Appendix

K

Appendix K

Maritime heritage

January 2020

Roads and Maritime Services

Western Harbour Tunnel and Warringah Freeway Upgrade

Technical working paper: Maritime heritage

January 2020

Prepared for

Roads and Maritime

Prepared by

Cosmos Archaeology Pty Ltd

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EXECUTIVE SUMMARY

The Western Harbour Tunnel and Beaches Link is a New South Wales (NSW) Government initiative to provide additional road network capacity across Sydney Harbour and to improve connectivity with Sydney's Northern Beaches. This includes the Western Harbour Tunnel and Warringah Freeway Upgrade project (the project), comprising a new tolled motorway tunnel connection across Sydney Harbour, and the Warringah Freeway Upgrade to integrate the new motorway infrastructure with the existing road network and to connect to the Beaches Link and Gore Hill Freeway Connection project.

Cosmos Archaeology Pty Ltd was engaged to satisfy the maritime archaeological aspects of the Secretary's Environmental Assessment Requirements for this project.

To achieve this, Cosmos Archaeology Pty Ltd carried out a baseline review and field survey of three zones in Sydney Harbour (Area A, Area B and Area C) to identify known sites, establish archaeological potential and assess the cultural heritage sensitivity of maritime heritage sites. This study was restricted to maritime heritage on or under the bed of the harbour below the Highest Astronomical Tide, including the former bed of the harbour under reclamation, as well as sites that have a land/water interface. With the available project design plans, Cosmos Archaeology Pty Ltd then assessed the likely impacts on maritime heritage and described appropriate mitigation measures.

Impacts within Sydney Harbour would be concentrated within Area A, between Yurulbin Park at Birchgrove and Balls Head at Waverton, which would be the location of an immersed tube tunnel with two temporary cofferdams. Area A is known to contain historical maritime infrastructure, shipwrecks and associated deposits, additional discard from vessels and the Railway Electricity Tunnel between Birchgrove and Greenwich. Maritime heritage sensitivity is considered to be low across the majority of Area A. However, there are areas of medium and high sensitivity where there are known maritime heritage sites or anomalies. Dredging associated with works in Area A is likely to have an impact on an unverified cultural magnetic anomaly (No. 1), the consequences of which would be minor. Piling for a wharf and other structures would have a minor, localised impact on potential maritime heritage remains.

Area B, at Berrys Bay, contains historical maritime infrastructure, shipwrecks and associated deposits, and additional discard from vessels in and under reclamation fill. The foreshore and associated maritime infrastructure in Area B is of medium maritime heritage sensitivity, with the rest of the area assessed as low. Impacts of the construction of two temporary wharves and possibly a barge shed would be minor to moderate in scale as a result of piling, limited excavation and the possible partial dismantling of Slipway 1.

Area C, including White Bay and Glebe Island Bridge, contains maritime infrastructure, is almost certain to contain discard from vessels, and is highly likely to contain discard in and under reclamation fill. Shipwrecks are unlikely in this area. Area C is considered to be of low maritime heritage sensitivity throughout except for areas under reclamation, which are of medium sensitivity, and the two extant bridges – Glebe Island Bridge and Anzac Bridge – which are of high sensitivity. However, it would be almost impossible for the temporary construction support site at White Bay to impact maritime heritage sites.

The following mitigation measures would ensure that potential impacts on maritime heritage remain either Negligible or Minor and, with respect to the archaeological remains associated with the NSW Torpedo Corps slipway and Berry and Wollstonecraft's Wharf, that potential impacts are reduced to Minor.

Mitigation Measure	Mitigated impact
Mitigation measure A – Prepare Maritime Heritage Management Plan	Ensures the impact on known and potential maritime heritage remains such as maritime infrastructure, shipwrecks and discarded objects remain either Negligible or Minor
Mitigation measure B – Investigate the potential to relocate or redesign the temporary wharves at WHT7 in Berrys Bay to minimise impact on maritime heritage. Where this is not feasible then carry out archaeological investigation and documentation under the direction of a qualified maritime archaeologist across all areas of impact.	Ensures the impact on the potential remains associated with the NSW Torpedo Corps slipway and Berry and Wollstonecraft's Wharf remain as Negligible or are reduced to Minor

Mitigation Measure	Mitigated impact
Mitigation measure C – Maritime archaeologist involvement in any pre-dredge clearance of the bed of the harbour	Would reduce the impact on potential maritime heritage remains such as maritime infrastructure, shipwrecks and discarded objects to Negligible or Minor
Mitigation measure D – Exclusion zone around Former Balls Head Coal Loader wharf	Would reduce the risk of potential impact on the Former Balls Head Coal Loader wharf
Mitigation measure E – Carry out archival recording of select maritime heritage sites	Would reduce the potential impact on these sites to Negligible or Minor
Mitigation measure F –Carry out requisite steps to reduce vibration and settlement impacts to sensitive maritime heritage sites	Would reduce the potential impact on these sites to Negligible
Mitigation measure G - Complete and review the side scan sonar survey for areas to be affected by project works	Would reduce the impact on potential maritime heritage remains such as maritime infrastructure, shipwrecks and discarded objects to Negligible or Minor
Mitigation measure H – Give reasonable time and notice for the vessel owners of M.V. Cape Don and Baragoola to find suitable alternate berths within Sydney Harbour before construction commences, and take no action that results in the degradation of the heritage significance of the items until relocation occurs.	Would ensure that any potential impact arising from the relocation of the vessel is avoided.

1 INTRODUCTION

1.1 Overview

The Greater Sydney Commission's *Greater Sydney Region Plan – A Metropolis of Three Cities* (Greater Sydney Commission, 2018) proposes a vision of three cities where most residents have convenient and easy access to jobs, education and health facilities and services. In addition to this plan, and to accommodate for Sydney's future growth the NSW Government is implementing the *Future Transport Strategy 2056* (Transport for NSW, 2018), a plan that sets the 40 year vision, directions and outcomes framework for customer mobility in NSW. The Western Harbour Tunnel and Beaches Link program of works is proposed to provide additional road network capacity across Sydney Harbour and to improve transport connectivity with Sydney's northern beaches. The Western Harbour Tunnel and Beaches Link program of works include:

- The Western Harbour Tunnel and Warringah Freeway Upgrade project comprises a new tolled motorway tunnel connection across Sydney Harbour, and an upgrade of the Warringah Freeway to integrate the new motorway infrastructure with the existing road network and to connect to the Beaches Link and Gore Hill Freeway Connection project
- The Beaches Link and Gore Hill Freeway Connection project which comprises a new tolled motorway tunnel connection across Middle Harbour from the Warringah Freeway and Gore Hill Freeway to Balgowlah and Killarney Heights and including the surface upgrade of Wakehurst Parkway from Seaforth to Frenchs Forest and upgrade and integration works to connect to the Gore Hill Freeway at Artarmon.

A combined delivery of the Western Harbour Tunnel and Beaches Link program of works would unlock a range of benefits for freight, public transport and private vehicle users. It would support faster travel times for journeys between the Northern Beaches and south and west of Sydney Harbour. Delivering the program of works would also improve the resilience of the motorway network, given that each project provides an alternative to heavily congested harbour crossings.

1.2 The project

Roads and Maritime Services (Roads and Maritime) is seeking approval under Division 5.2, Part 5 of the *Environmental Planning and Assessment Act 1979* to construct and operate the Western Harbour Tunnel and Warringah Freeway Upgrade (the project), which would comprise two main components:

- A new crossing of Sydney Harbour involving twin tolled motorway tunnels connecting the M4-M5 Link at Rozelle and the existing Warringah Freeway at North Sydney (the Western Harbour Tunnel)
- Upgrade and integration works along the existing Warringah Freeway, including infrastructure required for connections to the Beaches Link and Gore Hill Freeway Connection project (the Warringah Freeway Upgrade).

Key features of the Western Harbour Tunnel component of the project are shown in Figure 1. The key components which are relevant to this report includes:

- Twin mainline tunnels about 6.5 kilometres long and each accommodating three lanes of traffic in each direction, connecting the stub tunnels from the M4-M5 Link at Rozelle to the Warringah Freeway and to the Beaches Link mainline tunnels at Cammeray. The crossing of Sydney Harbour between Birchgrove and Waverton would involve a dual, three lane, immersed tube tunnel
- Connections to the stub tunnels at the M4-M5 Link project in Rozelle and the mainline tunnels at Cammeray (for a future connection to the Beaches Link and Gore Hill Freeway Connection project)
- Surface connections at Rozelle, North Sydney and Cammeray, including direct connections to and from the Warringah Freeway (including integration with the Warringah Freeway Upgrade), an off ramp to Falcon Street and an on ramp from Berry Street at North Sydney
- A ventilation outlet and motorway facilities (fitout and commissioning only) at the Rozelle Interchange
- A ventilation outlet and motorway facilities at the Warringah Freeway in Cammeray
- Operational facilities including a motorway control centre at Waltham Street, within the Artarmon industrial area and tunnel support facilities at the Warringah Freeway in Cammeray

- Other operational infrastructure including groundwater and tunnel drainage management and treatment systems, signage, tolling infrastructure, fire and life safety systems, lighting, emergency evacuation and emergency smoke extraction infrastructure, CCTV and other traffic management systems.

Key features of the Warringah Freeway Upgrade component of the project are shown in Figure 2 include:

- Upgrade and reconfiguration of the Warringah Freeway from immediately north of the Sydney Harbour Bridge through to Willoughby Road at Naremburn
- Upgrades to interchanges at Falcon Street in Cammeray and High Street in North Sydney
- New and upgraded pedestrian and cyclist infrastructure
- New, modified and relocated road and shared user bridges across the Warringah Freeway
- Connection of the Warringah Freeway to the portals for the Western Harbour Tunnel mainline tunnels and the Beaches Link tunnels via on and off ramps, which would consist of a combination of trough and cut and cover structures
- Upgrades to existing roads around the Warringah Freeway to integrate the project with the surrounding road network
- Upgrades and modifications to bus infrastructure, including relocation of the existing bus layover along the Warringah Freeway
- Other operational infrastructure, including surface drainage and utility infrastructure, signage, tolling, lighting, CCTV and other traffic management systems.

A detailed description of the project is provided in Chapter 5 (Project description) and construction of the project is described in Chapter 6 (Construction work) of the environmental impact statement. The project alignment at the Rozelle Interchange shown in Figure 1 reflects the arrangement presented in the environmental impact statement for the M4-M5 Link, and as amended by the proposed modifications. The project would be constructed in accordance with the now finalised M4-M5 Link detailed design (refer to Section 2.1.1 of Chapter 2 (Assessment process) of the environmental impact statement for further details).

The project does not include ongoing motorway maintenance activities during operation or future use of residual land occupied or affected by project construction activities, but not required for operational infrastructure. These would be subject to separate planning and processes at the relevant times.

Subject to the project obtaining planning approval, construction is anticipated to commence in 2020 and is expected to take around six years to complete.

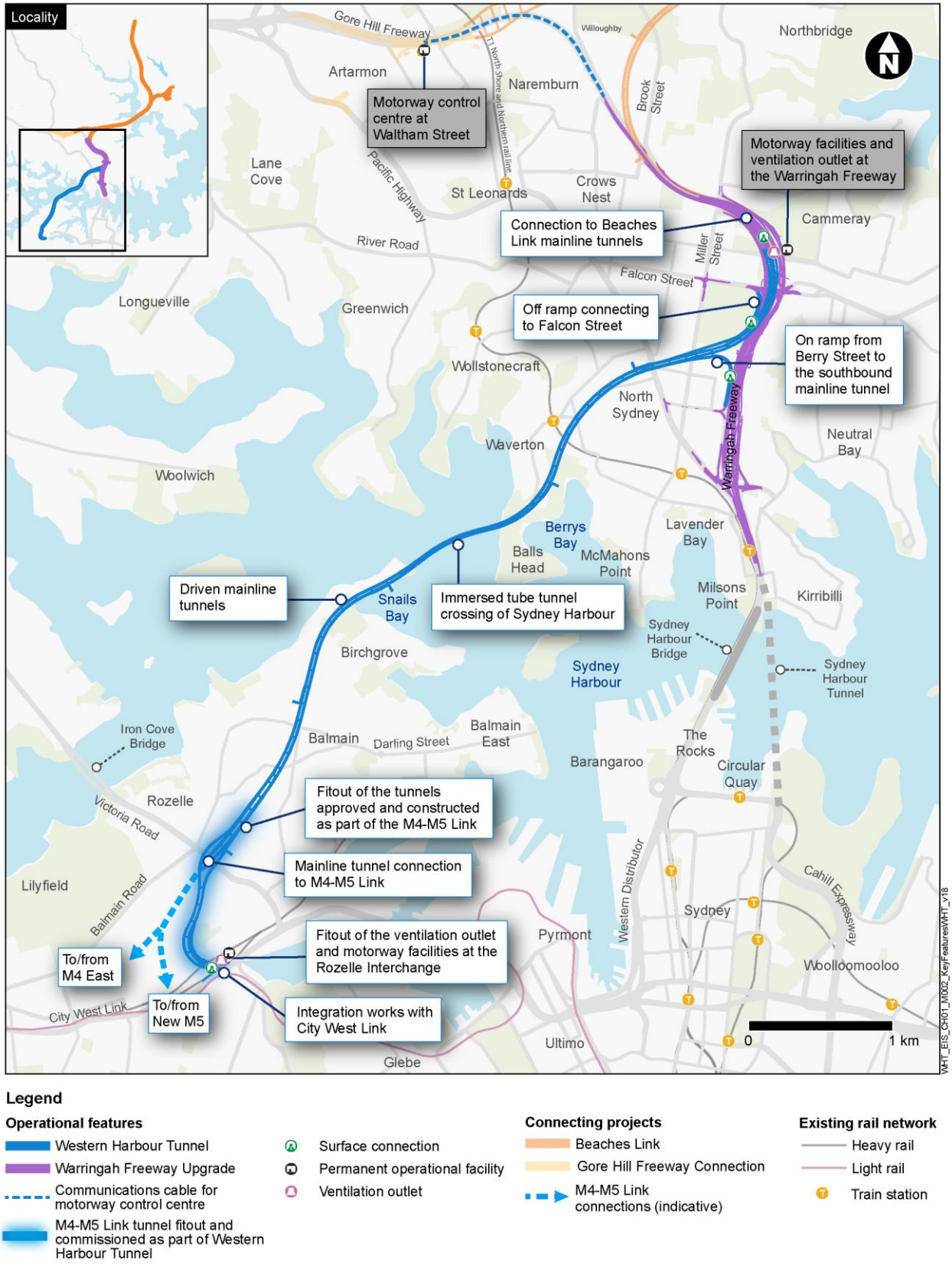


Figure 1 Key features of the Western Harbour Tunnel component of the project

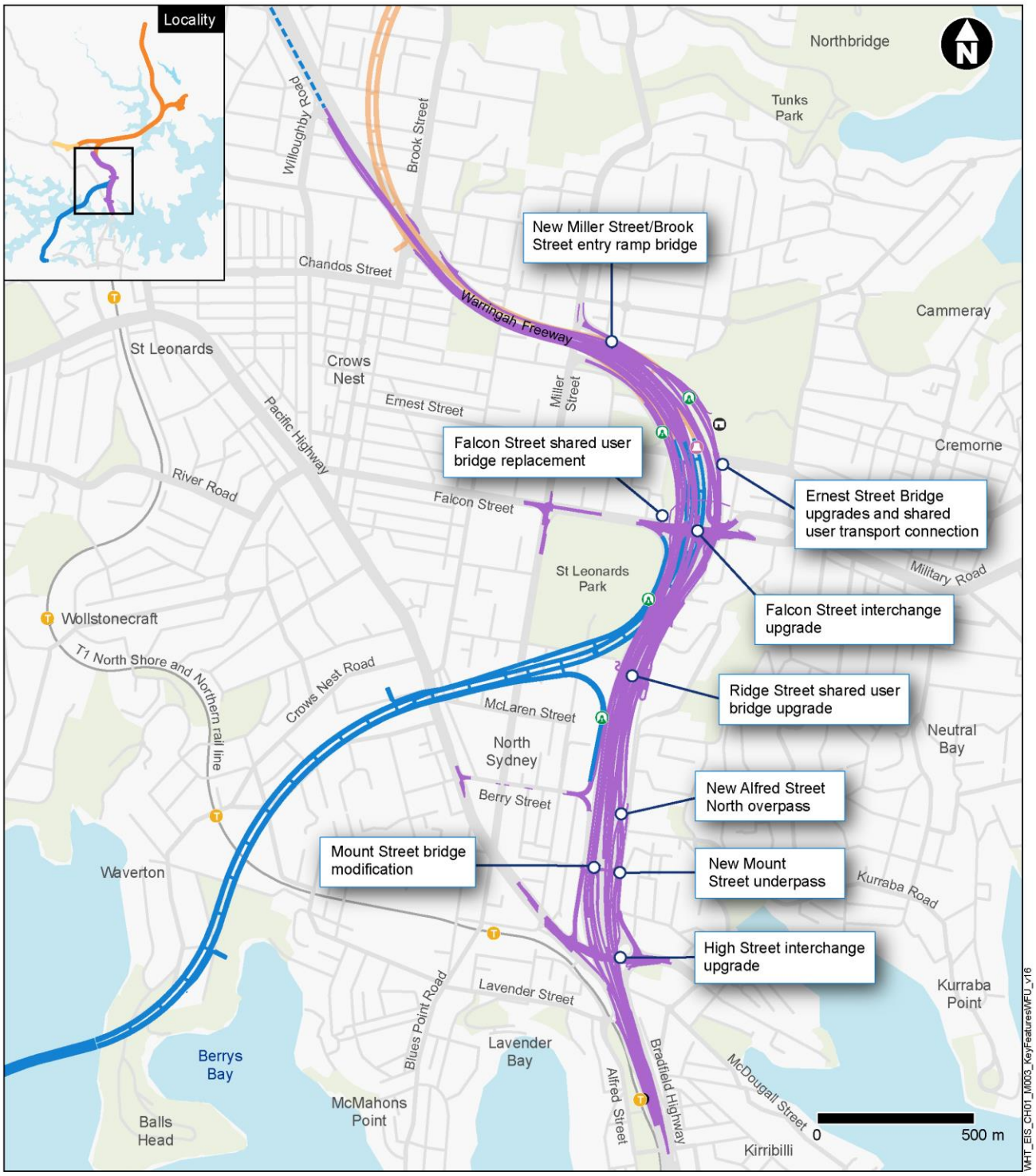


Figure 2 Key features of the Warringah Freeway Upgrade component of the project

1.2.1 Immersed tube tunnels

The key feature of the Western Harbour Tunnel component of the project relevant to this report is the crossing of Sydney Harbour between Birchgrove and Waverton, which would be constructed as immersed tube tunnels.

The immersed tube tunnels would connect to the driven mainline tunnels in Sydney Harbour offshore from Yurulbin Point at Birchgrove and from Balls Head at Waverton.

The immersed tube tunnels would be installed as a series of pre-cast units in a trench excavated in the bed of Sydney Harbour. Fill and armour materials would be placed around the immersed tube tunnels for stability and protection. The top of the immersed tube tunnels, including rock armour, would not reduce the navigation depth of existing shipping channels. Each immersed tube tunnel would accommodate three traffic lanes.

An indicative cross section of the immersed tube tunnel crossing of Sydney Harbour is shown in Figure 3. An indicative long section of the immersed tube tunnels are shown in and Figure 4.

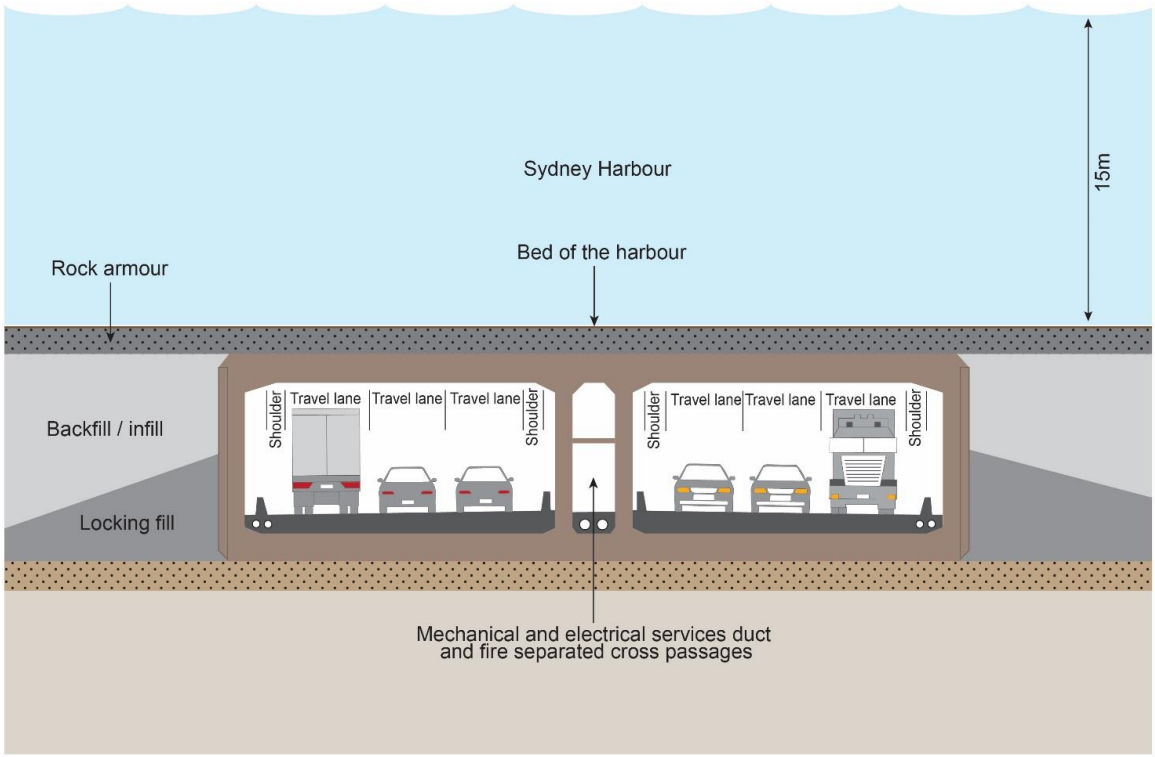


Figure 3 Indicative cross section of the immersed tube tunnels (Sydney Harbour)

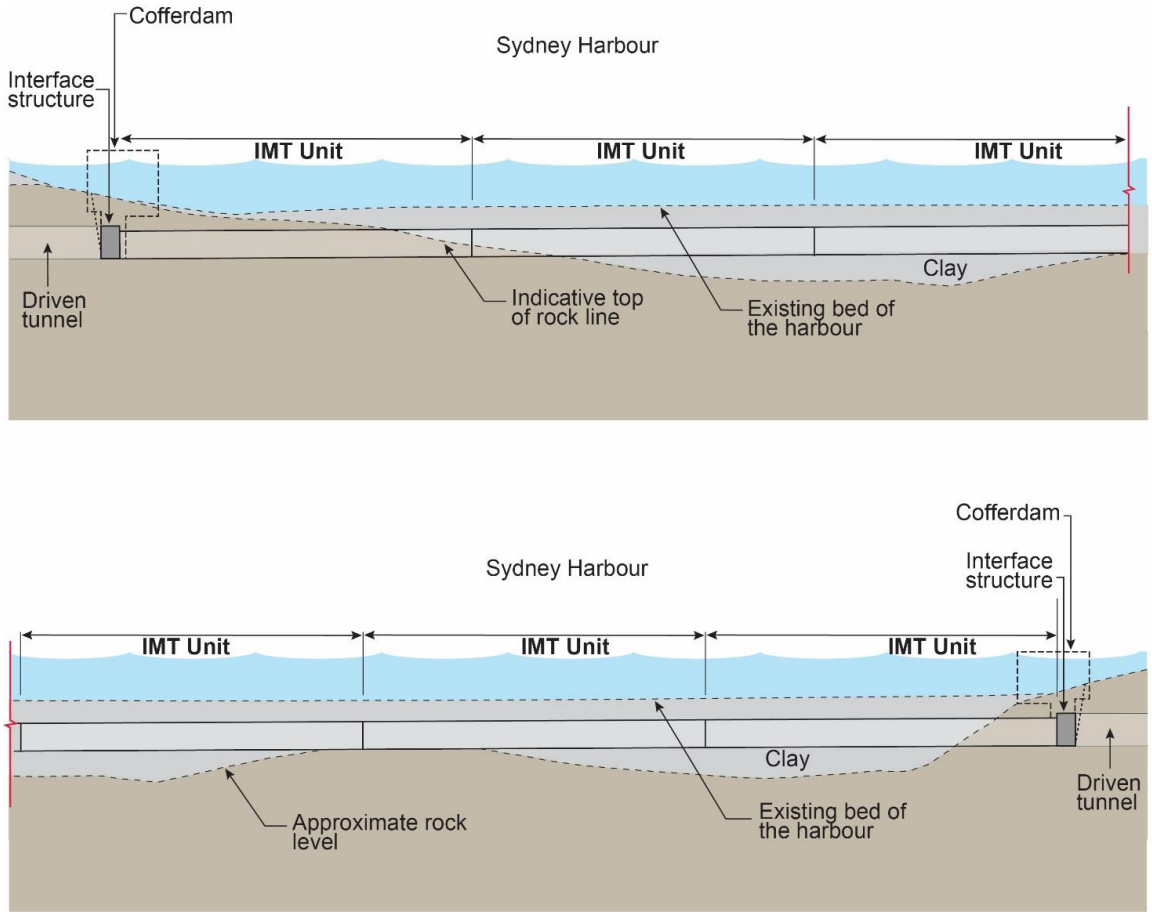


Figure 4 Indicative long section of the immersed tube tunnels (Sydney Harbour)

1.2.2 Key construction activities

The area required to construct the project is referred to as the construction footprint. The majority of the construction footprint would be located underground within the mainline tunnels. However, surface areas would be required to support tunnelling activities and to construct the tunnel connections, tunnel portals and operational ancillary facilities.

Key construction activities would include:

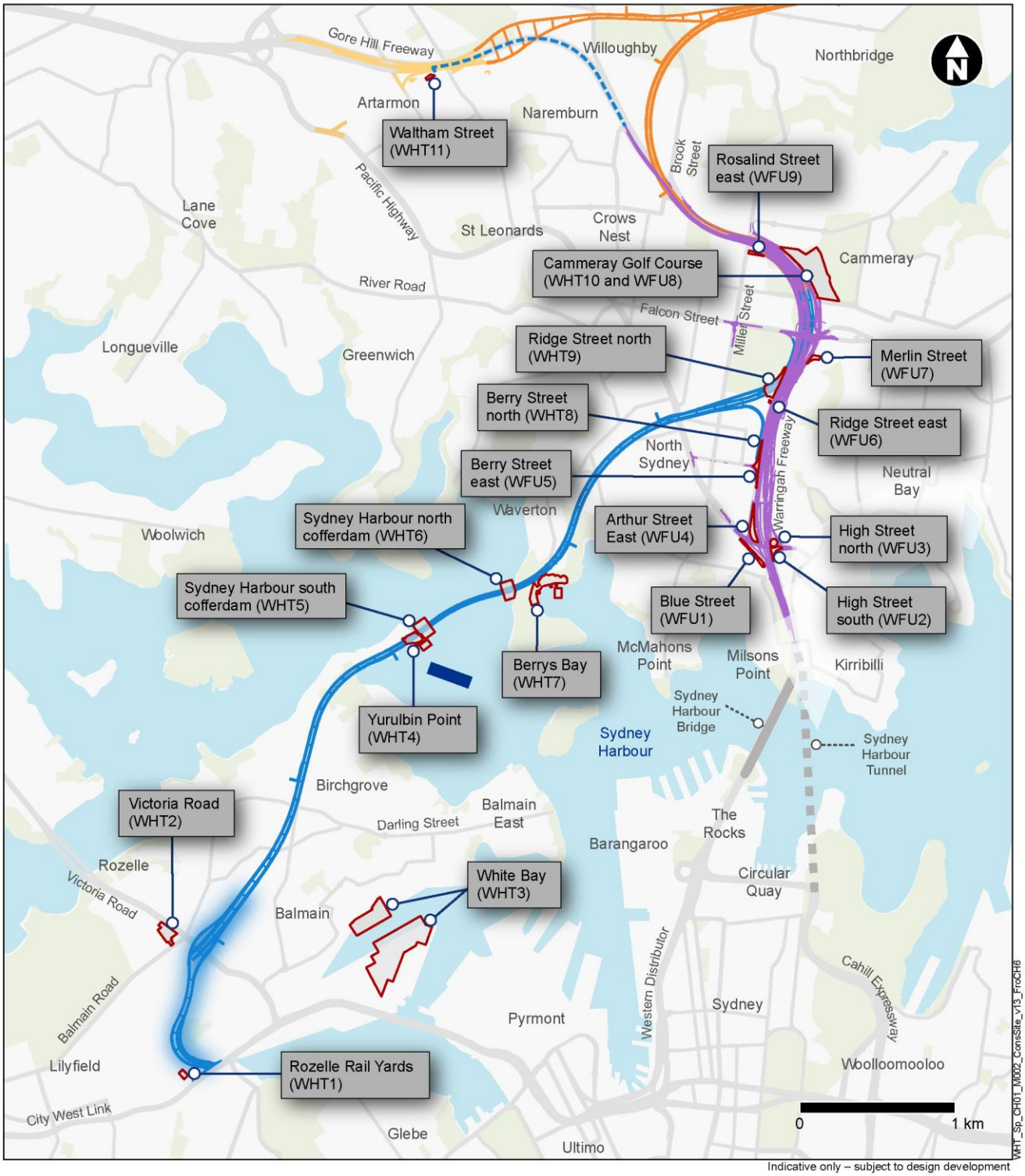
- Early works and site establishment, with typical activities being property acquisition, utilities protection, adjustments and relocations, installation of site fencing, environmental controls (including noise attenuation) and traffic management controls, vegetation clearing, earthworks and demolition of structures, establishment of construction support sites including acoustic sheds and associated access decline acoustic enclosures (where required), temporary relocation of swing moorings within Berrys Bay, relocation of the historic vessels and establishment of construction support sites
- Construction of Western Harbour Tunnel, with typical activities being excavation of tunnel construction access declines, construction of driven tunnels, cut and cover and trough structures, construction of surface upgrade works, construction of cofferdams, dredging and immersed tube tunnel piled support activities in preparation for the installation of immersed tube tunnels, casting and installation of immersed tube tunnels and civil finishing and tunnel fitout
- Construction of operational facilities comprising of a motorway control centre at Artarmon, motorway and tunnel support facilities and, ventilation outlets at Warringah Freeway in Cammeray, construction and fitout of the project operational facilities that form part of the M4-M5 Link Rozelle East Motorway Operations Complex, a wastewater treatment plant at Rozelle and the installation of motorway tolling infrastructure
- Construction of the Warringah Freeway Upgrade, with typical activities being earthworks, bridgeworks, construction of retaining walls, stormwater drainage, pavement works and linemarking and the installation of road furniture, lighting, signage and noise barriers

- Testing of plant and equipment, and commissioning of the project, backfill of access declines, removal of construction support sites, landscaping and rehabilitation of disturbed areas and removal of environmental and traffic controls.

Temporary construction support sites would be required as part of the project (refer to Figure 5), and would include tunnelling and tunnel support sites, civil surface sites, cofferdams, mooring sites, wharf and berthing facilities, laydown areas, parking and workforce amenities Only six construction support sites are relevant to this report. These are:

- Rozelle Rail Yards (WHT1)
- White Bay (WHT3)
- Yurulbin Point (WHT4)
- Sydney Harbour south cofferdam (WHT5)
- Sydney Harbour north cofferdam (WHT6)
- Berrys Bay (WHT7).

A detailed description of construction works for the project is provided in Chapter 6 (Construction work) of the environmental impact statement.



Legend

Construction features

- Western Harbour Tunnel
- Warringah Freeway Upgrade
- Communications cable for motorway control centre
- Fit out and commissioned as part of Western Harbour Tunnel, constructed as part of WestConnex M4-M5 Link
- Construction support sites
- Mooring site

Connecting projects

- Beaches Link
- Gore Hill Freeway Connection

Figure 5 Overview of construction support sites

1.3 Purpose of this report

This report has been prepared to support the assessment of non-Aboriginal maritime heritage for the environmental impact statement for the project. The environmental impact statement has been prepared to accompany the application for approval of the project, and address the environmental assessment require of the Secretary of the Department of Planning, Industry and Environment (formerly the Department of Planning and Environment) ('the Secretary's Environmental Assessment Requirements').

Cosmos Archaeology Pty Ltd was engaged to satisfy the maritime archaeological aspects of the Secretary's environmental assessment requirements (SEARs) reproduced in Section 1.4.

This report addresses all aspects of historical underwater cultural heritage, from now referred to as maritime heritage. The potential for submerged Aboriginal archaeological sites has been addressed in a separate document Technical working paper: Potential submerged sites assessment (Cosmos Archaeology Pty Ltd, 2020).

This report has been prepared in accordance with the following guidelines:

- *Criteria for the Assessment of Excavation Directors* (NSW Heritage Council 2011)
- *NSW Heritage Manual* (Heritage Office and Department of Urban Affairs and Planning 1994)
- *Assessing Heritage Significance* (NSW Heritage Office 2001)
- *The Australia ICOMOS Burra Charter*

1.4 Secretary's environmental assessment requirements

The Secretary's environmental assessment requirements (SEARs) relating to heritage, which includes maritime heritage, are shown in Table 1.

Table 1: Secretary's environmental assessment requirements for Heritage

SEARs	Where addressed
1. The Proponent must identify and assess any direct and/or indirect impacts (including cumulative, vibration and visual impacts to the heritage significance of listed (and nominated) heritage items inclusive of:	Addressed in Section 8.3 and 8.6.4 for cumulative impacts
a) Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines;	Not addressed in this report. See Technical working paper: Cultural heritage assessment report (Jacobs, 2020)
b) Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan;	Not addressed in this report. See Technical working paper: Cultural heritage assessment report
c) environmental heritage, as defined under the *Heritage Act 1977* (including potential items of heritage value, conservation areas, open space heritage landscapes, built heritage landscapes and archaeology);	Addressed in Chapters 4 to 6
d) items listed on the State, National and World Heritage lists (including Cockatoo Island);	Addressed in Section 3.1. Cockatoo Island is outside the study area (Section 2.1) and an assessment of impact on its maritime heritage values is not required.
e) heritage items and conservation areas identified in local and regional planning environmental instruments covering the project area; and	Addressed in Section 3.1
f) marine items of potential heritage significance within Sydney Harbour, such as any shipwrecks within proximity to the Balls Head Coal Loader Wharf	Addressed in Chapters 4 to 6
2. Where impacts to State or locally significant heritage items or archaeology are identified, the assessment must:	
a) include a significance assessment and statement of heritage impact for all heritage items (including any unlisted places that are assessed of heritage value;	Addressed in Chapter 7

SEARs	Where addressed
b) provide a discussion of alternative locations and design options that have been considered to reduce heritage impacts;	Addressed in Section 8.2
c) in areas identified as having potential archaeological significance, carry out a comprehensive archaeological assessment and management plan in line with Heritage Council guidelines which includes a methodology and research design to assess the impact of the works on the potential archaeological resource and to guide physical archaeological test excavations and include the results of these excavations. This is to be carried out by a suitably qualified archaeologist and is to discuss the likelihood of historical, maritime and Aboriginal archaeology of heritage significance on the site, how this may be impacted by the project, and includes measures to mitigate any impacts;	Addressed in Chapter 9
d) consider potential impacts to the Balls Head Coal Loader particularly associated with vibration and disturbance as part of the ongoing works. Due to the potential significance of this site, options to ensure that it is not impacted must be considered;	Addressed in Section 8.6 and Chapter 9
e) consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, increased traffic, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant);	Addressed in Section 8.6
f) provide a comparative analysis to inform the rarity and representative value of any heritage places proposed for demolition;	Addressed in Section 8.6
g) outline mitigation measures to avoid and minimise identified impacts in accordance with the current guidelines; and	Addressed in Chapter 9
h) be carried out by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the *NSW Heritage Council's Excavation Director* criteria).	Cosmos Coroneos is an experienced archaeologist of over 25 years who has obtained permits under the NSW *Heritage Act 1977* for the excavation of Local and State significant sites in NSW
3. Where archaeological investigations of Aboriginal objects are proposed these must be conducted by a suitably qualified archaeologist, in accordance with section 1.6 of the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW* (DECCW 2010).	Not addressed in this report. See Technical working paper: Cultural heritage assessment report

2 APPROACH TO THIS STUDY

This chapter outlines the methods used to determine the existing conditions of the project area, assess the potential impacts on non-Aboriginal maritime heritage and formulate focused and appropriate mitigation measures proportionate to the cultural heritage significance of the identified maritime heritage.

2.1 Study area

This maritime heritage assessment is separated into three study areas (Figure 6):

- Area A – the proposed tunnel alignment and cofferdams between Yurulbin Point at Birchgrove and Balls Head at Waverton, as well as the proposed construction support site at Yurulbin Park
- Area B – the proposed construction support site in the western half of Berrys Bay
- Area C – the construction support site at White Bay.

Figure 6: Primary study area separated into Areas A, B and C (Base image: Google Earth).

2.2 Assessment process

Cosmos Archaeology Pty Ltd (November 2017a) prepared an Issues Paper and Desktop Assessment for the project in 2017. The assessment drew on the findings of past reports. From this information, four areas were identified in Sydney Harbour and two in Middle Harbour which formed a focus for initial assessments. The areas in Sydney Harbour identified in the Issues Paper and Desktop Assessment have remained largely the same, with the exception that the relevant maritime heritage components of Area F, which covered Snails Bay, have been incorporated into Area A. These areas primarily cover the bed of the harbour but also include adequate buffers to account for areas of the foreshore that have may have been reclaimed as part of previous development.

This impact assessment report was carried out in four stages, as detailed below:

1. Baseline review
2. Field survey
3. Establishing maritime heritage potential, significance and sensitivity
4. Assessing impacts and appropriate mitigation measures.

2.2.1 Baseline review

The start of the assessment process involved reviewing available information to form a basic understanding of the potential extent, variety, condition and significance of maritime heritage within the study area, often referred to as a predictive model. The information obtained during this baseline review guided the direction and conduct of field investigations, which in turn refined the understanding of the maritime heritage resource. This allowed more informed assessments to be prepared on the heritage significance of the resource, potential impacts on that resource, and the formulation of suitable mitigation measures.

The baseline review comprised two main components: a desktop review of archival resources, heritage databases and secondary reports, and an examination of remote sensing data.

2.2.1.1 Desktop study

The following archival resources, heritage databases and reports were reviewed:

Resource	Description
Previous Cosmos Archaeology reports	Cosmos Archaeology Pty Ltd (2015) has previously carried out a maritime archaeological assessment at Balls Head Coal Loader wharf
NSW Roads and Maritime Services archives	Roads and Maritime has a collection of detailed surveys and plans of the project area shoreline dating back to the late 19th century. These surveys have been annotated over time to keep track of maritime leases and changes to the shoreline such as reclamations and construction of maritime infrastructure
NSW Maritime Heritage database	The Maritime Heritage Sites database, managed by the Heritage Division of the NSW Department of Premier and Cabinet (Heritage) , contains information on identified maritime heritage sites – mostly shipwrecks – in NSW
NSW Wrecks Info – Shipwreck Position Database (NSW Wrecks)	The NSW Wrecks Info website is managed by avocational wreck researchers and contains publicly available information on the position of shipwrecks compiled from a number of sources (NSW Wrecks Info 2017). The Shipwreck Position Database is available as a number of Google Earth files under different categories including checked waypoints (shipwrecks found and dived on), unchecked waypoints (possible shipwrecks that have not been inspected), side scan sonar hits, compiled targets from reported sinking positions, World War II echo sounder anomalies, trawler snags and others
NSW State Heritage Inventory	The NSW State Heritage Inventory is a database managed by the Heritage Division of the NSW Department of Premier and Cabinet (Heritage) and comprises a listing of all heritage places and objects included in state and local statutory registers across NSW
Australian National Shipwreck Database	The Australian National Shipwreck Database, maintained by the Commonwealth Department of the Environment and Energy, is an online database of known and potential shipwrecks, aircraft wrecks and other maritime heritage sites and objects in Australian waters
Archival sources and heritage reports	A review of a wide range of primary and secondary historical sources held by NSW libraries and State Records, and various published and unpublished heritage reports and articles, was also carried out.

2.2.1.2 Remote sensing data review

The following remote sensing data was examined to identify potential items of maritime heritage. A summary of the effectiveness of the remote sensing techniques used for the project in presented in Table 2.

Side scan sonar data

A side scan sonar survey was carried out specifically for the project for the purpose of mapping 'sea bed features and identify any significant features which could impact future drilling or near shore construction activities' (Earth Technology Solution Pty Ltd July 2017a). The survey covered most of the proposed extent of the disturbance footprint for Area A, apart from a strip along the northern edge measuring up to 500 metres by 25 metres (Figure 7). In Area B, the side scan sonar coverage stopped between 10 to 40 metres from the western shore of Berrys Bay because of the presence of maritime infrastructure, such as a slipway, impeding the survey vessel and tow-fish.

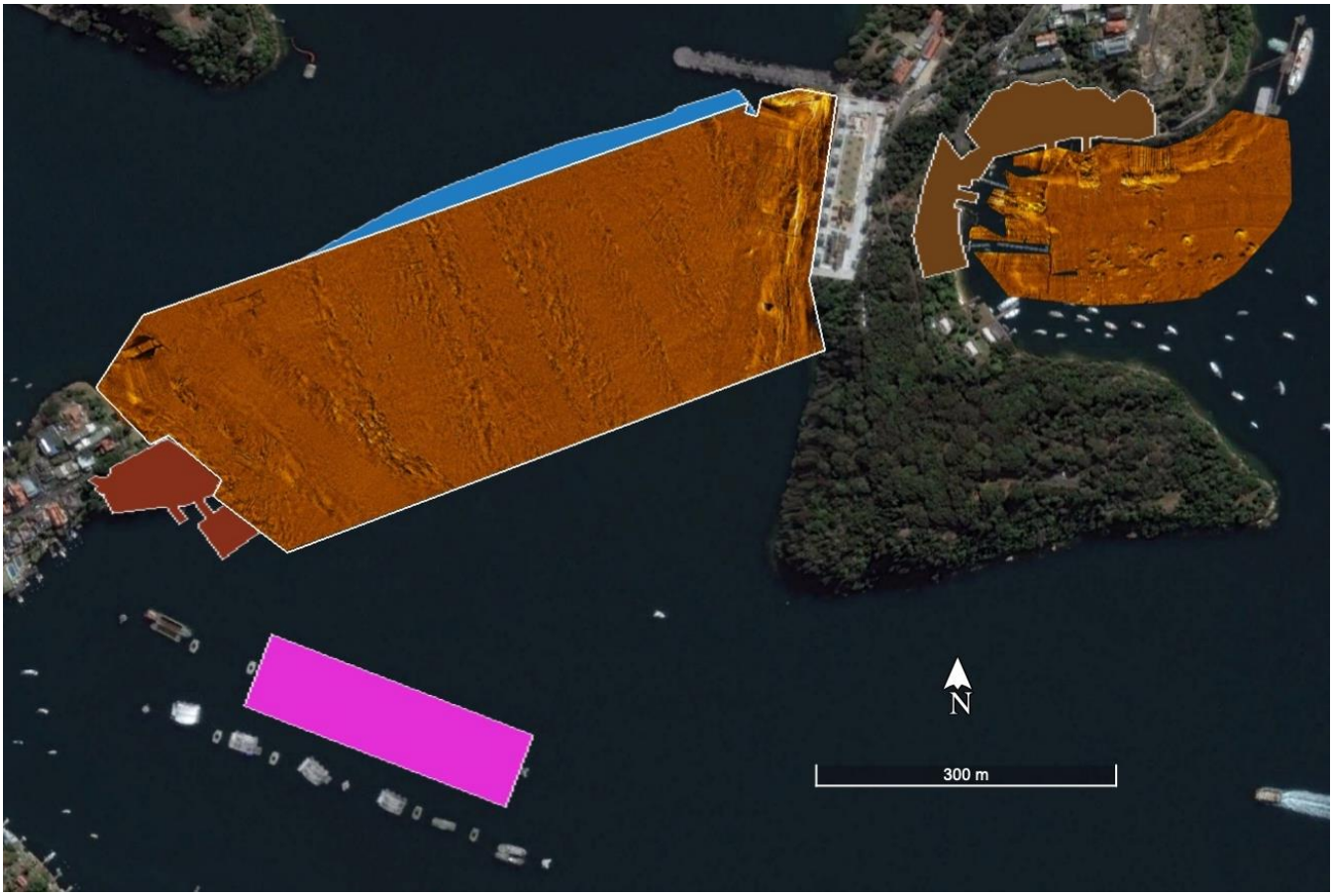


Figure 7: Extent of side scan sonar survey in relation to proposed extent of disturbance footprint in Area A
Note the solid pink strip at the top of the side scan sonar image between Birchgrove and Waverton signifies the portion of the disturbance footprint not covered by the side scan sonar survey **(**Base image: Google Earth, Side scan sonar data provided as .shp files by Podnar, A. Geotechnical Engineer, Douglas Partners 5 December 2017).

Seismic reflection profiling survey

Seismic or sub-bottom profiling is the marine equivalent of ground penetrating radar. This form of remote sensing technology is primarily used to record geological strata below the bed of the harbour to assist engineers in their design of marine structures as well as assist dredge contractors in understanding the material they will be encountering.

Two seismic reflection profiling surveys were carried out in the project area, gathering data to depths of around 40 metres below the bed of the harbour. The initial survey was carried out during May and June 2017 to 'map subsurface layers across the site to assess geological conditions for tunnel alignment assessment including the depth to top of rock and significant sediment layers and provide sufficient spatial coverage to allow production of contour plans of these layers' (Earth Technology Solution Pty Ltd July 2017a).

The seismic reflection data was examined, however it was determined to be of insufficient resolution to allow the identification of buried anomalies that may indicate the presence of historical cultural material

such as the remains of wreckage. This is more so the case with timber-hulled wrecks which are very difficult to identify through seismic reflection survey techniques unless the parameters of the data collection process are specifically calibrated to detect such sites.

Core and non-core drilling

Thirty-one boreholes were drilled in Area A throughout May and June 2017 (for purposes other than heritage assessment). The data collected from the drilling was determined to be of little value in identifying historical cultural material, because the small diameter (< 300 mm) and the relatively low frequency of the holes was very unlikely to intersect significant archaeological material.

Magnetometer survey

A magnetometer survey was conducted in Area A in June 2017 with the 'focus on the near shore (potential cofferdam) areas to attempt to delineate potential geological features such as a fault or dykes and also significant sized metal objects such as vessel wrecks and other debris' (Earth Technology Solution Pty Ltd July 2017a) (Figure 8).

Area B was not surveyed, because the number of moored vessels in the area would have had an adverse influence on the magnetic data.

The line spacing for the survey was 10 metres however there was no information on whether the tow-fish was kept at a constant altitude or what that altitude was. The absence of this information does not allow for a determination as to approximate size of ferrous objects that may be present on or under the bed of the harbour. The survey stated that the magnetometer survey was designed to identify 'significant sized metal objects', so it can be expected that the altitude of the tow-fish was not low enough to detect smaller ferrous components and fittings of timber-hulled wrecks.

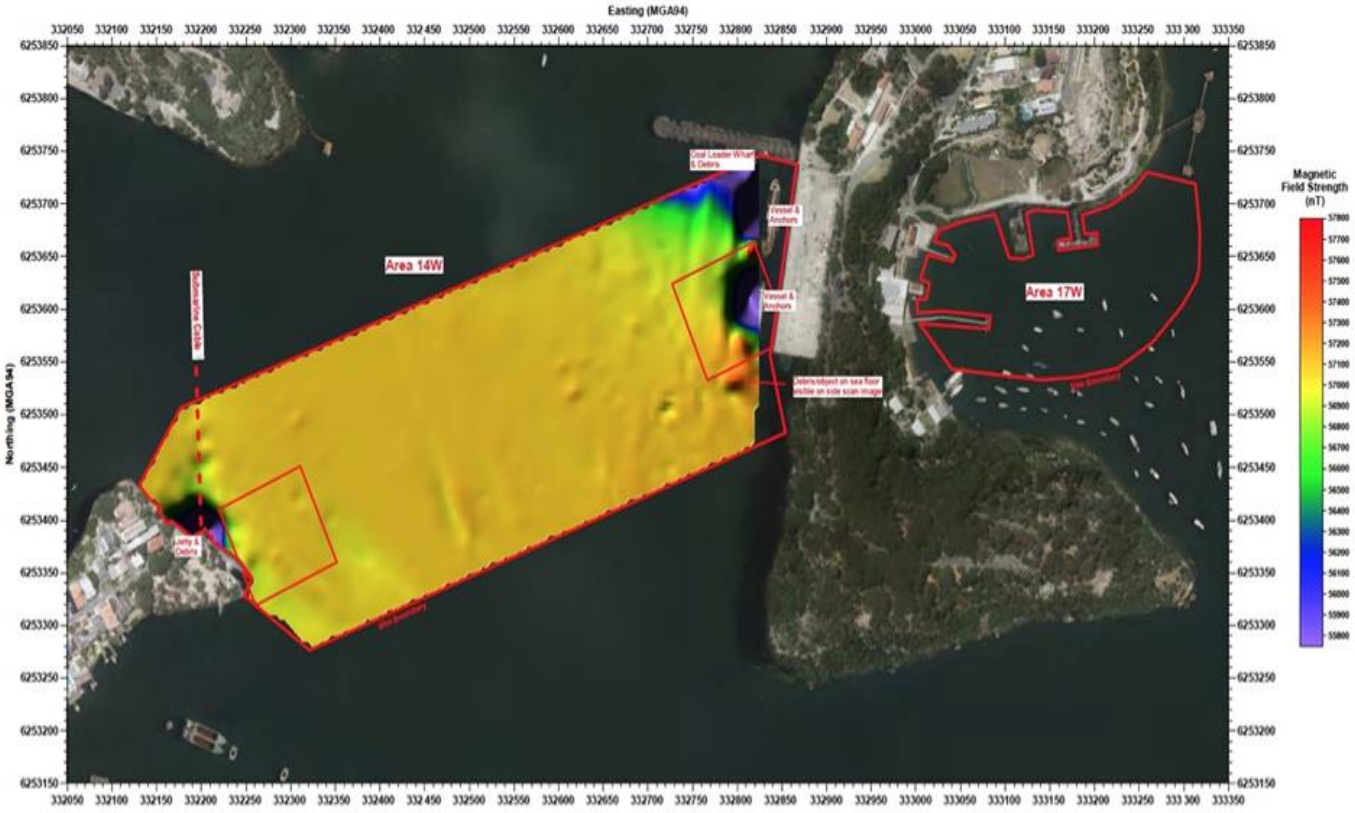


Figure 8: Extent of magnetometer survey in Area A (Earth Technology Solution Pty Ltd, July 2017a: Figure WH12A).

Table 2 Summary table of the effectiveness of remote sensing techniques employed for the detection of maritime heritage

Remote sensing type	Uses	Coverage	Effectiveness for this study
Side Scan Sonar	Excellent for detecting cultural objects on the bed of the	100% of the bed of the harbour in Areas A and B	Optimum

	harbour	where disturbance proposed	
Seismic profiling	Potential for detecting buried cultural remains	100% of bed of the harbour in Areas A and B where sub-surface disturbance proposed	Limited. Parameters of survey may not have included settings to provide sufficient resolution images for the detection of cultural buried objects closer to the bed of the harbour surface
Core drilling	Not very useful for finding buried objects unless looking for large sites such as a wreck, and only when the approximate location of the wreck is known	Carried out in Areas A and C	Very limited
Magnetometer	Excellent for looking for maritime heritage with ferrous components	100% of the bed of the harbour in Area A	Limited. Good for looking for larger sites with large ferrous components but not for timber hulled wrecks with limited ferrous content. Could not estimate size of ferrous objects

2.2.2 Field survey

The purpose of the field survey was to test the predictive model formulated in the baseline review as well as to inspect anomalies of potential cultural heritage significance identified from the geophysical surveys. The field survey, in the form of a diving investigation, took place over five days between 13 and 19 December 2017. The investigations were led by maritime archaeologists Cosmos Coroneos (Cosmos Archaeology Pty Ltd) and Matt Carter (archaeologist).

An archaeological review of the remote sensing data availablefor the study identified 22 anomalies of potential cultural heritage significance in Areas A and B. Of these anomalies, 13 were inspected. The remaining nine anomalies were not inspected in the time available as they were considered unlikely to be of cultural heritage value. Diving also took place at three locations where temporary wharves are proposed as part of the construction process.

The findings of the dive investigations are presented in Chapter 4 and Chapter 5 of this report. The conduct and the results of the dive investigation are presented in the Cosmos Archaeology January 2018 report *Western Harbour Tunnel and Beaches Link: Maritime Archaeological Dive Inspections December 2017*.

2.2.3 Establishing maritime heritage potential, significance and sensitivity

This report largely assesses maritime heritage that is either submerged or buried. Not all maritime heritage is documented in the historical record, and what is submerged and/or buried is archaeological in nature. Given the size of the study area it was not possible to carry out a complete visual examination of the bed of the harbour.

Maritime heritage potential has been determined through historical and comparative site research augmented with the findings of the field and geotechnical investigations carried out for this project. The conditions of the maritime heritage resource have also been predicted based on the understanding of the site conditions and underwater cultural site formation processes (see Cosmos Archaeology Pty Ltd November 2017). The level of maritime heritage potential has been rated according to the likelihood of it occurring and presented for areas A, B and C in sections 4.5, 5.5 and 6.5.

Understanding the cultural heritage significance of maritime heritage is critical in determining an appropriate level of impact mitigation. Maritime heritage assessments within the study area are provided in Chapter 7. It is noted that remote sensing anomalies that were not inspected could not have their cultural heritage significance assessed.

Maritime heritage sensitivity combines maritime heritage potential and significance to help devise appropriate mitigation measures. This has been done so as to help devise appropriate mitigation measures. Definitions and assessments of sensitivity for areas A, B and C are provided in Section 7.5.

2.2.4 Assessing impact and appropriate mitigation measures

The identified potential impacts arising from the implementation of the project are presented for Areas A, B and C in Chapter 8. Based on the findings of the impact assessments, appropriate mitigation measures are presented in Chapter 9.

2.3 Definitions

In this study, maritime heritage is defined as all material of potential heritage significance on or under the bed of the harbour below the Highest Astronomical Tide (the highest level of water which can be predicted to occur under any combination of astronomical conditions). This includes areas of the former bed of the harbour that are under reclamation.

Components of archaeological and heritage listed sites that have a land/water interface, such as slipways, seawalls and wharves, are also addressed.

Built heritage components of such sites such as roads, gates and buildings built on reclaimed land are not assessed within this study.

The following definitions are also used throughout this report:

- *Biological damage* includes impacts from biological organisms to organic materials of a site
- *Chemical damage* includes impacts affecting the fabric and structural integrity of a site, such as corrosion
- *Discard* includes items that have been accidentally or deliberately deposited in or on the bed of the harbour or within reclamation and now form an archaeological site
- *Fetch* is the distance travelled by wind or waves across open water, contributing to the generation of waves
- *Foreshore* includes areas in immediate contact with the edge of the harbour
- *Highest Astronomical Tide* refers to the highest tide level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions
- *Maritime infrastructure* are structures built for industrial or recreational use associated with activities on or near the harbour
- *Mechanical damage* includes impacts affecting the physical integrity of a site
- *Parramatta River for the purposes of this study is defined as the body of water west of the Gladesville Bridge*
- *Port Jackson* incorporates the water bodies of Sydney Harbour, Middle Harbour, Lane Cove and Parramatta Rivers
- *Reclaimed land* refers to fill being deposited onto the bed of the harbour usually adjacent to land for the purposes of extending, raising and/or levelling the land. Reclaimed land is usually retained by a seawall
- *Bed of the harbour* includes sediments and rock outcrops within the harbour that are currently under water or have become buried by reclamation.
- *Submerged* is used to describe land or archaeological heritage that are currently under water or have become buried by reclamation
- *Sydney Harbour* for the purposes of this study is defined as the body of water east of the Gladesville Bridge, not including Lane Cove River or Middle Harbour.

3 HERITAGE LEGISLATION AND POLICY

3.1 Heritage listings in study area

There are four levels of statutory listings for historical cultural heritage sites, objects and places in NSW:

- local listing on the heritage schedule of a Council's environmental planning instrument
- state listing on the NSW State Heritage Register
- national listing on the National Heritage List
- world listing on the United Nations Educational Scientific and Cultural Organization (UNESCO)World Heritage List.

Sites and items owned, occupied or managed by the NSW Government can also be included in the Heritage and Conservation Register of the respective agency or corporation under Section 170 of the NSW *Heritage Act 1977.*

Inclusion on such statutory heritage registers provides automatic legal protection. In NSW, protection for historical heritage sites and items is afforded by the NSW *Heritage Act 1977*, the NSW *Environmental Planning and Assessment (EPA) Act 1979*, the Commonwealth *Environment Protection and Biodiversity Conservation (EPBC) Act 1999* and the UNESCO *Convention Concerning the Protection of the World Cultural and Natural Heritage.*

Additional protection is also afforded to historic shipwrecks and associated relics within NSW waters under the Commonwealth *Historic Shipwrecks Act 1976.* However, this Act does not apply to internal state waters, including the study area.

Cultural heritage sites, objects and places may also be listed on non-statutory registers, most notably the Register of the National Estate. The act of listing a place on the Register of the National Estate does not constitute automatic legal protection, however the Register is widely recognised as an authoritative compilation of the heritage significance of many of Australia's natural and cultural places and is considered by planning agencies when decisions about development and conservation are being made.

Table 3 provides a summary of the statutory heritage registers listings and associated legislative protection within the study areas.

Table 3 Summary of heritage register listings within study area

HERITAGE REGISTER	STATUTORY PROTECTION	LISTED SITES IN PROJECT AREAS
World Heritage List	UNESCO *Convention Concerning the Protection of the World Cultural and Natural Heritage*	There are no sites on the World Heritage List within the study area. The closest listed site is the Sydney Opera House, which is over 2 kilometres from Areas A, B and C
National Heritage List	*Environment Protection and Biodiversity Conservation Act 1999*	There are no sites on the National Heritage List within the study area. The closest listed sites are the Sydney Opera House and the Sydney Harbour Bridge, while Cockatoo Island is over 1 km from Area A. These sites, including Cockatoo Island, have not been assessed in this study as their maritime heritage values would not be impacted by the proposed project
State Heritage Register	NSW *Heritage Act 1977*	• Railway Electricity Tunnel under Sydney Harbour – Birchgrove / Greenwich (Area A) • Glebe Island Bridge – Bank Street, Victoria Road, Pyrmont, and James Craig Road, Rozelle (Area C) • *Under consideration* Former coal loader – Balls Head Drive, Waverton, Lot 99, DP 1048930, Lots 1-3, DP 542933 (Area A)
Roads and Maritime S170 Heritage & Conservation Register	NSW *Heritage Act 1977*	• Railway Electricity Tunnel under Sydney Harbour – Birchgrove / Greenwich (Area A) • Former coal loader – Balls Head Drive, Waverton, Lot 99, DP 1048930, Lots 1-3, DP 542933 (Area A) • Glebe Island Bridge – Bank Street, Victoria Road, Pyrmont, and James Craig Road, Rozelle (Area C) • Anzac Bridge – Victoria Road, Pyrmont (Area C)
Sydney Regional	Sydney Regional Environmental Plan (REP)	• Railway Electricity Tunnel under Sydney Harbour – Birchgrove / Greenwich (Area A)

HERITAGE REGISTER	STATUTORY PROTECTION	LISTED SITES IN PROJECT AREAS
Environmental Plan 2005	made under the *Environmental Planning and Assessment Act 1979*	• Balmain to Greenwich Tunnel, including docking facilities and service buildings – Under harbour from Long Nose Point, Balmain, to Manns Point, Greenwich (Area A)[Same item as the Railway Electricity Tunnel listed above] • Long Nose Point Wharf*, Louisa Road, Birchgrove (Area A) • Glebe Island Bridge – Bank Street, Victoria Road, Pyrmont, and James Craig Road, Rozelle (Area C)
Leichhardt Local Environmental Plan (LEP) 2013	Leichhardt LEP made under the *Environmental Planning and Assessment Act 1979*	• Railway Electricity Tunnel under Sydney Harbour – Birchgrove / Greenwich (Area A) • Yurulbin Park – Louisa Road, Birchgrove, Lots 1-2, Section 9, DP 192096, Lot 1, DP 1112881, road reserve (Area A)
North Sydney Local Environmental Plan 2013	North Sydney LEP made under the *Environmental Planning and Assessment Act 1979*	• Former coal loader – Balls Head Drive, Waverton, Lot 99, DP 1048930, Lots 1-3, DP 542933 (Area A) • Balls Head Reserve – Balls Head Drive, Waverton, Lot 106, DP 1162896 (Area A) • BP site – 3a Balls Head Road, Waverton, Lots 2 and 20, DP 1048930 (Area B) • Woodleys Shipyard – 1 Balls Head Drive, Waverton, Lots 101-102, DP1162896 (Area B) • Former Quarantine Boat Depot – Balls Head Drive, Waverton, Lots 104-105, DP 1162896 (Area B)
Register of the National Estate	Non-statutory register	• Balls Head Coal Loader – Balls Head Drive, Waverton (Area A) • Balls Head Reserve and Whale Site – Balls Head Drive, Waverton • Glebe Island Bridge – Bank Street, Pyrmont
Australian Register of Historic Vessels	Non-statutory register	• M.V. *Cape Don (HV000208)* • *Baragoola (HV0004909)*
NSW Maritime Heritage Sites database	Non-statutory register	• Unidentified Balls Head Bay 1 • Unidentified Balls Head Bay 2

*Please note that Long Nose Point Wharf will now be referred to in this report as Long Nose Point (Birchgrove) Wharf for consistency with the project environmental impact statement

3.2 Statutory protection

As shown in Table 3, the project areas include several heritage sites listed under the NSW *Heritage Act 1977* and various development planning instruments made under the *Environmental Planning and Assessment Act 1979*. The following section provides a discussion of the statutory requirements attached to such heritage listings, as well as additional automatic heritage provisions afforded under the NSW *Heritage Act 1977,* as applies to the current project – an identified State significant infrastructure project.

3.2.1 NSW Heritage Act 1977

The *Heritage Act 1977* (the Heritage Act) provides protection for items of 'environmental heritage' in NSW. 'Environmental heritage' includes places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values. Items considered to be significant to the state are listed on the State Heritage Register and cannot be demolished, altered, moved or damaged, or their significance altered without approval from the Heritage Council of NSW.

For the purposes of the Heritage Act, the State of NSW includes the bed of the harbour and the water column up to three nautical miles from the coast. Shipwrecks currently under the jurisdiction of the Heritage Act are identified in the Historic Shipwrecks Register, maintained by the NSW Heritage Council.

The *Heritage Act 1977* also provides protection for 'relics', which includes archaeological material or deposits. Section 4 (1) of the Heritage Act (as amended in 2009) defines a relic as:

'...any deposit, artefact, object or material evidence that:

(a) relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and

(b) is of State or local heritage significance'.

Sections 139 to 145 of the *Heritage Act 1977* make it an offence to excavate or disturb land known or likely to contain relics, unless under an excavation permit. Section 139 (1) states:

> *A person must not disturb or excavate any land knowingly or having reasonable cause to suspect that the disturbance or excavation will or is likely to result in a relic being discovered, exposed, damaged or destroyed unless the disturbance is carried out in accordance with an excavation permit.*

Excavation permits are issued by the Heritage Council of NSW, or its Delegate, under Section 140 of the *Heritage Act 1977* for relics not listed on the State Heritage Register, or under Section 60 for relics listed on the State Heritage Register. An application for an excavation permit must be supported by an Archaeological Research Design and Archaeological Assessment prepared in accordance with the NSW Heritage Division archaeological guidelines. Minor works that would have a minimal impact on archaeological relics may be granted an exception under Section 139 (4) or an exemption under Section 57 (2) of the Act.

As the current project is subject to Division 5.2 (State Significant Infrastructure) provisions of the NSW *Environmental Planning & Assessment Act 1979*, excavation or exception permits issued under the *Heritage Act 1977* would not be required. Conditions of approval nonetheless require the same consideration of the heritage significance of archaeological relics and the management of impacts, including those through archaeological investigation.

Part 3C of the *Heritage Act 1977* also contains specific provisions for the protection of shipwrecks more than 75 years old. This section is included to provide a link to and consistency with the Commonwealth *Historic Shipwrecks Act 1976* (which was superseded by *Underwater Cultural Heritage Act 2019* in 1st July 2019) In NSW the 'relics' provision takes precedence over Part 3C when it comes to determining the legal and protected status of a wreck and associated artefacts. This applies to known and potential relics present on or in the bed of the harbour, even if the sites are not listed on the State Heritage Register.

3.2.2 NSW Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the framework for cultural heritage values to be formally assessed in the land use planning and development consent process.

The Act requires that environmental impacts are considered before land development including impacts on cultural heritage items and places as well as archaeological sites and deposits.

Environmental planning instruments are made under the EP&A Act, and are used to regulate land use, development and environmental impact assessment. They include State Environmental Planning Policies and Local Environmental Plans. Historically, Regional Environmental Plans were also made, but these instruments are now deemed to be State Environmental Planning Policies.

Sydney Regional Environmental Plan (Sydney Harbour Catchment) (2005)

Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 aims to protect, enhance and maintain the catchment, foreshores, waterways and islands of Sydney Harbour for existing and future generations.

Clause 52(b) of *Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005* requires public authorities and others to consider the matters listed in the Plan before they carry out activities to which Part 5 of the EP&A Act applies.

Local environmental plans – Leichhardt (2013), North Sydney (2013) and Sydney (2012)

While the majority of the study area is within the water bodies of Sydney Harbour, the shoreward extents of the study area cross into two local government areas:

- Inner West (Area A and C)
- North Sydney (Area A and B).

Local environmental plans constitute environmental planning instruments prepared at a state level in accordance with the EP&A Act and provide statutory protection of heritage assets within the land of their respective local government areas as declared by the Heritage Council.

As indicated above, although these local environmental plans do not apply to the project, their heritage schedules have been checked to identify waterside items that may contribute to the maritime heritage resource.

3.2.3 Summary of statutory provisions relevant to the study area

Table 4 provides a compilation of all the items listed on heritage registers that are located within the bed of the harbour and foreshore of the study area and are included in this study.

The Railway Electricity Tunnel is listed twice on the Sydney REP, as the 'Railway Electricity Tunnel under Sydney Harbour – Birchgrove/Greenwich' and as the 'Balmain to Greenwich Tunnel, including docking facilities and service buildings – Under harbour from Long Nose Point, Balmain, to Manns Point, Greenwich'. The latter listing appears to include former facilities associated with the construction of the tunnel at Manns Point, which is outside the study area.

The Balls Head Coal Loader is currently being considered for listing on the State Heritage Register. The management of the site complex is divided between Roads and Maritime and North Sydney Council.

Table 4: All identified items with statutory heritage protection discussed in this report

Area	Item	State Heritage Register (NSW *Heritage Act 1977*)	S170 Heritage Registers (NSW *Heritage Act 1977*)	Regional Environmental Plans *(Environmental Planning & Assessment Act 1979)*	Local Environmental Plans *(Environmental Planning & Assessment Act 1979)*
A	Railway Electricity Tunnel under Sydney Harbour – Birchgrove/Greenwich	01231	RailCorp Item 5062542	Sydney REP – SHC (2005) 10	Leichhardt LEP (2013) A2
A	Balmain to Greenwich Tunnel, including docking facilities and service buildings – Under harbour from Long Nose Point, Balmain, to Manns Point, Greenwich			Sydney REP – SHC (2005) 4	
A	Long Nose Point (Birchgrove) Wharf, Louisa Road, Birchgrove			Sydney REP – SHC (2005) 5	
A	Former coal loader – Balls Head Drive, Waverton, Lot 99, DP 1048930, Lots 1-3, DP 542933	Under consideration for listing	Roads & Maritime Services		North Sydney LEP (2013) I1040
A	Balls Head Reserve – Balls Head Drive, Waverton, Lot 106, DP 1162896				North Sydney LEP (2013) I1041
A	Yurulbin Park – Louisa Road, Birchgrove, Lots 1-2, Section 9, DP 192096, Lot 1, DP 1112881, road reserve				Leichhardt LEP (2013) I555
B	BP site – 3a Balls Head Road, Waverton, Lots 2 and 20, DP 1048930				North Sydney LEP (2013) I1036
B	Woodleys Shipyard – 1 Balls Head Drive, Waverton, Lots 101-102, DP1162896				North Sydney LEP (2013) I1038
B	Former Quarantine Boat Depot – Balls Head Drive, Waverton, Lots 104-105, DP 1162896				North Sydney LEP (2013) I1039
C	Glebe Island Bridge – Bank Street, Victoria Road, Pyrmont, and James Craig Road, Rozelle	01914	Roads and Maritime Services	Sydney REP – SHC (2005) 68	
C	Anzac Bridge – Victoria Road, Pyrmont		Roads and Maritime Services		

3.3 Heritage policies relevant to maritime heritage

3.3.1 UNESCO Convention on the Protection of the Underwater Cultural Heritage

The UNESCO *Convention on the Protection of the Underwater Cultural Heritage*, adopted in 2001, sets out the basic principles for the protection of underwater cultural heritage, provides a detailed cooperation system and provides widely recognised practical rules for the treatment and research of underwater cultural heritage. The main principles are:

- Obligation to preserve underwater cultural heritage
- *In situ* preservation as first option
- No commercial exploitation
- Training and information sharing.

3.3.2 The Burra Charter

The Burra Charter 2013 provides a best practice standard for managing cultural heritage places in Australia. The Burra Charter was first adopted in 1979 and is periodically updated to reflect developing understanding of the theory and practice of cultural heritage management. The current version was adopted in 2013.

The Charter can be applied to all types of places of cultural significance including natural, Indigenous and historic places with cultural values. The Burra Charter advocates a cautious approach to change: do as much as necessary to care for the place and to make it useable, but otherwise change it as little as possible so that its cultural significance is retained. The Charter includes 12 conservation principles which are further developed in the processes and practice sections of the Charter.

3.3.3 Guidelines for the Management of Australia's Shipwrecks

The *Guidelines for the Management of Australia's Shipwrecks* were produced as a combined publication by the Australian Institute for Maritime Archaeology Inc. (now the Australasian Institute for Maritime Archaeology) and the Australian Cultural Development Office (now the Australian Government Department of the Environment and Energy) in 1994.

The guidelines comprise principles and practices that have been adopted by Australia's professional maritime archaeologists and serve as useful modules for other groups. The document includes a Statement of Principles governing the broad approach to be taken when dealing with historic shipwreck sites and related archaeological collections.

3.3.4 NSW Heritage Manual

The *NSW Heritage Manual*, published in 1996 by the NSW Heritage Office and Department of Urban Affairs & Planning, is a comprehensive set of guidelines explaining all aspects of the NSW heritage management system. When the manual was first published, it served as the primary reference for heritage management in NSW. While there have been major amendments to the NSW *Heritage Act 1977* and sections of the manual are now outdated, much of the major principles within the manual remain relevant – in particular, the chapters on Investigating History, Investigating Heritage Significance, Assessing Heritage Significance and Statements of Heritage Impact.

3.3.5 Criteria for the Assessment of Excavation Directors

The *Criteria for the Assessment of Excavation Directors* was published by the NSW Heritage Council in 2011 and outlines the composition of skills required when selecting an archaeological Excavation Director, to be nominated as part of an application under relevant sections – including Sections 60 and 140 – of the NSW *Heritage Act 1977.*

4 AREA A – YURULBIN POINT TO BALLS HEAD, SYDNEY HARBOUR

4.1 Physical setting

Area A covers of a stretch of Parramatta River/Port Jackson bounded on three sides by the promontories of Yurulbin Point, Manns Point and Balls Head (Figure 9). The line between Yurulbin Point and Manns Point is generally seen as the demarcation between Parramatta River and Port Jackson (Blaxell 2009). The natural foreshore on all three headlands comprises exposed Hawkesbury sandstone sloping quite steeply down to the water's edge. The Yurulbin Point shoreline, however, has been modified through reclamation and a significant portion of Balls Head is dominated by the large seawall of the former Balls Head Coal Loader.

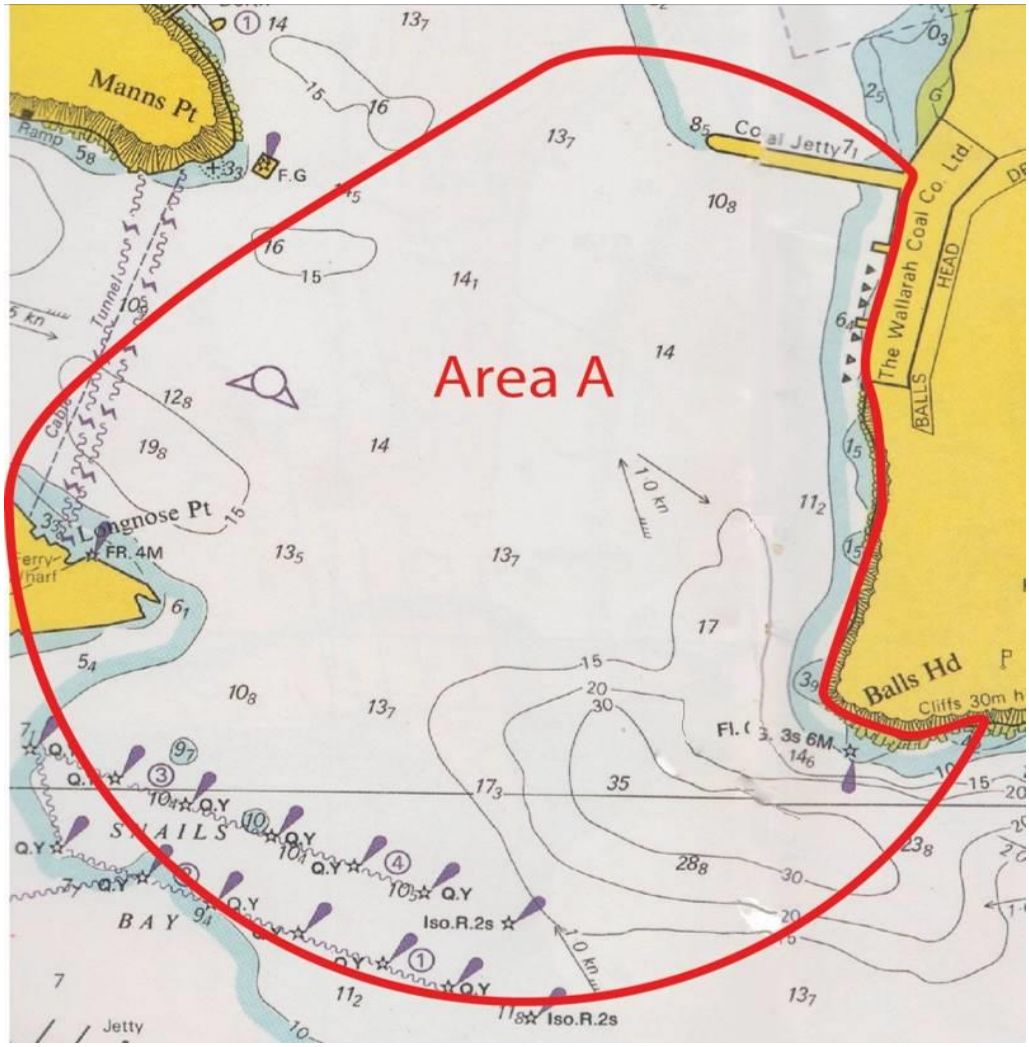


Figure 9: Portion of nautical chart showing Area A
Depths are in metres
(Commonwealth of Australia / Crawford House Publishing, 1995).

The bed of the harbour within Area A is largely flat and at a relatively shallow depth of 14 to 15 metres below Australian Height Datum across most of the area . A deeper patch of 20 metres below Australian Height Datum occurs to the north of Yurulbin Point, which is likely to be the result of tidal scouring. The tidal run between Balls Head, Manns Point and Yurulbin Point is quite high, reaching up to 1.7 knots (Maritime Services Board of NSW 1963 revised to 1975) and during the geophysical survey for the project, the highest sea current flows were experienced in this area north of Yurulbin Point (Earth Technology Solution Pty Ltd, July 2017b: 3).

The bed of the harbour rises sharply close to both Balls Head and Yurulbin Point, indicating that the steep sandstone bedrock of the headlands is not far below the bed of the harbour surface in these areas. Indeed, multi-beam sonar imaging revealed rock outcropping and boulders very close to the shoreline at Yurulbin Point (Figure 11). The composition of the bed of the harbour across the remainder of Area A ranges mostly from sand to silty sand, with areas of sandy clay gravel and clayey silt (Douglas Partners & Golder Associates August 2017). The coarseness of the bed of the harbour sediments in places is most likely the result of the relatively high tidal flows in the area.

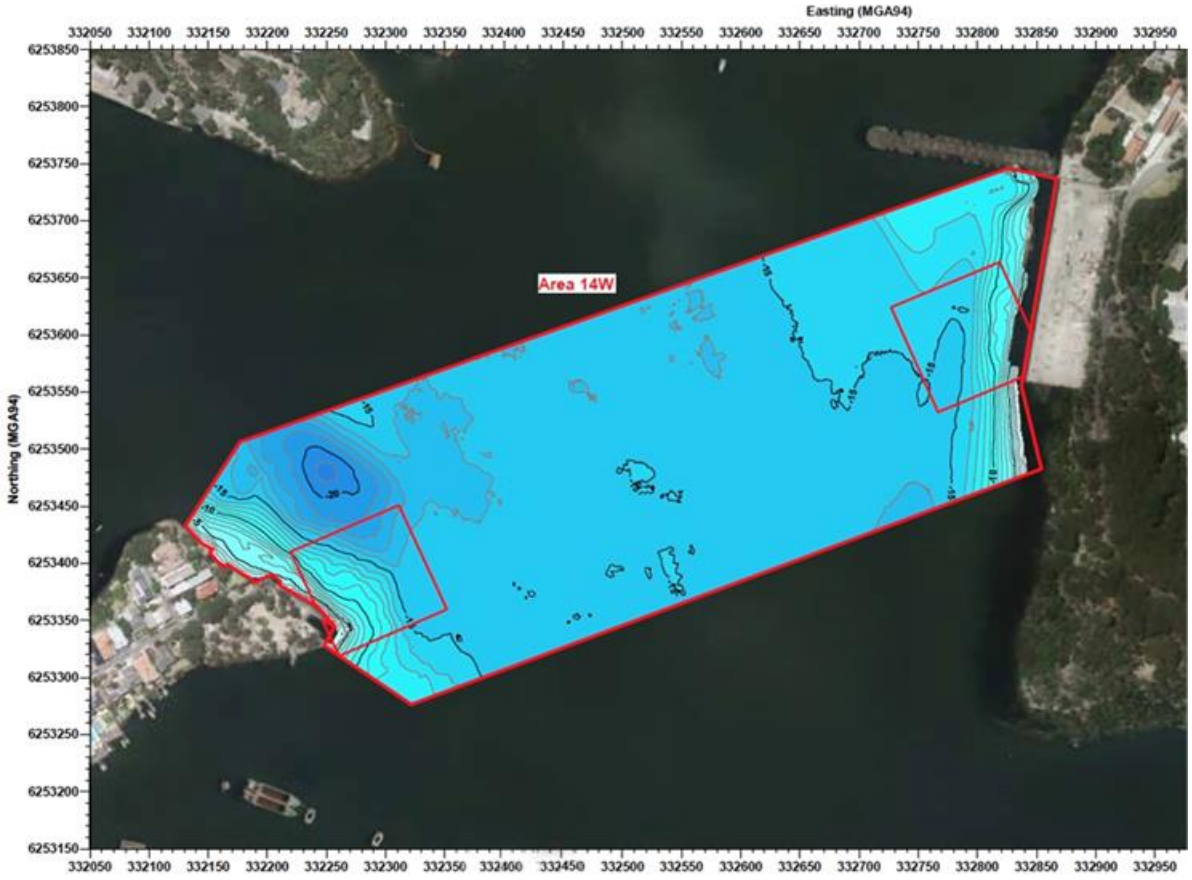


Figure 10: Bathymetric contour plan of Area A between Yurulbin Park and Balls Head
Depths are in metres AHD (Earth Technology Solution Pty Ltd, July 2017a: Figure WH2)

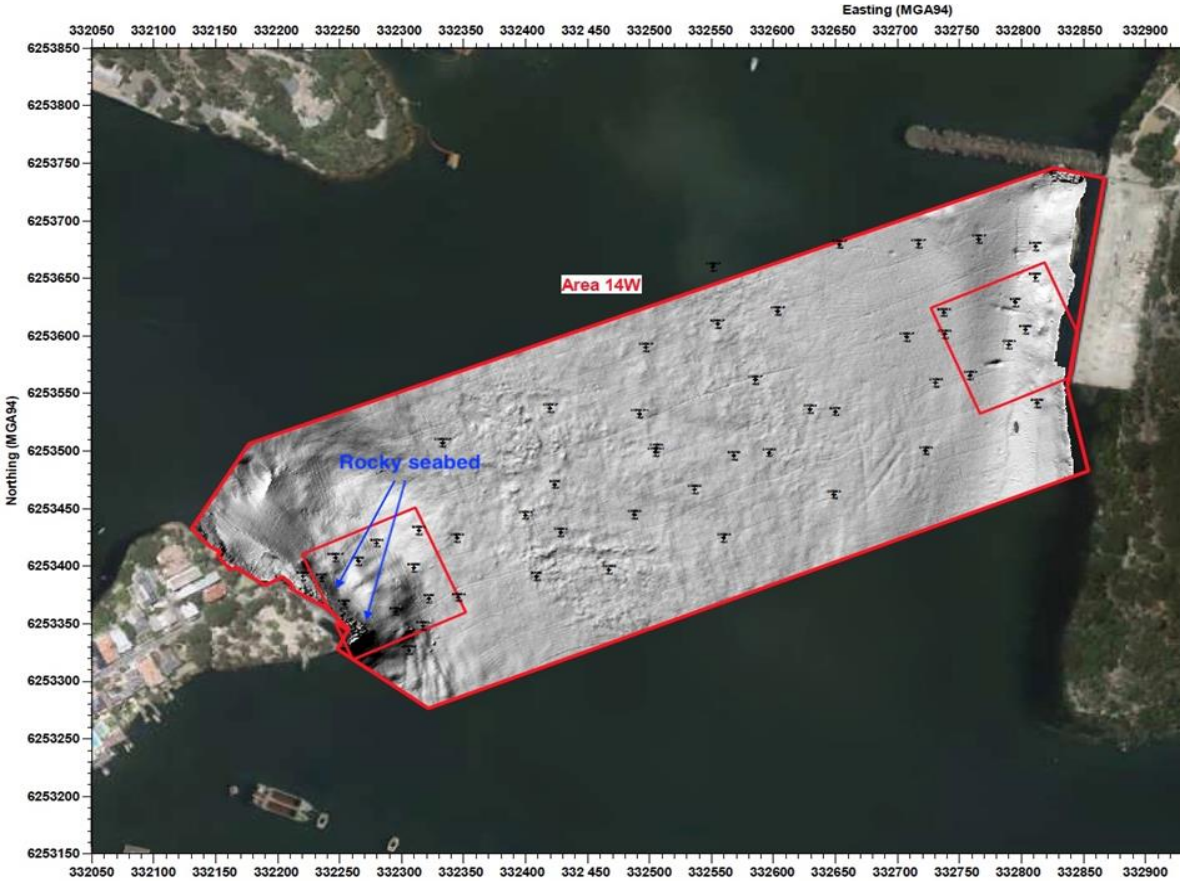


Figure 11: Bed of the harbour features within Area A showing rock outcrops and boulders near Yurulbin Park. Black spot marks and text are the locations of the boreholes drilled for this project
(Earth Technology Solution Pty Ltd, July 2017a: Figure WH2A)

4.2 Historical background

4.2.1 Yurulbin (formerly Long Nose) Point and Snails Bay

The promontory of Yurulbin Point (formerly Long Nose Point) was first subject to European occupation in 1796, with a large 30 acre land grant to Private George Whitfield of the NSW Corps (Figure 12), who used part of the land to establish an orange grove. Shortly thereafter, Whitfield sold the property and ownership of the land changed a few times until 1810, when the entire 30 acres was purchased by Lieutenant John Birch, paymaster of the 73rd Regiment of the British Army. In 1812, Birch constructed a large residence known as Birch Grove House near the centre of the promontory, in the present suburb of Birchgrove. Only two years later, however, Birch sold the house and estate to merchant Rowland Walpole Loane. Loane attempted unsuccessfully to subdivide and sell the estate, and over the following two decades, the land remained undeveloped (Blaxell 2009, Jeffery 1986, NSW Office of Environment & Heritage 2013).

Figure 12: Early 19th century Petersham parish map showing Whitfield's original grant ***(NSW Surveyor ca. early 19th century)***

In 1854, the Birchgrove Estate was acquired by merchant and property developer Didier Numa Joubert. In 1860, Joubert subdivided the land into ten large sections with many 'villa' allotments, creating a street grid named for his family members including his wife (Louisa), children (Numa and Rose) and nephew (Ferdinand) (Figure 13). The land at the end of Yurulbin Point was divided into two sections: Section 9 containing Lots 1 and 2 to the east, and Section 10 containing Lots 1, 2 and 3 to the west (NSW Office of Environment and Heritage, 2013) (Figure 14).

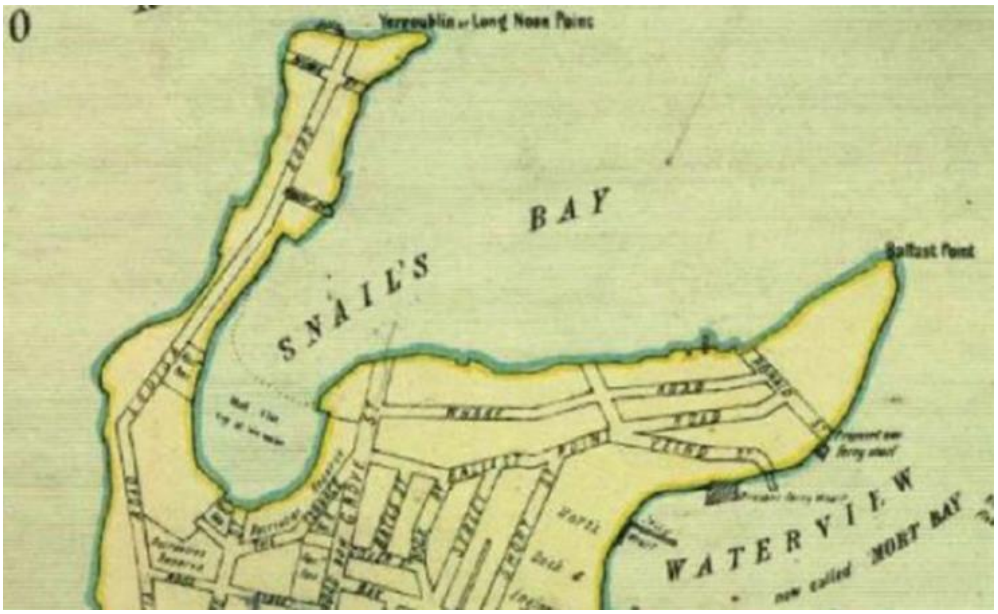


Figure 13: Section of an 1866 to 1868 map of Balmain showing Yurulbin Park with Louisa Road in the centre, Numa Road to the north, and Rose Street and Ferdinand Street to the south with mudflats in the south of Snails Bay **(**Higinbotham & Robinson, 1886-1888)

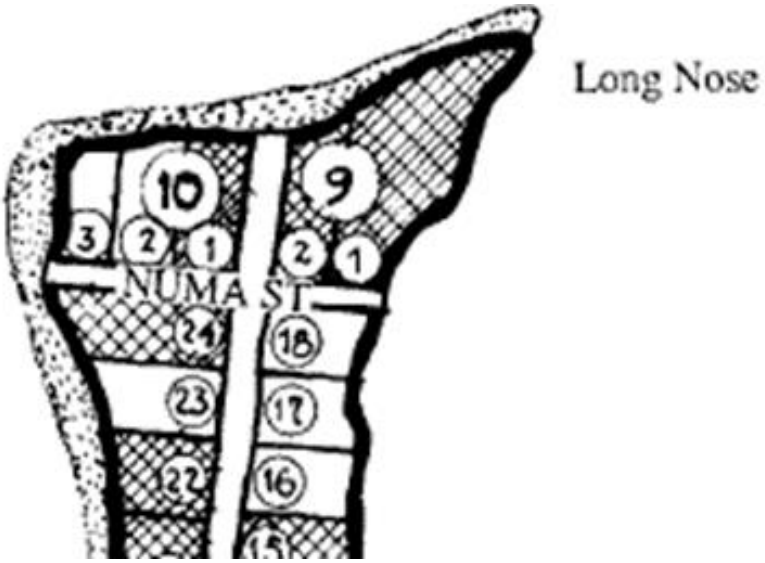


Figure 14: Joubert's subdivision of 1860 (Jeffery 1986: 12)

However, Joubert's subdivided allotments proved difficult to sell, quite possibly due to the inaccessibility of the area at this time. In 1860, Joubert sold Birch Grove House and surrounds to Jacob Levi Montefiore, and in 1862, transferred ownership of the remainder of the subdivided Birch Grove Estate to the Bank of NSW to cover his debts (Blaxell 2009, Jeffery 1986, NSW Office of Environment & Heritage 2013).

The first sale of the allotments at the end of Yurulbin Point occurred in 1868, when Lot 1 of Section 10 was purchased by a cooper, Charles King. King built two weatherboard cottages towards the centre of the lot, and at least two smaller weatherboard sheds on the foreshore; likely to house his cooperage (Jeffery 1986). The remainder of the foreshore along the end of Yurulbin Point remained undeveloped throughout the late 1860s to 1870s (Figure 15).

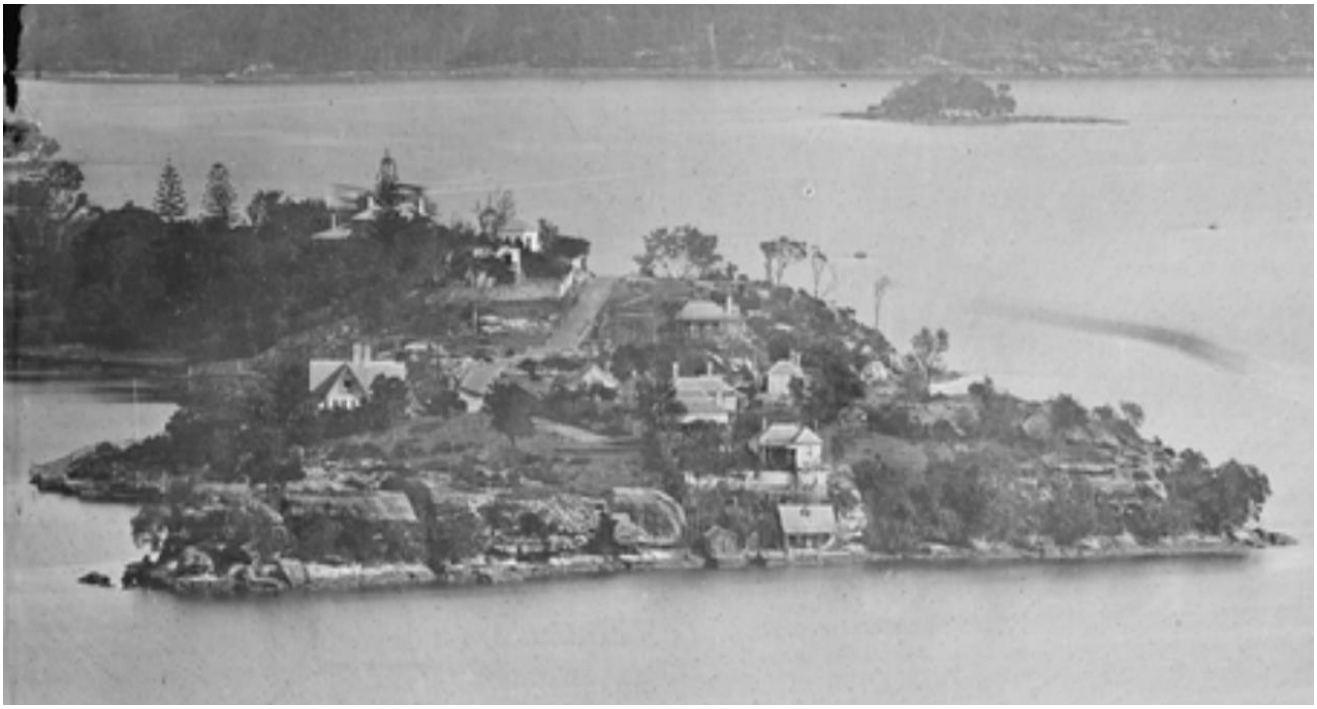


Figure 15: c. 1870-1875 view of Yurulbin (Long Nose) Point – showing King's foreshore sheds *(American & Australasian Photographic Company ca. 1870-1875)*

In 1888, Section 9 Lots 1 and 2 were purchased by Sydney cooper Alexander William Cormack. Soon after his purchase, Cormack constructed a number of galvanised steel workshops close to Numa Street and made an application to the NSW Harbours and Rivers Department for a special lease for a jetty on piles off the end of Louisa Road. The proposed jetty was described as being '21 feet in length and 14 feet in breadth' (City Plan Services 2017). By 1889, the jetty had been completed and appears to have incorporated a central set of steps down to a landing stage (NSW Office of Environment & Heritage 2013) (Figure 16).

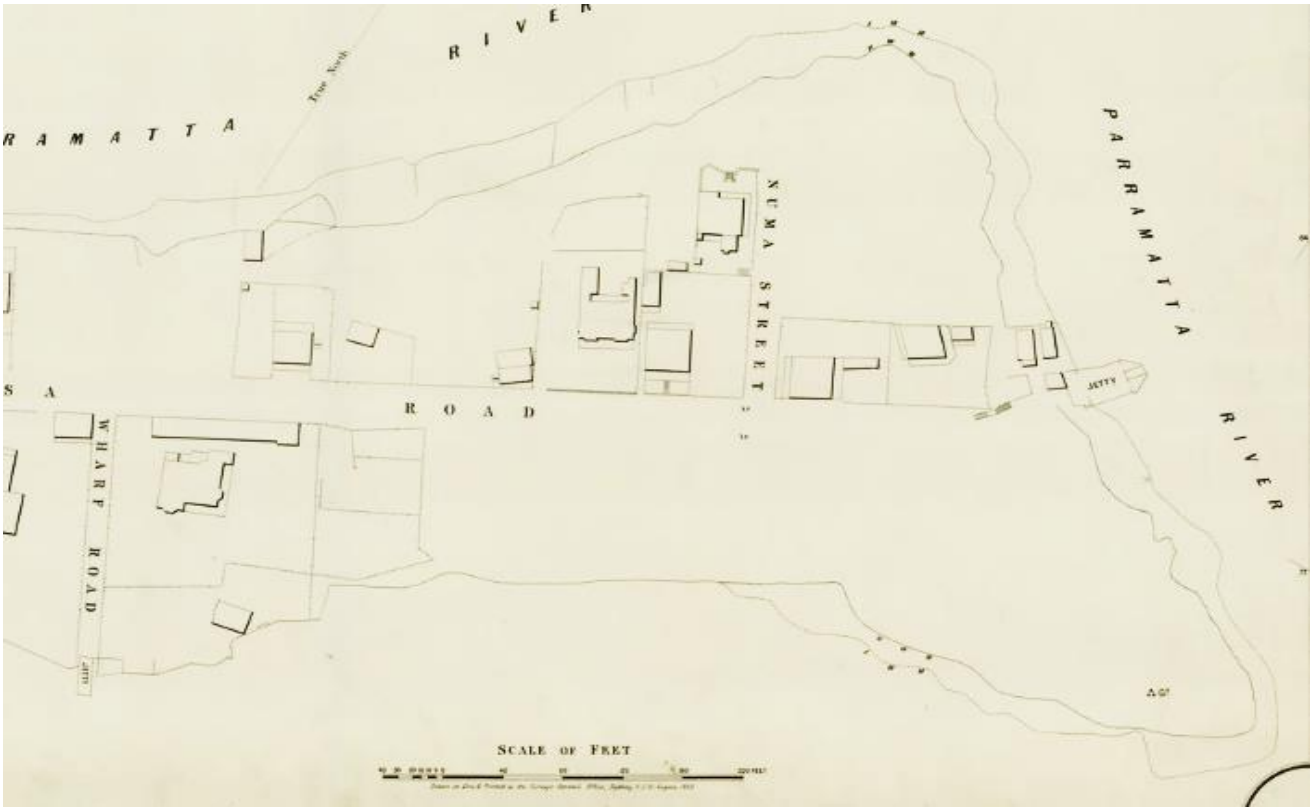


Figure 16: 1889 survey plan showing King's waterfront sheds and Long Nose Jetty (NSW Surveyor General's Office 1889)

By the early 1890s, Cormack had constructed a seawall around the eastern tip of Yurulbin Point (Figure 17) and built a large brick building (marked '89' in Figure 18) and store yard for his cooperage, and applied for a special lease for a second jetty into Snails Bay, on the south-eastern side of Yurulbin Point. The Long Nose Point Jetty at the end of Louisa Road began to be used as an occasional stopping point for steamers travelling along Parramatta River, with a regular ferry service from Long Nose Point commenced by Sydney Ferries Ltd in 1908 (Jeffery 1986, City Plan Services 2017). The north-eastern foreshore remained undeveloped.

Figure 17: c. late 1880s-1900s photograph facing north-west towards Yurulbin Point, showing Long Nose Point jetty, seawall and construction works at Cormack's cooperage (Kerry & Co. ca. late 18890s-1900)

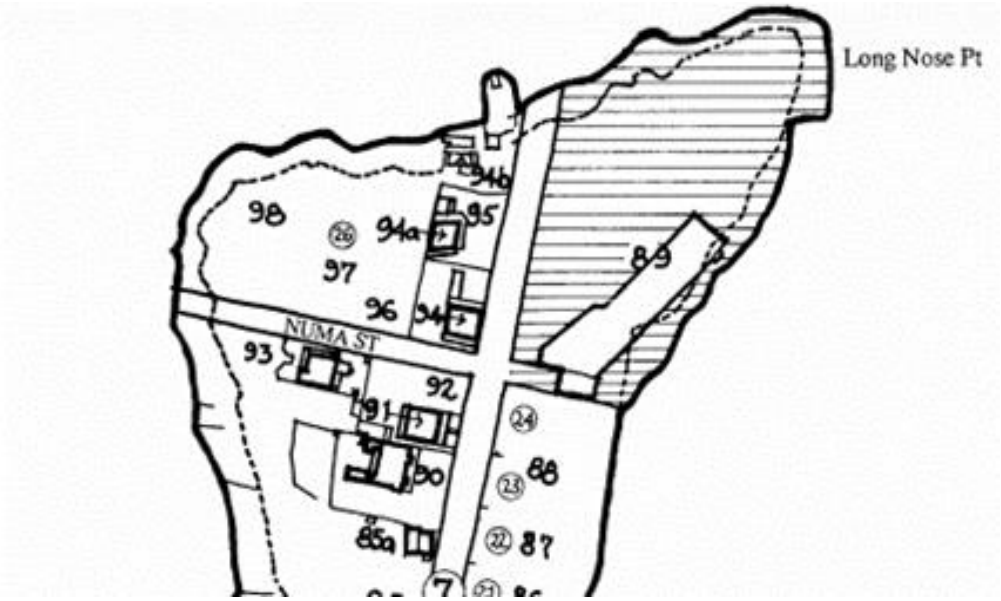


Figure 18: Birchgrove in 1887 to 1891, showing Cormack's reclamation and shed *(Jeffery 1986:* ***24)***

In 1909 Cormack died and his cooperage business was continued by his sons and renamed A W Cormack Ltd. In 1917, the Cormack company property at Long Nose Point was taken up by the Wallace Power Boat Company, who briefly utilised the site until 1920. In 1923, the property was sold to shipbuilders Morrison and Sinclair Ltd. By this time, additional facilities had been erected on the site, including three slipways on the south-eastern tip of Yurulbin Point and a large wharf facility on the southern side facing into Snails Bay (Figure 19). Originally based in Johnsons Bay in Balmain, Morrison and Sinclair designed, constructed and repaired a wide range of government vessels, naval vessels, island trading and merchant ships, and many Sydney ferries and yachts (Blaxell 2009).

By the mid 1920s, the northern portion at the end of Yurulbin Point had also been developed. The area had been subdivided into five waterfront allotments, with reclamation carried out along the length of the foreshore (Figure 19). Land use and occupation along this section of Yurulbin Point, however, appears to have been largely residential in nature.

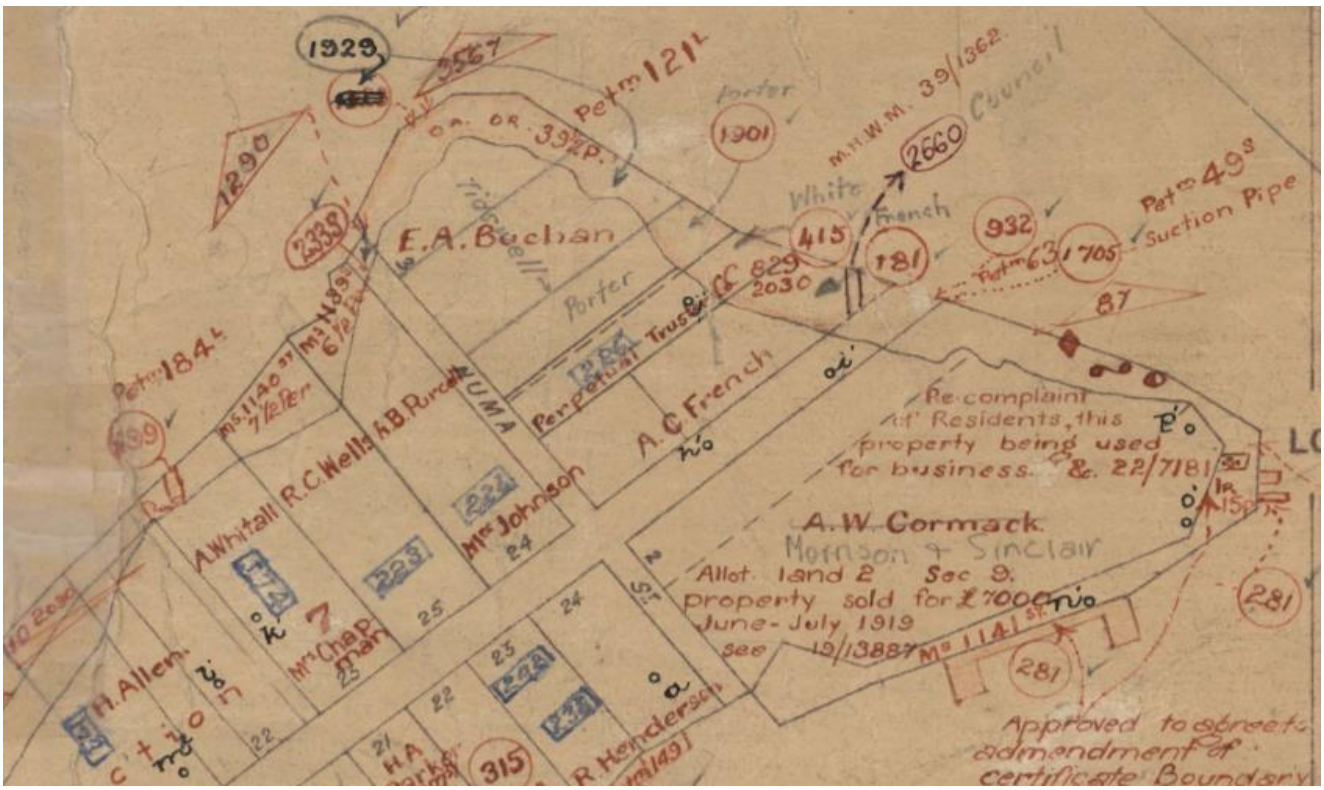


Figure 19: c.1910s Crown plan, with updates to 1925, showing 'A.W. Cormack' crossed out and replaced with 'Morrison and Sinclair' (Crown Plan ca. 1910s)

By the 1940s, the maritime infrastructure associated with Morrison and Sinclair's shipyard had been further expanded. The foreshore along the south-eastern end had been reclaimed, with a seawall, a slipway and additional mooring facilities established. The shipyard sheds and wharf facilities on the southern side of Yurulbin had been extended, and a timber deck and dolphin had been added to the Long Nose Jetty (Figure 20). An anchorage for large vessels had also been established in Snails Bay (Figure 20 and Figure 21), and was likely used by vessels carrying timber as a place to tie off as they offloaded their cargo onto lighters. The lighters would then take the timber to a number of sawmills that lined the Balmain foreshore. Further development had also occurred along the northern section of the foreshore at the head of Yurulbin Point, with a long seawall evident – likely built when the reclamation was carried out in the 1910s and 1920s. A cutout is evident in the seawall, extending across the waterfrontage of two allotments, containing an L-shaped jetty and associated shed (Figure 20).

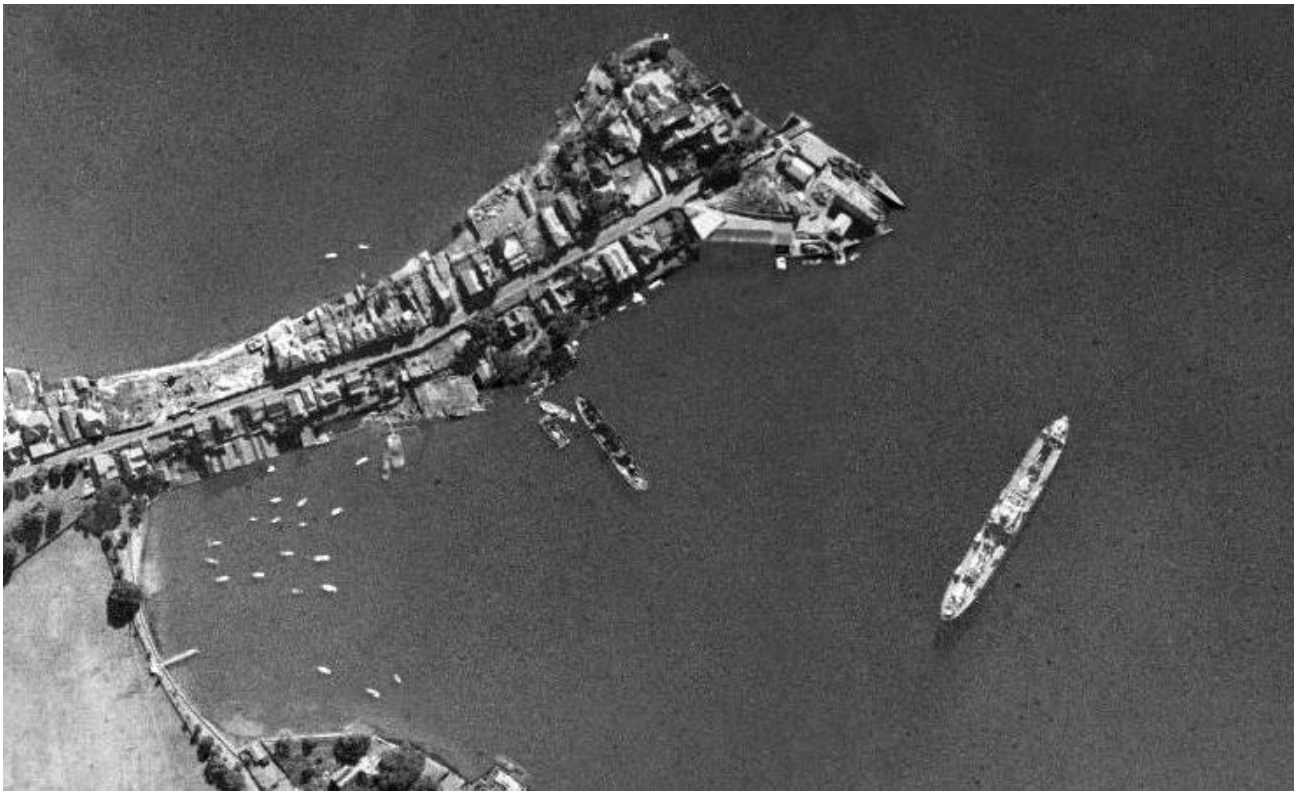


Figure 20: 1943 aerial photograph showing Morrison and Sinclair's shipyard, Long Nose Jetty and a large vessel moored at the anchorage in Snails Bay (RTA Photography 1943)

Figure 21: Navigation chart amended to 1945 showing mooring in Snails Bay (Great Britain Hydrographic Department 1887 amended to 1945)

By the early 1960s, the offshore mooring facility in Snails Bay had been expanded to incorporate two rows of six reinforced concrete dolphins connected by submarine cables, indicating that the complex had navigation lights (Figure 22). The Long Nose Jetty was also reconstructed by the NSW Maritime Services Board in 1969 (NSW Office of Environment and Heritage 2013).

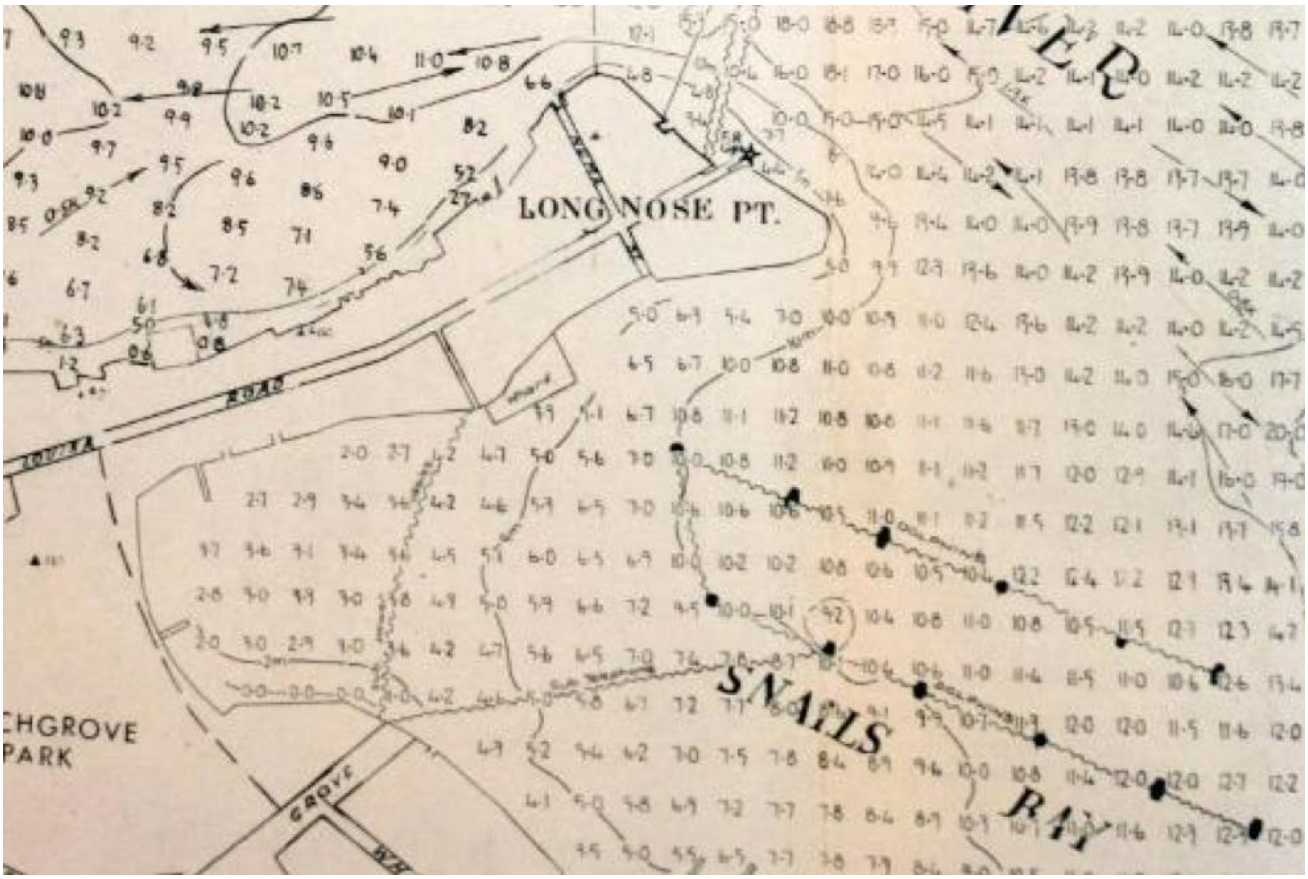


Figure 22: 1962 chart showing the wharf near Yerroulbin Street, off Louisa Road, and lines of dolphins in the bay **(**Maritime Services Board of NSW, 1963 revised until 1975)

Morrison and Sinclair continued to operate the shipyards at Yurulbin Point until the company ceased trading in 1971–72 (Figure 23 and Figure 24). The land was subsequently acquired by the NSW State Planning Authority for public recreation purposes and turned into the current Yurulbin Park (Jeffery 1986, NSW Office of Environment and Heritage 2013).

Figure 23: Part of the Morrison and Sinclair shipyard at Yurulbin Point in 1968. Note the slipway in the foreground, which can be also seen in the 1943 aerial (Blaxell 2009) (see Figure 20)

Figure 24: 1962 photograph of 'Boronia' in front of the Morrison and Sinclair shipyard (Wahlquist 1962)

The layout of Yurulbin Park was designed by landscape architects Bruce Mackenzie & Associates, between 1972 and 1977, and subsequently won the company the 1986 merit award from the Royal Australian Institute of Architects. Elements of Cormack's cooperage and Morrison and Sinclair's shipyards were incorporated into the park design, including the seawall and slipway at the north-eastern tip of Yurulbin Point and one of the jetties along the eastern foreshore, extending into Snails Bay. The park continues to be a popular recreational waterfront space (NSW Office of Environment and Heritage, 2013).

4.2.2 Yurulbin Point to Manns Point submarine electricity cable and tunnel

In the 1890s, a program of improving public transport across Sydney's North Shore was initiated via extensions to the existing cable tram services and the electrification of the tram network. By the late 1890s, extensions of the electric tramway to Mosman and Willoughby had caused the electricity generating plant at North Sydney to reach maximum capacity and plans were made to construct a new power plant in the inner city Sydney suburb of Ultimo. In order to supply the North Sydney electric tram network with power from the Ultimo plant, a series of submarine cables were laid across Sydney Harbour from Dawes Point. By the early 1910s, the electric tram network had expanded to the point that an additional power station was constructed at White Bay in Rozelle to meet increasing power requirements. The White Bay Power Station opened in 1913 and was also connected to the North Shore by submarine electricity cables – this time laid between Yurulbin Point and Manns Point, Greenwich (Dargan 1984, McCarthy 1979) (Figure 25).

These cables, however, were only a temporary measure. Previous damage to the submarine cables between Dawes Point and North Sydney (including a cable break in 1907), caused by vessels travelling through Sydney Harbour, led to a decision in 1912 to house the Yurulbin Point to Manns Point cable within a dry submarine tunnel (Dargan 1984).

Excavation of the tunnel began at both ends in October 1913, with the Yurulbin Point entrance to the west of the intersection of Louisa Road and Numa Street (Figure 25). Construction of the tunnel was originally predicted to take two years; however, due to numerous problems including fissures in the bedrock, structural collapse and flooding of the tunnel, the work was not completed until 1924.

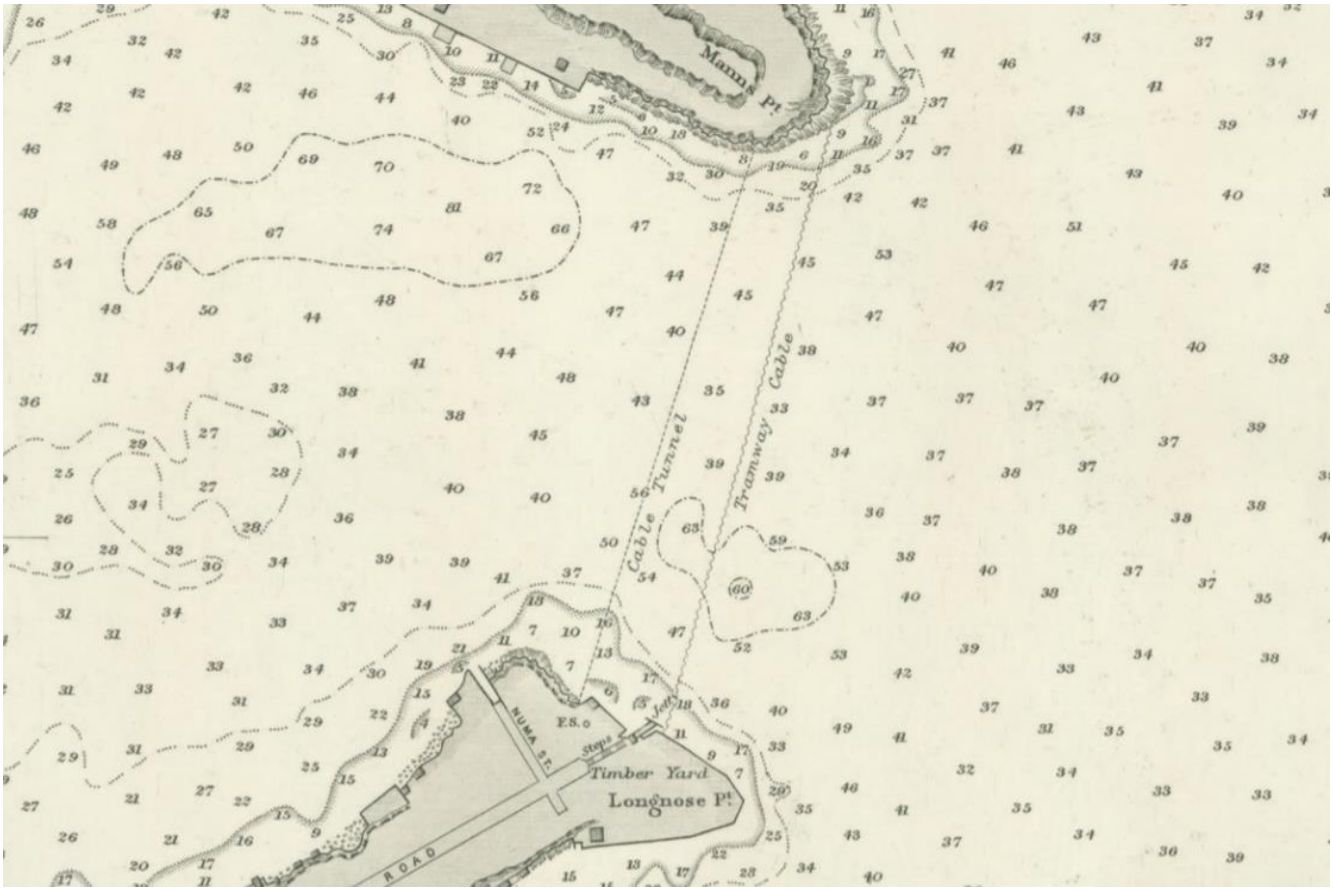


Figure 25: 1915-1921 navigational chart of Sydney Harbour, showing location of the submarine tramway cable and cable tunnel between Yurulbin Point and Manns Point (Great Britain Hydrographic Department 1915-1921)

The completed tunnel measures just over 551 metres long by 2.7 metres high and 2 metres wide, with a 1 in 134 to 1 in 16 gradient across the harbour (Figure 26). The tunnel was variously lined with concrete, cast iron and rock, and incorporated cement racks to hold the high tension electricity and communication cables (Figure 27). A large chamber to house pumps to remove water was also built into the centre of the tunnel (Forster 1988, NSW Office of Environment & Heritage 1999).

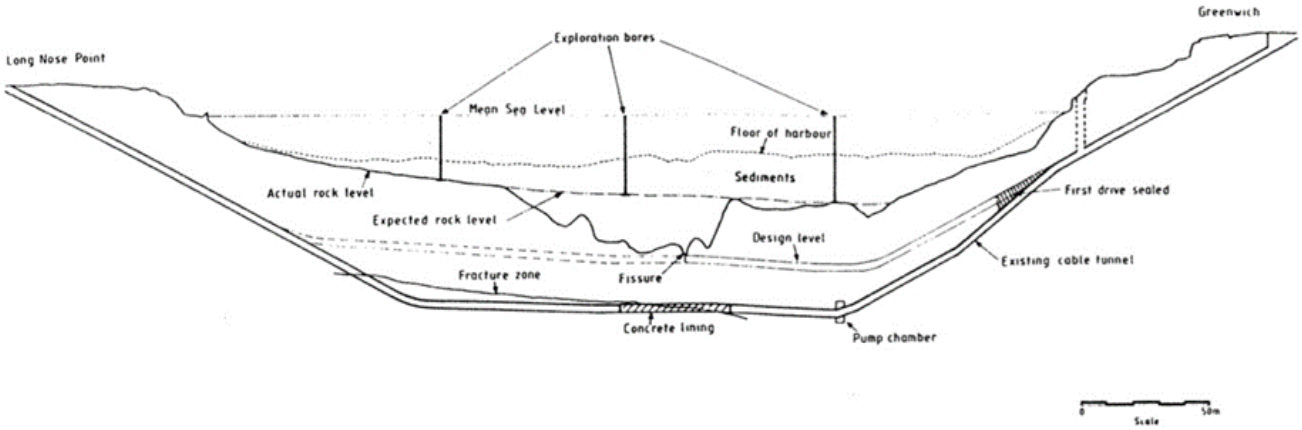


Figure 26: Longitudinal cross section of the cable tunnel (Forster 1988)

Figure 27: 1981 photograph of the cable tunnel, showing concrete slabs that bore the cables
(Williamson 1981)

In 1930, continued problems with water leaks led to the decision to insulate the cables and allow the tunnel to flood. By the 1960s, technological advances in the Sydney power grid meant that the existing submarine cables were no longer required, and in 1969, the electricity supply through the Yurulbin Point to Manns Point tunnel was disconnected. The tunnel itself, however, remains (NSW Office of Environment and Heritage, 1999).

4.2.3 Western side of Balls Head

The headland of Balls Head was first subject to European occupation in 1819 as part of a large estate of 524 acres granted to British merchant Edward Wollstonecraft (Figure 28), who shortly thereafter constructed a residence known as 'Crow's Nest' on the land in the current suburb of Waverton. In 1821, Wollstonecraft and his business partner, Alexander Berry, were granted 10,000 acres on the Shoalhaven River, which they commenced clearing for timber, and established pastoral and agricultural pursuits. The 524 acre North Shore estate was subsequently used as a depot for produce transported from Shoalhaven to Sydney markets. By 1830, a wharf had been constructed on the eastern shore of Berrys Bay, and a road cut north along the saddle of the headland. The western shore of Balls Head, however, remained undeveloped (RPS Australia East Pty Ltd 2016).

Figure 28: 1846 map of Willoughby parish, showing Wollstonecraft's 524 acre grant
(Brownrigg 1846)

In 1832, Wollstonecraft died and his estate passed to his sister, Elizabeth Berry, and then, upon her death in 1845, to her husband Alexander Berry. After his wife's death, Berry largely removed himself from his business enterprises and lived as a recluse in the 'Crows Nest' house until his death in 1873 – at which point the estate passed to David Berry, Alexander's brother. Neither David nor Alexander Berry used the western portion of the Balls Head promontory, and when the estate was passed to cousin John Hay after David's death in 1889, the western shoreline of Balls Head remained vacant and undeveloped (Jones 1988, Perry 1966, RPS Australia East Pty Ltd 2016, Stephen 1969) (Figure 29).

Figure 29: 1890 chart of Port Jackson, showing undeveloped nature of western shore of Balls Head (Great Britain Hydrographic Department, 1890)

In 1895, the estate – known at this point simply as 'Berry's Estate' – was subdivided into 13 large blocks of land and offered for sale. The Balls Head promontory and eastern shore of Balls Head Bay was offered as a single allotment called 'Block 6' (Figure 30). The sales attracted little interest, however, and in 1906, the NSW Government acquired a section of the western foreshore of Balls Head as part of an agreement with John Hay, in return for the construction and maintenance of a public hospital at Berry – part of the original Berry and Wollstonecraft Shoalhaven Estate (RPS Australia East Pty Ltd 2016) (Figure 31).

Figure 30: 1895 subdivision plan of 'Berry's Estate,' showing 'Block 6' incorporating Balls Head (Atchison & Schleicher 1895)

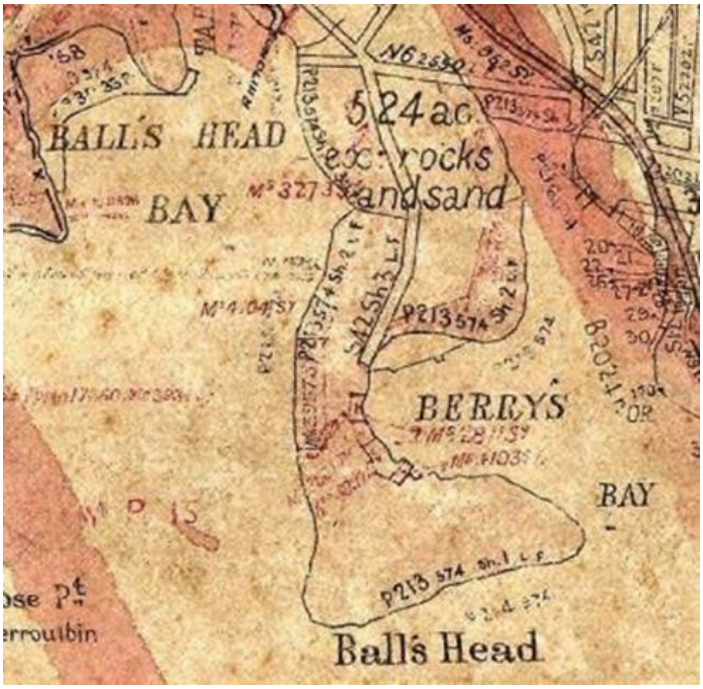


Figure 31: Section of 1899 parish map showing Balls Head and land transferred from David Berry to the government shaded in red (NSW Department of Lands, 1899)

In 1917, the NSW Government leased this portion of Balls Head to the Sydney Coal Bunkering Company, a subsidiary of the New Zealand Union Steam Ship Company, as the site for a steamship bunkering station that would serve as a transfer depot for coal from bulk carriers to smaller coal-fired vessels. The site provided a storage area for coal and the deep water in front was ideal for large vessels. Work began on the construction of the coal loader in 1917, with extensive clearing of bush and stone quarrying to level the site. Four tunnels were then cut through the sandstone cliff to enable coal to be gravity fed by chutes into containers below (Figure 33). From 1918 to 1920, a wharf was built extending into Balls Head Bay (Figure 32). Designed and built by joint engineers F Ernest Stowe and Kay MacNichol Coy, the wharf measured 169.8 metres long by 18.7 metres wide and consisted of timber piles driven into the harbour bed with cross bracing for lateral support and timber decking (Figure 35). In 1920, an electric-powered cable railway, designed and constructed by Mead-Morrison Company of Chicago, USA, was installed to bring the coal from the tunnels along the wharf on an elevated platform to the gantries for transfer onto waiting ships (Architectural Projects Pty Ltd 2016, Blaxell 2009) (Figure 34).

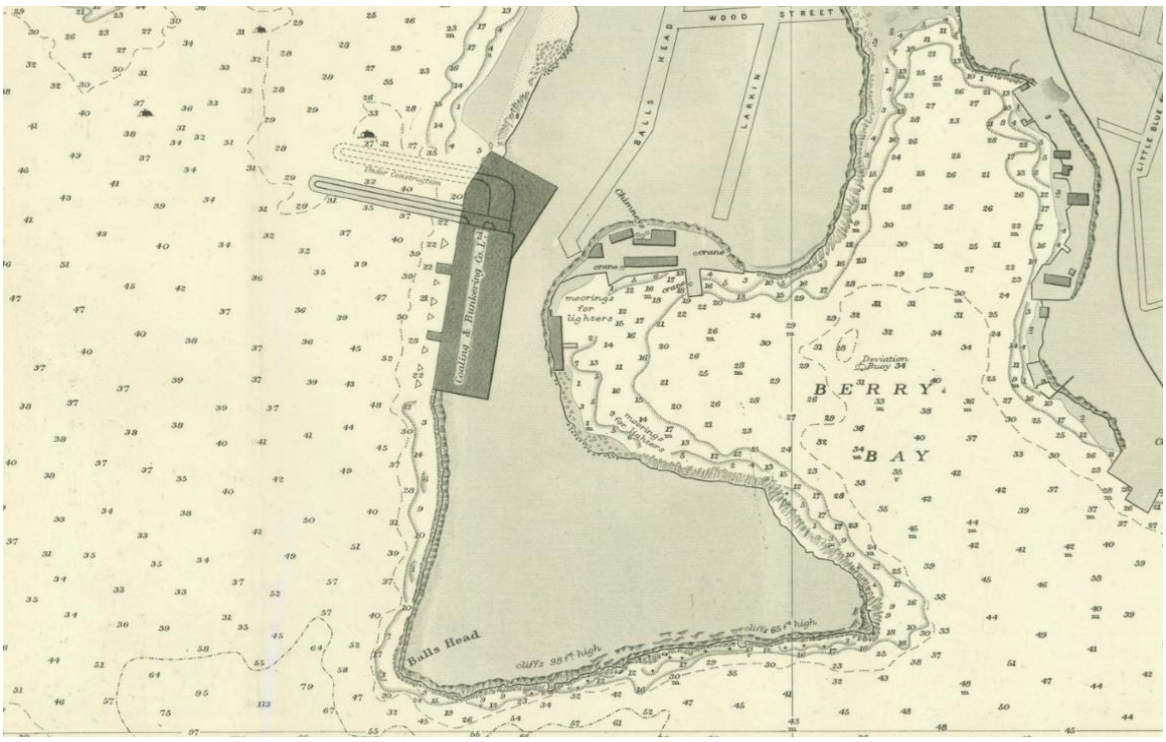


Figure 32: 1915-1921 chart showing Balls Head Coal Loader facility. Note the chart shows a second jetty 'under construction' to the north of the current wharf. It appears that that this second structure was never constructed (Great Britain Hydrographic Department 1915-1921)

Figure 33: Construction of seawall and No. 1 Tunnel c.1918 (left) (RPS Australia East Pty Ltd, 2016)
Figure 34: Ship docked at Balls Head Coal Loader, c. 1940s (right) (Donnell ca. 1940s)

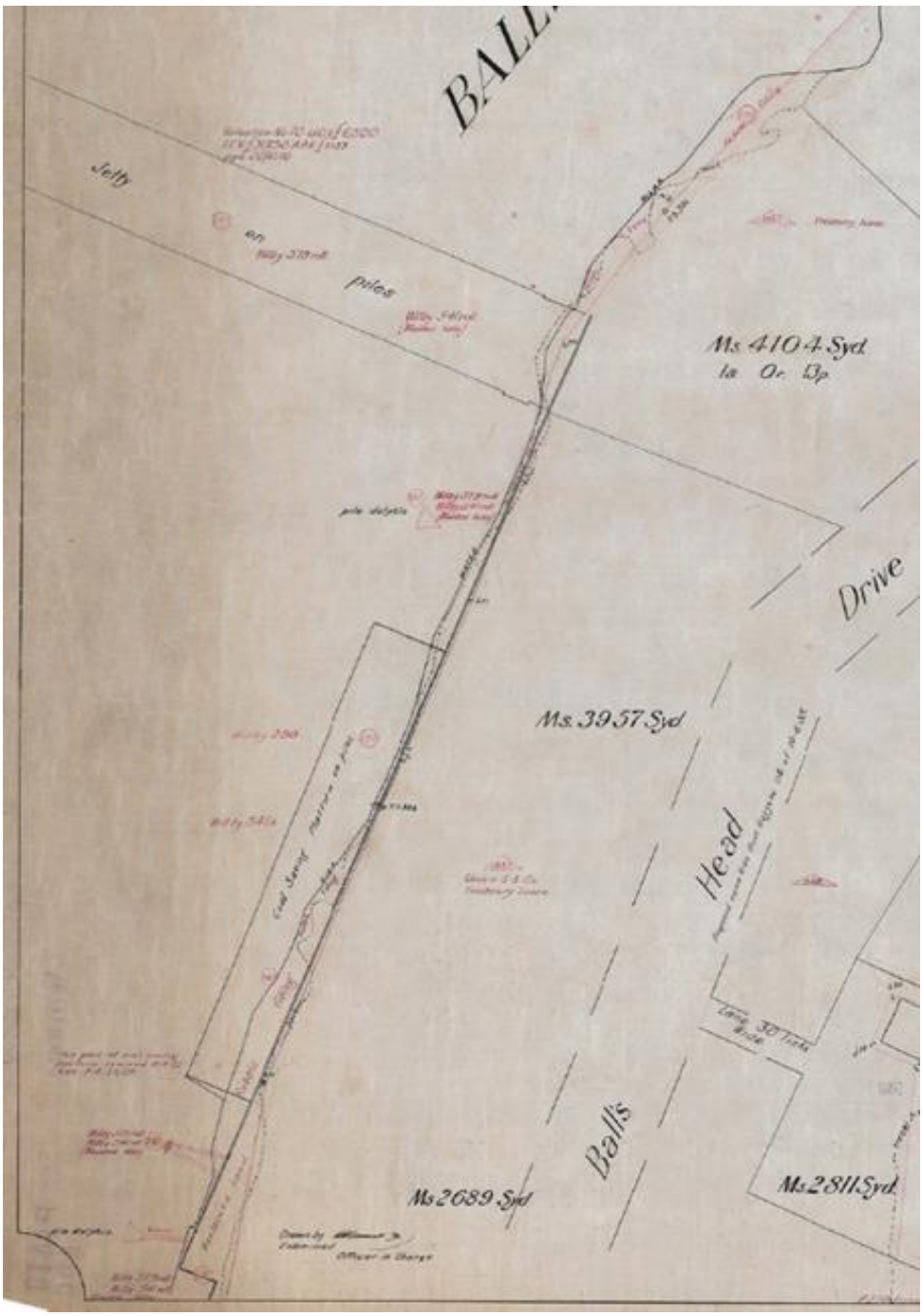


Figure 35: Portion of c.1936 plan showing the timber wharf and the relationship of the Balls Head Coal Loader platform to the original shoreline (Officer in Charge 1936)***.*** Also note the absence of any lower walkway or dolphins in front of the loader

The development of the coal loader wharf prompted strong public protest against the industrialisation of the natural landscape of Balls Head. In response, in 1926, the NSW Government set aside 14 acres at the southern end of the peninsula as a reserve for public recreation (Figure 36). A Beautification Committee was established in 1931, led by conservationist Walter Froggatt, and native trees were reintroduced to the headland throughout the following decade. The area has remained a recreational reserve since and is currently maintained by North Sydney Council (NSW Office of Environment and Heritage 2013).

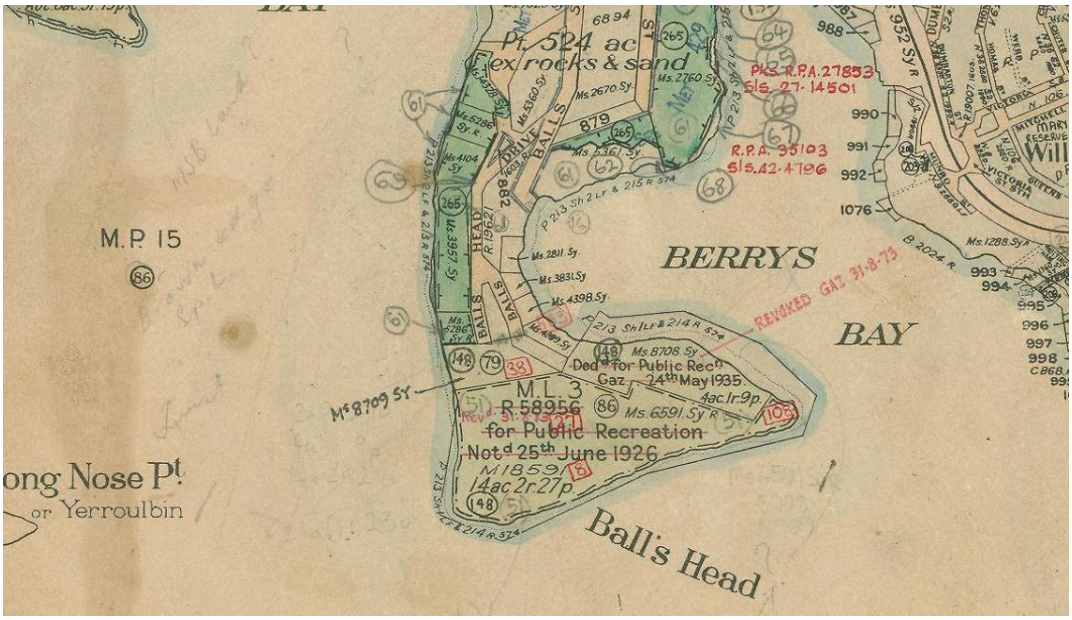


Figure 36: Willoughby parish map showing extent of Balls Head Reserve as declared in 1926 (NSW Department of Lands 1964)

In 1934, the Balls Head Coal Loader was taken over by the Wallarah Coal Company, which also owned the Catherine Hill Bay colliery and supplied much of the coal transferred through Balls Head. With the gradual decline of coal-burning steamships from the 1940s onward, the original bunkering purpose of the loader was reduced and operations began to be more focused on shipping coal between large vessels to road carriers and bulk carrier vessels for export. In 1937, a severe storm damaged one of the gantry cranes, leaving only one gantry crane operational until 1956, when an enlarged unloading grab crane was installed (Architectural Projects Pty Ltd 2016, Blaxell 2009).

Figure 37: 1943 aerial photograph of Balls Head, showing coal loader and Balls Head reserve (RTA Photography 1943).

In 1957, the Balls Head Coal Loader was taken over by J & A Brown and Abermain Seaham Colliers Company, which became a subsidiary of Coal & Allied Industries three years later. Following a significant slump in the coal industry, the loader facility was taken out of service in 1964. The site remained dormant until 1974, when it was recommissioned as a coal export facility. In 1976, the cable railway was replaced with a twin conveyor system to achieve a faster turnaround of larger vessels using the wharf. The conveyor consisted of remote controlled bin gates, travelling feeders, reclaim conveyors, two wharf conveyors and a travelling shiploader, and required the addition of steel pilings and cross braces to the timber wharf (Blaxell 2009) (Figure 38). The refurbished Balls Head Coal Loader served the export trade until 1992, when the operating licence held by Coal and Allied Industries lapsed and the facility was decommissioned (RPS Australia East Pty Ltd 2016: 30).

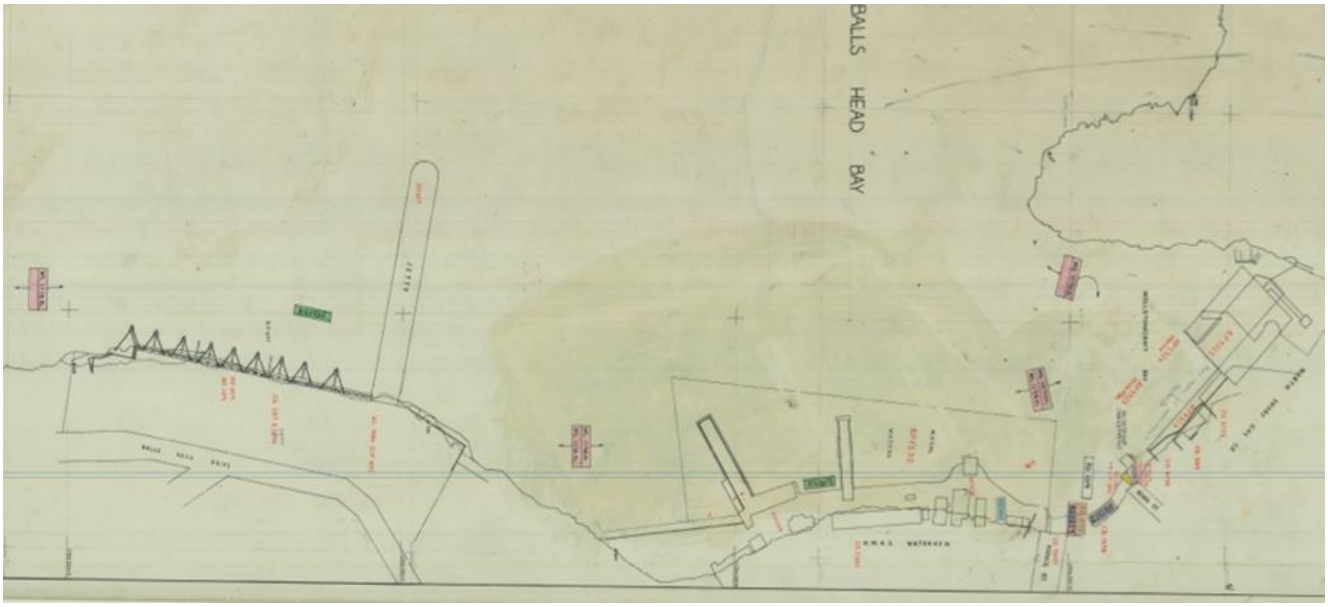


Figure 38: c.1980s Crown plan showing the Balls Head Coal Loader (orientated with north to right of image) (Crown Plan, c.1980s, 'P.J.567')

4.3 Known maritime heritage sites and items

Eleven known maritime archaeological sites and items occur within Area A, including maritime infrastructure sites, shipwrecks, historic vessels and a submerged archaeological site. The identification of these sites was based on historical research, review of heritage registers and the findings of the December 2017 field inspection. Summary descriptions of these sites are provided in Table 5 and Figure 39.

Table 5: Known maritime heritage sites in Area A

Site	Site Type	Location (WGS UTM 56H)	Heritage Listing
Yurulbin Park (limited to seawall, timber jetty & slipway)	Maritime infrastructure	Louisa Road, Birchgrove, Lots 1-2, Section 9, DP 192096, Lot 1, DP 1112681, road reserve	Leichhardt LEP (2013) I555
Long Nose Point (Birchgrove) Wharf	Maritime infrastructure	Louisa Road, Birchgrove / UTM 332193 E / 6253389 N	Sydney REP - SHC (2005) 5
Former coal loader	Maritime infrastructure	Balls Head Drive, Waverton, Lot 99, DP 1048930, Lots 1-3, DP 542933	North Sydney LEP (2013) I1040; nominated to State Heritage Register
Concrete block, possible former mooring (14W-001)	Maritime infrastructure	332143 E / 6253446 N	N/A
Unidentified Balls Head Bay No. 1	Shipwreck	332816 E / 6253769 N	NSW Maritime Heritage Sites (2609)
Unidentified Balls Head Bay No. 2	Shipwreck	332811 E / 6253737 N	NSW Maritime Heritage Sites (2610)
Plastic dinghy (14W-017)	Shipwreck	332805 E / 6253622 N	N/A
Fibreglass yacht (14W-018)	Shipwreck	332795 E / 6253526	N/A
Balls Head No. 1 Unknown wreck (From *nswwrecks.info)*	Shipwreck	332757 E / 6253312 N	N/A
Railway Electricity Tunnel	Submerged archaeological site	Birchgrove to Manns Point	State Heritage Register (01231)

Site	Site Type	Location (WGS UTM 56H)	Heritage Listing
Balls Head Reserve, western foreshore	Archaeological site	Balls Head Drive, Waverton, Lot 106, DP 1162896	North Sydney LEP (2013) I1041
M.V. *Cape Don*	Vessel	Moored alongside former coal loader	Australian Register for Historic Vessels (HV000208)
Baragoola	Vessel	Moored alongside former coal loader	Australian Register for Historic Vessels (HV0004909)

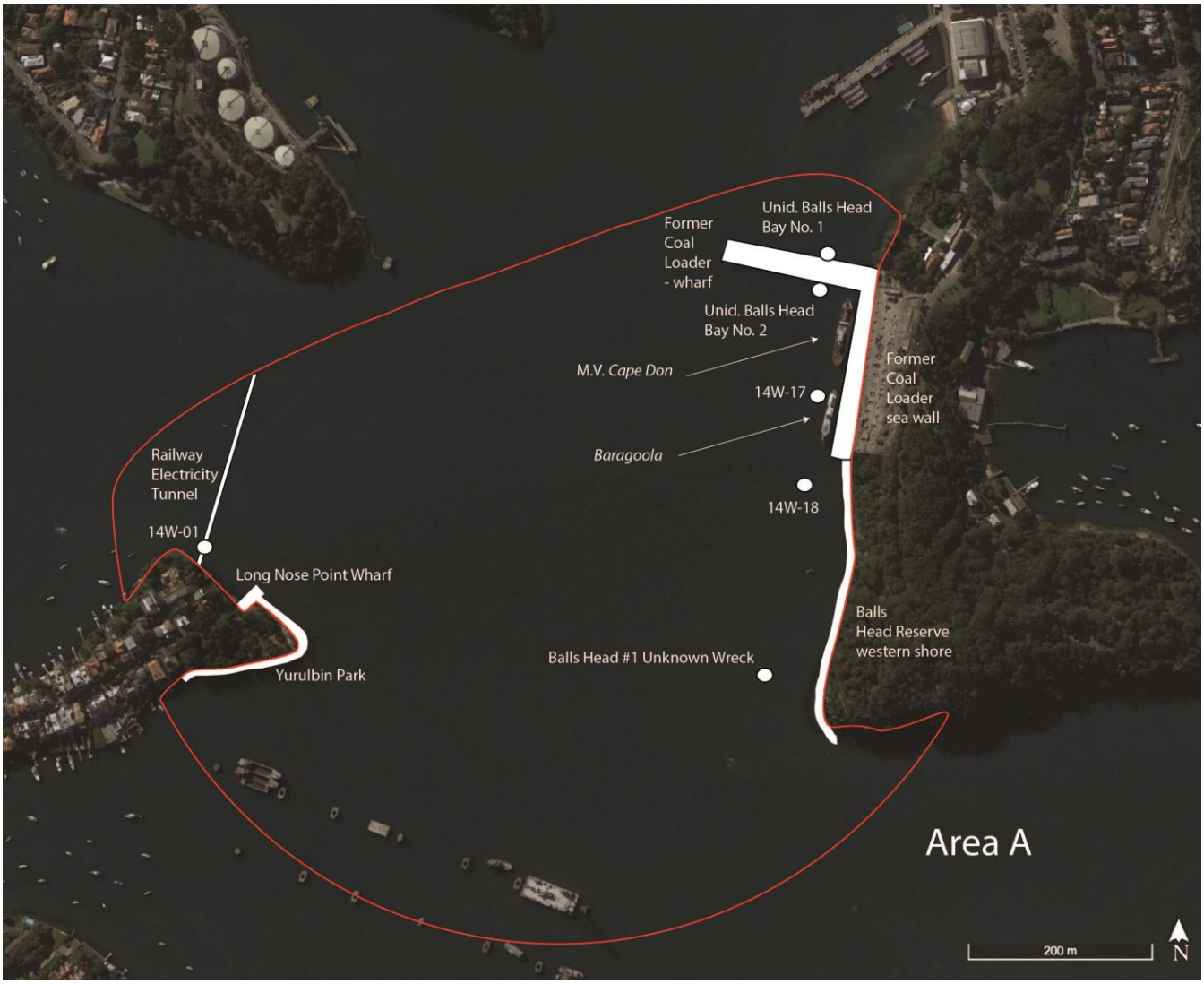


Figure 39: Known maritime heritage sites and items in Area A (Base image: Google Earth)

4.3.1 Maritime infrastructure

Yurulbin Park

Yurulbin Park retains visible remains of industrial maritime infrastructure. The most prominent maritime heritage feature on the site is the former slipway (shown below in Figure 40, Figure 41 and Figure 42). The photo in Figure 42 was taken from approximately the same location as the 1968 image of the slipway in Figure 23.

Figure 40: View of slipway looking east (left) (Image: Cosmos Archaeology, 15 December 2017)

Figure 41: Northern seaward arm or groyne of slipway which appears to have been formed through reclamation (right), looking north-east. Balls Head and the Balls Head Coal Loader facility in the background (Image: Cosmos Archaeology, 15 December 2017)

Figure 42: View of southern side of slipway, looking south-west
(Image: Cosmos Archaeology, 15 December 2017)

On the eastern side of Yurulbin Park is a timber jetty (Figure 43). It appears to be on the location of the northernmost jetty shown in Figure 19 and Figure 20. The decking is of relatively recent construction, while the piles of the jetty could be associated with the aforementioned jetty from the mid 20th century. The bed of the harbour at this location, and to the south, was inspected in December 2017 and, apart from rock armour placed in front of the seawall, no significant cultural material was observed (for further information see Cosmos Archaeology January 2018*)*.

Towards the southern end of the eastern seawall at Yurulbin Park, an earlier wall alignment is visible (Figure 44). It is not clear whether this is the visible remains of an earlier seawall – as can be seen in Figure 19 – or the footings of one of the shipyard buildings that was situated at this location (see Figure 24).

Yurulbin Park is bounded by a sandstone seawall that appears to have been constructed in the late 19th century (see Figure 17). It has most likely been repaired, with sections rebuilt over the last 120 years.

Figure 43: Timber jetty on eastern side of Yurulbin Park, looking north
(Image: Cosmos Archaeology, 15 December 2017)

Figure 44: Top of earlier seawall or building footing, from south-eastern end of site looking north
(Image: Cosmos Archaeology, 15 December 2017)

Long Nose Point (Birchgrove) Wharf

Long Nose Point (Birchgrove) Wharf is situated at the end of Louisa Road, which forms the western border of Yurulbin Park. When inspected in December 2017, the wharf was undergoing extensive renovations (Figure 45). A small rectangular parcel of reclaimed land was evident upon which the tidal steps are situated. The timber elements of the wharf were not visible. The passenger waiting shed on the wharf has been largely rebuilt in its original form.

It is extremely unlikely that the piles from the original late 19th century wharf were incorporated into the 1969 rebuild of the jetty. Such earlier remains, along with associated archaeological deposits, are most likely present under and around the current wharf in a buried state.

Figure 45: Long Nose Point (Birchgrove) Wharf undergoing renovations in December 2017
(Image: Cosmos Archaeology, 15 December 2017)

The shoreline west of Long Nose Point (Birchgrove) Wharf was not inspected; however, based on aerial imagery, it appears that the whole remaining northern shore is bounded by seawalls which retain reclamation fill.

Former Balls Head Coal Loader

The former Balls Head Coal Loader forms the north-eastern quadrant of Area A. The most dominant structure is the 180 metre seawall composed of sandstone blocks (Figure 46). The base of the seawall is founded on bedrock at the low tide level (Godden Mackay Logan May 2000). It has 31 engaged piers that terminate two metres below the top of the wall. Just above the high tide mark is a lower steel walkway supported by steel brackets attached to the seawall. This walkway allows access to vessels tied up at the mooring dolphins.

Figure 46: Seawall of the former Balls Head Coal Loader. The historic vessel *Baragoola* (with the black tipped funnel) is in the foreground and the M.V. *Cape Don* (with the yellow funnel) is moored behind it.
(Image: Cosmos Archaeology, 13 December 2017)

At either end of the seawall are large sandstone blocks which are founded on bedrock up to eight metres above the low tide level. These end walls have four arched entrances which allow access to the four parallel reclaim tunnels that extend the length of the seawall and platform that the wall retains (Godden Mackay Logan May 2000).

Immediately north of the seawall is a timber wharf with timber piles and cross bracing (Figure 47). It is about 170 metres long and about 19 metres wide. The timber deck planking for most of the length of the extant structure has been laid diagonally, at about 45 degrees to axis of the wharf (Figure 48). There is a small section of more conventional deck planking, laid perpendicular to the axis of the wharf, closer to the landward side of the structure. Atop the wharf are the steel remnants of the frames or bridges, which supported an elevated cable rail system installed in the 1920s (RPS Australia East Pty Ltd, 2016:12).

Figure 47: View of Balls Head Coal Loader wharf, from the south looking north
(Image: Cosmos Archaeology, 13 December 2017)

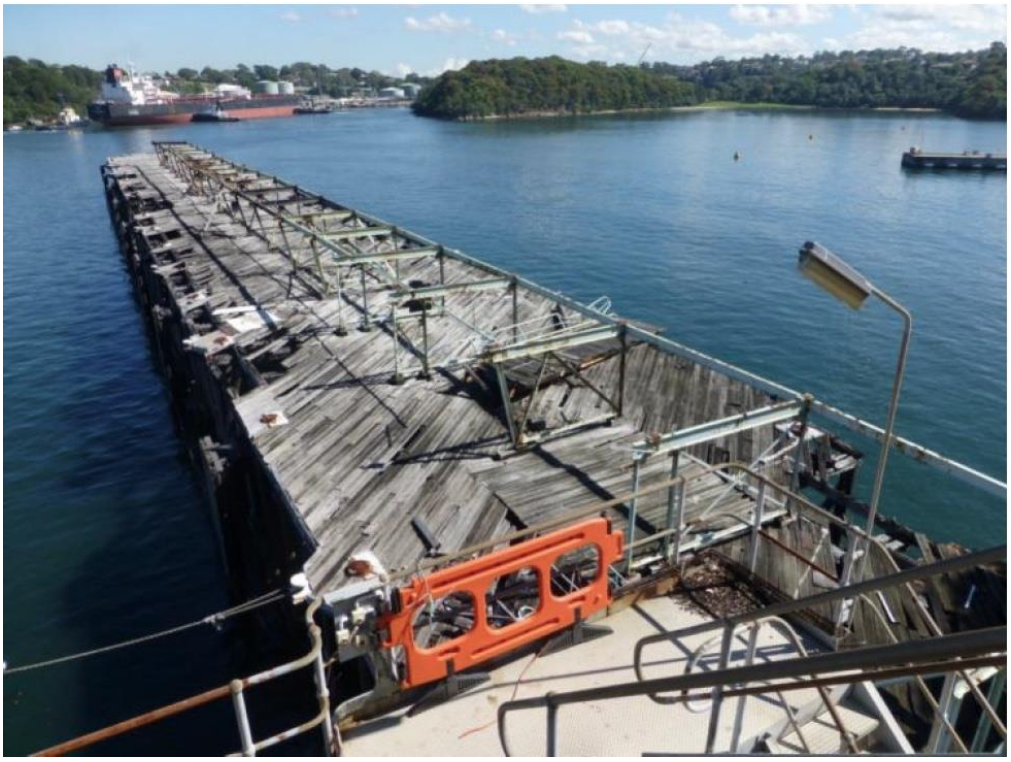


Figure 48: Timber diagonal decking of the former Balls Head Coal Loader wharf (RPS Australia East Pty Ltd, 2016: plate 5). Visible are the steel frames for the elevated cable rail system.

The timbers piles are generally in poor condition, with a relatively high number being completely 'necked'. This means the timber at water level has eroded away leaving a tapering pile stump underwater and often the upper part of the pile suspended above water, held in place by its attachments to girders and cross bracing. The timber structure of the wharf appears to be supported in places by a steel substructure which include cross bracing supports (Figure 49). This appears to have been added in the 1970s when the structure was given a major upgrade (RPS Australia East Pty Ltd, 2016:12).

Underneath the shoreward end of the wharf is the former pump room. Composed of corrugated galvanised iron on a timber frame structure, it sits on a concrete base and abuts the sandstone seawall (see Figure 49). It is in very poor condition.

Figure 49: Former pump room at shoreward end of the wharf, abutting the sandstone seawall (RPS Australia East Pty Ltd, 2016: plate 8).
One steel pile of the substructure on the right side of the image

Remnant maritime infrastructure

The dive inspection in December 2017 identified a rectangular concrete block measuring 1 by 1.5 metres and extending 700 millimetres from the bed of the harbour (Figure 50) (for further information see Cosmos Archaeology Pty Ltd January 2018*)*.

Figure 50: Concrete block covered in marine growth

4.3.2 Shipwrecks

A search of the Australian National Shipwrecks Database and NSW Department of Premier and Cabinet (Heritage) Sites database indicates there are two known wrecks within Balls Head Bay: 'Unidentified Balls Head No. 1' and 'Unidentified Balls Head No. 2' (NSW Office of Environment and Heritage NSW Maritime Heritage Database; Site Id 2609 and 2610). Both wrecks were identified and inspected by Cosmos Archaeology in 2013 (Cosmos Archaeology Pty Ltd 2015). The wrecks are located immediately adjacent to and either side of the Balls Head Coal Loader wharf.

Unidentified Balls Head No. 1, situated on the northern side of the wharf, is an iron-hulled vessel with wooden deck planking. It is 14.7 metres long and 4.7 metres wide (Figure 51). The hull is constructed of iron framework and riveted iron plates (Figure 52) – a construction method consistent with pre-World War II ship design. Except for gunwales and mooring bollards, no above-deck structures remain on the wreck, suggesting that it was stripped of most of its fittings before it sank. The vessel engine also appears to have been removed. The bow bollards and portside stern bollards all have mooring ropes attached (Figure 53), suggesting that the vessel was tied to the wharf at the time of sinking (Cosmos Archaeology Pty Ltd 2015). This wreck has been tagged on the NSW Wrecks Info website as 'Balls Head Number 8 unknown' and 'Wreck 1348'.

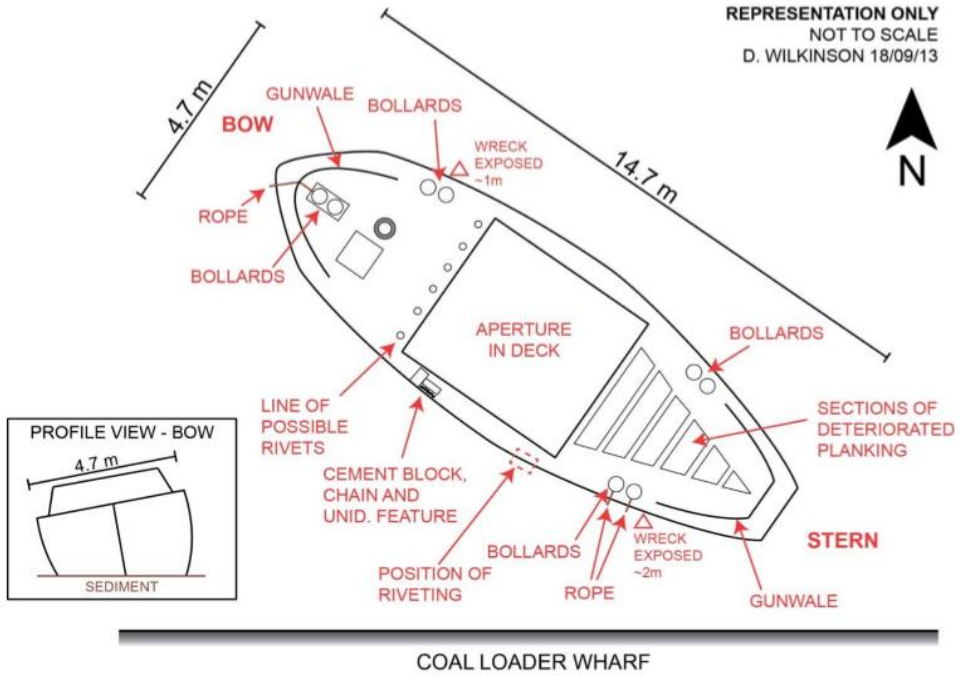
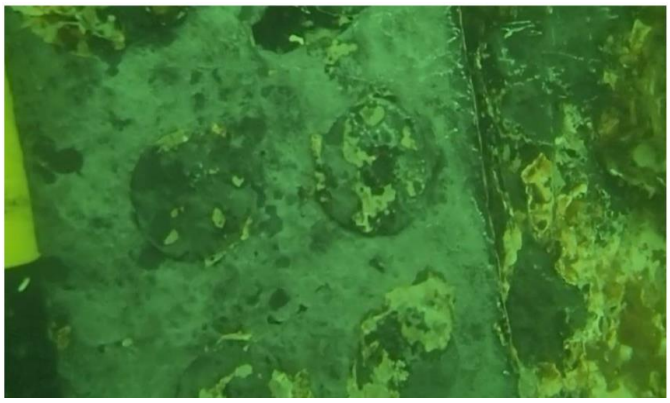


Figure 51: Sketch of Balls Head Unidentified No. 1 wreck (Cosmos Archaeology Pty Ltd 2015)



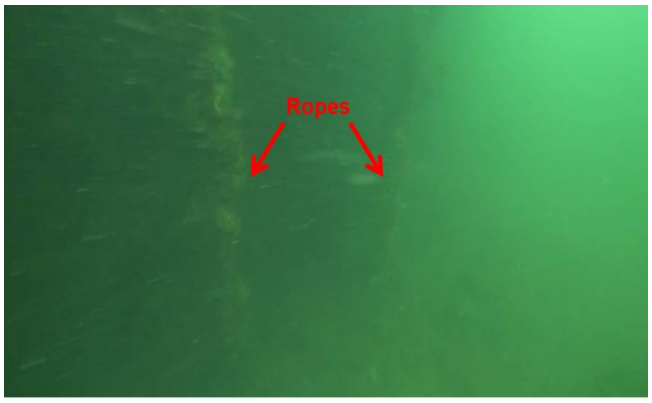


Figure 52: Detail of hull rivets and seam, with scale in 50 mm increments (left)
Figure 53: Port side of wreck facing towards stern, showing two ropes which are hanging from mooring bollards on the port side of the stern (right) (Cosmos Archaeology Pty Ltd 2015)

Unidentified Balls Head No. 2, on the southern side of the coal loader wharf, is a timber-hulled barge with internal metal hull framing and external fibreglass sheathing, measuring 23.5 metres long and 9.1 metres wide. Remnants of timber decking and bollards survive, however no other superstructure elements were observed. A large amount of fender piles, timber piles and debris from the coal loader wharf has fallen on top of the wreck in some areas, particularly the northern side of the wreck. The age of this wreck is unknown. A number of ropes were identified hanging over the northern and western sides of the wreck, suggesting that the vessel was tied to the wharf when it sank (Cosmos Archaeology Pty Ltd 2015).

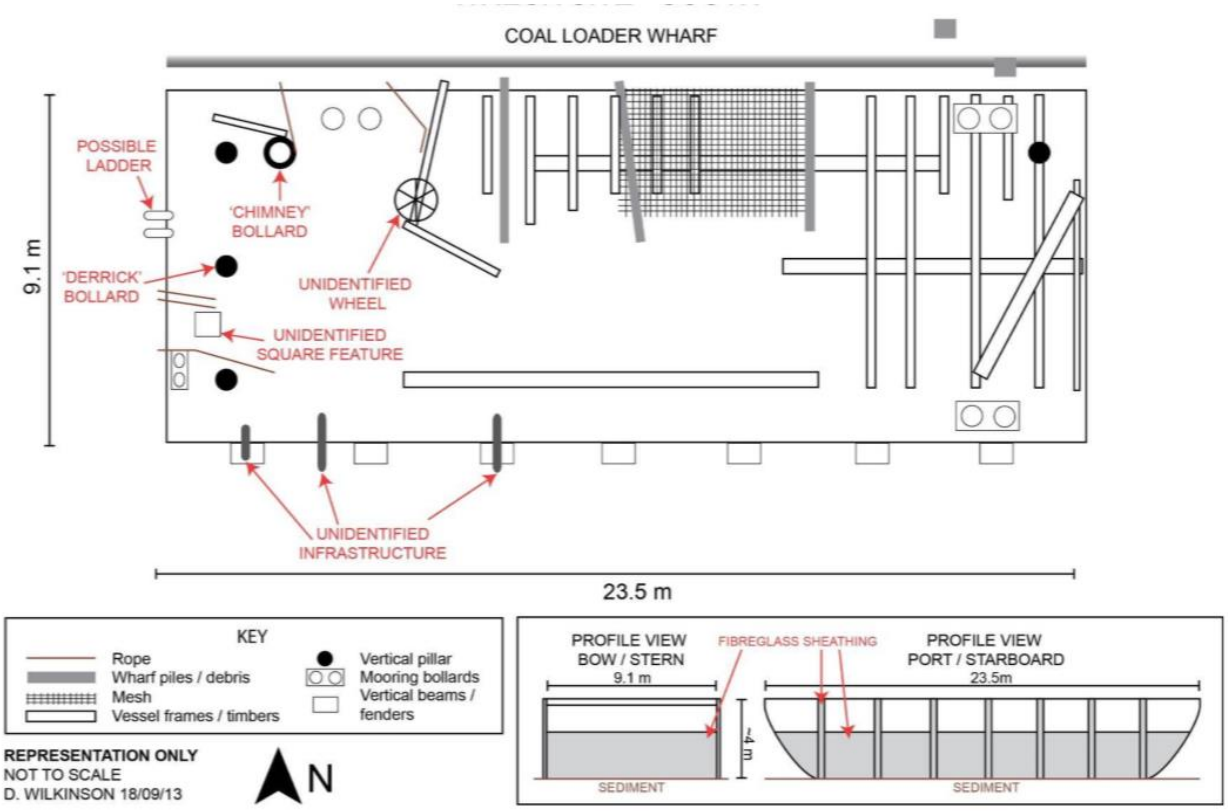


Figure 54: Sketch of Balls Head Unidentified No. 2 (Cosmos Archaeology Pty Ltd 2015)

Figure 55: Section of surviving timber decking (left) (Cosmos Archaeology Pty Ltd 2015)
Figure 56: Fender piles and meshing from coal loader wharf overlying the wreck (right) (Cosmos Archaeology Pty Ltd 2015)

The dive inspection in December 2017 recorded a fibreglass yacht (14W-018) measuring 10 metres by three metres (Figure 57) (For further information see Cosmos Archaeology Pty Ltd January 2018). This wreck has been tagged on the NSW Wrecks Info website as 'Balls Head 4' and 'Anomaly – wreck 1193'. It is not known when it sank; however, the amount of marine growth on the wreck suggests it has been underwater for at least a decade. The dive inspection also recorded the wreck of a plastic dinghy (14W-017) two metres long and 1.5 metres wide (Figure 58). It appears to have sunk in the last few years, judging by the marine growth.

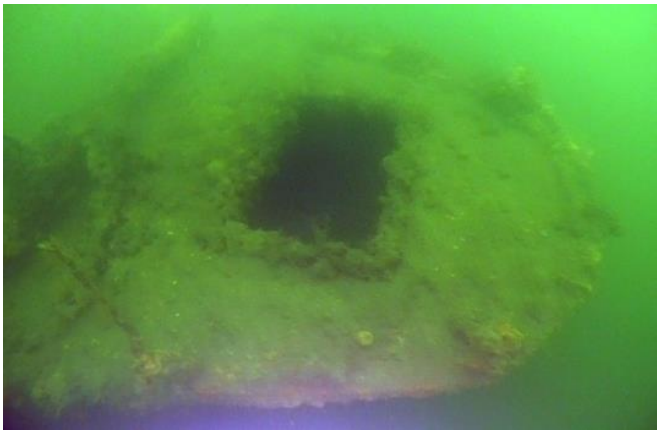


Figure 57: Port quarter of fibreglass yacht (14W-018) (Image: Cosmos Archaeology, 13 December 2017)
Figure 58: Underside of overturned plastic dinghy (14W-017) (Image: Cosmos Archaeology, 15 December 2017)

The NSW Wrecks Info website (nswwrecks.info), which contains publicly available information on the position of shipwrecks compiled from a number of sources, also notes a clearly identifiable wreck, Balls Head #1 Unknown Wreck, located closer to the southern point of Balls Head (Figure 59). The wreck (shown in Figure 59) is upright and shows a large rectangular opening in its deck extending from midships to the bow. Aft of the opening appears to be the bridge, while at the bow there might be visible a large winch. It appears to be a work barge, possibly a hopper barge, about 15 to 20 metres long and three to four metres wide.

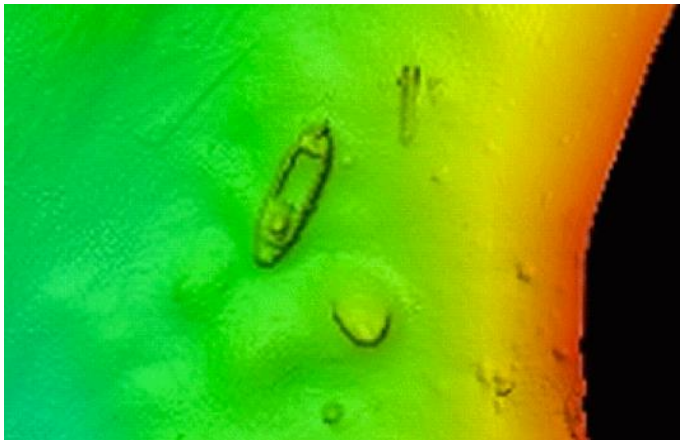


Figure 59: Multi-beam image of Balls Head #1 Unknown Wreck
(NSW Wrecks Info 2017)

4.3.3 Railway electricity tunnel

There is one known submerged archaeological feature within Area A which is the cable tunnel under Sydney Harbour between Birchgrove and Greenwich (Figure 60). The tunnel is listed on the State Heritage Register as the 'railway electricity tunnel', and also in the *Sydney Regional Environmental Plan 2005*, the *Leichhardt Local Environmental Plan 2013* and the Railcorp Section 170 Heritage Register. Although the cables have been cut and the tunnel flooded, the tunnel remains intact across the harbour. It measures about 2.7 metres high, 2 metres wide and 551.4 metres long and is formed from a mix of concrete, cast iron and rock (Forster 1924). It can be expected that this structure would remain largely intact and solid in form. The concrete and rock would have acquired marine growth, while the cast iron areas may have become concreted with a larger amount of marine growth. The internal chamber and shelving, cables and other facilities likely remain intact.

Figure 60: Alignment of railway electricity tunnel (NSW Office of Environment & Heritage 2018)

4.3.4 Balls Head Reserve

The western shoreline of the Balls Head Reserve, listed on the North Sydney Local Environmental Plan 2013, bounds Area A. The reserve encompasses low sandstone cliffs up to 10 metres high and extends about 280 metres from the southern side of the seawall of the Balls Head Coal Loader and the southern tip of Balls Head (Figure 61). Remnants of paths, steps and railings constructed in the 1930s, together with caves and chambers dug by squatters, survive but there do not appear to be any maritime heritage related remains.

Figure 61: View of western face of Balls Head, south of the sea wall of the Balls Head Coal Loader(Image: Cosmos Archaeology, 13 December 2017)

4.3.5 M.V. Cape Don and Baragoola

The 2,174 ton M.V. *Cape Don* was designed by the Australian Shipbuilding Board and built at the NSW State Dockyard at Newcastle in 1962 (The Australian National Maritime Museum). It was purpose built as a lighthouse tender, one of three such vessels commissioned by the Commonwealth Lighthouse Service, the other two being the *Cape Moreton* and the *Cape Pillar*. The *Cape Don* serviced lighthouse and navigation aids around the western and northern coasts around Australia until the 1980s. For a short time the vessel was renamed the *Western Express*.

The *Baragoola* is a former Manly ferry. The 490 tonne vessel has a double ended steel hull with a timber superstructure (The Australian National Maritime Museum). It was designed and constructed by Morts Dockyard and Engineering in 1922. Originally propelled by steam, the ferry was briefly re-fitted in the 1930s to use coal dust, then oil, before reverting to steam during World War II. It was converted to diesel-electric in the late 1950s. The *Baragoola* ended its career as a ferry in early 1983 and was withdrawn from service. The vessel has been berthed in the vicinity of its present location since 2010.

These two vessels are currently berthed along the steel walkways at the former Balls Head Coal Loader. They do not have any historical connection with the former Balls Head Coal Loader and are not the type of vessel that would have loaded coal at the facility.

4.4 Potential maritime heritage sites

Based on historical information as summarised in Section 4.2, the following cultural activities have occurred within Area A and immediate surrounds:

Yurulbin Point and entrance to Snails Bay:

- Cooperage and associated shipping (1880s to 1910s)
- Recreational boating (1880s onwards)
- Ferry service (1900s onwards)
- Submarine supply of electricity (1913 to 1966)
- Shipbuilding and ship repair (1923 to 1972)
- Anchorage (1940s onwards)
- Public park (1972 onwards).

Western side of Balls Head:

- Coal loading and associated shipping (1918 to 1992)
- Public reserve (1926 onwards).

Based on the above and the known sites within the study area, the following types of maritime heritage sites and items may occur in Area A:

- Maritime infrastructure (c.1880s onwards) – stone seawalls, jetties, wharves, dolphins, slipways and moorings
- Discard from maritime infrastructure (c.1880s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment as well as damaged and removed material from the infrastructure
- Shipwrecks, including deliberately scuttled vessels (c.1880s onwards)
- Discard from vessels (c.1880s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as items associated with industries and the movement of goods
- Submarine cables including the 1910s tramway electricity cable.

The potential of such maritime sites to survive depends largely on post-depositional events that may have occurred in the area – in particular, dredging.

Area A is a relatively shallow body of water with deeper 'holes' as a result of tidal scouring. The shallower sections are due to the submerged ridge line or promontory extending to the north-east from Yurulbin Park. Due to the ongoing use of this body of water by large vessels, including oil tankers, it is likely that the main shipping channels have been dredged.

The occurrence of dredging is supported by an overlay comparison of two charts covering the waters of Area A. The first is an undated chart, likely from c. 1900, with depths presented in fathoms (Figure 62) (A fathom is 1.82 metres). The second chart is from 1963 with depths presented in metres (Figure 63). Table 6 illustrates changes in depth in areas of Area A. It appears that dredging has occurred through the centre of the zone and into Gore's Cove, presumably for the Shell Company of Australia oil tankers. While dredging appears to have been limited to a few metres, there was one 'mound' evident on the c.1900 plan in the centre of the shipping channel that has been completely removed to match the level of the surrounding bed of the harbour, about seven metres deeper. This may have been a rock outcrop. Other areas with known vessel movement – such as between Manns Park and Yurulbin Park, the mooring dolphins in Snails Bay and along the western side of Balls Head – appear to be about the same depth in both plans, indicating no change or perhaps limited dredging to maintain depths in those areas. The bed of the harbour around the northern end of Yurulbin Park and that in the 'hole' off Balls Head appear to have experienced sedimentation, which would be expected across areas that have not required dredging for large vessel movement.

Table 6: Interpretation of the c.1900 and 1963 charts showing difference in depths

Location	c.1900 Average depth in fathoms	c.1900 Average depth in metres	1963 Average depth in metres	Difference
Centre of body of water	7	12.80	14	Possibly dredged about 1 m
Between Manns Point and Yurulbin Park	8	14.63	14	About the same. Potential minor dredging to maintain depth.
Northern end of Yurulbin Park	2	3.66	5	Sedimentation of about 1 m
Dolphins at Snails Bay	6	10.97	11	About the same. Potential minor dredging to maintain depth.
'Hole' off Balls Head	19	34.75	33	Sedimentation of about 2 m
Western side of Balls Head	8	14.63	14.5	About the same. Potential minor dredging to maintain depth.
Eastern side of Balls Head Bay	4.5	8.22	7	Possibly dredged about 1 m
Entrance to Gore Cove	6	10.97	13.5	Dredged about 2.5 m
Small 'mound' between Yurulbin Park and Balls Head	4	7.32	14.5	Dredged about 7 m

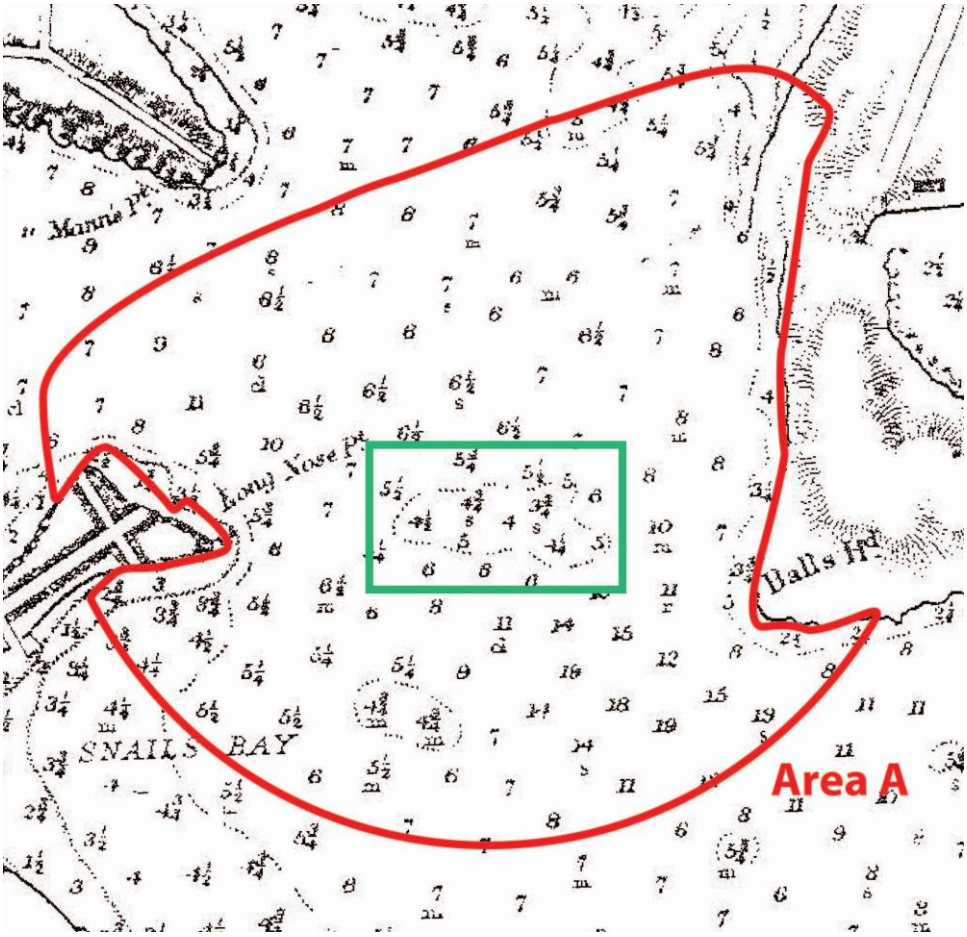


Figure 62: c.1900 chart with depth in fathoms. *Green rectangle indicates the 'mound'* (Anon ca. 1900).

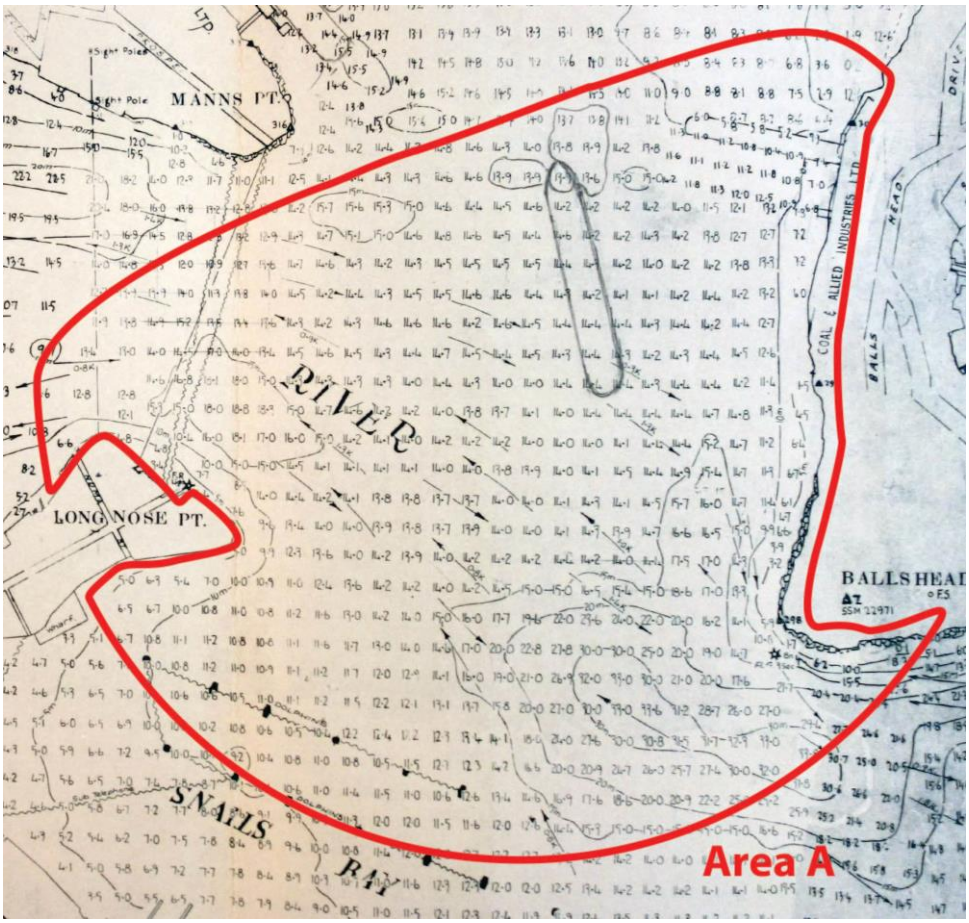


Figure 63: 1963 chart with depths in metres (Maritime Services Board of NSW 1963 revised until 1975).

4.4.1 Maritime infrastructure and associated deposits

The shoreline at the northern end of Birchgrove, of which of Yurulbin Park forms the eastern half, has been faced with maritime structures such as wharves, jetties, moorings, slipways and localised seawalls from the last quarter of the 19th century onwards. While some were for larger and more permanent industries, others were private or for short-lived industrial purposes. These structures would have been built, repaired, expanded and/or replaced since they were first constructed. A number of these are still extant and visible on the foreshore and have been discussed in Section 4.3.1, while the remains of previous structures may still exist in the bed of the harbour in the form of cut-off piles, abandoned moorings, and demolition debris such as dismantled timbers. Former slipways could be buried under fill.

The various phases of activity in the southwestern portion of the study area at Birchgrove contrast with Balls Head, where the high cliffs have prevented small enterprises from constructing shoreline maritime infrastructure. The former Balls Head Coal Loader is the only maritime infrastructure that has been built in the north-west part of the study area. There may also be remnant piling from two stub jetties protruding from the seawall, which may have been associated with the construction of the facility (see Figure 32 and Figure 33).

Deposits associated with maritime infrastructure would have built up around and beneath the structures. Artefacts would have fallen beneath and between the deck planking of jetties and wharves as well as off the vessels moored alongside. Such deposits can include accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment as well as damaged and removed material from maintenance of the structure. These smaller items may have fallen through the sandy bed of the harbour to become buried beneath the surface or similarly buried by any sedimentation in the area.

The process of dredging near earlier structures would have involved removal of any structural remains and associated archaeological deposits to the depth of the dredging. Dredging may also have taken place in areas where the bed of the harbour level appears to have remained the same, such as around the dolphins in Snails Bay, and involved cutting or removing earlier mooring facilities.

4.4.2 Shipwrecks and associated deposits

There are five known shipwrecks within Area A and a number of unverified anomalies that may be shipwrecks. The frequency and type of these wrecks, and the unverified images of wrecks in the multi-beam images, indicate that there are likely to be other shipwrecks within Area A.

Vessels moving through Area A included a mix of recreational craft and industrial vessels associated with a number of industries including oil and shipbuilding. Vessels would also have to pass through Area A to reach areas of Sydney Harbour towards the west of this area, for any number of purposes. The rocky promontories protruding into Area A may have contributed to the wrecking of smaller craft driven into the coast by faulty sailing. The tidal run is also relatively strong through this area, which would have made a stricken vessel's circumstances worse. Accidental wrecking could have occurred through collision, fire and, with steam-driven vessels, explosions. Some of these wrecks may have been re-floated or broken up if they impeded the movement of vessels or were hazardous to shipping.

As most of Area A forms a shipping channel, it is unlikely that deliberate wrecks would have been formed as they would cause a hazard. There are, however, two localities within Area A that are attractive for the scuttling/dumping of vessels. One is a pocket of deeper water to the south-west of Balls Head that appears to have become an unofficial dumping ground, and very likely includes scuttled vessels (see Section 4.4.4). The second locality conducive to the abandonment of vessels is the former Balls Head Coal Loader wharf. When maritime infrastructure such as jetties and wharves become disused, it is often the case that underutilised watercraft are moored alongside. Over time and without maintenance such vessels sink at their moorings. There are two known wrecks alongside the wharf and it is likely that there may be a few more, albeit smaller, wrecks.

Those wrecks that have been scuttled or dumped would most likely have been stripped of useable equipment and had all personal items removed. Hence, it is unlikely that these wrecks would have associated archaeological deposits. Other wrecks, such as of recreational or private vessels, would likely have associated debris or deposits within the wreck or scattered close by.

4.4.3 Discard from vessels

The movement of vessels through Area A would inevitably coincide with discard from vessels – both from smaller recreational craft and from larger passenger vessels and vessels associated with industries. Discard can be accidental or deliberate, and can include personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as cargo from vessels passing

through Sydney Harbour. Such deposits can consist of a range of materials and are mostly single items, but can also occur in scatters created by one event or multiple events. Higher concentrations would be expected closer to shore along the headlands in Area A and the anchorage in Snails Bay – locations where vessels were more likely to be moored, rather than in the shipping channel. Any items dropped from vessels moving through the shipping channels may have been removed by dredging.

4.4.4 Unverified anomalies

Magnetometer

The magnetometer survey carried out for this project identified a number of magnetic anomalies which are potentially cultural in origin. As expected, the survey encountered interference from the vessels moored against the former Balls Head Coal Loader facility and around the current ferry wharf at the end of Louisa Road (Figure 64). One of the strongest anomalies coincides with a fibreglass yacht (14W-018) inspected in December 2017. The magnetic anomaly between the yacht wreck and the moored vessels, referred to as magnetic anomaly 1, does not have a corresponding bed of the harbour anomaly on the side scan sonar data. This suggests that it is buried and is possibly an anchor.

The submarine cable identified in the magnetometer survey should not be confused with the Railway Electricity Tunnel (see Section 4.3.3). It also does not appear to be on the same axis as the 1910s tramway cable (see Figure 25) and the absence of any magnetic signal suggests that the cable has been removed. It would appear that the linear anomaly identified is one of the two submarine cables noted on a relatively modern chart (1963) leading from end of Louisa Road to Manns Point (see Figure 64Figure 63).

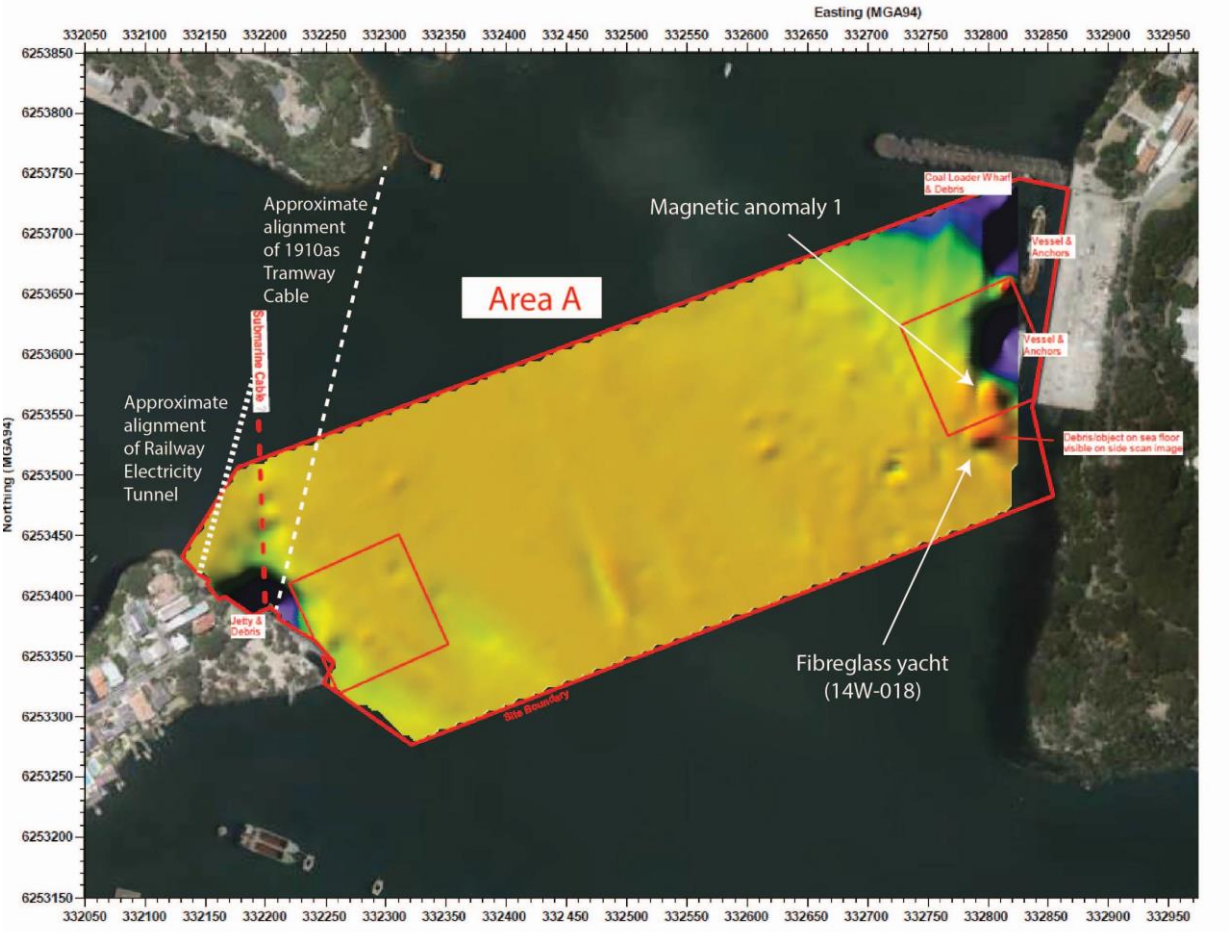


Figure 64: Magnetic anomalies of apparent significant magnitude in Area A (Earth Technology Solution Pty Ltd, July 2017b: Figure WH12A)

Other sources

Anomalies in Area A can be identified through online sources and databases. The NSW Wrecks Info website contains publicly available information on the position of shipwrecks and other cultural features compiled from a number of sources. The positions are divided into categories based on the type of source used. There are a number of anomalies within Area A that have been identified from other sources, principally earlier side scan sonar surveys, so these targets can be described. Some of these anomalies

have already been examined as part of this project (see Section 4.3.2). Table 7 lists the anomalies plotted in Figure 65.

Table 7 Unverified anomalies in Area A (datum is WGS84, with exception of magnetic anomaly 1, which is MGA94)

Object	Location – Easting	Location – Northing	Source	Description
'Wreck 1241'	332732	6253799	*nswwrecks*	From hydrographic data. Possible wreck. No description
SSS Anomaly 1	332134	6253476	*nswwrecks – sss data*	Low relief object four metres by two metres across with four linear features up to six metres long extending from it. Possible section of timber wharf lying flat on the bed of the harbour
SSS Anomaly 2	332183	6253534	*nswwrecks – sss data*	Three-metre-long object sitting up to two metres upright on bed of the harbour
SSS Anomaly 3	332691	6253773	*nswwrecks – sss data*	Five metre by three metre long object off the head of Balls Head Coal Loader wharf
SSS Anomaly 4	332296	6253215	*nswwrecks – sss data*	A collection of linear features up to 20 metres long which seem to be discarded piles or scaffolding
SSS Anomaly 5	332511	6253096	*nswwrecks – sss data*	Rectangular object six metres by 3.5 metres across. Possibly open container or work punt
SSS Anomaly 6	332564	6253193	*nswwrecks – sss data*	Linear object up to five metres long up to two metres wide and possibly one metre above the bed of the harbour
SSS Anomaly 7	332735	6253153	*nswwrecks – sss data*	Object 11 metres long, four metres across and about three metres high. Most likely a wreck
Mag Anomaly 1	332805	6253562	*2017 mag. survey*	Object appears buried. No description.

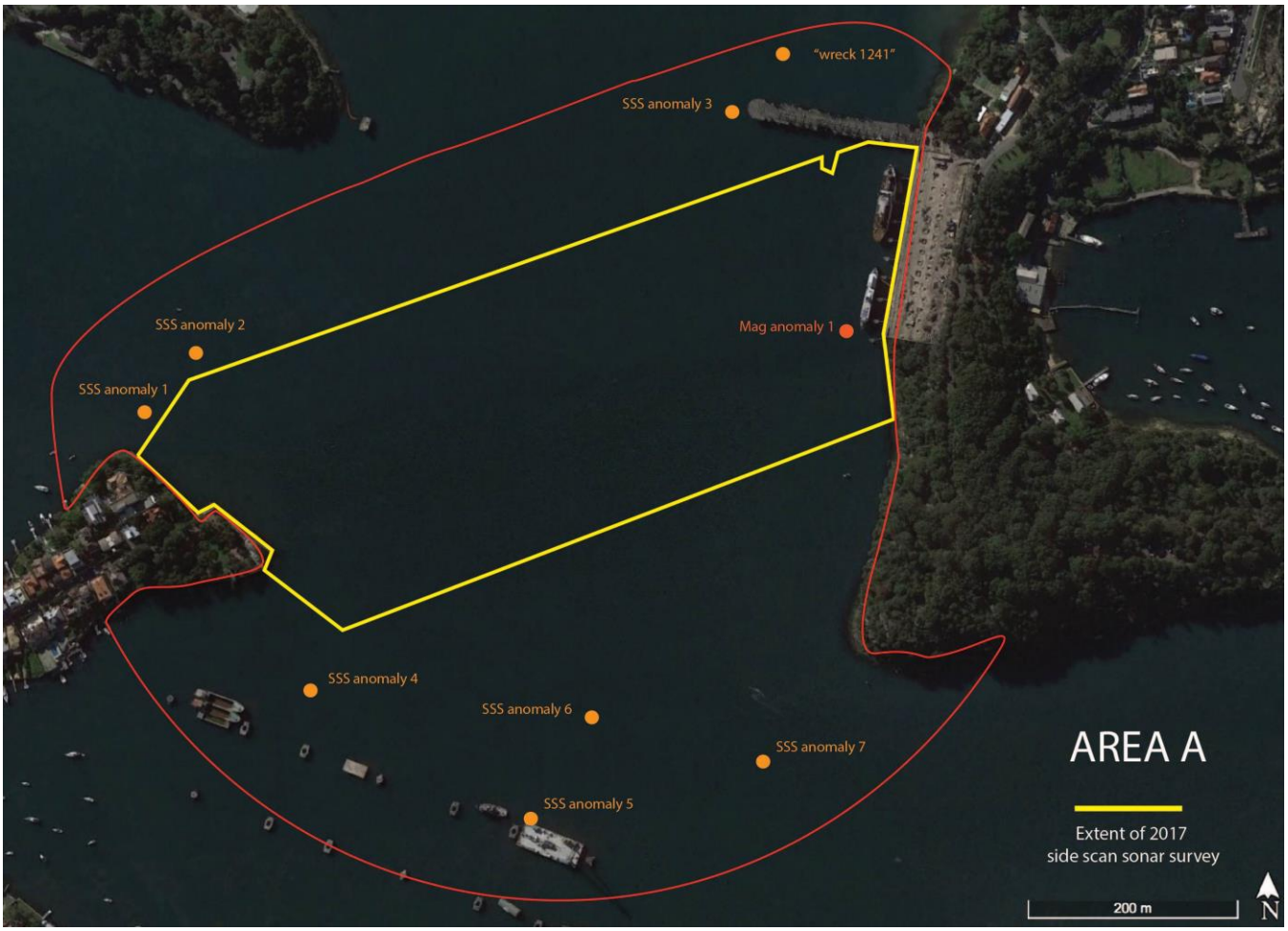


Figure 65: Locations of unverified anomalies in Area A. Yellow outline shows the extent of the side scan sonar survey carried out for this project

At the southern tip of Balls Head, and straddling the southeastern quadrant of Area A, there is a debris field that includes sunken vessels. The debris field is located here because of the relatively deep hole off Balls Head. Figure 66 is a multi-beam image of the area obtained by Sydney Ports. The positions of the debris could not be accurately obtained, but the most northern wreck – enclosed by the red rectangle at the top of the image – is the wreck referred to as Balls Head #1 Unknown wreck (see Section 4.3.2).

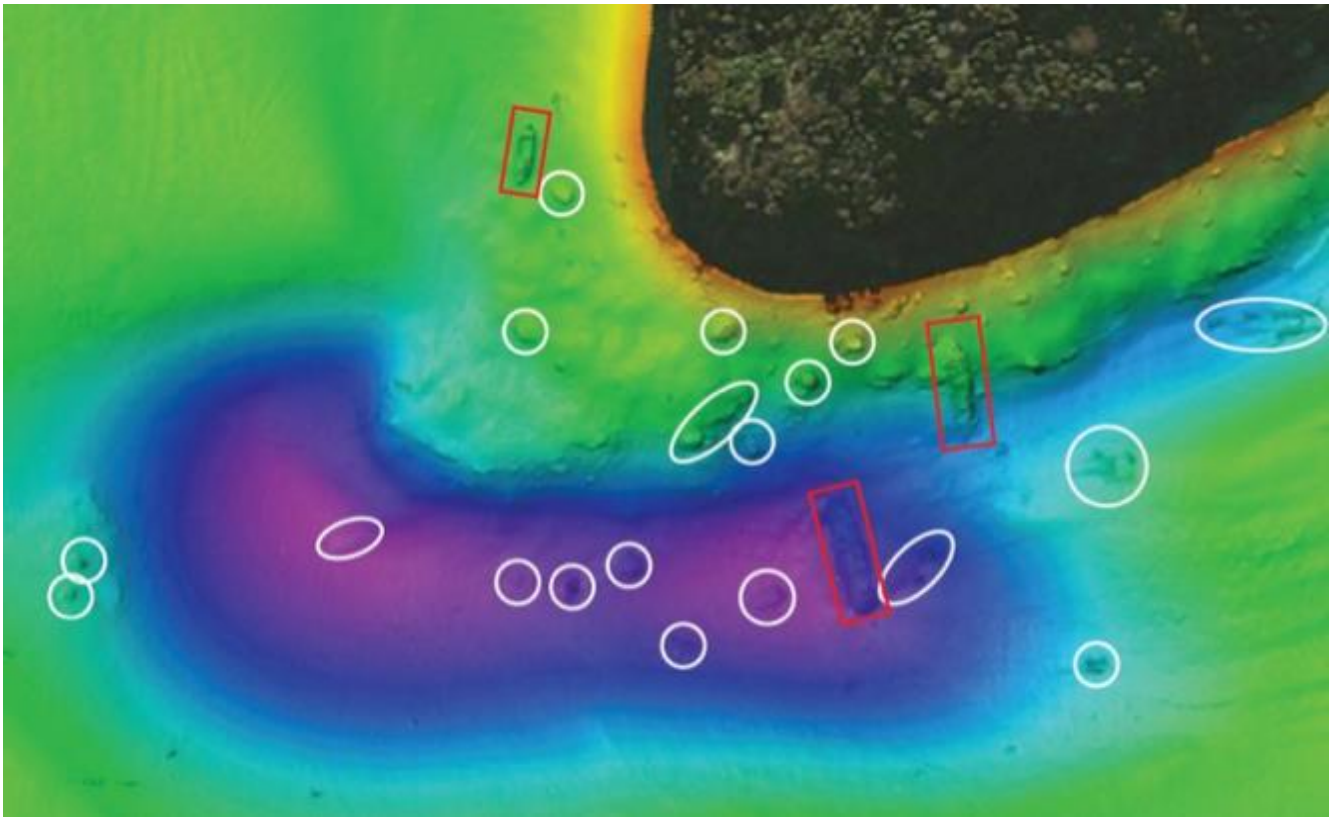


Figure 66: Portion of multi-beam image from an online media story of the bed of the harbour off Balls Head showing a number of easily identified recent wrecks, outlined with red rectangles, presumably scuttled in the deeper water. *White ovals and circles indicate other potential cultural debris* (O'Rourke 8 June 2014)

4.5 Summary of maritime heritage sites and archaeological potential in Area A

Area A has areas that have the potential to contain maritime heritage and archaeological remains, including maritime infrastructure, shipwrecks and areas there was relatively high vessel activity. Using known sites, the distribution of potential sites and the spread of activities within Area A, these areas have been separated by a rating of 'archaeological potential' as defined in Table 8.

Table 8: Defining archaeological potential

Archaeological Potential	Likelihood of presence
Certain	100%
Very likely	85–99%
Likely	50–84%
Unlikely	16–49%
Very unlikely	1–15%
Remote	< 1%

With regards to archaeological potential within Area A, the December 2017 dive inspection examined a number of side scan sonar targets within the proposed disturbance footprint and found two small recent

wrecks and what was likely a former mooring block. Bordering the proposed disturbance footprint there are certain maritime heritage items in the form of the maritime infrastructure and associated deposits connected with Yurulbin Park and the former Balls Head Coal Loader. The remainder of the region within the study area that has been covered by the geophysical survey can be considered to be very unlikely to have any archaeological potential.

Conversely, the bed of the harbour outside the proposed disturbance footprint, which has not been scanned by magnetometer or side scan sonar as part of this study, has been assessed as being likely to contain maritime heritage. This is evidenced by reported anomalies of potential cultural items from other data sources.

A summary of the maritime archaeological potential within Area A is presented in Table 9 and illustrated in Figure 67.

Table 9: Archaeological potential within Area A

Archaeological Potential	Site Type	Known or predicted location
Certain	Maritime infrastructure, shipwrecks, associated deposits and discard	Areas immediately adjacent to foreshores of Birchgrove and the former Balls Head Coal Loader, as well as the Railway Electricity Tunnel
Very likely	Maritime infrastructure, shipwrecks, associated deposits and discard	Archaeological deposits and potential remains of maritime infrastructure within 20 m of the shorelines at Balls Head and Birchgrove. A number of anomalies in the south, south-east and western portions of the study area, adjacent to the former Balls Head Coal Loader, may be wrecks or large discarded objects
Likely	Shipwrecks and discard	Within the study area beyond the limit of the geophysical surveys
Very unlikely	Shipwrecks and discard	Within the limit of the geophysical surveys

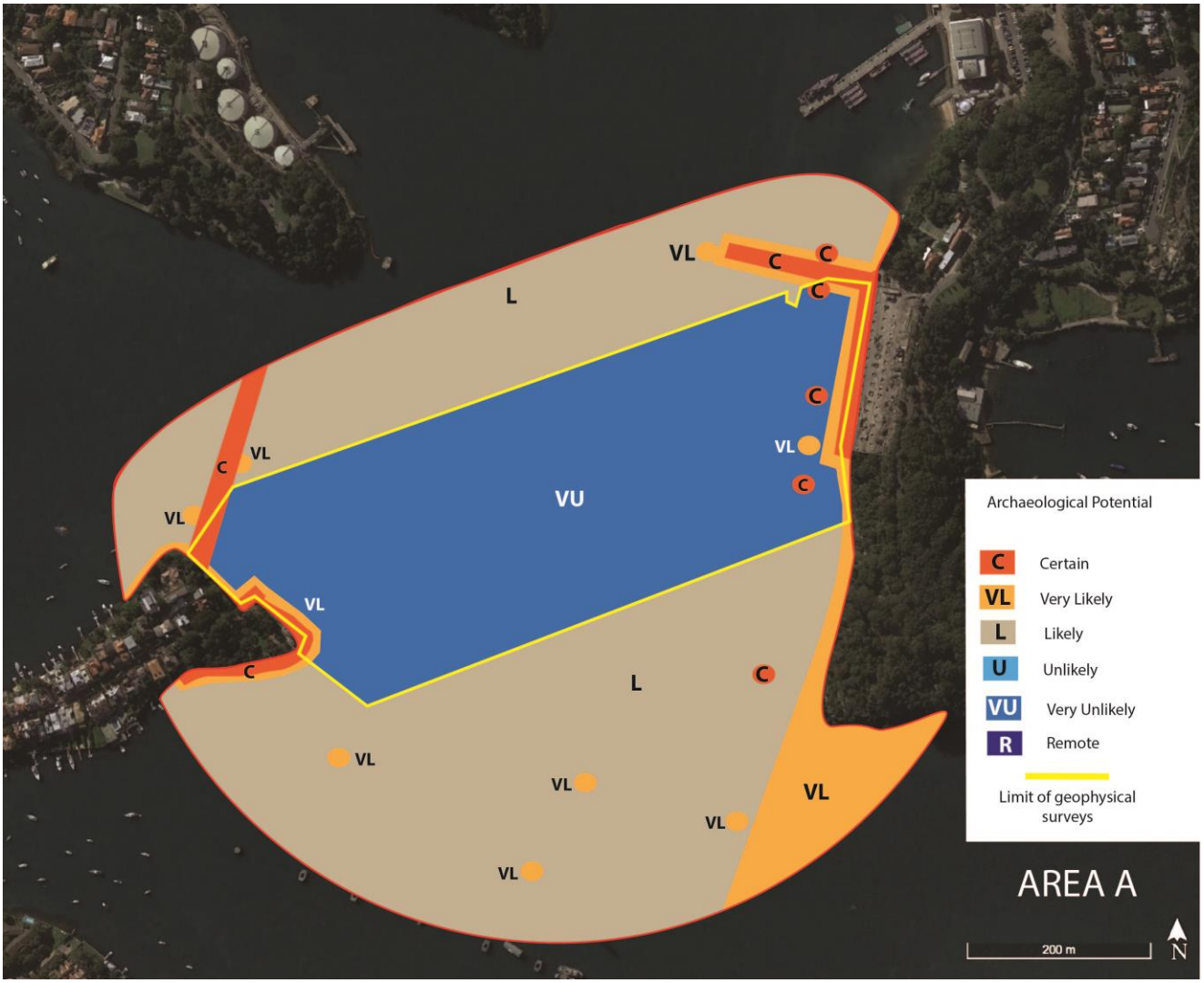


Figure 67: Archaeological potential in Area A

5 AREA B – BERRYS BAY

5.1 Physical setting

The current landscape of Area B consists of the eastern extent of Berrys Bay, opening to the south-east into Port Jackson. The bay entrance is dominated by the eastern face of Balls Head, forming a sandstone cliff 20 metres high which slopes steeply down to the water (Figure 68).

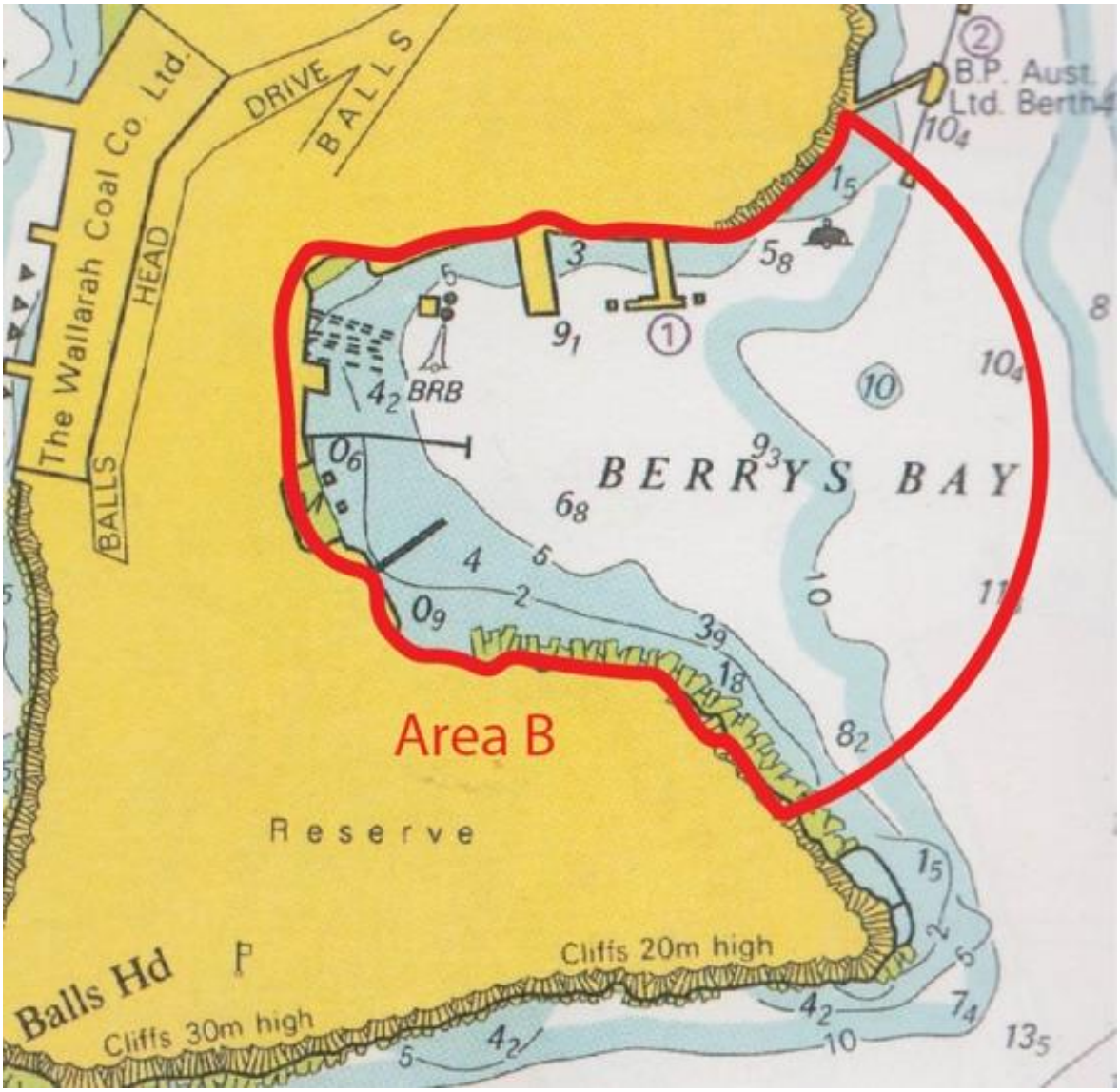


Figure 68: Portion of nautical chart showing Area B. *Depths are in metres* (Commonwealth of Australia/Crawford House Publishing, 1995: Chart 24)

The bed of the harbour in Berrys Bay, which is expected to be composed of a higher concentration of fluvial mud or silt than sand, slopes gradually down from the shoreline, reaching a maximum depth of about 12 metres below Lowest Astronomical Tide at the entrance to the bay. Bathymetric data acquired for this project in the western portion of Berrys Bay shows the bed of the harbour dropping away steeply along the northern shoreline to a depth of 10 metres below Australian Height Datum (Figure 69). In contrast, the bed of the harbour gradient is gentler on the western and southern sides of the western portion of Berrys Bay. The northern and eastern shorelines of the western portion of Berrys Bay have been completely modified and are bounded with seawalls and slipways. The side scan sonar imagery of the western part of Berrys Bay shows concentrations of functioning and derelict maritime infrastructure, principally that of timber jetties, iron rails of slipways and moorings.

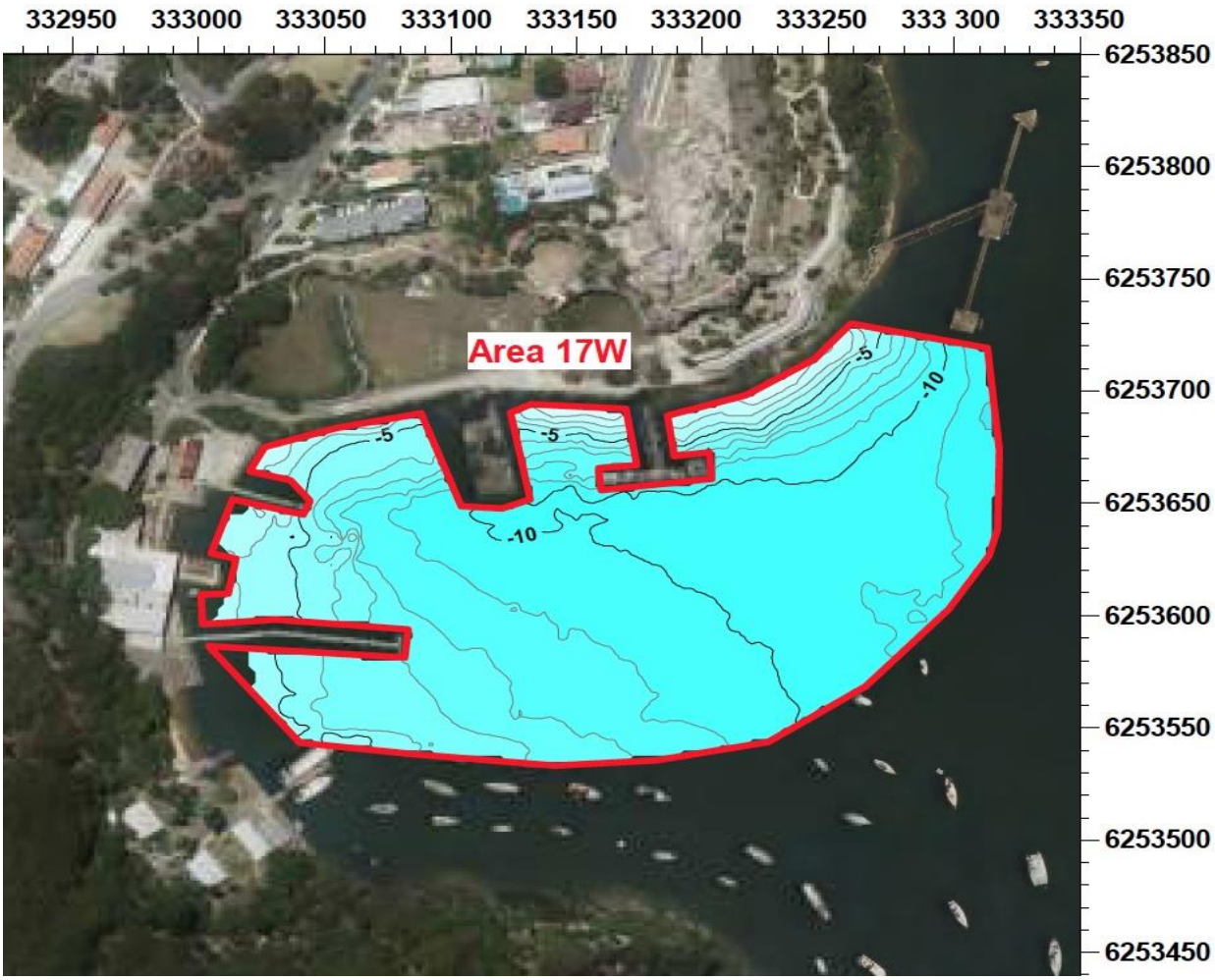


Figure 69: Bathymetric contour plan of Area B, Berrys Bay, Sydney Harbour. *Depths are in metres AHD*
(Earth Technology Solution Pty Ltd, July 2017a: Figure WH2)

5.2 Historical background

The western shore of Berrys Bay was first subject to European occupation as part of a large estate of 524 acres granted to British merchant Edward Wollstonecraft in 1819. Shortly thereafterWollstonecraft constructed a residence on the land in the current suburb of Waverton. In 1821 Wollstonecraft and his business partner, Alexander Berry, were granted 10,000 acres on the Shoalhaven River, which they commenced clearing for timber, and established pastoral and agricultural pursuits. The North Shore estate was subsequently used as a depot for produce transported from Shoalhaven to Sydney markets. By the early 1830s, a stone wharf, crane, warehouse, cottage and stables had been constructed on the northwestern shore of Berrys Bay, and a road cut north from the wharf along the saddle of the Balls Head headland (Jones 1988, NSW Office of Environment & Heritage 2013, Perry 1966, RPS Australia East Pty Ltd 2016, Stephen 1967) (Figure 70).

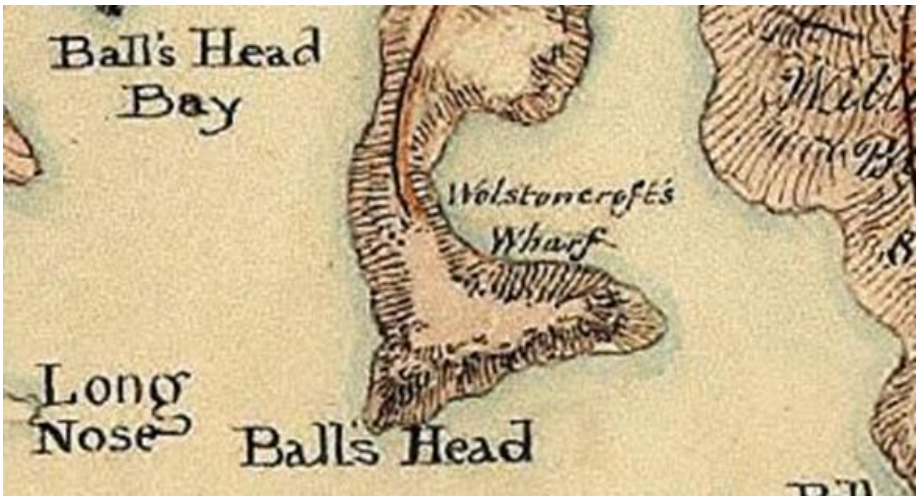


Figure 70: c.1840s map of Balls Head and Berrys Bay showing 'Wolstonecraft's [sic] Wharf' and road leading north (NSW Department of Lands ca. 1840s)

By the mid 1840s, Wollstonecraft had died and Berry had begun to retreat from business operations. In the early 1850s, Berry leased the wharf and associated facilities to several companies for the storage and discharge of patent fuel, including the Peninsula and Oriental Company and the General Screw Steam Company (Anon 22nd December 1888). The wharf and stores are depicted on an 1850 map, curving around the northwestern portion of Berrys Bay, as is a second feature (possibly a jetty) towards the south of Berrys Bay (Figure 71). A c. 1875 photograph (Figure 72) also shows the location of the jetty feature. Very little is known of this second feature, other than a brief reference to a timber jetty being situated south of the wharf (Anon 22nd December 1888). Given the early date, it was quite likely constructed by Berry and Wollstonecraft, perhaps as an initial or supplementary landing point to the larger wharf.

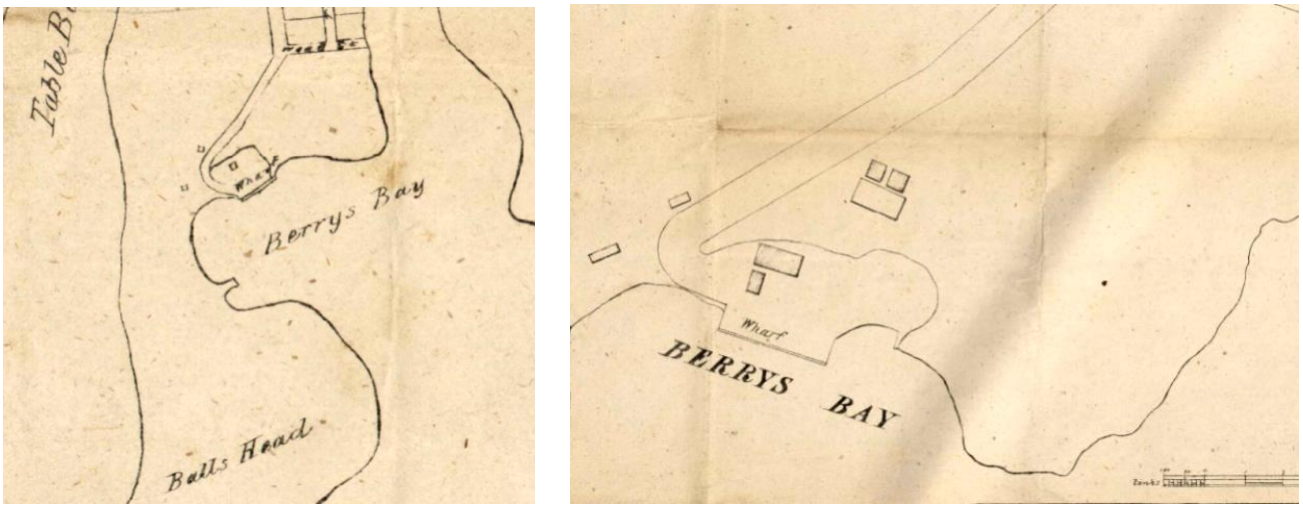


Figure 71: Portions of an 1850s map of part of the Crows Nest Estate, including a general sketch of Berrys Bay (left) showing location of wharf and feature/jetty to the south, and a detailed sketch of the wharf and associated structures on the northwestern shore of Berrys Bay (Edward J. Burrows, Surveyor, ca.1850s)

Figure 72: c. 1875 image looking west across Berrys Bay showing Berry and Wollstonecraft's Wharf and store on the far right. Towards the far left is a small clearing and possible landing spot, likely the 'jetty' feature on the 1850s map (Anon ca. 1875-1885)

In 1873, Berry died and the estate was passed to his brother David. In 1877, David Berry leased the northwestern portion of Berrys Bay, including the wharf and associated facilities, to the NSW Government as a depot for the Naval Brigade Torpedo and Signalling Corps. The depot was used for the storage of torpedos and associated materials (Figure 73), and as a mooring and maintenance facility for the torpedo boats *Acheron* and *Avernus*. By the mid 1880s the depot had been expanded to include additional workshops, a packing room, hydraulic testing house and office. A slipway for the torpedo boats had been constructed beyond the western end of the wharf (Anon 3rd March 1879, Curran 2010, Godden Mackay Logan 2000, NSW Office of Environment & Heritage 2013) (Figure 74). By the late 1880s several offshore moorings had also been established towards the centre of Berrys Bay, and the timber jetty situated towards the southern shore of Berrys Bay had apparently been abandoned and fallen into ruin (Anon 22nd December 1888) (Figure 75).

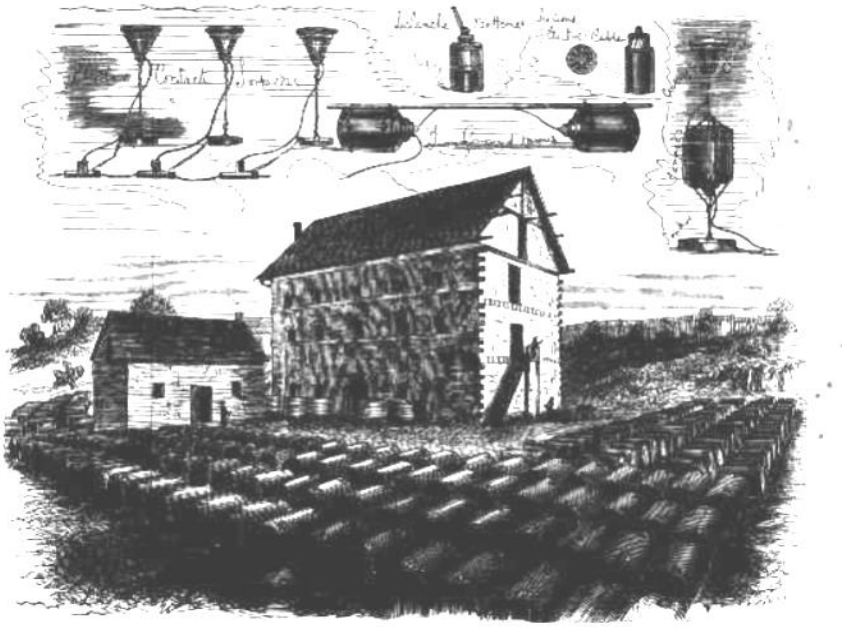


Figure 73: 1878 sketch of Wollstonecraft and Berry's original stone storehouse being used as torpedo storage (Anon 29th July 1878)

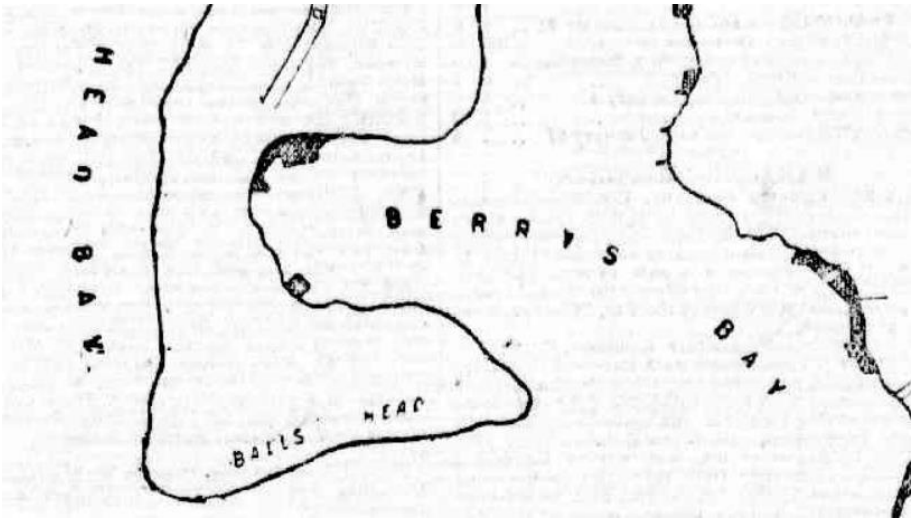


Figure 74: 1888 map showing Berrys Bay showing additional construction at the NSW Torpedo and Signalling Corps depot, and second 'jetty' towards the south (Anon 1888)

Figure 75: 1890 chart of Berry [sic] Bay, showing NSW Torpedo and Signalling Corps wharf, stores and slipway and offshore moorings. Note the 'jetty' to the south is no longer depicted (Great Britain Hydrographic Department 1890)

In 1902, the Commonwealth Government assumed responsibility for defence and the NSW Torpedo and Signalling Corps depot at Berrys Bay was decommissioned (Anon 14th June 1902). The wharf and associated stores at the northwestern corner of Berrys Bay were subsequently leased to the NSW Powell Wood Process Ltd., a company that specialised in the treatment of various hardwoods to make the timbers resistant to rot, white ant and marine borer attack. By 1908, a substantial timber treatment works had been established, including an extended area of reclamation and wharfage, a new jetty situated

towards the eastern end of the site, and additional cranes, sheds, vats and chimneys (Figure 76). Raw timbers were transported to the site by coastal steamers that moored towards the centre of Berrys Bay, with the logs unloaded onto lighters and taken to shore for treatment (Salmon 27th April 1911).

In 1906, the foreshore to the immediate south of the Berrys Bay wharf, including the slipway constructed by the NSW Torpedo and Signalling Corps, was leased to the family-run boilermaker company Woodleys Ltd. The company soon developed to include a docking contractor, general engineer, blacksmiths and shipbuilders. The family also carried out work on the site, quarrying stone blocks, building sea walls and reclaiming land behind the walls with spoil and rock to create flat working spaces, and constructing a small jetty on piers extending from the seawall (Figure 77 and Figure 78). In 1913, Woodleys Ltd acquired a second lease of adjoining land to the south, and subsequently extended the reclamation and seawall, extended the original jetty, constructed a small slip for yachts and launches and established adjacent moorings for lighters (Figure 76). Following these works, the Sydney Harbour Trust deepened the water in front of Woodleys Shipyard by dredging out 1250 tonnes of mud (GML Heritage 2014, NSW Land & Property Information 2011).

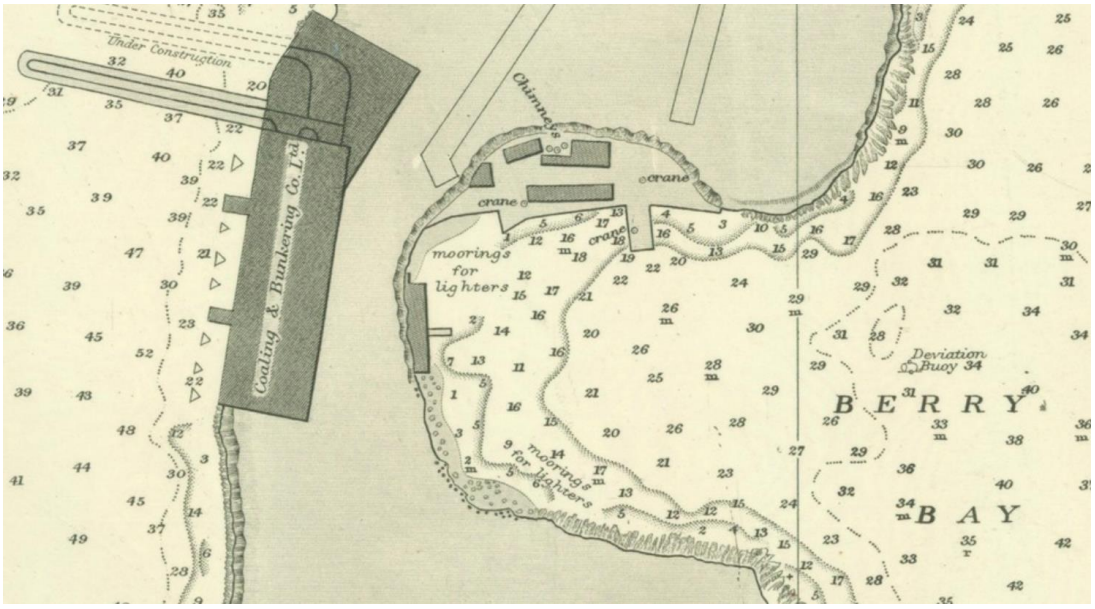


Figure 76: 1915 navigational chart of Sydney Harbour, showing expanded facilities at the NSW Powell Wood Process works, and the extended Woodleys Ltd shipyards (Great Britain Hydrographic Department, 1915)

Figure 77: 1908 photograph of a yacht in the slip at Woodleys Shipyard (Anon 1908)

Figure 78: c.1920s photograph of Woodleys Shipyard with the gantries of Balls Head Coal Loader in the background (Anon ca. 1930s)

In 1914 the Commonwealth Government leased a section of the Berrys Bay foreshore south of Woodleys Ltd's premises for quarantine purposes, specifically to establish a depot for fumigation operations carried out by the Federal Quarantine Service in conjunction with its well established quarantine facility at North Head. Construction of the quarantine depot commenced in 1916, with clearing and levelling of the foreshore and reclamation of the water frontage, contained within a stone seawall. A long timber jetty providing refuelling facilities was erected towards the centre of the seawall, and a slipway built into the northern end of the wall. The remainder of the complex consisted of two brick administration buildings, weatherboard cottages and workshop, and a timber coal store were subsequently erected (see Figure 79 to Figure 81). The depot was the base for two launches, *Pasteur* and *Jenner*, and a barge that were used to ferry doctors and staff out to the quarantine line at Bradleys Head, where inspections and fumigations of incoming ships would take place (Hoskins 2010, O'Malley 18 November 1915, NSW Office of Environment & Heritage 2013).

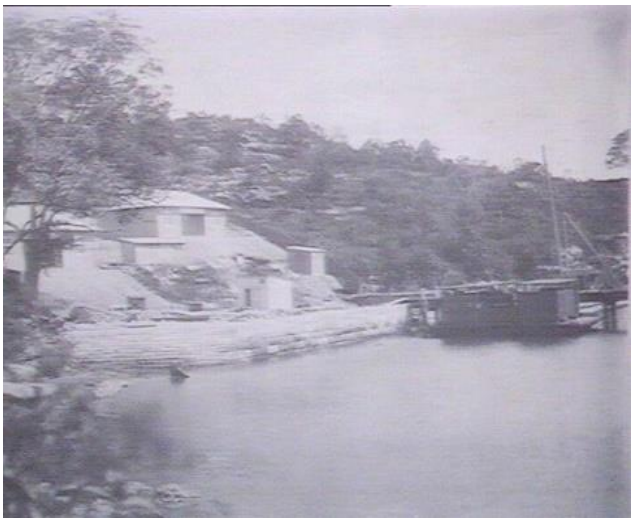


Figure 79: Quarantine depot, sea wall and wharf under construction, 1917 (left) (Anon 1917)
Figure 80: Quarantine depot and completed seawall, 1917 (right) (Anon 1917)

Figure 81: Completed quarantine depot, 1919 (Anon 1919)

By 1920, the NSW Powell Wood Process Ltd works on the northern shore of Berrys Bay had ceased operations and the site was leased to the British Anglo-Persian Oil Company Ltd for the establishment of an oil fuel bunkering depot. By mid 1922, the bunkering depot included a large oil fuel storage tank capable of holding 10,000 tonnes of fuel, pipelines connecting the tank to the wharf and a berthing scheme providing two substantial timber jetties: the pre-existing jetty towards the centre of the wharf and a new jetty at the far eastern end of the wharf (Figure 82 and Figure 83). By the late 1920s, the site was operated by the Commonwealth Oil Refineries, an Australian oil company established as a joint venture of the Australian Government and the Anglo-Persian Oil Company Ltd (Anon 9 December 1921, Anon 15 July 1922, NSW Office of Environment & Heritage 2013). From 1933 to 1936, the fuel bunkering depot was further expanded. Wollstonecraft and Berry's stone storehouse was demolished to make way for five additional oil storage tanks and a surrounding bund wall, built using stone from the storehouse. By 1939, two smaller storage tanks had also been erected behind the eastern end of the wharf, and four additional large tanks had been constructed along the curve of Berrys Bay to the north (NSW Office of Environment and Heritage 2013) (Figure 84).

Figure 82: c. 1930 aerial photograph of Berrys Bay, showing Anglo-Persian oil facility with vessel moored (Anon ca. 1930)

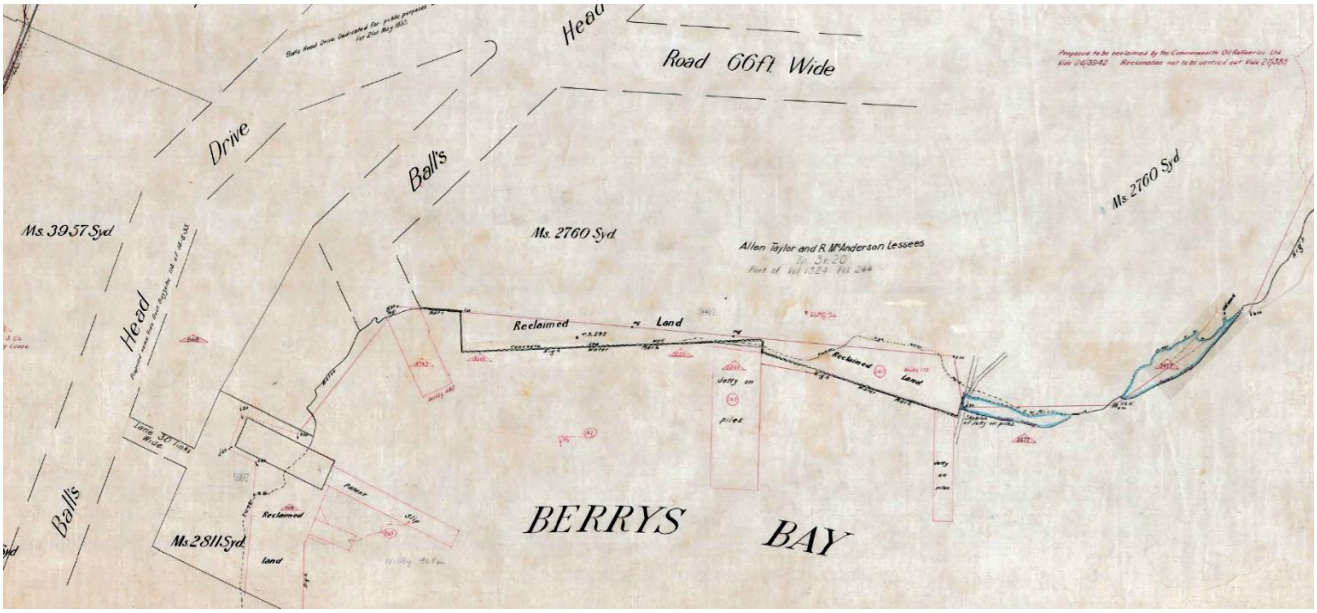


Figure 83: Portion of c.1936 annotated Crown plan of Berrys Bay showing areas of reclaimed land, wharf and timber pile jetties of the Commonwealth Oil Refineries works (Officer in Charge, 1936). The former NSW Torpedo and Signalling Corps slipway is shown in the left of the image, incorporated into the Woodleys Shipyard complex

Figure 84: 1943 aerial photograph showing the Commonwealth Oil Refineries works at northern end of Berrys Bay, Woodleys Ltd. Shipyard towards the centre and the quarantine depot towards the south (RTA Photography 1943)

In 1952, the Australian Government sold its interest in the Commonwealth Oil Refineries joint venture to the Anglo-Iranian Oil Company (formerly the Anglo-Persian Oil Company), which then became the British Petroleum Company (BP) in 1954. Further expansions to the Berry Bay depot were carried out in the 1960s, including the installation of a further 20 oil storage tanks and construction of a timber T-wharf to expand mooring capacity, replacing the earlier timber jetty at the eastern side of the wharf (Figure 85). By the late 1980s, the depot was no longer considered viable and the lease was terminated in 1994. The oil storage tanks and supporting equipment were subsequently demolished and removed during 1996 and 1997. The northern section of the site was converted to recreational open space, while the southern section was reserved for waterfront industrial use (GML Heritage 2014, NSW Office of Environment & Heritage 2013).

The Woodleys Ltd shipyard in Berrys Bay also saw expansion during the 1960s. Part of this included leasing a further portion of land to the north, which was used to build timber island-trading vessels up to 60 feet long; it was later used for the dry storage of boats on trailers. Two new slips were also built between the original slip and this new land; one was a large 700 tonne slip and the second a 300 tonne slip further to the north. The company again diversified and built a large 32 berth marina in 1968, greatly reconfiguring the site. By 1982, Woodleys Shipyard had evolved into Woodleys Slipway Pty Ltd, comprising nine separate companies and employing 50 people. A number of entities leased the site until 2011 (Figure 86). It is currently unoccupied (GML Heritage 2014, NSW Office of Environment & Heritage 2013).

The Quarantine Station at Berrys Bay ceased to be used in the 1970s when Australia moved away from a maritime quarantine focus. In 1988 it was acquired and reused by the Australian National Maritime Museum as a shipyard and workshop to maintain its heritage fleet (Hoskins 2010, NSW Office of Environment and Heritage 2013).

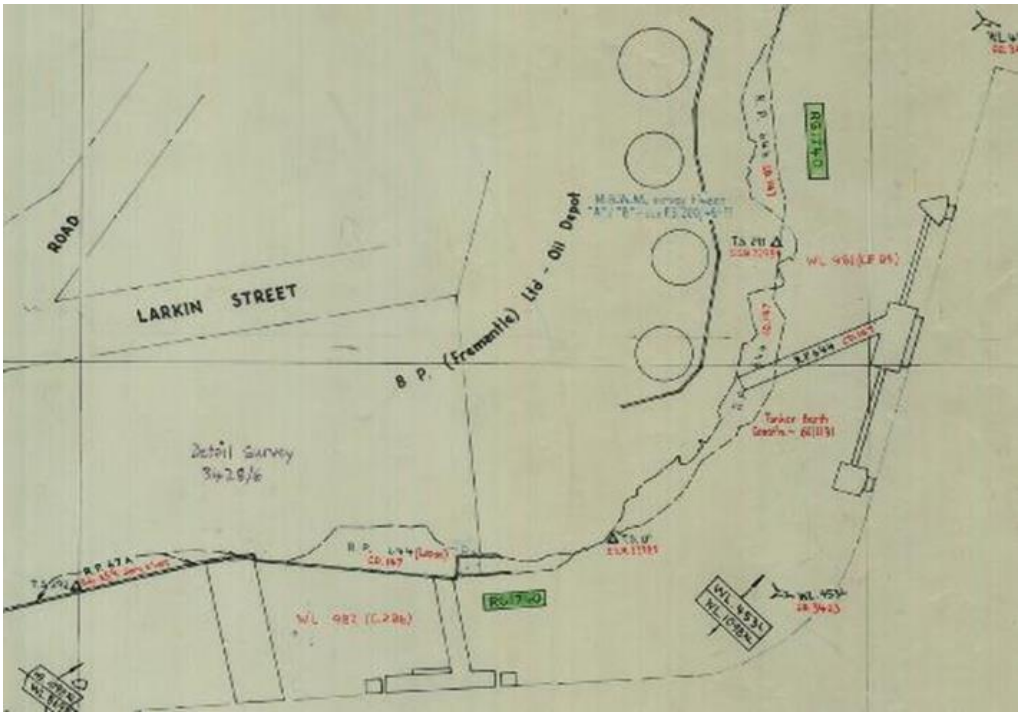


Figure 85: Part of c.1980s Crown plan of Berrys Bay showing the BP infrastructure, including T-wharf **(**Crown Plan, c.1980s, 'P.J.569')

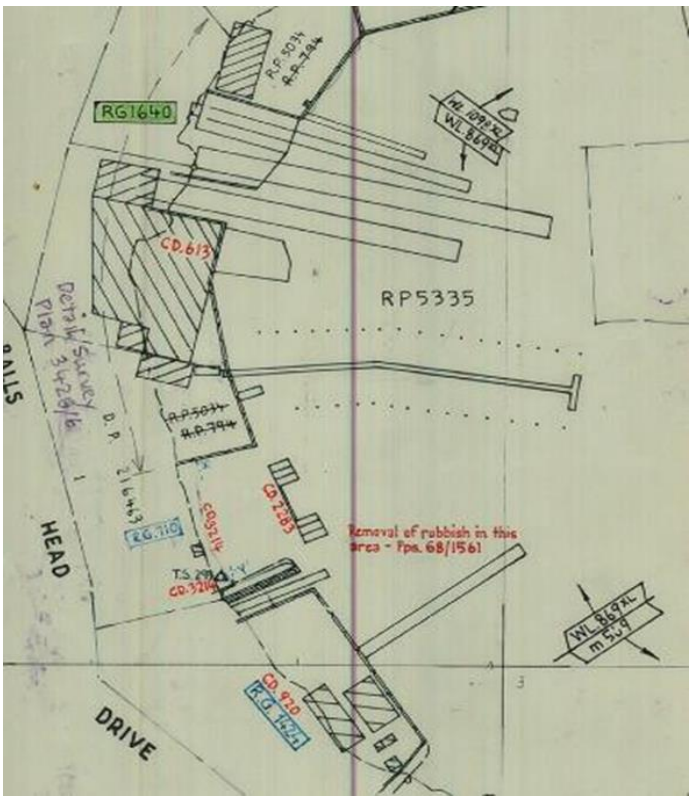


Figure 86: Part of c.1980s Crown plan of Berrys Bay showing Woodleys Shipyard infrastructure and Quarantine Station (Crown Plan ca. 1980s)

5.3 Known maritime heritage sites

The following discussion of known maritime heritage sites within Area B has been compiled from historical research, a review of statutory and non-statutory heritage registers, and the findings of the field inspection conducted in December 2017.

5.3.1 Maritime infrastructure

Former BP fuel bunkering site

The former BP fuel bunkering site, listed in the North Sydney Local Environmental Plan 2013, extends across the northern portion of Area B. The shoreline of the former BP fuel bunkering site consists of a continuous concrete retaining wall likely built in the middle decades of the 20th century (Figure 87). It can be expected that the remains of Berry and Wollstonecraft's 1830s stone wharf and possible later seawalls are present within the reclamation fill behind the present-day concrete seawall.

Figure 87: View of concrete seawall of the former BP site from the south-west looking north-east. Collapsing timber dolphin in foreground and collapsed timber jetty in background surrounded by floating boom (Image: Cosmos Archaeology, 12 December 2017)

The remains of a timber jetty that has recently collapsed can be seen in Figure 87, Figure 88 and Figure 89. It would appear the deck has been removed but the piles have been left in situ. This jetty was constructed in the early 20th century, when the site was still under the management of Powell Wood Process Ltd (see Figure 76). The jetty, which is about 50 metres to the east, was constructed in the 1930s with the 'T' being formed after World War II. This structure is also derelict (Figure 90).

The side scan sonar image of the bed of the harbour in front of the former BP site displays piles of the two aforementioned timber jetties and the associated debris field that is typically created as structures collapse (Figure 91). Dive inspections in December 2017 (transect BBT-02) identified a 350 millimetre diameter timber pile cut off close to the bed of the harbour. There is no record of a jetty structure in this location,the jetty-like image in the 1943 aerial of the site is a barge (Figure 84). This pile is also to the west of the protuberance extending from the seawall in the late 19th century when the site was occupied by the NSW Torpedo Corps. It is very unlikely to be associated with Berry and Wollstonecraft's 1830s stone wharf. It is most likely the remains of a solitary dolphin or mooring pile.

Figure 88: View of remains of the timber jetty associated with the former BP site, from the south-east looking north-west. *Remains surrounded by floating boom* (Image: Cosmos Archaeology, 12 December 2017)

Figure 89: View of remains of the timber jetty associated with the former BP site from the north looking south. *Remains surrounded by floating boom* (Image: Cosmos Archaeology, 12 December 2017)

Figure 90: View of remains of the timber 'T' jetty associated with the former BP site from the south looking north (Image: Cosmos Archaeology, 12 December 2017)

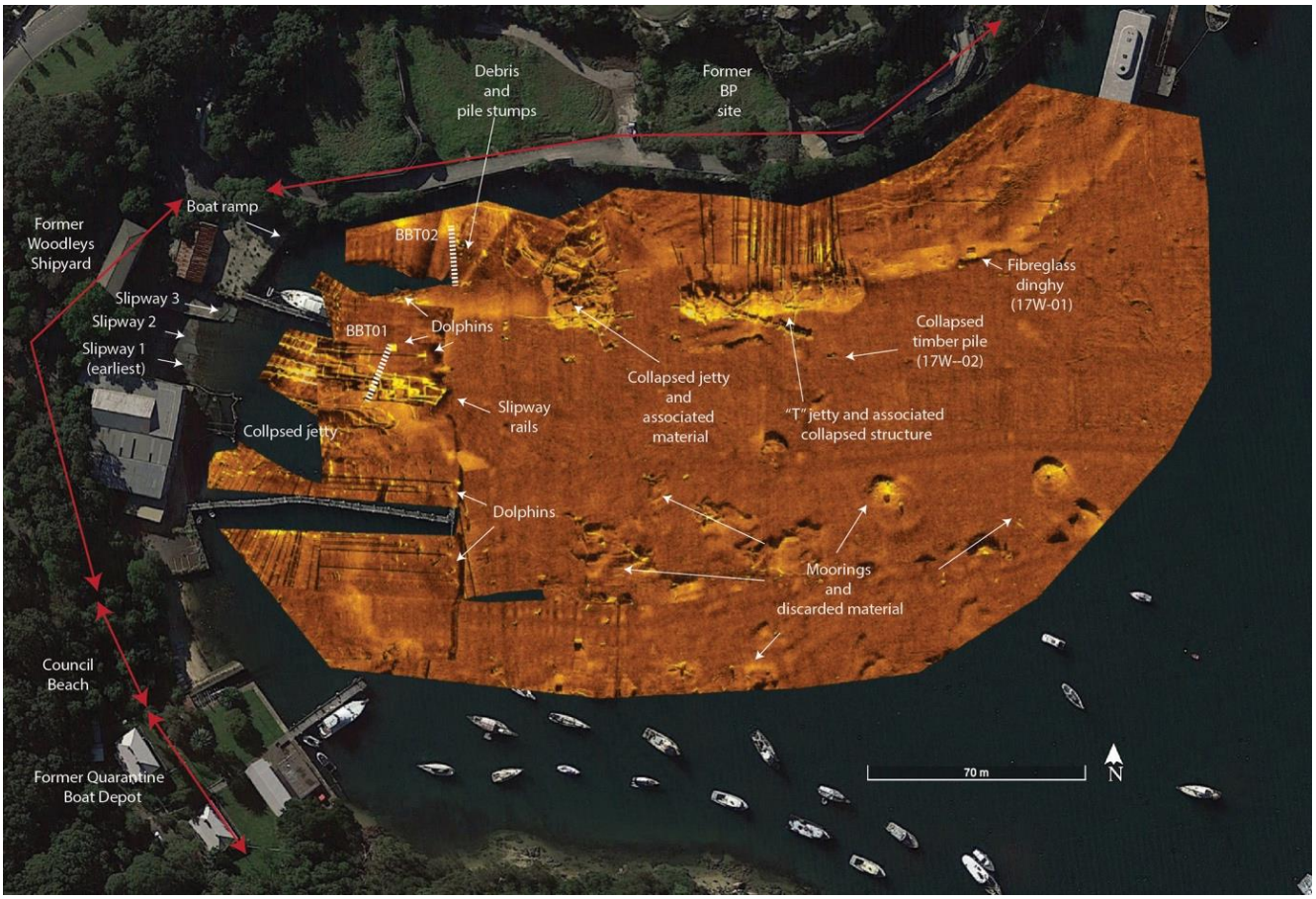


Figure 91: Side scan sonar image of Area B, the western portion of Berrys Bay (Side scan sonar data provided as .shp files by Podnar, A. Geotechnical Engineer, Douglas Partners 5 December 2017)

Former Woodleys Shipyard

The former Woodleys Shipyard, listed as a heritage site in the North Sydney Local Environmental Plan 2013, occupies the western portion of Area B. The shoreline has been totally modified, mostly through reclamation retained by seawalls. These seawalls are composed mostly of sandstone blocks which were quarried on the site at the start of the 20th century (GML Heritage, 2014: 22). The foreshore is covered by sloping concrete ramps with inset rails where the slipways are located (Figure 92).

Figure 92: View of former Woodleys Shipyard from the north-east looking west (Cosmos Archaeology, 12 December 2017)

The site has three timber jetties. Two jetties – a roughly 90 metre finger jetty and a shorter stub jetty in front of the former main shed – are derelict. The decking of the shorter jetty appears to have been removed and the structure has been enclosed with floating booms to prevent timbers breaking away and posing a hazard to navigation. A third timber jetty towards the northern end of the site remains functional. Associated with the jetties are individual piles (dolphins) placed a set distance apart, which would have been used to secure vessels.

Within the central part of the site is a complex of three iron-railed slipways (Figure 91). The southernmost slipway is situated on the site of the original NSW Torpedo Corps slipway. The middle slipway is the longest of the three and extends up to about 85 metres from shore. The submerged iron rails of this slipway were inspected in December 2017 (For further information see Cosmos Archaeology January 2018). The structure comprises two outer and two inner rails on which the cradle would have travelled. These rails are 100 millimetres high by 100 millimetres wide and appear to be railway iron. The rails sit on iron I-beam bearers 450 millimetres wide by 350 millimetres high, which in turn sit on a transverse capwale attached to piles that anchored the structure to the bed of the harbour (Figure 93 and Figure 94). The outer rails are located two metres from the inner rails, which are paired together 450 millimetres apart. The third slipway is sited on a raised sloping concrete platform, creating a steeper gradient.

Figure 93: Railway line on top of I-beam bearer

Figure 94: I-beam bearer supported by capwale and pile

The side scan sonar survey of Area B (Figure 91) shows the extent of the slipways, up to 85 metres from shore. With regards to the Woodleys Shipyard portion of the study area there appears to be discarded material in among the piles of the finger jetty and, while the coverage does not extend to the collapsed jetty next to the northern end of the main shed, there also appears to be a debris field extending out from the structure and south of the first slipway.

Former Quarantine Depot

The site of the former Quarantine Depot, listed as a heritage site in the North Sydney Local Environmental Plan 2013, has been recently used for the long-term berthing of yachts (Arup July 2012). It contains a fixed timber jetty about 30 metres long and appears to have been well maintained over the years, although in 1943 it was about 20 metres longer (see Figure 84). At the northern end of the site there is a slipway composed of sandstone blocks, capped with concrete. The slipway appears to be in a reasonable condition.

Between the former Quarantine Station Boat Depot and Woodleys Shipyard sites is a sandy beach, 30 metres wide, which is referred to as a North Sydney Council Beach (Arup, July 2012: 26).

5.3.2 Shipwrecks

A search of the Australian National Shipwreck Database and Maritime Heritage Sites database indicates that there are no previously known wrecks within Area B. The December 2017 inspection, however, identified the wreck of a fibreglass dinghy, measuring three metres long by 1.5 metres wide (Figure 95), in the northeastern section of Area B (Figure 91) (For further information see Cosmos Archaeology January 2018). It appears to have been in the water for at least a decade.

Figure 95:Starboard stern quarter of fibreglass dinghy

5.4 Potential maritime heritage sites

Based on the history presented in Section 5.2, the following cultural activities have occurred in the western portion of Berrys Bay within Area B:

- Depot for produce and shipping (c.1830 onwards)
- Localised reclamation (c.1830s onwards)
- Coal and fuel storage (c.1850s to 1870s)
- Munitions storage (1877 to 1902)
- Timber processing and shipping (1908-1920)
- Quarantine services (1916 to 1970s)
- Shipbuilding and repairs (1906 onwards)
- Oil fuel bunkering (1922 to 1994).

As such, in addition to the abovementioned known sites, the following maritime sites and items could also occur within Area B:

- Maritime infrastructure (c.1830s onwards) – stone seawalls, jetties, wharves, dolphins, slipways and moorings
- Discard from maritime infrastructure (c.1830s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment, industrial

equipment, vessel components such as engine parts and the movement of goods as well as damaged and removed material from the infrastructure. The period of occupation by the NSW Torpedo Corps could also have resulted in munitions being dumped within the bay

- Shipwrecks (c.1830s onwards)
- Discard from vessels (c.1830s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as items associated with industries and the movement of goods
- Discard in and under reclamation fill (c.1830s onwards).

The likelihood of such maritime sites surviving depends on post-depositional processes that may have occurred – in particular, dredging. However, the only dredging known to have taken place in Berrys Bay within Area B was carried out in 1913 by the Sydney Harbour Trust. This dredging seems to have been carried out only in front of the Woodleys Shipyard, and would have focused on deepening the approaches to the existing and planned maritime infrastructure.

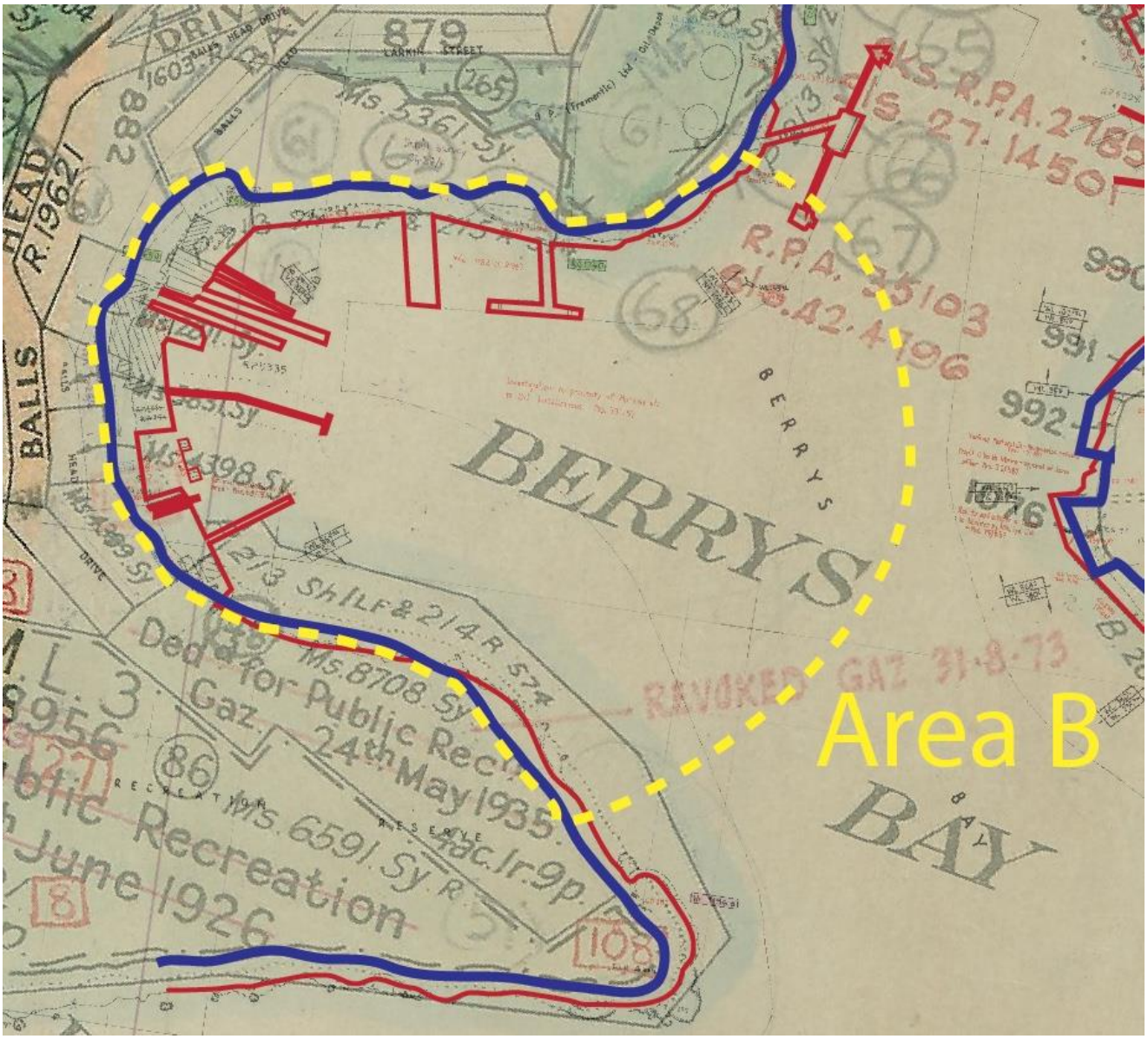


Figure 96: Overlay of 1965 parish map of Willoughby c.1980 Crown plan showing the 1965 coastline with thick blue line and the reclaimed/developed coastline of c.1980 with a thin red line (Crown Plan ca. 1980s, NSW Department of Lands 1964)

5.4.1 Maritime infrastructure and associated deposits

The shoreline of Berrys Bay within Area B has experienced the development of small and large industries requiring structures such as wharves, jetties, moorings and seawalls. The focus of these maritime activities was along the northern, western and southwestern shores of the study area.

Other than those structures already identified in Section 5.3.1, additional structures may be associated with merchants, quarrying, coal and fuel storage, ballast storage, munitions storage, timber works, shipbuilding, the oil industry, shipping and quarantine services. Most of these structures would have been relatively short lived, as they do not appear on maps or photographs. Remains of these structures may still exist in the bed of the harbour in the form of cut off piles and dismantled timbers.

Localised reclamation in areas where previous structures stood, such as Berry and Wollstonecraft's stone wharf, would have buried these remains and preserved them under reclamation fill. However, the opposite is true for dredging, which may have involved the removal of remains from previous structures. It is unlikely that the 1913 dredging would have removed former structures and associated archaeological deposits along the northern shore of Area B from the time of the construction of Berry and Wollstonecraft's stone wharf to the period of occupation by the NSW Torpedo Corps. This is because dredging is likely to have been confined to in front of the Woodleys Shipyard and would have focused on deepening the approaches to the existing and planned maritime infrastructure.

The types of moorings used throughout Berrys Bay are unknown, but were likely anchors or concrete blocks attached to long chains. Although the chains may have been replaced over time, or additional moorings added, it is likely that the original mooring facilities have been left on the bed of the harbour and are either still used or abandoned. Those that are still in use are not considered to be maritime archaeological remains. However, those that are not used do form part of the maritime archaeological record. As typically large solid features, the remaining moorings would likely be intact and easily visible on the bed of the harbour.

Deposits associated with maritime infrastructure would have built up around and beneath the structures. Artefacts would have fallen beneath and between the deck planking of jetties and wharves as well as off the vessels moored alongside. Such deposits can include accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment as well as damaged and removed material from maintenance of the structure. These smaller items may have fallen through the sandy bed of the harbour to become buried beneath the surface or similarly buried by any sedimentation in the area. Again, reclamation would bury and preserve these remains while dredging would remove them.

As the abovementioned structures were associated mostly with industrial activities, there could be a higher concentration of tools and machinery parts under, within and around the structures. Consideration should be given to the potential presence of discarded munitions associated with the NSW Torpedo Corps. Though it is very unlikely that munitions would have been deliberately discarded off the maritime structures associated with the facility, there is the possibility that accidental discard could have occurred during transfers between ship and shore. In some instances, there would not have been an incentive to recover munitions that had been immersed in seawater.

5.4.2 Shipwrecks and associated deposits

Vessels moving through Area B included those associated with industrial activities on the shores of Balls Head and McMahons Point. Berrys Bay is relatively protected, but accidental wrecking could have occurred through collision, fire, sinking at moorings and explosions. Some wrecks may have been re-floated or broken up if they impeded the movement of vessels or were hazardous to shipping.

There is the possibility that older timber-hulled vessels have been wrecked in Berrys Bay, given its long use as an industrial area. Such wrecks would have broken up and provide a low relief profile on the bed of the harbour. The remains of smaller vessels such as dinghies would be most likely completely buried.

Furthermore, as part of the study area was a shipyard, it should be expected that vessel components such as hull plating or frames could be present throughout the area, with a higher frequency closer to Woodleys Shipyard. However, it can also be expected that the dredging in 1913 would have directly removed any pre-existing wreckage that was in the dredge footprint at the time.

The side scan sonar survey of the larger portion of Area B did not show any signs of wrecks other than a fibreglass dinghy. However, there were areas where the survey could not cover, and a wreck underneath the timber jetties would be very difficult to identify from side scan sonar data.

5.4.3 Discard from vessels

The movement of vessels through Area B would inevitably coincide with discard from vessels, including from vessels associated with industries in Berrys Bay. Furthermore, there would have been a large amount of shipboard activity at Woodleys Shipyard for vessel fitouts and repairs. This would have allowed more opportunity for objects to be discarded among the slipway rails in deeper water and further out from the shore and jetties.

Discard can be accidental or deliberate, and can include items such as personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as cargo from vessels associated with the local industries. They can consist of a range of materials and are mostly single items but can occur in scatters created by one event or multiple events. Higher concentrations of discard would be closer to shore where vessels were more likely to be moored or anchored, rather than in the shipping channel.

As discussed in Section 5.4.1, consideration should be given to the potential presence of discarded munitions associated with the NSW Torpedo Corps. Though very unlikely that munitions would have been deliberately discarded off vessel, there is the possibility that accidental discard could have occurred during transfers between ship and shore. In some instances, there would not have been an incentive to recover munitions that had been immersed in seawater.

5.4.4 Structures and discard in and under reclamation fill

Localised reclamation has occurred along the coastline of Balls Head and McMahons Point. The fill used as part of reclamation is typically sourced from another location. This fill would have the effect of burying any archaeological remains, as well as possibly containing objects from the source of the fill. There may also have been opportunistic discard during the process of reclamation. The type, material kind, size and extent of these remains cannot be predicted. Regardless, the process of burial generally preserves material and it is likely that any such items are relatively intact.

There is a high likelihood that the remains, at least the lowest one or two courses of sandstone blocks, associated with Berry and Wollstonecraft's 1830s stone wharf could be present at the base of the fill and immediately behind the current concrete seawall of the BP site. It is also likely that remnants of seawalls bounding incremental reclamations from the late 19th to the early 20th century could be present within the current reclamation area.

5.4.5 Unverified anomalies

The side scan sonar imagery obtained for Area B shows a variety of bed of the harbour anomalies which were not inspected in the December 2017 field investigations (see Figure 91), primarily because they would not be impacted by the proposed construction activities (see Section 8.5.2) and/or because there was a reasonable degree of certainty about what they were – such as moorings and collapsed jetty structures.

5.5 Summary of maritime heritage sites and archaeological potential in Area B

Within Area B there are areas that have the potential to contain maritime heritage and archaeological remains associated with maritime infrastructure, shipwrecks and vessel activity. Using known sites, the distribution of potential sites and the spread of activities within Area B, these areas have been separated by a rating of 'archaeological potential' – see Table 8 in Section 4.5.

Figure 97 shows that a substantial portion of Area B has certain or very likely maritime heritage. This reflects the high level of maritime industry and activity in the area since the 19th century. This assessment is borne out by the spread of cultural material across the bed of the harbour that can be seen in the side scan sonar imagery. It is very likely that the physical remains of maritime heritage are present in the southern portion of Area B, on the basis that this area may have been used as an anchorage by vessels associated with the industries and facilities that lined the shore in the northern and western parts of the zone. The potential of specific site types within Area B is shown in Table 10.

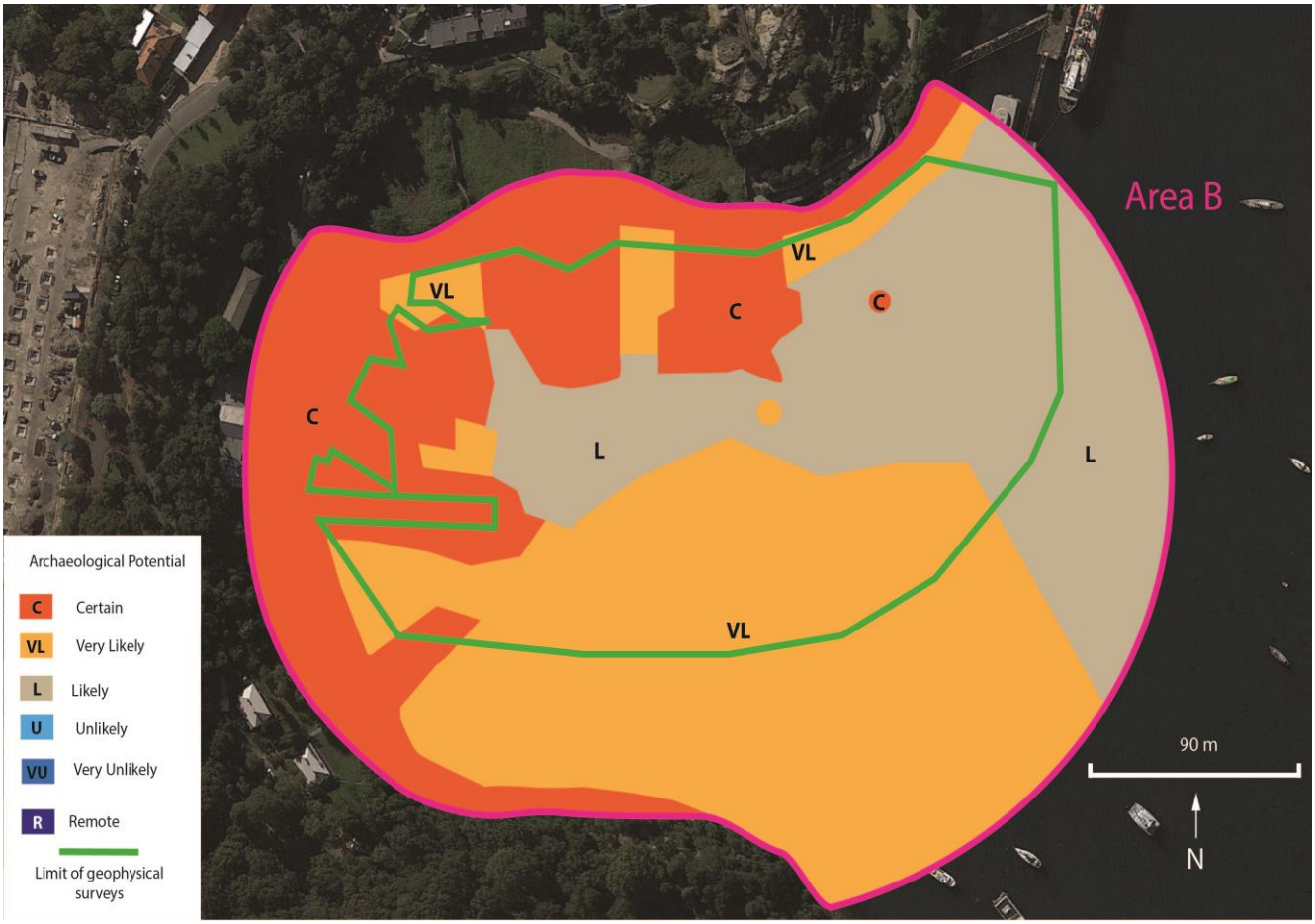


Figure 97: Likelihood of archaeological potential within Area B

Table 10: Degree of archaeological potential for site types in Area B

Potential	Site type	Known or predicted location
Certain	Maritime infrastructure, associated deposits and discard	Concentrated along the northern, western and southwestern shores where current structures are located
Very likely	Maritime infrastructure, shipwrecks, associated deposits and discard	Bed of the harbour between current structures and the southern half of the study area which has been used for mooring for vessels since the mid 19th century
Likely	Shipwrecks and discard	Shipwrecks are likely. Discards within the remainder of the study area would have been created/deposited from the early 20th century onwards, as this area would have mostly likely been dredged in 1913.

6 AREA C – WHITE BAY, JOHNSTONS BAY & GLEBE ISLAND

6.1 Physical setting

The current landscape of Area C consists of the highly modified and extensively reclaimed Glebe Island and the surrounding waters of White Bay and Johnstons Bay (Figure 98). The bed of the harbour of both bays is also highly altered, with water depths around Glebe Island maintained through dredging about 12 metres below Lowest Astronomical Tide to service the surrounding commercial port facilities. Before reclamation activities during the 20th century, Glebe Island was a true island, separated from the Rozelle foreshore by a narrow stretch of water. Borehole data collected for this project shows that the surface of the bed of the harbour is a mix of silt and silty sand (Douglas Partners & Golder Associates, August 2017: Boreholes B204W and B205W).

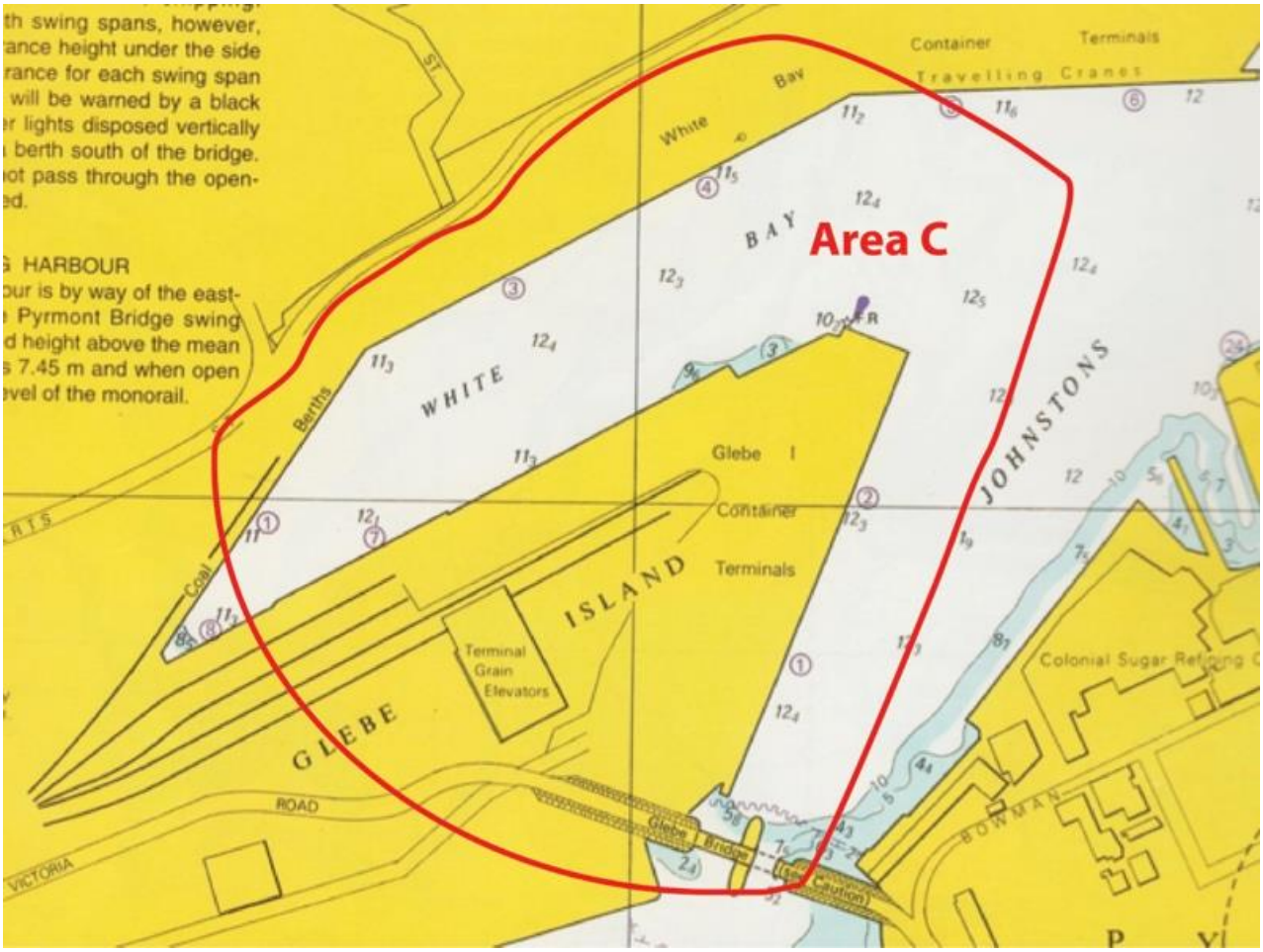


Figure 98: Portion of nautical chart showing Area C. Depths are in metres (Commonwealth of Australia / Crawford House Publishing, 1995, Chart 25)

6.2 Historical background

6.2.1 White Bay

Area C covers the whole of White Bay as well as the areas of Blackwattle Bay east of Glebe Island, including down to Glebe Island Bridge. Since the early years of European settlement, White Bay has been a hub of industry associated with Balmain. From 1854 the bay was dominated by John Booth's Steam Saw Mills, the first timber and joinery works in Sydney, until it ceased operating in 1902. A local ferry wharf was located on Bald Rock, a natural feature of the bay, until the 1960s. In 1875, the Australian Gas Light Company built its works on the waterfront to reticulate gas for street lighting. Gas lighting in Balmain was superseded by electricity in 1909 (Reynolds 2008a).

A British soap manufacturer, William Lever, established a subsidiary of Lever Brothers in 1895 and reclaimed some of the White Bay shoreline. After various changes of name, the company became the Unilever conglomerate (Figure 99). By 1988, when the complex began to relocate, it had expanded along a large stretch of the White Bay foreshore (Reynolds 2008).

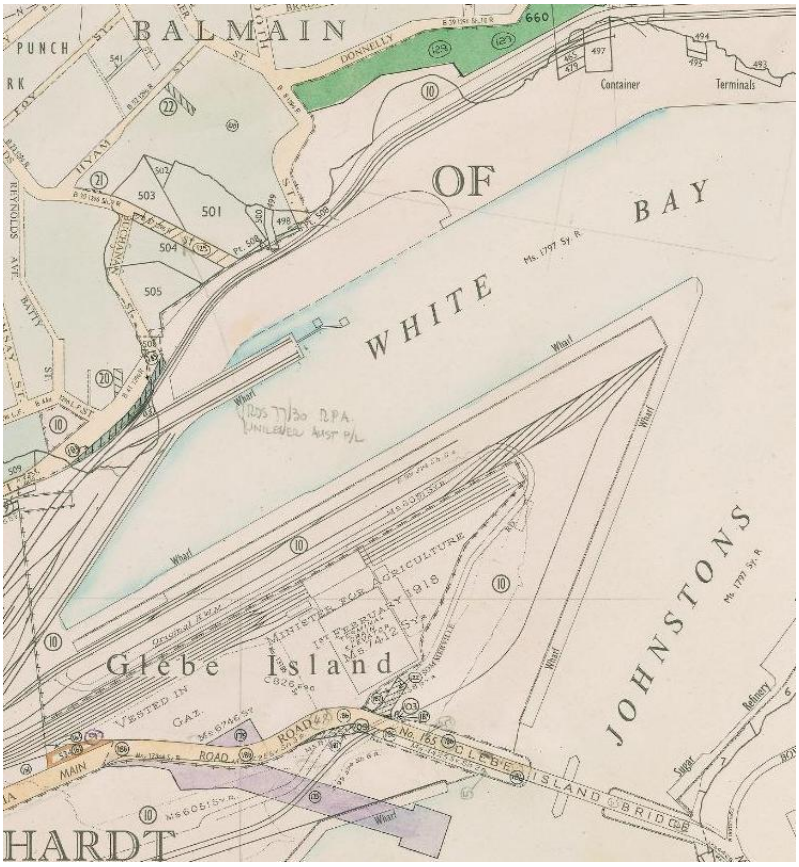


Figure 99: 1971 map of White Bay showing faintly pencilled notation containing 'Unilever Aust P/L' near the main wharf. On the north foreshore are 'Container Terminals' and to the south-west is the White Bay Power Station (NSW Department of Lands, 1971)

Also shown on this map is another major industry at the neck of the bay – the White Bay Power Station, built by the NSW Railway Commissioners from 1912 and coming into service in 1913 (Figure 99 and Figure 100). It operated continuously for about 70 years, generating electricity for railways, Glebe Island Bridge, Pyrmont Bridge and various pumping stations. By the end of World War I, White Bay Power Station was generating 75 per cent of all railway power in Sydney. The coal loader was fed by freighters docking at the wharf.

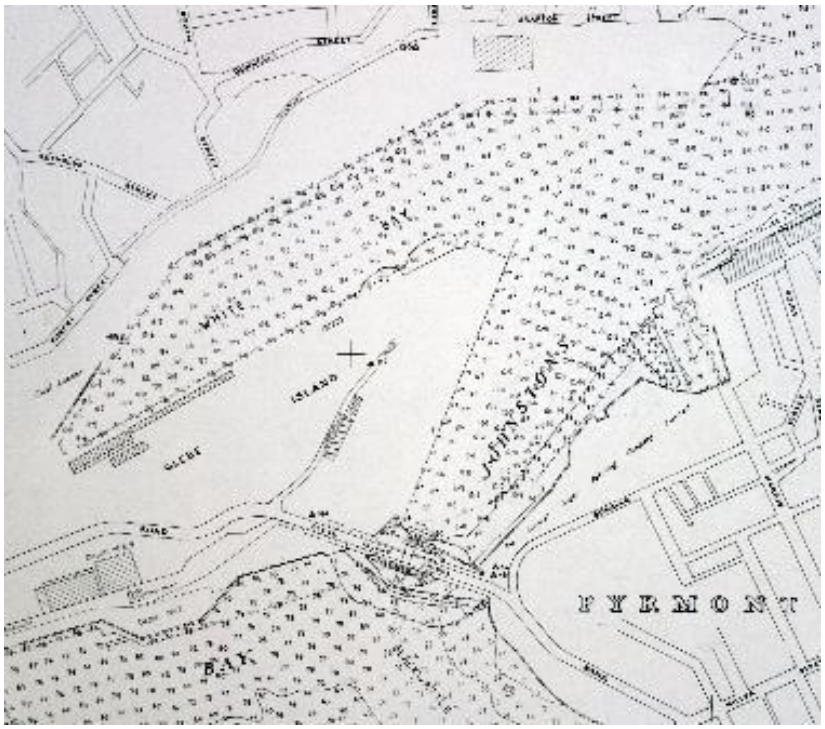


Figure 100: 1947 chart revised until 1983 showing Glebe Island with reclamation and the 'coal loader' at the head of White Bay (Maritime Services Board of NSW, 1947 revised until 1983)

The power station was acquired by the Electricity Commission of NSW in 1953 and was decommissioned in 1984 with the intention of conserving and adapting the building for compatible use (Reynolds 2008). Various other industries were based in White Bay, as shown by Crown plans from the early 20th century (Figure 101 and Figure 102). The first plan, from c.1920, includes notations for a 'Stephen St. Ferry Wharf' in White Bay, as well as land for a new wharfage scheme. The second plan includes labels for a fish yard, railway, rowing club, 'Blue Metal and Gravel' and 'Hume Steel' companies as well as areas reserved for the timber industry.

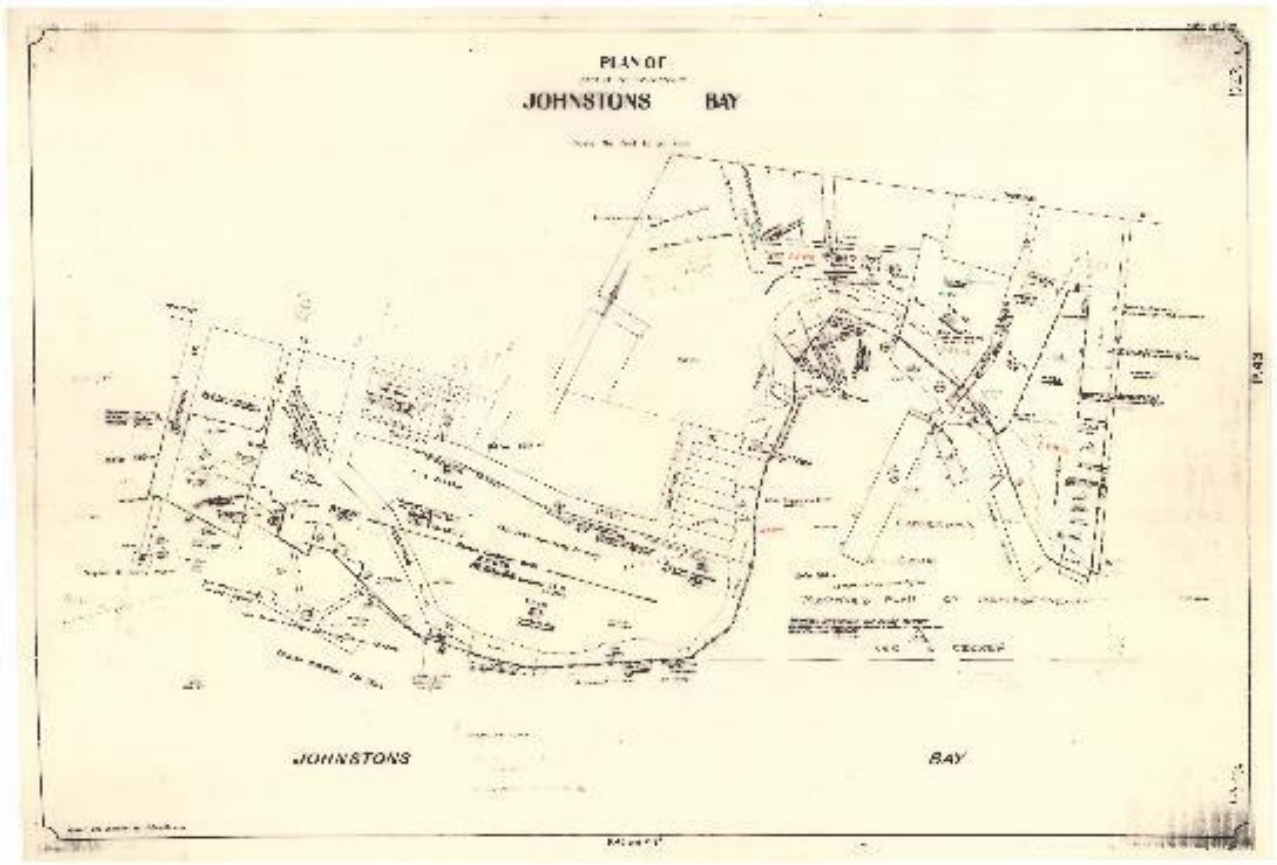


Figure 101: Crown plan of Johnstons Bay from c.1920s, annotated to c.1980s (Brewston ca.1920s annotated to c.1980s)

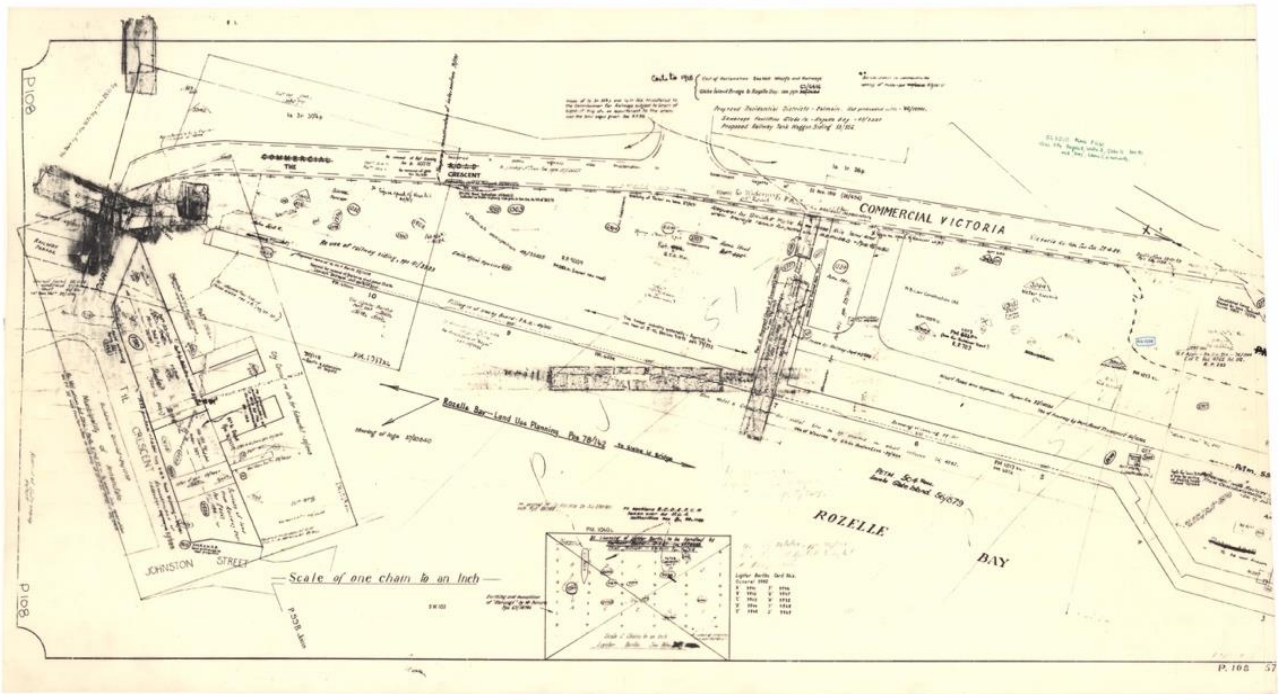


Figure 102: Crown plan of White Bay from 1920s, annotated to the 1970s (Crown Plan ca. 1920s annotated to ca. 1970s)

A search of the Australian National Shipwreck Database and Maritime Heritage Sites database indicates one known shipwrecking event in White Bay. The SS *Erina,* a timber-hulled, 55-tonne steamer built in 1903, was a well-known harbour excursion steamer, often used to convey pleasure and fishing parties outside the Sydney Heads (Anon 5 July 1911a & b, Anon 7 July 1911) (Figure 103). In July 1911, SS *Erina* caught fire while moored alongside Long Wharf in White Bay. The vessel sustained considerable damage to the deck fittings, wheelhouse, bridge, a lifeboat and the decking before the fire was extinguished. Although the vessel was removed and repaired, there may be items at the mooring location that were jettisoned or used to aid the removal efforts.

***Figure 103:* SS *Erina*, c. 1920s**
(Anon ca. 1920s)

6.2.2 Glebe Island

Glebe Island was originally a 13 hectare island of rock and scrub between Rozelle Bay and White Bay. It was part of a land grant given to Reverend Richard Johnson, the chaplain of the First Fleet. In 1872, Johnson exchanged Glebe Island for land to the west, with his new land ownership comprising the area of the current suburb of Glebe. An abattoir was established on Glebe Island in 1860, having moved from Blackwattle Creek due to complaints about its pollution into Blackwattle Bay. As a part of the abattoir, a causeway was constructed from the southwestern point of the island to the mainland so that cattle could be driven directly to the abattoir (Blaxell 2009).

A wooden bridge was constructed from Pyrmont to Glebe in 1861 (Figure 104 and Figure 105). This was the first Glebe Island Bridge and, along with Pyrmont Bridge, meant that meat could be transported directly into town (Blaxell 2009). This bridge was a private toll-bridge, a timber beam viaduct with a small, one-arm, hand-cranked wing-span tucked into the Pyrmont shore. After 30 years, the bridge needed extensive repairs. It was purchased by the Government and the Public Works Department began planning a replacement bridge (NSW Office of Environment &Heritage 2013).

Figure 104: 1870 photograph of the first Glebe Island Bridge (Pickering 1870)

Figure 105: 1886 to 1888 map showing Glebe Island with abattoirs and the first Glebe Island Bridge (Higginbotham and Robinson, 1886-1888)

A new Glebe Island Bridge was constructed in 1901 and still stands today (Figure 106). It is a swing bridge, swivelling on a massive central stone pivot-pier with timber-trussed side panels (Reynolds 2008b). Its construction was part of a larger project commenced in the 1880s called the Five Bridges Route, which involved building or replacing bridges at Pyrmont Bay, Glebe Island, Iron Cove, Gladesville and Fig Tree to enable access to the northern shore (NSW Office of Environment & Heritage 2013).

In the same year, Sydney Harbour Trust began a dredging operation to develop wharves on the island. By 1915, the abattoir on Glebe Island had been demolished and new abattoirs established near Homebush Bay. The island was quarried and flattened and, in 1918, grain silos and elevators were erected on the island (NSW Office of Environment and Heritage, 2013).

Glebe Island became the principal wharf for handling wheat and flour, with wharves built on three sides of the levelled rocky outcrop. The fourth side of Glebe Island was attached to the Rozelle shoreline as part of extensive reclamation works in Rozelle Bay and White Bay, which had begun in the 1890s (Reynolds 2008b) (Figure 107 and Figure 108). The mangrove swamps on both sides of the island were seen as home to disease and stench spread by effluent from the abattoir. The cultural and medical mindset of the late 19th century dealt with these issues by eradicating the mangroves with reclamation (Williams 2010). In the case of Glebe Island, this was of benefit as it resulted in wharf-building.

Figure 106: 1929 photograph of the second and current Glebe Island Bridge (Anon 1929)

Figure 107: 1943 aerial photograph showing the new shape of Glebe Island after reclamation, the second Glebe Island Bridge, wharf facilities and grain silos (RTA Photography 1943)

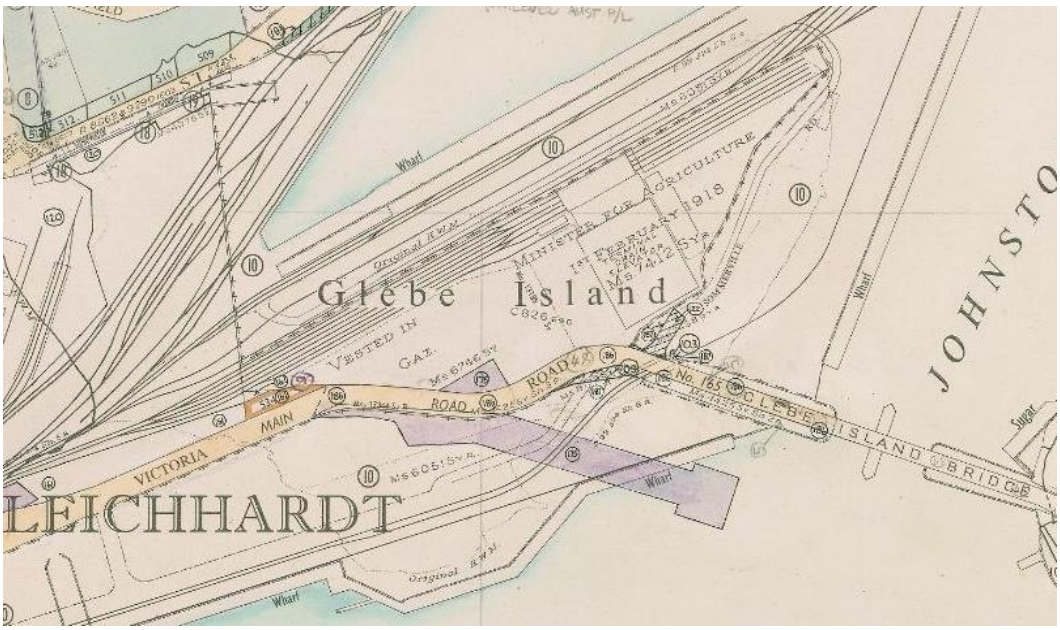


Figure 108: 1971 map of Glebe Island showing faint 'original H.W.M.' (high water mark) at the bottom of the image before reclamation (NSW Department of Lands, 1971)

A c.1920s Crown plan of Glebe Island, annotated to the c.1970s, shows the infrastructure in place and the industries that used them (Figure 109). Notations include 'terminal grain elevators', 'tanks', a customs wharf and even a 'canteen'. Agriculture related industries are noted as well as 'Clyde Sawmilling Co'.

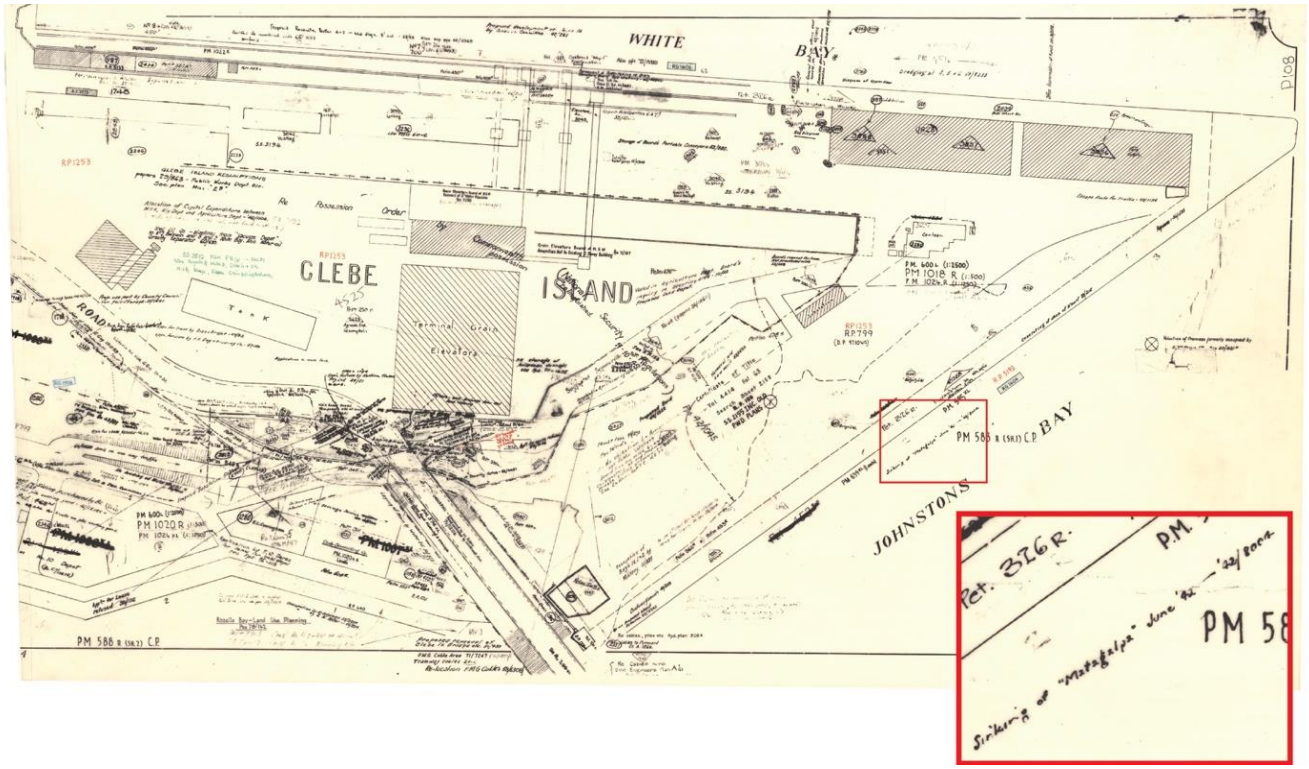


Figure 109: Crown plan of Glebe Island from c.1920s, annotated to c.1970s (Crown Plan ca. 1920s, annotated to ca. 1970s)

During World War II, much of the island was commandeered for the United States' main army depot in Sydney, although bulk handling of grain continued. A notation reading 'Occupation of Bays 1A, 1+2 by military' is present on the southern side of Glebe Island in the above plan (see Figure 109). Next to it is a note reading 'sinking of 'Matagalpa' June '42'.

The SS *Matagalpa*, formerly the USS *Osborne* (DD-295), was a Clemson Class destroyer that served with the United States Navy from 1919 to 1930 (Figure 110). After being decommissioned in 1930, the *Osborne* was sold to the Standard Fruit Company of New Orleans and subsequently converted into a cargo vessel with a new name *Matagalpa.* In February 1942, *Matagalpa* was requisitioned by the United States Army to serve as an armed transport ship in the Pacific Theatre of World War II. In June 1942, while moored in Johnstons Bay alongside the US Army Depot at Glebe Island, a fire broke out in one of *Matagalpa's* cargo holds and spread across the vessel. After 70 firemen fought unsuccessfully for seven hours to save

Matagalpa, the seacocks were opened and the vessel sank to the bed of the harbour alongside the wharf. The *Matagalpa* remained there until late 1942, when the submerged wreck and remaining cargo on board were offered for sale by the US War Shipping Administration. The *Matagalpa* was subsequently salvaged and relocated to Kerosene Bay, Sydney Harbour. Five years later, *Matalgalpa* again caught fire and sank while operating as a hulk in Kerosene Bay. This time the vessel was removed and scuttled in an offshore disposal area beyond Sydney Heads (Anon 29 June 1942, Anon 14 September 1947, Naval History & Heritage Command 2016, Pacific Wrecks 2018, U.S. War Shipping Administration 17 October 1942).

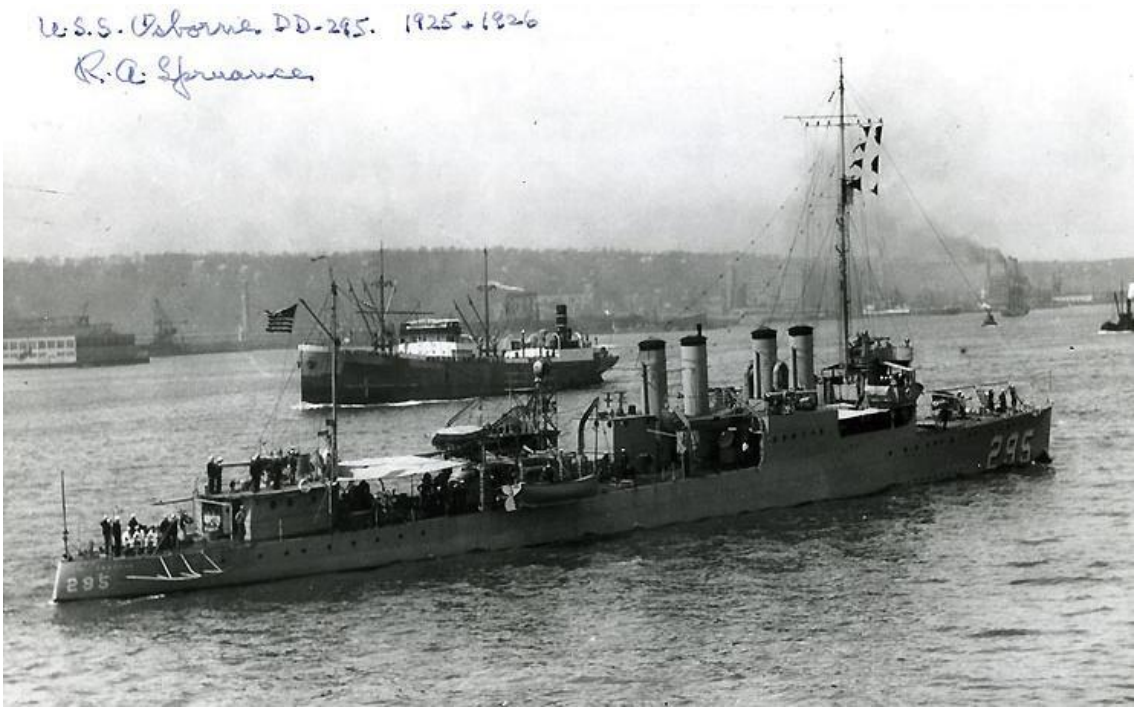


Figure 110: USS* Osborne *in Hudson River, USA during the 1920s (Anon ca. 1920s)

In 1990, the wheat terminal was transferred to Port Kembla and the wharfage at Glebe Island was remodelled for containerised cargo. It became the AAT terminal for imported motor vehicles. While some silos were demolished, Cement Australia has used 16 of them as a bulk cement terminal since 1991. In 1996 the Anzac Bridge was constructed near to the Glebe Island Bridge as the latter was too narrow to cope with Sydney's increased traffic flow (Blaxell 2009).

6.3 Known maritime heritage sites in Area C

6.3.1 Maritime infrastructure

There are no known maritime heritage infrastructure sites within Area C.

6.3.2 Shipwrecks

Two shipwrecking events are known to have occurred in Area C, the SS *Erina* in 1911 and SS *Matagalpa* in 1942. Both vessels were refloated and removed but there may be items present associated with either vessel that were jettisoned or used to aid the refloating efforts.

6.3.3 Built heritage

There are two known built heritage sites within Area C:

- Glebe Island Bridge – a swing bridge built in 1901 and listed on the State Heritage Register, the Roads and Maritime Services Section 170 register, the Sydney Regional Environmental Plan 2005 and the Register of the National Estate
- Anzac Bridge – a cable-stayed bridge constructed in 1996 and listed on the Roads and Maritime Services Section 170 Register.

6.4 Potential maritime heritage sites

Based on the history presented in Section 6.2, the following cultural activities have occurred within Area C:

White Bay and the broader surrounds:

- Timber and joinery works (1854 to 1902)
- Ferry service (c.1860s to 1960s)
- Gas reticulation (1875 to 1909)
- Soap manufacturing (1895 to 1988)
- Production of power (1913 to 1984).

Glebe Island and the broader surrounds:

- Abattoir (1860 to 1915)
- Bridge construction and use (1861 to 1901, 1901 to 1996, 1996 onwards)
- Reclamation works (1890s)
- Bulk shipping of grain (1918 to 1990)
- United States army depot (during World War II)
- Remodelling for container shipping (1990)
- Importing of motor vehicles (1990)
- Cement industry (1991 onwards).

Johnstons Bay and the broader surrounds:

- Shipping and iron works (c.1840)
- Quarrying of sandstone (c.1840s to c.1900s)
- Sugar refining (1878 to 1995).

As such, the following maritime sites and items could also occur within Area C:

- Maritime infrastructure (c.1840s onwards) – stone seawalls, jetties, wharves, dolphins, slipways, enclosures and moorings
- Discard from maritime infrastructure (c.1840s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment, industrial equipment, items associated with industries and the movement of goods as well as damaged and removed material from the infrastructure
- Shipwrecks (c.1840s onwards)
- Discard from vessels (c.1840s onwards) – accidental and/or deliberate discard of items such as personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as items associated with industries and the movement of goods
- Remains of original Glebe Island Bridge
- Discard in and under reclamation fill (1890s).

The likelihood of such maritime sites surviving depends on post-depositional processes that may have occurred – in particular, dredging and reclamation.

Extensive reclamation projects have occurred within Area C, concentrated along the shores of White Bay and surrounding Glebe Island (Figure 111 and Figure 112). As a result, the shorelines have been completely modified. The waters around Glebe Island are maintained through dredging at around 12 metres depth for the commercially active wharves, and the bed of the harbour is expected to be fine silt.

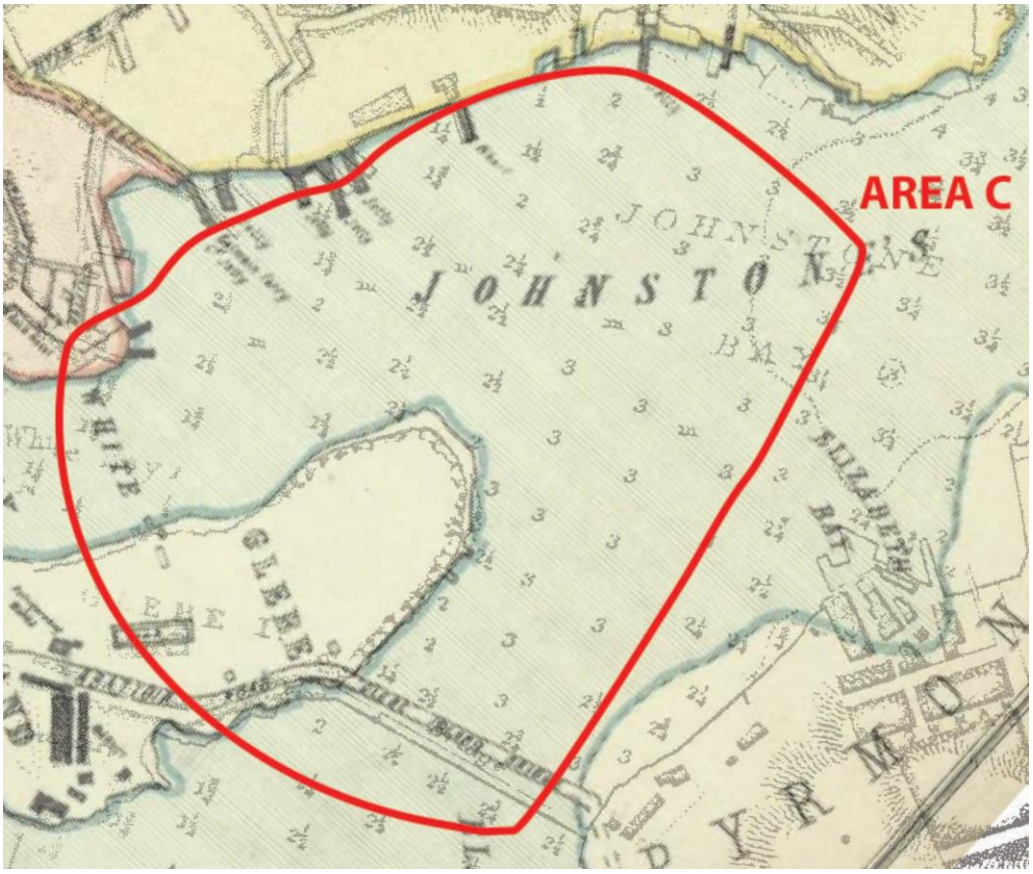


Figure 111: Overlay of 1886–1888 map of Balmain (see Figure 105) with a c.1900 chart showing reclamation between these periods (shaded) (Anon ca. 1900)

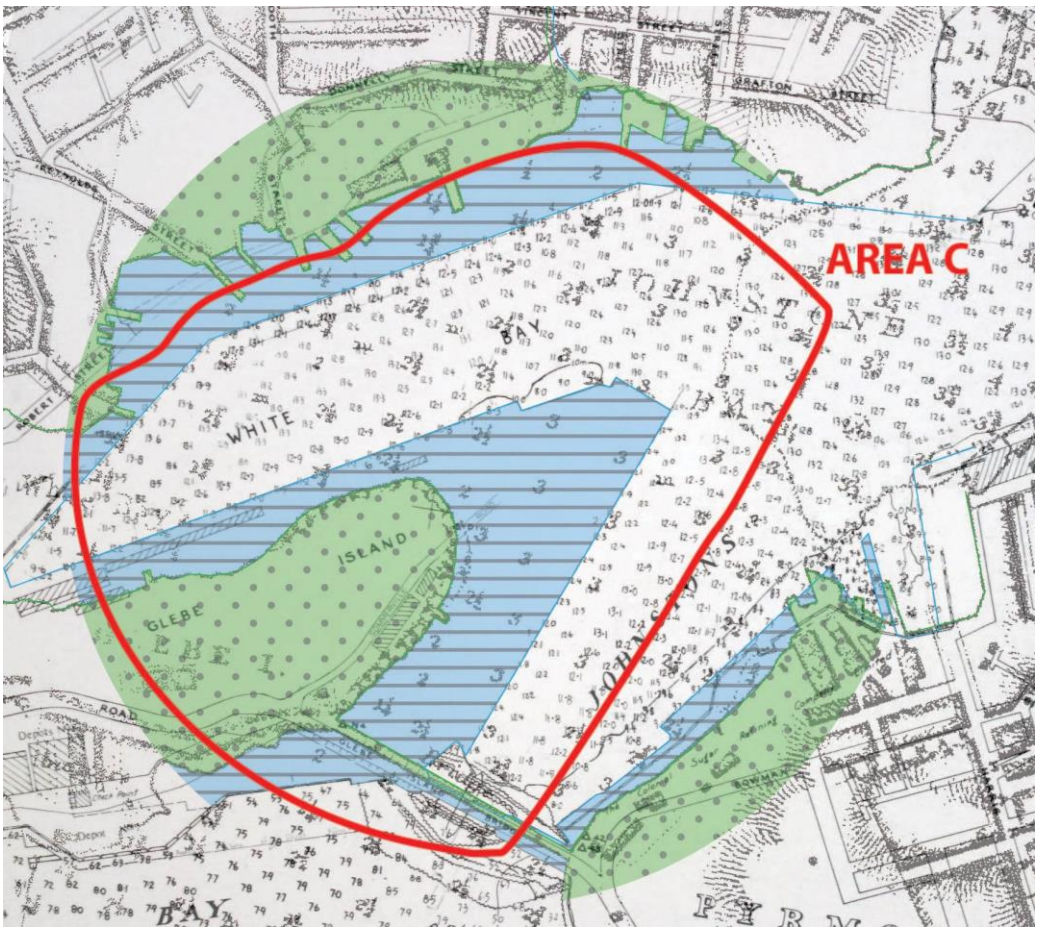


Figure 112: Overlay of c.1900 chart with 1947 chart (annotated to 1983). *Green (irregular border) indicates the ca.1900 coastline and blue (straight border) indicates the reclaimed coastline by 1947*

6.4.1 Maritime infrastructure and associated deposits

The earliest (mid to late 19th century) maritime infrastructure in Area C included timber wharves and jetties for industries including timber and joinery works, quarrying, and iron works. These timber structures would have been built, repaired, expanded and later removed or buried under reclamation. It is likely that maintenance and removal of the structures would have left piles cut off about one metre above the bed of the harbour, while jetties and wharves buried under reclamation would often be left largely intact to assist in stabilising the fill.

Deposits associated with the earlier infrastructure would have built up around and beneath the structures. Artefacts would have fallen between the deck planking of jetties and wharves as well as off the vessels moored alongside. Such deposits can include accidental and/or deliberate discard of items such as personal objects, food and drink containers, fishing equipment as well as damaged and removed material from maintenance of the structure. These deposits would also have been buried by successive reclamation.

The next phase of larger infrastructure that developed in the 20th century largely consisted of hardstand wharves, reclamation and seawalls and was associated with increased shipping activity, in particular, the bulk transport of grain. Materials such as iron, steel and reinforced concrete were likely used in the construction of these facilities. While this infrastructure would have required maintenance, damaged elements would have been removed entirely, leaving less discard. The conversion to container shipping again would have resulted in new infrastructure for larger container vessels. Deposits associated with later infrastructure could include accidental and/or deliberate discard of items such as personal objects as well as food and drink containers. Continual dredging of the waterways would likely have removed most of these deposits.

6.4.2 Shipwrecks and associated deposits

Shipwrecks would be associated with industrial activity in this area and most likely the result of accidental wrecking through collision, fire and explosions. Due to the importance of maintaining the shipping channels and wharfage areas, any shipwreck remains would likely have been re-floated or removed, as was the case with the SS *Erina* and the SS *Matagalpa,* though there is always the possibility that items may be present that were jettisoned or used to aid the re-floating efforts. No deliberately sunk vessels are likely to be in the area.

6.4.3 Discard from vessels

The movement and mooring of vessels in Area C would inevitably coincide with discard from industrial vessels. Discard can be accidental or deliberate, and can include personal objects, food and drink containers, ships fittings and equipment, fishing and boating equipment as well as cargo and shipping materials being loaded or offloaded at White Bay, Glebe Island or Johnstons Bay. Such discard can consist of a range of materials and are mostly single items, but can also occur in scatters created by one event or multiple events. Usually there are higher concentrations closer to shore or in mooring areas, however extensive dredging in the operating channels of Area C would have removed these materials. Any surviving discard from vessels would likely be associated with the earlier phases of industrial activity and be buried within reclamation.

6.4.4 Discard in and under reclamation fill

Extensive reclamation has occurred in White Bay and around Glebe Island. Fill used as part of reclamation is typically sourced from another location. This fill would have the effect of burying any archaeological remains as well as possibly containing objects from the source of the fill. There may also have been opportunistic discard during the process of reclamation. The type, material kind, size and extent of these remains cannot be predicted. Regardless, the process of burial generally preserves material and it is likely that any such items are relatively intact.

6.5 Summary of maritime heritage sites and archaeological potential in Area C

Area C includes areas that have the potential to contain remains associated with maritime infrastructure and discard. Using known sites, the distribution of potential sites and the extent of reclamation and dredging in Area C, these areas have been separated by a rating of 'archaeological potential' – see Table 8 in Section 4.5. The potential of specific site types within Area C is shown in Table 11 and illustrated in Figure 113.

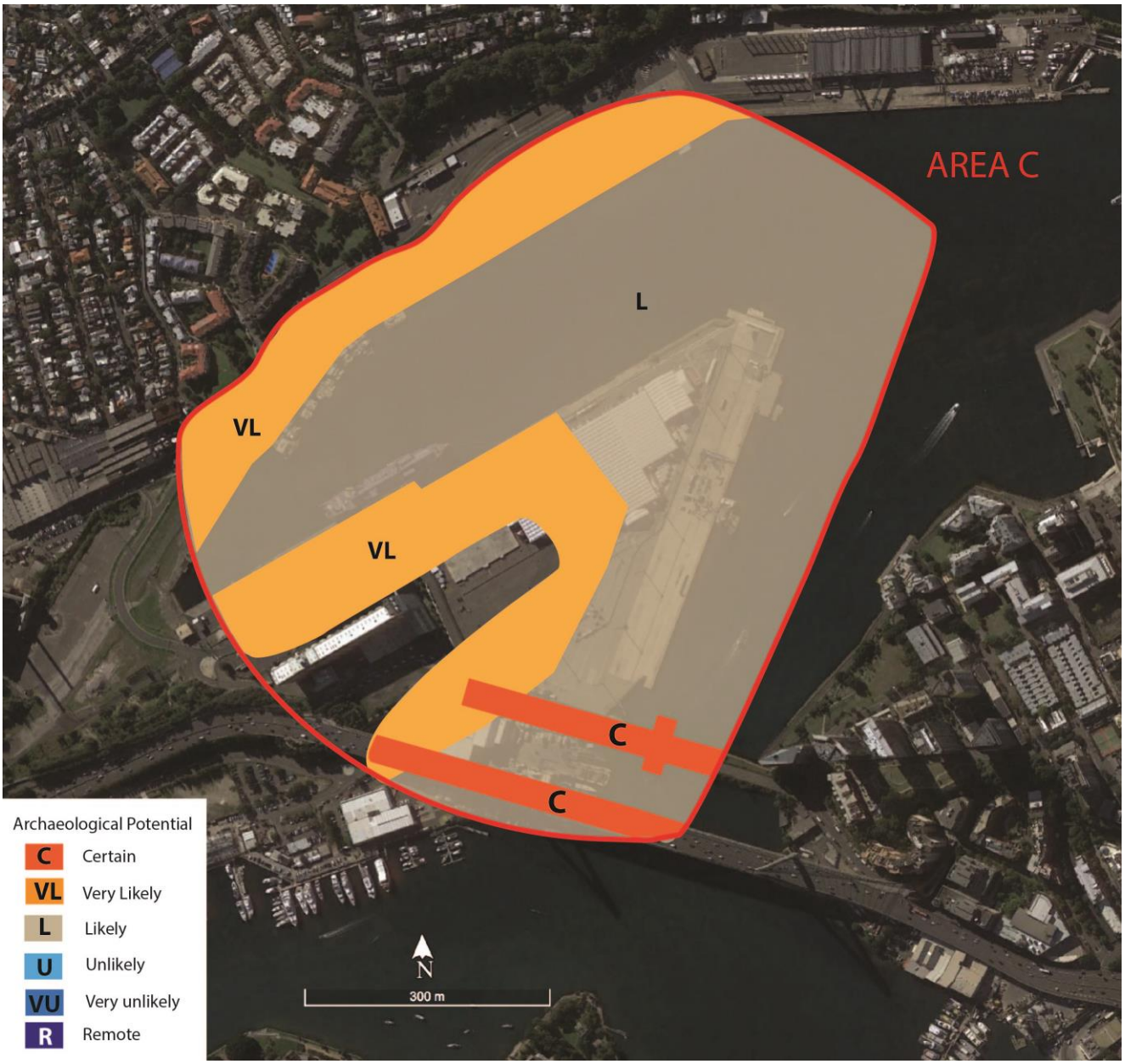


Figure 113: Areas of archaeological potential in Area C

Table 11: Archaeological potential for site types in Area C

Potential	Site type	Known or predicted location
Certain	Built heritage	Glebe Island and Anzac Bridges
Very likely	Maritime infrastructure and associated deposits	Within areas of reclamation at White Bay and Glebe Island
Likely	Discard from vessels	Across the current bed of the harbour within the study area

7 HERITAGE SIGNIFICANCE

7.1 Introduction

Understanding the cultural heritage significance of a known or potential maritime heritage site is critical in determining an appropriate and proportionate level of mitigation. The significance criteria are detailed below, followed by significance assessments for each of the known maritime heritage sites and potential maritime heritage site types.

7.2 Significance criteria

An assessment of cultural significance or heritage significance seeks to understand and establish the importance or value that a place, site or item may have to select communities and the general community. The Australian ICOMOS *Charter for the Conservation of Places of Cultural Significance* (the *Burra Charter 1979*, most recently revised in 2013) is the standard adopted by most heritage practitioners in Australia when assessing significance. It defines cultural significance as 'aesthetic, historic, scientific or social value for past, present or future generations'.

This value may be contained in the fabric of the item, its setting and relationship to other items, the response that the item stimulates in those who value it now, or the meaning of that item to contemporary society.

Accurate assessment of the cultural significance of sites, places and items is an essential component of the NSW heritage assessment and planning process. A clear determination of a site's significance allows informed planning decisions to be made, in addition to ensuring that their heritage values are maintained, enhanced, or at least minimally affected by development.

Assessments of significance are made by applying the following standard evaluation criteria provided by the NSW Department of Premier and Cabinet (Heritage) (NSW Heritage Office 2001) in order to establish a statement of significance. These criteria are based on the *Burra Charter*:

- **a.** An item is **important in the course or pattern** of NSW's **cultural or natural history** (or the cultural or natural history of the local area)
- **b.** An item has strong or special **associations with** the life or works of **a person, or group of persons, of importance** in NSW's cultural or natural history (or the cultural or natural history of the local area)
- **c.** An item is important in demonstrating **aesthetic characteristics** and/or a high degree of **creative or technical achievement** in NSW (or the local area)
- **d.** An item has strong or special **associations with a particular community or cultural group** in NSW (or the local area) for **social, cultural or spiritual reasons**
- **e.** An item has **potential to yield information** that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area)
- **f.** An item possesses **uncommon, rare or endangered** aspects of NSW's cultural or natural history (or the cultural or natural history of the local area)
- **g.** An item is important in **demonstrating the principal characteristics of a class** of NSW's cultural or natural places or cultural and natural environments.

In addressing the criteria above, it should be demonstrated whether the site meets the threshold for being of State or Local significance. If it does not meet either threshold it is considered to have minimal significance with respect to that particular criterion. If a site meets the threshold for State significance for at least one the above criteria it is considered to be of State significance.

7.3 Historical themes

Historical themes are a way of describing a major force or process which has contributed to our history. Themes provide a context within which the heritage significance of an item can be understood, assessed and compared. A theme could be specific to a local area or a region, or it could reflect a function (NSW Heritage Office & Department of Urban Affairs and Planning 1996). In the case of this report, historical themes are used to assess the significance of site types by demonstrating how the sites shaped the area in which they are located. This is particularly important as the broad scale of this assessment prevents detailed research into individual items.

Table 12 lists the relevant themes that are used in this assessment, based on the NSW Heritage Council's Historical Themes (Heritage Council of New South Wales 2001).

Table 12: NSW Historical Themes used in this assessment

NSW Theme	Description	Relevant Examples
7. Mining	Activities associated with the identification, extraction, processing and distribution of mineral ores, precious stones and other such inorganic substances	Quarry
8. Fishing	Activities associated with gathering, producing, distributing, and consuming resources from aquatic environments useful to humans	Moorings, jetties, fishing equipment
9. Environment – natural or modified and shaped	Activities associated with the interactions between humans, human societies and the shaping of their physical surroundings	Nature reserve, preservation of open space, place important in arguments for nature or cultural heritage conservation. Could also include seawall
10. Townships	Activities associated with creating, planning and managing urban functions, landscapes and lifestyles in towns, suburbs and villages	Abandoned wharf, village reserve
13. Transport	Activities associated with the moving of people and goods from one place to another, and systems for the provision of such movements	Ferry, wharf, barge, harbour, shipwreck
15. Utilities	Activities associated with the provision of services, especially on a communal basis	Electricity tunnel, cables
16. Industry	Activities associated with the manufacture, production and distribution of goods	Shipbuilding, oil and coal bunkering
18. Commerce	Activities relating to buying, selling and exchanging goods and services	Trading wharf
19. Technology	Activities and processes associated with the knowledge or use of mechanical arts and applied sciences	Coal loading facility
21. Government and administration	Activities associated with the governance of local areas, regions, the State and the nation, and the administration of public programs – includes both principled and corrupt activities.	Quarantine station
23. Defence	Activities associated with defending places from hostile takeover and occupation	Naval facility
26. Creative endeavour	Activities associated with the production and performance of literary, artistic, architectural and other imaginative or inventive works; and/or associated with the production and expression of cultural phenomena; and/or environments that have inspired such creative activities	Exemplar of an architectural style, bridges, park designs
27. Leisure	Activities associated with recreation and relaxation	Park, beach, fishing spot, picnic place
28. Sport	Activities associated with organised recreational and health promotional activities	Moorings for recreational watercraft
29. Health	Activities associated with preparing and providing medical assistance and/or promoting or maintaining the wellbeing of humans	Landscaped grounds
35. Persons	Activities of, and associations with, identifiable individuals, families and communal groups	Berry and Wollstonecraft

7.4 Assessment of cultural heritage significance

7.4.1 Cultural heritage significance of known maritime heritage sites

The assessment of the cultural heritage significance of the known maritime heritage sites is presented in Table 13 to Table 16. Where relevant and available, the assessments for listed sites have been used. Where the listings are not sufficient, cultural heritage significance assessments from other reports have been used. Where additional information has been added to that listed, the added text is italicised.

The recent wrecks with fibreglass or plastic hulls have been assessed as having Nil cultural heritage significance due to their recent age and widespread use. The history and identity of the other three known wrecks within Area A are not currently known. This limits any assessment of their cultural heritage significance. The assessments have been made based on the estimated age of the wrecks and their possible functions. They are currently assessed to be of local significance based on available information. It is possible, though unlikely, that further investigation into these sites may elevate them to State significance.

There is insufficient information on the anomalies within the study area, including “Wreck 1241”, to allow for an assessment of their cultural heritage significance.

Items and sites that do not meet the local significance threshold have been assessed to be of Nil significance. These sites and items so assessed will not be further addressed in this study.

Table 13: Cultural heritage significance assessment of known maritime heritage sites in Area A

Site	Criterion A (Historical)	Criterion B (Person)	Criterion C (Aesthetic / technical)	Criterion D (Social)	Criterion E (Research)	Criterion F (Comparative rarity)	Criterion G (Representativeness)	Significance	Themes / sub-themes
Yurulbin Park	Part of the early subdivision and waterfront development of the local area from the 1860s. **Local**	Associated with Morrison and Sinclair Pty Ltd, shipbuilders as well as prominent landscape architect Bruce Mackenzie. **Local**	The Park is of high local aesthetic significance due to its Harbour side location, rock outcrops and stone walls and sequence of spaces created by built structures and plantings. **Local**	The area is of social significance to the local and wider community as an open public foreshore park area. **Local**	Would yield some information on the phases of construction and activity related to the maritime industrial use of the site. **Local**	Relatively rare environment and cultural landscape that retains some evidence of the early use of the Balmain waterfront and evidence of landscape philosophies of the 1970s. **Local**	Yurulbin Park is one of two waterfront parks in the LGA designed by Bruce Mackenzie and Associates between 1972 and 1977. The firm also designed Illoura Reserve in 1970. **Local**	**Local**	13) Transport 16) Industry 26) Creative endeavour 27) Leisure / shipbuilding, Public parks, Public reserve, Park design, Public well-being
Long Nose Point (Birchgrove) Wharf	Has been a Balmain peninsula transport facility since the 1870s and, as one of several ferry wharves around the peninsula, forms part of the historic infrastructure around which the suburb has developed. **Local**	Has associations with Didier Joubert and the history of the early private ferry companies serving the Balmain and Hunters Hill localities. **Local**	Encapsulates many of the attractive qualities for which Sydney Harbour ferries are valued, including a human scale, grand visual and physical context, a relationship to the 'elements' and natural materials. **Local**	No known association with a particular community. **Nil**	The bed of the harbour around the current wharf site likely to contain archaeological deposits formed by passengers which would reflect the changing socio-economical demographic of the area in the late 19th and early 20th centuries. **Local**	Ferry wharf sites were and are common across Sydney Harbour. **Nil**	Representative of traditional peninsula ferry wharves around Sydney Harbour. **Local**	**Local**	13) Transport / private and public
Balls Head Coal Loader	Has played a prominent role in the area's development of coal as an export industry. **Local**	Associated with major coal and shipping companies. **Local**	Demonstrates technological change from coal lightering to shore-based bunkering. Significant for the aesthetic qualities of terraced form, massive sandstone walls as well as high level industrial wharf. **State**	Work schemes carried out in 1930s Depression to retain personnel. Similar undertakings in 1960s slump in coal industry. **Local**	Ability to demonstrate the practise of coal bunkering in the early to mid 20th century. **Local**	One of the first, and one of the few surviving shore-based coal loading facilities in Sydney Harbour. **State**	Represents early to mid 20th century coal handling technologies. **Local**	**State**	13) Transport 16) Industry / coal bunkering
Concrete block, possible former mooring (14W-01)	Associated with maritime related activities in the Birchgrove area. **Nil**	No known association with well-known person(s). **Nil**	This object has no technical or aesthetic merit. **Nil**	No known association with a particular community. **Nil**	No new relevant information is likely to be obtained from further study of this object. **Nil**	Concrete moorings are commonplace. **Nil**	This object is not a good representative example of remnant maritime infrastructure. **Nil**	**Nil**	13) Transport / moorings
Unidentified Balls Head Bay 1 shipwreck	Identity of vessel not known but likely work barge from 20th century. Of timber construction but use of fibreglass as part of repair work. **Nil**	No known association with well-known person(s). **Nil**	The wreck is largely intact thereby exudes an aesthetic quality. There does not appear to be any technical merit associated with this wreck. **Nil**	No known association with a particular community. **Nil**	Further investigation of the hull would provide more information as to the vessel's functional and historical context. **Local**	There is a limited number shipwrecks recorded in NSW and the wrecks of small harbour workboats are under reported. This is an uncommon site in the context that they are not well recorded. **Local**	This is a reasonably well-preserved example of a mid 20th century work boat. **Nil**	**Local**	13) Transport / shipwreck
Unidentified Balls Head Bay 2 shipwreck	Identity of vessel not known but likely work barge from 20th century. The use of riveting on the hull points to a date of construction before World War II. **Nil**	No known association with well-known person(s). **Nil**	The wreck is largely intact thereby exudes an aesthetic quality. There does not appear to be any technical merit associated with this wreck. **Nil**	No known association with a particular community. **Nil**	Further investigation of the hull would provide more information as to the vessel's functional and historical context. **Local**	There is a limited number shipwrecks recorded in NSW and the wrecks of small harbour workboats are under reported. **Local**	This is a reasonably well-preserved example of a mid 20th century work boat. **Nil**	**Local**	13) Transport / shipwreck
Balls Head #1 Unknown shipwreck	Identity of vessel not known but likely work barge from 20th century. **Nil**	No known association with well-known person(s). **Nil**	Not assessed as site not inspected.	No known association with a particular community. **Nil**	Further investigation of the hull and its contents would provide more information as to the vessel's historical context. **Local**	There is a limited number shipwrecks recorded in NSW and the wrecks of small harbour watercraft are under-reported. **Local**	Not assessed as the site was not inspected	**Local**	13) Transport / shipwreck
Railway Electricity Tunnel	First tunnel to be constructed under Sydney Harbour (1919 – 1926). Was a major link in the power supply to the railway and tramway system between Sydney and the North Shore and is an important element of the development of public transport in Sydney. **Local**	No known association with well-known person(s). **Nil**	The tunnel was a major technological and engineering achievement and was the first such venture to be carried out in Australia without overseas assistance. **State**	No known association with a particular community. **Nil**	Examination of remains would yield much information on construction methods as well as innovative ways deployed to overcome physical challenges. **State**	This is one of a handful of underwater Sydney Harbour crossings and seems to be the only tunnel that has been excavated solely through rock	This is the only example of its type and as it has been flooded it is likely to be in good condition	**State**	15) Utilities / tunnel

Site	Criterion A (Historical)	Criterion B (Person)	Criterion C (Aesthetic / technical)	Criterion D (Social)	Criterion E (Research)	Criterion F (Comparative rarity)	Criterion G (Representativeness)	Significance	Themes / sub-themes
Balls Head Reserve	Was originally part of the Wollstonecraft/Berry estate and remained as such until handed to the Government in 1906 eventually to be turned into a reserve in 1926. Was occupied by squatters during the Depression. **Local**	Associated with Alexander Berry and Edward Wollstonecraft. **Local**	A wooded headland bounded by short cliff faces. It is an ornament in western Sydney Harbour where it is surrounded by former maritime industrial landscapes and residential development. **Local**	Associated with those how have connection to the 1930s Depression. **Local**	Potential archaeological deposits which may provide new information on those who lived on the site during the 1930s Depression. **Local**	There is a limited number of headlands in Sydney Harbour as dedicated reserves. **Local**	This site is a good example of headland reserve in western Sydney Harbour. **Local**	**Local**	9) Environment 10) Townships 27) Leisure / squatters camp, recreational reserve
M.V *Cape Don*	Designed by the Australian Shipbuilding Board and built by the NSW State Dockyard, the vessel operated both as an Australian lighthouse supply ship and coastal navigation-aid service vessel from the 1960s to the 1980s. **Local**	No known association with well-known person(s). **Nil**	A handsome vessel with high raked bow designed to withstand the enormous waves of the Southern Ocean. **Local**	Has a strong connection with those who crewed the vessel and maritime enthusiasts as is evidenced M.V. Cape Don Society which is restoring the vessel. **Local**	The construction details of the vessel are well documented. Further research would yield limited information. **Local**	The M.V. *Cape Don* is the only surviving lighthouse ship in Australia. **State**	The vessel is representative of 1960s Australian design and shipbuilding, one of few remaining in Australia. **State**	**State**	13) Transport / lightship
Baragoola	Built and designed by Morts Dockyard and Engineering in 1920, operated as a Many Ferry for over 50 years. **Local**	No known association with well-known person(s). **Nil**	The vessel shows the evolution of the deep sea capable double ended screw ferry that began in the1890s and was an Australian concept. **State**	Has a strong connection with those Sydney siders who were passengers and was a familiar sight for over 50 years for those who lived along within view and worked on Sydney Harbour. Was an iconic Sydney vessel recognised internationally. **State**	The construction details of the vessel are well documented. Further research would yield limited information. **Local**	The *Baragoola* is a surviving member of a diminishing class of vessel, an Australian built Manly ferry from before World War II originally propelled by steam. **State**	The Baragoola is representative of the distinctive double ended Manly ferry that is seen in internationally recognised iconic images of Sydney Harbour. **State**	**State**	13) Transport / ferry

Table 14: Cultural heritage significance assessments of known maritime heritage sites in Area B

Site	Criterion A (Historical)	Criterion B (Person)	Criterion C (Aesthetic/ technical)	Criterion D (Social)	Criterion E (Research)	Criterion F (Comparative rarity)	Criterion G (Representativeness)	Significance	Themes / sub-themes
Former BP bunkering depot	Had a significant role in the establishment and development of North Sydney's maritime infrastructure landscape from trading port and defence establishment to oil storage facility. **Local**	Associated with Alexander Berry and Edward Wollstonecraft. **Local**	The maritime infrastructure aspects of the site – the seawall and the collapsing jetties – have limited aesthetic appeal or technical value. **Local**	A well-known landmark to the local community. **Local**	The site can provide maritime archaeological information with particular reference to the evolution of maritime infrastructure on the site, as well as the activities that took place when occupied by Berry and Wollstonecraft and then by the NSW Torpedo Corps. **Local**	Relatively intact maritime industrial waterfronts from the 20th century are becoming less common in the Sydney region. **Local**	A poorly preserved example of 20th century maritime industrial complex in Sydney Harbour. **Local**	**Local**	5. Agriculture 13. Transport 16. Industry 23. Defence 27. Leisure/ wharf, jetties
Former Woodleys Shipyard	Had a significant role in the establishment and development of North Sydney's maritime industrial activity from the mid 19th to 20th century. Was also associated with the NSW Torpedo Corps. **Local**	Associated with Alexander Berry and Edward Wollstonecraft and for most of the 20th century with the Woodley family. **Local**	The seawall, jetties and extant slipways appear to display no technical merit, however the ensemble of structures on the foreshore within a bay setting has a pleasing aspect for a maritime industrial landscape. **Local**	A well-known landmark to the local community as it is used now for recreational purposes. **Local**	Archaeological remains could provide new information into the cultural development of this site, with particular reference to its occupation by the NSW Torpedo Corps. **Local**	Relatively intact maritime industrial waterfronts from the 20th century are becoming less common in the Sydney region. **Local**	Representative of 20th century maritime industrial complex in Sydney Harbour. **Local**	**Local**	13.Transport 16. Industry 23. Defence/ shipyard, depot
Former Quarantine Depot	Associated with the operations of the Australian Quarantine Station (North Head), part of new federalised quarantine service developed at start of 20th century. **State**	Association with JHL Cumpston – designer of Commonwealth Quarantine Service. **Local**	Picturesque complex in parkland setting and some technical merit as it can demonstrate operational methods and technologies of steam and diesel launches. **Local**	No known association with a particular community. **Nil**	The site can provide maritime archaeological information with particular reference to documenting the changes in types of vessels used and their fitting out in relation to the operation of maritime quarantine. **Local**	This is a rare site type within a State context. **Local**	Representative of quarantine boat depot complex. **Local?**	**Local**	21. Government and administration/ Health, quarantine boat depot

Table 15: Cultural heritage significance assessments of known maritime heritage sites in Area C

Site	Criterion A (Historical)	Criterion B (Person)	Criterion C (Aesthetic/ technical)	Criterion D (Social)	Criterion E (Research)	Criterion F (Comparative rarity)	Criterion G (Representativeness)	Significance	Themes / sub-themes
Glebe Island Bridge	Demonstrates one of the earliest examples of an electrical powered bridge of its type in Australia. An important item of infrastructure in the history of Sydney, Australia's famous harbour city and the capital of New South Wales, for over 90 years. **State**	Associations with Percy Allan (1861-1930), a highly regarded Australian bridge designer of the late 19th and early 20th century and JJC Bradfield (1867-1943), later known for his work on the Sydney Harbour Bridge. **State**	Its design and construction represented a significant technical achievement in the era that it was built. Represents the pinnacle of 19th century engineering and material technology, before the development of locally produced modern steel. **State**	Valued by the Sydney community for its significant contribution to the social and commercial development of Sydney and the inner western suburbs. **Local**	The bridge is a fine example of late 19th and early 20th century technology and is almost completely in original condition. The combined structural, mechanical and electrical efficiency of the bridge established it as an epitome of well-designed bridge building of the time. **Local**	One of only two (the other is Pyrmont Bridge) examples of an electrically-operated steel swing bridge in New South Wales. **State**	An excellent example of a bridge of its type, as it features all the significant structural and technical features of a swing-span bridge. **State**	**State**	13. Transport 19. Technology 26. Creative endeavour 35. Persons / bridge
Anzac Bridge	A contemporary solution to the problem of conveying road traffic over Johnstons Bay, which was part of an important transport route from Sydney to the north shore and Parramatta since the mid 19th century, known as the Five Bridges Route. **Local**	The renaming of the bridge as Anzac Bridge in 1998 provided the structure with a link to the Anzac legend, a part of Australian heritage and folklore deeply rooted in the Australian psyche. **Local**	A world standard bridge in scale, aesthetics and design features. Forms a striking and integral part of the Sydney skyline. **State**	An iconic landmark to the wider Sydney community. **State**	Limited ability to provide new information about its construction. **Nil**	Largest cable stayed bridge in NSW. **Local**	Representative example of a reinforced concrete cable stayed bridge in the state. It is currently the longest such bridge in Australia. **Local**	**State**	13. Transport 19. Technology / bridge

7.4.2 Cultural heritage significance by site type

General statements of cultural significance for potential site types have been prepared in accordance with the principles of the *Burra Charter* (2013). The statements incorporate what is known about site types in Areas A, B and C.

Table 16: Cultural heritage significance assessment of potential maritime heritage sites across areas A, B and C

Site types	Criterion A (Historical)	Criterion B (Person)	Criterion C (Aesthetic/ technical)	Criterion D (Social)	Criterion E (Research)	Criterion F (Rarity)	Criterion G (Representativeness)	Significance Level	Themes / sub-themes
Maritime infrastructure (seawalls moorings, jetties, wharves, dolphins and slips) and associated deposits. Incudes such cultural material under reclamation	Maritime infrastructure within the study area has historical significance in demonstrating the development of a significant portion of Sydney Harbour's maritime industrial waterfront for more than 100 years from the 1830s. The maritime activities represented include punt and ferry services, shipbuilding, timberyards, quarrying, Colonial and Commonwealth Navy, Quarantine, as well as transport of grain, coal, oil, gas and electricity. **Local**	There are potential heritage remains in Area B associated with Alexander Berry and Edward Wollstonecraft, prominent merchants of the NSW colony in the early 19th century. **Local**	The remains of maritime infrastructure would have little technical merit because they would be of standard types and forms. They would likely have no aesthetic qualities. **Nil**	As any remains of maritime infrastructure would be associated with the private firms or the government bodies that created them, they would have no significance beyond a small group of individuals who used them. **Nil**	It can be expected that, for the majority of remains of maritime infrastructure, little could be learned from their study. However, earlier remains from the 19th century could provide detail about the development of Sydney's waterfront from the 1830s to mid 20th century with regards to type, size, construction methods and materials used. **Local**	Remains of maritime infrastructure would be ubiquitous across the Sydney region. **Nil**	It is very unlikely that the remains of maritime infrastructure within the study area would be a good representative example of its class. **Nil**	**Local**	7) Mining 9) Environment 13) Transport 16) Industry 18) Commerce 21) Government 23) Defence 29) Health / coal, stone, seawalls and reclamation, wharves, jetties, anchorages, shipbuilding, shipping, timberyard, cargoes, navy, quarantine
Shipwrecks (incudes potential wrecks under reclamation)	Shipwrecks within the study area would reflect the changing waterborne activities in Sydney Harbour, once ringed by an industrial waterfront with the constant transportation of cargoes and people, to one dominated by recreational boating and shipping. **Local**	No known association with well-known person(s). **Nil**	Any yet to be discovered timber shipwrecks present within the study area would of low relief, mostly buried and have little aesthetic appeal. However, the opposite would be the case for ferrous-hulled wrecks, which would also host abundant marine life. Shipwrecks in the study area would likely be of general construction and display little technical innovation. There is however the possibility of the remains of a well-made and technically superior hand crafted timber boat being present in the area. **Local**	No known association with a particular community. **Nil**	Early (19th to mid 20th century) locally built boats, both commercial and recreational, are rare and the wrecks of such vessels would contribute to our understanding of boat building traditions in the Sydney region. **Local**	There is a limited number of shipwrecks recorded in NSW. Locally built vessels from the 19th and early 20th century, particularly inshore fishing or recreational boats or even work punts and barges, are under-reported. **Local**	The sandy silt nature of the bed of the harbour in the study area is conducive to the preservation of wrecks, however the amount of water traffic and associated damage caused by anchors would have a destructive impact on a wreck site. This criterion can only be addressed on a site by site basis	**Local**	8) Fishing 13) Transport 16) Industry 18) Commerce 27) Leisure/ Boating/ work punts, fishing boats
Discard from vessels (incudes such cultural material under reclamation)	Discard from vessels would reflect the changing habits and material culture of those engaged in waterborne activities in Sydney Harbour, particularly relating to industry and commerce. **Nil**	No known association with well-known person(s). **Nil**	Discard from vessels within the study area would not reach the threshold for Local significance for this criterion. **Nil**	No known association with a particular community. **Nil**	For the most part these artefacts would be of no cultural heritage significance. The exception would be if they were unusual in character and date of manufacture and, as such, could provide some new understanding of the cultural development of the project area that is not readily available in the historical record. **Nil to Local**	The presence of cultural material on the bed of the harbour would be ubiquitous and form ambient background 'noise' in the underwater landscape. **Nil**	Discard from vessels within the study area would not be a good representative example of its class. **Nil**	**Nil to Local**	13) Transport 8) Fishing 27) Leisure/Food and drink, Maintenance, Cargo, Domestic life

7.5 Maritime heritage sensitivity

Maritime heritage *sensitivity* combines maritime heritage *potential* with *significance* and helps to devise appropriate and proportionate mitigation measures. For example, there may be extensive areas with high concentrations of dumped material and these may have high archaeological potential but be of low heritage significance, thereby leading to a grading of low heritage sensitivity. Alternatively, a discrete area such as an early 19th century wreck site could be considered to be of high heritage sensitivity. Definitions of sensitivity used throughout this section are provided in Table 17.

Table 17: Grading of maritime heritage sensitivity

Term	Heritage Sensitivity
High	Site assessed to be of State significance and in good condition
Medium	Site assessed to be State significance in poor or fragmentary condition or of Local significance in poor to good condition or uncommon site type such as a shipwreck
Low	Site of Local significance in very poor or fragmentary condition or isolated object of Local significance
Nil	Cultural material that does not meet the threshold of Local significance.

7.5.1 Maritime heritage sensitivity – Area A

The State Heritage Register listed Railway Electricity Tunnel and former Balls Head Coal Loader are of High maritime heritage sensitivity. The coal loader is assessed as being of State significance.

Sites of Medium sensitivity are the maritime infrastructure associated with Yurulbin Park and the wrecks of three work vessels – two located next to the former Balls Head Coal Loader wharf and the other wreck closer to the southern point of Balls Head. The shoreline of the western side of Balls Head is also of Medium sensitivity. The bed of the harbour off the southern point of Balls Head is of Medium sensitivity as there are a number of wreck-like anomalies in the area (see Figure 66). Three of the unverified anomalies (see numbers 1, 5 and 7 in Figure 65 and Table 7) are also of Medium sensitivity as they appear to be wrecks. “Wreck 1241”, located to the north of the end of Balls Head wharf is considered to be of low sensitivity as there is no information available to verify its identity.

Sites of Low sensitivity are the wrecks inspected in December 2017, along with the magnetic anomaly and the remaining unverified anomalies which appear to be discarded debris. They are shown as white circles in Figure 114.

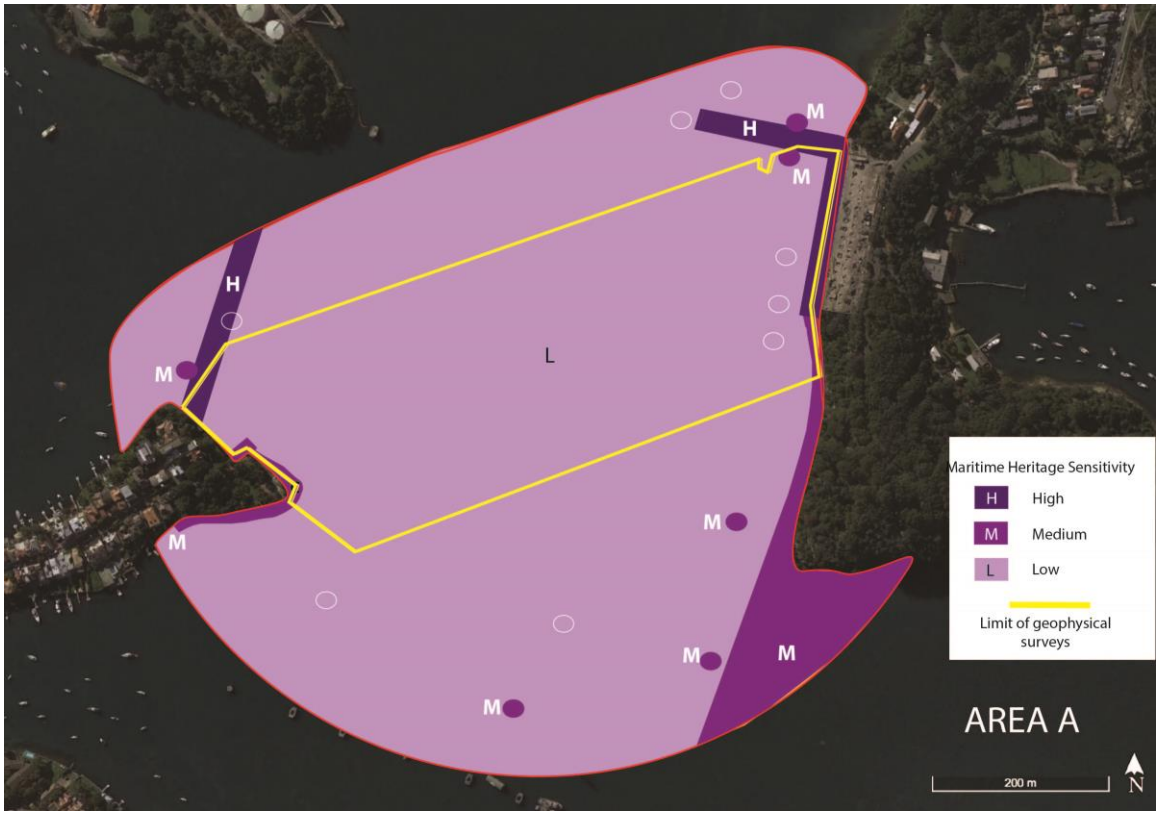


Figure 114: Area A – maritime heritage sensitivity

7.5.2 Maritime heritage sensitivity – Area B

The foreshore and associated maritime infrastructure in Area B is of Medium maritime heritage sensitivity (Figure 115). This includes the dilapidated and recently collapsed jetties. There are sufficient remains of these structures that new information can be obtained about their construction, and the bed of the harbour under and around these structures contains archaeological deposits associated with their usage. The present bed of the harbour in front of the seawall on the BP site and the former bed of the harbour behind it, is likely to contain archaeological evidence relating to the trading activities of Berry and Wollstonecraft. There are also structural remains and archaeological deposits associated with the slipway constructed by the NSW Torpedo Corps.

Figure 115: Area B – maritime heritage sensitivity

7.5.3 Maritime heritage sensitivity – Area C

The majority of Area C is of Low maritime heritage sensitivity because it consists of reclaimed bed of the harbour that was not near maritime infrastructure, or it has been dredged continuously (Figure 116). The areas of Medium sensitivity are currently under reclamation. The only areas of High sensitivity are Glebe Island Bridge and Anzac Bridge.

Figure 116: Area C – maritime heritage sensitivity

8 IMPACTS ON MARITIME HERITAGE

8.1 Proposed works

All project information detailed in this chapter has been obtained from Chapter 5 (Project description) and Chapter 6 (Construction work) of the environmental impact statement.

Five construction areas may impact the bed of the harbour and foreshore (Figure 117):

- Immersed tube tunnel crossing of Sydney Harbour between Birchgrove and Balls Head at Waverton, including temporary cofferdams – WHT5 and WHT6 – used during construction (Area A)
- Temporary construction support site at Yurulbin Point – WHT4 (Area A)
- Temporary mooring compound in Snails Bay (Area A)
- Temporary construction support site in Berrys Bay – WHT7 (Area B)
- Temporary construction support site in White Bay – WHT3 (Area C).

Only those construction activities that could impact all identified areas of known and potential maritime heritage are described in the following sections.

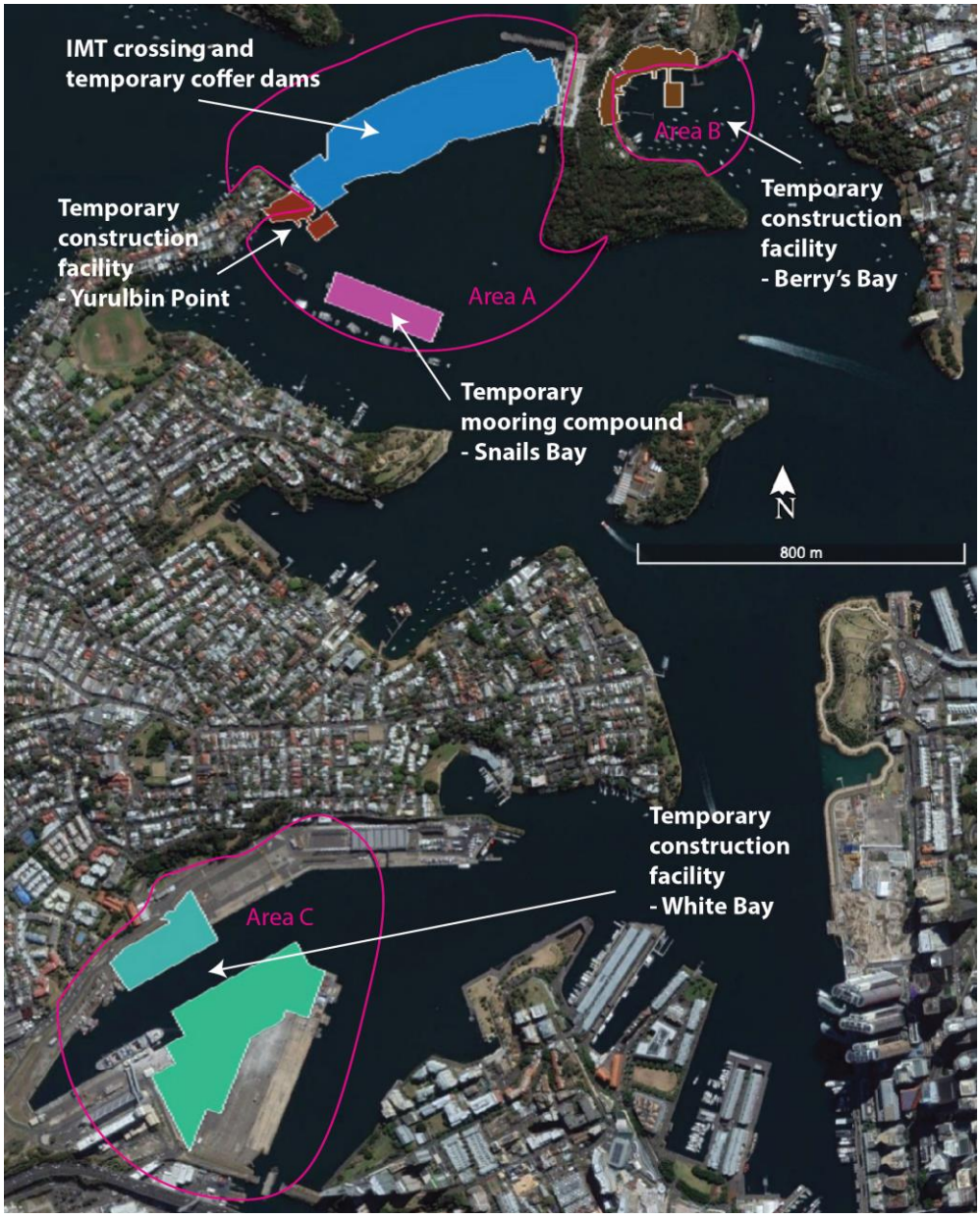


Figure 117 : Proposed construction areas in Sydney Harbour (Base image: Google Earth)

8.1.1 Area A

Immersed tube tunnel between Birchgrove and Balls Head, Waverton including temporary cofferdams

The proposed tunnel crossing would be 630 metres long. The activities that could impact areas of known and potential maritime heritage include:

- Construction of two cofferdams
- Excavation of rock within cofferdams
- Construction of two concrete transition structures to provide a connection between the bored tunnels and the immersed tube tunnel
- Dredging of a trench for the immersed tube tunnel
- Fit out of the immersed tube tunnel units (these would be fabricated elsewhere and transported by barge)
- Installation of the immersed tube tunnel units.

The cofferdams would be placed an appropriate distance away from the northeastern side of Yurulbin Point and the former Balls Head Coal Loader seawall (Figure 118) to avoid impacting the lower walkway and dolphins (Figure 119).

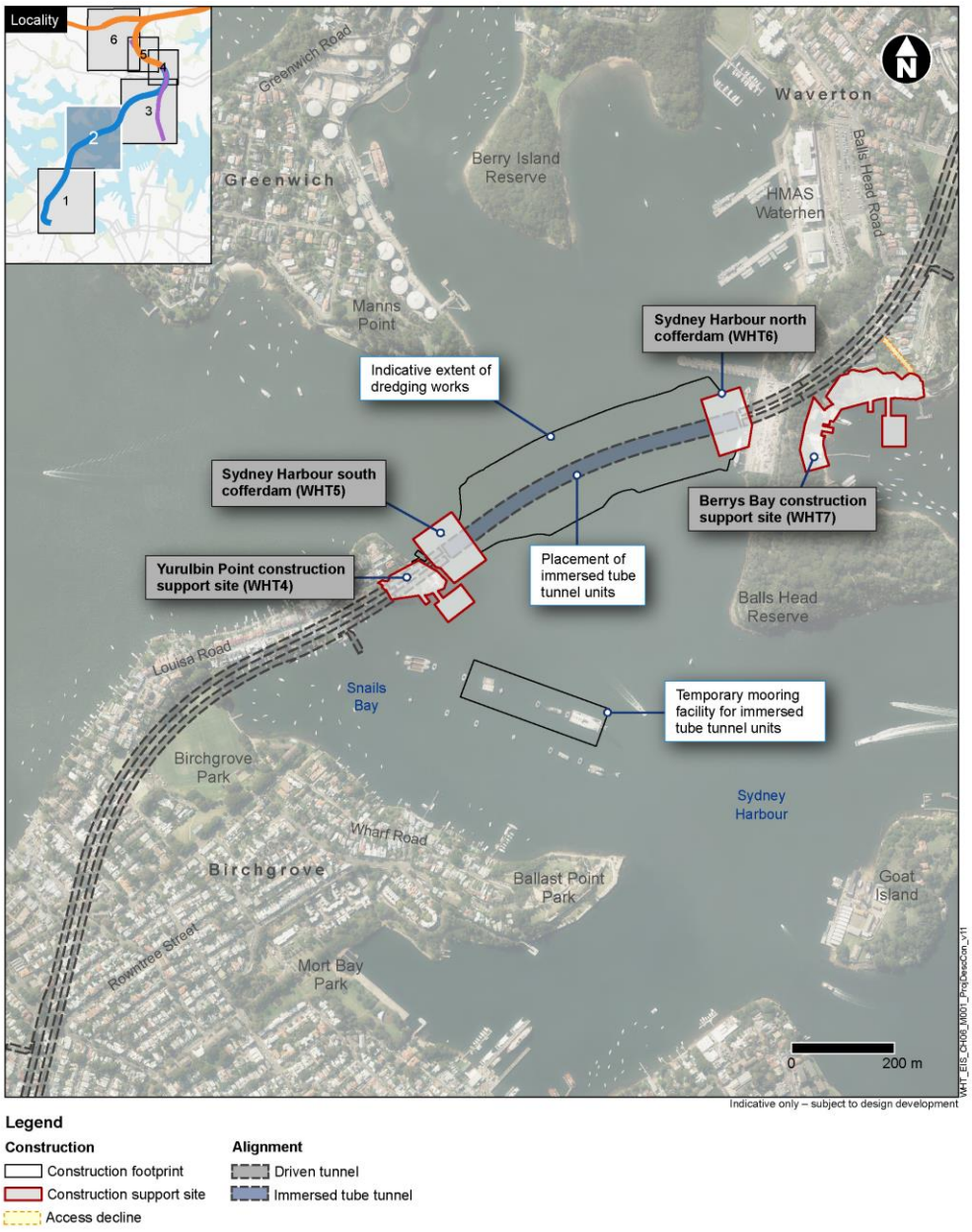


Figure 118: Plan showing proposed dredging extent, cofferdams and associated mooring arrangement

As described in Chapter 6 of the environmental impact statement, before the construction of the cofferdam can occur, the upper layer of the bed of the harbour would be injected with a permanent grouting material to improve its strength and water-tightness. Ground treatment would be carried out by drilling holes into the bed of the harbour. These holes would then be injected by a grouting machine located on a flat top barge, with either cement or chemical-based grouting.

The cofferdam structure would be made up of a series of interlocking, tubular piles. Each pile would be driven into the underlying sandstone within the areas that were subject to ground treatment. Piling would take place from a flat top barge (or similar barge) (refer Figure 119) using a crane fitted with a hydraulic vibrating hammer, offshore pile driving hammer and/or a similar piece of construction equipment.

Once all piles have been installed, the water level would be progressively lowered. Structural steel support would be installed within the cofferdams from a flat top barge so the cofferdams remain structurally sound.

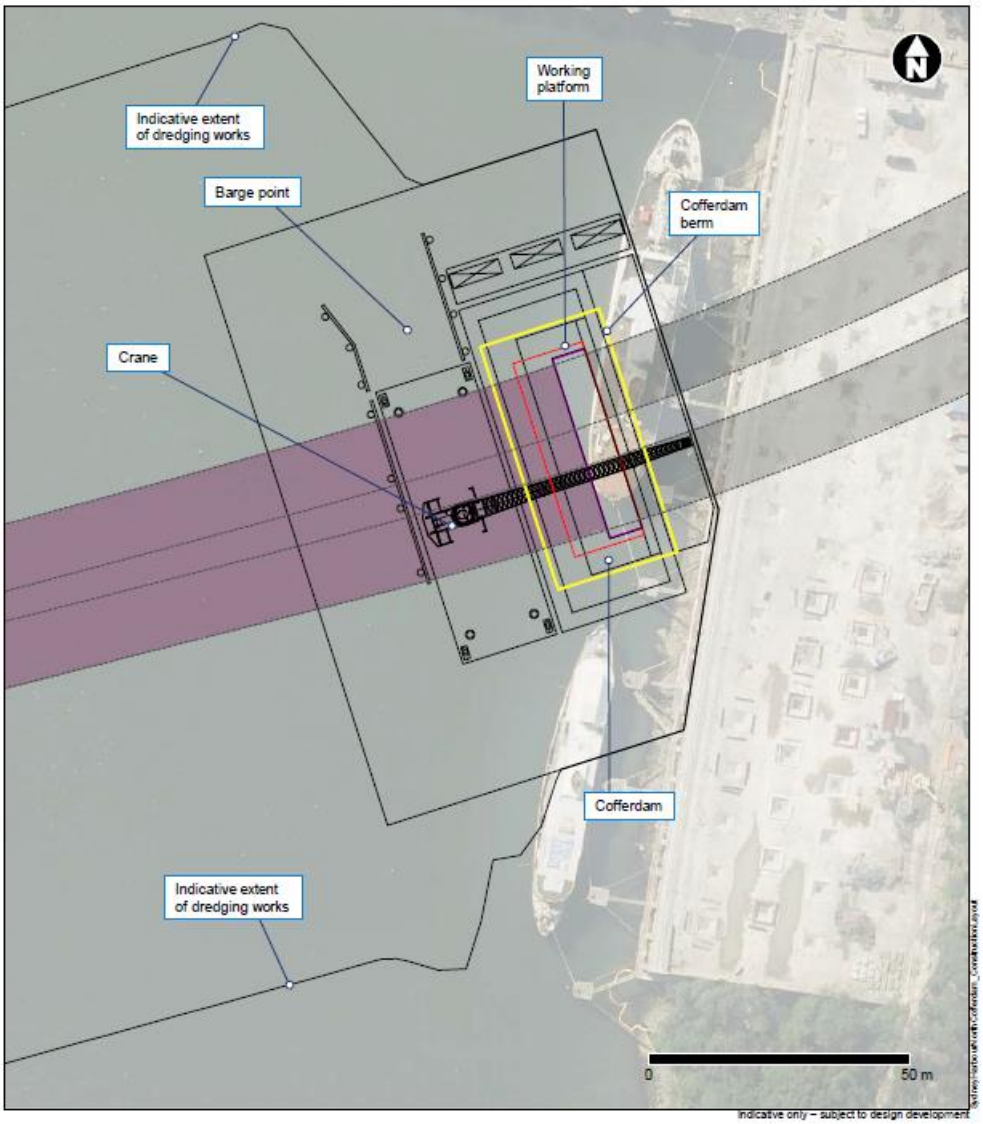


Figure 119: Detail of Sydney Harbour north cofferdam (WHT6) with cofferdam berm in yellow

The base of the immersed tube tunnel would be approximately -30 metres AHD (Figure 120). As the immersed tube tunnel units would rest on a series of uniformly graded gravel beds, the construction depth of the dredging is likely to be one to two metres deeper than this.

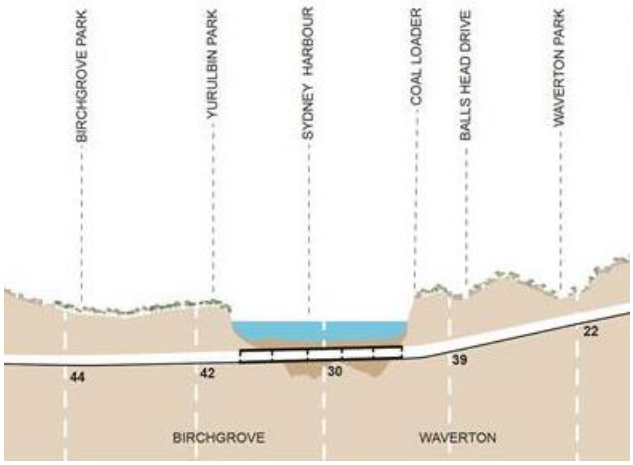


Figure 120: Indicative vertical alignment of the mainline tunnel crossing of Sydney Harbour

Once all preparations have been finalised, the tunnel element and immersion pontoons would be transported from the mooring to the immersion location by tug boats. At the immersion location, the immersion pontoon would be connected to the pre-installed anchors (Figure 121).

Once the work is completed, the cofferdams would be removed and there would be no visual evidence of the crossing of Sydney Harbour above water.

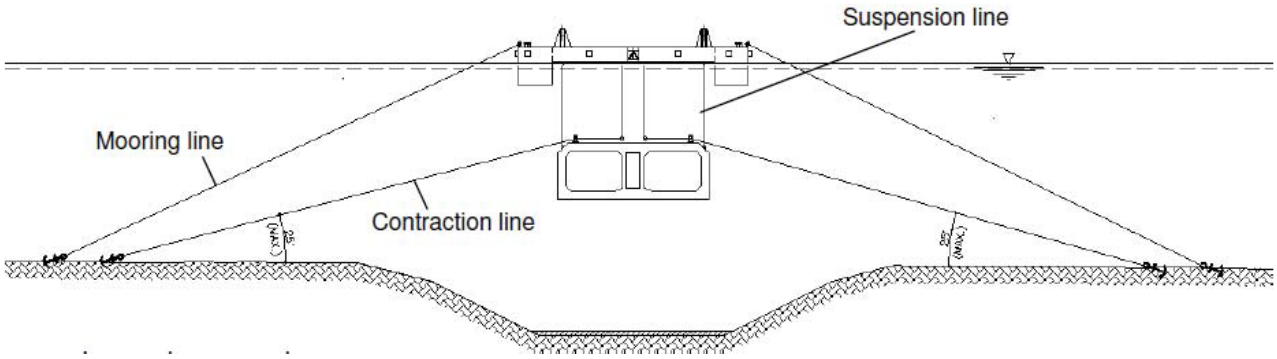


Figure 121: Typical immersion configuration – immersion pontoon

Temporary construction support site at Yurulbin Point – WHT4

This site is to be established to facilitate the mainline tunnel excavation and the tie into the immersed tube tunnel . It would temporarily occupy the public reserve called Yurulbin Park (Figure 122).

As described In Chapter 6, construction support site WHT4 would support excavation of the mainline tunnels (including for connection to the immersed tube tunnel crossing). Access for plant and equipment required to excavate the tunnels would be via an access shaft constructed on the lower portion of the site. The mainline tunnels would be excavated in both directions from this construction support site.

In the vicinity of the Long Nose Point (Birchgrove) Wharf at the end of Louisa Road there is proposed a rectangular structure which would be a floating barge / platform connected to the existing wharf by gangways. The floating barge would not require piling and would likely be tied off to the side of the cofferdam.

Access to the site would be via Sydney Harbour only. An access route to Louisa Road has been provided for emergency use only.

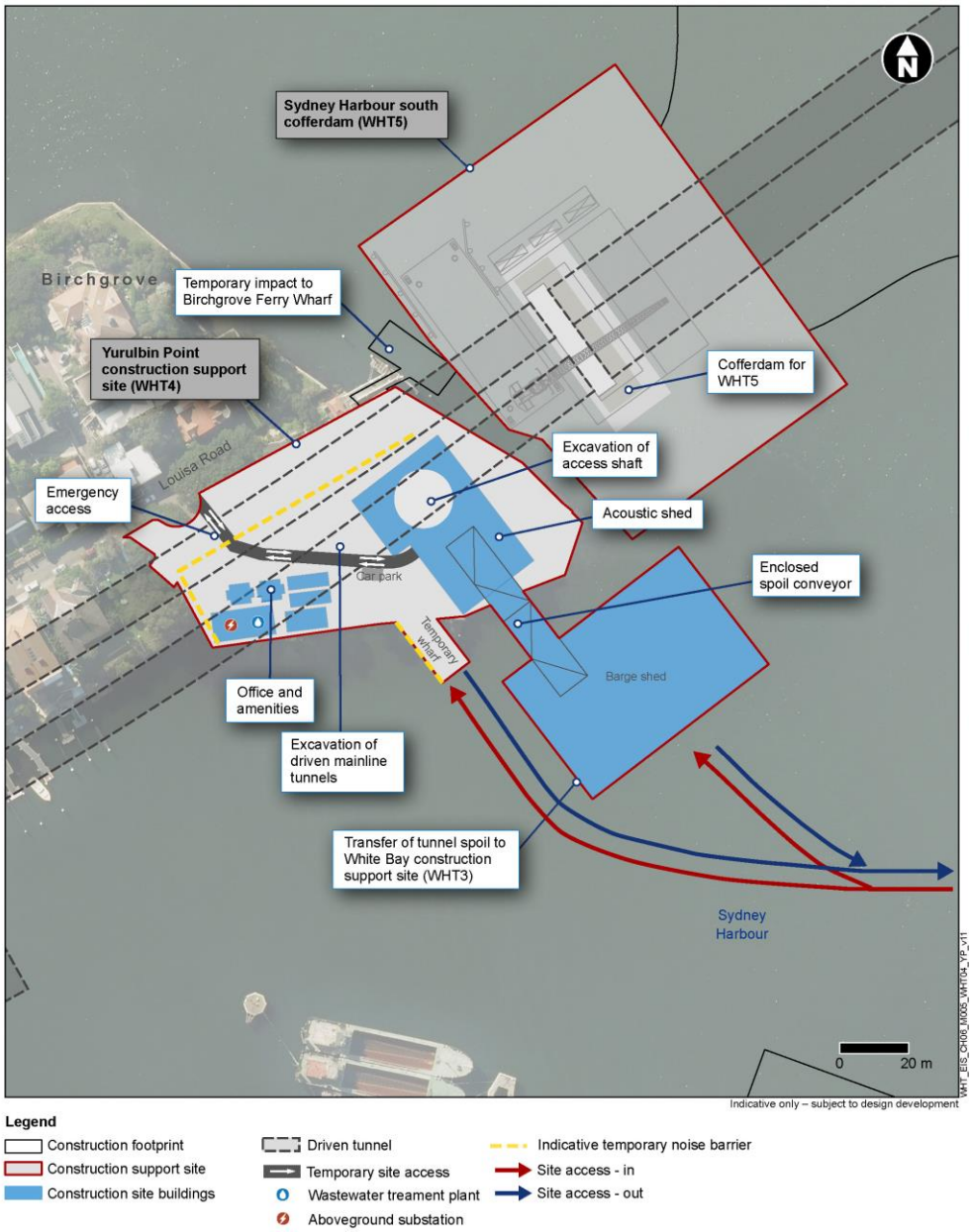


Figure 122: Layout of construction support site at Yurulbin Point

Temporary mooring compound in Snails Bay

In order to be able to immerse elements at regular intervals, the elements would be temporarily moored to existing concrete dolphins in Snails Bay. The proposed mooring location at Snails Bay is included on Figure 118.

8.1.2 Area B

A temporary construction facility – WHT7 – would be established in the western portion of Berrys Bay on the sites of the former Woodleys Shipyard and former BP site (Figure 123).

The main potential impacts of the temporary construction support site on maritime heritage would be from the positioning of a barge shed over the remains of the timber jetty associated with the use of the site as an oil storage facility. A conveyor would deliver spoil raised from the shaft in the centre of the site to barges within the barge shed. The barge shed would be supported by piles. It is assumed that the extant piles associated with the former jetty would need to be removed or cut down to the bed of the harbour level.

Two temporary wharves are proposed. One proposed wharf would extend from the concrete seawall associated with the BP site to the west of the proposed barge shed. The second would be located over Slipway 1, which is the site of the original NSW Torpedo Corps slipway.

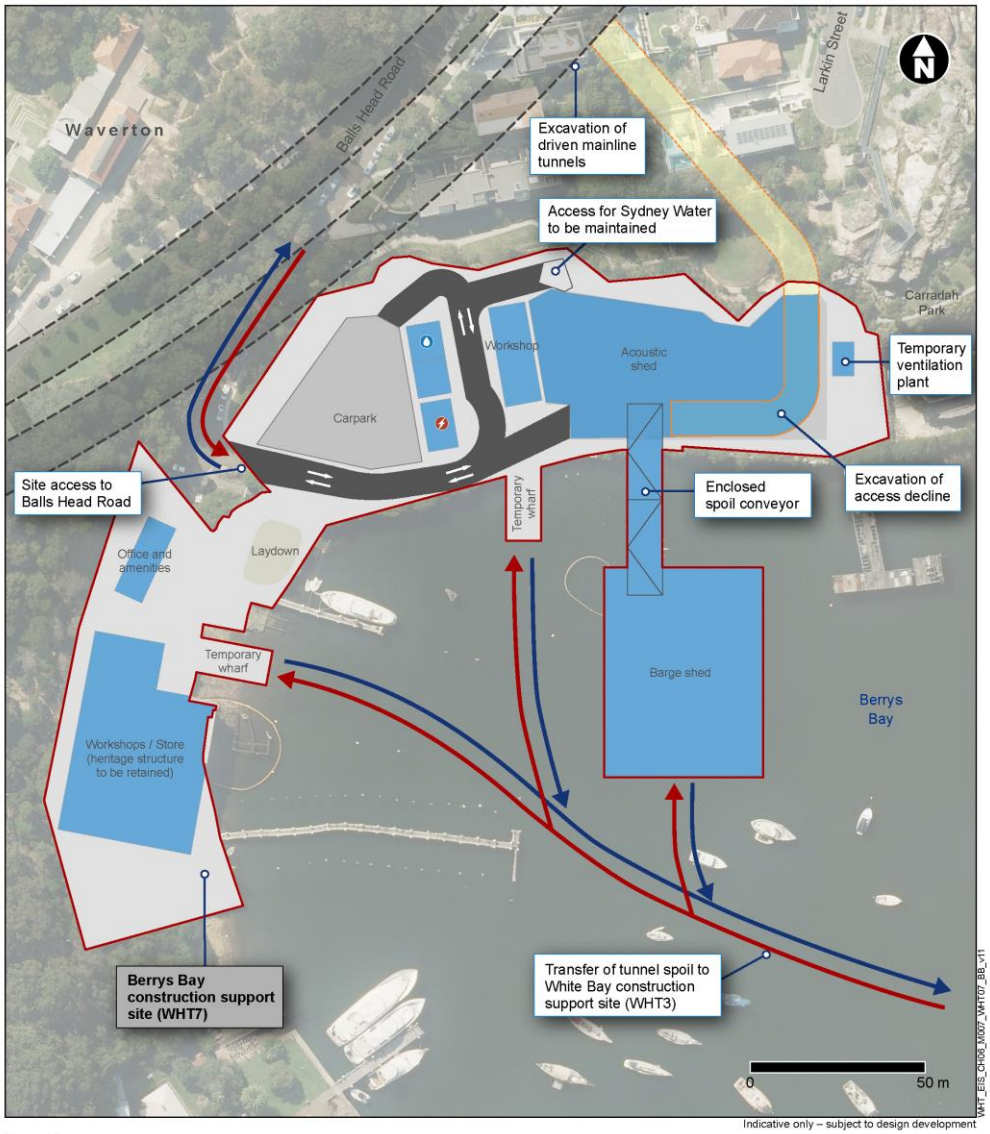


Figure 123: Layout of construction support site at Berrys Bay

8.2 Alternative design options

During design development of the Western Harbour Tunnel, several alignments were considered for the crossing of Sydney Harbour. At the crossing between Birchgrove and Waverton, key considerations included:

- Avoiding impacts on the coal loader facility (located on land) and the associated renewal precinct on Balls Head
- Avoiding encroachment into the HMAS *Waterhen* naval base to the north of the coal loader facility
- Improving constructability of the Western Harbour Tunnel by locating the northern cofferdam in rock where water depths are relatively shallow
- Keeping the northern cofferdam clear of the main shipping channel
- Maintaining close proximity to the temporary tunnelling decline at Berrys Bay to ensure efficient tunnelling access to the immersed tube tunnel
- Aligning the tunnel with favourable geology
- Minimising impacts on the Balls Head Coal Loader wharf.

The preferred alignment addresses all of these considerations, with the harbour crossing 'skewed' to enable construction of the temporary cofferdam to the south of the Balls Head Coal Loader wharf. This avoids direct impacts on the wharf and the HMAS *Waterhen* and follows favourable geology.

8.3 Types of impact

Review of Chapter 6 (Construction works) and the identification of known and potential maritime heritage sites has identified a number of potential impacts on the assessed maritime heritage sensitivity within the study area. These potential impacts can be divided into three broad categories: direct, potential direct and indirect impacts. For further discussion on impacts on maritime heritage sites see Section 11.2 in *Western Harbour Tunnel and Beaches Link : Maritime Archaeological Desktop Study* prepared by Cosmos Archaeology for Roads and Maritime Services in November 2017.

Impacts such as altered historical arrangements and access, increased traffic, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment have not been considered in this assessment as they are not relevant to maritime heritage in this study area.

8.3.1 Direct impact

Direct impact is defined as planned, intentional physical change occurring to a maritime heritage site or item from project activities resulting in the reduction of the cultural heritage values of that heritage site or item. Direct impact may include minor and peripheral changes or large scale removal and destruction including demolition, archaeological disturbance and the requirement for architectural noise treatment. Direct impacts that may occur to the identified maritime heritage in the study area are described in the following sections.

Dredging and excavation

Dredging and excavation within the cofferdam involves physical removal of the bed of the harbour. This would result in the removal of archaeological context. This impact can be mitigated by examining and recording cultural material recovered during dredging that may have heritage value.

For this project a backhoe dredger would be used to remove sediment and bring material to the surface to deposit into the skipper vessel for redistribution. It is envisaged that this method could, in the absence of adequate archaeological monitoring procedures, possibly result in the total removal of buried or exposed underwater archaeological sites. This particularly applies to the remains of small vessels, especially if they are of timber construction, and sites consisting mainly of artefact concentrations.

Installation of bed of the harbour structures

The proposed construction would require the installation of structures in the bed of the harbour. These structures could range from single piles (to support the immersed tube tunnel units or for tying up purposes) to continuous piled walls to allow works areas to be de-watered. Impacts would vary according to the size and extent of such structures.

8.3.2 Potential direct impact

Potential direct impact is defined as incidental physical impact and consequences occurring to a maritime heritage site or item from project activities resulting in the reduction of the cultural heritage values of that heritage site or item. Potential direct impacts may include a variety of changes including inappropriate access by vessels, which can be managed or mitigated by appropriate measures. Potential direct impacts that may occur to the identified maritime heritage are described in the following sections.

Anchoring and tilting spuds

Work vessels would be required at times to anchor within the project areas. This anchoring may use anchor/mooring block and chain systems or built-in legs (known as 'spuds') which pin the vessel to the bed of the harbour. Vessel anchors and associated swinging chains can impact underwater archaeological sites by potentially damaging fabric and moving objects around.

Vessel wake

Work vessels moving to and from the work site and construction facility can generate wakes which could undermine maritime infrastructure and maritime heritage sites in shallow waters, thereby weakening their

integrity. Any assessment of the impact of vessel wake on existing maritime infrastructure and shorelines should also consider impacts on cultural heritage sites.

Modelling suggests that marine-based shore wash generated by works would be no greater than current shore wash from present maritime activities. As such, shore wash will not be considered further as it would have no impact upon maritime heritage items. Full details can be found in Technical working paper: Navigation impact assessment (RHDHV, 2020).

Propeller jet scour

Work vessels in shallow waters can create scour trenches, which can impact an underwater archaeological site by exposing a previously buried object to potential biological, chemical and mechanical impact. These impacts are not confined to dredgers and hopper barges, but also relate to tug vessels which may be picking up and dropping anchors as well as helping manoeuvre larger vessels operating in confined spaces.

Vessel collision

Though vessel masters take the utmost care to prevent collisions, unforeseen events could on occasion result in a vessel potentially knocking a heritage item such as maritime infrastructure. Although maritime infrastructure is constructed to withstand accidental low energy impacts, structures that have not been properly maintained could be vulnerable to damage.

Disposal of sediment

The direct impacts associated with the disposal of dredge and tunnel spoil are outside the scope of this assessment.

8.3.3 Indirect impact

Indirect impact is defined as a secondary impact on a maritime heritage site or item which would reduce the cultural heritage significance of that site or item. The potential for indirect impact varies according to the nature of the heritage item, and its proximity to the project. Indirect impact as it may relate to heritage in general may include vibration, settlement, visual impacts, social impacts, impacts on landscapes and vistas, dust, changes to ongoing use, changed associations or change to access.

Indirect impacts of direct relevance to this study with respects to maritime heritage are described in the following sections.

Sediment erosion and accumulation

Changed conditions on the bed of the harbour may cause sediment disturbance, movement and loss within the vicinity of the dredged areas. This may result in increased exposure of underwater archaeological sites and some previously buried sites may become exposed. Sites buried in stable sediments are protected from damage caused by hydrodynamic processes, marine borers, chemical processes and human interference.

Following construction, the proposed works, including the installation of the immersed tube tunnel units and their covering, would restore the bed of the harbour close to existing conditions. The presence of the cofferdams during the construction phase of the project would alter water flows within Area A, but not sufficiently to create any appreciable sediment erosion or accumulation that could impact maritime heritage sites.

Vibration

Vibrations from construction work such as piling, dredging and tunnelling can impact the integrity of maritime infrastructure or shipwrecks thereby affecting their cultural heritage significance. Vibrations would have a negligible impact on the cultural heritage significance of archaeological deposits associated with maritime infrastructure, shipwrecks or discard from vessels. This is because the artefacts within the deposits may move from their original position, but not enough to lose any appreciable archaeological context.

The potential impact of vibration from construction activities including mainline tunnelling on the maritime heritage within the study area has been assessed in Technical working paper: Noise and vibration (Renzo Tonin, 2020).

Although heritage structures or items are generally considered on a case by case basis, as a screening test for the purposes of this project, all heritage structures are conservatively assumed to be unsound

without further investigation being carried out (Technical working paper: Noise and vibration). As such, a vibration level (PPV) of 2.5 mm/s has been adopted as the vibration damage screening level.

This is a conservative approach that will identify heritage items that need further inspection. Any heritage structure or item predicted to exceed the screening level would be investigated, and appropriate vibration criteria for the structure adopted. If a heritage item is found to be structurally unsound (following inspection) the conservative 'cosmetic' damage objective of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered, and appropriate protections put in place depending on the construction of the heritage item (Technical working paper: Noise and vibration). Cosmetic damage levels for this project are considered 'safe limits' up to which no damage due to vibration effects has been observed for particular building types (Technical working paper: Noise and vibration).

The general approach to manage potential vibration impacts on heritage items would be to:

1. Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities
2. Prepare a structural engineering report on identified heritage items, to confirm structural integrity of the building and confirm if item is 'structurally sound'
3. If the item was confirmed as 'structurally sound', adopt the screening criteria from BS7385 Part 2, or
4. If the item was confirmed as 'structurally unsound', adopt the more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity (Technical working paper: Noise and vibration).

For this assessment the potential impacts from vibration only apply to Area A. The vibrations caused by piling for the temporary wharves in Area B or the installation of moorings in Area C would be inconsequential to the heritage values of the known and potential maritime heritage in those areas.

Settlement

The proposed driven tunnels that would connect to the IMT units within Area A near Birchgrove and Balls Head would pass under maritime heritage items such as the seawalls and slipway at Yurulbin Park and the former Balls Head Coal Loader. The excavation of tunnels below ground stimulates potential settlement at the ground surface within the zone of influence of the tunnel. This can be the result of both stress redistribution in the surrounding ground, and groundwater drawdown around drained tunnels. Settlement modelling for this project for potential impacts to heritage items has been carried out by WSP ARUP (23 September 2019).

The WSP ARUP report (23 September 2019) states that most of the Western Harbour Tunnel and Beaches Link driven tunnels would be constructed in medium to high strength Hawkesbury Sandstone with a limited thickness of residual soil and fill cover. The majority of the induced settlement along the alignment due to tunnel excavation would therefore be the result of stress redistribution within the rock mass (WSP ARUP 23 September 2019).

For tunnelling projects, predicted impact to structures is assessed according to the level of approximate equivalent ground settlements and trough gradients. The WSP ARUP report (23 September 2019) provided a detailed table of criteria commonly used for risk assessments (WSP ARUP 23 September 2019: Table 2). For the purposes of this assessment an adapted version is presented in Table 18.

Table 18: Summary of damage categories to buildings and structures due to settlement (WSP ARUP ***23 September 2019***: adapted from Table 2).

Max. settlement of building/structure (mm)	Max. slope of ground (angular distortion)	Expected degree of severity	Category of damage	Type of damage
0	0	Negligible	0	Aesthetic
< 10	< 1:500	Very slight	1	Aesthetic
10 to 50	1:500 to 1:200	Slight	2	Aesthetic
50 to 75	1:200 to 1:50	Moderate	3	Serviceability
> 75	1:200 to 1:50	Severe	4	Serviceability
> 75	1:50	Very severe	5	Stability

Buildings and structures assessed as being at 'moderate' risk or higher would require additional assessments to better understand the potential impacts (WSP ARUP 23 September 2019: 6).

The initial assessment of buildings, including fixed maritime heritage structures, along the project alignment found that no site reached the 'moderate' threshold that required further assessment (WSP ARUP 23 September 2019: Section 6.2 and 8). The potential impact on individual maritime heritage sites is addressed in Section 8.6.

This study only assessed the potential impacts of settlement on fixed maritime heritage infrastructure because this could have an impact on their structural integrity. For items that are lying on or under the bed of the harbour, ranging in size from an anchor to a shipwreck, the predicted ranges of settlement as they relate to potential impact on heritage values are inconsequential. This is because objects on the bed of the harbour are in a constant state of downwards movements caused by bioturbation and wave action raising sediments into suspension, thereby causing the object to further 'sink' into the sediment. The modelling for this project indicates that the scale of settlement falls within existing conditions for non-fixed maritime heritage.

The WSP ARUP report (23 September 2019) recommended a range of management measures before and during construction to ensure that ground movement impacts are managed:

- Management of ground settlement to comply with the accepted settlement, angular distortion and limiting tensile strain criteria
- Development of detailed predictive settlement models for areas of concern to guide tunnel design and construction methodology, including the selection of options to minimise settlement where required
- Preparation of building condition surveys for properties within the zone of influence of tunnel settlement (for example within the 5mm predicted surface settlement contour and within 50 metres of surface works)
- Establishment of an Independent Property Impact Assessment Panel, comprising geotechnical and engineering experts, before the start of works to independently verify building condition survey reports, resolve any property damage disputes and establish ongoing settlement monitoring requirements
- Preparation of agreements with utility owners and infrastructure owners identifying acceptable limits of settlement, settlement monitoring and actions in the event that settlement limits are exceeded.

Visual Impact

All visual impacts in relation to maritime heritage for this project would be temporary as the cofferdams and temporary wharves would be removed at the completion of the project.

Relocation

The relocation of moveable heritage items can sometimes have an impact on the heritage values of that item if it is removed from its context or placed in a location where the rate of impact is potentially accelerated.

8.4 Approach to assessing impact

For this study there are three components to the assessment of impact:

- Level of impact on a maritime heritage site or item
- Consequence of the impact on the heritage site or item
- Probability of impact on a maritime heritage site or item.

Level of impact

The level of impact on the heritage significance of each heritage item in the study area has been assessed based on the definitions and framework for assessing severity of impacts from the *EPBC Act Significant impact guidelines 1.2 (*Department of Sustainability Environment Water Population and Communities 2013). The following criteria were used to assess the level of impact:

- The scale of the proposed works and its impacts
- The intensity of the proposed works and its impacts
- The duration and frequency of the proposed works and its impacts.

The levels of impact used in this study are defined in Table 19. For impacts to meet a certain level they generally need to have two of the three criteria – scale, intensity, duration/frequency – noted in the table. The level of impact assigned to each heritage item is based on the level assessed before the implementation of management or mitigation measures, which are discussed in Chapter 9.

Table 19 Definition of levels of impact

Level of impact	Scale	Intensity	Duration/frequency
Major	Medium – large	Moderate – high	Permanent/irreversible
Moderate	Small – medium	Moderate	Medium – long term
Minor	Small/localised	Low	Short term/reversible

Consequence of impact

The consequence of an impact on a maritime heritage item is a combination of the level of impact and its heritage sensitivity. A Major level of impact on a site or item of Low heritage sensitivity will have a lesser consequence for the maritime heritage resource of NSW than a Major level of impact on a site or item of high heritage sensitivity. For example, dredging would have a Major impact on any maritime heritage site or item within the footprint, however if this heritage is assessed to be of Low heritage sensitivity then the impact could be considered to be reduced to Minor. Alternatively, if dredging were to impact a maritime heritage site of High sensitivity, such as a 19th century wreck, then the scale of impact could range from Major or greater depending on whether the site is of State or Local significance.

Table 20 presents a matrix of consequence of the impacts of the proposed works on the heritage values of a site or item.

Table 20: Matrix of consequence of impact on heritage values of a maritime heritage site or item

Level of Impact / Maritime Heritage Sensitivity	Negligible	Minor	Moderate	Major
High	No discernible alterations to existing natural and human processes already impacting on maritime heritage sites	Detectable impact with maritime heritage values intrinsic to the site remaining largely intact	Partial reduction in maritime heritage values intrinsic to the site	Substantial reduction in maritime heritage values intrinsic to the site
Medium	No discernible alterations to existing natural and human processes already impacting on maritime heritage sites	Partial reduction in maritime heritage values intrinsic to the site or archaeological deposits	Substantial reduction in maritime heritage values intrinsic to the site or archaeological deposits	Complete loss of maritime heritage values intrinsic to the site or archaeological deposits
Low	No discernible alterations to existing natural and human processes already impacting on maritime heritage sites	Complete loss of maritime heritage values intrinsic to the site or archaeological deposits	N/A	N/A

In assessing consequence of impact, the complete loss of maritime heritage values intrinsic to a site of High sensitivity like a well preserved State significant site, would be considered to be an Extreme impact. There are no State significant sites within the study area and such a category therefore does not apply to this study. Any type and level of impact on sites and items assessed to be of Nil significance (see Section 7.4) can be considered to have a Negligible impact on their cultural heritage values. As such these sites and items will not be discussed further in Section 8.6.

Probability of impact

When assessing the potential impacts of a large scale development on maritime or underwater heritage there is always a level of uncertainty that needs to be considered. This is because the understanding of

the underwater archaeological/maritime heritage resource is largely reliant on the interpretation of remote sensing data. The limitations of available technologies that obtain such data mean that the presence or absence of underwater maritime heritage sites of significance cannot be stated with complete confidence. In addition, it is difficult to monitor construction activities around underwater sites as the sites themselves are not visible and impacts may not always be noticed at the time they occur. Such uncertainties can be addressed by the design of appropriate mitigation measures to prevent or minimise impacts on known and potential underwater/maritime heritage sites as well as assessing the probability, or risk, of impact.

For example, with regard to the probability of an impact, there are activities, such as dredging, that would definitely disturb any maritime heritage sites within the footprint of this construction activity. By contrast, there would be a lower likelihood of the chain of an anchored project vessel damaging a wreck assessed to have maritime heritage significance. The grading system for determining the probability of impact is presented in Table 21.

Table 21: Terms defining probability of impact

Term	Probability
Definite	100%
Highly probable	85–99%
Probable	50–84%
Improbable	25–49%
Highly improbable	1–14%
Almost impossible	< 1%

8.5 Limitations of assessment

As can be seen in Figure 124, the side scan sonar survey did not cover the full extent of the proposed disturbance footprints. As such, no diving inspection for maritime heritage sites could be effectively carried out in these areas. This is a limitation of the impact assessment for those areas.

For the area where the Sydney Harbour Crossing is proposed, there is a strip along the northern edge of the survey (up to 25 by 500 metres of the disturbance footprint) that was not surveyed. No dredging or piling is proposed in the unsurveyed area but anchoring is likely. At present it therefore cannot be assessed whether any maritime heritage present in this area would be impacted.

The proposed mooring compound at Snails Bay was not surveyed, although there is some side scan sonar data available on the internet. However, the project vessels would be using existing mooring facilities and there are no plans to install new moorings.

The side scan sonar survey in Berrys Bay was not able to cover the bed of the harbour next to the shoreline. This gap was covered by undertaking diver based transects in areas where impacts may occur, namely the locations of the two proposed wharves. The proposed disturbance footprint in the centre of the western portion of Berrys Bay which was not covered by the side scan survey is not an issue from a maritime heritage perspective, as it is understood that disturbance in this area would be confined to relocating existing moorings.

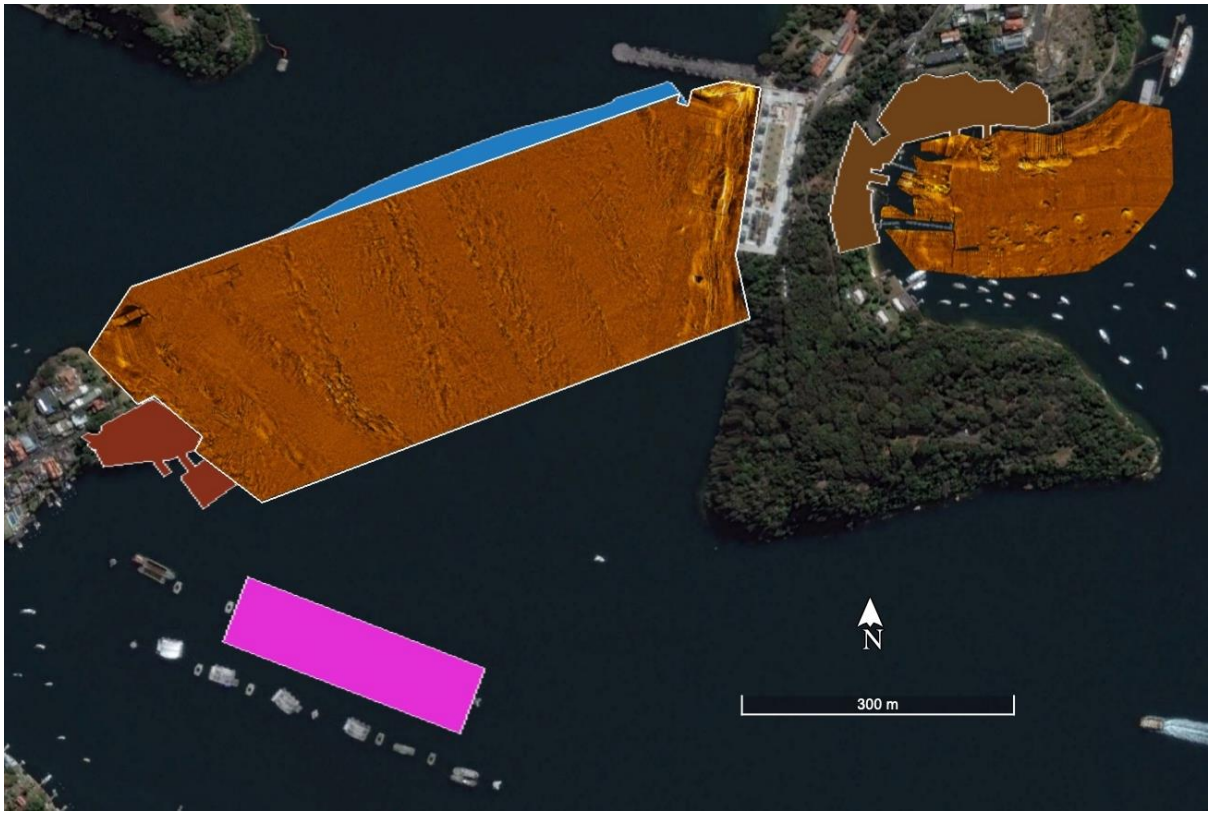


Figure 124: Extent of side scan sonar survey in relation to proposed extent of disturbance footprint for Zones C and D (Base image: Google Earth, Side scan sonar data provided as .shp files by Podnar, A. Geotechnical Engineer, Douglas Partners 5 December 2017).

8.6 Assessed potential impacts on maritime heritage

8.6.1 Area A

The proposed construction activities in Area A that would potentially have an impact on maritime heritage sites and items are discussed below under the impact categories of direct, potential direct.

Direct impacts

Dredging and excavation

The unverified magnetic anomaly no. 1 would be impacted by dredging (Figure 125 and Table 22), however the impact has been assessed as Minor as the object is assessed to be of low heritage sensitivity. There is a low risk that this anomaly may be of greater cultural heritage significance. As this potential cultural object would be removed by dredging it will not be assessed for other impacts.

Dredging and excavation elsewhere would almost definitely impact discarded material. However as the discarded material has been assessed to be of low sensitivity the impact therefore would be Minor. It is highly improbable that a shipwreck would be impacted by dredging because the dredging footprint has been examined using side scan sonar, though the presence of wreckage associated with small timber boats cannot be discounted. The impact on such a site, should it occur, could be as high as Major.

The south-east corner of the proposed cofferdam at Balls Head is partially within the area designated as High maritime heritage sensitivity because of its association with the former Balls Head Coal Loader. The cofferdam has been positioned to avoid impacting the lower walkway and dolphins associated with the heritage item (see Figure 119). A review of the side scan sonar data shows exposed bedrock and a linear feature which appears to be a mooring line (Figure 126). There do not appear to be any potential maritime heritage structures or items within the cofferdam footprint. Therefore, it is assessed as improbable that the installation of, and excavation within, the cofferdam in this area of High sensitivity would have a direct impact on any remains of maritime infrastructure or associated archaeological deposits related to the former Balls Head Coal Loader. Should such an impact occur, the effect on the heritage values of the site would be Minor.

Installation of bed of the harbour structures

Piling for the delivery wharf and the barge shed may impact potential archaeological remains, including maritime infrastructure. However such works would have a Minor localised impact on remains of maritime infrastructure associated with earlier phases of the current wharf and associated archaeological deposits.

Figure 125: Potential impact on maritime heritage in Area A. Yellow lines and text indicate proposed and potential bed of the harbour disturbances

Table 22: Assessment of probability and level of direct impacts on known and potential maritime heritage sites in Area A

Site	Sensitivity	Dredging Probability	Dredging Level	Installation Probability	Installation Level
Yurulbin Park (maritime infrastructure and associated archaeological deposits)	Medium	None	N/A	Probable	Minor
Long Nose Point (Birchgrove) Wharf site and shelter (remnant maritime infrastructure and associated archaeological deposits)	Medium	None	N/A	Probable	Minor
Former Balls Head Coal Loader	High	None	N/A	Improbable	Minor
Unidentified Balls Head Bay 1	Medium	None	N/A	None	N/A
Unidentified Balls Head Bay 2	Medium	None	N/A	None	N/A
Balls Head #1 Unknown shipwreck	Medium	None	N/A	None	N/A

Site	Sensitivity	Dredging Probability	Dredging Level	Installation Probability	Installation Level
Railway Electricity Tunnel	High	None	N/A	None	N/A
Balls Head Reserve, western foreshore	Medium	None	N/A	None	N/A
Magnetic Anomaly 1	Low	Definite	Minor	None	N/A
SSS Anomaly No. 1	Low	None	N/A	None	N/A
“Wreck 1241”	Low	None	N/A	None	N/A
SSS Anomaly No. 2	Low	None	N/A	None	N/A
SSS Anomaly No. 3	Low	None	N/A	None	N/A
SSS Anomaly No. 4	Low	None	N/A	None	N/A
SSS Anomaly No. 5	Low	None	N/A	None	N/A
SSS Anomaly No. 6	Low	None	N/A	None	N/A
SSS Anomaly No. 7	Low	None	N/A	None	N/A
Potential maritime infrastructure and associated archaeological deposits (other than around Yurulbin Park)	Low	Highly improbable	Minor	Highly improbable	Minor
Potential shipwrecks (as identified through remote sensing)	Medium	None	N/A	None	N/A
Potential shipwrecks (not detected through remote sensing)	Low	Highly improbable	Negligible to Major	Almost impossible	Negligible to Moderate
Potential discard from vessels	Low	Highly probable	Minor	Probable	Negligible

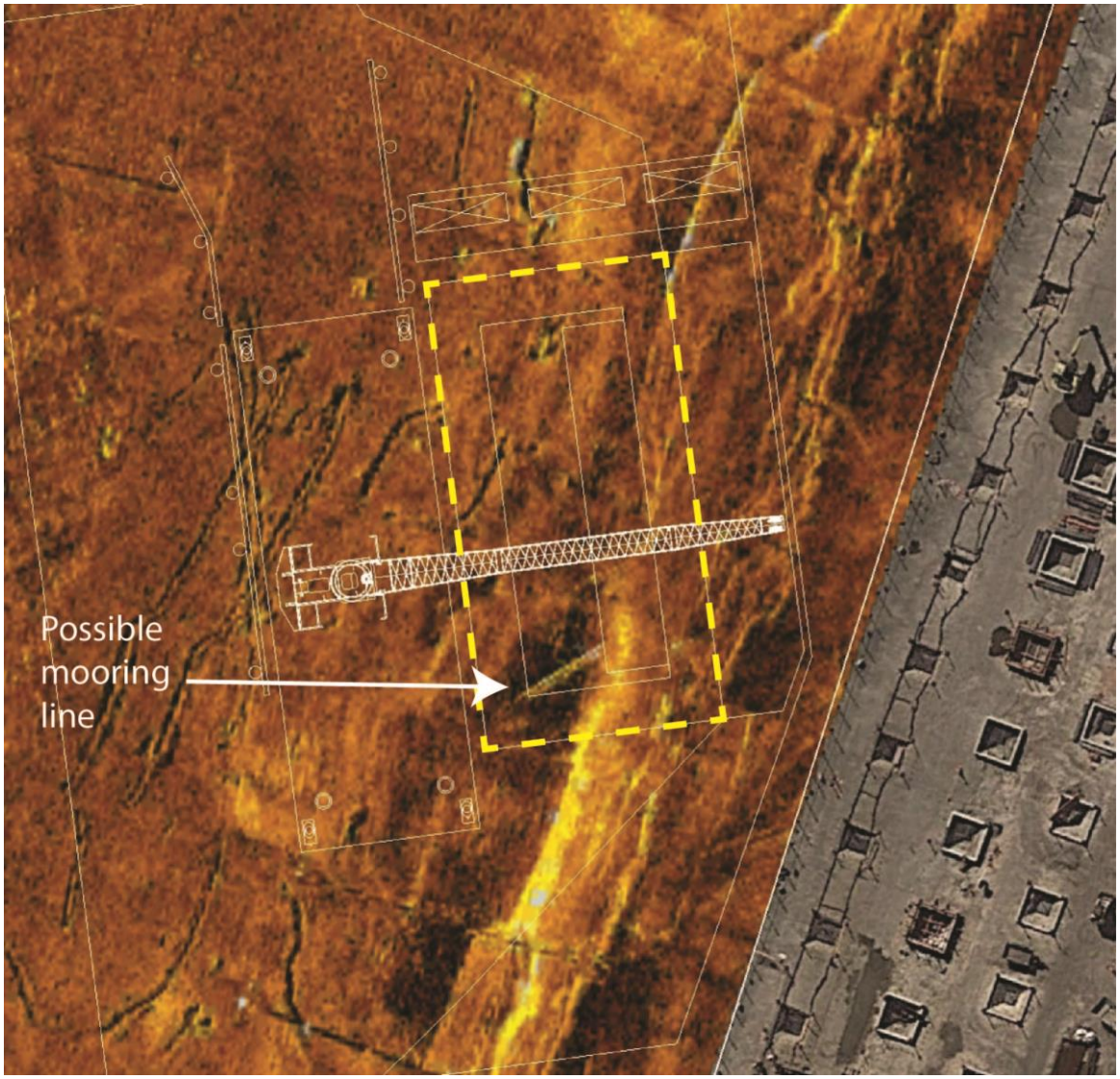


Figure 126: Side scan sonar image of the bed of the harbour overlaid with proposed location of cofferdam at Balls Head (shown as dotted yellow line). Dark linear features are anchor drag marks

Potential direct impacts

Table 23 shows the assessment of probability and level of potential direct impacts on known and potential heritage sites in Area A. Further details are provided below.

Anchoring and tilting spuds

It is improbable that anchoring within the proposed disturbance footprint would impact remains of maritime infrastructure or deposits associated with Yurulbin Point, the Long Nose Point (Birchgrove) Wharf site or the former Balls Head Coal Loader (Table 23), however should these impacts occur the level of impact is assessed to be Minor.

Propeller jet scour

Localised and shallow scouring from propeller jet turbulence could occur in shallower waters adjacent to Yurulbin Park, Long Nose Point (Birchgrove) Wharf and the former Balls Head Coal Loader, however the impacts would be negligible.

Vessel Collision

It is highly improbable that a project vessel would come into contact with existing maritime heritage infrastructure at Yurulbin Park, Long Nose Point (Birchgrove) Wharf or the former Balls Head Coal Loader with sufficient force to impact the heritage values of these sites. If contact was made then the level of impact could vary from Negligible to Moderate. The wharf associated with the former Balls Head

Coal Loader may be more vulnerable to the effects of vessel collision due to its relatively diminished structural integrity.

The risks of impacting these items during construction would be minimised by protocols and measures to prevent project vessels from colliding with maritime assets in general. These measures are covered elsewhere in the environmental impact statement.

Table 23: Assessment of probability and level of potential direct impacts on known and potential maritime heritage sites in Area A

Site	Sensitivity	Anchoring Probability	Anchoring Level	Propeller jet turbulence Probability	Propeller jet turbulence Level	Vessel collision Probability	Vessel collision Level
Yurulbin Park (maritime infrastructure and associated archaeological deposits)	Medium	Improbable	Minor	Probable	Negligible	Highly Improbable	Minor to Moderate
Long Nose Point (Birchgrove) Wharf site and shelter (remnant maritime infrastructure and associated archaeological deposits)	Medium	Improbable	Minor	Probable	Negligible	Highly Improbable	Minor
Former Balls Head Coal Loader	High	Improbable	Minor	Improbable	Negligible	Highly Improbable	Minor to Moderate
Unidentified Balls Head Bay 1	Medium	None	N/A	None	N/A	None	N/A
Unidentified Balls Head Bay 2	Medium	None	N/A	None	N/A	None	N/A
Balls Head #1 Unknown shipwreck	Medium	None	N/A	None	N/A	None	N/A
Railway Electricity Tunnel	High	None	N/A	None	N/A	None	N/A
Balls Head Reserve, western foreshore	Medium	None	N/A	None	N/A	None	N/A
“Wreck 1241”	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 1	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 2	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 3	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 4	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 5	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 6	Low	None	N/A	None	N/A	None	N/A
SSS Anomaly No. 7	Low	None	N/A	None	N/A	None	N/A
Potential maritime infrastructure and associated archaeological deposits (other than around Yurulbin Park)	Low	Improbable	Minor	Probable	Negligible	None	N/A
Potential shipwrecks (as identified through remote sensing)	Medium	None	N/A	None	N/A	None	N/A
Potential shipwrecks (not detected though remote sensing)	Low	Almost impossible	Moderate	Almost impossible	Negligible	None	N/A
Potential discard from vessels	Low	Probable	Negligible	Improbable	Negligible	None	N/A

Indirect impacts

Table 24 shows the assessment of probability and level of potential indirect impacts on known and potential heritage sites in Area A. Further details are provided below.

Vibration

Technical working paper: Noise and vibration assessed that activity associated with the construction of the cofferdams and the temporary construction support site at Yurulbin Park would reach the threshold for possible cosmetic damage to heritage items, defined as unsound structure, at Yurulbin Park and the former Balls Head Coal Loader (Technical working paper: Noise and vibration). Where work could take place within the minimum working distances for an unsound structure a structural assessment would be carried out and appropriate vibration criteria adopted and monitored prior to vibration intensive construction works proceeding.

The threshold for cosmetic impact on the section of the Railway Electricity Tunnel within the study area (the section which is under the bed of the harbour) would not be reached (Technical working paper: Noise and vibration, Appendix G, figure no. TJ500-01-6-1-3-1019-4(r3)).

The vibrations from the construction of the cofferdam may impact on the wreck 'Balls Head Unidentified No. 2' which is located on the southern side of the former Balls Head Coal Loader wharf (Technical working paper: Noise and vibration, Appendix G, figure no. TJ500-01-6-1-3-1019-4(r3)). The vibrations would reach the threshold for possible cosmetic damage to heritage items, defined as unsound structure, but the potential level of impact on the site is difficult to assess as it is a decaying timber structure resting on a soft silty mud at the bed of the harbour. It is expected that the impact on the wreck could range from Negligible to Minor.

With respect to remains of potential maritime infrastructure and discarded material, any impacts arising from vibration would have a negligible impact on the heritage values of these items.

Technical working paper :Noise and vibration examined the potential impact of vibrations arising from mainline tunnelling, found that the tunnel would pass under parts of the former Balls Head Coal Loader seawall at an estimated 18 metres below AHD and an estimated 50 metres from the wharf. During tunnelling, in particular during benching activities, the structure may fall within minimum working distances for tunnelling activities. Where work could take place within the minimum working distances for an unsound structure a structural assessment would be carried out and appropriate vibration criteria adopted and monitored prior to vibration intensive construction works proceeding.

Settlement

Settlement and ground movement may cause damage to the maritime heritage components of the Yurulbin Park such as the seawall and slipway above the driven main alignment tunnel from tunnel excavation. The settlement modelling for this project indicates that the ground settlement levels at Yurulbin Park would have a predicted maximum surface settlement of 40-45 mm and a predicted maximum surface angular distortion of 1:500 to 1:2000 (WSP ARUP 23 September 2019). As such, the severity of impacts on structures within the heritage item would be 'slight', and aesthetic in character. The potential impact on the maritime heritage values of this site would be Minor at most.

The Long Nose Point (Birchgrove) Wharf site and shelter is predicted to undergo lesser surface settlement of 15-35mm, with a maximum surface angular distortion of <1:500. As the more significant components of this site are buried remnants of archaeological deposits associated with earlier maritime infrastructure, the impact on the heritage values of this site would be Negligible.

There is a predicted maximum surface settlement of 20-25mm, with a maximum surface angular distortion of 1:500 to 1:2000, at the former Balls Head Coal Loader (WSP ARUP, 23 September 2019). This would presumably relate to the seawall component of the site only. The severity of impacts on the seawall within the heritage item would be 'slight', and aesthetic in character. The potential impacts on the maritime heritage values of this site would range from Negligible to Minor.

Visual impacts

Temporary visual impacts may occur due to the size, form and scale of the proposed works including the installation of the two cofferdams and the temporary construction support site at Yurulbin Park. The temporary impacts on the aesthetic values of Yurulbin Park and the Long Nose Point (Birchgrove) Wharf site would be considerable during the works. The aesthetic significance of these items is considered to be Local, and the temporary visual impacts on the heritage values of these sites would be Minor.

The installation of the cofferdam under the seawall associated with the former Balls Head Coal Loader would have a temporary visual impact on the aesthetic values of the seawall. This impact would be partly mitigated by the relocation of the M.V. *Cape Don* and *Baragoola* (see below) which would expose more of the seawall to public view than is the case presently. On balance, the temporary visual impact on the former Balls Head Coal Loader site would be Minor.

It is noted that the proposed construction activities would in fact echo a time when this part of Sydney Harbour was industrial in character - a time which, in large part, informs the cultural heritage significance values of sites such as Yurulbin Park and the former Balls Head Coal Loader.

No underwater maritime heritage site or item would be visually impacted by the proposed works.

Table 24: Assessment of probability and level of indirect impacts on known and potential maritime heritage sites in Area A

Site	Sensitivity	Vibration Probability	Vibration Level	Settlement Probability	Settlement Level	Visual Probability	Visual Level
Yurulbin Park (maritime infrastructure and associated archaeological deposits)	Medium	Definite	Negligible to Minor	Definite	Negligible to Minor	Definite	Minor
Long Nose Point (Birchgrove) Wharf site and shelter (remnant maritime infrastructure and associated archaeological deposits)	Medium	Definite	Negligible	Definite	Negligible	Definite	Minor
Former coal loader	High	Definite	Negligible to Minor	Definite	Negligible to Minor	Definite	Minor
Unidentified Balls Head Bay 1	Medium	None	N/A	None	N/A	N/A	N/A
Unidentified Balls Head Bay 2	Medium	Highly probable	Negligible to Minor	None	N/A	N/A	N/A
Balls Head #1 Unknown shipwreck	Medium	None	N/A	None	N/A	N/A	N/A
Railway Electricity Tunnel	High	None	N/A	None	N/A	N/A	N/A
Balls Head Reserve, western foreshore	Medium	None	N/A	None	N/A	N/A	N/A
“Wreck 1241”	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 1	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 2	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 3	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 4	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 5	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 6	Low	None	N/A	None	N/A	N/A	N/A
SSS Anomaly No. 7	Low	None	N/A	None	N/A	N/A	N/A
Potential maritime infrastructure (other than around Yurulbin Park)	Low	Probable	Negligible	None	N/A	N/A	N/A
Potential shipwrecks as identified through remote sensing)	Medium	None	N/A	None	N/A	N/A	N/A
Potential shipwrecks (not detected though remote sensing)	Low	Highly improbable	Negligible	None	N/A	N/A	N/A
Potential discard from vessels	Low	Probable	Negligible	None	N/A	N/A	N/A

Relocation

During construction, the M.V*. Cape Don* and *Baragoola* would need to be relocated, as would other vessels and moorings throughout the project area. The M.V*. Cape Don* and *Baragoola* do not have any known historical association with the former Balls Head Coal Loader site and as such their temporary relocation would not impact on their cultural heritage values or the values of the former Balls Head Coal Loader.

8.6.2 Area B

The proposed construction activities in Area B that would have an impact on maritime heritage sites and items are discussed under the direct, potential direct and indirect categories.

Direct impacts

Installation of bed of the harbour structures

Impacts on the cultural heritage significance of maritime heritage in Area B would be greatest from the construction of the two temporary wharves and the barge shed (Figure 127 and Table 25).

Impacts arising from piling would be localised and hence Minor in relation to the heritage values of potential maritime infrastructure and associated archaeological deposits, and in relation to any shipwreck remains.

Some excavation may be required on the shoreward end of the proposed wharves. The wharf proposed over Slipway 1 may have an impact on the earlier remains of the NSW Torpedo Corps slipway structure, and on archaeological remains from that period. Impacts would vary from Minor to Moderate, depending on the scale of excavation (if excavation is carried out) and on the condition of the archaeological remains. This potential impact could be mitigated to Minor by limiting or negating the need for excavation to build the wharf and/or archaeological excavation or monitoring (see Chapter 9).

The construction of the proposed wharf on the BP site could have an impact on archaeological deposits associated with the period of occupation by Berry and Wollstonecraft. Any excavation into the reclamation immediately behind the seawall may impact the remains of the 1830s stone wharf. The impact may vary from Minor to Moderate, depending on the scale of excavation (if excavation is carried out) and the condition of the archaeological remains. This potential impact could be mitigated to Minor by limiting or negating the need for excavation to build the wharf and/or archaeological investigation or monitoring (see Chapter 9).

The construction and operation of the temporary wharves and barge ramp/shed may necessitate the partial removal of Slipway 1 and the cutting down of the timber piles of the derelict wharf and jetty associated with the BP site. The impact on Woodleys Shipyard and the BP site from the partial removal of these elements of maritime infrastructure would be Minor.

Potential direct impacts

Anchoring and tilting spuds

During the construction of the temporary wharves and barge ramp/shed, project vessels may need to anchor within Area B. It is probable that anchoring would have a Minor impact on potential discarded items from vessels, and a lesser probability of impacting the potential remains of maritime infrastructure and associated archaeological deposits or potential shipwrecks.

Propeller jet turbulence

Localised and shallow scouring from propeller jet turbulence could occur in shallower waters adjacent to the shore, however the impacts should be Negligible.

Indirect impacts

Visual impacts

Temporary visual impacts in Area B may occur due to the presence of the temporary construction compound including the barge shed and enclosed spoil conveyor. These would detract from the visual appeal of the area both for the public using or looking across Berrys Bay and those viewing the area from Berrys Bay Lookout at Carradah. However, the impacts on the aesthetic values of the maritime heritage items associated with Woodleys Boat Shed and the BP sites would be Negligible. Impacts on the maritime heritage components associated with the former Quarantine Boat Depot, such as the intact jetty, would be Minor during this period.

Figure 127: Potential impact on maritime heritage in Area B. Yellow lines and text indicate proposed and potential bed of the harbour disturbances

Table 25: Assessment of probability and level of potential impacts on known and potential maritime heritage sites in Area B

Site	Sensitivity	Installation Probability	Installation Level	Anchoring Probability	Anchoring Level	Propeller jet turbulence Probability	Propeller jet turbulence Level	Visual Probability	Visual Definite
Former BP site (including archaeological remains associated with Berry and Wollstonecraft wharf)	Medium	Definite	Minor to Moderate	Improbable	Minor	Probable	Negligible	Definite	Negligible
Former Woodleys Shipyard (including archaeological remains associated with NSW Torpedo Corp)	Medium	Definite	Minor to Moderate	Improbable	Minor	Probable	Negligible	Definite	Negligible
Former Quarantine Boat Depot	Medium	N/A	N/A	N/A	N/A	N/A	N/A	Definite	Minor
Potential maritime infrastructure	Medium	Improbable	Minor	Highly improbable	Negligible	Highly improbable	Negligible	N/A	N/A
Potential shipwrecks	Low to Medium	Highly improbable	Minor	Highly improbable	Minor	Highly improbable	Negligible	N/A	N/A
Potential discard	Medium	Improbable	Minor	Probable	Negligible	Probable	Negligible	N/A	N/A

8.6.3 Area C

The proposed construction activities in Area C are limited to the installation of piles. Therefore only the direct impact category will be addressed.

The area where piling is proposed has been assessed to have low sensitivity, mostly because it has been dredged in the past (Figure 128 and Table 26). Given this, it is almost impossible that piling would impact the remains of maritime infrastructure and associated archaeological deposits, a shipwreck or discarded items of Local significance or higher. Any such impact would be at a Minor Level. There would be no impact on the heritage values of Glebe Island Bridge or Anzac Bridge.

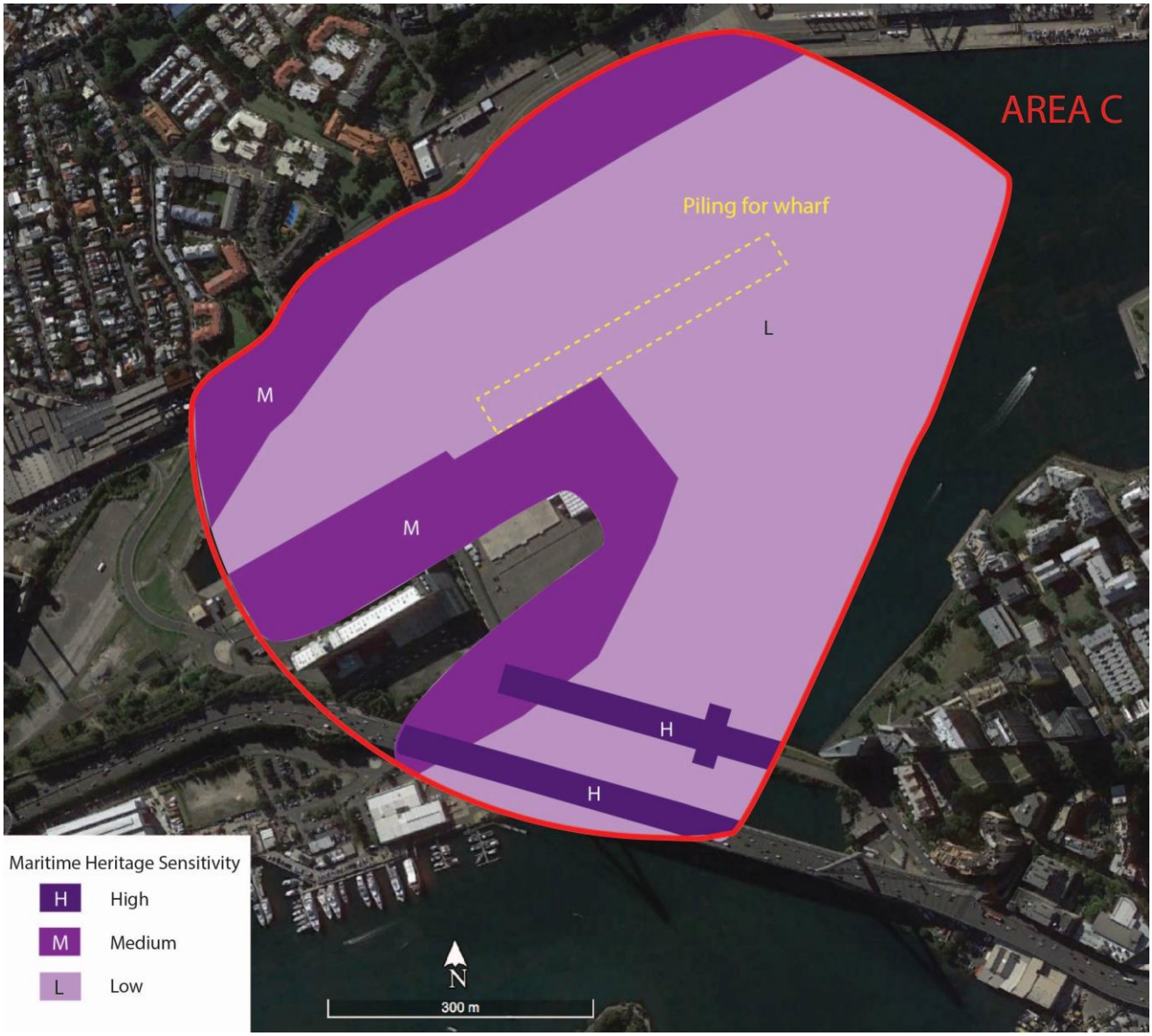


Figure 128: Potential impact on maritime heritage in Area C. Yellow lines and text indicate proposed and potential bed of the harbour disturbances

Table 26: Assessment of potential impacts on potential maritime heritage sites in Area C

Site	Sensitivity	Installation Probability	Installation Scale
Glebe Island Bridge	High	N/A	N/A
Anzac Bridge	High	N/A	N/A
Potential maritime infrastructure	Low	Almost impossible	Minor
Potential shipwrecks	Low	Almost impossible	Minor
Potential discard	Low	Almost impossible	Minor

8.6.4 Cumulative impacts

Cumulative impacts on the cultural heritage resource may be defined as impacts that result from incremental changes caused by past, present or reasonably foreseeable actions to which the project makes a contribution. Consideration of such impacts generally relies on a comprehensive understanding of the resource or baseline data against which to measure change. In the case of cultural heritage, an understanding of the entire inventory of items of cultural heritage significance within a particular locality, state or nation is not realistic. This is due in part to the framework for the heritage listing of items tending to be an *ad hoc* process, predominantly driven by development pressures and community concerns, rather than a systematic or strategic approach to recognising significant places in an area. Additionally, examining the cumulative impact of previous development is difficult as there is no comprehensive data on these impacts and no readily accessible data on earlier baselines of the cultural heritage resource prior to other developments. Because of these limitations, the discussion in this current assessment is focused on the impacts of the project on the current known maritime heritage resource, particularly those resources where project impacts, unmitigated, are potentially Moderate.

This assessment also considers that sub-surface bed of the harbour impacts in NSW tend to be localised either in the form of piling or trenching for services. Dredging tends to take place in areas that have been previously dredged and hence the cumulative impacts on maritime heritage are limited and localised. Development projects of this kind, involving extensive capital dredging, have become rare in recent decades in Sydney and across NSW. There are two comparable projects, both in the early 1990s: the excavation for the Sydney Harbour Tunnel and the Parramatta River Project to extend the ferry service to Parramatta. Both projects involved maritime archaeological input in the form of survey, excavation and monitoring (Atkinson 1988, Wolfe n.d). During the assessment phase these projects did not record any previously unidentified shipwrecks, however through dredging the Parramatta River Project recovered a considerable amount of cultural material associated with historically significant sites along the Parramatta River (Bower & Staniforth 1992).

Even without mitigation, the level of potential impacts on the majority of maritime heritage identified in this assessment would be Negligible or Minor. The risk of such impacts has been further minimised in the mitigation measures presented in Chapter 9.

The highest risk of Moderate impact on maritime heritage sites within the study area would be the highly improbable event(s) of project vessels colliding with the maritime infrastructure at Yurulbin Park and the former Balls Head Coal Loader. This risk would be minimised by protocols and measures to prevent project vessels from colliding with maritime assets in general. These measures are covered elsewhere in the environmental impact statement.

If the construction of the temporary wharves as part of the temporary construction facility WHT7 involves excavation, there could be Moderate impacts on the remains of the NSW Torpedo Corps slipway and the archaeological remains associated with Berry and Wollstonecraft's stone wharf. These impacts could be minimised by limiting the scale of excavation required and undertaking archaeological excavation and monitoring.

There is little probability of impacts on known shipwrecks being greater than Minor, and a low likelihood of undiscovered wrecks being present where dredging is to take place.

Wrecks of heritage significance are rarely impacted in NSW as a result of bed of the harbour development. This is partly because such sites are relatively uncommon when compared to the variety and number of terrestrial heritage sites, and as discussed above, extensive bed of the harbour development has become rarer. Only four wrecks of heritage significance are known to have been discovered during construction projects in NSW. Two of these wrecks were found in reclamation, the hulk of the P.S. *Leo* in Newcastle in 2008 and the remains of an early 1800s timber boat, UDHB01, in late 2018 at Darling Harbour on the site of the Barangaroo Metro station. The findings of these wrecks resulted in all construction works ceasing around these finds until the wrecks were exhaustively recorded *in situ* before being dismantled. UDHB01 was dismantled, recorded and packaged in a manner so as to allow it to be conserved and reconstructed in a museum display. Cosmos Archaeology provided technical assistance to the recording and excavation of these wrecks.

In January 2019 the remains of three timber boats, one of which was very likely built in the early 1800s, were discovered in Hawkesbury River during dredging, by bucket dredge, for the Windsor Bridge Replacement Project. Work in the area where the wreckage was found ceased until divers, under the supervision of maritime archaeologists cleared the work area of wreckage. Cosmos Archaeology has managed the archaeological monitoring, recovery and recording of the timbers.

The only submerged wreck that has been impacted by bed of the harbour development in NSW is the 19th century timber wreck, *Fame*, which was accidently uncovered during dredging operations for the Sydney Harbour Tunnel in 1990 (NSW Department of Premier and Cabinet (Heritage). The area where the *Fame* was located was not covered by the maritime archaeological assessment for the project.

The cumulative impact of the project on the identified maritime heritage resource can be considered to be Negligible. The risk of loss of heritage values associated the NSW Torpedo Corps slipway and the archaeological remains associated with Berry and Wollstonecraft's stone wharf would be minimised by the mitigation measures presented in Chapter 9.

8.6.5 Summary of potential impacts

Item name	Listing	Impact type	Impact rating
Known heritage items			
Yurulbin Park (maritime infrastructure and associated archaeological deposits)	Leichhardt LEP	Direct impacts: No planned direct physical impact, but there is potential (considered probable) for impact associated with installation of the cofferdam. Potential direct impacts: • There is potential, though highly improbable, for the site to be physically impacted from anchoring by project vessels • It is highly improbable that project vessels would collide with the site • Probable impact from propeller jet turbulence. Indirect impacts: • The site would definitely be impacted by vibrations arising from the construction of the nearby cofferdam • The site would definitely be impacted by settlement arising from the construction of the mainline tunnel • The site would definitely be visually impacted by the presence of the nearby cofferdam.	The majority of identified potential impacts of proposed works would result at most in a partial reduction in maritime heritage values intrinsic to the site through physical loss of integrity. As such the resultant level of impact would be **Minor**. There is a very low risk of a higher level of impact as a result of project vessel collision. Visual impacts would be temporary. The potential risk and level of impact can be further reduced or prevented by implementing Mitigation Measures A, E and F which are described in Section 9.2.
Long Nose Point (Birchgrove) Wharf site and shelter (remnant maritime infrastructure and associated archaeological deposits)	Sydney REP-SHC	Direct impacts: No planned direct physical impact, but there is potential (considered probable) for impact associated with installation of the cofferdam. Potential direct impacts: • There is potential, though improbable, for the site to be physically impacted from anchoring by project vessels • It is highly improbable that project vessels would collide with the site • There is potential, though improbable, impact from propeller jet turbulence. Indirect impacts: • The site would definitely be impacted by vibrations arising from the construction of the nearby cofferdam • The site would definitely be impacted by settlement arising from the construction of the mainline tunnel • The site would definitely be visually impacted by the presence of the nearby cofferdam.	The identified potential impacts of proposed works would result at most in a partial reduction in maritime heritage values intrinsic to the site through physical loss of integrity. As such the resultant level of impact would be **Minor**. Visual impacts would be temporary. The potential risk and level of impact can be further reduced or prevented by implementing Mitigation Measure A which is described in Section 9.2.

Item name	Listing	Impact type	Impact rating
Former Balls Head Coal Loader	S170, North Sydney LEP	Direct impacts: No planned direct physical impact, but there is potential (considered probable) for impact associated with installation of the cofferdam. Potential direct impacts: • There is potential, though highly improbable, for the site to be physically impacted from anchoring by project vessels • It is highly improbable that project vessels would collide with the site • Probable impact from propeller jet turbulence however the impacts would be Negligible. Indirect impacts: • The site would definitely be impacted by vibrations arising from the construction of the nearby cofferdam • The site would definitely be impacted by 'slight' settlement arising from the construction of the mainline tunnel • The site would definitely be temporarily visually impacted by the presence of the nearby cofferdam.	The majority of identified potential impacts of proposed works would result at most in a partial reduction in maritime heritage values intrinsic to the site through physical loss of integrity. As such the resultant level of impact would be **Minor**. There is a very low risk of a higher level of impact as a result of project vessel collision. Visual impacts would be temporary. The potential risk and level of impact can be further reduced or prevented by implementing Mitigation Measures A, D, E and F which are described in Section 9.2.
Railway Electricity Tunnel	SHR, S170, Sydney REP-SHC, Leichardt LEP	Direct impacts: No planned direct physical impact. Potential direct impacts: N/A Indirect impacts: N/A	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
Balls Head Reserve, western foreshore	North Sydney LEP,	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: N/A	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2
Unidentified Balls Head Bay 1	NSW Maritime Heritage Sites	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: N/A	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measures A and D which are described in Section 9.2
Balls Head #1 Unknown shipwreck	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
Unidentified Balls Head Bay 2	NSW Maritime Heritage Sites	Direct impacts: No planned direct physical impact Potential direct impacts: N/A Indirect impacts: It is highly improbable that the site would be impacted by vibrations arising from the construction of the cofferdam	The identified potential impacts of proposed works would result at most in a partial reduction in maritime heritage values intrinsic to the site through physical loss of integrity. As such the resultant level of impact would be **Minor**. The potential risk and level of impact can be further reduced or prevented by implementing Mitigation Measures A and E as described in Section 9.2.

Item name	Listing	Impact type	Impact rating
Baragoola	AHRV	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: The ability to maintain and repair the vessel could be reduced if relocated to unsuitable berth	The implementation of Mitigation Measure H as described in Section 9.2 would ensure that any potential impact arising from the relocation of the vessel is avoided.
M.V. *Don*	AHRV	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: The ability to maintain and repair the vessel could be reduced if relocated to unsuitable berth	The implementation of Mitigation Measure H as described in Section 9.2 would ensure that any potential impact arising from the relocation of the vessel is avoided.
Former BP site (including archaeological remains associated with Berry and Wollstonecraft wharf)	North Sydney LEP	Direct impacts: The site would definitely be physically impacted by the installation of bed of the harbour structures which would involve piling and excavation. Potential direct impacts: • There is potential, though improbable, for the site to be physically impacted from anchoring by project vessels • Probable impact from propeller jet turbulence however the impacts should be Negligible. Indirect impacts: The site would definitely be temporarily visually impacted by the presence of the barge shed and enclosed spoil conveyor	The identified potential impacts of proposed works could result in a substantial reduction in maritime heritage values intrinsic to the site through loss to site integrity. As such the resultant level of impact if left **unmitigated could be Moderate**. Visual impacts would be temporary. The potential level of impacts **can be reduced to Negligible or Minor** by implementing Mitigation Measures A, B and E as described in Section 9.2.
Former Woodleys Shipyard (including archaeological remains associated with NSW Torpedo Corp)	North Sydney LEP	Direct impacts: The site would definitely be physically impacted by the installation of bed of the harbour structures which would involve piling and excavation. Potential direct impacts: • There is potential, though improbable, for the site to be physically impacted from anchoring by project vessels • Probable impact from propeller jet turbulence however the impacts should be Negligible. Indirect impacts: The site would definitely be temporarily visually impacted by the presence of the barge shed and enclosed spoil conveyor	The identified potential impacts of proposed works could result in a substantial reduction in maritime heritage values intrinsic to the site through loss to site integrity. As such the resultant level of impact if left **unmitigated could be Moderate**. Visual impacts would be temporary. The potential level of impacts **can be reduced to Negligible or Minor** by implementing Mitigation Measures A, B and E as described in Section 9.2.
Former Quarantine Boat Depot	North Sydney LEP	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: The site would definitely be temporarily visually impacted by the presence of the barge shed and enclosed spoil conveyor	The only identified impact would be indirect (visual) and this would be **Minor** and temporary.
Glebe Island Bridge	SHR, S170,	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: N/A	There are no anticipated impacts for this site.
Anzac Bridge	S170	Direct impacts: N/A Potential direct impacts: N/A Indirect impacts: N/A	There are no anticipated impacts for this site.
Potential heritage items			

Item name	Listing	Impact type	Impact rating
Magnetic Anomaly 1	Unlisted	Direct impacts: This anomaly would be impacted by dredging Potential direct impacts: N/A Indirect impacts: N/A	This anomaly is expected to be of low heritage sensitivity. Its full removal, resulting in the complete loss of its intrinsic heritage values, can be considered to be a **Minor** impact at most. The implementation of Mitigation Measures A and C as described in Section 9.2 would ensure that the potential impact **remains at Minor or is reduced to Negligible.**
"Wreck 1241"	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A as which is described in Section 9.2.
SSS Anomaly No. 1	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 2	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 3	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 4	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 5	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 6	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.
SSS Anomaly No. 7	Unlisted	Direct impacts: No planned direct physical impact. Potential direct impacts: No anticipated potential direct physical impact. Indirect impacts: No anticipated potential indirect impact.	There are no anticipated impacts for this site. Potential risks of impact can be managed by implementing Mitigation Measure A which is described in Section 9.2.

Item name	Listing	Impact type	Impact rating
Potential archaeological remains			
Potential archaeological sites in Sydney Harbour between Birchgrove and Balls Head (Area A)	Unlisted	Direct impacts: There is potential impact from dredging and installation of the cofferdams, although this is considered highly improbable Potential direct impacts: • It is probable that potential archaeological remains would be physically impacted by anchoring of project vessels • It is probable that potential archaeological remains would be impacted by propeller jet turbulence Indirect impacts: • The potential archaeological remains would probably be impacted by vibrations arising from the construction of the nearby cofferdam	The identified potential impacts of proposed works on the bulk of potential archaeological remains could result at most in a partial reduction in maritime heritage values intrinsic to the item/site through physical loss of integrity, and as such would be considered a **Minor** impact. There is a much lesser likelihood for undiscovered historic shipwrecks to be affected, however the **unmitigated impact** on such sites could be **as high as Major**. The potential level of impact **can be reduced to Negligible and/or retained at Minor** by implementing Mitigation Measures A, C and G which are described in Section 9.2.
Potential archaeological sites in western portion of Berrys Bay (Area B)	Unlisted	Direct impacts: There is potential impact from installation of the temporary wharves, although this is considered improbable Potential direct impacts: • It is probable that potential archaeological remains would be physically impacted by anchoring of project vessels • It is probable that potential archaeological remains would be impacted by propeller jet turbulence Indirect impacts: No anticipated potential indirect impacts	The identified potential impacts of proposed works on the bulk of potential archaeological remains could result at most in a partial reduction in maritime heritage values intrinsic to the item/site through physical loss of integrity, and as such would be considered a **Minor** impact. The potential level of impact **can be reduced to Negligible and/or retained at Minor** by implementing Mitigation Measure A which is described in Section 9.2.
Potential archaeological sites in White Bay (Area C)	Unlisted	Direct impacts: There is potential impact from the installation of the temporary wharf, although this is considered almost impossible. Potential direct impacts: N/A Indirect impacts: N/A	The identified potential impacts of proposed works on the bulk of potential archaeological remains could result at most in a partial reduction in maritime heritage values intrinsic to the item/site through physical loss of integrity, and as such would be considered a **Minor** impact. The potential level of impact **can be reduced to Negligible and/or retained at Minor** by implementing Mitigation Measure A which is described in Section 9.2

8.7 Comparative analysis

Condition 2e of the SEARs requires the provision of *a comparative analysis to inform the rarity and representative value of any heritage places proposed for demolition*. No known heritage places, sites or items are to be demolished in the study area.

There is a reasonable probability that during the course of dredging and excavation within Area A the remains of maritime infrastructure – such as collapsed piles and the occasional mooring, as well as items discarded from vessels – would be removed from their context. These types of maritime heritage have been assessed to be of Low heritage sensitivity due to in large part to their ubiquitous nature within Sydney's underwater cultural landscape, as well as the relatively unremarkable historical associations with the study area. These items of maritime heritage are neither rare nor representative of their type. As such, a comparative analysis in relation to the potential loss of these maritime heritage remains is not required.

9 MANAGEMENT

9.1 Introduction

Appropriate forms of mitigation are presented in this chapter based on the consideration of a number of factors such as:

- Relevant heritage policies (refer Section 3.3)
- Best practice
- Consultant experience in forming and implementing mitigation measures in a marine environment.

The underlying principle in safeguarding the cultural heritage significance of maritime heritage is to avoid or minimise any impacts (immediate to long term) on a site. This approach is refined depending on the level of cultural heritage significance of an item or site, the risk of impact and the scale of impact. The scale or consequence of impact relates to the degree of loss (immediate or gradual) of cultural heritage significance.

Generally, the selection of an appropriate mitigation measure for a site follows the principles set out below:

- For sites of High significance, if impacts are assessed to be Moderate or higher, the appropriate mitigation measure would be to avoid the site. This could require re-designing a project element
- For sites of Medium significance, where there is a reasonably high probability that the impacts would be Moderate, some form of archaeological recording may be a more appropriate form of mitigation, whether through survey or excavation. Such recording would reduce the impact by saving information about the site that would otherwise be lost
- For sites or items of Low significance, for which the probability of impact is Low, some form of sampling or monitoring protocol during construction would be an appropriate form of mitigation.

9.2 Proposed mitigation measures

Mitigation measure A – Prepare a Maritime Heritage Management Plan

A Maritime Heritage Management Plan that details the objectives and methodologies to conserve maritime heritage and mitigate impacts should be prepared by a qualified and experienced maritime archaeologist. The Maritime Heritage Management Plan should specify:

- Unexpected finds protocols relevant to each type of activity such as dredging or piling
- Artefact management procedures, including identification of approved submerged reburial locations
- Relevant work method requirements and maritime heritage inductions tailored for each type of work activity such as dredging or piling
- Exclusion zone, archival, baseline and periodic monitoring protocols including before and during construction, and final site inspections within three months of completion of works for the following maritime heritage sites:
    - Balls Head Coal Loader wharf
    - Yurulbin Park maritime infrastructure
    - Unidentified Balls Head Bay 2 wreck
    - Collapsed wharf, BP site, Berrys Bay
- Requirements for any mitigation recovery or archaeological excavations.

This measure would ensure the impact on known and potential maritime heritage remains such as maritime infrastructure, shipwrecks and discarded objects, would be either Negligible or Minor.

Mitigation measure B – Berrys Bay

Investigate the potential to relocate or redesign the temporary wharves at the proposed temporary construction facility WHT7 in Berrys Bay to minimise impact on maritime heritage.

Where this is not feasible then appropriate mitigation should be implemented before construction in accordance with the Maritime Heritage Management Plan (Mitigation Measure A). It is recommended that such mitigation includes undertaking an archaeological investigation under the direction of a qualified maritime archaeologist across all areas of impact at the site.

This measure would ensure the impact on the potential remains associated with the NSW Torpedo Corps slipway and Berry and Wollstonecraft's Wharf remain as Negligible or are reduced to Minor.

Mitigation measure C – Maritime archaeologist involvement in pre-dredge bed of the harbour clearance

Any pre-dredge clearance of the bed of the harbour in Sydney Harbour should be carried out in the presence of a qualified maritime archaeologist who will identify any additional inspection or documentation that should be carried out during the clearance dives. This may include inspecting the locations of known or suspected submerged cultural heritage, detailed recording, or recovery and relocation of heritage objects.

This measure would reduce the impact on potential maritime heritage remains, such as maritime infrastructure, shipwrecks and discarded objects, to Negligible or Minor.

Mitigation measure D – Exclusion zone around Balls Head Coal Loader wharf

An exclusion zone should be established around the former Balls Head Coal Loader wharf extending at least 15 metres from the edge of the wharf apron and thus also covering the Unidentified Balls Head Bay 1 and 2 wrecks. The specific dimensions of the exclusion zone, and details of how it is to be physically marked, should be specified in the Maritime Heritage Management Plan (Mitigation Measure A).

This measure would further reduce the risk of potential impact on this site to less than highly improbable.

Mitigation measure E – Carry out archival recording of select maritime heritage sites

Archival recording of the following maritime heritage sites should be carried out before the start of works to mitigate against predicted or potential impacts, and to establish a baseline against which to measure any changes to these sites due to works:

- Balls Head Coal Loader wharf
- Unidentified Balls Head Bay 2 wreck
- Yurulbin Park maritime infrastructure
- Collapsed timber wharf, BP site, Berrys Bay
- Slipway No. 1, former Woodleys Shipyard, Berrys Bay.

The archival recording should include:

- Creation of a detailed site plan by a surveyor for Balls Head Coal Loader, Yurulbin Park maritime infrastructure, collapsed timber wharf and Slipway No. 1
- Detailed recording and inventory of all site elements
- Detailed diver survey and recording of submerged sites and site elements, primarily in the form of video and photography.

All archival recordings should be prepared consistent with the current NSW Heritage Council endorsed standards and guidelines.

This measure would reduce the potential impact on these sites to Negligible or Minor.

Mitigation measure F – Carry out requisite steps to reduce vibration and settlement impacts on sensitive maritime heritage sites

The recommended actions in the Technical working paper: Noise and Vibration should be carried out to minimise vibration and settlement impacts to acceptable levels for the following maritime heritage sites:

- Balls Head Coal Loader wharf
- Yurulbin Park maritime infrastructure.

This measure would reduce the potential impact on these sites to Negligible.

Mitigation measure G – Complete and review the side scan sonar survey for areas to be affected by project works

Prepare a side scan sonar survey for sections of the Sydney Harbour crossing not already included in the side scan sonar coverage (Area A).

A qualified maritime archaeologist should assess the results of the side scan survey to identify any additional potential heritage items requiring investigation and assessment.

This measure would reduce the impact on potential maritime heritage remains, such as maritime infrastructure, shipwrecks and discarded objects, to Negligible or Minor.

Mitigation measure H – M.V. Cape Don and Baragoola

Roads and Maritime should give reasonable time and notice for the vessel owners of the historic vessels *M.V Cape Don and Baragoola* to find a suitable alternate berthing within Sydney Harbour before construction commences.

Roads and Maritime should take no action that results in the degradation of the heritage significance of the items until relocation occurs.

This measure would maintain the existing heritage values of these vessels. Therefore the impact would be Negligible.

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