Review of Environmental Factors

for

Boardwalk and Bridge Replacement

at

Long Reef Headland

Prepared for Northern Beaches Council

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We acknowledge the traditional owners of this land and pay respect to Elders, past, present and emerging.

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1 Executive Summary

Background

This Review of Environmental Factors (REF) identifies the biodiversity, environmental and cultural values at the location of a replacement of a public boardwalk and bridge on the southern side of Long Reef headland. The boardwalk and bridge have been damaged by wave action on several occasions and the proposal will move the path several meters away from the sea.

This REF assists Council in fulfilling the requirements of Division 5.1 of the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act) by considering the factors that are likely to impact the environment as a result of the proposed works, so that Council can make an informed decision regarding the design, location and suitability of the proposal and determine whether the works are likely to significantly affect the environment.

This REF is consistent with the requirements of the DPE document Guidelines for Division 5.1 assessments July 2022.

The Proposal

Council proposes to replace the existing boardwalk and bridge with a different design and in a location that will be less susceptible to wave damage. During construction there will need to be a stockpile/works compound and an access route for construction vehicles. The footprint of the works consists of the location of the existing boardwalk to be demolished, the location of the new boardwalk and bridge, the adjacent excavation/disturbance/works area and the access route to the site.

Due to the high use of the boardwalk the existing path will need to be kept open for public use as much as possible requiring a sequence of works and fencing.

Dogs are currently permitted on a leash on the boardwalk and this will not change as part of this proposal.

Environmental Factors

This REF assesses the Activity by reference to the 18 Environmental Factors listed in clause 171 of the Environmental Planning and Assessment Regulations 2021.

These Factors are grouped into 6 categories that are the most relevant potential environmental impacts for this proposal.

- Biodiversity
- Soil Erosion and Water Quality
- Aboriginal Archaeology and History
- Waste Management and resources
- Socio economic / Landuse
- Other Factors.

Conclusion

The assessment of the Environmental Factors concludes that the proposal will have a minor or negligible impact on environmental factors and will not significantly affect the environmental values at the site. The works will realise several positive socio-economic, biodiversity appreciation, lifestyle and liveability impacts, that are centred around the use of outdoor space, exercise and establishing, accessing and maintaining social networks.

Residual impacts identified through the assessment process are proposed to be further minimised through the incorporation of mitigation and management safeguards as outlined in this report.

2 Introduction

2.1 Background

GIS Environmental Consultants have been commissioned by Thompson Berrill Landscape Design P/L, who were in turn commissioned by the Northern Beaches Council (Council), to prepare a Review of Environmental Factors (REF) to assess the potential environmental impacts of the replacement of the boardwalk and bridge on the public walkway on the southern side of Long Reef headland that has been damaged by wave action.

The purpose of this REF is to describe the proposed works, document and assess the likely impacts of the works on the environment, and detail any recommended environmental mitigation and management measures during construction and for the life of the development.

Impacts that could occur during demolition of the existing walkway, construction and use of the replacement boardwalk and bridge were identified and the design and layout has been modified to avoid and minimise these impacts. Recommendations to further ameliorate ecological impacts are included in this report.

This REF will assist Council in fulfilling the requirements of Division 5.1 of the Environmental Planning and Assessment Act 1979 (NSW) (EP&A Act) by considering and documenting a review of the matters affecting or likely to affect the environment as a result of the works, so that the Council may assess and take into full consideration the matters. As part of the assessment Council will need to determine whether the works is likely to significantly affect the environment.

This REF is consistent with the requirements of the DPE document titled Guidelines for Division 5.1 Assessments, dated July 2022.

The information in this Review of Environmental Factors (REF) will allow assessment of the application according to the following legislation; Environmental Planning and Assessment Act 1979, the Federal Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999), SEPPs, local government controls, orders, and policies such as LEPs and DCPs.

2.2 Aims of this Report

This REF describes the ecological values and constraints that are present and then assesses the environmental impact of the proposed replacement of the boardwalk and bridge and associated works.

The aims of this REF are to:

- Record the **findings of ecological, environmental and archaeological surveys** that describe the environmental habitats and ecological communities, physical environment and archaeological importance of the site and surrounding land;
- Determine the ecological **constraints** of the site and provide advice to the applicant on ways the impact can be **avoided** and **minimised** before finalising the proposal plans;
- **Assess** the likely **ecological**, **environmental and cultural impact** of the proposal with respect to the Environmental Factors listed in the EP&A Act;
- Determine if the proposal needs a **referral** to the Federal government for assessment under the EPBC Act; and
- Recommend ways the **ecological impacts** can be further **ameliorated** with management actions during construction for the life of the development.

2.3 Relevant Legislation

The ecological legislation relevant to this proposal are assessed in Table 1 and the relevant ones are further described in section 1.3.

Table 1: Ecologically Relevant Legislation Summary

Legislation/Policy	Triggers	Requirement	Assessment Requirements	How Addressed
Environment Planning and Assessment Act 1979	Part 5.1(a) clause 171	Yes	Review of Environmental Factors in clause 171	Addressed by this report.
Biodiversity Conservation Act 2016 (BC Act)	For an REF only the listing of Threatened species and ecological communities are relevant. The BC Act Regulation and BAM assessment is not required as this is a part 5 assessment.	For an REF the significance of impact to listed Threatened Species or Ecological Communities s7.2 & 7.3 is required.	Ecological survey and assessment. BAM assessment is not required.	Ecological survey and assessment included within this report. Entry into BOS, BAM assessment, BDAR not required.
NP&W Act	Potential Aboriginal objects or places. The activity is not within a National Park.	Yes	Heritage assessment	Due Diligence Code met by attached heritage report.
Heritage Act	Non-Aboriginal artefacts or sites that are older than 50-years-old and heritage registers.	Yes	Heritage assessment	Due Diligence Code met by attached heritage report.
Protection of the Environment Operations Act 1997	Water, air and noise pollution. The proposal is a Non Schedule 1 activity.	No licence required	N/a	N/a
Waste Avoidance and Resource Recovery Act 2001	Waste will be generated and resources used.	Yes	Landscape Design specifications	Landscape Design specifications
Local Land Services Act 2013 (LLS Act)	Native Vegetation Regulatory Map	No	N/a	N/a
Vegetation in Non-Rural Areas SEPP	Clearing of vegetation when there is no DA required. This is a part 5 Assessment.	No	N/a	N/a
Water Management Act 2000	Controlled activity on waterfront or riparian land.	Not a hydroline waterway. The boardwalk is within 40m of the sea. However, Local Councils are exempt.	N/a	N/a
Contaminated Land Management Act 1997	EPA Contaminated Land Public Register	No	N/a	N/a
Fisheries Management Act 1994 (FM Act)	Impact on marine vegetation or Threatened species listed in the FM Act. The site is adjacent and up slope of a Marine Reserve.	All of the proposal is above mean high water mark. There is no change to the drainage line proposed.	N/a	N/a
Resilience and Hazards SEPP 2021	Mapped on Coastal Wetlands and Littoral Rainforests Area Map –	No, not mapped	N/a	N/a

Legislation/Policy	Triggers	Requirement	Assessment Requirements	How Addressed
	NSW Planning Portal Spatial Viewer			
Biosecurity Act 2015 (Bio Act)	Priority weeds of environmental weeds at the site.	Yes	Priority and Environmental Weeds are identified.	Priority and Environmental Weeds are identified and management recommended
Koala Habitat Protection SEPP 2019	Evidence of viable Koala population in the locality	No Subject Site less than 1ha. No Koala population	N/a	N/a
Local Council LEP and DCP	WLEP and DCP	Yes	LEP and DCP addressed by separate Planning Report	LEP and DCP addressed by separate Planning Report
Community Strategic Plan	NBC	Yes	Is consistent with objectives and addressed by separate planning report	Is consistent with objectives and addressed by separate planning report
Northern District Plan 2018		Yes	Is consistent with objectives and addressed by separate planning report	Is consistent with objectives and addressed by separate planning report
Greater Sydney Regional Plan 2018		Yes	Is consistent with objectives and addressed by separate planning report	Is consistent with objectives and addressed by separate planning report
Local Strategic Planning Statement - Towards 2040	NBC	Yes	Is consistent with objectives and addressed by separate planning report	Is consistent with objectives and addressed by separate planning report
Other SEPPS	Various, mostly maps	Yes	Addressed by Planning Report	Addressed by Planning Report
Federal Environment Protection and Biodiversity Conservation	Matters of National Environmental Significance MNES including Commonwealth listed threatened species. Migratory birds and marine animals may be present or nearby.	Yes, not covered by Bilateral agreement	Assessment under the TSC Act	Addressed by this report, see 2.4.12

2.4 Statutory Considerations

2.4.1 Environment Planning and Assessment Act 1979

The NSW Environment Planning and Assessment Act 1979 and its regulation is the framework for approval of development in NSW.

The proposed works are the repairing of existing infrastructure that is used by members of the public for recreational purposes. The works (Activity) will not involve any enlargement, expansion, or intensification of the recreation use or a change in use.

The proposed Activity is a continuing use as defined in s 4.68 of the EP&A Act. As a result, the use may continue without the need for development consent under Part 4 of the EP&A Act. The proposal is likely to meet the definition of Activity as defined in section 5.1 of the EP&A Act. The appropriate assessment pathway is likely to be assessed under Part 5 of the Environmental Planning and Assessment Act 1979 (NSW) and as such the assessment of the environmental impact can be assessed by a Review of Environmental Factors (REF) as described in Clause 171 of the Environmental Planning and Assessment Regulations 2021.

Therefore, one of the purposes of this REF is to assess and record all matters affecting or likely to affect the environment by reason of the Activity. This will allow Council to examine and take these matters into account to the fullest extent reasonably possible.

This REF assesses the Activity by reference to the factors contained in clause 171 of the Environmental Planning and Assessment Regulations 2021 and the guidelines for Division 5.1 assessment.

2.4.2 Environmental Planning and Assessment Regulations 2021 s 5.10(a) clause 171

171 Review of environmental factors

(1) When considering the likely impact of an activity on the environment, the determining authority must take into account the environmental factors specified in the environmental factors guidelines that apply to the activity.

(2) If there are no environmental factors guidelines in force, the determining authority must take into account the following environmental factors—

(a) the environmental impact on the community,

(b) the transformation of the locality,

(c) the environmental impact on the ecosystems of the locality,

(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality,

(e) the effects on any locality, place or building that has—

(i) aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance, or

(ii) other special value for present or future generations,

(f) the impact on the habitat of protected animals, within the meaning of the Biodiversity Conservation Act 2016,

(g) the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,

(h) long-term effects on the environment,

(i) degradation of the quality of the environment,

(j) risk to the safety of the environment,

(k) reduction in the range of beneficial uses of the environment,

(l) pollution of the environment,

(m) environmental problems associated with the disposal of waste,

(n) increased demands on natural or other resources that are, or are likely to become, in short supply,

(o) the cumulative environmental effect with other existing or likely future activities,

(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions,

(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1,

(r) other relevant environmental factors.

(3) A determining authority must prepare a review of the environmental factors that demonstrates how the environmental factors specified in the environmental factors guidelines, or the environmental factors specified in subsection (2) if no guidelines are in force, were taken into account when considering the likely impact of an activity.

These Environmental Factors have been grouped into the following environmental topic groupings that are relevant to the environmental assessment of this proposal. Each topic group is addressed in a section in this report:

- Biodiversity

(c) the environmental impact on the ecosystems of the locality,

(f) the impact on the habitat of protected animals, within the meaning of the Biodiversity Conservation Act 2016,

(g) the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,

• Soil Erosion, Water Quality and Coastal Processes

(h) long-term effects on the environment,
(i) degradation of the quality of the environment,
(j) risk to the safety of the environment,
(k) reduction in the range of beneficial uses of the environment,
(l) pollution of the environment,
(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions,

• Aboriginal Archaeology, Cultural History and Future Generational Values

(e) the effects on any locality, place or building that has—
(i) aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance, or
(ii) other special value for present or future generations,

• Socio Economic / Land Use

(a) the environmental impact on the community,
(b) the transformation of the locality,
(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality,
(o) the cumulative environmental effect with other existing or likely future activities,
(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1,

• Waste Management and Resources

(m) environmental problems associated with the disposal of waste,
(n) increased demands on natural or other resources that are, or are likely to become, in short supply,

• Other Factors

(r) other relevant environmental factors.

2.4.3 Biodiversity Conservation Act 2016

The purpose of the *Biodiversity Conservation Act 2016 (BC Act)* "is to maintain a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future, consistent with the principles of ecologically sustainable development" (section 1.3).

The Biodiversity Conservation Act lists the Threatened flora and fauna species and defines the Ecological Communities in NSW. The Ku-ring-gai Council Local Environment Plan (KLEP 2015) aims to 'make local environmental planning provisions for land in Ku-ring-gai in accordance with the relevant standard environmental planning instrument under section 33A of the Act'. The Ku-ring-gai Development Control Plan (KDCP 2016) contains detailed planning controls. Both the LEP and the DCP must be considered when a determining authority assesses development in this area.

Part 7 of the BC Act sets out a process of assessment for an 'activity' as defined in Part 5 of the EP&A Act. As provided in Section 4.1.1 of this REF, the Activity is such an activity.

For the purposes of Part 5 of the *Environmental Planning and Assessment Act 1979,* an Activity is to be regarded as an activity that is likely to significantly affect the environment or if it is likely to significantly affect Threatened species.

Sections 7.2 and 7.3 of the BC Act sets out the test for determining whether an Activity is likely to significantly affect Threatened species. This test will be set out and considered in Section 5.6 of this REF.

When the proposal is to be assessed under Part 5 of the EP&A Act and the applicant has elected to carry out a REF, the requirement for a BAM assessment and a BDAR report is not required.

2.4.4 Water Management Act 2000

The primary piece of legislation for the management of water in NSW is the *Water Management Act 2000 (WM Act)*. The WM Act is designed to provide for the sustainable and integrated management of the water sources of the State for the benefit of both present and future generations.

The WM Act recognises the need to protect waterfront land and riparian land.

The Activity involves works within 40m of the sea. However, Clause 41 of the Water Management (General) Regulation 2018 states that Local Councils are exempt.

2.4.5 Biosecurity Act 2015 - Weeds

The aims of the *Biosecurity Act 2015* are to provide a framework for the prevention, elimination and minimisation of biosecurity risks by carriers or potential carriers.

The *NSW Biosecurity Act 2015* requires that "*the responsibility of any person who has any dealing with weeds (biosecurity matter), whether they have an infestation on their land, are selling a potentially invasive species, dumping garden rubbish, or supplying contaminated fodder or the like must prevent, minimise or eliminate the biosecurity risk (as far as is reasonably practicable)*". This report addresses the NSW Biosecurity Act 2015 by referring to the document 'Greater Sydney Regional Strategies Weed Management Plan 2017-2027' by the Local Land Services of Greater Sydney. The Management Plan seeks to provide guidance on the management of weeds on a local scale to comply with the NSW Biosecurity Act 2015. Appendix 1.1 of this Management Plan identifies 'State level determined priority weeds" and is broken up into the strategic response categories of 'Prevention', 'Eradication', 'Containment' and 'Asset Protection (Whole of State)'. Appendix 1.2 outlines the 'Regional priority weeds' and is also broken up into these same four strategic responses. Weeds in the 'prevention' category have not yet been identified in the state, but they pose a large biosecurity risk, so it is expected that these are prevented from entering the state. 'Eradication' applies to weeds that are only limited in distribution and abundance, and so, these must be fully removed. 'Containment' is appropriate for weeds that have a wide distribution, hence widescale eradication is not currently possible, but these must be prevented from spreading further. 'Asset Protection' refers to Weeds of National Significance whose spread must be minimised. Appendix 2 lists "Other weeds of regional concern". The weeds in appendices 1.1 and 1.2 must be managed to comply with the NSW Biosecurity Act 2015. However, the weeds in Appendix 2 are not legally binding, and it is not required by State law to manage these weeds.

The site includes weeds that are listed in the Greater Sydney Regional Strategic Weed Management Plan 2023-2027.

The appropriate weed control is discussed in section 5.4 of this report.

2.4.6 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* (NPW Act) aims to manage the following:

- The conservation of nature
- Conservation of objects, places, and features of cultural value
- Public appreciation, understanding and enjoyment of nature and cultural heritage
- Land reserved under this Act.

The Activity Areas are not located within a National Park. The Activity is not expected to directly or indirectly impact on the conservation and use of National Park land. Section 6.6 of this REF considers the impact of the Activity on the conservation of Aboriginal heritage, and places and features of cultural value.

Section 7.5 of the OEH Due Diligence Code of Practice for the Protection of *Aboriginal Objects in New South Wales (2010a)* notes that the Clause 57 of the National Parks and Wildlife Regulation 2019 removes the need to follow the due diligence process if carrying out a specifically defined "low impact activity".

An Aboriginal Objects Due Diligence Assessment has been prepared for the Activity under Part 6 of the NPW Act, as a part of the Aboriginal Archaeology and Heritage Report by Northern Beaches Council. This report is attached as Appendix D.

2.4.7 Heritage Act 1977

The Heritage Act 1977 encompasses non-Aboriginal artefacts or sites that are older than 50-years-old. This act aims to promote understanding, encourage conservation, provide identification and registration, provide protection and encourage adaptive reuse of State Heritage items.

A heritage assessment has been conducted. Searches of the various heritage registers were undertaken for the Activity Areas, with no heritage items identified within 200m of the Activity Areas.

2.4.8 Contaminated Land Management Act 1997

The *Contaminated Land Management Act 1997* was established to investigate and, where appropriate, remediate land that the Environment Protection Authority (EPA) has considered to be contaminated significantly enough to require regulation.

A search of the EPA's Public Register did not identify any known / recorded contaminated land within the Activity Areas.
A Geotechnical Assessment has been conducted. The sand used for the sand dunes will be tested for contamination and Acid Sulphate Soils.

2.4.9 Fisheries Management Act 1994

The *Fisheries Management Act 1994 (FM Act)* relates to the conservation of the fishery resources.

Department of Primary Industries (DPI) Fisheries, assess applications for dredging and reclamation works which may harm marine vegetation and cause obstruction of fish passage in accordance with Part 7 of the FM Act and the Policy and Guidelines for Fish Habitat Conservation and Management (2013 Update).

This Activity will be adjacent to but not involve any activities that will require an application to DPI Fisheries.

No Further assessment is required.

2.4.10 Protection of the Environment Operations Act 1997

The Protection of the *Environment Operations Act 1997* (POEO Act) regulates pollution in NSW including water pollution, air pollution, noise pollution and the pollution of land. The aims of the POEO Act are achieved by way of Protection of the Environment Policies, licensing and by the issuing of Environmental Protection Notices to persons or organisations that are found to be polluting the environment.

Council is the regulatory authority for this Activity as it is a non-scheduled activity defined by Schedule 1 of the POEO Act. For the purposes of Section 48 of the POEO Act, an Environmental Protection Licence is not required for this Activity as it is a non-scheduled activity.

2.4.11 Waste Avoidance and Resource Recovery Act 2001

The *Waste Avoidance and Resource Recovery Act 2001* sets out priorities and methods to reduce waste generated and waste resource recovery within NSW, aiming to reduce environmental harm and encouraging the most efficient use of resources.

2.4.12 Commonwealth Environment Protection and Biodiversity Conservation Act, EPBC Act

This report also identifies flora and fauna species or communities, relevant to the site that are listed under Part 13 Division 1 of the *Environment Protection & Biodiversity Act 1999* (Cwlth) (EPBC). Species or communities listed in the Act are considered to be "*matters of national environmental significance*" and consideration needs to be given as to whether the proposed development will or is likely to have a "*significant impact*" on "matters of national environmental significance". In determining whether a "*significant impact*" will occur, consideration is given to:

- EPBC Act Administrative guidelines on significance (DEH 2006)

Should the assessment in this report determine that a "significant impact" will occur or is likely to occur on "matters of national environmental significance" the proposed development will need to be referred to the Minister (Cwlth) to determine as to whether the proposed development is a "controlled action".

Part 13 Division 1 of the Environment Protection & Biodiversity Conservation Act 1999 (Cwlth) (EPBC) lists flora, fauna and ecological communities that are considered to be "*matters of national environmental significance*". Under the Act consideration must be given as to whether the proposed actions will or is likely to have a "*significant impact*" on "*matters of national environmental significance*".

There is currently an agreement in place between the State and Federal governments regarding the requirement for ecological assessment of Matters of National Significance.

To minimise duplication in the environmental assessment procedures, a bilateral agreement was made in January 2007 between the Commonwealth & NSW Governments giving accreditation of New South Wales assessment processes in relation to threatened species, populations and ecological communities. The agreement provides for "Controlled actions" as defined in the Environment Protection & Biodiversity Act 1999 (Cwlth) relating to threatened species, to no longer require assessment under Part 8 of the Environment Protection & Biodiversity Act 1999 (Cwlth) where they are assessed under Part 3A, 4 or 5 of the Environmental Planning and Assessment Act 1979 (NSW).

Assessment under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) is needed if the proposal is considered likely to have an impact on a 'matter of National Environmental Significance (NES)' then the proposal would need detailed assessment and referral to the Federal Department of Climate Change, Energy, Environment and Water thus providing a trigger for referral of the proposal to the Environment Department for assessment.

There are nine Protected Matters covered by EPBC Act:

1. World Heritage Areas
2. National Heritage Places
3. Wetlands of International Importance (listed under the Ramsar Convention)
4. Listed threatened species and ecological communities
5. Listed migratory species (protected under international agreements)
6. Commonwealth marine areas
7. Great Barrier Reef Marine Park
8. Nuclear actions (including uranium mines)
9. Water resources (that relate to coal seam gas development and large coal mining development).

This report addresses the requirements of this legislation.

None of the components of the Activity will be located within a World Heritage site, a National Heritage place, a wetland of international importance, a Commonwealth marine or land area or the Great Barrier Reef Marine Park. The Activity also does not involve a nuclear action or coal seam gas development and large coal mining development.

The provisions of the EPBC Act which are relevant to the Activity are those which relate to impacts on habitat for threatened species and ecological communities listed in the EPBC Act. The Activity's impacts on these aspects and the mitigation measures and controls (safeguards) to avoid and minimise impacts on the community and environment are considered in Section 6.

As the Activity is unlikely to have a significant impact on a MNES, referral under the EPBC Act is not considered necessary.

A Protected Matters search was conducted within a 10km radius of the site and the results are attached as Appendix A. A Protected Matters search is a broad-scale assessment that includes World Heritage Properties, National Heritage Places, Wetlands of International Importance, Great Barrier Reef Marine Park, Commonwealth Marine Areas, Listed Threatened Ecological communities, Listed Threatened Species and Listed Migratory Species.

The report lists the following ecologically relevant items:

- Threatened Ecological Communities
- Threatened species
- Migratory Species

Most of the migratory and aquatic bird species, as well as the fish, sharks and marine mammals, are not assessed in this report. This report addresses terrestrial species, which could potentially have suitable habitat on the site. A Significant Impact Criteria Assessment was undertaken in Appendix C.

2.5 Definitions and Acronyms

BC Act - (NSW Biodiversity Conservation Act 2016) - Contains the lists of threatened species, the definitions of the threatened ecological communities, the 5-part Test of Significance and the BOS. There are associated Biodiversity Conservation regulations which refers to the BAM.
DCCEEW – Commonwealth Department of Climate Change, Energy, Environment and Water.
DCP - (Development Control Plan) - A local planning instrument for each LGA.
Direct Impacts - impacts that directly affect habitat, ecosystems, and individuals. They include, but are not limited to, death, trampling, poisoning of the animal/plant itself and the removal of vegetation and suitable habitat. When applying each factor, consideration must be given to all of the likely direct impacts of the proposed activity or development during construction. As defined by the 2006 DECC Assessment of Significance guidelines.
DPE - NSW Department of Planning and Environment
DPIE – NSW Government of Department of Planning, Industry and Environment
EPA Act (EP&A Act) – NSW Environment Planning and Assessment Act 1979, controls development in NSW.
EPBC Act - (Federal Environment Protection and Biodiversity Conservation Act 1999) – Identifies matters of national environmental significance to protect nationally significant fauna, ecological communities, and heritage sites.
LEP (Local Environment Plan) - A local planning instrument for each LGA.
Native Vegetation - as defined in the LLS Act section **60B:** Meaning of "native vegetation"
"**native vegetation**" means any of the following types of plants native to New South Wales:

(1) (a) trees (including any sapling or shrub or any scrub),
(b) understorey plants,
(c) groundcover (being any type of herbaceous vegetation),
(d) plants occurring in a wetland.
(2) A plant is native to New South Wales if it was established in New South Wales before European settlement. The regulations may authorise conclusive presumptions to be made of the species of plants native to New South Wales by adopting any relevant classification in an official database of plants that is publicly accessible.
(3) For the purposes of this Part, native vegetation extends to a plant that is dead or that is not native to New South Wales if:
(a) the plant is situated on land that is shown on the native vegetation regulatory map as category 2-vulnerable regulated land, and
(b) it would be native vegetation for the purposes of this Part if it were native to New South Wales.
(4) For the purposes of this Part, native vegetation does not extend to marine vegetation (being mangroves, seagrasses, or any other species of plant that at any time in its life cycle must inhabit water other than freshwater). A declaration under section 14.7 of the *Biodiversity Conservation Act 2016* that specified vegetation is or is not marine vegetation also has an effect for the purposes of this Part.

Study Area - The subject Site and any additional areas which are likely to be affected by the proposal, either directly or indirectly. The study area should extend as far as is necessary to take all potential impacts into account (DECC 2006).
Test of Significance (5-Part Test) - Assessment under Section 7.3 of the BC Act to determine whether a proposed development or activity is likely to significantly affect threatened species, ecological communities, or their habitats.
Threatened Species or Ecological Community - Refers to those biotas listed in the schedules of the Biodiversity Conservation Act 2016 as "Critically Endangered ", "Endangered" or "Vulnerable".

For definitions that are relevant to the Assessment of Significance such as ***Life cycle***, ***Viable***, ***Local population***, ***Risk of extinction, Local occurrence***, ***Risk of extinction, Composition***, ***Habitat***, ***Extent***, ***Importance***, ***Locality***, "***likely***" and "***significant***" "***affect***" see the Assessment of Significance Appendix.

2.6 Assumptions and Limitations

- This report only addresses the impacts of the proposal described in this report and shown on the maps in this report. If there are changes or additions to the ecological impact of the proposal, then this report will require updating.
- This report describes the habitat and species within the Study Area at the time of the field survey. Vegetation and habitat will change over time, as does legislation. Therefore, the findings of this report are likely to need updating after 2 years.
- This report assesses only the current proposal and does not consider the cumulative impact of other developments on this property or on adjacent land or the potential edge effects or impacts caused by the occupation of the land.
- There may be flora and/or fauna species present within the study area that were not recorded because they are seasonal, migratory, cryptic and/or have large home ranges. Some threatened species may use the study area as habitat at some time. The conclusions drawn in this report are a result of testing, observation and experience.
- This report should be read in its entirety and no part should be taken out of context.
- No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.
- The preparation of this report has been in accordance with the brief provided by the Client and has relied upon the data and results collected within the time constraints set by the Client and as specified in the report. All findings, conclusions or recommendations contained within the report are based only on the aforementioned circumstances.

2.7 Qualifications and Experience of the Field Ecologist and Authors

Nicholas Skelton's formal qualifications include a Bachelor of Science with Honours (B. Sc. (Hons) USyd) and a Masters in Applied Science (M. App. Sc. in Vegetation Management UNSW). Nick has been an environmental scientist for 25 years, including a university lecturer, research ecologist and bush regenerator for 8 years. His work is focused on the Sydney bioregion, and he has published many papers in independently reviewed journals on the ecology of NSW. He has expert knowledge of the local soils, the climate of this area and the local indigenous plants and animals as a result of over 900 ecological surveys. Nick is a member of the relevant professional organisations including: a practising member of the Ecological Consultants Association of NSW and Royal Zoological Society. He is licensed by NSW OEH and NSW Department of Primary Industries to carry out surveys on threatened plants and animals and he is a qualified Biodiversity Assessor under the BC Act 2016. Nick was the principal ecologist on all field surveys and was responsible for map making and report writing and editing.

Lucas Brown has been studying, working in, and writing reports on the ecology of Sydney since 2021. He is currently studying a Bachelor of Biodiversity and Conservation at Macquarie University and has experience volunteering as a bush regenerator with Garigal Landcare.

Olivia Zurek holds a Bachelor of Science (Environmental Science) (B. Sc. in Environmental Science UTS). Olivia has one year of experience in fieldwork and report writing on ecological matters.

3 Environmental Context

3.1 Locality

Long Reef is a prominent headland that projects easterly into the Tasman Sea from the centre of the Northern Beaches Local Government Area 26km north of Sydney CBD.

The headland is geologically diverse and has an extensive wave cut rock platform at sea level. It is a popular recreational destination due to its scenic values, rock platform, geological features, Threatened Ecological Communities, strong winds and the headland is a well-known location for spotting whales and seabirds. The central part of the headland is used as a golf course (Map 3b) and playing fields (Griffith Park).

There is a well-used pathway that circumnavigates Long Reef headland and provides access to the beaches and rock shelf. The walkway is heavily used by hikers, dog walkers, runners, nature lovers and people appreciating the extraordinary natural beauty of Long Reef. The walkway is mostly a gravel or sealed surface, except for the section that is the subject of these works, which is a wooden boardwalk suspended over sand dunes and a bridge over a drainage line.

There are two environment protection areas at long reef headland, Long Reef Protection Area and Long Reef Aquatic Reserve (Map 3a).

The environmental features in the locality are shown on Maps 1, 2, 3a, 3b, 3c, 3d, 3e, 4a and 4b.

3.2 Topography

Long Reef headland is a tombolo where a high rocky headland is joined to the mainland by a wide sand dune system. The land slopes gently to the east where the dunes erode forming a revetment down to the beach. The highest point on the headland is at an altitude of approximately 36 RL, and the lowest of 0 RL. Maps 3c, 3d and 5b show the site with 2 m contours in pink while the topography in the locality is shown on Map 3b by 10m contours.

3.3 Drainage and Riparian Land

The central part of Long Reef regularly floods and is also fed by springs that provide the golf course with a reliable water source. There is a main spring south of the playing fields that contains a freshwater reed swamp as can be seen on Maps 3e, 4a, 4b, 5a and 8. The whole of Long Reef drains through a series of pools and a drainage line that empties directly into the sea on the southern side that is within the construction site and crosses under the existing boardwalk. There are several ponds on the golf course to the west of the Site. The location and extent of the drainage is shown in light blue on Map 3b, 3c, 3d and 5a. The site does not contain any identified Hydroline drainage line and does not contain any riparian land as defined in the Water Management Act. The site is water-front land within 40m of sea.

Map 1
Site, Aerial Photograph

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Date: 23/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 8 16 m

Legend

Long Reef Boardwalk

Subject Site

Source of Aerial Photo: Google

Map 2
Locality, Aerial Photograph

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ecology@ecology.net.au, ecology.net.au

Date: 23/8/2023
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Version 1
Projection: GDA 94 MGA 56

0 100 200 m

N

3.4 Nearby Conservation Reserves and Habitat Areas

Long Reef Wildlife Protection Area - contains several threatened plants and vegetation communities and provides habitat for threatened animals. The protected area includes Fisherman's Beach, Long Reef Headland, Long Reef Golf Club, foreshore and beaches surrounding the headland and dune systems, Long Reef Beach and Dee Why Lagoon. Dogs and cats are prohibited in this area at all times.

Long Reef Aquatic Reserve - extends from Collaroy rockpools to Long Reef Surf Lifesaving Club and from mean high water out 100m to mean low water. The reserve was declared in 1980 to protect marine invertebrates found on the rock platforms and subtidal marine plants and animals. With the exception of fin fish, collecting or harming marine plants or animals in the aquatic reserve is not allowed. Dogs and cats are prohibited in this reserve at all times. https://www.dpi.nsw.gov.au/fishing/marine-protected-areas/aquatic-reserves/long-reef-aquatic-reserve_old

The primary purpose of Aquatic Reserves in NSW according to the Marine Estate Management Act 2014 is to conserve biological diversity, or particular components of biological diversity (such as specific ecosystems, communities or species), in a specified area of the marine estate. Under the Act, within the Aquatic Reserve no marine plants or animals may be harmed, except for fin fish, which may be fished using a handheld line or spear only.

Exposed rocks within the intertidal range provide habitat to marine invertebrates such as sea snails, anemones and crabs, while also providing habitat to a wide variety of marine algae such as Neptune's necklace and sea Lettuce.

The location of the site, and its proximity to manmade and natural features in the locality are shown on Maps 1, 2, 3, 3b, 3c, 3d, 4, 5 and 6.

3.5 Geology and Soils

Long Reef is an outstanding geological feature that dominates the coastline of the northern beaches. The headland and reef occur in this location because of a geological fault line that crosses Dee Why Beach at approximately Dee Why Lagoon. The land to the north of the fault line has been lifted exposing the deeper, older geology. At Long Reef this has exposed the normally hidden Bulga geology which is the dark chocolate coloured iron rich shaly rocks that can be seen at Long Reef. Further north the exposed rock is of the Narrabeen Group that is above the Bulga and below the Hawkesbury Sandstone. This change in exposed geology can be seen by standing on the top of Long Reef and looking both south and north. To the south the headlands are grey with horizontal layers that are weathered by wave action to form steep cliffs with a moderate rock shelf at sea level, this rock is the youngest. Looking north the exposed rock on the headlands is more yellow and blocky with boulders on a small rock shelf at sea level, occasionally there are bands of grey shale. These are Newport and Garie formations of the Middle Triassic.

The geology of Long Reef is very different and much older and is made up of the Bulga formation that was underneath the Narrabeen sandstone and both of which were under the Hawkesbury Sandstone.

The Bulga rock formed in the Triassic period 230 million years ago, Long Reef Headland is unique due to its chocolate-coloured shales, (Bald Hill) claystones and ironstones. This forms the very large rock platform that you see at Long Reef.

Interestingly, there was a 60cm wide, 2m tall volcanic dyke made of dolerite, originating in the Jurassic. However, this has been reduced by mining and its location is no longer clear.

The mapped geology and soils in the locality around the site are shown on Map 3b.

The headland is a tombolo consisting of an island the remnant Bulga rock joined to the mainland by a spit of recent wind-blown sand.

The sand holds water that it releases slowly forming springs which can be seen to the west of the golf course and playing fields in the dog walking area see Map 5a. These springs feed the creek and ponds in the golf course and as a result, the Golf Course has a reliable independent source of water.

The proposal site is on a sand dune that overlays an unusual grey clay with dark red high iron rock which becomes exposed after storms. Between the sand and the clay, a layer of Humate, or Coffee Rock, has formed from the precipitation of the dissolved organic material such as tannins in the

freshwater leaching through the sand, where various physical and chemical reactions with the saltwater lead to its formation.

3.6 Fossils

Fossils of fish and plants are common in shale boulders on the rock platforms. In 1986 the Australian Museum uncovered the bones of a 200-million-year-old, 2-metre-long Labyrinthodont amphibian, similar to an axolotl within the Long Reef geological formation.

3.7 Disturbance History

The site is extensively disturbed due to over 80 years of use as a public golf course and walkway. Most of the original vegetation has been cleared however colonising native and exotic dune species regularly recover the site. On the site the dunes and beach sand are regularly moved by storms. The existing dune vegetation in the site contains small patches of rubbish and shows signs of having been extensively disturbed. The vegetation is now weedy and is a mix of weeds and natives.

Use as a golf course is likely to have included addition of phosphorous and nitrogen as fertiliser and introduced soil which is likely to favour pathogens and exotic weeds and is harmful for native plant species.

The vegetation on the site shows no signs of having been burnt for at least 50 years.

The existing board walk is built on piers and appears to have been built with minimal disturbance to the dune.

3.7.1 Dog Exercise Areas

There is an off-leash dog area at the corner of Anzac and Pittwater Rds. Dogs must be on a lead in all other areas and are not permitted on the beaches or rock platform. Dogs are allowed on the pathway that goes through the site.

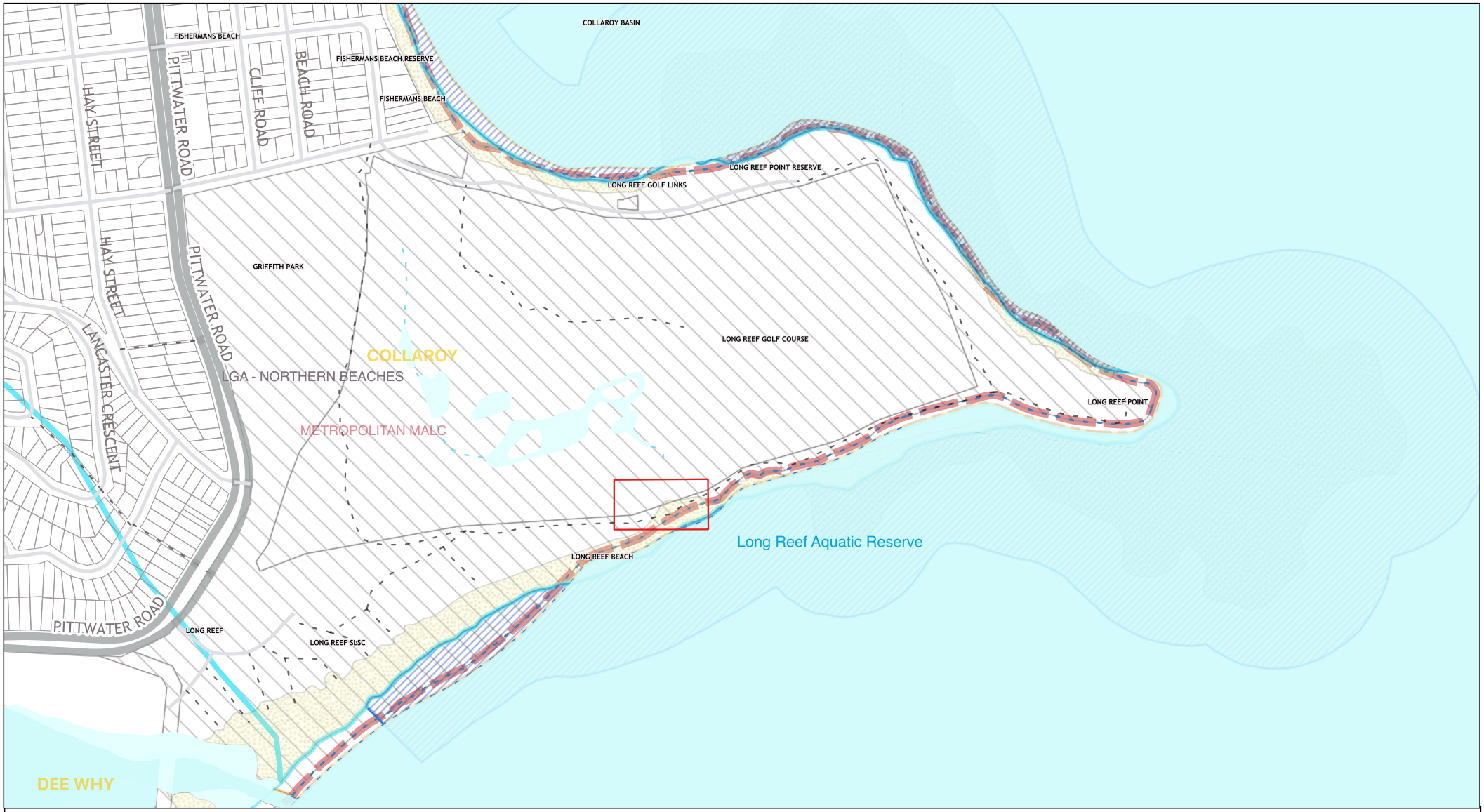
Photo Page 1 – The Site

Photo 1. The sand dune proposed to be cut, looking north

Photo 2. The Site, looking north

Photo 3. The Site, looking south

Photo 4. The sand dune proposed to be cut, looking south



Legend

Long Reef Boardwalk
- Subject Site

Road
- Arterial Road
- Local Road
- Path

Drainage Lines
- Watercourse Non Perennial

Esturine Features Islands
- Rock-Awash
- Sand

Coast and Watermark
- High Water Mark

Marine Protected Areas NSW
- Aquatic Reserve (IUCN IV)
- Local Aboriginal Land Council LALC
- LGA
- Suburb
- Crown Land

Map 3a
Locality, Topography and Features

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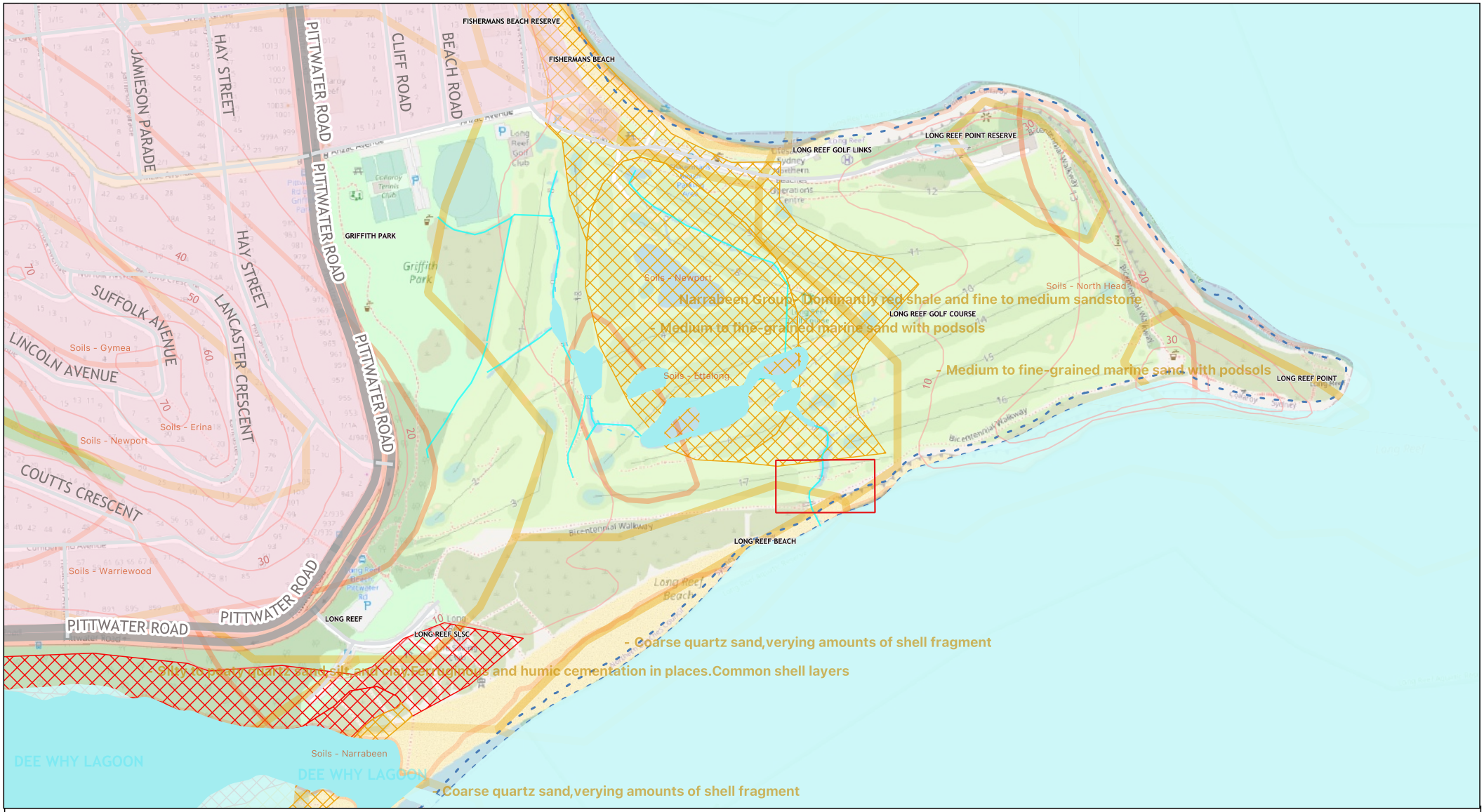
Date: 23/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 100 200 m

N



Legend

Long Reef Boardwalk
Subject Site
Drainage Body
Drainage Lines

Contour
Contour 10m

Road Major
Arterial Road
Local Road

Hydrology
Water Body

Drainage Lines
Watercourse Non Perennial

Coast and Watermark
High Water Mark
Low Water Mark
Built Up Area

Geology and Soils
Soil Landscapes of Sydney Chapman, et,al., 2009 Ed.

Geology Sydney100k Dykes
Geology Sydney 100k Rock Unit

Topographic Map (Source: OpenStreetMap)

Acid Sulfate Soil Risk
High probability of occurrence
Low probability of occurrence

Map 3b
Locality, Features Other

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Date: 23/8/2023
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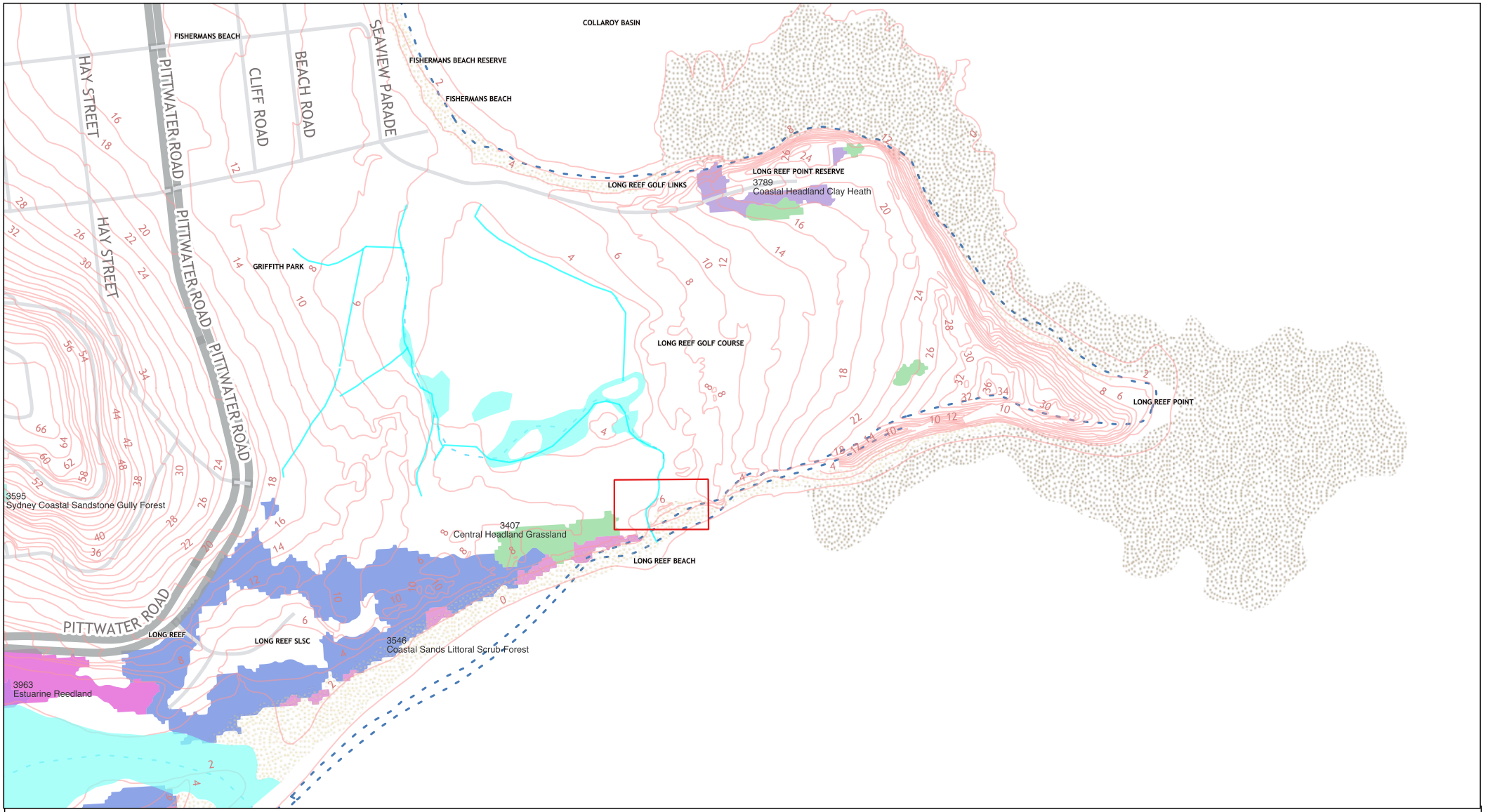
Version 1
Projection: GDA 94 MGA 56

0 100 200 m



Legend

Long Reef Boardwalk

Subject Site

Drainage Lines

Drainage Body

Contour

Contour 2m

Hydrology

Reefs and Mangroves

Rock-Awash

Sand

Drainage Lines

Watercourse Non Perennial

Coast and Watermark

Vegetation Type/Ecological Community

SVTM Extant C11M11 Dec 22 Sydney current Jul 23

Central Headland Grassland

Coastal Headland Clay Heath

Coastal Sands Littoral Scrub-Forest

Estuarine Reedland

Southern Estuarine Swamp Paperbark Creekflat Scrub

Map 3c
Locality, Mapped Vegetation Types (SVTM)

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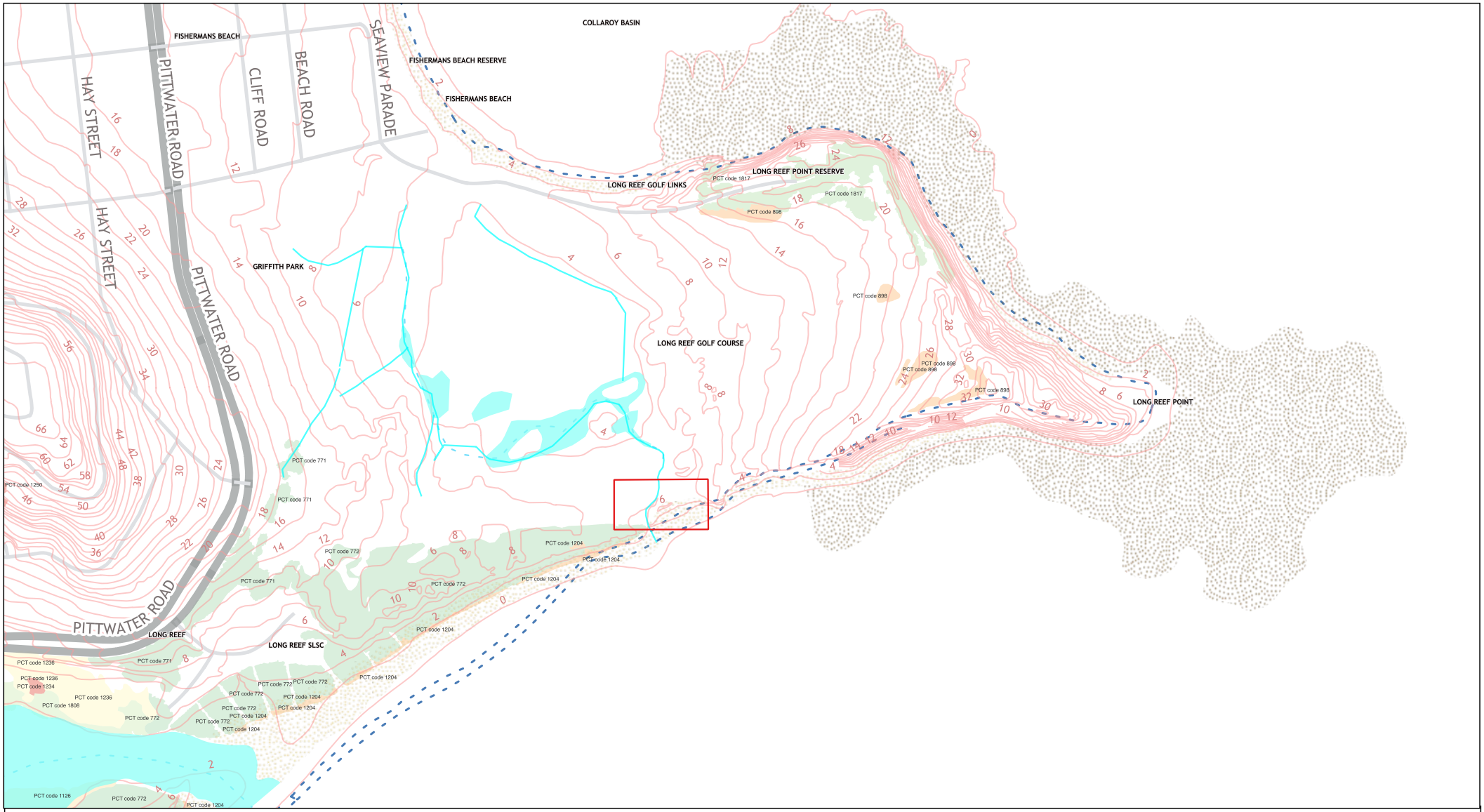
Date: 23/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 100 200 m

N



Legend

Long Reef Boardwalk

Subject Site

Drainage Lines

Drainage Body

Contour

Contour 2m

Drainage Lines

Watercourse Non Perennial

Coast and Watermark

High Water Mark

Low Water Mark

Vegetation Type/Ecological Community

Sydney Metro Area v3.1 OEH 2016 Native with PCT Names 25%

Forest PCT Number: 1234
S_FoW08: Estuarine Swamp Oak Forest

Forest PCT Number: 1250
S_DSF09: Coastal Sandstone Gully Forest

Grassland/Open Scrub PCT Number: 898
S_GL02: Coastal Headland Grassland

Grassland PCT Number: 1204
S_GL01: Beach Spinfex Grassland

Herbfield PCT Number: 1126

Map 3d Locality, Mapped Vegetation Types (Sydney Metro 3.1)

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Date: 23/8/2023
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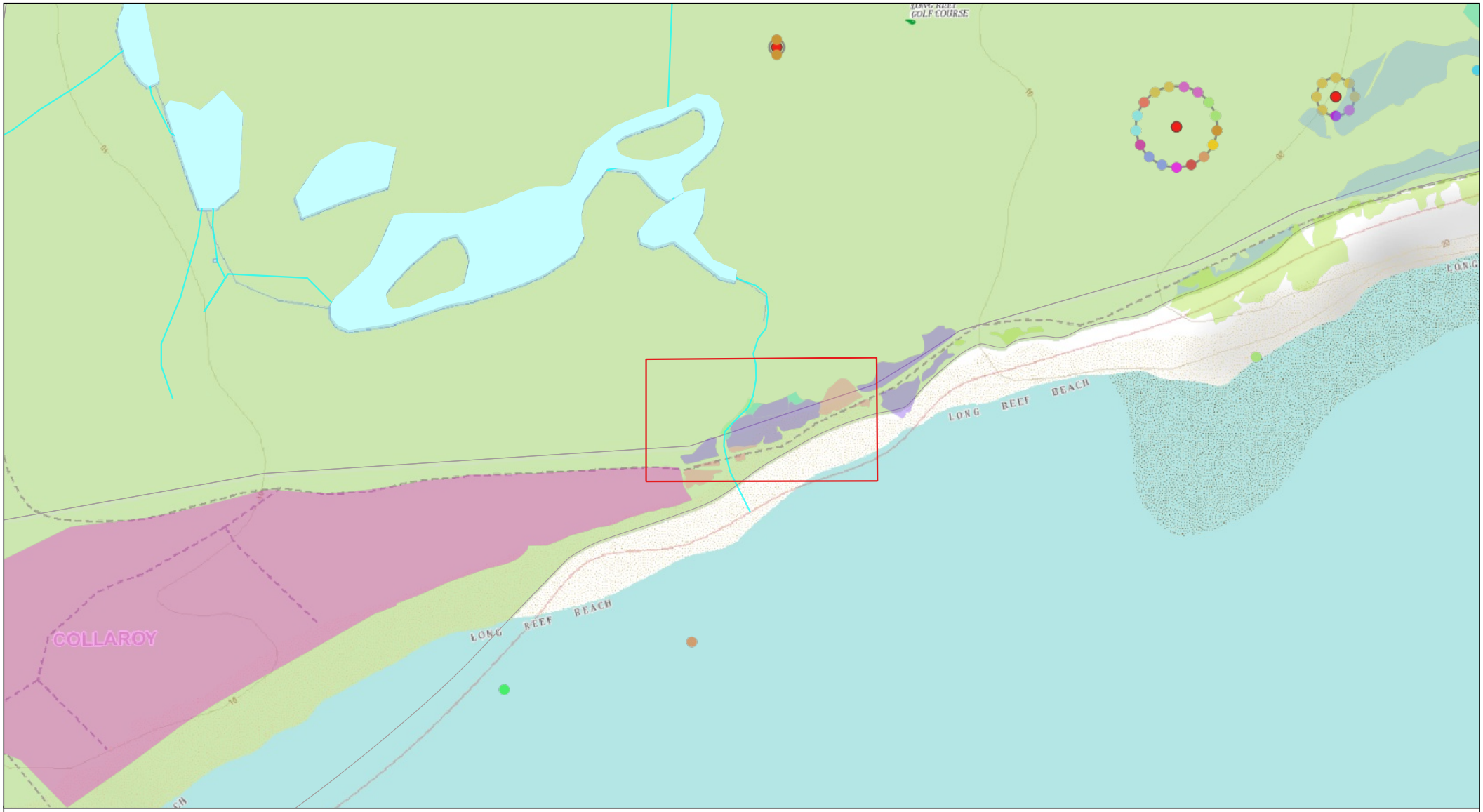
Version 1
Projection: GDA 94 MGA 56

0 100 200 m



Legend

Long Reef Boardwalk
Subject Site
Drainage Body
Drainage Lines

Native Vegetation
Central Headland Grassland
Coastal Headland Clay Heath
Coastal Heath on Sand
Coastal Sands Littoral Scrub Forest
FW Swamp Reedbed
Mostly Exotic Bitou
Spinifex Strandline Grassland
Adjacent Lots

Historic Species Records Bionet Atlas DPE

Fauna Threatened Sydney Historic Records
Black-browed Albatross
Common Tern
Crested Tern
Great Knot
Green and Golden Bell Frog
Green Turtle
Grey-tailed Tattler
Pacific Golden Plover
Red-necked Stint
Ruddy Turnstone
Short-tailed Shearwater
Shy Albatross
Sooty Oystercatcher
Wandering Albatross
Wedge-tailed Shearwater
White-bellied Sea-Eagle

Map 3e
Locality, Vegetation Types Ground Truthed and Threatened Species Records

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ecology@ecology.net.au, ecology.net.au

Date: 24/8/2023
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Version 1
Projection: GDA 94 MGA 56

N

0 50 100 m

4 The Proposal

4.1 Proposal Plans and Reports Used for this Report

Plan Title	Author	Rev	DWG./Doc. No./Ref.	Date
Survey	Byrne & Associates Pty ltd – Consulting Surveyors and Engineers		A1 – 11162D	29/10/2021
Long Reef Boardwalk 100% Detailed Design	Thompson Berrill Landscape Design	T1	LRB-DD-01, LRB-DD-03A, LRB-DD-03B, LRB-DD-04C, LRB-DD-07A, LRB-DD-07B	31/10/2023
Archaeological Report	APEX Archaeology	3 - Final		11/12/2023
Aboriginal Cultural Heritage Assessment Report	APEX Archaeology	3 – Final		11/12/2023
Wave runup on Long Reef walkway	UNSW Water Research Laboratory		WRL2021106 LR20220411	11/04/2022
Geotechnical Investigation Report	Alliance Geotechnical & Environmental Solutions	0	14801-GR-1-2	08/06/2022

4.1.1 Reason for the Works

On several occasions in the last year there has been extensive wave action associated with strong southerly winds that have eroded the dunes and beach and damaged the existing boardwalk and bridge requiring closure of the walkway and extensive repairs.

Council proposes to replace the existing boardwalk and bridge with another boardwalk and bridge that is further west and up the dune away from the wave action both in distance and height. The works will not involve any enlargement, expansion, or intensification of the recreation use or a change in use.

4.1.2 Avoiding and Minimising Impacts

To avoid and minimise the biodiversity, environmental and social impacts from the proposal, the type, size and location of the works have been subjected to review by the Council and other experts. Several design options have been considered and assessed, which has resulted in identifying the current proposed design.

Construction access routes have also been considered in the process of avoiding and minimising impact. There are 3 potential access routes, of which the western route (route 1-2) was chosen as it utilises an existing path and will, therefore, have the least impact, see map 5a. The other two access routes considered were abandoned due to their higher impact to the biodiversity on the site. This demonstrates the principles of avoid and minimise.

4.1.3 Proposed Use

The existing and proposed boardwalk and bridge are part of a public walkway around the top part of Long Reef headland and provide access to the small beach at the northern end of Long Reef

Beach. Dogs are currently permitted on a leash on the walkway only, and this will not change as part of this proposal.

4.1.4 Location of the Works

The site of the replacement boardwalk and bridge is on the southern side of Long Reef Headland between the golf course and a small section of beach at the northern end of Long Reef Beach as shown on the maps in this report.

The location of the works is outlined in red on Maps 2, 3a, 3b, 3c, 3d and 3e. Maps 1 and 2 are aerial photographs of the site.

Maps 2, 3a, 3b, 3c, 3d, 3e, and 5a show the local environmental context of the site.

Maps 1, 4a, 4b, 5b, 6a, 6b, 7a, 7b and 8 show site scale detail.

The geographic coordinates of the study area are MGA/GDA 343394 E, 6264870 N.

4.1.5 Footprint of the Works

The footprint of the works consists of the location of the existing boardwalk to be demolished, the location of the new boardwalk and bridge, the adjacent excavation/disturbance/works area and the access route to the site. The extent of these areas is shown on Maps 5a, 5b, 6a and 6b.

During construction, there will need to be a stockpile/works compound and an access route for construction machinery such as excavators, pile drivers' trucks and utility vehicles. The location of this is shown on Map 6b.

Due to the popularity of the boardwalk within the local community, the existing path will need to be kept open for public use for as long as possible, requiring a sequence of works. The staging is shown on Map 6a.

Table 2. Impact Footprint Size

Impact Type	Area (sqm)
Demolition and construction	1942
Access route (4m wide)	5437
Golf course works	620

4.1.6 Demolition

The existing wooden boardwalk and bridge are suspended above, and partly cut into, the dune that joins onto a section of concrete walkway at each end. The deck of the boardwalk is suspended on wooden piles. The wood used for both the deck and the balustrade is hardwood.

The current wood piles the boardwalk is comprised of will be pulled out and disposed of at a registered landfill site.

The metal will be recycled as scrap iron.

The disturbance resulting from demolition will be confined to the works area shown on Map 6b.

4.1.7 Earthworks Cut into Existing Dune

The existing dune will be cut in the locations shown in Map 6b.

The sand will be stockpiled on site for reuse in the northern part of the site.

4.1.8 Pile Driving and Construction

The new wooden piles will be made from treated hardwood.

The piles will be driven through the remaining sand dune and anchored into the soft rock below using a pile driver.

The boardwalk bearers and deck will be installed with the assistance of a small excavator.

4.1.9 Reforming of a New Mound

A new mound will be constructed as shown on Maps 6b and 7b.

The new northern mound will be made of fill with a layer of sand with the surface stabilised using coir (coconut fibre) net matting.

The fill will be certified as VENM.

The sand will be obtained partially from the excavation in the southern area, and the rest will be taken from existing mounds on the golf course. The location of these mounds is shown on Map 6c and is shown in the photograph below. The sand from these mounds will undergo appropriate testing for contaminants and Acid Sulphate Soils.

Existing sand mound on Golf Course

4.1.10 Dune Stabilisation

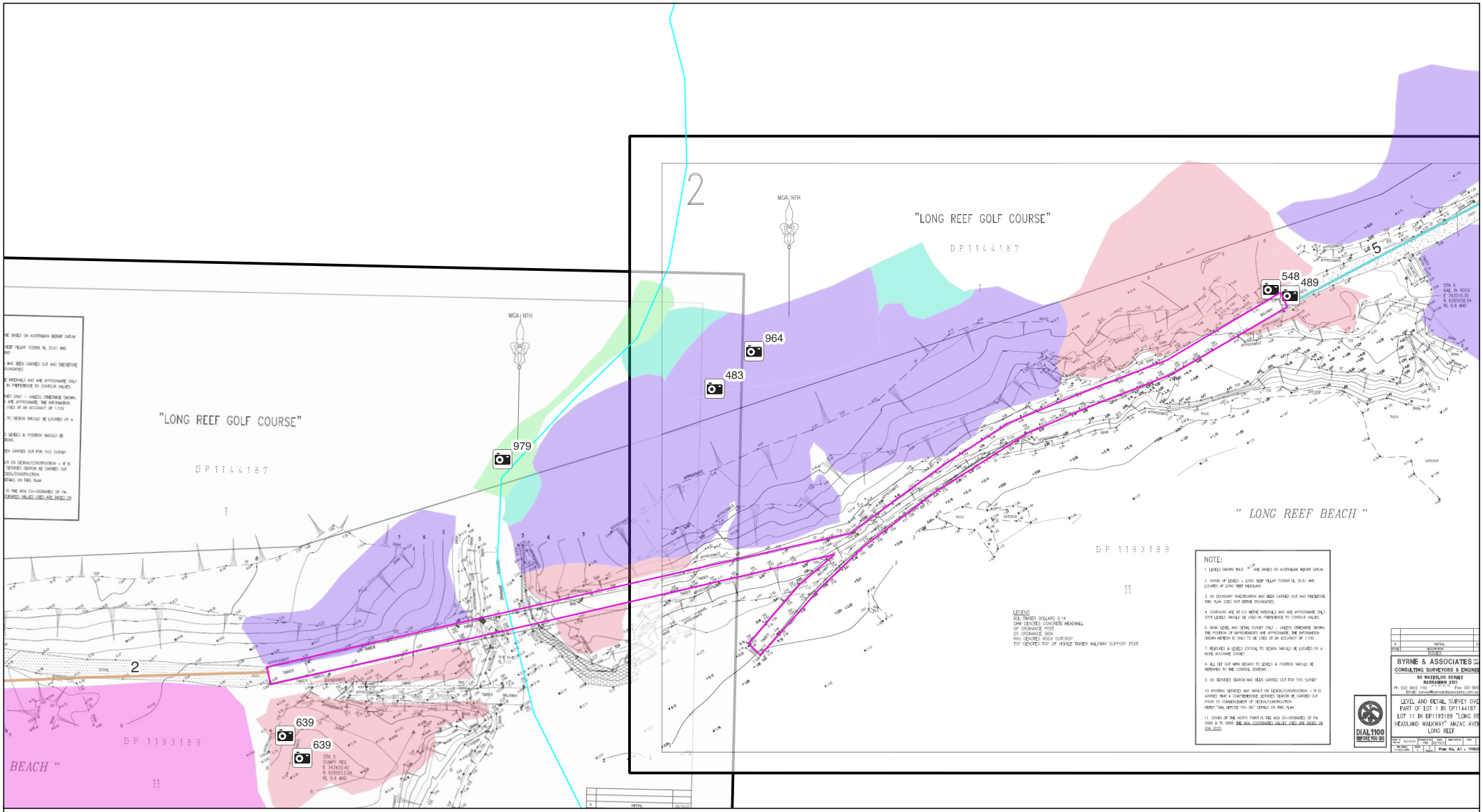
This site is exposed to the strong southerly winds that will erode the beach and dunes due to waves, storm surge and high winds.

The disturbed dune surface will be stabilised using a coir matting (400gsm) laid up and down the slope with an overlap of 200mm and pegged using GeoPro Biopins, 300mm fully biodegradable and compostable pins made from corn starch.

4.1.11 Revegetation

Local native dune plant species will be planted at a density of 5 plants/sqm with each species distributed randomly across the site.

The plants will be tube stock sized. The planting species will be provided with the Landscape Design and will comprise of indigenous grasses.



Legend

Long Reef Boardwalk
- Existing Boardwalk
- Photo Locations
- Drainage Lines

Access Routes
- 2
- 5

Native Vegetation
- Coastal Heath on Sand
- Coastal Sands Littoral Scrub Forest
- FW Swamp Reedbed
- Mostly Exotic Bitou
- Spinifex Strandline Grassland

Map 4a
Site, Existing Environmental Features

GIS Environmental Consultants
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ecology@ecology.net.au, ecology.net.au

Date: 24/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 8 16 m

Legend

Long Reef Boardwalk
- Existing Boardwalk
- Drainage Lines

Access Routes
- 2
- 5

Native Vegetation
- Coastal Heath on Sand
- Coastal Sands Littoral Scrub Forest
- FW Swamp Reedbed
- Mostly Exotic Bitou
- Spinifex Strandline Grassland

Map 4b
Site, Existing Vegetation

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ecology@ecology.net.au, ecology.net.au

Date: 24/8/2023
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0 8 16 m

N

Legend

Long Reef Boardwalk
Existing Boardwalk
Drainage Body
Drainage Lines

Access Routes
1
2
3
4
5
6

Impact Footprints
Preferred Access Route 5437 sqm
Demolition and Construction 1942 sqm
Golf Course Works 620 sqm

Native Vegetation
Central Headland Grassland
Coastal Headland Clay Heath
Coastal Heath on Sand
Coastal Sands Littoral Scrub Forest
FW Swamp Reedbed
Mostly Exotic Bitou
Spinifex Strandline Grassland
Built Up Area

Source of Aerial Photo: Google

Map 4b
Site, Existing Vegetation

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

Date: 24/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 60 120 m

N

Legend

Long Reef Boardwalk
Existing Boardwalk

Access Routes
2
5

Photo Locations

Drainage Lines

Contour
Contour 2m

Impact Footprints
Preferred Access Route 5437 sqm
Demolition and Construction 1942 sqm
Golf Course Works 620 sqm

Map 5b
Site Footprints

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ecology@ecology.net.au, ecology.net.au

Date: 23/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 8 16 m

Map 6a

Route 1 entry point traffic control required

Existing heavy vehicle access route 1 (built up) over the golf course

For construction safety, route 1 requires installation of temporary barrier fencing to culvert approaches and crossings and removal sign posts

Minor earthworks required to allow space for truck movements

Heavy vehicle access route via existing gravel pedestrain path 2

No vehicle access via beach

Temporary crossing culvert

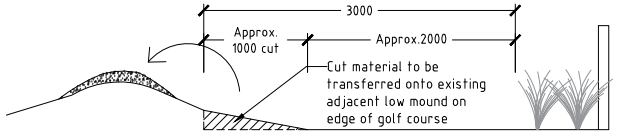
Widen route 2 to 3m wide, cut material to be transferred onto existing adjacent low mound on edge of golf course, refer detail 2/ LRB-DD-03B

1 LONG REEF VEHICLE ACCESS PLAN
NTS

KEY

Hard vehicle access route via existing gravel & grass track

Hard vehicle access route via existing gravel & pedestrian path



2 TYPICAL ROUTE 2 SECTION
1:25@A1 1:50@A3

Location of on site clean fill (available at no cost to Contractor) for transportation by Contractor to new mound site. Contractor to allow for transportation of required fill volume from stockpile to new mound.

Potential heavy vehicle access 3+4 or 5+6 from east

Temporary crossing culvert

Temporary work for construction access (indicative only)

Heavy vehicle access 2 from west

Pedestrian access during Stage 1 construction

Pedestrian access during Stage 1 construction

CONSTRUCTION STAGES KEY

STAGE 1		Construct middle part of new boardwalk and mound, and keep existing boardwalk open while constructing
STAGE 2		Close the whole boardwalk for 2 weeks, complete west and east ends of new boardwalk and demolish existing boardwalk
STAGE 3		Construct vegetation protection fence both sides of new boardwalk where shown

KEY

- New barrier and handrail
- Potential heavy vehicle access 3+4 or 5+6 from east
- Heavy vehicle access 2 from west
- Pedestrian access during Stage 1 construction
- Temporary work (indicative only)

TENDER ISSUE NOT FOR CONSTRUCTION

WARNING

BEWARE OF UNDERGROUND SERVICES

THE LOCATION OF UNDERGROUND SERVICES SHOWN ARE APPROXIMATE ONLY AND THEIR EXACT POSITION SHOULD BE PROVEN ON SITE. NO GUARANTEE IS GIVEN THAT ALL SERVICES ARE SHOWN. THE CONTRACTOR MUST VERIFY ALL SERVICES ON SITE PRIOR TO ANY EXCAVATION WORKS.

GENERAL NOTES:
Services shown hereon have been located by field survey. Further services may be present. Prior to any construction or excavation on site the relevant authorities should be contacted for possible location of further underground services and detailed locations of all services.

ENGINEERING CERTIFICATION:
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30/06/2023	P1	50% DETAILED DESIGN
06/07/2023	P2	80% DETAILED DESIGN FOR REF
13/07/2023	P3	80% DETAILED DESIGN FOR ENGINEER REVIEW
24/07/2023	P4	80% DETAILED DESIGN
29/09/2023	P5	100% DETAILED DESIGN
31/10/2023	T1	100% DD TENDER ISSUE

PROJECT TITLE
LONG REEF BOARDWALK

CLIENT
northern beaches council

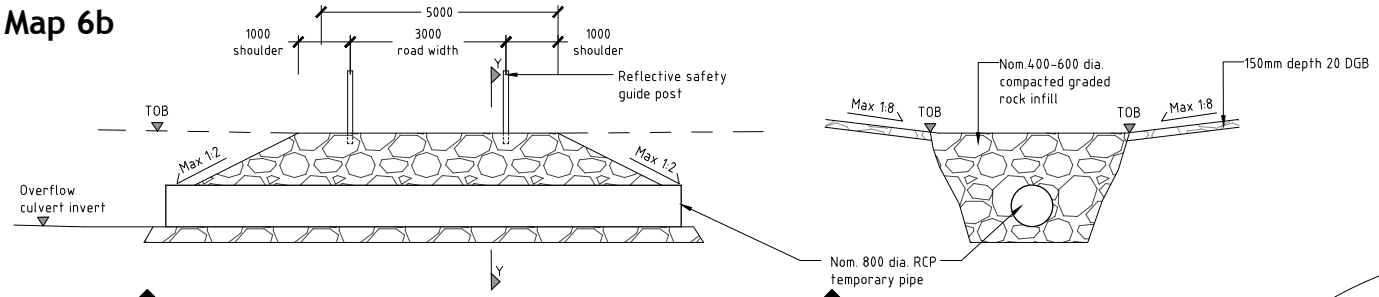
DRAWING NAME
SITE ACCESS AND CONSTRUCTION STAGING PLAN

THOMPSON BERRILL LANDSCAPE DESIGN P/L
PO BOX 665 MANLY NSW 2095 T: 02 9977 6444 E: info@tblad.com.au

SCALE BAR 0 2 4 8 10m

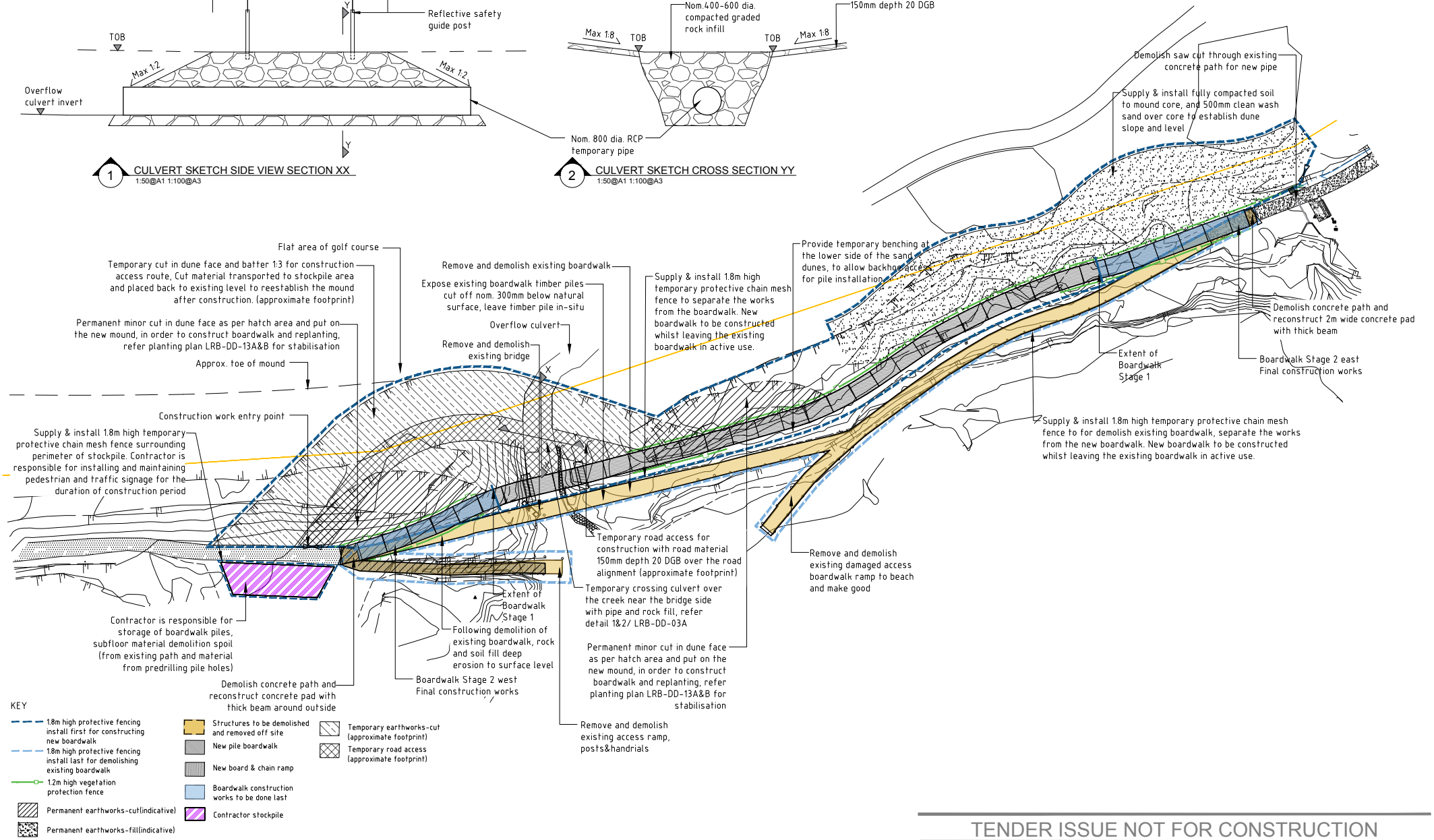
SCALE	1 : 200 @ A1
DATE	OCT 2023
DESIGN	GB
DRAWN	AY
CHECKED	GB
DATUM	AHD
PLAN No.	LRB-DD-03B

Map 6b



1 CULVERT SKETCH SIDE VIEW SECTION XX
1:50@A1 1:100@A3

2 CULVERT SKETCH CROSS SECTION YY
1:50@A1 1:100@A3



KEY

- 1.8m high protective fencing install first for constructing new boardwalk
- 1.8m high protective fencing install last for demolishing existing boardwalk
- 1.2m high vegetation protection fence
- Permanent earthworks-cut(indicative)
- Permanent earthworks-fill(indicative)
- Structures to be demolished and removed off site
- New pile boardwalk
- New board & chain ramp
- Boardwalk construction works to be done last
- Contractor stockpile
- Temporary earthworks-cut (approximate footprint)
- Temporary road access (approximate footprint)

TENDER ISSUE NOT FOR CONSTRUCTION

WARNING

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29/09/2023	P5	100% DETAILED DESIGN
31/10/2023	T1	100% DD TENDER ISSUE

PROJECT TITLE
LONG REEF BOARDWALK

CLIENT
northern beaches council

DRAWING NAME
CUT & FILL, PROTECTION AND DEMOLITION PLAN

SCALE BAR
0 2 4 8 10m

SCALE	1 : 200 @ A1
DATE	OCT 2023
DESIGN	GB
DRAWN	AY
CHECKED	GB
DATUM	AHD
PLAN No.	LRB-DD-03A

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Map 6c Location of Existing Mounds of Sand
lowry ledge

4.1.12 Machinery movement along access route

Table 3: List of machinery and frequency of movement

Type
Excavator (20 tonne, pneumatic driving head)
Trucks
Pile driver
Utility cars

The frequency of vehicle movements will depend on the Contractor's plant, approach and methodology, and will be detailed in their Traffic Management Plan on engagement.

The biodiversity impacts of the proposal are described in detail in section 5.3.

4.1.13 Construction Access Route Assessment

There are 3 potential route options for access to the site for construction, these routes are shown on Map 5a.

The routes are Route 1-2, comprising of section 1 and section 2, Route 3-4, comprising of section 3, section 4 and a minor part of section 5b and Route 5a-6-5b, comprising of section 5a, section 6 and section 5b respectively. These sections are shown on the site access and construction staging plan (LRB-DD-03B, 06/07/2023) which is Map 5a.

Route 1-2, section 1:

The first 100m of this route is across kikuyu grass along the edge of the oval. The next 200m is along a straight path of compacted sandstone fill (4m wide) which goes between the golf course and an area of native vegetation. A 5m strip of mown kikuyu grass sits between this vegetation and the path, acting as an effective buffer if this path is to be used as an access route. The route crosses a drainage line that has a culvert and pipe, and the track width at this point is restricted to 5m wide. It then goes across the golf course for a distance of 230m, and nears native trees, but access is not likely to harm these trees.

Route 1-2, section 2:

This section is 350m of existing gravel pedestrian pathway, and travels adjacent to PCT 3546 (Coastal Sand Littoral Scrub-Forest), PCT 772 (Coastal Sand Tea-tree-Banksia Scrub), and PCT 3407 (Central Headland Grassland EEC) on the southern side of the path. On the northern side there is an exotic grassland on which the golf course lies. In places the width is narrow and some trimming of native vegetation may be required.

Route 3-4, section 3:

Consisting of 400m of existing golf course road, no new routes will require construction. There are Native trees adjacent to some short sections of the path, but at the most they will only need to be trimmed. This section will cross drainage lines but otherwise will maintain a low ecological impact. However, utilising this route will have a large impact on the fairways of the golf course.

Route 3-4, section 4:

A proposed temporary vehicle access route around 175m long would have to be built over the golf course, in order to connect section 3 to the tail end of section 5b. This route would not run over any drainage lines or disturb any native vegetation.

Route 5a-6-5b, section 5a:

This section takes place over an existing pedestrian footpath, 220m in length, adjacent to the rock revetment and some coastal heathland. Adjacent on either side to native vegetation type PCT 3407 (Coastal Headland Grassland EEC). The potential for disturbance is high and utilising this section would most likely destroy the public pathway and some trimming of native vegetation.

Route 5a-6-5b, section 6:

This section runs 180m over an existing golf course track, then 50m over golf course exotic grassland. Adjacent on either side to native vegetation type PCT 3407 EEC. utilising this route will have a large impact on the fairways of the golf course and access to this section of the route is subject to the approval of the golf course.

Route 5a-6-5b, section 5b:

Consists of an existing emergency vehicle access path, 280m long and over 3m wide. Adjacent on either side to native vegetation type PCT 3407 (Coastal Headland Grassland EEC). The potential for ecological disturbance is high and utilising this section would most likely destroy the public pathway.

Conclusion:

Option 1-2 is the preferred option as it follows a recently used route and is the least likely to harm the golf course fairways. This option will have the least environmental impact. Option 1-2 has been chosen for this project.

4.2 Avoidance and Minimisation of Impact

The Biodiversity Conservation Act 2016 requires that all developments "Avoid" and then "Minimise" ecological impacts.

The main biodiversity constraints at this site are the sand dunes, waterway, native vegetation and habitat values.

Other potential environmental constraints are the unique geological features, archaeological impact and sand erosion of the beach and dunes.

This proposal will require cutting into a sand dune, which will mean the removal of some of the vegetation on this dune. Fortunately, the majority of the vegetation on the dune is comprised of the weed Bitou Bush, which has a low habitat value due to the monoculture it forms. Despite this, any removal of vegetation on a sand dune poses the risk of wind erosion, so the exposure of the bare sand needs to be minimised at all times.

The proposed method of minimising dune erosion by wind and wave action is for a coir mat to be laid immediately after the existing cover is removed and indigenous plants to be planted into the mat.

The proposal will also avoid and minimise by utilising the Access Route option with the least ecological impact as discussed in Section 4.1.

Recommendations are made in section 8 of this report to further reduce impact during construction and for the life of the development.

5 Biodiversity Impact Assessment

Relevant Environmental Factors clause 171 (2) EP&A Regulation.
(c) the environmental impact on the ecosystems of the locality,
(f) the impact on the habitat of protected animals, within the meaning of the Biodiversity Conservation Act 2016,
(g) the endangering of a species of animal, plant or other form of life, whether living on land, in water or in the air,

5.1 Biodiversity Survey

5.1.1 Literature and Spatial Search

Relevant information was obtained from literature, local knowledge, and established sources such as scientific journals, electronic databases and reports. Historic records from electronic databases including: BioNet (DPE Atlas of NSW Wildlife accessed 25/06/2012), Atlas of Australia, Protected Matters Search Tool and the BAM-C. This information was used to ascertain which threatened species are known to occur within approximately 5km of the study area. The data were then combined with local knowledge and the environmental features, as shown in Maps 1-5b and habitat conditions found during the field survey to compile a list of plant and animal species for specific targeting during the fieldwork. See Table 4.

Spatial databases used for mapping and spatial searches include:

Google earth, https://earth.google.com/web/
Six spatial information, https://six.nsw.gov.au
eSPADE https://www.environment.nsw.gov.au/eSpade2Webapp for Geology and soils
Directory of Important Wetlands in Australia,
https://www.environment.gov.au/cgi-bin/wetlands/search.pl?smode=DOIW
SEED, https://www.seed.nsw.gov.au/

The sources of the Spatial data are documented on the maps.

Relevant information was collated from printed literature, scientific journals, electronic databases, and reports and local knowledge, they are referenced in the text and the references are listed in the General references section, on maps, and below.

5.1.2 Biodiversity Field Survey

The ecological field survey was carried out on 4 occasions the 28th of November 2022, 16th of June 2023, 3rd of August 2023, and on the 20th of August 2023, each by experienced ecologists over a total of 7 person hours. The weather on all days was sunny, with no wind and the temperature was 17- 20°C. During the field surveys, all sections of the study area and some of the surrounding land were traversed on foot. The vegetation zones (type and condition) were determined and a 400m^2 quadrat was surveyed in each vegetation zone in the locations shown on Map 5. The landscape features and vegetation were surveyed using the Biodiversity Assessment Method (BAM) as a guide. The study area was searched for the presence of threatened flora and fauna species and their habitats. Endangered Ecological Communities were assessed for likelihood of occurrence.

The field survey involved the following procedures:

- Initial familiarisation with the study area and its extent and surrounding land;
- Assessment of the physical characteristics of the study area and location of the proposal;
- Identification and recording of all flora species using a random meander across the whole of the Site;
- Identification of fauna through sightings, calls and potential habitat;
- Search for scats, remains, nests, dreys, bones, feathers, fur, diggings, scratches, tracks, owl white-wash and food sources. Examination of trees for scratchings, sap-feeding notches and hollows;
- Classification of any vegetation into communities according to their structural and floristic attributes;
- Assessment of the habitats within the Study Area;
- Detailed search for targeted threatened species;
- Assessment of the extent of disturbance and weed invasion;
- Photography of the study area; and
- Creation of a 400sqm plot in order to record vegetation representative of the community on site.

5.1.3 Targeted Threatened Species

Table 4 lists the threatened species that have been historically found near the site, these species were determined by a spatial search of the NSW BioNet Atlas and other electronic databases for historic records within 5km of this site, the likelihood of each species occurring on the site was assessed by an ecologist with more than 30 years of experience in assessing habitat of threatened species of Sydney area. These species were actively searched for during the field survey and the suitability of the habitat determined.

5.1.4 Vegetation Survey

Field Assessment of the Vegetation Types (PCT)

The vegetation within the study area was classified using structural and floristic indicators according to Benson and Howell (1994) and was compared with both the Threatened Ecological Communities listed in the BC Act 2016 and with the BioNet PCT vegetation type database. A detailed description of the method to determine the presence of Threatened Ecological Communities (EEC) within the study area was determined. Map 5: Methods

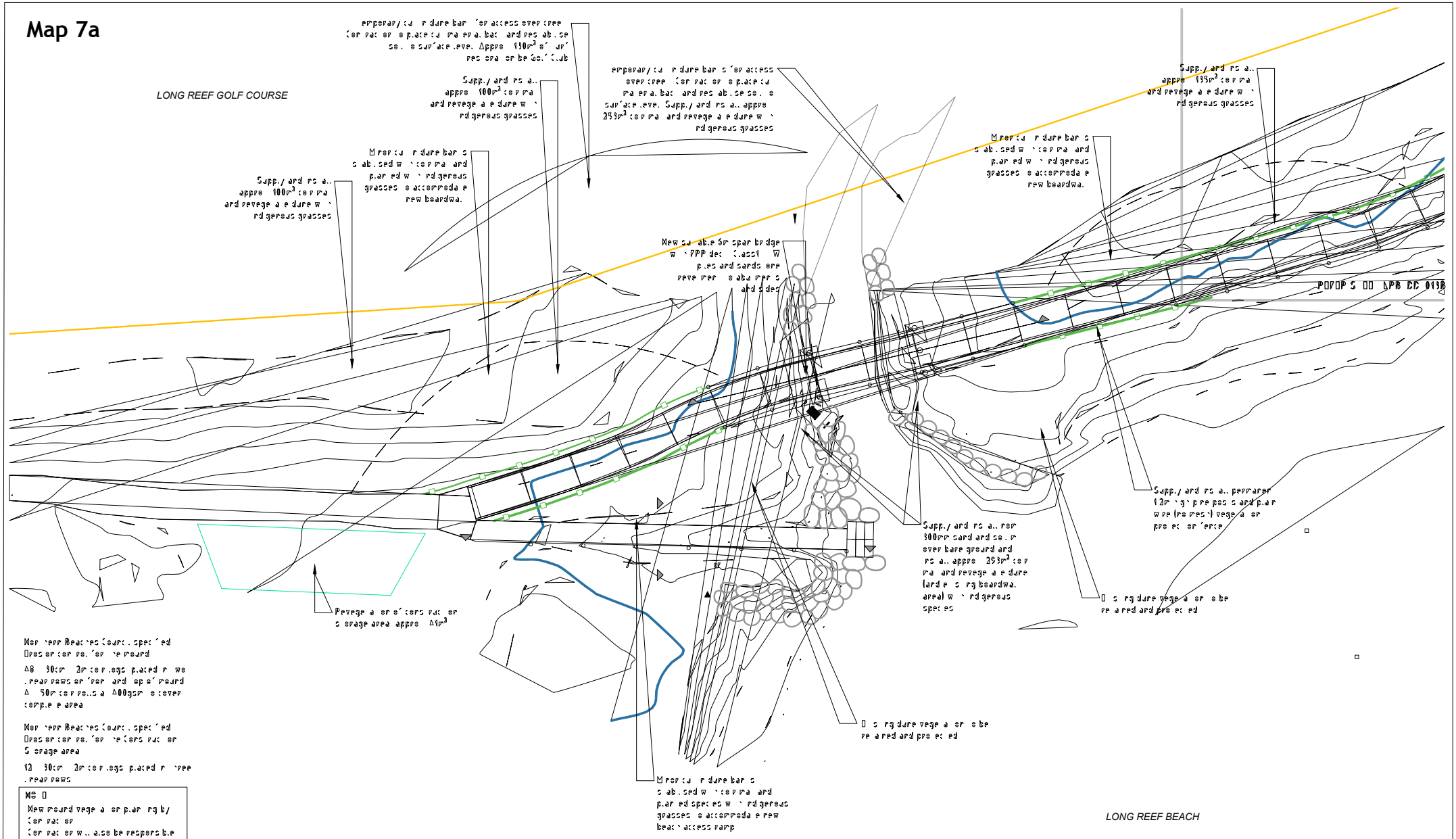
The floristic composition (plant species that occur on the site) is listed in Table 6.

This information was then used to determine the Plant Community Types (PCT) present (or most likely PCTs) and the presence of any endangered ecological communities (EECs) listed in schedule 2 of the BC Act 2016 and the composition and structure of the native vegetation.

5.1.5 Threatened Fauna Habitat Survey

Fauna species were actively searched for by examining the vegetation, searching for tree hollows and burrows, and looking for animals and/or for signs of use by animals.

Map 7a



TENDER ISSUE NOT FOR CONSTRUCTION

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31/10/2023	T1	100% DD TENDER ISSUE

PROJECT TITLE
LONG REEF BOARDWALK

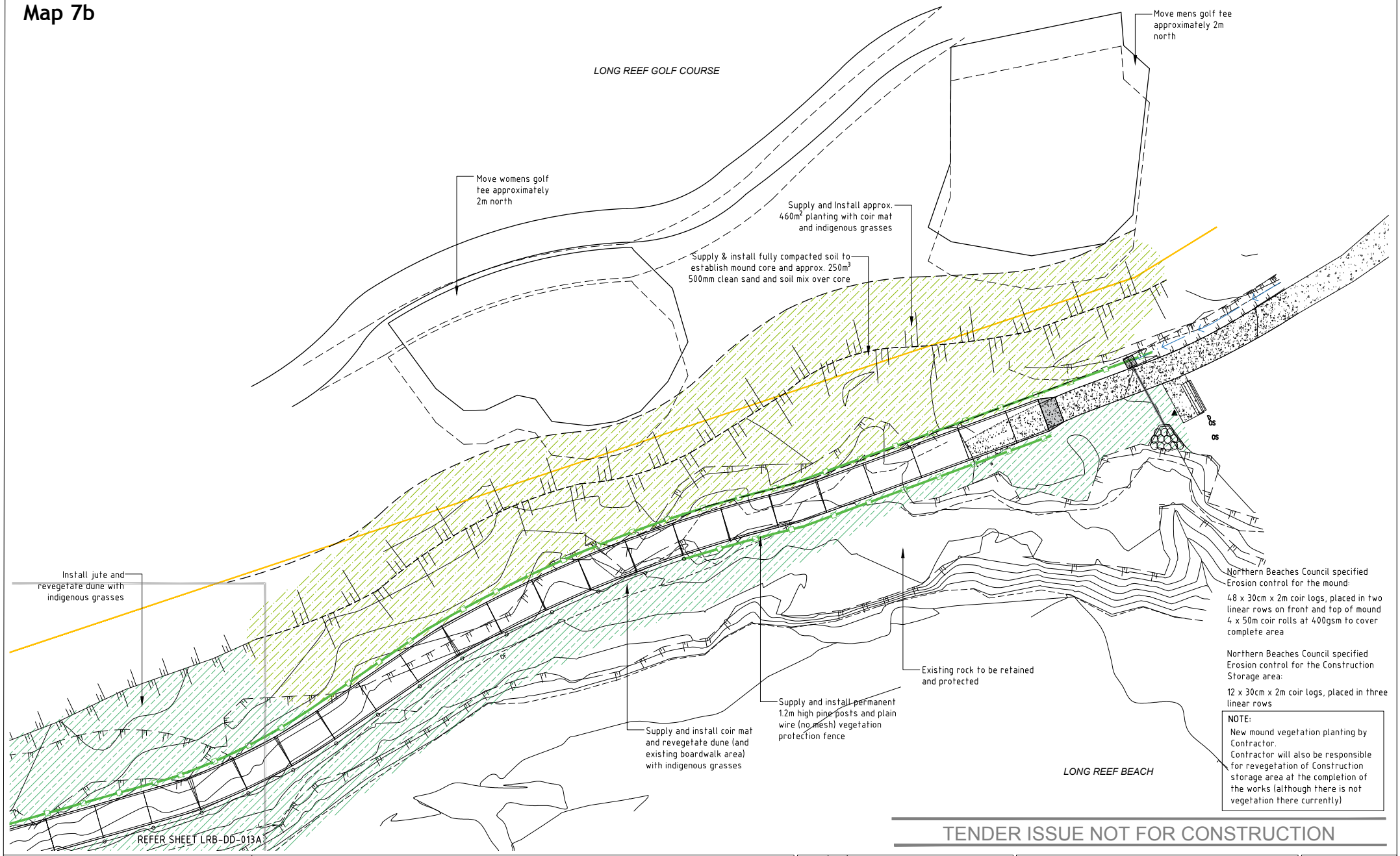
CLIENT
northern beaches council

DRAWING NAME
PLANTING WEST PLAN

SCALE BAR
0 1 2 3 5m

SCALE 1 : 100 @ A1
DATE OCT 2023
DESIGN GB
DRAWN AY
CHECKED GB
DATUM AHD
PLAN No. LRB-DD-13A

Map 7b



Northern Beaches Council specified Erosion control for the mound:

48 x 30cm x 2m coir logs, placed in two linear rows on front and top of mound
4 x 50m coir rolls at 400gsm to cover complete area

Northern Beaches Council specified Erosion control for the Construction Storage area:

12 x 30cm x 2m coir logs, placed in three linear rows

NOTE:
New mound vegetation planting by Contractor.
Contractor will also be responsible for revegetation of Construction storage area at the completion of the works (although there is not vegetation there currently)

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KEY

- Construction storage area revegetation
- Revegetation dune with coir mat indigenous grasses
- New mound with coir mat and indigenous grasses
- Temporary cut dune with coir mat indigenous grasses
- Restoration of turf by Golf Club
- 1.2m high vegetation protection fence

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PROJECT TITLE
LONG REEF BOARDWALK

CLIENT
northern beaches council

DRAWING NAME
PLANTING EAST PLAN

THOMPSON BERRILL LANDSCAPE DESIGN P/L
PO BOX 665 MANLY NSW 2095 T: 02 9977 6444 E: info@tbld.com.au

SCALE BAR
0 1 2 3 5m

SCALE	1 : 100 @ A1
DATE	OCT 2023
DESIGN	GB
DRAWN	AY
CHECKED	GB
DATUM	AHD
PLAN No.	LRB-DD-13B

Table 4. Targeted Threatened Species Assessment

Long Reef Boardwalk, Collaroy

Assessed by the Principal Ecologist: Nicholas Skelton GIS Environmental Consultants

Sources: TBDC, Historic Records and Dedicated Survey

GIS Environmental Consultants
Ph: (02) 9939 5129, Mobile: 0419 438 672
ecology@ecology.net.au, ecology.net.au

			Proximity of Historic Records (from past reports and databases)	Habitat Suitability on the Site (from TBDC, literature or BAM-C calculator tick boxes)			
			Determining Factor +ve	Determining Factor -ve and also can be a determining +ve factor	May be a -ve Determining Factor		
Derived (Predicted) Potential Candidate Species	**Habitat Requirements and Preferences (constraints) from DPIE, species profile, TBDC and literature**	**Historic Occurrences from Bionet Atlas in locality. See Fig 5.1.**	**Historic Occurrence on or immediately adjacent to Development Site**	**Habitat Requirements (constraints) within the Development Site**	**Disturbance, Habitat Degradation existing within Development Site**	**Results of Habitat Survey and Conclusion**	**5 Part Test or Significant Impact Criteria Assessment Needed**
Arctocephalus forsteri New Zealand Fur-seal S: Vunerable C: Not listed	**Habitat Requirements:** Coastal enviroments from southern NSW to Northern NSW/South Queensland, and New Zealand. **Habitat Preferences:** Prefers rocky coastline, with jumbled terrain and boulders. Foraging habitat includes key prey, such as; cephalopods, fish, seabirds and occasionally penguins. **Disturbance Factors:** Boats and marine traffic, marine debris such as fishing gear, oil spills, disturbance and displacement of seals at breeding sites, excessive by-catch in NSW fisheries, emerging diseases impacting popuation health including pollutiona and poor water quality, and climate changes impacts to resource avalibilty. **Breeding:** Breeding begins in spring and is localisded to colony grounds. They give birth and raise their pups in the confines of the colony from December to January.	8	Historic Occurance within 500m of the site	There is potential foraging habitat within 500m of the site. However, the development site does not provide habitat for haul-outs or breeding	The development site does not provide habitat for haul-outs or foraging.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Arctocephalus pusillus doriferus Australian Fur-seal S: Vunerable C: Not listed	**Habitat Requirments:** NSW coastline. **Habitat Preferences:** Rocky parts of islands with flat open terrain, although haul-outs have been known to occur across the NSW coast at isolated locations. **Disturbance Factors:** Boats and marine traffic, marine debris such as fishing gear, oil spills, disturbance and displacement of seals at breeding sites, excessive by-catch in NSW fisheries, emerging diseases impacting popuation health including pollutiona and poor water quality, and climate changes impacts to resource avalibilty. **Breeding:** Reported breeding grounds inclde Seal Rocks, near Port Stephens and Montague Island.	5	None on or directly adjacent to the site	There is potential foraging habitat within 500m of the site. However, the development site does not provide habitat for haul-outs or breeding	The development site does not provide habitat for haul-outs or foraging.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Ardenna Carneipes Flesh-footed Shearwater S: Vunerable C: Not listed	**Habitat Requirements:** Coastal and Marine environments. **Habitat Preferences:** Ranges throught the Pacific and Indian Oceans, foraging inshore on fish and squid. **Disturbance factors:** Ingestion of floating plastic while foraging, by-catch of Long-line fishing vessles, urbanisation disturbing breeding areas, trampling of breeding grounds by cattle, invasion of burrows by Kikuyu, herbicide use near breeding areas, predation by dogs, and increased mortality due to road kill. **Breeding:** Nesting colonys are located on Lord Howe Island in New Zealand and along the coast of Western Australia. Eggs are laid at the end of a burrow 1-2 meters in length.	2	Historic Occurance within 500m of the site	Moderately suitable foraging habitat on and around the Site, and does not not contain suitable breeding habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Calidria alba Sanderling S: Vunerable C: Not listed	**Habitat Requirments:** Coastal areas along the NSW coast. **Habitat Preferences:** Often found on low beaches of firm sand, near reefs and inlets and along tital mudflats and bare open coastal lagoons in small flocks or with other waders. Typically individuals run behind mall waves, preying on insects, larve and other small invertebrates in the sand before darting back up the beach before the next wave breaks. Additionally, they can feed on plants, seeds, worms, crustaceans, spiders jellyfish and fish, foraging around heaps on kelp and the edges of shallow pools on sandspits and mudflats. Typically they roost on bare sand, behind clumps of beach-cast kelp or in sand dunes. **Disurbance Factors:** Hydrological changes to estuaries and waterbodies, disturbance to feeding and rooting sites, pollution of estuaries and coastal areas, tourism or agricultural developments reducing costal or inland habitat areas. **Breeding:** Breeding occurs in the Northern Hemishpere in Siberian and Arctic breeding grounds. They leave these grounds in September and return around May.	9	None on or directly adjacent to the site	Site and areas surrounding the Site contain roosting and foraging habitat, but no breeding occurs in Australia	Habitat is somewhat disturbed, however it maintains its integrity	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Calidris canutus Red Knot S: Not Listed C: Endangered	**Habitat Requirements:** Along the NSW Coastline at intertidal mudflats, estuaries, bays, inlets, lagoons, habours, sandflats and sandy beaches of sheltered coasts. **Habitat Preferences:** While it prefers the aformentioned enviorments, they can also be found along sandy ocean beaches, shallow pools on exposed wave cut rock platforms and, occasionally, terrestrial saline wetlands and freshwater swamps. Foraging occurs along the water's edge, with their diet consisting of worms, bivalves, gastropods, crustacens and echinoderms. Roosting occurs at sandy beaches, spit, islets and mudflats close to feeding grounds. **Disturbance Factors:** Chemical or oil spills, human disturbance, Human infrastructure arounds migration pathways, roosting and foraging sites, and habitat loss and degredation. **Breeding:** Breeds in artic areas of siberia from March/April to around September/October.	2	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Calidris ferruginea Curlew Sandpiper S: Endangered C: Critically Endangered (**SAII** Principle 1)	**Habitat Requirements:** Interidal mudflats and sheltered coasts along NSW. **Habitat Preferences:** Foraging habitat includes in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast sea grass or seaweed for worms, molluscus, crustaceans, and seeds. Roosting habitat preferences include shingle, shell or sand beaches, spits or isles on the coast or in wetlands, among beach-cast seaweed or in rocky shores. **Disturbance factors:** Development and human disturbance in roosting or foraging sites in coastal areas, climate change, mangrove incursion into saltmarsh habitat, groundwater pollution impacting foraging habitat and resources, weed invasion of key habitat, habitat loss from erosion and development.	3	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Calidris tenuriostris Great Knot S: Vunerable C: Critically Endangered (**SAII** Principle 1)	**Habitat Requirments:** Sheltered Coastal habitats with large, mudflats or sandflats for foraging. **Habitat Preferences:** Sandy beaches with mudflats nearby, sandy spits and islets and sometimes exposed reefs or rock platforms. Forages by methodically thrusting its bill deep into the mud to serch for invertebrates, such as bivalve molluscs, gastropods, polychaete worms and crustaceans. **Disturbance Factors:** Hydrological changes, habitat loss, human disturbance, mangrove incursion, weed invasion, groundwater pollution and habitat loss from erosion, climate change inundation and sea-level rise. **Breeding:** Migratory bird which breeds in the northern hemishpere from March/April till August/September.	5	Historic Occurance within 500m of the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by existing dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Chamaesyce psammogeton Sand Spurge S: Endangered C: Not listed	**Habitat Requirments:** Dunes and sea strandlines. **Habitat Preferences:** Fore-dunes, pebbly strandlines and exposed headlands often alongside Spinifex and Prickly Couch. It has been recorded along the coast from south of Jervis Bay (at Currarong, Culburra and Seven Mile Beach National Park) to Queensland (and Lord Howe Island). **Disturbance Factors:** Sea level rise and storm surge, extention due to small population size, Bitou Bush, Dune Thistle and Primrose, excessive pedestrian trampling, off-road driving, substrate disturbance and removal of dune structure, competition with native species and coastal develoment. **Survey:** Plant growth and flowering occurs in spring and summer.	8	Historic Occurance within 500m of the site	Site and areas surrounding the Site contain suitable habitat.	Habitat is somewhat disturbed, however it maintains its integrity	Suitable habitat occurs on the site and adjacent. Site was searched at an unsuitable time of the year. This species was not found in the footprint or access route.	**Further Assessment required, see five-pa test (Appendix B)**
Charadrius leschenaultii Greater Sand-plover S: Vunerable C: Vulnerable	**Habitat Requirments:** Costal areas of NSW. **Habitat preferences:** Sheltered sandy,shelly or muddy beaches or esturaries with larger intertidal mudflats or sandbanks. Preys on insects, crustaceans, polychaete worms and molluscs. **Disturbance factors:** Human disturbance at roosting and foraging sites, hydrolocial changes to esturaries and similar water bodies may modify or remove important areas of sutiable habitat, habitat loss due to development, weed invasion of key habitat, industrial development, groundwater polution, and habitat loss from erosion, climate change inundation and sea-level rise. **Breeding:** Breeds in Central Asia, from Armenia to Mongolia and only travel south during the winter.	3	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**

			Proximity of Historic Records from past reports and databases	Habitat Suitability on the Site from TBDC, literature or BAM-C calculator tick boxes			
			Determining Factor +ve	Determining Factor -ve and also can be a determining +ve factor	May be a -ve Determining Factor		
Derived (Predicted) Potential Candidate Species	**Habitat Requirements and Preferences (constraints) from DPIE, species profile, TBDC and literature**	**Historic Occurrences from Bionet Atlas in locality. See Fig 5.1.**	**Historic Occurrence on or immediately adjacent to Development Site**	**Habitat Requirements (constraints) within the Development Site**	**Disturbance, Habitat Degradation existing within Development Site**	**Results of Habitat Survey and Conclusion**	**5 Part Test or Significant Impact Criteria Assessment Needed**
Charadrius mongolus Lesser Sand-plover S: Vunerable C: Endangered	**Habitat Requirements:** NSW and QLD coastline. **Habitat Preferences:** Beaches with sheltered bays, harbours and esturaries with large intertidal sandflats or mudflats. However, they will occasionally occur on sandy beaches, coral reefs and rock platforms. Seen in flocks exceeding 100 individuals and with other wader species. Roosts during high tide on sandy beaches, spits and rocky shores, and forages on insects, crustaceans, molluscs and marine worms. **Disturbance Factors:** Hydrological changes to water bodies, human disturbance to roosting and foraging sites, weed invasion, habitat loss due to development, mangrove incursion, industrial development, groundwater pollution and habitat loss from erosion, climate change inundation and sea level rise. **Breeding:** Breeds overseas, in central and north eastern Asia and migrates to Australia over winter.	3	Historic Occurance within 500m of the site	Site and areas surrounding the Site contain roosting and foraging habitat, but no breeding occurs in Australia	Weed invasion and disturbance by foot traffic occurs on site	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Diomedea exulans Wandering Albatross S: Endangered C: Vulnerable	**Habitat Requirments:** NSW Coastline, spending majority of their time over the southern oceans. **Habitat Preferences:** Off shore or inshore ocean waters, feeding on fish, squid, crustaceans and carrion. **Disturbance Factors:** Longline fishing boats, breeding affected by Subantartic Skuas and human disturbance, and the ingestion of plastics and hooks and entanglment in marine debris. **Breeding:** Breeds on a number of islands north of the Antartic circle, amound patchy vegetation and migrate Australian waters between June and September.	7	Historic Occurance within 500m of the site	The Site does not contain, but is adjacent to, an ocean.	The ocean adjacent to the Site is a popular spot for fishing and recreational water sports, which may disturb the Albatross.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Falsistrellus tasmaniensis Eastern False Pipistrelle S: Vunerable C: not listed	**Habitat requirements:** Found on the south-east coast and ranges of Australia. **Habitat preferences:** Prefers moist habitats, with trees taller than 20 m. Generally, roosts in eucalypt hollows, but has also been found under loose bark on trees or in buildings. Females are pregnant in late spring to early summer. **Disturbance factors:** loss of winter roosting and breeding sites	1	None on or directly adjacent to the site	There is no rooosting/breeding habitat on the Site	N/A	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Gygis alba White Tern S: Vulnerable C: not listed	**Habitat Requirments:** Coastal NSW water. **Habitat Preferences:** is a vagrant Bird and often occurs in NSW waters after storm events. Breeding and non-breeding birds roost in trees at nigh, particularly native Sallywood, Blackbutt, Greybark, Banyan and Pandanus. **Disturbance Factors:** Masked Owls prey on chicks, removal of nesting habitat and key tree species. **Breeding:** Breeds on Lord Howe Island.	1	None on or directly adjacent to the site	There is no rooosting/breeding habitat on the Site	N/A	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Haematopus fuliginosus Sooty Oystercatcher S: Vulnerable C: Not listed	**Habitat requirments:** Australian coastline. **Habitat preferences:** Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuarys. Typically forages on exposed rock or coral at low tide for foods such as limpets and mussels. **Disturbance factors:** Habitat destruction caused by residential, agricultural and tourism developments, habitat disturbance to feeding, nesting and roosting areas caused by, beach-combing, fishing, dog-walking, horse rding and 4WD vechicles, hydrological changes, predation of eggs and chicks by foxes, dogs, cats, rats and raptors, and insufficient understanding of trends of abundance and causes of nesting loss. **Breeding:** Breeds in spring and summer almost exclusively on offshore islands, and isolated promontorties on occassion. Nests are a shallow scrape on the ground or small mounds of pebbles, shells or seaweed when nesting among rocks.	44	Historic Occurance within 500m of the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Haematopus longirostris Pied Oystercatcher S: Endangered C: Not listed	**Habitat requirments:** Australian coastline. **Habitat preferences:** Intertidal flats, inlets, bays, open beaches and sandbanks. More commonly found in costal Tasmania and parts of Victoria, however, 200 breading pairs are thinly dispersed across the NSW coastline. **Disturbance factors:** predation of eggs and chicks by foxes, avian predators (corvids and gulls) and dogs, trampling of nests and removal of eggs by humans, innundation of nests by hightides, storms and other flooding, hydrological changes causing los or degredation of habitat, contamination of estuaries caused by urban and agricultural run-off, sediment re-suspension and oil spills, reduction of nesting area due to encrochment of vegetation, entagnglement or ingestion of marine debris, and the long-term decline of key food source, the pipi, due to overharvesting. **Breeding:** Nest mostly on costal and esturine beaches, occassionally using saltmarsh or grassy areas. Nests are shallow scrapes in sand above the high tide mark and are often amoungst seaweed, shells and small stones. Nesting season is August to January with two to three eggs being laid during that time.	10	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Haliaeetus leucogaster White-bellied Sea-Eagle **(Breeding only)** S: Vulnerable C: Not listed	**Habitat Requirements:** Large emergent eucalypts within 1km of water bodies. **Habitat Preferences:** Occurs at sites near the sea or sea-shore, such as around bays and inlets, beaches, reefs, lagoons, estuaries and mangroves; and at, or in the vicinity of freshwater swamps, lakes, reservoirs, billabongs and saltmarsh. **Disturbance Factors:** None documented. **Breeding:** Nest trees are typically large emergent eucalypts and often have emergent dead branches or large dead trees nearby which are used as 'guard roosts'.	38	Historic Occurance within 500m of the site	Site and areas surrounding the Site do not contain suitable breeding habitat.	No sensitivity documented	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Hirundapus caudacutus White-throated Needletail S: Not listed C: Vunerable	**Habitat requirments:** Widespread across NSW with a preference for costal areas. Habitat Preferences: seen in eastern Australia before storms, low pressure troughs and approaching cold fronts and occasionally bushfire. These conditions are often used by insects to swarm (eg termites and ants) or tend to lift insects away from the surface which favours sighting of White-throated Needletails as they feed. **Disturbance Factors:** Vegetation clearing and rotor strike from wind farms. **Breeding:** Breeds in forests in south-eastern Siberia, Mongolia, the Korean Penninsula and northern Japan June-August.	23	Historic Occurance within 500m of the site	Site and areas surrounding the Site contain suitable foraging habitat.	Vegetatiuon clearing has occurred in and around the Site	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Litoria aurea Green and Golden Bell Frog *Vulnerable* S: Endangered C: Vulnerable	**Habitat Requirements:** Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (Gambusia holbrooki), have a grassy area nearby and diurnal sheltering sites available. **Habitat Preferences:** Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (Typha spp.) or spikerushes (Eleocharis spp.). Vegetation up to 1km from suitable water bodies. **Disturbance Factors:** This species in known, especially in the Greater Sydney area, to occur in highly disturbed sites. **Breeding:** Can beed in coastal swamps, marches, dune swales, lagoons, lakes and other estuary wetlands as well as around riverine floodplain wetlands, billabongs and ponds in slow flowing or non-perennial steams.	2	Historic Occurance within 500m of the site. Records of this frog near the Site are most likely a result of an attempted introduction experiment by Pyke et al. that failed.	Site and areas surrounding the Site contain suitable habitat.	The habitat on site is man-made/disturbed; however, this species is able to inhabit disturbed sites.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**

			Proximity of Historic Records from past reports and databases	Habitat Suitability on the Site from TBDC, literature or BAM-C calculator tick boxes			
			Determining Factor +ve	Determining Factor -ve and also can be a determining +ve factor	May be a -ve Determining Factor		
Derived (Predicted) Potential Candidate Species	**Habitat Requirements and Preferences (constraints) from DPIE, species profile, TBDC and literature**	**Historic Occurrences from Bionet Atlas in locality. See Fig 5.1.**	**Historic Occurrence on or immediately adjacent to Development Site**	**Habitat Requirements (constraints) within the Development Site**	**Disturbance, Habitat Degradation existing within Development Site**	**Results of Habitat Survey and Conclusion**	**5 Part Test or Significant Impact Criteria Assessment Needed**
Macronectes giganteus Southern Giant Petrel S: Endangered C: Endangered	**Habitat Requirments:** NSW Coastline. **Habitat Preferences:** Scavenger and predator that will occasionally scavenge animal carcasses on land and is also an active predator of cephalopods and euphausiids at sea. **Disturbance Factors:** Long line fishing, predation by feral cats and black rats on breeding islands, habitat degredation on breeding islands, loss of southern cuttlefish populations, oill spills and changes to sea and air temperatures which affect marine prey abillity. **Breeding:** Over summer, the species nests in small colonies amongst open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.	2	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	None of the stated disturbance factors occur on this site.	The species was adequately searched for, no individual or trace was found. However, this does not confirm the absence of the species or possibility for future use as habitat as it is a highly mobile migratory specie.	**Further Assesment required, see EPBC Significant Impact Criteria Assessment (Appendix C)**
Macronectes halli Northern Giant Petrel S: Vunerable C: Vunerable	**Habitat Requirments:** NSW south east coastline during winter and autumn. **Habitat Preferences:** Adults usually remain near the breeding colonies throughout the year (though some do travel widely) while immature birds make long and poorly known circumpolar and trans-oceanic movements. Hence most birds recorded in NSW coastal waters are immature birds. Females obtain most of their prey live from the sea, while males also scavenge from the carcases of penguins and seals on land. **Disturbance Factors:** Mortality due to long-line fishing, predation by feral cats and black rats on breeding islands, loss of southern cuttlefish populations, oil spills, ingestion of plastics and hooks. **Breeding:** Breeding in Australian territory is limited to Macquarie Island and occurs during spring and summer.	1	None on or directly adjacent to the site	Moderately suitable foraging habitat on and around the Site, and does not not contain suitable breeding habitat.	None of the stated disturbance factors occur on this site.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Myotis macropus Southern Myotis S: Vulnerable C: Not listed	**Habitat Requirements:** Within 200m of suitable waterbody that is at least 3m wide and can be a river, creek, billabong, lagoon, dam, estuary or coastal lake. It does not include ocean, beach or marine harbour. Hollow bearing trees, caves, bridges or artificial structures within 200m of suitable water body. **Habitat Preferences:** Forage over streams and pools, catching insects and small fish on the water surface. **Disturbance Factors:** None documented. **Breeding:** Generally roost in groups of 10-15 close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. Survey: Oct-Mar	51	None on or directly adjacent to the site	Development site is within 200m of suitable waterbody. No known hollows occur on the entire development site.	No sensitivity documented	The species was adequately searched for, no individual or trace was found	**Further Assessment required, see five-pa test (Appendix B)**
Numenius madagascariensis Eastern Curlew S: Not listed C: Critically Endangered	**Habitat Requirments:** Coastal areas. **Habitat Preferences:** It generally occupies coastal lakes, inlets, bays and estuarine habitats, and in New South Wales is mainly found in intertidal mudflats and sometimes saltmarsh of sheltered coasts. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. It forages in or at the edge of shallow water, occasionally on exposed algal mats or waterweed, or on banks of beach-cast seagrass or seaweed. It roosts on sandy spits and islets, especially on dry beach sand near the high-water mark, and among coastal vegetation including low saltmarsh or mangroves. The Eastern Curlew is carnivorous, mainly eating crustaceans (including crabs, shrimps and prawns), small molluscs, as well as some insects. **Disturbance Factors:** Devlopment pressure and human disturbance, displacment from foraging and roosting sites, and hydrological changes to waterbodies. **Breeding:** Breeds in Russia and North-Eastern China.	4	None on or directly adjacent to the site	Moderately suitable foraging habitat near the Site, and does not not contain suitable breeding habitat.	Distrubance of foot traffic occurs on site	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Onychoprion fuscata Sooty Tern S: Vunerable C: Not listed	**Habitat Requirments:** Tropical and Subtropical seas and on associated islands and cays around Northern Australia. **Habitat Preferences:** In NSW only known to breed at Lord Howe Island. Occasionally seen along coastal NSW, especially after cyclones. Large flocks can be seen soaring, skimming and dipping but seldom plunging in off shore waters. **Disturbance Factors:** Predation on breeding grounds by domestic dogs and introduced rats, trampling and sdisturbance gf breeding grounds, modification and clearing of habitat, loss of nesting habitat due to invasion of exotic grasses (Kikuyu), loss of quality food source due to overfishing, and damage to eggs and nests. **Breeding:** Breeds in large colonies in sand or coral scrapes on offshore islands and cays including Lord Howe and Norfolk Islands.	5	None on or directly adjacent to the site	Site and areas surrounding the Site does not contain any important habitat. Breeding only occurs on Lord Howe and Norfolk Islands.	No sensitivity documented	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Pandion cristatus Eastern Osprey **(Breeding only)** S: Vulnerable C: Not listed	**Habitat Requirements:** Stick nests in living and dead trees (<15m) or artificial structures within 100m of a floodplain. **Habitat Preferences:** Favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Feed on fish over clear, open water. **Disturbance Factors:** None documented. **Breeding:** Breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	38	None on or directly adjacent to the site	The development site does not contain large trees with stick nests.	No sensitivity documented	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Pterodroma leucoptera leucoptera Gould's Petrel S: Vunerable C: Endangered	**Habitat Requirements:** Coastal Areas. **Habitat Preferences:** Breeds on both Cabbage Tree Island, 1.4 km offshore from Port Stephens and on nearby Boondelbah island. The range and feeding areas of non-breeding petrels are unknown. **Disturbance Factors:** Entanglement with the sticky Bird-lime tree, predation by avian predators, human disturbance, entanglement in invasive grass, climate change, and enchrochment of habitat by invasive weeds. **Breeding:** The first arrival of Gould's petrel on cabbage tree Island occurs from mid to late September. Principal nesting habitat is located within two gullies which are characterised by steeply, sloping rock scree with a canopy of Cabbage Tree Palms. They nest predominantly in natural rock crevices among the rock scree and also in hollow fallen palm trunks, under mats of fallen palm fronds and in cavities among the buttresses of fig trees.	1	None on or directly adjacent to the site	The site does not contain any important habitat and is outside of the known breeding areas.	Weed invasion and disturbance by foot traffic occurs on site	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Pteropus poliocephalus Grey-headed Flying-fox **(Breeding only)** S: Vulnerable C: Vulnerable	**Habitat Requirements:** Breeding camp. Breeds close to fresh water body. **Habitat Preferences:** Roosting camps are generally located within 20 km of a regular food source and are commonly found in gullies, close to water, in vegetation with a dense canopy. **Disturbance Factors:** None documented. **Breeding:** Site fidelity to camps is high. Individual camps may have tens of thousands of animals and are used for mating, and for giving birth and rearing young.	208	None on or directly adjacent to the site	No breeding or roosting habitat close to or on a water body within development site.	No sensitivity documented	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Puffinus assimilis Little Shearwater S: Vunerable C: Not listed	**Habitat Requirments:** Marine and Coastal Environments. **Habitat Preferences:** A widespread species in the subtropical Atlantic, Pacific and Indian Oceans. Lord Howe Island has one of the larger breeding colonies in the Australian region. Only nest on off-shore islands **Disturbance Factors:** Impact of weeds on habitat, predation by rodents on nesting grounds and big headed ants disturbance to nesting sites. **Breeding:** Breeding sites are located at Lord Howe Island include Roach Island, Muttonbird Island, Blackburn Island and on the main Island at Muttonbird Point and Transit Hill.	2	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat, but does not conain suitable breeding habitat.	Weed invasion	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Rostratula australis Australian Painted Snipe S: Endangered C: Endangered	**Habitat Requirments:** Swampy wetlands. **Habitat preferences:** Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. They nest on the ground amongst tall vegetation, such as grasses, tussocks or reeds and these nest consists of a scrape in the ground, lined with grasses and leaves. Forages nocturnally on mud-flats and in shallow water. Feeds on worms, molluscs, insects and some plant-matter. **Disturbance Factors:** Drainage of breeding sites and wetlands, reduced water quality caused by siltation and pollution, predation by foxes and feral cats, use of herbicies and other chemicals near wetlands, exotic weeds and invasive plants. **Breeding:** Breeding is often in response to local conditions; generally occurs from September to December. Incubation and care of young is all undertaken by the male only.	3	None on or directly adjacent to the site	Vegetation type unsuitable on site.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**

			Proximity of Historic Records from past reports and databases	Habitat Suitability on the Site from TBDC, literature or BAM-C calculator tick boxes			
			Determining Factor +ve	Determining Factor -ve and also can be a determining +ve factor	May be a -ve Determining Factor		
Derived (Predicted) Potential Candidate Species	**Habitat Requirements and Preferences (constraints) from DPIE, species profile, TBDC and literature**	**Historic Occurrences from Bionet Atlas in locality. See Fig 5.1.**	**Historic Occurrence on or immediately adjacent to Development Site**	**Habitat Requirements (constraints) within the Development Site**	**Disturbance, Habitat Degradation existing within Development Site**	**Results of Habitat Survey and Conclusion**	**5 Part Test or Significant Impact Criteria Assessment Needed**
Senecio spathulatus Coast Groundsel S: Endangered C: Not listed	**Habitat Requirements:** grows on frontal dunes. **Habitat Preferences:** occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park (with a possible occurrence at Cudmirrah) **Disturbance Factors:** habitat loss, pedestrian trampling, offroad driving, dune erosion, weeds invasion including bitou bush. **Survey:** All year Flowers sporadically throughout the year. Check local reference sites for flowering period. Survey when flowering as species is more obvious and identifiable, as easily confused with with S. pinnatifolius var pinnatifolius.	1	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat.	Weed invasion, dune erosion and disturbance by foot traffic occurs on site	Sutible habitat occurs on the site and adjacent. Site was searched at a sutible time of the year. This species was not found in the footprint or access route. No further assessment required.	**No Further Assessment needed**
Sternula albifrons Little Tern S: Endangered C: Not listed	**Habitat Requirements:** coastal sheltered environments. Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands. **Habitat Preferences:** Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria. **Disturbance Factors:** fox and domestic cat/dog predation of eggs and chicks, pedestrian trampling, offroad driving. **Breeding:** spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months.	6	None on or directly adjacent to the site	Sutible foraging and nesting habitat occurs on the site and adjacent.	Habitat is somewhat disturbed, however it maintains its integrity	The species was adequately searched for, no individual or trace was found. However, this does not confirm the absence of the species or possibility for future use as habitat as it is a highly mobile migratory specie.	**Further Assesment required, see EPBC Significant Impact Criteria Assessment (Appendix C)**
Stictonetta naevosa Freckled Duck S: Vunerable C: Not listed	**Habitat Requirements:** Wetlands. **Habitat Preferences:** Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds. Generally rest in dense cover during the day, usually in deep water. Feed at dawn and dusk and at night on algae, seeds and vegetative parts of aquatic grasses and sedges and small invertebrates. **Disturbance Factors:** Draining and clearing of wetlands and swamps, changes to natural river flows, grazing and trampling of wetland habitat, predation and disturbance by foxes, pigs and cats. **Breeding:** Nesting usually occurs between October and December but can take place at other times when conditions are favourable. Nests are usually located in dense vegetation at or near water level.	2	None on or directly adjacent to the site	Site and areas surrounding the Site do not contain suitable foraging habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Thalassarche cauta Shy Albatross S: Endangered C: Endangered	**Habitat Requirments:** Subantartic and subtropical marine waters. **Habitat Preferences:** Occasionally the species occurs in continental shelf waters, in bays and harbours. The species feeds on fish, crustaceans, offal and squid and may forage in mixed-species flocks. **Disturbance factors:** Coastal pollution, floating rubbish, oils and chemicals, longline fishing operations, and disturbance to nesting colonies by introduced predators. **Breeding:** Known breeding locations include Albatross Island off Tasmania, Auckland Island, Bounty Island and The Snares, off New Zealand, where nesting colonies of 6-500 nests occur and may contain other species such as the Australian Gannet. Located on sheltered sides of islands, on cliffs and ledges, in crevices and slopes, nests are used annually and consist of a mound of mud.	4	Historic Occurance within 500m of the site	The site does not contain, but is adjacent to, an ocean, which is suitable foraging habitat. It is not within one of the known breeding areas.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Thalassarche melanophris Black-browed Albatross S: Vunerable C: Vunerable	**Habitat Requirments:** Antarctic, subantartic, subtropical marine and coastal waters. **Habitat Preferences:** Can tolerate water temperatures between 0°C and 24°C and spends most of its time at sea, breeding on small isolated islands. When at sea, individuals soar on strong winds and rest on the ocean, when calm, often in groups. This species feeds on fish, crustaceans, offal and squid and often forages in flocks with other seabirds. **Disturbance Factors:** Coastal pollution, floating rubbish, oils and chemicals, longline fishing operations, and disturbance to nesting colonies by introduced predators. **Breeding:** Occuring September to December, this species nests annually on a mound of soil and vegetation, on the cliffs or steep slopes of vegetated antarctic and subantarctic islands. Colonies of up to 100,000 nests are formed, occasionally containing other species such as the Grey-headed Albatross.	15	Historic Occurance within 500m of the site	The site does not contain, but is adjacent to, an ocean, which is suitable foraging habitat. It does not contain suitable breeding habitat as it is not an island.	Heavy amount of foot traffic and disturbance by dogwalking in the area	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**
Xenus cinereus Terek Sandpiper S: Vulnerable C: Not listed	**Habitat Requirments:** Coastal mudflats, lagoons, creeks and estuaries. **Habitat Preferences:** Favours mudbanks and sandbanks located near mangroves, but may also be observed on rocky pools and reefs, and occasionally up to 10 km inland around brackish pools. The diet includes worms, crabs and other crustaceans, small shellfish and the adults and larvae of various flies, beetles and water-bugs. **Disturbance Factors:** Human disturbance at roosting and foraging sites, mangrove incursion into saltmarsh, habitat loss due to development, weed invasion of key habitat, hydrological changes to estuaries, industrial development, groundwater pollution and habitat loss from erosion, climate change inundation and sea-level rise. **Breeding:** Generally roosts communally amongst mangroves or dead trees, often with related wader species	2	None on or directly adjacent to the site	Site and areas surrounding the Site contain suitable foraging habitat, but does not conain suitable breeding habitat.	Heavy amount of foot traffic and disturbance by dogwalking in the area, and weed invasion.	The species was adequately searched for, no individual or trace was found	**No Further Assessment needed**

^ = sensitive species
^^ = sensitive species

Key for BC Act Status

Status	Status	Status Notes
P	Protected Animal	Fauna not listed in Schedule 11 of the NPW Act 1974. Only shown for species that are listed in the other Acts
V	Vulnerable	Schedule 1, part 3, BC Act 2016, Likely to become endangered unless the circumstances & factors threatening its survival or evolutionary development cease to operate.
E1	Endangered	Schedule 1, part 2, BC Act 1995, Likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary stop, in immediate danger of extinction
E2	Endangered Population	Schedule 1, part 2, division 4, BC Act 2016, Population where, numbers have been reduced to such a critical level, or its habitat has been so drastically reduced, that it is in immediate danger of extinction
E4A	Critically Endangered Species	Schedule 1a, part 1, TSC Act 1995, Species that is facing an extremely high risk of extinction in New South Wales in the immediate future
2	Category 2 sensitive species	Species are classed as highly sensitive, and provision of precise locations would subject the species to high risk from threats such as disturbance and collection.
3	Category 3 sensitive species	Species are classed as of medium sensitivity, and provision of precise locations would subject the species to medium risk from threats such as collection/deliberate damage.

Key for EPBC Act Status

Code	Description	Definition under the EPBC Act 1999, and Migratory Birds agreement.
C	CAMBA	China-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of The People's Republic of China for the protection of Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999.)
CE	Critically Endangered	Refers to a native species is eligible to be included in the critically endangered category at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria (Subdivision A of Division 1 of Part 13, Commonwealth EPBC Act 1999).
E	Endangered	Refers to a native species is eligible to be included in the endangered category at a particular time if, at that time: (a) it is not critically endangered; and (b) it is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria (Subdivision A of Division 2 of Part 13, Commonwealth EPBC Act 1999).
J	JAMBA	Japan-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Japan and the Government of Australia for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).
K	ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement: Refers to species listed in the Bilateral Agreement between the Government of Australia and the Government of the Republic of Korea for the protection of Migratory Birds and their Environment (Subdivision A of Division 1 of Part 5, Commonwealth EPBC Act 1999).
V	Vulnerable	Refers to a native species is eligible to be included in the vulnerable category at a particular time if, at that time: (a) it is not critically endangered or endangered; and (b) it is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria (Subdivision A of Division 1 of Part 13, Commonwealth EPBC Act 1999).
X	Extinct	Refers to a native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died (Subdivision A of Division 1 of Part 13, Commonwealth EPBC Act 1999).

5.2 Regional Vegetation Mapping

There are two regional scale vegetation maps of this locality these are the State Vegetation Type Map (SVTM) and the Vegetation map of the Sydney Metropolitan area v 3.1 these are shown on Maps 3c and 3d respectively. Neither of these maps were found to be accurate on this site or the locality.

Both of these maps are regional-scale maps that should be interpreted while keeping in mind the spatial and classification limitations of the data. This mapping data is only a guide to the occurrence and distribution of Plant Community Types before and after clearing, and botanical field survey must be used at a site scale. The maps, the classification used and the limitations can be found at https://datasets.seed.nsw.gov.au/dataset/nsw-state-vegetation-type-map.

Rather than using either of these maps the vegetation on the site was mapped using recent Nearmap aerial photos and the current PCT classification.

5.2.1 Native Vegetation Types (Ecological Communities, PCT)

The vegetation types that occur within or adjacent to the site are shown on Maps 3e, 4b and 5a and are listed below:

PCT Number	PCT Name	Formation	Class
3410	Spinifex Strandline Grassland	Grasslands	Maritime Grasslands
3546	Coastal Sands Littoral Scrub-Forest	Dry Sclerophyll Forests (Shrubby sub-formation)	Coastal Dune Dry Sclerophyll Forests
3407	Central Headland Grassland	Grasslands	Maritime Grasslands
3789	Coastal Headland Clay Heath	Heathlands	Coastal Headland Heaths

5.2.2 NSW Plant Community Type classification

3410, Spinifex Strandline Grassland

A mid-high grassland with occasional isolated shrubs found on beach and estuarine strand plains along the NSW Coastline. A mid-dense cover of *Spinifex sericeus* is almost always present and characterises the composition of this PCT. It is occasionally accompanied by salt tolerant forbs including *Carpobrotus glaucescens* and *Scaevola calendulacea* or rarely *Zoysia macrantha*. Isolated shrubs are sometimes present, commonly including Acacia longifolia. This PCT is often a temporary plant community found on mobile beach sands and dune blowouts.

3546, Coastal Sands Littoral Scrub-Forest

A low to mid-high open forest or very tall to extremely tall shrubland found in the littoral zone on coastal dunes and rarely headlands south from Forster on the Lower North Coast to the Victorian border. The upper stratum almost always includes *Banksia integrifolia*, commonly with a mix of *Leptospermum laevigatum*, *Cupaniopsis anacardioides* (only north from the Illawarra) and *Pittosporum undulatum*, rarely with *Casuarina glauca*. A eucalypt canopy may rarely be present, usually with either *Eucalyptus botryoides* or *Eucalyptus pilularis*. The shrub layer very frequently includes *Breynia oblongifolia* and *Monotoca elliptica*, commonly with *Acacia longifolia* and *Leptospermum laevigatum*, occasionally with hardy mesic species such as *Glochidion ferdinandi* and *Notelaea longifolia*. The ground layer is typically sparse to mid-dense and very frequently includes *Lomandra longifolia*, commonly with *Pteridium esculentum* and occasionally *Imperata cylindrica*. Climbers commonly include *Geitonoplesium cymosum*, occasionally *Hibbertia scandens* and *Stephania japonica var. discolor*, rarely with *Maclura cochinchinensis*. This PCT is very common within the greater Sydney Metropolitan area between the Illawarra and Newcastle on low-lying coastal sand plains. Plots include a relatively high proportion of exotic species, with some areas likely to have been impacted by past sand mining or urban land use pressures. On podsolised or more exposed hind dunes it grades into a range of shrubby sclerophyll sand forests including PCTs 3544, 3545 and 3638.

3407, Central Headland Grassland
A tall sparse to open shrubland with a very grassy ground cover, or rarely a grassland, found on clay rich soils on coastal headlands along the Illawarra, Sydney, Central and Lower North Coasts. One of three headland grassland PCTs in NSW, all are characterised by a mid-dense to dense cover of the grass *Themeda triandra*. A layer of wind sheared woody shrubs is variable in cover however very frequently includes *Westringia fruticosa* and *Banksia integrifolia*, commonly with *Leptospermum laevigatum* and *Acacia longifolia*. Some headlands include low forms of *Casuarina glauca* and occasionally *Allocasuarina distyla*. Other members of the ground layer almost always include clumps of *Lomandra longifolia*, commonly with *Ficinia nodosa*, *Cynodon dactylon*, *Oxalis perennans* and *Dichondra repens*. Compositional and structural attributes of this PCT are likely to be blurred by a long history of disturbance that persists at public vantage points on headland cliffs. It typically remains in small patches on remaining vegetated headland complexes or steep sea cliffs.

3789, Coastal Headland Clay Heath

A tall to very tall heathland or closed heathland, with a grassy ground cover found on coastal headlands with clay influenced soils. This PCT occurs mainly between the northern Beaches of Sydney and Lake Macquarie on the Central Coast, with a far southern site in the Shoalhaven district. The shrub canopy almost always includes *Acacia longifolia*, *Banksia integrifolia* and *Leptospermum laevigatum*. Both *Allocasuarina distyla* and *Westringia fruticosa* are also very frequently recorded and typically have a higher cover than other species, the former of which may occur as dense thickets. A sparse cover of hardy mesic shrubs is also common and include *Pittosporum undulatum* and *Glochidion ferdinandi* along with other soft leaved shrubs including *Lasiopetalum ferrugineum*. The ground layer almost always includes an abundance of *Themeda triandra* together with clumps of *Lomandra longifolia*. This PCT is restricted to Permo Triassic sediments of the Sydney Basin, with a southern outlier site at Ulladulla which is disjunct from the remaining samples by around 200 km. It occurs at elevations of generally below 50 metres asl, however persists on some elevated headlands of above 100 metres asl. This community grades into or adjoins headland grasslands PCT 3407 or PCT 3409.

The distribution of native vegetation can be seen on Maps 3, 4a, 4b and 5a.

5.2.3 Presence of Threatened Ecological Communities

The NSW Biodiversity Conservation Act, 2016 lists Threatened Ecological Communities (TECs) and Threatened Species that are likely to become extinct in nature unless the circumstances and factors threatening their survival cease to operate.

Method of Establishing if EEC's Occur on this Study area

To establish if any endangered ecological community occurs within the study area a combination of three separate methods were used:

The Mapping Method: The most accurate and up-to-date vegetation maps that are available were used to determine what is already known about the distribution of vegetation types in the locality. Where more accurate local maps are not available, the 'Vegetation of the Sydney Metropolitan Area' map and classification (OEH, 2016) are used. Vegetation mapping has inherent errors such as classification accuracy is limited due to the amount of field verification that was carried out when they were made, the spatial accuracy of the mapping and how old the mapping is. There are often different classification interpretations and the newest is not necessarily the best. Vegetation maps do not provide a sufficient level of spatial accuracy for the assessment of the impact at the scale of this proposal but are useful in determining the ecological communities that are likely to occur in the vicinity. These maps are based on aerial photography and normally little local field verification. They were produced for regional planning and are often not of an appropriate scale to be relied on for a DA proposal. Fieldwork is necessary to determine the site-specific accurate vegetation mapping. The SMCMA mapping was also used to determine the amount of Endangered Ecological Communities within the 100ha and 1000ha localities around the site.

The Correlation Method: Correlations between the species that occur in the study area and the listed characteristic species for the Endangered Ecological Community in; the Final Determination in Part 3 of Schedule 1 of the Threatened Species Conservation Act (1995),positive diagnostic

species from Tozer (2003) classification and also with the positive diagnostic species from the Draft SMCMA (2009) description (and/or Tozer 1993) were used to assist to determine if any EECs occur in the study area. The floristics were also compared to the document 'Vegetation of the Sydney Metropolitan Area V3' by OEH 2016.

The Comparison Method: Comparison of the ecological features on the site to the environmental description in the legal definition of the Endangered Ecological Community in the Final Determination in Biodiversity Conservation Act (2016) and the EPBC Act (1999). This comparison is essential when determining if the type of ecological community that occurs within a study area is an endangered community. Not all the sections of the determinations need to apply to the study area and the earlier sections are more important and should be given more weight (Preston and Adams).

5.2.4 Occurrence of EECs in the construction site

The small area of Central Headland Grassland that is outside the site to the north is consistent with the Endangered BC Act Themeda grassland on seacliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions - endangered ecological community.

The structure of the community is typically closed tussock grassland, but may be open shrubland or open heath with a grassy matrix between the shrubs

The community is characterised by the following assemblage of species:

Acacia sophorae
Banksia integrifolia subsp. integrifolia
Commelina cyanea
Glycine
Glycine microphylla
Hibbertia scandens
Isolepis nodosa
Kennedia rubicunda
Lepidosperma spp.
Leptospermum laevigatum
Lomandra longifolia
Monotoca elliptica
Opercularia aspera
Pimelea linifolia
Poranthera microphylla
Sporobolus virginicus
Themeda australis
Viola banksii
Westringia fruticose

Themeda australis is the dominant species in the community. *Themeda australis* is an extremely widespread species, but in this community may have a distinctive appearance, being prostrate and having glaucous leaves. These features are retained in cultivation and the form is believed to be genetically distinct (SWL Jacobs, pers. Comm.). Scattered shrubs occur in many stands, most frequently *Pimelea linifolia*, *Banksia integrifolia* and *Westringia fruticose*. These and other woody species often have dwarf growth forms. Although a number of woody species are listed as part of the community, these are usually sparsely distributed and may be absent from some stands. Tussocks of *Poa poiformis* may be found in some stands of the community, but *Poa poiformis*-dominated tussock grassland is generally found lower on cliffs (closer to the sea and more exposed to spray) and on steeper slopes.

This community does not occur in the construction area or on the chosen 1-2 route. It does occur a short distance to the north and within or immediately adjacent to the other two potential access routes. These routes will not be used, and hence an Assessment of Significance (5-Part Test) is not required for this proposal.

5.2.5 Fauna Habitat

The habitat on the Site consists of (in order of abundance):

- Bitou Bush Heath on dunes
- Heath on dunes
- Strandline Grassland on dunes
- Mown lawn (Golf Course)
- Beach

In the locations and abundance shown on Map 4a and 8.

The heathlands are habitat for invertebrates, small reptiles and small passerine birds. The low dense heath with areas of sparce spinifex or bare sand dune is habitat for Ghost Crabs and skinks. The mown golf course is mostly habitat for birds especially Magpies and Plovers and the beach is habitat for a range of seabirds and marine life. There is adjacent riparian habitat that is suitable for frogs and birds.

The site is likely to be part of a large foraging home range for common and threatened birds, small reptiles, mammals, and microbats but does not contain any specific or important habitat for any threatened species.

Tables 4 and 9 are an assessment of the suitability and importance of the site for the conservation of Threatened plant and animal species.

The habitat features on this site are shown on Maps 4a and 4b, and on the cover photo and the photos on Photo Page 1.

Green and Golden Bell Frog history

A study on reintroducing *Litoria aurea* (Pyke et al. 2008) was conducted from 1998 to 2008, where frog pond habitat in the Long Reef Golf Club was tried as a site for reintroduction of Green and Golden Bell Frog (*Litoria aurea*) habitat through a translocation experiment by the Australian Museum. The translocation experiment ceased in 2003, and was deemed unsuccessful, as the tadpoles were able to metamorphose into frogs, but none were recorded to be breeding.

5.2.6 Plant Species (Floristics)

Table 6 lists the plant species (scientific name and common name) that occur on the site. The species are categorised by taxonomic family, taxonomic group, growth form and conservation status.

There were 22 native plant species recorded within the site. 5 of these plants are Native to NSW and 3 of them were within a 400sqm survey plot. This includes 1 species of native tree and 5 species of native shrub. There are 10 herbs, 3 native grasses, 2 vines and one sedge.

There are also 21 weed or planted species found on the site. This includes 1 species of native tree and 5 species of native shrub. There are 10 herbs, 3 native grasses, 1 vine and 1 palm.

The high number of weeds reflects the long history of disturbance on this site. The number of additional plant species outside plot was 16 which contained 7 herbs, 3 trees, 3 shrubs, 2 ferns and 1 palm.

Acacia terminalis ssp. terminalis now called Acacia terminalis subsp. Eastern Sydney (G.P.Phillips 126) (Sunshine Wattle)

During the field survey, an Acacia terminalis ssp. terminalis specimen, an endangered plant, was identified approximately 500m northeast of the site. This specimen has been planted as a part of the bush regeneration adjacent to the coastal headland track.

5.2.7 Fauna Species

During the field survey the fauna species in Table 5 were found using the study area:

Table 5: Fauna Species Recorded

	Scientific Name	Evidence
Birds		
Common Myna	*Acridotheres tristis*	Observed
Superb Fairy-wren	*Malurus cyaneus*	Observed
Eastern Whipbird	*Psophodes olivaceus*	Heard call
Australian Coot	*Fulica atra*	Observed
Nankeen Kestrel	*Falco cenchroides cenchroides*	Observed
Magpie	*Gymnorhina tibicen*	Observed
Magpie-lark	*Grallina cyanoleuca*	Observed
Willie Wagtail	*Rhipidura leucophrys*	Observed
Masked Plover	*Vanellus miles*	Observed
Rainbow Lorikeet	Trichoglossus moluccanus	Observed
Pelican	Pelecanus conspicillatus	Observed
Silver Gull	Larus novaehollandiae	Observed
Eastern Osprey	Pandion cristatus	Observed
Little Pied Cormorant	*Microcarbo melanoleucos*	Observed
Mammals		
Domestic Dog	*Canis familiaris*	Observed
Rabbit	*Oryctolagus cuniculus*	Diggings
Fox	*Vulpes vulpes*	Scat
Long-nosed Bandicoot	*Perameles nasuta*	Diggings
Rakali	*Hydromys chrysogaster*	Tracks
Black Rat	*Rattus rattus*	Dead body
Reptiles		
Eastern Water Skink	*Eulamprus quoyii*	Observed
Eastern Blue-tongue	*Tiliqua scincoides*	Observed
Invertebrates		
Smooth-handed Ghost Crab	*Ocypode cordimanus*	Observed

Wildlife Corridors

The dune vegetation provides a corridor for small fauna species that use the understorey and groundcovers as foraging and sheltering habitat and East – West access through the site. The site is likely to be part of a large foraging home range for common and threatened birds, small reptiles, mammals, and microbats. The site does not contain any specific or important habitat for threatened species.

Threatened Species Occurrence

There was no Threatened plant or animal species, or important habitat found on the site during the field survey.

Table 6. Plant Species List
Floristics and Relative Abundances

Long Reef Boardwalk

16 June 2023

by Nicholas Skelton, GIS Environmental Consultants

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Vegetation Zone Species Composition

Native Species Richness Inside and Outside Plots, Summarised by Status and Growth Form

	Fern (EG)	Grass & like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)
Plot 1					
Additional oitside plot					

Vegetation Zone Structure

Projected Foliage Cover % of Native Plants by Growth Form Within Plots

	Fern (EG)	Grass & like (GG)	Forb (FG)	Shrub (SG)	Tree (TG)
Plot 1					

High Threat Weed Cover

	Plot 1		
High Threat weeds	None		

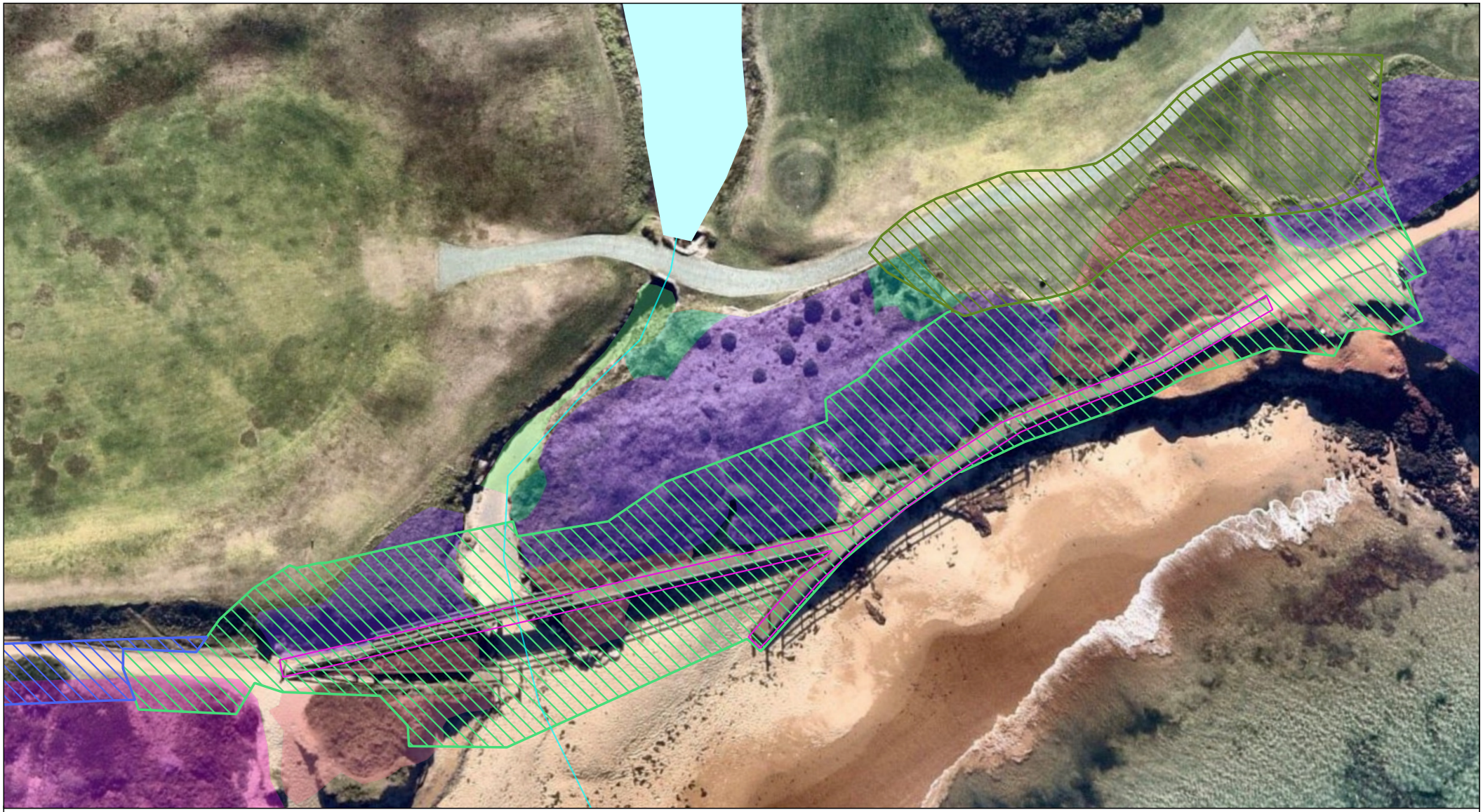
Native Plant Species

Genus and Species	Family	Growth Form	Group	Common Name	Status
Acacia longifolia var. sophorae	FABACEAE	Shrub	DICOTYLEDON	Coastal Wattle	Native Species
Banksia integrifolia ssp. integrifolia	PROTEACEAE	Tree	DICOTYLEDON	Coastal Banksia	Native Species
Carpobrotus glaucescens	AIZOACEAE	Herb	DICOTYLEDON	Pig Face	Native Species
Dianella caerulea var. producta	PHORMIACEAE	Herb	MONOCOTYLEDON	Blue Flax Lily (Taller)	Native Species
Hibbertia scandens	DILLENIACEAE	Vine	DICOTYLEDON	Golden Guinea Flower	Native Species
Isolepis nodosa	CYPERACEAE	Sedge	MONOCOTYLEDON	Knobby Club-rush	Native Species
Leptospermum laevigatum	MYRTACEAE	Shrub	DICOTYLEDON	Coastal Tea-tree	Native Species
Leucopogon parviflorus	ERICACEAE	Shrub	DICOTYLEDON		Native Species
Lobelia alata	LOBELIACEAE	Herb	DICOTYLEDON		Native Species
Lomandra longifolia	LOMANDRACEAE	Herb	MONOCOTYLEDON	Spiny-headed Mat-rush	Native Species
Melanthera biflora	ASTERACEAE	Herb	DICOTYLEDON		Native Species
Myoporum boninense ssp. australe	MYOPORACEAE	Shrub	DICOTYLEDON	Boobialla	Native Species
Oxalis rubens	OXALIDACEAE	Herb	DICOTYLEDON	Native Oxalis	Native Species
Pelargonium australe	GERANIACEAE	Herb	DICOTYLEDON	Coastal Geranium	Native Species
Rhagodia candolleana subsp. candolleana	CHENOPODIACEAE	Herb	DICOTYLEDON		Native Species
Scaevola calendulacea	GOODENIACEAE	Herb	DICOTYLEDON		Native Species
Spinifex sericeus	POACEAE	Grass	MONOCOTYLEDON	Spinifex	Native Species
Sporobolus virginicus	POACEAE	Grass	MONOCOTYLEDON	Sand Couch	Native Species
Stephania japonica var. discolor	MENISPERMACEAE	Vine	DICOTYLEDON	Snake Vine	Native Species
Tetragonia tetragonoides	AIZOACEAE	Herb	DICOTYLEDON	Warrigal Greens, Native Sp	Native Species
Westringia fruticosa	LAMIACEAE	Shrub	DICOTYLEDON	Coastal Rosemary	Native Species
Zoysia macrantha	POACEAE	Grass	MONOCOTYLEDON		Native Species

Weed Species

Acetosa sagittata	POLYGONACEAE	Vine	DICOTYLEDON	Turkey Rhubarb	Weed
Ambrosia sp.	ASTERACEAE	Herb	DICOTYLEDON	Rag Weed	Weed

Genus and Species	Family	Growth Form	Group	Common Name	Status
Asparagus aethiopicus	ASPARAGACEAE	Herb	MONOCOTYLEDON	Asparagus Fern	Weed
Bidens pilosa	ASTERACEAE	Herb	DICOTYLEDON	Cobbler's Pegs, Pitchforks	Weed
Cakile edentula	BRASSICACEAE	Herb	DICOTYLEDON	Sea Rocket	Weed
Carduus sp.	ASTERACEAE	Herb	DICOTYLEDON	Thistle	Weed
Cestrum parqui	SOLANACEAE	Shrub	DICOTYLEDON	Green Cestrum	Weed
Chrysanthemoides monilifera ssp. rotundi	ASTERACEAE	Shrub	DICOTYLEDON	Bitou bush/ Boneseed	Weed
Conyza bonariensis	ASTERACEAE	Shrub	DICOTYLEDON	Fleabane	Weed
Coprosma repens	RUBIACEAE	Shrub	DICOTYLEDON	Looking-glass Bush	Weed
Ehrharta erecta	POACEAE	Grass	MONOCOTYLEDON	Ehrharta	Weed
Hydrocotyle bonariensis	APIACEAE	Herb	DICOTYLEDON	Kurnell Curse	Weed
Paspalum dilatatum	POACEAE	Grass	MONOCOTYLEDON	Paspalum	Weed
Phoenix roebelenii	ARECACEAE	Palm	MONOCOTYLEDON	Dwarf Date Palm	Weed
Platanus occidentalis	PLATANACEAE	Tree	DICOTYLEDON	Plane Tree	Weed
Senecio madagascariensis	ASTERACEAE	Herb	DICOTYLEDON	Fire Weed	Weed
Solanum nigrum	SOLANACEAE	Herb	DICOTYLEDON	Black-berry Nightshade	Weed
Sonchus oleraceus	ASTERACEAE	Herb	DICOTYLEDON	Sow Thistle	Weed
Stenotaphrum secundatum	POACEAE	Grass	MONOCOTYLEDON	Buffalo Grass	Weed
Taraxacum officinale	ASTERACEAE	Herb	DICOTYLEDON	Dandelion	Weed



Legend

Long Reef Boardwalk
- Existing Boardwalk
- Drainage Body
- Drainage Lines

Impact Footprints
- Preferred Access Route 5437 sqm
- Demolition and Construction 1942 sqm
- Golf Course Works 620 sqm

Native Vegetation
- Coastal Heath on Sand
- Coastal Sands Littoral Scrub Forest
- FW Swamp Reedbed
- Mostly Exotic Bitou
- Spinifex Strandline Grassland

Map 8
Site, Habitats and Impact

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Date: 24/8/2023
Drawn by: Nicholas Skelton
Version 1
Projection: GDA 94 MGA 56

0 9 18 m

5.3 Description of Biodiversity Impacts

5.3.1 Vegetation Loss

Map 8 shows the types of vegetation that are within or near the construction footprint and map 5a shows the vegetation types that are adjacent to the access routes.

Table 7: Area Totals

	Access Route	Demolition and Construction	Golf Course Works	Total
Coastal Heath on Sand	450	39		**489**
Coastal Sands Littoral Scrub Forest			19	**19**
Mostly Exotic Bitou		624	20	**644**
Spinifex Strandline Grassland		364	67	**431**
Total	**450**	**1027**	**106**	**1583**

5.3.2 Impact on Wildlife Corridor

The proposal contains an east-west wildlife corridor between the large area of sand dune scrub and heath habitat to the west and the sparse and patchy heathland to the west.

5.3.3 Loss of Tree Hollows

There is not likely to be any loss of tree hollows due to this proposal.

5.3.4 Potential Indirect Impacts

If there is a storm event during construction with waves, high tides, storm surges or strong winds there may be significant erosion of areas of exposed sand.

Construction vehicles can potentially carry harmful fungal pathogens and seeds of weeds.

Plant stock used in revegetation may contain pathogens or weeds.

Recommendations to avoid these impacts have been made in section 7.

5.4 Weed Management

Priority and Environmental Weeds are identified, and management is recommended.

The aims of the Biosecurity Act 2015 are to provide a framework for the prevention, elimination, and minimisation of biosecurity risks by carriers or potential carriers.

The NSW Biosecurity Act 2015 requires that “the responsibility of any person who has any dealing with weeds (biosecurity matter), whether they have an infestation on their land, are selling a potentially invasive species, dumping garden rubbish, or supplying contaminated fodder or the like must prevent, minimise or eliminate the biosecurity risk (as far as is reasonably practicable)”.

This report addresses the NSW Biosecurity Act 2015 by referring to the document ‘Greater Sydney Regional Strategies Weed Management Plan 2023-2027’ by the Local Land Services of Greater Sydney. The Management Plan seeks to provide guidance on the management of weeds on a local scale in order to comply with the NSW Biosecurity Act 2015. Appendix 1.1 of this Management Plan identifies ‘State level determined priority weeds” and is broken up into the strategic response categories of ‘Prevention’, ‘Eradication’, ‘Containment’ and ‘Asset Protection (Whole of State)’. Appendix 1.2 outlines the ‘Regional priority weeds’ and is also broken up into these same four strategic responses. Weeds in the ‘prevention’ category have not yet been identified in the state, but they pose a large biosecurity risk, so it is expected that these are prevent from entering the state. ‘Eradication’ applies to weeds that are only limited in distribution and abundance, and so, these must be fully removed. ‘Containment’ is appropriate to weeds that have a wide distributed, hence widescale eradication is not currently possible, but these must be prevented from spreading

further. 'Asset Protection' refers to Weeds of National Significance whose spread must be minimised. The weeds in appendices 1.1 and 1.2 of the plan must be managed in order to comply with the NSW Biosecurity Act 2015.

State priority weeds pose a high biosecurity risk to the entire state. Mandatory measures for their management are identified in the Biosecurity Act 2015 and Biosecurity Regulation 2017. Regional priority weeds pose a high biosecurity risk to a particular part of NSW. These are identified through the development of regional strategic weed management plans. The Priority Weeds are listed in Table 8 below were found on this site.

Table 8: NSW State Priority Weeds and Greater Sydney Regional Priority Weeds occurring on the Site

Common Name	Scientific Name	Biosecurity Act Requirements
State Priority Weed - CONTAINMENT AND/OR ASSET PROTECTION		
Asparagus Weeds	*Asparagus aethiopicus, A. africanus, A. asparagoides including the Western Cape form*, A. densiflorus, A. plumosus, and A. scandens*	As Weeds of National Significance, their further spread through trade should be minimised to protect priority assets. Mandatory Measure – A person must not import into the State or sell.
Fireweed	*Senecio madagascariensis*	As Weeds of National Significance, their further spread through trade should be minimised to protect priority assets. Mandatory Measure – A person must not import into the State or sell.
Regional Priority Weed - Asset Protection		
Green Cestrum	*Cestrum parqui*	Implement quarantine and/or hygiene protocols. Targeted management of priority assets Promote best practice weed management principles to landholders. Land managers reduce the impact on priority assets

The appropriate weed control is discussed in the recommendations section.

5.5 Assessment of Significance 5-Part Test

No Threatened Ecological Community were identified on the Site. Therefore, no 5-part test is required. However, five-parts tests were done for the Sand Spurge (*Chamaesyce psammogeton*) and Southern Myotis (*Myotis Macropus*).

5.6 Biodiversity Conclusions and Recommendations

- The requirements of the Biosecurity Act in Table 8 need to be followed.
- The requirements of the Bitou Bush State Strategic Plan must be followed.
- Weed control will be required prior to and during works
- Machinery used on the site must be inspected prior to leaving the site.
- Soil must not be removed from the site.

- There will need to be a Weed management plan and weeds must be addressed in any contract and site induction.
- Temporary irrigation should be used during the establishment period where replanting is conducted.

Photo Page 2 – Goal State Vegetation

Photo 1. Goal State heathland

Photo 2. Goal State dune vegetation

Photo 3. Goal State heathland close-up

6 Soil Erosion, Water Quality and Coastal Processes

Relevant Environmental Factors clause 171 (2) EP&A Regulation.
(h) long-term effects on the environment,
(i) degradation of the quality of the environment,
(j) risk to the safety of the environment,
(k) reduction in the range of beneficial uses of the environment,
(l) pollution of the environment,
(p) the impact on coastal processes and coastal hazards, including those under projected climate change conditions,

6.1.1 Current & Past Erosion

This part of the coast is very active and the loss and gain of sand on this beach is evident in past air photos of the Site. Below we compare two photos of the Site, the former being the beach with the current amount of sand in 2023, and the latter with a large amount of sand missing, in July 2022.

Recent coastal dune erosion was evident on the southern side of the dune adjacent to the Site where the sand dune has been cut on the coastal side exposing the clay and coffee Rock shelf.

The proposal will not impact on current coastal processes.

6.1.2 Climate Change

Climate change is expected to increase sea levels and severity of storm events.

Various projections of the likely increases to sea levels are available. In 2009 the NSW government published guidelines for incorporating sea level rise benchmarks in coastal flood risk assessments, which provides a consistent set of sea level rise scenarios for undertaking land use planning for 2050 (0.4 m increase over 1990 levels) and 2100 (0.9 m increase over 1990 levels). It has also been predicted that the cyclone belt may move further southwards. The possible impacts of this outcome cannot be ascertained at this time as there is insufficient information about the mechanisms that determine the movement of cyclones under future climate scenarios.

Ref: NSW Department of Environment, Climate Change and Water, Incorporating sea level rise benchmarks in flood risk assessments, Floodplain Risk Management Guide, August 2010

6.1.3 Environmental Impacts

Recommendations are made regarding the type of fill material brought onto the site as there is potential for the fill to be eroded by future storm events and climate change and fine sediment entering the sea may impact the water quality adjacent marine reserve.

The current proposed works are unlikely to have any long-term effects to the surrounding environment and will not degrade the quality of the environment. Due to the proposal being a replacement of a pre-existing structure, it is unlikely the long-term effects will be any different to the effects of the pre-existing structure, which were minimal. Additionally, the proposal will not degrade the quality of the environment as a key aim is to revegetate the surrounding areas and enhance the PCTs in close proximity. This includes removing the invasive Bitou Bush from the area and replanting with native species.

There is a slight risk to the safety of the environment, but this risk is inherent with any development involving machinery in fragile ecosystems. However, if all recommendations made in this report are followed there will be no risk to the safety of the environment.

Current sand at the beach

After storm July 2022

6.1.4 Water Quality

An intermittent drainage line (pictured below) dissects the site. This drains water from the freshwater soaks (springs) and the catchment east of Pittwater Road including the golf course and playing fields. Waves and salt water occasionally wash up as far at the bridge shown.

The drainage line that goes through the site. Photo is taken on the northern side of the site looking north.

6.2 Soil Erosion, Water Quality and Coastal Survey Findings and Assessment of Impact

6.2.1 Sand Dune Erosion Potential

The sand dunes are particularly susceptible to wind and wave erosion, any removal of vegetation (dead or alive, weed or native) on a sand dune will be a high risk of wind erosion. The proposal includes a coir mesh net be laid over any bare sand areas, and planting of indigenous species on the sand dunes.

Recommendations are made regarding the type of fill material brought onto the site as there is potential for the fill to be eroded by future storm events and climate change and fine sediment entering the sea may impact the water quality adjacent marine reserve.

Further recommendations are made in Section 8 of this report to assist with this.

6.2.2 Adjacent Beach

The proposed works are unlikely to have any significant impact on the adjacent beach to and on the on the site.

No construction material is to be stored on the beach.

6.3 Conclusion and Recommendations Soil Erosion, Water Quality and Coastal Processes

The proposal is unlikely to have a significant negative impact upon the surrounding environment.

6.3.1 Recommendations for soil and water quality

- All sawdust from cutting CCA-treated wood found during the demolition process is to be vacuumed up and removed off-site immediately.
- Any construction material and debris should be carefully and thoroughly managed so that it does not enter the surrounding environment during storm events.
- All sand dune works must take place on days when the wind speed is low.
- Coir mesh must be laid on dunes as soon as possible after the removal of vegetation.
- Any fill material brought onto the site needs to have no clay content as there is potential for the fill to be eroded by future storm events and climate change and fine sediment entering the sea may impact the water quality adjacent marine reserve.

7 Aboriginal Archaeology, Cultural History and Future Generational Values

Relevant Environmental Factors clause 171 (2) EP&A Regulation.

(e) the effects on any locality, place or building that has—

(i) aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance, or

(ii) other special value for present or future generations,

An **Aboriginal Cultural Heritage Assessment** (ACHA) was prepared by Apex Archaeology (December 2023) for the study site. The ACHA report is accompanied by a separate **Archaeological Report** also by Apex Archaeology (December 2023) which details the results of the assessment preparedin accordance with the Code of Practice for Archaeological Investigation of

Aboriginal Objects in New South Wales (September 2010) (the Code of Practice). Both of these reports are attached as Appendix D.

7.1 Aboriginal Archaeology, Cultural History and Future Generational Values Survey Findings

An Aboriginal site is registered on the Aboriginal Heritage Information Management

Services (AHIMS) as being within the study area. It is AHIMS #45-6-741 (QP3) and is recorded as an Aboriginal shell midden.

A site inspection and pedestrian survey of the study area was undertaken by Jenni Bate, Leigh Bate and Rebecca Bryant from Apex Archaeology, and Justine Coplin from Darug Custodian Aboriginal Corporation on 21 July 2023. No shell or remnants of a shell midden were identified within the study area, nor were any other Aboriginal material such as stone artefacts located.

7.2 Aboriginal Archaeology, Cultural History and Future Generational Values Assessment of Impact

Given the extensive historical disturbance and that no areas of potentially intact archaeological deposits were identified, no further archaeological assessment is considered necessary for the site. The previously registered site is considered to have been completely impacted by natural forces and no longer exists. The site card for this site has been updated to reflect the destroyed status of the site.

7.3 Conclusions and Recommendations Archaeology and History

The Archaeological Report describes six recommendations which are summarised below:

1. No Further Archaeological Assessment Required – No Aboriginal Heritage Impact Permit (AHIP) is required prior to works commencing.
2. Aboriginal Heritage Site Induction – Site induction presented by a suitably qualified person including the types of Aboriginal archaeological remains that could potentially be found within the sand and outline the 'Unexpected Finds Policy'.
3. Installation of Interpretation – Interpretive signage along the boardwalk to explain the Aboriginal History and continuing connection to Country.
4. Development Boundaries – Further investigation required if there are alterations to the proposed development boundary.
5. Reporting – The ACHA and AR should be forwarded to Heritage NSW and each registered Aboriginal stakeholder.
6. Stop Work Provisions – Should unanticipated Aboriginal archaeological material be encountered during site works, all work must cease in the vicinity of the find and an archaeologist contacted to make an assessment of the find and to advise on the course of action to be taken. Further archaeological assessment and Aboriginal community consultation may be required prior to the recommencement of works. Any objects confirmed to be Aboriginal in origin must be reported to Heritage NSW. Human remains of Aboriginal people have previously been recorded in sand bodies in coastal bays and open beaches within Sydney area including Long Reef headland. In the unlikely event that suspected human remains are identified during works, all activity in the vicinity of the

find must cease immediately and the find protected from harm or damage. The NSW Police and the Coroner's Office must be notified immediately. If the finds are confirmed to be human and of Aboriginal origin, further assessment by an archaeologist experienced in the assessment of human remain and consultation with both Heritage NSW, the Aboriginal Heritage Office and the RAPs for the project would be necessary.

8 Socio Economic / Land Use

Relevant Environmental Factors clause 171 (2) EP&A Regulation.

(a) the environmental impact on the community,
(b) the transformation of the locality,
(d) reduction of the aesthetic, recreational, scientific or other environmental quality or value of the locality,
(o) the cumulative environmental effect with other existing or likely future activities,
(q) applicable local strategic planning statements, regional strategic plans or district strategic plans made under the Act, Division 3.1,

8.1 Socio Economic / Land Use Findings and Impacts

The proposed Long Reef Boardwalk will provide a similar level of amenity to the local community as the existing boardwalk. It will be constructed on a similar alignment (slightly inland and higher), for a similar length, with comparable structural materials and dimensions. The boardwalk deck will be constructed out of FRP mesh, which is a non-slip material that allows penetration of water and sunlight. It is anticipated that the proposed boardwalk would not encourage additional use or visitation to the site.

From an aesthetic perspective, the boardwalk will look similar to the existing structure. The proposed sand dune works will provide improved visual and physical separation between adjacent golf course and public users on the boardwalk, and the proposed planting works will improve the ecological and visual quality of the surrounding areas.

8.2 Conclusions Socio Economic / Land Use

The works will realise a number of positive socio economic, lifestyle and liveability impacts, that are centred around the use of outdoor space, exercise and establishing and maintaining social networks.

9 Waste Management and Resources

Relevant Environmental Factors clause 171 (2) EP&A Regulation.
(m) environmental problems associated with the disposal of waste,
(n) increased demands on natural or other resources that are, or are likely to become, in short supply,

9.1 Waste Management and Resources Findings

The existing wooden boardwalk and bridge are suspended above, and partly cut into, the dune that joins onto a section of concrete walkway at each end. The deck of the boardwalk is suspended on wooden piles. The wood used for both the deck and the balustrade is hardwood.

The current wood piles the boardwalk is comprised of will be pulled out and disposed of at a registered landfill site. The metal will be recycled as scrap iron.

9.2 Conclusions Waste Management and Resources

The activities discussed above will not cause any significant environmental problems or increase the demand on resources.

10 Other Factors

Relevant Environmental Factors clause 171 (2) EP&A Regulation.
(r) other relevant environmental factors.

The potential for impacts to traffic, noise and groundwater contamination, greenhouse gas emissions and air quality have also been considered and concluded that adverse impacts are unlikely.

Potential impacts to these aspects have been assessed as minor or negligible. No other factors are deemed as environmentally relevant.

11 Ameliorative Recommendations & Ongoing Management

It is recommended that ameliorative conditions and management recommendations in this report be followed to reduce disturbance during construction and to improve ecological outcomes.

11.1.1 General Construction Recommendations

- An Environment Protection Fence is to be installed in locations specified on the TBLD Demolition Plan (LRB-DD-03A) to minimise impacts to native and exotic vegetation.Any sediment moved onto the site must be VENM, to prevent the introduction of weeds, pathogens, excess nutrients into the environment or fine sediment that may make the water turbid in the adjacent marine reserve.
- Areas of sand are not to be left exposed. To prevent wind erosion of this fragile and windy site.
- The coir matting is to be applied as soon as possible.
- All vehicles and workers must remain on the access route pathway when accessing the site to avoid harming the adjacent Coastal Heath and Freshwater Swamp native vegetation.
- Care must be taken to prevent the spread of weeds on site, and all vehicles must be cleaned before arriving at the site.
- It is recommended that the plants to be replanted on the dune are of local native stock and are consistent with the native vegetation types within and continuous with those found in the Site.
- Biodegradable Coir Mat Mesh is to be installed on top of planted native dune cover species to prevent wind, wave and storm erosion of the sand on these dunes. These dune cover plants should be regularly watered (at least once a week for a month then also during periods of dry weather) and planted with replacement plants if any more than 10% of the original plants die.

11.1.2 Ecology recommendations

- The requirements of the Biosecurity Act in Table 8 need to be followed.
- The requirements of the Bitou Bush State Strategic Plan must be followed.
- Weed control will be required prior to and during works
- Machinery used on the site must be inspected for weeds prior to leaving the site.
- Soil must not be removed from the site to prevent the spread of prohibited weeds.
- There will need to be a weed management plan and weeds must be addressed in any contract and site induction.
- Temporary irrigation should be used during the establishment period where replanting is conducted.

11.1.3 Recommendations for soil and water quality

- All sawdust from cutting CCA-treated wood found during the demolition process is to be vacuumed up and removed off-site immediately.
- Any construction material and debris should be carefully and thoroughly managed so that it does not enter the surrounding environment during storm events.
- All sand dune works must take place on days when the wind speed is low.
- Coir mesh must be laid on dunes as soon as possible after the removal of vegetation.
- The fill material brought onto the site needs to have no clay content as there is potential for the fill to be eroded by future storm events and climate change and fine sediment entering the sea may impact the water quality adjacent marine reserve.

11.1.4 The Archaeological Report describes six recommendations which are summarised below:

1. No Further Archaeological Assessment Required – No Aboriginal Heritage Impact Permit (AHIP) is required prior to works commencing.
2. Aboriginal Heritage Site Induction – Site induction presented by a suitably qualified person including the types of Aboriginal archaeological remains that could potentially be found within the sand and outline the 'Unexpected Finds Policy'.
3. Installation of Interpretation – Interpretive signage along the boardwalk to explain the Aboriginal History and continuing connection to Country.
4. Development Boundaries – Further investigation required if there are alterations to the proposed development boundary.
5. Reporting – The ACHA and AR should be forwarded to Heritage NSW and each registered Aboriginal stakeholder.
6. Stop Work Provisions – Should unanticipated Aboriginal archaeological material be encountered during site works, all work must cease in the vicinity of the find and an archaeologist contacted to make an assessment of the find and to advise on the course of action to be taken. Further archaeological assessment and Aboriginal community consultation may be required prior to the recommencement of works. Any objects confirmed to be Aboriginal in origin must be reported to Heritage NSW. Human remains of Aboriginal people have previously been recorded in sand bodies in coastal bays and open beaches within Sydney area including Long Reef headland. In the unlikely event that suspected human remains are identified during works, all activity in the vicinity of the find must cease immediately and the find protected from harm or damage. The NSW Police and the Coroner's Office must be notified immediately. If the finds are confirmed to be human and of Aboriginal origin, further assessment by an archaeologist experienced in the assessment of human remain and consultation with both Heritage NSW, the Aboriginal Heritage Office and the RAPs for the project would be necessary.

Conclusion and Declaration

The environmental impacts of the Activity have been identified and assessed with the key aspects subject to detailed assessment by subject matter experts. The potential impacts of the Activity on the existing environment together with the mitigation and management safeguards are detailed. The potential impacts of the proposed Activity are considered to be relatively minor and would be unlikely to have a significant impact on the environment.

Date: Tuesday, 16 January 2023

Nicholas Skelton

Principal Ecologist
GIS Environmental Consultants

12 General References

Spatial (GIS) data sources are listed in section 5.1
State and Local government legislation and guidelines are referenced is listed in 1.3.

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13 Appendix A: Protected Matters Tool Search

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Dec-2023

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	92
Listed Migratory Species:	61

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	82
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	1
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	4
Key Ecological Features (Marine):	None
Biologically Important Areas:	3
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Coastal Swamp Oak (Casuarina glauca) Forest of New South Wales and South East Queensland ecological community	Endangered	Community likely to occur within area
Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland	Endangered	Community likely to occur within area
Coastal Upland Swamps in the Sydney Basin Bioregion	Endangered	Community may occur within area
Eastern Suburbs Banksia Scrub of the Sydney Region	Critically Endangered	Community may occur within area
River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus lathami lathami South-eastern Glossy Black-Cockatoo [67036]	Vulnerable	Species or species habitat likely to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Climacteris picumnus victoriae Brown Treecreeper (south-eastern) [67062]	Vulnerable	Species or species habitat likely to occur within area
Dasyornis brachypterus Eastern Bristlebird [533]	Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Melanodryas cucullata cucullata South-eastern Hooded Robin, Hooded Robin (south-eastern) [67093]	Endangered	Species or species habitat may occur within area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma neglecta neglecta Kermadec Petrel (western) [64450]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Stagonopleura guttata Diamond Firetail [59398]	Vulnerable	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
FISH		
Epinephelus daemelii Black Rockcod, Black Cod, Saddled Rockcod [68449]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Macquaria australasica Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Seriolella brama Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
FROG		
Heleioporus australiacus Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea Green and Golden Bell Frog [1870]	Vulnerable	Species or species habitat likely to occur within area
Mixophyes balbus Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area
MAMMAL		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Endangered	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
[Eubalaena australis](#) Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
[Isoodon obesulus obesulus](#) Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat likely to occur within area
[Notamacropus parma](#) Parma Wallaby [89289]	Vulnerable	Species or species habitat may occur within area
[Petauroides volans](#) Greater Glider (southern and central) [254]	Endangered	Species or species habitat likely to occur within area
[Petaurus australis australis](#) Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat likely to occur within area
[Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)](#) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Endangered	Species or species habitat known to occur within area
[Pseudomys novaehollandiae](#) New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
[Pteropus poliocephalus](#) Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
PLANT		
[Acacia terminalis subsp. Eastern Sydney (G.P.Phillips 126) listed as Acacia terminalis subsp. terminalis MS](#) Sunshine Wattle (Sydney region) [91564]	Endangered	Species or species habitat likely to occur within area
[Asterolasia elegans](#) [56780]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus camfieldii Camfield's Stringybark [15460]	Vulnerable	Species or species habitat likely to occur within area
Genoplesium baueri Yellow Gnat-orchid, Bauer's Midge Orchid, Brittle Midge Orchid [7528]	Endangered	Species or species habitat likely to occur within area
Lasiopetalum joyceae [20311]	Vulnerable	Species or species habitat may occur within area
Melaleuca biconvexa Biconvex Paperbark [5583]	Vulnerable	Species or species habitat may occur within area
Melaleuca deanei Deane's Melaleuca [5818]	Vulnerable	Species or species habitat may occur within area
Persicaria elatior Knotweed, Tall Knotweed [5831]	Vulnerable	Species or species habitat may occur within area
Persoonia hirsuta Hairy Geebung, Hairy Persoonia [19006]	Endangered	Species or species habitat may occur within area
Pimelea curviflora var. curviflora [4182]	Vulnerable	Species or species habitat may occur within area
Prostanthera densa Villous Mintbush [12233]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Rhodamnia rubescens		
Scrub Turpentine, Brown Malletwood [15763]	Critically Endangered	Species or species habitat likely to occur within area
Rhodomyrtus psidioides		
Native Guava [19162]	Critically Endangered	Species or species habitat may occur within area
Syzygium paniculatum		
Magenta Lilly Pilly, Magenta Cherry, Daguba, Scrub Cherry, Creek Lilly Pilly, Brush Cherry [20307]	Vulnerable	Species or species habitat likely to occur within area
Thesium australe		
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat may occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hoplocephalus bungaroides		
Broad-headed Snake [1182]	Endangered	Species or species habitat may occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
SHARK		
Carcharias taurus (east coast population)		
Grey Nurse Shark (east coast population) [68751]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Galeorhinus galeus		
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area
SNAIL		
Meridolum maryae		
Maroubra Woodland Snail, Maroubra Land Snail [89884]	Endangered	Species or species habitat known to occur within area

Listed Migratory Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Species or species habitat likely to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Migratory Marine Species		
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat may occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus		
Sooty Shearwater [82651]		Species or species habitat likely to occur within area
Bubulcus ibis as Ardea ibis		
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat likely to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]	Vulnerable	Species or species habitat may occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Pterodroma cervicalis White-necked Petrel [59642]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat likely to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna striata White-fronted Tern [799]		Foraging, feeding or related behaviour likely to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Symposiachrus trivirgatus as Monarcha trivirgatus Spectacled Monarch [83946]		Species or species habitat may occur within area overfly marine area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche eremita Chatham Albatross [64457]	Endangered	Foraging, feeding or related behaviour may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area overfly marine area
Fish		
Acentronura tentaculata Shortpouch Pygmy Pipehorse [66187]		Species or species habitat may occur within area
Festucalex cinctus Girdled Pipefish [66214]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus whitei White's Seahorse, Crowned Seahorse, Sydney Seahorse [66240]	Endangered	Species or species habitat likely to occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Solenostomus paradoxus Ornate Ghostpipefish, Harlequin Ghost Pipefish, Ornate Ghost Pipefish [66184]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Dugong dugon Dugong [28]		Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat known to occur within area
Hydrophis platurus as Pelamis platurus Yellow-bellied Sea Snake [93517]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Whales and Other Cetaceans		[Resource Information]
Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat may occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Long Reef	Aquatic Reserve	NSW

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Construction of a high-capacity fibre optic submarine cable	2006/2914	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
sewage treatmemt plant process and reliability renewals project	2005/2186	Not Controlled Action	Completed
Referral decision			
Breeding program for Grey Nurse Sharks	2007/3245	Referral Decision	Completed

Biologically Important Areas

Scientific Name	Behaviour	Presence
Dolphins		
Tursiops aduncus		
Indo-Pacific/Spotted Bottlenose Dolphin [68418]	Breeding	Likely to occur
Sharks		
Carcharias taurus		
Grey Nurse Shark [64469]	Foraging	Known to occur
Whales		
Megaptera novaeangliae		
Humpback Whale [38]	Foraging	Known to occur

Bioregional Assessments

SubRegion	BioRegion	Website
Sydney	Sydney Basin	BA website

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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14 Appendix B: 5-part Tests of Significance

14.1 Chamaesyce psammogeton (Sand Spurge) Assessment of Significance

1) **The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats:**

a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

The Sand Spurge was not found within the site during site survey efforts. The site was well searched. The vegetation where the plant has previously been recorded is 500m Northeast of the site, was well searched and no individuals were found.

Moderate quality habitat occurs within study site, sand dune vegetation habitat will be temporarily disturbed due to the proposal. The dune will be covered with 500mm of clean wash sand. It will then have jute installed and will be revegetated with indigenous grasses. The moderate quality is due to the high density of weeds, in particular *Chrysanthemoides monilifera* (Bitou Bush).

If the recommendations within this report are followed, then it is unlikely the proposal will result in long- term negative impacts to the potential Sand Spurge habitat.

b) In the case of an Endangered Population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the Endangered Population such that a viable local population of the species is likely to be placed at risk of extinction.

Response: *Chamaesyce psammogeton* is not listed as an Endangered Population; therefore this question is not applicable.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

*(i) is likely to have an adverse effect on the **extent** of the ecological community such that its **local occurrence is likely to be placed at risk of extinction, or***

*(ii) is likely to **substantially and adversely modify the composition of the ecological community** such that its **local occurrence is likely to be placed at risk of extinction,***

Response: *Chamaesyce psammogeton* is not listed as an Endangered Ecological Community or Critically Endangered Ecological Community; therefore this question is not applicable.

(c) in relation to the habitat of a threatened species or ecological community:

*(i) the **extent** to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*

*(ii) whether an area of habitat is likely to become **fragmented or isolated** from other areas of habitat as a result of the proposed development or activity, and*

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

Response:

i) Moderate quality habitat occurs within study site, with sand dune vegetation habitat temporarily disturbed due to the proposal. The moderate quality is due to the high density of weeds, in particular *Chrysanthemoides monilifera* (Bitou Bush).

ii) This habitat will be temporarily disturbed. It is highly recommended that the sand dune vegetation that will be temporarily disturbed within the site and adjacent for access is to be reinstated in accordance with a long-term ecological management plan.

iii) The moderate quality is due to the presence of many weed species, in particular *Chrysanthemoides monilifera* (Bitou Bush).

If the recommendations within this report are followed, then it is unlikely the proposal will result in long-term negative impacts to the potential Sand Spurge habitat.

e) Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly).

Response: No critical habitats have been defined for *Chamaesyce psammogeton* under the TSC Act (1995).

*f) Whether the action proposed is consistent with the objectives or actions of a **recovery plan** or **threat abatement plan**.*

Response: *Chamaesyce psammogeton* has been assigned to the Site-managed species management stream under the Saving our Species program. There was no population recorded within the Study Area.

*g) Whether the action proposed constitutes or is part of a **key threatening process** or is likely to result in the operation of, or increase the impact of, a key threatening process.*

Response: Key threatening processes and how they relate to the proposed development is outlined below;

- **Invasions of native plant communities by *Chrysanthemoides monifera*:** Bitou Bush was found within 75% of the sand dune vegetation that will be disturbed. This will be removed and revegetated with Indigenous grasses; thus the proposal is unlikely to increase the occurrence of Bitou Bush.
- **Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus*:** The European Rabbit is known to occur in this area. The proposed works are unlikely to result increased pressures of the European Rabbit.

This proposal is therefore not likely to result in the operation of, or increase the impact of, a key threatening process.

Conclusions of *Chamaesyce psammogeton* Assessment of Significance
This proposed development, shown on the maps and described in this report, is unlikely to have a significant impact on the conservation of *Chamaesyce psammogeton*. Further assessment in the form of a Species Impact Statement is not considered necessary for this proposal on this site. Ways to further reduce the impact of the proposal are within the Ameliorative Conditions and Recommendations section of this report.

14.2 Myotis Macropus (Southern Myotis) Assessment of Significance

1) **The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats:**
    a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Response:

The Southern Myotis was not found within the site during site survey efforts. The site was well searched. The closest record is about 2km southwest of the site and was documented in 2019.

The Southern Myotis generally roosts close to water in caves, mine shafts, hollow-bearing trees, storm water channels, buildings, under bridges and in dense foliage. There is moderate quality habitat within the study site in the form of dense vegetation and the foot path. These will be temporarily disturbed due to the proposal. The dune will be covered with 500mm of clean wash sand. It will then have jute installed and will be revegetated with indigenous grasses. The foot path will be taken out but replaced with a new footpath. As there have been no sightings of the Southern Myotis within or adjacent to the study site, it is unlikely that any individuals may be harmed in the process. As the impact is only temporary and the site will be restored to at least its original habitat value, this is unlikely to have an adverse effect on the lifecycle of that Southern Myotis

If the recommendations within this report are followed, then it is unlikely the proposal will result in long-term negative impacts to the potential Southern myotis habitat.

(b) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity:

*(i) is likely to have an adverse effect on the **extent** of the ecological community such that its **local occurrence is likely to be placed at risk of extinction, or***

*(ii) is likely to **substantially and adversely modify the composition of the ecological community** such that its **local occurrence is likely to be placed at risk of extinction,***

Response:

Myotis macropus is not listed as an Endangered Population; therefore, this question is not applicable.

(c) in relation to the habitat of a threatened species or ecological community:

*(i) the **extent** to which habitat is likely to be removed or modified as a result of the proposed development or activity, and*

*(ii) whether an area of habitat is likely to become **fragmented or isolated** from other areas of habitat as a result of the proposed development or activity, and*

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species or ecological community in the locality,

Response:

i) Moderate quality habitat occurs within study site, sand dune vegetation habitat will be temporarily disturbed due to the proposal. The moderate quality is due to the high density of weeds, in particular *Chrysanthemoides monilifera* (Bitou Bush). The sand dune will be revegetated using locally native species.

ii) This habitat will be temporarily disturbed but is proposed to be revegetated. It is highly recommended that the sand dune vegetation that will be temporarily disturbed within the study site is to be reinstated in accordance with a Long-term Ecological Management Plan.

iii) The moderate quality is due to the presence of many weed species, in particular *Chrysanthemoides monilifera* (Bitou Bush).

If the recommendations within this report are followed, then it is unlikely the proposal will result in long-term negative impacts to the potential Southern Myotis habitat as it would involve only a temporary disturbance to the habitat.

(d) whether the proposed development or activity is likely to have an adverse effect on any declared area of outstanding biodiversity value (either directly or indirectly),

Response:
No critical habitats have been defined for Myotis macropus under the TSC Act (1995).

*(e) whether the proposed development or activity is or is part of a **Key Threatening Process** or is likely to increase the impact of a Key Threatening Process.*

Response:
Key Threatening Processes that are listed in the Biodiversity Conservation Act 2016 and that are relevant to this site include:

- **Invasions of native plant communities by *Chrysanthemoides monifera*:** Bitou Bush was found within 75% of the sand dune vegetation that will be disturbed. This will be removed and revegetated with Indigenous grasses; thus the proposal is unlikely to increase the occurrence of Bitou Bush.
- **Competition and grazing by the feral European Rabbit*, Oryctolagus cuniculus*:** The European Rabbit is known to occur in this area. The proposed works are unlikely to result increased pressures of the European Rabbit.

This proposal is therefore not likely to result in the operation of, or increase the impact of, a Key Threatening Process.

Conclusions of *Myotis macropus* Assessment of Significance
This proposed development, shown on the maps and described in this report, is unlikely to have a significant impact on the conservation of *Myotis macropus*. Further assessment in the form of a Species Impact Statement is not considered necessary for this proposal on this site. Ways to further reduce the impact of the proposal are given within the Ameliorative Conditions and Recommendations section of this report.

15 Appendix C: EPBC Significant Impact Criteria Assessment

15.1 Migratory Species listed under the EPBC Act (Combined Assessment)

Migratory species listed under the EPBC Act (as per the Protected Matters Search) assessed below include:

Southern Giant Petrel (*Macronectus giganteus*)

Habitat Requirements: NSW Coastline.

Habitat Preferences: Scavenger and predator that will occasionally scavenge animal carcasses on land and is also an active predator of cephalopods and euphausiids at sea.

Disturbance Factors: Long line fishing, predation by feral cats and black rats on breeding islands, habitat degradation on breeding islands, loss of southern cuttlefish populations, oil spills and changes to sea and air temperatures which affect marine prey ability.

Breeding: Over summer, the species nests in small colonies amongst open vegetation on Antarctic and subantarctic islands, including Macquarie and Heard Islands and in Australian Antarctic territory.

Little Tern (*Sternula albifrons*)

Habitat Requirements: Coastal sheltered environments. Nests in small, scattered colonies in low dunes or on sandy beaches just above high tide mark near estuary mouths or adjacent to coastal lakes and islands.

Habitat Preferences: Migrating from eastern Asia, the Little Tern is found on the north, east and south-east Australian coasts, from Shark Bay in Western Australia to the Gulf of St Vincent in South Australia. In NSW, it arrives from September to November, occurring mainly north of Sydney, with smaller numbers found south to Victoria.

Disturbance Factors: fox and domestic cat/dog predation of eggs and chicks, pedestrian trampling, offroad driving.

Breeding: spring and summer along the entire east coast from Tasmania to northern Queensland, and is seen until May, with only occasional birds seen in winter months.

An action is likely to have a significant impact on a migratory species if there is a real change or possibility that it will:

a) Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.

Response:
No known important areas of habitat for migratory species occur within the study site. The habitat within the study site is unlikely to represent habitat critical to the survival of these species and likely constitutes a small part of their overall range, which they fly over on occasion. No habitat will be removed or become fragmented as a result of this Activity. Fire regimes and hydrological cycles will not be altered as a result of the proposed works. Nutrient cycles may be impacted through dog faeces within the study site, however, this already occurs on this site and the proposed works are unlikely to further increase the amount of dog activity in the area. In addition, maintenance of waste bins and the supply of dog faeces disposal bags has been recommended and would effectively mitigate this impact.

b) i) Results in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or
ii) Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

Response:
i) The proposed works are considered unlikely to facilitate an increase in feral animals (i.e., feral cats and foxes) that would disturb or predate on these species. Predation by domestic dogs is

possible, however is the proposed works are unlikely to increase the amount of dog activity that already occurs in this area. Due to the revegetation proposed, it is unlikely that the proposed works will increase the abundance or allow for the establishment of any new invasive plant species.

ii) The presence of dogs within the study site has the potential to disrupt breeding or resting behaviour of seabirds. However, no evidence was observed of any seabirds nesting or roosting in or near the study sites during the field surveys. Furthermore, the proposed works are unlikely to increase the amount of dog activity that already occurs in this area. No suitable breeding habitat for the Southern Giant Petrel occurs on the site. Suitable breeding habitat does occur for the Little Tern in the form of low dunes just above the high tide mark. However, the works will include the rehabilitation of the dune structure and will hence not cause long-term harm to this habitat. It is not an important breeding area as the Little Tern nests along the entire east coast of Australia, from Tasmania to northern Queensland.

The proposed works are unlikely to impact the migration patterns of these species.

In addition, it is considered unlikely that habitat within the study site is utilised by an ecologically significant proportion of populations of these species.

Conclusions of Migratory Seabirds Significant Impact Criteria Assessment
Given that the proposed works will not remove suitable habitat for these species in the long-term, the nutrient cycle will not be altered, the mitigation measures proposed, and no roosting or nesting activities have been observed within the study site, the proposed works are unlikely to result in a significant impact on these migratory birds.

16 Appendix D: Aboriginal Cultural Heritage Assessment Report and Archaeological Report

LONG REEF BOARDWALK, COLLAROY, NSW

ARCHAEOLOGICAL REPORT

Report to Northern Beaches Council

LGA: Northern Beaches

December 2023

APEX ARCHAEOLOGY

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ABN 56 625 618 993

Executive Summary

Apex Archaeology has been engaged by Northern Beaches Council to assist in preparing an Aboriginal Cultural Heritage Assessment (ACHA) for the proposed realignment and replacement of the existing boardwalk and bridge that is situated on the southern side of Long Reef Headland in Collaroy, NSW. The proposed works will impact on sections within Long Reef Golf Club and Long Reef Beach in Collaroy. The study area is within the Northern Beaches Local Government Area (LGA).

This report details the results of the archaeological assessment of the site, prepared in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (September 2010) (the Code of Practice). This Archaeological Report (AR) forms an appendix to the ACHA report prepared for the project.

An Aboriginal site is registered on the Aboriginal Heritage Information Management Services (AHIMS) as being within the study area. It is AHIMS #45-6-741 (QP3) and is recorded as an Aboriginal shell midden. It has been mapped as being on the northern side of the current boardwalk and approximately 50 m west of the bridge that crosses the man-made creek that drains onto Long Reef Beach. As the proposed works have the potential to impact on this registered site, an assessment is necessary to determine whether an application for an Aboriginal Heritage Impact Permit (AHIP) prior to the commencement of works will be required.

A site inspection and pedestrian survey of the study area was undertaken by Jenni Bate, Leigh Bate and Rebecca Bryant from Apex Archaeology, and Justine Coplin from Darug Custodian Aboriginal Corporation on 21 July 2023. No shell or remnants of a shell midden were identified within the study area, nor were any other Aboriginal material such as stone artefacts located.

The entire area was found to have been highly disturbed by natural and man-made impacts. The section along the cliff line where the current boardwalk is situated is under continuous erosion due to the nature of the underlying sandstone and claystone geology. This has been further exacerbated by the consistent impact of ocean waves. The other areas within the sandy soil landscape either side of the exposed cliff line have been largely impacted by either the introduction of fill or, in the case of the golf course, the original sand dunes have been excavated and contoured since the early 1800s. These disturbances were a result of initial farming practices, followed by the construction of Long Reef Golf Club, military exercises, and excavations for the construction of a drainage channel emptying onto Long Reef Beach.

Given the extensive historical disturbance and that no areas of potentially intact archaeological deposits were identified, no further archaeological assessment is considered necessary for the site. The previously registered site is considered to have been completely impacted by natural forces and no longer exists. The site card for this site has been updated to reflect the destroyed status of the site.

The Aboriginal Heritage Office requested that the initial earthworks be monitored by a suitably qualified representative from the Aboriginal community. Monitoring of the initial works in this instance is not considered warranted on archaeological grounds due to the wholesale disturbance to the area. The Aboriginal Heritage Office also requested that all personnel working on site are provided with an Aboriginal heritage site induction prior to the commencement of works.

Further, the Aboriginal Heritage Office and representatives of the Registered Aboriginal Parties (RAPs) for this project also requested that information signs on Aboriginal sites found within Long Reef Headland be erected along the new boardwalk or an appropriate viewing area to inform the public about the rich and diverse Aboriginal cultural heritage that would have been present within the area.

No further Aboriginal heritage investigations or approvals are considered warranted prior to the commencement of the proposed works.

The following recommendations are based on the research and conclusions of our assessment outlined in this report, and in consultation with the RAPs and the Aboriginal Heritage Office.

RECOMMENDATION 1: NO FURTHER ARCHAEOLOGICAL ASSESSMENT REQUIRED

The Aboriginal archaeological potential of Long Reef Boardwalk, Collaroy, NSW has been assessed as negligible. No further archaeological assessment is required for the site prior to the commencement of proposed development activities. No Aboriginal Heritage Impact Permit (AHIP) is required prior to works commencing.

RECOMMENDATION 2: ABORIGINAL HERITAGE SITE INDUCTION

An Aboriginal heritage site induction should be presented to the site workers by a suitably qualified person. This induction will include the possible kinds of Aboriginal archaeological remains that may be contained within the sand bodies and it will outline the 'unexpected finds policy'.

RECOMMENDATION 3: INSTALLATION OF INTERPRETATION

It is recommended that consideration is given to installation of interpretive signage along the boardwalk to explain the Aboriginal history of the place and the continuing connection to Country.

RECOMMENDATION 4: DEVELOPMENT BOUNDARIES

The proposed development works must be contained within the assessed boundaries for this project. If there is any alteration to the boundaries of the proposed development to include areas not assessed as part of this archaeological investigation, further investigation of those areas should be completed to assist in managing Aboriginal objects and places which may be present in an appropriate manner.

RECOMMENDATION 5: REPORTING

One digital copy of this report should be forwarded to Heritage NSW for inclusion on the Aboriginal Heritage Information Management System (AHIMS).

One copy of this report should be forwarded to each of the registered Aboriginal stakeholders for the project.

RECOMMENDATION 6: STOP WORK PROVISIONS

Should unanticipated Aboriginal archaeological material be encountered during site works, all work must cease in the vicinity of the find and an archaeologist contacted to make an assessment of the find and to advise on the course of action to be taken. Further archaeological assessment and Aboriginal community consultation may be required prior to the recommencement of works. Any objects confirmed to be Aboriginal in origin must be reported to Heritage NSW.

Human remains of Aboriginal people have previously been recorded in sand bodies in coastal bays and open beaches within Sydney area including Long Reef headland. In the unlikely event that suspected human remains are identified during works, all activity in the vicinity of the find must cease immediately and the find protected from harm or damage. The NSW Police and the Coroner's Office must be notified immediately. If the finds are confirmed to be human and of Aboriginal origin, further assessment by an archaeologist experienced in the assessment of human remains and consultation with both Heritage NSW, the Aboriginal Heritage Office and the RAPs for the project would be necessary.

Apex Archaeology acknowledges and pays respect to the past, present and future Traditional Custodians and Elders of this nation and in whose land this assessment took place, and to the continuation of cultural, spiritual and educational practices of Aboriginal and Torres Strait Islander peoples.

Document Control

The following register documents the development and issue of the document entitled 'Long Reef Boardwalk, Collaroy, NSW: Aboriginal Cultural Heritage Assessment Report', prepared by Apex Archaeology in accordance with its quality management system.

Revision	Prepared by	Reviewed by	Comment	Issue Date
1 – Draft	Rebecca Bryant	Jenni Bate	Client Review	27 October 2023
2 – Draft	Jenni Bate	Eliza Halsey	Issue for RAPs	11 November 2023
3 – Final	Jenni Bate	RAPs	Issue of final	11 December 2023

GLOSSARY OF TERMS

Aboriginal Object	An object relating to the Aboriginal habitation of NSW (as defined in the NPW Act), which may comprise a deposit, object or material evidence, including Aboriginal human remains.
ACHA	Aboriginal Cultural Heritage Assessment
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACHCRs	*Aboriginal cultural heritage consultation requirements for proponents 2010*
AHIMS	Aboriginal Heritage Information Management System maintained by Heritage NSW, detailing known and registered Aboriginal archaeological sites within NSW
AHIP	Aboriginal Heritage Impact Permit
AR	Archaeological report
ASIRF	Aboriginal Site Impact Recording Form
BP	Before Present, defined as before 1 January 1950.
Code of Practice	The DECCW September 2010 *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales*
Consultation	Aboriginal community consultation in accordance with the DECCW April 2010 *Aboriginal cultural heritage consultation requirements for proponents 2010.*
DA	Development Application
DECCW	The Department of Environment, Climate Change and Water (now Heritage NSW)
Disturbed Land	If land has been subject to previous human activity which has changed the land's surface and are clear and observable, then that land is considered to be disturbed
Due Diligence	Taking reasonable and practical steps to determine the potential for an activity to harm Aboriginal objects under the *National Parks and Wildlife Act 1974* and whether an application for an AHIP is required prior to commencement of any site works, and determining the steps to be taken to avoid harm
Due Diligence Code of Practice	The DECCW Sept 2010 *Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales*
GIS	Geographical Information Systems
GSV	Ground Surface Visibility
Harm	To destroy, deface or damage an Aboriginal object; to move an object from land on which it is situated, or to cause or permit an object to be harmed
Heritage NSW	Heritage NSW within the Department of Premier and Cabinet; responsible for overseeing heritage matters within NSW
ka	Kiloannus, a unit of time equating to 1,000 years
LALC	Local Aboriginal Land Council
LGA	Local Government Area
NPW Act	NSW *National Parks and Wildlife Act* 1974
NPWS	National Parks and Wildlife Service
OEH	The Office of Environment and Heritage of the NSW Department of Premier and Cabinet (now Heritage NSW)
PAD	Potential Archaeological Deposit
RAPs	Registered Aboriginal Parties

CONTENTS

FIGURES

1.0 Introduction

Apex Archaeology has been engaged by Northern Beaches Council to assist in preparing an Aboriginal Cultural Heritage Assessment (ACHA) for the proposed realignment and replacement of the existing boardwalk and bridge that is situated on the southern side of Long Reef Headland in Collaroy, NSW. The proposed works will impact on sections within Long Reef Golf Club and Long Reef Beach in Collaroy. The study area is within the Northern Beaches Local Government Area (LGA).

An Aboriginal site is registered on the Aboriginal Heritage Management Services (AHIMS) as being within the study area. It is AHIMS #45-6-0741 (QP3) and is recorded as an Aboriginal shell midden. The site is mapped as being on the northern side of the current boardwalk and approximately 50 m west of the current bridge that crosses the man-made creek that empties drains onto Long Reef Beach.

The proposed works have the potential to impact on this registered site and as such, an assessment is necessary to determine whether an application for an Aboriginal Heritage Impact Permit (AHIP) prior to the commencement of works. Is required.

This report details the results of the archaeological assessment of the site, prepared in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (September 2010) (the Code of Practice). This report forms an appendix to the ACHA report prepared for the project. It has been prepared to inform Northern Beaches Council prior to the proposed realignment and replacement of the existing boardwalk and bridge.

1.1 Project Proponent

The proponent for the project is Northern Beach Council and Environment. The client contact for the project was Eliza Halsey, Senior Project Officer.

1.2 Objectives of the Archaeological Assessment

The archaeological investigation was undertaken to meet the requirements of the Code of Practice.

The purpose of the archaeological investigation is to understand and establish the potential harm the proposed development may have on Aboriginal cultural heritage within the study area, both tangible and intangible.

Any development works which disturb the ground surface have the potential to impact Aboriginal archaeological deposits and therefore an assessment of whether the study area contains such deposits is required prior to the commencement of construction works. An assessment of whether the proposed development would impact these deposits (if present) is also necessary, and identification of to what extent the deposits would be impacted is also required. The degree of impact which may be allowable is determined, in part, with consideration of the level of cultural significance attributed to the cultural values of the study area, both tangible and intangible.

As such, the objectives of the assessment are to determine whether Aboriginal cultural values exist within the study area, and whether the proposed project can avoid impact to these values, or if mitigation measures may be necessary.

1.3 Study Area and Project Brief

The study area is located on the southern side of Long Reef Headland and is bound by the Pacific Ocean to the south and Long Reef Golf Course to the north (Figure 1 and Figure 2). The study area is located approximately 10 km north of Manly and 21 km northeast of the Sydney CBD. It is within the Northern Beaches LGA.

The Long Reef boardwalk and bridge within the Long Reef Headland loop track have been subjected to a high volume of use by the community and unusually large ocean swells that have caused significant structural damage to the lower section of the foreshore boardwalk. Repairs were carried out to ensure that it was serviceable for the short term (9-12 months). The structure Is now reaching the end of this period and approximately 120 m of the existing the existing boardwalk and bridge require replacement (Figure 3).

To ensure the new structures do not succumb to the same impacts it is proposed to reposition them further north up the dune face. Sections of the dune will have to be flattened by the removal of sand to accommodate the boardwalk. This will involve a cut of approximately 23 m long and a max depth of 1.2 m into the sand dune on a section west of the drainage line, and a cut approximately 22 m long with a maximum depth of .8 m deep on the eastern side of the drainage line (Figure 4). The proposed works will also move the northern section of the woman's and men's 17th tees approximately 2 m north, as well as the realignment of a section of the concrete path that parallel to the tees. This will also involve excavations that may be up to 30 cm below the current surface level (Figure 5).

An Aboriginal site is registered on The Aboriginal Heritage Information Management System (AHIMS) as #45-6-0741 (QPS) and is identified as being within the study area (Figure 6). It is recorded as an Aboriginal shell midden and mapped as being on the northern side of the current boardwalk and within an area of the proposed realigned boardwalk. This area is approximately 50 m west of the current bridge that crosses the man-made creek that drains onto Long Reef Beach.

As the proposed works have the potential to impact on this registered site an assessment is necessary to determine whether an application for an Aboriginal Heritage Impact Permit (AHIP) prior to the commencement of works is required.

The subject land is within Crown Lands, which are managed by the Northern Beaches Council.

1.4 Investigators and Contributors

This archaeological assessment was commissioned by the Northern Beaches Council. Apex Archaeology thanks Eliza Halsey from Northern Beaches Council for her assistance with the project. Thanks are also extended to the registered Aboriginal

groups for their participation and assistance with the project, with particular thanks to Justine Coplin from Darug Custodian Aboriginal Corporation who assisted with the fieldwork. We are also grateful for the advice and assistance provided by Archaeologist and Heritage Officer Susan Whitby, and Senior Archaeologist Phil Hunt, from the Aboriginal Heritage Officer.

This report has been prepared by Rebecca Bryant, Archaeologist with Apex Archaeology. The report was reviewed by Jenni Bate, Director and Archaeologist with Apex Archaeology. Both Jenni and Leigh have over sixteen years of archaeological consulting experience within NSW, and Rebecca has 11 years' experience in archaeological research projects (inc five years in consultancy). Project team roles and qualifications are shown in Table 1.

Table 1: Project team roles and qualifications

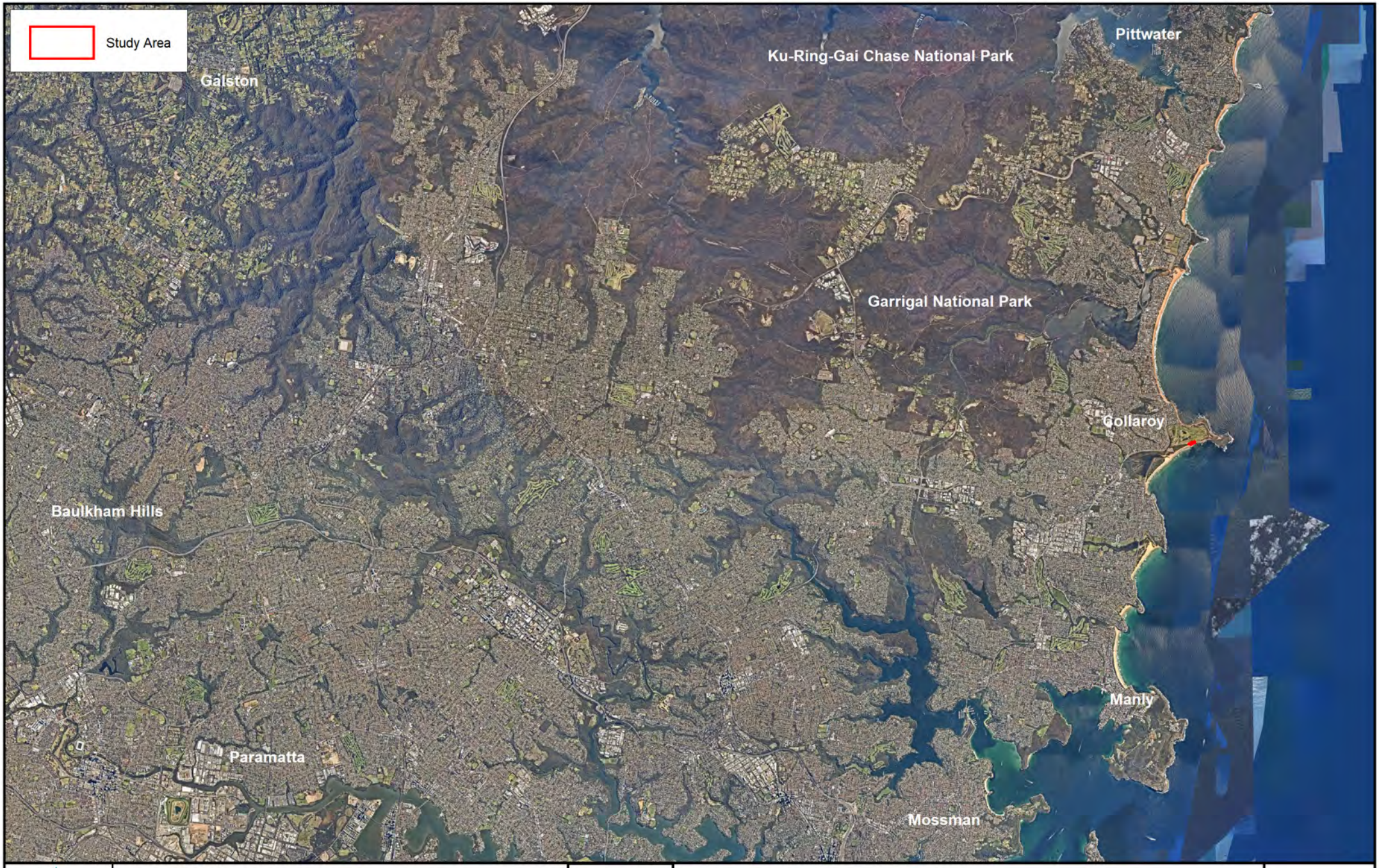
Name	Role	Qualifications
Rebecca Bryant	Report Author	B.Science (Arch/Paleo); Mphil (lithics)
Jenni Bate	Project Manager; Report Author; Field Inspection; Review	B.Archaeology; Grad. Dip. CHM
Leigh Bate	Field inspection; Review; GIS	B.Archaeology; Grad. Dip. Arch; Dip. GIS

1.5 LIMITATIONS

This report relies in part on previously recorded archaeological and environmental information for the wider region. This includes information from AHIMS, which is acknowledged to be occasionally inaccurate, due to inaccuracies in recording methods. No independent verification of the results of external reports has been made as part of this report.

It should be noted that AHIMS results are a record only of the sites that have been previously registered with AHIMS and are not a definitive list of all Aboriginal sites within an area, as there is potential for sites to exist within areas that have not previously been subject to archaeological assessment.

Field investigations for this report included survey. The results are considered to be indicative of the nature and extent of Aboriginal archaeological remains within the study area, but it should be noted that further Aboriginal objects and sites which have not been identified as part of this assessment may be present within the wider area.



PO Box 236
NOWRA
NEW SOUTH WALES 2541

0 5 10
kilometres

Projection:
MGA Zone 56 (GDA 94)
Base Map:
NearMaps 2023
Image Date: 21/10/2023
Final - Version 1

Figure 1: Study area within its regional context.

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NOWRA
NEW SOUTH WALES 2541

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metres

Projection:
MGA Zone 56 (GDA 94)
Base Map:
NearMaps 2023
Image Date: 21/10/2023
Final - Version 1

Figure 2: Study area within its local context.

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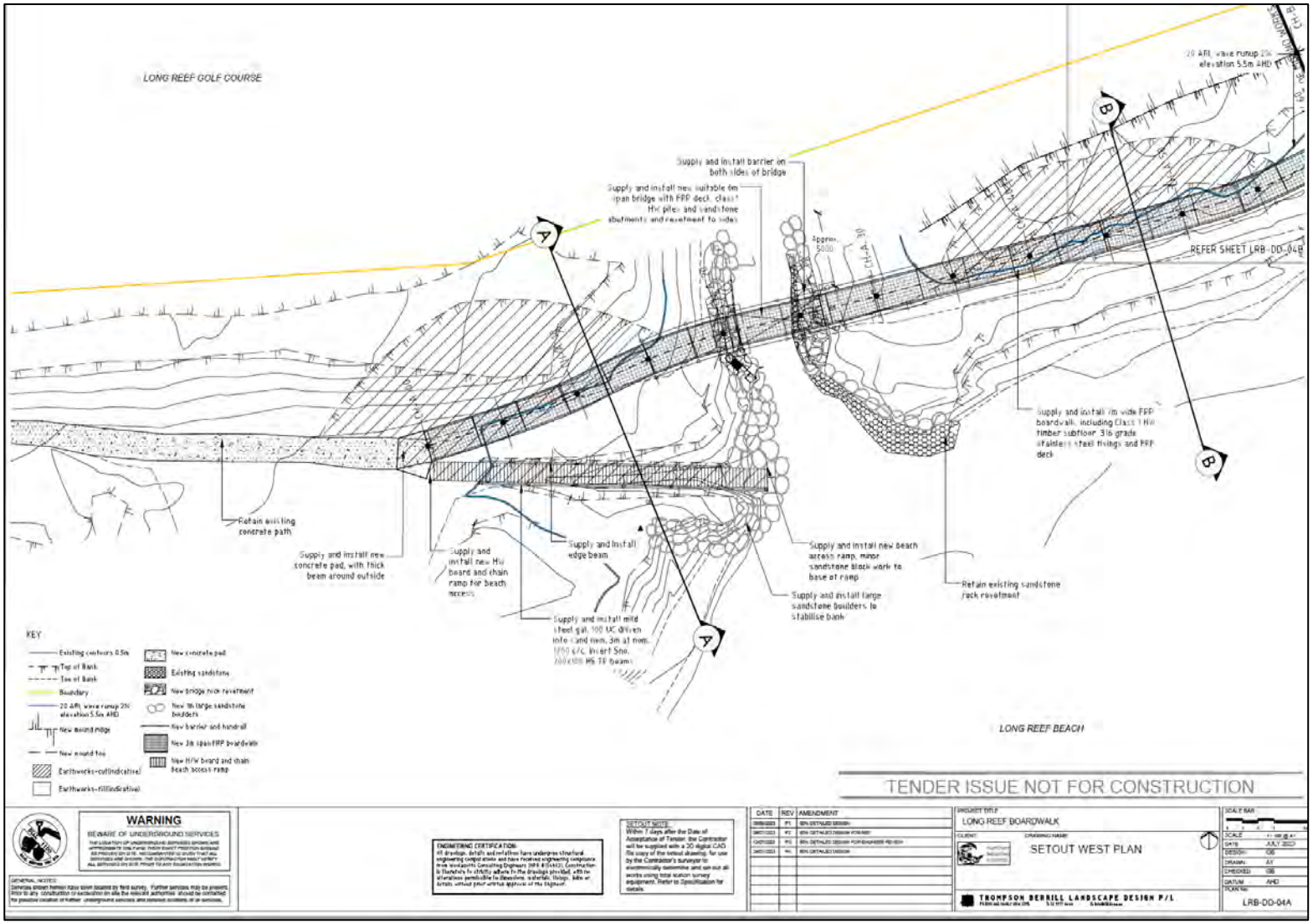

Figure 3: Preliminary draft of proposed works within the study area. (Source: Thompson Berrill Landscape Design July 2023 Plan No. LRB-DD-04A).

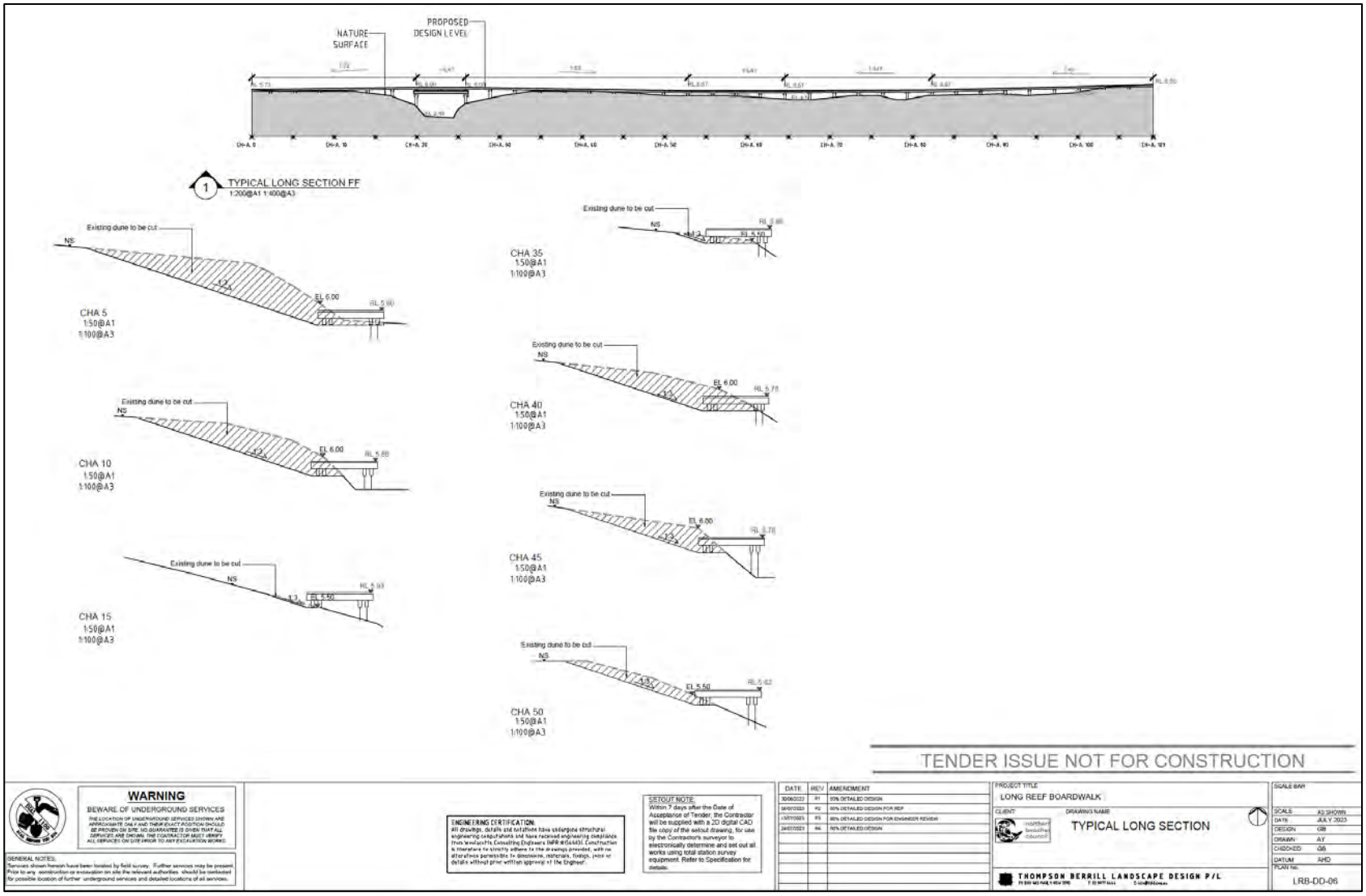

Figure 4: Preliminary draft of proposed cross section of excavation within the sand dune. (Source: Thompson Berrill Landscape Design July 2023 Plan No. LRB-DD-06).

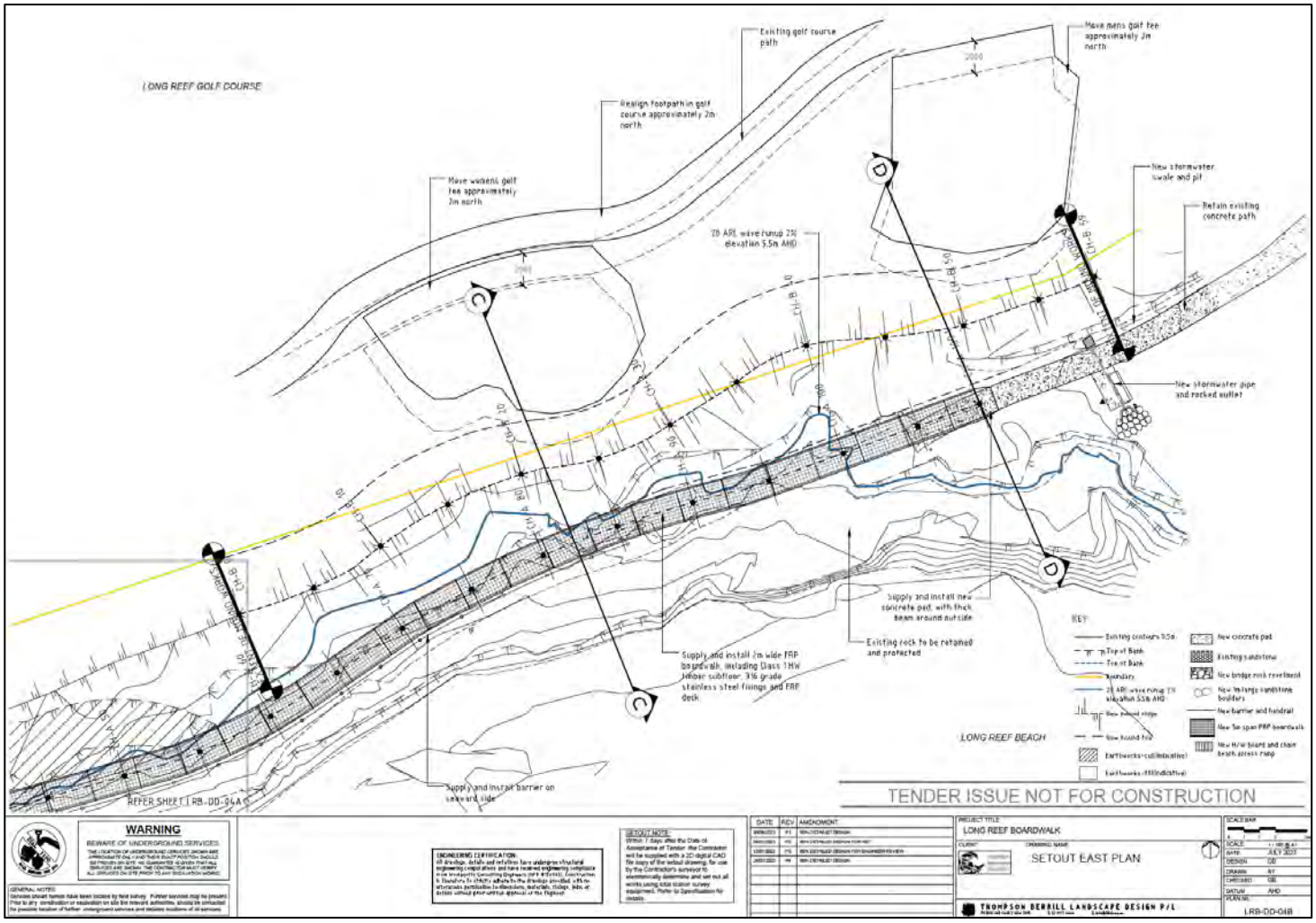

Figure 5: Preliminary draft of proposed realignment of the footpath within the golf course, approximately 2 m north (Source: Thompson Berrill Landscape Design July 2023 Plan No. LRB-DD-04B).

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NEW SOUTH WALES 2541

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metres

Projection:
MGA Zone 56 (GDA 94)
Base Map:
NearMaps 2023
Image Date: 21/10/2023
Final - Version 1

Figure 6: Location of registered AHIMS Site # 45-6-0741 in relation to study area.

N

2.0 Statutory Context

Heritage in Australia, including both Aboriginal and non-Aboriginal heritage, is protected and managed under several different Acts. The following section presents a summary of the applicable Acts which provide protection to cultural heritage within NSW.

2.1 Commonwealth Legislation

2.1.1 Aboriginal and Torres Strait Islander Heritage Protection Act 1984

This Act provides for the preservation and protection of injury and/or desecration of areas and objects in Australia and its waters that are of significance to Aboriginal people, in accordance with Aboriginal tradition.

Under this Act, the responsible Minister has provision to make both temporary and/or long-term declarations, in order to provide protection to areas and objects which are at threat of injury or desecration. In some instances, this Act can override State or Territory provisions, or be invoked if State or Territory provisions are not enforced. An Aboriginal or Torres Strait Islander individual or organisation must invoke the Act.

No items within the study area are listed or protected under this Act.

2.1.2 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act provides protection to environmental sites of national significance, including places with cultural heritage values that contribute to Australia's national identity. The Act aims to respect the role of Indigenous peoples in the conservation and ecologically sustainable use of Australia's biodiversity, and to enhance the protection and management of important natural and cultural places. Additionally, the Act is designed to promote the use of Indigenous peoples' knowledge of biodiversity with the involvement of, and in cooperation with, the owners of the knowledge.

The National Heritage List provides a listing of natural, historic and Indigenous places of outstanding significance to the nation, while the Commonwealth Heritage List details the Indigenous, historic and natural places owned or controlled by the Australian Government.

Under the EPBC Act, approvals are required if any action is proposed that will have (or is likely to have) a significant impact on the National Heritage values of a National Heritage place. Therefore, actions must be referred to the Australian Government Minister for the Environment and Heritage. A decision will be made as to whether the proposed action will have a significant impact on any matters of national significance.

Long Reef Aquatic Reserve in Collaroy is currently listed on the Australian Heritage Database as in 'Indicative Place' (ID No. 14684) for its 'Natural' significance. It is

within an aquatic reserve and includes numerous tropical invertebrate species and was registered. It was registered on the 21/10/1980 (ID 102514).

2.1.3 Native Title Act 1993

The *Native Title Act 1993*, as amended, provides protection and recognition for Native title. Native title is recognised where the rights and interests of over land or waters where Aboriginal and Torres Strait Islander practiced traditional laws and customs prior to the arrival of European settlers, and where these traditional laws and customs have continued to be practiced.

The National Native Title Tribunal (NNTT) was established to mediate native title claims made under this Act. Three registers are maintained by the NNTT, as follows:

- National Native Title Register
- Register of Native Title Claims
- Register of Indigenous Land Use Agreements.

Searching the NNTT registers allows identification of potential Aboriginal stakeholders who may wish to participate in consultation.

A search of all three registers did not identify any registered Native Title claims within, or close to the study area. The closest Native Title claim is by the South Coast People and commences approximately 40 km south of the current study area.

2.2 New South Wales Legislation

2.2.1 National Parks and Wildlife Act 1974

The *National Parks and Wildlife Act 1974* provides protection for all Aboriginal objects and places within NSW. Aboriginal objects are defined as the material evidence of the Aboriginal occupation of NSW, while Aboriginal Places are defined as areas of cultural significance to the Aboriginal community. All Aboriginal objects are protected equally under the Act, regardless of their level of significance. Aboriginal Places are gazetted if the Minister is satisfied that the location was and/or is of special significance to Aboriginal people.

Following amendments to the NPW Act in 2010, approval to impact Aboriginal cultural heritage sites is only granted under a Section 90 AHIP, which is granted by Heritage NSW in the Department of Premier and Cabinet.

2.2.2 NSW National Parks and Wildlife Regulation 2019

Part 5, Division 2 of the *National Parks and Wildlife Regulation 2019* addresses Aboriginal objects and places in relation to the NPW Act 1974, and outlines how compliance with relevant codes of practice can be met.

Clause 58(1) outlines the defence of low impact acts or omissions to the offence of harming Aboriginal objects, which includes maintenance works on existing roads and fire trails, farming and land management work, grazing of animals, activities on land

that has been disturbed that is exempt or complying development, mining exploration work, removal of vegetation (aside from Aboriginal culturally modified trees), seismic surveying or groundwater monitoring bores on disturbed ground, or environmental rehabilitation work (aside from erosion control or soil conservation works such as contour banks).

Clause 58(4) outlines the definition of 'disturbed land', as land that "has been the subject of a human activity that has changed the land's surface, being changes that remain clear and observable".

Clause 59 relates to the notification of Aboriginal objects and sites and Clause 60 relates to the requirements for the consultation process to support an AHIP application. The regulation sets out the requirements broadly in line with those outlined in the ACHCRs.

2.2.3 Environmental Planning & Assessment Act 1979

Under the EP&A Act, it is necessary to consider environmental impacts, including impact to cultural heritage, as part of the land use process. Local Environmental Plans (LEPs) and Development Control Plans (DCPs) are also required to be prepared by Local Government Areas (LGAs) in order to provide guidance on the applicable level of environmental assessment. LGAs are required to maintain a list of locally significant heritage items as part of their LEP.

Under the EP&A Act, Part 3 describes the planning instruments at both local and regional levels; Part 4 relates to development assessment and consent processes, and Part 5 refers to infrastructure and environmental impact assessment.

The determining authority in this instance is Northern Beaches Council, who will determine a Development Application for the project.

2.2.4 Warringah Local Environmental Plan 2014

The *Warringah Local Environmental Plan (LEP) 2014* is the overarching planning instrument applicable to the Northern Beaches LGA. Although Northern Beaches Council is an amalgamation of the former Manly Pittwater and Warringah councils, they do not yet have a separate LEP. This is due to be released sometime in 2023. It is noted that the WLEP contains the following clauses relevant to works near Aboriginal sites.

Clause 5.10(2) (e) identifies that no buildings may be erected on land within a heritage conservation area, or which contains an Aboriginal object, without first obtaining development consent. Further, Clause 5.10(2) (c) states that archaeological sites may not be disturbed or excavated without development consent. Exceptions to the requirement for development consent are detailed by Clause 5.10(3) (a) and include work that is minor in nature or is for the maintenance of a heritage item, Aboriginal object, Aboriginal place, archaeological site or heritage conservation area, and would not adversely affect the heritage significance

of the heritage item, Aboriginal object, Aboriginal place, archaeological site or heritage conservation area, or (b) the development is in a cemetery or burial ground and the proposed development would not cause disturbance to human remains, relics, Aboriginal objects in the form of grave goods, or to an Aboriginal place of heritage significance.

Clause 5.10(8) (a & b) requires that the effect of any development on an Aboriginal place of heritage significance must be considered, and the Aboriginal community must be notified of any proposed developments and take into consideration any responses received with 28 days after the notice was sent. This document details the notification to the registered Aboriginal community regarding the intention to develop the study area and the consultation undertaken regarding the proposed development's potential impact on Aboriginal cultural heritage in the area.

A portion of Long Reef Headland is shaded in green, which falls into the "Conservation Area – Landscape". The eastern section of the current study area appears to be just outside this. However, no archaeological sites, which would be identified in yellow, are mapped on the Warringah Local Environmental Plan 2011 (Figure 7), or within or in the vicinity of the study area.

Although there are no Aboriginal heritage items listed this does not mean that the land has low Aboriginal cultural heritage significance. Numerous sites have been recorded on Long Reef Headland.

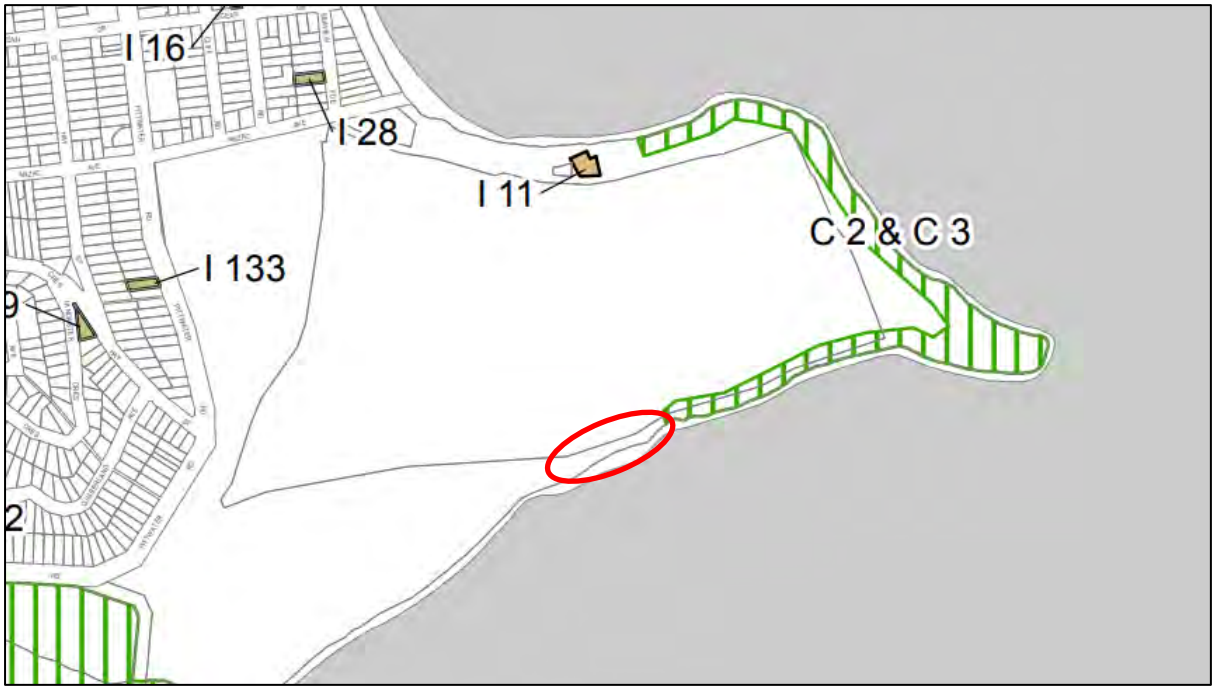

Figure 7. Detail of the Warringah LEP Heritage Map. Approx. location of study area indicated by red circle (Source: Warringah LEP 2014 Heritage Map Sheet HER_009)

3.0 Aboriginal Cultural Heritage

This section presents information about both the physical and cultural landscape in which the study area is located, as well as previous archaeological and ethnohistorical studies, to provide context and background to the existing knowledge of Aboriginal culture in the area.

3.1 Existing Environment

The study area is located within the geological structure known as the Sydney Basin, which is roughly bounded by the Great Dividing Range to the west, the coast to the east, Newcastle to the north and Durras, near Batemans Bay, to the south. More specifically, the study area is located on the southern side of Long Reef Headland within Sydney's Northern Beaches (Branagan & Packham 2000). The headland which slopes down in a westerly fashion from its eastern most point, is not actually a part of mainland Australia. It is a section of exposed bedrock that is connected by a tombolo, which comprise sand deposits and form a sand spit (Retallack 2015).

3.1.1 Soils, Geology and Topography

The underlying geology of Long Reef Headland is varied and complex. The Narrabeen Group of sedimentary rocks that were formed in the Triassic period (approx. 250 mya to 200 mya) are exposed here. This stratum is not often seen along the Sydney Coast because it lies below the Hawkesbury Sandstone, that is the geological layer usually visible in the cliff lines. The Bulgo sandstone that is within the study area is within the Narrabeen Group and is not as fine-grained as the Hawkesbury. It is capped by the Bald Hill Claystone, which is a striking red colour due to the high iron content (Retallack 2005).

There are also exposures of other claystones and shales within Long Reef headland that can contain fossils from ancient animals and plants. For example, the remnants of a jawbone measuring one meter from a giant salamander-like amphibian was found at Long Reef. Additionally, a 2 m volcanic dolerite dyke has also protruded through the sandstone but has largely been mined so it has been significantly reduced in size (Retallack 2005).

Long Reef Headland contains three soil landscapes: the Newport, North Head and Ettalong. The Newport and North Head soil landscapes are sandy soils that can be quite deep, especially the North Head which can be over 2 m deep. The Ettalong soil landscape is mapped in a small swampy area in the lower-lying western portion of the headland. The soils in this type of landscape can also be very deep (>150 cm) but comprise of spongy dark organic peat that has a high component of decomposing vegetation.

The study area falls entirely within the Newport soil landscape which comprises gentling undulating plains to rolling rises of shallow wind-blown Holocene sands. The A1 topsoil can be up to 30 cm of loose dark brown loamy sand that overlies up to 50 cm of greyish yellow brown massive clayey sand or bleached loose sand. There can

also be wind-blown sand that covers the underlying soil or has been deposited directly onto bedrock. Although archaeological remains tend to be contained in the top A1 horizon and A2 by downward movement, wind-blown sand accumulation in areas such as this can mean that original surfaces may have been buried quite deeply, depending on the landscape formation.

3.1.2 Flora and Fauna

The plants found within the Long Reef headland varied depending on the underlying soils. Around the edge of the swamp there would have been a variety of trees including: *Melaleucas* (paperbark), *Casuarinas*, (swamp-oak), *Livistona* (cabbage gum) and *Eucalyptus* (Gum trees). There also would have been sedges and rushes.

The frontal dunes along the coast tend to be made up of shifting sands that have not had time to form proper soils. They are inclined to be low in nutrients and covered by grasses such as Spinifex, which provide habitat for birds, reptiles and mammals that reside in the sand burrows and feed within the grasses and at the waterline. Tall grass trees, like *Xanthorroea arborea*, called 'Cadi' by the Aboriginal people who lived in Sydney, had many uses. Its long stalks were used to make spears, the dried flower stalk was used to generate fire, and the resin collected from the leaf bases and damaged area on the trunk, were used to adhere ornaments to hair and bind the parts of composite tools. Colonists also remarked on the extraordinary strength of this resin to fasten stone heads to their hatchets (Clarke 2012:138).

The coastal sand dunes would have supported *Banksia* species as well as *Eucalyptus* like red bloodwood, *Angophora* such as smooth-barked apple, and cycads including the *Macrozomia communis*. The *Macrozamia* produces seeds that were eaten by Aboriginal people after they were leached of their toxins (Asmussen 2011). The various *Eucalypts* would have provided wood for shields, canoes and coolamons. Another type of tree with creamy white to deep yellow flowers that grows within this habitat are the Acacias, commonly known as wattle. They were recorded as having been used to make wooden clubs in the Sydney area (Attenbrow 2010: 113)

Many other plants and trees found around Long Reef would have provided resources for Aboriginal people; to fulfill dietary needs, provide raw material for tools and implements, and used for medicinal purposes. For example, fur from possums would have been sewn together using a needle made from animal bones and thread made from the sinew of animal's muscles. The shellfish collected around the shoreline and rocky reef platform would have provided protein for food a raw material source to make implements such as fish hooks from turban shells (*Turbo marmoratus*) and scrapping tools from Sydney cockles (*Anadara trapezia*).

3.1.3 Hydrology

There are no fresh-water creeks mapped within the study area itself. However, there is an unnamed drainage line that appears to originate in the southwestern section and extend to approximately 40 m to the north of the study area. It also feeds into the wetland area in the western portion of the headland but it is not clear how

reliable these would have been as a water source. Recent aerial photos show a man-made channel has extended this drainage line, which now cuts through the study areas from north to south and empties onto Long Reef Beach.

In general, remnants of former Aboriginal occupation sites tend to be found close to a reliable fresh water source that would be considered a higher-order water course. For example, watercourse classification ranges from first order through to fourth order (and above), with first order being the lowest, ie a minor creek or ephemeral watercourse, and fourth or above being a large watercourse such as a river, as defined by the Department of Planning and Environment (DPE; Figure 8). This classification is recognised as a factor which helps the development of predictive modelling in Aboriginal archaeology in NSW.

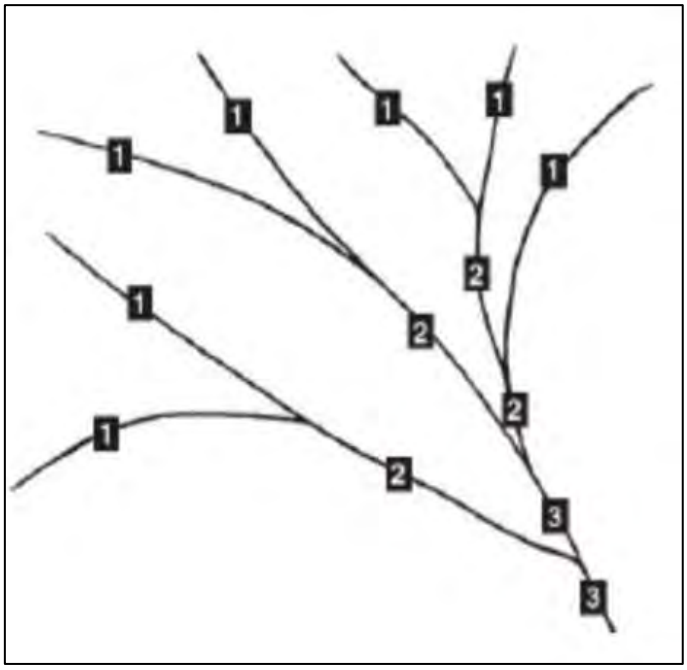

Figure 8: The Strahler system (Source: Department of Planning and Environment 2016).

3.1.4 Raw Materials

A wide range of raw materials were selected by Aboriginal people for flaking to create stone implements. Material types ranged from high quality to poor quality for flaking purposes, depending on the geology of the area and readily available material types. The following is a description of a range of raw material types known to have been utilised by Aboriginal people for the creation of stone artefacts. Not all occur naturally within all environments, although different resources can be identified within different regions due to trade or resource carrying (ie 'manuport' stone). Although quartz pebbles most probably would have been available within the sandstone within the Northern Beaches area, no major rocks sources such as silcrete outcrops have been recorded. It is likely that fine-grained material suitable for flaking into tools such as scrappers, eloueras and backed artefacts would have been brought into the area by direct access to the stone source or traded in. For

example, Yarrumundi along the Nepean River, approximately 78 km north west to the current study area has a plethora of cobbles made from silcrete, tuff, indurated mudstone.

As discussed in the literature review in the following section, Corkill (2005) inspected beaches and cliff lines from Palm Beach to Port Jackson to locate potential sources for ground-edged stone hatchets that have been found within the Sydney Coast and Hinterland Regions. She observed that, although there are basalt diatremes along this stretch of coast located (in Avalon and Bondi for example), no useful sources (bedrock and/or cobbles) were identified. Corkill proposed that the closest sites to obtain raw material is along the Hawkesbury/Nepean Rivers in western Sydney, and/or at Bellambi Point in the Illawarra Region to the south, and Kulnura (Peats Ridge/Popran Creek) in the Central Coast Region to the south.

Breccia

Breccias are coarse, angular volcanic fragments cemented together by a finer grained tuffaceous matrix.

Chalcedony

Chalcedony is a microcrystalline, siliceous rock which is very smooth and can be glossy. Introduction of impurities can produce different coloured versions of chalcedony, including yellow/brown (referred to as carnelian), brown (sard), jasper (red/burgundy) and multicoloured agate. It flakes with a sharp edge and was a prized material type for the creation of stone artefacts in parts of Australia (Kuskie & Kamminga 2000: 186).

Chert

Chert is a highly siliceous sedimentary rock, formed in marine sediments and also found within nodules of limestone. Accumulation of substances such as iron oxide during the formation process often results in banded materials with strong colours. Chert is found in the Illawarra Coal Measures and also as pebbles and colluvial gravels. It flakes with durable, sharp edges and can range in colour from cream to red to brown and grey.

Petrified Wood

Petrified wood is formed following burial of dead wood by sediment and the original wood being replaced by silica. Petrified wood is a type of chert and is a brown and grey banded rock and fractures irregularly along the original grain.

Quartz

Pure quartz is formed of silicon dioxide, and has a glossy texture and is translucent. Introduction of traces of minerals can lead to colouration of the quartz, such as pink, grey or yellow. The crystalline nature of quartz allows for minute vacuoles to fill with gas or liquid, giving the material a milky appearance.

Often quartz exhibits internal flaws which can affect the flaking quality of the material, meaning that in general it is a low-quality flaking material (Kuskie & Kamminga 2000: 186). However, quartz is an abundant and widely available

material type and therefore is one of the most common raw materials used for artefact manufacture in Australia. Flaking of quartz can produce small, very sharp flakes which can be used for activities such as cutting plant materials, butchering and skinning. Quartz may have been available locally in pebble form eroding out of sandstone and sandstone conglomerates.

Quartzite

Formed from sandstone, quartzite is a metamorphic stone high in silica that has been heated or had silica infiltrate the voids found between the sand grains. Quartzite ranges in colour from grey to yellow and brown.

Silcrete

Silcrete is a siliceous material formed by the cementing of quartz clasts with a matrix. These clasts may be very fine grained to quite large. It ranges in colour from grey to white, brown, red or yellow. Silcrete flakes with sharp edges and is quite durable, making silcrete suitable for use in heavy duty woodworking activities and also for spear barbs (Kuskie & Kamminga 2000:184).

Tuff/Indurated Mudstone

There is some disagreement relating to the identification of lithic materials as tuff or indurated mudstone. The material is a finely textured, very hard yellow/orange/reddish-brown or grey rock. Kuskie and Kamminga (2000: 6, 180) describe that identification of lithic materials followed the classification developed by Hughes (1984), with indurated mudstone described as a common stone material in the area. However, Kuskie and Kamminga's analysis, which included x-ray diffraction, identified that lithics identified as 'indurated mudstone' was actually rhyolitic tuff, with significant differences in mineral composition and fracture mechanics between the stone types. They define mudstone as rocks formed from more than 50% clay and silt with very fine grain sizes and then hardened.

The lithification of these mudstones results in shale (Kuskie & Kamminga 2000: 181) and thus 'indurated mudstone', in the opinion of Kuskie and Kamminga, do not produce stones with the properties required for lithic manufacture.

In 2011, Hughes, Hiscock and Watchman undertook an assessment of the different types of stones to determine whether tuff or indurated mudstone is the most appropriate terminology for describing this lithic material. The authors undertook thin section studies of a number of rocks and determined that the term 'indurated mudstone' is appropriate, with an acknowledgment that some of this material may have been volcanic in origin. They also acknowledge that precise interpretation of the differences between material types is difficult without detailed petrological examination, and suggest that artefacts produced on this material are labelled as 'IMT' or 'indurated mudstone/tuff'.

VOLCANIC

Both volcanic and acid volcanic stones are raw material type within the South Coast. Without detailed petrological analysis it can be sometimes difficult to identify the specific raw material. However, probably one of the most common and recognisable types of volcanic stone is basalt, which is commonly referred to as 'blue metal'. It is solidified lava that was produced by now extinct volcanoes and diatremes that are spread-out within the Sydney Basin. If the lava cools quickly it results in fine-grained basalt that is easily flaked or ground to make tools, implements or weapons. Tuff forms from the tiny ash particles that are also released during volcanic explosions. When it cools it hardens into a fine-grained rock called 'tuff', as discussed above.

Basalt would have been either collected from the primary deposits formed during the eruption, which would require pieces to be broken off (quarried) or it was collected in cobble-form from a creek bed or shoreline. Cobbles are referred to as secondary sources as they are formed from pieces of rock that have been dislodged from their primary source and end up in creeks and/or river systems (Petrequin 2016; Attenbrow *et al*. 2017). The flow of water moves them around and smooths them into water-rolled cobbles that can be transported considerable distance from the original source. Basalt was often used to make axes which were either flaked into the desired shape from quarried stone, or from cobbles which quite often only required only one end to be ground into a sharp working edge.

Basalt and other types of volcanic cobbles can be found along the banks of rivers, and in bedrock quarries within the Sydney Basin. Recent research undertaken by the Australian Museum and University of New England using portable XRF technology demonstrated that a number of stone axes and ground-edged artefacts held at the Australian Museum have been traced to these sources (Attenbrow et al. 2017). However, none of these have been matched to the diorite volcanic diatreme that outcrops on Long Reef headland (Attenbrow et al in prep)

3.1.5 PROCUREMENT

Assemblage characteristics are related to and dependent on the distance of the knapping site from raw materials for artefact manufacture, and different material types were better suited for certain tasks than other material types. Considerations such as social or territorial limitations or restrictions on access to raw material sources, movement of groups across the landscape and knowledge of source locations can influence the procurement behaviour of Aboriginal people. Raw materials may also have been used for trade or special exchange between different tribes.

3.1.6 MANUFACTURE

A range of methodologies were used in the manufacture of stone artefacts and tools, through the reduction of a stone source. Stone may have been sourced from river gravels, rock outcrops, or opportunistic cobble selection. Hiscock (1988:36-40) suggests artefact manufacture comprises six stages, as follows:

1. The initial reduction of a selected stone material may have occurred at the initial source location, or once the stone had been transported to the site.
2. The initial reduction phase produced large flakes which were relatively thick and contained high percentages of cortex. Generally, the blows were struck by direct percussion and would often take advantage of prominent natural ridges in the source material.
3. Some of these initial flakes would be selected for further reduction. Generally only larger flakes with a weight greater than 13-15 grams would be selected for further flaking activities.
4. Beginning of 'tranchet reduction', whereby the ventral surface of a larger flake was struck to remove smaller flakes from the dorsal surface, with this retouch applied to the lateral margins to create potential platforms, and to the distal and proximal ends to create ridges and remove any unwanted mass. These steps were alternated during further reduction of the flake.
5. Flakes were selected for further working in the form of backing.
6. Suitable flakes such as microblades were retouched along a thick margin opposite the chord to create a backed blade.

Hiscock (1986) proposed that working of stone materials followed a production line style of working, with initial reduction of cores to produce large flakes, followed by heat treatment of suitable flakes before the commencement of tranchet reduction. These steps did not necessarily have to occur at the same physical location, but instead may have been undertaken as the opportunity presented.

Although probably less common than the process of flaking stone to modify it, the grinding technique was used within the Sydney Basin. This has been documented by early settlers particularly in the manufacture of axe heads where the end of a cobble was ground to achieve a working edge (Corkill 2005).

3.2 Land Use History

3.2.1 Indigenous Occupation

When Aboriginal occupation of Australia is likely to have first commenced, around 60,000 years ago (Mulvaney and Kamminga 1999; Bowdler *et al* 2003; Attenbrow 2010), sea levels were around 30-35 m lower than present levels, and this further decreased to up to 130 m lower than present sea levels (Attenbrow 2010). Sea levels stabilised around 7-6,500 years ago, and as a result many older coastal sites would have been inundated with increasing sea levels. It is possible that areas that are now considered "coastal" would once have limited resources available to Aboriginal people, and as such would have been less likely to have been occupied or used for repeated habitation sites.

Archaeological work at the Madjedbebe site in Arnhem Land in the Northern Territory revealed evidence confidently dated to the period before 45-46 ka and possibly up to 50-55 ka (Clarkson *et al* 2015). In NSW, there is strong evidence available to support Aboriginal occupation of the Cumberland Plain region in the Pleistocene

period (approximately 40 ka) and possibly earlier. Work in Cranebrook Terrace was dated to 41,700 years BCE by Stockton and Holland (1974), and a site in Parramatta within deep sandy deposits was dated to 25-30 ka (JMcDCHM 2005). Kohen's 1984 assessment of Shaws Creek in the Blue Mountain foothills yielded ages of 13 ka, while Loggers Shelter at Mangrove Creek was dated to 11 ka by Attenbrow (1987). Deeply stratified occupation deposits at Pitt Town were dated to 39ka (Apex Archaeology 2018). These ages are obtained from both radiocarbon and optically stimulated luminescence (OSL) dating.

Some experts have cast doubt onto the assessment of the items from Cranebrook Terrace as artefactual (Mulvaney & Kamminga 1999; McDonald 2008), although they do not doubt the results of the radiocarbon dates – it is the association of the artefacts with the dated deposits that is problematic, and Mulvaney and Kamminga (1999) consider that there are better examples of sites with more robust identification of age available. There has certainly been a great deal of research undertaken within the Sydney region in the intervening years.

It is unknown when Aboriginal people first occupied the Northern Beaches as there has only been a limited amount excavations undertaken within this area. Additionally, sites that may have been along a former shoreline more than 6,000 years would now be submerged underwater due to rising sea levels around that period. In 1988 human remains were found on the surface of a rock shelter in Angophora Reserve in Avalon. The shelter was subsequently excavated and more remain were identified. One of the occupation layers was dated from charcoal samples to approximately 2,000 years ago, but it was believed occupation may have begin up to 5,000years ago (McDonald 1992). And, in 2005, a human skeleton was accidently unearthed during the building-excavation works at bus shelter in Narrabeen and was dated to approximately 4,000 years old (Fullagar et al. 2009).

The wide-range of material that was excavated from Angophora Reserve and analysed by a variety of experts, found that the former occupants utilised a wide-range of natural resources. Terrestrial animals contributed significantly to the diet with shellfish and fish contributing less than 10%. The former occupants would have acquired the animal and plants locally, and the stones, bones and shells used to manufacture implements and tools would have most likely been procured both locally and further afield (McDonald 1992).

3.2.2 Post Contact Occupation

One of the first documented evidence of Aboriginal settlement in the Northern Beaches region is a diary entry after Governor Phillip's trip to Broken Bay in 1788. It was noted by the surgeon, George Worgan (cited in Attenbrow 2010:53) that:

> *They met with vast number of natives here, some of what they thought they had seen before at Botany Bay, indeed, it is pretty clear that they wander up & down the Coast...*

During the first three months of initial settlement at Sydney Cove in 1788, Governor Arthur Phillip took exploratory trips to Manly Cove, Broken Bay, and the upper reaches of the Parramatta River. An area known as Rose Hill (now Parramatta) was settled by a small group of 11 soldiers and 10 convicts in response to the food shortage in the less-fertile areas around Sydney Cove. The grain crops had failed and the settlement at Rose Hill was ordered to be used for agriculture. These crops were successful, and a further settlement comprising a convict farm was established at Toongabbie. Exploration of the wider region continued, and in 1791, expeditions travelled the Hawkesbury and Nepean areas, identifying them as likely spots for agriculture. The Hawkesbury was subsequently settled in late 1793 (Champion and Champion 1997:15).

The body of water known as Pittwater is within the Northern Beaches and was named by Governor Phillip after the British Prime minister at the time, William Pitt the Younger. It is located on the western side of the Pittwater Peninsula and opens up into Broken Bay which is at the mouth of the Hawkesbury River. By the late 1700s land grants were allocated to former convicts and free settlers along the fertile banks of the Hawkesbury River (Grose 1794). The farmland provided agricultural produce that was transported by ships waiting in the sheltered waters of Pittwater Bay before forming a convoy to Sydney. Eventually the Pittwater area and parts of the Northern Beaches were also used for farming. There were also numerous reports of smuggling, piracy and bushranging being carried on at Middle Harbour, North Harbour and Broken Bay (Champion and Champion 1997:34)

Pittwater remained isolated throughout most of the 1800s but gradually a rough bush road was established from Manly to Narrabeen. The road ran parallel to the coast and a bridge was built to cross Narrabeen lagoon around 1880. By 1913 the trams, that terminated at Narrabeen, had replaced the horse-drawn coaches. From the 1920's a succession of bridges were built, including the Sydney Harbour Bridge in 1932, and the Northern Beaches became more accessible. Although the early settlements comprised mainly holiday shacks, by the 1950s Pittwater became more residential.

The name Long Reef was in use by 1814 and the first owner was a free settler, William Crossar who was granted 200 ha in 1815. Crossar sold his holdings to Matthew Bacon in 1822. It changed hands a couple of more time before been sold to the James Jenkins in 1825 who held on to the property and farmed the land until they sold it to the Salvation Army. The Salvation Army continued to farm the land for a few more years. In 1912 the State Government resumed 72 ha of Long Reef for public recreation and named it Griffith Park (Morecombe 2022).

3.2.3 Documentary Evidence

To assess natural and historical disturbance within the immediate study area and surrounds, a series of historical aerial photographs dating back to the 1930s were

reviewed, along with information obtained from the Lanes and Mellowes (2021) book, 'Long Reef Golf Club, The First One Hundred Years'.

The golf club initially was constructed in 1921 as a 9-hole layout because the lower south western portion was a swamp. The swamp was drained and subsequently filled in the late 1920s which enabled the course to increase to 19 holes in 1931 (Plate 1). In 1942 the Army requisitioned a section of the course on the southern side centred around the 17th hole, including where the current study area is located. It was used as an artillery range and in order to make defence observation easier they flattened the large sand dunes in 1943 (Plate 2). Some of this sand was used to make sandbags and the rest was spread over several holes. This led to ongoing sand erosion and sand settling over other areas. In some case the sand was over 4.5 m high and blocked some of the water sources and fairways. The military equipment and vehicle tracks further impacted and damaged the course. The Club received compensation from the Army and engaged course designer Eric Apperly to rebuild and redesign the golf course. (Lanes and Mellowes 2021).

By 1961 a drainage channel had been constructed from north to south through the study area (Plate 3), and in 1963 problems were also noted in the area. Sand had blown in and accumulated on the 16th hole which led to its abandonment and the creation of a new one west of the old 17th and 18th holes. (Lanes and Mellowes 2021:82). A boundary was also created at the new 17th hole to relieve problems of the sand invasion (Lanes and Mellowes 2021:128). In the 1990s the club commenced a drainage project to alleviate the problem of water pooling in the swampy south section of the course. It was called the Wetland Project Phase 1 and included the construction of two ponds adjacent to the 4th and 5th holes. The fill from these was used to raise the adjacent fairways. These ponds also became a collection point for the stormwater which was then piped south across the 6th and 17th fairways (including the study area). Strip and dish drains were also added. Images from the early 1980s to early 2000s (Plate 4, Plate 5, and Plate 6) show the progress of this project. Between 2005 and 2016 a bridge had been constructed through the study area (Plate 7).

The available information establishes that the study area has been heavily impacted since at least the 1930s, which was the earliest available image of the area. The southern section of the study area has been subject to natural erosion from wind and wave action that has severely compromised the underlying geology and boardwalk. The construction of Long Reef Golf Course in the northern section of the study area included the clearance of original vegetation and modification to the original sand dune landscape. This would have resulted in the loss of most, if not all, of the original topsoil profile. Further impacts by the Army's use of the golf course for training exercises during the 1940s, including impact from an artillery range, led to further damage to the sand dune landscape through the levelling of them to obtain better visuals of the ocean. Water drainage works involving deep excavation and the construction of walking paths from the 1960s have further damaged the

study area. The historical and continuing natural and man-made impacts indicate that it is unlikely that any Aboriginal material cultural in an intact context would remain.

Comparison of the 1943 historical imagery (Plate 8) and imagery from 2022 (Plate 9) with cadastral boundaries overlaid allows an assessment of the impact of natural erosion of the coast over time. Even allowing for discrepancies in the alignment of the imagery, the alteration to the coastline over these years is significant.

Plate 1: 1930 aerial. Approx study area in red (Source: NSW Spatial Services HV 2023).

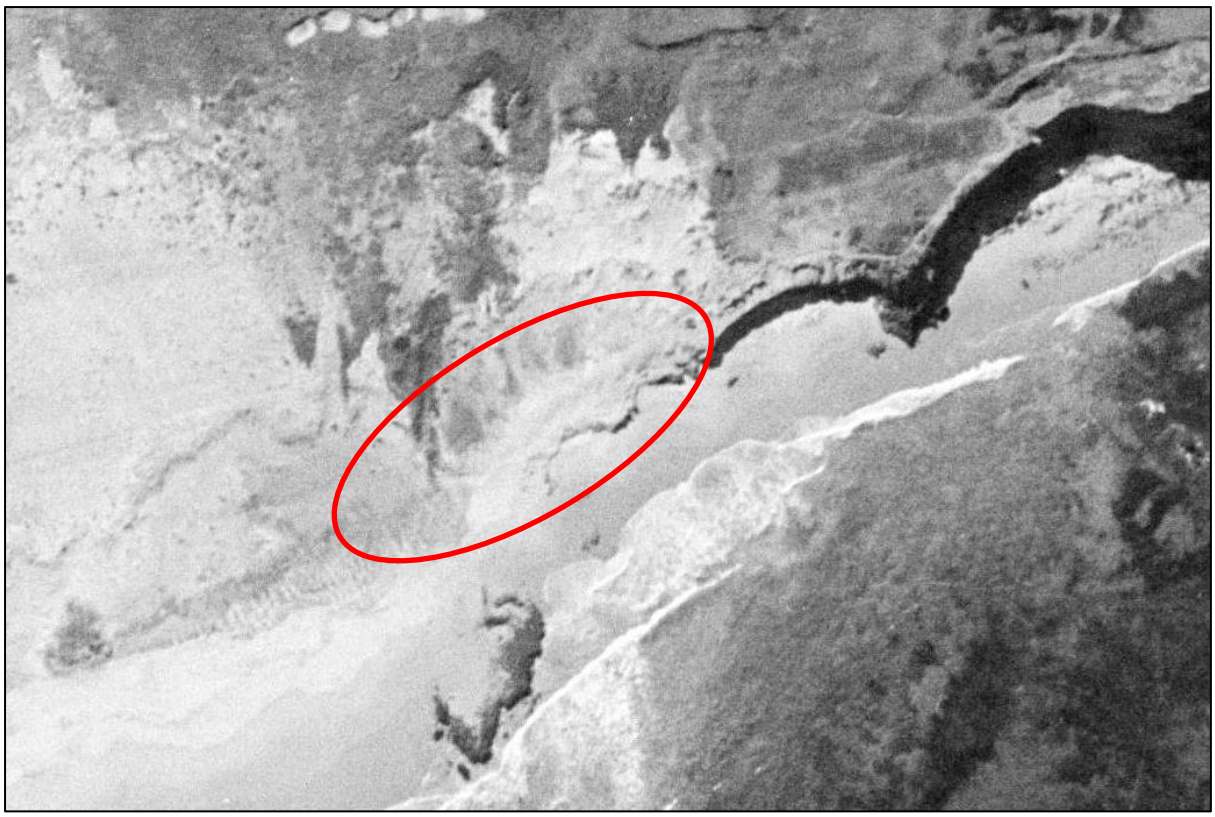

Plate 2: 1943 aerial. Approx study area in red. (Source: NSW Spatial Services HV 2023).

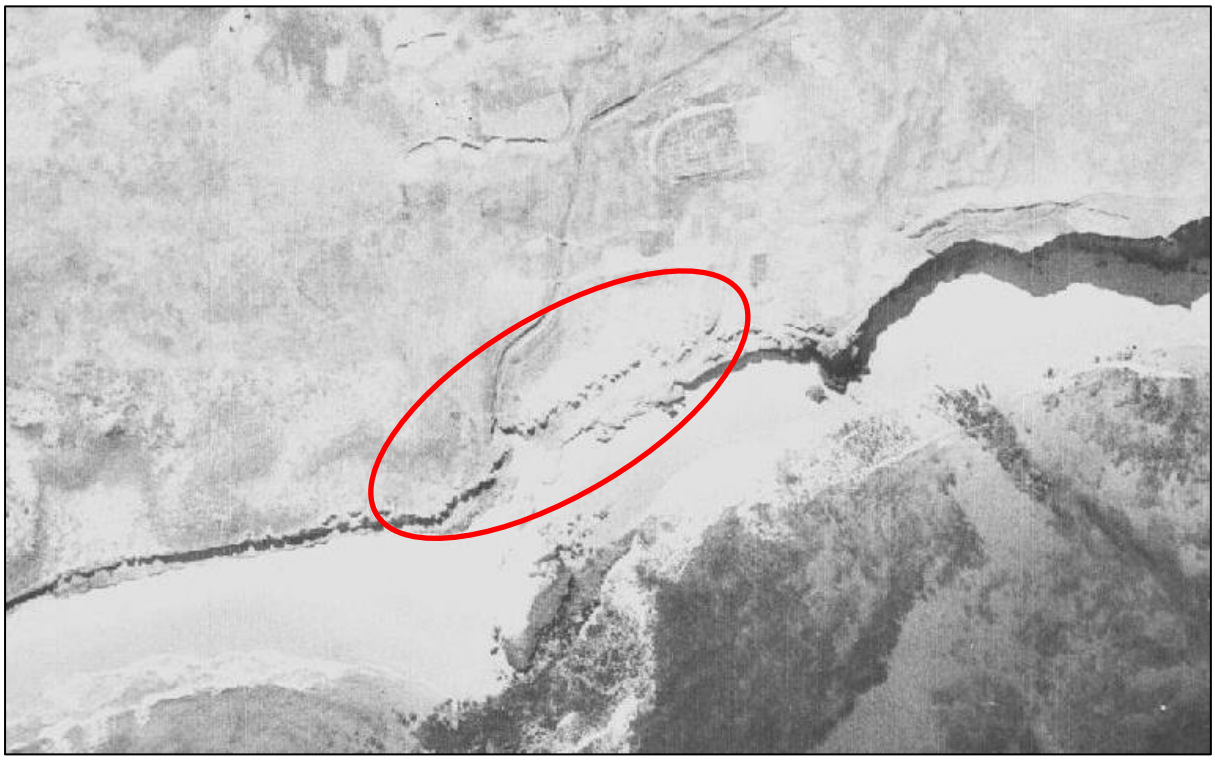

Plate 3: 1961 aerial. Approx study area in red (Source: NSW Spatial Services HV 2023).

Plate 4: 1986 aerial. Study area in red (Source NSW Spatial Services HV 2023).

Plate 5: 1996 aerial. Study area in red (Source; NSW Spatial Services HV 2023)

Plate 6: 2005 aerial. Study area outlined in red (Source; NSW Spatial Services HV 2023

Plate 7: 2016 aerial. Approx study area outlined in red

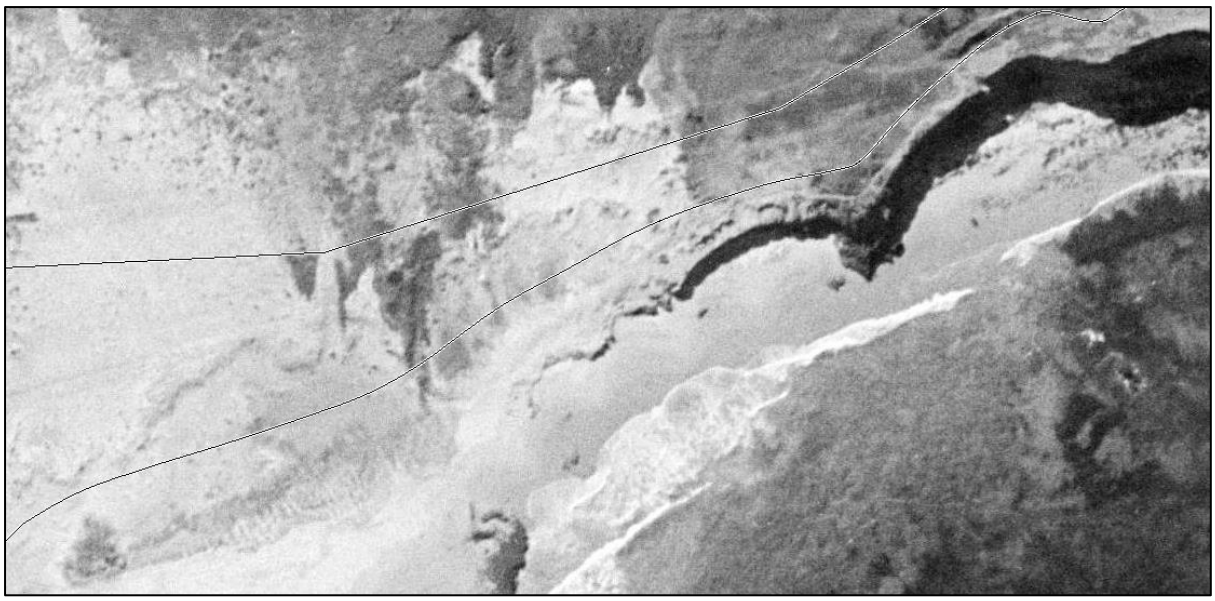

Plate 8: 1943 aerial imagery with current cadastral boundaries overlaid (Source: SIXMaps)

Plate 9: 2022 aerial imagery with current cadastral boundaries overlaid (Source: SIXMaps)

4.0 Literature Review

A review of previous archaeological work within the surrounding region of the study area was undertaken. A number of reports were identified from background research and the AHIMS database and are summarised below, with detailed summaries presented in Section 4.1.

Table 2: Previous heritage assessments undertaken by archaeological consultants in the region

Consultant	Date	Sites Identified	Region
Campbell	1899	Numerous	Broken Bay
Ross	1974	Numerous	Deep Creek
Denis Byrne	1984	Numerous	Palm Beach
Brayshaw McDonald	1987	Numerous	Queenscliff – Palm Beach
McDonald	1988	One	Bilgola/Avalon
Mary Dallas	1990	One	Cromer
R.G. Gunn	1992	Numerous	Garigal National Park
Tessa Corkill	2005	None	Palm Beach to Botany Bay
Fullagar et al.	2009	One	Narrabeen
Artefact	2020	None	Frenchs Forest
Coast History and Heritage	2021	None	Manly
Bryant	2023	Numerous	Northern Beaches

4.1 Previous Archaeological Work

An analysis of previous archaeological work within the study area assists in the preparation of predictive models for the area, through understanding what has been found previously. By compiling, analysing and synthesising the previous archaeological work, an indication of the nature and range of the material traces of Aboriginal land use is developed. An understanding of the context in which the archaeological assessment is vital, as development does not occur within a vacuum, but within a wider cultural landscape, and this must be considered during any archaeological assessment in order to develop appropriate mitigation and management recommendations.

4.1.1 Previous Regional Heritage Assessments

A number of previous archaeological assessments and research projects have been undertaken within the Northern Beaches area, as well as surveys that included Long Reef. Some of the more relevant investigations assessments are summarised below.

Campbell 1899

The government surveyor W.D Campbell undertook private archaeological surveys between 1886 and 1893 throughout the Sydney area and noted at the time that the creek beds within Narrabeen and Broken Bay warranted further investigation. Numerous rock engravings were identified in Manly and the wider Narrabeen Lake region. The many and varied engravings at Narrabeen around Middle Creek and Deep Creek included shields, boomerangs, waddys (wooden clubs), fishing spears, oval figures, fish, a whale, eels, ducks, kangaroos and wallabies, footprints

(mundoes) and net bags. Additionally, engravings on tessellated sandstone around the Beacon Hill area included shields, a boomerang, a club and an emu. Fred McCarthy from the Australian Museum later interpreted these in 1983 as an emu being hunted.

Ross 1974

In 1974 the Sydney University Prehistory Group undertook archaeological investigations around the Belrose and Beacon Hill areas, which are approx. 8 km northwest, and 4 km southwest, respectively of the current study area. Another survey was undertaken along Deep Creek in Narrabeen and Terry Hills approximately 5 km northwest of the current study area.

A number of engravings previously identified by Campbell were found in a reserve in Belrose, along with human-like anthropomorphic figures. Axe grinding grooves were located in a reserve at Beacon Hill close to Wheeler Creek, and a number of other engravings were relocated within private property in Beacon Hill. One site in a back garden contained a hammerhead shark engraving on a rock platform and water channels had been carved into the rock to divert water into holes. Axe grinding grooves were also around these waterholes.

The survey undertaken along Deep Creek identified engravings of a turtle, kangaroo and crest-shaped objects. These had not been recorded by Campbell and it was believed that some of them had been redone later by Europeans. A rock shelter with five artefacts made of quartz and jasper were found. Another site close to Monash Golf Club featured fish, a dolphin, snake and a shield on sandstone platform. The area around Terry Hills also noted rock engravings of figures including male and female figures, a shield, and kangaroo. Axe grinding grooves were also located here.

Byrne 1984

Byrne undertook an archaeological survey of the northern section for the Palm Beach sand barrier, approximately 19 km to the north of the current study area. The investigation was to inform the Warringah Shire Council (now the Northern Beaches Council).

The investigations identified 11 midden occurrences, and except for some intact *Anadara* (Sydney Cockle), the shells were only fragments. A 2 m x 2 m square was strung out on the surface of each midden and the material within each square was counted and classified. The middens ranged from a thin and sparce scattering of shell material to more concentrated layers. Although the majority of shells were Sydney cockle shells, oyster, and unspecified gastropods; *Nerita* and chiton were also identified. This demonstrated that the Aboriginal people were obtaining resources from both the rocky platform and estuarine environments. Stone artefacts, faunal remains and numerous pieces of sandstone pieces were also noted within the midden sites.

It was recommended that two of the middens were of high archaeological significance and should not be disturbed. If they were required to be buried, it was recommended that a durable material should be placed over them to enable relocation at a later date. The two other sites considered to be of 'medium' archaeological significance were also recommended to be avoided, but in the event impact could not be avoided, a thorough salvage was recommended. The remainder of the middens were considered to be of 'low' archaeological significance and destruction, if essential, was considered permissible.

Brayshaw McDonald Consultant Archaeologists 1987

Brayshaw McDonald Consultant Archaeologists (BMCA) undertook an archaeological survey for a bicentenary coast walk from Palm Beach to Queenscliff. The survey also included Long Reef Headland and the current study area.

A total of five previously unidentified archaeological sites were recorded and another eight known sites in the vicinity of the route were inspected to verify their location and the possible impact of the proposed development.

Although Hawkesbury sandstone was found to be outcropping along the headland it was generally found to be rough and unsuitable for engravings. The high levels of exfoliation of the sandstone were also considered to be pronounced and indicated a low probability for the survival of Aboriginal engravings. However, it was suggested that there was a high potential for sandstone platforms to contain engravings on Dee Why Head and Bangalley Head, but none were found.

As pointed out by BMCA at the time of their report, apart from Byrne's (1984) work at Palm Beach, few systematic archaeological surveys had taken place on the Northern Beaches. Previous investigations had been carried out away from the immediate coast, such as in the Narrabeen Lagoon area around Deep Creek.

The background research also found that 12 midden sites were the only site type recorded along the proposed walking route from the southern end of Palm Beach to Long Reef. However, several rock engravings including one at Palm Beach and three at Long Reef were recorded but not precisely located.

The pedestrian survey was undertaken by two archaeologists from BMCA. Although numerous attempts were made to contact the Metropolitan Local Aboriginal Land Council to invite them to participate in the survey, no response was received. The degree of disturbance along the route was considered very high and the only completely 'undisturbed' area was Bangalley Head at Avalon.

The five new sites identified are discussed in detail below. All were shell middens, three of them open sites, and two within rockshelters.

The Site QP3 (AHIMS #45-6-0741) falls within the current study area and was described as follows:

A sparse, scattered midden possibly a "dinnertime time camp" (Meehan 1982), the shells were found in an eroded section at the interface of a darker soil layer with a lighter horizon some 30- 40 cm below the present ground level. The lighter horizon is presumed to be post contact because of an in situ house brick 20 cm below the surface. Existing walking tracks in this area have accelerated erosion in several points across the site.

Shell was observed along only 22 m of the eroded bank, which is over 50 m long in total. A maximum of 20 individual shells were seen, most of these being large triton (over 80%), Cockle, oyster (Saccostrea commercialis) and sand snail (probably Polinices aulacoglossa) shells were also observed. Fragmented shell and an indurated mudstone artefact were observed below the bank, along the gullied and sheet washed erosion area. Another stone artefact was located 25 metres east of the erosion bank on a gravel lag. This was also of indurated mudstone, and consisted of an unmodified flake < 3 cm long.

The site was considered to be of low archaeological significance. As it was proposed that the access path could be moved to avoid it, no further archaeological investigations were considered warranted.

Plate 10: QP3 as recorded in 1987, located in eroded section to left of image (Brayshaw McDonald 1987)

AHIMS #45-6-07350 (QP1) was identified as being in a rock shelter immediately adjacent to the North Curl Curl Surf Life Saving Club car park. Only a portion of the midden deposit remained undisturbed due to the construction of a stone wall drain. It was approx. 40 cm deep in a black humic deposit in an area of 3 m x 1 m. It

contained approx. 80% triton and 20% black periwinkle, limpet, and other periwinkle species. The remaining has been reduced to bedrock. The site was not going to be impacted by the development and was considered to have limited potential due to the highly disturbed nature.

AHIMS #45-6-1756 (QP2) was in a rock shelter at Dee Why point situated approx. 15 m from the proposed track. It contained fragmented triton, black periwinkle and one cockle. There were also 14 stone artefact flakes and flaked pieces made from quartz, mudstone, and silcrete. The surface was also littered with broken glass, ring pulls and other garbage.

AHIMS #45-6-0746 (QP4) is approximately 460 m northeast of the current study area, it was described as an extensive, extremely rich and partially disturbed midden eroding out from the top of the cliff at Long Reef. It was approx. 100 m from the rock platform below and the variety of shell observable in the midden was considered to be a direct reflection of the abundance of the resource zone in the area. It was assessed as being 50 – 70 cm deep but the real extent was not known due to grass cover. The predominant species present in the midden were Sydney whelk (*Pyrazus ebinus*), the small whelk (*Velacumantus australis*), and many other species including cockle, periwinkle, triton, oyster, mussel, pipi and sand snail were present. It was recommended that a management plan be implemented as the scientific and cultural information were considered to be high.

AHIMS #45-6-0738 (QP5) on North Narrabeen headland was described as an open shell midden containing species including oysters, black periwinkle, whelks and cockle, positioned on a slope above a sheer drop from Narrabeen Head down to the entrance to Narrabeen Lakes. The site shell was intermixed with building rubble and other foreign matter.

A previously recorded site (AHIMS #45-6-112) at Turrimetta Head that was situated adjacent to the proposed walkway was also inspected and recorded. It comprised a shelter with midden and was at the base of the cliff at the northern end of the beach, just above the high tide mark. The deposit consisted of black humic sandy loam densely packed with shell material, including black periwinkle, triton, cockle, limpet, oyster and turban shell and sand snail. A fish scapula was also observed, as was a ground artefact measuring 4.5 cm x 5 cm and 1.4 cm. It was described as fine-grained basic and had grinding on both sides and was proposed to be the 'perfect shell-opening implement'.

Overall, the report assessed that the sites showed both estuarine and marine species of shell fish were targeted and only three of the six sites had stone artefacts. With the exception of AHIMS #45-6-0746 (QP4) on Long Reef Headland, the newly identified sites were considered to be of low archaeological potential due to the extensive disturbance. The AHIMS #45-6-0746 site was considered to have a rich deposit that had only been partially disturbed. It was recommended that this site be fenced off and stabilised. Further archaeological investigation would also be

required to define the limits of the site. It was also recommended that after the archaeological results had been completed, they be incorporated into the project as an interpretation feature.

Three of the four previously identified sites were found to have been destroyed. Only AHIMS # 45-6-112 at Turimetta Head was found to still exist. Although it was disturbed it was considered to potentially contain a rich deposit.

McDonald 1992

In 1988 human skeletal material was discovered on the surface of the deposit in an Aboriginal rock shelter within Angophora Reserve in Avalon, approximately 14 km to the north of the current study area. The examination of the bone fragment was initially considered to be of a 5-year-old child and the police conducted investigations within the shelter deposit. McDonald and her team conducted further controlled archaeological excavations. Although the top 10 cm was disturbed there was intact archaeology including a shell midden within the shelter. Preliminary carbon dating of the site indicated that the occupation of the site began approximately 2,000 before present (BP) but it was suggested that the site could be as old as 5,000 years old (McDonald 1992:96). The rock shelter was used most intensively as an occupation place around 2,000 years ago, after it had been used as a burial ground. Occupation ceased sometime around 1,150 years BP.

At the time of the report, it was considered that the remains of at least five (possibly six) Aboriginal people were recovered during the fieldwork. These included one adult buried with an Aboriginal baby around 6 months, two children between the ages of 3 and 5, and one (possibly two) other adult Aboriginal people. A total of 17 days were spent excavating selected areas within the site and 6,700 kg of deposit were removed from the site during this time, from which 3,350 kg of cultural material was also collected. The cultural material collected included shell, stone, plant, and faunal remains. Faint pigmented art work was also detected high on the western wall and featured faded charcoal drawings of several small anthropomorphic figures and red ochre drawings of two macropods (kangaroo/wallaby?) and a fish.

The shell species included over 30 species from the rock platform and estuarine environments with the dominate species being rock oyster that comprised 51% of the assemblage, followed by hairy mussel (21%), then Sydney cockle (10%). Most of the faunal material which made up the bulk of the protein (90%) brought into the site consisted of macropods (swamp wallabies, eastern grey kangaroos) and larger mammals such as possums and dingos, but also included; gliders, echidnas, bandicoots, reptiles, amphibians, birds and crustaceans. Seventeen species of fish were also retrieved but snapper was the dominant species, comprising 85% of the assemblage.

A total of 5,715 stone artefacts were recovered with the majority found within the shell midden (78%). The predominant stone material was quartz (55%), followed by indurated mudstone (14%), veined chert (11%) and chert (8%), and the remainder

comprised fine-grained volcanic, granite, fine-grained basic and other siltstone material. It was proposed that the quartz and veined chert would probably have been available locally as water-worn pebble. The tool/implement types included backed-blade (type of point that could be attached to a spear), and microliths (small stone tools) still coated in hafting resin from the *Xanthorrhoea* plant were also found. Other artefact types included several different types of bone points that were proposed to have been used as barbs for fishing spears, and some had evidence of polish that indicated use as awls for sewing baskets or animal skins. Shell scrapers made from Sydney cockle shells (*Anadara*) were also present and could have been used for cutting and scrapping wood to make implements. A piece of volcanic material with evidence of grinding that may have been from a ground-edged axe was also found.

Apart from the *Xanthorrhoea* residue, a variety of plant material including the poisonous *Macrozamia communis* kernels, burnt *Banksia* and *Casurina* seeds, paperbark and seaweed remnants were found. *Macrozamia* kernels were an important part of the Aboriginal diet and were ground to make flour. However, they are highly toxic and require extensive treatment through water and/or heat to leech the toxins.

The shell species included over 30 species from the rock platform and estuarine environments with the dominant species being rock oyster at 51% of the assemblage, followed by hairy mussel (21%), then Sydney cockle (10%). The majority of the faunal material comprised of macropods (swamp wallabies, eastern grey kangaroos) and larger mammals such as possums and dingos, but also included; gliders, echidnas, bandicoots, reptiles, amphibians, birds and crustaceans. Seventeen species of fish were also retrieved but snapper was the dominant species comprising 85% of the assemblage.

Overall, the assemblage provides evidence that Aboriginal people were occupying the southern part of Pittwater Peninsula since approximately 2,000 BP, but most probably closer to at least 5,000 years ago. The site appears to initially have been used as a burial ground around the same time that shell was been brought into the shelter. However, after this, it was used for more domestic purposes, as seen in the wide variety of plants, shell, faunal remains, stone implements and flakes. The locally available natural resources were gathered from the bush environment and ocean estuaries and rock platforms, which are approximately 1 km away. The quartz stone and veined chert may have been procured locally as small pebbles, but other stone would have been obtained through direct access or trade from further afield.

MARY DALLAS 1990

Mary Dallas conducted an archaeological survey near Narrabeen Lagoon, approximately 3 km to the northwest of the current study area. The investigation was to identify sites or areas of archaeological and Aboriginal significance. It was

undertaken for the Department of Housing and completed in consultation with the Metropolitan LALC.

The study area comprised 6 hectares of natural bushland within the catchment of Narrabeen Lagoon that were close to Cromer Golf Course. Dallas noted that previous investigations within the wider area, such as those undertaken by Campbell (1899), McCarthy (1983) and McDonald (1987), had been to identify specific site types within sandstone outcrops, such as rock engravings and rock art within rock shelters. Dallas also noted that Attenbrow (1980) had stated that even in rock shelters that have no apparent visible archaeology, there is a high potential for them to contain subsurface archaeology.

The survey relocated a kangaroo engraving site on a rock platform previously identified in 1983 by McCarthy. A rock shelter site was also identified on the western edge of Cromer Golf Club and contained a deposit 20 cm deep x 2 m wide, and 3 m long. Stone artefacts made from quartz and mudstone artefacts were located on the floor towards the front. Another rock shelter along Cromer Road was also identified but no archaeological material was found within in it. The floor of the shelter comprised of <5cm of soil washed in from upslope onto a rock base. It was not considered to be an Aboriginal site and it had no potential to contain archaeological deposit.

In consultation with the Metropolitan LALC it was recommended that although the site would not be impacted a management strategy should be implemented.

GUNN 1992

Gunn was engaged to undertake a study of Aboriginal sites within Garigal National Park. The area included approximately 1800 ha and included the greater part of Deep Creek and its catchment, and the lower valley of Middle Creek, approximately 6 km to the northwest of the study area. The aim of the study was to record a representative sample of the Park's archaeological sites so as to enable significance assessments of particular site types and the archaeological sensitivity of the region.

A review of the previous assessments found that the investigations tended to be directed towards ridge tops and upper slopes rather than lower slopes. It also found that a large number of rock engraving sites had been noted, along with a couple of axe grinding groove sites, a stone arrangement and a few rock shelters.

Garigal National Park is within sandstone country and is drained by two large creeks, Deep Creek and Middle Creek. Both trend eastward and feed Narrabeen Lake before emptying into the ocean. The upper reaches of Deep Creek are only 10 km from the ocean. It was noted that plants for making wooden implements included string and paperbark, *Xanthorrhoea* for spears and *Casuarina* for bark canoes and fibrous Kurrajong for fishing line. The Aboriginal people that once lived here would have enjoyed a coastal and estuarine economy.

The field work was conducted over 13 days in February 1992 and included a representative from Metro LALC and NPWS. It was suggested that as the park had already been walked over for a couple of previous archaeological surveys, it was unlikely that any major art sites or rock shelter with deposit had been overlooked. It was proposed to relocate the art sites and focus on trying to locate open artefacts scatters that are unrepresented in the Park.

A total of 17 sites were located. Twelve had been previously recorded and five were new sites. Of the other 23 sites previously recorded as being within the park, eight were considered to be unreliable and would require further investigation. All the sites occurred in only two landform units: ridge-tops and slopes. No sites were located in the creek-line or alluvial flats.

The most common rock engraving motif was mundoe (footprints) which accounted for 34%, followed by fish types 11%, macropod/bandicoot 9% and human 7% (one woman and ten men). Only 4.5% contained grinding grooves. The largest motif was the whale, which was 1.3 m long. The rock art within the four rock shelters consisted of red hand stencils, and black and white echidna, a line, and indeterminate motifs. The only stone artefact that was identified during the survey was a single quartz artefact.

Gunn proposed that the main habitation area for past occupancy would have been on the coastal headlands during the summer months, when food and water were plentiful. The Aboriginal people would have lived principally on a marine diet, but with occasional forays into the creek areas. Surprisingly Gunn doesn't mention the potential significance of so many engraving sites concentrated within Garigal National Park. He only states that they were probably etched during the summer months.

Various recommendations were made to protect the sites and it was also recommended that the Metropolitan LALC be involved at all stages of the management of the archaeological sites within the park.

CORKILL 2005

Tessa Corkill (2005) undertook a research project for the Australian Museum to identify potential rock sources that would have been used by Aboriginal people to make ground-edge hatchets that have been found within the Sydney Coast and hinterland Regions. Corkill inspected beaches and cliff lines from Palm Beach to Port Jackson and observed that, although there are basalt diatremes along this stretch of coast (located in Avalon and Bondi for example), no useful sources (bedrock and/or cobbles) were identified. Corkill proposed that the closest sites to source raw material for ground-edge hatchets would have been from cobbles found along the Hawkesbury/Nepean Rivers in Western Sydney, and/or at Bellambi Point in the Illawarra Region to the south, and bedrock from Kulnura (Peats Ridge/Popran Creek) in the Central Coast Region to the south.

Fullagar, McDonald and Donlon 2009

In 2007 the skeletal remains of an adult Aboriginal male were accidently exposed during cable installations in a remnant sand due on Ocean Street, Narrabeen, approximately 4 km to the north of the current study area. The man's skeleton was dated to 3677 cal BP and seventeen stone artefacts were recovered during salvage.

Twelve of the stone artefacts made from quartz, silcrete and quartzite were found to be 'backed blades'. These are small stone implements that have a sharp edge and pointy end. They can be secured to an implement such as a wooden spear because the side opposite the cutting edge has been 'backed' to provide suitable surface area that aids with friction. One backed artefact was found lodged between two of the vertebras near the hip. Other backed artefacts were found adjacent to or lodged in other vertebrae further up the spine suggesting two spears had penetrated from the back.

The study also found that the use-wear on other backed blades within the grave indicate that this type of tool also probably functioned as the piercing, cutting and lacerating elements of spears and knives.

Attenbrow 2012 (ongoing)

In 2012 Val Attenbrow and her team from the University of New England and the Australian Museum commenced a long-term provenancing study in 2012 to match ground-edged artefacts (GEAs) that had been collected within the Sydney Basin area to their geological source. The assemblage included a number of GEAs that had been collected along the northern beaches, including within the Long Reef area. The geological reference collection comprised 368 specimens from 169 locations, stretching from southeastern Queensland to the Shoalhaven River in southern New South Wales. Over 100 geological specimens were from locations within and adjacent to the Sydney Basin.

Although the provenancing-study Geological Reference Collection included mainly basalts there are also other igneous rock types, such as dolerites, dacite and porphrytic volcanics, alkaline andesites, tinguaite and diorites. The metamorphic rock, hornfels, is also included in the collection. Most of the rocks came from primary sources of exposed bedrock in diatremes, dykes and extinct volcanoes. However, a number were also collected from secondary sources as cobbles that formed when bedrock has broken off, entered a waterway, and over time were smoothed into rounded cobbles. For example, hornfels occurs as bedrock in the Upper Coxs River Valley in the Blue Mountains, and in cobble form in the Nepean Gravels at the mouth of the Grose River between Yarramundi and Penrith. Rocks from the upper Shoalhaven River occur in cobble form at Shellharbour South Beach and Bellambi Point on the South Coast (Attenbrow et al. 2017:177).

So far, the published research has matched numerous ground-edged artefacts to bed rock sources to a basalt bedrock quarry at Popran Creek-Peats Ridge in the Central Coast, the Nepean River in western Sydney, along with sources in the Hunter

Valley, South Coast and Blue mountains. Preliminary results have also have matched a number of ground edged hatchets and stone skinning knives found along the Northern Beaches including Long Reef to basalt out crops at Popran Creek-Peats Ridge within the Central Coast (Attenbrow pers com December 2022).

ARTEFACT 2020

Artefact was engaged to undertake an Aboriginal heritage assessment for the Northern Beaches Hospital Precinct. The investigation included background research, a site inspection and consultation with Metropolitan LALC. Although no sites were previously identified as being within the study area, 34 sites registered as being on the surrounds. The entire area was considered to have cultural heritage value as part of a wider Aboriginal cultural landscape.

A site survey was conducted and the area was found to be heavily disturbed and there was considerable vegetation in areas not built on. No archaeological sites were found but two areas of potential archaeology were identified. One was to the northwest of the sports oval within Forest High School, and the other was in the eastern portion of the Northern Beaches hospital site.

It was recommended that all DAs submitted to Council for land within the study area should be accompanied by an assessment in accordance with the OEH 'Due Diligence Code of Practice'.

COAST HISTORY AND HERITAGE 2021

Coast History and Heritage undertook an Aboriginal Due Diligence assessment for NSW National Parks & Wildlife Services for proposed upgrade works within North Head, approximately 12 km south of the current study area. A review of previous archaeological investigations, consideration of the underlying geology and soli landscapes, as well as historical land disturbance were reviewed. The initial desk-top investigations highlighted that although no Aboriginal sites had been identified within the study area, there was a large number of important sites that had been identified within a 3 km radius of the study area. These included rock shelters with art and archaeological deposits, engravings, shell middens in open areas, and Aboriginal burials.

A pedestrian survey was undertaken in conjunction with a representative from Metropolitan LALC, Kevin Telford. The headland had recently been subjected to a severe fire that burnt through much of the headland. This led to a greater number of exposures being visible that would ordinarily have been obscured by dense vegetation. Most of the area was found to have been heavily impacted by historical disturbances through the construction of roads, lookouts, and the construction and subsequent demolition of buildings. No rock shelters were identified within the area of proposed works and none of the exposed sandstone contained visible engravings. No stone artefacts or culturally marked trees were found.

It was recommended that no further archaeological investigations were warranted, but a site induction be provided to the construction team that included an Aboriginal heritage information which outlines the unexpected finds procedure.

BRYANT 2023

Rebecca Bryant undertook a research project for her Master's thesis at Sydney University that analysed the morphological difference and similarities of 492 ground-edged artefacts (GEAs) that had been provenanced to five regions within the Sydney Basin in NSW, which included the Sydney Coast, Sydney Hinterland, Central Coast, Hunter Valley and Blue Mountains. The Sydney Coast Region included numerous GEAs found within the Northern Beach. Ten of these had been found between Narrabeen and Curl Curl, of which four were found at Long Reef.

A set of variables were used to investigate whether there are morphological similarities and differences of GEAs within these regions, and if any of the GEAs could be considered prestige items. The variables analysed included the preform of the raw material source (cobble, bedrock or indeterminate), measurements, shapes, and degree of damage and modifications to the GEAs, including pitting, flaking, hammerdressing (a labour-intensive form of pecking) and grinding. This data was then incorporated with the pXRF findings undertaken by Attenbrow et al. 2012 (discussed above) and with use wear results that have been conducted by Nina Kononenko in 2017.

The results for the GEAs from the Northern Beaches showed that the majority of them were made from a bedrock outcrop source in the Central Coast Region. This indicates that Aboriginal people occupying the Northern Beaches were either travelling to the Central Coast to obtain the raw material and make the hatchets locally, or they were obtaining complete items by trade.

The results also showed that eight of the ten GEAs found in proximity to the study area could be classified as hatchets that would have been hafted to a wooden handle and used for woodwork, such as chopping into trees to remove branches, or cutting footholds for climbing to obtain animals or honey. A number of the hatchets also had percussion pits on one or both faces which were used to process food such as *Macrozamia* nuts or to break stone apart. For example, a quartz pebble could be placed on the face of the hatchet and another rock was used to break a flake off. This is called the bipolar method and was used on small rock pieces that are most likely too small to efficiently handle and flake.

Two of the GEAs were also noted to be Bulga Knives. One was found at Curl Curl and one was found at Narrabeen. Bulga or skinning knives were made from pieces of bedrock or cobble that have been ground on the long side of the material and resemble the blade of a knife. These have been found through usewear analysis to have been used on soft material like animal skins.

The overall results for the research project also showed that although no large completely polished GEAs of a standardised shape were identified, as seen in international axe studies on prestige axes, there is evidence that GEAs were, and continue to be, socially and culturally valued. This is established in their presentation in rock art, and inclusion in Dreaming stories and ceremonial practices. Ground edged hatchets and Bulga Knives have also been found in Aboriginal burials in Balmoral Beach and Manly.

SUMMARY

In summary, a number of archaeological investigations have been undertaken within the Northern Beaches area including Long Reef Headland since the late 1800s. These have been for research projects and to fulfill statutory requirements prior to the construction of buildings and civil works. The results of these investigations have demonstrated that this resource-rich coastal area has been used by Aboriginal people for at least 4,000 years BP, but probably for much longer.

The excavations undertaken at the Angophora rockshelter in Avalon by McDonald in 1988 showed that the Aboriginal people that once lived in the Northern Beaches area for thousands of years used an extraordinarily wide-ranging selection of natural resources. This included shellfish collected from estuarine waterways and rocky coastal platforms that were eaten, and the shells modified to make implements such as fishhooks and scrappers. Native plants such as the *Xanthorrhoea* grass plant were processed to make resin to attach tools to wooden handle, twine was used to make baskets and nets, and seeds ground to make flour for food. Stone that was collected locally and brought into the area was used to make a wide variety of implements/weapons including, ground-edged artefacts (hatchets and Bulga knives), backed blades and scrapers. Small and large animals were caught for food and their bones were also sometimes used. For example, bone points were made by sharping one or both ends. Some were used as tips on pronged fishing spears, and the large ones used as needles to puncture holes through animal skins to make cloaks. The discovery of the skeleton of the Aboriginal man at Narrabeen who had been speared to death over three thousand years ago, showed that that small stone backed blades were also used to inflect harm and could cause death.

Although the sandstone along the coastal area of the Northern Beaches was noted by previous investigations as generally unsuitable for engraving, a large number of interesting engravings of animals, tools and implements are found a little more inland on the western side of Pittwater Road around the Narrabeen Lake/Wakehurst area, Terry Hills and Belrose. Axe grinding grooves were also found in these areas along the creeks. However there was limited evidence found for occupation of these areas. This suggests that perhaps people visited here for more ceremonial activities but lived along the coast.

With regards to the current study area, except for sections within the coastal perimeter of Long Reef Headland, and its eastern point, the area now comprises

Long Reef Golf Club. Prior to the construction of the golf club in the early 1920s, the area had been used for agricultural purposes since the early 1800s. These activities have resulted in large-scale disturbance and only a paucity of tangible evidence for previous Aboriginal visitation and/or occupation appears to remain. Eight of the nine sites currently registered as being within the headland are shell middens. The other is registered as a burial. Although another burial was noted to have been found during the construction of the Long Reef Golf Club on the northern side of the headland during construction, this has not been verified[1]. Additionally, the skull in the 'burial' was noted in 1940[2] to be eroding from an embankment on the northern side of the headland and registered as a site in 2005. However, there are no further details on the skull, including confirmation that it was a skull from an Aboriginal person.

4.2 AHIMS Results

An extensive search centred on the study area and covering a 5,000 m x 10,000 m was conducted on 3 July 2023. This resulted in the identification of 62 registered sites including one within the immediate study area. This is registered as AHIMS #45-6-0741 (QP3). The site features listed are 'shell' and 'artefact'.

Sites can be recorded as a particular site type: closed or open. For the 62 sites in the search area, 15 (24%) are registered as rock shelters and 47 (76%) are open sites. Rock shelters are generally present where bedrock outcrops in escarpments. Within the search area this landscape is seen in the elevated cliffs fringing the coast.

Sites are also recorded with one or more of a set of twenty-two site features specified by AHIMS. For the 62 sites in the search area, a total of 75 instances of six site features have been recorded (Table 3). The two site features that have been most commonly recorded are art (pigment or engraving), and shell, followed by stone artefacts. The site feature 'shell' generally indicates the presence of middens. Eight of the 18 midden sites are in rock shelters and the remaining tend are in open sites. There are four grinding groove sites that occur on exposed sandstone platforms. There are also two burials of Aboriginal people that have been recorded.

As mentioned above in the literature summary, there are nine registered sites within Long Reef Headland, eight of these are shell middens and one is a burial. All of the sites, except for the one mapped as being within the current study area, are on the northern side or far eastern point of the headland and at least 400 m away from the current study area.

[1] Rebecca Bryant from Apex Archaeology contacted Ben Russell, the General Manger of Long Reef Golf Club in August 2023 for more details. Ben advised he would pass on Rebecca's details to the authors to contact her. No communication from them has yet been received.
[2] The information relating to the skull was reported to the Aboriginal Heritage Office (AHO) in 2005 by a woman who saw the skull eroding in 1940.

A copy of the search results is appended in Appendix F and have been utilised for the AHIMS site mapping.

Table 3: Site features recorded for 62 sites within the 10 km x 5 km search area

Site Features	No. of instances	% of total
Art (Pigment or Engraved)	32	43
Shell	18	24
Stone artefacts	16	21
Grinding Grooves	4	6
Potential Archaeological Deposits	3	3
Burial	2	3
Total	**75**	**100**

Figure 9: AHIMS sites within the study area and immediate surrounds

FIGURE NOT INCLUDED IN PUBLIC REPORT

4.3 Predictive Model

Based on the results of previous archaeological investigations within the wider region, a number of predictions regarding Aboriginal use of the area can be made. These predictions focus on the nature, extent and integrity of the remaining evidence.

The landscape characteristics of the area influence the prediction of the nature of potential sites within the landscape itself. Disturbance is the predominant factor determining whether or not artefacts are likely to be identified within a landscape.

Surface sites are likely to have been impacted by pedestrian activity, vegetation clearance, the construction of water drainage and structures within the area over the historic period. Natural actions such as erosion and bioturbation are likely to have also impacted not only the surface, but also at least the upper levels of subsurface archaeological deposits. Whilst these actions may impact the integrity of stratigraphy within the deposit, this does not necessarily mean associated archaeological objects will also be disturbed.

In general, Aboriginal use of an area is based on a number of factors, such as:

- Proximity to permanent water sources – generally permanent or areas of repeat habitation are located within approximately 200m of permanent water;
- Proximity to ephemeral water sources – generally sites near ephemeral water sources were utilised for one-off occupation;
- Ease of travel – ridgelines were often utilised for travel during subsistence activities; and
- The local relief – flatter, more level areas were more likely to be utilised for long term or repeat habitation sites than areas of greater relief, especially if the slopes are at a distance from water.

Stone Artefacts

Stone artefacts can be identified on the ground surface or within subsurface deposits. Generally, artefact concentrations are representative of debris from knapping activities, which includes flakes, flake fragments, cores, and pieces likely to have been knapped but with no or inconclusive diagnostic features, referred to as flaked pieces. Modified artefacts can also be identified, including backed artefacts, scrapers, or edge ground axes, although these are generally a smaller proportion of the artefact assemblage. During excavation, very small debris (~3-5mm) can be identified within sieved material, and is referred to as debitage. This is indicative of *in situ* knapping activities.

As the detection of stone artefacts relies on surface visibility, factors such as vegetation cover can prevent their identification. Conversely, areas of exposure can assist in their identification. Stone artefacts have previously been identified within the site mapped within the current study. However, given the site has been subjected

to natural and man-made erosion since it was recorded in the 1980s there is a low possibility these same artefacts may still be present within the registered site. However other stone artefacts may be present in a disturbed context elsewhere within the study area.

Quarry and Procurement

Exposures of stone which can be exploited for the production of lithics are referred to as quarries or procurement sites. Quarries generally have evidence of extraction visible, while procurement sites can be inferred through the presence of artefactual material made from raw material sources present within the area.

The underlying geology of the study area is sandstone which often contains small conglomerates of rock including quartz pebbles, which was used by Aboriginal people to make implements and weapons. It is unlikely the study area would have been an active quarrying site, but pebbles and gravels may be located here.

Middens

Middens are concentrations of shell, and may also contain stone artefacts, bone and sometimes human burials. These sites are generally recorded along coastal areas. Middens are formed through the exploitation of locally available species by humans for resources, and accumulation of the shell material within a specific location. Middens can range in size from small, discrete deposits, to deposits covering a large area.

Generally, middens reflect the species available in the local area. In estuarine regions, estuarine species will dominate the composition of the midden, while around headlands, rock platform species tend to dominate. A midden has been recorded as being within the current study area and others have been recorded within Long Reef Headland. As such, it is likely that the area contains midden material, and additional material may be identified.

Burials

Aboriginal people across Australia utilised a range of burial forms, which depended on the customs of the individual tribes. Common burial practices included inhumation, cremation, desiccation, and exposure. In the wider Sydney area burials have been found within coastal Holocene sand bodies, in association with shell middens, and in rockshelters. Burials have been recorded within sand dunes, and remnant sand dunes, and rock shelters within the Northern Beaches. However, they are generally not identified during field survey as there is usually minimal surface expression of this type of site.

To date, there appears to be no records of human burials being identified within the specific study area itself. However, it was noted during the background research for this current project that Aboriginal bones were unearthed during the construction of the Long Reef Golf Club, but no actual date was specified (Lanes and Mellowes 2012:2012). A skull was also noted to have been eroding out of an embankment on the northern side of Long Reef headland in 1940 and reported in 2005 to the

Aboriginal Heritage Office. However, there is no more information on this and the Aboriginal Heritage Office have noted in their report on the site that no other remains or cultural material has been found in the area where the skull was reportedly eroding from (AHO 2016).

The level of disturbance present within the study area suggests that intact burials are unlikely to occur within this area.

ROCK SHELTERS

Rock shelters are formed by rock overhangs which would have provided shelter to Aboriginal people in the past. Often, evidence of this occupation can be found in the form of art and/or artefacts. Shell, midden material, grinding grooves, pictographs (rock engravings), artworks including stencils and paintings, and potential archaeological deposits (PAD) are common features of rock shelter sites.

The available mapping of the underlying geology within the study area is sandstone. However, no rockshelters have been recorded within Long Reef Headland. It is considered unlikely that this site type will occur with the study area.

GRINDING GROOVES

Grinding grooves are formed on sandstone exposures through the creation and maintenance of ground edge tools, such as axes and spears. Usually, stone was ground to form a sharp edge, although bone and shell were also ground to create sharp points.

Generally, fine grained sandstone was favoured for these maintenance activities, and the presence of a water source nearby or overflowing the sandstone was also favoured. Grinding grooves range from individual examples through to hundreds of grooves within an area, sometimes arranged in a specific pattern. Horizontal sandstone was generally preferred, although there are examples of vertical grooves.

There is outcropping sandstone near the study area, but no grinding grooves have previously been recorded within or near the study area. It is considered unlikely that this site type occurs within the study area.

SCARRED AND CARVED TREES

Scarred and carved trees are created during the removal of back from a tree for a range of reasons, both domestic and ceremonial. This type of site can be identified within areas containing trees of the correct species and appropriate age. Deliberately scarred trees can be difficult to differentiate from naturally occurring damage to trees, and specific criteria must be considered when assessing a scar for a cultural origin.

No scared or carved trees have been recorded as being in or within the study area. Given the large-scale vegetation clearance that has been undertaken within the study area, there is a low potential for this site type to occur.

Ceremonial Sites

Specific places were used for ritual and ceremonial purposes, including initiation and burial practices. Secret rituals were also undertaken at specific places by specific individuals, such as at water holes and by clever men.

The landscape itself was also considered to hold significance to Aboriginal people, and the understanding of this is referred to as a sacred geography. This includes natural features which were associated with spirits or creation beings. The meaning attributed to the landscape provided Aboriginal people with legitimacy regarding their role as guardians of the places which had been created by the spiritual ancestors (Boot 2002).

Many areas within the Northern Beaches are considered to be sacred to the original inhabitants. There are no known recorded areas within the study area, although this does not preclude these values from existing within this location.

Contact Sites

Contact sites contain evidence of Aboriginal occupation concurrent with initial colonisers in an area. This could include evidence such as flaked artefacts formed on glass, or burials containing non-Aboriginal grave goods. Often Aboriginal camps would form around newly built towns, allowing for employment (or exploitation) of the Aboriginal people by the colonists, and also for trade to exist between the two communities. Contact sites can also occur around Aboriginal mission sites, where Aboriginal children were taken from their families to raise in the European manner. Families often camped around the mission boundaries to try to catch a glimpse of their children.

There is no known evidence of initial contact between Aboriginal people and colonists within the study area.

5.0 Field Work

5.1 Sampling Strategy

A sampling strategy was developed and provided to the Registered Aboriginal Parties (RAPs) as part of the consultation process completed for the ACHA. The strategy included assessment of all landforms within the study area that have the potential to be impacted by the proposed development. Areas considered likely to have archaeological potential were closely scrutinised, although the entire study area was considered.

The sampling strategy included consideration of the entirety of the study area due to the nature of the development proposal, in order to provide an accurate assessment of the study area in relation to the proposed impacts.

5.2 Site Inspection

A site survey was undertaken on 21 July 2023 by Leigh Bate, Jenni Bate and Rebecca Bryant from Apex Archaeology, and Justine Coplin from Darug Custodians Aboriginal Corporation.

5.3 Survey Coverage

The survey was conducted on foot within the study area and immediate surrounds to identify Aboriginal cultural material and areas that have the potential for subsurface cultural material to be present. It also provided an opportunity to access the ground disturbance that was identified in historical aerials and the documented land-use history of the area.

The survey was undertaken in accordance with the sampling strategy prepared for the project and included the entirety of the study area. It was undertaken by three participants. The area assessed is within a sand dune landform that has been subjected to extensive erosion from wind, water and historic land-use disturbance. Large sections have eroded to the point that it has exposed the underlying geology and the remaining areas are either covered in vegetation or present as exposed patches of sand. The study area was considered to consist of one land form that had eroded to the point that the underlying geology was exposed. As such it was assessed as one survey unit (Table 3Table 4).

Table 4: Survey units

Unit name	Landform Element	Number of participants	Total Length
ATU 1	Sand Dune/Disturbed Terrain	3	377 m

During the survey completed by Apex Archaeology the study area was inspected for Aboriginal archaeological evidence. An assessment of landform element and slope was made for the study area, with the results presented in Table 5.

Table 5: Survey unit results

Survey Area #	Landform Element	Slope	Vegetation	Detection Limiting Factors	Ground Disturbance
ATU 1	Sand Dune	Level-very gentle (<1.45°)	Coastal Dune/Cleared	Vegetation/Sediment	High

The total survey coverage (meaning the areas physically inspected for archaeological evidence) was approximately 2,262m^2. The total area of the development impact is approximately 2,500m^2. A range of factors were considered and recorded during the survey, including the surface visibility (percentage of bare ground within a survey unit); archaeological visibility (amount of bare ground within an area in which artefacts could be expected to be identified if present); exposure type (B soil horizon/underlying geology (G)) and calculations of how effective the survey coverage was. The results of the survey coverage are presented in Table 6.

Table 6: Survey coverage results

Survey Area #	Total Area Surveyed (m²)	Surface Visibility (%)	Arch Vis (%)	Exposure Type (B)	Effective Coverage (m²)	% Total Effective Survey Coverage of Context
ATU 1	2,262	40	30	B/G	271.4	12

Surface visibility across the study area was limited due to vegetation cover. Total effective survey coverage of the survey transect was 12%. Total effective survey coverage for the entire study area was 10% (Table 7).

Table 7: Total effective survey coverage results

Survey Area #	Total Area of Study Area (m²)	Total Area Effectively Surveyed (m²)	Surface Visibility (%)	Arch Vis (%)	Exposure Type (A/B)	% Effective Survey Coverage of Context (Total Area)
ATU 1	2,500	271.4	40	30	B/G	10.8

PO Box 236
NOWRA
NEW SOUTH WALES 2541

0 30 60
metres

Projection:
MGA Zone 56 (GDA 94)
Base Map:
NearMaps 2023
Image Date: 21/10/2023
Final - Version 1

Figure 10: Survey transect within the study area.

N

5.4 Survey Results

The survey centred on four main areas where the proposed works will be undertaken. These were; the land either side of the existing board walk; the section where the registered Aboriginal site AHIMS #45-6-0741 (AP3) has been mapped; the drainage area onto Long Reef Beach from the man-made creek that drains the golf course; and the areas on the greens within Long Reef Golf Course around the woman's and men's tees on the 17th hole.

The current walking track of Long Reef Golf Club within the study area is made of wood, except for a small portion in the eastern and western portions that are paved in concrete (Plate 11). The original dune landscape on the northern side of the walking track, and both sides of the track around the bridge has been severely impacted by wind, wave and pedestrian erosion. This has resulted in the exposure of the underlying sandstone, claystone and dark peat areas. It has also compromised the structural integrity of the wooden track within the path (Plate 12 and Plate 13).

The section on the northern side of the wooden track where the registered Aboriginal site AHIMS #45-6-0741 (AP3) has been mapped was closely inspected. This area has been subjected to extensive erosion and the construction of the boardwalk since it was recorded in the 1980s, and it is highly unlikely that the area retains an intact soil profile from that time. The current exposed areas were observed to comprise approximately 30 cm of a mixed-sand profile below the vegetation cover (Plate 14). This overlayed a sticky clayey peat-like profile that is part of the underlying geology. There was no evidence that a shell midden was still within the site. No shell, stone artefacts, charcoal and/or faunal remains were observed, and the site was considered to have been destroyed by natural actions in the more than 30 years since it was originally recorded.

The area around the existing bridge over the man-made creek that drains onto Long Reef Beach comprises introduced fill mixed with what was probably the original dune sand. The base of the drainage line has been shored up by sandstone boulders and the exposed sides showed sand mixed with vegetation and rubbish (Plate 15 and Plate 16). No intact stratification was evident and an exposed area on the southwestern side of the drainage line showed a burn event with a large amount of rubbish (Plate 17) including an old bottle with '1957' imprinted on the base (Plate 18).

The portions within the greens on the golf course, including the 17th fairway, the women's and men's 17th tees, and the 'rough' area to the south of the fairway were inspected (Plate 19). These areas were found to be heavily modified from the construction of the golf course and concrete path. These works would have included shallow, moderate and deep subsurface excavation, and the reworking and contouring of the original sand dune systems. Fill may have also been brought into the area from external sources or other areas within the headland.

Plate 11: View south east along the existing section of Long Reef board work that is to be replaced and a new board walk constructed approximately 10 m to the north (to the right in the image).

Plate 12: View north of western section of Long Reef boardwalk showing the exposed underlying geology on the south side of the boardwalk, and disturbed sand dunes profile on the north side.

Plate 13: View north of eastern section of Long Reef boardwalk showing the exposed underlying geology on the south side of the boardwalk, and disturbed sand dunes profile on the north side.

Plate 14: View north of exposed area where AHIMS #45-6-0741 was recorded.

Plate 15: View south of existing bridge over man-made creek that drains the golf course. The east and western banks bordering the drainage line comprise natural and introduced fill.

Plate 16: View north within drainage line showing introduced sandstone boulders.

Plate 17: View north showing exposure of a burn even and protruding rubbish at the southwest corner of drainage channel.

Plate 18: View north showing close up of exposure showing base of bottle with 1957 date stamp.

Plate 19: Facing east over green near tees for the 17th hole and walking path to the right of the image.

Plate 20: Facing east over green overlooking the tee box for the 17th hole and walking path to the right of the image.

5.5 Discussion

The survey inspection confirmed the high level of land disturbance that has been noted in historical images and information in Section 3.2 of this report. The areas either side of the board walk have been subjected to ongoing natural erosion processes through wind and wave action, as well as the impacts from continuous pedestrian activity. This has affected large portions of the study area to the point that underlying geology is exposed. The areas around the bridge including the drainage channel have been built up from redeposited dune sand which is mixed with historic rubbish. Evidence of this is notable in the exposed portion of the dune in the southwest portion of the drainage opening facing the beach. The disturbance within the golf course that was detailed in historic documents and seen in historical imagery was also confirmed in the site survey.

The AHIMS #45-6-0741 (QP3) shell midden site that was registered as being within the study had been recorded in 1987 and noted on the site card as being in 'poor, eroding badly' condition (Plate 21). The shell was recorded as being along 22 m of the eroded bank and within the interface of a darker soil layer, and lighter soil layer with a house brick in it. Two artefacts were also noted on the site card as being within the gullied and sheet washed area. The site inspection could not relocate the shell midden in the area where it had been mapped (Plate 22). There was no evidence of shell, stone artefacts or faunal remains in the exposed areas. It is suggested that the site has been destroyed by ongoing erosion and possible impacts from the construction of the coastal walk.

Overall, it is highly unlikely that any of the original A1 and A2 soil horizons, where cultural material would be expected to be found would survive in an intact profile within the study area. There has been heavy and consistent land disturbance since the 1800s that has included natural erosion from wind and wave activity, as well as deep excavations for drainage lines around the bridge area and within the golf course. The deliberate or unintentional introduction of fill into the sand dunes landscape has also caused further disturbance. Additionally, the construction of the boardwalk would have also impacted the original landscape, and the constant pedestrian traffic that continues on and off the walkway has further damaged the area bordering the cliff line and within the golf course.

The results of the pedestrian survey coupled with the historical documented evidence were discussed with Justine Coplin from Darug Custodian Aboriginal Corporation during the survey and afterwards. Justine agreed that the study area is highly disturbed and has limited potential to contain an intact soil profile with cultural archaeological material. Furthermore, there is no evidence that any part of the registered AHIMS #45-6-0741 (QP3) still exists.

Plate 21: QP3 as recorded in 1987

Plate 22: Location of QP3 during current assessment

6.0 Scientific Values and Significance Assessment

6.1 Introduction

The *Aboriginal cultural heritage consultation requirements for proponents 2010* acknowledge that:

- Aboriginal people have the right to maintain their culture, language, knowledge and identity
- Aboriginal people have the right to directly participate in matters that may affect their heritage
- Aboriginal people are the primary determinants of the cultural significance of their heritage

Undertaking consultation with Aboriginal people ensures that potential harm to Aboriginal objects and places from proposed developments is identified and mitigation measures developed early in the planning process.

6.2 Archaeological Significance

Archaeological or scientific significance relates to the value of archaeological objects or sites as they are able to inform research questions considered important to the archaeological community, which includes Aboriginal people, heritage consultants and academic researchers. The value of this type of significance is determined on how the objects and sites can provide information regarding how people in the past lived their lives. The criteria for archaeological significance assessment generally reflect the criteria of the ICOMOS Burra Charter.

6.3 Criteria

Archaeological significance is assessed based on the archaeological or scientific values of an area. These values can be defined as the importance of the area relating to several criteria. Criteria used for determining the archaeological significance of an area are as follows:

- **Research potential:** Can the site contribute to an understanding of the area/region and/or the state's natural and cultural history? Is the site able to provide information that no other site or resource is able to do?
- **Representativeness:** is the site representative of this type of site? Is there variability both inside and outside the study area? Are similar site types conserved?
- **Rarity:** is the subject area a rare site type? Does it contain rare archaeological material or demonstrate cultural activities that no other site can demonstrate? Is this type of site in danger of being lost?
- **Integrity/Intactness:** Has the site been subject to significant disturbance? Is the site likely to contain deposits which may possess intact stratigraphy?

Further, an assessment of the grade of significance is made, based on how well the item fulfils the assessment criteria. The Heritage Branch of the Department of Planning (now Heritage NSW) 2009 guideline *Assessing Significance for Historical Archaeological Sites and 'Relics'* defines the grading of significance as follows:

Table 8: Grading of significance, from Heritage Branch 2009

Grading	Justification
Exceptional	Rare or outstanding item of local or State significance. High degree of intactness. Item can be interpreted relatively easily.
High	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.
Moderate	Altered or modified elements. Elements with little heritage value but which contribute to the overall significance of the item.
Little	Alterations detract from significance. Difficult to interpret.
Intrusive	Damaging to the item's heritage significance.

Whilst this was developed for the assessment of significance of historical items, the criteria are applicable to archaeological significance assessments as well. It is important to note that the below assessment is specific to Aboriginal cultural heritage and does not consider the non-Aboriginal significance of the site.

6.4 Significance Assessment

Research Potential

The study area is highly disturbed, and the previously recorded site (AHIMS #45-6-0741) is considered to no longer exist. There may be more intact shell material and cultural material within subsurface deposits on the northern and eastern side of the Long Reef Headland which may have the potential to reveal information about Aboriginal occupation within the Long Reef Headland area. Overall, the study area is considered to have limited research potential.

Representativeness

The site (AHIMS #45-6-0741) is not considered to be a reliable representation of a midden deposit within the Long Reef Headland as it is considered to no longer exist. A more intact midden with clear stratigraphic deposits has been found within the rock shelter excavated in Angophora Reserve in Avalon within the Northern Beaches. This site is considered to offer a more detailed and reliable representation of former Aboriginal cultural material within Northern Beaches area. Overall, the study area is not considered to be a representative example of an Aboriginal shell midden deposit.

Rarity

The site is not considered to have value under this criterion.

Integrity/Intactness

The site assessed within the study area is considered to have been highly disturbed, and no longer exists. Therefore, it is not considered to have integrity, nor be intact.

6.5 Statement of Archaeological Significance

Overall, the archaeological significance of the area assessed within the registered site is considered to be low due to heavy disturbance and lack of archaeological evidence. There has been a high level of historic and current, man-made land disturbance, as well as natural erosion through wind and wave action.

7.0 Impact Assessment

7.1 Proposed Development

The study area is located on the southern side of Long Reef Headland. The Long Reef boardwalk and bridge within the study area have been subjected to a high volume of use by the community and unusually large ocean swells that have caused significant structural damage to the lower section of the foreshore boardwalk. Approximately 120 m of the existing the existing boardwalk and bridge require replacement. To ensure the new structures do not succumb to the same impacts it is proposed to reposition them further north up the dune face.

The proposed works will require sections of the dune to be flattened by the removal of sand to accommodate the boardwalk. This will involve a cut of approximately 23 m long and a max depth of 1.2m into the sand dune on the section west of the drainage line, and a cut approximately 22 m long with a maximum depth of .8 m deep on the eastern side of the drainage line. The proposed works will also move the northern section of the woman's and men's 17th tees approximately 2 m north, as well as the realignment of a section of the concrete path that runs parallel to the tees. This will involve excavations up to 30 cm below the current surface level.

7.2 Potential Impact

The proposed works will involve the removal of sections of the sand dune within the vegetated mound on the north side of the current board walk and areas around the 17th tees within Long Reeg Golf Course (detailed in the previous section). The whole of the study area has been assessed as highly disturbed with negligible potential for subsurface intact Archaeological material to be present. The Aboriginal site that is registered as being within the study area is considered to have been destroyed. Therefore, it is considered unlikely that the proposed works will impact on a registered Aboriginal site and it is unlikely that they will impact on intact cultural material within an original stratified context.

8.0 Management, Mitigation and Recommendations

8.1 Guiding Principles

Wherever possible and practicable, it is preferred to avoid impact to Aboriginal archaeological sites. In situations where conservation is not possible or practicable, mitigation measures must be implemented.

The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance, 2013 (The Burra Charter) provides guidance for the management of culturally sensitive places. The Burra Charter is predominantly focussed on places of built heritage significance, but the principles are applicable to other places of significance as well.

The first guiding principle for management of culturally significant sites states that "places of cultural significance should be conserved" (Article 2.1). A cautious approach should be adopted, whereby only "as much as necessary but as little as possible" (Article 3.1) should be changed or impacted.

Mitigation measures depend on the significance assessment for the site. Cultural significance of sites should also be considered in consultation with the Aboriginal community during community consultation.

8.2 Harm Avoidance or Mitigation

One previously identified shell midden site is registered within the current study area (AHIMS #45-6-0741). The previous assessments of the site in 1988 noted at the time that it had been subjected to erosion and in poor condition. It was determined to be of low archaeological significance and no further archaeological investigations were considered warranted at the time of recording.

The current assessment of the site has concluded that it has been subject to heavy natural erosion since it was recorded and man-made impacts to the extent that there is no evidence that it still exists. The remainder of the study area has also been assessed as heavily disturbed and modified though current and former land use, and natural erosion. It is unlikely that any intact cultural material would survive these impacts Therefore no avoidance or mitigation measures are considered warranted.

No impact beyond that described in this report should occur within this area.

The site card for AHIMS Site #45-6-0741 should be updated to reflect the destruction of the site by natural processes.

It is noted that the Aboriginal Heritage Office suggested that monitoring of initial earthworks should occur, in order to identify any cultural material (including burials) that may be present in the area. Given the level of disturbance that has been identified across the site, this is not considered necessary on archaeological grounds; however, Northern Beaches Council may wish to engage with the Aboriginal Heritage Office and/or the RAPs for the project to monitor initial works on site.

8.2.1 INTERPRETATION

There is an abundance of Aboriginal archaeological sites within the coastal areas of the northern beaches, including Long Reef Headland, that provide valuable evidence on the lives of past Aboriginal people who inhabited the area for thousands of years before the arrival of Europeans in 1788. Unfortunately, even if these sites are not in public-accessible areas, they are particularly vulnerable to increasing sea level rises and erosion.

In consultation with the Darug Custodian Aboriginal Corporation who participated in the field work, and the Aboriginal Heritage Office, it is recommended that information on some of these sites be included in interpretive boards that could be constructed along the new board walk, or appropriate viewing areas.

These panels could include information on shell middens in the region. This site type often contains shells, stone artefacts, and faunal remains. Although the majority of shells and faunal remains within the middens are remnants of past meals some types of shells were also modified to be used as tools and implements., e.g. a part of the turban shells (T*urbo torquata*) were made into hooks for fishing. Sydney cockles (*Anadara trapezia*) have found to have been used as scrapers for wood work, and. animal bone points sharped to a point to stitch animal skins together. Stone artefacts such as ground-edged hatchets, scrapers and spear tips have also been found in shell middens and burials within the Northern Beaches.

9.0 Recommendations

The following recommendations are made on the basis of:

- The statutory requirements of the NP&W Act 1974;
- The requirements of Heritage NSW;
- The results of the cultural and archaeological assessment;
- An assessment of the likely impacts of the proposed development; and
- The interests of the registered Aboriginal stakeholders and the cultural heritage record.

It was found that:

- There was one previously identified Aboriginal site located within the study area (AHIMS #45-6-0741).
- The study area was considered to be highly disturbed by man-made and natural impacts from review of the historical documents and aerial images. This assessment was confirmed during the pedestrian survey and no evidence of AHIMS #45-6-0741 or any other cultural material was identified during the physical inspection of the area.
- As there is no evidence of AHIMS #45-6-0741 present within the study area, and given the significant impact to the area by erosion and natural factors, the site is now considered destroyed.
- The proposed work required within the study area will involve the removal of sections of the existing dune on the northern side of the current board walk and within areas around the 17th tees within the Long Reef Golf Cub.

As such the following recommendations have been made.

Recommendation 1: No further archaeological assessment required

The Aboriginal archaeological potential of Long Reef Boardwalk, Collaroy, NSW has been assessed as negligible. No further archaeological assessment is required for the site prior to the commencement of proposed development activities. No Aboriginal Heritage Impact Permit (AHIP) is required prior to works commencing.

Recommendation 2: Aboriginal heritage site induction

An Aboriginal heritage site induction should be presented to the site workers by a suitably qualified person. This induction will include the possible kinds of Aboriginal archaeological remains that may be contained within the sand bodies and it will outline the 'unexpected finds policy'.

Recommendation 3: Installation of Interpretation

It is recommended that consideration is given to installation of interpretive signage along the boardwalk to explain the Aboriginal history of the place and the continuing connection to Country.

Recommendation 4: Development Boundaries

The proposed development works must be contained within the assessed boundaries for this project. If there is any alteration to the boundaries of the proposed development to include areas not assessed as part of this archaeological investigation, further investigation of those areas should be completed to assist in managing Aboriginal objects and places which may be present in an appropriate manner.

Recommendation 5: Reporting

One digital copy of this report should be forwarded to Heritage NSW for inclusion on the Aboriginal Heritage Information Management System (AHIMS).

One copy of this report should be forwarded to each of the registered Aboriginal stakeholders for the project.

Recommendation 6: Stop Work Provisions

Should unanticipated Aboriginal archaeological material be encountered during site works, all work must cease in the vicinity of the find and an archaeologist contacted to make an assessment of the find and to advise on the course of action to be taken. Further archaeological assessment and Aboriginal community consultation may be required prior to the recommencement of works. Any objects confirmed to be Aboriginal in origin must be reported to Heritage NSW.

Human remains of Aboriginal people have previously been recorded in sand bodies in coastal bays and open beaches within Sydney area including Long Reef headland. In the unlikely event that suspected human remains are identified during works, all activity in the vicinity of the find must cease immediately and the find protected from harm or damage. The NSW Police and the Coroner's Office must be notified immediately. If the finds are confirmed to be human and of Aboriginal origin, further assessment by an archaeologist experienced in the assessment of human remains and consultation with both Heritage NSW, the Aboriginal Heritage Office and the RAPs for the project would be necessary.

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17 Appendix E: Geotechnical Investigation Report

Geotechnical Investigation Report

Project

Proposed Replacement Footbridge & Boardwalk, Long Reef Beach, Collaroy

Prepared for

Northern Beaches Council

Date

8 June 2022

Report No

14801-GR-1-2

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DOCUMENT CONTROL

Revision	Date	Description	Author	Reviewer
0	08/06/2022	Original issue	ZK	MAG

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Contents

Appendices`

1 INTRODUCTION

This report presents the findings of a geotechnical investigation undertaken by Alliance Geotechnical Pty Ltd (Alliance) for Northern Beaches Council (Client) for the demolition and replacement of the existing board walk and footbridge at Long Reef Beach, Collaroy (the site). The investigation was undertaken in accordance with the scope of works outlined in Alliance's fee proposal (Estimate No. 6311, dated 4 March 2022).

Alliance was provided with a project brief by the client, and it is understood that the existing footbridge and boardwalk will be demolished and replaced with a proposed Fibre Reinforced Polymer (FRP) Footbridge and boardwalk. It is understood based on the brief that the new bridge and boardwalk is to retain the same alignment as the bridge and boardwalk to be demolished.

This geotechnical report is prepared to provide the findings of the geotechnical investigation completed for this site along with design recommendations. The geotechnical investigation was undertaken generally in accordance with Australian Standard AS 1726 – 2017 for "Geotechnical Site Investigations".

The purpose of this preliminary geotechnical investigation was to assess the subsurface conditions and provide preliminary comments and recommendations relating to:

- Geotechnical subsurface conditions.
- Groundwater conditions.
- Suitable bridge footing types and construction considerations.
- geotechnical foundation design parameters.
- Soil aggressivity in relation to concrete and steel.
- Provide commentary on risk from acid sulfate soils and saline soils.

2 SITE DESCRIPTION AND REGIONAL GEOLOGY

The site covers approximately 100m in total including the existing footbridge and boardwalk that is to be replaced. The site is located on the eastern side of Long Reef beach and is bounded by Long Reef Golf Club to the north, Long Reef Headland to the east and Long Reef Beach and the ocean to the south.

The site is within a localised low point in relation to the walking track and is generally undulating. The site RL is approximately RL 4m to 6m based on Google Earth. The surrounding topography around the site generally slopes downwards in the southern direction towards the ocean.

Figure 1 below shows the site location in relation to the surrounding area.

Figure 1 – General Site Layout (Bridge in Yellow and Board Walk in Red)

The Sydney 1:100,000 Geological Map indicates that the site is underlain by three Quaternary marine geologies including ”medium to fine grained marine sand with podsols”, ‘’medium to fine marine sand’’ and ‘’course quartz sand, varying amounts of shell fragments. Bald Hill Claystone is also bordering the site on the east and is defined as ‘’dominantly red shale and fine to medium sandstone’’.

The investigation confirms the presence of marine sand overlaying residual sandy clay.

3 FIELDWORK

The geotechnical site investigation was carried out over one day on 3 May 2022. Selected site photographs taken during the fieldwork are presented above and in Appendix A.

The investigation comprised the initial marking out test locations along with the drilling of six boreholes (BH01-LR to BH02-LR). Borehole BH01-LR was drilled using a track-mounted drilling rig and was advanced through the soil profile using solid flight augers fitted with a tungsten carbide bit (TC-bit). Boreholes BH02-LR through to BH06-LR were drilled using a hand auger to a maximum refusal depth of 1.25m. Dynamic Cone Penetrometer (DCP) tests were taken up to 2.4m depth adjacent to the borehole locations and Standard Penetration Tests (SPT) were carried out (within BH01-LR only) at approximately 1.5m depth intervals with the deepest test being undertaken at 9.0m depth. The encountered soils were logged and sampled by an experienced geotechnical engineer from Alliance.

Borehole BH01-LR is located west of the existing bridge in order to determine the required bridge footing design. Due to access issues the track mounted drill rig could not cross the bridge to be able to determine the subsurface materials on the eastern side of the bridge and therefore hand augers were carried out for the remainder of the boreholes along the board walk heading east from the bridge.

3.1 Subsurface Conditions

Table 1 below summarises the subsurface conditions encountered within the boreholes. For further information reference should be made to the attached borehole logs.

Table 1 - Summary of Subsurface Profile

Borehole	BH01	BH02	BH03
Description	**Depth below the ground surface (m)**		
ALLUVIAL: Sand, fine to medium grained (Loose)	-	0.0-0.2	0-0.1
DUNE SAND: Sand, fine to medium grained (Loose)	0.0-1.5	-	-
DUNE SAND: Sand, fine to medium grained (Medium Dense)	1.5-2.5	-	-
ESTUARINE: Clay/Clayey Sand, fine to medium grained, medium to high plasticity (Very Loose or Very Soft)	2.5-4.5	-	-
ESTUARINE: Clayey Sand, (medium dense)	4.5-6.3	-	-
RESIDUAL: Clay, high plasticity (Stiff)	6.3-9.5	-	0.1-1.2
Groundwater	2.3	NE*	NE*
Target depth	9.5	3.0	3.0

Table 2 - Summary of Subsurface Profile

Borehole	BH04	BH05	BH06
Description	**Depth below the ground surface (m)**		
ALLUVIAL: Sand, fine to medium grained (Loose)	0-0.5	-	-
RESIDUAL: Sandy Clay, medium plasticity (Soft)	-	0.0-0.5	-
RESIDUAL: Clay, high plasticity (Firm)	0.5-0.9	0.5-1.0	0.2-0.6
RESIDUAL: Clay, high plasticity (Stiff)	0.9-1.25	-	0.6-1.2
Groundwater	NE*	NE*	NE*
Target depth	9.5	3.0	3.0

*Non-Encountered

Groundwater

Groundwater was encountered at 2.3m depth within BH01-LR at the time of the investigation. All other boreholes refused at a maximum depth of 1.25m. It should be noted that groundwater is subject to weather conditions and may fluctuate. No long-term monitoring has been undertaken.

4 LABORATORY TEST RESULTS

Laboratory tests were carried out on selected soil samples collected from the boreholes during the site investigation. Two particle size distribution and moisture content tests were carried out at our NATA accredited laboratory and two soil aggressivity tests were carried out on selected soil samples at our nominated accredited external laboratory.

The laboratory test certificates of the laboratory tests are presented in Appendix D and the results are summarised in Table 2 and 3 below:

Table 2 – Particle Size Distribution Test Results

Borehole	Depth (m)	Moisture (%)	Particle Size Distribution (% passing)		
			1.18mm	0.425mm	0.075mm
BH01-LR	0.5-1.5	5.3	100	94	3

Table 3 – Atterberg Limit & Linear Shrinkage Test Results

Borehole	Depth (m)	Moisture (%)	Atterberg Limits			Linear Shrinkage (%)
			Liquid Limit (%)	Plastic Limit (%)	Plasticity index (%)	
BH01-LR	7.5-8.0	26.3	62	17	45	23.5

Table 4 - Soil Aggressivity Test Results

Test	Unit	BH01-LR (3.0m –3.4m)	BH01-LR (7.1m – 7.5m)
Chloride	mg/kg	31	24
pH	--	8.4	6.2
Conductivity	µS/cm	77	15
Resistivity	Ohm.cm	13000	68000
Sulfate	Mg/kg	12	<10
Moisture	%	21	19
In respect to Concrete		Mild	Non-aggressive
In respect to Steel		Non-aggressive	Non-aggressive

5 RECOMMENDATIONS

5.1 Demolition of Existing Footbridge & Boardwalk: Excavations & Batter Slopes

The material on site was generally dune sand underlain by residual clayey sand/ sandy clay.

The existing bridge should be demolished along with any associated structures and removed from the site. The natural material may both be excavated and re-used as fill on site after drying out the material.

A cut to fill plan was not yet available at the time of writing this report but it is assumed that no significant ‘’cut and fill’’ will be required for the construction of the new footbridge and boardwalk. It is assessed that conventional earth moving equipment such as excavators will be sufficient to excavate the subsurface materials.

The maximum batter slopes or benching should be 1H:2V above the water table level. No excavated vertical cut should be greater than 1.0m depth without being benched or battered.

5.2 Engineered Fill

Any fill being placed on site in order to achieve design subgrade levels should be placed in near-horizontal layers with maximum 300mm thick compacted layers (noting the maximum particle size should not be larger than 2/3^{rds} the layer thickness). The layers should be compacted to at least 95% standard dry density ratio to within 0.6m of the finished subgrade level. The upper 0.6m thickness should be compacted to achieve at least 100% standard dry density ratio, with placement moisture contents being within 2% dry of Optimum Moisture Content (OMC). Any fill being placed more than 0.4m total thickness should be placed under Level 1 geotechnical supervision.

5.3 Suitable Footings & Geotechnical Parameters for Foundation Design

The proposed bridge and boardwalk can be founded on screw or driven pile footings. It is recommended to found the footings for the footbridge within medium dense or better estuarine sand/clayey sand encountered at an approximate depth of 4.5m below the ground surface in BH01-LR located on the western side of the bridge. The western side of the bridge is anticipated to encounter similar consistency material at similar depths. The Boardwalk can also be designed on screw or driven piles on medium dense sands or stiff clays found at approximately 1.0m depth within BH02-LR to BH06-LR. To avoid any differential foundation settlement, it is recommended to found the whole structure on a similar layer and on a similar footing system.

Preliminary design parameters considered appropriate for the pile footings are presented in Table 3.

Table 3 – Recommended Preliminary Geotechnical Design Parameters for Deep Foundation

Description	Approximate Depth * (m)	Allowable End Bearing Pressure (kPa)	Allowable Shaft Adhesion (kPa)
Medium Dense estuarine Clayey Sand/ Sand or Stiff residual Clay	Below 4.5m in BH01-LR or deeper Below 1.0m in BH02-LR to BH06-LR or deeper	250 150	20 15
* It should be noted that the depths are estimated based on the drilled borehole location			

If a deep foundation system is adopted for this project, a minimum socket depth of 500mm is recommended into minimum medium dense alluvial sand with a minimum total depth of 4.5m below the existing surface level for the bridge and 1.5m below the existing surface level for the boardwalk. Where the boardwalk does not have any lateral support, the footings should extend deeper to compensate for the unsupported depth. It is recommended that the pile foundations be designed in accordance with AS 2159-2009 Piling – Design and Installation.

Further advice should be undertaken from a specialist piling contractor to design and install screw piles, should that be the chosen solution. Our allowable bearing pressure is based on a minimum helix diameter.

Based on the drilling investigation, the geotechnical design parameters are recommended in Table 4 below.

Table 4 – Geotechnical Design Parameters

Description	γ (kN/m^3)	C_u (kPa)	c' (kPa)	∅′ (degrees)	K_a	K_o	K_p	E (MPa)	ϑ
Estuarine: SAND/Clayey Sand (medium dense)	19	0	0	32	0.31	0.47	3.25	35	0.3
Residual: Clay/Sandy Clay (Stiff)	18	50	5	26	0.39	0.56	2.56	15	0.3
Legend: ∅′ : Effective Friction Angle γ: Unit Weight ϑ: Poisson's Ratio c': Effective Cohesion, C_u: Undrained cohesion						K_o: Earth pressure at rest K_a: Active earth pressure K_p: Passive earth pressure E: Elasticity Modulus			

5.4 Risk from Acid Sulfate and Saline Soils

It is assessed based on the NSW Planning Industry and Environment eSPADE Soil and Land Information map that the site falls an area that has had no occurrence of Acid Sulfate Soils. This indicates that there is minimal risk of acid sulfate soils within the area.

It is assessed that it is unlikely to encounter Saline Soils within the area based on the DIPNR 'Salinity Potential in Western Sydney 2002', dated March 2003. Saline soils generally follow a pattern of being near the creeks and waterways of Western Sydney, typically over shale bedrock.

6 LIMITATIONS

This report has been prepared for Northern Beaches Council to provide geotechnical input and commentary regarding Long Reef Beach footbridge and boardwalk, Long Reef Beach, Collaroy NSW. The findings and recommendations provided here are specific to this site for the purposes outline in this report.

The borehole investigation and test results provided in this report are indicative of the subsurface conditions at the site only at the specific testing locations, and to the depths drilled and tested at the time.

It is recommended that a qualified and experienced Geotechnical Engineer be engaged to provide further input and review during the design development; including site visits during construction to verify the site conditions and provide advice where conditions vary from those assumed in this report.

APPENDIX A – Site Photographs

Photo 1 – BH01-LR facing east towards the headland

Photo 2 – The existing boardwalk

APPENDIX B – Borehole Location Plan (Drawing 14801-GR-1-B)

Site Investigation Plan

Client Name:	Northern Beaches Council	Figure / Drawing Number:	14801-GR-2-A
Project Name:	Proposed Footbridge and Boardwalk	Figure / Drawing Date:	02/06/2022
Project Location:	Long Reef Beach, Collaroy NSW	Report Number:	14801-GR-1-2

N

APPENDIX C – Borehole Logs & Explanatory Notes

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BH No: BH01-LR
Sheet: 1 of 2
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 110 mm

Rig Type: Christie Rig
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: DR
Logged: MS
RL Surface: 6m
Contractor: BG Drilling
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT			5.5	0.5			SAND, fine grained, yellow-brown, poorly graded.		D	L	DUNE SAND
			5.0	1.0			SAND, fine to medium grained, red-brown, poorly graded.		M	L - MD	
			4.5	1.5				SPT 4, 5, 6 N=11		MD	
	▼ GW @ ~2.3m		4.0	2.0							
			3.5	2.5			Clayey SAND, fine to medium grained, poorly graded, dark grey/black, trace silt.		W	VL	ALLUVIUM/ESTUARINE
			3.0	3.0				SPT 0, 0, 0 N=0			
			2.5	3.5							
			2.0	4.0			CLAY, medium to high plasticity, grey-dark grey, trace silt and fine grained sand.		MC > PL		
			1.5	4.5			Clayey SAND, fine to medium grained, grey/pale grey, poorly graded, trace silt, with Sandy CLAY layers.	SPT 4, 6, 3 N=9	W	MD	
			1.0	5.0							

2.2. NON CORED BOREHOLE (NO COORD) 14801.GPJ GINT STD AUSTRALIA.GDT 8/6/22

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BH No: BH01-LR
Sheet: 2 of 2
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 110 mm

Rig Type: Christie Rig
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: DR
Logged: MS
RL Surface: 6m
Contractor: BG Drilling
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT			0.5	5.5			Clayey SAND, fine to medium grained, grey/pale grey, poorly graded, trace silt, with Sandy CLAY layers. *(continued)*		W	MD	
			0.0	6.0				SPT 3, 6, 10 N=16			
			-0.5	6.5			CLAY, high plasticity, pale grey, trace silt and fine grained sand.		MC ~ PL	St - VSt	RESIDUAL
			-1.0	7.0							
			-1.5	7.5				SPT 4, 5, 6 N=11		St	
			-2.0	8.0							
			-2.5	8.5							
			-3.0	9.0			CLAY, high plasticity, pale grey with red bands, trace fine grained sand and silt.				
			-3.5	9.5				SPT 5, 5, 6 N=11			
			-4.0	10.0			Target Depth Borehole BH01-LR terminated at 9.5m				

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BH No: BH02-LR
Sheet: 1 of 1
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 60 mm

Rig Type: HA
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: MY
Logged: MS
RL Surface: 3m
Contractor: BG Drilling
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	NE						SAND, fine to medium grained, brown, poorly graded.		W	L	ALLUVIUM
			2.5	0.5			Refusal on Inferred boulder. Borehole BH02-LR terminated at 0.2m				
			2.0	1.0							
			1.5	1.5							
			1.0	2.0							
			0.5	2.5							
			0.0	3.0							
			-0.5	3.5							
			-1.0	4.0							
			-1.5	4.5							
			-2.0	5.0							

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BH No: BH03-LR
Sheet: 1 of 1
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 60 mm

Rig Type: HA | **Hole Location:** Refer Drawing: 14801-GR-1-B | **Driller:** MY | **Logged:** MS
RL Surface: 4m | **Contractor:** Alliance Geotechnical | **Bearing:** --- | **Checked:** ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	NE						SAND, fine grained, red-brown, poorly graded, trace clay, trace rootlets.		M	L	DUNE SAND
							Sandy CLAY, high plasticity, pale grey mottled red-brown, fine grained sand, trace silt.		MC > PL	F	RESIDUAL
			3.5	0.5						St	
										VSt	
			3.0	1.0			Sandy CLAY, high plasticity, brown and pale grey mottled red-brown, fine grained sand, trace silt with ironstone gravel.				
							Hand Auger Refusal Borehole BH03-LR terminated at 1.2m				
			2.5	1.5							
			2.0	2.0							
			1.5	2.5							
			1.0	3.0							
			0.5	3.5							
			0.0	4.0							
			-0.5	4.5							
			-1.0	5.0							

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BH No: BH04-LR
Sheet: 1 of 1
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 60 mm

Rig Type: HA
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: MY
Logged: MS
RL Surface: 4m
Contractor: Alliance Geotechnical
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	NE						SAND, fine grained, brown, poorly graded.		M	L	DUNE SAND
							Clayey SAND, fine to medium grained, grey and dark grey, poorly graded, trace silt and organics.		W	MD	RESIDUAL
							Clayey SAND, fine to medium grained, pale grey, low plasticity, trace silt.				
			3.5	0.5			Sandy CLAY, medium plasticity, pale grey mottled red, fine grained sand.		MC > PL	St	
			3.0	1.0			1.0m: with fine ironstone gravel.			VSt	
			2.5	1.5			Hand Auger refusal Borehole BH04-LR terminated at 1.25m				
			2.0	2.0							
			1.5	2.5							
			1.0	3.0							
			0.5	3.5							
			0.0	4.0							
			-0.5	4.5							
			-1.0	5.0							

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BH No: BH05-LR
Sheet: 1 of 1
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 60 mm

Rig Type: HA
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: MY
Logged: MS
RL Surface: 4m
Contractor: Alliance Geotechnical
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
ADT	NE		3.5	0.5			Sandy CLAY, medium plasticity, pale grey mottled orange and red, fine grained sand, trace fine gravel.		MC > PL	F	RESIDUAL
			3.0	1.0			Sandy CLAY, medium plasticity, pale grey mottled orange red, fine grained sand, trace with silt and ironstone gravel.			St / VSt	
			2.5	1.5			Hand Auger refusal Borehole BH05-LR terminated at 1m				
			2.0	2.0							
			1.5	2.5							
			1.0	3.0							
			0.5	3.5							
			0.0	4.0							
			-0.5	4.5							
			-1.0	5.0							

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BH No: BH06-LR
Sheet: 1 of 1
Job No: 14801

Borehole Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Borehole Size 60 mm

Rig Type: HA
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: MY
Logged: MS
RL Surface: 5m
Contractor: Alliance Geotechnical
Bearing: ---
Checked: ZK

Method	Water	Well Details	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
HA	NE		4.5	0.5			SAND, fine grained, brown, trace with silt.		M	D	DUNE SAND
							Sandy CLAY, medium plasticity, brown and dark grey mottled red, trace with silt.		MC > PL	F	RESIDUAL
			4.0	1.0			Sandy CLAY, medium plasticity, brown and grey mottled red, trace with silt and ironstone.			St	
										VSt	
			3.5	1.5			Hand Auger refusal Borehole BH06-LR terminated at 1.2m				
			3.0	2.0							
			2.5	2.5							
			2.0	3.0							
			1.5	3.5							
			1.0	4.0							
			0.5	4.5							
			0.0	5.0							

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TP No: E01-LR
Sheet: 1 of 1
Job No: 14801

Exposure Log

Client: Northern Beaches Council
Project: Bridge Replacement
Location: Long Reef Beach

Started: 5/03/2022
Finished: 5/03/2022
Test Pit Size - m

Rig Type: Natural Exposure
Hole Location: Refer Drawing: 14801-GR-1-B
Driller: -
Logged: MS

RL Surface: 5m
Contractor: -
Bearing: ---
Checked: ZK

Method	Water	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description	Samples Tests Remarks	Moisture Condition	Consistency/ Density Index	Additional Observations
N					SC	Clayey SAND, fine to medium grained, poorly graded, pale grey and orange.		M	L	DUNE SAND
					CI-CH	Sandy CLAY, medium to high plasticity, pale grey mottled red, fine to medium grained sand, with fine ironstone gravel. % of gravel gradually increasing with depth.		MC ~ PL	St - VSt	RESIDUAL
		4.5	0.5							
		4.0	1.0							
		3.5	1.5							
		3.0	2.0		CG	IRONSTONE (40%) bands and nodules through CLAY matrix (60%). CLAY, high plasticity, pale grey. IRONSTONE, fine grained, red, highly weathered, medium strength.		MC ~ PL	VSt	
		2.5	2.5							
						Bottom of exposure Test Pit E01-LR terminated at 2.6m				
		2.0	3.0							
		1.5	3.5							
		1.0	4.0							
		0.5	4.5							
		0.0	5.0							

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Dynamic Cone Penetrometer (DCP) Test Report

Client:	Northern Beaches Council	Report Number:	14801-GR-2-1
Project Name:	Proposed Footbridge and Boardwalk	Project Number:	14801
Project Location:	Long Reef Beach	Date Tested:	03/05/2022
Test Method:	AS 1289.6.3.2		

Test Number	DCP-2 (BH02)	DCP-3 (BH03)	DCP-4 (BH04)	DCP-5 (BH05)	DCP-6 (BH06)
Test Locations	Refer to Drawing No. 14805-GR-2-A				
Surface Material	SAND (Moist)				
Depth (metres)					
0.00 – 0.15	4	1	4	2	2
0.15 – 0.30	14	3	6	2	3
0.30 – 0.45	4	4	2	2	4
0.45 – 0.60	5	7	3	3	3
0.60 – 0.75	8	11	4	6	5
0.75 – 0.90	7	14	4	3	5
0.90 – 1.05	10 @50mm	13	6	5	10
1.05 – 1.20	DB Refusal	18	8	12	11
1.20 – 1.35		25+	11	9	13
1.35 – 1.50			13	10	16
1.50 – 1.65			18	16	16
1.65 – 1.80			17	24	12
1.80 – 1.95			22	20	16
1.95 – 2.10			25+	20	18
2.10 – 2.25				25+	25+
2.25 – 2.40					
2.40 – 2.55					
2.55 – 2.70					

Notes:

1. This penetrometer test report is intended to be read in conjunction with the geotechnical report by Alliance Geotechnical (ref: -GR-1-1).

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Explanatory Notes
Drill & Excavation Logs

General

Information obtained from site investigations is recorded on log sheets. Soils and very low strength rock are commonly drilled using a combination of solid-flight augers with a Tungsten-Carbide (TC) bit. Descriptions of these materials presented on the “Borehole Log” are based on a combination of regular sampling and in-situ testing. Rock coring techniques commences once material is encountered that cannot be penetrated using a combination of solid-flight augers and Tungsten-carbide bit. The "Cored Borehole Log" presents data from drilling where a core barrel has been used to recover material - commonly rock.

The "Excavation - Geological Log" presents data and drawings from exposures of soil and rock resulting from excavation of pits or trenches.

The heading of the log sheets contains information on Project Identification, Hole or Test Pit Identification, Location and Elevation. The main section of the logs contains information on methods and conditions, material description and structure presented as a series of columns in relation to depth below the ground surface which is plotted on the left side of the log sheet. The scale is presented in the depth column as metres below ground level.

As far as is practicable the data contained on the log sheets is factual. Some interpretation is included in the identification of material boundaries in areas of partial sampling, the location of areas of core loss, description and classification of material, estimation of strength and identification of drilling induced fractures, and geological unit. Material description and classifications are based on Australian Standard Geotechnical Site Investigations: AS 1726 - 2017 with some modifications as defined below.

These notes contain an explanation of the terms and abbreviations commonly used on the log sheets.

Drilling

Drilling, Casing and Excavating

Drilling methods deployed are abbreviated as follows

AS	Auger Screwing
ADV	Auger Drilling with V-Bit
ADT	Auger Drilling with TC Bit
BH	Backhoe
E	Excavator
HA	Hand Auger
HQ	HQ core barrel (~63.5 mm diameter core) *
HMLC	HMLC core barrel (~63.5 mm diameter core) *
NMLC	NMLC core barrel (~51.9 mm diameter core) *
NQ	NQ core barrel (~47.6 mm diameter core) *
RR	Rock Roller
WB	Wash-bore drilling

* Core diameters are approximate and vary due to the strength of material being drilled.

Drilling Fluid/Water

The drilling fluid used is identified and loss of return to the surface estimated as a percentage. It is introduced to assist with the drill process, in particular, when core drilling. The introduction of drill fluid/water does not allow for accurate identification of water seepages.

Drilling Penetration/Drill Depth

Core lifts are identified by a line and depth with core loss per run as a percentage. Ease of penetration in non-core drilling is abbreviated as follows:

VE	Very Easy
E	Easy
F	Firm
H	Hard
VH	Very Hard

Groundwater Levels

Date of measurement is shown.

Standing water level measured in completed borehole

Level taken during or immediately after drilling

Groundwater inflow water level

Samples/Tests

Samples collected and testing undertaken are abbreviated as follows

ES	Environmental Sample
DS	Disturbed Sample
BS	Bulk Sample
U50	Undisturbed (50 mm diameter)
C	Core Sample
SPT	Standard Penetration Test
N	Result of SPT (*sample taken)
VS	Vane Shear Test
IMP	Borehole Impression Device
PBT	Plate Bearing Test
PZ	Piezometer Installation
HP	Hand Penetrometer Test
HB	Hammer Bouncing

Excavation Logs

Explanatory notes are provided at the bottom of drill log sheets. Information about the origin, geology and pedology may be entered in the "Structure and other Observations" column. The depth of the base of excavation (for the logged section) at the appropriate depth in the "Material Description" column. Refusal of excavation plant is noted should it occur. A sketch of the exposure may be added.

Material Description – Soil

Material Description - In accordance with AS 1726-2017

Classification Symbol - In accordance with the Unified Classification System (AS 1726-2017).

Abbreviation	Typical Names
GW	Well-graded gravels, gravel-sand mixtures, little or no fines.
GP	Poorly graded gravels and gravel-sand mixtures, little or no fines, uniform gravels
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures.
SW	Well graded sands, gravelly sands, little or no fines.
SP	Poorly graded sands and gravelly sands; little or no fines, uniform sands.
SM	Silty sand, sand-silt mixtures.
SC	Clayey sands, sand-clay mixtures.
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
CL, CI	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.
OL	Organic silts and organic silty clays of low plasticity. *
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, clastic silts.
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts. *
Pt	Peat and other highly organic soils. *

* Additional details may be provided in accordance with the Von Post classification system (1922).

Organic Soils - Identification using laboratory testing:

Material	Organic Content - % of dry mass
Inorganic	<2
Organic Soil	<2 ≤ 25
Peat	> 25

Organic Soils - Descriptive terms for the degree of decomposition of peat:

Term	Decomposition	Remains	Squeeze
Fibrous	Little or none	Clearly recognizable	Only water No solid
Pseudo-fibrous	Moderate	Mixture of fibrous and amorphous	Turbid water < 50% solids
Amorphous	Full	Not recognizable	Paste > 50% solids

Particle Characteristics– Definitions are as follows:

Fraction	Component (& subdivision)		Size (mm)
Oversize	Boulders		> 200
	Cobbles		> 63 ≤ 200
Coarse grained soils	Gravel	Coarse	> 19 ≤ 63
		Medium	> 6.7 ≤ 19
		Fine	> 2.36 ≤ 6.7
	Sand	Coarse	> 0.6 ≤ 2.36
		Medium	> 0.2 ≤ 0.6
		Fine	> 0.075 ≤ 0.21
Fine grained soils	Silt		0.002 ≤ 0.075
	Clay		< 0.002

Secondary and minor soil components

In coarse grained soils – The proportions of secondary and minor components are generally estimated from a visual and tactile assessment of the soils. Descriptions for secondary and minor soil components in coarse grained soils are as follows.

Designation of components	Percentage fines	Terminology (as applicable)	Percentage accessory coarse fraction	Terminology (as applicable)
Minor	≤ 5	Trace clay / silt	≤ 5	Trace sand / gravel
	> 5 ≤12	With clay / silt	> 5 ≤12	With sand / gravel
Secondary	> 12	Silty or clayey	> 30	Sandy or gravelly

Descriptions for secondary and minor soil components in fine grained soils are as follows.

Designation of components	Percentage coarse grained soils	Terminology (as applicable)
Minor	≤ 5	Trace sand / gravel / silt / clay
	> 5 ≤12	With sand / gravel / silt / clay
Secondary	> 30	Sandy / gravelly / silty / clayey

Plasticity Terms – Definitions for fine grained soils are as follows:

Descriptive Term	Range of Liquid Limit for silt	Range of Liquid Limit for clay
Low Plasticity	≤ 50	≤ 35
Medium Plasticity	N/A	> 35 ≤50
High Plasticity	> 50%	> 50

Particle Characteristics

Particle shape and angularity are estimated from a visual assessment of coarse-grained soil particle characteristics. Terminology used includes the following:

Particle shape – spherical, platy, elongated,

Particle angularity –angular, sub-angular, sub-rounded, rounded.

Moisture Condition – Abbreviations are as follows:

D	Dry, looks and feels dry
M	Moist, No free water on remoulding
W	Wet, free water on remoulding

Moisture content of fine-grained soils is based on judgement of the soils moisture content relative to the plastic and liquid limit as follows:

MC < PL	Moist, dry of plastic limit
MC ≈ PL	Moist, near plastic limit
MC > PL	Moist, wet of plastic limit
MC ≈ LL	Wet, near liquid limit
MC > LL	Wet of liquid limit

Consistency - of cohesive soils in accordance with AS 1726-2017, Table 11 are abbreviated as follows:

Consistency Term	Abbreviation	Indicative Undrained Shear Strength Range (kPa)
Very Soft	**VS**	< 12
Soft	**S**	12 ≤ 25
Firm	**F**	25 ≤ 50
Stiff	**St**	50 ≤ 100
Very Stiff	**VSt**	100 ≤ 200
Hard	**H**	≥ 200
Friable	**Fr**	-

Density Index (%) of granular soils is estimated or is based on SPT results. Abbreviations are as follows:

Description	Abbreviation	Relative Density	SPT N
Very Loose	VL	< 15%	0 - 4
Loose	L	15 - 35%	4 - 10
Medium Dense	MD	35 - 65%	10 - 30
Dense	D	65 - 85%	30 - 50
Very Dense	VD	> 85%	> 50

Structures - Fissuring and other defects are described in accordance with AS 1726-2017 using the terminology for rock defects

Origin - Where practicable an assessment is provided of the probable origin of the soil, e.g. fill, topsoil, alluvium, colluvium, residual soil.

MATERIAL DESCRIPTION - ROCK

Material Description

Descriptions of rock for geotechnics and engineering geology in civil engineering

Identification of rock type, composition and texture based on visual features in accordance with AS 1726-2017.

Rock Naming – Where possible conventional geological names are used within the logs. Engineering properties cannot be inferred directly from the rock names in the table, but the use of a particular name provides an indicative range of characteristics to the reader. Lithological identification of rock is provided to appreciate the geology of an area, to correlate geological profiles seen in boreholes or to distinguish boulders from bedrock.

Grain Size – Grain size is done in accordance with AS1726-2017 as follows:

Coarse grained	Mainly 0.6 to 2 mm
Medium grained	0.2 – 0.6 mm
Fine grained	0.06 – 0.2 mm

Colour – Rock colour is described in the moist condition.

Texture and Fabric - Frequently used terms include:

Sedimentary Rock	Metamorphic Rock	Igneous
Bedded	Cleaved	Massive
Interbedded	Foliated	Flow banded
Laminated	Schistose	Folded
Folded	Banded	Lineated
Massive	Lineated	Porphyritic
Graded	Gneissose	Crystalline
Cross-bedded	Folded	Amorphous

Bedding and Laminated – AS 1726 – 2017 bedding and laminated rock descriptions are provided below with additional detail from BS EN ISO 14689-1 as guidance.

Description	Spacing (mm)
Very Thickly Bedded	> 2000
Thickly Bedded	> 600 ≤ 2000
Medium Bedded	> 200 ≤ 600
Thinly Bedded	> 60 ≤ 200
Very Thinly Bedded	> 20 ≤ 60
Thickly Laminated	> 6 ≤ 20
Thinly Laminated	< 6

Features, inclusions and minor components – Features, inclusions and minor components within the rock material shall be described where those features could be significant such as gas bubbles, mineral veins, carbonaceous material, salts, swelling minerals, mineral inclusions, ironstone or carbonate bands, cross-stratification or minerals the readily oxidise upon atmospheric exposure.

Moisture content – Where possible descriptions are made by the feel and appearance of the rock using one according to following terms:

Dry	Looks and feels dry.
Moist	Feels cool, darkened in colour, but no water is visible on the surface
Wet	Feels cool, darkened in colour, water film or droplets visible on the surface

The moisture content of rock cored with water may not be representative of its in-situ condition.

Durability – Descriptions of the materials durability such as tendency to develop cracks, break into smaller pieces or disintegrate upon exposure to air or in contact with water are provided where observed.

Rock Material Strength – The strength of the rock material is based on uniaxial compressive strength (UCS). The following terms are used:

Rock Strength Class	Abbreviation	UCS (MPa)	Point Load Strength Index, $I_{s(50)}$ (MPa)
Very Low	VL	> 0.6 ≤ 2	> 0.03 ≤ 0.1
Low	L	> 2 ≤ 6	> 0.1 ≤ 0.3
Medium	M	> 6 ≤ 20	> 0.3 ≤ 1
High	H	> 20 ≤ 60	> 1 ≤ 3
Very High	VH	> 60 ≤ 200	> 3 ≤ 10
Extremely High	EH	> 200	> 10

Strengths are estimated and where possible supported by Point Load Index Testing of representative samples. Test results are plotted on the graphical logs as follows:

D	Diametral Point Load Test
A	Axial Point Load Test

Where the estimated strength log covers more than one range it indicates the rock strength varies between the limits shown. Point Load Strength Index test results are presented as $I_{s(50)}$ values in MPa.

Weathering - Weathering classification assists in identification but does not imply engineering properties. Descriptions are as follows:

Term (Abbreviation)	Description
Fresh (FR)	No signs of mineral decomposition or colour change.
Slightly Weathered (SW)	partly stained or discoloured. Not or little change to strength from fresh rock.
Moderately Weathered (MW)	material is completely discoloured, little or no change of strength from fresh rock.
Highly Weathered (HW)	material is completely discoloured, significant decrease in strength from fresh rock.
Extremely Weathered (EW)	Material has soil properties. Mass structure, material texture and fabric of original rock are still visible.
Residual Soil (RS)	Material has soil properties. Mass structure and material texture and fabric of original rock not visible, but the soil has not been significantly transported.

Alteration – Physical and chemical changes of the rock material due to geological processes by fluids at depth at pressures and temperatures above atmospheric conditions. Unlike weathering, alteration shows no relationship to topography and may occur at any depth. When altered materials are recognized, the following terms are used:

Term		Abbreviation		Definition
Extremely Altered		XA		Material has soil properties. Structure, texture and fabric of original rock are still visible. The rock name is replaced with the name of the parent material, e.g. Extremely Altered basalt. Soil descriptive terms are used.
Highly Altered	Distinctly altered	HA	DA	The whole of the rock material is discoloured. Rock strength is changed by alteration. Some primary minerals are altered to clay minerals. Porosity may be higher or lower due to loss of minerals or precipitation of secondary minerals in pores.
Moderately Altered	Distinctly altered	MA	DA	The whole of the rock material is discoloured Little or no change of strength from fresh rock. The term 'Distinctly Altered' is used where it is not practicable to distinguish between 'Highly Altered' and 'Moderately Altered'. Distinctly Altered is defined as follows: The rock may be highly discoloured; Porosity may be higher due to mineral loss; or may be lower due to precipitation of secondary minerals in pores; and Some change of rock strength.
Slightly Altered		SA		Rock is slightly discoloured Little or no change of strength from fresh rock.

Alteration is only described in the context of the project where it has relevance to the civil and structural design.

Defect Descriptions

General and Detailed Descriptions – Defect descriptions are provided to suit project requirements. Generalized descriptions are used for some projects where it is unnecessary to describe each individual defect in a rock mass, or where multiple similar defects are present which are too numerous to log individually. The part of the rock mass to which this applies is delineated.

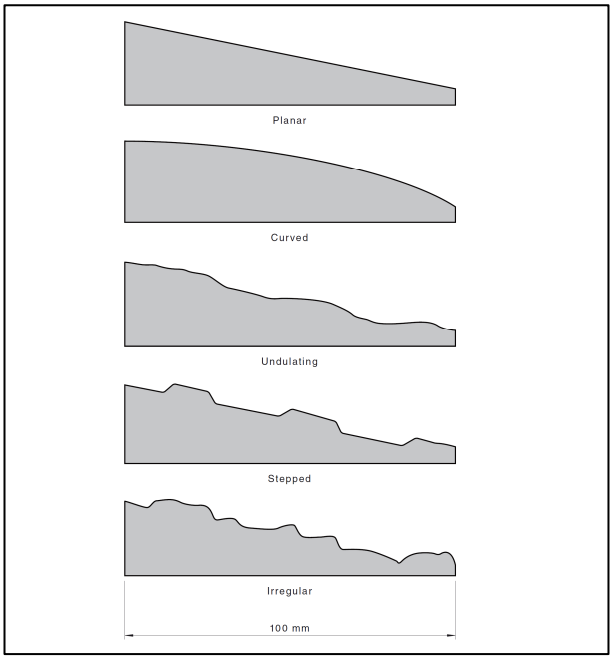
Detailed descriptions are given of defects judged to be particularly significant in the context of the project. For example, crushed seams in an apparently unstable slope. As a minimum, general descriptions outlining the number of defect sets within the rock mass and their broad characteristics are provided where it is possible to do so.

Defect Type – Defect abbreviations are as follows:

BP	Bedding Parting	FL	Foliation	SP	Shear Plane
CL	Cleavage	FZ	Fracture Zone	SZ	Shear Zone
CS	Crushed Seam	HB	Handling break	VN	Vein
DB	Drilling break	JT	Joint		
DL	Drill Lift	SM	Seam		

Defect Orientation – The dip and dip direction are recorded as a two-digit and three-digit number separated by a slash, e.g. 50/240 only when orientated core are collected and there is not core loss that could obscure core orientation. If alternative measurements are made, such as dip and strike or dip direction relative to magnetic north this shall be documented.

Surface Shape –At the medium scale of observation, description of the roughness of the surface shall be enhanced by description of the shape of the defect surface using the following terms, as illustrated below:



Defect Coatings and Seam Composition – Coatings are described using the following terms:

(a) *Clean* No visible coating.
(b) *Stained* No visible coating but surfaces are discoloured.
(c) *Veneer* A visible coating of soil or mineral, too thin to measure; may be patchy.
(d) *Coating* A visible coating up to 1 mm thick. Soil in-fill greater than 1 mm shall be described using defect terms (e.g. infilled seam). Defects greater than 1 mm aperture containing rock material great described as a vein.

Defect Spacing, Length, Openness and Thickness –described directly in millimetres and metres. In general descriptions, half order of magnitude categories are used, e.g. joint spacing typically 100 mm to 300 mm, sheared zones 1 m to 3 m thick.

Depending on project requirements and the scale of observation, spacing may be described as the mean spacing within a set of defects, or as the spacing between all defects within the rock mass. Where spacing is measured within a specific set of defects, measurements shall be made perpendicular to the defect set.

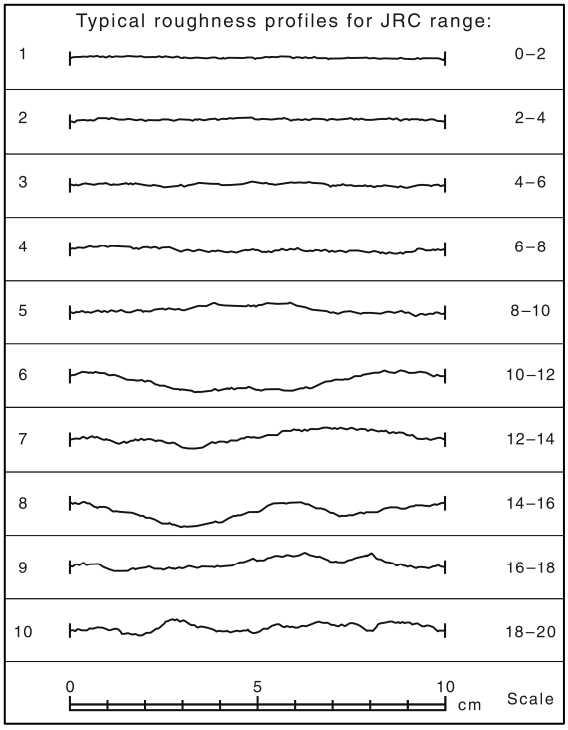
Defect spacing and length (sometimes called persistence), shall be described directly inmillimetres and metres.

Stratigraphic Unit - Geological maps related to the project are used for the designation of lithological formation name and, where possible geological unit name, e.g. Bringelly Shale, Potts Hill Sandstone Member.

Defect Roughness and Shape – Defect surface roughness is described as follows:

Very rough	Many large surface irregularities with amplitude generally more than 1 mm.
Rough	Many small surface irregularities with amplitude generally less than 1 mm.
Smooth	Smooth to touch. Few or no surface irregularities.
Polished	Shiny smooth surface
Slickensided	Grooved or striated surface, usually polished.

Where applicable Joint Roughness Range (JRC) is provided as follows:



Joint roughness profiles and corresponding JRC range based on Barton, N and Choubey, V. The Shear Strength of Rock Joints in Theory and Practice. *Rock Mechanics.* Vol. 10 (1977), pp. 1–54.

Where possible the mineralogy of the coating is identified.

Defect Infilling - abbreviated as follows:

CA	Calcite	KT	Chlorite
CN	Clean	MS	Secondary Mineral
Cy	Clay	MU	Unidentified Mineral
CS	Crushed Seam	Qz	Quartz
Fe	Iron Oxide	X	Carbonaceous

Parameters Related to Core Drilling

Total Core Recovery – T

Defect Spacing or Fracture Index – T

Rock Quality Designation – Y

Core Loss – Core loss occurs when material is lost during the drilling process It is shown at the bottom of the run unless otherwise indicated where core loss is known.

APPENDIX E – Laboratory Test Certificates

Material Test Report

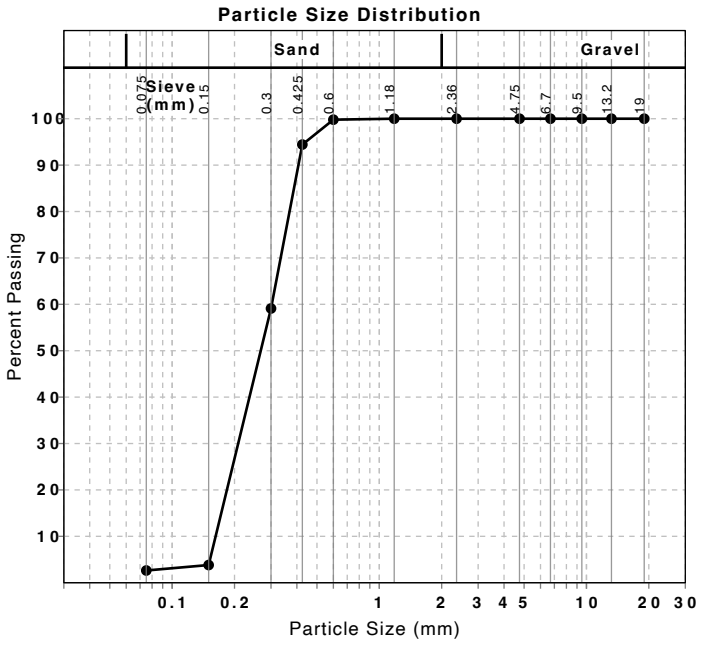
alliance
geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14801-2**
Issue Number: 1
Date Issued: 10/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Matt Swinbourn
Project Number: 14801
Project Name: Bridge Replacement - Tyagarah
Project Location: Tyagarah Reserve
Work Request: 19000
Sample Number: 22-19000A
Date Sampled: 28/02/2022
Dates Tested: 04/05/2022 - 06/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH01 - LR, Depth: 0.5-1.5m**
Material: SAND, fine to medium grained, trace clay/silt, red brown

Particle Size Distribution (AS1289 3.6.1)			
Sieve	Passed %	Passing Limits	
19 mm	**100**		
13.2 mm	**100**		
9.5 mm	**100**		
6.7 mm	**100**		
4.75 mm	**100**		
2.36 mm	**100**		
1.18 mm	**100**		
0.6 mm	**100**		
0.425 mm	**94**		
0.3 mm	**59**		
0.15 mm	**4**		
0.075 mm	**3**		



Material Test Report

alliance
geotechnical & environmental solutions
Alliance Geotechnical Pty Ltd
10 Welder Road Seven Hills NSW 2147
PO Box 275, Seven Hills NSW 1730
Phone: 1800 288 188
Email: brett@allgeo.com.au

Accredited for compliance with ISO/IEC 17025 - Testing

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Report Number: **14801-2**
Issue Number: 1
Date Issued: 10/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Matt Swinbourn
Project Number: 14801
Project Name: Bridge Replacement - Tyagarah
Project Location: Tyagarah Reserve
Work Request: 19000
Sample Number: 22-19000B
Date Sampled: 28/02/2022
Dates Tested: 04/05/2022 - 09/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Sample Location: **BH01 - LR, Depth: 7.5-8.0m**
Material: CLAY, high plasticity, pale grey, trace silt and trace fine sand

Atterberg Limit (AS1289 3.1.1 & 3.2.1 & 3.3.1)		Min	Max
Sample History	Air Dried		
Preparation Method	Dry Sieve		
Liquid Limit (%)	62		
Plastic Limit (%)	17		
Plasticity Index (%)	**45**		

Linear Shrinkage (AS1289 3.4.1)		Min	Max
Moisture Condition Determined By	AS 1289.3.1.1		
Linear Shrinkage (%)	23.5		
Cracking Crumbling Curling	Curling		

Material Test Report

Report Number: **14801-2**
Issue Number: 1
Date Issued: 10/05/2022
Client: Alliance Geotechnical
10 Welder Road, Seven Hills NSW 2147
Contact: Matt Swinbourn
Project Number: 14801
Project Name: Bridge Replacement - Tyagarah
Project Location: Tyagarah Reserve
Work Request: 19000
Date Sampled: 28/02/2022
Dates Tested: 04/05/2022 - 05/05/2022
Sampling Method: Sampled by Client
The results apply to the sample as received
Location: Tyagarah Reserve

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Accredited for compliance with ISO/IEC 17025 - Testing

Approved Signatory: Brett Bellingham
Conformance Testing Manager
NATA Accredited Laboratory Number: 15100

Moisture Content AS 1289 2.1.1			
Sample Number	Sample Location	Moisture Content (%)	Material
22-19000A	BH01 - LR, Depth: 0.5-1.5m	5.3 %	SAND, fine to medium grained, trace clay/silt, red brown
22-19000B	BH01 - LR, Depth: 7.5-8.0m	26.8 %	CLAY, high plasticity, pale grey, trace silt and trace fine sand

eurofins | Environment Testing

Certificate of Analysis

Alliance Geotechnical
10 Welder Road
Seven Hills
NSW 2147

NATA Accredited
Accreditation Number 1261
Site Number 18217

Accredited for compliance with ISO/IEC 17025 – Testing
NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing, medical testing, calibration, inspection, proficiency testing scheme providers and reference materials producers reports and certificates.

Attention: **Zubair Khan**

Report **886101-S**
Project name LONG REEF
Project ID 14801
Received Date May 04, 2022

Client Sample ID			**BH01-LR 3.0-3.4**	**BH01-LR 7.1-7.5**
Sample Matrix			**Soil**	**Soil**
Eurofins Sample No.			**S22-My0015727**	**S22-My0015728**
Date Sampled			**May 03, 2022**	**May 03, 2022**
Test/Reference	LOR	Unit		
Chloride	10	mg/kg	31	24
Conductivity (1:5 aqueous extract at 25°C as rec.)	10	uS/cm	77	15
pH (1:5 Aqueous extract at 25°C as rec.)	0.1	pH Units	8.4	6.2
Resistivity*	0.5	ohm.m	130	680
Sulphate (as SO4)	10	mg/kg	12	< 10
% Moisture	1	%	21	19

Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Chloride	Sydney	May 11, 2022	28 Days
- Method: LTM-INO-4270 Anions by Ion Chromatography			
Conductivity (1:5 aqueous extract at 25°C as rec.)	Sydney	May 11, 2022	7 Days
- Method: LTM-INO-4030 Conductivity			
pH (1:5 Aqueous extract at 25°C as rec.)	Sydney	May 11, 2022	7 Days
- Method: LTM-GEN-7090 pH by ISE			
Sulphate (as SO4)	Sydney	May 11, 2022	28 Days
- Method: In-house method LTM-INO-4270 Sulphate by Ion Chromatograph			
% Moisture	Sydney	May 06, 2022	14 Days
- Method: LTM-GEN-7080 Moisture			

eurofins | Environment Testing

web: www.eurofins.com.au
email: EnviroSales@eurofins.com

Eurofins Environment Testing Australia Pty Ltd
ABN: 50 005 085 521

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NATA # 1261 Site # 1254

Sydney
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Girraween NSW 2066
Phone : +61 2 9900 8400
NATA # 1261 Site # 18217

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Murarrie QLD 4172
Phone : +61 7 3902 4600
NATA # 1261 Site # 20794

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PO Box 60 Wickham 2293
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NATA # 1261 Site # 25079

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NATA # 2377 Site # 2370

Eurofins Environment Testing NZ Limited
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IANZ # 1327

Christchurch
43 Detroit Drive
Rolleston, Christchurch 7675
Phone : 0800 856 450
IANZ # 1290

Company Name: Alliance Geotechnical
Address: 10 Welder Road
Seven Hills
NSW 2147

Project Name: LONG REEF
Project ID: 14801

Order No.:
Report #: 886101
Phone: 1800 288 188
Fax: 02 9675 1888

Received: May 4, 2022 5:44 PM
Due: May 12, 2022
Priority: 5 Day
Contact Name: Zubair Khan

Eurofins Analytical Services Manager : Andrew Black

Sample Detail						Aggressivity Soil Set	Moisture Set
Melbourne Laboratory - NATA # 1261 Site # 1254							
Sydney Laboratory - NATA # 1261 Site # 18217						X	X
Brisbane Laboratory - NATA # 1261 Site # 20794							
Mayfield Laboratory - NATA # 1261 Site # 25079							
Perth Laboratory - NATA # 2377 Site # 2370							
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH01-LR 3.0-3.4	May 03, 2022		Soil	S22-My0015727	X	X
2	BH01-LR 7.1-7.5	May 03, 2022		Soil	S22-My0015728	X	X
Test Counts						2	2

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follows guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013 and are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil/sediment/solid results are reported on a dry basis, unless otherwise stated.
3. All biota/food results are reported on a wet weight basis on the edible portion, unless otherwise stated.
4. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
5. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds.
6. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
7. Samples were analysed on an 'as received' basis.
8. Information identified on this report with blue colour, indicates data provided by customer that may have an impact on the results.
9. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether the holding time is 7 days however for all other VOCs such as BTEX or C6-10 TRH then the holding time is 14 days.

Units

mg/kg: milligrams per kilogram
mg/L: milligrams per litre
µg/L: micrograms per litre
ppm: parts per million
ppb: parts per billion
%: Percentage
org/100 mL: Organisms per 100 millilitres
NTU: Nephelometric Turbidity Units
MPN/100 mL: Most Probable Number of organisms per 100 millilitres

Terms

APHA	American Public Health Association
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands and in the case of water samples these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment however free tributyltin was measured and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 5.4
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should be used as a guide only and may be different when site specific Sampling Analysis and Quality Plan (SAQP) have been implemented

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR: No Limit

Results between 10-20 times the LOR: RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS

PFAS field samples that contain surrogate recoveries in excess of the QC limit designated in QSM 5.4 where no positive PFAS results have been reported have been reviewed and no data was affected.

.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
Chloride	mg/kg	< 10			10	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	uS/cm	< 10			10	Pass	
Sulphate (as SO4)	mg/kg	< 10			10	Pass	
LCS - % Recovery							
Chloride	%	98			70-130	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	%	93			70-130	Pass	
Resistivity*	%	93			70-130	Pass	
Sulphate (as SO4)	%	95			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Chloride	S22-My0019061	NCP	%	106			70-130	Pass	
Sulphate (as SO4)	S22-My0019061	NCP	%	102			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1	Result 2	RPD	Acceptance Limits	Pass Limits	Qualifying Code
Duplicate									
				Result 1	Result 2	RPD			
Chloride	S22-Ma17668	NCP	mg/kg	120	120	<1	30%	Pass	
Conductivity (1:5 aqueous extract at 25°C as rec.)	S22-My0023942	NCP	uS/cm	230	190	17	30%	Pass	
pH (1:5 Aqueous extract at 25°C as rec.)	S22-My0023942	NCP	pH Units	5.3	5.3	<1	30%	Pass	
Resistivity*	S22-My0023942	NCP	ohm.m	44	53	17	30%	Pass	
Sulphate (as SO4)	S22-Ma17668	NCP	mg/kg	72	72	1.0	30%	Pass	
% Moisture	S22-My0015692	NCP	%	12	14	15	30%	Pass	

Comments

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	No
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Authorised by:

Robert Biviano	Analytical Services Manager
Harsha Kothalawala	Senior Analyst-Inorganic

Glenn Jackson
General Manager

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.