HYDROLOGIC SOIL GROUPS FOR IOWA SOILS

Many variables influence the volume and rate of runoff from the ground surface. Soil properties are included in these variables. Physical properties of each soil series have been utilized to determine a factor called the hydrologic soil group (HSG). All soils fall into one of four HSGs.

Persons familiar with NRCS hydrology may notice that the HSG for many soil series have changed from what has been published in previous technical documents. Originally, some soils were assigned a HSG based on measured rainfall, runoff, and infiltrometer data. Other soils were then assigned a HSG based on a comparison of the soil profile without taking into account actual soil properties. In recent years, a scientific approach has been developed to determine the HSG based on the physical properties of the soil. Using this procedure, the HSG is determined by the soil layer with the lowest saturated hydraulic conductivity and the depth to any impermeable or nearly impermeable layer or the depth to the water table (if present). The least transmissive layer can be any soil horizon that transmits water at a slower rate relative to those horizons above or below it.

The four hydrologic soil groups are described as follows:

A Soils in this group have low runoff potential when thoroughly wet. Water is transmitted freely through the soil. Group A soils typically have less than 10 percent clay and more than 90 percent sand or gravel and have gravel or sand textures. Some soils having loamy sand, sandy loam, loam or silt loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

B Soils in this group have moderately low runoff potential when thoroughly wet. Water transmission through the soil is unimpeded. Group B soils typically have between 10 percent and 20 percent clay and 50 percent to 90 percent sand and have loamy sand or sandy loam textures. Some soils having loam, silt loam, silt, or sandy clay loam textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

C Soils in this group have moderately high runoff potential when thoroughly wet. Water transmission through the soil is somewhat restricted. Group C soils typically have between 20 percent and 40 percent clay and less than 50 percent sand and have loam, silt loam, sandy clay loam, clay loam, and silty clay loam textures. Some soils having clay, silty clay, or sandy clay textures may be placed in this group if they are well aggregated, of low bulk density, or contain greater than 35 percent rock fragments.

D Soils in this group have high runoff potential when thoroughly wet. Water movement through the soil is restricted or very restricted. Group D soils typically have greater than 40 percent clay, less than 50 percent sand, and have clayey textures. In some areas, they also have high shrink-swell potential. All soils with a depth to a water impermeable layer less than 20 inches and all soils with a water table within 24 inches of the surface are in this group, although some may have a dual classification, as described in the next paragraph, if they can be adequately drained.

Certain wet soils are placed in group D based solely on the presence of a water table within 24 inches of the surface even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, then they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. The first letter applies to the drained condition and the second to the undrained condition. For the purpose of hydrologic soil group, adequately drained means that the seasonal high water table is kept at least 24 inches below the surface in a soil where it would be higher in a natural state.

For a more detailed description of the procedure to assign a HSG to a specific soil series or for more detailed definitions of the various HSGs, refer to the NEH, Part 630, Chapter 7, Hydrologic Soil Groups.

In the past, Iowa has published a list of Hydrologic Soil Groups for each soil series found in the state. Due to the improvement in the technology, it is now possible to determine the HSG more accurately by map unit and on a county by county basis. Instead of publishing a list, the method to use to determine the HSG for a given soil is to go to the Field Office Technical Guide. **As of the date of this amendment, select the link "Field Office Technical Guide" under "Helpful Links" on the Iowa NRCS home page and navigate to the HSGs using the path outlined below:**

FOTG → Section II → Soils Information → Soil Survey Area → County Listing (pick your county of interest) → Soils Tables → Erosion Factors → Hyd Grp (column 7)

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HYDROLOGIC SOIL-COVER COMPLEXES

A combination of the effects of hydrologic soil group (soil) and the land use and treatment class (cover) is used to determine the runoff curve number (CN). The CN indicates the runoff potential of a soil-cover complex during periods when the soil is not frozen. The higher the CN, the higher the potential for runoff.

Land Use

Fallow is the land use with the highest potential for runoff because the land is kept as bare as possible to conserve moisture for use by a succeeding crop.

A row crop is any field crop planted in rows far enough apart that most of the soil surface is exposed to rainfall impact during the early growing season (i.e.: corn, soybeans, sorghum).

Small grain is planted in rows close enough together that the soil surface is not exposed except during planting and shortly thereafter.

Close-seeded legumes or rotation meadow are either planted in close rows or broadcast. This cover may be allowed to remain for more than a year so that year-round protection is given to the soil.

Pasture is a long term stand of forage plants which gives year-round protection to the soil.

Meadow is a field in which grass is continually grown, protected from grazing, and generally mowed for hay.

Woods are forested areas that have at least 30 percent canopy coverage as viewed by aerial photography.

Farmsteads include the area surrounding the farm headquarters including buildings, lots, driveways, etc.

Roads are improved travelways (not farm lanes). Hard surface roads include any type of asphalt or concrete paving. Road right-of-way is included in the total road area used to determine CN.

Treatment or Practice

Straight row fields are those farmed in straight rows either up and down hill or across the slope.

Contoured fields are those farmed as nearly as possible on the contour. The hydrologic effect of contouring is due to the surface storage provided by the furrows because the storage prolongs the time during which infiltration can take place. The magnitude of the storage depends not only on the dimensions of the furrows but also on the land slope, crop, and manner of planting and cultivation. See Contour Farming (330) in the Field Office Technical Guide for additional guidance.

The contoured and terraced condition is to be used for systems containing open-end level or graded terraces with grassed waterway outlets where all tillage is done on the contour between the terraces. The area above closed-end level terraces and terraces with tile outlets is to be included with the contoured area for runoff curve number computations.

Hydrologic Condition

Ratings as to “poor” or “good” are based largely on the proportion of dense vegetation in the rotation.

Pasture is considered poor if it is heavily grazed and has no mulch or has plant cover on less than half of the area. Fair pasture has plant cover on 50 to 75 percent of the area. Heavily grazed pasture in Iowa is generally considered to be fair pasture. Good pasture is lightly grazed and has plant cover on more than 75 percent of the area.

Poor woods are heavily grazed or are regularly burned and have no litter or new young growth. Fair woods are grazed but not burned. There may be some litter but these woods are not protected. Good woods are protected from grazing and have litter and shrubs covering the soil.

Table IA2-1 gives CN’s for agricultural land uses and for selected suburban and urban land uses.

Effects of Conservation Tillage

Cropland with conservation tillage and residue management practices will be considered to be in good hydrologic condition.

RUNOFF CURVE NUMBERS[1/]

TABLE IA2-1

COVER TYPE	LAND USE AND TREATMENT[2/]	HYDROLOGIC CONDITION[3/]	A	CN	B	CN	C	CN	D	CN
1	**FULLY DEVELOPED URBAN AREAS (Veg Est)**									
2	Open space (Lawns, parks, etc.)									
3	Poor condition; grass cover < 50%			68		79		86		89
4	Fair condition; grass cover 50% to 75%			49		69		79		84
5	Good condition; grass cover > 75%			39		61		74		80
6										
7	***Impervious Areas:***									
8	Paved parking lots, roofs, driveways			98		98		98		98
9										
10	Streets and roads:									
11	Paved; curbs and storm sewers			98		98		98		98
12	Paved; open ditches (w/ right-of-way)			83		89		92		93
13	Gravel (w/ right-of-way)			76		85		89		91
14	Dirt (w/ right-of-way)			72		82		87		89
15										
16	***Urban Districts***	Avg % Imperv								
17	Commercial & business	85		89		92		94		95
18	Industrial	72		81		88		91		93
19										
20	***Residential districts (by average lot size)***	Avg % Imperv								
21	1/8 acre (town houses)	65		77		85		90		92
22	1/4 acre	38		61		75		83		87
23	1/3 acre	30		57		72		81		86
24	1/2 acre	25		54		70		80		85
25	1 acre	20		51		68		79		84
26	2 acre	12		46		65		77		82
27										
28	***Western Desert Urban Areas***									
29	Natural desert (pervious areas only)			63		77		85		88
30	Artificial desert landscaping			96		96		96		96
31										
32	***User defined urban (Click button to define)***	Custom CN								
33	% Impervious Area:									
34	% Unconnected Impervious Area:									
35	Pervious Curve Number:									
36										
37	**DEVELOPING URBAN AREA (NO VEGETATION)**									
38	Newly graded area (pervious only)			77		86		91		94
39										
40	**CULTIVATED AGRICULTURAL LANDS**									
41	Fallow Bare soil	——		77		86		91		94
42	Fallow Crop residue (CR)	poor		76		85		90		93
43	Fallow Crop residue (CR)	good		74		83		88		90
44										
45	Row crop Straight row (SR)	poor		72		81		88		91
46	Straight row (SR)	good		67		78		85		89
47	SR + Crop residue	poor		71		80		87		90
48	SR + Crop residue	good		64		75		82		85
49	Contoured (C)	poor		70		79		84		88
50	Contoured (C)	good		65		75		82		86
51	C + Crop residue	poor		69		78		83		87
52	C + Crop residue	good		64		74		81		85
53	Cont & terraced (C&T)	poor		66		74		80		82
54	Cont & terraced (C&T)	good		62		71		78		81
55	C&T + Crop residue	poor		65		73		79		81
56	C&T + Crop residue	good		61		70		77		80
57										
58	Small grain Straight row (SR)	poor		65		76		84		88
59	Straight row (SR)	good		63		75		83		87
60										

RUNOFF CURVE NUMBERS 1/

TABLE IA2-1

COVER TYPE	LAND USE AND TREATMENT 2/	HYDROLOGIC CONDITION	A	CN	B	CN	C	CN	D	CN
60	Rotational No-Till OR No-Till	Good		60		69		75		80

1/ Rotational No-Till – A mostly no-till operation but includes a mulch till or conventional till (full width tillage) operation once in a 2-7 year period. STIR (Soil Tillage Intensity Rating from RUSLE2) values are between 6-30.

2/ No-Till – Every year soil and residue are left undisturbed from harvest to planting except for nutrient injection. STIR values are between 0-5.

RUNOFF CURVE NUMBERS[1/]
TABLE IA2-1

COVER TYPE	LAND USE AND TREATMENT[2/]	HYDROLOGIC CONDITION[3/]	A	CN	B	CN	C	CN	D	CN
61	SR + Crop residue	poor		64		75		83		86
62	SR + Crop residue	good		60		72		80		84
63	Contoured (C)	poor		63		74		82		85
64	Contoured (C)	good		61		73		81		84
65	C + Crop residue	poor		62		73		81		84
66	C + Crop residue	good		60		72		80		83
67	Cont & terraced (C&T)	poor		61		72		79		82
68	Cont & terraced (C&T)	good		59		70		78		81
69	C&T + Crop residue	poor		60		71		78		81
70	C&T + Crop residue	good		58		69		77		80
71										
72	Close-seeded Straight Row	poor		66		77		85		89
73	legumes or Straight Row	good		58		72		81		85
74	rotation Contoured	poor		64		75		83		85
75	meadow Contoured	good		55		69		78		83
76	Cont & terraced	poor		63		73		80		83
77	Cont & terraced	good		51		67		76		80
78										
79	**OTHER AGRICULTURAL LANDS**									
80	Pasture, grassland or range[4/]	poor		68		79		86		89
81	Pasture, grassland or range	fair		49		69		79		84
82	Pasture, grassland or range	good		39		61		74		80
83										
84	Meadow - cont. grass (non grazed)			30		58		71		78
85										
86	Brush - brush, weed, grass mix[5/]	poor		48		67		77		83
87	Brush - brush, weed, grass mix	fair		35		56		70		77
88	Brush - brush, weed, grass mix	good		30[6/]		48		65		73
89										
90	Woods - grass combination[7/]	poor		57		73		82		86
91	Woods - grass combination	fair		43		65		76		82
92	Woods - grass combination	good		32		58		72		79
93										
94	Woods[8/]	poor		45		66		77		83
95	Woods	fair		36		60		73		79
96	Woods	good		30		55		70		77
97										
98	Farmsteads	——		59		74		82		86
99	Feedlots									
100	Earthen	——		90		90		90		90
101	Paved			98		98		98		98

1/ Average runoff condition, and I_a=0.2s.

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

3/ Hydrologic condition is based on combinations of 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 ≥20%), and (e) degree of surface toughness.
Poor: factors impair infiltration and tend to increase runoff.
Good: Factors encourage average and better than average infiltration and tend to decrease runoff.
For conservation tillage poor hydrologic condition, 5 to 20% of the surface is covered with residue (less than 750 pounds per acre for row crops or 300 pounds per acre for small grain).
For conservation tillage good hydrologic condition, more than 20% of the surface is covered with residue (greater than 750 pounds per acre for row crops or 300 pounds per acre for small grain).

4/ 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.

5/ Poor: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.

6/ If actual curve number is less than 30, use CN = 30 for runoff computation.

7/ CNs shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CNs for woods and pasture.

8/ 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 letter and brush adequately cover the soil.

RAINFALL FREQUENCY TABLES

The following rainfall frequency tables cover a majority of the situations encountered in design of conservation practices in Iowa. They are based upon information contained in U.S. Weather Bureau Technical Papers No. 40 and 49; Hydrometeorological Report 51; USDA-NRCS, National Engineering Handbook, Section 4, Hydrology; and USDA-NRCS, Technical Release 60. It is intended that these tables be used in conjunction with the Iowa Standards and Specifications for Conservation Practices and other appropriate design criteria.

Hydrologic Design Criteria

The hydrologic design criteria for detention structures are one of the following: A1, A2, A3, B, and C. Two considerations are given in classifying a detention structure; the hazard classification and the product (effective height of a dam times the storage).

With regard to hazard classification, **class (a) or "low" hazard** dams are structures located in areas where damages from a failure would be limited to loss of the dam, loss of livestock, damages to farm out-buildings, agricultural land, and lesser used roads, and where loss of human life is considered unlikely. **Class (b) or "significant" hazard** dams are structures located in areas where failure may damage industrial or commercial buildings, moderately traveled roads or railroads, interrupt major utility services, but without substantial risk of loss of human life. **Class (c) or "high" hazard dams** are structures located in areas where failure may create a serious threat of loss of human life or result in serious damage to residential, industrial or commercial areas, important public utilities, public buildings, or major transportation facilities.

Class (a) or "low hazard" structures are further broken down into 3 classes based upon their product (the effective height of a dam times the storage). The classes are:

A1 = product less than 3,000. Use this design class for NHCP-378 structures, not TR-60 structures.

A2 = product 3,000 to 30,000 (TR-60)

A3 = product greater than 30,000 (TR-60)

QUICK RETURN FLOW BY COUNTY
See NEH, Part 630, Hydrology, Chapter 21

COUNTY	C.S.M.*
ADAIR	4
ADAMS	4
ALLAMAKEE	4
APPANOOSE	4
AUDUBON	3.5
BENTON	4
BLACK HAWK	4
BOONE	4
BREMER	4
BUCHANAN	4
BUENA VISTA	3
BUTLER	4
CALHOUN	3.5
CARROLL	3.5
CASS	3.5
CEDAR	4
CERRO GORDO	4
CHEROKEE	2.5
CHICKASAW	4
CLARKE	4
CLAY	3
CLAYTON	4
CLINTON	4
CRAWFORD	3
DALLAS	4
DAVIS	4
DECATUR	4
DELAWARE	4
DES MOINES	4
DICKINSON	3
DUBUQUE	4
EMMET	3.5
FAYETTE	4
FLOYD	4
FRANKLIN	4
FREMONT	3
GREENE	4
GRUNDY	4
GUTHRIE	4
HAMILTON	4
HANCOCK	4
HARDIN	4
HARRISON	2.5
HENRY	4
HOWARD	4
HUMBOLDT	4
IDA	3
IOWA	4
JACKSON	4
JASPER	4

COUNTY	C.S.M.*
JEFFERSON	4
JOHNSON	4
JONES	4
KEOKUK	4
KOSSUTH	4
LEE	4
LINN	4
LOUISA	4
LUCAS	4
LYON	2
MADISON	4
MAHASKA	4
MARION	4
MARSHALL	4
MILLS	3
MITCHELL	4
MONONA	2.5
MONROE	4
MONTGOMERY	3.5
MUSCATINE	4
OBRIEN	2.5
OSCEOLA	2.5
PAGE	3.5
PALO ALTO	3.5
PLYMOUTH	2
POCAHONTAS	3.5
POLK	4
POTTAWATTAMIE	3
POWESHIEK	4
RINGGOLD	4
SAC	3
SCOTT	4
SHELBY	3
SIOUX	2
STORY	4
TAMA	4
TAYLOR	4
UNION	4
VAN BUREN	4
WAPELLO	4
WARREN	4
WASHINGTON	4
WAYNE	4
WEBSTER	4
WINNEBAGO	4
WINNESHIEK	4
WOODBURY	2
WORTH	4
WRIGHT	4

* C.S.M. = cu.ft/sec/sq.mi.

6-HOUR RAINFALL DEPTHS FOR IOWA (inches)

COUNTY	5-Yr	10-Yr	25-Yr	50-Yr	Class "a" AS & 100-Yr	Class "a" FB&Class "b" AS	Class b" FB	Class "c" AS	Class "c" FB/PMP
ADAIR	3.1	3.7	4.2	4.7	5.3	7.8	13.7	10.7	26.6
ADAMS	3.2	3.7	4.3	4.8	5.3	7.9	13.8	10.8	26.7
ALLAMAKEE	2.8	3.3	3.7	4.2	4.6	7.1	12.9	10.0	25.3
APPANOOSE	3.1	3.7	4.3	4.7	5.2	7.8	13.9	10.9	27.0
AUDUBON	3.1	3.6	4.2	4.7	5.2	7.7	13.6	10.6	26.3
BENTON	3.0	3.5	4.0	4.4	4.9	7.4	13.4	10.4	26.3
BLACK HAWK	2.9	3.4	3.9	4.4	4.8	7.3	13.3	10.3	25.9
BOONE	3.1	3.6	4.1	4.6	5.1	7.6	13.5	10.6	26.2
BREMER	2.9	3.4	3.8	4.3	4.8	7.3	13.2	10.2	25.7
BUCHANAN	2.9	3.4	3.9	4.3	4.8	7.3	13.3	10.3	25.9
BUENA VISTA	2.9	3.4	3.9	4.5	4.9	7.4	13.2	10.3	25.5
BUTLER	2.9	3.4	3.9	4.4	4.8	7.3	13.2	10.3	25.8
CALHOUN	3.0	3.5	4.0	4.6	5.0	7.5	13.4	10.4	25.9
CARROLL	3.1	3.6	4.1	4.6	5.1	7.6	13.5	10.5	26.2
CASS	3.1	3.6	4.2	4.7	5.3	7.8	13.7	10.7	26.5
CEDAR	2.9	3.4	3.9	4.4	4.8	7.4	13.4	10.5	26.5
CERRO GORDO	2.9	3.4	3.9	4.4	4.8	7.3	13.1	10.2	25.4
CHEROKEE	2.9	3.4	3.9	4.4	4.9	7.4	13.1	10.2	25.5
CHICKASAW	2.9	3.3	3.8	4.3	4.7	7.2	13.0	10.1	25.5
CLARKE	3.2	3.7	4.3	4.8	5.3	7.8	13.9	10.9	26.8
CLAY	2.9	3.3	3.9	4.4	4.8	7.3	13.0	10.1	25.3
CLAYTON	2.9	3.3	3.8	4.2	4.7	7.2	13.1	10.1	25.6
CLINTON	2.9	3.4	3.9	4.3	4.7	7.3	13.3	10.4	26.5
CRAWFORD	3.0	3.5	4.1	4.6	5.1	7.5	13.4	10.5	26.1
DALLAS	3.1	3.6	4.2	4.7	5.1	7.7	13.6	10.7	26.4
DAVIS	3.1	3.6	4.2	4.7	5.2	7.8	13.9	10.9	27.0
DECATUR	3.2	3.7	4.3	4.8	5.3	7.9	13.9	11.0	26.9
DELAWARE	2.9	3.3	3.8	4.3	4.7	7.3	13.3	10.3	25.8
DES MOINES	3.1	3.5	4.1	4.5	4.9	7.6	13.7	10.7	26.9
DICKINSON	2.8	3.3	3.8	4.4	4.7	7.2	12.9	10.0	25.2
DUBUQUE	2.8	3.3	3.8	4.2	4.7	7.2	13.2	10.3	25.8
EMMET	2.8	3.3	3.8	4.4	4.8	7.2	12.9	10.0	25.2
FAYETTE	2.9	3.3	3.8	4.3	4.7	7.2	13.1	10.1	25.6
FLOYD	2.9	3.4	3.8	4.3	4.8	7.2	13.0	10.2	25.5
FRANKLIN	2.9	3.4	3.9	4.4	4.9	7.4	13.3	10.3	25.8
FREMONT	3.2	3.7	4.3	4.8	5.3	7.9	13.8	10.9	26.7
GREENE	3.1	3.6	4.1	4.6	5.1	7.6	13.5	10.5	26.2
GRUNDY	2.9	3.5	3.9	4.4	4.9	7.4	13.4	10.4	26.0
GUTHRIE	3.1	3.6	4.2	4.7	5.2	7.7	13.6	10.7	26.4
HAMILTON	3.0	3.5	4.0	4.5	5.0	7.5	13.4	10.4	26.0
HANCOCK	2.9	3.4	3.9	4.4	4.9	7.3	13.1	10.2	25.4
HARDIN	3.0	3.5	4.0	4.5	4.9	7.4	13.4	10.4	26.0
HARRISON	3.0	3.5	4.1	4.6	5.1	7.6	13.5	10.5	26.3
HENRY	3.1	3.5	4.1	4.5	5.0	7.7	13.7	10.7	26.9
HOWARD	2.8	3.3	3.7	4.2	4.7	7.1	12.9	10.1	25.3
HUMBOLDT	3.0	3.4	4.0	4.5	4.9	7.4	13.2	10.3	25.6
IDA	2.9	3.5	4.0	4.5	4.9	7.4	13.3	10.3	25.8

6-HOUR RAINFALL DEPTHS FOR IOWA (inches)

COUNTY	5-Yr	10-Yr	25-Yr	50-Yr	Class "a" AS & 100-Yr	Class "a" FB&Class "b" AS	Class b" FB	Class "c" AS	Class "c" FB/PMP
IOWA	3.0	3.5	4.0	4.5	4.9	7.4	13.5	10.5	26.5
JACKSON	2.8	3.3	3.8	4.2	4.7	7.2	13.3	10.3	26.3
JASPER	3.0	3.6	4.1	4.6	5.1	7.6	13.6	10.7	26.4
JEFFERSON	3.1	3.6	4.1	4.6	5.1	7.7	13.7	10.7	26.9
JOHNSON	3.0	3.5	4.0	4.4	4.9	7.4	13.5	10.5	26.5
JONES	2.9	3.4	3.9	4.3	4.8	7.3	13.3	10.4	26.3
KEOKUK	3.1	3.6	4.1	4.6	5.0	7.6	13.7	10.7	26.7
KOSSUTH	2.9	3.4	3.9	4.4	4.8	7.3	13.0	10.2	25.3
LEE	3.1	3.6	4.1	4.6	5.1	7.7	13.8	10.8	27.0
LINN	2.9	3.4	3.9	4.4	4.8	7.4	13.4	10.4	26.3
LOUISA	3.0	3.5	4.0	4.5	4.9	7.6	13.6	10.6	26.7
LUCAS	3.1	3.7	4.2	4.7	5.2	7.8	13.9	10.9	26.8
LYON	2.7	3.2	3.7	4.3	4.7	7.2	12.9	10.0	25.1
MADISON	3.1	3.7	4.2	4.7	5.3	7.8	13.7	10.8	26.6
MAHASKA	3.1	3.6	4.1	4.6	5.1	7.7	13.7	10.7	26.8
MARION	3.1	3.6	4.2	4.7	5.1	7.7	13.7	10.7	26.8
MARSHALL	3.1	3.5	4.0	4.5	5.0	7.5	13.5	10.5	26.2
MILLS	3.1	3.6	4.2	4.8	5.3	7.8	13.7	10.8	26.6
MITCHELL	2.8	3.3	3.7	4.3	4.7	7.2	12.9	10.1	25.3
MONONA	2.9	3.5	4.0	4.6	5.0	7.5	13.4	10.4	26.0
MONROE	3.1	3.6	4.2	4.7	5.2	7.8	13.8	10.8	26.9
MONTGOMERY	3.1	3.7	4.3	4.8	5.3	7.8	13.8	10.8	26.7
MUSCATINE	3.1	3.4	4.0	4.4	4.9	7.5	13.5	10.5	26.6
OBRIEN	2.9	3.3	3.8	4.4	4.8	7.2	13.0	10.1	25.3
OSCEOLA	2.8	3.3	3.7	4.3	4.7	7.2	12.9	10.0	25.2
PAGE	3.2	3.7	4.3	4.8	5.4	7.9	13.9	10.9	26.8
PALO ALTO	2.9	3.4	3.9	4.4	4.9	7.3	13.1	10.1	25.4
PLYMOUTH	2.9	3.4	3.9	4.4	4.8	7.3	13.1	10.2	25.5
POCAHONTAS	2.9	3.4	4.0	4.5	4.9	7.4	13.3	10.3	25.5
POLK	3.1	3.6	4.1	4.6	5.1	7.6	13.6	10.7	26.4
POTTAWATTAMIE	3.1	3.6	4.2	4.7	5.2	7.7	13.6	10.7	26.5
POWESHIEK	3.0	3.5	4.0	4.5	5.0	7.6	13.5	10.6	26.5
RINGGOLD	3.2	3.7	4.3	4.8	5.4	8.0	13.9	10.9	26.9
SAC	3.0	3.5	4.0	4.5	5.0	7.5	13.3	10.3	25.8
SCOTT	2.9	3.4	3.9	4.3	4.7	7.4	13.4	10.5	26.6
SHELBY	3.1	3.6	4.1	4.7	5.2	7.6	13.5	10.6	26.2
SIOUX	2.8	3.3	3.8	4.3	4.7	7.2	12.9	10.1	25.3
STORY	3.1	3.6	4.1	4.6	5.1	7.5	13.5	10.5	26.2
TAMA	3.0	3.5	4.0	4.5	4.9	7.4	13.4	10.5	26.2
TAYLOR	3.2	3.7	4.3	4.8	5.4	8.0	13.9	10.9	26.8
UNION	3.2	3.7	4.3	4.8	5.3	7.9	13.9	10.9	26.8
VAN BUREN	3.1	3.6	4.2	4.6	5.1	7.8	13.8	10.9	27.0
WAPELLO	3.1	3.6	4.2	4.6	5.1	7.8	13.7	10.8	26.9
WARREN	3.1	3.6	4.2	4.7	5.2	7.8	13.7	10.8	26.6
WASHINGTON	3.0	3.5	4.1	4.5	4.9	7.6	13.6	10.6	26.7
WAYNE	3.2	3.7	4.3	4.8	5.3	7.9	13.9	10.9	27.0
WEBSTER	3.0	3.5	4.0	4.5	5.0	7.5	13.4	10.4	25.9

6-HOUR RAINFALL DEPTHS FOR IOWA (inches)

COUNTY	5-Yr	10-Yr	25-Yr	50-Yr	Class "a" AS & 100-Yr	Class "a" FB&Class "b" AS	Class "b" FB	Class "c" AS	Class "c" FB/PMP
WINNEBAGO	2.8	3.3	3.8	4.4	4.7	7.2	13.0	10.1	25.2
WINNESHIEK	2.8	3.3	3.7	4.2	4.6	7.1	12.9	10.0	25.3
WOODBURY	2.9	3.4	3.9	4.5	4.9	7.4	13.2	10.3	25.8
WORTH	2.8	3.3	3.8	4.3	4.7	7.2	13.0	10.1	25.2
WRIGHT	2.9	3.4	4.0	4.5	4.9	7.4	13.3	10.3	25.6

24-HOUR RAINFALL DEPTHS BY COUNTY (inches)

COUNTY	2 Yrs	5 Yrs	10 Yrs	25 Yrs	50 Yrs	100 Yrs
ADAIR	3.2	4.1	4.8	5.6	6.2	6.8
ADAMS	3.2	4.2	4.8	5.6	6.3	6.9
ALLAMAKEE	3.0	3.8	4.3	5.0	5.5	6.2
APPANOOSE	3.3	4.2	4.9	5.6	6.2	6.9
AUDUBON	3.1	4.0	4.7	5.4	6.1	6.7
BENTON	3.1	4.0	4.6	5.3	5.8	6.5
BLACK HAWK	3.1	3.9	4.5	5.2	5.8	6.5
BOONE	3.0	4.0	4.7	5.4	6.0	6.6
BREMER	3.1	3.9	4.5	5.2	5.7	6.4
BUCHANAN	3.1	3.9	4.5	5.2	5.7	6.4
BUENA VISTA	3.0	3.8	4.4	5.1	5.8	6.4
BUTLER	3.1	3.9	4.5	5.2	5.8	6.5
CALHOUN	3.1	3.9	4.5	5.3	5.9	6.5
CARROLL	3.1	4.0	4.6	5.3	6.0	6.6
CASS	3.1	4.1	4.8	5.5	6.2	6.8
CEDAR	3.1	4.0	4.5	5.2	5.7	6.5
CERRO GORDO	3.0	3.9	4.5	5.2	5.7	6.4
CHEROKEE	3.0	3.8	4.4	5.1	5.8	6.3
CHICKASAW	3.0	3.9	4.4	5.1	5.7	6.4
CLARKE	3.2	4.2	4.9	5.6	6.3	6.9
CLAY	3.0	3.8	4.4	5.1	5.7	6.3
CLAYTON	3.1	3.8	4.4	5.1	5.6	6.3
CLINTON	3.1	3.9	4.5	5.1	5.6	6.4
CRAWFORD	3.0	3.9	4.5	5.3	6.0	6.6
DALLAS	3.2	4.1	4.7	5.5	6.1	6.7
DAVIS	3.3	4.2	4.8	5.6	6.2	6.8
DECATUR	3.3	4.2	4.9	5.7	6.4	7.0
DELAWARE	3.1	3.9	4.5	5.1	5.7	6.4
DES MOINES	3.2	4.1	4.7	5.4	5.9	6.7
DICKINSON	2.9	3.7	4.3	5.0	5.6	6.2
DUBUQUE	3.1	3.9	4.4	5.1	5.6	6.3
EMMET	3.0	3.8	4.4	5.0	5.7	6.3
FAYETTE	3.0	3.9	4.4	5.1	5.6	6.4

24-HOUR RAINFALL DEPTHS BY COUNTY (inches)

COUNTY	2 Yrs	5 Yrs	10 Yrs	25 Yrs	50 Yrs	100 Yrs
FLOYD	3.0	3.9	4.5	5.2	5.7	6.4
FRANKLIN	3.1	3.9	4.5	5.2	5.8	6.5
FREMONT	3.2	4.1	4.8	5.6	6.3	6.9
GREENE	3.1	4.0	4.6	5.4	6.0	6.6
GRUNDY	3.1	4.0	4.6	5.3	5.8	6.5
GUTHRIE	3.1	4.1	4.7	5.5	6.1	6.7
HAMILTON	3.1	4.0	4.6	5.3	5.9	6.6
HANCOCK	3.0	3.9	4.5	5.2	5.7	6.4
HARDIN	3.1	4.0	4.6	5.3	5.9	6.6
HARRISON	3.0	3.9	4.6	5.3	6.0	6.6
HENRY	3.2	4.1	4.7	5.4	6.0	6.7
HOWARD	3.0	3.8	4.4	5.1	5.6	6.3
HUMBOLDT	3.1	3.9	4.5	5.2	5.8	6.5
IDA	3.0	3.8	4.5	5.2	5.9	6.4
IOWA	3.2	4.1	4.7	5.3	5.9	6.6
JACKSON	3.1	3.9	4.4	5.0	5.6	6.4
JASPER	3.2	4.1	4.7	5.5	6.0	6.7
JEFFERSON	3.2	4.2	4.8	5.4	6.0	6.8
JOHNSON	3.2	4.0	4.6	5.3	5.8	6.6
JONES	3.1	3.9	4.5	5.1	5.7	6.4
KEOKUK	3.2	4.1	4.7	5.4	6.0	6.7
KOSSUTH	3.0	3.8	4.4	5.1	5.7	6.4
LEE	3.3	4.2	4.8	5.4	6.0	6.8
LINN	3.1	4.0	4.6	5.2	5.8	6.5
LOUISA	3.2	4.1	4.7	5.4	5.9	6.6
LUCAS	3.2	4.2	4.8	5.6	6.2	6.9
LYON	2.8	3.6	4.2	4.9	5.5	6.1
MADISON	3.2	4.1	4.8	5.6	6.2	6.8
MAHASKA	3.2	4.1	4.8	5.5	6.1	6.8
MARION	3.2	4.1	4.8	5.5	6.1	6.8
MARSHALL	3.2	4.0	4.7	5.4	5.9	6.6
MILLS	3.1	4.1	4.8	5.5	6.2	6.8
MITCHELL	3.0	3.8	4.4	5.1	5.6	6.3
MONONA	3.0	3.8	4.5	5.2	5.9	6.5
MONROE	3.3	4.2	4.8	5.6	6.2	6.8
MONTGOMERY	3.2	4.1	4.8	5.6	6.3	6.8
MUSCATINE	3.2	4.0	4.6	5.2	5.8	6.5
OBRIEN	2.9	3.7	4.3	5.0	5.7	6.2
OSCEOLA	2.9	3.7	4.3	4.9	5.6	6.2
PAGE	3.2	4.2	4.9	5.7	6.4	6.9
PALO ALTO	3.0	3.8	4.4	5.1	5.7	6.4
PLYMOUTH	2.9	3.7	4.3	5.0	5.7	6.2
POCAHONTAS	3.0	3.9	4.5	5.2	5.8	6.4
POLK	3.2	4.1	4.7	5.5	6.1	6.7
POTTAWATTAMIE	3.1	4.0	4.7	5.4	6.1	6.7

24-HOUR RAINFALL DEPTHS BY COUNTY (inches)

COUNTY	2 Yrs	5 Yrs	10 Yrs	25 Yrs	50 Yrs	100 Yrs
POWESHIEK	3.2	4.1	4.7	5.4	6.0	6.7
RED RIVER	4.0	5.0	6.7	7.5	8.8	9.6
RINGGOLD	3.2	4.2	4.9	5.7	6.4	7.0
SAC	3.0	3.9	4.5	5.2	5.9	6.5
SCOTT	3.1	4.0	4.5	5.1	5.7	6.4
SHELBY	3.1	4.0	4.6	5.4	6.1	6.7
SIOUX	2.9	3.6	4.2	4.9	5.6	6.1
STORY	3.1	4.0	4.7	5.4	6.0	6.6
TAMA	3.1	4.0	4.6	5.3	5.9	6.6
TAYLOR	3.2	4.2	4.9	5.7	6.4	7.0
UNION	3.2	4.2	4.9	5.6	6.3	6.9
VAN BUREN	3.3	4.2	4.8	5.5	6.1	6.8
WAPELLO	3.2	4.2	4.8	5.5	6.1	6.8
WARREN	3.2	4.2	4.8	5.6	6.2	6.8
WASHINGTON	3.2	4.1	4.7	5.4	5.9	6.7
WAYNE	3.3	4.2	4.9	5.7	6.3	6.9
WEBSTER	3.1	4.0	4.6	5.3	5.9	6.6
WINNEBAGO	3.0	3.8	4.4	5.1	5.7	6.4
WINNESHIEK	3.0	3.8	4.4	5.1	5.6	6.3
WOODBURY	2.9	3.8	4.4	5.1	5.8	6.3
WORTH	3.0	3.8	4.4	5.1	5.7	6.4
WRIGHT	3.1	3.9	4.5	5.2	5.8	6.5

5 POINT RAINFALL DISTRIBUTION AND FREEBOARD RAINFALL DEPTHS

Technical Release 60 (TR-60), Earth Dams and Reservoirs, dated July 2005, requires both a 6-hour and a 24-hour storm be routed for the freeboard storm. The most critical result is to be used to check the discharge capacity and the integrity of the auxiliary spillway.

The stability, or auxiliary, design hydrograph will continue to use the 6-hour duration storm for velocities and maximum stresses on the auxiliary spillway.

Technical Release 60 allows the user to choose between two rainfall distributions for the 24-hour storm. These are called a Type B distribution and a 5 Point distribution. The SITES routings in Iowa will be completed using the 5 Point distribution for the 24-hour storm.

The following table lists the values for each of the five hydrograph points to be used with the 24-hour distribution. In addition, the freeboard storm rainfall depth is shown for each hazard class by county. The data in this table is to be used when doing freeboard design routings for TR-60 structures using the SITES program.

COUNTY	Point 1	Point 2	Point 3	Point 4	Point 5	A2 Hazard Class (Less than 30,000 Product) Rainfall (in)	A2 Hazard Class (Greater than 30,000 Product) Rainfall (in)	A3-B Hazard Class Rainfall (in)	C Hazard Class Rainfall (in)
ADAIR	0.0	0.025	0.837	0.975	1.0	9.9	13.5	17.1	32.6
ADAMS	0.0	0.024	0.838	0.976	1.0	10.0	13.6	17.3	32.8
ALLAMAKEE	0.0	0.027	0.844	0.973	1.0	9.2	12.7	16.2	31.0
APPANOOSE	0.0	0.023	0.835	0.977	1.0	10.0	13.7	17.3	33.0
AUDUBON	0.0	0.025	0.842	0.975	1.0	9.8	13.3	16.9	32.2
BENTON	0.0	0.025	0.841	0.975	1.0	9.6	13.2	16.7	32.0
BLACK HAWK	0.0	0.027	0.839	0.973	1.0	9.5	13.1	16.6	31.7
BOONE	0.0	0.023	0.842	0.977	1.0	9.7	13.2	16.8	32.0
BREMER	0.0	0.024	0.837	0.976	1.0	9.5	13.0	16.5	31.5
BUCHANAN	0.0	0.025	0.842	0.975	1.0	9.5	13.0	16.5	31.6
BUENA VISTA	0.0	0.027	0.837	0.973	1.0	9.4	12.9	16.4	31.5
BUTLER	0.0	0.030	0.840	0.970	1.0	9.5	13.0	16.5	31.6
CALHOUN	0.0	0.027	0.838	0.973	1.0	9.5	13.1	16.6	31.7
CARROLL	0.0	0.027	0.842	0.973	1.0	9.6	13.2	16.8	32.0
CASS	0.0	0.026	0.842	0.974	1.0	9.9	13.5	17.1	32.5
CEDAR	0.0	0.025	0.844	0.975	1.0	9.6	13.2	16.7	32.1
CERRO GORDO	0.0	0.027	0.838	0.973	1.0	9.4	12.8	16.3	31.2
CHICKASAW	0.0	0.024	0.840	0.976	1.0	9.3	12.8	16.3	31.3
CHEROKEE	0.0	0.028	0.844	0.972	1.0	9.3	12.8	16.2	31.0
CLARKE	0.0	0.023	0.837	0.977	1.0	10.0	13.6	17.3	32.8
CLAY	0.0	0.030	0.840	0.970	1.0	9.3	12.8	16.3	31.2
CLAYTON	0.0	0.024	0.847	0.976	1.0	9.3	12.7	16.2	31.0
CLINTON	0.0	0.027	0.845	0.973	1.0	9.5	13.1	16.6	32.0

5 POINT RAINFALL DISTRIBUTION AND FREEBOARD RAINFALL DEPTHS

COUNTY	Point 1	Point 2	Point 3	Point 4	Point 5	A2 Hazard Class (Less than 30,000 Product) Rainfall (in)	A2 Hazard Class (Greater than 30,000 Product) Rainfall (in)	A3-B Hazard Class Rainfall (in)	C Hazard Class Rainfall (in)
CRAWFORD	0.0	0.031	0.843	0.969	1.0	9.6	13.1	16.7	31.8
DALLAS	0.0	0.023	0.837	0.977	1.0	9.8	13.4	17.0	32.3
DAVIS	0.0	0.023	0.838	0.977	1.0	10.0	13.6	17.3	33.0
DECATUR	0.0	0.023	0.835	0.977	1.0	10.1	13.7	17.4	33.0
DELAWARE	0.0	0.028	0.842	0.972	1.0	9.4	12.9	16.5	31.6
DES MOINES	0.0	0.026	0.838	0.974	1.0	9.9	13.5	17.2	33.0
DICKINSON	0.0	0.029	0.842	0.971	1.0	9.2	12.7	16.2	31.0
DUBUQUE	0.0	0.027	0.843	0.973	1.0	9.4	12.9	16.4	31.5
EMMET	0.0	0.029	0.842	0.971	1.0	9.3	12.7	16.2	31.0
FAYETTE	0.0	0.027	0.845	0.973	1.0	9.3	12.8	16.3	31.2
FLOYD	0.0	0.029	0.840	0.971	1.0	9.4	12.9	16.4	31.3
FRANKLIN	0.0	0.027	0.840	0.973	1.0	9.5	13.0	16.5	31.5
FREMONT	0.0	0.024	0.834	0.976	1.0	10.0	13.6	17.3	32.8
GREENE	0.0	0.027	0.841	0.973	1.0	9.7	13.2	16.8	32.0
GRUNDY	0.0	0.028	0.840	0.972	1.0	9.6	13.1	16.7	31.8
GUTHRIE	0.0	0.028	0.842	0.972	1.0	9.8	13.4	16.9	32.3
HAMILTON	0.0	0.028	0.840	0.972	1.0	9.6	13.1	16.7	31.8
HANCOCK	0.0	0.032	0.841	0.968	1.0	9.4	12.9	16.4	31.4
HARDIN	0.0	0.027	0.844	0.973	1.0	9.6	13.1	16.6	31.7
HARRISON	0.0	0.027	0.842	0.973	1.0	9.6	13.2	16.8	32.0
HENRY	0.0	0.023	0.838	0.977	1.0	9.8	13.5	17.1	32.8
HOWARD	0.0	0.029	0.842	0.971	1.0	9.3	12.7	16.2	31.0
HUMBOLDT	0.0	0.029	0.844	0.971	1.0	9.5	13.0	16.5	31.4
IDA	0.0	0.030	0.841	0.970	1.0	9.5	13.0	16.6	31.7
IOWA	0.0	0.023	0.841	0.977	1.0	9.7	13.3	16.9	32.3
JACKSON	0.0	0.024	0.849	0.976	1.0	9.4	12.9	16.4	31.5
JASPER	0.0	0.025	0.842	0.975	1.0	9.8	13.3	16.9	32.2
JEFFERSON	0.0	0.021	0.838	0.979	1.0	9.9	13.5	17.2	32.8
JOHNSON	0.0	0.023	0.841	0.977	1.0	9.6	13.2	16.8	32.2
JONES	0.0	0.024	0.847	0.976	1.0	9.5	13.0	16.6	31.7
KEOKUK	0.0	0.023	0.844	0.977	1.0	9.8	13.4	17.0	32.4
KOSSUTH	0.0	0.030	0.845	0.970	1.0	9.3	12.8	16.3	31.2
LEE	0.0	0.023	0.838	0.977	1.0	9.9	13.6	17.3	33.0
LINN	0.0	0.027	0.845	0.973	1.0	9.6	13.1	16.7	32.0
LOUISA	0.0	0.025	0.843	0.975	1.0	9.8	13.4	17.0	32.5
LUCAS	0.0	0.023	0.837	0.977	1.0	10.0	13.6	17.3	32.8
LYON	0.0	0.028	0.837	0.972	1.0	9.0	12.5	16.0	30.9
MADISON	0.0	0.026	0.842	0.974	1.0	9.9	13.5	17.1	32.5

5 POINT RAINFALL DISTRIBUTION AND FREEBOARD RAINFALL DEPTHS

COUNTY	Point 1	Point 2	Point 3	Point 4	Point 5	A2 Hazard Class (Less than 30,000 Product) Rainfall (in)	A2 Hazard Class (Greater than 30,000 Product) Rainfall (in)	A3-B Hazard Class Rainfall (in)	C Hazard Class Rainfall (in)
MAHASKA	0.0	0.022	0.840	0.978	1.0	9.8	13.4	17.1	32.5
MARION	0.0	0.023	0.842	0.977	1.0	9.9	13.5	17.1	32.5
MARSHALL	0.0	0.023	0.842	0.977	1.0	9.7	13.2	16.8	32.0
MILLS	0.0	0.026	0.836	0.974	1.0	9.9	13.5	17.2	32.7
MITCHELL	0.0	0.027	0.840	0.973	1.0	9.3	12.7	16.2	31.0
MONONA	0.0	0.027	0.842	0.973	1.0	9.5	13.0	16.6	31.7
MONROE	0.0	0.024	0.836	0.976	1.0	10.0	13.6	17.3	32.9
MONTGOMERY	0.0	0.023	0.839	0.977	1.0	9.9	13.5	17.2	32.6
MUSCATINE	0.0	0.023	0.841	0.977	1.0	9.7	13.3	16.9	32.4
O'BRIEN	0.0	0.029	0.840	0.971	1.0	9.2	12.7	16.2	31.2
OSCEOLA	0.0	0.031	0.837	0.969	1.0	9.1	12.6	16.1	31.0
PAGE	0.0	0.027	0.836	0.973	1.0	10.0	13.7	17.3	33.0
PALO ALTO	0.0	0.030	0.842	0.970	1.0	9.3	12.8	16.3	31.3
PLYMOUTH	0.0	0.030	0.839	0.970	1.0	9.2	12.8	16.3	31.4
POCAHONTAS	0.0	0.029	0.841	0.971	1.0	9.5	13.0	16.5	31.5
POLK	0.0	0.025	0.842	0.975	1.0	9.8	13.4	16.9	32.3
POTTAWATTAMIE	0.0	0.026	0.838	0.974	1.0	9.8	13.4	17.0	32.5
POWESHIEK	0.0	0.026	0.844	0.974	1.0	9.7	13.3	16.9	32.3
RINGGOLD	0.0	0.023	0.832	0.977	1.0	10.1	13.7	17.4	33.0
SAC	0.0	0.028	0.836	0.972	1.0	9.5	13.1	16.6	31.8
SCOTT	0.0	0.025	0.844	0.975	1.0	9.5	13.1	16.7	32.1
SHELBY	0.0	0.029	0.838	0.971	1.0	9.7	13.3	17.0	32.4
SIOUX	0.0	0.027	0.840	0.973	1.0	9.1	12.6	16.1	31.0
STORY	0.0	0.024	0.845	0.976	1.0	9.7	13.2	16.8	31.9
TAMA	0.0	0.023	0.839	0.977	1.0	9.6	13.2	16.8	32.0
TAYLOR	0.0	0.023	0.832	0.977	1.0	10.1	13.7	17.4	33.0
UNION	0.0	0.023	0.836	0.977	1.0	10.0	13.6	17.2	32.7
VAN BUREN	0.0	0.023	0.835	0.977	1.0	9.9	13.6	17.3	33.0
WAPELLO	0.0	0.021	0.835	0.979	1.0	9.9	13.6	17.2	32.8
WARREN	0.0	0.021	0.837	0.979	1.0	9.9	13.5	17.1	32.6
WASHINGTON	0.0	0.023	0.844	0.977	1.0	9.7	13.3	17.0	32.4
WAYNE	0.0	0.023	0.838	0.977	1.0	10.1	13.7	17.4	33.0
WEBSTER	0.0	0.028	0.836	0.972	1.0	9.6	13.1	16.7	31.8
WINNEBAGO	0.0	0.027	0.840	0.973	1.0	9.3	12.8	16.2	31.0
WINNESHIEK	0.0	0.027	0.844	0.973	1.0	9.2	12.7	16.2	31.0
WOODBURY	0.0	0.028	0.839	0.972	1.0	9.3	12.9	16.4	31.6
WORTH	0.0	0.027	0.840	0.973	1.0	9.3	12.8	16.2	31.0
WRIGHT	0.0	0.027	0.840	0.973	1.0	9.5	13.0	16.5	31.5

10-DAY RAINFALL (inches)

COUNTY	25-yr 10-day	50-yr 10-day	100-yr 10-day
ADAIR	9.5	10.7	11.5
ADAMS	9.5	10.7	11.7
ALLAMAKEE	9.3	10.6	11.4
APPANOOSE	10.0	11.7	12.3
AUDUBON	9.3	10.2	11.3
BENTON	9.6	11.2	11.7
BLACK HAWK	9.5	10.9	11.6
BOONE	9.5	10.8	11.5
BREMER	9.3	10.9	11.6
BUCHANAN	9.5	10.9	11.6
BUENA VISTA	8.8	9.8	10.8
BUTLER	9.4	10.9	11.6
CALHOUN	9.2	10.2	11.0
CARROLL	9.2	10.2	11.0
CASS	9.5	10.5	11.4
CEDAR	9.5	11.2	11.7
CERRO GORDO	9.3	10.7	11.4
CHEROKEE	8.7	9.5	10.5
CHICKASAW	9.3	10.8	11.5
CLARKE	9.8	11.4	12.0
CLAY	8.7	9.7	10.7
CLAYTON	9.3	10.8	11.4
CLINTON	9.5	10.9	11.5
CRAWFORD	9.0	9.8	10.8
DALLAS	9.5	10.9	11.7
DAVIS	10.0	11.7	12.3
DECATUR	9.9	11.5	12.2
DELAWARE	9.5	10.9	11.5
DES MOINES	9.9	11.5	12.0
DICKINSON	8.6	9.7	10.6
DUBUQUE	9.4	10.9	11.4
EMMET	8.8	9.8	10.8
FAYETTE	9.3	10.8	11.5
FLOYD	9.3	10.8	11.5
FRANKLIN	9.4	10.8	11.5
FREMONT	9.3	10.2	11.4
GREENE	9.3	10.5	11.4
GRUNDY	9.5	11.0	11.6
GUTHRIE	9.5	10.5	11.4
HAMILTON	9.4	10.8	11.5
HANCOCK	9.3	10.6	11.4
HARDIN	9.5	10.9	11.6
HARRISON	9.0	9.8	10.6
HENRY	9.9	11.5	11.9
HOWARD	9.3	10.7	11.4
HUMBOLDT	9.3	10.4	11.2
IDA	8.7	9.7	10.7
IOWA	9.7	11.3	11.8
JACKSON	9.4	10.9	11.4
JASPER	9.7	11.3	11.8

COUNTY	25-yr 10-day	50-yr 10-day	100-yr 10-day
JEFFERSON	9.9	11.5	12.0
JOHNSON	9.7	11.3	11.8
JONES	9.5	11.0	11.6
KEOKUK	9.8	11.4	11.8
KOSSUTH	9.2	10.4	11.2
LEE	10.0	11.7	12.4
LINN	9.6	11.1	11.7
LOUISA	9.8	11.4	11.8
LUCAS	9.9	11.5	12.0
LYON	8.2	9.0	10.1
MADISON	9.6	11.0	11.8
MAHASKA	9.8	11.4	11.8
MARION	9.8	11.4	11.9
MARSHALL	9.6	11.2	11.7
MILLS	9.3	10.2	11.3
MITCHELL	9.3	10.7	11.4
MONONA	8.7	9.5	10.5
MONROE	9.9	11.6	12.1
MONTGOMERY	9.5	10.5	11.4
MUSCATINE	9.7	11.3	11.8
OBRIEN	8.5	9.5	10.5
OSCEOLA	8.5	9.4	10.4
PAGE	9.5	10.5	11.5
PALO ALTO	8.9	9.9	10.9
PLYMOUTH	8.5	9.3	10.3
POCAHONTAS	9.1	10.0	11.0
POLK	9.6	11.2	11.8
POTTAWATTAMIE	9.1	10.0	10.9
POWESHIEK	9.7	11.3	11.8
RINGGOLD	9.7	11.2	12.0
SAC	9.0	9.9	10.9
SCOTT	9.5	11.0	11.6
SHELBY	9.1	10.0	11.0
SIOUX	8.2	9.2	10.2
STORY	9.5	11.2	11.7
TAMA	9.6	11.2	11.7
TAYLOR	9.6	10.8	11.8
UNION	9.7	11.0	11.8
VAN BUREN	10.0	11.7	12.3
WAPELLO	9.9	11.6	12.1
WARREN	9.7	11.3	11.9
WASHINGTON	9.8	11.3	11.8
WAYNE	10.0	11.6	12.3
WEBSTER	9.3	10.5	11.4
WINNEBAGO	9.2	10.5	11.3
WINNESHIEK	9.3	10.7	11.4
WOODBURY	8.5	9.4	10.4
WORTH	9.2	10.6	11.4
WRIGHT	9.3	10.7	11.4

NORMAL ANNUAL AND MONTHLY EVAPORATION
AND
MEAN ANNUAL AND MONTHLY PRECIPITATION FROM SHALLOW LAKES AND RESERVOIRS

The design of waste storage ponds and waste treatment lagoons frequently requires an estimate of mean annual and monthly precipitation and evaporation. The following tables show this information.

The precipitation information is from the U.S. Weather Bureau Technical Paper No. 40. The evaporation information is taken from NOAA Technical Report NWS 33.

AVERAGE ANNUAL AND MONTHLY RAINFALL (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
ADAIR	34.86	0.89	1.01	2.23	3.50	4.40	4.48	4.51	3.92	3.83	2.56	2.12	1.19
ADAMS	35.31	0.83	1.01	2.27	3.39	4.52	4.48	4.58	3.96	4.09	2.63	2.18	1.15
ALLAMAKEE	33.72	0.92	0.92	1.90	3.61	3.80	4.44	4.35	4.59	3.29	2.28	2.22	1.17
APPANOOSE	37.17	1.01	1.13	2.31	3.47	4.74	4.49	5.03	3.98	4.02	2.87	2.46	1.45
AUDUBON	33.60	0.85	0.91	2.25	3.38	4.24	4.53	4.36	3.79	3.57	2.59	1.86	1.06
BENTON	35.19	1.01	1.04	2.17	3.40	4.18	4.79	4.16	4.44	3.52	2.57	2.35	1.34
BLACK HAWK	34.53	0.93	1.02	2.11	3.34	4.16	4.99	4.26	4.35	3.22	2.52	2.22	1.21
BOONE	34.13	0.88	0.91	2.16	3.30	4.27	5.04	4.34	4.22	3.11	2.50	2.03	1.16
BREMER	35.21	0.97	0.96	2.08	3.49	4.20	4.97	4.36	4.81	3.22	2.52	2.25	1.17
BUCHANAN	35.13	1.02	1.04	2.05	3.37	4.08	4.86	4.15	4.80	3.43	2.49	2.31	1.30
BUENA VISTA	31.83	0.67	0.63	2.05	3.32	3.84	4.85	4.13	4.31	3.12	2.19	1.67	0.84
BUTLER	34.40	0.88	0.90	2.05	3.34	4.20	5.12	4.42	4.29	3.23	2.51	2.12	1.12
CALHOUN	32.06	0.79	0.71	2.08	3.21	4.17	4.66	4.06	3.90	3.23	2.33	1.71	0.98
CARROLL	32.70	0.84	0.82	2.24	3.32	4.20	4.65	4.23	3.67	3.32	2.43	1.76	1.01
CASS	34.57	0.82	0.95	2.26	3.39	4.44	4.57	4.56	3.89	3.85	2.60	1.95	1.08
CEDAR	36.24	1.29	1.28	2.48	3.42	4.23	4.42	3.96	4.54	3.47	2.61	2.52	1.80
CERRO GORDO	34.00	0.90	0.79	2.05	3.29	4.15	5.02	4.38	4.46	3.24	2.44	1.97	1.08
CHEROKEE	29.64	0.65	0.63	1.98	3.00	3.73	4.54	3.85	3.76	2.89	2.02	1.60	0.79
CHICKASAW	35.34	0.98	0.93	2.08	3.59	4.16	4.84	4.42	4.87	3.26	2.50	2.25	1.24
CLARKE	35.95	0.89	1.10	2.21	3.55	4.62	4.49	4.62	4.05	3.96	2.67	2.30	1.26
CLAY	30.18	0.62	0.57	1.95	3.10	3.65	4.61	4.00	4.18	2.86	2.03	1.63	0.75
CLAYTON	34.23	1.03	1.10	2.05	3.54	3.88	4.52	4.10	4.66	3.21	2.35	2.32	1.26
CLINTON	35.82	1.35	1.36	2.51	3.38	4.04	4.47	3.61	4.56	3.26	2.62	2.57	1.88
CRAWFORD	31.32	0.75	0.72	2.17	3.16	4.12	4.45	3.99	3.57	3.29	2.33	1.61	0.95
DALLAS	33.80	0.87	0.94	2.14	3.32	4.31	4.73	4.27	4.05	3.29	2.50	2.01	1.15
DAVIS	37.41	1.17	1.22	2.42	3.48	4.77	4.31	4.76	4.03	4.02	2.81	2.58	1.63
DECATUR	35.63	0.89	1.14	2.32	3.51	4.67	4.40	4.77	3.95	4.07	2.92	2.35	1.32
DELAWARE	35.13	1.07	1.11	2.10	3.40	4.06	4.58	4.00	4.95	3.41	2.50	2.39	1.35
DES MOINES	36.75	1.30	1.41	2.67	3.49	4.35	4.22	4.25	3.89	3.60	2.71	2.67	1.97
DICKINSON	29.27	0.64	0.58	1.91	3.00	3.63	4.61	3.75	3.86	2.73	2.01	1.64	0.71
DUBUQUE	34.80	1.16	1.25	2.29	3.36	3.83	4.45	3.83	4.58	3.46	2.42	2.44	1.52
EMMET	30.04	0.73	0.59	1.86	3.08	3.65	4.64	3.92	4.01	2.74	2.14	1.68	0.77
FAYETTE	35.17	1.02	1.05	2.04	3.57	4.05	4.68	4.20	4.97	3.35	2.47	2.25	1.30

AVERAGE ANNUAL AND MONTHLY RAINFALL (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
FLOYD	34.57	0.94	0.84	2.01	3.39	4.18	5.06	4.40	4.57	3.31	2.46	2.07	1.12
FRANKLIN	33.84	0.85	0.82	2.04	3.21	4.19	5.15	4.36	4.32	3.16	2.44	1.98	1.10
FREMONT	34.03	0.77	0.91	2.35	3.27	4.51	4.37	4.79	3.81	3.49	2.52	1.98	1.04
GREENE	33.02	0.87	0.87	2.14	3.23	4.19	4.80	4.23	3.94	3.13	2.42	1.88	1.11
GRUNDY	34.61	0.89	0.97	2.18	3.26	4.26	5.25	4.34	4.16	3.10	2.56	2.23	1.20
GUTHRIE	34.19	0.87	0.96	2.24	3.36	4.34	4.68	4.36	4.11	3.43	2.51	1.95	1.16
HAMILTON	33.78	0.87	0.83	2.02	3.13	4.05	5.37	4.31	4.44	3.09	2.43	1.92	1.11
HANCOCK	32.15	0.80	0.72	1.93	3.21	3.89	4.81	4.23	4.22	3.02	2.26	1.83	1.01
HARDIN	34.22	0.91	0.90	2.13	3.19	4.20	5.29	4.23	4.24	3.14	2.51	2.15	1.13
HARRISON	31.69	0.73	0.75	2.25	3.15	4.33	4.42	4.03	3.42	3.37	2.39	1.68	0.94
HENRY	36.96	1.28	1.32	2.59	3.40	4.47	4.17	4.45	3.99	3.89	2.69	2.66	1.84
HOWARD	34.80	0.98	0.87	2.04	3.48	3.97	4.66	4.47	4.89	3.44	2.40	2.19	1.19
HUMBOLDT	32.37	0.83	0.72	2.05	3.20	3.94	4.77	4.22	4.20	3.12	2.28	1.80	1.02
IDA	30.71	0.77	0.67	2.11	3.14	3.97	4.59	3.85	3.78	3.01	2.17	1.57	0.89
IOWA	35.84	1.05	1.06	2.20	3.41	4.39	4.61	4.25	4.51	3.65	2.61	2.46	1.42
JACKSON	35.24	1.21	1.32	2.36	3.34	3.91	4.48	3.55	4.54	3.52	2.51	2.56	1.71
JASPER	35.08	0.97	1.05	2.18	3.35	4.45	4.65	4.27	4.32	3.46	2.67	2.28	1.22
JEFFERSON	36.48	1.22	1.23	2.46	3.39	4.55	4.08	4.45	4.00	3.87	2.77	2.55	1.70
JOHNSON	35.85	1.09	1.12	2.31	3.47	4.26	4.57	4.22	4.53	3.51	2.59	2.42	1.55
JONES	35.32	1.20	1.22	2.34	3.36	4.02	4.49	3.85	4.62	3.43	2.50	2.50	1.59
KEOKUK	35.74	1.07	1.1	2.35	3.37	4.40	4.28	4.31	4.20	3.79	2.70	2.52	1.44
KOSSUTH	31.25	0.74	0.65	1.89	3.11	3.86	4.71	4.20	4.13	2.85	2.24	1.78	0.88
LEE	37.89	1.39	1.46	2.79	3.52	4.72	4.18	4.34	3.72	3.81	2.79	2.88	2.08
LINN	35.37	1.08	1.09	2.18	3.40	4.16	4.65	4.12	4.58	3.52	2.50	2.41	1.46
LOUISA	36.19	1.24	1.32	2.58	3.44	4.29	4.11	4.17	4.17	3.57	2.67	2.57	1.85
LUCAS	36.36	0.92	1.15	2.23	3.52	4.60	4.57	4.67	3.99	4.05	2.84	2.35	1.25
LYON	27.16	0.53	0.55	1.87	2.71	3.35	4.24	3.43	3.58	2.52	1.94	1.54	0.67
MADISON	34.86	0.94	1.05	2.2	3.53	4.39	4.56	4.37	3.98	3.70	2.56	2.18	1.20
MAHASKA	35.87	1.02	1.14	2.18	3.40	4.49	4.38	4.37	4.18	3.83	2.73	2.56	1.36
MARION	35.49	0.92	1.1	2.11	3.64	4.49	4.47	4.38	4.17	3.68	2.75	2.33	1.23
MARSHALL	35.05	0.94	0.97	2.19	3.20	4.36	5.01	4.44	4.45	3.22	2.56	2.26	1.23
MILLS	33.42	0.73	0.85	2.26	3.27	4.61	4.54	4.51	3.76	3.42	2.42	1.85	0.99
MITCHELL	34.17	0.98	0.8	1.99	3.38	4.09	4.78	4.37	4.65	3.37	2.40	2.03	1.14

AVERAGE ANNUAL AND MONTHLY RAINFALL (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
MONONA	30.32	0.66	0.65	2.15	3.14	4.11	4.33	3.87	3.47	3.06	2.28	1.54	0.84
MONROE	36.72	1.05	1.17	2.26	3.51	4.63	4.45	4.84	3.94	4.03	2.72	2.52	1.40
MONTGOMERY	35.36	0.85	1.03	2.29	3.45	4.63	4.62	4.63	3.93	3.90	2.58	2.08	1.13
MUSCATINE	36.08	1.27	1.3	2.53	3.38	4.18	4.32	4.09	4.32	3.46	2.63	2.54	1.83
O'BRIEN	29.38	0.65	0.65	1.89	2.98	3.58	4.59	3.90	4.00	2.68	1.95	1.57	0.71
OSCEOLA	28.61	0.58	0.57	1.92	2.92	3.52	4.49	3.58	3.85	2.80	1.95	1.52	0.68
PAGE	35.37	0.86	1.0	2.34	3.30	4.59	4.54	4.78	3.98	3.82	2.63	2.21	1.10
PALO ALTO	31.09	0.74	0.64	1.95	3.13	3.71	4.70	4.17	4.17	2.88	2.19	1.76	0.85
PLYMOUTH	27.23	0.59	0.57	1.91	2.80	3.61	4.12	3.48	3.21	2.56	2.02	1.45	0.71
POCAHONTAS	32.0	0.81	0.7	2.07	3.20	3.90	4.66	4.20	4.23	3.11	2.20	1.77	0.93
POLK	34.4	0.89	1.02	2.15	3.35	4.32	4.81	4.30	4.29	3.24	2.55	2.09	1.19
POTTAWATTAMIE	33.3	0.76	0.84	2.28	3.30	4.50	4.55	4.48	3.57	3.60	2.41	1.80	0.99
POWESHIEK	35.74	1.05	1.11	2.19	3.44	4.36	4.53	4.25	4.43	3.72	2.70	2.43	1.31
RINGGOLD	35.8	0.83	1.06	2.31	3.26	4.53	4.44	4.73	4.00	4.03	2.91	2.25	1.24
SAC	32.02	0.77	0.71	2.19	3.28	4.07	4.70	4.06	3.90	3.19	2.30	1.69	0.97
SCOTT	35.82	1.34	1.35	2.56	3.41	4.04	4.50	3.78	4.37	3.19	2.60	2.56	1.91
SHELBY	33.11	0.78	0.81	2.21	3.28	4.26	4.48	4.22	3.69	3.86	2.53	1.77	1.00
SIOUX	27.67	0.6	0.59	1.92	2.77	3.46	4.27	3.56	3.52	2.54	1.99	1.53	0.72
STORY	34.61	0.87	0.91	2.14	3.19	4.21	5.19	4.62	4.40	3.10	2.48	2.14	1.14
TAMA	35.48	0.99	1.05	2.20	3.33	4.27	5.07	4.37	4.37	3.43	2.62	2.32	1.26
TAYLOR	36.01	0.88	1.04	2.32	3.27	4.62	4.50	4.87	4.00	4.02	2.84	2.27	1.17
UNION	35.15	0.87	1.05	2.21	3.45	4.48	4.45	4.55	3.80	3.96	2.64	2.27	1.21
VAN BUREN	37.14	1.30	1.28	2.49	3.51	4.69	4.16	4.55	3.72	3.93	2.79	2.65	1.84
WAPELLO	36.30	1.09	1.17	2.36	3.38	4.56	4.31	4.59	3.99	3.90	2.72	2.51	1.49
WARREN	35.13	0.95	1.10	2.16	3.58	4.48	4.59	4.35	3.97	3.62	2.70	2.19	1.23
WASHINGTON	35.62	1.18	1.16	2.38	3.27	4.37	4.19	4.27	4.15	3.68	2.63	2.47	1.66
WAYNE	36.91	0.95	1.14	2.31	3.52	4.63	4.42	4.95	3.97	4.10	2.93	2.41	1.35
WEBSTER	33.39	0.86	0.79	2.10	3.27	4.16	4.98	4.31	4.22	3.17	2.37	1.86	1.08
WINNEBAGO	32.44	0.84	0.67	1.90	3.19	3.92	4.83	4.27	4.51	2.95	2.30	1.86	0.99
WINNESHIEK	34.31	0.94	0.90	1.96	3.60	3.82	4.56	4.33	4.85	3.42	2.35	2.17	1.19
WOODBURY	28.76	0.63	0.63	2.05	3.01	3.89	4.17	3.63	3.34	2.76	2.13	1.51	0.78
WORTH	33.39	0.93	0.72	2.01	3.27	4.01	4.76	4.33	4.55	3.20	2.37	1.95	1.07
WRIGHT	33.03	0.80	0.75	1.99	3.21	4.05	5.13	4.26	4.23	3.13	2.35	1.88	1.04

AVERAGE ANNUAL AND MONTHLY EVAPORATION (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
ADAIR	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
ADAMS	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
ALLAMAKEE	38.0	0.8	1.1	1.5	4.0	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
APPANOOSE	39.0	0.8	1.2	1.6	3.8	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
AUDUBON	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
BENTON	39.0	0.8	1.2	1.6	4.0	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
BLACK HAWK	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
BOONE	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
BREMER	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
BUCHANAN	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
BUENA VISTA	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
BUTLER	38.0	0.8	1.1	1.5	4.0	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
CALHOUN	39.0	0.8	1.2	1.6	3.8	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.1
CARROLL	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CASS	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CEDAR	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CERRO GORDO	38.0	0.8	1.1	1.5	4.0	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
CHEROKEE	40.0	0.8	1.2	1.6	3.8	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CHICKASAW	38.0	0.8	1.1	1.5	4.0	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
CLARKE	40.0	0.8	1.2	1.6	3.8	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CLAY	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CLAYTON	39.0	0.8	1.2	1.6	4.0	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
CLINTON	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
CRAWFORD	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
DALLAS	39.0	0.8	1.2	1.6	4.0	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
DAVIS	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
DECATUR	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
DELAWARE	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
DES MOINES	39.0	0.8	1.2	1.6	4.0	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
DICKINSON	40.0	0.8	1.2	1.6	3.9	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
DUBUQUE	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
EMMET	39.0	0.8	1.2	1.6	4.0	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
FAYETTE	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8

AVERAGE ANNUAL AND MONTHLY EVAPORATION (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOYD	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
FRANKLIN	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
FREMONT	42.0	0.8	1.3	1.7	4.2	6.3	6.7	6.3	5.5	3.8	3.4	1.3	0.8
GREENE	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
GRUNDY	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
GUTHRIE	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
HAMILTON	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
HANCOCK	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
HARDIN	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
HARRISON	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
HENRY	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
HOWARD	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
HUMBOLDT	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
IDA	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
IOWA	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
JACKSON	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
JASPER	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
JEFFERSON	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
JOHNSON	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
JONES	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
KEOKUK	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
KOSSUTH	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
LEE	39.0	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.7	0.8	0.8
LINN	40.0	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8	0.8
LOUISA	40.0	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8	0.8
LUCAS	39.0	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8	0.8
LYON	41.0	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8	0.8
MADISON	40.0	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8	0.8
MAHASKA	39.0	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8	0.8
MARION	39.0	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8	0.8
MARSHALL	39.0	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8	0.8
MILLS	42.0	1.6	1.7	4.2	6.3	6.7	6.3	5.5	3.8	3.4	1.3	0.8	0.8
MITCHELL	38.0	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8	0.8

AVERAGE ANNUAL AND MONTHLY EVAPORATION (inches)

COUNTY	ANNUAL	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MONONA	41.0	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8	0.8
MONROE	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
MONTGOMERY	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
MUSCATINE	40.0	08	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
OBRIEN	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
OSCEOLA	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
PAGE	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
PALO ALTO	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
PLYMOUTH	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
POCAHONTAS	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
POLK	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
POTTAWATTAMIE	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
POWESHIEK	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
RINGGOLD	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
SAC	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
SCOTT	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
SHELBY	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
SIOUX	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
STORY	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
TAMA	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
TAYLOR	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
UNION	40.0	0.8	1.2	1.6	4.0	6.0	6.4	6.0	5.2	3.6	3.2	1.2	0.8
VAN BUREN	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WAPELLO	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WARREN	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WASHINGTON	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WAYNE	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WEBSTER	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8
WINNEBAGO	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
WINNESHIEK	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
WOODBURY	41.0	0.8	1.2	1.6	4.1	6.2	6.6	6.2	5.3	3.7	3.3	1.2	0.8
WORTH	38.0	0.8	1.1	1.5	3.8	5.7	6.1	5.7	4.9	3.4	3.0	1.1	0.8
WRIGHT	39.0	0.8	1.2	1.6	3.9	5.9	6.2	5.9	5.1	3.5	3.1	1.2	0.8

ONE-HOUR PEAK RUNOFF

The criteria for design for animal solid settling facilities refers to the peak runoff from a 10-year, 1-hour storm. The 10-year, 1-hour storm for the state of Iowa is 2.4". Following is a method for determining the peak runoff for a 1-hour storm.

Equation 16A-9, page 16A-2, National Engineering Handbook, Part 630, Hydrology, gives the equation for determining peak rate of flow:

$$q_p = \frac{484\,(A)\,(Q)}{\frac{\Delta D}{2} + 0.6\,(T_C)}$$

When: q_p = peak rate of flow, cfs

A = drainage area, sq. mi. = $\frac{a}{640}$

a = drainage area, acres

Q = runoff, inches

ΔD = storm duration, hours

T_c = $\frac{\text{Length, feet}}{(3600)\,(\text{Velocity, ft/sec})}$ = Time of concentration, hours

Length = Most distant point in the watershed to the settling basin, feet

Velocity = 2 ft/sec for unpaved lot, 4 ft/sec for paved lots

Then for a 1-hour storm:

$$q_p = \frac{484\,(A)\,(Q)}{\frac{1}{2} + 0.6\left[\frac{\text{Length}}{3600\,(\text{Velocity})}\right]} \quad \text{or} \quad q_p = \frac{\frac{484\,(a)\,(Q)}{640}}{\frac{1}{2} + 0.6\left[\frac{\text{Length}}{3600\,(\text{Velocity})}\right]} \quad \text{or} \quad q_p = FaQ$$

Determine value of F from the following table:

Length	Value of F	
	v = 2 fps	v = 4 fps
0	1.51	1.51
100	1.49	1.50
500	1.40	1.45
1000	1.30	1.40
1500	1.21	1.34
2000	1.13	1.30
2500	1.07	1.25
3000	1.01	1.21
4000	0.91	1.13
5000	0.83	1.07

Example:

Find the peak rate of runoff for a 10-year, 1-hour storm from a 4-acre paved feedlot in Humboldt County. All outside runoff is diverted from the lot. It is 1000 feet from the most distant point in the lot to the settling facility.

10-year, 1-hour rainfall = 2.4 inches (for the state of Iowa)
RCN = 98 for paved lots
Q = 1.78 inches
F = 1.40
Q_p = (1.40)(4)(1.78) = 9.97, Use 10 cfs

This procedure was developed by Herman W. Kopitzke, Jr., Hydraulic Engineer

RUNOFF FROM POTHOLE TOPOGRAPHY

The pothole topography in north central Iowa must be treated as a special case when determining the peak rate of flow and volume of runoff. The procedure described on these pages is for use in designing dams for which an IDNR permit is required. This type of topography is flat to gently undulating with depressional areas that may store the entire storm runoff. Sufficient survey must be made to evaluate the volume of pothole storage available. Design frequency will be based upon total drainage area. There are three situations that may occur. All three conditions may be present in the area contributing runoff to a dam or other point.

1. Potholes Store Entire Runoff Volume

   If the potholes have sufficient capacity to store the entire runoff volume of the design storm, that portion of the watershed may be excluded from the drainage area for estimating peak flow and temporary storage volume. If the potholes are subsurface drained, runoff from the pothole area shall be treated as base flow using a ½-inch drainage coefficient or the actual drainage coefficient, whichever is greater.

2. Potholes Store Partial Runoff Volume

   The runoff from the total drainage area may be reduced to allow for pothole storage. If the potholes have capacity to store a portion of the runoff volume of the design storm, measure the drainage area contributing to and controlled by potholes, estimate the available storage in the potholes, and convert to inches from the contributing watershed. The reduced or adjusted runoff is computed by use of the formula:

   $$Q_A = Q - \left(\frac{\text{Pothole Drainage Area}}{\text{Total Drainage Area}}\right) \text{(Inches Pothole Storage)}$$

   The peak discharge rate for the total drainage area may be reduced by the same percentage as the reduction in runoff volume using the formula:
   $q_{pA} = q_p(Q_A/Q)$.

   Where:

   Q_A = Adjusted runoff depth (inches)
   Q = Runoff depth (inches) for total drainage area
   q_{pA} = Adjusted peak discharge rate (cfs)
   q_p = Peak discharge rate (cfs) for total D.A.

   A base flow equivalent to a ½-inch drainage coefficient (or actual drainage coefficient, if larger) from the pothole area shall also be used. For large full-flow structures, contact the state hydrologist for more sophisticated procedures.

3. Extremely Flat Topography

Some watersheds have areas with steeper topography which contribute runoff which concentrates and then runs through an extremely flat area either into floodwater retarding pools or into a steeper channel or waterway and then into floodwater retarding pools. These areas have positive drainage without potholes. Develop a hydrograph for the runoff from the steeper areas and then route it downstream using GO, REACH in Sites. Add it to hydrographs for other areas and route through the proposed site. A sample Sites job is shown below. This sample job develops the runoff hydrograph from two areas, adds baseflow, routes through a steeper area, develops a runoff hydrograph from the areas draining directly into the structure site, adds an additional base flow, adds the two hydrographs, and routes them through structure “Pond.”

```
SITES     05/01/2000000        Pond
SAVMOV    0    101
SAVMOV    101  1
*         Subwatershed 1 reduced for ponded soils 1:1
*         1903 total acres; 159.5 ponded soils
*         Quite a bit of area may be blocked by old railroad bed not
*         accounted for in this analysis.
WSDATA    5S 3 1 AC 78        1743.5    5.16
BASEFLOW            4
PDIRECT             5.3       6.6
GO,DESIGN
SAVMOV    2    101  3                   3
SAVMOV    0    101
SAVMOV    101  1
*         Area 2 subwatershed reduced for ponded acres 1:1
*         925.2 total acres; 488.7 ponded soils
WSDATA    5S 2 1 AC 78        436.5     3.68
BASEFLOW            4
PDIRECT             5.3       6.6
GO,DESIGN
SAVMOV    2    101  5                   2
ADDMOV
SAVMOV    101  2
*         Channel from centerline to jct w/ Rhoades lateral
GO,REACH  1    A1             8000      0.4       1.4
SAVMOV    2    101  2                   1
SAVMOV    101  1
*         Subwatershed 1 area reduced for ponded soils
*         1427.3 total acres; 129.8 acres ponded soils
STRUCTURE 000       Pond Site
                    80        0
                    82        0.04
                    84        0.13
                    86        0.35
                    88        1.01
                    90        1.99
                    92        3.26
                    94        5.09
                    96        7.49
                    98        9.84
                    100       12.47
                    102       15.35
                    104       19.7
                    106       24.28
ENDTABLE
WSDATA    5S 1   AC 78        1287.5    3.38
BASEFLOW            4
PDIRECT             5.3       6.6
POOLDATA  ELEV                98        98
PSINLET             1         19
PSDATA    1         120       48                  .025      85
GRAPHICS  I
GO,DESIGN QLN
SAVMOV    2    101  1                   000
ENDJOB
ENDRUN
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EFFECTS OF TERRACES AND WATER & SEDIMENT CONTROL BASINS ON RUNOFF

Runoff may be adjusted for the effect of terraces in the design of many conservation practices. Terraces may have a shorter design life than some other practices so a partial credit is used. For areas that have or definitely will have closed-end terraces, the runoff may be reduced by 1.0 inch. The same considerations apply to water & sediment control basins. The adjusted runoff is computed by the use of the formula:

$$Q_a = Q - \left(\frac{\text{Area\_Terraced}}{\text{Total\_Drainage\_Area}} \right) (1.0\_\text{inch})$$

Where :

Q = Runoff Depth, inches

Q_a = Adjusted Runoff Depth, inches

On level terraced areas, the water stored by the terrace will infiltrate into the soil and will not be considered as part of the runoff. For terraces using underground outlets that drain into the practice being designed, a base flow of 0.05 cfs per acre needs to be added to the inflow.

Peak flow rates may be reduced by the same percentage as the reduction in runoff volume.

Many software packages are not able to directly give credit for the runoff reduction. For those situations a revised rainfall value can be calculated from the adjusted runoff depth and the runoff curve number.

A spreadsheet has been developed to perform the calculations. The spreadsheet can be found on the Iowa Engineering web page using the following path from the Iowa NRCS home page:

Iowa NRCS home page → Topics → Technical Resources → Engineering → Engineering Spreadsheets → IaTerraceCredit.xls

The first tab on the spreadsheet, labeled “IA EFH2-91(35-36)”, gives two examples that show how the Peak Flow Adjustment Factor is calculated. These examples refer to a rainfall-runoff nomograph located in EFH Chapter 2. An alternative to using the nomograph is to use tables giving rainfall-runoff relationships by curve number. These tables are located in the National Engineering Handbook Part 630, Hydrology; Chapter 10, Estimation of Direct Runoff from Storm Rainfall; Appendix 10A, Rainfall - Runoff Tables for Selected Runoff Curve Numbers. These tables have rainfall-runoff values for curve numbers 50 - 98.