Amendments to Bulletin 53

The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method

Attached are amendment pages for Bulletin 53, *The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method*, December 1994.

The amendments relate to two aspects of the Bulletin:

- the design spatial distribution (Section 6 and Section A2.2 of Appendix 2); and
- notable point rainfall events recorded in Australia (Appendix 3).

It is important that practitioners adopt the new spatial distribution method described in this amendment and no longer use the method described in Bulletin 53, December 1994.

Replacements are provided for the following existing pages: viii, 34, 35, 38. The new pages 15, 16 and 16a replace existing pages 15 and 16, and new pages 28, 29 and 29a replace existing pages 28 and 29.

Issued December 1996.

Tables

6. Design spatial distribution of PMP

The design spatial distribution for convective storm PMP is given in Figure 10. It is based on that given by the United States Weather Bureau (1966) and the World Meteorological Organization (1986) but has been modified in the light of Australian experience. It assumes a virtually stationary storm and can be oriented in any direction with respect to the catchment. Instructions for the application of the spatial distribution are given below and an example is given in Appendix 2.2.

For simplicity and consistency of application, it is recommended that PMP depth be distributed using a step-function approach. This means having a constant value at all points in the interval between consecutive ellipses (or within the central ellipse), and stepping to a new constant value at each new ellipse. This constant value between ellipses is the mean rainfall depth for that interval and is derived by the procedure described below.

Instructions for the use of the spatial distribution diagram

Step 1 Positioning the spatial distribution diagram

Enlarge or reduce the size of the spatial distribution diagram (Figure 10) to match the scale of the catchment outline map. Overlay the spatial distribution diagram on the catchment outline and move it to obtain the best fit by the smallest possible ellipse. This ellipse is now the outermost ellipse of the distribution.

Step 2 Areas of catchment between successive ellipses

Determine the area of the catchment lying *between* successive ellipses ($CBtn_i$, where the ith ellipse is one of the ellipses A to J).

Where the catchment completely fills both ellipses, this is just the difference between the areas enclosed by each ellipse as given in Table 2:

$$CBtn_i = Area_i - Area_{i-1}$$

Where the catchment only partially fills the interval between ellipses, use planimetering or a similar method to determine this area.

Step 3 Area of catchment enclosed by each ellipse

Determine the area of the catchment *enclosed by* each ellipse ($CEnc_i$):

$$CEnc_i = \sum_{k=A}^{i} CBtn_k$$

The area of the catchment enclosed by the outermost ellipse will be equal to the total area of the catchment.

Step 4 Initial mean rainfall depth enclosed by each ellipse

Obtain the x-hour initial mean rainfall depths ($IMRD_i$) for each of the areas enclosed by successive ellipses ($CEnc_i$) (Step 3).

Where the catchment completely fills an ellipse ($CEnc_i$ ' $Area_i$), determine the x-hour initial mean rainfall depth for this area from Table 2. Where the catchment only partially fills an ellipse ($CEnc_i < Area_i$), determine the x-hour initial mean rainfall depth for that area from the appropriate DDA curves (Figure 4).

Table 2 Initial mean rainfall depth enclosed by ellipses A-H in Figure 10.

Ellipse label	Area enclosed (km^2)	Area between (km^2)	Initial mean rainfall depth (mm)										
			Duration (hours)										
			0.25	0.5	0.75	1	1.5	2	2.5	3	4	5	6
Smooth													
A	2.6	2.6	232	336	425	493	563	628	669	705	771	832	879
B	16	13.4	204	301	383	449	513	575	612	642	711	765	811
C	65	49	177	260	330	397	453	511	546	576	643	695	737
D	153	88	157	230	292	355	404	459	493	527	591	639	679
E	280	127	141	207	264	321	367	418	452	490	551	594	634
F	433	153	129	190	243	294	340	387	422	460	520	562	599
G	635	202	118	174	223	269	314	357	394	434	491	531	568
H	847	212	108	161	208	250	293	335	373	414	468	506	544
Rough													
A	2.6	2.6	232	336	425	493	636	744	821	901	1030	1135	1200
B	16	13.4	204	301	383	449	575	672	742	810	926	1018	1084
C	65	49	177	260	330	397	511	590	663	717	811	890	950
D	153	88	157	230	292	355	459	527	598	647	728	794	845
E	280	127	141	207	264	321	418	480	546	590	669	720	767
F	433	153	129	190	243	294	387	446	506	548	621	664	709
G	635	202	118	174	223	269	357	417	469	509	578	613	656
H	847	212	108	161	208	250	335	395	441	477	541	578	614

Note that no initial mean rainfall depths are required for ellipses I and J because the areas of these ellipses are greater than 1,000 km^2 which is the areal limit of the DDA curves.

Step 5 Adjusted mean rainfall depth enclosed by each ellipse

Adjust the initial mean rainfall depths for moisture and elevation using the adjustment factors and procedure described in Section 4:

$$AMRD_i = IMRD_i \times MAF \times EAF$$

The adjusted mean rainfall depth for the area enclosed by the outermost ellipse will be equal to the (unrounded) PMP for the whole catchment (Section 4.5).

Step 6 Volume of rainfall enclosed by each ellipse

Multiply the area of the catchment enclosed by each ellipse ($CEnc_i$) (Step 3) by the corresponding adjusted mean rainfall depth for that area ($AMRD_i$) (Step 5) to obtain the volume of rainfall over the catchment and within each ellipse ($VEnc_i$):

$$VEnc_i = AMRD_i \times CEnc_i$$

Step 7 Volume of rainfall between successive ellipses

Obtain the volume of rainfall over the catchment and between successive ellipses ($VBtn_i$) by subtracting the consecutive enclosed volumes ($VEnc_i$) (Step 6):

$$VBtn_i = VEnc_i - VEnc_{i-1}$$

The volume of rainfall within the central ellipse has already been obtained in Step 6.

Step 8 Mean rainfall depth between successive ellipses

Obtain the mean rainfall depth over the catchment and between successive ellipses (MRD_i) by dividing the volume of rainfall between the ellipses ($VBtn_i$) (Step 7) by the catchment area between them ($CBtn_i$) (Step 2):

$$MRD_i = \frac{VBtn_i(Step7)}{CBtn_i(Step2)}$$

Step 9 Other PMP Durations

Repeat steps 1 to 8 for other durations.

A2.2. Spatial distribution over the example catchment

In this example the distribution of the three-hour PMP only will be derived. Results are given in columns a-h of Table A2.2.

Step 1 Positioning the spatial distribution diagram

The scale of the spatial distribution diagram was altered to match that of the catchment outline map. The spatial distribution diagram was placed over the catchment outline to obtain the best fit by the smallest possible ellipse. Ellipse E encloses the catchment as shown in Figure A2.1.

Step 2 Areas of catchment between successive ellipses

The catchment areas *between* successive ellipses ($CBtn_i$) were determined. The results are listed in column b.

e.g. between ellipses A and B, $CBtn_B = 13.4\ km^2$ (from Table 2)
between ellipses B and C, $CBtn_C = 37.7\ km^2$ (by planimetering)

Step 3 Area of catchment enclosed by each ellipse

The catchment area *enclosed by* each ellipse ($CEnc_i$) (column c) was calculated by progressively accumulating the catchment areas between ellipses (column b).

e.g. for ellipse C, $CEnc_C = 2.6 + 13.4 + 37.7 = 53.7\ km^2$

As a check, the area enclosed by the outermost ellipse, ellipse E, which is 110 km^2, should equal the area of the catchment.

Step 4 Initial mean rainfall depth enclosed by each ellipse

Since the catchment completely fills ellipses A and B, the 3-hour initial mean rainfall depths ($IMRD_i$) at these areas may be determined from Table 2, weighting and summing the 'smooth' and 'rough' depths according to the proportions of 'smooth' and 'rough' terrain (Section A2.1).

i.e., 3 hr, ellipse A, 'smooth' = 705 mm
3 hr, ellipse A, 'rough' = 901 mm
❙ $IMRD_A = (0.1 \times 705 + 0.9 \times 901) = 881$ mm

For ellipses C, D and E, the initial mean rainfall depths were determined from the 3-hour DDA curves in Figure 4.

e.g. for ellipse C, 3 hr, 53.7 km^2, 'smooth' = 585 mm
3 hr, 53.7 km^2, 'rough' = 731 mm
❙ $IMRD_C = (0.1 \times 585 + 0.9 \times 731) = 716$ mm

The initial mean rainfall depths are listed in column d.

Step 5 Adjusted mean rainfall depth enclosed by each ellipse

The initial mean rainfall depths (column d) were adjusted for moisture and elevation (column e) by multiplying by the moisture and elevation adjustment factors (Section A2.1).

e.g. for ellipse C, $AMRD_C = 716 \times 0.59 \times 0.96 = 406$ mm

As a check, the adjusted mean rainfall depth for the area enclosed by the outermost ellipse, ellipse E, which is 376 mm, should equal the 3-hour (unrounded) PMP for the catchment (Section A2.1).

Step 6 Volume of rainfall enclosed by each ellipse

The adjusted mean rainfall depths (column e) were multiplied by the areas of the catchment enclosed by each ellipse (column c) to give values for the volume of rainfall enclosed by each ellipse ($VEnc_i$) (column f).

e.g. for ellipse C, $VEnc_C = 406 \text{ x } 53.7 = 21{,}802 \text{ mm km}^2$

Step 7 Volume of rainfall between successive ellipses

Consecutive enclosed rainfall volumes (column f) were subtracted to obtain the rainfall volume between ellipses ($VBtn_i$) (column g).

e.g. between ellipses B and C, $VBtn_C = 21{,}802 - 7{,}184 = 14{,}618 \text{ mm km}^2$

Step 8 Mean rainfall depth between successive ellipses

The mean rainfall depths between successive ellipses (MRD_i) (column h) were obtained by dividing the rainfall volume between ellipses (column g) by the area between ellipses (column b).

e.g. between ellipses B and C, $MRD_C = 14{,}618 / 37.7 = 388$ mm

Step 9 Other PMP Durations

Repeat the above steps for other durations for which the spatial distribution of PMP is required.

Table A2.2 Calculation of the spatial distribution of three-hour PMP over the example catchment

a	b	c	d	e	f	g	h
	Step 2	**Step 3**	**Step 4**	**Step 5**	**Step 6**	**Step 7**	**Step 8**
Ellipse	Catchment area between ellipses (km^2)	Catchment area enclosed by ellipse (km^2)	Initial meanl rainfall depth (mm)	Adjusted mean rainfall depth (mm)	Rainfall volume enclosed by ellipse (mm km^2)	Rainfall volume between ellipses (mm km^2)	Mean Rainfall depth between ellipses (mm)
A	2.6	2.6	881	499	1,297	1,297	499
B	13.4	16	793	449	7,184	5,887	439
C	37.7	53.7	716	406	21,802	14,618	388
D	42.6	96.3	673	382	36,787	14,985	352
E	13.7	**110**	663	**376**	41,360	4,573	334

Table A3.4 Notable point rainfall events - Queensland.

Location	Date ended	Duration (min)	Rainfall (mm)	Source
Tamborine Village	26 Oct 1960	4	18	
Theodore	11 Jan 1977	6	33	BoM
Eton	8 Dec 1984	6	39	BoM
Winton	16 Nov 1902	8	44	
Prairie	16 Nov 1974	12	52	BoM
Gatton-Lawes	1 Jan 1969	12	53	BoM
Gogango	1 Jan 1964	15	73	
Gatton-Lawes	1 Jan 1969	18	65	BoM
Mary Valley	4 Dec 1940	20	89	
Nobby	11 Mar 1939	20	203	
Enoggera	2 Oct 1869	25	100	
Benarby	28 Nov 1949	25	102	
Gatton-Lawes	1 Jan 1969	30	90	BoM
Wamuran	19 Mar 1963	30	152	
Wegonning Station	24 Feb 1913	40	130	
Townson (Laidley)	19 Dec 1991	45	176	BoM
Florence	4 Dec 1920	60	230	
Gunyerwarilli	20 Nov 1937	80	270	
Mt Dangar	19 Jan 1970	120	279	
Upper Ross	3 Mar 1946	120	305	
Dingo	14 Feb 1911	130	260	
Topaz	15 Apr 1982	140	204	BoM
Mt Pelion	17 Feb 1958	150	292	
Ingham	4 Jan 1980	180	315	BoM
Kumbia	14 Mar 1941	180	356	
Mt Kumba	13 Mar 1941	210	406	
Binbee	6 Jan 1980	270	607	
Mt Dangar	19 Jan 1970	300	463	
Mackay	18 Feb 1958	300	508	
Elaroo	18 Feb 1958	300	538	BoM
Ingham	4 Jan 1980	360	488	BoM
Mt Pelion	18 Feb 1958	360	589	
Kamo	18 Feb 1958	480	508	
Paluma	9 Jan 1972	720	617	BoM
Duck Creek	20 Jan 1970	840	864	
Bellenden Ker Top	4 Jan 1979	1440	960	BoM
Bellenden Ker Top	4 Jan 1979	1800	1330	BoM
Bellenden Ker Top	5 Jan 1979	2520	1577	BoM
Beerwah (Crohamhurst)	2 Feb 1893	2880	1417	BoM
Bellenden Ker Top	5 Jan 1979	2880	1947	BoM
Bellenden Ker Top	5 Jan 1979	4320	2517	BoM
Bellenden Ker Top	8 Jan 1979	11520	3847	BoM

Table A3.5 Notable point rainfall events - South Australia.

Location	Date ended	Duration (min)	Rainfall (mm)	Source
Adelaide	3 May 1942	2	11	BoM
Adelaide	3 May 1942	5	14	BoM
Punyelroo	28 Dec 1916	5	18	
Woomera	27 Nov 1977	6	20	BoM
Adelaide	6 Feb 1925	7	17	BoM
Coonalpyn	2 Jan 1963	8	22	
Woomera	27 Nov 1977	12	30	BoM
Yangya	4 Nov 1934	15	51	
Cunliffe	25 Mar 1974	20	61	
Myponga Beach	6 Dec 1986	20	68	Private
Arcoona	27 Nov 1903	25	65	
Mt Remarkable	4 Jun 1978	46	80	
Angaston	13 Feb 1913	60	96	
Kanmantoo	12 Dec 1894	60	115	
Strathalbyn	19 Apr 1980	90	107	
Gladstone	14 May 1974	90	112	
Port Pirie	31 Dec 1979	90	125	
Adelaide	6 Feb 1925	120	121	BoM
Dutton	2 Mar 1983	135	228	Private
Old Koomooloo	26 Nov 1903	150	146	
North Adelaide	6 Feb 1925	180	164	
North Dutton	2 Mar 1983	180	330	
Buckleboo	26 Jan 1981	240	191	
Waikerie	8 May 1989	420	239	Private
Nilpena	14 Mar 1989	1440	247	BoM
Motpena Station	14 Mar 1989	1440	273	BoM
Balcanoona	14 Mar 1989	2880	341	BoM
Innaminka Station	30 Jan 1974	4320	356	BoM
Hindmarsh Valley	26 Jan 1941	4320	376	EWSD

Table A3.8 Notable point rainfall events - Western Australia.

Location	Date ended	Duration (min)	Rainfall (mm)	Source
Karridale	25 Jun 1901	5	22	
Pannawonica	25 Jan 1967	6	32	BoM
Derby	20 Feb 1966	12	38	BoM
Broad Arrow	4 Nov 1902	15	51	
Frankland	30 Mar 1918	15	51	BoM
Pannawonica	25 Jan 1967	16	44	BoM
Halls Creek	23 Jan 1990	18	49	BoM
Derby	20 Feb 1966	18	57	BoM
Derby	20 Feb 1966	30	71	BoM
Ruby Plains	23 Mar 1904	45	88	
Geraldton	1 Aug 1909	50	84	BoM
Onslow	25 Jan 1971	60	91	BoM
Broome	18 Jan 1974	60	125	BoM
Broome	17 Jan 1982	120	127	BoM
Broome	18 Jan 1974	120	151	BoM
Broome	17 Jan 1982	180	154	BoM
Broome	18 Jan 1974	180	164	BoM
Condon	27 Mar 1896	300	234	
Fortescue	3 May 1890	1440	593	
Broome (Kilto)	5 Dec 1970	1440	635	BoM
Roebourne	3 Apr 1898	1440	747	BoM
Broome (Roebuck Plains)	6 Jan 1917	2880	924	BoM
Roebourne (Whim Creek)	3 Apr 1898	2880	927	BoM

Source

BoM: Bureau of Meteorology Climate Archives
EWSD: Engineering and Water Supply Department, South Australia
MW: Melbourne Water, Victoria
PAWA: Power and Water Authority, Northern Territory
Private: Privately owned rain gauge
PWD: NSW Public Works Department, New South Wales
SWB: Water Board, Sydney-Illawarra-Blue Mountains, New South Wales

Where the source is not listed the data were obtained from newspapers or the publications "Bureau of Meteorology, Results of Rainfall Observations made in ..."(All States) (- 1938) and were not able to be confirmed with original records or correspondence. The data were compiled prior to March 1993.