marine Environmental Data and Information Network (MEDIN)-compliant ArcGIS Project was created using a WGS1984 geodetic datum projected to UTM Zone 30N. The acquired data and fieldwork results were entered into ArcGIS. ESRI's ArcGIS software was chosen as the most suitable program for use on this project due to its advanced tools, database connections and graphical output capabilities. A shapefile was created within an ArcGIS *.mxd project, ensuring compatibility with the Canmore database and HES data management systems. Each asset in the GIS and the database has been assigned a Unique ID number allowing easy spatial querying of the GIS, enabling the auditing and assessment of the sites and anomalies.

Images, including all of the side scan mosaics, have been geo-rectified into the GIS where necessary and worldfiles created for appropriate image files such as TIFFs and JPEGs. Relevant datasets have been imported into this database, and have been linked to the mapped shapefiles of records within the GIS. These have been modelled closely on existing National Record of the Historic Environment (NRHE) and Orkney Sites and Monuments Record (SMR) databases and data fields allowing for easier integration. The GIS data was filtered and compiled on an interactive map on the Scapa Flow wrecks website (http://www.scapaflowwrecks.com) for public engagement and educational purposes.

4.3 Side Scan Sonar Survey

The side scan sonar surveys were completed using a standard C-MAX Sonar CM2 Digital Towfish with depth sensor. A high frequency setting of 780kHz with a varied range setting 12.5m (25.4 pings per second); 25m (25.4 pings per second); 37.5m (17.8 pings per second); 50m (13.8 pings per second) was used. A medium frequency setting of 325kHz, with a varied range set of 50m (9.1 pings per second) and 75m (7 pings per second) was used. This resulted in either a 100m or 150m swathe during each run. The survey lines were completed to ensure each run overlapped with the water column of the previous run, to ensure complete coverage of the search area.

Spatial data collected used an Evermore SA380 Marine GPS, attached to the portside of the research vessel. A counter-pulley secured to a davit at the stern of the vessel calculated the layback of the towfish. The distance between the GPS and the counter pulley is used during post processing to determine the location of the towfish (and thus the site) relative to the boat. This has an accuracy of +/- 3m.

4.4 Side Scan Sonar Processing

Side scan sonar data was collected and post processed using SonarWiz 5 following guidance in the *Marine Geophysics Data Acquisition, Processing and Interpretation: Guidance Notes* (Plets et al. 2013: 34-36). SonarWiz 5 software allows other data such as basemaps in ESRI shapefile format to be viewed alongside the side scan sonar data. Additionally, it can be used to produce a mosaic of several survey transects achieving the best possible images of the sites. The data is processed with slant range correction (where the water column is removed during processing) to produce continual imaging of the seafloor.

Side scanning was an appropriate survey methodology for this project as it provided a detailed overview of seabed features with sufficient detail to create a detailed plan of the search areas. The project area surveyed is illustrated in Figure 1. The large quantity of anthropogenic anomalies encountered due to the large survey areas covered by this project, necessitated the contact report being limited to those anomalies considered representative of potential High Seas Fleet salvage remains. The main reasons for characterising an anomaly as representative of High Seas Fleet salvage remains were:

- locational, for example if they were within the vicinity of primary and secondary salvage site areas;
- the nature of remains on the seabed. Readily identifiable anthropogenic remains such as known wreck sites or boom buoys (rectangular boxes) were not taken into consideration during this project, except when located near a primary or secondary site; and
- anomalies located out with the known salvage areas of the vessel (for example, parts of their superstructure were lost or dropped whilst being towed to secondary sites or Lyness) were ascertained as High Seas Fleet remains due to the high-resolution side scan data collected, aiding identification of the contact.

4.5 Diver Survey

Diving operations ground-truthed geophysical anomalies. Self-contained underwater breathing apparatus (SCUBA) was used for diving operations. Divers maintained surface contact by marker buoy. Video footage of the dive and photographs of key features observed were taken and the footage reviewed by a marine archaeologist and marine historian. SCUBA diving followed all recommendations of the Scientific and Archaeological Diving Projects Approved Code of Practice and a complete Health and Safety Risk Assessment was completed by the diving contractor to ensure diver and crew safety.

A refined list of target sites for diver ground-truthing were identified from the research and geophysical survey in conjunction with HES. Diver survey gathered photographic, video, written records and measured sketches to assess survival, identification, character and apparent condition. A shot line was deployed on the target coordinates. The position was determined using an Evermore SA380 Marine GPS (approximate accuracy 3m).

5. Salvage of the High Seas Fleet

In June 1919, the German High Seas Fleet sat anchored in Brings Deep, Scapa Flow, Orkney under the terms of the armistice of the 11th November 1918. There were seventy-four vessels interned when Admiral Ludwig Von Reuter ordered the fleet scuttled. There were fifty-two vessels scuttled with twenty-two saved (Figure 1Figure 1 Project Area: Side Scan Sonar Survey Area) including one battleship, three light cruisers and eighteen destroyers (Bowman, 1964; Friedman, 1992; George, 1973; Gröner, 1982; The Orcadian; UKHO). The salvage operations that followed to raise the German Fleet during the interwar period challenged the current accepted schools of thought on marine salvage (Grossett, 1953). It was an unprecedented feat, the quantity and size of ships lifted, each with varied challenges, led to these operations being the first of their kind, a significant development and knowledge building exercise in marine salvage.

Small scale salvaging since the scuttling by locals stripped the ships of valuable and accessible components where possible, and many instances of re-use of the ship could be seen in Orcadian homes (George, 1973). Professional opinion at the time stated salvage was not viable, and the vessels must be left to rust due to a variety of reasons: for example, the destroyers sank two or three to a buoy and lay in entangled heaps on the seafloor, and no pontoons existed capable of lifting the capital ships from the seafloor (Bowman, 1964). It was ascertained that the cost of lifting would be equal to the value of the scrapping (Bowman, 1964), and it was this statement by the experts that would ring true for the salvors that came and went from Scapa Flow.

There were six destroyers lifted by three companies prior and contemporary to the salvage efforts of Cox & Danks. Led by Ernest Cox, Cox & Danks salvaged the majority of destroyers along with seven capital ships before selling out to Metal Industries Ltd who continued work to lift six more of the capital ships. Ernest McKeown and Tom McKenzie were Cox's key team members, both chief salvage officers who would continue working in salvage operations for Metal Industries Ltd. This HES project focused on the salvage works undertaken on *Derfflinger*; *Hindenburg*; *Von der Tann; Grosser Kurfürst; Friedrich Der Grosse; König Albert*

and *Kaiserin.* Cox & Danks salvaged SMS *Hindenburg* and SMS *Von der Tann*, whilst Metal Industries Ltd salvaged the other ships investigated. The timeframe of this project necessitated prioritising a portion of salvage sites for investigation. Ships were prioritised where only a brief description of their salvage sites existed, whereas some of the other salvage sites have previously been recorded by the projects listed above (Project Background).

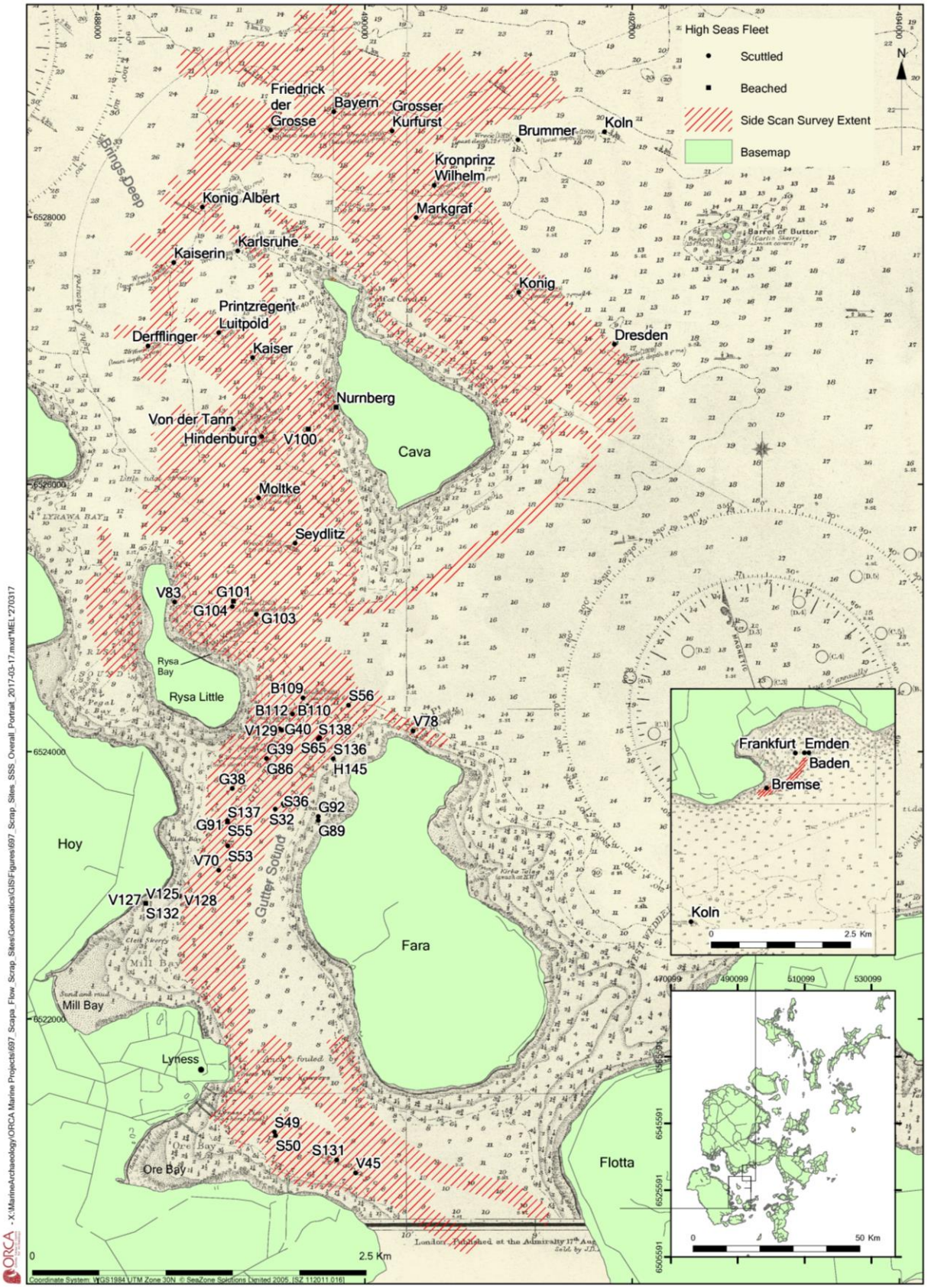

Figure 1 Project Area: Side Scan Sonar Survey Area

6. Destroyers

There were fifty destroyers among the seventy-four German High Seas Fleet vessels interned in Scapa Flow. Previous records and lists of destroyers interned at Scapa Flow vary considerably from one source to another. This project has cross referenced the various sources to ascertain exactly which fifty High Seas Fleet destroyers were interned at Scapa Flow. Providing for perhaps the first time the complete record of destroyers interned and their fate (see Appendix 2). It has been ascertained through examining various sources that eighteen destroyers were beached (Bowman, 1964; Friedman, 1992; George, 1973; Gröner, 1982; The Orcadian; UKHO). The Orcadian 7th August 1919 records fifteen destroyers as saved, with work happening on two. The beached vessels were divided among the allies, many of which ended up being sunk during gunnery tests or broken up for scrap; the French reused the boilers of the scrapped vessels on a number of occasions (Gröner, 1982). Two of the beached vessels are now dive sites after breaking their tow on route south from Scapa Flow.

Plate 1 a) The chain that snapped in the first lifting attempt on V70 in July 1924 (Illustrated London News) b) Salvage operations on S131 by ScapaFlow Salvage & Shipbreaking Company (Illustrated London News) c) Salvaged destroyer lying in Cox & Danks 'boneyard' at Mill Bay, Hoy (Illustrated London News) d) Postcard showing salvage operations on G102 by Cox & Danks (courtesy Kevin Heath)

SMS *S54* (Canmore ID 102996), a German V25 class destroyer, Leader of No. 3 Flotilla, was being towed out of Hoxa Sound on her way to the breaking yard when she ran aground of Flotta. Today, the *S54* is a dive site located in 14-17m of water with broken wreckage lying close inshore against a rock face. Cox & Danks brought *S54* and various attempts were undertaken for salvage, resulting in partial salvage in-situ (Gröner, 1982; Swannay, 1996; Wessex, 2012).

SMS *V81* (Canmore ID 101973), a German V25 class destroyer, a member of No.3 Flotilla, was being towed south for breaking up when she broke free in fog and wrecked just south of Buchollie Castle, Freswick, Caithness. Today she lies scattered close to shore in a general depth of 6 to 10m. The wreckage includes the remains of her two steam turbines (with rows of non-ferrous blades still in place), possible gearbox, a small gun and some other general wreckage (Hellsmouth Diving and Shipwreck Company).

SMS *V83* (Canmore ID 102284) is the only scuttled destroyer not successfully refloated. However, she was partially salvaged by the East Coast Salvage company before being sold onto Peter Kerr, a foreman diver with Cox & Danks. On the 16th of October 1925, Mr. Kerr was making efforts towards salvaging her, involving blasting and the removal of valuables. In the early hours of the 17th October, the salvage vessel *Energy* sank over *V83*: she was sitting off *V83*, when an inrush of water occurred from forward, and the crew moved to bring her inshore. She sank rapidly on an even keel with her mainmast showing just above the water (The Orcadian 22nd October 1925).

There were thirty-one destroyers salvaged at Scapa Flow during the interwar period (Bowman, 1964; Friedman, 1992; George, 1973; Gröner, 1982; The Orcadian; UKHO). Cox and Danks salvaged twenty-five vessels. The Scapa Flow Salvage & Shipbreaking Co. salvaged four destroyers and the Stromness Wrecking Company salvaged one, and one destroyer SMS *G92* was salvaged by an unknown source. In 1919, *G92* is recorded as scuttled, and in 1922 as salved and ashore on Fara before beaching at Stromness (UKHO). The salvage company or salvor is unknown; however it is quite probable the work was by the East Coast Wrecking Co. who were contracted on blockship salvage operations. The Stromness Wrecking Company salvaged *G89* on the 10th December 1922 after being active on the vessel for some time removing various fittings (The Orcadian, 14th December 1922). This Stromness Wrecking Company contracted Mr. J. W. Robertson of Lerwick, Shetland for the salvage operations. After this initial salvage operation, Mr. J.W. Robertson of the Scapa Flow Salvage & Shipbreaking Co. purchased four destroyers from the Admiralty.

Mr. J.W. Robertson convenor of the county of Zealand, Scapa Flow Salvage & Shipbreaking Co bought part of the German Fleet from the Admiralty in 1923 (George, 1973). Scapa Flow Salvage & Shipbreaking Co. used Ore Bay, Hoy for the beaching of their vessels once salvaged. The destroyers lifted and the quantity of which by this company has varied among sources or cited as unknown (Bowman, 1964; Friedman, 1992; George, 1973; Gröner, 1982; The Orcadian; UKHO). The first vessel lifted by the Scapa Flow Salvage & Shipbreaking Co. was the *S131* on the 29th August 1924 (The Orcadian 4th September 1924). The SMS *V45* is the second vessel lifted by this company in September 1924 (Gröner, 1982; UKHO) and beached at Ore Bay. The SMS *S50* is the third vessel to be raised by Mr. J.W. Robertson in October 1924, whilst the SMS *S49* was raised in December 1924. However, the record for this last vessel is more questionable as it is listed by UKHO as being raised in 1923 and moved south, however in 1925 it is cited as located in Ore Bay beside *S131* (Gröner, 1982; UKHO).

In 1924, Ernest F.G. Cox, Cox & Danks Ltd. purchased salvage rights to the German Fleet. He predominately used Mill Bay, Hoy for the beaching of salvaged destroyers. The first vessel lifted by Cox was the SMS *V70*. The first lift of *V70* was attempted on the 10th July 1924,

however it failed due to the lifting equipment used (Plate 1). Nine-inch wires were obtained for future operations. She was successfully lifted on August 9th 1924, and beached at Mill Bay before being towed to Lyness. After lifting, Cox discovered pirate divers had stripped her of her gunmetal torpedo tubes, and all else that could be lifted (George, 1973). She was pumped dry and made watertight, renamed Salvage Unit 3, and function as a floating workshop. She was broken up in 1929 at Scapa (Gröner, 1982). Cox went on to successfully raise twenty-five destroyers in total, often re-using the raised vessels for multiple purposes throughout his salvage operations.

Cox used two floating platforms for lifting operations, named Dock A and Dock B. In April 1925, the raising and righting of SMS *S36* resulted in the ship's oil settling on the surface of the water. A spark from the boiler located on Dock A caught the oil, setting fire to Dock A. The fire spread quickly. The quick action of the officials in charge brought the fire under control, averting disaster. This event only delayed lifting operations by a day (The Orcadian April 23rd 1925).

SMS *G103,* a German G101 class destroyer, was the first of the larger destroyers to be lifted, and one of the most troublesome vessels of the entire salvage operations at Scapa Flow. *G103* used the newly purchased large floating dock that was adjusted for purpose during the course of operations; the dock and boat were sunk during the salvage work. Retrieval of both became one of the most difficult salvage operations. Cox used his original Dock A & B for this task (Bowman, 1964; George, 1973). The Orcadian 24th November 1925 records *G103* moving south. On the 3rd December, she was reported as wrecked aground in the Moray Firth during a storm.

The lifting of the destroyers of the High Seas Fleet lay the necessary groundwork for Cox to tackle the capital vessels. Cox lifted the 25 destroyers in a period of 21 months.

6.1 Destroyer Side Scan Sonar Survey

The destroyers were predominantly anchored in Gutter Sound: the 1923 UKHO charts detail the position of the scuttled destroyers. This area was surveyed using side scan sonar survey, and geophysical anomalies were identified (Figure 2). There were sixteen anomalies identified in the destroyer survey area (see Appendix 1) within 150m of a known destroyer anchorage or scuttled location (Figure 2). The ground-truthing of contacts located at Rysa Little established that SS080 and SS085 are not materials associated with the destroyer salvage operations. The ground-truthing of the other contacts, potentially associated with destroyer remains, were out with the remit of this phase of work. The majority of destroyers were lifted upright with little or no removal of structural elements of the vessel, therefore only a few features of these salvaged ships are expected to exist on the seabed apart from such items as anchors. The greatest extent of submerged remains of the German High Seas Fleet destroyers are represented in Scapa Flow by wrecks such as *B109*, *S54* and *V83*, along with examples of the re-use of destroyers such as at the site of SMS *Hindenburg,* SMS *Seydlitz* or *S36* (see Appendix 2).

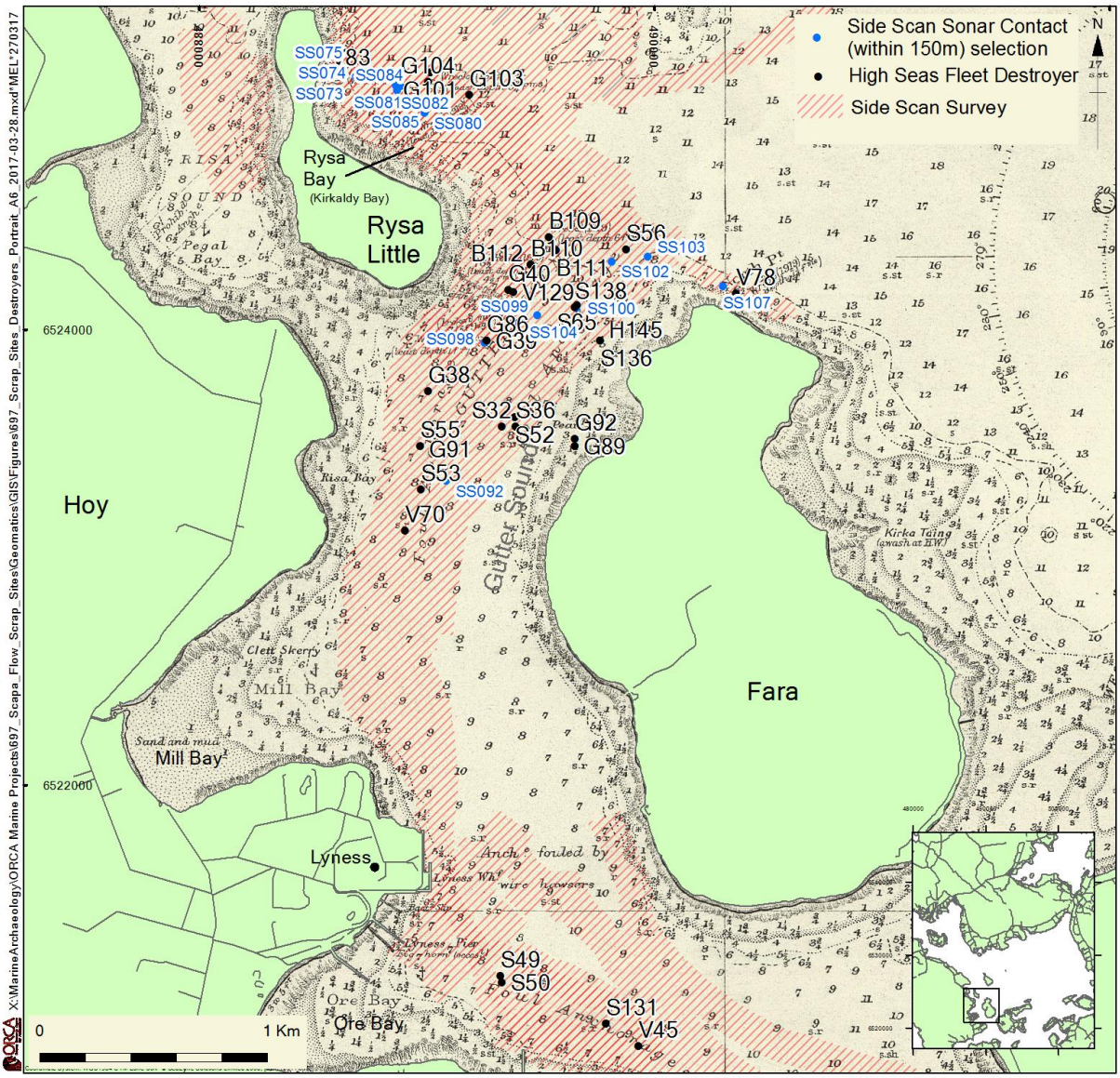

Figure 2 Side Scan Sonar Survey covering area of destroyer wreck sites or anchorages, all anomalies within 150m of a destroyer location are shown on the map.

7. SMS *Hindenburg*

SMS *Hindenburg* was a Derfflinger Class battlecruiser. She was laid down on the 9th June 1913, launched on the 1st of August 1915, and commissioned at the Imperial dockyard, Wilhelmshaven. She had a displacement of 26,200 tons as designed, an approximate length of 210m, breadth 29m and 8.3m draught. Her armament included eight 30.5 cm SK L/50 guns, fourteen 15 cm SK L/50 guns, four 8.8cm semi-automatic anti-aircraft guns fitted with curved shields and four 60 cm submerged tubes. *Hindenburg* could reach speed of 28 knots (Friedman, 1992; Gröner, 1982). *Hindenburg* was delayed in completion due to the removal of various components for the repair of damage to ships from the Battle of Jutland (Friedman, 1992).

After the scuttling, *Hindenburg* represented one of the most iconic images of the German Fleet sitting on the seabed of the Royal Naval base at Scapa Flow (Plate 2). The Orcadians heavily salvaged her along with SMS *Seydlitz* due to her accessibility. After the lifting of the

G104 on the 30th April 1926, Cox endeavoured to salvage *Hindenburg*, his first capital ship, which he considered the biggest salvage task ever attempted (The Orcadian 1st May 1926). The system used for salving of the *Hindenburg* involved making her watertight; this eventually led to the use of over eight hundred watertight patches during the duration of operations - fish fed on the tallow used for the patches causing large quantities to be used before the addition of cement to the tallow stopped this (Bowman, 1964; Cox, 1932; George, 1973). After the ship was determined to be watertight, pumping operations would remove the water causing *Hindenburg* to float. Pumping operations began in August, however on the 24th of that month 1926 a gale drove the bow section of SMS *G38* acting as a breakwater onto one of the floating docks, causing damage. The destroyer had to be immediately removed, the dock repaired and *Hindenburg* completely flooded.

Hindenburg's position on solid rock at the stern caused difficulties as it was intended that the expected seabed of sand and shingle would provide support in the lifting of bow: instead the entire battleship was being balanced on a stern 3ft wide (Cox, 1932). During lifting a list developed, and in an effort to keep her upright several nine inch wire hawsers were fastened from her masthead to a destroyer on Cava. These wires snapped during the lifting attempt and *Hindenburg* returned to the seafloor (Aberdeen Press and Journal, 6th September 1926; Cox, 1932; George 1973). Shortly after this, operations were aborted for the rest of the year. It was January 1930 before further attempts to lift *Hindenburg* would be made, this time a number of new measures were taken including fitting out the docks with new machinery. To improve stability her forward gun, tripod mast and her superstructure were removed. To prevent her from heeling over when the bow was raised a concrete wedge was placed under the stern at the propellers on the portside, where she had repeatedly developed a list during earlier lifting attempts. A German destroyer was cut in two, the engine room section was chosen as it was strongly built. This wedge was 12.1m x 9.1m and filled with six hundred tons of concrete (Bowman, 1964; Cox, 1932; George, 1973).

On the 21st June 1930 pumping began on *Hindenburg*, she was at first steady as she lifted but when her bow was 4.8m up she began to list to starboard and sank again. Cox ordered his salvage officer to construct another concrete wedge using a destroyer section to stop her listing to starboard. At the same time, Cox was in Germany, and obtained plans of the Hindenburg. Simultaneously, Tom McKenzie while exploring the vessel's control room recovered non-ferrous metal ship plans showing all parts of the ship (Bowman, 1964; Cox, 1932; Illustrated London News 28th June 1930). On the 22nd July 1930 during pumping, a man called out the angle of tilt from an indicator scale on the bridge. She listed slightly to six degrees but this subsided and with that she was successfully lifted. *Hindenburg* was the biggest ship in the world lifted at that time (Bowman, 1964; Cox, 1932; George, 1973; The Nottingham Evening post 23rd July 1930; Aberdeen Press and Journal 23rd July 1930). On August 13th, she was taken in tow to Rosyth, Firth of Forth.

*Plate 2 a) Postcard of the iconic image of the Hindenburg superstructure protruding above the water of Scapa Flow after the scuttling (courtesy Kevin Heath) b) Postcard of ongoing salvage operations on Hindenburg, destroyer in use as a barge visible in background (courtesy Kevin Heath) c) Image of workers clearing marine growth from the successfully salvaged Hindenburg (*Illustrated London News*)*

7.1 Side Scan Sonar Survey

The side scan sonar survey of *Hindenburg* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage area of the battlecruiser. The survey identified anomalies associated with the salvage operations on the *Hindenburg.* Anomaly SS025 (Figure 3, see Appendix 1) was identified as representative of the starboard and portside blocks used in the salvage operations.

Figure 3 Anomaly SS025 identified as the remains of the portside and starboard blocks used in Hindenburg salvage operations. This side scan sonar image has been overlain with an image showing the outline of SMS Hindenburg, as she would have sat between the destroyer sections. Wreckage material from the salvage operations on SMS Von der Tann is visible on either side of the northern half of the outline of Hindenburg.

7.2 Diver Survey

Diver survey focused on the two destroyer sections used as supporting blocks for the upright lifting operations. The two destroyer sections sit across the site SW to NE, they supported the *Hindenburg* at the stern as she sat upright on the seabed aligned NW to SE. The portside block was laid first due to her initially developing her list to portside, the starboard support was added before the final lifting operations. The diver survey began by investigating the starboard destroyer section. The sub-oval concrete sacks placed in the destroyers were clearly visible (Plate 3a; 3b), the saddle shape taken by the concrete is due to the load from overlying concrete bags and the imprint of the bags was visible on the blocks. Chains that were used to secure the concrete bags within the destroyer section were visible along the side of the destroyer section (The Dundee Courier 15th July 1930), and large quantities of lifting wire lay strewn on the seafloor (Plate 3f). The concrete bags located on the side of the destroyer sections where *Hindenburg* sat were broken down to rubble by her weight, forming heaps on the seafloor between the two destroyer sections.

Plate 3 a) Concrete bags in starboard destroyer b) concrete, imprint of the bag is visible on the concrete c) doorway portside destroyer d) cross section portside destroyer e) stacked corking lying to north of the portside destroyer f) lifting wire on the seafloor

The portside destroyer section (Plate 3d) contained a door at the SW end (Plate 3c), and large quantities of corking were scattered on the seafloor along with contained stacked cork sections (Plate 3e). This identification of the cork substantiates that it was a destroyer engine room section (George, 1973) used for the portside block, as corking was regularly used in engine rooms for insulation, although it was also used for this purpose in various locations around a vessel. Divers recorded deadlights on the seafloor approximately 75m north of SS025 (Plate 4c). A deadlight is a protective cover or shutter fitted over a porthole or window on a ship. The deadlights are most likely associated with the site of the *Hindenburg* as due to her upright position, the deadlights were removed and portholes were sealed off (Plate 4b).

This is the only vessel recorded as having this practice happening, and the remains on the seafloor are likely from loss overboard. An enamel bathtub was located in the salvaged area that is similar in style to the bathtub found on the site of the *Dresden* (http://www.scapaflowwrecks.com/wrecks/dresden/diving.php).

Divers recorded the seabed as a thin layer of muddy silt with small stone inclusions overlying bedrock. Outcrops of bedrock were visible. The remains of the destroyers have acted as artificial reefs rich in marine growth and life.

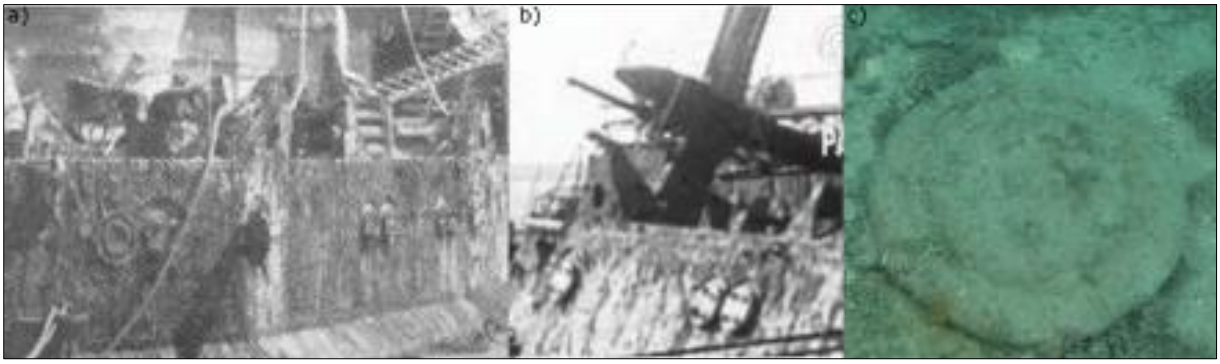

Plate 4 a) Image showing Hindenburg's with deadlights b) After lifting Hindenburg's portholes can be seen to be blocked, with deadlights removed (British Pathe) c) Deadlights on the seafloor located north of SS025 at approx. 75m.

8. SMS *Von der Tann*

SMS *Von der Tann* was the first battlecruiser and first large turbine ship built for the German Navy, and fitted as a flagship (Friedman, 1992). Laid down on the 28th March 1908, launched on the 20th March 1908 and commissioned on the 1st September 1910 at Blohm and Voss, Hamburg. She had a displacement of 19,100 tons as designed, length of 171.7m, breadth 26.6m and 8.3m draught. Her armament included eight 28 cm QF L/45 guns, ten 15 cm QF L/45 guns, sixteen 12cm QF guns, four 8.8cm semi-automatic anti-aircraft, two machine guns and four 45cm submerged tubes. *Von der Tann* could reach speed of 27.4knots (Friedman, 1992; Gröner, 1982).

Work on raising *Von der Tann* followed closely behind the *Hindenburg* salvage operations. *Von der Tann* sat on the seabed with an upturned hull, and once sealed with airlocks attached, pumping operations started. It was discovered the air inside was foul and explosive gases arose from decaying matter inside the hull. Use of a liquid spray reduced the risk of fires. However, a violent explosion occurred during works on the *Von der Tann* where a flame cutter used in an unsprayed room caused a large explosion injuring four men including Tom McKenzie. All of the men fully recovered from their injuries (Bowman, 1964; George, 1973; Portsmouth Evening News 19th November 1930).

Von der Tann was lifted after four months of operations on the 7th December 1930, and was moved to within a mile of Cava. During towing part of her bridge and two masts were removed as they were dragging on the seafloor, then she was taken within half a mile of Cava. Cox intended to lay her broadside to the island. However, she was beached with her bow pointed towards Cava with a line run from her bow to the destroyer section (*S36*) on Cava. Her stern floated in deeper water (Aberdeen Press and Journal, 15th December 1930; 16th December

1930; Bowman, 1964; George, 1973; The Orcadian 11th December 1930; The Orcadian 18th December 1930; The Courier and advertiser 9th December 1930; The Scotsman 9th December 1930). This indicates after *Von der Tann* was lifted from her scuttled position, removal of her superstructure continued as she was moved and turned around in the process of beaching off Cava. The side scan sonar and diver survey substantiated this with anomalies mapping the movement of the vessel.

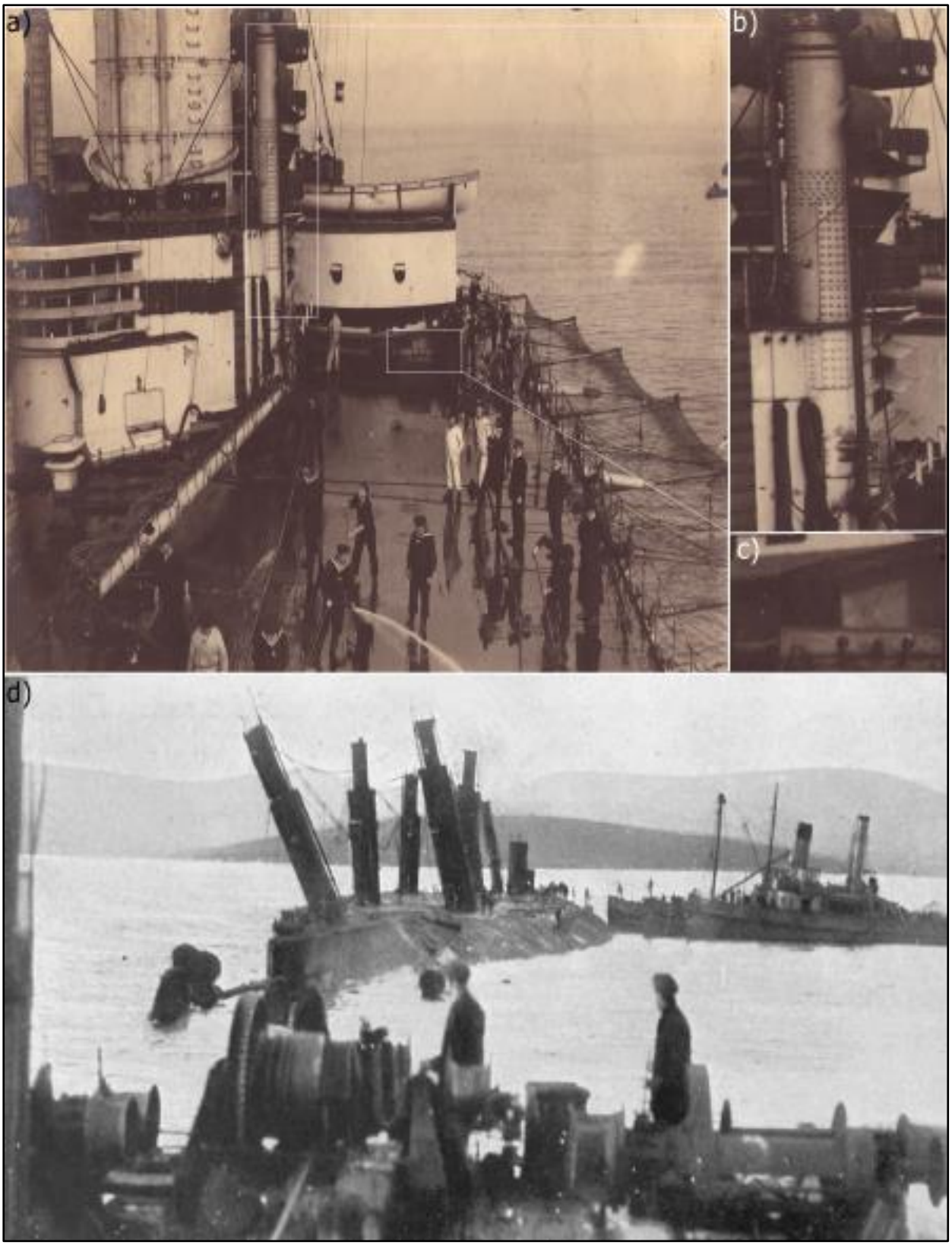

Plate 5 a) Von der Tann (courtesy Gary Staff) b) Riveted samson post c) rectangular storage boxes for sub calibre barrel liners under the gun turrets on Von der Tann d) Von der Tann after lifting, salvage vessel visible in the background (The Sphere 20th December 1930)

8.1 Side Sonar Survey

The side scan sonar survey of *Von der Tann* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage area of the battlecruiser. The survey identified anomalies associated with the salvage operations on the *Von der Tann*. Anomaly SS027; SS028; SS029 and SS042 are located in the vicinity of the primary scuttled position of the *Von der Tann* (Figure 4) (ref. Appendix 1 for full descriptions).

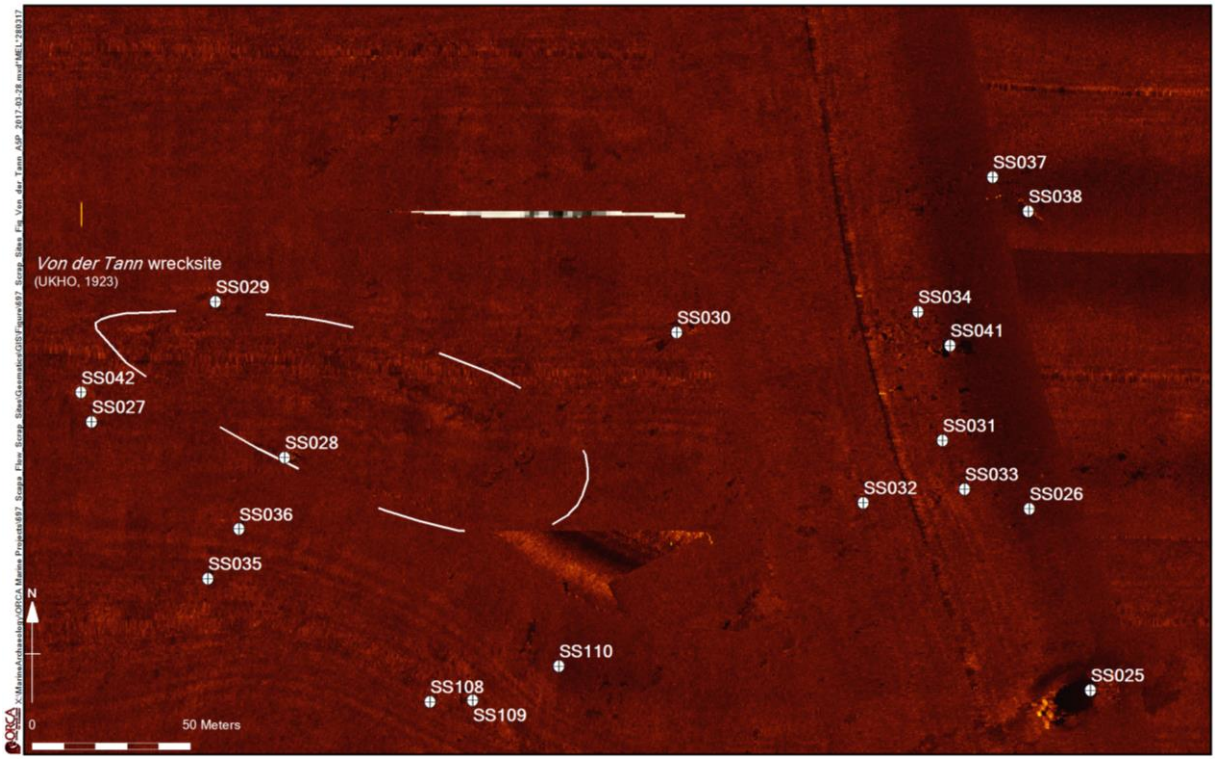

Figure 4 Von der Tann anomalies, charted outline of Von der Tann (UKHO, 1923)

Anomalies SS035; SS036; SS108; SS109; SS026; SS031; SS032; SS033; SS034; SS037; SS038 and SS041 are representative of the movement of the *Von der Tann* after towing into Cava took place (Figure 4) (see Appendix 1 for full descriptions). The sonar survey results along with archival research indicated the extent of the *Von der Tann* material remains on the seabed, with direct evidence of the salvage operations and movement of the vessel once lifted.

8.2 Diver Survey

Diver survey focused initially on anomalies that mapped the movement of *Von der Tann* as taken inshore after lifting. The diver survey ascertained that SS027, SS028, SS029 and SS042 were likely to represent loss or blasting activity when scuttled or lifted. Anomalies SS036, SS035 SS108 and SS109 show her movement as she is taken south before being towed back to the northeast across the *Hindenburg* salvage site where anomalies SS026, SS031, SS032, SS033, SS034, SS037, SS038 and SS041 show her movement in this direction towards Cava.

SS028 is a platform with struts, two rectangular boxes with an interior cylindrical tube and two coal winches (Plate 7d; 7f). A coal winch is an electric winch for lifting coal, eight were

fitted each side of the upper deck on *Von der Tann* (Plate 6) (Friedman, 1992). The two rectangular boxes on this site are containers for sub calibre barrel liners; these were used for training to prevent wear on the gun barrels by firing a smaller round. Heavy wear on the ship's main armament when firing means that after approximately 150 rounds the gun liner needs replacement. This big operation involves returning the gun to the manufacturer. The use of these sub calibre gun liners would have been both time saving and cost effective. The rectangular containers had hatches at each end to facilitate cleaning of the barrel without removing it from the box. The two holes in the back of the gun turret were used to insert the sub calibre tubes. The holes line up exactly with the 28 cm gun barrels inside the turret. This type of rectangular sub calibre storage box is rare, and largely unknown as most were cylindrical in shape (Plate 5a; 5c) (*per com* Marsden Samuel).

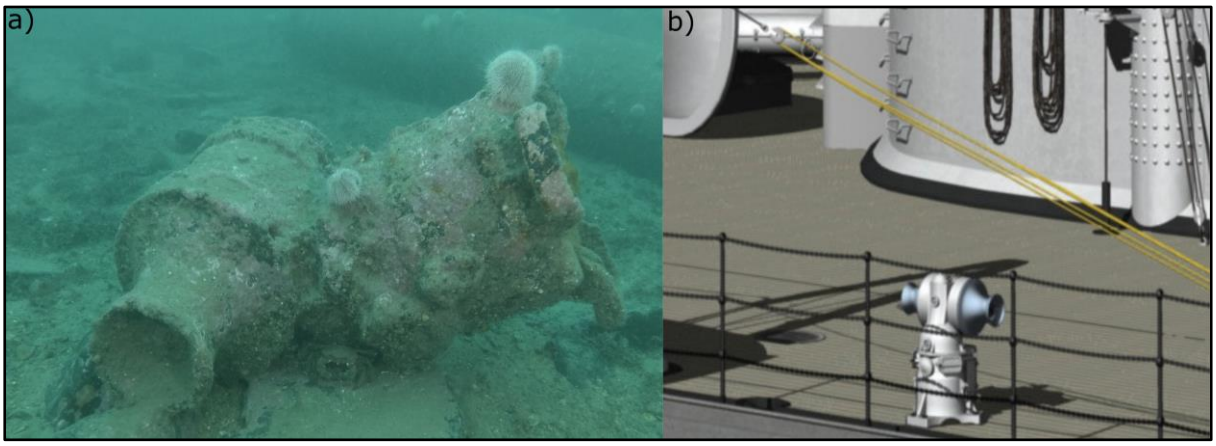

Plate 6 a) coal winch on Von der Tann salvage site b) Von der Tann 3D model coal winch (Samuel, M., sites.google.com/site/3dwarships/Home)

SS029 is a heavily built oval platform that is overlain with piping, bronze gearwheel and various objects. A sub calibre gun barrel liner in its rectangular storage box is located on this site along with an electrical metal box, and steel debris (Plate 7e; 7g), which is very heavy plating with riveted seams. Alongside this is a brass stand for a repeater compass but the compass is missing (Plate 8). A short distance away is a large steel door and a quantity of wood. SS042 is an upturned platform with steel girders and wires visible, a circular object with a handle is located underneath the platform, and a small object is located to the edge of the platform (Plate 7a; 7b). SS027 appears to be the bridge extension with lattice base (Plate 7a; 7c).

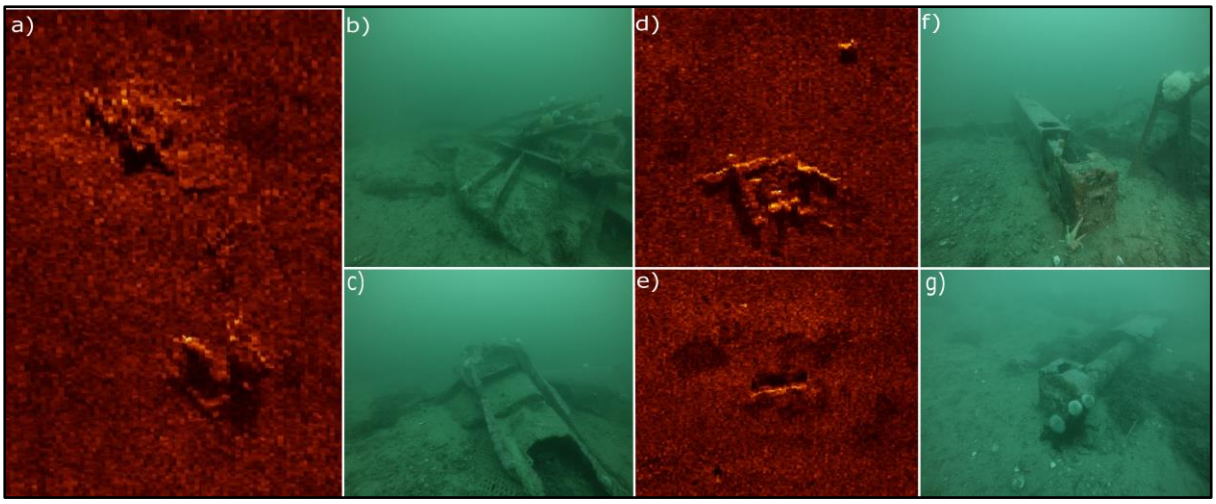

Plate 7 a) side scan sonar site image SS042, which sits to the north of SS027 b) SS042 upturned platform c) SS027 possible bridge extension d) SS028 side scan sonar site image e) SS029 side scan sonar site image f) SS028 platform with sub calibre barrel liner in rectangular storage box g) SS029 sub calibre barrel liner in rectangular storage box

Plate 8 a) repeater compass found on site SS029, heavy riveted plating visible in background b) Image of German repeater compass c) repeater compass located in a coffee shop at Finstown, Orkney from the Grosser Kurfürst (source of origin unknown)

SS036 is a small pinnace boiler standing on its funnel, with a brass valve located to its right when in normal position, on the underside and on the front inspection and cleaning hatches are located, and boiler grating is visible inside as the end has corroded. Mounting brackets are present on the side of the boiler (Plate 9a; 9b). SS035 is the upper forward mast section and spotting top of *Von der Tann* (Plate 9a; 9c). The top of the spotting top is heavily corroded, and a section on the seafloor still shows evidence of the viewing ports. Electrical cables are visible, with no evidence of attachments; there is a corroded hole in the base of the spotting top and a small pipe in the base along with various components on the floor. SS108 is probable

the lower forward mast section from the *Von der Tann* with a crows nest identifiable by the bent handrails (Plate 9d; 9e). SS109 is a diesel pinnace from the *Von der Tann*: the site contains a small engine, copper pipes and fittings (Plate 9d; 9f). The *Von der Tann's* smaller motor boats were mounted on the middle two gun turret tops (*per com* Marsden Samuel).

Plate 9 a) side scan sonar image of SS036 and SS035 lying in close proximity on the seafloor, image inset of SS035 b) SS036 pinnace boiler c) SS035 mast with spotting top d) side scan sonar image of SS108 and SS109 lying in close proximity on the seafloor e) SS108 lower mast section with crows nest f) SS109 diesel pinnace engine

Diver survey ground-truthed the anomalies representative of *Von der Tann* movement overlying the scuttled site of *Hindenburg*. This survey focused on a debris field approximately 100m by 60m that showed the movement of the *Von der Tann* northeast. SS032 is a heavily corroded rectangular platform with two circular mounts visible that may represent the base of a searchlight platform or searchlight control platform (Plate 10a; 10b). SS033 is a rectangular box structure with cleats on its upper side, possibly part of a ventilation system (Plate 10c; 10d). SS026 is buried platform of sub oval shape with truncated corners, with the rim and strengthening elements of the platform protruding from the seabed (Plate 10e; 10f). SS031 is a davit spar with rigging still visible (Plate 10f; 10g). SS041 is a searchlight platform with the location of where the two searchlights were mounted identifiable as circular apertures alongside a larger circular hole for the mast showing evidence of stress damage and the entrance hatch to allow access to the platform (Plate 11). Evidence of boltholes for securing the searchlight is visible around the searchlight circular apertures. Cables and a search light base with rubber mounts are located next to the platform. The rubber mounts would protect the searchlight from shock damage when the main guns were fired, and it is one of two types of searchlight mounting systems noted on the various searchlight platform sites recorded during this project. No other evidence of the searchlight is present on the site (Plate 10i; 10j). The platform is the type present on *Von der Tann* and not the *Hindenburg* type, it was dragged and turned upright as the ship was pulled inshore. The platform shape indicates this is the aft searchlight platform (Plate 11). To the southwest of the searchlight

platform a second searchlight base with one rubber mount was located. A section of mast lies nearby. SS034 and SS041 are located within a boulder field, and within this area is a mast broken by impact rather than blasting, a coal winch and small anchor. To the west of this lies another section of mast raised off the seabed at its eastern end. SS038 is a derrick arm, with SS037 a heavily riveted samson post of the style found on the *Von der Tann* lying in close proximity (Plate 5a; 5b; Plate 10k; 10l). Deadlights (as described above) most likely from the *Hindenburg* were noted in a number of locations throughout this debris field.

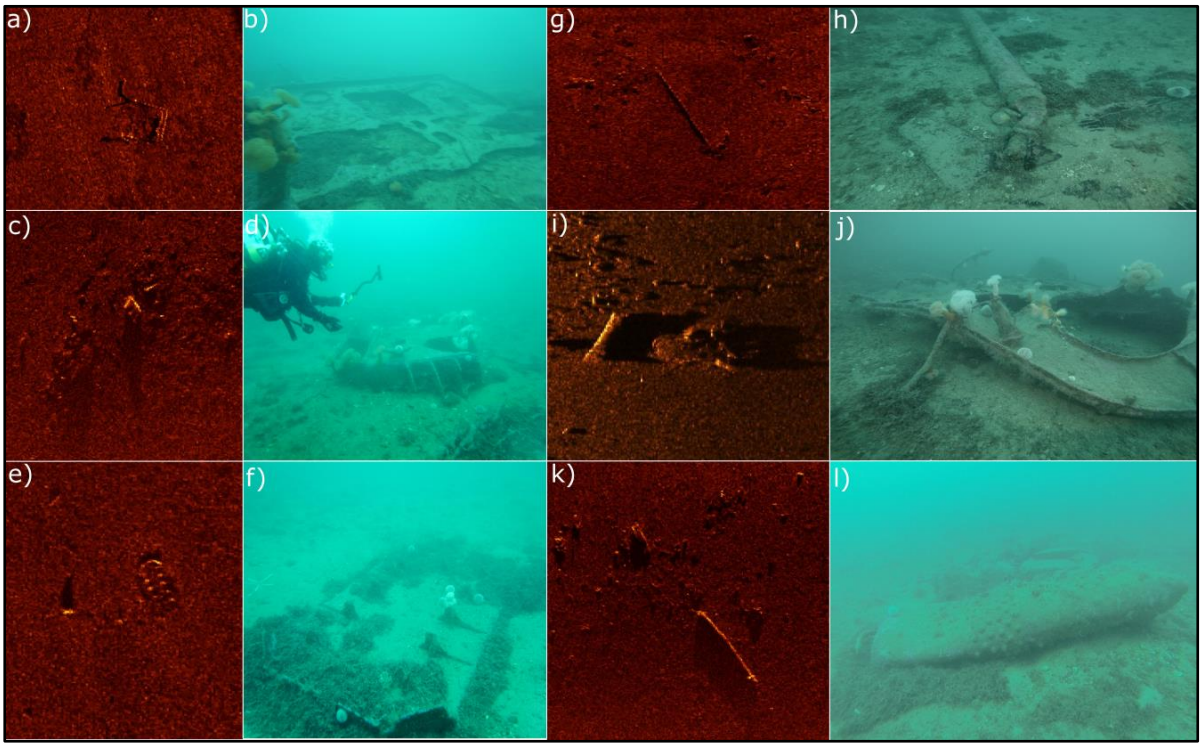

Plate 10 a) side scan sonar Image SS032 b) SS032 heavily corroded rectangular platform c) side scan sonar SS033 d) SS033 rectangular box with cleats e) side scan sonar Image SS026 f) SS026 partially buried platform g) side scan sonar Image SS031 h) SS031 davit arm i) side scan sonar Image SS034 & SS041 j) SS041 includes a searchlight platform and searchlight bases k) side scan sonar Image SS037 & SS038 f) SS038 riveted samson post (see Plate 5)

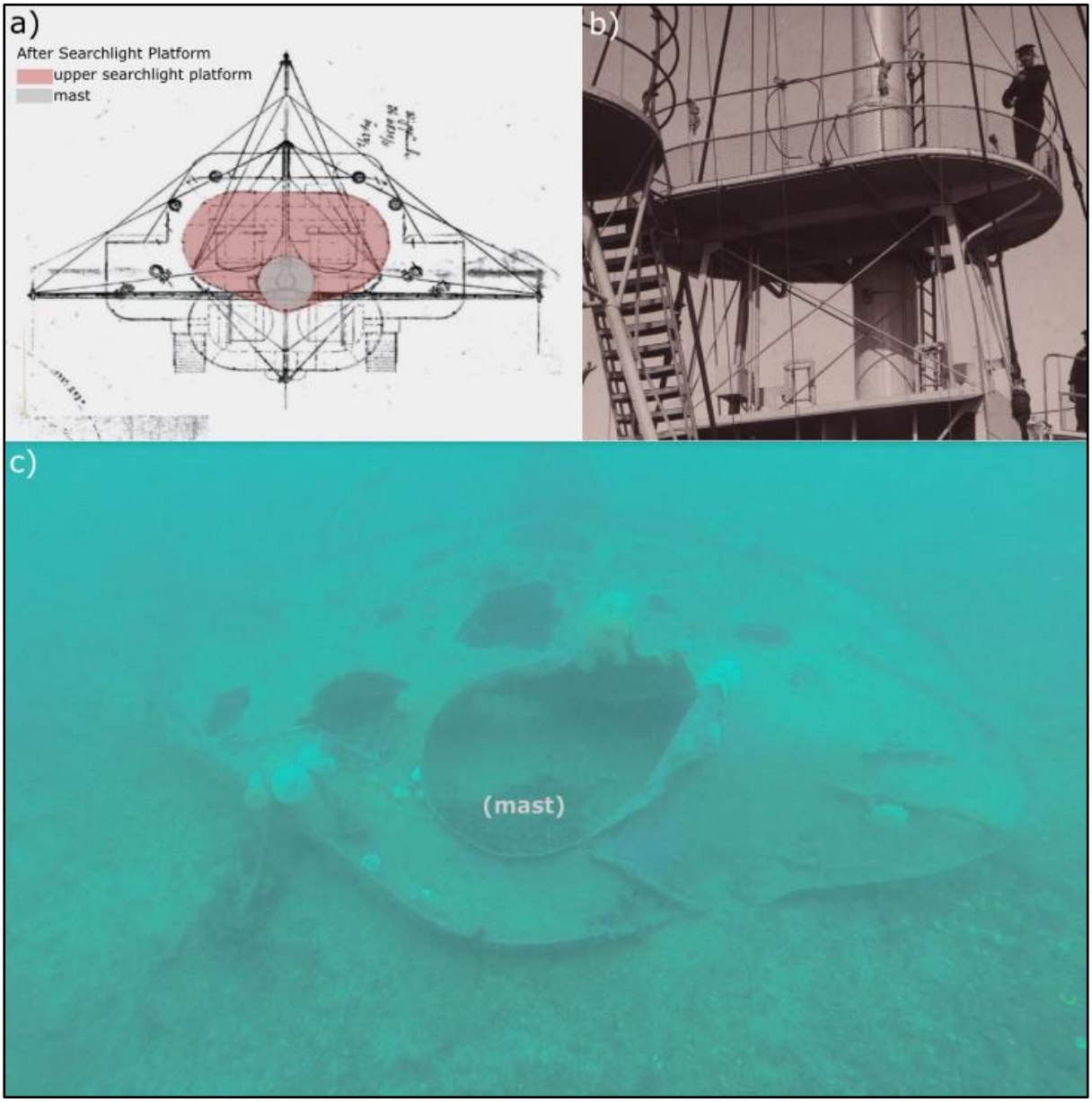

Plate 11 a) Von der Tann ship plan showing after searchlight platform plan view (courtesy Marsden Samuel) b) aft searchlight platform of the Von der Tann (courtesy Gary Staff) c) searchlight platform on the seafloor is the after upper searchlight platform

SS110 was ground-truthed and identified as geological. SS030 possibly represents a geological feature in this area, but was not ground-truthed during this phase of work.

9. SMS *Grosser Kurfürst*

SMS *Grosser Kurfürst* was a König Class battleship, laid down in October 1911, launched on the 5th May 1911 and commissioned on the 19th August 1914 at AG Vulcan, Hamburg. She had a displacement of 25,390 tons as designed, length of 174.7m, breadth 19.5m and 9.19m draught. Her armament included ten 30.5 cm QF L/45 guns, fourteen 15 cm QF L/45 guns, six 8.8cm L/45 QF guns, four 8.8cm L/45 semi-automatic anti-aircraft and five 50cm submerged

tubes. These were the first German battleships with all centre line turrets. *Grosser Kurfürst* could reach speeds of 21.2knots (Friedman, 1992; Gröner, 1982).

Grosser Kurfürst was raised by Metal Industries Ltd on 26th April 1938 (The Orcadian 28th April 1938). After lifting, she was taken into shallow water at the bay at Rysa referred to as Kirkaldy [*sic*] Bay in the Metal Industries salvage logs, and moored to four anchors. The initial diver report from Rysa states her derricks are touching the seafloor with the rest of the vessel sitting clear of the seabed. The following day, blasting commences and her starboard derrick is dropped. Works then focused on aft funnel, bridge structure and port samson prior to taking place on the forward funnel and bridge structure. On May 15th *Grosser Kurfürst* was towed to Lyness (Metal Industries Logbook D1/59/3/5; The Scotsman 6th May 1938).

9.1 Sides Scan Sonar Survey

The side scan sonar survey of *Grosser Kurfürst* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage area of the battleship. Anomalies SS063 & SS064 (see Appendix 1) were identified as associated with the salvage operations on the *Grosser Kurfürst* at her primary site.

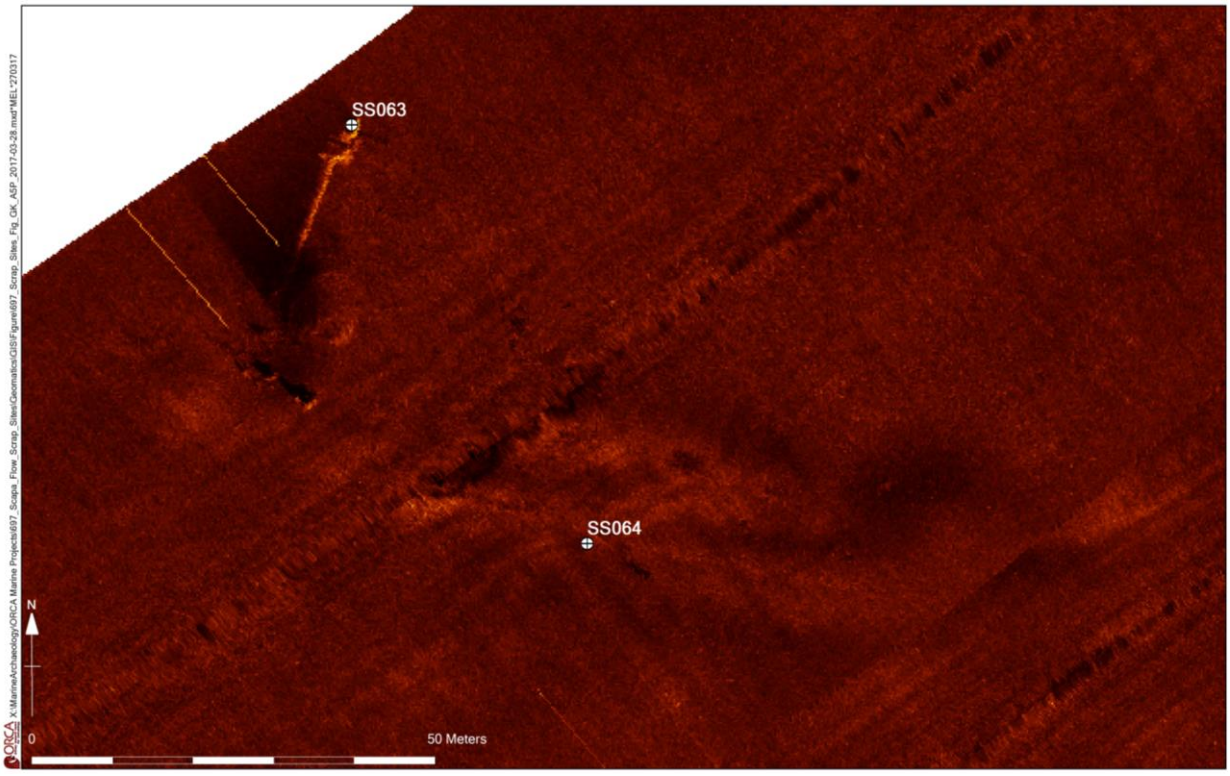

Figure 5 Primary site of the Grosser Kurfürst where she sat on the seabed in Scapa Flow until she was lifted by Metal Industries Ltd.

Anomalies identified off Rysa Little, the secondary location used by Metal Industries Ltd for the removal of superstructure, were assumed (see below) to have come from the *Grosser Kurfürst* (SS080).

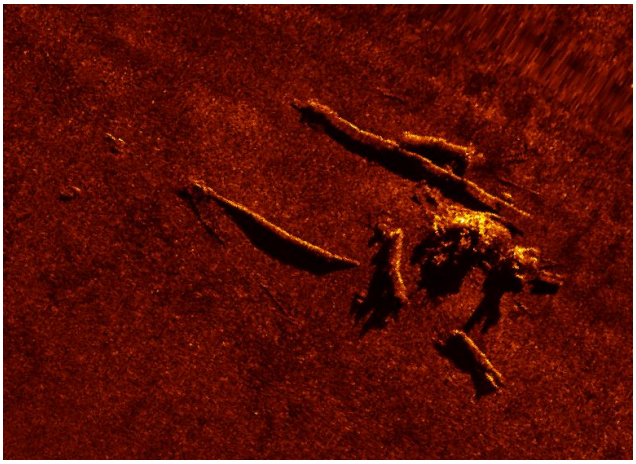

Plate 12 SS080: Grosser Kurfürst superstructure located at Rysa Little secondary site

9.2 Diver Survey

At the primary *Grosser Kurfürst* site, Robert Swannay (1996) cites two pinnaces, a mast and spotting top (SS063 & SS064) present on the scuttled location of *Grosser Kurfürst*. These anomalies were not dived during this phase of work. Diver survey off the secondary site at Rysa Little on SS080 identified the remains of the *Grosser Kurfürst*'s derricks, which were used for lifting the ships pinnaces. This was confirmed from the record of the removal of her derricks at Rysa (Metal Industries Logbook D1/59/3/5;) and that the remains are König Class in design, establishing they are most likely representative of wreckage material from the *Grosser Kurfürst* at this secondary site (Plate 13a).

The König Class derricks are arranged one each side of the forward funnel. The divers encountered two davit arms lying parallel to each other orientated east to west, one samson post lies parallel to this, while another is lying perpendicular to the davit arms. A pulley wheel is attached to the top of the samson post as is common in the König class but not the Kaiser class (Plate 13b). This end of the post shows evidence of blasting/cutting. Off the top of the posts at the eastern end of the site, a large quantity of funnel gratings and plating are present on the site of a platform with a mast and a heavy duty supporting structure that the mast pasts through. Rungs are visible within the mast that was shredded by blasting. A mast sheared by blasting is located off this wreckage. This structure and the wreckage material located on top of it is more evidence of the working on the aft superstructure including the derricks, funnel and searchlight platforms.

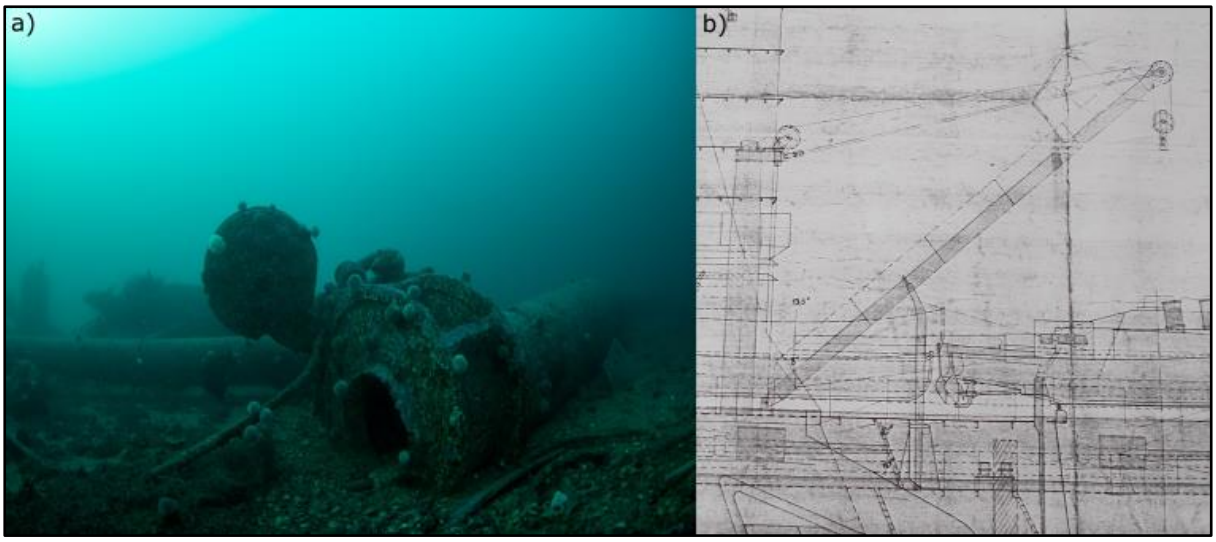

Plate 13 a) derrick arm on seafloor b) ship plans showing the type of derrick on Grosser Kurfürst

10. SMS *Derfflinger*

SMS *Derfflinger* was a Derfflinger Class battlecruiser, she was laid down in March 1912, launched on the 1st July 1913 and commissioned in August 1914 at Blohm and Voss, Hamburg. She had a displacement of 26,180 tons as designed, length of 210.4m, breadth 29m and 9.2m draught. Her armament included eight 30.5 cm SK L/50 guns, twelve 15 cm SK L/50 guns, four 8.8cm/45 QF guns, two 8.8cm/45 semi-automatic anti-aircraft guns and four 50 cm submerged tubes. She was the first German battlecruiser with all centre line turrets. *Derfflinger* could reach speeds of 25.5knots (Friedman, 1992; Gröner, 1982).

The work of raising *Derfflinger* started in autumn 1938, and Metal Industries Ltd raised her on 25th July 1939. The following day her tripod mast and main mast were blasted after lifting, before she was towed into the bay at Rysa for continued works on her superstructure before towing south. Her after and forward funnels, bridge, mast, control room, portside ventilator, starboard air intake casing, samson posts and miscellaneous components of superstructure hanging below deck level were removed here. On Friday 25th August 1939 *Derfflinger* was moved to the inside of Rysa, where cleaning of light gear was continued, along with the blasting of the remaining portions of the funnels and ventilators. On the 5th September 1939, she was moved further inshore so she rested on the bottom at all states of the tide, with the blockship *Cape Ortegal* moored up alongside (McKenzie, 1949; Metal Industries Ltd Records D1/59/4/1; The Orcadian 27th July 1939). *Derfflinger* was unable to be taken to Rosyth as the Admiralty required use of the dry dock, which resulted in her being moored behind Rysa Little for seven years. In April 1946, she was towed to Faslane for scrapping (Buxton, 1992; Pottinger, 1974).

10.1 Side Scan Sonar Survey

The side scan sonar survey of *Derfflinger* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage areas of the battleship. Anomalies SS050, SS051 & SS052 (see Appendix 1) were identified as associated with the salvage operations on the *Derfflinger* at her primary site.

Swannay (1996) describes the site as consisting of two pinnace diesel engines, masts, spotting tops, searchlights and deep scour. These anomalies were not dived during this phase of work. The sonar survey at Rysa Little identified a number of anomalies that may represent remains of the *Derfflinger* at her secondary site (see Rysa Little Secondary Sites).

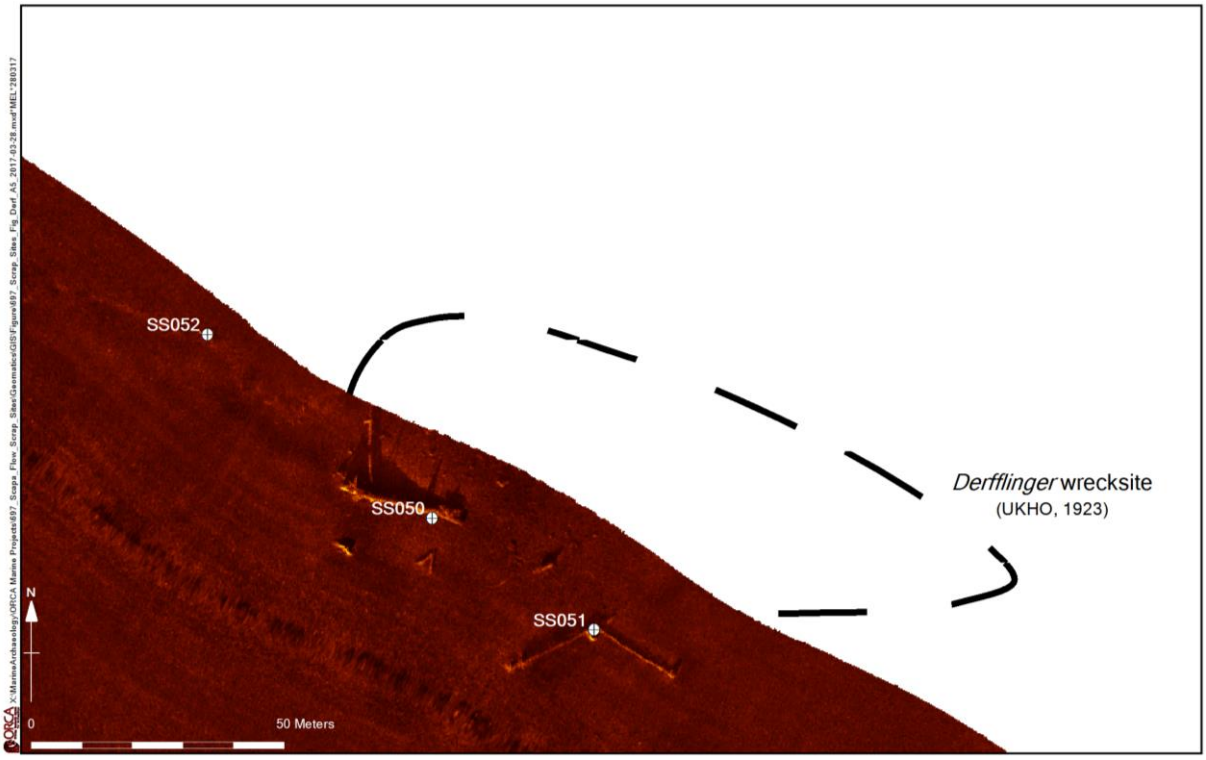

Figure 6 Primary site of the Derfflinger

11. SMS *Friedrich der Grosse*

SMS *Friedrich der Grosse* was a Kaiser Class battleship, laid down on the 26th January 1910, launched on the 19th June 1911 and commissioned on the 15th December 1912 at AG Vulcan, Hamburg. She had a displacement of 24,310 tons as designed, length of 172.4m, breadth 29m and 9.1m draught. Her armament included ten 10.5 cm QF L/50 guns, fourteen 15 cm QF L/45 guns, eight 8.8cm L/45 QF guns, four 8.8cm L/45 semi-automatic anti-aircraft guns and five 50cm submerged tubes. *Friedrich der Grosse* could reach speed of 22.4knots (Friedman, 1992; Gröner, 1982).

Friedrich der Grosse was raised by Metal Industries Ltd on the 29th April 1937 (Dundee Courier and Advertiser 30th April 1937; The Scotsman 30th April 1937). Ironically, the *Friedrich Der Grosse* was used in the salvage efforts on the salvage steamer *Metinde* (Aberdeen Press and Journal 9th July 1937).

11.1 Side Scan Sonar Survey

The side scan sonar survey of *Friedrich der Grosse* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage areas of the battleship. Anomalies SS059, SS060, SS061 & SS062 (ref. Appendix 1) were identified as associated with the salvage operations on the *Friedrich der Grosse* at her primary site. These anomalies were not dived during this phase of work.

Swannay (1996) describes the site as being scoured out, consisting of a pinnace, mast and searchlights. The sonar survey at Rysa Little identified a number of anomalies that may represent remains of the *Friedrich der Grosse* at her secondary site. Smith (1989) states that the bell of *Friedrich der Grosse* was recovered from one of the scrap sites at Rysa Little in 1984 by the Golden Lion Sub Aqua Club of Wrexham. The bell is now in Stromness museum.

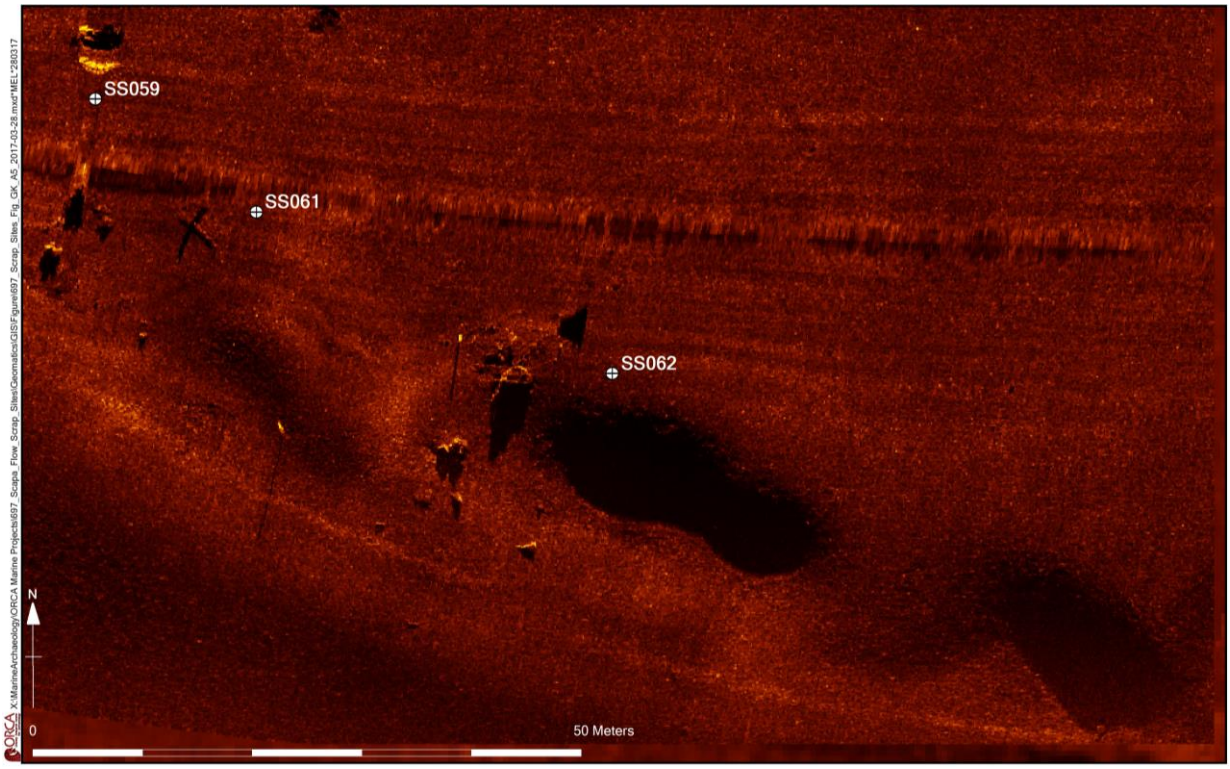

Figure 7 Primary site of Friedrich der Grosse

12. SMS *Kaiserin*

SMS *Kaiserin* was a Kaiser Class battleship, laid down in November 1910, launched on the 11th November 1911 and commissioned on the 14th May 1913 at Howaldt's Works, Kiel. She had a displacement of 24,310 tons as designed, length of 172.4m, breadth 29m and 9.1m draught. Her armament included ten 10.5 cm QF L/50 guns, fourteen 15 cm QF L/45 guns, eight 8.8cm L/45 QF guns, four 8.8cm L/45 semi-automatic anti-aircraft guns and five 50cm submerged tubes. *Kaiserin* could reach speed of 22.1knots (Friedman, 1992; Gröner, 1982).

Kaiserin was raised by Metal Industries Ltd on the 14th May 1936. It took eight months to lift *Kaiserin*, after which she was towed into Rysa for removal of her superstructure (The Orcadian 21th May 1936).

12.1 Side Scan Sonar Survey

The side scan sonar survey of *Kaiserin* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage areas of the battleship. Anomalies SS053, SS054 & SS055 (see Appendix 1) were identified as associated with the salvage operations on the *Kaiserin* at her primary site. These anomalies were not dived during this phase of work. Swannay (1996) describes the site as a double scour with pinnace and masts. The sonar survey at Rysa Little identified a number of

anomalies that may represent remains of the *Kaiserin* at her secondary site (see Rysa Little Secondary Sites).

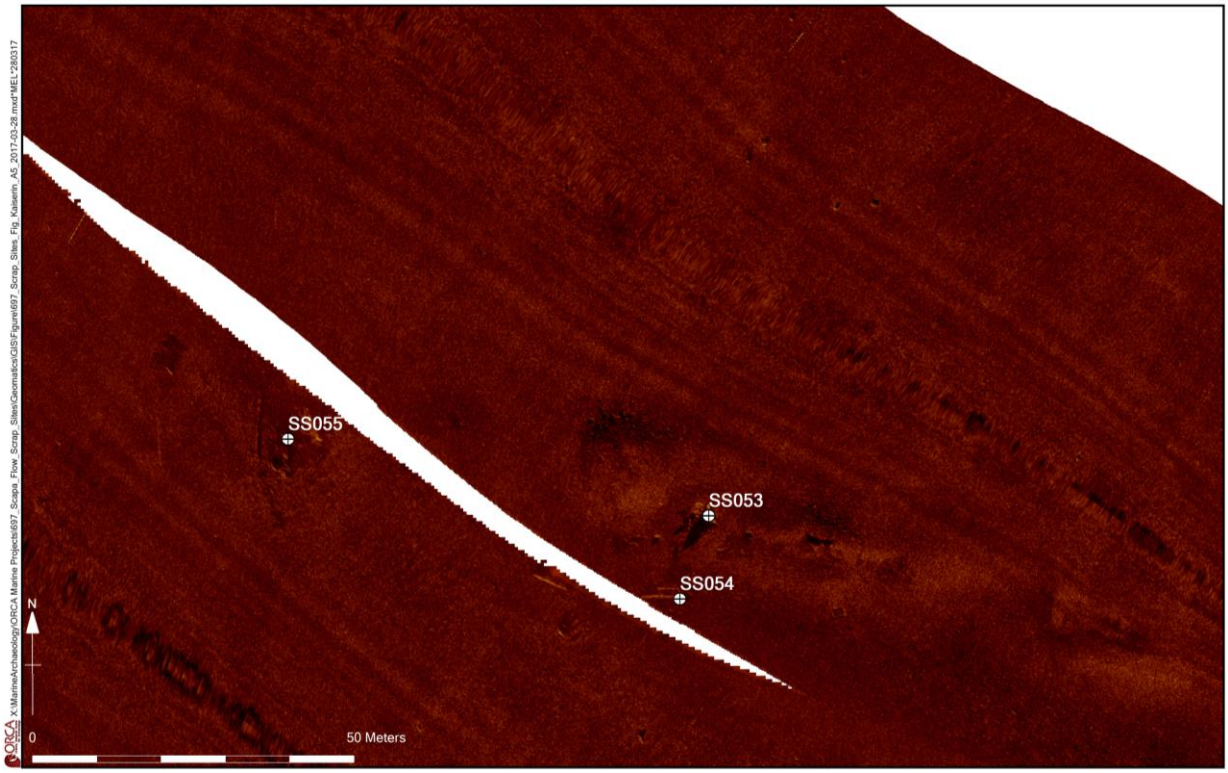

Figure 8 Primary Site of the Kaiserin

13. SMS *König Albert*

SMS *König Albert* was a Kaiser Class battleship, laid down on the 17th July 1910, launched on the 27th April 1912 and commissioned on the 31st July 1913 at Schichau Works, Kiel. She had a displacement of 24,310 tons as designed, length of 172.4m, breadth 29m and 9.1m draught. Her armament included ten 10.5 cm QF L/50 guns, fourteen 15 cm QF L/45 guns, eight 8.8cm L/45 QF guns, four 8.8cm L/45 semi-automatic anti-aircraft guns and five 50cm submerged tubes. *König Albert* could reach speeds of 22.1knots (Friedman, 1992; Gröner, 1982).

König Albert was raised by Metal Industries Ltd on 31st July 1935 (Aberdeen Press and Journal 1st August 1935; The Orcadian 1st August 1935). The towing south of the *König Albert* was delayed for a number of weeks due to gales (The Orcadian 7th May 1936).

13.1 Side Scan Sonar Survey

The side scan sonar survey of *König Albert* collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the final scuttled location and salvage areas of the battleship. Anomalies SS056, SS057 & SS058 (see Appendix 1) were identified as associated with the salvage operations on the *König Albert* at her primary site. These anomalies were not dived during this phase of work. Swannay (1996) describes the site as a pinnace, steam engine and main mast. The sonar survey at Rysa Little identified a number of anomalies that may represent remains of the *König Albert* at her secondary site (see Rysa Little Secondary Sites).

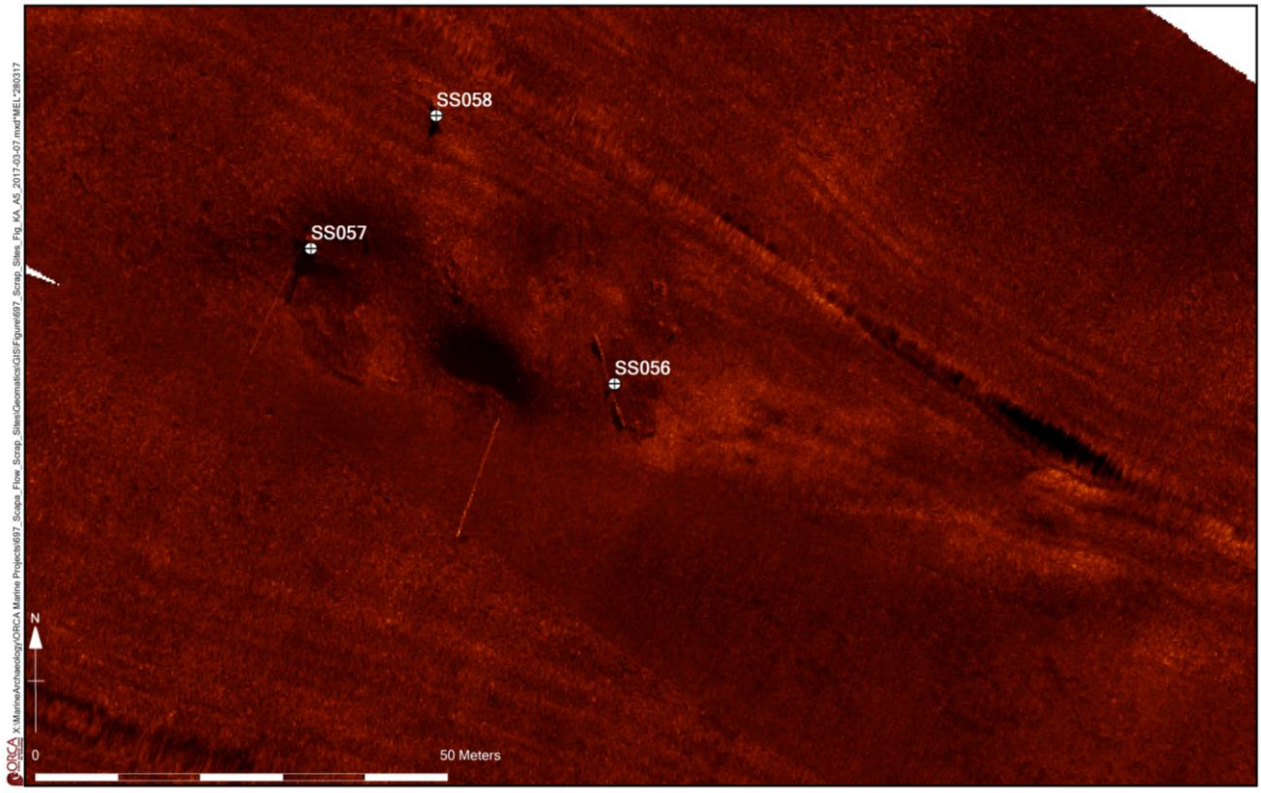

Figure 9 Primary site of König Albert

14. Rysa Little Secondary Sites

Rysa Little was used as a secondary location by Metal Industries Ltd. Raised vessels were towed into the shallows around Rysa to prepare the vessel for travelling south. Rysa Little has a steep shoreline that is ideal for beaching of the salvaged vessels with their deep draughts, allowing work to continue on the superstructure in shallower water than the deeper primary wreck sites. This work involved reducing the draught of the vessel by compression of her superstructure or by blasting and cutting as described above for each ship. The blasted superstructure was later salvaged for scrapping, although this was not the case in all instances. A number of ships of the same class were taken into Rysa for further work and therefore in some cases it is only possible to determine the class of ship the wreckage material belongs to.

14.1 Side Scan Sonar Survey

The side scan sonar survey of Rysa collected medium frequency data (325KHz) and focused high frequency data (780kHz). This provided an overview of the area. Anomalies SS065, SS066, SS067, SS068, SS069, SS070, SS071, SS072, SS073, SS074, SS075, SS076, SS077, SS078, SS079, SS080, SS081, SS082, SS083, SS084 and SS085 (ref. Appendix 1) were identified in the area of the salvage operations at Rysa.

Figure 10 Side Scan Sonar image of anomalies located at Rysa Little

14.2 Diver Survey

The diver survey assessed the nature of the remains identified through the geophysical survey. SS070 is an 8.8cm L/45 gun (Plate 14a; 14c) located just to the north west of SS069.

SS069 is the upper part of an upright searchlight platform with searchlights missing, electrical cables and plugs protrude through the searchlight apertures, and underneath the platform lies a coal winch and extensive debris (Plate 14a; 14b). SS071 is a searchlight control platform complete with two searchlight controllers (Plate 14d; 14e), one in-situ and the other has fallen out from its mounting (Plate 14d; 14f). The searchlight controller head is missing, and a junction box and morse key were located on this site. The platform shows no evidence for the mast penetrating the platform, indicating that it is a standalone platform typical of the Kaiser Class.

Plate 14 a) side scan sonar image SS070 & SS069 b) SS069 searchlight platform c) SS070 8.8cm L/45 gun d) side scan sonar image SS071 e) SS071 searchlight platform f) SS071 in-situ searchlight controller

SS078 is an extensive area of heavily corroded funnel plating and bands, extensive grating and wires are visible (Plate 15c; 15d). A brass box with two switches and a small whistle is located on the site. Part of a platform is located here, possibly from a searchlight platform. A sub calibre gun barrel liner is visible on this site located inside its partially corroded cylindrical storage container. SS079 is an area of debris with funnel grating and in this area is a brass doorframe (Plate 15e; 15f). SS078 and SS079 are lying 32.8m apart centre to centre of contact, orientated 185-105 degrees. At SS068 there are two samson posts. One is buried in the seabed at one end and it rises at an angle of 45 degrees from the seabed at the other end (Plate 15a; 15b). Under this is a platform and beside this is a door with a porthole aperture and two hinges visible. The second samson post runs perpendicular to the previously described samson post and lies flat on the seabed, with copper pipes lying off to one side, which are possibly voice pipes. A mast with a small spotting top is located here, most likely an aft mast. A section of mast protruding at an angle from the seabed is also located on this site.

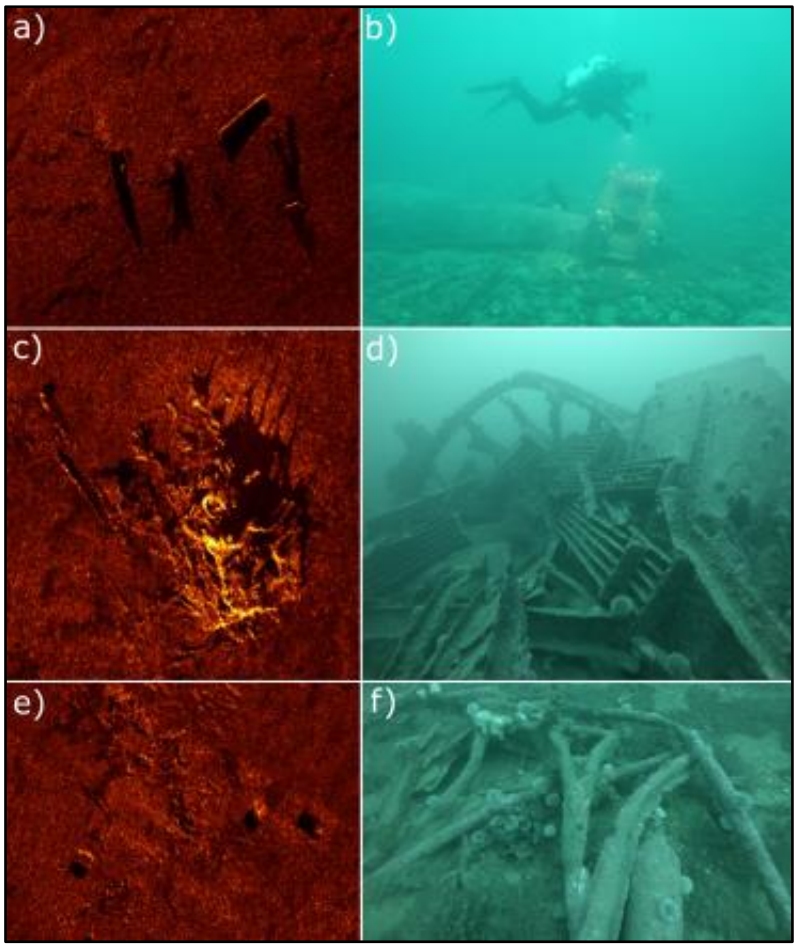

Plate 15 a) side scan sonar image SS068 b) SS068 diver over samson post, partially buried in the seabed at this end c) side scan sonar image SS078 d) SS078 funnel plating and bands e) side scan sonar image SS079 f) SS079 large quantities of wire visible on this site

SS085 is bridge structure cabin with a heavily corroded surrounding platform. A sheared mast abuts the front of the cabin, the deck was formed to receive a curved structure, most likely the aft part of the armoured control room; funnel gratings are also present on this site (Plate 16a; 16b). The cabin is most likely of the Kaiser Class style. SS065 is a top searchlight platform, with a derrick arm and samson post along with a lower searchlight platform. No searchlights are visible (Plate 16c; 16d). There is a coal winch located to the south of this. In close proximity to SS065 is SS066, a derrick arm and samson post, and the remains of a deck mounted winch. There is an abandoned scallop dredge on this site. SS065 and SS066, because of their positioning on the seafloor, match the layout of a Kaiser Class vessel, which are offset one on the starboard forward funnel and one on the port aft funnel. The Kaiser Class derrick arrangement differs from the Konig Class due to their layout on the ship and pulley arrangement at the top of the samson post (Plate 16e).

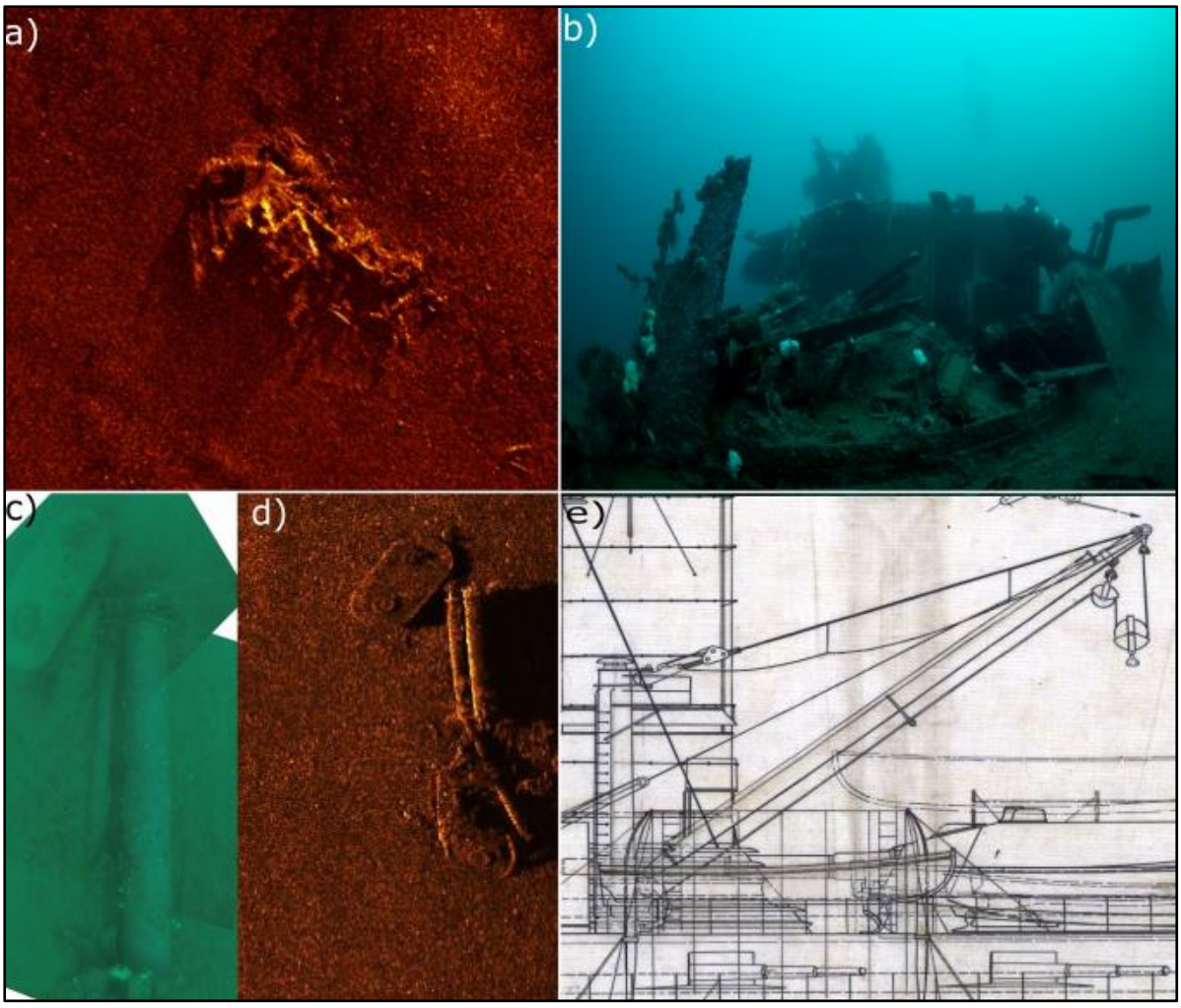

Plate 16 a) side scan sonar image SS085 b) SS085 bridge structure cabin c) side scan sonar image SS066 d) SS066 photographic mosaic of the site showing searchlight platform, samson post and derrick arm d) Kaiser Class derrick

15. Discussion & Conclusion

The High Seas Fleet salvage activity has left extensive evidence dotted across the seafloor in Scapa Flow. This type of site is an immense cultural heritage asset that prior to this project has been relatively undocumented and unappreciated. The evidence on the seafloor tells the story of the lifting and movement of each of the salvaged vessels in Scapa Flow before towing south for scrapping. These remains are evidence not only of the scuttling of the German Navy, but subsequent feats of salvage that were pioneering for the time and introduced new salvage practices. The raising of the destroyers allowed the development of skill, capabilities and salvage techniques to raise the capital ships.

The multi-disciplinary methodology used for this project shows how much new and detailed evidence can be discovered about what is assumed to be a well understood heritage resource of the High Seas Fleet. Geophysical survey provided an overall image of large quantities of salvage site wreck remains on the seafloor. Diver survey ground-truthed a selection of geophysical contacts, identifying and recording in detail the nature and extent of individual sites. Research aided the identification and interpretation of the seafloor remains, and placed them within the context of the scuttling and the later salvage operations. This is exemplified

by the details gained about the *Hindenburg*, the *Von der Tann* and activities at Rysa Little, summarised below.

This project investigated the High Seas Fleet in Orkney establishing the fifty interned destroyers present in Scapa Flow on the 21st June 1919 and their subsequent fate. This list has been determined through cross-referencing of various sources, creating the most comprehensive list ever produced on the German fleet destroyers and their fate. The extent of discrepancies dealt with in the production of this list can be evidenced by comparison to Von Reuter's list and the differences between the two (George, 1973). The associated remains of the destroyers on the seafloor in Orkney include the wreck sites of *S54, V83* and the salvage vessel *Energy, B109* and the re-use of destroyers at the salvage sites of SMS *Hindenburg and SMS Seydlitz.* Further work is required to understand the full extent of the seafloor evidence for the destroyer resource in Orkney.

Cox's first attempt at raising a capital ship was *Hindenburg,* enticed by her upright position on the seafloor. However, *Hindenburg* would become an arduous and expensive task taking over four years to be raised successfully. Today, the remains of the lifting operations on *Hindenburg,* the ingenious engineering feats and problem solving undertaken by Cox's team during the Scapa Flow salvage operations are represented within these remains. The engine room door and the corking on the sea floor all add to the story, showing the selection of the engine room section as it was the strongest part of the vessel. Along with this, evidence in the form of deadlights remains on the seafloor because of the unique way she sat upright on the seafloor.

The remains of *Von der Tann* show her movement from her scuttled position as she was taken into Cava. Her remains on the seafloor provide a previously unknown view into her superstructure and the unique discoveries made by this project on this salvage site have revealed the storage of sub calibre barrel liners in rectangular storage boxes. The extent of the *Von der Tann* wreck site was previously unknown. Evidence similar in nature to that on the primary site of the *Von der Tann* is present for the other primary sites of the High Seas Fleet. This evidence includes large impressions where the ships sat on the seabed, lifting wire and various superstructure elements such as masts, spotting tops, platforms and pinnaces.

Metal Industries Ltd used Rysa Little for the reduction of the draught of the vessel. Cox & Danks used Cava for the beaching of vessels. At these secondary sites, extensive remains of the salvaged vessels are present on the seabed. Continued work would include ongoing ground-truthing of contacts, and allow further identification and assessment to refine beyond ship class which superstructure components are associated with individual ships. There were contacts such as masts discovered out with the immediate location of the primary and secondary salvage areas. These parts of the ships superstructure would have been lost or removed during towing operations, most likely in route to Lyness.

Further work is required to build upon the baseline data from this project to ensure the documentation, survival and protection of the primary and secondary salvage sites and associated debris trails. The collection of data on sites not included within this phase of work

will further the understanding of the salvage operations and help protect these sites that are vulnerable to looting and salvage due to their broken down and undisturbed nature.

Protection of the High Seas Fleet salvage sites is important for promotion, education and engagement with this this submerged cultural heritage resource. The data gathered for the interwar salvage operations during this project provides protection in the form of the production of records of the composition of the scrap sites. The awareness created of these sites as part of this project enables divers and others to engage with the story of the scuttling and salvage sites of the High Seas Fleet. Acknowledgement of the historical importance of these sites facilitates their promotion and protection.

This project used volunteer archival researchers; this involved training volunteers in archival research and the majority of volunteers engaged with this type of heritage resource for the first time, providing an opportunity to acquire a wide new knowledge set. The new skillsets learned are applicable for many other uses for the volunteers, and this platform generated public interest and engagement with this project. The volunteers enjoyed the work, and the archival group will continue to work on wartime and other maritime remains in Orkney.

This project and further work on the salvage sites brings this important historic resource to the surface. Divers and non-divers nationally and internationally can engage with and access the historic resource of Scapa Flow. These sites tell the story of significant historical events in wartime Orkney and Europe. Through this project, the salvage sites are available for engagement and education through imagery, reporting, talks and online resources such as the interactive project map (http://www.scapaflowwrecks.com/). Further site recording by active archaeological and dive groups (for example NAS, BSAC and Seasearch) of the contacts that have undergone diver ground-truthing as part of this project will be promoted.

While it is not within the remit of this survey project to address management issues, the evidence from this project (and the outcomes of previous surveys) should contribute to HES and stakeholders formulating appropriate management and monitoring strategies for marine heritage assets within Scapa Flow.

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17. Acronyms

BSAC	British Sub Aqua Club
DBA	Desk Based Assessment
ESRI	Environmental Systems Research Institute
GIS	Geographical Information System
GPS	Global Positioning System (US Navstar)
HES	Historic Environment Scotland
MBES	Multi Beam EchoSounder
MEDIN	Marine Environmental Data Information Network
MoD	Ministry of Defence
NAS	Nautical Archaeology Society
NRHE	National Record of the Historic Environment
ORCA	Orkney Research Centre for Archaeology
RCAHMS	Royal Commission on the Ancient and Historical Monuments of Scotland
SCUBA	Self-Contained Underwater Breathing Apparatus
SMR	Sites and Monument Record
SULA	Scientific and Underwater Logistics And
UHI	University of the Highlands and Islands
UKHO	United Kingdom Hydrographic Office
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 84

Appendix 1: Side Scan Sonar Contact Report

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS001	489258	6525790	Sub rectangular feature aligned SW-NE	Pinnace engine	2.9	0.4	2.0	4.0
SS002	489259	6525814	Linear feature aligned almost N-S, ending in wedge shape to S	*Moltke* Torpedo loading mast	7.7	0.8	0.1	0.3
SS003	489257	6525830	Linear feature aligned W-E		4.7	1.0	0.0	0.0
SS004	489246	6525852	Collection of linear anthropogenic features aligned predominately N-S		12.9	8.0	0.0	0.0
SS005	489228	6525871	Miscellaneous collection of anthropogenic features extending from SW to NE		24.9	5.3	0.0	0.0
SS006	489203	6525896	Linear feature aligned N-S	Possible mast portion	5.6	0.6	0.5	1.6
SS007	489170	6525945	Miscellaneous anthropogenic feature		5.4	2.0	0.0	0.0
SS008	489159	6525871	Linear feature aligned SW-NE with linear elements leading off of it	Possible capstan winch	4.2	2.0	0.0	0.0
SS009	489138	6525901	Linear feature aligned SW-NE with broader elements at various stages along its length, increasing in width to NE	Possible capstan winch	5.1	1.7	0.0	0.0
SS010	489214	6525913	Miscellaneous collection of anthropogenic features		5.1	2.1	1.4	6.6
SS011	489327	6525918	T shaped feature, with long leg of T aligned E-W	Possible anchor although looks like a winch	3.0	1.8	0.0	0.0
SS012	489176	6526214	Linear feature aligned almost N-S, ending in wedge shape to S		2.3	0.8	0.3	1.1
SS013	489371	6525821	Miscellaneous collection of anthropogenic features		7.7	3.9	0.0	0.0
SS014	489362	6525975	Feature consists of linear elements arranged around a prominent T shape	Possible mast fitting	3.9	2.0	1.9	8.6

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS015	489403	6526016	Miscellaneous collection of anthropogenic features		28.4	6.6	0.0	0.0
SS016	489362	6526001	Linear feature aligned NW-SE		2.4	0.9	0.7	1.5
SS017	489382	6526020	Sub rectangular feature aligned N-S		0.8	0.8	1.0	2.3
SS018	489409	6525923	Linear item, aligned NW-SE		1.4	0.5	0.4	1.1
SS019	489677	6525762	Linear elements aligned NW-SE.	Probable debris as it is on the right alignment, although could be rocks.	5.9	2.5	0.5	3.4
SS020	489563	6525905	Linear feature aligned NW-SE	Possible mast element	3.9	1.3	0.5	2.2
SS021	489472	6525981	Linear feature , aligned S-N ending in wedge shape to N	Torpedo mast	9.1	0.8	0.0	0.0
SS022	489490	6526010	Feature made up of cylindrical items		2.4	2.1	0.4	1.1
SS023	489480	6526076	Linear feature aligned NW-SE	Possible mast element	19.3	0.6	0.2	1.7
SS024	489709	6525833	Linear feature aligned SW-NE. Curves round to N.	Could be torpedo mast, derrick or mast element	3.0	1.7	2.2	10.7
SS025	489245	6526285	Anthropogenic structures	Destroyer sections, filled with concrete bags and bound by chains. Wedged against the port and starboard side of *Hindenburg's* stern (Diver Survey)	29.9	7.2	2.9	22.4
SS026	489225	6526342	Sub oval feature, aligned NW-SE	Buried platform of sub-oval shape (Diver Survey)	3.8	2.4	0.0	0.0
SS027	488928	6526369	Miscellaneous collection of anthropogenic features	Superstructure platform, probably lost during scuttling of from blasting activity when lifted (Diver Survey)	13.3	6.2	0.9	1.5
SS028	488989	6526358	Miscellaneous collection of anthropogenic features	Platform with interior pole, two coal winches, a metal box and	10.3	4.5	1.1	3.8

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
				electrical and steel debris (Diver Survey)				
SS029	488967	6526407	Linear feature aligned W-E	Heavily built oval platform with piping and bronze gearwheel and remains of repeater compass (Diver Survey)	4.0	0.8	0.3	0.5
SS030	489114	6526398	Miscellaneous anthropogenic features although possibly rocks	Possibly geological	18.5	2.7	0.9	2.2
SS031	489198	6526363	Linear feature aligned NW-SE	Davit spar with rigging (Diver Survey)	10.6	0.0	0.0	0.0
SS032	489173	6526344	Miscellaneous collection of anthropogenic features	Heavily corroded rectangular platform (Diver Survey)	5.0	0.0	0.0	0.0
SS033	489205	6526348	Miscellaneous collection of anthropogenic features	Rectangular box structure, possible forming part of a ventilation system (Diver Survey)	2.4	1.3	0.0	0.0
SS034	489190	6526404	Miscellaneous collection of anthropogenic features	Debris representing movement of *Von der Tann* after towing into Cava (Diver Survey)	34.6	30.2	0.0	0.0
SS035	488965	6526320	Circular feature	Upper foremast section and spotting top of *Van der Tann*	1.6	1.6	1.9	3.3
SS036	488975	6526335	Circular feature	Small pinnace boiler standing on its funnel (Diver Survey)	1.5	1.6	0.0	0.0
SS037	489214	6526447	Miscellaneous collection of anthropogenic features	Heavily riveted samson post (Diver Survey)	3.6	1.3	0.5	3.7
SS038	489225	6526436	Linear feature aligned NW-SE	Derrick arm (Diver Survey)	11.4	0.0	0.0	0.0
SS039	489246	6526509	Linear feature aligned NW-SE		3.1	1.2	0.0	0.0
SS040	489445	6526512	Rectangular anthropogenic features aligned NW-SE	Possible plating	5.8	2.1	0.6	4.7

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS041	489200	6526393	Miscellaneous collection of anthropogenic features	Searchlight platform (Diver Survey)	5.6	3.6	0.7	3.7
SS042	488925	6526379	Rectangular feature aligned NW-SE, with linear element protruding from SE end	Upturned platform with steel girders and wires (Diver Survey)	0.0	0.0	0.0	0.0
SS043	489289	6526596	Linear feature aligned NW-SE, with semi-circular element at its SE end	Possible gun	3.5	2.4	0.0	0.0
SS044	489170	6526947	Miscellaneous anthropogenic features with prominent linear features aligned SW-NE	*Kaiser* main site containing complete masts, spotting top and other miscellaneous items	0.0	0.0	0.0	0.0
SS045	488900	6527116	Miscellaneous anthropogenic features with prominent linear features aligned SW-NE and SW-NE	*Prinzregent Luitpold* main site including masts, spotting top and miscellaneous structure items	0.0	0.0	0.0	0.0
SS046	488952	6527158	Rectangular and miscellaneous anthropogenic features aligned SE-NW	Isolated element off *Prinzregent Luitpold* main site	9.1	3.9	0.0	0.0
SS047	488868	6527134	Miscellaneous anthropogenic features	2nd element of *Prinzregent Luitpold* main site, smaller mast items and structure elements	16.6	11.2	0.0	0.0
SS048	489450	6526514	Sub oval feature aligned NW-SE	Possible searchlight platform	6.3	2.6	0.8	4.7
SS049	489582	6526299	Miscellaneous anthropogenic features	Superstructure elements and platforms	10.4	6.4	0.0	0.0
SS050	488481	6527063	Miscellaneous anthropogenic features including prominent linear features aligned SE-NW and S-N	*Derfflinger* tripod mast	23.3	1.4	0.0	0.0
SS051	488513	6527040	Miscellaneous anthropogenic features including prominent linear features aligned SE-NW and SW-NE	*Derfflinger* mast	22.7	0.0	0.0	0.0
SS052	488436	6527099	Linear feature aligned NW-SE	Part of *Derfflinger* main site	5.3	0.0	0.0	0.0

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS053	488612	6527645	Miscellaneous anthropogenic features	*Kaiserin* mast and superstructure elements	0.0	0.0	0.0	0.0
SS054	488608	6527632	Miscellaneous anthropogenic features	*Kaiserin* mast and superstructure elements	7.8	0.0	0.0	0.0
SS055	488547	6527656	Miscellaneous anthropogenic features	*Kaiserin* mast and superstructure elements	0.0	0.0	0.0	0.0
SS056	488798	6528083	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	König Albert mast	12.8	0.0	0.0	0.0
SS057	488761	6528099	Miscellaneous anthropogenic features	*König Albert* superstructure element	3.6	2.0	1.4	6.6
SS058	488777	6528116	Miscellaneous anthropogenic features	*König Albert* possible mast element	3.8	0.7	1.4	2.6
SS059	489279	6528648	Miscellaneous anthropogenic features including prominent linear features aligned S-N	*Friedrich der Grosse* spotting top	25.8	0.0	1.2	4.2
SS060	489265	6528705	Linear feature aligned S-N	*Friedrich der Grosse* mast	11.4	0.0	0.0	0.0
SS061	489294	6528637	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	*Friedrich der Grosse* mast and superstructure elements and main depression	5.9	2.6	3.3	19.9
SS062	489326	6528623	Miscellaneous anthropogenic features including prominent linear features aligned SW-NE and depression aligned SE-NW	*Friedrich der Grosse* main site	0.0	0.0	0.0	0.0
SS063	490172	6528667	Miscellaneous anthropogenic features including prominent linear features aligned S-N and depression aligned E-W	*Grosser Kurfürst* spotting top and mast	25.3	3.2	3.3	11.6

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS064	490202	6528615	Linear feature aligned NW-SE and depression aligned E-W	*Grosser Kurfürst* aft mast	13.0	0.7	0.4	1.1
SS065	488757	6525698	Oval feature and linear features (aligned NW-SE) and miscellaneous anthropogenic features	Top searchlight platform, derrick arm, samson post and lower searchlight platform from a Kaiser class battleship (Diver Survey)	19.3	9.5	1.5	3.4
SS066	488767	6525642	Linear feature aligned NE-SW	Derrick arm, samson post and deck mounted winch from a Kaiser class battleship (Diver Survey)	13.7	0.0	0.0	0.0
SS067	489012	6525417	Linear feature and associated items aligned E-W with sub rectangular feature 19.36m to the SW	Possible mast elements and searchlight platform (Diver Survey)	9.8	4.7	0.0	0.0
SS068	489011	6525464	Miscellaneous anthropogenic features including linear feature aligned SW-NE	Two samson posts and a mast with a small spotting top (Diver Survey)	35.5	22.6	1.8	8.7
SS069	488967	6524839	Miscellaneous anthropogenic features including sub oval feature	Searchlight platform (Diver Survey)	0.0	0.0	0.0	0.0
SS070	488953	6524842	Linear feature aligned SW-NE	8.8cm L/45 gun	0.0	0.0	0.0	0.0
SS071	488944	6524872	Miscellaneous collection of anthropogenic features	Searchlight control platform (Diver Survey)	0.0	0.0	0.0	0.0
SS072	488779	6524960	Rectangular feature aligned W-E with portions at different levels of elevation	Miscellaneous wreck items associated with salvage operations at Rysa	4.1	3.0	0.9	5.3
SS073	488633	6525105	Anthropogenic structure aligned E-W	*V83* stern	0.0	0.0	0.0	0.0
SS074	488689	6525108	Sub circular feature	Boom buoys	0.0	0.0	0.0	0.0
SS075	488628	6525146	Linear feature aligned NW-SE	Miscellaneous wreck items associated with salvage	6.3	0.0	0.9	3.3

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
				operations at Rysa (Diver Survey)				
SS076	488921	6524937	Two rectangular features	Wooden boxes to anchor boom nets	5.1	2.4	0.7	1.3
SS077	488989	6524922	Miscellaneous collection of anthropogenic features	Miscellaneous wreck items associated with salvage operations at Rysa	5.7	3.6	0.7	2.1
SS078	489102	6524847	Miscellaneous collection of anthropogenic features including linear features aligned NW-SE and rectangular features	Heavily corroded funnel plating and bands with extensive grating, wires and a possible searchlight platform (Diver Survey)	25.4	12.0	0.0	0.0
SS079	489100	6524877	Miscellaneous collection of anthropogenic features including linear features aligned NW-SE and rectangular features	Funnel grating and a brass doorframe (Diver Survey)	27.0	17.5	0.0	0.0
SS080	488990	6524949	Linear features aligned NW-SE	Samson posts that formed part of derricks for lifting *Grosser Kurfürst's* pinnaces	0.0	0.0	0.0	0.0
SS081	488864	6525068	Rectangular feature aligned N-S	Wooden boxes to anchor boom nets	5.0	2.7	0.9	2.4
SS082	488887	6525066	Linear feature aligned NW-SE	Possible mast element	6.4	0.5	0.9	3.6
SS083	488818	6525086	Linear feature aligned NW-SE	Possible mast element	4.5	0.8	1.0	1.8
SS084	488869	6525047	Rectangular feature aligned W-E	Wooden box to anchor boom nets	6.1	2.7	0.0	0.0
SS085	488965	6524980	Miscellaneous collection of debris	Bridge structure cabin with heavily corroded surrounding platform (Diver Survey)	18.8	10.2	0.0	0.0

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS086	488124	6524952	Miscellaneous collection of debris including circular features and linear features aligned N-S	Identified as a *Derfflinger* site	0.0	0.0	0.0	0.0
SS087	488184	6525071	Miscellaneous collection of debris including linear features align N-S and sub oval features		3.3	0.8	0.6	6.1
SS088	488083	6524849	Miscellaneous collection of debris		15.0	7.8	0.0	0.0
SS089	488083	6524956	Miscellaneous collection of debris		0.0	0.0	1.8	5.0
SS090	488109	6524929	Miscellaneous collection of debris including linear feature align NW-SE		26.7	7.6	0.0	0.0
SS091	489563	6523810	Sub rectangular feature		2.5	1.5	1.0	1.9
SS092	489086	6523332	Linear feature aligned NW-SE with additional elements on NW terminus	Possible anchor	3.9	0.0	1.1	4.6
SS093	488660	6522939	Anthropogenic structure sub oval in shape aligned NW-SE, cylindrical object 11.97 metres from SE end	Shipwreck *B109*	29.6	11.8	3.5	15.9
SS094	488642	6522749	Linear feature aligned W-E with additional elements on E terminus	Possible anchor	4.1	0.0	0.0	0.0
SS095	489072	6521489	Sub Circular features	Funnel elements as identified in Christie, A.C., Heath, K., and Littlewood, M.E., (2014) Scapa Flow 2013 Marine Archaeology Survey: Final Report (Canmore ID 102248)	20.0	6.3	0.0	0.0
SS096	489108	6521471	Sub Circular features	Funnel elements as identified in Christie, A.C., Heath, K., and Littlewood, M.E., (2014) Scapa Flow 2013 Marine Archaeology	4.4	0.0	0.0	0.0

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
				Survey: Final Report. (Canmore ID 102248)				
SS097	488941	6522863	Shipwreck aligned N-S, possible starboard propeller shaft visible	Shipwreck MV *Mara*	23.9	7.1	3.3	22.3
SS098	489253	6523938	Linear feature aligned W-E, with possible rope attachment leading off from E end	Possible anchor	4.0	2.4	0.0	0.0
SS099	489487	6524058	Linear feature aligned W-E	Possible anchor	5.1	2.2	0.5	2.0
SS100	489659	6524092	Rectangular feature aligned N-S	Unknown- block	2.6	1.0	0.0	0.0
SS101	489741	6524235	Linear feature aligned N-S with sub oval feature at N end	Possible mast and searchlight platform	4.4	12.4	0.0	0.0
SS102	489813	6524296	Linear feature aligned SW-NE		2.7	1.0	0.8	2.9
SS103	489971	6524317	Rectangular feature aligned SW-NE. In elevation sonar shadow reveals curved profile on NE end		2.2	1.2	1.1	2.6
SS104	489407	6524029	Two linear features aligned W-E. Lower feature appears to have some rock attached to eastern end	Two possible anchors	5.4	0.4	0.1	0.4
SS105	488851	6522243	Anthropogenic structure aligned SW-NE	Shipwreck portion	15.3	4.7	2.8	18.7
SS106	488841	6522919	Anthropogenic structure aligned SW-NE	Shipwreck aligned SW-NE	0.0	0.0	0.0	0.0
SS107	490304	6524186	Miscellaneous anthropogenic features aligned NW-SE		23.8	12.2	0.0	0.0
SS108	489035	6526281	Linear feature aligned N-S	*Von der Tann* lower foremast section with crow's nest (Diver Survey)	12.0	0.8	0.0	0.0
SS109	489049	6526281	Rectangular feature aligned W-E and miscellaneous debris	*Von der Tann* pinnace with small engine, copper pipes and fittings (Diver Survey)	3.2	1.5	1.0	2.6
SS110	489076	6526292	Miscellaneous anthropogenic features aligned SW-NE	Identified as geological (Diver Survey)	11.0	1.0	0.5	1.9

Identifier	X_UTM30N	Y_UTM30N	Description	Potential Feature	L (m)	W (m)	H (m)	Shadow(m)
SS111	488866	6526797	Linear feature	Probable Mast	14.4	0.7	0.5	2.5

Appendix 2: High Seas Fleet Destroyer Table

Ship	**Fate**	**Salvage Company**	**UKHO No.**	**Dates Raised: The Orcadian***	**Additional Information**
G92	Salvaged	Unknown (East Coast Wrecking Co.)	1009	1922	Ashore on Fara in 1922, before beaching at Stromness (UKHO) Broken up in Sunderland 1921-22 (Gröner, 1982) Potentially salvaged by the East Coast Wrecking Co. who were undertaking salvage operations on the Blockships at this time
G89	Salvaged	Stromness Wrecking Co	1006	10/12/1922	Work contracted to Mr. J.W. Robertson. The vessel is recorded as purchased by Cox & Danks in 1928, and was located in Stromness Harbour until that time (UKHO). It was used as a counter weight to balance the list of the *Seydlitz* (Pottinger, 1974). Broken up at Scapa (Gröner, 1982)
V70	Salvaged	Cox & Danks	1001	01/08/1924	1st Destroyer lifted by Coxs & Danks
S53	Salvaged	Cox & Danks	1004	14/08/1924	2nd Destroyer lifted by Coxs & Danks Broken up at Scapa (Gröner, 1982) There is a discrepancy in dates raised listed as 13/08/1924 (Bowman, 1964; The Orcadian, 17th December 1925)
S55	Salvaged	Cox & Danks	1007	29/08/1924	3rd Destroyer lifted by Cox & Danks Broken up at Granton (Gröner, 1982)
S131	Salvaged	Scapa Flow Salvage & Shipbreaking Co	981	29/08/1924	1st vessel lifted by Mr. J.W. Robertson under Scapa Flow Salvage & Shipbreaking Co. Broken up at Granton (Gröner, 1982)
G91	Salvaged	Cox & Danks	1008	13/09/1924	4th Destroyer lifted by Coxs & Danks Broken up at Inverkeithing (Gröner, 1982) There is a discrepancy in dates raised listed as 12/09/1924 (Bowman, 1964; The Orcadian, 17th December 1925)

Ship	Fate	Salvage Company	UKHO No.	Dates Raised: The Orcadian*	Additional Information
V45	Salvaged	Scapa Flow Salvage & Shipbreaking Co	979	09/1924 (UKHO)	Raised September 1924. Broken up Liverpool- Troon (Gröner, 1982; UKHO). This vessel represents the 2nd vessel lifted by Scapa Flow Salvage & Shipbreaking Co.
G38	Salvaged	Cox & Danks	1013	27/10/1924	5th Destroyer lifted by Coxs & Danks Broken up at Scapa (Gröner, 1982)
S52	Salvaged	Cox & Danks	1012	13/10/1924	6th Destroyer lifted by Coxs & Danks Broken up at Inverkeithing (Gröner, 1982)
S50	Salvaged	Scapa Flow Salvage & Shipbreaking Co	983	10/1924 (Gröner, 1982)	Raised October 1924, possibly the 3rd vessel lifted by Scapa Flow Salvage & Shipbreaking Co. Broken up at Stranraer (Gröner, 1982)
S49	Salvaged	Scapa Flow Salvage & Shipbreaking Co	984	12/1924 (Gröner, 1982)	Raised 1923 (UKHO); 1925 in Ore Bay along *S131* (UKHO). If raised December 1924 (Gröner, 1982), possibly the 4th vessel lifted by Scapa Flow Salvage & Shipbreaking Co. The Orcadian records Mr. J.W. Robertson working into the winter month, although Cox has stopped operations by this time. Broken up at Granton (Gröner, 1982)
H145	Salvaged	Cox & Danks	1017	13/03/1925	7th Destroyer lifted by Coxs & Danks Broken up at Scapa (Gröner, 1982). There is a discrepancy in dates raised listed as 14/03/1925 (Bowman, 1964; The Orcadian, 17th December 1925)
S136	Salvaged	Cox & Danks	1019	03/04/1925	8th Destroyer lifted by Cox & Danks Broken up at Scapa (Gröner, 1982)
S36	Salvaged-Wreck site	Cox & Danks	1073	18/04/1925	9th Destroyer lifted by Cox & Danks. The *S36* was partially salvaged and reused in connection with the salvage activities on the SMS *Hindenburg*, she was beached on the west side of Cava, with her bow high on the beach (UKHO). Broken up at Scapa (Gröner, 1982)
S138	Salvaged	Cox & Danks	1025	30/04/1925	10th Destroyer lifted by Cox & Danks

Ship	Fate	Salvage Company	UKHO No.	Dates Raised: The Orcadian*	Additional Information
					Broken up Inverkeithing (Gröner, 1982). There is a discrepancy in dates raised listed as 01/05/1925 (Bowman, 1964; The Orcadian, 17th December 1925)
S65	Salvaged	Cox & Danks	1024	16/05/1925	11th Destroyer lifted by Cox & Danks
S56	Salvaged	Cox & Danks	1037	05/06/1925	12th Destroyer lifted by Cox & Danks Broken up at Scapa (Gröner, 1982)
S32	Salvaged	Cox & Danks	1011	19/06/1925	13th Destroyer lifted by Cox & Danks Broken up at Granton (Gröner, 1982)
G39	Salvaged	Cox & Danks	1020	03/07/1925	14th Destroyer lifted by Coxs & Danks Broken up at Scapa (Gröner, 1982)
G86	Salvaged	Cox & Danks	1018	14/07/1925	15th Destroyer lifted by Cox & Danks. The fastest lift to date; 3 days according to the Orcadian (July 16th 1925), whilst stated as 4 elsewhere (George, 1973). Broken up at Granton (Gröner, 1982)
G40	Salvaged	Cox & Danks	1029	29/07/1925	16th Destroyer lifted by Cox & Danks Broken up at Inverkeithing (Gröner, 1982))
V129	Salvaged	Cox & Danks	1028	11/08/1925	17th Destroyer lifted by Cox & Danks Broken up at Inverkeithing (Gröner, 1982)
V78	Salvaged	Cox & Danks	1034	07/09/1925	18th Destroyer lifted by Cox & Danks Broken up at Granton (Gröner, 1982)
G103	Salvaged-Wreck site	Cox & Danks	1048	01/10/1925	19th Destroyer lifted by Cox & Danks. First of the larger Destroyers lifted. The Orcadian reports the vessel on the 3rd December as lost in wrecking incident in Moray Firth. There is a discrepancy in dates raised listed as 30/09/1925 (Bowman, 1964) and 07/10/1925 (The Orcadian, 17th December 1925)
B110	Salvaged	Cox & Danks	1035	11/12/1925	20th Destroyer lifted by Cox & Danks Broken up at Granton (Gröner, 1982)

Ship	Fate	Salvage Company	UKHO No.	Dates Raised: The Orcadian*	Additional Information
B112	Salvaged	Cox & Danks	1036	11/02/1926	21st Destroyer lifted by Cox & Danks; First vessel raised in 1926. Broken up at Granton (Gröner, 1982)
B111	Salvaged	Cox & Danks	1038	08/03/1926	22nd Destroyer lifted by Cox & Danks. Grounded on north end of Fara during salvage operations. Broken up at Granton (Gröner, 1982)
B109	Salvaged-Wreck site	Cox & Danks	1114	27/03/1926 (Gröner, 1982)	23rd Destroyer lifted by Cox & Danks. Partially scrapped. Dive Site: Mid-section of wreck located on seabed at entrance to Mill Bay, she was re-sunk for unknown reasons (UKHO; Whittaker, 1998). The identity of this wreck is questionable as *B109* is recorded as broken up by Alloa Shipbreaking Company at Rosyth, recorded arriving on 25/06/26; sold with G101 & G104 demolition commenced 10/07/26 (Buxton, 1992).
G101	Salvaged	Cox & Danks	1051	20/04/1926	24th Destroyer lifted by Cox & Danks. Broken up at Charleston (Gröner, 1982). There is a discrepancy in dates raised listed as 13/04/1926 (Bowman, 1964)
G104	Salvaged	Cox & Danks	1049	30/04/1926 (Gröner, 1982)	25th Destroyer lifted by Cox & Danks. Final destroyer lifted. 30th of April 1926 (Bowman); *G82* broken up at Charleston(Gröner, 1982)
G102	Beached				US Prize: Sunk as target in US; sunk on 13th July 1921 off Cape Henry (Virginia) by aircraft bombing tests (Gröner, 1982)
S51	Beached				British Prize: Broken up in Rosyth in 1922 (Gröner, 1982)
S54	Beached-Wreck site		978		Dive Site: Stranded on the way to the breaking yard
S60	Beached				Japanese prize: Sold 1920 to a British company, broken up in England (Gröner, 1982)
S132	Beached				US prize: Sunk 15th July 1921 off Cape Henry, Virginia by gunfire from the US battleship *Delaware* and the destroyer *Herbert* (Gröner, 1982)
S137	Beached				British Prize: Broken up in Bo'ness 1922 (Gröner, 1982)

Ship	Fate	Salvage Company	UKHO No.	Dates Raised: The Orcadian*	Additional Information
V43	Beached				US prize: taken on the 09 October 1920; sunk 11th July 1921 off Cape Henry, Virginia by gunfire from the US battleship *Florida* (Gröner, 1982)
V44	Beached				British prize: Broken up at Portsmouth 1922 (Gröner, 1982)
V46	Beached				French prize: Broken up at Cherbourg 1924 (Gröner, 1982)
V73	Beached				British prize: Broken up at Grangemouth 1922 (Gröner, 1982)
V80	Beached				Japanese prize: Sold 1920 to a British company, broken up 1922 in England (Gröner, 1982)
V81	Beached-Wreck site		916		Dive Site: Located off Caithness coast, broke her tow
V82	Beached				British prize: Broken up at Portsmouth 1922 (Gröner, 1982)
V83	Wreck site		1052		Dive Site: Partially salvaged, overlain by salvage vessel *Energy*
V100	Beached				French prize: Broken up 1921, boiler reused in *Aventurier* (Gröner, 1982)
V125	Beached				British prize: Broken up in Newport 1922 (Gröner, 1982)
V126	Beached				French Prize: Broken up 1925 at Lorient, boiler reused in *Intrepide* (George, 1973; Gröner, 1982)
V127	Beached				Japanese Prize: broken up in Dordrecht in 1922 (George, 1973; Gröner, 1982)
V128	Beached				Italian prize (George, 1973) British Prize (UKHO) Broken up Grangemouth 1922 (Gröner, 1982)

*All dates given are from The Orcadian newspaper articles from the dates of lifting unless otherwise stated

Shipbuilding Yard Prefix	
B	Blohm & Voss
G	Germania
H	Howaldtswerke
S	F Schichau

V	AG 'Vulcan'

Appendix 3: High Seas Fleet Capital Ships and Light Cruisers Table

Ship	Class	**Fate**	Salvage Company	UKHO No.	Dates Raised:
Baden	Bayern Class battleship	Beached			
Bayern	Bayern Class battleship	Salvaged		1094	1st September 1934
Bremse	Brummer Class light cruiser	Salvaged	Cox & Danks	1120	27th November 1929
Brummer	Brummer Class light cruiser	Wreck site	Wreck site	1089	
Cöln	Cöln Class light cruiser	Wreck site	Wreck site	1090	
Derfflinger	Derfflinger Class battlecruiser	Salvaged	Metal Industries Ltd	1046	25th July 1939
Dresden	Cöln Class light cruiser	Wreck site	Wreck site	1080	
Emden	Königsberg Class light cruiser	Beached	Beached		
Frankfurt	Wiesbaden Class light cruiser	Beached	Beached		
Friedrich der Grosse	Kaiser Class battleship	Salvaged	Metal Industries Ltd	1092	29th April 1937
Grosser Kurfürst	König Class battleship	Salvaged	Metal Industries Ltd	1091	26th April 1938
Hindenburg	Derfflinger Class battlecruiser	Salvaged	Cox & Danks	1069	22nd July 1930
Kaiser	Kaiser Class battleship	Salvaged	Cox & Danks	1078	20th March 1929
Kaiserin	Kaiser Class battleship	Salvaged	Metal Industries Ltd	1084	14th May 1936
Karlsruhe	Königsberg Class light cruiser	Wreck site	Wreck site	1085	
Kronprinz Wilhelm	König Class battleship	Wreck site	Wreck site	1088	
König	König Class battleship	Wreck site	Wreck site	1083	
König Albert	Kaiser Class battleship	Salvaged	Metal Industries Ltd	1093	31st July 1935
Markgraf	König Class battleship	Wreck site	Wreck site	1087	
Moltke	Moltke Class battlecruiser	Salvaged	Cox & Danks	1062	10th June 1927
Nürnberg	Königsberg Class light cruiser	Beached	Beached		
Printzregent Luipold	Kaiser Class battleship	Salvaged	Cox & Danks	1082	9th July 1931

Ship	Class	**Fate**	Salvage Company	UKHO No.	Dates Raised:
Seydlitz	Seydlitz Class battlecruiser	Salvaged	Cox & Danks	1058	2nd November 1928
Von der Tann	Von der Tann Class battleship	Salvaged	Cox & Danks	1071	7th December 1930