Project Silent ANZAC

Annex E – Maritime Archaeology Report

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HMAS AE2 at Port Melbourne –© John Thomson

Maritime Archaeology Report

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1 Comparative Submarine Archaeology Projects

In terms of non-disturbance archaeological examinations of submarine wreck sites, *Project Silent Anzac* is one of the most sophisticated projects underway internationally. The documentation of the physical fabric, both external and internal, the environmental modelling, corrosion assessment, anodic protection activities, installation of site warning systems (surface buoy and tracking), and the extensive educational programs, makes it an exemplar of best practice scientific approaches to the management of a complex submarine site anywhere in the world today.

In terms of comparative pre-war and First World War submarine sites subject to archaeological investigation, the *A7 Project* [1] in the United Kingdom is a useful recent addition (2014 ongoing). Here, a similarly volunteer team is undertaking external archaeological documentation of the early British designed submarine *A7* (1905-1914). Work includes an extensive geophysical survey, gathering corrosion data, developing 3D site modelling for public interpretation, and developing ongoing management frameworks. *Holland 5*, also located in the United Kingdom near Sussex and found in 1995 is currently subject to an environmental survey by the Nautical Archaeology Society (NAS, 2014 - ongoing), supported by English Heritage [2].

A number of comparable British E-Class submarines have been located by divers, or through remote sensing surveys since the 1998 discovery of the Australian *AE2* site. Inspection of many these sites has been varied, often the capture of stills and video being the outcome, in lieu of management reports and scientific analysis, documentation and site data. But they provide useful comparative information for *AE2* in terms of E-Class hull survival, site formation processes in a range of underwater environments, and unfortunately in some cases, insights into the dangers of un-regulated site management and protection.

Recent finds include the *E18* (2009) in the Baltic[3], and inside Turkish waters, the *E14* (2012) with past discoveries of the fragmentary remains of *E7* and *E15*[4]. The core team members of these Turkish sites, Selçuk Kolay and Savaş Karakaş, have also found associated remains of the French submarines *Joule* and *Mariotte*, and the German submarine *UB46* on the Black Sea coast, providing a local wealth of comparative sites.

Some sister E-Class wrecks have, at times, been subject to uncontrolled diver visitation and recovery of internal artefacts. *E3* discovered in 1994 off the Dutch island of Schiermonnikoog lies in only 30 metres of water and offers diver entry into the interior due to the past removal of the stern section. Many internal fixtures, fittings and individual archaeological relics have been recovered for private display[5]. *E10* was found near Helgoland in the North Sea during 2002 with *E16* by the same dive team in 2001. Both sites have been subject to some artefact recovery. *E24*, found back in 1973, was extensively salvaged leading to the recovery of human remains, plus the removal of the conning tower and isolated artefacts, ultimately for display at the Wrackmuseum in Cuxhaven, Germany. *E17* located in the 1990's near Texel Island in the North Sea has also been subject to diver recovery of its conning tower, which was accepted by the Royal Navy Submarine Museum at Gosport in the United Kingdom and is now on public outdoor display. *E49* located in the Shetland Islands, United Kingdom, located c. 1987 is a well visited E-Class wreck site, lost to German mines and substantially buried with its conning tower off to one side and subject to some past salvage. It has been subject to more recent monitoring and recording.

The discovery of new submarine sites is ongoing, with the 2014 detection of the German U-boat *U26* (1913-1915) in the Gulf of Finland demonstrating the pristine nature of some archaeological remains of this period[6]. In terms of German First World War submarines, a staggering 63 wreck sites are now claimed as located worldwide[7].

[1] http://www.promare.co.uk/a7project/
[2] http://www.nauticalarchaeologysociety.org/content/holland-no5-submarine
[3] http://www.hmse18.org/
[4] Kolay, S., & Karakaş, S., et al, "Echoes From The Deep: Wrecks of the Dardanelles Campaign" Vehbi Koç Foundation. Istanbul. 2013.
[5] http://www.hollandadventureproductions.nl/E.E3.html
[6] http://yle.fi/uutiset/video_finnish_divers_find_century-old_german_sub/7274726
[7] http://www.uboat.net/wwi/fates/discovered.html

In terms of Second World War submarine sites; there are a number of projects aimed at locating lost casualties, though many equally less expansive in their archaeological scope. Positive contributions include the *Archaeological Atlas of The Two Seas* 2009-2012 project[8,9], a joint venture between organisations in the United Kingdom and Europe to document English Channel shipwrecks including the *U-1195* (1943-1944) and *UB-21* (1916-1920). Second World War submarine wreck sites offer many parallels for the sound management of archaeological sites like *AE2*. A number like the Japanese midget submarine wrecks at Hawaii and Sydney, Australia, being subject to archaeological documentation, corrosion studies, and other management interventions[10].

There has been a recent international focus particularly on the examination of Great War underwater archaeological sites with the *Centenary of the First World War* and UNESCO's advocacy of seminal projects like the *AE2* through *Project Silent Anzac*[11]. The organisation's June 2014 conference in Belgium heralded such projects as key contributors to knowledge of past military conflict, noting the well preserved nature of many underwater sites, and their unique research and public education values. Projects like *AE2* were also welcomed in their adherence to and advancement of UNESCO's *Convention on the Protection of Underwater Cultural Heritage* 2001 principle.

2 MAA 2014 Archaeological Methodology

The joint Turkish-Australian Project Silent Anzac was begun as an archaeological project and its key ongoing focus has been building on our learning of the site and its physical fabric as an intact time capsule of the historic past. By understanding the form and condition of the hull and its associated materials, the project seeks to preserve the *AE2* submarine and its unique historical associations as part of the military heritage of Turkey, Australia and the world, now and into the future.

The 2014 archaeological investigations were developed over a number of years and intended to expand on the scientific data obtained during the last major documentation of the *AE2* site in 2007. Applications were appropriately made to the Government of the Republic of Turkey to obtain requisite archaeological and other approvals, with a formal application report documenting the intended project aims, methodology to be deployed, and the safeguards to be put in place to obtain scientific data and protections to the site's heritage values[12].

The Governments of Turkey and Australia have supported archaeological surveys at the *AE2* submarine site initiated by the allied *Project AE2 expedition* (1998) and later the operations of the AE2CF (2007). All of this archaeological work has sought to build on our knowledge of the *AE2* and to ensure appropriate strategies are in place to protect it, following the site's discovery in 1988 (over the past 16 years).

The work has been associated with several Government and private workshops initiated by the archaeological team to debate long-term management options for the site (Istanbul 2002, 2004 and 2008).

3 Project Mission Statement

Project *Silent Anzac* aims to protect and preserve the historic remains of the Australian submarine *AE2* archaeological site, located near Karaburun, within the Marmara Denizi (Sea of Marmara), Turkey.

It aims to tell the story of *AE2* and the Ottoman torpedo boat *Sultanhisar* that caused the loss of the Australian submarine in combat during the "Battle of Çanakkale" 1915 (the Allied "Dardanelles Campaign").

The "Joint Proposal" established the range of activities to be undertaken at *AE2* as part of the ongoing management of the site. The project has and will continue to be fully implemented within the

[8] www.vliz.be/imisdocs/publications/236023.pdf

[9] McCartney, Innes, 2003, "Lost Patrols: Submarine Wrecks of the English Channel". Periscope Publishing.

[10] Smith, T., 2009, "Managing an Australian midget: The Imperial Japanese Navy Type A Submarine M24 at Sydney", Bulletin of the Australasian Institute for Maritime Archaeology vol. 32, 2008. Pp.79-89.

[11] http://www.unesco.org/new/en/culture/themes/underwater-cultural-heritage/world-war-i/

[12] "Joint Proposal" – "Project Silent Anzac: Proposal to the Turkish and Australian Governments for the Implementation Phase AE2, 2013" dated 23 August 2013".

archaeological and Government approvals processes of the Government of Turkey and the UNESCO *Convention of the Protection of The Underwater Cultural Heritage* 2001 frameworks.
An initial assessment of the external condition and internal spaces of the *AE2* submarine was completed by the AE2CF during its 2007 Turkish Government approved Maritime Archaeological Assessment (MAA) program. Following the production of the MAA Report and development of an options paper, a joint Australian/Turkish workshop was held in Istanbul on 26 and 27 April 2008 to consider the future options for the management of *AE2*.

The workshop opened by the (then) Australian Defence Minister and attended by members of the AE2CF, the Turkish Institute of Nautical Archaeology and Australian/Turkish maritime archaeological experts. The workshop unanimously recommended joint Turkish-Australian activities to safeguard *AE2* and tell the story of *AE2* and *Sultanhisar*. These included measures to:

- Protect and preserve *AE2* in situ.
- Complete an internal archaeological assessment using remotely operated vehicles (ROV) with suitable cameras and instrumentation.
- Undertake education programs in Turkey and Australia to ensure the roles of *AE2* and *Sultanhisar* in the Çanakkale War (Gallipoli campaign) are better understood as a basis for on-going friendship and cooperation.
- Defer any consideration of artefact recovery until the internal assessment results have been completed.

The 2014 Maritime Archaeology Assessment (MAA14) program aimed to implement the agreed outcomes of the joint Turkish Australian workshop and to obtain a more detailed internal examination of the site to determine:

- The physical condition of the internal hull and components and relationship to long-term site conservation;
- The appearance and spatial layout of the internal spaces compared to historic records;
- The existence and location of archaeological relics ("objects")
- Evidence of the crew's life and actions during the fatal loss of the submarine, as part of the research investigations into *AE2* and its sinking.

The 2007 MAA and Joint Workshop had previously identified the need to implement long-term cathodic protection of the hull, to fit a secure hatch to safeguard illegal access to the submarine's interior, and to mark the wreck with a navigational buoy to avoid inadvertent damage from ships anchoring or fishing in the vicinity. This was in order to mitigate observed impacts to the site since its 1998 discovery and to prolong *AE2's* physical protection as a key heritage site to Turkey and Australia into the future.

4 Archaeology Permit Application – 2014

The 2013 archaeological application sought and obtained approval for the *Project Silent Anzac* team to deploy to Turkey in June 2014 to undertake the following archaeological activities. As noted, the work built on the results of the successful Joint 2007 AE2CF Expedition.

- Deployment of remotely operated vehicles (ROV) to record the external condition of the hull (non-disturbance).
- Deployment of an ROV to record the internal condition of the hull (including possible need to remove and recover the historic conning tower hatch to enable ROV access).
- Archaeological recovery of the submarine's upper conning tower hatch for scientific analysis if required through site intervention.
- Attachment to the *AE2* hull at three points, forward, amidships and aft, of a low impact sacrificial anode cathodic protection system to reduce hull corrosion activity, and
- Installation of a navigational buoy to limit inadvertent shipping impacts with the site.

5 Background – *AE2* Discovery

The remains of the Australian submarine *AE2* were located in 1998 by Turkish businessman, diver and renowned explorer, Selçuk Kolay OAM. With the support of an Australian archaeological team headed by Dr Mark Spencer and professional Australian Government Maritime Archaeologist, Mr Tim Smith, the site was confirmed to be *AE2* in September that year. The inspection work and initial archaeological report formed the first scientific analysis of the site and assessment of its archaeological and heritage significance [13]

The *AE2* site lies in 73 metres of water (236 feet) in the Marmara Denizi (Sea of Marmara) within Turkish territorial waters, subject to the heritage controls of the Government of the Republic of Turkey.

Post discovery discussion has focused on how best to manage the site in its current contextual setting. To answer these questions, the original 1999 report identified the need to derive additional quantitative data on the state and condition of the hull and associated relic collections. A series of Joint Workshops held in Istanbul in 2002 and 2004 aimed at generating a shared approach to the management and interpretation of the site and in fostering an innovative approach to its protection.

The major archaeological activity at the site followed in 2007 as part of the Joint Turkish-Australian AE2CF expedition which came about from these formative discussions. Details of the project's successful outcomes are contained in the project report. Since 2007, only limited investigations of *AE2* had occurred, including Mr Kolay's additional high-resolution side scan sonar surveys in 2008 and 2010 (Reson sidescan sonar), with limited diving inspections with colleague and renowned Turkish underwater filmmaker Savaş Karakaş.

The 2014 joint MAA therefore aimed to build on the shared knowledge of the site and to obtain additional quantitative information on the archaeological wreck site. Up to that time, the major focus has been on the external assessment of the hull and its environmental setting, and an exploratory non-disturbance inspection into the conning tower and control room area. It was clear that to formulate meaningful site management options for *AE2*, we needed to have a much better understanding of the complexities of the interior and its condition, including associated fittings and relics collections.

6 Heritage Significance

The site has been identified to be of national heritage significance to Australia, and similarly an important site in the focus of Turkish interests in their ultimate defence against the Allied invasion of the Gelibolu Yarimadasi (Dardanelles) Peninsula during the early stages of the First World War.

As such both governments have taken an increasing interest in the safeguarding of the site, with the Turkish Government specially declaring the *AE2* submarine an item of archaeological heritage protected under its national heritage legislation in 2006.

AE2 is one of 57 completed E-Class British submarines that served as the backbone of the British submarine force during the First World War. She played a critical role in the Dardanelles offensive by making the first successful penetration of the Türk Bogazlari (Dardanelles Strait) during the opening hours of the ground offensive (25 April 1915).

Although subsequently caught on the surface by Ottoman gunboats, damaged and forced to scuttle (30th April 1915), *AE2* led the first Australian forces into battle, opened up the ensuing Allied submarine campaign and interrupted the flow of supplies and troops to the Çanakkale War. Her successful wireless message to the Allied Commander in Chief considering evacuation on the day after the awful landing at Anzac Koyu (Anzac Cove) may have had a seminal role in the decision to keep the troops ashore, leading to the prolonged eight - month campaign.

The wreck survives as one of the key E-Class submarines located underwater internationally and one of the most intact and undisturbed (refer above). The *AE2's* archaeological potential has been identified as significant, with potential to generate new insights into the design, construction and operation of this class of submarine.

[13] Smith, Tim., 1999, Project AE2: Investigations of the HMA AE2 Submarine Wreck Site, Turkey 1998. NSW Heritage Office, Sydney.

7 Government Archaeological Approval Process & Control of Relics

All activities at the *AE2* submarine site are subject to approval of the Government of the Republic of Turkey. As part of the project's archaeological approval, this report fulfils the statutory requirements to report on all Permitted project outcomes. This includes, but is not limited to, the formal lodgement of all survey and archaeological data obtained, a complete inventory of the site including internal elements obtained through agreed non-disturbance activities, and the results of the site stabilisation and conservation measures as approved.

All activities were planned to be in keeping with the principles of the UNESCO *Convention on the Protection of the Underwater Cultural Heritage* 2001, noting that both Turkey and Australia are not currently signatories to the Convention, and to abide by Turkish Articles 10 of 25 of its cultural regulations.

The AE2CF undertook its planning with the key understanding that *AE2* is an asset of high significance to the people of Turkey and the country's military and archaeological past. As such, the provisions of Turkish heritage and military heritage controls were strictly observed. Article 25 of the *Preservation of Cultural and Natural Resources Law*, includes provisions to protect key sites beyond the normal heritage legislative controls. In regions where weapons or other artefacts related to Turkish military history are located, further exploration and the examination and evaluation of historical characteristics of these weapons and artefacts requires approval of the General Staff of the Republic of Turkey.

Artefacts contained within the *AE2* archaeological hull and the submarine itself, are therefore also classified as archaeological remains and artefacts defined as of militarily historic and cultural assets belonging to the Republic of Turkey ("cultural assets"). These are subject to the *Regulations for Military Museums*, specifically the 7th, 15th and 16th provisions.

All survey activities also required approval from the Marmara and Bosporus Coast Guard District Command for all vessel movements related to the expedition, including the precise coordinates of areas being visited and the intended hours of commencement and conclusion. All research related to the expedition had to be conducted outside of the local maritime traffic zones so as not to endanger the safety or disrupt the navigation of maritime traffic in the Turk Bogazlari (Çanakkale Straits). Similarly, the Directorate of Hydrography Navigation and Oceanography had to be kept informed so as to make any necessary announcements to ensure safe navigation in the region.

8 Site Safety Controls during the MAA

Precautions were to be taken to avoid damage to the wreck by inadvertent contact by the support vessel's anchoring arrangements or by action of personnel and equipment associated with the afloat activities. The wreck was marked with small buoys placed at its bow and stern prior to commencing operations to assist in locating it and avoiding inadvertent damage.

In considering the mooring arrangements for the support vessel, the vessel was chosen partly for its ability to be positioned with a secure four-point anchoring system involving anchors and heavy chain. This was to mitigate observed movement of the 2007 survey vessel, which resulted in contact with the concrete clump weights deployed at that time.

The mooring enabled the positioning and holding of the support vessel in the vicinity of the wreck. All afloat operations were under the overall control of the AE2CF Director of Operations; assisted by the AE2CF Project Manager Turkey. The *AE2* Director of Operations had full authority to act on behalf of the AE2CF, to negotiate variations to the agreed scientific work program and if necessary, to cease operations.

9 Archaeological Supervision

The Project Silent Anzac archaeological activities were headed by Mr Tim Smith, Director Maritime Archaeology for the project[14], a professional maritime archaeologist who has been leading the archaeological interventions at *AE2* since its discovery in 1998. Mr Smith worked in partnership with renowned Turkish maritime archaeologist Dr Harun Ozdas[15], Assistant Professor at the Dokuz Eylul University in Izmir, which hosts the Institute of Marine Sciences and Technology of which he is Director. Dr Ozdas served as the Turkish Government's professional Maritime Archaeologist assigned to the Project. Ozdas was joined by Ms Nilhan Kizildag, his associate at the university. The Turkish experts provided a vital support to the successful delivery of all archaeological activities.

Dr Nigel Erskine, a Maritime Archaeologist employed at the Australian National Maritime Museum (ANMM) in Sydney, Australia, served as an additional professional observer during the project.

Zülküf Bey, a Turkish Maritime Archaeologist at the Çanakkale Naval Museum served as the Ministry of Culture and Tourism's representative and visited the operations on several occasions to observe the progress of the work and to ensure that all Turkish archaeological approvals were being upheld.

The Team included the original finder of *AE2*, Mr Selçuk Kolay who received an Order of Australia Medal (OAM) from the Australian Government for his work. Mr Kolay visited the archaeological operations to advise on changes to the site since his last observations.

10 Previous Archaeological Knowledge of *AE2*

September 2007 had witnessed the successful completion of the first systematic archaeological surveys, documentation and sampling of the *AE2* site, since discovery in 1998. The scope of works included video and still photographic survey of the external hull, corrosion and ultrasonic testing of the underlying riveted steel hull, and environmental sampling of surrounding sediments, water column and limited metallurgical analysis of hull fittings.

These core studies were used to obtain baseline data on the site's fabric, condition and factors effecting *in situ* preservation. Additional surveys included a battle damage inspection of the visible portions of the external hull and fittings and a critical internal inspection of the fin and control room spaces to observe condition, amount of sediment penetration, localised environment and artefact distribution. In total, the individual surveys significantly contributed to the AE2CF's knowledge of the submarine as an archaeological site, its current condition and setting, and have been critical in underpinning all subsequent discussions regarding future management options for the site.

11 Joint Workshop, Istanbul 2008: Agreed Objectives

The technical workshop held at Istanbul in April 2008 deliberated on the preferred future management response to the *AE2* wreck site and identified ongoing professional and public activities at the site. The following Objectives had a direct bearing on the 2014 maritime archaeological survey operations:

To achieve an outcome acceptable to both Parties as to how the wreck should be preserved and presented to the international public for the foreseeable future.

These Objectives are supported by activities to:

- Preserve, Protect and Promote the fragile archaeological *AE2* wreck structure, with a view to engaging public knowledge of, and learning from, the role of *AE2*, the Dardanelles Campaign generally and the importance of the wreck to both nations involvement in the campaign.
- This work is to be undertaken in a professional manner, within the controls of the Turkish legal system and meet the highest international professional maritime archaeological standards, giving regard to the rules annexed to the UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001.

[14] Mr. Tim Smith, Executive Director, Heritage Victoria. State Government Maritime Archaeologist. Department of Environment, Land, Water and Planning. Victorian State Government. Melbourne, Australia.

[15] Dr Harun Ozdas, Assistant Professor at the Dokuz Eylul University. Director, Baku Blvd. Nr.100 Inciralti, 35340, Izmir, Turkey.

- Preserve the *AE2* wreck as far as practicable so that future generations can use it as a means of achieving the Objectives.
- This includes surveys to ascertain the materiel state of the wreck and obtain comprehensive images of the wreck.
- The results of the archaeological investigations and surveys should be presented with absolute transparency and with no underlying agendas.

The 2008 Workshop unanimously recommended joint Turkish-Australian activities to safeguard *AE2* and tell the wider campaign story. The fundamental agreement was that *AE2* should be retained in situ within its 1915 battle context, and that all management actions would serve to support and preserve *AE2* in its natural environment. The 2014 scope of works reported here document the delivery and success of the identified archaeological measures to achieve these aims.

12 Archaeological Survey

The 2008 Joint Workshop signalled a number of additional tasks appropriate to deliver the overall objectives of the AE2CF Program. In summary, these are tasks that assist strategies that Protect, Preserve and Promote the *AE2* site. Each task had an archaeological component depending on the level of interference required to the site, or the nature of the information to be gathered. The following key activities were determined to meet these objectives.

12.1 Protect

- Installation of a surface navigational buoy.
- **Secure access hatch** (fitted to conning tower).

12.2 Preserve

- Additional corrosion and ultrasonic hull assessments to determine and model.
- Site chemistry and degradation rates.
- Installation of a **Cathodic Protection System** to artificially prolong the physical life of the *AE2* hull as an archaeological artefact.
- Undertake environmental monitoring.

12.3 Promote - Tell the Story

- External and Internal Archaeological Assessment.

A principle aim of the 2014 MAA was the completion of the 1998 and 2007 external surveys to identify conditions at time of survey, observe any changes to the site since the last inspections, and to complete the external battle damage survey. These activities did not involve any significant contact with the *AE2* site and were considered largely non-disturbance in nature.

AE2 had already been subject to detailed sidescan sonar (SSS) recording in 2007 (C- Max SSS) and again in 2010 (Reson SSS). The additional multibeam sonar (Reson Seabat 8125) survey in June 2010 by Kolay Marine Ltd. Aboard MV *Bothnia* had provided additional three-dimensional geo-referenced imagery of the submarine, hard objects surrounding the hull, and the nature of the seabed profile.

An update survey was undertaken in September/October 2013 prior to the major fieldwork exercise to provide current measurements on the state of the wreck. The data provided critical information on the archaeological form, orientation, structural intactness, and environmental setting of *AE2*.

This imagery has other beneficial uses in promoting the site and its historical and archaeological values to an interested public.

As noted, the archaeological inspections conducted at *AE2* (1998 and 2007) confirmed the need to obtain comprehensive information on the internal condition of the archaeological site.

The 2007 drop camera internal inspection proved critical in determining that the inner conning tower hatch was open and that there was unencumbered camera/probe access into the immediate internal confines of the submarine. The inspection exceeded all objectives providing the first vision ever inside

the key control room space in 92 years, revealing a very low level of silt ingress, confirming items of hull structure, machinery and fittings, and revealed additional structure not captured in historic plans.

The inspection also noted the presence of a potential halocline within the internal water space suggesting a unique layering of salt density layers that required additional investigation.

Samples of fuel oil were recovered under the upper conning tower hatch for scientific analysis. A key result was the documentation of items last seen by the crew as they escaped the vessel under fire in 1915 – the bronze internal conning tower ladders, a telegraph, upper steering gear and covers over the internal conning tower viewing ports. The drop camera inspection established the possibility of additional more sophisticated interrogations of the internal spaces of *AE2* (e.g. by ROV) by confirming that access to the internal compartments was now possible and that the submarine hull appeared largely free of sediment or introduced obstacles. The surveys would aim to explore beyond the limited confines of the crew access ladder, and to deploy more sophisticated camera and lighting platforms. The 2007 activities were constrained by being fixed, with torch lighting, and low-resolution camera capture of data.

13 2014 Archaeological Research Methodology

The Internal archaeological assessment was critical to:

- Identify the current visual condition of the internal surfaces and equipment.
- Obtain water quality samples of the interior space and implications for hull and examine chemical condition (e.g. water densities, presence of haloclines, pH, salinity, dissolved O2, temperature).
- Document through video/still photography, the location, appearance and interrelationships of fixtures and fittings (and to compare them against the historic record of the vessel and its construction).
- Document the depth and nature of the introduced sediments and any impacts on preservation factors.
- Document through video and still imagery the condition of compartments beyond the central control room in order to form a considered opinion on the management implications for the site.
- Identify the existence and condition of the presumed "missing" 8th torpedo from the submarine's armament and to develop management strategies to ensure its stability and to mitigate future possible impacts to the site, if found.
- Document the location, condition and densities of any observed movable archaeological relics within the sealed archaeological hull (and to compare their type and location to historic records of the vessel's fit out and crash sinking event).
- Develop strategies for the on-going protection, management and public interpretation of internal relics, including possible options for scientific archaeological recovery for public interpretation and research purposes.
- Gain high quality, high definition video and still imagery of the internal spaces of the *AE2* to augment public interpretation projects aimed at telling *AE2's* story.

13.1 The Principal Tasks Included

- External ROV inspection of hull condition to compare changes to 2007 observed condition.
- An initial fixed camera survey of the internal upper Conning Tower space.
- Deployment of Instrument Probes for the internal environmental monitoring.
- Attempt opening or removal of the Conning Tower hatch to allow ROV insertion for extended internal documentation.
- Extended ROV survey of the interior compartments, including high definition video capture and sonar spatial mapping via deployment of imaging sonar.
- Fitting of a secure access hatch that replicates the existing water flow at end of the intrusion.

The objective of the internal archaeological survey was to collect a comprehensive internal archaeological and environmental record of the interior of the submarine.

The first phase of the internal archaeological required the insertion of the DSTO "drop camera" and fixed instrumentation probe without disturbing the conning tower access hatch to any significant extent, other than localised clearing of sediment and shell debris, and some corrosion products.

The task was to assess environmental conditions within the wreck (e.g. salinity, temperature, dissolved oxygen, and to obtain water samples), prior to the more intrusive actions of opening or removing the conning tower hatch and inserting a larger drop camera and instrumentation probe, followed by an ROV for detailed mapping and investigation of internal spaces.

13.1.1 Drop Camera Upper Conning Tower Inspection

The upper Conning Tower (between the upper hatch and lower hatch) received the most detailed inspection. The original white gloss enamel painted surfaces were very evident and largely intact. Of key interest in this key working space with *AE2* was the engine room telegraph repeater, with face clearly readable, piping and electrical equipment, the Coning Tower Helm (steering wheel), and the stowed external deck helm (steering wheel) stowed against the starboard side. Interestingly, the wheel was observed to be collapsed into two pieces, explaining how they brought the wheel into the boat from outside when diving.

The horizontal ribs (framing) of the tower were very pronounced and an unknown detail, a timber flag locker, was observed built into the ribs on the starboard side. The timberwork here was in exceptional condition and it was clear that the shelves still had stowed organic items that have been identified as probable signal flags. It is tempting to think that the oversized White Ensign that Captain Stoker hoisted when surfaced within the Sea of Marmara, is also contained in this shelving. Tell-tale copper alloy corrosion products suggest the presence of cleats attached to the flags for attachment to the rigging line.

Also of key interest were the pairs of soft shoes observed stacked in this shelving, identified as Plimsolls used when walking on the deck casing. Divers from the E3 submarine interior had recovered similar items. These items provided a remarkable connection to the crew of *AE2* and the human element of the archaeological study.

An equally important observation was the state of the viewing ports that provide a visual link to the outside of *AE2*. All ports had their brass scuttles (covers) in the open, drop down position. This detail exactly matched crew accounts that record the First Officer Lt. Haggard, looking through the ports as *AE2* came back to the surface on 30 April 1915. It was in this position that he observed the *Sultanhisar* getting ready to perhaps ram *AE2* on the surface, and urging that the crew abandon-ship.

Another unique feature was a coil of electrical wire and possible stand that has been identified as a possible jury-rigged portable radio antennae. This might be evidence of the historic transmission of a radio signal to the Allied Command that *AE2* had successfully breached the Narrows and was "running amok" inside the Sea of Marmara.

As with the 2007 internal survey, pooling of oils and other lubricants was observed against the underside of all elements within the space. Puddling was predominantly noted under the conning tower deck and convex domed access hatch. The stable presence of these fluids suggests that the internal waters within the *AE2* hull is subject to minimal flow change, also evidenced in 2007 by the very silt build up retained on the access ladder treads. For the first time, the source of these introduced fluids was located when the ROV inspection of the forward torpedo room identified bubbling of oils from the floor sediments, indicating a partially leaking fuel tank below the deck ("Floor") covers (Tank 1). It is possible that this lighter fluid has slowly migrated along the roof cavity to "escape" up the conning tower and then become trapped. It cannot be ruled out that other sources for fuel and lubricant escape exist. Sampling of the material under the access hatch post 2007 indicated the presence of both diesel fuel and engine lubricating oils. A sample recovered in 2014 similarly confirmed the presence of diesel (see Annex C)

A comprehensive assessment of the internal observations within the Conning Tower or fin is provided in Annex B.

13.1.2 Deployment of Instrument Probe for Internal Environmental Monitoring

A key outcome of this exercise was the careful gathering of water quality data at discreet "spits" from the height of the conning tower to the floor of the control room. The measurements were obtained in an attempt to determine if any changes in water quality existed within the water column, and the presence or otherwise of a possible halocline witnessed during the initial 2007 drop camera insertion.

It was thought that this data could be compared to the historical sinking event with the team hypothesising that some upper Marmara Denizi (Sea of Marmara) water (less saline) may have been captured inside the hull as *AE2* sank. This may have mixed with more saline (Mediterranean) water that flows in a counter flow pattern up the Çanakkale (Dardanelles) Strait in this locality. Any mixed water components may have then separated inside the submarine at its resting depth of 73 metres leading to the possibly sighted phenomenon.

The nature of the internal water could also be analysed for any effect it might have on the internal corrosion patterns both observed and predicted.

Drop camera vision was also used to determine if a physical distinction between water layers could be observed, to compare against the measured readings.

The documentation of the water column inside the *AE2* hull was successfully achieved through deployment of the instrumentation package. However, the sampling identified that there was no physical change in water quality inside the submarine; rather that it was consistent throughout the sample plane. Equally, the camera vision failed to identify any distinct layers, although there were daily observed with the standard halocline nearer the surface waters above *AE2*. So the experiment proved that the 2007 observed water layer was an aberration.

The implications of the water quality on site survival and longevity are examined in more detail in Annex C.

13.1.3 Opening of Conning Tower Hatch

Insertion of the larger drop camera and instrumentation probe and ROV-borne camera for an internal archaeological assessment necessitated the mechanical opening of the upper conning tower hatch. The methodology employed was to first manually attempt to open the hatch by divers, requiring some clearing of built up shell and concretion materials around the hatch cover and hatch rim. The removal of such protective coverings was identified as possibly leading to some localised accelerated corrosion activity and required monitored before, during and after the clearing works were undertaken.

The divers spent a considerable time clearing the area to determine the outline of the hatch and its hinge mechanism. The build-up of sediments and shell exceeded past predictions and was observed at 10-15 centimetres in thickness. Close to the original "deck" surface, the concretion products were considerably harder requiring manual chipping away with lumpy hammer and chisel to clear a suitable work area.

A sample of Oyster shells was recovered for species identification, silt samples having previously been obtained in 2007. The silt material proved a constant issue, being of very fine sediment size and staying suspended in the water column long after contact.

One of the archaeological tasks was to obtain a good cross-sectional sample of the marine concretion layer formed against the original Phosphor Bronze Conning Tower structure. A series of corrosion potential measurements were also obtained at the hatch and immediately forward of it on the upper deck during the cleaning works. These were used as base measurements prior to opening of the hatch and later fitting of the cathodic protection system.

Unfortunately, the depth of shell deposit, the very hard nature of the concretion products (estimated at 2.5 centimetres in section), and the limited diver working time, meant that a representative sample could not be obtained.

The Turkish divers temporarily sealed the hatch opening to limit contamination of the interior water column and hull space of debris and sediment manufactured a cloth bung. The latter proved a major difficulty and visibility within the upper conning tower was extensively compromised by suspended sediment that took several days to dissipate.

Working on the principle of least possible disturbance to the submarine's historic fabric and marine growth and concretions, divers resumed the manual attempts to open the upper hatch. After several dives using a hand-operated jack, the hatch was opened to about the 80-degree angle in the vertical access. This was a significant achievement at 73 metres depth and showed great skill on behalf of the Turkish commercial divers (DEEP Offshore).

Prior to attempts to open the Upper Hatch, divers were provided with a specially constructed syringe to try and recover an oil sample from under the domed hatch. As mentioned above, oil had been observed and collected under the hatch in 2007 with a sample being identified as a mixture of diesel fuel and lubricating oil. Unfortunately a solid sample could not be extracted despite several attempts during the 2014 activities.

The manual opening of the hatch revealed that a substantial accumulation of oil had indeed formed under the hatch and across the underside of the Upper Deck. This oil occasionally made it to the surface 73 metres above the submarine and could be observed as tell-tale spotting on the surface around the dive platform.

The only alternative for access would have been the removal of the circular upper hatch lid entirely. This activity was considered the most intrusive and the final resort, should the manual options prove impossible. Once removed from the wreck it was clearly impossible to re-attach the hatch to the conning tower, or to leave it safely associated with the wreck structure. The cutting of the hatch dictated its recovery to the surface for immediate conservation care and long-term treatment in an appropriate materials conservation laboratory, for later public exhibition and interpretation.

Sufficient professional guidance and funding for the conservation treatment had been included in project arrangements and funding. The project's Maritime Archaeologists and the Materials Conservator would guide all work. Strict conservation controls were to be followed to ensure the minimum impact to the object. A proposed conservation methodology was prepared in advance should this activity be required in the field and all required treatment chemicals and suitable recovery containers were at standby.

Divers undertook all interactions with the hatch under archaeological supervision from the surface by live ROV video feed and in-water communications to the diver support staff.

Fortunately, the divers managed to successfully open the hatch to about 80 degrees vertical by using a combination of levers, strops and jacks which meant that the ROV could be inserted without the need for such a drastic intervention as cut and recovery. The only intervention that left a physical mark was the need to first manually cut the lugs that secured the hatch lid to the inside of the conning tower coaming. Despite prior detailed planning, examination of extant plans (none survived for the upper lid construction), and observations from the 2007 expedition, the ~10 centimetre hatch opening proved too tight to allow insertion of the fixed camera and instrumentation package. It was later found that reinforcing ribs in the underside of the hatch casting were probably to blame, as they could not be observed as obstructions externally.

To enable a sufficient opening, it was agreed by all relevant parties that the cutting of the lugs was required in order to progress the broader internal imaging tasks. In this case, the damage to a limited amount of fabric was outweighed by the ability to successfully enter the interior spaces and gain critical archaeological and site-wide data. The necessity to cut the hatch lugs using an angle grinder introduced suspended sediment that impacted the following fixed camera inspection of the upper conning tower area, but could not be averted.

The manual and gradual opening of the hatch also had an effect on the fieldwork scheduled but was deemed a successful outcome in that the loss of context of the hatch with the submarine was averted; there was no ongoing conservation requirement to stabilise and safeguard the recovered relic, and the security of the site was not compromised because the "dummy" hatch was available to secure the opening into *AE2's* interior post archaeological work. The expedition team left the wreck in the knowledge that it had left *AE2* and its key features such as the evocative hatch opening and mine jumping wire intact.

The fitting of a secure hatch (of inert materials) to maintain the protection of the internal spaces of the submarine to secure internal relics collections and environmental conditions has international precedents. Several wreck sites of German and Japanese World War two era submarines have been similarly sealed by fitting/welding of hatch covers and plates to maintain site security, particularly where human remains are involved.

13.1.4 ROV Insertion for Extended Internal Documentation

As stated above, the principle aim of extended internal documentation of the *AE2* hull was to gather more visual and scientific data. Key here is detail on the internal makeup of a British E-Class submarine for comparison to limited surviving historic plans, photographs written records, and to compare against previously located E-Class wreck sites.

The inspection had the aim of examining the state and condition of the internal hull surface area and associated fittings, fixtures and major plant (e.g. torpedo tubes, engines, crew working areas).

The visual inspection of corrosion activity and physical condition, including the build-up of concretion products, coupled with internal water quality data, would be a key to identifying the current state of the vessel overall. This information, compared with data obtained on the external hull, would allow a far more rigorous, scientific assessment of the *AE2's* condition, the development of future plans and will guide long term management options.

Only an ROV had the capability of moving the distance through the confined hull of the submarine, with sufficient instrumentation, power and illumination. The ROV introduces few risks to the archaeological site if carefully operated. The major impacts to be mitigated were contact with fixtures and fittings, fouling of the tether, loss of the ROV internally, and excessive destabilisation of internal water layers and sediment deposits in the short term.

14 Archaeological Relics

The 2014 expedition was designed as a non-disturbance archaeological exercise. The purpose of the internal examination of the hull was to identify its condition, historic layout, to document key features, and to assess the existence, condition and spatial extent of any observable archaeological relics. As stated, the internal exploration of the *AE2* hull was proposed by:

1. Initial flexible drop camera inserted through the conning tower opening;
2. Insertion of a larger fixed pole drop camera and instrumentation probe once the hatch has been opened, followed by;
3. An internal "swim through" ROV survey through the hull.

The ROV has the unique ability of penetrating areas of hull that will never be reached by the human eye. In this regard, the information recovered from the vision would be new and unprecedented for *AE2*. In terms of other E-Class submarine wrecks, it would be the first controlled archaeological examination of such a pristine environment, compared to diver looting and uncontrolled recovery of relics in other wrecks. The approach was considered to greatly inform our knowledge of this class of vessel and our understanding of their configuration, fit out in combat and use. A critical element of the ROV survey was the inspection and documentation of any small isolated artefacts located within the hull and compartment areas.

The original 1998 report by *Project AE2* identified the potential for a significant archaeological relic collection inside *AE2*. That study identified that the *"associated artefacts have the potential to provide information about life on board a submarine during wartime, including, hardships, fitting out, victualing and organisation of supplies and resources"*, (page 59). It also found that *"the site and the artefact collection are deemed of such significance that they must be protected at all cost",* and that *"that archaeological excavation be carried out only for justified research or conservation purposes by appropriately qualified individuals".*

15 Research Focus

One of the key research activities associated with the 2014 ROV inspection was the examination of the scatter patterns of relics within the hull area. The 2007 drop camera inspection failed to find any relics on the control room floor in the immediate vicinity of the exit ladders. This was considered a clue to the location of the bulk of the smaller articles within the hull.

Analysis of the historical literature has shown that when the submarine sank, *AE2* suddenly lost all control and shot back to the surface bow first, only a mile away from the *Sultanhisar* torpedo boat. Forced to flood a forward tank, *AE2* dived out of control past its 100-foot depth limit. Quickly the

Commanding Officer ordered the engines reversed and blew main ballast. Thankfully the submarine regained the 100 feet mark while the CO attempted to regain control of the trim.

AE2 had its own mind however and popped to the surface stern first right under attack from the enemy craft. Barely remaining on the surface, *AE2* in a terrifying repeat dived again at a near vertical angle, shooting out of control past 100 feet. Nobody was able to stand and *AE2 "seemed to be trying to stand on her nose"*. All manner of items came tumbling down, the crew hanging off any fixtures to keep them at their stations. The cook Lionel Churcher was just preparing dinners, which *"flew here and there mingling with other various articles"*.

The archaeological team hypothesised that the bulk of relics would be located in the forward part of the submarine with the potential for accumulations of relics against solid fixtures and the sole forward bulkhead. The diaries also noted other items that floated in suspension as the vessel filled with water upon levelling out and sinking. There also remains the possibility then of artefacts scattered throughout the hull area and possibly just buried under the fine sediments that have settled over the internal floor.

The ROV would be used to locate, image and position these artefact scatters for appropriate analysis. The proposed deployment of imaging 3D sonar – the Aris, was identified as a critical way to record such small finds in proper context.

This was considered as a possible international archaeological "first" for a submarine archaeological project and a critical task to enable the proper context of archaeological relics to be determined, important for their evaluation and future analysis.

16 Artefact Controls & Documentation

An aim of the 2014 expedition was to initially confirm the presence of relics, their location and general condition, so that future consideration of their care and management might be made. No recovery of artefacts was proposed or approved, other than the hatch recovery if deemed necessary.

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The AE2CF acknowledged that the Turkish Government has the control of archaeological collections contained within the *AE2* hull, namely:

1. According to the relevant Articles of the Law on the Protection of Cultural and Natural Heritage No: 2863, the ownership of the Australian submarine and all its movable inventory that is considered as cultural property, belongs to our Government and as "both parties cannot assert a claim on the ownership of the vessel", it is not possible to include a statement in the project that would imply concession of a privilege to a third government in our inland waters/territorial waters.
2. On the condition that all items are returned and after necessary indemnities are given (i.e., Government guarantees), only the Turkish Cabinet can decide on temporary export of some recovered artefacts and inventories for exhibition purposes. Should the Turkish Government approve the archaeological recovery and conservation of the *AE2* conning tower hatch cover, a suitable Turkish museum or authority will be identified to undertake the care, curating and display of the historic relics. The AE2CF will provide all necessary assistance and advice to Turkish conservators pertaining to any proposed treatment program for any recovered items.

Details of the internal archaeological surveys by ROV and associated relic discoveries are discussed below in Section 16.2.

16.1 Replacement of Original Hatch with a Secure Hatch

Permanent physical removal of the hatch would have led to an altered localised corrosion environment that should modify over time as concretion products and marine growth re-stabilise. However, removal or opening of the hatch would also create a considerably larger entry point into the submarine that would alter water flow patterns and increase the potential for drift silt to enter the submarine and render it more vulnerable to illicit entry. These actions could alter the corrosion environment inside the vessel and have a negative effect on long-term corrosion patterns. It will be imperative that a modern replacement secure hatch cover be installed over the now open Conning Tower opening.

This hatch was designed to retain the present scale of opening into the vessel to maintain the current flow dynamics (the conning tower is currently slightly open as left by the crew on 30 April 1915, with a ~10 centimetre vertical aperture).

The replacement hatch was constructed of neutral material to avoid impact on the natural corrosion processes operative at the conning tower area. The device will be designed to be removable for future archaeological and corrosion monitoring activities. The replacement cover has the ability of being able to be secured, providing a level of better long term protection from any divers who might wish to attempt an illegal entry into the submarine at a future time, reducing the risk of the uncontrolled recovery of internal relics. The practice has international precedents (e.g. hatch covers welded to German U-boat sites to prevent illegal diver entry), and the level of disturbance to the archaeological site is argued as acceptable for the body of quantitative site data that would be obtained via a planned archaeological interrogation program.

With complete access into the confines of *AE2* assured with the opening of the hatch sufficient to enable insertion of the expedition's custom-made Seabotix ROV.

The ROV ran into complications however as the tolerance for insertion through the hatch coaming (opening) was very slight. Thicker build-up of concretion products on these surfaces, and unforseen obstructions (metal lugs), caused difficulty in inserting the ROV into the upper hatch, and then an inability to move it through the lower pressure hull hatch. Whilst the recovery operations were underway, the ROV did obtain some 80% coverage of the interior surfaces of the Conning Tower. This was in addition to the previous fixed camera inspection prior to the hatch being fully opened.

With the recovery of the ROV, the DSTO Team successfully inserted a smaller Seabotix ROV into the interior and began a successful navigation of the interior (see Science Report). This ROV had some limitations in terms of lighting, thrusters control and lack of a high definition camera. It also could not carry the ARIS Sonar, which was hoped to generate a 3D image of the interior spaces. Testing of the ARIS had to be restricted to the fixed camera insertion through the conning tower and into the control room below, but it proved a useful imaging tool especially where visibility was constrained by agitated internal sediments. A major difficulty identified in the 2014 MAA was how to spatially map the existence of internal artefacts and fixtures within an intact hull remotely 74 metres deep. It was hoped that a full 3D spatial model of the interior could have been built up with the ARIS data once post processed and "stitched" together. Ongoing trials with the sonar data captured to date will continue to explore these possibilities. In this light, all observed relics were mapped and given a locational assignment noting the compartment found in, and against the fixed pattern of internal hull frames, as a convenient reference tool the ROV survey proved extremely successful, generating images of the interior features of *AE2* and its working spaces previously only interpreted through two-dimensional historic construction plans and a 3D interactive model built from the plans (DSTO).

The internal ROV survey was conducted over 3 days and in the following pattern:

- Immediate Control Room area in vicinity of internal Conning Tower ladders;
- Auxiliary Electrical board (Starboard side) and Hydroplane stations within Control Room;
- Main Electrical Board (Port side);
- Officers' Quarters (forward of Control Room;
- Forward Torpedo Room (through forward bulkhead);
- Amidships Torpedo Tubes.

Details of key features observed through these spaces are recorded in Annex B, and will be subject to more intensive study and identification once the many hours of footage are fully interrogated.

All major spaces expected to be locatable from the historic plans could be identified. The two electrical switchboards provided a wealth of detail through which to add to the historic plans.

16.2 Control Room

Throughout the Control Room and forward areas, the overall impression was of the complexity of the interior spaces and the abundance of pipes, valves, motors, gearing and other machinery.

Of great interest was the clarity of the water in the main Control Room and the very limited concretion and marine growth build up on all surfaces. The plethora of observed dials and gauges were in remarkable condition. The glass covers were intact in every observed instance and the needles and units of measure also readily observable.

In many cases, the name of the manufacturer was clearly visible.

Key machinery items were searched for, located and documented. These included both periscopes that were observed to have retracted into the floor wells, suggesting that they were intact. This would equate with historic accounts of the sinking which make no mention of the periscopes being raised in the frantic actions at time of loss.

On the deck beside the forward periscope was the compass repeater that played such a critical role in *AE2's* passage through the Narrows and the minefields on its journey into the Sea of Marmora.

Whilst most items were related to the operations or fit out of the boat, a timber picture frame hanging above the forward periscope perhaps once held the printed operational orders or some other rules, giving a glimpse into the lives of the crew.

Remarkable throughout the boat was the strong evidence of the original gloss white enamel paint that once adorned all interior surfaces. This was particularly evident within the Conning Tower but also in the main pressure hull areas.

One of the key research questions was an assessment of the sediment levels inside *AE2*. The ROV examinations indicated that the main Control Room up to the Officers' Quarters was rather devoid of sediment on the deck spaces. This enabled the ROV to be flown around with comparative ease and ongoing forward visibility.

The depth of sediment was perhaps in the order of 5 centimetres. This changed dramatically however as the ROV progressed forward into the Officers Wardroom and especially the Forward Torpedo Room.

One of the puzzling observations was the absence of the two large hydroplane wheels where the plamesmen controlled the diving and surfacing of *AE2*. The pedestals for both wheels and associated depth gauges were readily located. The loss of the wheels will require more analysis as both steering helms from the Conning Tower (steering wheels), were found intact.

This puzzle was compounded when the main steering helm near the periscopes was also observed to be missing. Speculation on the metal used in their construction might be an answer if they have sacrificially corroded in comparison to the boat (perhaps of Aluminium construction). Here, the wheels may have fallen off onto the floor and not been observed.

An alternative theory is that the crew deliberately removed these wheels whilst they escaped the boat, perhaps to compromise any Turkish attempts to enter the flooding *AE2* submarine to affect a capture.

A metal box was observed under the Hydroplane Stations that might equate with the location of the scuttling (demolition) charge that was known to have been carried in that location (*AE2* crew diaries).

16.3 Officers Wardroom

Perhaps of greatest surprise was the state of conservation of the Officers' Quarters. The timber cabinetry, known from the plans, was found absolutely intact. Such was the condition of the organic materials that all handles and knobs were intact and all cupboards, drawers and shelving could be readily interpreted. Known to have been built from Teak or Mahogany, the state of preservation provided a unique opportunity to interpret this personal space within *AE2*.

Remarkably, the officers' writing desk, most likely used by Captain Stoker to write his Log and for plotting the course of *AE2*, was intact. A timber drawer beneath it was partially open and revealed a tube of toothpaste or perhaps Brylcream hair cream still intact.

Between the two bays (port and starboard) of timber cupboards was found the upturned officers timber wardroom table. Two beautifully turned solid legs pointed vertically from the floor and the other two removed legs were found stowed neatly together. It is unclear if the table was deliberately turned upside down when not in use to limit restriction of the passage way in this part of the boat, or if this reflects the state of chaos in the boat when crash diving to escape the attack of the Ottoman torpedo boat *Sultanhisar*.

Even more remarkable was the presence of a small (approximately 10 centimetre) glass or crystal flask, possibly a decanter, sitting upright on the writing table. Its glistening surfaces were clear and the fluted shoulder detail could be readily observed. It is unknown what this flask once contained and whether it was standard naval issue or a personal item introduced into *AE2* by one of the officers.

Remarkable above the writing desk was the intact ceiling light fitting. A glass fluted style light fitting, its elongated shape and scalloped edge seemed incongruous on a fighting warship. Again, it is possible that this was an individual item brought into the boat to bring a "touch of home". Also, on the writing desk amongst built up sediment, was another globular vessel that may have been an ink well.

All other ship light fittings were of the standard naval glass dome and webbed cover type (Bunker light equivalents). Most observed were intact except some that had smashed glass cases.

Inspection of the sleeping fixtures revealed a different construction fit out to the original plans. The officers were originally supplied with three timber drawers expected to be pulled out into the passage way to serve as sleeping berths. The *AE2* instead appeared to have fold down metal cots suspended from chains with intricate brass brackets for setting inclination. More detailed investigation of these elements can be found in Annex B. What is clear is a deviation from the indicative fit out identified by the building plans for *AE2*, and what was finally constructed. Whilst largely comparable, there were a number of changes or absolute omissions, as with the "Map Cupboard" shown on the plans aft of the officer's Writing Desk, but not observed in the archaeological record.

The craftsmanship of the cabinetry was quite obvious, from the detail of timber mouldings, to the beautifully crafted handles and other fastenings. This showed quite a sophisticated quality in fitting out the boat and the exacting standards prior to the advent of war. Examination of this space proved a very humbling experience because of the close associations with the officers of *AE2* and their life aboard the vessel. Touching details included the coat hook on the aft side of the cupboards on the starboard side, where it could be imagined Stoker or Haggard hanging their sea coats after coming off a bridge watch. Again, the survival of the interior fabric was remarkable and near complete.

Also on the floor immediately aft of the Officers Wardroom was a large timber drawer that appeared to have been thrown out of place onto the floor area. This again is probable evidence of the sinking events where the crew described *AE2* "trying to stand on her nose", and all loose items tumbling through the boat including spanners and tools from the engine room. These historical accounts are all the more remarkable when one considers the survival of the glass flask on the officers' table. It is possible that it sits within a circular recess cut into the desk surface providing some stability.

Remarkable also in the Officers Wardroom was the clear evidence of substantial quantities of decomposed organic materials. The build-up of this material was readily visible and severely constrained the forward movement of the ROV. Combined with confined spaces travelling forward, dark, and increasing sediment build up on the floor area; visibility was largely lost with any use of the ROV thrusters.

It appears that this localised build-up of organic material reflects the bedding materials of the officers' quarters, perhaps the decomposed (straw?) mattresses, uniforms and other organic materials such as the velvet curtains once used to create some personal space from the 29 crew.

16.4 Forward Torpedo Room

Access was made into the Forward Torpedo Room although it was very challenging due to the risk of ROV tether hook-up, the narrowness of the boat going forward and elevated build-up of organic materials that became easily suspended in the water column. Only limited examination could be made of this space.

It was uncertain whether the torpedo tube was actually sighted, although it appeared to be seen in one pass forward on the starboard side. One of the wheels used for activating the forward hydroplanes was visible on the starboard side and matched historic drawings of this compartment. Interestingly though, it appeared partially buried suggesting that the Forward Torpedo Room was perhaps one third – half buried in silt at the floor level.

It was clear that sediment and organic materials had accumulated in a much thicker state here. The 2007 MAA had captured evidence of some minimal internal water flow movements when "jets" of

sediment were seen escaping from small corrosion holes in the external plating. This suggested some level of internal water flow. As mentioned, this level was not enough to upset the very gentle build up of observed sediment that had entered through the partially opened conning tower and settled on the treads of the near vertical ladders. There may well be a general passage of silt through the boat over 99 years towards the bow perhaps supported by the observed slightly bow down attitude. Examination of the ROV footage confirmed a very slight water flow from the stern towards the bow indicating that some opening to the sea must exist in the main hull aft. It is possible that the observed damage to the beam torpedo tubes could indicate a failure of the external framing in the ballast tank. It is clear that there is a very complex micro-environment within the *AE2* hull and the inability to identify corrosion holes and other openings externally due to the build up of marine growth and shifting sediment levels means that a clear picture may be difficult to obtain.

What is clear is the extraordinary build up of organic materials in the forward part of the hull from the Officers Quarters forward into the Bow Torpedo Room. Obviously the higher percentage of organic materials stored in the area is a leading cause with bedding observed on the Officer's berths and debris on all flat surfaces such as the Officer's desk. This material is highly degraded and very mobile with any ROV activity almost making visibility impossible.

It is clear that elevated levels of sediment exist on the passageway forward. It is still unclear if this is just organic matter or a mixture of that and introduced sediments (silt/sand). The absence of any observed depth of sediment within the central control room passageway area remains an anomaly, perhaps supporting an argument that sediments have travelled forward over time and accumulated forward, however incrementally.

The forward bulkhead wall was examined and appeared to be rectangular in section, although it was difficult to extract much meaningful data in this space. A possible frame of the curtain that once separated the Officer's Quarters from the Torpedo Room was identified in the floor sediments in this vicinity.

Clearly evident in this confined space was the presence of fuel oil. Landing the ROV on the accumulated floor deposits within the Forward Torpedo Room readily released bubbles of oil that coated the ROV camera lenses and rose upward. It is clear that the oil is leaking from below the floor area and likely from the Number One Fuel Oil tank situated under the bow in this location.

It is not known how much capacity this tank still retains and whether this is an ongoing localised leak, or evidence of a future more substantial collapse of fuel bunkers within the *AE2* hull. The presence of fuel leaking from the submarine to the surface should be monitored into the future.

Only a limited examination of the Forward Torpedo Room could be made due to the poor visibility, lighting restrictions and the extreme and dangerous problems of driving the ROV so far forward within a confined space at depth. The key finding was the small and restricted nature of the space and the highest level of accumulated sediments, identified from observed hydroplane gear wheels to be possibly 20-30 centimetres in depth, noting the elevated floor levels in this compartment.

16.5 Amidships Torpedo Room

This complex area of *AE2* could only be imaged in the final days of the survey operation and a complete inspection could not be made. One of the interesting research questions guiding the 2014 expedition was whether the rear bulkhead door to the engine room was sealed, matching historic crew accounts.

Unfortunately the rear area of this compartment could not be viewed and ROV passage through it was undertaken at high risk. The survey did confirm that both replacement torpedoes for the midships tubes were missing, again appearing to confirm historic accounts that all torpedoes were expended from these tubes. Interestingly, the archaeological inspection confirmed that the crew had taken down the slings for the spare torpedoes, showing evidence of trying to improve crew amenity and movements within the boat.

An interesting finding involves the covers to the beam torpedo tubes that hinged horizontally to allow reload torpedoes to be ‘dropped into’ the tube.

The forward (Port) torpedo is intact, apart from two minor ruptures (3 and 10cm) in way of the (probable) air charging connection located to starboard of the walkway.

The aft (Starboard) beam tube is either damaged, or dismantled:

- There is a breach in the tube to port of the walkway – consistent with there having being an explosion inside the tube, though it could simply be that a section has been removed.
- There is something inside the tube void – consistent with the shape of a torpedo, but other options are also possible (spare gear, etc.).
- There is a cylindrical object lying above the tube immediately to port of the walkway and at an angle to the tube.
- This is consistent with being a pressure vessel with a rounded end that has a fluted ring mounted to allow mating, or to be stood on end – just possibly a warhead whose shaped nose is out of the picture.
- There is a coil of rope and possibly, rags on the walkway – consistent with some kind of work going on when abandoned.

As mentioned, the historic records indicate that each of the beam torpedo tubes (2) were fired successfully, twice each. This would suggest that both presumably loaded tubes were fired and both the suspended re-load shots were also loaded and fired. The 2014 archaeological surveys have certainly confirmed that no torpedo reloads were visible in the compartment.

An option is that the stern reload was loaded into the starboard tube after the two starboard torpedoes had been expended. Possibly after a fault developed on the stern tube at its last firing obliging the stern reload to be moved to the nearest functioning tube overnight. It may be that the torpedo was being prepared for loading when the action with *Sultanhisar* occurred.

Alternatively, the torpedo was in the starboard tube when the submarine sank and in the intervening time the torpedo's air reservoir failed causing a build-up of pressure in the tube lifting one section of the tube to one side, exposing the breach and possibly displacing the forward end of the torpedo.

Should future examinations confirm the presence of a torpedo in the beam tube, it would confirm that the crew had been attempting to use the suspected spare and unexpended torpedo from the stern. Historic research had suggested that the last torpedo would be found in the Starboard tube. The crew certainly could move torpedoes and their separate warheads around within the confines of a submarine, but it was a challenging task. *AE2* had rested on the floor of the Sea of Marmara on the night before its loss, providing sufficient time and an opportunity to undertake the transfer.

None of these scenarios are mentioned by Captain Stoker in his official and unofficial accounts; nor in any of the remaining crew diaries. It is possible if a major event had occurred the night prior to the *AE2's* loss, it had receded in importance in terms of the dramatic sinking of *AE2* and capture on 30 April 1915. Only a future archaeological examination will be able to delve into this intriguing beam tube to unlock its secrets.

17 Summary of Research Findings

As previously noted, the 2014 Archaeological project had the following key aims:

1. To record the physical condition of the internal hull and components to aid long-term site conservation;
2. To map the appearance and spatial layout of the internal spaces compared to historic records;
3. To confirm the existence and location of archaeological relics ("objects");
4. Document evidence of the crew's life and actions during the fatal loss of the submarine, as part of the research investigations into *AE2* and its loss.

The 2014 Maritime Archaeological Assessment has provided a wealth of information on these aspects. The archaeological surveys confirmed the main structural features of the submarine, key equipment, fixtures and fittings.

Importantly, the survey confirmed the wonderful state of preservation of the interior spaces that has enabled a unique insight into the design, construction and use of this important British submarine type.

The survey also confirmed the presence, though limited, of personal effects related to the crew and their life on board. It was apparent that the heavier build-up of sediment levels in the bow perhaps hides the bulk of the artefact scatters. Crew accounts clearly document the accumulation of small articles into the bow area as *AE2* crashed dived before its final scuttling. The absence of artefact scatters within the Control Room perhaps supports the more likely accumulation of relics in the forward spaces, now buried by accumulated sediment. The 2014 surveys have suggested that these small artefacts may never be fully observed and will remain hidden.

The documentation of personal effects, particularly in the Conning Tower, provided an insight into life on board an E-Class submarine and a direct link to *AE2*'s crew. The tube of cream or some other substance found in the open drawer in the Officer's Quarters is another direct attachment to the daily life of living aboard the submarine. These discoveries have added another human dimension to the project's work and validated the archaeological methodology and overall survey aims.

The confirmation that the majority of the submarine is devoid of sediment, flooded and largely sterile in terms of water movement, will assist the management of the wreck site into the future.

The survey has confirmed the potential for ongoing archaeological interrogation of the *AE2* to build on the knowledge gained on this special class of vessel. The future opportunity for controlled archaeological recovery of specific relics for research and display has also been highlighted. While the internal examination has been successful, it was not complete in its coverage. Future explorations of the Forward Torpedo Room and Midships Torpedo area will still yield scientific and historical insights into *AE2* and its final days. Critical questions such as the state of the aft bulkhead door remain unanswered, and the potential to explore the engine room if found open. Additional trialling of 3D imaging sonar's is seen as an ongoing aim to explore opportunities to map and present the internal confines of sealed archaeological sites like submarines. The ability to spatially map artefacts, fixtures and fittings in a virtual environment remains a significant challenge in sites like *AE2*.

The 2014 MAA has achieved most of its intended aims and brought back robust data and observations of the site that are unique. This knowledge builds upon the previous 1998 and 2007 archaeological projects and confirms that *AE2* has many secrets yet to be revealed. The archaeological and scientific sampling, including the exhaustive external mapping and progressive internal documentation, is critical to develop proper management proposals for the site going forward. We now know a lot more about *AE2* and its condition. The preventative measures put in place such as the surface marker buoy and cathodic protection systems will ensure its continuing survival and protection into the future to enable ongoing scientific programs at this critically important site.