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Planning Proposal Road Inundation.docxThe General Manager
Goulburn Mulwaree Council
184 Bourke Street
GOULBURN NSW 258013th September 2024**Attention: Ms Kate Wooll**

Dear Kate,

GOULBURN OVERLAND FLOODING RISK STUDY & MANAGEMENT PLAN
NORTH GOULBURN PLANNING PROPOSALS – OVERLAND FLOODING AFFECTATION OF ROADS**1. Background**

I refer to our fee proposal dated 7th August 2024 to provide additional information to support a number of planning proposals in North Goulburn. The relevant planning proposals are listed below.

- Large lot residential subdivision at 515 Crookwell Road, Kingsdale.
- Rezoning of 44 Middle Arm Road, Goulburn.
- Rezoning of a part of 129 Marys Mount Road and a part of 110-118 Middle Arm Road, Goulburn.
- Rezoning of 407 & 457 Crookwell Road, Goulburn.

Goulburn Mulwaree Council (Council) has completed preliminary Flood Impact and Risk Assessments (FIRA) for these planning proposals using existing flood model results from the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021).

It is understood that the NSW State Emergency Service (SES) is generally accepting of the findings presented in the FIRAs prepared by Council but requires additional information such as warning times and the estimated duration of inundation of several key roads in the vicinity of the subject lots. These key roads have been nominated as part of proposed evacuation routes for the four planning proposals listed above. The key roads to be assessed are shown in **Figure 1**.

Worley Consulting is currently engaged by Council to undertake the Goulburn Overland Flooding Risk Study and Management Plan. As part of this project, Council has provided a copy of the flood models developed for the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021).

Accordingly, Council has requested Worley Consulting to extract flood model results from the existing models developed for the 2021 overland flows study to determine warning times and duration of inundation of the key roads shown in **Figure 1**.

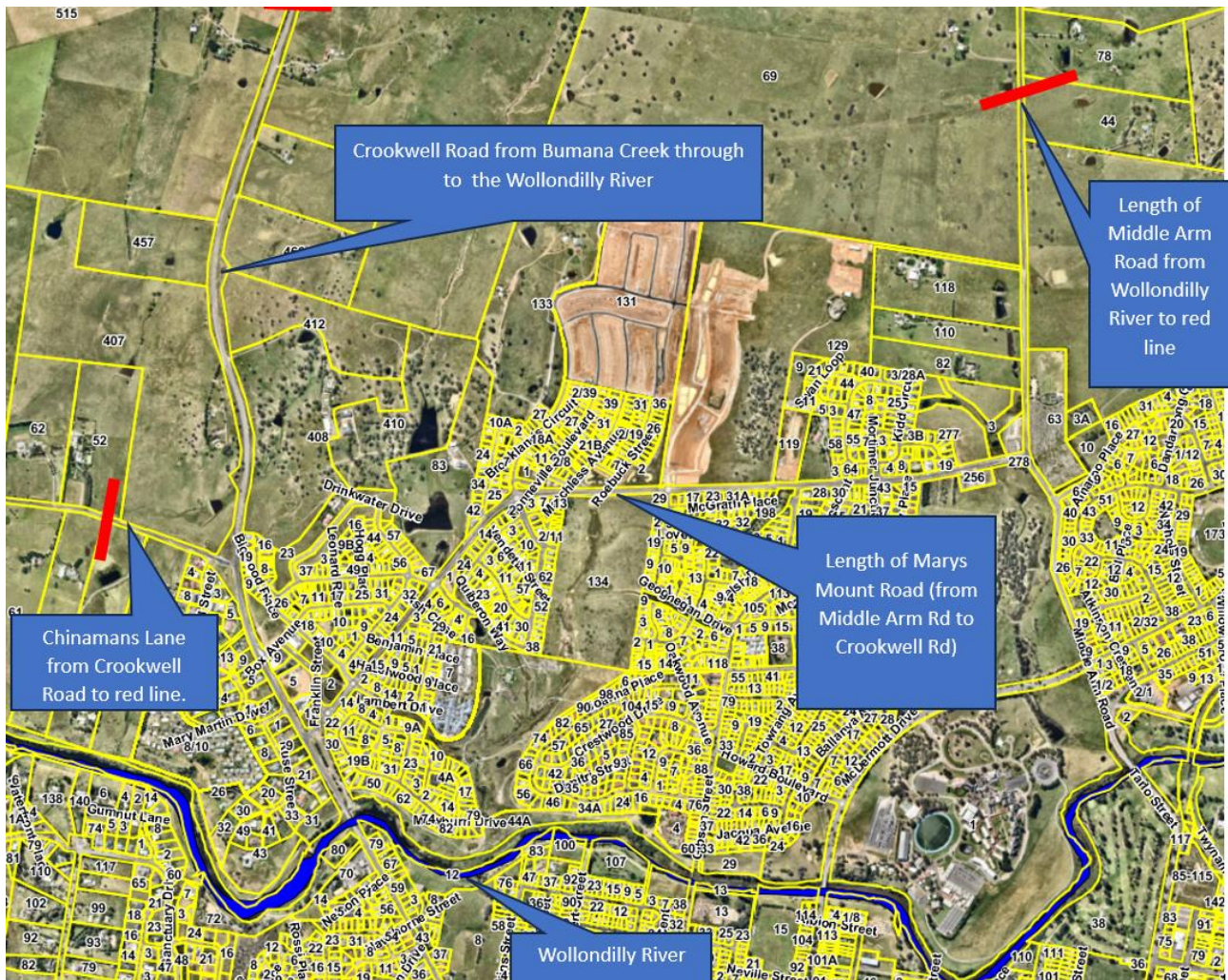


Figure 1 Location of roads to be analysed

2. Methodology and Assumptions

Worley Consulting has completed the following tasks.

- Established the provided WBNM and TUFLOW flood models which were developed for the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021).
- Utilised the existing flood models to simulate the critical duration storms for the 1% AEP event (2 hour and 9 hour storms), the 1 in 2000 AEP event (1 hour and 6 hour storms) and the Probable Maximum Flood (1 hour storm). These critical durations were specified in Section 6.1 of the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021).
- Extracted and tabulated available warning times and duration of inundation for the roads nominated by Council (refer **Figure 1**) for the five design events nominated above.

The following items were assumed when extracting available warning times and duration of inundation.

- It was assumed that the models developed for the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021) and which were provided by Council were suitable for the purposes of this analysis.
- It is understood that the flood models developed for the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021) were completed using rainfall data and techniques from Australian Rainfall and Runoff 1987 (ARR 1987). Therefore, the outcomes of this analysis may be subject to change when the modelling

is updated to Australian Rainfall and Runoff 2019 (ARR 2019) as part of the *Goulburn Overland Flooding Risk Study & Management Plan*.

- It is noted that the *Goulburn Overland Flow Modelling Report* (GRC Hydro, 2021) undertook a preliminary comparison of ARR 2019 and ARR 1987 rainfall data for the purposes of assessing overland flooding. The 2021 report recommended the adoption of ARR 1987 rainfall data and techniques as it achieved a closer match to the outcomes of an at-site rainfall intensity frequency analysis which was undertaken for the Bungonia (Inverary Park) gauge (gauge number 070012).
- Therefore, the adoption of ARR 1987 rainfall data and techniques for the purposes of assessing overland flooding of the key roads near the North Goulburn sites is considered appropriate.

3. Findings

The available warning time and duration of inundation for the key roads shown in **Figure 1** for the five nominated design events is documented in **Table 1**. The available warning time refers to the length of time from the onset of rainfall to the time when floodwaters first inundate the road.

It is noted that not all locations that become inundated have been reported, given that there are some locations where significant stretches of the road are inundated at the peak of the storm. Information has been provided for the locations where the earliest or most severe inundation is expected.

The locations where warning time and duration of inundation is provided is shown in **Figure 2**.

I trust that the findings documented above suitably addresses the requirements to update Council's existing Flood Impact and Risk Assessment for the North Goulburn Planning Proposals. Please feel free to contact me on 02 8456 7238 should you require anything further.

Yours faithfully,

WORLEY CONSULTING

A handwritten signature in grey ink, appearing to read "Lennox To".

Lennox To

Water Resources Engineer

FIGURE 2

LEGEND

▲ Reporting Locations

Peak 1 in 2000 AEP Flood Depths [m]

- 0 - 0.15
- 0.15 - 0.3
- 0.3 - 0.5
- 0.5 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 4
- > 4

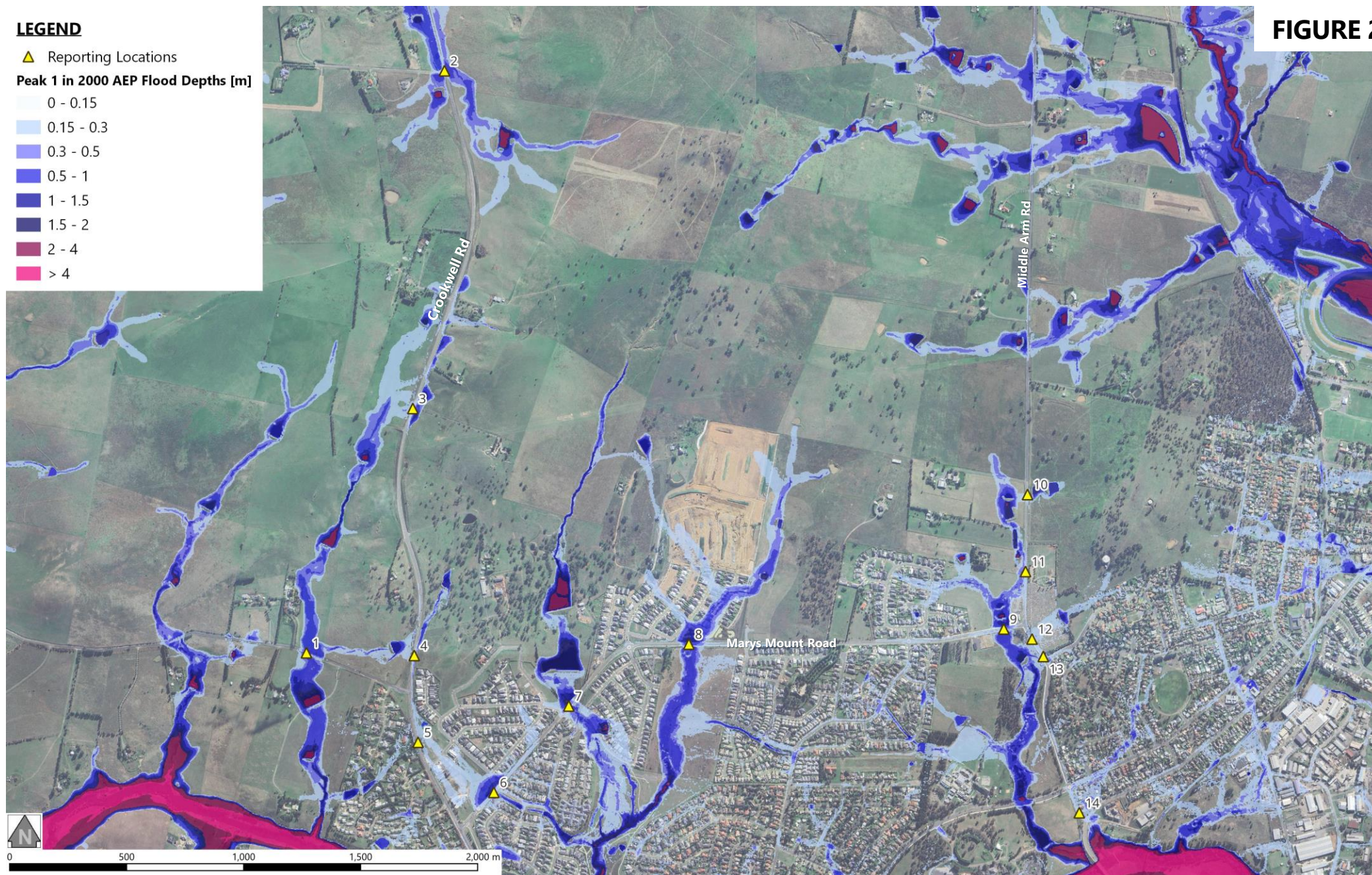


Table 1 Summary of warning times and duration of inundation at key locations

ID	Road	Location	Event	Peak flood depth (m)	Inundation greater than 0.00 m		Inundation greater than 0.15 m	
					Time to inundation (min)	Duration of inundation# (mins)	Time to inundation (min)	Duration of inundation# (min)
1	Chinamans Ln	480m west of Crookwell Rd / Chinamans Ln intersection	1% AEP 2 hour storm	0.34	41	140	44	137
			1% AEP 9 hour storm	0.37	170	911	180	463
			1 in 2000 AEP 1 hr storm	0.63	15	106	17	104
			1 in 2000 AEP 6 hr storm	0.47	43	578	47	453
			PMF 6hr storm	0.80	8	113	9	112
2	Crookwell Rd	Onslow Rd / Crookwell Rd intersection	1% AEP 2 hour storm	<0.01	64	19	N/A*	N/A*
			1% AEP 9 hour storm	<0.01	302	30	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.18	25	53	42	14
			1 in 2000 AEP 6 hr storm	0.02	61	244	N/A*	N/A*
			PMF 6hr storm	0.34	15	70	25	44
3	Crookwell Rd	1.2km north of Crookwell Rd / Chinamans Ln intersection	1% AEP 2 hour storm	0.12	58	123	N/A*	N/A*
			1% AEP 9 hour storm	0.12	224	857	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.21	21	100	24	45
			1 in 2000 AEP 6 hr storm	0.16	58	539	67	105
			PMF 6hr storm	0.27	11	110	14	60
4	Crookwell Rd	150m north of Crookwell Rd / Chinamans Ln intersection	1% AEP 2 hour storm	0.07	34	90	N/A*	N/A*
			1% AEP 9 hour storm	0.07	176	149	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.18	10	97	26	40
			1 in 2000 AEP 6 hr storm	0.14	37	328	N/A*	N/A*
			PMF 6hr storm	0.20	3	118	10	62
5	Crookwell Rd	100m north of Crookwell Rd / Box Av intersection	1% AEP 2 hour storm	<0.01	50	99	N/A*	N/A*
			1% AEP 9 hour storm	<0.01	302	109	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	<0.01	22	99	N/A*	N/A*
			1 in 2000 AEP 6 hr storm	<0.01	55	332	N/A*	N/A*
			PMF 6hr storm	<0.01	14	107	N/A*	N/A*

ID	Road	Location	Event	Peak flood depth (m)	Inundation greater than 0.00 m		Inundation greater than 0.15 m	
					Time to inundation (min)	Duration of inundation# (mins)	Time to inundation (min)	Duration of inundation# (min)
6	Marys Mount Rd	Lambert Dr / Marys Mount Rd intersection	1% AEP 2 hour storm	0.13	46	135	N/A*	N/A*
			1% AEP 9 hour storm	0.18	184	897	326	37
			1 in 2000 AEP 1 hr storm	0.29	20	101	26	75
			1 in 2000 AEP 6 hr storm	0.23	46	512	70	279
			PMF 6hr storm	0.35	14	107	16	105
7	Marys Mount Rd	Donnelly Cr / Marys Mount Rd intersection	1% AEP 2 hour storm	0.28	7	174	43	86
			1% AEP 9 hour storm	0.38	11	1070	299	176
			1 in 2000 AEP 1 hr storm	0.64	4	117	14	107
			1 in 2000 AEP 6 hr storm	0.52	5	478	47	387
			PMF 6hr storm	0.88	3	118	8	113
8	Marys Mount Rd	250m west of Kavanagh St / Marys Mount Rd intersection	1% AEP 2 hour storm	0.39	19	162	44	111
			1% AEP 9 hour storm	0.38	41	1040	206	238
			1 in 2000 AEP 1 hr storm	0.67	10	111	15	106
			1 in 2000 AEP 6 hr storm	0.50	17	425	48	349
			PMF 6hr storm	0.83	7	114	9	112
9	Marys Mount Rd	90m east of Middle Arm Rd / Marys Mount Rd intersection	1% AEP 2 hour storm	0.28	10	171	42	83
			1% AEP 9 hour storm	0.28	16	1065	287	98
			1 in 2000 AEP 1 hr storm	0.57	6	115	12	104
			1 in 2000 AEP 6 hr storm	0.41	8	713	49	318
			PMF 6hr storm	0.71	5	116	7	114
10	Middle Arm Rd	560m north of Middle Arm Rd / Marys Mount Rd intersection	1% AEP 2 hour storm	0.26	42	139	45	136
			1% AEP 9 hour storm	0.26	108	973	130	951
			1 in 2000 AEP 1 hr storm	0.36	18	103	20	101
			1 in 2000 AEP 6 hr storm	0.29	41	680	47	489
			PMF 6hr storm	0.42	12	109	13	108

ID	Road	Location	Event	Peak flood depth (m)	Inundation greater than 0.00 m		Inundation greater than 0.15 m	
					Time to inundation (min)	Duration of inundation# (mins)	Time to inundation (min)	Duration of inundation# (min)
11	Middle Arm Rd	230m north of Middle Arm Rd / Marys Mount Rd intersection	1% AEP 2 hour storm	0.10	59	122	N/A*	N/A*
			1% AEP 9 hour storm	0.08	202	879	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.32	15	106	19	46
			1 in 2000 AEP 6 hr storm	0.15	62	659	69	1
			PMF 6hr storm	0.47	6	115	8	67
12	Middle Arm Rd	70m south of Middle Arm Rd / Marys Mount Rd intersection	1% AEP 2 hour storm	0.04	23	131	N/A*	N/A*
			1% AEP 9 hour storm	0.04	180	270	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.24	3	118	21	40
			1 in 2000 AEP 6 hr storm	0.14	22	380	N/A*	N/A*
			PMF 6hr storm	0.33	2	119	14	53
13	Middle Arm Rd	Amaroo Pl / Middle Arm Rd intersection	1% AEP 2 hour storm	0.14	11	170	N/A*	N/A*
			1% AEP 9 hour storm	0.13	35	1046	N/A*	N/A*
			1 in 2000 AEP 1 hr storm	0.27	5	116	11	58
			1 in 2000 AEP 6 hr storm	0.19	8	713	53	209
			PMF 6hr storm	0.32	3	118	6	68
14	Middle Arm Rd	Taralga Rd / Middle Arm Rd intersection	1% AEP 2 hour storm	0.20	11	170	37	46
			1% AEP 9 hour storm	0.18	18	1063	290	50
			1 in 2000 AEP 1 hr storm	0.26	6	115	12	66
			1 in 2000 AEP 6 hr storm	0.21	9	638	41	273
			PMF 6hr storm	0.30	4	117	6	77

Notes:

- Duration of inundation varies across design storm events given the different critical durations for the 1% AEP, 1 in 2000 AEP and PMF events

* - Peak depth of flooding at this location is shallower than 0.15 metres