Independent International Panel of Experts for Flood Studies of Inland Rail in Queensland

Final Report

September 6, 2022

Document History

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Abbreviations and Definitions

Abbreviation/Terminology	Meaning/Definition
AEP	Annual exceedance probability
ARR 2019	Australian Rainfall and Runoff: A Guide to Flood Estimation, current edition
ARTC	Australian Rail Track Corporation Ltd
B2G	Border to Gowrie section
CCC	Community Consultative Committee
CSSI	Critical State significant infrastructure under NSW Environmental Planning & Assessment Act 1979
D&C	Design and construct
DSDTI	Queensland Department of State Development, Tourism and Innovation
DTMR	Queensland Department of Transport and Main Roads
EIS	Environmental Impact Statement
FDR	Feasibility Design Report
FFA	Flood frequency analysis
FIO	Flood impact objective
G2H	Gowrie to Helidon section
H2C	Helidon to Calvert section
IMR	Issues Management Register
JWG	The Joint Working Group of DTMR and IA
LGA	Local government area
LiDAR	Light Detection and Ranging, a method of remote airborne laser scanning
NS2B	North Star to Border section
OCG	Office of the Queensland Coordinator General, DSDTI
PIR	Preferred Infrastructure Report
PMF	Probable Maximum Flood
PPP	Public private partnership
QDL	Quantitative design limits, from other sections of Inland Rail
QR	Queensland Rail

Abbreviation/Terminology	Meaning/Definition
TOR	Terms of reference
ToS	Time of submergence
TRC	Toowoomba Regional Council

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Executive Summary

Background

The Inland Rail route in Queensland crosses diverse terrain, including the Macintyre, Condamine and Bremer River floodplains and numerous catchments including the Macintyre Brook/Canning Creek, Gowrie, Westbrook and Oakey Creeks, Lockyer Creek, Western Creek, Warrill and Purga Creeks and Teviot Brook.

Community safety and the potential for Inland Rail to change and impact on flood behaviour is a key concern of many stakeholders along the Inland Rail route. The Commonwealth has tasked the Australian Rail Track Corporation (ARTC) with the delivery and operation of Inland Rail. In Queensland, this requires the cooperation of the State of Queensland (State) to regulate the effective approval of the design, construction and operation of Inland Rail.

In developing the Inland Rail project, ARTC is required to comply with State planning and environmental approval requirements. The Queensland Coordinator-General (OCG) has declared the Border to Gowrie (B2G), Gowrie to Helidon (G2H), Helidon to Calvert (H2C), and Calvert to Kagaru (C2K) project sections to be coordinated projects subject to Environmental Impact Statements (EIS).

To inform the development of the respective Reference Designs for each of the project sections and meet the relevant EIS Terms of Reference (TOR), ARTC has prepared a detailed assessment of hydrologic and hydraulic impacts to ensure it has appropriate environmental and safety protections in place, as well as adequate mitigation to minimise any potential impacts.

An Independent International Panel of Experts for Flood Studies of Inland Rail in Queensland (*the Panel*) has been established to advise the Commonwealth and Queensland governments on matters in regard to the extent, interpretation, assumptions and application of flood modelling, as well as best practice for the design of waterway structures in a floodplain environment. The role and work of the Panel is to review the existing modelling as defined by the TOR established by the two governments following a period of public comment. The Panel's TOR is available at: https://www.tmr.qld.gov.au/projects/inland-rail/independent-panel-of-experts-for-flood-studies-in-queensland.

The Panel comprises Mark Babister, (WMAwater, Chair), Ferdinand Diermanse (Deltares), Tina O'Connell (HDR), Martin Giles (BMT) and Steve Clark (Water Technology).

Final Report

This report presents the outcomes of the Panel's review of the flood models and Reference Designs developed by ARTC for the B2G, G2H, H2C and C2K project sections. This report brings together and addresses the findings of the Panel's initial draft reports for each of the project sections.

ARTC has undertaken a substantial amount of work to identify existing flooding characteristics and to assess and mitigate potential impacts associated with the four project sections. This work includes responding to the issues raised by the Panel in its respective draft reports that are publicly available at:

https://www.tmr.qld.gov.au/projects/inland-rail/independent-panel-of-experts-for-flood-studies-in-queensland.

ARTC has responded to all issues raised in the draft reports with either (or a combination of):

- Providing additional information which addressed the queries raised;
- Completing additional work to address issues and committing to incorporating the revised results in future documentation (specifically Revised Draft EIS documentation);
- Committed to undertaking additional works to address the Panel's comments and incorporating the results in future documentation (specifically Revised Draft EIS documentation); and
- Recommending that some issues raised be dealt with at Detailed Design stage

A detailed summary of these issues and ARTC responses is presented in the Issues Management Register (IMR) at Appendix A to Appendix D.

Panel Findings

The Panel concludes that the review process has been a constructive process with tangible outcomes. The overall process has also allowed interested stakeholders to provide input through the Community Consultative Committee (CCC) meetings and to provide direct input to the Panel.

In reviewing the work by ARTC, including flood models, Reference Designs and responses to issues raised in the draft reports, the Panel notes the substantial amount of work undertaken by ARTC to identify existing flooding characteristics and to assess and mitigate potential impacts associated with each of the project sections.

Taking into consideration the additional information provided by ARTC, the Panel found ARTC's modelling framework *to be in accordance with both national guidelines and current industry best practice with the issues in the IMR to be addressed.*

Significant infrastructure projects, like Inland Rail, are accomplished through an iterative process. As such, it is normal practice for iterative improvements and changes to occur through the various project design and approval stages. Therefore, it is normal for issues associated with the design to be identified throughout the project, such as those identified by the Panel and for them to be progressively addressed at the relevant stage of the project.

Consistent with the above, the Panel has identified a number of issues in the IMR where ARTC has agreed to provide additional information in the respective Revised Draft EIS or address the issue during the subsequent design stages of the project.

Findings specific to the Panel's TOR

The Panel findings with respect to the outputs specified in the Panel's TOR for the reference design reviewed are:

1. ***Whether the development of the models and their application accords with the relevant requirements of national and state guidelines/manuals (guidelines) for flood estimation and design of structures in flood prone environments.***

   Models have been improved as a result of the process to accord with relevant national and state guidelines with the issues in the IMR to be addressed.

2. ***Whether the extent of the floodplain covered by the flood model is appropriate, and if not recommendations as to what additional extent would be appropriate.***

   The currently adopted extent of each of the models is considered appropriate.

3. ***Whether the method and extent, of calibration of the model accords with guidelines and industry standards for calibration.***

   The method and extent of calibration accords with guidelines and industry standards, including the updated models for the Macintyre River, Condamine River and Gowrie Creek.

4. ***Whether the method for validation of the model accords with guidelines and industry standards and whether the assumptions used underpin the validation process, and the data points used in the validation are appropriate.***

   All models were validated in accordance with guidelines and industry standards. For Bringalilly Creek, Cattle Creek and Nicol Creek there is limited data and considerable uncertainty about design flows. ARTC has adopted the Panel's recommendation that the highest modelled design flow will be used.

5. ***Whether the model adequately accounts for the impacts of the reference design and whether those impacts are capable of appropriate local mitigation that either removes the impacts or reduces the impact to landholders in the area.***

   The models were found to account for the impacts of the reference design. Flood Impact Objectives (FIOs) have been developed by ARTC in conjunction with the Panel to determine the acceptability or otherwise of potential impacts. The final recommended version of the FIOs is included in Chapter 3.

6. ***Whether the model is fit for purpose, taking into account the above and any public comments or comments from external stakeholders in relation to the flood model that arises from the public exhibition of the draft Environmental Impact Statement (EIS) for the relevant Inland Rail Project.***

   The models are "fit for purpose" (suitable for an EIS and subsequent Detailed Design), noting that the issues captured in the IMR are matters to be addressed at future design stages of the project. Reports were prepared to the OCG by the Panel. These reports reviewed and responded to all flooding-related submissions that were provided by the OCG following the public exhibition of the B2G, G2H, H2C and C2K Draft EIS.

7. ***Whether the reference design for the proposed structure meets industry standards for railway structures in a floodplain and if so, whether the reference design is in accordance with best practice.***

   The modelling of the reference design for the proposed structures meets industry standards in a floodplain and is in accordance with best practice. Reference designs can be taken forward as the basis for the Detailed Design.

Recommendations

The Panel makes the following recommendations to assist ARTC in its future design and delivery of the Inland rail project in Queensland. That ARTC:

1. Incorporates the revised (as a result of issues identified in the IMR) modelling results into an updated EIS and addresses the issues as captured in the IMR at the appropriate future work stage;
2. Establishes appropriate information transfer processes to ensure that project knowledge pertaining to the development, calibration, validation and application of the models and reference designs is retained and available to inform the future design of the project;
3. Implements, both directly and through its appointed constructors, verification processes consistent with State and industry best practices to confirm that the impacts of any waterway crossings (viaducts and bridges) and structures (culverts and pipes) have been considered in accordance with the FIOs and appropriate mitigation measures identified;
4. Adopts the FIOs at Table 3-1 with the Panel's recommendations as described in Section 3.5 as design parameters/constraints to inform the future identification and mitigation of potential flood impacts during the future design stages of the project;
5. Considers the late 2021 and early 2022 flood events as either a validation event or a calibration event (in catchments where there is a lack of calibration data). Such consideration should include a review of the following aspects of the analysis and any implications that arise:
    i. the at-site Flood Frequency Analysis (FFA) incorporating the late 2021 or early 2022 event; and
    ii. Any new or altered Flood Sensitive Receptors identified as a result of the late 2021 or early 2022 event.
6. Undertakes a geomorphic risk assessment either during the Revised Draft EIS or at the start of the design stage to inform and modify, where necessary, the Reference Design and future design stages.

In making these recommendations the Panel notes that these should be considered as advice to the governments and are not intended to limit or restrict any conditions that the governments may wish to place on ARTC as a result of the respective EIS process or other planning approval processes in relation to the design and construction of waterway crossings and structures.

1 Acknowledgements

The Panel would like to acknowledge assistance throughout the Inland Rail review process from the following colleagues:

- Monique Retallick, Thomas Allingham, Daniel Verrall, and Daniel Wood from WMA Water;
- Jarrod Brooks, Clarissa Campbell, Laura Bergener (Editor), and Rusty Jones from HDR;
- Carl Wallis, Michael Cheetham, Sachi Canning, and Donnie Carroll from Water Technology;
- Gary Lambourne from BMT; and
- Geert Prinsen and Eelco Verschelling from Deltares.

Additionally, the Panel would like to thank the relevant Community Consultative Committees (Southern Darling Downs, Inner Darling Downs, Lockyer Valley, Scenic Rim, Ipswich and Millmerran Rail Group) for inviting Panel participation in specific meetings during the Inland Rail review process.

2 Introduction

2.1 Inland Rail Overview

Inland Rail is a proposed railway project between Melbourne and Brisbane via regional Victoria, New South Wales, and Queensland. The proposed route is approximately 1,700 km in length and provides a new freight corridor, expanding the national rail network (600 km of greenfield corridor and 1100 km of upgrade to existing corridors) and increasing connectivity. The project is funded by the Australian Government.

2.2 Purpose of this Report

This report summarises the outcomes of the Panel's review of the flood modelling, its extent, interpretation, assumptions and application as reviewed both directly and as expressed in the Draft EIS, design reports, and supporting documents for four Queensland sections of Inland Rail by the Panel. The Panel (refer to Section 2.3) reviewed the B2G, G2H, H2C, and C2K sections.

A review report (herein referred to as a Draft Review Report) was developed for each section. Appended to those four reports were a further 24 individual reports (herein referred to as Technical Appendices) that reviewed each flood model that comprised the sections, plus a geomorphology Technical Appendix for each section.

This report summarises the four Draft Review Reports, the 24 Technical Appendices, and the four geomorphology Technical Appendices. Those documents list the issues identified with the modelling, reporting, and design of the four sections. Additionally, this report makes recommendations regarding the FIOs of the project and summarises submissions to the Panel, both directly and via the Draft EIS public consultation period. Figure 2-1 presents the extents of the sections that were reviewed by the Panel.

Figure 2-1: Queensland Inland Rail Section Extents

2.3 The Panel

An Independent International Panel of Experts for Flood Studies of Inland Rail in Queensland (the Panel) was established by the Australian and Queensland Governments as represented by the Queensland Department of Transport and Main Roads' (DTMR) Rail Planning Directorate (out of the Policy, Planning and Investment Branch), and the Australian Government Department of Infrastructure, Transport, Regional Development, Communications and the Arts. The Panel reported to a Joint Working Group (JWG) from the two departments. Table 2-1 lists the members of the Panel.

Table 2-1: Panel Members

Name	Company
Mark Babister (Chair)	WMA Water
Ferdinand Diermanse	Deltares
Tina O'Connell	HDR
Martin Giles	BMT
Steve Clark	Water Technology

2.4 Terms of Reference (Scope of the Review)

The scope of the review of the Inland Rail sections by the Panel was defined by the *Terms of Reference for an Independent International Panel of Experts for Flood Studies of Inland Rail in Queensland* (June, 2020). Table 2-2 presents the items to be addressed in the review, as stated in the TOR.

2.5 Flood Panel Review Process

In accordance with the Panel's TOR and based on both information made available to the Panel and relevant discussions, the Panel has focused on identifying whether, and to what level, industry best practice has been applied to the flood modelling techniques and outputs that created the existing flood models. Table 2-2 shows the specific topics and where they have been addressed by the Panel.

Where gaps in the provided documentation or models were identified during the review process, the Panel requested additional information from the ARTC.

At a high level, this process involved:

- Review of the flood models;
- Review of documentation (the Draft EIS in particular) providing background, approach, results and the reference design, along with supporting technical information for each section of the route;
- Discussions and submission of requests for additional information or clarification of provided information;
- Preparation of Draft Review Reports for each of the four sections. Table 2-2 provides an overview of how the Draft Review Reports have addressed the Panel's TOR. The Draft Review Reports consisted of:
    i. An overview document for the section;
    ii. Detailed technical appendices for each model; and
    iii. A detailed IMR, with each issue assigned a level of importance.

In response to the Draft Review Reports and using the framework established by the IMR, ARTC have responded with additional information in the form of technical notes on a model basis.

The Panel has reviewed the additional information provided by ARTC and updated the IMR. The final status of each issue was categorised as one of the following:

- Closed;
- Accepted subject to additional information in a Revised Draft EIS;
- Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design; and
- Accepted subject to Panel's implementation of geomorphological assessment.

Table 2-2: Panel Review Documents that Addressed the TOR

Terms of Reference (TOR) Item	Location Where TOR
Confirmation that key design criteria are considered reasonable and appropriate compared with typical similar linear infrastructure projects	Technical Appendices & Draft Review Report
Appropriateness of model arrangements and input parameters	Technical Appendices & Draft Review Report
Appropriateness of model calibration process	Technical Appendices
Appropriate application of input data (including addressing data gaps)	Technical Appendices
Assumptions around land-use (crops etc.)	Technical Appendices
Appropriateness of blockage/debris assumptions	Technical Appendices
Appropriateness of future events application (that is, climate change)	Draft Review Report
Appropriateness of assumed soil conditions	Technical Appendices & Technical Appendices
Application	
Appropriate sensitivity analysis to various items (for example, flow inputs, coefficients	Technical Appendices & Draft Review Report
Appropriateness of change indicators	Technical Appendices & Draft Review Report
Appropriateness of structure and embankment representation (depending on the stage of the design)	Technical Appendices & Draft Review Report
Flood frequency analysis	Technical Appendices & Draft Review Report
Interpretation	
Achievement of Design Criteria	Technical Appendices
Appropriateness of relevant sensitivity analysis	Technical Appendices
Confirm Inland Rail-related flood impacts, if any, are comprehensively quantified and interpreted to their local property context	Technical Appendices
Appropriateness of the route, with regard the related flood impacts, within the current EIS Study Corridor	Technical Appendices

Terms of Reference (TOR) Item	Location Where TOR Item was Addressed by the Panel
Consider whether reasonable and practical steps have been taken to mitigate flood impacts, if any, outside of the project boundary	Technical Appendices
Additional information that would be required to be addressed in the Detailed Design phase of the program.	Technical Appendices & Draft Review Report

2.6 Supplied Documentation

The Panel was provided with significant documentation for the four sections and 24 models that required review, in addition to the hydrologic and hydraulic models. In general, the relevant pieces of documentation for each section have included:

- Flood models (Hydrologic and Hydraulic);
- The Feasibility Design Report (FDR);
- Relevant technical memoranda and technical notes provided either as background or in response to Panel requests;
- The Draft EIS; and
- Additional supporting information as relevant to site-specific considerations.

2.7 Reviewed Sections and Models

For the Queensland sections of Inland Rail, four sections (B2G, G2H, H2C, and C2K) were reviewed. For each section, both regional (large catchment area) models and local (small catchment area) models were developed by ARTC. These models were split into three drainage catchment classifications: major, moderate, and minor. The minor drainage catchments were not part of the scope of this review. Most moderate, plus all major catchments were reviewed and the models were provided to the Panel.

The following sections describe the sections and models that were reviewed in further detail.

2.7.1 Border to Gowrie (B2G)

The B2G section of the route was split into 13 regional catchment flood models (see Figure 2-2). The shaded areas represent the hydraulic model extents, the same coloured polygons represent the hydrologic model extents.

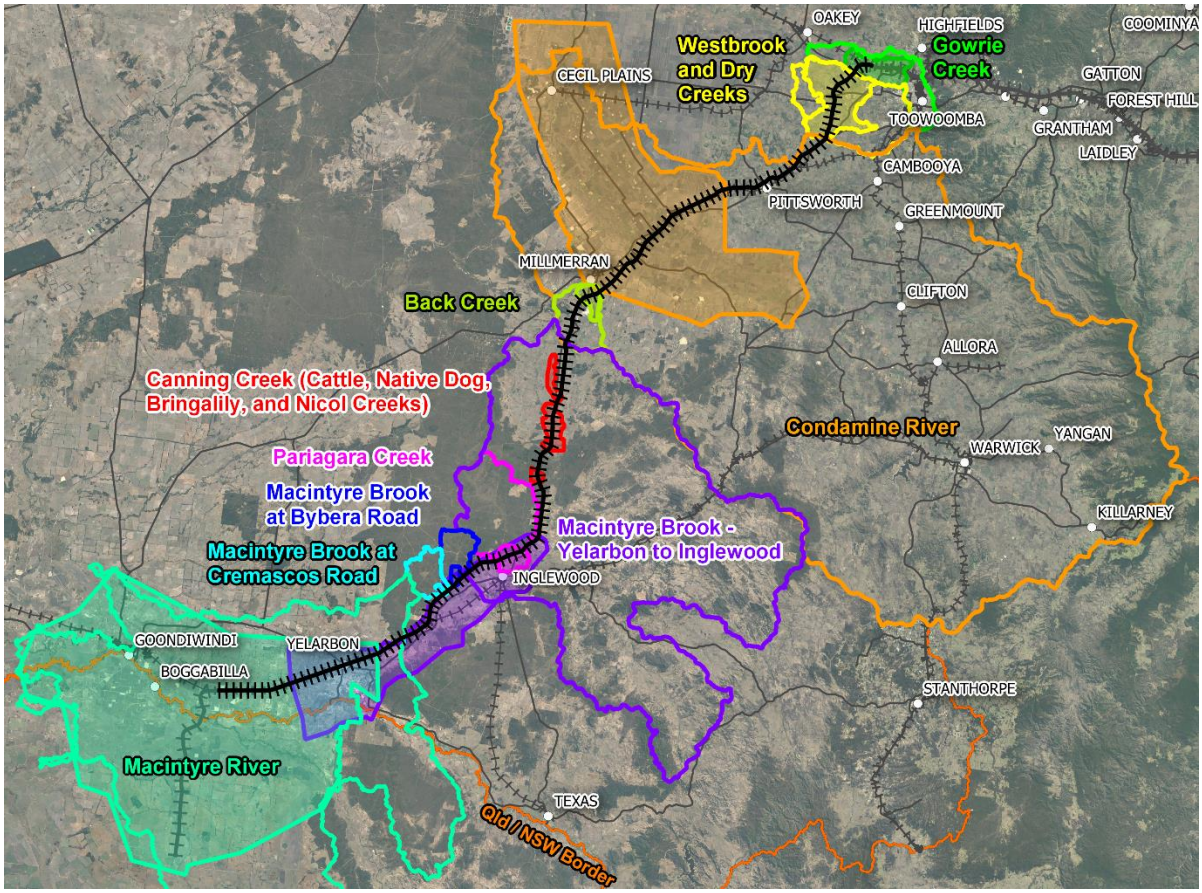

Figure 2-2: Site Location (B2G)

Gowrie Creek, to the west of Toowoomba, flows into the downstream end of Westbrook Creek before it joins Oakey Creek. Back Creek is a tributary of the Condamine River which is situated along the central part of the route. The central to southern section of the route crosses Cattle Creek, Native Dog Creek, Nicol Creek, Bringalily Creek, and Pariagara Creek, which flow into Canning Creek, a tributary of Macintyre Brook. Macintyre Brook ultimately discharges into the Dumaresq River, a tributary of the Macintyre River.

The Queensland Rail (QR) South Western Line is part of the route in the Macintyre Brook / Canning Creek regional catchment. At the northern end, the Millmerran Branch forms part of the route in the Condamine River catchment.

2.7.2 Gowrie to Helidon (G2H)

The G2H route starts by following the existing QR West Moreton Line route. It then diverges at Gowrie Junction into a tunnel that emerges in the Lockyer Creek catchment. From there, it weaves along hillsides on the descent into the Lockyer Valley floodplain, crossing Oaky Creek and Six Mile Creek, before finally traversing Lockyer Creek and joining the H2C route near Helidon.

The G2H section of the route has been split into five regional catchment flood models, as shown in Figure 2-3. The shaded areas represent the hydraulic model extents, the same coloured polygons represent the hydrologic model extents.

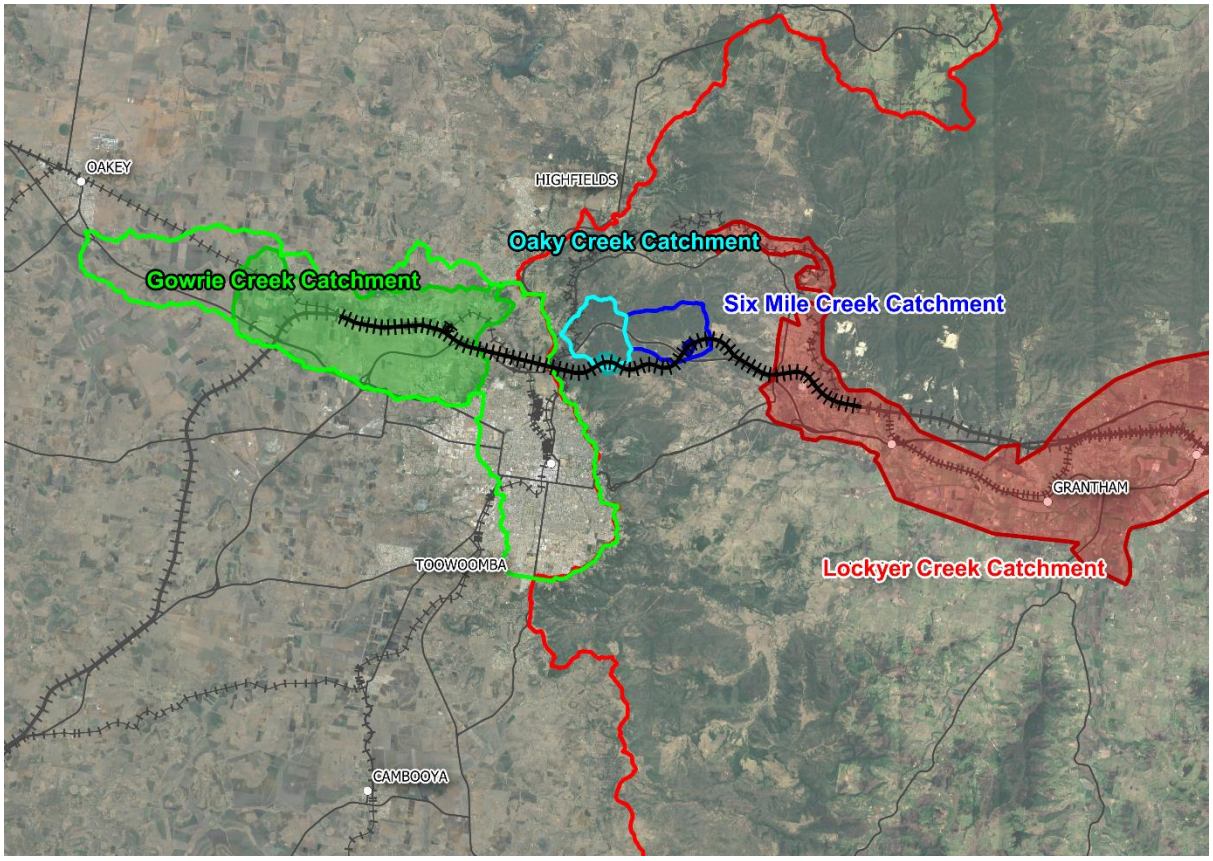

Figure 2-3: Site Location (G2H)

Gowrie Creek, to the north and north-west of Toowoomba, flows into the downstream end of Westbrook Creek before it joins Oakey Creek (not to be confused with Oaky Creek). The Gowrie Creek catchment also contains part of the B2G section of the route.

Oaky Creek and Six Mile Creek are tributaries of Lockyer Creek.

Lockyer Creek flows directly into the Brisbane River. Note that the Lockyer Creek catchment also contains part of the H2C section of the route.

2.7.3 Helidon to Calvert (H2C)

The H2C route largely follows the existing QR West Moreton Line route.

Figure 2-4 shows the extent of the H2C section and the two models. The shaded areas represent the hydraulic model extents, the same coloured polygons represent the hydrologic model extents.

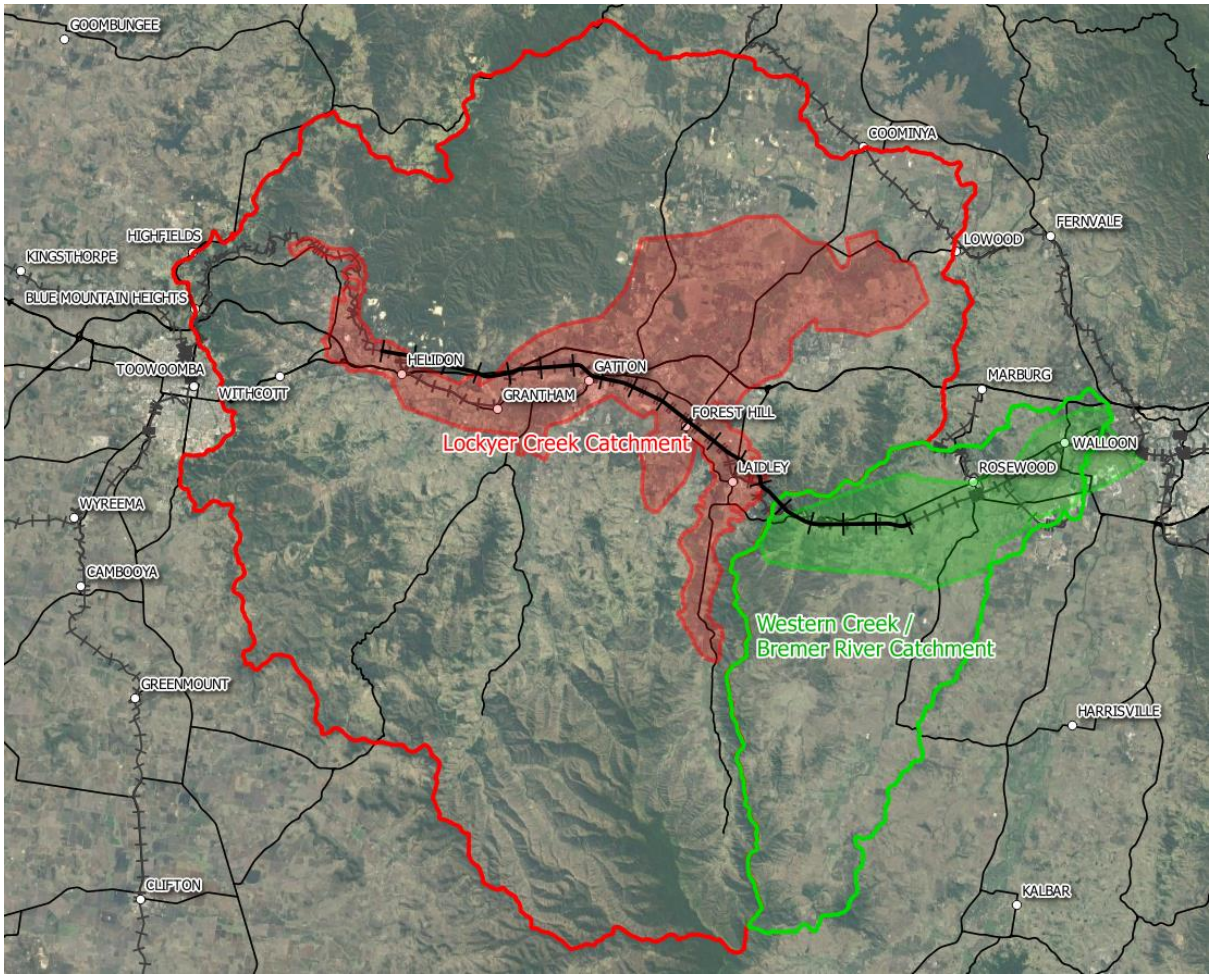

Figure 2-4: Site Location (H2C)

Lockyer Creek flows directly into the Brisbane River, whilst Western Creek flows into the Bremer River, which passes through Ipswich before also joining the Brisbane River. The Western Creek model is part of the larger Bremer River model, which is also relevant to the C2K section.

2.7.4 Calvert to Kagaru (C2K)

The C2K section of the route covers four major catchments, as shown in Figure 2-5. The shaded areas represent the hydraulic model extents, the same coloured polygons represent the hydrologic model extents.

Warrill Creek and Purga Creek flow into the Bremer River near Ipswich and ultimately into the Brisbane River. Teviot Brook is a tributary of the Logan River. Four regional models have been developed for each of these catchment areas, with additional local models developed for minor waterways or tributaries.

The QR West Moreton Line and the Rosewood Connection Fork are part of the route in the Bremer River regional catchment. At the eastern end, the Sydney to Brisbane Interstate Line and the Bromelton Connection Fork fall in the Teviot Brook regional model.

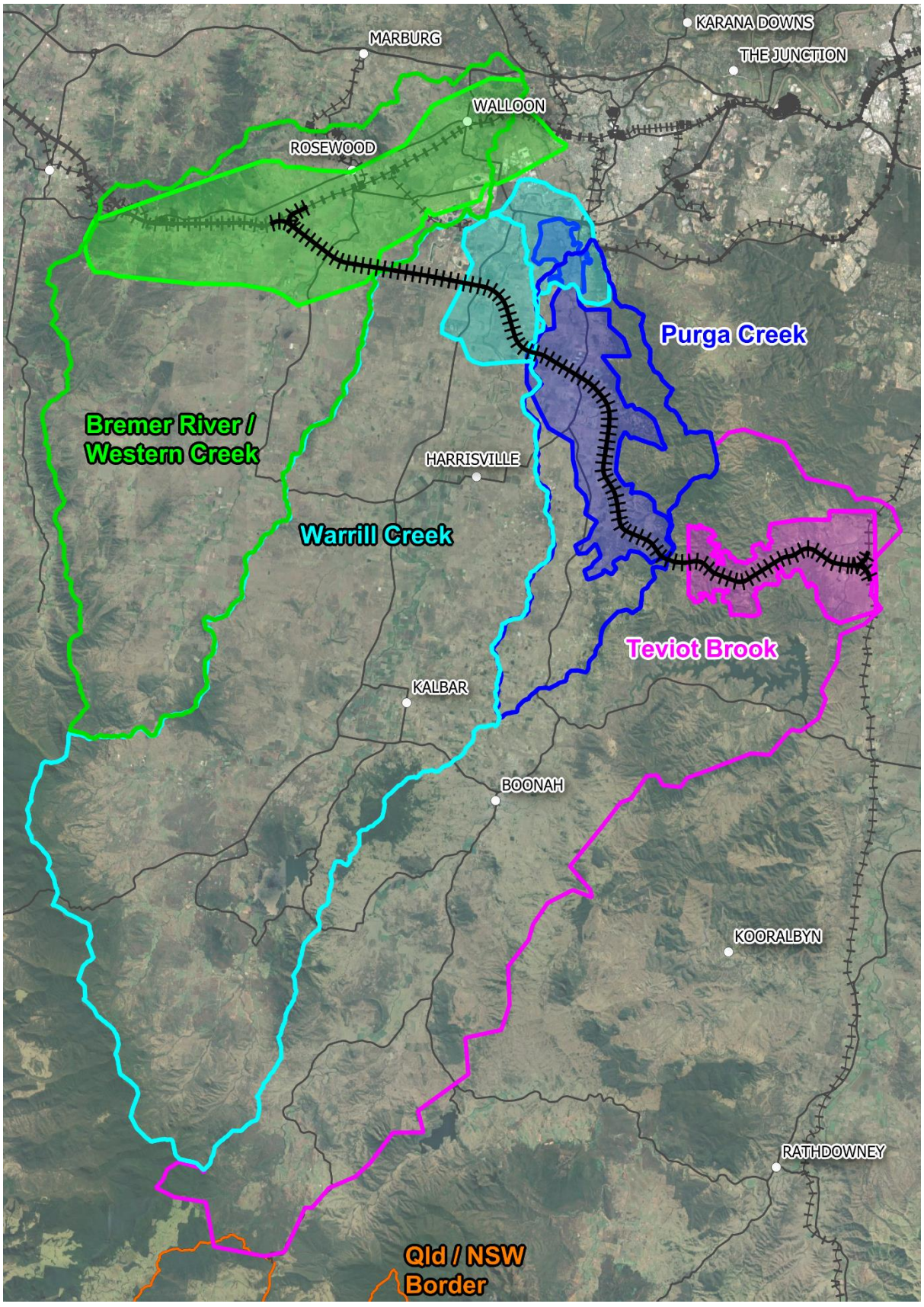

Figure 2-5: Site Location (C2K)

3 Design Criteria – Flood Impact Objectives

3.1 Overview

Each of the Draft EIS documents reviewed by the Panel contained inward-facing hydraulic design criteria and outward-facing FIOs. The design criteria address the serviceability and longevity requirements adopted for the asset, whilst the flood impact objectives reflect the need to protect the environment and minimise impacts on properties including houses, other buildings and land uses, and existing infrastructure such as roads.

The reviews completed by the Panel noted that a number of the FIOs nominated in the Draft EIS documents were qualitative, rather than quantitative in nature. While qualitative FIOs are often used in the industry, the Panel's view is that quantitative FIOs would be considered industry Best Practice. As a result, for each section of Inland Rail that was reviewed by the Panel, it was recommended that quantitative objectives be adopted to provide improved surety with respect to the intention for each parameter.

In response to this recommendation by the Panel, quantitative FIOs were proposed and subsequently revised in consultation with the Panel. The currently proposed (at the time of this report) FIOs are detailed in the ARTC Technical Note *EIS Flood Impact Objectives – Response and updates to Expert Panel feedback* (Document 2-0001-340-IHY-01-TN-0011, Revision 2, 8 April 2022).

The Panel considers that the adoption of quantitative FIOs is a significant advancement on the FIOs that were nominated in the Draft EIS documents. In particular, whilst landowners tend to have a wealth of knowledge regarding flooding conditions, this understanding may not extend to an appreciation of the impact of development on the use of their land based on the information supplied in the Draft EIS documents. The adoption of quantitative FIOs improves the ability of key stakeholders and landowners to assess impacts.

However, even with the adoption of quantitative FIOs, there is still a residual reliance on affected stakeholders and landowners having a reasonable degree of understanding of hydraulic processes to participate in the development of local solutions to local impacts.

The Panel reviewed the proposed FIOs. This section of the report (Section 3) lists comments of the Panel on the proposed FIOs, and recommended refinements to the proposed FIOs. The Panel considers that the proposed FIOs are acceptable.

3.2 Purpose of Flood Impact Objectives

It is important to note that the Panel considers FIOs to not reflect absolute requirements with respect to acceptable impacts in a particular situation. With regard to the length of corridor in the sections reviewed by the Panel, and the variable nature of flooding, it is not feasible to define impact limits that can be rigidly applied to the entire route. Local, site-specific conditions need to be considered to confirm whether an impact at a particular location that does not nominally meet the objectives is acceptable.

As noted in Section 13.6.2.2 of Chapter 13 of the Draft EIS (Document 2-0001-320-EAP-10-RP-0113, Revision E, 19 March 2021) for the H2C section (the Draft EIS documents for the other sections contained similar statements):

> *…Acceptable impacts will ultimately be determined on a case-by-case basis with interaction with stakeholders/landholders through the community engagement process using these objectives as guidance.*

Rather than defining fixed limits, the Panel considers that the purpose of the objectives is to provide guidance as to the point at which a more detailed consideration of impacts is required. The Panel notes that this approach is proposed because there is often a practical limit to how much flood impacts are able to be mitigated. Based on the findings of the impact review, if necessary, the identified impacts can be addressed by a number of means, including consultation with affected landowners, or the adoption of additional mitigation measures where appropriate. Such an approach is standard practice on linear infrastructure projects.

Depending on the nature of the impact and its location, it may be possible to accept an impact in excess of the nominated objectives. For example, an increase in flood level of 30 mm at a road might be accepted if the depth of flooding is greater than this at another section of that road, meaning that the road would effectively be no less trafficable than the existing road.

The Panel also notes that all model results need to be interpreted with a level of engineering judgment and this is particularly relevant to the application of the FIOs. It is common for models to show localised impacts that are not realistic, and which are referred to as model artefacts or model ‘noise’. This type of impact should be disregarded and can include isolated impacts far removed from the project corridor or marginal exceedances around the flood fringe.

The Panel’s comments on the proposed FIOs are presented in the following sections.

3.3 Proposed Flood Impact Objectives

Table 3-1 presents the FIOs that were proposed in the 8 April 2022 ARTC Technical Note. FIOs for which refinements have been identified by the Panel are shaded in green. The following sections document the Panel's responses to each of the proposed quantitative FIOs.

Table 3-1: Proposed Quantitative Flood Impact Objectives

Parameter	Objectives					
Change in peak water levels (afflux)[1]	Existing habitable[2] and/or commercial and industrial buildings/premises (e.g. dwellings, schools, hospitals, shops) and sensitive infrastructure[3]	Yards or gardens of residential or commercial/ industrial properties/lots (excluding habitable[2] dwellings/ buildings)	Existing non-habitable structures (e.g. agricultural sheds, pump-houses)	Existing local roads currently in use Existing rail lines	State Controlled Roads	Agricultural and grazing land/forest areas and other non-agricultural land
	≤ 10 mm[4]	≤ 50 mm[5]	≤ 100 mm[4,6]	≤ 100 mm[7]	≤ 20mm[7]	≤ 200[8] mm with localised[9] areas up to 400 mm
	Changes in peak water levels are to be assessed against the FIOs. Changes in peak water levels can have varying impacts on different infrastructure/land. FIOs were developed to consider the flood sensitive receptors in the vicinity of the Project. It should be noted that in many locations the presence of existing buildings or infrastructure limits the change in peak water levels. For peak water levels assessed at any structure, the change in peak water level is measured relative to the existing floor level.					

Parameter	Objectives
Change in duration of inundation[1]	Identify changes to time of inundation by determining time of submergence (ToS) in Existing and Developed[10] Cases. Assess impacts against the following objectives for habitable floors[2]: ■ Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation ■ Where existing flood inundation of 1 hour or more occurs – up to a 5% increase in duration of inundation For impacted roads/rail, the duration of inundation can increase by up to 10%, subject to the determination of the time of submergence (ToS) and consideration of impacts on accessibility/egress during flood events in consultation with the relevant authority. Assess impacts against the following objectives for all other land uses: ■ Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation ■ Where existing flood inundation of 1 hour or more occurs – up to a 10% increase in duration of inundation The duration performance targets do not apply to newly flooded land where compliant with afflux criteria (see also General Notes).
Flood flow distribution[1]	Aim to minimise changes in natural flow patterns and minimise changes to flood-flow distribution across floodplain areas. This includes the objective of maintaining drainage paths that are conveying runoff from adjoining terrain, minor watercourses, and gullies, to avoid ponding of water and/or excessive duration of inundation. Identify any changes and justify acceptability of changes by assessing the risk with a focus on land use and flood sensitive receptors. The identification of changes to flow distribution is to include the

	consideration of a range of floods, from small (frequent) events (for conditions throughout the event) to large and extreme (infrequent) events. This exercise will be undertaken to identify (and where deemed necessary, mitigate) any increased risk to flood sensitive receptors associated with flow distribution changes.
Velocities[1]	Maintain existing velocities where practical or minimise increases in velocities. Identify changes to velocities and impacts on external properties. The Erosive Threshold Velocity (ETV) for natural ground surfaces should be established from a site-specific assessment by a suitably qualified specialist, and in consideration of engineering guidelines. For sealed surfaces, this same approach could be applied, or through reference to suitable guidelines/specifications. Assess against the following performance objectives: ■ Sealed surfaces (or surfaces otherwise protected against erosion): – For existing velocities equal to or greater than 1m/s (or the defined ETV), the increase in velocity is limited to 20% – For existing velocities (or velocities associated with new flowpaths) less than 1 m/s, the maximum design velocity is 1.2 m/s (or the defined ETV) ■ Natural ground surfaces including watercourses, agricultural land, unimproved grazing land and other unsealed or unprotected areas: – For existing velocities equal to or greater than 0.5 m/s (or the defined ETV), the increase in velocity is limited to 10% (or within an acceptable range as determined by geomorphological assessment) – For existing velocities (or velocities associated with new flowpaths) less than 0.5 m/s (or the defined ETV), the maximum design velocity is 0.5 m/s (or the defined ETV).
Hazard (velocity x depth product)[1]	Assess against the following objectives: **Roads/rail, urban and commercial areas, dwellings:** ■ A 10% increase in velocity x depth product. **Other land:** ■ A 20% increase in velocity x depth product. (In both cases where the velocity x depth product is below 0.15 m^2/s in the Developed[6] Case, no percentage change performance targets apply)

Extreme event risk management	Consider risks posed to neighbouring properties and emergency access/egress for events larger than the 1% AEP event to minimise unexpected or unacceptable impacts. At sites with existing sensitive infrastructure[3], uses involving vulnerable people and/or any critical road network that was designed to be immune to flooding in any extreme event, the objective for increase in peak water level under the 0.2% AEP (1 in 500) is 10 mm[11]. At existing habitable[2] dwellings and/or commercial and industrial buildings/premises under the 0.05% (1 in 2000) AEP event, a maximum increase in peak water level of 250 mm applies.
Sensitivity testing	Consider risks posed by climate change and blockage in accordance with Australian Rainfall and Runoff (ARR) 2019. Undertake assessment of impacts associated with project alignment for both scenarios.

Table notes:

1. These FIOs apply for events up to and including the 1% AEP event, and relate to land outside the rail corridor (as well as roads and level crossings that lie within/traverse the rail corridor). Where transport corridors are shared or lie immediately adjacent to the Inland Rail corridor, relevant FIOs apply as outlined in Table 1 (i.e. for existing rail, State Controlled roads, local roads, etc.).
2. Habitable floors include all lawfully occupied dwellings regardless of land use zoning.
3. Sensitive infrastructure means infrastructure that is an essential service required to operate during emergency events, including water treatment facilities, telecommunications substations and electrical substations.
4. Data permitting and based on a review of calibration outcomes, where negative calibration bias is identified, a suitable tolerance (commensurate with the bias) will be added to the design flood levels to assess afflux and duration acceptability against the nominated FIO threshold.
5. This FIO reduces to ≤20 mm for developed lots that are less than 1000 m^2 in area.
6. The current usage of non-habitable structures will be reviewed as design progresses and additional detail becomes available (e.g. animal shelter versus horticultural packing facility). This could influence the application of one of the other FIOs, which may be more suited to the specific usage of the structure.
7. Consultation will be undertaken with the relevant asset owner based on the application of the appropriate FIOs. This consultation will present all changes (>20mm) across the road or rail network to identify specific roads or sections of rail that require local and/or route specific considerations. In flood sensitive locations this may entail a lower afflux threshold being adopted.
8. Where the alignment crosses the Condamine River and Lockyer Creek floodplains, this objective reduces to 100 mm (with localised[9] areas up to 200 mm), in light of the combination of floodplain sensitivity, inundation duration, and land use (intensive horticulture).
9. Localised is defined as the lesser of <1.0 ha or 5% of an individual lot.
10. Developed scenario implies fully constructed/operational rail line and associated works.
11. The 0.2% AEP (1 in 500) event is only required to be assessed where adherence to the FIO cannot be inferred from the 1% AEP and 1 in 2000 AEP event results.

General notes:

- Justification must be provided in the selection of a governing QDL where two or more competing QDLs may apply – in the absence of such justification the most limiting of the applicable QDLs shall apply.
- Erosive Threshold Velocity (ETV) means the velocity at which water movement has the potential to create scour or erosion. For natural surfaces, the erosive threshold of the soil/ground cover/vegetative conditions shall be established from an assessment by a suitably qualified specialist. In the absence of such assessment being undertaken an ETV of 0.5 m/s shall be assumed.
- The effects of any increased lateral spread of floodwaters (i.e. associated with permissible afflux) beyond 1ha or 5% of the affected lot area should be considered on merit, taking into account affected receptors and land-usage (e.g. flood depth, flood duration, etc.).
- The term “Road” relates to the operational road surface.
- Within the rail corridor erosion protection measures will be installed (as required). This is with a view to managing the risk of scour propagating beyond the rail corridor boundary.
- Consultation shall be undertaken using the full suite of flood impact information (including afflux, velocity, duration and hazard). In locations where the afflux or velocity FIOs are exceeded, the change in flood hazard shall be communicated to the landholder with respect to the combined flood hazard classifications as defined in ARR 2019 and the velocity x depth product.

3.3.1 Change in Peak Water Level

The proposed FIOs nominate change in peak water level (flood impact / flood afflux) objectives with respect to a range of scenarios for events up to and including the 1% Annual Exceedance Probability (AEP) event. This approach was considered to be appropriate by the Panel because the ability to tolerate changes in peak water level would depend on the situation being considered. The reasonableness of the proposed tolerances is discussed below:

Habitable/commercial buildings

Situation: Existing habitable and/or commercial and industrial buildings/premises (e.g. dwellings, schools, hospitals, shops) and sensitive infrastructure.

Objective: ≤ 10 mm

The nominated 10 mm or less impact is generally in accordance with standards in urban areas with stringent planning schemes (for example Brisbane City Council Local Government Area (LGA)) and may be more severe than some of the LGA requirements that the route traverses. For habitable areas, the nominated tolerance is considered to be reasonable.

The Technical Note indicates that for peak water levels assessed at any structure, the change in peak water level is measured relative to the existing floor level. The Panel understands that detailed survey will be completed to collect floor level data as part of further design to assist in the assessment of impacts.

Whilst this is acceptable practice, depending on the calibration of the models, there is a concern that the approach could inadvertently exclude impacts in excess of 10 mm at some buildings.

On the topic of model calibration, the Panel acknowledges that it is typically not possible to calibrate a model to match recorded flood levels at all points. The process of calibration is intended to provide the best possible agreement at each calibration point (within a desirable range) between calculated and recorded flood levels across the area being modelled. The aim is to achieve an acceptable level of agreement at most of the points with minimal overall bias (i.e., the average of the positive and negative differences between recorded and calculated levels is close to zero). However, even with the best calibration, there will be differences between calculated and recorded levels and there will also be points (outliers) where it is not possible to achieve a close agreement between calculated and recorded levels without changing the model in a manner that cannot be justified based on other available data. In such cases, “over-fitting” the model to available data reduces the reliability and predictive capacity of the model.

As a consequence, in cases where the calculated level is lower than the recorded level, there is the concern that the calculated flood level for a particular design event could be underestimated (or be perceived as being underestimated). While this is of limited relevance to the calculation of the relative impact associated with the railway (i.e., the change in flood level caused by the construction of the railway), it is potentially of relevance when considering whether an increase will result in or worsen above floor inundation.

For example, if at a particular point the calibrated model predicts a flood level 100 mm lower than the recorded flood level and the 1% AEP event is calculated as causing a flood level 50 mm below floor level, an increase in level of 20 mm may be considered to be acceptable as it does not result in above-floor flooding for the event. However, it could be argued that if the model calibration matched the recorded level (i.e. the modelled flood level was 100 mm higher), then the design flood level would be 50 mm above the floor level and the allowable impact would most likely be limited to 10 mm.

Similarly, the agreement between the aerial laser (LiDAR) survey used for modelling and detailed survey of floor levels will need to be considered.

To address this issue and recognising that these circumstances may only affect a limited number of buildings, Note 4 to the FIOs requires the addition of a suitable tolerance to design flood levels to assess afflux in cases where the calibration indicates flood levels lower than those recorded. The Panel considers this to be an acceptable approach.

Finally, the review of the Draft EIS documents completed by the Panel identified that no objectives were defined with respect to critical infrastructure. The proposed FIO for existing habitable areas now includes sensitive infrastructure and therefore an associated objective of ≤ 10 mm, satisfactorily addressing this issue.

Areas associated with residential or commercial/industrial buildings

Situation:	Yards or gardens of residential or commercial/industrial properties/lots (excluding habitable dwellings/buildings)
Objective:	≤ 50 mm

The adopted constraint of 50 mm or less where flooding does not impact dwellings/buildings is less stringent than some urban areas (for example Brisbane City Council LGA). Although an increase in flood level of this order could be unacceptable in certain situations (that is, where new building works or subdivisional approval is already granted under local planning schemes), the adopted tolerance is considered to be generally sufficient for the purpose of initial guidance.

Recognising that a more stringent criterion is typically applied in urban areas, Note 5 to the FIOs reduces the objective to ≤ 20 mm on lots less than 1,000 m^2 in area. The Panel considers that this provides a suitable balance between the criteria relevant to small and large lots.

Existing non-habitable structures

Situation:	Existing non-habitable structures (e.g. agricultural sheds, pump-houses)
Objective:	≤ 100 mm

The FIO does not agree with performance criteria from the Basis of Design (Australian Rail Track Corporation Limited, May 2018) which states *"the increase in flood level above the floor level of buildings must be less than 0.01 m*", with no differentiation between habitable and non-habitable floors.

However, it is acknowledged that a greater flood level impact may be suitable for non-habitable structures such as sheds compared to habitable buildings. Consequently, the acceptable constraint will depend on the use of the structure.

To address this issue, Note 6 to the FIOs requires the current usage of non-habitable structures to be reviewed as the design progresses. The Panel considers that this approach is acceptable and provides a reasonable balance between the range of uses that can occur in non-habitable structures.

The FIO also refers to Note 4 and consequently also takes account of differences between calibrated and recorded levels when considering the calculated afflux.

Existing local roads and rail lines

Situation:	Existing local roads currently in use
	Existing rail lines
Objective:	≤ 100 mm

The FIO does not agree with performance criteria from the Basis of Design (Australian Rail Track Corporation Limited, May 2018) which states *"must be less than 0.01 m and this impact criterion must also apply to other sensitive infrastructure … including changes to any associated roads*".

The constraint of 100 mm or less may or may not be appropriate depending on the situation being considered**.** The matters to be considered in relation to the acceptability of an impact at a road include:

- What is the relative importance of the road (e.g. is it a critical escape route where there is a reduced ability to accept increases in flood level) and are there alternate flood-free routes?
- Would an increase in depth of 100 mm change the hazard classification?
- What is the impact of the change on the time of inundation (refer to Section 3.3.2)?

Given the low immunity and usage of many roads in the vicinity of the corridor, the nominated tolerance could be reasonable in many cases. However, it is noted that councils could require less impact, depending on the particular road being considered. It is also noted that Council officers will have an understanding of the acceptable changes in flood level within a particular LGA and can interpret the results of modelling accordingly.

In response to the Panel's concern that impacts in excess of 10 mm could be of importance depending on the nature of the road being considered, Note 7 to the FIOs requires all impacts >20 mm to be presented in order to identify specific roads where local or route specific considerations are required. The Panel understands that the 20 mm value is nominated based on the understanding of the requirements for state-controlled roads.

While the Panel appreciates that the acceptable limit will vary depending on the nature of the road being considered, as the intent of the objective is to define the point at which additional consideration is required (and not the limit of impact), the Panel recommends that Note 7 be retained and the objective set at *"between the limit for state-controlled roads and 100 mm"*.

Similarly, the objective of ≤ 100 mm may not be acceptable with respect to existing railways depending on the situation being considered, noting that in the case of Inland Rail the railway embankment is located in close proximity to the existing railway in a number of areas and as a result it may not be practicable to achieve minimal impact. The Panel also acknowledges email correspondence from QR that indicates that an afflux of up to 100 mm could be acceptable. The Panel therefore recommends that the objective for railways be set at *"≤10-100 mm or as nominated by Queensland Rail"*.

In both cases, similar to the consideration of habitable floor levels, the Panel recommends that a tolerance be added to calculated flood levels to determine whether flooding of existing road and railways could occur when considering the acceptability of calculated impacts.

State-controlled roads

Situation: State-controlled Roads

Objective: ≤ 20 mm

Similar to the case with existing local roads, the FIO does not agree with performance criteria from the Basis of Design (Australian Rail Track Corporation Limited, May 2018) which states *"must be less than 0.01 m and this impact criterion must also apply to other sensitive infrastructure … including changes to any associated roads*".

Again, whilst many of the state-controlled roadways in the vicinity of the rail corridor have a low immunity, the constraint of 20 mm or less may not be appropriate, depending on the particular situation being considered**.** It is necessary to consider the effects of any increase in peak water level in terms of road immunity, hazard, and time of submergence/closure.

The Panel notes that DTMR's technical requirements for the Inland Rail project nominate an impact of 10 to 20 mm as being acceptable. Consequently, the Panel recommends that the objective be set at *"≤10 to 20 mm*".

Agriculture and grazing

Situation: Agricultural and grazing land/forest areas and other non-agricultural land.

Objective: ≤ 200 mm with localised areas up to 400 mm.

Note 8 to the FIOs reduces the objective to ≤100 mm with localised areas up to 200 mm in the case of the Condamine River and Lockyer Creek. The Panel supports the adoption of a more restrictive objective with respect to the Condamine River and Lockyer Creek due to the particular sensitivity of the two floodplains to flooding.

Although the objective provides initial guidance and reflects the expected higher tolerance for increases on rural land, whether the impact is acceptable will depend on the current and future use of the land and will require consideration of factors such as:

- Does this increase in peak water level result in altered flow patterns (particularly for more frequent events) or increased scour?
- What is the impact on the agricultural viability of the land?

Overall, the objective is considered to be reasonable for the land uses being considered. Note 9 to the FIOs provides additional guidance, defining localised as being the lesser of 1 hectare or 5% of an individual lot. The Panel considers that this definition of the extent of localised impact is acceptable.

3.3.2 Change in Duration of Inundation

The proposed FIOs nominate the following quantitative objectives with respect to changes in the duration of inundation for events up to and including the 1% AEP event:

> *Identify changes to time of inundation by determining time of submergence (ToS) in Existing and Developed Cases.*
>
> *Assess impacts against the following objectives for habitable floors:*
>
> - *Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation*
> - *Where existing flood inundation of 1 hour or more occurs – up to a 5% increase in duration of inundation*
>
> *For impacted roads/rail, the duration of inundation can increase by up to 10%, subject to the determination of the ToS and consideration of impacts on accessibility/egress during flood events in consultation with the relevant authority.*
>
> *Assess impacts against the following objectives for all other land uses:*
>
> - *Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation*
> - *Where existing flood inundation of 1 hour or more occurs – up to a 10% increase in duration of inundation*
>
> *The duration performance targets do not apply to newly flooded land where compliant with afflux criteria.*

Whether a change in the duration of inundation is acceptable will depend on the use being considered (for example a road or an agricultural area) and the nature of the activity (e.g. the use of the road or the type of crop being grown). The nominated FIOs differentiate between habitable buildings and other land uses and is considered to be reasonable with respect to land already inundated.

The Panel considers that the nominated FIOs for change in the duration of inundation for habitable floors are reasonable because the change in duration of inundation is unlikely to materially affect flood damage or inconvenience during a flood event.

To account for cases where the calibration provides calculated values lower than recorded values, Note 4 to the FIOs includes the requirement to consider the duration of inundation relative to an adjusted flood level hydrograph. The Panel considers this to be acceptable and note that the objective needs to refer to Note 4.

When reviewing the Draft EIS documents, the Panel noted that an important criterion is a change in flood fringe (i.e., areas that were dry becoming wet as a result of flood level increases or changes to flow paths). The Panel concluded that buildings or lots that change from being dry in a certain sized flood to being within the flood extent for the same sized flood when the rail line is built should be considered, with those areas plotted as “Was Dry, Now Wet” on the developed case afflux maps considered under a flood impact objective.

To address this issue, a general note to the FIOs requires that ‘the effects of any increased lateral spread of floodwaters (i.e. associated with permissible afflux) beyond 1ha or 5% of the affected lot area should be considered on merit, taking into account affected receptors and land-usage (e.g. flood depth, flood duration, etc.).’

The Panel considers that this general note satisfactorily addresses the issue.

3.3.3 Flood Flow Distribution

The proposed FIOs nominate the following objectives with respect to changes in the distribution of flood flows for events up to and including the 1% AEP event.

> *Aim to minimise changes in natural flow patterns and minimise changes to flood-flow distribution across floodplain areas. This includes the objective of maintaining drainage paths that are conveying runoff from adjoining terrain, minor watercourses, and gullies, to avoid ponding of water and excessive duration of inundation.*
>
> *Identify any changes and justify acceptability of changes by assessing the risk with a focus on land use and flood sensitive receptors. The identification of changes to flow distribution is to include the consideration of a range of floods, from small (frequent) events (for conditions throughout the event) to large and extreme (infrequent) events. This exercise will be undertaken to identify (and where deemed necessary mitigate) any increased risk to flood sensitive receptors associated with flow distribution changes.*

The flood flow distribution objectives do not provide a quantitative objective in relation to changes in the distribution of flow. This is considered to be acceptable in this case given that changes to flood flow distribution will be associated with the adopted locations for drainage structures and provided that the change in flow distribution at each crossing is considered.

Given the rural nature of much of the route, the consideration of impacts on flood flow distribution will necessarily need to focus on the lower flood flows associated with more frequent events as these will be of relevance to local landholders. For example, farm drain connectivity is a significant issue for agricultural landowners. The Panel considers that this requirement is reflected in the nominated FIO.

3.3.4 Velocities

The proposed FIOs nominate the following quantitative objectives with respect to changes in flow velocity for events up to and including the 1% AEP event.

Maintain existing velocities where practical or minimise increases in velocities. Identify changes to velocities and impacts on external properties.

The Erosive Threshold Velocity (ETV) for natural ground surfaces should be established from a site-specific assessment by a suitably qualified specialist, and in consideration of engineering guidelines. For sealed surfaces, this same approach could be applied, or through reference to suitable guidelines/ specifications.

Assess against the following performance objectives:

- *Sealed surfaces (or surfaces otherwise protected against erosion):*
  - *For existing velocities equal to or greater than 1 m/s (or the defined ETV), the increase in velocity is limited to 20%*
  - *For existing velocities (or velocities associated with new flowpaths) less than 1 m/s, the maximum design velocity is 1.2 m/s (or the defined ETV)*
- *Natural ground surfaces including watercourses, agricultural land, unimproved grazing land and other unsealed or unprotected areas:*
  - *For existing velocities equal to or greater than 0.5 m/s (or the defined ETV), the increase in velocity is limited to 10% (or within an acceptable range as determined by geomorphological assessment)*
  - *For existing velocities (or velocities associated with new flowpaths) less than 0.5 m/s (or the defined ETV), the maximum design velocity is 0.5 m/s (or the defined ETV).*

It is acknowledged that the specification of velocity limits for natural ground surfaces is difficult given the soil types documented for considerable portions of the route and their potential to scour. In turn, the potential for scour to occur can depend on whether a crop is being grown at the time of a flood. Consequently, the completion of site-specific assessments by suitably qualified specialists to define allowable velocities, shear stress values and unit discharges is preferred over a general quantitative criterion.

Noting the need to take careful consideration of the potential for soils (and black soils in particular) to scour, the Panel considers that the adopted FIOs with respect to velocity are appropriate.

3.3.5 Flood Hazard

The proposed FIOs nominate the following quantitative objectives with respect to flood hazard (velocity - depth product) for events up to and including the 1% AEP event.

Assess against the following objectives:

Roads/rails, urban and commercial areas, dwellings:

- *A 10% increase in velocity x depth product.*

Other land:

- *A 20% increase in velocity x depth product.*

(In both cases where the velocity x depth product is below 0.15 m^2/s in the Developed Case, no percentage change performance targets apply).

Flood hazard is normally considered in terms of velocity of flow, depth of flow, and the velocity - depth product. Chapter 7 of Book 6 of ARR 2019 defines a number of hazard classifications based on limiting flow velocities, flow depths and the velocity - depth product. Given the FIOs that are defined with respect to changes in water level (refer to Section 3.3.1) and velocity (refer to Section 3.3.4), the use of only the velocity - depth product for the consideration of flood hazard is considered by the Panel to be appropriate in this case.

The nominated objectives with respect to increases in velocity - depth product are considered by the Panel to be appropriate.

The Panel proposed that the objective be modified to include a statement indicating that if a change in flood hazard does not change the associated flood hazard category or only involves a 10% change in hazard in cases where the flood hazard category does change, then the change is acceptable. An alternate approach was adopted by ARTC, with the general notes to the FIOs revised to require consultation to be undertaken using the full suite of flood impact information and flood hazard classifications as defined in ARR2019. The Panel considers that the nominated general note is acceptable.

3.3.6 Extreme Event Risk Management

The proposed FIOs nominate the following quantitative objectives with respect to extreme events (i.e. events greater than the 1% AEP event):

> *Consider risks posed to neighbouring properties and emergency access/egress for events larger than the 1% AEP event to minimise unexpected or unacceptable impacts.*
>
> *At sites with existing sensitive infrastructure, uses involving vulnerable people and/or any critical road network that was designed to be immune to flooding in any extreme event, the objective for increase in peak water level under the 0.2% AEP (1 in 500) is 10 mm.*
>
> *At existing habitable dwellings and/or commercial and industrial buildings/premises under the 0.05% (1 in 2000) AEP event, a maximum increase in peak water level of 250 mm applies.*

The proposed FIOs require an assessment of risks posed to neighbouring properties for events larger than the 1% AEP event to *"minimise unexpected or unacceptable*" impacts. As extreme events have a very low probability of occurrence, it is typically not appropriate to apply the same objectives as those adopted for the 1% AEP event. As a consequence, it is necessary to consider whether any impacts are either unexpected (for example a change in flow direction) or unacceptable.

The proposed FIOs include a quantitative objective in relation to habitable dwellings and commercial/industrial buildings. The specification of an objective for areas that people would be expected to congregate in is considered to be reasonable. In other areas, it is agreed that it is appropriate to retain a qualitative assessment of extreme events.

The *State Planning Policy – State Interest Guidance Material, Natural Hazards, Risks and Resilience – Flood* (DILGP, July 2017) includes recommendations for the adoption of higher levels of immunity for critical infrastructure (such as hospitals and emergency services facilities) and uses involving vulnerable people (for example retirement villages). Table 18 of the policy indicates a level of immunity between the 0.2% AEP event and the Probable Maximum Flood (PMF).

It is recognised that critical infrastructure and uses involving vulnerable persons may have been constructed prior to the guidelines being issued or that it may simply not be possible to provide the level of immunity recommended by the guidelines. Consequently, it is necessary to ensure that flooding of critical infrastructure and uses involving vulnerable persons is not significantly worsened as a result of the construction of the Inland Rail project. Similarly, the level of immunity of any critical road network that was designed to remain flood-free in an extreme event needs to be maintained.

The nominated FIO addresses this requirement by nominating an objective with respect to impacts on sensitive infrastructure. The Panel considers that the objective, including Note 11 which allows the impacts associated with the 1% AEP and 1 in 2000 AEP events to be used to initially consider whether modelling of the 0.2% AEP event is required, is acceptable.

3.3.7 Sensitivity Testing

The proposed FIOs nominate the following objectives with respect to sensitivity testing:

> *Consider risks posed by climate change and blockage in accordance with Australian Rainfall and Runoff (ARR) 2019.*
>
> *Undertake assessment of impacts associated with project alignment for both scenarios.*

The proposed FIOs require the risks of impacts posed by climate change or blockage to be assessed. These FIOs have not been changed from the FIOs that were proposed in the Draft EIS documents. The nominated objectives are considered to be both good practice and acceptable.

3.4 Flood Impact Objectives for Approved Sections of Inland Rail

In the previous section, the proposed FIOs were compared to relevant standards and best/standard practice. For context, it is also worth considering the flood impact limits that have been adopted within the NSW sections of the Inland Rail Project (Quantitative Design Limits or *QDL*(s)). The QDLs from the Narrabri to North Star section of the northern NSW portion of the Inland Rail route are presented in Table 3-2. These QDLs were published as Appendix A to the conditions attached to the approval of the Critical State Significant Infrastructure (CSSI) issued on 13 August 2020 under the NSW *Environmental Planning & Assessment Act, 1979*.

For comparative purposes, the table also lists the proposed FIOs for Queensland sections of the railway, noting that the values nominated for Queensland are a summary of the nominated objective, not the entire FIO. The proposed FIOs for Queensland do not incorporate the changes that are recommended by the Panel in Section 3.3.

Table 3-2: Quantitative Design Limits – Conditions of Approval for Inland Rail – Narrabri to North Star

Parameter	Location or Land Use	QDL	
Change in water level	Habitable floors	10mm inc.	≤ 10mm
	Non-habitable floors	20mm inc.	Not defined
	Other urban and recreational	100mm inc.	≤ 100mm
	Agricultural	200mm inc.	≤ 100-200mm
	Forest and unimproved grazing land	300mm inc.	≤ 100-200mm
	Highways and sealed roads >80km/h	No increase in depth where aquaplaning exists and remains unmitigated. Otherwise 50mm increase	≤ 20mm (State-controlled roads) ≤ 100mm (local roads)
	Sealed and unsealed roads <80 km/h	100mm increase	≤ 100mm (local roads)
Scour Erosion Potential	Ground surfaces that have been sealed or otherwise protected against erosion. This includes roads and most urban, commercial, industrial, recreational and forested land.	20% increase in velocity where existing velocity already exceeds 1m/s	20% increase in velocity where existing velocity ≥ 1m/s (or the defined ETV[1]) For velocities less than 1m/s, maximum 1.2m/s (or the defined ETV)
	Other areas including watercourses, agricultural land, unimproved grazing land and other unsealed or unprotected areas	No velocities to exceed 0.5m/s unless justified by site-specific assessment conducted by an experienced geotechnical or scour/erosion specialist. In addition, the increase in velocity is to be limited to 20% where the existing velocity already exceeds 0.5 m/s	10% increase in velocity where existing velocities ≥ 0.5m/s (or defined ETV) Where existing velocity is < 0.5m/s, maximum velocity is 0.5m/s (or defined ETV).
Flood Hazard	Urban, commercial, industrial, highways and sealed roadways	10% increase in VxD[2] where H1 or H2 category 0% increase in VxD where H3 or greater hazard category No target for VxD ≤ 0.1m^2/s	10% increase in VxD No target for VxD ≤ 0.15m^2/s
	Elsewhere	20% increase in VxD No target for VxD ≤0.1m^2/s	20% increase in VxD No target for VxD ≤ 0.15m^2/s

[1] ETV refers to Erosion Threshold Velocity.

[2] VxD refers to velocity-depth product.

Parameter	Location or Land Use	QDL (NSW Narrabri to North Star)	Proposed FIO (Queensland)
Flood Duration	Habitable floors	No increase in inundation duration above floor level. 10% increase in inundation duration where below floor level and when existing inundation duration exceeds one hour. Otherwise, inundation duration not to exceed one hour. Does not apply to areas < 100m^2	If < 1 hour, up to 1 hour If > 1 hour, up to 5% increase in inundation duration
	Highways and sealed roads >80 km/h	10% increase in inundation duration Does not apply to areas < 100m^2	Up to 10% increase in inundation duration, subject to the consideration of the impact of the change in time of submergence on the access/egress in consultation with relevant authority
	Elsewhere	10% increase in inundation duration when existing inundation duration exceeds one hour. Otherwise inundation duration not to exceed one hour. Does not apply to areas < 100m^2	If < 1 hour, up to 1 hour If > 1 hour, up to 10% increase in inundation duration

The following sections discuss the comparison between the New South Wales QDLs and the Queensland FIOs.

3.4.1 Change in Peak Water Level

With the exception of roads, the proposed FIOs are considered to be similar or slightly more conservative than the QDLs (refer to Section 3.3.1).

For state-controlled roads (referred to as highways and high-speed sealed roads for the QDLs), the QDLs could be more or less conservative than the proposed FIOs, depending on the situation. The objective recommended by the Panel (≤ 10 – 20 mm) is considered to align with current Queensland practice and to be acceptable.

For lower speed roads, the proposed FIO matches the QDL. For higher speed roads, the Panel considers that a more stringent objective may need to be adopted, depending on the road being considered and the requirements of the relevant LGA (refer to Section 3.3.1).

3.4.2 Scour/Erosion Potential

The proposed FIOs for scour and erosion potential generally match or are more conservative than the QDLs.

Given the sensitivity of the soils present over the route to erosion and the purpose of the FIOs (refer to Section 3.2), the Panel considers that the FIOs and in particular referencing the erosion threshold velocity (based on site-specific assessments) are appropriate.

3.4.3 Flood Hazard

There are slight differences between the QDLs and the proposed FIOs with respect to flood hazard. Whilst the QDLs adopt a velocity - depth product (VxD) threshold of 0.1 m^2/s, the proposed FIOs are based on a threshold of 0.15 m^2/s. The slightly higher threshold in the proposed FIOs is considered by the Panel to still be relatively low and acceptable.

The allowable increases in velocity - depth product nominated in the QDLs are similar to the proposed velocity - depth product increases in the FIOs. Although the QDL for the allowable increase in velocity - depth product for urban, commercial/industrial, highways, and sealed roadways is nil when the hazard category is H3 (unsafe for vehicles, children and the elderly) or higher, the Panel considers that the allowance of an increase in velocity - depth product (within reason) is acceptable for H3 and higher conditions because H3 and higher are considered to be unsafe according to ARR 2019. There is little benefit achieved from limiting the velocity - depth product value.

3.4.4 Flood Duration

For habitable floors, the QDLs are more restrictive in the case of above floor flooding and less restrictive with respect to below floor flooding compared to the proposed FIOs. The Panel considers the proposed FIOs to be reasonable (refer to Section 3.3.2).

For highways and high-speed roads, the QDLs match the FIOs.

For other locations, the proposed FIOs match the QDLs.

3.5 Summary

The Panel considers that the quantitative FIOs provide a significant improvement over the qualitative FIOs that were nominated in the Draft EIS documents. The FIOs included specific, quantitative objectives with respect to impacts associated with flood levels, duration of inundation, velocities, extreme events, and flood hazard. The use of quantitative objectives provides increased confidence in the evaluation of project impacts and the requirements to enter negotiations with potentially impacted properties.

Following a review of the FIOs, the Panel recommends that the FIOs relating to the change in peak flood level on existing local roads, existing rail lines and state-controlled roads be modified.

The recommended refinements are detailed below.

- ***Existing local roads***

  For existing local roads it is recommended that the objective be set at *"≤ the limit for state-controlled roads - 100 mm"* rather than ≤ 100 mm.

- ***Existing rail lines***

  For existing rail lines, it is recommended that the objective be set at *"≤10-100 mm or as nominated by Queensland Rail"* rather than ≤ 100 mm.

- ***State-controlled roads***

  For state-controlled roads, it is recommended that the objective be set at *"≤10 to 20mm"* rather than ≤ 20 mm.

- ***Change in duration of inundation***

  Finally, it is noted that a reference to *Note 4 to the FIOs (which deals with calibration accuracy) needs to be added to the Change in duration of inundation objective* as the note relates to both changes in peak levels and duration of inundation.

The amended changes are summarised in Table 3-3, which presents an updated version of the FIO Table (Table 3-1) for those FIOs for which a refinement is made. In each case, the amended refinements are shaded in green.

Table 3-3: Summary of Revisions to the FIOs

Parameter	Objectives						
Change in peak water levels (afflux)[1]	Existing habitable[2] and/or commercial and industrial buildings/premises (e.g. dwellings, schools, hospitals, shops) and sensitive infrastructure[3]	Yards or gardens of residential or commercial/ industrial properties/lots (excluding habitable[2] dwellings/ buildings)	Existing non-habitable structures (e.g. agricultural sheds, pump-houses)	**Existing local roads currently in use**	**Existing rail lines**	**State Controlled Roads**	Agricultural and grazing land/forest areas and other non-agricultural land
	≤ 10 mm[4]	≤ 50 mm[5]	≤ 100 mm[4,6]	**≤ the limit for state-controlled roads to 100 mm[7]**	**≤ 10-100 mm or as nominated by Queensland Rail[7]**	**≤ 10 to 20mm[7]**	≤ 200[8] mm with localised[9] areas up to 400 mm
	Changes in peak water levels are to be assessed against the FIOs. Changes in peak water levels can have varying impacts on different infrastructure/land. FIOs were developed to consider the flood sensitive receptors in the vicinity of the Project. It should be noted that in many locations the presence of existing buildings or infrastructure limits the change in peak water levels. For peak water levels assessed at any structure, the change in peak water level is measured relative to the existing floor level.						
Change in duration of inundation [1,4]	Identify changes to time of inundation by determining time of submergence (ToS) in Existing and Developed[10] Cases. Assess impacts against the following objectives for habitable floors[2]: • Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation • Where existing flood inundation of 1 hour or more occurs – up to a 5% increase in duration of inundation For impacted roads/rail, the duration of inundation can increase by up to 10%, subject to the determination of the ToS and consideration of impacts on accessibility/egress during flood events in consultation with the relevant authority. Assess impacts against the following objectives for all other land uses: • Where existing flood inundation is less than 1 hour – up to 1 hour duration of inundation • Where existing flood inundation of 1 hour or more occurs – up to a 10% increase in duration of inundation The duration performance targets do not apply to newly flooded land where compliant with afflux criteria (see also General Notes).						

4 Waterway Processes (Geomorphology, Active Sediment Transport, Diversion)

4.1 Background

Provision of railway infrastructure across floodplains and waterways needs to consider and make appropriate allowances for ongoing waterway/geomorphic processes that:

- are already occurring along the proposed route;
- may be impacted by the proposed infrastructure; or
- may impact the proposed infrastructure.

As discussed in *A Guide to Bridge Technology* (Austroads, 2019) frequently, environmentalists and hydraulic engineers consider a river to be static, i.e. unchanging in shape, dimensions and pattern. However, an alluvial river continually changes its position and shape as a consequence of hydraulic forces acting on its bed and banks. These changes may be slow or rapid and may result from natural environmental changes or from changes by man's activities.

Consideration of fluvial geomorphic processes within, upstream and downstream of a waterway crossing prior to design is rapidly becoming best practice within the industry (*Bridge Scour Manual: Supplement to Austroads Guide to Bridge Technology Part 8, Chapter 5: Bridge Scour, 2019*). A geomorphic assessment of the channel and floodplain characteristics, particularly when combined with hydraulic modelling results of the existing case, allow for an appreciation of the natural changes of fluvial environments and prevent catastrophic damage to railway, waterways crossings and other infrastructure.

With regards specifically to the Inland Rail route, black vertosol soils are prevalent within the study area (sometimes referred to as black earths or cracking clays). In general, these soils can extend up to 10 m deep and have very little resistance to erosion by flowing water or immersion. These soils are readily observed in the bank profile along many waterways in this area.

Vertosol soils must be considered in detail through any design process for the following reasons:

- The sediments, combined with the concentration of flow in a channel, have led to significant erosion in some portions of the study area;
- Exposed vertosol bank sediments, especially but not only when combined with erosion, are a significant problem in some portions of the study area and lead to bank collapse and channel widening;
- Concentrated overland flow has led to many large floodplain gullies in the area such as those on Dry Creek. As with the bank collapse and channel widening, this is an escalated problem in this area due to the easily erodible nature of the vertosol bank sediments; and
- Hard structures such as concrete or rock are known to be problematic with respect to erosion in these soils.

Given these conditions, particular attention will need to be paid to the specification of appropriate scour protection throughout the length of the route during Detailed Design.

4.2 Outcomes of Geomorphology Review

On advice from the Panel, ARTC has committed to undertake an early geomorphological risk-based assessment of waterways and drainage lines at risk of erosion to inform the design of cross-drainage and waterway structures, including scour mitigation measures

The Panel recommends the following scope for such a geomorphological risk assessment:

The assessment should be undertaken by a suitably qualified fluvial geomorphologist, and should be aimed at identifying:

- Potential impacts of the crossing arrangement on stream processes such as sediment transport capacity and/or scour that would lead to environmental impact to the surrounding riverine environment. This should include cumulative impacts on catchment processes including sediment budget and other related potential impacts; and
- Likely erosive or depositional processes that have the potential to impact the crossing arrangement.

Ideally, the geomorphic assessment would include the following components:

- Desktop assessment of:
    i. Detailed digital terrain models;
    ii. Current and historic aerial photography;
    iii. Hydraulic modelling outputs;
    iv. Design details for crossing arrangements (bridge and culvert crossings), including proposed conceptual level scour protection methods;
    v. Proposed setout of the rail route;
    vi. Proposed construction methods, including post construction rehabilitation intent;
    vii. Geotechnical and/or soils information if available;
- On-ground assessment of representative crossing locations and all high-risk crossings as identified through the desktop assessment with this on-ground assessment being carried out prior to or at the very start of Detailed Design; and
- A qualitative (or semi-quantitative) assessment of potential changes to the waterway over time that would lead to environmental impacts as a result of the crossings or impacts to the crossings resulting in failure or high maintenance costs.

5 Community Concerns

The following sections provide an overview on submissions to the Panel, submissions on the Draft EIS and additional community consultation that was undertaken by the Panel. All of these submissions and consultations were considered in the Panel's review of Inland Rail.

5.1 Submissions to the Panel

The Panel received a submission from one member of the public, which was related to the Westbrook Creek and Dry Creek catchments.

Dr John MacIntosh of Water Solutions made a submission (in relation to his review for the Southern Darling Downs Community Consultative Committee) of early documentation related to the Condamine River and Back Creek flood modelling.

Discussions were held with Dr Sharmil Markar of WRM Water and Environment (in relation to his review for community members) of early documentation related to the Condamine River and Back Creek flood modelling.

Discussions were also held with Goondiwindi Regional Council (GRC) and Toowoomba Regional Council (TRC) to detail issues of relevance to each Council.

5.2 Submissions on the Draft EIS

To allow community input, Queensland's OCG invited the community to provide feedback submissions on the respective draft Environmental Impact Statements for Inland Rail in Queensland. As part of the Panel process, stakeholder and community responses were provided to the Panel by the OCG for review. The process focussed on reviewing the concerns raised by stakeholders and the community that are directly aligned with the technical focus of the Panel. As such, the review and compilation has occurred only for responses that discuss or are focussed on the assessment of flooding and or the impact of flooding associated with the Inland Rail project. Submissions were reviewed for concerns that had not been considered in the EIS or the Panel's draft reports, or that shed new light on previously considered issues.

Reports were prepared by the Panel between August and December 2021 to respond to all flooding-related submissions that were provided by the OCG during the public exhibition of the Draft EIS. For the B2G section, 371 submissions were provided. For the G2H section, 14 submissions were provided. For the H2C section, 232 submissions were provided. For the C2K section, 44 submissions were provided. In addition, several further submissions were provided from organisations, including government departments, about specific concerns. All of these submissions, minus the duplicates, were considered and responded to in the reports, which were provided to the OCG for information.

5.3 Additional Consultation

In response to ongoing community concerns, several members of the Panel met with members of the community on-site and presented an update on progress of the Panel's review to the Millmerran Rail Group on 18 November 2021.

Whilst the Panel were aware of the concerns that were raised as part of the site visit and subsequent meeting, these meetings did provide valuable reinforcement of the key concerns, both in this vicinity and others, including concerns associated with the potential impact on neighbouring properties, potential scour associated with concentration of flows in areas of fragile soils, and the concerns of potentially impacted property owners and residents who currently experience significant flooding and are anxious to not have the flooding situation worsened.

6 Issues Identified

6.1 Issues Register Framework

The review identified a number of areas where additional work is required, either as part of further design or to allow the Draft EIS to be revised.

To facilitate the resolution of the identified issues, each issue has been assigned a level of importance, as described below.

Low Importance

Additional work is required that will not significantly affect the findings of the Draft EIS. The work can be completed as part of further design (prior to the use of flood models for Detailed Design).

Medium Importance

Clarification or confirmation is sought in relation to an aspect of the supplied reports and flood models. Depending on the response to the issue, the issue can be addressed via sensitivity testing (i.e., if the matter is deemed to be of high importance as a result of the response) or by the revision of modelling as part of a Revised EIS and/or as part of further design (i.e. it is deemed to be of low importance).

High Importance

Sensitivity testing is recommended to determine the significance of the issue to the interpretation of Inland Rail related flood impacts and for documentation and flood modelling regarding the results of the sensitivity testing to be supplied to the Panel to confirm whether the issue can be dealt with (if necessary) as part of a Revised EIS and/or as part of further design.

Very High Importance

An issue of significance that warrants the revision of the documentation provided to the Panel or the provision of additional documentation to include either additional justification regarding a conclusion drawn or amended flood modelling. Such issues will need to be addressed prior to the models being used for Detailed Design.

Figure 6-1 presents a flow chart indicating the process by which it is proposed to resolve each issue relative to its assigned level of importance. The colour-coding used in the figure was applied to the tables in Appendix A to Appendix D to allow the relative importance of each issue to be readily identified.

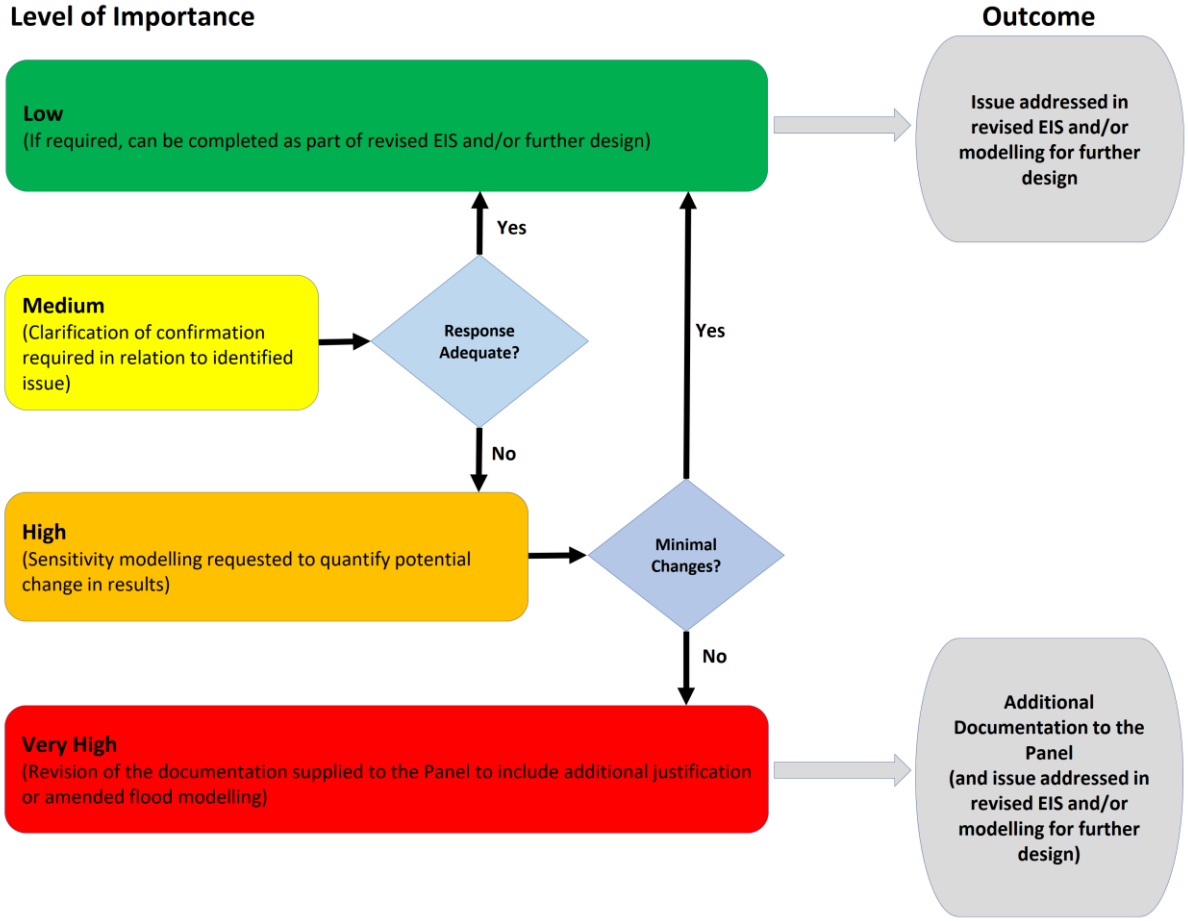

Figure 6-1: Flow Chart for Resolution of Identified Issues

6.2 Overview of Identified Issues

The following sections provide a summary of the IMR and how issues identified by the Panel have been resolved through the course of the project. Whilst there were many issues raised and tracked individually, these issues could be grouped into broad categories and their strategic resolutions are detailed in Table 6-1.

Appendix A to Appendix D present the IMR for the four Inland Rail sections that were reviewed.

Table 6-1: Strategic Outcomes of the Panel Review

Issue	Description	Resolution
Issues applicable to all sections		
Potential for unacceptable impacts	Potential for impacts to occur, but not be identified in the FIOs.	Quantitative FIOs have been recommended with adoption by ARTC.
Potential for long term damage that might not be identified by hydraulic modelling	Long term geomorphic processes, or short term, induced impacts associated with the introduction of structures in fragile soils not assessed in hydraulic modelling.	Geomorphological risk assessment has been committed to and which the Panel recommends be done before Detailed Design.
Issues regarding the appropriateness of the calibration for some models for use in design event and impact assessment	Apparent discrepancies between parameters as during the calibration process and those used for design modelling leading to issues regarding structure sizing.	Additional information and sensitivity testing undertaken in response to queries.
B2G Section		
Calibration issues in Condamine model	Issues regarding the accuracy of the model in specific locations leading to issues regarding structure sizing and impact assessment.	Modelling has been revised and reviewed, with improved calibration.
Calibration issues in Macintyre model	Issues regarding the accuracy of the model in specific locations leading to issues regarding structure sizing and impact assessment.	Refined modelling has been undertaken, with improved calibration and additional design flood events.
Issues regarding accuracy of Gowrie Creek models	Issues regarding the accuracy of the model in specific locations leading to issues regarding structure sizing and impact assessment.	ARTC have adopted a more developed TMR model.
G2H Section		
Issues regarding accuracy of Gowrie Creek models	Issues regarding the accuracy of the model in specific locations leading to issues regarding structure sizing and impact assessment.	ARTC have adopted a more developed TMR model.
H2C Section		
-	-	-
C2K Section		
Issues with magnitude of design flows adopted in some catchments	Potential for the design flows to be too low (compared with other available technical work) with associated implications that structures may be undersized for nominated design flows	Ipswich City Council Bremer River model adopted for design purposes.

6.3 Draft Review Report Issues Management Register

Table 6-2 summarises the Draft Review Report IMR that was submitted by the Panel.

Table 6-2: Draft Review Report IMR Summary

Report	Submission Date	Issues Raised				
		Low	Medium	High	Very High	Total
Border to Gowrie Draft Review Report	17/03/2021	59	60	55	19	**193**
Gowrie to Helidon Draft Review Report	01/07/2021	27	30	29	1	**87**
Helidon to Calvert Draft Review Report	12/05/2021	10	8	11	3	**32**
Calvert to Kagaru Draft Review Report	18/02/2021	20	13	23	7	**66**
Total		**116**	**114**	**118**	**30**	**378**

6.4 Draft Review Report Issues Management Register Following ARTC Responses

In response to the issues raised by the Panel, ARTC have undertaken significant work to address the issues. This additional work included:

- Clarification to documentation (or a commitment to provision of additional information in the Revised Draft EIS);
- Provision of additional information; or
- Further technical work (with associated documentation) to investigate issues raised by the Panel.

In general, these responses have been provided in the form of technical notes.

As a result of this additional work, the Panel updated the IMR using new categories. These categories were selected to describe where and how the issues were or will be addressed. The updated IMR summary is provided in Table 6-3.

Table 6-3: Draft Review Report Issues Registers Summary Following ARTC Responses

Status	B2G	G2H	H2C	C2K	Total
Closed	81	41	6	18	**146**
Accepted Subject to Additional Information in Revised Draft EIS	58	28	15	31	**132**
Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	52	16	7	14	**89**
Accepted subject to Panel's recommended implementation of geomorphological assessment	2	2	4	3	**11**
Total	**193**	**87**	**32**	**66**	**378**

The following sections explain the definitions of the status options in greater detail. Appendix A to Appendix D list all issues and their status. The issue numbers in the IMR reflect those that are in the Panel's Draft Reports.

6.4.1 Closed Issues

Issues categorised as closed have been resolved following further consideration, discussions with ARTC, and in many cases, the provision of additional information by ARTC.

6.4.2 Issues Accepted Subject to Further Demonstration in Revised Draft EIS

Issues falling into this category were those identified by the Panel for which ARTC committed to providing additional information in the Revised Draft EIS. In general this will require either additional information to be documented, a revised approach, or both.

In most instances, ARTC provided further evidence that the issue was addressed in their response to the Panel, and it is that evidence, or the detailed results and mapping based on that evidence, that needs to be incorporated into the Revised Draft EIS.

6.4.3 Issues Accepted Subject to ARTC Committing to Panel's Recommendations being Addressed in Detailed Design

Issues in this category are those that can only be addressed during the next stages of design. The Panel advises that the issues are resolved on the basis that additional work will be undertaken by ARTC and or its constructor in the Detailed Design stage of the project.

In general, the issues that fall under this status are of lower importance and can be rectified during future stages of the project, subject to the relevant FIOs, without altering the results and conclusions drawn from the flood models and presented in the EIS.

6.4.4 Issues Accepted Subject to Panel's Recommended Implementation of Geomorphological Assessment

Issues falling into this category were those identified by the Panel as being accepted subject to ARTC agreeing to the Panel's final recommendation on geomorphological risk assessment. This category was used for all geomorphology issues as the Panel would like to see the following recommendations occur:

1. All high-risk sites to have detailed onsite assessments; and
2. Inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.

7 Implications/Constraints for Future Stages

7.1 Implications for Knowledge Transfer

At this stage, it is expected that of the four Inland Rail sections in Queensland, one is to be delivered using a Design and Construct (D&C) contract method (including B2G), and three to be delivered as a combined Public Private Partnership (PPP) (G2H, H2C, and C2K).

The Panel notes that some sections of B2G have already been awarded and has been novated across to the B2G project. The novation to the B2G project ensures continuity into the next phase. However, the Panel further notes that this will not necessarily be the case for other sections, so processes ensuring comprehensive transfer of knowledge to other design teams will be essential (see recommendation 3).

7.2 Technical Implications

In some instances, the Panel's review has resulted in the adoption of significantly higher design flow rates with respect to a number of catchments. In these locations, ARTC have committed to addressing the issues identified in the Panel's review in the Revised Draft EIS. In Detailed Design, while the embankment level would appear to be well above flood level and unlikely to be affected by the increase in level associated with higher flows, the adoption of higher flows could necessitate larger drainage structures (bridges and culverts) to provide impacts similar to those nominated in the Draft EIS and Technical Report.

Alternatively, even in the event of sensitive receptors not being affected by changed flow conditions, additional negotiations would be required with landowners to gain agreement to greater impacts than discussed in relation to the FIOs.

In either situation, additional scour protection works could also be required to protect against the higher velocities associated with higher flows (see recommendation 6).

7.3 Implementing the Panel's recommendations

The Panel recommends that a process is put in place to ensure that the key recommendations are implemented and the IMR be used as the basis for this assessment. The Detailed Design stage often results in better alternative design solutions that will need a careful checking against the flood criteria. A suitable qualified practitioner with the relevant skills should be engaged to review the design against the FIO and IMR at each of the key stages. This would be aided by the designer producing a short compliance report.

It is crucial that proper processes are in place to enable design reviews at key stages. Alternative designs will need to be checked against the FIOs particularly if they result in a reduction in waterway area.

8 Conclusions

8.1 Overview

The Panel has reviewed the 24 flood models that were adopted in the Draft EIS of the Queensland section of Inland Rail between the NSW border and Kagaru. The review generated a list of 378 issues for discussion with ARTC. 30 of the issues were designated a “Very High” level of importance, 118 were designated a “High” importance, 114 were designated a “Medium” importance, and 116 were designated a “Low” importance.

Out of the 378 issues that were generated:

- 146 were closed following discussions with ARTC;
- 132 were accepted, subject to additional information in the Revised Draft EIS;
- 89 were accepted, subject to ARTC committing to Panel's recommendations being addressed in Detailed Design; and
- 11 were accepted, subject to Panel’s implementation of geomorphological assessment.

Tables of these issues are provided in Appendix A to Appendix D.

8.2 Terms of Reference Conclusions

The following sections state extracts of the *Terms of Reference for an Independent International Panel of Experts for Flood Studies of Inland Rail in Queensland* (June, 2020). For these extracts, conclusions were drawn on whether the modelling met the requirements for the entire Queensland section of work between the NSW border and Kagaru.

In summary, the models are “fit for purpose”, meaning suitable for an EIS and subsequently Detailed Design, once the recommended actions have been adopted by ARTC.

8.2.1 Relevant Guidelines

Whether the development of the models and their application accords with the relevant requirements of national and state guidelines/manuals (guidelines) for flood estimation and design of structures in flood prone environments.

Models have been improved as a result of the process to accord with relevant national and state guidelines and the majority of issues have been addressed. Remaining issues (which are the subject of further design) are captured in the IMR.

8.2.2 Floodplain Extent

Whether the extent of the floodplain covered by the flood model is appropriate, and if not recommendations as to what additional extent would be appropriate.

The current adopted extent of each of the models is considered appropriate.

8.2.3 Calibration

Whether the method, and extent of calibration of the model accords with guidelines and industry standards for calibration.

The method and extent of calibration accords with guidelines and industry standards, including updated models for the Macintyre River, Condamine River and Gowrie Creek.

8.2.4 Validation

Whether the method for validation of the model accords with guidelines and industry standards and whether the assumptions used underpin the validation process, and the data points used in the validation are appropriate.

All models were validated in accordance with guidelines and industry standards. For Bringalilly Creek, Cattle Creek and Nicol Creek there is limited data and considerable uncertainty about design flows. ARTC has adopted the Panel's recommendation that the highest modelled design flow will be used.

8.2.5 Impacts and Impact Mitigation

Whether the model adequately accounts for the impacts of the reference design and whether those impacts are capable of appropriate local mitigation that either removes the impacts or reduces the impact to landholders in the area.

The models were found to account for the impacts of the reference design. Flood Impact Objectives (FIOs) have been developed by ARTC in conjunction with the Panel to determine the acceptability or otherwise of potential impacts. The final recommended version of the FIOs is presented in Section 3.5.

8.2.6 Fit for Purpose

Whether the model is fit for purpose, taking into account the above and any public comments for comments from external stakeholders in relation to the flood model that arises from the public exhibition of the draft Environmental Impact Statement (EIS) for the relevant Inland Rail Project.

In summary, the models will be "fit for purpose", (suitable for an EIS and subsequently Detailed Design), noting issues captured in the IMR are matters to be addressed at further design stages of the project.

Reports were prepared to the OCG by the Panel. These reports reviewed and responded to all flooding-related submissions that were provided by the OCG following the public exhibition of the B2G, G2H, H2C and C2K Draft EIS.

8.2.7 Best Practice

Whether the reference design for the proposed structure meets industry standards for railway structures in a floodplain and if so, whether the reference design is in accordance with best practice.

Across the four project sections that were assessed by the Panel, all models were found to have proposed structures that met industry standards for railway structures in a floodplain, meaning that the reference design was completed in accordance with best practice. Based on this work, the reference designs can be taken forward as the basis for the Detailed Design.

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Appendix A B2G Issues Management Register

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Yelarbon to Inglewood	B2G.Y1	Three hydrologic models were adopted for the Yelarbon to Inglewood hydraulic model.	High	Responded to in Technical Note	23	It will be necessary to review the impacts associated with the revised modelling unless there are no significant differences to the hydraulic model results as a result of the revised hydrology.	Accepted subject to additional information in Revised Draft EIS	Include the revised hydrology in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y2	Subcatchments downstream of the DNRM Booba Sands gauge (416415A) (subcatchments 44 and 45) were not discussed in the Technical Report in high detail, meaning that the lower portion of the Macintyre Brook catchment may not have been properly included in the NS2B URBS Macintyre Brook model and subsequently not included in the TUFLOW model accurately.	Medium	Responded to in Technical Note	23	It will be necessary to review the impacts associated with the revised modelling at and downstream of Yelarbon unless there are no significant differences to the hydraulic model results as a result of the revised hydrology.	Accepted subject to additional information in Revised Draft EIS	Include the revised hydrology in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y3	Local catchment flows were generally not included within the hydraulic model as separate inflows. They were lumped together with larger catchment flows instead.	Low	To be addressed in Detailed Design	23	Local catchment flows to be delineated in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Local catchment flows to be delineated in Detailed Design.
B2G	Yelarbon to Inglewood	B2G.Y4	Fewer historical event calibrations were performed than previous studies for this catchment and this is despite there being historical data available for many events.	Very High	Responded to in Technical Note	23	Figure 4(a) of the provided Technical Note is incorrect, but the following comments remain true: The minimum recommended historical events have now been modelled (1976, 1996 and 2011). It was desirable that the 1988 event, the largest event on record at the Inglewood stream gauge, be modelled, but the three chosen events show an acceptable match for a range of flood magnitudes, so the number of historical events used for calibration purposes can now be considered acceptable.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y5	Historical stream gauge data was not utilised in the hydrologic or hydraulic modelling calibration process except for at one gauge. There are six more DNRM stream gauges within the catchment known to have data for the 1976 flood event that can be used for calibration purposes. There are also four more DNRM gauges that can be used for some other storm events, plus some BoM gauges that may be suitable. Note that hydraulic model(s) would be required for some gauges to derive rating curves.	Very High	Responded to in Technical Note	23	Table A1 of the provided PIR Appendix A has the wrong gauge ID for Canning Creek @ Woodspring. Stream gauge 416409A Macintyre Brook at Coolmunda Dam H/W, stream gauge 416413A Macintyre Brook at 1.6km and stream gauge 416406A Macintyre Brook at Ben Dor Weir were excluded from the assessment despite having data for at least one of the adopted calibration events. Due to Appendix A of the updated PIR making clear that there is some uncertainty around the 1976 calibration, the data from these gauges should be considered to determine if they can give additional confidence to the model result. The Ben Dor Weir gauge in particular may be good for determining the calibration in the lower portion of the catchment, where no other gauge data exists for the 1976 event. That being said, the data presented in the updated PIR shows a reasonable match for a range of events, indicating an acceptable calibration for the upper portions of the catchment. The 1996 event calibration does show some inconsistencies for some gauges, but the peaks generally match well.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to report on fit at gauges 416413A and 416406A for calibration events and if these gauges improve calibration or confidence in the results.
B2G	Yelarbon to Inglewood	B2G.Y6	The rating curve at the DNRM stream gauge 416402B/C has not been verified with a hydraulic model.	Low	Responded to in Technical Note	23	The updated technical note presents checks of the rating curve at Inglewood using the hydraulic model, but it notes that the match could also be good due to calibration to that rating curve. The discrepancy to the historical curve is unusual, but the claim of it possibly being explained by technology of the time holds some merit and is the only logical explanation at this time. Recommend that continued investigation of the issue be considered over the course of the project.	Accepted subject to additional information in Revised Draft EIS	The updated modelling methodology and modelling outcomes are to be presented in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y7	Insufficient details were provided for adopted historical rainfall data.	Medium	Responded to in Technical Note	23	Demonstration of PIR detail transferred to Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Demonstration of PIR detail transferred to Revised Draft EIS. Updated modelling methodology and modelling outcomes to be presented in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y8	Design storm events in the hydrologic models assumed that Coolmunda Dam was at full supply level.	Medium	Responded to in Technical Note	23	Suggest relevant detail from PIR be included in EIS.	Accepted subject to additional information in Revised Draft EIS	Relevant detail from the PIR to be included in Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y9	The adopted storage-discharge relationships of Coolmunda Dam in the two Macintyre Brook hydrologic models do not match each other, and they were not verified against the SunWater level-discharge relationship.	Medium	The Coolmunda Dam routing characteristics for the 1% AEP event should match those from the 2011 historical calibration event not the 1976 event. The Technical Note has been updated to reflect this and to confirm detail will be included in the Revised Draft EIS.	23	Revised Draft EIS to include explanation for why the design storm events utilise the 2011 dam routing functions rather than the 1976 routing functions.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to include explanation for why the design storm events utilise the 2011 dam routing functions rather than the 1976 routing functions.
B2G	Yelarbon to Inglewood	B2G.Y10	The routing parameters of the adopted NS2B and Inglewood Flood Study URBS models were different, with the alpha parameter of the Inglewood Flood Study being outside of the "normal" range. Additionally, the adopted NS2B URBS model differed from the actual NS2B URBS model.	High	Responded to in Technical Note	23	The Macintyre Brook URBS model has the same parameters as the other reaches. A check of all 4 URBS models confirms this has been applied.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y11	The Inglewood Flood Study URBS model has channel slope (Sc) values written within the catchment (.cat) file, but they were not activated because the "USES" command did not activate it.	Medium	Responded to in Technical Note	23	No slopes are included in the URBS models provided for the PIR. The URBS model was originally built with slope then not used as it did not benefit calibration.	Closed	n/a

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B2G	Yelarbon to Inglewood	B2G.Y12	The rainfall losses of the two hydrologic models were not consistent. The Dumaresq River model, which was not provided to the Panel, may also have different rainfall losses.	High	The validity of the FFA projection to large events is questionable due upstream reservoir influence hence dependent on rainfall-based method. Supporting documentation provided to Expert Panel.	23	Supporting evidence demonstrates that ARTC did a comprehensive assessment of the anomaly but was unable to determine the cause. The adopted approach is therefore the most reasonable, though its deficiencies are noted. Revised Draft EIS is to document this information.	Accepted subject to additional information in Revised Draft EIS	Supporting evidence demonstrates that ARTC did a comprehensive assessment of the anomaly but was unable to determine the cause. The adopted approach is therefore the most reasonable, though its deficiencies are noted. Revised Draft EIS is to document this information.
B2G	Yelarbon to Inglewood	B2G.Y13	Some hydraulic controls, such as roads and railways, were not enforced within the Existing Case hydraulic model. For those that were enforced, it is unclear if better than 5m resolution data was used to define the hydraulic control (e.g. LiDAR point cloud).	High	Responded to in Technical Note	23	Sensitivity assessment performed and showed minor changes to flood levels from enforcing features. Changes to be incorporated into Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Changes to be incorporated into Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y14	The spatial delineation of roughness was poor in some locations, particularly around Macintyre Brook.	High	Responded to in Technical Note	23	Suggest relevant detail from PIR be included in EIS.	Accepted subject to additional information in Revised Draft EIS	Relevant detail from PIR be included in Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y15	Inflow boundaries near the model boundary were applied as source-area polygons instead of discharge-time inflow lines, which means that they entered the model with zero velocity. The boundaries are, however, generally a reasonable distance from the proposed alignment. These boundaries resulted in water flowing somewhat upstream.	High	Responded to in Technical Note	23	Sensitivity assessment completed which showed changes in flood levels from applying inflows as discharge-time boundaries. Suggested SAs would be applied going forward due to stability unless too close to alignment.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y16	Inflow_39 and Inflow_43 are located within local catchments, rather than within Macintyre Brook.	High	Responded to in Technical Note	23	Inflows moved to within Macintyre Brook with minor differences in flood levels. Change to be incorporated into Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Changes to be incorporated into Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y17	Some inflow boundary locations differ between the calibration and the design storm event models.	High	Responded to in Technical Note	23	Inflow boundaries updated to be consistent between hydrology and hydraulic models.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y18	The Dumaresq River inflows of the hydraulic model were scaled by a factor of 0.7 and there is no mention in the B2G report that the Dumaresq River URBS model was used in the Yelarbon to Inglewood models.	Medium	Responded to in Technical Note	23	Scaling factor removed from updated modelling.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y19	The bridge form loss and blockage parameters are not consistent with the TMR Technical Guideline on Hydrologic and Hydraulic Modelling for existing and proposed bridges and no explanation was provided for how they were derived.	Medium	Responded to in Technical Note	23	Parameters in line with industry standards, with validation of coefficient proposed to be completed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Bridge losses to be updated to industry standard and consistent with TMR guidelines in Detailed Design phase.
B2G	Yelarbon to Inglewood	B2G.Y20	Safety barriers were not added to the hydraulic model, specifically not at road overpasses.	Low	To be addressed in Detailed Design	23	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Safety barriers to be added to the hydraulic model during Detailed Design.
B2G	Yelarbon to Inglewood	B2G.Y21	The hydraulic model roughness was left unchanged between the Existing Case hydraulic model and the Design Case hydraulic model.	Low	To be addressed in Detailed Design	23	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The hydraulic model roughness in the Existing Case hydraulic model and the Design Case hydraulic model to be addressed in Detailed Design.
B2G	Yelarbon to Inglewood	B2G.Y22	The distribution of the critical duration along the alignment was not described, so it is unclear if the critical duration changes across the approximately 60km long model.	Medium	Responded to in Technical Note	23	Details of the critical design event not provided but to be included in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y23	The reported flood frequency analysis results show a poor match to previous FFAs and the adopted TUFLOW model.	Very High	The validity of the FFA projection to large events is questionable due upstream reservoir influence hence dependent on rainfall-based method. Supporting documentation provided to Expert Panel.	23	Supporting evidence demonstrates that ARTC did a comprehensive assessment of the anomaly but was unable to determine the cause. The adopted approach is therefore the most reasonable, though its deficiencies are noted. EIS is to document this information. Should a large flood event occur in the catchment between the time of the previous analysis, such as the event that occurred in early December 2021, consideration should be given to re-running the assessment to determine whether a better match can be achieved.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document this issue and why approach was adopted. As large flood events occurred in the catchment between the time of the previous analysis, it is recommended to rerun the assessment to determine whether a better match can be achieved.
B2G	Yelarbon to Inglewood	B2G.Y24	The flood frequency analysis was only performed at one stream gauge, despite several other stream gauges having data available.	High	Responded to in Technical Note	23	ARTC have completed an additional FFA at Booba Sands in the Macintyre Brook catchment.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y25	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	23	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Yelarbon to Inglewood	B2G.Y26	Culvert 1D/2D connection lines are coarsely located and oftentimes far longer than the culvert opening width.	High	Responded to in Technical Note	23	Sensitivity assessment performed and showed minor changes to flood levels from updated connections. Changes to be incorporated into Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	All connections lines to be updated and adjusted as required for the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y27	Not all culverts and bridges were included in the hydraulic model.	High	Responded to in Technical Note	23	RFI lodged with QR for missing culvert and bridge information. Revised Draft EIS to incorporate these structures.	Accepted subject to additional information in Revised Draft EIS	Hydraulic model to be updated to capture any additional existing bridges and culverts not already included in the modelling and reflected in the Revised Draft EIS documentation.

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B2G	Yelarbon to Inglewood	B2G.Y28	Several culvert loss parameters are non-standard.	Medium	Responded to in Technical Note	23	Sensitivity assessment performed and showed minor changes to flood levels from updated loss parameters. Changes to be incorporated into Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Updated sensitivity loss parameters to be adopted in the Revised Draft EIS model.
B2G	Yelarbon to Inglewood	B2G.Y29	The proposed culverts in the hydraulic model do not always match what was reported upon in Section 8 (Drainage) of the Feasibility Design Report.	High	The FDR was finalised at a point in time. The draft EIS has further refined structures and this will continue in the Revised Draft EIS. Therefore, structures will not match FDR. The Technical Note has been updated to reflect this position.	23	Revised Draft EIS to have structures in the FDR and technical documentation synchronised.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to have structures in the FDR and technical documentation synchronised.
B2G	Yelarbon to Inglewood	B2G.Y30	Large 1D culverts are schematised incorrectly.	High	The Technical Note has been updated to reflect this position.	23	Schematisation updated and sensitivity assessment completed as part of Y26. Alternative culvert configuration modelled. Unable to determine impact based on provided maps (inappropriate scale selected) however reported impacts are minor and localised. Correct schematisation to be utilised for EIS.	Accepted subject to additional information in Revised Draft EIS	All connections lines to be updated and adjusted as required for the Revised Draft EIS. The modelling of large culverts to be revised in the Revised Draft EIS.
B2G	Yelarbon to Inglewood	B2G.Y31	Many culverts are abnormally large and not flowing at 100% of capacity, indicating potentially incorrect modelling.	Low	To be addressed in Detailed Design	23	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The modelling of large culverts to be revised in Detailed Design.
B2G	Yelarbon to Inglewood	B2G.Y32	The implementation of structure blockage within the hydraulic model was not in accordance with the TMR Hydrologic and Hydraulic Modelling Technical Guideline. 25% blockage was applied to some structures, though blockage usually varies by AEP and opening size.	Low	Responded to in Technical Note	23	To be deleted as per discussions with Flood Panel.	Closed	n/a
B2G	Yelarbon to Inglewood	B2G.Y33	Some increases in flood level were not reported upon, both at private properties and buildings.	Very High	Technical Note updated to include commitment in accordance with FIOs in the Revised Draft EIS.	23	Revised Draft EIS to document all impacts in accordance with the revised FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts in accordance with the revised FIOs.
B2G	Yelarbon to Inglewood	B2G.Y34	Some flood level increases were significant and in excess of the flood impact objectives, with no conclusions drawn about their acceptability and why further mitigation was not possible.	Medium	Technical Note updated to include commitment in accordance with FIOs in the Revised Draft EIS.	23	Revised Draft EIS to document all impacts in accordance with the revised FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts in accordance with the revised FIOs.
B2G	Yelarbon to Inglewood	B2G.Y35	Increases in duration of inundation are reported on local and state-controlled roads, with no conclusions drawn as to their acceptability to Council and TMR.	Medium	Technical Note updated to include commitment in accordance with FIOs in the Revised Draft EIS.	23	Revised Draft EIS to document all impacts in accordance with the revised FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts in accordance with the revised FIOs.
B2G	Yelarbon to Inglewood	B2G.Y36	Only the 1% AEP change in duration of inundation was reported, which is insufficient to draw conclusions on change in duration of inundation to stakeholders.	Medium	Responded to in Technical Note	23	Impacts to be reviewed based on updated modelling and included in Revised Draft EIS including events up to 1%.	Accepted subject to additional information in Revised Draft EIS	Impacts to be reviewed based on updated modelling and included in Revised Draft EIS including events up to 1%.
B2G	Yelarbon to Inglewood	B2G.Y37	Insufficient information has been provided to draw conclusions around changes in velocity.	Medium	Technical Note updated to include commitment in accordance with FIOs in the Revised Draft EIS.	23	Revised Draft EIS to document all impacts in accordance with the revised FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts in accordance with the revised FIOs.
B2G	Cremascos Road	B2G.CRE1	A small proportion of the subcatchment has not been included in the hydrologic model.	Low	To be addressed in Detailed Design	21	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	A small proportion of the subcatchment has not been included in the hydrologic model. This issue is to be rectified in Detailed Design.
B2G	Cremascos Road	B2G.CRE2	The alpha and beta routing parameters of the hydrologic model were outside of the typical range.	High	Response provided in updated Technical Note, with changes/updates highlighted.	21	ARTC explained how the parameters were adopted (via command line overrides) and that typical parameters were used when using only stream length to define catchment and channel storage.	Closed	n/a
B2G	Cremascos Road	B2G.CRE3	The downstream boundary was not placed sufficiently far downstream of the proposed rail alignment and levels were not validated to the Yelarbon to Inglewood model results.	High	Responded to in Technical Note	21	Sensitivity assessment undertaken as requested with very little change to modelled impacts.	Closed	n/a
B2G	Cremascos Road	B2G.CRE4	A small number of hydraulic controls (roads) were not enforced within the Existing Case hydraulic model.	High	Responded to in Technical Note	21	Sensitivity assessment undertaken as requested with no impact on water levels.	Closed	n/a
B2G	Cremascos Road	B2G.CRE5	One of the roughness parameter values was outside of the ARR19 recommended parameter range and the 'Crops' roughness was higher than what aerial imagery suggests to be true.	Medium	Responded to in Technical Note	21	The roughness values were updated in line with ARR and only had a minor impact on water levels.	Closed	n/a
B2G	Cremascos Road	B2G.CRE6	The spatial delineation of roughness is immature in some locations, particularly around the creek.	Medium	Responded to in Technical Note	21	The locations of poor roughness delineation are isolated and likely would not alter current flood model results. These isolated locations should be delineated in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The locations of poor roughness delineation are isolated and likely would not alter current flood model results. These isolated locations should be delineated in Detailed Design.
B2G	Cremascos Road	B2G.CRE7	Inflow boundaries near the model boundary were applied as source-area polygons instead of QT inflow lines, which means that they entered the model with zero velocity.	Low	To be addressed in Detailed Design	21	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Inflow boundaries near the model boundary were applied as source-area polygons instead of QT inflow lines, which means that they entered the model with zero velocity. This issue is to be rectified in Detailed Design.
B2G	Cremascos Road	B2G.CRE8	Inflow 13L crosses the proposed rail alignment.	High	Responded to in Technical Note	21	Sensitivity assessment undertaken as requested with no impact on water levels.	Closed	n/a
B2G	Cremascos Road	B2G.CRE9	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	21	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Cremascos Road	B2G.CRE10	A diversion channel is proposed in the hydraulic model, but not documented in the reports and it appears that the diversion can easily be avoided through the use of cross-drainage culverts.	Medium	Responded to in Technical Note	21	Justification of catch drain provided with discussion to be added to the technical report.	Closed	n/a

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B2G	Cremascos Road	B2G.CRE11	The hydraulic model roughness was left unchanged between the Existing Case and Design Case hydraulic models.	Medium	Responded to in Technical Note	21	Embankment roughnesses updated with no impact on water levels.	Closed	n/a
B2G	Cremascos Road	B2G.CRE12	The proposed bridge was not applied to the hydraulic model with a corresponding form loss or blockage. It was only modelled as an opening in the rail embankment.	Low	To be addressed in Detailed Design	21	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The proposed bridge to be corrected in Detailed Design with a corresponding form loss or blockage.
B2G	Cremascos Road	B2G.CRE13	Change in velocity is not discussed in sufficient detail for the Cremascos Catchment in Chapter 12 of the EIS.	Medium	Responded to in Technical Note	21	Discussion provided in Macintyre Brook sections of report with additional mapping to be provided in the Revised Draft EIS. Change in velocity should be mapped for other than the 1% AEP event.	Accepted subject to additional information in Revised Draft EIS	Mapping to be included within the Revised Draft EIS to provide further information on percentage change in velocity depth product, percentage change in velocity and percentage change in time of inundation with the text augumented accordingly.
B2G	Bybera Road	B2G.BYB1	The subcatchment delineation is not accurate in the south-western portion of the catchment.	Low	To be addressed in Detailed Design	20	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The subcatchment delineation in the south-western portion of the catchment to be revisited in Detailed Design.
B2G	Bybera Road	B2G.BYB2	The alpha and beta routing parameters of the hydrologic model were outside of the typical range.	High	Response provided in updated Technical Note, with changes/updates highlighted.	20	ARTC explained how the parameters were adopted (via command line overrides) and that typical parameters were used when using only stream length to define catchment and channel storage.	Closed	n/a
B2G	Bybera Road	B2G.BYB3	The downstream boundary was not placed sufficiently far downstream of the proposed rail alignment and set to a slope slightly steeper than the topography, unverified to Yelarbon to Inglewood results.	High	Responded to in Technical Note	20	Sensitivity assessment undertaken for downstream boundary location as requested with very little change to modelled impacts. Updated downstream boundary to be adopted in Revised Draft EIS. Sensitivity assessment also undertaken for regional 1% AEP flood event with very little change to modelled impacts.	Closed	n/a
B2G	Bybera Road	B2G.BYB4	One of the roughness parameter values in the vicinity of the alignment was outside of the ARR19 recommended parameter range.	Medium	Responded to in Technical Note	20	The roughness values were updated in line with ARR and had no impact on water levels.	Closed	n/a
B2G	Bybera Road	B2G.BYB5	The spatial delineation of roughness is immature in some locations, particularly around the creek.	Medium	Responded to in Technical Note	20	The roughness of the "creek" has been updated to be sparser than dense vegetation. This resulted in a slight reduction in water levels.	Closed	n/a
B2G	Bybera Road	B2G.BYB6	Inflow boundaries near the model boundary were applied as source-area polygons instead of QT inflow lines, which means that they entered the model with zero velocity.	Low	To be addressed in Detailed Design	20	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Inflow boundaries near the model boundary were applied as source-area polygons instead of QT inflow lines, which means that they entered the model with zero velocity. This issue is to be rectified in Detailed Design.
B2G	Bybera Road	B2G.BYB7	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	20	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Bybera Road	B2G.BYB8	The hydraulic model roughness was left unchanged between the Existing Case and Design Case hydraulic models.	Medium	Responded to in Technical Note	20	Embankment roughnesses updated with no impact on water levels.	Closed	n/a
B2G	Bybera Road	B2G.BYB9	The culvert (7/1050mm RCP) at Ch 55.06 km was excluded from the hydraulic model.	High	Sensitivity Test completed and Response provided in updated Technical Note, with additional text highlighted.	20	ARTC explained that the addition of the culvert does not cause afflux issues. Culvert to be included in the Detailed Design hydraulic model.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Culvert to be included in the Detailed Design hydraulic model.
B2G	Bybera Road	B2G.BYB10	The proposed bridge was not applied to the hydraulic model with a corresponding form loss or blockage. It was only modelled as an opening in the rail embankment.	Low	To be addressed in Detailed Design	20	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The proposed bridge to be corrected in Detailed Design with a corresponding form loss or blockage.
B2G	Bybera Road	B2G.BYB11	There is a significant amount of instability in the hydraulic model timestep.	Low	To be addressed in Detailed Design	20	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Instability in the hydraulic model timestep to be rectified in Detailed Design.
B2G	Bybera Road	B2G.BYB12	Two properties are reported to have flood level increases in excess of the design objectives.	Medium	Responded to in Technical Note	20	Maximum flood impact values provided and do not exceed FIO of 200mm.	Closed	n/a
B2G	Bybera Road	B2G.BYB13	Change in velocity is not discussed in sufficient detail for the Bybera Catchment in Chapter 12 of the EIS.	Medium	Responded to in Technical Note	20	Discussion provided in Macintyre Brook sections of report with additional mapping to be provided in the Revised Draft EIS. Change in velocity should be mapped for other than the 1% AEP event.	Accepted subject to additional information in Revised Draft EIS	Discussion provided in Macintyre Brook sections of report with additional mapping to be provided in the Revised Draft EIS.
B2G	Pariagara Creek	B2G.PC1	Inflow has been applied to the model via an SA polygon utilising the 'ALL' command.	Low	To be addressed in Detailed Design	26	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Inflow has been applied to the model via an SA polygon utilising the 'ALL' command to be addressed in Detailed Design.
B2G	Pariagara Creek	B2G.PC2	Critical duration analysis and temporal pattern selection has only been undertaken for the hydrologic model outlet, with a single duration and temporal pattern selected.	Medium	Sensitivity Test performed and Response provided in updated Technical Note, with additional text highlighted.	26	The sensitivity analysis demonstrated that increases in water level in excess of the FIOs will be created, so they must be reported accordingly. The Technical Note did not explicitly say that they would be reported upon, but they must be reported in the EIS because they are impacts to private property. Reporting should not be left to Detailed Design, as suggested by the technical note, which is why the status of this comment has been made "Accepted subject to additional information in Revised Draft EIS".	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to present results of sensitivity analysis and to present results where impacts are in excess of FIOs.

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B2G	Pariagara Creek	B2G.PC3	Downstream catchment inflows and coincident flooding has not been accounted for in the model.	Medium	Sensitivity Test performed and Response provided in updated Technical Note, with additional text highlighted.	26	Tailwater changes to be adopted in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Tailwater changes to be adopted in Detailed Design.
B2G	Pariagara Creek	B2G.PC4	Peak flow estimates do not show a reasonable approximation to RFFE and QRT.	High	Responded to in Technical Note	26	Item is closed.	Closed	n/a
B2G	Pariagara Creek	B2G.PC5	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	26	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Pariagara Creek	B2G.PC6	No losses applied to bridge "openings". Bridge loss coefficients not calibrated or verified against alternate methods.	Low	To be addressed in Detailed Design	26	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to confirm reasonableness of bridge losses using alternate approaches.
B2G	Pariagara Creek	B2G.PC7	Level of detail in Technical Report.	Very High	Responded to in Technical Note	26	Further technical information required to be provided in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further technical information required to be provided in the Revised Draft EIS.
B2G	Pariagara Creek	B2G.PC8	Justification for flood impacts.	Very High	Response provided in updated Technical Note, commitment added. Updated text has been highlighted.	26	Revised Draft EIS to document all impacts against the updated FIOs and justify why any impacts were not within the FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts against the updated FIOs and justify why any impacts were not within the FIOs.
B2G	Cattle Creek	B2G.CC1	Insufficient information is provided in relation to the Macintyre Brook FFA and its use in the validation process.	High	Updated response has been provided in updated Nicol Creek Tech Memo, with updated text highlighted.	22	Refer to N2 comment.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.
B2G	Cattle Creek	B2G.CC2	Parameters used in URBS model.	Medium	Updated response has been provided in updated Nicol Creek Tech Memo, with updated text highlighted.	22	Refer to N2 comment.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.
B2G	Cattle Creek	B2G.CC3	Final loss rates not detailed in Technical Report. Potential variation in loss rates could mask inadequacies with other URBS parameters.	Low	Responded to in Technical Note	22	Have detailed loss rates and gave undertaking to include in next report. This is acceptable noting that the ultimate response to ND1/ND2 may result in the adoption of different loss values.	Closed	n/a
B2G	Cattle Creek	B2G.CC4	Incorrect ARF parameter for the Ch87.37 and Ch87.19 culverts.	Very High	Responded to in Technical Note	22	Revised flows to account for local catchment upstream revision accepted.	Closed	n/a
B2G	Cattle Creek	B2G.CC5	Incorrect design event selection for the Ch87.37 and Ch87.19 culverts.	Very High	Responded to in Technical Note	22	Revised flows to account for local catchment upstream revision accepted.	Closed	n/a
B2G	Cattle Creek	B2G.CC7	SA polygon setup for the two smaller tributaries results in unrealistic additional flow routing.	Medium	Responded to in Technical Note	22	Outcome noted and accepted, recommended correct inflow setup is utilised in Detailed Design.	Closed	n/a
B2G	Cattle Creek	B2G.CC8	Design flows are lower than the estimates provided by RFFE and QRT.	High	Responded to in Technical Note	22	As recommended by ARTC in technical note 22, this should be revisited in Detailed Design to ensure conservative flow estimation.	Closed	n/a
B2G	Cattle Creek	B2G.CC9	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	22	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Cattle Creek	B2G.CC10	Level of detail in Technical Report.	Very High	Responded to in Technical Note	22	Further technical information required to be provided in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further technical information required to be provided in the Revised Draft EIS.
B2G	Native Dog Creek	B2G.ND1	Insufficient information is provided in relation to the Macintyre Brook FFA and its use in the validation process.	Low	Responded to in Technical Note	24	Updated Technical Note for Nicol Creek deals with this at Item N2. Whilst rejected for other 3 catchments, ND has good agreement with QRT and RFFE, hence why we scored Low originally.	Closed	n/a
B2G	Native Dog Creek	B2G.ND2	Parameters used in URBS model.	Low	Responded to in Technical Note	24	Primary issue seems to be the use of a single URBS model to try and model several unique catchments. Updated Technical Note for Nicol Creek deals with this at Item N3. Whilst rejected for other 3 catchments, ND has good agreement with QRT and RFFE, hence why we scored Low originally.	Closed	n/a
B2G	Native Dog Creek	B2G.ND3	Final loss rates not detailed in Technical Report. Potential variation in loss rates could mask inadequacies with other URBS parameters.	Low	Responded to in Technical Note	24	ARTC have detailed loss rates and given undertaking to include in next report. This is acceptable noting that the ultimate response to ND1/ND2 may result in the adoption of different loss values.	Closed	n/a
B2G	Native Dog Creek	B2G.ND4	Inflow has been applied to the model via an SA polygon utilising the 'ALL' command.	Low	Responded to in Technical Note	24	Outcome noted and accepted, recommended correct inflow setup is utilised in Detailed Design.	Closed	n/a
B2G	Native Dog Creek	B2G.ND5	The hydraulic model extent is not set at sufficient distance from the flood extent.	Medium	Responded to in Technical Note	24	Extended boundary to enable appropriate assessment of PMF.	Closed	n/a
B2G	Native Dog Creek	B2G.ND6	Adjacent catchment inflows have not been included as in the hydraulic model.	High	Response provided in updated Technical Note, commitment added to present results in Revised Draft EIS. Updated text has been highlighted.	24	0.05%, 0.01% and PMF event impact mapping to be presented in the Revised Draft EIS. Whilst the Technical Note did not state that 0.05% and 0.01% AEP event mapping would be included, it was requested in the previous Panel response and it is therefore expected that it will be mapped in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Rare event mapping to be included in Revised Draft EIS.
B2G	Native Dog Creek	B2G.ND7	The downstream HQ boundary is set between 80 m and 150 m downstream of the alignment.	High	Response provided in updated Technical Note, commitment added to present results in Revised Draft EIS. Commitment added to extend downstream boundary in Detailed Design. Updated Technical Note text has been highlighted.	24	Downstream model boundary to be moved further downstream of alignment and updated impact mapping to be presented in the Revised Draft EIS submission.	Accepted subject to additional information in Revised Draft EIS	Downstream model boundary to be moved further downstream of alignment and updated impact mapping to be presented in the Revised Draft EIS submission.
B2G	Native Dog Creek	B2G.ND8	The adopted TUFLOW HPC engine was not the latest version.	Low	To be addressed in Detailed Design	24	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Native Dog Creek	B2G.ND9	Level of detail in Technical Report.	Very High	Responded to in Technical Note	24	Further technical information required to be provided in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further technical information required to be provided in the Revised Draft EIS.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Bringalily Creek	B2G.BL1	Sub-catchment extents details not provided and local sub-catchment inflows include upstream catchment flows.	High	Responded to in Technical Note	19	Explanation is reasonable (noting a total hydrograph was annotated as an L hydrograph in its name). However, there is also the issue raised in the main report (3.3) about the URBS flows not fully matching the TUFLOW inflows. Inflows need to be checked at Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	For Detailed Design, further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment is necessary.
B2G	Bringalily Creek	B2G.BL2	The location of the downstream model extents and boundary intersects the rail alignment and may impact on results.	High	Responded to in Technical Note	19	The sensitivity assessment is generally acceptable, noting if was completed for the 1% AEP- for larger events the extent of inundation covers the alignment on the western side of the boundary. This needs to be corrected for Detailed Design where higher flows may still be recommended.	Closed	n/a
B2G	Bringalily Creek	B2G.BL3	Insufficient information is provided in relation to the Macintyre Brook FFA and its use in the validation process.	Medium	Updated response has been provided in updated Bringalily Creek Tech Memo, with updated text highlighted.	19	Flow in Bringalilly Creek is likely to be conservative based on other methods of flow calculation.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.
B2G	Bringalily Creek	B2G.BL4	Parameters used in URBS model.	Medium	Updated response has been provided in updated Bringalily Creek Tech Memo, with updated text highlighted.	19	Flow in Bringalilly Creek is likely to be conservative based on other methods of flow calculation.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.
B2G	Bringalily Creek	B2G.BL5	Final loss rates not detailed. Potential variation in loss rates could mask inadequacies with other URBS parameters.	Low	Responded to in Technical Note	19	Refer Nicol Creek response to N4- Response has detailed loss rates and given undertaking to include in next report. This is acceptable noting that the ultimate response to BL3/BL4 may result in the adoption of different loss values.	Closed	n/a
B2G	Bringalily Creek	B2G.BL6	The adopted TUFLOW HPC engine is not the latest version.	Low	To be addressed in Detailed Design	19	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Bringalily Creek	B2G.BL7	Not all base model files provided to verify critical duration/temporal patterns.	Low	To be addressed in Detailed Design	19	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
B2G	Bringalily Creek	B2G.BL8	Minor differences between URBS output hydrographs and input hydrographs for TUFLOW model.	Low	To be addressed in Detailed Design	19	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Minor differences between URBS output hydrographs and input hydrographs for TUFLOW model to be addressed in Detailed Design.
B2G	Bringalily Creek	B2G.BL9	Location of inflows applied to the hydraulic model are inconsistent.	High	Updated response has been provided in updated Technical Memo, with updated text highlighted.	19	Detailed Design to adopt the revised inflow boundaries. Further assessment and justification of impacts at Detailed Design and subject to acceptance of revised FIOs is an acceptable outcome.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to adopt the revised inflow boundaries. Further assessment and justification of impacts at Detailed Design and subject to acceptance of revised FIOs is an acceptable outcome.
B2G	Bringalily Creek	B2G.BL10	No losses applied to bridge "openings". Bridge loss coefficients not calibrated or verified against alternate methods.	Low	To be addressed in Detailed Design	19	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to confirm reasonableness of bridge losses using alternate approaches.
B2G	Bringalily Creek	B2G.BL11	Level of detail in Technical Report.	Very High	Agreed with Flood Panel this item would be closed.	19	The Panel agrees that the response is acceptable.	Closed	n/a
B2G	Bringalily Creek	B2G.BL12	Justification for flood level impacts and changes to time of submergence.	Very High	Commitment added to updated Technical Note to provided updated impact mapping and discussion around impacts in Revised Draft EIS. Update text has been highlighted in Technical Note.	19	Updated impact mapping will be presented in the Revised Draft EIS, including an updated summary and discussion regarding FIO exceedances and proposed mitigation.	Accepted subject to additional information in Revised Draft EIS	Updated impact mapping to be presented in the Revised Draft EIS, including an updated summary and discussion regarding FIO exceedances and proposed mitigation.
B2G	Bringalily Creek	B2G.BL13	Immunity of Heckles Road.	Medium	Responded to in Technical Note	19	The additional information provided is considered sufficient to justify minimal impacts on the road- would have been preferable to get the results for a range of events and not just the 1% but based on the results for the 1% event probably acceptable for the lesser events.	Closed	n/a
B2G	Nicol Creek	B2G.N1	Sub-catchment extents-details not provided.	High	Responded to in Technical Note	25	ARTC have provided catchment plan including sub-catchments and have given undertaking to include map in the next version. Sub-catchment definition (number of catchments) is ok for creek crossing modelled.	Closed	n/a
B2G	Nicol Creek	B2G.N2	Insufficient information is provided in relation to the Macintyre Brook FFA and its use in the validation process. Design flows lower than RFFE and QRT values.	High	Updated response provided in updated Technical Note, with updated text highlighted.	25	ARTC has undertaken sensitivity analyses with lower rainfall losses to confirm that these would only have a small increase in flows (+4%). To see what the resultant impacts would be with flows increased to match the QRT, ARTC factored up the flows by 1.45 with the resultant levels increasing by 400mm. The freeboard of 1m to the rail design is still maintained. Afflux increases to 220mm but only impacts on 0.1ha areas and not at sensitive receptors. ARTC state that overall, the sensitivity tests demonstrate that both the rail design and FIO outcomes are not influenced by the uncertainties in inflow. ARTC state: Noting that the URBS parameters are already conservative and the otherwise lack of evidence to favour adoption of the regional estimates, the current URBS design discharges are considered appropriate for adoption in the Detail Design phase of the Project. The Panel recommend higher flows still be used in Detailed Design phase to ensure higher velocities in particular are accounted for.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.

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B2G	Nicol Creek	B2G.N3	Parameters used in URBS model.	Medium	Updated response provided in updated Technical Note, with updated text highlighted.	25	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Higher design flow estimates are to be used in Detailed Design phase to ensure higher velocities in particular are accounted for.
B2G	Nicol Creek	B2G.N4	Final loss rates not detailed. Potential variation in loss rates could mask inadequacies with other URBS parameters.	Low	Responded to in Technical Note	25	ARTC have detailed loss rates and given undertaking to include in next report. This is acceptable noting that the ultimate response to N2/N3 may result in the adoption of different loss values.	Closed	n/a
B2G	Nicol Creek	B2G.N5	The adopted TUFLOW HPC engine is not the latest version.	Low	To be addressed in Detailed Design	25	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Nicol Creek	B2G.N6	Not all base model files provided to verify critical duration/temporal patterns.	Low	To be addressed in Detailed Design	25	Response proposes to address in Detailed Design.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
B2G	Nicol Creek	B2G.N7	Location of inflows applied to the hydraulic model are inconsistent.	High	Responded to in Technical Note	25	Now that subcatchment map has been supplied, most of the inflows are considered to be in a reasonable position except sub-catchment 12. The response states that there is an issue but that the change (splitting the inflow and applying in two locations) was necessary to reflect the catchment and that the impact of the change is minimal.	Closed	n/a
B2G	Nicol Creek	B2G.N8	No losses applied to bridge “opening”. Bridge losses not calibrated or verified against alternate methods.	Low	To be addressed in Detailed Design	25	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to include bridge losses and to look at alternate approaches.
B2G	Nicol Creek	B2G.N9	Level of detail in Technical Report.	Very High	Responded to in Technical Note	25	Seems a reasonable way forward as long the level of detail in the final report is adequate. So far the details in the Technical Note are not of sufficient detail though. Also note that the commitment is for 'some' which is not an overwhelming commitment to change the report.	Closed	n/a
B2G	Back Creek	B2G.BC1	Sub-catchment extents only partially based on railway alignment. No changes made between existing and developed cases.	Low	To be addressed in Detailed Design	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	For Detailed Design, further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment is necessary.
B2G	Back Creek	B2G.BC2	Insufficient information is provided in relation to the Canal Creek FFA and its use in the validation process. Design flows lower than RFFE and QRT values.	High	Responded to in Technical Note	18	ARTC has raised flow to agree with QRT. Given other uncertainties associated with modelling, propose that this is reasonable and acceptable. Note: need to ensure that changes in impacts need to be communicated to affected stakeholders.	Closed	n/a
B2G	Back Creek	B2G.BC3	Areal Reduction Factor (ARF) derived at downstream catchment boundary rather than at crossing. Apparent inconsistency between values nominated in Technical Report and in model files.	Medium	Updated response provided in updated Technical Note, with updated text highlighted.	18	Flows now raised to match QRT values and the focal point used for the ARF moved to rail location. Revised Draft EIS to adopt the revised approach.	Accepted subject to additional information in Revised Draft EIS	Flows now raised to match QRT values and the focal point used for the ARF moved to rail location. Revised Draft EIS to adopt the revised approach.
B2G	Back Creek	B2G.BC4	Calibration/ validation of hydraulic model.	Medium	Updated response provided in updated Technical Note and validation against the 2010 event undertaken. Updated text in Technical Note has been highlighted.	18	The model was extended to encompass 10 flood mark locations from the 2010 event that would be solely as a result of local creek flows. The updated URBS model (to increase flows to the QRT values) uses an alpha of 0.85 with losses adjusted to match the QRT flows. For the 2010 event simulation, losses have reverted back to ARR2019 values. It is not detailed what the differences in losses ultimately were. The resultant comparison of flood levels at the 10 flood marks is reasonable with an overall bias of +25mm.	Accepted subject to additional information in Revised Draft EIS	Results from the 2010 event validation to be documented in the Revised Draft EIS.
B2G	Back Creek	B2G.BC5	Final loss rates not detailed. Potential variation in loss rates could mask inadequacies with other URBS parameters.	Low	Responded to in Technical Note	18	Given commitment to higher flow, it is acceptable now.	Closed	n/a
B2G	Back Creek	B2G.BC6	The adopted TUFLOW HPC engine is not the latest version.	Low	To be addressed in Detailed Design	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Back Creek	B2G.BC7	Flow estimates produced by hydrologic model differ from those estimated using Condamine River hydrologic model.	High	Responded to in Technical Note	18	Sensitivity has been completed as requested.	Closed	n/a
B2G	Back Creek	B2G.BC8	Not all base model files provided to verify critical duration/temporal patterns.	Low	To be addressed in Detailed Design	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
B2G	Back Creek	B2G.BC9	Location of inflows applied to the hydraulic model are inconsistent.	High	Responded to in Technical Note	18	The need to sub-divide sub-catchment 09 confirms that our recommendation to further refine the catchments is justified. Further refinement is to be included in the Detailed Design phase together with correct inflow application.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Sub catchment layout to be refined in Detailed Design.
B2G	Back Creek	B2G.BC10	No losses applied to bridge “openings”. Bridge losses not calibrated or verified against alternate methods.	Low	To be addressed in Detailed Design	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to confirm reasonableness of bridge losses using alternate approaches.
B2G	Back Creek	B2G.BC11	Level of detail in Technical Report.	Very High	Responded to in Technical Note	18	Seems a reasonable way forward as long as the level of detail in the final report is adequate.	Closed	n/a
B2G	Back Creek	B2G.BC12	Justification for flood level and velocity impacts and changes to time of submergence.	Very High	Response provided in updated Technical Note. Commitment added to update Revised Draft EIS with associated impacts against the FIOs with further justification to be provided. Updated text has been highlighted in Technical Note.	18	Revised Draft EIS to document all impacts against the updated FIOs and justify why any impacts were not within the FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document all impacts against the updated FIOs and justify why any impacts were not within the FIOs.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Back Creek	B2G.BC13	Whether the immunity of the local public road (at the first point of overtopping) is adversely affected.	Medium	Responded to in Technical Note	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design needs to demonstrate that the impact on road flood immunity is acceptable for the proposed drainage structures to be adopted.
B2G	Back Creek	B2G.BC14	Potential for scour to occur given generally poor soil conditions.	Low	To be addressed in Detailed Design	18	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	As part of Detailed Design, it will be necessary to ensure that the velocity of flow (including an allowance for climate change) does not result in scour on a case by case basis.
B2G	Condamine River	B2G.C1	The existing scenario hydrologic model has been used with minimal alteration to account for local features.	Low	Responded to in Technical Note	14	Given large upstream catchment area, the minor discrepancy in catchment area is likely to be insignificant.	Closed	n/a
B2G	Condamine River	B2G.C2	The joint calibration generally presents a reasonable match to gauged peak water levels. However, there are discrepancies between the 1991 and 2013 event gauged peak water levels. Furthermore, there are significant differences in recorded versus modelled shape and timing of peaks.	High	Commitment added to updated Technical Note to issue revised model.	14	Revised Draft EIS to document the recalibration of the model. Refer to issue C19.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document the recalibration of the model. Refer to issue C19.
B2G	Condamine River	B2G.C3	The comparison between the 2010 flood mark levels and modelled levels shows a bias towards underestimation of levels. There is also no inclusion or discussion regarding validation to 2013 historic flood marks.	High	Commitment added to updated Technical Note to issue revised model.	14	Item C3 is linked to Item C19. Revised Draft EIS to document the recalibration of the model sufficiently to present the spatial distribution of the flood mark differences to demonstrate that there is no pattern to the results, meaning that the debris marks are not showing a specific area as being too low or too high. This has not been documented in the Technical Note.	Accepted subject to additional information in Revised Draft EIS	Item C3 is linked to Item C19. Revised Draft EIS to document the recalibration of the model sufficiently to present the spatial distribution of the flood mark differences to demonstrate that there is no pattern to the results, meaning that the debris marks are not showing a specific area as being too low or too high.
B2G	Condamine River	B2G.C4	Critical duration and temporal pattern selection are based on a single discharge location. It has therefore not been adjusted to assess different locations of interests throughout the alignment.	High	ARTC believe this assessment has already been completed with results provided in Revision B of Technical Note.	14	A thorough sensitivity analysis has been carried out and is reasonable.	Closed	n/a
B2G	Condamine River	B2G.C5	The ARF appears to have been set based on each of the sub-model extents . It has therefore not been adjusted to assess different locations of interest throughout the alignment. Furthermore, the adopted sub-model ARF values could not be replicated.	High	Commitment added to updated Technical Note to issue revised model.	14	New updated hydrology results provided which justifies response.	Closed	n/a
B2G	Condamine River	B2G.C6	The adopted approach for applying internal design flow inputs does not follow standard practice. The inflow polygons negate the routing calculations undertaken within the hydrologic model.	High	Response provided in updated Technical Note, with updated text highlighted.	14	The figure shows changes in flood level only on the flood fringes. Change in flood level impacts in the 1% AEP event are not meaningfully affected. It is unclear if it affects smaller events (smaller than the 1% AEP event), so that should be checked by the ARTC for the Revised Draft EIS. The figures also show that flood levels in the default source-area inflow approach are typically lower on the fringes and rarely at flood sensitive receptors does the difference exceed 20 mm. There are some locations with changes in excess of 100 mm, but these are not at flood sensitive receptors.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to present results applying internal design flows in an industry standard way.
B2G	Condamine River	B2G.C7	The URBS model differs from the recommended centroidal inflow approach and instead routes flow to the downstream end of the sub-catchment.	Low	Responded to in Technical Note	14	The Panel has noted the response and is acceptable. The item can be closed.	Closed	n/a
B2G	Condamine River	B2G.C8	Initial and continuing loss selection has been based on ARR Data Hub and not informed by the calibrated modelling that was undertaken.	Low	Responded to in Technical note	14	Acceptable but update report with commentary to close off.	Accepted subject to additional information in Revised Draft EIS	Provide updated information for Revised Draft EIS.
B2G	Condamine River	B2G.C9	The TUFLOW model incorporates a forced model build of 2017-09-AC-iSP-w64.	Low	To be addressed in Detailed Design	14	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Condamine River	B2G.C10	Ridge lines have been included in the TUFLOW model to enforce roadway levels. However, in some locations, there appears to be gaps in this application which allows flow to pass through roadway embankments.	Low	To be addressed in Detailed Design	14	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	In some locations, there appears to be gaps in this application which allows flow to pass through roadway embankments. This issue to be addressed in Detailed Design.
B2G	Condamine River	B2G.C11	Culverts at existing minor waterway crossings, especially those under the Gore Highway, have not been included in the TUFLOW model.	High	To be addressed in Detailed Design	14	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The model is to be updated in Detailed Design to test the sensitivity of the model to the missing culverts.
B2G	Condamine River	B2G.C12	The "CUMULATE" loss approach has been applied to all design bridges (as opposed to the default PORTION loss method).	Low	To be addressed in Detailed Design	14	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The default PORTION loss method be adopted in future model runs to ensure consistent results in extreme events in Detailed Design.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Condamine River	B2G.C13	There are several issues with the modelling approach adopted for the Condamine (north branch) crossing at the proposed rail alignment. these issues include high velocity results presented in the 1% AEP event, missing HX boundaries and no representation of the proposed rail bridge in the 1D channel.	High	Responded to in Technical Note	14	Checks confirm approach is reasonable and providing appropriate outcomes.	Closed	n/a
B2G	Condamine River	B2G.C14	The boundary arrangements utilised to link the one-dimensional culverts to two-dimensional systems appear to be deficient.	High	ARTC will issue the revised Condamine model to the Flood Panel to address these questions.	14	The sensitivity test demonstrates that the hydraulic outcomes presented in the Draft EIS are reasonable, with isolated inefficient applications which could generate impacts that are locally conservative. ARTC will adopt a Quadtree approach for Condamine floodplain design culverts along the embankment and refine all culvert connections as part of the update.	Accepted subject to additional information in Revised Draft EIS	ARTC to adopt a Quadtree approach for Condamine floodplain design culverts along the embankment and refine all culvert connections as part of the update. This is to be included in the Revised Draft EIS.
B2G	Condamine River	B2G.C15	Cross drainage culvert structures under the rail alignment at one location (north of Pampas Pit Road) have been represented using two-dimensional layered flow constriction shapes.	Medium	Responded to in Technical Note	14	The Panel agrees that the response is acceptable.	Closed	n/a
B2G	Condamine River	B2G.C16	Limited documentation provided for sensitivity modelling undertaken with respect to the interaction of Back Creek and the Condamine.	Medium	Responded to in Technical Note	14	Additional testing of Back Creek indicates minimal variance between the EIS modelling and the various sensitivity scenarios - the Panel agrees based on this work that the influence of Back Creek on the Condamine, when focussing on the impacts generated by the alignment, is appropriately considered.	Closed	n/a
B2G	Condamine River	B2G.C17	Limited information provided for crop Manning's roughness selection.	Low	Commitment added to updated Technical Note to provide further justification in Revised Draft EIS. Updated text has been highlighted in Technical Note.	14	Further information on selection of crop Manning's roughness to be provided in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further information on selection of crop Manning's roughness to be provided in the Revised Draft EIS.
B2G	Condamine River	B2G.C18	Flow distribution differences across the floodplain between the Back Creek model and Condamine model is currently not addressed. Furthermore, flow outbreaks (from Back Creek) occur in extreme events which are not reciprocated in the Condamine model.	Low	Response provided in updated Technical Note, as highlighted.	14	Extreme event commentary has been added.	Closed	n/a
B2G	Condamine River	B2G.C19	Analysis of the combined FFA approach shows that it may be preventing the identification of flow distribution issues between the North Condamine and Condamine Rivers.	Very High	Commitment added to Technical Note to issue revised model.	14	These Comments Relate to the new revised Condamine Model provided to the Panel: While C2, C3, C11 and C15 need to be addressed in the Revised Draft EIS, the Detailed Design phase should include the following: 1. A new command was added to the TUFLOW model: "SGS Map Extent Trim == All". This command trims the flood extent at partially wet cells. This risks not showing impacts at flood sensitive receptors or on private properties. ARTC should confirm that it is showing impacts everywhere and should consider disabling the command; 2. The application of river roughness is (spatially) more coarse in the extension area. This makes the channel of the extension smoother than the remainder of the model, potentially resulting in slightly lower water levels. The impacts of this are likely to be minor, but it should be investigated and potentially adjusted; 3. Part of the downstream portion of the model has no inflows applied (10km downstream of Cecil Plains). That being said, the confluence is 10km downstream of the Cecil Weir gauge and is unlikely to affect calibration results, meaning that no further action is required for this item; 4. Roads and railways in the extension area have not been enforced, which could affect flood levels; 5. 2m LiDAR data was adopted when 1m LiDAR data was available. Additionally, design railway embankment was applied as 2m grids instead of 1m grids (or a TIN). Previously, this was fine, but with the adoption of sub-grid sampling, this means that some definition in the model has been unnecessarily lost. This should be tested and implemented if it affects results; 6. Part of the downstream model extent is missing an outflow boundary, so some of the larger flows are being contained by a hard boundary; 7. Cecil Weir, the adjacent upstream rail bridge and the downstream road bridge have not been explicitly modelled. They should be added to the model; and 8. The bridge crossing 3km upstream of the downstream boundary has not been included and should be.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	These Comments Relate to the new revised Condamine Model provided to the Panel: While C2, C3, C11 and C15 need to be addressed in the Revised Draft EIS, the Detailed Design phase should include the following: 1. A new command was added to the TUFLOW model: "SGS Map Extent Trim == All". This command trims the flood extent at partially wet cells. This risks not showing impacts at flood sensitive receptors or on private properties. ARTC should confirm that it is showing impacts everywhere and should consider disabling the command; 2. The application of river roughness is (spatially) more coarse in the extension area. This makes the channel of the extension smoother than the remainder of the model, potentially resulting in slightly lower water levels. The impacts of this are likely to be minor, but it should be investigated and potentially adjusted; 3. Part of the downstream portion of the model has no inflows applied (10km downstream of Cecil Plains). That being said, the confluence is 10km downstream of the Cecil Weir gauge and is unlikely to affect calibration results, meaning that no further action is required for this item; 4. Roads and railways in the extension area have not been enforced, which could affect flood levels; 5. 2m LiDAR data was adopted when 1m LiDAR data was available. Additionally, design railway embankment was applied as 2m grids instead of 1m grids (or a TIN). Previously, this was fine, but with the adoption of sub-grid sampling, this means that some definition in the model has been unnecessarily lost. This should be tested and implemented if it affects results; 6. Part of the downstream model extent is missing an outflow boundary, so some of the larger flows are being contained by a hard boundary; 7. Cecil Weir, the adjacent upstream rail bridge and the downstream road bridge have not been explicitly modelled. They should be added to the model; and 8. The bridge crossing 3km upstream of the downstream boundary has not been included and should be.
B2G	Condamine River	B2G.C20	Sensitivity testing has been undertaken for climate change and blockage factors but does not appear to have resulted in any changes to the design.	Medium	Response provided in updated Technical Note, as highlighted.	14	Climate change and blockage scenarios to be assessed at Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Climate change and blockage scenarios to be assessed at Detailed Design.
B2G	Condamine River	B2G.C21	Impacts for events up to the 1% AEP event are noted in most areas. However, there are several impacts greater than the flood impact objectives due to newly flooded areas which have not been reported.	Very High	Response updated in updated Technical Note, as highlighted.	14	The Revised Draft EIS should be updated to include the details of an updated assessment of impacts using FIOs, including information on properties and sensitive receptors that were previously undocumented. Where those impacts exceed the FIOs, justification should be given to explain why it is not practical to achieve the FIOs.	Accepted subject to additional information in Revised Draft EIS	The Revised Draft EIS to be updated to include the details of an updated assessment of impacts using FIOs, including information on properties and sensitive receptors that were previously undocumented. Where those impacts exceed the FIOs, justification should be given to explain why it is not practical to achieve the FIOs.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Condamine River	B2G.C23	Level of detail in Technical Report.	Very High	Commitment added to updated Technical Note to provide appropriate impact assessment in Revised Draft EIS. Updated text in Technical Note has been highlighted.	14	The Revised Draft EIS to be updated to include the details of all impacts including those that exceed the agreed FIOs with justification where the FIOs are exceeded after mitigation.	Accepted subject to additional information in Revised Draft EIS	The Revised Draft EIS to be updated to include the details of all impacts including those that exceed the agreed FIOs with justification where the FIOs are exceeded after mitigation.
B2G	Westbrook & Dry Creeks	B2G.CC1	No climate change modelling has been undertaken.	Medium	Responded to in Technical Note	15	CC analysis is included.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC1	An alternative hydrologic and hydraulic model for Gowrie Creek was recently developed by TMR for Stage 2C of the Toowoomba North South Transport Corridor (TNSTC) project. The models correct most of the identified issues from the ARTC models used for the current studies.	Medium	Model to be issued to Flood Panel.	17	Details of the adopted hydrologic and hydraulic modelling parameters will be included in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Details of the adopted hydrologic and hydraulic modelling parameters will be included in the Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC2	Several subcatchment nodes and links were placed incorrectly and changed from the previous studies.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC3	Catchment areas differ between the XPRAFTS model and spatial data. There are also gaps and overlaps in catchment boundaries.	Medium	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC4	The subcatchments were not split at the alignment.	Medium	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC5	Subcatchment areas were found to be inconsistent or incorrect in some areas.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC6	Detention/retention basins and their details were not always accurate and they were not always linked correctly in the hydrologic model.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC7	The rainfall losses for both historical and design storm events are not sufficiently justified.	High	Model to be issued to Flood Panel.	17	The critical duration was comprehensively assessed to capture the range of local catchments draining to the alignment. Additional detail on the method adopted will be included in the Revised Draft EIS to provide further clarity.	Accepted subject to additional information in Revised Draft EIS	The critical duration was comprehensively assessed to capture the range of local catchments draining to the alignment. Additional detail on the method adopted will be included in the Revised Draft EIS to provide further clarity.
B2G	Gowrie Creek B2G	B2G.GC8	The January 2011 event's rainfall distribution was inconsistent in selection of pluviographs to define temporal variation. The applied total rainfall was also somewhat inconsistent with recorded rainfall, mainly in the Highfields area of the model.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC9	The rating curves at the DNRM stream gauges have not been verified with a hydraulic model.	High	Additional information provided in updated Technical Note, as highlighted.	17	Technical Note (1/12/2021) shows deviation between DNRM rating and TUFLOW only for flows up to 120m3/s. Adoption of the DRNM rating seems appropriate.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC10	An additional two years of data is now available at the Oakey gauge. This data includes a flood peak greater than 350 m3/s which is likely to change the FFA estimate.	Medium	Additional information provided in updated Technical Note, as highlighted.	17	The original Item/Issue contained a typographical error, 350 m3/s should have been 150m3/s. Response 3.15 to Item GC15 discusses the design event peak flows. They show a good match to the expected quantiles for Cranley, but a poor match at Oakey. This is a similar outcome to previous modelling. Given the uncertainties in the modelling, the findings from updating the FFA estimate are acceptable, but the Panel notes the ARTC intention to refine channel/floodplain storage and improve the match in Detailed Design.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC11	Some hydraulic controls, such as existing roads and railways, were not enforced within the Existing Case hydraulic model.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC12	Some existing developments of the floodplain have not been properly incorporated, such as existing ARTC survey of the railway, Toowoomba Second Range Crossing and Nass Road Detention Basin. Some other developments are proposed that may be built before Inland Rail that have also not been modelled/tested for sensitivity: InterlinkSQ and Charlton North Urban Stormwater Management Plan works.	High	Model to be issued to Flood Panel.	17	ARTC to state assumptions around works to be constructed prior or post construction of Inland Rail (InterlinkSQ and Charlton North USMP). The design case TUFLOW model is missing Inland Rail roughnesses. It is not clear whether available ARTC corridor survey information has supplemented the TNSTC base case model.	Accepted subject to additional information in Revised Draft EIS	ARTC to state assumptions in Revised Draft EIS around works to be constructed prior or post construction of Inland Rail (InterlinkSQ and Charlton North USMP). The design case TUFLOW model is missing Inland Rail roughnesses.
B2G	Gowrie Creek B2G	B2G.GC13	Several existing culverts were modelled with incorrect lengths and were incorrectly placed (outlets placed in existing rail embankment).	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC14	The downstream outflow boundary slope is steeper than the channel slope.	Low	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Gowrie Creek B2G	B2G.GC15	The design storm event flows differed somewhat from the FFA results.	Medium	Model to be issued to Flood Panel.	17	During Detailed Design the channel routing upstream of Cranley is to be refined to improve the match at Oakey between design flows and the FFA. Additionally, the FFA is to be re-evaluated to consider 2022 large flood events.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	During Detailed Design the channel routing upstream of Cranley is to be refined to improve the match at Oakey between design flows and the FFA. Additionally, the FFA is to be re-evaluated to consider 2022 large flood events.
B2G	Gowrie Creek B2G	B2G.GC16	The bridge form loss and blockage parameters were "typical" values, but clearly not calculated in accordance with Austroads. The layer 2 and layer 3 values are not consistent with the TMR Technical Guideline on Hydrologic and Hydraulic Modelling and no explanation was provided for how the bridge parameters were derived.	Medium	Model to be issued to Flood Panel.	17	All existing and design bridge layered flow constrictions will be included in the blockage sensitivity runs for the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	All existing and design bridge layered flow constrictions will be included in the blockage sensitivity runs for the Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC17	Safety barriers were not added to the hydraulic model.	Low	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC18	The adopted TUFLOW HPC engine was not the latest version.	Low	Model to be issued to Flood Panel.	17	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
B2G	Gowrie Creek B2G	B2G.GC19	Not all culverts were included in the Design Case hydraulic model.	Medium	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC20	Culvert 1D/2D connection (SX) lines are coarsely located, particularly where the proposed alignment is parallel to the existing railway.	High	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Gowrie Creek B2G	B2G.GC21	Several culvert loss parameters are non-standard.	Medium	Model to be issued to Flood Panel.	17	Four rectangular culverts have width contraction coefficient greater than one, ARTC to provide clarification. Various existing culverts removed from the rail alignment do not have sufficient cover (e.g. GOW11_E063, GOW11_EO65), ARTC to state model limitations. Some instabilities in culverts GOW11_E013 & GOW30_E017 in close proximity to the rail need correcting.	Accepted subject to additional information in Revised Draft EIS	Revised information on culvert loss parameters to be provided in the Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC23	Some of the reported impacts were not consistent with the provided hydraulic model results, with larger impacts identified in the provided results.	Very High	Model to be issued to Flood Panel.	17	No reporting on impacts has been provided for the updated model to date. Report on impacts based off new FIOs in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Report on impacts based off FIOs in Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC24	Increases in duration of inundation were reported on local roads, with no conclusions drawn as to their acceptability to Council and TMR.	High	Model to be issued to Flood Panel.	17	No reporting on impacts has been provided for the updated model to date. Report on impacts based off new FIOs in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Report on impacts based off FIOs in Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC25	Only the 1% AEP change in duration of inundation and change in velocity was reported, which is insufficient to draw conclusions on change in duration of inundation and velocity to stakeholders.	Medium	Model to be issued to Flood Panel.	17	No reporting on impacts has been provided for the updated model to date. Report on impacts based off new FIOs in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Report on impacts based off FIOs in Revised Draft EIS.
B2G	Gowrie Creek B2G	B2G.GC26	Future development of the catchment was not considered when assessing future climate change, which is an unrealistic scenario.	Medium	Model to be issued to Flood Panel.	17	The Panel agrees the response is acceptable.	Closed	n/a
B2G	Geomorphology B2G	B2G.G1	No assessment of upstream or downstream channel condition and processes to gain an understanding of the likely rate or trajectory of channel change.	Low	Response updated in updated Technical Memo	16	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
B2G	Geomorphology B2G	B2G.G2	Impacts of minor waterway crossings not assessed.	Low	Response updated in updated Technical Memo	16	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
B2G	Macintyre River	B2G.MR1	Appears to be duplication of sub-catchment area in Lower and Ottley URBS hydrologic models.	Medium	Technical Note updated to commit to this being reviewed as part of Revised Draft EIS.	10	Revised Draft EIS to adopt the revised hydrological model and document a review of all sub-catchment boundaries.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to adopt the revised hydrological model and document a review of all sub-catchment boundaries.
B2G	Macintyre River	B2G.MR2	Lack of variation and the relatively low value of the URBS sub-model beta parameter is unexpected over the wide range of topographies and landscapes.	Medium	Responded to in Technical Note	10	The Panel agrees with the response and the item can be closed.	Closed	n/a
B2G	Macintyre River	B2G.MR3	There were several concerns raised over the baseflow modelling approach and results.	Medium	Responded to in Technical Note	10	Additional commentary provided on selection of baseflow parameters. Worthwhile including in reporting.	Closed	n/a
B2G	Macintyre River	B2G.MR4	No discussion on the assumption of initial dam storage level adopted in the URBS model for design events.	Low	Responded to in Technical Note	10	The Panel agrees with the response and the item can be closed.	Closed	n/a
B2G	Macintyre River	B2G.MR5	The critical duration for the Macintyre River at the Inland Rail alignment was the 24-hour event in both levee scenarios in a 1% AEP flood. This critical duration should be confirmed by the designer and sufficient discussion in the report added. It is noted that this duration seems relatively short for the scale of the catchment.	Medium	Technical Note updated to commit to this being reviewed as part of Revised Draft EIS.	10	Revised Draft EIS to review and document the critical durations and whether the hydrologic and hydraulic models are in agreement for the 1% AEP event to show that the hydrologic model's routing is acceptable.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to review and document the critical durations and whether the hydrologic and hydraulic models are in agreement for the 1% AEP event to show that the hydrologic model's routing is acceptable.
B2G	Macintyre River	B2G.MR6	More discussion on low flow outliers at each gauge could add value to the FFA. The report only mentions the multiple Grubbs Beck test was adopted without any details on number of values omitted.	Medium	Responded to in Technical Note	10	The Panel agrees with the response and the item can be closed.	Closed	n/a
B2G	Macintyre River	B2G.MR7	A 25% blockage factor has been applied to majority of culverts although there are six culverts where no blockage applied.	Medium	Technical Note updated to commit to this being reviewed as part of Revised Draft EIS.	10	Revised Draft EIS to include updated and consistent culvert blockage case.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to include updated information for all culverts.
B2G	Macintyre River	B2G.MR8	Upstream river boundaries have used source-area polygons. Placement of the source-area boundaries is slightly downstream of the boundary and in some cases not centred over the river channel/does not cover the flood extent.	Low	A sensitivity run has been undertaken to demonstrate the impact on the Macintyre River modelling. The Technical Note has been updated with details of the assessment undertaken and presents the findings.	10	Sensitivity analysis showed that there was no impact on the alignment. ARTC have committed to refining placement of SA inflows. ARTC have not proposed to adopt 2d_bc (boundary line) inflows, which is standard practice in TUFLOW, but have explained that the source-area boundaries provide a more stable flow. Considering all information, the decision is acceptable.	Closed	n/a

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
B2G	Macintyre River	B2G.MR9	Floodplain roughness appears somewhat higher than would be expected. Floodplain is mainly cleared so would expect <0.05. Further discussion in report is warranted to justify values chosen.	Low	Responded to in Technical Note	10	The Panel agrees with the response and the item can be closed.	Closed	n/a
B2G	Macintyre River	B2G.MR10	Missing hydraulic structures in existing model.	Low	Responded to in Technical Note	10	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The hydraulic model should be updated during the Detailed Design phase to include all existing and any new or modified structures.
B2G	Macintyre River	B2G.MR11	No blockage has been applied to the substructure of bridges to account for piers or any potential debris blockage. No form loss applied to superstructure to account for bridge deck loss.	Medium	Responded to in Technical Note	10	Can be addressed at Detailed Design when considering extreme events.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The Detailed Design phase should include assessment of impact of blockage factors and form losses on the performance of bridge structures.

Appendix B G2H Issues Management Register

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
G2H	Gowrie Creek G2H	G2H.MGC1	An alternative hydrologic and hydraulic model for Gowrie Creek was recently developed by TMR for Stage 2C of the Toowoomba North South Transport Corridor (TNSTC) project. The models correct most of the identified issues from the ARTC models used for the current studies.	Low	Responded to in Technical Memo	4	Details of the adopted hydrologic and hydraulic modelling parameters will be included in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Details of the adopted hydrologic and hydraulic modelling parameters to be included in the Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC2	Several subcatchment nodes and links were placed incorrectly and changed from the previous studies.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC3	Catchment areas differ between the XPRAFTS model and spatial data. There are also gaps and overlaps in catchment boundaries.	Medium	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC4	The subcatchments were not split at the alignment.	Medium	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC5	Subcatchment areas were found to be inconsistent or incorrect in some areas.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC6	Detention/retention basins and their details were not always accurate and they were not always linked correctly in the hydrologic model.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC7	The rainfall losses for both historical and design storm events are not sufficiently justified.	High	Responded to in Technical Memo	4	The critical duration was comprehensively assessed to capture the range of local catchments draining to the alignment. Additional detail on the method adopted will be included in the Revised Draft EIS to provide further clarity.	Accepted subject to additional information in Revised Draft EIS	Additional detail on the method adopted will be included in the Revised Draft EIS to provide further clarity.
G2H	Gowrie Creek G2H	G2H.MGC8	The January 2011 event's rainfall distribution was inconsistent in selection of pluviographs to define temporal variation. The applied total rainfall was also somewhat inconsistent with recorded rainfall, mainly in the Highfields area of the model.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC9	The rating curves at the DNRM stream gauges have not been verified with a hydraulic model.	High	Responded to in Technical Memo	4	Technical Note (6/12/2021) shows deviation between DNRM rating and TUFLOW only for flows up to 120m3/s at Cranley and conservative DNRM rating at Oakey. Adoption of the DRNM rating seems appropriate.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC10	An additional two years of data is now available at the Oakey gauge This data includes a flood peak greater than 350 m3/s which is likely to change the FFA estimate.	Medium	Responded to in Technical Memo	4	The original Item/Issue contained a typographical error, 350 m3/s should have been 150m3/s. Response 3.15 to Item MGC15 discusses the design event peak flows. They show a good match to the expected quantiles for Cranley, but a poor match at Oakey. This is a similar outcome to previous modelling. Given the uncertainties in the modelling, the findings from updating the FFA estimate are acceptable, but the Panel notes the ARTC intention to refine channel/ floodplain storage and improve the match in Detailed Design.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC11	Some hydraulic controls, such as existing roads and railways, were not enforced within the Existing Case hydraulic model.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC12	Some existing developments of the floodplain have not been properly incorporated, such as existing ARTC survey of the railway, Toowoomba Second Range Crossing and Nass Road Detention Basin. Some other developments are proposed that may be built before Inland Rail that have also not been modelled/tested for sensitivity: InterlinkSQ and Charlton North Urban Stormwater Management Plan works.	High	Responded to in Technical Memo	4	ARTC to state assumptions around works to be constructed prior or post construction of Inland Rail (InterlinkSQ and Charlton North USMP). The design case TUFLOW model is missing Inland Rail roughnesses. It is not clear whether available ARTC corridor survey information has supplemented the TNSTC base case model.	Accepted subject to additional information in Revised Draft EIS	ARTC to state assumptions around works to be constructed prior or post construction of Inland Rail (InterlinkSQ and Charlton North USMP) in the Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC13	Several existing culverts were modelled with incorrect lengths and were incorrectly placed (outlets placed in existing rail embankment).	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC14	The downstream outflow boundary slope is steeper than the channel slope.	Low	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC15	The design storm event flows differed somewhat from the FFA results.	Medium	Responded to in Technical Memo	4	During Detailed Design the channel routing upstream of Cranley is to be refined to improve the match at Oakey between design flows and the FFA. Additionally, the FFA is to be re-evaluated to consider 2022 large flood events.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	During Detailed Design the channel routing upstream of Cranley is to be refined to improve the match at Oakey between design flows and the FFA. Additionally, the FFA is to be re-evaluated to consider 2022 large flood events.
G2H	Gowrie Creek G2H	G2H.MGC16	The bridge form loss and blockage parameters were "typical" values, but clearly not calculated in accordance with Austroads. The layer 2 and layer 3 values are not consistent with the TMR Technical Guideline on Hydrologic and Hydraulic Modelling and no explanation was provided for how the bridge parameters were derived.	Medium	Responded to in Technical Memo	4	All existing and design bridge layered flow constrictions will be included in the blockage sensitivity runs for the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	All existing and design bridge layered flow constrictions to be included in the blockage sensitivity runs for the Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC17	Safety barriers were not added to the hydraulic model.	Low	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC18	The adopted TUFLOW HPC engine was not the latest version.	Low	Responded to in Technical Memo	4	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
G2H	Gowrie Creek G2H	G2H.MGC19	Not all culverts were included in the Design Case hydraulic model.	Medium	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
G2H	Gowrie Creek G2H	G2H.MGC20	Culvert 1D/2D connection (SX) lines are coarsely located, particularly where the proposed alignment is parallel to the existing railway.	High	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Gowrie Creek G2H	G2H.MGC21	Several culvert loss parameters are non-standard.	Medium	Responded to in Technical Memo	4	Four rectangular culverts have width contraction coefficient greater than one, ARTC to provide clarification. Various existing culverts removed from the rail alignment do not have sufficient cover (e.g. GOW11_E063, GOW11_EO65), ARTC to state model limitations. Some instabilities in culverts GOW11_E013 & GOW30_E017 in close proximity to the rail need correcting.	Accepted subject to additional information in Revised Draft EIS	Revised information on culvert loss parameters to be provided in the Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC22	Increases in duration of inundation were reported on local roads, with no conclusions drawn as to their acceptability to Council and TMR.	High	Responded to in Technical Memo	4	No reporting on impacts has been provided for the updated model to date. Report on impacts based off new FIOs in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Report on impacts based off new FIOs in Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC23	Only the 1% AEP change in duration of inundation and change in velocity was reported, which is insufficient to draw conclusions on change in duration of inundation and velocity to stakeholders.	Medium	Responded to in Technical Memo	4	No reporting on impacts has been provided for the updated model to date. Report on impacts based off new FIOs in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Report on impacts based off new FIOs in Revised Draft EIS.
G2H	Gowrie Creek G2H	G2H.MGC24	Future development of the catchment was not considered when assessing future climate change, which is an unrealistic scenario.	Medium	Responded to in Technical Memo	4	The Panel agrees that the response is acceptable.	Closed	n/a
G2H	Oaky Creek	G2H.OKY1	Justification of adopted URBS parameters.	Medium	Include in Revised Draft EIS. Approach taken will depend on outcomes of comparison.	5	Comparison of flows between RFFM, QRT and Rational Method to be provided in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Comparison of flows between RFFM, QRT and Rational Method to be provided in Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY2	Model validation.	Medium	Include in Revised Draft EIS. Approach taken will depend on outcomes of comparison.	5	Comparison of flows between RFFM, QRT and Rational Method to be provided in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Comparison of flows between RFFM, QRT and Rational Method to be provided in Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY3	Roughness Values.	Low	Address in Detailed Design	5	Sensitivity testing has shown increase in velocity with reduced Manning's 'n'. ARTC have agreed to complete additional modelling as part of Detailed Design and to keep piers out of main channel.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Further sensitivity checks on roughness parameters to be performed at Detailed Design to inform the design of scour protection.
G2H	Oaky Creek	G2H.OKY4	TUFLOW Version.	Low	Include in Revised Draft EIS	5	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
G2H	Oaky Creek	G2H.OKY5	Temporal patterns.	Low	Include in Revised Draft EIS	5	Unlikely to be a significant issue in this case if model is validated as per OKY1. The peak flow, and therefore the velocity, will be calculated.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY6	Calculation of critical storm duration.	Medium	Include in Revised Draft EIS	5	Unlikely to be a significant issue in this case if model is validated as per OKY1. The peak flow, and therefore the velocity, will be calculated.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY7	Modelling of bridge losses.	Low	Include in Revised Draft EIS	5	Pier losses to be calculated using the guidelines for backwater coefficients for bridge piers and presented in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Pier losses to be calculated using the guidelines for backwater coefficients for bridge piers and presented in Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY8	Afflux reported downstream of railway.	Medium	Include in Revised Draft EIS	5	The new version of TUFLOW, combined with putting the layered flow constrictions in the correct location, removes the increase. Technical Note offers to provide results for this in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	The new version of TUFLOW, combined with putting the layered flow constrictions in the correct location, removes the increase. Technical Note offers to provide results for this in the Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY9	Velocity/ changes in peak.	Low	Address in Detailed Design	5	Refer to response for OKY3.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Further sensitivity checks on roughness parameters to be performed at Detailed Design to inform the design of scour protection.
G2H	Oaky Creek	G2H.OKY10	Increase in duration of inundation at 320-BR05.	Medium	Include in Revised Draft EIS	5	Response in Technical Note reasonable. Additional detail will be supplied in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Review and confirm that additional information regarding the change duration of inundation has been provided in the Revised Draft EIS.
G2H	Oaky Creek	G2H.OKY11	Redirection of flow at Ch 15.05.	Medium	Include in Revised Draft EIS	5	Technical Note agrees to the review of whether the diverted flow causes any issues in the affected reach.	Accepted subject to additional information in Revised Draft EIS	Design of long drain and culvert to be reviewed as part of the Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC1	Justification of adopted URBS parameters.	Medium	Include in Revised Draft EIS. Outcomes of flow checks will determine what is adopted.	6	Have agreed to compare flows to RFFM, QRT and Rational. No definitive undertaking in relation to level of agreement proposed (i.e. will they increase flows to match QR if necessary to be conservative).	Accepted subject to additional information in Revised Draft EIS	Compare flows to RFFM, QRT and Rational Method in Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC2	Model validation.	Medium	Include in Revised Draft EIS	6	Sensitivity testing has shown increase in velocity with reduced Manning's 'n'. ARTC have agreed to complete additional modelling as part of Detailed Design and to keep piers out of main channel.	Accepted subject to additional information in Revised Draft EIS	Compare flows to RFFM, QRT and Rational Method in Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC3	Roughness Values.	Low	Address in Detailed Design	6	Sensitivity testing has shown increase in velocity with reduced Manning's 'n'. ARTC have agreed to complete additional modelling as part of Detailed Design and keep piers out of the main channel.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Further sensitivity checks on roughness parameters to be performed at Detailed Design to inform the design of scour protection.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
G2H	Six Mile Creek	G2H.SMC4	TUFLOW Version.	Low	Include in Revised Draft EIS	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
G2H	Six Mile Creek	G2H.SMC5	Temporal patterns.	Low	Include in Revised Draft EIS	6	Unlikely to be a significant issue in this case if model is validated as per SMC1. The peak flow, and therefore the velocity, will be calculated.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC6	Calculation of critical storm duration.	Medium	Include in Revised Draft EIS	6	Unlikely to be a significant issue in this case if model is validated as per SMC1. The peak flow, and therefore the velocity, will be calculated.	Accepted subject to additional information in Revised Draft EIS	Further justification of the temporal pattern and critical duration selection to be provided in the Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC7	Downstream model boundary.	Low	Include in Revised Draft EIS	6	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Revised boundary condition to be taken forward to the Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC8	Modelling of bridge losses.	Low	Include in Revised Draft EIS	6	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Pier losses to be calculated using the guidelines for backwater coefficients for bridge piers and presented in Revised Draft EIS.
G2H	Six Mile Creek	G2H.SMC9	Velocity/ changes in peak.	Low	Address in Detailed Design	6	Sensitivity testing has shown increase in velocity with reduced Manning's 'n'. ARTC have agreed to complete additional modelling as part of Detailed Design and keep piers out of the main channel.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Further sensitivity checks on roughness parameters to be performed at Detailed Design to inform the design of scour protection.
G2H	Six Mile Creek	G2H.SMC10	Increase in flood levels downstream of Ch 17.08 km.	Medium	Address in Detailed Design	6	Response in Technical Note acceptable (will be dealt with as part of further design).	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Where there are impacts, waterway stability to be considered in Detailed Design. All local catchments to consider impacts for a full suite of events in the Detailed Design phase. In this impact assessment slope stability to be in conjunction with the geomorphologic assessment outcomes.
G2H	Lockyer Creek G2H	G2H.UL1	The BRCFS model has been used with minimal alterations to account for local features.	Low	Address in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
G2H	Lockyer Creek G2H	G2H.UL2	The adopted IFD values may not be the most current.	Low	Address in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The latest values at the time of the project inception were adopted. The study that reviewed IFD values within the Brisbane, Ipswich, Lockyer Valley and Moreton Bay catchments are to be reviewed and incorporated in the Detailed Design stage of the project.
G2H	Lockyer Creek G2H	G2H.UL3	A lower beta value was adopted for local inflows than what was used for regional inflows.	Medium	Updated response in Technical Note	7	For improved calibration between hydrologic and hydraulic models the alpha (stream routing) should be altered, not the beta as discussed in the response. Implementation of some of the more detailed techniques available in URBS, such as spatially varied losses, recovering initial losses etc. may produce an improved calibration for specific events.	Accepted subject to additional information in Revised Draft EIS	A more detailed calibration to be undertaken including implementation of some of the more detailed techniques available in URBS (such as spatially varied losses, recovering initial losses etc.) for the Revised Draft EIS.
G2H	Lockyer Creek G2H	G2H.UL4	The joint hydrologic/hydraulic model uses different hydrologic parameters to the hydrologic design model.	High	Updated response in Technical Note	7	For improved calibration between hydrologic and hydraulic models the alpha (stream routing) should be altered, not the beta as discussed in the response. Implementation of some of the more detailed techniques available in URBS, such as spatially varied losses, recovering initial losses etc. may produce an improved calibration for specific events.	Accepted subject to additional information in Revised Draft EIS	A more detailed calibration to be undertaken including implementation of some of the more detailed techniques available in URBS (such as spatially varied losses, recovering initial losses etc.) for the Revised Draft EIS.
G2H	Lockyer Creek G2H	G2H.UL5	The adopted ARF value is not appropriate for assessing flows at the G2H crossing of Lockyer Creek.	High	Include in Revised Draft EIS	7	Results shown for the impact of changing the focal point location. Sensitivity testing shown to determine impact of using the local design flows. ARTC to incorporate this information in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Results shown for the impact of changing the focal point location. Sensitivity testing shown to determine impact of using the local design flows. ARTC to incorporate this information in the Revised Draft EIS.
G2H	Lockyer Creek G2H	G2H.UL6	Limited discussion regarding hydrologic model loss parameters and their impact on design flows.	High	Include in Revised Draft EIS	7	Response is noted and is acceptable subject to additional information from ARTC.	Accepted subject to additional information in Revised Draft EIS	Losses to be reviewed and better discussion regarding hydrologic model loss parameters and their impact on design flows.
G2H	Lockyer Creek G2H	G2H.UL7	The latest available LiDAR data which includes, but is not limited to, the Lockyer Valley LGA LiDAR dataset flown 2018 to be used in Detailed Design.	Low	Address in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The latest available LiDAR data which includes, but is not limited to, the Lockyer Valley LGA LiDAR dataset flown 2018 to be used in Detailed Design.
G2H	Lockyer Creek G2H	G2H.UL8	Several issues with the model calibration.	Very High	Updated response in Technical Note	7	Revised Draft EIS to include a more rigorous hydrological assessment to improve calibration and to consider spatially varied losses.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to include a more rigorous hydrological assessment to improve calibration and to consider spatially varied losses.
G2H	Lockyer Creek G2H	G2H.UL9	The flood frequency analysis was only performed at one stream gauge (far downstream of the G2H crossing of Lockyer Creek), despite several other stream gauges having data available.	High	Include in Revised Draft EIS	7	Information provided for FFA assessment at Helidon, associated with the revised losses and focus at Helidon. ARTC to incorporate this information into the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Information provided for FFA assessment at Helidon, associated with the revised losses and focus at Helidon. ARTC to incorporate this information into the Revised Draft EIS.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
G2H	Lockyer Creek G2H	G2H.UL10	The adopted TUFLOW HPC engine was not the latest version.	Low	Include in Revised Draft EIS	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Adopt the latest version of TUFLOW HPC engine in Detailed Design.
G2H	Lockyer Creek G2H	G2H.UL11	Issues surrounding the application of hydraulic roughness.	Low	Address in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Issues surrounding the application of hydraulic roughness to be addressed in Detailed Design.
G2H	Lockyer Creek G2H	G2H.UL12	Varied and inconsistent approaches adopted to apply inflows within the hydraulic model.	Medium	n/a	7	Agreed the issue is unlikely to present large issues to the overall scheme given the locations of concern.	Closed	n/a
G2H	Lockyer Creek G2H	G2H.UL13	Differing source area inflows used between historic and design models.	Low	Address in Detailed Design	7	Differing source area inflows used between historic and design models to be addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Differing source area inflows used between historic and design models to be addressed in Detailed Design.
G2H	Lockyer Creek G2H	G2H.UL14	Missing hydraulic structures in existing model.	Low	Address in Detailed Design	7	The hydraulic model should be updated during the Detailed Design phase to include all existing and any new or modified structures.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The hydraulic model should be updated during the Detailed Design phase to include all existing and any new or modified structures.
G2H	Lockyer Creek G2H	G2H.UL15	Bridge losses are identical at all bridges.	Medium	Include in Revised Draft EIS	7	Individual bridge losses to be reviewed and updated for Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Pier losses to be calculated using the guidelines for backwater coefficients for bridge piers and presented in Revised Draft EIS.
G2H	Geomorphology G2H	G2H.G1	No assessment of upstream or downstream channel condition and processes to gain an understanding of the likely rate or trajectory of channel change.	Low	Response updated in updated Technical Memo	3	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
G2H	Geomorphology G2H	G2H.G2	Impacts of minor waterway crossings not assessed.	Low	Response updated in updated Technical Memo	3	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.

Appendix C H2C Issues Management Register

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
H2C	Lockyer Creek H2C	H2C.L1	Interaction between local and regional catchments does not seem to be appropriately captured within the models.	Very High	Updated response in Technical Note	6	Develop more detailed local hydrologic models covering the relevant sub-areas of the regional model.	Accepted subject to additional information in Revised Draft EIS	Develop more detailed local hydrologic models covering the relevant sub-areas of the regional model.
H2C	Lockyer Creek H2C	H2C.L2	The BRCFS model has been used with minimal alterations to account for local features.	Low	Address in Detailed Design	6	Further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
H2C	Lockyer Creek H2C	H2C.L3	The joint hydrologic/hydraulic model uses different hydrologic parameters to the hydrologic design model.	High	Updated response in Technical Note	6	For improved calibration between hydrologic and hydraulic models the alpha (stream routing) should be altered, not the beta as discussed in the response. Implementation of some of the more detailed techniques available in URBS, such as spatially varied losses, recovering initial losses etc. may produce an improved calibration for specific events.	Accepted subject to additional information in Revised Draft EIS	A more detailed calibration to be undertaken including implementation of some of the more detailed techniques available in URBS (such as spatially varied losses, recovering initial losses etc.) for the Revised Draft EIS.
H2C	Lockyer Creek H2C	H2C.L4	The ARF does not appear to have been adjusted to assess different locations of interest throughout the alignment. While the use of a single ARF may be appropriate, the provided information does not justify its use in this manner.	Medium	Updated response in Technical Note. Include in Revised Draft EIS.	6	Results shown for the impact of changing the focal point location. Sensitivity testing shown to determine impact of using the local design flows. ARTC to incorporate this information in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Results shown for the impact of changing the focal point location. Sensitivity testing shown to determine impact of using the local design flows. ARTC to incorporate this information in the Revised Draft EIS.
H2C	Lockyer Creek H2C	H2C.L5	Limited discussion regarding hydrologic model loss parameters and their impact on design flows.	High	Include in Revised Draft EIS	6	Losses to be reviewed and better discussion regarding hydrologic model loss parameters and their impact on design flows presented in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Losses to be reviewed and better discussion regarding hydrologic model loss parameters and their impact on design flows presented in the Revised Draft EIS.
H2C	Lockyer Creek H2C	H2C.L6	The topographic setup is deemed acceptable for the purposes of the assessment undertaken. However, future stages of the project should utilise the latest available LiDAR data which includes, but is not limited to, the Lockyer Valley LGA LiDAR dataset flow in 2018.	Low	Address in Detailed Design	6	The latest available LiDAR data which includes, but is not limited to, the Lockyer Valley LGA LiDAR dataset flown 2018 to be used in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The latest available LiDAR data which includes, but is not limited to, the Lockyer Valley LGA LiDAR dataset flown 2018 to be used in Detailed Design.
H2C	Lockyer Creek H2C	H2C.L7	Several issues with the model calibration.	Very High	Updated response in Technical Note	6	Revised Draft EIS to include a more rigorous hydrological assessment to improve calibration and to consider spatially varied losses.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to include a more rigorous hydrological assessment to improve calibration and to consider spatially varied losses.
H2C	Lockyer Creek H2C	H2C.L8	Justification for flood level impacts and changes to time of submergence.	High	Updated response in Technical Note	6	Updated FIO criteria to be used in Revised Draft EIS to provide additional mapping and interrogation of modelling results against FIOs. Include documentation of model's performance against FIOs with summary tables itemising all non-compliance at each flood sensitive receptor and at each bridge/culvert structure.	Accepted subject to additional information in Revised Draft EIS	Updated FIO criteria to be used in Revised Draft EIS to provide additional mapping and interrogation of modelling results against FIOs. Include documentation of model's performance against FIOs with summary tables itemising all non-compliance at each flood sensitive receptor and at each bridge/culvert structure.
H2C	Lockyer Creek H2C	H2C.L9	Increase in level at Gatton and Forest Hill area for extreme events.	High	Updated response in Technical Note. Include in Revised Draft EIS.	6	Revised Draft EIS to document the increases and justify them in accordance with the updated FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document the increases and justify them in accordance with the updated FIOs.
H2C	Lockyer Creek H2C	H2C.L10	Potential for scour to occur given generally poor soil conditions.	Medium	Updated response in Technical Note	6	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
H2C	Lockyer Creek H2C	H2C.L11	The adopted critical durations and Rank-6 temporal patterns do not always match what the Panel determined to be the critical duration or Rank-6 temporal pattern.	Medium	n/a	6	ARTC have demonstrated that there is minimal change in results based on slightly different methodologies for selecting the critical duration and temporal pattern. It is noted that the response refers to median although it has been assumed that this is in error and should be the mean.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L12	Issues surrounding the application of hydraulic roughness.	Low	Address in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Issues surrounding the application of hydraulic roughness to be addressed in Detailed Design.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
H2C	Lockyer Creek H2C	H2C.L13	There are a number of 1D/2D connection issues that exist between structures and channels within the model.	Medium	n/a	6	Differences in results quantified, showing minimal change. Final model to be updated regardless.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L14	The flood frequency analysis was only performed at one stream gauge, despite several other stream gauges having data available.	High	n/a	6	Technical Note presents an additional FFA at Helidon and also describes specific reasons why other gauges were not used.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L15	Varied and inconsistent approaches adopted to apply inflows within the hydraulic model.	High	n/a	6	Agreed the issue is unlikely to present large issues to the overall scheme given the locations of concern.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L16	Differing source area inflows used between historic and design models.	Medium	n/a	6	Sensitivity analysis showed no change in results.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L17	Downstream boundary extent and application issues.	Low	Address in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Downstream boundary extent and application issues to be addressed in Detailed Design.
H2C	Lockyer Creek H2C	H2C.L18	Applied minimum nodal storage area of 200 m2 by default.	Medium	n/a	6	Sensitivity analysis undertaken showing minimal impacts.	Closed	n/a
H2C	Lockyer Creek H2C	H2C.L19	Missing hydraulic structures in existing model.	Low	Address in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	The hydraulic model should be updated during the Detailed Design phase to include all existing and any new or modified structures.
H2C	Lockyer Creek H2C	H2C.L20	Existing and design structure flow instabilities present in modelling.	Medium	Include in Revised Draft EIS	6	Where instability is identified as important for the design, adjustment of the culvert banks to be implemented as part of the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Where instability is identified as important for the design, adjustment of the culvert banks to be implemented as part of the Revised Draft EIS.
H2C	Lockyer Creek H2C	H2C.L21	Bridge losses are identical at all bridges.	Medium	Include in Revised Draft EIS	6	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Individual bridge losses to be updated for Revised Draft EIS.
H2C	Western Creek	H2C.WC1 (B1)	Additional information is available for 2011 calibration.	High	Include in Revised Draft EIS	5	As ARTC was not supplied with the data, the agreement to look at the Grandchester Alert is acceptable, and in any case, it is proposed to change to the ICC IRFSU as part of the review. Whilst it is agreed that there is no rating for the gauge and this affects the ability to consider calculated vs recorded flows, it does provide a good guide to timing (which is reasonable) and peak flood level (the model is 400 mm low and would therefore require adjustment if not for the fact the ICC IRFSU model will be used). Do need to be careful that the IRFSU is adjusted as necessary to reflect the railway, including elements such as subcatchment boundaries.	Accepted subject to additional information in Revised Draft EIS	ICC IRFSU modelling and Grandchester Alert gauge data to be used in a revised calibration for the Revised Draft EIS.
H2C	Western Creek	H2C.WC2 (B4)	Sub-catchment extents not based on railway alignment, with alignment passing through sub-catchments.	Low	Address in Detailed Design	5	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
H2C	Western Creek	H2C.WC3 (B5)	Inflow for main flow path (TOT034) located too far within model and too close to the railway.	Low	Include in Revised Draft EIS	5	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	ICC IRFSU modelling to be used and ensure that subcatchments are located appropriately relative to the corridor in the Revised Draft EIS.
H2C	Western Creek	H2C.WC4 (B9)	Focal point for the calculation of design rainfalls located at stream gauge (well downstream) rather than also at railway.	High	Updated response in Technical Note. Include in Revised Draft EIS.	5	IRFSU hydrology to be applied for the Revised Draft EIS assessment. Focal points to match the location of the corridor.	Accepted subject to additional information in Revised Draft EIS	IRFSU hydrology to be applied for the Revised Draft EIS assessment. Focal points to match the location of the corridor.
H2C	Western Creek	H2C.WC5 (B11)	Applicability of areal temporal pattern set applicable to the gauge (500[FD1] [MG2] km2) compared to the set applicable to the two main crossings (200 km2) and the point temporal patterns applicable to catchments less than 75km2 in area.	High	Updated response in Technical Note	5	IRFSU hydrology to be applied for the Revised Draft EIS assessment with focal points and temporal patterns updated.	Accepted subject to additional information in Revised Draft EIS	IRFSU hydrology to be applied for the Revised Draft EIS assessment with focal points and temporal patterns updated.
H2C	Western Creek	H2C.WC6 (B17)	Model stability.	Low	Address in Detailed Design	5	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Need to remove instability as part of modelling for Detailed Design.
H2C	Western Creek	H2C.WC7 (B22)	Justification for flood level impacts and changes to time of submergence.	Very High	Updated response in Technical Note	5	Compliance to FIOs (and negotiations in cases where FIOs exceeded) is acceptable. Item Resolved (subject to Draft EIS review).	Accepted subject to additional information in Revised Draft EIS	Updated FIO criteria to be used in Revised Draft EIS to provide additional mapping and interrogation of modelling results against FIOs. Include documentation of model's performance against FIOs with summary tables itemising all non-compliance at each flood sensitive receptor and at each bridge/culvert structure.
H2C	Western Creek	H2C.WC8	Increase in level in Grandchester area for extreme events.	High	Updated response in Technical Note	5	Compliance to FIOs (and negotiations in cases where FIOs exceeded) is acceptable. Item Resolved (subject to Draft EIS review).	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS modelling results to be assessed against FIO criteria and refinement of drainage structures to be undertaken. Exceedances of these criteria to be detailed and justified.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
H2C	Western Creek	H2C.WC9 (B25)	Potential for scour to occur given generally poor soil conditions.	High	Updated response in Technical Note	5	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
H2C	Geomorphology H2C	H2C.G1	No assessment of upstream or downstream channel condition and processes to gain an understanding of the likely rate or trajectory of channel change.	Low	Response updated in updated Technical Memo	4	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
H2C	Geomorphology H2C	H2C.G2	Impacts of minor waterway crossings not assessed.	Low	Response updated in updated Technical Memo	4	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.

Appendix D C2K Issues Management Register

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
C2K	Bremer River	C2K.B1	Insufficient information is provided in relation to recorded data (rainfall, pluviograph and stream gauge data) available for the calibration events and its use in modelling.	Medium	Responded to in Technical Note	6	Response confirms that the modelling for the BRCFS was adopted- while the quality of the BRCFS is acknowledged, the focus of the modelling was on Walloon and D/S, not the corridor and it is not certain that the model is applicable without modification further upstream. The study has also not made full use of gauges for which a level hydrograph is available. Recommend that available data for at least level/stream gauges be tabulated and reasons for data not being included in calibration be provided.	Accepted subject to additional information in Revised Draft EIS	Available data for at least level/stream gauges be tabulated and reasons for data not being included in calibration be provided in Revised Draft EIS.
C2K	Bremer River	C2K.B2	Whether events selected for calibration are appropriate.	Medium	Responded to in Technical Note	6	Acknowledged and tabulated suitability of events relative to Walloon gauge, supporting use of selected 1974, 2011 and 2013 events.	Closed	n/a
C2K	Bremer River	C2K.B3	Whether events that have occurred subsequent to the BRCFS should be used for calibration or validation. The 2017 event is suggested as it is recent and reasonable data is available.	Medium	To be addressed in Revised Draft EIS	6	It is acknowledged that it may not result in a significant change to the calibration but the 2017 flood event to be used at least for a validation event and possibly a calibration event given the number of gauge failures that have occurred across the other events. A close match to the 2017 event would increase confidence in model.	Accepted subject to additional information in Revised Draft EIS	2017 flood event to be used as a calibration event or at least for a validation event with results to be documented in the Revised Draft EIS.
C2K	Bremer River	C2K.B4	Sub-catchment extents not based on railway alignment, with alignment passing through sub-catchments.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
C2K	Bremer River	C2K.B5	Inflow for main flow path (TOT022) located too far within model and too close to the railway.	High	To be addressed in Revised Draft EIS	6	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Noting potential increase in flow associated with implentation of IRFS, revised inputs to be used in further design - even if it continues to make a small difference at the embankment.
C2K	Bremer River	C2K.B6	Different URBS parameters used between hydrologic and hydraulic calibration models. Beta changed from 2.8 to 1.5.	High	The effect of the beta value on the Bremer model is relatively minor, but was adopted partly for consistency with the approach adopted for the other models, but mainly because although slight, it was still a slight improvement of the match with the gauge timing/shape. The discretization of the sub-catchments could potentially be reviewed to improve consistency and minimize overlap of storages. It is currently proposed to adopt the ICC hydrology going forward, and the calibration of the models can be reviewed as part of this process. Technical Note updated with this text.	6	ARTC have explained why the beta value was modified, though the choice to modify it is still viewed by the Panel as undesirable. Because its effect is minor and it is currently proposed that the ICC hydrology will be adopted "going forward, and the calibration of the models can be reviewed as part of this process", the response is acceptable for the current level of design.	Accepted subject to additional information in Revised Draft EIS	Use of alpha and beta to be reviewed and ICC hydrology to be applied for the Revised Draft EIS assessment.
C2K	Bremer River	C2K.B7	Potential variation in loss rates.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Need to confirm suitable loss rates given the potential for variation over the catchments as part of Detailed Design.
C2K	Bremer River	C2K.B8	IFD data provides rainfall estimates that result in low flow estimates compared to other available flow information. For the adjacent catchment and for the Council Bremer River study flows were scaled up to account for the low estimated flows.	High	Technical Note updated to make clearer that this will be done in the Revised Draft EIS.	6	Item to be addressed in conjunction with modelling utilising IRFSU flows in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Item to be addressed in conjunction with modelling utilising IRFSU flows in the Revised Draft EIS.
C2K	Bremer River	C2K.B9	Focal point for the calculation of design rainfalls located at stream gauge (well downstream) rather than also at railway.	High	Responded to in Technical Note	6	The use of an ARF at the crossing has resulted in a slight increase in levels and impacts, as is expected. The issue is that the IFD is giving low flows for design events and these are reduced further by the ARF value for Walloon gauge being used. Consideration of higher flows as per IRFSU will also further increase flows and possibly impacts. There is no commitment to the use of a different ARF. However, if flows are adjusted to match the IRFS, the magnitude of the change will be minimal.	Accepted subject to additional information in Revised Draft EIS	IRFSU hydrology to be applied for the Revised Draft EIS with focal points and ARF values reviewed and updated.
C2K	Bremer River	C2K.B10	Rainfall data for use in local catchment is expected to be too low.	Low	Technical Note updated to make clearer that this will be done in the Revised Draft EIS.	6	Item to be addressed in conjunction with modelling utilising IRFSU flows in the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Item to be addressed in conjunction with modelling utilising IRFSU flows in the Revised Draft EIS.
C2K	Bremer River	C2K.B11	Applicability of areal temporal pattern set applicable to the gauge (500 km2) compared to the set applicable to the two main crossings (200 km2) and the point temporal patterns applicable to catchments less than 75km2 in area.	High	Responded to in Technical Note	6	Suitably addressed.	Closed	n/a
C2K	Bremer River	C2K.B12	Modelling of critical storm duration at crossings other than main crossings.	Medium	Technical Note updated to make clearer that this will be done in the Revised Draft EIS.	6	ARTC have committed to reviewing the design of the culverts in the Revised Draft EIS. It is assumed that this will include a critical duration assessment, as requested by the Panel.	Accepted subject to additional information in Revised Draft EIS	ARTC to review the design of culverts including a critical duration assessment and document in the Revised Draft EIS.
C2K	Bremer River	C2K.B13	Difference in ground level data and potential impact on calibration.	Medium	Technical Note updated to confirm that this will be done in the Revised Draft EIS.	6	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	The topography used in the Bremer River/Western Creek hydraulic model and the impact on calibration outcomes to be updated in the Revised Draft EIS.
C2K	Bremer River	C2K.B14	Derivation of gully lines in model.	Medium	Responded to in Technical Note	6	Methodology used to define gully lines is provided.	Closed	n/a
C2K	Bremer River	C2K.B15	Location of inflows applied to the hydraulic model are inconsistent.	High	Responded to in Technical Note	6	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Bremer River	C2K.B16	Assignment of roughness values.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Minor discrepancies in roughness value application in model to be addressed in Detailed Design.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
C2K	Bremer River	C2K.B17	Model stability.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Need to remove instability as part of modelling for Detailed Design.
C2K	Bremer River	C2K.B18	Calculated flood levels.	Medium	Technical Note updated to make clearer that this will be done in the Revised Draft EIS.	6	ARTC to use IRFSU flows.	Accepted subject to additional information in Revised Draft EIS	Flood levels to be calculated from IRFSU flows and presented in the Revised Draft EIS.
C2K	Bremer River	C2K.B19	Sensitivity of roughness coefficients.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Sensitivity of roughness coefficients to confirm variation associated with use of higher and lower roughness values in Detailed Design.
C2K	Bremer River	C2K.B20	Bridge loss coefficients not calibrated or verified against alternate methods.	Low	To be addressed in Detailed Design	6	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to confirm reasonableness of bridge loss coefficients using alternate approaches.
C2K	Bremer River	C2K.B21	Level of detail in information provided to the Panel.	Very High	Technical Note updated to include reference to use of updated FIOs and OCG C2K RFI requirements.	6	Details in Technical Notes provided to the Panel are of sufficient detail, as long as the level of detail in the Revised Draft EIS is adequate.	Accepted subject to additional information in Revised Draft EIS	An adequate level of detail is to be provided in the Revised Draft EIS.
C2K	Bremer River	C2K.B22	Justification for flood level impacts and changes to time of submergence.	Very High	Technical Note updated to include reference to use of updated FIOs and OCG C2K RFI requirements.	6	The Revised Draft EIS will have an additional criteria applied by the OCG regarding non-compliances and how they are to be addressed. The latter portion will ensure that the acceptability will be discussed.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to discuss any non-compliance with FIOs in regards to impacts and time of submergence.
C2K	Bremer River	C2K.B23	Whether flood level impact on Waters Road is acceptable with regard to trafficability of remainder of road and whether the immunity of the road (at the first point of overtopping) is adversely affected.	Very High	Responded to in Technical Note	6	Suitably addressed with further details provided.	Closed	n/a
C2K	Bremer River	C2K.B24	Whether all sensitive receptors have been included in listing. Would appear that 91 and 695 are missing from extreme event table.	Medium	EIS Chapter updated and response provided.	6	Additional detail provided.	Closed	n/a
C2K	Bremer River	C2K.B25	Potential for scour to occur given generally poor soil conditions.	High	Technical Note updated to include the OCG C2K RFI requirements for additional information for the Revised Draft EIS that will address. (a) description of the existing fluvial geomorphic processes within, upstream and downstream of proposed waterway crossings (b) desktop assessment of the potential changes to channel characteristics as a result of the C2K project including any proposed drainage diversions (c) risk assessment of alterations to geomorphic processes from project infrastructure including local drainage culverts within waterways/watercourses and provide suitable mitigation and management measures (d) detailed assessment of potential changes to channel characteristics for high-risk sites.	6	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
C2K	Warrill Creek	C2K.W1	Sub-catchment extents not based on railway alignment, with alignment passing through sub-catchments.	Low	To be addressed in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
C2K	Warrill Creek	C2K.W2	Inflow for main flow path (TOT050) located too far within model and too close to the railway. Sub-catchment 50 needs to be subdivided to ensure that the flow path in the eastern part of the sub-catchment is properly represented.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Warrill Creek	C2K.W3	Sub-catchment 51 is divided by the proposed rail alignment with all flow from this catchment placed downstream of the rail embankment.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Warrill Creek	C2K.W4	Inflow from Purga Creek not included in the Warrill Creek model.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Warrill Creek	C2K.W5	Breakouts/diversions to Purga Creek not reported to adjacent model.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
C2K	Warrill Creek	C2K.W6	Different URBS parameters used between hydrologic and hydraulic calibration models. Beta changed from 2.8 to 1.0.	High	Using the hydraulic model to inform alpha may be appropriate for an uncalibrated hydrologic model and/or if trying to reconcile the hydrologic model to the hydraulic model. However, we are attempting to reconcile both hydrologic and hydraulic models to the stream gauge data. The URBS alpha value is considered to be good based on matching of the hydrographs at Amberley as well as gauges at Churchbank Weir and Greens Rd upstream of the hydraulic model domain. Adjusting the alpha value would adversely affect the flow timings set by these gauges. Adjusting the alpha (or reach length factors) for the areas overlapped by the hydraulic model would have no effect since this routing is performed in the hydraulic model. The Beta value was adjusted for the reasons explained in the Technical Note and because it appeared to slightly improve the match of the stream gauge data. Other options include modifying the discretization of the sub-catchments to improve consistency and minimize overlap of storages, and/or in the hydraulic model domain, checking the effect of sub-grid sampling (not available when the original modelling was performed) and roughness assumptions. It is currently proposed to adopt the ICC hydrology going forward, and the calibration of the models can be reviewed as part of this process. The Technical Note has updated based with this text.	7	Given it is proposed that the ICC hydrology be used "going forward", the response is acceptable, noting that the calibration should be reviewed again in the Revised Draft EIS stage of the project against this previous issue.	Accepted subject to additional information in Revised Draft EIS	Use of alpha and beta to be reviewed and ICC hydrology to be applied for the Revised Draft EIS assessment.
C2K	Warrill Creek	C2K.W7	Ebenezer Creek inflow (WAR056) placed too far within the model.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Warrill Creek	C2K.W8	Location of inflows applied to the hydraulic model are inconsistent.	High	Responded to in Technical Note	7	Sensitivity quantified and shown to be negligible.	Closed	n/a
C2K	Warrill Creek	C2K.W9	Sensitivity of roughness coefficients.	Low	To be addressed in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Sensitivity of roughness coefficients to confirm variation associated with use of higher and lower roughness values in Detailed Design.
C2K	Warrill Creek	C2K.W10	Blockage for first layer of bridges set to zero. Span of bridge in model different to that reported in FDR.	Low	To be addressed in Detailed Design	7	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to confirm reasonableness of bridge representation using alternate approaches.
C2K	Warrill Creek	C2K.W11	Minor waterway culverts do not match culverts listed in Appendix I of the technical report.	High	To be addressed in Revised Draft EIS	7	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Include relevant local drainage structures in Revised Draft EIS.
C2K	Warrill Creek	C2K.W12	Changes made to the BRCFS model not detailed in the draft EIS documentation.	Very High	Technical Note updated to confirm this will be documented in the Revised Draft EIS.	7	No changes have been made to the BRCFS mdoel other than to add additional output locations for transfer of flow to the TUFLOW model. Revised Draft EIS to document the additional output locations that were added to the BRCFS model.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to document the additional output locations that were added to the BRCFS model.
C2K	Warrill Creek	C2K.W13	Level of detail in information provided to the Panel.	Very High	Technical Note updated to include reference to use of updated FIOs and OCG C2K RFI requirements.	7	Revised Draft EIS to include sufficient documentation of the work undertaken and adopted measures, and also in accordance with the new FIOs.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to include sufficient documentation of the work undertaken and adopted measures, and also in accordance with the new FIOs.
C2K	Purga Creek	C2K.P1	The BRCFS model has been used with minimal alteration to account for local features.	High	To be addressed in Revised Draft EIS	8	Discussion acknowledged regarding several crossings and generally agreed. Review subdivision of catchments for local tributary flows in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Review subdivision of catchments for local tributary flows in Revised Draft EIS.
C2K	Purga Creek	C2K.P2	The joint calibration generally presents a poor fit to recorded data. This may be due to a reliance on events used in the BRCFS which were not significant for the Purga catchment.	High	Technical Note updated to include commitment to include modelling of calibration events modelled as part of the IRFSU.	8	IRFSU hydrology to be applied for the Revised Draft EIS assessment and the 1996 and 2017 events should be included.	Accepted subject to additional information in Revised Draft EIS	IRFSU hydrology to be applied for the Revised Draft EIS assessment and the 1996 and 2017 events should be included.

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
C2K	Purga Creek	C2K.P3	The joint hydrologic/hydraulic model uses different hydrologic parameters to the hydrologic model to achieve the same flow rates.	High	Using the hydraulic model to inform alpha may be appropriate for an uncalibrated hydrologic model and/or if trying to reconcile the hydrologic model to the hydraulic model. However, we are attempting to reconcile both hydrologic and hydraulic models to the stream gauge data. The URBS alpha value is considered to be reasonable based on matching of the hydrographs at Loamside in the lower catchment and Peak Crossing in the upper catchment, as well as the timing of flows between these points. Adjusting the alpha value would adversely affect these timings in the hydrologic model. The Beta value was adjusted for the reasons explained in the Technical Note and because it appeared to improve the match. There is a large overlap between the hydrologic and hydraulic models. Adjusting the alpha would have no effect on the hydraulic model results since this routing is performed in the hydraulic model. Other options include modifying the discretization of the sub-catchments to improve consistency and minimize overlap of storages, and/or in the hydraulic model domain, checking the effect of sub-grid sampling (not available when the original modelling was performed) and roughness assumptions. It is currently proposed to adopt the ICC hydrology going forward, and the calibration of the models can be reviewed as part of this process. The Technical Note has updated based with this text.	8	ICC hydrology to be applied for the Revised Draft EIS assessment. Use of alpha and beta to be reviewed again at that stage against this issue.	Accepted subject to additional information in Revised Draft EIS	Use of alpha and beta to be reviewed and ICC hydrology to be applied for the Revised Draft EIS assessment.
C2K	Purga Creek	C2K.P4	The ARF does not appear to have been adjusted to assess different locations of interest throughout the alignment. While the use of a single ARF may be appropriate, the provided information does not justify its use in this manner.	Medium	To be addressed in Revised Draft EIS	8	Differences in ARF quantified and shown to be non-impactful. Justification to be summarised in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Justification to be summarised as part of the Revised Draft EIS.
C2K	Purga Creek	C2K.P5	Design flow inputs are (based on catchment delineation) are generally coarse and have insufficient resolution to adequately assess several structures proposed as part of the design.	Very High	To be addressed in Revised Draft EIS	8	Further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment to be untertaken in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment to be untertaken in Revised Draft EIS.
C2K	Purga Creek	C2K.P6	The model setup presented in the report is inconsistent with the model provided (roughness is different).	Low	To be addressed in Detailed Design	8	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Model setup presented in report to be consistent with model provided (roughness) in Detailed Design.
C2K	Purga Creek	C2K.P7	There are several issues associated with the representation of 1D-2D boundary conditions that may affect the water levels and impacts present at culvert structures.	High	Responded to in Technical Note	8	Improvements and outcomes are noted. Response is acceptable.	Closed	n/a
C2K	Purga Creek	C2K.P8	Some bridge layered flow constrictions shapes do not align with the main rail alignment.	Low	To be addressed in Detailed Design	8	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Bridge layered flow constrictions shapes to align with the main rail alignment in Detailed Design.
C2K	Purga Creek	C2K.P9	The sparse flow application due to the coarse hydrologic model may have an influence on the overall value of the hydraulic model.	High	To be addressed in Revised Draft EIS	8	Discussion acknowledged regarding several crossings and generally agreed. Review subdivision of catchments for local tributary flows in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Review subdivision of catchments for local tributary flows in Revised Draft EIS.
C2K	Purga Creek	C2K.P10	The FFA is consistent with the BRCFS however there is a potential underestimation of design flows. E.g. design flows for the 1% AEP event are lower than the 2% AEP FFA estimate.	Very High	To be addressed in Revised Draft EIS	8	The Panel will await the findings in the revised Technical Document. Approach, however, is agreed.	Accepted subject to additional information in Revised Draft EIS	Justification to be summarised as part of the Revised Draft EIS.
C2K	Purga Creek	C2K.P11	Sensitivity testing has been undertaken for climate change and blockage factors but does not appear to have resulted in any changes to the design.	Medium	Responded to in Technical Note	8	The response is acceptable.	Closed	n/a
C2K	Purga Creek	C2K.P12	Impacts for events up to the 1% AEP event are noted. There are several non-conformances due to level which are justified by the rural nature of the area.	High	To be addressed in Revised Draft EIS	8	Revised Draft EIS to discuss any non-compliances with new FIOs in regards to impacts.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to discuss any non-compliances with new FIOs in regards to impacts.
C2K	Purga Creek	C2K.P13	Further work needs to be done to assess if potential impacts associated with minor crossings are acceptable when considered within the regional flood model.	High	To be addressed in Revised Draft EIS	8	Design of structures to be reviewed and justification to be summarised as part of the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Design of structures to be reviewed and justification to be summarised as part of the Revised Draft EIS.
C2K	Purga Creek	C2K.P14	There are velocity increases noted and not considered to have scour risk. It is understood that they are likely manageable or of no consequence, but the decision making does not seem to consider absolute velocities.	Medium	Responded to in Technical Note	8	Further discussion and mapping of impacts provided.	Closed	n/a
C2K	Purga Creek	C2K.P15	Reporting indicates there are no significant redistribution of flows, the main corridor (at 340-BR08 and 340-BR09) redistributes flow east and west near a sensitive habitat. There is also a diversion of flow present in more frequent events near Washpool Road which impacts a residential access.	Medium	Technical Note updated to confirm that this will be assessed again in Revised Draft EIS when the IRFSU hydrology is adopted and that a range of AEPs will be considered.	8	Impacts reviewed by ecologist and results provided are acceptable. IRFSU hydrology to be applied for the Revised Draft EIS assessment. The flow redistribution is then to be re-assessed for a range of AEPs. Additionally, the potential impact on the access road is to be reviewed and documented.	Accepted subject to additional information in Revised Draft EIS	IRFSU hydrology to be applied for the Revised Draft EIS assessment. The flow redistribution is then to be re-assessed for a range of AEPs. Additionally, the potential impact on the access road is to be reviewed and documented.
C2K	Teviot Brook	C2K.TB01	Key Design Criteria.	Low	Technical Note updated to include reference to use of updated FIOs and OCG C2K RFI requirements.	9	The Revised Draft EIS is to document the impacts and how each non-compliance is to be addressed.	Accepted subject to additional information in Revised Draft EIS	The Revised Draft EIS is to document the impacts and how each non-compliance is to be addressed.
C2K	Teviot Brook	C2K.TB02	Critical duration assessment not documented for rail formation.	Medium	Responded to in Technical Note	9	Critical duration assessment provided for rail alignment crossings.	Closed	n/a
C2K	Teviot Brook	C2K.TB03	Local catchment cross-drainage.	Low	To be addressed in Detailed Design	9	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Review local catchment cross-drainage in Detailed Design.
C2K	Teviot Brook	C2K.TB04	Derivation of gully lines in model.	Low	Responded to in Technical Note	9	Additional information provided for how gully lines were derived.	Closed	n/a

Section	Model Name	Draft Report Issue No.	Issue	Level of Importance	Response Status	Technical Note Number	Final Panel comment	Final Panel Status	Action Required
C2K	Teviot Brook	C2K.TB05	Sub-catchment extents not based on railway alignment, with alignment passing through sub-catchments.	Low	To be addressed in Detailed Design	9	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Detailed Design to consider further sub-division of sub-catchments and adjustment of catchment boundaries to reflect areas upstream and downstream of the alignment.
C2K	Teviot Brook	C2K.TB06	Whether events selected for calibration are appropriate.	Medium	To be addressed in Revised Draft EIS	9	2017 flood event to be looked at for calibration or demonstrate why 2017 and other flood events are not more suitable than those studied.	Accepted subject to additional information in Revised Draft EIS	The Revised Draft EIS is to document calibration to the 2017 event or demonstrate why 2017 and other flood events are not more suitable than those studied.
C2K	Teviot Brook	C2K.TB07	Whether events that have occurred subsequent to the Teviot Brook Flood Modelling should be used for calibration or validation.	Medium	Technical Note updated to include commitment to include modelling of calibration events modelled as part of the IRFSU.	9	ARTC have committed to undertake modelling of the 2017 calibration event for the Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	The Revised Draft EIS is to document calibration to the 2017 event. It is preferable that the 2021 event be included, or explanation given for why it was not included.
C2K	Teviot Brook	C2K.TB08	Critical cross-drainage has been missed from the assessment.	High	Responded to in Technical Note	9	Justification provided for why flows not provided upstream of bridges reasonable.	Closed	n/a
C2K	Teviot Brook	C2K.TB09	Location of inflows applied to the hydraulic model are inconsistent.	Medium	To be addressed in Revised Draft EIS	9	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Inflow locations to be corrected as part of the Revised Draft EIS.
C2K	Teviot Brook	C2K.TB10	Bridge loss coefficients not verified against alternate methods.	Low	To be addressed in Detailed Design	9	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design.	Accepted subject to ARTC committing to Panel's recommendations being addressed in Detailed Design	Bridge loss coefficients to be verified against alternate methods in Detailed Design.
C2K	Teviot Brook	C2K.TB11	Reported 1% and 0.05% AEP flows through structures are incorrect for regional cross-drainage.	Low	To be addressed in Revised Draft EIS	9	ARTC offering improved approach and will include in Revised Draft EIS.	Accepted subject to additional information in Revised Draft EIS	Revised Draft EIS to confirm 1% AEP and 0.05% AEP discharges and velocities applicable to structural design of all bridges.
C2K	Geomorphology C2K	C2K.G1	No assessment of upstream or downstream channel condition and processes to gain an understanding of the likely rate or trajectory of channel change.	Low	Technical Note updated to include the OCG C2K RFI requirements for additional information for the Revised Draft EIS that will be address. (a) description of the existing fluvial geomorphic processes within, upstream and downstream of proposed waterway crossings (b) desktop assessment of the potential changes to channel characteristics as a result of the C2K project including any proposed drainage diversions (c) risk assessment of alterations to geomorphic processes from project infrastructure including local drainage culverts within waterways/watercourses and provide suitable mitigation and management measures (d) detailed assessment of potential changes to channel characteristics for high-risk sites.	10	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.
C2K	Geomorphology C2K	C2K.G2	Impacts of minor waterway crossings not assessed.	Low	Technical Note updated to include the OCG C2K RFI requirements for additional information for the Revised Draft EIS that will be address. (a) description of the existing fluvial geomorphic processes within, upstream and downstream of proposed waterway crossings (b) desktop assessment of the potential changes to channel characteristics as a result of the C2K project including any proposed drainage diversions (c) risk assessment of alterations to geomorphic processes from project infrastructure including local drainage culverts within waterways/watercourses and provide suitable mitigation and management measures (d) detailed assessment of potential changes to channel characteristics for high-risk sites.	10	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.	Accepted subject to Panel's implementation of geomorphological assessment	1. All high risk sites to have detailed on-site assessments; and 2. On-site assessment inspection to occur either during the Revised Draft EIS or at the start of Detailed Design.