Probable Maximum Precipitation Application Guidelines

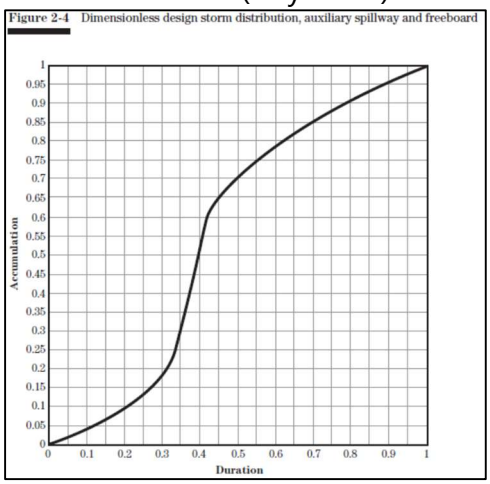
"Probable Maximum Precipitation Study for the State of Ohio" (April 2013, Applied Weather Associates, LLC) is acceptable and appropriate for determining Probable Maximum Precipitation (PMP) values under Ohio Administrative Code Rule 1501:21-13-02. This study shall supersede Hydrometeorological Report No. 51 (HMR51) by the National Weather Service for the purpose of determining design floods for dams within the division's jurisdiction.

"Probable Maximum Flood" or "PMF" means the flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the drainage basin under study. The "PMF" is derived from the PMP and is determined by using a hydrologic model to simulate the drainage basin's response to those critical conditions which produce the most severe flood runoff. **Because each basin is different, it is necessary to simulate multiple flood events using different PMP durations to determine the most severe flood. The most severe flood would then be called the PMF**. The table below provides guidance for application of PMP values for determining the PMF for a given drainage basin. These guidelines are intended for PMF analyses only. Other frequency-based flood analyses should use other appropriate procedures.

Drainage Basin Size	**Storm Duration**	**Rainfall Depth and Spatial Extent**	**Temporal Distribution**
<1 mi^2	6 hours	Obtain the rainfall depth from the 1 mi^2 PMP chart. The spatial extent of the storm is 1 mi^2.	Dimensionless Design Storm Distribution[A]
	24 hours	Obtain the rainfall depth from the 1 mi^2 PMP chart. The spatial extent of the storm is 1 mi^2.	SCS Type II at 1.5-hour time step[B]
1 mi^2 - 10 mi^2	6 hours	Determine the rainfall depth by interpolation between 6-hour, 1 mi^2 and 6-hour, 10 mi^2 PMP rainfall depths based on the drainage basin size.[C] The spatial extent of the storm is equal to the drainage basin size.	Dimensionless Design Storm Distribution[A]
	24 hours	Determine the rainfall depth by interpolation between 24-hour, 1 mi^2 and 24-hour, 10 mi^2 PMP rainfall depths based on the drainage basin size.[C] The spatial extent of the storm is equal to the drainage basin size.	SCS Type II at 1.5-hour time step[B]
>10 mi^2	72 hours	Use HMR52 to generate a 72-hour basin-specific storm[D]	Use HMR52 to generate a 72-hour basin-specific storm[D]

[A] The Dimensionless Design Storm Distribution is from NRCS, Technical Release 60 (July 2005).

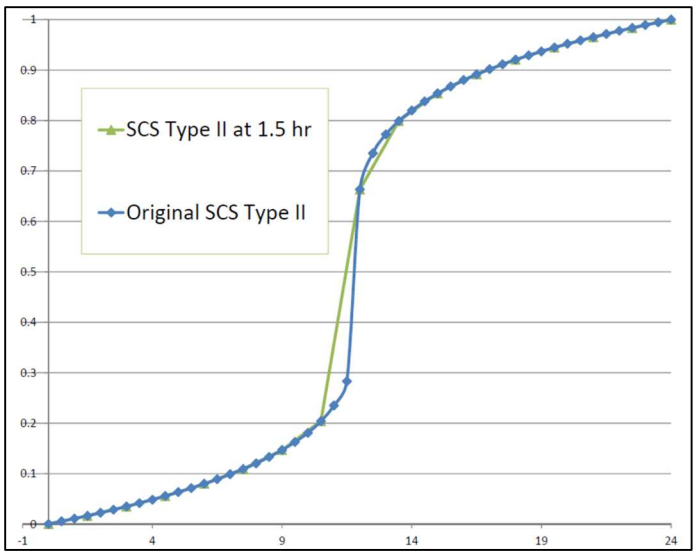
Hr.	Cum.	Incr	Hr.	Cum.	Incr	Hr.	Cum.	Incr
0	0.000	0	2.2	0.379	0.150	4.2	0.856	0.020
0.2	0.013	0.013	2.4	0.530	0.150	4.4	0.875	0.019
0.4	0.026	0.013	2.6	0.625	0.095	4.6	0.893	0.018
0.6	0.041	0.015	2.8	0.670	0.045	4.8	0.910	0.017
0.8	0.058	0.017	3	0.705	0.035	5	0.927	0.016
1	0.077	0.019	3.2	0.736	0.031	5.2	0.942	0.016
1.2	0.098	0.021	3.4	0.764	0.028	5.4	0.957	0.015
1.4	0.121	0.023	3.6	0.790	0.026	5.6	0.972	0.015
1.6	0.146	0.025	3.8	0.814	0.024	5.8	0.986	0.014
1.8	0.179	0.033	4	0.836	0.022	6	1.000	0.014
2	0.229	0.050						

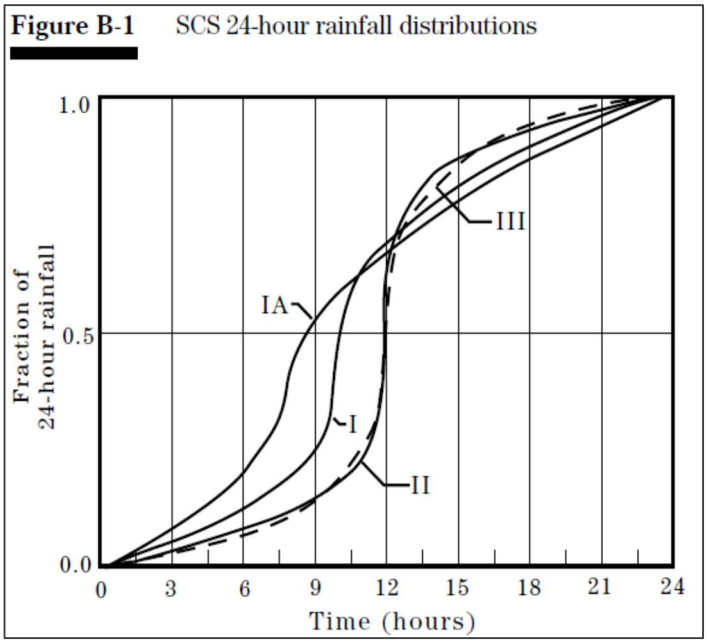


[B] The SCS Type II distribution at a 1.5-hour time step is shown below. The time step has been modified from the original distribution to provide peak intensities that are appropriate for Ohio storms. Please note that computer programs that use the original SCS Type II distribution will likely generate a flood peak that is inappropriately high. Note that this distribution has been converted to half hour increments for computer programs with limited data entry capabilities (2nd table below).

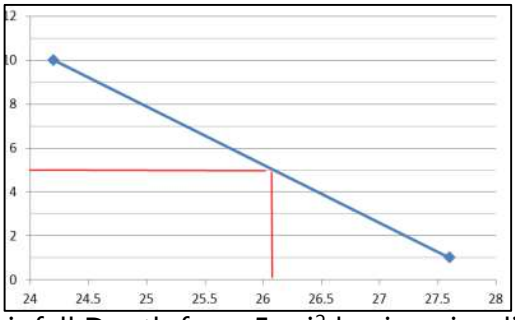
Hr.	Cum.	Incr	Hr.	Cum.	Incr
0	0	0	12	0.663	0.459
1.5	0.016	0.016	13.5	0.799	0.136
3	0.035	0.018	15	0.854	0.055
4.5	0.056	0.021	16.5	0.891	0.038
6	0.080	0.024	18	0.921	0.029
7.5	0.109	0.029	19.5	0.945	0.024
9	0.147	0.038	21	0.965	0.021
10.5	0.204	0.058	22.5	0.984	0.018
12	0.663	0.459	24	1	0.016

Hr.	Cum.	Hr.	Cum.	Hr.	Cum.	Hr.	Cum.	Hr.	Cum.	Hr.	Cum.
0	0	4.5	0.05525	9	0.147	13.5	0.799	18	0.921	22.5	0.98294
0.5	0.005377	5	0.0635	9.5	0.166	14	0.817167	18.5	0.929063	23	0.988627
1	0.010753	5.5	0.07175	10	0.185	14.5	0.835333	19	0.937127	23.5	0.994313
1.5	0.01613	6	0.08	10.5	0.204	15	0.8535	19.5	0.94519	24	1
2	0.022253	6.5	0.08975	11	0.357	15.5	0.866063	20	0.95171		
2.5	0.028377	7	0.0995	11.5	0.51	16	0.878627	20.5	0.95823		
3	0.0345	7.5	0.10925	12	0.663	16.5	0.89119	21	0.96475		
3.5	0.041417	8	0.121833	12.5	0.708333	17	0.901127	21.5	0.970813		
4	0.048333	8.5	0.134417	13	0.753667	17.5	0.911063	22	0.976877		

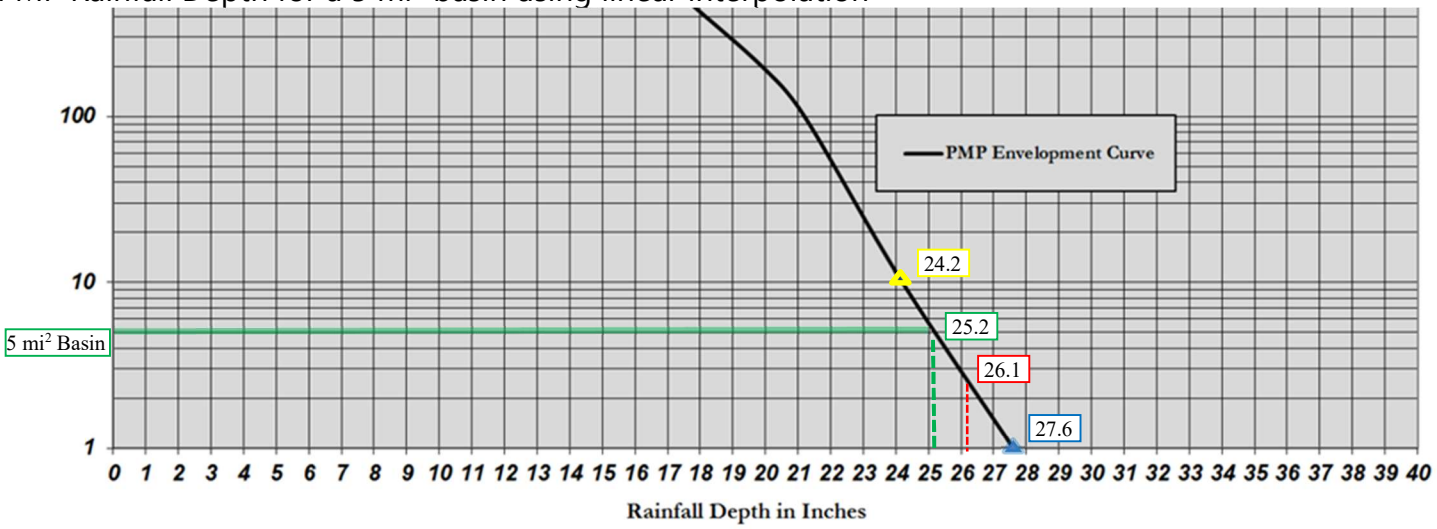




[C] PMP rainfall depths for drainage basins between 1 mi^2 and 10 mi^2 generally fit a straight line when the drainage basin/storm area is taken as log10. For the example shown below, the PMP rainfall depth for a 10 mi^2 basin (storm area) is 24.2 inches, and the PMP rainfall depth for 1 mi^2 basin is 27.6 inches. For a 5 mi^2 basin, a straight line interpolation (no log10) would calculate the PMP to be 26.1 inches, which is incorrect. The correct value for the 5 mi^2 PMP rainfall depth is 25.2 inches.



PMP Rainfall Depth for a 5 mi^2 basin using linear interpolation



PMP Rainfall Depth for a 5 mi^2 basin using interpolation with basin size as log10

[D] Hydrometeorological Report No. 52 (HMR52) describes application of PMP values east of the 105th Meridian. The US Army Corps of Engineers' HEC-HMS software includes a module for application of HMR52.

Comments:
In past analyses, there was confidence that the PMP values from HMR51 and the rainfall distributions were very conservative. The new PMP values and distributions no longer provide an additional safety factor; therefore, it is important to assure that appropriate, justified hydrologic parameters are used. Important items that need to be specifically addressed and documented in a hydrologic study for a dam are listed below:

- More detailed investigation of the time of concentration/lag time
- Justification for unit hydrograph duration
- When assessing infiltration/runoff using curve numbers, specifically address connected impervious, and the "Quality Cover" should be no higher than "fair" unless specifically justified.

Important References:
Natural Resources Conservation Service, National Engineering Handbook
Part 628 Dams, Chapter 50 Earth Spillway Design (1997)
Part 630 Hydrology, Chapter 9 Hydrologic Soil-Cover Complexes (2004), Chapter 15 Time of Concentration (2010), Chapter 16 Hydrographs (2007)

Natural Resources Conservation Service, Conservation Engineering Division
Earth Dams and Reservoirs, TR–60 (2019)

US Army Corps of Engineers, Hydrologic Engineering Center
HEC-1, Flood Hydrograph Package, User's Manual (1998)