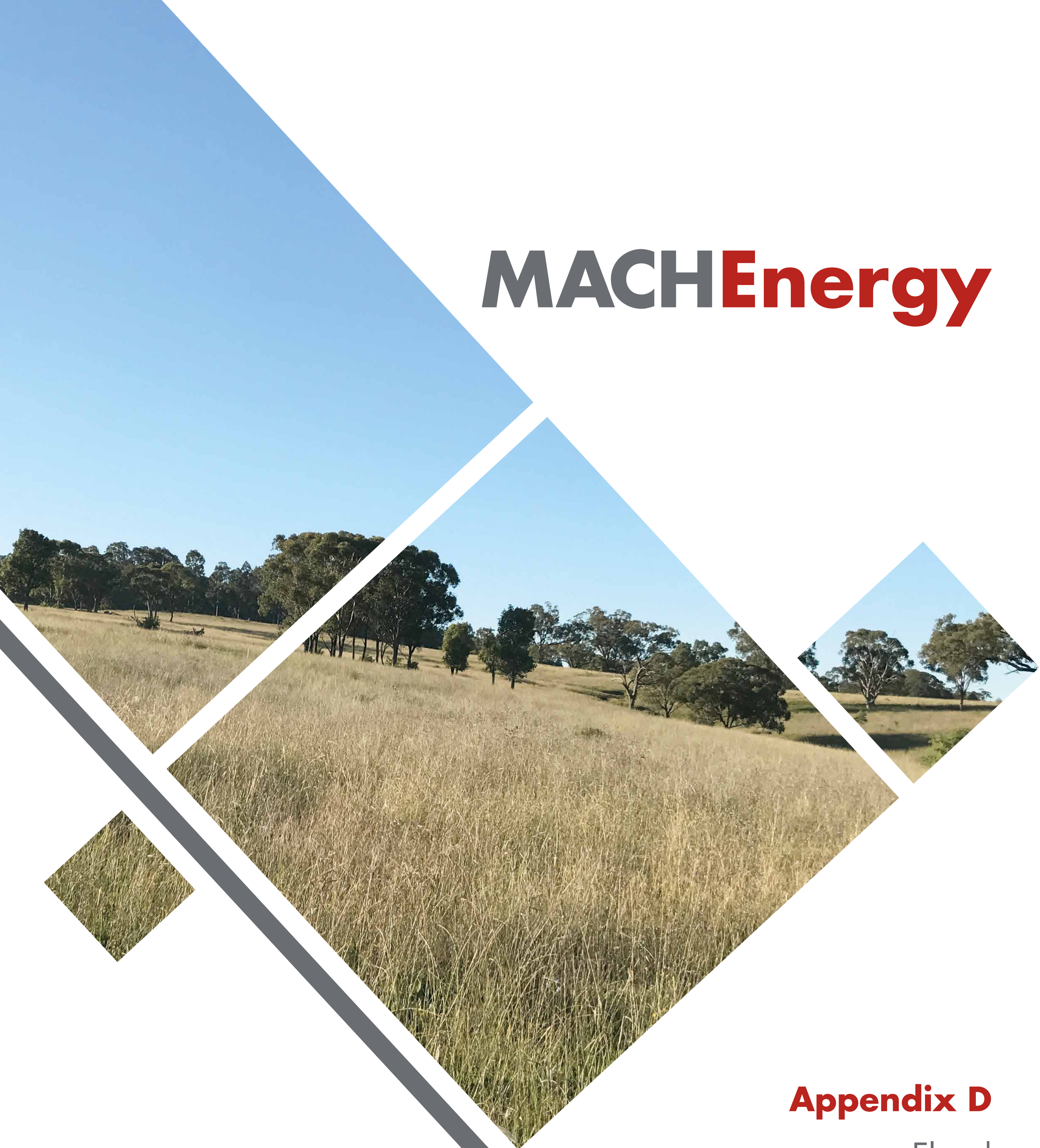
MACH Energy



Appendix D

Flood Assessment

Mount Pleasant Operation

Rail Modification Flood Assessment

MACH Energy Australia Pty Ltd

0744-09-B3, 19 December 2017

Report Title	Mount Pleasant Operation - Rail Modification Flood Assessment
Client	MACH Energy Australia Pty Ltd
Report Number	0744-09-B3

Revision Number	Report Date	Report Author	Reviewer
B3	19 December 2017	DN/BC	MB

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1 Introduction

1.1 PROJECT OVERVIEW

The Mount Pleasant Operation Development Consent DA 92/97 was granted on 22 December 1999. The Mount Pleasant Operation was also approved under the *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in 2012 (EPBC 2011/5795).

MACH Energy Australia Pty Ltd (MACH Energy) acquired the Mount Pleasant Operation from Coal and Allied Operations Pty Ltd (Coal & Allied) on 4 August 2016. MACH Energy commenced construction activities at the Mount Pleasant Operation in November 2016 and commenced mining operations in October 2017, in accordance with Development Consent DA 92/97 and EPBC 2011/5795.

The approved Mount Pleasant Operation includes the construction and operation of an open cut coal mine and associated rail spur and product coal loading infrastructure located approximately three kilometres (km) north-west of Muswellbrook in the Upper Hunter Valley of New South Wales (NSW) (Figure 1.1).

The mine is approved to produce up to 10.5 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal. Up to approximately nine trains per day of thermal coal products from the Mount Pleasant Operation will be transported by rail to the port of Newcastle for export or to domestic customers for use in electricity generation.

1.2 PROPOSED MODIFICATION

The ultimate extent of the approved Bengalla Mine open cut intersects the approved Mount Pleasant Operation rail spur.

While the intersection of the Bengalla Mine open cut with the approved Mount Pleasant Operation rail infrastructure is still some years away, MACH Energy is proposing a Rail Modification to obtain approval for future product transport facilities to manage this interaction.

The Rail Modification would primarily comprise:

- duplication of the approved rail spur, rail loop, conveyor and rail load-out facility and associated services;
- duplication of the Hunter River water supply pump station, water pipeline and associated electricity supply that currently follows the rail spur alignment; and
- demolition and removal of the redundant approved infrastructure within the extent of the Bengalla Mine, once the new rail, product loading and water supply infrastructure has been commissioned and is fully operational.

The Rail Modification would not alter the number of approved train movements on the rail network or operational workforce of the Mount Pleasant Operation. The alignment of the proposed rail spur is shown in Figure 1.2.

1.3 SCOPE OF FLOOD ASSESSMENT

WRM Water & Environment Pty Ltd (WRM) was commissioned by MACH Energy to assess the potential impacts of the new rail spur on Hunter River flooding and provide advice on appropriate design criteria and mitigation measures to prevent adverse flooding impacts on nearby private properties and public infrastructure.

Figure 1.1 – Locality map, Mount Pleasant Operation

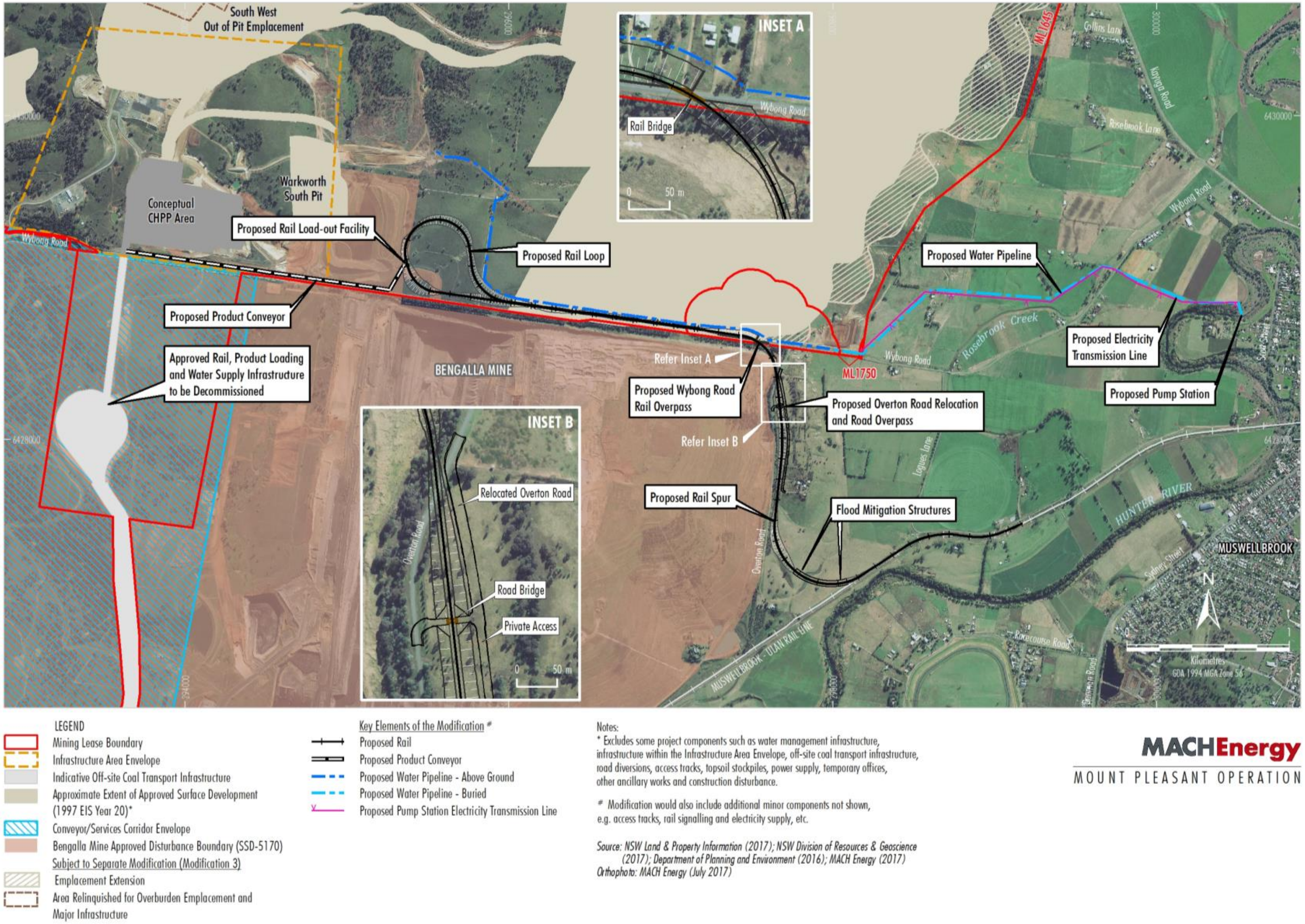


Figure 1.2 – Alignment of proposed rail spur

The Rail Modification involves construction of a new rail spur across part of the floodplain of the Hunter River. The Rail Modification also includes the construction of a water supply pump station and associated water pipeline however these are not considered to have any material effect on flooding given the water supply pipeline would be buried within the Hunter River floodplain and therefore would not impede overland flow during a flood event.

This flood assessment includes detailed hydrologic and hydraulic modelling of the Hunter River floodplain in the area of interest to assess the potential impacts of the proposed rail spur on flood levels and velocities.

1.4 REPORT STRUCTURE

This report details the methodology and results of the flood assessment. The report is structured as follows:

- Section 2 describes the drainage characteristics of catchments in the vicinity of the study area and general data relating to Glenbawn Dam, which is located upstream of the Mount Pleasant Operation.
- Section 3 outlines available data including stream gauge data and previous relevant studies.
- Section 4 describes the development and verification of the hydrologic model and the estimation of design flood discharges.
- Section 5 describes the development and verification of the hydraulic model.
- Section 6 outlines the results of the flood assessment.
- Section 7 presents the conclusions of the study.
- Section 8 is a list of references.

2 Drainage network

2.1 CATCHMENT AND FLOODPLAIN CONFIGURATION

The proposed rail spur is located on the northern floodplain of the Hunter River. The Hunter River has a catchment area of 4,220 square kilometres (km^2) upstream of Muswellbrook.

The Hunter River floodplain in the vicinity of Muswellbrook consists of a wide, flat floodplain with a width of about 2 km. An incised main channel approximately 10 metres (m) deep meanders across the floodplain. The floodplain is drained by a number of meandering floodplain drainage channels which collect local runoff from the floodplain and local catchment inflows. These floodplain channels also convey breakout flows from the Hunter River main channel during flood events.

Figure 2.1 shows a cross-section of the Hunter River floodplain near the proposed rail spur location. The existing Muswellbrook-Ulan Rail Line is located on an existing embankment across the floodplain.

The existing rail and road embankments crossing the floodplain incorporate various cross-drainage structures, including bridges and culverts, to convey in-bank and floodplain flows. The existing rail embankment impedes some flow but overtops under certain flooding conditions. The Rail Modification rail spur remains at the same elevation as the existing Muswellbrook–Ulan Rail Line for approximately 1 km from the turnout location before it begins rising toward the foothills adjacent to the Bengalla Mine waste emplacement.

Where the proposed rail spur is increasing in elevation relative to the existing rail line on the floodplain, it will impede flows that would have previously overtopped the existing Muswellbrook–Ulan Rail Line. MACH Energy would implement additional hydraulic structures to reduce the amount of flow that is impeded in order to reduce any potential change in flood levels/velocity at private properties and public infrastructure to acceptable limits.

2.2 GLENBAWN DAM

Glenbawn Dam is a major water supply dam located on the Hunter River upstream of Muswellbrook. The structure is an ungated, rock embankment dam, utilising both a chute spillway and fuse plugs for water level control.

The original dam was completed in 1958, however the dam was raised with a three-fold increase in capacity in 1987. Relevant details of Glenbawn Dam are as follows[a]:

- Catchment area = 1,300 km^2
- Surface area at Full Supply Level (FSL) = 26.1 km^2
- Main wall height = 100 m
- Spillway crest level = 280.6 metres above Australian Height Datum (mAHD)
- FSL = 276.2 mAHD
- Storage capacity at FSL = 750,000 megalitres (ML)
- Spillway length = 190 m

[a] Source = NSW Office of Water website

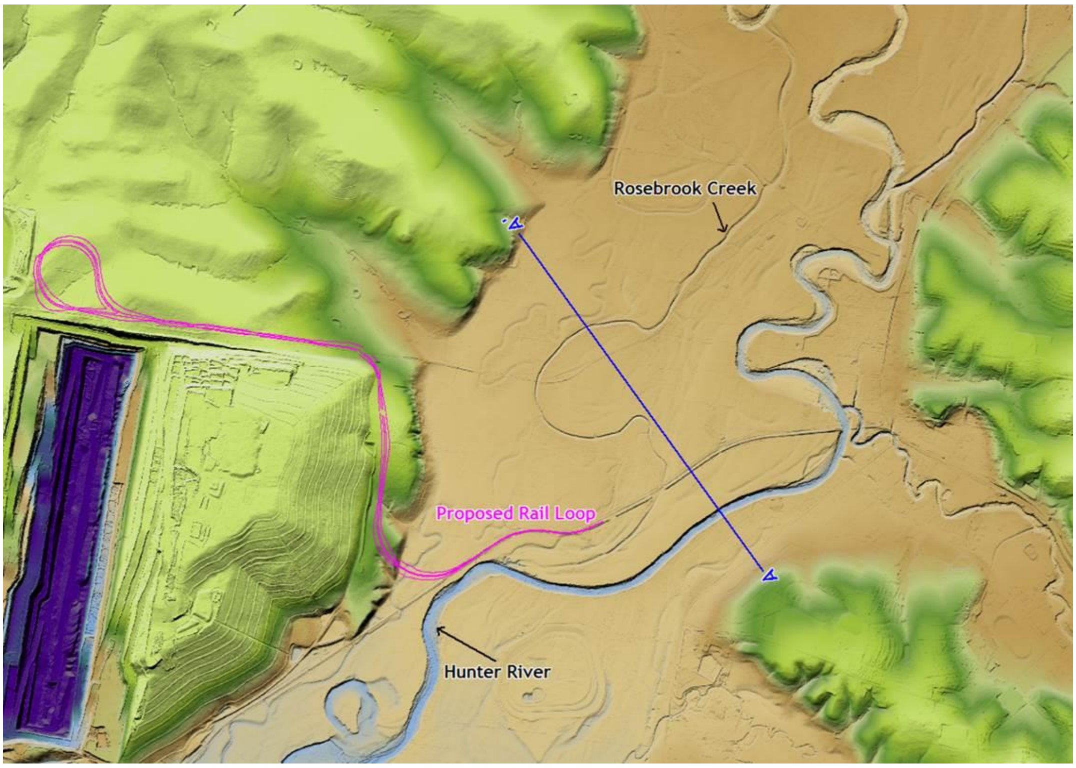


Figure 2.1 – Hunter River floodplain cross-section

3 Available data

3.1 STREAMFLOW DATA

Recorded streamflow data is available at a number of stream gauges within the Hunter River catchment (shown in Table 3.1). Figure 3.1 shows the locations of these streamflow gauges. The most relevant stream gauge is Hunter River at Muswellbrook Bridge gauge, which is only 3 km north-east of the proposed rail spur.

The Hunter River at Muswellbrook Bridge gauge has recorded streamflow data since 1913, but significant data was missing prior to 1961. The data recorded since 1961 was used to undertake the flood frequency analysis (FFA) for the study.

Table 3.1 – Stream gauges within the study area

Station Name	Station Number	Catchment area (km^2)	Latitude Longitude	Period of Available Data
Hunter River at downstream Glenbawn Dam	210015	1,295	-32.11 150.99	Aug 1940 - Oct 2017
Hunter River at Aberdeen	210056	3,090	-32.16 150.88	Mar 1959 – Oct 2017
Hunter River at Muswellbrook Bridge	210002	4,220	-32.26 150.89	Jan 1913 – Oct 2017
Hunter River at Denman	210055	4,530	-32.38 150.71	Feb 1959 – Oct 2017

3.2 PREVIOUS STUDY

A detailed flood study for the Hunter River (Muswellbrook to Denman) was undertaken by WorleyParsons Services Pty Ltd (Worley Parsons) for Muswellbrook Shire Council in 2014. RAFTS hydrologic and TUFLOW hydraulic models were developed for the Hunter River and calibrated to the 1998, 2000 and 2007 historical flood events. The calibrated RAFTS model and TUFLOW model were used to estimate design flood discharges and design flood levels for a range of design events.

The detailed model configuration and parameters of the Hunter River RAFTS model were provided in the 2014 Hunter River flood study report (WorleyParsons, 2014). This includes detailed RAFTS node and link parameters, design rainfall intensities and design rainfall losses.

The design discharges in the 2014 Hunter River flood study (WorleyParsons, 2014) were estimated using standard procedures outlined in 'Australian Rainfall and Runoff – A Guide to Flood Estimation' (1987) (ARR 1987) (Pilgrim, 1987). This includes the Intensity-Frequency-Duration data, temporal patterns and areal reduction factor methodology from the ARR 1987 documentation.

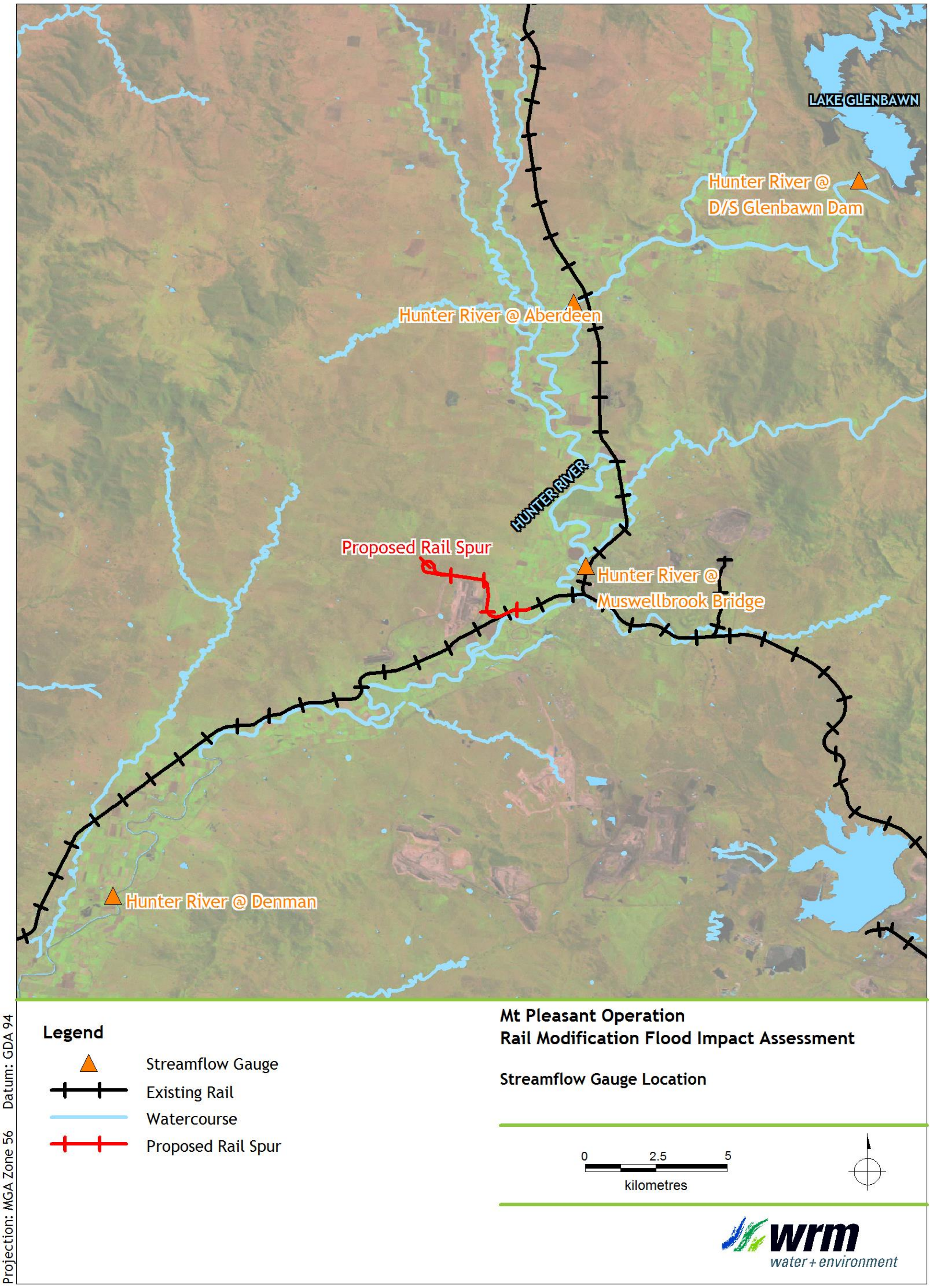


Figure 3.1 – Location of streamflow gauges

4 Estimation of discharges

4.1 METHODOLOGY

The calibrated Hunter River RAFTS model developed by WorleyParsons (2014) was reproduced using the detailed configuration and parameters reported in the 2014 Hunter River flood study report (WorleyParsons, 2014) and was used for this flood assessment.

The design discharge hydrographs were determined in accordance with the methodology recommended in Australian Rainfall and Runoff (ARR) 2016 (Ball et al., 2016), replacing ARR 1987 (Pilgrim, 1987). The major changes between ARR 2016 and ARR 1987 include:

- the use of new rainfall Intensity–Frequency–Duration (2016 IFDs), which are based on a more extensive database, with more than 30 years of additional rainfall data and data from extra rainfall stations;
- the use of an ensemble of 10 temporal patterns to derive the design discharges (the temporal pattern that gives the peak discharge closest to the mean is used), compared to using a single temporal pattern as in ARR 1987; and
- modified areal reduction factors.

The design rainfall losses were selected so that the RAFTS design peak discharges at Hunter River at Muswellbrook Bridge aligned with the results of the FFA.

4.2 FLOOD FREQUENCY ANALYSIS

4.2.1 Selection of period for FFA

A FFA was undertaken on the Hunter River at Muswellbrook Bridge gauge (Station No. 210002). The catchment area to Muswellbrook Bridge gauge is 4,220 km^2 and includes Glenbawn Dam. The catchment area of Glenbawn Dam is 1,300 km^2. Glenbawn Dam provides some 120,000 ML of flood storage between the full supply level and the spillway level. The available flood storage volume has a significant impact on the downstream discharges. Hence, hydrology of the Hunter River at Muswellbrook would be expected to be different after the upgrade of Glenbawn Dam in 1987.

Muswellbrook Bridge gauge has recorded streamflow data from 1913 to present. However, significant data was missing prior to 1961. A FFA reflecting post-dam hydrology would use data from 1987 onwards. However, this would only provide 30 years of data.

An additional 26 years of data is available if the full record from 1961 is adopted. However it is noted that this period includes data prior to the dam upgrade in 1987. Hence, a FFA based on data since 1961 is likely to slightly overestimate design discharges at Muswellbrook Bridge gauge. This is considered acceptable because it is a conservative approach for estimation of design discharges and also acceptable for a flood assessment. The model results will not be used to set design flood levels for the proposed rail spur which are determined by the existing rail embankment levels.

4.2.2 FFA results

The peak annual discharges recorded at Muswellbrook Bridge gauge between 1961 and 2016 shown in Table 4.1 were used in the FFA. The FFA was undertaken using the Bayesian inference methodology recommended in the ARR 2016 using the FLIKE software. The FFA results are given in Table 4.1, and represented graphically in Figure 4.1. There is a 90% likelihood that the design discharge is within the 90% confidence limits shown in Figure 4.1. The 5 percent (%) Annual Exceedance Probability (AEP) and 1% AEP design peak discharges are 1,732 cubic metres per second (m^3/s) and 3,721 m^3/s, respectively.

Table 4.1 - Peak annual discharges at Hunter River at Muswellbrook Bridge gauge

Year	Peak Annual Discharge (m^3/s)	Year	Peak Annual Discharge (m^3/s)
1961	93	1989	546
1962	874	1990	808
1963	385	1991	107
1964	542	1992	2,144
1965	28	1993	217
1966	28	1994	72
1967	394	1995	321
1968	701	1996	999
1969	383	1997	120
1970	313	1998	1,502
1971	3,207	1999	227
1972	232	2000	1,598
1973	117	2001	237
1974	327	2002	87
1975	136	2003	117
1976	2,109	2004	182
1977	679	2005	52
1978	865	2006	12
1979	255	2007	256
1980	8	2008	245
1981	86	2009	77
1982	77	2010	197
1983	165	2011	424
1984	1,153	2012	195
1985	237	2013	259
1986	57	2014	20
1987	183	2015	83
1988	139	2016	183

Table 4.2 - Flood frequency analysis results for Muswellbrook Bridge gauge

AEP	Design Discharge (m^3/s)
5%	1,732
2%	2,754
1%	3,721
0.5%	4,872
0.2%	6,705
0.1%	8,348

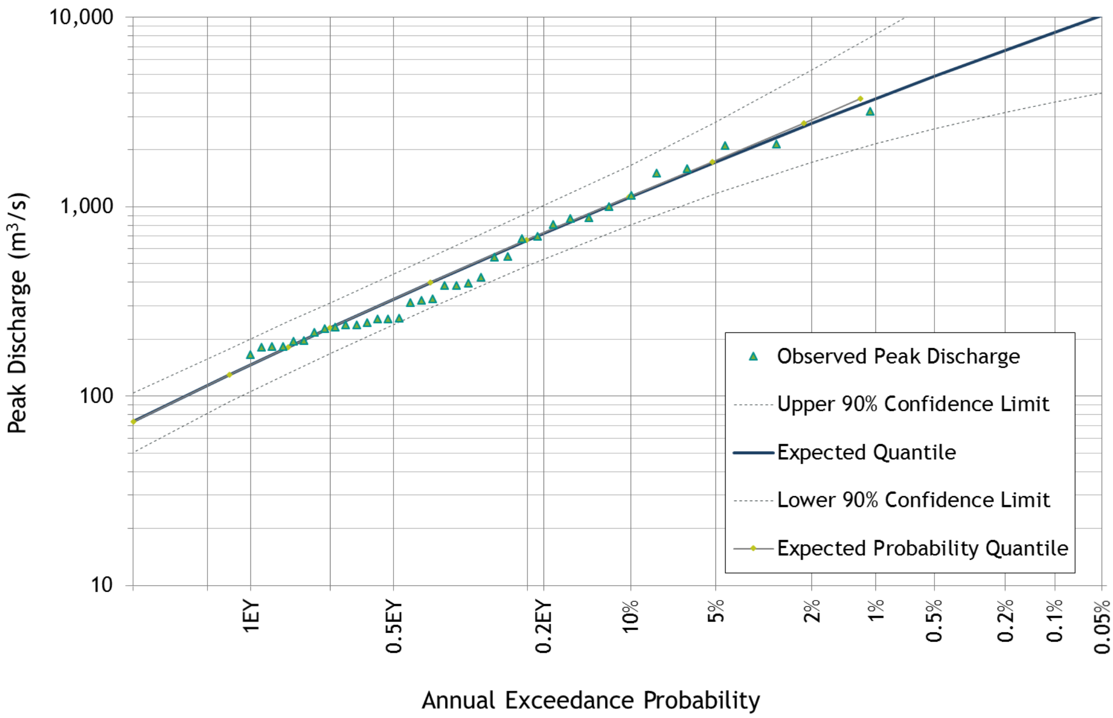


Figure 4.1 - LPIII distribution of recorded flows, Muswellbrook Bridge gauge

4.3 HYDROLOGIC MODEL CONFIGURATION

The model configuration and parameters of the calibrated Hunter River RAFTS model developed by WorleyParsons (2014) are generally unchanged. The adopted Glenbawn Dam configuration is provided in Section 4.3.4.

4.3.1 Design rainfalls

Design rainfall depths were obtained from the Commonwealth Bureau of Meteorology (BOM) for a range of design AEPs and storm durations, as shown in Table 4.3.

Table 4.3 - Design rainfall depths

Storm Duration (Hours)	Rainfall Depths (millimetres [mm])			
	10% AEP	5% AEP	2% AEP	1% AEP
12	74	86	102	115
18	87	101	121	137
24	97	113	136	154
36	113	133	160	182
48	125	147	178	203
72	141	166	201	229

4.3.2 Areal reduction factor

Table 4.4 shows the adopted areal reduction factors for the Hunter River catchment to Muswellbrook. The areal reduction factors were estimated in accordance with recommendations of Chapter 4 in ARR 2016. The Hunter River catchment is within the South-East Coast zone.

Table 4.4 – Areal reduction factors for Hunter River to Muswellbrook

Storm Duration (Hours)	Areal Reduction Factor			
	10% AEP	5% AEP	2% AEP	1% AEP
12	0.768	0.758	0.745	0.735
18	0.818	0.810	0.800	0.792
24	0.868	0.863	0.855	0.850
30	0.876	0.871	0.864	0.858
36	0.882	0.877	0.870	0.864
48	0.892	0.886	0.879	0.874
72	0.903	0.898	0.891	0.885

4.3.3 Temporal patterns

The temporal patterns define the variability of rainfall during an event. The ensemble event approach described in ARR 2016 has been used for this analysis. This approach uses an 'ensemble' of 10 temporal patterns for each storm duration to derive a range of estimated flood peaks for each AEP up to the 1% AEP event.

The temporal patterns of relevance to the Hunter River (South-East Coast temporal patterns) were obtained from the ARR 2016 Data Hub (Geoscience Australia, 2016).

4.3.4 Glenbawn Dam

Glenbawn Dam was included in the RAFTS model to account for the effect of available flood storage from the dam. Dam data including the storage curve, full supply level and spillway level were obtained from the NSW Office of Water website. The full supply level was adopted as the initial water level in the dam for all design events.

4.3.5 Rainfall losses

The rainfall losses were adjusted so that the RAFTS peak design discharges matched the results of the FFA. Table 4.5 shows the adopted rainfall losses for the 5% and 1% AEP design events. The adopted rainfall losses are comparable to the recommended rainfall losses from ARR 2016.

Table 4.5 – Adopted rainfall losses

Design Event (AEP)	Initial Loss (mm)	Continuing Loss (mm/hr)
5%	47	1.7
1%	35	1.5

4.4 ADOPTED PEAK DESIGN DISCHARGES

Table 4.6 shows the 5% and 1% AEP RAFTS design discharges and comparison to the FFA results at Hunter River at Muswellbrook Bridge gauge. The RAFTS predicted design discharges match reasonably well to FFA and hence the RAFTS design discharges were adopted in the hydraulic model to estimate design flood levels and velocities. This is considered conservative given the RAFTS discharges are slightly higher than the FFA discharges. The adopted 5% AEP and 1% AEP peak design discharges are 1,776 m^3/s and 3,841 m^3/s, respectively.

Table 4.6 – Comparison of RAFTS predicted design discharges and FFA at Muswellbrook Bridge gauge

Design Event (AEP)	FFA (m^3/s)	RAFTS (m^3/s)	Difference (RAFTS minus FFA)
5%	1,731	1,776	+2.6%
1%	3,721	3,841	+3.2%

5 Hydraulic modelling

5.1 OVERVIEW

The TUFLOW two-dimensional unsteady flow model (BMT WBM, 2016) was used to estimate flood levels and flood velocities along the channel and floodplain of the Hunter River in the vicinity of the Project.

TUFLOW estimates flood levels and velocities on a fixed grid pattern by solving the full two-dimensional depth averaged momentum and continuity equations for free surface flow. It also incorporates a one-dimensional or quasi two-dimensional modelling system (ESTRY).

5.2 TUFLOW MODEL CONFIGURATION

5.2.1 Spatial configuration

Figure 5.1 shows the extent of the hydraulic model and the locations of the inflow and outflow boundaries. The model extends approximately 6 km upstream and 13 km downstream of Muswellbrook and covers an area of some 70 km^2 including Sandy Creek. The model also includes Rosebrook Creek on the northern floodplain of the Hunter River.

The hydraulic model developed for the Rail Modification covers a smaller area than the model developed by WorleyParsons for the Hunter River (Muswellbrook to Denman) Flood Study (2014). The WorleyParsons hydraulic model was developed to define the characteristics of flooding around the townships of Muswellbrook and Denman to inform the preparation of a Floodplain Risk Management Study and Plan. The smaller spatial extent of the hydraulic model developed for this study is considered more appropriate for identifying the potential impacts of the Rail Modification at a finer scale.

5.2.2 Topographic data

LiDAR survey data was provided by MACH Energy covering an area of 560 km^2. The LiDAR was adopted as the topographic data in the hydraulic model. A digital elevation model was derived from the Lidar and a 5 m grid size was adopted for the model.

5.2.3 Manning's roughness

The TUFLOW model uses Manning's 'n' values to represent hydraulic resistance. Discrete regions of continuous vegetation types and land uses were mapped using aerial photography, and an appropriate roughness value assigned to each region. The adopted Manning's 'n' values are shown in Table 5.1. The Manning's 'n' values were refined during model verification and were applied to all design event modelling.

5.2.4 Inflow and outflow boundaries

Figure 5.1 shows the locations of two inflow boundaries, the Hunter River and Sandy Creek, for the hydraulic model. The discharge hydrographs adopted as inflows to these boundaries were obtained from the RAFTS model.

A single normal depth outflow boundary with 0.1% slope was adopted for the Hunter River model. The outflow boundary of this model is located approximately 13 km downstream of Muswellbrook and will not have an impact on flood levels in the vicinity of the proposed rail spur.

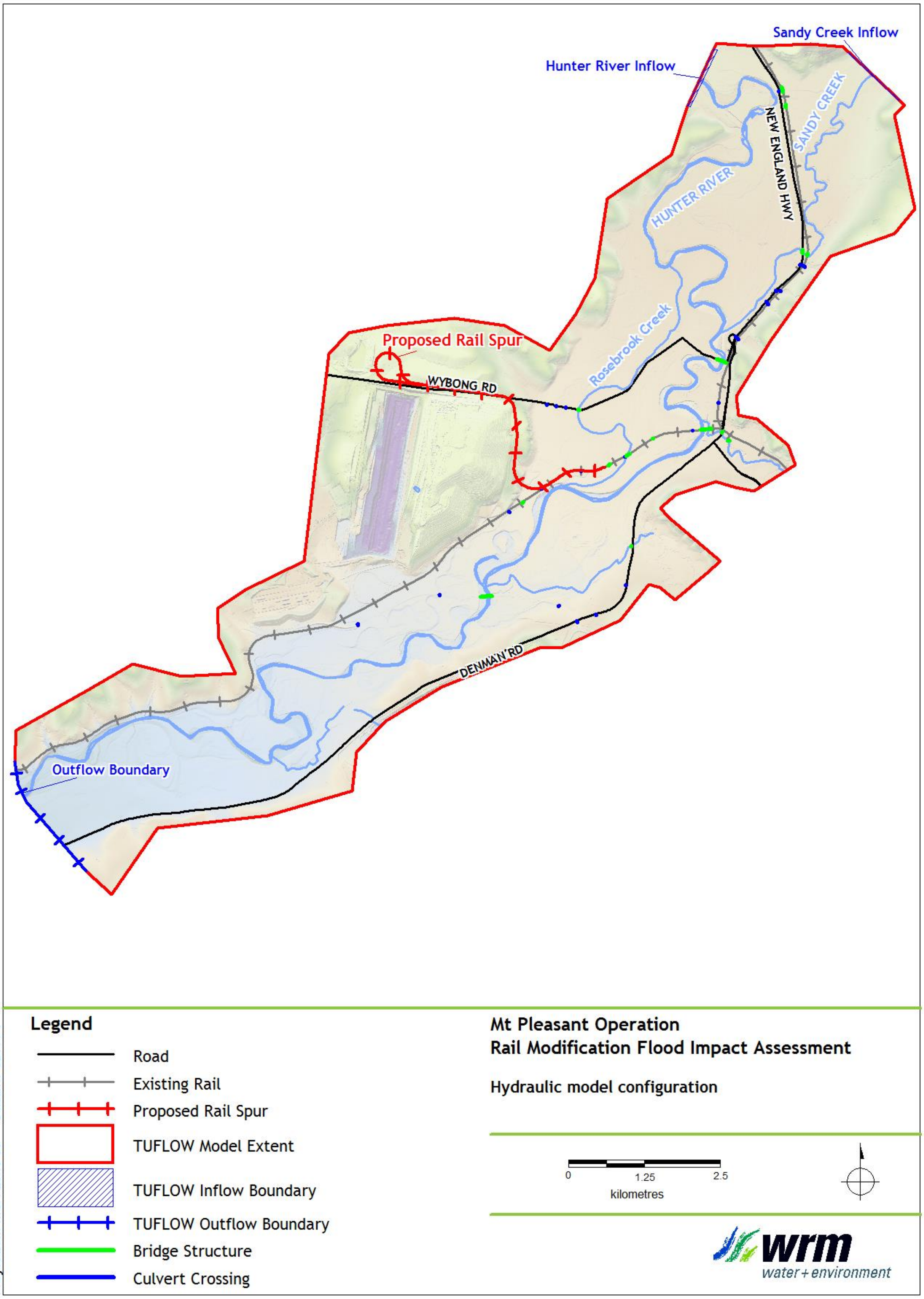


Figure 5.1 – TUFLOW model configuration

5.2.5 Existing hydraulic structures

Survey information on the existing hydraulic structures including culvert crossings and bridges were provided by FYFE (surveyors) dated 15 November 2017. A total of 26 culvert structures and 16 bridge structures were included in the hydraulic model based on the survey information. Figure 5.1 shows the locations of the modelled culvert and bridge structures.

A number of the modelled culvert and bridge structures shown on Figure 5.1 were not included in the WorleyParsons model, which focused on larger structures that had a greater potential to affect flooding at a regional scale.

Table 5.1 – Adopted Manning's roughness for different land use types

Land use	Manning's 'n'
Pasture / Overbank	0.040
Channel	0.030
Dense vegetation	0.065
Road	0.020
Rail	0.035
Urban area	0.100

5.3 HYDRAULIC MODEL VERIFICATION

5.3.1 Overview

The hydraulic model described in Section 5.2 was validated to the August 1998 and November 2000 historical events. These are the largest flood events in the last 24 years.

The recorded flow hydrographs for the Hunter River at Muswellbrook Bridge gauge for the two historical events were obtained from NSW Department of Primary Industries Office of Water (DPI Water) website and adopted as inflows to the hydraulic model. The recorded flow hydrographs were shifted by about 1.5 hours earlier to account for the model inflow boundary being about 10 km (channel length) upstream of the Muswellbrook Bridge gauge. The model predicted flow and level hydrographs were then compared to the recorded hydrographs to validate the hydraulic model.

5.3.2 Model verification results

Figure 5.2 to Figure 5.5 show the recorded and predicted flow and water level hydrographs at Hunter River at Muswellbrook Bridge gauge for the August 1998 and November 2000 flood events. Table 5.2 shows the comparison of recorded and predicted peak flood levels at Muswellbrook Bridge gauge for the two historical flood events. The following is of note:

- Using the recorded flow hydrographs, the model predicted discharges at Muswellbrook Bridge gauge match the recorded discharges well for the historical flood events. This indicates there is little channel storage or attenuation from the model inflow boundary to the gauge.
- The model predicted water levels at Muswellbrook Bridge gauge match the recorded water levels well for the historical flood events. The predicted peak flood levels at the gauge are within 0.1 m of the recorded peak flood levels.
- Figure 5.6 shows the comparison of model results and a historical photograph at New England Highway near Muscle Creek (WorleyParsons, 2014) for the November 2000 flood event. The model predicted depths at this locations are comparable to the historical photo.
- Overall, a good validation has been achieved for the August 1998 and November 2000 flood events, and the model is suitable for determining design flood levels and assessing impacts across the study area.

Table 5.2 - Comparison of recorded and predicted peak flood levels at Hunter River at Muswellbrook Bridge gauge

Event	Peak Flood Level at Muswellbrook Bridge (mAHD)		
	Recorded	Predicted	Difference (m)
August 1998	146.29	146.37	+0.09
November 2000	146.61	146.58	-0.03

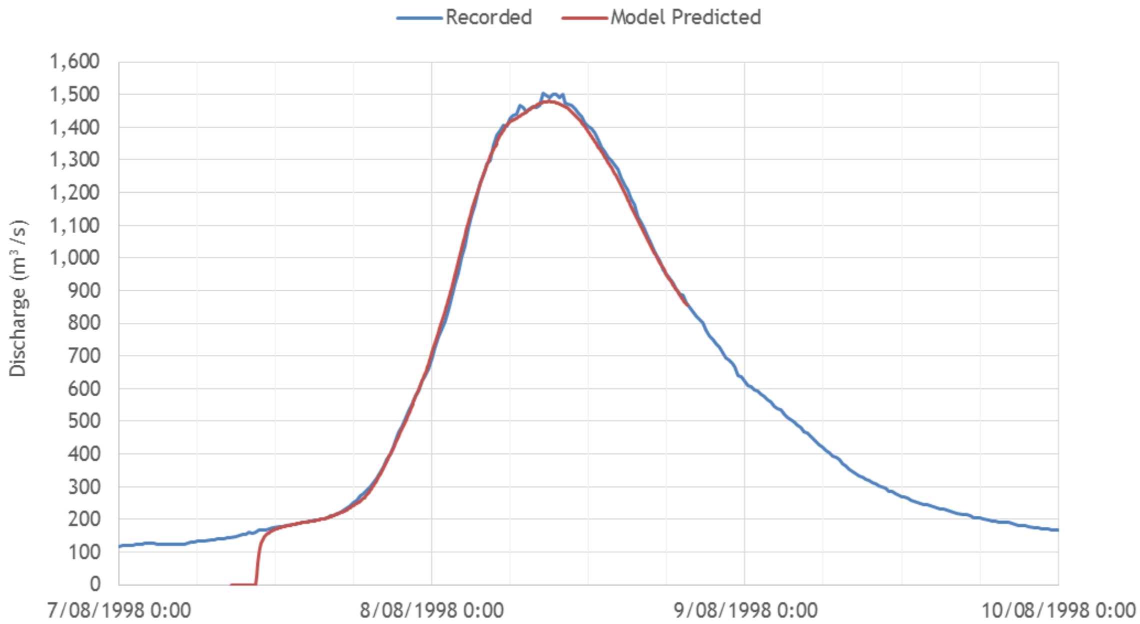


Figure 5.2 - Comparison of recorded and predicted flow hydrographs, Hunter River at Muswellbrook Bridge, August 1998 flood event

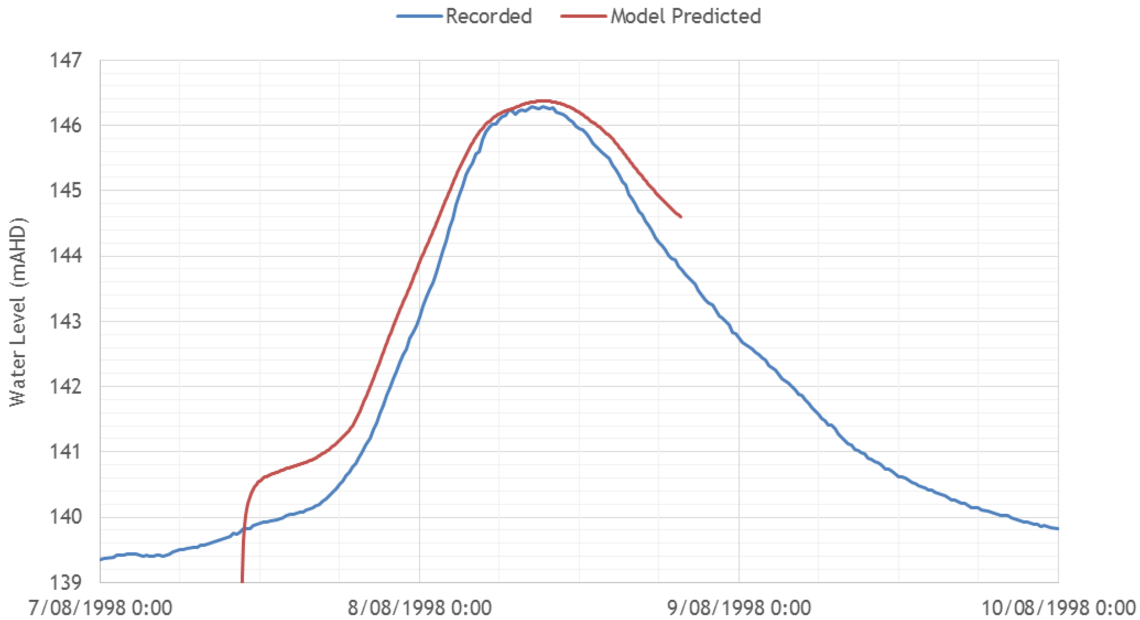


Figure 5.3 - Comparison of recorded and predicted water level hydrographs, Hunter River at Muswellbrook Bridge, August 1998 flood event

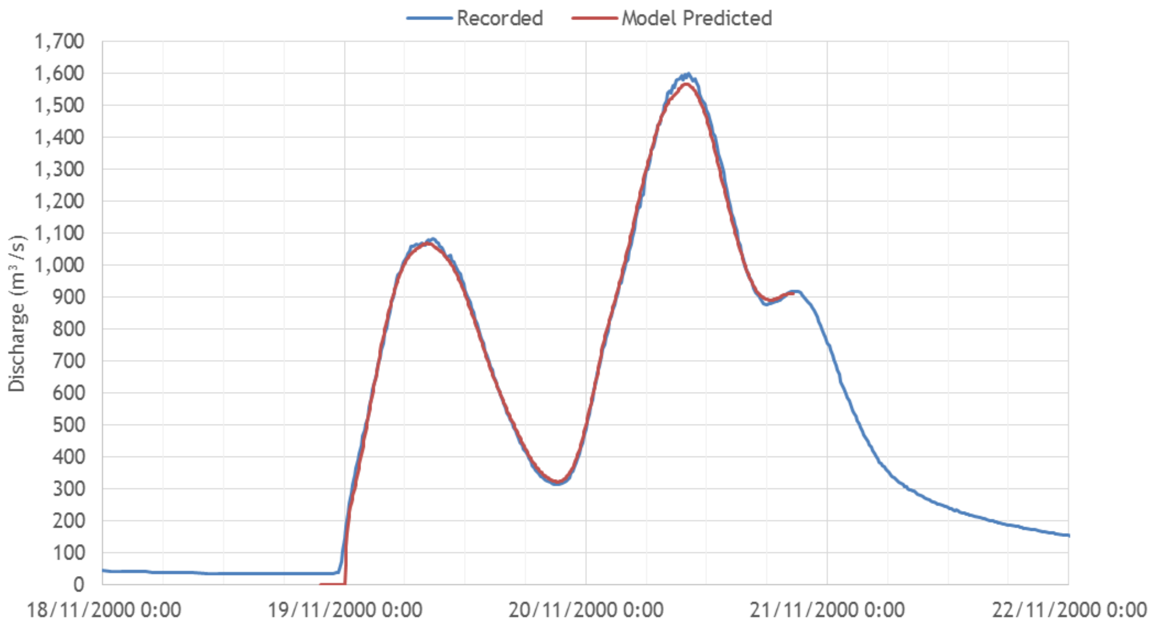


Figure 5.4 - Comparison of recorded and predicted flow hydrographs, Hunter River at Muswellbrook Bridge, November 2000 flood event

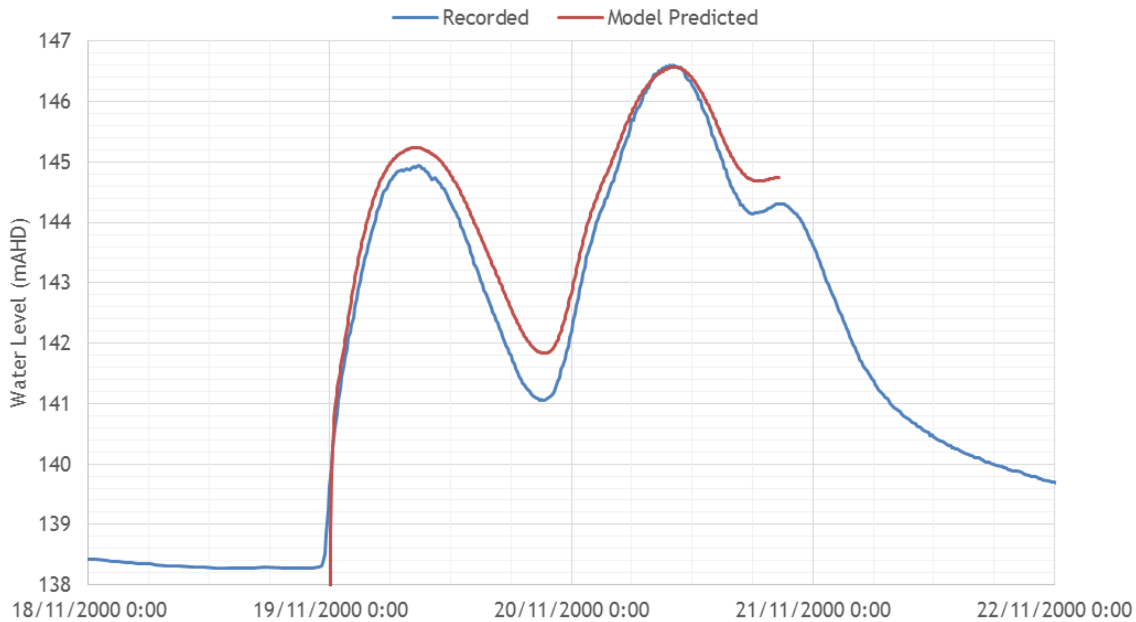
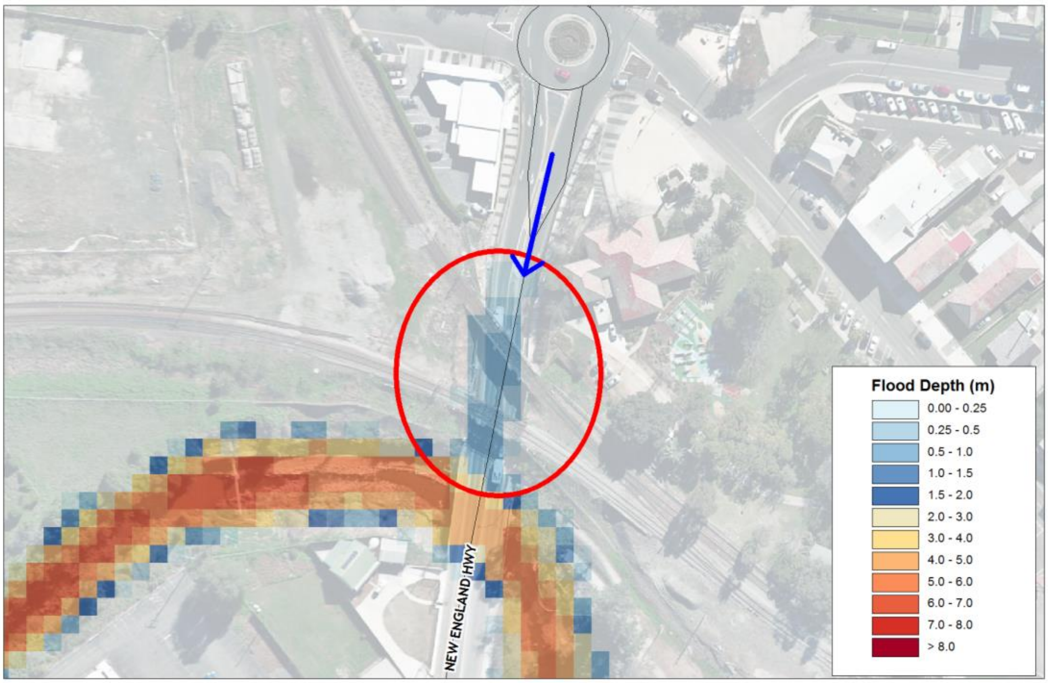


Figure 5.5 - Comparison of recorded and predicted water level hydrographs, Hunter River at Muswellbrook Bridge, November 2000 flood event



NOVEMBER 2000 – MUSWELLBROOK

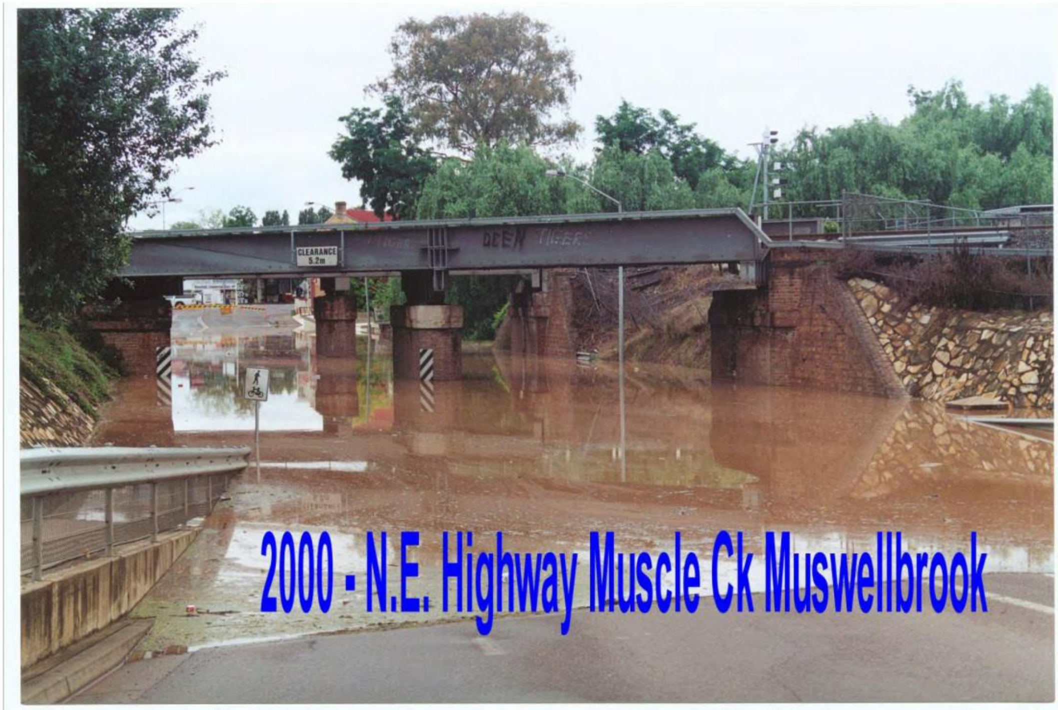


Figure 5.6 – Comparison of model results and historical photographs, November 2000 flood event

6 Flood impact assessment

6.1 OVERVIEW

The hydrologic and hydraulic models described in Section 4 and 5 were used to assess the impacts of the proposed rail spur on flooding. The design discharges from the hydrologic model were input into the hydraulic model to assess the existing conditions flood characteristics. The hydraulic model was then re-run with the proposed rail spur (as described in Section 6.2) and compared to the existing conditions to assess flood impacts.

6.2 PROPOSED RAIL SPUR

An earthworks model of the proposed rail spur was provided by MACH Energy (dated 9 November 2017). The proposed rail spur earthworks model was included in the hydraulic model to assess the flood impacts. Figure 1.2 shows the proposed rail spur.

6.3 DESIGN CRITERIA AND MITIGATION MEASURES

A conceptual design of the proposed rail spur has been modelled to consider potential impacts of the Rail Modification on flooding. The final detailed design of the proposed rail spur (and associated hydraulic structures) will be designed to meet the following criteria for potential flooding impacts for a 1% AEP flood event:

- no more than 0.1 m increase in flood levels on any privately owned land;
- no more than 0.01 m increase in flood levels at any privately owned dwellings or commercial spaces;
- no more than 0.01 m increase in flood levels at any public roads servicing privately owned properties; and
- no more than 0.1 metres per second (m/s) increase in flood velocities on privately owned dwellings or commercial spaces.

Conceptual mitigation measures were included in the modelled design to confirm that the proposed rail spur can be designed to meet the criteria above. The modelled mitigation measures include extension of two existing railway culvert crossings and two bridge openings in the rail embankment. Figure 6.4 shows the proposed mitigation measures, which consist of two bridge openings of 105 m and 90 m. Rail bridges with 15 m span length were assumed at the two proposed bridge openings.

6.4 EXISTING CONDITIONS PEAK FLOOD DEPTHS AND EXTENTS

The hydraulic model was used to estimate flood levels across the Hunter River floodplain for the 5% AEP and 1% AEP design flood events. A sensitivity run with 1% AEP discharge scaled up by 20% (1% AEP plus 20% flow) was also assessed. The peak discharge of the 1% AEP plus 20% flow is 4,609 m^3/s at Muswellbrook gauge, which is similar to the 1% AEP design discharge (4,857 m^3/s) estimated by WorleyParsons (2014) using the ARR 1987 guideline and different baseline data period.

Figure 6.1 to Figure 6.3 show the existing conditions peak flood depths in the vicinity of the proposed rail spur, for the 5% AEP, 1% AEP and 1% AEP plus 20% flow design events. The private dwellings south of the Hunter River channel are generally not inundated for a 5% AEP flood and inundated to a peak flood depths between 0.4 m and 0.7 m for the 1% AEP flood. The peak flood depths at the private dwellings south of the Hunter River channel are between 0.6 m and 1.0 m for the 1% AEP plus 20% flow design flood.

The 5% AEP and 1% AEP peak flood levels at Muswellbrook Bridge gauge are 146.94 mAHD and 148.26 mAHD, respectively. The peak flood level at Muswellbrook Bridge gauge for the sensitivity run (1% AEP plus 20% flow) is 148.56 mAHD.

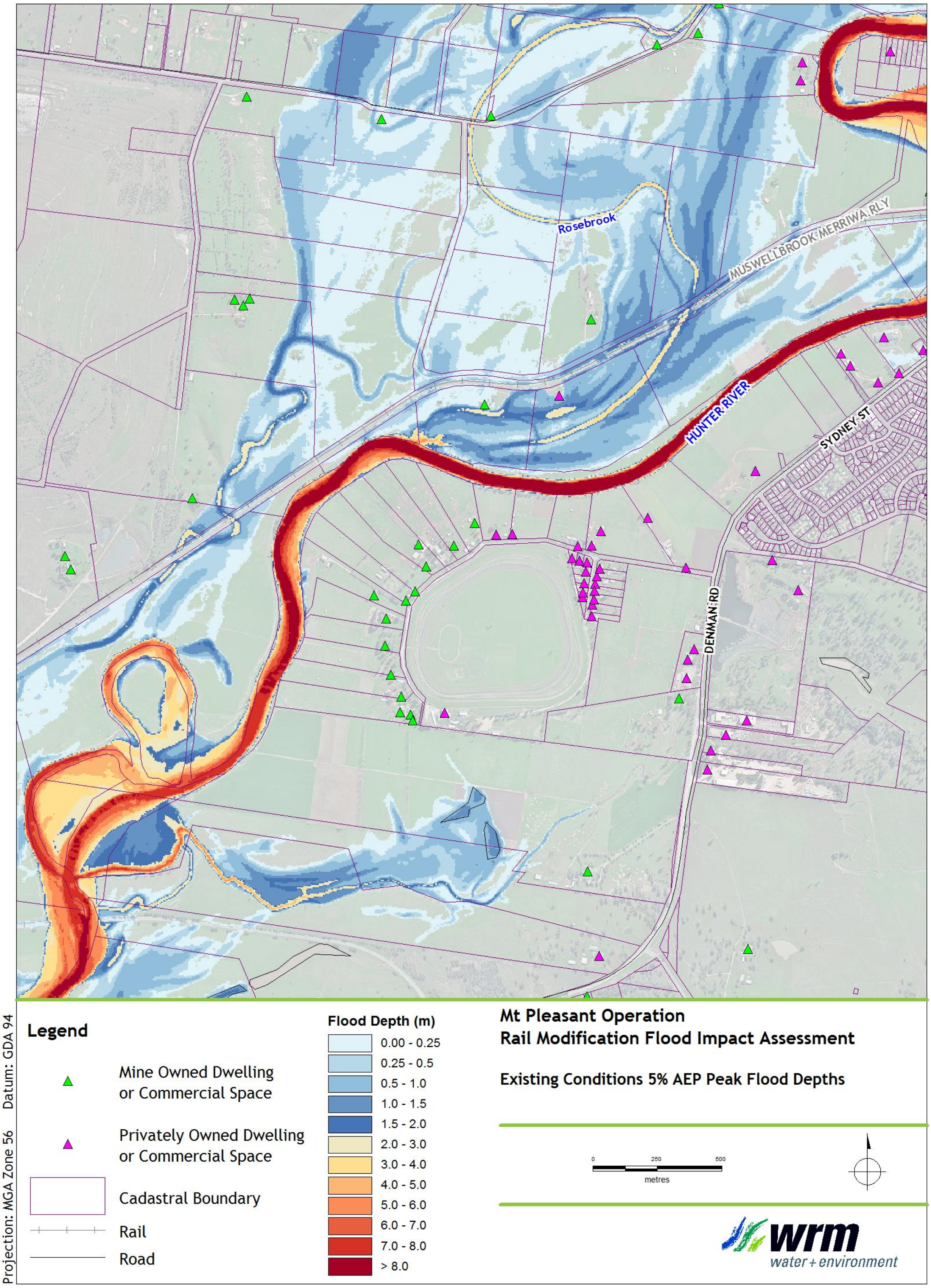


Figure 6.1 – Existing conditions peak flood depths, 5% AEP design event

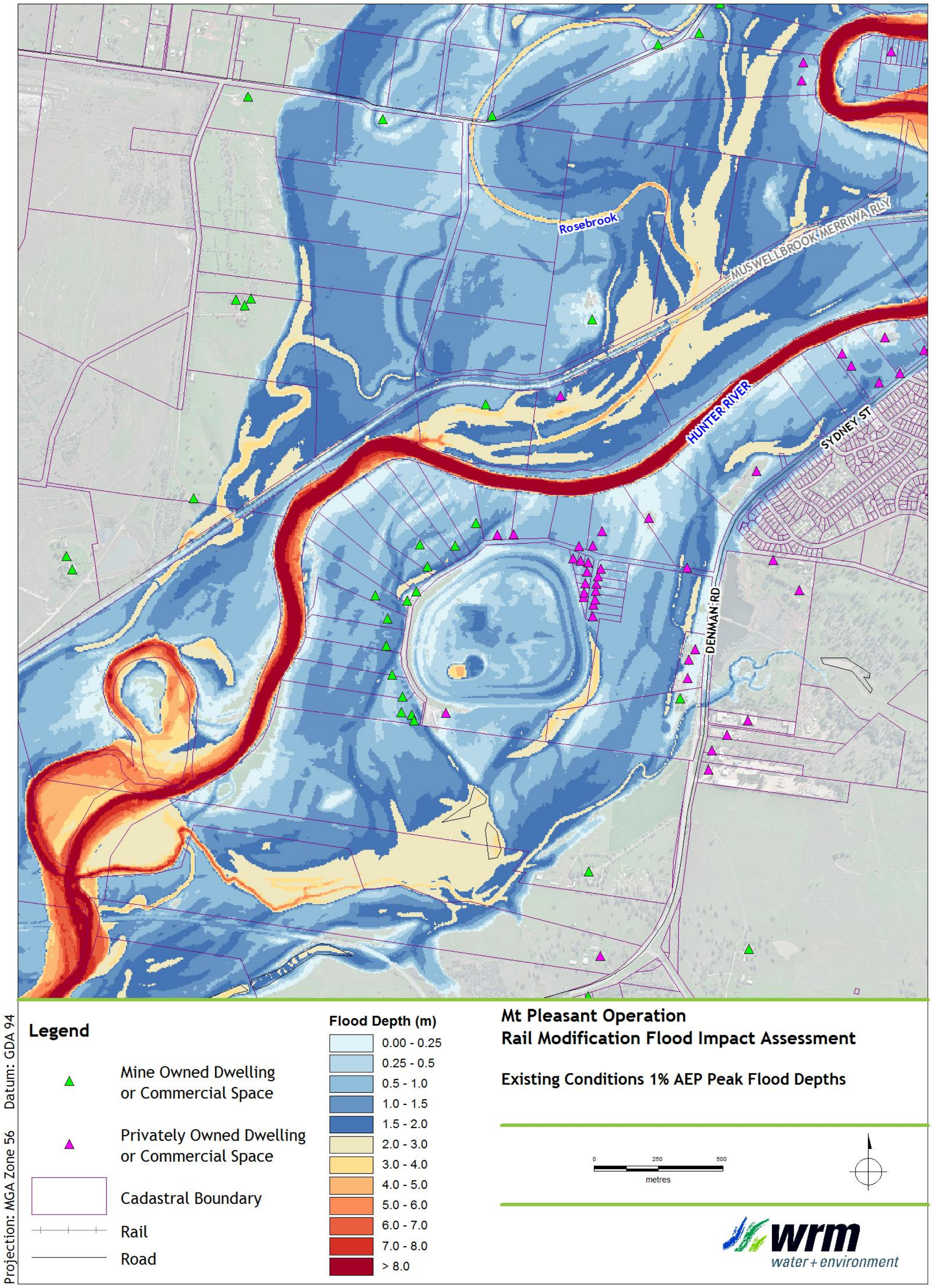


Figure 6.2 – Existing conditions peak flood depths, 1% AEP design event

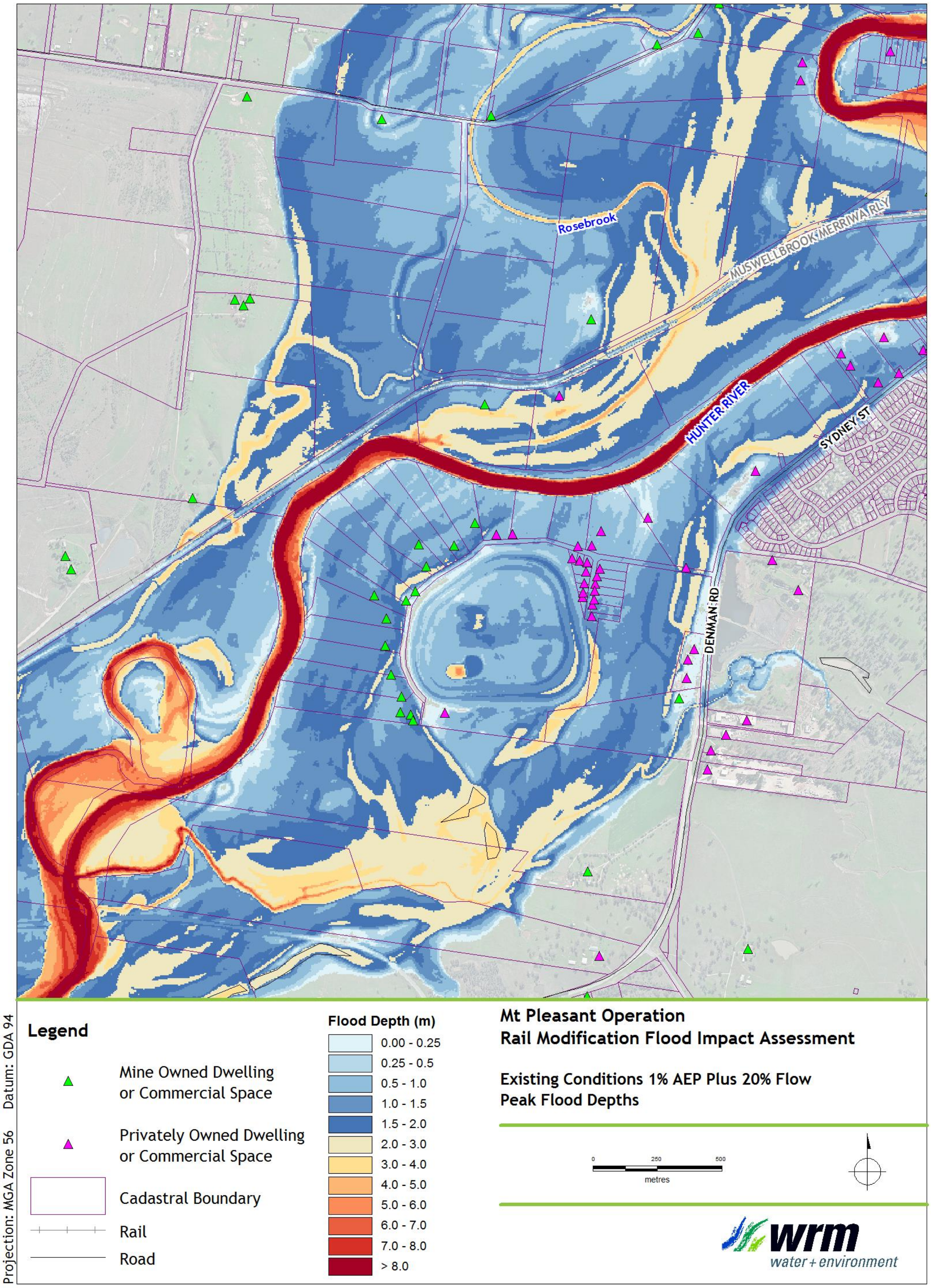


Figure 6.3 – Existing conditions peak flood depths, 1% AEP plus 20% flow design event

6.5 PREDICTED FLOOD LEVEL IMPACTS

The proposed conditions (with proposed rail spur and mitigation measures) were compared to the existing conditions to assess the flood impacts. Figure 6.4 to Figure 6.6 show the flood level impacts for the 5% AEP, 1% AEP and sensitivity run with 1% AEP plus 20% flow. The following is of note:

- The proposed rail spur generally has no adverse flood impacts for the 5% AEP event.
- The proposed rail spur increases peak flood levels immediately upstream (north) of the rail spur by up to 0.16 m and 0.21 m for the 1% AEP and 1% AEP plus 20% flow design events, respectively.
- The proposed rail spur increases the peak flood levels at the existing railway by about 0.05 m for the 1% AEP and 1% AEP plus 20% flow design event. This is mainly due to proposed rail spur redirecting more overtopping flows across the existing railway.
- The peak flood levels downstream (south) of the existing rail line increase by up to 0.01 m for the 1% AEP design events. No private dwellings or commercial spaces are impacted (no peak flood level increases of more than 0.01 m) from the proposed rail spur and mitigation measures.
- For the sensitivity run with 1% AEP plus 20% flow, peak flood levels at a number of private dwellings to the south of the existing rail way increase by just over 0.01 m, compared to existing conditions.

6.6 PREDICTED FLOOD VELOCITY IMPACTS

Figure 6.7 to Figure 6.9 show the flood velocity impacts for the 5% AEP, 1% AEP and sensitivity run with 1% AEP plus 20% flow. The following is of note:

- The proposed rail spur with mitigation measures generally has no flood velocity impacts for the 5% AEP event.
- The flood velocities at the existing railway increase by up to approximately 0.5 m/s for the 1% AEP and 1% AEP plus 20% flow design events. This is mainly due to the proposed rail spur redirecting more overtopping flows across the existing railway.
- The flood velocities at the proposed openings increase by 0.8 m/s and 1.0 m/s for the 1% AEP and 1% AEP plus 20% flow design events, respectively. The peak flood velocity at the proposed openings is 2.1 m/s for the 1% AEP design event.
- There is no adverse flood velocity impacts on private dwellings or commercial spaces.

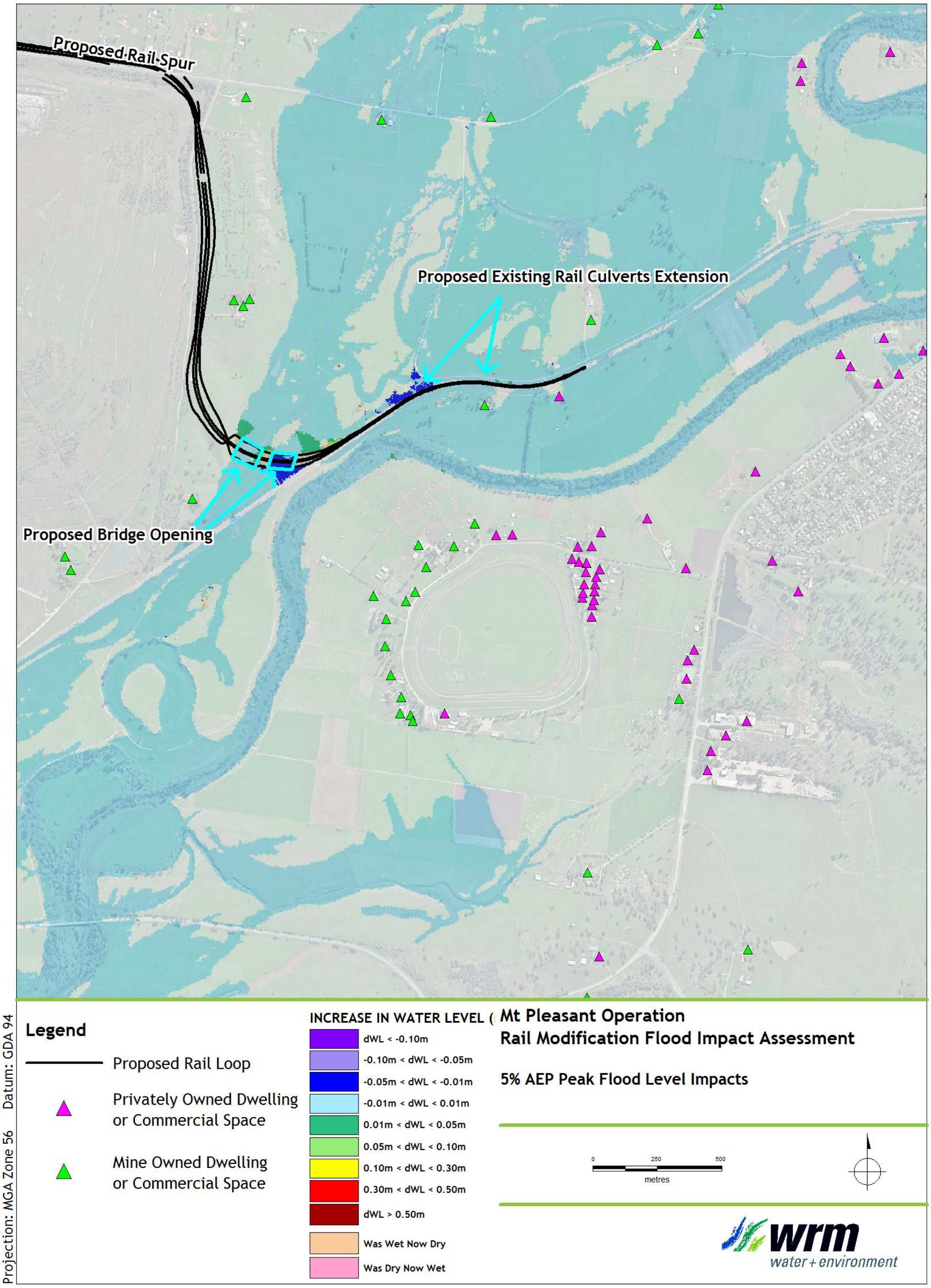


Figure 6.4 – Peak flood level impacts, 5% AEP design event

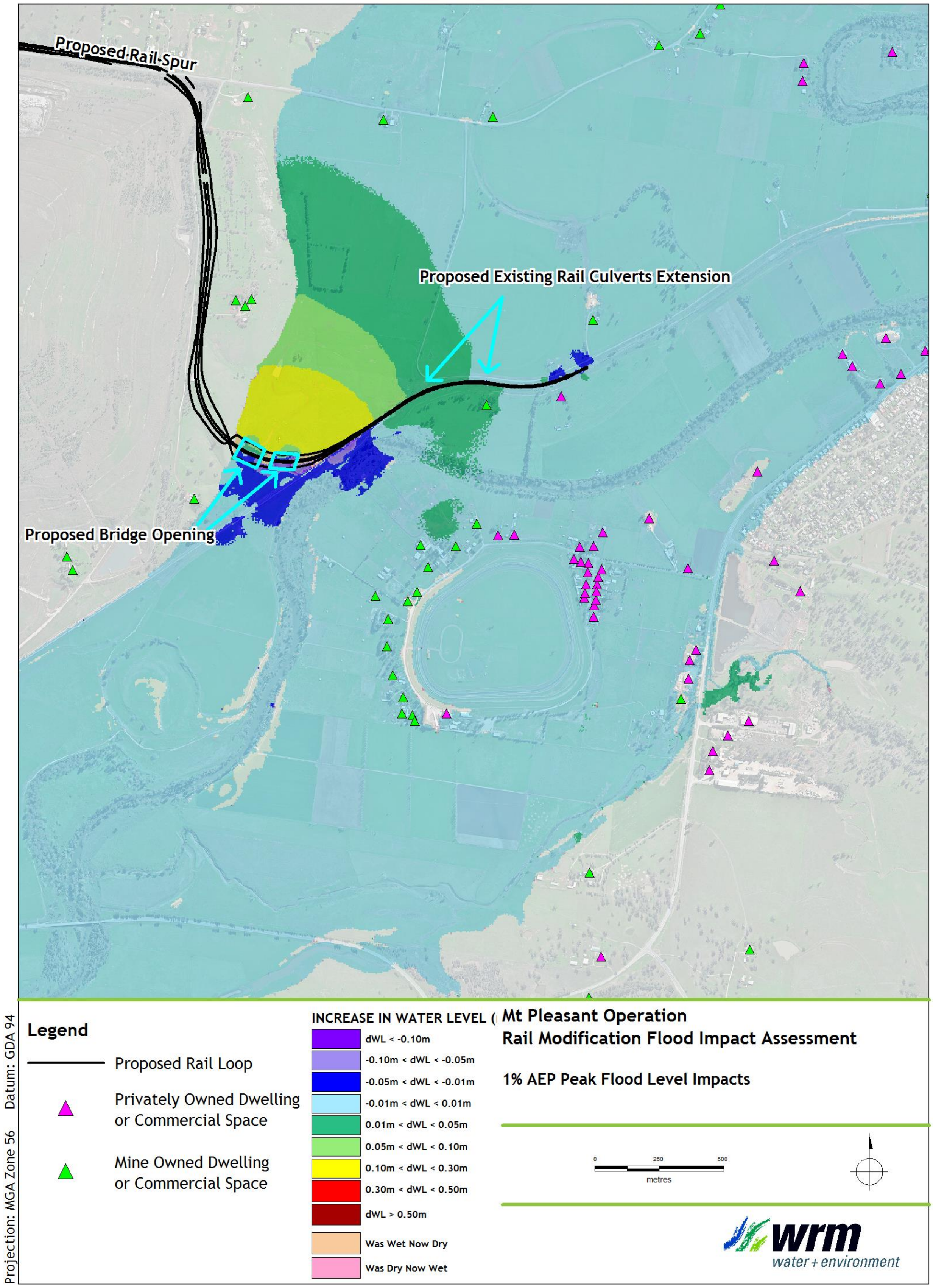


Figure 6.5 – Peak flood level impacts, 1% AEP design event

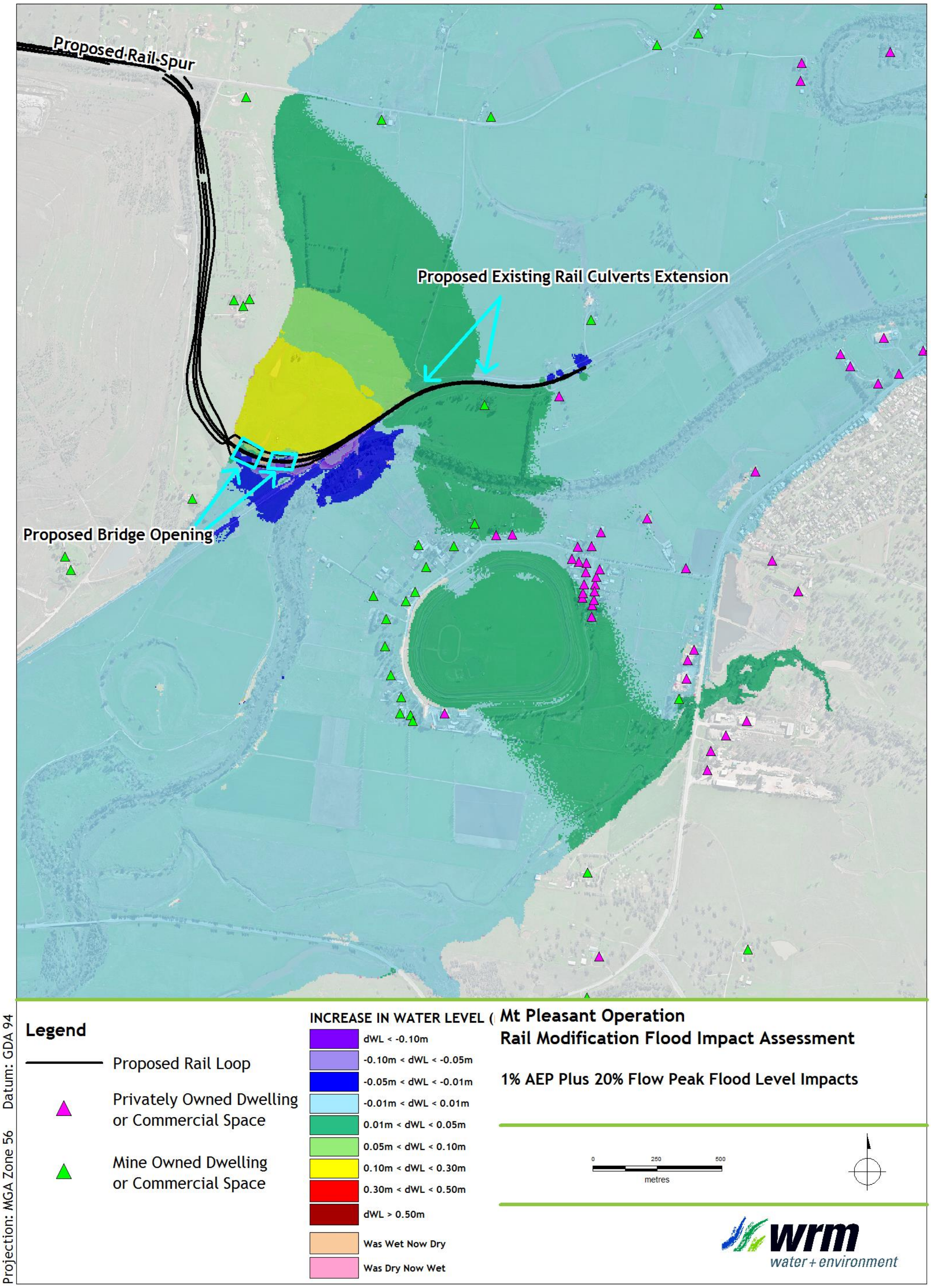


Figure 6.6 – Peak flood level impacts, 1% AEP plus 20% flow design event

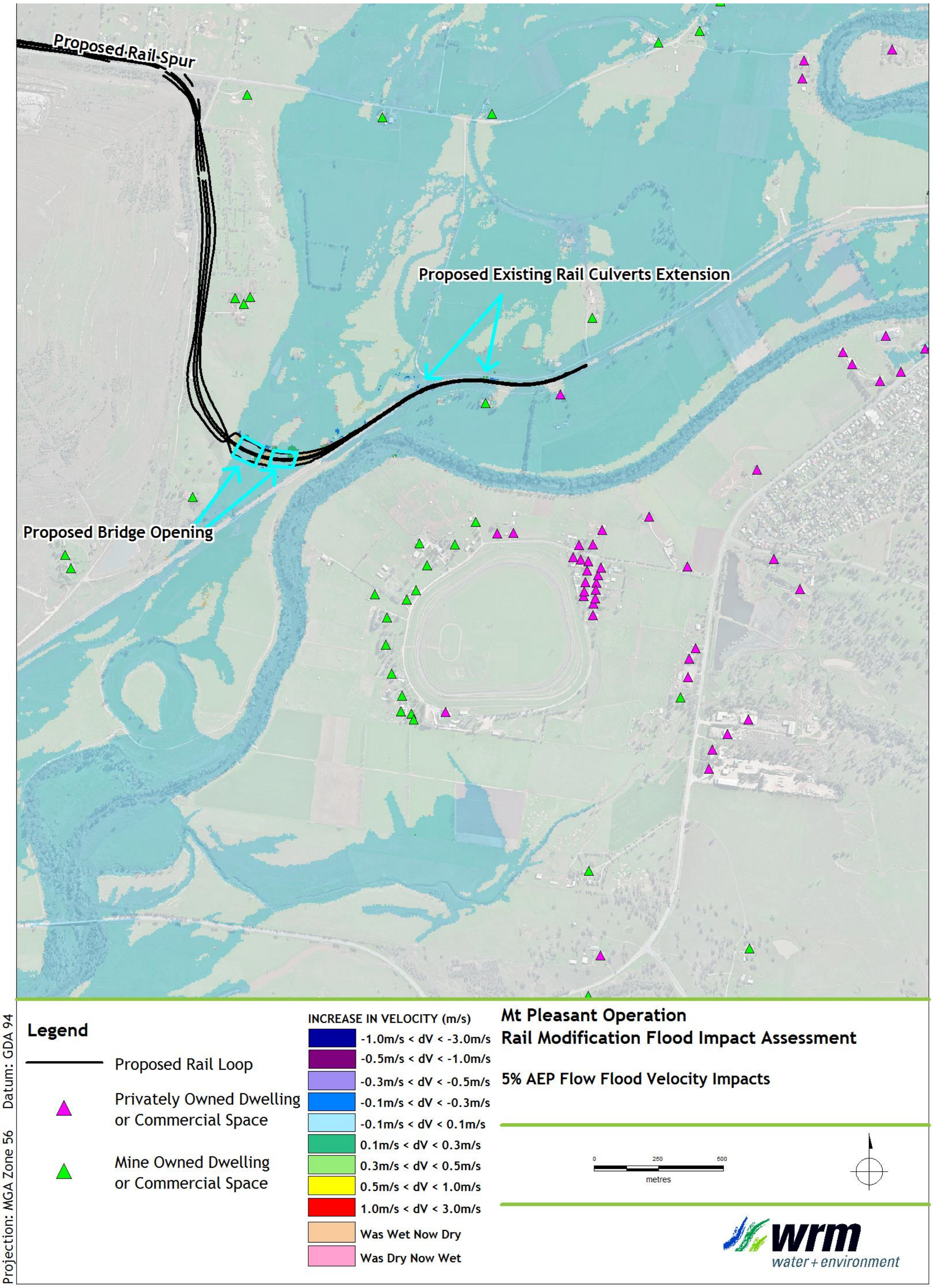


Figure 6.7 – Flood velocity impacts, 5% AEP design event

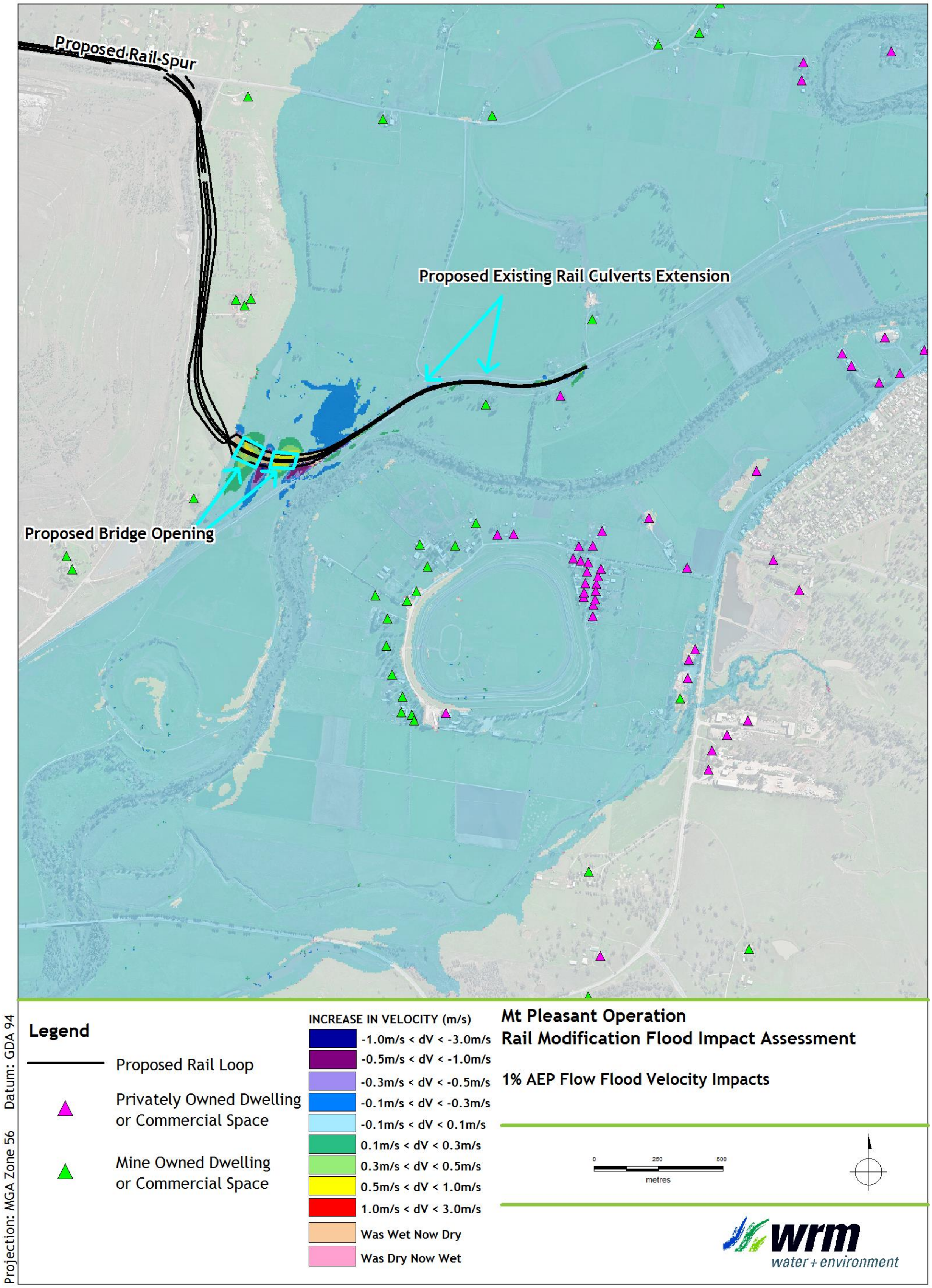


Figure 6.8 – Flood velocity impacts, 1% AEP design event

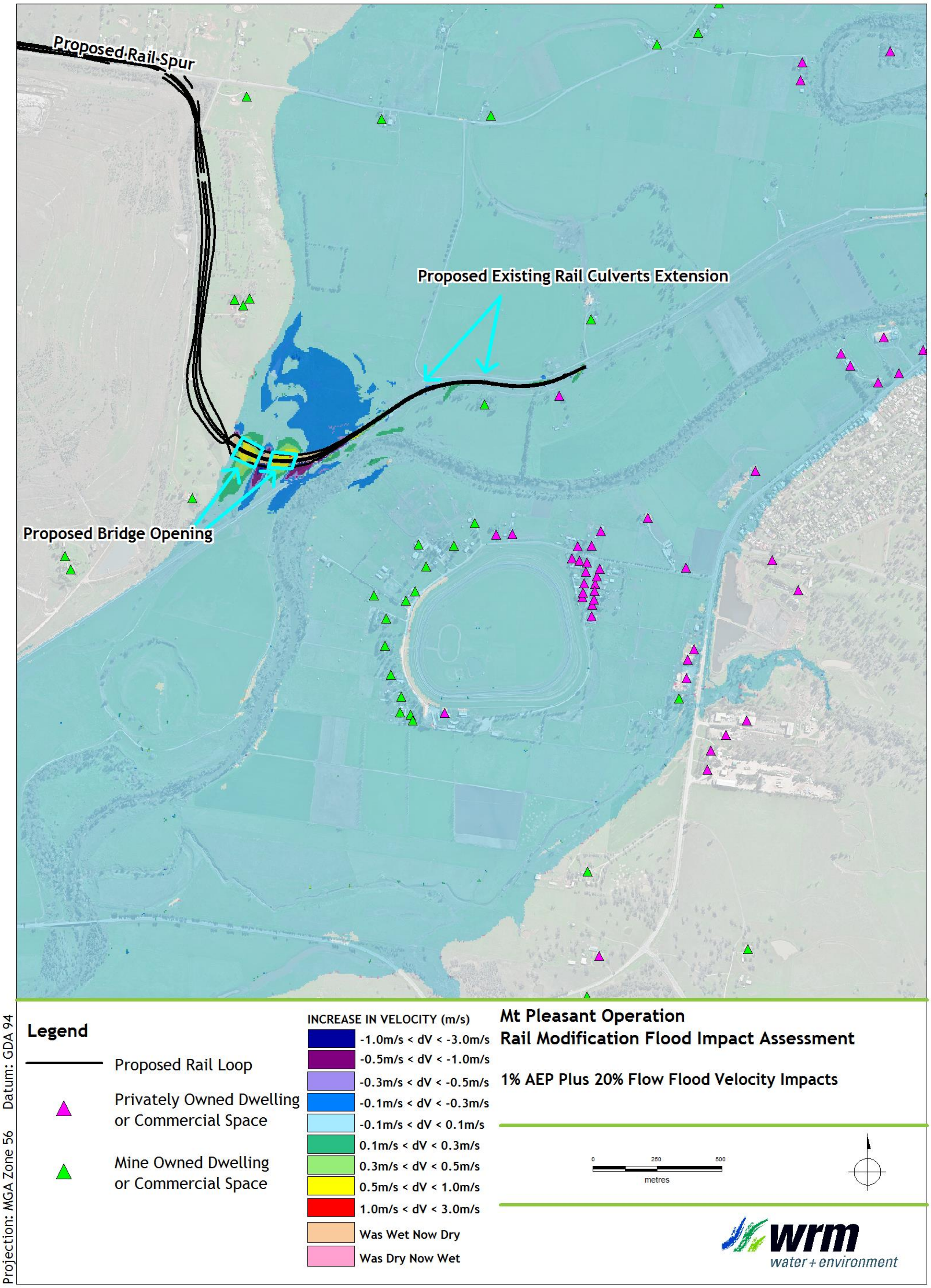


Figure 6.9 – Flood velocity impacts, 1% AEP plus 20% flow design event

7 Conclusion

Detailed hydrologic and hydraulic modelling of the Hunter River floodplain in the area of interest was undertaken to assess the impacts of the proposed rail spur on flood levels and velocities.

The model results show that the proposed rail spur has no adverse flood level and velocity impacts on private dwellings or commercial spaces for the 5% AEP and 1% AEP flood events. For the sensitivity run (1% AEP plus 20% flow), peak flood levels at a number of dwellings are predicted to increase by just over 0.01 m. To put these impacts into context, the modelling suggests that these residences would be subject to 0.6 m to 1.0 m of flooding above ground level without the rail spur and 0.61 to 1.01 m of flooding with the rail spur.

The model results indicate that potential flooding impacts of the rail spur are manageable with the conceptual mitigation works including bridge openings and extension of existing culverts.

8 References

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