Alternative Inland Rail route across the Namoi River at Narrabri NSW

Flood impact assessment

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1 Introduction

1.1 BACKGROUND

WRM Water & Environment Pty Ltd (WRM) was commissioned to develop concept designs of the waterway structures required for an alternative alignment of the proposed Inland Rail across the Namoi River at Narrabri. The waterway structures of the alternative alignment are to satisfy the flooding quantitative design objectives adopted by the Australian Rail Track Corporation (ARTC) for the alignment given in the Inland Rail (N2N) Environmental Impact Statement (ARTC alignment). A locality map showing the ARTC alignment, and the proposed alternative alignment is shown in Figure 1.1.

Figure 1.2 shows the location of structures such as the embankments, bridges, and culverts proposed along the alternative alignment.

1.2 QUANTITATIVE DESIGN OBJECTIVES

Table 1.1 shows the quantitative design objectives adopted by ARTC.

1.3 METHOD OF ASSESSMENT

A TUFLOW two-dimensional model was developed for the assessment. The model was based on:

- the MIKE Flood model of the Namoi River developed by WRM for Narrabri Shire Council and presented in the Narrabri Flood Study (WRM, 2016) (Narrabri Study)
- the TUFLOW model of Bohena Creek developed by WRM for Narrabri Shire Council and presented in the Bohena Creek Flood Study (WRM, 2019) (Bohena Study); and
- the TUFLOW model developed by JacobsGHD for ARTC and presented in the Flooding and Hydrology Assessment Technical Report 3 (JacobsGHD, undated) (ARTC Study).

Flood impacts for the proposed alternative alignment have been determined for the 10%, 1% and 0.5% annual exceedance probability (AEP) flood events from both Namoi River and Bohena Creek.

Note that the alternative alignment and proposed culvert/bridge configurations has not been optimised. Should ARTC opt to use this alignment, further work and investigations will be required.

Table 1.1 – Quantitative design objectives

Parameter	Location or land use	Quantitative design objective	Justification / description
Afflux i.e., increase in flood level resulting from implementation of the proposal	Habitable floors	10 mm	For the proposal, the increase in flood level (afflux) should be minimal. A target maximum afflux of 10 mm has been adopted for habitable floors where there us above floor flooding. This target is unlikely to result in a significant impact to land use and hazard. Afflux being the relative difference between the modelled existing flood levels and the predicted flood level after construction of the proposal. This is reported against surveyed flood levels (where available) or assumed floor levels where existing surveyors have not been carried out for both habitable and non-habitable buildings. For the remaining areas (excluding forestry and unimproved agricultural areas) a target of 200 mm afflux at the rail corridor boundary has been generally adopted. For forestry and unimproved agricultural areas, a target of 400 mm afflux has been applied in some circumstances due to lower human exposure and infrastructure in these areas.
	Sensitive infrastructure, assumed to include • Emergency services (e.g., hospitals, ambulance, fire, police stations) • Flood evacuation routes • Electricity substations • Water treatment plants.	10 mm	
	Other urban and recreational	200 mm	
	Agricultural	200 mm	
	Forest and unimproved grazing land	400 mm	
	Highways and sealed roads greater than 80 km/hr	Less than 10 mm at sensitive infrastructure.	Target has been adopted to minimise as far as practicable impacts to transport routes.
	Unsealed roads and sealed roads less than 80 km/hr	Less than 10% change in length of overtopping.	
Scour/erosion potential i.e., increase in flood velocity resulting from implementation of the proposal	Ground surfaces that have been sealed or otherwise protected against erosion. This includes roads and most urban, commercial, industrial, recreational, and forested land. Other areas including watercourses, agricultural land, unimproved grazing land and other unsealed or unprotected areas.	Outlet velocities from the rail corridor to be in accordance with site-specific assessment conducted by an experienced geotechnical or scour/erosion specialist. In addition, the increase in velocity is to be in accordance with the requirements of the NSW Blue Book (DECC, 2008a and 2008b)	In all areas a target of minimising any increase in velocities has been adopted. Scour protection provided downstream of new drainage culverts within the rail corridor where outlet velocities are greater than 0.5 m/s and/or as required in accordance with the NSW Blue Book (DECC, 2008a and 2008b). For bridges in water courses, scour protection provided at piers and abutments as required. Energy dissipaters would be provided downstream of structures where increased velocities may result in scour to adjacent land.

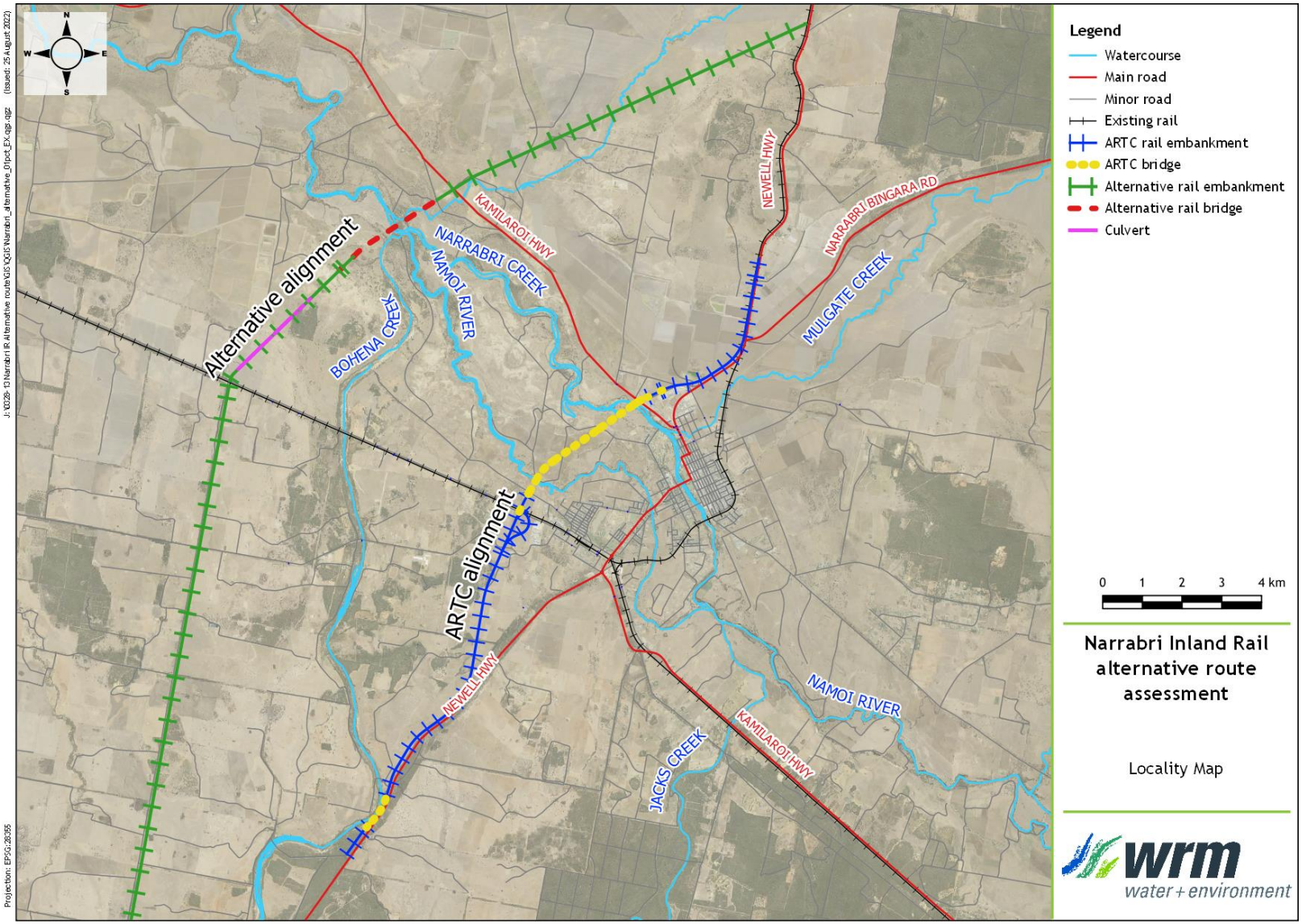

Figure 1.1 – Locality map

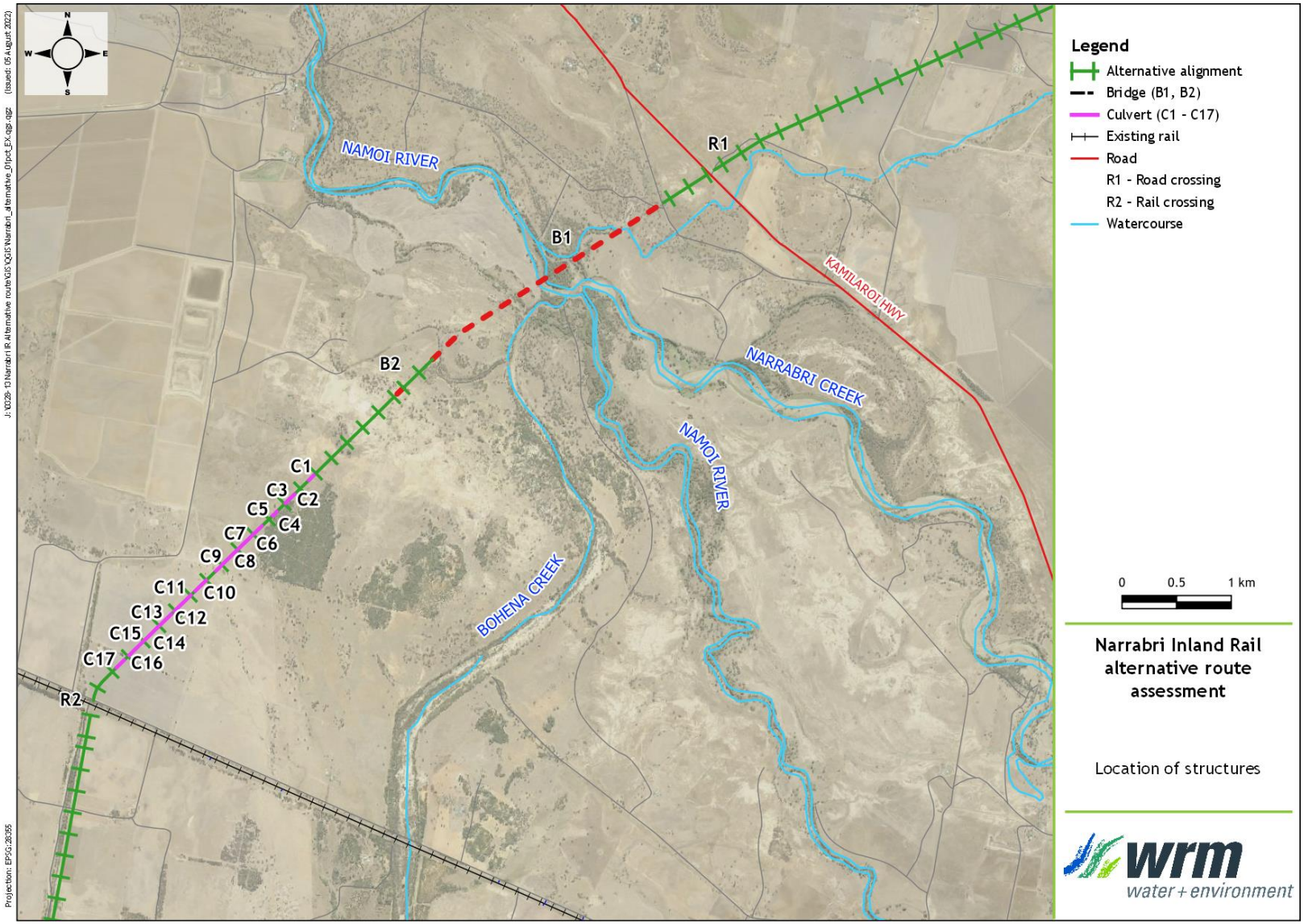

Figure 1.2 – Locations of structures

2 Design discharges

Table 2.1 shows the design discharges adopted for the Namoi River and Bohena Creek. Namoi River design discharges for the 10% and 1% AEP events were adopted from the Narrabri Study (WRM, 2016) and taken from the ARTC study for the 0.5% AEP event. Bohena Creek design discharges were obtained from the Bohena Study (WRM, 2019) for the 10% and 1% AEP events. An approximate 0.5% AEP design discharge was used for Bohena Creek as this was not calculated in the WRM (2019) study. The approximation is expected to be reasonable.

Table 2.1 – Namoi River and Bohena Creek design discharges

AEP	Design discharge (m^3/s)	
	Namoi River	Bohena Creek
10%	1,980	273
1%	4,860	1,562
0.5%	6,360	2,622

For modelling, the Namoi River and Bohena Creek discharge hydrographs were simulated consecutively within the same simulation with the flood peaks offset by more than 24 hours.

Local catchment inflows for Mulgate/Horsearm Creek and across Narrabri for each event were taken from the JacobsGHD model developed for the ARTC study. The local catchment flows at the proposed alternative alignment are not significant when compared to the peaks from Bohena Creek and the Namoi River.

3 Hydraulic modelling

3.1 METHODOLOGY

A TUFLOW (BMT, 2020) two-dimensional hydrodynamic model was developed to estimate design peak flood levels, depths, and extents in the vicinity of the rail. The model extent was based on that adopted for the ARTC study, which included the floodplains of both the Namoi River and Bohena Creek. The ARTC model was based on the model developed for the Narrabri Study (WRM, 2016) but was extended by ARTC to include Bohena Creek.

The topography and Manning's roughness values adopted for the Namoi River/Narrabri Creek floodplain were consistent with the ARTC study model. The Manning's roughness values for Bohena Creek were taken from the Bohena Study. The Bohena Study adopted conservatively high creek roughness values of 0.06, (compared to 0.03 adopted for the ARTC study). This would increase the volume and frequency of overflows from the channel onto the Bohena Creek floodplain and therefore increase the number of culverts required for the alternative alignment.

Note that further assessment of the bridge alignment would require the model to be extended downstream to remove the impacts associated with the downstream boundary assumptions.

Further to this, the model extent does not cover Spring Creek, which drains along the alternative alignment to the north of the Kamilaroi Highway. It is likely that additional structures would be required along Spring Creek. These structures are not expected to be significant.

3.2 BRIDGE AND CULVERT STRUCTURES

3.2.1 Existing structures

The existing bridge and culvert structures within the model extent were obtained from the ARTC study model and were unchanged for this assessment. These structures are upstream of the alternative alignment and will therefore not impact the assessment.

3.2.2 Alternative alignment structures

Figure 1.2 shows the locations of the proposed bridge and culvert structures across the Namoi River and Bohena Creek floodplain.

The following bridges are proposed:

- Kamilaroi Highway overpass (50 m long)
- Namoi River (2,560 m long)
- Pig Creek (120 m)
- Culgoora Road overpass (140 m)

ARTC may consider extending the Namoi River bridge to incorporate the Kamilaroi Highway overpass and Pig Creek if it was found to be less expensive than the embankment. The water level impacts of this option would be less than has been predicted for the above configuration. ARTC may also consider maintaining the rail near ground level at Culgoora Road to reduce the costs associated with the future rail connection to the Narrabri West Walgett Rail line. If this was to occur, a signalled level crossing at Culgoora Road or an overpass would be required. This option has not been assessed but would appear feasible.

The Namoi and Pig Creek bridges were modelled assuming a 10% blockage (associated with the piers) and an obvert of 208 mAHD, which is generally at or above the peak flood level for the 0.5% AEP event.

Table 3.1 shows the dimensions of the culverts proposed across the Bohena Creek floodplain. The locations of the culvert structures are shown in Figure 1.2. A Manning's 'n' value of 0.013 was adopted for all culverts. The embankment was assumed to have a width of 12 m with the embankment elevation set above the 0.5% AEP event (so that it is not overtopped for the events modelled). Approximately 1,300 m of box culverts would be required across the floodplain. Note that the locations and number of box culverts have not been optimised for this assessment.

Table 3.1 - Culvert dimensions

Structure	Type	Width (m)	Depth (m)	Number	Approx. Length (m)
Culvert (C1)	RBC	2.7	0.9	22	62
Culvert (C2)	RBC	3.6	1.2	9	33
Culvert (C3)	RBC	3.6	1.2	7	26
Culvert (C4)	RBC	3.6	1.2	9	33
Culvert (C5)	RBC	3.6	1.2	19	70
Culvert (C6)	RBC	3.6	1.2	19	70
Culvert (C7)	RBC	3.6	1.2	19	70
Culvert (C8)	RBC	3.6	1.2	19	70
Culvert (C9)	RBC	3.6	1.2	28	104
Culvert (C10)	RBC	3.6	1.2	31	115
Culvert (C11)	RBC	3.6	1.2	19	70
Culvert (C12)	RBC	3.6	1.2	19	70
Culvert (C13)	RBC	3.6	1.5	32	118
Culvert (C14)	RBC	3.6	1.2	19	70
Culvert (C15)	RBC	3.6	1.2	19	70
Culvert (C16)	RBC	3.6	1.2	19	70
Culvert (C17)	RBC	3.6	1.2	19	70

RBC – reinforced concrete box culvert

3.3 FLOOD LEVEL IMPACT (AFFLUX)

Figure 3.1, Figure 3.2 and Figure 3.3 show the predicted flood extents and the change in flood levels in the vicinity of the proposed alternative alignment for the 10%, 1% and 0.5% AEP events. The model results indicate:

- the flood level impacts would generally be confined to about 1.5 km upstream of the proposed alternative alignment;
- flood level impacts greater than 0.2 m would be confined to the river corridor or unimproved agricultural areas;
- there would be no flood impacts greater than 0.4 m for the 1% AEP event; and
- there would be no dwellings impacted for any of the events investigated.

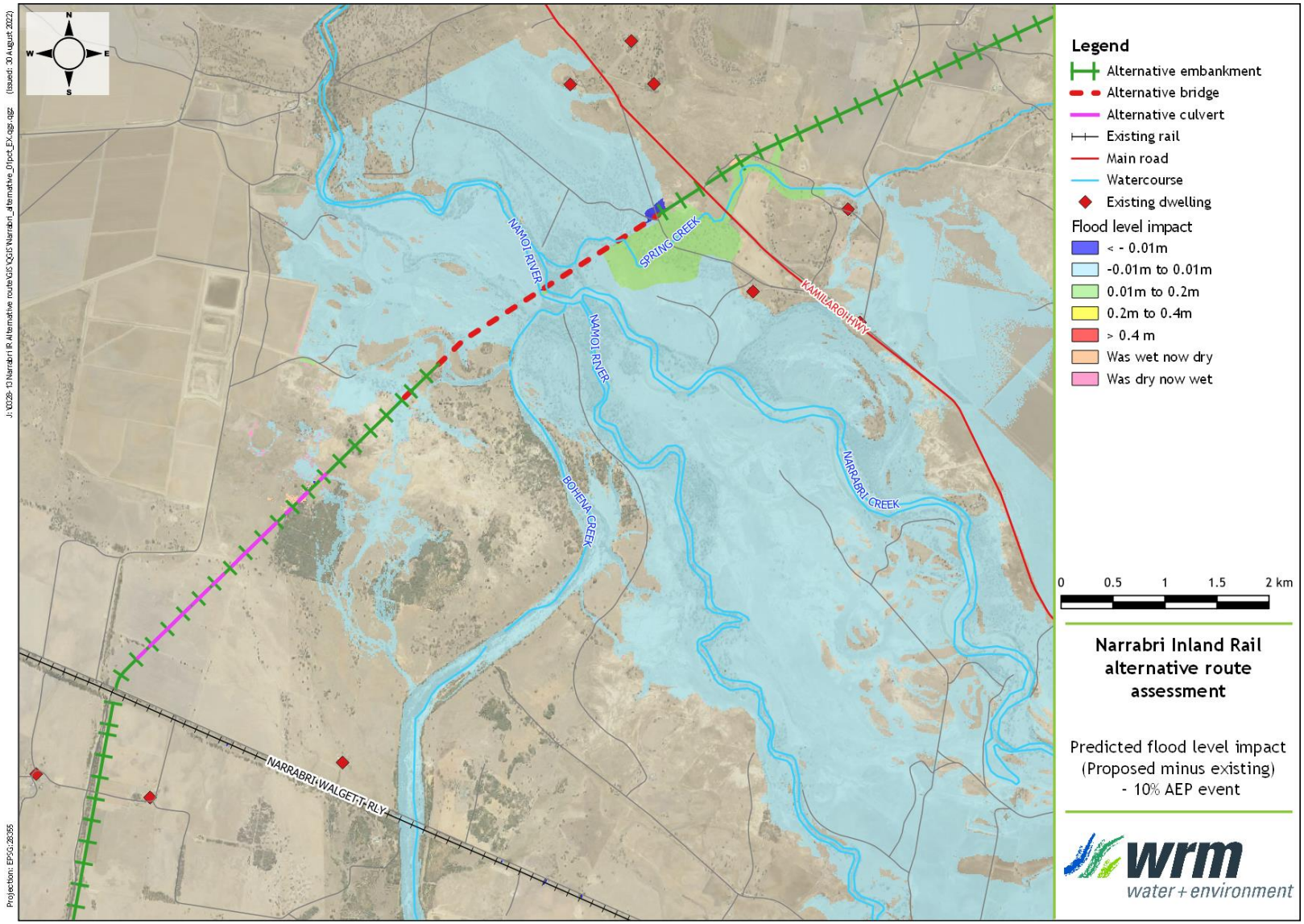

Figure 3.1 – Predicted change in flood level, 10% AEP event

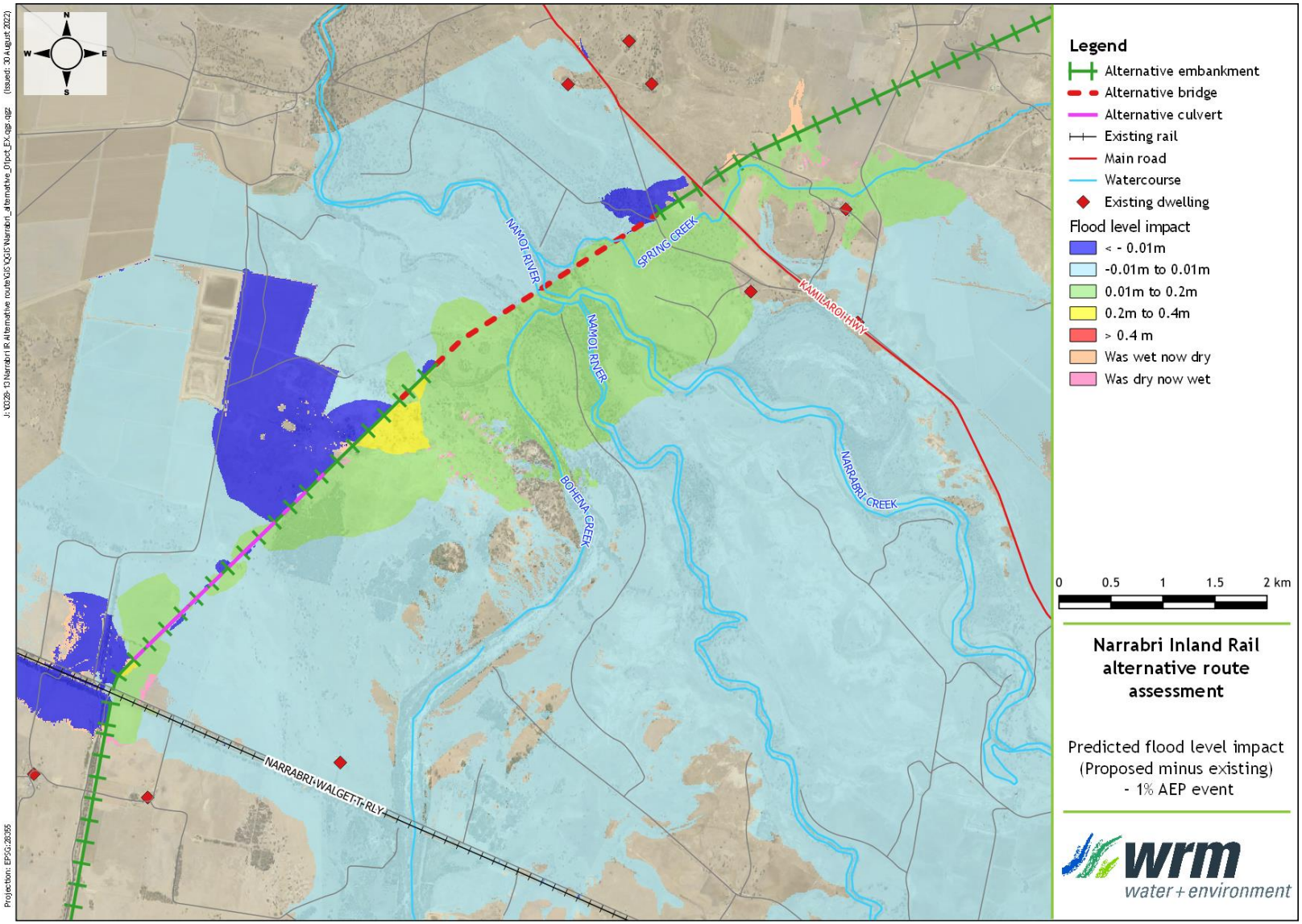

Figure 3.2 – Predicted change in flood level, 1% AEP event

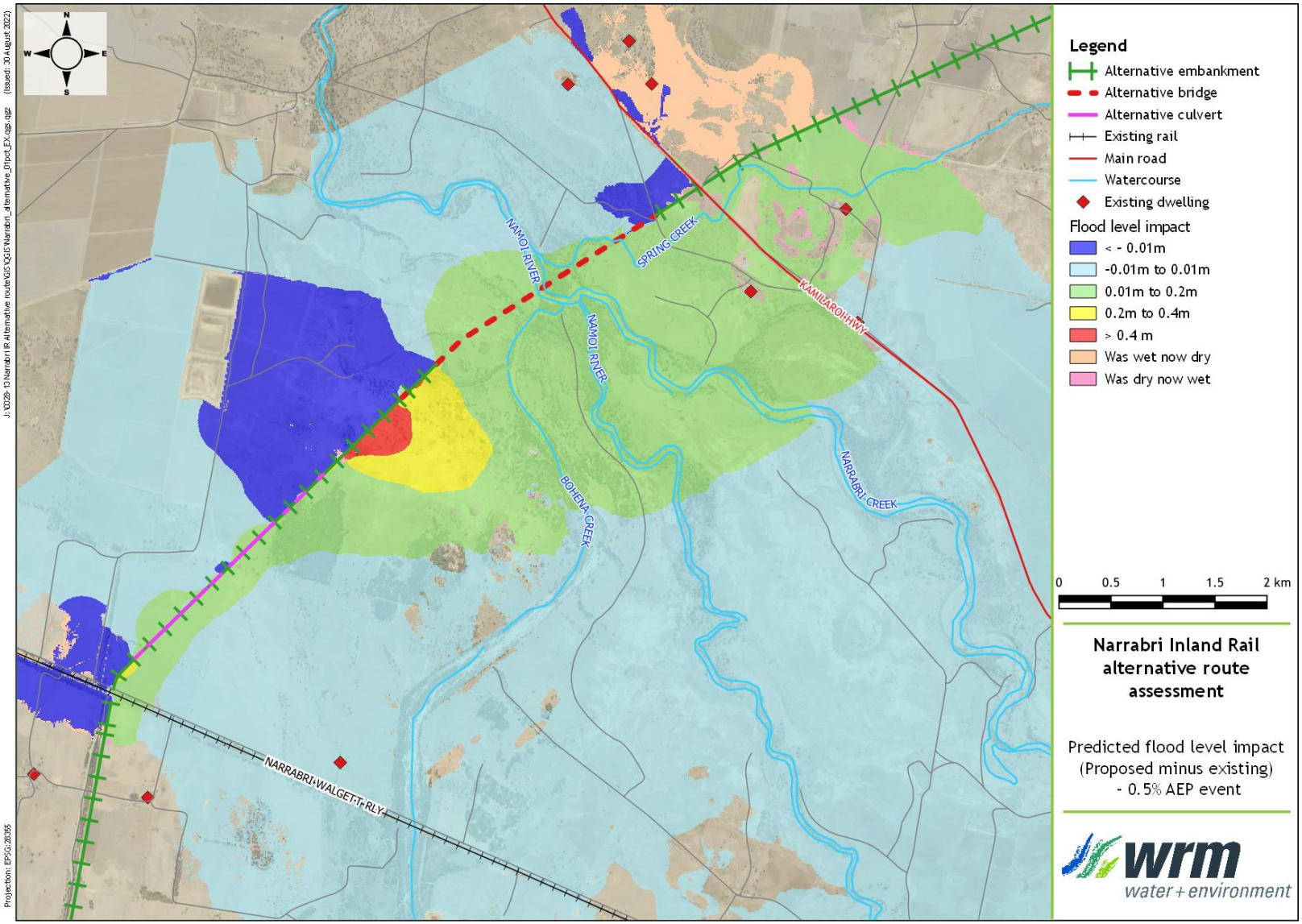

Figure 3.3 – Predicted change in flood level, 0.5% AEP event

3.4 SCOUR/EROSION POTENTIAL

The modelling shows that the peak velocities through the proposed culverts range between 0.5 m/s and 1.1 m/s for the 1% AEP event. These velocities are similar to velocities encountered across the Namoi River floodplain for this event.

The critical velocity for grazing pasture (grass) given in the NSW Blue Book (Landcom, 2004) (assuming moderate soil erodibility) is 1.2 m/s. This suggests that additional erosion would not be expected. Notwithstanding, to satisfy the quantitative design objectives (Table 1.1) scour protection may be required downstream of each culvert.

4 Summary

Concept designs of the waterway structures for an alternative alignment of the proposed Inland Rail across the Namoi River at Narrabri have been developed and assessed. A hydraulic TUFLOW model was developed and run for the 10% AEP, 1% AEP and 0.5% AEP design events from both the Namoi River and Bohena Creek. The results of the modelling demonstrate that the proposed alternative alignment would satisfy the quantitative design objectives adopted by ARTC for both waterways. In particular:

- the flood level impacts would generally be confined to about 1.5 km upstream of the proposed alternative alignment and not extend into the urban areas of Narrabri;
- flood level impacts greater than 0.2 m would be confined to the river corridor or unimproved agricultural areas;
- there would be no flood impacts greater than 0.4 m for the 1% AEP event;
- there would be no dwellings impacted for any of the events investigated; and
- exit velocities for each proposed culvert are generally consistent with existing conditions velocities across the Namoi River floodplain.

The alternative alignment and proposed culvert/bridge configurations have not been optimised as part of this study. Should ARTC opt to use this alignment, further work and investigations will be required.

5 References

BMT WBM, 2020	*'TUFLOW User Manual'*, BMT WBM, 2020.
JacobsGHD, undated	*'ARTC Inland Rail Narromine to Narrabri Project Flooding and Hydrology Assessment Technical Report 3 2-0001-250-EAP-00-RP-0010'* prepared by JacobsGHD IR Joint Venture (JacobsGHD) for ARTC
Landcom, 2004	*Soils and Construction, Volume 1,* (NSW Blue Book), 4th Edition, March 2004
WRM, 2016	*'Narrabri Flood Study, Namoi River, Mulgate Creek and Long Gully'* report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, 2 December 2016
WRM, 2019	*'Bohena Creek Flood Study'* report prepared for Narrabri Shire Council by WRM Water & Environment Pty Ltd, 9 October 2019