

Flood Management Report

Long Reef Golf Club, Anzac Avenue,
Collaroy NSW 2097



May 2025

| Long Reef Golf Club |

Revision 04

| 24-0850-02

Orion Group

info@theoriongroup.au

theoriongroup.au

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1 Executive Summary

Orion Group has prepared this flood impact assessment to support a Planning Proposal for a proposed development at the site of the exiting Long Reef Golf Club, Collaroy.

The proposed development includes the upgrade of the existing golf club building as well as new access/egress and landscaping.

This flood management report has been requested to assess the flood risk at the site confirm compliance of the proposed development with council's flood control requirements in the development control plan.

This report documents the procedures and findings of hydraulic modelling of the site in existing and proposed conditions in the 1% AEP and PMF events.

The Long Reef Golf Club is not directly affected by the 1% AEP flood event. Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse

The overall drainage system from Long Reef Club house drains to the open water storage and piped system in the golf course. Part of Anzac Road Drainage is also diverted through the Golf Course drainage system to ensure the water supply for irrigation is maintained. This reduces demand on the potable water supply system.

The flood Hazard near the Long Reef Golf Course Clubhouse remains at H1 for the 1%AEP Flood which is safe for people, vehicle and buildings

The Long Reef Golf Course, Golf Club carpark and access roads are affected by the PMF flood event. The Club House Building is just above the probable maximum flood level.

Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse.

The flood Hazard at the Long Reef Golf Course Clubhouse remains at H1 for the PMF Flood event which is safe for people, vehicle and buildings. However the flood risk increases to unsafe levels for the golf course and surrounding road network in the PMF flood event.

2 Introduction

Orion Group has been engaged by Long Reef Golf Club to prepare a Flood Management Report in accordance with the Northern Beaches Council requirements to support a planning proposal for the proposed development at Long Reef Golf Club.

The report provides an assessment on flood conditions of the site and summarises the flood modelling results for the Council-approved existing and proposed post-development conditions in the 1% AEP (Annual Exceedance Probability) and PMF (Probable Maximum Flood) events.

2.1 Site Description

The proposed upgrades to the existing Long Reef Golf Club is located on Anzac Avenue, Collaroy NSW 2097 on Lot 1, DP 1144187.



Figure 1 Site Locality Plan (Imagery courtesy of MetroMap© October 2024)

The site encompasses approximately 0.37ha and is currently functioning as a golf club. The topography of the site is predominantly gently sloping, descending from the north-western corner near the intersection of the driveway and Anzac Avenue toward Fishermans Beach, with a gradient of 2.6% observed in the existing car park. Along the north-eastern boundary, the slope becomes steeper, reaching a gradient of 15% as it descends toward the sand.

2.2 The Proposed Development

2.2.1 Project Description

Alterations and additions to the existing LRGC Club House to improve facilities for members and the wider community. Works will include partial demolition of roof and walls with alterations and additions to the existing one (1) storey building to create a refurbished two-storey clubhouse with provision of two (2) new accessible car spaces. Internal works will create the following areas of use:

Ground Floor

- new lobby entry space
- three (3) Members & Community Multi-use Rooms
- two (2) bar areas
- members lounge with external terrace area
- commercial kitchen
- dining area
- amenities
- office spaces
- storage rooms
- keg room
- kiosk
- covered outdoor terrace dining area; and
- garden seating area.

First Floor

- lobby and entry area
- back of house space
- Members & Community Multi-use Room
- bar lounge
- amenities
- members lounge and terrace area; and
- two (2) outdoor terrace areas

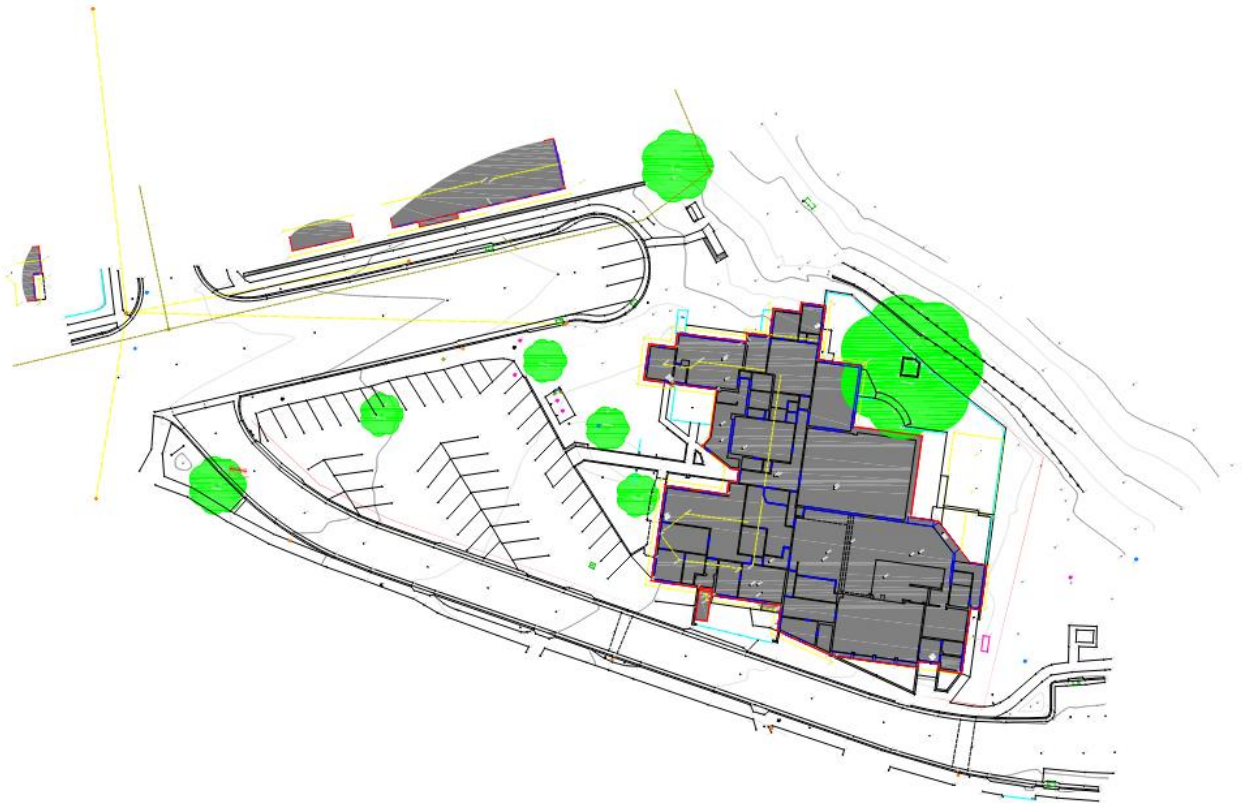
2.2.2 Site Location

The Site is positioned within the suburb of Collaroy, which forms part of the Northern Beaches Local Government Area (LGA). The Site is located at the eastern end of Anzac Avenue, Collaroy. The Site is located within Griffith Park which includes the Long Reef Golf Course (LRGC), Griffith Park Playing Field and amenities building, Collaroy Tennis Club, Long Reef Surf Lifesaving Club and associated facilities.

The Site is zoned RE1 Public Recreation and is subject to the provisions of Warringah Local Environmental Plan 2011. The Site is situated on the southern side of Anzac Avenue between Seaview Parade to the west and Fisherman's Beach to the east.

In its current state, the Site comprises the existing LRGC Club House which is a single storey rendered brick building with hipped tile roof and part flat metal roof. The Club House has been subject to various additions and extensions over the years and is no longer fit for purpose. There is an existing at grade parking area to the west of the existing building that will remain largely unchanged.

The Site adjoins Fisherman's Beach to the north and east, open reserve and Fisherman's Beach Boat Ramp to the east, an access road to car parking along the foreshore, Pro Shop and golf course to the south and south-west and low-density residential housing to the north-west.



The wider Site context is a combination of recreational and sporting facilities within Griffith Park, beach and intertidal areas, and low-density residential development.

The proposed site layout is shown in Figure 2. The civil plans by Orion Group are in Annexure A of the Stormwater Report.

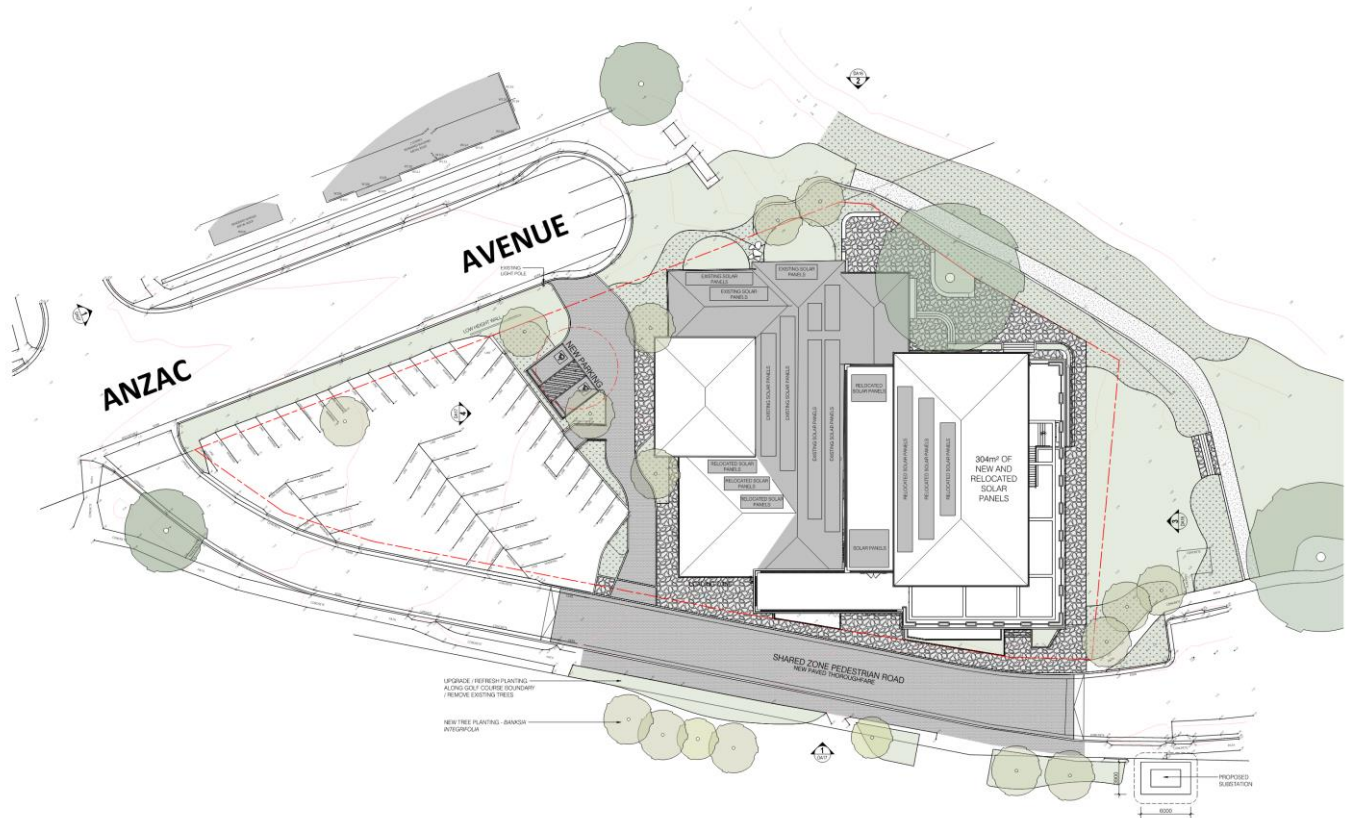


Figure 2 Proposed Site Plan

2.3 Existing Flood Information

The upstream stormwater system and catchment contours indicate there is about 26.5Ha of upstream catchment draining toward the Long Reef Golf Club



Figure 3 Council Pipe Network

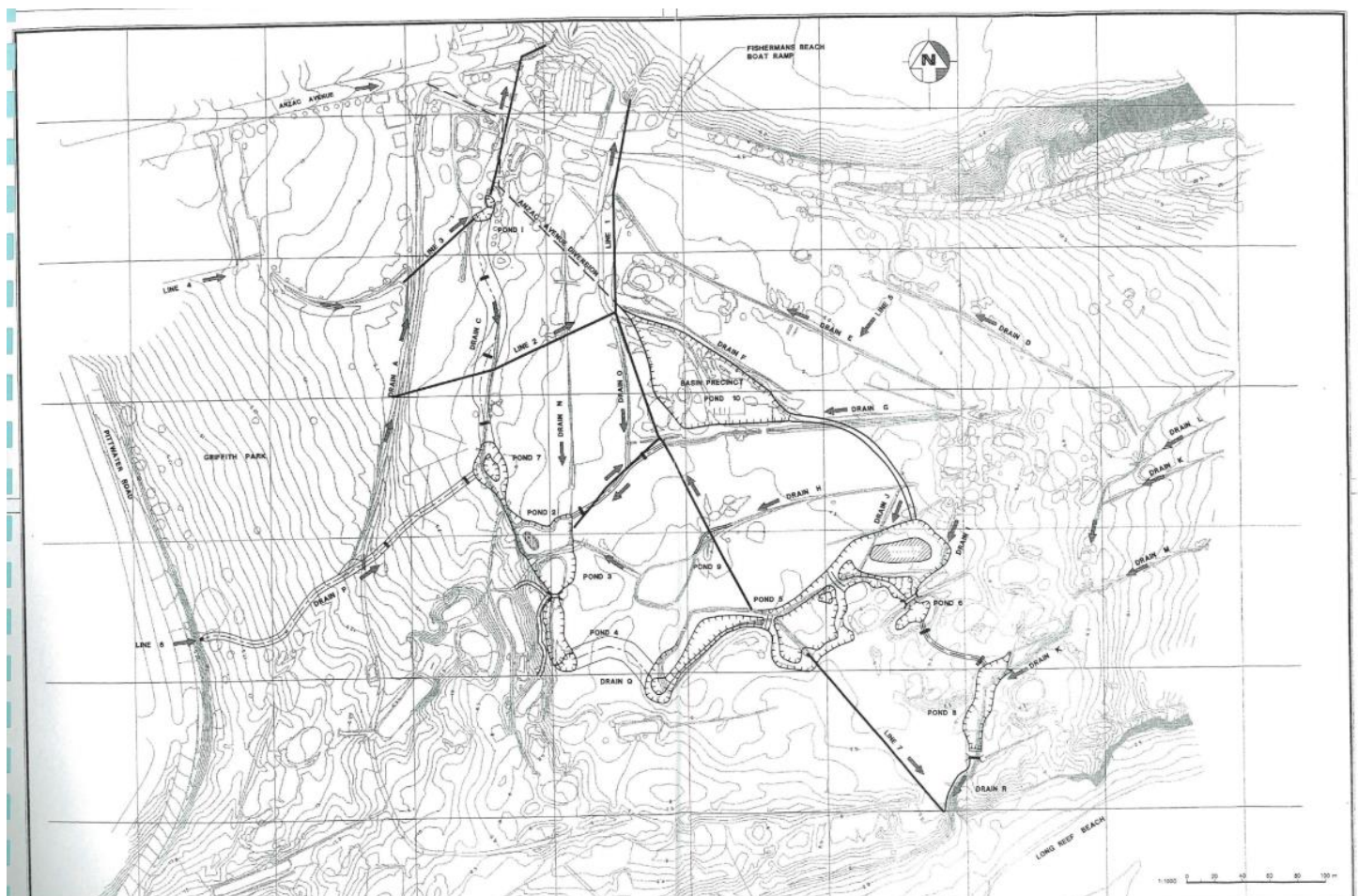


Figure 4 Pipe infrastructure in the vicinity of the Golf Club building

While there are no specific flood hazard maps shown on Council's web site, this would be indicative of incomplete flood analysis results availability rather than no flood risk for this watershed subcatchment.

The works required for the flood modelling to form the basis of the drains model and TufLOW model is

- Obtain council's drains model / pipe asset information to determine the pipe system performance.
- Develop a flood model using existing available lidar information and available survey information to determine the existing surface.
- Develop the Hydrological model using drains to ARR 2019 to develop flows for the 10% AEP storm event, 1% AEP storm event and the PMF storm event and run the flood model for the existing conditions.
- Determine, where required, if any additional flood resilience can be achieved without worsening flood risk for existing external residential properties or external road infrastructure.
- Ensure the proposed external site works does not worsen the flood risk to the existing building.

2.4 Project Objectives and Methodology

Project scope and objectives are as follows:

- Create new TUFLOW hydraulic model representing the catchment area surrounding the Long Reef Golf Club using LiDAR Elevation data, site topographical survey, land-use mapping, and stormwater infrastructure layout plans.
- Calculate the design rainfall storms as per Australian Rainfall & Runoff 2019 (ARR2019) guidelines.
- Estimate PMP (Probable Maximum Precipitation) rainfall storms using the Generalised Short-Duration Method (GSDM).
- Determine the design tailwater tidal levels to be used in conjunction with the design rainfall storms.
- Run Direct Rainfall (Rain on Grid) simulations for all storm durations and temporal patterns to determine the critical storm for each return period event.
- Prepare relevant flood maps including flood extents, depths, levels, velocities, hazards and impacts.
- Comment on the site's flood characteristics and model outcomes in the existing and proposed conditions.

2.5 Reference Documents

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

- Australian Rainfall and Runoff (ARR) Data 2019 with ARR 2016 rainfall datasets sourced from Bureau of Methodology (BoM)
- ARR 2019 – A Guide to Flood Estimation
- The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method (Bureau of Meteorology, Melbourne, Australia, June 2003)
- NSW Department of Planning and Environment (2023), Flood Risk Management Manual and associated 'toolkit' guidelines
- Warringah Council Development Control Plan (DCP, 2011)
- Warringah Council Local Environment Plan (LEP, 2011)

2.6 Site

The site is located at Long Reef Golf Club, Anzac Avenue, Collaroy NSW 2097 and is within Northern Beaches Council Local Government Area (LGA), as shown in **Figure 5**. This area was previously contained within Warringah Council until the merging of Warringah, Pittwater and Manly Councils to establish Northern Beaches Council in 2016.

The site is bordered by Fisherman's Beach along its northeastern boundary, Long Reef Golf Course to the south, and Anzac Avenue to the north-west.

The site generally slopes from 6.8mAHD at the car park to the west of the site to 6.4mAHD around the existing building. The southern portion of the site slopes southward to the existing access road while the northern portion of the site drains northward to Fisherman's Beach. See **Figure 6** for existing site topography layout.

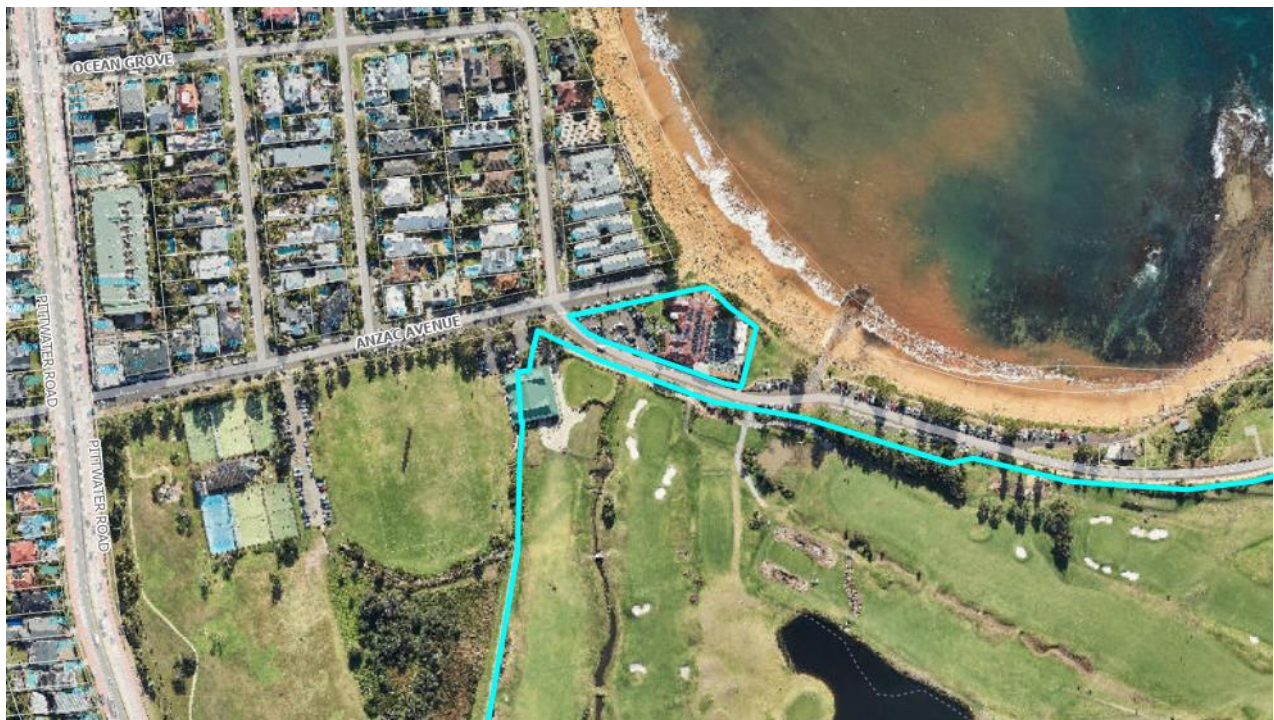


Figure 5 Site Location Map

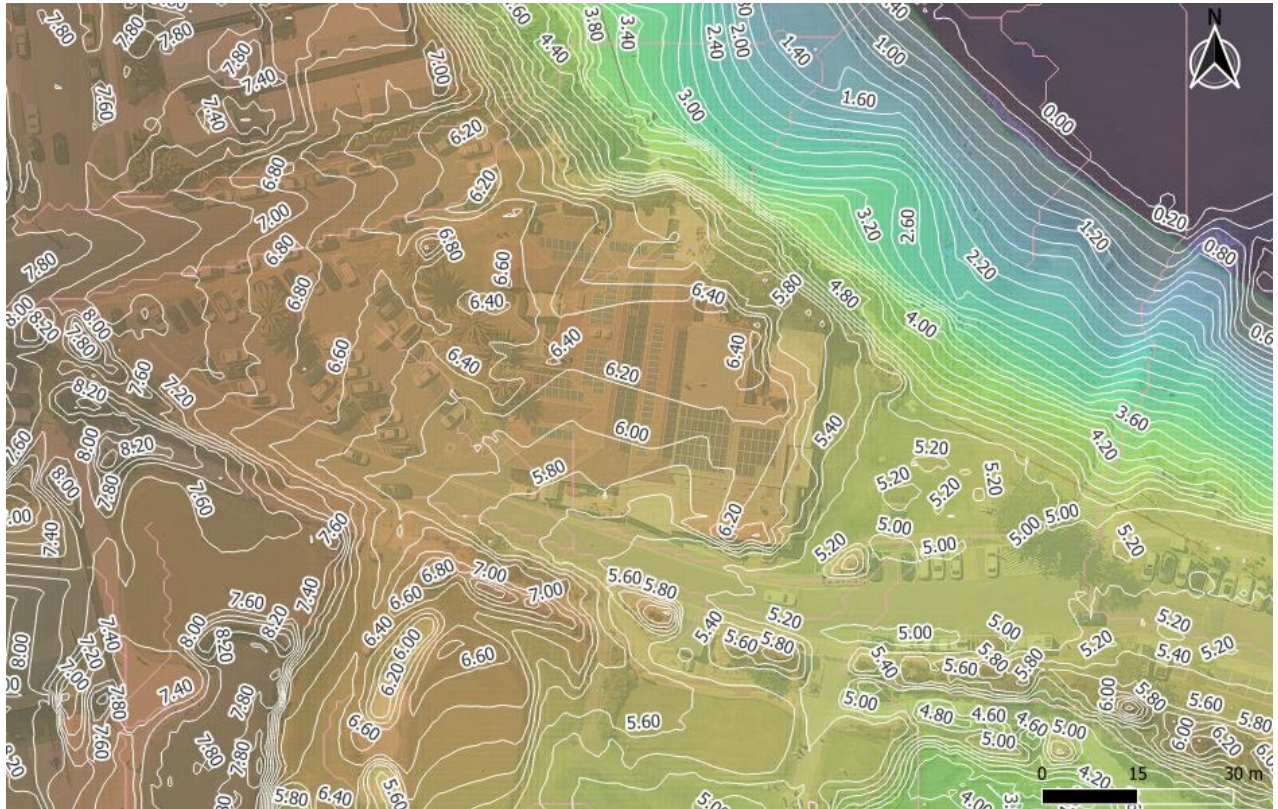


Figure 6 Existing Site Topography

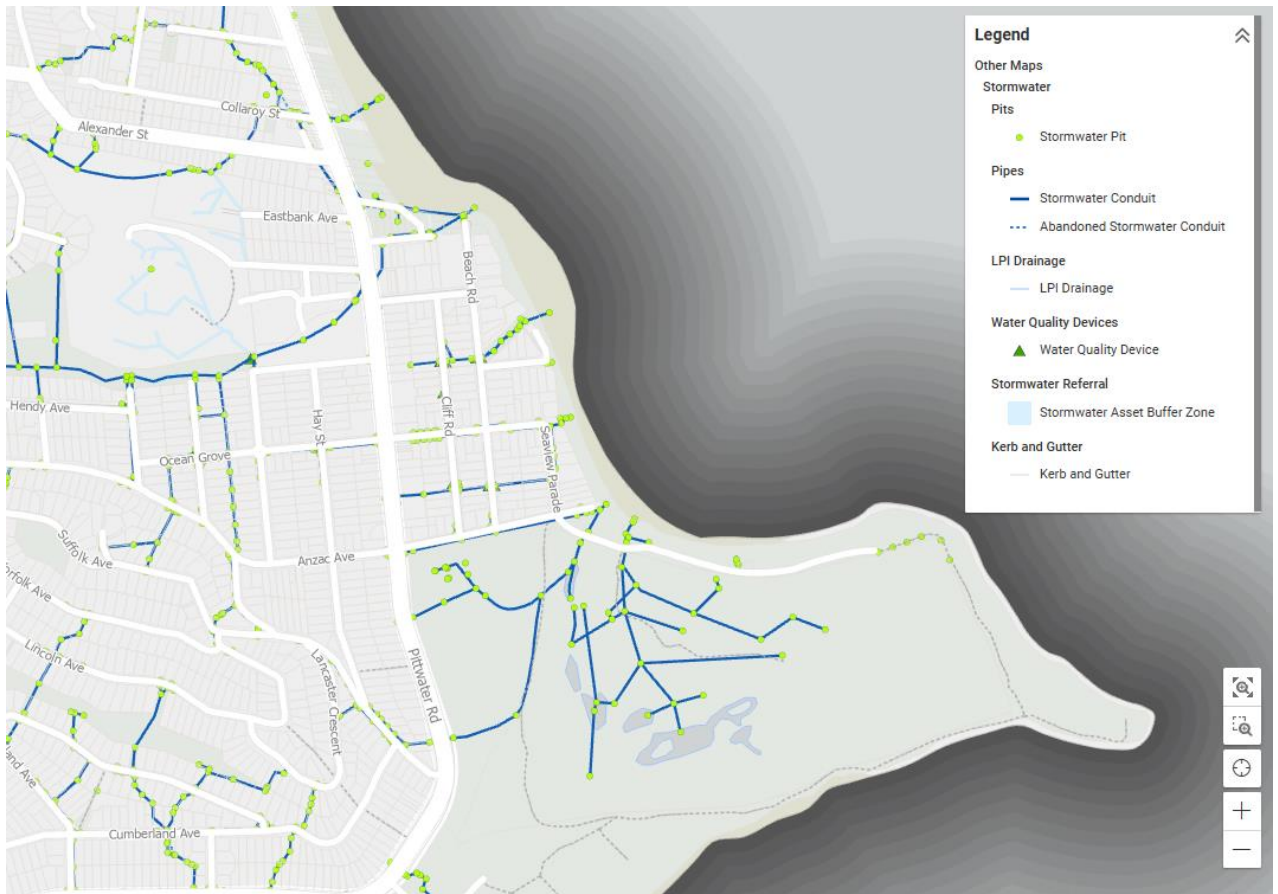


Figure 7 Existing Site Drainage



Figure 8 Warringah Council Catchment Groupings

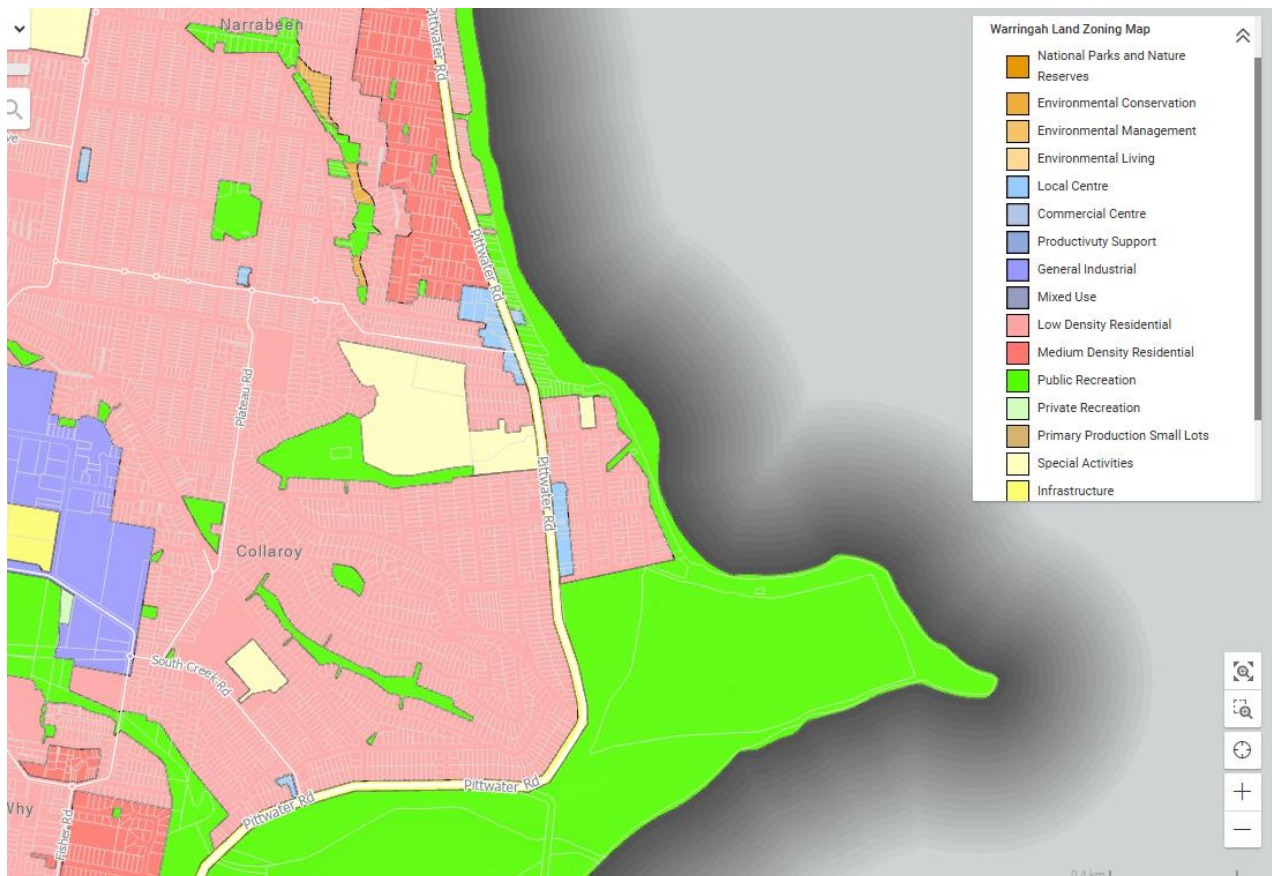


Figure 9 Zoning of catchment upstream of Long Reef Golf Club, Collaroy

3 Available Data

3.1 Previous studies

3.1.1 Narrabeen Lagoon Floodplain Risk Management Study 2019

The most relevant previous flood study is the Narrabeen Lagoon Floodplain Risk Management Study undertaken by Cardno on behalf of Northern Beaches Council in 2019. While the Long Reef Golf Club does not lie within the study area of the Narrabeen Lagoon Flood Study, the report provided useful information regarding rain loss parameters imperative in producing realistic runoff volumes in the catchment.

3.2 Survey Data

LiDAR data was downloaded from ELVIS. This data was recorded in June 2020 and is of 1 m cell resolution.

Further survey of the Long Reef Golf Club and surrounding golf course area were provided to Orion in order to undertake this assessment.

The two sets of survey data were examined and validated to ensure realistic inputs to and outputs from the hydraulic model.

4 Hydrology

A hydrological model was not developed for this assessment as the rainfall runoff simulations were undertaken by the TUFLOW Direct Rainfall hydraulic model. The following section will detail the preparation of the design rainfall storms.

4.1 Design Rainfall

The following subsections details the update of the XP-RAFTS model using the ARR2019 guidelines.

4.1.1 Sub-catchment Delineation

In order to determine the overall extents of the Direct Rainfall TUFLOW model, the LiDAR elevation data was used to determine the subcatchments for the surrounding area. It is important to note that these subcatchments did not take into account stormwater infrastructure, which will be examined in the hydraulic modelling section of this report.

4.1.2 Rainfall Data

The Depth-Duration-Frequency tables were downloaded from BOM at location -33.7403, 151.3062 at the approximate centroid of the study catchment.

4.1.3 Loss Model Parameters

The Direct Rainfall TUFLOW model utilises an Initial Loss-Continuous Loss (IL-CL) rainfall loss model. These values were determined based on the land-use materials and values used in previous studies and ARR2019 guidelines.

4.1.4 Temporal Patterns

Temporal patterns were applied to the rainfall data as per the ARR2019 guidelines. The recommended 10nr patterns were downloaded from ARR Data Hub and applied to the design rainfall depths for each duration of the required events.

4.1.5 Areal Reduction Factors

No Areal Reduction Factors were implemented.

4.1.6 Climate Change Factors

As part of the study a sensitivity analysis was undertaken to determine the impacts of climate change on flood levels within the catchment. A value of 20% was applied to all design rainfall depths.

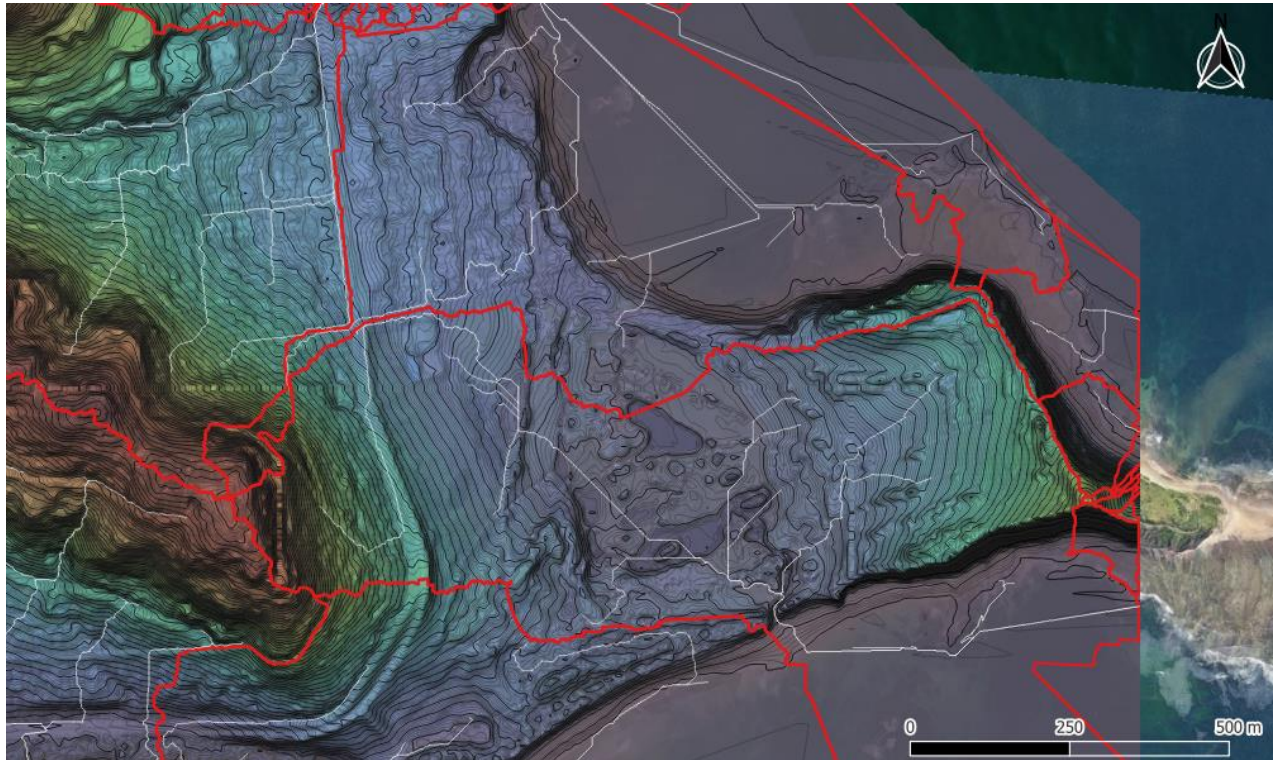


Figure 10 Sub-catchments and flow lines delineated using LiDAR

5 Hydraulic Flood Model

TUFLOW software was used to develop a dynamic 1d/2d hydraulic model as part of the study. TUFLOW engine version 2023-03-AF-TUFLOW_iSP_w64 was used.

5.1 Model Calibration

5.1.1 2D Model Domain

The 2D model domain was delineated using the subcatchment delineation used above, clipping the domain along the tidal boundary at an elevation contour of 0.5m AHD. The digital elevation model was created using a combination of 1m resolution Aerial LiDAR Surveys (ALS) and topographical drone surveys. The hydraulic model extent is shown in **Figure 11**.

5.1.2 Ground Surface Elevations

Ground surface elevations were assigned to grid cells within the TUFLOW model based on the elevation data described above in **Section 3.2**. The local Long Reef Golf Course elevation model was improved through the supplementation of detailed topographical survey as described in **Section 3.2**.

5.1.3 Model Cell Size

A square grid was utilised for this study, with the grid size of 2m x 2m. The grid cell size of 4m² is considered to be sufficiently fine to appropriately represent the variations in topography and land use within the study area. It should be noted that TUFLOW samples elevation points at the cell centres, mid sides, and corners, therefore a 4m² cell size results in surface elevations being sampled every 1m.

5.1.4 Building Footprints

Buildings at the site were represented in the model by polygons with a 2D_code of either 'null' or '-1' meaning that the cells in these areas are inactive and excluded from calculations.

5.1.5 Hydraulic Roughness

The hydraulic roughness of a material is an estimate of the resistance to flow and energy loss due to friction between a surface and the flowing water. A higher hydraulic roughness indicates more resistance to the flow. Roughness in TUFLOW is modelled using the Manning's (n) roughness co-efficient.

Manning's zones were based on the recommended values in the literature and land use types within the catchment model data.

5.1.6 1D Model Domain

The stormwater infrastructure data has been delineated by hand using the Northern Beaches planning maps. Several assumptions have been made in the modelling based on site observations and discussions with LRGC representatives to represent the stormwater pipe system data as accurately as possible.

5.1.7 Boundary Conditions

Inflow to the TUFLOW model was defined as a 2d_rf layer across the study area domain. The 2d_rf layer applies the design rainfall storms directly to the model. A combination of tidal water levels were tested at the tailwater ocean boundary.



Figure 11 TUFLOW 1d/2d Model Domain

6 Results

The TUFLOW model as run for the 1% AEP min storm and PMF storm for both the existing and proposed conditions as detailed in **Section 5** above. This section will illustrate and discuss the existing and proposed conditions for each AEP.

6.1 1% AEP



Figure 12 Existing 1% AEP flood depth – project vicinity

The Long Reef Golf Club is not directly affected by the 1% AEP flood event. Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse



Figure 13 Existing 1% AEP flood depth – catchment view

The overall drainage system from Long Reef Club house drains to the open water storage and piped system in the golf course. Part of Anzac Road Drainage is also diverted through the Golf Course drainage system to ensure the water supply for irrigation is maintained. This reduces demand on the potable water supply system.



Figure 14 1% AEP flood velocity near the Golf Club



Figure 15 1% AEP flood velocity in the catchment area



Figure 16 flood hazard near the Golf Club H1 flood hazard is noted as safe for people, vehicles and building

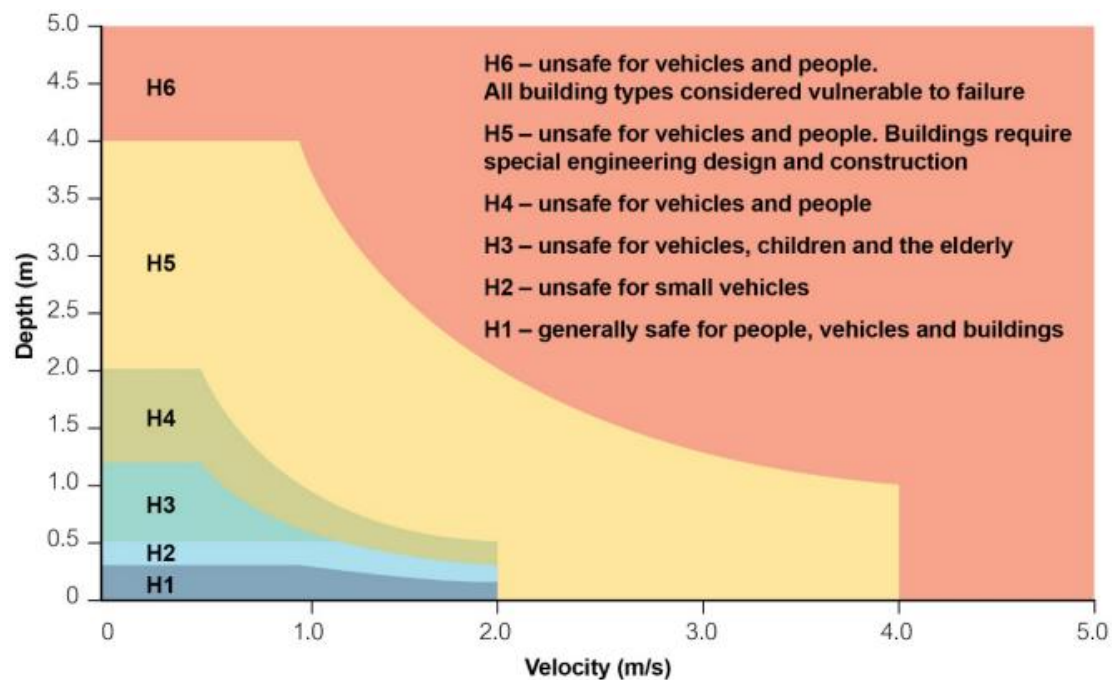


Figure 17 Flood Hazard risk vulnerability curve



Figure 18 1% AEP flood hazard in the catchment area

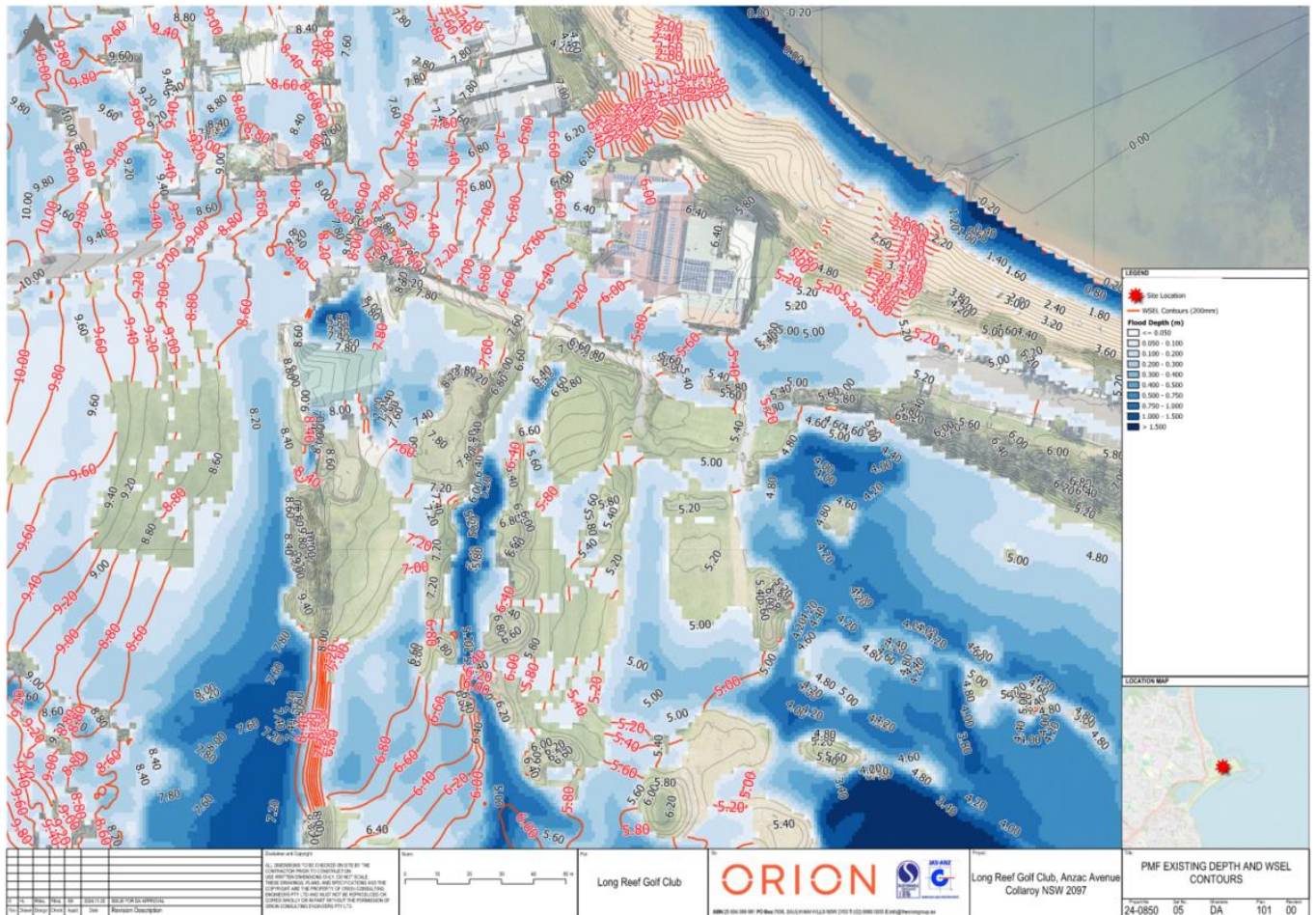


Figure 19 PMF flood levels in the vicinity of the club house

The Long Reef Golf Course, Golf Club carpark and access roads are affected by the PMF flood event. The Club House Building is just above the probable maximum flood level.

Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse



Figure 20 PMF flood levels in the catchment

The Long Reef Golf Course, Golf Club carpark and access roads are affected by the PMF flood event. The Club House Building is just above the probable maximum flood level.

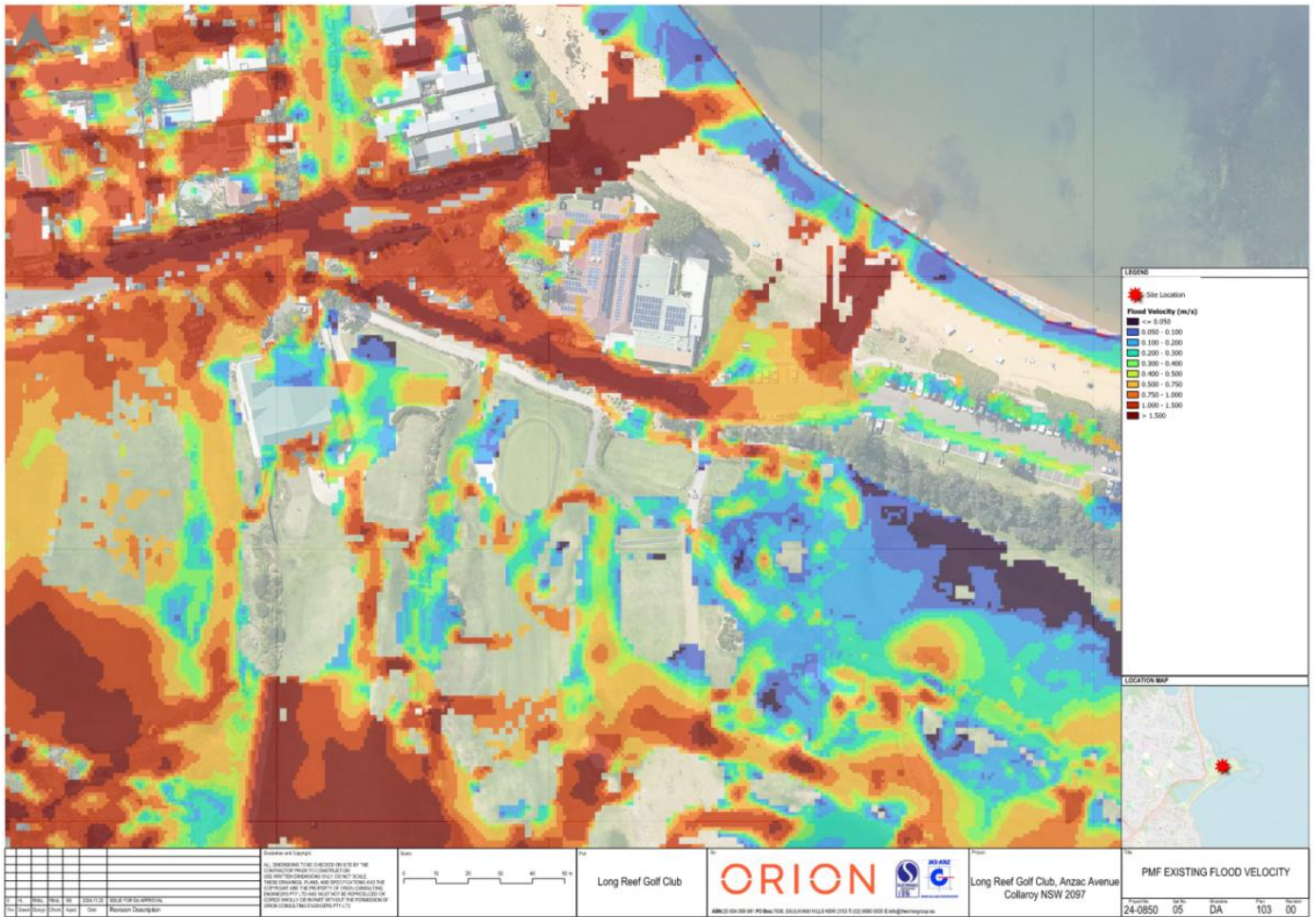


Figure 21 PMF flood velocity in the vicinity of the club house

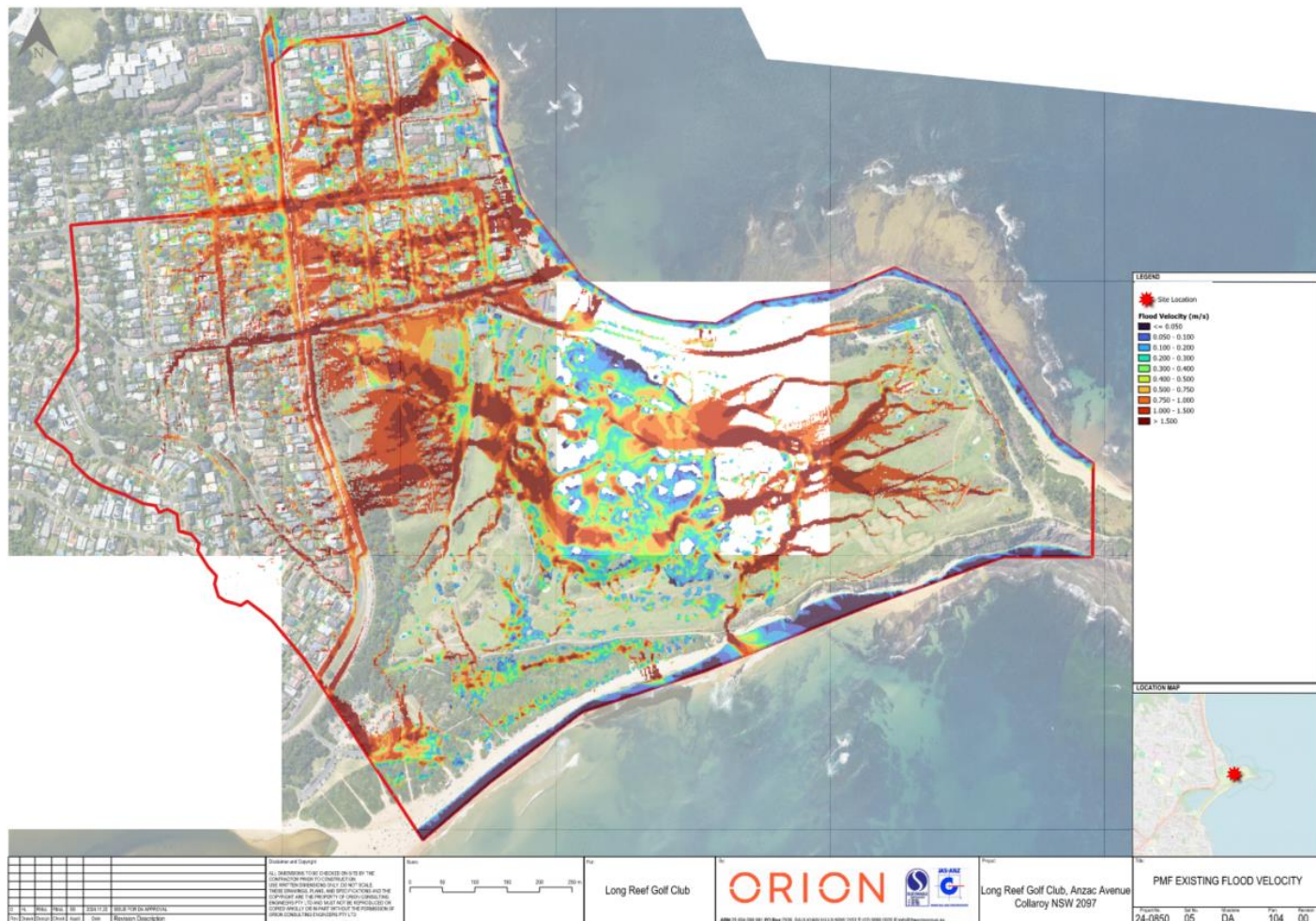


Figure 22 PMF flood velocity in the catchment

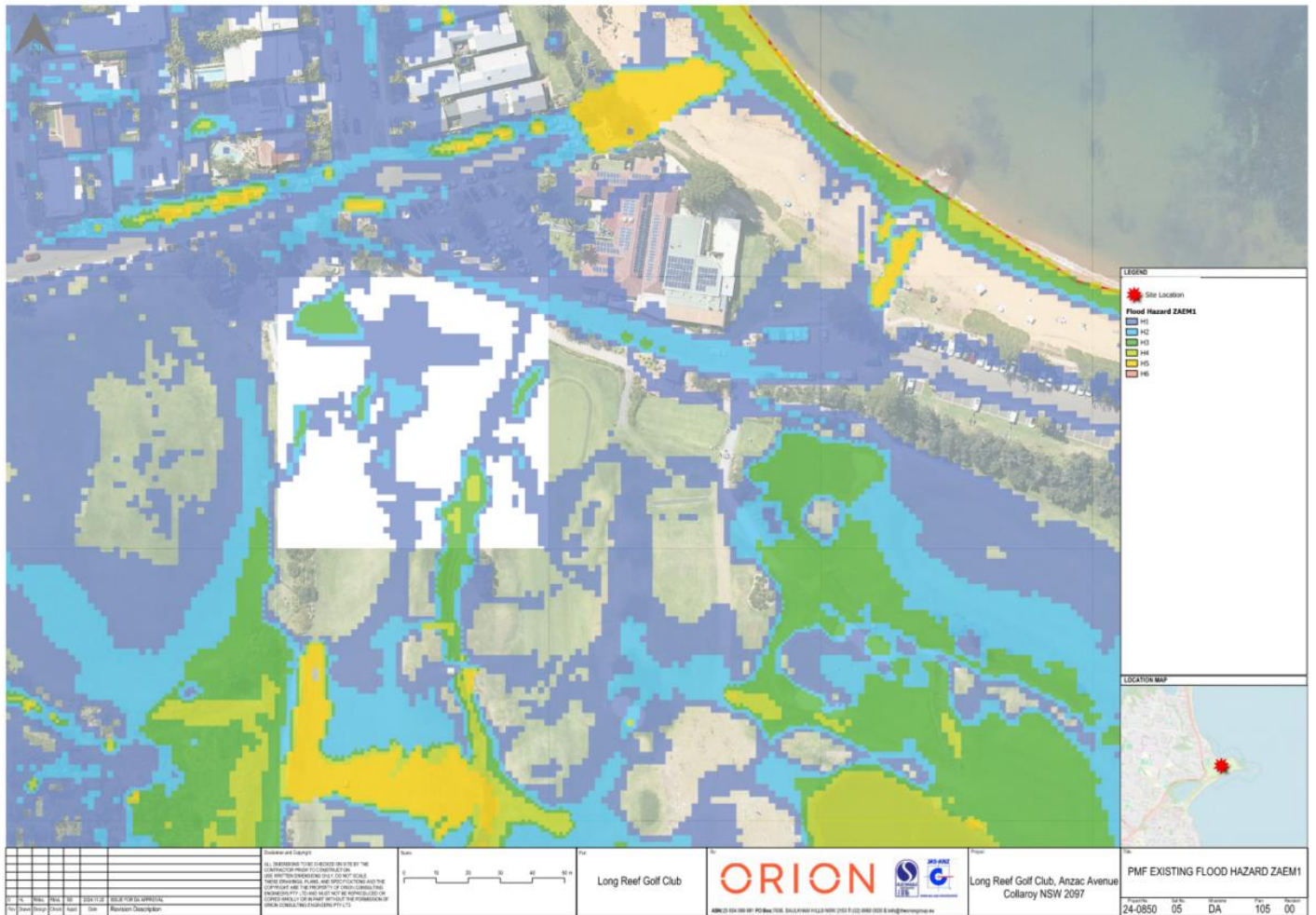


Figure 23 PMF flood hazard in the vicinity of the club house

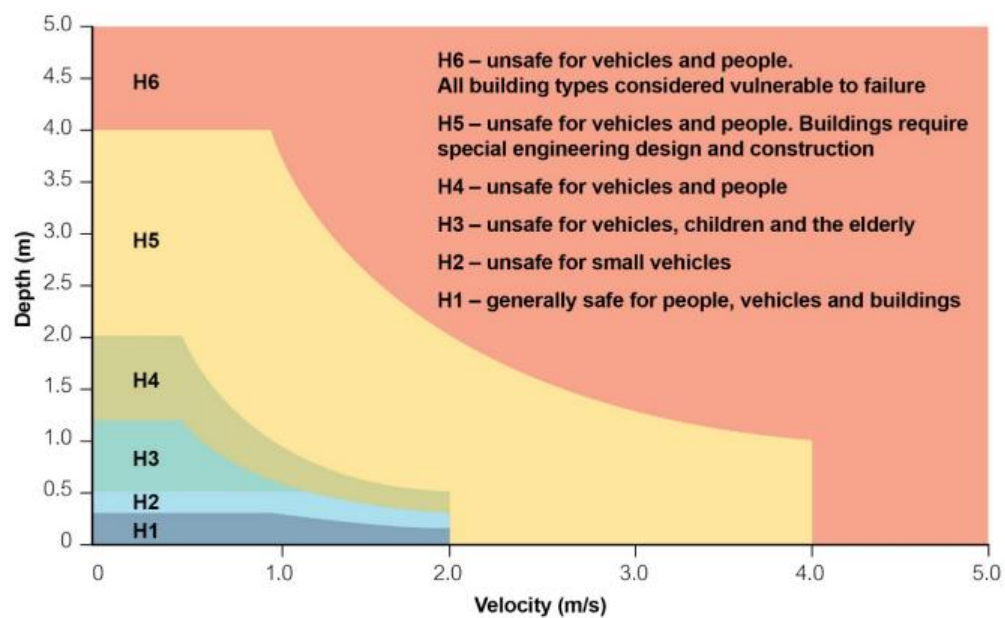




Figure 24 PMF flood hazard in the vicinity of the catchment

7 Conclusion and Recommendations

The Long Reef Golf Club is not directly affected by the 1% AEP flood event. Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse

The overall drainage system from Long Reef Club house drains to the open water storage and piped system in the golf course. Part of Anzac Road Drainage is also diverted through the Golf Course drainage system to ensure the water supply for irrigation is maintained. This reduces demand on the potable water supply system.

The flood Hazard near the Long Reef Golf Course Clubhouse remains at H1 for the 1%AEP Flood which is safe for people, vehicle and buildings

The Long Reef Golf Course, Golf Club carpark and access roads are affected by the PMF flood event. The Club House Building is just above the probable maximum flood level.

Regular operation and maintenance of the Golf Course stormwater drainage and reuse system forms part of the protection for the drainage system for the Long Reef Golf Clubhouse.

The flood Hazard at the Long Reef Golf Course Clubhouse remains at H1 for the PMF Flood event which is safe for people, vehicle and buildings however the flood risk increases to unsafe levels for the golf course and surrounding road network in the PMF flood event.

Yours sincerely,



Stephen Brain

Orion Group | Technical Director

8 References

Australian Rainfall and Runoff: A Guide to Flood Estimation, Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), Commonwealth of Australia (Geoscience Australia), 2019

Flood Risk Management Manual and associated 'toolkit' guidelines, NSW Department of Planning and Environment, 2023



LEGEND

 Site Location

Flood Depth (m)

<= 0.050

0.050 - 0.100

0.100 - 0.200

0.200 - 0.300

0.300 - 0.400

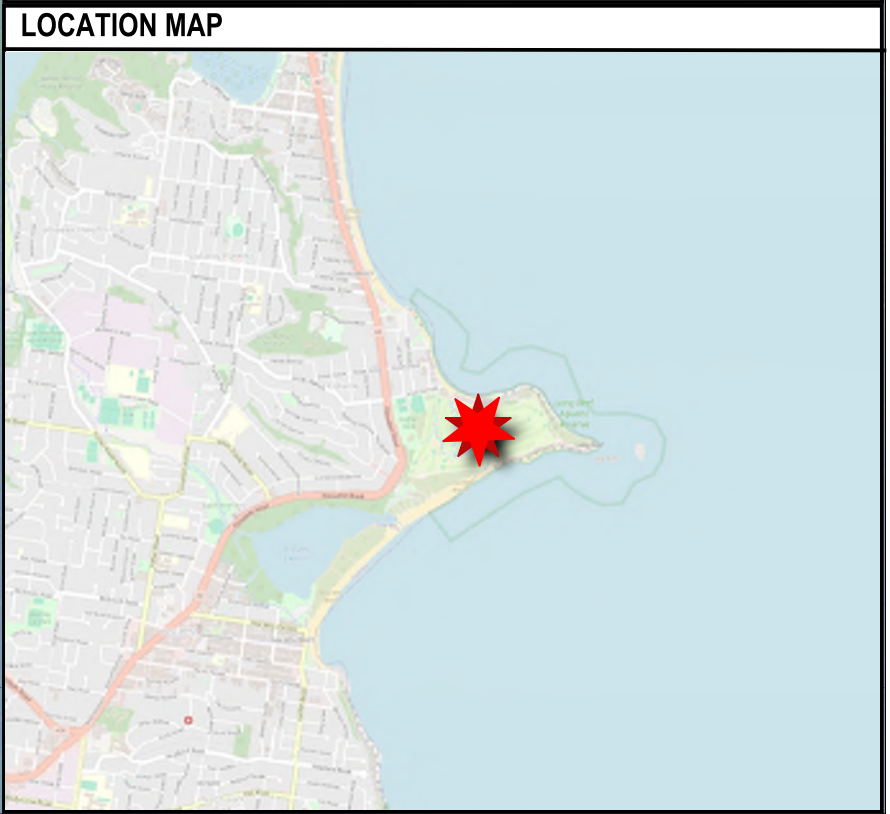
0.400 - 0.500

0.500 - 0.750

0.750 - 1.000

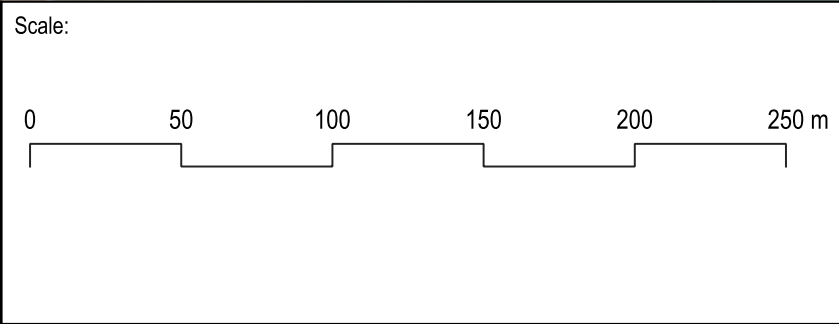
1.000 - 1.500

> 1.500



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Rev	Drawn	Design	Check	Appd.	Date	Revision Description	

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Long Reef Golf Club

By:

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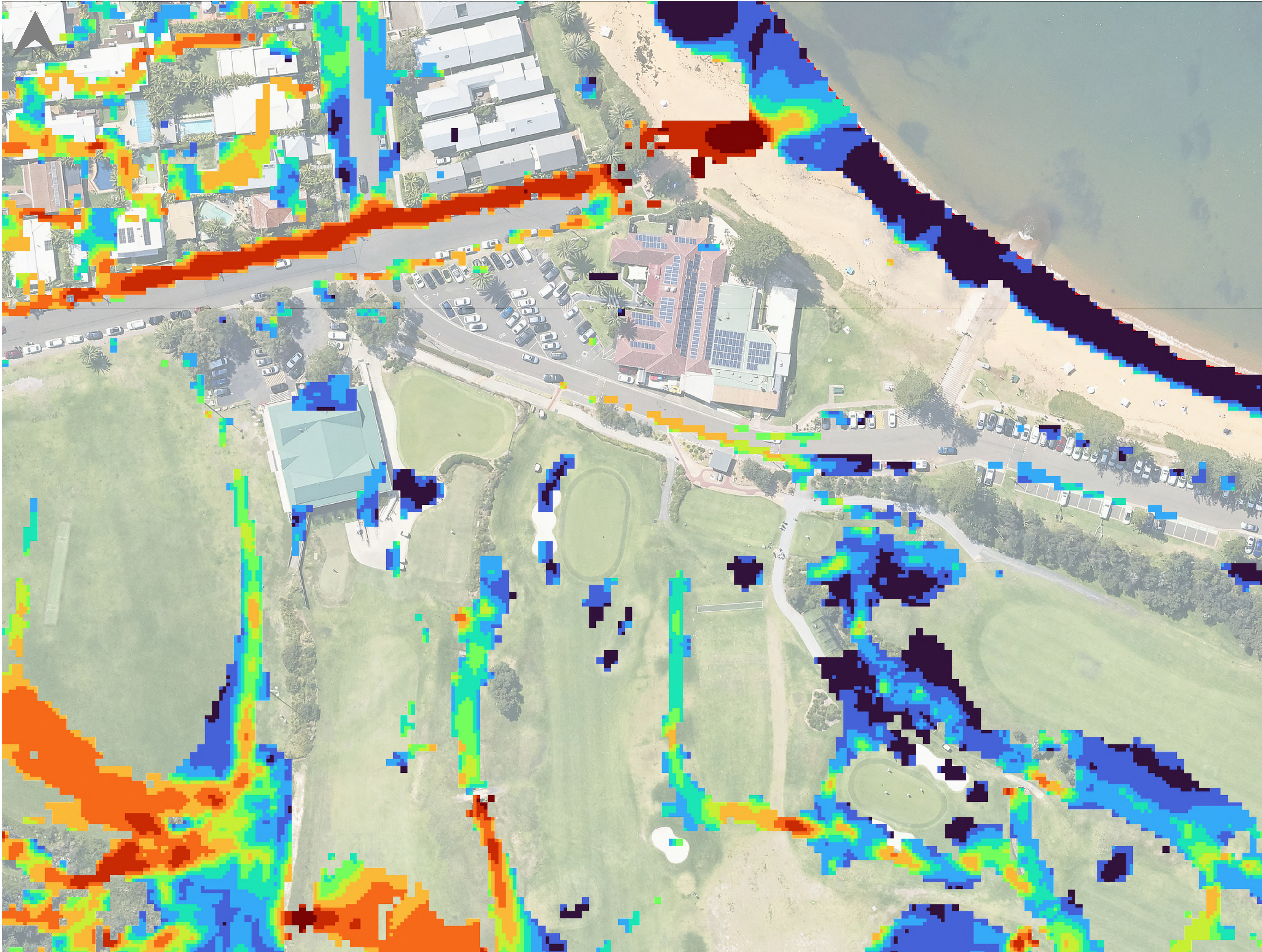
 

ABN:25 604 069 981 PO Box:7936, BAULKHAM HILLS NSW 2153 T:(02) 8660 0035 E:info@theoriongroup.au

Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:				
100YR PRE-DEVELOPMENT DEPTH AND WSEL CONTOURS				
Project No.	Set No.	Milestone	Plan	Revision
24-0850	04	DA	102	00



LEGEND

Site Location

Flood Velocity (m/s)

<= 0.050

0.050 - 0.100

0.100 - 0.200

0.200 - 0.300

0.300 - 0.400

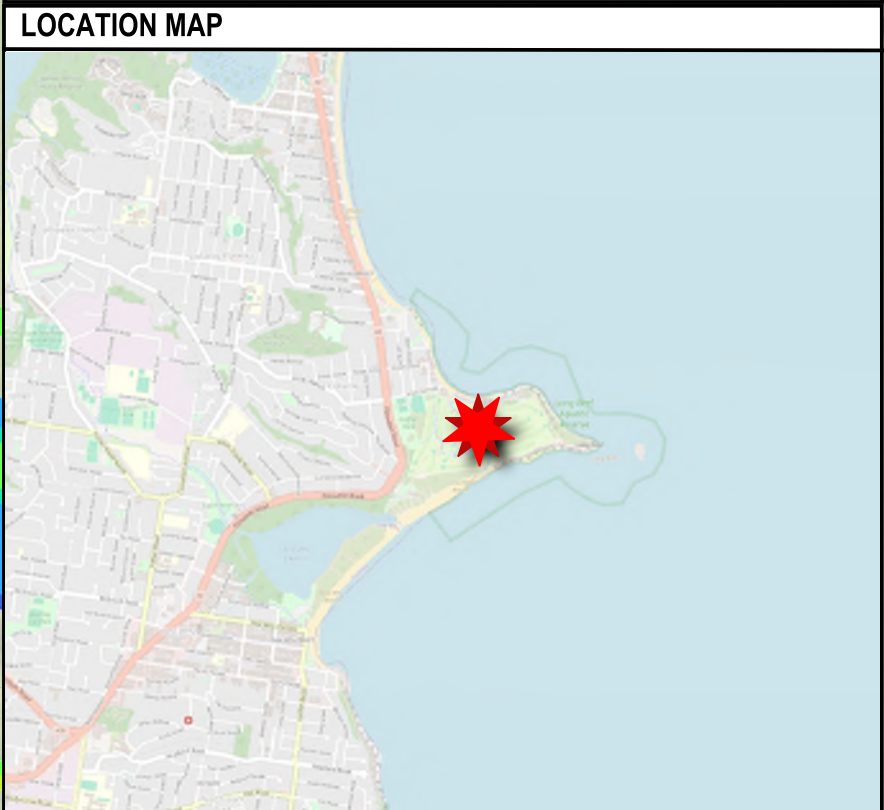
0.400 - 0.500

0.500 - 0.750

0.750 - 1.000

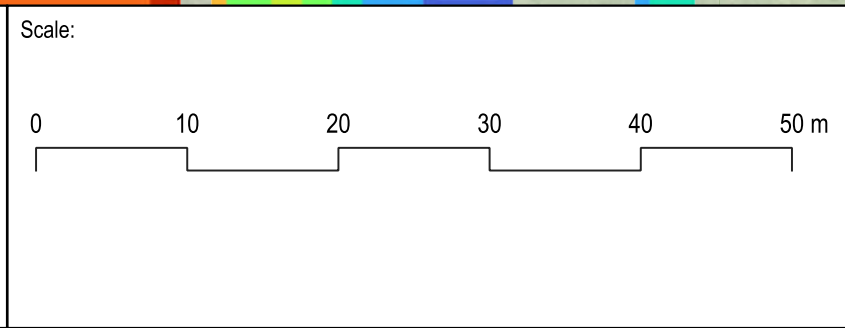
1.000 - 1.500

> 1.500



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By:

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ABN:25 604 069 981 PO Box:7936, BAULKHAM HILLS NSW 2153 T:(02) 8660 0035 E:info@theoriongroup.au

Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:

100YR PRE-DEVELOPMENT FLOOD VELOCITY

Project No.	Set No.	Milestone	Plan	Revision
24-0850	04	DA	103	00



LEGEND

Site Location

Flood Velocity (m/s)

<= 0.050

0.050 - 0.100

0.100 - 0.200

0.200 - 0.300

0.300 - 0.400

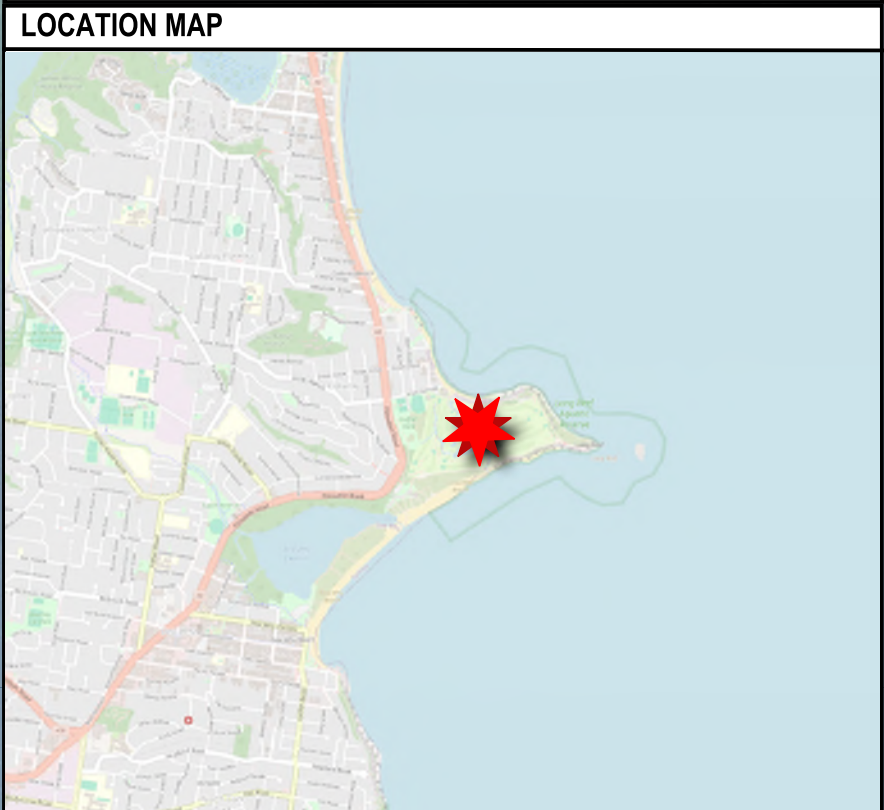
0.400 - 0.500

0.500 - 0.750

0.750 - 1.000

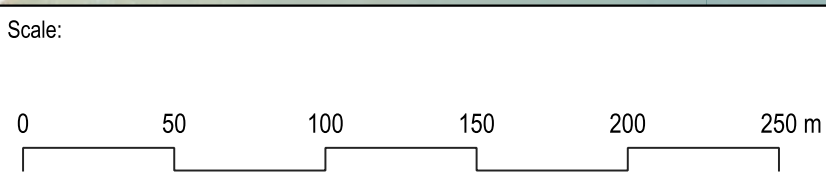
1.000 - 1.500

> 1.500



0	HL	RMCL	RMCL	SB	2024.11.22	ISSUE FOR DA APPROVAL			
Rev	Drawn	Design	Check	Appd.	Date	Revision Description			

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For:

Long Reef Golf Club

By:

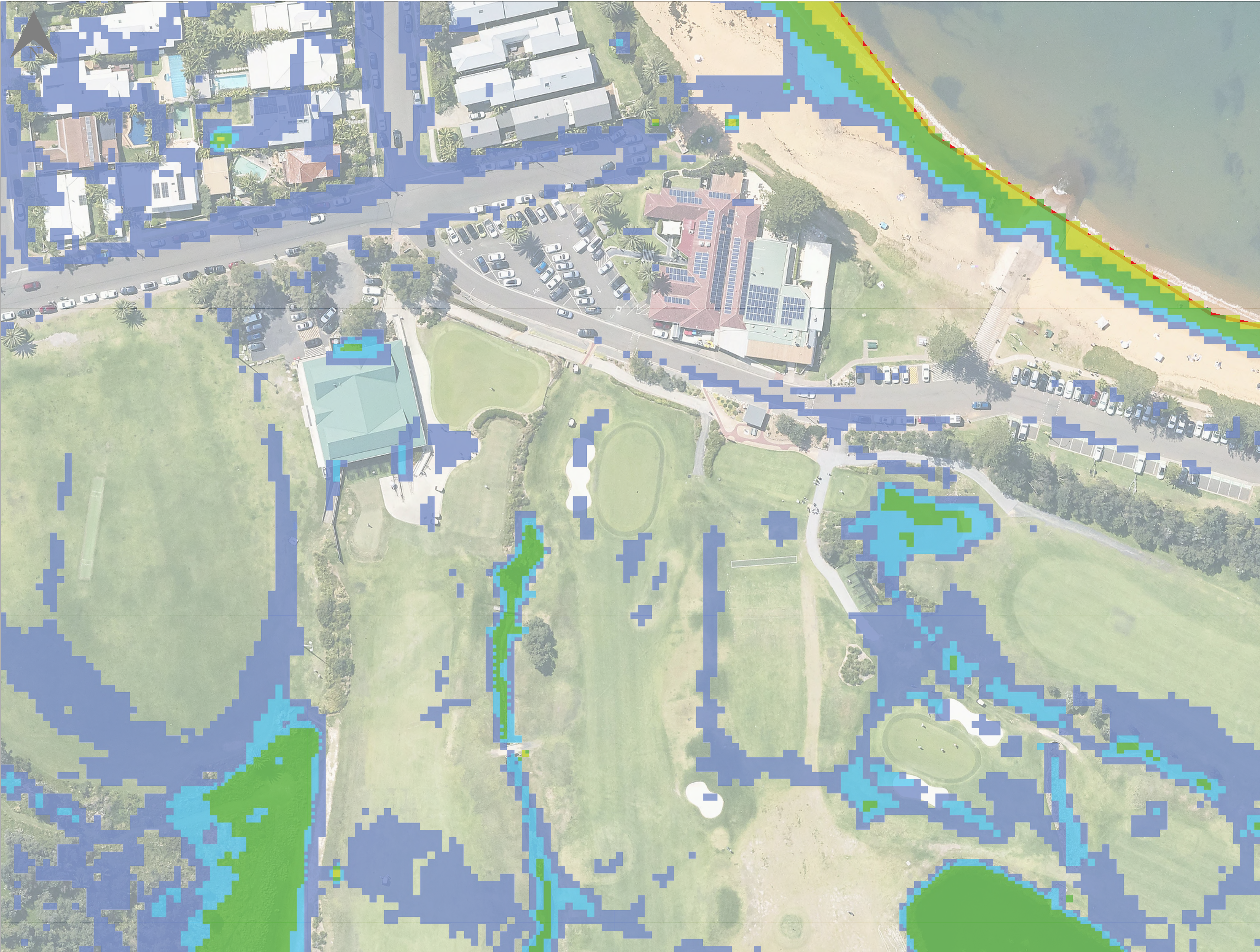
ORION

ABN:25 604 069 981 PO Box:7936, BAULKHAM HILLS NSW 2153 T:(02) 8660 0035 E:info@theoriongroup.au

Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title: 100YR PRE-DEVELOPMENT FLOOD VELOCITY					
Project No.	Set No.	Milestone	Plan	Revision	
24-0850	04	DA	104	00	

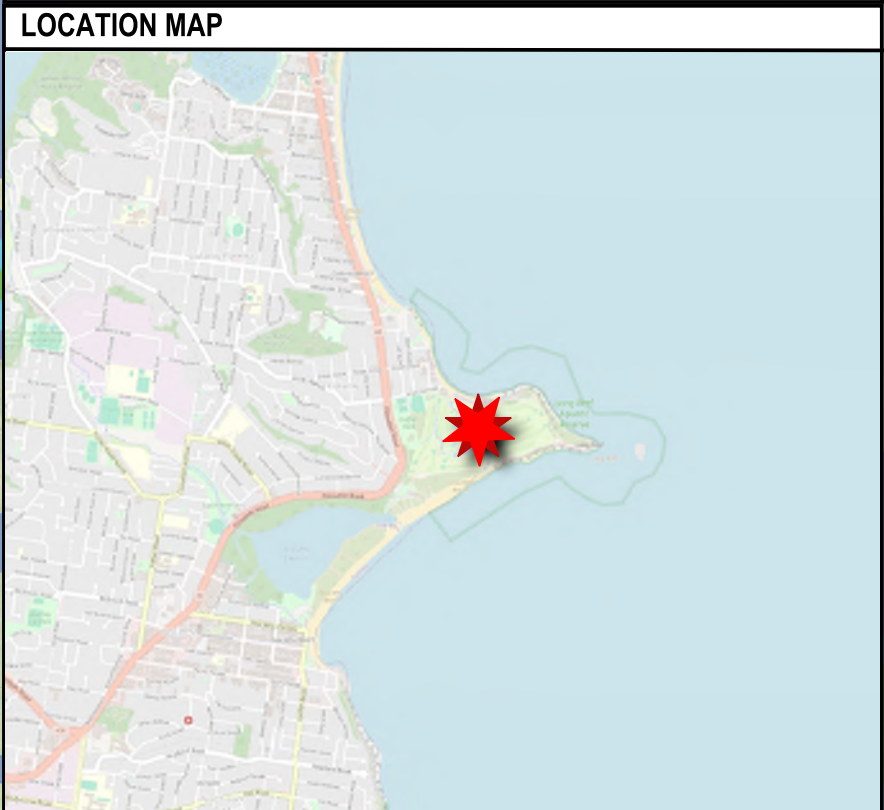


LEGEND

Site Location

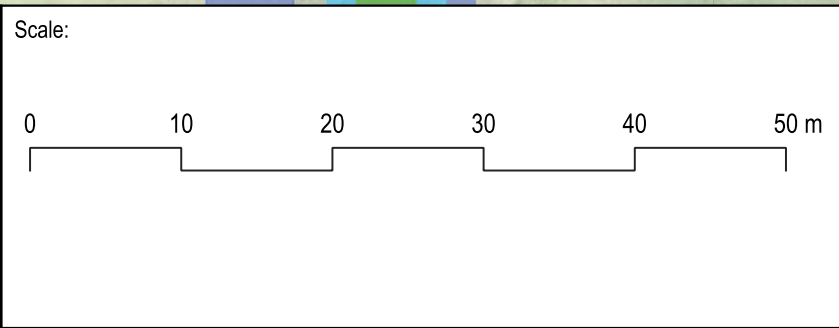
Flood Hazard ZAEM1

- H1
- H2
- H3
- H4
- H5
- H6



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For:

Long Reef Golf Club

By:

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Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:

100YR PRE-DEVELOPMENT FLOOD
HAZARD ZAEM1

Project No.	Set No.	Milestone	Plan	Revision
24-0850	04	DA	105	00

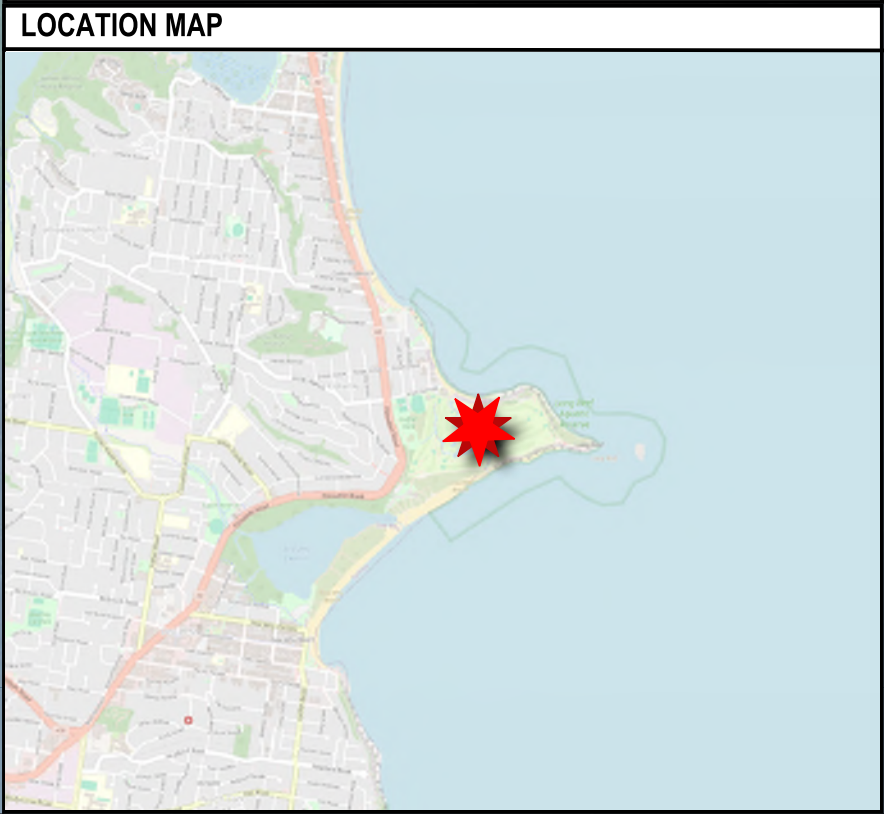


LEGEND

 Site Location

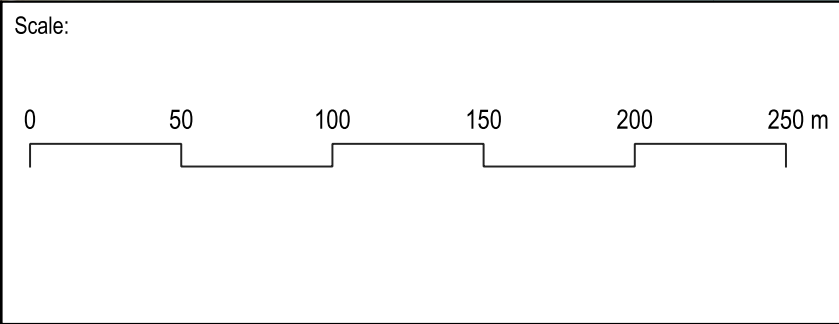
Flood Hazard ZAEM1

- H1
- H2
- H3
- H4
- H5
- H6



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For:

Long Reef Golf Club

By:

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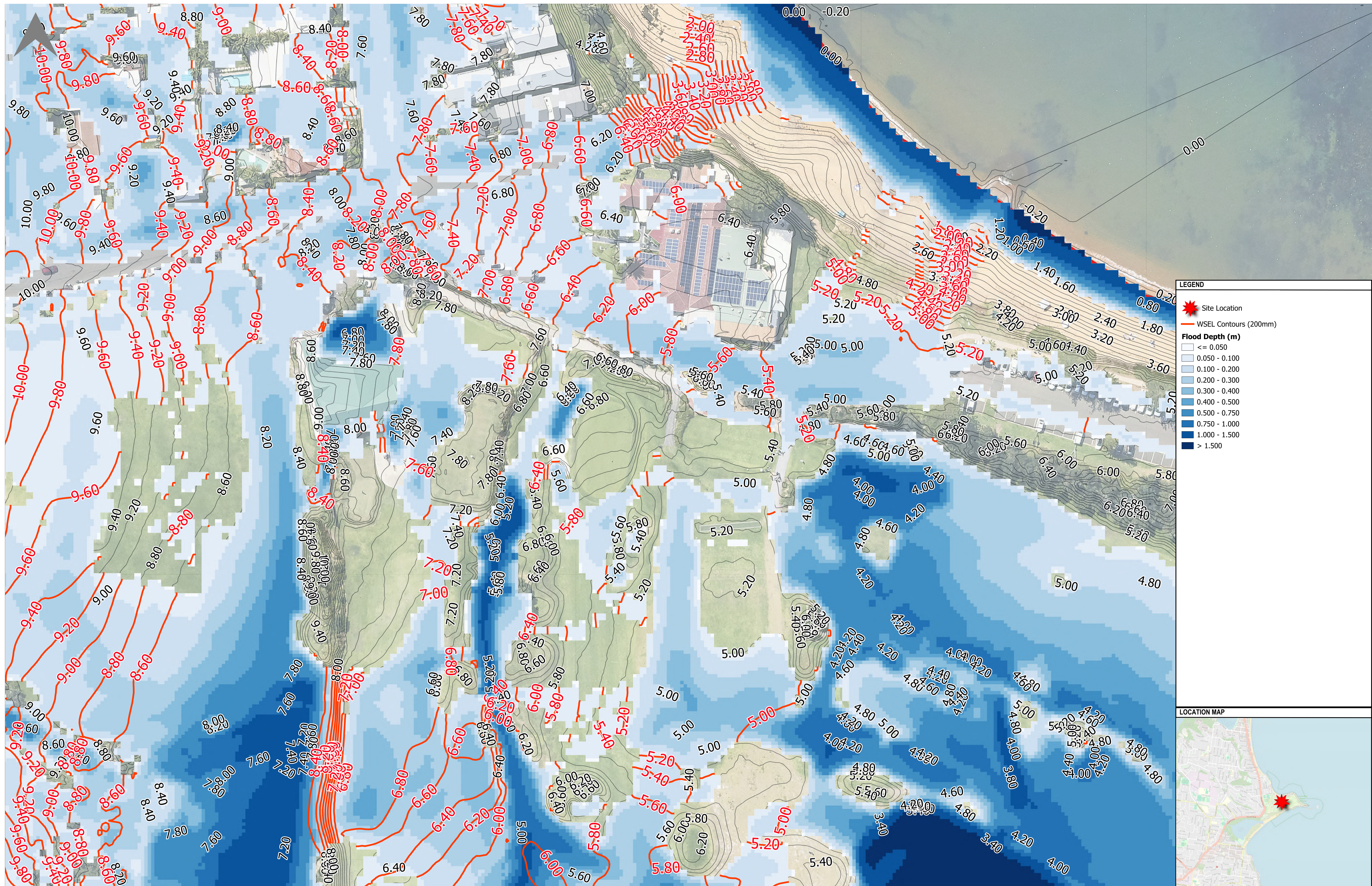
ABN:25 604 069 981 PO Box:7936, BAULKHAM HILLS NSW 2153 T:(02) 8660 0035 E:info@theoriongroup.au

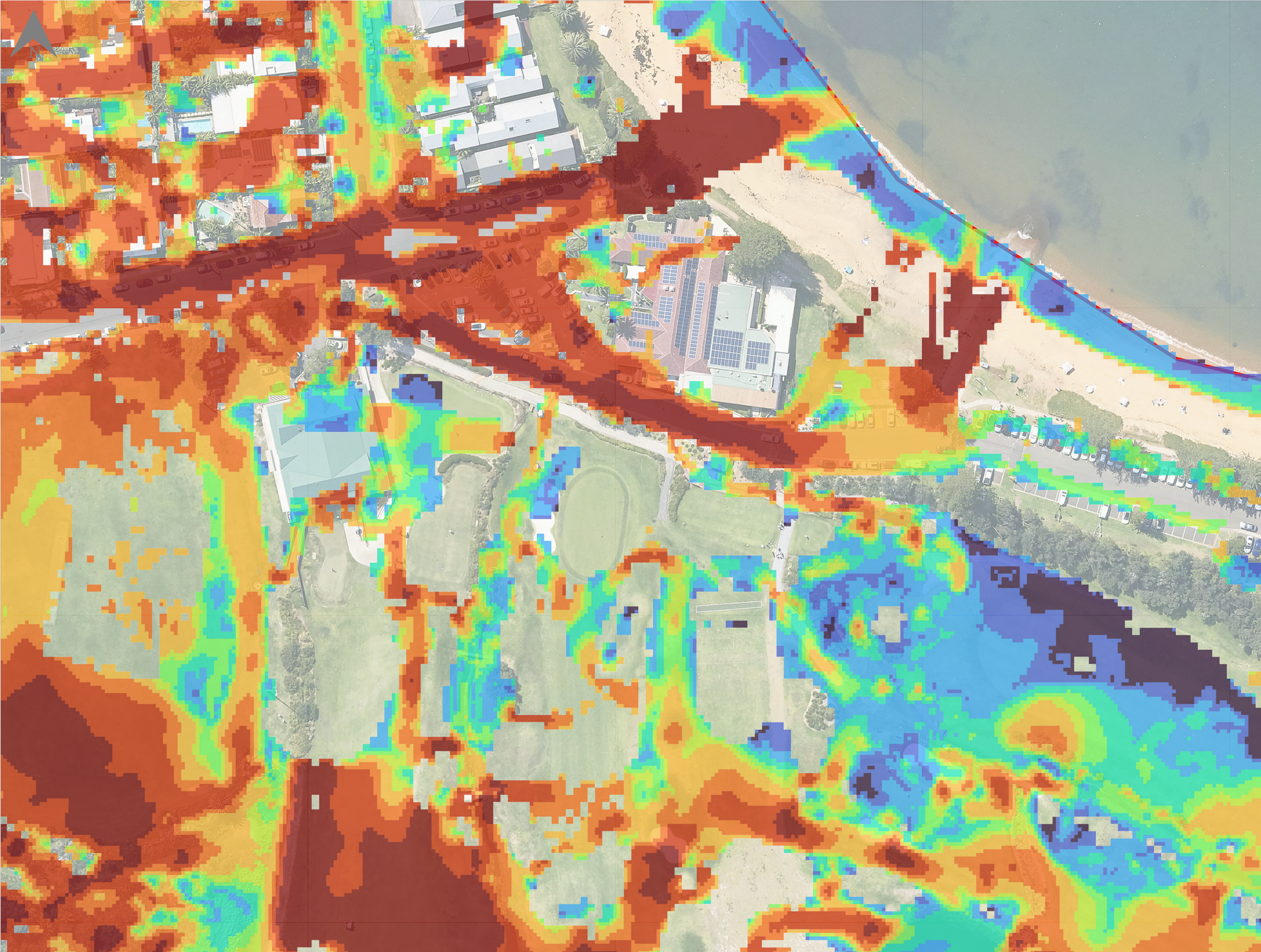
Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:				
100YR PRE-DEVELOPMENT FLOOD HAZARD ZAEM1				
Project No.	Set No.	Milestone	Plan	Revision
24-0850	04	DA	106	00

[illegible]

[illegible]



LEGEND

 Site Location

Flood Velocity (m/s)

<= 0.050

0.050 - 0.100

0.100 - 0.200

0.200 - 0.300

0.300 - 0.400

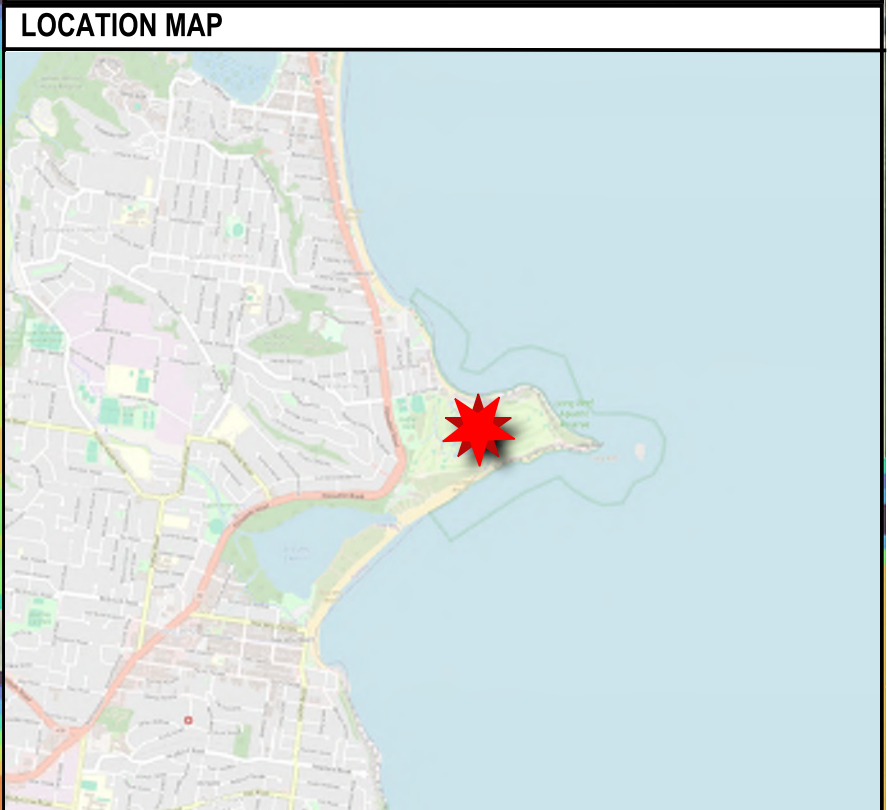
0.400 - 0.500

0.500 - 0.750

0.750 - 1.000

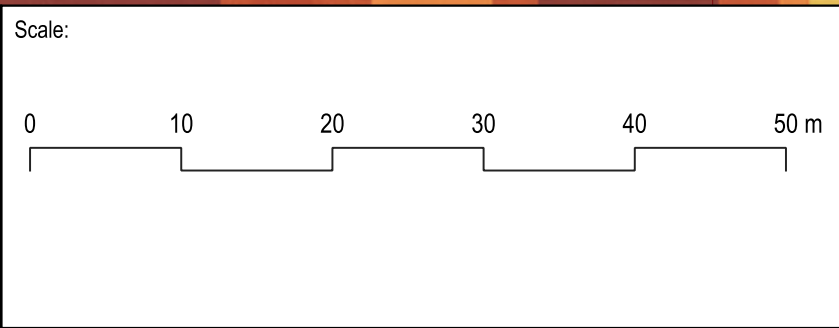
1.000 - 1.500

> 1.500



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For:

Long Reef Golf Club

By:

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ABN:25 604 069 981 PO Box:7936, BAULKHAM HILLS NSW 2153 T:(02) 8660 0035 E:info@theoriongroup.au

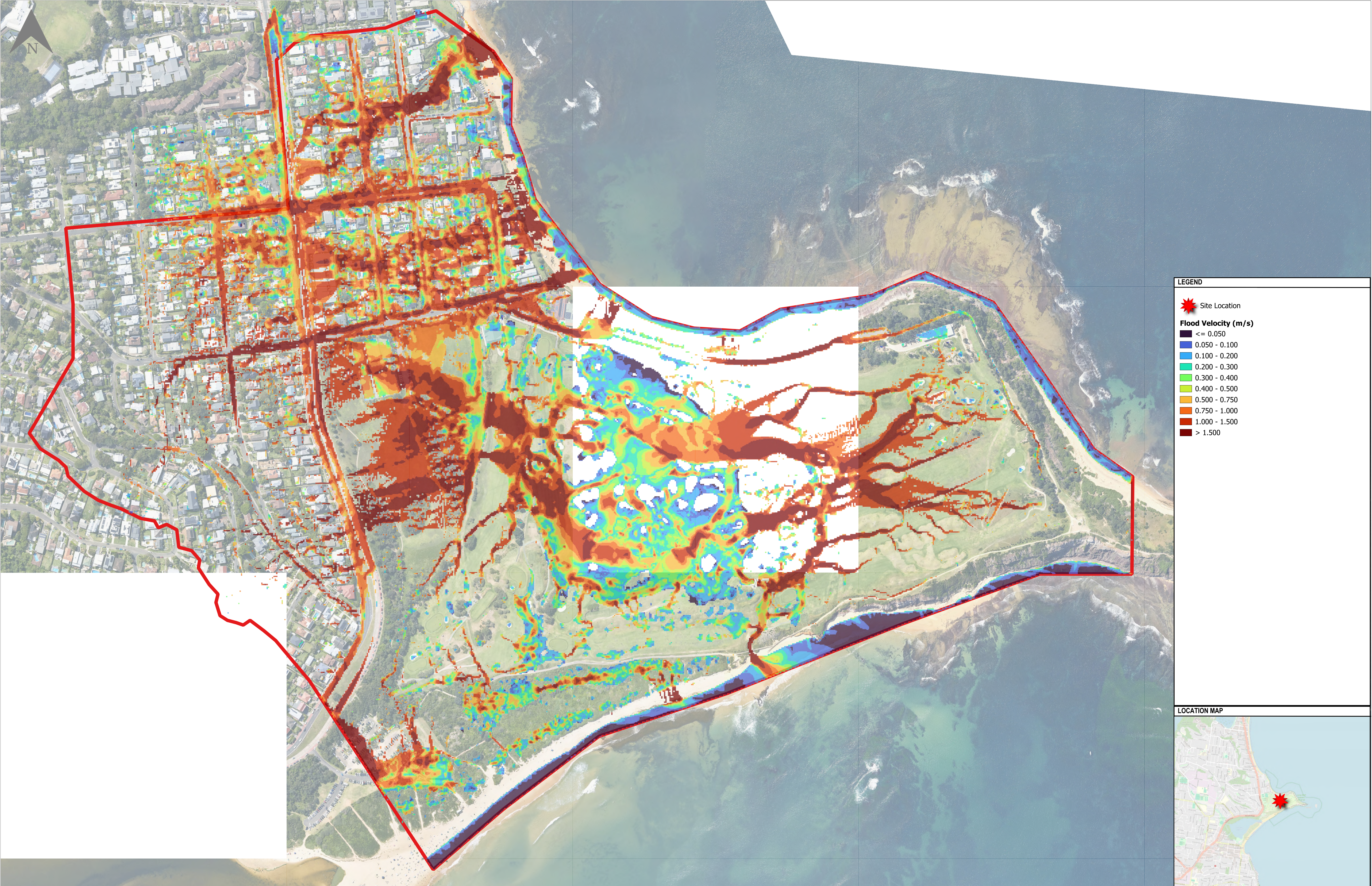
Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:

PMF EXISTING FLOOD VELOCITY

Project No.	Set No.	Milestone	Plan	Revision
24-0850	05	DA	103	00



LEGEND

 Site Location

Flood Velocity (m/s)

<= 0.050

0.050 - 0.100

0.100 - 0.200

0.200 - 0.300

0.300 - 0.400

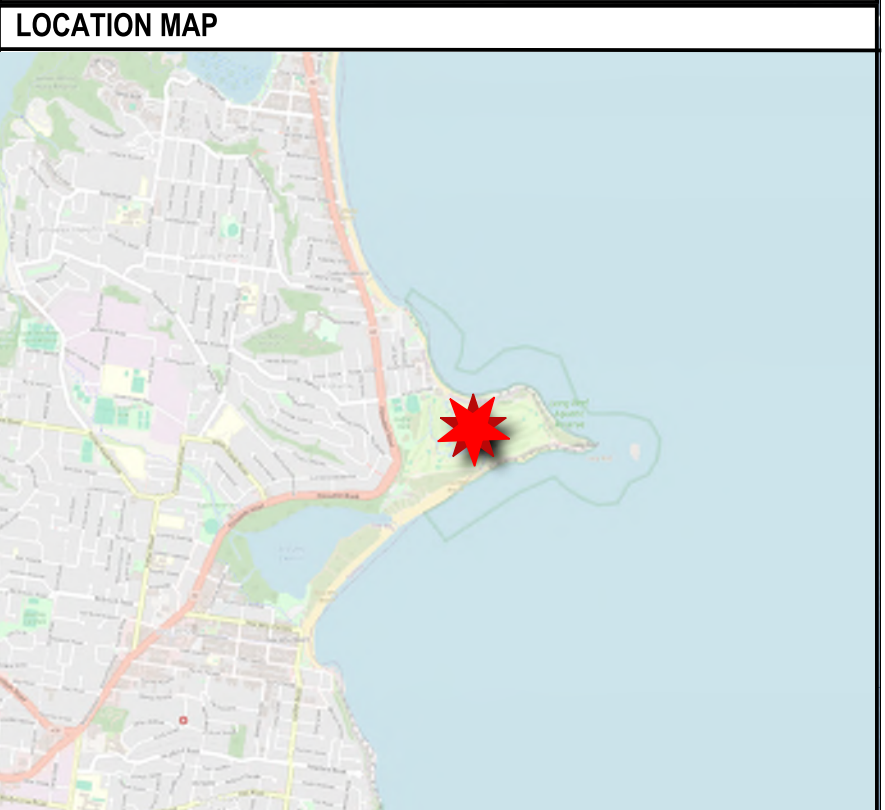
0.400 - 0.500

0.500 - 0.750

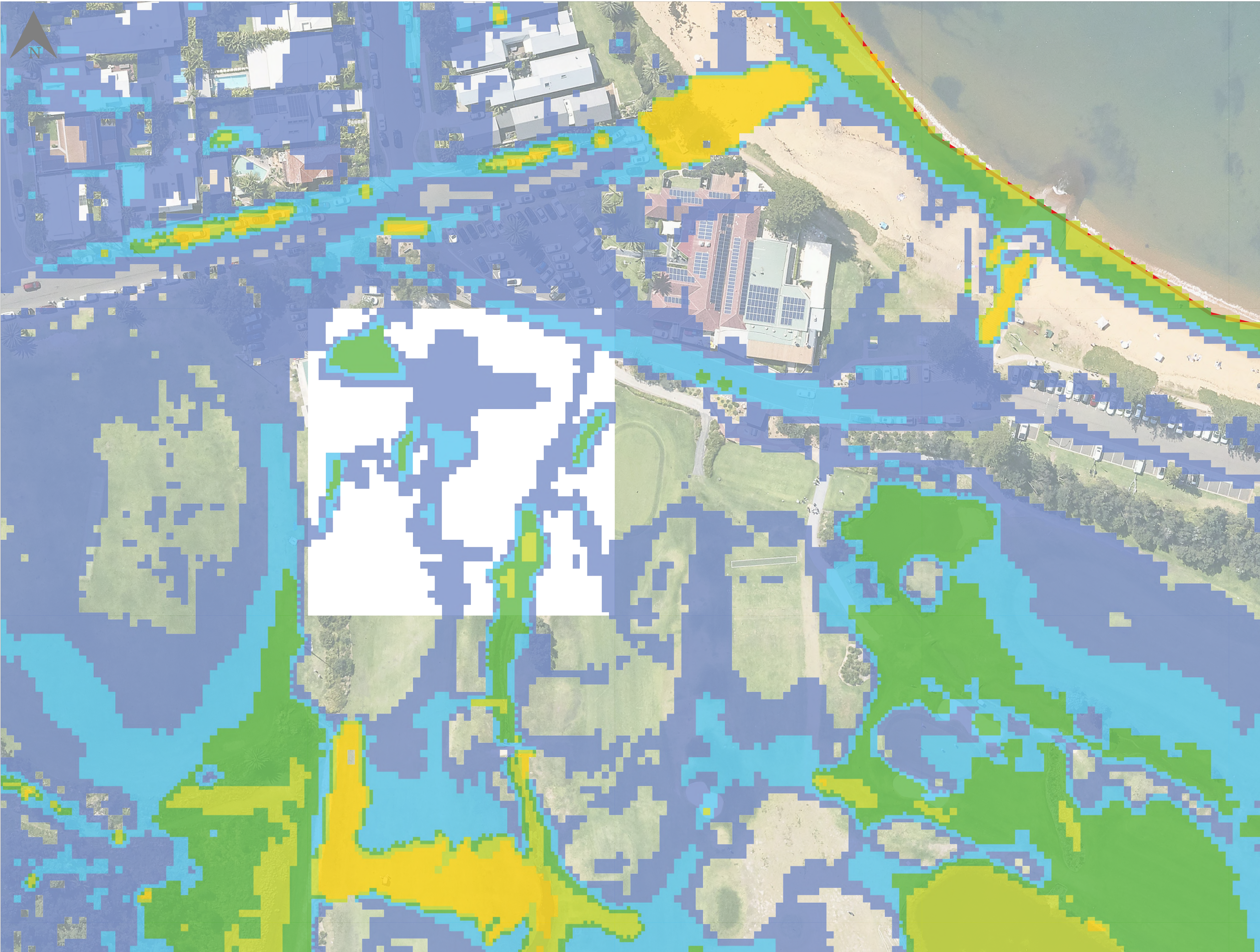
0.750 - 1.000

1.000 - 1.500

> 1.500



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										</	



LEGEND

Site Location

Flood Hazard ZAEM1

H1

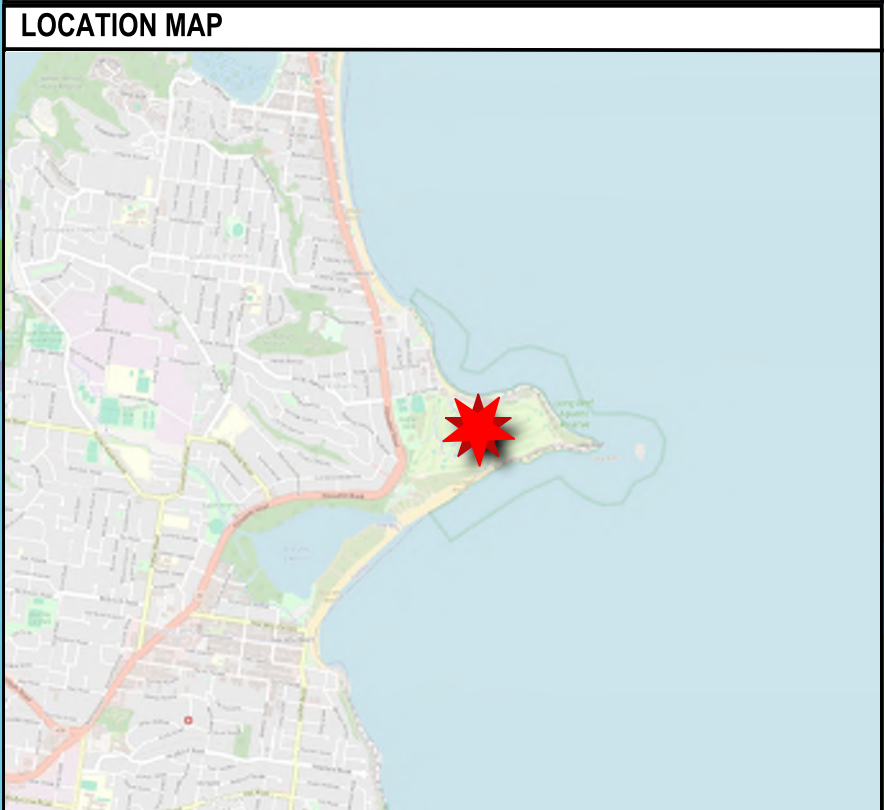
H2

H3

H4

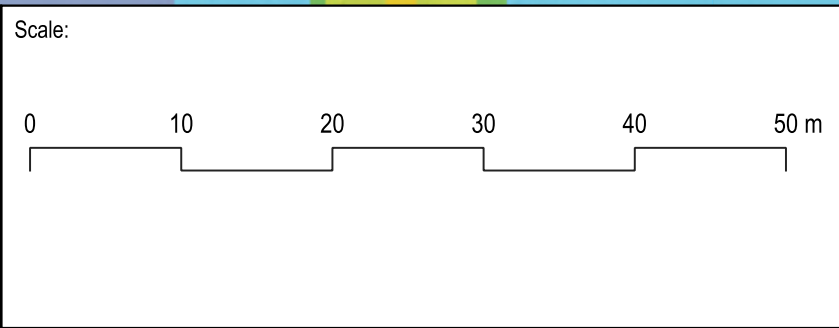
H5

H6



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For:

Long Reef Golf Club

By:

ORION

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Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title:

PMF EXISTING FLOOD HAZARD ZAEM1

Project No.	Set No.	Milestone	Plan	Revision
24-0850	05	DA	105	00



LEGEND

Site Location

Flood Hazard ZAEM1

H1

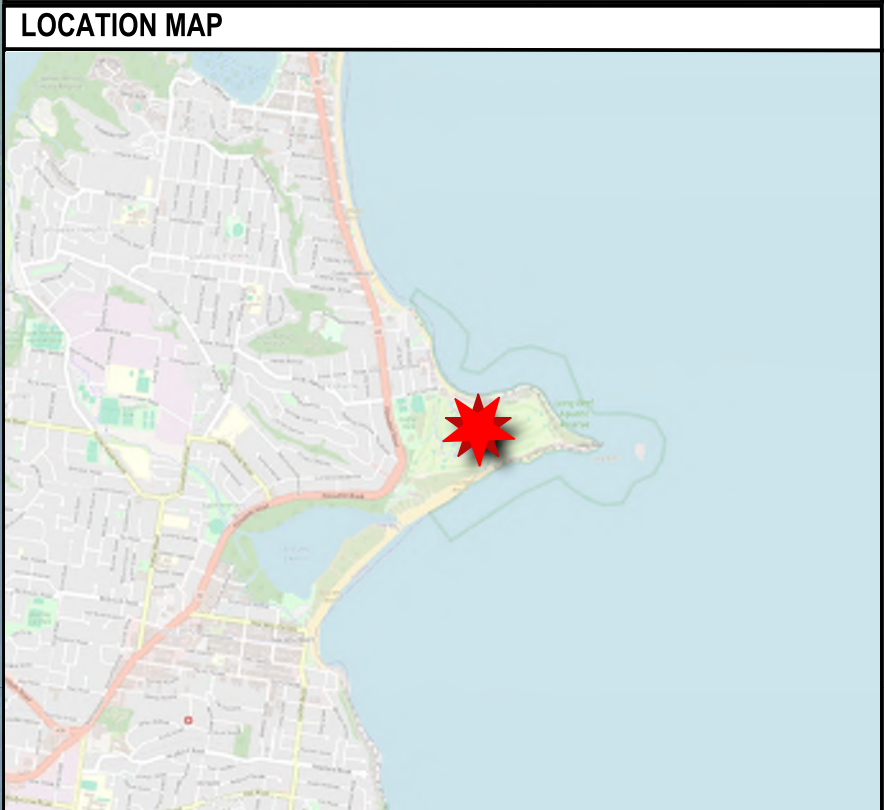
H2

H3

H4

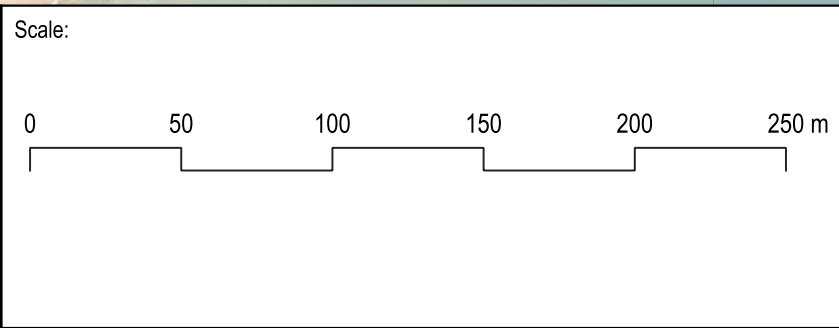
H5

H6



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For:

Long Reef Golf Club

By:

Project:

Long Reef Golf Club, Anzac Avenue
Collaroy NSW 2097

Title: PMF EXISTING FLOOD HAZARD ZAEM1				
Project No. 24-0850	Set No. 05	Milestone DA	Plan 106	Revision 00