Our Ref: 82017142-02:SBR
Contact: Shaza Raini

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Department of Planning and Environment
GPO Box 39
Sydney NSW 2001

Attention: Anthony Witherdin

Cardno (NSW/ACT) Pty Ltd
ABN 95 001 145 035

16 Burelli Street
Wollongong NSW 2500
Australia

Phone +612 4228 4133
Fax +612 4228 6811

Dear Anthony,

TECHNICAL MEMORANDUM – FLOOD RISK ASSESSMENT FOR THE PROPOSED MODIFICATION TO THE TALLAWARRA LAND CENTRAL PRECINCT

Cardno (NSW/ACT) Pty Ltd (Cardno) has been engaged by Bridgehill (Tallawarra) Pty Ltd to undertake additional flood risk assessment for the Tallawarra Land development to supplement the analysis undertaken in August 2017 (*Letter Ref. 82014142-01*).

Bridgehill Group have acquired some of the Tallawarra Lands in the Northern and Central Precincts from Energy Australia to develop new residential development, light industrial development and tourism facilities. Bridgehill proposed to modify the Concept Approval by increasing the footprint for the residential development in the Central and Northern Precincts and modify the overall approved residential yield from 1010 to 1480 lots.

A flood risk assessment analysing the proposed modifications was undertaken by Cardno in August 2017. Following this submission, Council and the Department of Planning and Environment had issued some concerns with regards to flooding within the industrial land and roadway located in the Central Precinct. Additional flood analysis within the Central Precinct has since been undertaken to address the issues raised. This letter provides a summary of the analysis undertaken and outcomes of the assessment.

Aim and Objectives

The objective for this assessment is to demonstrate that the proposed industrial land and surrounding roadway within the Central Precinct (referred to the *"Central Precinct industrial area"* in this letter) is located outside the areas of high flood risk. The analysis should also demonstrate that the proposed development still conforms to the outcome of the approved Flood Risk Assessment (*Tallawarra Lands Flood Risk Assessment, Bewsher 2010*) and the Standard Secretary's Environmental Assessment Requirements (SEARs) for the Tallawarra Lands modification (MP 09_0131 MOD 1).

Updated Flood Risk Assessment

1. Flood Modelling

The Flood Risk Assessment undertaken in August 2017 was updated to include the finish design levels proposed within the Central Precinct industrial area. This was undertaken by updating the flood model based on the finish design levels and proposed designs to mitigate any flood affectation caused by the additional industrial area fill.

The model was updated to incorporate earthworks changes to the former railway embankment to the west of the proposed industrial area and a culvert adjacent to Yallah Bay Road to mitigate the impacts due to the proposed industrial area. The updated flood model was simulated for 100 year ARI design events.

2. Modelling Results

The result of the flood model is enclosed in this letter. The flood maps include the 100 year ARI flood depths from the previous flood risk assessment undertaken in August 2017 (Existing Conditions), the updated 100 year ARI flood depth (Developed

Conditions) and the 100 year ARI flood impacts as a result of the Central Precinct industrial area.

The Existing Conditions result demonstrates that the proposed Central Precinct industrial area lies within a flood affected area. Flows in this area are displaced by the proposed fill and causes impacts immediately adjacent to the proposed industrial area. The flood level increases are fully contained within the Central Precinct boundary and are considered acceptable.

The outcome of the updated flood model demonstrates that the proposed Central Precinct industrial area is located outside the areas of high flood risk and high hydraulic risk as the proposed area is flood free up to the 100 year ARI design storm event.

Review of the SEARs Requirements

The SEARs requirements were re-assessed for the proposed amendment in the Central Precinct industrial area. They are outlined below:

3. Flood Risk Assessment

    a. Potential Encroachment into Flood Prone Areas

The flood modelling results show that the proposed Central Precinct industrial area encroaches into the existing 100 year ARI flood zone to the north of Yallah Bay Road (refer flood maps enclosed). It is demonstrated that inundation to the west and east of the proposed footprint has increased due to this encroachment.

Based on the impacts analysed, the flood increases are generally localised and contained within the proposed Central Precinct boundary. Additionally, the impacts in areas external to the proposed Central Precinct boundary are negligible (refer impacts map enclosed). The outcome of the assessment establishes that the proposed modification to the Central Precinct industrial area will not impose additional impacts on the flood extent and behaviour elsewhere.

    b. Flood-Time Access

The proposed Central Precinct industrial area will be filled to a level higher than the predicted 100 year ARI design event flood level. Consistent with the Updated Flood Risk Assessment (Cardno, August 2017), the additional fill does not involve modifications to the overall access arrangement to the Central Precinct. Therefore, the proposed modifications to the Central Precinct development does not impair the validity of the approved flood study regarding the Flood-Time Access.

    c. Implications of Potential Climate Change

    > Sea Level/Lake Level Rise

The analysis in the Flood Risk Assessment (Bewsher, 2010) states that the proposed Tallawarra Lands project will not be impacted by potential climate change effects as the proposed development levels are higher than the predicted sea/lake level rise. Consequently, the effect of sea/lake level rise will not have direct impact on the proposed Central Precinct industrial area as the fill will result in levels that are higher than that the approved concept development levels.

Additionally, the potential impacts of the climate change on the flood-time access remains unchanged from the Flood Risk Assessment (Bewsher, 2010) as the proposed addition does not include any modification to the access arrangement to the site.

    > Rainfall Intensity Increases

A 500mm freeboard allowance relative to Duck Creek 100 year ARI flood levels were adopted in the approved design to cater for the increased flood levels due to the potential increase in rainfall intensities. It can be established that the proposed Central Precinct industrial area is outside the potential influence of the increased rainfall intensities as the proposed elevation will be higher (by approx. 30m) than the lowest point in the approved design.

4. Impact of Hydrologic changes on the Tallawarra Lands Site

    a. Changes in Runoff and Associated Impacts

The increase in development footprint within the proposed Tallawarra Lands will cause changes in the runoff discharged from the development. A pre-post peak discharge assessment will be undertaken in future design development stages to demonstrate that the proposed development will not result in increased peak discharges into Lake Illawarra.

Additionally, a preliminary stormwater quality assessment was undertaken by Cardno in January 2019 to establish a Water Sensitive Urban Design (WSUD) strategy for the development. A treatment train comprised of a combination of rainwater tanks, GPTs, vegetated swales, bio-retention basins, sedimentation basins and constructed wetlands was proposed to provide adequate stormwater treatment for the Central Precinct. Detailed of the assessment undertaken and modelling results are presented in Letter 82017142:02.

b. Changes to Tidal Movements and Associated Impacts

The approved flood study indicates that the proposed development will have nil impact on the local tidal regime as the proposed development will not include any filling of lands within the tidal zone. Accordingly, the proposed Central Precinct industrial area will have no impact on the local tidal regime as the proposed extensions are located in elevations higher than the rest of the development.

c. Changes to Flood Flows and Associated Impacts

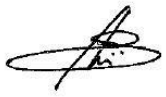
The Flood Risk Assessment (Bewsher, 2010) indicates that the Central Precinct is located within the relatively large Duck Creek catchment. The report indicates that the increase in the peak discharges as a result of the development will be extremely small compared to the peak discharges generated from the greater Duck Creek catchment and therefore the changes in the site hydrologic regime will be insignificant in the overall Duck Creek flood regime.

It is established that the additional Tallawarra Lands modification footprint (which includes the Central Precinct industrial area) is marginal and should achieve the same outcome as previously anticipated in the Flood Risk Assessment (Bewsher, 2010). As a result, no impacts are expected on the Duck Creek flood behaviour as a result of the Central Precinct industrial area.

Conclusion

It is demonstrated that the updated flood risk assessment for the proposed amendment to the industrial area within the Central Precinct area presented in this letter addresses the flooding issues previously raised. It is also concluded that the proposed Central Precinct industrial area is anticipated to meet the SEARs requirements and conforms to the approved Flood Risk Assessment (*Bewsher 2010*).

Yours sincerely,



Shaza Raini
Water Engineer
for Cardno
Direct Line: +61 2 4231 9643
Email: Shaza.Raini@cardno.com.au

Enc: 100 Year ARI Flood Extent - Existing Conditions
100 Year ARI Flood Extent – Developed Conditions
100 Year ARI Flood Impacts

100 Year ARI Flood Extent - Existing Conditions

TALLAWARRA LANDS

PRINCES MOTORWAY
BROOKS CREEK
YALLAH GULLY
DUCK CREEK

Legend

- Concept Approval
- Proposed Superlot Boundary
- 1m Flood Height Contour (mAHD)
- Watercourses (LPI)
- Cadastre (DFSI-SS, 2018)
- Concept Plan Boundary

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- > 3

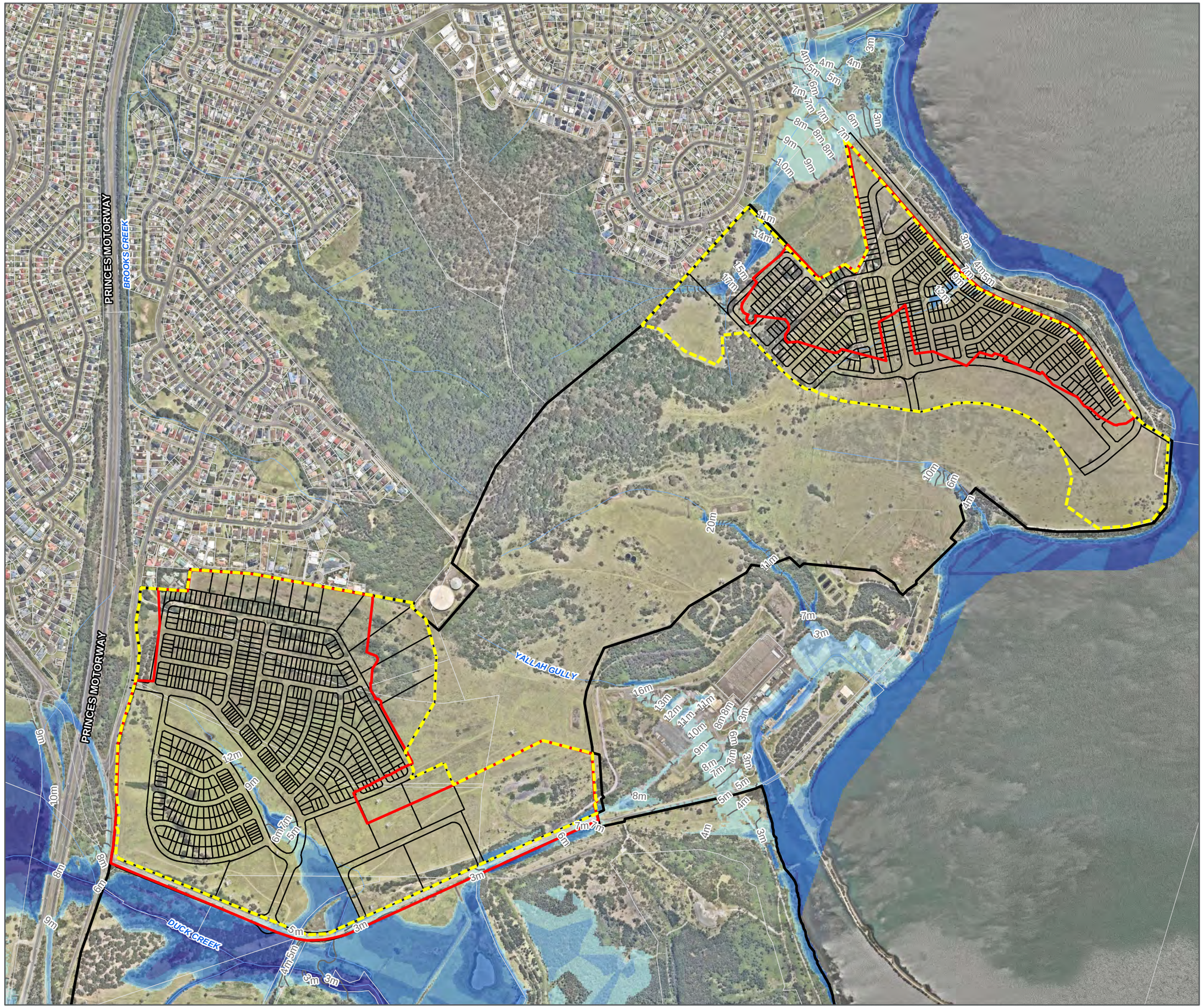
1:9,500 Scale at A3

Metres

0 100 200 300 400 500

N

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
Date: 2019-02-12
Coordinate System: GDA 1994 MGA Zone 56
Project: 82017142
Map: 82017142-01-GS-019-100yr_Existing.mxd 03
Aerial imagery supplied by nearmap (December, 2018)



100 Year ARI Flood Extent - Developed Conditions

TALLAWARRA LANDS

Legend

- Concept Approval
- Proposed Superlot Boundary
- Lot Layout
- 1m Flood Height Contour (mAHD)
- Watercourses (LPI)
- Cadastre (DFSI-SS, 2018)
- Concept Plan Boundary

Flood Depth (m)

- 0 - 0.25
- 0.25 - 0.5
- 0.50 - 1.00
- 1.00 - 2.00
- 2.00 - 3.00
- > 3

1:9,500 Scale at A3

Metres

0 100 200 300 400 500

Map Produced by Cardno NSW/ACT Pty Ltd (WOL)
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Project: 82017142
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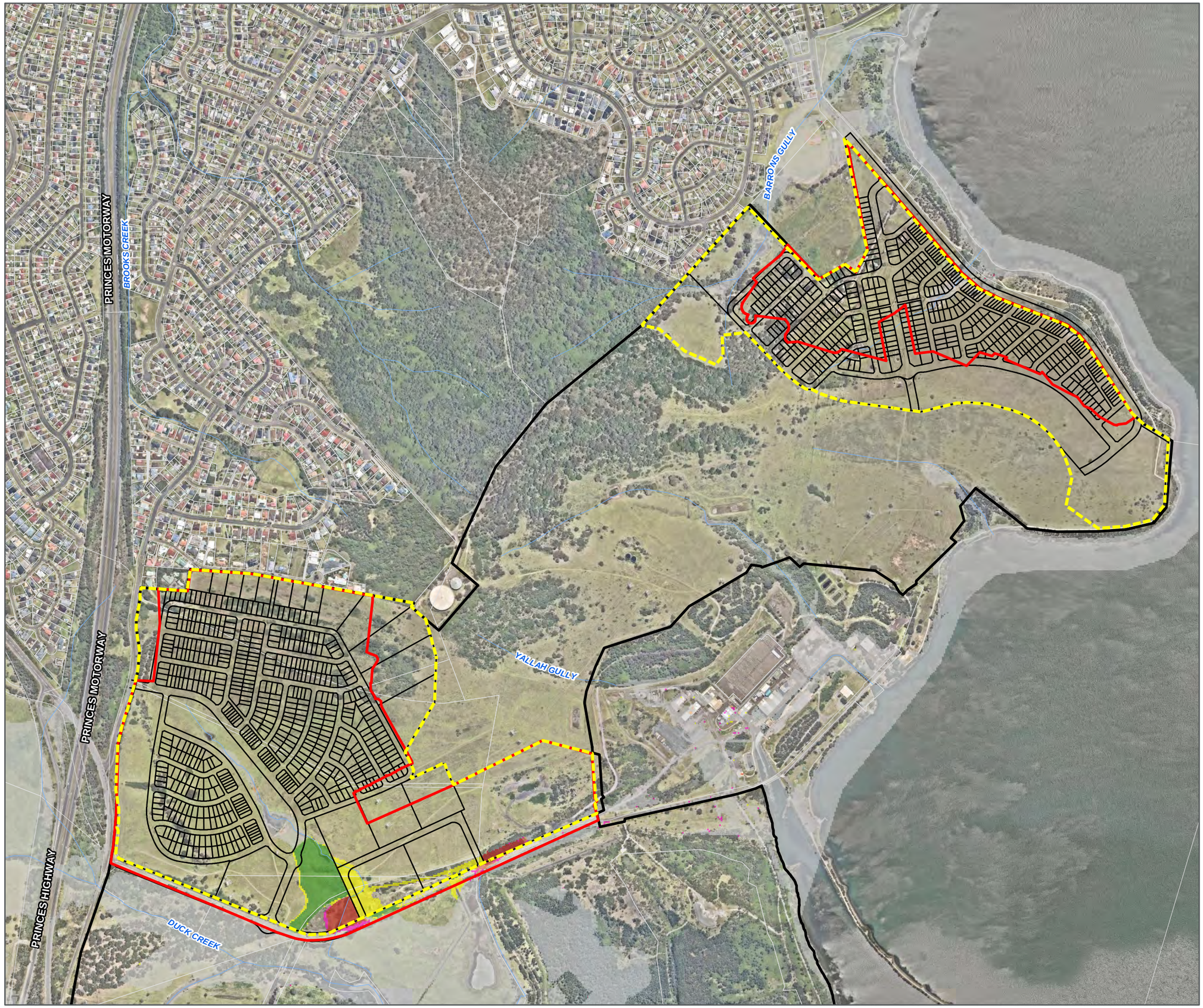

BRIDGEHILL

100 Year ARI Flood Impacts

TALLAWARRA LANDS

Legend

- Concept Approval
- Proposed Superlot Boundary
- Lot Layout
- Watercourses (LPI)
- Cadastre (DFSI-SS, 2018)
- Concept Plan Boundary

Change in Flood Levels (m)

- Was Wet Now Dry
- < -0.1
- -0.1 to -0.05
- -0.05 to -0.02
- -0.02 to 0.02
- 0.02 to 0.05
- 0.05 to 0.1
- > 0.1
- Was Wet Now Dry

1:9,500 Scale at A3

Metres

0 100 200 300 400 500

N

Cardno

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Date: 2019-02-12
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Map: 82017142-01-GS-074-100yr_ARI_FloodImpacts.mxd 01
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