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Report

Aura Brook Flood Investigation Report

Prepared for Stockland Development Pty Ltd

30 June 2020

Calibre Professional Services Pty Ltd
55 070 683 037

QUALITY ASSURANCE STATEMENT

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Executive Summary

Calibre Professional Services Pty Ltd has been commissioned by Stockland Development Pty Ltd to prepare a Flood Investigation Report for part of Precincts 11, 12 and 14 of the Aura Development. The assessment has been focused on the design of the Aura Brook, major stormwater drainage throughout the Brook and determining adjacent minimum allotment levels.

The intent of the Aura Brook is to provide a channel for stormwater conveyance and provide a joint recreational space of benefit to the surrounding community with integrated water sensitive urban design devices. A system of water bodies are proposed to be located within the base of the channel. Paired with bioretention basins and wetlands, the lakes will provide community benefit through generating recreational interest around the water bodies and also work towards improving downstream water quality.

The aim of this report is to investigate flooding capacity of the Aura Brook and determine the minimum allotment levels of the surrounding lots. Through the use of a two-dimensional (2D) flood model using TUFLOW, this investigation has concluded the following:

- Water surface levels (WSL) throughout the Brook were determined for a range of design and sensitivity scenarios to determine capacity of the low flow channel and major stormwater infrastructure within the Brook
- As shown in **Section 4.6**, minimum allotment levels and minimum habitable floor levels were determined;
- A number of sensitivity scenarios have been addressed investigating the effects of increased vegetation and potential blockage of the culvert structures;
- The channel downstream of the CAMCOS rail line has capacity to convey up to and including the 1% AEP climate change storm event flows from the Brook to Bells Creek (South); and
- The low flow channel proposed along the extent of the Brook has sufficient capacity to convey the minor flows whilst maintaining 39% AEP flood immunity for the bioretention basin.

Further details in relation to the above outcomes are provided within the following report.

1. Introduction

Calibre Professional Service Pty Ltd has been commissioned by Stockland Development Pty Ltd to prepare a Flood Investigation Report for part of Precincts 11, 12 and 14 within the Aura development Priority Development Area (PDA). This document has been prepared to support the Reconfiguration of Lot (ROL) Development Approval (DA) for the aforementioned precincts.

The investigation presented in this report is focused on determining minimum allotment levels for Precincts 11, 12 and 14. Through the use of hydrological and 2D hydraulic modelling of a range of sensitivity and design scenarios to optimise the capacity and flow conveyance of the Brook and to set minimum allotment levels.

The major channel traversing Aura Precincts 11, 12 and 14 will herein referred to as the "Brook". Refer to **Appendix A** for the layout of the site.

1.1 Scope of this Report

The scope of this investigation includes the following:

- *Hydrological Modelling*: prepare and calibrate a hydrological model within XPSWMM to generate inflows for the hydraulic modelling. Undertake a comparison between different rainfall intensities and temporal patterns.
- *Hydraulic Investigation*: hydraulic analysis of the Brook was undertaken using the TUFLOW modelling software with the aim of detailing the following:
  - Determine the conveyance capacity and characteristics of the model;
  - Optimise the major culvert structures located throughout the channel;
  - Model water surface levels (WSL's) within the Brook for a range of design and sensitivity scenarios; and
  - Set minimum allotment levels.

The scope of this report is to focus on the trunk conveyance of flow through the Brook itself, modelling of detailed drainage networks feeding into the Brook will be completed during the respective detailed design phase for that network.

2. Background

2.1 Location

The site is located within the Sunshine Coast Council (SCC) Local Government Area and the Caloundra South Priority Development Area (PDA).

The site is located approximately 8km south west of Caloundra's Main Street and is bounded by the Bruce Highway to the west, Bells Creek (North) to the north and Bells Creek (South) to the south.

An extract from Drawing No**. 18-000340-SK3100** attached in **Appendix A** is shown below identifying the extent of the Aura Brook.

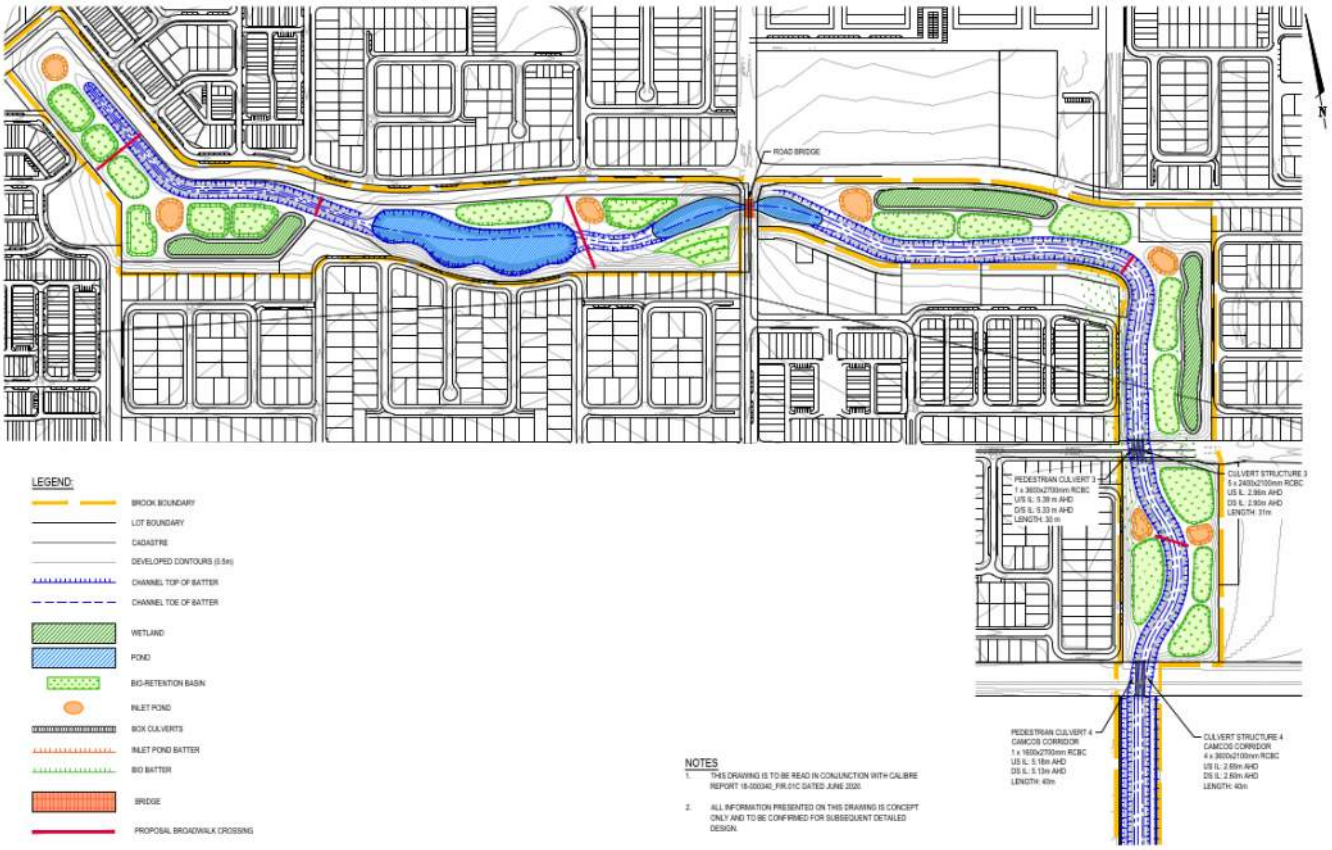


Figure 1: Site Location and Surrounding Area

2.2 Previous/Ongoing Investigations

Aura Regional Flood Model – 2017 Revision – Addendum Report (BMT WBM 2017)

Regional flood modelling has been undertaken by BMT WBM to investigate the regional effects of the proposed development on regional flooding and to provide detention basin sizing for the development. This 2017 investigation was completed as an update to their previous investigation Caloundra South Development: Flood Risk Management Strategy (August 2015).

Ongoing Regional Flood Modelling being completed by BMT

BMT has undertaken and continues to undertake a number of flooding investigations as part of the broader Aura Flood Modelling Strategies to keep current and inform design. As part of this investigation Calibre was provided with maximum water height rasters for the regional event which included both ARR2019 hydrology and a 50m span Road bridge. These results were provided to be consistent with the ARR2019 methodology adopted for the Brook.

2.3 Report Reviews and Revisions

Revision B of this report dated 9 August 2019 was prepared in support of a Priority Development Area (PDA) development application (ref: DEV2018/987) submitted by Stockland Development Pty Ltd to Economic Development Queensland (EDQ) for a preliminary review by the Minister for EDQ. Subsequent to this preliminary review, the Minister identified further issues which are detailed in two 'Further Issues' letters prepared by EDQ to Stockland dated 10 December 2019 and 23 December 2019.

Further to the Minister's preliminary review, EDQ commissioned Jacobs Group (Australia) Pty Ltd to undertake a peer review Calibre's revision B of this report. Jacobs' peer review is detailed in their report Aura Stormwater Investigations for Precincts 11, 12 and 14 – Peer Review (ref: IH169500-101-CH-001), dated 10 September 2019.

As mentioned in EDQ's Further Issues letter on 23 December 2019, there has been correspondence between Jacobs and Calibre regarding the Stormwater documentation that was submitted as part of the PDA development application. A number of matters were resolved; however, there were a number of outstanding 'Further Issue' items outstanding.

In order to address the conditions of the Preliminary approval and Part Approval for Operational work for Waterway barrier works decided by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), dated 28 February 2019 (ref: 1710-2004 SDA), special consideration for fish passage is required in the design and modelling methodology for the proposed culvert structures. Provisions such as internal baffles, embedment depth, culvert length and gradient have been incorporated into the TUFLOW model for 1D elements.

This revision C report has been prepared to address the following:

- 'Further Issues' items raised by EDQ pertaining to the Aura Brook Flood Investigation in their 10 December 2019 letter to Stockland;
- Peer review items raised by Jacobs' August 2019 report, and subsequently tabled in EDQ's 23 December 2019 letter to Stockland; and
- Conditions of Preliminary Approval and part approval pertaining to fish passage requirements for the proposed culvert structures, which are deemed Waterway barrier works by DSDMIP.

As such, the structure and methodology of the earlier revisions of this report have generally been maintained, but sections have been added or amended to comply with the latest subdivision layout, bulk earthworks and the aforementioned approval items by various statutory authorities and peer reviewers.

3. Hydrological Analysis

Hydrological analysis of the developed catchments discharging to the Aura Brook has been undertaken to generate inflow hydrographs for the hydraulic model. The hydrological analysis was undertaken using XPSWMM modelling software. Catchments were delineated to ensure accurate water surface levels and flows at the key infrastructure and channel elements.

As identified by BMT, the Bells Creek Catchment does not contain sufficient gauge data for calibration. Therefore, the XPSWMM hydrological model has been calibrated against peak flow results calculated through the Rational Method. The Rational Method is no longer supported in the Australian Rainfall and Runoff guideline 2019 (ARR 2019). However, its use is still supported in Queensland Urban Drainage Manual 2017 (QUDM 2017) and is a requirement of the SCC Planning Scheme (SC6.14.3.9 (21)). This is also a common undertaking within the Sunshine Coast Area.

It is noted that the requirements for peak flow mitigation has been addressed by BMT within their regional flood modelling.

3.1 Land Use Assumptions

Fraction impervious values have been determined based on the lot density for each catchment and the expected land use breakdown as per Calibre **Drawing No. 18-000340-SK3102 in Appendix D**. To ensure consistency with the previous analysis undertaken for the Aura Master Plan development and regional flooding analysis, land use fraction impervious values have been adopted in accordance with Calibre's Concept Stormwater Management Plan (Internal Conveyance) Report and BMT WBM's Aura Regional Flood Model – 2017 Revision Addendum Report. Refer to **Table 1** for the land use fraction impervious values adopted and Table 2 for the catchment parameters for fraction impervious.

Table 1: Land Use Fraction Impervious

Land Use	Percentage Impervious (%)
Commercial/Industrial	90
Urban/Retirement Living	90
Emerging Community	90
Schools	80
Community Facilities	70
Low and Medium Density Residential	80
High Density	90
Parks	5
Open Space & Sports Fields	0

3.2 Catchment Delineation

Catchments were delineated based upon the latest site layout (presented in **Appendix A**), preliminary bulk earthworks design, concept drainage and discharge locations to the Brook. The catchment delineation adopted in the XPSWMM model is detailed on Drawing No. **18-000340-SK3101** in **Appendix D**.

Note 1: A minor increase to the total catchment area of approximately 0.32 ha was made after the modelling presented in this report was completed. The primary change was made to Catchment B8B which consists of a 1.01 ha increase in the catchment area from 14.24 ha to 15.25 ha, while the remaining minor catchment changes totalling -0.69 ha were made across catchments B6B (-0.06 ha), B8C (-0.67 ha) and B11 (+0.04 ha). This minor change will not materially change the outcome of this investigation and is considered suitable for this investigation. This minor catchment discrepancy will be updated as part of future modelling.

Table 2: Catchment Parameters

Catchment Label	Area (ha)	Fraction Impervious (%)
B1	24.46	31%
B2A	6.20	80%
B2B	1.86	74%
B3A	7.88	80%
B3B	6.17	77%
B4	17.07	79%
B5A	6.61	80%
B5B	3.95	80%
B6A	19.05	62%
B6B	15.62*	62%
B7	9.91	82%
B8A	10.89	77%
B8B	14.24*	54%
B8C	5.93*	72%
B9A	4.32	80%
B9B	4.85	84%
B10	12.33	76%
B11	10.31*	6%
B13	7.61	8%
B15	2.92	9%
B16	3.46	14%
B17	8.57	13%
B18	1.94	5%

*Refer Note 1 in **Section 3.1.2**.

3.3 Model Parameter Verification

A XPSWMM 1D model was configured to simulate the hydrology for the site under developed conditions. To confirm the hydrology models suitability for purpose it was compared to the Rational Method. Refer to **Appendix B** for Rational Method calculations.

3.3.1 Verification Model Rainfall

The calibration originally undertaken to develop the Rational Method itself was undertaken using hydrologic modelling which was set up using (now superseded) ARR 1987 rainfall intensities. For this reason, the rainfall adopted within the XPSWMM verification model also adopts ARR 1987 rainfall intensities and temporal patterns. This rainfall was adopted only for comparison against the Rational Method for the selection of infiltration parameters. Once infiltration parameters were set, the current ARR 2019 rainfall intensities and ensemble temporal patterns were then applied to the XP-SWMM model to calculate the critical storms for each catchment and generate inflow hydrographs to be applied in the hydraulic investigation. Details of the hydrologic analysis undertaken to accord with ARR 2019 is in **Section 3.4**.

3.3.2 Rational Method Peak Flow Estimation

To verify the XPSWMM model configuration, Rational Method calculations have been undertaken for three (3) catchments identified as Catchment B4, B5A and B7, as shown on Drawing No. **18-000340-SK3101** in **Appendix D**. The catchments chosen to verify the hydrological model were chosen for their large size and flow path length, furthermore they provide a good representative sample of the overall investigation area.

For the detailed Time of Concentration and peak flow calculation, refer to the Rational Method calculations provided in **Appendix B**. A summary of the peak flows determined for the verification are summarised in **Table 3.**

Table 3: Rational Method Peak Flows

AEP	Catchment B4 (m3/s)	Catchment B5 (m3/s)	Catchment B7 (m3/s)
63%	3.13	1.91	1.80
39%	4.23	2.58	2.43
18%	5.83	3.55	3.35
10%	6.80	4.15	3.91
5%	8.11	4.95	4.67
2%	10.27	6.26	5.91
1%	11.47	6.98	6.56

3.3.3 Infiltration Losses and Lag Parameter Value

In order to achieve an acceptable correlation between the XPSWMM model (Laurenson's Method) to the Rational Method, differing parameters were adopted for the major and minor exceedance probabilities. A range of Initial and Continuing Loss values were trialled to achieve a close correlation of the XPSWMM model against the Rational Method calculation presented in **Section 3.3.2**. The verified XPSWMM parameters which achieve the closest correlation are presented in **Table 4** below.

Table 4: XPSWMM Minor Storms Verified Parameters

XPSWMM Model Parameter	Minor (63%-5% AEP)	Major (2%-0.05% AEP)
Pervious Area – Initial Loss (mm/hr)	35	5
Pervious Area – Continuing Loss (mm/hr)	5	5
Impervious Area – Initial Loss (mm/hr)	1	1
Impervious Area – Continuing Loss (mm/hr)	0	0
BX Factor	1.5	1.0

The configuration was verified by comparing peak flows generated by the XPSWMM model and the Rational Method calculations for sub-catchments B4, B5 and B7. Catchments B4, B5 and B7 are proposed as primarily residential land use and are typical of other sub-catchment areas surrounding The Brook. The verification was conducted for the 63% AEP to 1% AEP storm events using ARR 1987 Bureau of Meteorology (BOM) IFD data for the site location.

It is noted that a comparison of the results of the Regional Flood Frequency Method (RFFE) analysis was considered unsuitable for application to the highly urbanised catchment proposed for the Developed Scenario. Furthermore, the ARR Data Hub (https://data.arr-software.org/) identifies a rural initial loss of 27mm with a continuing loss of 2.7mm/hr for the site. A comparison of the results of a hydrological analysis in XPSWMM adopting the ARR Data Hub values found peak runoff to be lower when adopting the ARR Data Hub values. Therefore, since the infiltration parameters presented in **Table 4** provide a higher minimum lot level, these values were considered to be more justifiable for the application.

3.3.4 Verification Result Comparison

Adopting the above verification parameters, the peak flow relationships from the XPSWMM model was amended to more closely represent the peak flow characteristics estimated using the Rational Method. The resulting verification results are provided below in **Table 5, Table 6** and **Table 7.**

Table 5: Catchment B4 Calibration Verification

Model Configuration	AEP	Rational Method	XPSWMM	Difference	Average
Minor Storm Events	63	3.13	4.25	36%	Excluded
	39	4.23	5.45	29%	16%
	18	5.83	6.76	16%	
	10	6.80	7.53	11%	
	5	8.11	8.59	6%	
Major Storm Events	2	10.27	10.59	3%	3%
	1	11.47	11.47	2%	

Table 6: Catchment B5 Calibration Verification

Model Configuration	AEP	Rational Method	XPSWMM	Difference	Average
Minor Storm Events	63	1.91	2.74	44%	Excluded
	39	2.58	3.49	35%	21%
	18	3.55	4.33	22%	
	10	4.15	4.83	16%	
	5	4.95	5.51	11%	
Major Storm Events	2	6.26	6.54	4%	4%
	1	6.98	7.22	3%	

Table 7: Catchment B7 Calibration Verification

Model Configuration	AEP	Rational Method	XPSWMM	Difference	Average
Minor Storm Events	63	1.80	2.57	43%	Excluded
	39	2.43	3.27	35%	21%
	18	3.35	4.06	21%	
	10	3.91	4.52	16%	
	5	4.67	5.16	11%	
Major Storm Events	2	5.91	6.10	3%	3%
	1	6.56	6.73	3%	

Due to the hydrological models tendency to overestimate flows for the 63% AEP event it has been excluded from the verification process.

The results presented above show a tight calibration for the major design events. Due to the differences between the two runoff estimation approaches a calibration within 5% for all catchments were unable to be achieved for the minor events with such large catchments. However, the above calibration is considered to be acceptable for the following reasons:

- The purpose of this investigation is to detail the flows through the channel and the major infrastructure to set allotment levels. These outputs are dependent on the major design events which are achieving a close calibration.
- The minor events will be modelled in a conservative manner and will not affect how the minimum lot levels are set.

3.4 XP-SWMM Design Model

3.4.1 Design Rainfall Depths

Design rainfall Intensity-Frequency-Duration (IFD) data and temporal pattern ensembles were obtained via the ARR Data Hub for the study area. The design rainfall depths for each standard storm duration and AEP are presented in **Figure 2**.

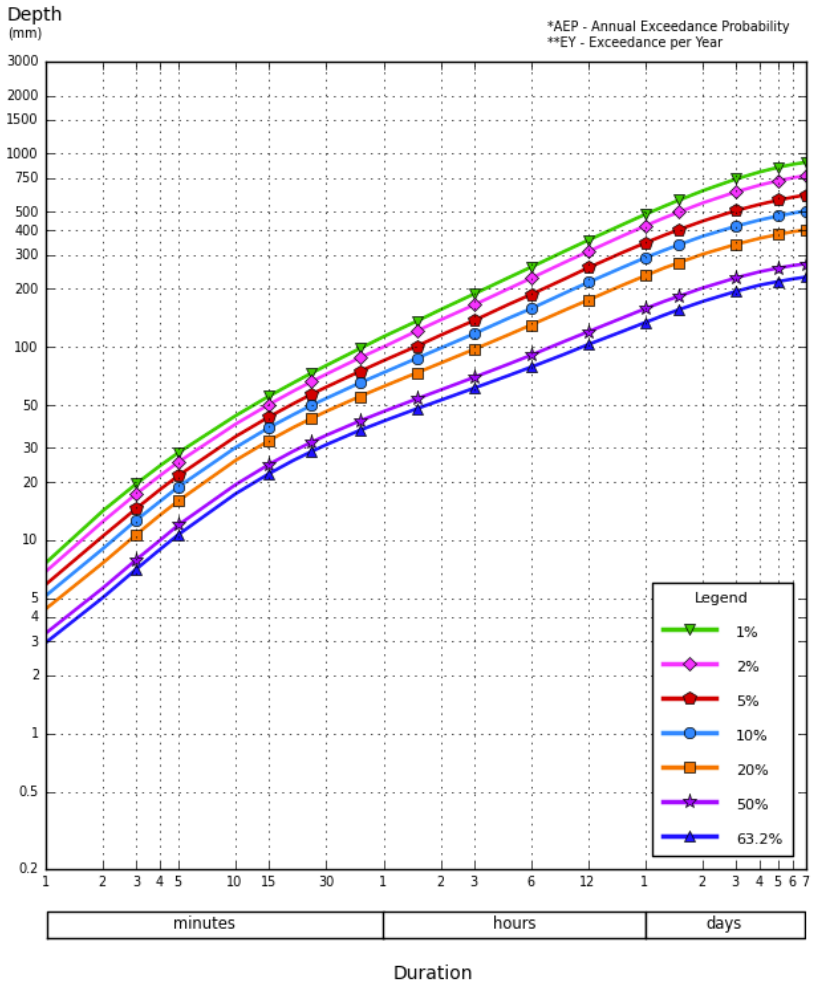


Figure 2: Design Rainfall Depth by IFD

3.4.2 Critical Duration and Temporal Patterns

Ensembles containing ten different storm temporal patterns were obtained from the AR&R Data Hub. Temporal patterns define the time-varying distribution of rainfall for the storm duration, which varies depending on the duration and AEP of the design storm event. Temporal pattern ensembles were loaded into the XP-SWMM model for each design AEP event for the following standard storm durations:

- 10 minute
- 15 minute
- 20 minute
- 25 minute
- 30 minute
- 45 minute
- 1 hour
- 1.5 hour
- 2 hour
- 3 hour

In order to reduce the number of 2D simulation undertaken in TUFLOW a 1D fast model was first constructed within XPSWMM. Through the benefit of reduced run times in the 1D model all model simulations were able to be first run and identify which critical durations and temporal patterns were necessary to progress through to 2D modelling in TUFLOW.

The following methodology was applied in accordance with AR&R 2019 to ascertain the design flow hydrograph to be adopted in the hydraulic modelling;

- For each 1D link, take the average of 10 peak flow rates corresponding to each temporal pattern (TP);
- Select the storm duration that produces the maximum average peak flow and adopt as the critical duration for each link;
- For each link select the temporal pattern that produces the median peak flow rate as the critical temporal pattern for that link;
- Tabulate the selected critical storms for each link by critical duration and temporal pattern for each AEP event (refer); and
- Use best engineering judgement (as detailed below) to select which critical storms hydrographs to simulate in the hydraulic model.

For the purposes of this assessment, each of the critical storms were selected for input into the hydraulic model for each AEP (48 simulations total). The critical storms adopted for the hydraulic analysis are summarised in **Table 8** and **Table 9**, below.

Table 8: Critical storms by analysis location for 39% and 18% AEP Storms

Analysis Location	39% AEP		18% AEP		Rationale for selected location
	Critical Storm	Peak Flow	Critical Storm	Peak Flow	
Link 20	15 min TP 6	3.47	30 min TP 6	4.50	Uppermost reach of Brook
Link 21	15 min TP 7	6.74	30 min TP 10	8.58	Pinch point along upper reach
Link 22	15 min TP 5	12.53	15 min TP 5	15.25	Immediately upstream of road bridge
Link 24	30 min TP 5	13.13	30 min TP 5	15.86	90 degree bend in Brook causing super-elevated flow
Link 46	30 min TP 7	13.25	3 hr TP 9	16.99	Immediately upstream of Culvert 3
Link 26	45 min TP 1	13.59	3 hr TP 2	17.19	Immediately upstream of Culvert 4 (CAMCOS)

Table 9: Critical storms by analysis location for 1% and 1% Climate Change AEP Storms

Analysis Location	1% AEP		1% AEP CC*		Rationale for selected location
	Critical Storm	Peak Flow	Critical Storm	Peak Flow	
Link 20	30 min TP 1	9.01103	30 min TP 7	11.80679	Uppermost reach of Brook
Link 21	45 min TP 5	13.89839	30 min TP 8	17.68705	Pinch point along upper reach
Link 22	25 min TP 8	23.67523	25 min TP 5	29.27799	Immediately upstream of road bridge
Link 24	1 hr TP 3	30.26599	45 min TP 6	37.77552	90 degree bend in Brook causing super-elevated flow
Link 46	1.5 hr TP 6	31.20425	1.5 hr TP 6	36.95083	Immediately upstream of Culvert 3
Link 26	1.5 hr TP 6	31.94321	2 hr TP 6	38.65712	Immediately upstream of Culvert 4 (CAMCOS)

*Climate change scenario for a year 2100 climate

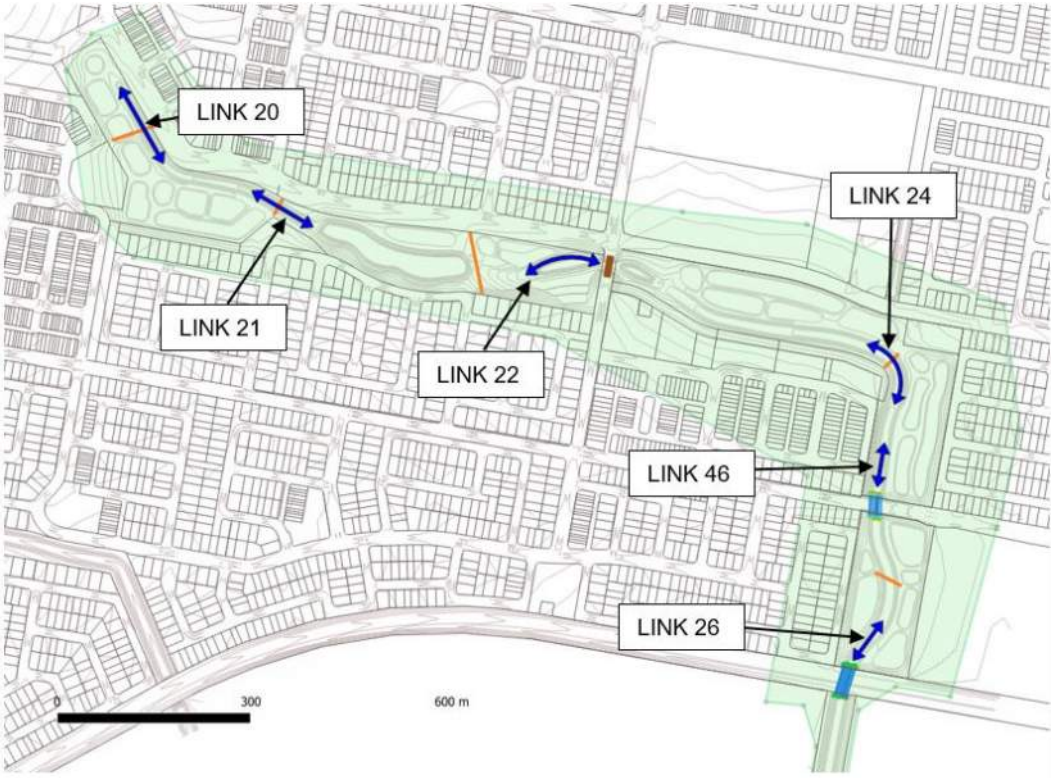


Figure 3: Analysis Locations for Critical Storms

3.4.3 DIS Rainfall Scenarios

The above ARR 2019 methodology is the adopted method for all design elements including identifying minimum lot levels. As a sensitivity however a duration independent storm (DIS) rainfall methodology was modelled as a sensitivity.

DIS events were run for the following AEP events:

- 1% AEP + Climate Change; and
- 0.05% AEP + Climate Change.

4. Hydraulic Analysis

4.1 Strategy

The aim of this investigation is to analyse the concept channel design, determine the conveyance capacity of the channel/major stormwater infrastructure and to set minimum allotment levels. This analysis has been undertaken using the TUFLOW modelling software to provide accurate results through the Brook while incorporating the relevant aspects of the regional flood analysis.

The Brook has been designed to serve a variety of different purposes for the development with approximately eighteen (18) bioretention basins to mitigate the increase in pollutants generated from the site, (3) online wetland and recreational spaces. A minor flow channel runs along the full length of the Brook connecting two (2) proposed lakes. The minor flow channel has been designed to ensure the bioretention basins have 39% AEP flood immunity.

The Brook is traversed by two (2) road crossings and the Caboolture to Maroochydore Corridor Study (CAMCOS) railway line. In addition to this five (5) pedestrian boardwalks have been modelled within the Brook. To ensure stormwater remains unimpeded by these crossings, two (2) major culvert structures and one vehicle bridge are proposed to convey flows. During the construction phase, the CAMCOS railway corridor is likely to be used as a haul road which will traverse the Aura Brook channel via a bed level crossing (or similar, to be confirmed). As such, the channel only will be built through to Bells Creek (South) during this interim phase of works.

The proposed culvert structure at the CAMCOS corridor (designated Culvert Structure 4) represents the possible configuration of the Brook in the 'ultimate design' scenario, which will result in a constriction to flows through the Brook. The losses through this proposed culvert structure will result in headwater that will raise the upstream water surface levels through the Brook, and therefore the minimum allotment levels. As such, this preliminary crossing has been included within this analysis to present a possible ultimate design scenario and future-proof the analysis to demonstrate that future railway works will not be critically restricted by the proposed allotment levels. Importantly, the final sizing of these culverts (or bridge) is the responsibility of the future railway designer and will require additional flood modelling by them to ensure they're not reducing freeboards to the surrounding properties.

During the interim phase, while the CAMCOS corridor facilitates a haul road, unimpeded flow across the haul road will result in lower WSLs through the upstream development. Analysis of this interim scenario has therefore been omitted from this analysis. Further analysis to ensure flooding conditions are not exacerbated by the proposed haul road configuration will be undertaken with future design works.

For the purpose of detailing the minor flow conveyance through the Brook and setting minimum allotment levels, the following analysis has been undertaken for the 39% AEP and 1% AEP Climate Change storm events and the sensitivity scenarios documented in **Section 4.5** below. All remaining storm events are not considered to be relevant to achieve the outcomes of this investigation.

4.2 Hydraulic Objectives

The following hydraulic objectives have been the focus of design for the following TUFLOW model.

4.2.1 Residential Lots Adjacent to Open Channels

In order to maintain consistency with the design standards of the wider regional flood modelling undertaken by BMT in *Aura Regional Flood Model – 2017 Revision – Addendum Report* (2017) a freeboard of 350mm from the defined flood event (DFE) to the lot has been adopted. Given the Brook acts to provide local drainage for the adjacent areas a freeboard of 300mm would generally only be required in accordance with QUDM. Therefore, the adoption of 350mm freeboard to lots is considered conservative.

Also in accordance with the design standards set out by BMT, the adopted freeboard to the minimum habitable floor level is to be set 500mm above the DFE.

4.2.2 Culvert Design

Sunshine Coast Regional Council Stormwater Guidelines (Schedule 6 2014, p SC6-200) identifies the design immunity for urban drainage to be in accordance with QUDM.

QUDM (2017) Table 7.3.1 identifies the following design criteria for cross drainage (culverts) based upon the Average Annual Daily Traffic (AADT):

- Major Road (>3,000 AADT) – 2% AEP (50yr ARI); and
- Minor Road (<3,000 AADT) – 10% AEP (10yr ARI).

Based on the expected AADT's all culverts modelled within this assessment have been assumed to be major culverts.

In addition to the above conveyance requirements, trafficability requirements require maximum flow depths of 200mm and a depth x velocity product not exceeding 0.3m^2/s.

Railway crossings have been provided with 1% AEP overtopping immunity.

Conditions of Preliminary Approval pertaining to fish passage requirements for the proposed culvert structures within the proposed fish habitat areas, which are deemed Waterway barrier works by DSDMIP. Further details are provided in **Section 4.3.7.**

4.3 Model Configuration

4.3.1 Topographical Data and Projection

The Digital Terrain Model's (DTM) used in this analysis consisted of a 1km by 1km LIDAR tile at the outlet of the Brook to Bells Creek (South) and a bulk earthworks TIN over the extent of the Master Plan site. The model was projected to the GDA94 / MGA Zone 56 coordinate system.

The design tin adopted for this modelling is shown on Drawing Numbers 17-000934-3015-DA06 to DA08, DA21, DA21A and DA21B, included as part of this DA submission.

4.3.2 2D Model Area

The 2D model extent for this analysis focuses on the Brook with the boundary extending over the surrounding residential lots to capture any potential flows overtopping the Brook. Refer to **Figure 4** below for the 2D model extent (39% AEP results shown on figure). A 2D grid cell size of 3m combined with a starting time step of 1 second was used for this analysis.

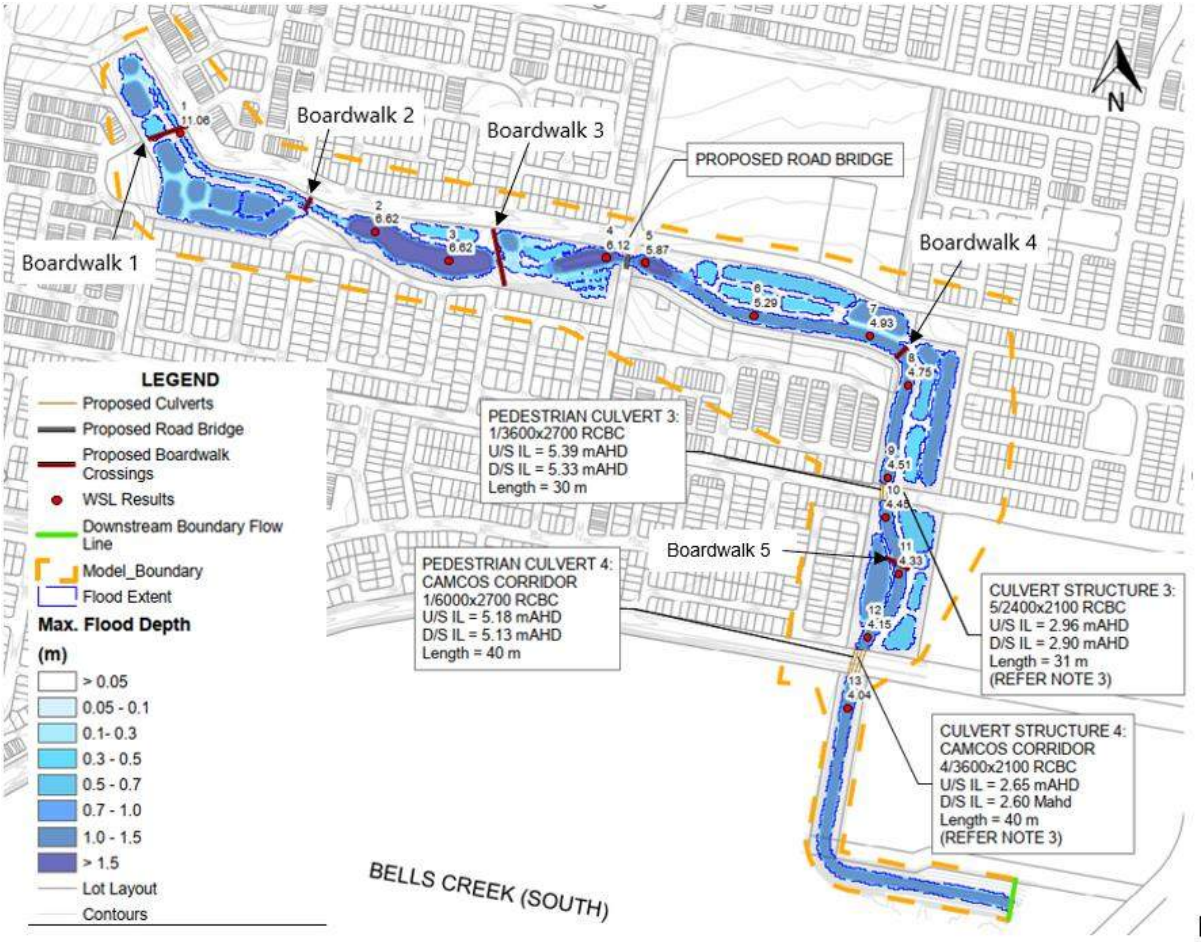


Figure 4: TUFLOW Model Area.

4.3.3 Manning's N Value

Various Manning's n roughness values have been utilised to represent the 2D topographical areas within the flood. Mannings values within the drain have generally been adopted as Manning's Roughness of 0.12, a sensitivity scenario whereby the roughness was increased to 0.15 was completed and is discussed further in **Section 4.5**. Mannings roughness's external to the Brook were assumed to be 0.15 to simulate a lumped roughness for the developed landuses.

These values are consistent with hydraulic roughness recommended in the SSC Planning Scheme, however, it should be noted that the use if this high roughness is likely to yield conservatively high water levels and flow velocities are likely to be under predicted. Calibre's understanding is that SCC prefer developed allotment levels to be set off of the assumption that the channels may not be maintained and will therefore have increased hydraulic roughness.

A hydraulic roughness of 0.014 was adopted for the concrete culverts (slightly rougher than the standard 0.013) to reflect the roughening required at the bottom of the culverts to meet fish passage requirements. The outermost culvert cell on both channel banks incorporate rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).

4.3.4 Inflow Locations

The inflow hydrographs (time vs flow) for each of the storm durations outlined in **Section 3.4.2** were input into the model using SA Polygons. Inflow location assumptions were adopted as follows:

- Piped Flows (63% & 39% AEP) – The upstream stormwater drainage network for each catchment will be conveyed to the appropriate outlet location. This was generally assumed to be the inlet pond where one was present or directly into the Brook low flow where no inlet pond was provided.
- Overland Flows (5% to 0.05% AEP) – Runoff from all remaining storm events are to be conveyed to the Brook overland flow via the internal road network. As such inflow polygons have been provided within the Brook along the extent of each catchment frontage.

The inflow locations (TUFLOW SA polygons) for the overland flows for each catchment are presented in blue in **Figure 5** (pipe outlet locations may differ and are subject to future detailed design).

Figure 5: Hydrograph inflow locations

4.3.5 Initial Water Levels

Initial water levels were provided within the bioretention basins and wetlands as part of the 2D modelling to represent possible pre-burst rainfall filling the extended detention depths of the WSUD elements. Initial water levels were adopted as follows:

- Bioretention Basins – Top of filter media level plus 300mm extended detention.
- Wetlands – Standing water surface levels plus 500mm extended detention.

4.3.6 Tailwater Conditions

The proposed Brook is situated between Bells Creek (North) and Bells Creek (South) with the Brook itself discharging to the south. The hydraulic model was analysed for a number of storm durations to determine the critical durations as discussed in **Section 3.4.2**, above, with the longest critical duration being the 3 hour event at the lower reaches of the Brook. Importantly, it was identified that the Brook with a total catchment area of approximately 200 ha has a significantly faster rainfall/runoff response than the larger regional catchment draining to Bells Creek South. Accordingly, the regional peak maximum water surface level (WSL) (provided by BMT) occur significantly after the peak discharge from the Brook (non-coincidental flooding). To account for the effect of non-coincidental flooding, guidance from Table B-1 of the *Maroochy Shire Council IWM Guidelines*, 2006 were adopted. This approach is used to identify the appropriate AEP regional flood level to use for the tailwater condition within the local model.

Based upon the ratio of the local catchment area to the regional catchment area the 2.5% AEP regional storm was identified. As such, the maximum WSL corresponding to the regional 2% AEP was adopted for the downstream tailwater for the 1% AEP storms (both present and future climate) for the purpose of the major infrastructure drainage optimisation, flow conveyance and setting minimum allotment levels. This constitutes a conservative approach for the selection of downstream boundary conditions.

For each design AEP, a WSL at the downstream boundary location was adopted from BMT's regional flood model rasters assuming the non-coincident regional flooding method described above, for each flood AEP. The coincident regional flood event and resultant maximum regional WSL adopted as tailwater conditions for the Brook discharging to Bells Creek (South) are summarised below in **Table 10**.

Table 10: Adopted Tailwater Conditions for Aura Brook.

Design AEP	Coincident Regional Flood AEP (BMT flood model)	Adopted Downstream Boundary Condition (mAHD)
63%	Nil	0.1% slope boundary
39%	Nil	0.1% slope boundary
18%	39%	4.198
10%	18%	4.606
5%	18%	4.606
2%	5%	4.889
1%	2%	5.141
1% (Year 2100 Climate Change Scenario)	2%	5.141
0.05% (Year 2100 Climate Change Scenario)	1% (Climate Change)	5.400

Design AEP values above in addition to the 39% and 1% climate change AEPs have been provided for information purposes only.

It is noted that from the preliminary hazard and depth results, the model downstream boundary appears to be sufficiently far downstream from the area of interest to not cause significant distortion of the results. A sensitivity analysis of the adopted tailwater levels was therefore considered unnecessary.

4.3.7 1D Model Elements

The major stormwater infrastructure proposed to convey flows under the proposed road crossings and CAMCOS railway line has been represented by 1D elements. A 10% blockage factor has been applied to the culverts in accordance with ARR (Book 6, Chapter 6). A sensitivity analysis of increased culvert blockage was also undertaken and is detailed in **Section 4.5.**

In order to address the conditions of the *Preliminary approval and Part Approval* for *Operational work for Waterway barrier works* decided by the Department of State Development, Manufacturing, Infrastructure and Planning (DSDMIP), dated 28 February 2019 (ref: 1710-2004 SDA), special consideration for fish passage is required in the design and

modelling methodology for the proposed culvert structures. Provisions such as internal baffles, embedment depth, culvert length and gradient have been incorporated into the TUFLOW model for 1D elements.

Further details of the proposed culverts have been provided in **Appendix C** and summarised below in **Table 11** and **Table 12**.

Table 11: Culvert Structure Group 3 Details

Culvert ID	Culv3_FP	Culv3_FP_RB	Culv3_FP_LB	Culv3_PED
Function	Hydraulic / Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Pedestrian Passage
Structure type	RCBC	RCBC	RCBC	RCBC
Structure size (mm)	2400 x 2100	2400 x 2100	2400 x 2100	3600 x 2700
No. barrels	3	1	1	1
Modelled width x height (mm)	2400 x 1800[1]	2250[2] x 1800[1]	2250[2] x 1800[1]	3600 x 2700
Structure Invert Upstream	2.96	2.96	2.96	5.39
Modelled Invert Upstream	3.26[1]	3.26[1]	3.26[1]	As above
Structure Invert Downstream	2.90	2.90	2.90	5.33
Modelled Invert Downstream	3.20 [1]	3.20 [1]	3.20 [1]	As above
Hydraulic Roughness (Manning's n)	0.014	0.028	0.028	0.014
Grade[3]	0.20%	0.20%	0.20%	0.20%
Approx. Length[4]	31	31	31	30

[1] Culvert installed 300mm below bed level to enable fish passage design. First 300mm depth from structure invert assumed blocked. Modelled invert raised 300mm and modelled culvert height reduced 300mm to reflect hydraulic conveyance.
[2] This outermost culvert cell incorporates rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant loss of flow width has been subtracted from the structure width. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).
[3] Culverts with fish passage function must be installed at no steeper gradient than the waterway bed gradient.
[4] Desirable culvert length less than 30m, width maximum 40m for sufficient sunlight within culvert to promote fish passage.

Table 12: Ultimate Culvert Structure Group 4 (CAMCOS Corridor) Details

Culvert ID	Culv4_FP	Culv4_FP_RB	Culv4_FP_LB	Culv4_PED
Function	Hydraulic / Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Baffled Fish Passage	Hydraulic / Pedestrian Passage
Structure type	RCBC	RCBC	RCBC	RCBC
Structure size (mm)	3600 x 2100	3600 x 2100	3600 x 2100	6000 x 2700
No. barrels	2	1	1	1
Modelled width x height (mm)	3600 x 1800[1]	3450[2] x 1800[1]	3450[2] x 1800[1]	6000 x 2700
Structure Invert Upstream	2.65	2.65	2.65	5.18
Modelled Invert Upstream	2.95 [1]	2.95 [1]	2.95 [1]	As above
Structure Invert Downstream	2.60	2.60	2.60	5.13
Modelled Invert Downstream	2.90 [1]	2.90 [1]	2.90 [1]	As above
Hydraulic Roughness (Manning's n)	0.014	0.028	0.028	0.014
Grade[3]	0.13%	0.13%	0.13%	0.12%
Approx. Length[4]	40	40	40	45

[1] Culvert installed 300mm below bed level to enable fish passage design. First 300mm depth from structure invert assumed blocked. Modelled invert raised 300mm and modelled culvert height reduced 300mm to reflect hydraulic conveyance.
[2] This outermost culvert cell incorporates rigid baffles on the bankside internal sidewalls with 150mm horizontal protrusion (width) into the flow. The resultant loss of flow width has been subtracted from the structure width. The resultant increase in culvert roughness has been modelled with Manning's n=0.028 in accordance with AR&R (Book 6, Chapter 2, Equation 6.2.33).
[3] Culverts with fish passage function must be installed at no steeper gradient than the waterway bed gradient.
[4] Desirable culvert length less than 30m, width maximum 40m for sufficient sunlight within culvert to promote fish passage.

All 1D elements incorporate SX connections to dynamically link to the 2D surface. Each SX line has been modelled with a SX Storage Factor equal to 3. The SX Storage Factor adds additional storage to the 1D/2D linking cells, thus providing increased stability within the 1D elements. A range of SX Storage Factor values were trialled, however results demonstrate the storage factor value of 3 provide stable 1D results whilst not causing in a loss or reduction in peak flows through the culverts.

4.3.8 Layered Flow Constrictions

Layered flow constrictions were incorporated into the 2D model to represent the five (5) boardwalk crossings expected to be present within the Brook as well as one road bridge (refer **Figure 4**). Details of the adopted flow constrictions are presented below in **Table 13**. It is noted the road bridge has been assumed to be a single span bridge (approx. 20m span) and therefore no blockage below the deck has been adopted.

Table 13: Adopted Layered Flow Constrictions (Concept)

Structure	Underside of Deck Level (mAHD)	Pier Blockage	Deck Level (mAHD)	Deck Blockage	Top of Handrail Level (mAHD)	Handrail Blockage
Boardwalk 1	12.60	10%	13.10	100%	14.30	50%
Boardwalk 2	10.55	10%	11.05	100%	12.25	50%
Boardwalk 3	9.20	10%	9.70	100%	10.90	50%
Road Bridge	8.75	0%	9.75	100%	10.95	50%
Boardwalk 4	5.50	10%	6.00	100%	7.20	50%
Boardwalk 5	5.25	10%	5.75	100%	6.95	50%

4.4 Model Scenarios

The 1% AEP Climate Change event as the Defined Flood Event (DFE) for the analysis. Further analysis of various sensitivity scenarios including varying severity of culvert blockage and hydraulic roughness were also analysed. As such, the minimum levels for allotments adjacent to the Brook have been derived from a maximum of the following:

- The Defined Flood Event + 350mm freeboard to the minimum allotment level; and
- Maximum WSL resulting from each of the sensitivity scenarios.

It is noted the minimum habitable floor level for each allotment should be a minimum of 150mm above the adopted minimum lot level, thus providing 500mm freeboard to habitable floor levels (refer **Section 4.2.1**)

A 10% blockage factor has been applied to the culverts in accordance with ARR (Book 6, Chapter 6) for all modelled scenarios, except where sensitivity scenarios modelled an increased culvert blockage as detailed in **Section 4.5.** For the design storm event flood plans, sensitivity event flood plans and water surface level results, refer to **Appendix E**, **Appendix F** and **Appendix G** respectively.

4.4.1 Design Storm

39% AEP Storm Event - To detail the conveyance efficiency of the low flow channel which runs the length of the Brook, the 39% AEP (2yr ARI) event was simulated for the six critical durations established in **Section 3.4.** A maximum of all flood results for depth, velocity and hazard were generated from a maximum envelope of these critical durations. Rainfall

was established using ARR 2019 temporal patterns and rainfall intensities. Incorporating a maximum water surface level boundary condition as documented in **Table 10** , the results are presented in **Appendix E** and **Appendix G**.

1% AEP Climate Change - To set minimum allotment levels the 1% AEP storm event under climate change (2100yr) rainfall event was simulated for the six critical durations established in **Section 3.4.** A maximum of all flood results for depth, velocity and hazard were generated from a maximum envelope of these critical durations. Rainfall was established using ARR 2019 temporal patterns and rainfall intensities plus 20% to allow for climate change.

4.5 Sensitivity Events

Sensitivity investigations have been undertaken to determine the robustness of the proposed design over its expected life. The sensitivity investigation undertaken includes significant increases in upstream vegetation causing a high Manning's roughness for the channel and also provisions for culvert blockages (ie. from high sediment loads or dislodged vegetation). Refer to **Appendix F** for the sensitivity scenario flood plans and **Table G.2** for the WSL throughout the Brook. The following scenarios were undertaken:

High Manning's Sensitivity - The analysis was undertaken for the 1% AEP Climate Change (2100) rainfall event, whereby the sensitivity scenario roughness was increased from 0.12 within the drain to 0.15.

1% AEP + CC, 50% Blockage Scenario – Under this scenario a 50% bottom up blockage has been applied to all culverts within the Brook for the 1% AEP Climate Change (2100) rainfall event. To report maximum WSL's each culvert blockage factor was iteratively increased from 10% to 50% (ie. not all 50% blocked simultaneously). The results presented in **Appendix F** document the maximum of all blockage scenarios for the critical durations throughout the Brook.

39% AEP, Severe Blockage Scenario – Under this scenario severe blockages were applied to all culverts for a 39% AEP (2yr ARI) rainfall event. The blockage factor for all culvert 3 structures was increased from 10% to a 100% blockage scenario. Due to the CAMCOS Rail Line embankment level a blockage of 95% was applied for Culvert 4 instead of 100%. The adoption of a 95% blockage is still considered overly conservative based on the following:

- The upstream catchment is entirely urbanised (as opposed to heavily wooded areas which have a higher risk of generating fodder contributing to culvert blockages); and
- The large size of the culvert and number of cells make it extremely unlikely that 95% blockage would occur across the entire culvert bank (especially considering the pedestrian culvert inverts and obverts are more than two metres higher).

As noted previously, the delivery of the crossing underneath the CAMCOS line will be delivered in future works by others. The CAMCOS line is currently designed at an elevation higher than the surrounding residential areas. Therefore, any major blockage to the CAMCOS culverts may impact the surrounding residential areas. As a result, prior to the CAMCOS line being designed and constructed (by others) detailed blockage and risk analysis should be undertaken (by others) to prevent major blockages occurring.

4.5.1 Secondary Analysis

To confirm the capacity of the proposed Brook alignment and cross-sectional area, two Duration Independent Storm (DIS) rainfall events were modelled. The purpose of the analysis was to determine if the Brook has the appropriate capacity to convey flows during these DIS events. Refer to **Table G.1** in **Appendix G** for the WSL's within the Brook during the following DIS storm events.

1% AEP + CC DIS – Under this scenario the 1% AEP Climate Change DIS rainfall event was modelled. The Duration Independent Storm (DIS) temporal patterns were provided by Sunshine Coast Council and run to consider peak water levels within the Brook.

0.05% AEP DIS – Under this scenario the 0.05% AEP (2,000yr ARI) DIS rainfall event was modelled. The 0.05% AEP DIS event was undertaken to detail the impact to the lots bounding the Brook to inundation does not cause a threat to life within the effected properties or properties. It is noted this simulation is beyond the Design Flood Event (DFE) for designing lot levels.

4.6 Minimum Allotment Levels – WSL Results

A summary of the water surface levels provided by the TUFLOW model is tabulated in **Table G.2** in **Appendix G**. In order to define the minimum levels for allotments adjacent to the Brook the maximum of the below was adopted:

- The Defined Flood Event + 350mm freeboard; and
- Maximum WSL resulting from each of the sensitivity scenarios.

Minimum lot levels are provided in **Table 14** below with WSL throughout the Brook presented on the flood plans provided in **Appendix F** and **Table G.2** in **Appendix G**.

It is noted the minimum habitable floor level for each allotment should be a minimum of 150mm above the adopted minimum lot level.

Table 14: Minimum Lot Levels

Reporting Location	Critical Storm Scenario	Minimum Design Level	Required Minimum Lot Levels (mAHD)	Approximate Lot Levels Achieved[#] (mAHD)
1	1% AEP Climate Change	DFE + 350mm	12.14	13.12
2	1% AEP Climate Change	DFE + 350mm	9.77	11.06
3	1% AEP Climate Change	DFE + 350mm	9.77	10.15
4	1% AEP Climate Change	DFE + 350mm	7.94	8.62
5	1% AEP Climate Change	DFE + 350mm	7.50	8.00
6	1% AEP Climate Change	DFE + 350mm	7.34	7.40
7	1% AEP Climate Change	DFE + 350mm	7.28	7.45
8	1% AEP Climate Change	DFE + 350mm	7.23	7.73
9	1% AEP Climate Change	DFE + 350mm	7.19	7.61
10	1% AEP Climate Change	DFE + 350mm	6.86	7.84
11	1% AEP Climate Change	DFE + 350mm	6.84	7.37
12	1% AEP Climate Change	DFE + 350mm	6.81	7.17
13	1% AEP Climate Change	DFE + 350mm	6.34	6.55

*Note - Refer to Appendix G for the water surface levels at each reporting location.
[#]Note – Achieved lot levels are minimum levels from properties approximately perpendicular to the direction of flow at each reporting location.

4.6.1 Severe Storm WSL Results

The severe storm (2000 year DIS storm event) results are presented on the Flood Plans **15-000340-DIS-2000-A** to **C** in **Appendix F**. Although results demonstrate the banks of the Brook are overtopped during a severe storm event, the lots bounding the Brook have a maximum depth*velocity product of 0.4 m^2/s. It is noted that inundation within the southern extents interact with the model boundary. As the purpose of this severe storm investigation is to predominately analyse flood hazard and risk to life, results in this area is considered conservative, since the model boundary artificially constricts flows. Furthermore, the culverts under the CAMCOS is preliminary only and to be designed and delivered by others.

5. Conclusion

Calibre Professional Services Pty Ltd has been commissioned by Stockland Development Pty Ltd to prepare a *Flood Investigation Report* for part of Precincts 11, 12 and 14 of the Aura Development. The aim of this report is to investigate flooding capacity of the Aura Brook and determine the minimum allotment levels of the surrounding lots. This investigation has concluded the following:

- Through the use of a 2D TUFLOW model, the water surface levels throughout the site for a range of design and sensitivity scenarios were determined;
- As shown in **Section 4.6**, minimum allotment levels and minimum habitable floor levels were determined in accordance with freeboard requirements from BMT's regional flood investigations;
- A number of sensitivity scenarios have been addressed investigating the effects of increased vegetation and potential blockage of the culvert structures demonstrating that the Brook channel has been designed to mitigate adverse flood impacts to the development;
- The channel downstream of the CAMCOS rail line has capacity to convey up to and including the 1% AEP climate change storm event flows from the Brook to Bells Creek (South); and
- The low flow channel proposed along the extent of the Brook has sufficient capacity to convey the minor flows (39% AEP) whilst maintaining freeboard to the top of embankment of the various WSUD devices.

6. Recommendations

Based on the outcomes of the flood impact assessment it is recommended that the conceptual design and management strategies provided in this report be approved and incorporated into the final design. The concepts presented in this report can be amended provided that the design objectives are maintained.

Throughout future design development it is expected that some changes to the Brook will be made from what is modelled. It is recommended these changes be incorporated into a working model as required.

7. References

- BMT WBM (2017) Aura Regional Flood Model – 2017 Revision – Addendum Report.
- Institute of Public Works Engineering Australasia (Queensland Division) (2016), Queensland Urban Drainage Manual.
- Institution of Engineers, Australia 2019, Australian Rainfall and Runoff.
- Sunshine Coast Council (2015), Planning Scheme.
- Qld State Government (2017), State Planning Policy.

8. Disclaimer

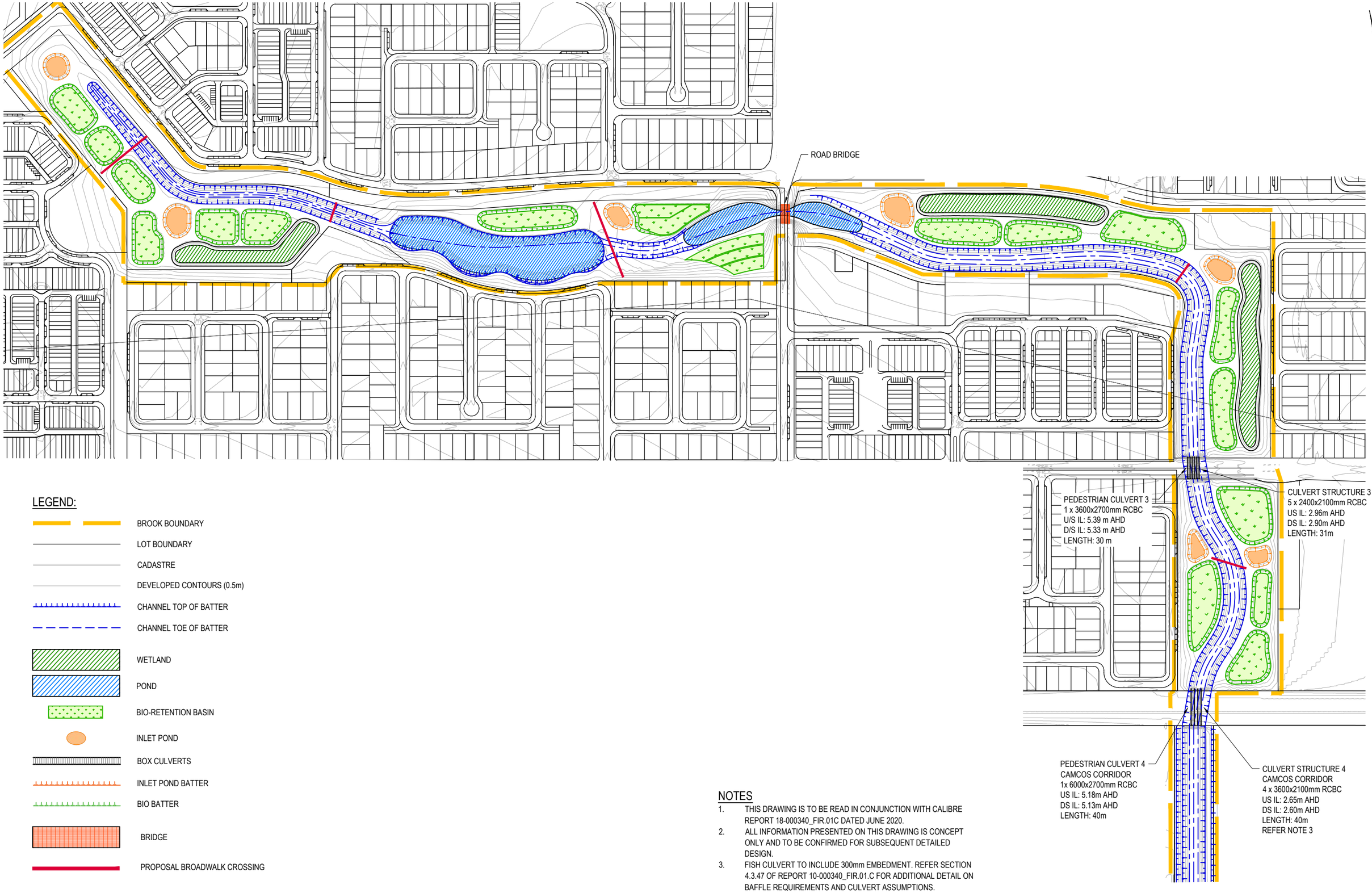
This report has been prepared on behalf of and for the exclusive use of Stockland Development Pty Ltd and is subject to and issued in accordance with the agreement between Calibre Professional Services Pty Ltd and Stockland Development Pty Ltd.

Our investigation and analysis has been specifically designed for the particular requirements of Stockland Development Pty Ltd and may not be applicable beyond this scope. For this reason, any third parties are not authorised to utilise this report without further input and advice from Calibre Professional Services Pty Ltd.

Calibre Professional Services Pty Ltd accepts no liability or responsibility whatsoever for the report in respect to any use of or reliance upon this report by any third party.

The investigation and analysis has relied on information provided by others. Calibre accepts no responsibility for accuracy of material supplied by others. The accuracy of the investigation, analysis and report is dependent upon the accuracy of this information.

Appendix A Site Layout



LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CONTOURS (0.5m)
- CHANNEL TOP OF BATTER
- CHANNEL TOE OF BATTER
- WETLAND
- POND
- BIO-RETENTION BASIN
- INLET POND
- BOX CULVERTS
- INLET POND BATTER
- BIO BATTER
- BRIDGE
- PROPOSAL BROADWALK CROSSING

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT 18-000340_FIR.01C DATED JUNE 2020.
2. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPT ONLY AND TO BE CONFIRMED FOR SUBSEQUENT DETAILED DESIGN.
3. FISH CULVERT TO INCLUDE 300mm EMBEDMENT. REFER SECTION 4.3.47 OF REPORT 10-000340_FIR.01.C FOR ADDITIONAL DETAIL ON BAFFLE REQUIREMENTS AND CULVERT ASSUMPTIONS.

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	23.11.18	ORGINAL ISSUE	DMP	MP
B	30.07.19	LAYOUT UPDATE	MC	RH
C	12.06.20	RFI RESPONSE	JC	DY
D				
E				
F				
G				
H				

DRAWN

DESIGN

STATUS
PRELIMINARY
NOT FOR CONSTRUCTION

SCALE
1:2000 20 0 20 40 60 80 100 A1
1:4000 A3

CLIENT
STOCKLAND DEVELOPMENT PTY LTD

calibre
calibregroup.com
C

PROJECT
AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

DRAWING TITLE
AURA BROOK LAYOUT

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3100	C

Appendix B Calculations

Rational Method Peak Flow Estimation

File:
Date: 08/08/2019
Job: 18-000340
Locality: AURA
IFD Ref: IFD_AURA
IFD Source: *From Bureau of Meterology (on 3/10/2018)*

Catchment	B4

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/Hortons)	Sub Total (mins)	tc (min)
Table 4.6.2 QUDM (2017)	QUDM Standard Inlet Times	19.95		1.0							5	**15**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friends Equation		0	1.0						0.045	0	
4.6.8 QUDM (2017)	Kerb and Channel Flow		0	1.0							0	
4.6.3 (a) QUDM (2017)	Assumed Channel Velocity		0			1.5					0	
4.6.9 QUDM (2017)	Pipe Flow Time		0	1.0	750		0.4	2.4	0.188	0.013	0	**0**
											Adopted tc	**15**

C10 VALUE

Enter Fraction Impervious	Development Category	f_i	$1I_{10}$ (mm/hr)	C10
		0.79	71	0.86
			Adopted C10	**0.86**

Flow Calculations (QUDM 4.03.1)

		tc (min)	15	
ARI	**Cy**	**$^{tc}I_y$**	**A (ha)**	**Q (m^3/s)**
1	0.69	82	19.950	3.131
2	0.73	104	19.950	4.226
5	0.82	129	19.950	5.827
10	0.86	143	19.950	6.801
20	0.90	162	19.950	8.111
50	0.99	188	19.950	10.270
100	1.00	207	19.950	11.466

Rational Method Peak Flow Estimation

File:
Date: 08/08/2019
Job: 18-000340
Locality: AURA
IFD Ref: IFD_AURA
IFD Source: *From Bureau of Meterology (on 3/10/2018)*

Catchment	B5

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/Hortons)	Sub Total (mins)	tc (min)
Table 4.6.2 QUDM (2017)	QUDM Standard Inlet Times	11.30		1.0							13	**13**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friends Equation		0	1.0						0.045	0	
4.6.8 QUDM (2017)	Kerb and Channel Flow		0	1.0							0	
4.6.3 (a) QUDM (2017)	Assumed Channel Velocity		0			1.5					0	
4.6.9 QUDM (2017)	Pipe Flow Time		0	2.5	750		0.4	2.4	0.188	0.013	0	**0**
											Adopted tc	**13**

C10 VALUE

Enter Fraction Impervious	Development Category	f_i	$1I_{10}$ (mm/hr)	C10
		0.80	71	0.86
			Adopted C10	**0.86**

Flow Calculations (QUDM 4.03.1)

		tc (min)	13
ARI	Cy	$^{tc}I_y$	A (ha)	Q (m^3/s)
1	0.69	89	11.298	1.911
2	0.73	112	11.298	2.579
5	0.82	139	11.298	3.554
10	0.86	154	11.298	4.148
20	0.90	175	11.298	4.946
50	0.99	202	11.298	6.261
100	1.00	222	11.298	6.980

Rational Method Peak Flow Estimation

File:
Date: 08/08/2019
Job: 18-000340
Locality: AURA
IFD Ref: IFD_AURA
IFD Source: *From Bureau of Meterology (on 3/10/2018)*

Catchment	B7

Time of Concentration Calculations

Reference	Equation Type / Method	Area (ha)	Length (m)	Av. Slope (%)	Pipe Diameter (mm)	Velocity (m/s)	Wetted Area (m^2)	Wetted Perimeter (m)	Hydraulic Radius R	Roughness (Mannings/Hortons)	Sub Total (mins)	tc (min)
Table 4.6.2 QUDM (2017)	QUDM Standard Inlet Times	10.25		1.0							12	**12**
4.6.6 QUDM (2017)	Overland Sheet Flow - Friends Equation		0	1.0						0.045	0	
4.6.8 QUDM (2017)	Kerb and Channel Flow		0	1.0							0	
4.6.3 (a) QUDM (2017)	Assumed Channel Velocity		0			1.5					0	
4.6.9 QUDM (2017)	Pipe Flow Time		0	2.5	750		0.4	2.4	0.188	0.013	0	**0**
											Adopted tc	**12**

C10 VALUE

Enter Fraction Impervious	Development Category	f_i	$1I_{10}$ (mm/hr)	C10
		0.82	71	0.86
			Adopted C10	**0.86**

Flow Calculations (QUDM 4.03.1)

		tc (min)	12	
ARI	**Cy**	**$^{tc}I_y$**	**A (ha)**	**Q (m^3/s)**
1	0.69	92	10.253	1.803
2	0.73	116	10.253	2.434
5	0.82	144	10.253	3.353
10	0.86	159	10.253	3.913
20	0.91	181	10.253	4.666
50	0.99	209	10.253	5.905
100	1.00	230	10.253	6.556

Appendix C TUFLOW Model Configurations

TUFLOW Model Configuration - 1D Elements and Layered Flow Constrictions

File:	\\bnenas01\Projects\18\000340 - AURA Sustainability\9_Technical\Calculations\SF\[Run008_ModelSetUp.xlsx]Sheet1
Date:	10/06/2020
Job:	18-000340
By:	DY

Culvert Details

ID	Type	Ignore	UCS	Length	Manning's n	US Invert	DS Invert	Blockage	Width	Height	Number	Height Con	Width Cont	Entry Loss	Exit Loss
Culv3_FP_LB	R	F	T	-1	0.028	3.26	3.20	10	2.25	1.8	1	0.6	0.9	0.5	1
Culv3_FP	R	F	T	-1	0.014	3.26	3.20	10	2.4	1.8	3	0.6	0.9	0.5	1
Culv3_FP_RB	R	F	T	-1	0.028	3.26	3.20	10	2.25	1.8	1	0.6	0.9	0.5	1
Culv3_PED	R	F	T	-1	0.014	5.39	5.33	10	3.6	2.7	1	0.6	0.9	0.5	1
Culv4_FP_LB	R	F	T	-1	0.028	2.95	2.90	10	3.45	1.8	1	0.6	0.9	0.5	1
Culv4_FP	R	F	T	-1	0.014	2.95	2.90	10	3.6	1.8	2	0.6	0.9	0.5	1
Culv4_FP_RB	R	F	T	-1	0.028	2.95	2.90	10	3.45	1.8	1	0.6	0.9	0.5	1
Culv4_PED	R	F	T	-1	0.014	5.18	5.13	10	6	2.7	1	0.6	0.9	0.5	1

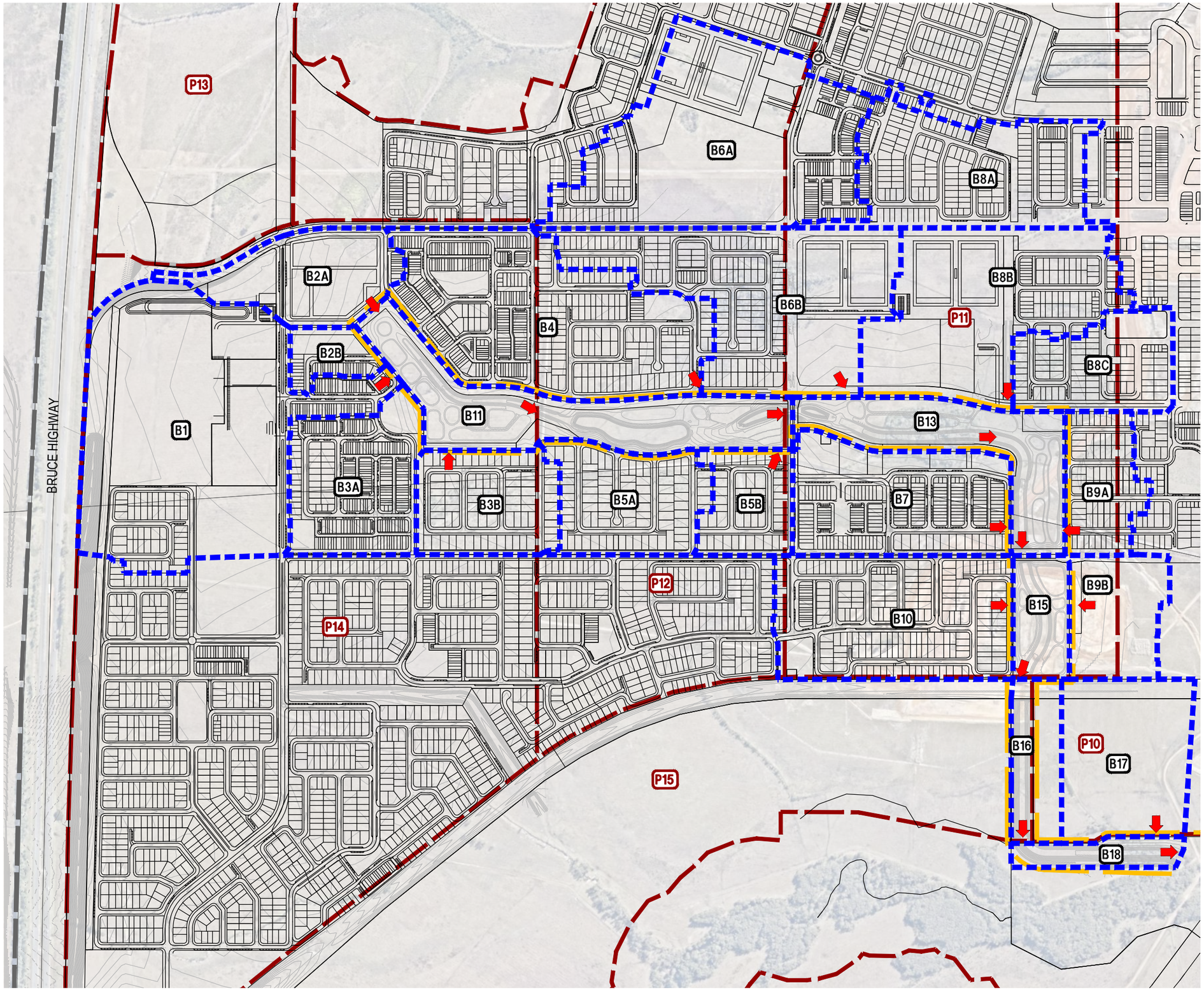
1D/2D Connections

ID	Type	Flag	Storage Factor
Culv3 (All)	SX	Z	3
Culv4 (All)	SX	Z	3

Layered Flow Constrictions

Structure	Width	Layer 1 Obvert	Layer 1 Blockage	Layer 1 LFC	Layer 2 Depth	Layer 2 Blockage	Layer 2 LFC	Layer 3 Depth	Layer 3 Blockage	Layer 3 LFC
Boardwalk 1	4m	12.60	10%	0.3	0.5	100%	0.8	1.2	50%	0.5
Boardwalk 2	4m	10.55	10%	0.3	0.5	100%	0.8	1.2	50%	0.5
Boardwalk 3	4m	9.20	10%	0.3	0.5	100%	0.8	1.2	50%	0.5
Boardwalk 4	4m	5.50	10%	0.3	0.5	100%	0.8	1.2	50%	0.5
Boardwalk 5	4m	5.25	10%	0.3	0.5	100%	0.8	1.2	50%	0.5
Bridge 1	10m	8.75	0%	-	1.0	100%	0.8	1.2	50%	0.5

Appendix D Concept Drawings



N

CATCHMENT DATA TABLE

CATCHMENT NAME	AREA (ha)	% IMPERVIOUS
B1	24.46	31
B2A	6.20	80
B2B	1.86	74
B3A	7.88	80
B3B	6.17	77
B4	17.07	79
B5A	6.61	80
B5B	3.95	80
B6A	19.05	62
B6B	15.62	62
B7	9.91	82
B8A	10.89	77
B8B	14.24	54
B8C	5.93	72
B9A	4.32	80
B9B	4.85	84
B10	12.33	76
B11	10.31	6
B13	7.61	8
B15	2.92	9
B16	3.46	14
B17	8.57	13
B18	1.94	5
TOTAL	206.15	-

LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CONTOURS (0.5m)
- DEVELOPED CATCHMENT BOUNDARY
- PRECINCT BOUNDARY
- A — DEVELOPED CATCHMENT LABEL
- A — PRECINCT LABEL
- DISCHARGE DIRECTIONS

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT 18-000340_FIR.01C DATED JUNE 2020.
2. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPT ONLY AND TO BE CONFIRMED FOR SUBSEQUENT DETAILED DESIGN.

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	23.11.18	ORGINAL ISSUE	DMP	MP
B	30.07.19	LAYOUT UPDATE	MC	RH
C	12.06.20	RFI RESPONSE	JC	DY
D				
E				
F				
G				
H				

DRAWN

DESIGN

STATUS
PRELIMINARY
NOT FOR CONSTRUCTION

SCALE
1:4000 40 0 40 80 120 160 200 A1
1:8000 A3

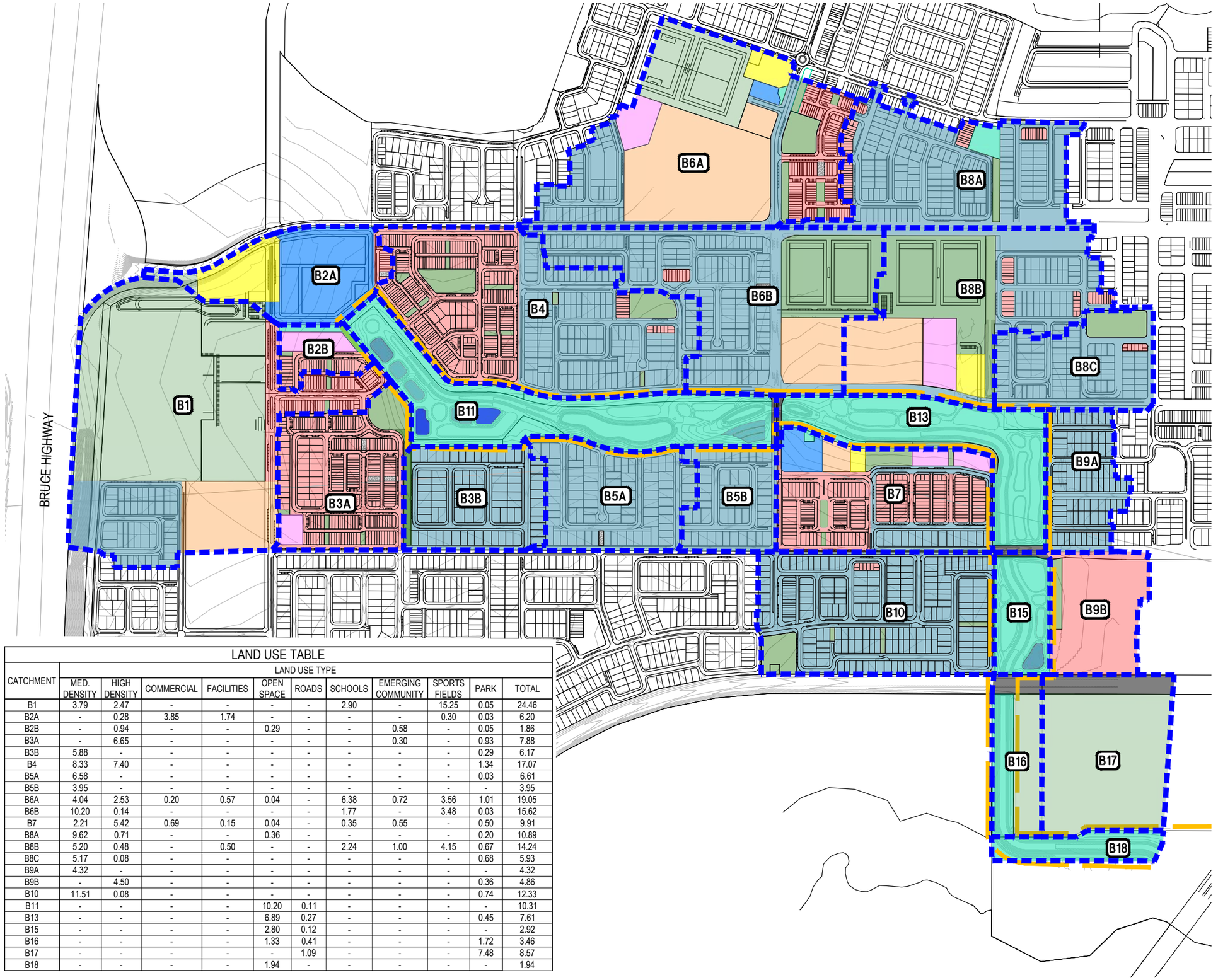
CLIENT
STOCKLAND DEVELOPMENT PTY LTD

PROJECT
AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

DRAWING TITLE
CATCHMENT PLAN

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3101	C



LAND USE TABLE

CATCHMENT	LAND USE TYPE										
	MED. DENSITY	HIGH DENSITY	COMMERCIAL	FACILITIES	OPEN SPACE	ROADS	SCHOOLS	EMERGING COMMUNITY	SPORTS FIELDS	PARK	TOTAL
B1	3.79	2.47	-	-	-	-	2.90	-	15.25	0.05	24.46
B2A	-	0.28	3.85	1.74	-	-	-	-	0.30	0.03	6.20
B2B	-	0.94	-	-	0.29	-	-	0.58	-	0.05	1.86
B3A	-	6.65	-	-	-	-	-	0.30	-	0.93	7.88
B3B	5.88	-	-	-	-	-	-	-	-	0.29	6.17
B4	8.33	7.40	-	-	-	-	-	-	-	1.34	17.07
B5A	6.58	-	-	-	-	-	-	-	-	0.03	6.61
B5B	3.95	-	-	-	-	-	-	-	-	-	3.95
B6A	4.04	2.53	0.20	0.57	0.04	-	6.38	0.72	3.56	1.01	19.05
B6B	10.20	0.14	-	-	-	-	1.77	-	3.48	0.03	15.62
B7	2.21	5.42	0.69	0.15	0.04	-	0.35	0.55	-	0.50	9.91
B8A	9.62	0.71	-	-	0.36	-	-	-	-	0.20	10.89
B8B	5.20	0.48	-	0.50	-	-	2.24	1.00	4.15	0.67	14.24
B8C	5.17	0.08	-	-	-	-	-	-	-	0.68	5.93
B9A	4.32	-	-	-	-	-	-	-	-	-	4.32
B9B	-	4.50	-	-	-	-	-	-	-	0.36	4.86
B10	11.51	0.08	-	-	-	-	-	-	-	0.74	12.33
B11	-	-	-	-	10.20	0.11	-	-	-	-	10.31
B13	-	-	-	-	6.89	0.27	-	-	-	0.45	7.61
B15	-	-	-	-	2.80	0.12	-	-	-	-	2.92
B16	-	-	-	-	1.33	0.41	-	-	-	1.72	3.46
B17	-	-	-	-	-	1.09	-	-	-	7.48	8.57
B18	-	-	-	-	1.94	-	-	-	-	-	1.94

LEGEND:

- BROOK BOUNDARY
- LOT BOUNDARY
- CADASTRE
- DEVELOPED CATCHMENT BOUNDARY
- COMMERCIAL
- HIGH DENSITY
- MEDIUM DENSITY
- COMMUNITY FACILITIES
- OPEN SPACE
- EMERGING COMMUNITIES
- ROAD
- SCHOOL
- SPORTS FIELD
- PARK
- A — CATCHMENT LABEL

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH CALIBRE REPORT 18-000340_FIR.01C DATED JUNE 2020.
2. ALL INFORMATION PRESENTED ON THIS DRAWING IS CONCEPT ONLY AND TO BE CONFIRMED FOR SUBSEQUENT DETAILED DESIGN.

REVISION	DATE	ISSUE DETAILS	DRAWN	DESIGN
A	23.11.18	ORGINAL ISSUE	DMP	MP
B	29.05.20	LAYOUT UPDATE	MC	RH
C	12.06.20	RFI RESPONSE	JC	DY
D				
E				
F				
G				
H				

DRAWN

DESIGN

STATUS: **PRELIMINARY** NOT FOR CONSTRUCTION

SCALE: 1:4000 / 1:8000 — 40 0 40 80 120 160 200 — A1 / A3

CLIENT: **STOCKLAND DEVELOPMENT PTY LTD**

calibre

calibregroup.com

PROJECT: **AURA BROOK - NORTH CENTRAL LOCALITY PRECINCTS 11 & 12**

DISCLAIMER
ALL DIMENSIONS TO BE CHECKED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION. USE WRITTEN DIMENSIONS ONLY, DO NOT SCALE.

DRAWING TITLE: **WATER BODIES LAYOUT**

PROJECT No.	DRAWING No.	REVISION
18-000340	SK3102	C

Appendix E Flood Plans – Design Events

BRUCE HIGHWAY

BELLS CREEK (NORTH)

BELLS CREEK (SOUTH)

1
11.06

2
6.62

3
6.62

4
6.12

5
5.87

6
5.29

7
4.93

8
4.75

9
4.51

10
4.45

11
4.33

12
4.15

13
4.04

PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600x2700 RCBC
U/S IL = 5.39 mAHD
D/S IL = 5.33 mAHD
Length = 30 m

PEDESTRIAN CULVERT 4:
CAMCOS CORRIDOR
1/6000x2700 RCBC
U/S IL = 5.18 mAHD
D/S IL = 5.13 mAHD
Length = 40 m

CULVERT STRUCTURE 3:
5/2400x2100 RCBC
U/S IL = 2.96 mAHD
D/S IL = 2.90 mAHD
Length = 31 m
(REFER NOTE 3)

CULVERT STRUCTURE 4:
CAMCOS CORRIDOR
4/3600x2100 RCBC
U/S IL = 2.65 mAHD
D/S IL = 2.60 Mahd
Length = 40 m
(REFER NOTE 3)

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5

- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m
1:7,000 (A3)

N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-D-002-A**
ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
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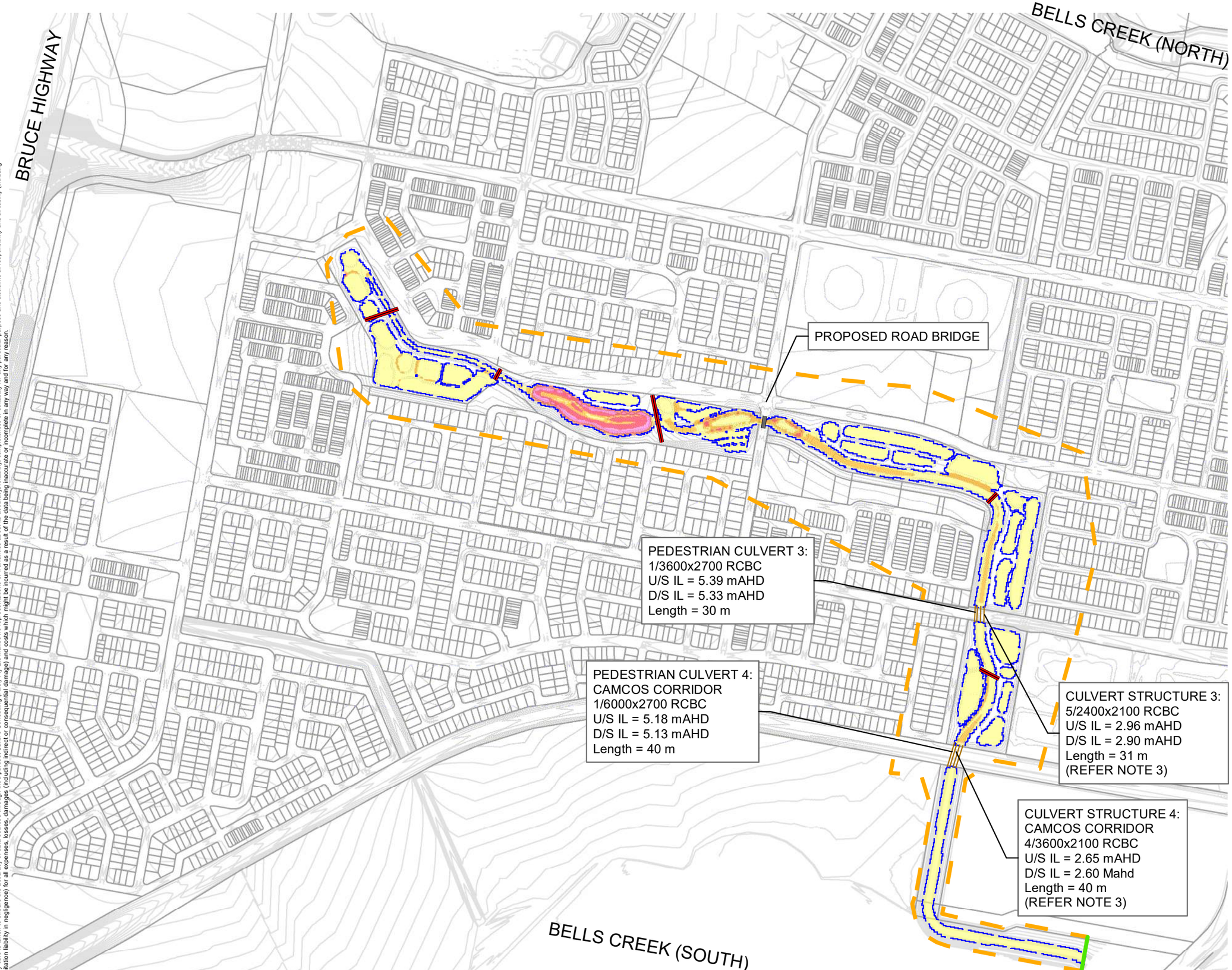
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m
1:7,000 (A3)

N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO
39% AEP STORM EVENT
MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-D-002-B**
ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
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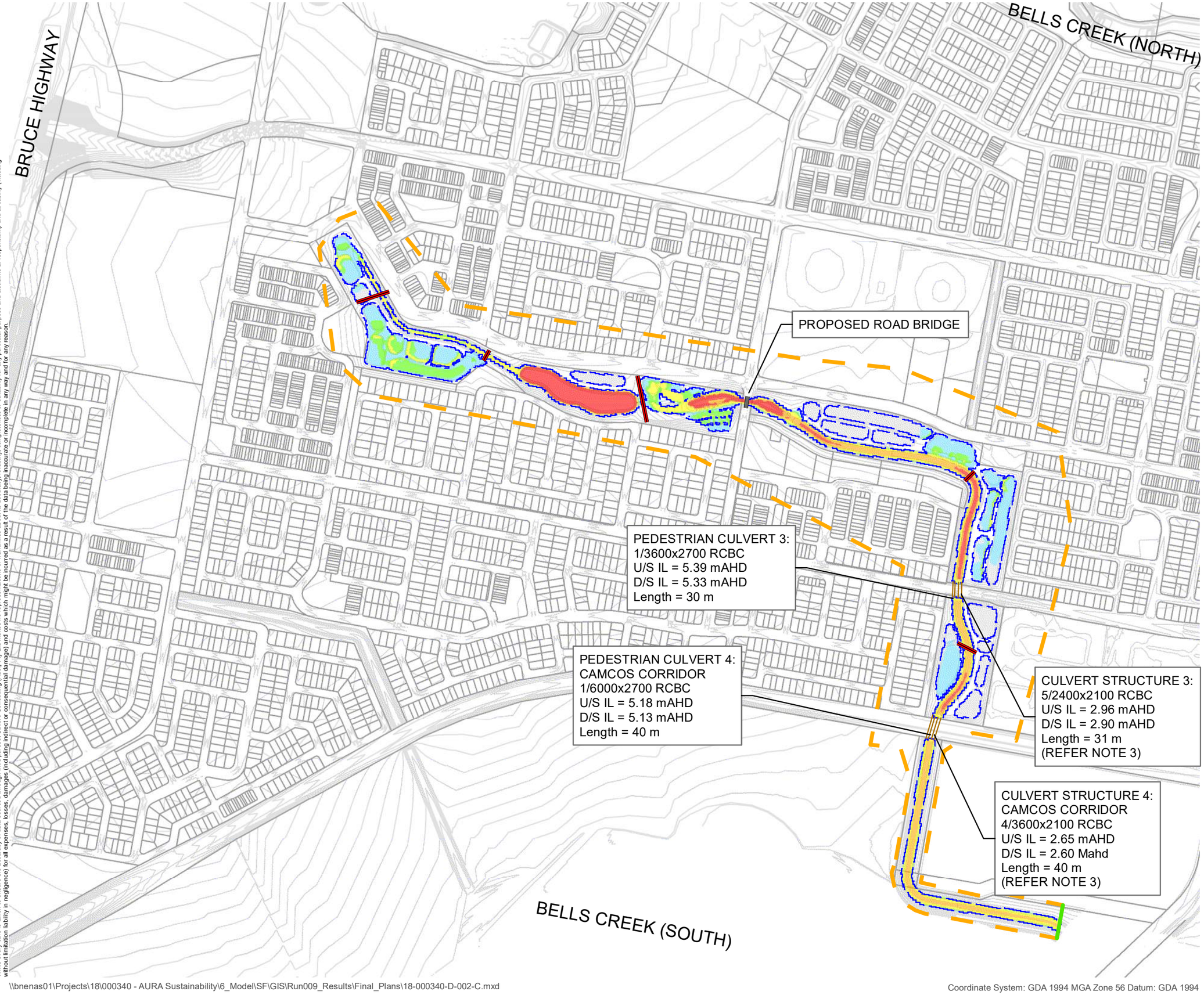
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1. RESULTS PRESENT THE MAXIMUM OF ALL MODELLED 1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

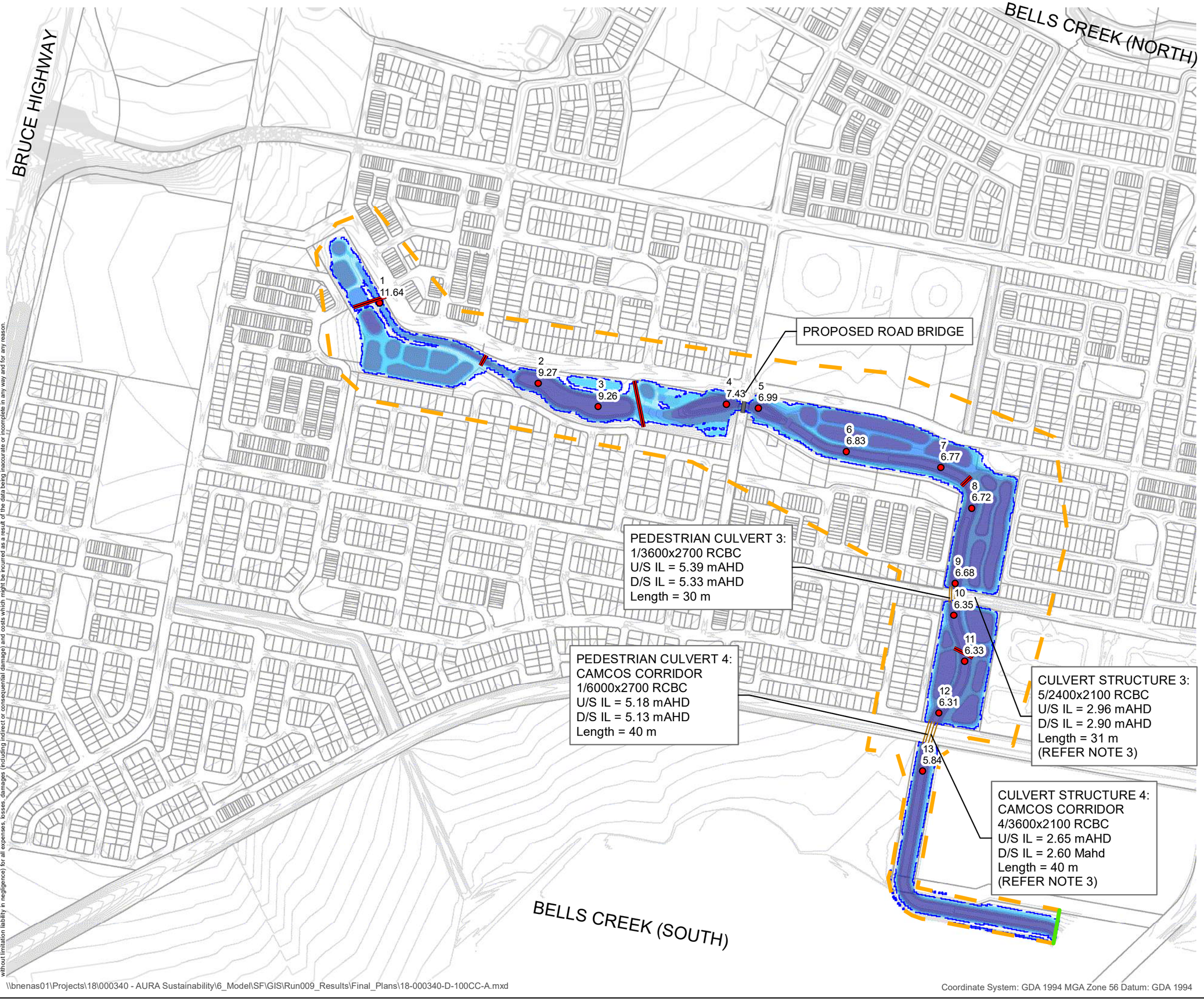
ULTIMATE DEVELOPMENT SCENARIO

39% AEP STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-D-002-C** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

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LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

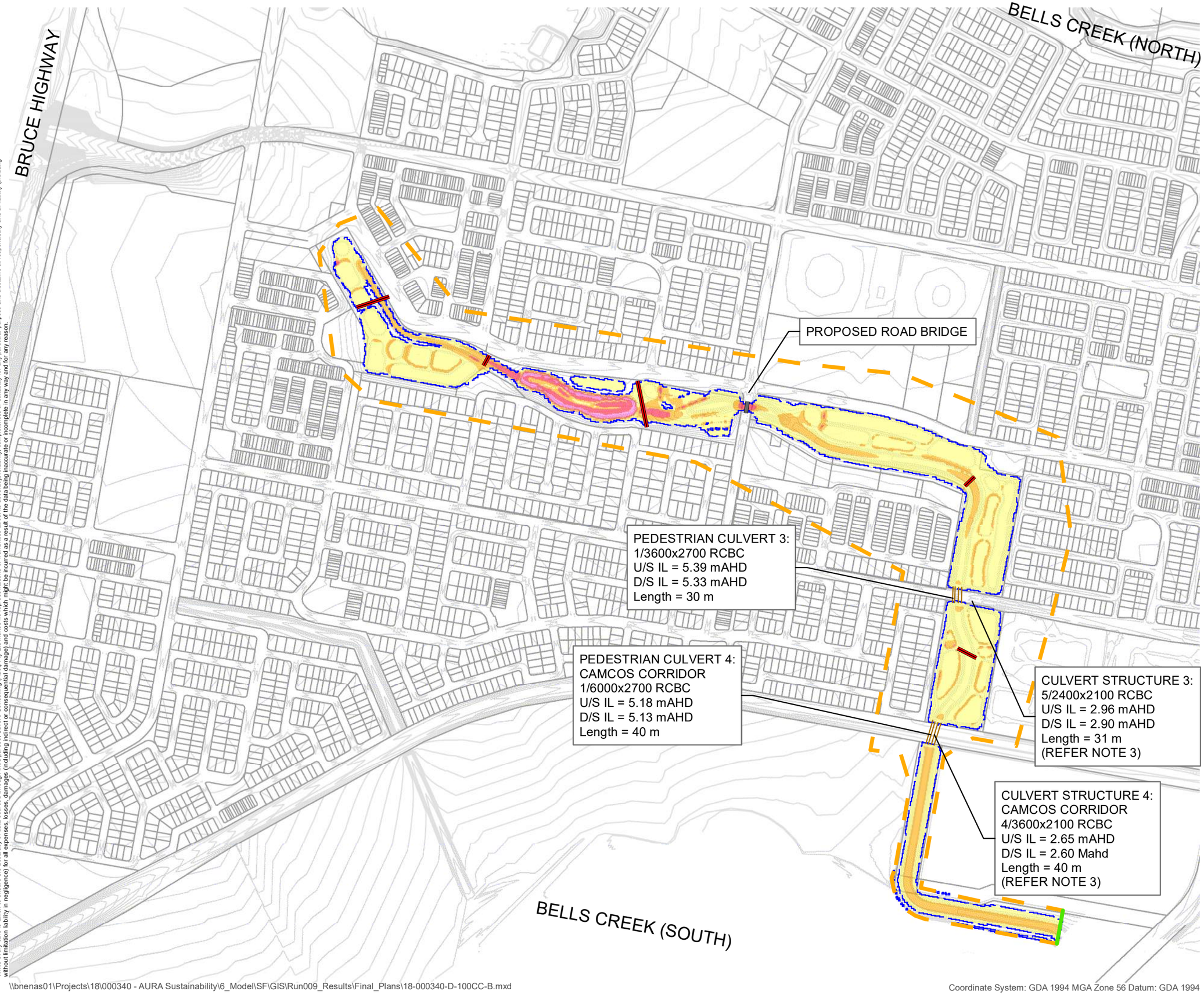
STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT SCENARIO
1% AEP YEAR 2100 CLIMATE STORM EVENT MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-D-100CC-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
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0 70 140 280 m
1:7,000 (A3)
N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO
1% AEP YEAR 2100 CLIMATE STORM EVENT MAXIMUM FLOOD VELOCITY

DRAWING NO: **18-000340-D-100CC-B** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
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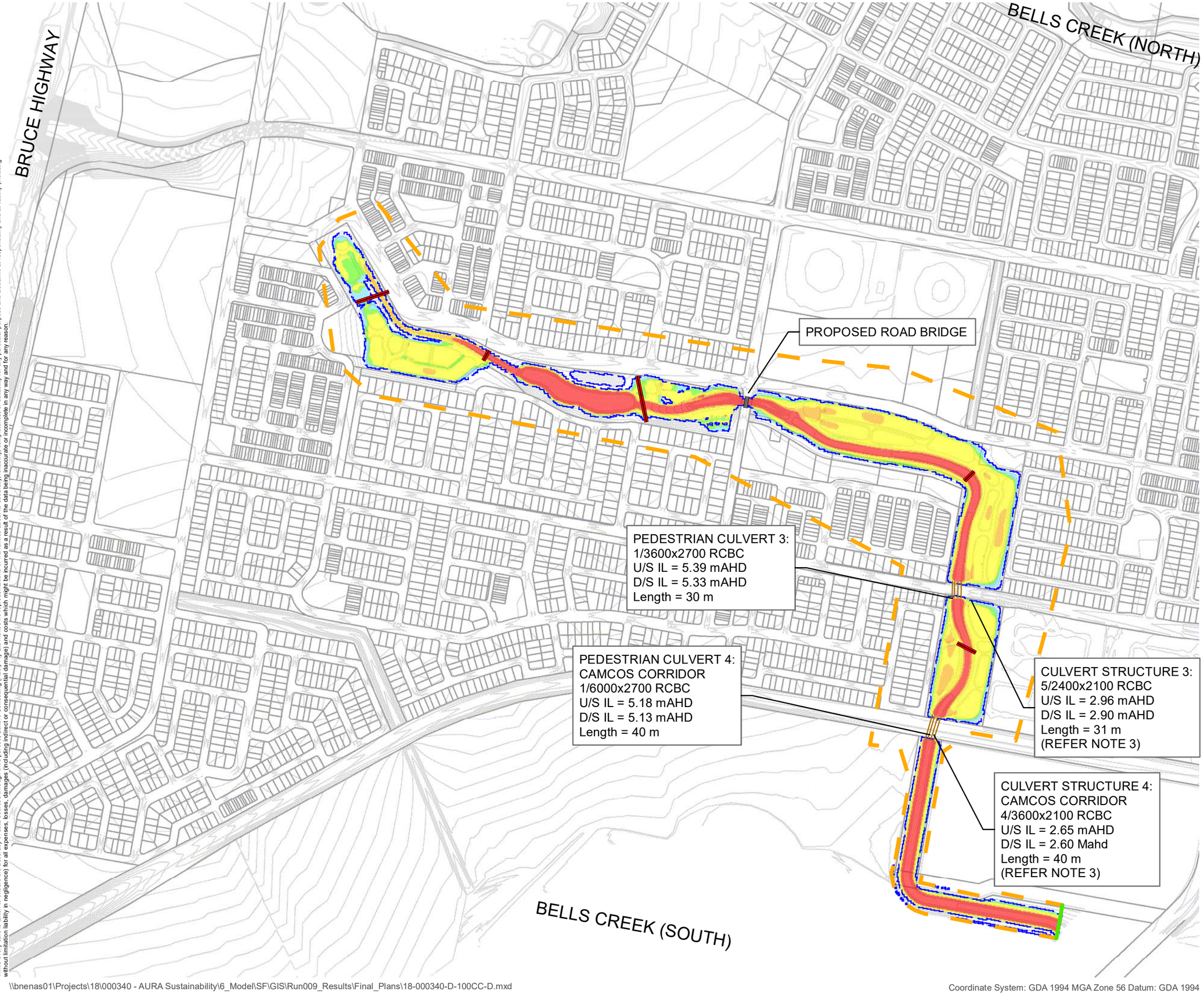
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
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0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT SCENARIO

1% AEP YEAR 2100 CLIMATE STORM EVENT MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-D-100CC-D** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE

Appendix F Flood Plans – Sensitivity Events

BRUCE HIGHWAY

BELLS CREEK (NORTH)

BELLS CREEK (SOUTH)

1
11.17

2
8.53

3
8.53

4
6.23

5
5.97

6
5.77

7
5.77

8
5.77

9
5.77

10
5.16

11
5.16

12
5.16

13
3.46

PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600x2700 RCBC
U/S IL = 5.39 mAHD
D/S IL = 5.33 mAHD
Length = 30 m

PEDESTRIAN CULVERT 4:
CAMCOS CORRIDOR
1/6000x2700 RCBC
U/S IL = 5.18 mAHD
D/S IL = 5.13 mAHD
Length = 40 m

CULVERT STRUCTURE 3:
5/2400x2100 RCBC
U/S IL = 2.96 mAHD
D/S IL = 2.90 mAHD
Length = 31 m
(REFER NOTE 3)

CULVERT STRUCTURE 4:
CAMCOS CORRIDOR
4/3600x2100 RCBC
U/S IL = 2.65 mAHD
D/S IL = 2.60 Mahd
Length = 40 m
(REFER NOTE 3)

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. MAJOR BLOCKAGE SCENARIO CONSIDERS 100% BLOCKAGE OF CULVERT STRUCTURE GROUP 3 AND 95% BLOCKAGE OF CULVERT STRUCTURE GROUP 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

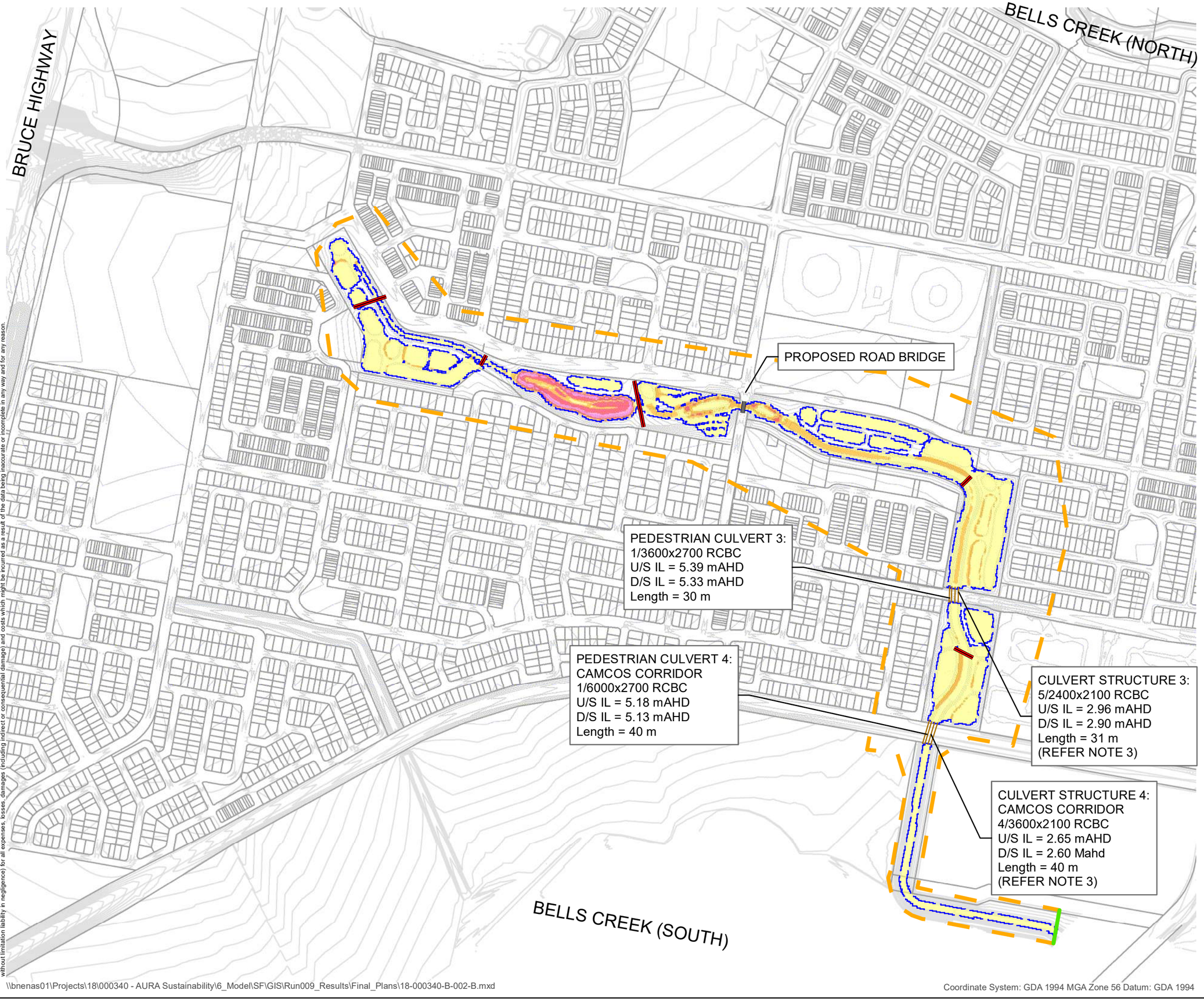
STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT MAJOR BLOCKAGE SCENARIO 39% AEP STORM EVENT MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-B-002-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4

- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. MAJOR BLOCKAGE SCENARIO CONSIDERS 100% BLOCKAGE OF CULVERT STRUCTURE GROUP 3 AND 95% BLOCKAGE OF CULVERT STRUCTURE GROUP 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

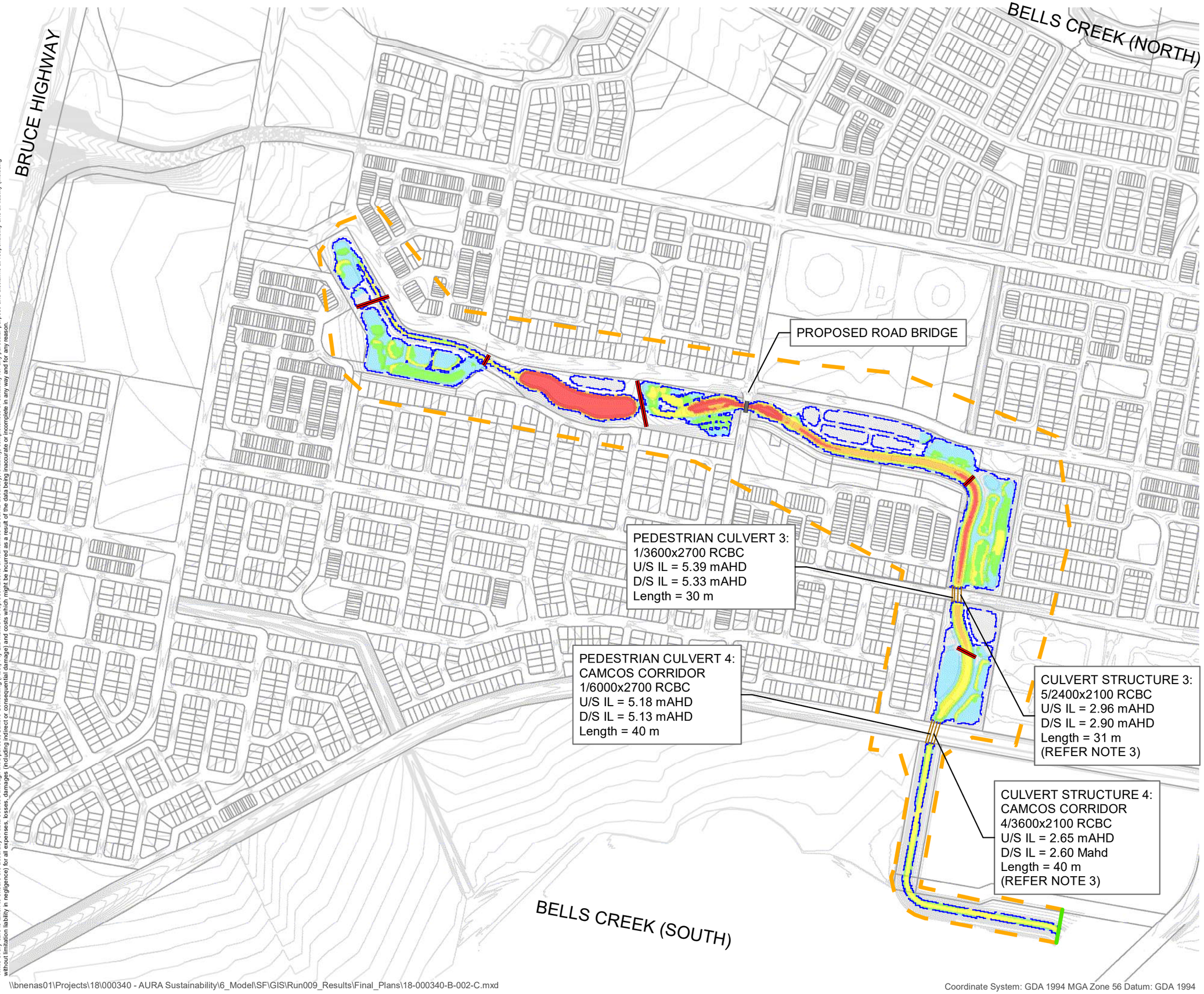
DRAWING TITLE:

ULTIMATE DEVELOPMENT MAJOR BLOCKAGE SCENARIO 39% AEP STORM EVENT MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-B-002-B**

ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. MAJOR BLOCKAGE SCENARIO CONSIDERS 100% BLOCKAGE OF CULVERT STRUCTURE GROUP 3 AND 95% BLOCKAGE OF CULVERT STRUCTURE GROUP 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT MAJOR BLOCKAGE SCENARIO 39% AEP STORM EVENT MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-B-002-C**

ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE

BRUCE HIGHWAY

BELLS CREEK (NORTH)

BELLS CREEK (SOUTH)

1
11.64

2
9.27

3
9.26

4
7.48

5
7.12

6
7.03

7
7

8
6.97

9
6.94

10
6.56

11
6.54

12
6.52

13
5.85

PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600x2700 RCBC
U/S IL = 5.39 mAHD
D/S IL = 5.33 mAHD
Length = 30 m

PEDESTRIAN CULVERT 4:
CAMCOS CORRIDOR
1/6000x2700 RCBC
U/S IL = 5.18 mAHD
D/S IL = 5.13 mAHD
Length = 40 m

CULVERT STRUCTURE 3:
5/2400x2100 RCBC
U/S IL = 2.96 mAHD
D/S IL = 2.90 mAHD
Length = 31 m
(REFER NOTE 3)

CULVERT STRUCTURE 4:
CAMCOS CORRIDOR
4/3600x2100 RCBC
U/S IL = 2.65 mAHD
D/S IL = 2.60 Mahd
Length = 40 m
(REFER NOTE 3)

\\bnenas01\Projects\18\000340 - AURA Sustainability\6_Model\SF\GIS\Run009_Results\Final_Plans\18-000340-B-100CC-A.mxd

Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. 50% BLOCKAGE SCENARIO CONSIDERS 50% BLOCKAGE OF CULVERT STRUCTURE GROUPS 3 AND 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

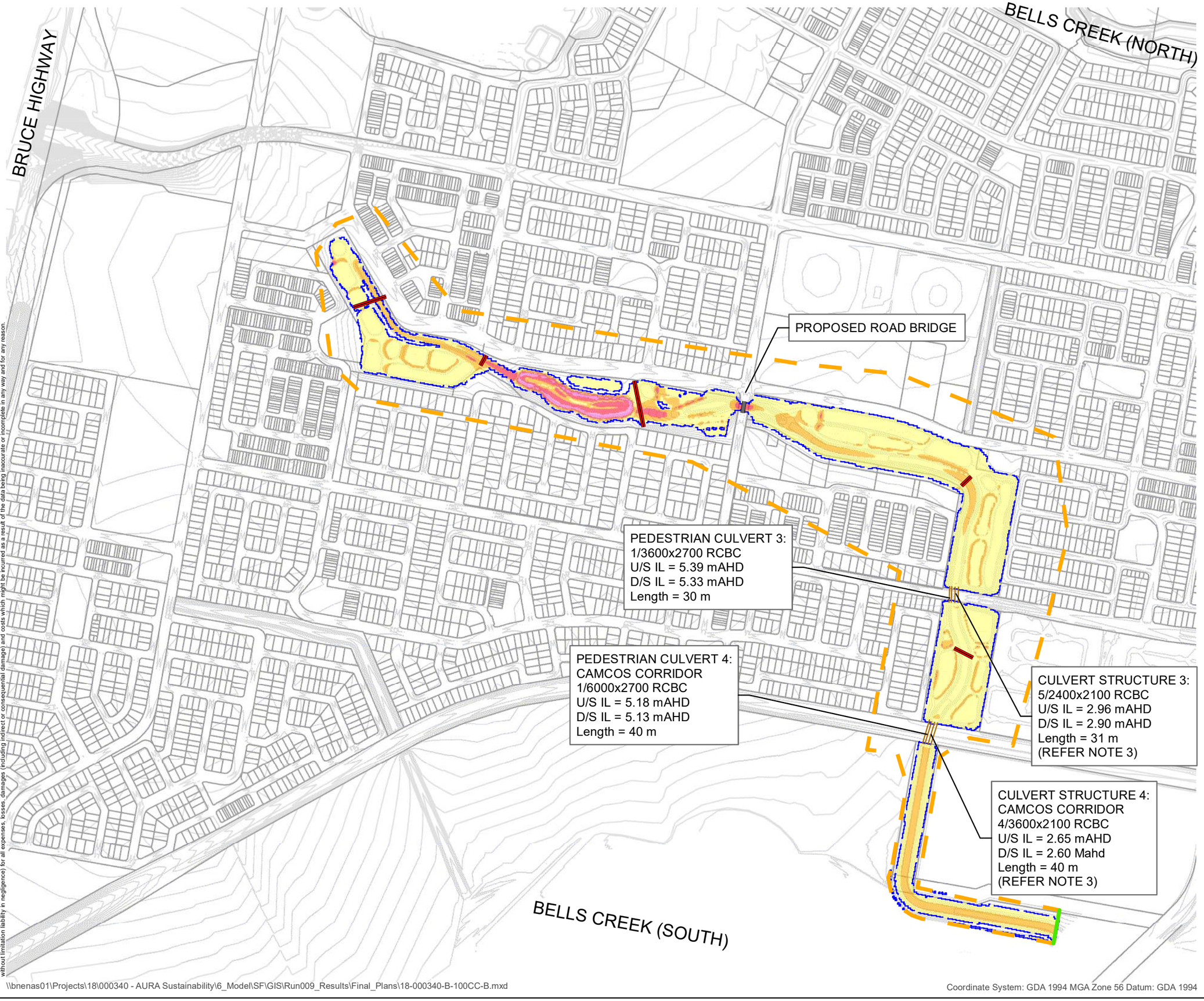
ULTIMATE DEVELOPMENT 50% BLOCKAGE SCENARIO

1% AEP YEAR 2100 CLIMATE STORM EVENT

MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-B-100CC-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. 50% BLOCKAGE SCENARIO CONSIDERS 50% BLOCKAGE OF CULVERT STRUCTURE GROUPS 3 AND 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT 50% BLOCKAGE SCENARIO

1% AEP YEAR 2100 CLIMATE STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-B-100CC-B** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE

BRUCE HIGHWAY

BELLS CREEK (NORTH)

PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600x2700 RCBC
U/S IL = 5.39 mAHD
D/S IL = 5.33 mAHD
Length = 30 m

PEDESTRIAN CULVERT 4:
CAMCOS CORRIDOR
1/6000x2700 RCBC
U/S IL = 5.18 mAHD
D/S IL = 5.13 mAHD
Length = 40 m

CULVERT STRUCTURE 3:
5/2400x2100 RCBC
U/S IL = 2.96 mAHD
D/S IL = 2.90 mAHD
Length = 31 m
(REFER NOTE 3)

CULVERT STRUCTURE 4:
CAMCOS CORRIDOR
4/3600x2100 RCBC
U/S IL = 2.65 mAHD
D/S IL = 2.60 Mahd
Length = 40 m
(REFER NOTE 3)

BELLS CREEK (SOUTH)

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).
4. 50% BLOCKAGE SCENARIO CONSIDERS 50% BLOCKAGE OF CULVERT STRUCTURE GROUPS 3 AND 4 (INCLUDING PEDESTRIAN CULVERTS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

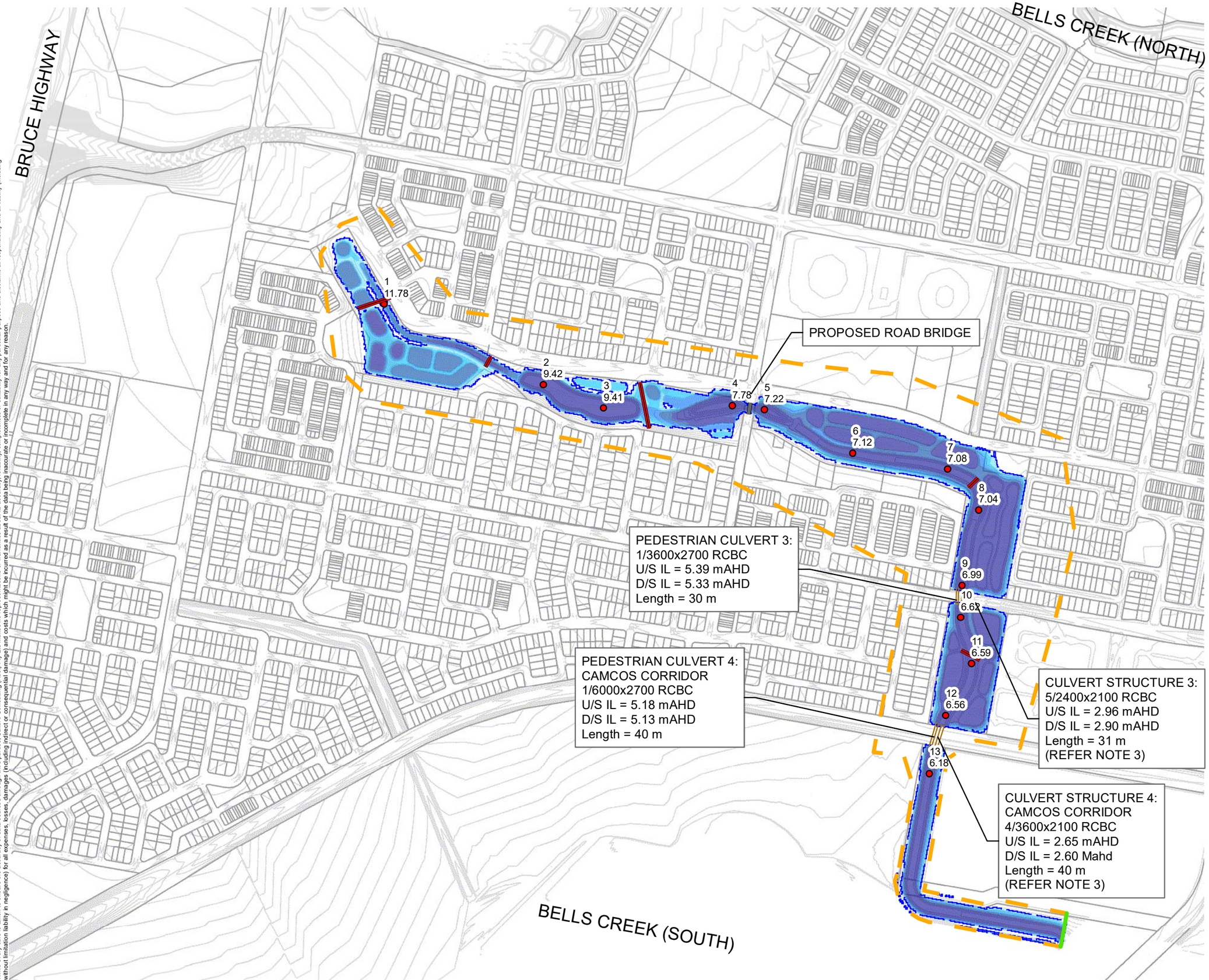
ULTIMATE DEVELOPMENT 50% BLOCKAGE SCENARIO

1% AEP YEAR 2100 CLIMATE STORM EVENT

MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-B-100CC-C** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5

- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

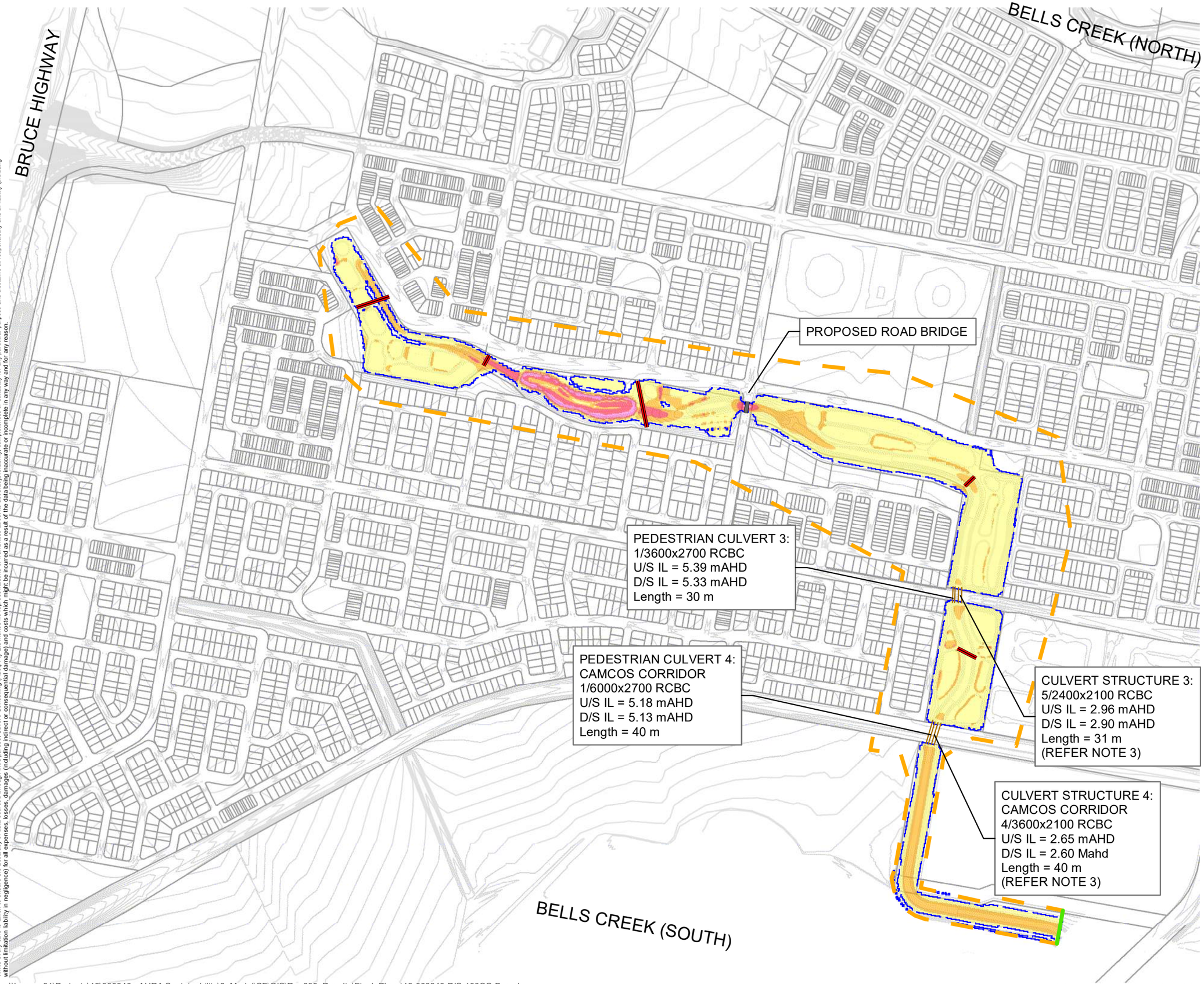
STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT SCENARIO 1% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-DIS-100CC-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m
1:7,000 (A3)
N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO 1% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-DIS-100CC-B**
ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE

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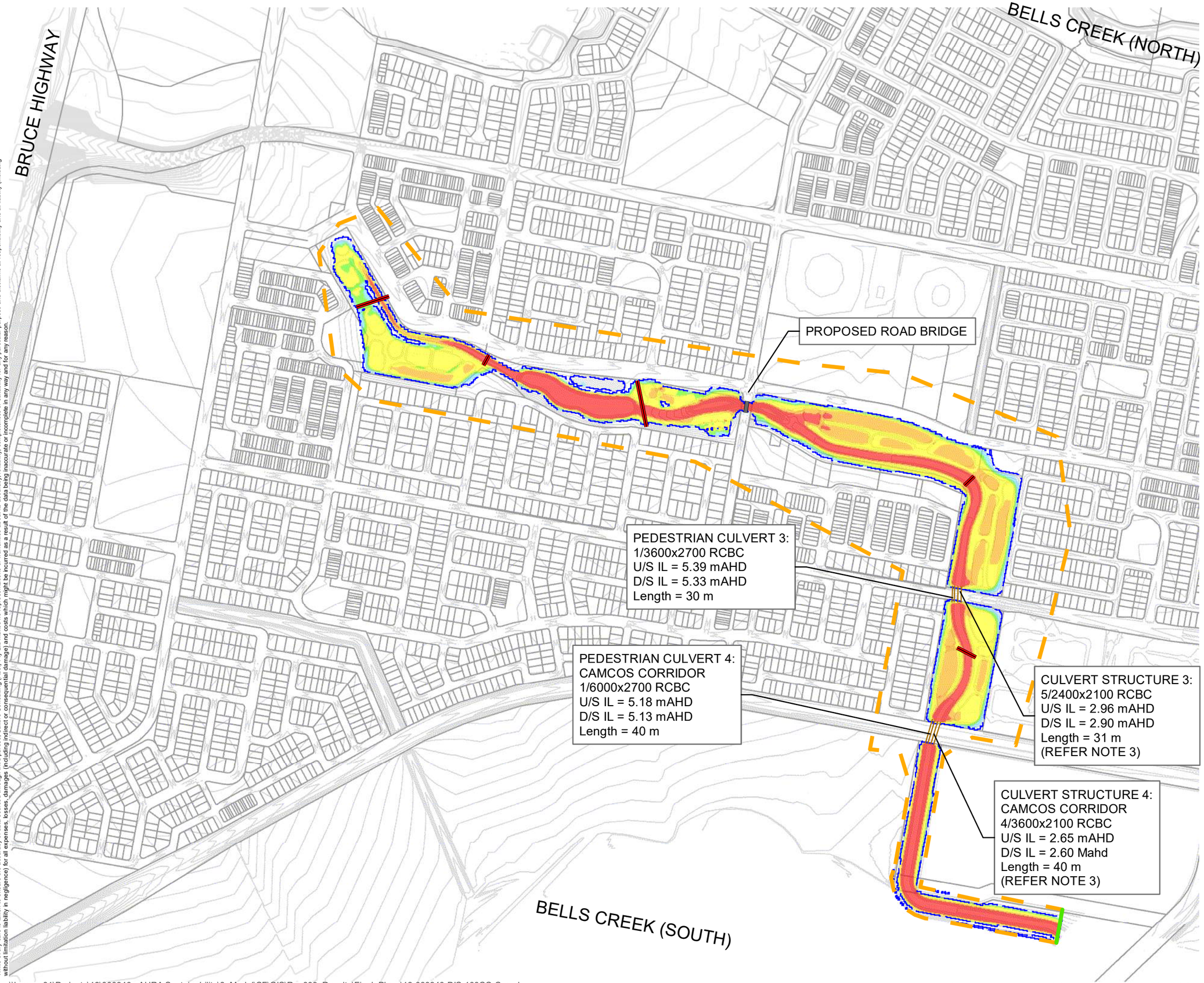
Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m
1:7,000 (A3)
N

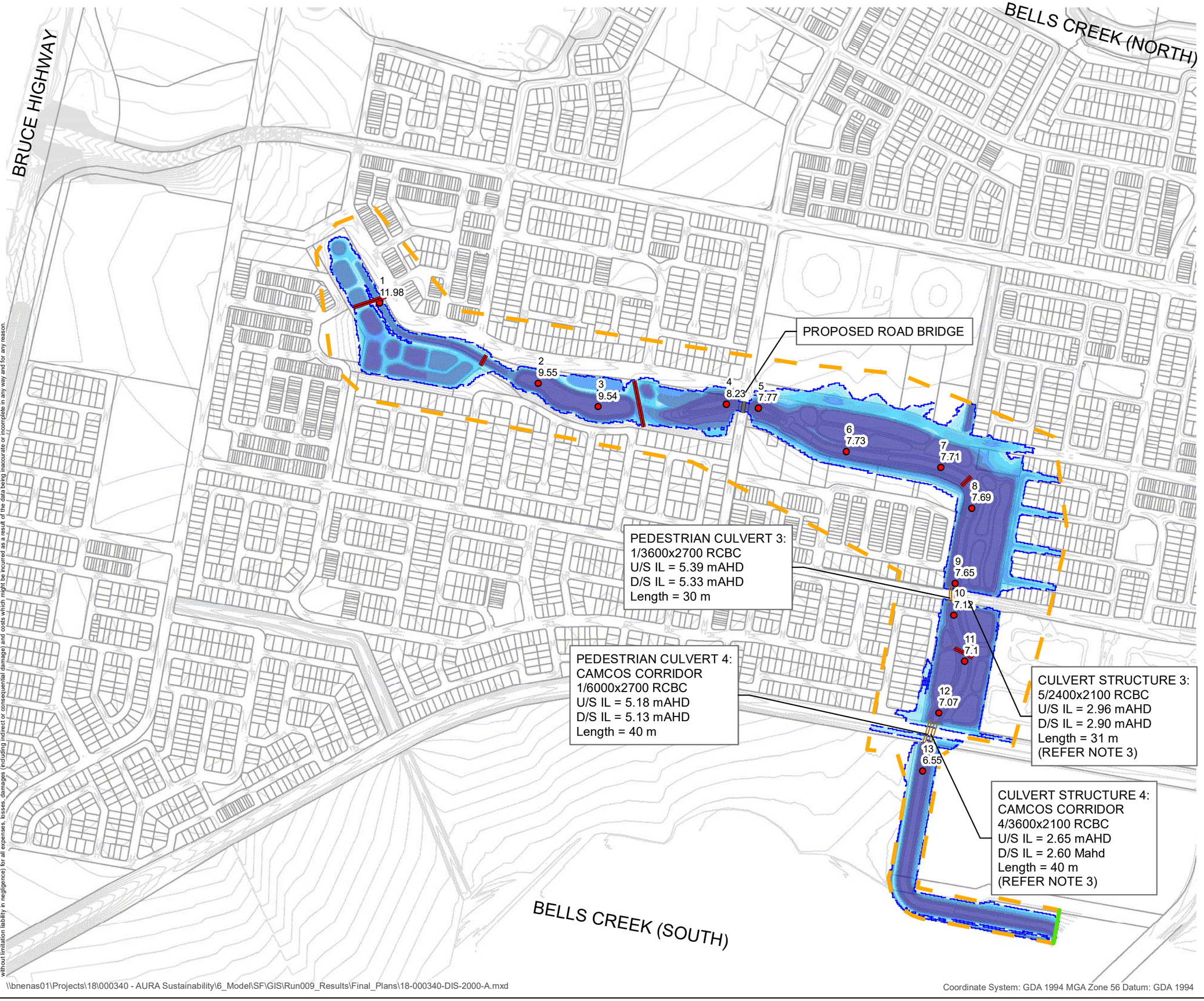
PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO 1% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-DIS-100CC-C** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m

1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

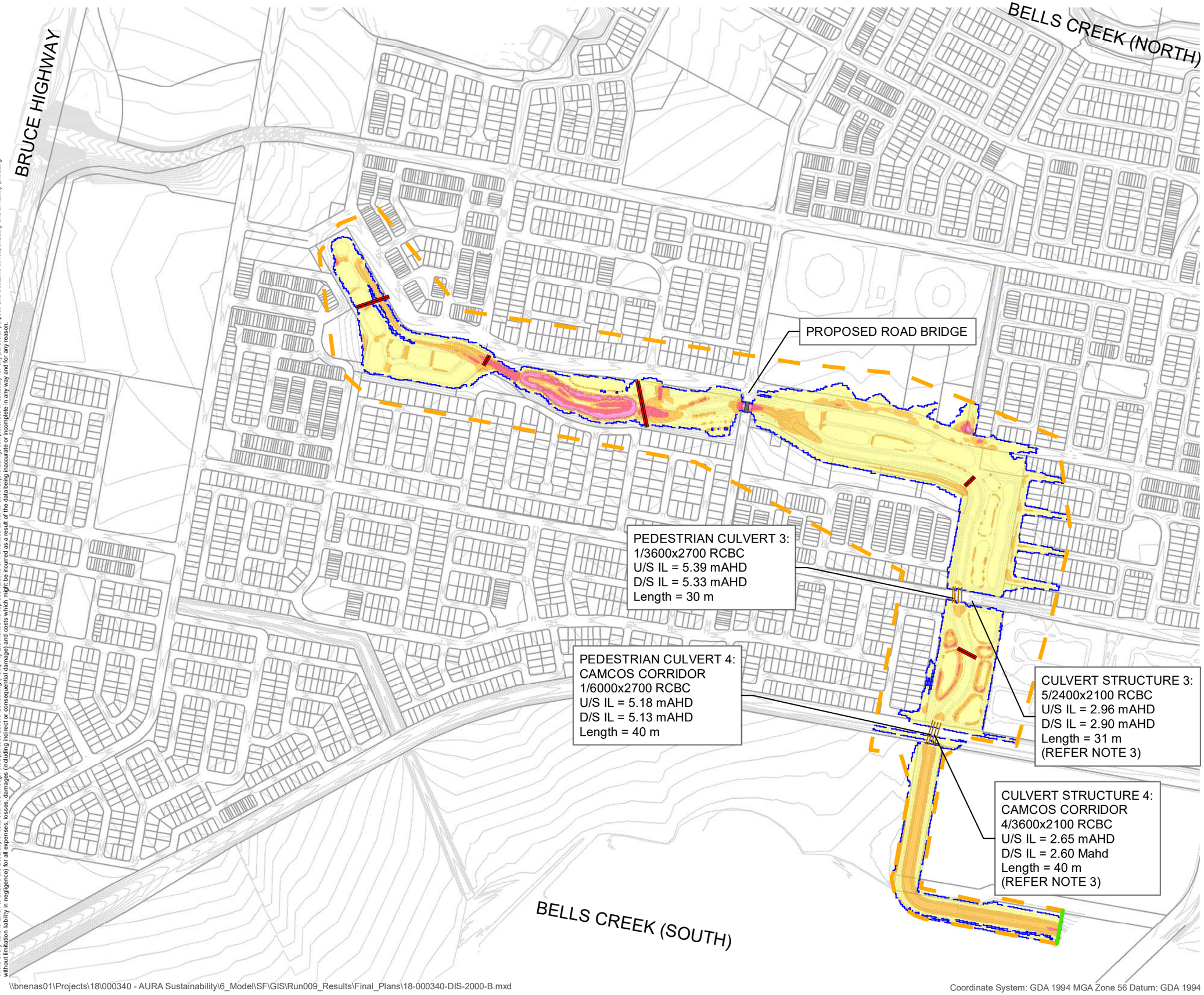
STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT SCENARIO 0.05% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-DIS-2000-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
2. FLOODING RESULTS AND PLAN DETAILS ARE TO BE INTERPRETED IN CONJUNCTION WITH THE 'AURA BROOK: FLOOD INVESTIGATION REPORT' (REF: 18-000340-FIR.01C) DATED JUNE 2020.
3. CULVERT DETAILS DIFFER FROM MODELLED DETAILS DUE TO ALTERED HYDRAULIC CONVEYANCE ASSOCIATED WITH FISH PASSAGE PROVISIONS (I.E. INTERNAL BAFFLES AND BED LEVEL ALTERATIONS).

0 70 140 280 m
1:7,000 (A3)
N

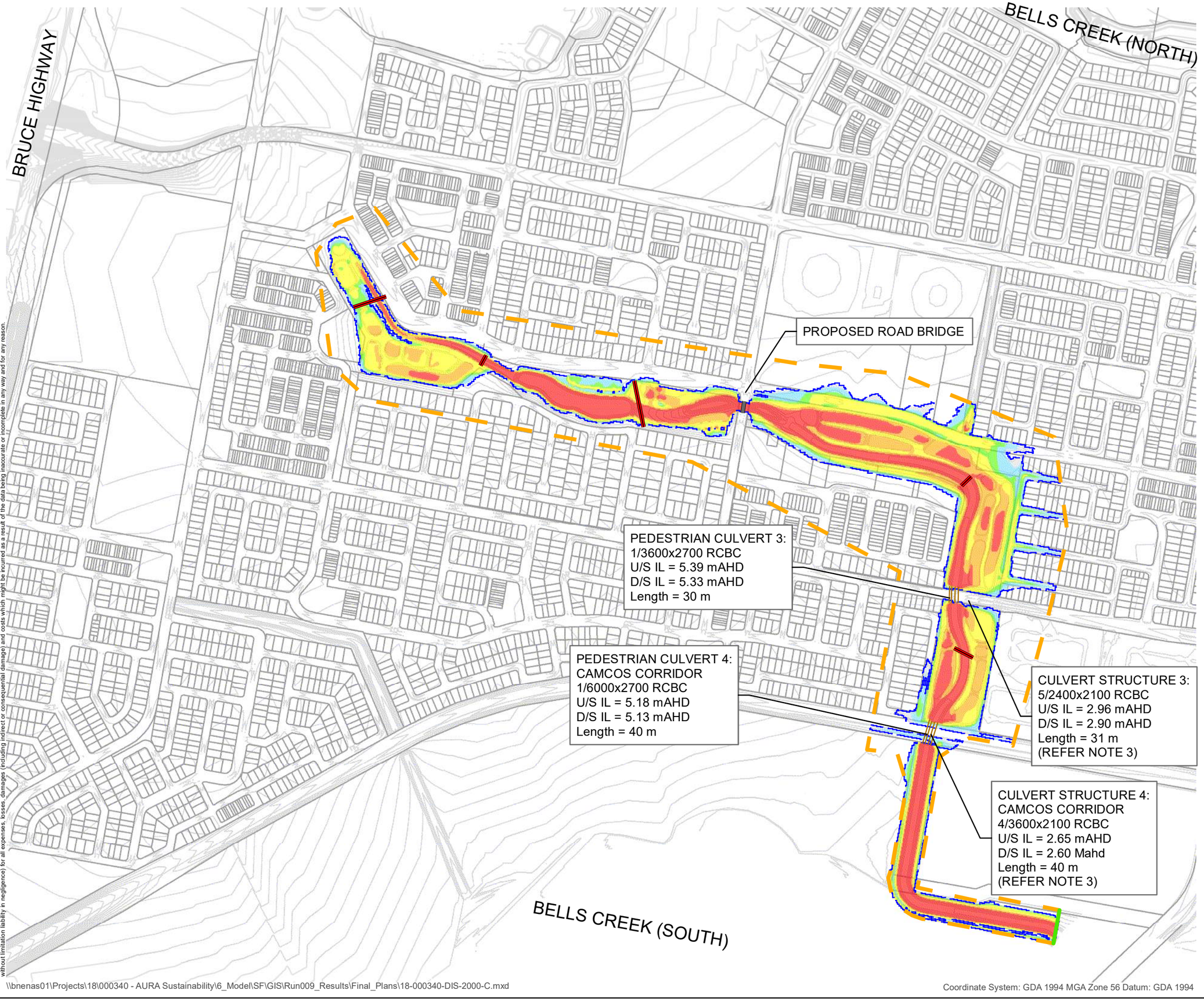
PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO 0.05% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-DIS-2000-B**
ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
B	GB	LM	08.08.19	ISSUE B
C	JC	DY	30.06.20	RFI RESPONSE



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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

- < 0.01
- 0.01 - 0.05
- 0.05 - 0.1
- 0.1 - 0.4
- 0.4 - 0.6
- > 0.6
- Lot Layout
- Contours

NOTES:
1.RESULTS PRESENT THE MAXIMUM OF ALL MODELLED CRITICAL STORM DURATIONS AND TEMPORAL PATTERNS.
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0 70 140 280 m
1:7,000 (A3)
N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT SCENARIO 0.05% AEP YEAR 2100 CLIMATE DURATION INDEPENDENT STORM (DIS) EVENT MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-DIS-2000-C**
ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
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BRUCE HIGHWAY

BELLS CREEK (NORTH)

BELLS CREEK (SOUTH)

1
11.71

2
9.33

3
9.32

4
7.6

5
7.13

6
6.93

7
6.85

8
6.77

9
6.71

10
6.44

11
6.4

12
6.36

13
6.1

PROPOSED ROAD BRIDGE

PEDESTRIAN CULVERT 3:
1/3600x2700 RCBC
U/S IL = 5.39 mAHD
D/S IL = 5.33 mAHD
Length = 30 m

PEDESTRIAN CULVERT 4:
CAMCOS CORRIDOR
1/6000x2700 RCBC
U/S IL = 5.18 mAHD
D/S IL = 5.13 mAHD
Length = 40 m

CULVERT STRUCTURE 3:
5/2400x2100 RCBC
U/S IL = 2.96 mAHD
D/S IL = 2.90 mAHD
Length = 31 m
(REFER NOTE 3)

CULVERT STRUCTURE 4:
CAMCOS CORRIDOR
4/3600x2100 RCBC
U/S IL = 2.65 mAHD
D/S IL = 2.60 Mahd
Length = 40 m
(REFER NOTE 3)

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- WSL Results
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Depth (m)

- > 0.05
- 0.05 - 0.1
- 0.1- 0.3
- 0.3 - 0.5
- 0.5 - 0.7
- 0.7 - 1.0
- 1.0 - 1.5
- > 1.5

- Lot Layout
- Contours

NOTES:
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4. 'HIGH MANNINGS' SENSITIVITY MODELLING ADOPTS MANNING'S ROUGHNESS VALUE OF 0.15 FOR THE BROOK, REPRESENTATIVE OF A FULLY VEGETATED AND UNMAINTAINED CHANNEL.

0 70 140 280 m
1:7,000 (A3)

N

PROJECT:
AURA BROOK FLOOD INVESTIGATION

CLIENT:
STOCKLAND DEVELOPMENT

DRAWING TITLE:
ULTIMATE DEVELOPMENT HIGH MANNINGS SCENARIO
1% AEP YEAR 2100 CLIMATE STORM EVENT
MAXIMUM FLOOD DEPTH PLAN

DRAWING NO: **18-000340-SEN-100CC-A** ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
A	MP	LM	23.11.18	ORIGINAL ISSUE
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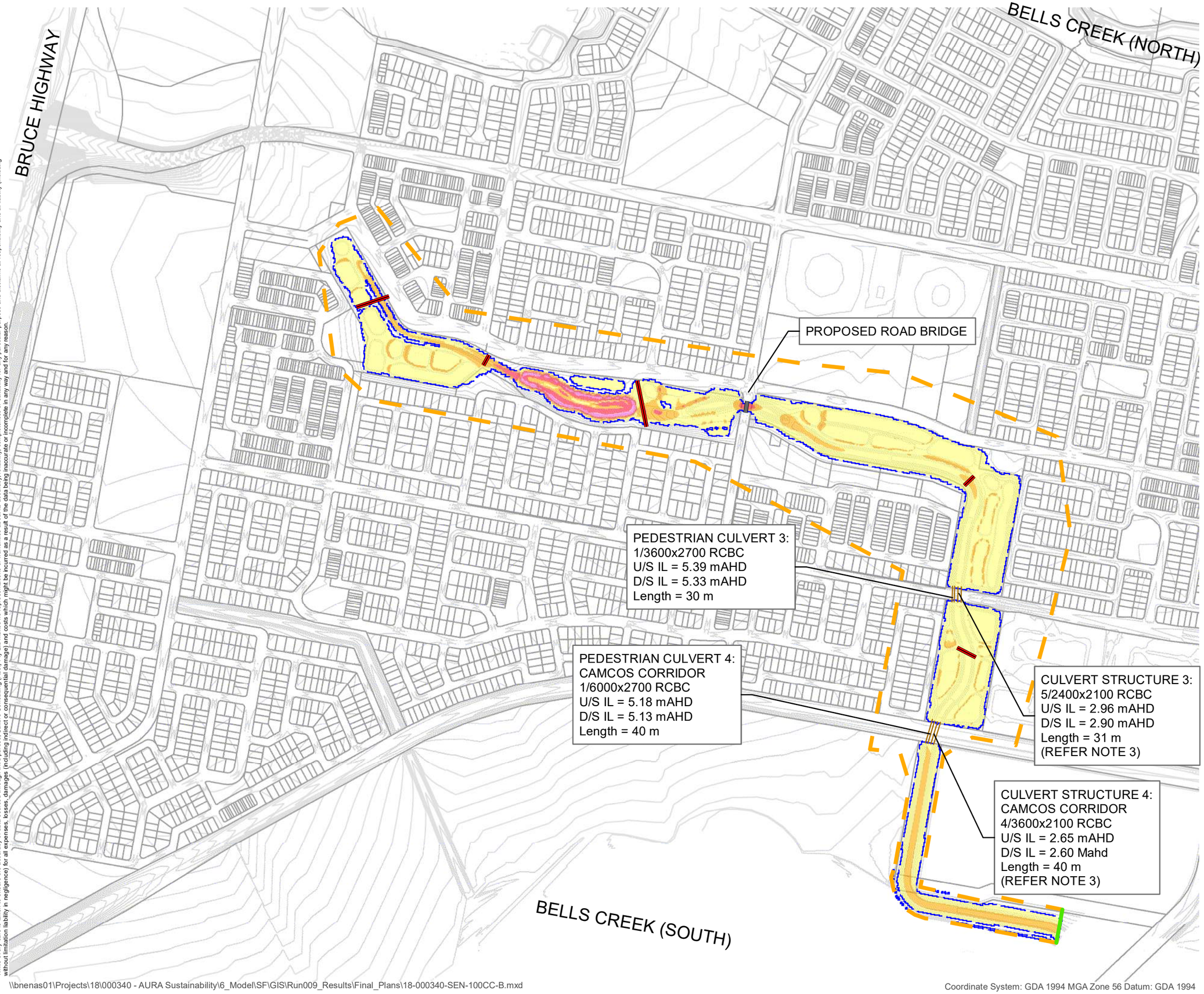

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Velocity (m/s)

- 0 - 0.5
- 0.5 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- > 4

- Lot Layout
- Contours

NOTES:
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1:7,000 (A3)

N

PROJECT:

AURA BROOK FLOOD INVESTIGATION

CLIENT:

STOCKLAND DEVELOPMENT

DRAWING TITLE:

ULTIMATE DEVELOPMENT HIGH MANNINGS SCENARIO

1% AEP YEAR 2100 CLIMATE STORM EVENT

MAXIMUM FLOOD VELOCITY PLAN

DRAWING NO: **18-000340-SEN-100CC-B**

ISSUE: **C**

ISS	BY	CHK	DATE	DETAILS
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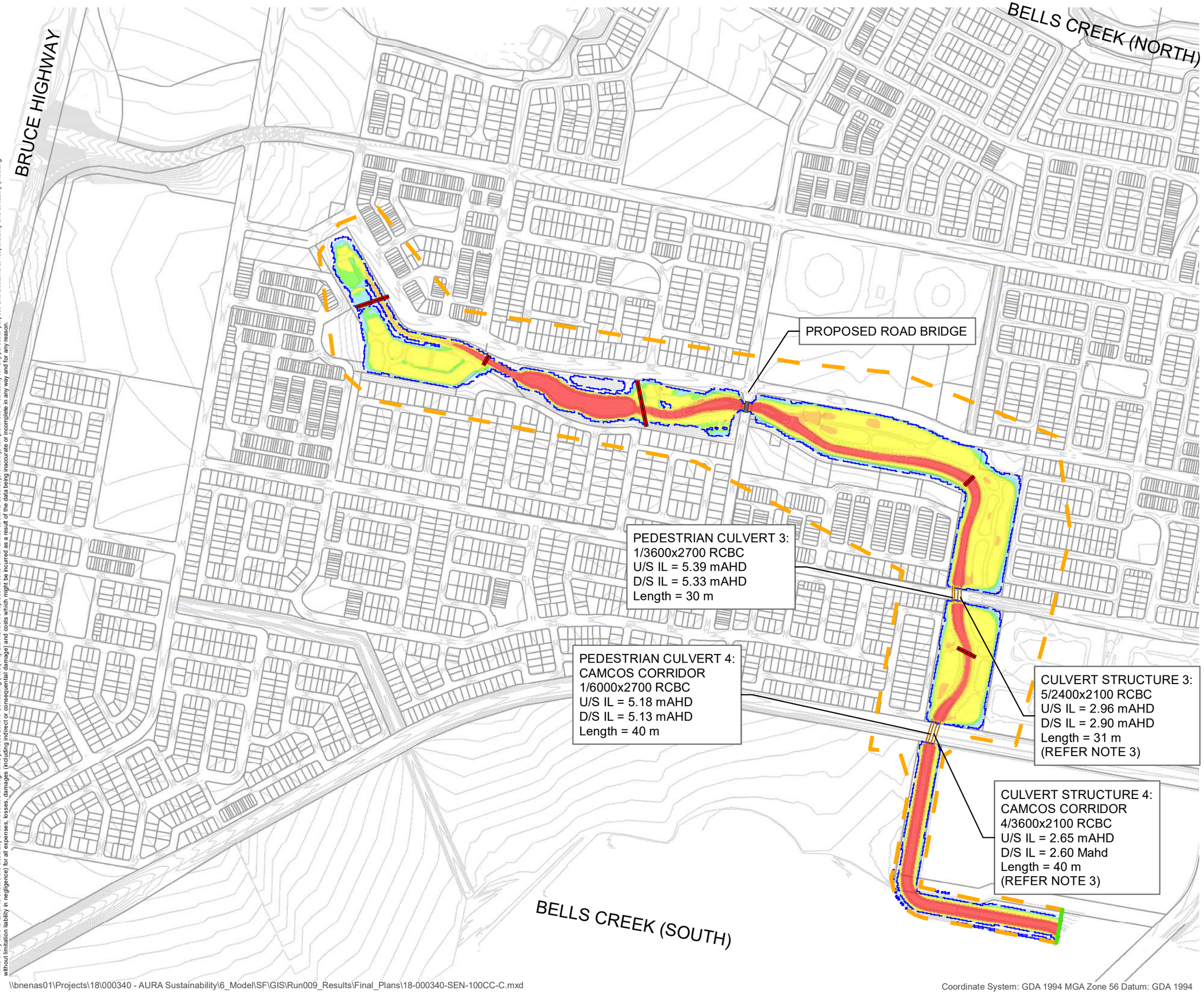

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Coordinate System: GDA 1994 MGA Zone 56 Datum: GDA 1994

calibre

LEGEND

- Proposed Culverts
- Proposed Road Bridge
- Proposed Boardwalk Crossings
- Downstream Boundary Flow Line
- Model_Boundary
- Flood Extent

Max. Flood Hazard (m²/s)

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- 0.01 - 0.05
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MAXIMUM FLOOD HAZARD PLAN

DRAWING NO: **18-000340-SEN-100CC-C**

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Appendix G Water Surface Level Results

2D Flood Results

18-000340 - Aura Brook 2D Flood Investigation

File: \\bnenas01\Projects\18\000340 - AURA Sustainability\2_Docs\Stormwater\FIR.01C\APPENDICES\Appendix G - 2D Flood Results\

Date:	10/06/2020
By:	DY

Table G.1

Reporting Location	Design Storms		Sensitivity Scenarios				Severe Storm
	39% AEP	1%AEP+CC	39% AEP Major Blockage	1% AEP +CC 50% Blockage	1% AEP +CC High Mannings	1% AEP +CC DIS	0.05% AEP DIS
1	11.062	11.635	11.169	11.635	11.705	11.776	11.975
2	6.622	9.267	8.525	9.268	9.327	9.422	9.551
3	6.622	9.262	8.525	9.263	9.320	9.414	9.536
4	6.117	7.435	6.226	7.482	7.598	7.782	8.250
5	5.869	6.991	5.970	7.122	7.128	7.218	7.712
6	5.287	6.832	5.767	7.030	6.934	7.118	7.662
7	4.934	6.774	5.767	6.998	6.850	7.079	7.641
8	4.750	6.723	5.767	6.969	6.772	7.038	7.616
9	4.508	6.680	5.767	6.940	6.708	6.989	7.579
10	4.451	6.353	5.156	6.555	6.435	6.615	7.150
11	4.328	6.333	5.156	6.542	6.403	6.593	7.135
12	4.149	6.306	5.155	6.521	6.363	6.557	7.103
13	4.041	5.835	3.463	5.849	6.101	6.180	6.570

Table G.2

Reporting Location	Adopted Minimum Lot Level	Governing Scenario	Adopted Minimum Floor Level
1	11.99	100yrCC Design Event + 350mm Freeboard	12.14
2	9.62	100yrCC Design Event + 350mm Freeboard	9.77
3	9.62	100yrCC Design Event + 350mm Freeboard	9.77
4	7.79	100yrCC Design Event + 350mm Freeboard	7.94
5	7.35	100yrCC Design Event + 350mm Freeboard	7.50
6	7.19	100yrCC Design Event + 350mm Freeboard	7.34
7	7.13	100yrCC Design Event + 350mm Freeboard	7.28
8	7.08	100yrCC Design Event + 350mm Freeboard	7.23
9	7.04	100yrCC Design Event + 350mm Freeboard	7.19
10	6.71	100yrCC Design Event + 350mm Freeboard	6.86
11	6.69	100yrCC Design Event + 350mm Freeboard	6.84
12	6.66	100yrCC Design Event + 350mm Freeboard	6.81
13	6.19	100yrCC Design Event + 350mm Freeboard	6.34

Contact Us

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PO Box 997, Buddina Qld 4575

calibregroup.com