Addendum to Blayney Flood Study

Update to Australian Rainfall and Runoff 2019 Guidelines

For Blayney Shire Council

INDEX

DOCUMENT CONTROL				
Revision	Date	Details	Author	Reviewed
Draft	23.12.21	Draft report	TP/JK/LZ	MG
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1 Introduction

1.1 Project Background

Blayney Shire Council (Council) have recently determined to update the Blayney (Town) Flood Study (Jacobs, 2015) and Floodplain Risk Management Study and Plan for Blayney (Jacobs, 2016). The update is to address the recommendations set out in the Blayney Flood and Floodplain Management Study Peer Review (Storm, 2021).

Council has developed a flood study for the township of Blayney noted as the *Blayney Flood Study – Flood Study Report – Rev 2* (Jacobs, 2015) which provided details of the Belubula River flood behaviour and the overland flood behaviour affecting the town of Blayney. This Flood Study was primarily undertaken in accordance with Australian Rainfall and Runoff 1987 which has since become obsolete and replaced with the Australian Rainfall and Runoff 2019 (ARR19) guidelines.

Following this, a flood risk management study was prepared and noted as *Floodplain Risk Management Study and Floodplain Risk Management Plan for Blayney – Rev 04*' (Jacobs, 2016). This provided further details on the existing flood behaviour within the Blayney township and proposed nine detention basins, to manage the overland flooding of the Blayney township.

Subsequently a peer review was undertaken of the above-mentioned studies and noted as '*Blayney Flood and Floodplain Management Study Peer Review Report* (Storm, 2021) which reviewed the modelling approaches and provided recommendations for improvement. These are further discussed in Section 1.2 Objectives and Scope.

1.2 Objectives and Scope

The objective of this report is to document the update of the existing Flood Study Report from the outdated AR&R 1987 standards to the current AR&R 2019 standards. This addendum report is an extension of the modelling carried out in the Blayney (Town) Flood Study (Jacobs, 2015) which should be referenced for background information and the development of modelling components.

Specifically, the following recommendations of the *Blayney Flood and Floodplain Management Study Peer Review Report* (Storm, 2021) will be addressed in this report:

- *It is recommended that the RAFTS design flow estimates for the Belubula River catchment and Blayney be updated in accordance with the recent updates in Australian Rainfall and Runoff (2019).*
- *It is recommended that the design flood levels for the Belubula River and across the town of Blayney be updated and revised using the design flows obtained with ARR (2019).*
- *It is recommended that Jacobs' TUFLOW hydraulics model be updated to incorporate the main stormwater drainage lines discharging into the Belubula River, which are currently not in Jacobs' model.*

The existing hydrologic and hydraulic models (RAFTS and TUFLOW) will be updated using ARR19 methodology for the following storm events:

- 20% AEP – 25min, 3hr, 9hr, 30hr, 36hr

- 5% AEP - 25min, 1hr, 6hr, 30hr, 36hr
- 1% AEP – 25min, 1h, 2hr, 6hr

This report outlines the modelling approach and results of the ARR19 flood modelling for Blayney.

2 Flood Study

2.1 Introduction

This flood study is an extension of the original Blayney (Town) Flood Study (Jacobs, 2015). The hydrologic and hydraulic models prepared by Jacobs were updated to be in accordance with ARR19 so that a like for like comparison can be made between the original flood results and the results of this study.

2.2 Study Area

The '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015) study area focused on the riverine flood behaviour of the Belubula River to downstream Carcoar Dam and the overland flow within the Blayney township.

The study catchment area stretches from the uppermost streams forming the Belubula River to the downstream Carcoar Dam. The total study catchment area is approximately 160 km^2 and is presented in Figure 1.

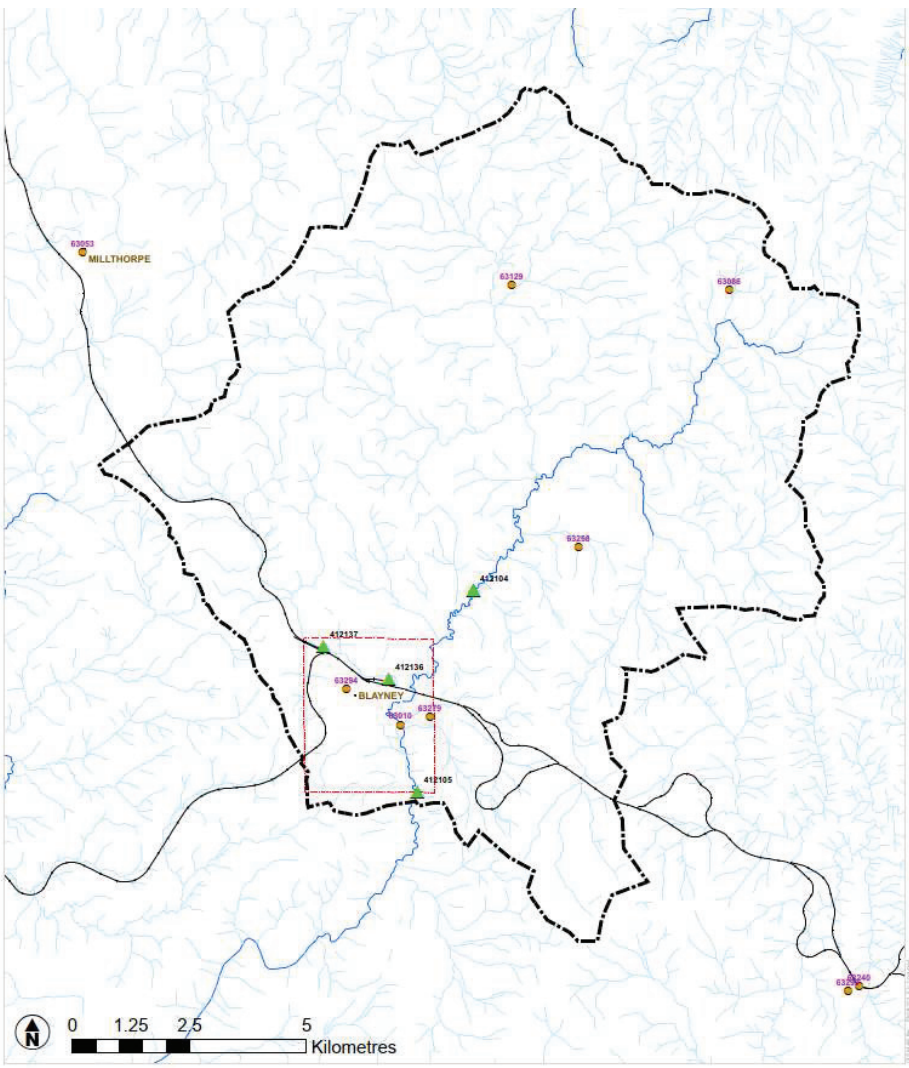


Figure 1 Belubula River Catchment Extent (to Carcoar Dam) *Source: Jacobs Flood Study*

2.3 Nature of Flooding

The town of Blayney is located adjacent to the Belubula River. The river is flood prone due to the large upstream contributing catchments and as such there are little practical options to attenuate the static flood levels from the rising Belubula River during rain events.

While properties close to the Belubula River are at high risk from the rising Belubula River floodwaters, properties away from the Belubula River are also at risk from overland flooding as a result of the large upstream catchments draining through the Blayney township.

2.4 Available Existing Information

2.4.1 Belubula River & Blayney Catchment Mapping

Catchment delineations of the Belubula River and Blayney Town have been undertaken as part of the '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015).

2.4.2 Hydrologic/Hydraulic Models

RORB, XP-RAFTS and TUFLOW modelling has been undertaken as part of the '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015). The RORB hydrological model of the river catchments has been integrated into the XP_RAFTS model by Jacobs as direct inflow hydrographs. The XP-RAFTS and TUFLOW models used in this flood study have been provided by Jacobs to be updated by Storm.

The following 'existing scenario' XP-RAFTS models have been supplied by Council/Jacobs:

- 20% AEP – 25min, 3hr, 9hr, 30hr, 36hr
- 5% AEP - 25min, 1hr, 6hr, 30hr, 36hr
- 1% AEP – 25min, 1h, 2hr, 6hr

3 Hydrologic Modelling

Two separate hydrologic model (XP-RAFTS) scenarios have been prepared for this study. These are the 'existing' and 'proposed' scenarios. The 'existing' scenario is defined as the scenario adopting 'existing' catchment assumptions in the '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015). The 'existing' scenario models have been amended to ARR19 procedures as described in the following sections.

The 'proposed' scenario is defined as the scenario generally adopting the catchment assumptions from the '*existing'* scenario but with the addition of proposed future developments and stormwater drain upgrades. This will reflect the runoff from the township in the near future and should be adopted for future flood scenarios. The 'proposed' scenario model follows ARR19 procedures as described in the following sections.

3.1 Catchment Mapping and Parameters

Catchment mapping undertaken by Jacobs in '*Blayney Flood Study – Flood Study Report – Rev 2 - Appendix C: Figure C002*' (Jacobs, 2015) has been adopted and applied to the *XP-RAFTS* model.

Catchment parameters in the 'existing' and 'proposed" scenarios including catchment areas, slope and fraction imperviousness remain unchanged to the parameters adopted in the Flood Study (Jacobs, 2015). However, the fraction imperviousness of the catchments in the 'proposed' scenario have been increased to reflect future development of these areas (see Table 1 below – changed figures shown in red)

Table 1 'Proposed' Scenario catchments with increased %Imperviousness

Catchment ID	%Impervious (Existing Scenario)	%Impervious (Proposed Scenario)
C0	5	5
C1	5	5
C2	5	5
C3	5	5
C4	5	5
C5	5	5
C6	5	5
C7	5	5
C8a	22	22
C8b	11	11
C9a	5	5
C9b	5	5
C10a	8	8
C10b	5	5
C11	5	5

C12	5	5
C13	5	5
C14a	15	15
C14b	17	17
C15a	38	38
C15b	34	34
C16	19	19
C17a	34	34
C17b	19	19
C18	5	5
C19a	5	5
C19b	5	5
C20a	5	5
C20b	5	5
C21	5	5
C22	24	24
C23	29	29
C24	33	33
C25a	5	5
C25b	5	5
C25c	5	5
C25d	5	5
C26	43	43
C27	24	24
C28	5	25
C29	8	8
C30	5	20
C31	15	15
C32	10	25
C33a	48	48
C33b	38	38
C33c	5	5
C34	11	11
C35a	29	29
C35b	34	34
C35c	24	24

C36	19	19
C37a	5	20
C37b	5	20
C38a	5	20
C38b	5	20
C39	5	5
C40	5	5
C41	5	5
C42	5	5

3.2 Catchment Routing

Catchment routing (XP-RAFTS lag times), for both 'existing' and 'proposed' scenarios have been retained from the original *XP-RAFTS* models in '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015).

3.3 Design Flood Estimation Input Parameters

The 'existing' and 'proposed' XP-RAFTS models have been revised using ARR19 procedures.

3.3.1 Rainfall Depths (IFD)

Rainfall IFD depths have been sourced from ARR Datahub at location of Blayney town centre and is presented in Table 2.

Table 2 Adopted Rainfall IFD Depths (in mm) as per ARR19 Data

	Annual Exceedance Probability (AEP)		
Duration	**20%**	**5%**	**1%**
25 min	19.2	26.4	35.3
1 hour	26	35.4	46.8
3 hour	36.5	48.9	63.9
6 hour	46	61.1	79.5
9 hour	53.1	70.2	91.2
30 hour	80.3	106	136
36 hour	84.9	112	144

3.3.2 Temporal Patterns

Temporal patterns have been sourced from ARR Datahub at location of Blayney town centre. A total of ten temporal patterns are provided for each storm duration.

3.3.3 Design Rainfall Losses

The Initial Loss/Continuing Loss (IL/CL) model was adopted for the 'rural' and 'developed' land type and for the pervious and impervious portions of each land type as presented in Table 3.

Table 3 Adopted IL/CL as per ARR19 Data

	PERVIOUS		IMPERVIOUS	
	IL	CL	IL	CL
RURAL	REFER Table 6 FOR PREBURST MODIFIED LOSS	2*	1**	0**
URBAN	14.4****	2***	1**	0**
	* 0.4 multiplier to ARR Datahub CL losses (Refer Table 4) as per ARR Datahub 'NSW Specific Data Info' ** Retained from Jacobs Flood Study *** ARR19 recommends typical 2.5mm/h with 1-3mm/h range for S.E Aust. 2mm/h adopted **** ARR19 recommends 60-80% of ARR Datahub IL. 60% adopted			

ARR87 modelling generally assumed the ground was dry at the beginning of a storm event. In reality, rainfall may have occurred prior to the main rainfall burst resulting in wetter (more saturated) soil conditions. This in turn results in surface runoff occurring sooner. ARR19 takes this into account by modifying initial losses with "pre-burst" losses to obtain the Pre-burst Modified Loss.

The Pre-burst Modified Loss (refer Table 6) is calculated by subtracting Pre-Burst Loss (refer Table 5) from the Initial Loss (refer Table 4) for each storm duration/AEP.

Table 4 ARR Datahub Storm Losses ARR19 for Blayney

ARR DATAHUB STORM LOSSES	
INITIAL LOSS (mm)	24
CONTINUING LOSSES (mm/h)	5

Table 5 ARR Datahub Median Pre-burst Loss Depths (mm) for Blayney

ARR DATAHUB MEDIAN PREBURST DEPTHS (mm)			
Durn/AEP	**20% AEP**	**5% AEP**	**1% AEP**
25m	1.1	1.3	1.4
1h	-	1.3	1.4
2h	-	-	1
3h	1	-	-
6h	-	0.7	4.2
9h*	0.8	-	-
30h*	0	0	-
36h	0	0	-
* **Loss Value interpolated**			

Table 6 Adopted Pre-Burst Modified Initial Loss for Blayney

PREBURST MODFIED IL (mm)

	20% AEP	5% AEP	1% AEP
25m	22.9	22.7	22.6
1h	-	22.7	22.6
2h	-	-	23
3h	23	-	-
6h	-	23.3	19.8
9h	23.2	-	-
30h	24	24	-
36h	24	24	-

The pre-burst modified initial losses were input into the XP-RAFTS hydrologic models to obtain hydrographs for each storm event.

3.4 Hydrologic Model Methodology

The source of flooding within the Blayney township is largely attributed to the surface runoff within the township's catchments and from the external catchments upstream of the township. The Belubula River mostly affects the lower (eastern) parts of the town which in turn creates a tailwater restriction for the drainage of Blayney.

The Belubula River has a long hydrograph and accounts for the majority of flow in the overall hydrologic model. This skews the data when choosing a 'critical' storm for the overall study. The runoff from the town is relatively minor compared to the flow in the Belubula River.

To determine the critical storm of the overland flooding within the Blayney township, the direct river inflow hydrograph and contributing Belubula River catchments (Catchments C, C0, C1, C10a, C10b, C11, C12 and C18 shown in red in Figure 2) were temporarily removed from the hydrologic model. This allowed for more appropriate critical storms to be chosen for hydraulic modelling. They were reinstated once the critical storms were observed.

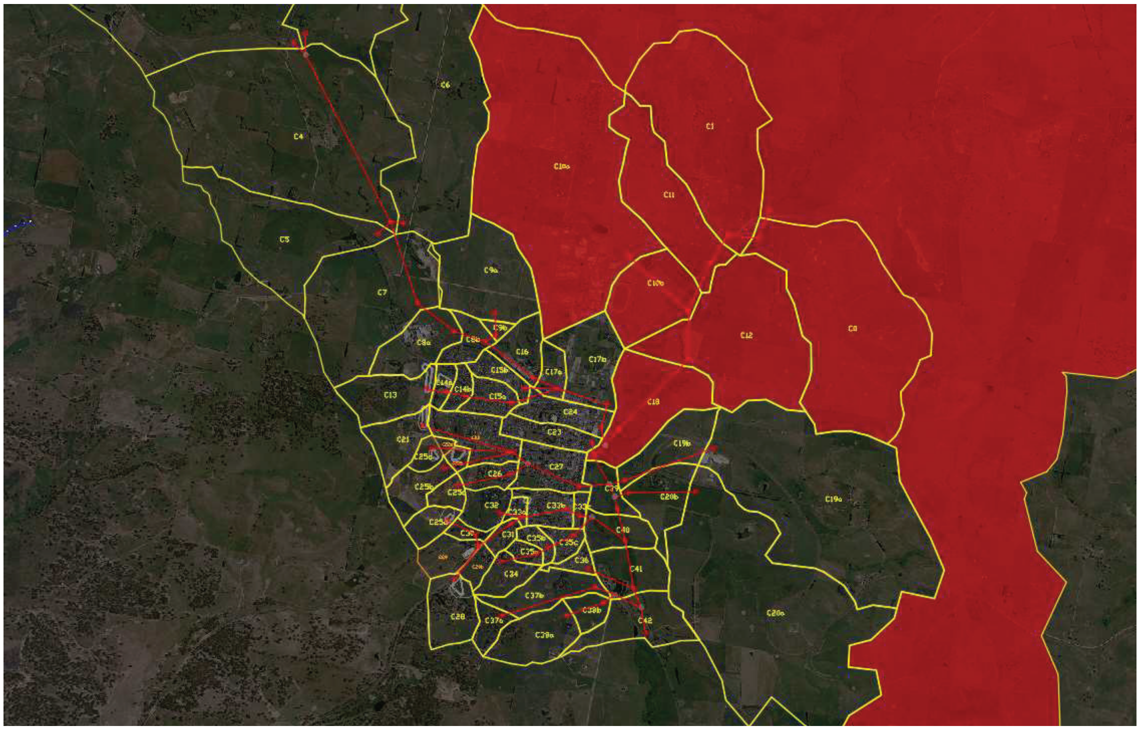


Figure 2 XP-RAFTS Model Layout with Belubula River Catchments Removed

The 20%, 5% and 1% AEP storms were then run for each duration as adopted in Jacobs Flood Study. This allows for direct comparison with the original flood modelling. For each duration, the temporal pattern corresponding to the median peak flow (as per ARR19) was assigned as the critical temporal pattern for that duration at the most downstream node (Node C42) in the model.

To determine the critical duration for each AEP, the duration producing the largest median peak flow was chosen. The ‘existing’ scenario critical durations for each AEP is shown in Table 7 below.

Table 7 ‘Existing’ scenario critical durations for each AEP at Node C42

EXISTING MODEL (Without Belubula River Catchment)		
	Median Total Flow (m^3/s)	Median Temporal Pattern
20%AEP*		
25m	6.11	#8
3h	29.69	#7
9h	**37.54**	**#3**
30h	35.07	#3
36h	35.14	#2
5%AEP*		
25m	15.4	#9
1h	39.79	#5

6h	**77.69**	**#7**
30h	52.89	#7
36h	50.32	#2
1%AEP*		
25m	42.16	#2
1h	78.85	#8
2h	114.24	#8
6h	**128.85**	**#7**

The ‘proposed’ scenario critical durations for each AEP is shown in Table 8.

Table 8 ‘Proposed’ scenario critical durations for each AEP at Node C42

PROPOSED MODEL (Without Belubula River Catchment)		
	Median Total Flow (m^3/s)	Median Temporal Pattern
20%AEP*		
25m	11.06	#8
3h	29.89	#7
9h	**38.07**	**#3**
30h	35.41	#3
36h	35.49	#2
5%AEP*		
25m	22.06	#3
1h	38.29	#9
6h	**76.68**	**#7**
30h	53.46	#7
36h	50.14	#2
1%AEP*		
25m	42.95	#1
1h	79.01	#2
2h	114	#8
6h	**128.98**	**#7**

4 Hydraulic Modelling

4.1 Model Development

As part of the original flood study '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015) a hydraulic model was created using TUFLOW to determine flood behaviour in 2D and provide flood maps. The original TUFLOW model was adopted for this study as the foundation for detailed hydraulic modelling.

The hydraulic model was setup to represent the flood behaviour under existing conditions (as per original Flood Study) and a proposed development condition which was used to assess the flood conditions for the 20% AEP, 5% AEP, and 1% AEP storm events as discussed in Section 2.4.2. The modelled storm durations for the 20% AEP, 5% AEP and 1% AEP storms were unchanged from the existing Jacobs flood study.

4.2 Existing Conditions

The following modelling elements were modified from the Jacobs flood study and adopted for the existing conditions scenario:

1. The TUFLOW software version was updated to the latest at the time of modelling (2020-10-AB).
2. As the RAFTS hydrological model was updated in accordance with ARR19, the hydrograph inflows to the source area boundary conditions were updated, however the sub-catchment and boundary condition delineations remain unchanged.
3. Additional stormwater drainage data was added to the model as a 1D network to convey flows throughout the township.
    a. Pit and pipe sizes, invert levels and locations were based on detailed survey by Craig & Rhodes (2020).
    b. No pit or pipe blockages were assumed as is consistent with the other existing 1D network elements from the original Flood Study.

All other model inputs and assumptions were adopted as per the Jacobs flood study.

4.3 Proposed Development Conditions

The following model elements were adopted for the proposed conditions scenario:

1. The sub-catchment delineations in the RAFTS hydrological model were modified in accordance with future proposed developments in Blayney (as per Table 1 in Section 3.1), and subsequently the source area boundary conditions were modified to reflect these catchments accordingly.
2. The 1D network was updated with a stormwater drainage network from Oliver Street, discharging to a culvert underneath Orange Road.
    a. Pit and pipe sizes, invert levels and locations were based on detailed design by Craig & Rhodes (2021).
    b. No pit or pipe blockages were assumed as is consistent with the existing 1D network elements.

c. The terrain at the downstream end of the 1D network was smoothed out to allow the pipe to discharge to the surface.

All other modelling elements remain unchanged from the existing conditions model.

4.4 Results Mapping

4.4.1 Introduction

The hydraulic model was run for the exiting and proposed scenarios for the following storms:

- 20% AEP – 25min, 3hr, 9hr, 30hr, 36hr
- 5% AEP - 25min, 1hr, 6hr, 30hr, 36hr
- 1% AEP – 25min, 1h, 2hr, 6hr

Flood maps were developed and are shown in **Appendix A and Appendix B.**

4.4.2 Flood Depth and Level Mapping

Flood depths and levels of the existing condition are shown in **Appendix A** as Maps 01-03 for the 20%, 5% and 1% storms. They represent the combination of the modelled storm durations for each AEP.

Upon review, the 20% AEP storm shows minor flooding within the north-west and central regions of Blayney. The Belubula River shows more significant flood depth which partially impacts the town in the north-eastern regions. The 5% AEP storm shows further flooding within the central and north-western portions of Blayney with increased flooding along Plumb St.

The 1% AEP storm shows more widespread flooding particularly along the Orange/Church St corridor and the Plumb/Water Street corridor. More significant flooding is experienced along the eastern edge of Blayney due to the inundation from Belubula River.

Flood depths and levels of the proposed condition are shown in **Appendix B** as Maps 11-13 for the 20%, 5% and 1% storms. The results between the existing and proposed scenarios are very similar with only minor differences.

4.4.3 Flow Velocities

Flood velocities of the existing condition are shown in **Appendix A** as Maps 04-06 for the 20%, 5% and 1% storms. Apart from the more significant velocities along the Belubula River corridor, majority of the higher flow velocities (1m/s +) are mostly contained within road corridors.

Flood velocities of the proposed condition are shown in **Appendix B** as Maps 14-16 for the 20%, 5% and 1% storms. The results between the existing and proposed scenarios are very similar with only minor differences.

4.4.4 Hazard Maps

Hazard maps for the existing condition are shown in **Appendix A** as Maps 07-09 for the 20%, 5% and 1% storms. Hazard maps for the proposed condition are shown in **Appendix B** as Maps 17-19 for the 20%, 5% and 1% storms. These are shown for reference and are discussed in the *'Addendum to Blayney Floodplain Risk Management Study'* (Storm, 2021).

4.4.5 Change in Afflux between ARR87 and ARR19

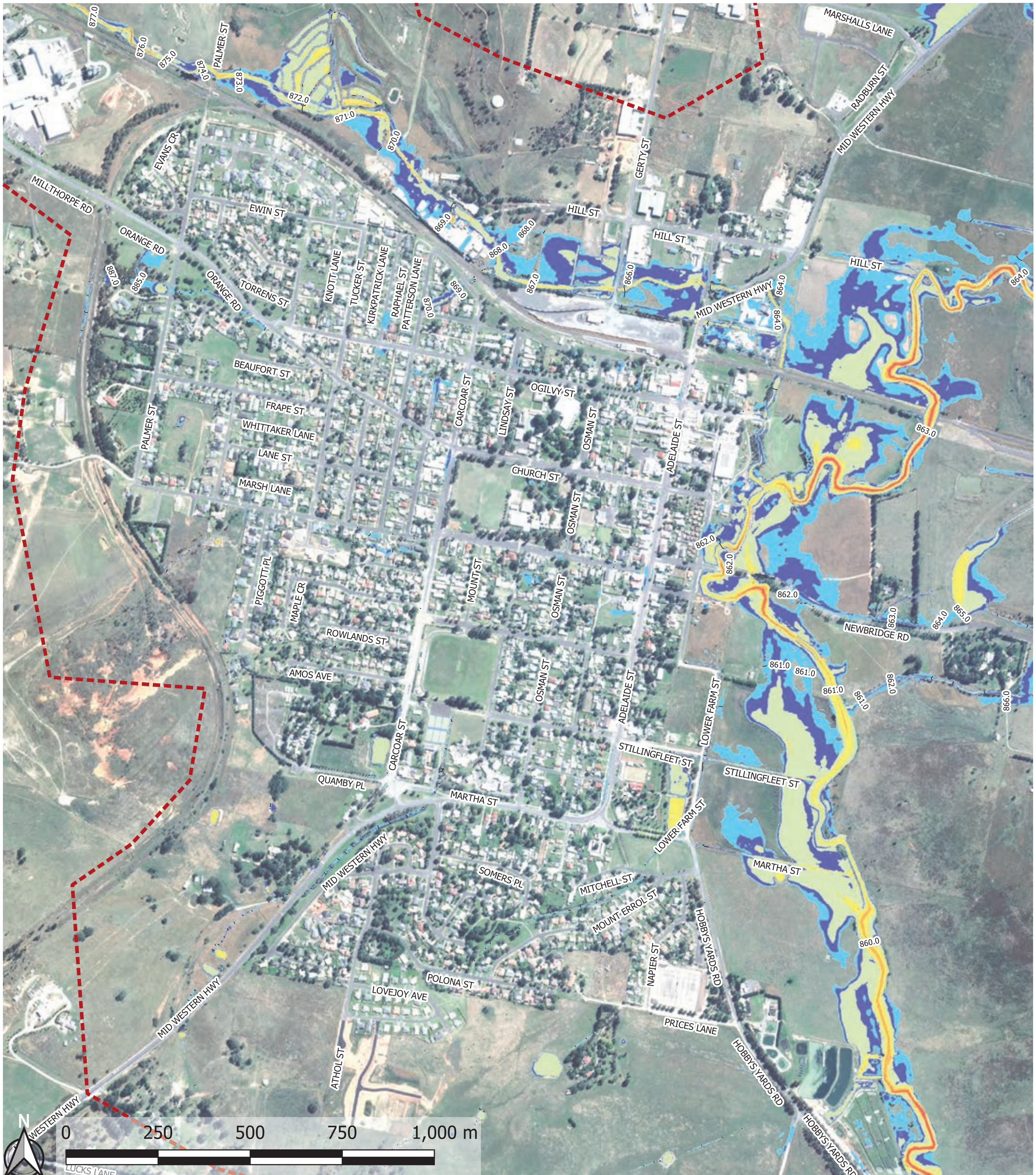
An afflux map showing the water level differences between the ARR87 modelling and ARR19 modelling has been generated as Map 10 and shown in Appendix C. It shows a significant amount of change however the changes are relatively slight. For the most part, reductions are in the order of 0.01 to 0.2m throughout the township with only minor increases in depth in concentrated areas. These increases are primarily due to the higher rainfall runoff rates (as per ARR19 conditions) in the rural catchments to the west of town.

5 REFERENCES:

- '*Blayney Flood Study – Flood Study Report – Rev 2*' (Jacobs, 2015)
- '*Floodplain Risk Management Study and Floodplain Risk Management Plan for Blayney – Rev 04*' (Jacobs, 2016)
- '*Blayney Retarding Basins Study – Concept Design Report – Draft*' (Storm, 2021)
- *Blayney Flood and Floodplain Management Study Peer Review Report* (Storm, 2021)

APPENDICES

Appendix A – Flood Mapping of the Existing Conditions



Map 01: Existing Flood Depth and Level 20% AEP Event (ARR 2019)

Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

1m Flood Level Contour (mAHD)

Note: A 150 mm cutoff depth has been applied to this map.

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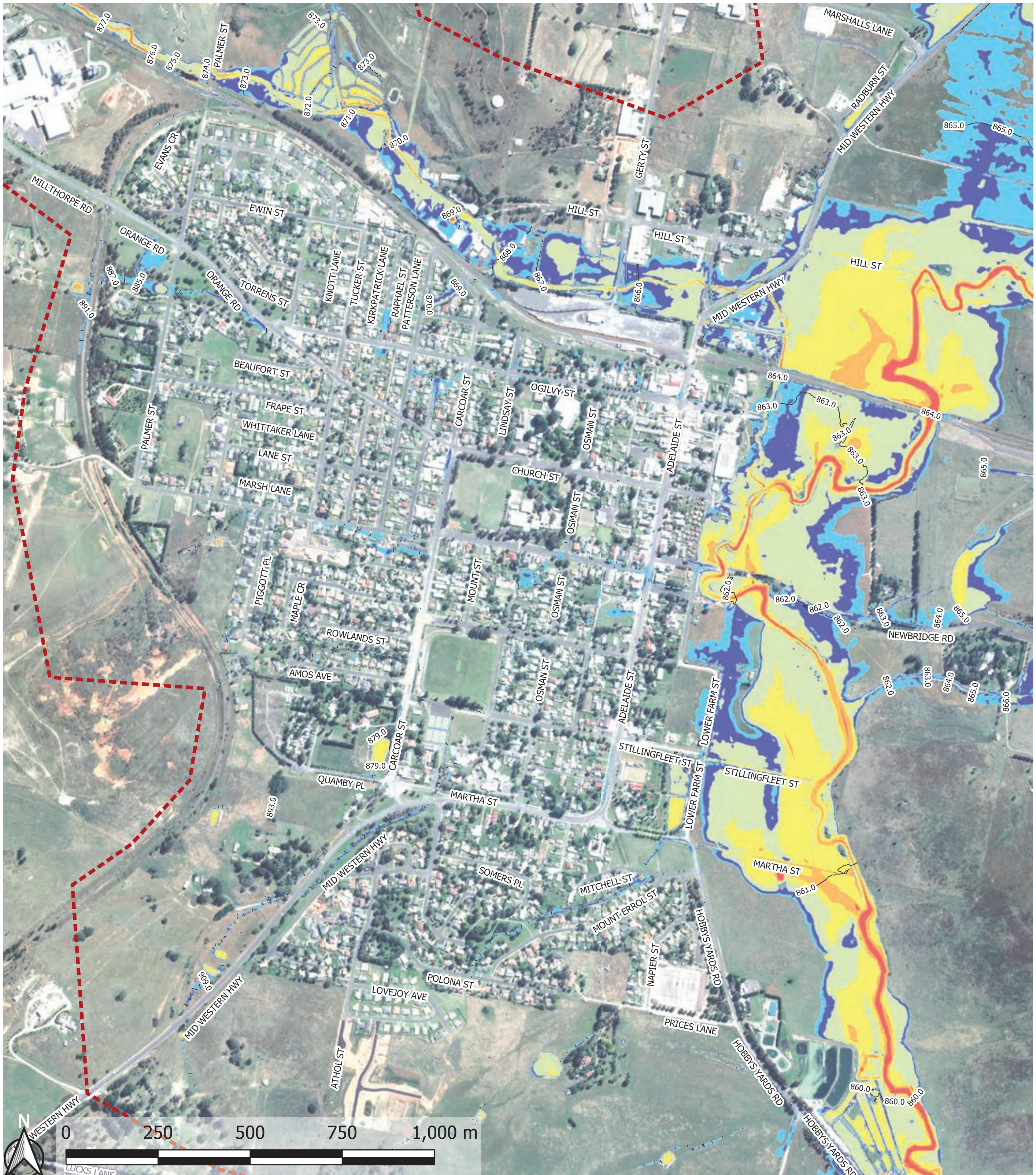

Map 02: Existing Flood Depth and Level
5% AEP Event (ARR 2019)

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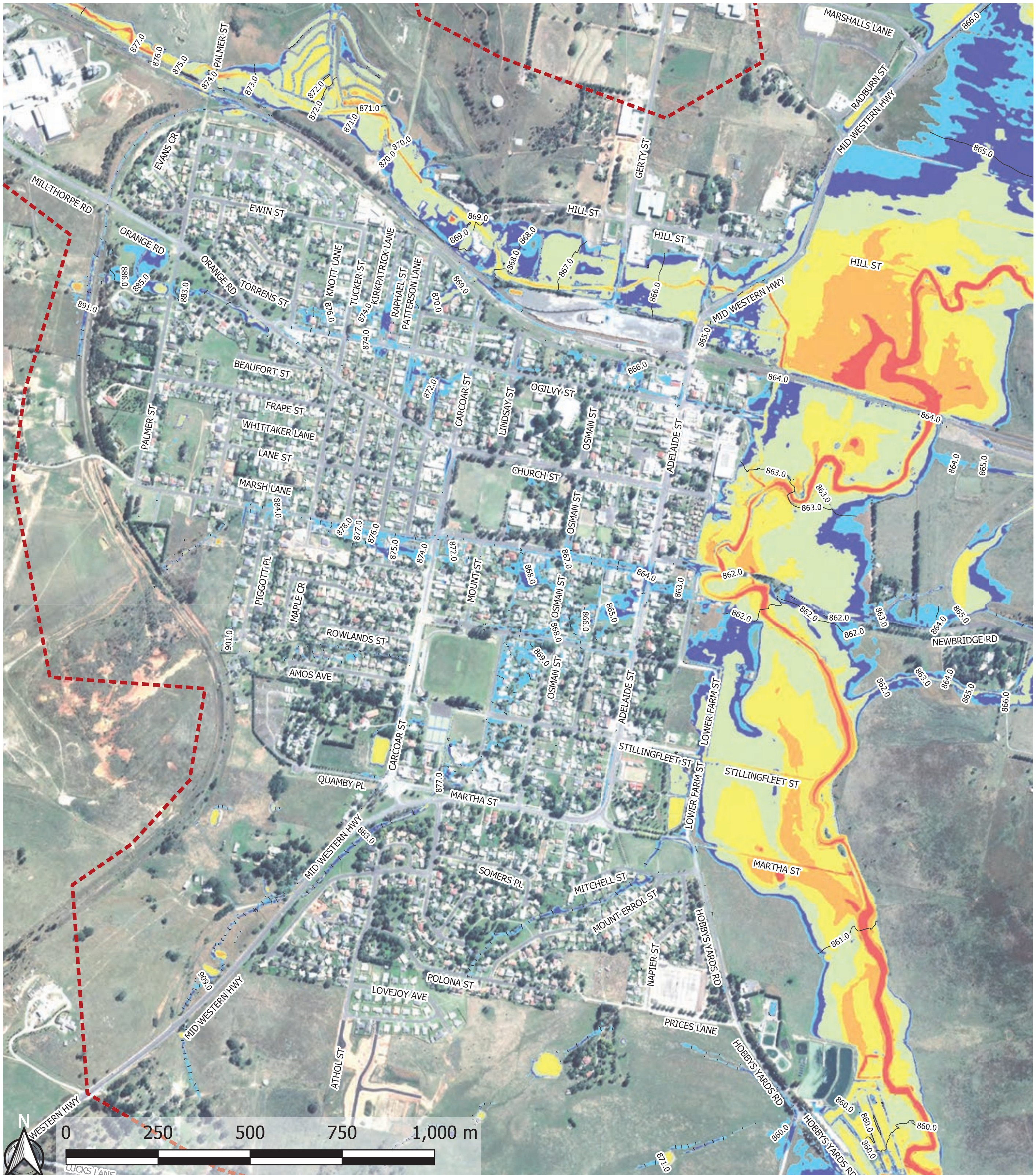
Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Model Boundary
- 1m Flood Level Contour (mAHD)

Note: A 150 mm cutoff depth has been applied to this map.



Map 03: Existing Flood Depth and Level
1% AEP Event (ARR 2019)

Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Model Boundary
- 1m Flood Level Contour (mAHD)

Note: A 150 mm cutoff depth has been applied to this map.

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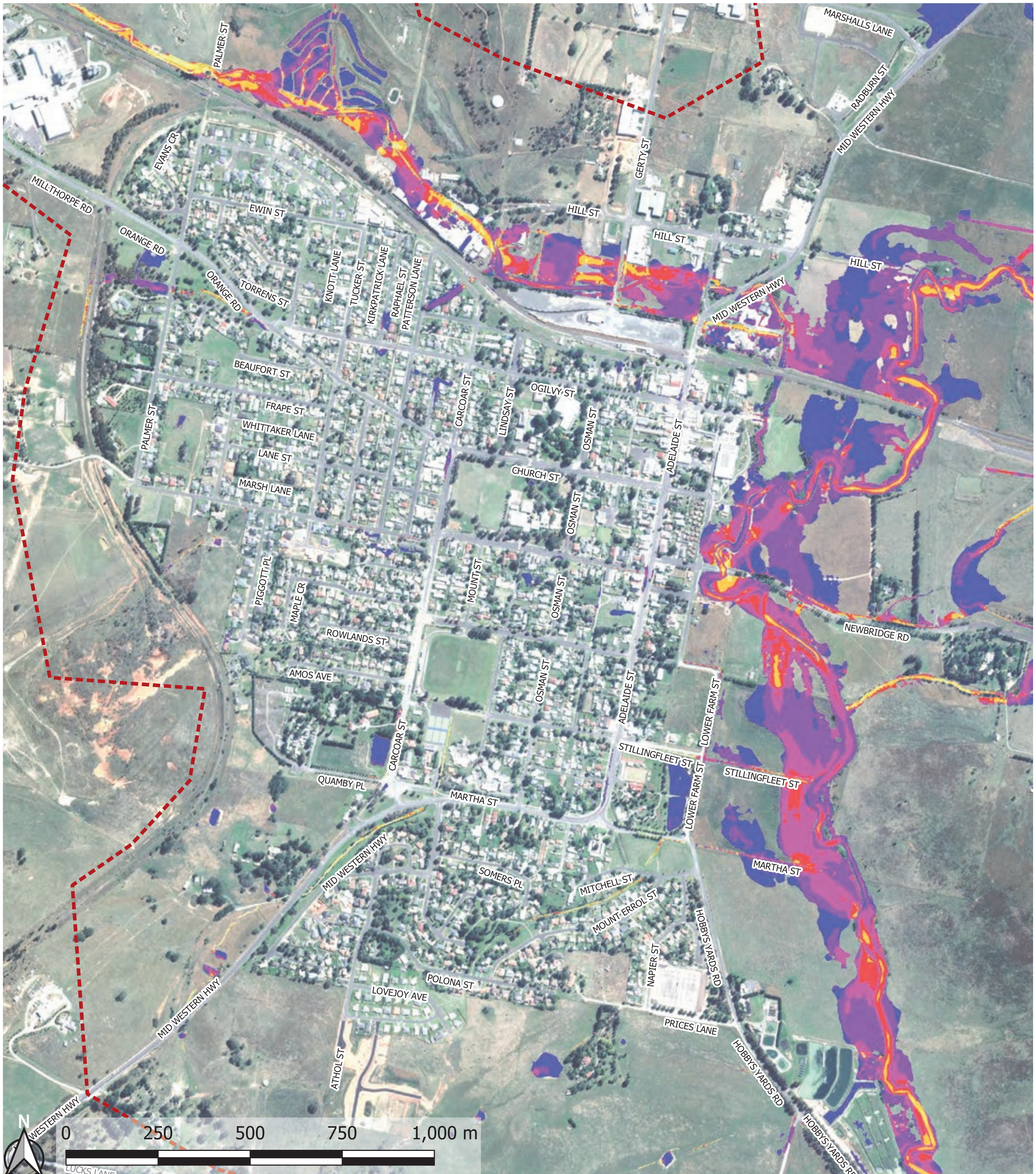

Map 04: Existing Flood Velocity
20% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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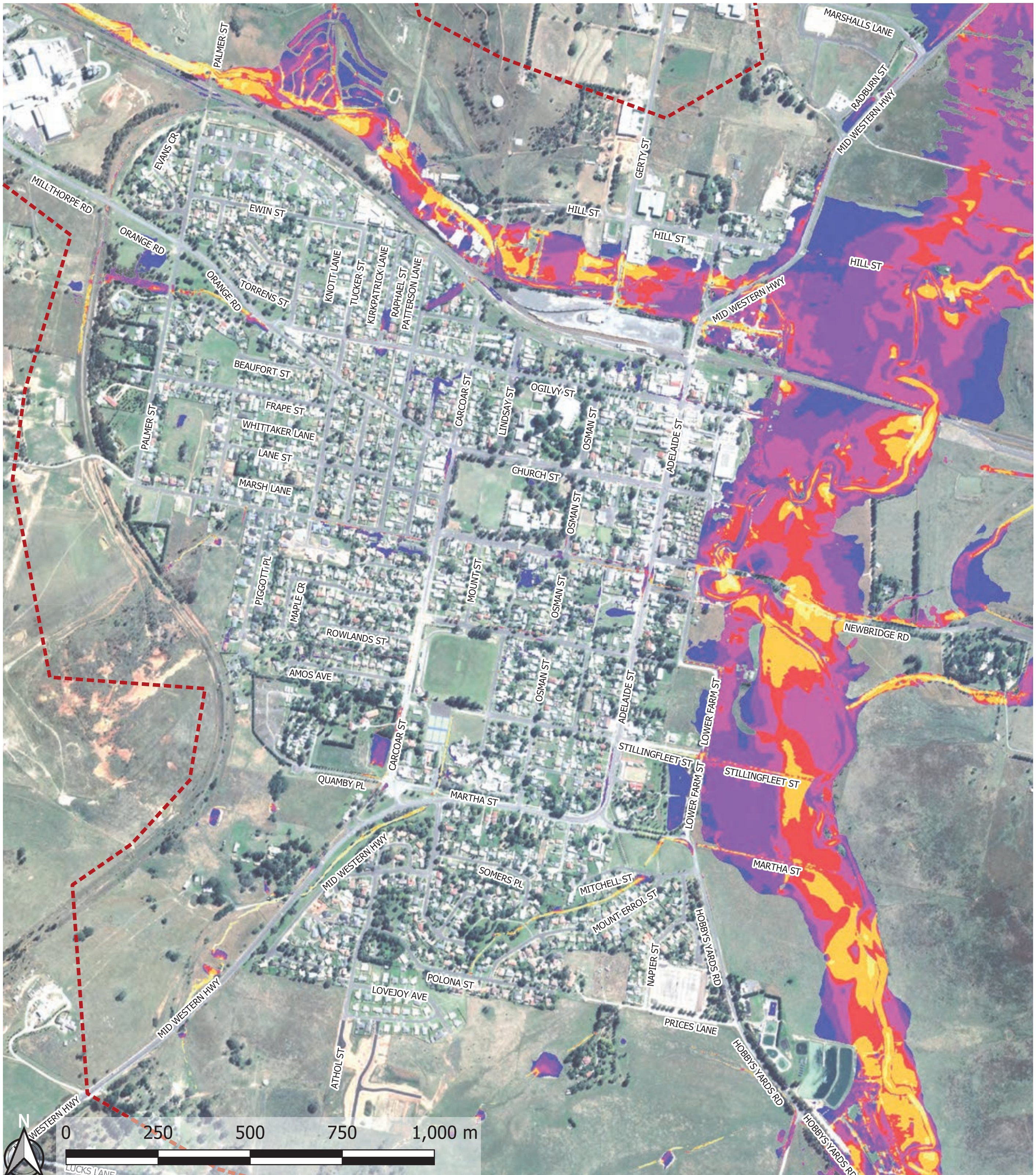

Map 05: Existing Flood Velocity
5% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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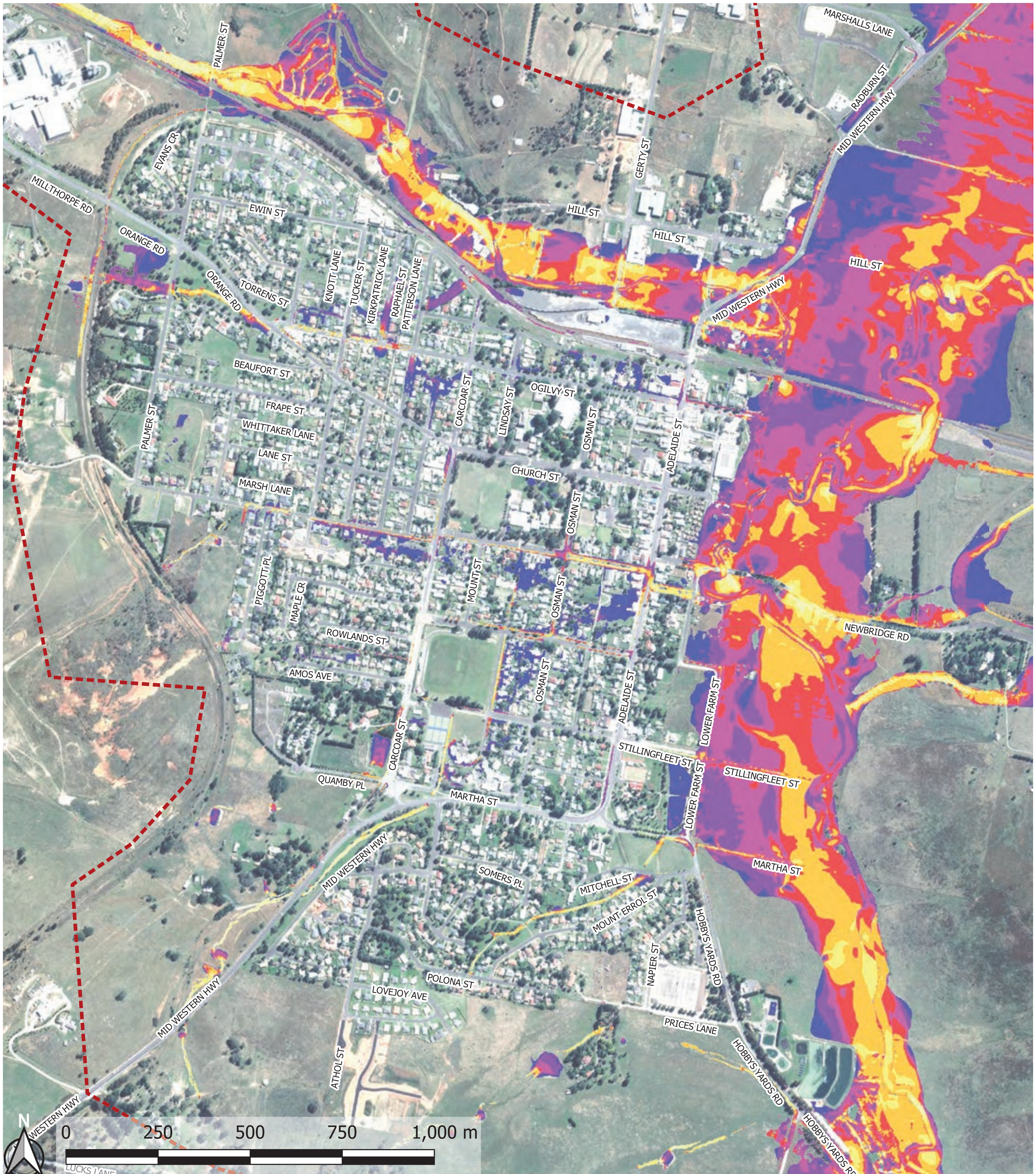

Map 06: Existing Flood Velocity
1% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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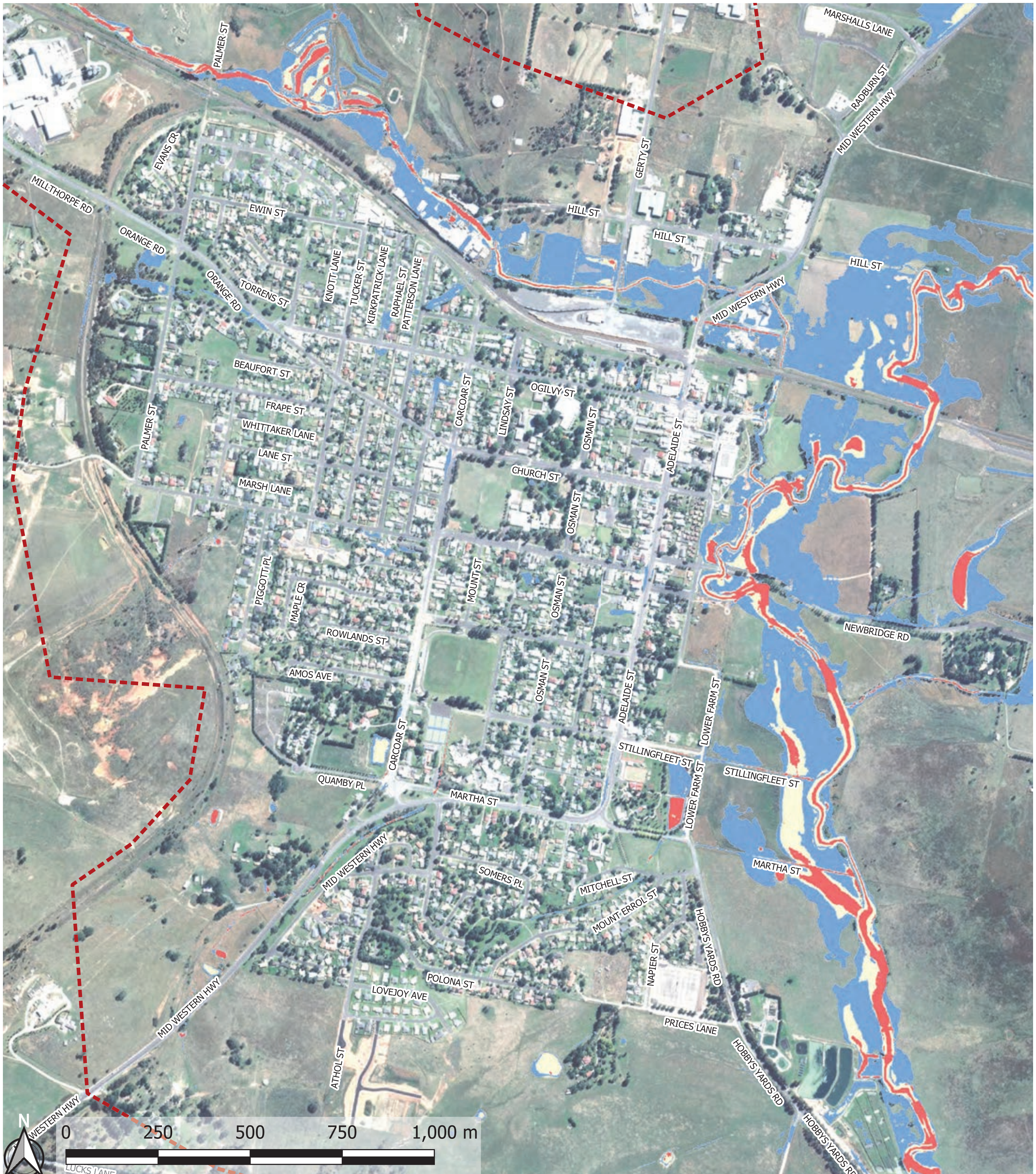

Map 07: Existing Flood Hazard 20% AEP Event (ARR 2019)

Legend

Flood Hazard (FDM 2005)

- Low Hazard
- Transitional Hazard
- High Hazard
- Model Boundary

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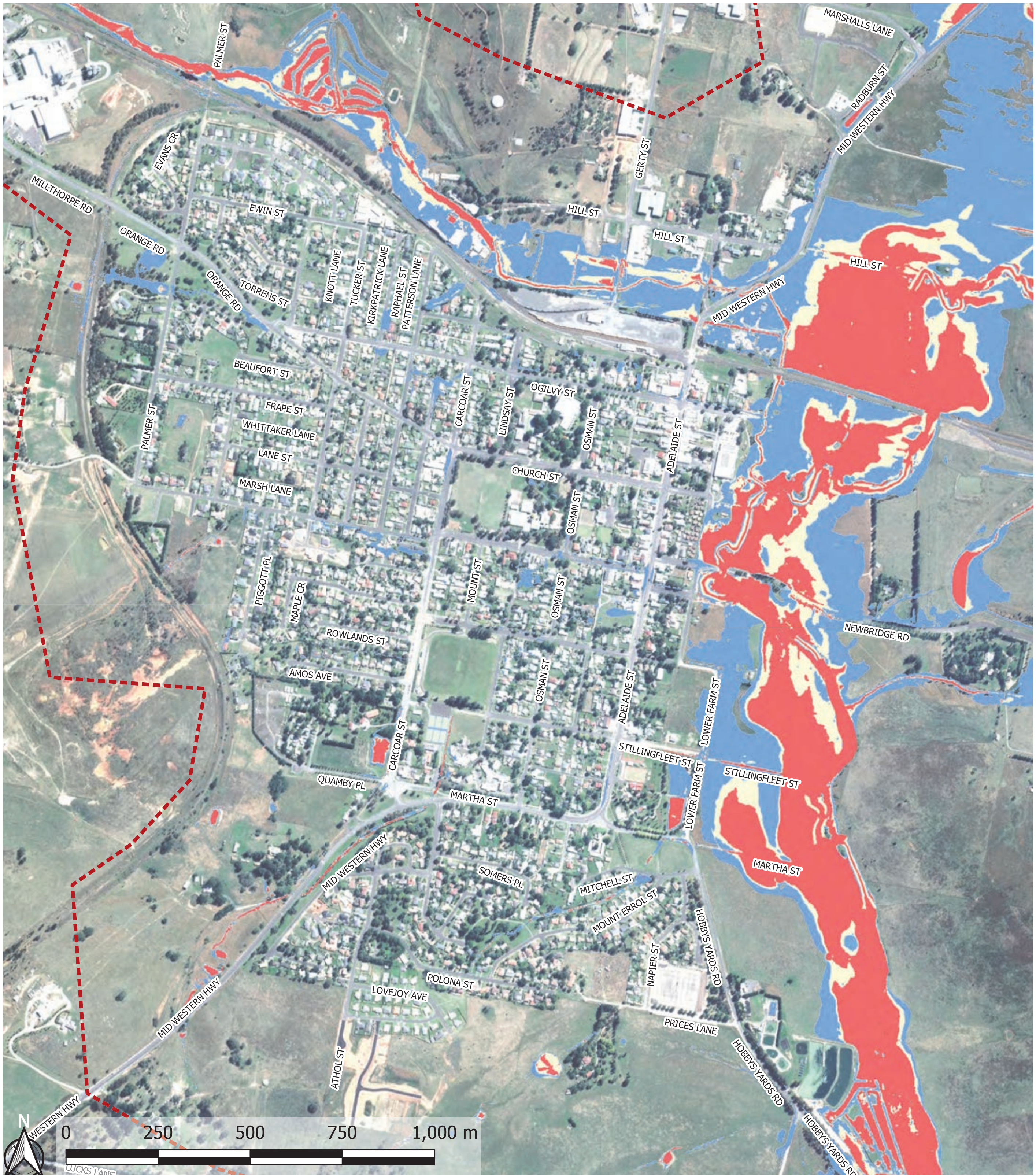
Note: A 150 mm cutoff depth has been applied to this map.



Map 08: Existing Flood Hazard 5% AEP Event (ARR 2019)

Legend

Flood Hazard (FDM 2005)

- Low Hazard
- Transitional Hazard
- High Hazard

Model Boundary

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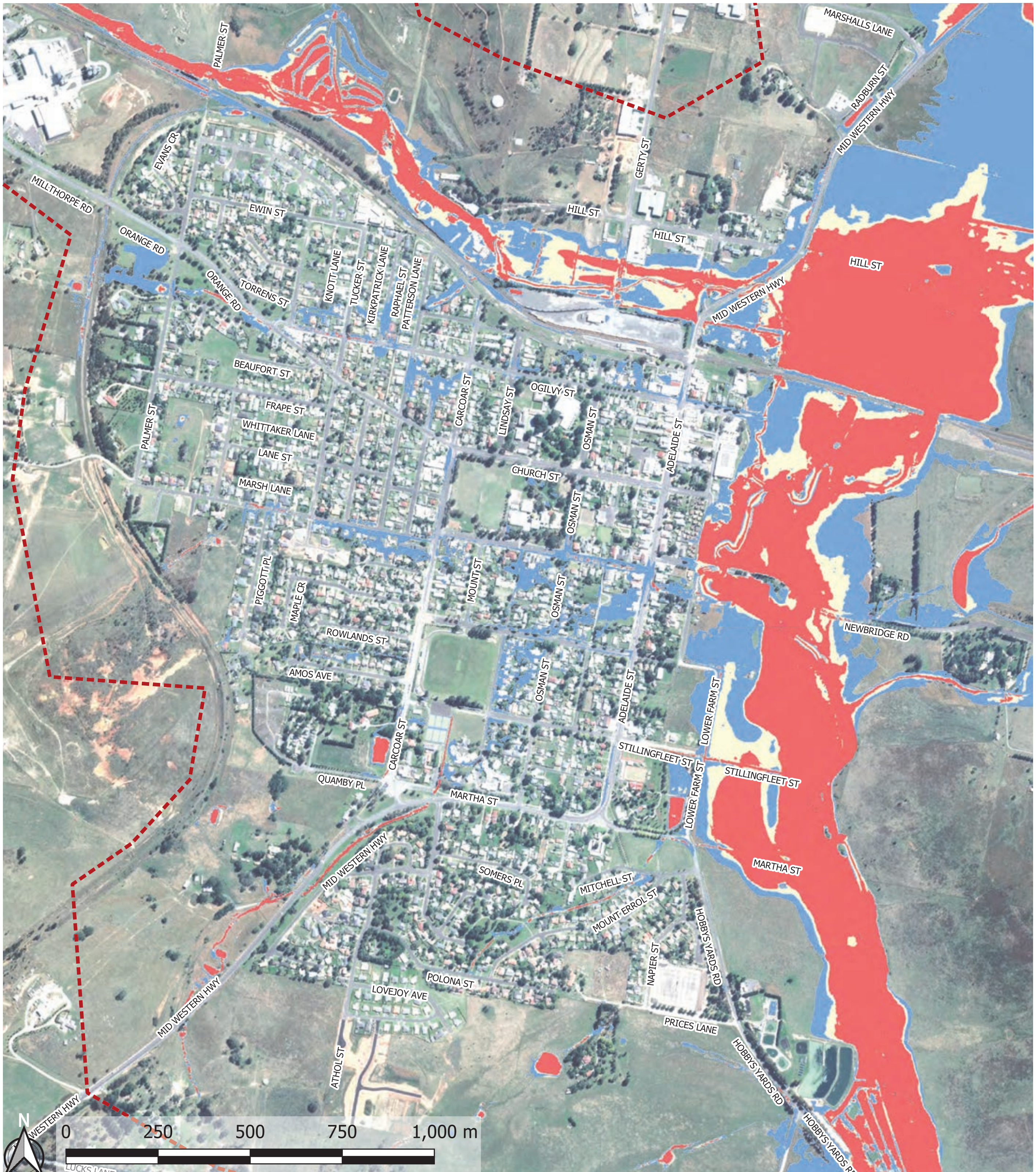
Note: A 150 mm cutoff depth has been applied to this map.



Map 09: Existing Flood Hazard 1% AEP Event (ARR 2019)

Legend

Flood Hazard (FDM 2005)

- Low Hazard
- Transitional Hazard
- High Hazard

Model Boundary

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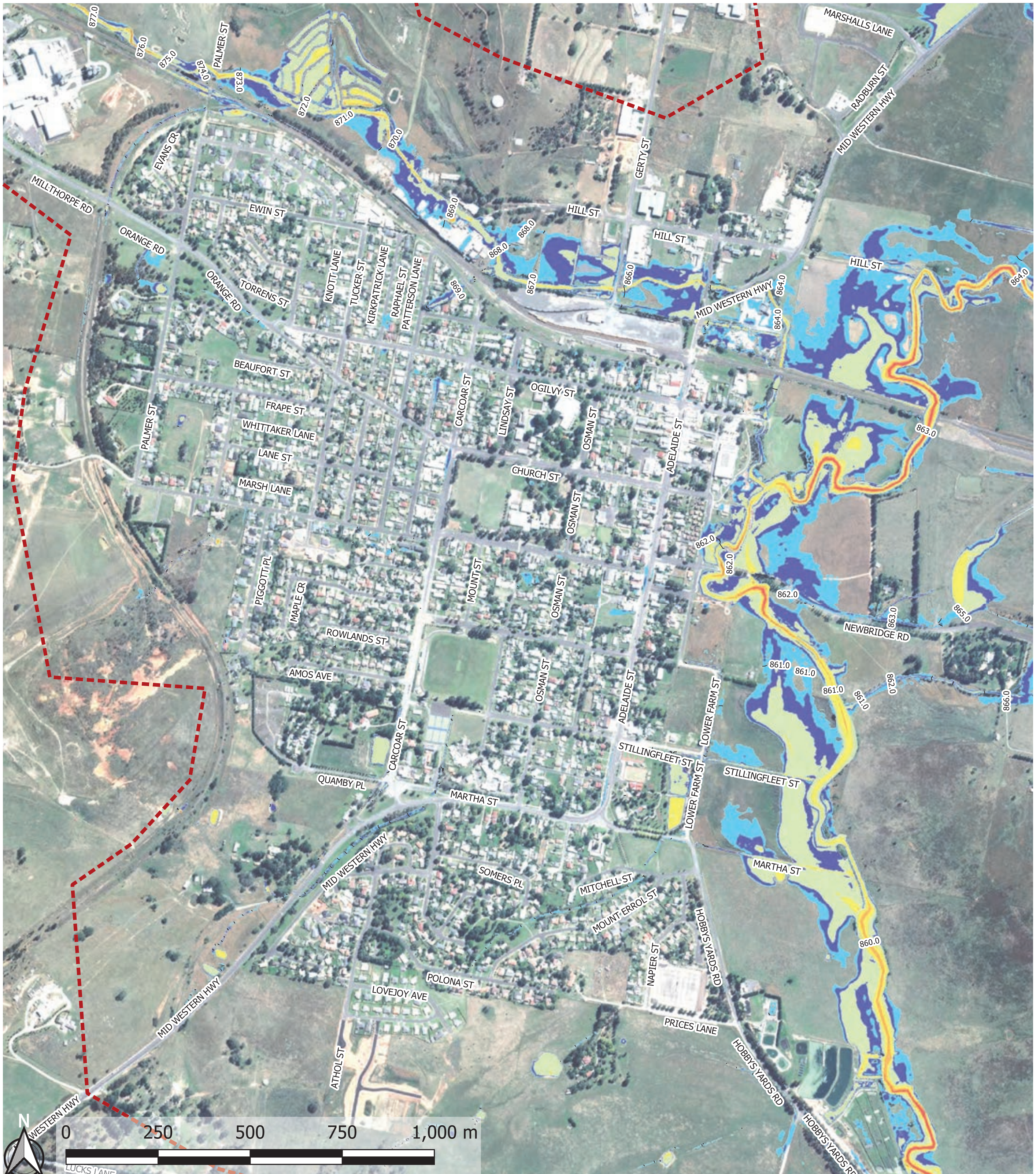
Note: A 150 mm cutoff depth has been applied to this map.

Appendix B – Flood Mapping of the Proposed Conditions



Map 11: Proposed Without Basins Flood Depth and Level 20% AEP Event (ARR 2019)

Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Model Boundary
- 1m Flood Level Contour (mAHD)

Note: A 150 mm cutoff depth has been applied to this map.

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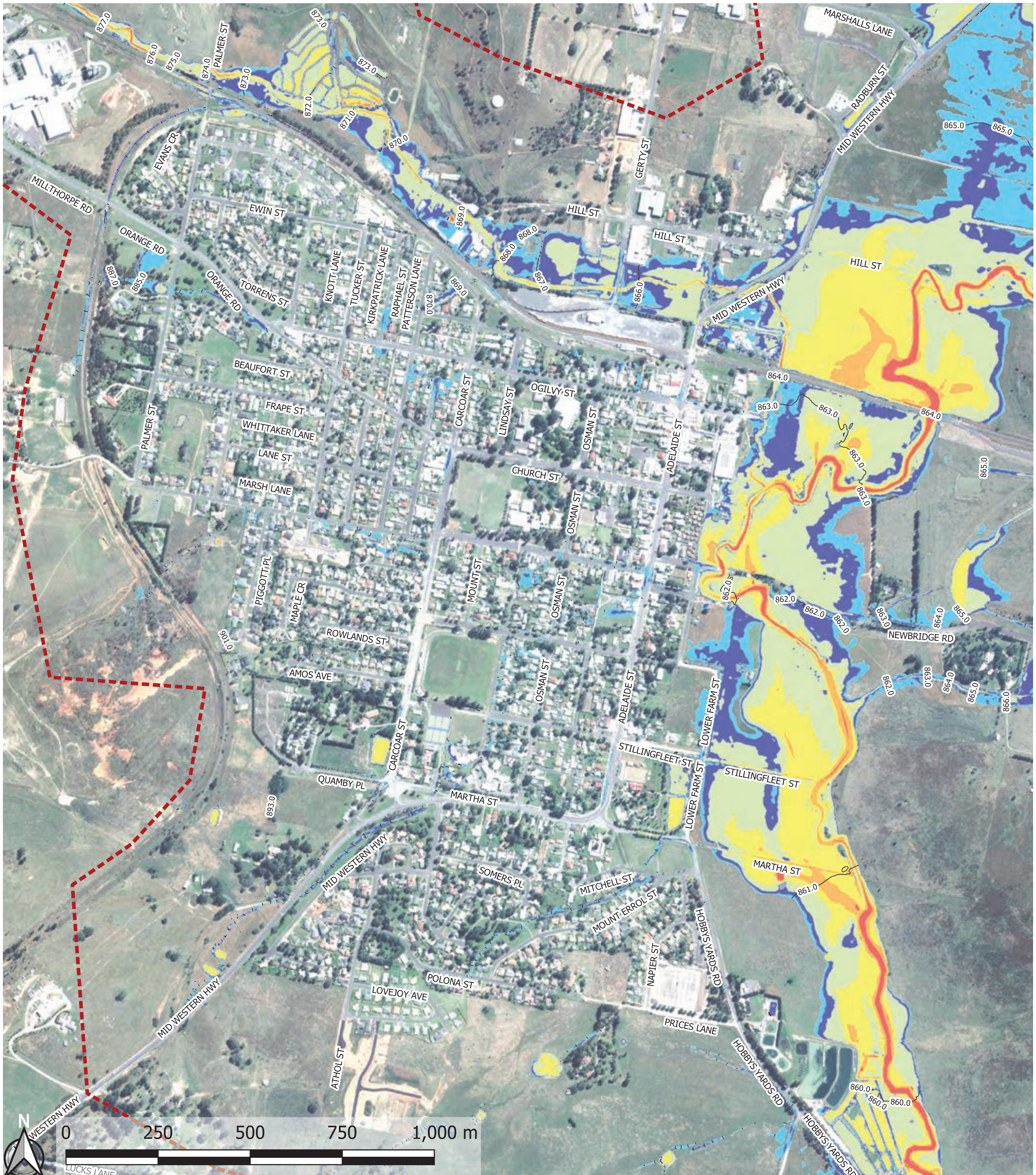

Map 12: Proposed Without Basins Flood Depth and Level 5% AEP Event (ARR 2019)

Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Model Boundary
- 1m Flood Level Contour (mAHD)

Note: A 150 mm cutoff depth has been applied to this map.

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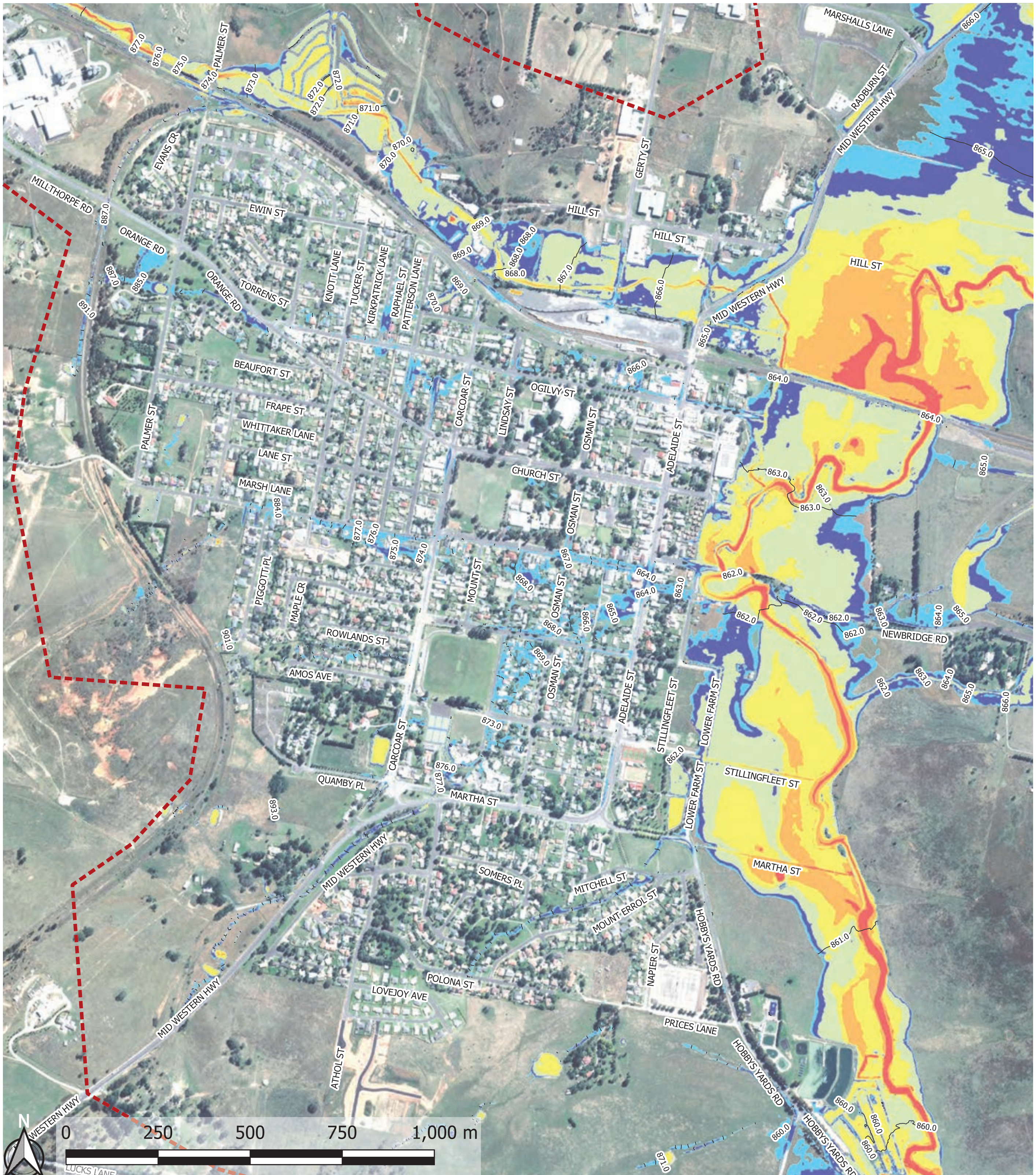

Map 13: Proposed Without Basins Flood Depth and Level
1% AEP Event (ARR 2019)

Legend

Flood Depth (m)

- 0.15 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

- Model Boundary
- 1m Flood Level Contour (mAHD)

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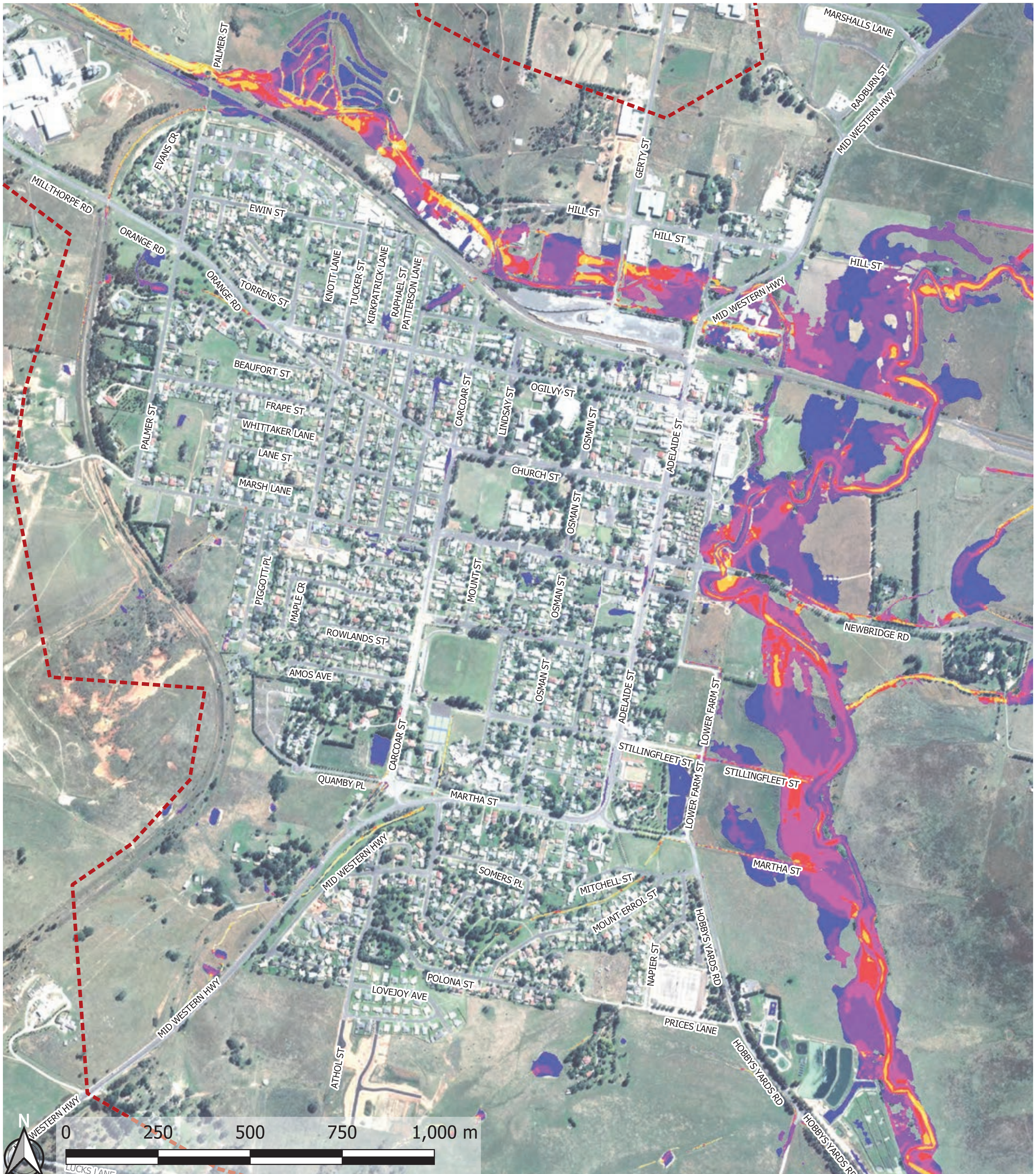
Note: A 150 mm cutoff depth has been applied to this map.



Map 14: Proposed Without Basins Flood Velocity 20% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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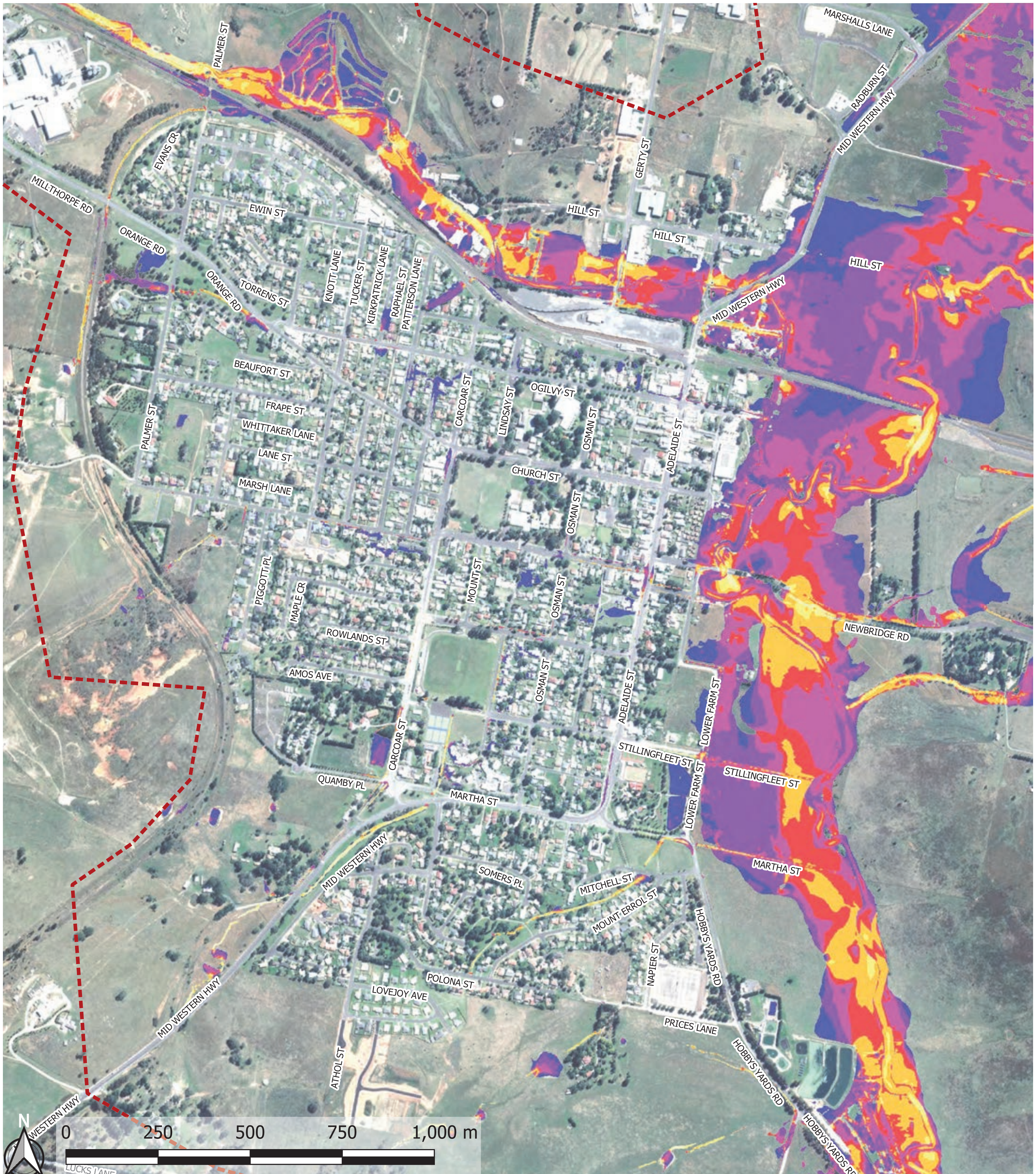

Map 15: Proposed Without Basins Flood Velocity 5% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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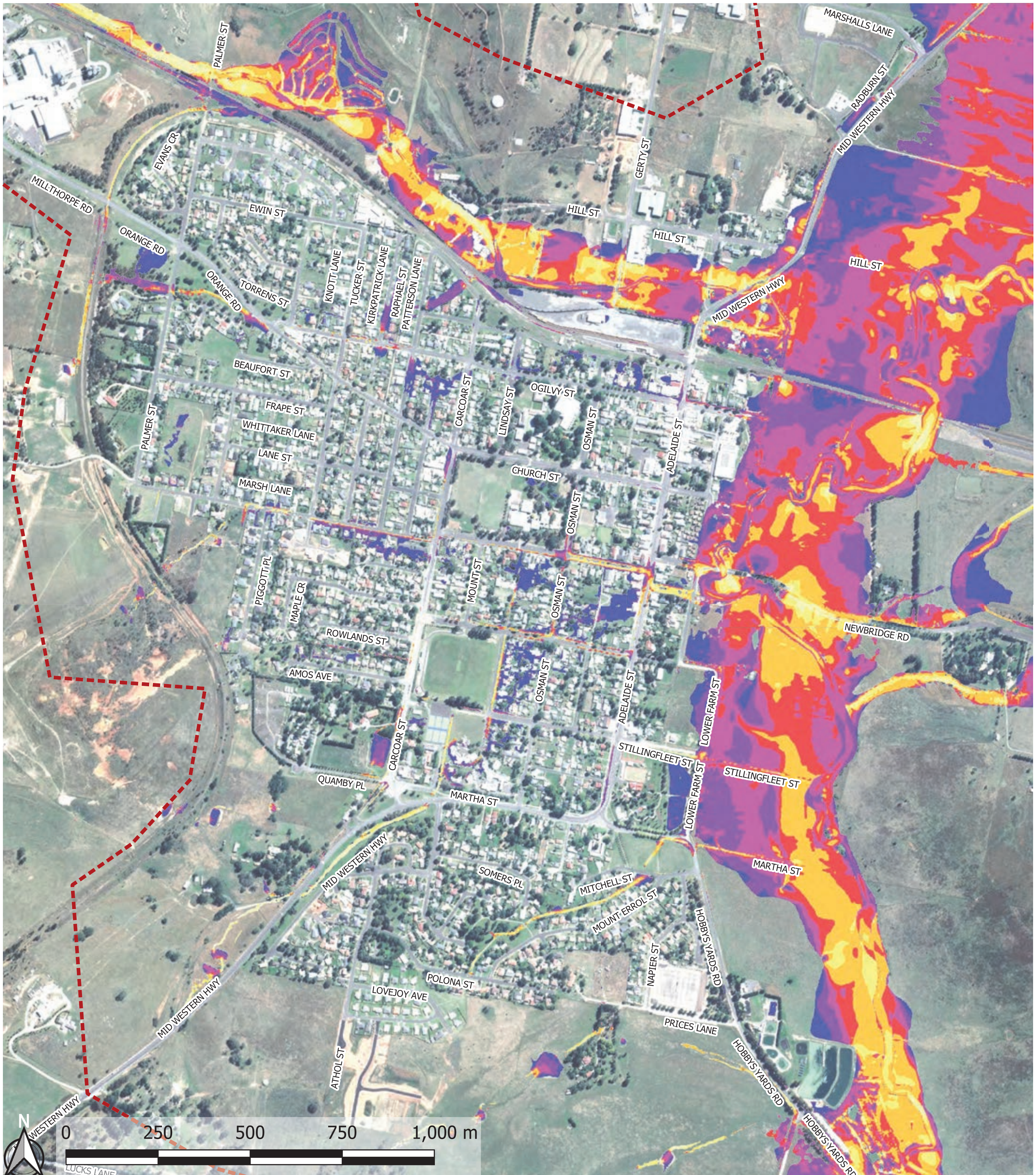

Map 16: Proposed Without Basins Flood Velocity 1% AEP Event (ARR 2019)

Legend

Flood Velocity (m/s)

- 0.00 - 0.25
- 0.25 - 0.50
- 0.50 - 0.75
- 0.75 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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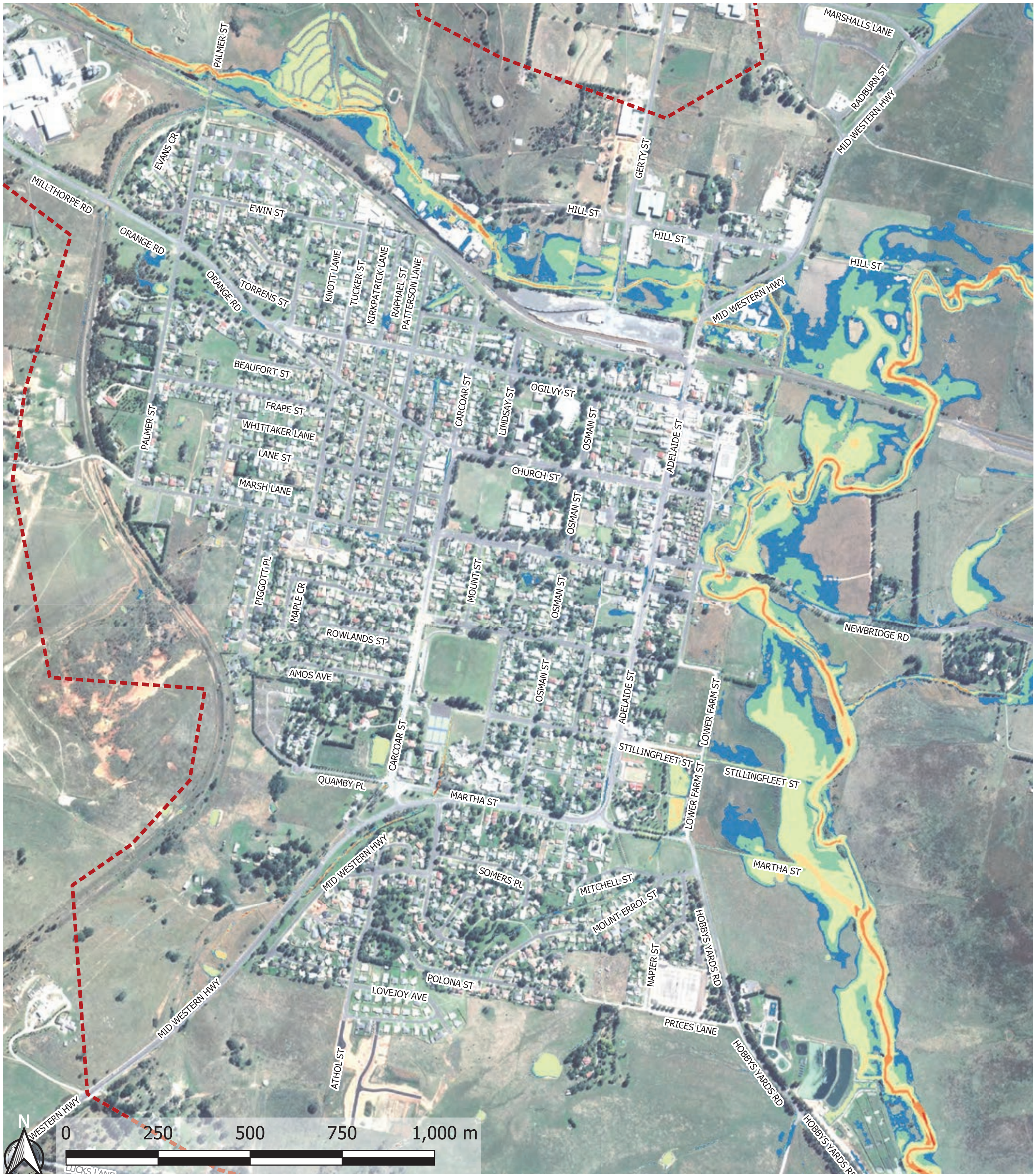

Map 17: Proposed Without Basins Flood Hazard 20% AEP Event (ARR 2019)

Legend

Flood Hazard (ARR 2019)

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

Model Boundary

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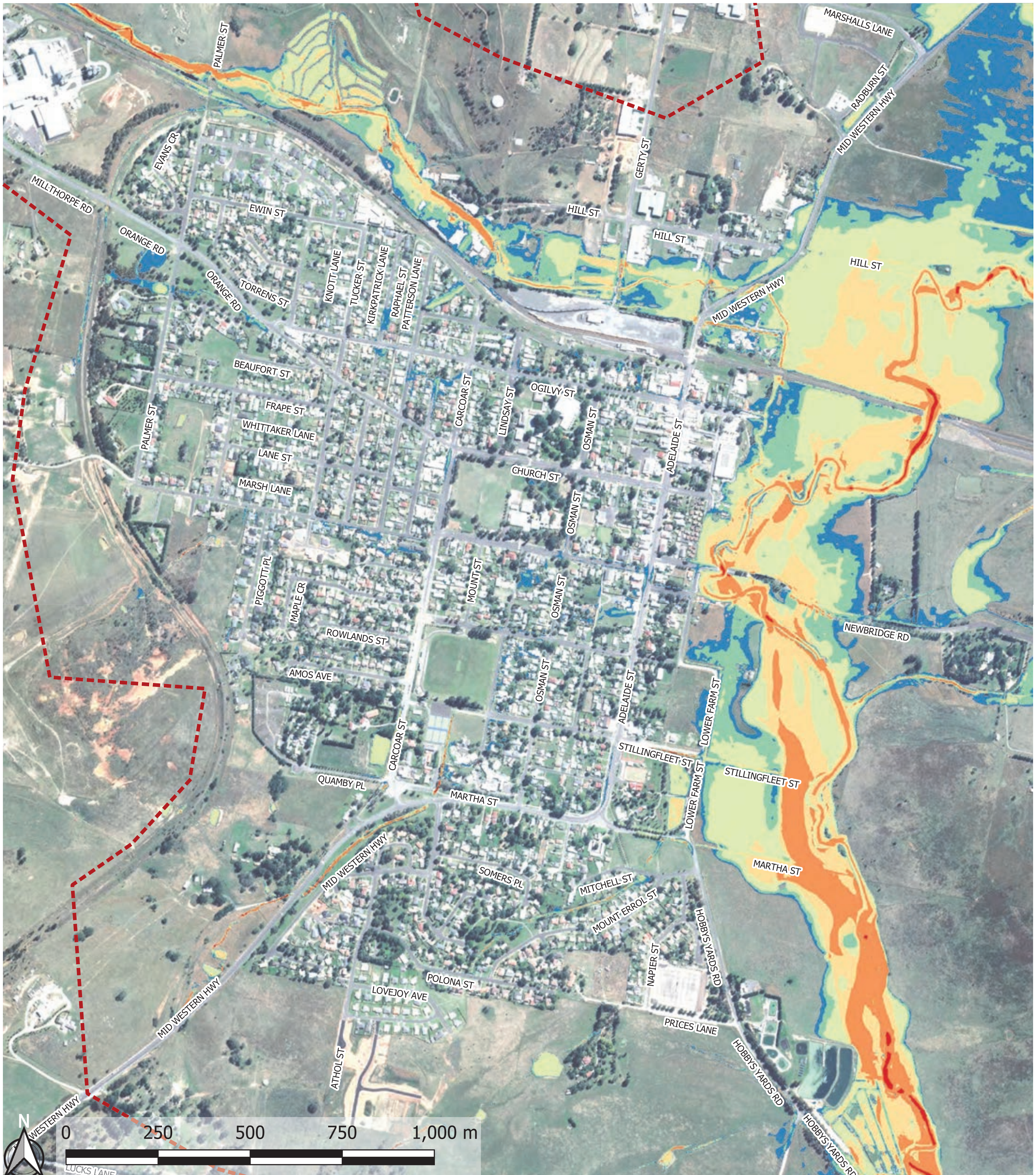
Note: A 150 mm cutoff depth has been applied to this map.



Map 18: Proposed Without Basins Flood Hazard 5% AEP Event (ARR 2019)

Legend

Flood Hazard (ARR 2019)

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

Model Boundary

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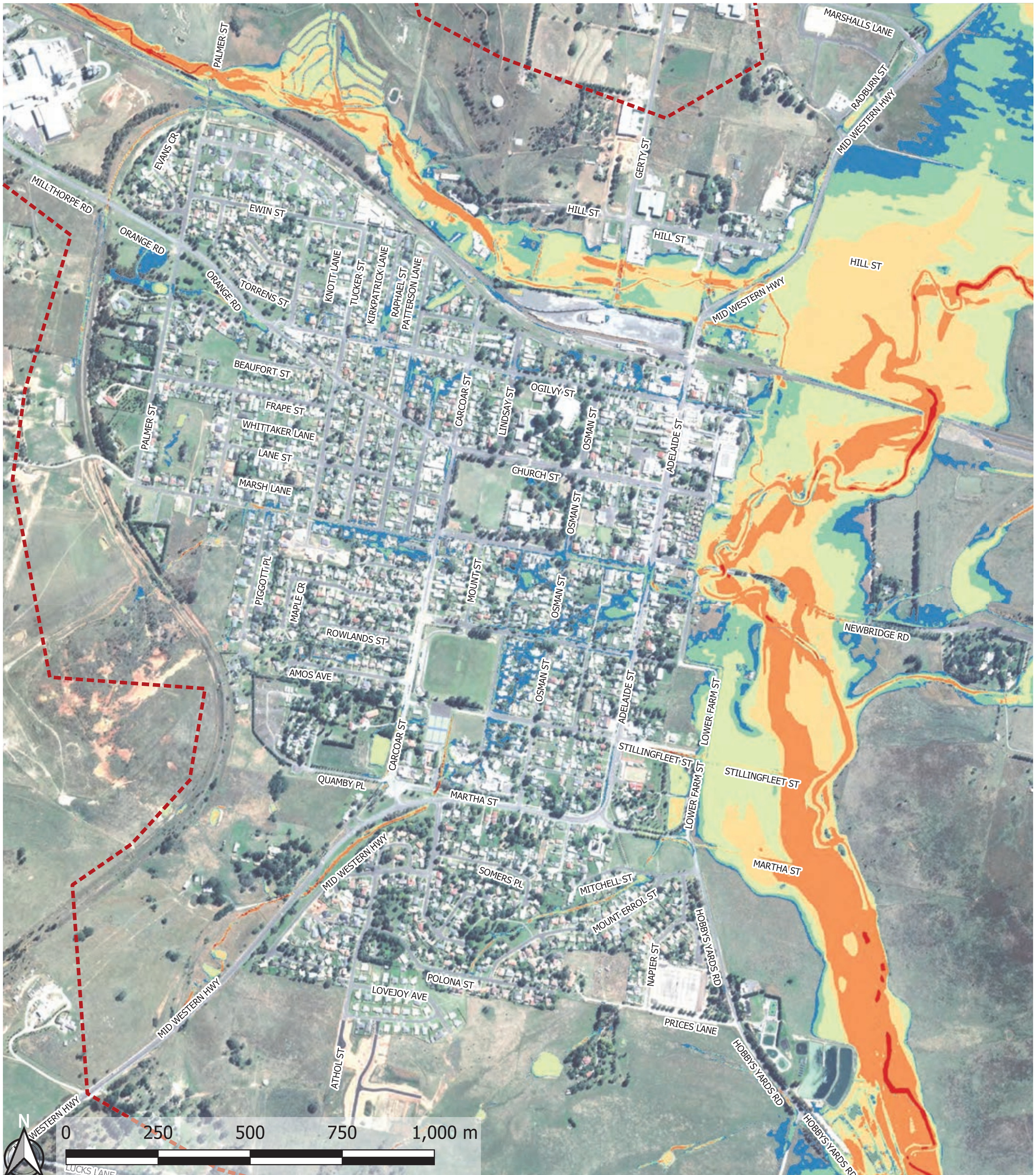
REVISION:	A

Storm

Note: A 150 mm cutoff depth has been applied to this map.



Map 19: Proposed Without Basins Flood Hazard 1% AEP Event (ARR 2019)

Legend

Flood Hazard (ARR 2019)

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

Model Boundary

Note: A 150 mm cutoff depth has been applied to this map.

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Storm

Appendix C – Change in Afflux

Map 10: Water Level Afflux
1% AEP Event (Storm's ARR 2019 - Jacobs' ARR 87)

Legend

Flood Level Afflux (m)

- <= -0.50
- -0.50 - -0.20
- -0.20 - -0.10
- -0.10 - -0.01
- -0.01 - 0.01
- 0.01 - 0.10
- 0.10 - 0.20
- 0.20 - 0.50
- > 0.50
- Model Boundary

PROJECT ID:	117-20
DATE:	23.12.2021
REVISION:	A

Storm

Note: A 150 mm cutoff depth has been applied to this map.