Batemans Bay Urban Creeks Flood Study

Final Report

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Document Control

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Foreword

The primary objective of the New South Wales (NSW) Government's Flood Prone Land Policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible.

Through the NSW Department of Planning, Industry and Environment (DPIE) and the NSW State Emergency Service (SES), the NSW Government provides specialist technical assistance to local government on all flooding, flood risk management, flood emergency management and land-use planning matters.

The *Floodplain Development Manual* (NSW Government, 2005) is provided to assist councils to meet their obligations through the preparation and implementation of floodplain risk management plans, through a staged process. **Figure F1-1**, taken from this manual, documents the process for plan preparation, implementation, and review.

The *Floodplain Development Manual* (NSW Government, 2005) is consistent with Australian Emergency Management Handbook 7: *Managing the floodplain: best practice in flood risk management in Australia* (AEM Handbook 7) (AIDR, 2017).

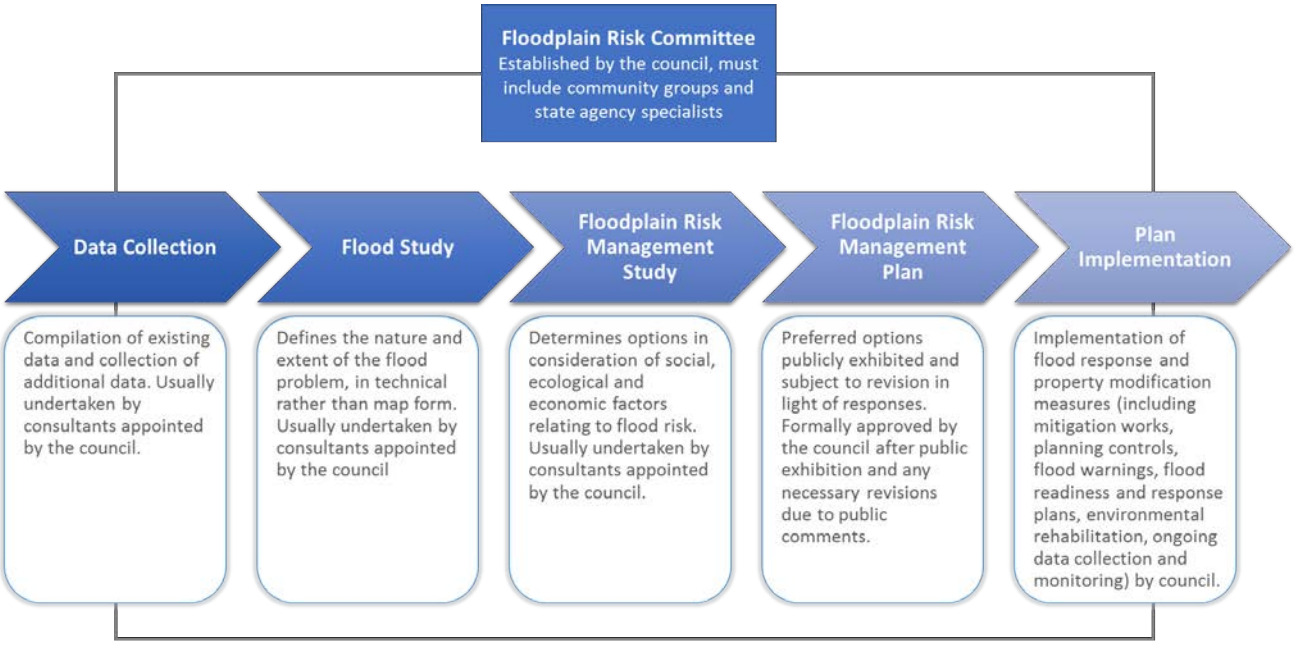

Figure F1-1 The Floodplain Risk Management Process (source: NSW Government, 2005)

Eurobodalla Shire Council is responsible for local land use planning in its service area, including in the Batemans Bay catchment and its floodplain. Through its Coast and Environment Management Advisory Committee, Council has committed to prepare a comprehensive Floodplain Risk Management Plan for the study area in accordance with the NSW Government's *Floodplain Development Manual* (2005). This document relates to the flood study phase of the process.

Executive Summary

The Batemans Bay Urban Creeks Flood Study has been prepared for Eurobodalla Shire Council (Council) to define the existing flood behaviour in the catchment and establish the basis for subsequent floodplain management activities.

Study Area and Scope

The study area covers the catchments of Maloneys Beach, Long Beach, Surfside, Water Gardens, Catalina, Batehaven, and Sunshine Bay with a focus on understanding the flood behaviour and risk in these catchments. The study area is shown in Map G101 (provided in Volume 2 of this study, and also replicated within this executive summary).

This project is a flood study, which is a comprehensive technical investigation of flood behaviour that provides the main technical foundation for the development of a robust floodplain risk management plan. It aims to provide a better understanding of the full range of flood behaviour and consequences. It involves consideration of the local flood history, available collected flood data, and the development of hydrologic and hydraulic models that are calibrated and verified, where possible, against historic flood events and extended, where appropriate, to determine the full range of flood behaviour.

Engagement

Comprehensive stakeholder engagement was undertaken throughout the development of the flood study. This involved:

- Engaging agency and industry stakeholder to obtain details of historical flooding, survey data and other relevant data sets. Stakeholders will be invited to provide feedback on the draft flood study during public exhibition.
- Community engagement has been undertaken through the mail out of an information brochure and brief survey. A series of community drop in sessions were also held. The purpose of the engagement was to raise awareness of the study and flood risk in the catchment, as well and obtain observations of historical flooding to assist in model calibration. Respondents were contacted for further information by phone and email, as required. The community information sessions were held on:
  - 20 November 2018, Batemans Bay Community Centre
  - 21 November 2018, Narooma Youth Centre

Public exhibition of this draft document will be undertaken to obtain feedback from the community and other stakeholders.

Hydrological and Hydraulic Modelling

Due to the complex nature of flooding across the study area, flood modelling has been undertaken using a combination of hydrological, hydraulic, and hydrodynamic models. This allows flooding to be assessed with regards to coastal processes, estuarine dynamics (in particular entrance scour), riverine flooding and overland flow. Hydrological modelling was undertaken for the study area using XP-RAFTS, catchment driven flooding was modelled in TUFLOW and the Joes Creek entrance breakout was modelled in Delft3D.

Historical flood data was limited. A comparison against design flood events and community observations was undertaken to validate the flow behaviour in the models. The assessment indicated a general level of consistency between the modelling and the observations from the community.

The hydrological, hydraulic, and hydrodynamic models were analysed for the Probable Maximum Flood (PMF), 0.2% AEP, 0.5% AEP, 1% AEP, 2% AEP, 10% AEP and 20% AEP events. The models were analysed for durations ranging from 60 minutes to 36 hours, using the 10 temporal pattern ensemble approach detailed in ARR2019.

The 1% AEP flood depths and depth of flow over key roads are shown on Maps G801-a to G801-g (provided in Volume 2 of this study, and also replicated within this executive summary).

Flooding within the study area is driven by both lake flooding and catchment flooding. The extent of influence of lake flooding is limited in the smaller events, but flooding driven by elevated lake levels increasingly affect larger regions of the catchments in the 1% AEP and PMF. Catchment driven flooding in the upper catchment regions is typically well contained in events up to the 1% AEP. Road access is lost in some locations in events as small as the 10% AEP.

Hydrological and Hydraulic Model Sensitivity

The sensitivity of the modelling to rainfall losses, lag time and rainfall intensity were undertaken in the hydrological model for the Water Gardens and Batehaven catchments. Overall, the models were very insensitive to changes in lag time, and marginally more sensitive to changes in rainfall intensity than rainfall losses. The smaller Water Gardens catchment was more sensitive to all changes than the larger Batehaven catchment.

While a greater sensitivity was observed for both rainfall losses and rainfall intensity, neither resulted in substantially different peak flows given the scale of the parameter change. A 20% variation in both these parameters typically delivered a 15 – 25% change in peak flows.

The sensitivity of the hydraulic model to inflows, roughness and downstream boundary conditions was assessed for the 1% AEP event.

The results show that the model is reasonably sensitive to flow increases and downstream boundary levels, marginally sensitive to flow decreases, and relatively insensitive to roughness changes.

As a result of a 20% increase in flows, isolated pockets showed increases in the 0.1 – 0.2m range, while typical changes in non-storage driven systems were in the order of 0.05 – 0.1m.

Changes arising from a 20% reduction in flows were more modest, both in size and extent. Reductions were relatively constant across the study area, in the order of 0.1 – 0.15m, and generally focused on areas of storage or local depressions.

The models were relatively sensitive to downstream boundary levels. Increases in the boundary levels resulted in water level increases propagating over 1.5km upstream of the shore in Surfside, Catalina and Batehaven. Impacts in catchments with more controlled entrance conditions such as Maloneys Beach and Long Beach were smaller for both increased and decreased downstream levels. The low-lying areas of Surfside, Catalina and Batehaven were particularly sensitive to water level changes.

The model was relatively insensitive to changes in roughness values. The 20% change in roughness values typically resulted in in changes of less than 0.03m. Larger differences of +/- 0.05m were observed in the Maloneys Beach and Batehaven catchments.

Overall, it was concluded from the results of the sensitivity analysis that the design event flood behaviour produced by the model is robust and reliable.

Climate Change

The impacts of future sea level rise on the study area was assessed in the model for:

- A 0.35m sea level rise, modelled for the 5% AEP and 1% AEP (nominally a 2050 scenario); and
- A 0.72m sea level rise, modelled for the 1% AEP (nominally a 2100 scenario).

In the 5% AEP, the 0.35m sea level rise had a modest impact in most catchment areas. Maloneys Beach, Long Beach and Water Gardens had no impacts arising from a 0.35m sea level rise in the 5% AEP. Impacts of 0.01m were observed in the Surfside in the tributary running adjacent to Mundarra Way. Increases of up to 0.21m where observed across developed areas in Catalina, and smaller increases of up to 0.17m and 0.02m were observed at Batehaven and Sunshine Bay respectively.

The 1% AEP climate change assessment showed that the catchments responded in markedly different manners:

- Maloneys Beach had had increases of up to 0.05m and 0.15m in the 2050 and 2100 scenarios respectively. There were only minimal impacts across developed areas in the 2100 scenario.
- Impacts at Long Beach were restricted to the entrance channel and adjacent properties for both scenarios.
- Within Surfside, impacts extended upstream to the highway for both scenarios. Significantly greater numbers of properties were affected in both scenarios across the low-lying region between the beach and Timbara Crescent and Bayview Street. Increases of up to 0.8m were observed in the 2100 scenario.
- Impacts within the Water Gardens catchment were most significant adjacent to the bay, with levels at the North Street and Clyde Street intersection increasing in line with sea levels, by 0.35m and 0.72m in the 2050 and 2100 scenarios.
- Flood levels along Beach Road and Herarde Street in Catalina increased by 0.32m 0.7m in the 2050 and 2100 scenarios.
- The Big 4 Resort in Batehaven experienced increased levels in both 2050 and 2100 scenarios of up to 0.17m and 0.32m respectively.
- Caseys Holiday Beach Park and Pleasurelea Tourist resort both experienced increased flood levels under both scenarios, with increases of up to 0.35m and 0.25m in the 2100 scenario. The Sunshine Bay Public School as became flood affected in the 2050 scenario.

Conclusion

This report provides an understanding of the flood risk within the study area and provides Council with the tools for planning. This study provides a baseline against which a Floodplain Risk Management Study and Plan can be prepared.

Council's current DCPs (Section 5.5) do not currently contain comprehensive flood related controls for mainstream or overland flow flooding. Although it is also noted that Council does not currently have any specific overland flow studies completed. It is noted that the Draft LSPS makes reference to the introduction of a Council-wide Flood Management Code.

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Map G101

Catchment Areas

Legend

Catchment Boundary

Study Areas

500 0 500 1,000 1,500 m

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Date : 18 January 2019
Revision : A
Created by : LRE
Coordinate System : MGA 56

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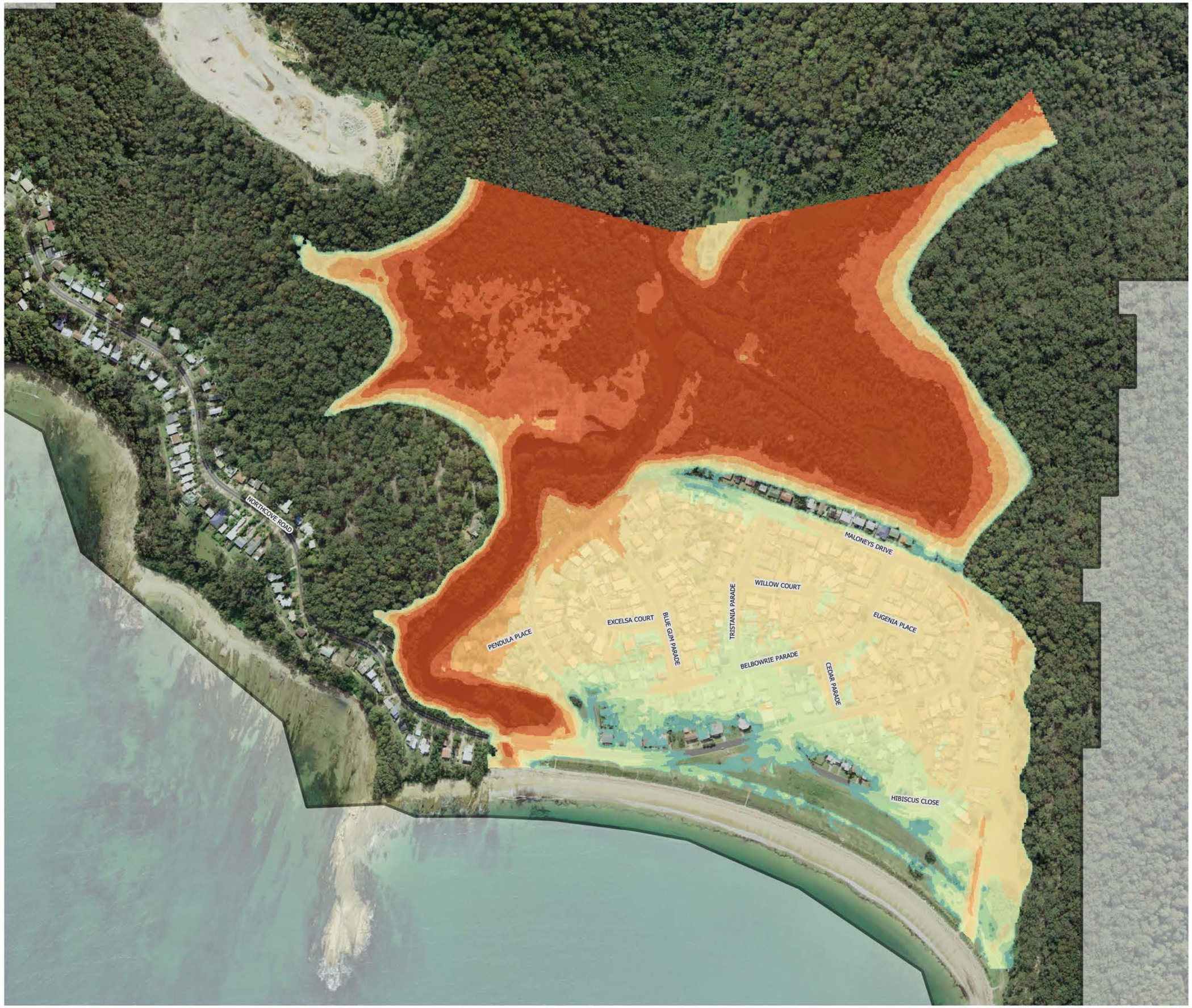

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G801-a-1
Maloneys Beach
PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5,000

Size : A3
Date : 15 June 2020
Revision : A
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G801-a-2
Maloneys Beach
1% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5000

Size : A3
Date : 15 June 2020
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G801-a-3
Maloneys Beach
10% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5000

Size : A3
Date : 15 June 2020
Revision : A
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G801-b-1
Long Beach
PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5,000

Size : A3
Date : 15 June 2020
Revision : A
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Coordinate System : MGA 56

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G801-b-2
Long Beach
1% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5000

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G801-b-3
Long Beach
10% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 80 160 240 m

1:5000

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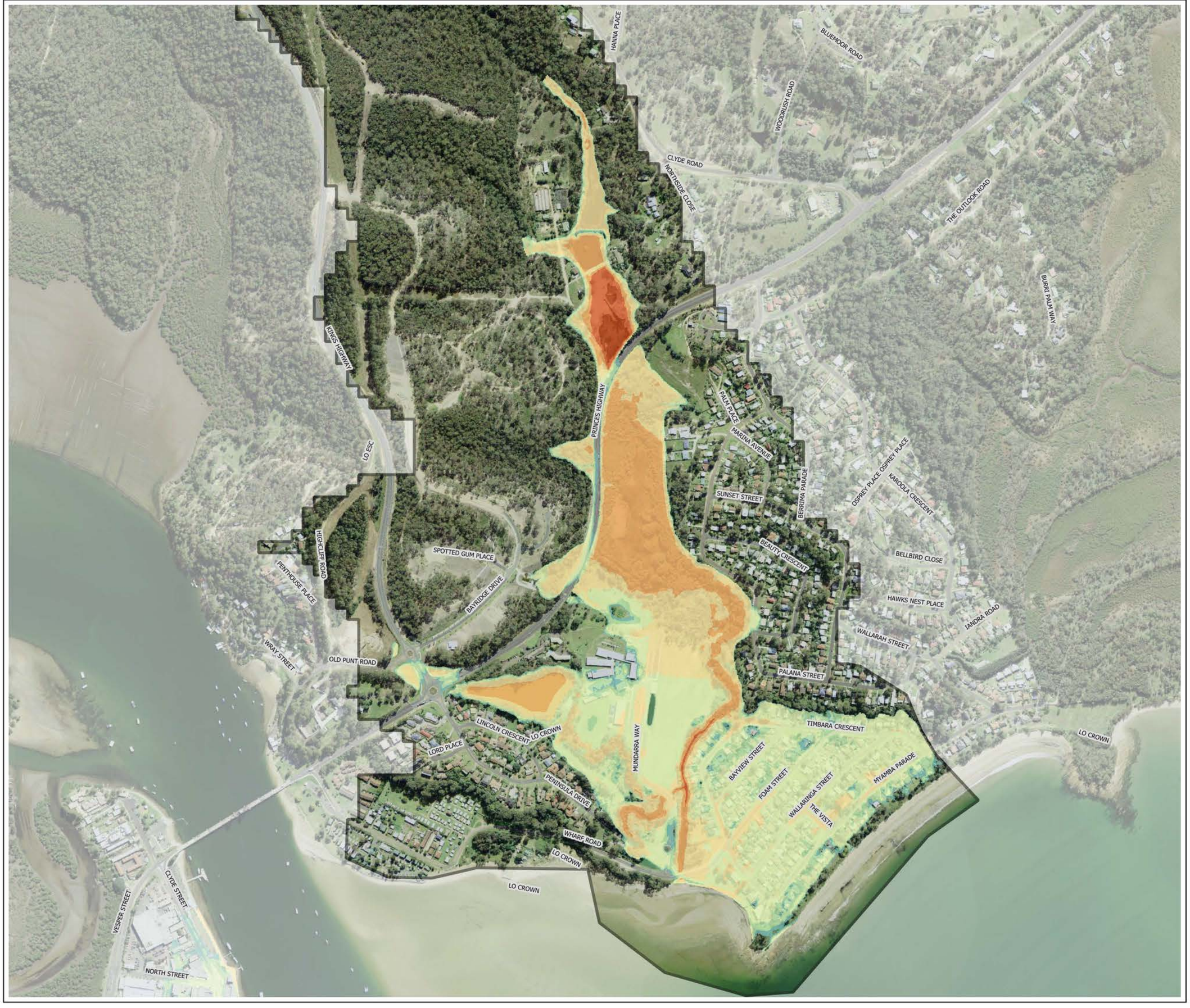

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G801-c-1 Surfside PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8,000

Size : A3
Date : 15 June 2020
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G801-c-2
Surfside
1% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8000

Size : A3
Date : 15 June 2020
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G801-c-3
Surfside
10% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8000

Size : A3
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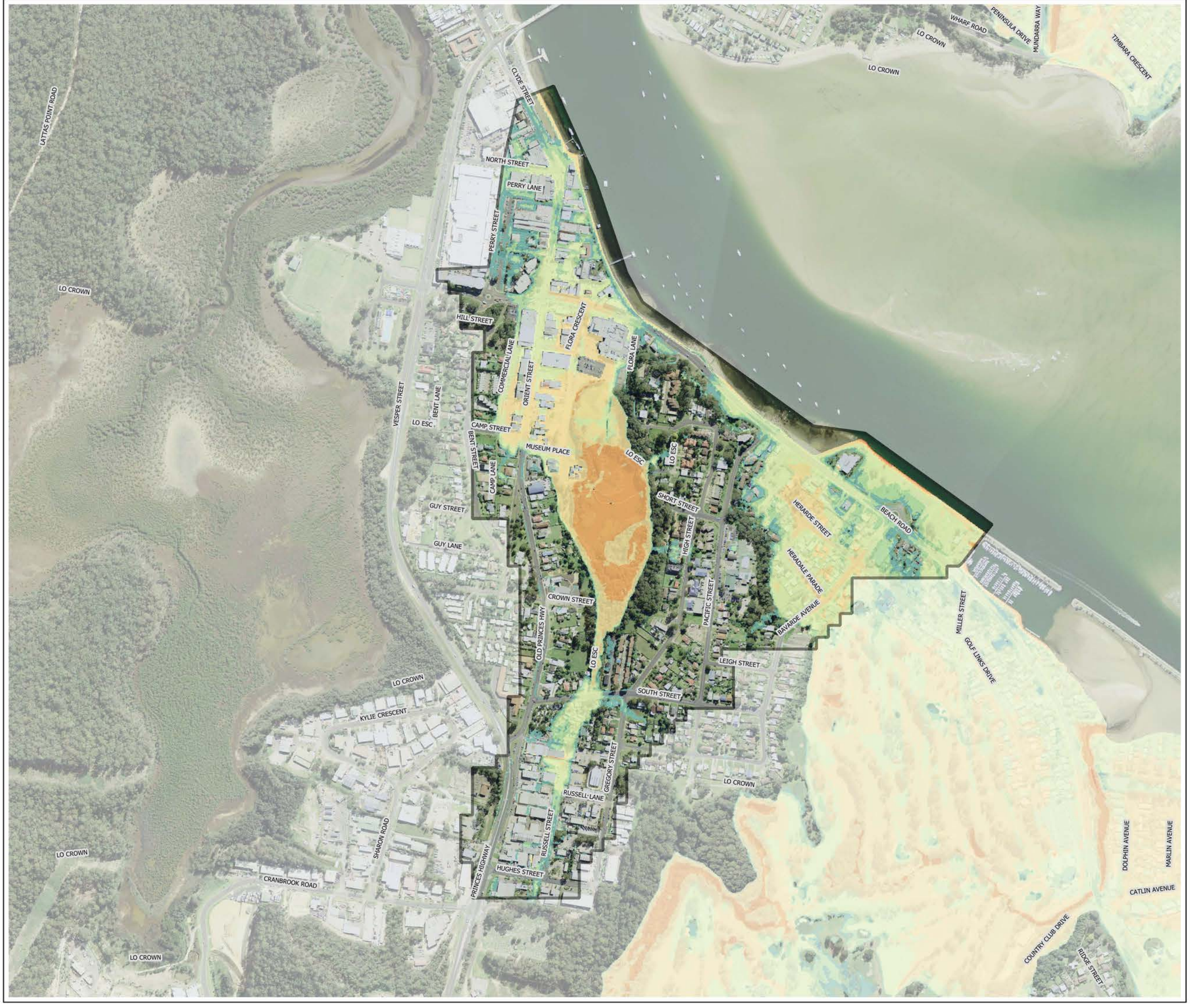

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G801-d-1
Water Gardens
PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 100 200 300 m

1:7,500

Size : A3
Date : 15 June 2020
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G801-d-2
Water Gardens
1% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 100 200 300 m

1:7500

Size : A3
Date : 15 June 2020
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G801-d-3
Water Gardens
10% AEP Depth

Legend

- Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 100 200 300 m

1:7500

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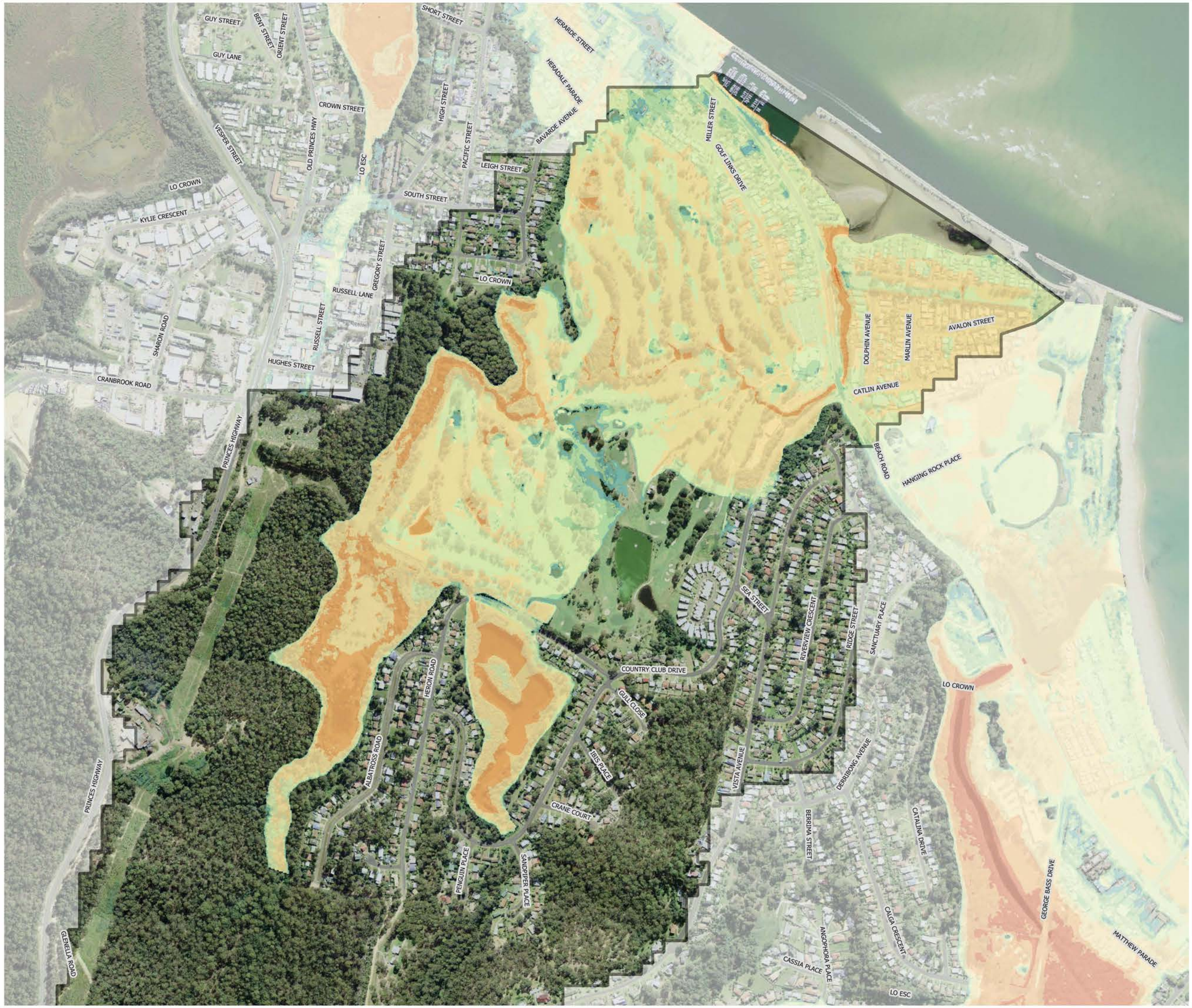

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G801-e-1
Catalina
PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8,000

Size : A3
Date : 15 June 2020
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G801-e-2
Catalina
1% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8000

Size : A3
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G801-e-3
Catalina
10% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 130 260 390 m

1:8000

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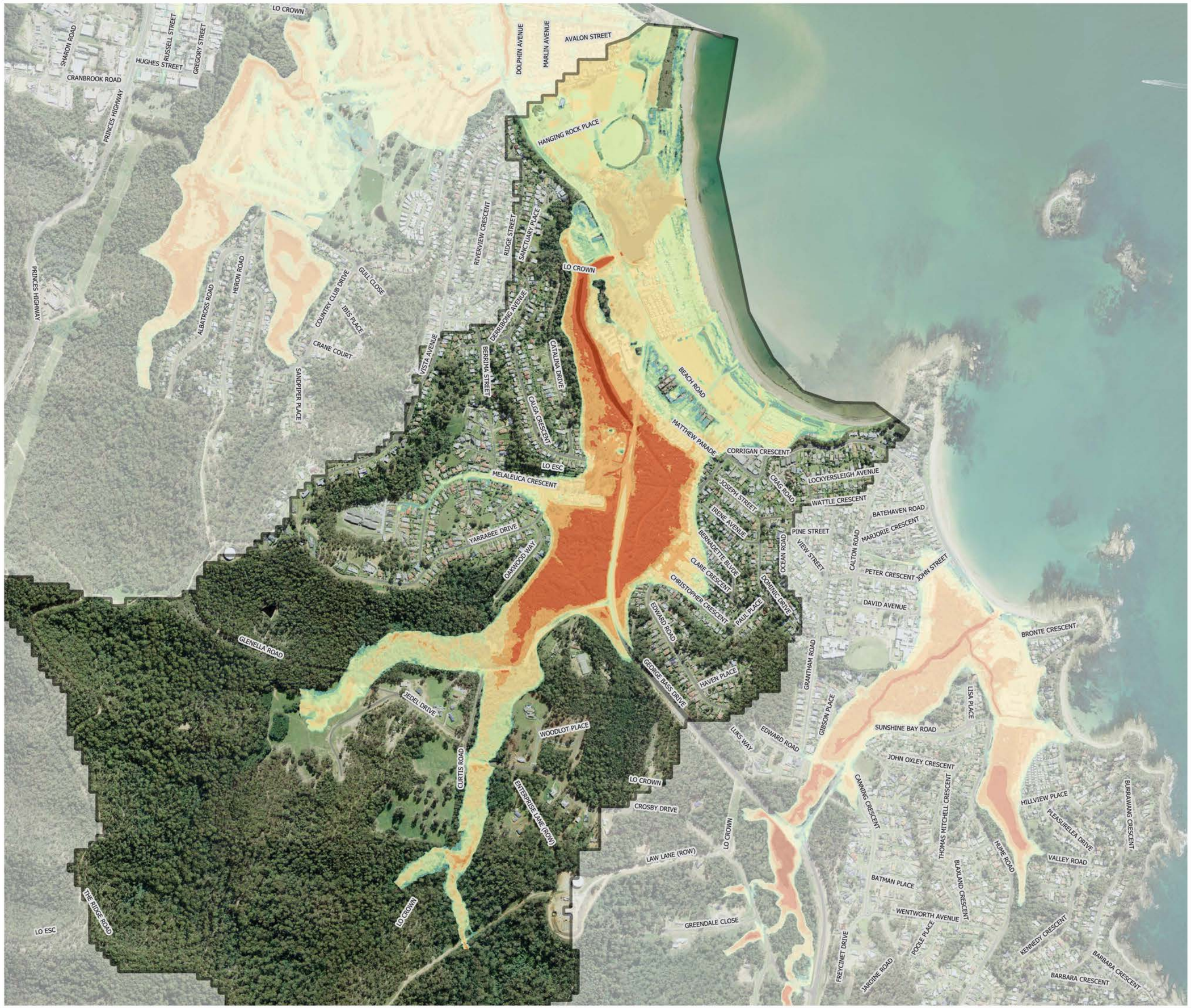

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G801-f-1 Batehaven PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 200 400 600 m

1:12,500

Size : A3
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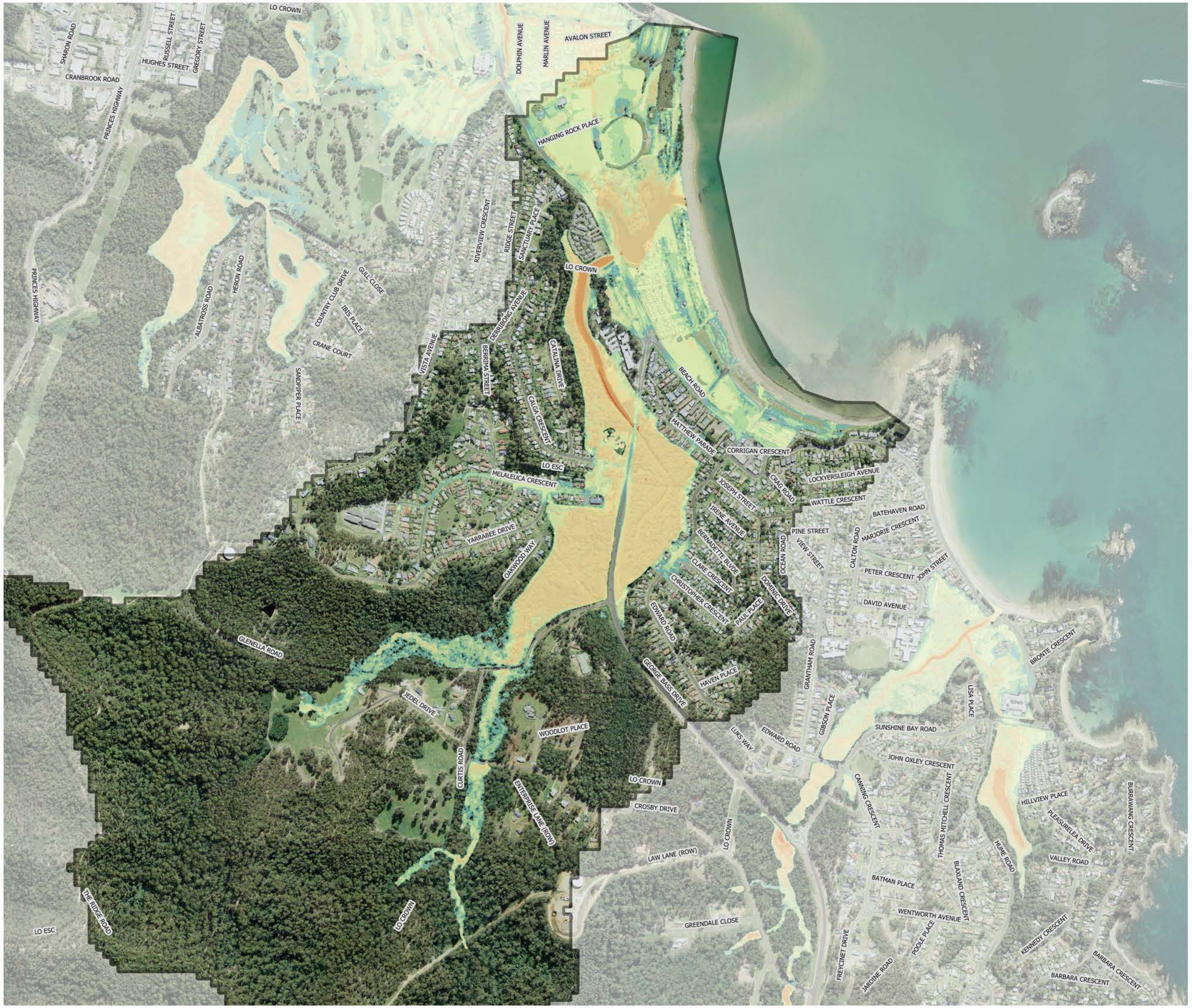

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G801-f-2
Batehaven
1% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 200 400 600 m

1:12500

Size : A3
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G801-f-3
Batehaven
10% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 200 400 600 m

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G801-g-1
Sunshine Bay
PMF Depth

Legend

Study Area

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 160 320 480 m

1:10,000

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G801-g-2
Sunshine Bay
1% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 160 320 480 m

1:10000

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G801-g-3
Sunshine Bay
10% AEP Depth

Legend

Study Areas

Depth (m)

- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- >4

0 160 320 480 m

1:10000

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