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1 Introduction

1.1 Background

BMT Commercial Australia Pty Ltd (BMT) has undertaken numerous flooding assessments over the past 10 years to support the proposed mixed-use development for the development site (Aura site) and its Priority Development Area (PDA). The previous assessments were undertaken to support EPBC Act, Material Change of Use (MCU) and Reconfiguration of Lot (ROL) approvals, as well as to inform the design of the proposed development. The work documented in this report builds on the previous work in support of a ROL application for precincts 11, 12 and 14.

The purpose of this Flood Risk Management report is to inform Stockland and Economic Development Queensland (EDQ) and other relevant institutions about the strategies that have been developed to manage flood risk within the proposed Aura PDA, and the impact these strategies have on flooding. As such, the Flood Risk Management Report aims to ensure:

- The proposed development is not subject to an unacceptable level of flood risk (including consideration of climate change);
- The proposed development maintains risk or flood warning times external to the PDA as per previous the previous *Aura Flood Risk Management Report 2020 – (BMT 2021)*; and
- Peak flows downstream of the site are not increased by the proposed development.
- The main elements of the flood risk management report are as follows:
- Develop hydrologic and hydraulic models to define the flooding characteristics of the pre-and post-developed Aura site using Australian Rainfall and Runoff guideline 2019 (ARR 2019¹);
- Update the flood model with proposed designs across the Aura site;
- Determine the flood impacts caused by the proposed development; and
- Simulate and analyse events up to the Probably Maximum Flood (PMF) to inform the Development Approval and emergency management.

1.2 Previous Flood Studies

A number of previous flooding investigations of the Aura region (previously referred to as Caloundra South) have been completed including:

- Caloundra South Informal Land Use Investigation Flooding Assessment - Supporting Technical Study no.5 (Cardno MBK, 1999);
- Caloundra South 2 Hydrological & Hydraulic Analysis Supplementary Report - Supporting Technical Study no.17 (Cardno MBK, 2000);
- Caloundra City Storm Tide Study – Development Report (Connell Wagner, 2003a);

¹ Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors), 2019, Australian Rainfall and Runoff: A Guide to Flood Estimation, Commonwealth of Australia

- Caloundra City Storm Tide Study – Counter Disaster Planning Report (Connell Wagner, 2003b);
- Lamerough Creek and Duckholes Creek Flood Study and Stormwater Management Plan; Volumes 1, 2 & 3 (Cardno MBK, 2003);
- Joint Probability Assessment – Storm Tide and Freshwater Flooding, Caloundra City and Maroochy Shire Councils, in Draft (Connell Wagner, 2005);
- Caloundra South Flood Study – Caloundra Local Growth Management Strategy (SKM, 2006);
- Bellvista II Development Reconfiguration of a Lot Application: Flood Impact Assessment (BMT WBM, 2011a);
- Caloundra South Development: Flood Risk Management Strategy (BMT WBM, 2011b);
- Precincts 2-5 and 6-10 and 16, Caloundra South: Flood Risk Management Strategy (BMT WBM, 2013);
- Caloundra South Development: Flood Risk Management Strategy (BMT WBM 2014b);
- Caloundra South: Flood Risk Management Strategy – September 2014 Update (BMT WBM, 2014c);
- Caloundra South: Updated Flood Risk Management Strategy 2018 Final Report (BMT WBM, 2018);
- Upgraded Hydraulic Assessment of Bells Creek Arterial Crossing at Bells Creek South (BMT Eastern Australia, 2019a); and
- Flood Modelling and application of ARR 2019 guideline for the proposed Aura development (BMT Commercial Australia, 2019b).
- Aura Flood Risk Management Report 2020 – (BMT 2021)
- Aura Western detention Basin Flood Impact Assessment – (BMT 2026)

This report has been prepared to as an update to BMT 2021, the latest EDQ approved report. The report considers the updates to the Aura development design since 2021, including the design of:

- Aura Precinct P13
- The Bruce Highway Interchange
- The Western Detention Basin (WDB) and associated drainage design.

1.3 Scope

BMT was commissioned to provide a detailed regional flood impact assessment of the completed WDB, Bruce Highway Interchange (BHI) and Aura development precincts. The investigation updates the previous modelling that was undertaken prior to finalisation of the design earthworks for the remaining Aura precincts (12 and 13), the design of the BHI, and the ultimate design of the WDB.

The investigation included the following elements:

- **Hydrologic Assessment:** The approved XP RAFTS hydrologic model of the catchment was updated to include the latest revision (ARR Guidebook Ver 4.2) to *the Australian Rainfall and Runoff*

guidelines and included consideration of the 1% AEP Year 2100 Climate (SSP3, 3.6DW) design storm event. The hydrologic model was used to provide inflows to the hydraulic model.

- **Hydraulic Assessment:** The approved two-dimensional hydraulic model of the Aura development was updated to reflect the latest proposed design of the WDB, BHI and Aura development to demonstrate that the proposed development does not lead to any unacceptable adverse off-site impacts with respect to flooding.

2 Site Description

2.1 Location

The development site (Aura site) is located within the Sunshine Coast Regional Council area, to the east of the Bruce Highway and to the south-west of Caloundra. This report supports a Development Application (DA).

The Caloundra South PDA covers an area of approximately 2,400 hectares and has been identified under the SEQ Regional Plan as being contained within the Urban Footprint.

A recent aerial photograph of the site is presented in Figure 2.1.

2.2 Site Topography and Drainage

There are three watercourses that flow through the Caloundra South PDA – Lamerough Creek, Bells Creek North and Bells Creek South. On site, these three watercourses are characterised by a network of smaller channels with a relatively wide and flat floodplain. The site generally slopes downwards to the east with a typical channel slope of about 1 in 400 to 1 in 500 in the upper reaches (western part of the Caloundra South PDA).

Further downstream, the eastern part of the Caloundra South PDA is characterised as typical coastal plains. In this area, the site is relatively flat with ground levels generally ranging between 1 m AHD and 2 m AHD (around the eastern boundary of the site).

The highest ground elevations on the Caloundra South site occur adjacent to the Bruce Highway with levels of up to approximately 31m AHD in these areas.

The topography of the pre-developed site and surrounding areas is presented in Figure 2.2

2.3 Pre-developed Land Usage

The pre-developed site was a highly modified catchment largely cleared and denuded of vegetation through previous forestry and grazing practices. Landuse downstream of the site includes a turf farm, golf course and urban development. The BMT WBM (2011) "*Caloundra South Consolidated Water Report*" further describes the temporal land use changes across the Caloundra South area.

2.4 Proposed Development

The proposed development of 2,400 ha includes two main roads that traverse the proposed development in north south direction: 'Bells Creek Arterial' and 'Aura Boulevard' (refer to Figure 2.4 for locality). Aura Boulevard is predicted to be flood immune up to and including the 0.05% AEP event.

Precincts 1 – 5 are located in the most northern part and is located between Bells Creek North and Lamerough Creek. Precincts 7-10 include the town centre and will include commercial and residential lots. Precincts 11-15 are located in between Bells Creek North and Bells Creek South and include 'The Brook' a major waterway as part of the development, that facilitates drainage across the Aura site.

In the coming years, P13 and P15 will also be developed, and it is proposed to design an additional turn off from the Bruce Highway to connect people to the proposed development efficiently and ease transport volumes on existing roads. The precinct boundaries and topography of the proposed development is presented in Figure 2.3.

Stage of Construction

The following precincts have already been developed in accordance with the ROL approvals and the final design for bulk earthworks, drainage and WSUD incorporated into the updated flood model:

- Precincts 1 to 5 of the Aura development. Precinct 1 is considered developed in the pre-developed case as well as the post-developed case;
- Construction of the mitigation drainage depression north of Bells Creek North and South of Precinct 4, as shown in Figure 2.4;
- Planned revegetation in Bells Creek North;
- Aura Boulevard Bridge across Bells Creek North;
- Bells Creek Arterial from the northern most chainage to the top of Precinct 7, including the Bells Creek North bridge;
- The entire town centre area (Precincts 7, 8, 9 and 10);
- Part of Precincts 11 and 12;
- Planned revegetation;
- Bells Creek Arterial stage 4, including the bridge and culvert crossing of Bells Creek South;
- Constructed compensatory frog habitats along Bells Creek North and south.

2.5 Flood Risk Mitigation Strategy

In general, without mitigation measures, the proposed development has the potential to affect flooding in the following ways:

- The paved areas associated with urban areas of proposed development have the tendency to reduce infiltration of rainfall into the ground and cause a quicker and more intense flood water runoff response during storm events. This can lead to earlier and greater peak creek inflows.
- In areas where fill is proposed in the floodplain to provide onsite flood immunity, pre-developed floodplain flow paths may be obstructed. This can impact on the hydraulic conveyance of the creek systems and distort flooding behaviour offsite. In addition, fill can reduce the floodwater storage capacity of a floodplain, resulting in an increase in flood levels both onsite and in areas upstream and downstream of the development.

This flood risk management report shows how the Aura PDA development can be implemented without causing adverse implications for flood risk such as those described above.

The flood model has been iteratively adapted during the development of Aura to develop the proposed flood mitigation concepts. Several key flood mitigation features are included in the proposed site layout, refer to Figure 2.4.

- Raise developed ground levels (fill) within the proposed development to mitigate flooding to the proposed development and reduce the associated flood risk.

- Implementation of drainage channels to drain flood water from the various Bruce Highway culvert crossings to the creeks.
- A western detention basin (WDB) was included, located west of the Bruce Highway on land owned by Stockland. The basin outlet is a channel connecting to the Bells Creek North culvert under the Bruce Highway.
- The Bells Creek Arterial Road embankment on Bells Creek North has been used to restrict the flow of water to downstream catchments. The model was optimised several times with different bridge and culvert arrangements. The ultimate adopted arrangement was a 65 m wide bridge span (at the soffit level) with an average soffit level of 7.80 m AHD (which is above the 1% AEP flood level) and a set of four 1.5 m diameter culverts to the south of the bridge. A 1 m in 1 m slope was assumed for the abutment batter, and 5 m wide pedestrian/cycle underpasses at the 50% AEP flood level (5.1 m AHD) were included on both the north and south side of the bridge.
- The design of the Aura Boulevard crossing over Bells Creek North was refined. Several bridge and culvert arrangements were explored. The final adopted arrangement was a 120 m wide main bridge and a 20 m wide segmented bridge north of the main bridge, both with a soffit level of 8.0 m AHD which is above the 15 AEP flood level. A 5 m wide underpass was included on the southern side of the main bridge at the 50% AEP flood level (7.3 m AHD). Box culverts (2.1 m x 2.1 m) were included for frog passage on the southern side of both the segmented and main bridge (i.e. two frog passage culverts, one to the north and one to the south of the Bells Creek North waterway).
- A series of 2 lakes within the proposed development area south of Bells Creek South is proposed to provide additional floodwater storage capacity. The geometry of these lakes is included as part of the current 3D design topography provided.
- The Bells Creek Arterial crossing of Bells Creek South was refined to reduce flood impacts downstream of Bells Creek Arterial while also allowing for safe fish passage, a culvert to allow large animals to cross (kangaroo culvert) and achieving high flood immunity of the road. The design of these cross-drainage structures is discussed in report R.B20047.028.02. The final design includes:
 - 27 m wide bridge over Bells Creek South with soffit level of 2.4 m AHD;
 - 1/3x2400 RCBC culvert with an invert level of 1.7 m AHD, located approximately 20 m south of the bridge, designed for fauna passage;
 - 3/3600x2100 SLBC culverts at the tributary to the south of Bells Creek South;
 - 600 RCP to allow for local drainage.
- A large drainage depression has been included to the west of Aura Boulevard and north of Bells Creek North to mitigate increases in flood levels external to the PDA. Various path locations and sizes were tested. A final design is now included in the 3D design provided and included in the model topography.