

# Appendix

# E

## Minimum Depth of Rain at Which Runoff Begins



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This appendix provides a methodology for estimating the minimum depth of precipitation required to produce runoff for a given field with a given runoff curve number.

**Step 1:** Estimate the runoff curve for the field or land area of concern. Table 3 in Appendix R provides curve numbers for various combinations of land uses (e.g., row crops), cover treatment or practices (e.g., contoured), and hydrologic conditions (e.g., poor). The runoff curve numbers in this table represent Antecedent Runoff Condition III (e.g., saturated soils). To identify corresponding runoff curve numbers for Antecedent Runoff Condition II (i.e., average conditions) use either Appendix R-3 or Tables 2-2b and 2-2c in *Urban Hydrology for Small Watersheds*, USDA-NRCS, 1986 (see Appendix E-2).

To predict the possibility of runoff where rainfall is forecast in a season other than winter, it may be reasonable to use runoff curves for Antecedent Runoff Condition II.

**Step 2:** Using Table 10-1 on page 10-7 of the USDA-NRCS National Engineering Handbook Part 630, Hydrology (see Appendix E-1); select the curve number (CN) for the field being investigated.

**Step 3:** For the selected curve number in Table 10-1, identify the minimum depth of precipitation in inches required to produce runoff for a given runoff curve number (Column 5, designated with the column header of Curve\* starts where P =).

## Appendix E-1

## National Engineering Handbook Table 10-1 Curve Numbers (CN) and Constants for the Case $I_a = 0.2 S$

**Table 10-1** Curve numbers (CN) and constants for the case  $I_a = 0.2S$ 

1	2	3	4	5	1	2	3	4	5
CN for ARC II	-- CN for ARC -- I III		S values* (in)	Curve* starts where P = (in)	CN for ARC II	-- CN for ARC -- I III		S values* (in)	Curve* starts where P = (in)
100	100	100	0	0	60	40	78	6.67	1.33
99	97	100	.101	.02	59	39	77	6.95	1.39
98	94	99	.204	.04	58	38	76	7.24	1.45
97	91	99	.309	.06	57	37	75	7.54	1.51
96	89	99	.417	.08	56	36	75	7.86	1.57
95	87	98	.526	.11	55	35	74	8.18	1.64
94	85	98	.638	.13	54	34	73	8.52	1.70
93	83	98	.753	.15	53	33	72	8.87	1.77
92	81	97	.870	.17	52	32	71	9.23	1.85
91	80	97	.989	.20	51	31	70	9.61	1.92
90	78	96	1.11	.22	50	31	70	10.0	2.00
89	76	96	1.24	.25	49	30	69	10.4	2.08
88	75	95	1.36	.27	48	29	68	10.8	2.16
87	73	95	1.49	.30	47	28	67	11.3	2.26
86	72	94	1.63	.33	46	27	66	11.7	2.34
85	70	94	1.76	.35	45	26	65	12.2	2.44
84	68	93	1.90	.38	44	25	64	12.7	2.54
83	67	93	2.05	.41	43	25	63	13.2	2.64
82	66	92	2.20	.44	42	24	62	13.8	2.76
81	64	92	2.34	.47	41	23	61	14.4	2.88
80	63	91	2.50	.50	40	22	60	15.0	3.00
79	62	91	2.66	.53	39	21	59	15.6	3.12
78	60	90	2.82	.56	38	21	58	16.3	3.26
77	59	89	2.99	.60	37	20	57	17.0	3.40
76	58	89	3.16	.63	36	19	56	17.8	3.56
75	57	88	3.33	.67	35	18	55	18.6	3.72
74	55	88	3.51	.70	34	18	54	19.4	3.88
73	54	87	3.70	.74	33	17	53	20.3	4.06
72	53	86	3.89	.78	32	16	52	21.2	4.24
71	52	86	4.08	.82	31	16	51	22.2	4.44
70	51	85	4.28	.86	30	15	50	23.3	4.66
69	50	84	4.49	.90	25	12	43	30.0	6.00
68	48	84	4.70	.94	20	9	37	40.0	8.00
67	47	83	4.92	.98	15	6	30	56.7	11.34
66	46	82	5.15	1.03	10	4	22	90.0	18.00
65	45	82	5.38	1.08	5	2	13	190.0	38.00
64	44	81	5.62	1.12	0	0	0	infinity	infinity
63	43	80	5.87	1.17					
62	42	79	6.13	1.23					
61	41	78	6.39	1.28					

\* For CN in column 1.

**Appendix E-2**

**USDA Urban Hydrology for Small Watersheds (TR-55)**

**Table 2-2b** Runoff curve numbers for cultivated agricultural lands <sup>1/</sup>

Cover description			Curve numbers for hydrologic soil group				
Cover type	Treatment <sup>2/</sup>	Hydrologic condition <sup>3/</sup>	A	B	C	D	
Fallow	Bare soil	—	77	86	91	94	
	Crop residue cover (CR)	Poor	76	85	90	93	
		Good	74	83	88	90	
Row crops	Straight row (SR)	Poor	72	81	88	91	
		Good	67	78	85	89	
	SR + CR	Poor	71	80	87	90	
		Good	64	75	82	85	
	Contoured (C)	Poor	70	79	84	88	
		Good	65	75	82	86	
	C + CR	Poor	69	78	83	87	
		Good	64	74	81	85	
	Contoured & terraced (C&T)	Poor	Poor	66	74	80	82
			Good	62	71	78	81
		C&T+ CR	Poor	65	73	79	81
			Good	61	70	77	80
Small grain	SR	Poor	65	76	84	88	
		Good	63	75	83	87	
	SR + CR	Poor	64	75	83	86	
		Good	60	72	80	84	
	C	Poor	63	74	82	85	
		Good	61	73	81	84	
	C + CR	Poor	62	73	81	84	
		Good	60	72	80	83	
	C&T	Poor	61	72	79	82	
		Good	59	70	78	81	
	C&T+ CR	Poor	60	71	78	81	
		Good	58	69	77	80	
Close-seeded or broadcast legumes or rotation meadow	SR	Poor	66	77	85	89	
		Good	58	72	81	85	
	C	Poor	64	75	83	85	
		Good	55	69	78	83	
	C&T	Poor	63	73	80	83	
		Good	51	67	76	80	

<sup>1</sup> Average runoff condition, and  $I_a = 0.2S$

<sup>2</sup> Crop residue cover applies only if residue is on at least 5% of the surface throughout the year.

<sup>3</sup> Hydraulic condition is based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year-round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good  $\geq 20\%$ ), and (e) degree of surface roughness.

Poor: Factors impair infiltration and tend to increase runoff.

Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

**Table 2-2c** Runoff curve numbers for other agricultural lands <sup>1/</sup>

Cover description Cover type	Hydrologic condition	Curve numbers for hydrologic soil group			
		A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. <sup>2/</sup>	Poor	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.	—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. <sup>3/</sup>	Poor	48	67	77	83
	Fair	35	56	70	77
	Good	30 <sup>4/</sup>	48	65	73
Woods—grass combination (orchard or tree farm). <sup>5/</sup>	Poor	57	73	82	86
	Fair	43	65	76	82
	Good	32	58	72	79
Woods. <sup>6/</sup>	Poor	45	66	77	83
	Fair	36	60	73	79
	Good	30 <sup>4/</sup>	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.	—	59	74	82	86

<sup>1</sup> Average runoff condition, and  $I_a = 0.2S$ .

<sup>2</sup> *Poor:* <50% ground cover or heavily grazed with no mulch.

*Fair:* 50 to 75% ground cover and not heavily grazed.

*Good:* > 75% ground cover and lightly or only occasionally grazed.

<sup>3</sup> *Poor:* <50% ground cover.

*Fair:* 50 to 75% ground cover.

*Good:* >75% ground cover.

<sup>4</sup> Actual curve number is less than 30; use CN = 30 for runoff computations.

<sup>5</sup> CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

<sup>6</sup> *Poor:* Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

*Fair:* Woods are grazed but not burned, and some forest litter covers the soil.

*Good:* Woods are protected from grazing, and litter and brush adequately cover the soil.

## Appendix E-3

# Instructions for Determining Precipitation Forecasts for CAFO Permits Using the National Weather Service Website

**WARNING: Do not be intimidated.** This is much easier than it may seem at first. Once you learn how to do this and save the results in your Favorites you can check both forecasts in less than a minute (or up to a few minutes depending on your internet connection speed). In fact, you may find these forecast models useful in planning other areas of work on your farm.

Start at this website: [www.weather.gov/mdl/synop/products.php](http://www.weather.gov/mdl/synop/products.php). Once you are there you may wish to save it in your Favorites. If the website has changed or the required forecast models are not longer available, please contact the Michigan Department of Environmental Quality Office listed on your Certificate of coverage or on the cover page of your permit

1. Click on "Forecast Graphics" in the "GFS MOS (MAV)" box (near the center of the page).
2. In the column on the left side, in the drop down box under "Precipitation", click on "24H Prob. >= 0.50 in.". Note: if it has been determined that a smaller precipitation event is capable of producing runoff or erosion then use a smaller precipitation probability such as "24H Prob. >=0.25 in.".
3. This will bring up a map of the U.S. showing precipitation probabilities as colored bands or areas for the upcoming 24 hour period. Precision is not ideal because it covers all of the U.S. but estimate the color for the proposed land application area. If the precipitation probability is 70% or greater (blue shades) then you should not land apply. You can save the map in your favorites.
4. Underneath the map are day & time boxes such as "Tuesday" and "00" and "12". That would be Tuesday midnight and noon, GMT (Greenwich Mean Time) which is 5 hours ahead of EST (Eastern Standard Time) and 4 hours ahead of EDT (Eastern Daylight Time). So "Tuesday 00" would be 7 p.m. EST or 8 p.m. EDT Monday. The map forecast is for the 24 hour period ending at the highlighted time. The first box, which will be highlighted when you bring up the map, will give the map for the upcoming 24 hour period. You can click on subsequent time periods to see future forecasts. You should always check the immediate upcoming 24 hour forecast just prior to a planned land application event.

After you have finished checking the maps use your back button or go to your Favorites to return to the above website.

1. Click on "Text Message By Station List" in the "GFS MOS (MEX)" box (toward the right side on the page).
2. In the list of states on the left side click on "Michigan".

3. In the list that comes up on the right side click in the box for the station closest to the land application location. You may need to select 2 or 3 stations if none are close to the land application area. If selecting more than one station, note the 4-letter station designation after each station name so you know which chart is for which station.
4. Once you have selected the station(s) scroll to the bottom of the Michigan station list and click on "Go to the bottom to submit now". Then click on the "Submit Query" box.
5. You will now have a very confusing chart for each selected station (you can save this page in your Favorites). Look down the left hand column for "Q24" and read across the first number. It will be one digit from 0 to 6. This is the only number you need to be concerned with. This number is the quantity precipitation forecast for the upcoming 24 to 48 hour period. 0 = no precipitation, 1 = 0.01" to 0.09", 2 = 0.1" to 0.24", 3 = 0.25" to 0.49", 4 = 0.5" to 0.99", 5 = 1.0" to 1.99" and 6 = > 2.0". If it is 4 or greater you may not land apply. Note: if it has been determined that a smaller precipitation event is capable of producing runoff or erosion then use a smaller precipitation quantity forecast number. For example, if 0.35" of precipitation in 24 hours on a particular field will produce runoff or erosion then you may not land apply if the number is 3 or greater.
6. You may need to check the charts 2 or 3 times in advance of a planned land application event to determine the precipitation amount forecasted for the land application time frame.

In the event that you are immensely curious as to what all the rest of the data on these charts mean, then go back to the website at the top on these instructions and in the left hand column click on "GFS Description" to get to an explanation page.

Once you have saved the map and charts in your Favorites, you can click on those links and get to the current map or chart(s) with just one click!