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FLOOD DESIGN REPORT

A2I | Albury to Illabo

Package: Riverina Highway Bridge

Contract Number: 0052

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5-0052-210-IHY-B4-RP-0001

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DOCUMENT OWNER:	Engineering Manager		
PREPARED BY:	Thinesh Thirumurugan	**TITLE:**	Water Engineer
	Yucen Lu	**TITLE:**	Senior Water Engineer
REVIEWED BY:	Jasmine Lee	**TITLE:**	Associate Water Engineer
VERIFIED BY:	Eric Lam	**TITLE:**	Technical Director
APPROVED BY:	Zoe Cruice	**TITLE:**	Engineering Manager

Approved by

NAME	TITLE	SIGNATURE	DATE
Zoe Cruice	Engineering Manager		08/12/2025

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GLOSSARY

Specific terms and acronyms used throughout this plan and sub-plans are listed and described in Table 0- 1 below.

Table 0- 1: Definitions

Term	Definition
A2I	Albury to Illabo
A2P	Albury to Parkes Enhancement Project
AEP	Annual Exceedance Probability
ADC	Assumptions, Dependencies and Constraints
AHD	Australian Height Datum
ALCAM	Australian Level Crossing Assessment Model
ARF	Areal Reduction Factor
ARI	Average Recurrence Interval
ARR	Australian Rainfall and Runoff
ARTC	Australian Railway Track Corporation
BoD	Basis of Design
BoM	Bureau of Meteorology
CIZ	Construction Impact Zone
CO	Construct Only
CRS	Coordination Reference System
CSSI	Critical State Significant Infrastructure
D&C	Design and Construct
DCN	Design Change Notice
DDR	Detailed Design Review
EMC	Electromagnetic compatibility
EDPM	Engineering, Design and Project Management
ECMP	Electromagnetic compatibility management plan
EIS	Environmental Impact Statement
FDR	Feasibility Design Review
FS	Finish-Start constraint type
FSL	Finished Surface Level
GDA	Geocentric Datum of Australia
GIR	Geotechnical Interpretative Report
HF	Human Factors
I2S	Illabo to Stockinbingal
IFC	Issued for Construction
IR	Inland Rail
ITC	Incentivised Target Cost
IV	Independent Verifier
Km	Kilometres

Term	Definition
LPA	Licensed Project Area
LiDAR	Light Detection and Ranging
MGA	Map Grid of Australia
MIRDA	Master Inland Rail Development Agreement
NCR	Non-Conformance Report
NLPA	Non-Licensed Project Area
NtP	Notice to Proceed
PDR	Preliminary Design Review
PMF	Probable Maximum Flood
PSR	Project Scope and Requirements
QDL	Quantitative Design Limits
REF	Review of Environmental Factors
RFI	Request for Information
RMAR	Rail Maintenance Access Road
S2P	Stockinbingal to Parkes
SAQP	Sampling, Analysis and Quality Plan
SDR	Systems Definition Review
SEMP	System Engineering Management Plan
TfNSW	Transport for New South Wales
TWL	Tail Water Level
V & V	Verification and Validation
WAD	Works Authorisation Deed
WAE	Work-as-Executed

1 A2P PROJECT INTRODUCTION

1.1 Albury to Parkes (A2P)

As part of the Inland Rail program of projects, the Australian Rail Track Corporation (ARTC) has appointed Martinus as the delivery contractor for the Albury to Parkes (A2P) project, which comprises the brownfield sections between Albury and Illabo (A2I) and Stockinbingal to Parkes (S2P). The greenfield portion between Illabo to Stockinbingal (I2S) is not a part of the A2P project scope.

1.2 Project Scope

The S2P section will be delivered under an REF and as such construction works associated with the two (2) Construct Only packages can commence at Contract Award. The Design and Construct for the other seven (7) projects sites will also commence at Contract Award.

The A2I section will be delivered under an EIS and requires a Notice to Proceed from ARTC before works can commence on site. Design for A2I will however commence at Contract Award. The project received State Planning approval on 8th Oct 2024, and Martinus received the Notice to Proceed from IRPL on 18 Oct 2024.

Within the A2I section there are twenty (20) locations with twenty-nine (29) Design and Construct (D&C) projects of varying degrees of design gate development:

- Murray River bridge (Structure modifications)
- Albury Station Yard (Track slews, track reconfigurations)
- Albury Station Yard Track Slews (retained 3-track alignment)
- Albury Station Yard Footbridge (footbridge replacement), both pre- and post- SDRP-response
- Riverina Highway bridge (Track lowering)
- Billy Hughes bridge (Track lowering)
- Tabletop Yard (Structure modification)
- Culcairn Station Yard (Track slews and bridge removal)
- Henty Yard (Track slews)
- Yerong Creek Yard (Track slews)
- The Rock Yard (Structure modification)
- Uranquinty Yard (Track slews)
- Pearson Street bridge (Track lowering)
- Cassidy Parade footbridge (Bridge replacement), both pre- and post- SDRP-response
- Edmondson Street Bridge (stand-alone road bridge)
- Edmondson Street Footbridge (stand-alone road bridge)
- Edmondson Street bridge and footbridge (combined Bridge replacement), post- SDRP-response
- Wagga Wagga Station Yard (Track slews)
- Wagga Wagga Footbridge (footbridge replacement), both pre- and post- SDRP-response
- Bomen Yard (Track slews)
- Harefield Yard (Track slews)
- Kemp Street Bridge (stand-alone road bridge)
- Kemp Street Footbridge (stand-along footbridge)
- Kemp Street bridge and footbridge (combined Bridge replacement)
- Junee Station Yard (Track slews and bridge removal)
- Olympic Highway Underbridge (Track reconfiguration and Structure modification)
- Junee to I2S dual track section (Track slews)
- LX605 & LX1472 Activations
- LX605 relocation and LX1472 closure, both 16m and 4m slew options

Within the S2P section, there are two (2) Construct only projects:

- Daroobalgie New Loop
- Wyndham Avenue (Track lowering)

and seven (7) Design and Construct (D&C) projects:

- Milvale Yard (Structure modification)

- Bribbaree Yard (Track slews)
- Quandialla Yard (Structure modification)
- Caragabal Yard (Track slews)
- Wirrinya Yard (Track slews)
- Lachlan River bridge (Structure modifications)
- Forbes Station (Track slews and awning modifications)

The D&C scope typically includes works associated with route clearance to accommodate the new F2M clearance envelope, necessary to accommodate the double-stacked freight container trains and this includes.

- Structure modifications
- Track reconfigurations
- Bridge replacements
- Track lowering
- Track slews and level crossing upgrades
- Bridge removal

1.3 Site Description

This study conducts a flood assessment for the Riverina Highway bridge (refer to Figure 1-1 for site location). The background and previous studies for the site are listed below.

Figure 1-1: Site Locations

1.3.1 Background

The Riverina Highway bridge (Site) forms part of the Albury to Illabo Section, with works between the Main Line's Chainage Ch 644.819km and Ch 645.400km. It is located within the Albury City Local Government Area, with the existing bridge passing over the existing railway tracks. The Riverina Highway bridge only caters to vehicle traffic and will be retained without any changes. The project scope involves lowering the existing railway track, which crosses beneath the bridge, for a vertical clearance of 7.1m over the Main line to allow the passage of double-stack rail traffic underneath the bridge.

1.4 Objectives

This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Issued for Construction (IFC) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary.

This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001).

1.5 Scopes

The scope of this study includes:

- Review the changes in design between IFC and DDR.
- Carrying out the flood assessment for the design in the DDR stage for the design events of 10%, 5%, 2%, 1%AEPs and 1% AEP with climate change and PMF (Probable Maximum Flood).
- Checking flood assessment results against the criteria, including flood impact and flood immunity.
- Proposing any mitigation measures if required.

1.6 Previous Studies

1.6.1 Flood Studies

The table below summarises the flood studies associated with the Riverina Highway bridge site.

Table 1-1: Summary of the Previous Studies

Item No.	Flood Study	Description	Comments
1	Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011)	This flood study defines flood behaviour under the conditions of the model that was built in 2011. The hydrologic models were developed in RAFTS and DRAINS software packages and the 2D hydraulic model was developed using the TUFLOW software. The hydrologic model was calibrated using historical flood data. The TUFLOW model was simulated for design rainfall events ranging between the 20% and 0.2% AEPs based on the Australian Rainfall and Runoff 1987 (ARR87).	-
2	Albury Floodplain Risk Management Study (FRMS) and Plan (WMA Water, 2016)	This report assessed flood behaviour, flood risk, and flood management issues in the Albury LGA. It used the Lyall & Associates (2011) model and updated it to consider the elevated water levels in the Murray River and the terrain changes for recently developed land throughout the catchment.	The TUFLOW model from this FRMS has been adopted to be updated and used for flood assessment in this current assessment. A summary of the TUFLOW model parameters is provided in Table 4-2.
3	Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Wagga Wagga (June 2022)	No detailed flood modelling is documented in the Reference Design report. The Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) was adopted to inform the flooding across the site. It indicated that a minor 1% AEP overland flow (0.4m^3/s) would occur upstream of the rail box culvert (3/ 1.2mWx0.9mH) crossing located at CH644770 and adjacent to the Scots School. Shallow overland flow then traverses the rail corridor southwards. There is a localised low point below the Riverina Highway overbridge and limited storage occurs prior to overtopping the railway track with continued overland flow towards Wilson Street. A DRAINS model was built to estimate the peak flows associated with the Reference Design and this indicated that the track could achieve 1% AEP flood immunity	-

Item No.	Flood Study	Description	Comments
		resulting from the design and is not expected to produce an increase in downstream flood levels of more than 100 mm.	
4	Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, Flooding and Water quality (July 2022)	No detailed flood modelling is documented in the EIS report. The Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) was adopted to inform the flooding across the site. Four design events, including the 20%, 5%, 1% AEP events and the Probable Maximum Flood (PMF) event were assessed and modelling demonstrated that the three box culverts (CH644+770) do not have sufficient capacity to convey the upstream runoff. As a consequence, water spills into the rail corridor during the 20% AEP and greater events. The portion of overland flow that spills into the rail corridor proceeds in a south-west direction, following the terrain slope. A DRAINS model was developed to assess rail flood immunity. Modelling confirmed that the railway line can achieve 1% AEP flood immunity with the proposed drainage system and that there were no adverse flood impacts associated with the proposed works.	-

1.6.2 Reference Design

The below report was produced by Others, as part of the Reference Design.

- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Albury (June 2022)

The site is located within the South Albury catchment which is the smallest of the subject catchments discharging to the Murray River. The flood study predicts a minor 1% AEP overland flow (0.4 m^3/s) will occur into the rail upstream of the 3x 1.2Wx0.9H transverse box culvert crossing arrangement located at Ch 644.770km and adjacent to The Scots School. Shallow overland flow then traverses the rail corridor southwards. There is a localised low point below the Riverina Highway overbridge and limited storage occurs prior to overspilling with continued overland flow towards Wilson St. This flow path will be impacted by the proposed track lowering and there are no watercourses within the project site.

1.6.3 Environmental Impact Statement

The below report was produced by Others, as part of the Environmental Impact Assessment.

- Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (July 2022)

There is no detailed flood modelling within this report. A qualitative assessment was undertaken to assess the overland flood condition of the site based on the Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011) and regional floods condition based on the Albury Floodplain Risk Management Study and Plan (WMA Water, 2016). The site is not affected by regional flooding from Murray River (refer to Figure 1-2) but is affected by local overland flooding during the 20 % AEP, 5% AEP, 1% AEP and PMF flood events (refer to Figure 1-3).

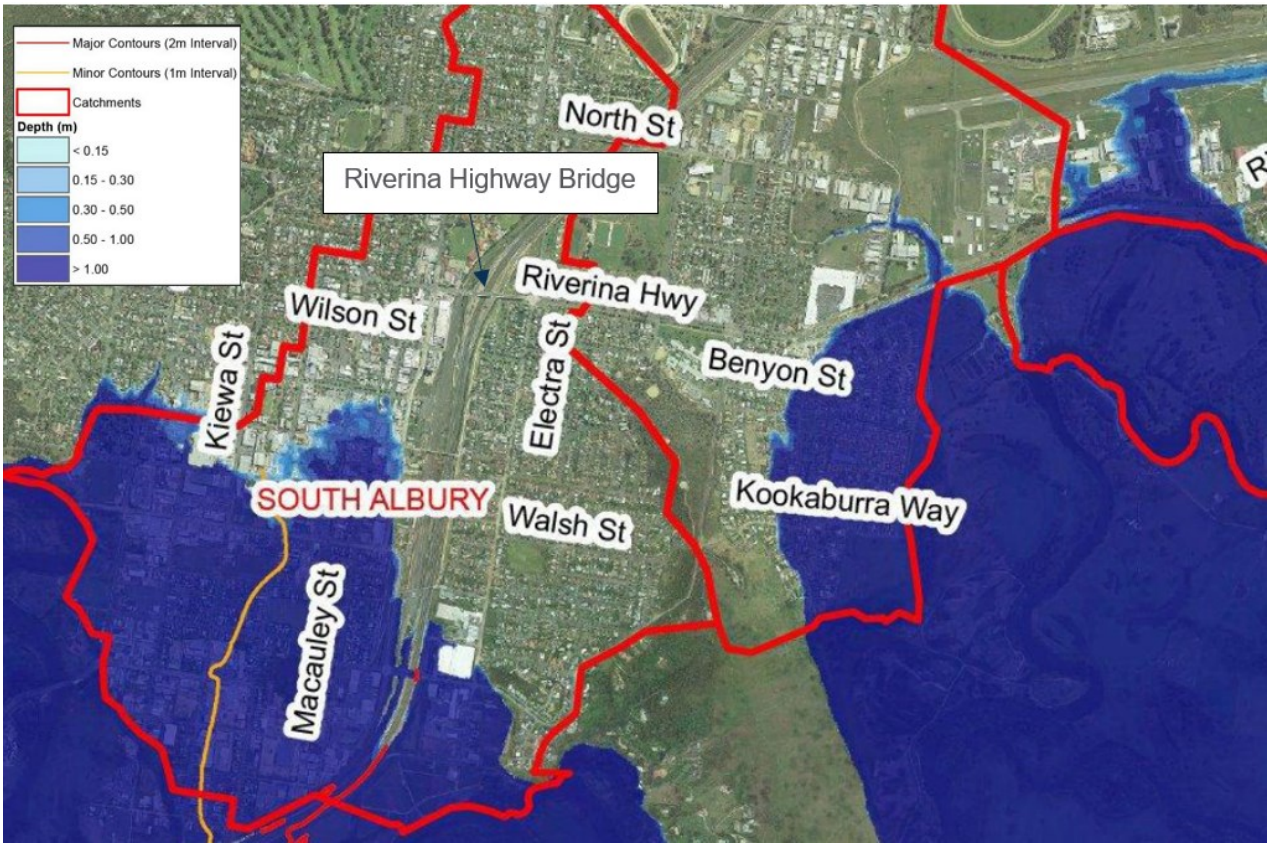


Figure 1-2: PMF Murray Catchment Regional Flooding (Image source: Albury to Illabo EIS Technical Paper 11, July 2022)

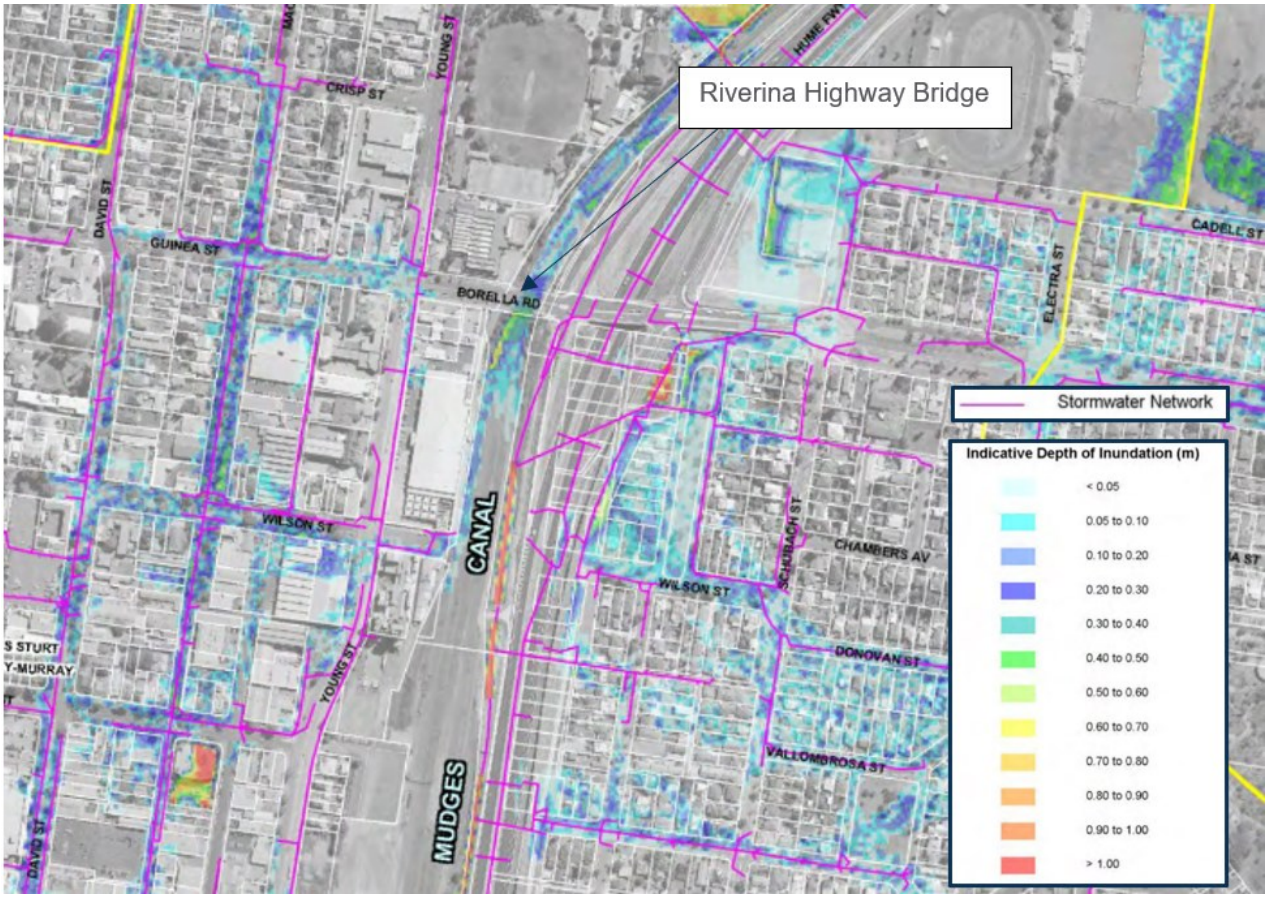


Figure 1-3: 1% AEP Local Flooding (Image source: Albury to Illabo EIS Technical Paper 11 (July 2022))

1.7 Purpose and Requirements

The primary purpose of this IFC flood design report is to investigate the flood behaviour and its potential flood impact.

The secondary purpose of this report is to provide evidentiary documentation on consultation with external stakeholders, and review conducted by the independent suitably-qualified flood consultant, in demonstrating compliance with the CSSI conditions of approval. Refer to Appendix D for the ARTC review and Appendix E for the Independent Flood Consultant Review.

1.8 Information Documents

The following documents have been provided 'For Information' and have been referenced/reviewed as part of the design development:

- Albury Floodplain Risk Management Study (FRMS) and Plan, WMA Water, 2016
- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Albury (WSP, June 2022), 2-0008-210-PEN-03-RP-0002
- Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (WSP, July 2022), 2-0008-210-EAP-00-RP-0010

1.9 Inputs

The inputs to this flood assessment report include:

- Australian Standards and Guidelines: AS 7637 Railway Infrastructure – Hydrology and Hydraulics
- Australian Rainfall and Runoff: A Guide to Flood Estimation 2019
- Austroads Guide to Bridge Technology – Part 8: Hydraulic Design of Waterway Structures
- Inland Rail Climate Change Risk Assessment Framework

1.9.1 Input Data

The table below outlines the available information relevant to the site and used for flood modelling.

Table 1-2: Available Information

Item	Information	Type	Description / Comments
1	Flood model used in Albury Floodplain Risk Management Study and Plan (WMA water, 2016)	TUFLOW model	Received from Martinus on 29/08/2023
2	LiDAR 2020 (The data used to create this DEM has an accuracy of 0.3m (95% Confidence Interval) vertical and 0.8m (95% Confidence Interval) horizontal)	TIF format in 1m resolution	Downloaded from https://elevation.fsdf.org.au/ on 08/09/2023
3	1m 2015 LiDAR and High-Resolution Aerial Imagery. The data derived points have an accuracy of 0.15m (68% confidence interval) ARTC LiDAR	TIF format in GDA94	The existing 1m LiDAR (flown by ARTC in 2015) was received from Martinus on 12/11/2024. However, the LiDAR2020 (item 2) is newer and in GDA2020. Therefore, only LiDAR 2020 (item 2) is used.
4	V2 DR RIVE NET EX	12da	Existing drainage system Received from DJV Drainage team on 18/09/2023
5	A2P RVR RAIL EXT GDA20Z55.12da A2P RVR ROAD EXT GDA20Z55.12da	12da	Point cloud survey Received from DJV civil team on 15/04/2024
6	A2P RVR EXT GDA20Z55 COMBINED 241202.dxf A2P RVR EXT GDA20Z55 COMBINED 241202.12da	12da and dxf file in GDA2020 projection	Detailed topography survey and existing track levels Received from DJV Civil team on 02/12/2024

Item	Information	Type	Description / Comments
7	5-0052-210-CAL-B4-MD-0004-RIVERINA_HWY_3D_RAIL_DESIGN_STRINGS_DWG.dwg	Dwg file in GDA2020 projection	Rail Design Strings Received from DJV Rail team on 06/12/2024
8	BALLAST 21 B4 MR21B4001.dem CAPPING 21 B4 MR21B4001.dem DESIGN MD21B4501.dem RMAR MC21B4201.dem OPTION - DRAIN MD21B4505 -3m CHANNEL.dem 5-0052-210-CCW-B4-MD-0002-RIVERINA_HWY_3D_CIVIL_DESIGN_STRINGS_DWG.dwg	Dem Grid file (0.05m grid) in GDA2020 projection	Civil Design for ballast, capping, RMAR and associated channels in the GDA2020 projection Received from DJV Civil team on 11/02/2025
9	B4 EXIS DRAINAGE.12daz B4 Existing Pit Schedule.xlsx	12Da file and Excel file	Existing drainage data. Received from DJV Drainage team on 21/01/2025
10	A2P - Riverina Pump Sump - Design Calculations V1.xlsm Riverina Pump Station - Check print for page turn.pdf	PDF file and Excel file	DDR Pump design specifications Received from DJV Pump team on 29/01/2025
11	B4 DRAINAGE STRINGS.12daz 5-0052-210-CDR-B4-SC-0001-RIVERINA_DRAINAGE PIT SCHEDULE.xlsx	12Da file and Excel file	Drainage design system Received from DJV Drainage team on 31/01/2025
12	Riverina U-drain to overland flow channel detail draft	Sketch and PDF	Draft details on channel transition design details for the IFC stage Received from DJV Drainage team on 09/05/2025
13	Proposed rock mattress extent sketch	JPG file	Details on the proposed rock mattress sketch for the IFC stage Received from DJV Drainage team on 24/06/2025

1.10 IFC Design

Minor design changes to the drainage elements were made in the IFC stage, including:

- Two localised channel smoothing transitions between the U-drain and overland flow channel (at around CH645050 and CH645175) which will be implemented in IFC Design. The cross-sections of the U-drain and overland flow channel remain the same with the DDR stage design. As the overall channel conveyance remains unchanged, the changes in flood results will be negligible.
- 6m of channel section next to the pump station to be lined with rock mattress. Manning's roughness of the channel will increase from 0.03 (Grass lining) to 0.04, while the cross-section remains the same. This is only anticipated to cause a negligible flood level increase locally within the channel.

Overall, the above changes are not anticipated to affect the overall flooding behaviour or results, nor to lead to any significant impacts. Apart from these, there have been no alterations to the civil, track, and pump designs since the DDR stage (refer to Section 3.4)

Given that the changes in the IFC are minimal compared to the DDR, the flood assessment will not result in any non-compliance. Therefore, the flood assessment results from the DDR stage will be utilised to inform the IFC flood assessment from Section 2 onwards.

1.11 Outputs

The list of flood maps and the flood maps are included in Appendix A.

1.12 Limitations and Assumptions

The hydrologic and hydraulic modelling assumptions and constraints are listed below:

- An assessment of temporary works and staging has not been undertaken as it is out of the flooding scope.
- According to Clause 5.4.2 and Clause 5.4.3 in Annexure B of PSR (Table 2-1), the highest flood event shall be the one stipulated by the ARTC Safety Management System (SMS). As per Section 10.1.3 of Track and Civil Code of Practice Section 10 Flooding, the 1% AEP shall be used. The flood impact would be assessed up to the 1% AEP for the project.
- Blockage assessment is carried out for the 1% AEP design scenario as per the guidance set out in ARR2019 for the culverts within the project boundary while 20% blockage is adopted for all the other culverts, pits and pipes outside the project boundary (Refer to 5-0052-210-IHY-99-ME-0001)

2 COMPLIANCE WITH REQUIREMENTS

2.1 Project Scope and Requirements

Assessment of the detailed design to see if it meets the Project Scope and Requirements (PSRs) has been undertaken. This is demonstrated throughout the flood assessment, with Table 2-1 below summarising the Riverina Overbridge track lowering Design's Compliance with the PSRs.

Table 2-1: Flooding Criteria within PSR Annexure B Technical Requirements

Requirement	Identifier	A2P Technical Requirements Description	Compliance Evidence Reference
Project Wide	5.4.10	Without limiting the environmental management requirements in Annexure F, section 6.1.1, all D&C Works in watercourses shall comply with the NSW Department of Primary Industries Standards: Policy and Guidelines for Fish Friendly Waterway Crossings; Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings; and Policy and Guidelines for Fish Habitat Conservation and Management Update.	N/A (structure modifications do not affect waterway flow)
Project Wide	5.4.2	Where existing flood immunity is lower than ARTC SMS minimum requirements, the functional requirements for flood immunity take precedence over the ARTC SMS.	The ARTC minimum requirement is 1% AEP. The top of the track is overtopped in the 1% AEP in the existing scenario. Thus, the existing track does not achieve immunity in 1% AEP. The existing immunity is maintained under design conditions. Refer to Section 5.3.
Project Wide	5.4.3	Where existing flood immunity is higher than ARTC SMS minimum requirements, the ARTC SMS requirements for flood immunity take precedence over the functional requirements.	The ARTC minimum requirement is 1% AEP. The top of the track is overtopped in the 1% AEP in the existing scenario. Thus, the existing track does not achieve immunity in 1% AEP. The existing immunity is maintained under design conditions. Refer to Section 5.3.
Project Wide	5.4.5	Bridge and culvert hydraulics shall comply with Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures.	There are no bridge structures or Waterway structures within the Riverina Highway bridge Scope.
A2I Technical Requirements	IR-SR-A2I-116	The System shall comply with 0-0000-900-ESS-00-ST-0001 Inland Rail Climate Change Risk Assessment Framework.	Climate change assessment was carried out by running the 1% AEP + 2090 RCP 8.5 and identifying potential flood behaviour. Refer to Section 5.5.2.
A2I Technical Requirements	IR-SR-A2I-349	The Corridor System for Enhancement Corridors shall have a flood immunity of no worse than existing.	The existing immunity is maintained under design conditions. Refer to Section 5.3.
A2I Technical Requirements	IR-SR-A2I-350	The Corridor System, where the existing track is lowered, shall maintain the existing flood immunity.	The existing immunity is maintained under design conditions. Refer to Section 5.3.

Requirement	Identifier	A2P Technical Requirements Description	Compliance Evidence Reference
A2I Technical Requirements	IR-SR-A2I-352	The Corridor System shall prevent damage of the formation due to ponding of water.	No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site. Refer to Sections 5.2 & 5.3.
A2I Technical Requirements	IR-SR-A2I-458	The Corridor System shall prevent ponding in longitudinal open channels.	The proposed channels have grading that prevents ponding. Refer to Section 4.5 (Drainage Design) on the Riverina Highway Bridge Design Report (5-0052-210-PEN-B4-RP-0001)
A2I Technical Requirements	IR-SR-A2I-459	The Corridor System for Enhancement Corridors shall provide mitigation for flood impacts no worse than existing condition.	Existing condition is maintained. Flood impacts are no worse than existing conditions. Refer to Section 5.4.
A2I Technical Requirements	IR-SR-A2I-464	The Corridor System shall cause no adverse impacts either inside or outside the rail corridor when diverting water away from the track.	Existing condition is maintained. Flood impacts no worse than existing condition. Refer to Section 5.4.
A2I Technical Requirements	IR-SR-A2I-465	The Corridor System shall minimise changes to the existing or natural flow patterns.	The corridor system has minimised changes to the existing flow patterns. Flood impacts no worse than existing condition. Refer to Section 5.4.
A2I Technical Requirements	IR-SR-A2I-541	The Structures System new underbridges shall withstand the 0.05% annual exceedance probability design flood event.	N/A. There is no new underbridge structure change.
A2I Technical Requirements	IR-SR-A2I-735	The Third-Party System private roads shall have flood immunity no worse than existing.	No third-party private roads are impacted. Refer to Section 5.4.1.
A2I (Annexure F)	6.1.1	Without limiting clauses 8 and 14 of the Deed, the Contractor shall ensure that the Contractor's Activities and the Works comply with the following for A2I, the Conditions of Approval and the environmental assessment reports available on: https://www.planningportal.nsw.gov.au/major-projects/projects/inland-rail-albury-illabo"	Refer to Table 2-2

*A2I Technical requirements are used in A2P as A2P is a part of A2I.

2.2 Conditions of Approval – Flooding

The Conditions of Approval (CoA) have been provided as part of the CSSI approval and Inland Rail Deed of Variation. The detailed design has been assessed to check if it meets the CoA and the compliance is presented in Table 2-2 below.

Table 2-2: Conditions of Approval Compliance Table – Flooding

Condition	Condition or Criteria	Compliance Evidence Reference
E38	All practicable measures must be implemented to ensure the design, construction and operation of the CSSI will not adversely affect flood behaviour, or adversely affect the environment or cause	Compliant. Refer to Section 5.

Condition	Condition or Criteria	Compliance Evidence Reference
	avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.	
E39	The CSSI must be designed with the objective to meet or improve upon the flood performance identified in the documents listed in **Condition A1**. Variation consistent with the requirements of this approval at the rail corridor is permitted to effect minor changes to the design with the intent of improving the flood performance of the CSSI.	Compliant. Refer to Section 5.
E40	Updated flood modelling of the project's detailed design must be undertaken for the full range of flood events, including blockage of culverts and flowpaths, considered in the documents listed in **Condition A1**. This modelling must include:	Compliant. Refer to Sections 0 and 5.
E40	a) Hydrologic and hydraulic assessments consistent with *Australian Rainfall and Runoff – A Guide to Flood Estimation* (GeoScience Australia, 2019);	Compliant. Refer to Section 0.
E40	b) Use of modelling software appropriate to the relevant modelling task;	Compliant. Section 0 shows that the appropriate software (TUFLOW) was used
E40	c) Field survey of the existing rail formation and rail levels, should be included within the models; and	Compliant. The existing rail level was used to inform the flood immunity. Refer to Section 5.1 and 5.2.
E40	d) Confirmation of predicted afflux at industrial properties adjacent to Railway Street, Wagga Wagga based on field survey.	N/A. This criterion is related to the Wagga Wagga Yard enhancement site but not the Riverina Highway track lowering site, which is the subject of this report.
E40	Updated flood modelling must be made publicly available in accordance with **Condition B18**.	Flood design report and independent review of the flood design report shall be provided to IR, through this submission, for IR to upload on the IR website, as per CoA B18 responsibility allocation.
E41	The Proponent's response to the requirements of **Conditions E38** and **E40** must be reviewed and endorsed by a suitably qualified flood consultant, who is independent of the project's design and construction and approved in accordance with **Condition A16,** in consultation with directly affected landowners, DCCEEW Water Group, TfNSW, DPI Fisheries, BCS, NSW State Emergency Service (SES) and relevant Councils.	Independent review of the flood modelling, model and Flood Design Report is undertaken by the Proof Engineer's specialist contractor, who satisfies and complies with the requirements of A16. Consultation with the council and other stakeholders is being undertaken through a formal review of this Flood Design Report.
E42	The CSSI must be designed and constructed to limit impacts on flooding characteristics in areas outside the project boundary during any flood event up to and including the 1% AEP flood event, to the following:	See items below

Condition	Condition or Criteria	Compliance Evidence Reference
E42	(a) a maximum increase in inundation time of one hour, or 10%, whichever is greater;	Compliant. Refer to Section 5.4.4.
E42	(b) a maximum increase of 10 mm in above-floor inundation to habitable rooms where floor levels are currently exceeded;	Compliant. No flood level increase of 10mm in above-floor inundation on any properties. Refer Section 5.4.1.
E42	(c) no above-floor inundation of habitable rooms which are currently not inundated;	Compliant. No increase for above floor inundation of habitable rooms on any properties. Refer Section 5.4.1.
E42	(d) a maximum increase of 50 mm in inundation of land zoned as residential, industrial or commercial;	Compliant. No flood level increase of more than 50mm in residential, industrial and commercial areas. Refer Section 5.4.1.
E42	(e) a maximum increase of 100 mm in inundation of land zoned as environment zone or public recreation;	Compliant. No flood level increase of more than 100mm in the environment zone or public recreation. Refer to Section 5.4.1.
E42	(f) a maximum increase of 200 mm in inundation of land zoned as rural or primary production, environment zone or public recreation;	Compliant. No flood level increase of more than 200mm in rural or primary production, environment zone or public recreation. Refer to Section 5.4.1.
E42	(g) no increase in the flood hazard category or risk to life; and	Compliant Refer to Section 5.4.3.
E42	(h) maximum relative increase in velocity of 10%, or to 0.5m/s, whichever is greater, unless adequate scour protection measures are implemented and/or the velocity increases do not exacerbate erosion as demonstrated through site-specific risk of scour or geomorphological assessments	Compliant Refer to Section 5.4.2
E42	Where the requirements set out in clauses (d) to (f) inclusive cannot be met alternative flood levels or mitigation measures must be agreed to with the affected landowner.	N/A, Clause (d) to (f) are compliant
E43	A **Flood Design Report** confirming the:	
E43	a) final design of the CSSI meets the requirements of **Condition E42;** and	Compliant Refer to Section 5.
E43	b) the results of consultation with the relevant council in accordance with **Condition E46**	Refer to E46
E43	must be submitted to and approved by the Planning Secretary prior to the commencement of permanent works that would impact on flooding.	This report will be submitted to the Planning Secretary for approval prior to the commencement of permanent works that would impact on flooding.
E44	The **Flood Design Report** required by **Condition E43** must be approved by the	This report will be submitted to the Planning Secretary for approval prior to

Condition	Condition or Criteria	Compliance Evidence Reference
	Planning Secretary prior to works that may impact on flooding or the relevant council's stormwater network.	the commencement of permanent works that would impact on flooding.
E45	Flood information including flood reports, models and geographic information system outputs, and work as executed information from a registered surveyor certifying finished ground levels and the dimensions and finished levels of all structures within the flood prone land, must be provided to the relevant Council, BCS and the SES in order to assist in preparing relevant documents and to reflect changes in flood behaviour as a result of the CSSI. The Council, BCS and the SES must be notified in writing that the information is available no later than one (1) month following the completion of construction. Information requested by the relevant Council, BCS or the SES must be provided no later than six (6) months following the completion of construction or within another timeframe agreed with the relevant Council, BCS or the SES.	Flood information will be provided to the relevant Council, BCS and the SES in order to assist in preparing relevant documents and to reflect changes in flood behaviour as a result of the CSSI in accordance with the requirements of CoA E45
E46	The design, operation and maintenance of pumping stations and storage tanks and discharges to council's stormwater network must be developed in consultation with the relevant council. The results of the consultation are to be included in the report required in **Condition E47.**	Although the flow balance has been changed, (i.e. more flow down Mudges Canal and less towards Wilson Street), the overall catchment area and imperviousness remain the same as per the existing condition, there is no additional flow towards the existing Council's stormwater network. The design has not worsened the existing condition. Albury City Council has been consulted through design review process in accordance with the Master Inland Rail Deed Agreement. Refer to Section 4.5 (Drainage Design) in the Riverina Highway Bridge Design Report (5-0052-210-PEN-B4-RP-0001).

2.3 Updated Mitigation Measures - Flooding

The Updated Mitigation Measures (UMM) have been provided, and the detailed design has been assessed to meet the UMM and the compliance is presented in Table 2-3 below.

Table 2-3: Updated Mitigation Measures Compliance Table - Flooding

Condition	Condition or Criteria	Compliance Evidence Reference
HFWQ3	Further consultation will be undertaken with local councils and other relevant authorities to identify opportunities to coordinate the proposal with flood mitigation works committed to as part of the council's flood management plans, or other strategies.	Consultation with the Council and other relevant authorities will be undertaken through a formal review of this Flood Design Report.
HFWQ4	At Wagga Wagga Yard enhancement site, flood modelling would be carried out during detailed design to confirm predicted afflux at industrial properties located at Railway Street and	This criterion is related to the Wagga Wagga Yard enhancement site lowering site but not the Riverina

Condition	Condition or Criteria	Compliance Evidence Reference
	compliance with the Quantitative Design Limits for Inland Rail. This would be informed by topographic and building floor surveys and a review of localised drainage structures (as required). Quantitative assessment of the sites of low and moderate hydraulic complexity will be carried out during detailed design and will consider the impact of the Possible Maximum Flood event at built-up areas (where information is available) and the tenure of the upstream areas that are impacted by drainage and/or flooding. The outcomes of the assessment are to be provided to DCCEW– BCS	Highway track, which is the subject of this report. Compliant. Quantitative assessment has been undertaken. Refer to Section 4.3 & 5.
HFWQ5	At Riverina Highway bridge enhancement site, flood and drainage network modelling (including capacity and operation of the stormwater storage and pump system) will be carried out during detailed design to confirm predicted compliance with the Quantitative Design Limits (QDLs)* for Inland Rail. The modelling would be undertaken in consultation with Albury City Council.	The flood model included the proposed stormwater drainage and Pump design and storage. Refer to Section 4.3.2. The flood assessment results comply with CoA E42. Refer to Section 5.4

* QDL is superseded by CoA E42.

3 CHANGE MANAGEMENT

This section summarises the changes made to this design package due to changes in the project scope and/or evolution of the design.

3.1 Concept Design to SDR

Key design changes between the Concept Design and the SDR Design are listed in Table 3-1.

Table 3-1: Design Differences Between Concept and SDR

Item	Difference	Reason for Change
1	Incorporation of LiDAR survey	An existing condition topography
2	Incorporation of Design Drainage	New drainage design
3	Incorporation of Civil Design	New civil design
4	Incorporation of Railway track Design	New rail design for the site

3.2 SDR to PDR

Key design changes between the SDR and the PDR Design are listed in Table 3-2.

Table 3-2: Design Differences Between SDR and PDR

Item	Difference	Reason for Change
1	Updated hydrology from ARR 1987 to ARR 2019.	Project requirements for PDR. Additional information is provided in Section 4.2.
2	Incorporation of the latest existing condition survey (Point cloud data)	A new existing condition survey was provided
3	Incorporation of Design Drainage	New drainage design for the site
4	Incorporation of Civil Design	New civil design for the site
5	Incorporation of Railway track Design	New rail design for the site

3.3 PDR to DDR

Key design changes between the PDR and the DDR Design are listed in Table 3-3.

Table 3-3: Design Differences Between PDR and DDR

Item	Difference	Reason for Change
1	Incorporation of the latest existing condition survey	A new detailed topography survey was provided
2	Incorporation of Design Drainage and Pump design	Updated drainage and pump design for the site
3	Incorporation of Civil Design	Updated civil design for the site
4	Incorporation of Railway track Design	Updated rail design for the site

3.4 DDR to IFC

Key design changes between the DDR and the IFC Design are listed in Table 3-5.

Table 3-4: Design Differences Between DDR and IFC

Item	Difference	Reason for Change
1	Updating sections and text throughout the report	To address the ARTC / IR / PE / TfNSW review comments. Text at E41 was amended to correct cross-referencing to other CoA numbers, and text to E41 and E46 was amended to reflect that ACC has been consulted through the process of design and report review.

Item	Difference	Reason for Change
2	Design addition only at the tie-in sections of the U-drain and overland flow channel for a smoother channel transition, while the cross-sections of both the U-drain and overland flow channel remain the same with the DDR stage design at the western overland channel.	IFC stage design update
3	6m of channel section next to pump station to be lined with rock mattress	IFC stage design update

3.5 IFC to IFC Rev1

Key design changes between the IFC and the IFC Rev 1 are listed in Table 3-5.

Table 3-5: Design Differences Between IFC and IFC Rev1

Item	Difference	Reason for Change
1	Including the Section 5.5.3 for Primary Pump Failure Assessment	To address the CPHR comment

4 MODELLING METHODOLOGY

Detailed hydraulic modelling using TUFLOW was undertaken for this flood and impact assessment. The study area is the track area under the Riverina Highway bridge.

The overall approaches for flood modelling are listed below:

- Update the Hydrology from ARR 1987 to ARR 2019 and produce inflows to be used in the hydraulic model.
- Updating the received TUFLOW model by incorporating the latest LiDAR (2020) and survey data (Items 2, 5 and 6 from Table 1-2).
- Comparison of the existing case TUFLOW against the flood study around the site area.
- Using the updated TUFLOW model to predict existing hydraulic behaviour, which forms the existing case against which the implementation of the design works is assessed.
- Updating the TUFLOW model from existing conditions to design conditions by incorporating the design into the existing case model.
- The Riverina Highway bridge deck is not included but the bridge abutment and embankments are captured as per the detailed survey in the flood assessment. This is because the bridge does not have a pier which would impact the flooding characteristics within the railway corridor, and the bridge deck is too high to be an obstruction to flooding characteristics within the railway corridor,
- Conducting a climate change sensitivity test for the 1% AEP to inform the potential impact on the railway track flood immunity.
- Conduct a blockage assessment as per ARR 2019 procedures.
- Conduct a pump failure sensitivity assessment.

4.1 Catchment Description

The Riverina Highway bridge site is located within the urban area of Albury and away from Murray River. Thus, it is not subject to regional flooding. However, the site is affected by overland flooding. The flood water coming from the northern catchment of The Scots School Albury runs along the rail corridor in a south-east direction. This surface runoff flows through a 3-cell box culvert (CH644770 in Figure 4-4) into an open channel on the eastern side of the railway, followed by a piped section connecting with Mudges Canal. Mudges Canal continues about 1.5km to the south before discharging into the Murray River.

4.2 Hydrologic Modelling

4.2.1 ARR2019 Approach

The hydrology models (DRAINS-RAFTS and DRAINS-ILSAX) related to Albury FRMSP (WMAwater, 2016) and Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Lyall & Associates, 2011) were originally built based on ARR1987, by Others. An excerpt from the study report is shown in the Figure below.

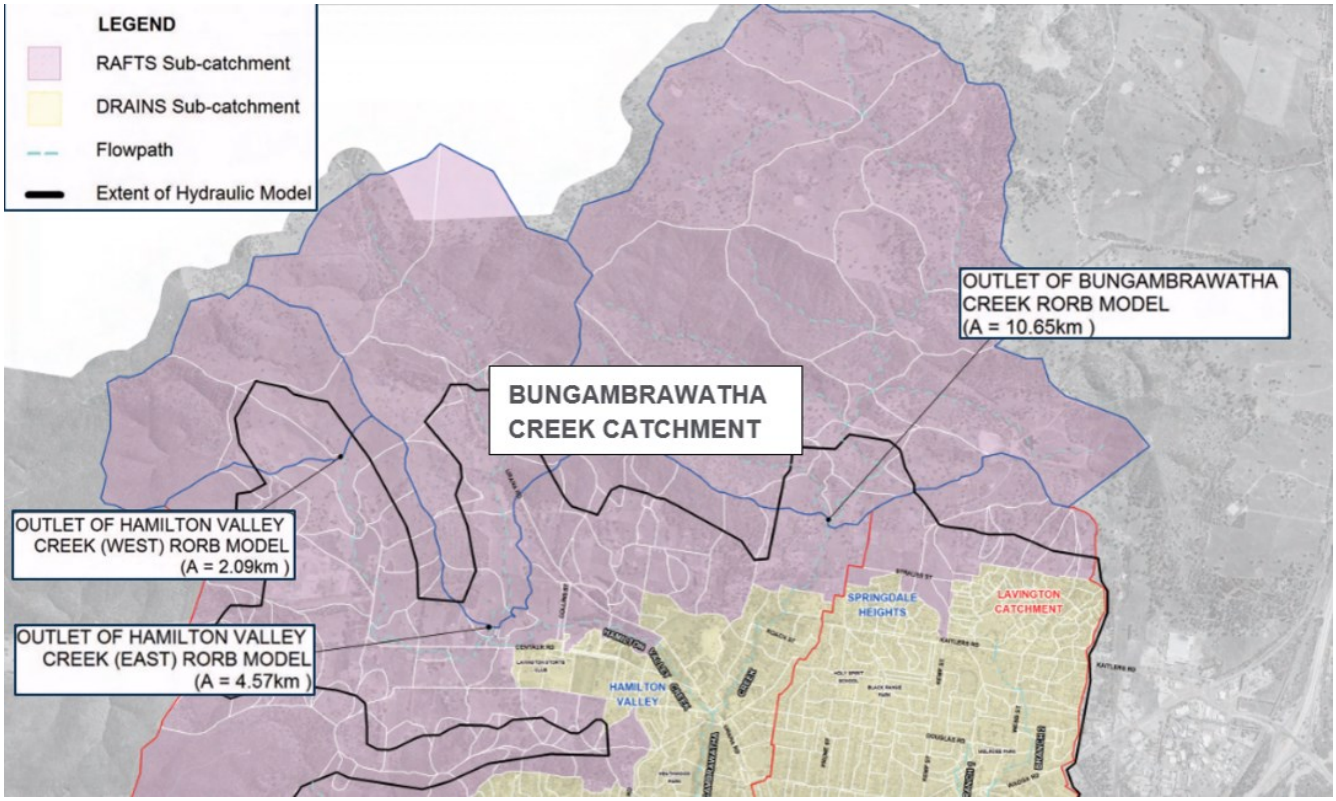


Figure 4-1 Sub-catchment Plan from Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study (Source: Figure 3.1-1 of Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study, Lyall & Associates, 2011).

Figure 4-1 describes that a RAFTS model was used for the upstream catchment while the DRAINS model was used for the densely populated catchment within the Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study. These hydrology models were not received from the Council and consequently, hydrology models have been built adopting ARR2019 to provide inflows to TUFLOW as part of the detailed design engagement. The sub-catchments delineation is shown in Figure 4-2. The DRAINS-RAFTS model was used to provide the SA inflow for the upstream catchment and the catchment within the study area but does not contain any drainage network (this inflow approach is consistent with the one adopted by the hydraulic model from Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study). Instead of DRAINS-ILSAX (ARR2019 recommended initial loss and continue losses cannot be used in DRAINS-ILSAX), Rainfall Excess was calculated to be applied to the urbanised catchment with drainage network. The parameters for the two types of models were summarised in Table 4-1. The PMF Hydrology model was based on the ARR1987 guidelines. This was then updated as per ARR2019 guidelines incorporating an ensemble of 11 temporal patterns for GSDM PMF from 15 minutes to 180 minutes.

Table 4-1: Hydrology Models Parameters

Parameters	Hydrology model for upstream catchment and the catchment within the study area but does not contain any drainage network	Hydrology approach for urbanised catchment
Model Type	DRAINS-RAFTS[1]	Rainfall Excess only
Areal Reduction Factor	Not Applied (As per Bungambrawatha Creek, Lavington, South Albury and West Albury Flood Study)	
Temporal Patterns	ARR2019 Temporal patterns (refer to Appendix B)	
Rainfall Losses	Refer to Section 4.2.3 and Appendix B	
Rainfall Depth	Refer to Appendix C	
Output	Routed hydrograph	Rainfall excess
Design Events	10% AEP, 5% AEP, 2% AEP, 1%AEP, 1%AEP with Climate Change, PMF	

Drains software with Rafts storage routing module, enables detailed simulation of the storage and routing of stormwater through various catchment elements. It also supports the latest guidelines and methodologies outlined in the Australian Rainfall and Runoff 2019 (ARR2019).

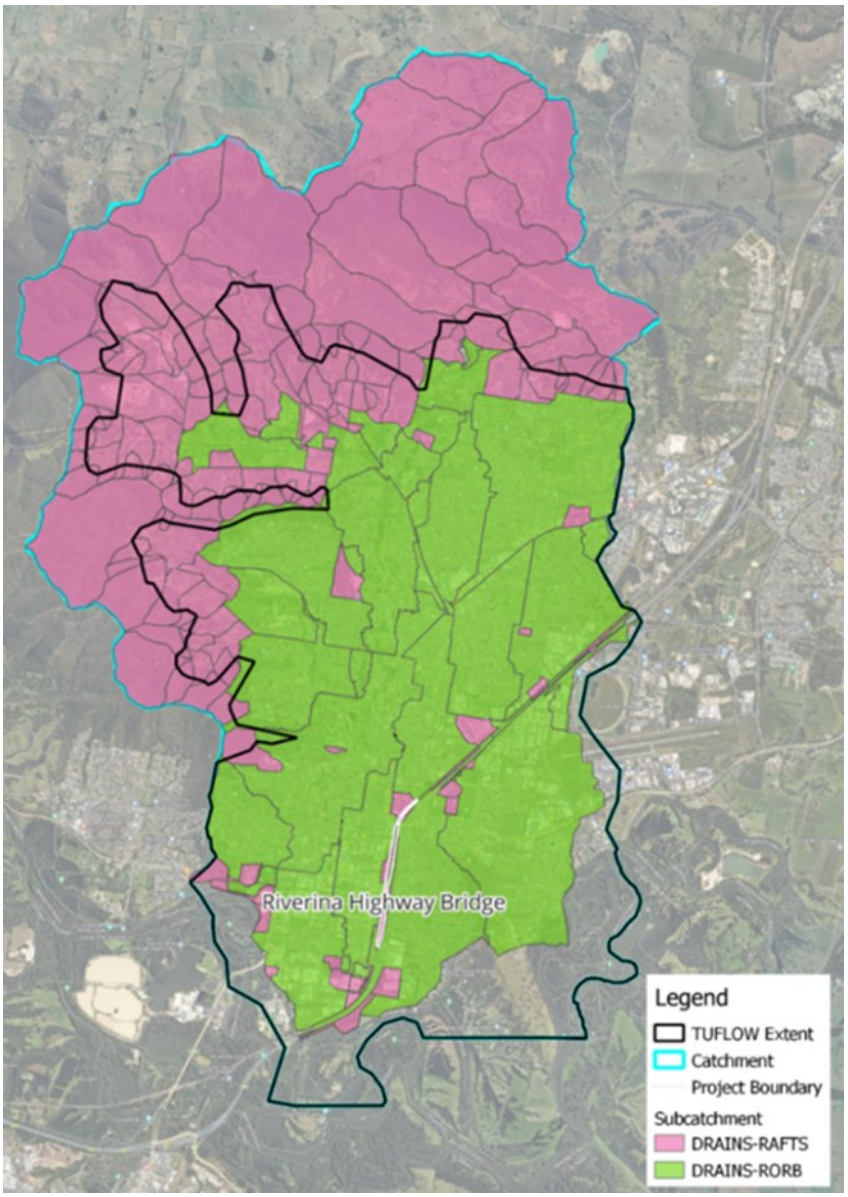


Figure 4-2 Excerpt from the flood study showing sub-catchments

4.2.2 Climate Change

An assessment was conducted to evaluate the influence of climate change on flooding to anticipate future climate change flood risk. As per the EIS report (Section 3.3.5 of Albury to Illabo Environmental Impact Statement Technical Paper 11), 2090 RCP8.5 interim climate change factor sourced from the ARR Data Hub (https://data.arr-software.org/) was adopted.

Sea level rise will not affect the site as it is far away from the sea. In addition, as per FRMS (Figure 9), the site is outside of the Murray River PMF extent. Therefore, the water level resulting from climate change in the Murray River will not affect the site.

4.2.3 Input Data for Design Flood Estimation

This study adopted the ARR 2019 procedure for NSW Specific Data to run the hydrological model. Probability Neutral Burst Initial Loss and storm continuing losses times 0.4 (1.8 mm/h) were used for pervious area. An initial loss of 1mm and continuing losses of 0 mm/h were adopted for impervious area. The design events of 10%, 5%, 2%, 1% AEPs, PMF and 1% AEP with Climate Change were selected to run.

Flow hydrographs were generated for input to the hydraulic model for the 10% AEP, 5% AEP, 2% AEP, 1% AEP, PMF and 1% AEP + Climate Change events to perform critical duration analysis (Refer to Section 4.3.1).

4.3 Hydraulic Modelling

4.3.1 Existing TUFLOW Model Update

The TUFLOW hydraulic model was updated with modelling based on the received Albury FRMSP (WMAwater, 2016) detailed in Section 1.9.1. A summary of the received Albury FRMSP 2016 TUFLOW Model (item 1 from Table 1-2) and updated DDR model parameters can be found in Table 4-2. The model extent encompasses Bungambrawatha Creek, South Albury and Lavington catchments (Figure 4-3).

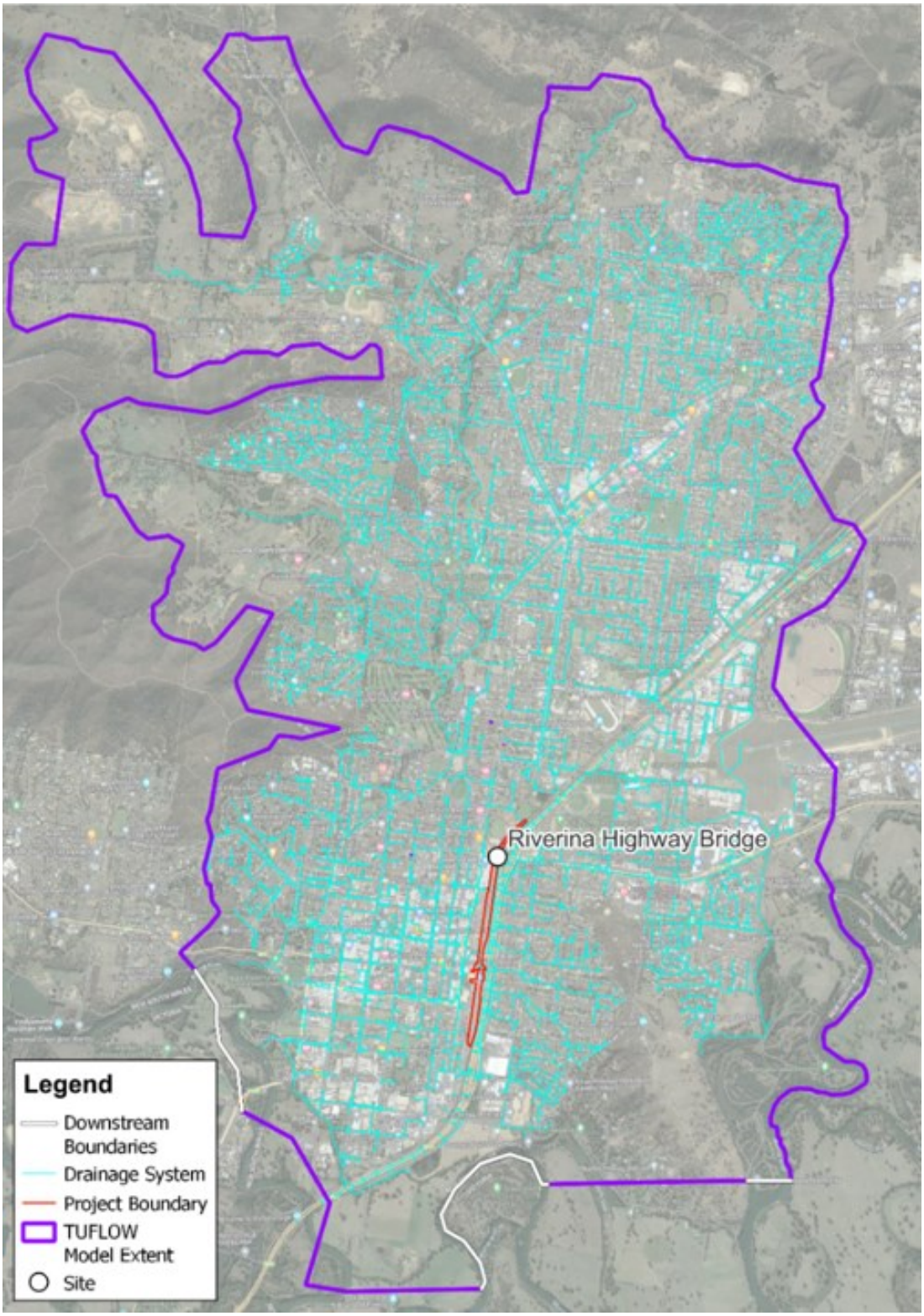


Figure 4-3: TUFLOW Model Extent

Table 4-2: Model Parameters in the Albury FRMSP 2016 TUFLOW Model and the Updated DDR Existing Case TUFLOW Model

Parameters	Albury FRMSP 2016 TUFLOW Model	Updated DDR TUFLOW Model (Existing Case)
Software Version	TUFLOW 2012-05-AB-w64 Classic	TUFLOW.2020-10-AF HPC
Coordination Reference System (CRS)	GDA94 MGA 55	GDA2020 MGA 55 Refer to the following Section 4.3.1.3 for more details.
Grid Size	5m	0.625m within the quadtree area (Site area) and 5m outside of the quadtree area (refer to Figure 4-4)
Hydrology	DRAINS-RAFTS and DRAINS-ILSAX (ARR1987)	DRAINS-RAFTS and DRAINS-RORB (ARR2019)
Inflow type	External inflow and SA Polygons	External inflow, Rainfall Excess, and SA Polygons Refer to the following Section 4.3.1.4 for updating details
Key Features	Existing railway track was not defined	Surveyed existing railway track was included
Extent	Bungambrawatha Creek, South Albury and Lavington catchments	Bungambrawatha Creek, South Albury and Lavington catchments
Downstream Boundary	Constant downstream water boundary	Constant downstream water boundary
Timestep	0.5s	Dynamic
Building Representation	High Manning's (10)	High Manning's (10)
Topography	DTM (5m resolution) based on Airborne Laser Scanning (ALS) survey in May 2005. The accuracy is ±100mm for urban area and ±250mm for wider Albury LGA. Cross section data for major trunk infrastructure	DTM (5m resolution) based on Airborne Laser Scanning (ALS) survey in May 2005. The accuracy is ±100mm for urban area and ±250mm for wider Albury LGA. Cross section data for major trunk infrastructure 2020 LiDAR for sites Point cloud survey and detailed survey for Riverina Highway bridge and railway corridor (Items 4 and 5 in Table 1-2 respectively)
Roughness	Asphalt or concrete road surface: 0.02 Concrete Surfaces: 0.015 Well Maintained Grassed Cover e.g. sporting oval: 0.03 Grass or Lawns: 0.045 Macrophytes: 0.06 Lightly Vegetated Areas: 0.07 Trees: 0.08 Trees and Shrub: 0.09 Mildly Dense Vegetation: 0.12 Dense vegetation: 0.135 Buildings: 10 Water Bodies/Wetlands: 0.035 Pastoral Grass, Tough Scrub Grass: 0.05 Rock Riprap: 0.06 Selected Roads in the Bungambrawatha Creek catchment: 0.06	Asphalt or concrete road surface: 0.02 Concrete Surfaces: 0.015 Well Maintained Grassed Cover e.g. sporting oval: 0.03 Grass or Lawns: 0.045 Macrophytes: 0.06 Lightly Vegetated Areas: 0.07 Trees: 0.08 Trees and Shrub: 0.09 Mildly Dense Vegetation: 0.12 Dense vegetation: 0.135 Buildings: 10 Water Bodies/Wetlands: 0.035 Pastoral Grass, Tough Scrub Grass: 0.05 Rock Riprap: 0.06 Selected Roads in the Bungambrawatha Creek catchment: 0.06

Parameters	Albury FRMSP 2016 TUFLOW Model	Updated DDR TUFLOW Model (Existing Case)
	Allotments where fences and outbuildings are present: 0.1	Allotments where fences and outbuildings are present: 0.1 Concrete Open channel: 0.02 (adapted to be in line with the drainage design) Proposed Channel: 0.03
Design Events	PMF, 0.2% AEP, 0.5% AEP, 1%AEP, 2% AEP, 5% AEP, 10% AEP, 20% AEP	PMF, 1% AEP with climate change, 1% AEP, 2% AEP, 5% AEP, 10% AEP

4.3.1.1 GDA2020 conversion

The conversion to GDA2020 of the Tuflow data received from Albury Council, represents a crucial update to modernise and align the model with the latest geodetic standards and reference systems and to meet project requirements on the CRS. The model layers and the rasters were converted into GDA2020 MGA 55 from GDA94 MGA 55.

4.3.1.2 Topography

The model topography was updated by incorporating the 2020 LiDAR, point cloud survey and detailed survey. This update was performed to enhance the accuracy of the model, ensuring a proper representation of the most recent topography within the study area (Refer to Figure 4-4).

4.3.1.3 TUFLOW Model Version and Grid Size

To capture the design including railway track, cess drain, and open channel in the model, a fine grid was required. Therefore, a newer TUFLOW model version needed to be adopted to provide a finer grid for the required area (this function is called “quadtree” and is available in TUFLOW versions from 2020 onwards). For this purpose, a finer resolution of 0.625m was adopted for the site and 5m outside the site to enable detailed representation and assessment of the design.

The model is set up using point terrain data (*.mid) instead of the grid (ASCII) for topography outside the LiDAR extent (as per the original received model). The latest TUFLOW version 2023-03-AC does not support when using quadtree with point terrain data. Therefore, TUFLOW release 2023 onwards cannot be used. However, the version before the 2023 release would run without any issues (as long as the quadtree extent does not extend into the point terrain data - refer to Figure 4-4). Thus, TUFLOW 2020-10-AF HPC (the latest version prior to the 2023 release) was selected to conduct this flood assessment.

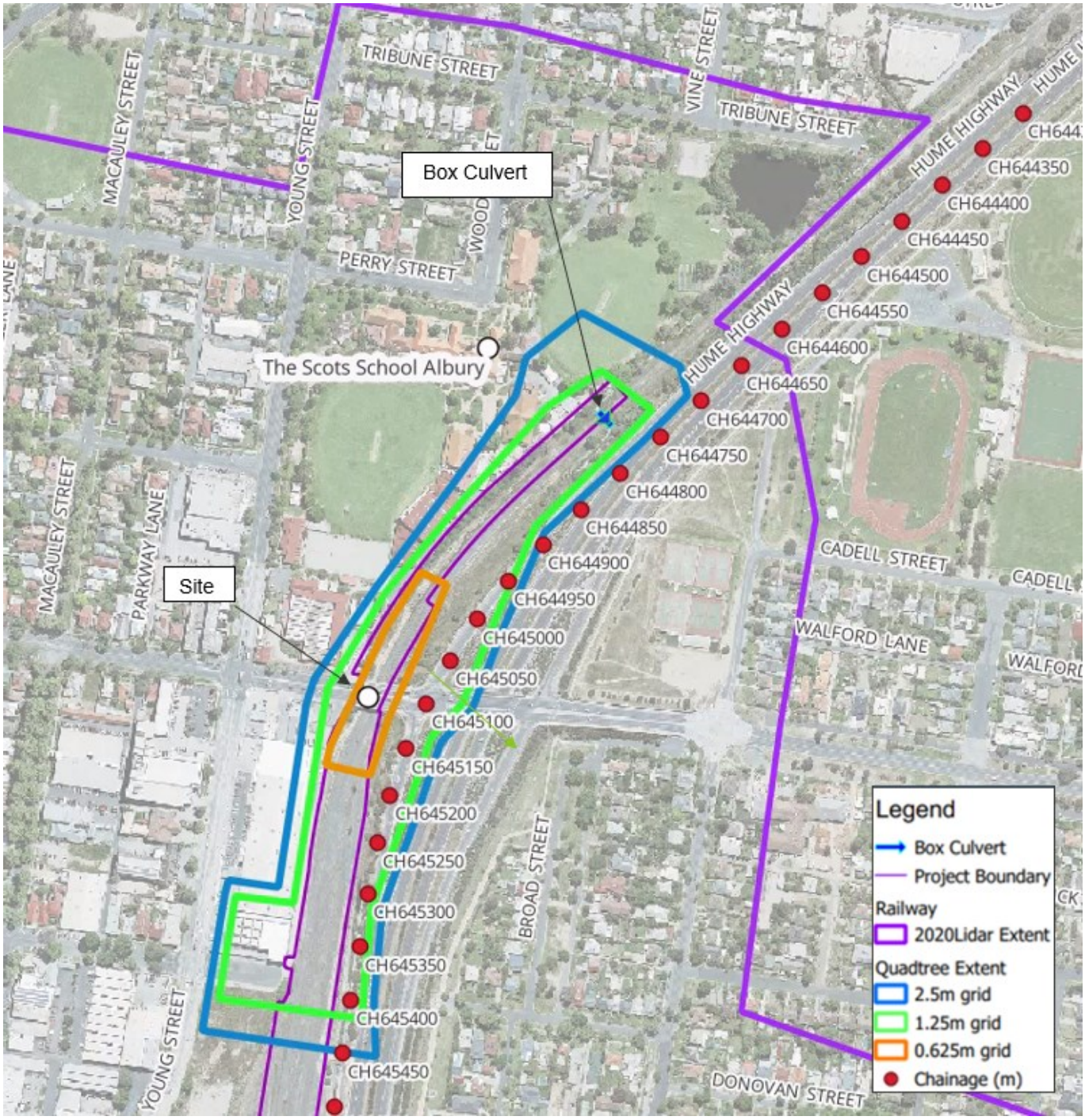


Figure 4-4: Adopted LiDAR 2020 Extent and Grid Size Extent

4.3.1.4 Inflows

The inflow polygons (CH644800 to CH645100) covering the railway corridor upstream of the Riverina Highway bridge were updated based on the review of the LiDAR 2020. As is shown in Figure 4-5, the original inflow polygon covers the whole railway corridor then all the inflow is assumed to be assigned to the location indicated by the red arrow on the western side of the railway. However, this does not reflect the real situation as within the green polygon area in Figure 4-5 there should be two drainage lines on either side of the rail line (cyan dash lines in the right panel of Figure 4-5), capturing the water from the east and west catchment of the railway. To reproduce the realistic flood behaviour, the original inflow polygon was split into two.

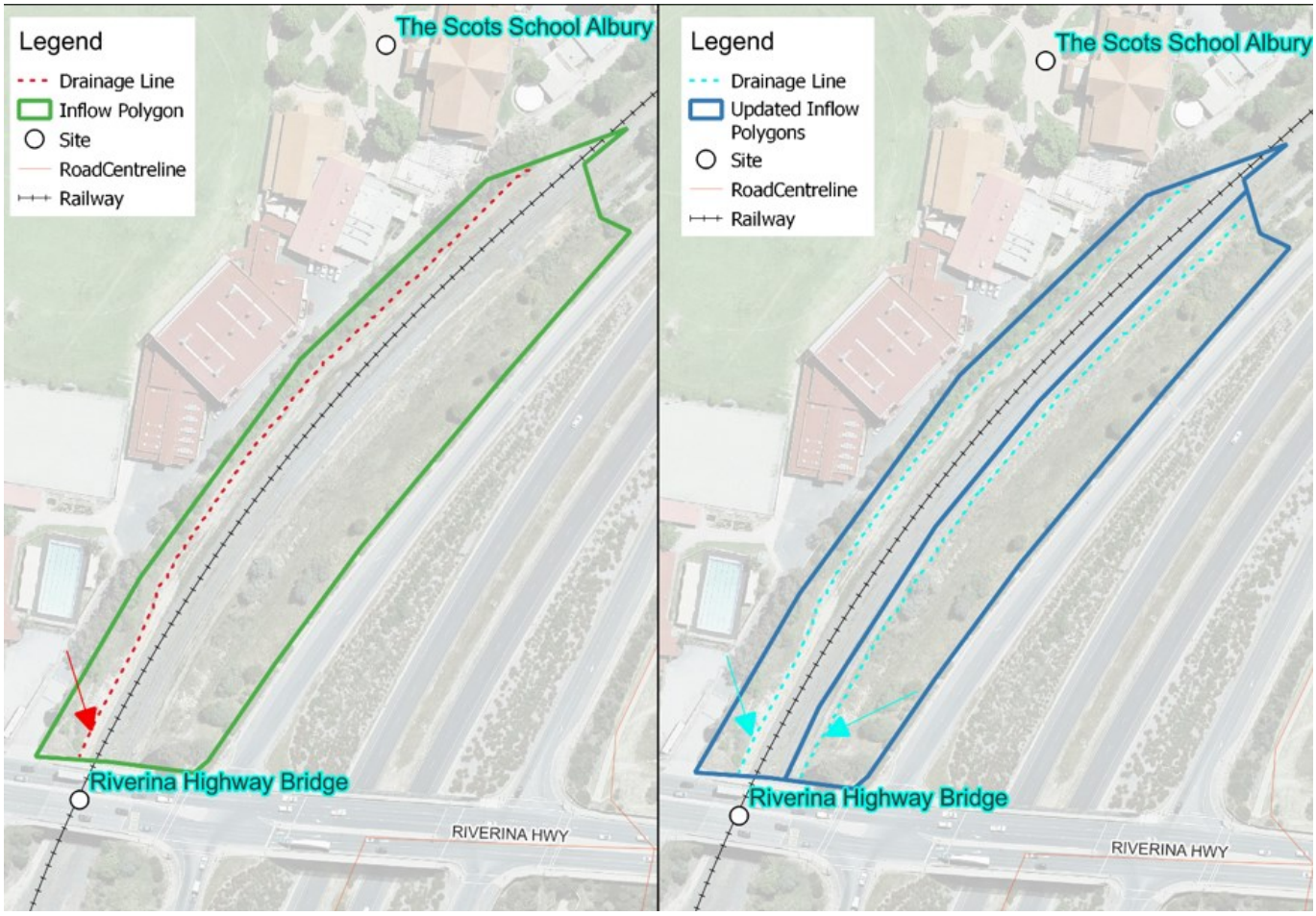


Figure 4-5: Inflow Polygons Update (Left: Original Inflow Location; Right: Updated Inflow Location)

4.3.1.5 Key Features

The Albury FRMPS TUFLOW model did not model the railway track line within the study area. As the key feature, ignoring the railway track will result in inaccurate results. As such, the existing railway track around the Riverina Highway bridge (CH644750 to CH645650) was included in the updated existing case TUFLOW model (refer to Item 6 in Table 1-2).

4.3.1.6 Drainage Network

The drainage data based on detailed survey was incorporated into the updated DDR TUFLOW model (refer to Item 9 in Table 1-2). The Albury FRMPS TUFLOW model drainage data is used outside the site and updated in relation to the 2020 LiDAR.

4.3.1.7 Design Events

The storm durations of 30min, 45min, 60min, 90min, 120min, 180min, 270min, 360min, 540min and 720min were modelled. An ensemble of 10 temporal patterns was run for each duration as recommended in ARR2019. The critical durations were determined based on the maximum envelope method across the selected durations. The model was run for the design events of 10%, 5%, 2%, 1% and 1% AEP with climate change. The critical duration and temporal patterns determined and elaborated below in Table 4-3 summarise the information of the design events.

Table 4-3: Summary of Events and Critical Durations Run in TUFLOW –Riverina Highway Bridge.

Design Events	Master Design Critical Duration and Temporal Pattern	Temporal Pattern
10% AEP	30minutes, 45minutes, 120minutes, 180minutes, 540minutes	All 10 temporal patterns for each duration
5% AEP	30 minutes, 45 minutes, 60 minutes, 120 minutes	
2% AEP	30 minutes, 60 minutes, 270 minutes	
1% AEP	30 minutes, 90 minutes, 120 minutes, 270 minutes	

Design Events	Master Design Critical Duration and Temporal Pattern	Temporal Pattern
1% AEP + Climate Change	30 minutes, 90 minutes, 120 minutes	
PMF	180 minutes	All 11 temporal patterns for each duration

4.3.2 Design TUFLOW Model Update

4.3.2.1 Key Features

To establish the model for design condition, updates were undertaken to incorporate the Inland Rail Project Works as part of the DDR stage. Table 4-4 and Figure 4-6 include proposed work details.

Table 4-4: Design Condition Key Features

Item	Design	Details
1	Track	The railway tracks within the site underwent a significant modification by lowering them to an approximate depth of up to 1.1 metres from the existing track level under the Riverina Highway bridge. (Refer to Section 4.2 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding track design changes)
2	Drainage	• A 450mm diameter pipe network connecting to a new pump. (Refer to Section 4.5 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding Drainage design) • Inclusion of western overland flow channel. A crest was created near CH644920 to produce a storage area with an approximate height of 0.6m towards the Mudges Canal. The channel is used as a Rail Maintenance Access Road at the southern side of the Riverina Highway bridge. • Inclusion of a cess drain between the western overland flow channel and the railway track. • Inclusion of eastern overland flow channel parallel to the Loop Railway line (Refer to Drawing 5-0052-210-CDR-B4-DR-0015 and 5-0052-210-CDR-B4-DR-0201 for channel schedule and long section respectively. The drainage channels and earthworks design incorporate positive grades, preventing any trapped low points that could cause ponding within the proposed work area. Between two cross-sections, there will be no localised depressions between adjacent cross-sections).
3	Civil	Rail Maintenance Access Road at the south-eastern side of the Riverina Highway bridge. (Refer to Section 4.3 of 5-0052-210-PEN-B4-RP-0001_D for more details regarding civil design)
4	Pump System	Inclusion of pump system and associated storage. In the design scenario, flow from the 450mm pipe located upstream of the pumps will be channelled into a storage tank, from which the water will subsequently be pumped out. Two identical pumps were included in the model and they were modelled in dynamic ways with 0.075 m^3/s pumping out flow during higher head. To be specific, the first pump will be activated when the water level reaches 156.726mAHD, while the second pump will engage when the water level rises to 158.310mAHD. Both pumps are designed to convey water to Mudges Canal, through a 225 mm diameter pipe (Refer to Figure 4-6). This operation rule is based on DJV pump team input. For details of the pump refer to Section 4.10 of the Design Report 5-0052-210-PEN-B4-RP-0001.

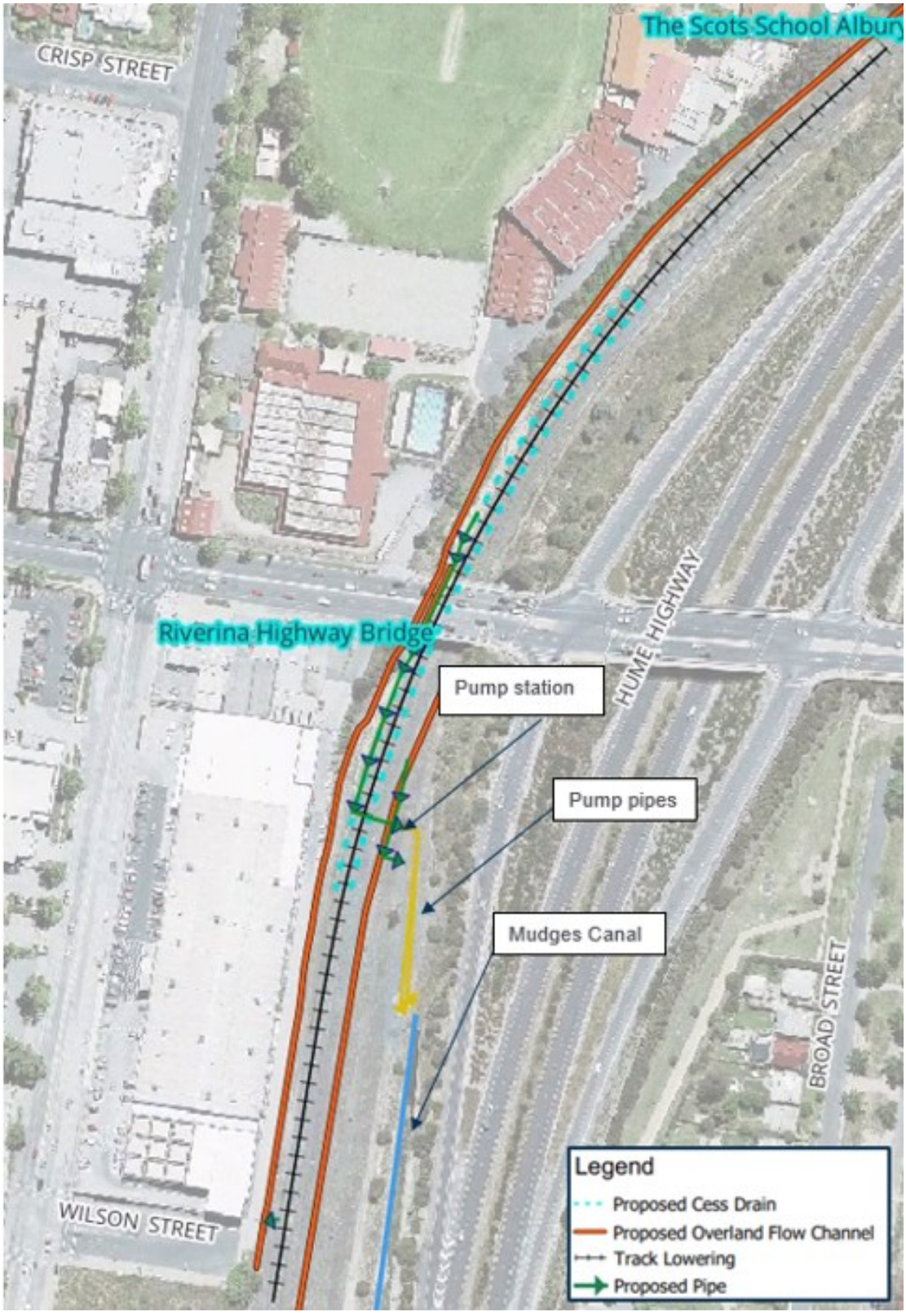


Figure 4-6: Proposed Designs Included in the Model

4.3.2.2 Catchment area Inflows

As shown in Figure 4-7, compared with the existing model inflow locations (Figure 4-5, right panel), the western catchment was divided into three sub catchments: one for railway corridor catchment draining to the new proposed cess drain (cyan arrow); one for western catchment draining to the proposed overland flow channel (red arrow) and the upper small catchment will flow towards Mudges Canal (blue arrow). The eastern catchment remained unchanged (black arrow).

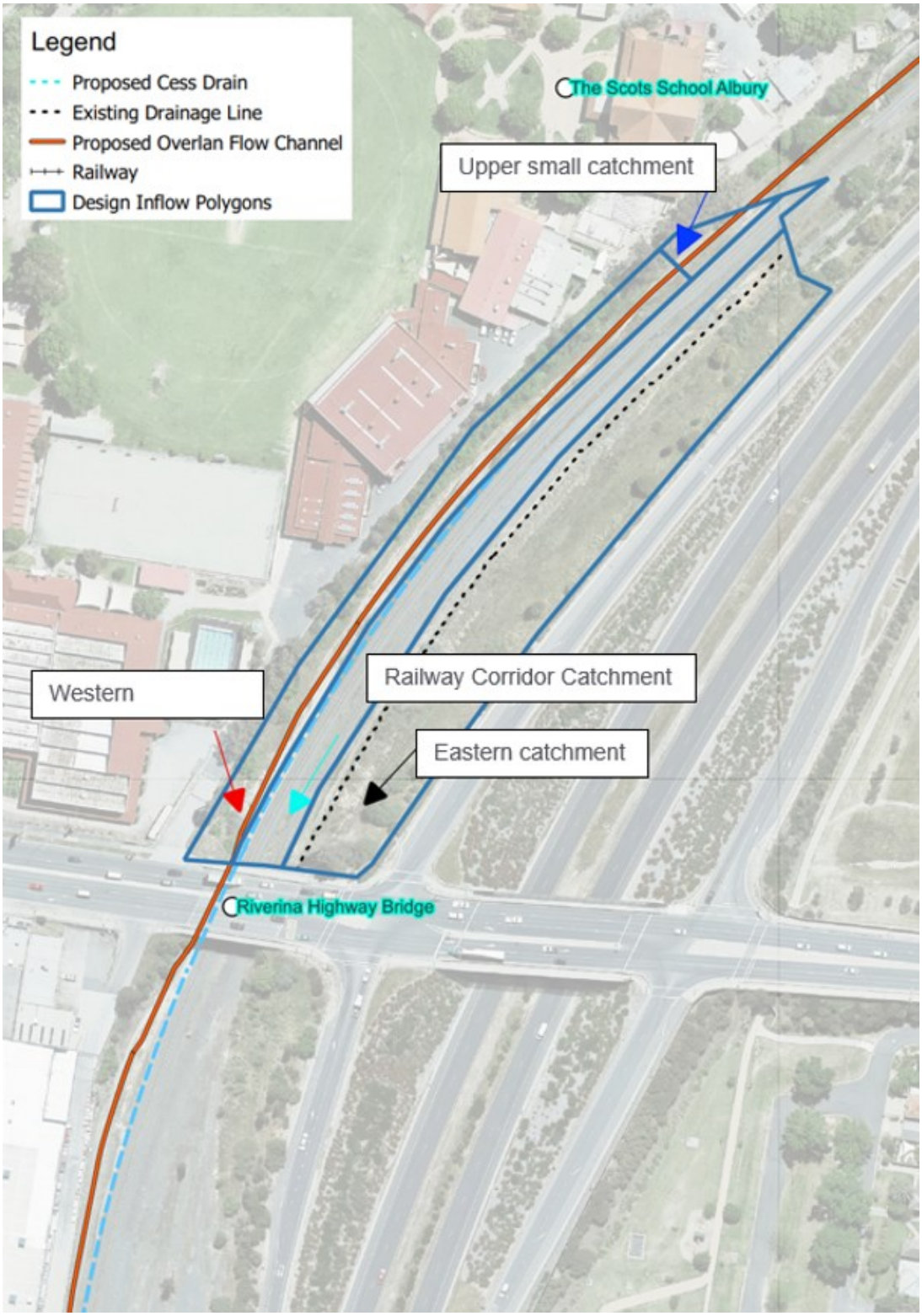


Figure 4-7: Design Inflow Polygons

4.3.3 Existing Flow Comparison between ARR2019 and ARR1987 at Key Location

The updated existing case TUFLOW model with ARR2019 was compared against the information provided in Table E3 of Bungambrawatha Creek, Lavington, South Albury and West Albury flood study (Lyall & Associates, 2011). As a key inflow into the study area, the 1% AEP flow breaking out from the 3-cell culvert (Ch644.770km) into the railway corridor from the updated model (ARR2019) was compared with the flows reported in the flood study (indicated in Figure 4-8). The flood study indicates that the flow is around 0.4m3/s (1% AEP) while the flow from the updated existing model in this assessment is around 0.87m3/s (1% AEP, critical duration 120 min Temporal pattern 10). This indicated that at around the site area (purple polygon in Figure 4-8), ARR2019 will produce a higher flow than ARR1987 for the 1% AEP event.

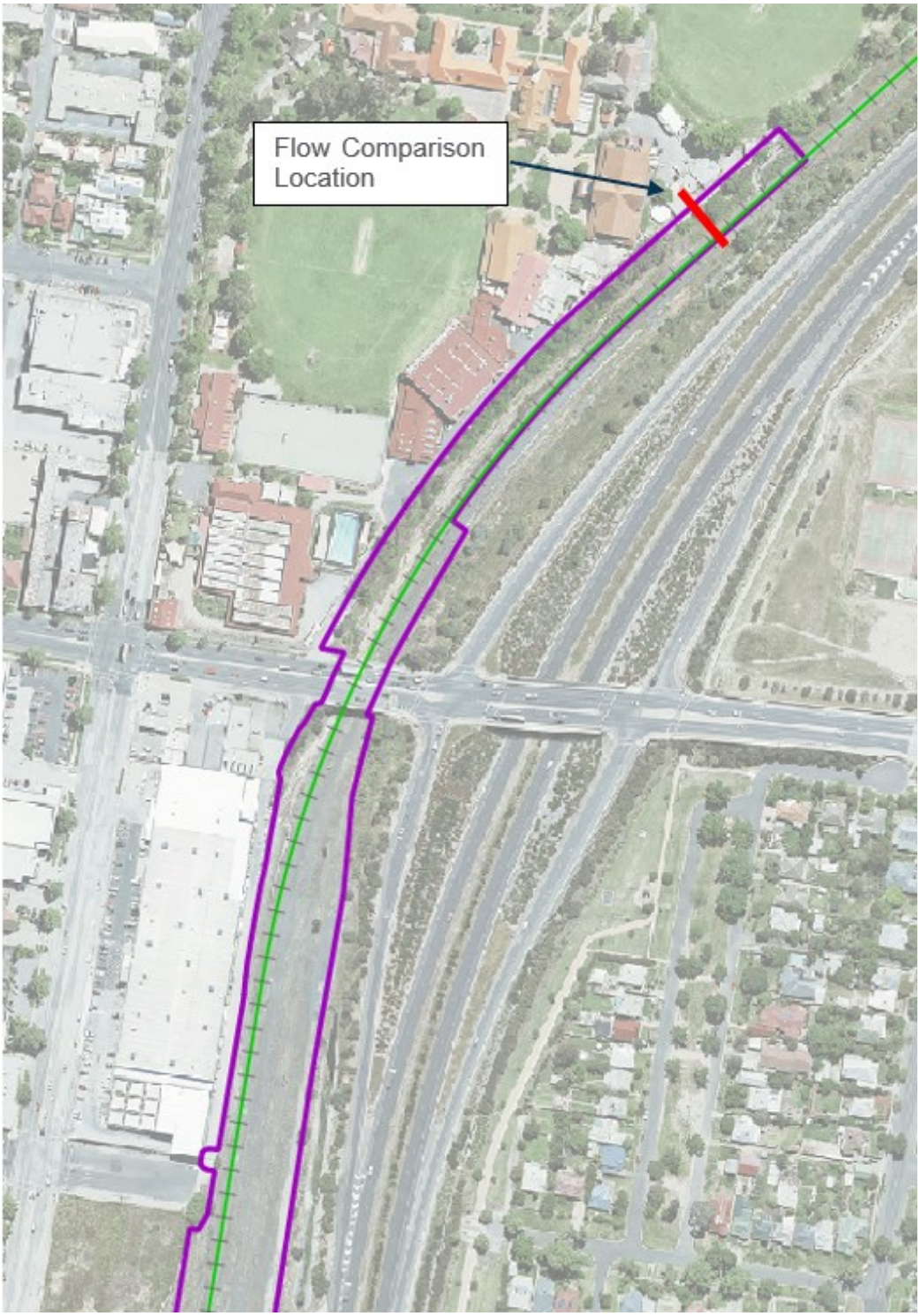


Figure 4-8: Flow Comparison Location

5 FLOOD ASSESSMENT

5.1 Existing Condition

Existing flood maps presenting peak flood depths and level contours, peak velocities, and flood hazard for the events modelled are provided in Appendix A.

The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert (Figure 4-4) positioned to the north of the site (CH644.770km). The existing open channel at the western side of the Main railway track collects this excess flooding water and redirects it towards the south (refer to

Figure 5-1). The primary existing drainage network in the site flows towards to the Mudges Canal and secondary drainage network flows towards Wilson Street (refer to Figure 5-2).

According to the Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, flooding and water quality (July 2022), the Albury FRMSP 2016 TUFLOW Model indicated that the existing railway line experienced overtopping in 20% AEP event. The updated modelling of this project now demonstrates that the existing rail level remains immune to overtopping up to the 2% AEP event under the Riverina Highway bridge area. This is due to:

- The existing railway track was not represented in the Albury FRMSP 2016 TUFLOW Model. Subsequent updates to the TUFLOW model, which included incorporating data from an existing rail survey and employing a finer grid size within the site, have improved the accuracy of the TUFLOW model and the presentation of the actual rail line levels.
- As discussed in Section 4.3.1, the initial model utilised a single SA polygon that covered two channels, directing water to the lowest point of one channel. SA polygon was now divided into two separate polygons, each designed to direct flows into its respective channel. This modification corrected the flooding situation downstream of the channels because the flow was now correctly divided into two distinct pathways, aligning with the natural drainage patterns.
- The railway corridor under the Riverina Highway bridge was not properly represented in the Albury FRMSP 2016 TUFLOW Model. The railway corridor levels underneath the Riverina Highway bridge were 0.5m lower than the surrounding area, which was created artificially by implementing a terrain modification and was not real. This was corrected in the updated TUFLOW model by using LiDAR 2020 and survey data.
- Points of interest in the site are indicated below (Refer to

Figure 5-1)

  - Point 1 - Located at western overland channel north of the crest
  - Point 2 - Located at western overland channel south of the crest
  - Point 3 - Located at western overland channel North of Riverina Highway Bridge
  - Point 4 - Located at railway corridor channel
  - Point 5 - Located at main railway track line
  - Point 6 - Located at railway corridor channel
  - Point 7 - Located east to the railway track lines
  - Point 8 - Located at western overland channel North of Wilson Street
  - Point 9 - Located at western overland channel near Wilson Street

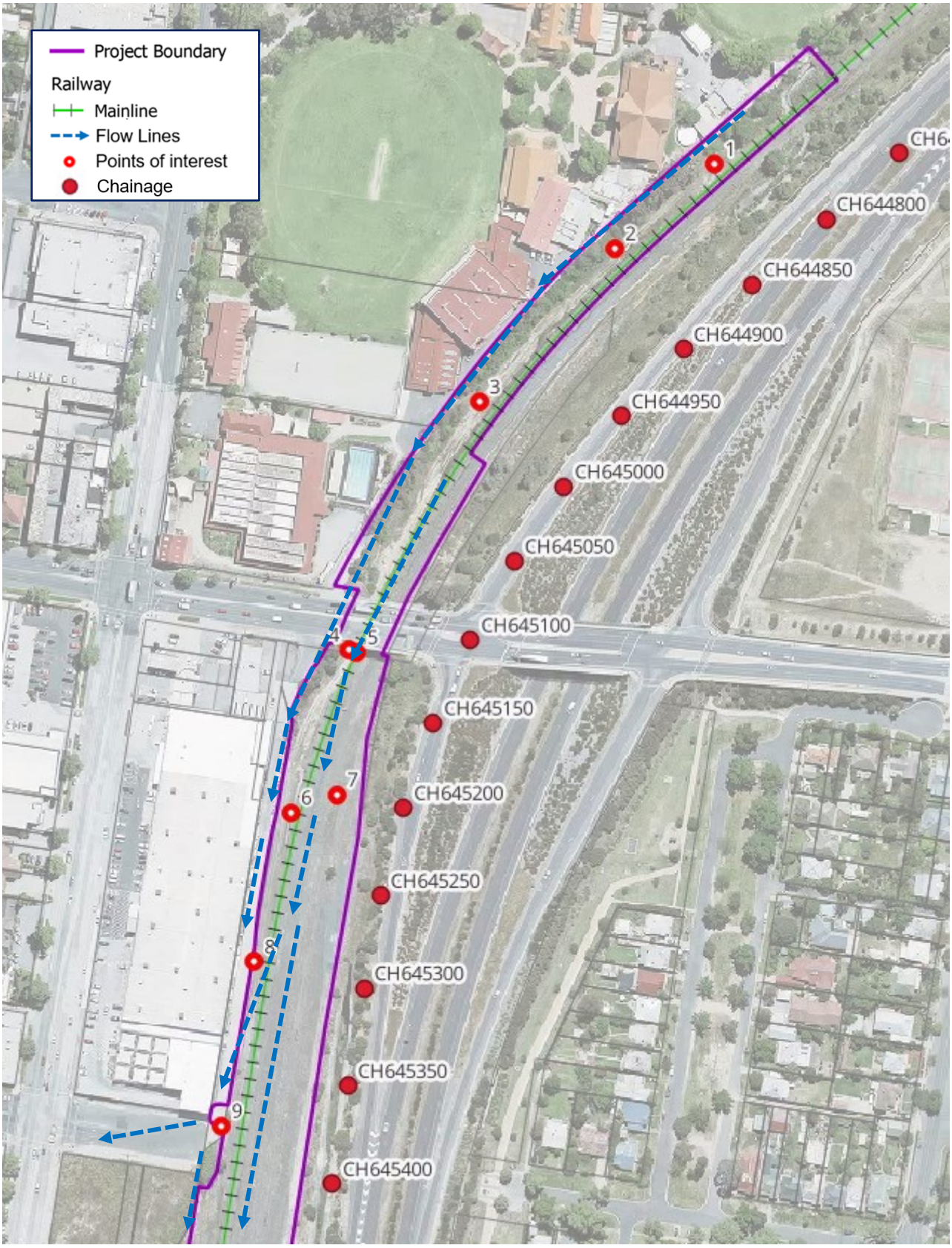


Figure 5-1: Riverina Highway Site Existing Scenario Overland Flow Paths for 1% AEP

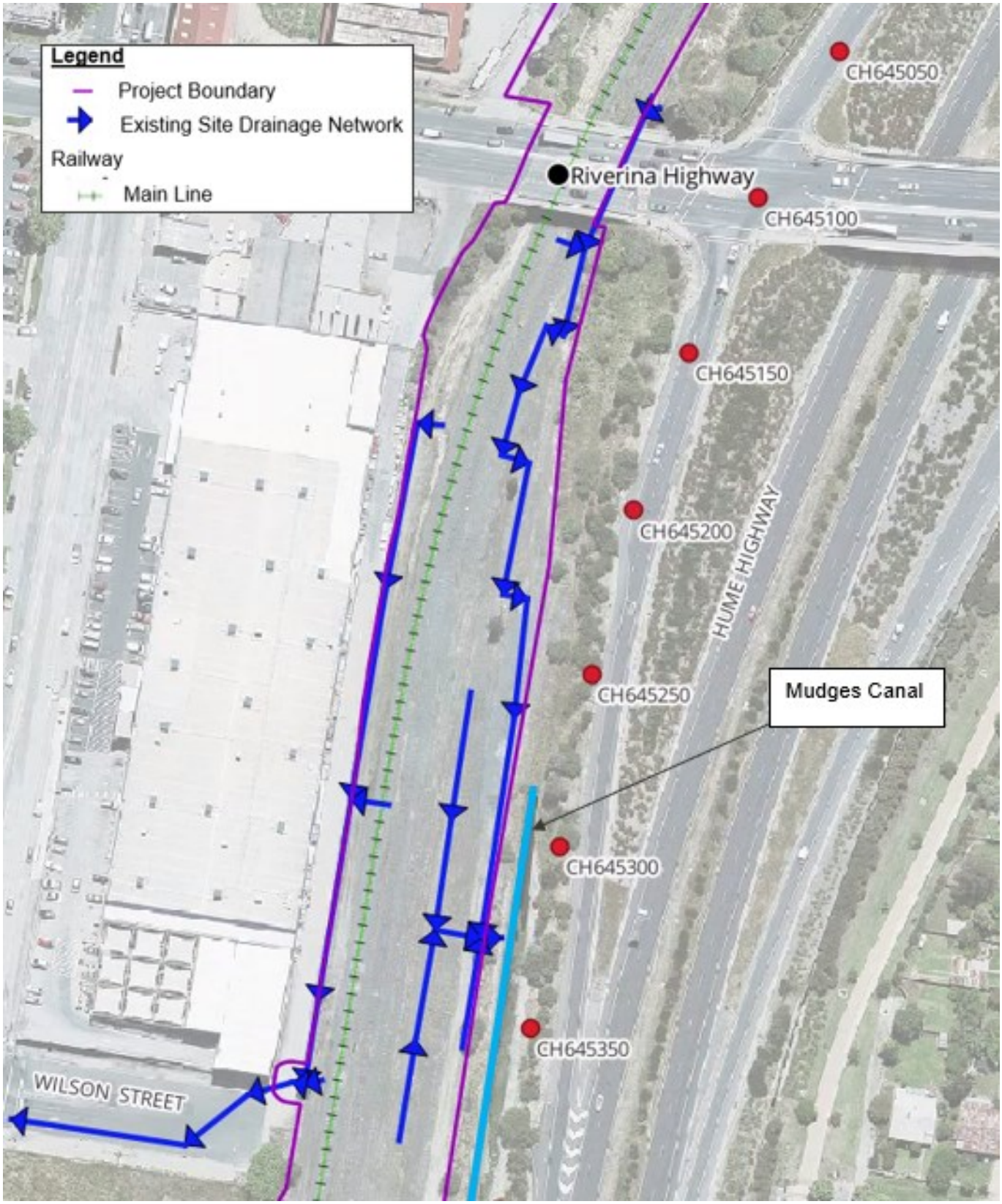


Figure 5-2: Riverina Highway Site Drainage

Table 5-1 summarise the peak flood level results for the existing condition in the study area and points of interest (refer to Figure 5-1 for the location).

Table 5-1: Peak Flood Levels – Existing Condition

Design Events	Flood Levels
10% AEP	The flood waters do not overtop the existing railway tracks. (Refer to Figure A1 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.40 m.
5% AEP	The flood waters do not overtop the existing railway tracks. (Refer to Figure A2 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.55 m.
2% AEP	The flood waters do not overtop the existing railway tracks. (Refer to Figure A3 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.60 m.
1% AEP	The flood waters overtop the top of rail levels between CH645250 - CH645350, generally with a depth of less than 50mm (Refer to Figure A4 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 0.10 - 0.70 m.
1% AEP + Climate Change	The flood waters overtop at multiple locations over the existing railway tracks south of the Riverina Highway bridge, generally with a depth of less than 200mm. (Refer to Figure A5 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 0.2 - 0.9 m.
PMF	The flood waters overtop at multiple locations over the existing railway tracks south to Riverina Highway bridge generally with a depth of less than 2.5 – 4m. (Refer to Figure A6 in Appendix A). The flood depth along the existing rail corridor is generally in a range of about 2 - 3 m.

Table 5-2: Points of Interest Data – Peak Flood Levels (mAHD) – Existing Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	Not flooded	163.15	163.16	163.31	163.49	166.20
Point 2	162.98	162.99	162.99	163.09	163.22	165.78
Point 3	161.91	161.91	161.92	162.03	162.21	165.31
Point 4	161.36	161.37	161.38	161.56	161.77	163.76
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	161.74	163.81
Point 6	161.08	161.11	161.14	161.43	161.59	163.73
Point 7	161.30	161.34	161.37	161.39	161.54	163.74
Point 8	160.98	160.99	161.00	161.32	161.49	163.40
Point 9	Not flooded	Not flooded	Not flooded	160.89	160.95	161.78

Table 5-3 summarises the Peak flood velocity results and Table 5-4 summarises Peak flood velocity at points of interest for the existing condition in the study area.

Table 5-3: Peak Flood Velocity – Existing Condition

Design Events	Flood Velocity
10% AEP	The peak velocity below the Riverina Highway bridge generally ranges up to 0.4 m/s. (Refer to Figure A7 in Appendix A). The peak velocity along the rail corridor open channel is generally less than 0.4 m/s
5% AEP	The peak velocity below the Riverina Highway bridge generally ranges up to 0.5 m/s. (Refer to Figure A8 in Appendix A).

Design Events	Flood Velocity
	The peak velocity along the rail corridor open channel is generally less than 0.5 m/s
2% AEP	The peak velocity below the Riverina Highway bridge generally ranges up to 0.5 m/s. (Refer to Figure A9 in Appendix A). The peak velocity along the rail corridor open channel is generally less than 0.6 m/s
1% AEP	The peak velocity below the Riverina Highway bridge generally ranges up to 0.8m/s. (Refer to Figure A10 in Appendix A). The peak velocity along the rail corridor open channel is generally less than 0.9 m/s
1% AEP + Climate Change	The peak velocity below the Riverina Highway bridge generally ranges up to 1.0m/s. (Refer to Figure A11 in Appendix A). The peak velocity along the rail corridor open channel is generally less than 1.1 m/s
PMF	The peak velocity below the Riverina Highway bridge generally ranges up to 4 m/s. (Refer to Figure A12 in Appendix A). The peak velocity along the rail corridor open channel is generally less than 3 m/s

Table 5-4: Points of Interest Data – Peak Flood Velocity (m/s) – Existing Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	Not flooded	0.1	0.1	0.5	0.7	1.5
Point 2	0.3	0.3	0.4	0.7	0.9	2.5
Point 3	0.1	0.1	0.2	0.4	0.5	1.8
Point 4	0.4	0.4	0.4	0.7	0.8	3.8
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	< 0.1	4.1
Point 6	0.1	0.2	0.2	0.4	0.8	2.1
Point 7	< 0.1	< 0.1	< 0.1	< 0.1	0.1	2.2
Point 8	0.2	0.3	0.3	0.4	0.4	2.1
Point 9	Not flooded	Not flooded	Not flooded	0.3	0.8	4.0

The flood hazard assessment is based on the general flood hazard classification set by the Australian Institute for Disaster Resilience in Australian Disaster Resilience Handbook Collection - Flood Hazard, 2017. Figure 5-3 and the tables below describe the hazards.

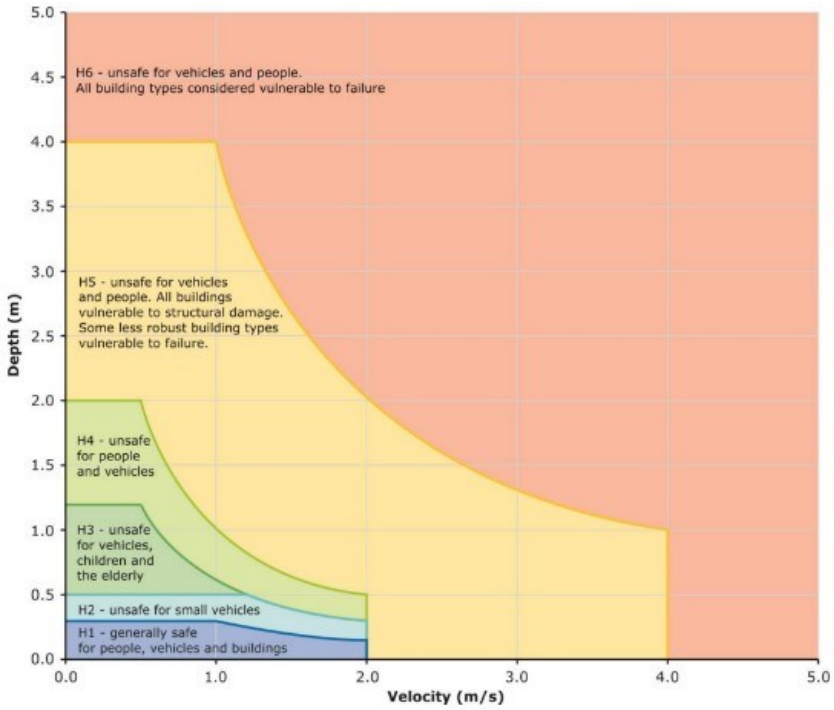


Figure 5-3: Hazard Category Classification

Table 5-5 summarises the Peak flood hazard results and Table 5-6 summarises Peak flood hazard at points of interest for existing condition in the study area.

Table 5-5: Flood Hazard – Existing Condition

Design Events	Flood Hazard
10% AEP	The flood hazard along the rail corridor open channel is generally H1. (Refer to Figure A13, Figure A14 and Figure A15 respectively in Appendix A).
5% AEP	
2% AEP	
1% AEP	The flood hazard along the rail corridor open channel is generally H1 and H2. (Refer to Figure A16 in Appendix A).
1% AEP + Climate Change	The flood hazard along the rail corridor open channel is generally less than H3. (Refer to Figure A17 in Appendix A).
PMF	The flood hazard along the rail corridor open channel is H6. (Refer to Figure A17 in Appendix A).

Table 5-6: Points of Interest Data – Peak Flood Hazard – Existing Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	Not flooded	H1	H1	H1	H2	H6
Point 2	H1	H1	H1	H1	H1	H6
Point 3	H1	H1	H1	H1	H2	H6
Point 4	H1	H1	H1	H2	H3	H6
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	H1	H6
Point 6	H2	H2	H2	H3	H4	H6
Point 7	H1	H1	H1	H1	H1	H6
Point 8	H1	H1	H1	H2	H3	H6
Point 9	Not flooded	Not flooded	Not flooded	H1	H1	H5

5.2 Design Condition

Design condition flood maps, including peak flood depths and level contours, peak velocities, and flood hazard for the events modelled are provided in Appendix A.

Table 5-7 summarises the peak flood level results for design condition within the study area.

The site primarily encounters flooding as a consequence of the surcharge from the existing box culvert positioned to the north of the site. The raised crest near Point 2 prevents the water from flowing south during small storm events up to the 2% AEP. However, in large storm events from the 1% AEP, the crest is overtopped, and water is flowing south along the overland flow channel (refer to Figure 5-3). The raised crest at point 2 will divert the water back into the Mudges Canal.

Point 1 experiences a greater flood depth under design conditions compared to existing conditions. This is due to the reduction in topographic levels near the Mudges Canal, which forces more water to flow into Point 1. The changes in flood levels at point 1 between the existing and design scenarios will be greater due to alterations in topography, particularly when compared to the upstream areas of the Mudges Canal.

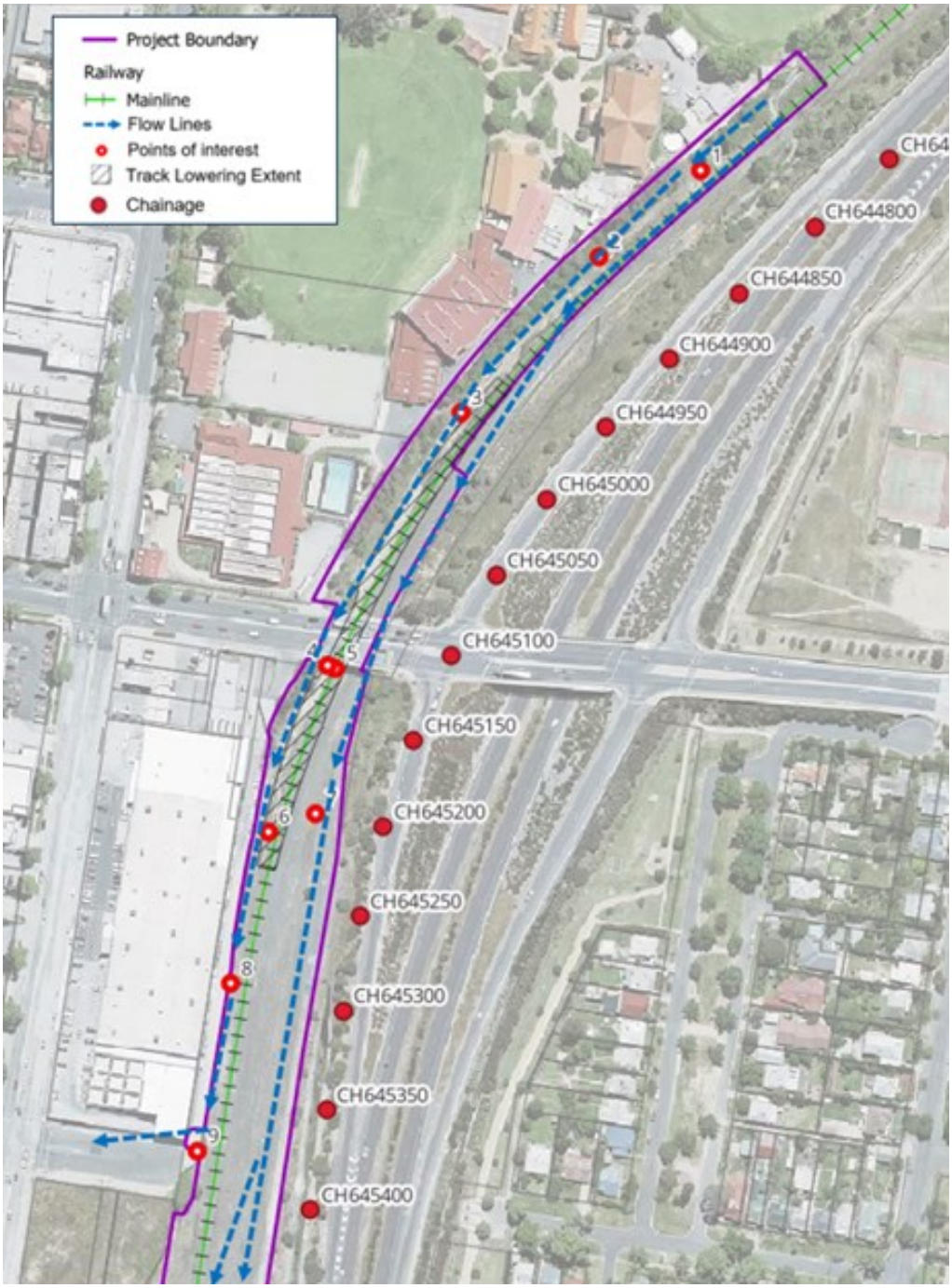


Figure 5-4: Riverina Highway Site Design Scenario Overland Flow Paths for 1% AEP

Table 5-7: Peak Flood Levels – Design Condition

Design Events	Flood Levels
10% AEP	The flood waters do not overtop the proposed railway tracks. (Refer to Figure A19 in Appendix A). The flood depth along the proposed overland flow channel is generally less than 0.09 m.
5% AEP	The flood waters do not overtop the proposed railway tracks. (Refer to Figure A20 in Appendix A). The flood depth along the proposed overland flow channel is generally less than 0.1 m.
2% AEP	The flood waters do not overtop the proposed railway tracks. (Refer to Figure A21 in Appendix A). The flood depth along the proposed overland flow channel is generally less than 0.2 m.
1% AEP	The flood waters do not overtop the proposed railway tracks. (Refer to Figure A22 in Appendix A). The flood depth along the proposed overland flow channel is generally less than 0.5 m.
1% AEP + Climate Change	The flood waters overtop the proposed railway tracks at multiple locations with overtopping depths up to approximately 0.9m. (Refer to Figure A24 in Appendix A). The railway corridor is significantly flooded, with flood depth reaching up to 1.75m.
PMF	The flood waters overtop the proposed railway tracks at multiple locations with overtopping depths up to approximately 2.5 to 4m. (Refer to Figure A25 in Appendix A). The railway corridor is significantly flooded, with flood depth reaching up to 4m.

Table 5-8: Points of Interest Data – Peak Flood Levels (mAHD) – Design Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	162.98	163.13	163.21	163.55	163.70	166.16
Point 2	Not flooded	Not flooded	Not flooded	162.50	162.68	165.59
Point 3	Not flooded	Not flooded	Not flooded	162.10	162.36	165.03
Point 4	159.71	159.71	159.72	159.73	161.48	163.71
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	161.48	163.73
Point 6	Not flooded	Not flooded	Not flooded	Not flooded	161.47	163.77
Point 7	Not flooded	161.27	161.28	161.32	161.47	163.77
Point 8	161.12	161.12	161.13	161.24	161.34	163.37
Point 9	Not flooded	Not flooded	Not flooded	Not flooded	160.92	161.76

Table 5-9 summarises the peak flood velocity results for design condition within the study area.

Table 5-9: Peak Flood Velocity – Design Condition

Design Events	Flood Velocity
10% AEP	The flood velocity along the proposed overland flow channel is generally less than 0.15m/s. (Refer to Figure A26 in Appendix A).
5% AEP	The flood velocity along the proposed overland flow channel is generally less than 0.1m/s. (Refer to Figure A27 in Appendix A).
2% AEP	The flood velocity along the proposed overland flow channel is generally less than 0.3 m/s. (Refer to Figure A28 in Appendix A).
1% AEP	The flood velocity along the proposed overland flow channel is generally less than 0.6 m/s. (Refer to Figure A29 in Appendix A).
1% AEP + Climate Change	The flood velocity along the proposed overland flow channel is generally less than 1 m/s. (Refer to Figure A31 in Appendix A).
PMF	The flood velocity along the proposed overland flow channel is generally less than 4 m/s. (Refer to Figure A32 in Appendix A).

Table 5-10: Points of Interest Data – Peak Flood Velocity (m/s) – Design Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	0.1	0.1	0.2	0.2	0.3	1.6
Point 2	Not flooded	Not flooded	Not flooded	0.6	1.0	2.7
Point 3	Not flooded	Not flooded	Not flooded	0.7	0.8	2.1
Point 4	< 0.1	< 0.1	< 0.1	< 0.1	0.9	3.8
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	0.3	3.9
Point 6	Not flooded	Not flooded	Not flooded	Not flooded	0.2	2.1
Point 7	Not flooded	0.0	0.1	0.1	0.1	2.1
Point 8	0.1	0.1	0.1	0.5	0.6	2.2
Point 9	Not flooded	Not flooded	Not flooded	Not flooded	0.6	4.2

The flood hazard for the design condition at the Riverina Highway bridge study area is presented in Table 5-11 and the maps are presented in Appendix A.

Table 5-11: Flood Hazard – Design Condition

Design Events	Flood Hazard
10% AEP	▪ The flood hazard along the rail corridor open channel is generally H1. (Refer to Figures A33, A34 and A35 in Appendix A).
5% AEP	
2% AEP	
1% AEP	▪ The flood hazard along the rail corridor open channel is generally H1 and H2. (Refer to Figure A36 in Appendix A).
1% AEP + Climate Change	▪ The flood hazard along the rail corridor open channel is generally less than H4. (Refer to Figure A38 in Appendix A).
PMF	▪ The flood hazard along the rail corridor open channel is generally less than H6. (Refer to Figure A39 in Appendix A).

Table 5-12: Points of Interest Data – Peak Flood Hazard – Design Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	H3	H3	H3	H3	H4	H6
Point 2	Not flooded	Not flooded	Not flooded	H1	H2	H6
Point 3	Not flooded	Not flooded	Not flooded	H1	H2	H6
Point 4	H1	H1	H1	H1	H4	H6
Point 5	Not flooded	Not flooded	Not flooded	Not flooded	H3	H6
Point 6	Not flooded	Not flooded	Not flooded	Not flooded	H3	H6
Point 7	Not flooded	H1	H1	H1	H1	H6
Point 8	H1	H1	H1	H1	H1	H6
Point 9	Not flooded	Not flooded	Not flooded	Not flooded	H1	H6

In the design condition, track flood immunity is up to the 1% AEP. The design condition velocities are generally less than 1m/s and with low hazard values.

5.3 Flood Immunity and Scour Protection

During the existing scenario, the top of rail is overtopped in 1% AEP. However, the flood immunity is improved in design scenario where the top of rail is not overtopped at 1% AEP. Immunity improvement is attributed to the introduction of the 2 proposed channels and the crest in the western proposed channel. Scour protection is applied on the ends of the proposed channels. The channels are also grass lined with jute-mesh which provides local scour protection to the channel (refer to Drainage Design at Section 4.5 on Riverina Highway Bridge Report (5-0052-210-PEN-B4-RP-0001)). The proposed design results in an improvement of the immunity of the rail in terms of overtopping, which complies with the criteria in PSRs and CoA.

Table 5-13: Comparison of Flood Immunity at Overtopping Locations

Overtopping Location	Existing Condition Overtopping AEP	Design Condition Overtopping AEP
Ch645.275	1% AEP event	1% AEP event with climate change
Ch645.125	1% AEP event with climate change	1% AEP event with climate change

An assessment of the flood immunity at the noted locations of overtopping along the rail is seen in Table 5-14 and Table 5-15 for CH645275 and CH645125 where overtopping of the rail occurs.

Table 5-14: Overtopping Details at CH645275

Chainage	Top of the Rail Level (mAHD)		Top of the Formation Level (mAHD)		1% AEP Flood Level (mAHD)		1% AEP with climate change Flood Level (mAHD)	
	Existing	Design	Existing	Design	Existing	Design	Existing	Design
CH645275	161.30	161.33	160.63*	160.66*	161.34	161.07	161.50	161.44

*Note that the existing top of the formation level has been assumed to be 667mm below the existing top of the rail level

Table 5-15: Overtopping Details at CH645125

Chainage	Top of the Rail Level (mAHD)		Top of the Formation Level (mAHD)		1% AEP Flood Level (mAHD)		1% AEP with climate change Flood Level (mAHD)	
	Existing	Design	Existing	Design	Existing	Design	Existing	Design
CH645125	161.76	160.65	161.10**	159.98**	161.57	159.73	161.74	161.48

**Note that the existing top of the formation level has been assumed to be 667mm below the existing top of the rail level

Furthermore, in the design condition, the flood velocity along the proposed road design outside the project boundary complied with the CoA Scour/Erosion potential criteria (less than 10% increase or less than 0.5m/s changes in velocity) (refer to Clause E42 (h) in Table 2-2) up to the 1% AEP storm event. Hence, there is no need for scour protection measures outside the project boundary.

5.4 Flood Impact Assessment

The flood level generally decreases within the project boundary from CH644750 to CH645450 due to the lowered track. An increase in flood depths generally within 100 – 250 mm during the 1% AEP event occurs within the project boundary spanning from CH644900 to CH645050 due to a raised crest. Mudges Canal experiences additional afflux due to the proposed pump outflow and raised crest, but the afflux is well confined within the channel.

Water is discharged from the site at 2 locations, which include an overland flow path towards Wilson St, and a pumped discharge to Mudges Canal. Overland flows to Wilson St maintain the existing flow pattern with no adverse impacts. The flow regime is maintained as per the existing condition (Refer to Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001). Pumped discharge to Mudges Canal is minimal relative to the available capacity with less than 20mm afflux within the canal during the 1% AEP event.

The proposed design is compliant with PSR Annexure B items IR-SR-A2I-459 (no worse than existing), IR-SR-A2I-464 (no adverse impacts), IR-SR-A2I-465 (maintain existing/natural flow paths). Additionally, consultation with the Council has been undertaken at each design stage, and no objections have been raised to date with the proposed design.

5.4.1 Changes in Peak Flood Level

Table 5-16 details the changes in peak flood levels that occur and are associated with the proposed works.

Table 5-16: Flood Level Impact Assessment

Design Events	Changes in Peak Flood Levels
10% AEP	The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A40 in Appendix A) The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use. Less than 25 mm of afflux within the Mudges Canal.
5% AEP	The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A41 in Appendix A) The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use. Less than 25 mm of afflux within the Mudges Canal.
2% AEP	The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A42 in Appendix A) The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use. Less than 30 mm of afflux within the Mudges Canal.
1% AEP	The changes in flood level outside the project boundary are less than 0.05m and no residential, commercial or industrial properties are impacted. (Refer to Figure A43 in Appendix A) The newly inundated area to the south of Wilson Street at CH645450 experiences less than 200mm of flood impact. This land is classified as grazing and native vegetation land use. Changes in water levels less than 200m occur outside the project boundary within the railway corridor due to overflowing water from the Mudes canal at CH644800. Although it is outside the boundary, it is classified as ARTC land. Therefore, this afflux is deemed compliant. Less than 25 mm of afflux within the Mudges Canal.

The changes in flood level outside the project boundary comply with the PSR and CoA clause E42 (b), (c), (d), (e) & (f) project requirements.

Table 5-17: Points of Interest Data – Changes in Peak Flood Level (m) – Design Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP
Point 1	0.51 (Newly inundated)	-0.02	0.05	0.24
Point 2	No more inundated	No more inundated	No more inundated	-0.59
Point 3	No more inundated	No more inundated	No more inundated	0.07
Point 4	-1.65	-1.66	-1.66	-1.82
Point 5	Not flooded	Not flooded	Not flooded	Not flooded
Point 6	No more inundated	No more inundated	No more inundated	No more inundated
Point 7	No more inundated	-0.08	-0.09	-0.07
Point 8	0.14	0.14	0.12	-0.08
Point 9	Not flooded	Not flooded	Not flooded	No more inundated

5.4.2 Changes in Peak Flood Velocity

Table 5-18 provides details of changes in peak flood velocity for the design condition.

Table 5-18: Flood Velocity Impact Assessment

Design Events	Changes in Peak Flood Velocity
10% AEP	The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A46 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s.
5% AEP	The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A47 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s.
2% AEP	The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A48 in Appendix A). Newly wet area created outside the project boundary has a velocity less than 0.5m/s.
1% AEP	The changes in velocity outside the site is less than 0.5m/s. (Refer to Figure A49 in Appendix A).

Design Events	Changes in Peak Flood Velocity
	Newly wet area created outside the project boundary has a velocity less than 0.5m/s.

Points 1 to 9 experience less than 0.5m/s of velocity increase for events 10% AEP, 5% AEP, 2% AEP and 1% AEP. The changes in flood velocity outside the project boundary comply with the PSR and CoA clause E42 (h) project requirements.

5.4.3 Changes in Flood Hazard

Table 5-19 details the changes in peak flood hazard for the design scenario.

Table 5-19: Flood Hazard Impact Assessment

Design Events	Changes in Peak Flood Hazard
10% AEP	There is no increase in hazard outside the project boundary. (Refer to Figure A51 in Appendix A).
5% AEP	Generally, no increase in hazard outside the project boundary. (Refer to Figure A52 in Appendix A). The newly inundated area to the south of Wilson Street at CH645450 experiences H1 Hazard which is generally safe for people, vehicles and buildings.
2% AEP	Generally, no increase in hazard outside the project boundary. (Refer to Figure A53 in Appendix A). The newly inundated area to the south of Wilson Street at CH645450 experiences H1 Hazard which is generally safe for people, vehicles and buildings.
1% AEP	Generally, no increase in hazard outside the project boundary. (Refer to Figure A54 in Appendix A).

Changed in hazard for the points of interest is provided in Table 5-20.

Table 5-20: Points of Interest Data – Changes in Hazard (m) – Design Condition

Locations	10% AEP	5% AEP	2% AEP	1% AEP
Point 1	Increased 3 Classes (Newly inundated)	Increased 2 Classes	Increased 2 Classes	Increased 2 Classes
Point 2	No more inundated	No more inundated	No more inundated	No change in hazard
Point 3	No more inundated	No more inundated	No more inundated	No change in hazard
Point 4	No change in hazard	No change in hazard	No change in hazard	Reduced 1 Class
Point 5	Not flooded	Not flooded	Not flooded	Not flooded
Point 6	No more inundated	No more inundated	No more inundated	No more inundated
Point 7	No more inundated	No change in hazard	No change in hazard	No change in hazard
Point 8	No change in hazard	No change in hazard	No change in hazard	Reduced 1 Class
Point 9	Not flooded	Not flooded	Not flooded	No more inundated

The changes in flood hazard outside the project boundary comply with the PSR and CoA clause E42 (g) project requirements.

5.4.4 Changes in Duration of Inundation

The analysis around the changes in the duration of inundation was undertaken by comparing the existing and design flood level vs time in selected locations. The locations adopted for the comparison are shown in the Figure below.

Figure 5-5: Reporting Location 1 and 2 for the Changes in Duration of Inundation, noting that the flood water flow direction is perpendicular to Location 1

Figure 5-6 and Figure 5-7 shows the comparison of flood level vs time for Reporting Locations 1 and 2. Both the existing and design flood level vs time are mostly similar for Location 1 and 2. These demonstrate that the design will not create an extra duration of inundation upstream and downstream outside the project boundary. Consequently, the changes in the duration of inundation comply with the CoA E42(a).

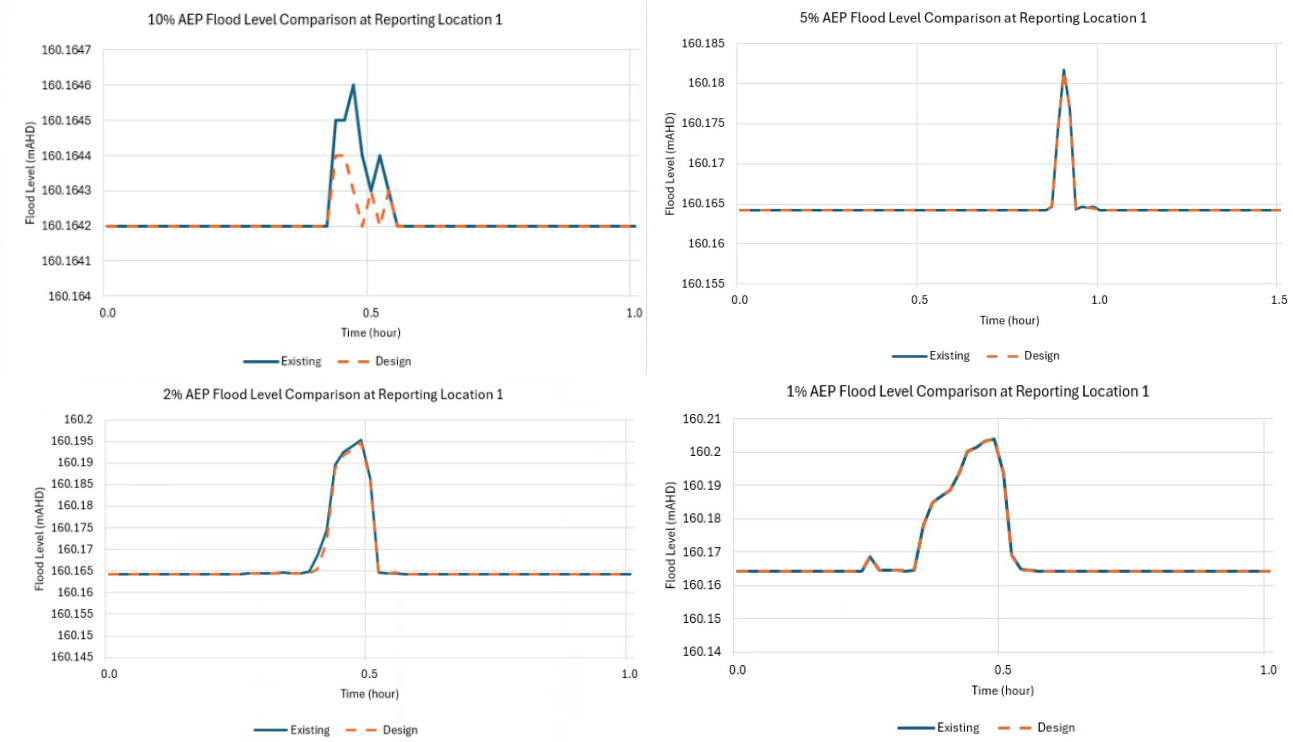


Figure 5-6: Comparison of Flood Level vs. Time at Reporting Location 1

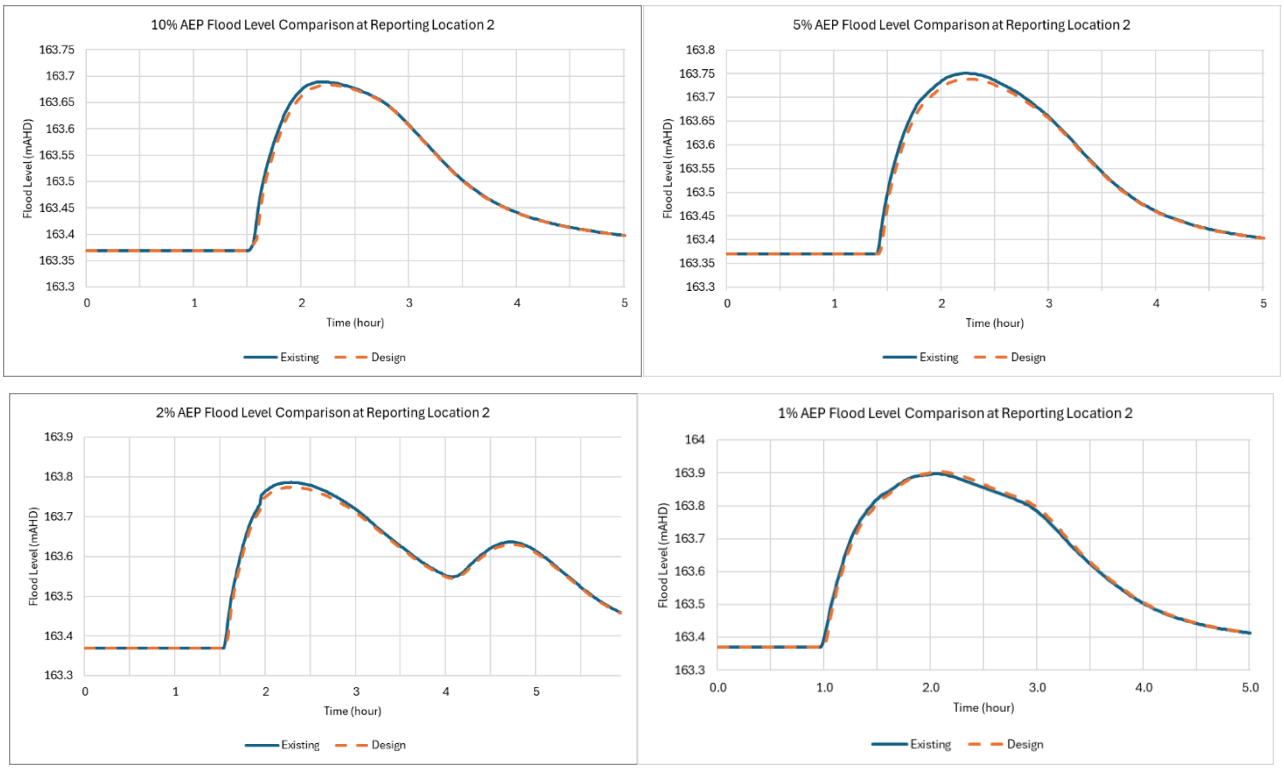


Figure 5-7: Comparison of Flood Level vs. Time at Reporting Location 2

5.5 Sensitivity Test

5.5.1 Blockage Assessment

A hydraulic blockage assessment was carried out for the 1% AEP design scenario as per the guidance set out in ARR2019. The assessment involved assessing the site area for debris availability, mobility and transportability and this, in conjunction with culvert size was used to determine the relevant blockage factors shown in Table 5-21 and Table 5-22. 25% blockage was adopted for all pipes within the site and 20% blockage was adopted for all the other culverts, pits and pipes outside the project boundary (Refer to Figure 5-8).

The above methodology was adopted by considering the following:

- ARR2019 does not require blockage assessments in all design runs. ARR Book 6 Sections 6.4.3 and 6.4.5 allow for an "All Clear" condition when there is no long-term history of blockage at a particular structure. There is no reporting of long-term historical blockage around the site to cause major flooding risk. Therefore, only 1% AEP design was run as a sensitivity test.
- The approach matches the Environmental Impact Statement (EIS) report as per CoA Condition E40, ensuring consistency and reliability.
- For detailed information, refer to the memo 5-0052-210-IHY-99-ME-0001

A flood level comparison between the blockage design scenario and the design is shown in Figure 5-8. The overall flood behaviour at the site is influenced by the blockage of the Mudges Canal box culvert (SA12335), which results in a change in water level of up to 0.17m in the western overland channel. This causes flood water to overflow the channel bund and flow into the railway corridor channel. Nevertheless, the mainline railway track remains unaffected by overtopping. But the loop line is overtopped by additional water entering the site from the Mudges Canal. The north-eastern part of the site experiences an increase in water level of approximately 0.1m, while the south-eastern part sees an increase of less than 0.03m. Far south of the site is not significantly influenced by the blockage, where the change in water level is within +-10mm.

Table 5-21: Culvert Blockage Percentage

Culvert	Blockage Percentage (1%AEP)	Comments
SA12335 (3 cell 1.2m (W) x 0.9m (H))	25%	Inside the project boundary
B4-E1-01 to B4-E1-02 (1 cell 0.3m in diameter)	25%	Inside the project boundary
B4-E2-01 to B4-E1-02 (1 cell 0.3m in diameter)	25%	Inside the project boundary
All other pipes (Stormwater pipes)	25%	Inside the project boundary
All other pits	20% (on grade pit), 50% (Sag pits)	Inside the project boundary
All others (culvert, pit and pipe)	20%	Outside of the project boundary

Table 5-22: Culvert Blockage Parameters

Culvert	Debris Availability	Debris Mobility	Debris Transportability	AEP Adjusted Debris Potential
SA12335	Low	Medium	Medium	Low
B4-E1-01 to B4-E1-02	Low	Medium	Medium	Low
B4-E2-01 to B4-E1-02	Low	Medium	Medium	Low

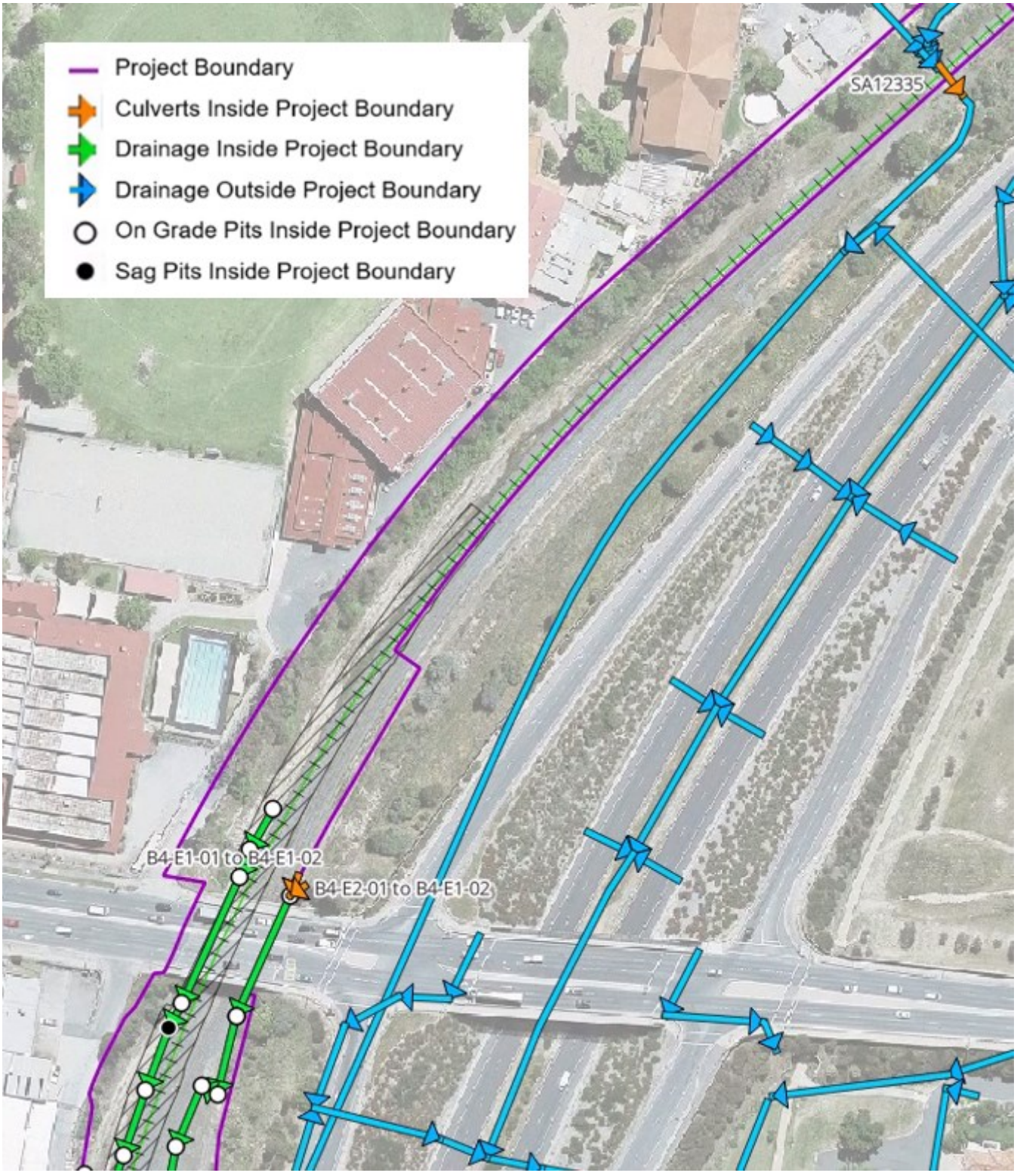


Figure 5-8: Culverts at Riverina Highway Bridge Site

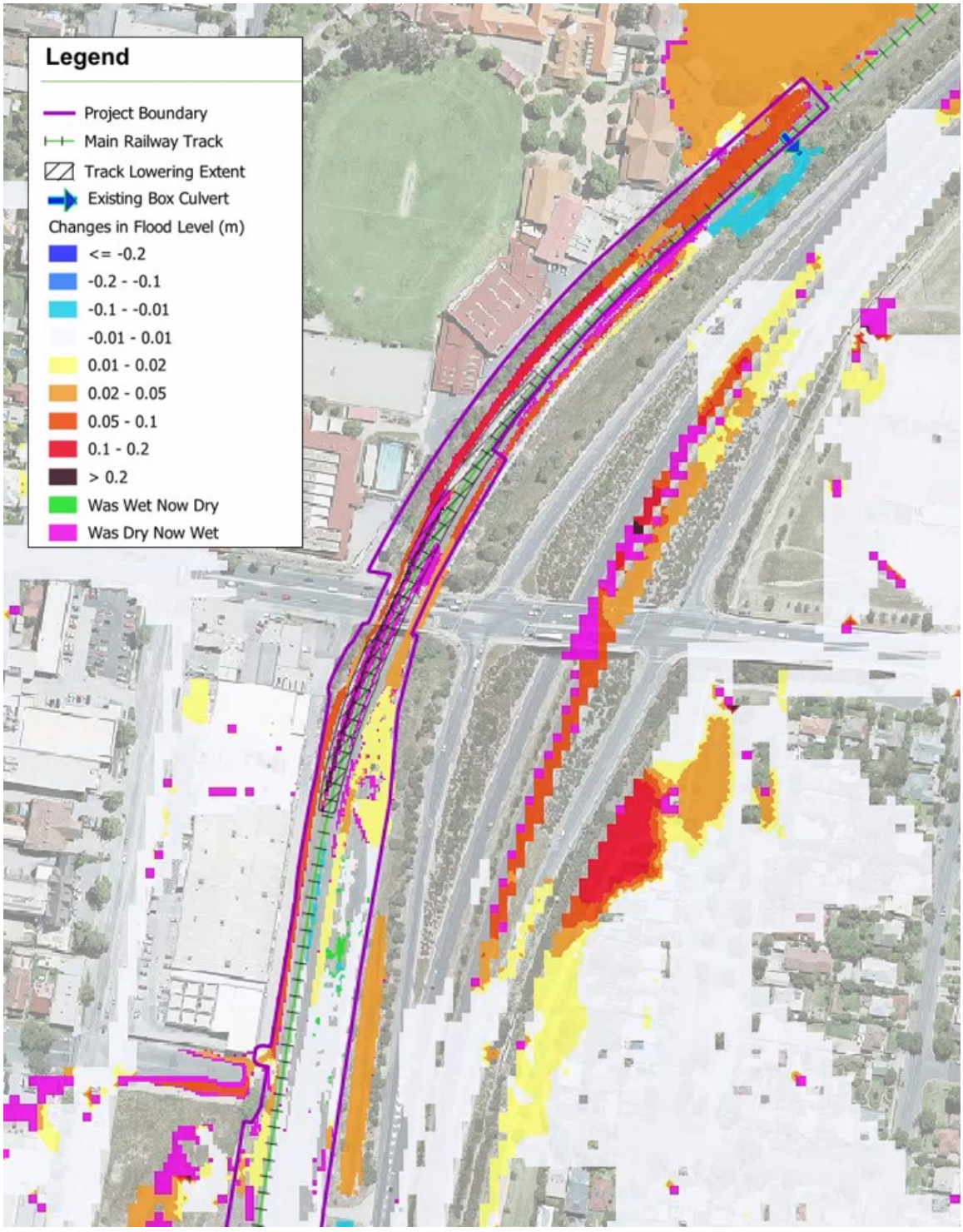


Figure 5-9: Flood Level Comparison for 1% AEP Design Condition – Blockage vs Design

5.5.2 Climate Change Risk Assessment

As discussed in Section 4.2.2, climate change risk assessment was carried out by running the 1% AEP design event with the use of the Year 2090 RCP8.5 interim climate change factor and the associated 20.2% increase in rainfall (refer to Section 4.2.2 for details of the approach and section 5.1 and 5.2 for the results). Flood depth, flood velocity and flood hazard and corresponding flood maps can be found in Appendix A. The assessment is summarised below:

- Within the study area, both the existing railway track and lowered railway track cannot achieve flood immunity in climate change condition.
- Within the study area, the flood velocity in climate change condition increased by generally 0.3 m/s compared with 1% AEP.
- The site experiences up to the H4 flood hazard were classified as a significant hazard in climate change condition.

5.5.3 Primary Pump Failure Assessment

As stated in Table 4-4, the site is equipped a secondary (backup) pump to mitigate the risk of the primary pump failure. During the 1% AEP event, generally only the primary pump operates, as the water level in the storage tank does not rise sufficiently to activate the secondary pump. To assess the impact of primary pump failure, a sensitivity analysis was undertaken using only the secondary pump as operational.

The sensitivity analysis was performed for the 1% AEP. Figure 5-10, Figure 5-11 and Figure 5-12 show the results of changes in flood level, velocity and hazard respectively between the 1% AEP Pump sensitivity design scenario (primary pump failure but secondary pump is operational) and the original design scenario (both pump are operational). It can be seen that no differences were observed in terms of flood levels, velocities and hazard at the railway corridor. This is due to the pump activation levels for both pumps are below the ballast drain levels and both pumps have the same flow capacity.

Thus, when the primary pump fails, the secondary pump can still adequately discharge the flood water from the site.

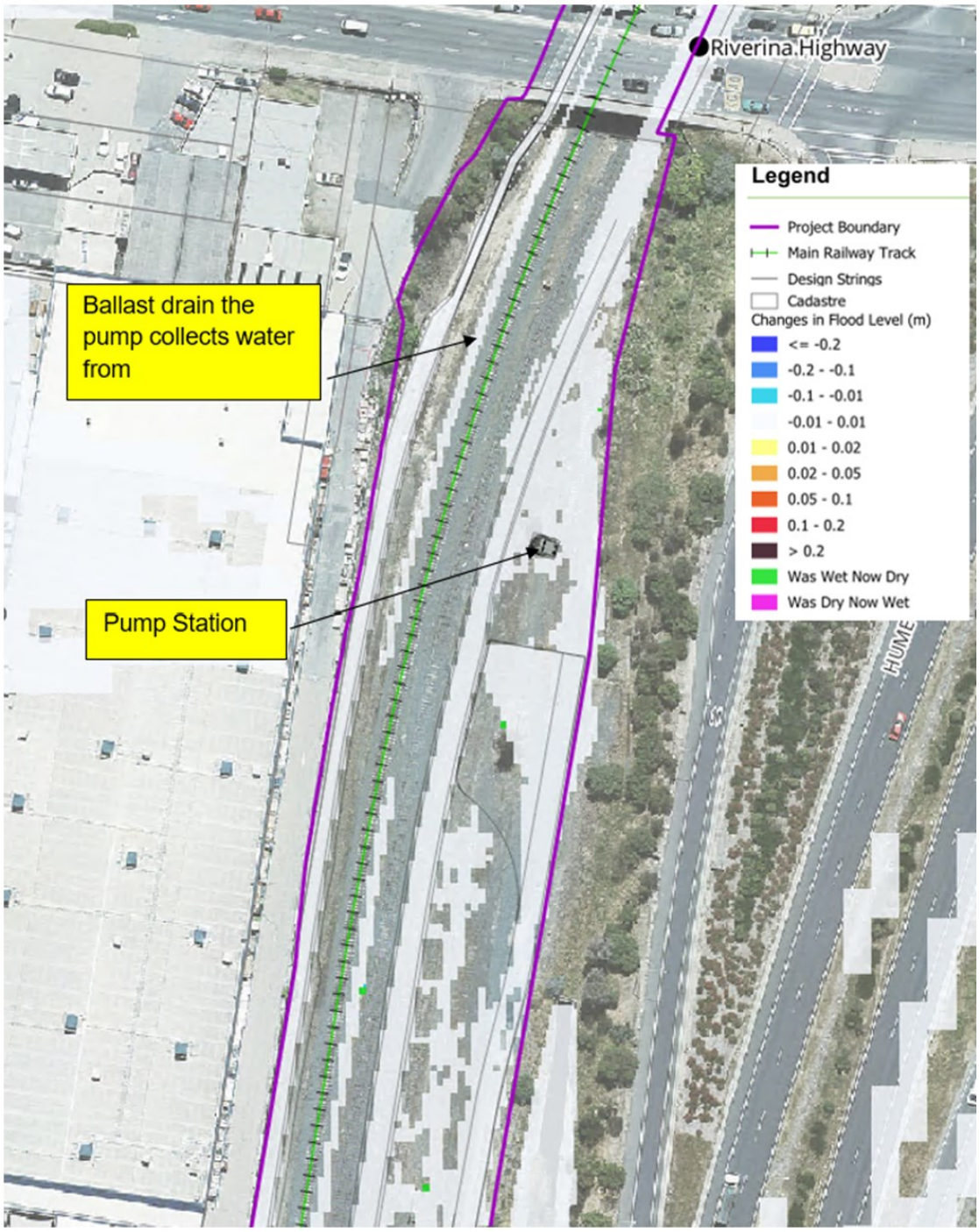


Figure 5-10: Pump Sensitivity Design Scenario vs Original Design Scenario – Changes in Peak Flood Level

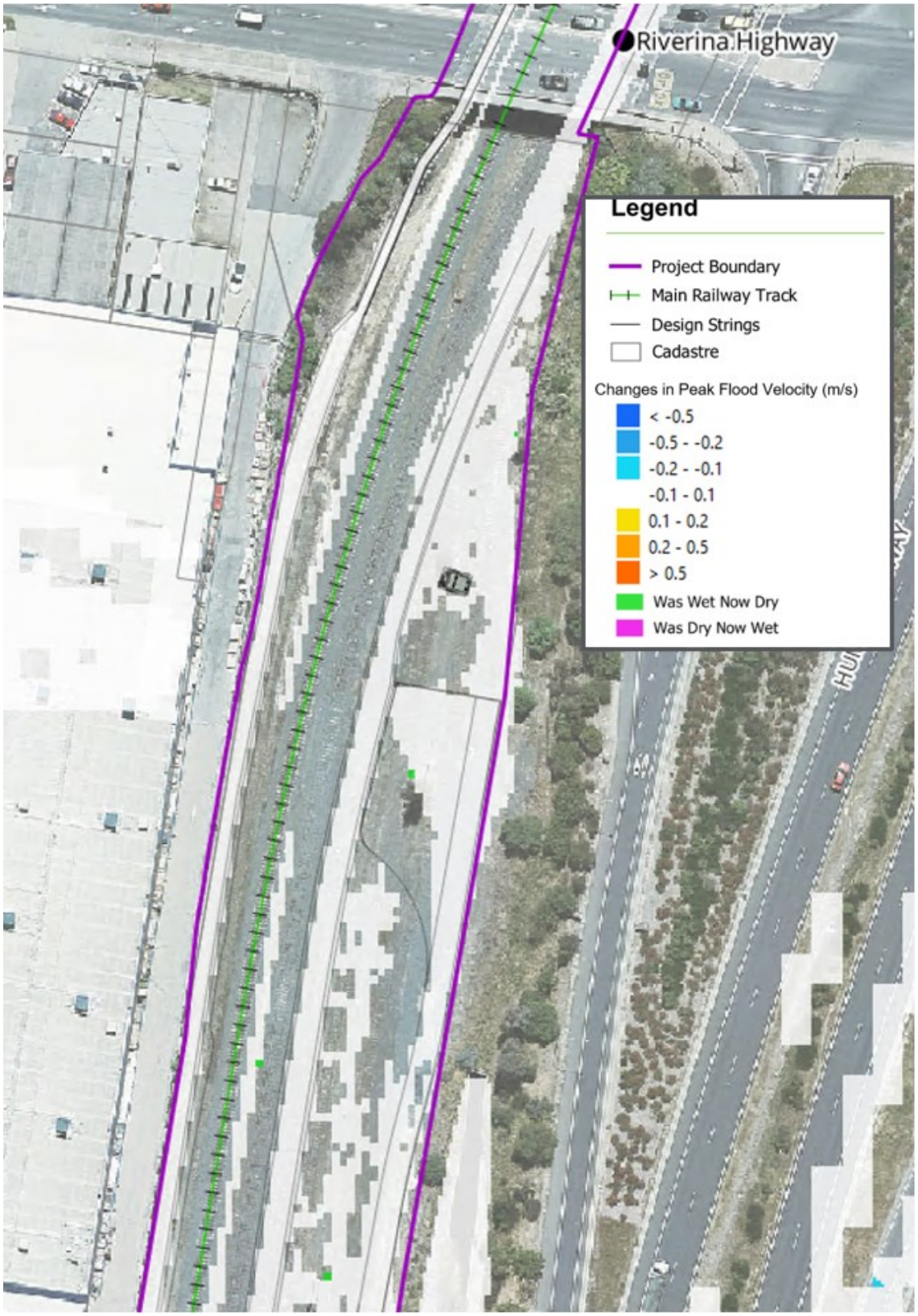


Figure 5-11: Pump Sensitivity Design Scenario vs Original Design Scenario – Changes in Peak Flood Velocity

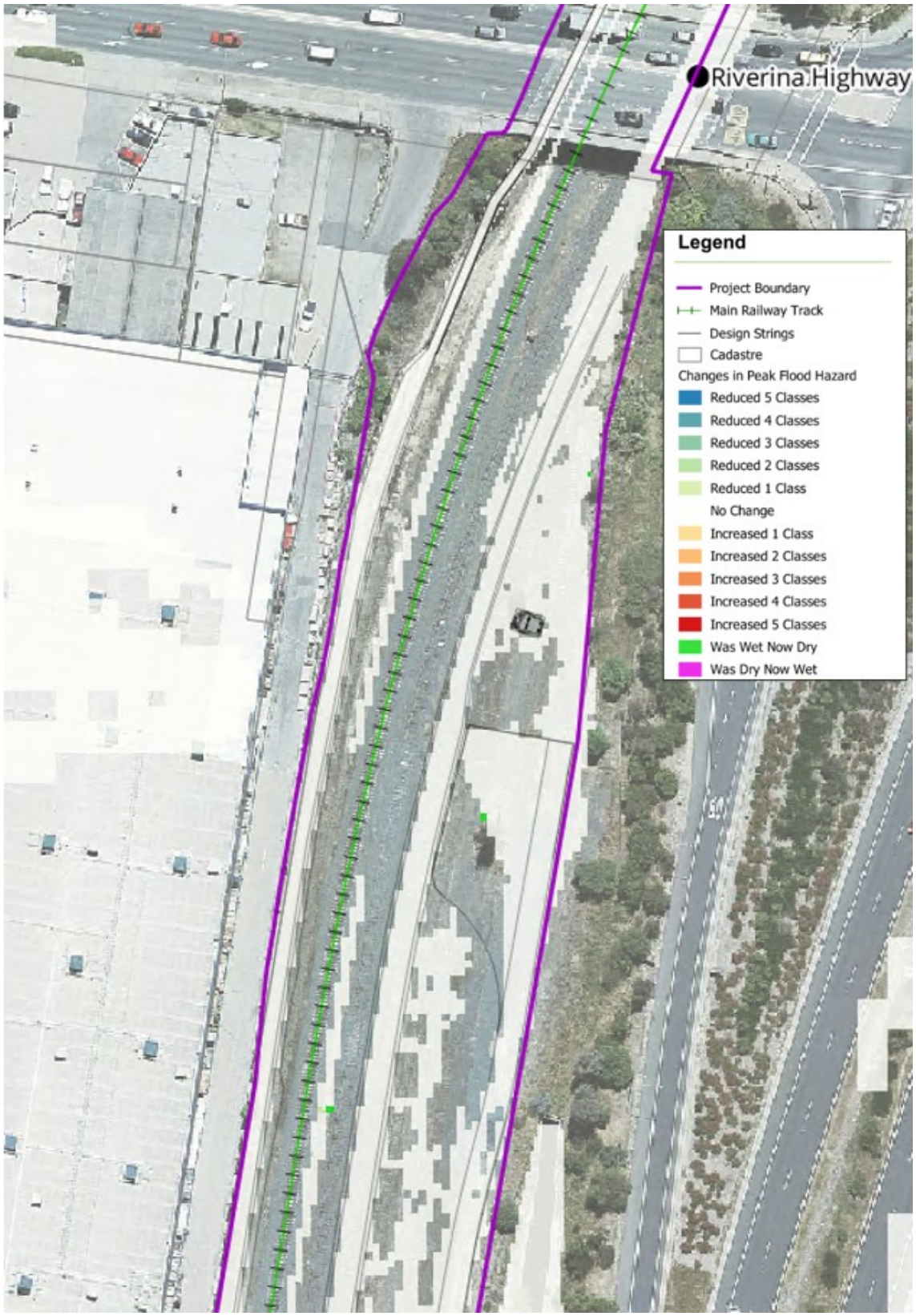


Figure 5-12: Pump Sensitivity Design Scenario vs Original Design Scenario – Changes in Peak Flood Hazard

6 MITIGATION MEASURES

No other instances of non-compliance in terms of flood impact were documented. Therefore, no additional mitigation measures are necessary unless the design changes.

7 RECOMMENDATIONS AND NEXT STAGE

This is the final IFC stage of the report, and the following are finalised:

- No instances of non-compliance have been identified through the assessment.
- All comments raised by relevant parties have been resolved (refer to Appendices D, E and F)

Consequently, there are no further recommendations.

APPENDICES

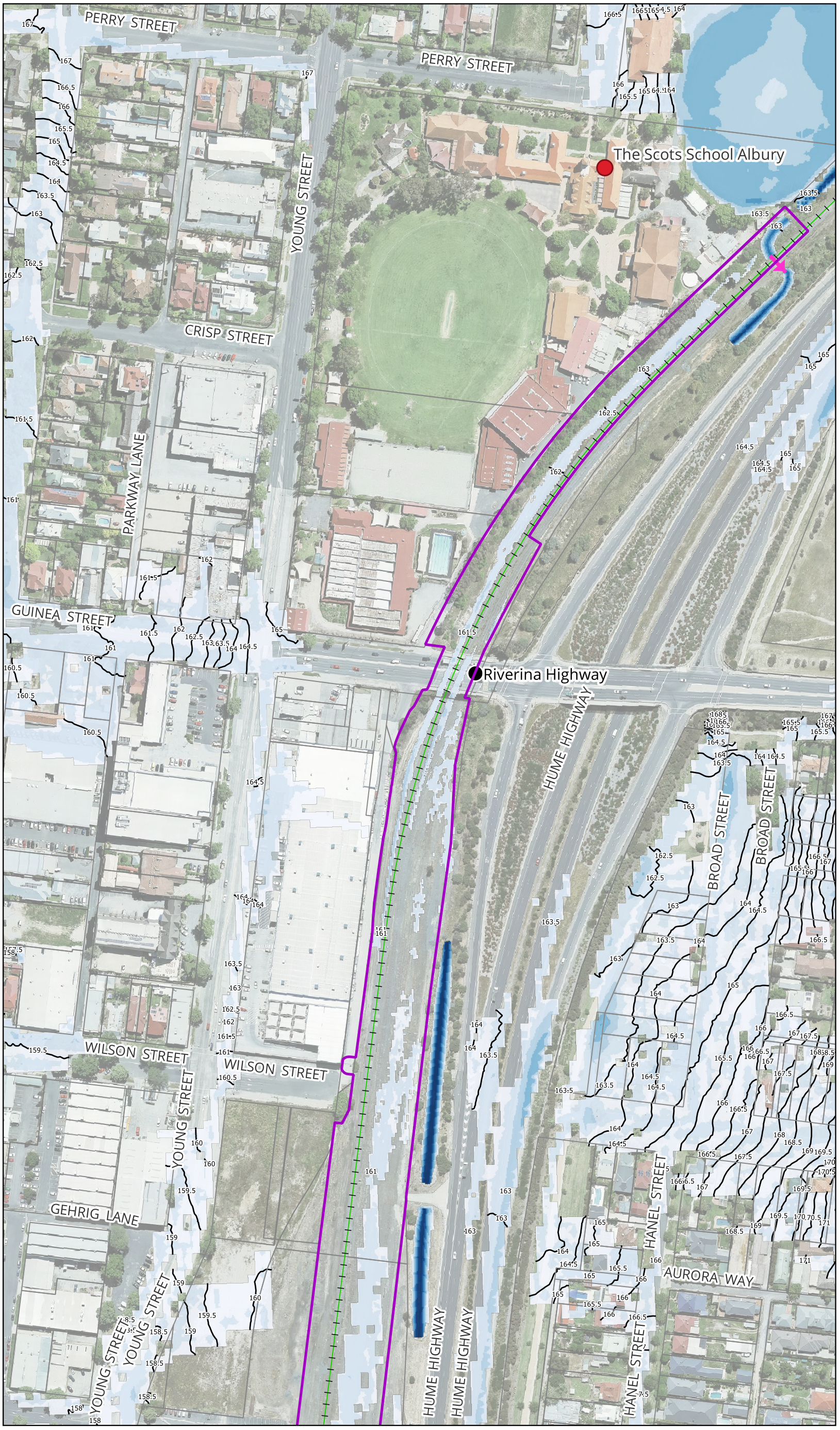
APPENDIX A

Flood Maps

Table A- 1: List of Maps in Appendix A

Map ID	Map description
Figure A01	10% AEP Peak Flood Depth and Levels - Existing Condition
Figure A02	5% AEP Peak Flood Depth and Levels - Existing Condition
Figure A03	2% AEP Peak Flood Depth and Levels - Existing Condition
Figure A04	1% AEP Peak Flood Depth and Levels - Existing Condition
Figure A05	1% AEP Climate Change Peak Flood Depth and Levels - Existing Condition
Figure A06	PMF Peak Flood Depth and Levels - Existing Condition
Figure A07	10% AEP Peak Flood Velocity - Existing Condition
Figure A08	5% AEP Peak Flood Velocity - Existing Condition
Figure A09	2% AEP Peak Flood Velocity - Existing Condition
Figure A10	1% AEP Peak Flood Velocity - Existing Condition
Figure A11	1% AEP Climate Change Peak Flood Velocity - Existing Condition
Figure A12	PMF Peak Flood Velocity - Existing Condition
Figure A13	10% AEP Peak Flood Hazard - Existing Condition
Figure A14	5% AEP Peak Flood Hazard - Existing Condition
Figure A15	2% AEP Peak Flood Hazard - Existing Condition
Figure A16	1% AEP Peak Flood Hazard - Existing Condition
Figure A17	1% AEP Climate Change Peak Flood Hazard - Existing Condition
Figure A18	PMF Peak Flood Hazard - Existing Condition
Figure A19	10% AEP Peak Flood Depth and Levels - Design Condition
Figure A20	5% AEP Peak Flood Depth and Levels - Design Condition
Figure A21	2% AEP Peak Flood Depth and Levels - Design Condition
Figure A22	1% AEP Peak Flood Depth and Levels - Design Condition
Figure A23	1% AEP Peak Flood Depth and Levels - Design Blockage Condition
Figure A24	1% AEP Climate Change Peak Flood Depth and Levels - Design Condition
Figure A25	PMF Peak Flood Depth and Levels - Design Condition
Figure A26	10% AEP Peak Flood Velocity - Design Condition
Figure A27	5% AEP Peak Flood Velocity - Design Condition
Figure A28	2% AEP Peak Flood Velocity - Design Condition
Figure A29	1% AEP Peak Flood Velocity - Design Condition
Figure A30	1% AEP Peak Flood Velocity - Design Blockage Condition
Figure A31	1% AEP Climate Change Peak Flood Velocity - Design Condition
Figure A32	PMF Peak Flood Velocity - Design Condition
Figure A33	10% AEP Peak Flood Hazard - Design Condition
Figure A34	5% AEP Peak Flood Hazard - Design Condition
Figure A35	2% AEP Peak Flood Hazard - Design Condition
Figure A36	1% AEP Peak Flood Hazard - Design Condition
Figure A37	1% AEP Peak Flood Hazard - Design Blockage Condition
Figure A38	1% AEP Climate Change Peak Flood Hazard - Design Condition
Figure A39	PMF Peak Flood Hazard - Design Condition

Map ID	Map description
Figure A40	Changes in Peak Flood Levels for 10% AEP - Design Condition vs Existing Condition
Figure A41	Changes in Peak Flood Levels for 5% AEP - Design Condition vs Existing Condition
Figure A42	Changes in Peak Flood Levels for 2% AEP - Design Condition vs Existing Condition
Figure A43	Changes in Peak Flood Levels for 1% AEP - Design Condition vs Existing Condition
Figure A44	Changes in Peak Flood Levels for 1% AEP Climate Change - Design Condition vs Existing
Figure A45	Changes in Peak Flood Velocity for 10% AEP - Design Condition vs Existing Condition
Figure A46	Changes in Peak Flood Velocity for 5% AEP - Design Condition vs Existing Condition
Figure A47	Changes in Peak Flood Velocity for 2% AEP - Design Condition vs Existing Condition
Figure A48	Changes in Peak Flood Velocity for 1% AEP - Design Condition vs Existing Condition
Figure A49	Changes in Peak Flood Velocity for 1% AEP Climate Change - Design Condition vs Existing
Figure A50	Changes in Peak Flood Hazard for 10% AEP - Design Condition vs Existing Condition
Figure A51	Changes in Peak Flood Hazard for 5% AEP - Design Condition vs Existing Condition
Figure A52	Changes in Peak Flood Hazard for 2% AEP - Design Condition vs Existing Condition
Figure A53	Changes in Peak Flood Hazard for 1% AEP - Design Condition vs Existing Condition
Figure A54	Changes in Peak Flood Hazard for 1% AEP Climate Change - Design Condition vs Existing



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A01: 10% AEP Peak Flood Depth and Levels - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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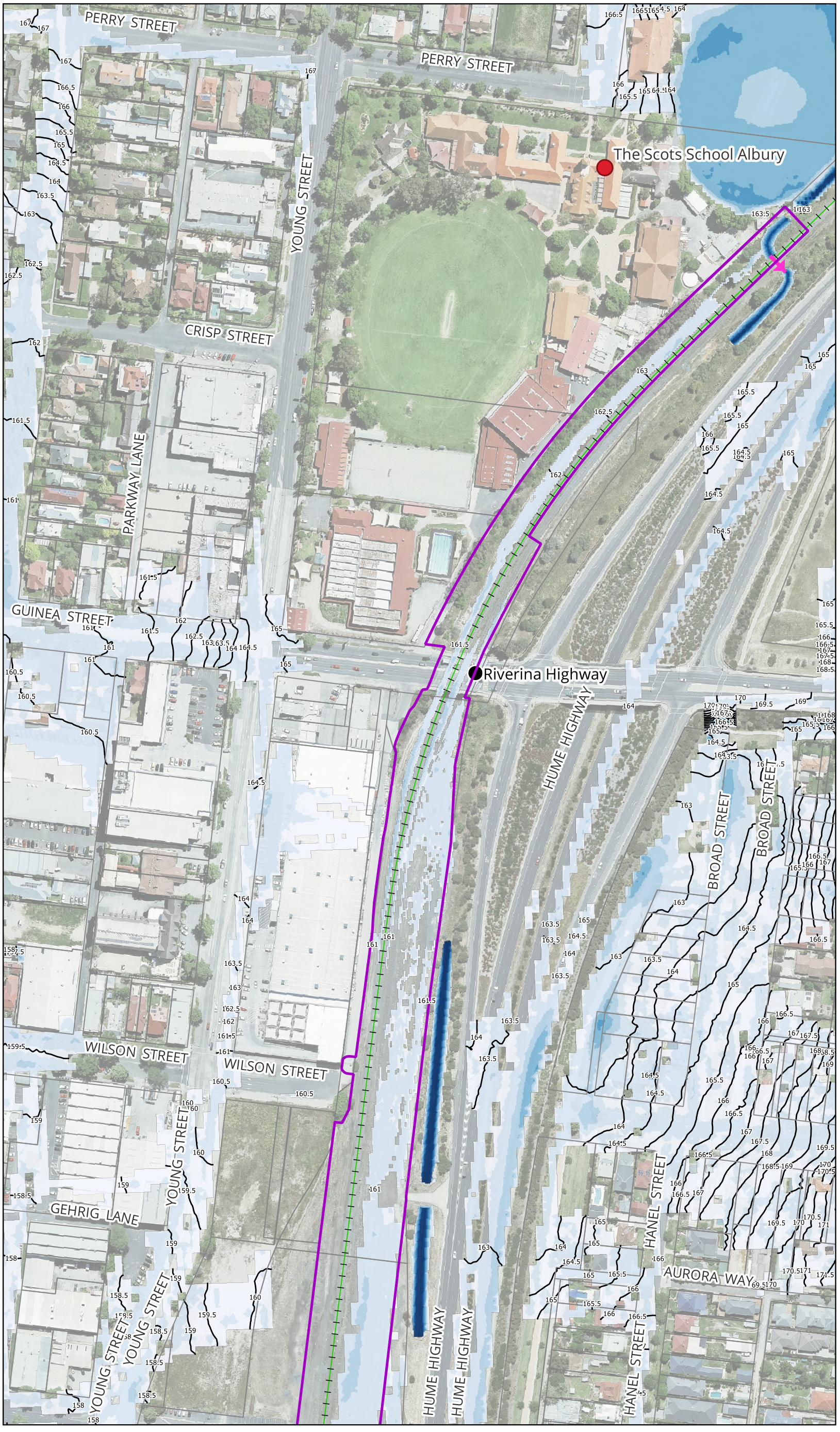
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A02: 5% AEP Peak Flood Depth and Levels - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

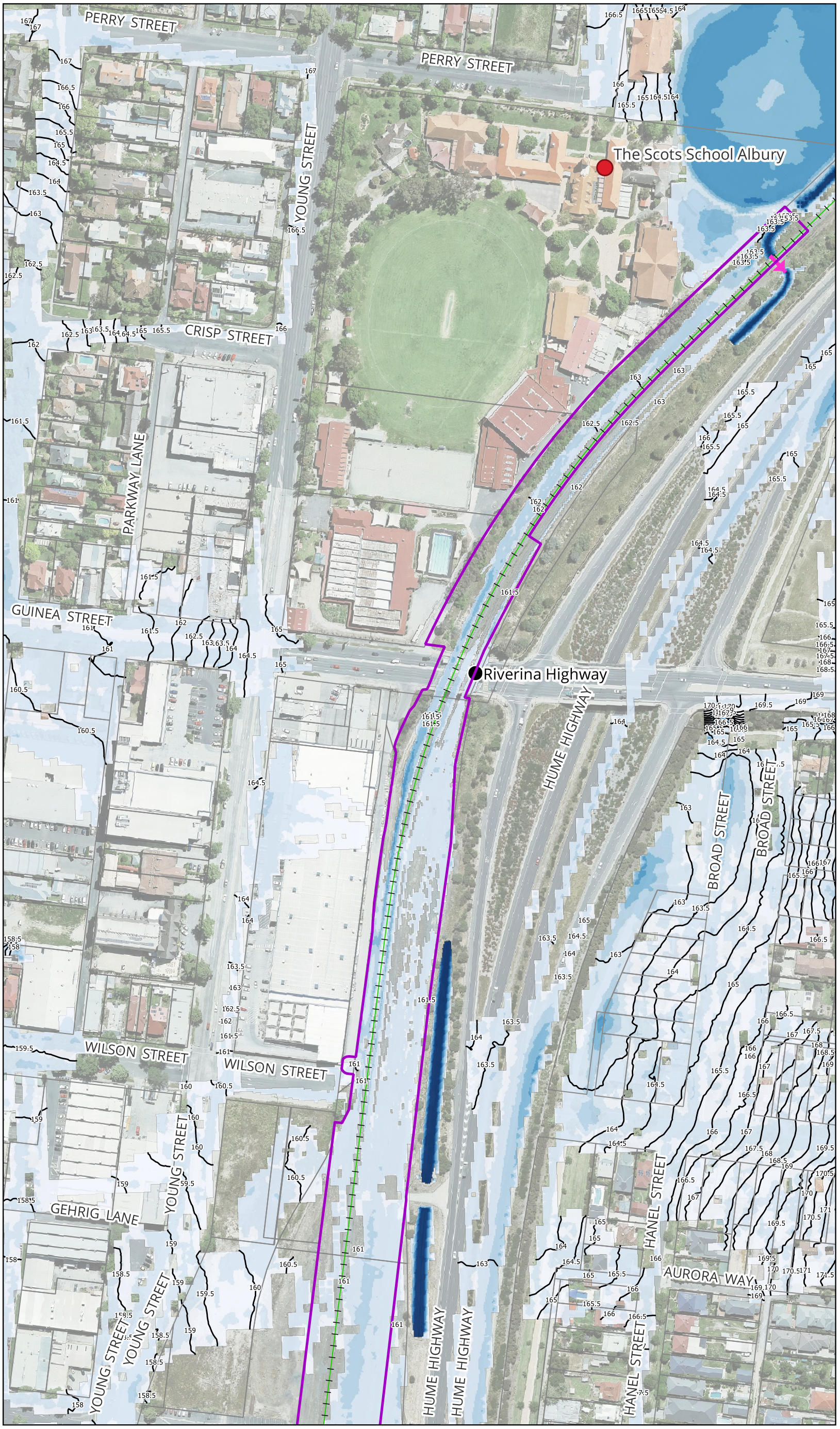
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A03: 2% AEP Peak Flood Depth and Levels - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

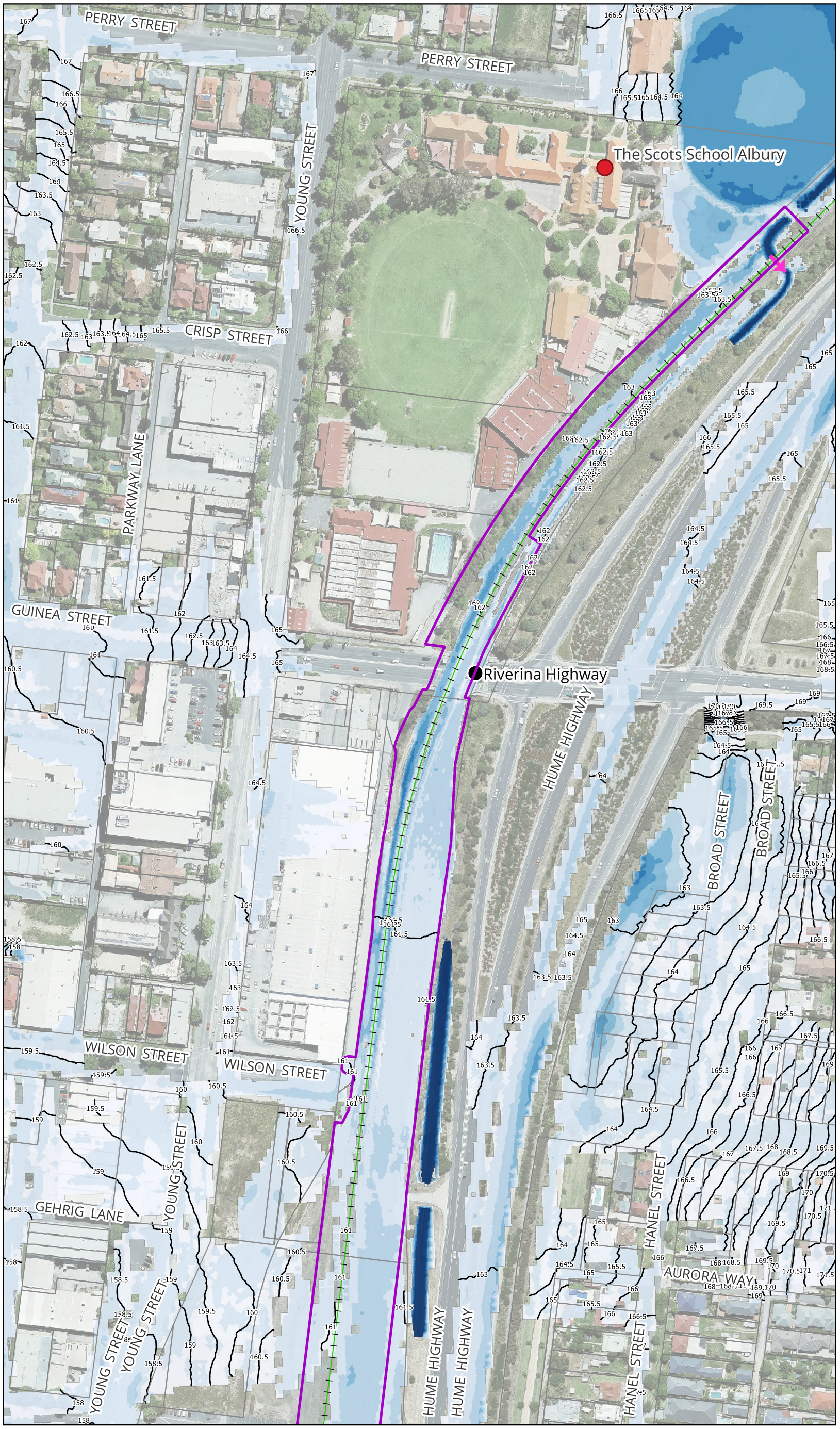
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A04: 1% AEP Peak Flood Depth and Levels - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A05: 1% AEP Climate Change Peak Flood Depth and Levels - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A06: PMF Peak Flood Depth and Levels - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A07: 10% AEP Peak Flood Velocity - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

PERRY STREET
PERRY STREET
YOUNG STREET
The Scots School Albury
CRISP STREET
PARKWAY LANE
GUINEA STREET
Riverina Highway
HUME HIGHWAY
BROAD STREET
BROAD STREET
WILSON STREET
WILSON STREET
YOUNG STREET
GEHRIG LANE
YOUNG STREET
HANEL STREET
AURORA WAY
HUME HIGHWAY
HUME HIGHWAY
HANEL STREET
SWIFT STREET

Map by: TT

0 100 200 m

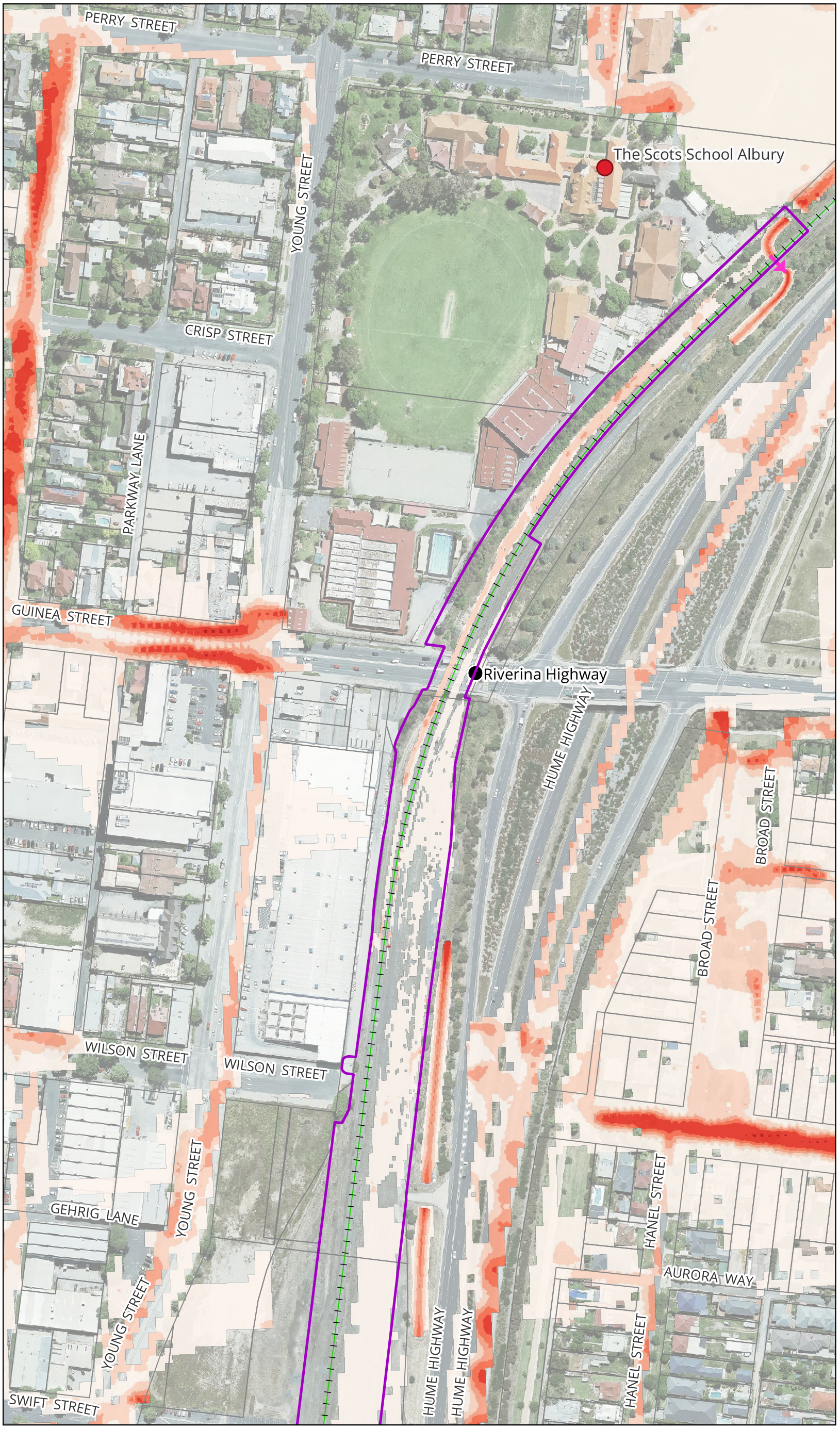
A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Notes:

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A08: 5% AEP Peak Flood Velocity - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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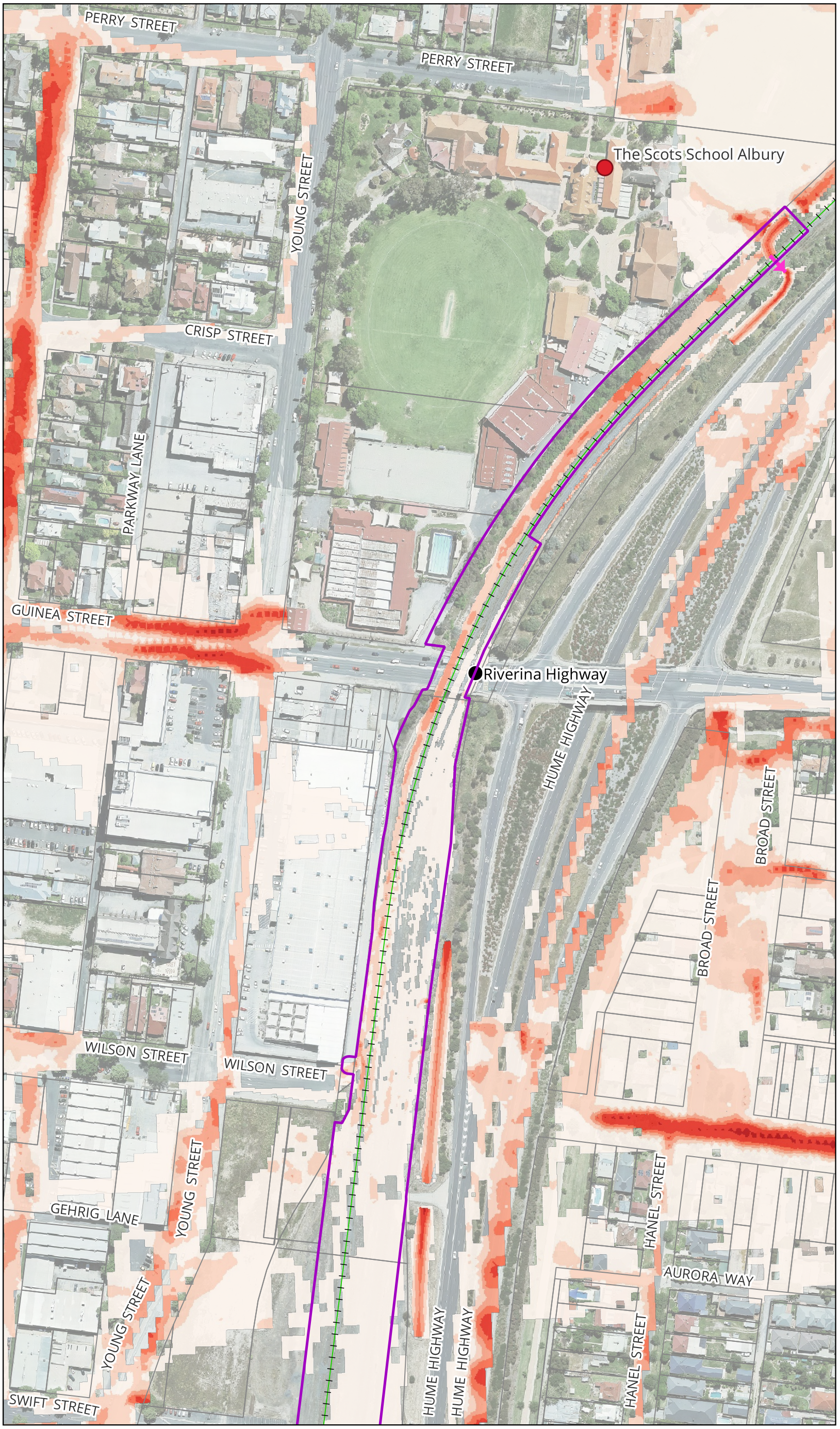
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A09: 2% AEP Peak Flood Velocity - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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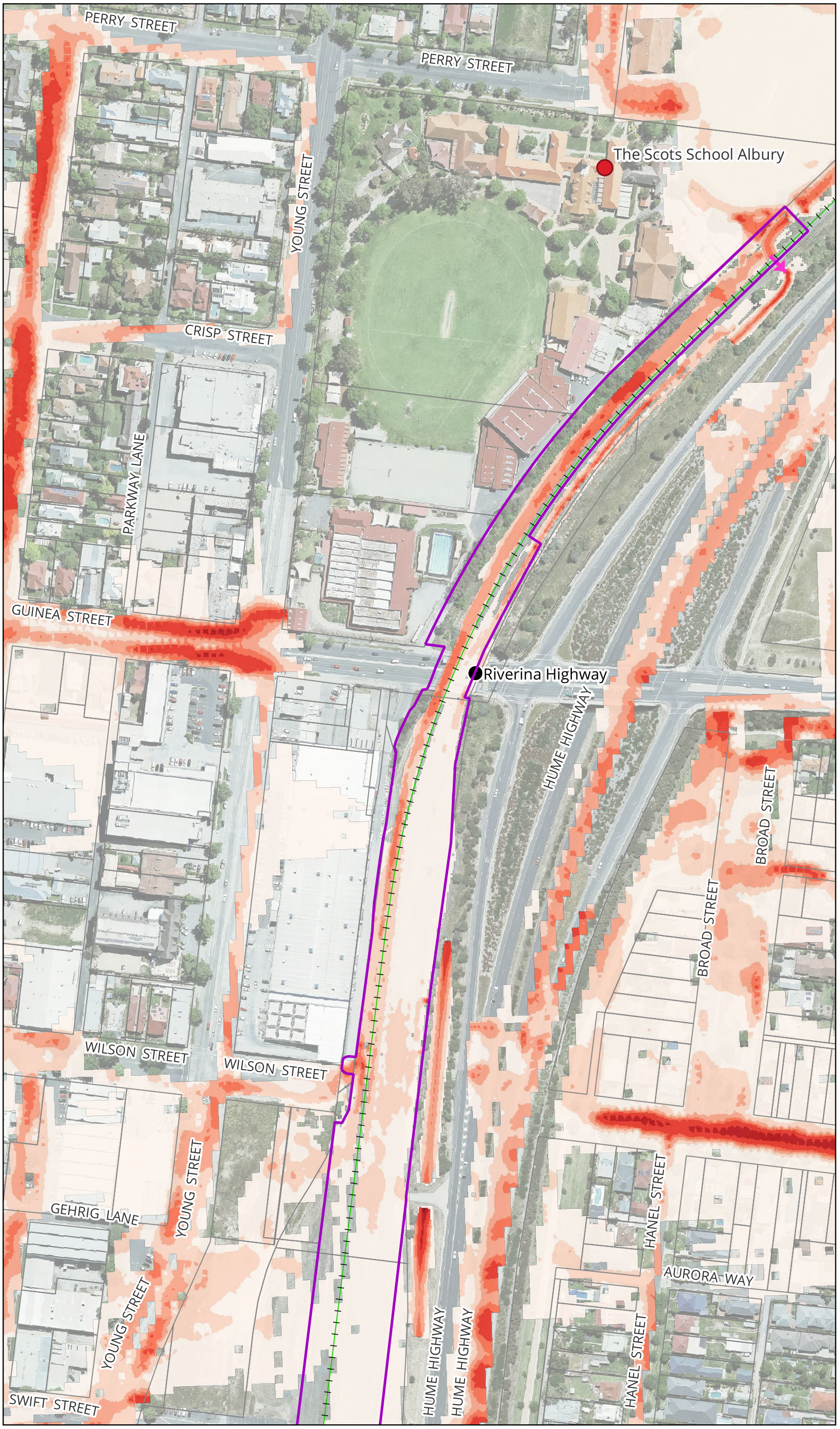
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A10: 1% AEP Peak Flood Velocity - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

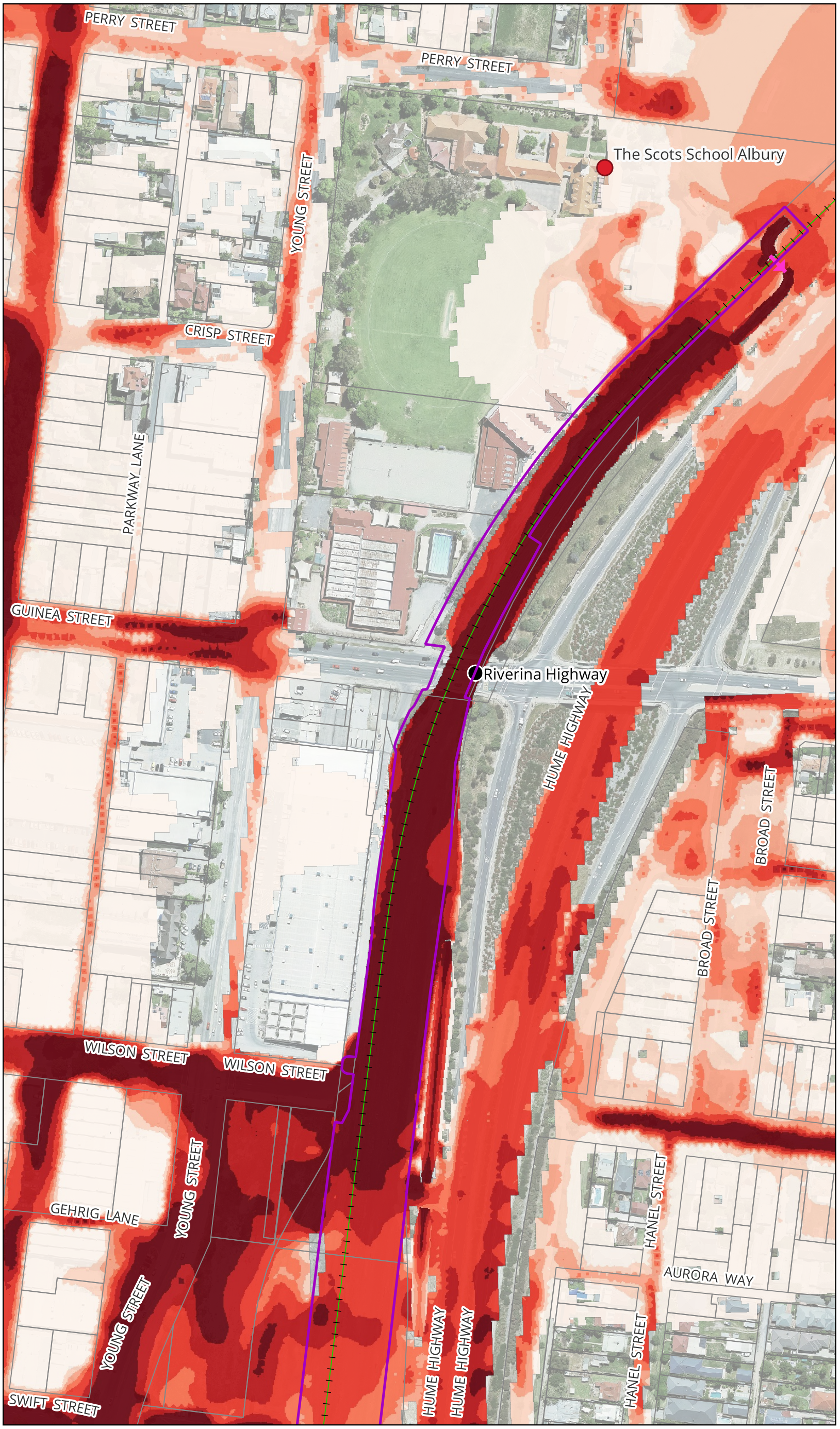
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A11: 1% AEP Climate Change Peak Flood Velocity - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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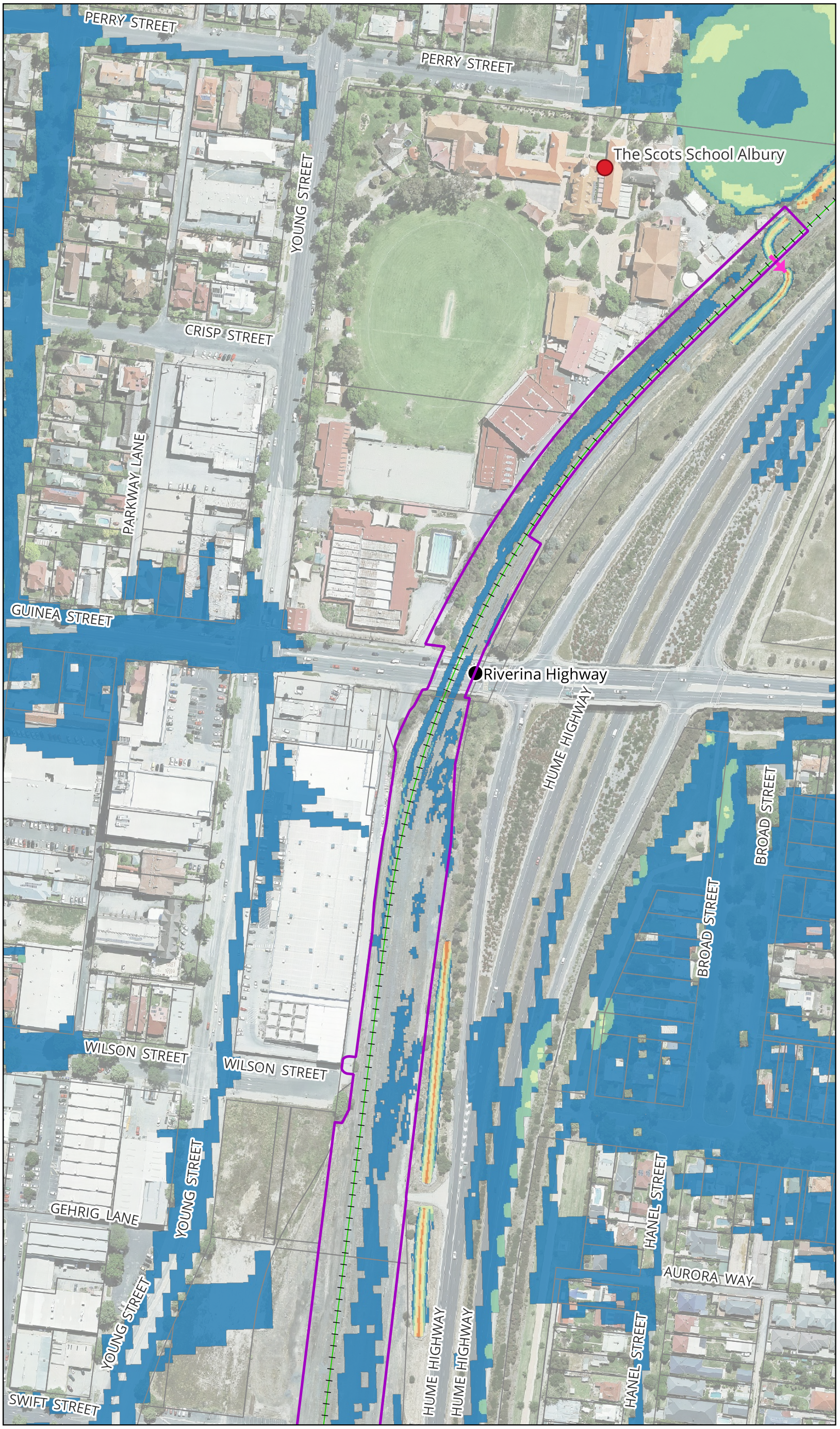
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A12: PMF Peak Flood Velocity - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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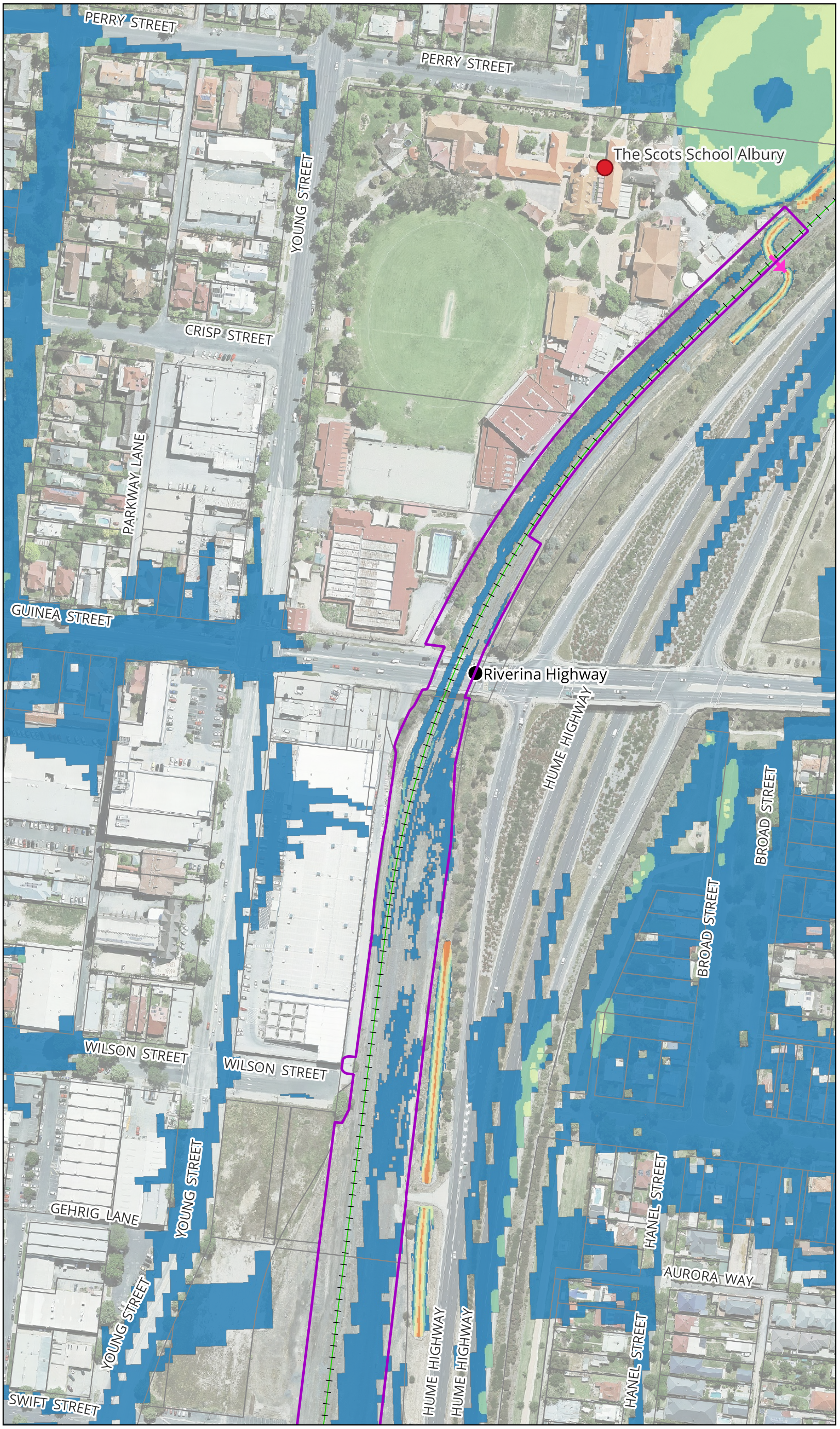
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A13: 10% AEP Peak Flood Hazard - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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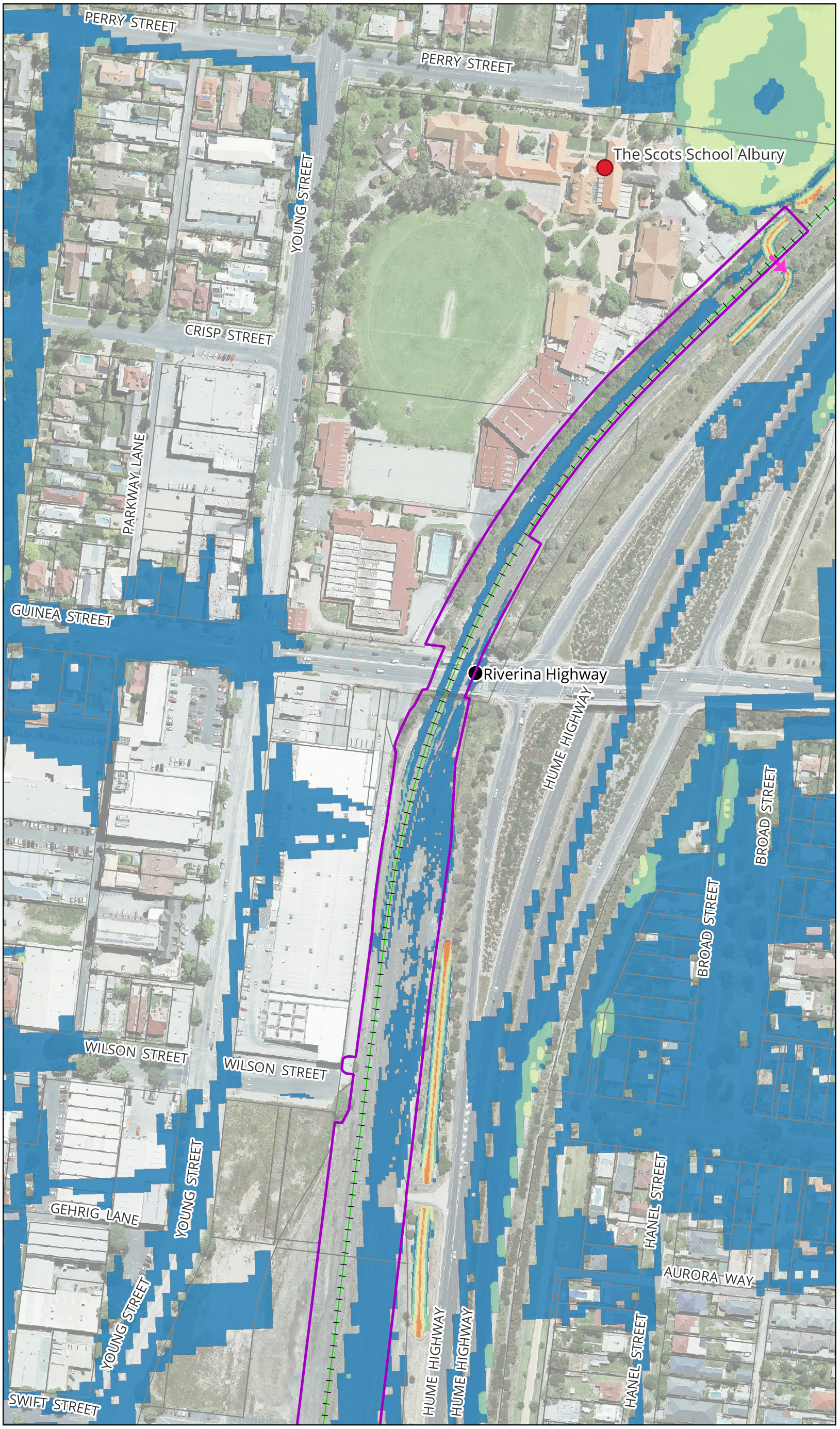
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A14: 5% AEP Peak Flood Hazard - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A15: 2% AEP Peak Flood Hazard - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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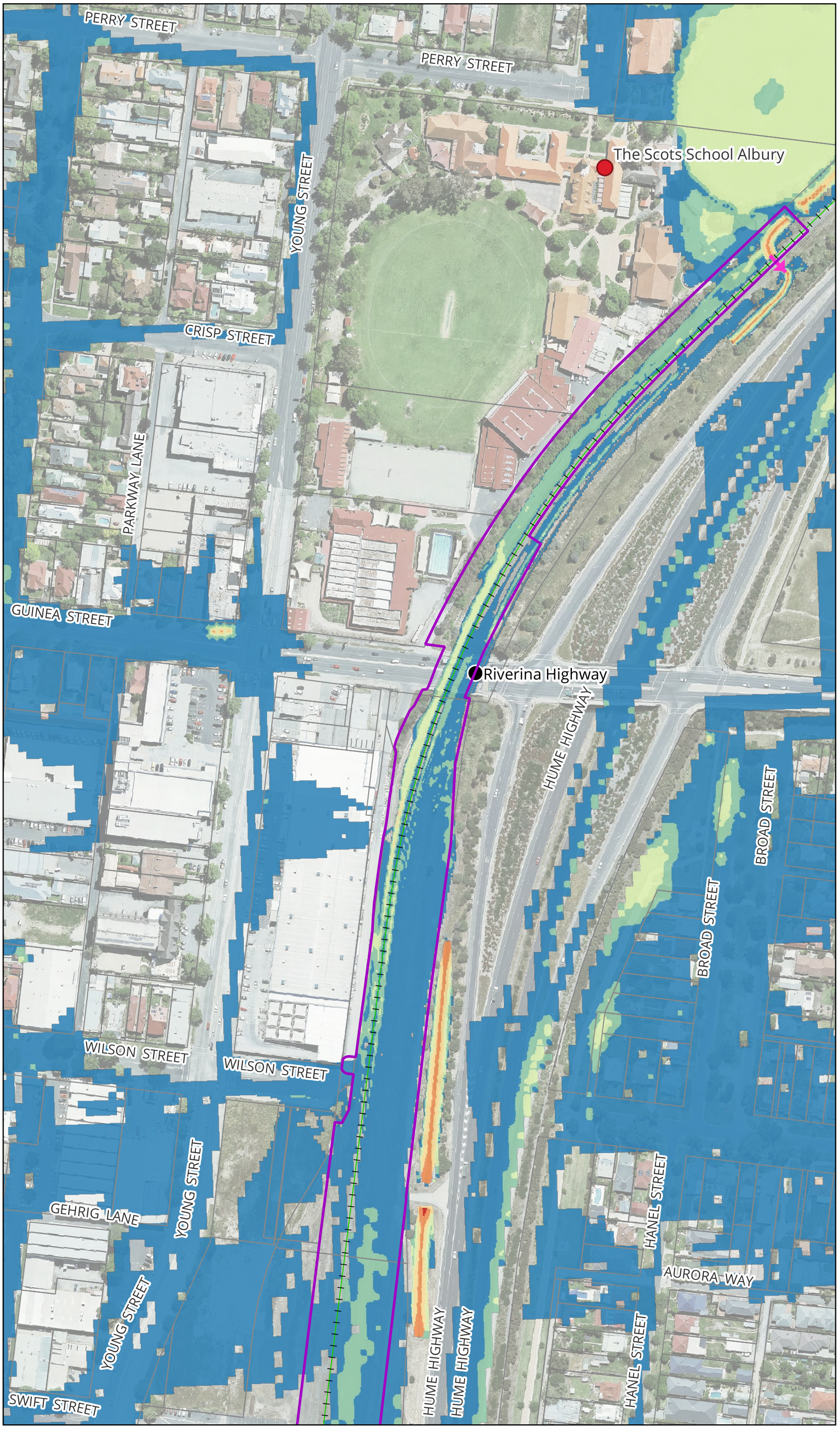
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A16: 1% AEP Peak Flood Hazard - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A17: 1% AEP Climate Change Peak Flood Hazard - Existing Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

PERRY STREET
PERRY STREET
YOUNG STREET
The Scots School Albury
CRISP STREET
PARKWAY LANE
GUINEA STREET
Riverina Highway
HUME HIGHWAY
BROAD STREET
BROAD STREET
WILSON STREET
WILSON STREET
YOUNG STREET
GEHRIG LANE
HANEL STREET
AURORA WAY
YOUNG STREET
HUME HIGHWAY
HUME HIGHWAY
HANEL STREET
SWIFT STREET

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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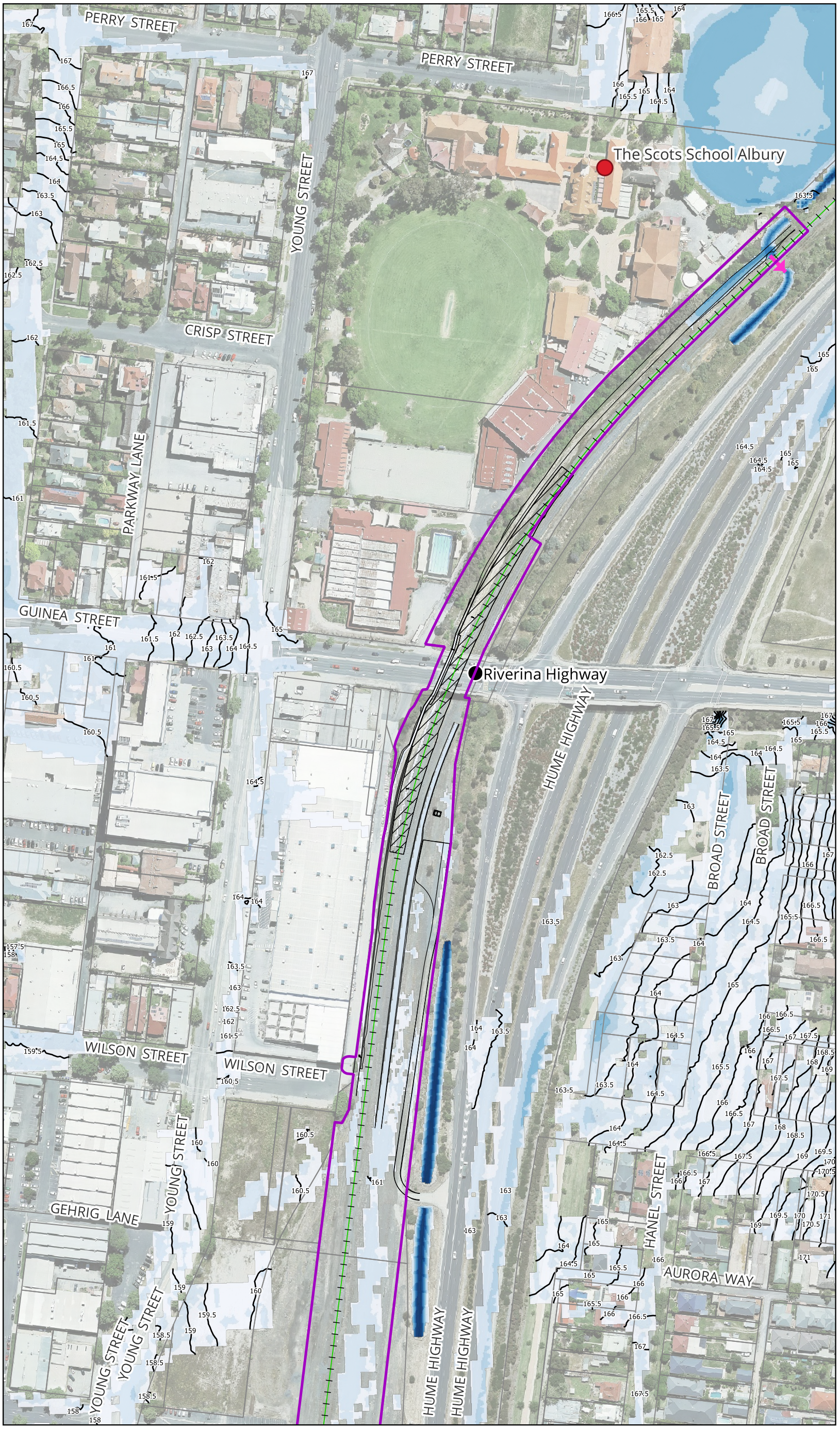
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A18: PMF Peak Flood Hazard - Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

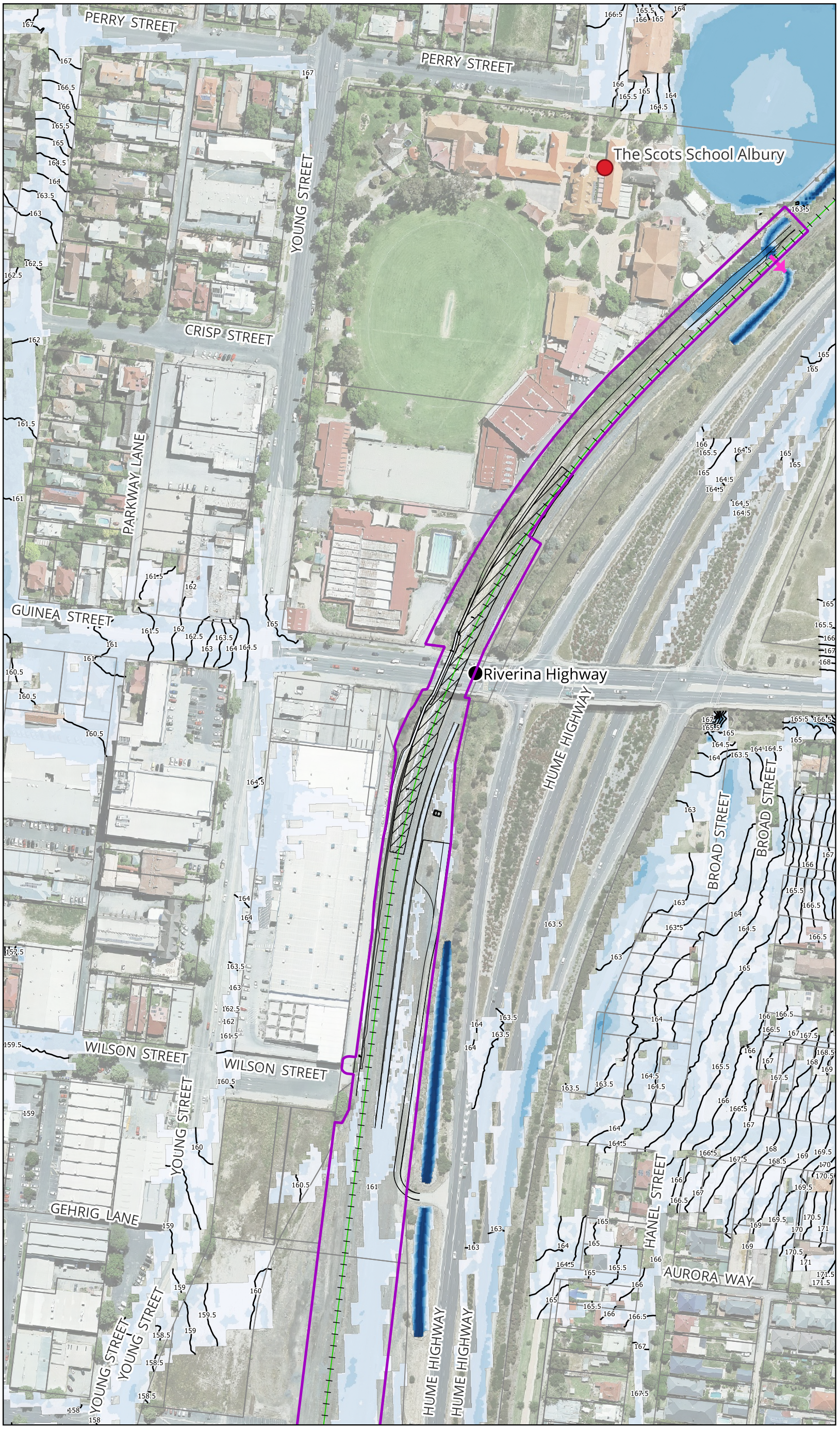
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A19: 10% AEP Peak Flood Depth and Levels - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

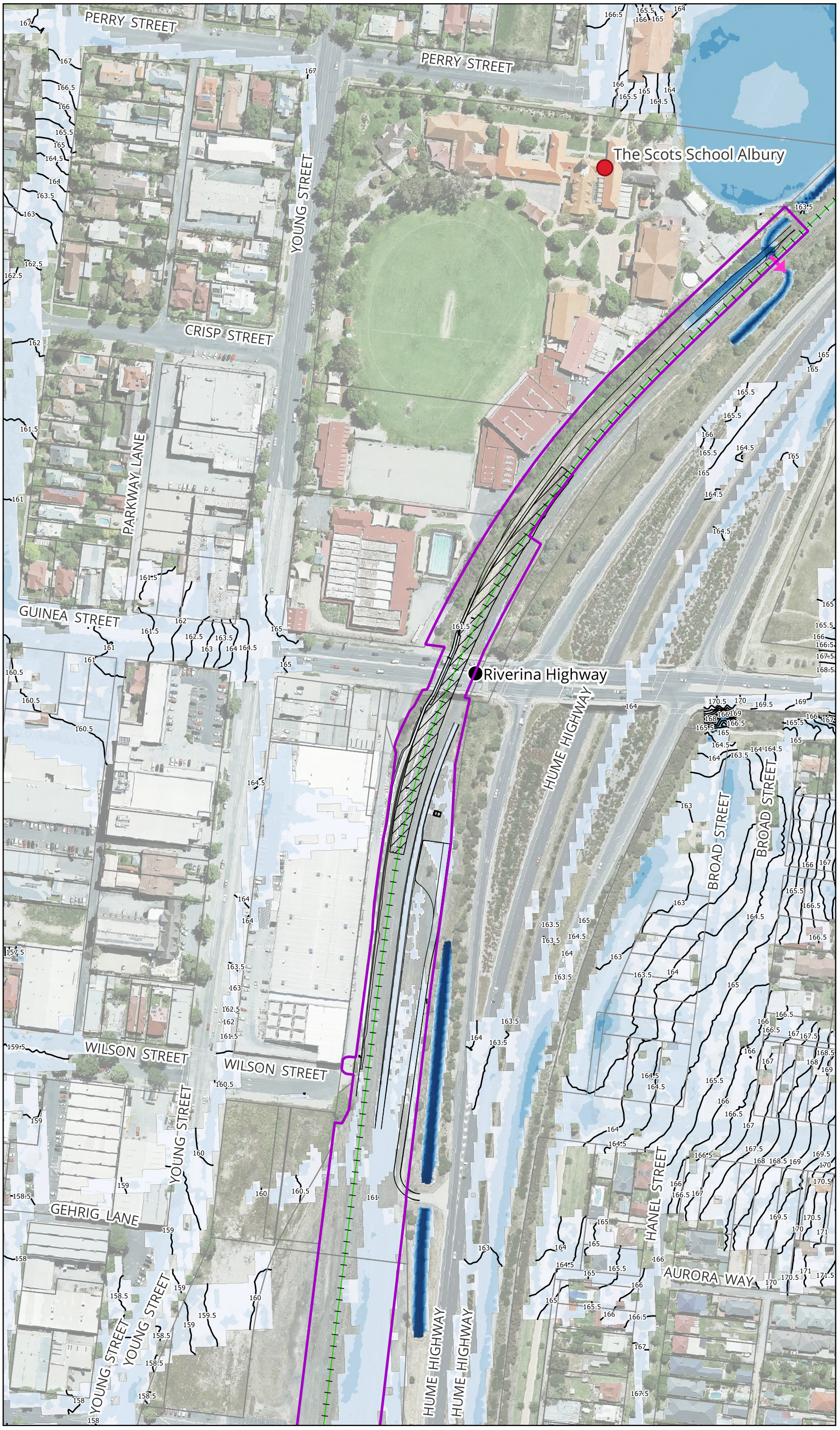
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A20: 5% AEP Peak Flood Depth and Levels - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

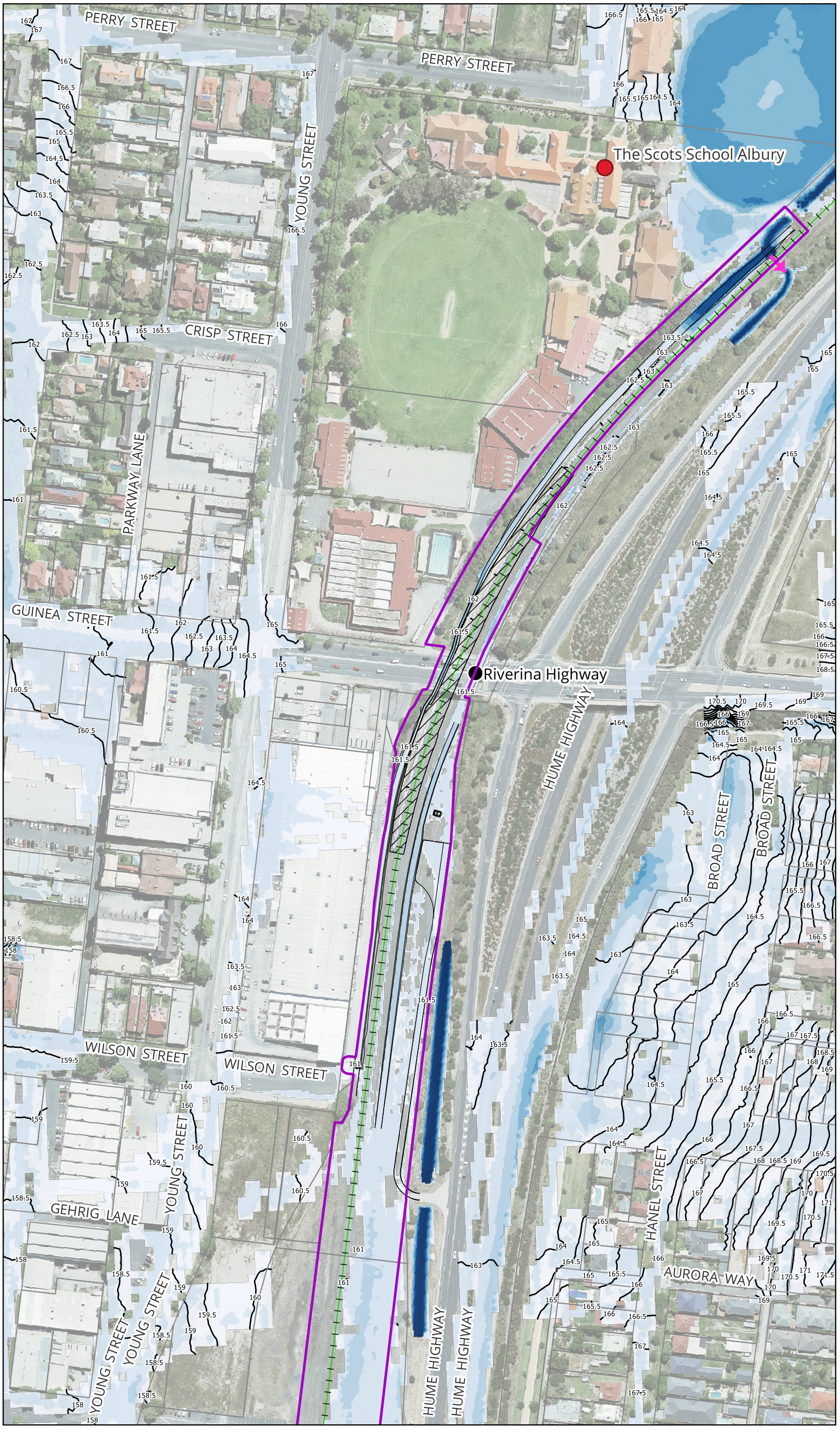
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A21: 2% AEP Peak Flood Depth and Levels - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

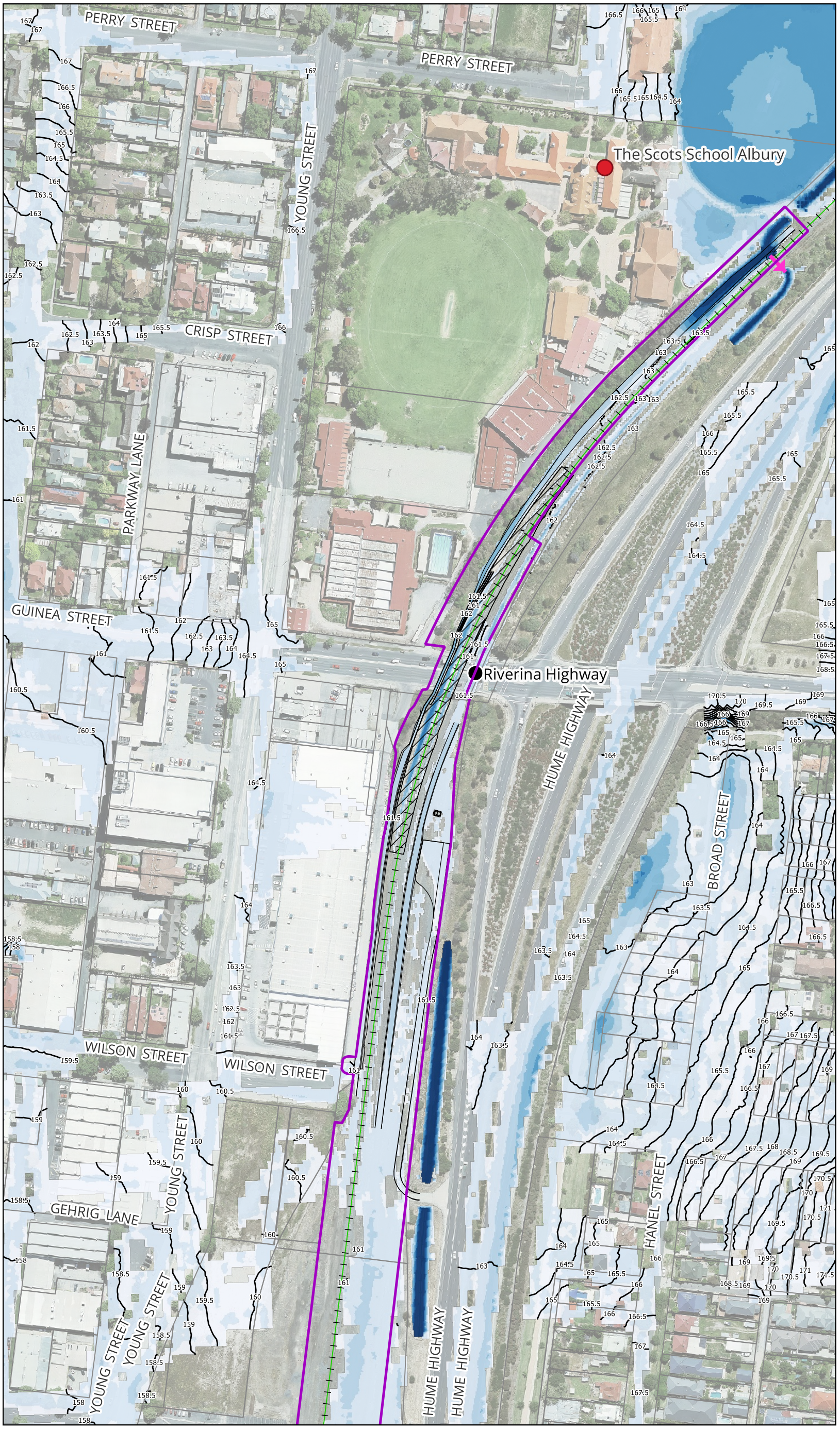
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A22: 1% AEP Peak Flood Depth and Levels - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

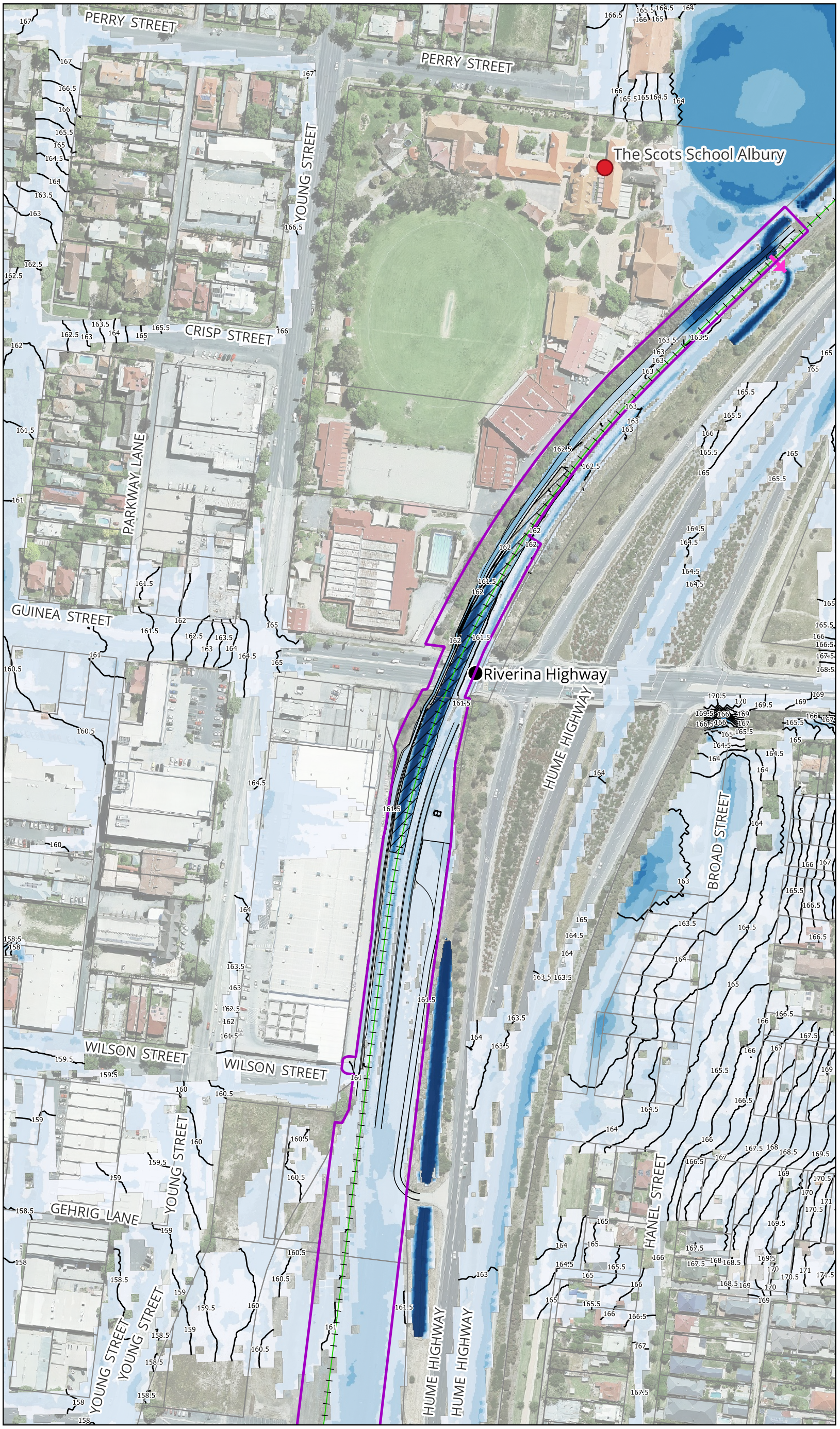
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A23: 1% AEP Peak Flood Depth and Levels - Design Blockage Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

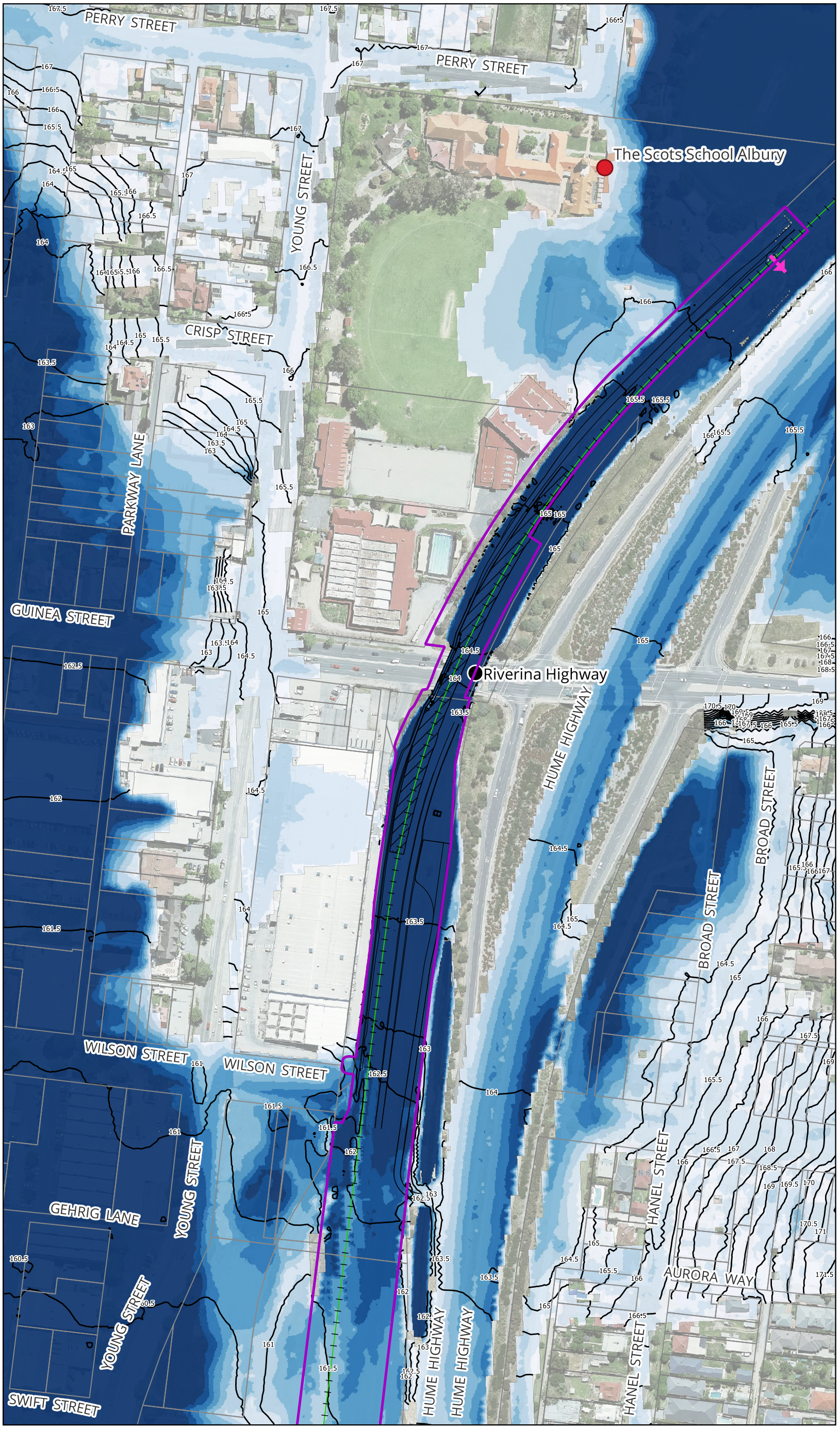
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A24: 1% AEP Climate Change Peak Flood Depth and Levels - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert
- Flood Level Contours (mAHD)

Peak Flood Depth (m)

- <= 0.03
- 0.03 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2
- > 1.2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A25: PMF Peak Flood Depth and Levels - Design Condition

MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

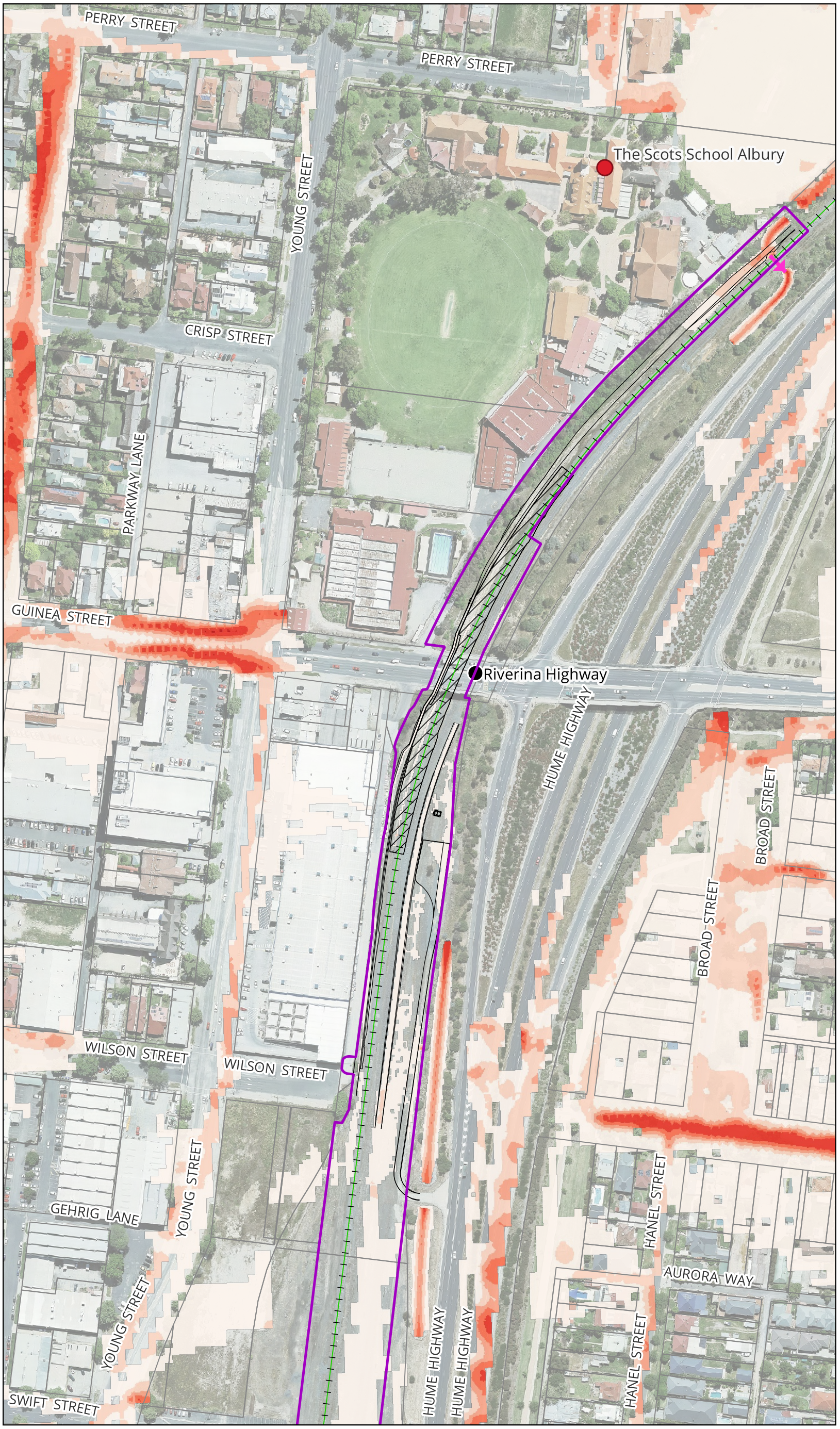
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A26: 10% AEP Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

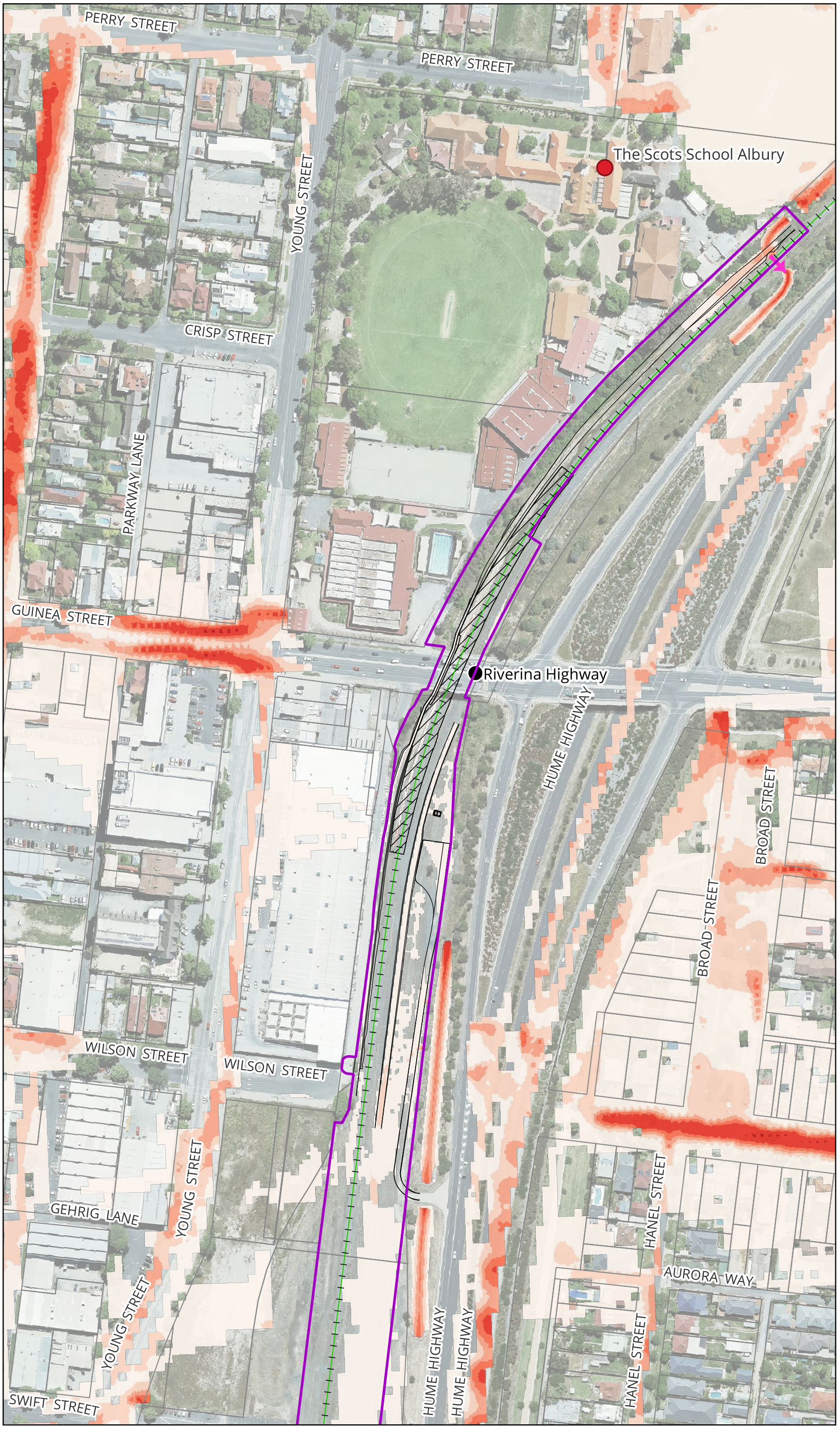
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A27: 5% AEP Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

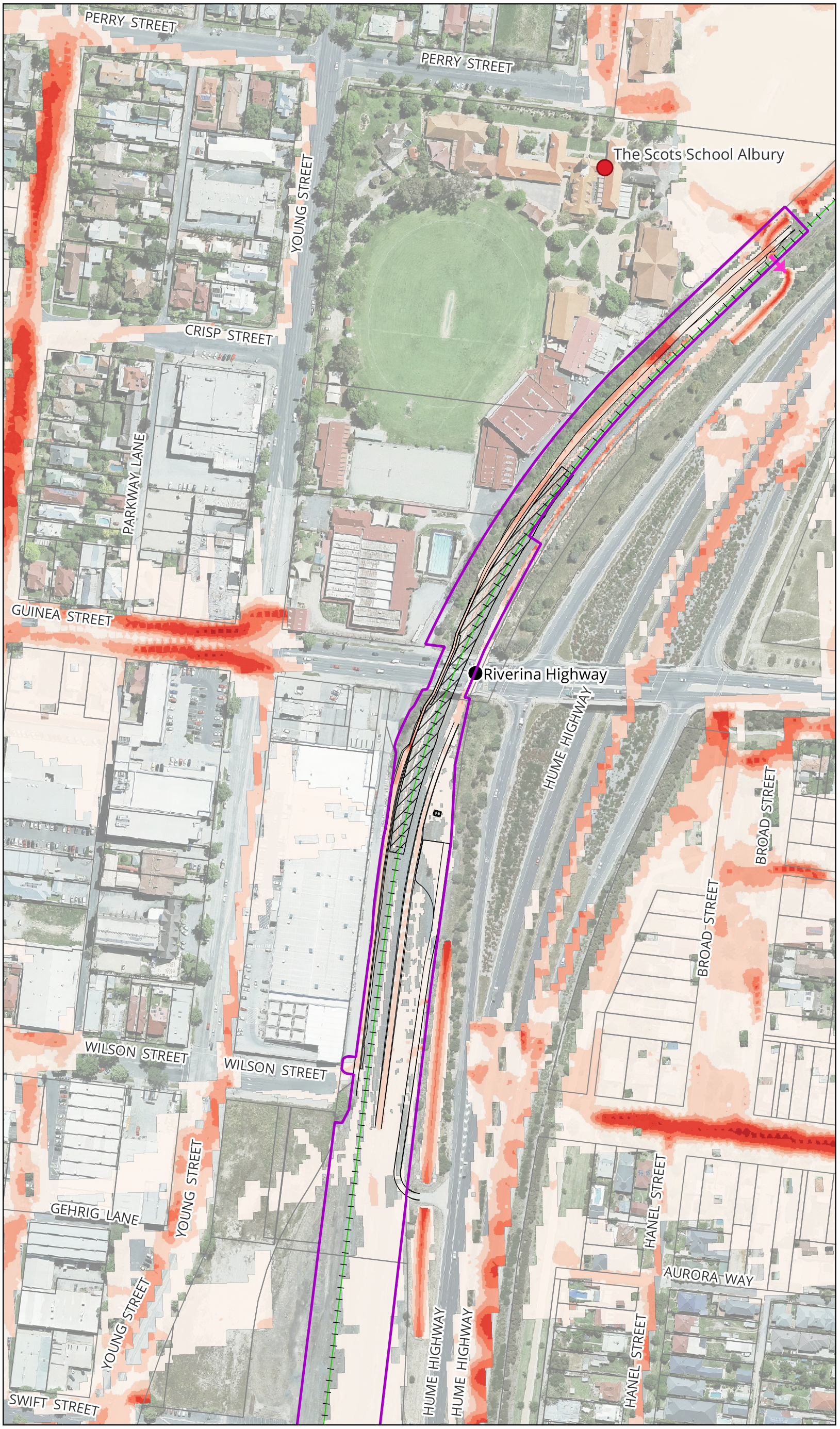
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A28: 2% AEP Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

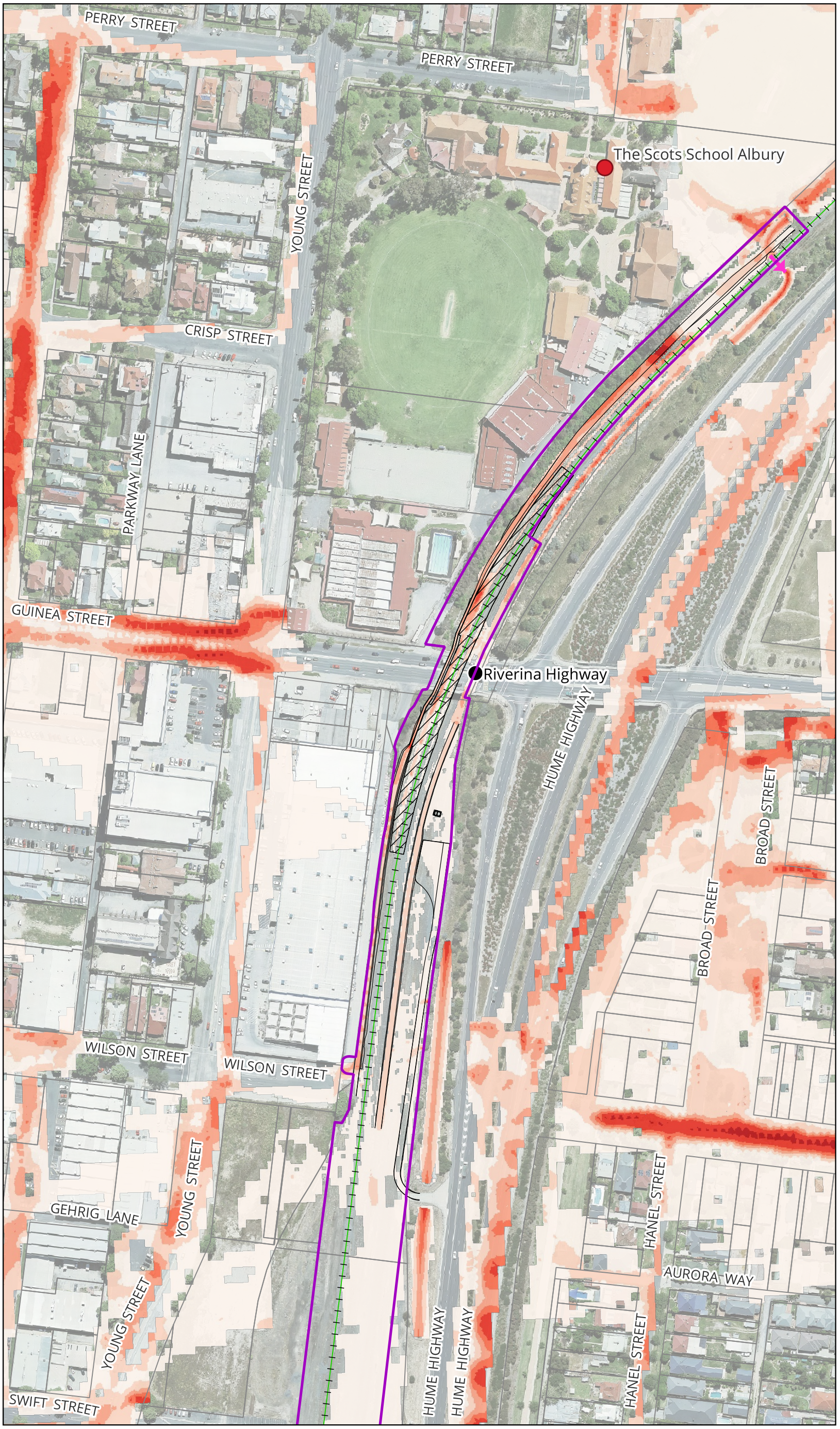
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A29: 1% AEP Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

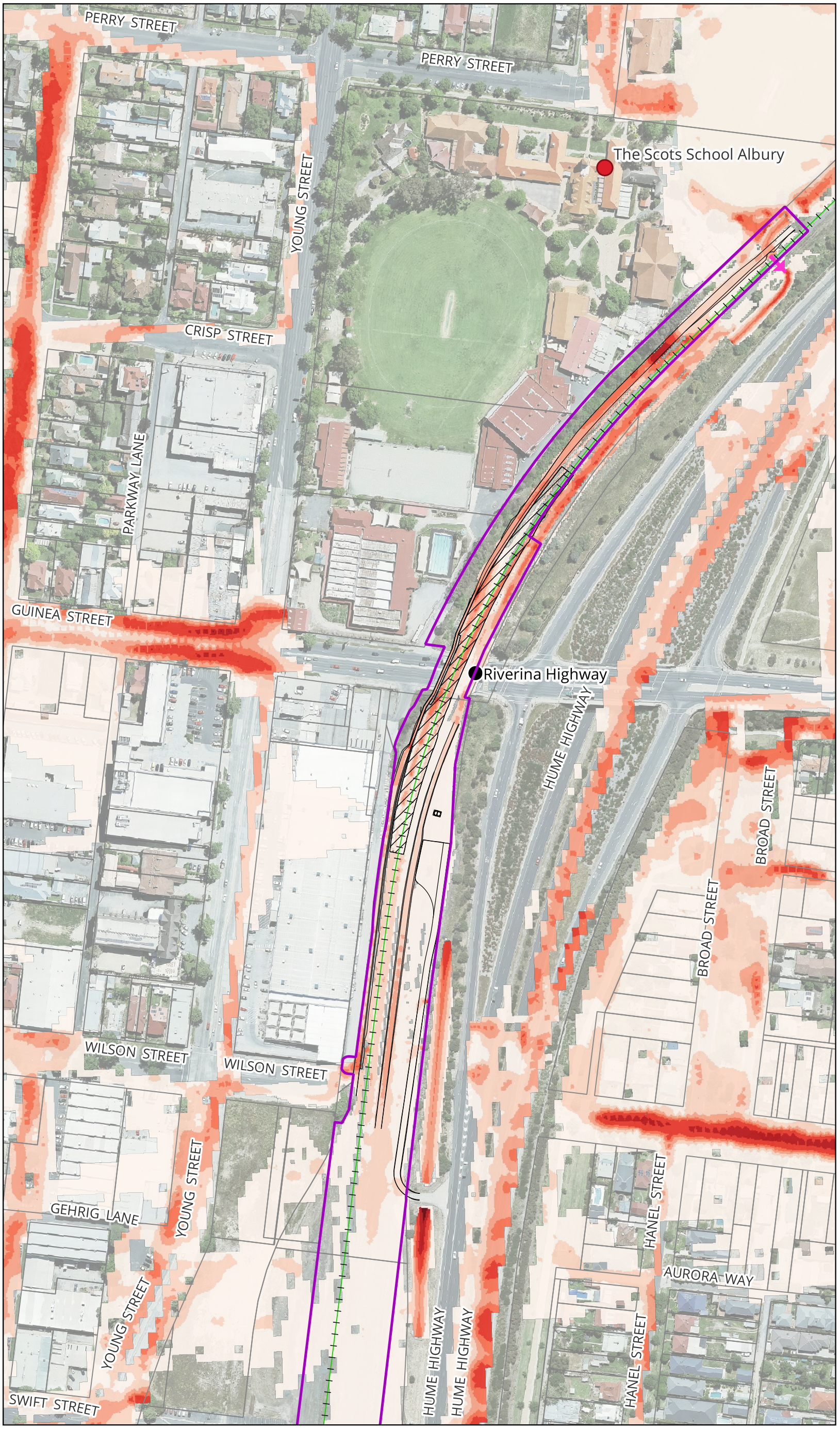
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A30: 1% AEP Peak Flood Velocity - Design Blockage Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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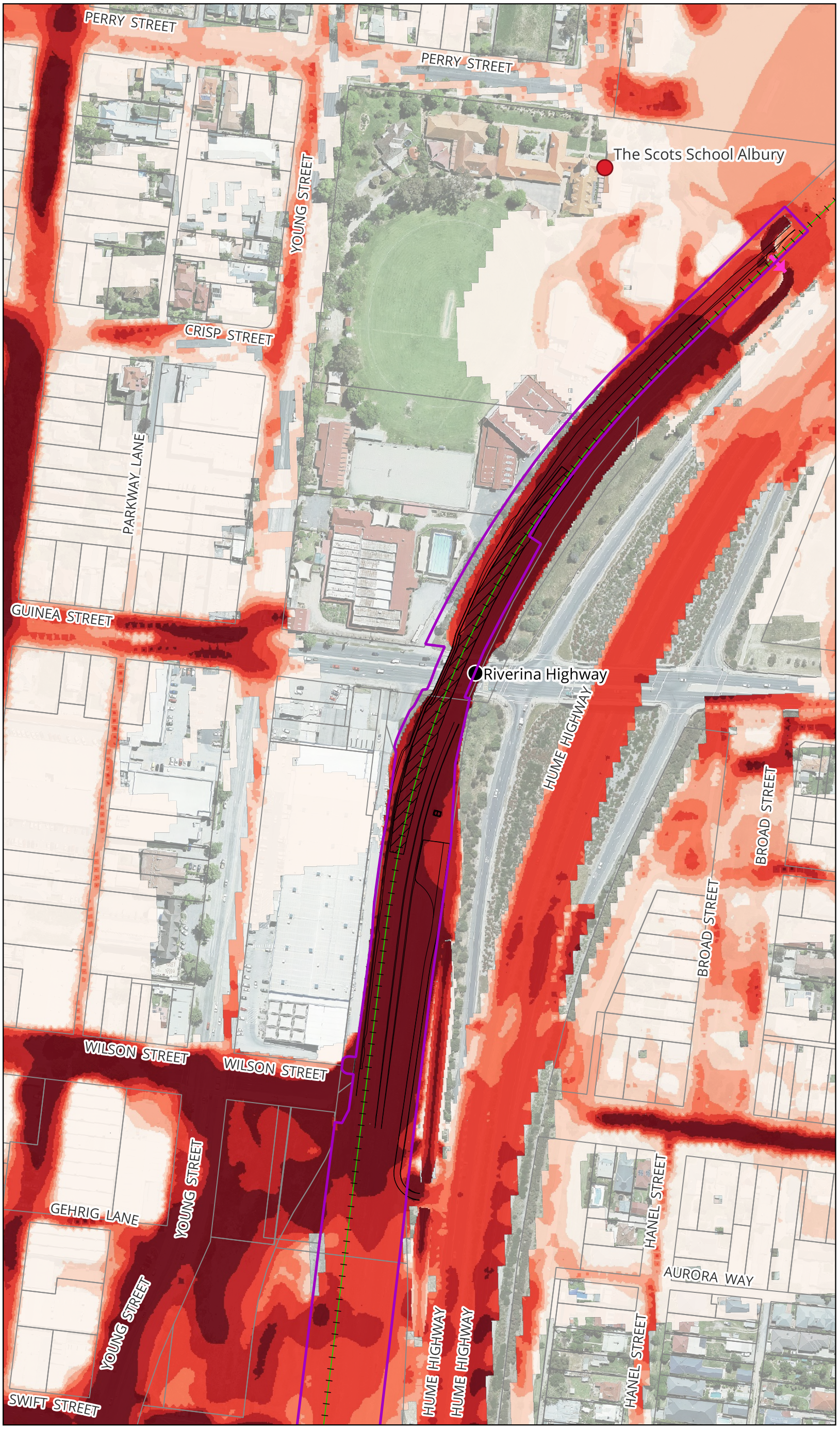
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A31: 1% AEP Climate Change Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Velocity (m/s)

- <= 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.5
- 1.5 - 2
- > 2

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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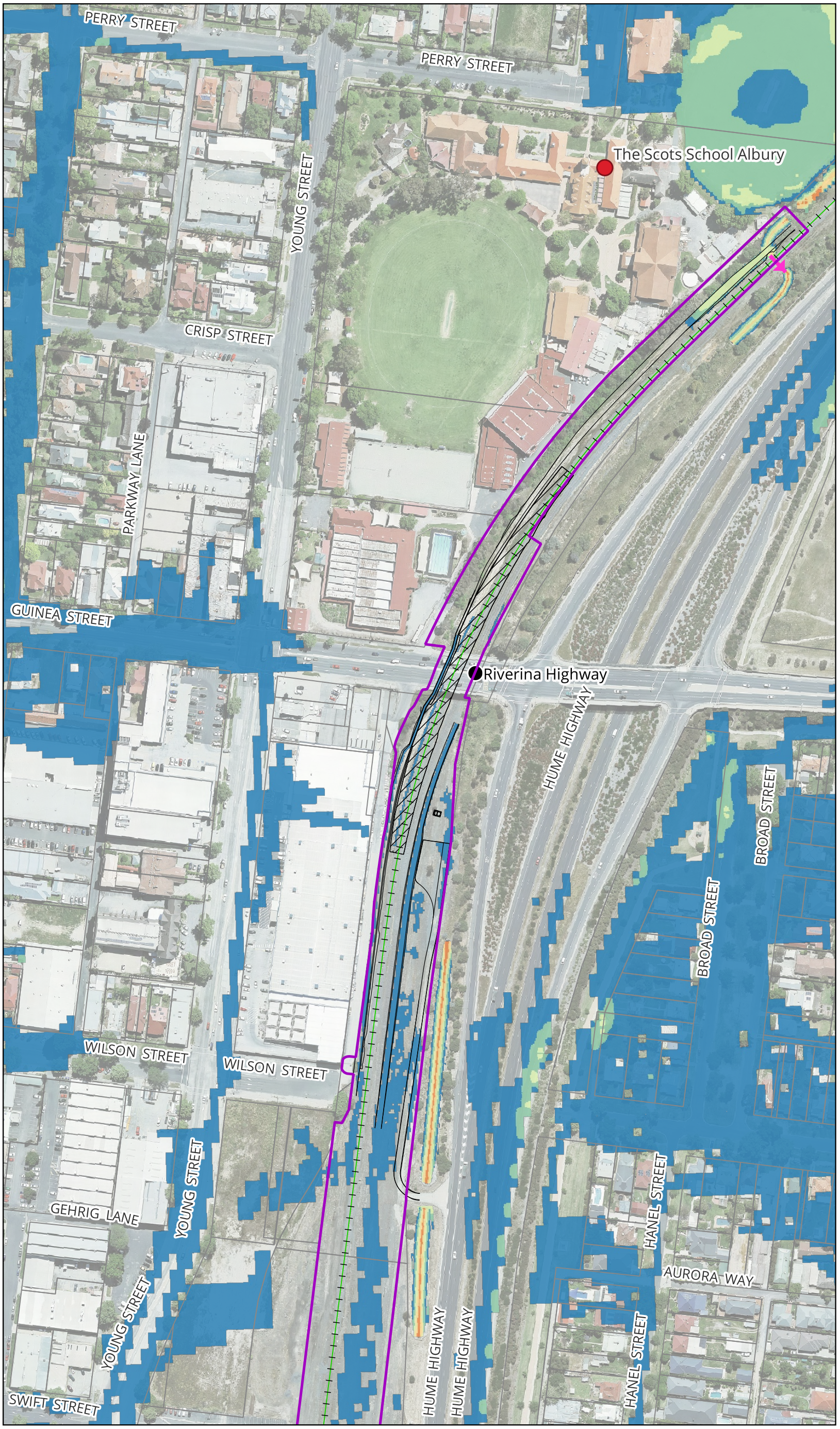
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A32: PMF Peak Flood Velocity - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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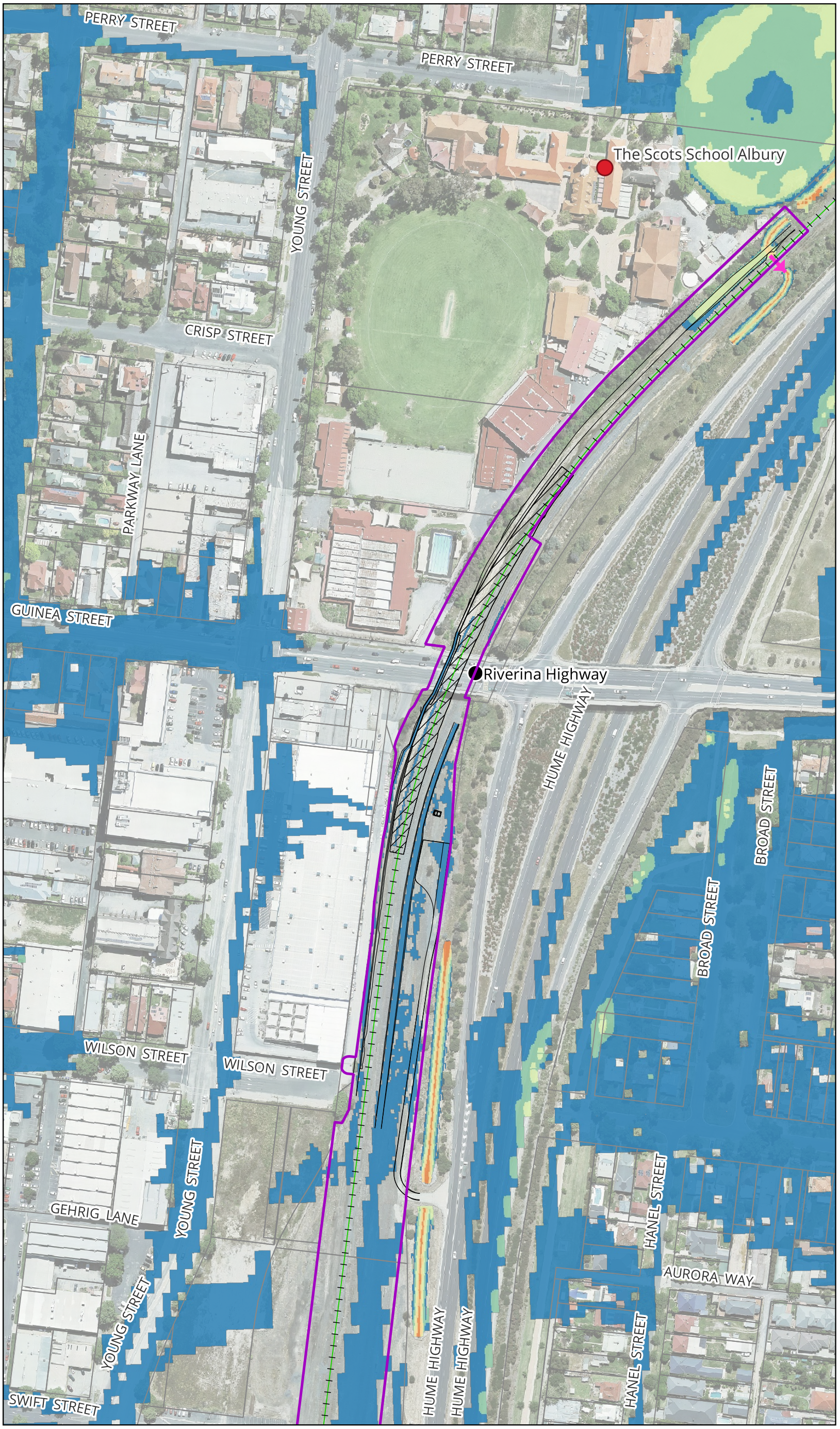
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A33: 10% AEP Peak Flood Hazard - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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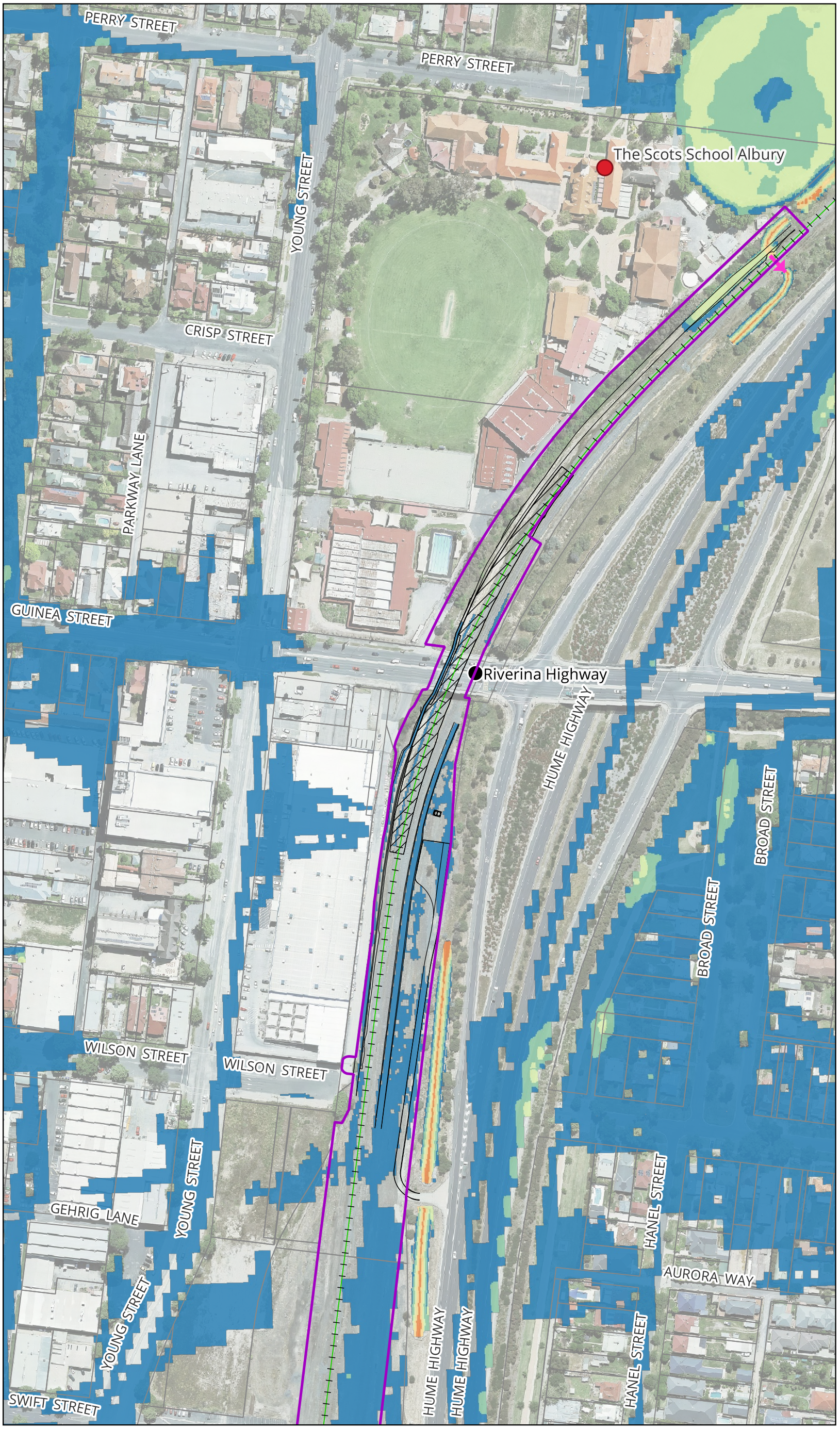
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A34: 5% AEP Peak Flood Hazard - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A35: 2% AEP Peak Flood Hazard - Design Condition

MARTINUS

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Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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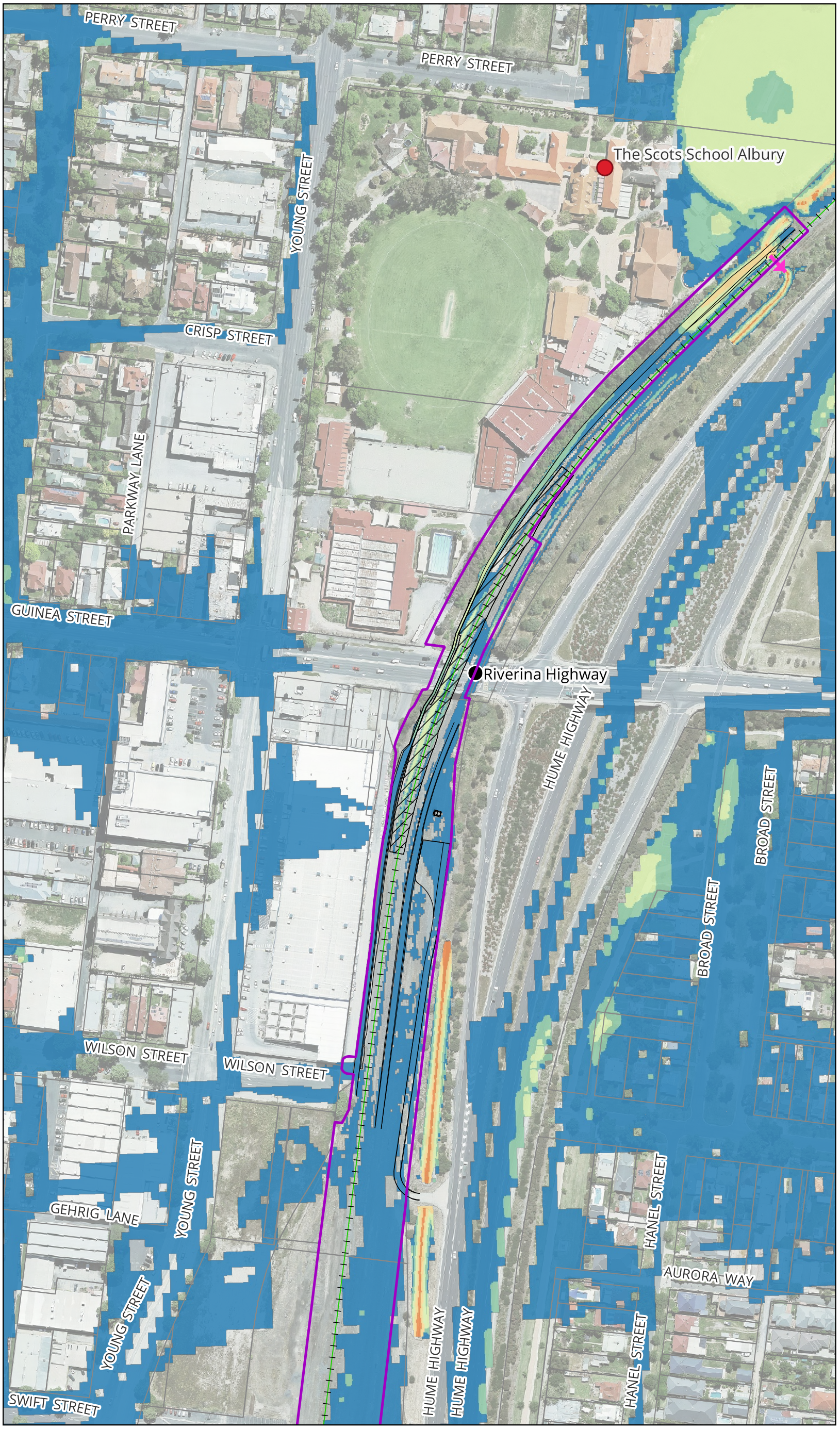
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A36: 1% AEP Peak Flood Hazard - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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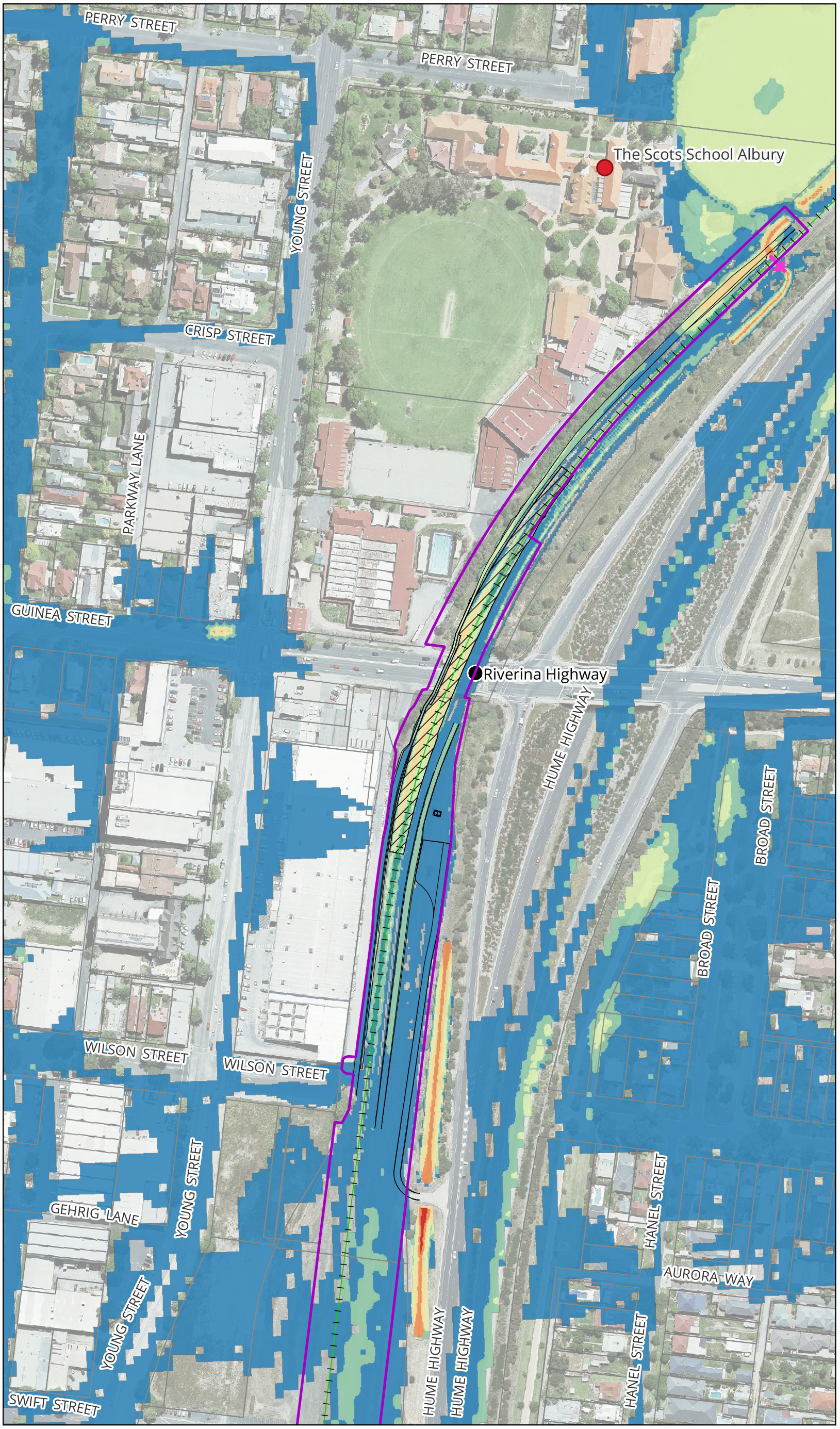
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A37: 1% AEP Peak Flood Hazard - Design Blockage Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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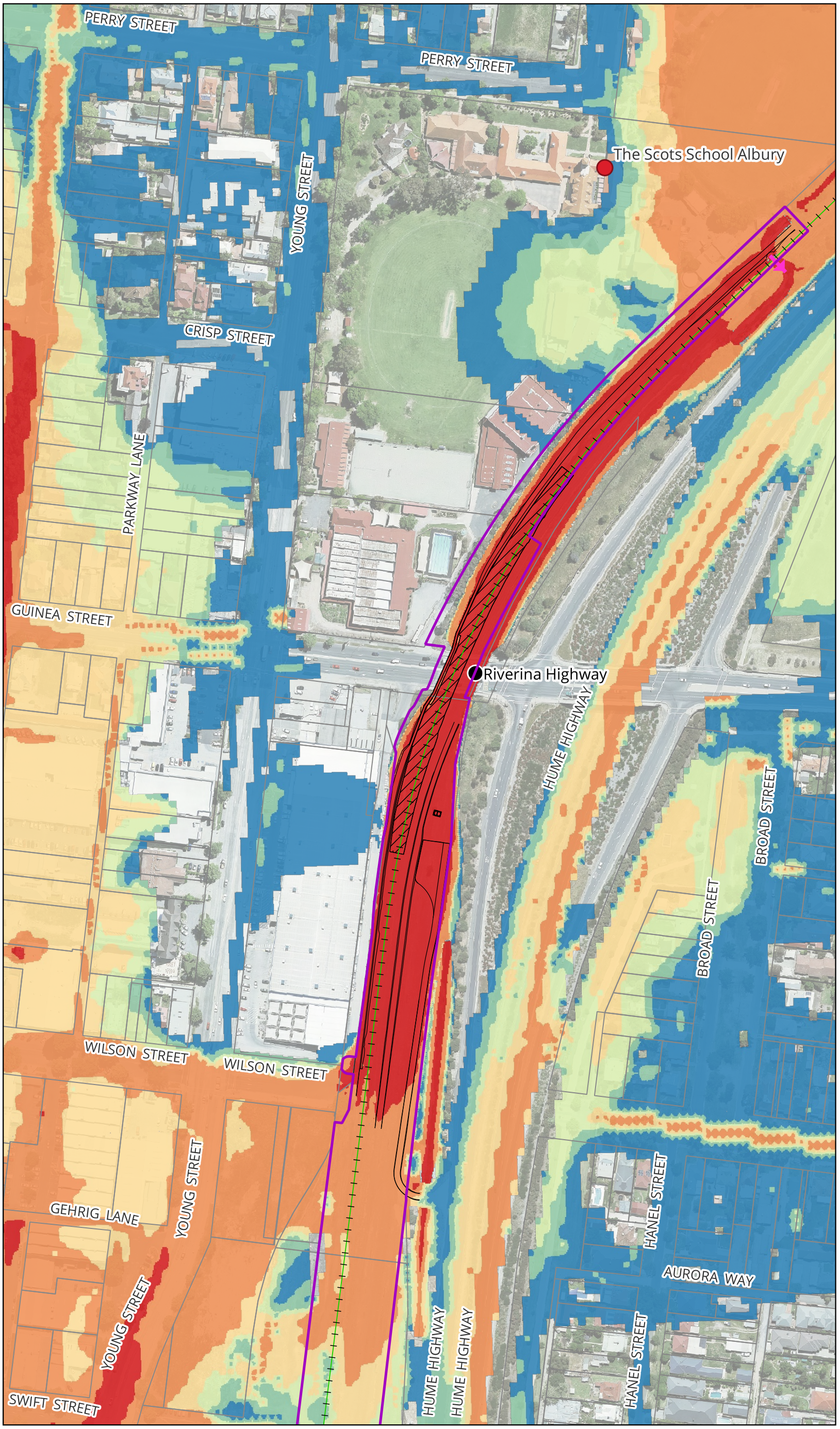
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A38: 1% AEP Climate Change Peak Flood Hazard - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Peak Flood Hazard

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

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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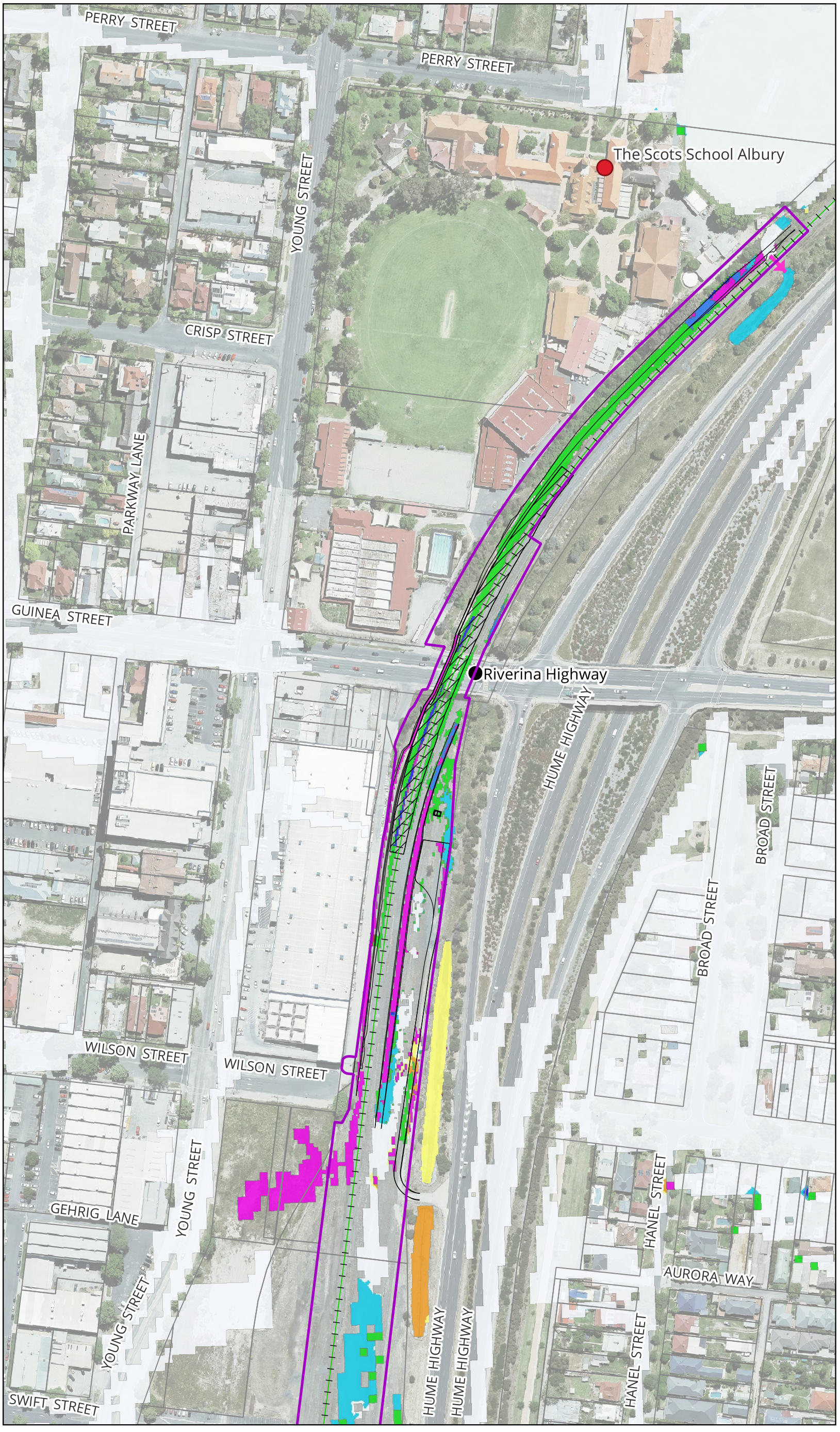
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A39: PMF Peak Flood Hazard - Design Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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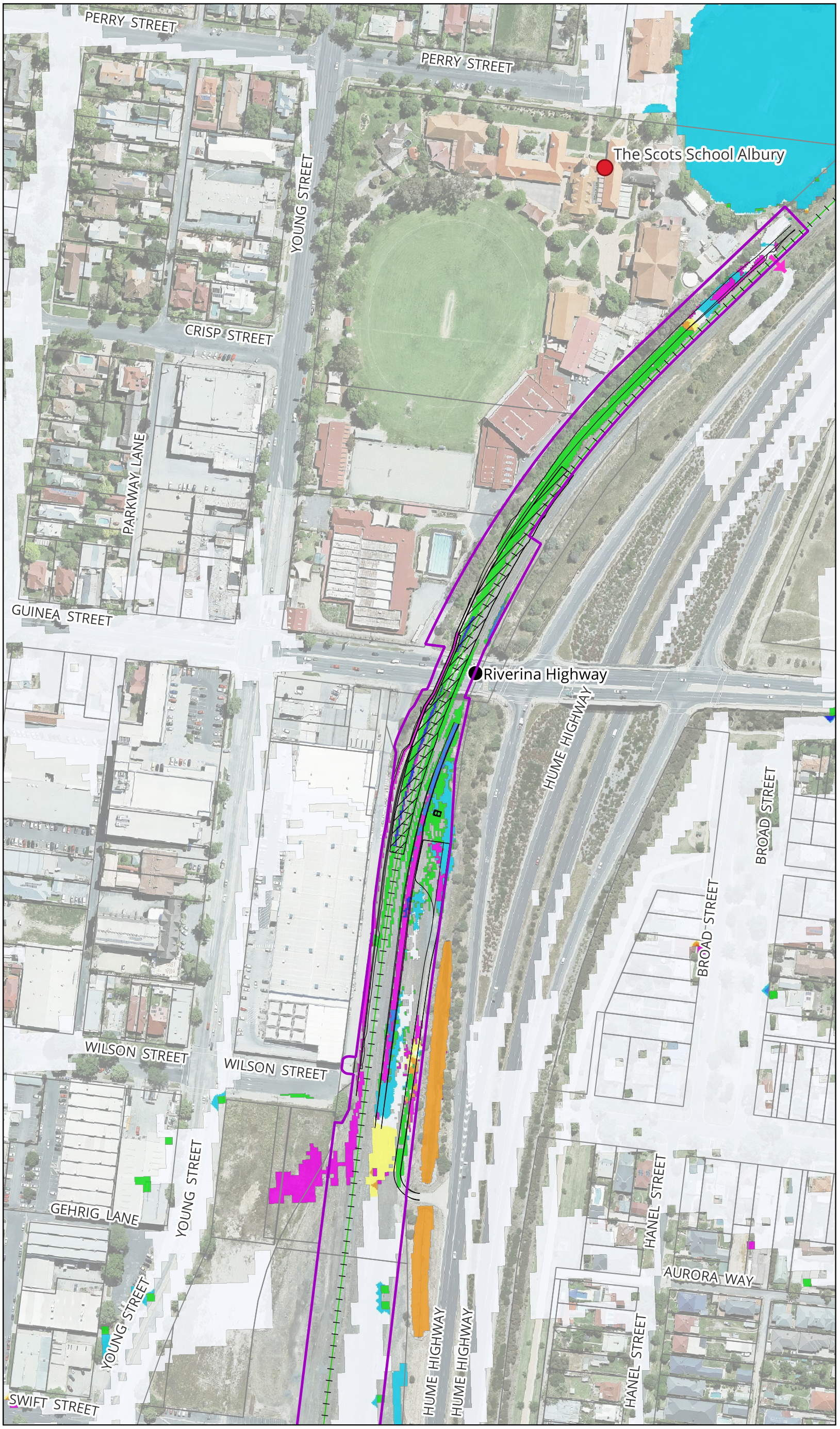
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A40: Changes in Peak Flood Levels for 10% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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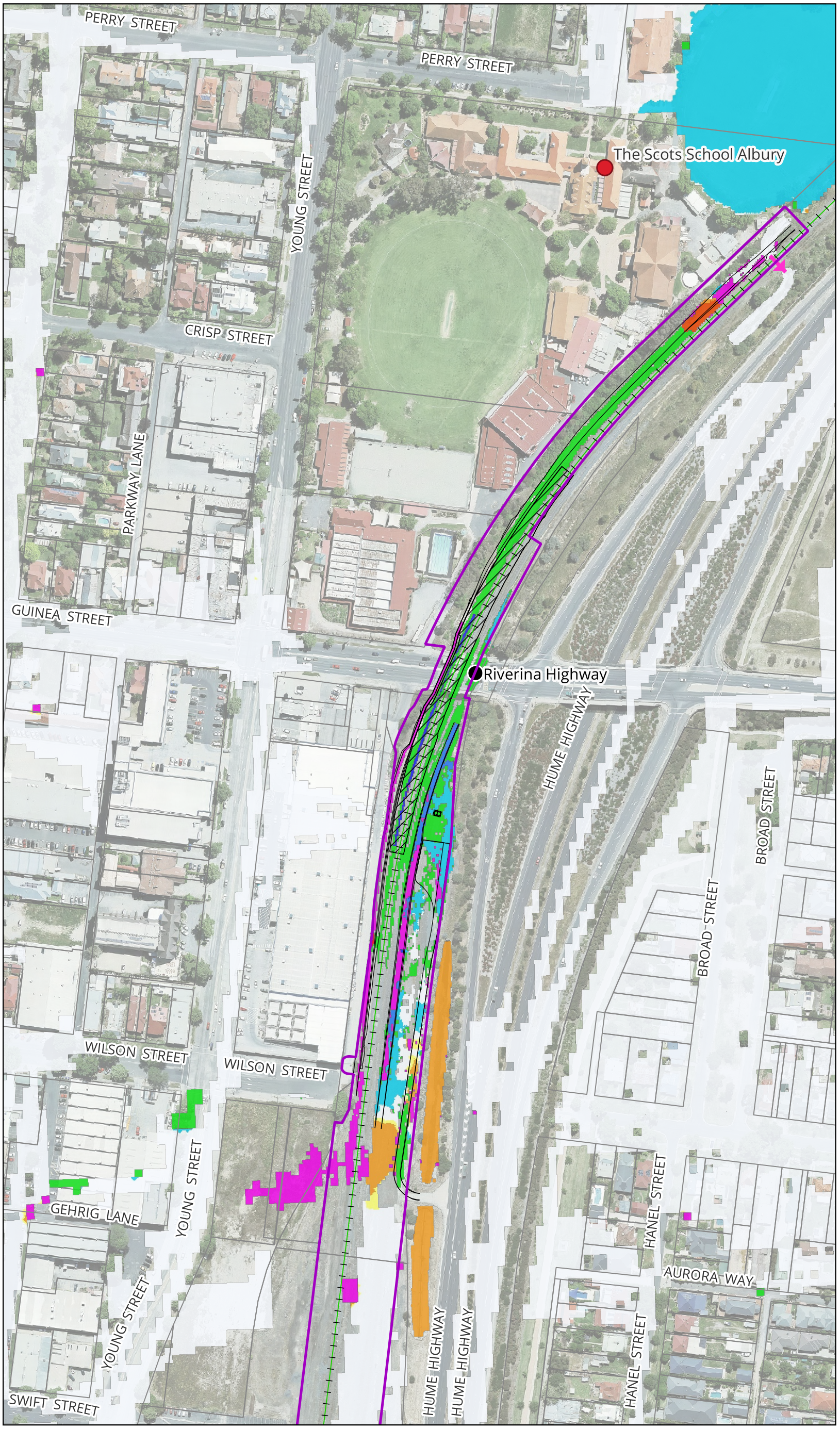
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A41: Changes in Peak Flood Levels for 5% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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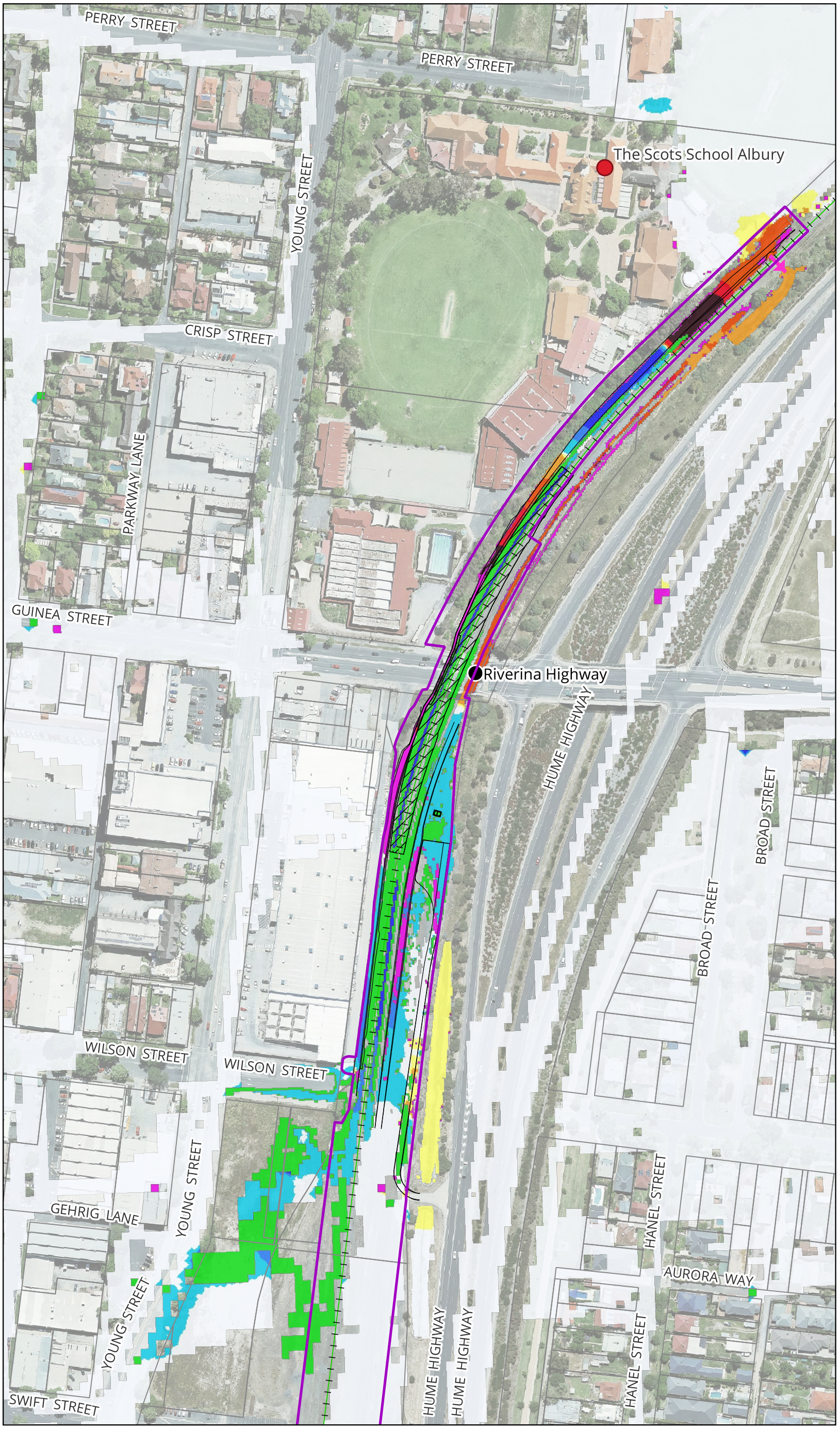
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A42: Changes in Peak Flood Levels for 2% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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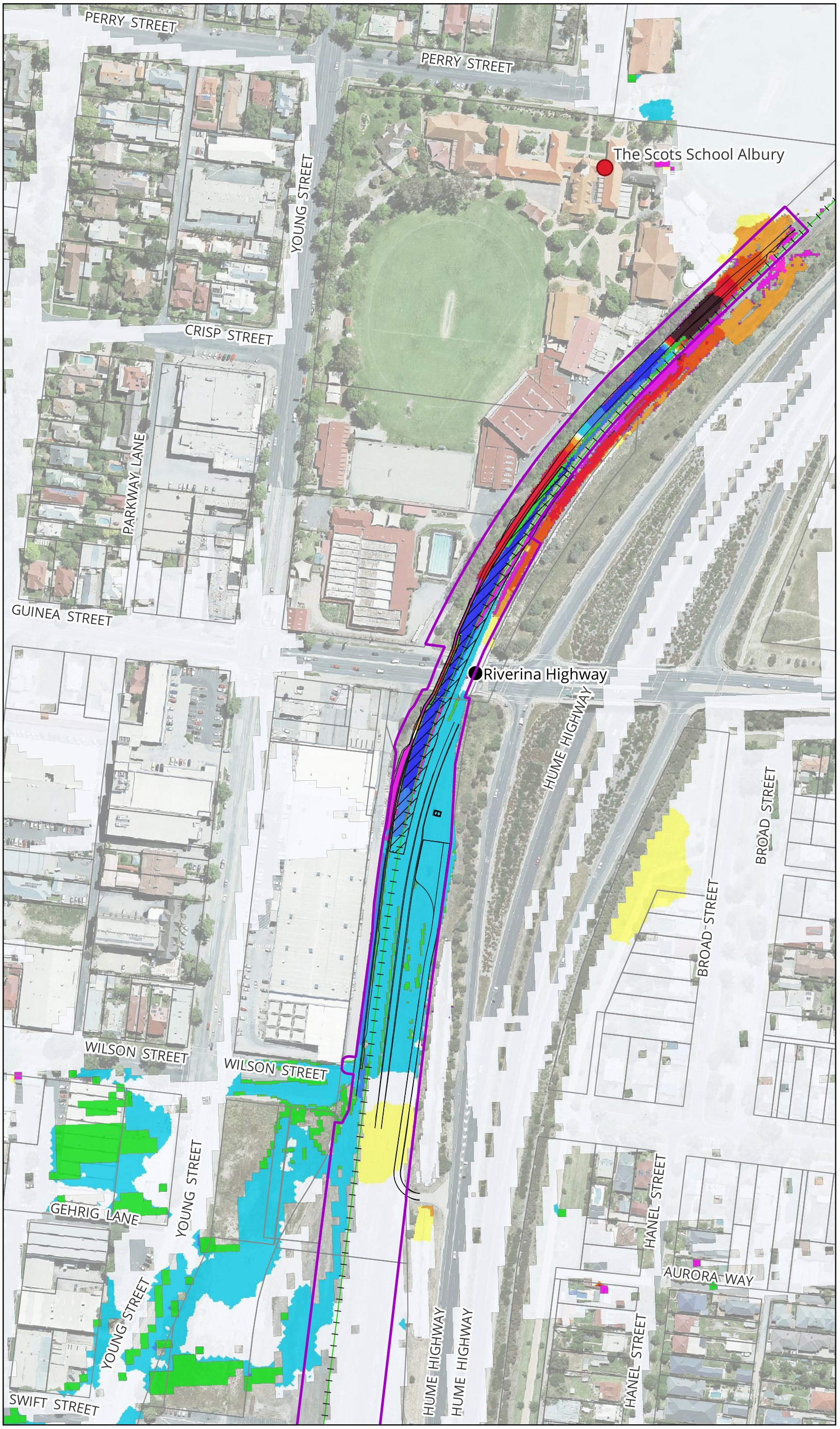
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A43: Changes in Peak Flood Levels for 1% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Flood Level (m)

- <= -0.2
- -0.2 - -0.1
- -0.1 - -0.01
- -0.01 - 0.01
- 0.01 - 0.02
- 0.02 - 0.05
- 0.05 - 0.1
- 0.1 - 0.2
- > 0.2
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

0 100 200 m

A3 Scale: 1:2,500

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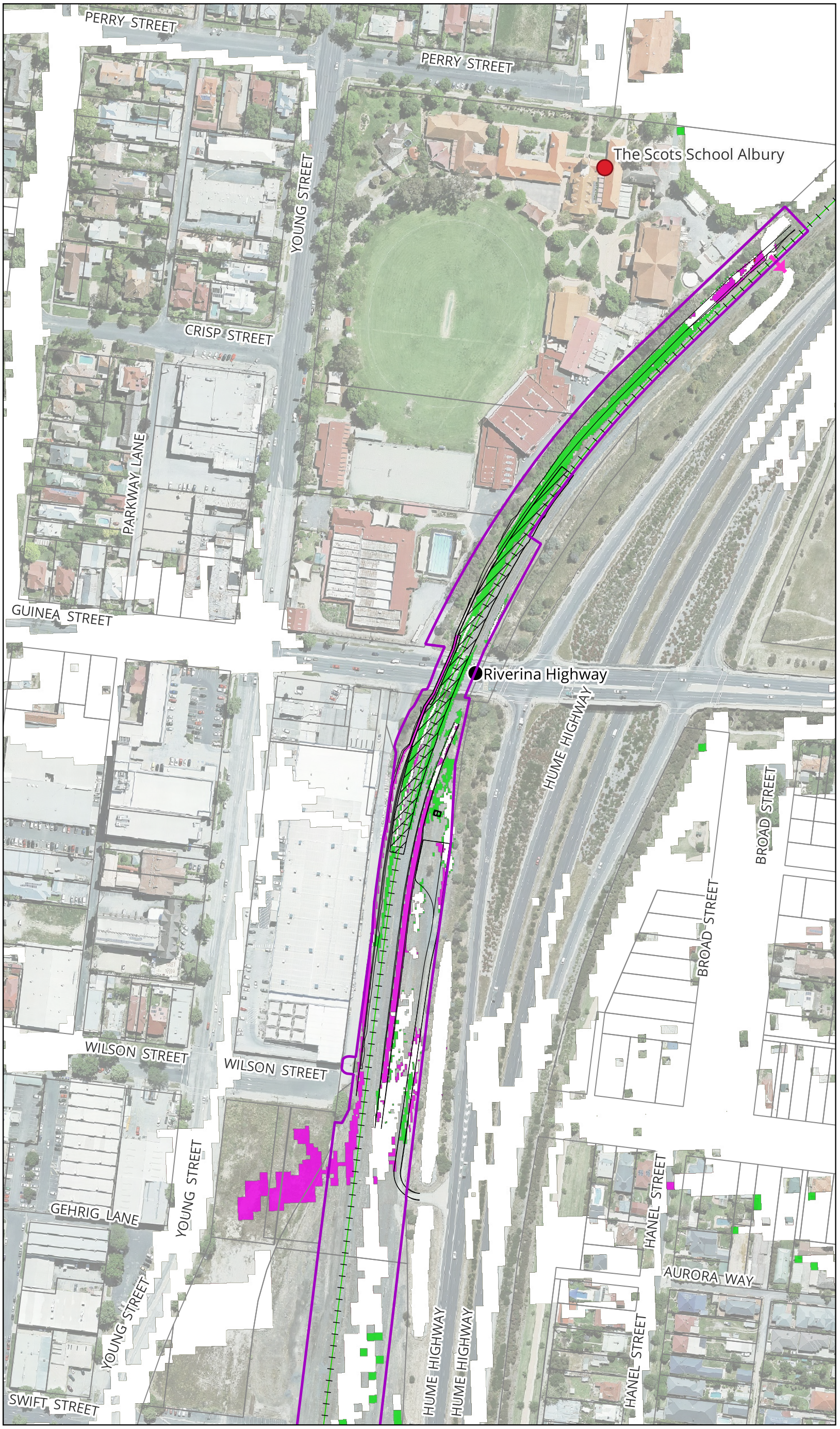
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A44: Changes in Peak Flood Levels for 1% AEP Climate Change - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A45: Changes in Peak Flood Velocity for 10% AEP - Design Condition vs Existing Condition

MARTINUS

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Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

<= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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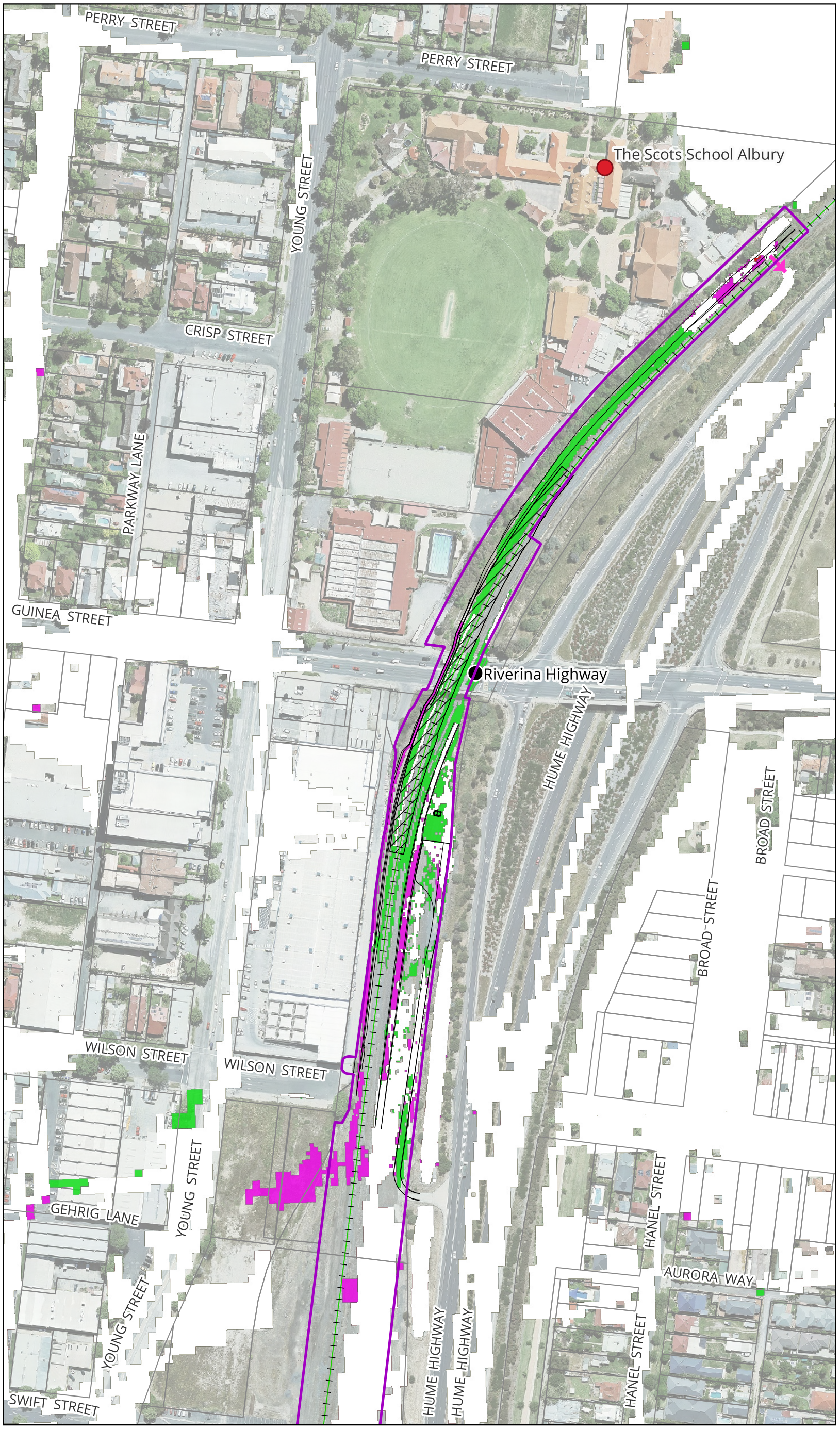
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A46: Changes in Peak Flood Velocity for 5% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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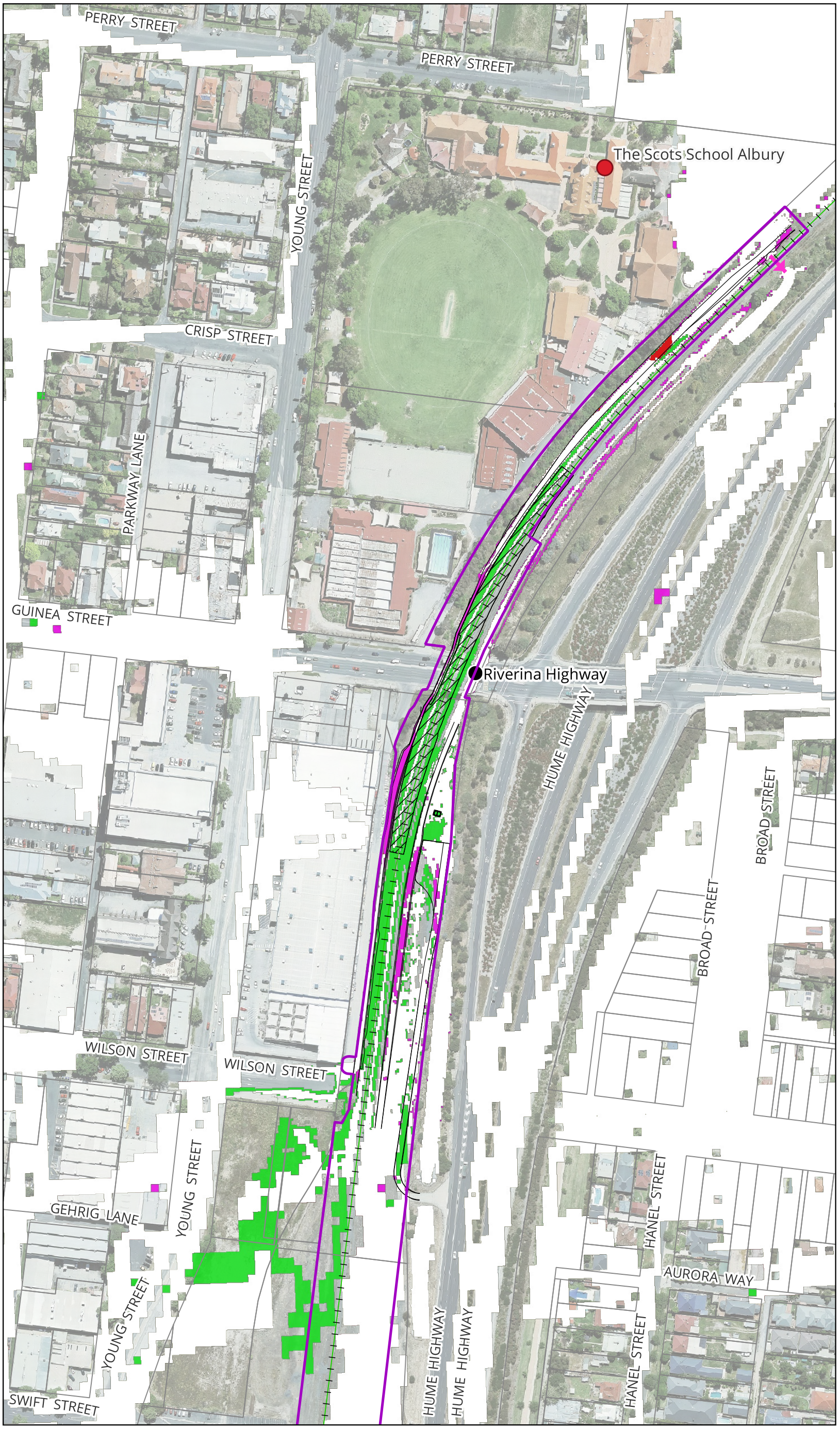
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A47: Changes in Peak Flood Velocity for 2% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

- <= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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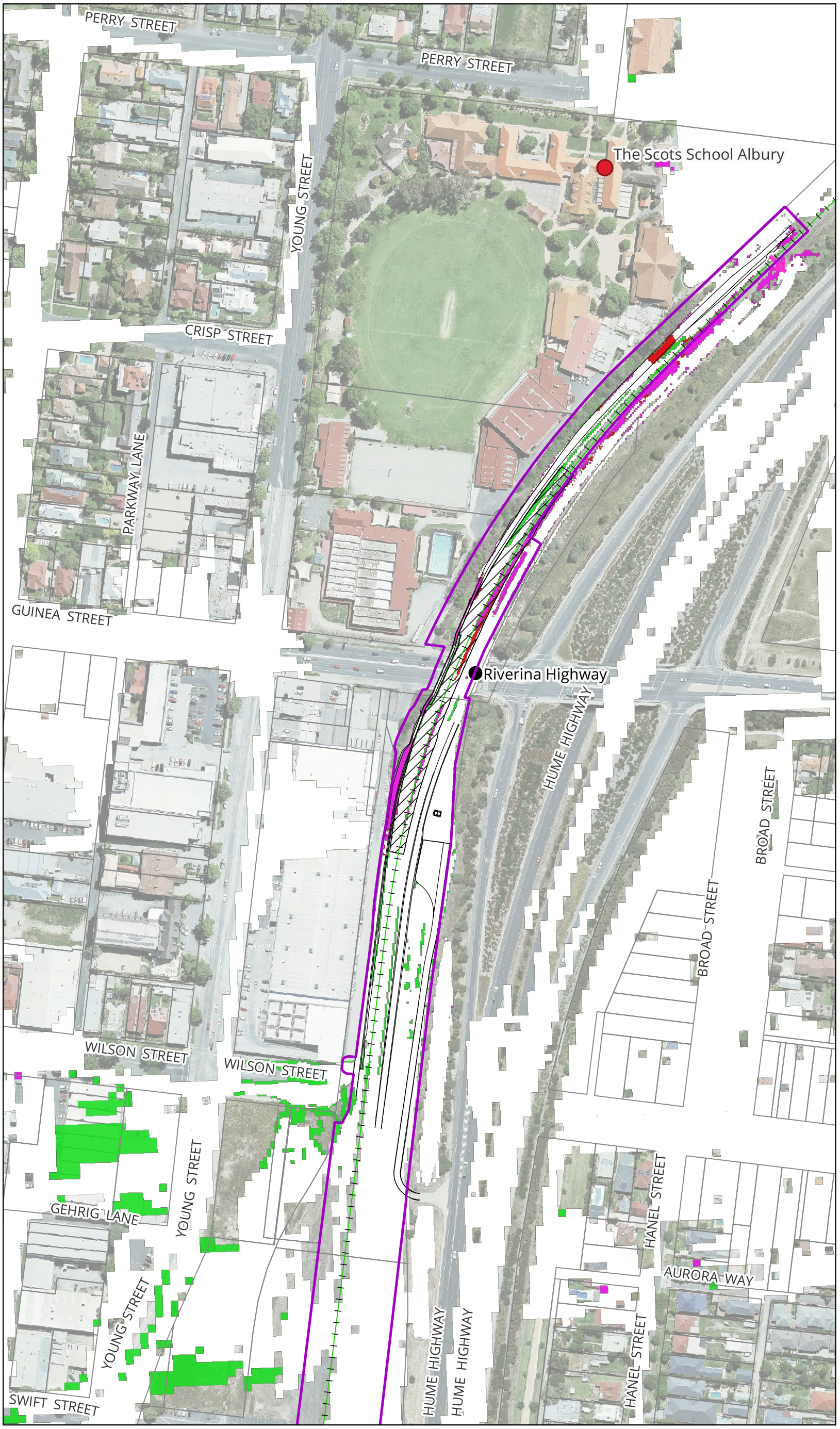
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A48: Changes in Peak Flood Velocity for 1% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Velocity (m/s)

<= 0.5

Changes in Velocity (%)

- <= 10%
- 10% - 20%
- > 20%
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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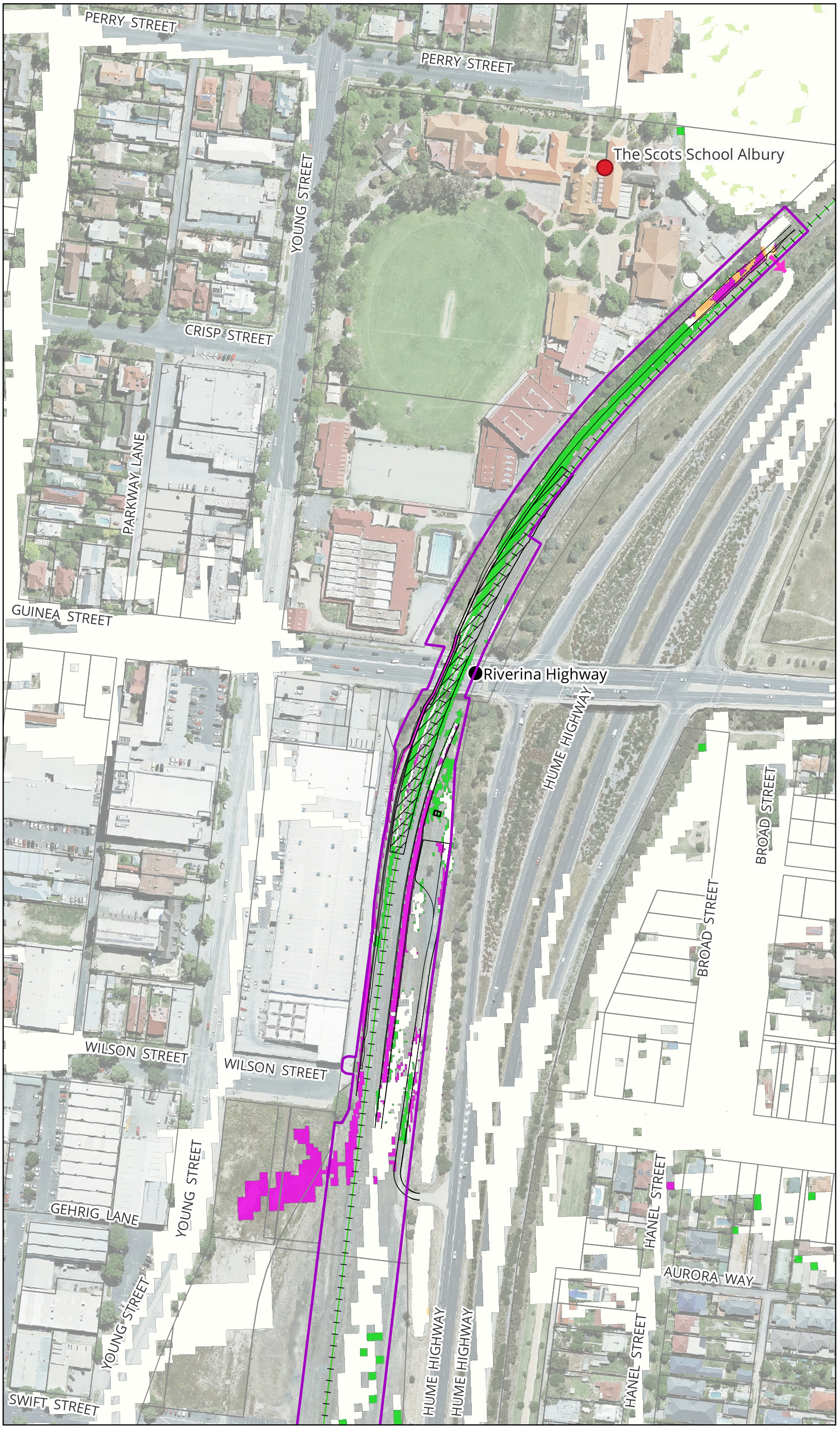
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A49: Changes in Peak Flood Velocity for 1% AEP Climate Change - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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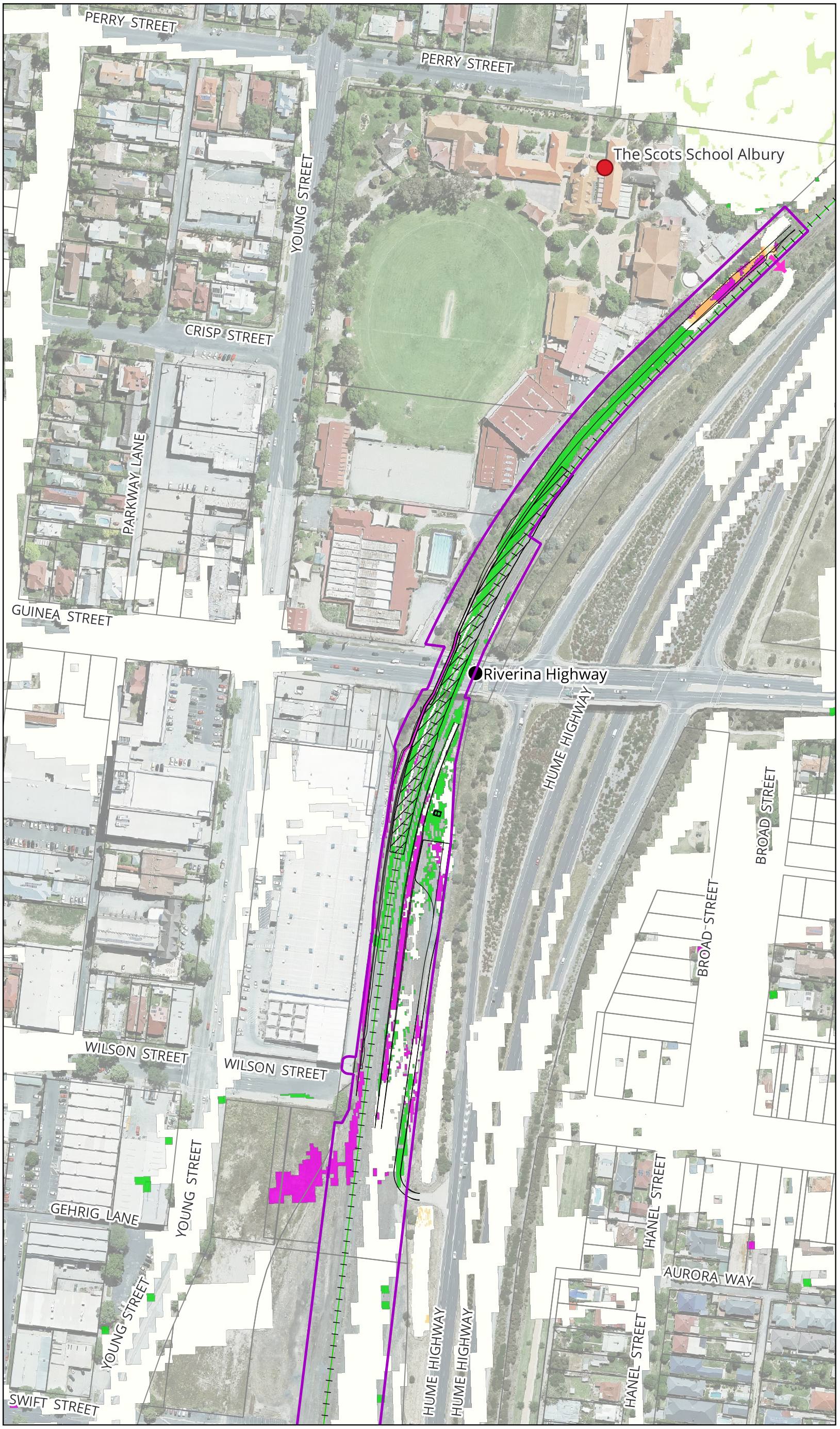
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A50: Changes in Peak Flood Hazard for 10% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

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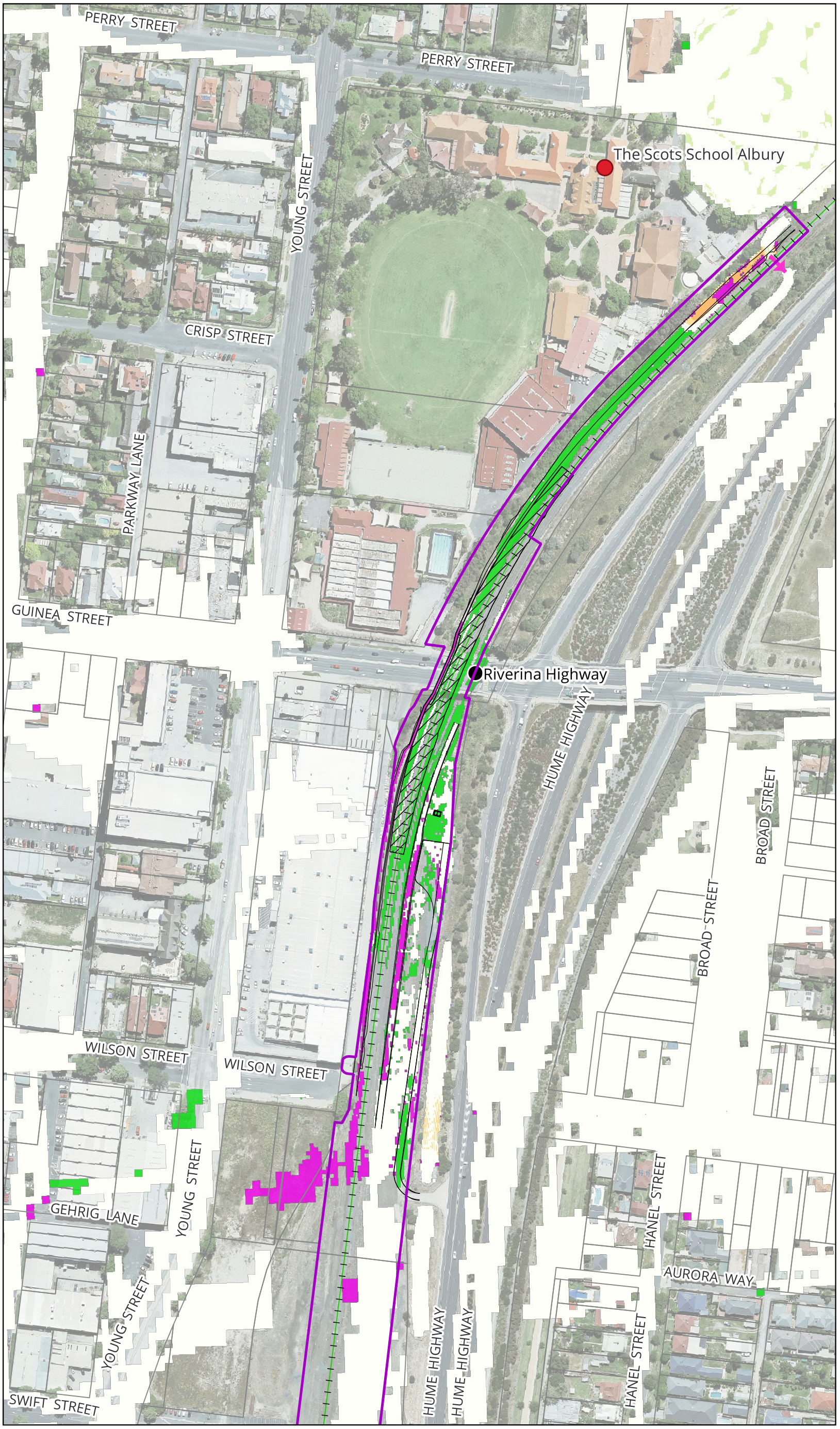
Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A51: Changes in Peak Flood Hazard for 5% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

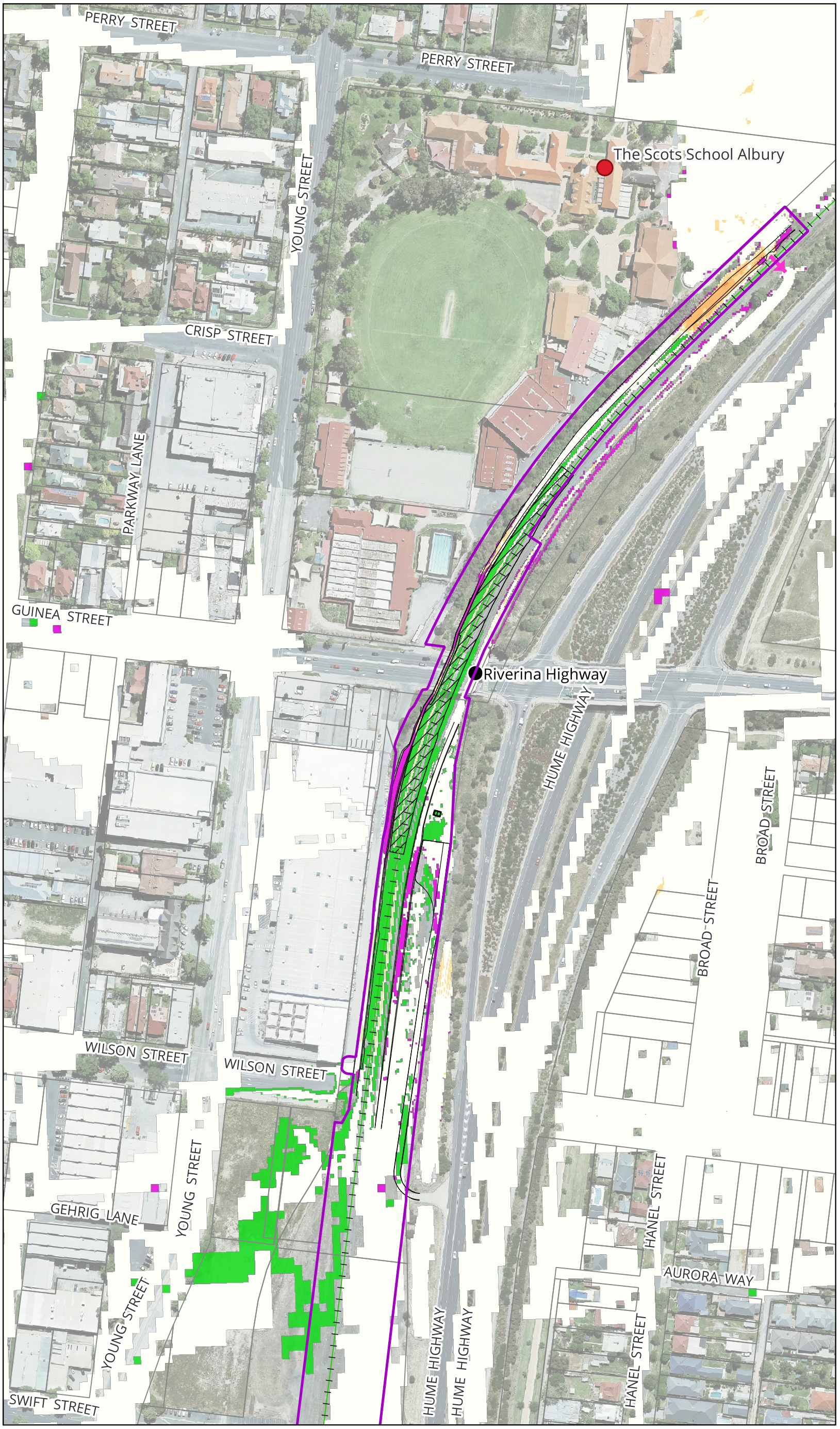
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A52: Changes in Peak Flood Hazard for 2% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

H1: Generally safe for vehicles, people and buildings.
H2: Unsafe for small vehicles.
H3: Unsafe for vehicles. children and the elderly.
H4: Unsafe for vehicles and people.
H5: Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

Map by: TT

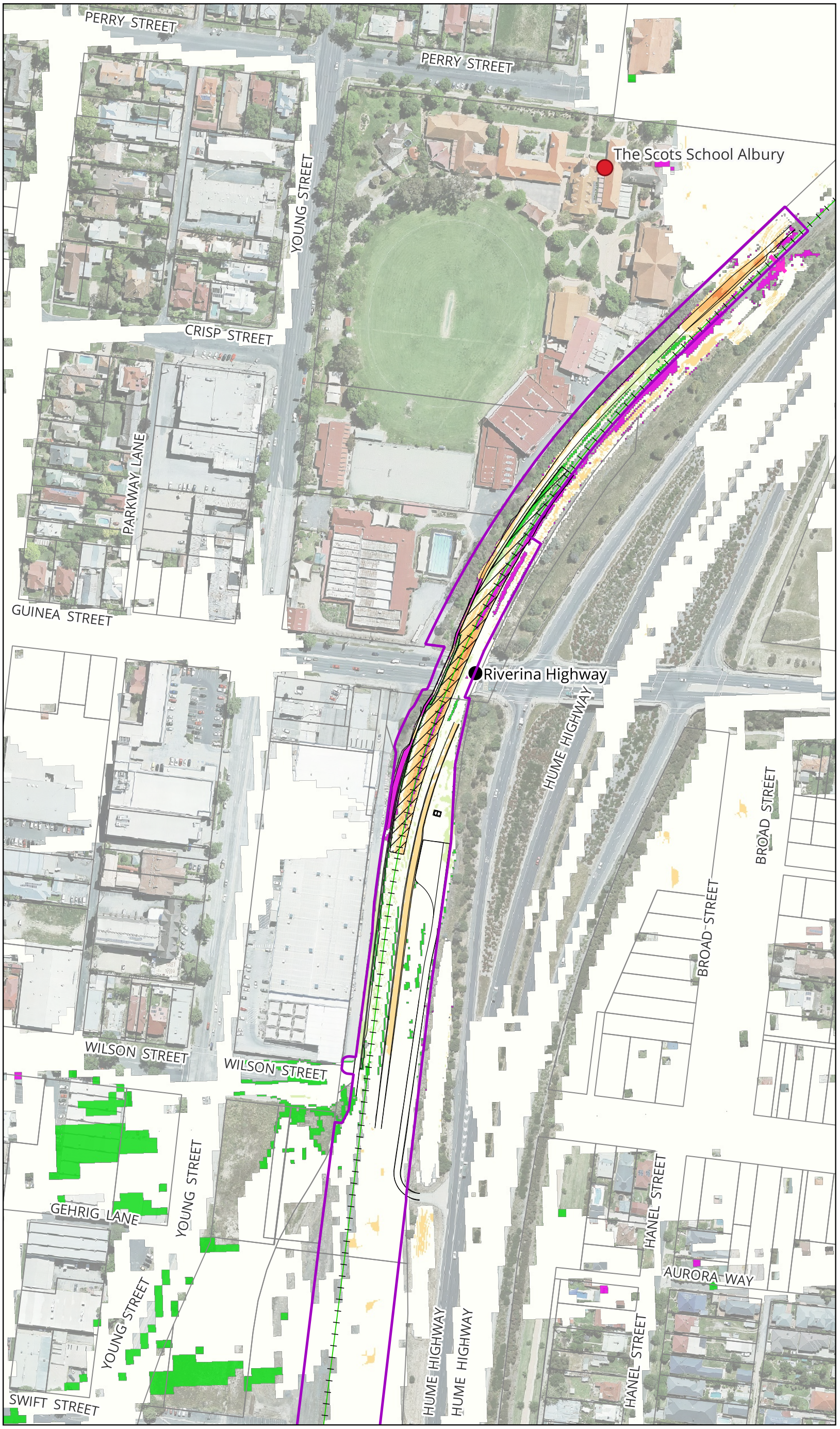
0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A53: Changes in Peak Flood Hazard for 1% AEP - Design Condition vs Existing Condition



MARTINUS

aurecon BG&E

Legend

- Project Boundary
- Main Railway Track
- Design Strings
- Track Lowering Extent
- Cadastre
- Existing Box Culvert

Changes in Peak Flood Hazard

- Reduced 5 Classes
- Reduced 4 Classes
- Reduced 3 Classes
- Reduced 2 Classes
- Reduced 1 Class
- No Change
- Increased 1 Class
- Increased 2 Classes
- Increased 3 Classes
- Increased 4 Classes
- Increased 5 Classes
- Was Wet Now Dry
- Was Dry Now Wet

Notes:

Map by: TT

0 100 200 m

A3 Scale: 1:2,500

25/6/2025 GDA2020 MGA 55

Riverina Highway Bridge - Inland Rail (A2P) - IFC Stage

Figure A54: Changes in Peak Flood Hazard for 1% AEP Climate Change - Design Condition vs Existing Condition

APPENDIX B

ARR2019 Information

Results - ARR Data Hub
[STARTTXT]

Input Data Information
[INPUTDATA]
Latitude,-36.046717
Longitude,146.927849
[END_INPUTDATA]

River Region
[RIVREG]
Division,Murray-Darling Basin
River Number,10
River Name,Murray Riverina
[RIVREG_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v1
[END_RIVREG]

ARF Parameters
[LONGARF]
Zone,Southern Temperate
a,0.158
b,0.276
c,0.372
d,0.315
e,0.000141
f,0.41
g,0.15
h,0.01
i,-0.0027
[LONGARF_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v1
[END_LONGARF]

Storm Losses
[LOSSES]
ID,25723.0
Storm Initial Losses (mm),27.0
Storm Continuing Losses (mm/h),4.5
[LOSSES_META]

Time Accessed,30 May 2024 09:28PM
Version,2016_v1
[END_LOSSES]

Temporal Patterns
[TP]
code,MB
Label,Murray Basin
[TP_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v2
[END_TP]

Areal Temporal Patterns
[ATP]
code,MB
arealabel,Murray Basin
[ATP_META]
Time Accessed,30 May 2024 09:28PM
Version,2016_v2
[END_ATP]

Median Preburst Depths and Ratios
[PREBURST]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),2.5 (0.126),1.9 (0.074),1.6 (0.051),1.2 (0.035),1.2 (0.028),1.1 (0.024)
90 (1.5),2.5 (0.113),2.1 (0.073),1.9 (0.055),1.7 (0.043),1.0 (0.022),0.5 (0.009)
120 (2.0),4.0 (0.169),3.4 (0.108),3.0 (0.082),2.7 (0.063),1.3 (0.026),0.2 (0.004)
180 (3.0),2.8 (0.104),2.9 (0.081),2.9 (0.071),3.0 (0.064),1.4 (0.026),0.2 (0.004)
360 (6.0),2.6 (0.080),2.1 (0.050),1.8 (0.036),1.5 (0.026),3.4 (0.052),4.8 (0.067)
720 (12.0),0.3 (0.008),1.0 (0.019),1.4 (0.023),1.8 (0.027),3.1 (0.038),4.0 (0.045)
1080 (18.0),0.0 (0.000),0.5 (0.009),0.9 (0.012),1.2 (0.015),1.9 (0.021),2.5 (0.025)
1440 (24.0),0.0 (0.000),0.1 (0.002),0.2 (0.003),0.3 (0.004),0.9 (0.009),1.3 (0.012)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST]From preburst class

10% Preburst Depths
[PREBURST10]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST10_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST10]From preburst class

25% Preburst Depths
[PREBURST25]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),0.1 (0.006),0.1 (0.003),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)
90 (1.5),0.1 (0.005),0.1 (0.002),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)
120 (2.0),0.1 (0.004),0.1 (0.002),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000)
180 (3.0),0.0 (0.001),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
360 (6.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
720 (12.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1080 (18.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
1440 (24.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2160 (36.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
2880 (48.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
4320 (72.0),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000),0.0 (0.000)
[PREBURST25_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST25]From preburst class

75% Preburst Depths
[PREBURST75]

min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),17.2 (0.879),16.2 (0.615),15.5 (0.501),14.8 (0.418),14.8 (0.356),14.7 (0.319)
90 (1.5),16.8 (0.763),17.7 (0.601),18.3 (0.530),18.8 (0.477),14.8 (0.322),11.9 (0.232)
120 (2.0),16.5 (0.688),17.3 (0.545),17.8 (0.481),18.4 (0.433),15.6 (0.317),13.6 (0.248)
180 (3.0),14.6 (0.543),15.4 (0.435),15.9 (0.387),16.4 (0.351),14.1 (0.259),12.3 (0.205)
360 (6.0),12.5 (0.380),13.7 (0.322),14.6 (0.295),15.4 (0.275),18.0 (0.278),20.0 (0.279)
720 (12.0),5.4 (0.133),8.3 (0.158),10.2 (0.169),12.0 (0.176),15.7 (0.198),18.5 (0.210)
1080 (18.0),1.9 (0.042),6.1 (0.103),8.9 (0.130),11.5 (0.149),12.1 (0.133),12.5 (0.123)
1440 (24.0),1.5 (0.030),4.4 (0.067),6.3 (0.083),8.1 (0.095),9.6 (0.096),10.8 (0.096)
2160 (36.0),0.0 (0.000),0.9 (0.013),1.6 (0.018),2.2 (0.022),3.9 (0.034),5.3 (0.041)
2880 (48.0),0.0 (0.000),0.6 (0.007),1.0 (0.011),1.4 (0.013),2.0 (0.016),2.4 (0.017)
4320 (72.0),0.0 (0.000),0.1 (0.001),0.2 (0.002),0.3 (0.002),0.3 (0.002),0.4 (0.003)
[PREBURST75_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST75]From preburst class

90% Preburst Depths
[PREBURST90]
min (h)\AEP(%),50,20,10,5,2,1
60 (1.0),39.4 (2.013),34.2 (1.303),30.9 (0.997),27.6 (0.777),27.7 (0.667),27.9 (0.602)
90 (1.5),32.5 (1.475),37.1 (1.259),40.1 (1.161),42.9 (1.087),33.0 (0.716),25.5 (0.499)
120 (2.0),36.1 (1.509),39.1 (1.232),41.1 (1.108),43.1 (1.015),45.5 (0.923),47.3 (0.866)
180 (3.0),27.2 (1.012),32.9 (0.933),36.8 (0.894),40.5 (0.864),34.4 (0.633),29.8 (0.497)
360 (6.0),23.4 (0.715),26.5 (0.622),28.6 (0.579),30.5 (0.546),36.2 (0.559),40.4 (0.565)
720 (12.0),19.0 (0.468),22.7 (0.433),25.1 (0.416),27.5 (0.403),29.7 (0.374),31.4 (0.356)
1080 (18.0),13.1 (0.284),18.7 (0.315),22.4 (0.327),26.0 (0.335),25.8 (0.284),25.7 (0.253)
1440 (24.0),12.5 (0.249),18.4 (0.283),22.3 (0.297),26.1 (0.306),24.8 (0.247),23.8 (0.213)
2160 (36.0),4.8 (0.085),9.7 (0.131),12.8 (0.150),15.9 (0.163),19.1 (0.165),21.4 (0.166)
2880 (48.0),4.6 (0.075),7.3 (0.091),9.2 (0.098),10.9 (0.102),18.7 (0.148),24.6 (0.173)
4320 (72.0),1.4 (0.021),6.2 (0.069),9.3 (0.089),12.3 (0.103),13.7 (0.096),14.7 (0.092)
[PREBURST90_META]
Time Accessed,30 May 2024 09:28PM
Version,2018_v1
Note,Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.
[END_PREBURST90]From preburst class

Interim Climate Change Factors
[CCF]
,RCP 4.5,RCP6,RCP 8.5
2030,0.816 (4.1%),0.726 (3.6%),0.934 (4.7%)

2040,1.046 (5.2%),1.015 (5.1%),1.305 (6.6%)

2050,1.260 (6.3%),1.277 (6.4%),1.737 (8.8%)

2060,1.450 (7.3%),1.520 (7.7%),2.214 (11.4%)

2070,1.609 (8.2%),1.753 (8.9%),2.722 (14.2%)

2080,1.728 (8.8%),1.985 (10.2%),3.246 (17.2%)

2090,1.798 (9.2%),2.226 (11.5%),3.772 (20.2%)

[CCF_META]

Time Accessed,30 May 2024 09:28PM

Version,2019_v1

Note,ARR recommends the use of RCP4.5 and RCP 8.5 values. These have been updated to the values that can be found on the climate change in Australia website.

[END_CCF]

Probability Neutral Burst Initial Loss

[BURSTIL]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),18.3,9.5,8.9,9.7,9.7,8.7

90 (1.5),18.6,10.2,9.1,9.2,9.2,8.8

120 (2.0),17.8,10.1,9.2,9.2,9.0,7.8

180 (3.0),19.0,11.6,10.1,10.2,9.7,9.2

360 (6.0),19.7,13.3,11.6,12.1,10.3,6.7

720 (12.0),22.1,15.8,14.4,14.5,12.6,8.0

1080 (18.0),23.7,17.7,16.4,16.1,14.8,10.9

1440 (24.0),24.2,18.4,17.6,17.8,16.8,12.2

2160 (36.0),26.2,21.2,21.1,22.0,20.1,14.0

2880 (48.0),26.5,22.1,22.4,22.8,22.0,14.2

4320 (72.0),27.3,22.6,23.6,24.1,23.6,19.0

[BURSTIL_META]

Time Accessed,30 May 2024 09:28PM

Version,2018_v1

Note,As this point is in NSW the advice provided on losses and pre-burst on the NSW Specific Tab of the ARR Data Hub is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. Probability neutral burst initial loss values for NSW are to be used in place of the standard initial loss and pre-burst as per the losses hierarchy.

[END_BURSTIL]

Transformational Pre-burst Rainfall

[PREBURST_TRANS]

min (h)\AEP(%),50.0,20.0,10.0,5.0,2.0,1.0

60 (1.0),8.6,17.4,18.0,17.2,17.2,18.2

90 (1.5),8.3,16.7,17.8,17.7,17.7,18.1

120 (2.0),9.1,16.8,17.7,17.7,17.9,19.1

180 (3.0),7.9,15.3,16.8,16.7,17.2,17.7

360 (6.0),7.2,13.6,15.3,14.8,16.6,20.2

720 (12.0),4.8,11.1,12.5,12.4,14.3,18.9

1080 (18.0),3.2,9.2,10.5,10.8,12.1,16.0

1440 (24.0),2.7,8.5,9.3,9.1,10.1,14.7

2160 (36.0),0.7,5.7,5.8,4.9,6.8,12.9

2880 (48.0),0.4,4.8,4.5,4.1,4.9,12.7

4320 (72.0),0.0,4.3,3.3,2.8,3.3,7.9

[PREBURST_TRANS_META]

The tranformational pre-burst is intended for software suppliers in the NSW area and is simply the Initial Loss - Burst Initial Loss. It is not appropriate to use these values if considering a calibrated initial loss.

[END_PREBURST_TRANS]

[ENDTXT]

APPENDIX C

Rainfall Depth

Duration	50%	20%	10%	5%	2%	1%	1 in 200	1 in 500	1 in 1000	1 in 2000
1 min	1.92	2.59	3.06	3.52	4.13	4.61	5.06	5.72	6.24	6.78
2 min	3.25	4.38	5.16	5.9	6.81	7.5	8.35	9.54	10.5	11.5
3 min	4.42	5.95	7	8.02	9.28	10.2	11.3	12.9	14.2	15.5
4 min	5.43	7.32	8.61	9.87	11.5	12.7	14	15.9	17.4	19
5 min	6.32	8.52	10	11.5	13.4	14.9	16.4	18.6	20.3	22.1
10 min	9.55	12.9	15.3	17.6	20.7	23.1	25.3	28.5	31.1	33.7
15 min	11.7	15.8	18.7	21.6	25.5	28.5	31.2	35.2	38.4	41.6
20 min	13.3	18	21.2	24.5	28.9	32.4	35.5	40.1	43.7	47.4
25 min	14.5	19.7	23.2	26.8	31.6	35.3	38.8	43.9	47.9	52
30 min	15.5	21	24.8	28.6	33.7	37.7	41.4	46.9	51.2	55.7
45 min	17.9	24.1	28.4	32.7	38.4	42.8	47.1	53.4	58.4	63.6
1 hour	19.5	26.3	30.9	35.5	41.6	46.3	51	57.8	63.3	68.9
1.5 hour	22	29.4	34.5	39.5	46.1	51.1	56.3	63.8	69.8	76
2 hour	23.9	31.8	37.1	42.4	49.3	54.6	60.1	68	74.3	80.9
3 hour	26.8	35.3	41.1	46.8	54.3	60	65.8	74.3	81	88
4.5 hour	30.1	39.3	45.6	51.8	60	66.3	72.3	81.5	88.7	96
6 hour	32.8	42.6	49.3	55.9	64.7	71.6	77.9	87.6	95.2	103
9 hour	37.1	47.9	55.3	62.6	72.7	80.5	87.5	98.2	107	115
12 hour	40.5	52.3	60.3	68.2	79.5	88.2	95.9	108	117	126
18 hour	46	59.4	68.6	77.6	90.9	101	110	124	135	147
24 hour	50.3	65.1	75.3	85.4	100	112	123	139	152	165
30 hour	53.8	69.9	81	91.9	108	121	138	159	176	194
36 hour	56.8	74	85.9	97.6	115	129	149	174	194	216
48 hour	61.5	80.6	93.8	107	127	143	165	193	217	242
72 hour	68.1	89.7	105	119	142	161	183	213	238	264
96 hour	72.4	95.5	111	127	151	171	191	221	246	273
120 hour	75.3	99	115	131	156	177	196	226	250	276
144 hour	77.4	101	117	133	159	180	198	229	253	280
168 hour	78.8	102	117	133	159	180	200	231	256	283

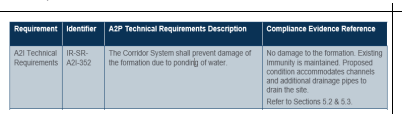
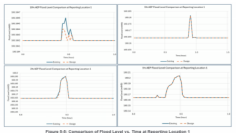
APPENDIX D

ARTC Review

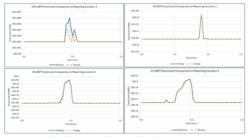
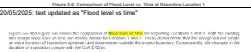
ARTC INLAND RAIL

Document Control Information

	Contractor DC to update for re-submission		
		Submitted Document No. or Transmittal No.:	Martinus-PTRAN-001532
Project:	2100 - A2I	**Date Submission Received:**	10/07/2025
Comment Sheet Number, Revision:	5-0052-210-IHY-B4-CS-0001_E	**Comment Sheet Title:**	*External Comment Sheet - A2I | Flood Design Report - Riverina Highway Bridge*
Revision Date:	10/07/2025	**Documents related in Aconex** (by IR DC)	n/a

	Review Comments (Reviewer)								Responses (Document Owner)					Close-Out			
#	PSR ID No. or Compliance Reference Document (State the fully qualified reference the deliverable is non-compliant with)	Document / drawing number - Revision Number	Section # / page #	Engineering Assurance Stage	Comment *(for example must be specific on non compliance. Reference mark-ups, if required)*	Comment Type	Full Name	Date	Full Name	Company	Date	Response *(must be specific on how the comment has been addressed. Agreed approach for re-submission)*	Documentation Section # / Figure #	Full Name	Date	Comment Status	Close-Out Comment
Example	*IR-SR-A2I-517 or 01-3500-PD-P00-DE-0008-A*	*5-0000-900-PEN-00-TE-0020_A*		*CRR*	*Is there sufficient space for a 10m maintenance vehicle to turn around at the end of the RMAR?*	*Non-Compliant*	*Joe Bloggs*	*15/02/2023*	*Fred Bloggs*	*Designer*	*15/03/2023*	*The area has been increased - now possible to turn 12.5m vehicle. The drawings are updated.*	*01-3500-PD-P00-DE-0008-A* *01-3500-PD-P00-DE-0014-C*	*Jane Doe*	*27/09/2023*	CLOSED	
1	Opportunity	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 8, 5-0052-210-IHY-B4-RP-0001_A, Section 1.4	PDR	I believe it would be "Design" instead of "Definition".	Opportunity	Ayub Ali	25/07/2024	Jasmine Lee	DJV Flooding Lead	17/09/2024	Noted. It will be updated in the next design phase report. 26/9 Comments workshop - need to see evidence to close (Next Phase) 05/03/25 - Updated for DDR to read Detailed Design Review - refer snip at right	**1.4 Objectives** This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Detailed Design Review (DDR) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary. This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001)	Ayub Ali	14/03/2025	CLOSED	**IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H
2	PSR Annexure B Technical Requirements (IR-SR-A2I-352)	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 15, 5-0052-210-IHY-B4-RP-0001_A, Table 2-1	PDR	Any damage due to ponding of water adjacent to the formation also to be considered (not necessarily due to ponding on the formation only).	Non-Compliant	Ayub Ali	25/07/2024	Steve Ho / Jasmine Lee	DJV Drainage/Flooding Lead	17/09/2024	There is no water ponding next to the proposed formation. The statement will be revised and updated in the next design stage report. This clause is addressed in Drainage Section (Section 4.3 of the 5-0052-210-PEN-B4-RP-0001) 26/9 Comments workshop - need to see evidence to close (Next Phase) 05/03/25 - Compliance Evidence Refrence updated to read: "No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site. Refer to Sections 5.2 & 5.3." Refer snip at right	 Requirement: A2I Technical Requirements Identifier: IR-SR-A2I-352 A2P Technical Requirements Description: The Corridor System shall prevent damage of the formation due to ponding of water. Compliance Evidence Reference: No damage to the formation. Existing Immunity is maintained. Proposed condition accommodates channels and additional drainage pipes to drain the site. Refer to Sections 5.2 & 5.3.	Ayub Ali	14/03/2025	CLOSED	**IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H
3	Opportunity	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 24, 5-0052-210-IHY-B4-RP-0001_A, Section 4.3.1.4	PDR	Figure numbers have been referenced twice in every cases. Hence correction is required.	Opportunity	Ayub Ali	25/07/2024	Jasmine Lee	DJV Flooding Lead	17/09/2024	Noted. It will be updated in the next design phase report. 26/9 Comments workshop - need to see evidence to close (Next Phase)		Ayub Ali	14/03/2025	CLOSED	**IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H
4	PSR Annexure B (items IR-SR-A2I-459, IR-SR-A2I-464, IR-SR-A2I-465)	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 29, 5-0052-210-IHY-B4-RP-0001_A, Section 5	PDR	Could you please compare flow rates at all locations where IR is discharging stormwater into Council's drainage systems and demonstrate that the post development peak flow rates at above points do not exceed the existing peak flow rates. Please include appropriate mitigation measures (e.g. on-site detention) if required to achieve this objective.	Non-Compliant	Ayub Ali	12/08/2024	Steve Ho/ Thinesh Thirumurugan	DJV Drainage Lead/ Flood modeller	18/09/2024	Water is discharged from the site at 2 locations, via overland flow path towards Wilson St, and pumped discharge to Mudges Canel. Overland flows to Wilson St maintains existing flow regime with no adverse impacts. Pumped discharge to Mudges Canal is minimal relative to the available capacity with less than 20mm afflux within the canal during the 1% AEP event. These have been assessed in the flood model. The proposed design is compliant with PSR Annexure B items IR-SR-A2I-459 (no worse than existing), IR-SR-A2I-464 (no adverse impacts), IR-SR-A2I-465 (maintain existing/natural flow paths). Additionally, consultation with Council has been undertaken at each design stage and no objection were raised to date with the proposed design. 26/9 Comments Workshop - ACTION for IR: If Council comments have been received, may IR please provide these to IMR. Comments Sheet are the formal, contractual mechanism for obtaining council review and comment. 05/03/25: to date, no Council comments have been received. May IRPL pelase confirm ACC has been provided with the Riverina Hwy FDR?	5-0052-210-IHY-B4-RP-0001_A, Section 5.2 and Section 6. **1.4 Objectives** This report has been prepared to support the delivery of the Riverina Highway track lowering and comply with the CSSI Conditions of Approval (CoA) and Updated Mitigation Measures (UMM) for quantitative flood modelling demonstrating compliance with pre- and post- development criteria. This report provides a flood impact assessment for the Detailed Design Review (DDR) stage. The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts as a result of the design outside of the project boundary. This report should be read in conjunction with the Detailed Design Report – Riverina Highway bridge (5-0052-210-PEN-B4-RP-0001) TT 20/05/2025 5-0052-210-IHY-B4-RP-0001_C, Section 5.4 & Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001	Ayub Ali	2/06/2025	CLOSED	This is closed based on the response and screenshot evidence
5	NA	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 31, Table 5-2	PDR	this table needs the levels of the shoulder of the capping layer of the embankment so that the flood levels can be compared (i.e. how much flood immunity there is at each point)	Opportunity	Hartley Bulcock	7/08/2024	Jasmine Lee	DJV Flooding Lead	17/09/2024	The survey data for the corner of the capping layer (existing) is not available. The surveyed top of rail level could be provided as references.		AyubAli	14/03/2025	CLOSED	This item is cosed based on the additional information in Section 5.3 of the report.
6	PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458)	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 34, 5-0052-210-IHY-B4-RP-0001_A, Section 5.1.2	PDR	Please include long sections along the centre of all open channels / cess drains identifying ground levels and water surface levels.	Non-Compliant	Ayub Ali	13/08/2024	Steve Ho / Zoe	DJV Drainage Lead	18/09/2024	As per response to Comment 191. 26/9 Comments workshop - need to see evidence to close (Next Phase) 05/02/25: In place of long-sections, direction and grade-vale arrows are provided on CDR drainage drawings, as part of the track and civil design package. Longitudinal drainage flows patterns are not a part of the Flood Design Report. Refer to the track and civil Detailed Design Report for full drainage assessment and findings. TT 20/05/2025: Drainage design drawinns referenced in The Flooding report 5.2 Design Condition IA 20/05/25: Snip from design drawings showing [illegible] shown below ZC 30/6/25: Sentence added below to confirm that in construction there will be no localised depression between adjace [illegible] be will be the nominated average grade	5-0052-210-CDR-B4-DR-0101 and 5-0052-210-CDR-B4-DR-0102 5.4 Flood Impact Assessment	Ayub Ali	14/03/2025	CLOSED	This item is closed based on the snipshot of updated design report with inserted Table 4-4 along with its note.
7	PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458)	5-0052-210-IHY-B4-RP-0001_A.pdf	Page 34, 5-0052-210-IHY-B4-RP-0001_A, Section 5.1.2	PDR	I believe, the raised crest near Point 2 will cause ponding unless it is diverted through an alternative drainage system. What is the design solution to prevent any ponding? Please clarify it with further details.	Non-Compliant	Ayub Ali	12/08/2024	Steve Ho / Jasmine Lee	DJV Drainage/Flooding Lead	17/09/2024	The raised level at point 2 will divert the water back into the Mudge Canal with the lowering bank at the western side of the Mudge Canal bank. As such, the ponding will not happen. This clarification will be added to the next design phase report. 26/9 Comments workshop - need to see evidence to close (Next Phase) 05/03/25: refer to Appendix A flood maps for assessment of impacts arising from the incorporation of the raised creat. This shows that the raised crest diverts water back towards Mudges Canal. Positive flow is providing and	To be added in next stage flood report 5-0052-210-IHY-B4-RP-0001	Ayub Ali	14/03/2025	CLOSED	**IR DC 06/03/2025:** This comment transferred from 5-0052-210-PEN-B4-CS-0001_H
8	PSR Annexure B (items IR-SR-A2I-459, IR-SR-A2I-464, IR-SR-A2I-465)	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 34, 5-0052-210-IHY-B4-RP-0001_B, Section 5	DDR	Could you please compare flow rates at all locations where IR is discharging stormwater into Council's drainage systems and demonstrate that the post development peak flow rates at above points do not exceed the existing peak flow rates. Please include	Non-Compliant	Ayub Ali	13/03/2025	Thinesh Thirumurugan	DJV Flood Modeller	20/05/2025	20.05/2025: close out Comment addided in the flooding report as per Comment #4 above	20/05/2025 5-0052-210-IHY-B4-RP-0001_C, Section 5.4 and Section 4.5.6.6 of 5-0052-210-PEN-B4-RP-0001	Ayub Ali	2/06/2025	CLOSED	This is closed based on the response and screenshot evidence
9	PSR Annexure B (item IR-SR-A2I-333, IR-SR-A2I-352, IR-SR-A2I-458)	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 39, 5-0052-210-IHY-B4-RP-0001_B, Section 5.2	DDR	Please include long sections along the centre of all open channels / cess drains identifying ground levels and water surface levels.	Non-Compliant	Ayub Ali	13/03/2025	Zoe Cruice / Isaac Attfield	Martinus	17/05/2025	Long-section on open channels and swales will not be provided. As previously discussed and agreed, the flow direction and grade is shown on the drainage plans, to demonstrate compliant with the requirement to drain the formation and prevent ponding. TT 20/05/2025: Drainage design drawings referenced in The Flooding report 5.2 Design Condition IA 20/05/25: Snip from design drawings showing plan grade annotations shown below ZC 30/6/25: A sentence addressed has been provided to the drainage report. Wording added regarding "Between two cross-sections, there will be n [illegible] tashop of 30/6/25 HB okay to close	5-0052-210-CDR-B4-DR-0101 and 5-0052-210-CDR-B4-DR-0102	Ayub Ali	14/03/2025	CLOSED	This item is closed based on the snipshot of updated design report with inserted Table 4-4 along with its note.
10	CoA E42	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 44, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4	DDR	Flow rate vs time is not an appropriate parameter for estimating duration of inundation. Rather flood level vs time should be used at all locations for estimating the change in duration of inundation.	Non-Compliant	Ayub Ali	13/03/2025	Thinesh Thirumurugan	DJV Flood Modeller	20/05/2025	20/05/2025: all flow rate vs time graphs are removed and replaced with flood level vs time graphs.  Figure 5-3: Comparison of Flood Level vs. Time at Ravenline Location 1	5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4	Ayub Ali	2/06/2025	CLOSED	This is closed based on the response and screenshot evidence

Comment Sheet Number, Revision:	5-0052-210-IHY-B4-CS-0001_E	**Comment Sheet Title:**	***External Comment Sheet - A31 | Flood Design Report - Riverina Highway Bridge***
Revision Date:	10/07/2025	**Documents related in Aconex** (by IR DC)	no

	Review Comments (Reviewer)								Responses (Document Owner)					Close-Out			
#	PSR ID No. or Compliance Reference Document *(State the fully qualified reference the deliverable is non-compliant with)*	Document / drawing number - Revision Number	Section # / page #	Engineering Assurance Stage	Comment *(for example must be specific on non compliance. Reference mark-ups, if required)*	Comment Type	Full Name	Date	Full Name	Company	Date	Response *(must be specific on how the comment has been addressed. Agreed approach for re-submission.)*	Documentation Section # / Figure #	Full Name	Date	Comment Status	Close-Out Comment
11	CoA E42	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 46, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4	DDR	I believe, it would be "flow rate vs time" instead of "flow level vs time". However, all flow rate vs time graphs to be replaced with flood level vs time graphs as it is not an appropriate parameter for estimating duration of inundation.	Non-Compliant	Ayub Ali	13/03/2025	Thinesh Thirumurugan	DJV Flood Modeller	20/05/2025	20/05/2025: all flow rate vs time graphs are removed and replaced with flood level vs time graphs. 	5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4	Ayub Ali	2/06/2025	CLOSED	This is closed based on the respose and screenshot evidence
12	Clarification	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 46, 5-0052-210-IHY-B4-RP-0001_B, Section 5.4.4	DDR	I believe, it would be "flood level vs time" instead of "flow level vs time".	Non-Compliant	Ayub Ali	13/03/2025	Thinesh Thirumurugan	DJV Flood Modeller	20/05/2025	20/05/2025: text updated as "Flood level vs time" 	5-0052-210-IHY-B4-RP-0001_C, Section 5.4.4	Ayub Ali	2/06/2025	CLOSED	This is closed based on the respose and screenshot evidence
13	CoA E42	5-0052-210-IHY-B4-RP-0001_B.pdf	Page 47, 5-0052-210-IHY-B4-RP-0001_B, Section 5.5.1	DDR	Outcome of the blockage assessment to be discussed here under a separate subsection identifying the impact, risks and proposed mitigation measures.	Non-Compliant	Ayub Ali	13/03/2025	Zoe Cruice	Martinus		Blockage impact is shown in Figure 5-8. It is not a requirement to mitigate impacts from blockage, but rather check the sensitivity of the results to blockage. 30/6/25 ZC: in workshop, the current wording and scope was discussed. HB indicated okay to close.		Ayub Ali	10/07/2025	CLOSED	The blockage assessment is a sensitivity check. Hence, some sorts of discussion was requested on the outcome in that context. However, due to non-criticality and non-effect on the design outcome, this iteme is closed now.

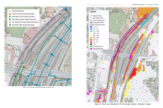
Non-Compliant:	Non-compliance which requires correction before further design development occurs.
Opportunity:	Comment which identifies an opportunity to save capex, achieve increased quality or operational outcome. Not a non-compliance.

OPEN:	Comment has not been addressed.
CLOSED:	Comment is closed. No further action.
NEXT PHASE:	Comment response has been accepted. Resulting actions have been deferred to the next Phase of the Project (for Doc Control purposes the comment is considered OPEN)
TRANSFERRED:	Response is not acceptable or review has been split and the comment has been transferred to another comment sheet. (for Doc Control purposes comment is considered CLOSED)

APPENDIX E

External Consultation Review

A2i Flood Design Report CONSULTATION - COMMENTS REGISTER

Stakeholder Category	Stakeholder Name	Flood Design Report name	Document reference (e.g. section, figure, table)	Date raised	Topic that comment relates to	Comments	Full Name	Role	Date	Response (must be specific on how the comment has been addressed)	Where addressed (Volume / Section)	Full Name	Company	Date	Comment Outcome	Close-Out Comment	Full Name	Role	Date	Response (must be specific on how the comment has been addressed)	Where addressed (Volume / Section)
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Generally	30/09/2025	Major change to the design from that proposed in the EIS	The EIS proposed the stormwater storage tank and pumps to be located on the western side of the rail line discharging to the western drainage line and Wilson St. This seems to have now changed to be located to the east of the rail line discharging to Mudgets Canal. The need for this significant change in the design should be explained and justified.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	The reason for the change has already been discussed in the Main Design report. The location was changed to "To facilitate the sweet path inwarements of maintenance vehicular access for the storage tank and pump. "	S-0052-210-PEN-BE-RP-0001_D Section 3.2, Table 3-1, item 4 S-0052-210-PEN-BE-RP-0001_D Section 4.5.4.4	Wade Small	DPHR	7/10/2025	CLOSED	If this is clearly discussed in the Main Design Report then this comment can be closed.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Figure 4-4	30/09/2025	Unclear features	The existing box/culvert under the rail is a critical element controlling flooding into the site. However, it is not clear exactly where this structure is on Figure 4-4. I think the label for CN44/fh0 may be overlaying it? Important that this is clearly represented snow sections of the report refer to the culvert in this figure.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	The image has been updated to show the existing Box culvert clearly.	S-0052-210-SHY-BE-RP-0001_C Figure 4-4	Wade Small	DPHR	7/10/2025	CLOSED	Figure updated.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Table 4-4 & Figure 4-6	30/09/2025	Detail lacking	The exploration of the design condition features, and supporting Figure 4-6, is lacking in detail (i.e. "approximate depth of up to 1.1 metres from the existing track level" – over what extent? Cess drain dimensions? Again the design Report would have probably answered these questions if supplied.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	Yes, the Main design report discusses the design features in more detail and the image in the Flood design report is only a general indication. Relevant sections of the main report have been referenced in the flood design report.	S-0052-210-SHY-BE-RP-0001_C Table 4-4	Wade Small	DPHR	7/10/2025	CLOSED	If this is clearly discussed in the Main Design Report then this comment can be closed. Recommend that future FDRs are submitted with the relevant accompanying Main Design Report for reference.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Section 5.1	30/09/2025	Detail lacking	Section 5.1 states "stormwater network in the site flows towards to the Mudgee Canal", however Figure 5-1 shows a "flow line" discharging form the site into Wilson St. How to and from Point 3 on Figure 5-1 needs exploration.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	Figure 5-1 only shows the overland flow paths. A new figure showing the existing stormwater network has been added to the report with reference to additional details in Section 5.1 to provide more clarity.	S-0052-210-SHY-BE-RP-0001_C Section 5.1 and Figure 5-3	Wade Small	DPHR	7/10/2025	CLOSED	Figure updated.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Section 5.2 & Figure 5-3	30/09/2025	Clarification needed	Section 5.2 states "The raised crest at point 2 will divert the water back into the Mudgee Canal." However, the flow lines on Figure 5-3 clearly show flows from point 2 onwards remaining to the west of the tracks and discharging into Wilson St as discussed above.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	The raised crest fully diverts the water into Mudgee canal only during small storm events. During large storm events like 1% AEP the water overtops the crest which flows south and then via Wilson Street. The section already addresses the details, however, to provide more clarity, the caption of Figure 5-3 was updated to clarify the flow path is for the 1% AEP.	S-0052-210-SHY-BE-RP-0001_C Figure 5-3	Wade Small	DPHR	7/10/2025	CLOSED	Clarity provided.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Design vs Existing Condition Mapping	30/09/2025	Detail lacking	The "raised crest" at point 2 seems to be causing elevated flood levels at point 1 (upstream) under design conditions, particularly in the 10% AEP. However, this does not translate to increases in flood levels elsewhere like the Mudgee Canal and upstream areas. It would be worth discussing this more.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	During the 10% AEP, point 1 experiences an increase in flood depth but a reduction in flood levels due to the lowered design surface levels. So the flood level increase was not shown on the map. In addition, compared to the existing surface, the design surface is lowered at the southern side of the Mudgee Canal, which allows more water from the Mudgee Canal to flow back to the area between the Mudgee Canal south bank and point 2. Mudge's canal water level experiences less than a 10-mm reduction. Therefore, no afflux is shown in the Mudgee Canal on the map. Additional details were added in the report to provide clarity.	S-0052-210-SHY-BE-RP-0001_C Section 5.2	Wade Small	DPHR	7/10/2025	CLOSED	Clarity provided.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Section 5.5	30/09/2025	Pumps	A sensitivity assessment should be included that evaluates the flood impacts if the pumps fail during a flood event/s.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	The pump failure sensitivity assessment is not part of the DIV flooding scope. In addition, there are 2 pumps proposed (one on duty and one backup) as well as a standby generator if loosing power to the site. The risk of pump failure is minimal.	N/A	Wade Small	DPHR	7/10/2025	OPEN	Pumping of stormwater from the site is the main mitigation measure to reduce the impact of flooding on the site. Therefore, pump failure presents a risk. If a back-up generator is proposed then this should clearly be discussed in the FDR. A sensitivity assessment is warranted and should be presented in this report. If one pump fails (mechanical fault) can the remaining pump adequately discharge from site? At the very least, Albury City Council should be aware of the risk through specific consultation.	Thinesh Thirumurugan	DIV flood midwriter	31/10/2025	The Riverina Site pump system has a main pump and a backup pump. The main pump trigger level is lower while backup pump trigger level is higher. Generally, during the 1% AEP event, only the main pump is operated, and the water level in the storage tank doesn't raise up to trigger the backup pump level. A sensitivity assessment for the 1% AEP scenario was conducted using only the backup pump as operational. Since the pump activation levels for both pumps are below the ballast drain levels, and both pumps have the same flow capacity no significant differences were observed in terms of flood levels at the railway corridor. The below image compares the zhusgins in water level between 1% AEP Pump sensitivity design scenario (main pump failure but Backup pump is operational) and Original design scenario (the both pump are operational).
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Figures 5-7 & 5-8	30/09/2025	Duplicated and poor quality figures	Impossible to discern details in these figures. Suggest replacing with a higher quality images. Also these figures seem to be duplicated.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	Duplicated images were deleted and poor quality images were updated to high quality 	S-0052-210-SHY-BE-RP-0001_C Figure 5-8 and 5-7	Wade Small	DPHR	7/10/2025	CLOSED	Updated images provided.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Throughout report	30/09/2025	Incorrect referencing	Incorrectly referenced the Bugain Creek FS regularly throughout the report. Sometimes referred to as WAT 2015 or WMAwater 2015. Obviously should be L&A 2011. Other than being poor practice it does make it difficult to determine whether they are meant to be referring to the Bugain Creek FS (L&A, 2011) or the Albury FIRMP (WMAwater, 2016)	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	Bugain Creek FS references have been corrected and updated.	S-0052-210-SHY-BE-RP-0001_C Section 4.2.1 and 4.3.3, Figure 4-5	Wade Small	DPHR	7/10/2025	CLOSED	Updated.					
	DPHR	A2i-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-BE-RP-0001)	Generally	30/09/2025	Mudgee Canal	There is a small but significant increase in the flows down Mudgee Canal as a result of these works especially in more frequent events. This Canal flows down through urban areas of South Albury which are already significantly flood affected. Suggest inserting some commentary concerning this in consultation with Albury City Council.	Thinesh Thirumurugan	DIV flood midwriter	31/05/2025	Based on the flood modelling, the flood impacts outside the project boundary are within the Conditions of Approval limits. The flood impact section discusses the impacts outside the project. In addition, the design has been presented to Albury City Council during workshops (PDR and DDR stage), and the wording has been included in Table 2-2 d&k.	S-0052-210-SHY-BE-RP-0001_C Section 5.4 S-0052-210-SHY-BE-RP-0001_C Section 2.2	Wade Small	DPHR	7/10/2025	CLOSED	Clarity provided					

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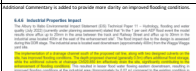
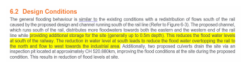
	CPHR	A20-Riverina Hwy Bridge Flood Design Report (S-0052-210-SHY-MI-RP-0001)	Table 2-1	10/04/2025	Compliance with Condition 4.46	Condition of Approval 4.46 stated *"The design, operation and maintenance of pumping stations and storage tanks and discharges to council's stormwater network must be developed in consultation with the relevant council. The results of the consultation are to be included in the report required in Condition B4".* A specific response to this condition was included in Table 2-2 that indicated that since no changes to the catchment areas and impervious/areas are proposed then there is no additional flows towards Councils stormwater networks. This may be the case but the balance of these flows have changed i.e. more flow down Mudgee Canal and less towards Wilson St. Suggest that the response to this Condition is modified to suit and additional details regarding consultation with Council on this matter added.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The words are updated and this has been presented to Council or the workshops during PDR and DDR stages.	A-00052-210-SHY-MI-RP-0001_C Section 2.2	Wade Small	DHeR	7/10/2025	CLOSED	Clarity provided					
	CPHR	A20-Riverina Hwy Bridge-**Detailed Design Report** (s-0052-210-PEN-MI-RP-0001_C)	Section 7.1 - Outstanding Items and Actions	21/04/2025	Drainage Pump design	Note that the designs of the drainage pump and sump are still in development (Table 7-1). Once this design is complete the actual dimensions and performance of this drainage system should be included in the flood model and revise to verify that the flood impacts remain within acceptable ranges. Also concerned that Table 6-1 indicates that there is a risk that this drainage pump station cannot be located in this location due to clashes with a proposed drainage bund resulting in the possibility of alternative solutions needing to be developed. If this eventuates it is important to revise the design reports and models to suit and seek further comments from CPHR and Council.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The pump design in DD4 stage has been assessed in DD6 flood assessment and the flood impact shows compliance with CoA. If the pump's location will be changed in a later stage, further investigation will be implemented.		Wade Small	DHeR	7/10/2025	CLOSED	Response indicates that the pump design and location is finalised.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Generality	10/04/2025	Change to the design from that proposed in the EIS	The EIS flood assessment identified significant impacts at the industrial area located to the east of the site. These impacts seem to have been mitigated by the redesign of the works including cess drains and culverts to redirect the overland flows through existing culverts under the rail line. Commentary on this major change in the design and the resultant change in flood impacts is lacking.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	Additional Commentary is added to provide more clarity on improved flooding conditions. 	A-00052-210-SHY-WT-RP-0001_D Section 6.4.6	Steve Manwaring	DHeR	21/7/2025	CLOSED	Support the additional words added.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Figure 6-3	10/04/2025	Poor quality figure and not referenced in the text.	Impossible to discern details in this figure (6-3). suggest replacing with a higher quality image. important since it seems that the changes between the different models are significant in the areas surrounding the site. WWCC need to be made aware of this as many areas are no longer flooded in the *5%AEP event* whereas others are newly inundated. This figure is also not referenced in the text, I believe.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The image issue will be investigated in the IFC stage. The flood model has been submitted to Wagga Wagga City Council for review. Areas with newly inundated and no longer dry cannot be directly compared with the results from the previous council flood study (MOFFS 2021). This is because the DJV model is updated specifically to assess the flooding characteristics of the Wagga Yard site area. It has been updated from the original Council model to incorporate a finer Model grid size and more detailed topographical data, including LIDAR, detailed surveys, drainage data, and inflow applications. These details are discussed in Section 5. **5 HYDRAULIC MODEL COMPARISON** The comparison in this section involved the results from the updated DJV9 model existing condition against the results from the MOFFS 7.5(R) 2D model for the 1% AEP design event storm duration of 12h minutes and 72 hours. The results comparison indicated that the flood behaviour between the two models are generally similar with variations typically falling within the range of +/- 10 mm (refer to Figure 5-1). In some localised areas, larger differences were found, ranging around from 0.05 to 0.3 metres. The possible reasons are listed below: • It was initially expected that transitioning to a newer version of TUFLOW, which incorporates the quadtree method, might lead to minor changes in flood levels. The quadtree method could alter the model running time, potentially affecting the results. However, this was not observed in the 1% AEP and 1% AEP+CC at the northern downstream boundary. However, since this area is distant from the sites, any such changes would not impact the flood behaviour at the site. • The changes in flood levels around the sites primarily stem from the integration of the 2020 LIDAR data and the comprehensive site survey. • The existing drainage networks were updated (as data by the DJV Drainage team) based on the latest survey. These modifications in terms of pipe location, pipe size and inverts to reflect the existing site conditions accurately. • Modifications to the GA inflow polygons were made following proof engineer review, to achieve a better alignment between the ground elevations and the existing model ground storage.	A-00052-210-SHY-WT-RP-0001_D Section 5	Steve Manwaring	DHeR	21/7/2025	CLOSED	Exploration accepted.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Section 6.1 & Figure 6-1	10/04/2025	Accurate representation of existing drainage system	Figure 6-1 and the corresponding text details that overland flows are diverted via a gully pit (pit point 4) under the rail to an existing open drain to the north of the rail line to point 6. After this location there is confusion as to the details of the existing drainage infrastructure. The figure (6-1) seems to indicate an overland flow path to the north headed towards the Sturt Hwy between buildings. but discussions at the site visit (held between Martinus and CPHR on 2 April 2025) with Council Staff indicated that there is a box culvert that connects this drain to Bolton Park which does not seem to be represented correctly in this figure nor the modelling. Need to confirm with WWCC the details of this drainage infrastructure and correct the modelling if required.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The flood model does contain a culvert at the end of Point 6. However, this was based on the data that was already modelled in the flood model, as no survey data was available during the time of modelling. The flow patterns indicate that the water overflows from the channel flowing further north. The section has been updated to provide more clarity..	A-00052-210-SHY-WT-RP-0001_D Section 6.1	Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept this explanation but still suggest that the details (location, dimensions) of the box culvert located after point 6 be confirmed with Wagga Council and included in the model to ensure accuracy.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Section 2.3 and Table 2-4	10/04/2025	Updated Mitigation Measures Compliance	Condition HH4(1)A required additional survey and a review of the existing drainage structures at the Industrial area to confirm the adverse impacts identified at the EIS stage. Pleasingly this seems to have been completed and the model updated to now show no adverse impacts at this location. Although this seems to have been achieved through the addition of the cess drain to the south of the rail line it is unclear how the general reductions in flood impacts both north and south of the rail line has been achieved.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The proposed channel, which runs south of the rail, provides additional storage for the area (generally up to 0.5m depth). This reduces the flood water levels south of the railway which also reduces the flood water overtopping the rail to the north. The section has been updated to provide more clarity.	A-00052-210-SHY-w7-RP-0001_D Section 6.2 and 6.4.6	Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept the explanation and additions to the report.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Section 6.2	10/04/2025	Cross drainage infrastructure	This section states that *"two proposed culverts drain the site via an inspection pit located at approximately CH 620.880lm, improving the flood conditions at the site during the proposed condition".* The recently supplied design report indicates that the existing culverts will be retained. As such, suggest changing "proposed" to "existing" for consistency.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The DD6 Flood model was developed based on the DD6 Drainage design elements. The below image (4-2c) from the A-0052-210-PEN-WT-RP-0001 suggests that the 2 proposed pipes are located left and right of the inspection and existing pipes are retained at the top and bottom of the inspection pit. The wording will be changed if the design is changed in IFC stage and this will be communicated with DJV Drainage Team during IFC stage. 		Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept this clarification.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Figure 6-7	10/04/2025	Countermitigation reduction in flow rates downstream	Figure 6-7 shows that in all flood events modelled the peak flows in the existing drainage channel to the north of the rail line have decreased. Given that the flows that previously were directed towards the Railway Avenue industrial area (to the east of the site) are now redirected through new culverts into this drainage channel (I think) this general decrease in peak flows does not make sense. Please explain how this has been achieved.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The Proposed channel design provides additional storage (generally up to 0.5m depth). This reduces the flood water levels south of the railway. The reduction in water level in the south leads to reduce the flood water overtopping the rail to the north and flowing to the east towards the industrial area. This resulted in a decrease in flood levels in the north and west. Additional details added in the report to clarify. 	A-0052-210-SHY-w7-RP-0001_D Section 6.2	Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept this clarification and the added words.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Section 6.4.6	10/04/2025	Decrease in the impacts at the industrial area.	As above, if this area now experiences a net decrease in flood impacts (as per Figure 6-9) where does the afflux now go? Please elaborate.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The implementation of the drainage channel (about 0.5m of depth) reduces the flood water levels (generally up to 0.02m or 20mm in the 1% AEP) south of the railway. The design channel adds additional flood storage. The reduction in water level in the south leads to reduce the flood water overtopping the rail to the north and flowing to the west towards the industrial area. The flood water overflows to the west near Edmondson Street Bridge where an increase in flood water level and a new wet area can be observed within the project boundary. The flood level increase outside the project boundary is less than 10mm. The flood design report was updated to provide more clarity. Please note that the water is not diverted but reduced due to additional flood storage which is the main reason for the improvement in water levels. A figure noting the changes in topography is included in the report for more clarification. 	A-0052-210-SHY-w7-RP-0001_D Section 6.4	Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept this clarification and added words. The additional figure adds to the understanding.					
	CPHR	A20-Wagga Wagga Yard-Flood Design Report (S-0052-210-SHY-WT-RP-0001)	Figure H.A37-A41	10/04/2025	Design vs existing Condition flood mapping	We cannot understand how a general decrease in flood impacts have been achieved across the board except for a localised area of afflux at the ATRC owned site adjacent to Edmonson St. Generally when there is a flood level decrease somewhere there is usually a corresponding increase somewhere else. Clarification required.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The implementation of the drainage channel (about 0.5m of depth) reduces the flood water (generally up to 0.02m or 20mm in the 1% AEP) levels at the south of the railway and increased the flood depth in the proposed scenario. The design channel adds additional flood storage. The reduction in water level in the south leads to reduce the flood water overtopping the rail to the north and flowing to the west towards the industrial area. Please note that the water is not diverted but reduced due to additional flood storage which is the main reason for the improvement in water levels. A figure noting the changes in topography is included in the report for more clarification. 	A-0052-210-SHY-w7-RP-0001_D Section 4.2.2	Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept this clarification and the added figure.					
	CPHR	A20-Wagga Wagga Yard-**Detailed Design Report** (s-0052-210-PEN-WT-RP-0001_C)	Section 4.6.1 - Existing Culverts	22/04/2025	Existing culvert at Chainage 620.860km	This section states that existing culverts passing underneath the track will be retained without modification. However there seems to be some confusion regarding the actual number and dimensions of the culvert/s located at chainage 620.860km with a detailed survey report not being available. As a result the flood design report and corresponding flood modelling has assumed that 2x0.39dia.Ctm box culverts exist in this location consistent with ARTC records but contravening Council records and flood modelling. Table 2-7 in the DD6 Hydro states that *"existing drainage representations in the flood model have not been modified as there is no further drainage survey available at this stage".* Before finalising the design it is recommended that detailed survey of this culvert structure is obtained and incorporated into the design reports and flood modelling to confirm impacts.	Thinesh Thirumurugan	DJV flood midwriter	22/05/2025	The existing culvert information adopted in the flood model is consistent with the information stated in the main report (S-0052-210-PEN-WT-RP-0001_C Section 4.6.1). The culvert size will be confirmed via survey and if there is a significant discrepancy, further investigation will be carried out. 		Steve Manwaring	DHeR	21/7/2025	CLOSED	Accept that the culvert dimensions will be confirmed with a physical survey and the modelling and reports corrected if needed.					

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	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Section 1.11	30/06/2025	Survey and Kemp St Bridge	Let dot point states that detailed survey of the drainage infrastructure at this site has not been included in the flood assessment. Why? Also, 3rd dot point indicates that the impacts of the Kemp St Bridge works has not been included in the assessment. Due to their proximity suggest that a cumulative assessment of both sites (Lurnea yard and Kemp St Bridge) needs to be completed similar to that done for Wagga Yard that included in the Edmonson St Bridge works.	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	Detailed survey had not been received at the time of the DDR submission for Lurnea Yard. Due the package submission timings the Lurnea package is submitted before the Kemp Street package, when the Kemp Street design has not been fully developed and therefore a cumulative assessment cannot take place in this package. A cumulative assessment has been undertaken in the Kemp Street package.		Steve Manwaring	DHiR	21/7/2025	CLOSED	Yes, Jon confirms that a cummulative assessment was completed and provided with the Kemp St Bridge Package that was recently reviewed.					
	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Section 6.2.2	30/06/2025	Drainage Network	Why is only Council-supplied data being used for the ARTC drainage elements? Detailed survey should be used.	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	Detailed survey of the ARTC elements has since been acquired post the submission of this document. The modelling and report will be updated in the next design stage.		Steve Manwaring	DHiR	21/7/2025	CLOSED	Accept that the newly acquired survey will be used in the next version of modelling and reporting.					
	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Section 5.1	30/06/2025	Existing Conditions flood Assessment	All references to "Rusk Creek" should be changed to "Rocky Creek". Also, this creek flows from east to west not west to east. Several types in the section require correcting.	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	The typos were updated in the report. 5 FLOOD ASSESSMENT 5.1 Existing Condition Existing flood maps, including peak flood depth and levels, peak flood velocity, and peak flood hazard for the nominated events, are provided in Appendix A in the existing scenario. The Rocky Creek catchment is located to the south of the Lurnea Yard and flows from east to west. The catchment is bounded by Canterbury Road to the south and one minor one from a local hillsides catchment north. The rail corridor and area outside Lewis		Steve Manwaring	DHiR	21/7/2025	CLOSED	Updated.					
	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Section 5.2	30/06/2025	Design Conditions flood Assessment	A figure that shows the location of any new or existing drainage elements (including culverts under the rail) would assist greatly in understanding the flow patterns.	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	Please refer to Figure 4-3 about the existing drainage elements in the modelling with their associated sizes and as per Section 4.2.2. The IFC flood assessment is ongoing and the drainage elements for existing and design will be added into Figure 5-3 in the IFC design submission.	S-0052-210-RPT-I-6-RP-0001, Section 5.2	Steve Manwaring	DHiR	21/7/2025	CLOSED	The culvert labelling in Figure 4-6 is unreadable. Happy if this is improved in the next version.					
	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Table 5-11	30/06/2025	Impacts on the Lurnea Aquatic Centre	Table 5-11 states that there are increases of up to 0.1m in the 1% AEP on the eastern side of the rail outside the project boundary but do not impact the neighbouring Lurnea Recreation and Aquatic Centre. However, Figure 10a shows some impacts within the grounds of the Aquatic Centre with some isolated patches of newly flooded land. Does this comply with the CDCV? If not mitigation measures need to be developed. Also need to include a more descriptive description of the flood risks within this property.	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	As seen in the mapping this flooding does not affect the floor levels of the Aquatic Centre as the site is raised higher than the Edgar Street Channel, and is compliant with 6426) no increase of 10 mm in above floor inundation to habitable rooms. As per 6426)i) a maximum increase of 50mm is allowable in land zoned as residential or commercial. The increase in flood levels does not affect the floor levels and there are no increases on some Street where the site is accessed there is a negligible increase to flood risk at the property. Please note that a cumulative flood assessment together with Kemp Street Bridge and Footbridge has been undertaken. The results and description will be included in the IFC stage report.		Steve Manwaring	DHiR	21/7/2025	CLOSED	Explanation accepted. Can also confirm that a cummulative assessment was completed and provided with the Kemp St Bridge Package that was recently reviewed.					
	DHiR	K2I-Lurnea Yard-Flood Design Report (S-0052-210-RPT-I-6-RP-0001)	Section 7	30/40/2025	Recommendations for the next stage	It is noted that three recommendations for the next stage (IFC) address some of the issues identified above. Why were these were not addressed in this detailed design stage?	Scott Mortimer	Dirr Road Inbaeiter	31/06/2025	Survey of the rail culverts was not yet received at the time that the DDR design was submitted, and due the package submission timings the Lurnea package is submitted before the Kemp Street package, when the Kemp Street design has not been fully developed and therefore a cumulative assessment cannot take place in this package. A cumulative assessment has been undertaken in the Kemp Street package.		Steve Manwaring	DHiR	21/7/2025	CLOSED	Explanation accepted.					

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APPENDIX F

Independent Flood Consultant Review

Project: 2100 **Deliverable:** Riverina Highway Bridge

Comment Sheet Reference: 5-0052-210-IHY-B4-RP-0001-PE_G

Review Comments (Reviewer)										Responses (Document Owner)					Close-Out				
#	Document number / drawing number - Revision Number	Section # / page #	Company	Full Name	Functional Area	Date	Design Gate	Comment (for example must be specific on non compliance. Reference mark-ups, if required)	Compliance Reference Document (State the	Comment Type	Full Name	Role	Date	Response (must be specific on how the comment has been addressed)	Where addressed (Section # / Figure #)	Full Name	Company	Date	Comment Outcome	Close-Out Comment
1	5-0052-210-IHY-B4-RP-0001_A	Section 4.2.2	Hatch	Dan Williams	Flood Assessment	3/10/2024	PDR	The report text indicates that the interim climate change factors from the ARR data hub were used to represent the 1% AEP CC conditions. However, there are notes on some of the mapping figures that suggest the 0.2% AEP event was used to represent climate change. This should be updated for consistency to whichever is correct (I expect that the figure notes are incorrect?)		Minor	Jasmine Lee	DJV Flooding Lead	25/10/2024	The interim climate change factors from the ARR data hub were used to represent the 1% AEP CC conditions. The note on the mapping will be removed in next stage of mapping.	DDR flood design report	Dan Williams	Hatch	6/11/2024	CLOSED	Noted
2	5-0052-210-IHY-B4-RP-0001_A	Section 4.3.2.1	Hatch	Dan Williams	Flood Assessment	3/10/2024	PDR	Table 4-4 includes reference to the overland flow channel. This is the key feature in the proposed design that has the potential to impact on the broader catchment flood behaviour because otherwise we are effectviely dealing with stormwater management. To minimise the potential for the proposed design to alter the catchment flood flow distribution, the control crest level along the overland flow channel should be set to match the existing level of control, which appears to have been undertaken within the proposed design. However, the lowest level of control along the existing surface is much narrower than that being provided in the design and so the flood flow distribution is altered. For example, in the existing case a peak flow of around 6.7 m^3/s is discharged through the Mudges Canal box culverts at the 1% AEP 90m event (the critical durationat this location), with around 0.9 m^3/s being conveyed along the overland flow channel. Under the proposed design conditions the peak flow distribution for these events changes to around 6.4 m^3/s and 1.2 m^3/s, respectively. This does not appear to result in any significant change to the off-site peak flood levels due to other existing hydraulic controls. However, it is good practice to try and maintain the existing flood flow distribution to reduce the liklihood of any unforseen impacts.		Minor	Jasmine Lee	DJV Flooding Lead	25/10/2024	It is acknowledged that maintaining the existing flow distribution in the design condition is the most desirable approach. However, the track lowering site design must meet the requirements of all disciplines involved. Therefore, the scope of the flood assessment is to control floodwaters to ensure that there is no adverse flood impact beyond the stipulated criteria outside the project boundary. During the Detailed Design Review (DDR) stage, the flow distribution will be checked and maintained as closely as possible to the existing condition. Nevertheless, it should be noted that the flood assessment will adhere to the stipulated criteria.	DDR flood design report	Dan Williams	Hatch	6/11/2024	CLOSED	Noted
3	5-0052-210-IHY-B4-RP-0001_A	TUFLOW files	Hatch	Dan Williams	Flood Assessment	3/10/2024	PDR	A longitudinal profile of the overland flow channel is provided in Figure 4-25 of the Detailed Design Report (5-0052-210-PEN-B4-RP-0001_B). There are inconsistencies between this longitudinal profile and the TUFLOW files that represent it, including the design terrain model (240705_DESIGN_MD21B4501), the Z Shape overwriting it (2d_zsh_010Dtest8_RMAR_modification_R) and the 1D channel cross-sections where the RMAR crosses Mudges Canal. The inconsistencies are in the bed level of the channel, the crest level controlling the overflow and the level of tie-in between the Mudges Canal channel and the overland flow channel. As discussed above, this is the one aspect of the design with the potential to alter broader catchment flood conditions and so we need to ensure that there is consistency between the final design and final TUFLOW model representation.		Minor	Jasmine Lee	DJV Flooding Lead	25/10/2024	The differences between the overland flow profiles occurred because, during the Preliminary Design Review (PDR) flood assessment, the overland flow channel was modelled in TUFLOW as a mitigation option first and then the drainage design DEM was updated. For the DDR submission, the DEM for the overland flow channel will be made consistent between the TUFLOW and drainage models.	DDR flood design report	Dan Williams	Hatch	6/11/2024	CLOSED	Noted
4	5-0052-210-IHY-B4-RP-0001_A	TUFLOW files	Hatch	Dan Williams	Flood Assessment	3/10/2024	PDR	The way in which the proposed pump has been set up within the TUFLOW model is incorrect. The pump has not been modelled dynamically and that is OK as this is acknowledged as such in the Flood Assessment Report. However, whilst a contstant outflow of 0.075 m^3/s has been applied to Mudges Canal in the model, the intake is configured with a contant water level boundary, which effectively enables an infinite outflow from the drainage sag. For example, in the modelled design case scenario the peak flow within the 450 mm pipe discharging to the pump chamber is 0.56 m^3/s at the 1% AEP 120 m event, with a velocity of 3.5 m/s. The pump inlet boundary should be configured as a constant flow of -0.075 m^3/s. This has been undertaken in the Proof Engineering review modelling and it results in a peak flood level within the drainage sag some 0.45 m higher at the 1% AEP 120 m event. This means that rather than the top of rail level being (just) flood free at the 1% AEP event (as suggested in Table 5-9 of the Flood Assessment Report), it is instead submerged to a depth of around 0.4 m. This represents a worsening of the rail flood immunity, as in the existing case the depth of rail overtopping is less than 50 mm. The design of the pump sizing should be re-visited and increased accordingly. It is important that the critical flood conditions at the drainage sag location are determined to ensure that the pump performance is confirmed across the full range of storm durations.		Major	Jasmine Lee	DJV Flooding Lead	25/10/2024	During the PDR stage, the manufacturer's pump capacity curve was not available, and the pump design was undertaken by the drainage and pump teams. As a result, in our flood modelling assessment, the pump was considered only in terms of its outflow impact downstream. This is why the pump intake was modelled at a constant level, under the assumption that it could handle all incoming water. For the DDR design, the pump will be accurately modelled using the provided manufacturer's pump capacity curve with the 1d_nwke pump.	DDR flood design report	Dan Williams	Hatch	6/11/2024	CLOSED	Noted
5	5-0052-210-IHY-B4-RP-0001_A	TUFLOW files	Hatch	Dan Williams	Flood Assessment	3/10/2024	PDR	The TUFLOW model for the proposed design has included the subdivision of the open channel immediately upstream of the Mudges Canal box culverts into lengths as short as ~3.5 m. This inevitably causes model instabilities, which appear to have been resolved by supressing the intertial terms of the hydraulic equations, through the application of the "SN" channel type in the 1d_nwk file. This appears to have been undertaken within the existing scenario representation, which is appropriate for ensuring consistency. However, it would be best to not use the "SN" channel type and retain the 1d_nwk representation of the existing scenario in the design scenario, i.e. with a single 30 m long open channel reach. The additional detail that has been incorporated within the open channel in the design scenario is superfluous, as the box culverts through the embankment provide a dominant hydraulic control and the impacts of the minor change in channel geometry at the overland flow channel causeway will be negligible. This has not been undertaken for the Proof Engineering modelling as it would involve re-simulation of the existing flood conditions as well as those of the design. It is not expected that this change will have any significant impact on the modelling results but it would be preferable for it to be addressed moving forward to DDR.		Minor	Jasmine Lee	DJV Flooding Lead	25/10/2024	To accurately represent changes in the channel's cross-sections, the channel was divided into smaller segments, and the 'SN' type was utilised. In the existing condition, the channel has a uniform cross-section, so modelling it as a single open channel reach was sufficient. However, in the design condition, the southern side of the channel bank has been lowered. To model this revised cross-section accurately, multiple channel reaches were necessary. The purpose of lowering the channel bank is to redirect overland water flow into Mudges Canal instead of allowing it to flow into the RMAR, which would cause downstream afflux. Without properly representing the changes in the channel cross-section, this objective could not be achieved.	DDR flood design report	Dan Williams	Hatch	6/11/2024	CLOSED	The channel bank control is represented in the 2D domain, with the 1D channel cross-sections only relevent for conveyance and stage-storage calculations. In this case the cross-section modifications only result in a negligible change to the storage volume upstream of the box culverts and aren't integral to the modelling of the proposed design. However, I am happy for this to be left as-is for DDR, as it won't affect the model outcome. It was just raised as an observation to uneccesary changes having been made to the existing TUFLOW model.
6	5-0052-210-IHY-B4-RP-0001_B	TUFLOW files	Hatch	Dan Williams	Flood Assessment	20/05/2025	DDR	Confirmed that the pump is now set up and working correctly in the model.			Zoe Cruice	Engineering Manager	17/06/2025	Noted. No further action at DDR. Package to be provied at IFC to confirm no further change.		Darren Lyons	Hatch	20/05/2025	CLOSED	No further comments.
7	5-0052-210-IHY-B4-RP-0001_0	1.1	Hatch	Dan Williams	Flood Assessment	7/10/2025	IFC	It is agreed that the minor changes from DDR to IFC will not significantly alter the outcome of the flood assessment undertaken at DDR.			Zoe Cruice	Engineering Manager	17/06/2025	Noted. No further action.						

APPENDIX G

Independent Flood Consultant Confirmation of prior Certification Currency

Zoe Cruice

From: Daniel Williams <dan@torrentconsulting.com.au>
Sent: Monday, 8 December 2025 4:36 PM
To: Zoe Cruice
Cc: Mullard, John; Yucen Lu; André Wepener; Darren Lyons
Subject: RE: Riverina FDR - Rev 1 updated for CPHR comments

Hi Zoe,

Apologies it has taken this long to respond.

We can confirm no change to prior review and certification.

Thanks,
Dan

Dan Williams
Director

tel: 0408 023 262
web: www.torrentconsulting.com.au

From: Zoe Cruice <zoe.cruice@martinus.com.au>
Sent: Tuesday, 2 December 2025 6:17 AM
To: Daniel Williams <dan@torrentconsulting.com.au>
Cc: Mullard, John <john.mullard@hatch.com>; Yucen Lu <yucen.lu@aurecongroup.com>; André Wepener <Andre.Wepener@aurecongroup.com>
Subject: FW: Riverina FDR - Rev 1 updated for CPHR comments

Hi Dan,

We received some late comments from CPHR on the Riverina Hwy bridge track lowering flood design report. Comments with responses are attached FYI.

DJV have updated the report accordingly, and added a new sub-section to Section 5: **Section 5.5.3 Primary Pump Failure Assessment.**
2512XX_B4 - Riverina Flood Design Report IFC Rev 1

May you please review the changes and either:

1) Provide review comments in here: 5-0052-210-IHY-B4-CS-0001-PE_H Torrens Rev 1 IFC FDR review - as required.xlsm
   OR
2) Confirm no change to prior review and certification, by reply to this email confirm as such.

Cheers
Zoe

MARTINUS

Head Office | 1/23-27 Waratah Street | KIRRAWEE NSW 2232