

Regional Flood Mapping Lower Wimmera – Flood Intelligence (R04)



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1. INTRODUCTION

Water Technology was commissioned by Wimmera CMA to undertake the Lower Wimmera Regional Flood Investigation.

The overall objective of the study was to develop regional scale flood mapping for the Lower Wimmera River between Quantong and Lake Hindmarsh. This mapping will be used to satisfy a range of business requirements from planning and emergency response to community awareness and insurance. The study area was extended upstream by Water Technology to the Wimmera River at Horsham (Walmer) gauge location in order to utilise the long period of record at the gauge as an inflow boundary and link the mapping to the gauge for flood response purposes.

This report details the flood intelligence gathered from the hydrology and hydraulic analysis undertaken within this project and detailed in earlier reports. This report should be read in conjunction with the previous Data Review Report (R01), Hydrology Report (R02), and Hydraulic Report (R03).

2. STUDY AREA

The Wimmera River originates in the Pyrenees Ranges, near the township of Elmhurst, and flows generally westward, toward Horsham, and then northwards to Lake Hindmarsh. Downstream of Glenorchy, the river has very little catchment north of the river as the catchment slopes away from the river with a number of distributary systems flowing between ancient sand dunes which are roughly aligned north-south. This is clearly shown in Figure 2-1 and Figure 2-3.

The catchment of the Wimmera River upstream of the Horsham (Walmer) streamflow gauge, located just downstream of Horsham is approximately 4,000 km². The Mackenzie River catchment which flows into the Wimmera River immediately downstream of the Horsham (Walmer) streamflow gauge is approximately 400 km², with Norton, Sandy and Darragan Creeks having smaller catchments again. The Wimmera River catchment downstream of Quantong has limited tributary inflows with the river flowing between the ancient sand dunes of the Wimmera-Mallee. The contributing catchment downstream of Quantong is approximately 1,500 km² but much of this is likely to be ineffective as a series of terminal lakes and depressions in the ancient sand dunes store local rainfall.

The Lower Wimmera River study area as shown in Figure 2-4, extends downstream from Horsham to Lake Hindmarsh. It is characterised by a lower gradient than the upper catchment. The study area is dominated by agricultural land with floodplains of the Wimmera River and its tributaries containing agricultural assets that are likely to be subject to inundation during large rainfall events. Various residential areas are at risk also, including properties on the outskirts of Horsham, Quantong, Dimboola and Jeparit, as well as rural properties at Duchembegarra, Arkona, Antwerp and Tarranyurk.

Rainfall across the Wimmera Catchment varies considerably, with the upper catchment generally receiving 500-600 mm/year (but increasing to 800-900 mm/year at the top of the Grampians), and the lower catchment generally receiving 350-400 mm/year. Months with the highest average rainfall are typically June to August. Although the region north of Horsham does experience significant storms similar to the catchment south of Horsham, the confined nature of the catchment is such that the runoff generated downstream of Horsham is much less and what little runoff is generated is often through the system well before the upper catchment peak arrives from the Wimmera River and Mackenzie River.

Historical records indicate that peak flow rates experienced in the lower section of the river are lower than those in the upstream/middle sections. This is due to attenuation and the presence of distributary waterways upstream (Swedes Cutting, Dunmunkle Creek and Yarriambiack Creek). These distributary waterways allow flow to exit the Wimmera River catchment, with Swedes Cutting transferring flow into the Richardson River catchment. The Mackenzie River and other tributaries, namely Norton,

Sandy and Darragan Creeks provide inflow to the Wimmera River downstream of Horsham as shown in Figure 2-2 . Often these tributary inflows peak prior to the Wimmera River, passing through the system before the Wimmera River peak arrives. The dominant flood causing mechanism in the lower Wimmera River is the upper Wimmera River catchment flood flows.

There are a number of irrigation channels within the lower Wimmera River catchment, formerly used for stock and domestic supply. The construction of the Northern Mallee and Wimmera Mallee Pipelines has superseded these channels and a number of domestic water storages. These pipelines have increased water availability by reducing water losses in the supply system and have also increased the control of environmental flow releases.

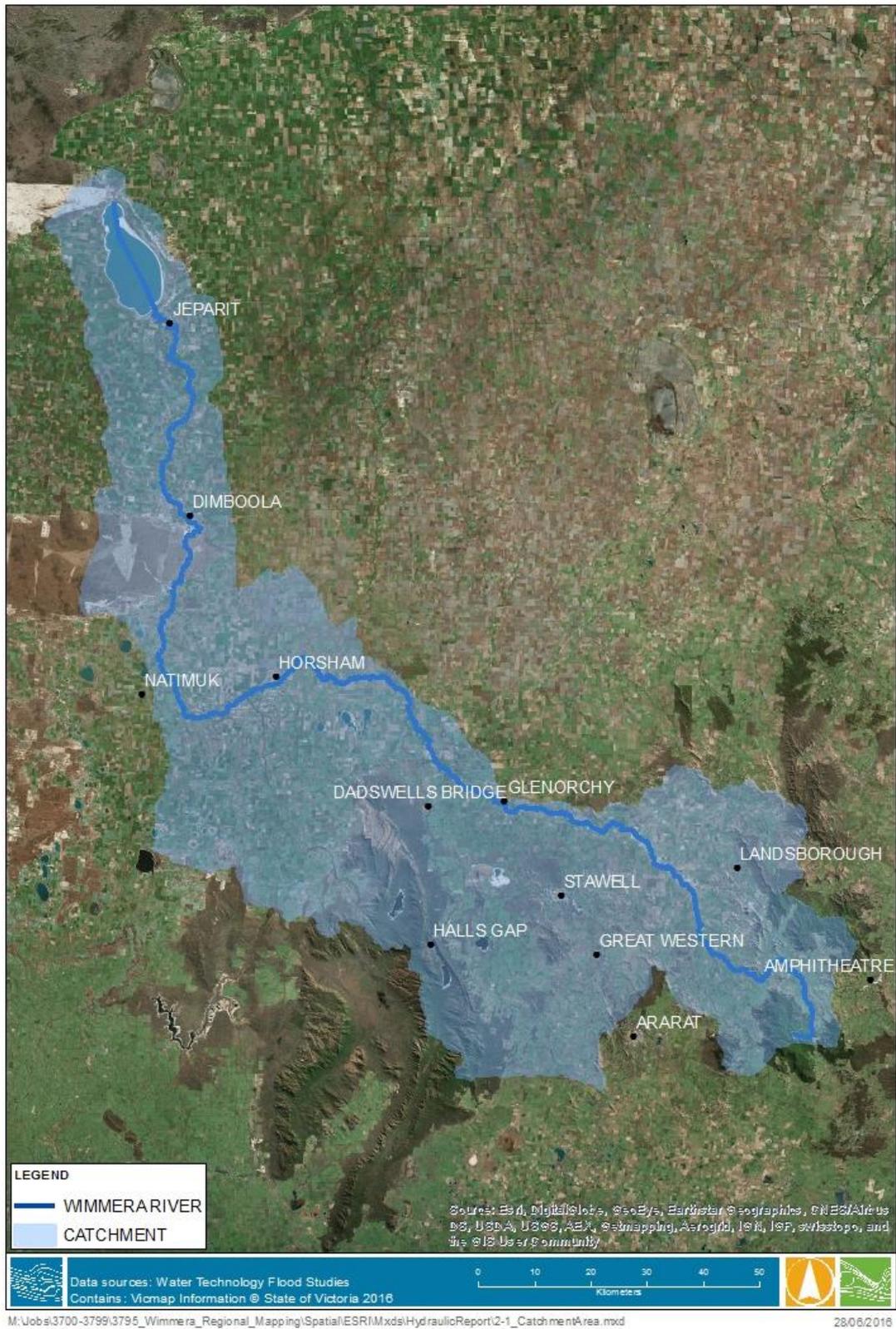


Figure 2-1 Catchment Area of the Wimmera River

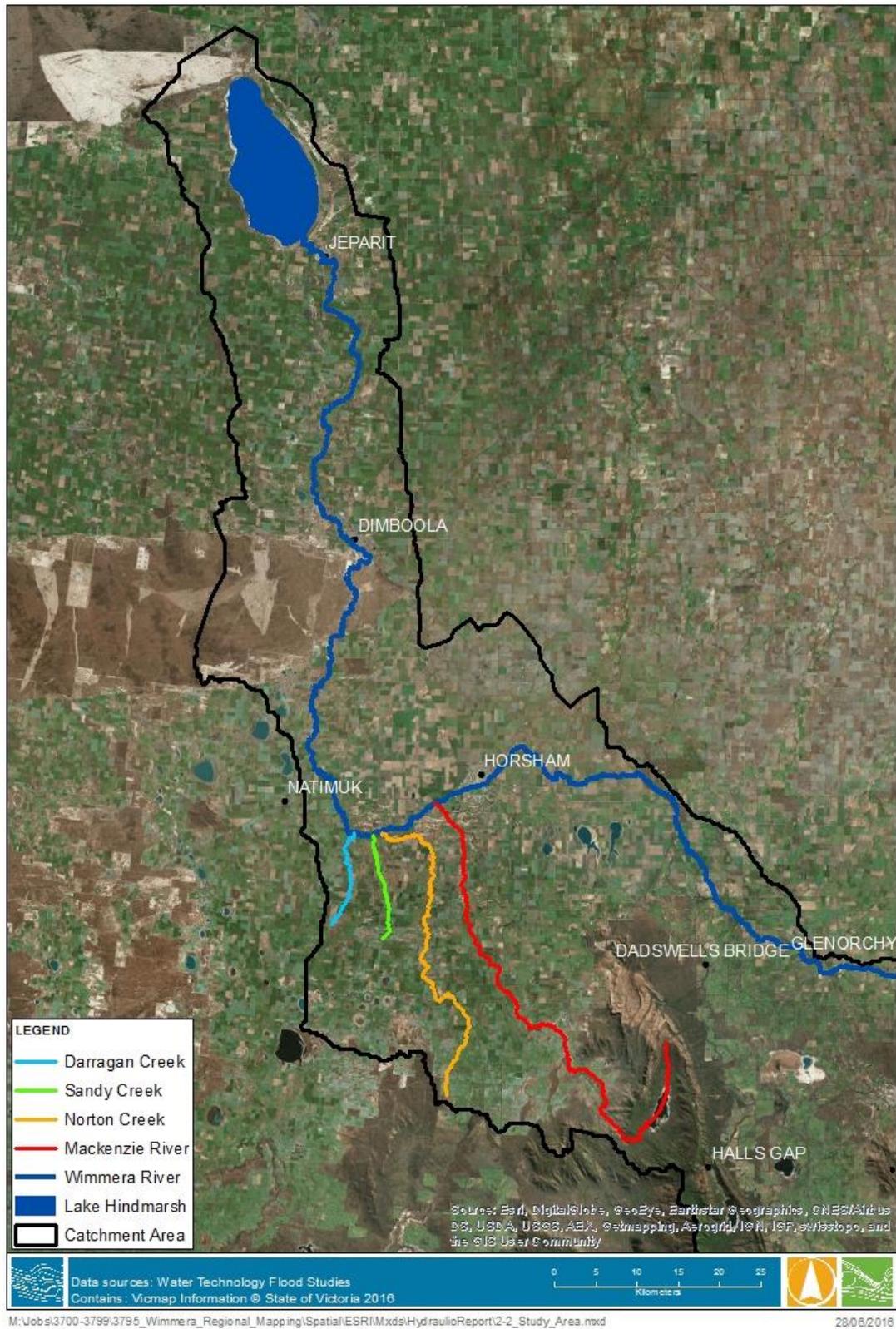


Figure 2-2 Lower Wimmera Study Area and Major Tributaries

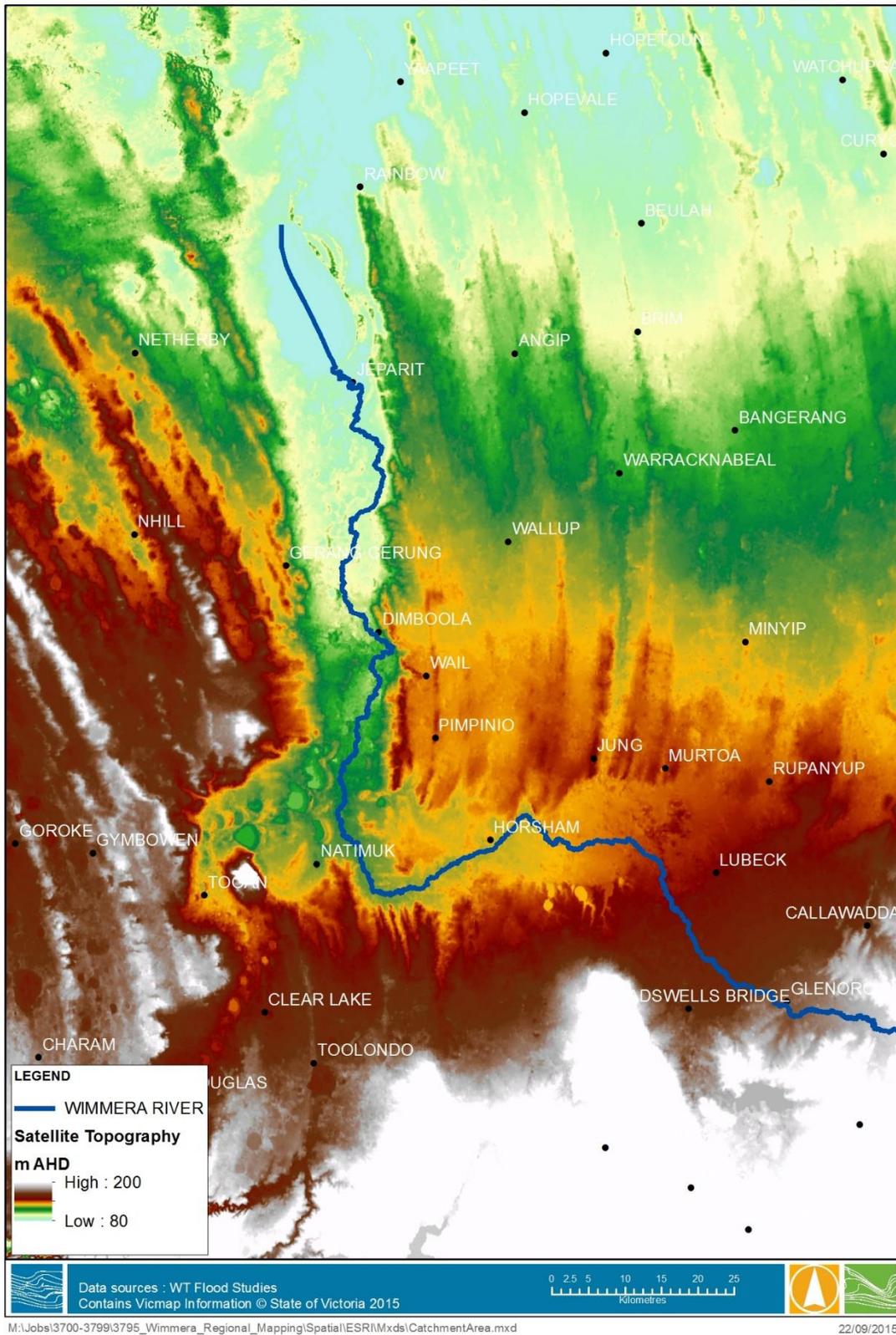


Figure 2-3 Topography of the Lower Wimmera River

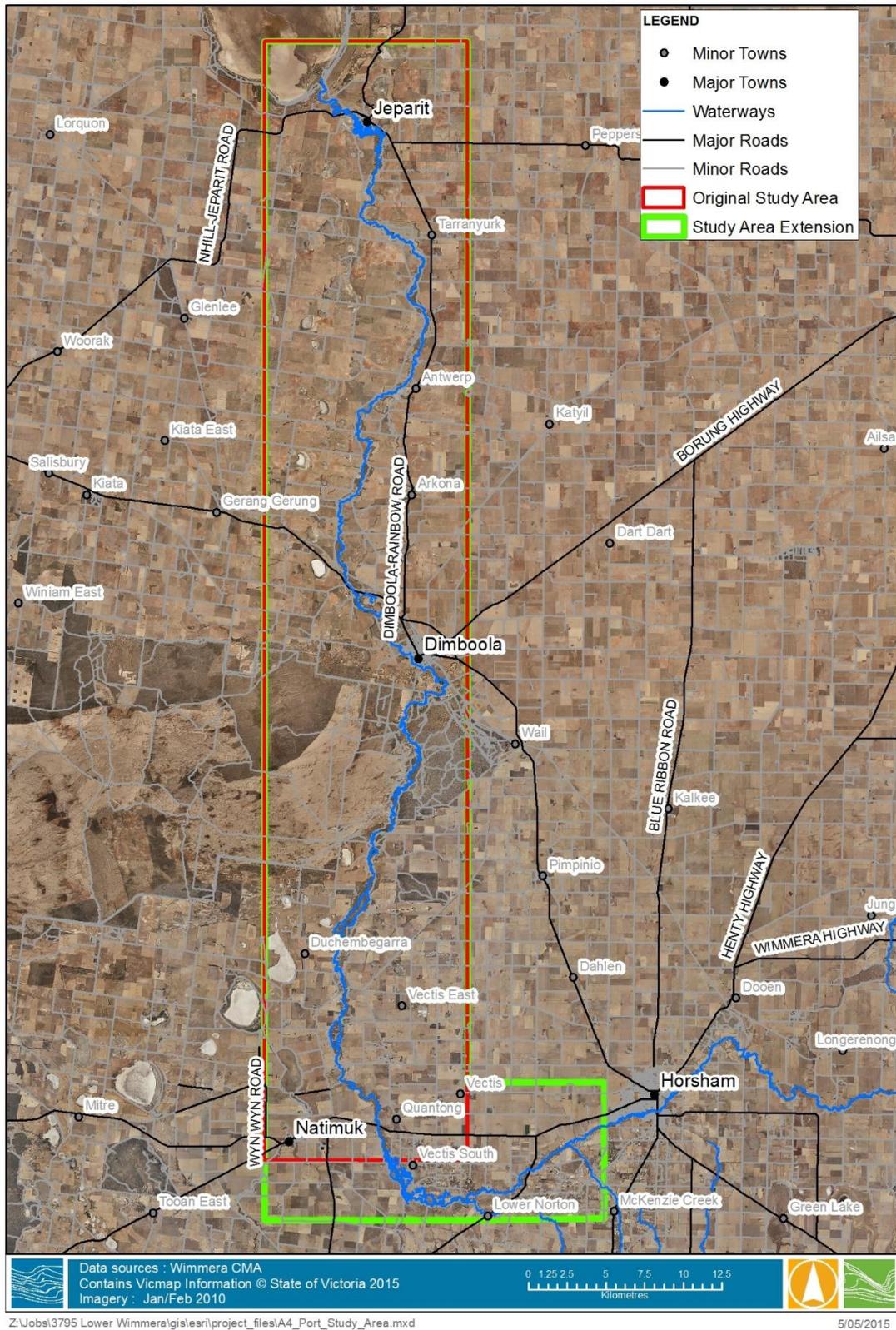


Figure 2-4 Lower Wimmera Study Area

3. SUMMARY OF FLOOD ANALYSIS

3.1 Hydrology

The hydrology analysis is described in detail in the R02 Hydrology Report. The flood hydrology of the lower Wimmera River downstream of Horsham is dominated by the Wimmera River, and this is well gauged at the Wimmera River @ Horsham (Walmer) gauge (415200). The tributaries of Mackenzie River, Norton Creek, Sandy Creek and Darragan Creek do contribute volume to the start of a flood event, but they typically peak days prior to the Wimmera River peaking at Horsham. An analysis of the Mackenzie River gauge indicated that the peak typically occurs 2.5 to 3.5 days prior to the Wimmera River peak.

3.1.1 Wimmera River Travel Times

The East Horsham Flood Intelligence Report (Water Technology, 2013) provides a description of typical flood timing. From the start of intense rainfall to the peak of flooding in Glenorchy takes approximately 45 to 60 hours. The time between flood peaks between Glenorchy and Horsham is then between 3 to 4 days. From Horsham to Dimboola the travel time between peaks is 3 days or more, with another 2 days to Tarrenyurk. From Tarrenyurk to Jeparit the travel time between peaks is approximately 6 hours.

3.1.2 Wimmera River Peak Flows

The Wimmera River @ Horsham (Walmer) gauge has one of the longest continuous streamflow records in Victoria. This study investigated historic flows in detail, gathering Historical Society and State archive documents to gain a better understanding of peak flows in historic flood events. A detailed analysis of the rating curve at the gauge location was undertaken, including meetings with the hydrographers who gauge the site.

Prior to this study there was considerable uncertainty in the gauge rating curve amongst floodplain practitioners. This study reviewed the previous and current rating curves and confirmed that the rating curve developed after the January 2011 flood event, which was gauged close to the peak of the flood, was accurate and should be adopted.

A flood frequency analysis using an annual series between 1889 and 2015 was carried out using FLIKE. The Grubbs Beck test censored 58 low flow years from the annual series. A Log Pearson III distribution was fitted to the censored annual series, producing the design flows below in Table 3-1.

Table 3-1 Wimmera River at Horsham FFA results (LP3 with low flow censoring)

AEP (%)	Peak Flow (ML/d)	Peak Flow (m ³ /s)	Gauge Level (m)
20	13,100	152	3.40
10	19,200	222	3.72
5	25,000	289	3.96
2	31,900	369	4.23
1	36,500	423	4.40
0.5	40,700	471	4.52
0.2	45,400	525	>4.60*

*Exceeds extrapolated rating curve

3.1.3 Wimmera River Hydrograph

The January 2011 hydrograph was used as a donor hydrograph to provide the shape of the design flood hydrograph. The January hydrograph was then scaled to produce the design peak flow and the design seven-day volume calculated through flood frequency analysis.

3.1.4 Tributary Inflows

A preliminary RORB model being developed for the Horsham and Wartook Valley Flood Investigation (Water Technology, ongoing), was used to estimate tributary inflows for Norton, Sandy and Darragan Creeks, for both calibration and design events. The Mackenzie River @ McKenzie Creek streamflow gauge was used for calibration inflows, with the January 2011 event hydrograph scaled for design flows.

3.2 Hydraulics

The hydraulics analysis is described in detail in the R03 Hydraulics Report. The hydraulic model was well calibrated to the January 2011 and September 2010 flood events, using available flood level survey, gauge levels, aerial flood imagery and anecdotal reports. The community consultation process provided a good means of verifying the results with landholders who witnessed the flooding first hand. In general, the feedback was very positive.

3.2.1 Hydraulic Model Development

The hydraulic modelling framework used the MIKE21 Flexible Mesh software run on Graphical Processing units (GPUs). This enabled a detailed representation of the river channel, with a coarser representation of the floodplain where fine resolution was not required, and a run time that was acceptable given the size of the model area.

The flexible mesh used both triangles and quadrilateral elements. Quadrilateral elements were used along the river channel, with approximately four elements across the channel, with each element being approximately 5 m wide and around 15 m long. Across the broader floodplain elements are a mix of triangle and quadrilateral elements with elements general having node spacing of around 15 m (i.e. a quadrilateral element will be 225 m² in area and a triangular element may be half that area). Lake Hindmarsh was modelled using very large element sizes around 0.25 km², as the detail is not required to model inundation within the lake.

3.2.2 Hydraulic Roughness

A range of Mannings 'n' roughness values were trialled during the model calibration and a final uniform roughness of 0.06 was adopted. A Mannings 'n' of 0.05 and 0.07 was trialled and it was found that this reduced and raised the water levels by approximately 0.1 m respectively from the adopted roughness results. The uniform roughness provided good calibration results and is well within the expected roughness of a rural floodplain such as the Wimmera River.

3.2.3 The Impact of Tributary Inflows

The Wimmera River between Horsham and Quantong has a few tributaries which contribute inflows to the river during flood events, but downstream of Quantong the catchment is very limited as the floodplain cuts through the ancient sand dunes of the Wimmera-Mallee region. The Mackenzie River, Darragan Creek, Sandy Creek and Norton Creek all contribute flows.

During the calibration stage, the January 2011 flood event was modelled with and without estimated inflows from the four tributaries. The impact of the tributary inflows on peak flood level was found to be less than 0.05 m except for a 6 km stretch of river south of Dimboola and a region around Jeparit, both of which were less than 0.1 m higher with tributary inflows. Comparing the water level

hydrographs at Quantong, the tributary inflow increased the water levels on the rising limb of the hydrograph, but didn't significantly alter the peak water level during the event.

3.2.4 Model Calibration

The January 2011 and September 2010 flood events were used for calibration purposes. Both events had surveyed flood levels of varying levels of accuracy and streamflow gauge levels. The January 2011 event had a number of georeferenced aerial flood images, which provided excellent calibration for flood extents. The September 2010 event did not have the same level of aerial flood imagery, but did have a series of oblique flood photographs taken from the window of an aircraft.

January 2011

The hydraulic model was calibrated for the January 2011 event, to within 100 mm of the surveyed flood levels at 20 of the 33 survey points. A further 10 points were within 200 mm of the surveyed levels. The modelled peak flood level at Quantong was 0.08 m higher than the streamflow gauge (after correction to new surveyed gauge zero datum), 0.1 m lower than the Lochiel Bridge gauge, and 0.036 m higher than the U/S of Dimboola gauge. The hydrograph shapes were replicated well also.

The flood extents showed a very close match to the available aerial flood imagery across the entire study area.

September 2010

The surveyed flood heights for the September 2010 event showed a lot more variability to the modelled levels, with a number of surveyed points being inconsistent with surrounding surveyed flood levels. The modelled levels were within 100 mm at 12 of the 37 points and a further 9 points were within 200 mm of survey. The remaining points showed no bias higher or lower compared to surveyed levels, and it is likely that there has been a degree of error in defining the peak flood height using debris marks. The peak modelled level was 0.14 m higher than the gauged level at Quantong, 0.096 m lower than gauged at Lochiel Bridge, and 0.009 m lower than gauged at Dimboola.

Without georeferenced flood imagery to compare to, effort was directed into identifying the locations of a series of aerial oblique photographs taken from the window of an aircraft, the flood results were loaded into Google Earth and the map positioned from the same perspective as the photograph to enable comparison. The flood extents matched very well in the Dimboola area, where the flood was peaking at around the time the photographs were taken.

3.2.5 Design Modelling

The design scenarios of the 20%, 10%, 5%, 2%, 1%, 0.5% and 0.2% AEP events were modelled. These all included tributary flows from the Mackenzie River, Darragan Creek, Sandy Creek and Norton Creek. The design flood extents are overlaid in Figure 3-1 to Figure 3-3 across three reaches of the study area. The PMF design flood extent is shown in Figure 3-4 along with the study area mapping limits.

The 1% AEP modelling was compared to previous township mapping carried out in 2008. The flood levels at Jeparit was approximately 5 cm higher than the 2008 study in the middle of the previous study area between the Wimmera Mallee Pioneer Museum and the Nhill-Jeparit Road. Closer to the boundaries, the model results diverged more and it is likely that the regional modelling is more accurate in these locations due to the localised influence of the model boundary with the smaller township model. At Dimboola, the flood levels matched closely, within 10 cm, however the flood extents from the 2003 study were restricted due to a lack of topography survey.

It is recommended that for future flood response and land use planning that the regional flood mapping be used in preference over the earlier township modelling given the age of the studies, the lack of survey in the earlier studies and the fact that the flood levels are in general agreement. The earlier studies adopted a very simple steady state approach to the hydrology, not as rigorous as this study.

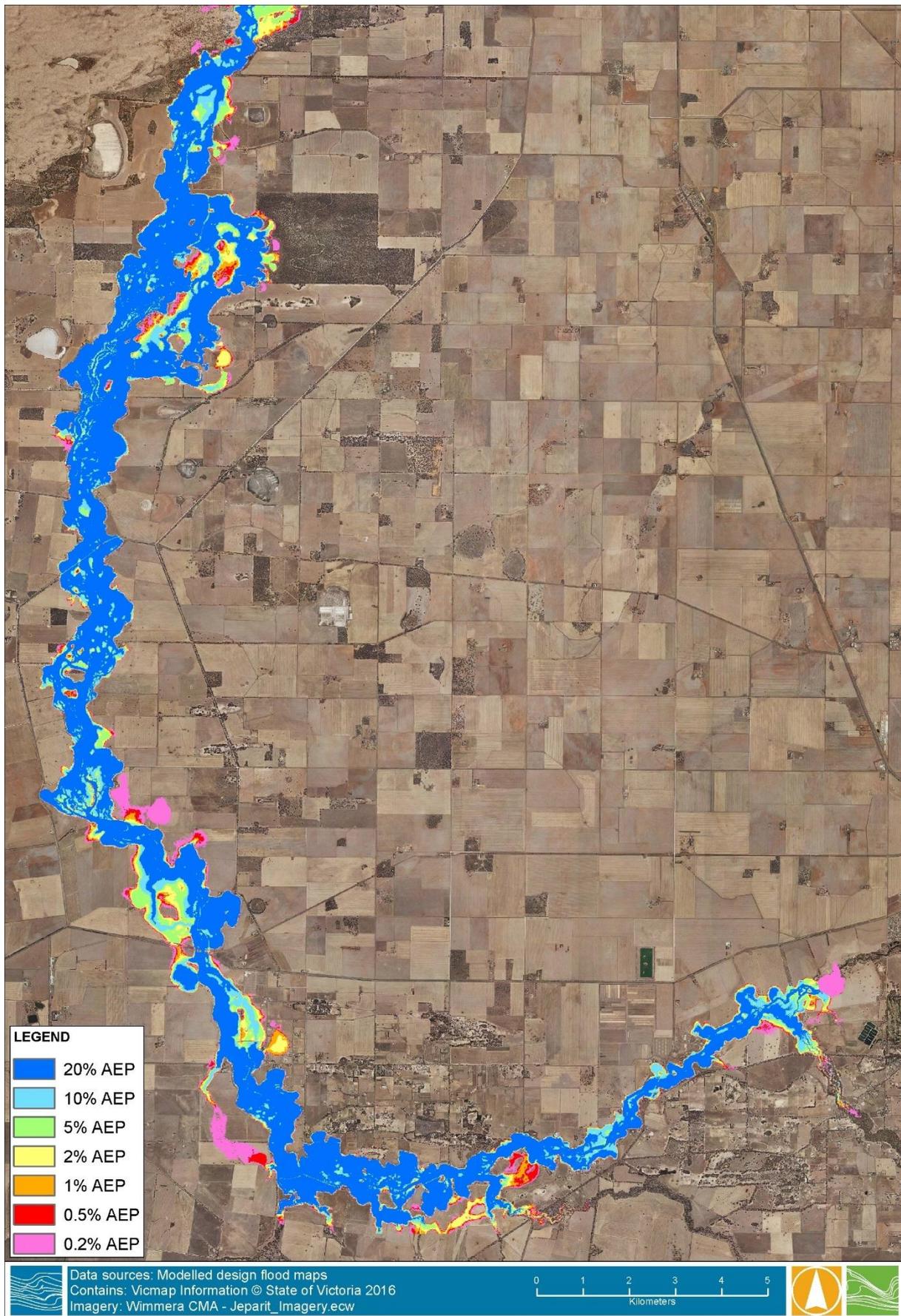


Figure 3-1 Lower Wimmera River Design Flood Extents – Horsham to Duchembegarra

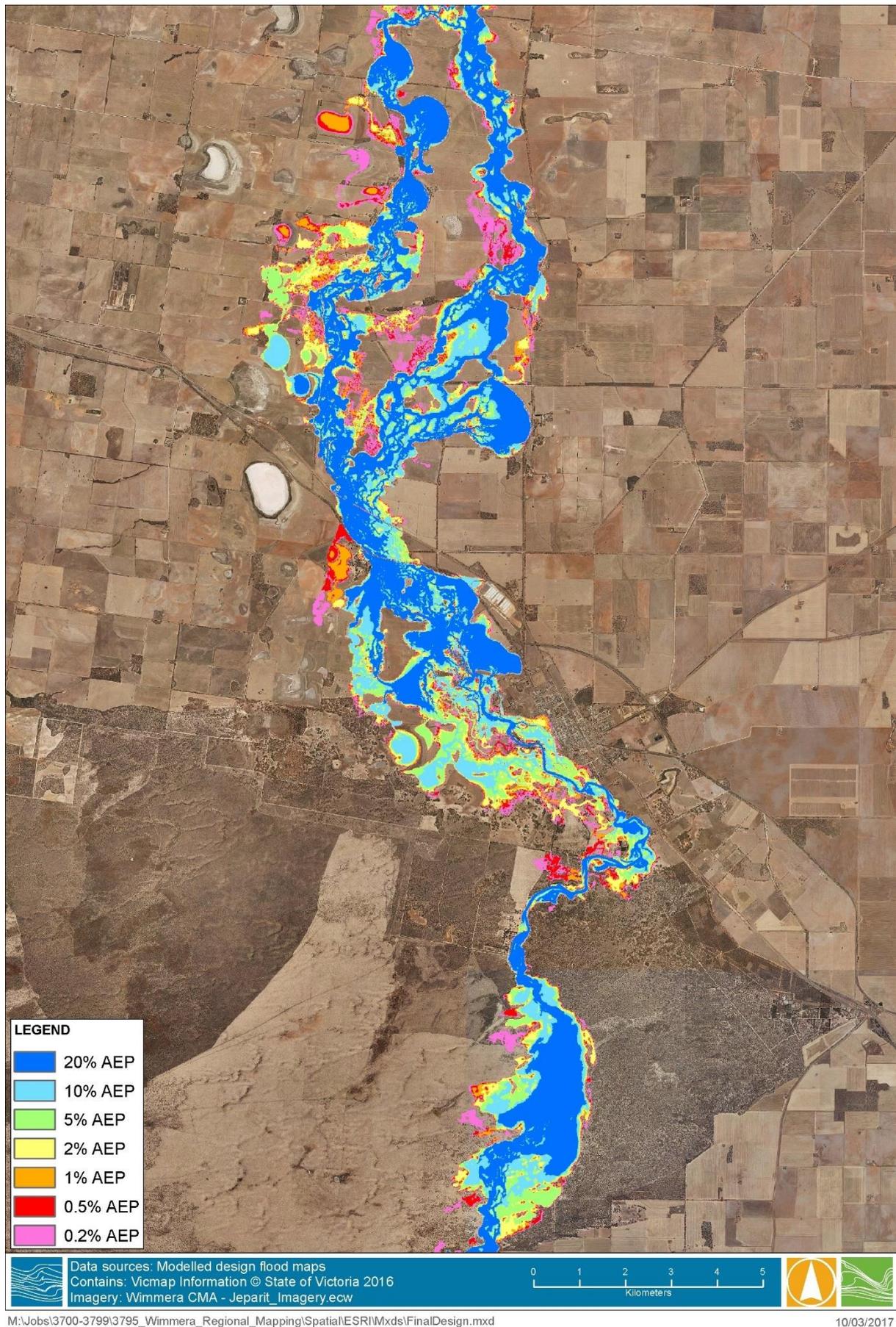


Figure 3-2 Lower Wimmera River Design Flood Extents – Duchembegarra to Antwerp

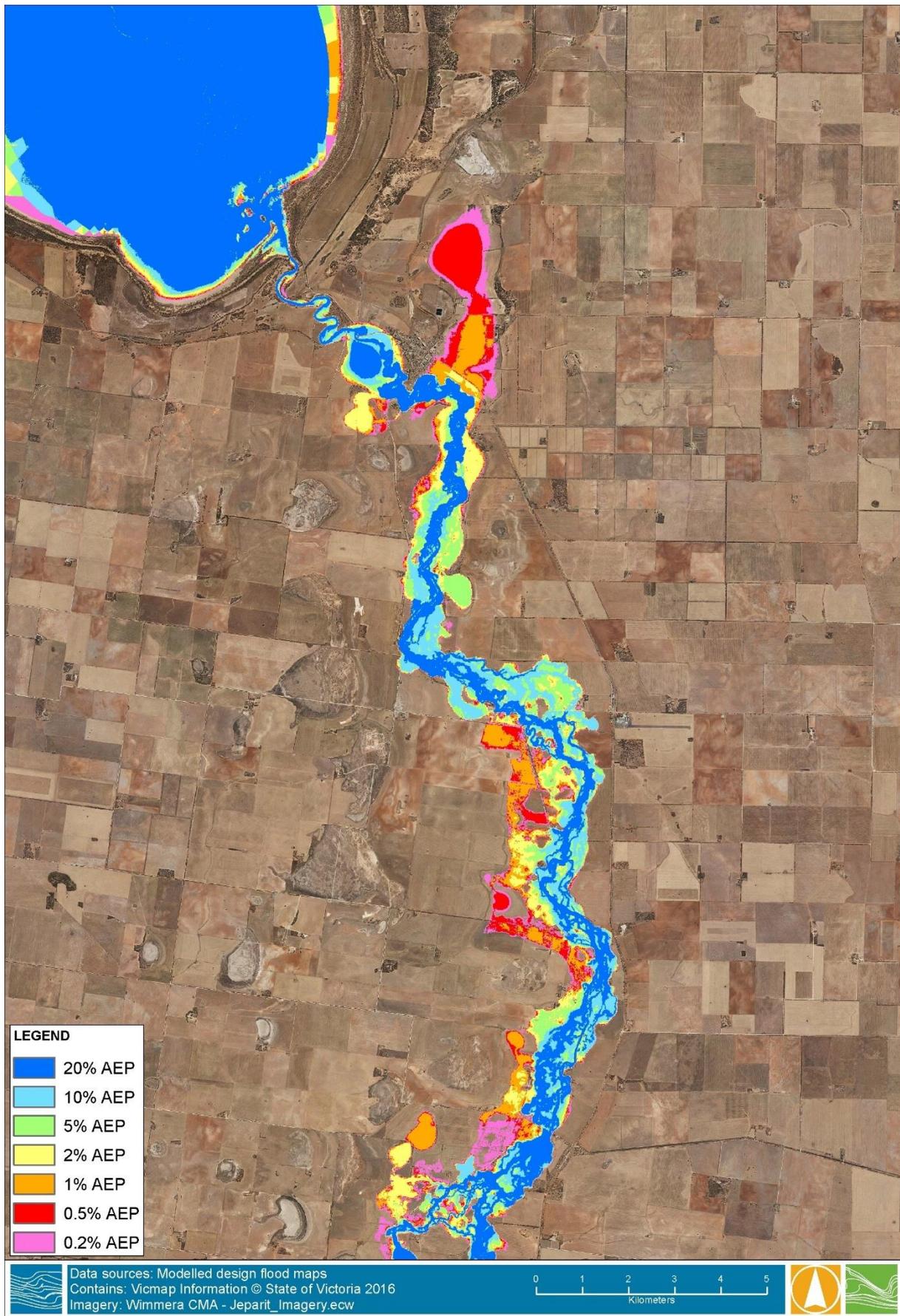


Figure 3-3 Lower Wimmera River Design Flood Extents – Antwerp to Lake Hindmarsh



Figure 3-4 Lower Wimmera River PMF Flood Extent

4. FLOOD BEHAVIOUR AND INTELLIGENCE OUTPUTS

4.1 Overview

The flood behaviour and intelligence outputs developed as part of the Lower Wimmera Regional Flood Mapping Study are described in this section.

4.2 Gauge Height Relationships

For each design flood event the model results were interpreted to provide information on the relationship between the flood level at each of the gauges on the Wimmera River within the study area.

Table 4-1 Wimmera River @ Horsham (Walmer) Gauge Heights for Design Flood Events

Gauge Level		Design Flood Event		Design Flood Flow	
Relative (m)	m AHD	AEP (%)	ARI (years)	ML/d	m ³ /s
3.40	123.78	20	5	13,100	152
3.72	124.10	10	10	19,200	222
3.96	124.34	5	20	25,000	289
4.23	124.61	2	50	31,900	369
4.40	124.78	1	100	36,500	423
4.52	124.90	0.5	200	40,700	471
4.67	125.05	0.2	500	45,400	525

Note: Gauge located immediately upstream of Mackenzie River confluence, large Mackenzie River flows can impact on water levels recorded at the gauge. Gauge zero equal to 120.381 m AHD, rating curve extrapolated beyond 4.20 m. Hydraulic model not well calibrated at this gauge due to boundary of model, design flow and gauge level relationship based on the gauge rating curve not modelled results.

Table 4-2 Wimmera River @ Quantong Gauge Heights for Design Flood Events

Gauge Height		Design Flood Event		Design Flood Flow	
Relative (m)	m AHD	AEP (%)	ARI (years)	ML/d	m ³ /s
6.72	116.73	20	5	12,300	142
6.98	116.99	10	10	18,300	212
7.18	117.19	5	20	24,000	278
7.34	117.35	2	50	30,100	349
7.43	117.44	1	100	34,000	394
7.50	117.51	0.5	200	37,400	433
7.58	117.59	0.2	500	41,000	475

Note: Gauge located downstream of the Wimmera Highway at the timber rail bridge. Gauge zero of 110.01 m AHD was surveyed during this study, prior to that the gauge zero was incorrect by almost 2 m. Quantong gauge does not have a rating curve, it is a level gauge only. Design flows are extracted from hydraulic model.

Table 4-3 Wimmera River @ U/S Dimboola Gauge Heights for Design Flood Events

Gauge Level		Design Flood Event		Design Flood Flow	
Relative (m)	m AHD	AEP (%)	ARI (years)	ML/d	m ³ /s
4.78	105.27	20	5	11,900	138
5.19	105.68	10	10	18,000	208
5.49	105.98	5	20	23,600	274
5.77	106.25	2	50	29,500	341
5.93	106.42	1	100	33,400	387
6.07	106.55	0.5	200	36,800	426
6.21	106.69	0.2	500	40,600	470

Note: Gauge located off dirt track immediately north of Hinnebergs Road. Gauge zero equal to 100.486 m AHD, the rating curve is extrapolated beyond 5.50 m. Design flows are extracted from hydraulic model and may be slightly different to flows from rating curve.

Table 4-4 Wimmera River @ Lochiel Bridge Gauge Heights for Design Flood Events

Gauge Height		Design Flood Event		Design Flood Flow	
Relative (m)	m AHD	AEP (%)	ARI (years)	ML/d	m ³ /s
4.10	96.39	20	5	10,500	122
4.26	96.55	10	10	15,800	183
4.39	96.68	5	20	21,200	245
4.50	96.79	2	50	26,800	310
4.56	96.85	1	100	30,200	349
4.61	96.90	0.5	200	32,800	379
4.65	96.94	0.2	500	35,500	410

Note: Gauge located immediately upstream of the rail bridge downstream of Dimboola. Gauge zero of 92.289 m AHD, the rating curve is extrapolated beyond 4.60 m. Design flows are extracted from hydraulic model and may be slightly different to flows from rating curve.

4.3 Summary of Flood Behaviour

Table 4-5 describes the key flood characteristics of the Wimmera River between Horsham and Lake Hindmarsh. The table has been developed to be read from top to bottom, with each subsequent larger magnitude event reporting on the incremental changes in consequences. For example, if the reader is wishing to understand the consequences of a 2% AEP event, then the flood characteristics should be read for the 20%, 10%, 5% and 2% AEP events in succession. It is also recommended that the reader refer to the standard PDF maps provided alongside this study. There is a separate map for each modelled design event and they provide peak flood depths, extents and water surface elevations for each flood event.

Due to the confined nature of the Wimmera River floodplain, there is not a significant difference in the flood extent across the design flood events in many locations. In some lower flatter areas, larger differences in flood extents are observed as the flow magnitude increases.

Table 4-5 Summary of Flood Behaviour for Various Flood Events

Event	Flood Characteristics	Key roadways inundated
20% AEP	<ul style="list-style-type: none"> • Intersection at Horsham-Noradjuha Road and Three Bridges Road becomes inundated • Dimboola golf course inundated in low areas • Between Dimboola and Antwerp, potential for rural properties to be isolated around Five Chain, Klinge and Bothe Roads • No properties are flooded above floor • 2 properties in Dimboola and 1 property in Quantong experience below floor flooding • Rural cropping land inundated 	<ul style="list-style-type: none"> • Horsham-Noradjuha Rd at intersection with Three Bridges Rd and north of the bridge • Dimboola-Rainbow Rd (300m upstream of Arkona-Katyl Rd) • Obrees Rd, Vectis • Forts Ln, Vectis • Old Duchembegarra School Rd, Duchembegarra • Riverside Rd, Dimboola • Swallows Ln, Dimboola • Howland Rd, Dimboola • Bothe Rd, Dimboola • Ebenezer Mission Rd, Dimboola • Tarranyurk West Rd, Jeparit • Spears Crossing Rd, Antwerp
10% AEP	<ul style="list-style-type: none"> • Extent of flooding increases directly downstream of Horsham-Noradjuha Rd • Breakout flow in Quantong across Struthers Ave, re-connects with Wimmera River downstream of Overall Ave • Extent of flooding increased across floodplain adjacent to Little Desert National Park • Floodwaters begin to encroach on the western side of Dimboola • Property on Hateleys Road near river is isolated • Properties between Antwerp and Jeparit isolated • No properties are flooded above floor • 6 properties in Dimboola, 1 in Vectis and 1 in Quantong experience below floor flooding 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Collard Rd, Dimboola • Five Chain Rd, Dimboola • Klinge Rd, Dimboola • Park Street, Dimboola • Wimmera St, Dimboola • Antwerp-Woorak Rd, Antwerp • River Rd, Antwerp • Polkemmet Road

Event	Flood Characteristics	Key roadways inundated
5% AEP	<ul style="list-style-type: none"> • Floodwaters extend across farmland around the confluence of Mackenzie River and Wimmera River • Floodwaters from Norton Creek cross the floodplain adjacent to Wimmera River and connect with Sandy Creek (north of Horsham-Noradjuha Road) • 1 property in Dimboola is flooded above floor, 3 properties in Dimboola experience inundation within 100mm of the floor level • 20 properties in Dimboola, 3 in Vectis and 1 in Quantong experience below floor flooding 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Lloyd St, Dimboola • Blocks Rd, Quantong
2% AEP	<ul style="list-style-type: none"> • Extent of flooding very similar to 5% AEP event • 8 properties in Dimboola and 2 in Jeparit experience over floor flooding • 4 properties in Dimboola and 1 property on the river 6 km from Natimuk experience inundation within 100mm of the floor level • 43 properties in Dimboola, 1 in Jeparit, 1 in Quantong and 4 in Vectis experience below floor flooding 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Nhill-Jeparit Rd, Jeparit

Event	Flood Characteristics	Key roadways inundated
1% AEP	<ul style="list-style-type: none"> • Breakout from Wimmera River south at Lindners Road towards Norton Creek • Floodwaters overtop levee and inundate land between Dimboola-Rainbow Rd and Jeparit East Rd near Jeparit • 11 properties in Dimboola and 16 in Jeparit experience over floor flooding • 5 properties in Dimboola, 5 in Jeparit are flooded and 1 property on the river 6 km from Natimuk are flooded within 100 mm of the floor level • 2 properties in Antwerp, 61 properties in Dimboola, 10 in Jeparit, 1 in Lower Norton, 3 in Quantong and 5 in Vectis experience below floor flooding 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Charles St, Jeparit
0.5% AEP	<ul style="list-style-type: none"> • Banksia Court properties south of Dimboola are inundated • 14 properties in Dimboola, 20 in Jeparit and 1 property on the river 6 km from Natimuk experience over floor flooding • 6 properties in Dimboola and 2 in Jeparit are flooded within 100 mm of the floor level • 2 properties in Antwerp, 66 in Dimboola, 11 in Jeparit, 1 in Lower Norton, 3 in Quantong and 6 in Vectis experience below floor flooding 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Banksia Court, Dimboola • Jeparit East Road, Jeparit
0.2% AEP	<ul style="list-style-type: none"> • Flood waters starting to get close to sewerage treatment plant outside of Horsham • Wimmera River breakout near Darragan Ck to the west, across farm land and back to the river at Hateleys Rd • Property south of Obrees Rd, Vectis, isolated by breakout • Increased inundation of Banksia Court, Dimboola 	<p>In addition to above:</p> <ul style="list-style-type: none"> • Horseshoe Bend Rd, Dimboola

4.4 Flood Impacts

Floor level survey was captured for properties deemed at risk of flooding in Vectis, Lower Norton, Quantong, Natimuk, Duchembegarra, Pimpino, Antwert, Dimboola and Jeparit. Comparison of these levels to the modelled flood level at the property location provides an indication of the type of flooding (above or below floor) that may be expected across the range of design events. Tables of flood impacts to surveyed properties are provided in Appendix 1, sorted by locality and in order of flood risk.

Note that water surface elevations have been sampled at the location of the property and is not representative of flooding across the entire parcel. It is therefore possible that a property that is identified as not flooded in the following tables experiences inundation across the associated land, but away from the building footprint.

All properties surveyed were included in the tables, regardless of their risk of flooding.

During the study a number of observations regarding flood impacts were made by community members during discussion at community meetings that are worth noting. The Wimmera Hwy at Asplins Rd was inundated via overland flow during the January 2011 event, this was potentially hazardous to traffic. A slide gate located on Hughes Lane between Lanes Avenue and Struthers Avenue, Quantong, was opened in an attempt to reduce flooding around Quantong. The slide gate is a part of a decommissioned channel system, it is unlikely that this would impact flood levels upstream. It is recommended that the effectiveness of the gate is reviewed, as it may not warrant operation in future floods. Significant levee removal works were undertaken during January 2011 on a private property north of the Wimmera Highway in an attempt to alleviate flooding. This most likely had no impact on flood levels and it is recommended that this levee not be removed again in future floods.

4.5 Flood Class Levels

Currently the Bureau of Meteorology have determined flood class levels for the Wimmera River at Horsham (Walmer) gauge, Quantong and U/S of Dimboola as shown below in Table 4-6. As can be seen in Table 4-6 the AEP associated with the flood class levels at gauges down the river is highly variable. This is most likely a result of a lack of available data in the past when flood class levels have been set. It is also a result of flood class levels being associated with flood risk at different locations, i.e. a certain magnitude event may not impact Horsham, but may impact Dimboola to a higher level.

The Bureau of Meteorology uses the following definitions to define the flood class levels.

Minor flooding

Causes inconvenience. Low-lying areas next to water courses are inundated. Minor roads may be closed and low-level bridges submerged. In urban areas inundation may affect some backyards and buildings below the floor level as well as bicycle and pedestrian paths. In rural areas removal of stock and equipment may be required.

Moderate flooding

In addition to the above, the area of inundation is more substantial. Main traffic routes may be affected. Some buildings may be affected above the floor level. Evacuation of flood affected areas may be required. In rural areas removal of stock is required.

Major flooding

In addition to the above, extensive rural areas and/or urban areas are inundated. Many buildings may be affected above the floor level. Properties and towns are likely to be isolated and major rail and traffic routes closed. Evacuation of flood affected areas may be required. Utility services may be impacted.

Table 4-6 Current Bureau of Meteorology Flood Class Levels and Associated Design Flood Event from Lower Wimmera Regional Flood Mapping Study

Gauge	Major Flood Class Level (m)	Moderate Flood Class Level (m)	Minor Flood Class Level (m)
Wimmera River at Horsham (Walmer)	3.60 (20-10% AEP)	3.10 (<20% AEP)	2.80 (<20% AEP)
Wimmera River at Quantong	5.90 (<20% AEP)	5.40 (<20% AEP)	4.50 (<20% AEP)
Wimmera River at U/S Dimboola	6.00 (1-0.5% AEP)	5.70 (5-2% AEP)	5.30 (10-5% AEP)

Wimmera River at Horsham (Walmer)

The moderate and minor flood class levels at the Wimmera River at Walmer are both below the smallest event modelled in this study (20% AEP). The major flood class level is between the 20% and 10% AEP event. This study did not include mapping of Horsham township, so it is recommended that the flood class level for this gauge be reviewed as part of the Horsham and Wartook Valley Flood Investigation (Water Technology, ongoing).

Wimmera River at Quantong

The following recommendations for flood class levels at this gauge have been based on the impacts around Quantong itself and rural areas to around Duchembegarra. In the 20% AEP event there is significant floodplain inundated, but no houses are impacted, and only minor farm roads are inundated. In the 10% AEP event Polkemmet Road is inundated, which is a major road in the area. Inundation of this road would not be a significant impact as drivers could use the Wimmera Hwy crossing upstream near Quantong. The flood class levels of the Quantong gauge appear far too low, with concerns raised shortly after the September 2016 flood event that the flood class levels were not in line with flood impacts. The smallest event modelled was the 20% AEP event which is equivalent to 6.7 m on the gauge. The modelled results were assessed and lowered until a flood extent fitting of the minor flood class category was observed. It is recommended that the flood class level be increased to 5.7 m on the gauge. The moderate flood class level could be set at the 10% AEP event level of 7.0 m, at which point Polkemmet Road is inundated, a house on Hateleys Road is isolated and a property in Quantong experiences below floor flooding. The flood extents in the area around Quantong do not change dramatically for events above the 10% AEP, with the impacts to buildings and major infrastructure very minimal. It is suggested that the major flood class level could be set at the 1% AEP event at 7.4 m.

Wimmera River at U/S Dimboola

The current flood class levels all seem too high for the area downstream of Dimboola compared to the impacts shown through the flood modelling. The 20% AEP flood mapping shows impacts at the golf course, along with a number of minor rural roads impacted. It is recommended that the 20% AEP level at 4.8 m on the gauge be used for the minor flood class level. In this event the river is contained within banks through the town, but the rural area downstream, sees flood water breaking out across wide areas. The moderate flood class level could be based on the 10% AEP flood mapping with a level at the gauge of 5.2 m. At this level flood waters are encroaching on the town, inundating a number of public recreational areas, and isolates a number of houses. The major flood class level could be based on the 5% AEP event, at 5.5 m, which the modelling shows is when the first building experiences above floor flooding. This is a significant reduction in the current flood class levels and should be discussed with the Bureau of Meteorology.

Wimmera River at Tarrenyurk

The Bureau of Meteorology do not monitor this gauge for flood warning purposes, however Wimmera CMA requested that equivalent flood class levels be developed for this gauge. Flood impacts for the area from Tarrenyurk to Jeparit were assessed in the development of the suggested flood class levels for this gauge site. There are no real impacts in the 20% AEP event between Tarrenyurk and Jeparit other than inundation of the lowest part of the floodplain. It is recommended that the 20% AEP event at 83.19 m AHD be used for the minor flood class level. The 10% AEP begins to inundate farmland and public recreational areas along the river with a few rural properties isolated. It is recommended that the 10% AEP event at 83.45 m AHD be used for the moderate flood class level. The 2% AEP event inundates two buildings above floor in Jeparit. It is recommended that the 2% AEP at 83.78 m AHD could be adopted as the major flood class level.

It is recommended that the Bureau of Meteorology be consulted regarding the above flood class level recommendations as they differ significantly from current flood class levels at the Wimmera River at Quantong and Wimmera River at U/S of Dimboola gauges.

4.6 Model Result Outputs

The model result data including grids and extents was delivered in the specified Victorian Flood Database (VFD) format for each flood event. The following result components were generated:

- Flood level, flood depth, flood velocity, flood hazard and model topography grids
- Flood elevation contours
- Flood extents
- Hydrographs at key locations
- Long-section of river water levels

4.6.1 Data Sets

The following datasets were provided. All GIS files provided in ESRI VFD format or Excel csv/xlsx format. A summary of the datasets is provided below and an example of the mapped area is shown in Section 3.2.5.

Grids

Gridded datasets of model results were provided for the following:

- Design events (20%, 10%, 5%, 2%, 1%, 0.5%, 0.2% AEP, and PMF events) – maximum depth, hazard, velocity and water surface elevation.
- Calibration events (January 2011 and September 2010 events) – maximum depth, hazard, velocity and water surface elevation.
- Model topography

Vector Data

ERSI shapefiles in VFD format were provided for the following:

- Peak flood extents
- Peak flood elevation contours
- Levee Layer
- Mapping limits

The hydraulic analysis was conducted using a flexible mesh approach, with results processed to produce a 10x10 m regular grid of flood elevations across the hydraulic model study area. The flood extent was defined by converting the flood elevation grid to an extent polygon. The extent is smoothed to remove the sharp edges of the grid cells for cartographic / presentation purposes.

Data Tables

Data tables in excel CSV format were provided for the following based on discussions with DEWLP and the CMA on key locations:

- Stage height hydrographs at key locations across the study area for all events.
- Water surface level profile along the river for all events.

4.6.2 Maps

The flood response inundation maps were produced for all design flood events, including:

- Flood extent
- Flood level contour at 1m intervals
- Depth of inundation
- Identification of essential services
- Major Road/street names
- Cadastral base
- Gauge height indication

For each design event, a map was produced of the entire study area, as well as three zoomed maps as per Section 3.2.5.

A mapping limits layer was provided in the vector data. This layer shows the model extent and is important because it identifies where modelling from this study finished. This allows the users of the outputs to understand that flooding doesn't stop at the flood mapping limit, but that is the limit of mapping created in this investigation.

The above described maps were provided as standalone PDF maps.

4.7 Study Deliverables

The study deliverables provide a comprehensive set of data that support the study outcomes. The deliverables are supplied on a study USB and consist of background data and outputs as listed below:

- Digital copies of study reports in PDF format.
- Digital copies of the maps (PDF format)
- GIS datasets for the model results (ArcGIS VFD format and Excel csv format)
- Digital elevation models

There is a readme.txt file on the USB that describes the directory structure of the data contained on the USB.

APPENDIX A PROPERTY FLOOD IMPACTS

Table A-1 Flood Impacts to properties in Vectis, Lower Norton, Quantong, Natimuk, Duchembegarra and Pimpinio

Vectis, Lower Norton, Quantong, Natimuk, Duchembegarra & Pimpinio									
It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card									
<ul style="list-style-type: none"> This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016). All properties surveyed have been included in this table regardless of their susceptibility to flooding. Properties are listed in order of their susceptibility to flooding. 									
LEGEND:			 Flooded at property	 Within 100 mm of flooding over floor					 Flooded above floor
			DEPTH OF OVER FLOOR FLOODING						
Location	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	Comment	
1771 OBREES ROAD, NATIMUK 3409						0.06	0.13	GALV. IRON SHED (NON RESIDENTIAL)	
133 BLOCKS ROAD, QUANTONG 3401								WEATHERBOARD DWELLING	
55 STRUTHERS AVENUE, QUANTONG 3401								WEATHERBOARD DWELLING	
165 HORSHAM-NORADJUHA ROAD, VECTIS 3401								WEATHERBOARD DWELLING	
185 HORSHAM-NORADJUHA ROAD, VECTIS 3401								BRICK DWELLING	
35 CREASEY COURT, VECTIS 3401								BRICK DWELLING	
38 CREASEY COURT, VECTIS 3401								BRICK DWELLING	
39 CREASEY COURT, VECTIS 3401								WEATHERBOARD DWELLING	
176 HUGHES ROAD								2 STOREY WEATHERBOARD DWELLING	
41 CREASEY COURT, VECTIS 3401								WEATHERBOARD DWELLING	

Vectis, Lower Norton, Quantong, Natimuk, Duchembegarra & Pimpinio

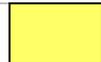
It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:



Flooded at property



Within 100 mm of flooding over floor



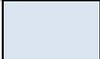
Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
63 BALL ROAD, LOWER NORTON 3401								WEATHERBOARD DWELLING
558 HORSHAM-NORADJUHA ROAD, LOWER NORTON 3401								WEATHERBOARD DWELLING
1722 POLKEMMET ROAD, DUCHEMBEGARRA 3409								WEATHERBOARD DWELLING
87 BLOCKS ROAD, QUANTONG 3401								BRICK DWELLING
1614 POLKEMMET ROAD, PIMPINIO 3401								WEATHERBOARD DWELLING
96 BLOCKS ROAD, QUANTONG 3401								WEATHERBOARD DWELLING
266 HORSHAM-NORADJUHA ROAD, LOWER NORTON 3401								BRICK DWELLING
296 ASPLINS ROAD, QUANTONG 3401								CORRUGATED IRON DWELLING
99 THREE BRIDGES ROAD, LOWER NORTON 3401								WEATHERBOARD DWELLING
166 HUGHES ROAD								WEATHERBOARD DWELLING
378 HATELEYS ROAD, NATIMUK 3409								WEATHERBOARD DWELLING

Vectis, Lower Norton, Quantong, Natimuk, Duchembegarra & Pimpinio

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
121 THREE BRIDGES ROAD, LOWER NORTON 3401								BRICK DWELLING
416 HORSHAM-NORADJUHA ROAD, LOWER NORTON 3401								RENDERED BRICK DWELLING
198 HUGHES ROAD, QUANTONG 3401								WEATHERBOARD DWELLING
37 CREASEY COURT, VECTIS 3401								WEATHERBOARD DWELLING
36 CREASEY COURT, VECTIS 3401								BRICK DWELLING

Table A-2 Flood Impacts to properties in Antwerp and Dimboola

Antwerp & Dimboola								
It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card								
<ul style="list-style-type: none"> This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016). All properties surveyed have been included in this table regardless of their susceptibility to flooding. Properties are listed in order of their susceptibility to flooding. 								
LEGEND:  Flooded at property			 Within 100 mm of flooding over floor				 Flooded above floor	
Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
1 WIMMERA STREET DIMBOOLA 3414			0.04	0.16	0.21	0.24	0.27	
BOAT SHED, DIMBOOLA RECREATION RESERVE				0.07	0.12	0.16	0.19	
1A WIMMERA STREET DIMBOOLA 3414				0.06	0.11	0.14	0.17	
FOOTBALL CLUB, DIMBOOLA RECREATION RESERVE				0.07	0.14	0.18	0.23	
10-12 ST LEONARDS AVENUE DIMBOOLA 3414				0.08	0.19	0.27	0.33	
DIMBOOLA RECREATION RESERVE				0.01	0.08	0.12	0.16	
18 MOULDER STREET DIMBOOLA 3414				0.51	0.74	0.77	0.81	
171 HORSESHOE BEND ROAD, DIMBOOLA 3414				0.35	0.42	0.46	0.50	GALV. IRON SHED (NON RESIDENTIAL)
4 PARK STREET DIMBOOLA 3414					0.07	0.14	0.20	
14 LLOYD STREET DIMBOOLA 3414					0.05	0.13	0.20	

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
9 CHAPEL STREET, DIMBOOLA 3414					0.04	0.05	0.10	GALV. IRON SHED (NON RESIDENTIAL)
461 COLLARD ROAD, DIMBOOLA 3414						0.03	0.07	BRICK DWELLING
35 PICNIC BEND ROAD, DIMBOOLA 3414						0.008	0.18	WEATHERBOARD DWELLING
3 WIMMERA STREET DIMBOOLA 3414						0.01	0.04	
6-8 ST LEONARDS AVENUE DIMBOOLA 3414							0.03	
DIMBOOLA RECREATION RESERVE								
12 MOULDER STREET DIMBOOLA 3414								
5 WIMMERA STREET DIMBOOLA 3414								
7 NORMANBY STREET DIMBOOLA 3414								
RECREATION ROOM - DIMBOOLA RIVERSIDE CARAVAN PARK								
1780 RIVER ROAD, ANTWERP 3414								WEATHERBOARD DWELLING

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
7 MOULDER STREET DIMBOOLA 3414								
14 ST LEONARDS AVENUE DIMBOOLA 3414								
12 LLOYD STREET DIMBOOLA 3414								
17 LLOYD STREET DIMBOOLA 3414								
1120 RIVER ROAD, ANTWERP 3414								RENDERED BRICK DWELLING
11 BANKSIA COURT, DIMBOOLA 3414								GALV. IRON SHED (NON RESIDENTIAL)
14 MOULDER STREET DIMBOOLA 3414								
7 WIMMERA STREET DIMBOOLA 3414								
1 MOULDER STREET DIMBOOLA 3414								
19 MOULDER STREET DIMBOOLA 3414								
AMMENITIES - DIMBOOLA RIVERSIDE CARAVAN PARK								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
20 MOULDER STREET DIMBOOLA 3414								
8-10 WIMMERA STREET DIMBOOLA 3414								
21 MOULDER STREET DIMBOOLA 3414								
11 MOULDER STREET DIMBOOLA 3414								
9 NORMANBY STREET DIMBOOLA 3414								
16 MOULDER STREET DIMBOOLA 3414								
FOOTBALL CLUB, DIMBOOLA RECREATION RESERVE								
9 WIMMERA STREET DIMBOOLA 3414								
5 LOCHIEL STREET DIMBOOLA 3414								
5 CHAPEL STREET, DIMBOOLA 3414								
1A LLOYD STREET DIMBOOLA 3414								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
60 RIVERSIDE DIMBOOLA 3414								
150 RIVERSIDE ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
15 MOULDER STREET DIMBOOLA 3414								
17 MOULDER STREET DIMBOOLA 3414								
11 LLOYD STREET DIMBOOLA 3414								
23 MOULDER STREET DIMBOOLA 3414								
9 MOULDER STREET DIMBOOLA 3414								
20 LLOYD STREET, DIMBOOLA 3414								WEATHERBOARD DWELLING
1B LLOYD STREET DIMBOOLA 3414								
OFFICE - DIMBOOLA RIVERSIDE CARAVAN PARK								
12 NORMANBY STREET, DIMBOOLA 3414 - DWELLING								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
24 MOULDER STREET DIMBOOLA 3414								
54 HORSESHOE BEND ROAD DIMBOOLA 3414								
3 MOULDER STREET DIMBOOLA 3414								
1780 RIVER ROAD, ANTWERP 3414								CEMENT SHEET DWELLING
13 LLOYD STREET DIMBOOLA 3414								
22 LLOYD STREET, DIMBOOLA 3414								BRICK DWELLING
120 HORSESHOE BEND ROAD DIMBOOLA 3414								
22 MOULDER STREET DIMBOOLA 3414								
13 MOULDER STREET DIMBOOLA 3414								
12 NORMANBY STREET DIMBOOLA 3414								
50 HORSESHOE BEND ROAD DIMBOOLA 3414								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
1 CHAPEL STREET, DIMBOOLA 3414								CORRUGATED IRON DWELLING
OFFICE - DIMBOOLA RIVERSIDE CARAVAN PARK								
11 NORMANBY STREET DIMBOOLA 3414								
2 LOCHIEL STREET DIMBOOLA 3414								
3 LLOYD STREET DIMBOOLA 3414								
1C LLOYD STREET DIMBOOLA 3414								
FOOTBALL STAND, DIMBOOLA RECREATION RESERVE								
859 DIMBOOLA-RAINBOW ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
141 LLOYD STREET DIMBOOLA 3414								
4 LLOYD STREET, DIMBOOLA 3414								BRICK DWELLING
8-10 LLOYD STREET, DIMBOOLA 3414								BRICK DWELLING

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
DIMBOOLA GOLF CLUB								
13 WIMMERA STREET DIMBOOLA 3414								
3 LOCHIEL STREET DIMBOOLA 3414								
5 LLOYD STREET DIMBOOLA 3414								
24 MOULDER STREET DIMBOOLA 3414								
18A MOULDER STREET DIMBOOLA 3414								
174 HORSESHOE BEND ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
37 BANKSIA COURT, DIMBOOLA 3414								LOG CABIN (NON RESIDENTIAL)
9 LLOYD STREET DIMBOOLA 3414								
143 LLOYD STREET DIMBOOLA 3414								
10 ANDERSON STREET DIMBOOLA 3414								WEATHERBOARD DWELLING

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
OLD WEIR LANE DIMBOOLA 3414								
1 CHAPEL STREET DIMBOOLA 3414								
111 BUSHBY LANE DIMBOOLA 3414								
145 LLOYD STREET DIMBOOLA 3414								
137 LLOYD STREET DIMBOOLA 3414								
3 LOCHIEL STREET DIMBOOLA 3414								
15 WIMMERA STREET DIMBOOLA 3414								
7 LLOYD STREET DIMBOOLA 3414								
1D LLOYD STREET DIMBOOLA 3414								
2/4 ST LEONARDS AVENUE DIMBOOLA 3414								
2 RIVERVIEW DRIVE DIMBOOLA 3414								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
151 HORSESHOE BEND ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
1 FAITH STREET, DIMBOOLA 3414								WEATHERBOARD DWELLING
26 LLOYD STREET, DIMBOOLA 3414								
5 LLOYD STREET, DIMBOOLA 3414								BRICK DWELLING
12 ANDERSON STREET DIMBOOLA 3414								WEATHERBOARD DWELLING
25 MOULDER STREET DIMBOOLA 3414								
159 LLOYD STREET DIMBOOLA 3414								
155 LLOYD STREET DIMBOOLA 3414								
153 LLOYD STREET DIMBOOLA 3414								
151 LLOYD STREET DIMBOOLA 3414								
149 LLOYD STREET DIMBOOLA 3414								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
147 LLOYD STREET DIMBOOLA 3414								
139 LLOYD STREET DIMBOOLA 3414								
135 LLOYD STREET DIMBOOLA 3414								
121 LLOYD STREET DIMBOOLA 3414								
119 LLOYD STREET DIMBOOLA 3414								
123 LLOYD STREET DIMBOOLA 3414								
127 LLOYD STREET DIMBOOLA 3414								
115-117 LLOYD STREET DIMBOOLA 3414								
103 LLOYD STREET DIMBOOLA 3414								
103 LLOYD STREET DIMBOOLA 3414								
107 LLOYD STREET DIMBOOLA 3414								

Antwerp & Dimboola

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
101 LLOYD STREET, DIMBOOLA 3414								LIBRARY
95 LLOYD STREET DIMBOOLA 3414								
93 LLOYD STREET DIMBOOLA 3414								
91 LLOYD STREET DIMBOOLA 3414								
89 LLOYD STREET DIMBOOLA 3414								
87 LLOYD STREET DIMBOOLA 3414								
85 LLOYD STREET DIMBOOLA 3414								
83 LLOYD STREET DIMBOOLA 3414								
77 LLOYD STREET DIMBOOLA 3414								
69-71 LLOYD STREET DIMBOOLA 3414								
67 LLOYD STREET, DIMBOOLA 3414								

Antwerp & Dimboola

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- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
65 LLOYD STREET DIMBOOLA 3414								
2/61 LLOYD STREET DIMBOOLA 3414								
59 LLOYD STREET DIMBOOLA 3414								
18 ST LEONARDS AVENUE DIMBOOLA 3414								
16 ST LEONARDS AVENUE DIMBOOLA 3414								
7 OLD WEIR LANE DIMBOOLA 3414								
4 RIVERSIDE ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
1631 RIVER ROAD, ANTWERP 3414								WEATHERBOARD DWELLING
211 RIVER ROAD, DIMBOOLA 3414								CEMENT SHEET DWELLING
1204 RIVER ROAD, ANTWERP 3414								RENDERED BRICK DWELLING
85 NHILL ROAD, DIMBOOLA 3414								CEMENT SHEET DWELLING

Antwerp & Dimboola

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- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
171 RIVER ROAD, DIMBOOLA 3414								BRICK DWELLING
21 SPEARS CROSSING ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
2320 RIVER ROAD, ANTWERP 3414								BRICK / CEMENT SHEET DWELLING
833 DIMBOOLA-RAINBOW ROAD, DIMBOOLA 3414								IRON CLAD DWELLING
80 KLINGE ROAD, DIMBOOLA 3414								CORRUGATED IRON DWELLING
991 RIVER ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
2360 ANTWERP-WOORAK ROAD, ANTWERP 3414								WEATHERBOARD DWELLING
81 NHILL ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
10 RIVERSIDE ROAD, DIMBOOLA 3414								WEATHERBOARD DWELLING
24 LLOYD STREET, DIMBOOLA 3414								BRICK DWELLING
6 ANDERSON STREET, DIMBOOLA 3414								WEATHERBOARD DWELLING

Table A-3 Flood Impacts to properties in Jeparit

Jeparit								
It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card								
<ul style="list-style-type: none"> This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016). All properties surveyed have been included in this table regardless of their susceptibility to flooding. Properties are listed in order of their susceptibility to flooding. 								
LEGEND:  Flooded at property			 Within 100 mm of flooding over floor				 Flooded above floor	
Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
SIR ROBERT MENZIES PARK				0.47	0.66	0.76	0.85	IRON SHED
SIR ROBERT MENZIES PARK				0.10	0.28	0.39	0.47	IRON SHED
FOOTY SHED, SHOW GROUNDS STREET, JEPARIT					0.02	0.12	0.20	BRICK SHED
4 TULLYVEA STREET					0.74	0.82	0.88	IRON SHED
70 CHARLES STREET, JEPARIT (MUSEUM)					0.55	0.62	0.69	BRICK SHED
70 CHARLES STREET, JEPARIT					0.54	0.61	0.68	IRON SHED
70 CHARLES STREET, JEPARIT					0.53	0.60	0.67	MUD HUT
70 CHARLES STREET, JEPARIT					0.47	0.54	0.61	IRON SHED
2 TULLYVEA STREET					0.42	0.50	0.56	BRICK
70 CHARLES STREET, JEPARIT					0.41	0.48	0.55	IRON SHED

Jeparit

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- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
88 CHARLES STREET, JEPARIT					0.37	0.44	0.51	RENDERED
70 CHARLES STREET, JEPARIT					0.25	0.32	0.39	WEATHERBOARD
60 CHARLES STREET, JEPARIT					0.20	0.27	0.34	WEATHERBOARD
61 CHARLES STREET, JEPARIT					0.09	0.16	0.23	IRON
70 CHARLES STREET, JEPARIT					0.07	0.14	0.21	IRON HALL
5 RIVERSIDE STREET, JEPARIT					0.04	0.11	0.18	WEATHERBOARD
86 CHARLES STREET, JEPARIT						0.07	0.14	CLADDING
70 CHARLES STREET, JEPARIT						0.06	0.13	CLADDING
22 SCOTT STREET, JEPARIT						0.05	0.11	CLADDING
SIR ROBERT MENZIES PARK						0.02	0.10	IRON SHED
56 CHARLES STREET, JEPARIT							0.06	IRON

Jeparit

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- Properties are listed in order of their susceptibility to flooding.

LEGEND: Flooded at property Within 100 mm of flooding over floor Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
59 CHARLES STREET, JEPARIT								CLADDING
57 CHARLES STREET, JEPARIT								WEATHERBOARD
12 SCOTT STREET, JEPARIT								IRON
55 CHARLES STREET, JEPARIT								WEATHERBOARD
58 CHARLES STREET, JEPARIT								FIBRO
54 CHARLES STREET, JEPARIT								WEATHERBOARD
16 SCOTT STREET, JEPARIT								WEATHERBOARD
14 SCOTT STREET, JEPARIT								FIBRO
53 CHARLES STREET, JEPARIT								RENDERED
58 CHARLES STREET, JEPARIT								FIBRO
52 CHARLES STREET, JEPARIT								WEATHERBOARD

Jeparit

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- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND:  Flooded at property  Within 100 mm of flooding over floor  Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
8 TULLYVEA STREET								IRON SHED
6 TULLYVEA STREET								IRON SHED
11 RIVERSIDE STREET, JEPARIT								IRON
51 CHARLES STREET, JEPARIT								CLADDING
74 JEPARIT EAST RD STREET, JEPARIT								WEATHERBOARD
72 JEPARIT EAST RD STREET, JEPARIT								CLADDING
72 LOWER ROY STREET, JEPARIT								IRON SHED
4 SCOTT STREET, JEPARIT								IRON SHED
4 SCOTT STREET, JEPARIT								IRON SHED
4 SCOTT STREET, JEPARIT								IRON SHED
60 LOWER ROY STREET, JEPARIT								IRON SHED

Jeparit

It is suggested that this table is used in conjunction with the flood inundation maps and flood intelligence card

- This table has been developed based aerial survey to obtain the ground and water surface level at each building location from hydraulic modelling results (Water Technology, 2016).
- All properties surveyed have been included in this table regardless of their susceptibility to flooding.
- Properties are listed in order of their susceptibility to flooding.

LEGEND: Flooded at property Within 100 mm of flooding over floor Flooded above floor

Location	DEPTH OF OVER FLOOR FLOODING							Comment
	5y (20%)	10y (10%)	20y (5%)	50y (2%)	100y (1%)	200y (0.5%)	500y (0.2%)	
48 CHARLES STREET, JEPARIT								RENDERED
443 TULLYVEA BUS ROUTE ROAD, JEPARIT 3423								RENDERED BRICK DWELLING