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MARTINUS INLAND RAIL

FLOOD DESIGN REPORT

A2I | Albury to Illabo

Package: A2I – The Rock Yard

CONTRACT NUMBER: 0052

PROJECT DOCUMENT NUMBER:

5-0052-210-IHY-G4-RP-0001

Document Control

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Revision History

REVISION	REVISION DATE	AMENDMENT	DATE TO CLIENT
A	17/092024	DDR Issue for review	17/09/2024
A.1	25/10/2024	Updated for Consultation	25/20/2024
0	23/01/2025	IFC issue for Construction	23/01/2025
1	30/05/2025	IFC update for consultation review comments. Amendment to wording in Section 1.11 to clarify prior flood study graphics and report maps were used, but the model was not available.	30/05/2025

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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
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

Term	Definition
NtP	Notice to Proceed
PDR	Preliminary Design Review
PMF	Probable Maximum Flood
PSR	Project Scope and Requirements
QDL	Quantitative Design Limits
RCP	Representative Concentration Pathways
REF	Review of Environmental Factors
RFI	Request for Information
RORB	Runoff Routing Burroughs
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
UMM	Updated Mitigation Measures
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

This Incentivised Target Cost (ITC) project is an Enhancement project where ARTC has identified the Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) tracks to be authorised for double-stacked freight container trains.

The S2P section will be delivered under a 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) project sites will also commence at Contract Award.

The A2I section will be delivered under an EIS and will require a Notice to Proceed from ARTC before works can commence on site. Design for A2I will, however, commence at Contract Award.

Within the A2I section, there are twenty-two (22) Design and Construct (D&C) projects:

- Murray River bridge (Structure modifications)
- Albury Station Yard (Track slews, track reconfiguration and footbridge replacement)
- 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)
- Edmondson Street bridge (Bridge replacement)
- Wagga Wagga Station Yard (Track slews and Bridge replacement)
- Bomen Yard (Track slews)
- Harefield Yard (Track slews)
- Kemp Street bridge (Bridge replacement)
- Kemp Street footbridge (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 and LX1472 activations

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 Rock Yard (refer to Figure 1-1 for site location, the red polygon is the current Construction Impact Zone (CIZ)). The background and previous study for the site is listed below.

Figure 1-1: Site Location

1.3.1 Background

The Rock Yard forms part of the Albury to Illabo Section works. The Rock Yard is located in The Rock, south-west of Wagga Wagga. The project scope comprises structure modifications to a gantry at this location.

1.4 Objectives

This report has been prepared to support the delivery of the structure modifications at The Rock Yard and comply with the CSSI Condition of Approval and updated mitigation measures 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). The flood assessment aims to estimate the flood behaviour within the study area and assess the potential flood impacts due to the proposed works.

1.5 Scopes

The scope of this study includes:

- Carrying out the flood assessment for the design in the IFC stage for design events of 5%, 2%, 1%, AEPs, 1% AEP with climate change, and PMF.
- 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

Table 1-1 summarises all the flood studies related to The Rock Yard.

Table 1-1: Summary of the previous flood studies

Item No.	Flood Study	Description	Comments
1	The Rock Flood Study (WMAwater, 2014)	This flood study provided hydrologic and hydraulic assessments and information regarding flood behaviour in the local area, as well as some information regarding hydraulic structures in the area. The hydrologic modelling had been undertaken using ARR1987 and so this information was used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1). The information regarding hydraulic information in the flood study (culvert details) was adopted where relevant.	NA

1.6.2 Reference Design

The Reference Design provided are:

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

There was no flooding assessment as per this Reference design.

1.6.3 Environmental Impact Statement

- Albury to Illabo Environmental Impact Statement (EIS) Technical Paper 11 – Hydrology, Flooding and Water Quality (July 2022)

The EIS report states that the flooding in The Rock occurs via both local catchment flooding from Flowerpot Hill to the south of the town as well as regional from Burkes Creek that runs west to the north of the town. The EIS references The Rock Flood Study (WMA Water, 2014), which shows that the site is affected by the 1% AEP flood extent as well as the Probable Maximum Flood (PMF) event.

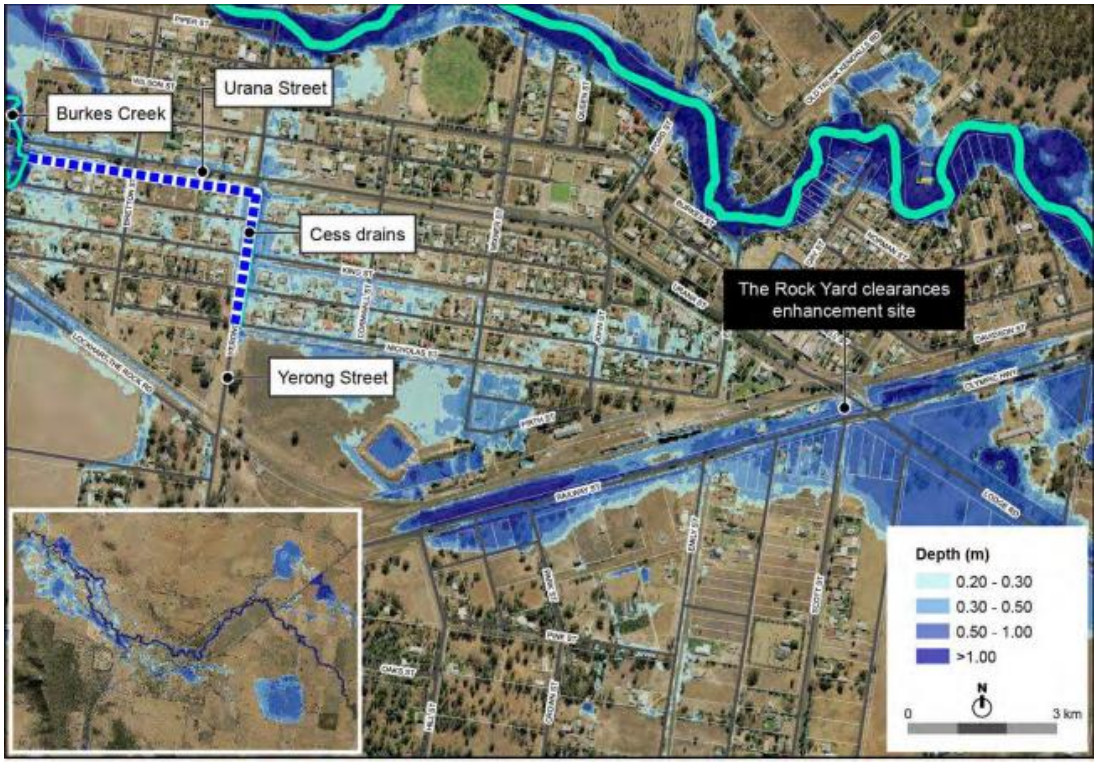


Figure 1-2: 1% AEP Flooding Extent at The Rock Yard clearances enhancement site (Image source: Albury to Illabo EIS Technical Paper 11 Figure 4.23 (July 2022))

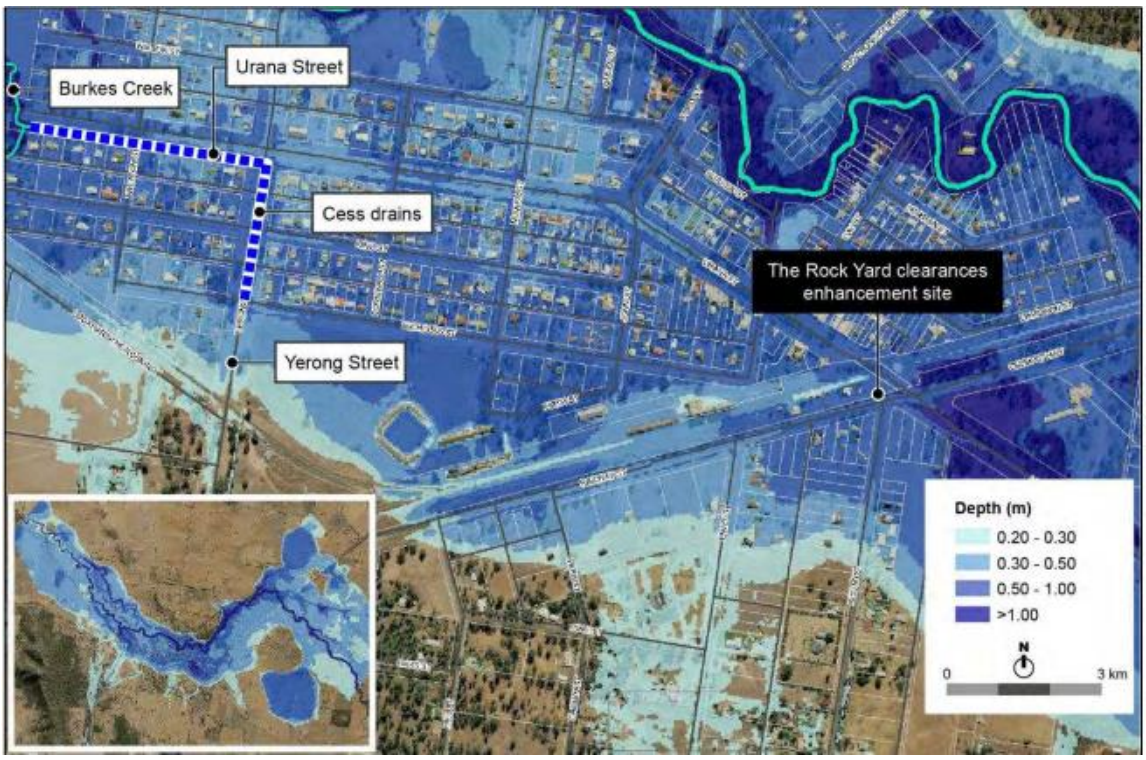


Figure 1-3: PMF flooding extent at The Rock Yard clearances enhancement site (Image source: Albury to Illabo EIS Technical Paper 11 Figure 4.24 (July 2022))

1.7 Purpose and Requirements

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

The secondary purpose of this report is to provide evidentiary documentation of consultation and review by external stakeholders, and the independent suitably-qualified flood consultant, in demonstrating compliance with the CSSI conditions of approval. Refer Appendix B for ARTC review, Appendix C for external consultation review, and Appendix D 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:

- The Rock Flood Study (WMAwater, 2014)
- Albury to Illabo (A2I) and Stockinbingal to Parkes (S2P) Projects Reference Design Report – Lockhart & Greater Hume (WSP, June 2022), 2-0008-210-PEN-02-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

Table 1-2 outlines the available information relevant to the site and used for flood modelling.

Table 1-2: Available Information

Item	Information	Type	Description / Comments
General			
1	Hydraulic model details found in The Rock Flood Study (WMAwater, 2014)	Hydraulic Model details	Received from ARTC on 29/08/2023. Used structure details and Mannings roughness values as inputs in the developed TUFLOW flood model
2	Hydrology model results found in The Rock Flood Study (WMAwater, 2014)	Hydrologic Model Results	Received from ARTC on 29/08/2023. Provided hydrologic flows for Probable Maximum Flood (PMF), 1% AEP, 2% AEP and 5% AEP events which were then used as a reference in determining the hydrologic parameters See Section 4.1.1
4	LiDAR 2012 (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 in GDA2020 projection	Downloaded from https://elevation.fsdf.org.au/ on 18/07/2024
5	A2P_TheRock_RT_Export_V1.dwg	DWG	Existing top of the rail centreline lines for Main track, Up loop and Down loop. Received from DJV rail team on 26/08/2024.

1.10 Outputs

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

1.11 Limitations and Assumptions

The following limitations and assumptions are applied to The Rock Yard site.

- The hydraulic and hydrologic models of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable. However, the results were available as part of the report and figures within this report were used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1) and hydraulic modelling (See Section 5).
- For some culverts outside the project boundary where information was not available, the culvert details were assumed based on aerial imagery and LiDAR.
- In the absence of detailed survey of the bridge structure across Burkes Creek at Ford Street, this was modelled as a layered flow constriction with blockage parameters assumed to represent pier dimensions.
- The allowable threshold for flood impacts was adopted from the Conditions of Approval (CoA)
- The TUFLOW hydraulic model has not been calibrated or validated based on historical data.
- An assessment of temporary works and staging has not been undertaken.
- 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 Practise Section 10 Flooding, the 1% AEP shall be used.
- Blockage assessment is carried out for the 1% AEP design scenario as per the guidance set out in ARR2019 for the culverts within project boundary while 20% blockage is adopted for all the other culverts, pit and pipes outside the project boundary. Refer also to the Technical Memo provided on blockage analysis: 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 Rock Yard 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 (No watercourse associated with this site.)
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.	Compliant. No change in flood immunity
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.	N/A (Clause 5.4.2 will apply)
Project Wide	5.4.5	Bridge and culvert hydraulics shall comply with Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures.	No bridge and culvert design within the site.
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 + Year 2090 Representative Concentration Pathways (RCP) 8.5. Refer to Section 7.1
A2I Technical Requirements*	IR-SR-A2I-349	The Corridor System for Enhancement Corridors shall have a flood immunity of no worse than existing.	No change to flood immunity. Refer to Section 6.3
A2I Technical Requirements*	IR-SR-A2I-350	The Corridor System, where the existing track is lowered, shall maintain the existing flood immunity.	No material flood impacts, Refer to Section 6.4
A2I Technical Requirements*	IR-SR-A2I-352	The Corridor System shall prevent damage of the formation due to ponding of water.	No material flood impacts, Refer to Section 6.4
A2I Technical Requirements*	IR-SR-A2I-458	The Corridor System shall prevent ponding in longitudinal open channels.	No material flood impacts, Refer to Section 6.4
A2I Technical Requirements*	IR-SR-A2I-459	The Corridor System for Enhancement Corridors shall provide mitigation for flood impacts no worse than existing condition.	N/A (no underbridges assessed in this scope of work)
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.	No material flood impacts, Refer to Section 6.4
A2I Technical Requirements*	IR-SR-A2I-465	The Corridor System shall minimise changes to the existing or natural flow patterns.	No material flood impacts, Refer to Section 6.4

Requirement	Identifier	A2P Technical Requirements Description	Compliance Evidence Reference
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 (no underbridges assessed in this scope of work)
A2I Technical Requirements*	IR-SR-A2I-735	The Third-Party System private roads shall have flood immunity no worse than existing.	No material flood impacts, Refer to Section 6.3

*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 the table 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 avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses.	Compliant with regards to flood impact. Section 6.4. Flood Impact assessment demonstrates this.
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 6)
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 4 and 6)
E40	a) Hydrologic and hydraulic assessments consistent with *Australian Rainfall and Runoff – A Guide to Flood Estimation* (GeoScience Australia, 2019);	Compliant. Section 4 methodology shows that ARR2019 guidelines were used for this assessment.
E40	b) Use of modelling software appropriate to the relevant modelling task;	Compliant. Section 4 shows that 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. Section 4 Inputs show that rail levels were used in the models. However, the topographic survey was not available for this design stage.
E40	d) Confirmation of predicted afflux at industrial properties adjacent to Railway Street, Wagga Wagga based on field survey.	N/A – Railway Street in Wagga Wagga is not relevant to this site.
E40	Updated flood modelling must be made publicly available in accordance with **Condition B18**.	Flood design report and independent review of 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.

Condition #	Condition or Criteria	Compliance Evidence Reference
E41	The Proponent's response to the requirements of **Conditions E42** and **E44** 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 satisfy and comply with the requirements of A16. Consultation with Council will be undertaken through formal review of this Flood Design Report. Consultation with other stakeholders will occur prior to finalisation of the 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 below
E42	(a) a maximum increase in inundation time of one hour, or 10%, whichever is greater;	Compliant. Refer to Section 6.4
E42	(b) a maximum increase of 10 mm in above-floor inundation to habitable rooms where floor levels are currently exceeded;	Compliant. Refer to Section 6.4
E42	(c) no above-floor inundation of habitable rooms which are currently not inundated;	Compliant. Refer to Section 6.4
E42	(d) a maximum increase of 50 mm in inundation of land zoned as residential, industrial or commercial;	Compliant. Refer to Section 6.4
E42	(e) a maximum increase of 100 mm in inundation of land zoned as environment zone or public recreation;	Compliant. Refer to Section 6.4
E42	(f) a maximum increase of 200 mm in inundation of land zoned as rural or primary production, environment zone or public recreation;	Compliant. Refer to Section 6.4
E42	(g) no increase in the flood hazard category or risk to life; and	Compliant. Refer to Section 6.4
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 6.4
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.	Compliant. Refer to Section 6.4
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 6.4
E43	b) the results of consultation with the relevant council in accordance with **Condition E46**	N/A – No drainage design is included within the scope of works at this site.

Condition #	Condition or Criteria	Compliance Evidence Reference
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 Planning Secretary prior to works that may impact on flooding or the relevant council's stormwater network.	This report will be submitted to the Planning Secretary for approval prior to works that may impact on flooding or the relevant council's stormwater network
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.**	N/A – No drainage design is included within the scope of works at this site.

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 the table below.

Table 2-3 Updated Mitigation Measures Compliance Table - Flooding

Condition	Condition or Criteria	Compliance Evidence Reference	Comment if non-compliant
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 Council and other relevant authorities will be undertaken through formal review of this Flood Design Report. Refer Appendix C, D and E.	-
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 compliance with the Quantitative Design Limits for Inland Rail.	This report relates to The Rock Yard site, and so is not relevant to the Wagga Wagga Yard enhancement site. Refer to Wagga	-

Condition	Condition or Criteria	Compliance Evidence Reference	Comment if non-compliant
	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	Yard Flood design report (5-0052-210-IHY-W7-RP-0001) for predicted afflux at industrial properties. Compliant. Quantitative assessment has been undertaken. Refer to Section 6.	
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.	This report relates to The Rock Yard site, and so is not relevant to the Riverina Highway bridge enhancement site.	-

* 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

No SDR was submitted as this package is a Simple Package.

3.2 Concept to PDR

Flood modelling is not applicable to this stage.

3.3 PDR to DDR

The table below outlines the changes occurring between PDR and DDR submissions.

Table 3-1: Design Differences Between PDR and DDR

Item	Difference	Reason for Difference
1	The DJV created a new TUFLOW hydraulic model to model the area of interest and proposed design	No TUFLOW hydraulic model was available for the PDR stage or earlier.

3.4 DDR to IFC

The table below outlines the changes occurring between DDR and IFC submissions.

Table 3-2: Design Differences Between DDR and IFC

Item	Difference	Reason for Difference
1	Updates to Conditions of Approval numbering to reflect the final conditions as per the CSSI instrument of approval	CSSI approval and issuance of instrument of approval.
2	Amendment of wording throughout to remove ‘draft’ from Conditions of Approval	CSSI approval and issuance of instrument of approval.
3	Correction of section numbering and hyperlinked references throughout	Formatting errors corrected.

4 MODELLING METHODOLOGY

The overall approaches for flood modelling are listed below:

- Based on ARR2019, develop a RORB hydrological model and generate flow hydrographs for input to the hydraulic model for all events (5% AEP, 2%AEP, 1%AEP, 1% with climate change and PMF) to perform critical duration analysis.
- Calibrate the hydrologic results against information from the available flood study (WMA Water, 2014) and the Regional Flood Frequency Estimation model
- Develop a TUFLOW hydraulic model with all available information to develop an existing conditions flood model.
- Determine whether a design conditions flood model is required based on the results of the existing conditions flood model
- To complete a flood impact assessment for the site.
- Conduct a climate change sensitivity assessment for the 1% AEP to inform the potential impact on the railway track flood immunity.
- Conduct a blockage sensitivity assessment for the 1% AEP event, to inform the potential impact of blockage of hydraulic structures

4.1 Hydrology Modelling

Flood behaviour at The Rock comprises of two main mechanisms, local catchment flooding from the local catchment of Flowerpot Hill as well as regional flooding from Burkes Creek.

A RORB hydrologic model was developed to generate flow hydrographs for the various AEP events to be used as input to the hydraulic model. The hydrologic model was divided into sub-catchments as per the Figure 4-1.

The RORB model was set up to output flow hydrographs from Burkes Creek at an area just upstream and to the west of the town, as well as flow hydrographs from the local catchment to the site. The model was set up using Storm Injector, which used the created RORB model, in addition to the IFD rainfall values, rainfall losses, and relevant temporal patterns to derive the flow hydrographs at the areas of interest. The Storm Injector was then used to perform a critical duration analysis for the entire ensemble of events to determine the critical duration and temporal pattern for each event.

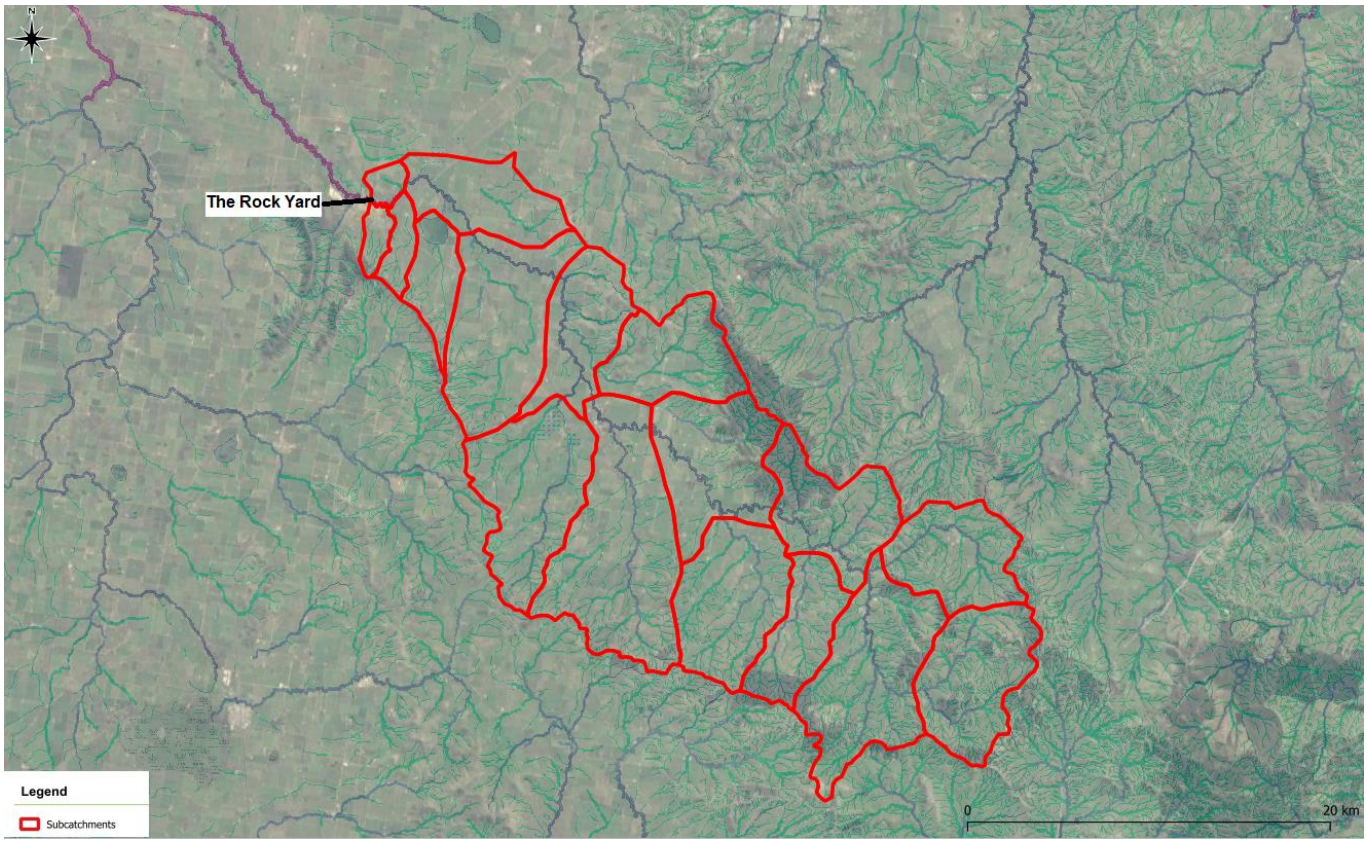


Figure 4-1: Hydrology Subcatchment Extents

Table 4-1: Model Parameters of Hydrology Model

Parameters	Developed Hydrology Model	Notes
Hydrology model and version	RORB model (Version 6.45) using Storm injector HL(V 1.3.7.0).	
Total catchment area	597 km^2	
Initial Loss	Probability Neutral Burst Loss for all events except PMF (refer Appendix B) PMF event (0mm)	ARR Data Hub (Downloaded 20/8/24) Refer to Appendix B
Continuing Loss	1.84 mm/hr (PMF 1 mm/hr)	ARR Data Hub (Downloaded 20/8/24) Refer to Appendix B
Kc Routing Parameter	36.55	See Section 4.1.1 for discussion
M value	0.8	As per ARR2019 guidelines
Catchment Slope	Based off LiDAR	
Impervious Area	Based off Aerial imagery	
Events	PMF, 1% AEP + Climate Change, 1%AEP, 2% AEP, 5% AEP	
Duration Temporal pattern received/generated	Ensemble temporal pattern for each duration ranging from 35 minutes to 1440 minutes Ensemble 11 temporal patterns for GSDM PMF from 15 minutes to 180minutes 1 Temporal pattern for GSAM PMF for durations greater than 180 minutes up until 96 hours	As per ARR2019 guidelines

4.1.1 Hydrology Model Comparison

The RORB hydrology model that was developed was compared against available data from both The Rock Flood Study (WMA Water, 2014) as well as the Regional Flood Frequency Estimation tool. Specifically, a comparison was undertaken by changing the Kc routing parameter by utilising 4 separate equations that are used to derive this parameter (shown in Table 4-2). Each of these Kc values were run through RORB and Storm Injector to derive the peak flows for the 5%, 2% and 1% AEP events. These values were then compared against the flows from the RFFE for the site as well as the Flood Study. The flow derived from the Yu and Dyer equations provided flows for all AEP events that were similar to both the Flood Study and RFFE flows. A further comparison of IFD rainfall between ARR2019 and ARR87 was undertaken (Table 4-4) which showed that for long duration events (which are relevant for the critical duration for the creek), the ARR2019 depths are slightly higher. Therefore, the Kc Parameter from the Yu equation was adopted as this produced flows slightly higher than the flood study which used the ARR87 IFD depths.

Table 4-2: Kc Parameters

Kc Value	Equation
22.33	ARR2019 Equation 7.6.13
53.75	RORB manual, equation 2.5
43.40	Dyer (1994, Pearse et. al. 2002)
36.55	Yu (1989, Pearse et. al. 2002)

Table 4-3: Kc Parameter Comparison

AEP (%)	RFFE Expected Value	Flood Study (ARR87)	ARR2019 Equation 7.6.13	RORB manual, equation 2.5	Dyer (1994, Pearse et. al. 2002)	Yu (1989, Pearse et. al. 2002)
5%	172	262	492	175	230	284*
2%	292	346	643	250	327	399*
1%	400	431	828	324	424	509*

*Adopted Kc Parameter

Table 4-4: IFD Rainfall % increase comparison between ARR2019 and ARR87

	Difference (%) (ARR2019 - ARR87)				
AEP (%)	20	10	5	2	1
5 mins	13%	13%	9%	5%	2%
10 mins	14%	16%	11%	8%	5%
20 mins	8%	11%	8%	5%	3%
30 mins	3%	8%	5%	3%	1%
1 hour	-3%	3%	1%	-1%	-2%
2 hours	-5%	0%	0%	-2%	-3%
3 hours	-6%	1%	0%	-1%	-1%
6 hours	-6%	1%	0%	1%	1%
12 hours	-6%	1%	2%	3%	3%
24 hours	-8%	1%	1%	2%	3%
48 hours	-8%	1%	0%	2%	2%
72 hours	-4%	3%	3%	4%	4%

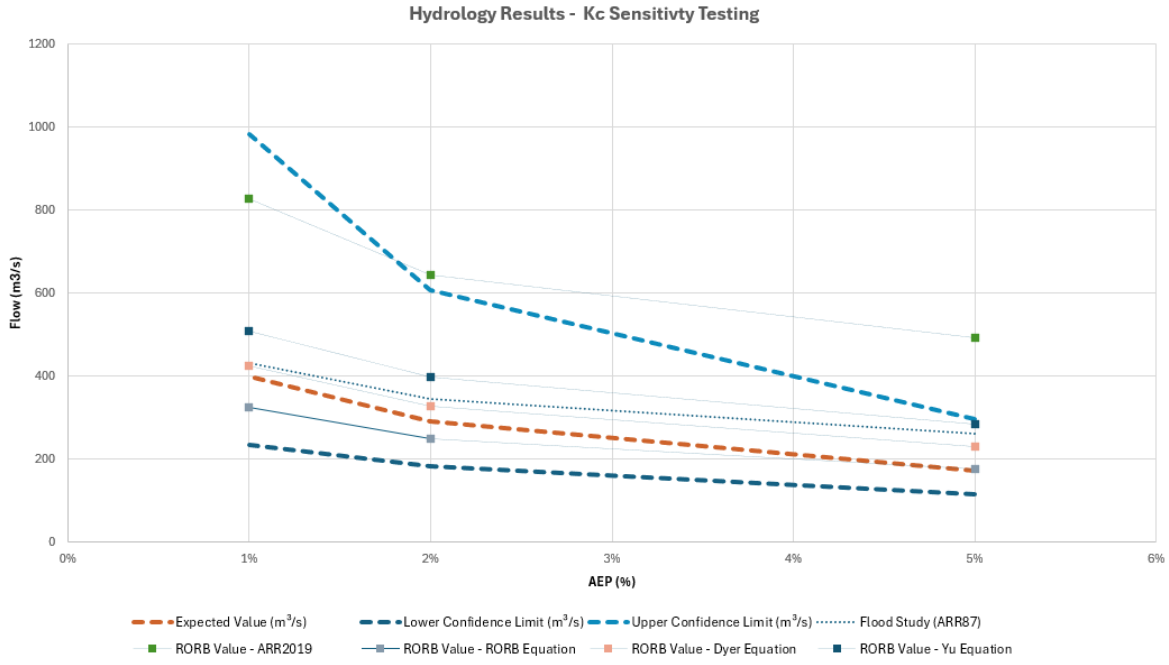


Figure 4-2: Peak Flow Comparison

4.2 Hydraulic Modelling

A TUFLOW model was developed to model the flood behaviour at The Rock Yard site. The model extent encompasses the town of The Rock, Burkes Creek to the north and Flowerpot Hill to the south (Refer to Figure 4-3).

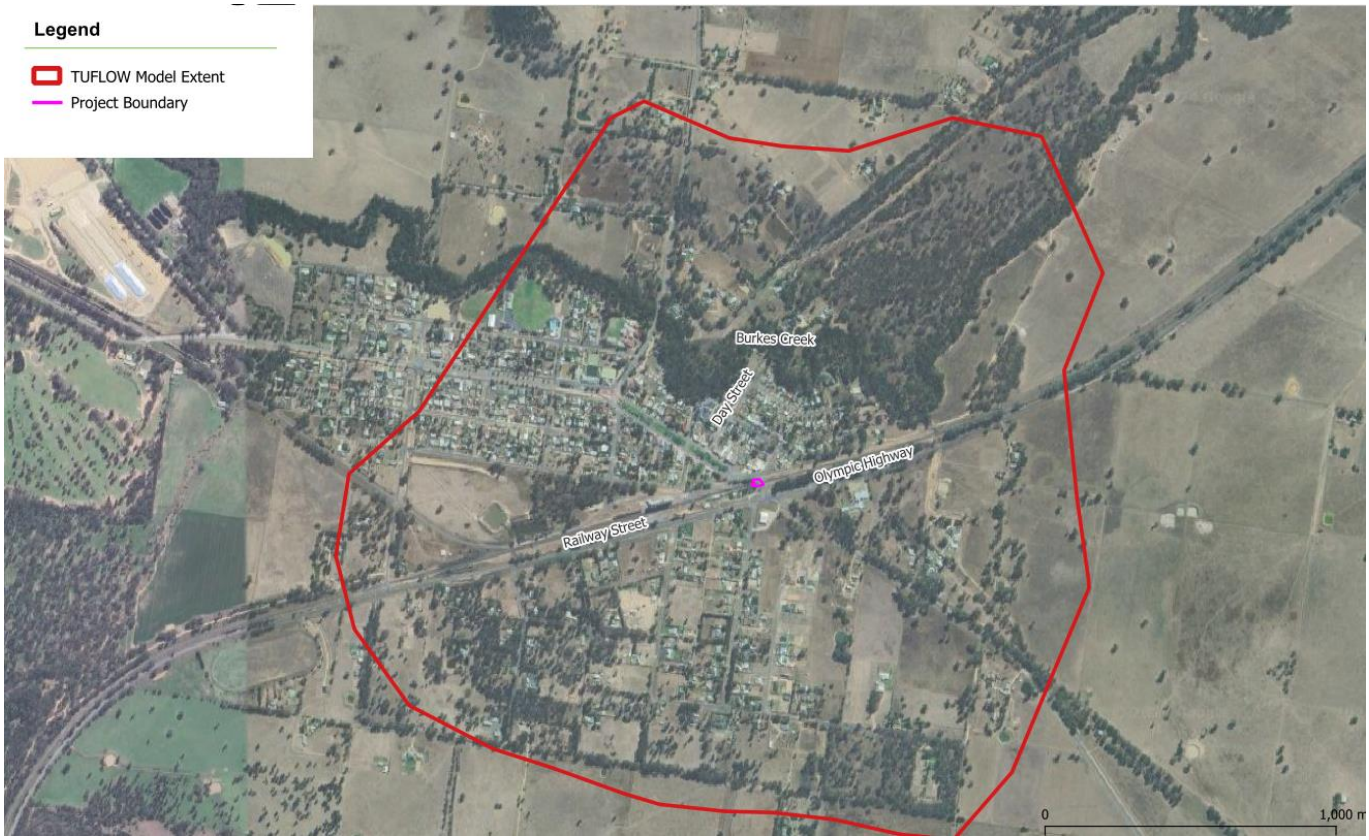


Figure 4-3: TUFLOW Model Extent – The Rock Yard Model

Table 4-5: Model Parameters in the TUFLOW Model

Parameters	TUFLOW Model
TUFLOW version	TUFLOW 2023-03-AE HPC
Coordination Reference System (CRS)	GDA2020 MGA 55
Grid Size	2m (1m within Quadtree Extent, see Figure 4-4)
Hydrology	RORB ARR2019
Inflows	Flow vs Time Boundary Inflow Source Area Rainfall Polygon
Downstream Boundary	Set as HQ (head vs flow) boundary with a slope of 0.01 based on the general slope of the area
Building Representation	Buildings were nulled out of the model extent
Model Topography	1m resolution LiDAR collected in 2012 downloaded from Elvis. Supplemented by terrain modifications for top of rail line, roads, channels.
Dams Initial Water Levels	All farm dams were assumed to be full as a conservative approach.
Drainage	Culverts and Pipes were modelled as 1d network elements with connections to the 2d domain via 2d_bc lines.

Parameters	TUFLOW Model
Mannings Roughness Values	Floodplain – 0.045 Basins/Channels/Water – 0.075 Streets/Roads – 0.020 Rail – 0.030 Medium to Dense Bush – 0.06
Design Events	PMF, 1% AEP, 2% AEP, 5% AEP

While a grid size of 2 metres was adopted for the model, this was reduced to 1 metre within the site area by utilising the TUFLOW Quadtree functionality. The Quadtree extent is shown in Figure 4-4.

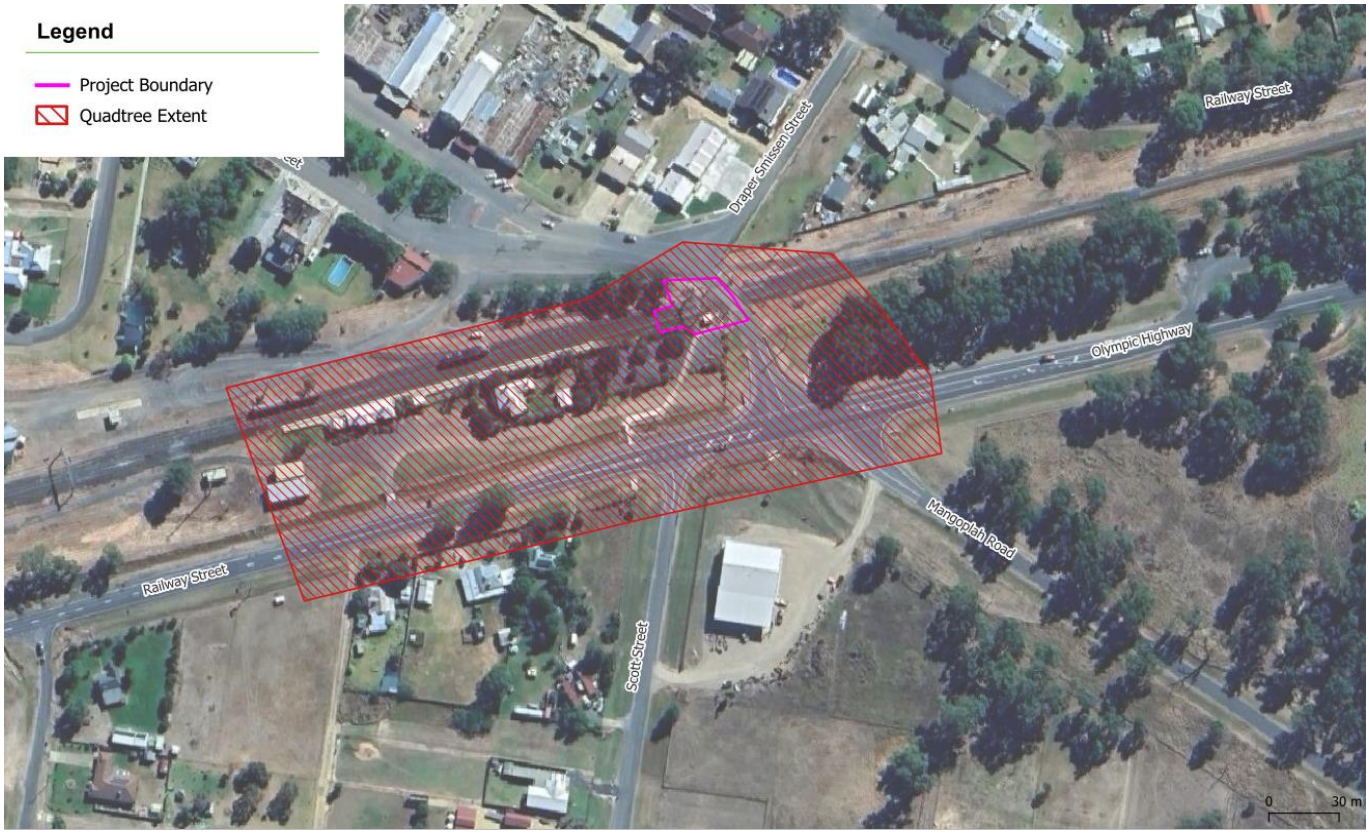


Figure 4-4: Quadtree Extent – The Rock Yard

4.2.1 Topography

The model topography was updated by incorporating the 2012 1 metre LiDAR for the entirety of the model extent. This was then supplemented by incorporating top of rail strings for the Main Line, Up Loop and Down Loop line as well as break lines for roads and channels.

4.2.2 Drainage Network

The drainage elements used in the model were based on the data found in The Rock Flood Study (WMA Water 2014), which provided details and invert levels for some of the drainage elements. Where they were not available, these were assumed based on Street View imagery and LiDAR. These were modelled as 1D elements with links to the 2D model domain.

4.2.3 Inflows

The hydrologic inflows occurred at 2 different locations. The regional inflow was set upstream of the town at Burkes Creek using a Flow vs Time Hydrograph that was produced by the hydrologic model. The local inflow was applied to the south of the rail line to represent the flow from the local catchment from Flowerpot Hill. This was applied using the excess rainfall for the relevant storm, and then this was applied based on the total local catchment area at this location.

4.2.4 Design Model Update

The design works associated with this site are structural works on an existing gantry. As such, due to the minor and localised nature of the works, a design model was not developed as there will be no material impact on flood behaviour. This is further discussed in Section 6.

4.2.5 Design Events

The critical duration analysis was conducted by utilising inflow hydrographs generated from the hydrology. The storm durations of 15min up to 2880min were modelled for the events of 5%, 2%, 1% AEP and 1% AEP with climate change.

An ensemble of 10 temporal patterns was run for each duration as recommended in ARR2019. The medium for the 10 temporal patterns will represent each duration. For PMF, storms from 15 minutes to 96 hours were modelled, and 11 temporal patterns were run for durations from 15 minutes up to 3 hours and 1 temporal pattern for storms greater, which is in line with ARR2019 guidance.

The critical duration and temporal patterns determined and elaborated below in Table 4-6 summarise the information of the design events.

Table 4-6: Summary of Events and Critical Durations Run in TUFLOW

Design Events	Critical Duration	Critical Temporal Pattern
5% AEP	720min/120min	4085/3944
2% AEP	720min/360min	4057/3862
1% AEP	720min/360min	4007/3862
1% AEP + Climate Change	720min/360min	4007/3862
PMF	360min/60min	01/09

4.2.5.1 Climate change

An assessment was conducted to evaluate the influence of climate change on flooding to anticipate future climate change flood risk. The existing RORB model was employed to generate hydrographs for the TUFLOW model for the 1% AEP with climate change (Refer to Section 1.11 for assumptions). As per the EIS report (Section 3.3.5 of Albury to Illabo Environmental Impact Statement Technical Paper 11), Year 2090 RCP8.5 interim climate change factor sourced from the ARR Data Hub (https://data.arr-software.org/) was adopted.

As per the EIS report (Section 3.3.5 of Albury to Illabo Environmental Impact Statement Technical Paper 11), Year 2090 RCP8.5 interim climate change factor sourced from the ARR Data Hub (https://data.arr-software.org/) and the associated 20.2% increase in rainfall was adopted and was incorporated into the RORB hydrologic model.

5 HYDRAULIC MODEL COMPARISONS

The comparison in this section involves the results from the developed TUFLOW model's existing condition results against the results from The Rock Flood Study (WMA Water, 2014) for the 1% AEP event at the area of interest.

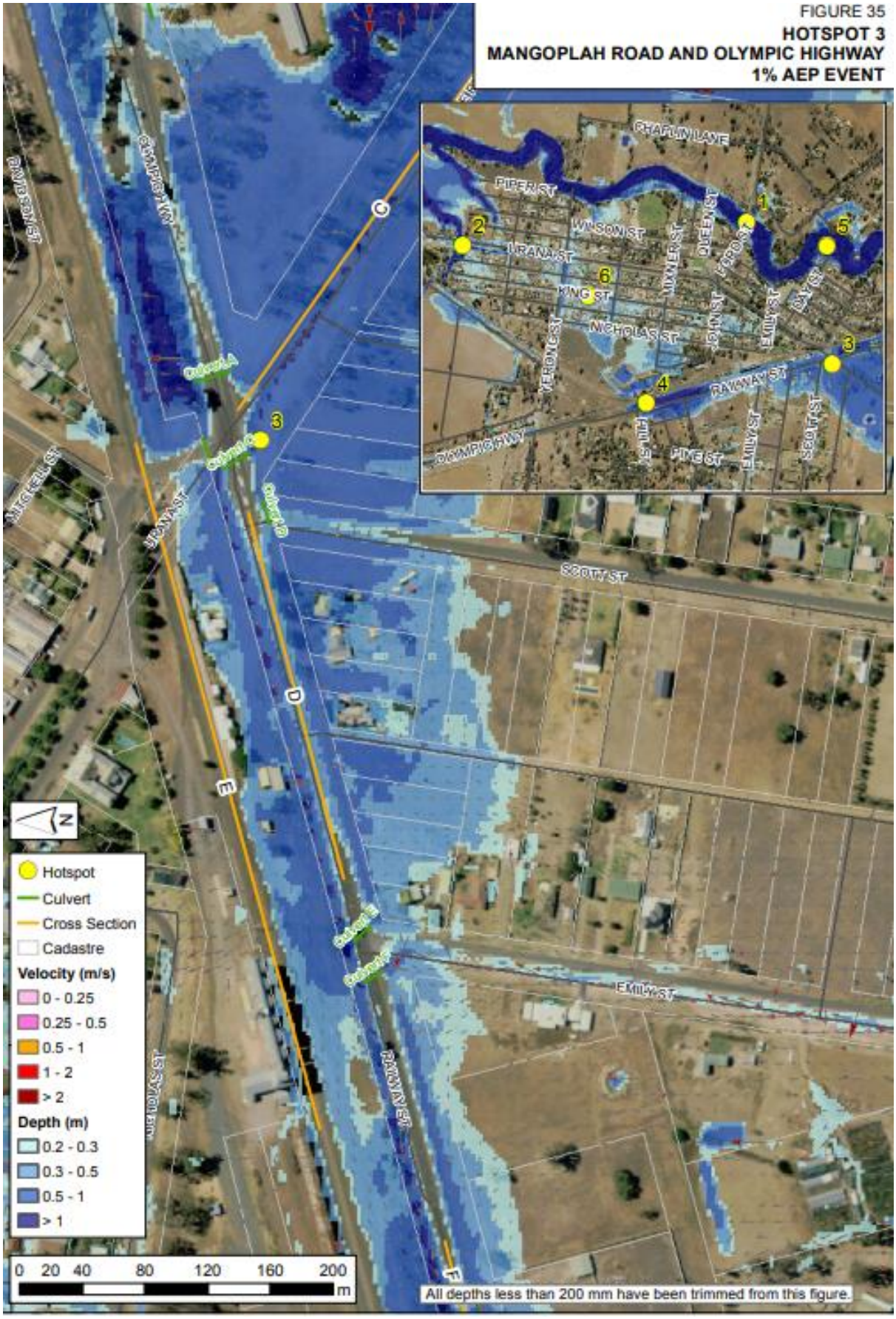


Figure 5-1: The Rock Flood Study (WMA Water, 2014) 1% AEP Flood Depths

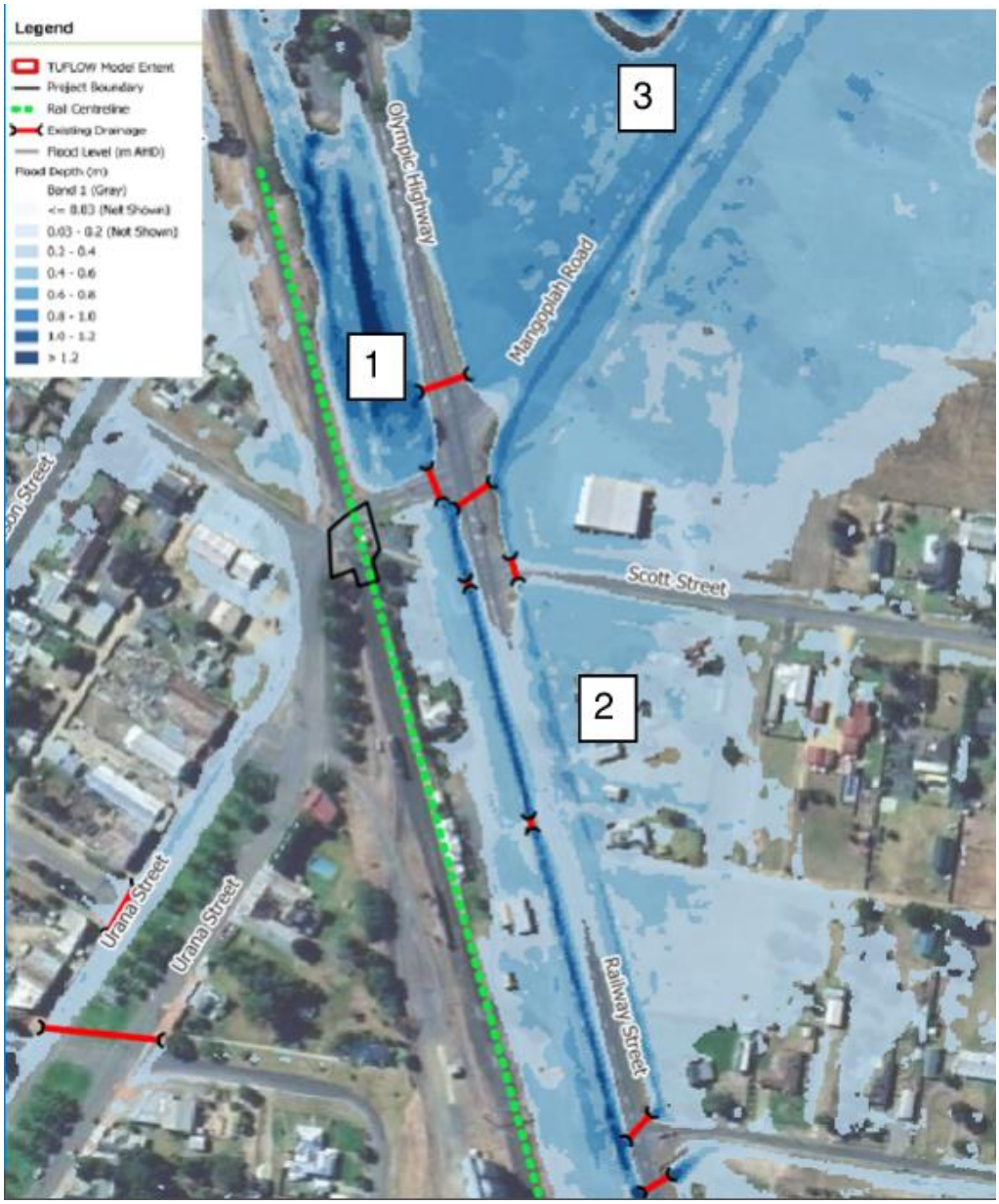


Figure 5-2: Developed TUFLOW model 1% AEP Flood Depths (see location descriptions in Table 5-1)

Generally, the comparison shows that the developed IFC TUFLOW model produced a similar result to the results of the flood study. There are some areas in which the developed IFC TUFLOW model produced slightly lower flood depths than the flood study. This is likely due to the differences in IFD rainfall between ARR2019 and ARR1987 as shown in Table 4-4 which shows that for the 2-hour event, which was deemed to be the critical event for the local catchment as shown in Table 4-6, that the ARR2019 IFD values are slightly lower.

Table 5-1: Comparison of Flood Behaviour between Flood Study and Developed IFC TUFLOW Model

Area of Interest	1% AEP Flood Behaviour (Flood Study)	1% AEP Flood Behaviour (Developed IFC Flood Model)
The area between Olympic High and the Rail line (Mangoplah Road) (Location 1)	Flow depths of greater than 1m	Flow depths of greater than 1m
Properties adjacent to Olympic Highway near Mangoplah Road (Location 2)	Flow depths of greater than 1m	Flow depths of greater than 0.8m
Olympic Highway north of Mangoplah Road and Scott Street (Location 3)	Flow Depths of up to 0.2m	Flow depths of up to 0.2m

6 FLOOD ASSESSMENT

Existing flood maps, including peak flood depth and levels, peak flood velocity, and peak flood hazard for the modelled events, are provided in Appendix A.

Flows enter the vicinity of the site area from two different sources. Firstly, in events greater than the 2% AEP, flow from Burkes Creek overtops its banks and flows southwest to the site area. Secondly, in all events, flow from the local catchment from Flowerpot Hill to the south of the site flows north to the site location. The general flow behaviour is shown below in Figure 6-1.

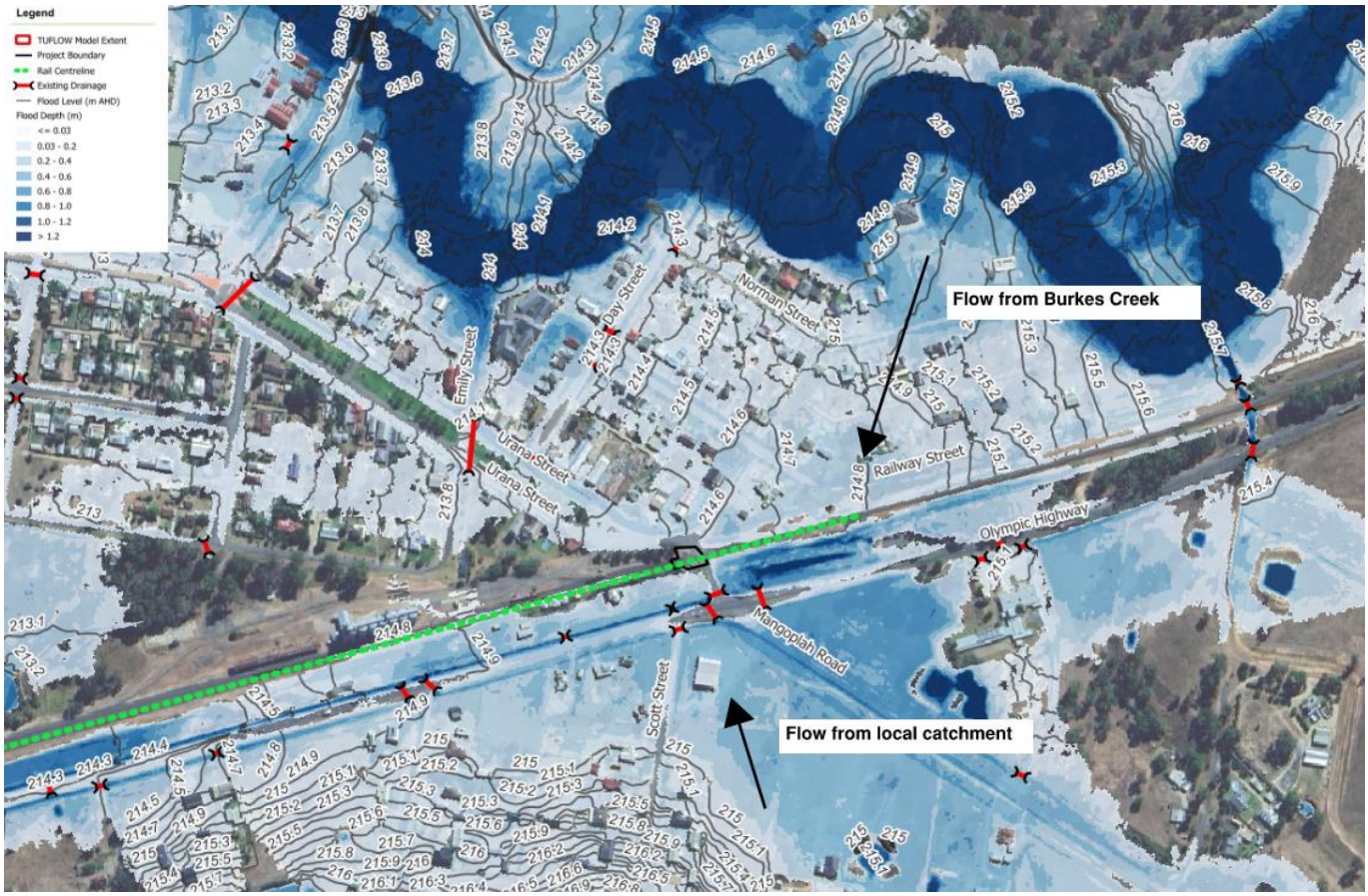


Figure 6-1: The Rock Yard Site Flow Paths (1% AEP event)

6.1 Existing Condition

Figure 6-1 shows points of interest that have been used for the flood impact assessment presented in the following sections and Table 6-1 below describes the location at each point of interest.

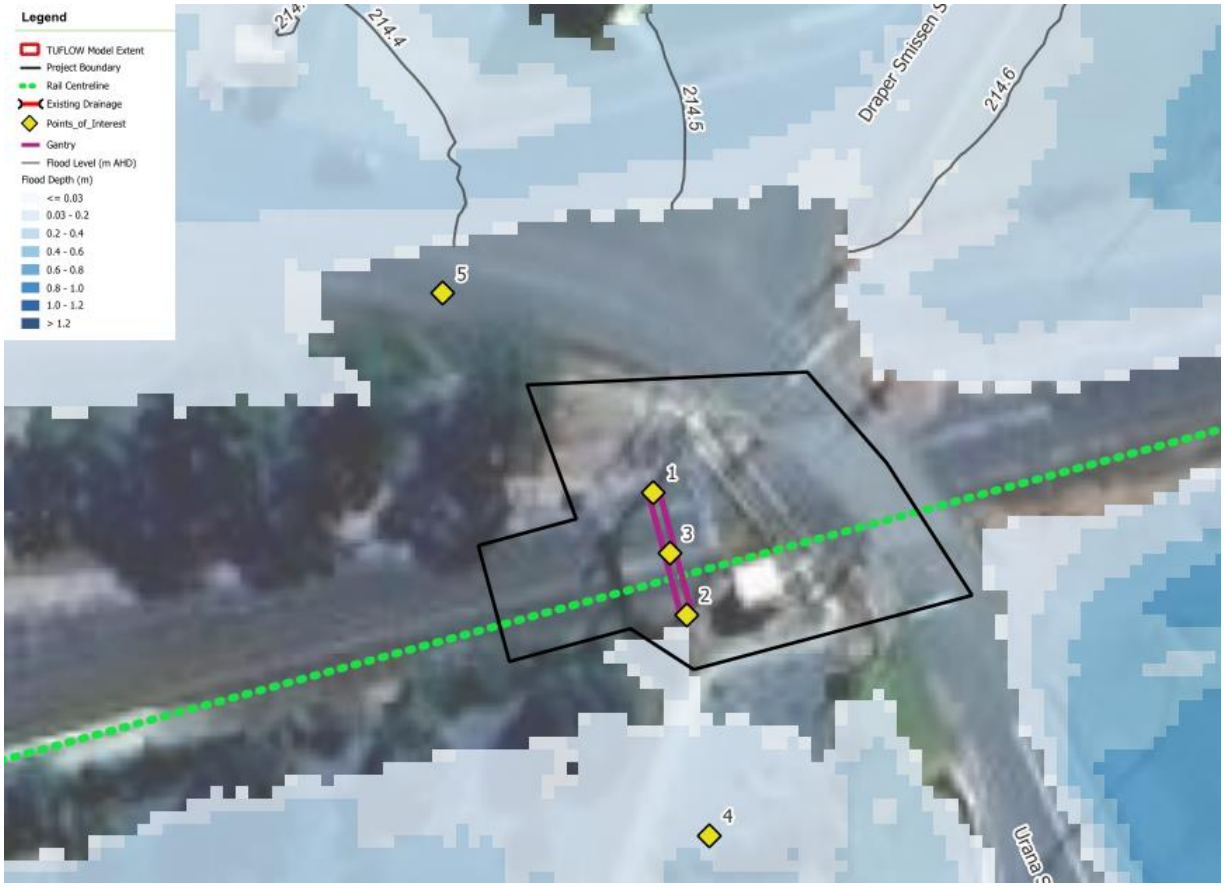


Figure 6-2: Reporting Points of Interest 1 to 5

Table 6-1: Points of Interest

Point of Interest	Chainage (m)	Description
1	CH557177	North side of Gantry
2	CH557177	Centre of Gantry on rail line
3	CH557177	South side of Gantry
4	CH557177	Upstream of site boundary
5	CH557177	Downstream of site boundary

The existing condition flood behaviour is discussed in Table 6-2 to Table 6-7.

Table 6-2: Peak Flood Levels – Existing Conditions

Design Events	Flood Levels
PMF	▪ Floodwaters overtop the rail at the site location (CH557177) ▪ Flood depths within the project boundary are up to 2.6m
1% AEP + Climate Change and 1% AEP	▪ Floodwaters do not overtop the rail at the site location (CH557177) ▪ However, it should be noted that in events greater than and including the 1% AEP event, the floodwaters overtop the rail further to the west of the site location at Chainage 550420 ▪ Flood depths within the project boundary are up to 0.1m
All other % AEP events	▪ Floodwaters do not overtop the rail at the site location (CH557177) ▪ Floodwaters do not enter the project boundary

Table 6-3: Points of Interest Data – Peak Flood Levels (mAHD) – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	No flooding	No flooding	No flooding	No flooding	217.5
Point 2	No flooding	No flooding	No flooding	215.0	217.6
Point 3	No flooding	No flooding	No flooding	No flooding	217.5
Point 4	214.8	214.9	214.9	215.0	217.6
Point 5	No flooding	No flooding	No flooding	214.7	217.3

Table 6-4: Peak Flood Velocity – Existing Conditions

Design Events	Flood Velocities
Probable Maximum Flood (PMF)	Peak velocities within the site are a maximum of 2.5m/s
1% AEP + Climate Change and 1% AEP	Peak velocities within the site area are less than 0.1m/s
All other % AEP events	Floodwaters do not enter the project boundary

Table 6-5: Points of Interest Data – Peak Flood Velocity (m/s) – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	No flooding	No flooding	No flooding	No flooding	2.4
Point 2	No flooding	No flooding	Less than 0.1	Less than 0.1	2.1
Point 3	No flooding	No flooding	No flooding	No flooding	2.2
Point 4	Less than 0.1	Less than 0.1	Less than 0.1	Less than 0.1	2.0
Point 5	No flooding	No flooding	No flooding	0.6	2.8

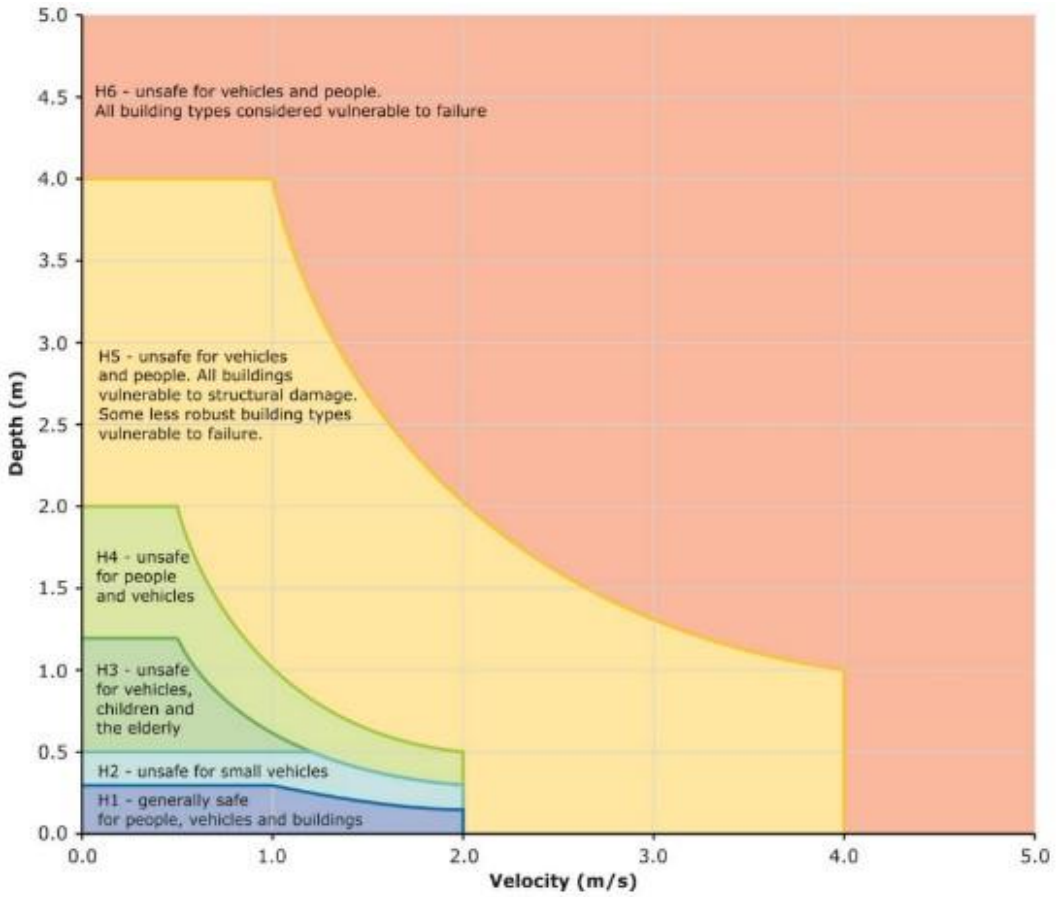


Figure 6-3: Hazard Category Classification

Table 6-6: Flood Hazard – Existing Conditions

Design Events	Flood Hazard
Probable Maximum Flood (PMF)	Peak flood hazard within the site boundary is H6
1% AEP + Climate Change and 1% AEP	Peak flood hazard within the site boundary is H1
All other % AEP events	Floodwaters do not enter the project boundary

Table 6-7: Points of Interest Data – Peak Flood Hazard Category – Existing Conditions

Locations	5% AEP	2% AEP	1% AEP	1% AEP + Climate Change	PMF
Point 1	No flooding	No flooding	No flooding	No flooding	H6
Point 2	No flooding	No flooding	H1	H1	H6
Point 3	No flooding	No flooding	No flooding	No flooding	H6
Point 4	H1	H1	H1	H1	H6
Point 5	No flooding	No flooding	No flooding	H1	H6

6.2 Design Condition

Design conditions flood modelling was not undertaken due to the relatively minor nature of the structural modifications of the gantry at the site. As stated in the Detailed Design Report (refer to document 5-0052-210-PEN-G4-RP-0001), the modifications to the structure involve no terrain modifications (including to the footing) and only involve a change to bracing and bolt configurations.

Table 6-8: Gantry Measures (refer also Table 4-5 from 5-0052-210-PEN-G4-RP-0001 – Detailed Design Report)

	Details	
Details	Location	The Rock
	Structure Owned By	ARTC
	ARTC Track Chainage	550.175KM
	Rail Configuration	Double Track
Dimensions (mm)	Height (Top of BP to the bottom face of bridge member)	7276
	Length (Inside face of legs)	10100
	DS Leg to Rail	2343
	US Leg to Rail	2217
	Grout Thickness	15

Figure 6-4: Gantry 07 26 / 07 28

As shown in Table 6-8: Gantry Measures (refer also Table 4-5 from 5-0052-210-PEN-G4-RP-0001 – Detailed Design Report)Table 6-8, the overall height of the gantry to the bottom of the horizontal bridge member (which corresponds to A in Figure 6-4) is more than 7m. In addition, as shown in Figure 6-4, the bracings are connected more than halfway up this height. As stated in Section 6.1, in events smaller than 1% AEP event, the site is not affected by flooding. In the 1% AEP and 1% AEP + Climate Change events, the flood depths are minor, being up to 100mm. It is only the PMF in which the site is affected by a reasonable depth of flooding, being up to 2.5m, however due to the height of the gantry being above the PMF depth, it is unlikely to have any material impact on flood behaviour. Therefore, it was deemed justified that a design conditions flood model was not necessary.

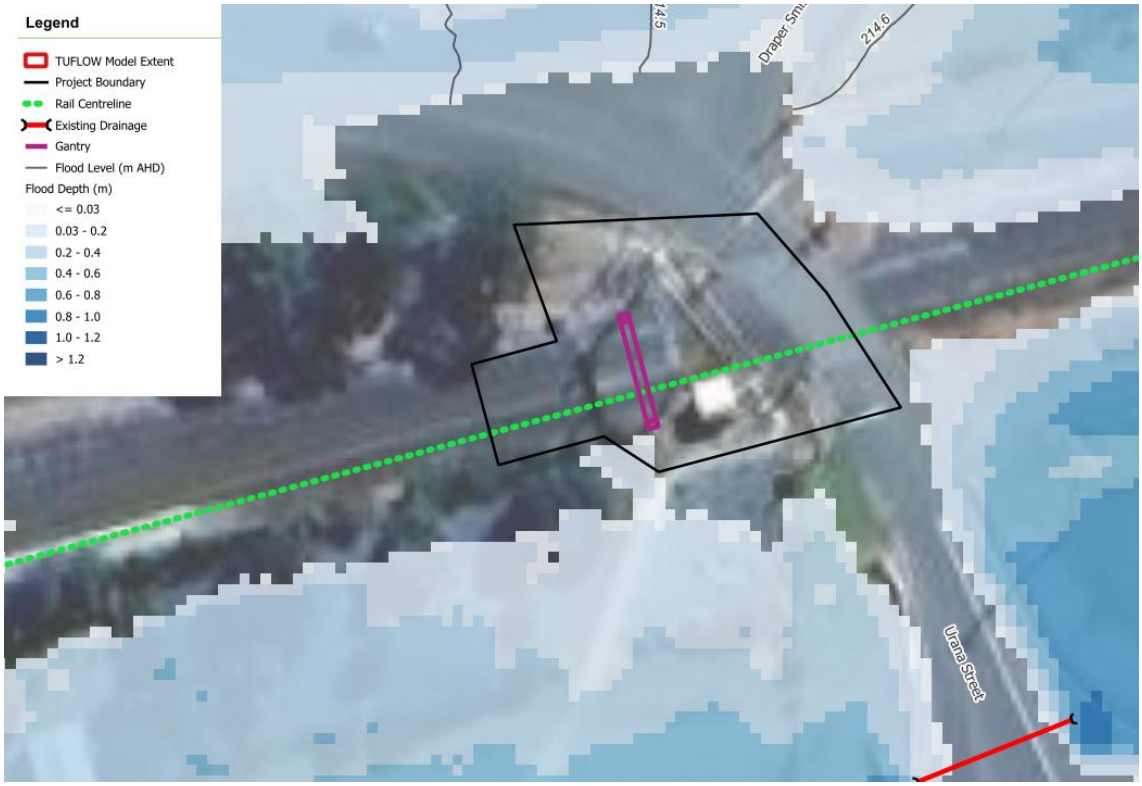


Figure 6-5: 1% AEP Flood Extent in relation to Gantry

6.3 Flood Immunity and Scour Protection

The railway at the site location achieves immunity to the 1% AEP event, as shown in Figure 6-5. However, as mentioned previously, the rail is overtopped further to the west of the site location at Chainage 550420 in this event.

As discussed in Section 6.2, the design works at the site are unlikely to have any material impact on flood behaviour and hence, flood immunity will be unaffected.

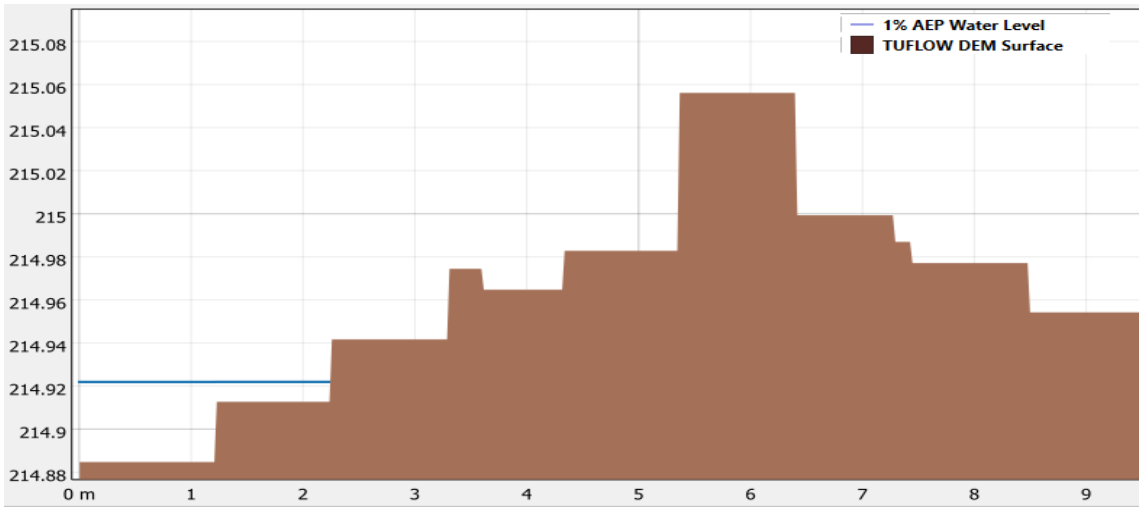


Figure 6-6: 1% AEP Railway Immunity (CH557177) (Elevation m AHD)

Furthermore, as discussed in Section 6.1, the velocities on the site in events up to and including the 1% AEP event are negligible so investigations into scour protection are not warranted.

6.4 Flood Impact Assessment

As discussed in Section 6.2, there are no flood impacts associated with the design works.

6.5 Sensitivity Test

6.5.1 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 6-9 below. For culverts within the project boundary, the methodology within ARR2019 was to be followed. However, there were no culverts or hydraulic structures within the project boundary. For all other hydraulic structures outside the project boundary, a 20% blockage was applied.

Table 6-9: Culvert Blockage Percentage

Culvert	Blockage Percentage (1% AEP)	Comments
All others (culvert, pit and pipe)	20%	Outside of the project boundary

The above methodology was adopted by considering the followings:

- 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, please refer to 5-0052-210-IHY-99-ME-0001.

As shown in Figure 6-7 and comparison with Figure 6-6, the blockage of hydraulic structures makes a negligible difference to the rail immunity at the site location.

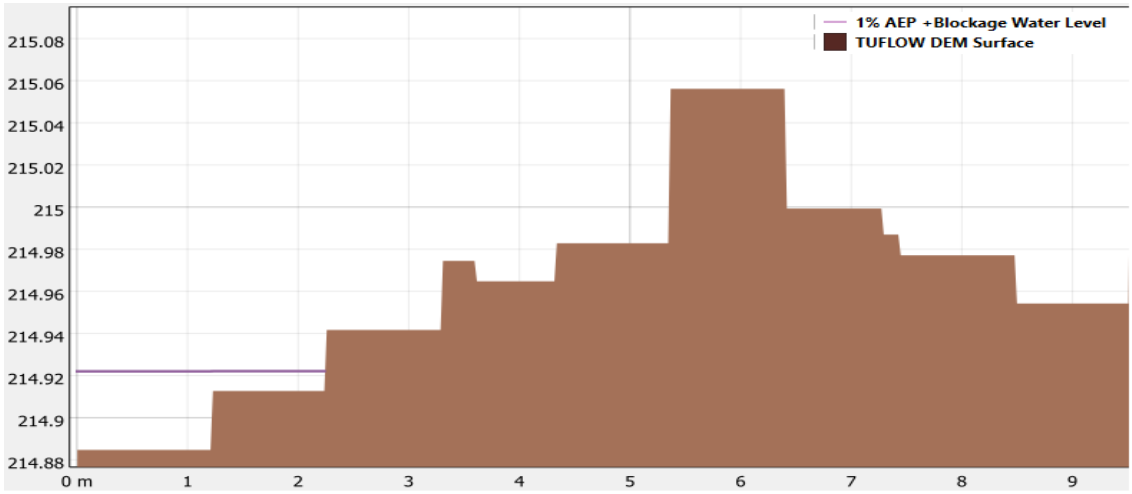


Figure 6-7: 1% AEP + Blockage Railway Immunity (CH557177) (Elevation m AHD)

6.5.2 Climate Change Risk Assessment

Climate change risk assessment was carried out by running the 1% AEP with Year 2090 RCP8.5 interim climate change factor (refer to Section 4.2.5.1 for details of the approach) and the results of flood depth, flood velocity and flood hazard can be found in Section 6.1 and Section 6.2. The corresponding flood maps can be found in Appendix A. The assessment is summarised below:

- The floodwaters do not overtop the rail line at the site location
- The overtopping further to the west of the line at Chainage 550420 is now increased

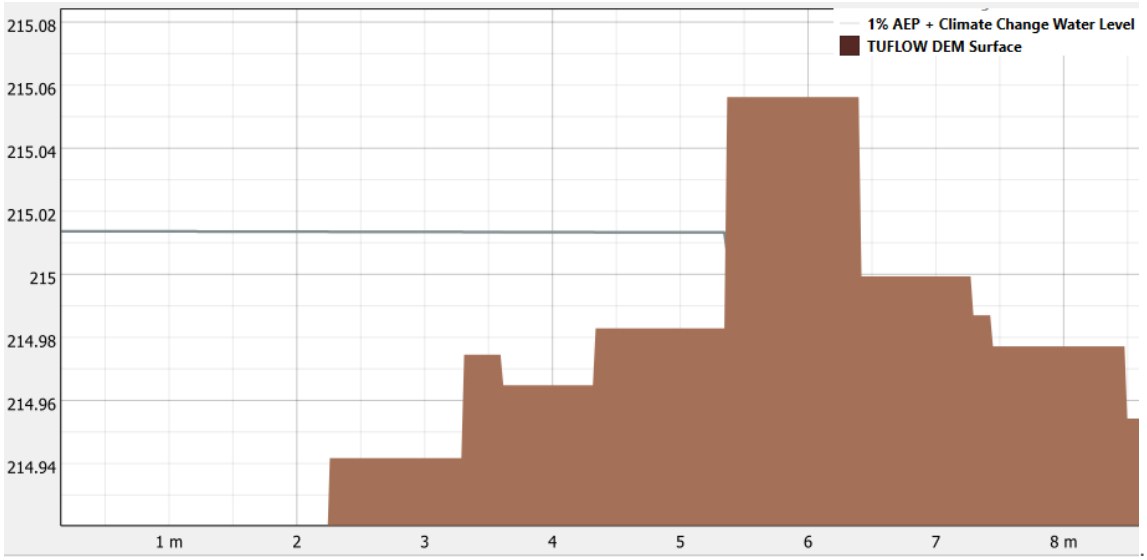


Figure 6-8: 1% AEP + Climate Change Railway Immunity (CH557177) (Elevation m AHD)

7 MITIGATION MEASURES

No mitigation measures are required as there are no non-compliances.

8 RECOMMENDATIONS

This is the final IFC stage of the report, and the followings 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 C, D, and E)

Consequently, there are no further recommendations.

APPENDICES

APPENDIX A

Flood Maps

Table 0-1: List of Maps in Appendix A

Map ID	Map description
Figure A1	5% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A2	2% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A3	1% AEP Peak Flood Depth and Levels (Existing Condition)
Figure A4	1% AEP with Climate Change Peak Flood Depth and Levels (Existing Condition)
Figure A5	PMF Peak Flood Depth and Levels (Existing Condition)
Figure A6	5% AEP Peak Flood Velocity (Existing Condition)
Figure A7	2% AEP Peak Flood Velocity (Existing Condition)
Figure A8	1% AEP Peak Flood Velocity (Existing Condition)
Figure A9	1% AEP with Climate Change Peak Flood Velocity (Existing Condition)
Figure A10	PMF Peak Flood Velocity (Existing Condition)
Figure A11	5% AEP Peak Flood Hazard (Existing Condition)
Figure A12	2% AEP Peak Flood Hazard (Existing Condition)
Figure A13	1% AEP Peak Flood Hazard (Existing Condition)
Figure A14	1% AEP with Climate Change Peak Flood Hazard (Existing Condition)
Figure A15	PMF Peak Flood Hazard (Existing Condition)
Figure A16	1% AEP Peak Flood Depth and Levels (Blockage Assessment)
Figure A17	1% AEP Peak Flood Velocity (Blockage Assessment)
Figure A18	1% AEP Peak Flood Hazard (Blockage Assessment)

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
5% AEP Flood Depth (m) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
2% AEP Flood Depth (m) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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:

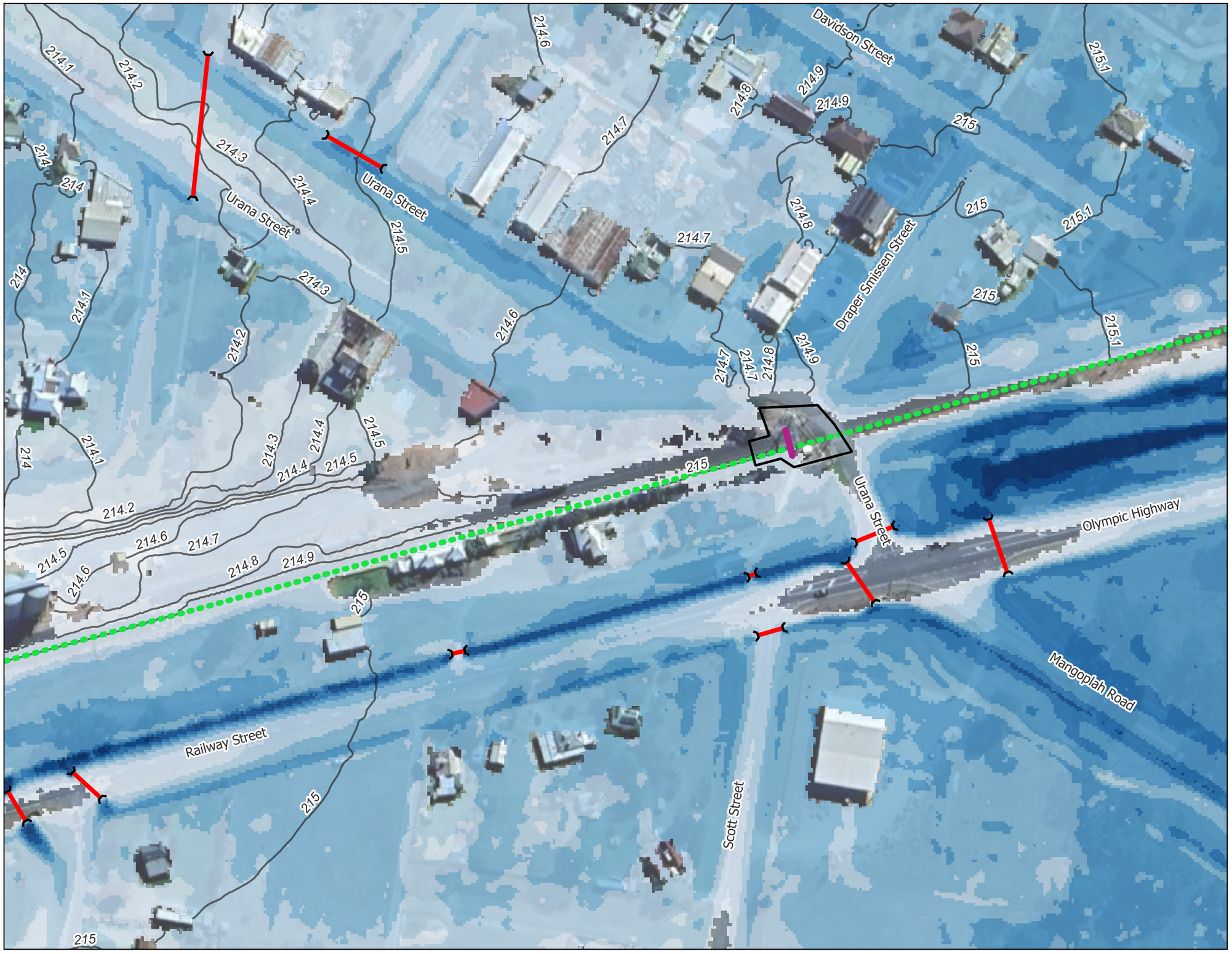
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP Flood Depth (m) - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Climate Change Flood Depth (m) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
PMF Flood Depth (m) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
5% AEP Velocity (m/s) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Velocity (m/s)

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

Notes:

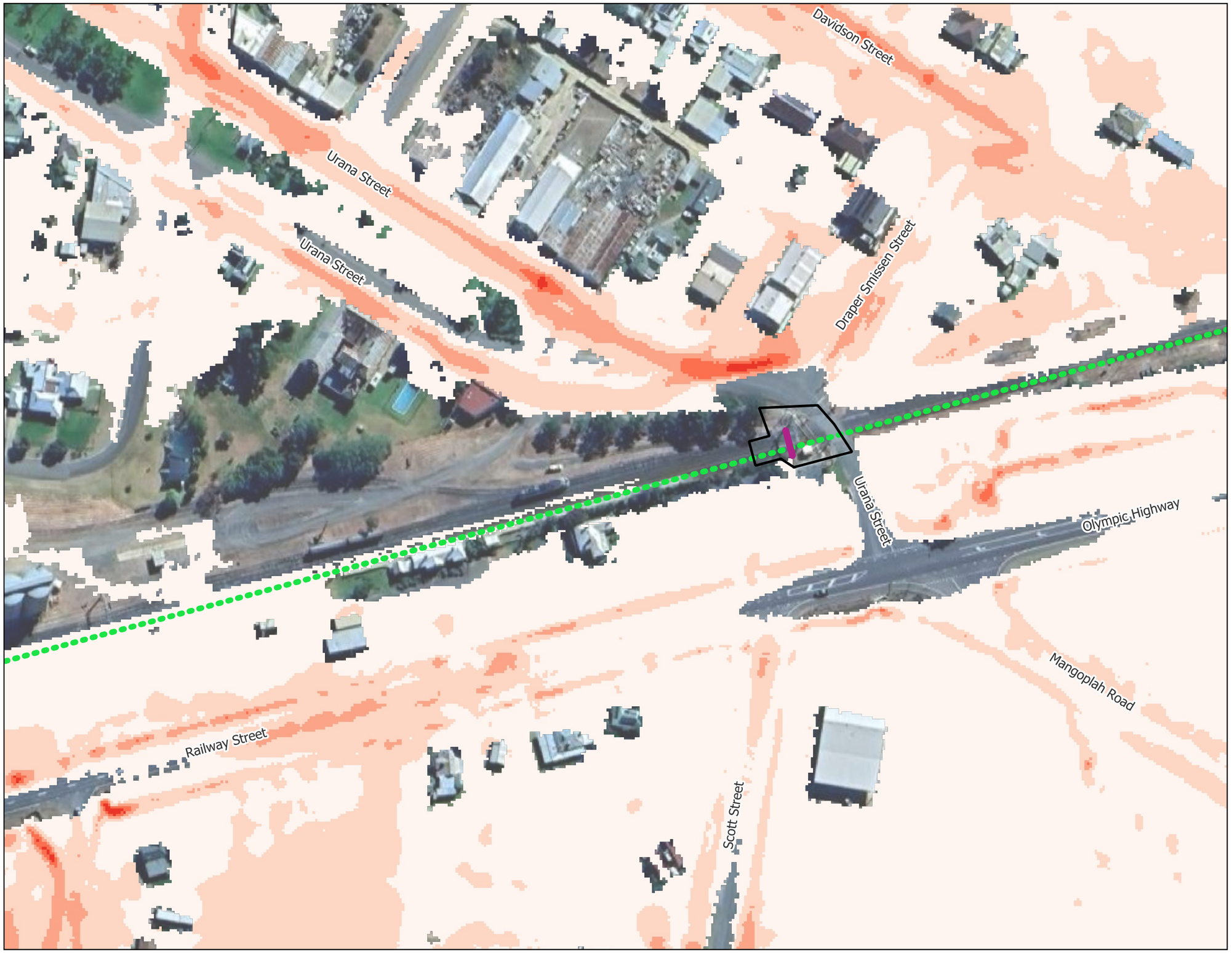
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
2% AEP Velocity (m/s) - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Velocity (m/s)

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

Notes:

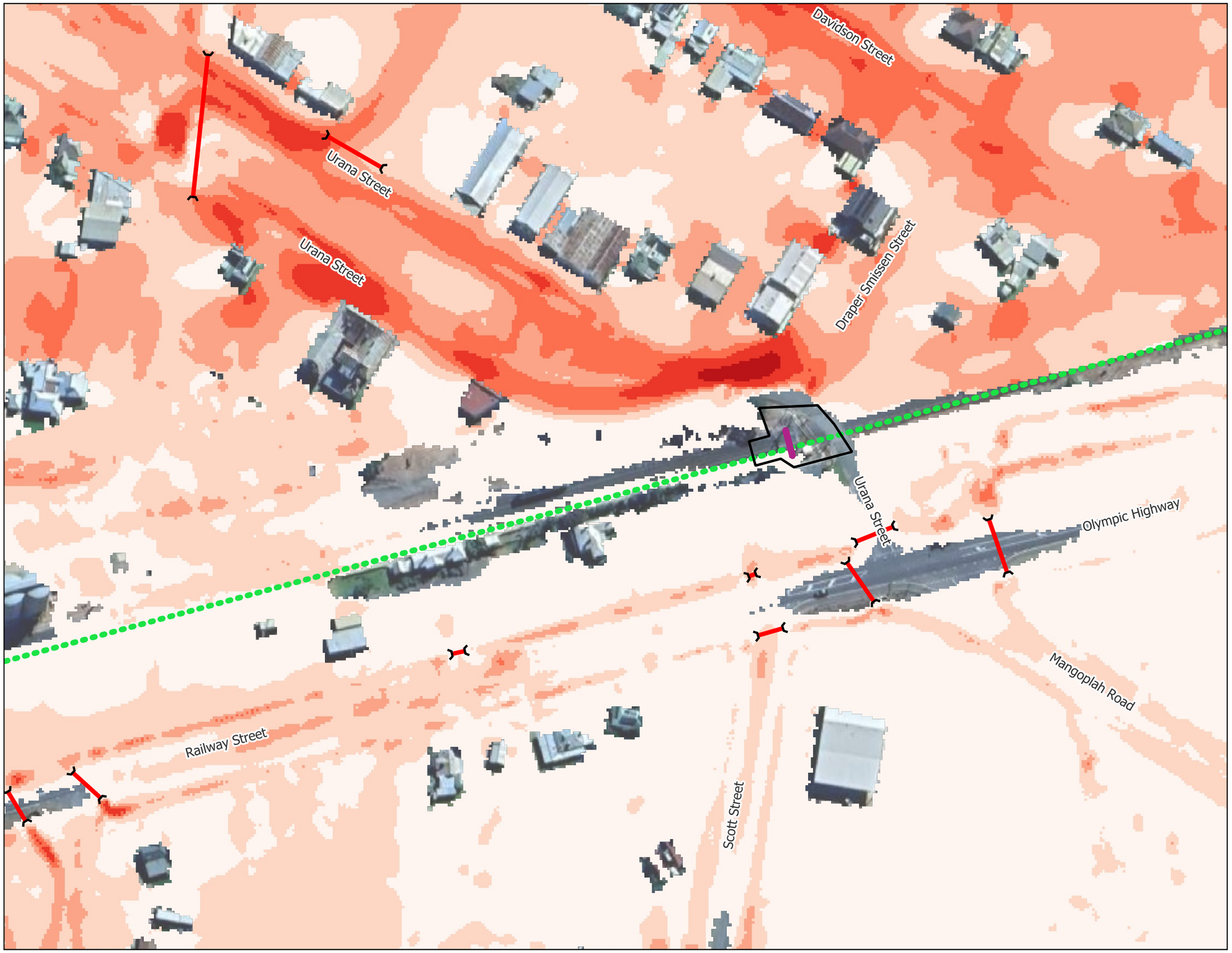
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP Velocity (m/s) - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Velocity (m/s)

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

Notes:

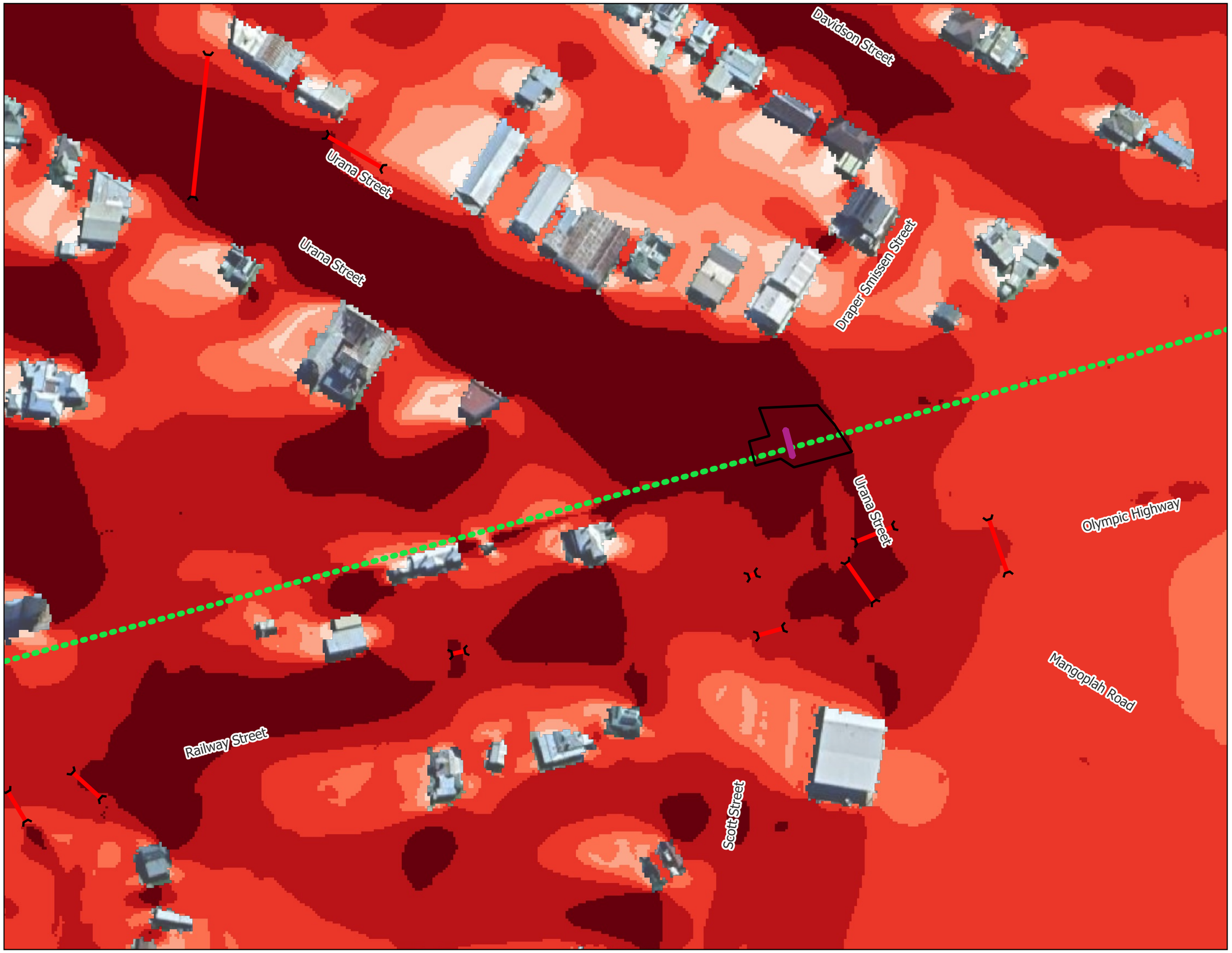
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Climate Change Velocity (m/s) - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
PMF Velocity (m/s) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
5% AEP Flood Hazard - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
2% AEP Flood Hazard - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

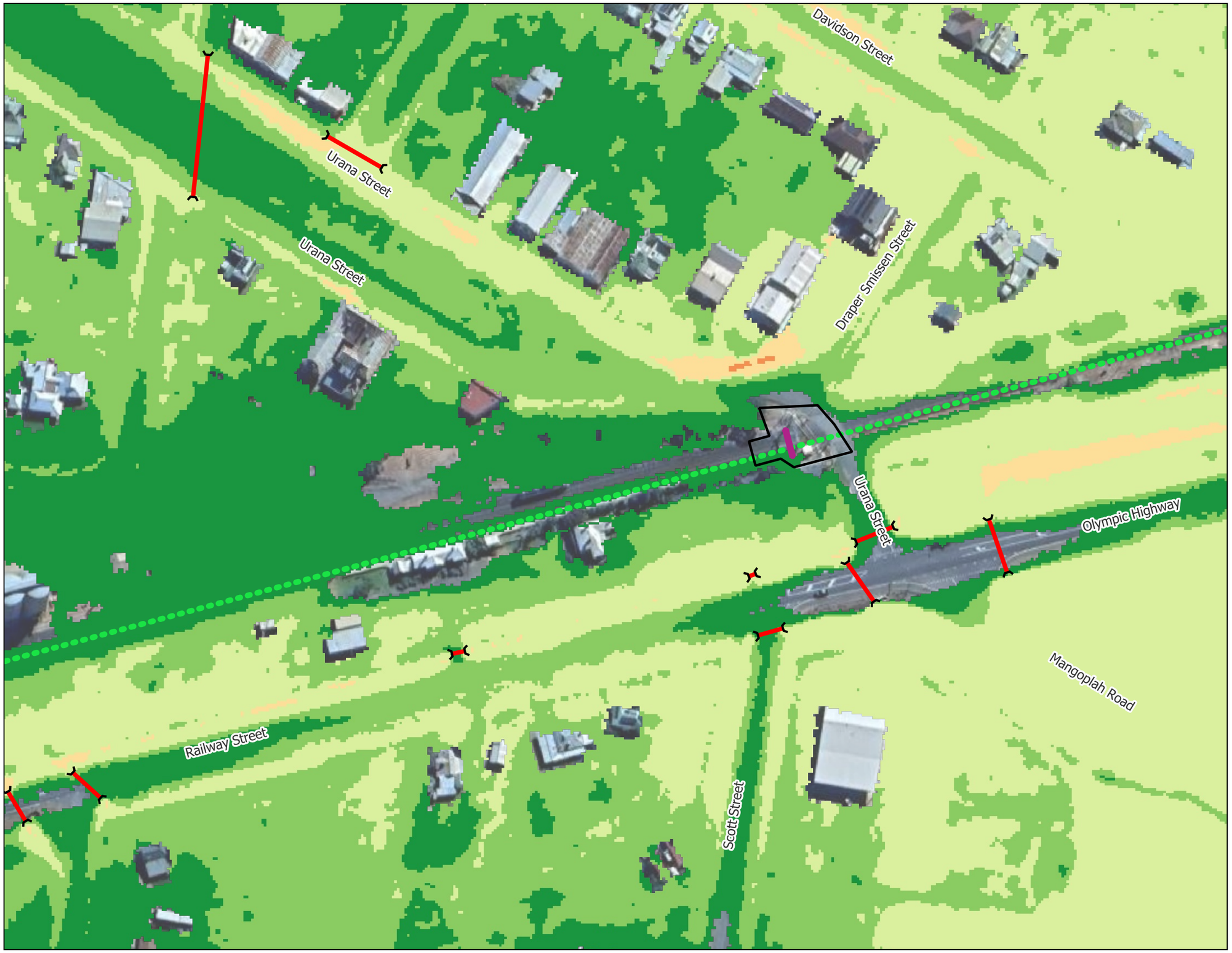
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP Flood Hazard - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

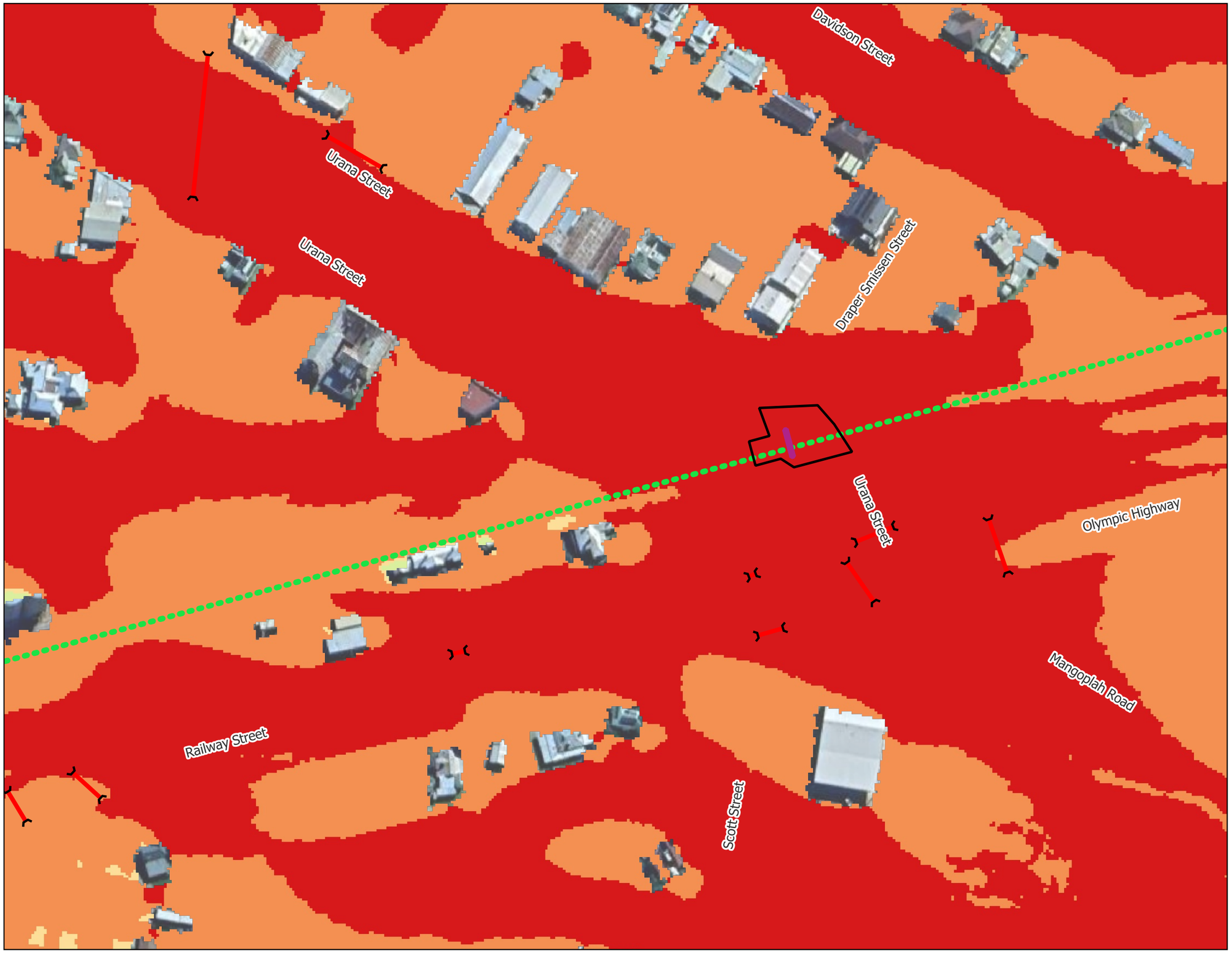
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Climate Change Flood Hazard - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

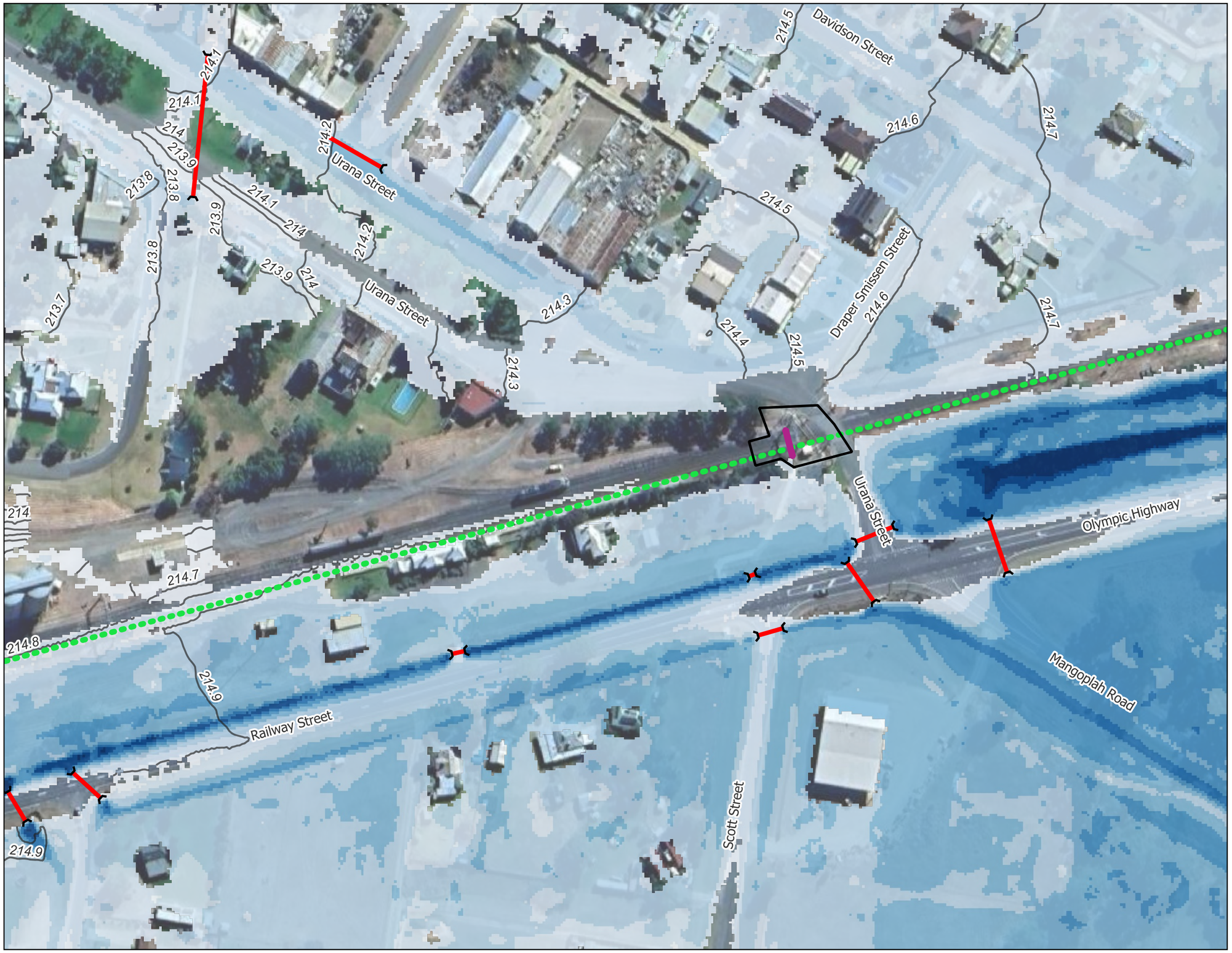
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
PMF Flood Hazard - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry
- Flood Level (m AHD)

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:

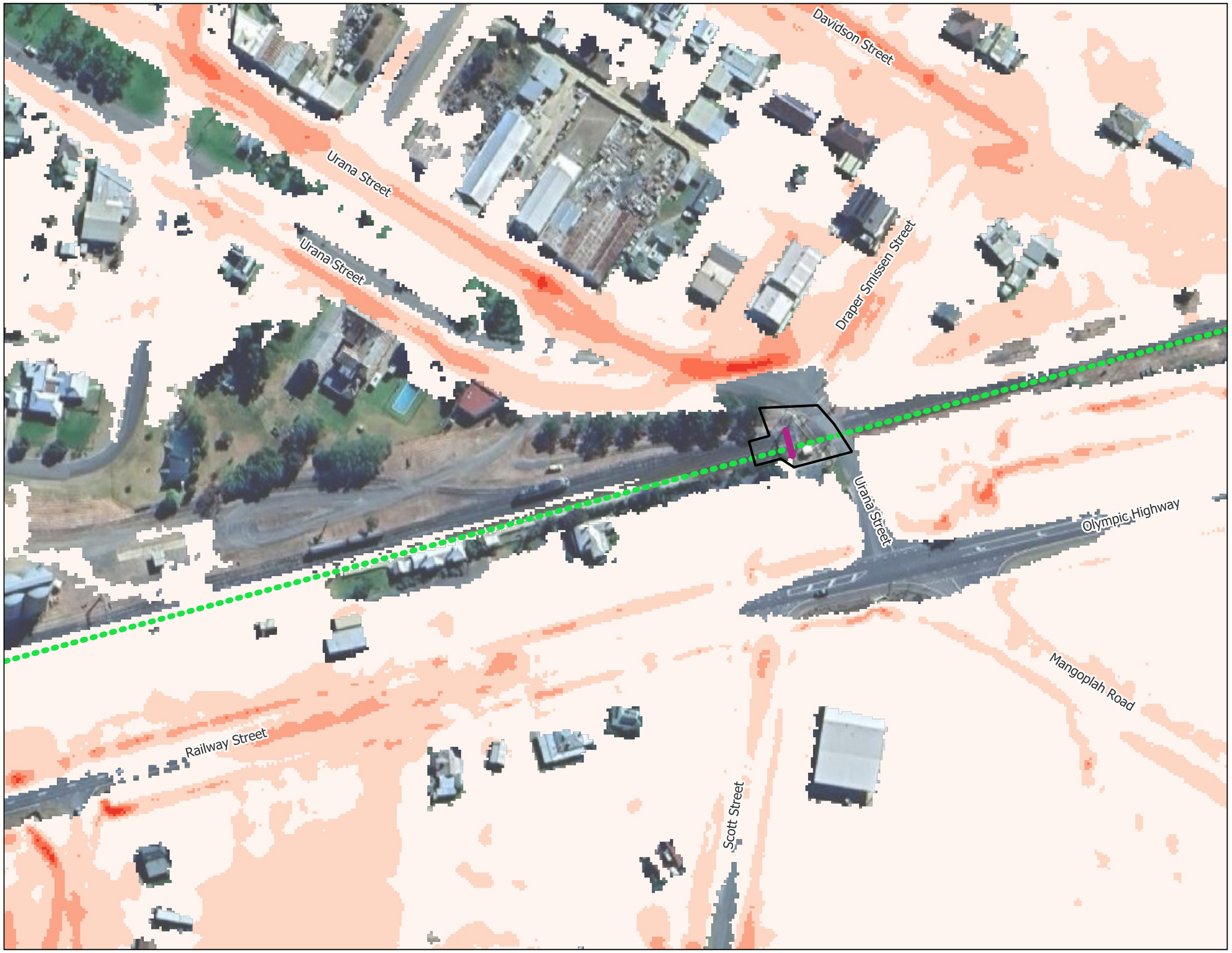
Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Blockage Flood Depth (m) - Existing Conditions



MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

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 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Blockage Velocity (m/s) - Existing Conditions

MARTINUS

aurecon BG&E

Legend

- TUFLOW Model Extent
- Project Boundary
- Rail Centreline
- Existing Drainage
- Gantry

Flood Hazard Category

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

Notes:

Map by: TT

0 50 100 m

A3 Scale: 1:1,476.949

21/1/2025 GDA2020 MGA Zone55

The Rock Yard - Inland Rail (A2P) - IFC Stage
1% AEP + Blockage Flood Hazard - Existing Conditions

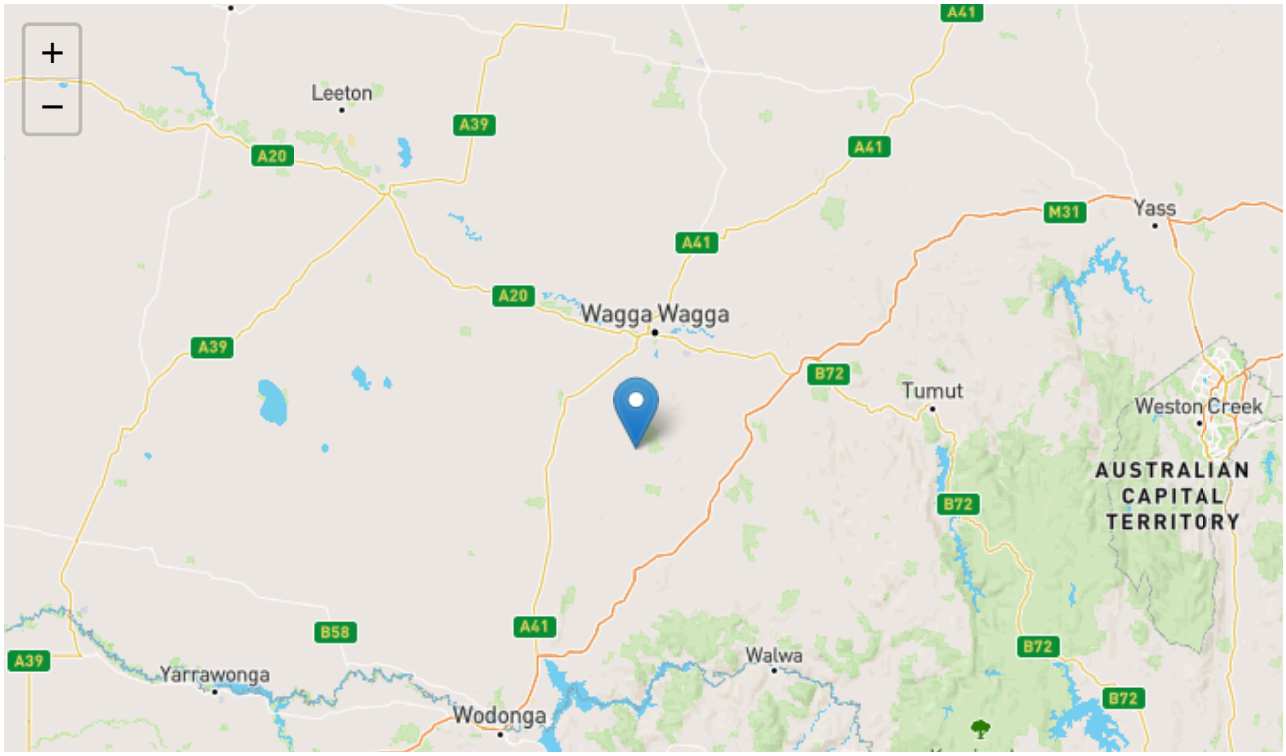
APPENDIX B

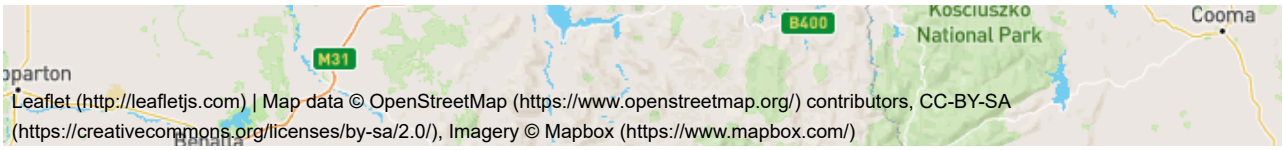
Hydrologic Data (ARR Data Hub)

Australian Rainfall & Runoff Data Hub - Results

Input Data

Longitude	147.307
Latitude	-35.406
Selected Regions (clear)	
River Region	show
ARF Parameters	show
Storm Losses	show
Temporal Patterns	show
Areal Temporal Patterns	show
BOM IFDs	show
Median Preburst Depths and Ratios	show
10% Preburst Depths	show
25% Preburst Depths	show
75% Preburst Depths	show
90% Preburst Depths	show
Interim Climate Change Factors	show
Probability Neutral Burst Initial Loss (./nsw_specific)	show
Baseflow Factors	show





Data

River Region

Division	Murray-Darling Basin
River Number	12
River Name	Murrumbidgee River

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v1

ARF Parameters

$$ARF = Min\left\{1, \left[1 - a\left(Area^{b} - c\log_{10}Duration\right)Duration^{-d} + eArea^{f}Duration^{g}\left(0.3 + \log_{10}AEP\right) + h10^{iArea\frac{Duration}{1440}}\left(0.3 + \log_{10}AEP\right)\right]\right\}$$

Zone	a	b	c	d	e	f	g	h	i
Southern Temperate	0.158	0.276	0.372	0.315	0.000141	0.41	0.15	0.01	-0.0027

Short Duration ARF

$$ARF = Min\left[1, 1 - 0.287\left(Area^{0.265} - 0.439\log_{10}(Duration)\right).Duration^{-0.36} + 2.26\ \text{x}\ 10^{-3}\ \text{x}\ Area^{0.226}.Duration^{0.125}\left(0.3 + \log_{10}(AEP)\right) + 0.0141\ \text{x}\ Area^{0.213}\ \text{x}\ 10^{-0.021\frac{(Duration-180)^{2}}{1440}}\left(0.3 + \log_{10}(AEP)\right)\right]$$

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v1

Storm Losses

Note: Burst Loss = Storm Loss - Preburst

Note: These losses are only for rural use and are **NOT FOR DIRECT USE** in urban areas

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 (./nsw_specific) is to be considered. In NSW losses are derived considering a hierarchy of approaches depending on the available loss information. The continuing storm loss information from the ARR Datahub provided below should only be used where relevant under the loss hierarchy (level 5) and where used is to be multiplied by the factor of 0.4.

ID	3687.0
Storm Initial Losses (mm)	27.0
Storm Continuing Losses (mm/h)	4.5

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v1

Temporal Patterns | Download (.zip) (static/temporal_patterns/TP/MB.zip)

code	MB
Label	Murray Basin

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v2

Areal Temporal Patterns | Download (.zip) (./static/temporal_patterns/Areal/Areal_MB.zip)

code	MB
arealabel	Murray Basin

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v2

BOM IFDs

Click here (http://www.bom.gov.au/water/designRainfalls/revised-ifd/?year=2016&coordinate_type=dd&latitude=-35.40615&longitude=147.30704&sdmin=true&sdhr=true&sdday=true&user_label=) to obtain the IFD depths for catchment centroid from the BoM website

Layer Info

Time Accessed	04 September 2024 03:26PM

Median Preburst Depths and Ratios

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	1.8 (0.089)	1.5 (0.057)	1.4 (0.043)	1.3 (0.034)	0.9 (0.020)	0.6 (0.012)
90 (1.5)	1.7 (0.078)	1.5 (0.049)	1.4 (0.037)	1.2 (0.029)	0.7 (0.014)	0.3 (0.006)
120 (2.0)	4.2 (0.170)	3.6 (0.107)	3.2 (0.080)	2.8 (0.061)	1.2 (0.023)	0.1 (0.001)
180 (3.0)	2.8 (0.103)	3.6 (0.097)	4.2 (0.094)	4.7 (0.091)	2.6 (0.043)	1.1 (0.016)
360 (6.0)	2.4 (0.072)	1.4 (0.031)	0.7 (0.014)	0.1 (0.002)	1.8 (0.024)	3.0 (0.037)
720 (12.0)	0.1 (0.001)	1.2 (0.021)	1.9 (0.029)	2.6 (0.035)	4.3 (0.049)	5.5 (0.056)
1080 (18.0)	0.0 (0.000)	0.3 (0.006)	0.6 (0.008)	0.8 (0.009)	2.6 (0.026)	3.9 (0.035)
1440 (24.0)	0.0 (0.000)	0.2 (0.003)	0.3 (0.004)	0.4 (0.005)	0.8 (0.008)	1.1 (0.009)
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)

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

10% Preburst Depths

Values are of the format depth (ratio) with depth in mm

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)

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

25% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.001)	0.0 (0.001)	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)	0.1 (0.003)	0.0 (0.001)	0.0 (0.001)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)
180 (3.0)	0.1 (0.002)	0.0 (0.001)	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)

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

75% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	13.9 (0.705)	13.1 (0.483)	12.5 (0.389)	12.0 (0.321)	13.6 (0.307)	14.9 (0.298)
90 (1.5)	13.2 (0.590)	14.6 (0.477)	15.5 (0.427)	16.4 (0.390)	12.7 (0.254)	10.0 (0.177)
120 (2.0)	16.2 (0.664)	16.3 (0.488)	16.3 (0.412)	16.3 (0.357)	12.4 (0.229)	9.5 (0.156)
180 (3.0)	11.5 (0.418)	15.6 (0.416)	18.2 (0.412)	20.8 (0.407)	20.4 (0.337)	20.1 (0.297)
360 (6.0)	15.2 (0.449)	13.7 (0.300)	12.7 (0.236)	11.8 (0.190)	18.1 (0.247)	22.8 (0.279)
720 (12.0)	5.9 (0.141)	9.1 (0.163)	11.2 (0.171)	13.3 (0.177)	18.5 (0.210)	22.5 (0.228)
1080 (18.0)	2.2 (0.047)	5.7 (0.091)	7.9 (0.109)	10.1 (0.121)	12.9 (0.131)	15.0 (0.136)
1440 (24.0)	0.3 (0.006)	3.9 (0.058)	6.2 (0.079)	8.5 (0.094)	10.3 (0.097)	11.6 (0.098)
2160 (36.0)	0.0 (0.000)	1.2 (0.016)	2.0 (0.023)	2.7 (0.027)	3.4 (0.029)	3.9 (0.030)
2880 (48.0)	0.0 (0.000)	0.2 (0.003)	0.4 (0.004)	0.6 (0.005)	1.4 (0.011)	2.0 (0.014)
4320 (72.0)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.0 (0.000)	0.1 (0.001)	0.2 (0.001)

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

90% Preburst Depths

Values are of the format depth (ratio) with depth in mm

min (h)\AEP(%)	50	20	10	5	2	1
60 (1.0)	27.0 (1.374)	24.1 (0.892)	22.2 (0.690)	20.4 (0.545)	24.9 (0.560)	28.3 (0.566)
90 (1.5)	30.4 (1.358)	33.7 (1.102)	35.9 (0.988)	38.1 (0.903)	32.8 (0.655)	28.8 (0.512)
120 (2.0)	38.0 (1.558)	35.2 (1.057)	33.3 (0.844)	31.6 (0.690)	33.5 (0.618)	34.9 (0.574)
180 (3.0)	26.4 (0.956)	29.6 (0.789)	31.7 (0.714)	33.7 (0.658)	39.5 (0.652)	43.8 (0.646)
360 (6.0)	37.1 (1.095)	34.5 (0.754)	32.7 (0.607)	31.0 (0.500)	45.2 (0.619)	55.8 (0.684)
720 (12.0)	16.2 (0.391)	24.8 (0.445)	30.5 (0.466)	35.9 (0.478)	39.3 (0.445)	41.9 (0.425)
1080 (18.0)	14.1 (0.302)	17.8 (0.286)	20.2 (0.277)	22.6 (0.269)	29.1 (0.295)	34.0 (0.309)
1440 (24.0)	11.1 (0.221)	15.9 (0.237)	19.1 (0.242)	22.1 (0.244)	23.5 (0.222)	24.6 (0.208)
2160 (36.0)	3.7 (0.066)	10.1 (0.136)	14.3 (0.165)	18.4 (0.185)	17.0 (0.145)	15.9 (0.122)
2880 (48.0)	0.9 (0.014)	6.2 (0.079)	9.8 (0.105)	13.2 (0.124)	20.4 (0.164)	25.9 (0.186)
4320 (72.0)	0.3 (0.005)	2.9 (0.034)	4.6 (0.046)	6.3 (0.055)	15.0 (0.112)	21.5 (0.144)

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2018_v1
Note	Preburst interpolation methods for catchment wide preburst has been slightly altered. Point values remain unchanged.

Interim Climate Change Factors

	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%)**

Layer Info

Time Accessed	04 September 2024 03:26PM
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.

Probability Neutral Burst Initial Loss

min (h)\AEP(%)	**50.0**	**20.0**	**10.0**	**5.0**	**2.0**	**1.0**
60 (1.0)	19.7	11.4	10.8	11.8	11.3	9.7
90 (1.5)	19.4	11.5	10.4	10.7	10.2	9.8
120 (2.0)	18.0	11.1	10.4	10.9	10.9	9.7
180 (3.0)	19.3	12.6	11.0	11.2	10.1	7.7
360 (6.0)	18.3	13.2	12.7	13.9	11.7	7.6
720 (12.0)	22.5	16.7	15.1	15.0	12.3	8.5
1080 (18.0)	23.8	18.6	18.0	18.0	15.5	10.0
1440 (24.0)	24.9	19.7	19.1	19.3	17.2	12.2
2160 (36.0)	26.4	21.8	21.6	22.2	20.1	16.9
2880 (48.0)	27.5	23.0	23.1	23.6	21.3	14.8
4320 (72.0)	28.0	23.6	24.5	25.0	22.7	16.3

Layer Info

Time Accessed	04 September 2024 03:26PM
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 (./nsw_specific) 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.

Baseflow Factors

Downstream	10746
Area (km2)	709.414976
Catchment Number	10798
Volume Factor	0.283123
Peak Factor	0.049495

Layer Info

Time Accessed	04 September 2024 03:26PM
Version	2016_v1

Download TXT (downloads/d26e553c-2c16-4209-9d96-7d7f33a9f659.txt)

Download JSON (downloads/5ecdb814-7cb0-4569-9a01-adfa51bdbdef.json)

Generating PDF... (downloads/98e2e2c2-4b43-4d4a-87ce-ba7fd711db44.pdf)

APPENDIX C

ARTC Review

Document Control Information			
	Contractor DC to update for re-submission	**Submitted Document No. or Transmittal No.:**	Martinus-PTRAN-000705
Project:	2100 - A2I	**Date Submission Received:**	26/11/2024
Comment Sheet Number_Revision:	5-0052-210-IHY-G4-CS-0001_C	**Comment Sheet Title:**	***External Comment Sheet - A2I | Flood Design Report - The Rock Yard***
Revision Date:	7/01/2025	**Documents related in Aconex** (by IR DC)	*Yes*

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*	*0-0000-900-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-0015-C*	*Jane Doe*	*27/09/2023*	CLOSED	
1		5-0052-210-IHY-G4-RP-0001_A.pdf	Page 20, 4.1.1 Hydrology Model Comparison	DDR	Some formatting issues need to be addressed.	Opportunity	Hartley Bulcock	26/09/2024	Malinda Gunasekera/Jasmine Lee	DJV	25/11/2024	Noted. This will be updated in the report for the IFC stage.		Stephen Brierley	5/01/2025	CLOSED	
2	Opportunity	5-0052-210-IHY-G4-RP-0001_A.pdf	Page 24, 5-0052-210-IHY-G4-RP-0001_A, Section 4.2.5.1	DDR	It is mentioned here that existing WBNM model has been employed for 1% AEP with climate change flow. However, it appears from previous sections that RORB model has been utilised for other cases. Therefore, a clarification is required why the same hydrologic model has not been used for all scenarios.	Opportunity	Ayub Ali	19/09/2024	Malinda Gunasekera/Jasmine Lee	DJV	25/11/2024	This is a typo. The same RORB hydrology model was used for all design events. This will be corrected in the report for the IFC stage.		Stephen Brierley	5/01/2025	CLOSED	

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 D

External Stakeholder Review

Attachment 1: A2I Flood Design Report CONSULTATION - COMMENTS REGISTER

Stakeholder Category	Stakeholder Name	Flood Design Report name	Document reference (e.g.	Date raised	Topic that comment relates to	Comments	Full Name	Company & Role	Date	Response	Documentation Section # / Figure #
State Government Agency	TfNSW	S-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation S-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation S-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation S-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation S-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Whole document	14/11/2024	Administrative	Multiple cross-referencing links are broken in the reports. TfNSW assumes administrative errors such as these will be corrected.	Zoe Cruice	Martinus - Engineering Manager	29/11/2024	Noted. Apologies. These will be fixed to hyperlink and reference correctly.	Rev 0 reporting
State Government Agency	TfNSW	S-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation S-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation S-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation S-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation S-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Blockage Assessment section of each report	14/11/2024	Blockage assumptions	All assessments adopted a site-specific blockage, but a consistent 20% blockage for all culverts outside of the project area. What informed this assumption? If the purpose was to assess ARR2019 blockage guidelines, TfNSW suggests that the blockage rates for all culverts should be informed by this guidance as even off-site culverts have the potential to influence flows within the sites.	Yucen Lu	DJV Flood Modeller	3/12/2024	A technical memo has been provided to provide explanation and justification of the proposed approach. Please review this memo (S-0052-210-IHY-99-ME-0001) and advise if the blockage assessment and assumptions are acceptable.	Technical Memo
State Government Agency	TfNSW	S-0052-210-IHY-G1-RP-0001_A.1 Flood Design Report - Culcairn Yard - For Consultation S-0052-210-IHY-G2-RP-0001_A.1 Flood Design Report - Henty Yard - For Consultation S-0052-210-IHY-G4-RP-0001_A.1 The Rock Yard - Flood Design Report - For Consultation S-0052-210-IHY-W1-RP-0001_A.1 Flood Design Report - Uranquinty Yard - For Consultation S-0052-210-IHY-W9-RP-0001_A.1 Bomen Yard Flood Design Report - For Consultation	Blockage Assessment section of each report	14/11/2024	Blockage assumptions	Why was the ARR2019 blockage guidance not included in the design runs? One of the compliance requirements is that all modelling be undertaken in line with this guidance. The design runs have not been undertaken with this blockage guidance incorporated. A typical blockage sensitivity test would have been to include the ARR2019 blockage guidance in the design runs, and then to assess higher and/or lower rates of blockage as necessary.	Yucen Lu	DJV Flood Modeller	3/12/2024	A technical memo has been provided to provide explanation and justification of the proposed approach. Please review this memo (S-0052-210-IHY-99-ME-0001) and advise if the blockage assessment and assumptions are acceptable.	Technical Memo

APPENDIX E

Independent Flood Consultant Review

APPENDIX E1

Consultant Comments

Project: 2300 **Deliverable:** The Rock Yard

Comment Sheet Reference: 5-0052-210-IHY-G4-CS-0001-PE_D

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 fully qualified reference the deliverable is non-compliant with)	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-G4-RP-0001_A	TUFLOW files	Hatch	Dan Williams	Flood Assessment	22/11/2024	DDR	No comments		Minor	Zoe Cruice	Engineering Manager	3/12/2024	Noted.		Darren Lyons	Hatch	6/12/2024	CLOSED	No further comments
2	5-0052-210-IHY-G4-RP-0001_0		Hatch	Dan Williams	Flood Assessment	13/02/2025	IFC	No further comments			Zoe Cruice	Engineering Manager	3/12/2024	Noted.		Darren Lyons	Hatch	13/02/2025	CLOSED	No further comments

APPENDIX E2

Continued Certification Statement

Zoe Cruice

From: Daniel Williams <dan@torrentconsulting.com.au>
Sent: Friday, 23 May 2025 8:54 AM
To: Zoe Cruice
Cc: Mullard, John
Subject: RE: Flood Design Report - The Rock Yard

Hi Zoe,

Yes, that is fine. It does not impact our prior certification and the choice of updated wording is good.

Thanks,
Dan

Dan Williams
Director

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

From: Zoe Cruice <zoe.cruice@martinus.com.au>
Sent: Thursday, 22 May 2025 10:57 PM
To: Daniel Williams <dan@torrentconsulting.com.au>
Cc: Mullard, John <john.mullard@hatch.com>
Subject: FW: Flood Design Report - The Rock Yard

Hi Daniel,

One of our conditions of the project approvals is to consult with local councils and other agencies on the flood design reports.

We received a comment back from the Council on The Rock Yard FDR, regarding some clarity around the prior (by Others) flood model:

1. Section 1.6.1 on Prior Flood Studies notes the prior WMAWater Flood model:
   "This flood study provided hydrologic and hydraulic assessments and information regarding flood behaviour in the local area, as well as some information regarding hydraulic structures in the area. The hydrologic modelling had been undertaken using ARR1987 and so this information was used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1). The information regarding hydraulic information in the flood study (culvert details) was adopted where relevant."
2. Section 1.11 on Limitation notes:
   "The hydraulic and hydrologic model and results of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable."

This wording produced some confusion for the reviewer as to whether the model was actually used and available or not. We have proposed to amend the wording of Section 1.11 to read: *"The hydraulic*

and hydrologic models of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable. However, the results were available as part of the report and figures within this report were used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1) and hydraulic modelling (See Section 5).”

May you please confirm that this does not impact your prior certification of the IFC report? You can confirm by either:

1) Issuance of another certificate, referencing Rev 1 report review, or
2) Reply to this email thread with a positive statement as to the continued applicability of the Rev 0 certification.

The amended Rev 1 report is saved here: 250523_G4 - The Rock Flood Design Report IFC Rev 1

Revision History

REVISION	REVISION DATE	AMENDMENT	DATE TO CLIENT
A	17/092024	DDR Issue for review	17/09/2024
A.1	25/10/2024	Updated for Consultation	25/20/2024
0	23/01/2025	IFC issue for Construction	23/01/2025
1	23/05/2025	IFC update for consultation review comments. Amendment to wording in Section 1.11 to clarify prior flood study graphics and report maps were used, but the model was not available.	23/05/2025

1.11 Limitations and Assumptions

The following limitations and assumptions are applied to The Rock Yard site.

- The hydraulic and hydrologic models of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable. However, the results were available as part of the report and figures within this report were used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1) and hydraulic modelling (See Section 5).
- For some culverts outside the project boundary where information was not available, the culvert details were assumed based on aerial imagery and LiDAR.
- In the absence of detailed survey of the bridge structure across Burkes Creek at Ford Street, this was modelled as a layered flow constriction with blockage parameters assumed to represent pier dimensions.
- The allowable threshold for flood impacts was adopted from the Conditions of Approval (CoA)
- The TUFLOW hydraulic model has not been calibrated or validated based on historical data.
- An assessment of temporary works and staging has not been undertaken.
- 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 Practise Section 10 Flooding, the 1% AEP shall be used.
- Blockage assessment is carried out for the 1% AEP design scenario as per the guidance set out in ARR2019 for the culverts within project boundary while 20% blockage is adopted for all the other culverts, pit and pipes outside the project boundary. Refer also to the Technical Memo provided on blockage analysis: 5-0052-210-IHY-99-ME-0001.

Cheers
Zoe

I'm sending you this message now because it's a good time for me, but do not expect you to read, respond or action it outside your regular hours.

Zoe Cruice
Head of Engineering & Technology
Growth Team
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zoe.cruice@martinus.com.au
Australia | New Zealand | Chile
SAVE CONTACT

From: Simon Fisher <simon.fisher@martinus.com.au>
Sent: Thursday, 22 May 2025 9:31 AM
To: Zoe Cruice <zoe.cruice@martinus.com.au>; Chris Standing <chris.standing@martinus.com.au>
Cc: Nichole Darke <Nichole.Darke@martinus.com.au>
Subject: Re: Flood Design Report - The Rock Yard

I think that revised statement is much clearer

Regards,

Simon Fisher
Design and Approvals Support
Inland Rail - A2P

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SAVE CONTACT

From: Zoe Cruice <zoe.cruice@martinus.com.au>
Sent: Wednesday, 21 May 2025 8:59 PM
To: Simon Fisher <simon.fisher@martinus.com.au>; Chris Standing <chris.standing@martinus.com.au>
Cc: Nichole Darke <Nichole.Darke@martinus.com.au>
Subject: FW: Flood Design Report - The Rock Yard

Hi Simon,

Our flood modeller has provided clarity: both statements are in fact true, and the subtly of it lies in the use of the word 'model'.

The actual model was not available to us, but the findings and maps and graphics of the study were. So, the study results were used to check our results, but the actual study-*model* was not used – as it wasn't available.

Does that make sense? Yucen has suggested amending the wording in Section 1.11 to read: *"The hydraulic and hydrologic models of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable. However, the results were available as part of the report and figures and these were used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1) and hydraulic modelling (See Section 5)."*

Would this help improve the clarity on this?

Cheers
Zoe

I'm sending you this message now because it's a good time for me, but do not expect you to read, respond or action it outside your regular hours.

Zoe Cruice
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SAVE CONTACT

From: Yucen Lu <Yucen.Lu@aurecongroup.com>
Sent: Wednesday, 21 May 2025 7:02 PM
To: Zoe Cruice <zoe.cruice@martinus.com.au>; Jasmine Lee <Jasmine.Lee@aurecongroup.com>
Cc: Simon Fisher <simon.fisher@martinus.com.au>; Max Koschmann <max.koschmann@bgeeng.com>; Michal Plesko <michal.plesko@bgeeng.com>
Subject: RE: Flood Design Report - The Rock Yard

Hi Zoe,
Those two statements are correct. We used the results from the WMAwater Flood Study instead of the model as we did not receive the model. The results are extracted from the flood study (tables/figures).

Based on this, the following changes can be made to the words within Section 1.11:

"The hydraulic and hydrologic models of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable. However, the results were available as part of the report and figures and these were used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1) and hydraulic modelling (See Section 5)."

Thanks.
Regards,

Yucen Lu B.Eng(Hydropower) M.Eng(Coastal) Ph.D (Hydrodynamics) CPEng NER
Senior Engineer, Water Resources, Aurecon

From: Zoe Cruice <zoe.cruice@martinus.com.au>
Sent: Monday, 19 May 2025 3:51 PM
To: Jasmine Lee <Jasmine.Lee@aurecongroup.com>; Yucen Lu <Yucen.Lu@aurecongroup.com>
Cc: Simon Fisher <simon.fisher@martinus.com.au>; Max Koschmann <max.koschmann@bgeeng.com>; Michal Plesko <michal.plesko@bgeeng.com>
Subject: FW: Flood Design Report - The Rock Yard

Hi Jasmine, Yucen,

An external reviewer of The Rock Flood Design Report has noted that:

1. Section 1.6.1 on Prior Flood Studies notes the prior WMAWater Flood model:

"This flood study provided hydrologic and hydraulic assessments and information regarding flood behaviour in the local area, as well as some information regarding hydraulic structures in the area. The hydrologic modelling had been undertaken using ARR1987 and so this information was used as a point of reference for comparison in the development of the hydrologic modelling (See Section 4.1.1). The information regarding hydraulic information in the flood study (culvert details) was adopted where relevant."

2. Section 1.11 on Limitation notes:

"The hydraulic and hydrologic model and results of the previous flood study (The Rock Flood Study (WMA Water, 2014)) are currently unavailable."

So can you clarify which is correct? And which should be amended? Did we have and use the prior WMAWater hydraulic and hydrologic info? Or not.

Cheers
Zoe

I'm sending you this message now because it's a good time for me, but do not expect you to read, respond or action it outside your regular hours.

Zoe Cruice
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SAVE CONTACT

From: Simon Fisher <simon.fisher@martinus.com.au>
Sent: Monday, 19 May 2025 3:05 PM
To: Zoe Cruice <zoe.cruice@martinus.com.au>
Cc: Chris Standing <chris.standing@martinus.com.au>
Subject: Fw: Flood Design Report - The Rock Yard

Hi Zoe,

Comments back from Lockhart Council on The Rock FDR, one minor inconsistency. Can we update and reissue.

Regards,

Simon Fisher
Design and Approvals Support
Inland Rail - A2P

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SAVE CONTACT

From: Matthew Holt <mholt@lockhart.nsw.gov.au>
Sent: Monday, 19 May 2025 2:37 PM
To: Simon Fisher <simon.fisher@martinus.com.au>
Cc: Chris Standing <chris.standing@martinus.com.au>; grhodes <grhodes@lockhart.nsw.gov.au>; Austin Morris <amorris@lockhart.nsw.gov.au>; Jesse Rapley <jrapley@lockhart.nsw.gov.au>
Subject: RE: Flood Design Report - The Rock Yard

Hi Simon
Thanks again for the opportunity to provide feedback

We have provided two small comments on the register, which are also below.

Can council be notified when the model is publicly published?
Table 1.2 says Hydraulic and hydrologic models from WMA water were used. Sec 1.11 says they were unavailable.

Any questions, please let me know

Kind regards
Matt

Matt Holt
Manager Communications, Tourism and Economic Development
Our Values: Leadership • Integrity • Progressiveness • Commitment • Accountability • Adaptability

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Council Website • Tourism Website

From: Simon Fisher <simon.fisher@martinus.com.au>
Sent: Thursday, 15 May 2025 3:06 PM
To: Matthew Holt <mholt@lockhart.nsw.gov.au>

Cc: Chris Standing <chris.standing@martinus.com.au>
Subject: Flood Design Report - The Rock Yard

Hi Matt,

Thanks for your time on the phone earlier today. As mentioned it has just come to my attention that the Flood Design Report for The Rock Yard which we thought we had issued in November last year was never actually issued to Lockhart Council for consultation.

As mentioned on the phone I am now seeking to rectify this issue and am seeking your feedback on the report as soon as reasonably possible. A copy of the report and comment register is available at the link below.

04. Lockhart Council

We are also happy to facilitate a workshop to address any questions or comments that you may have following review of the document.

Please don't hesitate to reach out directly if you have any questions.

Regards,

Simon Fisher
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