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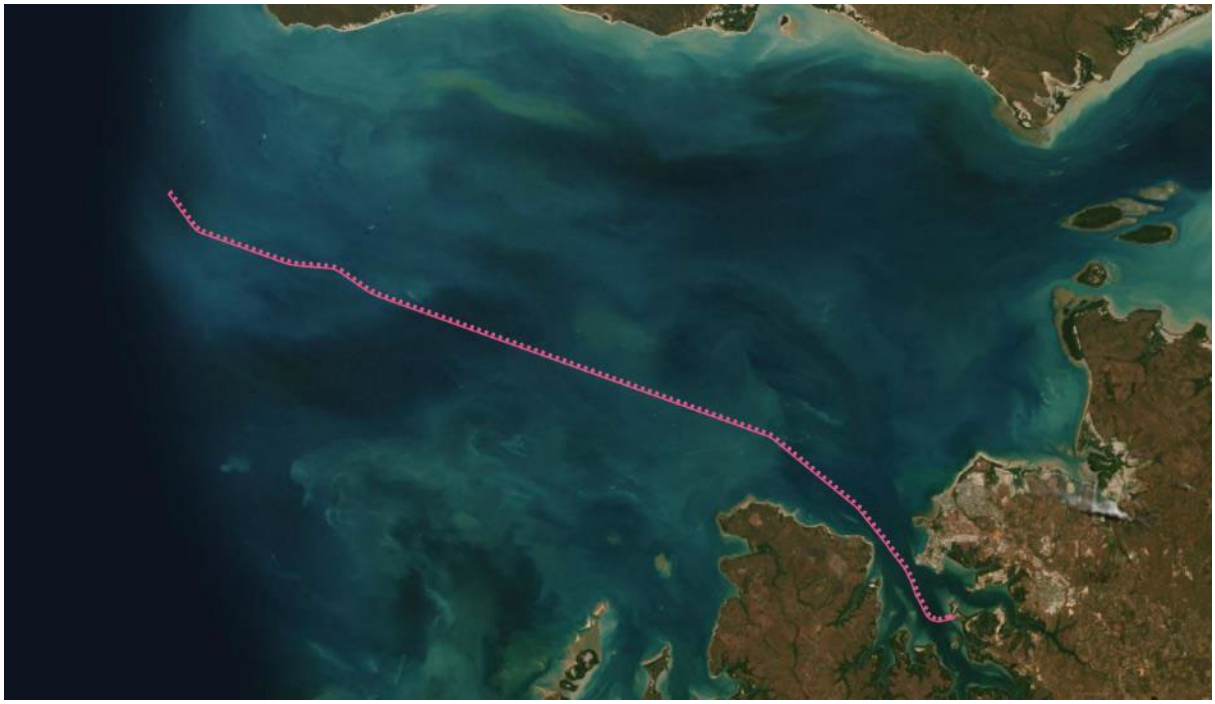
Santos (Barossa)
Gas Export Pipeline

Additional and Nearshore Barossa GEP Stage (Beagle Gulf and Darwin Harbour)



Maritime Heritage Assessment

Beagle Gulf and Darwin Harbour
Northern Territory

December 2022

Santos (Barossa) Gas Export Pipeline

Additional and Nearshore Barossa GEP Stage (Beagle Gulf and Darwin Harbour)

Maritime Heritage Assessment

Prepared for:

Santos Pty Ltd

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December 2022

Cosmos Archaeology Job Number J21/22b

Cover Image: Geophysical survey data overlaid on satellite imagery of Tiwi Islands and Darwin.

Revision	Description	Date	Originator	Reviewer	Approver
V0	Draft Report	8/02/2022	CM, CW	CW, CC	CC
V1	Draft with comments addressed	24/02/2022	CM	CC	CC
V2	Draft included review of additional geophysical data, review FUGRO report, and review of targets	26/05/2022	CM	CC	CC
V3	Inclusion of ROV survey results	06/07/2022	CM	CC	CC
V4	Client comments addressed, addition of anchoring and trenching zones	10/19/2022	CM	CC	CC
V5	Client comments addressed	05/12/2022	CM	CC	CC
V5.1	Appendix B comments addressed	08/12/2022	CM	CC	CC
V5.2	Finalised report	12/12/2022	CM	CC	CC

EXECUTIVE SUMMARY

Santos Pty Ltd is proposing to install a gas export pipeline (GEP) off the northwest coast of the Northern Territory (NT). The proposed GEP begins at the Barossa gas field, north of the Tiwi Islands, and extends south to feed the Darwin LNG plant, located in Middle Arm, Darwin Harbour. Two stages are proposed for the GEP. The first stage is a GEP from the Barossa gas field to a point at the existing Bayu-Undan to Darwin pipeline southwest of Bathurst Island. The second stage is to extend the GEP from this point to the Darwin LNG plant. This maritime archaeological heritage assessment (MAHA) examines the second stage, with the first stage being the subject of a separate report.

A review of historical sources, databases and marine geophysical information has found that within the study area, Larrakia and Tiwi people conducted maritime travel and subsistence activities – likely concentrated in coastal environments. Macassan trepang fishing and trade occurred throughout the 18th to early 20th centuries.

British exploration and surveying began in the early 19th century, following which a wide range of colonial shipping including Government and commercial cargo and passenger transport, fishing and pearling industry trade and transport, and recreational shipping occurred, from the establishment of colonial settlement in Darwin in the 1860s to present. In the 1870s and 1880s, three subsea telegraph cables were laid. Quarantine and leper station transport and service supply were established in Middle Arm throughout the late 19th to early 20th century.

The study area saw significant military action during World War II, including air and sea combat between Allied and Japanese forces, which resulted in the sinking of numerous ships and aircraft within Beagle Gulf and Darwin Harbour. Areas near and adjacent to the study area have been designated as live-fire ranges, and the pipeline route enters a gazetted air-to-air range, though it is unknown if live fire exercises have been undertaken.

There are seventeen located shipwrecks, six instances of maritime infrastructure, and five instances of UXO within the study area. There are no known aircraft wrecks or sea dumping sites within the study area. There are twenty-nine unlocated shipwrecks recorded to have wrecked within the vicinity of the study area. Any of these could possibly be wrecked within the study area. There are twenty-five known, but unlocated, aircraft wrecks in Beagle Gulf and Darwin Harbour that could potentially occur within the study area based on historical accounts of the wreck event and general wreck location.

The remains of these vessels, and their contents and fittings, are automatically protected under the Cwlth *Underwater Cultural Heritage Act 2018*. Remains within the coastal waters boundary (3nm seaward from the Territorial Sea Baseline 'TSB' – see Section 3.1) are protected under the NT *Heritage Act 2011,* and United States military shipwrecks and aircraft wrecks are protected under the US *Sunken Military Craft Act 2004.*

Side scan sonar data and MBES data from a marine geophysical survey conducted by Fugro in 2021 were reviewed, as well as 1 m resolution MBES data collected between 2011 and 2015, published by Geosciences Australia, covering the entirety of Darwin Harbour. Thirty-nine sonar and magnetometer contacts were identified from the Fugro survey data as being possibly cultural and hence of potential cultural heritage significance. These anomalies could be natural features, remains of anti-submarine defences, 19th century telegraph cables, shipwrecks, possible aircraft wreckage, debris fields, or isolated instances of debris and/or discard.

Santos has advised that an 1800 m wide corridor, located between KP 91.5 and the GEP terminus, has been proposed for anchoring of work vessels during GEP installation. Because this corridor is wider than the Fugro geophysical survey corridor, CA conducted a review of the Geosciences Australia MBES data to cover this gap. Clear evidence of eight shipwrecks were identified within the anchoring corridor. Two of these wrecks, USAT *Mauna Loa* and USAT *Meigs,* are protected under the NT *Heritage Act 2011* and may be protected under the

US *Sunken Military Craft Act 2004.* The remaining six shipwrecks identified during review of geophysical survey data are not protected under statutory regulations. No aircraft wrecks were identified within the anchoring corridor. In addition to the geophysical targets and Fugro geophysical survey targets identified, an additional 135 targets were identified within the gap between the geophysical survey corridor and the anchoring corridor. 90 of these targets are between KP 107 and 108, known to be the location of the WWII anti-submarine boom net moorings. It is believed that most, if not all, of these are large cement mooring blocks. The remaining 45 targets have been identified as most likely debris, with some instances of isolated discard and possible cable remains. These targets are scattered along the length of the anchoring corridor.

An ROV survey was conducted in June 2022 on 16 geophysical targets located within 50m of the proposed GEP route. Additionally, three transects were conducted on the likely location of WWII anti-submarine boom net moorings. The ROV survey identified three anti-submarine net mooring trots, Trots 16, 17, and 18. Trot 17 directly crosses the path of the proposed GEP route. The northern-most clump of Trot 16, identified as a repurposed ship's anchor, is located approximately 37m from the proposed GEP route, and the southernmost chain section of Trot 18 is located 32m from the proposed GEP route. The location of Clump 1, Trot 18, if still extant would likely be located within 25m of the proposed route.

In addition to the anti-submarine net trots, four isolated objects were observed during ROV surveys. Target MA_007 is located 6m from the proposed GEP route. Targets 174, MA_001, and NCL_SC_016 are located 15-35m from the proposed GEP route. While Target MA_001 was determined to be the remains of a modern buoy mooring, of minimal heritage significance. Targets 174, MA_007, and NCL_SC_016 could not be conclusively identified through ROV survey. Target 174 appears to be a ship's bollard with rope attached and MA_007 is a rectangular metal structure consisting of metal beams. NCL_SC_016 appears to be a subsea cable of unknown provenance but is not believed to be part of a DP&W or Telstra cable between Mandorah and Darwin, as the object is disarticulated and severed at both ends.

The identity, and hence cultural heritage significance of targets MA_007, 174, and NCL_SC_016, as well as other uninspected anomalies is not known. If identified geophysical anomalies and cultural heritage objects cannot be avoided, then a detailed heritage impact assessment will need to be conducted, consistent with the Heritage Branch of the Northern Territory Government (NT Heritage Branch) Archaeological Scope of Works.[1] This would inform a Maritime Heritage Management Plan, that would include specific mitigation measures and management recommendations for each anomaly, such as, but not confined to, archaeological recording, clearance, removal, and/or recovery. For example, any clearance of cultural material from the seabed should be recorded by a maritime archaeologist on-site. For the INPEX project, this involved maritime archaeologists with suitable diving qualifications embedded with the commercial dive teams.

It is recommended that if further remote sensing surveys of the proposed GEP are undertaken – i.e., to fill in data gaps or assess the risk of UXO – the additional survey data should be reviewed by a qualified maritime archaeologist.

In the unlikely event of significant maritime archaeological remains being discovered during the construction phase, an Unexpected Maritime Archaeological Finds Protocol to responsibly manage such finds should be prepared and implemented. If a Maritime Heritage Management Plan is deemed necessary, this would be a component of such a plan.

Based on the findings above, the recommendations made in this report are as follows:

[1] **NT Heritage Branch, 2021,** Archaeological Scope of Works: Gas export pipeline Barossa gas field to Middle Arm, Darwin Harbour.

Recommendation 1	***If feasible, the proposed GEP alignment be altered to avoid the WWII anti-submarine net mooring Trot 17 as well as cultural heritage objects identified at Target MA_007.***
Recommendation 2	***If potentially cultural anomalies and objects identified in this assessment are likely to be impacted, undertake a detailed heritage impact assessment by a qualified maritime archaeologist.***
Recommendation 3	***Establish no-anchoring zones around protected shipwreck locations, the anti-submarine net moorings, and unverified geophysical anomalies within the anchoring corridor.***
Recommendation 4	***If additional remote sensing data is collected for the proposed GEP it should be reviewed by a qualified maritime archaeologist.***
Recommendation 5	***Prepare and implement an Unexpected Maritime Archaeological Finds Protocol.***
Recommendation 6	***Review of this assessment if proposed alignment of pipeline changes.***

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Abbreviations

AHS SD	Australian Hydrographic Service Sea Dumping Database
AUCHD	Australasian Underwater Cultural Heritage Database
CA	Cosmos Archaeology Pty Ltd
GEP	gas export pipeline
GPS	global positioning system
IJNAF	Imperial Japanese Navy Air Force
IJN	Imperial Japanese Navy
KP	Kilometres along proposed pipeline route
.kmz	keyhole markup file
MHA	maritime archaeological heritage assessment
MBES	multi-beam echosounder
NT	Northern Territory
RAAF	Royal Australian Air Force
ROV	remotely operated underwater vehicle
SMCA	USA *Sunken Military Craft Act 2004*
SSS	side scan sonar
UCH	underwater cultural heritage
UCHA	Cwth *Underwater Cultural Heritage Act 2018*
USAAF	United States Army Air Force
USN	United States Navy
UXO	unexploded ordnance
WWII	World War II

1 INTRODUCTION

1.1 Background

Cosmos Archaeology (CA) has been commissioned by Santos Pty Ltd to undertake a maritime archaeological heritage assessment (MAHA) for the proposed installation of a gas export pipeline (GEP) off the northwest coast of the Northern Territory. The proposed GEP begins at the Barossa gas field, north of the Tiwi Islands, and extends south to feed the Darwin LNG plant, located in Middle Arm, Darwin Harbour. The first proposed route is a GEP from the Barossa gas field to a point at the existing Bayu-Undan to Darwin pipeline southwest of Bathurst Island. Cosmos Archaeology prepared and delivered a maritime heritage assessment for this offshore GEP route, issued for use 30 June 2022.[2]

The second proposed route is to extend the GEP to the Darwin LNG plant. This will include an additional 123 km of seabed pipeline, running through the harbour to the Darwin LNG plant, parallel to the existing Bayu-Undan pipeline.

This MAHA assesses only the second stage, the proposed new pipeline parallel with the existing Bayu-Undan pipeline from Beagle Gulf to the Darwin LNG plant. A MAHA for the first stage will be presented in a separate report.

1.2 The Maritime Archaeological Study Area

A project survey area has been provided by Santos Pty Ltd. This area has been subject to a marine geophysical survey, which will be discussed further in Section 6. The survey area consists of a corridor of variable width, between 700 and 180 m across, primarily around the centreline of the proposed pipeline alignment. The maritime archaeological study area defined by CA for this report is larger than the marine geophysical or project survey area. This is because the exact positions of many of the documented shipwrecks and aircraft wrecks in Beagle Gulf are not known, and some could potentially be located within a wider area. Historical or estimated positions for some wrecks could have a margin of error of a few kilometres. The maritime archaeological study area has been defined as a 1000 m buffer on either side of the proposed GEP centreline (Figure 1). The proposed pipeline route has been provided with markers (KPs) at each kilometre along the length from KP 0 at the junction with the GEP from proposal 1, to KP 122.475 where the pipeline terminates at the Darwin LNG plant.

[2] **Cosmos Archaeology, 2022,** *Santos (Barossa) Gas Export Pipeline, Original Barossa GEP Stage (Timor Sea and Tiwi Islands): Maritime Heritage Assessment.* Prepared for Santos Ltd (BAS 210-0017).

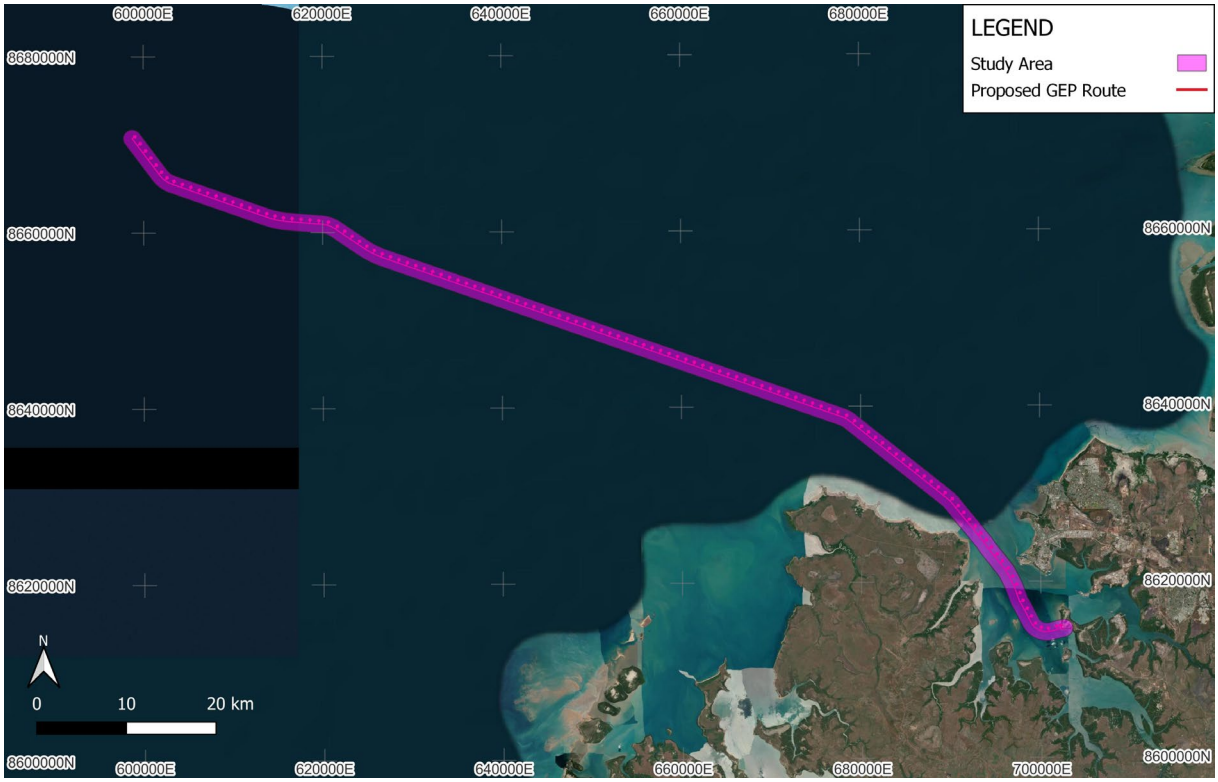

Figure 1: Maritime archaeological study area, 1000 m either side of pipeline centre route.

The coordinates for the survey area were provided by Santos Pty Ltd in the Geophysical survey reports for the Barossa Pipeline.[3] A .kmz file was provided by Santos displaying the centreline of the proposed pipeline route along with geotiff and shapefiles of the geophysical survey data. Additionally, the coordinates for the pipeline routes were provided by Santos Pty Ltd in the same report.[4]

1.3 Scope of the Study

This study addresses the Archaeological Scope of Works for the GEP Barossa Gas Field to Middle Arm, Darwin Harbour, prepared by the NT Heritage Branch in November 2021 and includes the following:

- Provide a list of located and potential maritime archaeological sites (including shipwrecks, aircraft wrecks and dump sites) known to be, or possibly located, within the study area
- Provide an outline of potential impacts from the pipeline installation.
- Provide a description of the different types of potential maritime archaeological sites on the seabed.
- Provide an expert analysis of geophysical survey data in regard to anomalies indicating potential maritime archaeological remains.
- Review of relevant legislative requirements.
- Provide mitigation measures for potential impacts on maritime archaeological remains.

This study examines maritime archaeological sites which are defined as wrecks (ship or aircraft) and associated material, dumped material, maritime infrastructure, and associated deposits on or under the seabed below the highest astronomical tide. While this report

[3] **Fugro, 2022,** *Barossa Pipeline to Shore Project – Survey Results Report – Offshore Geophysical Survey – (Work Package 1) North Route 2,* provided for Santos Pty Ltd. (BAS-200 0629).
[4] *Op. Cit.* **Fugro, 2022.**

addresses only the potential cultural heritage aspects of dumped and spent munitions, more information about unexploded ordnance (UXO) should be obtained from a suitably qualified UXO specialist or the Department of Defence. This heritage assessment should not be considered a UXO assessment.

1.4 Previous Work

CA has undertaken previous maritime cultural heritage surveys and assessments of the study area as part of the Darwin INPEX project between 2010 and 2014. The following is a list of reports previously completed by CA with a focus on the study area:

Cosmos Archaeology, 2011, *Ichthys Gas Field Development Project: Nearshore Development Area, Assessment of Marine Heritage Survey Methods,* report prepared for INPEX Browse Ltd.

Cosmos Archaeology, 2012, *Ichthys Project Darwin Harbour, East Arm Gas Export Pipeline: Assessment of Heritage Impact of 7 side scan targets.* Prepared for Tek Ventures Pty Ltd.

Cosmos Archaeology, 2014, *INPEX Ichthys LNG Project: Nearshore Development – Dredging. East Arm, Darwin Harbour, Northern Territory. Relocation of Heritage Objects and Removal of debris.* Prepared for Tek Ventures Pty Ltd.

Cosmos Archaeology, 2016, *INPEX Ichthys Project, Catalina Flying-Boat Monitoring 2012 to 2015,* Prepared for Tek Ventures Pty Ltd.

Cosmos Archaeology, 2022, *Santos (Barossa) Gas Export Pipeline, Original Barossa GEP Stage (Timor Sea and Tiwi Islands): Maritime Heritage Assessment.* Prepared for Santos Ltd.

2 METHODOLOGY

This desktop study has used various sources to prepare a list of known and potential shipwrecks, as well as other maritime archaeological sites in the study area (Table 1). Research is confined to what is available online and in the consultant's extensive library. Additionally, the Northern Territory Department of Heritage has been consulted for the location of sites which may not be publicly available.

Table 1: Historic resources consulted in this report.

Source	Description
Australasian Underwater Cultural Heritage Database (AUCHD)	The Australasian Underwater Cultural Heritage Database, maintained by the Commonwealth Department of Agriculture, Water and the Environment, is an online database of known and potential shipwrecks, aircraft wrecks and other maritime heritage sites and objects in Australian and Commonwealth waters.
Australian Government Department of Defence and Australian Hydrographic Service – Sea Dumping in Australia (AHS SD)	This database of sea dumping sites is managed by the Australian Government Department of Defence with information supplied by the Australian Hydrographic Service. http://www.hydro.gov.au/n2m/dumping/dumping.htm
NT Heritage Register	The NT Heritage Register is a register of all declared heritage places and objects (as declared under Part 2.2 of the NT *Heritage Act 2011*), and all heritage places and objects that have been nominated to the register. The register includes places and objects within NT waters. However, the public NT Heritage Register does not include heritage places and objects that are automatically declared under Part 2.1 of the NT *Heritage Act 2011*, including Aboriginal and Macassan places and objects.
Northern Territory Heritage Branch	Direct consultation with the Heritage Branch of the Northern Territory to determine the location of located heritage sites within the study area. *Email received from Heritage Branch on 28/3/2022 with recommendations for potential heritage items that might be located within study area.
Archival sources and heritage reports	A review of a wide range of primary and secondary historical sources held by NT Library and Archives, the National Library of Australia, the National Archives of Australia, and various published and unpublished heritage reports and articles was undertaken.
Previous reports completed by Cosmos Archaeology	A review of numerous reports on projects Cosmos Archaeology has conducted within the Northern Territory in Darwin Harbour and surrounds.

In addition to the heritage inventories, databases, historical resources, and previous reports, a detailed review of available geophysical survey data was also conducted. Section 6 details the results of the geophysical survey review and includes a table of targets identified to be potentially cultural in origin.

2.1 General Statements on site locations

Locations are known for 17 shipwrecks, six instances of maritime infrastructure, and four instances of UXO, however, there are many more sites that are known from the historical record but have not been located. At least 29 shipwrecks and 25 aircraft wrecks are known to have occurred within Beagle Gulf and Darwin Harbour but have not been located. The location data for these wrecks provided by heritage inventories and historical records are not always accurate.

As for the wrecks which have been located, designating accurate positions was not always possible as, in most cases, it is not known how their positions were recorded, such as with global positioning systems (GPS) or a compass/sextant. Furthermore, positions of known wrecks may have been taken off the charts and, therefore, reductions in precision due to plotting and scaling could be expected. Coordinates provided in some databases could also have been inferred from vague historical accounts which in fact could place the site within a relatively large area. This issue is proportionately compounded for sites that are lost at increasingly greater distances from the coast of Australia.

GPS coordinates have become increasingly reliable, but it must be noted that positions recorded with GPS in the 1980s to 1990s had accuracies of 100-300 metres. Those sites found and recorded by GPS closer to shore are likely to have had their location updated over time, but sites further from the coast and/or less accessible may still be listed with old and inaccurate coordinates. There are also different geodetic datums used by GPS units, but if datum is not recorded with the coordinates this can lead to errors when using the same coordinates with a different datum. User error can also occur when a recorder, or someone copying the location records, interprets the coordinates in the wrong style, such as reading coordinates in degrees, minutes, seconds rather than degrees and decimal minutes, for example. Based on these scenarios, it is safe to assume that there is always a degree of inaccuracy with the provision of site coordinates.

Australasian Underwater Cultural Heritage Database (AUCHD) [5]

Information presented in the AUCHD is compiled from each of the State and Territory historic shipwreck agencies or supplied by collecting institutions holding historic shipwreck objects. The integrity or source of the information held by these agencies is unknown. The size of the area in which an individual wreck could be found varies depending on the historical information available. Some wrecks which have been found have a latitude and longitude position, but the accuracy of that position could not be determined as the method used in obtaining the position is not known.

Department of Defence and Australian Hydrographic Service – Sea Dumping in Australia (AHS SD) [6]

The locations of sea dumped materials are provided by the Department of Defence Australian Hydrographic Service. Dumped materials of heritage value can include abandoned vessels and historic munitions, such as WWII-era aircraft components and Lend-Lease material.[7] It is unclear where the Australian Hydrographic Service obtained the positions of the dumped materials. It is important to note that these locations are where the materials were designated to be dumped, but it has been found that those dumping the materials may not have been particular about the final location. An example of this was identified in a previous CA study that found the Narrabeen Dumping Ground, Sydney (a ships graveyard), despite having a high concentration of wrecks within its boundary, also had a dense concentration of sites between four to five kilometres to the east, outside of the designated dumping area.[8]

[5] **Department of Agriculture, Water and the Environment, 2020**, *Australasian Underwater Cultural Heritage Database*, available at https://www.environment.gov.au/heritage/underwater-heritage/auchd
[6] **Department of Defence and Australian Hydrographic Service, 2020**, *Sea Dumping in Australia*, available at http://www.hydro.gov.au/n2m/dumping/dumping.htm
[7] **Cosmos Archaeology, 2014,** INPEX Ichthys LNG Project : Nearshore Development – Dredging. East Arm, Darwin Harbour, Northern Territory. Relocation of Heritage Objects and Removal of debris. Prepared for Tek Ventures Pty Ltd.
[8] **Cosmos Archaeology, 2007b,** Submarine Cable System, Landfall Option – Collaroy: Underwater Heritage Impact Assessment Baseline Review, report prepared for Patterson Britton and Partners.

3 LEGISLATION

The proposed subsea pipeline route passes through Northern Territorian waters. The NT Heritage Branch administers both the NT *Heritage Act 2011* and the Commonwealth *Underwater Cultural Heritage Act 2018* (under delegation from the Commonwealth Department of Agriculture, Water and the Environment). Both the *Heritage Act 2011* and the *UCH Act 2018* apply to NT waters including harbours, rivers, and estuaries.

3.1 Commonwealth *Underwater Cultural Heritage Act 2018*

The Commonwealth *Underwater Cultural Heritage* (UCH) *Act 2018* (replacing the *Historic Shipwrecks Act 1976*) provides for the protection, conservation, and management of Australia's historic shipwrecks, sunken aircraft, and other types of underwater cultural heritage. The Act is also designed to enable the cooperative implementation of national and international maritime heritage responsibilities, and to promote public awareness, understanding, appreciation, and appropriate use of Australia's underwater cultural heritage.

Under Part 1, Division 2 of the *UCH Act 2018*, underwater cultural heritage is defined as "any trace of human existence that has a cultural, historical or archaeological character; and is located under water." Traces of human existence are considered to be located under water whether they are located partially or totally under water, and whether they are under water periodically or continuously. A "trace of human existence" is further defined to include:

(a) sites, structures, buildings, artefacts and human and animal remains, together with their archaeological and natural context; and

(b) vessels, aircraft and other vehicles or any part thereof, together with their archaeological and natural context; and

(c) articles associated with vessels, aircraft or other vehicles, together with their archaeological and natural context.

Seabed pipelines and cables, and other installations that are placed on the seabed and are still in use, are not considered to be underwater cultural heritage under the Act.

Different articles of underwater cultural heritage are, or can be, protected under the *UCH Act 2018*, depending on the kinds of articles, their heritage significance, and their location. Part 2, Division 1 of the Act provides that certain articles of underwater cultural heritage are automatically protected, including:

(a) all remains of vessels that have been in Australian waters for at least 75 years;

(b) every article that is associated with a vessel, or the remains of a vessel, and that has been in Australian waters for at least 75 years;

(c) all remains of aircraft that have been in Commonwealth waters for at least 75 years;

(d) every article that is associated with an aircraft, or the remains of an aircraft, and that has been in Commonwealth waters for at least 75 years.

These articles of underwater cultural heritage are automatically protected whether or not the existence or location of the article is known, and even if the article is or has been removed from Australian or Commonwealth waters – after the passage of 75 years.

The term "associated with" is defined under Part 1, Division 2 of the Act whereby an article is considered to be associated with a vessel, aircraft, or other vehicle if the article:

(a) appears to have formed part of the vessel, aircraft or other vehicle; or

(b) appears to have been installed or carried on the vessel, aircraft or other vehicle; or

(c) is remains of humans or animals that appear to have been on board the vessel, aircraft or other vehicle; or

(d) appears to have been constructed or used by a person associated with a vessel.

"Australian waters" and "Commonwealth waters" have different meanings under the *UCH Act 2018* (Part 1, Division 2), whereby "Australian waters" extend from the seaward limits of a State to the outer limit of Australia's continental shelf, and "Commonwealth waters" extend from waters 3 nautical miles seaward of the Territorial Sea Baseline adjacent to the States and the NT – i.e., beyond State or Territory coastal waters – to the outer limit of Australia's continental shelf. Specifically, under Part 1, Division 2 of the Act:

"Australian waters" means:

(a) any waters on the landward side of the territorial sea of Australia that are not within the limits of a State; and

(b) the territorial sea of Australia; and

(c) the sea above the continental shelf of Australia; and

(d) the seabed and subsoil beneath any such sea or waters.

"Commonwealth waters" means:

(a) the territorial sea of Australia, other than coastal waters of a State or the Northern Territory; and

(b) the sea above the continental shelf of Australia; and

(c) the seabed and subsoil beneath any such sea or waters.

The Territorial Sea Baseline generally corresponds with the low water line along the coast, measured to the level of Lowest Astronomical Tide. However, in some cases, straight baselines have been established in areas where the coastline is deeply indented and cut into, or where there is a fringe of islands along the coast in its immediate vicinity.

The Territorial Sea Baseline in the region of the current study area incorporates straight baselines that connect the mainland to the Tiwi Islands. As such, the Beagle Gulf forms part of the coastal waters of the NT – see Figure 2.

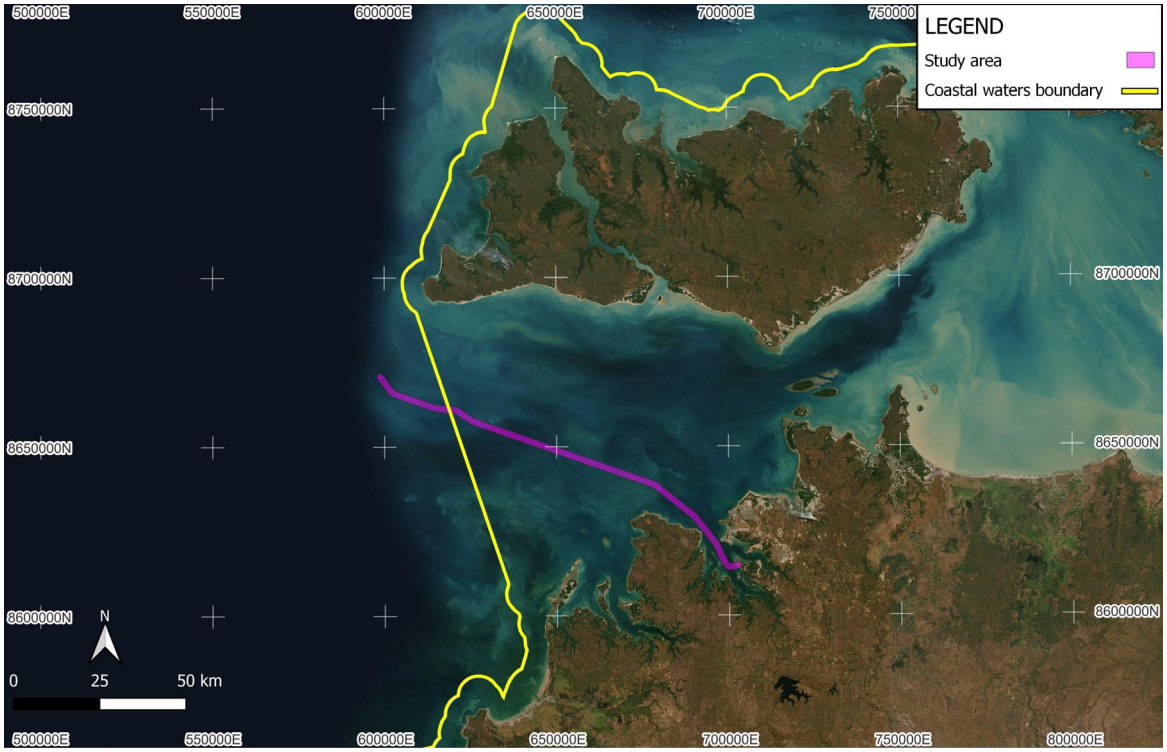

Figure 2: Boundary of NT coastal waters around Darwin and Tiwi Islands.[9]

[9] **Australian Government Geoscience Australia**. **2022.** *Coastal Waters (State / Territory Powers) Act 1980.* Australian Marine Spatial Information System (AMSIS).

These definitions of Australian and Commonwealth waters in the *UCH Act 2018* have been carried over from the *Historic Shipwrecks Act 1976.* In its original form, the *Historic Shipwrecks Act 1976* applied to waters adjacent to a State's coasts upon Commonwealth proclamation and applied automatically to waters adjacent to a Territory's coast. In 1980, the Act was amended to apply to waters adjacent to a State only with the consent of the State, however, the automatic application to waters adjacent to a Territory's coast remained.

As such, NT waters – including coastal waters, bays, rivers, and bodies of water within the jaws of the land and inland waters, below the low water mark – i.e., all waters on the landward side of the NT coastal water boundary shown above in Figure 2.

The study area is situated within "Australian waters" as defined in the *Underwater Cultural Heritage Act 2018*, and as such, shipwrecks and all associated articles that have been in the water for over 75 years are automatically protected, and other forms of underwater cultural heritage sites can be declared protected.

Part 3, Division 2 of the *Underwater Cultural Heritage Act 2018* provides for the regulation of activities relating to protected underwater cultural heritage. Specifically, any conduct that has or is likely to have an adverse impact on protected underwater cultural heritage is prohibited unless carried out in accordance with a permit granted under the Act. Conduct is considered to have an adverse impact on protected cultural heritage if it:

(a) directly or indirectly physically disturbs or otherwise damages the protected underwater cultural heritage; or

(b) causes the removal of the protected underwater cultural heritage from waters or from its archaeological context.

3.2 Sunken Military Craft Act 2004 (USA)

The United States (US) *Sunken Military Craft Act* enacted in 2004 (as Title XIV of the "Ronald W. Reagan National Defense Authorization Act for Fiscal Year 2005") provides for the protection of sunken US military vessels and aircraft and the remains of their crews from unauthorized disturbance, salvage, or recovery. The Act applies to sunken US military ships and aircraft wherever located around the world and preserves the sovereign status of sunken US military vessels and aircraft by codifying both their protected sovereign status and permanent US ownership, regardless of the passage of time.

Under Section 1408 of the *Sunken Military Craft Act*, the term "sunken military craft" is defined as:

(A) any sunken warship, naval auxiliary, or other vessel that was owned or operated by a government on military non-commercial service when it sank;

(B) any sunken military aircraft or military spacecraft that was owned or operated by a government when it sank; and

(C) the associated contents of a craft referred to in subparagraph (A) or (B), if title thereto has not been abandoned or transferred by the government concerned.

"Associated contents" are defined as:

(A) the equipment, cargo, and contents of a sunken military craft that are within its debris field; and

(B) the remains and personal effects of the crew and passengers of a sunken military craft that are within its debris field.

Under Section 1402 of the *Sunken Military Craft Act* it is prohibited for any person to engage in or attempt to engage in any activity directed at sunken military craft that disturbs, removes,

or injures the craft, or possess any articles of sunken military craft, except in accordance with prior permission from the US Department of the Navy. As authorised by the Act, the Department of the Navy has established a permitting program to allow for controlled site disturbance of sunken military craft for archaeological, historical, or education purposes.

However, as sunken military craft and their associated contents represent a collection of non-renewable and significant historical resources that often serve as war graves, carry unexploded ordnance, or contain oil or other hazardous materials, it is the overall policy of the Department of the Navy that its sunken military craft remain in place and undisturbed, and non-intrusive *in situ* research is preferred. Sunken military craft that serve as the maritime grave sites of lost crew in particular are accorded the highest respect and protection by the Department of the Navy.

The Naval History and Heritage Command's (NHHC) Underwater Archaeology Branch (UAB) manages sunken military craft and research permit applications on behalf of the US Department of the Navy.

This Act is of relevance to this study as a number of US military craft – planes and vessels – were lost in the Northern Territory during WWII. As a matter of precedence, the INPEX project obtained a permit from the NHHC to relocate the remains of sunken USN Catalinas that were to be impacted by dredging off Blaydin Point.

3.3 Northern Territory *Heritage Act 2011*

The NT *Heritage Act 2011* (replacing the *Heritage Conservation Act 1991)* provides for the conservation of the Territory's natural and cultural heritage, including places and objects within NT waters.

The aim is achieved under the Act by:

(a) declaring places and objects of heritage significance to be heritage places and objects; and

(b) declaring classes of places and objects of heritage significance to be protected classes of heritage places and objects; and

(c) establishing the Heritage Council; and

(d) providing for heritage agreements to encourage the conservation, use and management of heritage places and objects; and

(e) regulating work on heritage places and objects; and

(f) establishing enforcement and offence provisions.

Under Part 2.1 of the NT *Heritage Act 2011*, all Aboriginal and Macassan archaeological places and objects are provided automatic protection under the Act, regardless of whether their existence or location is known.

An Aboriginal or Macassan archaeological places is defined under the Act as a place that:

(a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
(b) has been modified by the activity of those people.

An Aboriginal or Macassan archaeological object is defined as a relic that:

(a) relates to the past human occupation of the Territory by Aboriginal or Macassan people; and
(b) is:

(i) in an Aboriginal or Macassan archaeological place; or
(ii) stored in a place in accordance with Aboriginal tradition, including, for example, in an Aboriginal keeping place.

A relic is defined under the Act as:

(a) an artefact or thing given shape by a person; or
(b) human or animal skeletal remains; or
(c) something else prescribed by regulation.

Under Part 2.2. of the NT *Heritage Act 2011,* other places and objects – i.e., non-Aboriginal and non-Macassan places and objects – can be declared by the Minister as protected heritage places and objects.

A place is defined as an area of land, and includes:

(a) a building or, a part of a building, on the place; and
(b) an item historically or physically associated with the place if the primary importance of the item derives (completely or partly) from that association; and
(c) equipment, furniture, fittings and articles on, or historically or physically associated with, the place.

Examples of places, as provided in the Act, include

1. A reef or a cliff, cutting, gorge, spring or other landform
2. A plant or animal community
3. Fossil beds
4. A park or garden
5. A lighthouse, church, homestead, railway station or gaol
6. A stock well
7. A cemetery, burial site or grave
8. An airstrip, magazine, storage tunnel or other military installation
9. The site of a shipwreck or aircraft crash.

The process for declaring heritage places and objects involves a nomination or Heritage Council initiation for assessment of the heritage significance – including aesthetic, historical, scientific, and social significance of a place or object. The Heritage Council then considers whether the place or object is of heritage significance and make a decision whether or not to recommend that the Minister declare the place or object to be a protected heritage place or object.

Under Part 5.5 of the Act, it is an offence to knowingly engage in conduct that results in damage to a heritage place or object, removes a part of the place, or removes a heritage object from the NT, unless the conduct is carried out in accordance with a relevant heritage agreement, work approval, repair order, or exemption.

3.4 UNESCO 2001 *Convention on the Protection of Underwater Cultural Heritage*

The United Nations Educational, Scientific and Cultural Organization (UNESCO) 2001 *Convention on the Protection of the Underwater Cultural Heritage* is an international treaty that was developed to provide a common framework for States Parties on how to better identify, research, and protect underwater heritage whilst ensuring its preservation and sustainability. The UNESCO 2001 *Convention* consists of a main text that sets out basic principles for the protection of underwater cultural heritage and provides a detailed State cooperation system, and an Annex that outlines widely recognised practical rules for the treatment and research of underwater cultural heritage. The UNESCO 2001 *Convention* entered into force in 2009.

The Commonwealth of Australia supported the principles and drafting of the UNESCO 2001 *Convention* and is currently considering ratification of the Convention in accordance with requirements under Australia's *Treaty Making Guidelines.* The *Underwater Cultural Heritage Act 2018* was also developed specifically to align with the UNESCO 2001 Convention.

In 2010, the Commonwealth, States, and the NT signed the *Australian Underwater Cultural Heritage Intergovernmental Agreement* that would enable the Australian Government to ratify the UNESCO Convention 2001, should it so choose. The Agreement establishes the roles and responsibilities of Commonwealth, State and NT governments for the identification, protection, management, conservation, and interpretation of Australia's underwater cultural heritage. One of the key aims of the Agreement is for all parties to meet internationally recognised best practice management of Australia's underwater cultural heritage as outlined in the Rules in the Annex to the UNESCO 2001 *Convention*.

The main principles of the UNESCO 2001 Convention are as follows:

- Obligation to Preserve Underwater Cultural Heritage – States Parties should preserve underwater cultural heritage and take action accordingly. This does not mean that States would necessarily have to undertake archaeological excavations; they only have to take measures according to their capabilities. The Convention encourages scientific research and public access.
- *In Situ* Preservation as first option – The *in situ* preservation of underwater cultural heritage (i.e., in its original location on the seafloor) should be considered as the first option before allowing or engaging in any further activities. The recovery of objects may, however, be authorized for the purpose of making a significant contribution to the protection or knowledge of underwater cultural heritage.
- No Commercial Exploitation – The 2001 Convention stipulates that underwater cultural heritage should not be commercially exploited for trade or speculation, and that it should not be irretrievably dispersed. This regulation is in conformity with the moral principles that already apply to cultural heritage on land. It is not to be understood as preventing archaeological research or tourist access.
- Training and Information Sharing – States Parties shall cooperate and exchange information, promote training in underwater archaeology and promote public awareness regarding the value and importance of underwater cultural heritage.

The general principles concerning activities directed at underwater cultural heritage as contained in the Annex of the UNESCO 2001 *Convention* are

Rule 1. The protection of underwater cultural heritage through in situ preservation shall be considered as the first option. Accordingly, activities directed at underwater cultural heritage shall be authorized in a manner consistent with the protection of that heritage, and subject to that requirement may be authorized for the purpose of making a significant contribution to protection or knowledge or enhancement of underwater cultural heritage.

Rule 2. The commercial exploitation of underwater cultural heritage for trade or speculation or its irretrievable dispersal is fundamentally incompatible with the protection and proper management of underwater cultural heritage. Underwater cultural heritage shall not be traded, sold, bought or bartered as commercial goods.

Rule 3. Activities directed at underwater cultural heritage shall not adversely affect the underwater cultural heritage more than is necessary for the objectives of the project.

Rule 4. Activities directed at underwater cultural heritage must use non-destructive techniques and survey methods in preference to recovery of objects. If excavation or recovery is necessary for the purpose of scientific studies or for the ultimate protection of the underwater cultural heritage, the methods and techniques used must be as non-destructive as possible and contribute to the preservation of the remains.

Rule 5. Activities directed at underwater cultural heritage shall avoid the unnecessary disturbance of human remains or venerated sites.

Rule 6. Activities directed at underwater cultural heritage shall be strictly regulated to ensure proper recording of cultural, historical and archaeological information.

Rule 7. Public access to in situ underwater cultural heritage shall be promoted, except where such access is incompatible with protection and management.

Rule 8. International cooperation in the conduct of activities directed at underwater cultural heritage shall be encouraged in order to further the effective exchange or use of archaeologists and other relevant professionals.

4 KNOWN AND POTENTIAL MARITIME ARCHAEOLOGY

4.1 Environment and Morphology

The proposed GEP route is planned to cross through Beagle Gulf, between the Tiwi Islands and the Northern Territory mainland, before turning south into Darwin Harbour to terminate at the Darwin LNG plant. Based on this route, the environment can generally be separated into two sections, Beagle Gulf and Darwin Harbour.[10]

4.1.1 *Beagle Gulf*

Beagle Gulf is characteristic of an offshore marine environment. The seabed in the vicinity of the proposed GEP route is composed of clay/silts and is featureless, though sand waves in places can reach 4.9m in height.[11] Geophysical surveys conducted confirm this characterisation of the area as a flat, featureless seabed at depths ranging 53 – 20m.

Beagle Gulf is exposed to greater swells and localised wind-generated waves than in Darwin Harbour. Relatively protected to the east and to some extent from the north by the Tiwi Island, the greatest fetch is from the western quadrants. Highest ambient wave activity takes place in the summer months when westerly winds are constant.[12] Wave heights during this season vary between 1 to 2m. Cyclones can increase wave heights by 50% to 100% with accompanying increases in current velocities.

Water temperature in the area is a constant 23.5°C with salinity close to the global average of 35 ppt.[13]

4.1.2 *Darwin Harbour*

Darwin Harbour is subject to large diurnal tidal variations (macrotidal). The difference between low and high tide during springs can be up to 7.5m.[14] This can result in current velocities between 2 to 2.5m/s (4 to 5kts). The tidal flows are the strongest in the narrowest sections of the harbour; the area most relevant to this study being the stretch of water between Tale Head and Emery Point (Larrakeyah).

The waters of Darwin Harbour are relatively well protected. The greatest fetch is to the northwest, from Beagle Gulf, thereby making the coastline around the western side of Wickham Point the most exposed within the study area. Having noted this, the ambient wave height in the harbour in the summer months can reach around 1m.[15] Waves generated by localised cyclonic activity can be much higher. It has been modelled that some waves reached heights of 4.5m in the harbour during Cyclone Tracy but were substantially lower – 0.7m – within the inner parts of the harbour.[16] During such events, tidal heights can potentially increase up to 9.1m LAT, which is around 2m higher than the highest annual spring high tide.[17]

Water temperatures in the near shore development area of Darwin Harbour are typically high, ranging from 23.5°C to 32.7°C.[18] Salinity varies within the harbour during the year. The large influx of fresh water from adjacent streams during the wet season is responsible for this variation. During the months of February and March, salinity levels can be as low as 19 parts per thousand (ppt), while during the dry season levels rise to around 37 ppt.[19] The global

[10] **Cosmos Archaeology, 2011,** Ichthys Gas Field Development Project: Nearshore Development Area, Assessment of Marine Heritage Survey Methods, report prepared for INPEX Browse Ltd.
[11] **Fugro Survey Pty Ltd, August 2008** Volume 1a, 2-40.
[12] *Op. Cit.* **Fugro, 2008**:2-36.
[13] *Op. Cit.* **Fugro, 2008**:2-42.
[14] **INPEX**, **2010**, Ichthys Gas Field Development Project: Draft environmental impact statement, 33.
[15] *Op. Cit.* **INPEX, 2010:**56.
[16] *Op. Cit.* **INPEX, 2010:**56.
[17] *Op. Cit.* **INPEX, 2010:**56.
[18] *Op. Cit.* **INPEX, 2010:**62.
[19] *Op. Cit.* **INPEX, 2010:**62.

average for salinity is 35 ppt. During the wet season, water stratification can occur where freshwater intrusions from the adjoining streams can form a layer over the denser saline waters of the harbour.

The large tidal variations within the harbour result in the waters remaining well oxygenated, ranging from 74 to 96%.[20] There are some differences in dissolved oxygen levels from the mouth of the harbour where they are the highest, to waters closer to the streams at low tide where they are the lowest. Higher dissolved oxygen levels are also found closer to the water surface than at the base of the water column.

Darwin Harbour is well known for its poor visibility for diving due to suspended sediments in the water. Turbidity is at its highest during wet season spring tides due to the capacity of the spring water flows to mobilise sediments that have been flushed into the harbour from the land.[21] During these times, light levels at the bottom of the harbour can be 1% of that at surface levels.

The strong tidal flows coupled with the large volumes of water flowing out from the streams entering the harbour, have had a scouring effect on the seabed, creating and/or enlarging relatively deep channels, which are drowned Pleistocene river courses.

The main channel through Darwin Harbour mostly ranges between 15-25m deep, with a maximum depth of 36m. At Wickham Point the channel forks, with the western and shallower channel/tributary trending southwards into the Middle Arm. A smaller channel separates Channel Island from Wickham Point.[22] The eastern and deeper channel shapes a course to the southeast between East Arm to the north and Wickham and Blaydin Points to the south.

The sides of the main drainage channels are mostly rocky and the sediments within the study area are coarse sands with some gravels, silt and clay.[23] In the portion of the study area between Larrakeyah and Mica Beach, the seabed is more gravelly and provides a thin covering over sandstone and phyllite formations of which large weathered sand veneered expanses are also exposed in the form of relatively flat/level pavements. [24] At the entrance to Darwin Harbour there are numerous cemented ridges.[25] The thickness of the sediments over the sandstone and phyllite substrate varies. In the same area, where there are extensive areas of exposed sand veneered bedrock, there are pockets of sediments up to 6m thick.[26]

A sandbank is also located in the study area between Channel Island and the Darwin LNG plant on Wickham Point.[27] The bank is over 1.5km long, 12m high and has a minimum of 0.6 m of water over it.

Sand waves are also present throughout the northern part of the entrance to Darwin Harbour.[28] Silty to sandy seabed is present in the study area close to the landfall of the proposed pipeline with coarser sediments covering shallower waters towards the south.[29]

Silty seabed surfaces are found in the shallower waters adjacent to the mangrove flats around Wickham Point; their occurrence signifying sheltered waters not greatly affected by strong tidal currents.[30] More carbonate (shell) based sediments mixed with sand and gravels

[20] *Op. Cit.* **INPEX, 2010:**62.
[21] *Op. Cit.* **INPEX, 2010:**63.
[22] *Op. Cit.* **INPEX, 2010:**Figure 3-11
[23] *Op. Cit.* **INPEX**, **2010**:64, 69 and Figure 3-16.
[24] *Op. Cit.* **INPEX, 2010:**71.
[25] **Fugro Survey Pty Ltd March 2010** Report on the Offshore Pipeline Route Unexploded Ordnance (UXO) Survey. Volume 1 – Survey Results, 5
[26] *Op. Cit.* Fugro Survey Pty Ltd, August 2008 Volume 1a, 2-25
[27] *Op. Cit.* **Fugro, 2008**:2-32.
[28] *Op. Cit.* **Fugro, 2008**:2-54.
[29] *Op. Cit.* **Fugro, 2008**:2-36.
[30] *Op. Cit.* **Fugro, 2008**:2-19.

are situated in the spits and shoals close to the entrance to the harbour.[31] Mudflats are also present, adjacent to the western shore of Wickham Point. [32]

4.2 Cultural Activities in Darwin Harbour and Beagle Gulf

4.2.1 *Larrakia*

The Darwin region was traditionally occupied by the Larrakia people, whose country stretches along the NT coast from Finniss River and Fog Bay in the west to Gunn Point and Adelaide River in the east and extends inland along the Charlotte River. The waters of Darwin Harbour, Bynoe Harbour, Shoal Bay, Adam Bay, and parts of Beagle Gulf also form part of Larrakia country. Larrakia people refer to themselves as "Saltwater People," and traditional society and subsistence was largely centred around their coast and sea country.

Regional archaeological evidence suggests that Larrakia people have occupied the NT coastal region for at least 7-8,000 years, throughout the early to recent late Holocene, and likely further back through periods of lower sea level during the terminal Pleistocene when Darwin Harbour would have been a down-cut river valley.[33]

Various ethno-historical accounts dating back to the 19th century describe extensive Larrakia knowledge of the marine environment and a long tradition of the use of bark canoes and dugout canoes for estuarine and coastal subsistence fishing and hunting of dugong and turtles. Canoes were also used to travel throughout the waters of Larrakia sea country, and occasionally to travel and trade with neighbouring groups along the NT coast and across the Beagle Gulf to the Tiwi Islands.[34]

4.2.2 *Macassan traders*

In the early to mid-1700s, Indonesian traders began visiting parts of the northern coast of Australia to fish for trepang – sea cucumber or *bêche-de-mer* – prized for its culinary and medicinal values in Chinese markets. The term "Macassan" – originally denoting people from Macassar, the major fishing port in south-west Sulawesi, is generally used to apply to all the trepangers who came to Australia, even though some were from other islands in the Indonesian Archipelago, including Timor, Rote and Aru.

Throughout the latter 1700s to early 1900s, fleets of Macassan *perahus* or *praus*, timber multi-hulled sailing vessels, travelled to the north Australian coast with the north-westerly winds during the tropical wet season, and departed with the south-easterly winds of the dry season. A single fleet could be composed of thirty or more vessels, and in some periods up to 200 *perahus,* amounting to over 2,000 men, were estimated to be fishing the coastline from Cobourg Peninsula to south-eastern Arnhem land.

The sea route from the Indonesian archipelago took the Macassans through the Timor Sea and along the north coast of the Tiwi Islands and on to the Cobourg Peninsula. There is no clear evidence in historical accounts that Macassan trepangers travelled into Beagle Gulf or Darwin Harbour; however, artefacts believed to be of Macassan origin have been found on beaches in the wider Darwin region, including a cast iron swivel gun collected from an

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[31] *Op. Cit.* **Fugro, 2008**:2-55.
[32] *Op. Cit.* **INPEX**, **2010:**Figure 3-16.
[33] **Burns, T. 1999.** "Subsistence and settlement patterns in the Darwin coastal region during the late Holocene period: a preliminary report of archaeological research." *Australian Aboriginal Studies.* Issue 1; pp. 59-70.; **Brockwell, S., P. Faulkner, P. Bourke, A. Clarke, C. Crassweller, D. Guse, B. Meehan & R. Sim. 2009.** "Radiocarbon dates from the Top End: A cultural chronology for the Northern Territory coastal plains." *Australian Aboriginal Studies*. Volume 1, pp. 54–76.; **Sim, R. & L. A. Wallis. 2008.** "Northern Australian offshore island use during the Holocene: The archaeology of Vanderlin Island, Sir Edward Pellew Group, Gulf of Carpentaria." *Australian Archaeology*. Volume 67, pp. 95–106.
[34] **Foelsche, P. 1882.** "Notes of the Aborigines of North Australia." *Transactions of the Royal Society of South Australia.* Vol 2; pp, 1-18.; **Hodgson, R. 1997.** *Aboriginal use of natural resources in the Darwin region – past and present.* Report to the Australian Heritage Commission. **Parkhouse, T. A. 1895.** "Native tribes of Port Darwin and its neighbourhood." *Australasian Association for the Advancement of Science.* Vol. 6; pp. 638-647.;

unknown location on the shoreline of Darwin Harbour in 1908, and a bronze swivel gun found at Dundee Beach, south-west of Darwin in 2010.[35]

4.2.3 *European exploration*

The first documented European exploration of Darwin Harbour and Beagle Gulf occurred in 1839 by a British Admiralty survey expedition led by Royal Navy Commander John Clements Wickham and Lieutenant John Lort Stokes aboard the HMS *Beagle.*

The harbour and surrounding coastline were surveyed in detail (see Figure 3) and numerous features named – Wickham named the harbour Port Darwin after famed naturalist Charles Darwin, with whom he had sailed on earlier expeditions of HMS *Beagle,* Beagle Gulf was named after the vessel itself. Wickham and Stokes both wrote of the advantages of the protected nature of the "splendid stretch of water" of Port Darwin; however, the area saw little further visitation for several decades.[36]

Figure 3: Chart of Beagle Gulf, Port Darwin, and surround from HMS Beagle 1839 survey.[37]

[35] **Clark, M. & S. K. May (eds). 2013** *Macassan History and Heritage – Journeys, Encounters and Influences.* Australian National University Press, ACT.; **Coroneos, C. 1996.** "The shipwreck universe of the Northern Territory." *Bulletin of the Australian Institute for Maritime Archaeology.* Vol. 20; pp. 11-22.; **Jung, S. 1992.** *Annotated Bibliography of Macassan Perahu Wrecks & Sightings.* Maritime Archaeology & History, Northern Territory Museum of Arts and Sciences, Darwin, NT. **Jateff, E. 2011.** "An Oddity in South Australia. An Indonesian imitation swivel gun?" *AIMA Newsletter.* Volume 30, Issue 1.; **MacKnight, C. C. 1976.** *The Voyage to Marege; Macassan Trepangers in Northern Australia.* Melbourne University Press, VIC.

[36] **Bolton, G. C. 1967.** "Stokes, John Lort (1812-1885)." *Australian Dictionary of Biography.* Vol. 2. Australian National University Press, ACT.; **Ingleton, G. C. 1944.** *Charting a Continent – A Brief Memoir on the History of Marine Exploration and Hydrographical Surveying in Australian Waters from the Discoveries of Captain James Cook to the War Activities of the Royal Australian Navy Surveying Service.* Sydney.; **Morrison, A. A. 1967.** "Wickham, John Clements (1798-1864)." *Australian Dictionary of Biography.* Vol. 2. Australian National University Press, ACT.

[37] **Great Britain. Hydrographic Department / Richards, G. H., J. L. Stokes, E. Weller & J. C. Wickham. 1839.** *Australia - N.W. coast, Port Darwin and adjacent inlets.* Published at the Admiralty 1st March 1870 under the Superintendence of Capt'n G.H. Richards, R. N., F. R. S., Hydrographer, London, UK.

4.2.4 *Initial colonial settlement at Port Darwin*

In the late 1850s, the beginnings of a network of telegraph lines linking capital cities across Australia was being established, and speculation soon arose regarding a possible international connection between Australia and the new telegraph line from Europe to the East Indies. Competition between the Australian colonies over the route was fierce, with both the Victorian and South Australian governments organising expeditions to cross the continent from south to north and identify potential overland telegraph routes. In 1863, following John McDouall Stuart's successful expedition from Adelaide to Chambers Bay (east of Darwin), the SA Government annexed the Northern Territory – an area that had previously been a nameless part of New South Wales, with the aim of securing the land as a potential telegraph bridge to Asia and thence Europe. In 1865, the Australian Parliament authorised the construction of a telegraph line between Adelaide and Port Augusta (322km north of Adelaide), strengthening SA's position in the race for the cross-country telegraph connection.

In the meantime, SA Government surveyors were sent to the north coast of the NT to select a potential landing site for the telegraph and establish a supporting settlement. The first site, selected in 1864 by Surveyor Boyle Travers Finniss at Escape Cliffs near the mouth of the Adelaide River, was abandoned in 1867. After examination of several other suggested areas, a settlement was finally laid out by Surveyor-General George Goyder at Fort Point headland in Port Darwin in 1869. The township was named "Palmerston" after the then British Prime Minister Lord Palmerston.

The final telegraph contract was secured in 1870 when the SA Government proposed to extend the line from Port Augusta to Palmerston and the British-Australian Telegraph Company agreed to lay the undersea cable from Java to Port Darwin.[38]

The undersea cable was constructed in 1871 by a team of marine engineers and electricians from the British Telegraph Construction and Maintenance Company (Telcon) and the British-Australian Telegraph Company (BAT). The cable was first landed at Palmerston, at Fort Point – considered the most suitable site for the telegraph buildings – before being laid out across the seabed to Banjowangie, Java. The landward-end of the cable was carried from cable-ship SS *Hibernia* to the shore in bights held up by boats, hauled up the beach to the cable-house and buried in a shallow trench (see Figure 5 and Figure 6). Hibernia then commenced paying the cable out along the seabed; travelling north-east to east around Point Emery, then northwards past Fannie Bay and gradually veering north-east towards the entrance to the harbour (see Figure 4). The cable consisted of seven small copper wires – including a central wire with six twisted around it – insulated by gutta-percha latex and tarred hemp, covered with a sheathing of galvanised iron wire and another outside covering of tarred hemp. The cable was ¾" (19 mm) in diameter in the deep-sea sections, 1" (25 mm) in diameter in the intermediate sections and 3" (76 mm) in diameter at the shore end.[39]

In 1879, a duplicate telegraph cable was laid between Darwin and Java, which allowed for increased telegraph capacity and the establishment of a day and night service between Australia and Britain. The second cable was again laid by Telcon, this time under contract to the Eastern Extension Australasia and China Telegraph (EEACT) Company, which had absorbed BAT in 1873. The duplicate cable was of the same composition as the original

[38] **Clune, F. 1955.** Overland telegraph: the story of a great Australian achievement and the link between Adelaide and Port Darwin. Angus and Robertson, Sydney, NSW.; **Cross, J. 2011.** Great Central State – The Foundation of the Northern Territory. Wakefield Press, South Australia. **Reece, R. 1989.** "Palmerston (Darwin); Four Expeditions in Search of a Capital." Statham, P. (ed.) The Origins of Australia's Capital Cities. Cambridge University Press, Cambridge, UK.;

[39] **Anon 23 January 1872** "The Australian Submarine Cable." *The Argus.*; **Nicols, J. 1870-1874** *Notebook.* Transcribed by Vickers, M. 2005. http://atlantic-cable.com/CableStories/Nicol/index.htm; **NT Heritage Branch. 2019.** *The Darwin Subsea Telegraph Cables – Heritage Assessment Report.*; **Wildey, W. B. 1876.** *Australasia and the Oceanic Region, With Some Notice of New Guinea, From Adelaide – Via Torres Straits – to Port Darwin, Thence Round West Australia.* George Robertson, Melbourne, Victoria.

1871 cable, and was laid out in the same manner; this time with the majority of the work being carried out by cable ship SS *Siene.*[40] The duplicate cable was laid to the west of the 1871 cable within Darwin Harbour, before crossing over the 1871 cable towards the harbour entrance and then running along the northern side of the 1871 cable through Beagle Gulf (see Figure 4).

In 1884, EEACT decided to renew the eastern end of the original 1871 Darwin to Java telegraph cable. EEACT had found that this section of cable, particularly where it passed through shallow waters, was being frequently damaged by marine borers – namely teredo worm (*Teredo navalis*). A new cable was thus designed with a patent brass ribboned core to prevent teredo attack and was laid out by cable ship SS *Siene* in early 1884. The replacement cable was laid between the 1871 cable and the 1879 duplicate cable through Darwin Harbour, crossing over near the harbour entrance and then running along the southern side of the 1871 cable (see Figure 4). Some broken sections of the original 1871 cable were recovered by *Siene* during the process, however, most of the original cable appears to have been left on the seabed.[41]

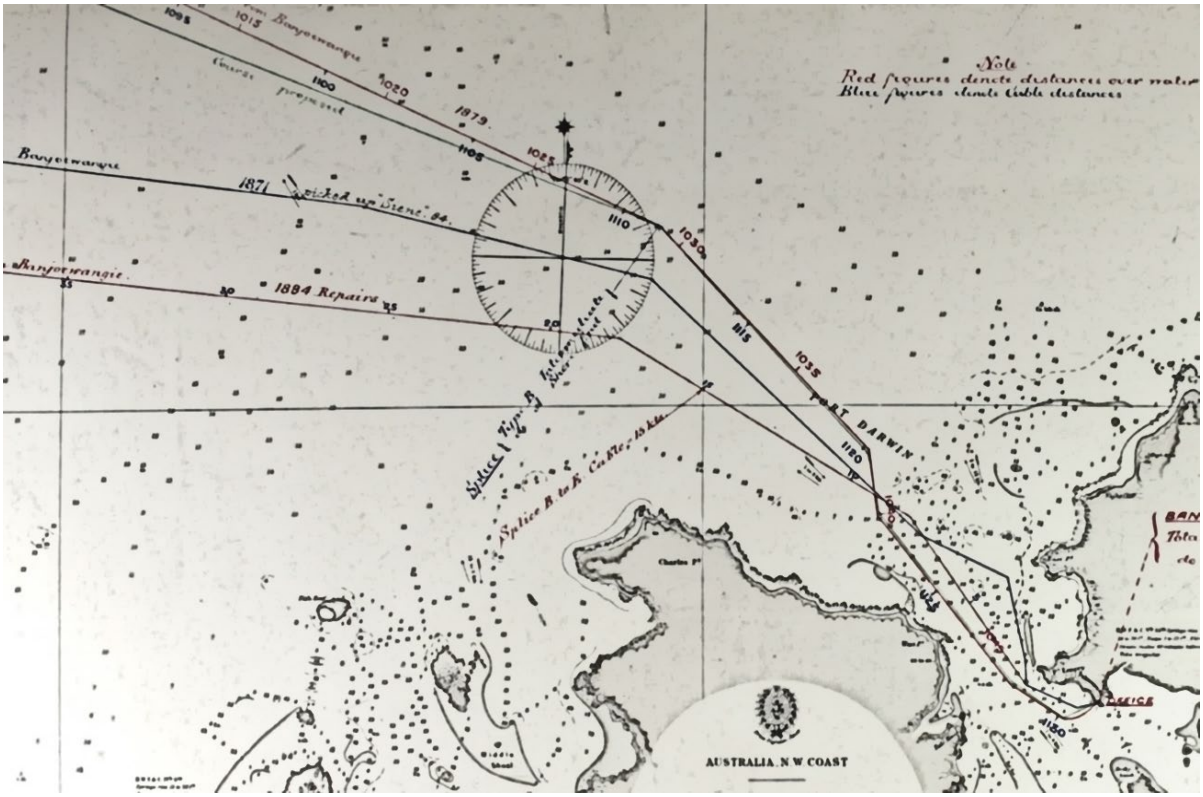

Figure 4: 1870 map of Port Darwin with annotations showing proposed and actual routes of 1871, 1879, and 1884 subsea telegraph cables.[42]

[40] Anon. 13 September 1879. "The New Cable." *The Week.* p. 11.; NT Heritage Branch. 2019.
[41] **Anon. 5 January 1884.** "The Port Darwin Cable." *The Telegraph.* p. 5.; **NT Heritage Branch. 2019.**
[42] **Stokes, J. L., E. Weller, & J. C. Wickham. 1870.** *Port Darwin and Adjacent Inlets.* Great Britain Hydrographic Department – annotated with proposed and actual routes of the Darwin-Java subsea telegraph cables 1871, 1879, and 1884. PK Porthcurno Museum of Global Communications, Cornwall, UK. Item CH3.4 Map 13. Reproduced in **NT Heritage Branch 2019**.

Figure 5: Telegraph cable fleet in Port Darwin, 1871.[43]

Figure 6: Landing the telegraph cable, Darwin, 1871.[44]

4.2.5 *Late 19th - early 20th century development*

Throughout the 1870s, Palmerston developed from a telegraph constructor's camp to a small township and the landing at Fort Point served as the focus of trade and transport to supply the new settlement. Early growth was spurred by the discovery of gold near Pine Creek (225 km south of Darwin) in 1871 during the construction of the overland telegraph, sparking a gold rush in surrounding areas that attracted thousands of prospectors and pioneers to the NT. Development was further facilitated throughout the 1880s by the establishment of a railway line between Palmerston and the Pine Creek goldfields, and the construction of a railway jetty at Stokes Hill. The population continued to expand and regional industries, including tin mining, cattle rearing, coastal fishing, and pearling, began to emerge – the latter attracting fleets from Japan, Timor, Malaysia, and the Philippines.[45]

Port Darwin was described during this period as one of the safest and best in the world; with a wide entrance and large port doubly sheltered by the outer headlands of East Point and West Point and the inner headlands of Point Emery and Talc Head. Shipping was centred around the port facilities at Fort Hill and Stokes Hill – see Figure 7. The maritime economy during this period was dominated by coastal sailing vessels and steam ships, with a wide range of smaller craft used in the fishing and pearling industry, regional trade and transport, and recreational vessels (see Figure 8 and Figure 9).

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[43] **Sweet, S. W. 1871.** "Palmerston. Cable fleet in the harbour below Fort Hill: Gulnare, Bengal, Hibernia, Investigator, Edinburgh." State Library of South Australia, Image No. B 9745.
[44] **Anon. 1871.** "Port Darwin - landing the cable ashore - 7 November 1871." National Archives of Australia, Image No. 32018586.
[45] **Cross, J. 2011; Wade-Marshall, D. 1988.** *The Northern Territory: settlement history, administration and infrastructure.* Strategic and Defence Studies Centre, Australian National University, Canberra.

Figure 7: 1886 chart of Port Darwin, showing port facilities at Fort Hill and Stokes Hill.[46]

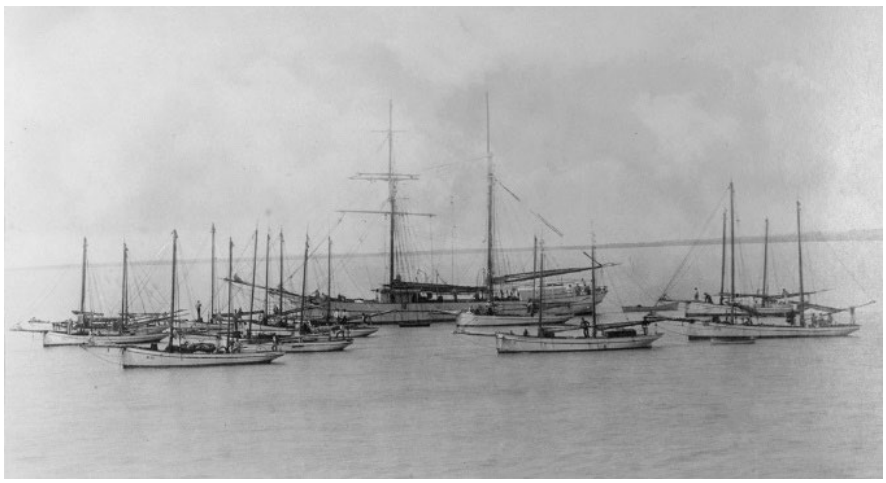

Figure 8: Pearling fleet of luggers and mothership at Port Darwin, 1895.[47]

[46] **Comm'r R. F. Hoskyn RN, Great Britain Hydrographic Department 1886** *Australia – North Coast Port Darwin.* State Library of Victoria, Map 50901638.
[47] **Anon 1895.** "Pearl shelling fleet at Palmerston." State Library of South Australia, Image No. B2418.

Figure 9: steam ships and sailing vessels moored alongside the Port Darwin railway jetty, 1892.[48]

A number of vessels were wrecked in Darwin Harbour in the late 19th century to early 20th century – most consisting of small to moderate timber sailing vessels and composite steam and sail vessels lost in sudden squalls and strong monsoons during the tropical wet season. A single event of devastating loss occurred in January 1897, when Port Darwin was hit with one of the worst cyclones ever recorded at the time. Palmerston township was torn apart with almost every building destroyed or severely damaged, and at least thirteen people killed. The cyclone also wreaked havoc in the harbour, coinciding with high tide and causing massive storm surges. Vessels of all types were wrecked or blown ashore and a further fifteen people were killed. Eighteen pearling luggers, three steam launches, a cutter, and three sampans are amongst the vessels recorded as lost. Many of these vessels were swept off their moorings in Port Darwin and found driven into mangroves at the mouths of East Arm and Middle Arm; several were never recovered.[49]

In 1911, a decade after Australian Federation, the NT was separated from SA and transferred to Commonwealth control as a result of the *Northern Territory Surrender Act 1908* in South Australia and the Federal *Northern Territory Acceptance Act 1910.* The township of Palmerston was subsequently officially renamed "Darwin." Around this time, the importance of Port Darwin as a potentially valuable naval strategic position began to be realised; although there were no immediate plans to establish military facilities due to the still relatively small size and isolation of the Darwin settlement. A 1911 Royal Navy recommendations report stated that once the north to south transcontinental railway line was completed, Port Darwin should be developed into a Naval Fleet secondary base, complete with reserves of coal, oil and naval stores and provisions, and docks capable of receiving the largest ships and machine shops adequate for carrying out repairs to warships. Such plans were put into abeyance following the advent of World War I, during which Darwin was only periodically used as an anchorage and coaling station.[50]

Middle Arm and Middle Point, far removed from the centre of the Palmerston settlement and Port Darwin facilities, saw little use during the late 19th and early 20th centuries. In 1884, Channel Island in Middle Arm was declared by the Government as a site for a quarantine

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[48] **Edwardes, A. D. 1892.** "Shipping in Port Darwin in 1892 with the ships 'Falkland Hill', 'S.S. Tsinan', 'Menmuir' and 'Catterthun.'" State Library of South Australia, Image No PRG 1373/34/49.

[49] **Anon 16 January 1897.** "The Port Darwin Cyclone. Details of the Damage." *The South Australian Register.*; **Anon 5 February 1897.** "Terrible Hurricane at Port Darwin." *The Northern Territory Times and Gazette.;* **Murphy, K. 1984.** *Big Blow Up North (A History of Tropical Cyclones in Australia's Northern Territory).* University Planning Authority, Darwin, NT.

[50] **Dermoudy, P. & P. Cook. 1991.** *East Point. A History of the Military Precinct, East Point, Darwin.* National Trust of Australia and Royal Australian Artillery Association of the Northern Territory, NT.; **Admiral Sir Henderson, R. 1911** "The Naval Forces of the Commonwealth – Recommendations." Reproduced in *The Time Documentary History of the War.* (1917) The Times Publishing Company, London.

station – see Figure 10. No permanent structures were established on the island until the early 1900s, however, and throughout the late 19th century most quarantine patients were held onboard quarantine hulks moored in an anchorage set up around Channel Island. One of these hulks, schooner rigged steamship *Ellengowan,* sank at its moorings in 1888, and the wreck – situated to the south of the current study area – is the oldest known shipwreck in Darwin Harbour.[51]

In 1889, a small spit of land extending from the tip of Middle Point was proclaimed as a leper station – see Figure 10. The station, known as Mud Island Lazaret – or colloquially as Living Hell Lazaret due to the exceedingly poor living conditions – was in operation from the 1880s through to the early 1930s. The lazaret consisted of a single galvanised iron building and treatment consisted of weekly visit from a health officer who travelled by vessel to Mud Island.[52] In 1931, the quarantine station at Channel Island was converted into a leprosarium and Mud Island Lazaret was permanently closed. Several new accommodation buildings, and medical clinic, and associated facilities were constructed at Channel Island, and a twice-weekly supply service via launch from Darwin was established. The Channel Island Leprosarium remained in operation until 1955, when a new leprosarium was established at East Arm.[53]

Figure 10: 1929 chart of Port Darwin, showing location of Mud Island lazaret and Channel Island quarantine station / later leprosarium near East Arm (shown by red circles).[54]

[51] **Anon. 11 February 1886.** "Quarantine at Port Darwin." *South Australian Register.* p. 3.; **Jung, S. 2008.** "Ellengowan 1866-1888: a 19th century transitional iron steamship sunk at Middle Arm." in Clark, P. (ed.) *Ten Shipwrecks of the Northern Territory.* Museum and Art Gallery of the Northern Territory, Darwin, NT.; **Kettle, E. 1991.** *Health Services in the Northern Territory – A History 1824-1970.* Australian National University, Darwin, NT.
[52] **George, G. & K. George. 2014.** "Mud Island Lazaret (1889-1931)" https://www.findandconnect.gov.au/ref/nt/biogs/YE00283b.htm; **Kettle, E. 1991.**
[53] **George, G. & K. George. 2011.** "Channel Island Leprosarium (1931-1955)" https://www.findandconnect.gov.au/ref/nt/biogs/YE00047b.htm#related; **Kettle, E. 1991.**
[54] **Great Britain Hydrographic Department. 1929.** *Australia - North coast, Port Darwin from a survey by Lieut-Comm'r. Harry T. Bennett, D. S. O., R. N. and the officers of H. M. Australian surveying ship "Geranium" 1925, with additions from a survey by Comm'r. R.F. Hoskyn, R. N., and the officers of H. M. S. "Myrmidon" 1885.* National Library of Australia, MAP RM 3394.

4.2.6 *World War II*

In the aftermath of World War I, and particularly following the demise of the Anglo-Japanese Alliance in 1921, the British Empire began to evolve a series of war plans crafted for various predicted contingencies. A British Imperial Conference in 1923 led to the development of the Royal Navy "Singapore Strategy," which made Singapore the pivot of British defence against potential aggression from the Empire of Japan. Under this strategy, Darwin was seen as the southern end of the Singapore-Australia defence line. Following subsequent recommendations made by the Royal Australian Navy, plans were put in place to develop Port Darwin as a naval refuelling depot and support base. Throughout the 1920s to early 1930s, naval fuel tanks were constructed at Stokes Hill and development of a coastal defence battery commenced at East Point. By the mid-1930s, a worsening international situation, particularly in Europe and Japan, led to further increases in Port Darwin's defences and the establishment of a Royal Australian Air Force (RAAF) base, an Australian Army barracks, and Royal Australian Navy (RAN) depot. Naval infrastructure within was further expanded, including the construction of additional naval fuel tanks at Stokes Hill, a battery at Emery Point, and establishment of additional shipping, mooring and maintenance facilities.[55]

In 1938, following harbour defence advice from the British Admiralty, plans were drawn up by the RAN to construct an anti-submarine boom net across the entrance to Port Darwin between East Point and Dudley Point (see Figure 11), along with anti-submarine indicator loop installations that would operate in conjunction with the coastal defence batteries. The Australian Naval Board initiated the construction of two boom working vessels required to lay the boom net, and the establishment of a boom depot yard at Fort Hill to manufacture and assemble components for the boom net and indicator loop systems. The boom net was designed by the British Admiralty and consisted of high tensile wire rope mesh floating nets supported by a series of trots consisting of cylindrical buoys that were anchored to the seabed via concrete mooring clumps. A gate was set into the middle of the net that could be opened to allow passage of friendly vessels. The indicator loops – designed to provide magnetic sensing of enemy vessels whereby an induced current was passed through each loop that triggered a signal when a ship or submarine passed overhead – were formed of steel and copper cable linked to an onshore indicator loop hut erected at Dudley Point.

In late 1940, transit markers for the anti-submarine boom net were erected at Dudley Point and West Point, and marker buoys, moorings for boom gate vessels and net trot moorings began to be laid out, and two indicator loops were laid to the seaward side of the net. The construction of the net was initially scheduled to be completed by the end of 1940. However, due to delays in the assembly of the net and difficulties in laying the moorings due to strong tides, the net was not fully installed until late 1942.[56]

In September 1940, Japan entered the World War II "Axis" military alliance with Germany and Italy, and in late 1941, launched direct attacks on British holdings in Malaya, Singapore and Hong Kong and the United States military base at Pearl Harbour, Hawaii. These actions led Britain, America, and Australia to formally declare war on Japan, initiating the Asia-Pacific War. Over the following few months, Darwin underwent a significant metamorphosis.

Organised evacuation programs of women and children from Darwin and surrounding areas quickly commenced under the orders of the Commonwealth War Cabinet and the township rapidly emptied of civilians. Australian and Allied forces were sent to defend Australia's northern coastline and by early 1942, almost 15,000 troops were stationed in Darwin. Port

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[55] **Dennis, P. 2010.** "Australia and the Singapore Strategy". in Farrell, .B P. & S. Hunter (eds.) *A Great Betrayal?: The Fall of Singapore Revisited*. Marshall Cavendish Edition, Singapore. pp. 20–31.; **Lockwood, D. 2005.** *Australia Under Attack; The Bombing of Darwin – 1942.* New Holland Publishers (Australia) Pty Ltd.; **Rayner, R. J. 2001.** *Darwin and the Northern Territory Force.* Rudder Press, NSW.

[56] **Forster, P. 2007.** *Fixed Naval Defences in Darwin Harbour 1939-1945; how the Navy secured Darwin Harbour against submarine attacks between 1939 and 1945.* Museum & Art Gallery of the N.T. Darwin.; **Walding, R. 2006.** *Indicator Loops, Royal Australian Navy Harbour Defences – Darwin.*

Darwin became an important staging point for Allied naval shipping and aircraft engaged in battles throughout Southeast Asia and Netherlands East-Indies.

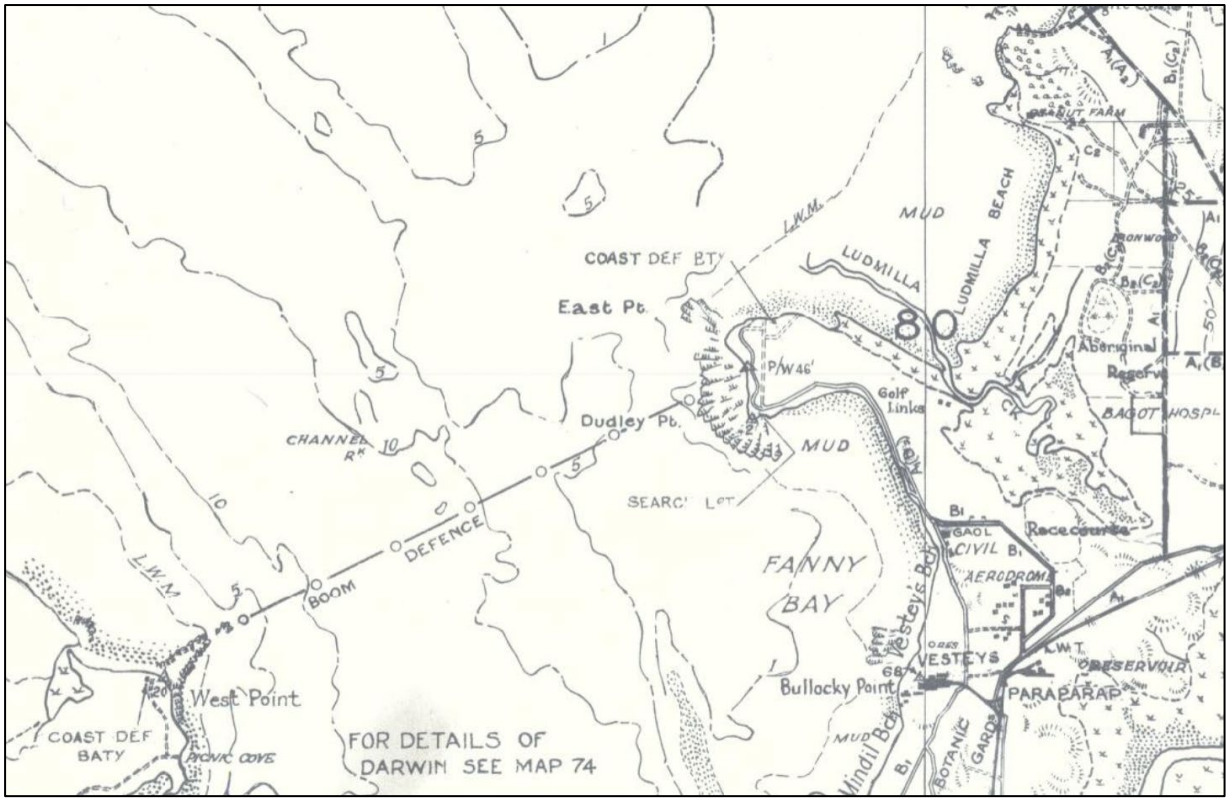

Figure 11: 1941-1945 plan of Darwin showing alignment of anti-submarine boom net.[57]

Figure 12: Boom vessel working on the Darwin anti-submarine boom net – showing detail of the net and buoys.[58]

Figure 13: Darwin anti-submarine boom net – showing gates opening to allow the passage of a ship.[59]

On 19 February 1942, Japan mounted a two-wave air raid on Darwin, marking the first attacks on the Australian mainland in World War II. The first raid consisted of a carrier-based

[57] **Australia. Army. Australian Survey Corps. 1941-1945** *Darwin and environs.* National Library of Australia, Map G9040 194-.
[58] **Turner, H.** 1943. "The Royal Australian Navy on boom defence duty at Darwin Harbour." Australian War Memorial, Image No. 014523.
[59] **McInnes, G.** 1943. "Darwin, NT. 1943-07-06. Boom gates open to allow the passage of a ship. Australian War Memorial, Image No. 053443.

aerial strike force of 188 bomber and fighter aircraft launched from a Japanese Imperial Navy fleet stationed approximately 350 km north-west of Darwin in the Timor Sea. The second raid comprised fifty-four land-based aircraft launched from the newly acquired Imperial Japanese Navy bases and Kendari and Laha, Ambon, Netherlands East-Indies. The raids attacked port facilities and shipping in Darwin Harbour, Darwin township, military installations, and aerodromes. The two raids killed at least 243 people and 300-400 were wounded. Eight Allied military vessels were sunk in the harbour – including United States Army Transport (USAT) *Mauna Loa*, USAT *Meigs*, and United States Navy destroyer USS *Peary*, situated within the current study area. Twenty-seven Allied military aircraft were also destroyed, and most civil and military facilities in Darwin suffered extensive damage. This raid was the first of many; during the course of World War II, Darwin and surrounds endured a total of sixty-four airborne Japanese attacks and several attempted submarine attacks. [60]

Following a Commission of Inquiry into the events of 19 February 1942 held by Commissioner Sir Charles John Lowe that concluded Darwin could not be defended without substantial reinforcements, the Commonwealth Government decided to place Darwin and the portion of the NT north of Alice Springs, under direct military administration. Extensive military re-organisation took place and substantial strengthening of military units and construction of new military bases occurred around Darwin Harbour.[61]

Extensions and improvements to the anti-submarine boom net and indicator loop system were conducted throughout 1942. By this time, it had been ascertained that the high variation and strength of the tides in Darwin was causing unforeseen problems in the maintenance of the boom net, and the current alignment left a strip of unprotected water at both ends of the net during high tide that would be deep enough to allow enemy vessels to pass around the boom and gain entrance to the harbour. A series of pylons were subsequently erected across the shallow and reefs at Dudley Point and West Point, connecting the boom directly to land (see Figure 15 and Figure 16). It had also been determined that the two indicator loops installed seaward of the boom net were giving frequent cable faults due to the rough seabed on which they were laid and the force of the changing tides. Following seabed surveys conducted by the Royal Australian Navy, a decision was made to replace these loops with a set of five positioned approximately 3 nm further north, between Midway on the western side of the entrance and Nightcliff on the East, and to move the Indicator Loop Control Station from East Point to Nightcliff. Works on these modifications to both the boom net and the indicator loops commenced in mid to late 1942, however, would not be completed for almost two years.[62]

An expansion of coastal defences around Darwin Harbour in 1943 saw the construction of several military facilities at Middle Point. In early 1943, an anti-aircraft search light station was established at the northern tip of Middle Point. In mid-1943, construction of a heavy anti-aircraft gun station and a satellite training camp for the Lugger Maintenance Section of the Allied Intelligence Bureau Services Reconnaissance Department commenced at Peak Hill on Middle Point. The Lugger Maintenance Section, established at East Arm in 1942, was an advance base for covert espionage, intelligence gathering, and raiding operations against Japanese forces throughout Indonesia, Timor, and the Philippines. By mid-1944, both the anti-aircraft gun station and Services Reconnaissance Department training camp were established and operational.[63]

[60] **Alford, B. 2017.** *Darwin 1942. The Japanese Attack on Australia. Campaign 304.* Osprey Publishing Ltd., Oxford, UK.; **Lockwood, D. 2005.** *Australia Under Attack: The Bombing of Darwin – 1942.* New Holland Publishers, Sydney, NSW.
[61] Ibid.
[62] *Op. Cit.* **Forster, P. 2007**; Walding, R. 2006.
[63] *Op. Cit.* **Rayner, R. J. 2001**.

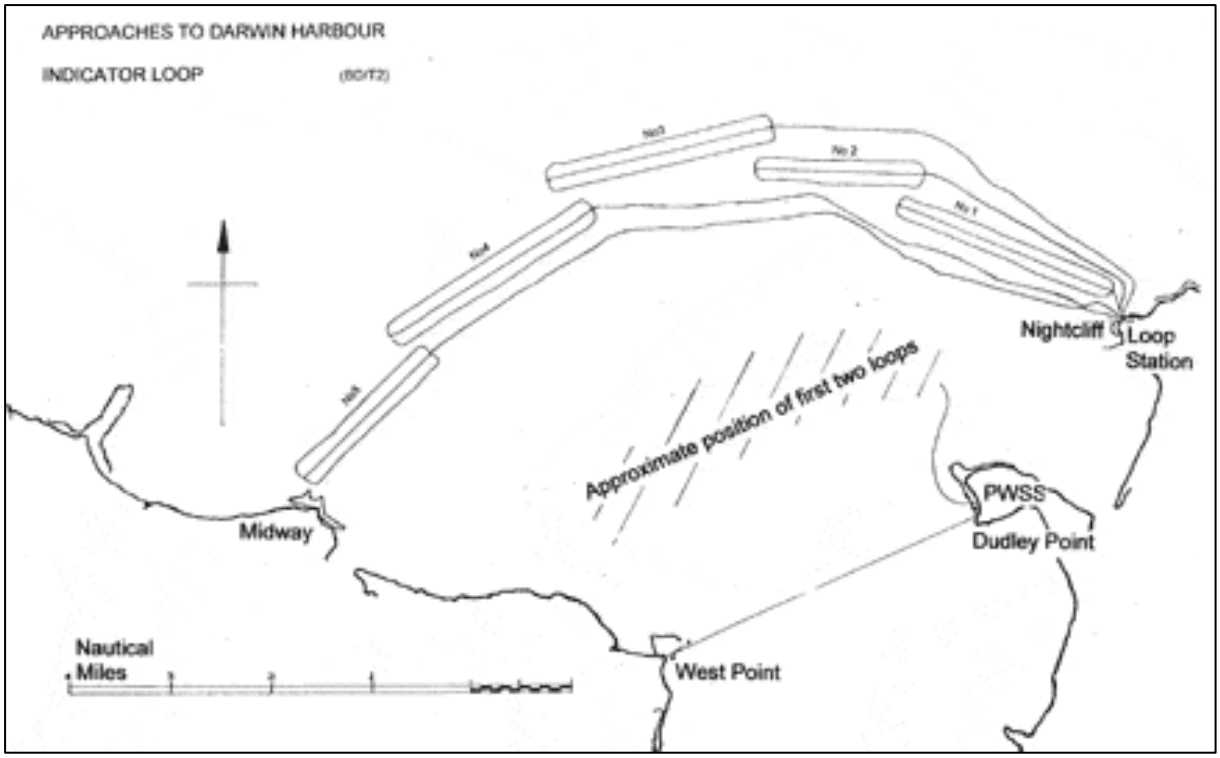

Figure 14: Sketch map showing position of anti-submarine boom net and indicator loops, Darwin Harbour.[64]

Figure 15: Anti-submarine boom net pylon, East Point.[65]

Figure 16: Anti-submarine boom net pylons, West Point.[66]

[64] *Op. Cit.* **Forster, P. 2007.**
[65] **Anon 1946** "Darwin, NT. 1946-03-05. East Point, Darwin, on which are situated the main part of Darwin's coastal defences." Australian War Memorial, Image No. 126154.
[66] **Woodrow, B. 1944** "Pylons for defence boom net, West Point." Northern Territory Library, Image No. PH0168/0082.

Figure 17: Middle Point anti-aircraft gun emplacement.[67]

From mid-1944, the Australian military was largely relegated to subsidiary fronts and the NT force was reduced in strength. However, work on some of Darwin's defence installations, including the extensions to the anti-submarine boom net and laying of the second set of indicator loops, continued throughout late 1944. These installations were finally fully operational in December 1944 – just over eight months before Allied victory and the end of World War II in 1945.[68]

4.2.7 *Post war*

After the end of World War II, control of the NT was handed back to the Commonwealth and the military units stationed in Darwin began to be demobilised and disbanded. By the late 1940s to early 1950s, most military structures and facilities were either removed or converted to civilian use. The NT economy shifted back towards pastoral, fishing, and mining industries. By the early 1960s, the Darwin population had increased over five-fold and commercial expansion and development had led to a significant increase in exports and shipping in the harbour.

The most significant event in the history of post-war Darwin was the destruction of the town by Cyclone Tracy on Christmas morning, 1974. Cyclone Tracy was the most compact cyclone on record in the Australian basin, with winds officially recorded at 217km per hour prior to the Bureau of Meteorology anemometer being destroyed. Waves in Darwin Harbour reached up to 4.5m in height. Seventy-one people were killed during the cyclone, including sixteen lost at sea. More than 70% of Darwin buildings were destroyed, all public services, including communications, power and water, were severed and the overall damage caused has been estimated at $837 million (1974 value). At least twenty-six vessels in Darwin Harbour, including a RAN patrol boat, a pilot boat, a fuel tanker, several prawn trawlers, traders, work boats, and passenger vessels, were wrecked or lost without a trace. A further twenty-one vessels were damaged.[69] Three of the known Cyclone Tracy wrecks – the Northern Research prawner *NR Diemen*, and passenger ferries *Darwin Princess* and *Mandorah Queen* – are situated within the current study area.

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[67] **Anon. 1945.** "Middle Point, Darwin, NT. 1945-04-14. Officers from 134 Anti-Aircraft Battery, 54 Anti-Aircraft Regiment inspect the gun positions after a king tide of 27 feet had lapped its base." Australian War Memorial, Image No. 088694.
[68] *Op. Cit.* **Forster, P. 2007**; Walding, R. 2006.

[69] **Attorney-General's Department Disasters Database. 2021.** "Cyclone Tracy." Australian Emergency Management Institute. http://www.emknowledge.gov.au/disaster-information; **Murphy, K. 1984.** *Big Blow Up North (A History of Tropical Cyclones in Australia's Northern Territory).* University Planning Authority, Darwin, NT.

4.2.8 *Summary of cultural activities within the study area*

From the review of the known history of the study area the following activities can be identified:

- Larrakia and Tiwi people maritime travel and subsistence activities – although these activities would likely be concentrated closer to coastal environments;
- Macassan trepang fishing and trade throughout the 18th to early 20th centuries;
- British exploration and surveying in early 19th century;
- A wide range of colonial shipping including Government and commercial cargo and passenger transport, fishing and pearling industry trade and transport, and recreational shipping, from the establishment of colonial settlement in Darwin in 1860s to present;
- Laying of subsea telegraph cables (x 3) in 1870s and 1880s;
- Quarantine and leper station transport and service supply in Middle Arm throughout late 19th to early 20th century;
- Military shipping – transport and mooring – throughout World War II;
- Air and sea combat between Allied and Japanese forces during World War II;
- Installation of anti-submarine boom net and indicator loops during World War II;
- A wide range of post war commercial, industrial, and recreational shipping activities.

4.3 Known Maritime Archaeological Sites in the Study Area

4.3.1 *Shipwrecks*

There are seventeen known shipwrecks located within the study area – refer to Table 2 and Figure 18 to Figure 20.

Four of these shipwrecks are military vessels sunk during battle in World War II, including three Allied vessels lost during the first Japanese air raid on Darwin on 19 February 1942 – United States Army transport vessels USAT *Mauna Loa* and USAT *Meigs*, and United States Navy destroyer USS *Peary*, and an Imperial Japanese Navy submarine *I-124* sunk by Allied forces on 20 January 1942. All of these shipwrecks are protected under the *Underwater Cultural Heritage* (UCH) *Act 2018*, and USAT *Mauna Loa*, USAT *Meigs*, and USS *Peary* are also protected under the NT *Heritage Act 2011.*

Three shipwrecks within the study area were lost in Cyclone Tracy, 25 December 1975, including passenger ferries *Darwin Princess* and *Mandorah Queen*, and a Northern Research prawn trawler *NR Diemen.*

Five vessels were intentionally scuttled in the 1970s and 1980s, including Taiwanese fishing vessel *Yu Han 22*, Thai fishing vessel *Medkhanun 3*, Vietnamese refugee vessels *Ham Luong* and *Song Saigon*, and workboat *John Holland Barge.*

The remaining five shipwrecks include a World War II LVT Buffalo amphibious tracked landing craft sunk in the 1960s, and three unidentified wrecks including three timber hulled vessels, and a steel barge.

Table 2: Known shipwrecks within the study area. Shipwrecks with names highlighted in gold located within proposed anchoring corridor.[70]

Name	Type	Year lost	Wreck event	Location (WGS84)	Approx. distance from proposed GEP	Statutory heritage protection
Barge - Unknown No. 1	Steel barge; likely WWII era	Not known	Not known	-12.44830° 130.81038°	1700 m	N/A
Buffalo Amphibian	Steel LVT Buffalo amphibious tracked landing craft – 16.5 tons, 7.95 m in length	1960s	Foundered whilst being used as support vessel for Mandorah Ferry	-12.41033° 130.80294°	1380 m	N/A
Darwin Harbour Unidentified Wreck 2	Timber hulled vessel – 30 m in length, carrying 10 tons of steel cargo	Not known	Not known	-12.48333° 130.83333°	2000 m	N/A
Darwin Princess	Steel motor vessel passenger ferry – 22.8 m in length	1974	Wrecked in Cyclone Tracy	-12.39815° 130.76535°	1300 m	N/A
NR Diemen	Motor vessel prawn trawler – 124 tons, 20.4 m in length	1974	Wrecked in Cyclone Tracy	-12.42660° 130.76528°	700 m	N/A
Ham Luong	Steel Vietnamese refugee motor vessel – 15 m in length	1983	Scuttled to form an artificial reef	-12.47509° 130.80067°	1140 m	N/A
John Holland Barge	Steel work barge – 18 m long by 12 m wide	1982	Scuttled to form an artificial reef	-12.47386° 130.80139°	930 m	N/A
Medkhanun 3	Steel Thai fishing motor vessel – 25 m in length	2007	Scuttled to form an artificial reef	-12.47870° 130.80236°	850 m	N/A
Mandorah Queen	Steel and aluminium motor vessel passenger ferry – 22 m in length	1974	Wrecked in Cyclone Tracy	-12.442722° 130.778306°	690 m	N/A
Mandorah Unidentified Wreck 1	Timber hull motor vessel	Not known	Not known	-12.446660° 130.766950°	2000 m	N/A
Mandorah Unidentified Wreck 2	Timber hull motor vessel	Not known	Not known	-12.448100° 130.766100°	2000 m	N/A
Song Saigon	Steel Vietnamese refugee motor vessel – 200 tons, 38 m in length	1982	Scuttled to form an artificial reef	-12.474722° 130.801278°	755 m	N/A
USAT *Mauna Loa*	Steel single screw steamship, former passenger cargo vessel commissioned as a United States Army transport during World War II. 5436 tons, 125 m in length	1942	Sunk by enemy action during first Japanese air raid on Darwin Harbour on 19 February 1942	-12.49704° 130.81936°	15 m*	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)
USAT *Meigs*	Steel single screw steamship, former cargo vessel commissioned as a United States Army transport during World War II. 12568 tons, 131.3 m in length	1942	Sunk by enemy action during first Japanese air raid on Darwin Harbour on 19 February 1942	-12.48765° 130.81838°	270 m*	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)

[70] All data obtained from the Australian Underwater Cultural Heritage Database (AUCHD)

Name	Type	Year lost	Wreck event	Location (WGS84)	Approx. distance from proposed GEP	Statutory heritage protection
USS *Peary*	Steel twin screw steamship, United States Navy Clemson Class destroyer – 1190 tons, 95.8 m in length	1942	Sunk by enemy action during first Japanese air raid on Darwin Harbour on 19 February 1942	-12.47533° 130.82982°	2000 m*	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)
Yu Han 22	Timber Taiwanese fishing motor vessel – 25 m in length	1975	Partially burned and scuttled	-12.5175° 130.82166°	730 m	N/A
I-124	Steel Imperial Japanese Navy I-121 Class minelaying submarine – 1470 tons, 85.2 m in length	1942	Sunk during counterattack by Allied forces on 20 January 1942.	-12.120091° 130.106561°	100 m*	*UCH Act 2018* – 800 m radius (under *UCH Act 2018*)

Note – distances with asterisk are measured from closest boundary of heritage protection zone to GEP route. Locations highlighted in yellow have been determined by examination of MBES data and differ from locations provided on AUCHD.

Figure 18: Location of known shipwrecks in study area – Darwin Harbour.

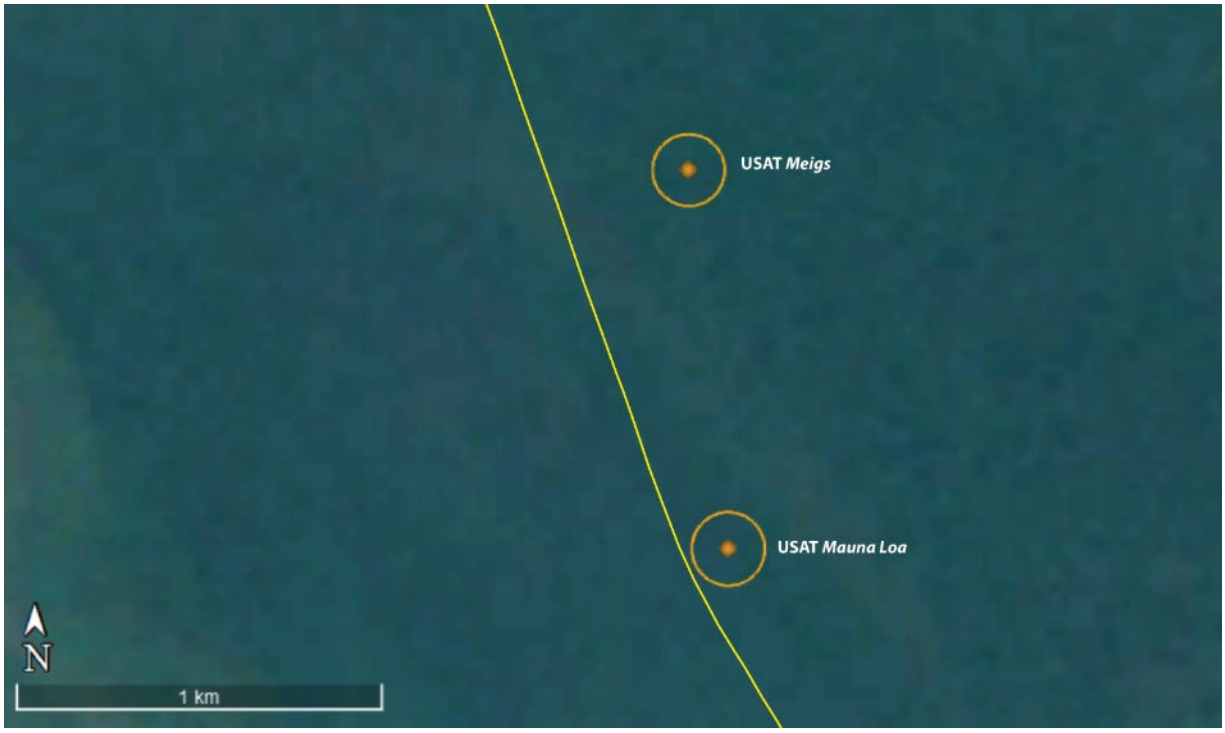


Figure 19: Detail of proximity of USAT Mauna Loa and USAT Meigs to proposed GEP.

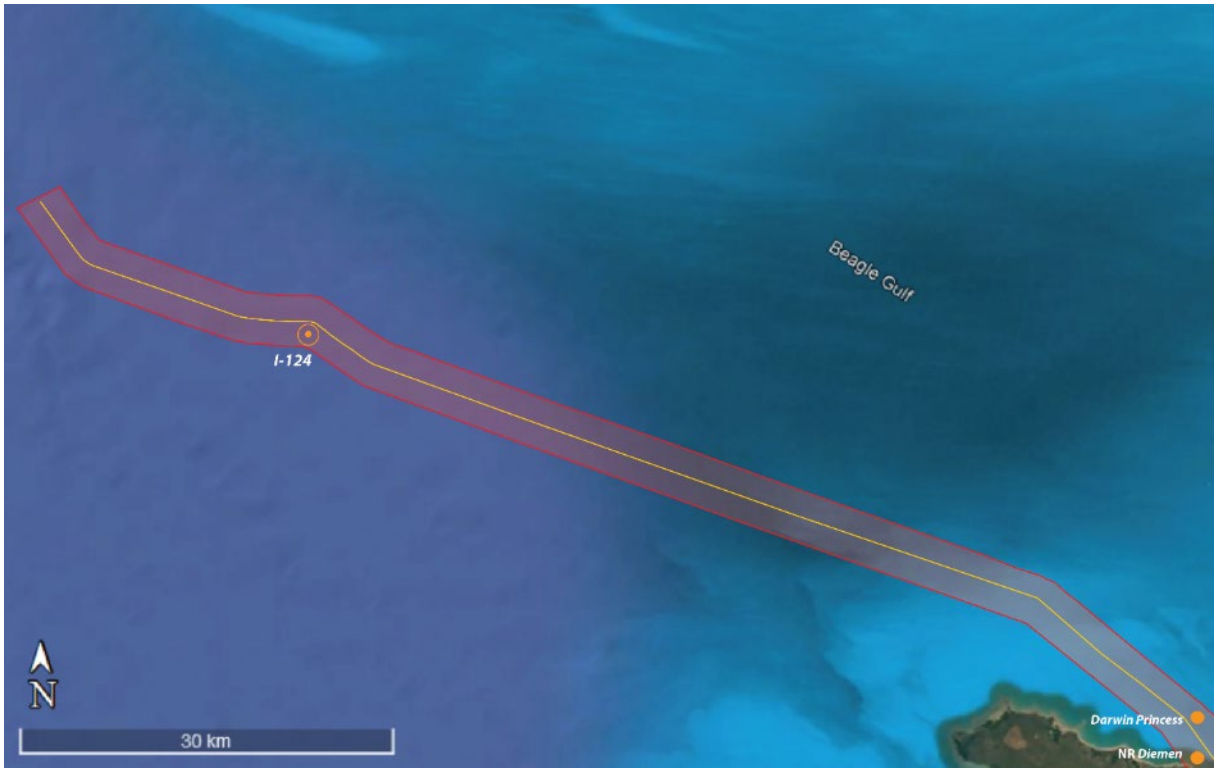


Figure 20: Location of known shipwrecks in study area – Beagle Gulf.

Figure 21: USAT Mauna Loa.[71]

Figure 22: USAT Meigs.[72]

Figure 23: Darwin Princess.[73]

Figure 24: Song Saigon being scuttled.[74]

4.3.2 *Aircraft wrecks*

There are no known aircraft wrecks located within the study area. The closest known aircraft wreck is the wreck of a Douglas C-47 Dakota, RAAF A65-115, that was forced to ditch into the harbour due to engine failure during a test flight in 1946. The wreck of the C-47 is situated in Fannie Bay, approximately 2km north-east of the study area.

4.3.3 *Maritime infrastructure*

Six historical maritime infrastructure installations are known to occur within parts of the study area, including three 19th century subsea telegraph cables, a World War II anti-submarine boom net installation, and two groups of World War II indicator loops – see Table 3, Figure 25 and Figure 26.

Table 3: Known historical maritime infrastructure within the study area.[75]

Name	Type	Year built	Statutory heritage protection
Subsea telegraph cable - original	First installation of an approximately 1,561 km long subsea telegraph cable linking Darwin cable station to Banjoewangi cable station, Java, Indonesia. The cable consists of seven stranded copper wires, insulated with gutta-percha latex, sheathed in galvanised iron wire armour, and an outside covering of tarred hemp. The cable ranges in diameter from 3" at shore ends, 1" in intermediate portions, and ¾" in deep sea portions.	1871	The subsea cable landing at Darwin is protected under the NT *Heritage Act 2011*.

[71] **Frost, W. E. 1932.** "S.S. *Golden Eagle."* City of Vancouver Archives, Item AM1506-S3-2-: CVA 447-2246.
[72] **Anon. 1942.** "The United States Army Transport (USAT) Meigs underway in Darwin Harbour some days before the Japanese air raid on 19 February 1942." Australian War Memorial, Image No. P05303.019.
[73] **Anon. 1973.** "*Darwin Princess."* Library and Archives NT, Image No. PH0366/0017.
[74] **Anon. 1982.** "*Song Saigon* being scuttled." Darwin Sub-Aqua Club files; https://www.dsac.com.au/Divesite_files/Song.htm
[75] Data obtained from **Forster, P. 2007.** *Fixed Naval Defences in Darwin Harbour 1939-1945; how the Navy secured Darwin Harbour against submarine attacks between 1939 and 1945.* Museum & Art Gallery of the N.T. Darwin.; **NT Heritage Branch.**

Name	Type	Year built	Statutory heritage protection
Subsea telegraph cable - duplicate	Duplicate subsea telegraph cable linking Darwin cable station to Banjoewangi cable station, Java, Indonesia. The duplicate cable was of the same composition as the original 1871 cable.	1879	The subsea cable landing at Darwin is protected under the NT *Heritage Act 2011*.
Subsea telegraph cable - replacement	Replacement subsea telegraph cable linking Darwin cable station to Banjoewangi cable station, Java, Indonesia. Cable is of similar composition to the earlier two but contained an additional layer of brass tape around the core to protect the cable from marine borer (namely *teredo navalis)* attack.	1884	The subsea cable landing at Darwin is protected under the NT *Heritage Act 2011*.
Anti-submarine boom net	A 6km-long anti-submarine boom net constructed between Dudley Point and East Point, across the entrance to Port Darwin. The boom consisted of high tensile wire rope (1-2" diameter), 8' mesh floating nets. The nets were supported by a series of trots laid out 195' (60 m) apart, each consisting of three cylindrical buoys anchored via 1 ½ - 2"chain cable to eight 5-8 ton reinforced steel concrete mooring clumps laid on the seabed – four on the seaward side of the net, four on harbour side. A total of 265 clump moorings were laid. A permanently guarded gate was set into the net within the Port Darwin shipping channel. The boom net and buoys were largely cleared at the end of World War II; however the concrete clump moorings and chains were left *in situ*. ***Anti-submarine boom net mooring trots were located and identified during ROV survey. Refer to Section 7 and Annex A for details.**	1940-1942	N/A
Indicator loops – original (x2)	Initial installation of two indicator loops between Dudley Point and West Point, across the entrance to Port Darwin on the seaward side of the anti-submarine boom net. The loops provided magnetic sensing of enemy vessels, whereby an induced current was passed through each loop that triggered a signal when a ship or submarine passed overhead. The loops were formed of 33 mm diameter cable consisting of a single core of tinned copper wire, insulated with India rubber, hessian tape, tarred jute yarn, steel armour wires, hot pitch and resin coating. Each loop was typically 5000 yards long by 400 yards wide, with a central cable running the length of the loop, connected to a 25 mm diameter tail cable linked to the onshore indicator loop hut. The loops were dismantled and lifted following the end of World War II, however, it is not known if all components were recovered.	1940	N/A
Indicator loops - replacement (x 5)	Following several breakages of the initial two indicator loops due to strong tides and rough seabed, a replacement set of five indicator loops was installed ca. three miles further seaward, stretching between Midway and Nightcliff. The loops were of the same design and construction as the original set. The loops were dismantled and lifted following the end of World War II, however, it is not known if all components were recovered.	1943	N/A

2019. *The Darwin Subsea Telegraph Cables – Heritage Assessment Report.*; **Walding, R. 2006.** *Indicator Loops, Royal Australian Navy Harbour Defences – Darwin.*

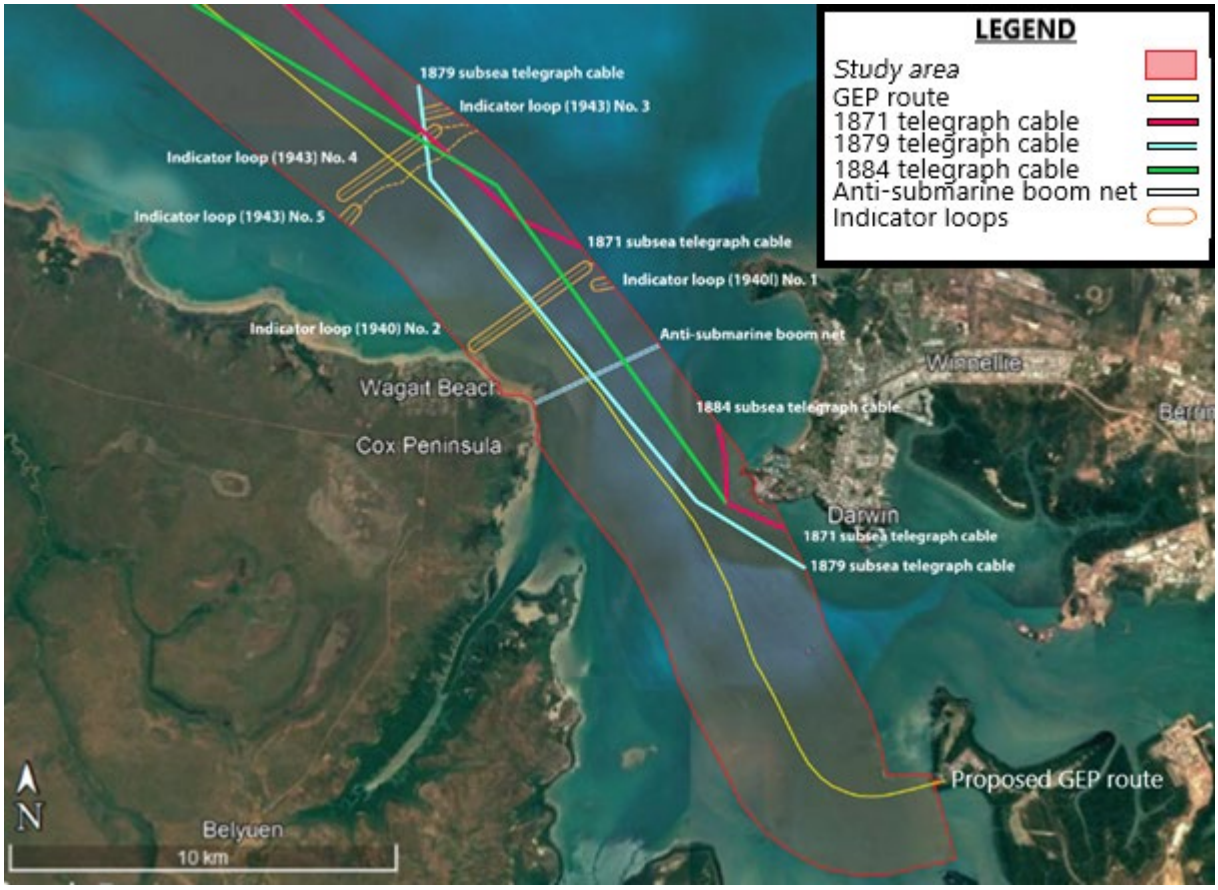


Figure 25: Location of historical maritime infrastructure in study are a (based on historical map overlays) – Darwin Harbour.

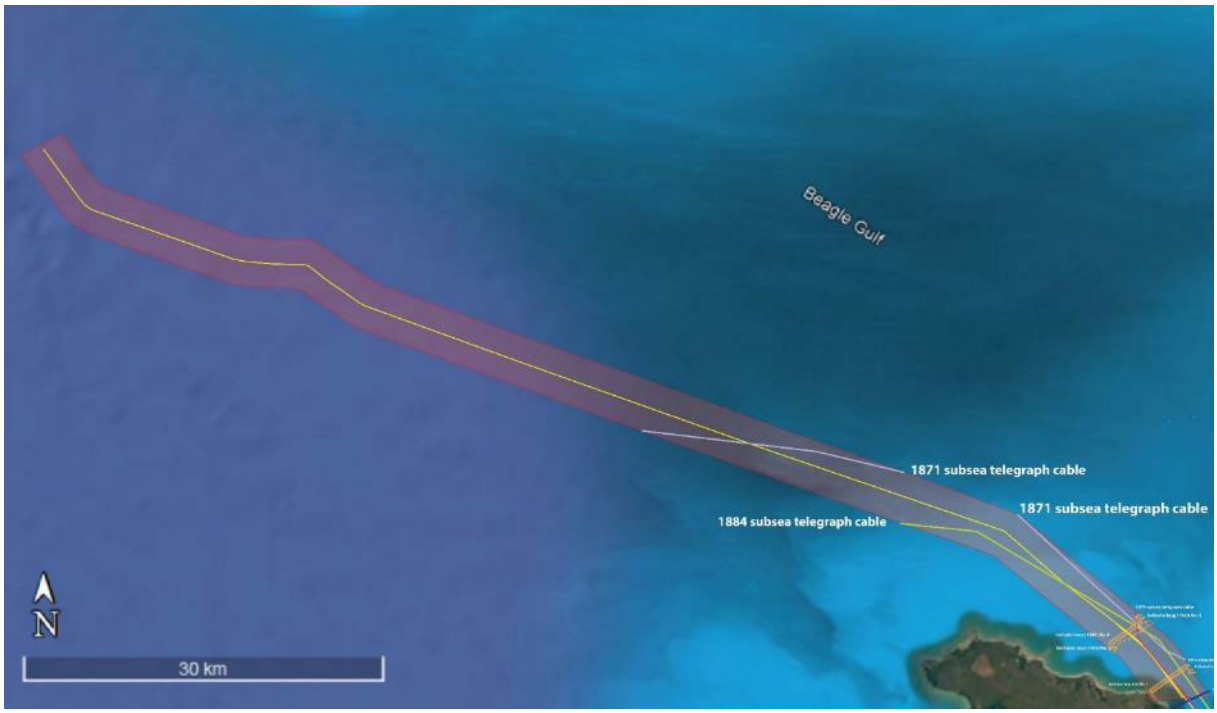


Figure 26: Location of historical maritime infrastructure in study area (based on historical map overlays) – Beagle Gulf.

Figure 27: Section of the 1871 Darwin to Java subsea telegraph cable recovered from Timor Sea in 2016.[76]

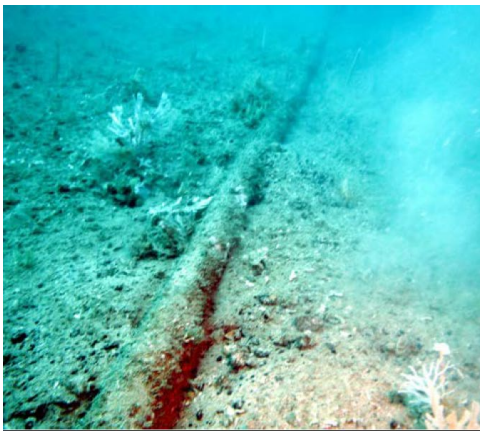


Figure 28: Surviving section of 1871 subsea telegraph cable, Darwin Harbour.[77]

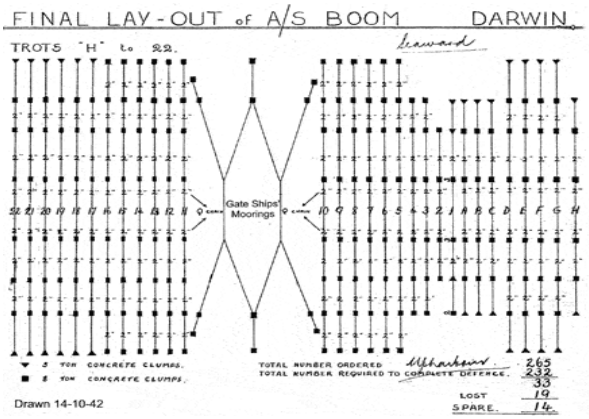


Figure 29: Layout of the Darwin anti-submarine boom net.[78]

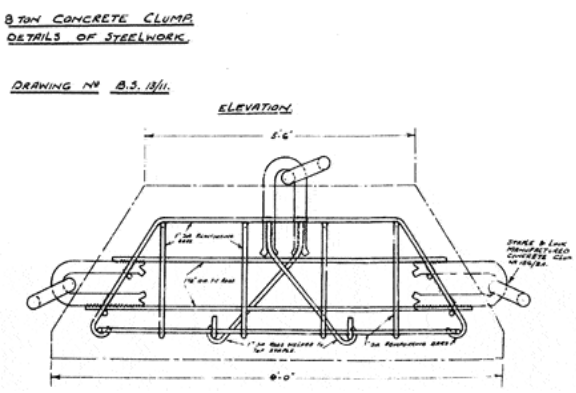
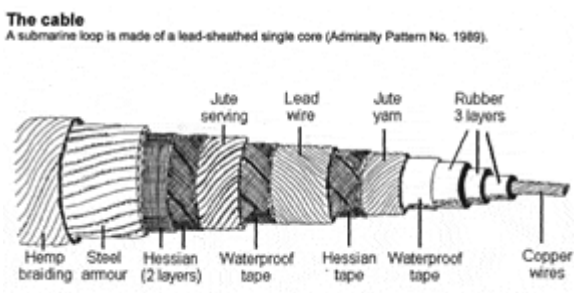


Figure 30: Construction details of the Darwin anti-submarine boom net mooring blocks.[79]



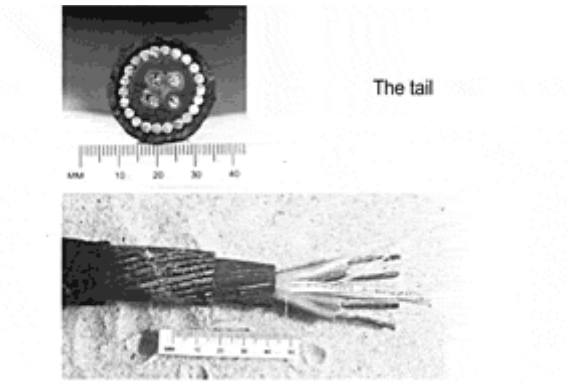


Figure 31: Construction details of the Darwin indicator loop cables.[80]

[76] **"A section of the Port Darwin to Java underwater telegraph cable, 1871-1872." Held at the National Museum of Australia.**
[77] **NT Heritage Branch. 2019.**
[78] **Forster, P. 2007.**
[79] **Forster, P. 2007.**
[80] **Forster, P. 2007.**

4.3.4 *Sea dumping*

Other than the intentional scuttling of vessels and UXO located during INPEX surveys – discussed in Section 4.3.1 and 4.3.5 respectively – no known episodes of sea dumping are located within the study area.

4.3.5 *Unexploded Ordnance*

*** This section looks at UXO only from a heritage perspective. It is not intended to provide UXO specialist advice or to constitute a detailed UXO risk assessment.*

Documented unexploded ordnance (UXO) is known to occur at four shipwrecks located within the study area – see Table 4.

In each instance, this UXO consists of munitions cargo and unfired / unexploded naval ordnance payload associated with World War II military vessels wrecked in 1942. All items of UXO associated with these four shipwrecks are protected under the *UCH Act 2018.*

***Table 4: Known UXO within the study area.*[81]**

Shipwreck	UXO type	Wreck location (WGS84)	Approx. distance to proposed GEP*	Statutory heritage protection
USAT *Mauna Loa*	.303 calibre and .45 calibre ammunition, and 3" mortars	-12.49704° 130.81936°	15 m	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)
USAT *Meigs*	.303 calibre ammunition and possible depth charges or land mines	-12.48765° 130.81838°	270 m	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)
USS *Peary*	3" and 4" artillery shells	-12.47533° 130.82982°	2000 m	*UCH Act 2018* and *NT Heritage Act 2011* – 100 m radius (under *NT Heritage Act 2011*)
I-124	5.5" artillery shells and 21" torpedoes	-12.120091° 130.106561°	100 m	*UCH Act 2018* – 800 m radius (under *UCH Act 2018*)
Contact 2	Mechanical time fuses and fuse cones	-12.416111° 130.762500°	175 m	No statutory protection, no heritage protection radius.
***Note – distances highlighted in yellow are measured from closest boundary of heritage protection zone to GEP route.**				

***Figure 32: Artillery shell within the wreck of USS Peary.*[82]**

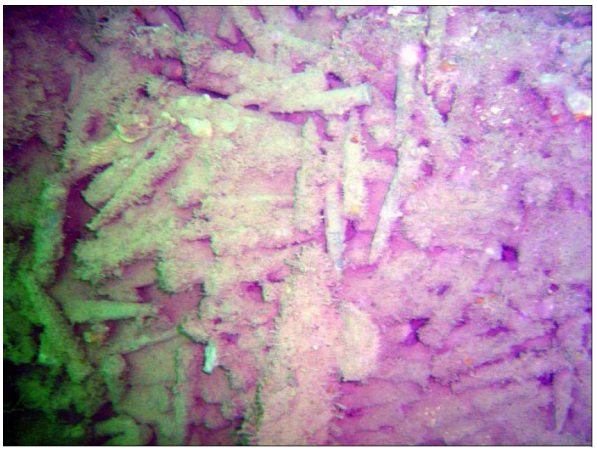


***Figure 33: Small arms ammunition inside cargo hold of USAT Mauna Loa wreck.*[83]**

[81] All data obtained from the Australian Underwater Cultural Heritage Database (AUCHD)
[82] **Steinberg, D. 2015.** The World War II Shipwrecks of Darwin Harbour; a report on the archaeological inspection and assessment of seven historic shipwrecks. NT Heritage Branch.
[83] Ibid.

Additionally, one location of dumped UXO was recorded during the INPEX GEP survey conducted by CA in 2012.[84] This consisted of a collection of dumped mechanical time fuses and fuse cones located near KP 105 at 691614 m E and 8626792 m N, approximately 175 m from the proposed GEP route (see Section 6.4.1.2, Figure 34).

Figure 34: Collection of mechanical time fuses and fuse cones located at Contact 2, on the alignment of the INPEX GEP. Contact 2 is located approximately at location of KP 105 along proposed Barossa GEP route. (Source: CA 2012).

4.4 Potential Maritime Archaeological Sites in the Study Area

4.4.1 *Shipwrecks*

There are twenty-nine known but unlocated shipwrecks in Darwin Harbour and Beagle Gulf that could potentially occur within the study area based on historical accounts of the wreck event and wreck location – see Table 5.

The majority of these shipwrecks comprise small timber-hulled sailing vessels lost during the late 19th to early 20th centuries – in many cases due to extreme weather events, such as nine pearling luggers and a Chinese junk wrecked during a major cyclone that struck Darwin in January 1897, two sailing vessels lost in strong gales during the 1880s, and a launch lost in a cyclone that hit Darwin in March 1915. The remainder includes a composite clipper ship / Royal Australian Navy (RAN) coal hulk scuttled in 1932, three workboats lost during World War II, mid-20th century wrecks of a motor launch and a barge, and a timber-hulled motor vessel sloop lost in Cyclone Tracy in December 1974.

There is also potential for shipwrecks not documented in the historical record to be located within the study area, including Aboriginal, Macassan, and early colonial watercraft.

Any shipwreck within the study area that dates prior to 1947 – whether located or not – is automatically protected under the *UCH Act 2018*.

Table 5: Potential shipwrecks within the study area. [85]

Name	Type	Year lost	Wreck event	General location
Ark	Timber pearling lugger	1897	Wrecked in 1897 cyclone	Darwin Harbour
Astraea	Timber barque	1886	Disappeared on voyage	Between Darwin and Queensland.
Bear Sing	Timber sailing vessel	1886	Wrecked in a strong gale	Darwin Harbour
Black Jack	Timber pearling lugger	1897	Wrecked in 1897 cyclone	Darwin Harbour
Charity	Timber lugger	1897	Disappeared on voyage	Between Darwin and WA

[84] *Op. Cit.* **Cosmos Archaeology, 2012**:11.
[85] All data obtained from the Australian Underwater Cultural Heritage Database (AUCHD)

Name	Type	Year lost	Wreck event	General location
Darwin Harbour Unidentified Chinese Junk 1	Timber junk	1897	Wrecked in 1897 cyclone	Darwin Harbour
Darwin Harbour Unidentified Lugger 1	Timber lugger	1939	Destroyed by fire after stove explosion	Darwin Harbour
Darwin Harbour Unidentified Lugger 2	Timber lugger	1910	Scuttled	Darwin Harbour
Dawn	Timber ketch; 51 tons	1893	Broken up	Darwin Harbour
Eileen	Timber ketch; 13 tons	1939	Foundered	Near Charles Point, Beagle Gulf
Good Intent	Timber ketch	1892	Foundered	Between Darwin and Charles Point, Darwin Harbour – Beagle Gulf
Gertrude	Timber pearling lugger	1897	Wrecked in 1897 cyclone	In shoal water on Middle Point, Darwin Harbour
Gunyana	Timber motor vessel sloop	1974	Disappeared in Cyclone Tracy	Darwin Harbour – Beagle Gulf
HMAS *Hankow*	Composite clipper ship, coal hulk, 1249 tons, 223 m in length	1932	Scuttled with demolition charges	Outside entrance to Darwin Harbour / west of East Point
Harbour Tug	Tug	1942	Foundered	Beagle Gulf – Timor Sea
Hibernia	Timber ketch, 13 tons	1882	Foundered	Darwin Harbour, within the fairway to the anchorage
Jack	Timber pearling lugger	1897	Wrecked in 1897 cyclone	Darwin Harbour
Karalee	Timber lighter, 117 tons	1943	Foundered	Darwin Harbour
Lighter No. 2	Steel lighter, 86 tons	1943	Lost by enemy action	Near Darwin
Olga	Timber motor vessel launch	1926	Sunk after onboard chemical explosion	Ca. 48 km from Darwin, towards Bathurst Island, Beagle Gulf
Olive	Timber pearling lugger	1897	Wrecked in 1897 cyclone	South-west of Fort Hill, Darwin Harbour
Peron	Motor launch	1948	Disappeared	Near Darwin; Darwin Harbour – Beagle Gulf
Pinafore	Timber sailing vessel	1881	Wrecked in a gale	Darwin Harbour, ca. 4 km out of Fannie Bay
Revenge	Timber pearling lugger	1897	Wrecked in 1897 cyclone	Darwin Harbour
Roebuck	Timber pearling lugger	1897	Wrecked in 1897 cyclone	In mangroves, one mile south of Middle Point, Darwin Harbour
Scout	Timber pearling lugger	1897	Wrecked in 1897 cyclone	On eastern side of Middle Point, Darwin Harbour
Spray	Timber launch	1915	Wrecked in 1915 cyclone	Darwin Harbour
Triumph	Steel barge	1954	Foundered	Off Darwin, Darwin Harbour - Beagle Gulf
Zulieka	Timber sailing vessel	1897	Wrecked in 1897 cyclone	On a reef off Channel Island, Middle Arm, Darwin Harbour

4.4.2 *Aircraft wrecks*

There are twenty-five known but unlocated aircraft wrecks in Darwin Harbour and Beagle Gulf that could potentially occur within the study area based on historical accounts of the wreck event and general wreck location – see Table 6.

All of these wrecks are military combat aircraft, including eleven Imperial Japanese Navy (IJN) and Navy Air Force (IJNAF) aircraft, seven United States Army Air Force (USAAF)

aircraft, six Royal Australian Air Force (RAAF) aircraft, and one Royal Air Force (RAF) aircraft. All but one of these aircraft – an RAAF fighter wrecked in 1961 – were lost during World War II.

Any of these World War II aircraft wrecks that are situated within Commonwealth waters (from waters 3 nm seaward of the territorial sea baseline) are automatically protected under the *UCH Act 2018.* All USAAF aircraft wrecks are also automatically protected under the US *Sunken Military Craft Act 2004.*

Table 6: Potential aircraft wrecks within the study area.

Aircraft type / number	Operator	Wreck event	Year Lost	General location
CAC Sabre A94-360 (military fighter); pilot Irvine	Royal Australian Air Force (RAAF) – 81 Wing	Failure of port wing caused catastrophic mid-air explosion.	1961	Darwin Harbour, near Talc Head
Curtiss P-40E Kittyhawk (military fighter); pilot Andrew	United States Army Air Force (USAAF) - 7th Squadron, 49th Pursuit Group	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1942	West of Charles Point, Beagle Gulf
Curtiss P-40E Kittyhawk (military fighter); pilot Drake	USAAF - 7th Squadron, 49th Fighter Group	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1942	Off West Point, Darwin Harbour
Curtiss P-40E Kittyhawk (military fighter); pilot Fish	USAAF - 8th Squadron, 49th Pursuit Group	Shot down by IJNAF A6M2 "Zero" fighters.	1942	Approximately 3 km S-SE of Swires Bluff, Darwin Harbour
Curtiss P-40E Kittyhawk (military fighter); pilot McComsey	USAAF - 9th Squadron, 49th Pursuit Group	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1942	Off West Arm, southern side of Darwin Harbour
Curtiss P-40E Kittyhawk (military fighter); pilot Pell	USAAF - 33rd Pursuit Squadron	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1942	Camerons Beach, Shoal Bay, Darwin Harbour
Curtiss P-40E Kittyhawk (military fighter); pilot Strauss	USAAF - 8th Squadron, 49th Pursuit Group	Shot down by IJNAF A6M2 "Zero" fighters.	1942	Approximately 2.7 km north-west of Emery Point, Fannie Bay, Darwin Harbour
Curtiss P-40E Kittyhawk (military fighter); pilot Wiecks	USAAF - 33rd Pursuit Squadron	Shot down by IJNAF A6M2 "Zero" fighters.	1942	Darwin Harbour; near harbour entrance
Kawanishi H6K4 "Mavis" (military bomber); pilot Mirau	Imperial Japanese Navy (IJN) - Toko Ku Southwest District Fleet	Shot down by USAAF 3rd Pursuit Squadron P-40 Kittyhawk.	1942	South / south-west of Melville Island, Beagle Gulf – Timor Sea
Lockheed Hudson A16-137 (ex 41-23207) (military bomber)	RAAF - No. 13 Squadron	Disappeared after departing Darwin for an attack mission on Kupang, Indonesia.	1942	Possibly Beagle Gulf - Timor Sea
Lockheed Hudson A16-170 (ex 41-23607) (military bomber)	RAAF - No. 13 Squadron	Disappeared after departing Darwin for an attack mission on Kupang, Indonesia.	1942	Possibly Beagle Gulf - Timor Sea
Mitsubishi A6M2 "Zero" (military fighter); pilot Murakami	Imperial Japanese Navy Air Force (IJNAF) - 3 Ku, 23rd Koku Sentai	Shot down by USAAF 7th Squadron, 49th Pursuit Group P-40 Kittyhawks. .	1942	ca. 32 km north-west of Darwin, Beagle Gulf
Mitsubishi A6M2 "Zero" (military fighter); pilot Tajiri (m/n 6540)	IJNAF - 202 Ku, 23rd Koku Sentai	Shot down by RAAF / RAF No. 54 Squadron Spitfire.	1943	Darwin Harbour; immediately south of West Point
Mitsubishi G4M1 "Betty" (military bomber); pilot Asahiro	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF P-40 Kittyhawks.	1942	Beagle Gulf
Mitsubishi G4M1 "Betty" (military bomber); pilot Fujiwara	IJNAF – 753 Ku, 23rd Koku Sentai	Shot down by RAAF 457 Squadron Spitfires.	1943	West / north-west of Charles Point, Cox Peninsula, Beagle Gulf
Mitsubishi G4M1 "Betty" (military bomber); pilot Inada	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group P-40 Kittyhawks and / or 14 HAA anti-aircraft battery Darwin.	1942	In sea north-west of Darwin, Beagle Gulf.

Aircraft type / number	Operator	Wreck event	Year Lost	General location
Mitsubishi G4M1 "Betty" (military bomber); pilot Kato	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group.	1942	North-west of Darwin; Beagle Gulf - Timor Sea
Mitsubishi G4M1 "Betty" (military bomber); pilot Kirino	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group.	1942	North-west of Darwin; Beagle Gulf - Timor Sea
Mitsubishi G4M1 'Betty" (military bomber); pilot Ozaki	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group.	1942	North-west of Darwin; Beagle Gulf - Timor Sea
Mitsubishi G4M1 "Betty" (military bomber); pilot Tomohara	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group.	1942	North-west of Darwin; Beagle Gulf - Timor Sea
Mitsubishi G4M1 "Betty" (military bomber); pilot Unohara	IJNAF - Takao Ku, 23rd Koku Sentai	Shot down by USAAF 49th Pursuit Group.	1942	North-west of Darwin; Beagle Gulf - Timor Sea
Supermarine Spitfire A58-6 (ex AR563) (military fighter)	RAAF - No. 452 Squadron	Engine failure during formation practice flight caused pilot to force land in intertidal mangroves.	1943	Middle Arm, Darwin Harbour
Supermarine Spitfire A58-34 (ex-BR525) (military fighter)	RAAF - No. 452 Squadron	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1943	Approximately 48 km north-west of Darwin, Beagle Gulf.
Supermarine Spitfire A58-86 (ex-BS221) (military fighter)	Royal Air Force (RAF) - No. 54 Squadron	Engine failure during flight to intercept incoming IJNAF attack forced pilot to bail out and aircraft crashed into sea.	1943	Approximately 48 km north-west of Darwin, Beagle Gulf.
Supermarine Spitfire A58-89 (ex-BS225) (military fighter)	RAAF - No. 452 Squadron	Damaged during dogfight with incoming IJNAF attack, forcing pilot to bail out and aircraft to crash into sea.	1943	North-west of Darwin, Beagle Gulf - Timor Sea

4.4.3 *Maritime infrastructure*

The study area passes through some historical anchorages within Darwin Harbour, including a late 19th to mid-20th century quarantine anchorage, and 1930s to 1940s naval anchorages. It is possible that permanent moorings were established in some areas of these anchorages, and that remnants of such moorings, most likely large clump anchors or concrete mooring blocks and associated chains, remain on the seabed.

4.4.4 *Sea dumping*

Previous maritime archaeological investigations have found substantial evidence of sea dumping of World War II era military material within Darwin Harbour: including aircraft parts, armament and ammunition, automotive parts and accessories, camp furniture and equipment, power and electrical equipment, fuel storage containers, and manual tools. Much of this material has been found in piles or clusters across the seabed, suggesting discrete dumping events from a barge or similar vessel. It was concluded that this material most likely represents post-war disposal of surplus and / or unserviceable military equipment.[86]

There is a potential for similar evidence of post-World War II sea dumping of military material to occur within the study area.

4.4.5 *UXO*

*** This section looks at UXO only from a heritage perspective. It is not intended to provide UXO specialist advice or to constitute a detailed UXO risk assessment.*

[86] **Cosmos Archaeology Pty Ltd. 2014.** INPEX Ichthys LNG Project, Nearshore Development – Dredging, East Arm, Darwin Harbour, Northern Territory – Relocation of Heritage Objects and Removal of Debris. Report prepared for Tek Ventures Pty Ltd.

There is a potential for various types of UXO – namely World War II era UXO – to occur within the study area, including:

- Crashed Allied and Japanese military aircraft ordnance payloads;
- Japanese air-delivered munitions;
- Japanese sea-delivered munitions;
- Allied artillery munitions from coastal defences and anti-aircraft bases, and;
- Sea dumping of surplus military ammunition.

The Department of Defence maintains a record of sites confirmed as, or reasonably suspected of, being affected by UXO.[87] These records show that various areas of Darwin Harbour and Beagle Gulf have historically been used for military training – see Figure 35. The study area passes through the location of a former air to air weapons range; however, Defence records do not confirm whether this area was used for live firing, and UXO or explosive ordnance fragments have not been recovered from the area.

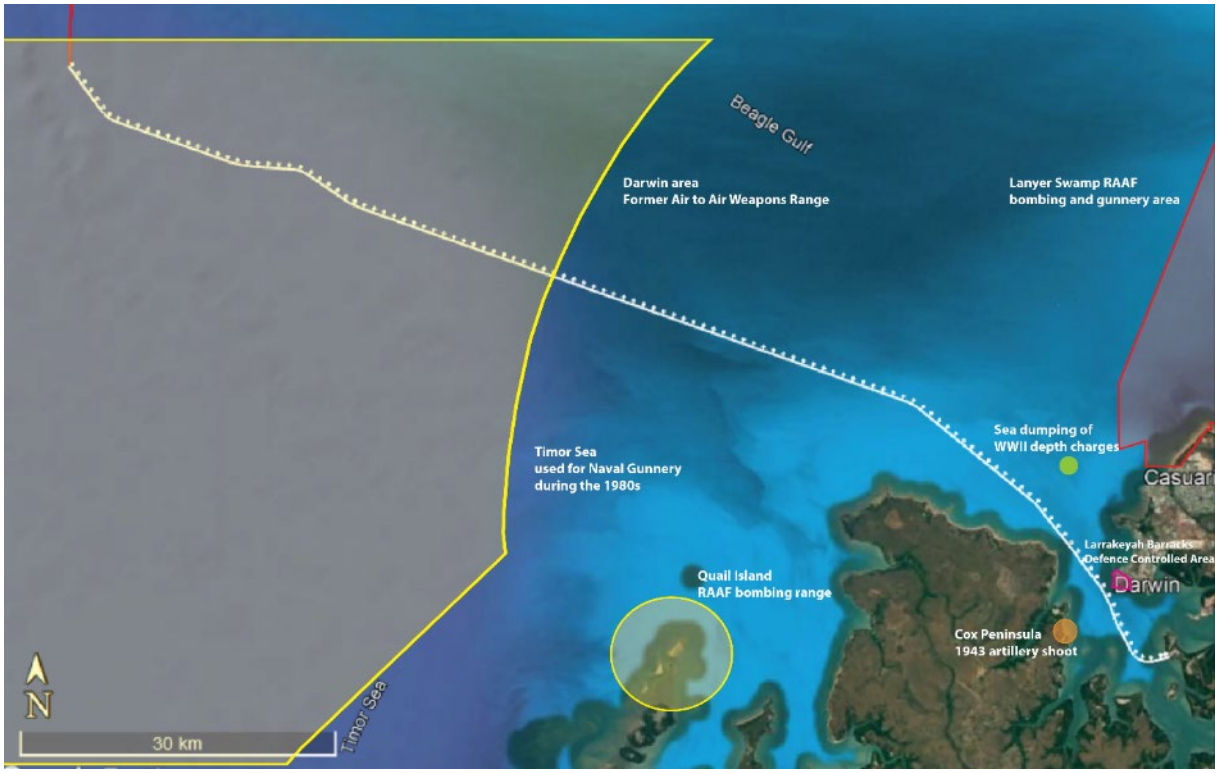


Figure 35: Areas where UXO may occur based on Department of Defence records.[88]

[87] **Australian Government Department of Defence. 2022.** Defence UXO Mapping Application. whereisuxo.org.au
[88] **Australian Government Department of Defence. 2022**.

5 PREDICTED CONDITION OF MARITIME ARCHAEOLOGICAL SITES

5.1 Introduction

The condition of any maritime archaeological resource is affected by environmental and cultural factors as well as the nature of the seabed.

With regards to the study area, the following factors will have the greatest impact on site formation processes:

- Type of event leading to presence on seabed;
- Soft marine sediments;
- Mechanical damage caused by waves;
- Salvage;
- Anchor and trawl drags;
- Chemical and biological degradation.

5.2 Site Environment

As discussed in Section 4.1, the seabed is primarily sandy and featureless along most of the Beagle Gulf portion of the proposed GEP route. From KP 0 to KP 100, the seabed appears to be primarily flat and almost featureless sand, crossed in several places by gullies. Around KP 105, where the GEP route enters Darwin Harbour, the flat sand gives way to rock outcrops and other hardgrounds. Between Larrakeyah and Mica Beach, the seabed becomes more gravelly and forms a thin cover over flat sandstone and phyllite pavements. The hardgrounds within Darwin Harbour are punctuated by isolated deposits of thick sediments, before giving way to sand and mudflats as the GEP approaches its terminus at Wickham Point.

5.3 Shipwrecks

The wrecking event is the first factor that influences site formation. Depending on the reasons or forces behind wrecking, the ship may be mostly complete or extensively broken up. A vessel rarely falls or sinks as a result of little or no damage; it is more likely that a vessel would run aground, cause damage to the hull, and then sink with part of the vessel intact and part damaged. Often the force of initial impact is sufficient to break the vessel and cause considerable damage. The vessel would then sink in large pieces, depending on the damage, or remain stuck until it is broken up by physical or human forces. Another reason for a wrecking event is fire which, depending on the extent, can cause a considerable amount of breaking up and scrambling of the ship material before it reaches the seabed.

It is reasonable to assume that a large majority of potential shipwrecks within the study area foundered or were forced ashore. In this scenario, the vessel's structural remains would remain highly intact, although if run ashore it may have been salvaged for key parts before discard and therefore would have less artefactual remains.

The seabed upon which a shipwreck lies has the greatest effect on site formation processes, in particular with wooden hulled vessels, with other factors also having contributory effects.

With regards to vessels coming to rest on a sandy seabed, the archaeological site will usually be formed in the following manner:

- Vessel comes to rest on the seabed.

- The wreck will settle into the seabed up to a certain depth, dependent on the resistance of the sediments and the weight of the vessel. It is a general rule, especially with iron hulled vessels, that wrecks sink into softer sediments up to their waterline.
- Parts of the vessel which protrude above the water may be salvaged for re-use. Non-perishable, accessible and high value parts of the vessel situated underwater may also be removed. It is a general rule that the deeper the water in which a vessel sinks and the more remote the location, the less likelihood of it being salvaged at the time of loss. Rapidly changing technology in recent times, however, has allowed salvage at greater depths.
- Biological processes will commence immediately on a timber wreck, attacking the exposed timbers and other organic elements of the wreck. This will lead to a weakening of the hull's integrity and eventually organic elements above the seabed will disappear.
- If it is in shallow water, wind generated waves would act upon the broader surfaces of a wreck thereby breaking down exposed components into sections. These sections will orientate themselves to prove the least resistance to the direction from which the waves are more commonly generated.
- Large waves will raise sediments into suspension, thereby resulting in cultural objects, including the hull of the wreck, sinking further into the marine sediments. The older the wreck the deeper it would be buried, unless a hard-alluvial substrate is present close to the surface of the seabed against which the wreck will rest.
- Cultural behaviour will have the effect of scrambling wreck sites and masking their presence. Dragging anchors, scallop dredgers and trawling will spread wreck material and may also result in the 'ploughing up' of buried cultural material.
- Salvaging will have a destructive effect on the hull and organic elements that have survived below the seabed, as well as by removing artefacts and creating a scatter of remaining material around the wreck site.

A wreck coming to rest on a rocky bottom would eventually collapse under its own weight as it would not be able to sink into the seabed. With such a collapse the integrity or coherence of the wreck begins to dissipate. Pockets of surviving structure and other artefacts can remain well preserved amongst boulders, gullies and depressions.

Assessing the condition or, more precisely, the structural integrity of the shipwrecks is of relevance because this can provide an indication of the nature and scale of the obstacle that could affect the pipeline installation process. Shipwreck condition also relates to its 'detectability'. A number of factors influence the condition of shipwrecks, the primary ones being the materials used in the construction of the vessel, the bottom type upon which the wreck rests, the depth of the wreck and its age.

With regards to detecting wreck sites, the two most common remote sensing techniques that are applied would be magnetometer and side scan sonar surveys. The side scan sonar would be more useful in detecting high- and low-profile wreck sites while the magnetometer is best employed in searching for sites with a high ferrous content which are partially buried or resting on a rocky bottom.

Generally speaking, the 'younger' the wreck is, and the deeper it sank in the water column, the better preserved it would be. Also, a wreck resting on a sandy bottom would be better preserved than if it was resting on a rocky bottom. In conjunction with these factors, the

method and type of construction of the vessel is the most important variable when it comes to assessing the condition of a wreck.

Iron/Steel Hulled Wrecks

If resting on a sandy bottom it could be expected that the hull integrity of the wreck would be relatively intact. The hull along midships may have collapsed but the stern and bow sections may still be upright or heeled to one side. The engine components, if any, would be largely intact and *in situ*. Such vessels on a rocky bottom would be relatively disarticulated, though the components of the vessel would still be present. Iron/steel wrecks on either bottom type can be detected using a magnetometer. Locating such a wreck site on a rocky bottom with side scan sonar would be difficult but the opposite is true with such wrecks on a sandy seabed.

Wooden Hulled Wrecks with Engines

In most cases the hulls of such wrecks would have disappeared. In situations, however, where the wreck rests on a sandy bottom, sections of the hull may have been preserved under the sand. The engine components of such wrecks would be visible. A magnetometer can detect such wrecks on either bottom type. Such wrecks on a rocky bottom would be difficult to detect with side scan sonar but the opposite can be true with such wrecks on a sandy seabed. However, engine components can be partially or completely covered by sediments and would appear as scattered dumped debris or a linear mound.

Large Tonnage (> 100 ton) Wooden Hulled Wrecks (Sail)

In most cases the hulls of such wrecks would have disappeared. In situations, however, where the wreck rests on a sandy bottom, significant sections of the hull may have been preserved under the sand. There would be enough ferrous material present, such as anchors, chain and winches, for such wreck sites to be detected using a magnetometer. The identification of such wreck sites using side scan sonar would be difficult as it could appear as scattered dumped debris, unless the cargo was non-perishable, in which case a linear mound may be visible.

Small Tonnage (< 100 ton) Wooden Hulled Wrecks (Sail)

The same as for large tonnage vessels except that the size of the target and the amount of ferrous material present would be considerably less. It would be difficult to detect using a magnetometer and may be mistaken for dumped material debris from side scan sonar imaging.

5.4 Aircraft Wrecks

There are significant differences between the site formation of underwater aircraft wrecks and shipwrecks due to the vastly different construction, in terms of both shape and material used, as well as the depositional process, i.e., the wrecking event. These are two key determining factors that will influence site formation.[89] The wrecking event for aircraft is the first factor affecting site formation, and can take many forms, from deliberate scuttling on the water's surface and dumping of material to high impact crashes and slower, more controlled ditching events. Aircraft dumping was considered 'fairly commonplace' following WWII, and significant dump sites exist near Sydney and Greencape in NSW, along with sites near Brisbane, and Rottnest Island in WA.[90] Aircraft wrecked as a result of military combat may have sustained significant damage before crashing into the water. Aircraft sitting on the

[89] **Burgess, A., 2013**, *Underwater Aviation Archaeology: What is its Place and Value Within Archaeology, and in Particular Maritime Archaeology?*, Masters thesis, Faculty of Humanities, University of Southampton, United Kingdom.
[90] **Smith, T., 2004,** Plane Sailing: The archaeology of aircraft losses over water in NSW, Australia. *Bulletin of the Australasian Institute for Maritime Archaeology.* Vol. 28:113-124.

surface of the water may have also been attacked and sunk through military action.[91] The initial integrity of the aircraft hull depends largely on the wrecking incident, and is influenced by numerous factors, such as the speed and angle of impact upon entry.

Upon entering the water, the shape of the aircraft and the depth of the water column will determine how the aircraft comes to rest on the seafloor. Aircraft hulls and wings are typically made of lightweight material, such as aluminium or even wood and fabric, while machinery and components such as engines will weigh significantly more and contain more ferrous elements. This disparity in weight will cause some aircraft to invert on descent, coming to a rest on their back. Other aircraft, such as single engine WWII fighter planes built with engines at the front, will sink to the bottom nose first. As the aircraft sinks in the water column, it may break up further, with the loss of wings or tail sections being sometimes noted.[92] Once on the seafloor, the combination of increased weight and galvanic corrosion due to differing metals means that larger components, such as engines, may detach and fall away from the rest of the structure. The depth of the wreck has a significant role in its deterioration, as aircraft sunk in shallower waters are more at risk from wave surge and corrosion due to warmer water temperature and increased oxygen levels.[93]

The seafloor composition will determine the burial environment for a sunken aircraft which in turn will have a large impact on the survival and condition of the aircraft. Aircraft are generally lighter than ships and are therefore less likely to penetrate the seabed, and less of the hull may be buried. As with shipwrecks, it is assumed that aircraft that are quickly buried in an anaerobic, stable environment, deep underwater will be better preserved than those in shallow inshore environments, particularly those with hard seabed and heavy surf.[94]

The composition of alloys used in aircraft construction can have a significant impact on the rate of deterioration once an aircraft has sunk. Aluminium, the primary material used in aircraft construction, is highly reactive. When alloyed with metals like copper, its corrosion rate is accelerated. This leads to a phenomenon known as ‘pitting,’ where perforations appear as the aluminium corrodes.[95] Water with a higher acidity will cause more rapid deterioration.

Direct cultural impacts can also play a role in site formation, especially on sites located in areas of high boat traffic. Fishing nets have frequently become entangled with aircraft wrecks, resulting in damage and fragmentation.[96] Impacts and damage by anchors was frequently noted on PBY Catalina wrecks in Darwin Harbour, including some anchors that remained embedded in the aircraft.[97] Further damage can occur from propeller jet turbulence in shallow water. Due to the lightweight construction of aircraft, these anchor and fishing net collisions can easily move pieces of a sunken aircraft from one location to another, resulting in highly fragmented wreck sites.[98] Aircraft parts can be light enough that even recreational fishing line has been known to snag and disturb sites. Seafloor dredging has also been shown to have a significant negative impact on aircraft crash sites.[99] Other cultural impacts include salvaging, which can include initial salvaging efforts shortly after the wrecking event, as well as looting, illicit salvage, and souvenir taking. Sunken aircraft may become popular with recreational divers and can be damaged by careless visitors.

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[91] **Wilkinson, D., 2012,** Underwater aircraft sites in Australia: a summary of what has been learnt so far. *Bulletin of the Australasian Institute for Maritime Archaeology.* Vol. 36:31-35.
[92] **Wessex Archaeology, 2008,** *Aircraft Crash Sites at Sea: A Scoping Study,* Prepared for English Heritage.
[93] *Op. Cit.* **Smith, 2004.**
[94] *Op. Cit.* **Wessex Archaeology, 2008**.
[95] *Op. Cit.* **Burgess, 2013**.
[96] *Op. Cit.* **Smith, 2004.**
[97] **Cosmos Archaeology, 2016,** *INPEX Ichthys Project, Catalina Flying-Boat Monitoring 2012 to 2015,* Prepared for Tek Ventures Pty Ltd.
[98] *Op. Cit.* **Cosmos Archaeology, 2016**.
[99] *Op. Cit.* **Wessex Archaeology, 2008**.

Although the site formation processes for sunken aircraft display large variation between sites, a general flow of deposition can be summarized:

- An aircraft enters the water, either through a violent and high-impact uncontrolled crash, slower deliberate bailout, or through dumping/scuttling on the surface. Aircraft may have sustained damage prior to entering water, such as those suffering mid-air explosions and aircraft shot down in combat.
- As the aircraft sinks, its orientation and hull integrity will change depending on its construction. Wings and tail may separate, and heavier components may invert an aircraft.
    - It has been noted on Catalina wrecks that the tails and wings are very rarely found with the rest of the fuselage, indicating that they have potentially broken off and drifted away as the aircraft sunk.[100]
- The aircraft will settle on the sea bottom. Aircraft deposited on hard substrate may not be buried, while those settling on sandy, muddy, or silty bottoms may partially sink into the seafloor.
- In certain cases, salvaging operations may take place immediately, including the removal of high value components. In other cases, illicit salvaging, looting, treasure hunting, and souvenir taking can damage wrecks.
- Aircraft materials will begin to deteriorate over time, due to corrosion as well as natural and cultural external factors.
    - Corrosion will cause deterioration of metals, particularly aluminium, and may cause heavier ferrous components to detach.
    - Surf and surge can further disarticulate aircraft and spread material around a larger area.
    - Human activities such as dredging, fishing and recreational boating can further disperse sites by dragging fishing nets and anchors across sunken aircraft.

5.5 Sea dumping and UXO

Ordnance from WWII

Generally, ordnance resting on rocky seabeds in high energy environments will corrode and disintegrate at a more rapid rate while those in lower energy environments or completely buried will retain their integrity for much longer.[101] Such objects will appear as scattered low relief and highly reflective debris on the seabed.

Ballast mounds

Ballast mounds are usually composed of rock and occasionally of scrap iron. They will present as high relief and highly reflective on the seabed.

5.6 Maritime Infrastructure

Moorings

Moorings are selected for their durability and therefore remain in a solid condition, whether they be anchors or concrete blocks. They tend to become buried over time in sandy/silty seabeds. Associated chain can also become buried, with exposed sections eventually corroding to a point where they become brittle and break easily. The length of time required

[100] *Op. Cit.* **Cosmos Archaeology, 2016**.
[101] **G-tek Australia, 2010:6.**

for chain to reach this state of deterioration depends very much on its thickness, but it can be expected that such material in Darwin Harbour will still retain some tensile strength.

Cable and nets

On a sandy/silty seabed, wire and netting can become partially buried. Similarly, to chain, exposed sections eventually corrode to a point where they become brittle and break easily, but the length of time required to reach this state of deterioration depends very much on the object's thickness. Given that these objects are around 70 years old, they can be expected to still retain tensile strength. They would appear as meandering low relief and highly reflective linear anomalies. The associated 'clumps' would appear as round or square low relief and highly reflective objects.

6 REVIEW OF GEOPHYSICAL SURVEY DATA

6.1 Introduction

Geophysical data was provided by Santos in the form of high-resolution geo-tiffs for side scan sonar (SSS) and multi-beam echosounder (MBES) survey data. Magnetometer data was provided as georeferenced feature points. Additionally, a detailed geophysical survey report was provided to supplement the raw data.[102] The proposed anchoring corridor for vessels installing the GEP is wider than the geophysical survey corridor conducted by Fugro. Therefore, an additional MBES dataset published by Geosciences Australia was consulted to cover this data gap.

Of relevance to this assessment in particular was the SSS. Additionally, MBES and magnetometer data was used as a second and third data source to support the selection of targets from SSS. SSS data was provided as geo-tiffs at 0.5m resolution which were imported into QGIS software and laid over basemaps. This provided highly accurate coordinates of seabed anomalies as well as their dimensions. The 0.5m resolution allowed for the selection of small, isolated anomalies due to the high resolution.

SSS and MBES data adequately covered the proposed pipeline route, with no discernible gaps in coverage. Magnetometer data, though useful in identifying cultural objects, was provided only as feature points, and raw data was not provided.

6.2 Geophysical survey data provided

6.2.1 *Side Scan Sonar survey*

SSS data was provided as 0.5m resolution black and white geo-tiffs covering the entirety of the proposed GEP route (see Figure 36 and Figure 37). Additionally, targets identified by FUGRO during geophysical survey reporting were provided. These were assessed against the available raw SSS and MBES data to assess their potential historical significance and cultural origin (see Table 7).

[102] **Fugro, 2022,** *Barossa Pipeline to Shore Project – Survey Results Report – Offshore Geophysical Survey – (Work Package 1) North Route 2*, provided for Santos Pty Ltd. (BAS-200 0629).

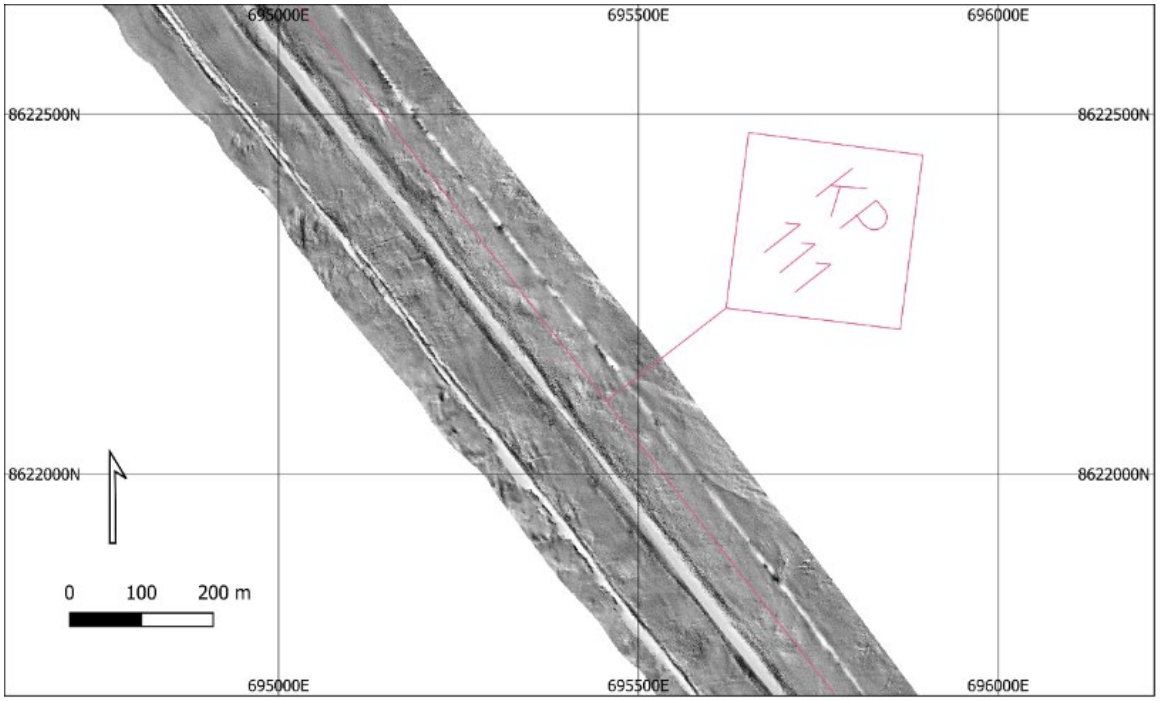


Figure 36: Detail example of SSS data at KP 111.

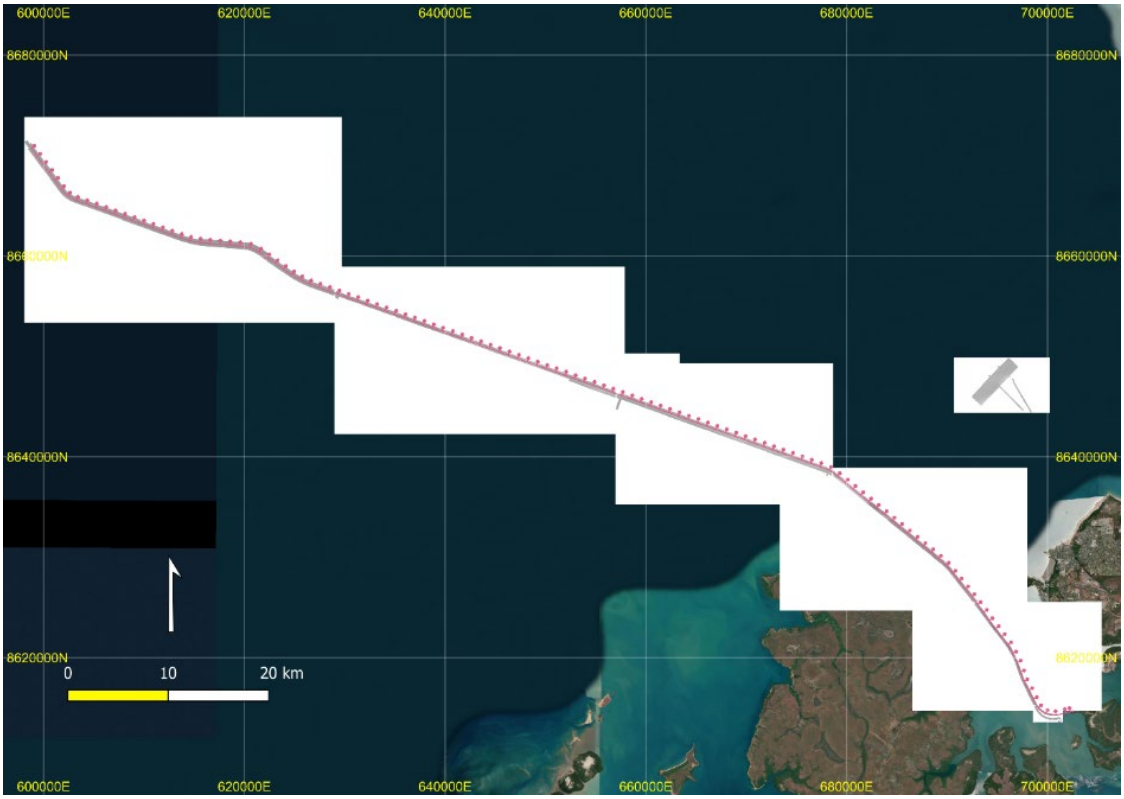


Figure 37: Overview of SSS data provided. Isolated survey location at upper right is proposed spoil dumping ground and has not been assessed as part of this study.

Table 7: SSS targets identified by FUGRO.

Contact ID	Easting	Northing	KP	Lateral Offset (m)	Target Length (m)	Target Width (m)	Target Height (m)	Comments
NCL_SC_001	700 423.74	8 614 259.84	120.575	14.2	2	0.6	0.5	Interpreted as possible debris
NCL_SC_002	698 297.94	8 616 489.78	117.323	-11.6	0.9	0.4	0.3	Interpreted as possible debris
NCL_SC_003	696 916.66	8 619 697.08	113.822	-18.7	1	0.9	0.5	Likely Cable Support
NCL_SC_004	696 907.83	8 619 708.85	113.807	-15.9	1	1	0.6	Likely Cable Support with indicated floating feature
NCL_SC_005	696 407.33	8 620 690.74	112.705	-0.2	5.4	4.8	2.2	Interpreted area of boulders
NCL_SC_006	696 419.44	8 620 731.18	112.674	-28.9	15.2	2.6	4.1	Interpreted area of boulders
NCL_SC_007	696 392.69	8 620 736.62	112.658	-7.3	37.9	4.8	4.1	Interpreted area of boulders
NCL_SC_008	695 229.68	8 622 439.49	110.594	-29.6	4.4	4.2	2.3	Interpreted as possible boulder
NCL_SC_009	695 133.04	8 622 512.87	110.476	1.6	19.4	9.8	2.2	Interpreted area of boulders
NCL_SC_010	694 982.00	8 622 822.59	110.139	-69.5	17.2	0.4	0.0	Interpreted as linear debris
NCL_SC_011	694 570.93	8 623 163.28	109.618	45.6	7.9	3	0.0	GEP Support
NCL_SC_012	694 554.56	8 623 338.56	109.47	-49.1	1.7	0.6	0.5	Interpreted as possible debris
NCL_SC_013	694 194.43	8 623 694.54	108.967	16.4	2.4	0.9	0.3	Interpreted as possible debris
NCL_SC_014	694 154.18	8 623 697.79	108.94	46.1	5.6	3.1	0.0	GEP Support
NCL_SC_015	694 149.50	8 623 705.26	108.931	45.2	4.8	3.1	0.0	GEP Support
NCL_SC_016	694 168.64	8 623 820.49	108.85	-39.5	3.5	1.6	0.3	Likely Cable Support
NCL_SC_017	693 408.43	8 624 885.18	107.544	-42.5	2.2	1.6	1.6	Likely Cable Support
NCL_SC_018	693 397.60	8 624 896.59	107.528	-41.6	3.7	1.5	1.6	Likely Cable Support
NCL_SC_019	693 392.07	8 624 908.88	107.515	-45.2	3.2	0.5	0.5	Likely Cable Support
NCL_SC_020	693 289.83	8 624 881.53	107.472	51.4	1.2	0.7	1.0	Likely Cable Support
NCL_SC_021	693 256.72	8 625 008.55	107.351	-0.7	1.2	0.7	0.3	Likely Cable Crossing
NCL_SC_022	693 204.05	8 625 169.57	107.192	-57.9	7.3	0.5	0.8	Likely rock outcrop
NCL_SC_023	693 194.32	8 625 167.23	107.188	-48.7	3.3	3	1.4	Likely Cable Support
NCL_SC_024	693 197.88	8 625 175.94	107.183	-56.9	1.6	1.2	0.6	Likely as possible boulder
NCL_SC_025	693 173.38	8 625 221.05	107.133	-65.2	2.4	1.2	0.6	Likely Cable Support
NCL_SC_026	693 033.94	8 625 246.57	107.027	29.2	2.2	1.1	2.1	Likely Cable Support
NCL_SC_027	692 377.30	8 626 358.51	105.749	-140.6	3.8	0.6	0.5	Interpreted as possible debris
NCL_SC_028	692 201.01	8 626 347.87	105.646	2.8	5.9	1.7	0.3	Interpreted as possible boulders
NCL_SC_029	692 113.89	8 626 472.65	105.494	-8.4	7.3	4.9	1.0	Interpreted as possible boulders
NCL_SC_030	692 203.88	8 626 576.45	105.471	-143.7	2.7	0.5	0.8	Interpreted possible depression
NCL_SC_031	691 780.61	8 626 909.95	104.945	-26	1.4	0.7	0.3	Interpreted as possible debris
NCL_SC_032	691 794.14	8 626 925.97	104.941	-46.6	5.9	3.9	0.7	Interpreted seabed depression
NCL_SC_033	691 531.47	8 627 231.14	104.538	-35.5	3.9	3	0.5	Interpreted as boulders area
NCL_SC_034	690 883.80	8 628 009.18	103.526	-18.2	2.4	2.2	1.8	Interpreted as possible boulders
NCL_SC_035	690 884.02	8 628 053.80	103.49	-45.7	5.4	3.4	0.5	Interpreted as possible debris
NCL_SC_036	690 874.11	8 628 054.11	103.484	-38.1	3.2	2.1	1.4	Interpreted as possible boulders
NCL_SC_037	690 850.08	8 628 066.18	103.46	-26.5	6.4	2.1	1.4	Interpreted as possible boulders

Contact ID	Easting	Northing	KP	Lateral Offset (m)	Target Length (m)	Target Width (m)	Target Height (m)	Comments
NCL_SC_038	690 694.00	8 628 289.49	103.188	-40.4	4.3	3.1	1.2	Interpreted as possible boulder
NCL_SC_039	690 654.94	8 628 293.38	103.161	-11.9	10.8	9.1	2.2	Interpreted as possible boulders
NCL_SC_040	690 656.57	8 628 303.24	103.154	-19.3	3.4	1.6	1.3	Interpreted as possible boulders
NCL_SC_041	690 751.17	8 628 441.21	103.103	-178.6	18.5	7.2	0.6	Unknown contact
NCL_SC_042	690 507.00	8 628 467.70	102.932	-2.1	4.7	3.3	1.5	Interpreted as possible boulder
NCL_SC_043	690 594.22	8 628 586.13	102.892	-143.7	5.6	1.6	1.1	Interpreted as possible item of debris
NCL_SC_044	690 589.91	8 628 584.83	102.891	-139.5	4	1.3	0.9	Interpreted as possible debris
NCL_SC_045	690 572.03	8 628 605.50	102.863	-138	5.2	1.7	0.9	Interpreted as possible debris
NCL_SC_046	690 576.71	8 628 624.49	102.851	-153.4	5	1.4	0.3	Interpreted as possible debris
NCL_SC_047	689 666.39	8 629 478.40	101.621	-47	22.8	0	0.0	Interpreted as possible linear debris
NCL_SC_048	689 718.75	8 629 576.50	101.595	-155	2.3	1.2	0.4	Interpreted as possible debris
NCL_SC_050	689 665.26	8 629 484.58	101.616	-50.9	1.9	1.6	1.5	Interpreted as possible debris
NCL_SC_049	681 875.94	8 635 783.35	91.6	-1.89	2.47	0.32	NA	Possible linear contact, Debris

6.2.2 *Multi-beam sonar*

Multi-beam bathymetry for the entire route was provided as high-resolution geo-tiffs with colouring and shading to designate elevation changes. MBES resolution was 0.5m.

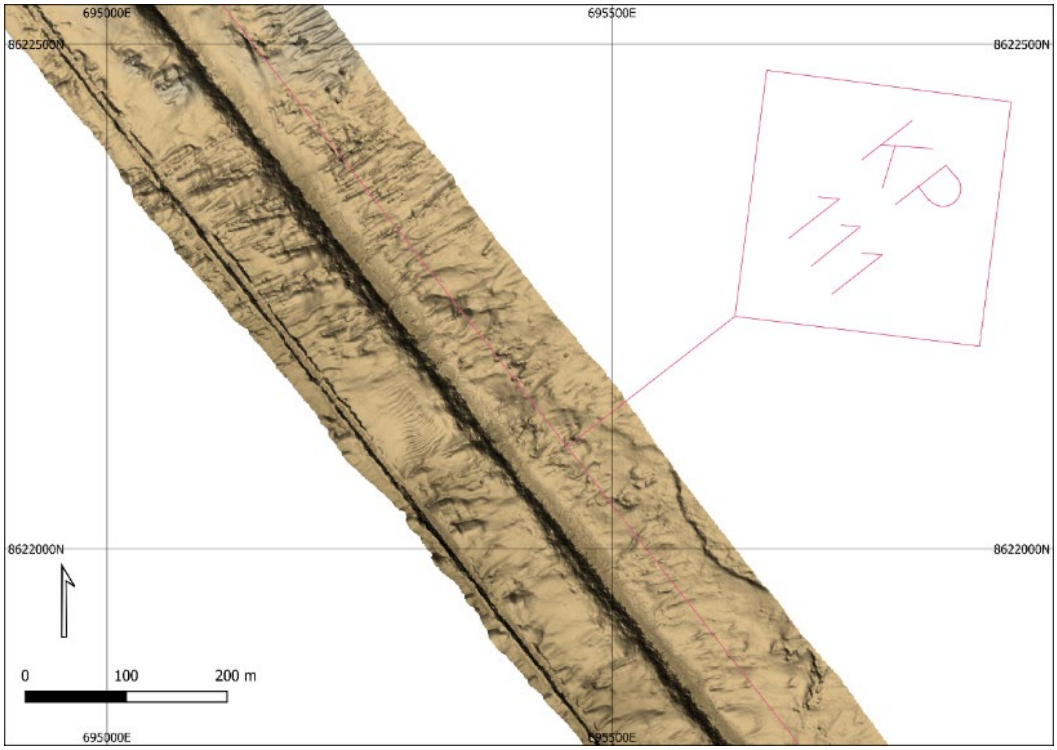


Figure 38: Example of MBES data provided at KP 111. Note INPEX GEP and Bayu-Undan pipeline clearly visible.

A second set of multi-beam data was provided 13 April 2022 as an XYZ data file. This second set of data was recorded by FUGRO in 2021 and is higher resolution (0.25m). The

second MBES data set covers roughly the last third of the proposed pipeline route, from approximately KP 87 to the terminus.

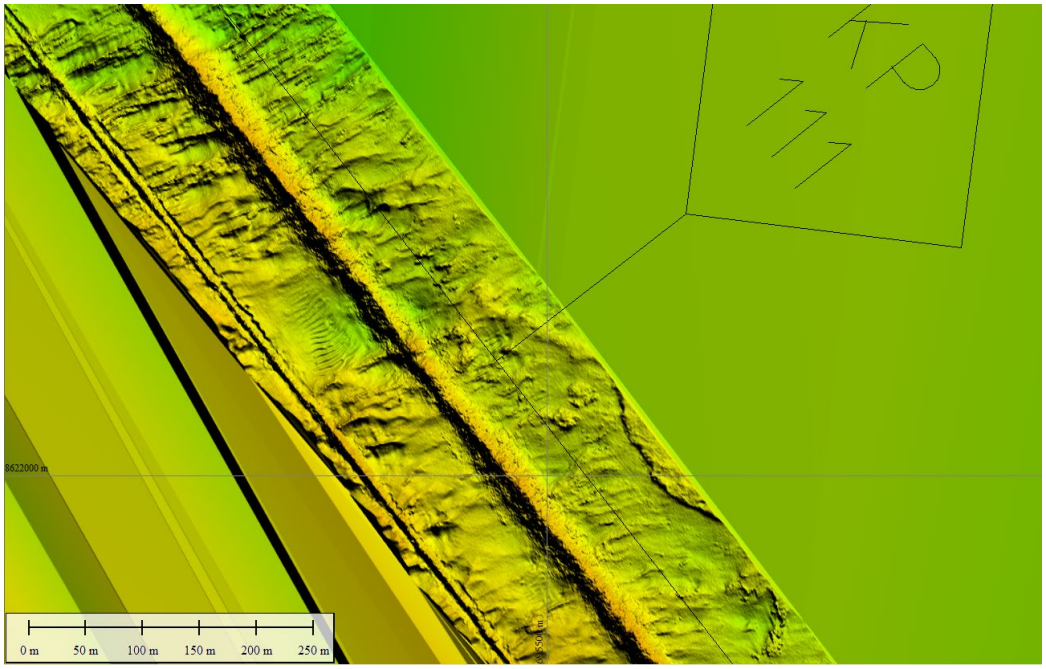


Figure 39: Example of 2022 MBES data with higher resolution (0.25m) in approximately the same location as previous figure.

The anchoring corridor for the proposed works, located between KP 91.5 and the terminus, is wider than the geophysical survey corridor. Therefore, public MBES data covering the entirety of Darwin Harbour was examined to identify underwater cultural heritage located in the area between the Fugro survey corridor and the anchoring corridor (see Figure 40 and Figure 41). This publicly available dataset is published by Geoscience Australia and consists of 1 m resolution gridded MBES data.[103]

[103] **Siwabessy, P.J.W., Smit, N., Nicholas, W.A., Nansen, R., Picard, K. 2020.** Data package – Darwin Harbour Habitat Mapping Program, Northern Territory. Geoscience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/127494.

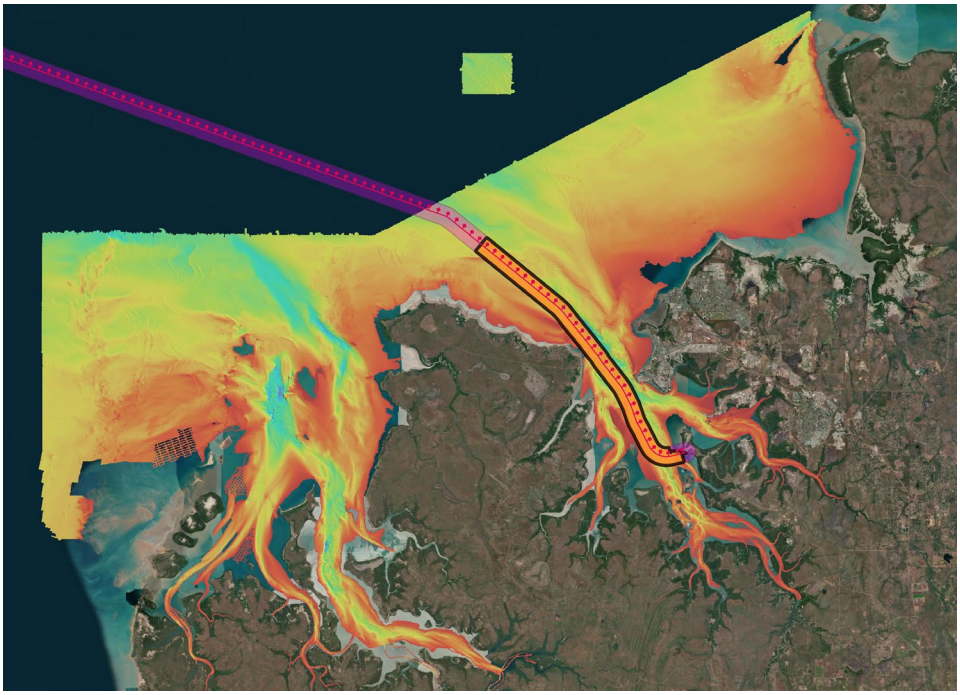


Figure 40: Overview of total coverage of public Darwin Harbour MBES data. Study area in purple, anchoring corridor in orange.

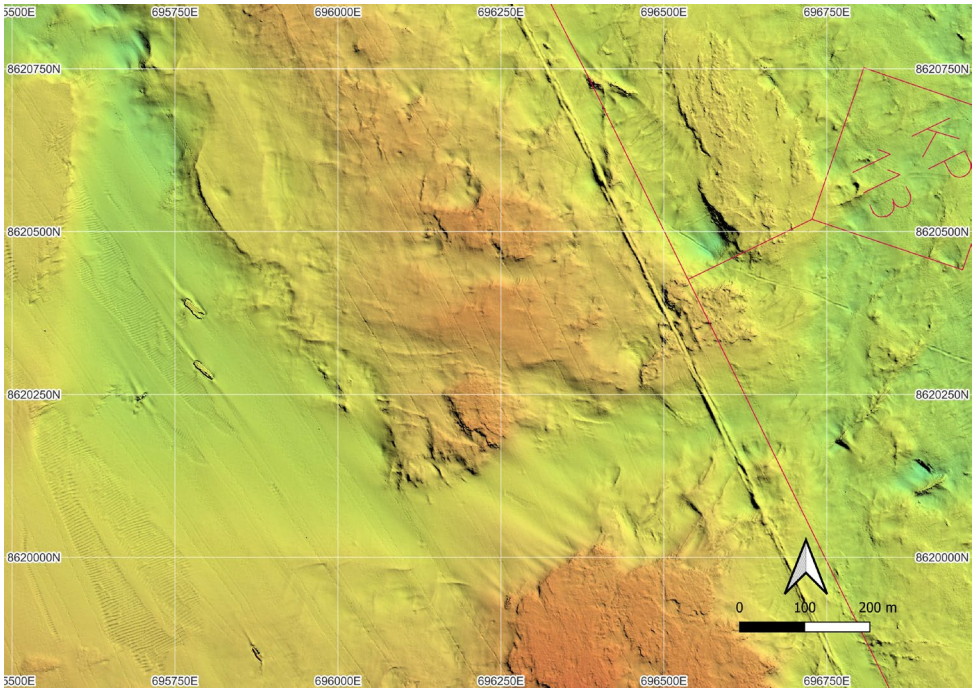


Figure 41: Detail of same dataset at KP 113, showing GEP route and several shipwrecks at left.

6.2.3 *Magnetometer*

Magnetometer data was collected from a single channel mag and provided as a shapefile of georeferenced points. Additionally, the same magnetic anomaly contacts were provided as part of a report delivered by FUGRO in April 2022 (see Table 8).[104]

Magnetometer data was collected using a SeaSpy magnetometer deployed behind the combined SSS/SBP system via an 11m long cable. Altitude of the magnetometer was approximately 1.5m lower than that of the SSS/SBP, and therefore achieved results at elevations less than ~10m above the seafloor.[105]

Due to the tow height and line spacing of the MAG survey, actual locations of magnetic contacts given are approximate and may not be located directly below survey lines. Their locations are proportional to the distance of the magnetic sensor to detected object. Therefore, actual magnetic contacts may be laterally offset to the magnetic survey lines.[106]

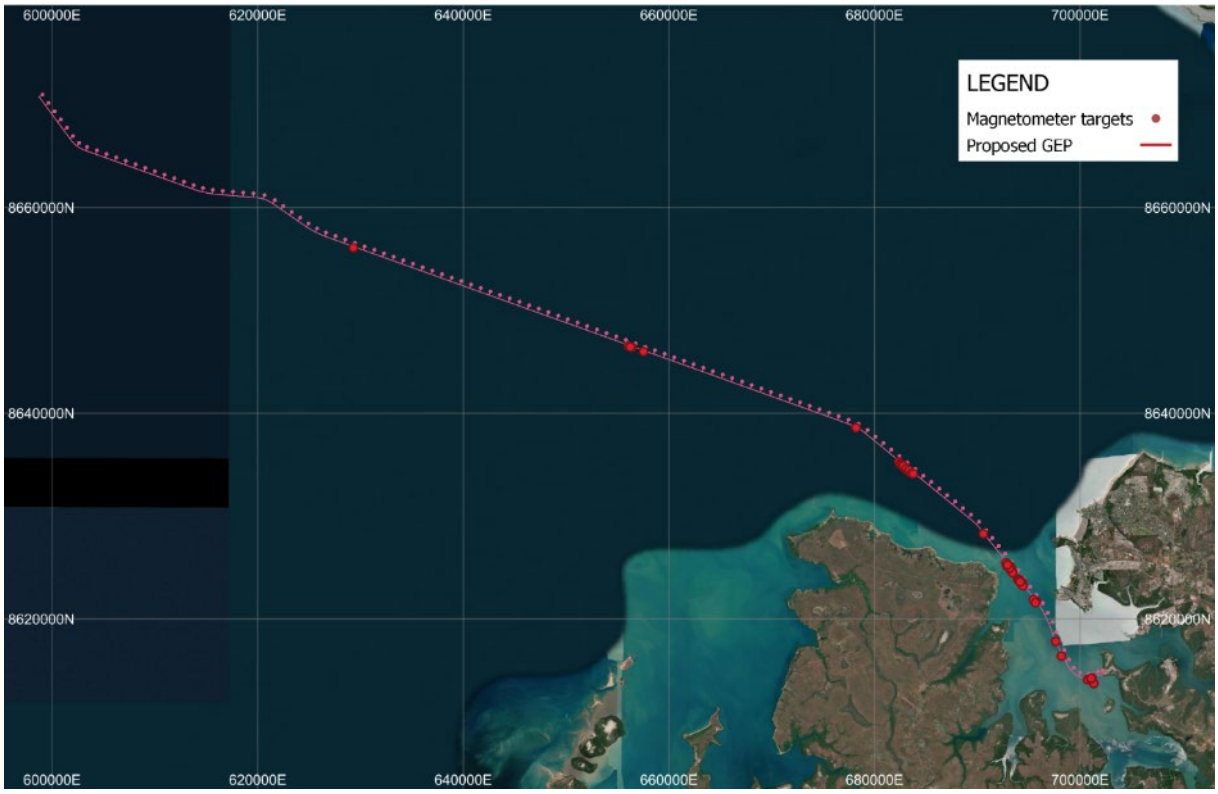


Figure 42: Locations of magnetometer targets provided by FUGRO survey.

Table 8: List of magnetometer strikes provided by FUGRO.

Contact ID	Easting	Northing	KP	Lateral Offset	Magnetic Intensity (nT)	Magnetic sensor altitude	Comments
MA_051	629 303.20	8 656 083.30	35.014	112.6	36.8	20	Bayu-Undan GEP
MA_038	682 530.80	8 635 126.40	92.524	93	225.7	13.5	Bayu-Undan GEP
MA_039	682 697.00	8 634 980.60	92.745	100.9	596.4	10.2	Bayu-Undan and Icthys GEPs
MA_040	682 824.80	8 634 880.90	92.907	97.3	168.3	15.2	Bayu-Undan GEP

[104] **FUGRO, 2022,** *Results Report – North Route 2 – Offshore Geophysical Survey (Work Package 1): Barossa Pipeline to Shore Project, Darwin,* report prepared for Santos NA Barossa Pty Ltd.
[105] *Op. Cit.* **FUGRO, 2022:**13.
[106] *Op. Cit.* **FUGRO, 2022:**14.

Contact ID	Easting	Northing	KP	Lateral Offset	Magnetic Intensity (nT)	Magnetic sensor altitude	Comments
MA_041	682 820.00	8 634 759.60	92.980	194.3	139.5	10.8	Icthys GEP
MA_042	683 109.80	8 634 510.30	93.362	204.3	47.1	16.2	Icthys GEP
MA_043	683 119.80	8 634 630.10	93.294	105.1	42.7	18.2	Bayu-Undan GEP
MA_044	683 371.80	8 634 440.50	93.609	92.7	182.1	12.3	Bayu-Undan GEP
MA_045	683 329.80	8 634 341.30	93.640	196.1	101.9	14	Ichthys GEP
MA_046	683 585.80	8 634 131.90	93.970	196.5	302.8	12	Ichthys GEP
MA_047	683 772.10	8 634 111.30	94.128	94.6	88.6	15	Bayu-Undan GEP
MA_048	656 411.80	8 646 395.20	63.802	96.3	22.4	6.2	Bayu-Undan GEP
MA_049	656 056.10	8 646 529.60	63.422	89.6	119.5	25.1	Bayu-Undan GEP
MA_050	656 258.10	8 646 432.00	63.645	113.4	31.7	16.3	Bayu-Undan GEP
MA_052	657 533.60	8 645 980.50	64.998	108.6	33.2	9.4	Bayu-Undan GEP
MA_053	678 201.60	8 638 571.20	86.966	94.3	16.3	25.7	Bayu-Undan GEP
MA_001	697 628.20	8 617 803.70	115.846	-35.3	13.3	14.2	Inferred Buried Debris
MA_002	693 037.60	8 625 230.40	107.042	36.3	33.6	19.4	Inferred Cable Infrastructure
MA_003	693 280.20	8 624 938.20	107.421	24	19.1	26.5	Inferred Cable
MA_004	694 088.70	8 623 805.80	108.816	34.2	23.8	29.2	Inferred Cable
MA_005	694 270.00	8 623 584.10	109.101	24.6	11.2	28.1	Inferred Cable
MA_006	694 340.30	8 623 487.70	109.22	28.3	53	27.7	Inferred Cable
MA_007	695 763.20	8 621 695.50	111.508	6.4	21.5	17.1	Inferred Buried Debris
MA_008	694 368.90	8 623 483.00	109.241	8.6	2.4	21.8	Inferred Cable
MA_009	694 288.70	8 623 586.70	109.11	8.2	10	22	Inferred Cable
MA_010	694 195.20	8 623 712.20	108.954	4.9	45.7	24.7	Inferred Cable
MA_011	693 259.90	8 625 000.50	107.36	1.8	10.1	19.6	Inferred Cable
MA_012	693 160.20	8 625 119.90	107.204	7.2	13.9	14.7	Inferred Buried Debris
MA_013	693 294.80	8 624 761.80	107.565	123.9	57.9	22	Inferred Buried Debris
MA_014	693 327.90	8 624 726.50	107.613	121.4	68.3	20.4	Inferred Buried Debris
MA_015	693 395.30	8 624 640.10	107.723	125.6	101.2	20.8	Inferred Buried Debris
MA_016	693 438.60	8 624 583.40	107.794	129.1	46.3	21.8	Inferred Buried Debris
MA_017	694 427.20	8 623 200.30	109.5	136.2	94.9	20.5	Inferred Cable
MA_018	694 230.10	8 623 485.50	109.154	116.6	33.1	21.9	Inferred Cable
MA_019	694 143.00	8 623 584.60	109.023	124.5	13.5	23.8	Inferred Cable
MA_020	694 041.00	8 623 720.90	108.857	122.3	19.2	23.6	Inferred Cable
MA_021	695 672.30	8 621 568.70	111.553	156	148.8	17.1	Inferred Buried Debris
MA_022	695 454.30	8 621 871.00	111.18	142.3	177.5	21.1	Inferred Buried Debris
MA_023	693 904.20	8 623 870.50	108.663	152.2	802.4	25.1	Inferred Buried Debris
MA_024	694 000.90	8 623 742.90	108.816	142.2	46.5	26.5	Inferred Cable
MA_025	693 425.00	8 624 481.80	107.863	205	137.4	10.1	Inferred Buried Debris
MA_026	693 264.60	8 624 703.70	107.59	184.4	66.8	18	Inferred Buried Debris
MA_027	692 796.90	8 625 441.70	106.727	96.7	936.1	18.6	Bayu-Undan GEP
MA_028	693 130.70	8 624 923.90	107.341	150.8	33.2	18.4	Inferred Cable
MA_029	694 058.20	8 623 721.40	108.864	108.1	30.9	27.2	Inferred Cable

Contact ID	Easting	Northing	KP	Lateral Offset	Magnetic Intensity (nT)	Magnetic sensor altitude	Comments
MA_030	694 165.40	8 623 591.30	109.031	102.7	6.6	25.8	Inferred Cable
MA_031	698 180.90	8 616 372.60	117.376	145.6	34.3	14.6	Inferred Buried Debris
MA_032	701 103.60	8 614 208.70	121.233	106.2	2.4	19.5	Bayu-Undan GEP
MA_033	700 725.60	8 614 092.30	120.866	172.1	16.4	14.5	Bayu-Undan GEP
MA_034	701 167.90	8 614 234.30	121.3	96.1	285.3	10.8	Bayu-Undan GEP
MA_035	701 039.40	8 614 186.30	121.169	115	330.6	16.4	Bayu-Undan GEP
MA_036	701 078.90	8 614 217.70	121.211	91.9	2.1	15.9	Bayu-Undan GEP
MA_037	701 335.50	8 613 704.20	121.335	650.9	32.1	18.3	Ichthys GEP
MA_054	692 947.20	8 625 244.60	106.975	98.9	58.7	5.3	Bayu-Undan GEP
MA_055	692 865.40	8 625 182.90	106.974	201.4	15.3	14.9	Ichthys GEP

6.3 Anomaly Identification

The following table shows the identified geophysical targets, arranged in their priority level for visual survey. The priority level is defined as:

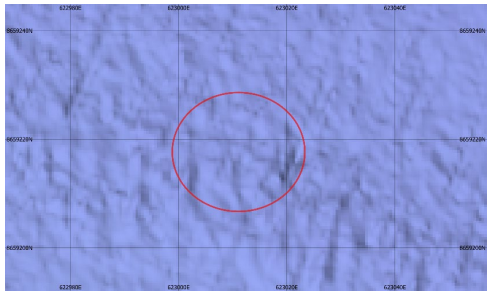
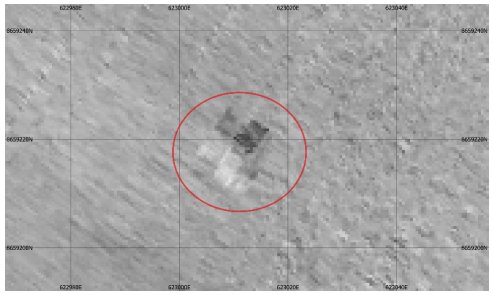
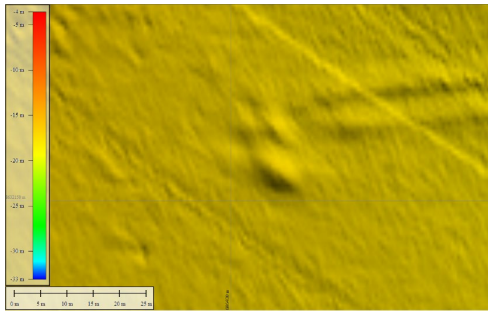
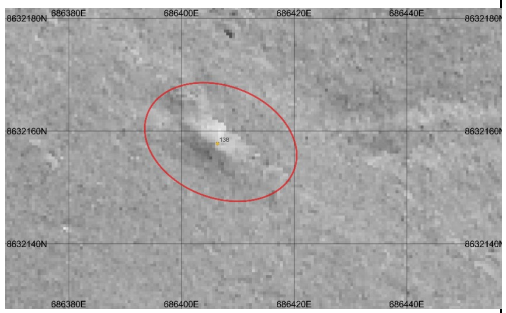
A = Primary – Identified as most likely cultural (unlikely but possibly natural), significance determined by dive survey or ROV

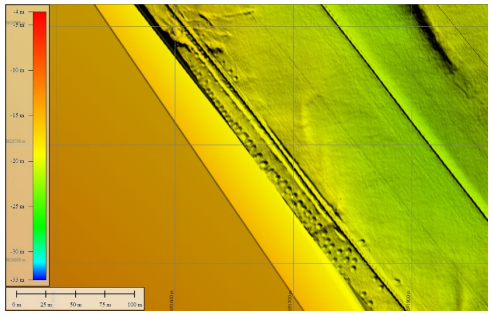
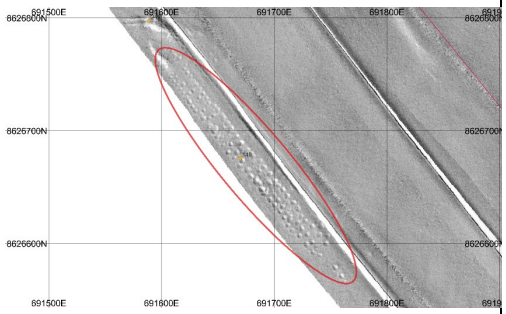
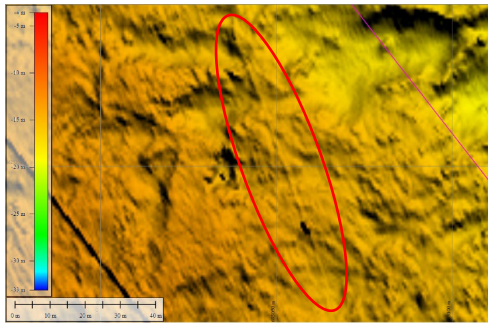
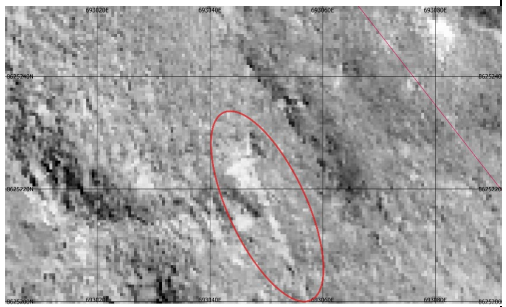
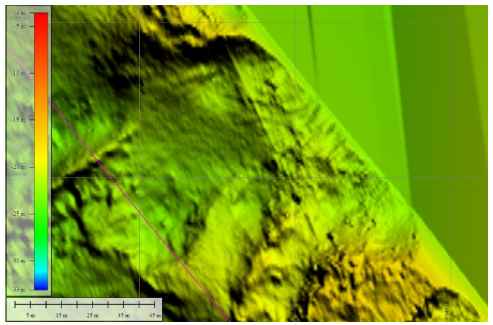
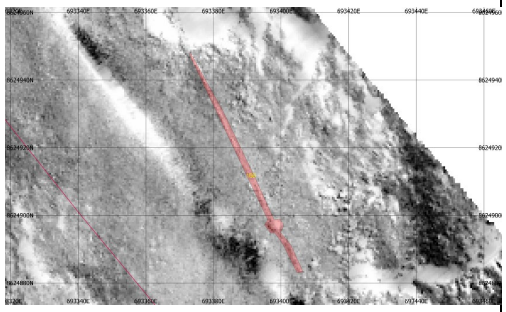
B = Secondary – Possibly cultural, possibly natural, significance determined by dive survey or ROV

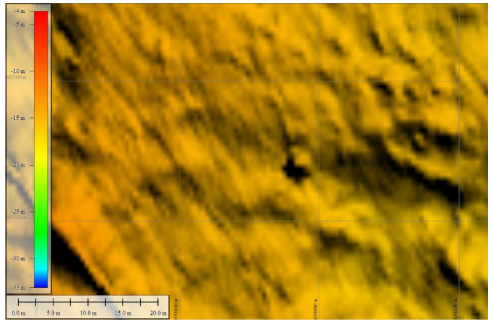
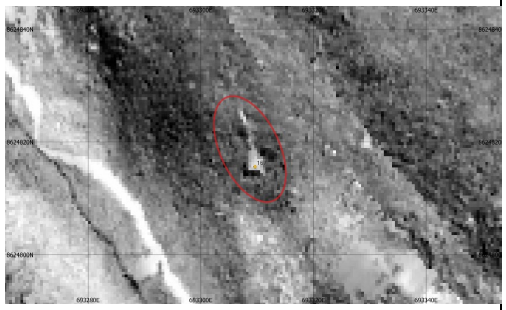
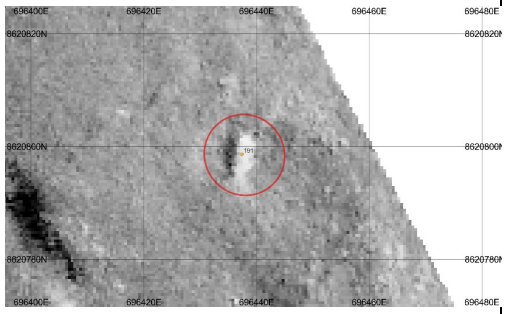
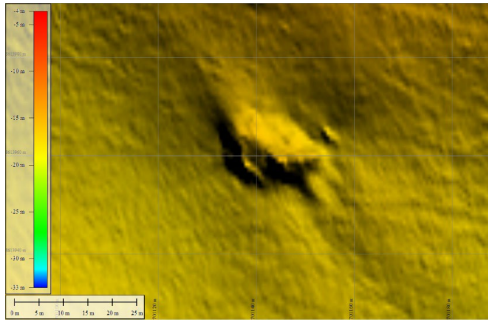
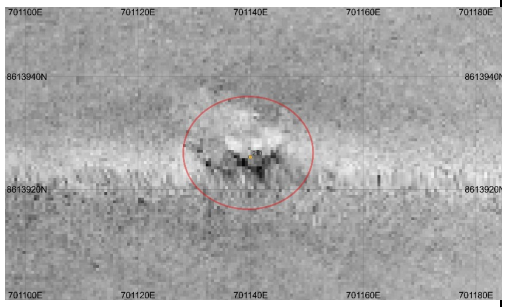
C = Low priority – Identified features determined to be not culturally significant

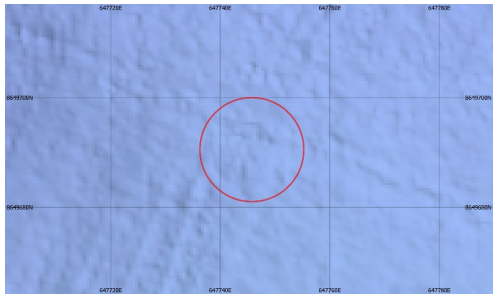
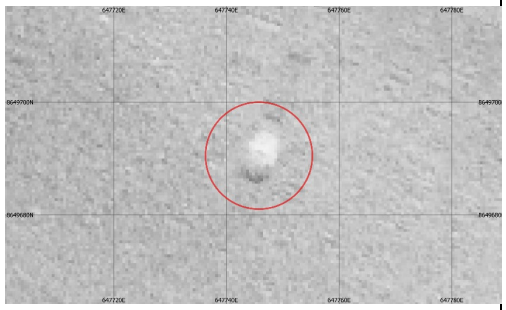
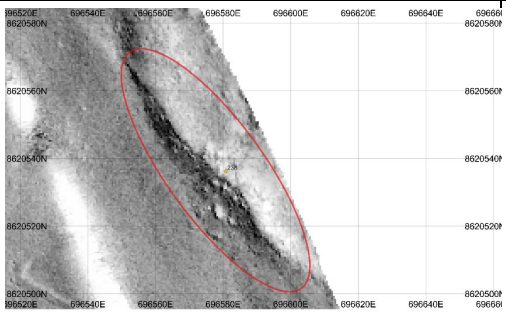
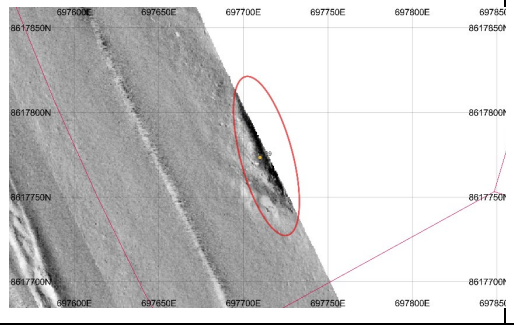
All images are oriented with north at the top. Where available, imagery from the 2022 MBES survey is used. Targets identified by CA are correlated with targets identified by FUGRO where appropriate. Targets surveyed during ROV surveys have IDs marked with *.

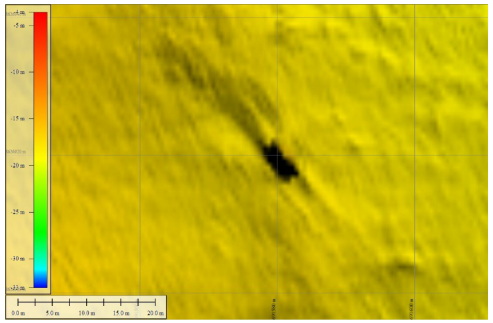
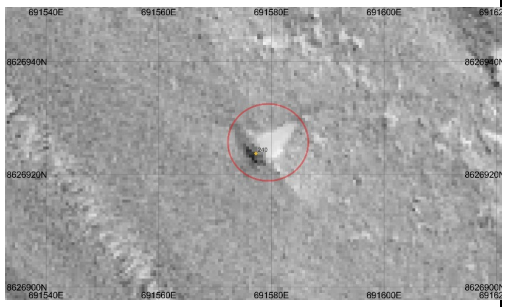
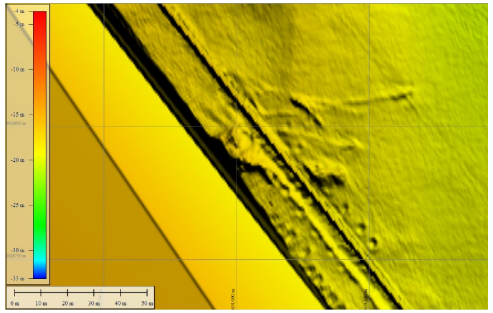
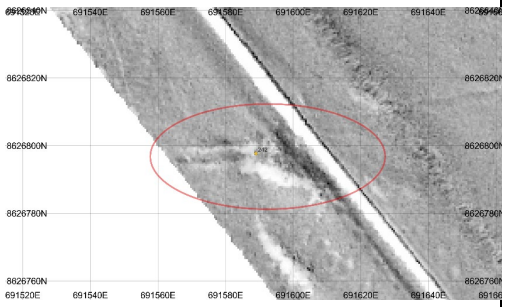
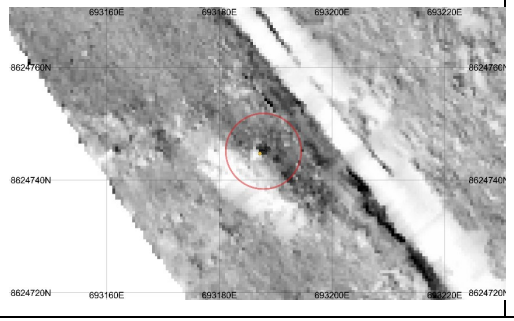
6.3.1 *Targets within survey corridor*

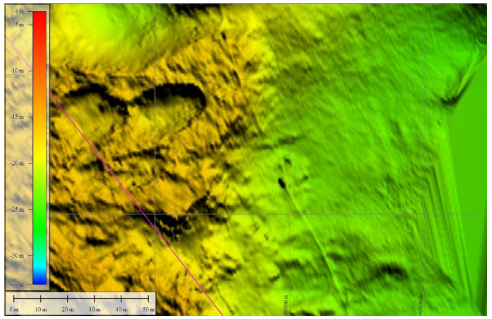
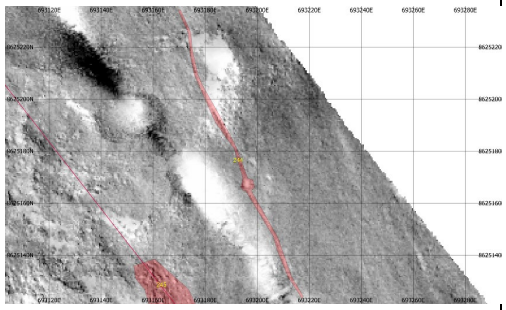
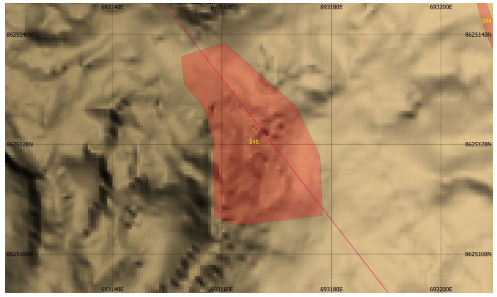
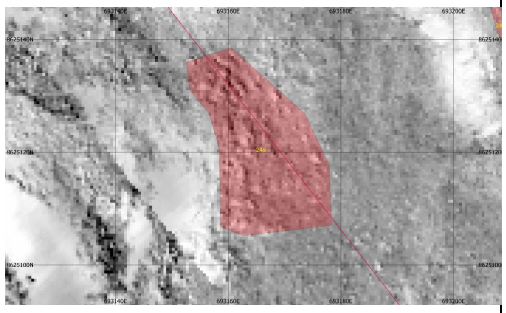
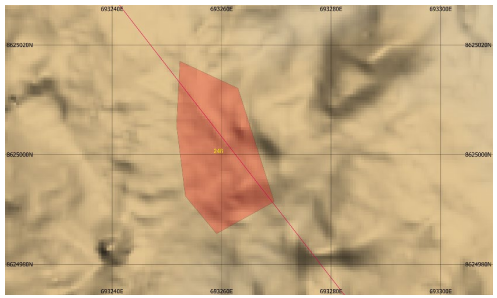
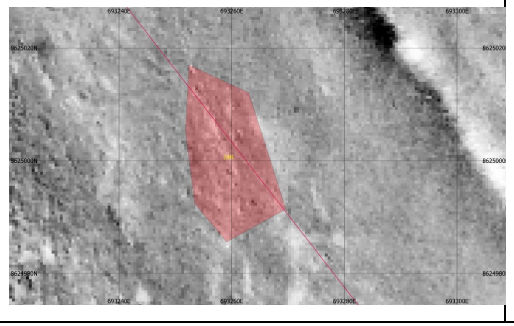
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	112	623 013.42	8 659 220.00			No	Single object of high relief. Possible debris related to I-124.	Length: 8m Width: 6m	46m	68m
A	138	686 407.37	8 632 159.33			No	Mound associated with anchor scars	Length: 13m Width: 16m	17m	59m

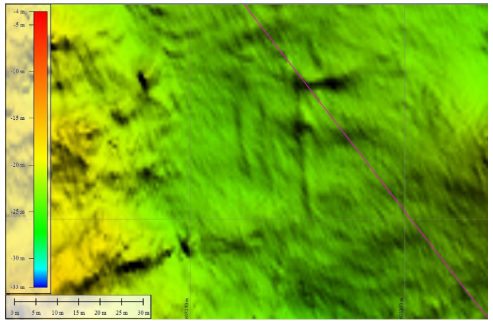
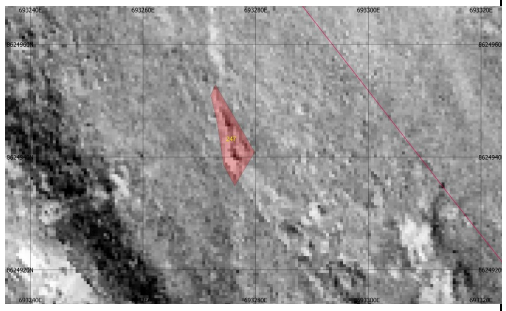
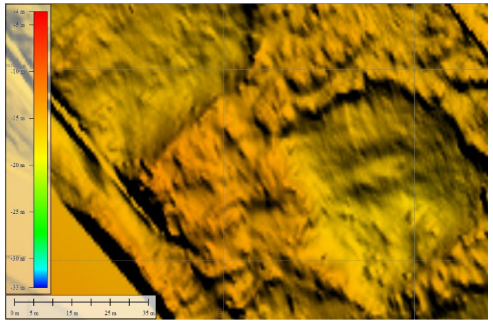
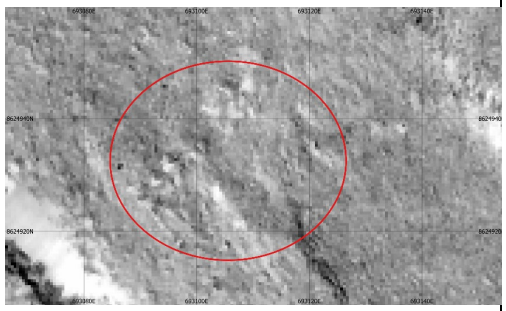
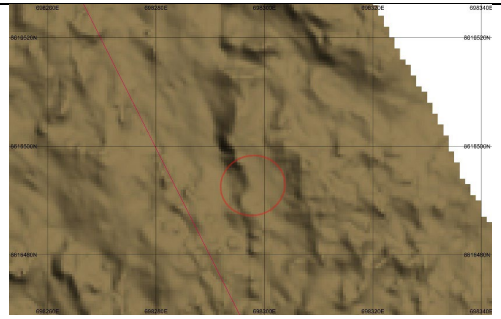
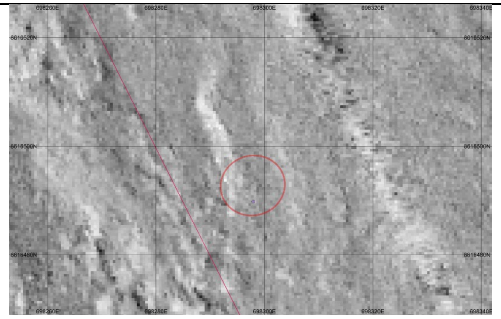
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	149	691 670.76	8 626 677.01			No	Unknown, may be related to pipeline or another cultural feature.	Total length: 258m Total Width: 19m Ind. Diameter: 5m	19m	200m
A	164*	693 038.56	8 625 231.53			Yes, MA_002	Possible 1879 subsea cable remains or anti-sub defences/ net. Likely connected to Target ID: 167 FUGRO ID: NCL_SC_026	Total length: 209m Width: 2m	16m	30m
A	166*	693 399.74	8 624 898.55			No	Series of high relief single objects with connecting line. Possible 1879 subsea cable remains or anti-sub defences. FUGRO ID: NCL_SC_017, 018, 019	Length: 73m Width: 5m	21m	41m

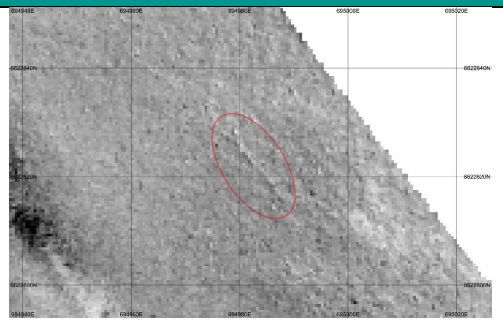
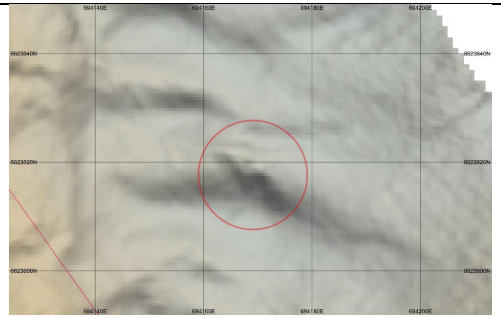
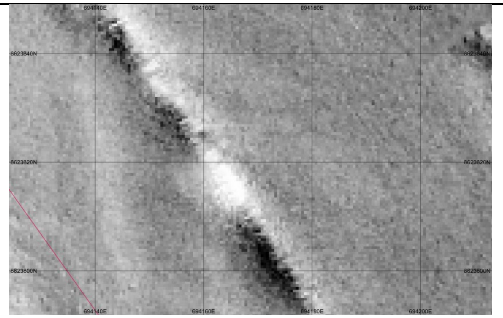
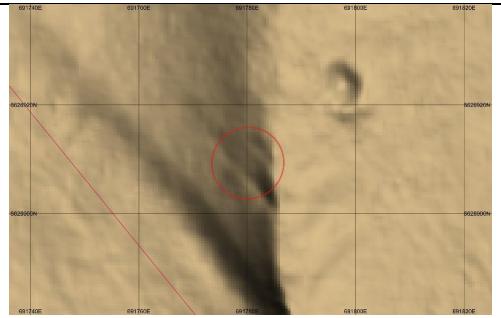
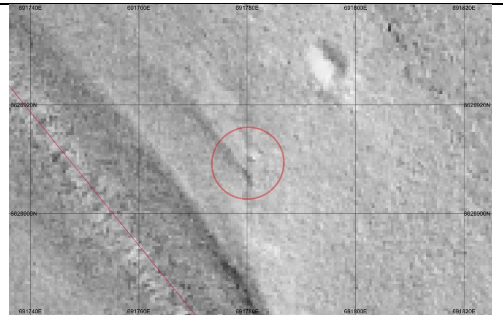
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	167*	693 085.69	8 625 121.75			No	Series of high relief single objects with connecting line. Possible 1879 subsea cable remains or anti-sub defences. Likely connected to Target ID: 164	Length: 3m Width: 3m	16m	76m
A	191	696 438.36	8 620 800.13	N/A		No	Single object of high relief. Possible small boat.	Length: 8m Width: 3m	19m	73m
A	210	701 140.90	8 613 958.61			No	Possible aircraft wreck or natural feature.	Length: 12m Width: 7m	17m	389m

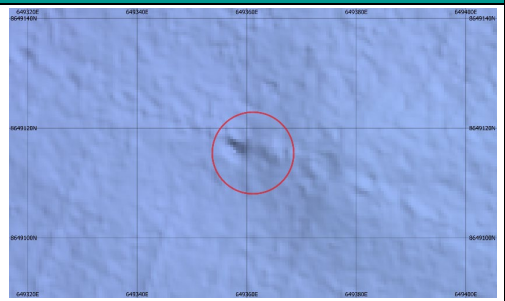
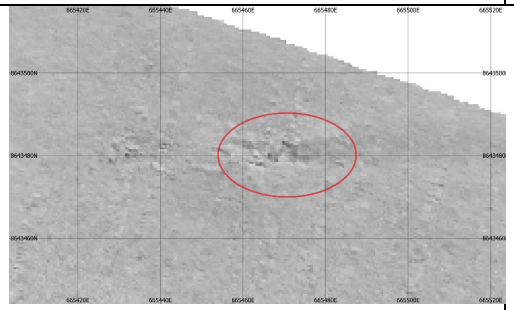
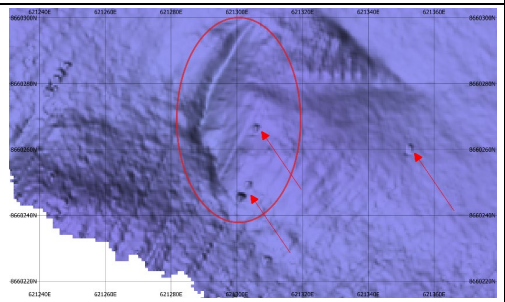
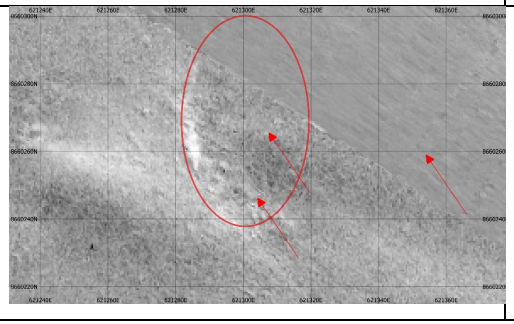
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	234	647 746.21	8 649 692.16			No	Single mound, indicating lone discarded object.	Length: 5m Width: 4m	43m	173m
A	238	696 581.70	8 620 537.67	N/A		No	Possible scattered debris.	Length: 70m Width: 10m	21m	78m
A	239	697 710.77	8 617 774.90	N/A		Yes, MA_001	USAT *Mauna Loa*	Length: 124.97m Width: 16.46m	19m	90m

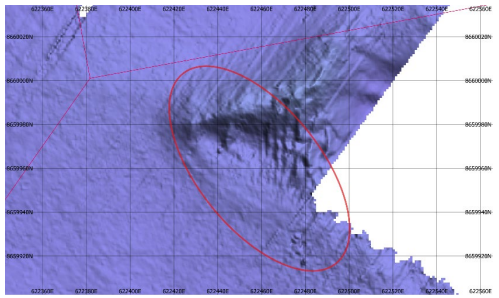
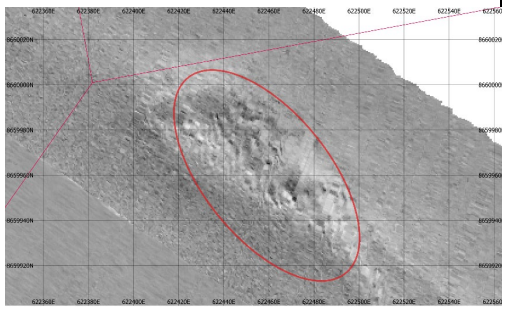
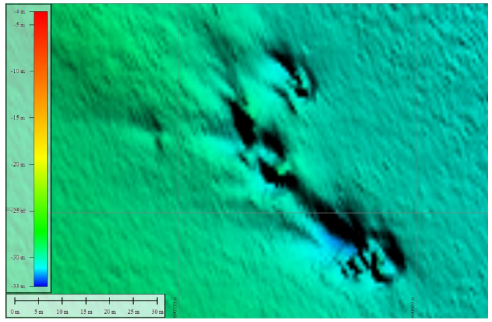
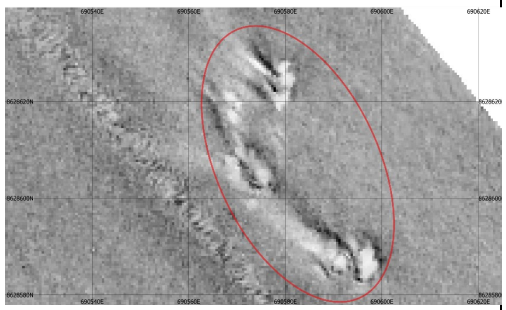
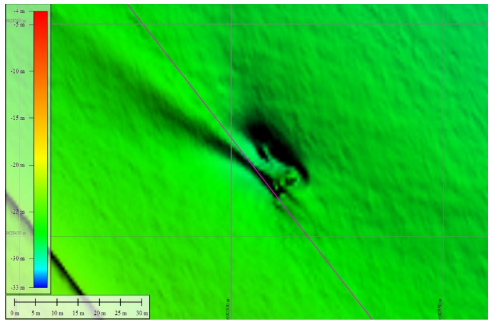
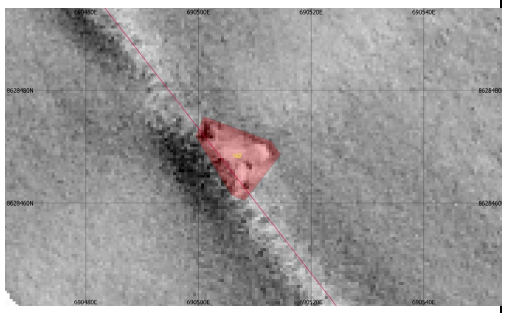
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	240	691 578.22	8 626 925.25			No	Possible mooring block for anti-submarine defences	Length: 4m Width: 2m	16m	122m
A	242	691 589.94	8 626 799.20			No	Steel wire rope and chain associated with anti-submarine defences. (boom net), UXO including mechanical fuses and fuse cones. (See Section 6.4)	Length: 23m Width: 13m	17m	186m
A	243	693 188.00	8 624 746.00	N/A		No	Possible mooring block related to anti-submarine defences.	Length: 2m Width: 2m	15m	216m

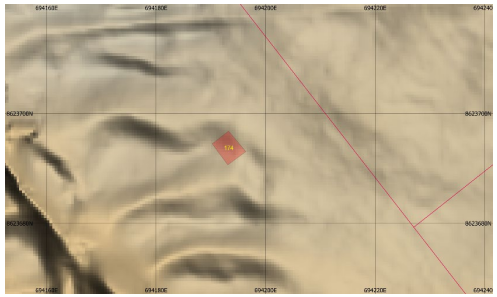
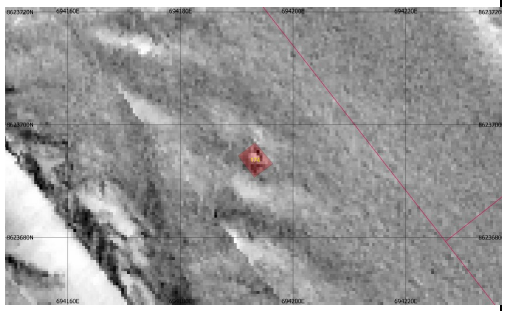
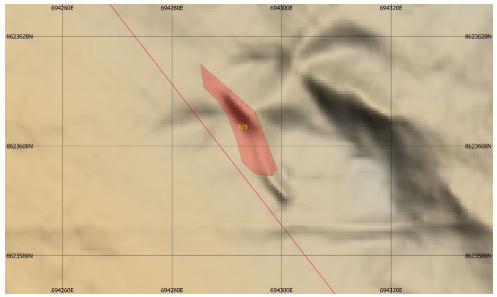
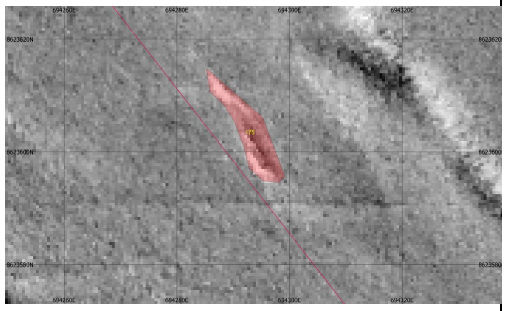
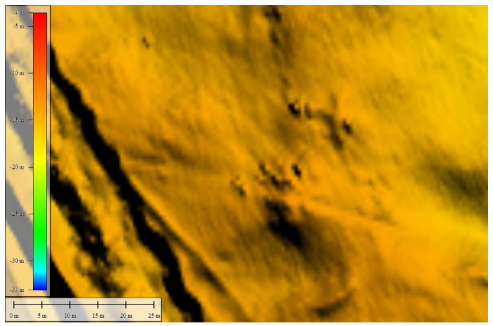
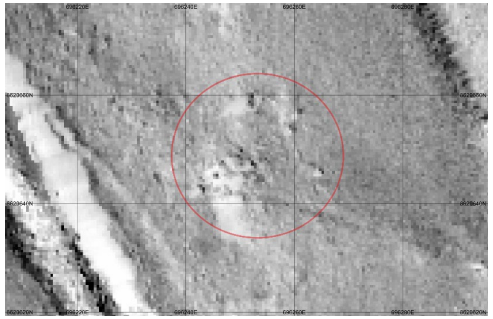
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	244*	693 196.00	8 625 167.00			No	Series of high relief single objects with connecting line. Possible 1879 subsea cable remains or anti-sub defences. FUGRO ID: NCL_SC_022, 023, 024, 025	Total Length: 120m Width: 5m (at arrow)	22m	50m
C	245*	693 161.00	8 625 121.00			Yes, MA_012	Rocks	Length: 38m Width: 22m	16m	0m
C	246*	693 260.86	8 625 002.53			Yes, MA_011	Boulders FUGRO ID: NCL_SC_021	Length: 31m Width: 15m	23m	0m

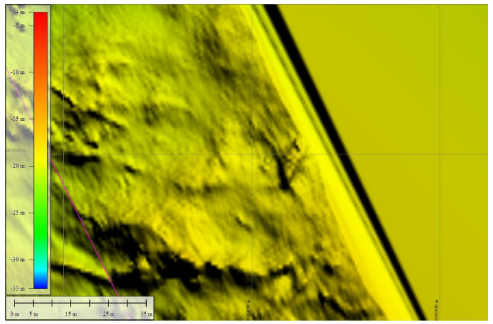
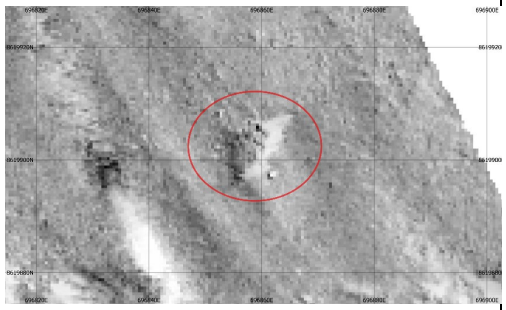
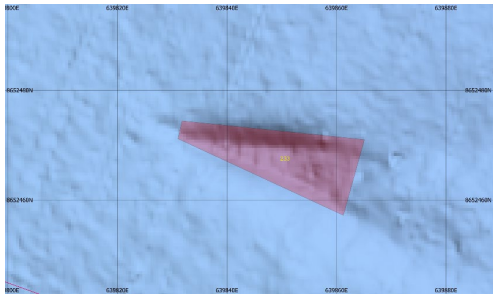
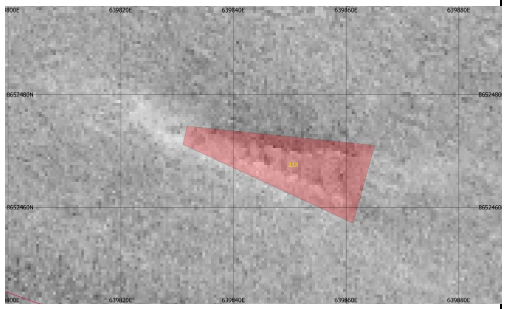
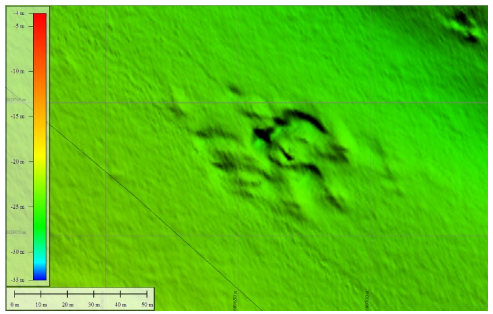
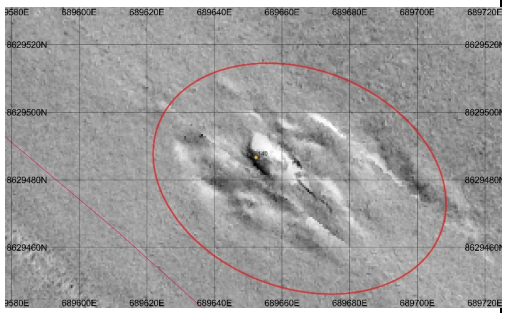
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	247*	693 281.16	8 624 939.53			Yes, MA_003	No cultural material found	Length: 18m Width: 6m	23m	23m
A	248	693 131.66	8 624 925.53			Yes, MA_028	Debris scatter, or possible anti-submarine net remains	Length: var. Width: var.	16m	150m
B	NCL_SC_002*	698 297.94	8 616 489.78			No	Single isolated object, possible debris or natural feature	Length: 1m Width: 0.4m	17m	11m

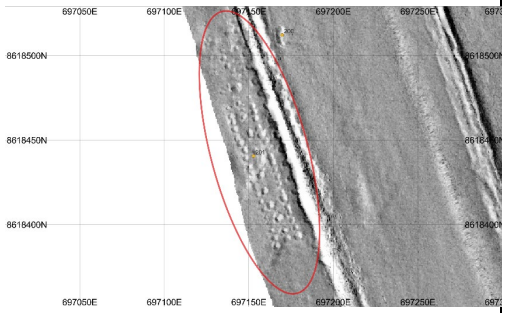
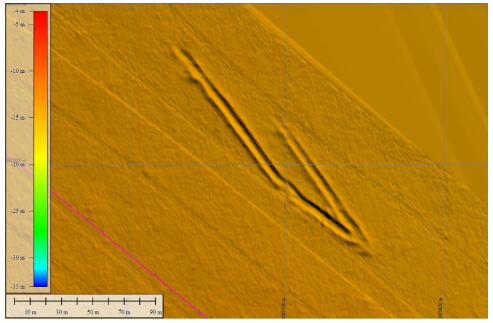
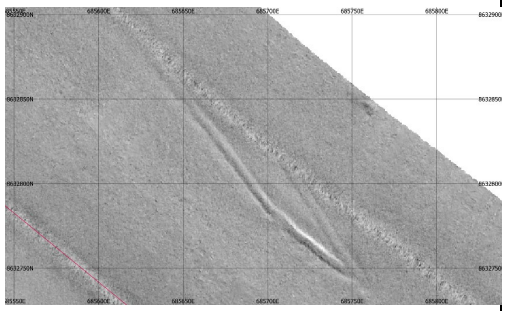
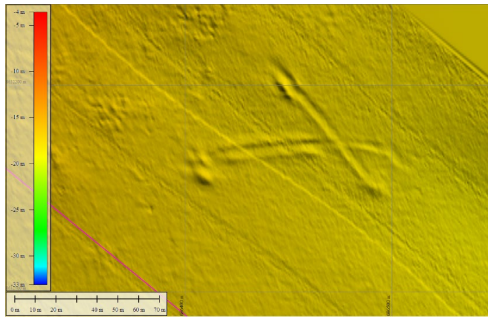
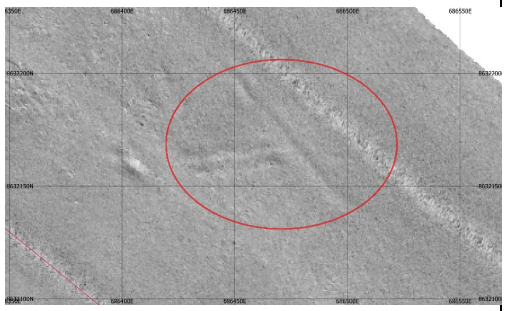
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
B	NCL_SC_010	694 982.00	8 622 822.59	N/A		No	Linear debris, likely cable remains.	Length: 17m Width: 0.5m	20m	70m
B	NCL_SC_016*	694 168.64	8 623 820.49			No	Possible cable support, or isolated non-ferrous object.	Length: 3.5m Width: 1.6m	24m	40m
B	NCL_SC_031*	691 780.61	8 626 909.95			No	Single isolated non-ferrous object, likely debris.	Length: 1.4m Width: 0.7m	16m	26m

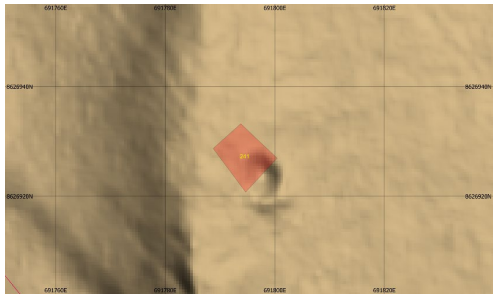
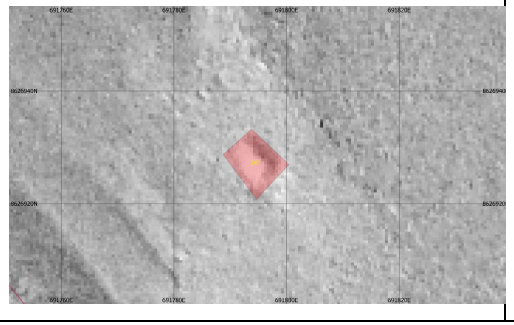
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
B	115	649 361.40	8 649 116.46			No	Shallow depressions with low relief object.	Length: 8m Width: 4m	44m	86m
B	130	665 465.07	8 643 481.67	N/A		No	Possible debris scatter.	Length: 18m Width: 8m	29m	208m
B	135	621 286.34	8 660 259.37			No	Likely natural feature, closest proximity target to I-124	Length: 62m Width: 58m	48m	143m

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
B	136	622 455.26	8 659 969.89			No	Possible debris scatter or natural feature.	Length: 98m Width: 32m	49m	214m
B	141	690 574.96	8 628 606.67			No	Debris or rocks FUGRO ID: NCL_SC_043, 044, 045, 046	Length: 53m Width: 20m	30m	137m
C	142*	690 511.00	8 628 469.00			No	Boulders FUGRO ID: NCL_SC_042	Length: 15m Width: 12m	29m	0m

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
A	174*	694 194.43	8 623 696.01			Possibly associated with MA_010	Windlass or winch from vessel with rope FUGRO ID: NCL_SC_013	Length: 5m Width: 4m	24m	16m
C	175*	694 295.02	8 623 601.00			Possibly associated with MA_009	Natural ridge	Length: 24m Width: 5m	24m	2m
B	192	696 253.89	8 620 643.48			No	Possible debris	Length: 24m Width: 22m	14m	147m

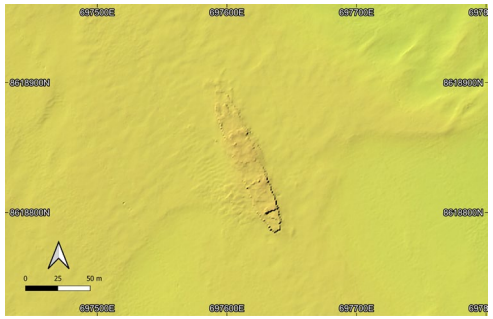
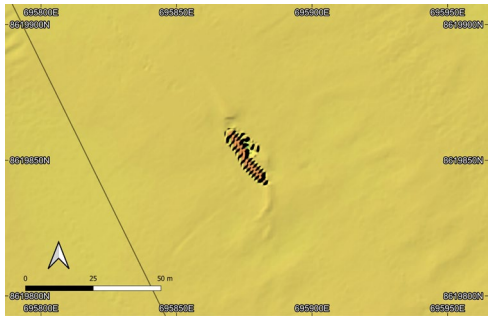
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
B	196	696 859.94	8 619 902.39			No	Debris or rocks	Length: 9m Width: 6m	19m	53m
B	233*	639 844.98	8 652 470.81			No	Triangular depression, Likely natural feature.	Length: 39m Width: 8m	41m	34m
C	140	689 653.25	8 629 488.15			No	Darwin Harbour Lateral Buoy 5 mooring FUGRO ID: NCL_SC_047, 050	Length: 89m Width: 42m	24m	28m

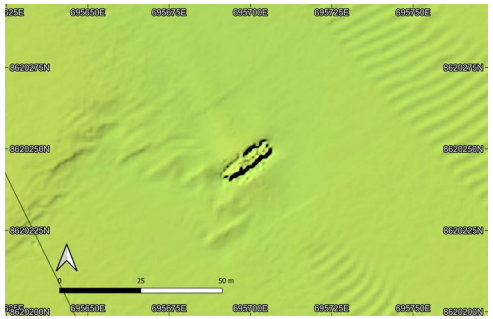
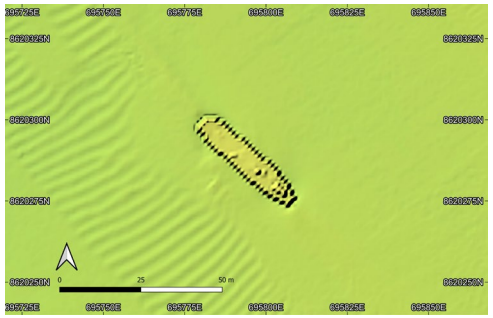
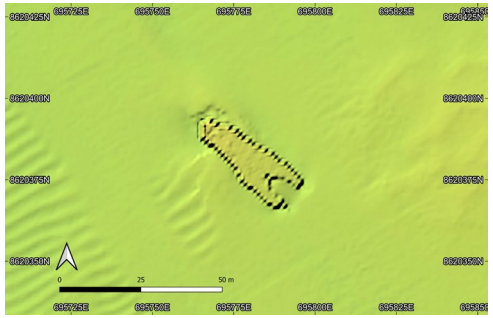
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
C	201	697 153.77	8 618 442.04	N/A		No	Spud marks from BU pipeline construction	Total length: 129m Total Width: 19m Ind. Diameter: 4m	16m	188m
C	235	685 698.53	8 632 788.44			No	Anchor drag	Length: 170m Width: 6m	14m	95m
C	236	686 460.34	8 632 164.86			No	Anchor drag	Length: 89m Width: 7m	18m	72m

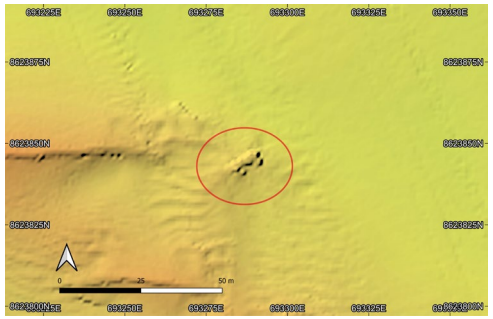
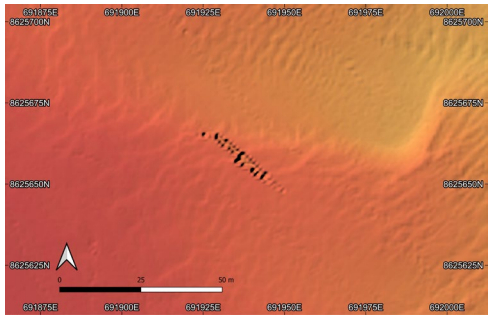
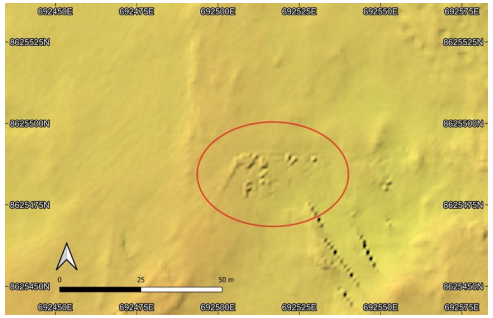
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Image SSS	Mag Target	Interpretation	Dimensions	Depth	Distance from pipeline
		Easting	Northing							
C	241*	691 796.25	8 626 930.15			No	Depression on seabed, possibly cultural, anchor drag. FUGRO ID: NCL_SC_032	Length: 9m Width: 8m	20m	46m

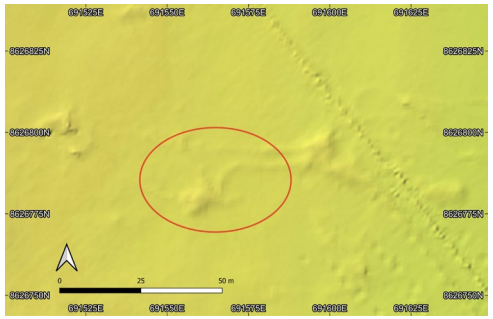
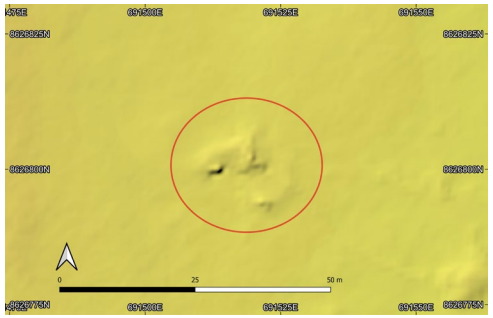
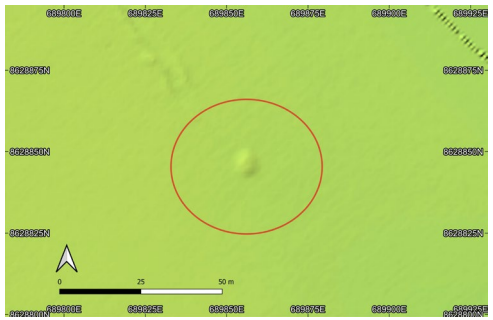
6.3.2 *Targets within anchoring corridor*

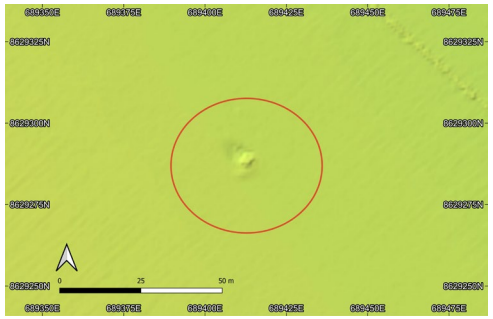
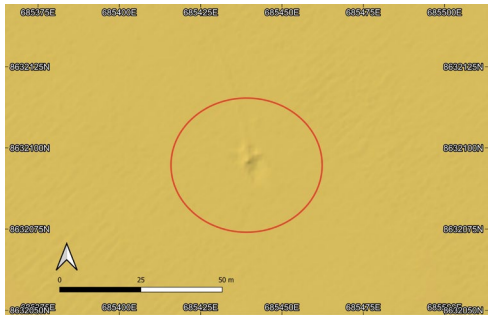
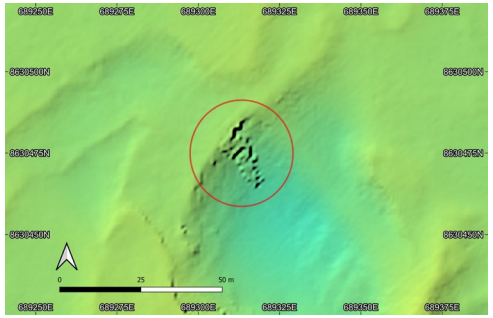
Table 9: Targets within anchoring corridor identified from Darwin Harbour public MBES data.

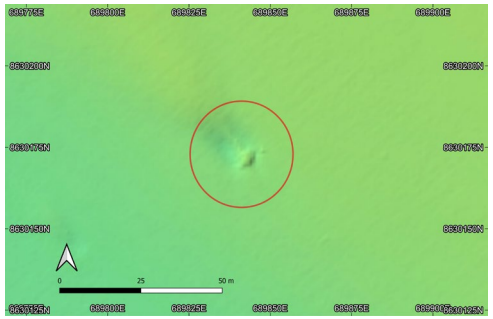
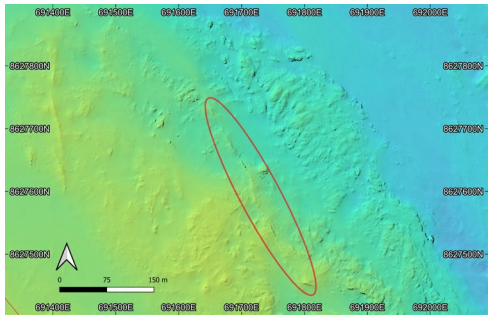
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	500	697,615.17	8,618,840.23		USAT Meigs	121.00	20.00	3.30	20	369
A	501	695,875.84	8,619,850.01		Medkhanun 3	25.00	8.00	7.00	19	847

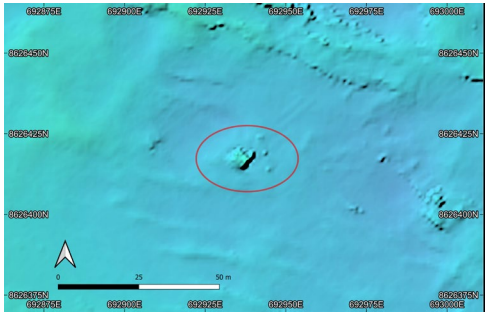
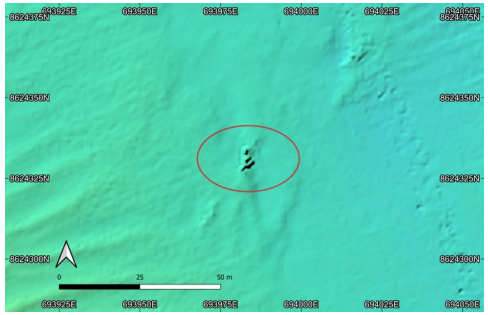
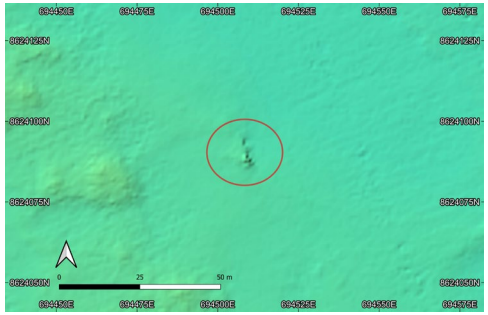
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	502	695,698.81	8,620,246.53		Ham Luong	18.00	5.00	3.00	25	832
A	503	695,794.02	8,620,287.72		Song Saigon	40.00	10.00	5.00	24	728
A	504	695,778.93	8,620,381.31		John Holland Barge	38.00	15.00	5.00	25	700

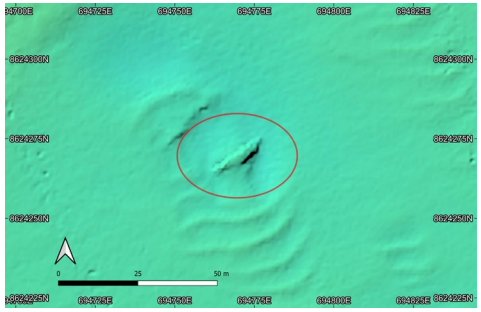
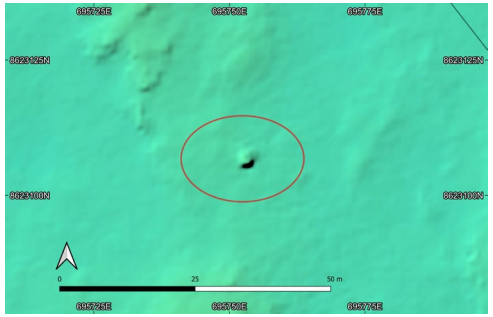
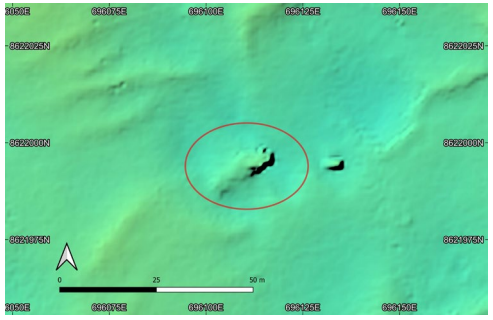
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	505	693,287.42	8,623,844.84		Mandorah Queen	12.00	5.00	2.00	20	683
A	506	691,938.35	8,625,657.51		NR Diemen	29.00	5.00	0.00	8	642
A	573	692,508.78	8,625,489.01		Debris	26.00	15.00	0.50	17	295

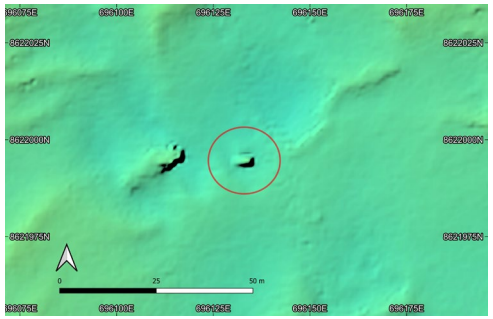
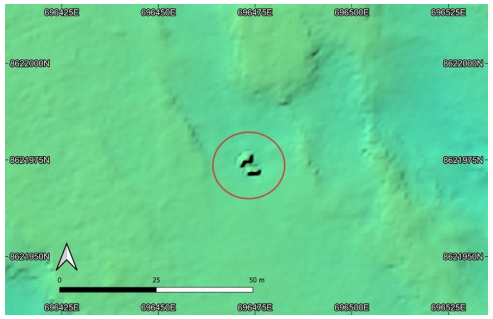
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	574	691,574.41	8,626,791.47		WWII anti-sub boom net	41.00	21.00	1.00	21	209
A	575	691,518.71	8,626,801.77		Debris	10.00	6.00	0.75	20	245
B	576	689,856.12	8,628,847.08		Mound	7.00	6.50	0.40	25	268

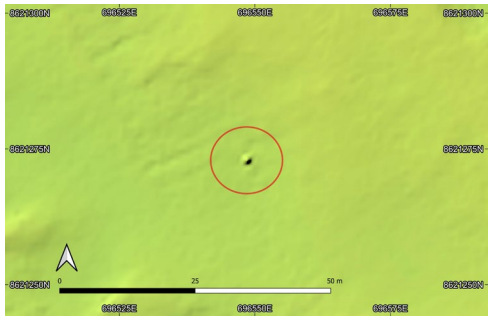
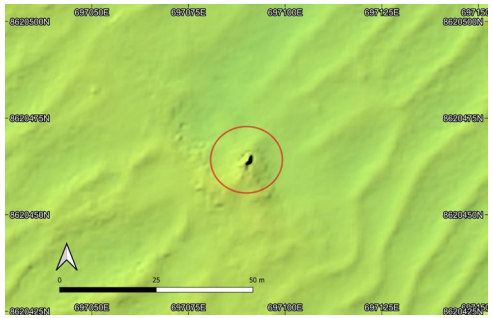
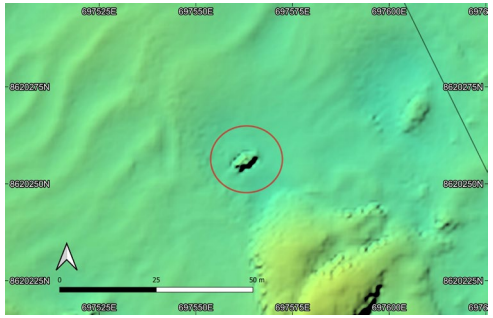
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	577	689,412.76	8,629,288.62		Isolated object	4.00	4.50	0.50	24	263
B	578	685,439.11	8,632,096.37		Mound associated with trawl scar	8.00	4.50	0.40	17	603
A	579	689,314.84	8,630,473.13		Debris	20.00	9.00	1.30	31	592

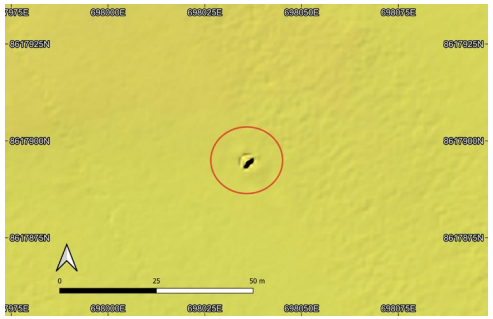
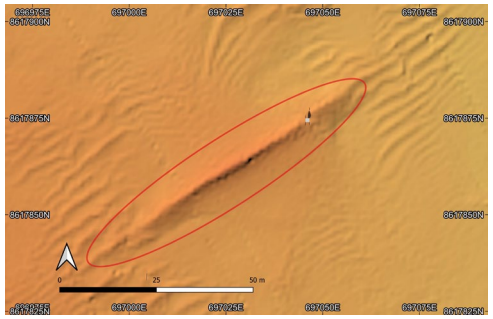
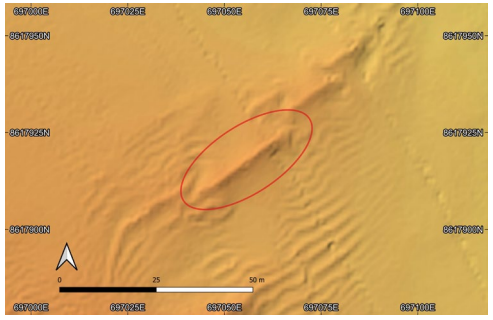
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	580	689,842.70	8,630,171.05		Mound	5.00	4.00	1.50	30	691
A	581	691,692.88	8,627,659.36		Possible cable	312.00	2.50	1.40	31	431
A	583	692,918.80	8,626,550.93		Linear debris	11.00	2.00	1.50	39	682

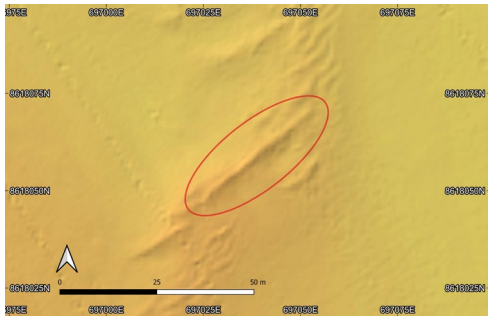
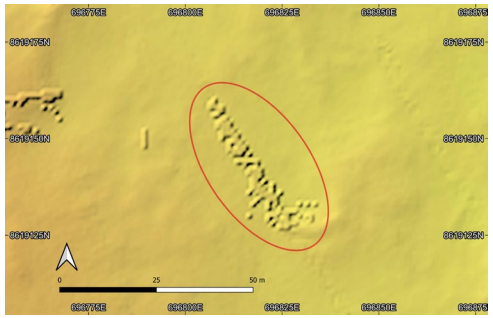
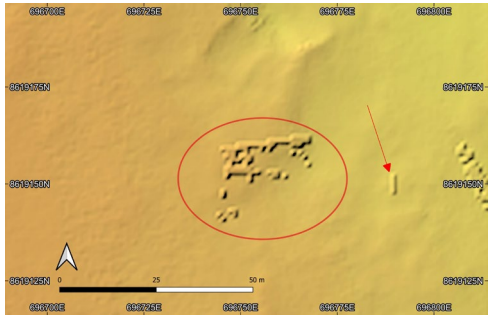
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	584	692,936.90	8,626,417.56		Debris or boulder	7.00	6.00	3.50	39	613
A	588	693,982.49	8,624,331.38		Debris	8.00	4.00	2.50	35	165
A	585	694,508.35	8,624,088.70		Debris	9.00	3.00	0.50	32	472

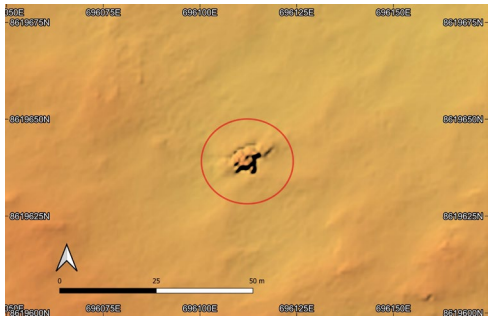
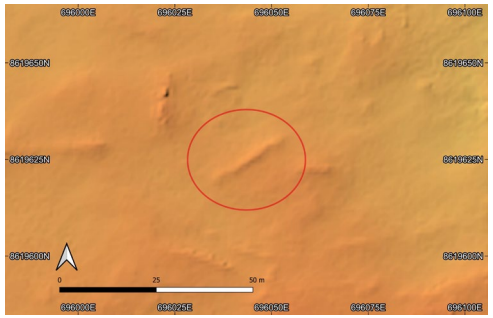
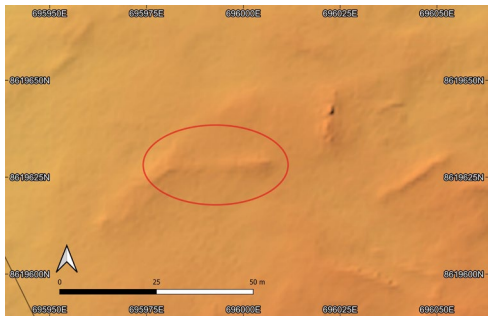
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	586	694,770.88	8,624,269.65		Possible small boat or natural feature	17.00	4.00	1.25	35	791
A	587	695,753.15	8,623,106.77		Mooring block	3.00	2.50	0.80	33	852
A	589	696,110.51	8,621,995.74		Debris	17.00	7.00	2.50	33	452

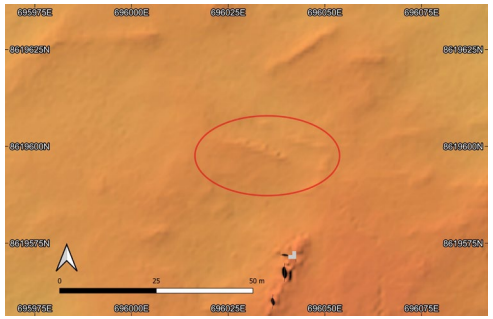
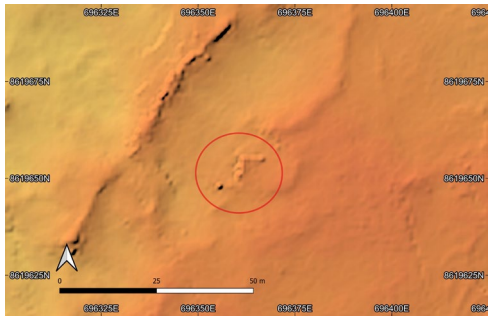
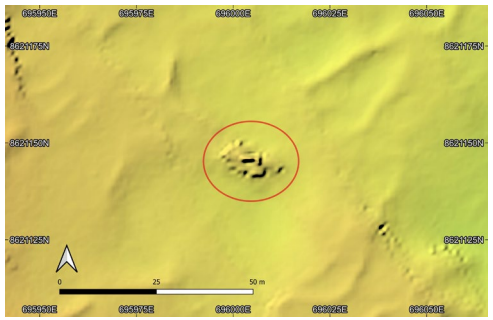
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	590	696,133.59	8,621,994.69		Debris	4.50	2.50	2.00	33	470
A	591	696,472.78	8,621,975.02		Debris	6.40	6.20	1.50	32	727
A	592	696,535.45	8,621,187.11		Debris	8.50	2.70	1.30	25	345

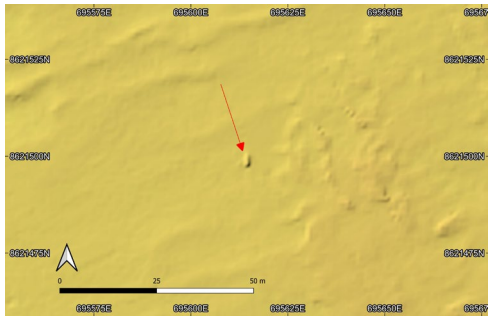
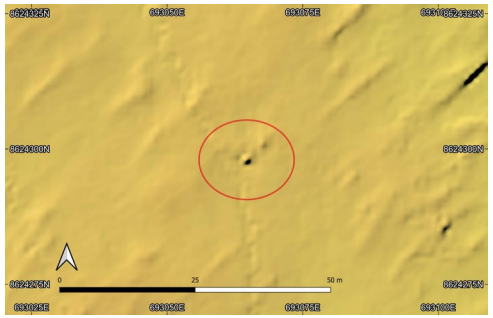
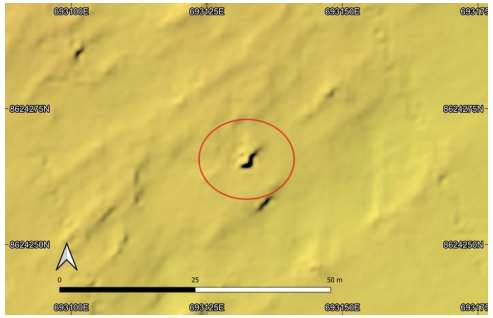
Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	593	696,548.46	8,621,272.90		Mooring block	1.40	1.40	0.75	25	399
A	594	697,090.00	8,620,464.24		Debris	3.50	3.00	1.75	25	513
A	595	697,563.09	8,620,256.32		Debris	6.50	4.20	1.75	32	845

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	597	698,035.82	8,617,894.98		Debris	3.00	3.00	2.00	20	443
B	598	697,030.36	8,617,864.23		Linear feature	59.00	2.00	0.75	12	504
B	599	697,055.70	8,617,918.12		Linear feature	24.00	2.00	0.75	13	462

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	600	697,036.34	8,618,057.64		Linear feature	33.00	2.00	1.00	16	434
A	601	696,815.85	8,619,144.52		Debris	40.00	8.00	0.50	19	286
A	602	696,751.52	8,619,156.36		Debris	24.00	11.00	0.75	16	343

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
A	603	696,112.03	8,619,639.40		Debris	8.00	6.60	3.00	14	729
B	604	696,043.52	8,619,624.92		Linear feature, log	18.70	2.40	1.00	13	797
B	605	696,000.91	8,619,629.09		Linear feature, log	15.80	2.40	0.50	13	833

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	606	696,032.94	8,619,598.74		Linear feature, log	13.00	2.40	0.75	13	818
B	607	696,362.60	8,619,654.65		Debris	7.00	6.50	1.00	12	497
A	609	696,003.49	8,621,145.27		Debris	16.00	7.50	3.00	21	132

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Image MB	Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing			Length	Width	Height		
B	610	695,614.51	8,621,498.95		Isolated object	3.30	1.50	0.60	18	244
A	611	693,064.64	8,624,298.00		Mooring block	1.70	1.70	0.50	17	599
A	612	693,132.32	8,624,265.69		Debris	3.00	2.50	0.90	18	568

6.3.3 *WWII anti-submarine net moorings*

Targets located between KP 107 and 108 have been identified as the remains of World War II anti-submarine net moorings. Targets listed in Table 10 omit geophysical survey images, as well as target dimensions, because all targets are highly uniform in size and shape.

Table 10: Location of potential WWII anti-submarine boom net moorings, identified from Fugro survey data and Darwin Harbour public MBES data.

ID		Datum: GDA94 CRM: UTM Zone 52S		Distance from GEP (m)
		Easting	Northing	
A	620	692,571.44	8,624,809.47	663
A	621	692,539.74	8,624,860.74	656
A	622	692,523.80	8,624,892.44	649
A	623	692,599.70	8,624,754.58	674
A	624	692,709.75	8,624,594.89	685
A	625	692,769.99	8,624,467.63	716
A	626	692,749.61	8,624,525.87	696
A	627	692,726.33	8,624,548.70	700
A	628	692,147.90	8,624,971.06	898
A	629	692,431.95	8,624,717.81	829
A	630	692,412.02	8,624,771.61	812
A	631	692,453.33	8,624,625.24	869
A	632	692,922.97	8,624,532.76	556
A	633	692,914.46	8,624,593.08	525
A	634	692,897.79	8,624,648.33	504
A	635	692,876.05	8,624,702.14	488
A	636	692,763.55	8,624,903.58	453
A	637	692,729.14	8,624,950.23	452
A	638	692,816.54	8,624,826.14	459
A	639	693,066.90	8,624,638.82	377
A	640	693,040.27	8,624,691.00	365
A	641	693,020.88	8,624,746.07	347
A	642	692,944.62	8,625,014.99	242
A	643	692,919.53	8,625,081.20	221
A	644	692,908.66	8,625,150.86	187
A	645	692,905.94	8,625,190.98	164
A	646	693,039.04	8,625,225.45	38
A	647	693,058.79	8,625,182.69	49
A	648	693,076.54	8,625,127.44	69

ID		Datum: GDA94 CRM: UTM Zone 52S		Distance from GEP (m)
		Easting	Northing	
A	649	693,093.03	8,625,071.10	90
A	650	693,205.80	8,624,728.36	213
A	651	693,234.87	8,624,680.26	222
A	652	693,144.21	8,624,841.13	191
A	653	693,182.07	8,624,784.25	196
A	654	693,311.23	8,624,817.58	75
A	655	693,293.93	8,624,874.10	53
A	656	693,197.83	8,625,161.77	48
A	657	693,162.23	8,625,272.64	88
A	658	693,173.46	8,625,217.02	63
A	659	693,400.45	8,624,893.93	42
A	660	693,420.92	8,624,841.76	24
A	661	693,376.72	8,624,944.02	56
A	662	693,282.43	8,625,202.62	140
A	663	693,307.79	8,625,145.38	125
A	664	693,254.26	8,625,282.33	167
A	665	693,362.50	8,625,014.22	88
A	666	693,460.95	8,625,089.13	211
A	667	693,555.33	8,624,959.96	203
A	668	693,650.62	8,624,848.92	204
A	669	693,506.97	8,624,814.32	72
A	670	693,465.48	8,624,923.37	111
A	671	693,643.69	8,624,929.98	251
A	672	693,469.78	8,625,242.93	313
A	673	693,711.60	8,625,070.97	394
A	674	694,135.50	8,625,135.19	759
A	675	694,161.68	8,625,283.10	875
A	676	694,183.69	8,625,228.03	856
A	677	694,250.36	8,625,094.43	821
A	678	693,923.28	8,625,184.46	629
A	679	693,952.90	8,625,141.07	624
A	680	693,970.93	8,625,083.92	601
A	681	693,751.64	8,625,475.17	678
A	682	693,775.01	8,625,422.23	664

ID		Datum: GDA94 CRM: UTM Zone 52S		Distance from GEP (m)
		Easting	Northing	
A	683	693,794.64	8,625,355.29	638
A	684	693,902.95	8,625,554.38	846
A	685	694,101.63	8,625,224.18	791
A	686	693,979.35	8,625,516.11	883
A	687	693,951.72	8,625,500.98	852
A	688	693,595.12	8,625,397.09	506
A	689	693,625.83	8,625,262.22	448
A	690	693,861.92	8,624,914.00	408
A	691	694,235.64	8,625,020.33	763
A	692	694,004.85	8,624,910.74	515
A	693	693,790.27	8,625,076.31	458
A	694	692,680.70	8,625,066.80	418
A	695	692,486.05	8,624,972.60	630
A	696	692,274.19	8,624,850.32	872
A	697	692,370.93	8,624,932.20	746
A	698	692,376.54	8,624,652.46	913
A	699	693,479.77	8,625,162.13	271
A	700	693,373.52	8,625,219.83	223
A	701	692,476.81	8,624,552.19	895
A	702	692,545.01	8,624,451.33	903
A	703	692,536.68	8,624,530.67	861
A	704	692,512.14	8,624,583.21	848
A	705	692,731.65	8,624,460.66	750
A	706	693,612.40	8,625,501.30	584
A	707	693,639.40	8,625,450.30	414
A	708	693,667.30	8,625,396.10	435
A	709	693,801.20	8,625,027.90	562
A	710	693,812.30	8,624,981.60	576

6.4 Summary of Fugro Geophysical Survey Data Review

In total, 39 potentially cultural anomalies were identified from a review of the Fugro geophysical data, including three magnetic anomalies with no sonar or multibeam presence (see Figure 43). Of these 39, 21 were classed as category A, 15 as category B, and 3 as category C, with the three magnetic anomalies unranked. The distribution of targets increases with the approach into Darwin Harbour, with the highest concentration between KP 101 and KP 116 (see Figure 43).

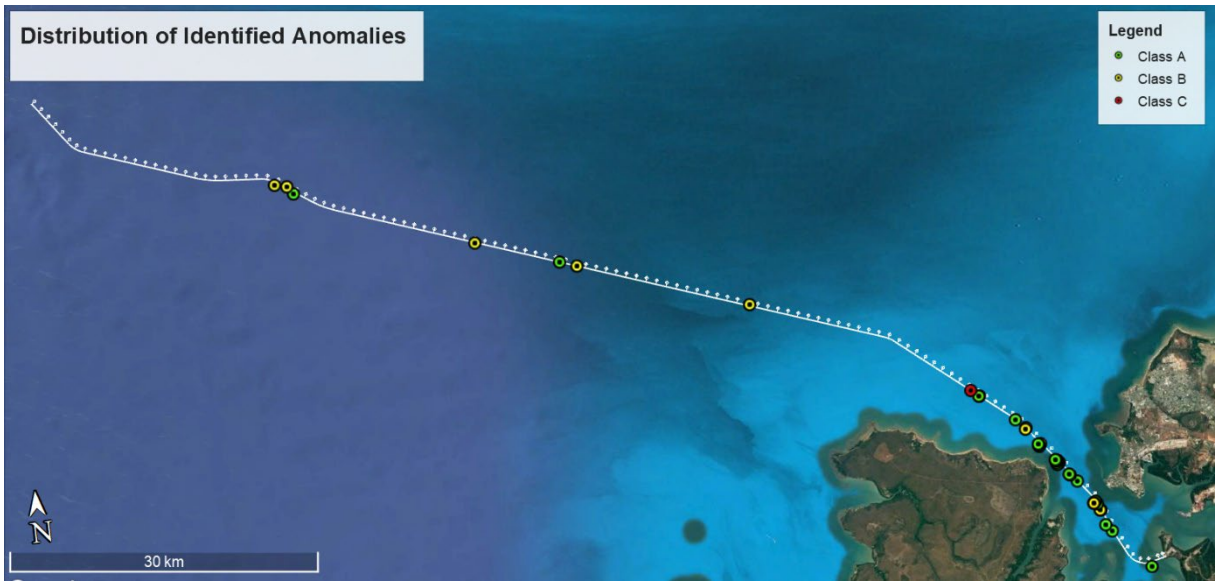


Figure 43: Overview of identified geophysical survey anomalies, colour coded by category type.

Figure 44: Identified geophysical anomalies within Darwin Harbour and approach, approx. KP 93 to 122 (terminus).

6.4.1 *Clusters of geophysical anomalies*

This section reviews five clusters of potential cultural heritage anomalies, and include mostly Class A anomalies, associated Class B anomalies, and associated magnetometer strikes.

6.4.1.1 Cluster 1: KP 25 – 28 (anomalies near I-124)

A cluster of targets was identified between KP 22-28 in the section of the proposed pipeline route that curves around the protected zone of the wreck of the Japanese submarine I-124 (see Figure 45). While the location of the wreck is well documented, and no evidence of I-124 was identified from the geophysical survey, the existence of geophysical anomalies in the area indicates a small likelihood that cultural material associated with the wreck may be present in the area. Of the three identified anomalies between KP 25 and 28, two are ranked in category B, and one is ranked category A. The category B targets cannot be positively identified as cultural or natural based on the available geophysical data. The single category A target, anomaly 112, appears to be a single object of relatively high relief, measuring approximately 8m by 6m. It is located over 2.5 km from the centre of the I-124 protected zone, indicating a very remote chance that it is associated with the Japanese submarine.

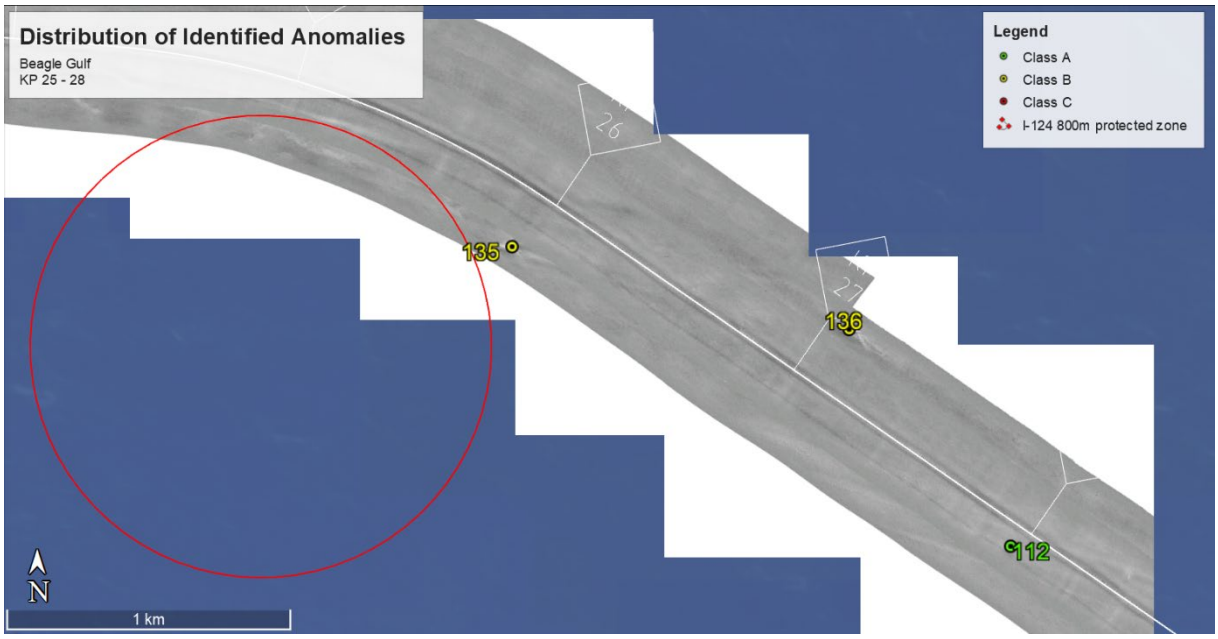


Figure 45: Cluster of geophysical survey anomalies between KP 25 and KP 28. 800m protection zone for I-124 indicated by red circle.

6.4.1.2 Cluster 2: KP 104 – 106 (anti-submarine defences/indicator loop remains)

A second cluster of targets was located between KP 104 and 106. Four geophysical anomalies were identified by SSS and MBES at KP105, three were categorised as A and one as category B.

Previous surveys by CA identified the remains of anti-submarine netting and mechanical time fuses and fuse cones located at 691614 m E and 8626792 m N (see Figure 48 and Figure 49). These remains, labelled Contact 2 in the CA report, are located within the immediate vicinity of anomaly 242, approximately 25m away at a bearing of 286 degrees:

> *Contact 2 consists of a large collection of steel wire rope and chain associated with the WWII anti-submarine boom net* [Figure 48]*. Also located were the remains of at least 4 boom net float buoys and what appear to be supporting frames for the boom net. On the south eastern side of the site is a collection of UXO consisting of mechanical time fuses and fuse cones* [Figure 49]*. These fuses and cones are most likely from artillery shells. A total of 15 fuses were identified but it is likely that more are buried beneath the sediment. The fuses and use cones were most likely stored together in a box but this has deteriorated and spilt the fuses and cones onto the sea floor. Contact 2 covers an area of approximately 25 metres by 30 metres.*[107]

This survey also identified the remains of an underwater telephone cable at 692023 m E and 8626266 m N, designated Contact 3 in the same report:

> *Contact 3 consists of two lengths of underwater telephone cable. There are two parallel sections of cable that run for 30m in approximately an east west orientation* [Figure 51]*. The two cables are set 300 mm apart. The western end of the cable has been cut while the eastern end disappears into the sea floor sediment and is most likely still in situ. The cable is approximately 25 mm across and consists of a six core copper wire encased in black rubber that is then encased in grey rubber. The outside is bound in canvas with steel wire armour* [Figure 52]*. Approximately 5 metres south west of the in situ cables is a jumbled collection of broken telephone cable that appears to have been dumped in a pile.*[108]

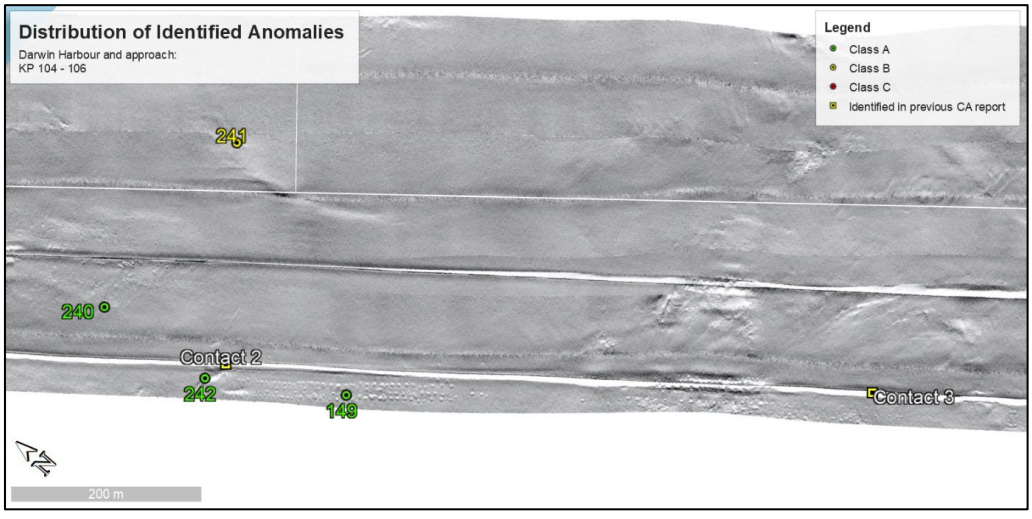


Figure 46: Cluster of geophysical anomalies from KP 104 – 106. Contact 2, associated with anti-submarine netting, and Contact 3 is indicated by yellow square.

[107] **Cosmos Archaeology, 2012,** Ichthys Project Darwin Harbour, East Arm Gas Export Pipeline: Assessment of Heritage Impact of 7 side scan targets, report prepared for Tek Ventures Pty Ltd, p.11.
[108] *Op. Cit.* **CA, 2012:**12.

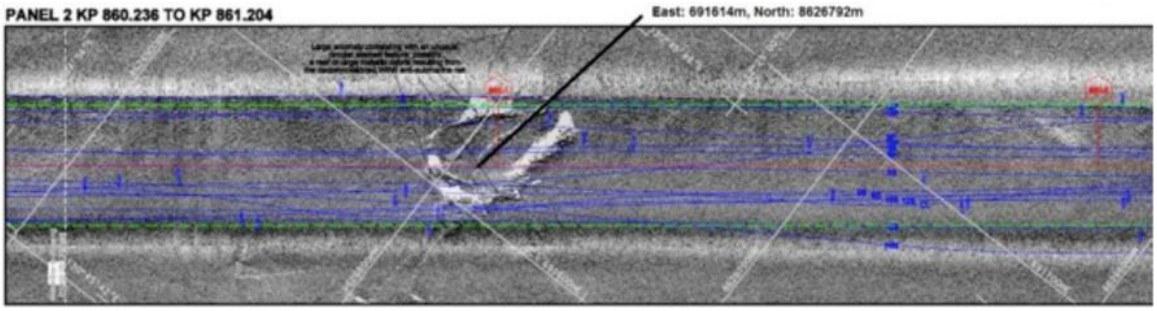


Figure 47: SSS image of Contact 2, taken during 2012 geophysical surveys for INPEX GEP. (Source: CA 2012).

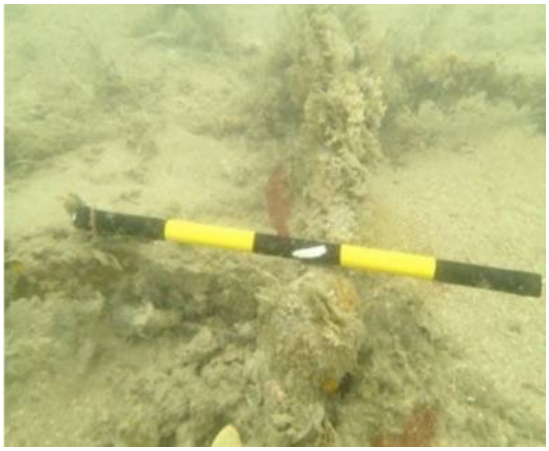


Figure 48: Remains of anti-submarine netting recorded at contact 2. (Source: CA 2012).

Figure 49: Collection of mechanical time fuses and fuse cones located at Contact 2. (Source: CA 2012).

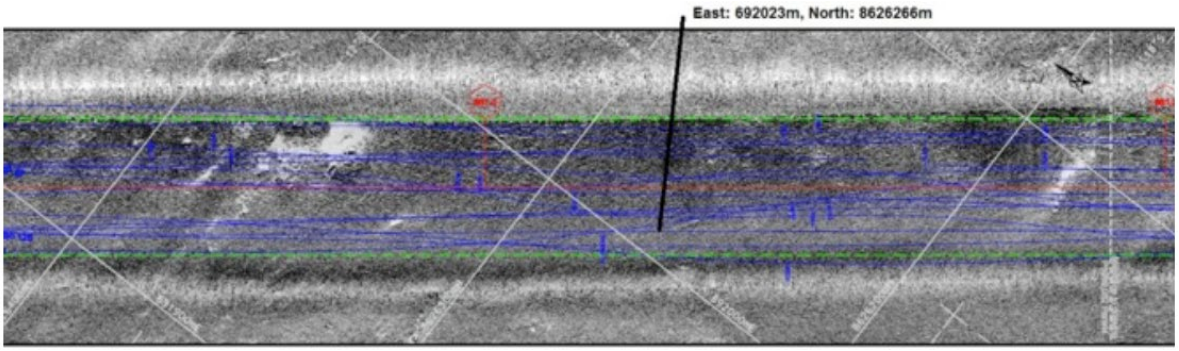


Figure 50: SSS image of Contact 3, taken during 2012 geophysical surveys for INPEX GEP. (Source: CA 2012).

Figure 51: Image of the two parallel lies of communication cable laying on sea floor. (Source: CA 2012).

Figure 52: Cross section of broken communication cable. (Source: CA 2012).

It appears from comparison of the SSS data from 2012 and 2018, that Contact 2 and Anomaly 242 are the same object, however new surveys show the INPEX GEP directly crossing the location (see Figure 47 and Figure 53). Adjacent to 242 is a series of small circular depressions, regularly spaced in several rows and uniform in size, 3-4m in diameter (Anomaly 149). The identity of these depressions is unknown, they may be related to either the anti-submarine defences or to the laying of the INPEX pipeline (see review of Anomaly 210 below). Despite the known location of ferrous material at Contact 2, no magnetometer strike was reported in the vicinity. Anomaly 240 is a high relief object rectangular in shape, potentially a mooring block related to the anti-submarine defences.

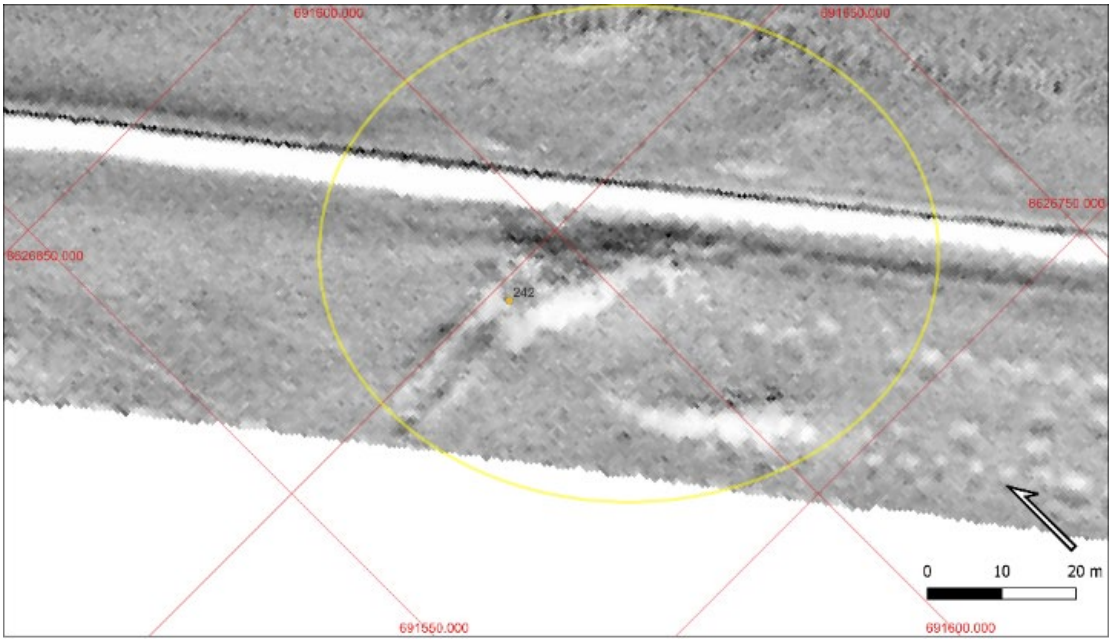


Figure 53: Anomaly 242 (circled in yellow). Note INPEX GEP crossing the target. Note circular depressions in lower right, designated Anomaly 149.

6.4.1.3 Cluster 3: KP 107-108 (anti-submarine boom net moorings)

Of particular interest is a cluster of targets located between KP 107 and 108 at a point directly between Mandorah and Dudley point at the entrance of Darwin Harbour (see Figure 54). A total of nine targets were identified within this 1km section of the proposed pipeline route, with five of those also registering as magnetometer targets, indicating the presence of ferrous materials. It was believed initially that some of these were related to WWII anti-submarine nets, identified by historical sources (see Section 4.3.3) and during CA investigations related to the INPEX project.[109] This conclusion was confirmed by ROV surveys conducted in June 2022 (see Section 7 and Annex A for summary of these surveys).

ROV surveys were conducted along three transects and identified a total of 11 moorings, including 10 large concrete clump weights and one ship's anchor (Target 164), repurposed as a mooring. These moorings were connected by heavy gauge chain and spaced roughly 60m apart. Three "trots", lines of mooring weights connected by chain, were identified within the geophysical survey corridor, and were visually inspected during ROV surveys.

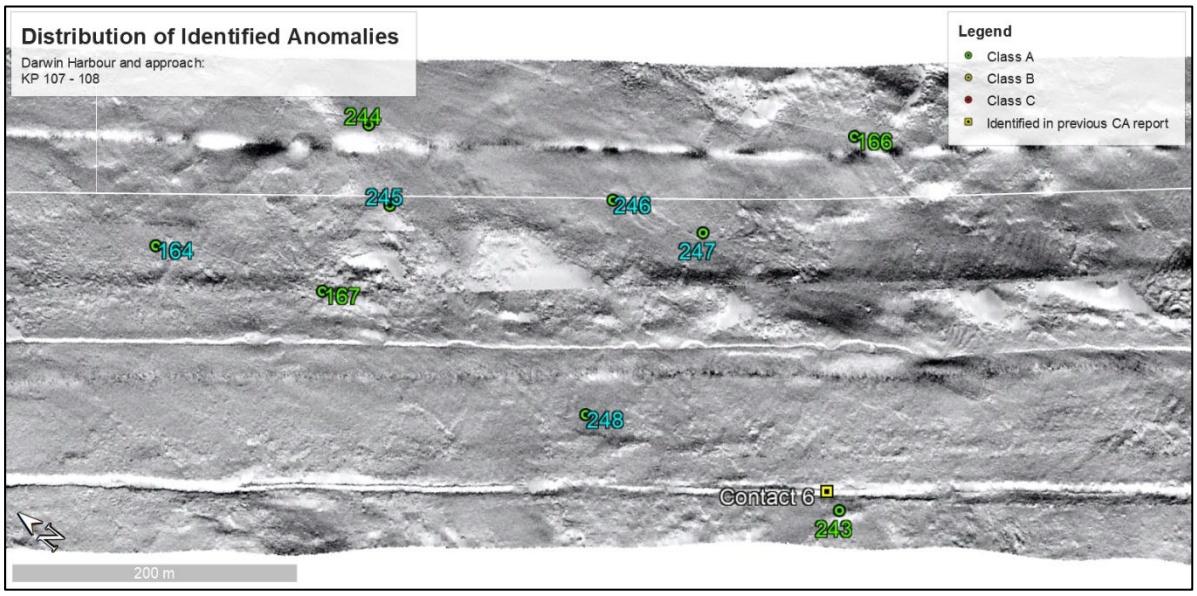


Figure 54: Identified geophysical survey anomalies between KP 107 and 108, overlaid on SSS data. Targets with blue labels are also magnetometer strikes. Contact 6 identified with yellow square.

Target 243 is approximately in the close vicinity of a mooring block (Contact 6) surveyed by CA in 2012. Contact 6, located at 693193 m E and 8624761 m N, was determined to be a structure related to an anti-submarine boom net installed during WWII (see Figure 55-56):

> *Contact 6 is a section of the mooring system for the WWII anti-submarine boom net. On the southern end of the site is a large concrete mooring block approximately 1.6 metres long, 1.4 metres wide and 0.8 metres high* [Figure 56]. *The block is sitting proud of the sea floor and there is some minor scouring around the base. On the north and the south sides of the mooring block are two large iron loops approximately 200mm from the bottom. Connected to these loops are stud link chains (350mm long, 230mm wide and 70mm across) leading off on a north and south axis* [Figure 57]. *The northern side of the chain extends for approximately 5 metres before disappearing into the sea floor. The southern side of the chain extends for approximately 7 metres before disappearing into the sediment. Although there would have originally been chain and wire rope that*

[109] *Op. Cit.* **Cosmos Archaeology, 2012**:14.

connected this mooring system to the anti-submarine net there is no indication of the chains or net left in this area. [110]

The high presence of ferrous material in this location, not associated with the existing pipelines, and sonar contacts supports the theory that most, if not all, of these targets are cultural in origin. Anomaly 245 presents as a magnetometer strike in an area of extensive rocky material. Lines seen on sonar running NW to SE are possibly remains of undersea cables installed during the 1870s (see Section 4.3.3). Note similarity in SSS image of Contact 6 (Figure 55) and Anomaly 166 (Figure 58). These two targets are approximately 250 m apart in a straight line between Mandorah and Dudley's Point.

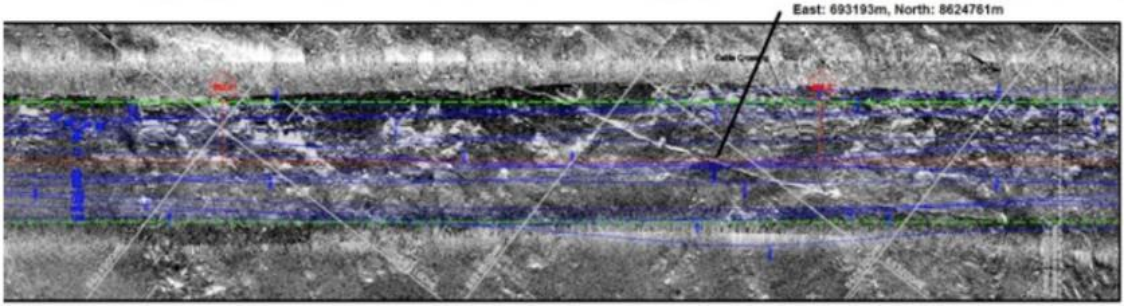


Figure 55: SSS image of Contact 6 taken during 2012 geophysical survey. Location 693193 m E and 8624761 m N.

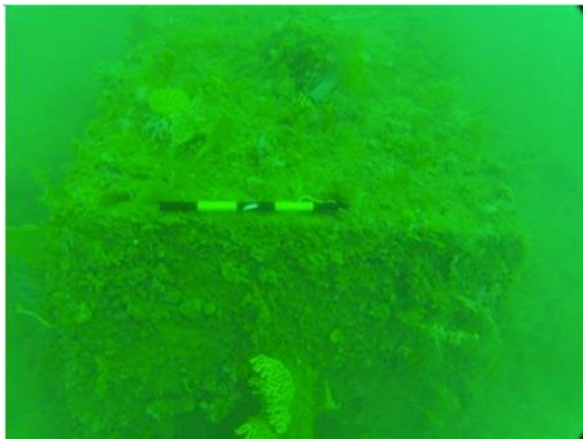


Figure 56: Concrete mooring block for anti-submarine net. (Source: CA 2012).

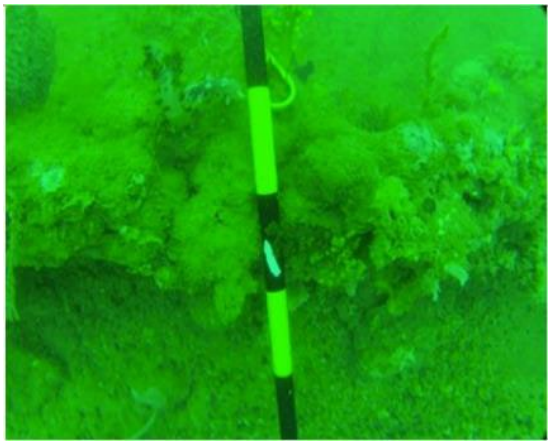


Figure 57: Detail of chain for anti-submarine netting. (Source: CA 2012).

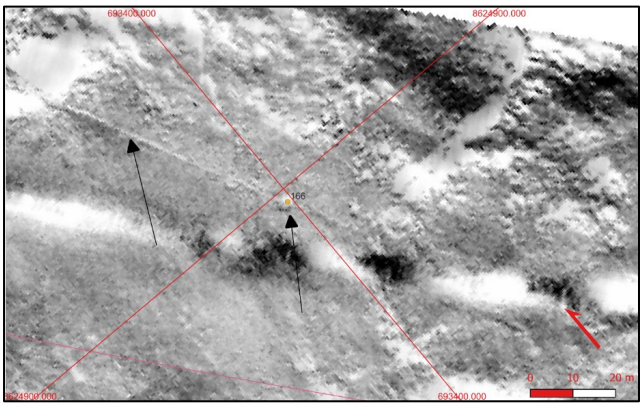


Figure 58: Geophysical anomaly 166. Black arrows pointing to mooring block and chain. DOF Subsea 2018.

[110] Op. Cit., Cosmos Archaeology, 2012, p.14.

6.4.1.4 Cluster 4: KP 108 – 110 (magnetic anomalies)

Centred at KP 109 is a cluster of magnetometer targets potentially unrelated to the existing Bayu-Undan and INPEX GEPs. Although only two geophysical anomalies were identified by review of SSS and MBES, there are an additional 10 magnetometer strikes located at least 20m away from the existing pipelines. Faint lines seen on the seabed indicate that these magnetometer strikes are possibly the remains of undersea cables, anti-submarine defences, or debris associated with the pipelines (Figure 59). Anomaly 174 was designated class A and listed as potentially associated with a magnetometer strike. ROV survey was conducted on Target 174, and identified the target as a possible winch, windlass or ship's bollard with rope still coiled around the object (see Section 7.2).

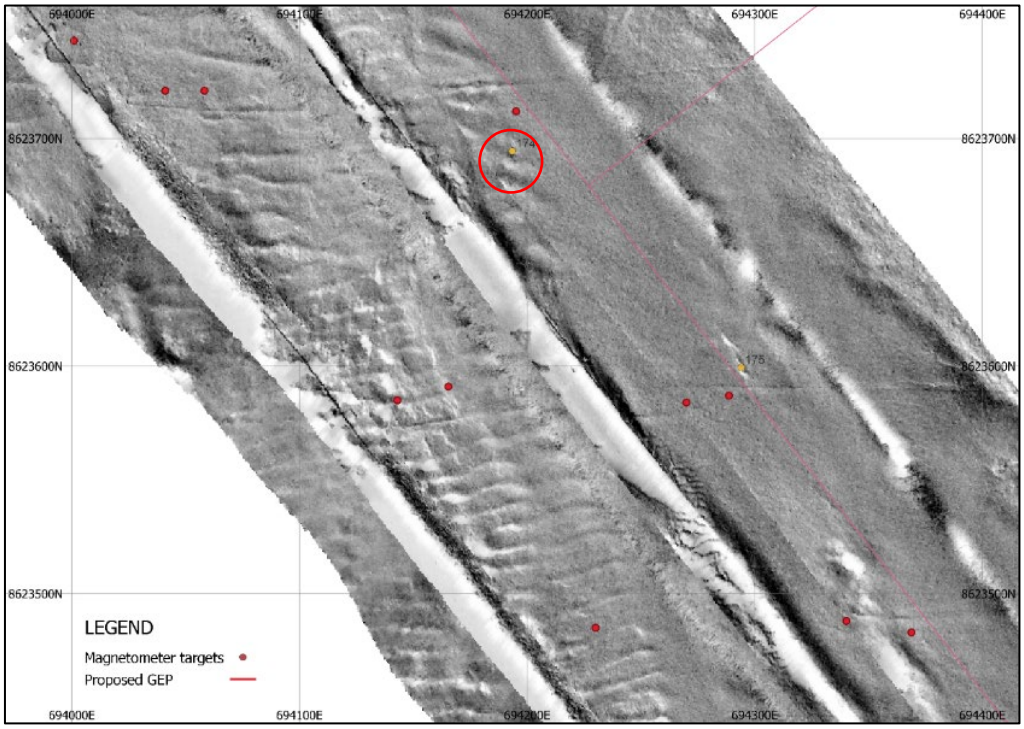


Figure 59: Location of magnetometer strikes and geophysical survey anomalies around KP 109. Note linear features along magnetometer targets. Anomaly 174 circled in red.

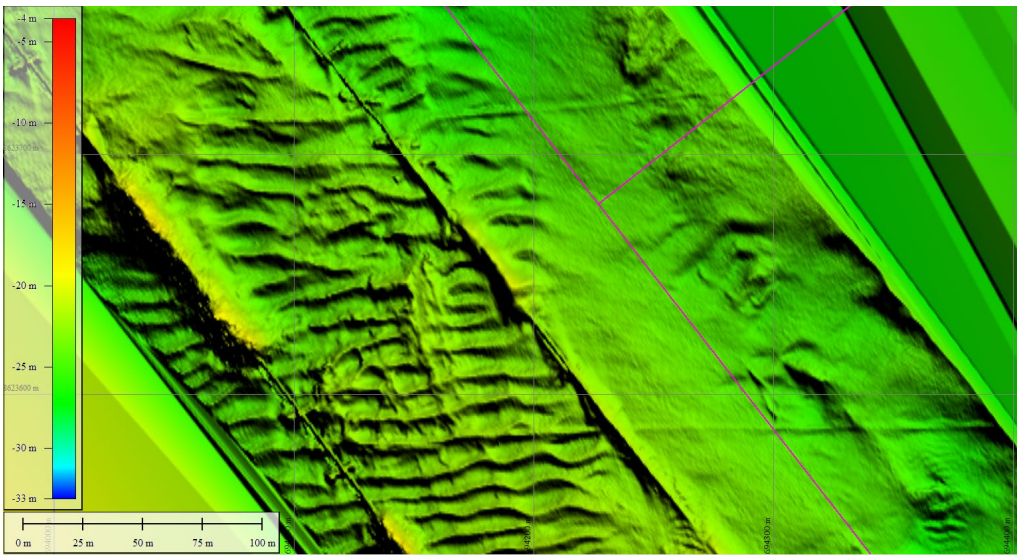


Figure 60: High resolution MBES data of same area, showing linear features near KP 109.

6.4.1.5 Cluster 5: KP 112 – 114 (debris scatters)

Around KP 113, between KP 112 and 114, is a cluster of six geophysical survey anomalies. Three are classed as category A and three are classed as category B, and no magnetometer strikes were recorded in the vicinity. One anomaly, 191, presents as a single high relief object approximately 8m in length and roughly the shape of a small boat. The remaining four targets appear to be either debris scatters or natural features.

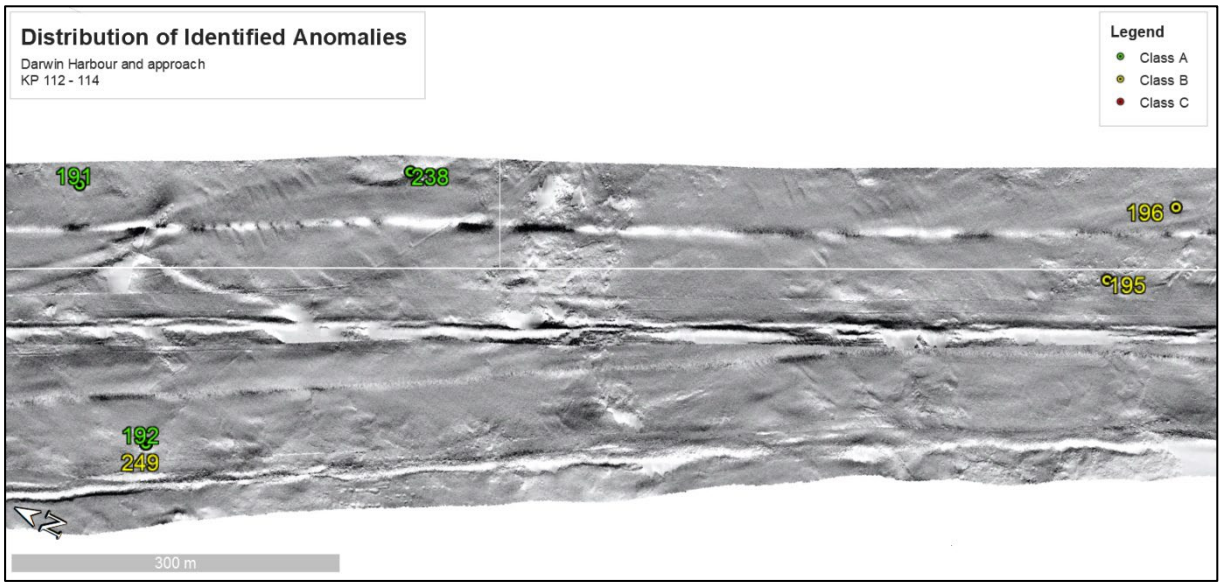


Figure 61: Cluster of geophysical survey anomalies between KP 112 and KP 114.

6.4.2 *Isolated Class A anomalies*

Anomaly 234: KP 54 – 55 (single mound, low relief)

Anomaly 234 appears to be, from SSS, a small mound of low relief, approximately 5m x 4m. It is in the general area of the known location of the 1871 subsea cable and may be related. Anomaly 234 is approximately 173m from the centreline of the proposed GEP route.

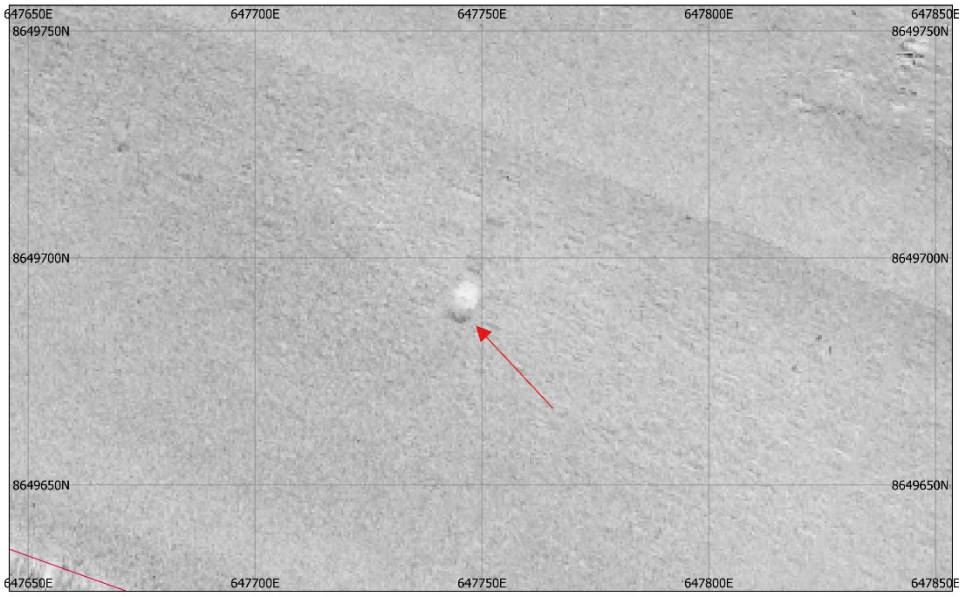


Figure 62: SSS view of anomaly 234.

Anomaly 138: KP 97 – 98 (mound in proximity to anchor scars)

Anomaly 138 appears on SSS to be a relatively large mound, measuring 13m by 16m, and is in close proximity to a pair of gouges on the seabed, crossing in an "X" pattern, identified as C Class anomaly 236. It is believed that these gouges are likely anchor scars. Both gouges are approximately 75m long and 6m wide.

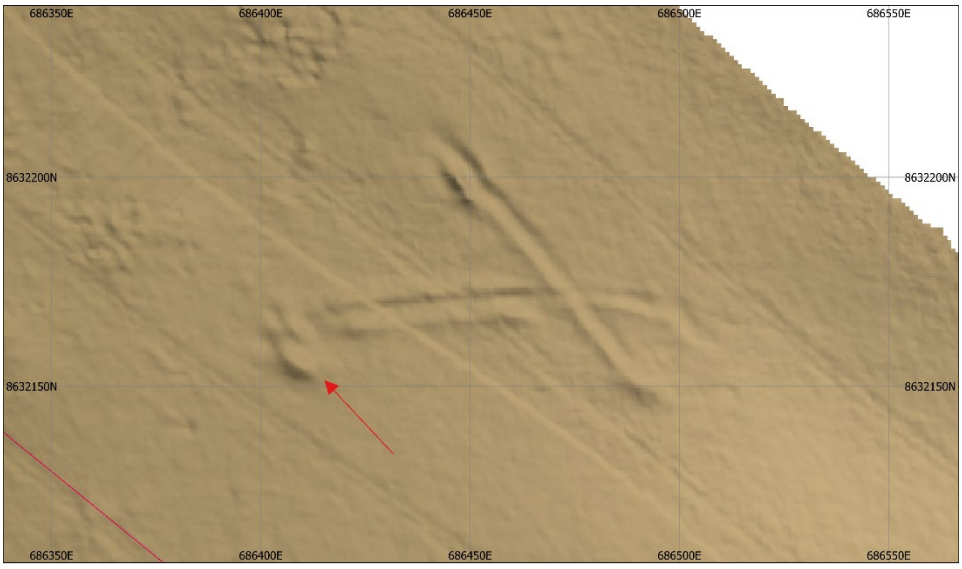


Figure 63: MBES image of Anomaly 138 with associated seabed gouges in X pattern. Anomaly 138 marked by red arrow.

Anomaly 239: KP 115 – 116 (USAT Mauna Loa)

Anomaly 239 is located at approximately KP 116 and is identified as the wreck site of USAT *Mauna Loa. Mauna Loa* was a steel hulled US military cargo ship, measuring 410 feet in length, 54 feet in depth, and 5,436 tons. The vessel was sunk by Japanese aircraft during a raid on Darwin on February 19, 1942, resulting in five casualties (see Section 4.3.1, Figure 19, and Figure 21).[111] Although the upper portions of the wreck were removed during salvage operations between 1959 and 1960, the lower portion of the wreck, and its cargo, is largely intact. Cargo remains include motorbikes, ammunition, gun carriers, and trucks.[112] The wreck is well known and protected under the *UCHA 2018, Northern Territory Heritage Act 2011,* and may be protected by the *SMCA 2004* (USA).

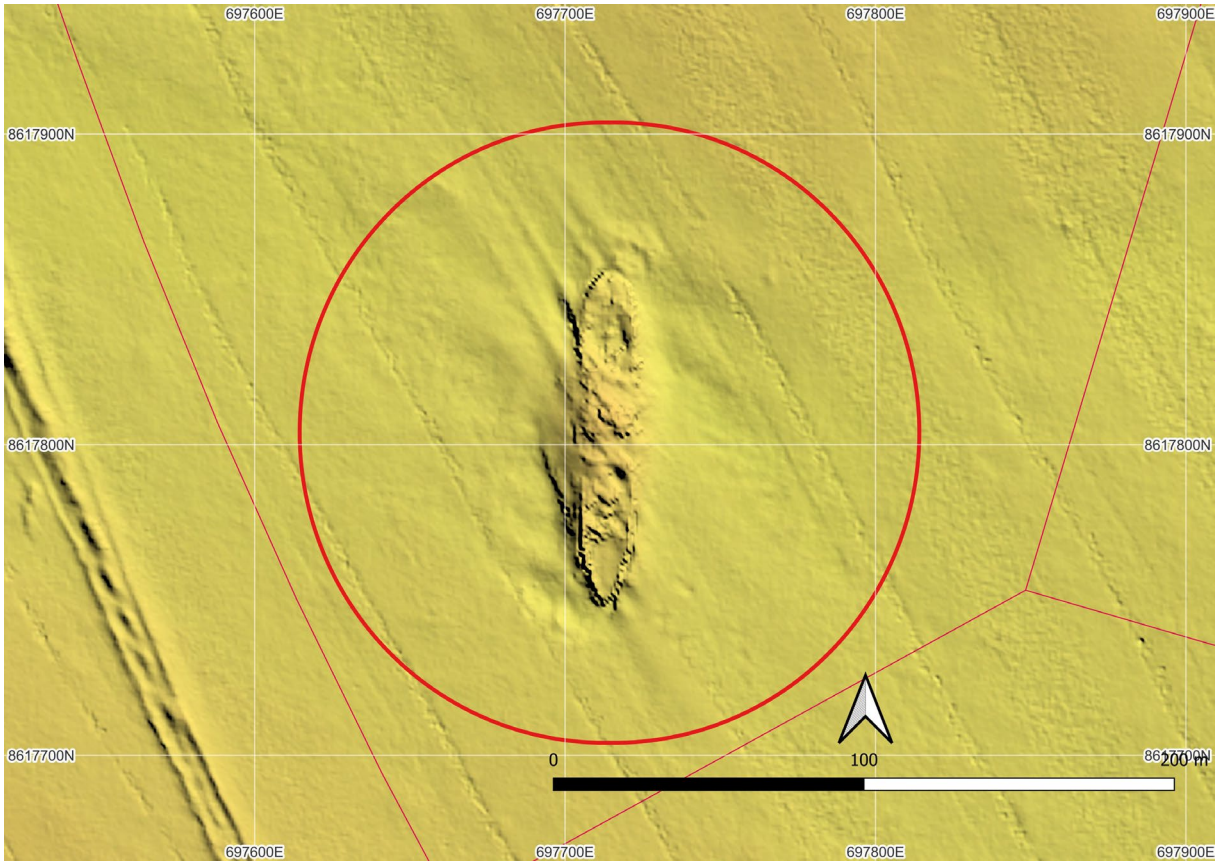


Figure 64: MBES image of anomaly 239, the USAT Mauna Loa. Statutory protection zone represented by red circle.

[111] **AUCHD,** shipwreck ID: 3503.
[112] **AUCHD,** shipwreck ID: 3503.

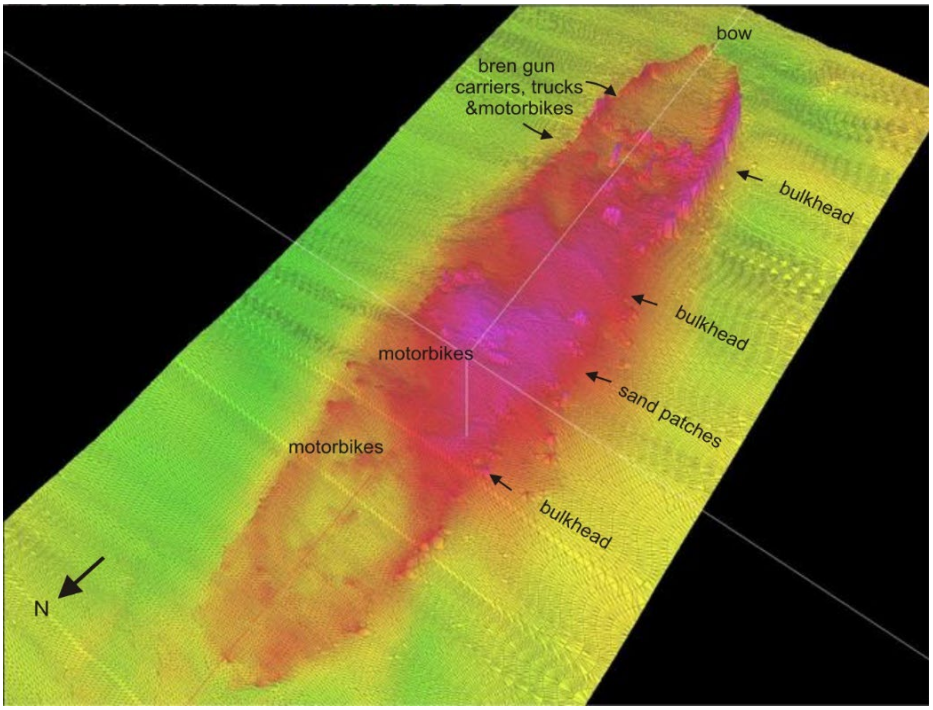


Figure 65: 2012 multi-beam sonar image of USAT Mauna Loa.[113]

Anomaly 210: KP 121 – 122 (unidentified debris)

Anomaly 210 is located between KP 121 and 122, approximately 360 m south of the proposed GEP route. The debris is unidentified, and due to the lack of comprehensive magnetometer data, it is unknown whether any ferrous material is present at the site. The shape of the debris bears a passing resemblance to known aircraft wrecks in the area, including five Consolidated Catalinas wrecked on the opposite side of Wickham Point, East Arm, Darwin (see Figure 67 and Figure 68). The size of the debris is approximately 12m by 7m - closer to the size of military fighter aircraft known to have operated over Darwin during World War II, such as RAAF Supermarine Spitfires (9m long fuselage and 11m wingspan), USAAF Curtiss P-40E Kittyhawks (9.6m long fuselage and 11.4m wingspan) and IJNAF Mitsubishi A6M2 “Zeros” (9m long fuselage and 12m wingspan). There are eight as yet unlocated World War II fighter aircraft wrecks that could potentially be situated within the study area – including six USAAF Kittyhawks, one RAAF Spitfire, and one IJNAF Zero (see Section 4.4.2).

[113] **AUCHD,** shipwreck ID: 3503.

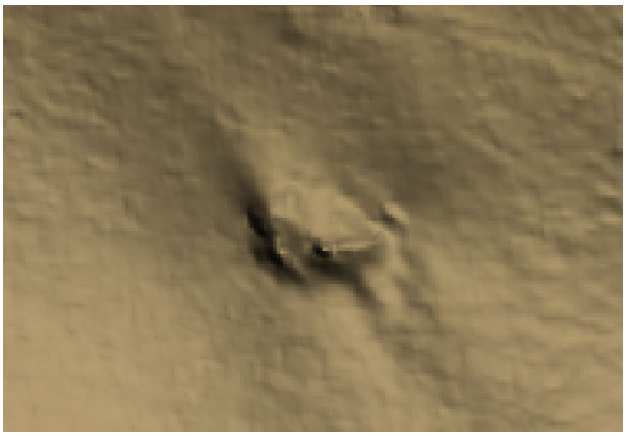


Figure 66: Anomaly 210, unidentified debris.

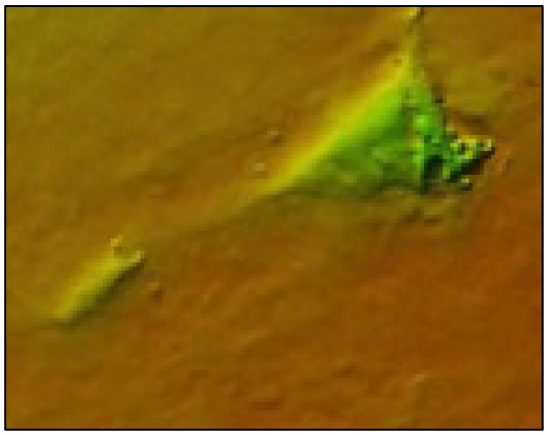


Figure 67: High resolution SSS image of Catalina 3, wrecked at East Arm.[114]

6.4.3 *Isolated Class B & C anomalies*

- *Anomaly 233: KP 46 – 47 (triangular depression)* - Anomaly 233 is a large triangular depression measuring roughly 39m by 8m. It was not identified as a magnetometer target and is likely a natural feature.
- *Anomaly 115: KP 56 – 57 (parallel depressions)* – Anomaly 115 is an isolated set of rectangular depressions measuring approximately 8m by 4m and may represent an area of debris or a natural feature.
- *Anomaly 130: KP 73 – 74 (possible debris field)* – Anomaly 130 is an area of numerous small, low-lying objects across a field approximately 18m by 8m. This likely represents a debris field, possibly of discarded objects, or an area of loose rocky seabed, which is incongruous with the surrounding flat sandy seabed. MBES and magnetometer survey did not cover Anomaly 130.
- *Anomaly 140: KP 101 – 102 (navigational buoy mooring)* – Anomaly 140 was determined to be in the same location as navigational buoy 5, used as a guide for the Port of Darwin shipping lane. Images seen on SSS and MBES are most likely the mooring and mooring line for Buoy 5.
- *Anomaly 141: KP 102 – 103 (possible field of large debris)* – Anomaly 141 is an area of several large, high-profile ridges across a total area measuring 53m by 20m, with each individual portion measuring 6 – 12m across. Objects are likely natural rocks, as similar features become more frequent following KP 113, or are cultural in origin, possibly indicating a dump site.
- *Anomaly 142: KP 102 – 103 (possible debris)* – Anomaly 142 is located approximately 150m southwest of Anomaly 141 and lays on the proposed GEP route. 142 appears similar to 141 on MBES, and on SSS appears as several relatively high-profile objects in a field roughly 13m by 8m.
- *Anomaly 235: KP 96 – 97 (anchor drag)* – Anomaly 235 is an anchor drag, vaguely U-shaped and measuring 244m in total length and 5m in width.

[114] **AUCHD,** Aircraft Id: 8072.

6.4.4 Isolated Magnetic Anomalies

Three isolated magnetic anomalies were detected during magnetometer surveys. One is located beyond 50m from the proposed GEP route, one located approximately 35 m from the route, and one is located 6.4 m from the proposed route. These anomalies are inferred to be buried ferrous debris. Thus, these targets may represent buried cultural items.

- *MA_001: KP 115.846* – inferred buried debris, 13.3 nT magnetic intensity, 35.3m from GEP route. This magnetic anomaly was initially thought to possibly be associated with USAT *Mauna Loa,* because it is located approximately 65m from the wreck site. MA_001 was inspected during ROV survey and confirmed to be the remains of a buoy mooring.
- *MA_007: KP 111.508* – inferred buried debris, 21.5 nT magnetic intensity, 6.4m from GEP route. MA_007 was inspected during ROV survey. An unidentified metal structure was seen at the location of MA_007 and was assessed as cultural in origin. This structure may represent wreckage remains or discarded debris.
- *MA_031: KP 117.376* – inferred buried debris, 34.3 nT magnetic intensity, 145.6m from GEP route.

7 ROV SURVEY

7.1 Conduct of field survey

As part of environmental and heritage impact assessments, a geophysical survey was conducted, including multi-beam bathymetry (MBES), side scan sonar (SSS), and magnetometer surveys, to identify locations of potential cultural material (see Section 6). Review of the available geophysical survey data identified forty targets of possible cultural origin (see Section 6.3). Sixteen of these targets were located within 50m of the proposed GEP route and were shortlisted for visual survey to potentially confirm their identity and significance (Figure 69). In addition to these individual targets, three transects were planned solely for heritage purposes in the location of known WWII anti-submarine netting (Figure 70). The sixteen chosen targets were inspected over the course of three days between 6-8 June 2022.

Figure 68: Location of ROV survey shortlisted targets. All targets located between KP 102 and KP 118.

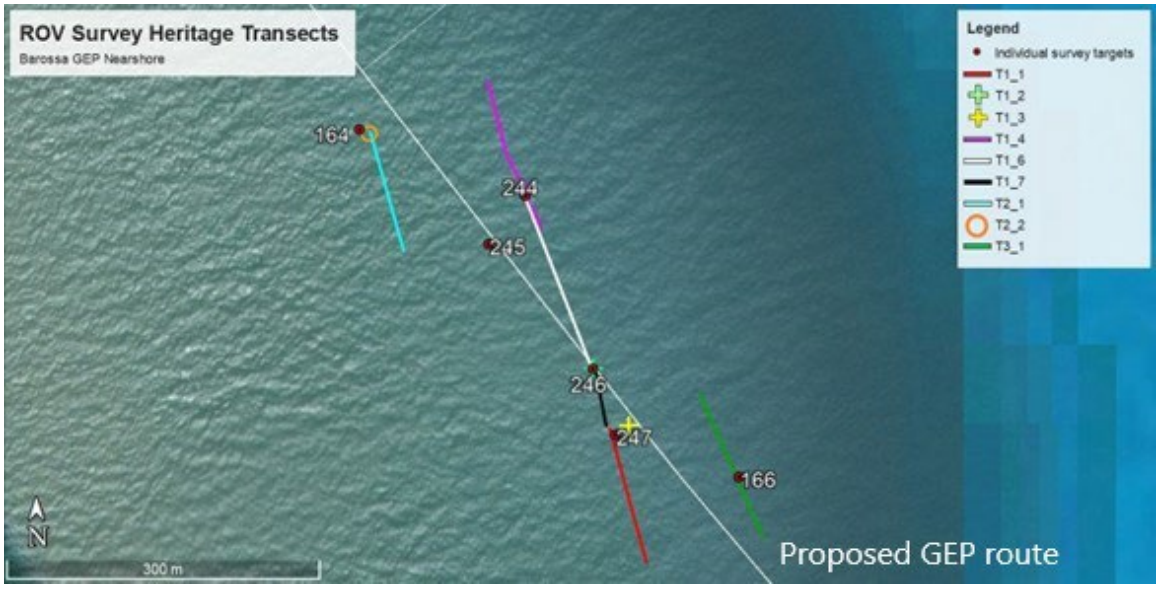


Figure 69: Location of ROV survey heritage transects between KP 107 and KP 108.

The objectives of this ROV survey were to:

> *Visually inspect targets identified through geophysical data for their potential cultural heritage significance and recommend measures to reduce impacts to their cultural heritage values.*

The underwater heritage survey was conducted with the use of an ROV, operated by crew from FUGRO under the direction of the maritime archaeologist. The features believed to be the anti-submarine net mooring trots were surveyed along transects following the features in a linear pattern. Isolated targets were targeted by dropping a clump weight with a buoy attached on the target coordinates while the vessel was moving, and then following the buoy line to the seabed with the ROV once the vessel was anchored. Once on the bottom, the ROV was manoeuvred in cross shaped search patterns, 10m out in each cardinal direction, using the clump weight as a reference point.

The ROV was battery powered and controlled remotely by the pilot from inside the survey vessel cabin. Because the ROV was not equipped with transponders or any location fixing devices, the exact location of the ROV had to be estimated based on identifiable features on the seabed that could be compared to MBES data, course headings, and position relative to the survey vessel.

7.2 Summary of ROV survey findings

In total, 21 ROV dives were attempted to locate and identify potential cultural objects identified in the marine geophysical survey. Of these 21 dives, 3 were aborted due to poor conditions or issues with the ROV. Despite these failed attempts, ROV surveys were conducted on all 16 targets shortlisted for ROV survey.

Remains of historic maritime infrastructure were identified during the ROV surveys (Figure 71). The remains of WWII anti-submarine boom net moorings were clearly identified by the three heritage transects.

Figure 70: ROV survey shortlisted target locations overlaid on map of known historic maritime infrastructure in Darwin Harbour.

Heritage Transects 1, 2, and 3 identified the remains of WWII anti-submarine net moorings near the entrance to Darwin Harbour. It was concluded based on these surveys that the northern and southern mooring trots (Transects 2 and 3) did not cross the proposed GEP route (Figure 72). It was noted that the northern end of the trot surveyed by Transect 2 was anchored with a potentially historical ships anchor.

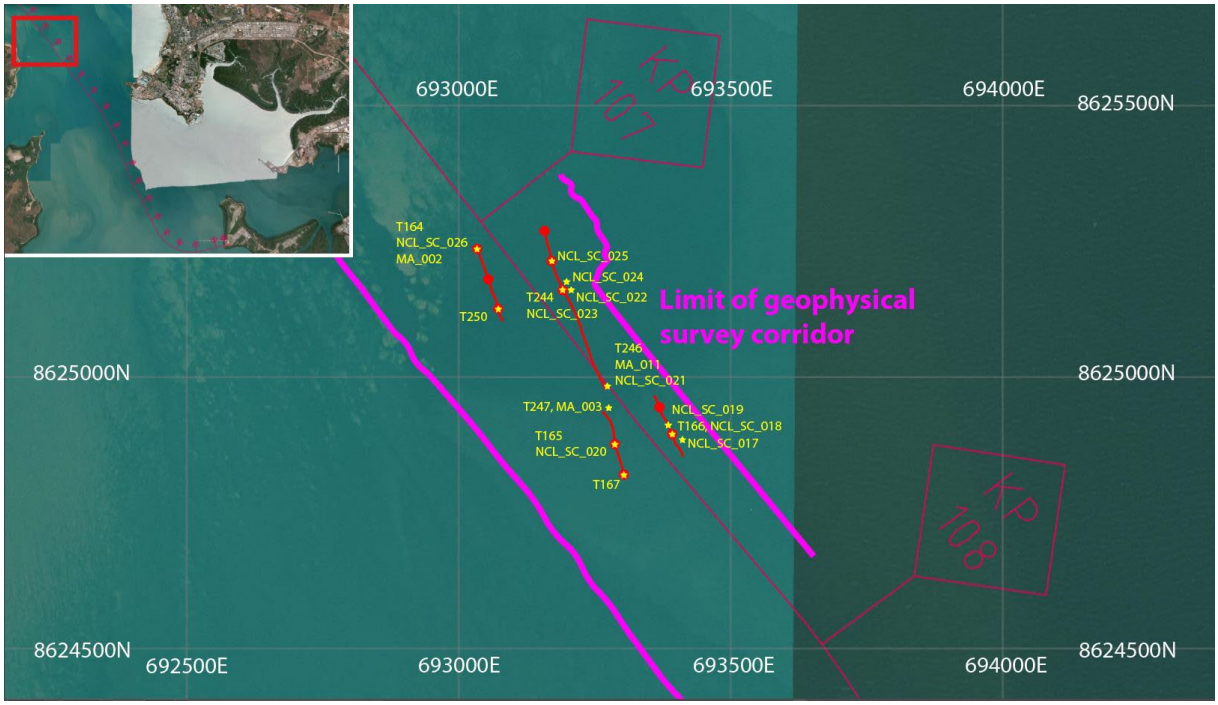
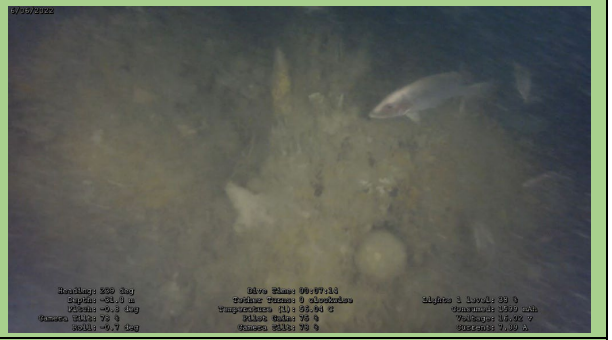
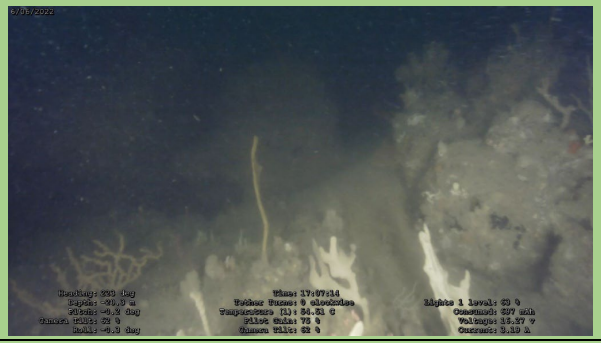
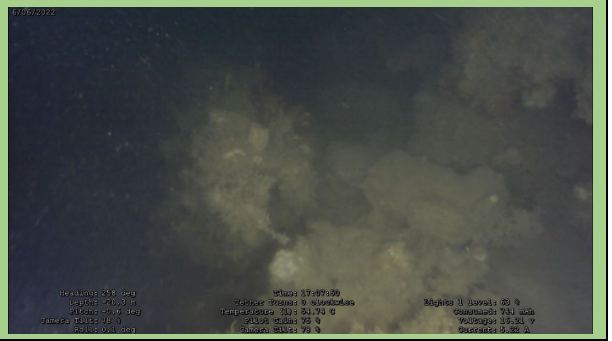
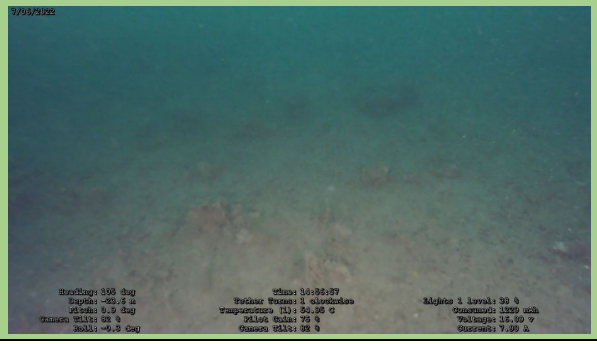


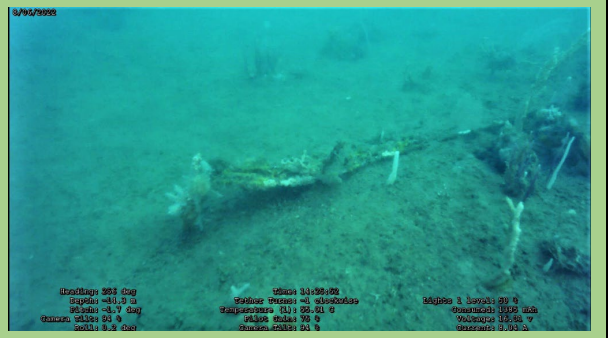
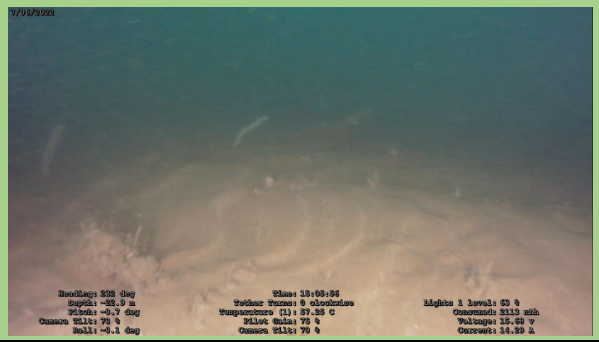
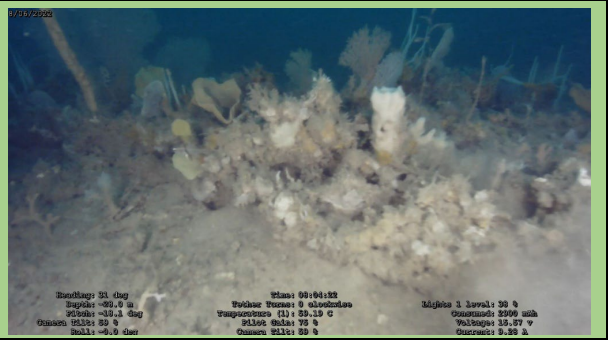
Figure 71: Location of anti-submarine net trots identified during ROV surveys. Circles represent mooring blocks/anchors, lines indicate chains in between blocks, stars represent geophysical survey anomalies, with IDs.

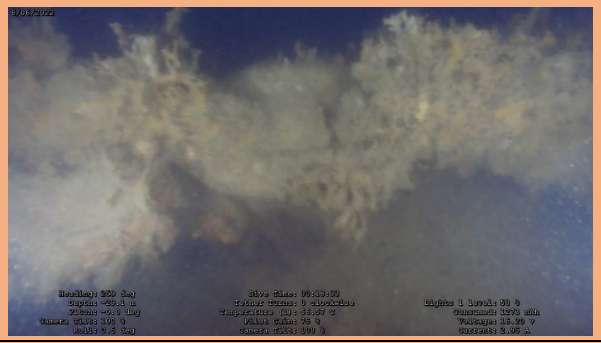
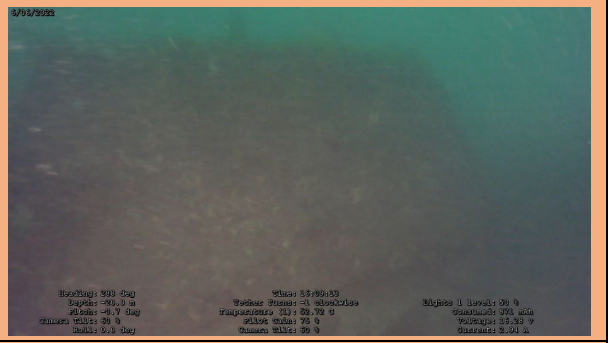
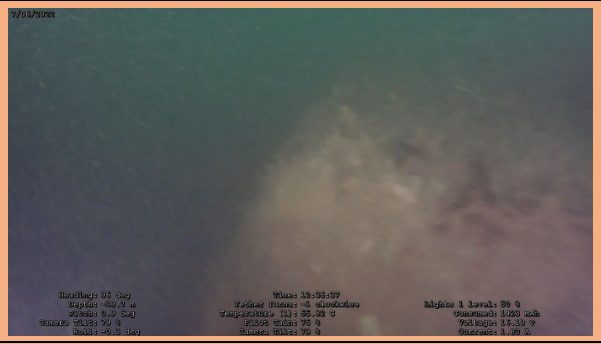
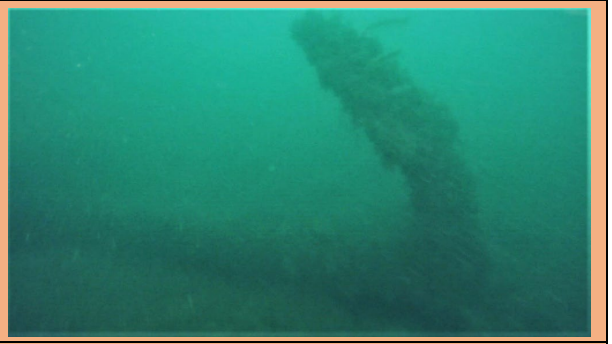
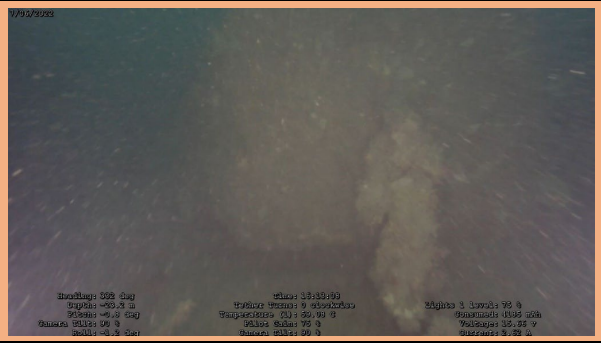
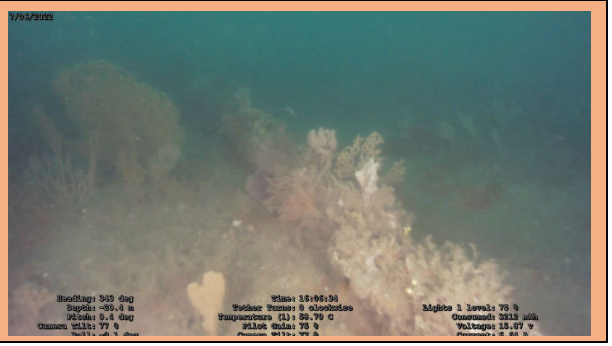
ROV survey of the middle trot (Transect 1) identified mooring chains that did cross the proposed GEP route. However, it was also seen that a gap exists between sections of the chain, southeast of the location of Target 246, which was not located.

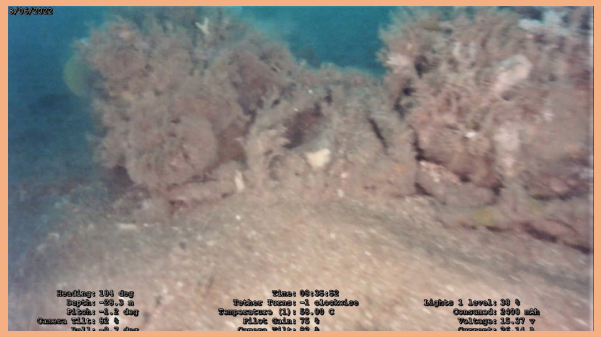
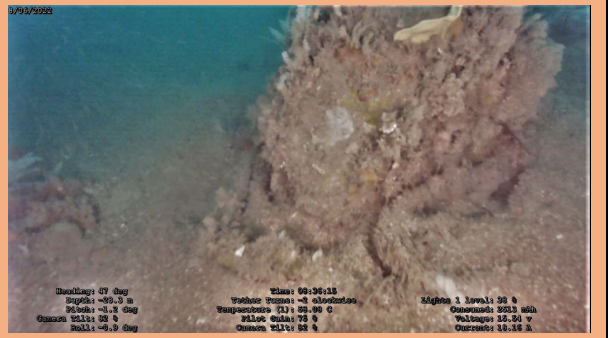
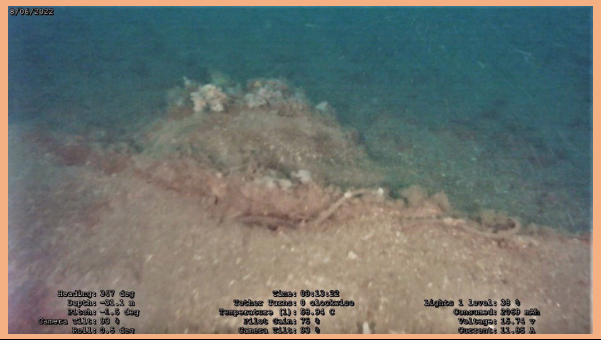
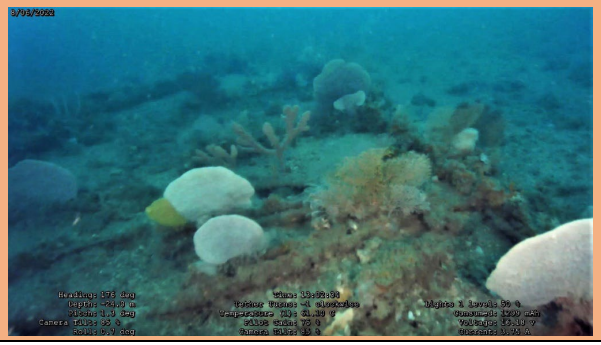
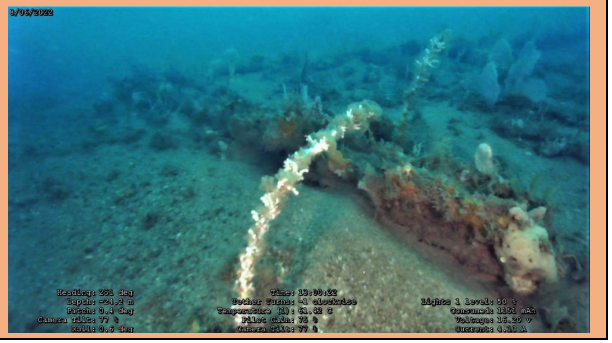
Individual dives on 10 isolated heritage targets identified 6 instances of natural features, not considered to be cultural in origin. The remaining four are conclusively cultural. All three heritage transects identified cultural remains. Table 11 summarizes the results of the survey of these features. The full summary of the ROV survey is attached to this report as Annex A.

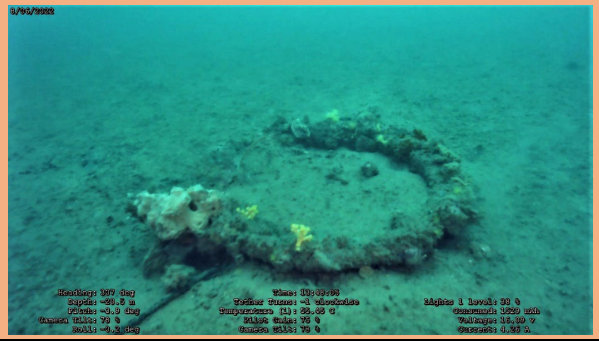
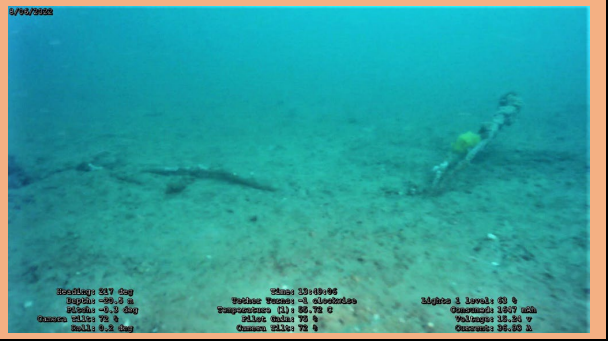
Table 11: ROV survey target identification

Target ID	Likely identification	Cultural/Natural	Image 1	Image 2
142	Boulders	Natural		
245	Rock rubble	Natural		
241	Shallow depression	Natural		

Target ID	Likely identification	Cultural/Natural	Image 1	Image 2
NCL_SC_002	Rock ridge	Natural		
NCL_SC_031	Sand ripples	Natural		
175	Narrow rock/coral ridge	Natural		

Target ID	Likely identification	Cultural/Natural	Image 1	Image 2
Heritage Transect 1 (incl. Targets MA_003, 011; Targets NCL_SC_020, 021, 022, 023, 024, 025; Targets 165, 167, 244, 246, 247)	Anti-submarine net mooring trot	Cultural		
Heritage Transect 2 (incl. Targets MA_002; Target NCL_SC_026; Targets 164 and 260)	Anti-submarine net mooring trot, with ship's anchor as northernmost mooring	Cultural		
Heritage Transect 3 (incl. Targets NCL_SC_017, 018, 019; Target 166)	Anti-submarine net mooring trot	Cultural		

Target ID	Likely identification	Cultural/Natural	Image 1	Image 2
174	Possibly winch, windlass, or ship's bollard	Cultural		
NCL_SC_016	Telegraph or other cable	Cultural		
MA_007	Metal structure, possible wreckage	Cultural		

Target ID	Likely identification	Cultural/Natural	Image 1	Image 2
MA_001	Buoy mooring and cable	Cultural		

7.3 Interpretation of survey results

7.3.1 *Anti-submarine net mooring trots (Heritage Transects 1, 2, and 3)*

In response to the threat of a Japanese invasion, a network of anti-submarine infrastructure was constructed around Darwin Harbour. This included the construction of a 6 km-long anti-submarine boom net, between Dudley Point and West Point (see sections 4.2.6, 4.3.3). Indicator loops and sonar systems were also put in place at the entrance to Darwin Harbour to detect any ships moving near the boom gates.

The submarine boom net was anchored to the seabed with 5- and 8-ton concrete clumps. A total of 265 clumps were used for the boom, which were arranged in groups of eight. Each group of eight clumps was called a “trot” and each trot was laid out 195 ft (~60m) apart, perpendicular to the axis of the submarine net. The clumps were connected by 2” chain.

ROV surveys visually identified the locations of nine mooring clumps, and one ship’s anchor repurposed as a mooring clump, representing three separate trots. The locations of the three trots located during the ROV survey correspond roughly to trots 16, 17, and 18 shown on historic charts (see Figure 73).

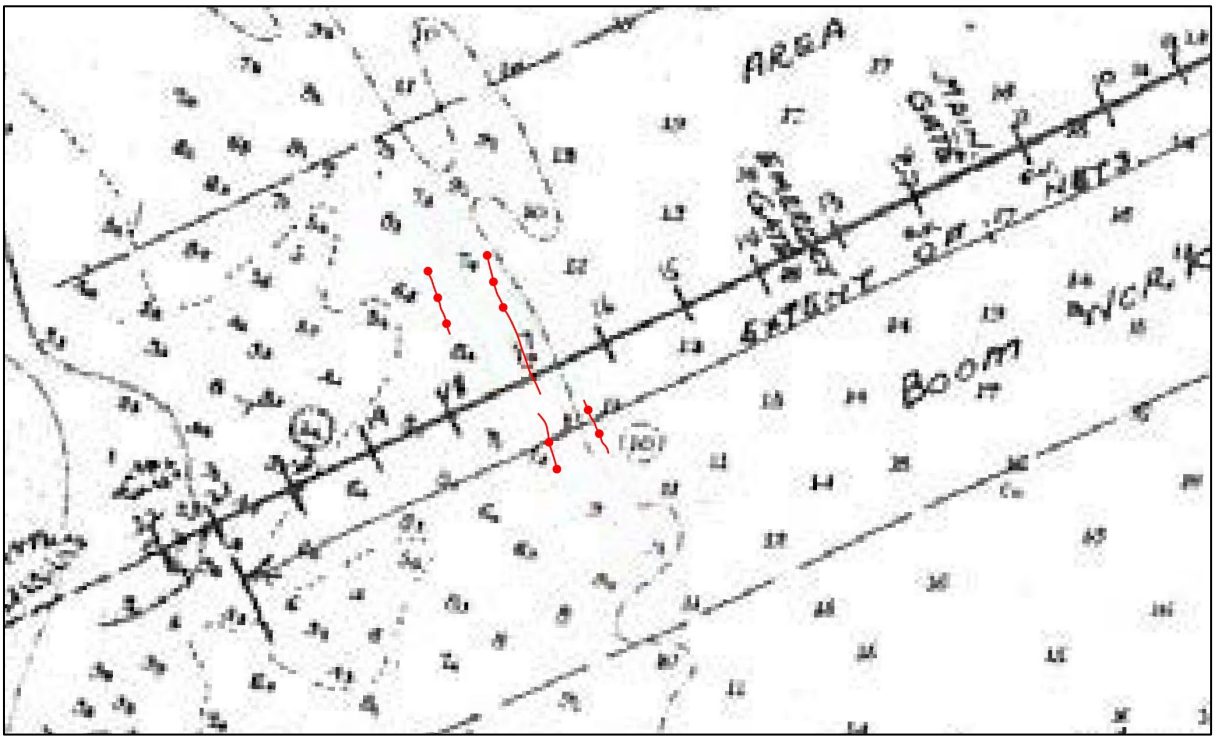


Figure 72: Historic chart of WWII anti-submarine boom net mooring trots overlaid with location of clump weights and chain identified by ROV (in red).

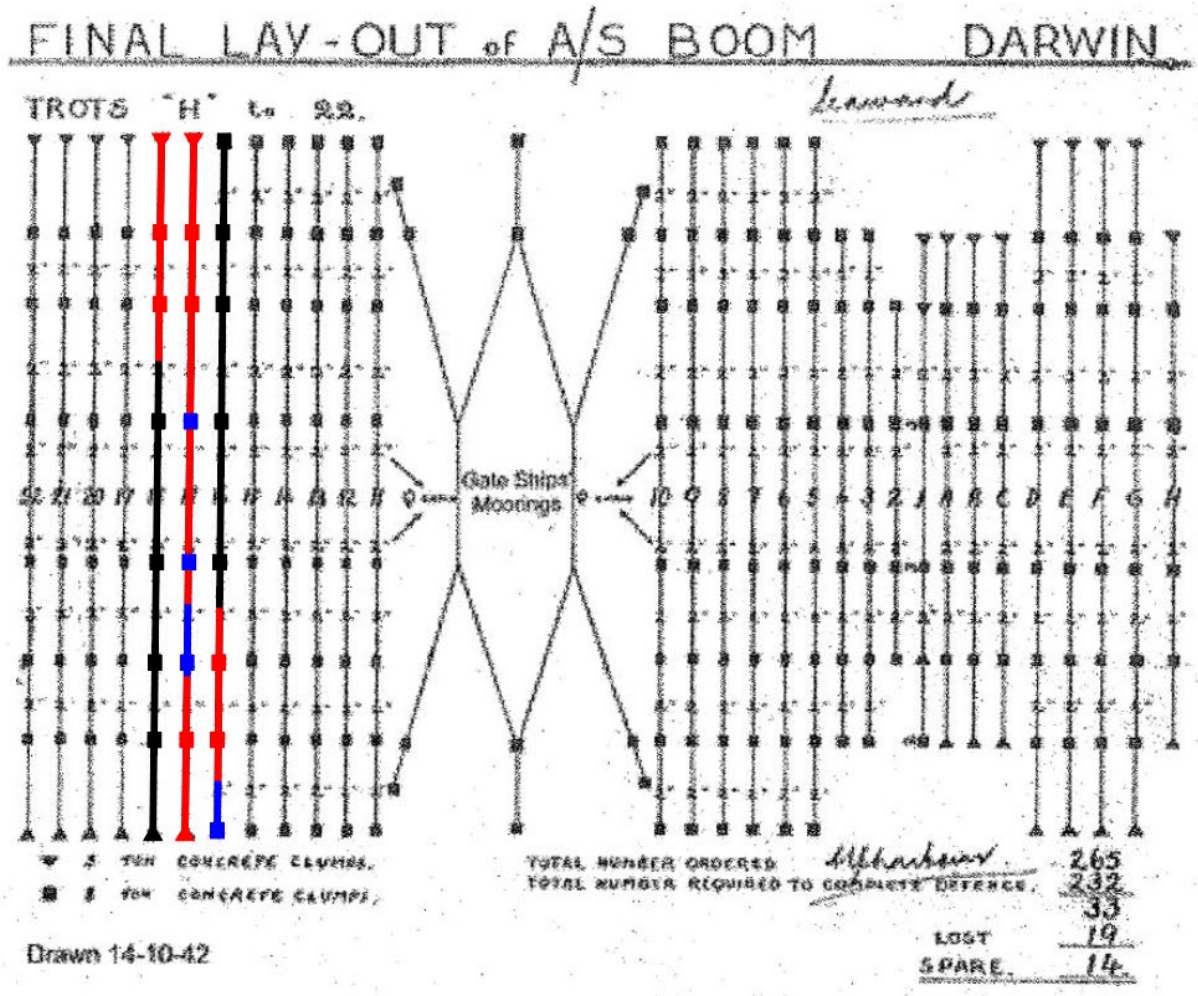


Figure 73: Schematic of anti-submarine net trots, with surveyed net trots highlighted. Clump weights shown by rectangles and triangles and chain shown by lines. Red represents features identified during ROV survey, blue represents features that were missing, and black represents features that were omitted from the survey.

Heritage Transect 1 (Trot 17)

Heritage transect 1 corresponds with the location of trot 17, and is the central trot of the three surveyed. Five mooring clumps were identified along this trot, two on the southern end, including the southernmost clump, and three on the northern end, including the northernmost clump. The location of the other three mooring clumps is unknown. The entire length of the trot is approximately 482m.

The chain ran continuously between the Clump 8 (northernmost) to around the location of where the Clump 4 should have been. At this location, there was a break in the chain, with an array of metal chain branching in multiple directions. The nature of this structure is unknown; however, it is clearly connected to the chain and the northern clump weights. Likewise, the chain from Clump 1 (southernmost) was observed to run from Clump 1 to Clump 2 unbroken before disappearing near the location where Clump 3 should have been. There appears to be a gap between the southern section of the mooring trot and the northern section of approximately 20-30m where no chain or clumps were observed. Between Clumps 5 and 6, a large kink was seen in the chain, indicating that it had perhaps been dragged out of position by an anchor or trawler.

Four of the five clumps observed appeared to be the 8-ton trapezoidal concrete weights shown in Figure 30 in section 4.3.3. Clump 2 appeared on video as a twin set of concrete blocks.

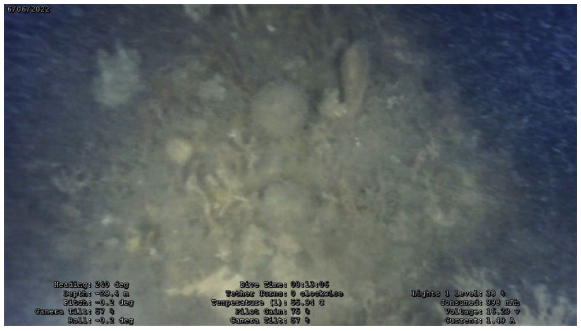


Figure 74: Clump 1 (aka geophysical target 167).

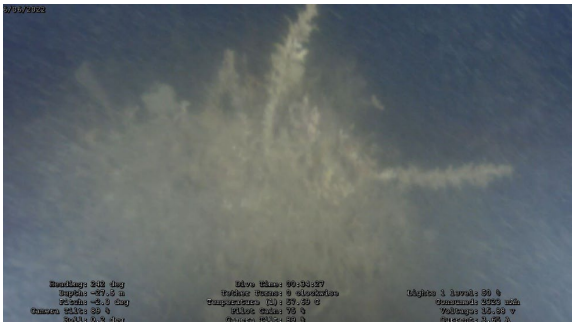


Figure 75: Trot 17, Clump 2 (aka geophysical anomaly NCL_SC_020).

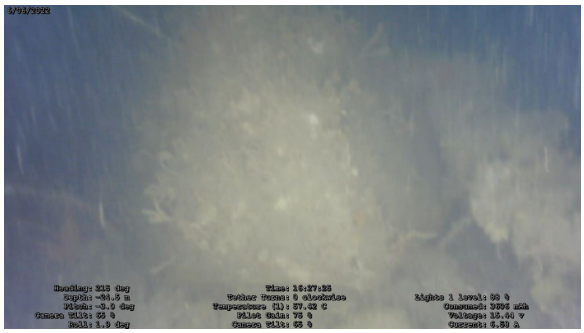


Figure 76: Trot 17, Clump 6 (aka geophysical anomaly 244).

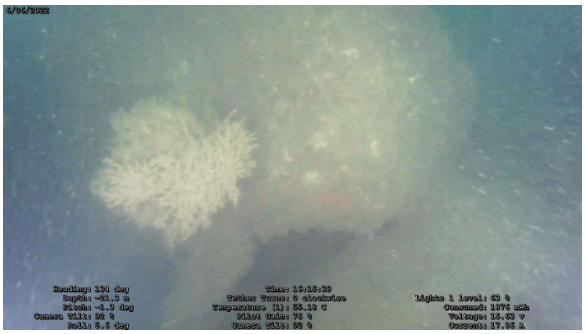


Figure 77: Trot 17, Clump 7 (aka geophysical anomaly NCL_SC_022).

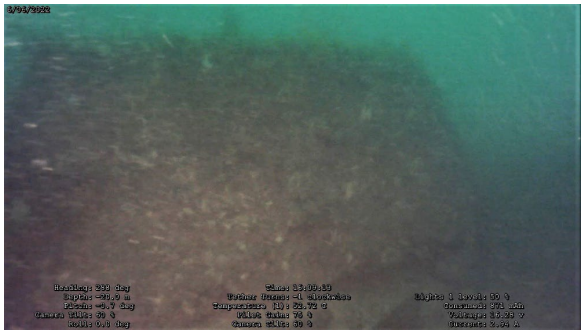


Figure 78: Trot 17, Clump 8 (not identified during geophysical survey).

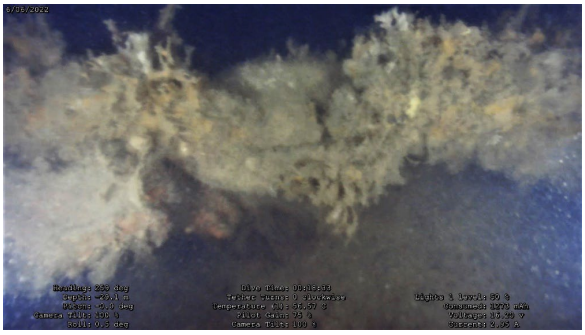


Figure 79: Detail of chain between Clumps 1 and 2.

Heritage Transect 2 (Trot 18)

Heritage Transect 2 corresponds roughly with the location of Trot 18 and is the western trot of the three surveyed. Three mooring clumps were observed by ROV survey comprising most of the northern half of the trot (Clumps 6, 7, and 8). Several of the southern clumps are clearly visible on geophysical survey data. Trot 18 is bisected by the Bayu-Undan GEP, with Clump 5 almost abutting the pipeline as seen on MBES and SSS data. The southern sections of Trot 18 were not surveyed, as their proximity to the existing GEP and their distance from the proposed GEP indicated they are unlikely to be impacted by the proposed works.

The chain ran continuously from Clump 6 to Clump 8, with no breaks or kinks. Clumps 6 and 7 were observed to be the same trapezoidal concrete weights identified in Trot 17, with the same gauge chain connecting them. Clump 8 was unique however, as it consisted of a large

ship's anchor that had apparently been repurposed as a mooring for the anti-submarine net. The anchor appeared to be an admiralty pattern style, with a long narrow shank and curving arms with triangular flukes. The anchor laid perpendicular to the seabed, with one arm buried and one arm standing proud from the seafloor. A large rectangular stock was observed, with what appeared to be metal bands wrapped around the sides, indicating that the stock is possibly (but very unlikely) of wooden construction. However, it was impossible to determine from ROV footage precisely what material was used for the stock due to the extensive marine growth covering it. The crown of the anchor was connected to the trot chain with a large D-shackle.

The ROV's depth gauge was used to measure the length of the visible arm by taking a depth reading at the top of the fluke and another at the seabed. The arm measured approximately 1.9m in length, while measurements taken from SSS data indicate that the total length of the shank is approximately 4m.

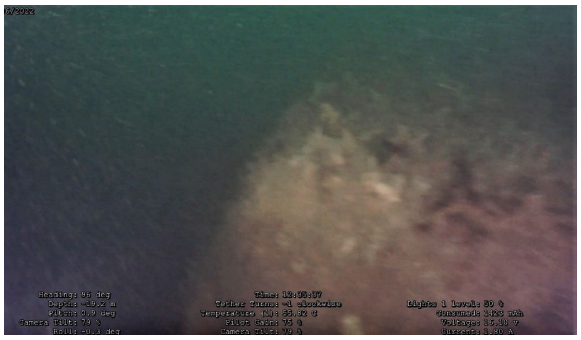


Figure 80: Trot 18, Clump 6.

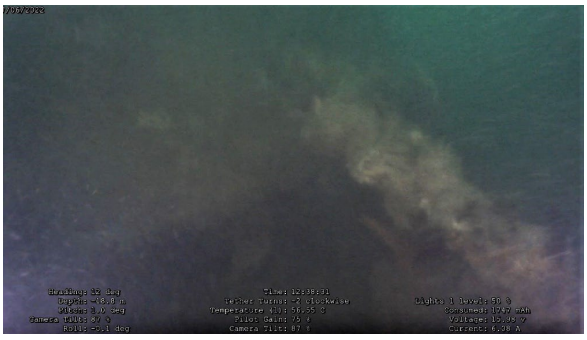


Figure 81: Trot 18, Clump 7.

Figure 82: Trot 18, Clump 8, repurposed ship's anchor. Photo shows anchor arm and fluke.

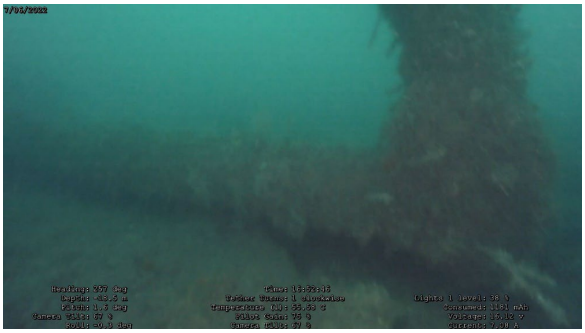


Figure 83: Trot 18, Clump 8, repurposed ship's anchor. Photo shows anchor throat and shank.

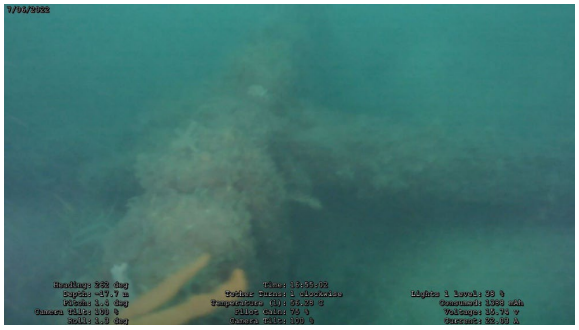


Figure 84: Trot 18, Clump 8, repurposed ship's anchor. Photo shows anchor stock and shank.

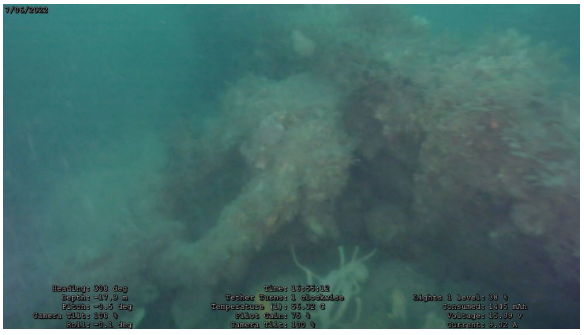


Figure 85: Trot 18, Clump 8, repurposed ship's anchor. Detail of stock and shackle connecting anchor to mooring trot chain.

Heritage Transect 3 (Trot 16)

Heritage Transect 3 corresponds roughly with the location of Trot 16 and is the eastern trot of the three surveyed. Two mooring clumps were observed by ROV survey, comprising a portion of the southern section of the trot (Clumps 2 and 3). The southernmost clump, Clump 1, was not observed on ROV survey or on geophysical survey data. The chain, running south from Clump 2, was observed to be severely kinked about 15m south of Clump 2 before ending abruptly. Further search of the area with ROV yielded no further evidence of the chain or Clump 1.

The chain ran continuously from Clump 2 to Clump 3 and extended north beyond Clump 3. It was decided to omit any survey of the northern section of the chain due to the distance from the proposed GEP route and the lack of geophysical survey data north of this location (see Figure 72 in section 7.2). Both clumps observed were 8-ton trapezoidal concrete weights.

Trot 16 had clearly been subjected to some disturbance, as the chain connecting Clumps 2 and 3 was heavily kinked and Clump 3 was observed to be upside down.

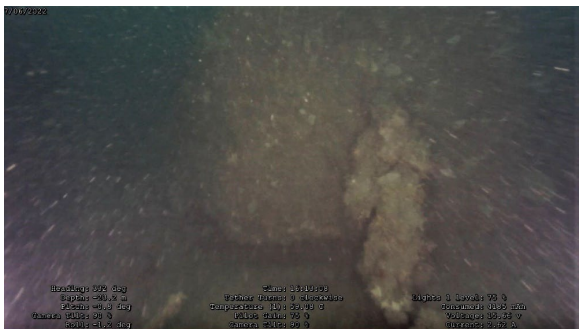


Figure 86: Trot 16, Clump 2 (aka geophysical anomaly 166).

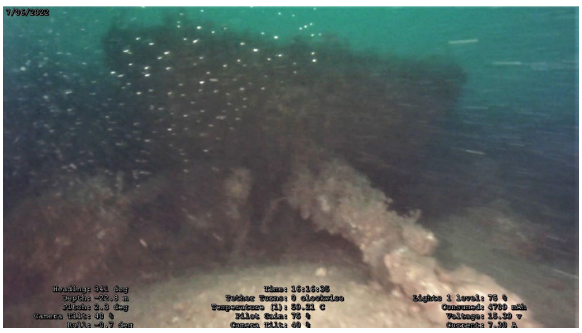


Figure 87: Trot 16, Clump 3. Note block appears to be flipped upside down.

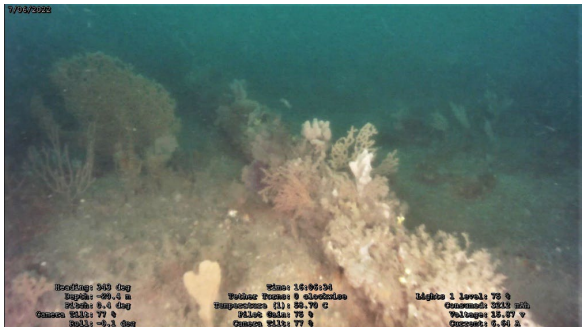


Figure 88: Chain between Clumps 2 and 3, Trot 16.

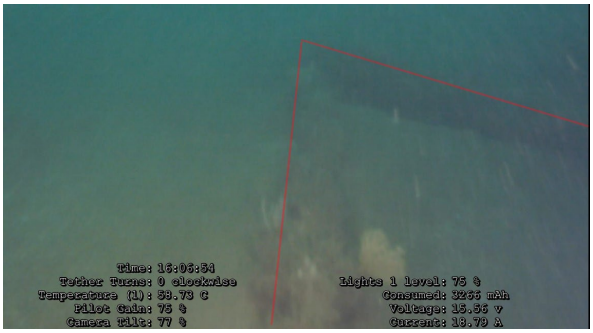


Figure 89: Chain south of Clump 2. Note right angle kink in chain (highlighted in red).

7.3.2 *Target 174 (winch, windlass, or bollard)*

Target 174 was located near KP 109, approximately 15m from the proposed GEP route. Investigation of the target by ROV found a small metal structure, reminiscent of a dumbbell weight, with two vertical protuberances sticking out of the seabed. The seabed around Target 174 was flat and sandy, relatively featureless, and showed no other debris or cultural material within the immediate vicinity of the target. A length of rope was observed wrapped around the centre of the object with a coil underneath one part. Initial identification suggested that the target was a small ship's winch or windlass, or possibly a bollard. The lack of other identifiable cultural material in the area, i.e., wreckage, suggests that this is an isolated artefact that may have been deliberately discarded or accidentally lost. The exact nature of the cordage is unknown. If the rope is synthetic poly-rope, it would most likely be modern and not historically significant. If the rope is made of natural fibre, it is possible that the object is historic. Flexible steel wire rope has been in use since WWII and could represent historic cultural heritage.

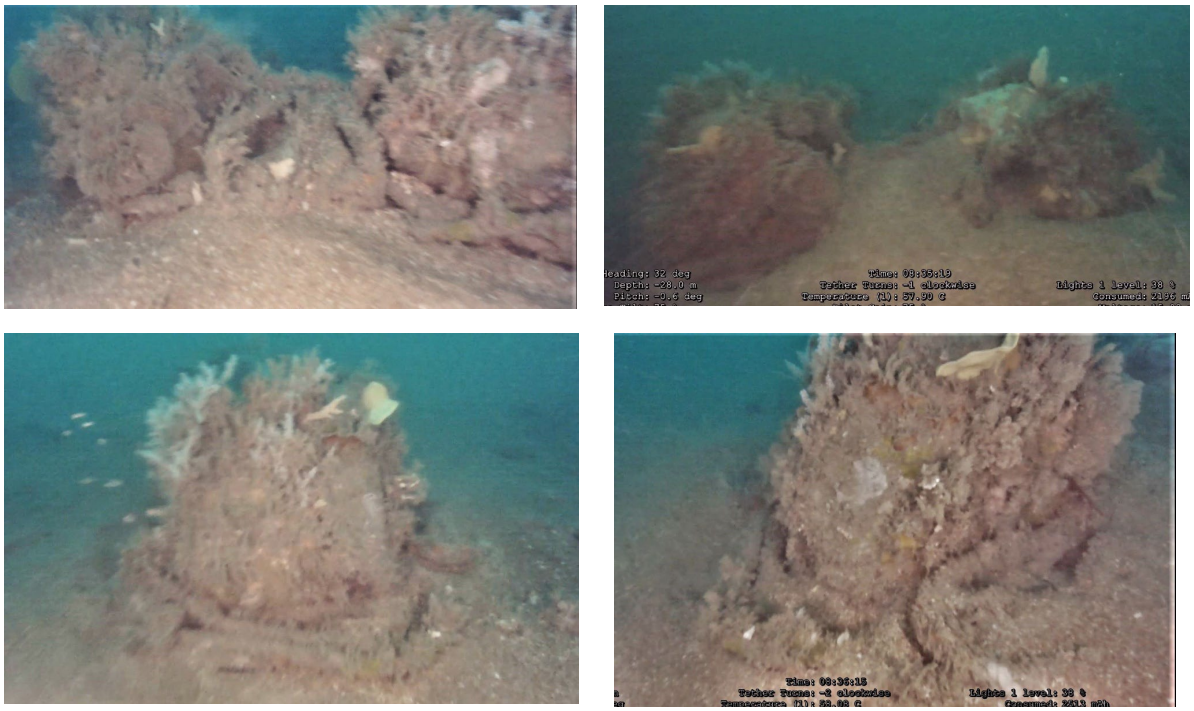


Figure 90: Images of Target 174 taken from ROV survey. Note rope wrapped around middle of structure.

Figure 91: "Coastal trading vessel MV* Zenalyn *(ex-Catalina refuelling vessel) in Darwin Harbour." Note winch on foredeck (detail of winch on right).[115]

[115] **Spillet, P. ca. 1950s-1960s**. "Coastal trading vessel MV Zenalyn (ex-Catalina refuelling vessel) in Darwin Harbour." Library & Archives NT, image PH0238/4149.

Figure 92: "Winches on the deck of Fujita Salvage Boat." Note bollard at bottom of picture.[116]

Figure 93: Small winch with rope used on Darwin working vessel, 1975.[117]

7.3.3 *MA_007 (unidentified metal structure)*

Target MA_007 was identified during geophysical surveys as a magnetic anomaly, with no discernible images seen on MBES and SSS. The target is located approximately halfway between KP 111 and 112 and is roughly 6m from the proposed GEP route.

ROV survey identified a field of debris located in a mostly sandy seabed. The debris was partially buried and had a low relief above the seabed. The primary artefact observed was a rectangular metallic structure made up of multiple rows of connected small beams. It was not possible to take measurements with the ROV, so the full scale and size of the structure, along with its composition, is unknown. The main structure is estimated to be roughly five metres long and 2 metres wide. Small fragments of apparently associated material were scattered around the primary structure in a debris field.

It is unknown, with the data available, whether Target MA_007 represents the wreckage of a vessel or aircraft, deliberate or accidental discard of materials, or disarticulated maritime infrastructure. The main structure bears some resemblance to historic photographs of small work barges as well as the internal support structures of some aircraft hulls and wings. Further investigation is needed to conclusively identify what the remains are likely to be.

[116] **Fujita Salvage Company, 1960**. "Winches on the deck of Fujita Salvage boat." Library & Archives NT, Senichiro Fujita Collection, PH0874/0120.
[117] **Bruce, H. 1975**. "Kay Laforest, Darwin." NLA PIC P805/30a LOC Q28.

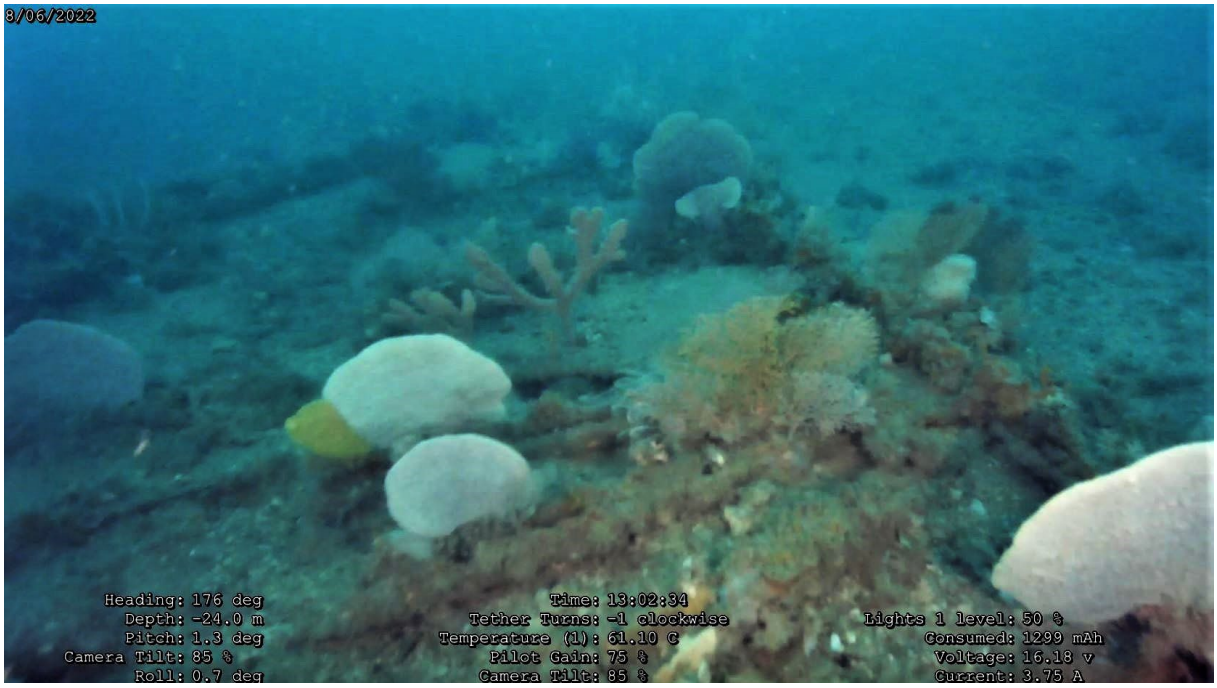


Figure 94: Target MA_007 as seen during ROV survey.

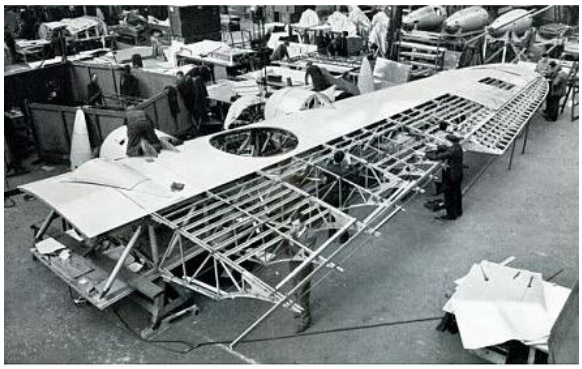


Figure 95: Short Empire flying boat wing under construction, showing structure of internal supports.

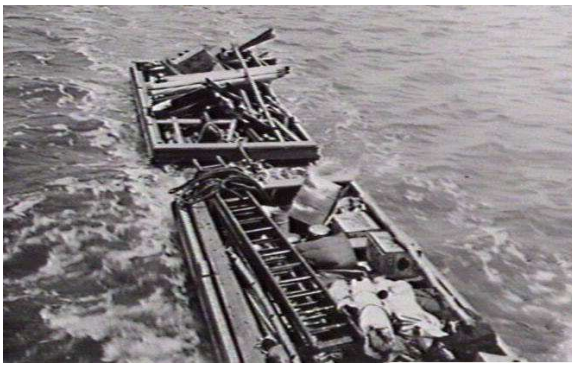


Figure 96: "Barges with materials for leper station being towed across harbour" 1937.[118]

7.3.4 *MA_001 (buoy mooring)*

Target MA_001 was identified during geophysical surveys as a magnetic anomaly, with no discernible images seen on MBES and SSS. The target is located approximately 150m north of KP 116 and is 35m from the proposed GEP route.

ROV survey identified three artefacts of cultural origin in the location of Target MA_001. The first located appeared to be a metal wheel rim and was mostly buried in sandy sediments. A small section of cable was observed protruding from the object. The second object, a length of metal cable with a loop tied in the end, was located a few metres away. It is believed that these two objects are related and represent the remains of a possible buoy mooring. The

[118] **Anon, 1937.** "Barges with materials for leper station being towed across harbour." Library & Archives NT, Australian Department of the Interior Collection, PH0125/0018.

wheel and cable are located within 70m of the wreck of USAT *Mauna Loa* and may be related to a navigational buoy used to identify the wreck site.

The third object noted was a piece of debris, likely concrete or metallic, with several wires protruding from the object. The exact composition of this artefact was impossible to determine by ROV survey, but may represent discard or a piece of wreckage, possibly from *Mauna Loa,* which was extensively salvaged in the 1950s (see section 4.3.1).

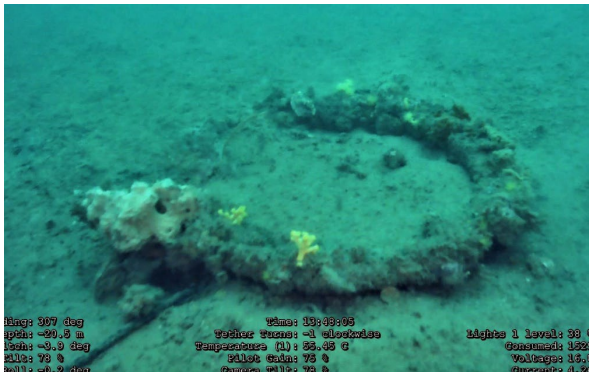


Figure 97: Metal wheel rim with cable protruding.

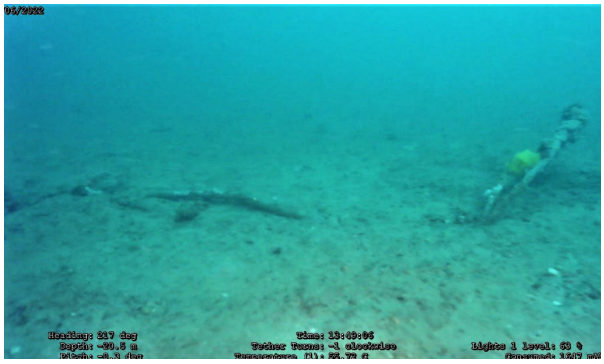


Figure 98: Mooring cable with loop at right of image.

Figure 99: Unidentified debris located several metres north of wheel rim and cable.

7.3.5 *NCL_SC_016 (cable)*

Target NCL_SC_016 was identified during geophysical surveys as a “likely cable support”, appearing as a small linear feature on SSS and MBES. The target is located approximately 145m north of KP 109 and is 25m from the proposed GEP route.

ROV survey located a section of cable lying on the seabed which appeared to be disarticulated at both ends. The section of cable was approximately 35m in total length with a width of less than 100mm. The precise make up and composition of the cable could not be determined by ROV survey, so its identity cannot be conclusively stated. The object is located in an area known to have contained 19th century telegraph cables (see section 4.3.3) and may represent a section of a cable that was cut or disarticulated.

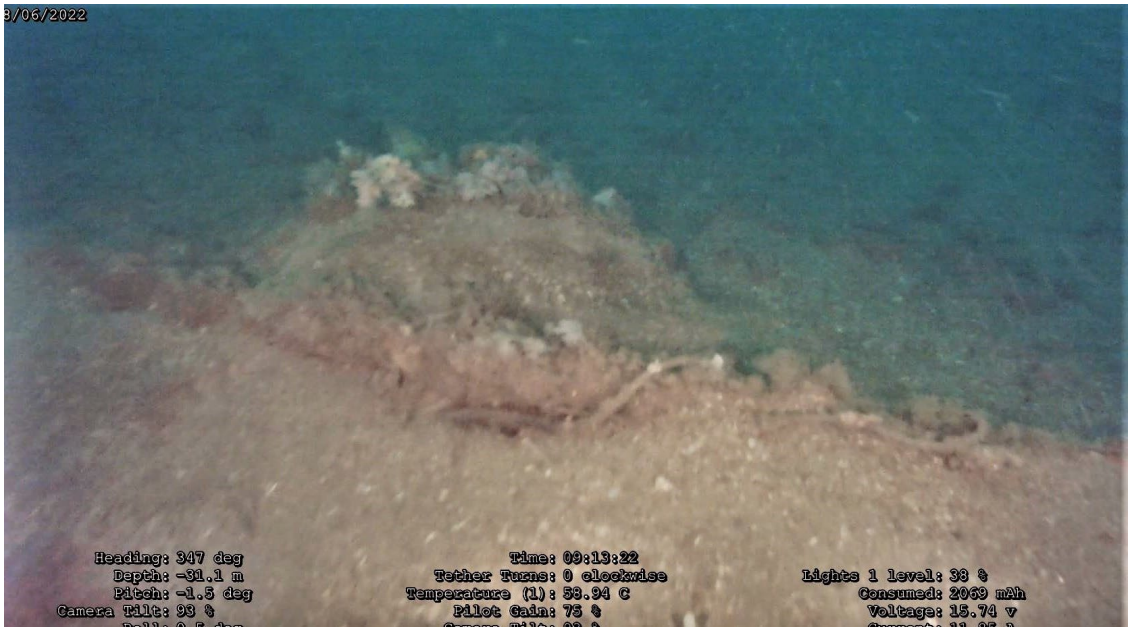


Figure 100: Detail of cable located at Target NCL_SC_016.

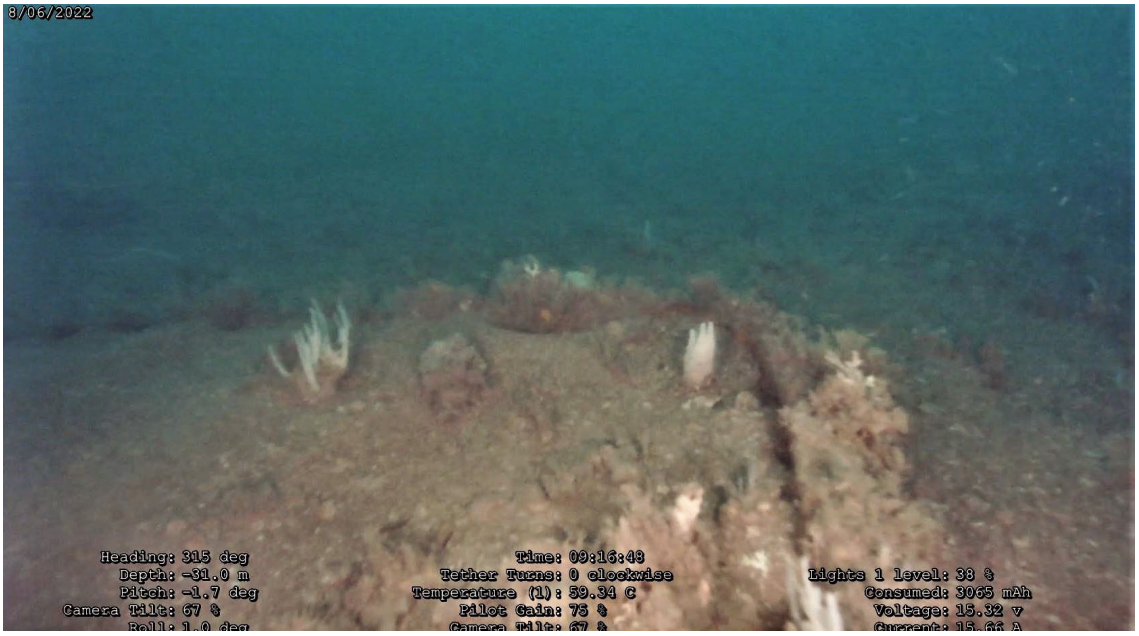


Figure 101: Detail of kink in cable.

8 DISCUSSION

8.1 Assessing cultural significance

Cultural Significance Criteria

All cultural objects have significance. The cultural significance of an object or a group of objects (a 'site') depends on what aspects of cultural activity the community values. In those jurisdictions where there are heritage laws, an established set of criteria is used to assess what objects or sites are eligible to be afforded greater statutory protection.

The Northern Territory *Heritage Act 2011* has provisions to declare a 'Heritage Place' or 'Heritage Object'. Such a declaration regulates activities within the site curtilage, hence protecting the site. To assist in the determination of whether a site, place, or object should be recommended for declaration under Part 2.2 of the Act, heritage assessment criteria (Part 1.2, Division 2, Section 11) have been established. The criteria are listed below.

A. *Whether it is important to the course, or pattern of the Territory's cultural or natural history;*
B. *Whether it possesses uncommon, rare or endangered aspects of the Territory's cultural or natural history;*
C. *Whether it has potential to yield information that will contribute to an understanding of the Territory's cultural or natural history;*
D. *Whether it is important in demonstrating the principal characteristics of a class of cultural or natural places or environments;*
E. *Whether it is important in exhibiting particular aesthetic characteristics;*
F. *Whether it is important in demonstrating a high degree of creative or technical achievement during a particular period;*
G. *Whether it has a strong or special association with a particular community or cultural group for social, cultural, or spiritual reasons, including the significance of a place to Aboriginal people as part of their continuing and developing cultural traditions;*
H. *Whether it has a special association with the life or works of a person, or group of persons, of importance in the Territory's history.*

The threshold for a site or object being declared is whether it can be demonstrated to have '…*special significance in the Territory'.* These cultural significance criteria have been adopted for this survey and all cultural objects found have been assessed against these criteria.

Cultural significance gradings

The Northern Territory heritage assessment criteria have been established to select sites/objects of 'special' significance to be protected. To date, no site/object found in the study area can be considered to have special significance. The significance of a site/object varies mostly depending on their rarity or representativeness and their condition; the latter point referring to the site/object's ability to provide information.

Table 12 provides five grades of cultural significance ranging from Minimal to Special. Identified cultural sites or objects have been assessed according to how well they may be able to contribute to the cultural heritage criteria set out in the Northern Territory Heritage Conservation Regulations.

Sites or objects can be considered of low significance if they are commonplace and recent even if they are associated with a significant individual or event. Such sites/objects, however, which are well preserved and are excellent representative examples can have an elevated level of significance. Higher significance tends to be given to those sites/objects which are older on the basis that such sites are rare and represent extinct or near extinct lifeways and/or technology. they can also be given higher significance because of their association with defining events in Northern Territory history; World War II being a good example.

Assessing the level of significance of each cultural object found will help determine what would be appropriate and proportionate mitigation measures against the proposed impacts. It may be sufficient for sites of low significance to be recorded *in situ* to a certain level before they are impacted. Other sites/objects could be considered significant enough to be excavated, relocated and/or recovered for conservation.

Table 12: Levels of cultural heritage significance.

Degree	Significance
Special	A rare or unique object or site in a relatively good state of preservation that provides an irreplaceable insight on the development of the Northern Territory and Australia. Eligible for listing as a 'Heritage Place' or 'Object'
High	A rare object or site type in a relatively good state of preservation that provides a new insight on the development of the Northern Territory and Australia.
Moderate	A rare object/site in a poor state of preservation or a common object/site in a relatively good state of preservation that provides an insight into the development of the Northern Territory.
Low	A common object or site type in a poor to fragmentary state of preservation that contributes to the understanding of the development of the Northern Territory.
Minimal	A ubiquitous object type, usually of recent manufacture, which provides little new information to the understanding of the development of the Northern Territory.

8.2 Preliminary evaluation

The following preliminary evaluation is based on the cultural significance of each of the 7 sites observed during the ROV surveys rather than individual objects (Table 13). Where the cultural significance of individual objects within a target varies, the significance rating of the target will be set to the highest rating object.

Table 13: Preliminary cultural significance assessments.

Target	Preliminary Significance Statement	Degree
Anti-submarine net Trot 16	WWII was a significant period in Australian and Northern Territory history and the remnants of the boom defence system related directly to the defence of Darwin Harbour during this period. Such items are rare as only a small number of boom defences were established in Australia during WWII. The anti-submarine defences of Darwin during WWII may have been the largest boom defence network in the world at the time. The boom defence mooring clumps and chains are *in situ* on the seafloor and in a good state of preservation. This makes them rare not only in the Northern Territory but in a National Context.	**High**

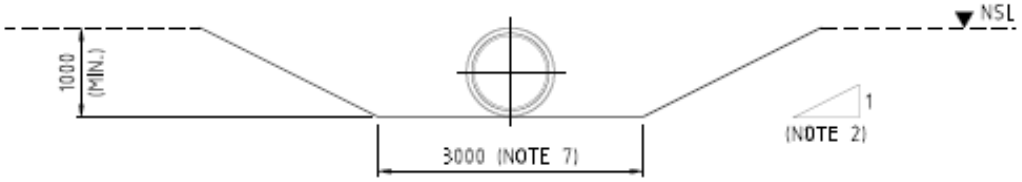
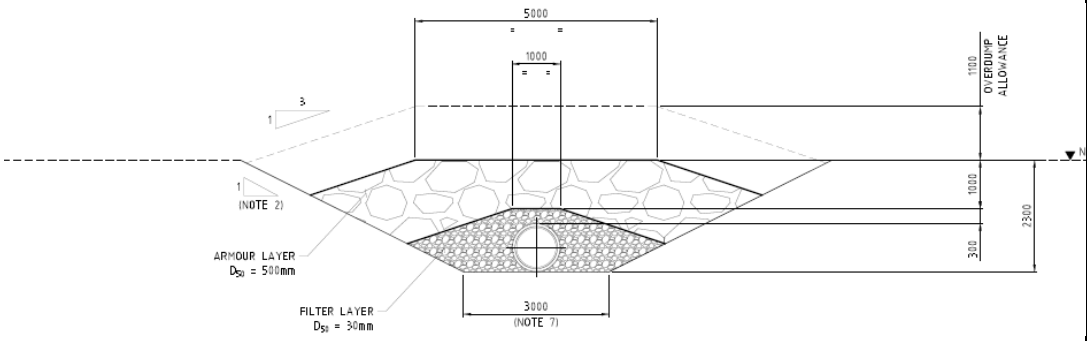
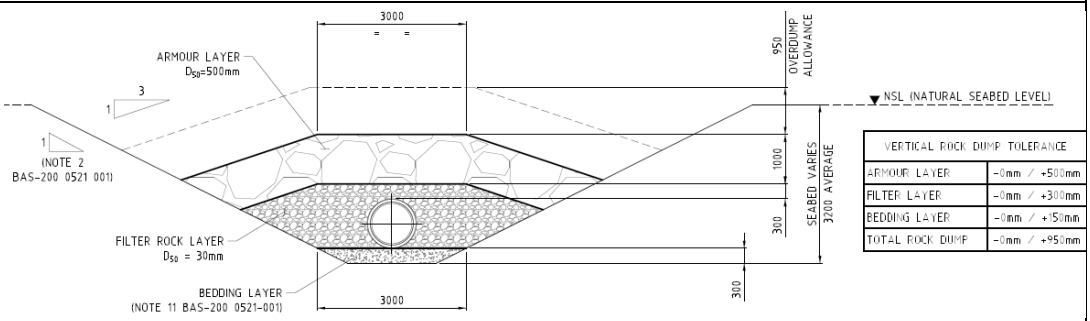
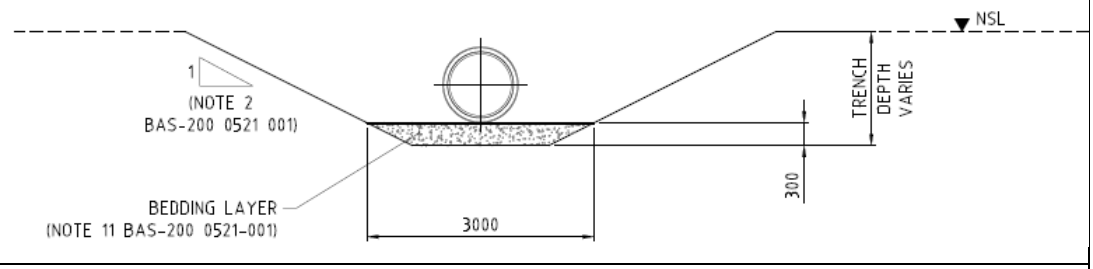
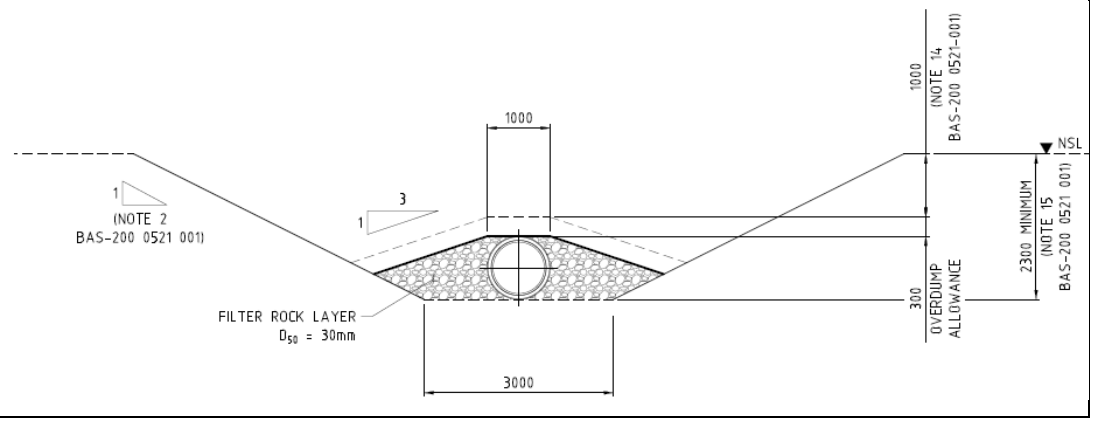
Target	Preliminary Significance Statement	Degree
Anti-submarine net mooring Trot 17	WWII was a significant period in Australian and Northern Territory history and the remnants of the boom defence system related directly to the defence of Darwin Harbour during this period. Such items are rare as only a small number of boom defences were established in Australia during WWII. The anti-submarine defences of Darwin during WWII may have been the largest boom defence network in the world at the time. The boom defence mooring clumps and chains are *in situ* on the seafloor and in a good state of preservation. This makes them rare not only in the Northern Territory but in a National Context.	**High**
Anti-submarine net mooring Trot 18	WWII was a significant period in Australian and Northern Territory history and the remnants of the boom defence system related directly to the defence of Darwin Harbour during this period. Such items are rare as only a small number of boom defences were established in Australia during WWII. The anti-submarine defences of Darwin during WWII may have been the largest boom defence network in the world at the time. The boom defence mooring clumps and chains are *in situ* on the seafloor and in a good state of preservation. In addition, the substitution of a conventional concrete mooring block with a repurposed ship's anchor increases the diagnostic value of this site by providing a unique display of adaptation and material scarcity during war time. The anchor itself is most likely of higher historic significance depending on its age and rarity. This makes them rare not only in the Northern Territory but in a National Context.	**High**
Target 174	The precise identity and nature of the object located at Target 174 cannot be conclusively determined based solely on a visual ROV survey. Further investigation would be needed to positively identify it within its historical context. However, if the object is a winch, windlass or bollard from a historic vessel its heritage significance could be substantially higher than if it was simply discarded. Target 174 is not believed to be part of a larger buried shipwreck.	Unknown, likely **Low**
MA_007	The precise identity and nature of the object located at Target MA_007 cannot be conclusively determined based solely on a visual ROV survey. Further investigation would be needed to positively identify it within its historical context. However, if the object is part of the wreckage of an historic aircraft or vessel, its heritage significance could be substantially higher than if it is discarded material.	Unknown, likely **Minimal** to **Moderate**
MA_001	The objects located at Target MA_001 are most likely the remains of a buoy mooring. Steel wire rope and steel wheel rims are commonly used as mooring devices across Australia, with numerous examples extant. The use of steel wire rope points to a likely late 20th century historical context. Not considered rare or culturally significant.	**Minimal**
NCL_SC_016	The precise identity and nature of the object located at Target NCL_SC_016 cannot be conclusively determined based solely on a visual ROV survey. Further investigation would be needed to positively identify it within its historical context. If the object is the remains of a 19th century telegraph cable, its cultural significance would be considerably higher than if it is modern material or discard.	Unknown, likely **Minimal** to **Low**

8.3 Potential impacts

Santos has advised that the pipeline will primarily be laid directly on the seabed. It is understood that trenching and placement of rock armour will be undertaken in several sections within Darwin Harbour (see Figure 103). The potential footprint of trenching has been identified as up to 40 m wide at top of batter due to use of cutter suction dredge. These sections include spans between KP 101 and 107, 110 and 114, 119 and 121, and 121 to terminus. It is understood, based on design documents provided by Santos, that five different

trenching configurations will be used, types A2, C1b, D1, D3, and E. Cross sections detailing the designs of the five trench types are shown in Table 14.

Table 14: Trench type cross section. NSL - natural seabed level.

Trench Type	Cross Section
A2	
C1b	
D1	
D3	
E	

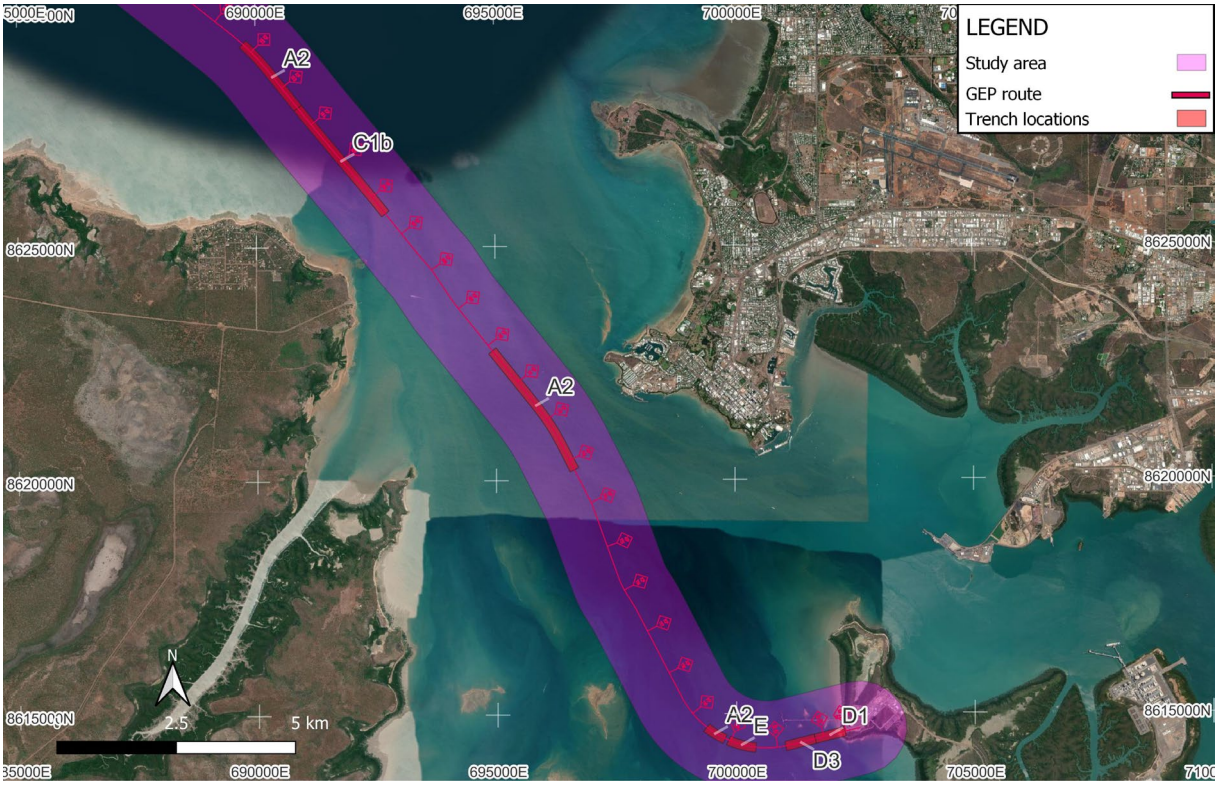


Figure 102: Map of proposed trenching locations with trench type labelled. (Polygons for trench locations are indicative of location only, not to scale by width).

One instance of underwater cultural heritage, Target MA_007, is within the trench extent overview. The target is located within the A2 trench between KP 111 and 113 (see Figure 104).

The laying of a pipe over a wreck site will not destroy such a site but will disturb or impact it. Such an activity, however, may damage and destabilise the site. It is understood that some sections will require the placement of mattresses to address spanning issues. Mattresses would cover parts of a site, which will protect it in the long term, but would negatively impact the site if it is not recorded before partial burial. If the wreck site is legally protected such disturbances could be considered unlawful without appropriate approvals under relevant heritage legislation. Additionally, Santos has identified a 900 m wide corridor on either side of the proposed GEP route between KP 91.5 and the terminus where work vessels may need to anchor. Anchor chains present a significant hazard to maritime cultural heritage sites within their deployment zone, as sweeping chains can damage or move archaeological sites and artefacts.

Within the anchoring corridor there are eight known shipwrecks (see Section 4.3.1, Table 2). Two of these, USAT *Mauna Loa* and USAT *Meigs,* fall under the protection of the NT *Heritage Act 2011* and may be protected under the USA *SMCA 2004.* The remaining six wrecks are under no legislative protection. Three objects of cultural heritage, inspected during ROV surveys, are also within the anchoring corridor, Targets 174, MA_007, and NCL_SC_016 (see Section 6.3.1). Additionally, the anti-submarine net mooring trots 16, 17, and 18 are within this corridor. It is highly likely, based on review of historical sources and geophysical survey data, that many of the remaining trots are also located within the anchoring corridor. In addition to trots 16, 17, and 18, an additional 90 geophysical targets within the anchoring corridor were identified as likely remains of anti-submarine net moorings (see Section 6.3.3).

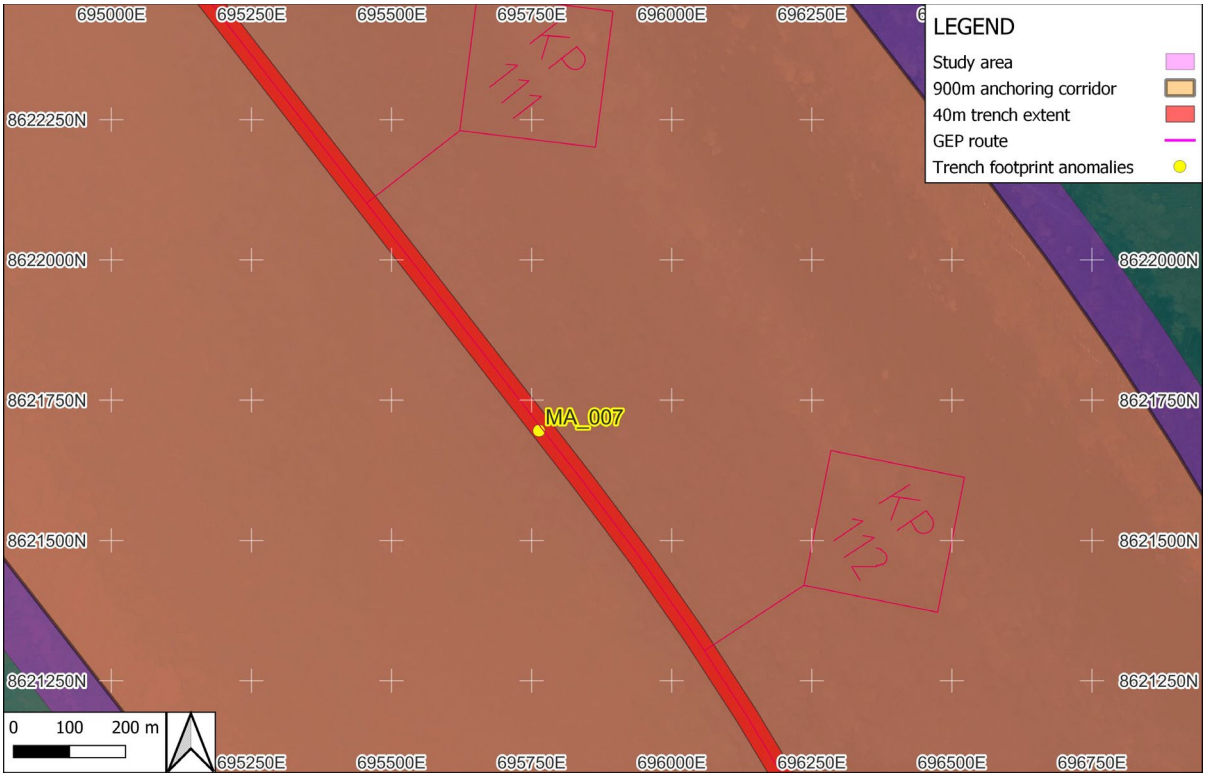


Figure 103: Underwater cultural heritage within trench extent overview.

A further 63 unverified geophysical anomalies, identified during geophysical survey data review but not inspected by ROV, are within the anchoring corridor (Figure 105). 18 of these targets were identified during review of Fugro survey data (see Section 6.3.1) and 45 were identified from review of the Geoscience Australia MBES dataset (see Section 6.3.2).

The location of these additional unverified anomalies, shipwrecks, and known cultural heritage is shown in Figure 105 and Table 15.

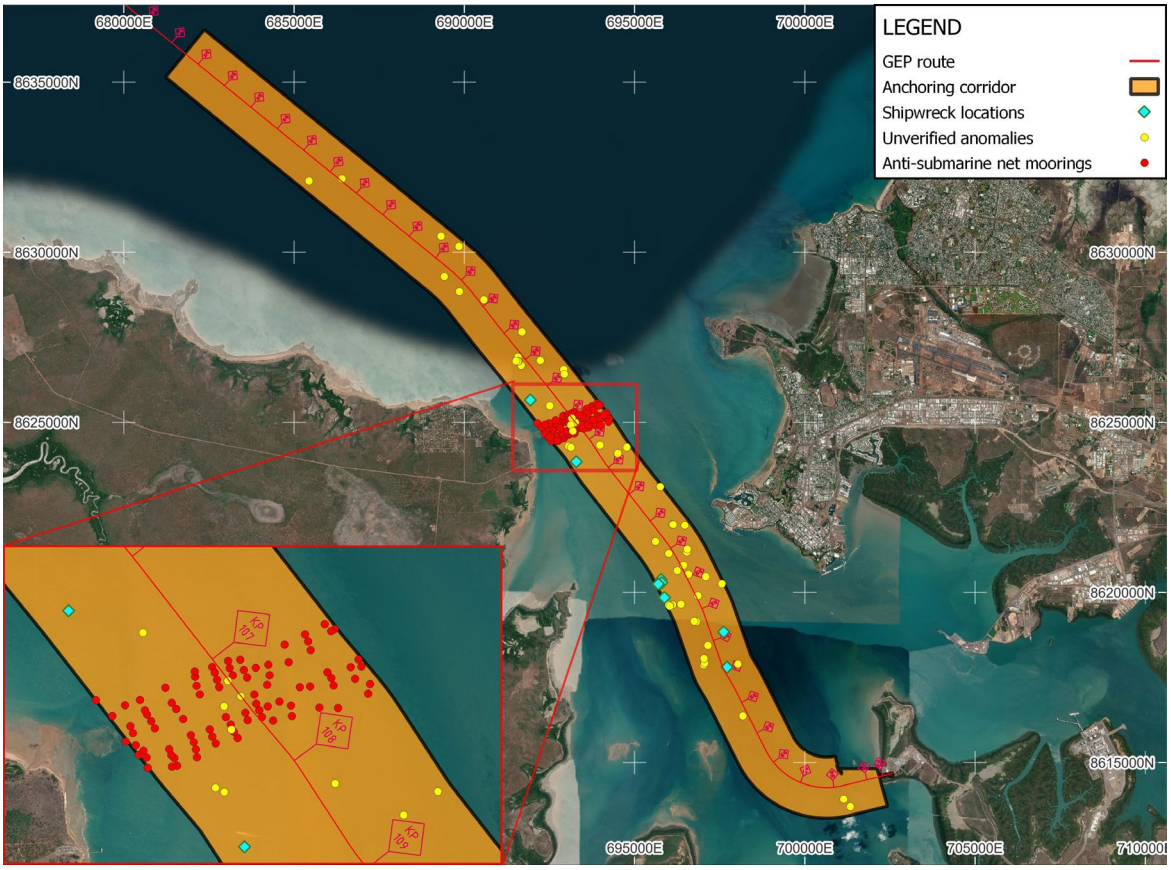


Figure 104: Location of unverified geophysical survey anomalies and other underwater cultural heritage within anchoring corridor.

Table 15: Unverified anomalies, shipwrecks, and known maritime cultural heritage within anchoring corridor.

Anomaly ID	Identification	Datum: GDA94 CRM: UTM Zone 52s		Distance from GEP (m)
		Easting	Northing	
138	Mound associated with anchor scar	686,407.37	8,632,159.33	59
141	Debris or rocks	690,574.96	8,628,606.67	137
191	Single object of high relief. Possible small boat.	696,438.36	8,620,800.13	73
192	Possible debris	696,253.89	8,620,643.48	147
196	Debris or rocks	696,859.94	8,619,902.39	53
210	Possible aircraft wreck or natural feature.	701,140.90	8,613,958.61	360
238	Possible scattered debris.	696,581.70	8,620,537.67	78
239	USAT *Mauna Loa*	697,710.77	8,617,774.90	90
240	Possible mooring block for anti-submarine defences	691,578.22	8,626,925.25	122
242	Steel wire rope and chain associated with anti-submarine defences. (boom net), UXO including mechanical fuses and fuse cones. (See Section 6.4)	691,589.94	8,626,799.20	186
243	Possible mooring block related to anti-submarine defences.	693,188.00	8,624,746.00	216
500	USAT *Meigs*	697,615.17	8,618,840.23	369
501	Medkhanun 3	695,875.84	8,619,850.01	847

Anomaly ID	Identification	Datum: GDA94 CRM: UTM Zone 52s		Distance from GEP (m)
		Easting	Northing	
502	*Ham Luong*	695,698.81	8,620,246.53	832
503	*Song Saigon*	695,794.02	8,620,287.72	728
504	John Holland Barge	695,778.93	8,620,381.31	700
505	*Mandorah Queen*	693,287.42	8,623,844.84	683
506	*NR Diemen*	691,938.35	8,625,657.51	642
573	Debris	692,508.78	8,625,489.01	295
574	WWII anti-sub boom net	691,574.41	8,626,791.47	209
575	Debris	691,518.71	8,626,801.77	245
576	Mound	689,856.12	8,628,847.08	268
577	Isolated object	689,412.76	8,629,288.62	263
578	Mound associated with trawl scar	685,439.11	8,632,096.37	603
579	Debris	689,314.84	8,630,473.13	592
580	Mound	689,842.70	8,630,171.05	691
581	Possible cable	691,692.88	8,627,659.36	431
582	Possible cable	692,233.25	8,626,819.69	320
583	Linear debris	692,918.80	8,626,550.93	682
584	Debris or boulder	692,936.90	8,626,417.56	613
588	Debris	693,982.49	8,624,331.38	165
585	Debris	694,508.35	8,624,088.70	472
586	Possible small boat or natural feature	694,770.88	8,624,269.65	791
587	Mooring block	695,753.15	8,623,106.77	852
589	Debris	696,110.51	8,621,995.74	452
590	Debris	696,133.59	8,621,994.69	470
591	Debris	696,472.78	8,621,975.02	727
592	Debris	696,535.45	8,621,187.11	345
593	Mooring block	696,548.46	8,621,272.90	399
594	Debris	697,090.00	8,620,464.24	513
595	Debris	697,563.09	8,620,256.32	845
597	Debris	698,035.82	8,617,894.98	443
598	Linear feature	697,030.36	8,617,864.23	504
599	Linear feature	697,055.70	8,617,918.12	462
600	Linear feature	697,036.34	8,618,057.64	434
601	Debris	696,815.85	8,619,144.52	286
602	Debris	696,751.52	8,619,156.36	343
603	Debris	696,112.03	8,619,639.40	729
604	Linear feature, log	696,043.52	8,619,624.92	797
605	Linear feature, log	696,000.91	8,619,629.09	833
606	Linear feature, log	696,032.94	8,619,598.74	818
607	Debris	696,362.60	8,619,654.65	497
609	Debris	696,003.49	8,621,145.27	132
610	Isolated object	695,614.51	8,621,498.95	244
611	Mooring block	693,064.64	8,624,298.00	599

Anomaly ID	Identification	Datum: GDA94 CRM: UTM Zone 52s		Distance from GEP (m)
		Easting	Northing	
612	Debris	693,132.32	8,624,265.69	568
620	Anti-submarine net mooring	692,571.44	8,624,809.47	663
621	Anti-submarine net mooring	692,539.74	8,624,860.74	656
622	Anti-submarine net mooring	692,523.80	8,624,892.44	649
623	Anti-submarine net mooring	692,599.70	8,624,754.58	674
624	Anti-submarine net mooring	692,709.75	8,624,594.89	685
625	Anti-submarine net mooring	692,769.99	8,624,467.63	716
626	Anti-submarine net mooring	692,749.61	8,624,525.87	696
627	Anti-submarine net mooring	692,726.33	8,624,548.70	700
628	Anti-submarine net mooring	692,147.90	8,624,971.06	898
629	Anti-submarine net mooring	692,431.95	8,624,717.81	829
630	Anti-submarine net mooring	692,412.02	8,624,771.61	812
631	Anti-submarine net mooring	692,453.33	8,624,625.24	869
632	Anti-submarine net mooring	692,922.97	8,624,532.76	556
633	Anti-submarine net mooring	692,914.46	8,624,593.08	525
634	Anti-submarine net mooring	692,897.79	8,624,648.33	504
635	Anti-submarine net mooring	692,876.05	8,624,702.14	488
636	Anti-submarine net mooring	692,763.55	8,624,903.58	453
637	Anti-submarine net mooring	692,729.14	8,624,950.23	452
638	Anti-submarine net mooring	692,816.54	8,624,826.14	459
639	Anti-submarine net mooring	693,066.90	8,624,638.82	377
640	Anti-submarine net mooring	693,040.27	8,624,691.00	365
641	Anti-submarine net mooring	693,020.88	8,624,746.07	347
642	Anti-submarine net mooring	692,944.62	8,625,014.99	242
643	Anti-submarine net mooring	692,919.53	8,625,081.20	221
644	Anti-submarine net mooring	692,908.66	8,625,150.86	187
645	Anti-submarine net mooring	692,905.94	8,625,190.98	164
646	Anti-submarine net mooring	693,039.04	8,625,225.45	38
647	Anti-submarine net mooring	693,058.79	8,625,182.69	49
648	Anti-submarine net mooring	693,076.54	8,625,127.44	69
649	Anti-submarine net mooring	693,093.03	8,625,071.10	90
650	Anti-submarine net mooring	693,205.80	8,624,728.36	213
651	Anti-submarine net mooring	693,234.87	8,624,680.26	222
652	Anti-submarine net mooring	693,144.21	8,624,841.13	191
653	Anti-submarine net mooring	693,182.07	8,624,784.25	196
654	Anti-submarine net mooring	693,311.23	8,624,817.58	75
655	Anti-submarine net mooring	693,293.93	8,624,874.10	53
656	Anti-submarine net mooring	693,197.83	8,625,161.77	48
657	Anti-submarine net mooring	693,162.23	8,625,272.64	88
658	Anti-submarine net mooring	693,173.46	8,625,217.02	63
659	Anti-submarine net mooring	693,400.45	8,624,893.93	42
660	Anti-submarine net mooring	693,420.92	8,624,841.76	24

Anomaly ID	Identification	Datum: GDA94 CRM: UTM Zone 52s		Distance from GEP (m)
		Easting	Northing	
661	Anti-submarine net mooring	693,376.72	8,624,944.02	56
662	Anti-submarine net mooring	693,282.43	8,625,202.62	140
663	Anti-submarine net mooring	693,307.79	8,625,145.38	125
664	Anti-submarine net mooring	693,254.26	8,625,282.33	167
665	Anti-submarine net mooring	693,362.50	8,625,014.22	88
666	Anti-submarine net mooring	693,460.95	8,625,089.13	211
667	Anti-submarine net mooring	693,555.33	8,624,959.96	203
668	Anti-submarine net mooring	693,650.62	8,624,848.92	204
669	Anti-submarine net mooring	693,506.97	8,624,814.32	72
670	Anti-submarine net mooring	693,465.48	8,624,923.37	111
671	Anti-submarine net mooring	693,643.69	8,624,929.98	251
672	Anti-submarine net mooring	693,469.78	8,625,242.93	313
673	Anti-submarine net mooring	693,711.60	8,625,070.97	394
674	Anti-submarine net mooring	694,135.50	8,625,135.19	759
675	Anti-submarine net mooring	694,161.68	8,625,283.10	875
676	Anti-submarine net mooring	694,183.69	8,625,228.03	856
677	Anti-submarine net mooring	694,250.36	8,625,094.43	821
678	Anti-submarine net mooring	693,923.28	8,625,184.46	629
679	Anti-submarine net mooring	693,952.90	8,625,141.07	624
680	Anti-submarine net mooring	693,970.93	8,625,083.92	601
681	Anti-submarine net mooring	693,751.64	8,625,475.17	678
682	Anti-submarine net mooring	693,775.01	8,625,422.23	664
683	Anti-submarine net mooring	693,794.64	8,625,355.29	638
684	Anti-submarine net mooring	693,902.95	8,625,554.38	846
685	Anti-submarine net mooring	694,101.63	8,625,224.18	791
686	Anti-submarine net mooring	693,979.35	8,625,516.11	883
687	Anti-submarine net mooring	693,951.72	8,625,500.98	852
688	Anti-submarine net mooring	693,595.12	8,625,397.09	506
689	Anti-submarine net mooring	693,625.83	8,625,262.22	448
690	Anti-submarine net mooring	693,861.92	8,624,914.00	408
691	Anti-submarine net mooring	694,235.64	8,625,020.33	763
692	Anti-submarine net mooring	694,004.85	8,624,910.74	515
693	Anti-submarine net mooring	693,790.27	8,625,076.31	458
694	Anti-submarine net mooring	692,680.70	8,625,066.80	418
695	Anti-submarine net mooring	692,486.05	8,624,972.60	630
696	Anti-submarine net mooring	692,274.19	8,624,850.32	872
697	Anti-submarine net mooring	692,370.93	8,624,932.20	746
698	Anti-submarine net mooring	692,376.54	8,624,652.46	913
699	Anti-submarine net mooring	693,479.77	8,625,162.13	271
700	Anti-submarine net mooring	693,373.52	8,625,219.83	223
701	Anti-submarine net mooring	692,476.81	8,624,552.19	895
702	Anti-submarine net mooring	692,545.01	8,624,451.33	903

Anomaly ID	Identification	Datum: GDA94 CRM: UTM Zone 52s		Distance from GEP (m)
		Easting	Northing	
703	Anti-submarine net mooring	692,536.68	8,624,530.67	861
704	Anti-submarine net mooring	692,512.14	8,624,583.21	848
705	Anti-submarine net mooring	692,731.65	8,624,460.66	750
706	Anti-submarine net mooring	693,612.40	8,625,501.30	584
707	Anti-submarine net mooring	693,639.40	8,625,450.30	414
708	Anti-submarine net mooring	693,667.30	8,625,396.10	435
709	Anti-submarine net mooring	693,801.20	8,625,027.90	562
710	Anti-submarine net mooring	693,812.30	8,624,981.60	576
MA_028	Inferred Cable	693,130.70	8,624,923.90	151
MA_031	Inferred Buried Debris	698,180.90	8,616,372.60	146
MA_037	Icthys GEP	701,335.50	8,613,704.20	651

Four geophysical anomalies were identified within 10m of the proposed GEP route, ID: 142, 175, 245, and 246. Targets 142, 175, 245, and 246 were observed during ROV surveys and determined to be natural. An additional six geophysical anomalies were identified within 50m of the proposed GEP route, ID: 166, 174, 233, 241, 244, and 247. Targets 166 and 244 were identified by ROV survey as part of Trot 18, while 233, 241, and 247 were identified to be natural features by ROV. Target 174 was identified as cultural in origin.

The ROV survey identified three anti-submarine net mooring trots, Trots 16, 17, and 18. Trot 17 directly crosses the path of the proposed GEP route. The northern most clump of Trot 16, identified as a repurposed ship's anchor, is located approximately 37m from the proposed GEP route, and the southernmost chain section of Trot 18 is located 32m from the proposed GEP route. The location of Clump 1, Trot 18, if still extant would likely be located within 25m of the proposed route.

In addition to the anti-submarine net trots, four isolated instances of cultural heritage were observed during ROV surveys. Target MA_007 is located 6m from the proposed GEP route. Targets 174, MA_001, and NCL_SC_016 are located 15-35m from the proposed GEP route.

Table 16: Targets and anomalies located within 50m of proposed GEP route.

Anomaly/Target ID	Target surveyed by ROV	Cultural/Natural	Within 10m of GEP route
Trot 16 (incl. Targets 166, NCL_SC_017, 018, and 019)	Yes	Cultural	No
Trot 17 (incl. Targets 165, 167, MA_011, NCL_SC_020, 021, 022, 023, 024, and 025)	Yes	Cultural	Yes
Trot 18 (incl. Targets 164, 167, 244, and NCL_SC_026)	Yes	Cultural	No
142	Yes	Natural	Yes
174	Yes	Cultural	Yes
175	Yes	Natural	Yes
233	Yes	Natural	No
241	Yes	Natural	No
245	Yes	Natural	Yes
246	Yes	Natural	Yes
247	Yes	Natural	No

Anomaly/Target ID	Target surveyed by ROV	Cultural/Natural	Within 10m of GEP route
MA_001	Yes	Cultural	No
MA_007	Yes	Cultural	Yes
NCL_SC_016	Yes	Cultural	No
NCL_SC_031	Yes	Natural	No

8.4 Legislative compliance

Certain objects may be protected under various local, state, and Commonwealth heritage acts, depending on their historical contexts and assessed heritage significance. Protected objects may require permits to be obtained before they may be disturbed. Noncompliance with heritage legislation may result in fines or criminal charges.

None of the cultural objects identified by ROV survey would be protected under the *NT Heritage Act 2011.*

The *UCH 2018* automatically protects shipwrecks over 75 years of age within all Australian waters (incorporating Territory internal and Commonwealth waters, see section 3.1), including articles associated with these shipwrecks. Although unlikely, if the objects located at Targets 174 and MA_007 are historic ship wreckage, over 75 years old, a permit may be required to disturb them.

The *UCH 2018* automatically protects aircraft wrecks over 75 years of age within Commonwealth waters. This excludes internal state waters, including Darwin Harbour and portions of Beagle Gulf. If the objects located at Target MA_007 are aircraft wreckage, it would **not** be protected under this act.

Installations including maritime infrastructure, such as the WWII anti-submarine boom net moorings and historic telegraph cables, are **not** automatically protected under the *UCH 2018*. Currently, the historic submarine telegraph landings are afforded statutory protection and are listed on the NT Heritage Register. The anti-submarine net moorings are not under statutory protection. Historic maritime infrastructure, especially infrastructure from the 19th century or associated with WWII, is likely of heritage interest and may rate as high heritage significance. Previously, the anti-submarine net moorings have been rated as having 'High' heritage significance.[119]

8.5 Mitigation measures

Mitigation for heritage objects and sites depends on the likelihood of potential impacts as well as the degree of heritage significance. Several of the targets identified as cultural during ROV surveys cannot have their heritage significance assessed due to lack of information. For cultural heritage sites, objects, and unverified anomalies likely to be impacted by proposed works, the first preference for mitigation is avoidance. If not possible, a more detailed investigation may be needed to conclusively identify their historical context and condition, to inform a heritage management plan with specific alternative mitigation measures. Such a management plan would only need to be adopted for those objects deemed likely to be impacted.

Cosmos Archaeology has previously completed impact assessments for anti-submarine net mooring trots that were likely to be impacted by the installation of the Icthys GEP.[120] This

[119] **Cosmos Archaeology, 2012,** *Icthys Project Darwin Harbour, East Arm Gas Export Pipeline: Assessment of Heritage Impact of 7 side scan targets,* Report prepared for Tek Ventures Pty Ltd.
[120] Op. Cit., **Cosmos Archaeology, 2012.**

assessment rated the trots and clump weights as **High** significance, and **Certain** to be impacted by installation of the GEP. Recommended mitigation was as follows:

> *Prior to disturbance undertake video recording of the concrete boom defence mooring blocks and chain. The chain is to be followed to either side of the block to see where they end. The distance between the blocks is expected to range from 30 to 60 m.*
>
> *Each block should be placed in an upright position with the chain laid alongside close – without the possibility of causing a hindrance – to the proposed pipeline route.*
>
> *Once the blocks and chain are in place, video footage, a site map and description, is to be obtained, preferably by a maritime archaeologist.*[121]

For this project, it was determined sufficient that the mooring trots were recorded fully *in situ* before being moved out of the path of the GEP. Once relocated, the trot was recorded again, and its location was documented. The proposed Barossa GEP route directly crosses the path of mooring Trot 17, identified during ROV survey Heritage Transect 1. Ideally, the proposed GEP alignment could be altered to avoid anti-submarine net mooring Trot 17 and Target MA_007 however relocation of chain and mooring blocks from this trot as done for theINPEX project would be acceptable if the GEP route cannot be changed to avoid impacting this site.

All other anomalies, targets, and surveyed cultural heritage is considered unlikely to be impacted by the direct action of GEP installation. However, unassessed cultural heritage, identified significant cultural heritage, and unverified anomalies should be avoided during the works, including during ship anchoring. Establishment of no-anchoring zones around these will help ensure significant maritime cultural heritage is not adversely impacted.

If the identified cultural material cannot be avoided, then a detailed heritage impact assessment will need to be conducted, consistent with the NT Heritage Branch Archaeological Scope of Works.[122] The impact assessment will likely require further inspections, diving would produce best results, to conclusively assess the significance of Target MA_007. A work class ROV may assist with accurate measurements and precise positioning but would not allow the tactile investigation that a diver could do. This would inform a Maritime Heritage Management Plan, which would include specific mitigation measures and management recommendations for each target, such as, but not confined to, archaeological recording, clearance, removal, and/or recovery. For example, any clearance of cultural material from the seabed could be recorded by a maritime archaeologist on-site. For the INPEX project this involved maritime archaeologists with suitable diving qualifications embedded with the commercial dive teams.

It is recommended that any further remote sensing undertaken for the proposed GEP should be reviewed by a qualified maritime archaeologist.

Finally, there is always the possibility of unexpected finds being made during the construction phase. Prior to the commencement of construction an Unexpected Maritime Archaeological Finds Protocol should be prepared by a suitably qualified maritime archaeologist. If a Maritime Heritage Management Plan is deemed necessary, this would be a component of such a plan. This protocol should include:

- Unexpected finds, stop work triggers and notification procedures
- Heritage induction for contractors
- Recording and reporting methods and procedures

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[121] *Op. Cit.* **Cosmos Archaeology, 2012:**27.
[122] **NT Heritage Branch, 2021,** Archaeological Scope of Works: Gas export pipeline Barossa gas field to Middle Arm, Darwin Harbour.

- Artefact collection and retention policies

9 CONCLUSION

9.1 Summary of findings

A review of historical sources, databases and marine geophysical information has found that;

- Within the study area, Larrakia and Tiwi people conducted maritime travel and subsistence activities – likely concentrated in coastal environments. Macassan trepang fishing and trade occurred throughout the 18th to early 20th centuries.
- British exploration and surveying began in the early 19th century, following which a wide range of colonial shipping including Government and commercial cargo and passenger transport, fishing and pearling industry trade and transport, and recreational shipping occurred, from the establishment of colonial settlement in Darwin in 1860s to present.
- In the 1870s and 1880s three subsea telegraph cables were laid.
- Quarantine and leper station transport and service supply were established in Middle Arm throughout late 19th to early 20th century.
- The study area saw significant military action during World War II, including air and sea combat between Allied and Japanese forces, which resulted in the sinking of numerous ships and aircraft within Beagle Gulf and Darwin Harbour.
- The entrance to Darwin Harbour was the location of numerous anti-submarine defences during WWII, including anti-submarine boom nets and indicator loops, some of which have been located and recorded by previous CA surveys.
- There are seventeen known, located shipwrecks within the study area, along with five known locations of UXO and six instances of maritime infrastructure (including the above-mentioned anti-submarine defences and telegraph cables). Four of five instances of UXO are related to WWII shipwrecks and are protected by statutory legislation. One instance, Contact 2, was identified and disposed of during INPEX heritage investigations. See Section 4.3.5, Table 4 for details and locations.
- There are 29 known but unlocated shipwrecks and 25 known but unlocated aircraft wrecks recorded to have sunk within the vicinity of the study area. Any of these could potentially be located within the study area.
- The remains of these vessels, and their contents and fittings, are automatically protected under the Cwlth *Underwater Cultural Heritage Act 2018*. Remains within the TSB are protected under the NT *Heritage Act 2011,* and United States military shipwrecks and aircraft wrecks are protected under the US *Sunken Military Craft Act 2004.*
- Side scan sonar, magnetometer, and MBES data from a marine geophysical survey conducted by Fugro in 2022 was reviewed, as well as MBES data published by Geosciences Australia.
- Clear evidence of eight shipwrecks was identified within the study area, and no aircraft wrecks were identified. Two of these shipwrecks, USAT *Meigs* and USAT *Mauna Loa* are under statutory heritage protection. Furthermore, there is a possibility that anomaly ID: 210 could potentially be aircraft remains.
- Thirty-nine sonar, MBES, and magnetometer contacts were identified by CA within the Fugro geophysical survey corridor as being probably cultural and hence of potential cultural heritage significance.

- An additional 133 anomalies were identified by CA from publicly available MBES data within the anchoring corridor, but outside of the Fugro geophysical survey corridor. These 133 anomalies were identified as being probably cultural and hence of potential cultural heritage significance. Ninety of these targets were identified as likely WWII anti-submarine net mooring devices located between KP 107 and KP 108.
- These anomalies could be remains of anti-submarine defences, 19th century telegraph cables, possible aircraft wreckage, debris fields, or isolated instances of debris and/or discard.
- An ROV survey was conducted between 6-8 June 2022 on 16 targets identified by the geophysical survey review as being within 50m of the proposed GEP route. Survey included three dive transects conducted on the likely remains of WWII anti-submarine net moorings.
- 11 anti-submarine net moorings, connected by heavy grade chain were identified during ROV survey, located between KP 107 and KP 108. These moorings and chain represent three “trots”, or lines of moorings, used to anchor WWII anti-submarine nets. Based on historic chart overlays, it is believed that heritage transects 1, 2, and 3 corresponded to Trots 17, 16, and 18, respectively. 10 moorings were conventional trapezoidal concrete weights, while one mooring, Target 164, was identified as a large ship’s anchor, repurposed for use as mooring.
- In addition to the anti-submarine net moorings, a further 10 isolated geophysical survey targets were inspected during ROV surveys. Six of these (Targets NCL_SC_002, NCL_SC_031, 142, 175, 241, and 245) were determined to be natural features. The other four targets (Targets MA_001, MA_007; Target NCL_SC_016; Target 174) were determined to be cultural in origin.
- Due to the limitations of a visual ROV survey, the identity of Targets 174, MA_007, and NCL_SC_016 could not be conclusively confirmed. Therefore, their heritage significance, as well as the significance of any other uninspected geophysical anomalies, cannot be properly assessed without further investigation.
- The proposed GEP installation will likely impact the central trot, Trot 17, identified by ROV heritage transect 1, and MA_007. Additionally, vessel anchoring as part of proposed works could impact any anomalies or cultural heritage within a 900 m corridor on either side of the GEP route. Therefore, the establishment of no-anchoring zones around uninspected anomalies and cultural heritage objects and sites within this corridor is recommended. A 15 m radius is considered appropriate for isolated anomalies, while a radius of 50 m is generally considered acceptable for larger sites, such as shipwrecks or aircraft wrecks. It is recommended that a buffer of 15 m is also afforded to the linear space between lines of potential anti-submarine net mooring trots to protect the chain in between moorings.
- If Trot 17 and Target MA_007 cannot be avoided, then a detailed heritage impact assessment will need to be conducted, consistent with the NT Heritage Branch Archaeological Scope of Works. Likewise, if no-anchoring zones cannot be established around other cultural heritage or unverified anomalies within the 900 m anchoring corridor, these will need to be assessed as well. Depending on the identity and historical significance of said objects, permits to disturb may be required under the *UCH 2018* Act.
- It is recommended that if further remote sensing surveys of the proposed GEP are undertaken, the additional survey data should be reviewed by a qualified maritime archaeologist.

- In the event of significant maritime archaeological remains being discovered during the construction phase, an Unexpected Maritime Archaeological Finds Protocol to responsibly manage such finds should be prepared and implemented.

9.2 Recommendations

Recommendation 1 ***If feasible, the proposed GEP alignment should be altered to avoid the WWII anti-submarine net mooring Trot 17 as well as cultural heritage objects identified at Target MA_007.***

Recommendation 2 ***If potentially cultural anomalies objects identified in this assessment are likely to be impacted, undertake a detailed heritage impact assessment by a qualified maritime archaeologist.***

If the identified anomalies cannot be avoided and are likely to be impacted, then a detailed heritage impact assessment would need to be conducted, consistent with the NT Heritage Branch Archaeological Scope of Works.[123] The impact assessment may include further ROV and/or dive inspections to assess significance of the anomalies. This would inform a Maritime Heritage Management Plan, which would include specific mitigation measures – such as relocation of certain objects - and management recommendations.

Recommendation 3 ***Establish no-anchoring zones around shipwreck locations, the anti-submarine net moorings, and unverified geophysical anomalies within the anchoring corridor.***

50 m radius for larger sites such as shipwrecks, 15 m for isolated anomalies and anti-sub net moorings/chains.

Review of Geosciences Australia MBES data with full coverage of Darwin Harbour from the proposed GEP terminus to KP 85 has identified eight shipwrecks within the 900 m anchoring corridor. Two of these wrecks, USAT *Meigs* and USAT *Mauna Loa,* are under statutory heritage protection. No-anchoring zones should be established around all eight wrecks, as well as the anti-submarine net corridor and any unverified geophysical anomalies. This information should be included in a Maritime Heritage Management Plan.

Recommendation 4 ***If additional remote sensing data is collected for the proposed GEP it should be reviewed by a qualified maritime archaeologist.***

Recommendation 5 ***Prepare and implement an Unexpected Maritime Archaeological Finds Protocol.***

Prior to the commencement of the construction phase an Unexpected Maritime Archaeological Finds Protocol should be prepared by a suitably qualified maritime archaeologist. This protocol should include:

- *Unexpected finds, stop work triggers and notification procedures*
- *Heritage induction for contractors*

[123] **NT Heritage Branch, 2021,** Archaeological Scope of Works: Gas export pipeline Barossa gas field to Middle Arm, Darwin Harbour.

- *Recording and reporting methods and procedures*
- *Artefact collection and retention policies*

This protocol would form a component of the Maritime Heritage Management Plan referenced in Recommendation 2.

Recommendation 6 Review of this assessment if proposed alignment of pipeline changes.

This review should be undertaken by a suitably qualified maritime archaeologist.

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10 ANNEX A: ROV SURVEY TECHNICAL MEMO

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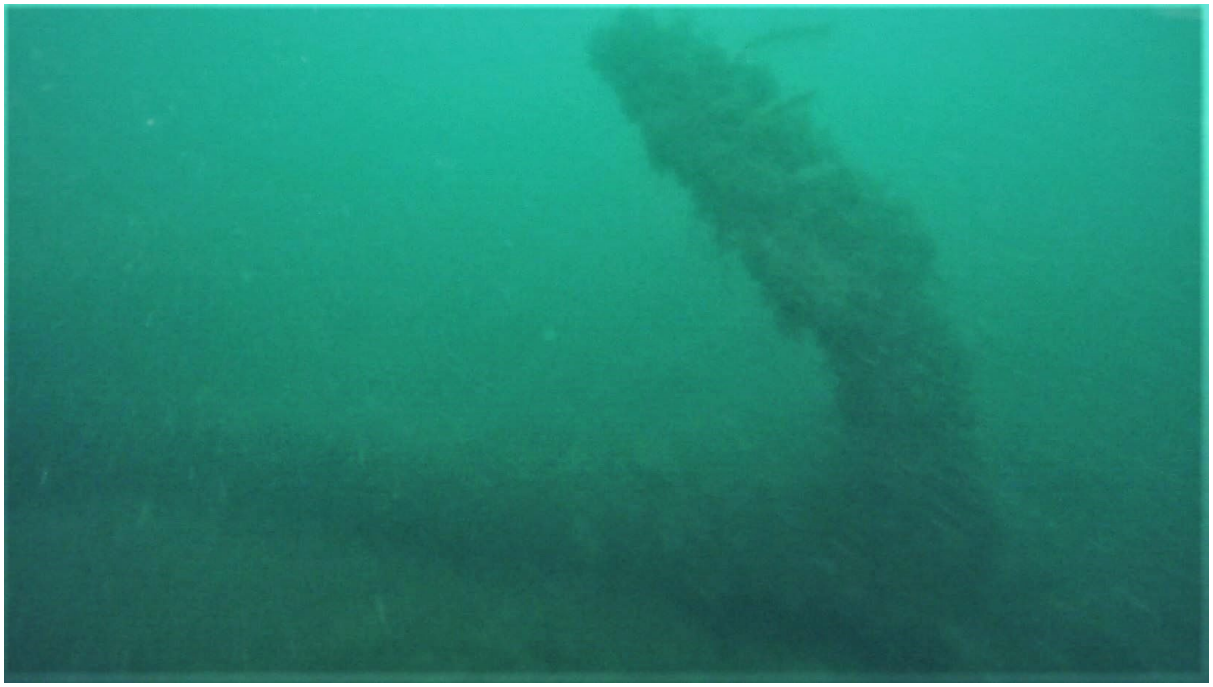
Barossa Pipeline



Maritime Cultural Heritage

ROV Survey

June 2022

Darwin Harbour

NT

June 2022

Barossa Pipeline
Maritime Cultural Heritage ROV Survey June 2022

Prepared for:

Santos Pty Ltd

By:

Connor McBrian

June 2022

Cosmos Archaeology Job Number J21/22

Cover Image: *Anchor located during survey.*

Revision	Description	Date	Originator	Reviewer	Approver
V1	DRAFT Darwin Harbour ROV Survey	28-06-2022	CM		

Abbreviations

CA	Cosmos Archaeology	MBES	Multi-beam echosounder
GPS	Global Positioning System	ROV	Remote operated vehicle
m	Metres	SSS	Side Scan Sonar

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Background

The Santos (Barossa) Gas Export Pipeline is a proposed installation a gas export pipeline (GEP) off the northwest coast of the Northern Territory (NT). The proposed GEP begins at the Barossa gas field, north of the Tiwi Islands, and extends south to feed the Darwin LNG plant, located in Middle Arm, Darwin Harbour. The first proposed route is a GEP from the Barossa gas field to a tie in point into the existing Bayu-Undan to Darwin pipeline, tying in at a point southwest of Bathurst Island. The second proposal is to extend the GEP from Barossa to the Darwin LNG plant. This second proposal traverses through the entrance of Darwin Harbour directly to the Darwin LNG at Middle Arm.

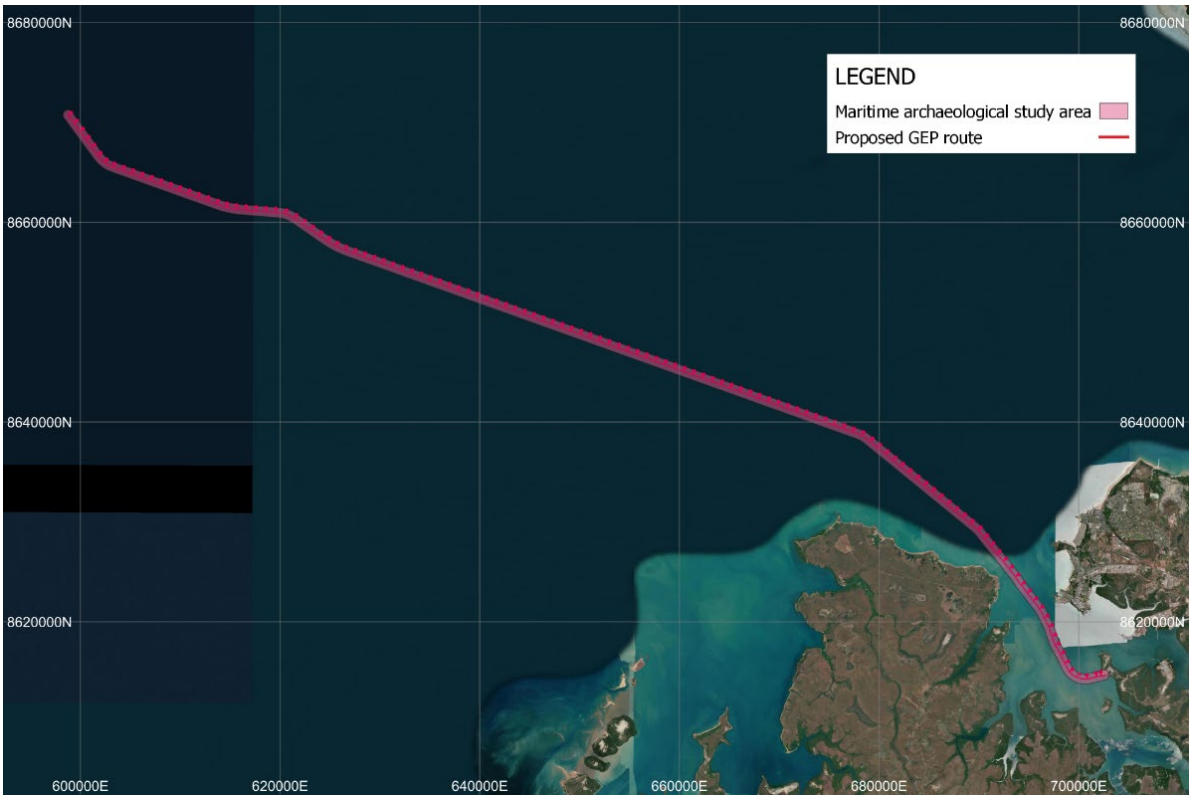


Figure 1: Proposed route of the Barossa GEP in Beagle Gulf and Darwin Harbour.

As part of environmental and heritage impact assessments, a suite of geophysical surveys were conducted including multi-beam bathymetry (MBES), side scan sonar (SSS), and magnetometer surveys to identify locations of potential cultural material. Review of the available geophysical survey identified forty targets of possible cultural origin. Sixteen of these targets were located within 50m of the proposed GEP route and were shortlisted for visual survey to confirm their identity and origin. The sixteen chosen targets were inspected over the course of three days between 6-8 June 2022.

1.1.1 *Objectives*

The objectives of this dive survey were to:

> *Visually inspect targets identified through geophysical data for their potential cultural heritage significance and recommend measures to reduce impacts to their cultural heritage values.*

2 MARITIME ARCHAEOLOGICAL DIVE SURVEY

2.1 Dates and Personnel

The dive survey was carried out over three days: 6-9 June 2022. Connor McBrian from Cosmos Archaeology was the maritime archaeologist supervising the heritage inspections. ROV support was provided by FUGRO in the form of two ROVs, while boat and marine services were supplied by Bhagwan Marine. In addition to this, a representative from Santos Pty Ltd was on board to supervise surveys along with an environmental specialist from RPS. ROV operations were run and supervised by FUGRO. Personnel involved during the inspection are listed in Table 1.

Table 1: Dive inspection personnel

Name	Title	Company
Connor McBrian	Maritime Archaeologist	Cosmos Archaeology
James Clarke	Survey Party Chief	Fugro
Luke Eller	ROV Pilot / Tech	Fugro
Simon Bochow	Skipper	Bhagwan Marine
Pete Ivicevich	Client Representative	Santos NA Barossa Pty Ltd
Garnet Hooper	Environmental Specialist	RPS Group

2.2 Weather and Tide Conditions

Weather and tide conditions are factors when operating an ROV within the study area. Tides were especially considered in relation to the current and visibility, which could limit ROV operations. As much as possible, dives were conducted at slack tides to avoid excessive current and drift. The tide conditions during the surveys are provided in Table 2 and weather conditions during the survey are provided in Table 3.

Table 2: Tides for the days of survey.

06-06-2022	Time	0341	1016	1612	2147
	Height (m LAT)	2.3	6.1	3.3	5.2
07-06-2022	Time	0430	1102	1721	2300
	Height (m LAT)	2.6	5.8	3.4	4.9
08-06-2022	Time	0534	1200	1847	0031 (next day)
	Height (m LAT)	3.0	5.7	3.3	4.9

Note: For ease of identifying high and low tide, low tide is blue and high tide is red.

Table 3: Rain and wind conditions for the day previous to the dive inspections and the days of the inspection.

Date	Rain (mm)	Wind 09:00 (km/h)	Wind 15:00 (km/h)
05-06-2022	0.0	13 ESE	17 N
06-06-2022	0.0	9 SE	13 NW
07-06-2022	0.0	11 E	17 ENE
08-06-2022	0.0	20 E	17 ESE

2.3 Conduct of Survey

The underwater survey was conducted with the use of an ROV, operated by crew from FUGRO under the direction of the maritime archaeologist. Certain features, such as the anti-submarine net mooring trots were surveyed along transects following the features in a linear pattern. Isolated targets were targeted by dropping a clump weight with a buoy attached on the target coordinates while the vessel was moving, and then following the buoy line to the seabed with the ROV once the vessel was anchored. Once on the bottom, the ROV was manoeuvred in cross shaped search patterns using the clump weight as a reference point.

The ROV was battery powered and controlled remotely by the pilot from inside the survey vessel cabin. Because the ROV was not equipped with transponders or any location fixing devices, the exact location of the ROV had to be estimated based on identifiable features on the seabed that could be compared to MBES data, course headings, and position relative to the *Warrigal.*

2.3.1 Target inspection dives

The targeted inspection dives required the ROV pilot and maritime archaeologist to locate and identify seafloor anomalies from existing geophysical data. GPS locations of targets derived from MBES data was used to locate the potential targets and manoeuvre the *Warrigal* into position.

Targets identified within the location of WWII submarine netting were surveyed along three transects, as these consisted of large concrete clump weights connected by thick chain. The chain was easily visible above the seabed, and provided a reliable way of tracking and locating the ROV as it completed the linear transects.

From review of the geophysical survey data, 15 targets were identified for visual investigation, based on their assessed likelihood of being cultural material, and their proximity (within 50m) of the proposed GEP route. These targets were given a priority status for the targeted inspections. These were:

- A = top priority
    - Images appear to be cultural and representative of a ‘site’ such as a small wreck.
- B = secondary
    - Images appear to be cultural but are representative of an individual object, or discard and less likely to constitute a site.
- C = tertiary
    - Targets unlikely to be cultural, or known to be culturally insignificant.

2.4 Findings of the Diving Survey

For organisational purposes, the following list of targets is separated into the three heritage transects, T1, T2, and T3, used to record the anti-submarine net moorings, and isolated targets surveyed individually.

2.4.1 *Heritage Transect 1*

T1 followed a line of concrete clump weights, connected by heavy chain, that were identified as the moorings for the WWII anti-submarine net. This transect was located between KP 107 and KP 108, and ran NNW from a target just south of 165, located at 693309.60 m E, 8624815.60 m N to target 244, located at 693195.40 m E, 8625165.60 m N. The transect continued at the same heading north from Target 244 to a final concrete clump weight located at 693162.30 m E, 8625272.50 m N.

Along this transect, attempts were made to locate two isolated anomalies, Targets 246 and 247, without success.

7 dives were attempted on T1, of which one (T1_5) had to be aborted due to currents overpowering the capabilities of the ROV.

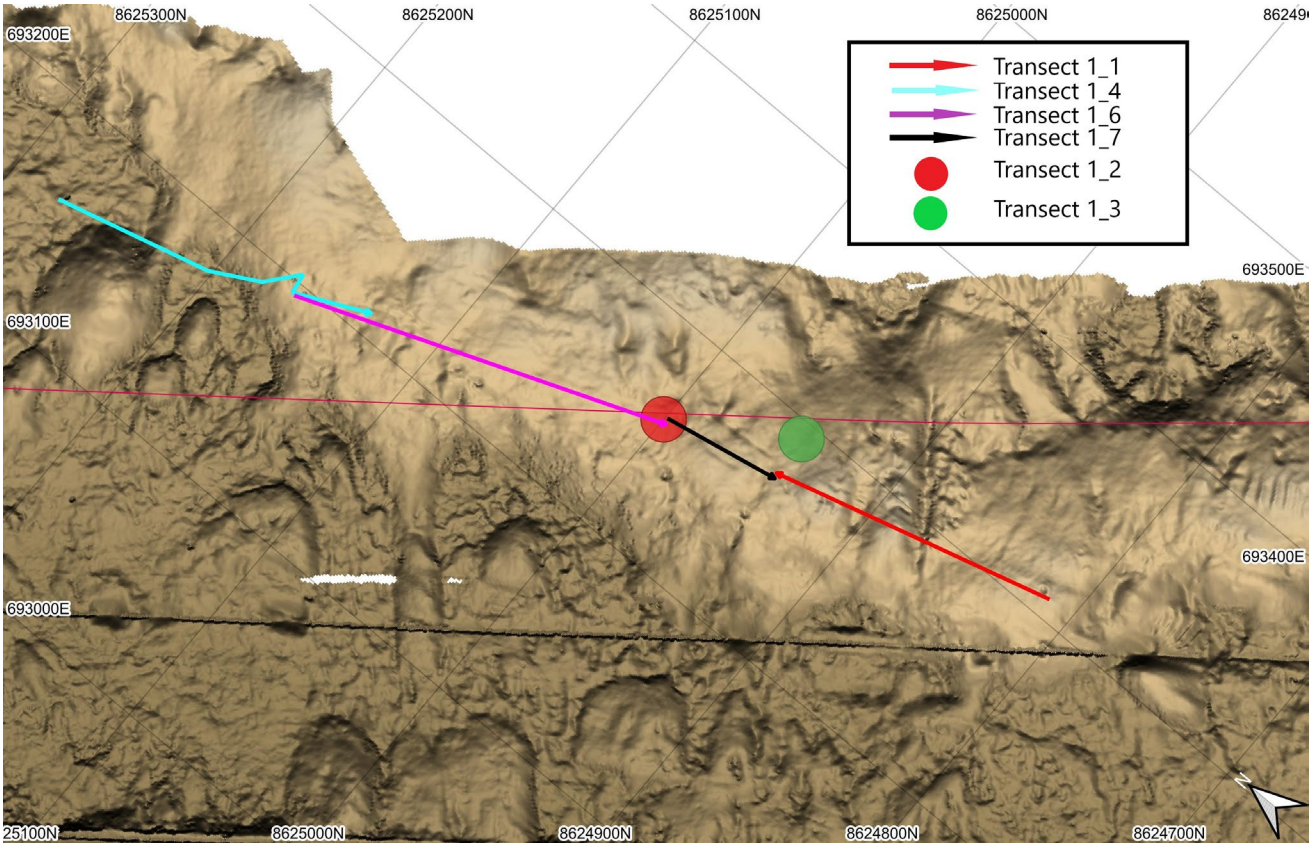


Figure 2: Dive locations for Heritage Transect 1.

The datum for all coordinates for the targets is GDA94.

2.4.1.1 T1_1

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Depth	Distance from GEP route (m)
3	693309.76	8624814.97	Anti-submarine net moorings. Large concrete trapezoidal mooring blocks connected by lengths of thick chain.	Width: 0.00 Height: 0.00 Length: 1.54 Shadow: 0.00	29 m	Variable, from 25 to 80

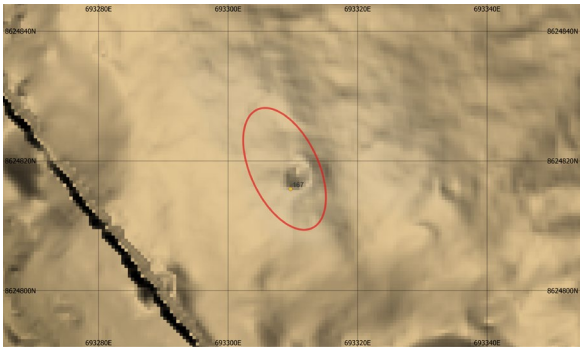


Figure 3: Target 167 MBES image.

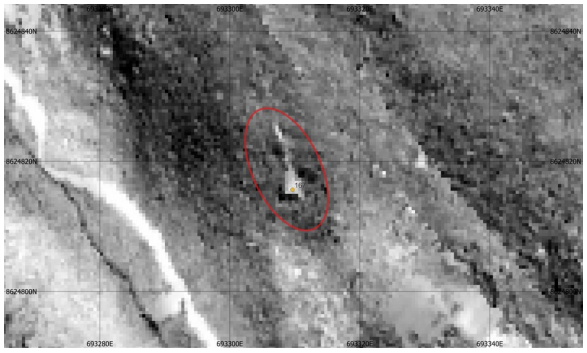


Figure 4: Target 167 SSS image.

Inspection details for T1_1		
Date: 06-06-2022	**Method:** ROV	**Tide:** Slack
Distance and direction: 125 m, 345° NNW		
Swim start (min): 1027	**Swim end (min):** 1138	**Total time (min):** 71
Depth: 14.2 m	**Water visibility:** 1 m	**Seabed visibility:** Poor

Target description: The seabed within the search area was generally rocky with a layer of easily disturbed sediment and large amount of marine growth, including soft corals. Transect 1_1 began by locating Target 167 and following a length of chain extending from Target 167 at a heading of 345° NNW for approximately 125m. Despite low visibility, target 167 was quickly located through the use of the ROV's sonar. 167 was determined to be a large concrete mooring block, used as part of the anchoring system for the anti-submarine nets installed during WWII (Figure 7). A cable connected to the southern end of the block appeared to anchor to the seafloor, while length of thick chain (Figure 8) was attached to the northern face of the concrete block and connected 167 to a twin set of mooring blocks, located at 693294 m E 8624875 m N (Target ID: NCL_SC_020; Figure 9 and Figure 10). Another section of the same chain continued further north from the twin blocks before disappearing into the seabed ~30m further NNW. The ROV's tether ran out before the next mooring block could be positively located.

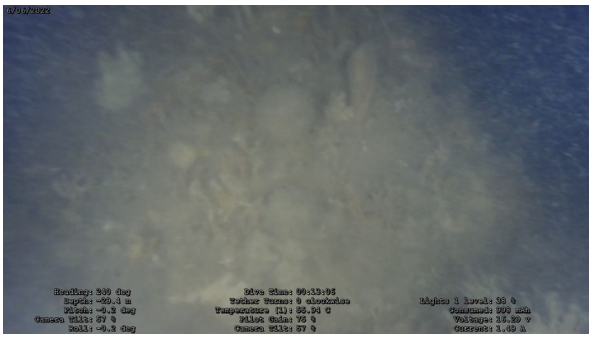


Figure 5: Screen grab of Target 167, concrete anti-sub net mooring block. (Video 2022-06-06_10.27.18; 11:17).

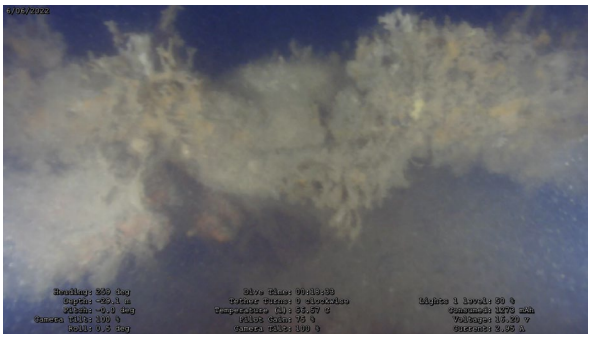


Figure 6: Screen grab of chain leading NNW from Target 167. (Video 2022-06-06_10.27.18; 16:47).

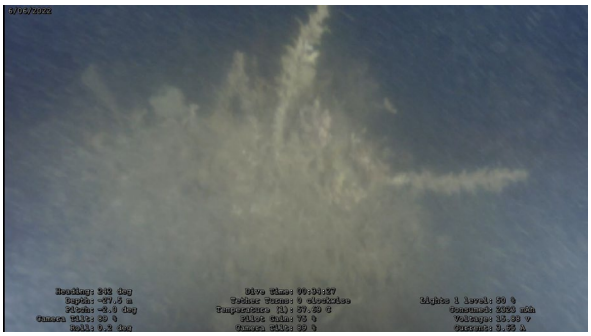


Figure 7: Screen grab of NCL_SC_020, first concrete block. (Video 2022-06-06_10.58.29; 01:29).

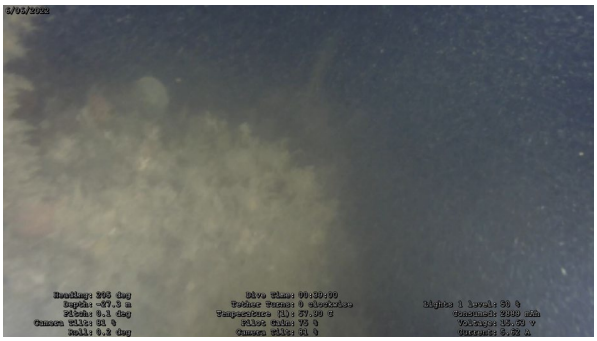


Figure 8: Screen grab of NCL_SC_020, second concrete block. (Video 2022-06-06_10.58.29; 06:01).

2.4.1.2 T1_2

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
4	693286.00	8624946.00	Target 247, aka MA_003	Width: 0.00 Height: 0.00 Length: 7.96 Shadow: 0.00	0	28 m

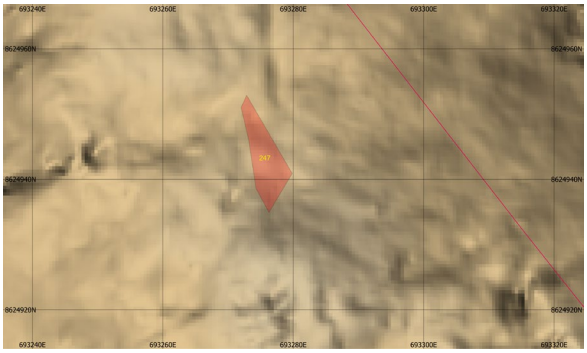


Figure 9: Target 247 MBES image.

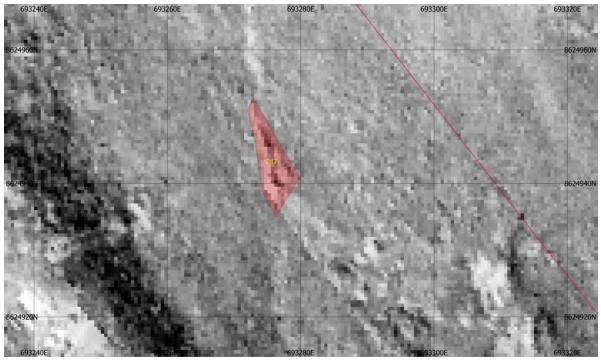


Figure 10: Target 247 SSS image.

Inspection details for T1_2		
Date: 06-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Circular search 10 m		
Swim start (min): 1215	**Swim end (min):** 1238	**Total time (min): 13**
Depth: 28 m	**Water visibility:** 0 m – 1 m	**Seabed visibility:** Poor

Target description: This dive was an attempt to locate Target 247, possibly associated with magnetometer target MA_003. In addition to locating 247, an attempt was made to locate the anti-sub net chain that disappeared into the seabed at the end of transect T1_1. The seabed in the search area was similar to Transect T1_1 with fine grain sandy sediment as well as scattered rocks and marine growth. Not cultural features were identified during the dive. While an attempt at a circular 10m search was made, strong current and low visibility meant only a small portion of the seafloor was able to be surveyed before the dive was aborted.

2.4.1.3 T1_3

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
5	693293.00	8624947.00	Debris scatter, or possible anti-submarine net remains FUGRO ID: NCL_SC_021	Width: 0.00 Height: 0.00 Length: 0.59 Shadow: 0.00	10	27 m

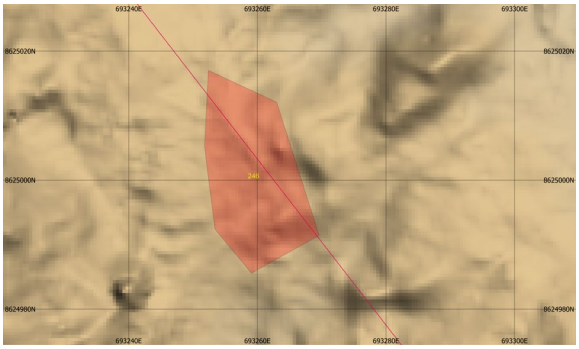


Figure 11: Target 246, MBES image.

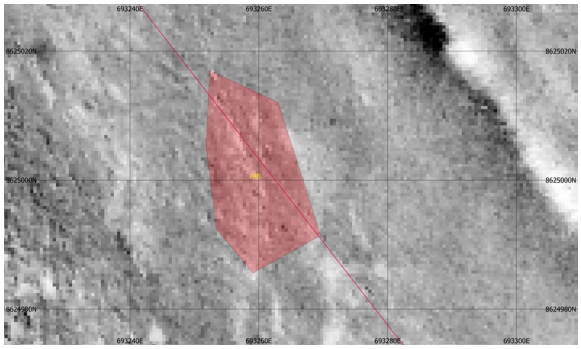


Figure 12: Target 246, SSS image.

Inspection details for T1_3		
Date: 06-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Circular search 10 m		
Swim start (min): 1247	**Swim end (min):** 1311	**Total time (min):** 24
Depth: 27 m	**Water visibility:** 0 m – 1 m	**Seabed visibility:** Poor

Target description: This dive was an attempt to locate Target 246 aka NCL_SC_021. In addition to locating 246, an attempt was made to locate the anti-sub net chain that disappeared into the seabed at the end of transect T1_1. The seabed in the search area was similar to Transect T1_1 with fine grain sandy sediment as well as scattered rocks and marine growth. Not cultural features were identified during the dive. While an attempt at a circular 10m search was made, strong current and low visibility meant only a small portion of the seafloor was able to be surveyed before the dive was aborted.

2.4.1.4 T1_4

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
8	693163.04	8625273.25	Anti-submarine net mooring blocks and chain NCL_SC_022 and Target ID: 244 (aka NCL_SC_023, 024, 025)	Width: 2.18 m Height: 0.00 m Length: 6.65 m Shadow: 0.00m	Variable, from 40 to 86	21 m

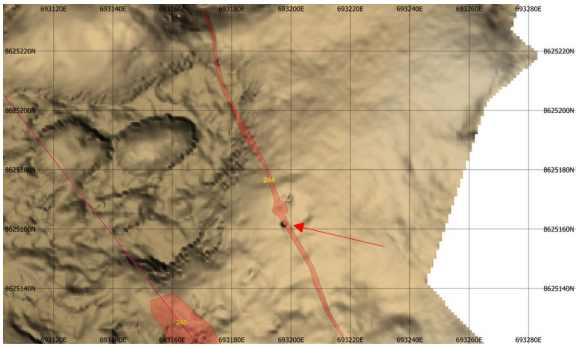


Figure 13: Target 244 (aka NCL_SC_023, 024, 025) MBES image.

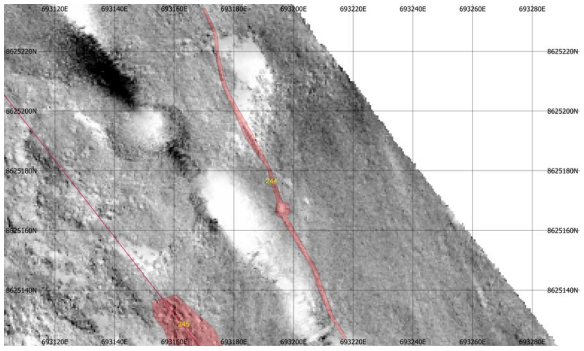


Figure 14: Target 244 (aka NCL_SC_023, 024, 025) SSS image.

Inspection details for T1_4		
Date: 06-06-2022	**Method:** ROV	**Tide:** Slack
Distance and direction: 150 m, 160° SSE		
Swim start (min): 1605	**Swim end (min):** 1644	**Total time (min):** 39
Depth: 21 m	**Water visibility:** 1 – 2 m	**Seabed visibility:** Poor

Target description: The ROV was dropped on a target that appeared on MBES data to be a concrete block mooring used for the anti-submarine netting, located at 693163.04 m E, 8625273.25 m N. The target chosen was not identified previously by FUGRO or CA but was identified immediately upon visual inspection by the ROV. This concrete block was determined to be the northern terminus of the "trot" of moorings (running to the southern terminus at Target 167) because no chain extended from the northern side of the block. After identification, the ROV followed the chain in a SSE course at 160° for approximately 55m until reaching target NCL_SC_022. This target was again identified as a concrete mooring block for the anti-sub netting. Following the chain at roughly the same heading, the ROV was piloted to the location of Target 244 (aka NCL_SC_023, 024, 025), approximately 60m SSE of NCL_SC_022. Between NCL_SC_022 and Target 244, the chain was seen to have several breaks along its length and appeared to have been dragged out of position by an anchor or trawl. A sharp kink in the line of chain was seen immediately north of target 244. The ROV continued following the chain SSE from Target 244 until tether ran out, approximately 50m further SSE.

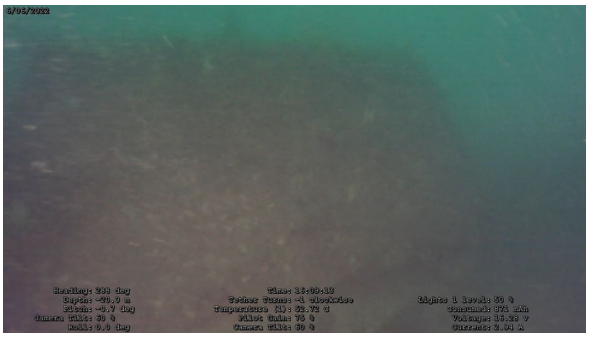


Figure 15: Mooring block at northern terminus of trot. (Video 2022-06-06_16.08.58; 00:15).

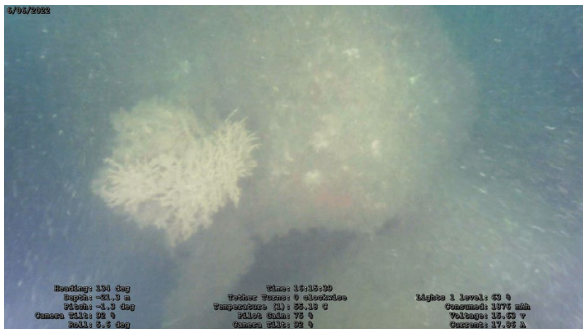


Figure 16: Mooring block NCL_SC_022 with chain extending from north face. (Video 2022-06-06_16.08.58; 06:40).

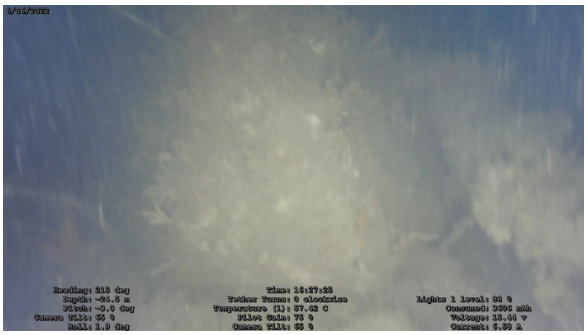


Figure 17: Mooring block Target 244 with chain extending from north face. (Video 2022-06-06_16.08.58; 18:24).

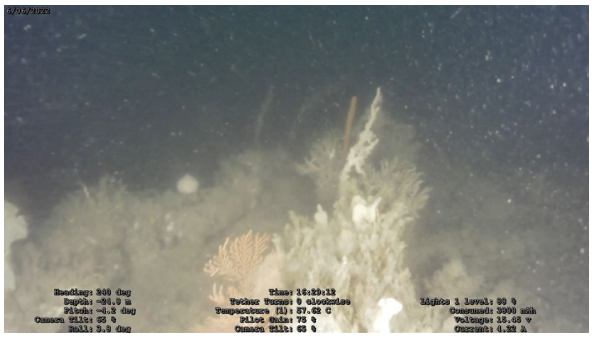


Figure 18: Kinked chain near Target 244. (Video 2022-06-06_16.08.58; 20:11).

2.4.1.5 T1_6

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
14	693212.30	8625132.30	Anti-submarine net mooring blocks and chain	Width: 0.00 Height: 0.00 Length: 0.00 Shadow: 0.00	Variable, from 46 to 0	28 m

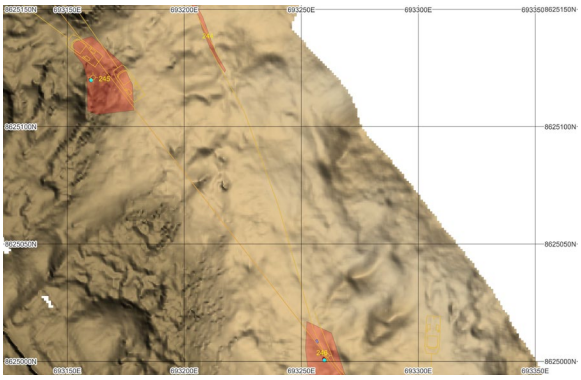


Figure 19: MBES image of general area of T1_6.

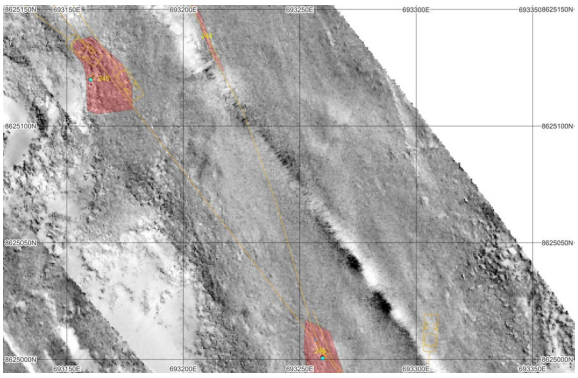


Figure 20: SSS image of general area of T1_6.

Inspection details for T1_6		
Date: 07-06-2022	**Method:** ROV	**Tide:** Slack
Distance and direction: 200 m, 160° SSE		
Swim start (min): 1045	**Swim start (min):** 1106	**Total time (min):** 21
Depth: 28 m	**Water visibility:** 2 – 3 m	**Seabed visibility:** Fair

Target description: Dive 14, transect T1_6, was started approximately 40 metres south-southeast of target 166 at a point close to or overlapping the termination of T1_4. A previous attempt at this transect, Dive 10 (T1_5), had been aborted due to heavy currents preventing the ROV from submerging. The anchor chain was quickly located upon descent and was followed in a similar SSE heading to T1_4, at approximately 160° for around 200 metres until the ROV's tether ran out (Figure 22). Throughout the length of T1_6, the chain was periodically buried under silty sediment, occasionally to the point where no marine growth could be seen above the seabed. At the end of the tether, the chain occurred to have several kinks, and a potential area of debris field or small rocks (Figure 23). Marine growth inhibited identification of the exact nature of these objects. No concrete blocks were seen along the length of the T1_6.

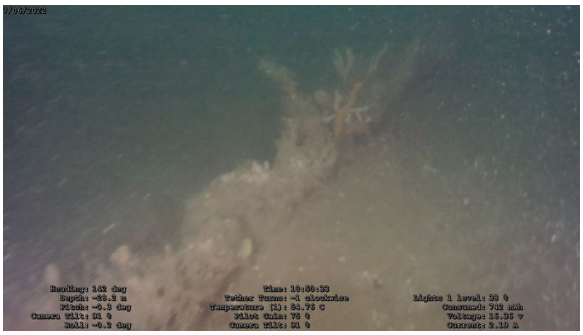


Figure 21: Length of chain southeast of target 166. (Video 2022-06-07_10.46.37; 03:54).

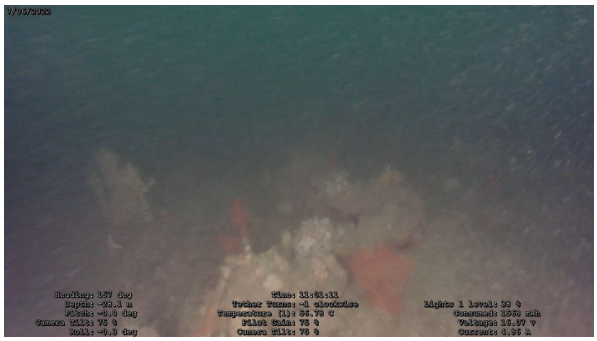


Figure 22: Kink in chain near end of T1_6. (Video 2022-06-07_10.46.37; 14:30).

2.4.1.6 T1_7

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
15	693255.71	8625021.11	Anti-submarine net mooring blocks and chain	Width: 0.00 Height: 0.00 Length: 0.00 Shadow: 0.00	Variable, from 26 to 0	29 m

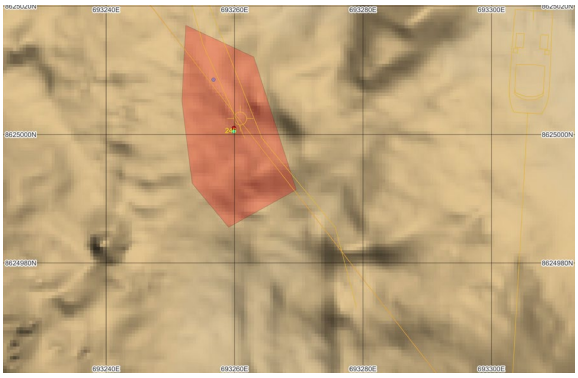


Figure 23: MBES image of general area of T1_7.

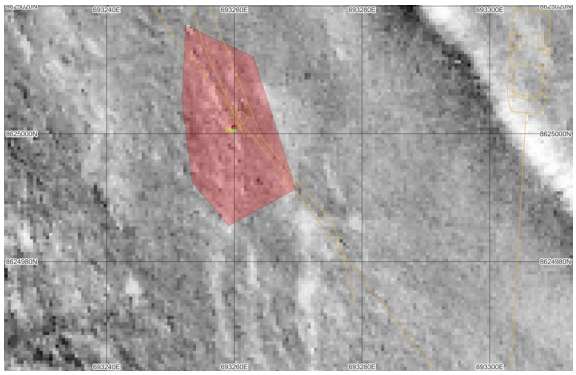


Figure 24: SSS image of general area of T1_7.

Inspection details for T1_7		
Date: 07-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: 200 m, 160° SSE		
Swim start (min): 1130	**Swim end (min):** 1200	**Total time (min):** 30 min
Depth: 29 m	**Water visibility:** 0 – 1 m	**Seabed visibility:** Poor

Target description: T1_7 was intended to "close the gap" between T1_6 and T1_1, approximately covering the area where Target 246 was thought to be. The ROV was dropped close to the position of 246 and was able to locate the chain identified in T1_6 (Figure 27). Following the chain SSE, the ROV recorded the chain ending at an indeterminate point in the seabed. At this location, a pile of branching metal debris was seen (Figure 28). The debris appeared to be either steel wire rope or cable, not chain, and extended several metres in multiple directions from a central point, near the end of the chain (Figure 29 & Figure 30). Heavy current and low visibility inhibited the ROV from obtaining a clear picture of the area, however, a cross shaped search pattern of 20m east-west-south from the branching cable indicated that a gap existed along the anti-submarine net trot chain, about 20m south of the proposed GEP route.

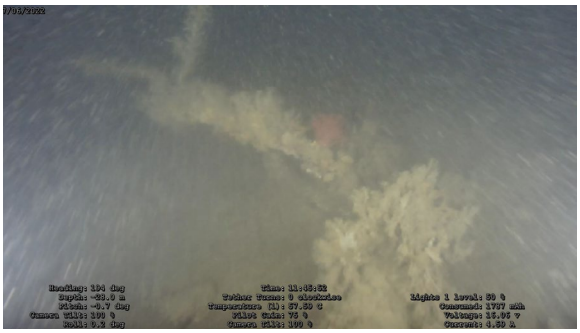


Figure 25: Screen grab of chain at a southern heading, with a large protuberance extending to the west. (Video 2022-06-07_11.30.28; 15:20).

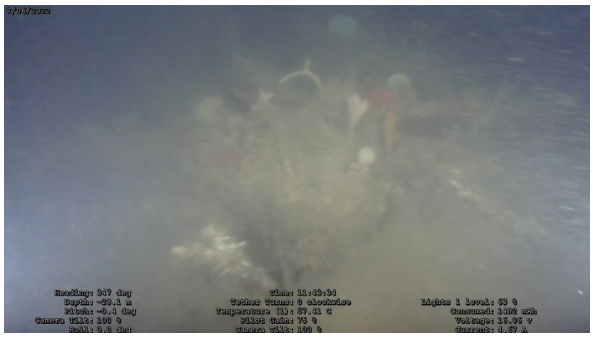


Figure 26: Screen grab of central location of branching "cable" or steel rope. (Video 2022-06-07_11.30.28; 13:01).

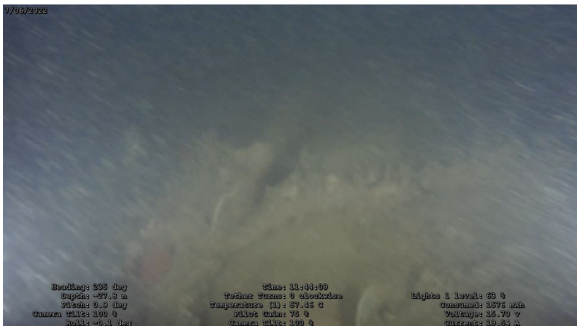


Figure 27: Screen grab of several arms of branching "cable". (Video 2022-06-07_11.30.28; 13:41).

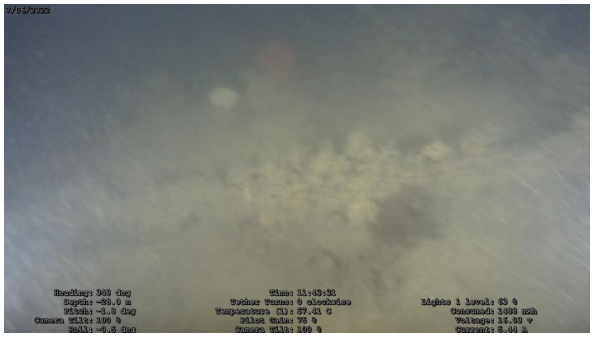


Figure 28: Detail of "cable". (Video 2022-06-07_11.30.28; 12:40).

2.4.2 *Heritage Transect 2*

T2_1 followed a line of concrete clump weights, connected by heavy chain, that were identified as the moorings for the WWII anti-submarine net. This transect was located between KP 107 and 108, adjacent to KP 107 and ran NNW from target 167, located at 693076.70 m E, 8625127.70 m N to target 164 (aka MA_002), located at 693039.84 m E, 8625225.61 m N. It was determined that the northernmost mooring device for the anti-submarine net trot was a large admiralty style anchor. A second dive (T2_2) was conducted on the anchor to take clearer images and aid in identification.

Chain was also seen extending south from Target 167 and targets likely to be mooring blocks were seen on MBES and SSS indicating that the trot extended further south to the Bayu-Undan GEP. It was decided that the proximity of these targets to the existing pipeline, and their distance from the proposed GEP, meant that further investigation in this direction was unnecessary.

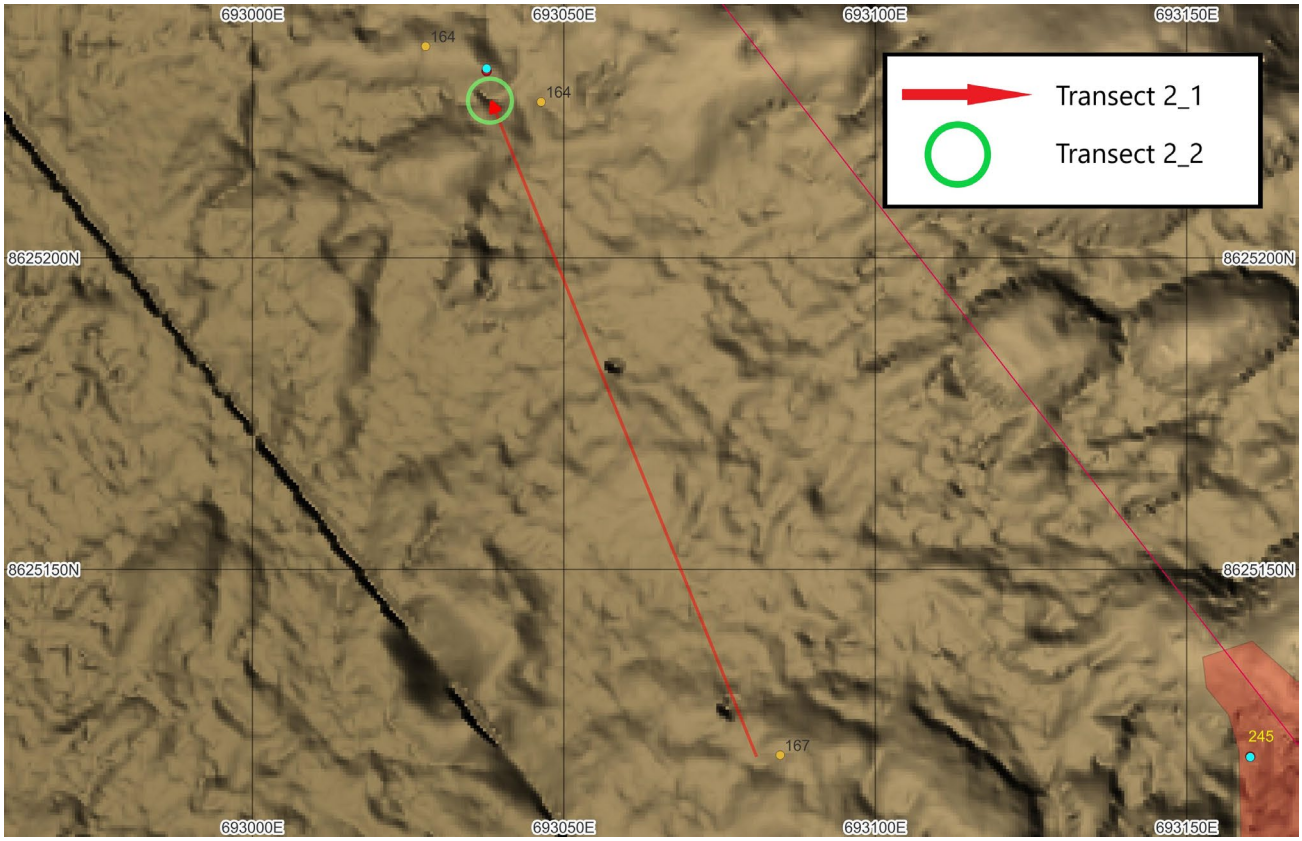


Figure 29: Dive locations for Heritage Transect 2.

2.4.2.1 T2_1

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
16	693077.90	8625120.30	Anti-submarine net mooring blocks and chain.	Width: 0.00 Height: 0.00 Length: 0.00 Shadow: 0.00	Variable, from 33 to 87	20 m

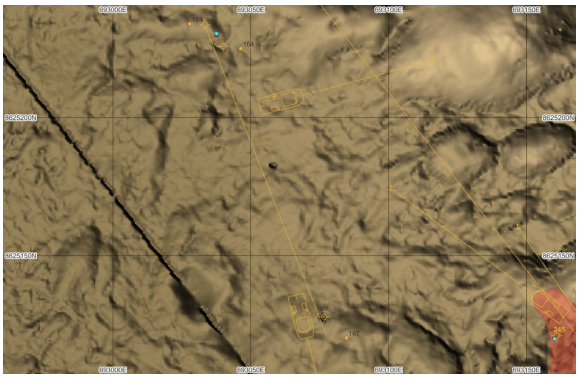


Figure 30: MBES image of general area of T2_1.

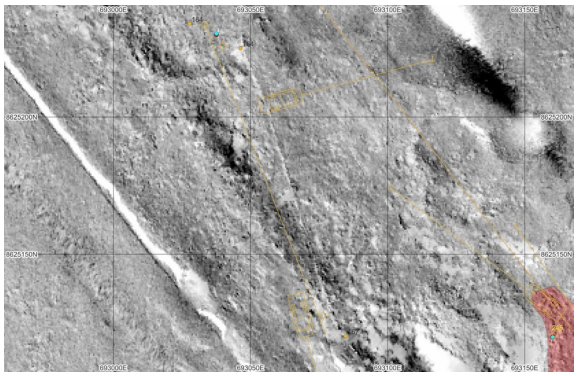


Figure 31: SSS image of general area of T2_1.

Inspection details for T2_1		
Date: 07-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: 123 m at 345° NNE		
Swim start (min): 1231	**Swim end (min):** 1255	**Total time (min):** 24
Depth: 20 m	**Water visibility:** 0.5 - 1 m	**Seabed visibility:** Poor - Fair

Target description: ROV was dropped almost exactly Target 167, identified as an anti-submarine net mooring block (Figure 34). The ROV confirmed that chain was extant in a southerly direction from Target 167, away from the proposed GEP route. The ROV was then turned at a NNE heading and continued along the line of the chain to the second mooring block located at 693058.40 m E and 8625182.00 m N (Figure 35). The ROV again continued along the chain until reaching Target 164 (aka NCL_SC_026, MA_002). Upon reaching Target 164, it was immediately clear that this target was an anchor adapted for use as a mooring device for the anti-submarine net chain. Due to poor visibility and worsening currents, it was decided to finish the dive at this point and return to investigate Target 164 when a slack tide would provide more favourable conditions.

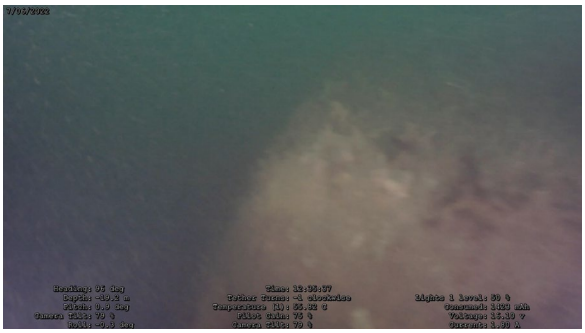


Figure 32: Screen grab Target 167, mooring block. (Video 2022-06-07_12.31.43; 03:35).

Figure 33: Screen grab of second anti-submarine net mooring block and chain, southern side of block. (Video 2022-06-07_12.31.43; 06:46).

2.4.2.2 T2_2

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
21	693036.33	8625230.54	Large ship's anchor, adapted for use as anti-submarine net mooring device.	Width: 4.00 Height: 1.90 Length: 7.00	33	18 m

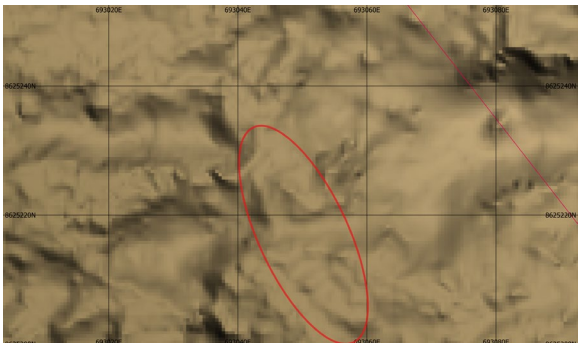


Figure 34: MBES image of Target 164 and chain extending south.

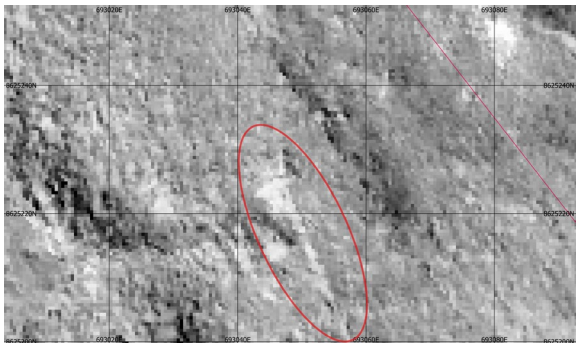


Figure 35: SSS image of Target 164 and chain extending south.

Inspection details for T2_2		
Date: 07-06-2022	**Method:** ROV	**Tide:** Slack
Distance and direction: Investigation of specific feature		
Swim start (min): 1646	**Swim end (min):** 1702	**Total time (min):** 16
Depth: 18 m	**Water visibility:** 3 m - 4 m	**Seabed visibility:** Good

Target description: T2_2 was undertaken specifically to record higher quality images of Target 164 and to determine if any portion of the anti-submarine trot extended north towards the proposed GEP route. Upon relocating the chain, the ROV was manoeuvred north to Target 164, a large anchor, seemingly admiralty pattern in style. The ROV made a full three-dimensional survey of the anchor and determined that the anti-submarine net chain was attached by a large D-shackle to the head of the anchor (Figure 41). The anchor had a large rectangular stock with possible evidence of iron bands, suggesting that the stock may be made of wood (Figure 43). The ROV took measurements of the length of the arm protruding from the seabed by measuring the depth at the tip of the fluke to the crown, determining the arm to be approximately 1.9m in length (Figure 38, Figure 39, and Figure 42). The relatively narrow, round shank extended north from the stock, ending at a fluke and arm protruded at a 90-degree angle from the seabed (Figure 40). No further mooring devices, chain or cable was identified to the north of Target 164, indicating that the anchor was the northern terminus of this trot.

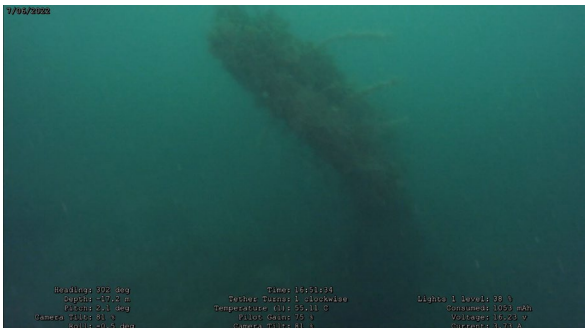


Figure 36: Arm and fluke of anchor, looking west. (Video 2022-06-07_16.47.23; 04:08).

Figure 37: Detail of fluke, looking west. (Video 2022-06-07_16.47.23; 05:46).

Figure 38: Anchor shank, looking east. (Video 2022-06-07_16.47.23; 11:22).

Figure 39: Anchor ring, head, and stock, looking northwest. Note chain extending from D-shackle attached to head, and possible iron band on stock on right side of photo. (Video 2022-06-07_16.47.23; 05:51).

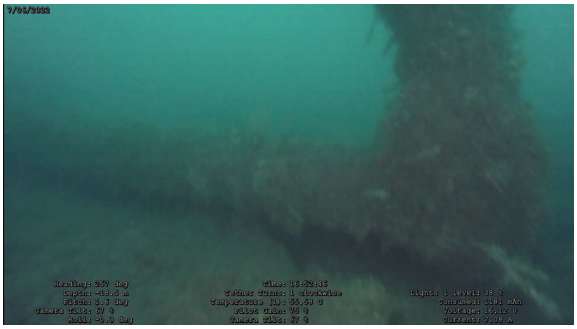


Figure 40: Anchor throat, crown, and arm, looking southwest. (Video 2022-06-07_16.47.23; 05:19).

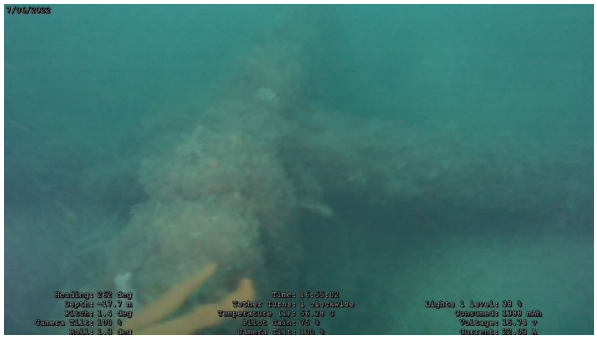


Figure 41: Transverse view of stock, shank, and head, looking west. Note possible iron band around stock in foreground. (Video 2022-06-07_16.47.23; 07:37).

2.4.3 *Heritage Transect 3*

T3_1 followed a line of concrete clump weights, connected by heavy chain, that were identified as the moorings for the WWII anti-submarine net. This transect was located approximately halfway between KP 107 and 108 and ran NNW from a location several metres south of target NCL_SC_017, at 693417.30 m E, 8624861.20 m N to target 166 (aka NCL_SC_018), and beyond before finishing at a location near 693375.80 m E, 8624949.10 m N. The chain was clearly seen extending north from this location, however, it was determined that because this was in the opposite direction from the proposed GEP route, no further investigation was required.

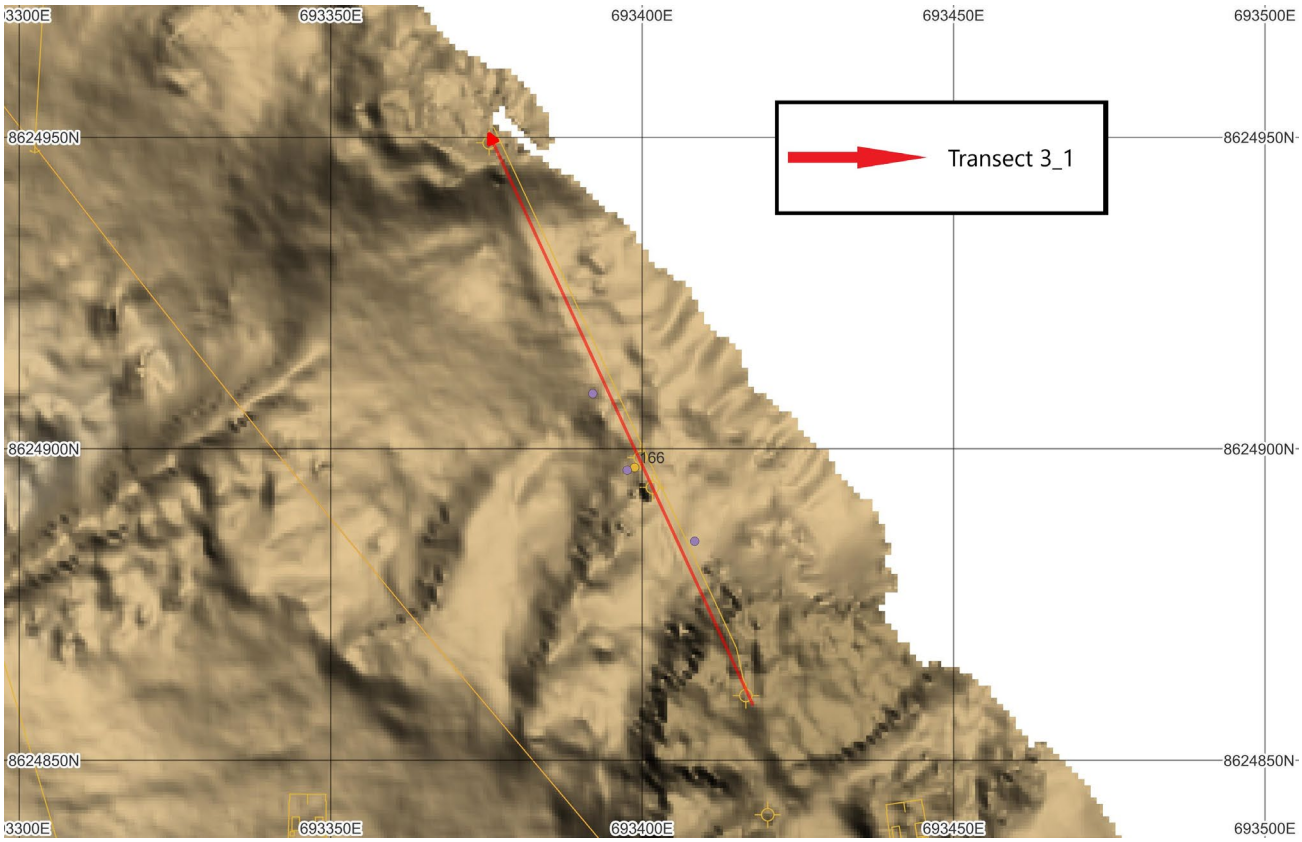


Figure 42 : Dive location for Heritage Transect 3.

2.4.3.1 T3_1

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
20	693416.67	8624860.36	Anti-submarine net mooring blocks and chain.	Width: 0.00 Height: 0.00 Length: 0.00 Shadow: 0.00	Variable, from 21 to 62	20 m

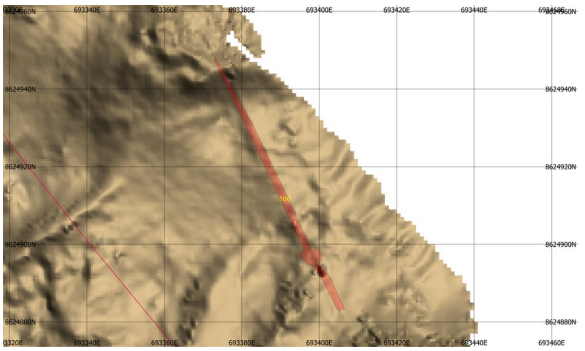


Figure 43: MBES image of general area of T3_1 and target 166.

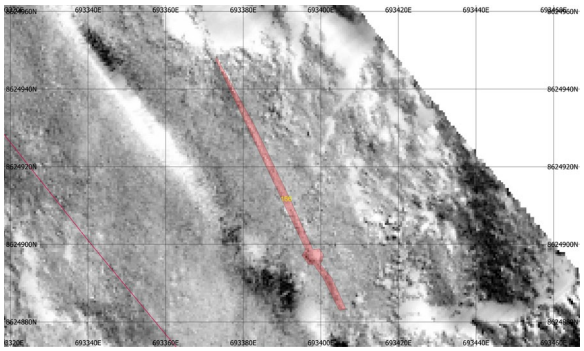


Figure 44: SSS image of general area of T3_1 and target 166.

Inspection details for T3_1		
Date: 07-06-2022	**Method:** ROV	**Tide:** Slack
Distance and direction: 150 m at 336° NNE		
Swim start (min): 1558	**Swim end (min):** 1626	**Total time (min):** 28
Depth: 20 m	**Water visibility:** 2 m – 3 m	**Seabed visibility:** Fair

Target description: The ROV was dropped on an area of seabed that was very rocky, with large rock shelfs and individual pebbles scattered around. This seabed topography made locating the chain and mooring blocks difficult, as potential cultural objects may have been obscured by the rocky seafloor and marine growth. Once the chain was located, the ROV took a southern heading and followed the chain towards the proposed GEP location at a heading of 120° ESE (Figure 47). Approximately 20 m further the chain was kinked at almost a 90-degree angle, with a clear break (Figure 48). Further investigation south found no further sign of the chain or mooring blocks, indicating that the chain had likely been broken and possibly removed or buried in this area. Turning north, the ROV followed the chain at a heading of 325° NW, finding this length of chain broken around the rocks and rock shelfs. Four more sections of broken chain were identified, all oriented on approximately the same heading, before the mooring block at Target 166 was located (Figure 49). The chain continued unbroken NNW from Target 166 for approximately 60 m before a second mooring block was identified (Figure 50). This second block appeared to be flipped upside down and had possible debris trapped under it (Figure 51). The chain continued the same heading from the north side of the second block, but as this was in the opposite direction of the proposed GEP route, it was decided to end investigation.

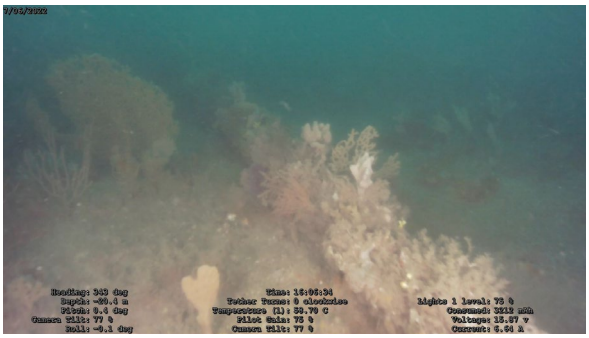


Figure 45: Chain located near ROV drop site. (Video 2022-06-07_15.56.55; 09:37).

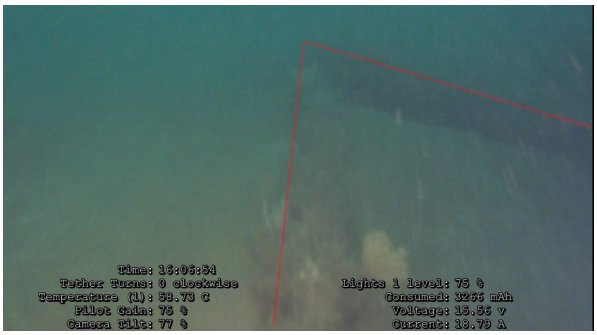


Figure 46: Chain kinked south of drop site. Direction of chain shown by red line. (Video 2022-06-07_15.56.55; 09:56).

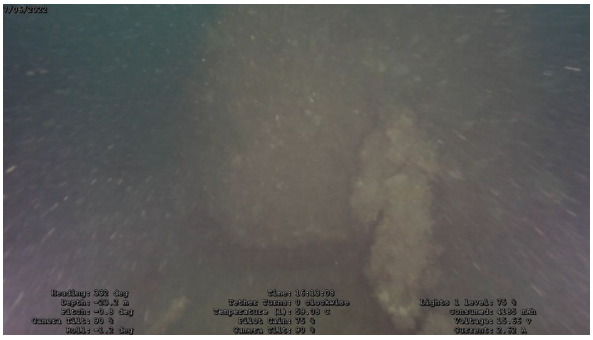


Figure 47: Target 166, mooring block, facing north. (Video 2022-06-07_15.56.55; 16:10).

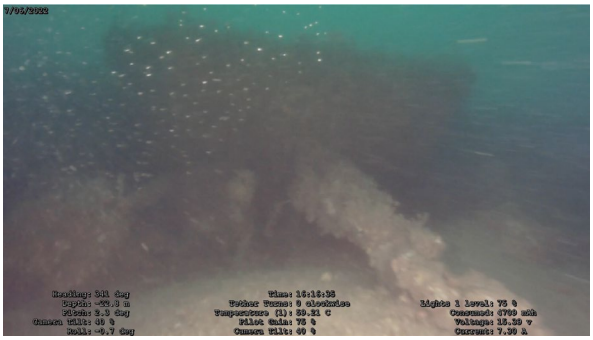


Figure 48: Second mooring block, apparently flipped upside down. (Video 2022-06-07_15.56.55; 19:37).

Figure 49: Apparent debris wedged under second mooring block. (Video 2022-06-07_15.56.55; 21:23).

2.4.4 *Individual Heritage Targets*

In addition to the three heritage transects undertaken on the anti-submarine net mooring trots, an additional 10 isolated targets located within 50m of the proposed GEP route were investigated.

2.4.4.1 Target 142

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
7	690559.00	8628514.00	Large boulders FUGRO ID: NCL_SC_042	Width: 12.00 Height: 0.00 Length: 15.00 Shadow: 0.00	0	32 m

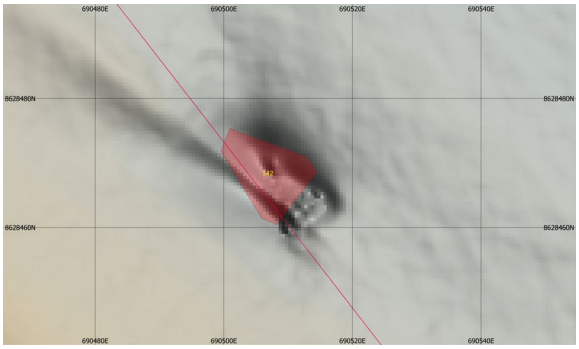


Figure 50: MBES image of Target 142.

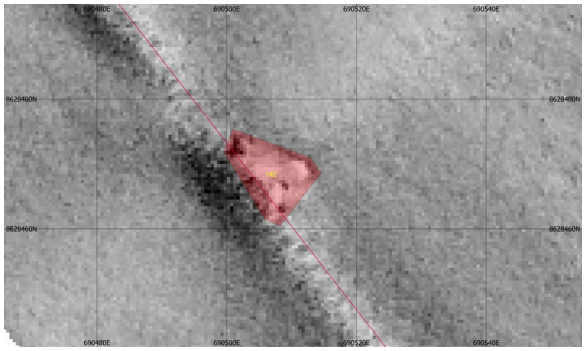


Figure 51: SSS image of Target 142.

Inspection details for Target 142		
Date: 06-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Circular search 10 m		
Swim start (min): 1458	**Swim end (min):** 1535	**Total time (min):** 37
Depth: 32 m	**Water visibility:** 0 m – 2 m	**Seabed visibility:** Poor

Target description: The investigation for Target 142 was combined with ecology survey 26_BACI-5P. Target was located and determined to be numerous large boulders, non-cultural. Boulders ranged from 2 – 5 metres in size (Figure 54, Figure 55).

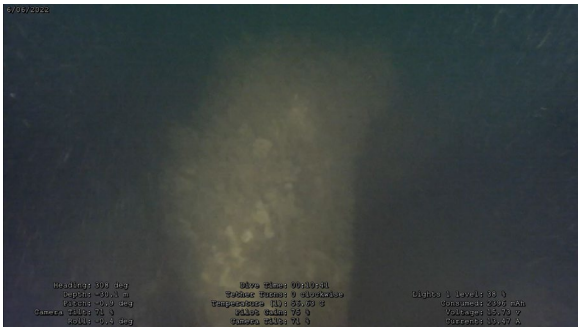


Figure 52: Boulder located at Target 142. (Video 2022-06-06_15.00.03; 05:01).

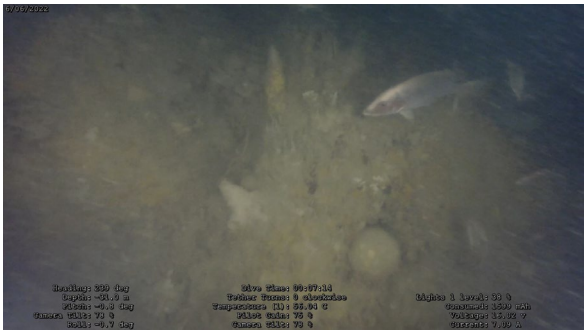


Figure 53: Detail of large boulder at Target 142. (Video 2022-06-06_15.00.03; 04:30).

2.4.4.2 Target 245

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
9	693164.00	8625128.00	Field of pebbles and rocks. Possibly MA_012	Width: 22.00 Height: 0.00 Length: 31.00 Shadow: 0.00	0	21 m

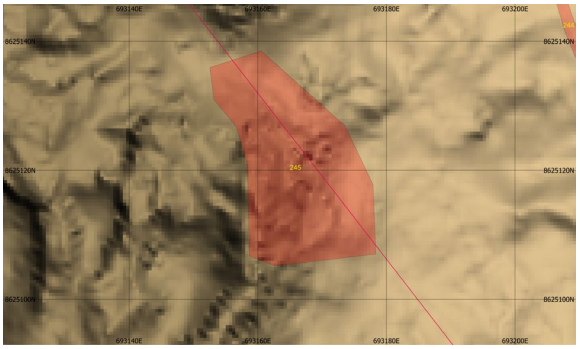


Figure 54: MBES image of Target 245, area of debris field highlighted.

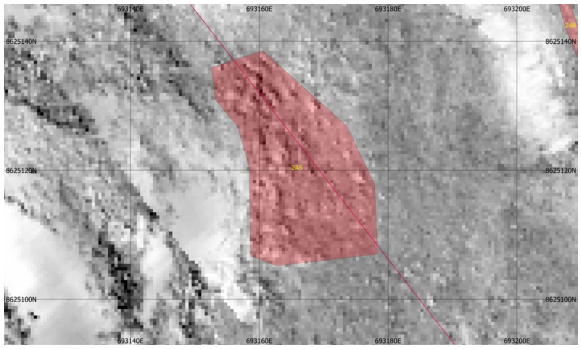


Figure 55: SSS image of Target 245, area of debris field highlighted.

Inspection details for Target 245		
Date: 06-06-2022	**Method:** ROV	**Tide:** Flowing
Distance and direction: Circular search 10 m		
Swim start (min): 1701	**Swim end (min):** 1710	**Total time (min):** 9
Depth: 21 m	**Water visibility:** 0 m – 2 m	**Seabed visibility:** Poor

Target description: Target 245 was located and determined to be a mound or field of rocks and pebbles, ranging in size from several centimetres to 2 metres across (Figure 58, Figure 59).

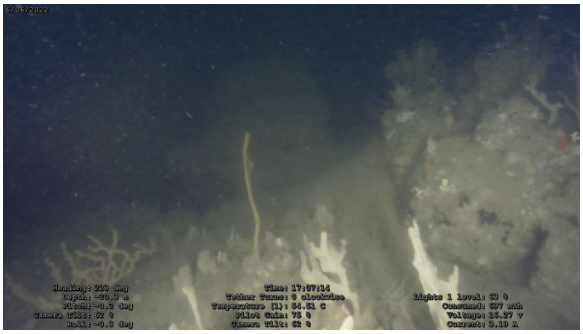


Figure 56: Larger rocks located at Target 245. (Video 2022-06-06_17.02.18; 03:20).

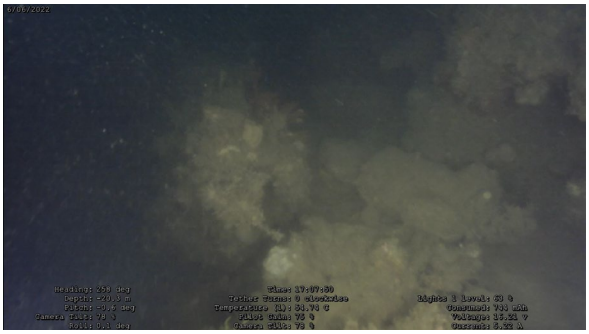


Figure 57: Smaller rocks located at Target 245. (Video 2022-06-06_17.02.18; 05:29).

2.4.4.3 Target 241

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
19	691791.84	8626921.00	Seabed depression FUGRO ID: NCL_SC_032	Width: 8.00 Height: 0.00 Length: 9.00 Shadow: 0.00	42	24 m

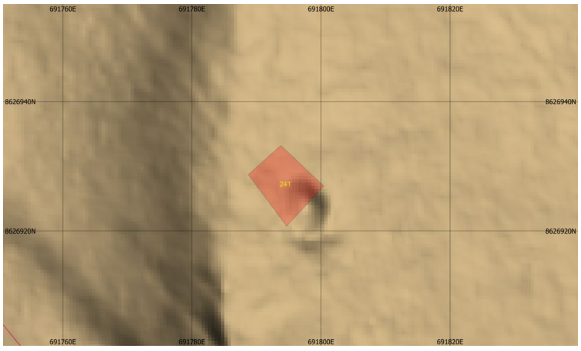


Figure 58: MBES image of Target 241.

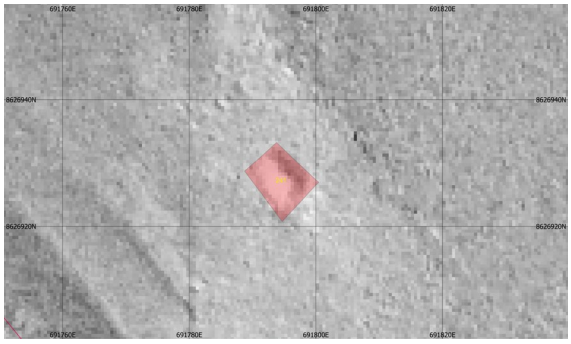


Figure 59: SSS image of Target 241.

Inspection details for Target 241		
Date: 07-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Circular search 10m		
Swim start (min): 1453	**Swim end (min):** 1529	**Total time (min):** 36
Depth: 24 m	**Water visibility:** 2 – 3 m	**Seabed visibility:** Fair

Target description: Target 241 was determined to be a shallow depression in the seabed, approximately 1.5m deep with gently sloping sides. Dive for 241 was combined with investigation of NCL_SC_031 and ecology survey 24_BACI-4P.

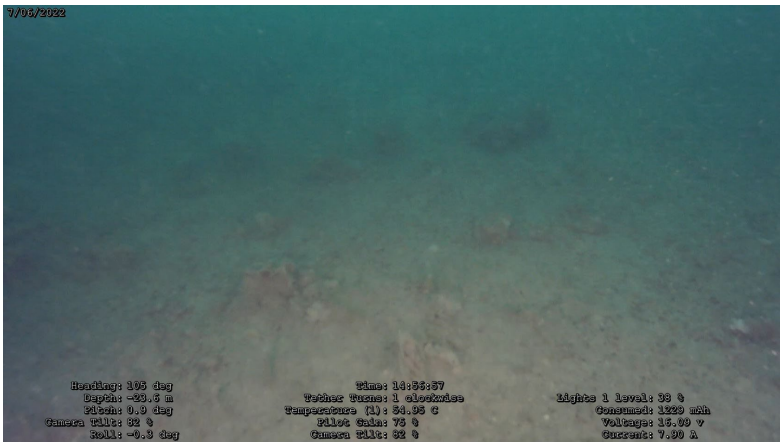


Figure 60: Detail of seabed in depression located at Target 241. (Video 2022-06-07_14.54.13; 02:42).

2.4.4.4 Target NCL_SC_031

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
19	691791.84	8626921.00	Possible debris.	Width: 0.70 Height: 0.00 Length: 1.40 Shadow: 0.00	25	24 m

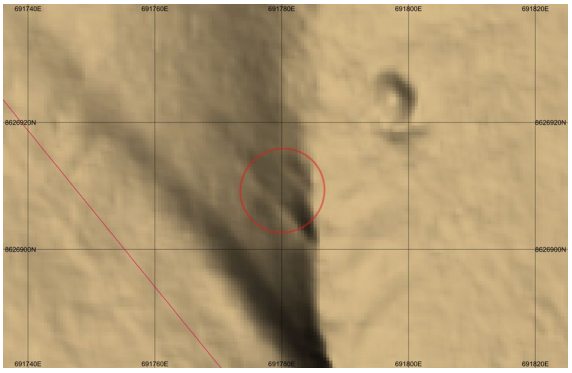


Figure 61: MBES image of Target NCL_SC_031.

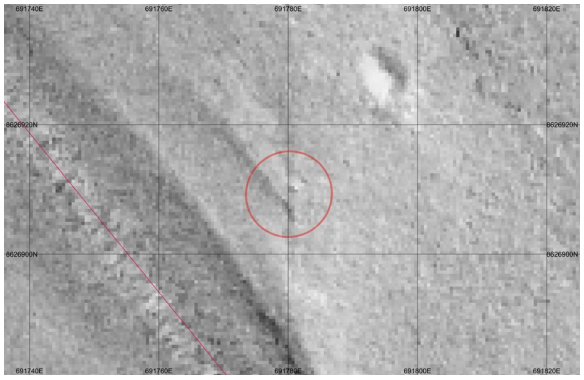


Figure 62: SSS image of Target NCL_SC_031.

Inspection details for Target NCL_SC_031		
Date: 07-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Circular search 10m		
Swim start (min): 1453	**Swim end (min):** 1529	**Total time (min):** 36
Depth: 24 m	**Water visibility:** 2 – 3 m	**Seabed visibility:** Fair

Target description: The ROV continued directly from Target 241 to the location of NCL_SC_031 at a bearing of 232° SW. No cultural material was identified at this location. Seabed consisted of fine sand with numerous sand ripples.

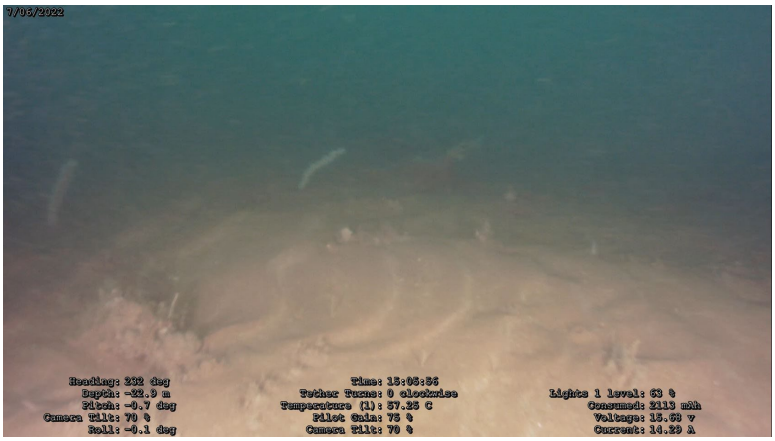


Figure 63: Seabed and sand ripples at NCL_SC_031. (Video 2022-06-07_15.04.06; 01:48).

2.4.4.5 Target 175

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
22, 23	694295.02	8623601.00	Linear ridge. Possibly associated with MA_009	Width: 5.00 Height: 0.00 Length: 24.00 Shadow: 0.00	1.5	28 m

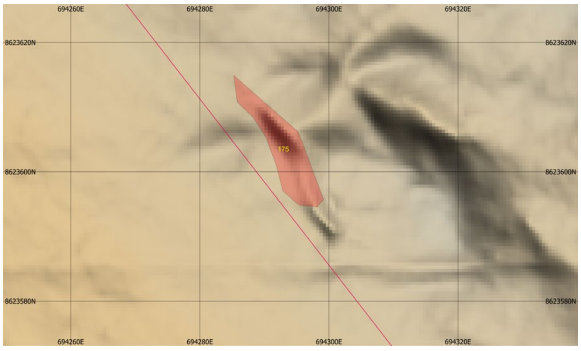


Figure 64: MBES image of Target 175.

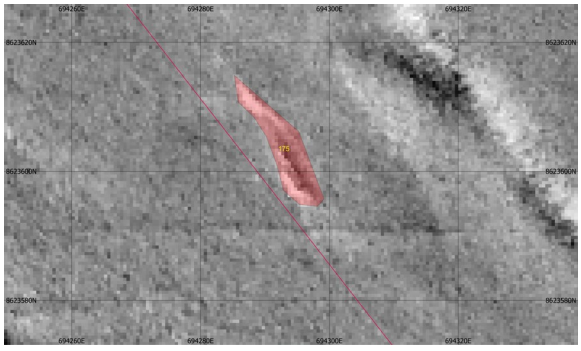


Figure 65: SSS image of Target 175.

Inspection details for Target 175		
Date: 08-06-2022	**Method:** ROV	**Tide:** Flowing
Distance and direction: 25 m at 147° SE		
Swim start (min): 0748	**Swim end (min):** 0810	**Total time (min):** 22
Depth: 28 m	**Water visibility:** 3 m – 4 m	**Seabed visibility:** Good

Target description: Two dives were attempted on Target 175. The first, dive 22, was unsuccessful in finding the target, and was aborted. The second, dive 23, was successful in locating the target.

Target 175 appeared to be a low ridge of rock and coral, rising approximately 1 – 2 m from the surrounding seabed, which was mostly sand. The ridge measured approximately 25 m in total length and 2-3 m in width and was separated in two sections by a small gap about halfway along the ridge. No obvious cultural material was seen during the dive.

Figure 66: North section of ridge, facing northeast. (Video 2022-06-08_07.51.14; 01:05).

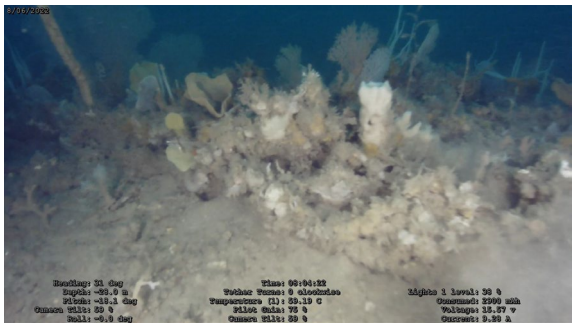


Figure 67: Detail of southern section of ridge. (Video 2022-06-08_07.51.14; 13:04).

2.4.4.6 Target 174

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
24	694194.61	8623695.89	Single discrete object in close location to series of mag strikes across KP 109 FUGRO ID: NCL_SC_013, MA_010	Width: 2.00 Height: 1.00 Length: 3.00 Shadow: 0.00	15	28 m

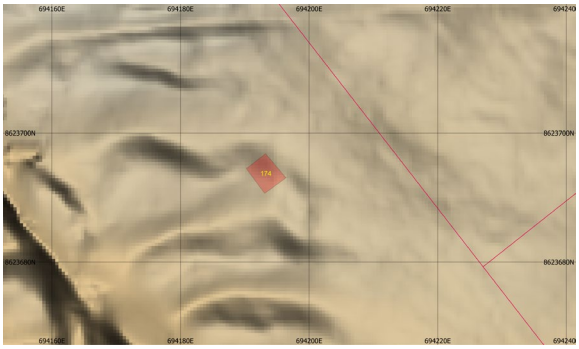


Figure 68: MBES image of Target 174.

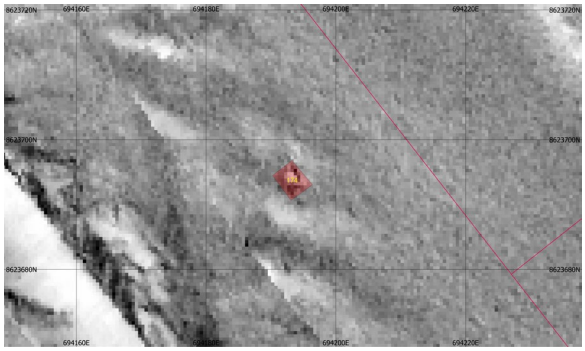


Figure 69: SSS image of Target 174.

Inspection details for Target 174		
Date: 08-06-2022	**Method:** ROV	**Tide:** Flowing
Distance and direction: Cross search pattern, 10m NESW		
Swim start (min): 0826	**Swim end (min):** 0841	**Total time (min):** 15
Depth: 28 m	**Water visibility:** 3 m – 4 m	**Seabed visibility:** Good

Target description: In an improvement on target locating, a clump weight with a line attached to the buoy was dropped on the location of the target while the vessel was moving. Once the vessel was anchored, the ROV used the buoy line as a target reference and descended on the line to the seabed. Once on the bottom, the ROV began a cross shaped search pattern with 10 m transects out from the clump weight in all four cardinal directions.

Target 174 was located a short distance west of the drop weight and appeared as two round mounds protruding from a sandy seabed, similar to a dumbbell in form. A full 360° visual survey of the object was completed. The whole structure was estimated to measure 2-3 m from end to end, 1 m wide, and 1 m above the seabed. The remains of cable or rope appeared to be wrapped around the middle arm connecting the two ends, with a coil wedged underneath the western end. The shape and presence of cable or rope suggests that Target 174 may be a windlass or winch. No other cultural objects were identified in the surrounding area.

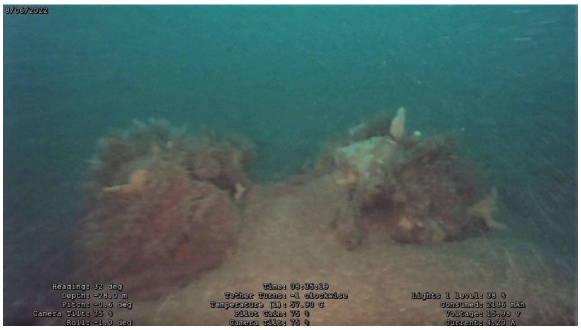


Figure 70: Target 174, facing north. (Video 2022-06-08_08.26.18; 08:58).

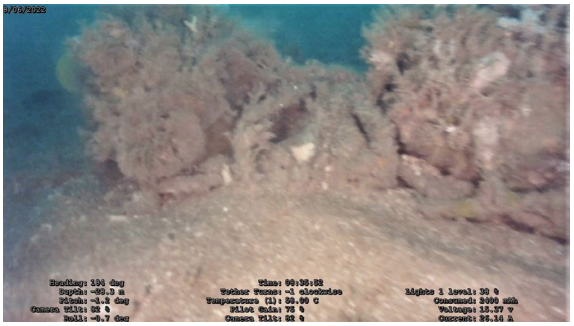


Figure 71: Target 174 facing south. Note possible cable or rope remains wrapped around middle. (Video 2022-06-08_08.26.18; 09:31).

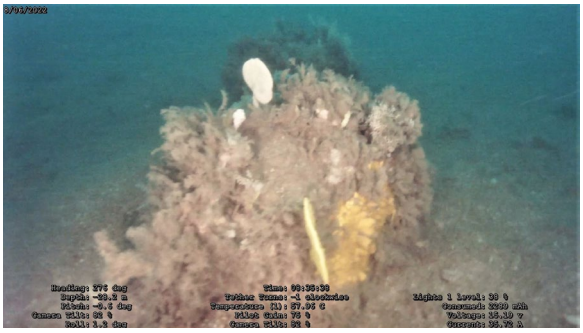


Figure 72: Target 174, facing west. (Video 2022-06-08_08.26.18; 09:17).

Figure 73: Target 174, facing east. Notice cable coiled underneath. (Video 2022-06-08_08.26.18; 09:35).

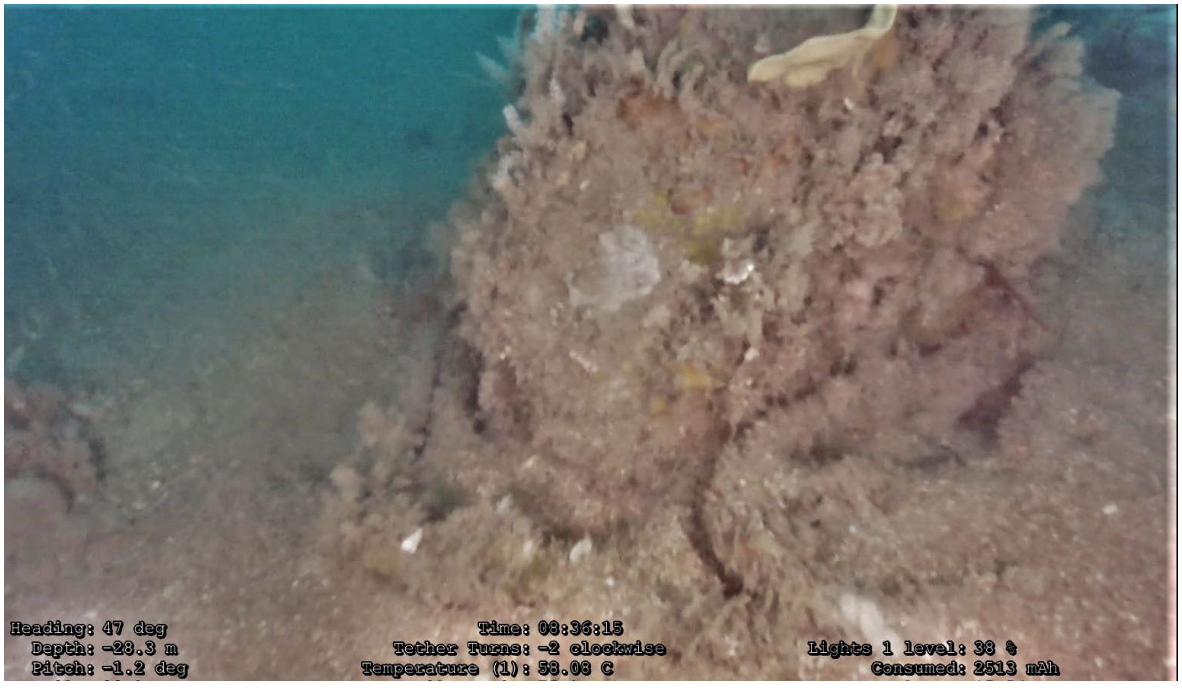


Figure 74: Detail of coil, facing east. (Video 2022-06-08_08.26.18; 09:55).

2.4.4.7 Target NCL_SC_016

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
25, 26	694168.64	8623820.49	Possible cable support or isolated non-ferrous object	Width: 1.60 Height: 0.00 Length: 3.50 Shadow: 0.00	39	30 m

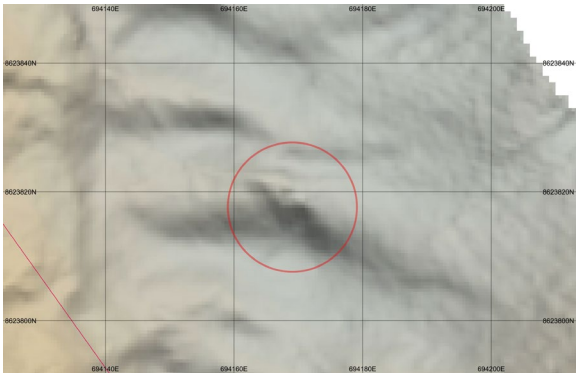


Figure 75: MBES image of Target NCL_SC_016.

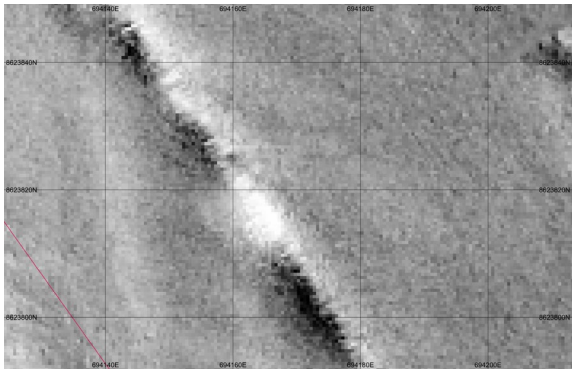


Figure 76: SSS image of Target NCL_SC_016.

Inspection details for Target NCL_SC_016		
Date: 08-06-2022	**Method:** ROV	**Tide:** Flowing
Distance and direction: Cross search pattern, 10m NESW		
Swim start (min): 0907	**Swim end (min):** 0933	**Total time (min):** 26
Depth: 30 m	**Water visibility:** 2 m – 3 m	**Seabed visibility:** Good

Target description: Two dives were attempted on Target NCL_SC_016. The first was aborted because the ROV lost sight of the guide rope. The second dive, 26, was successful in locating the target using the same methodology adopted for dive 24.

Target NCL_SC_016 was located several metres north of the drop weight and appeared to be a length of cable running in a generally east-west orientation (Figure 79). The cable was approximately 70mm in diameter and extended for about 35m in total length. Portions of the cable were buried in the sandy seabed, with both ends disappearing into the sand. Around 20 m west of the drop weight, the cable veered slightly north before turning sharply southwest and a 90-degree dogleg (Figure 80). The portion of the cable at the dogleg was clearly visible above the seabed and appeared to be ferrous (Figure 81). The location of the cable is roughly in the location of the 1879 telegraph cable and may be the disarticulated section of a 19th century telegraph cable.

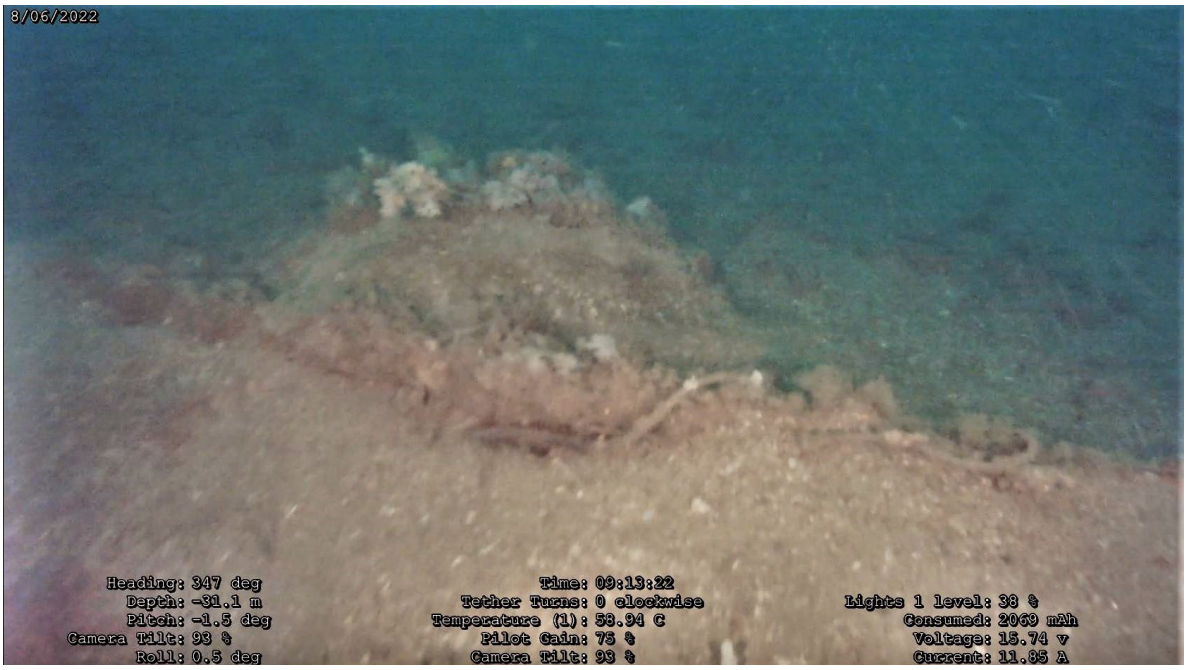


Figure 77: Target NCL_SC_016 just north of drop line. Cable running at heading of 274° W. (Video 2022-06-08_09.06.58; 06:10).

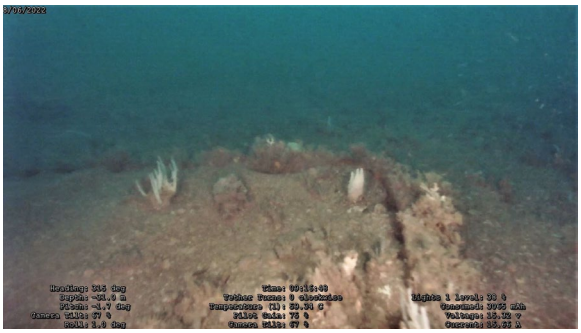


Figure 78: Dogleg in cable. (Video 2022-06-08_09.06.58; 09:47).

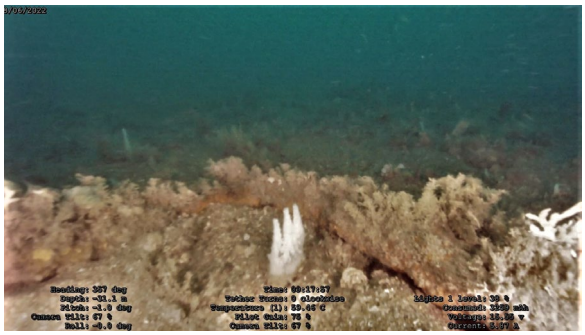


Figure 79: Detail of cable at dogleg. Note possible ferrous nature of cable. (Video 2022-06-08_09.06.58; 10:56).

2.4.4.8 Target MA_007

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
29	695763.20	8621695.50	Inferred buried debris	21.5 nT	6	24 m

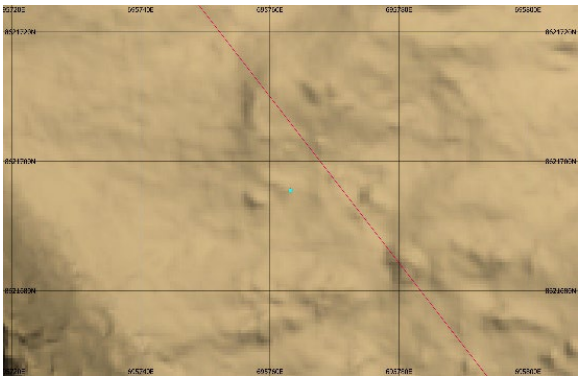


Figure 80: MBES image of the general area of Target MA_007.

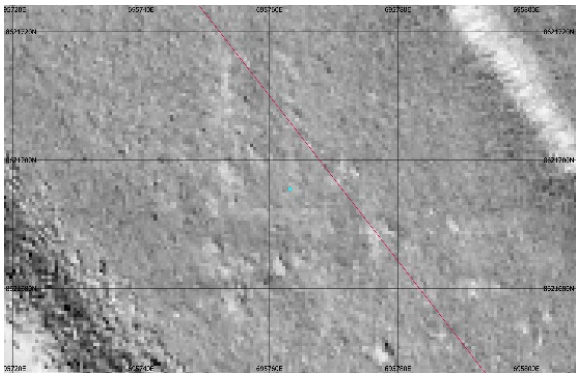


Figure 81: SSS image of the general area of Target MA_007.

Inspection details for Target MA_007		
Date: 08-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Cross search pattern, 10m NESW		
Swim start (min): 1256	**Swim end (min):** 1312	**Total time (min):** 16
Depth: 24 m	**Water visibility:** 2 m – 3 m	**Seabed visibility:** Good

Target description: Dive methodology was repeated from previous dives. A clump weight with buoy was dropped on the target from the moving vessel. Once anchored, the ROV was placed in the water and followed the line down to the seabed. Once on bottom, a cross shaped search pattern was conducted, with 10m transects in each cardinal direction from the clump weight.

The clump weight was dropped almost directly on top of Target MA_007, which was located 2m west. The target appeared to be a rectangular structure made of steel I-beams with very low relief above the sandy seabed. The structure consisted of at least 10 beams and possibly more as it was partially buried in the seabed. Three long beams delimited the structure on three sides, with the fourth side buried. Between these several smaller beams extended from one side of the structure, parallel with the other two sides. The main structure is estimated to be roughly five metres long and 2 metres wide. In addition to this contiguous material, there were several isolated and disarticulated beams scattered nearby. MA_007 may represent the remains of a steel barge, or possible discard.

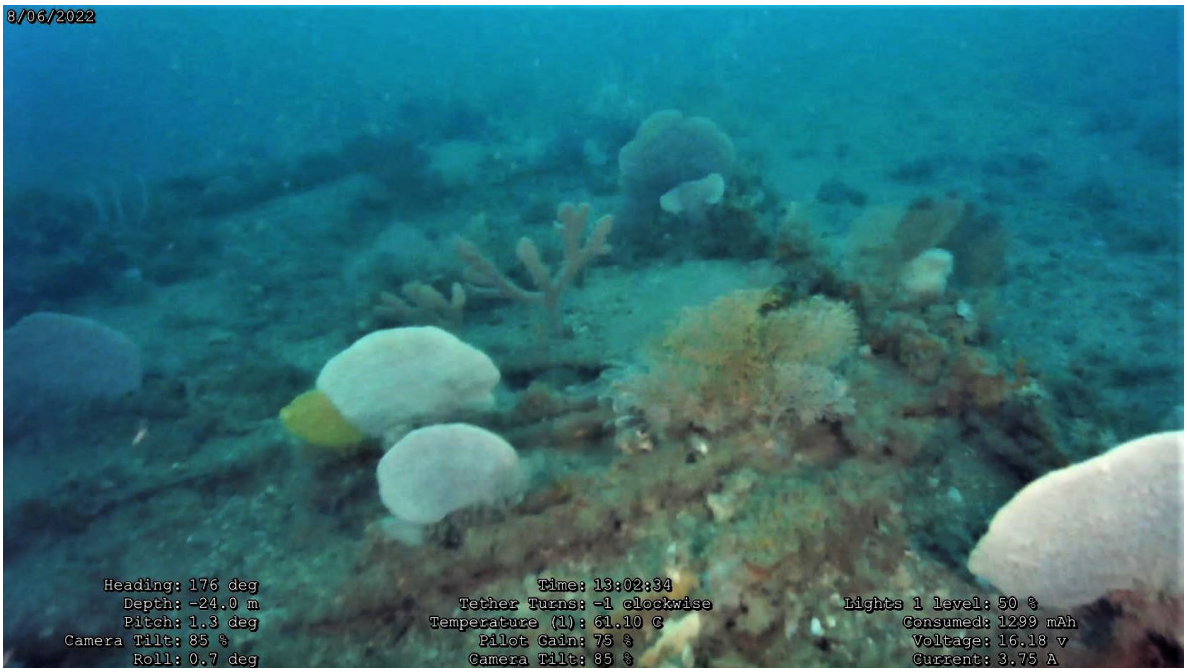


Figure 82: Overview of structure located at Target MA_007, facing south. Note rectangular shape of outer beams, with interior beams. (Video 2022-06-08_12.56.09; 06:23).

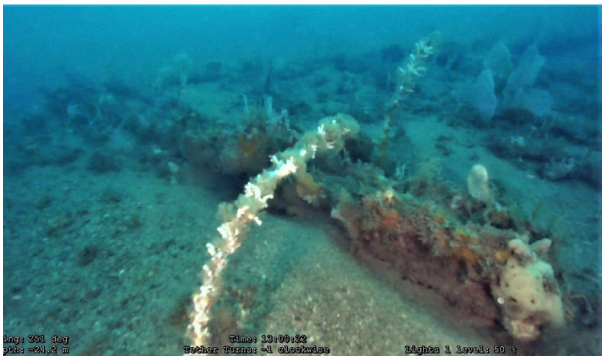


Figure 83: Overview of structure, facing west. (Video 2022-06-08_12.56.09; 04:10).

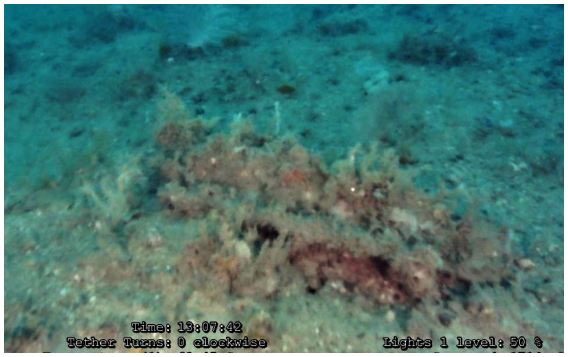


Figure 84: Isolated debris likely associated with the contiguous structure at MA_007. Debris located approximately 5m from structure. (Video 2022-06-08_12.56.09; 11:31).

2.4.4.9 Target MA_001

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
30	697628.20	8617803.70	Inferred buried debris	13.3 nT	35	20 m

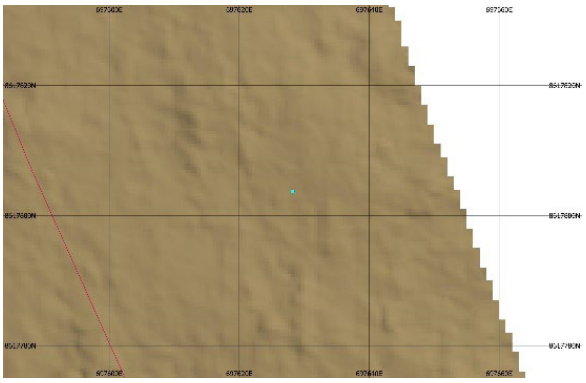


Figure 85: MBES image of the general area of Target MA_001.

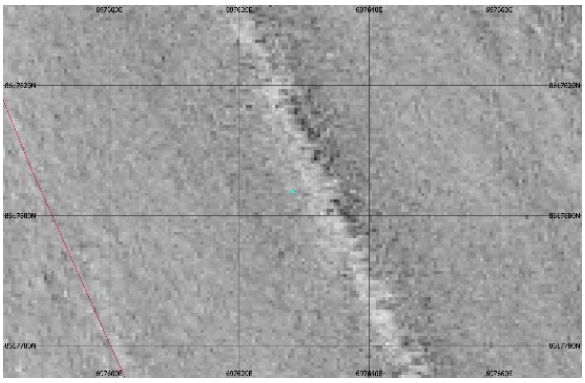


Figure 86: SSS image of the general area of Target MA_001.

Inspection details for Target MA_001		
Date: 08-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Cross search pattern, 10m NESW		
Swim start (min): 1338	**Swim end (min):** 1358	**Total time (min):** 20
Depth: 20 m	**Water visibility:** 2 m – 3 m	**Seabed visibility:** Good

Target description: Dive methodology was repeated from previous dives. A clump weight with buoy was dropped on the target from the moving vessel. Once anchored, the ROV was placed in the water and followed the line down to the seabed. Once on bottom, a cross shaped search pattern was conducted, with 10m transects in each cardinal direction from the clump weight.

The cross search found three instances of debris in the search area. A metal wheel rim was located 5m south of the clump weight, mostly buried in soft sediment (Figure 89). Next to the wheel was a length of steel rope, with one end tied in a loop (Figure 90 and Figure 91). These two objects are likely related and may represent a mooring for a buoy or other device.

A third piece of debris was located about 5m north of the clump weight. This object consisted of a cement block or possible metal scrap with two wires protruding (Figure 92). No other debris or cultural objects were seen in the area.

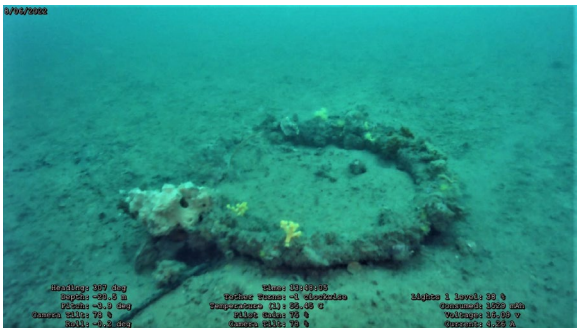


Figure 87: Metal wheel rim located at MA_001. Note wire protruding from side. (Video 2022-06-08_13.43.09; 04:54).

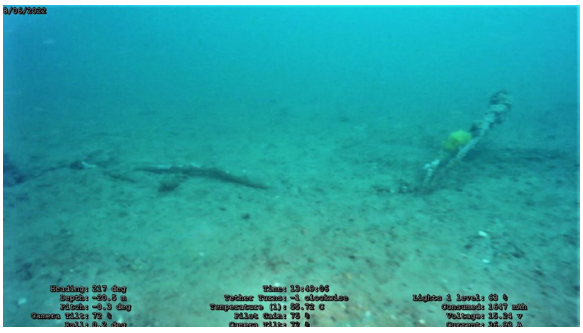


Figure 88: Steel rope or cable located next to the wheel rim. (Video 2022-06-08_13.43.09; 05:56).

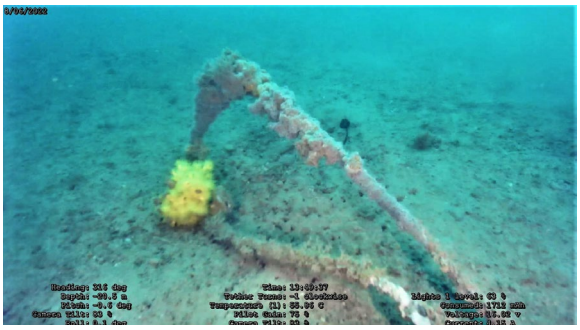


Figure 89: Detail of loop in cable. (Video 2022-06-08_13.43.09; 06:27).

Figure 90: Debris located north of clump weight. (Video 2022-06-08_13.43.09; 07:57).

2.4.4.10 Target NCL_SC_002

ROV dive	Dive Start Easting	Dive Start Northing	Interpretation	Dimensions	Distance from GEP (m)	Depth
31	698297.94	8616489.78	Single isolated object, possible debris or natural feature	Length: 1.00 Width: 0.40	11	14 m

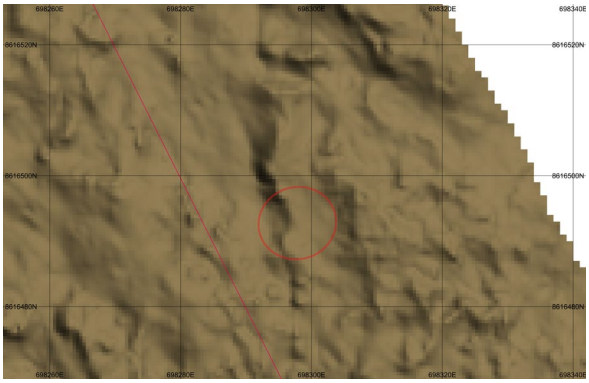


Figure 91: MBES image of Target NCL_SC_002

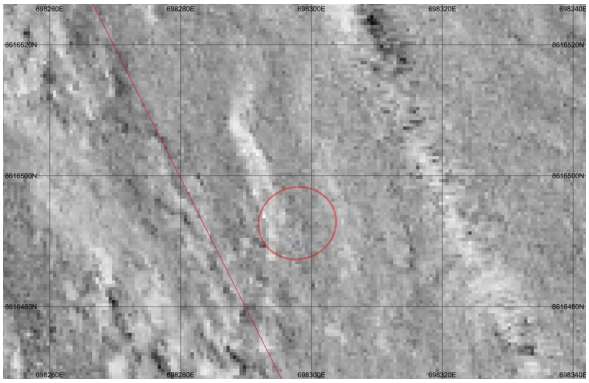


Figure 92: SSS image Target NCL_SC_002.

Inspection details for Target NCL_SC_002		
Date: 08-06-2022	**Method:** ROV	**Tide:** Ebbing
Distance and direction: Cross search pattern, 10m NESW		
Swim start (min): 1420	**Swim end (min):** 1440	**Total time (min):** 20
Depth: 14 m	**Water visibility:** 2 m – 3 m	**Seabed visibility:** Good

Target description: Dive methodology was repeated from previous dives. A clump weight with buoy was dropped on the target from the moving vessel. Once anchored, the ROV was placed in the water and followed the line down to the seabed. Once on bottom, a cross shaped search pattern was conducted, with 10m transects in each cardinal direction from the clump weight.

A small piece of possible debris was located 5m south of the clump weight. The object was long and thin, possibly aluminium if metal. After locating this object, the ROV lost the location of the clump weight and surfaced to locate the target again. After reaching the bottom again, the ROV swam north of the weight, and completed its cross-pattern search. No other cultural material was seen in the area.

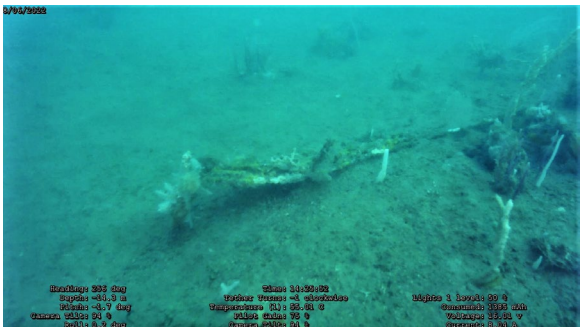


Figure 93: Possible debris located south of clump weight. (Video 2022-06-08_14.22.27; 03:23).

Figure 94: Natural feature north of clump weight. (Video 2022-06-08_14.22.27; 15:11).

3 ROV SURVEY SUMMARY

In total, 21 dives were attempted to locate and identify geophysical survey targets. Of these 21 dives, 3 were aborted due to poor conditions or issues with the ROV. Despite these failed attempts, ROV surveys were conducted on all 16 targets shortlisted for ROV survey.

Heritage Transects 1, 2, and 3 identified the remains of WWII anti-submarine net moorings near the entrance to Darwin Harbour. It was concluded based on these surveys that the northern and southern mooring trots (Transects 2 and 3) did not cross the proposed GEP route. It was noted that the northern end of the trot surveyed by Transect 2 was anchored with a potentially historical ships anchor, likely of cultural heritage significance.

ROV survey of the middle trot (Transect 1) identified mooring chains that did cross the proposed GEP route. However, it was also seen that a gap exists between sections of the chain, southeast of the location of Target 246, which was not located.

Individual dives on 10 isolated heritage targets identified 5 instances of natural features, not considered to be cultural in origin. Of the remaining 5, four are conclusively cultural, while one was inconclusive. The table below summarizes the results of the survey of these features.

Target ID	Likely identification	Cultural/Natural
142	Boulders	Natural
245	Rock rubble	Natural
241	Shallow depression	Natural
NCL_SC_031	Sand ripples	Natural
175	Narrow rock/coral ridge	Natural
174	Winch or windlass	Cultural
NCL_SC_016	Telegraph cable	Cultural
MA_007	Remains of barge	Cultural
MA_001	Buoy mooring and cable	Cultural
NCL_SC_002	Metal debris	Inconclusive

ANNEX A – DIVE LOG

Dive	Date	Objective of dive	Swim Start	Swim Finish	Total bottom time (min)
3	06/06/2022	T1_1	10:27	11:38	11
4	06/06/2022	T1_2	12:15	12:38	13
5	06/06/2022	T1_3	12:47	13:11	24
7	06/06/2022	Target 142	14:58	15:35	37
8	06/06/2022	T1_4	16:05	16:44	39
9	06/06/2022	Target 245	17:01	17:10	9
10	07/06/2022	T1_5	8:09	8:11	2
14	07/06/2022	T1_6	10:45	11:06	21
15	07/06/2022	T1_7	11:30	12:00	30
16	07/06/2022	T2_1	12:31	12:55	24
19	07/06/2022	Targets 241 and NCL_SC_031	14:53	15:29	36
20	07/06/2022	T3_1	15:58	16:26	28
21	07/06/2022	T2_2	16:46	17:02	16
22	08/06/2022	Target 175	7:18	7:34	16
23	08/06/2022	Target 175	7:48	8:10	22
24	08/06/2022	Target 174	8:26	8:41	15
25	08/06/2022	Target NCL_SC_016	8:53	9:00	7
26	08/06/2022	Target NCL_SC_016	9:07	9:33	26
29	08/06/2022	MA_007	12:56	13:12	16
30	08/06/2022	MA_001	13:38	13:58	20
31	08/06/2022	NCL_SC_002	14:20	14:40	20
Total Dives	**21**			Total bottom time	**432**

ANNEX B – VIDEO LOG

Dive	Name	File	Size (GB)	Length
3	2022-06-06_10.27.18	MKV	2.00	31:08
	2022-06-06_10.58.29	MKV	3.22	41:18
4	2022-06-06_12.24.46	MKV	0.68	12:37
5	2022-06-06_12.48.12	MKV	1.51	21:01
7	2022-06-06_15.00.03	MKV	0.68	13:47
8	2022-06-06_16.08.58	MKV	2.30	32:31
	2022-06-06_16.41.31	MKV	0.25	03:55
9	2022-06-06_17.02.18	MKV	0.45	07:53
10	2022-06-07_08.06.12	MKV	0.00	00:02
14	2022-06-07_10.46.37	MKV	0.79	16:17
15	2022-06-07_11.30.28	MKV	1.79	30:19
16	2022-06-07_12.31.43	MKV	1.86	23:41
19	2022-06-07_14.54.13	MKV	0.55	09:51
	2022-06-07_15.04.06	MKV	0.28	03:37
20	2022-06-07_15.56.55	MKV	2.30	29:18
21	2022-06-07_16.47.23	MKV	0.87	14:23
22	2022-06-08_07.19.04	MKV	0.68	15:45
23	2022-06-08_07.51.14	MKV	0.91	19:44
24	2022-06-08_08.26.18	MKV	0.79	14:40
25	2022-06-08_08.58.47	MKV	0.38	05:37
26	2022-06-08_09.06.58	MKV	1.28	24:43
29	2022-06-08_12.56.09	MKV	1.27	16:06
30	2022-06-08_13.43.09	MKV	1.17	14:50
31	2022-06-08_14.22.27	MKV	1.62	20:39

11 ANNEX B: CONSOLIDATED TARGET LIST

The table below is a consolidated list of all targets identified as potentially cultural from geophysical survey data review. Additionally, several known shipwrecks within the study area and anchoring corridor are included, as well as targets surveyed during ROV surveys (see main report, Section 7, and Annex A).

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
B	MA_001 *	697,628.20	8,617,803.70	Likely buoy mooring and cable	1	1	0.25	20	35
A	MA_007 *	695,763.20	8,621,695.50	Metal frame and debris	5	2	0.25	24	6
B	MA_028	693,130.70	8,624,923.90	Buried ferrous object near anti-sub net moorings	N/A	N/A	N/A	21	150
B	MA_031	698,180.90	8,616,372.60	Buried ferrous object	N/A	N/A	N/A	13	146
B	MA_037	701,335.50	8,613,704.20	Buried ferrous object	N/A	N/A	N/A	19	651
A	112	623 013.42	8 659 220.00	Single object of high relief. Possible debris related to I-124.	8	6	N/A	46	68
A	138	686 407.37	8 632 159.33	Mound associated with anchor scars	13	16	N/A	17	59
A	149	691 670.76	8 626 677.01	Unknown, may be related to pipeline or another cultural feature.	Total length: 258m Ind. Diameter: 5m	19	N/A	19	200
A	164*	693 038.56	8 625 231.53	Part of anti-submarine net mooring trot 18 FUGRO ID: NCL_SC_026	209	2	N/A	16	30
A	166*	693 399.74	8 624 898.55	Part of anti-submarine net mooring trot 16 FUGRO ID: NCL_SC_017, 018, 019	73	5	N/A	21	41

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	167*	693 085.69	8 625 121.75	Part of anti-submarine net mooring trot 17 Likely connected to Target ID: 164	3	3	N/A	16	76
A	191	696 438.36	8 620 800.13	Single object of high relief. Possible small boat.	8	3	N/A	19	73
A	210	701 140.90	8 613 958.61	Possible aircraft wreck or natural feature.	12	7	N/A	17	389
A	234	647 746.21	8 649 692.16	Single mound, indicating lone discarded object.	5	4	N/A	43	173
A	238	696 581.70	8 620 537.67	Possible scattered debris.	70	10	N/A	21	78
A	239	697 710.77	8 617 774.90	USAT *Mauna Loa*	124.97	16.46	N/A	19	90
A	240	691 578.22	8 626 925.25	Possible mooring block for anti-submarine defences	4	2	N/A	16	122
A	242	691 589.94	8 626 799.20	Steel wire rope and chain associated with anti-submarine defences. (boom net), UXO including mechanical fuses and fuse cones. (See Section 6.4)	23	13	N/A	17	186
A	243	693 188.00	8 624 746.00	Possible mooring block related to anti-submarine defences.	2	2	N/A	15	216
A	244*	693 196.00	8 625 167.00	Part of anti-submarine net mooring trot 18 FUGRO ID: NCL_SC_022, 023, 024, 025	120	5	N/A	22	50
A	248	693 131.66	8 624 925.53	Debris scatter, or possible anti-submarine net remains	Var.	Var.	N/A	16	150

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
B	NCL_SC_002*	698 297.94	8 616 489.78	Debris	1	0.4	N/A	17	11
B	NCL_SC_010	694 982.00	8 622 822.59	Linear debris, likely cable remains.	17	0.5	N/A	20	70
A	NCL_SC_016*	694 168.64	8 623 820.49	Cable, possible telegraph	3.5	1.6	N/A	24	40
B	NCL_SC_031*	691 780.61	8 626 909.95	Single isolated non-ferrous object, likely debris.	1.4	0.7	N/A	16	26
B	115	649 361.40	8 649 116.46	Shallow depressions with low relief object.	8	4	N/A	44	86
B	130	665 465.07	8 643 481.67	Possible debris scatter.	18	8	N/A	29	208
B	135	621 286.34	8 660 259.37	Likely natural feature, closest proximity target to I-124	62	58	N/A	48	143
B	136	622 455.26	8 659 969.89	Possible debris scatter or natural feature.	98	32	N/A	49	214
B	141	690 574.96	8 628 606.67	Debris or rocks FUGRO ID: NCL_SC_043, 044, 045, 046	53	20	N/A	30	137
A	174*	694 194.43	8 623 696.01	Winch or windlass with rope FUGRO ID: NCL_SC_013	5	4	N/A	24	16
B	192	696 253.89	8 620 643.48	Possible debris	24	22	N/A	14	147
B	196	696 859.94	8 619 902.39	Debris or rocks	9	6	N/A	19	53
B	233*	639 844.98	8 652 470.81	Triangular depression, Likely natural feature.	39	8	N/A	41	34
A	500	697,615.17	8,618,840.23	USAT Meigs	121.00	20.00	3.30	20	369
A	501	695,875.84	8,619,850.01	Medkhanun 3	25.00	8.00	7.00	19	847
A	502	695,698.81	8,620,246.53	Ham Luong	18.00	5.00	3.00	25	832
A	503	695,794.02	8,620,287.72	Song Saigon	40.00	10.00	5.00	24	728
A	504	695,778.93	8,620,381.31	John Holland Barge	38.00	15.00	5.00	25	700

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	505	693,287.42	8,623,844.84	Mandorah Queen	12.00	5.00	2.00	20	683
A	506	691,938.35	8,625,657.51	NR Diemen	29.00	5.00	0.00	8	642
A	573	692,508.78	8,625,489.01	Debris	26.00	15.00	0.50	17	295
A	574	691,574.41	8,626,791.47	WWII anti-sub boom net	41.00	21.00	1.00	21	209
A	575	691,518.71	8,626,801.77	Debris	10.00	6.00	0.75	20	245
B	576	689,856.12	8,628,847.08	Mound	7.00	6.50	0.40	25	268
B	577	689,412.76	8,629,288.62	Isolated object	4.00	4.50	0.50	24	263
B	578	685,439.11	8,632,096.37	Mound associated with trawl scar	8.00	4.50	0.40	17	603
A	579	689,314.84	8,630,473.13	Debris	20.00	9.00	1.30	31	592
B	580	689,842.70	8,630,171.05	Mound	5.00	4.00	1.50	30	691
A	581	691,692.88	8,627,659.36	Possible cable	312.00	2.50	1.40	31	431
A	583	692,918.80	8,626,550.93	Linear debris	11.00	2.00	1.50	39	682
A	584	692,936.90	8,626,417.56	Debris or boulder	7.00	6.00	3.50	39	613
A	588	693,982.49	8,624,331.38	Debris	8.00	4.00	2.50	35	165
A	585	694,508.35	8,624,088.70	Debris	9.00	3.00	0.50	32	472
B	586	694,770.88	8,624,269.65	Possible small boat or natural feature	17.00	4.00	1.25	35	791
A	587	695,753.15	8,623,106.77	Mooring block	3.00	2.50	0.80	33	852
A	589	696,110.51	8,621,995.74	Debris	17.00	7.00	2.50	33	452
A	590	696,133.59	8,621,994.69	Debris	4.50	2.50	2.00	33	470
A	591	696,472.78	8,621,975.02	Debris	6.40	6.20	1.50	32	727
A	592	696,535.45	8,621,187.11	Debris	8.50	2.70	1.30	25	345
A	593	696,548.46	8,621,272.90	Mooring block	1.40	1.40	0.75	25	399
A	594	697,090.00	8,620,464.24	Debris	3.50	3.00	1.75	25	513
A	595	697,563.09	8,620,256.32	Debris	6.50	4.20	1.75	32	845
A	597	698,035.82	8,617,894.98	Debris	3.00	3.00	2.00	20	443
B	598	697,030.36	8,617,864.23	Linear feature	59.00	2.00	0.75	12	504
B	599	697,055.70	8,617,918.12	Linear feature	24.00	2.00	0.75	13	462
B	600	697,036.34	8,618,057.64	Linear feature	33.00	2.00	1.00	16	434
A	601	696,815.85	8,619,144.52	Debris	40.00	8.00	0.50	19	286

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	602	696,751.52	8,619,156.36	Debris	24.00	11.00	0.75	16	343
A	603	696,112.03	8,619,639.40	Debris	8.00	6.60	3.00	14	729
B	604	696,043.52	8,619,624.92	Linear feature, log	18.70	2.40	1.00	13	797
B	605	696,000.91	8,619,629.09	Linear feature, log	15.80	2.40	0.50	13	833
B	606	696,032.94	8,619,598.74	Linear feature, log	13.00	2.40	0.75	13	818
B	607	696,362.60	8,619,654.65	Debris	7.00	6.50	1.00	12	497
A	609	696,003.49	8,621,145.27	Debris	16.00	7.50	3.00	21	132
B	610	695,614.51	8,621,498.95	Isolated object	3.30	1.50	0.60	18	244
A	611	693,064.64	8,624,298.00	Mooring block	1.70	1.70	0.50	17	599
A	612	693,132.32	8,624,265.69	Debris	3.00	2.50	0.90	18	568
A	620	692,571.44	8,624,809.47	Ant-sub net mooring	1.00	1.00	1.00	12	663
A	621	692,539.74	8,624,860.74	Ant-sub net mooring	1.00	1.00	1.00	15	656
A	622	692,523.80	8,624,892.44	Ant-sub net mooring	1.00	1.00	1.00	15	649
A	623	692,599.70	8,624,754.58	Ant-sub net mooring	1.00	1.00	1.00	11	674
A	624	692,709.75	8,624,594.89	Ant-sub net mooring	1.00	1.00	1.00	15	685
A	625	692,769.99	8,624,467.63	Ant-sub net mooring	1.00	1.00	1.00	10	716
A	626	692,749.61	8,624,525.87	Ant-sub net mooring	1.00	1.00	1.00	10	696
A	627	692,726.33	8,624,548.70	Ant-sub net mooring	1.00	1.00	1.00	11	700
A	628	692,147.90	8,624,971.06	Ant-sub net mooring	1.00	1.00	1.00	12	898
A	629	692,431.95	8,624,717.81	Ant-sub net mooring	1.00	1.00	1.00	7	829
A	630	692,412.02	8,624,771.61	Ant-sub net mooring	1.00	1.00	1.00	7	812
A	631	692,453.33	8,624,625.24	Ant-sub net mooring	1.00	1.00	1.00	9	869
A	632	692,922.97	8,624,532.76	Ant-sub net mooring	1.00	1.00	1.00	16	556
A	633	692,914.46	8,624,593.08	Ant-sub net mooring	1.00	1.00	1.00	16	525

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	634	692,897.79	8,624,648.33	Ant-sub net mooring	1.00	1.00	1.00	18	504
A	635	692,876.05	8,624,702.14	Ant-sub net mooring	1.00	1.00	1.00	15	488
A	636	692,763.55	8,624,903.58	Ant-sub net mooring	1.00	1.00	1.00	11	453
A	637	692,729.14	8,624,950.23	Ant-sub net mooring	1.00	1.00	1.00	11	452
A	638	692,816.54	8,624,826.14	Ant-sub net mooring	1.00	1.00	1.00	17	459
A	639	693,066.90	8,624,638.82	Ant-sub net mooring	1.00	1.00	1.00	20	377
A	640	693,040.27	8,624,691.00	Ant-sub net mooring	1.00	1.00	1.00	18	365
A	641	693,020.88	8,624,746.07	Ant-sub net mooring	1.00	1.00	1.00	19	347
A	642	692,944.62	8,625,014.99	Ant-sub net mooring	1.00	1.00	1.00	22	242
A	643	692,919.53	8,625,081.20	Ant-sub net mooring	1.00	1.00	1.00	15	221
A	644	692,908.66	8,625,150.86	Ant-sub net mooring	1.00	1.00	1.00	15	187
A	645	692,905.94	8,625,190.98	Ant-sub net mooring	1.00	1.00	1.00	16	164
A	646	693,039.04	8,625,225.45	Ant-sub net mooring	1.00	1.00	1.00	19	38
A	647	693,058.79	8,625,182.69	Ant-sub net mooring	1.00	1.00	1.00	18	49
A	648	693,076.54	8,625,127.44	Ant-sub net mooring	1.00	1.00	1.00	19	69
A	649	693,093.03	8,625,071.10	Ant-sub net mooring	1.00	1.00	1.00	18	90
A	650	693,205.80	8,624,728.36	Ant-sub net mooring	1.00	1.00	1.00	17	213
A	651	693,234.87	8,624,680.26	Ant-sub net mooring	1.00	1.00	1.00	18	222
A	652	693,144.21	8,624,841.13	Ant-sub net mooring	1.00	1.00	1.00	18	191
A	653	693,182.07	8,624,784.25	Ant-sub net mooring	1.00	1.00	1.00	19	196
A	654	693,311.23	8,624,817.58	Ant-sub net mooring	1.00	1.00	1.00	27	75
A	655	693,293.93	8,624,874.10	Ant-sub net mooring	1.00	1.00	1.00	26	53

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	656	693,197.83	8,625,161.77	Ant-sub net mooring	1.00	1.00	1.00	26	48
A	657	693,162.23	8,625,272.64	Ant-sub net mooring	1.00	1.00	1.00	21	88
A	658	693,173.46	8,625,217.02	Ant-sub net mooring	1.00	1.00	1.00	21	63
A	659	693,400.45	8,624,893.93	Ant-sub net mooring	1.00	1.00	1.00	24	42
A	660	693,420.92	8,624,841.76	Ant-sub net mooring	1.00	1.00	1.00	22	24
A	661	693,376.72	8,624,944.02	Ant-sub net mooring	1.00	1.00	1.00	24	56
A	662	693,282.43	8,625,202.62	Ant-sub net mooring	1.00	1.00	1.00	28	140
A	663	693,307.79	8,625,145.38	Ant-sub net mooring	1.00	1.00	1.00	25	125
A	664	693,254.26	8,625,282.33	Ant-sub net mooring	1.00	1.00	1.00	27	167
A	665	693,362.50	8,625,014.22	Ant-sub net mooring	1.00	1.00	1.00	26	88
A	666	693,460.95	8,625,089.13	Ant-sub net mooring	1.00	1.00	1.00	26	211
A	667	693,555.33	8,624,959.96	Ant-sub net mooring	1.00	1.00	1.00	25	203
A	668	693,650.62	8,624,848.92	Ant-sub net mooring	1.00	1.00	1.00	27	204
A	669	693,506.97	8,624,814.32	Ant-sub net mooring	1.00	1.00	1.00	21	72
A	670	693,465.48	8,624,923.37	Ant-sub net mooring	1.00	1.00	1.00	25	111
A	671	693,643.69	8,624,929.98	Ant-sub net mooring	1.00	1.00	1.00	26	251
A	672	693,469.78	8,625,242.93	Ant-sub net mooring	1.00	1.00	1.00	28	313
A	673	693,711.60	8,625,070.97	Ant-sub net mooring	1.00	1.00	1.00	32	394
A	674	694,135.50	8,625,135.19	Ant-sub net mooring	1.00	1.00	1.00	36	759
A	675	694,161.68	8,625,283.10	Ant-sub net mooring	1.00	1.00	1.00	36	875
A	676	694,183.69	8,625,228.03	Ant-sub net mooring	1.00	1.00	1.00	36	856
A	677	694,250.36	8,625,094.43	Ant-sub net mooring	1.00	1.00	1.00	34	821

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	678	693,923.28	8,625,184.46	Ant-sub net mooring	1.00	1.00	1.00	34	629
A	679	693,952.90	8,625,141.07	Ant-sub net mooring	1.00	1.00	1.00	28	624
A	680	693,970.93	8,625,083.92	Ant-sub net mooring	1.00	1.00	1.00	28	601
A	681	693,751.64	8,625,475.17	Ant-sub net mooring	1.00	1.00	1.00	35	678
A	682	693,775.01	8,625,422.23	Ant-sub net mooring	1.00	1.00	1.00	35	664
A	683	693,794.64	8,625,355.29	Ant-sub net mooring	1.00	1.00	1.00	35	638
A	684	693,902.95	8,625,554.38	Ant-sub net mooring	1.00	1.00	1.00	36	846
A	685	694,101.63	8,625,224.18	Ant-sub net mooring	1.00	1.00	1.00	35	791
A	686	693,979.35	8,625,516.11	Ant-sub net mooring	1.00	1.00	1.00	34	883
A	687	693,951.72	8,625,500.98	Ant-sub net mooring	1.00	1.00	1.00	33	852
A	688	693,595.12	8,625,397.09	Ant-sub net mooring	1.00	1.00	1.00	36	506
A	689	693,625.83	8,625,262.22	Ant-sub net mooring	1.00	1.00	1.00	34	448
A	690	693,861.92	8,624,914.00	Ant-sub net mooring	1.00	1.00	1.00	33	408
A	691	694,235.64	8,625,020.33	Ant-sub net mooring	1.00	1.00	1.00	35	763
A	692	694,004.85	8,624,910.74	Ant-sub net mooring	1.00	1.00	1.00	34	515
A	693	693,790.27	8,625,076.31	Ant-sub net mooring	1.00	1.00	1.00	33	458
A	694	692,680.70	8,625,066.80	Ant-sub net mooring	1.00	1.00	1.00	16	418
A	695	692,486.05	8,624,972.60	Ant-sub net mooring	1.00	1.00	1.00	16	630
A	696	692,274.19	8,624,850.32	Ant-sub net mooring	1.00	1.00	1.00	7	872
A	697	692,370.93	8,624,932.20	Ant-sub net mooring	1.00	1.00	1.00	10	746
A	698	692,376.54	8,624,652.46	Ant-sub net mooring	1.00	1.00	1.00	6	913
A	699	693,479.77	8,625,162.13	Ant-sub net mooring	1.00	1.00	1.00	26	271

Target ID		Datum: GDA94 CRS: UTM Zone 52S		Interpretation	Dimensions (m)			Depth (m)	Distance from pipeline (m)
		Easting	Northing		Length	Width	Height		
A	700	693,373.52	8,625,219.83	Ant-sub net mooring	1.00	1.00	1.00	25	223
A	701	692,476.81	8,624,552.19	Ant-sub net mooring	1.00	1.00	1.00	9	895
A	702	692,545.01	8,624,451.33	Ant-sub net mooring	1.00	1.00	1.00	13	903
A	703	692,536.68	8,624,530.67	Ant-sub net mooring	1.00	1.00	1.00	14	861
A	704	692,512.14	8,624,583.21	Ant-sub net mooring	1.00	1.00	1.00	10	848
A	705	692,731.65	8,624,460.66	Ant-sub net mooring	1.00	1.00	1.00	10	750
A	706	693,612.40	8,625,501.30	Ant-sub net mooring	1.00	1.00	1.00	37	584
A	707	693,639.40	8,625,450.30	Ant-sub net mooring	1.00	1.00	1.00	37	414
A	708	693,667.30	8,625,396.10	Ant-sub net mooring	1.00	1.00	1.00	36	435
A	709	693,801.20	8,625,027.90	Ant-sub net mooring	1.00	1.00	1.00	33	562
A	710	693,812.30	8,624,981.60	Ant-sub net mooring	1.00	1.00	1.00	32	576

*Targets with starred ID's have been visually inspected during ROV surveys (see Section 7).