<table>
<tr><th colspan="2">Macdonald River 18/02/2022</th></tr>
<tr><td>
Looking upstream of MacDonald River, across from Bulga Street</td><td>
Sandbank along mid-McDonald River next to St Albans RFS</td></tr>
<tr><td>
St Albans Bridge</td><td>
St Albans Road Bridge across Flemmings Creek</td></tr>
</table>

Macdonald River 18/02/2022	
 Culvert next to St Albans Road Bridge across Flemmings Creek	

Webbs Creek 17/02/2022	
 Looking towards Webbs Creek from Webbs Creek Road, near Dinki Dell Campsite	 Looking upstream from bridge at Chaseling Road North, just upstream of confluence of Webbs Creek and Hawkesbury River

Greens Creek 17/02/2022	
 Greens Creek looking north from Greens Road	 Greens Road Bridge across Greens Creek, next to Green Swamp Trail
 Floodplain at confluence of Greens Creek and Haweksbury River from Greens Road	

Appendix C

Hydraulic Model Calibration

Appendix C – Hydraulic Model Calibration and Validation

Please note: gauge zero values of 1.468 mAHD and 2.76 mAHD were adopted for Upper Colo gauge (212290) and the St Albans gauge (212228) respectively.

1 July 2022

1.1 Stage hydrograph comparison

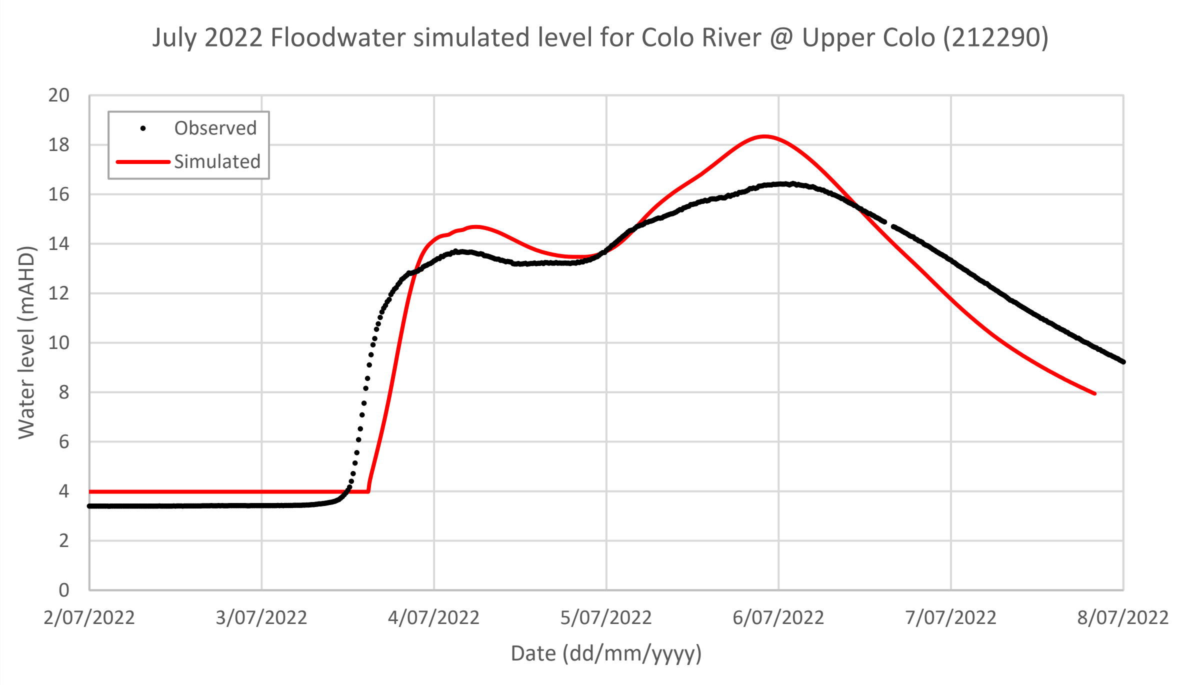


Figure C1 July 2022 Observed vs Simulated water level for Upper Colo gauge (212290)

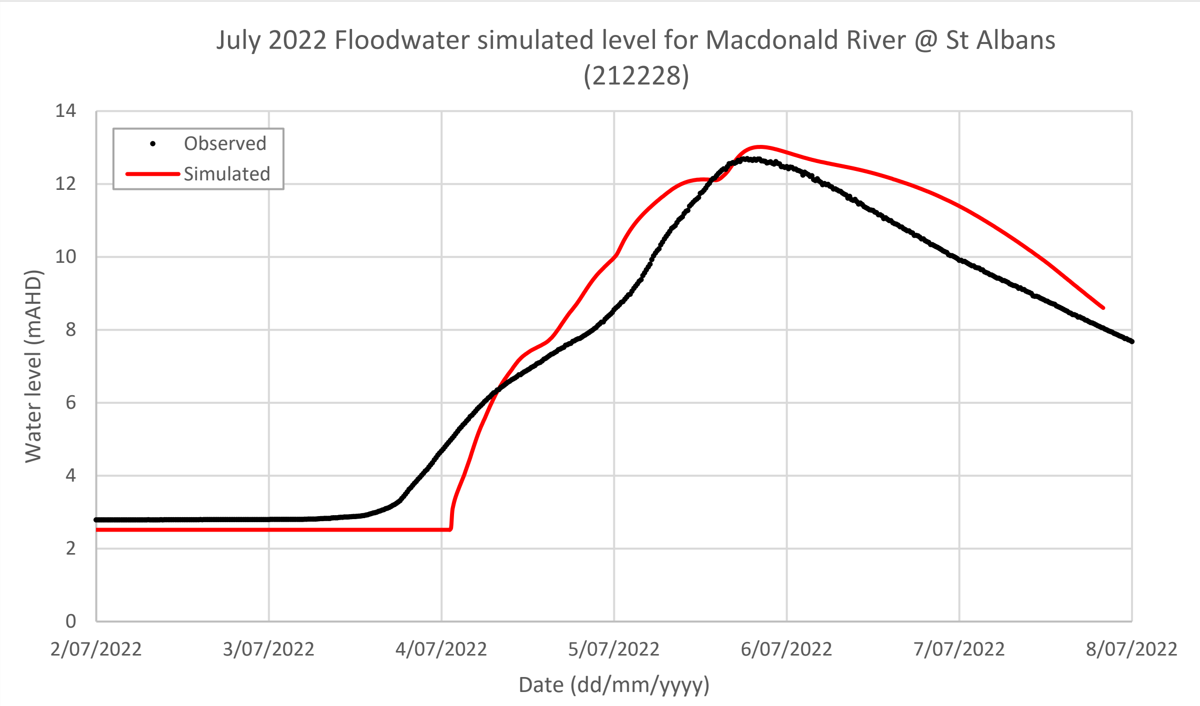


Figure C2 July 2022 Observed vs Simulated water level for St Albans gauge (212228)

Appendix C – Hydraulic Model Calibration and Validation

1.2 Surface water profile

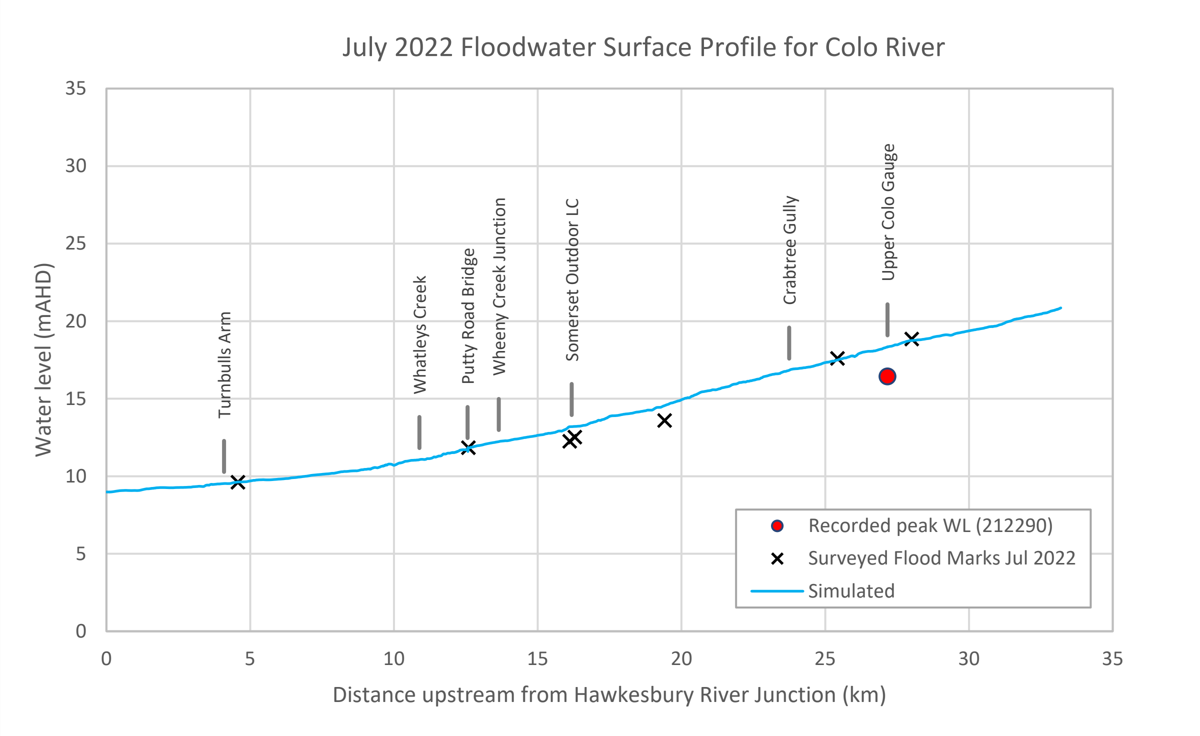


Figure C3 Simulated July 2022 floodwater surface profile for Colo River

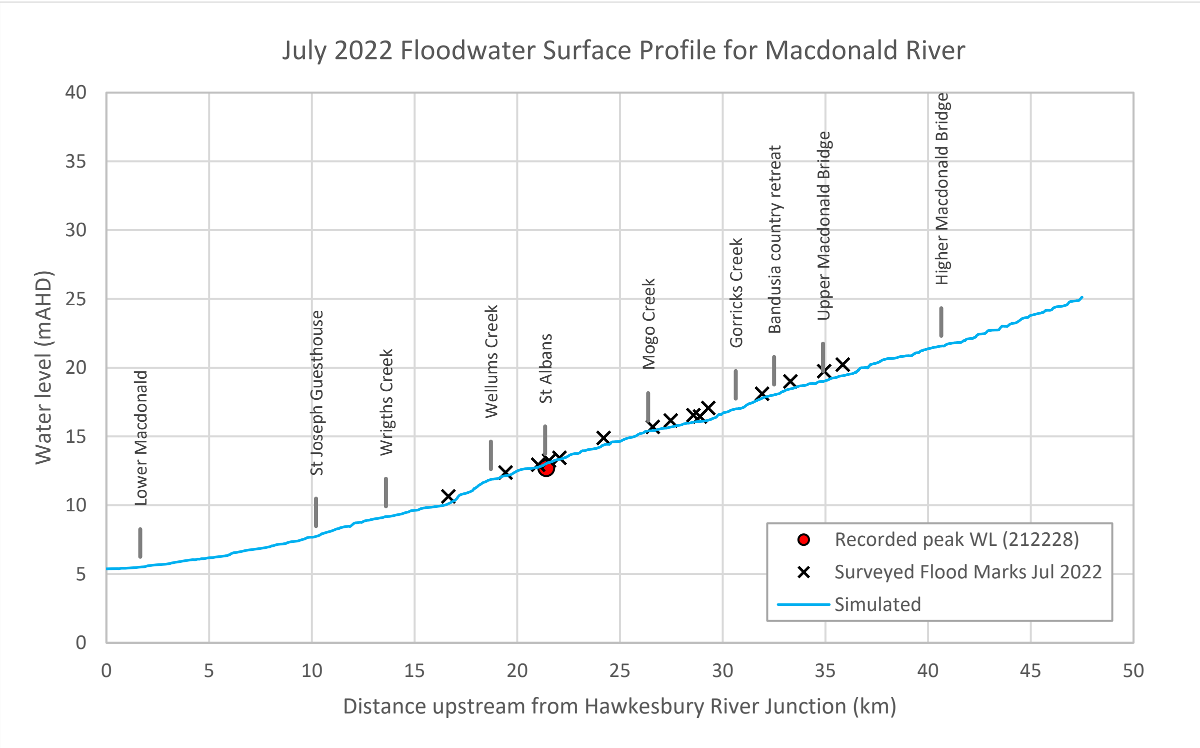


Figure C4 Simulated July 2022 floodwater surface profile for Macdonald River

Appendix C – Hydraulic Model Calibration and Validation

1.3 Flood mark comparison

Table C1 Simulated and surveyed flood levels the July 2022 flood in Colo River

Site	Quality of Evidence	Survey (mAHD)	Simulated (mAHD)	Difference (m)	Comments
Site 800	High	19.77	19.10	-0.67	
Site 802	Med	18.85	18.76	-0.08	
Site 802	Med	17.00	18.06	1.07	Survey 0.6m lower than DS flood mark. Survey mark likely problematic.
Site 803	Low	17.60	17.39	-0.21	
Site 804	Low	13.60	14.26	0.65	
Site 805	Med	12.25	13.04	0.78	
Site 806	Med	12.53	13.15	0.63	
Site 806	Med	10.42	12.24	1.82	Survey 1.4m lower than DS flood mark at Putty Road bridge. Survey mark likely problematic.
Site 808	Med	11.81	11.72	-0.08	
Site 809	Med	11.84	11.73	-0.11	
Site 808	Med	9.61	9.64	0.03	
			Average	0.35	

Table C2 Simulated and surveyed flood levels the July 2022 flood in Macdonald River

Site	Quality of Evidence	Survey (mAHD)	Simulated (mAHD)	Difference (m)	Comments
Site 900	Med	19.74	19.02	-0.72	
Site 900	Med	19.26	19.02	-0.23	
Site 901	Med	20.23	19.38	-0.84	
Site 904	Med	19.47	18.94	-0.53	
Site 904	Med	20.37	18.93	-1.44	
Site 904	Med	19.44	18.94	-0.51	
Site 905	High	19.00	18.48	-0.52	
Site 905	Med	19.00	18.45	-0.55	
Site 906	High	18.10	17.71	-0.39	
Site 906	High	18.06	17.70	-0.36	
Site 907	High	15.69	15.32	-0.37	
Site 908	Med	14.55	14.38	-0.16	
Site 908	High	14.88	14.38	-0.50	
Site 909	High	16.16	15.63	-0.52	
Site 909	Med	15.88	15.64	-0.24	
Site 910	Low	17.07	16.18	-0.89	
Site 911	Low	16.45	16.09	-0.36	
Site 912	Med	16.73	16.01	-0.71	
Site 912	Med	16.54	16.01	-0.53	

Appendix C – Hydraulic Model Calibration and Validation

Site	Quality of Evidence	Survey (mAHD)	Simulated (mAHD)	Difference (m)	Comments
Site 913	Med	13.44	13.33	-0.11	
Site 913	Med	13.45	13.33	-0.12	
Site 914	Low	14.47	13.76	-0.71	
Site 915	High	13.21	13.08	-0.13	
Site 915	High	13.25	13.08	-0.17	
Site 915	High	13.25	13.05	-0.19	
Site 915	High	13.32	13.12	-0.20	
Site 915	High	13.09	12.98	-0.10	
Site 916	Med	12.95	12.72	-0.23	
Site 916	Med	12.94	12.72	-0.22	
Site 917	Low	12.31	12.17	-0.14	
Site 917	High	12.37	12.16	-0.21	
Site 917	High	12.30	12.16	-0.13	
Site 918	High	11.03	10.01	-1.02	
Site 918	Med	10.64	10.04	-0.60	
Site 918	Med	10.63	10.00	-0.63	
			Average	-0.44	

2 March 2022

2.1 Stage hydrograph comparison

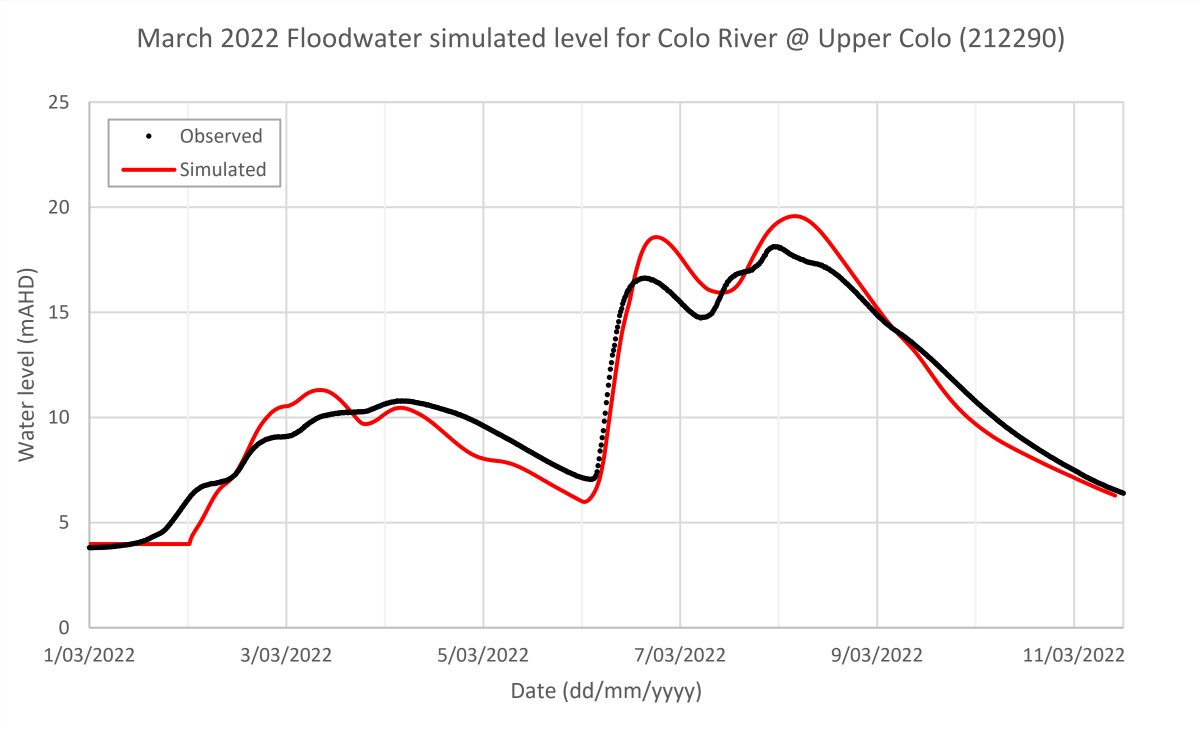


Figure C5 March 2022 Observed vs Simulated water level for Upper Colo gauge (212290)

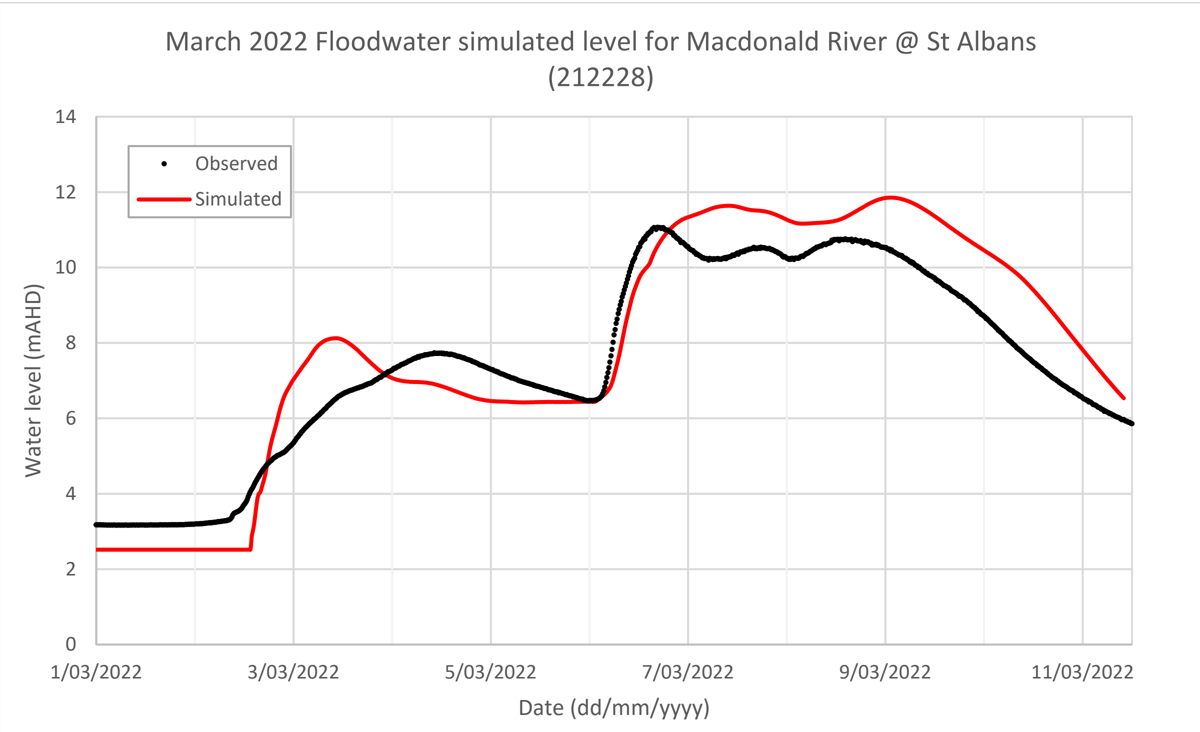


Figure C6 March 2022 Observed vs Simulated water level for St Albans gauge (212228)

2.2 Surface water profile

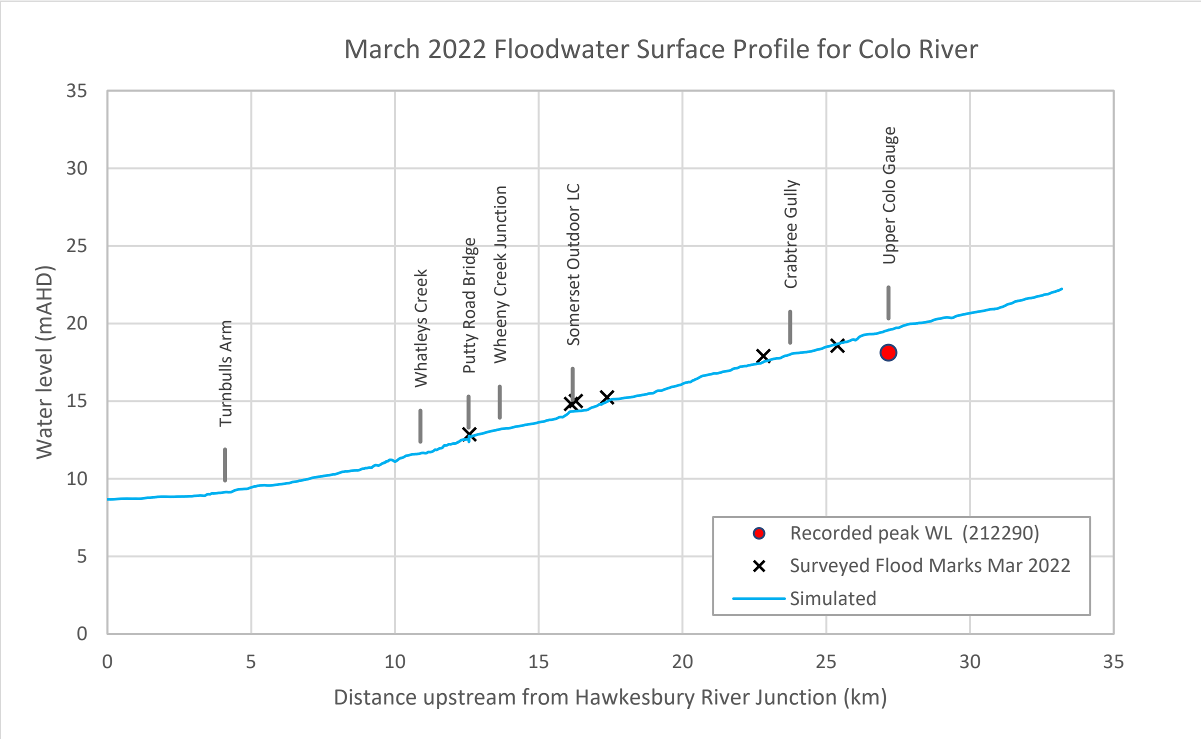


Figure C7 Simulated March 2022 floodwater surface profile for Colo River

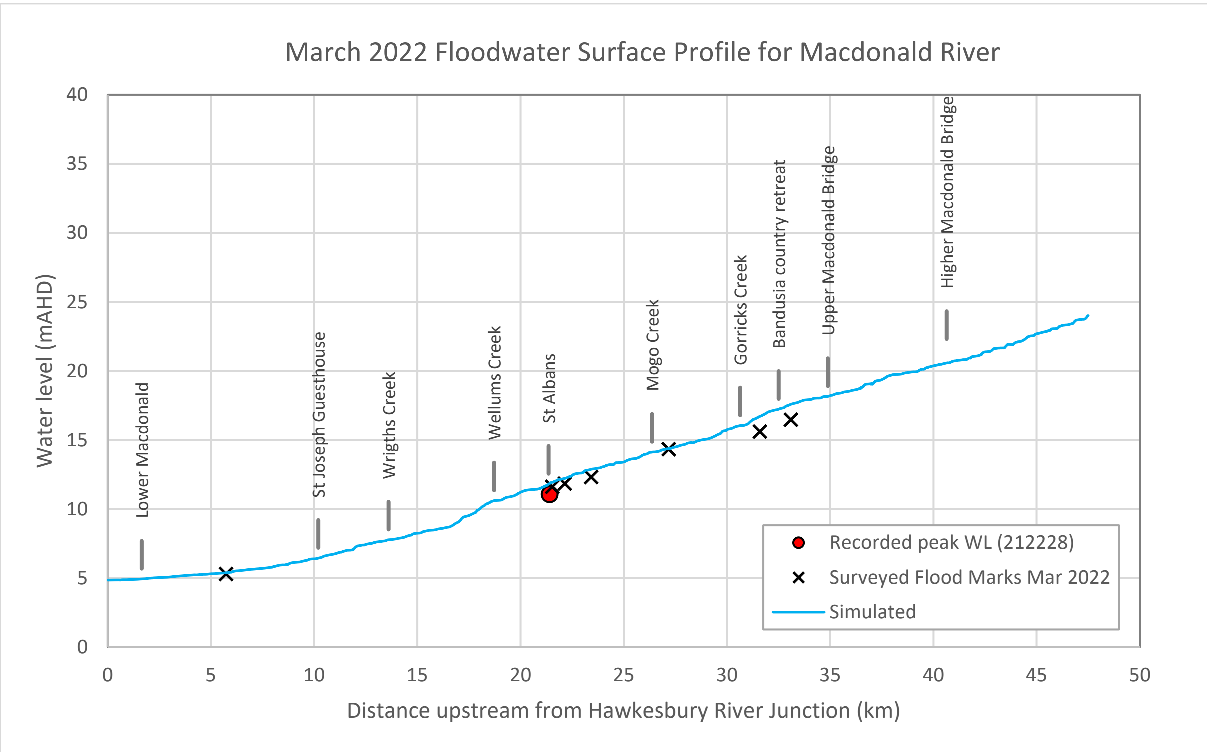


Figure C8 Simulated March 2022 floodwater surface profile for Macdonald River

Appendix C – Hydraulic Model Calibration and Validation

2.3 Flood mark comparison

Table C3 Simulated and surveyed flood levels the March 2022 flood in Colo River

Site	Quality of Evidence	Survey (mAHD)	Simulated (mAHD)	Difference (m)	Comments
Site 400	High	20.97	20.40	-0.56	
Site 401	High	19.99	19.33	-0.66	
Site 403	Low	18.58	18.58	0.00	
Site 404	Low	17.90	17.44	-0.46	
Site 405	Low	15.25	15.16	-0.09	
Site 406	Low	14.82	14.16	-0.66	
Site 407	Low	15.01	14.27	-0.74	
Site 408	Med	12.44	13.20	0.77	Surveyed flood mark 0.4m lower than DS flood mark near Putty Road bridge. Likely problematic survey mark.
Site 410	High	8.93	9.32	0.39	Poor reception during survey
Site 411	High	12.87	12.61	-0.25	
			Average	-0.23	

Table C4 Simulated and surveyed flood levels the March 2022 flood in Macdonald River

Site	Quality of Evidence	Survey (mAHD)	Simulated (mAHD)	Difference (m)	Comments
Site 100-CORS	High	5.22	4.87	-0.36	
Site 101	Low	5.13	5.38	0.25	
Site 101	Low	5.30	5.38	0.08	
Site 101	Low	5.32	5.41	0.09	
Site 106	Low	11.86	12.60	0.74	
Site 106	High	12.27	12.60	0.33	
Site 107	Low	11.32	12.19	0.86	
Site 108	Low	11.59	11.92	0.33	
Site 109	High	11.34	11.94	0.61	
Site 110	High	11.61	11.93	0.32	
Site 111	Low	11.31	12.11	0.80	
Site 112	Med	11.85	12.22	0.37	
Site 114	Low	12.31	12.92	0.61	
Site 113	Low	11.75	12.92	1.17	
Site 115	High	14.33	14.36	0.03	
Site 116	Med	16.46	17.60	1.14	
Site 117	Med	16.41	17.58	1.17	
Site 118	Low	15.61	16.74	1.14	
Site 119	Med	15.21	16.69	1.49	
			Average	0.59	

3 February 2020

3.1 Stage hydrograph comparison

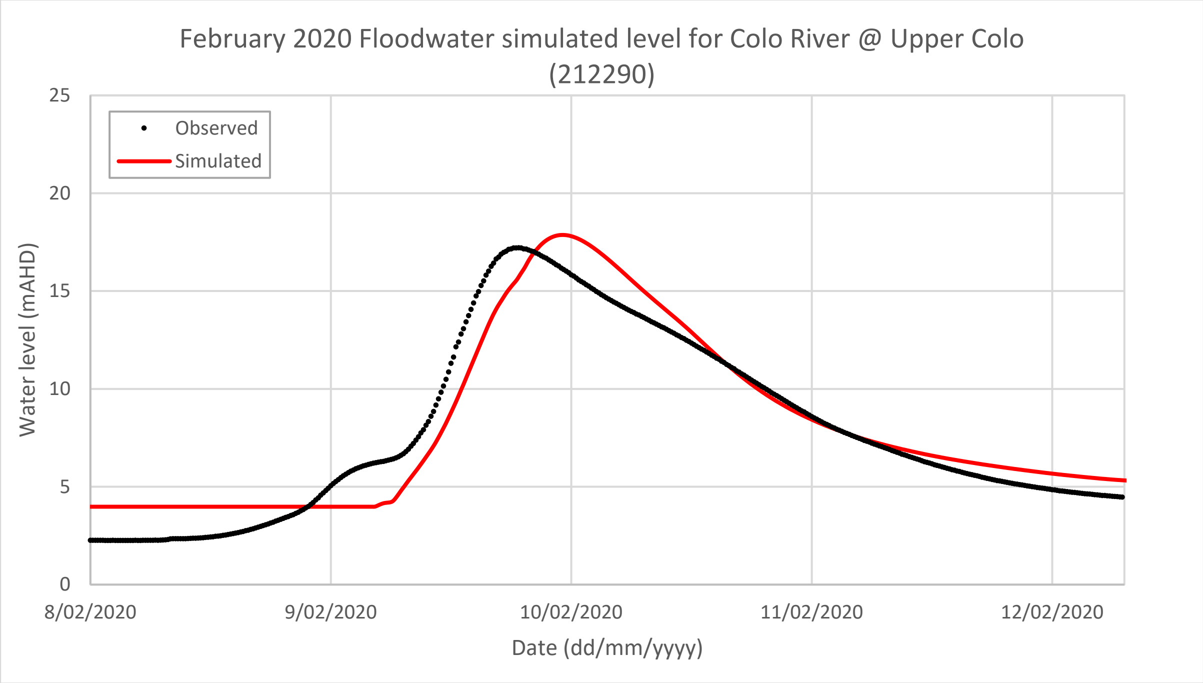


Figure C9 February 2020 Observed vs Simulated water level for Upper Colo gauge (212290)

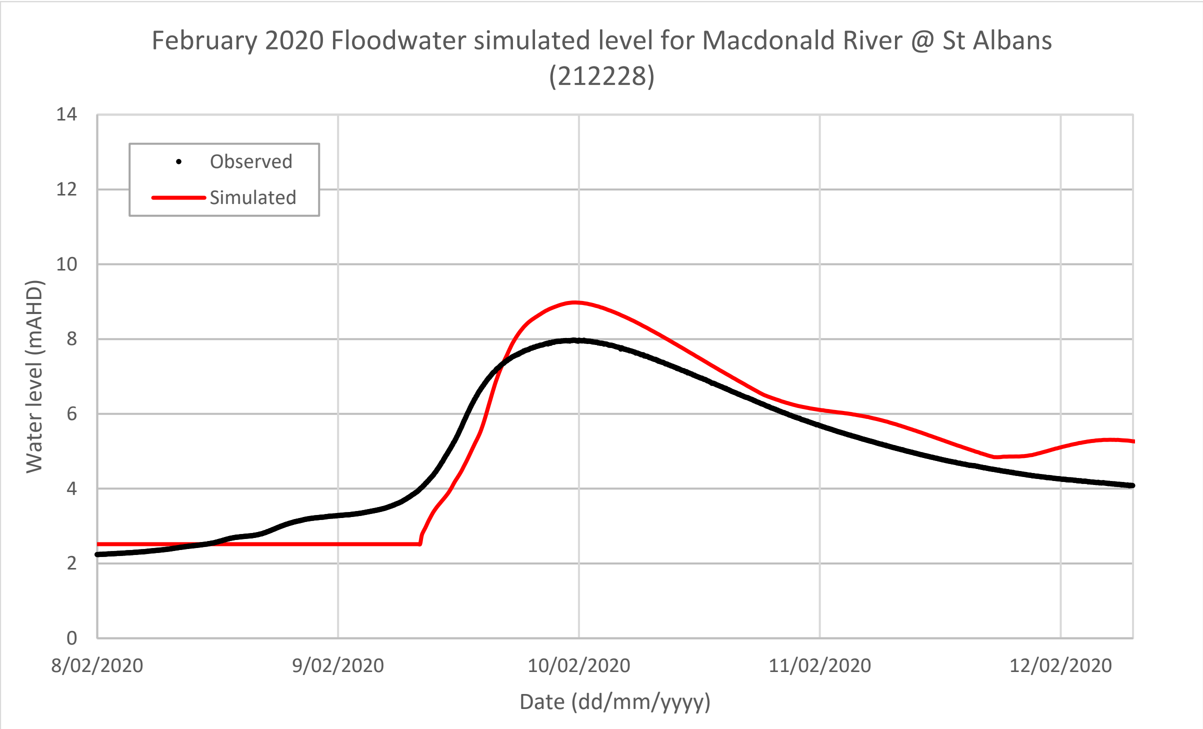


Figure C10 February 2020 Observed vs Simulated water level for St Albans gauge (212228)

3.2 Surface water profile

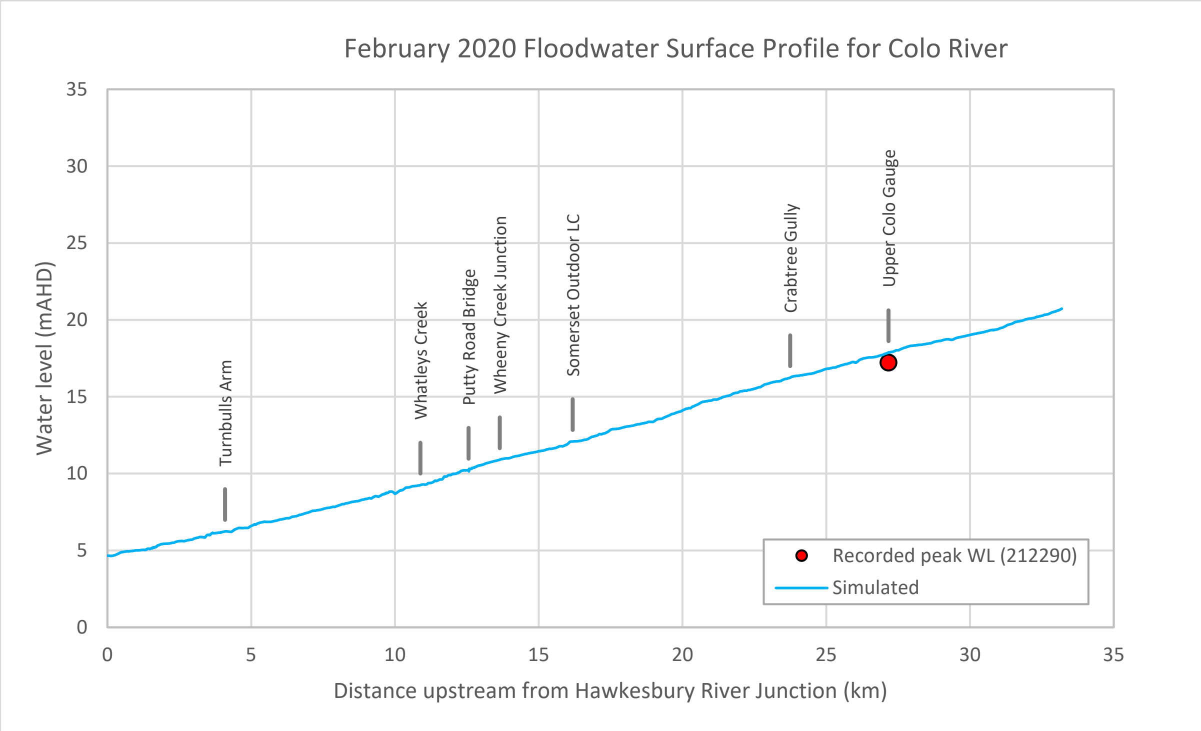


Figure C11 Simulated February 2020 floodwater surface profile for Colo River

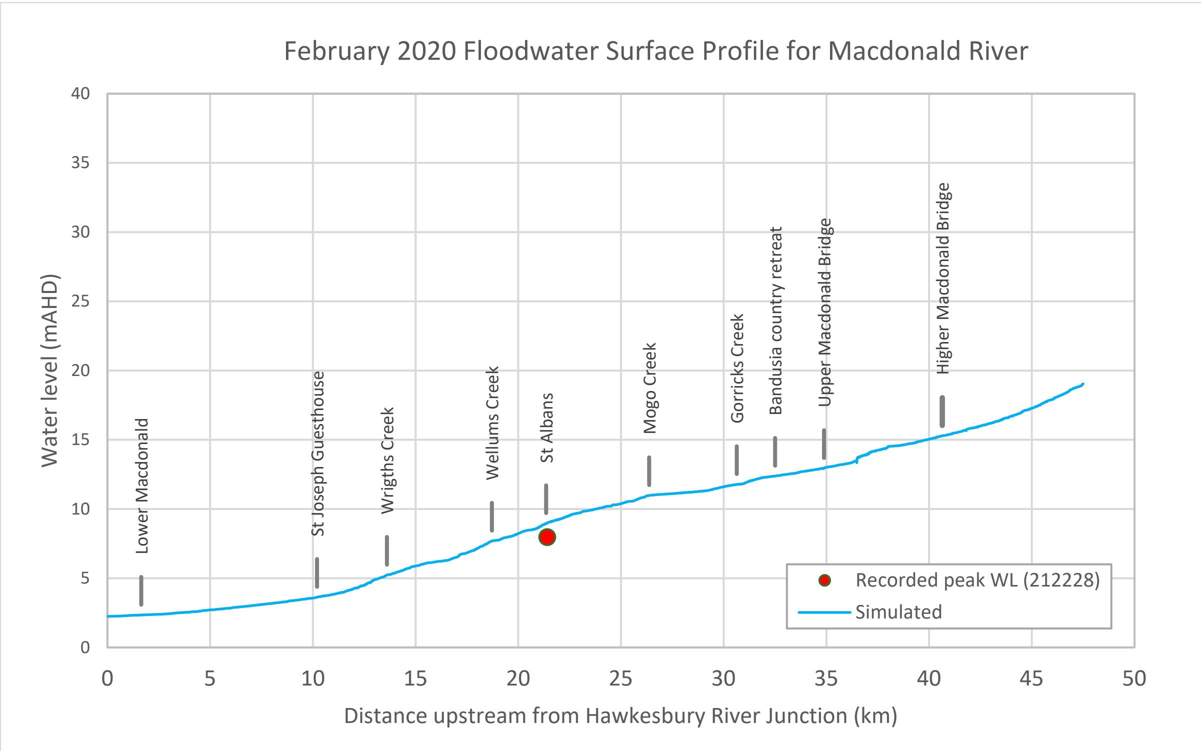
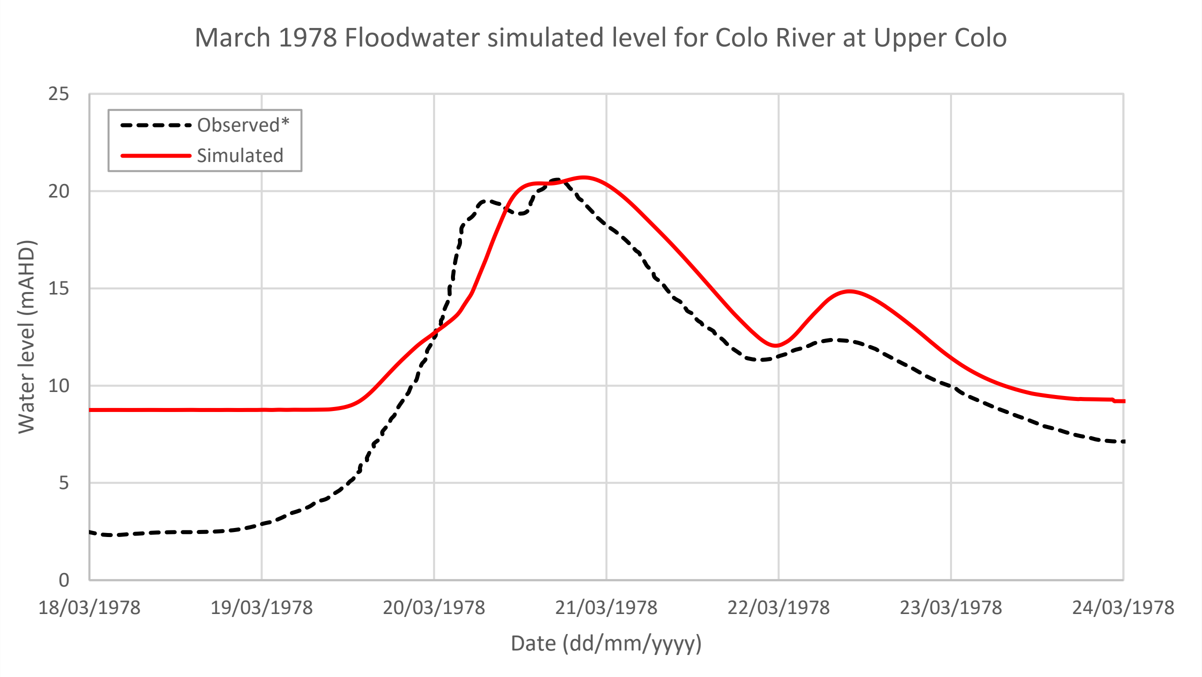


Figure C12 Simulated February 2020 floodwater surface profile for Macdonald River

Appendix C – Hydraulic Model Calibration and Validation

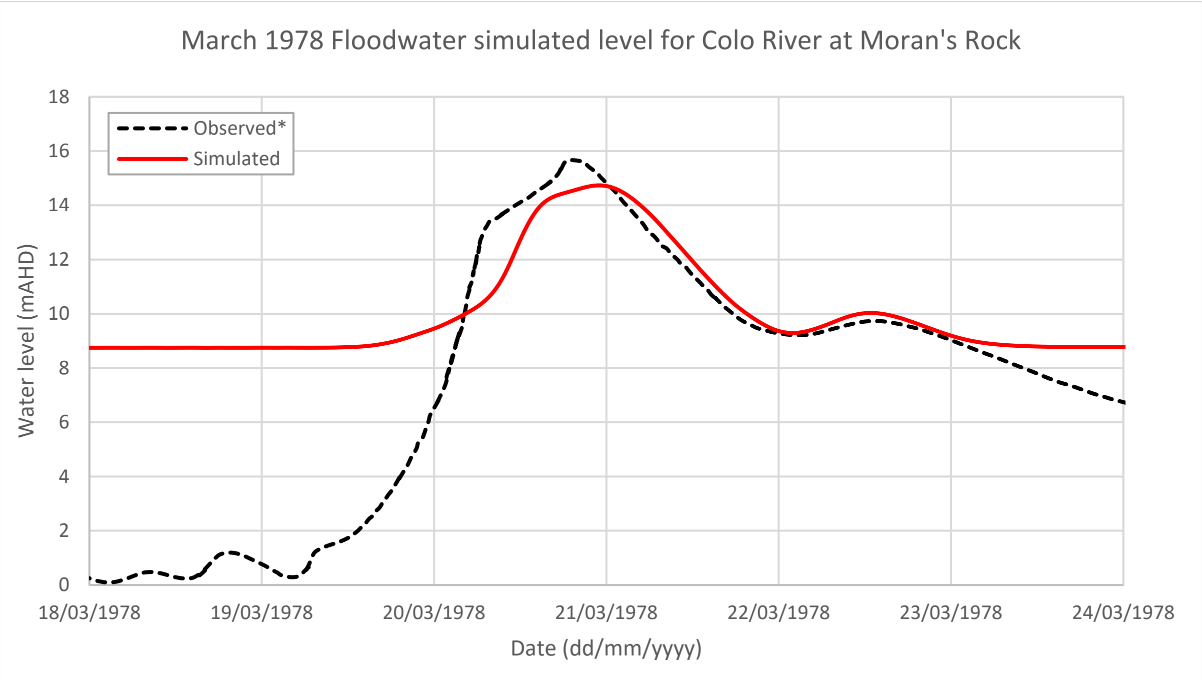
4 March 1978

4.1 Stage hydrograph comparison



**Observed water level time series extracted from PWD (1979) Figure 4. Please note 'Upper Colo' location in PWD (1979) Figure 1 is not equivalent to current Upper Colo gauge (212290) location.*

Figure C13 March 1978 Observed vs Simulated water level for Colo River at Upper Colo



**Observed water level time series extracted from PWD (1979) Figure 4.*

Figure C14 March 1978 Observed vs Simulated water level for the Colo River at Moran's Rock

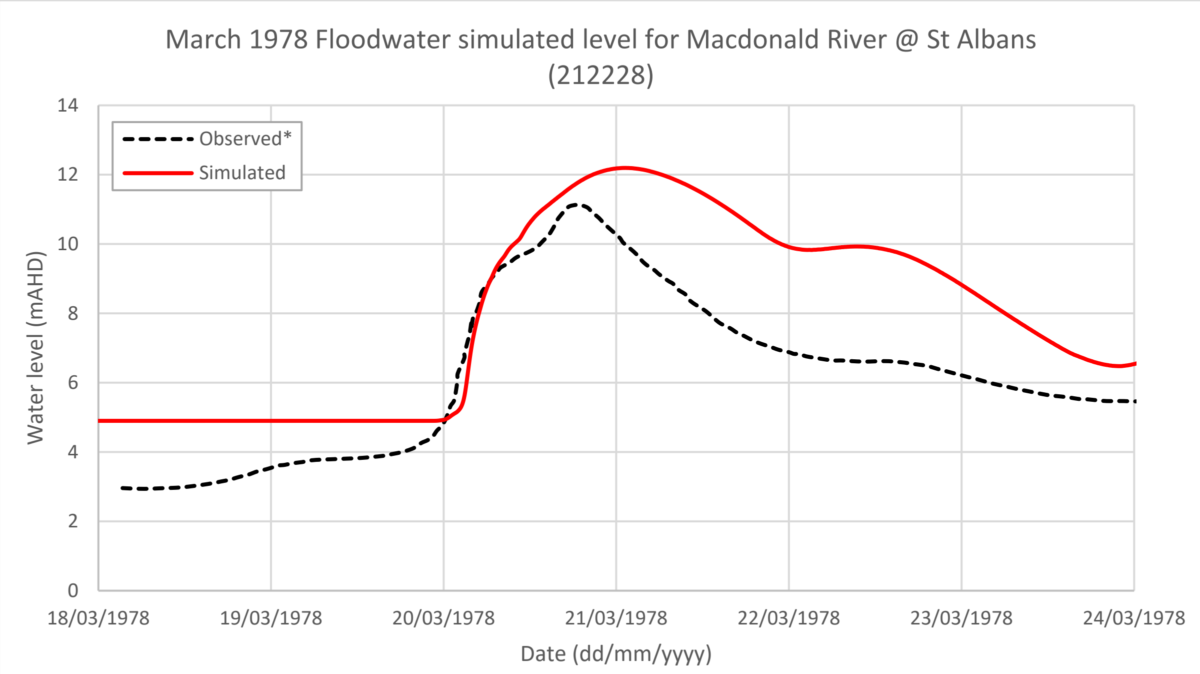
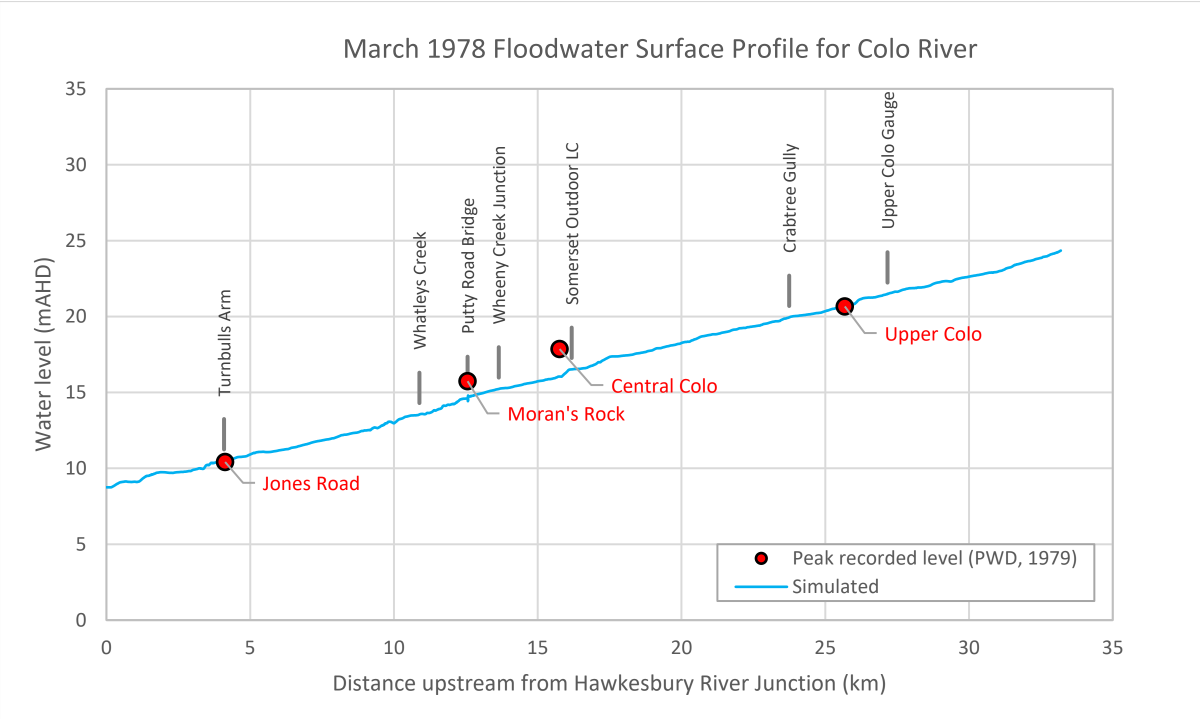


Figure C15 March 1978 Observed vs Simulated water level for Macdonald River at St Albans gauge (212228)

**Observed water level time series extracted from PWD (1979) Figure 4*

4.2 Surface water profile



**Peak water levels extracted from PWD (1979) Table 1. Please note 'Upper Colo' location in PWD (1979) Figure 1 is not equivalent to current Upper Colo gauge (212290) location.*

Figure C16 Simulated March 1978 floodwater surface profile for Colo River

Appendix C – Hydraulic Model Calibration and Validation

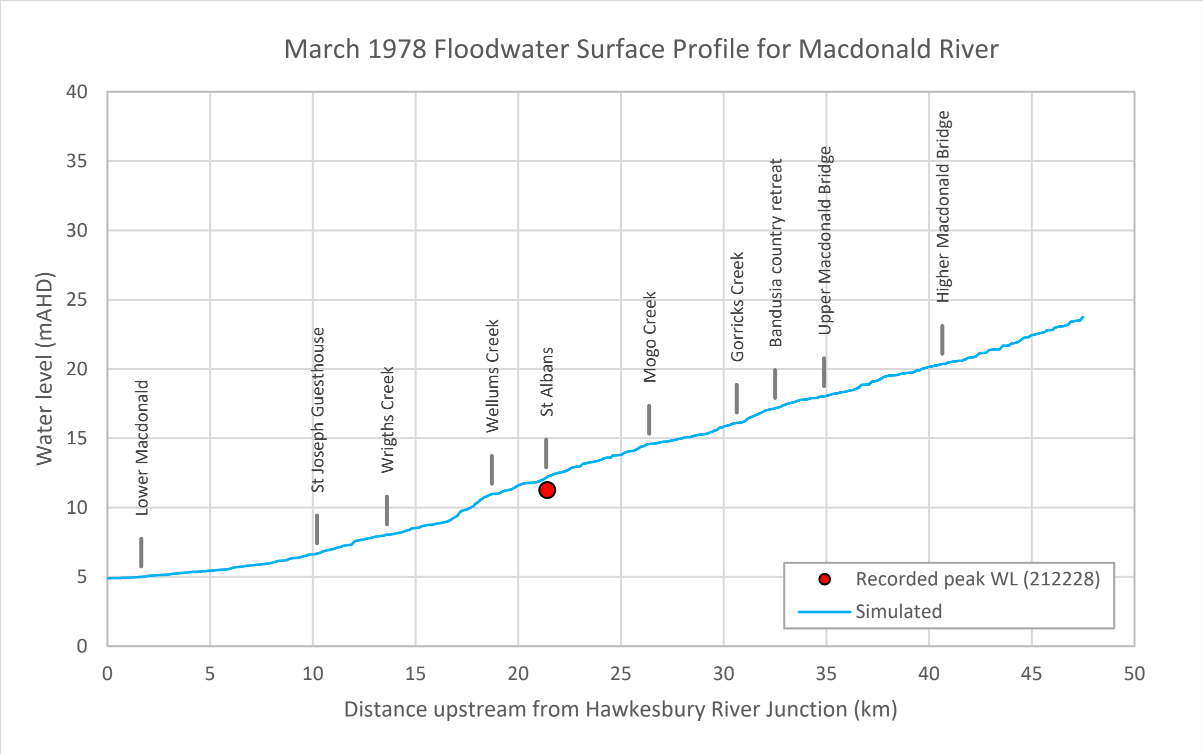


Figure C17 Simulated March 1978 floodwater surface profile for Macdonald River

Appendix D

Design Stage Hydrographs and Profiles

1 Catchment driven events

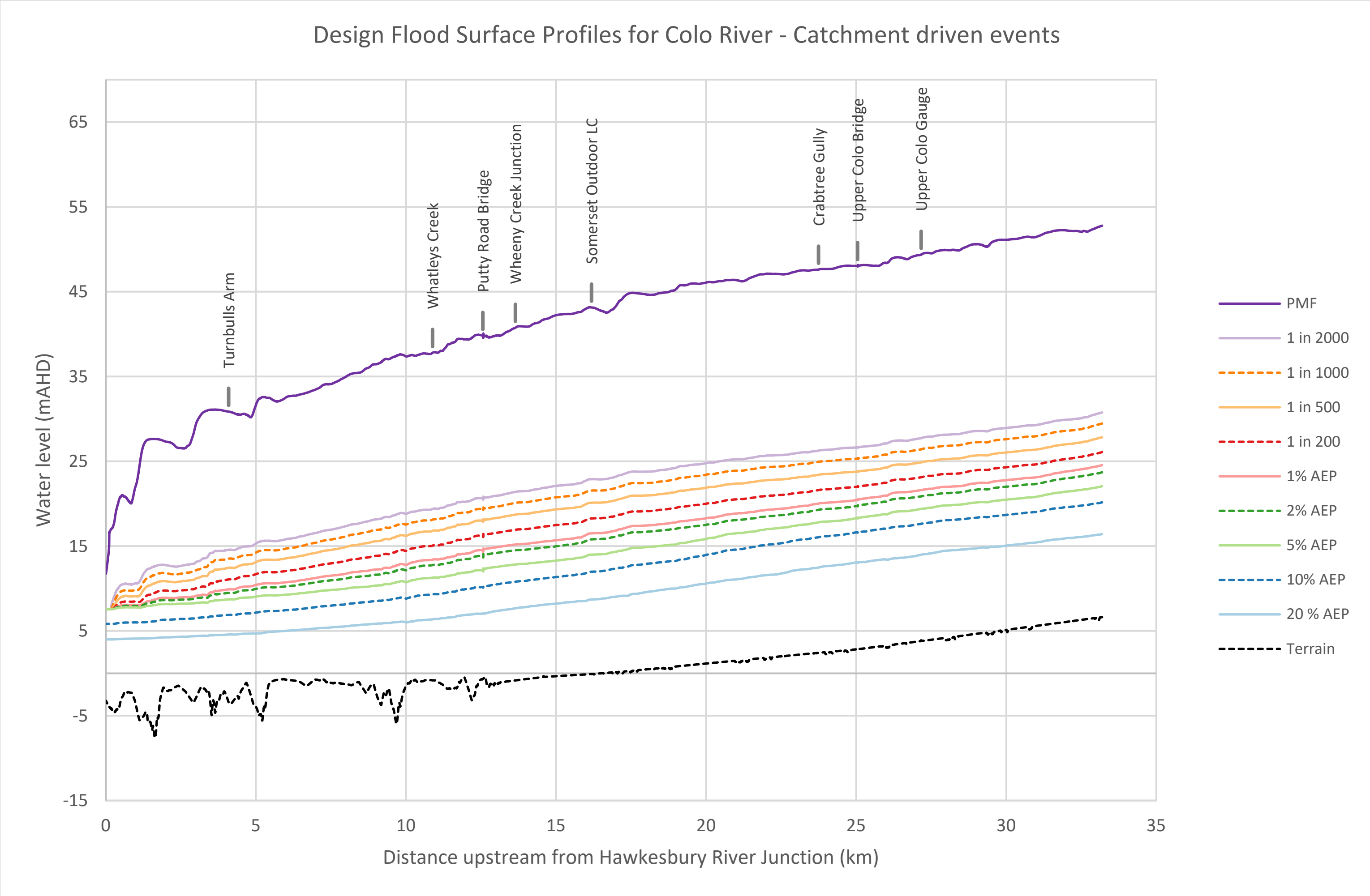


Figure D1 Design event peak flood level profiles for catchment driven events in Colo River

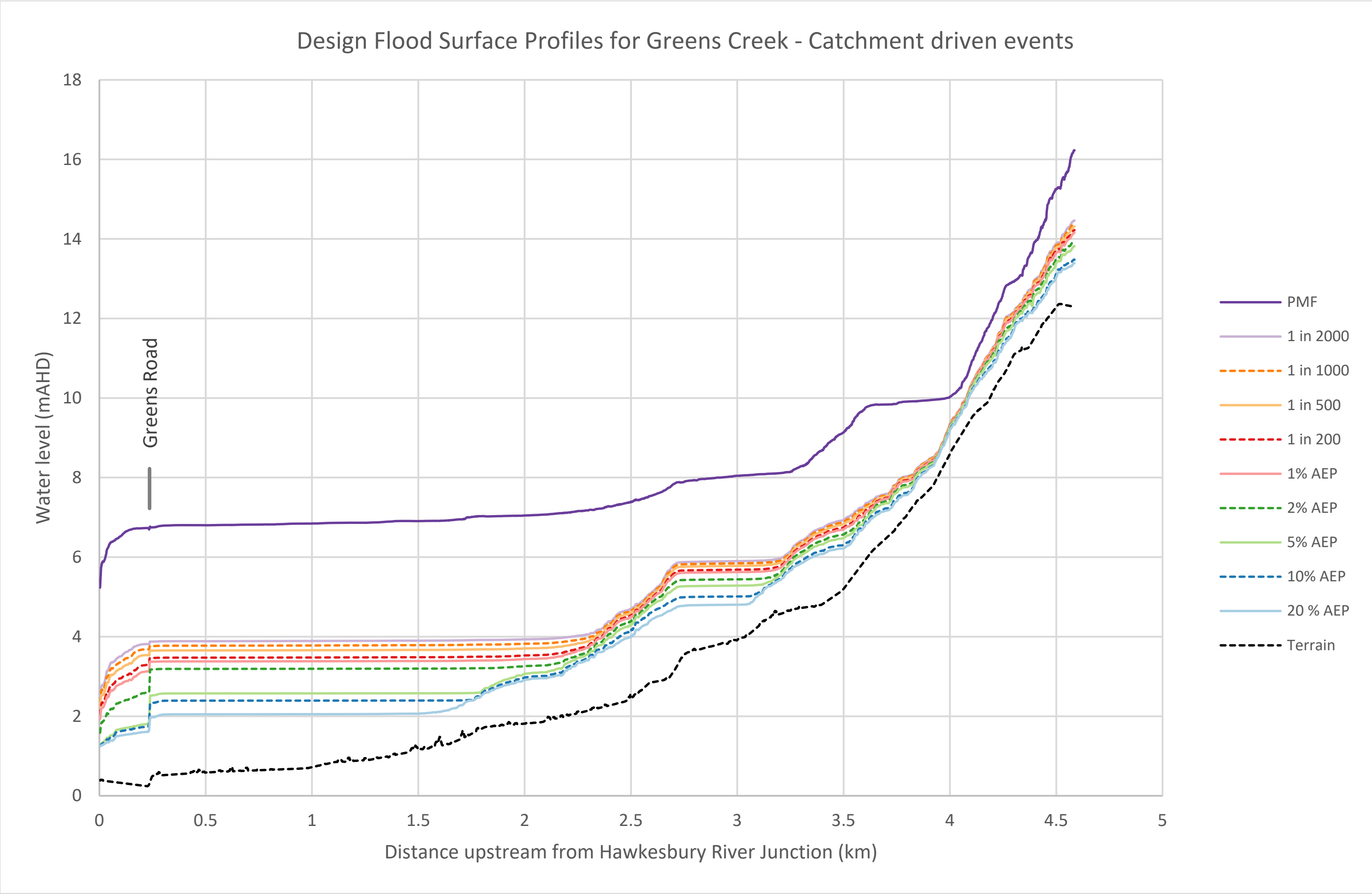


Figure D2 Design event peak flood level profiles for catchment driven events in Greens Creek

Appendix D – Design stage hydrographs and flood level profiles

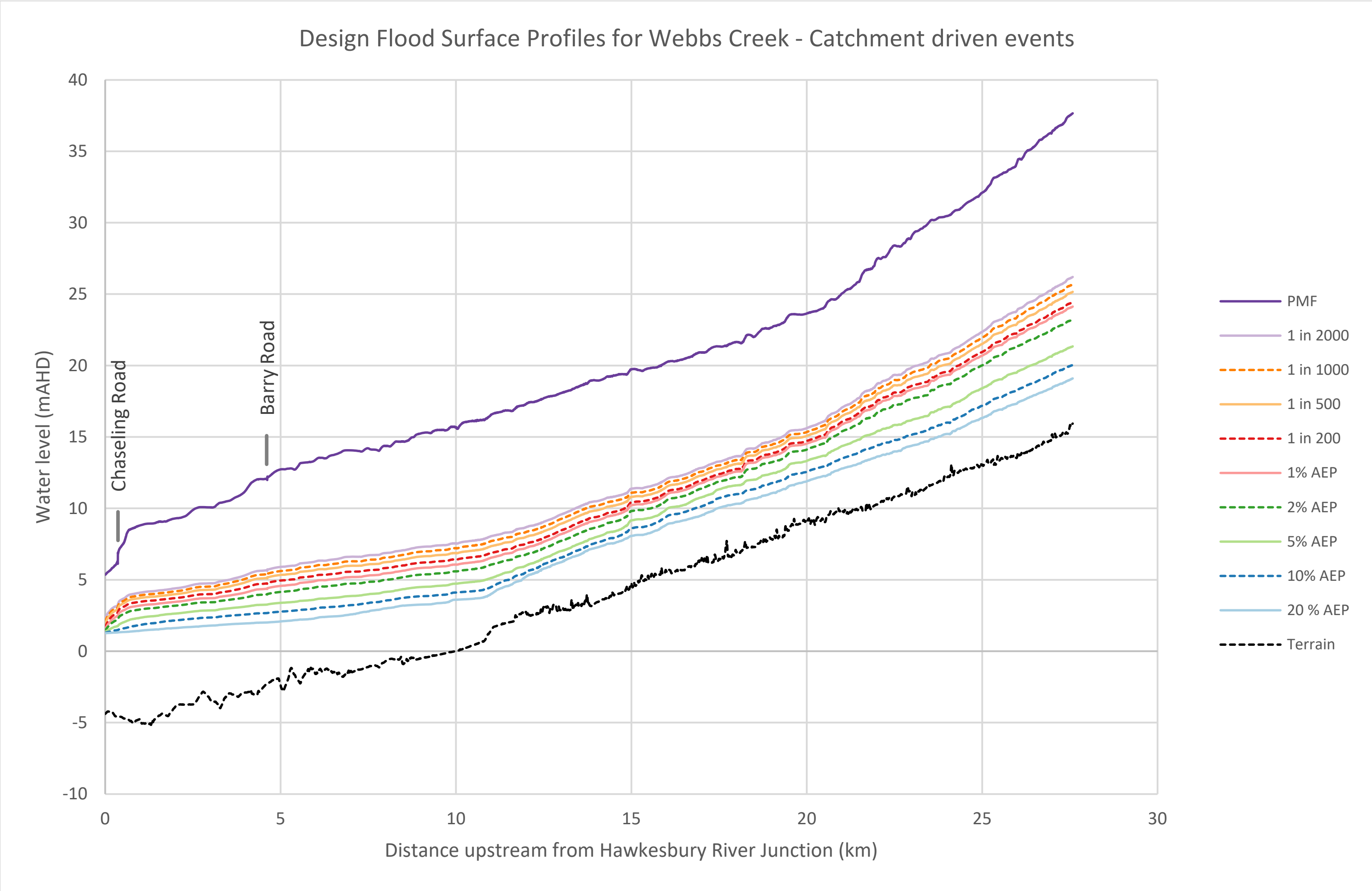


Figure D3 Design event peak flood level profiles for catchment driven events in Webbs Creek

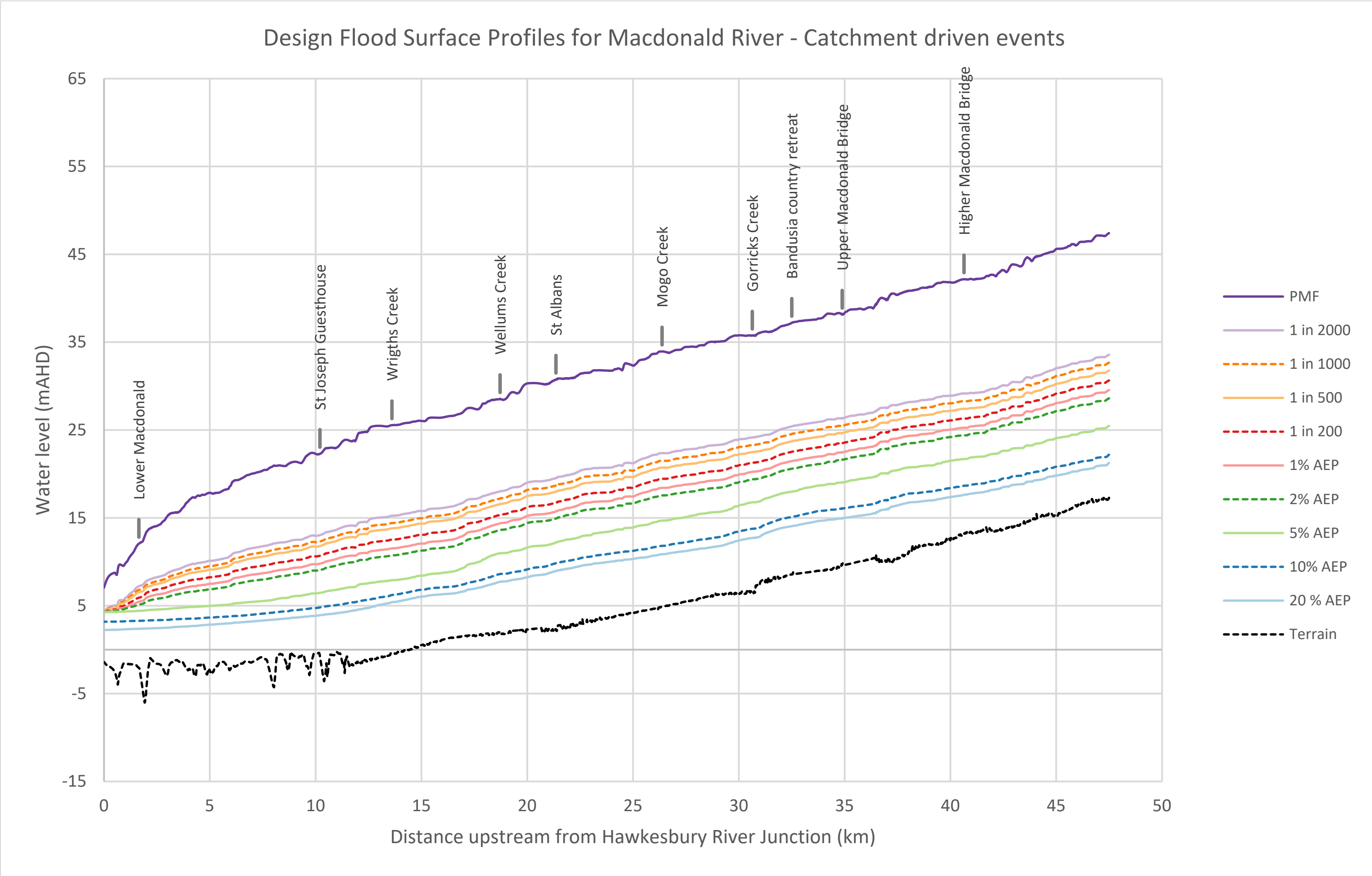


Figure D4 Design event peak flood level profiles for catchment driven events in Macdonald River

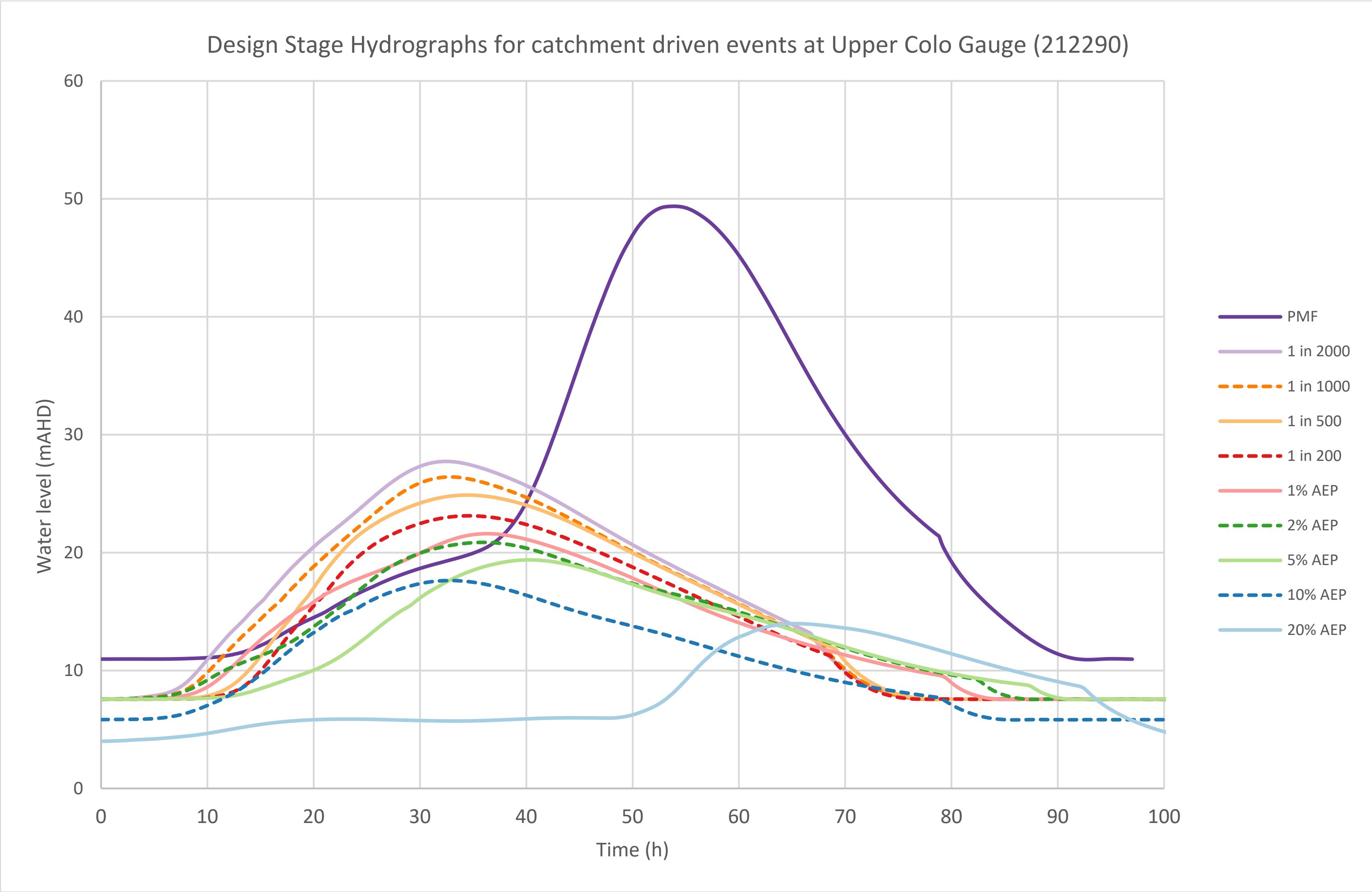


Figure D5 Design stage hydrographs for catchment driven events at Upper Colo gauge (212290)

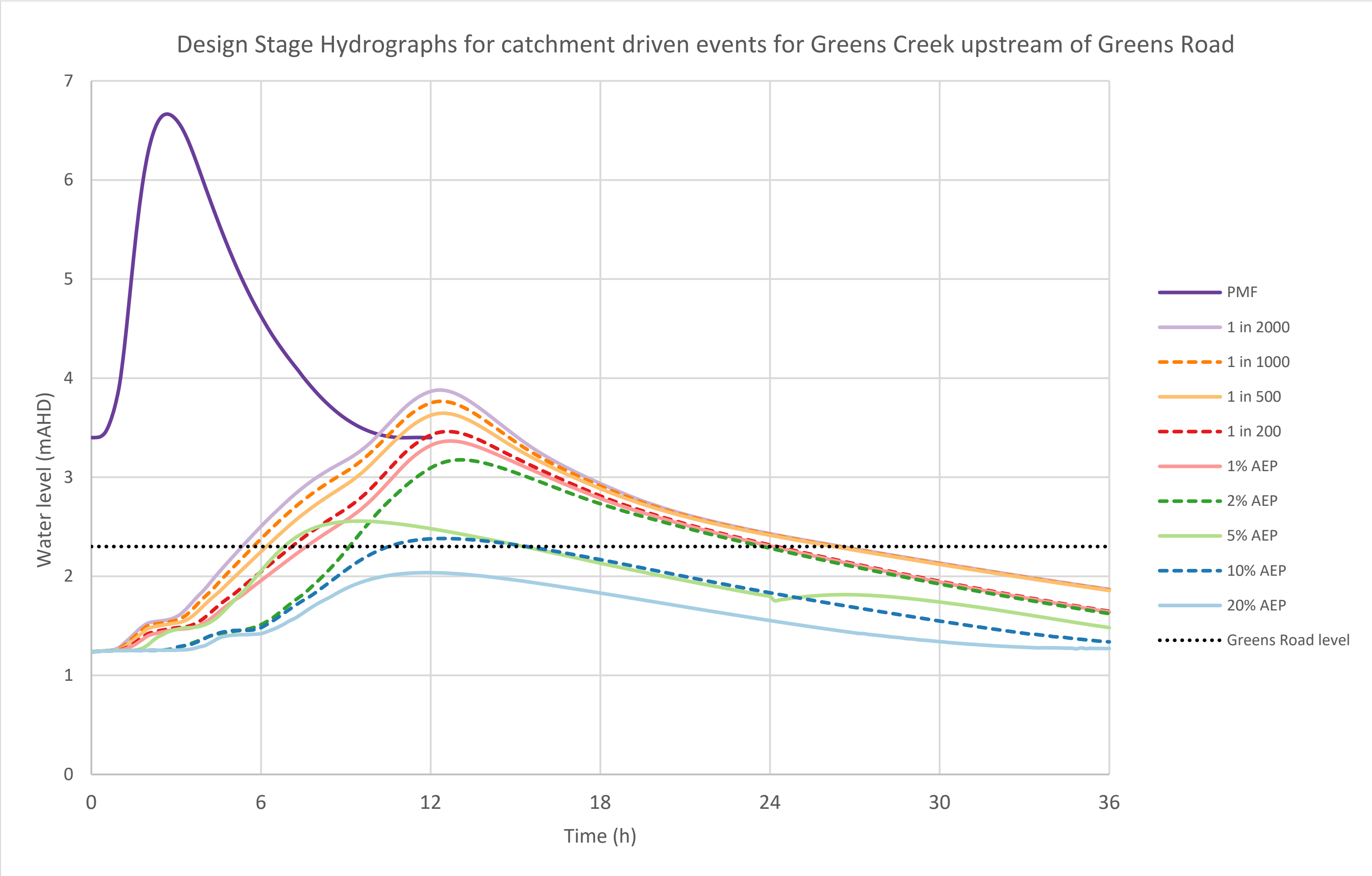


Figure D6 Design stage hydrographs for catchment driven events at Greens Creek upstream of Greens Road

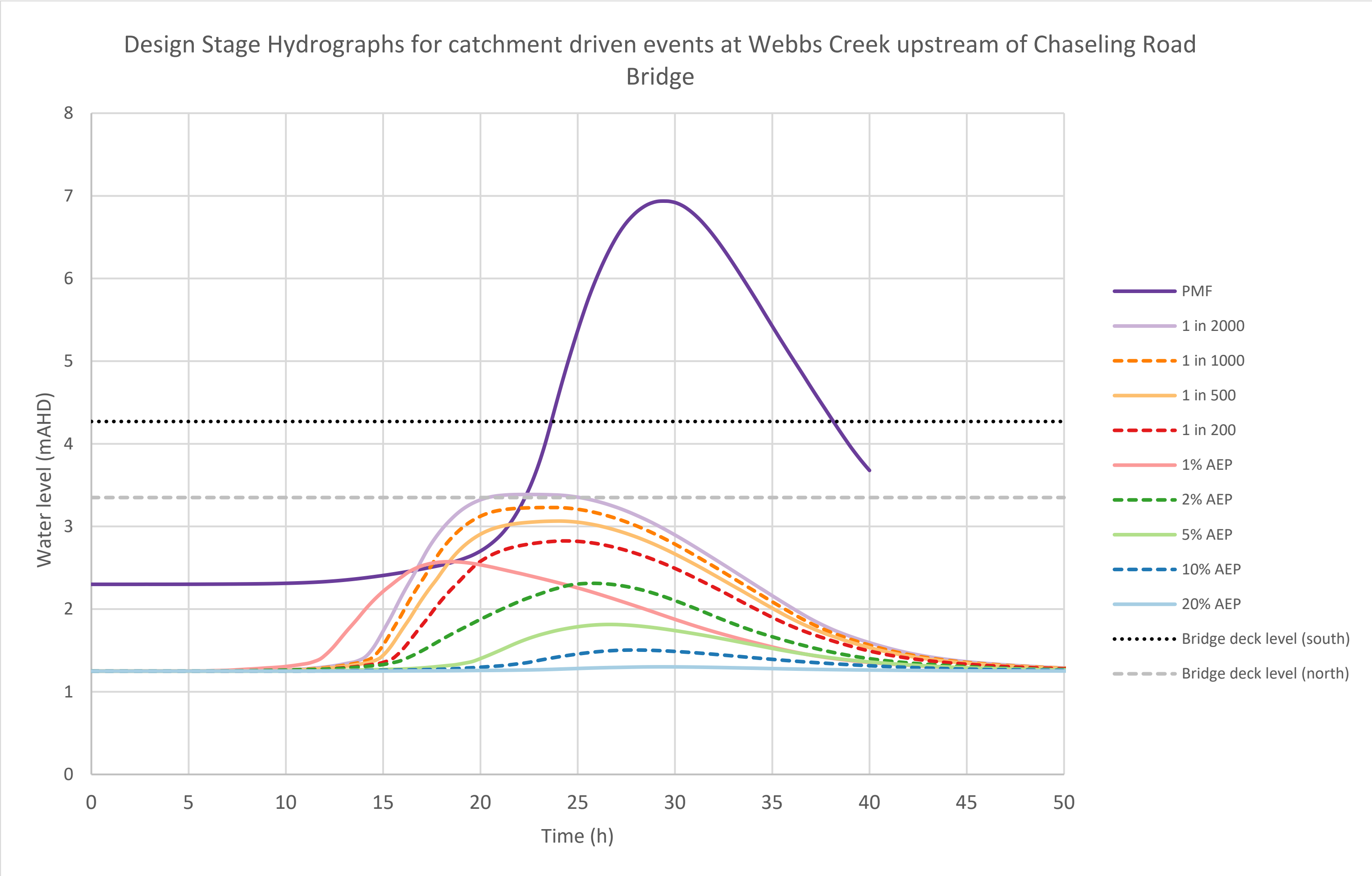


Figure D7 Design stage hydrographs for catchment driven events at Webbs Creek upstream of Chaseling Road Bridge

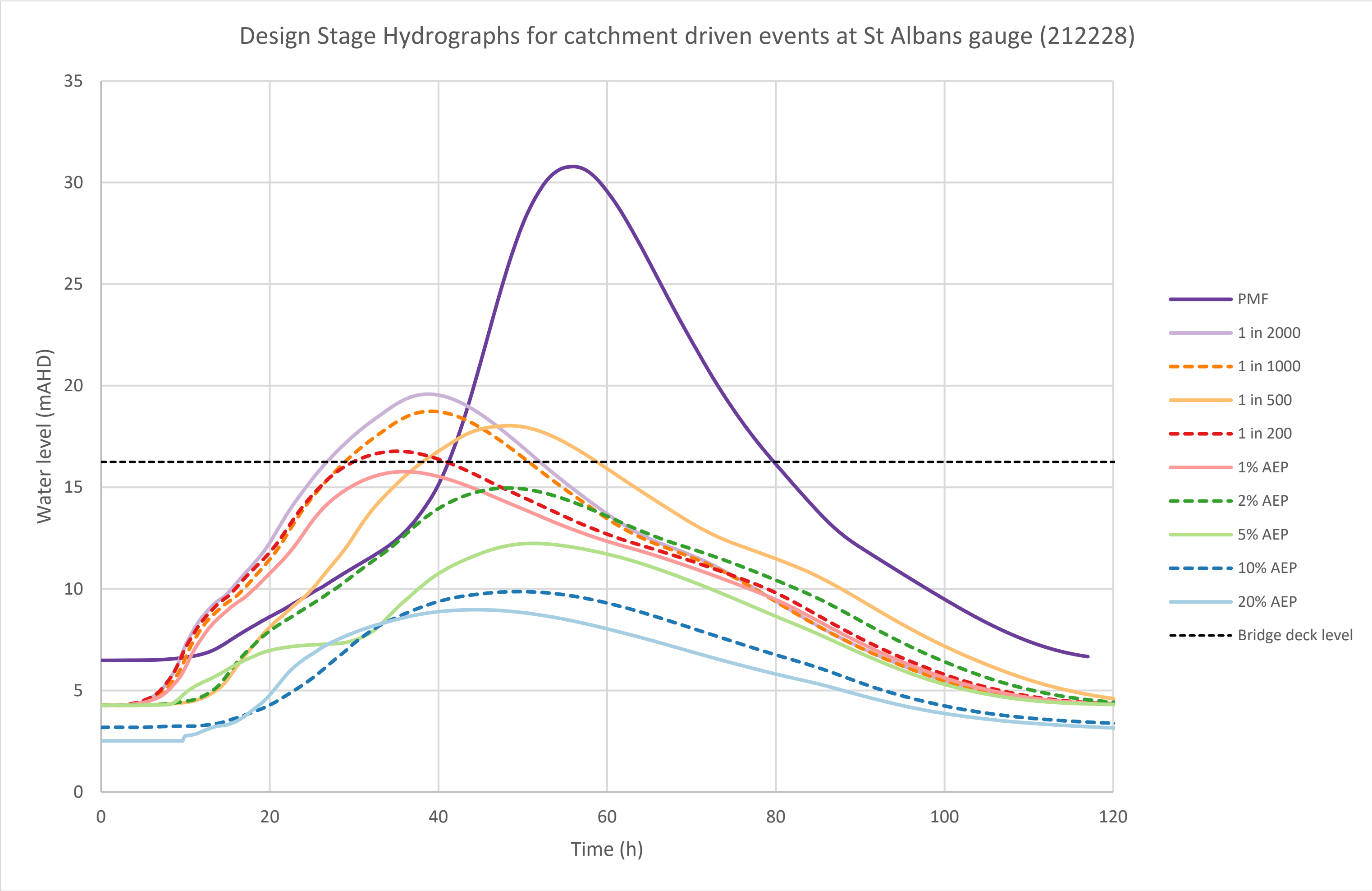


Figure D8 Design stage hydrographs for catchment driven events at St Albans gauge (212228)

2 Hawkesbury River driven events

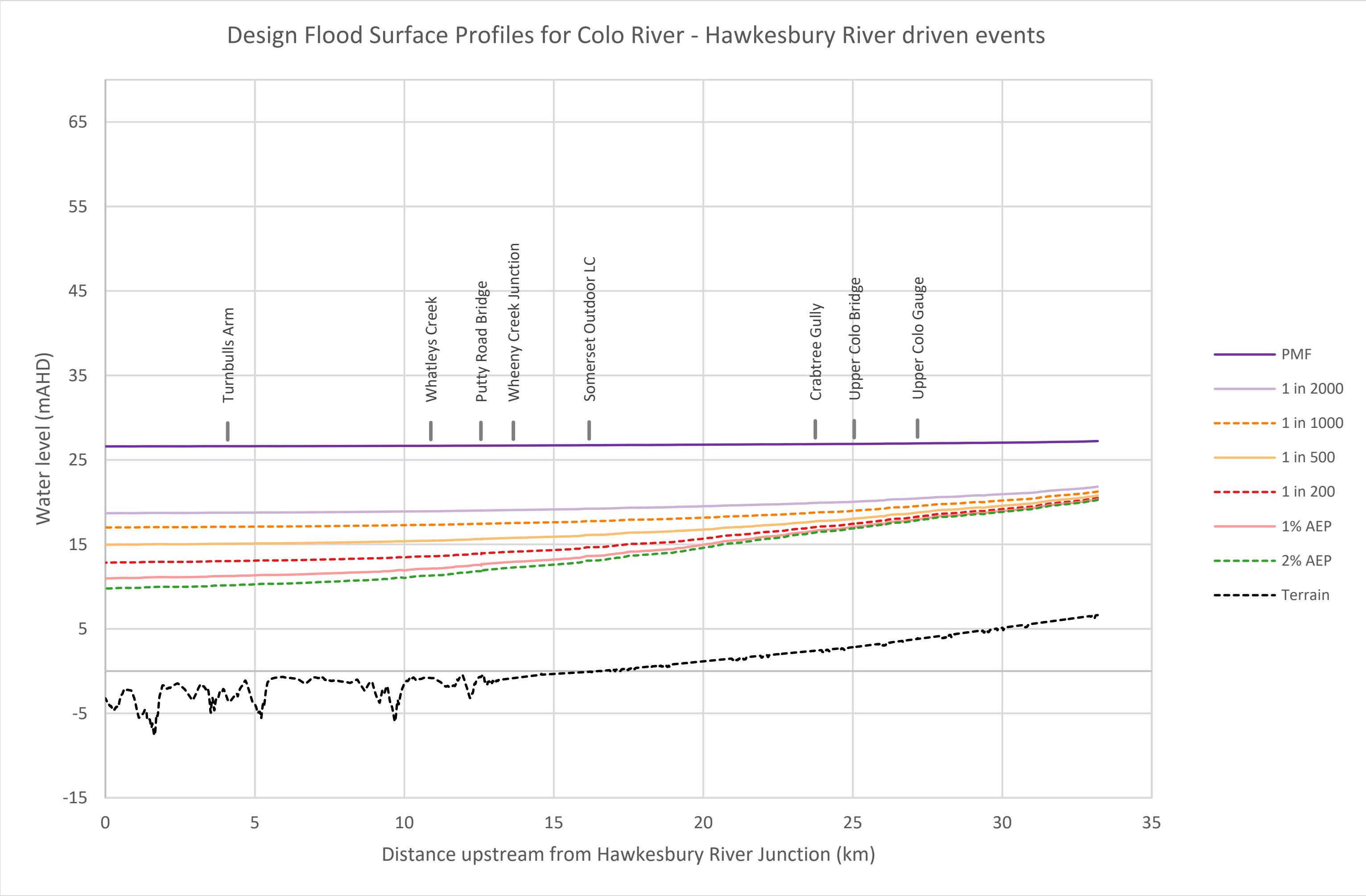


Figure D9 Design event peak flood level profiles for Hawkesbury River driven events in Colo River

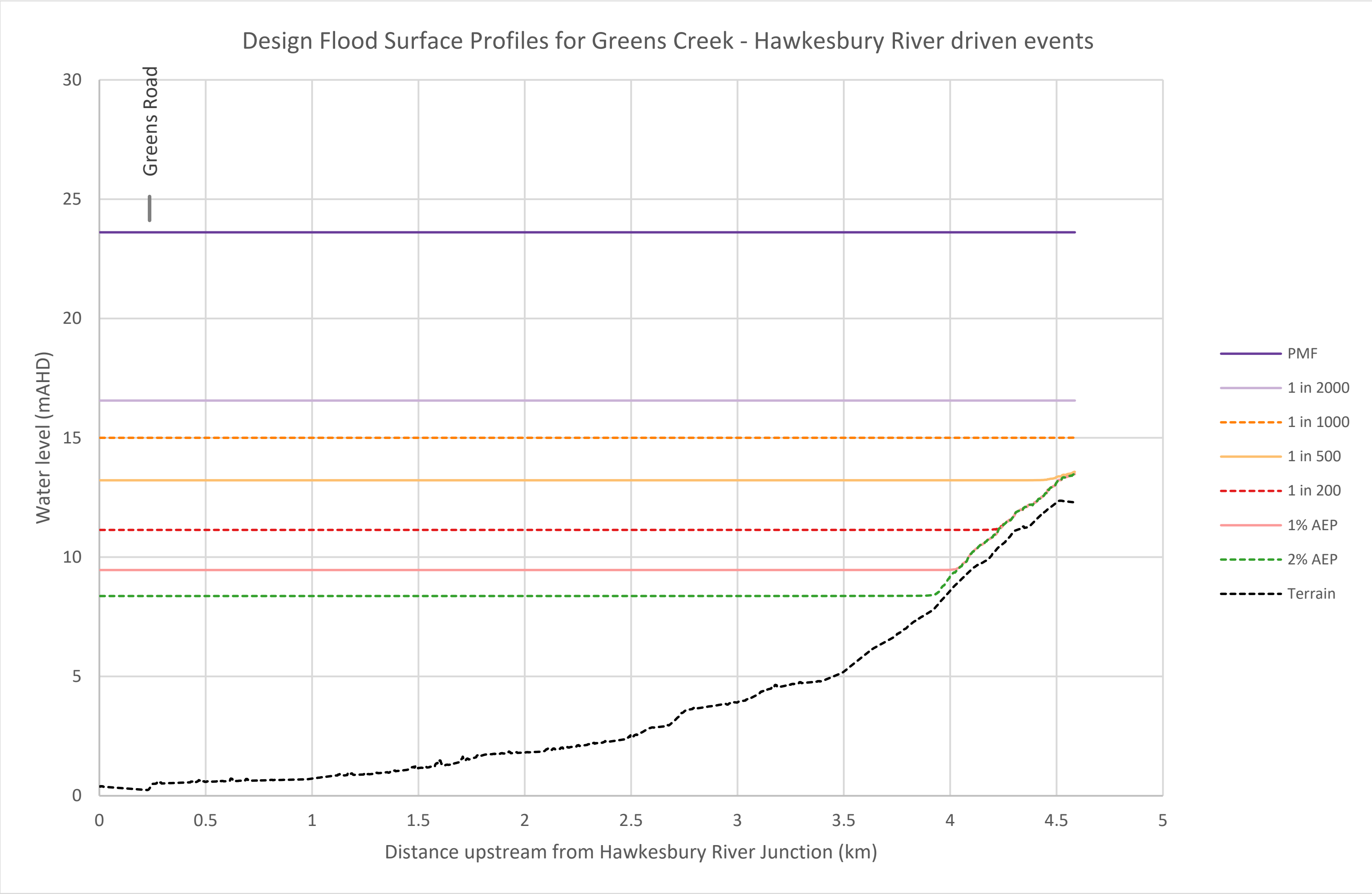


Figure D10 Design event peak flood level profiles for Hawkesbury River driven events in Greens Creek

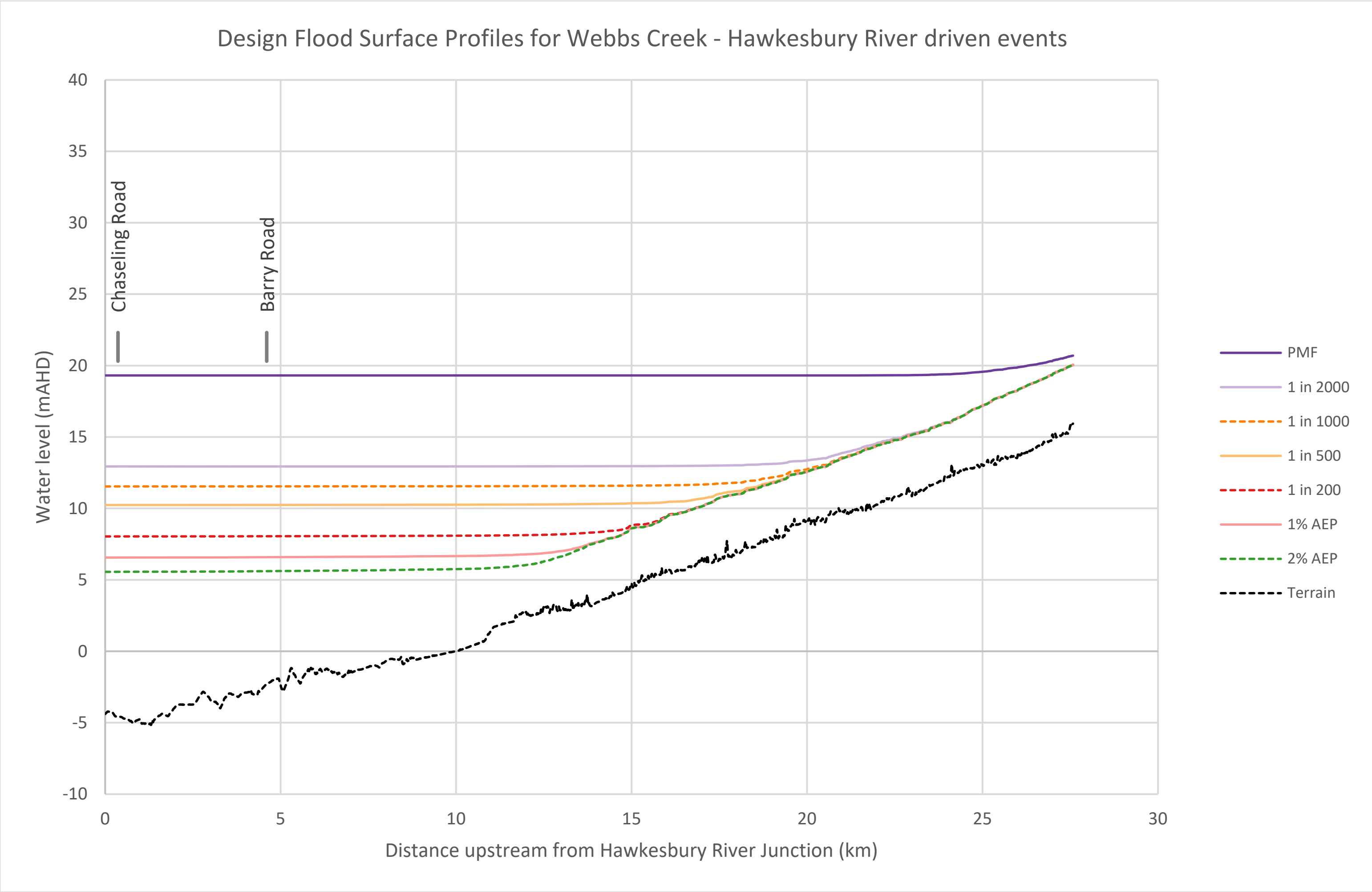


Figure D11 Design event peak flood level profiles for Hawkesbury River driven events in Webbs Creek

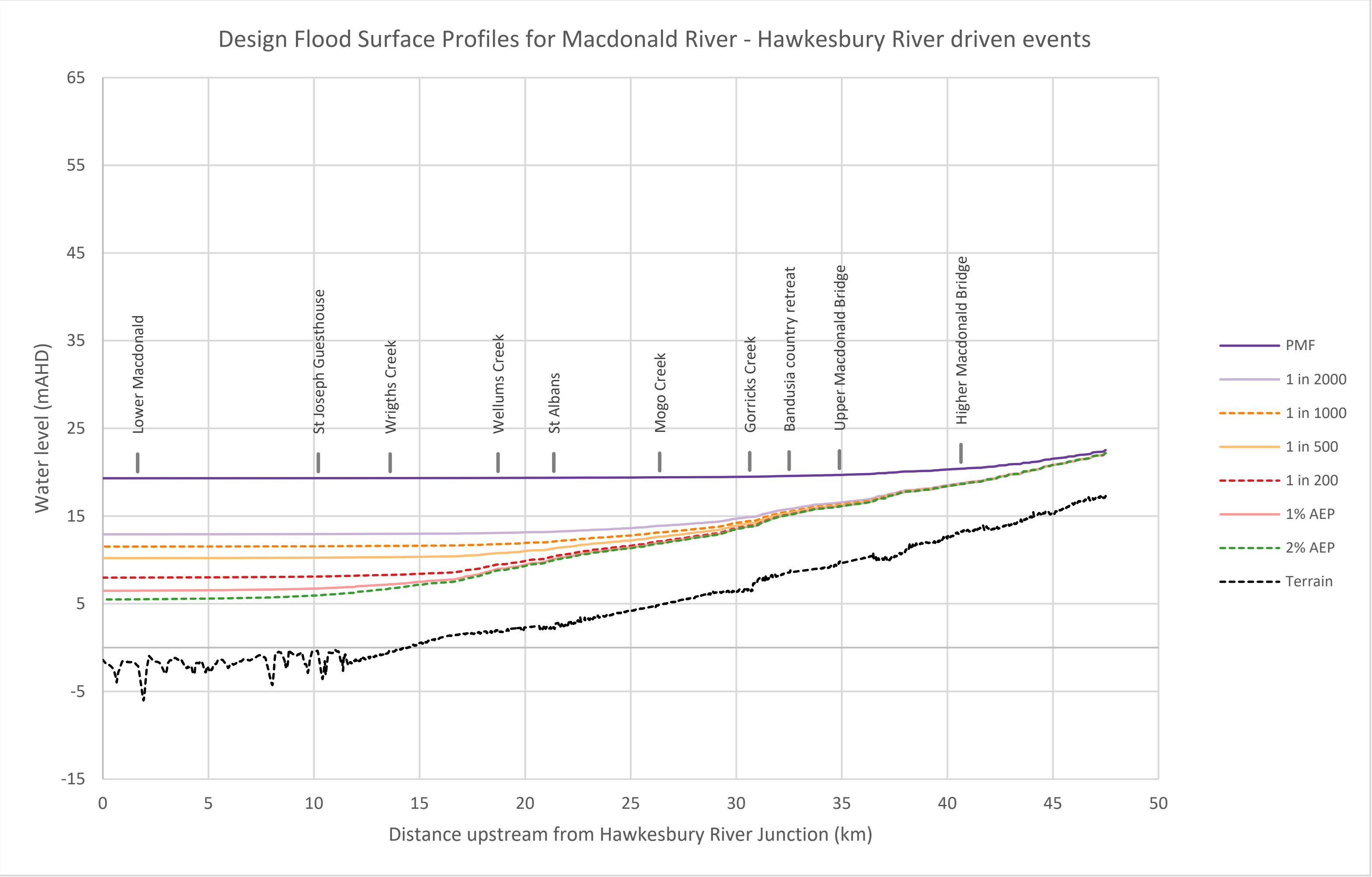


Figure D12 Design event peak flood level profiles for Hawkesbury River driven events in Macdonald River

Appendix E

Flood Function Verification

Appendix E – Flood Function Verification

1 Overview

Flood function (hydraulic) categories are an important output from the Flood Study process as they assist in defining the potential for development across different sections of the floodplain to impact on existing flood behaviour and highlights areas that should be retained for the conveyance and storage of floodwaters. Further details on how the hydraulic categories were defined are provided in Section 7.3 of the Flood Study Report.

The following sections describe how the flood function categories developed as part of the flood study were verified.

2 Floodway

A floodway is an area that if only partially blocked would produce a significant impact on upstream water levels and/or would divert water from existing flowpaths resulting in the development of new flowpaths (NSW Government, 2023c). Accordingly, the suitability of the delineated floodways was verified by partially blocking the floodways and quantifying the impact that this blockage had on peak 1% AEP flood levels. This approach is consistent with verification techniques outlined in the '*Flood Risk Management Guideline FB02 – Flood Function*' (NSW Government, 2023c).

The TUFLOW hydraulic model was updated to include partial blockage of the delineated floodways at several locations across the model areas and was re-run for the 1% AEP event. The peak 1% AEP flood levels from the partly obstructed floodway models runs were compared against 'existing' 1% AEP flood levels to create flood level difference maps (i.e., maps showing the location and magnitude of changes in flood level). The difference maps are shown in **Figure E1** to **Figure E5**.

Figure E1 and **Figure E2** show that the obstructions increase peak 1% AEP flood levels in the Colo River by up to 0.5 metres upstream of each blockage locations. This is considered to be a 'significant impact' on upstream water levels. Increases in flood extent are limited due to the steep terrain. **Figure E3** shows that lower increases of up to 0.15 metres in peak 1% AEP flood levels are experienced upstream of blockage locations in Greens Creek. **Figure E4** and **Figure E5** show that obstructions increase peak 1% AEP flood levels in Webbs Creek and Macdonald River by approximately 0.3-0.5 meters.

Overall, the partial blockage of the delineated floodways is predicted to produce significant impacts on upstream water levels. Therefore, it is considered that the delineated floodway extents for each catchment conform to the '*Flood Risk Management Guideline FB02 – Flood Function*' definitions and are suitable for application across the study area.

Appendix E – Flood Function Verification

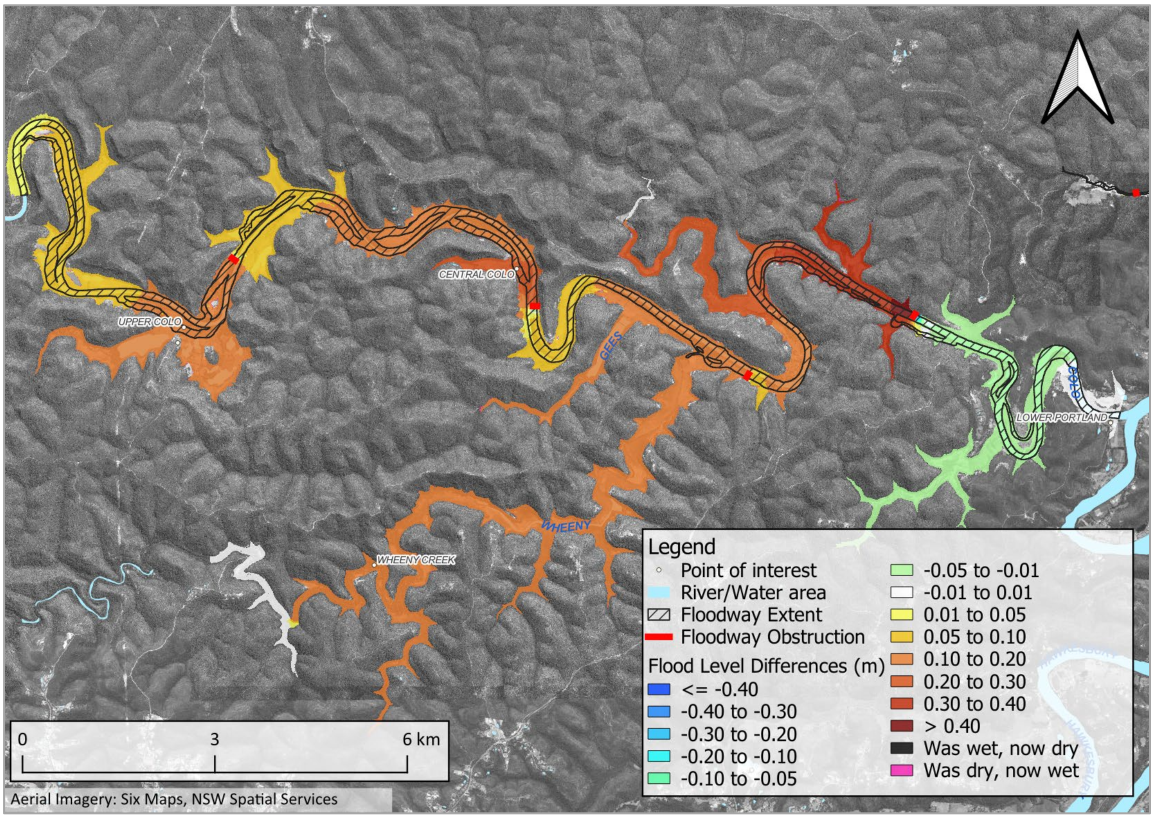


Figure E1 1% AEP Flood Level Differences associated with obstructions of the floodway in Colo River

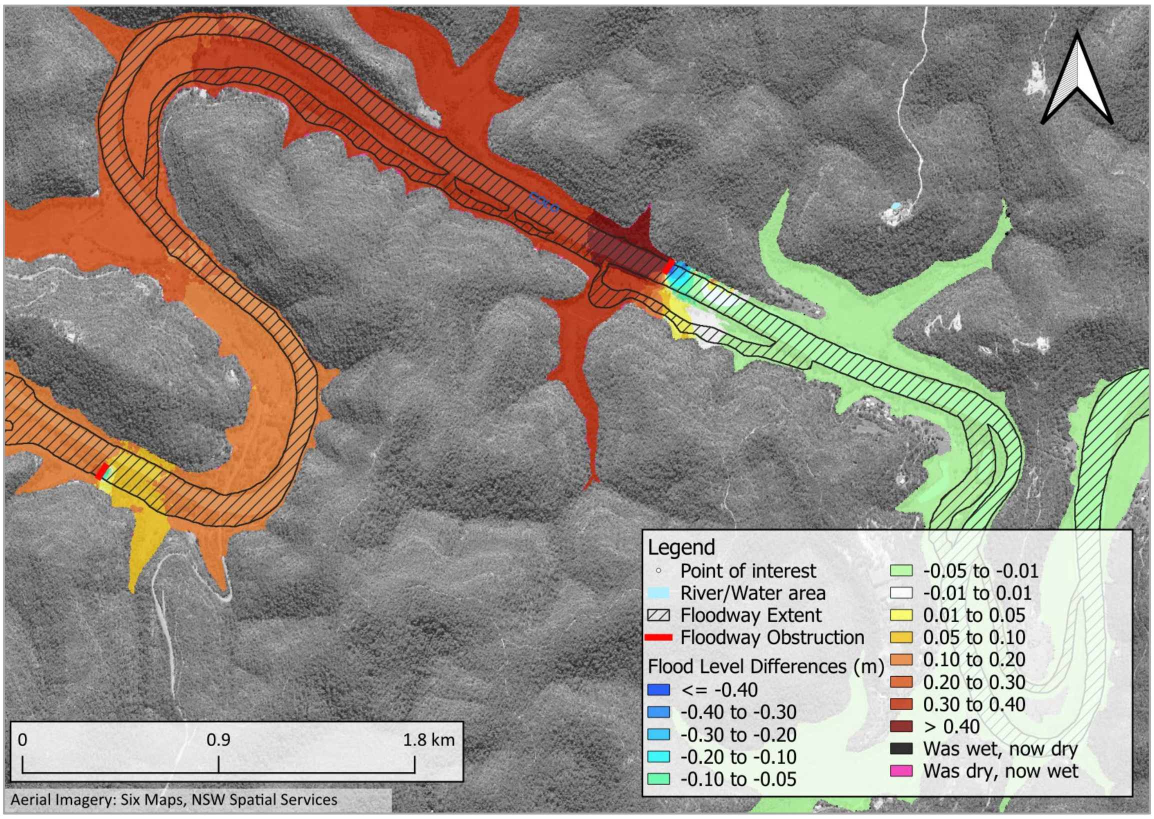


Figure E2 1% AEP Flood Level Differences associated with obstructions of the floodway in Colo River (lower reach)

Appendix E – Flood Function Verification

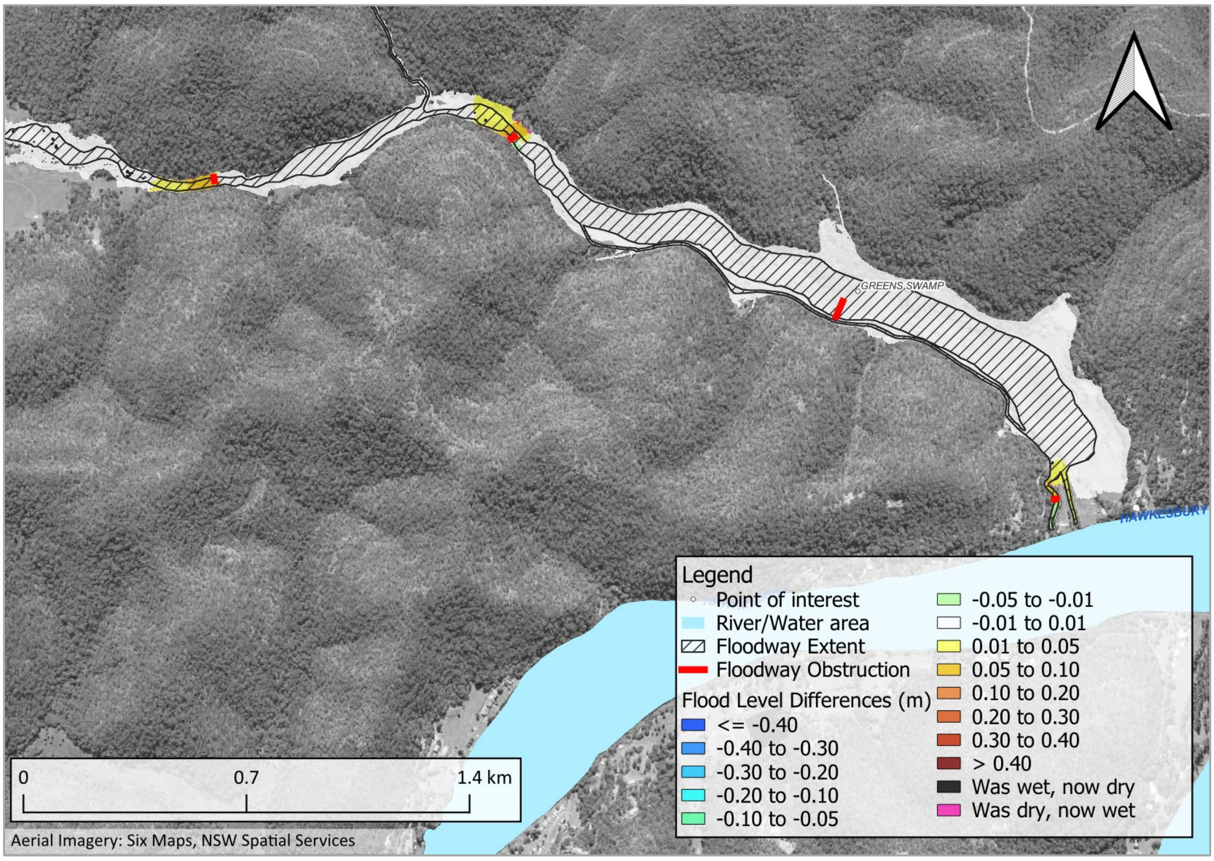


Figure E3 1% AEP Flood Level Differences associated with obstructions of the floodway in Greens Creek

Appendix E – Flood Function Verification

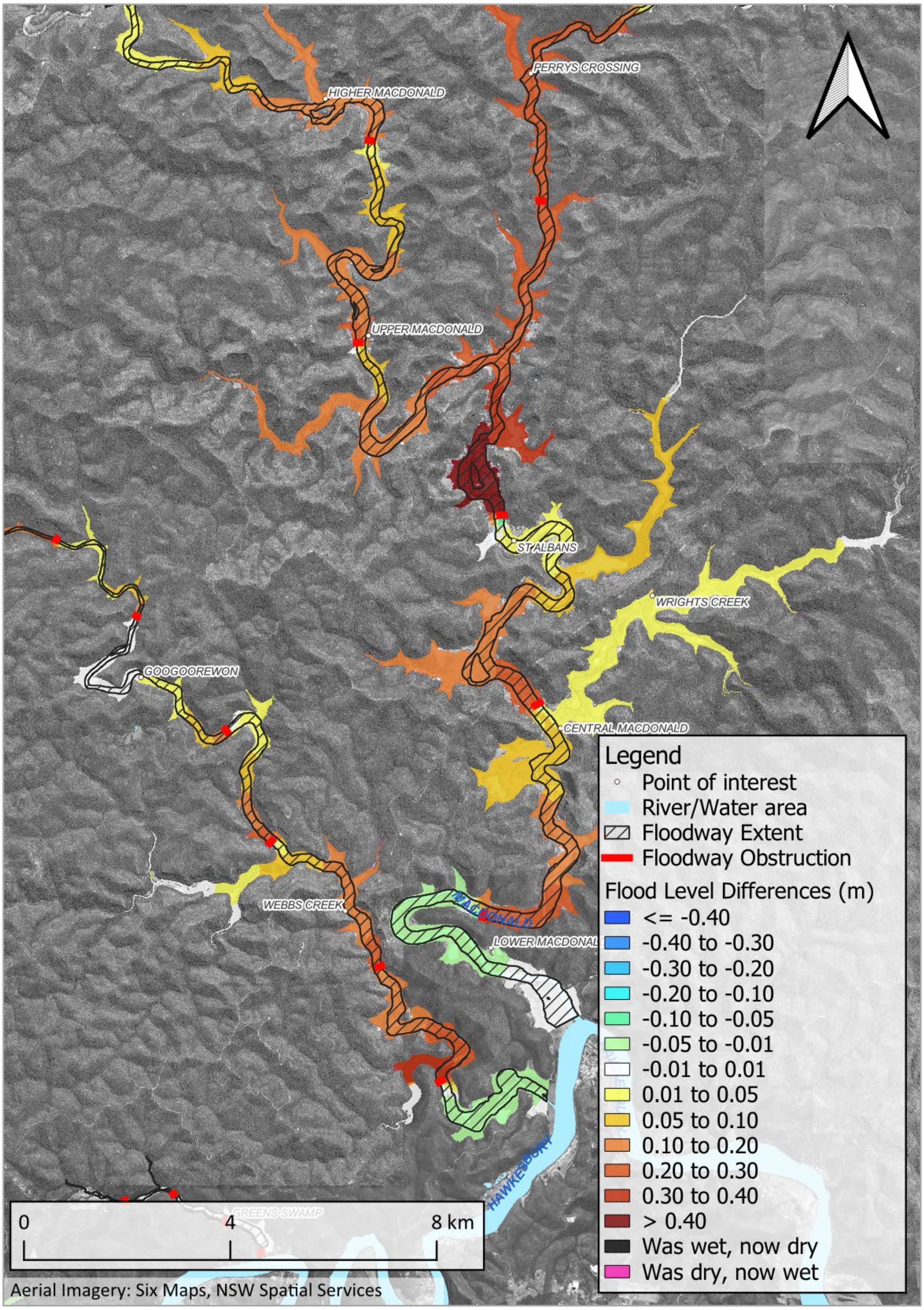


Figure E4 1% AEP Flood Level Differences associated with obstructions of floodway in Webbs Creek and Macdonald River

Appendix E – Flood Function Verification

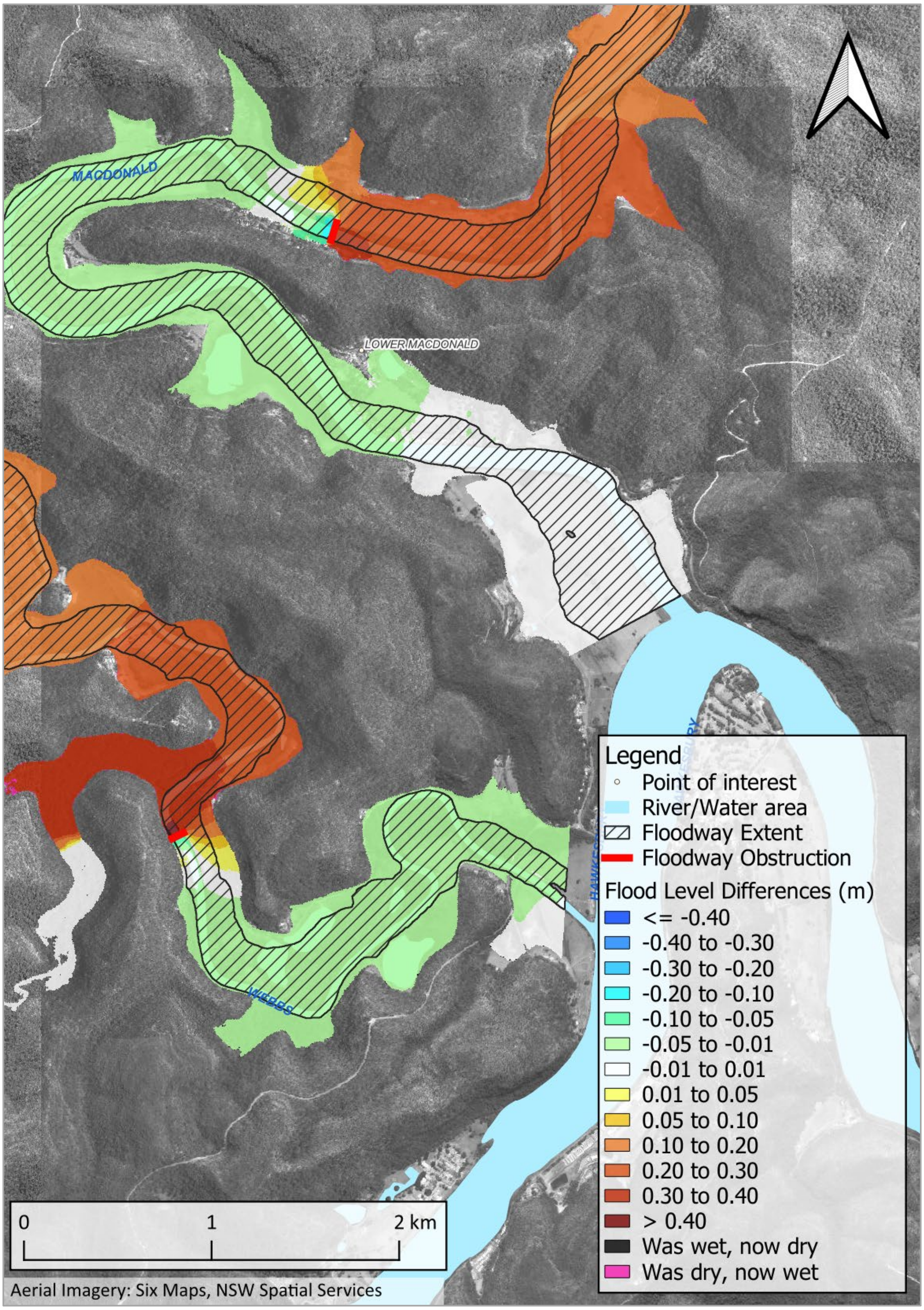


Figure E5 AEP Flood Level Differences associated with obstructions of floodway in Webbs Creek and Macdonald River (lower reaches)

Appendix E – Flood Function Verification

3 Flood Fringe

Flood fringe areas are areas that, if filled/removed, would result in insignificant impacts to flood levels and extents. To confirm the suitability of the flood fringe areas, flood fringe areas were 'blocked out' from the modelled domain. The updated model was used to re-simulate the 1% AEP flood with the flood fringe areas removed. Peak 1% AEP flood levels were compared against 'existing' 1% AEP flood levels and the resulting difference mapping is shown in **Figure E6** and **Figure E10**.

The difference maps show that removal of all flood fringe areas would generate increases and decreases in peak 1% AEP flood levels. However, the differences are generally less than 0.05 metres, with isolated areas of slightly higher increases and decreases (although all flood level impacts are les than 0.1 metres). Considering this assessment considered blockage of all fringe areas, flood level differences of this magnitude are considered to be insignificant. Accordingly, it is considered that the extent of the delineated flood fringes is appropriate and suitable for application across the study area.

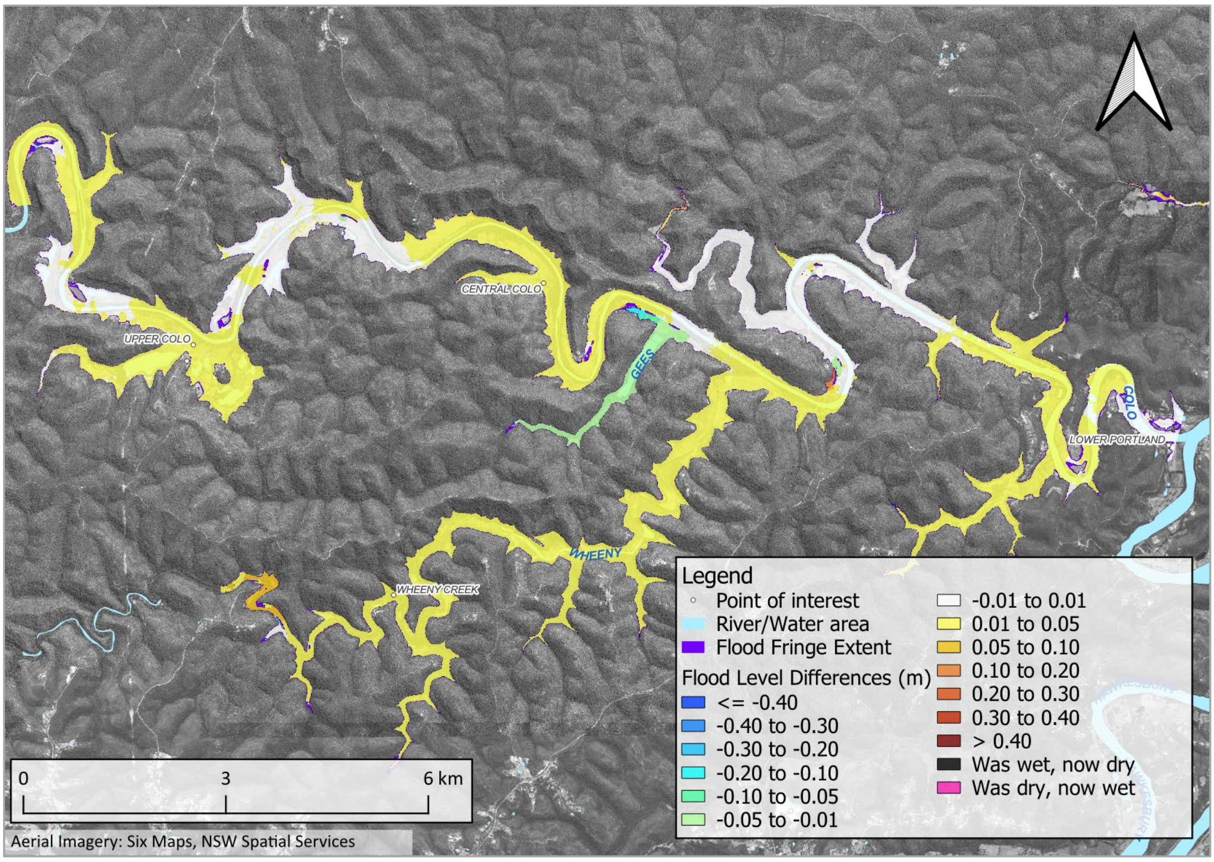


Figure E6 1% AEP flood level differences associated with filling across Flood Fringe Areas of Colo River

Appendix E – Flood Function Verification

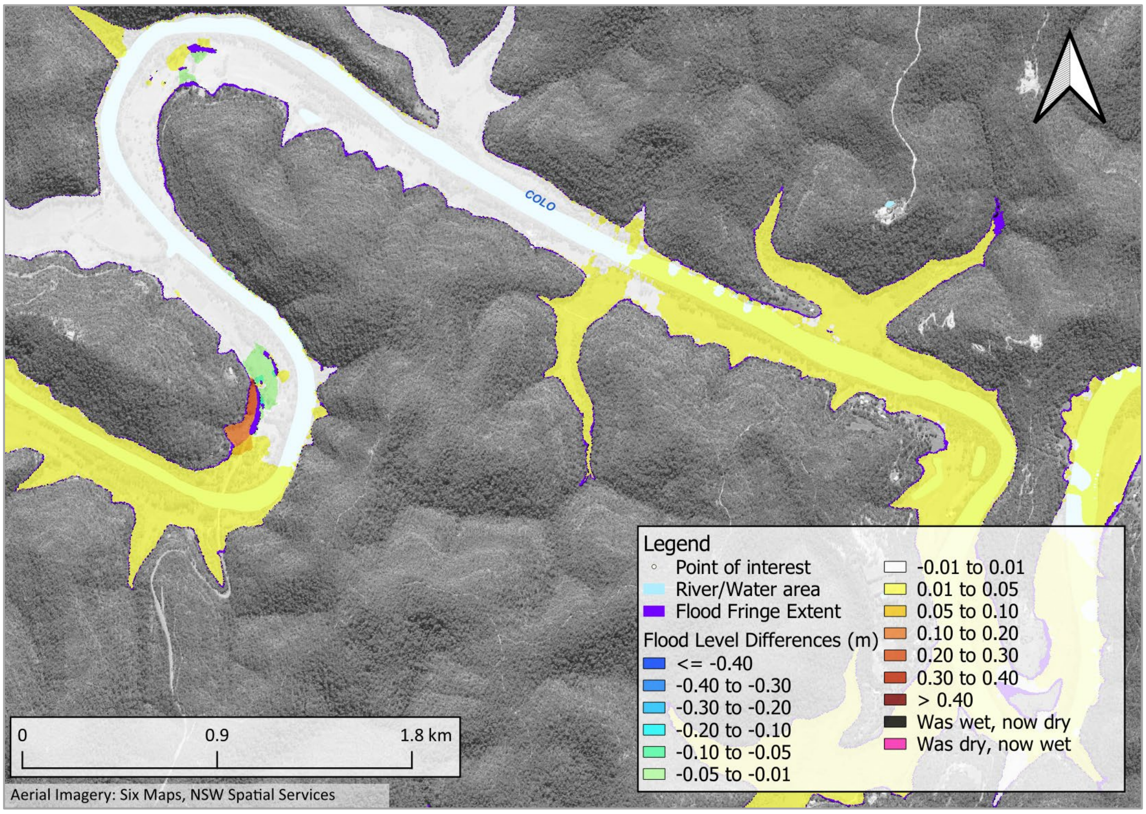


Figure E7 1% AEP flood level differences associated with filling across Flood Fringe Areas in Colo River (lower reach)

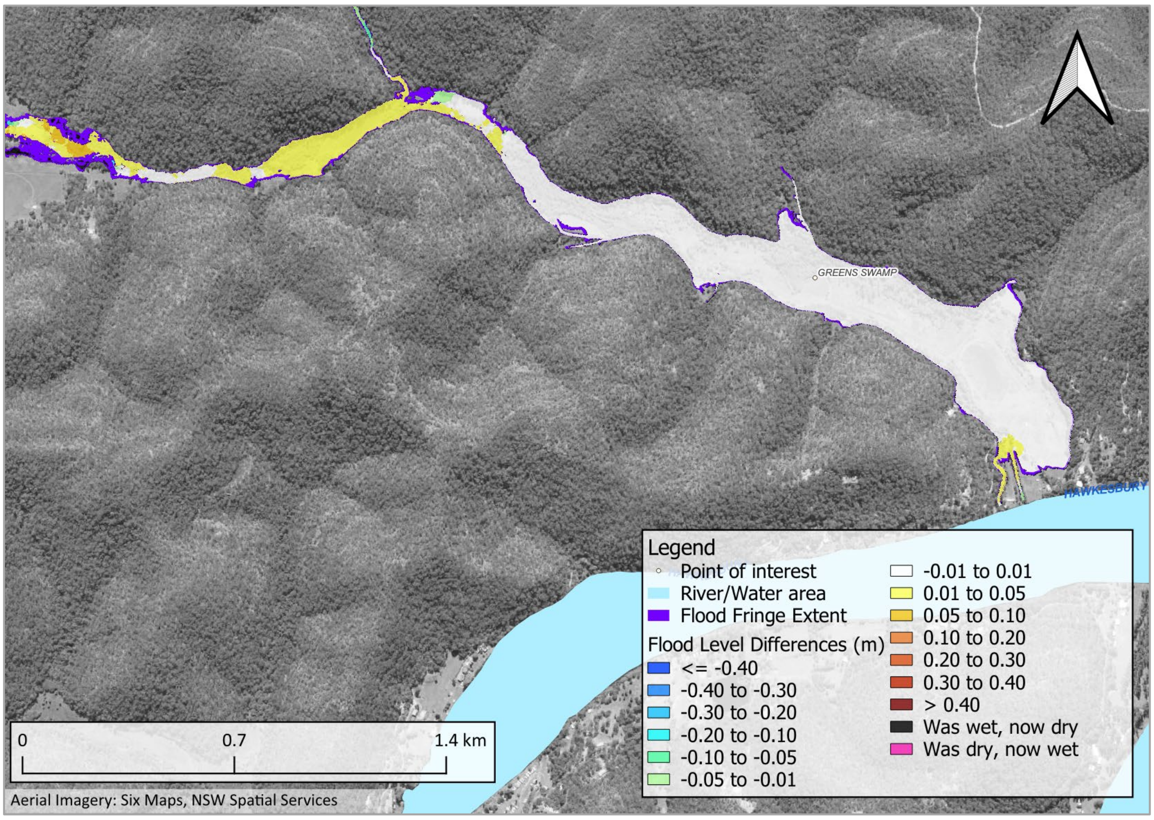


Figure E8 1% AEP flood level differences associated with filling across Flood Fringe Areas in Greens Creek

Appendix E – Flood Function Verification

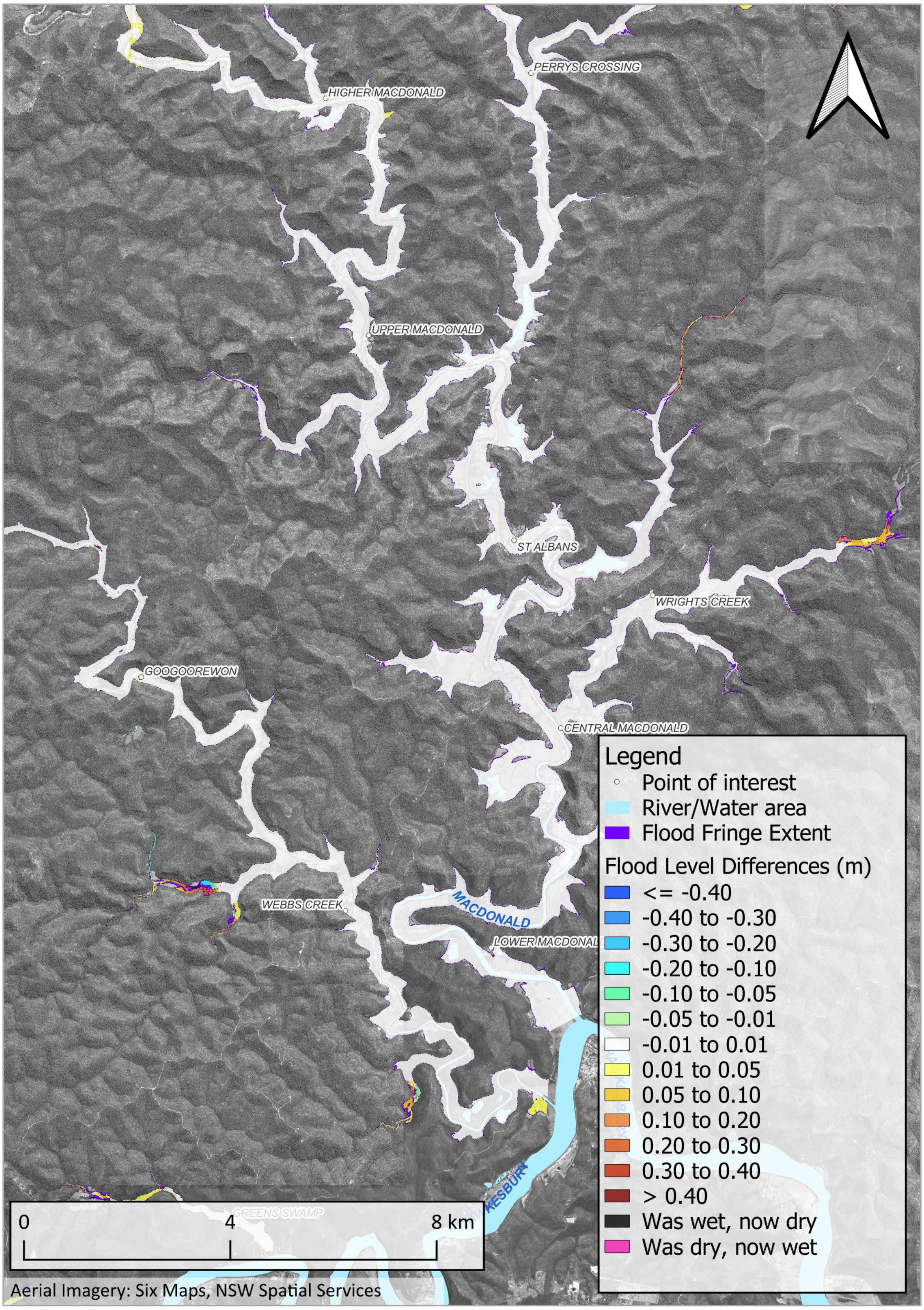


Figure E9 1% AEP flood level differences associated with filling across Flood Fringe Areas in Webbs Creek and Macdonald River

Appendix E – Flood Function Verification

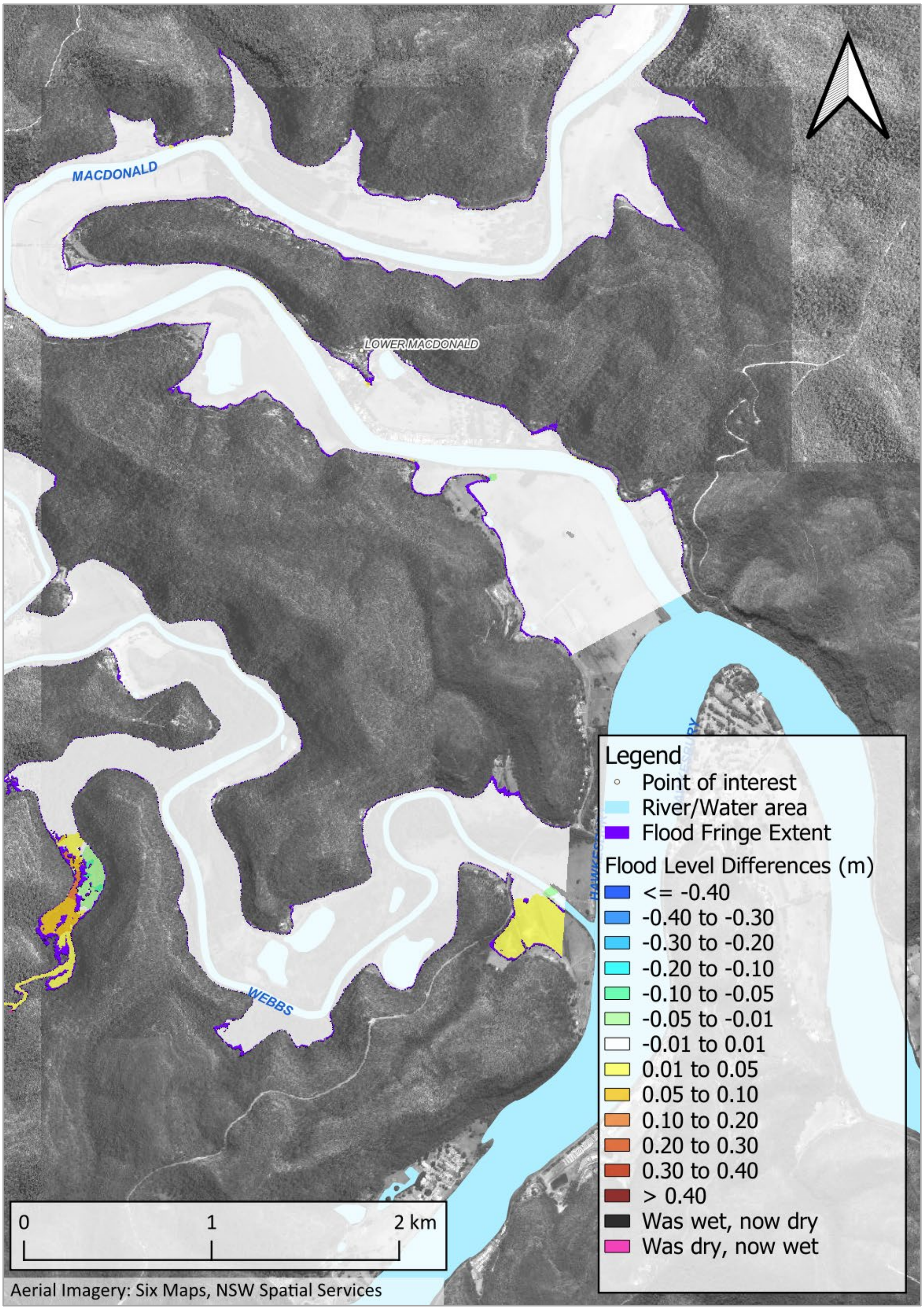


Figure E10 1% AEP flood level differences associated with filling across Flood Fringe Areas in Webbs Creek and Macdonald River (lower reach)

Appendix F

Bridge Loss Calculations and Blockage

Name:	Upper Colo Bridge (Previous)
Road:	Colo Heights Road
Watercourse:	Colo

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Hawkesbury City Council Design Plans

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D   M = 1

K_b = **0.00**

K_p (Pier Coefficient)

Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	5.60	-1.00	6.60	0.6	0.6
2	5.60	-1.00	6.60	0.6	0.6
3	5.60	-1.00	6.60	0.6	0.6
4	5.60	-1.00	6.60	0.6	0.6

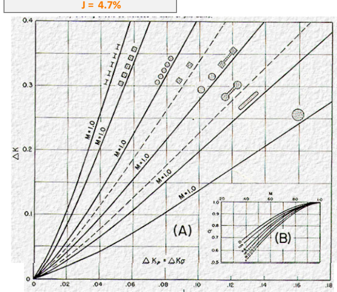
Area calculations based on river stage = 5.60 mAHD

Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$ A_p = 16 m^2

J = 0.046830653 A_{n2} = 338 m^2

J = 4.7%



Pier Type: Dual Circular Pier

σ = 1.00
ΔK = 0.11

$K_p = \sigma\Delta K$

K_p = **0.11**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K^*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K^* = 0.11   **Blockage = 4.7%**

Bridge Deck and Guardrails

<u>Bridge deck:</u> Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)
<u>Guardrail:</u> Lc = 0.0 & 50% blockage (TMR, 2019)

Name:	Upper Colo Bridge
Road:	Colo Heights Road
Watercourse:	Colo

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Bridge Design Pty Ltd 2021

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

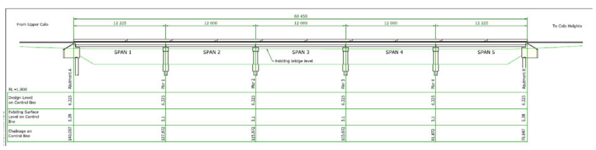
K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D

M = 1

K_b = **0.00**

K_p (Pier Coefficient)



Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	4.95	2.90	2.05	0.6	0.6
2	4.95	2.90	2.05	0.6	0.6
3	4.95	2.90	2.05	0.6	0.6
4	4.95	2.90	2.05	0.6	0.6

Area calculations based on river stage = 4.95 mAHD

Ratio of gross waterway area to pier area

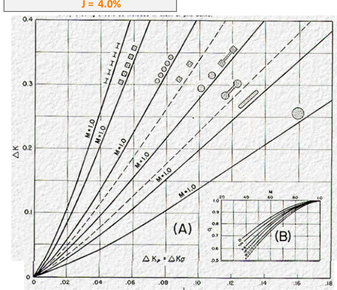
$J = A_p / A_{n3}$

A_p = 5 m^2

A_{n2} = 124 m^2

J = 0.039735099

J = 4.0%



Pier Type: Dual Circular Pier

σ = 1.00

ΔK = 0.09

$K_p = \sigma\Delta K$

K_p = **0.09**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K* = 0.09

Blockage = 4.0%

Bridge Deck and Guardrails

Bridge deck: Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)
Guardrail: Lc = 0.0 & 50% blockage (TMR, 2019)

Name:	Putty Road Bridge
Road:	Putty Road
Watercourse:	Colo

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Roads and Traffic Autority NSW 1993

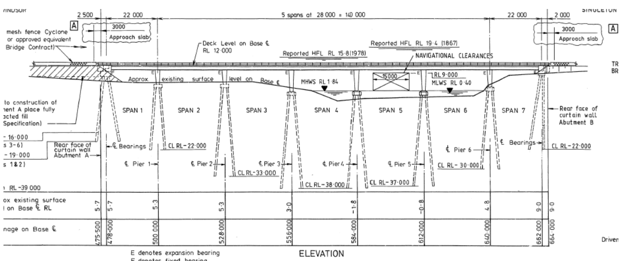
The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D   M = 1

K_b = **0.00**

K_p (Pier Coefficient)



Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	9.00	5.30	3.70	1.6	6.8
2	9.00	5.30	3.70	1.6	6.8
3	9.00	3.00	6.00	1.6	6.8
4	9.00	-1.80	10.80	1.6	6.8
5	9.00	-0.80	9.80	1.6	6.8
6	9.00	4.80	4.20	1.6	6.8

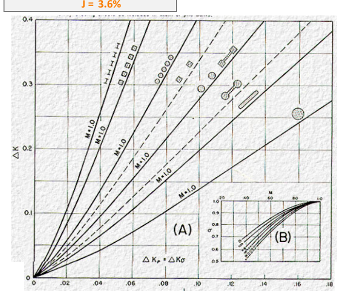
Area calculations based on river stage = 9.00 mAHD

Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$ A_p = 61 m^2

J = 0.036027115 A_{n2} = 1697 m^2

J = 3.6%



Pier Type: Single Rectangular Pier

σ = 1.00
ΔK = 0.06

$K_p = \sigma\Delta K$

K_p = **0.06**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K* = **0.06**   Blockage = 3.6%

Bridge Deck and Guardrails

Bridge deck: Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)
Guardrail: Lc = 0.0 & 50% blockage (TMR, 2019)

Name:	Lower Portland Bridge
Road:	Greens Road
Watercourse:	Colo

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Department of Public Works NSW 1966

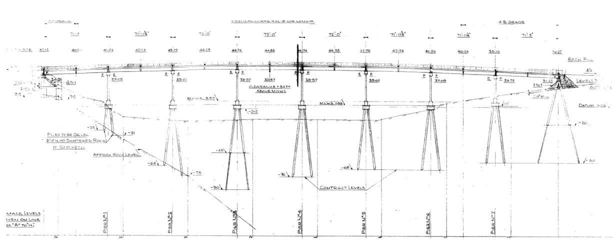
The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D — M = 1

K_b = **0.00**

K_p (Pier Coefficient)



Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	10.57	-0.66	11.23	0.4572	0.4572
2	11.40	-4.96	16.36	0.4572	0.4572
3	11.99	-4.48	16.47	0.4572	0.4572
4	12.32	-3.67	15.99	0.4572	0.4572
5	12.28	-2.63	14.91	0.4572	0.4572
6	11.99	-0.66	12.65	0.4572	0.4572
7	11.40	3.35	8.05	0.4572	0.4572

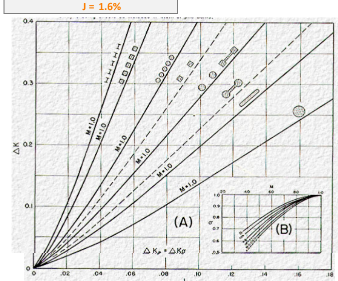
Area calculations based on river stage = 10.00 mAHD

Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$ — A_p = 38 m^2

J = 0.015996093 — A_{n2} = 2392 m^2

J = 1.6%



Pier Type: Linked Circular Pier

σ = 1.00
ΔK = 0.02

$K_p = \sigma \Delta K$

K_p = **0.024**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K* = 0.024 — **Blockage = 1.6%**

Bridge Deck and Guardrails

Bridge deck: Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)
Guardrail: Lc = 0.0 & 50% blockage (TMR, 2019)

Name:	Webbs Creek Bridge
Road:	Chaseling Road
Watercourse:	Webbs Creek

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Department of Main Roads, NSW 1970

The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

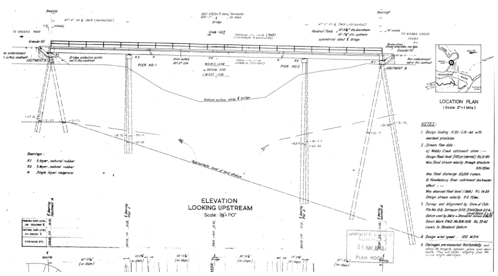
K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D

M = 1

K_b = **0.00**

K_p (Pier Coefficient)



Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	3.04	0.30	2.74	0.635	0.635
2	2.56	0.30	2.26	0.635	0.635

Area calculations based on river stage = 2.56 mAHD

Ratio of gross waterway area to pier area

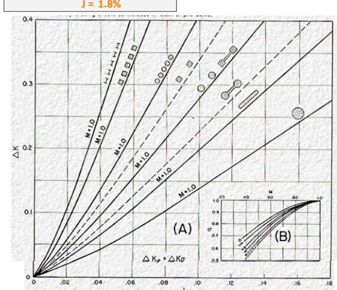
$J = A_p / A_{n3}$

A_p = 3 m^2

A_{n2} = 156 m^2

J = 0.018345531

J = 1.8%



Pier Type: Multi- Circular Pier

σ = 1.00

ΔK = 0.06

$K_p = \sigma\Delta K$

K_p = **0.06**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K* = 0.06

Blockage = 1.8%

Bridge Deck and Guardrails

Bridge deck: Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)

Guardrail: Lc = 0.0 & 50% blockage (TMR, 2019)

Name:	St Albans Bridge
Road:	Wollombi Road
Watercourse:	Macdonald

Reference: 'Hydraulics of Bridge Waterways: HDS 1' (Bradley, March 1978) + 'Technical Guideline: Hydrologic & Hydraulic Modelling' (TMR, 2019)

Department of Public Works

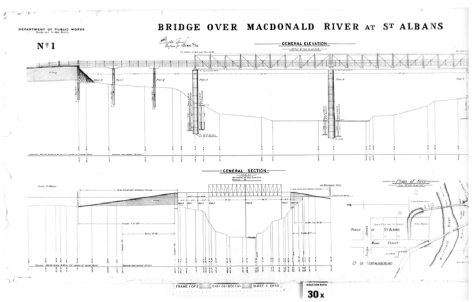
The total backwater (i.e., energy loss) coefficient is calculated as:
$K^* = K_b + K_p + K_e + K_s$

K_b (base coefficient)

Kb = 0 as contraction losses are fully represented in 2D   M = 1

K_b = **0.00**

K_p (Pier Coefficient)



Pier Number	Pier Top Elevation (mAHD)	Pier Bottom Elevation (mAHD)	Pier Height (m)	Pier Width (perpendicular to direction of flow) (m)	Pier Length (parallel to direction of flow) (m)
1	14.89	10.98	3.91	0.4826	0.4826
2	14.89	10.30	4.60	0.4826	0.4826
3	14.89	5.08	9.81	1.39065	1.39065
4	14.89	0.75	14.14	1.8288	1.8288
5	14.89	7.28	7.61	0.3048	0.3048

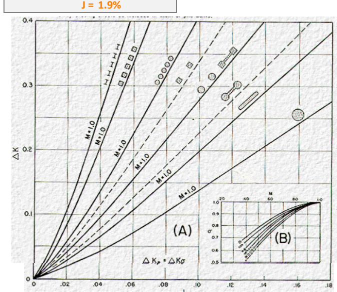
Area calculations based on river stage = 8.00 mAHD

Ratio of gross waterway area to pier area

$J = A_p / A_{n3}$ A_p = 15 m^2

J = 0.018531196 A_{n2} = 808 m^2

J = 1.9%



Pier Type: Linked Circular Pier

σ = 1.00
ΔK = 0.03

$K_p = \sigma\Delta K$

K_p = **0.028**

K_e (Eccentricity Coefficient)

Ecentricity represented in 2D.

K_e = **0.00**

K_s (Skew Coefficient)

Bridge skew represented in 2D

K_s = **0.00**

(K*) Total Backwater Coefficient for Bridge Substructure

$K^* = K_b + K_p + K_e + K_s$

K* = 0.028   Blockage = **1.9%**

Bridge Deck and Guardrails

Bridge deck: Lc = 1.6 & 100% blockage (AustRoads Waterway Design, Fig 5.18, 1994)
Guardrail: Lc = 0.0 & 50% blockage (TMR, 2019)

STRUCTURE BLOCKAGE ASSESSMENT

Structure Details			Structure Dimensions			Debris Potential								Adjustment for AEP			Design Blockage Level		
ID	Structure Type	Culvert Type: C - Circular, R-Rectangular	Inlet clear width (W)	Inlet clear height (D)	Cells / Spans	Upstream Land Use	Max. L10 (m)	Control Dimension	Debris Availability (L, M, H)	Debris Mobility (L, M, H)	Debris Transportability (L, M, H)	Debris Potential	Debris Potential at Structure	AEP >5%	AEP 5%-0.5%	AEP < 0.5%	AEP >5%	AEP 5%-0.5%	AEP < 0.5%
6	Culvert	C	1.2		1	Trees - high density	3.00	W<L	M	L	M	**MLM**	Low	Low	Low	Medium	25%	25%	50%
7	Culvert	C	0.6		1	Trees - high density	3.00	W<L	M	L	M	**MLM**	Low	Low	Low	Medium	25%	25%	50%
8	Culvert	C	1.2		2	Trees - high density	3.00	W<L	M	L	M	**MLM**	Low	Low	Low	Medium	25%	25%	50%
9	Culvert	C	0.9		1	Trees - high density	3.00	W<L	M	L	M	**MLM**	Low	Low	Low	Medium	25%	25%	50%

Rhelm

engineering | environmental | economics | engagement

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