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NORMALCY TESTS OF PRECIPITATION AND FREQUENCY STUDIES OF RUNOFF ON SMALL

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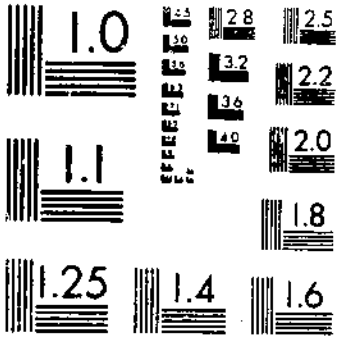
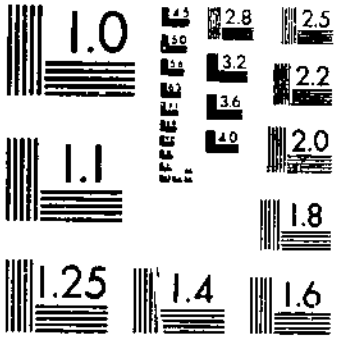



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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**UNITED STATES**
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# Normalcy Tests of Precipitation and Frequency Studies of Runoff on Small Watersheds [1]

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## CONTENTS



## INTRODUCTION

The establishment of 10 conservation experiment stations in different agricultural regions of the United States resulted from adoption of the Buchanan amendment to the agricultural appropriation bill by the House of Representatives, February 16, 1929. This amendment appropriated $160,000 for soil-erosion investigations. With these funds the stations were established during the period 1929–32 to study the causes, rates, and effects of erosion in order to determine the most effective and practical methods of checking and controlling soil and

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[2] The author gratefully acknowledges the assistance of Bernadette A. Reid who made the many tedious calculations necessary to the preparation of this bulletin.

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water losses from agricultural lands. With the passage by Congress of the Soil Conservation Act (Public No. 46), in April 1935, the Soil Conservation Service was created and the 10 experiment stations became a part of the research program of that Service.

Investigations carried on at the conservation experiment stations included those to determine the effect of various types of vegetative cover, soil treatments, and cultural and cropping systems on erosion and surface runoff. Also included were investigations to determine the effectiveness of terraces of various types, grades, and spacing in conserving soil and water. These investigations were made on small plots of various sizes and on natural watersheds, in cooperation with the State agricultural experiment stations.

The results of these investigations, covering the 10-year period, 1930–40, have either been published or are pending publication in technical bulletins for most of the experiment stations (*1*, *3*, *4*, *5*, *10*, *11*, *12*, *13*, and *18*).[3] In interpreting these results the question arises as to what extent the data were affected by the weather experienced during the period of record. For example: Was a reduction in peak rates of surface runoff due entirely to differences in land use or should part of the reduction be ascribed to weather that was particularly favorable to the land use tested? This bulletin was prepared to assist the technician to answer these questions and to present the results of frequency studies made on peak rates of surface runoff from the small natural watersheds (*2*, *6*, *8*, *9*, *15*, *16*, *17*, *19*, *21*, *22*, and *23*). Maps of the soil-conservation stations from which the data were derived are to be found in the folder on the back inside cover page of this bulletin.

## NORMALCY TESTS

Although it is recognized that other phases of weather may also have affected the experimental results, the comparisons presented in this bulletin are limited to precipitation only. Normal precipitation was defined by frequency studies or by averages determined from long-term Weather Bureau records. Three tests of normalcy were made at each experiment station. These tests were for: (1) Amounts of annual and monthly precipitation; (2) intensities for various time intervals; and (3) average number of annual and monthly excessive storms.

### Amounts of Precipitation

Frequency studies were made of amounts of precipitation based on long-term Weather Bureau records. These studies were made for annual precipitation and for the precipitation that occurred during each calendar month. The maximum amounts of precipitation that could be expected for various recurrence intervals were then tabulated and compared with corresponding values determined from frequency studies of the experiment station record. These comparisons are shown in tables 1, 5, 9, 13, 17, 21, 25, and 29 which give pertinent rainfall and runoff data from eight soil-conservation experiment stations. The data for each station appear in the tables under the heading for that station.

[3] Italic numbers in parentheses refer to Literature Cited, p. 22.

### Intensities

Frequency studies were made of rainfall intensities for 5-, 15-, and 30-minute periods. These studies were based on long-term records from the first-order Weather Bureau station closest to the experiment station. When an experiment station was found to be nearly equidistant from two first-order stations, frequency studies were made of the intensity data from both such stations. The rainfall intensities that could be expected for various recurrence intervals were then tabulated for each time period and compared with similar values determined from frequency studies based on the experiment station records. Tables 2, 6, 10, 14, 18, 22, 26, and 30 give these figures for each of the eight stations.

Prior to 1935, first-order Weather Bureau stations reported the amount of rainfall at the end of each 5-minute period of excessive rainfall. Since changes in rainfall intensity do not necessarily coincide with these 5-minute division points, maximum intensities for any time interval computed from the Weather Bureau tabulations are usually less than the true maximum. Yarnell (*20*) found the difference to be 8 to 10 percent of the computed figure for 5-minute periods and 4 to 5 percent for periods of 1 hour. For the frequency studies used in this bulletin, 5-, 15-, and 30-minute maximum intensities computed from Weather Bureau records were, therefore, increased 8 percent to approximate the true maximum intensities.

### Excessive Storms

An excessive storm was taken as one in which the amount of rain that fell during any 5-minute period was equal to or greater than 0.25 inch or in which the amount that fell during any period in excess of 5 minutes was equal to or greater than 0.25 inch plus 0.01 inch for each minute in excess of 5.

The average numbers of annual and monthly excessive storms were determined from Yarnell's (*20*) 30-year totals. These averages were then tabulated and compared with similar values obtained from the experiment station records. They are given in tables 3, 7, 11, 15, 19, 23, 27, and 31 for each of the stations.

Yarnell's (*20*) totals were based on maximum rainfall intensities computed from Weather Bureau records for periods prior to 1936. Since maximum intensities computed from such records have been found to be less than the true maximums, it follows that the number of excessive storms defined by these values must also be less than the true number. Maximum 5-, 15-, and 30-minute intensities for the period of record for each conservation experiment station were reduced by dividing by 1.08 to obtain values comparable with those used by Yarnell. The average annual number of excessive storms was then determined from these reduced intensities and compared with the true average. As a result of these comparisons it was concluded that the number of excessive storms based on Weather Bureau records for the period prior to 1935 should be increased by 16 percent to approximate the actual number. Yarnell's 30-year totals were accordingly increased by this amount when used in this bulletin.

## PEAK RATES OF RUNOFF

A brief description of each watershed including size, land use, and period of record is given for each of the stations in tables 4, 8, 12, 16, 20, 24, 28, and 32. Frequency studies were made of the peak rates of surface runoff from each of the natural watersheds and from some selected terraces at the stations. These tables also show the peak rates that could be expected to be equaled or exceeded for various recurrence intervals at the various stations.

## FREQUENCY STUDIES

For the frequency studies of annual and monthly amounts of precipitation there was, of course, only one such amount for each calendar year of record. This was not true, however, for studies of rainfall intensities and peak rates of runoff and in these studies only the maximum value for each calendar year was considered. Since the calendar year was taken as the time unit, the results indicate that over a long period of years an average of 1 year in 2, 5, 10, 25, or 50 years can be expected during which specified values will be equaled or exceeded.

Since distributions of rainfall and runoff data are usually considerably skewed, Gumbel's (*7*, *14*) method for computing frequencies, in which he implies a constant skew, was found to be very well adapted to frequency studies of these phenomena. The procedures developed by Gumbel were, therefore, selected for the derivation of the 329 frequency curves computed as part of the studies in this bulletin.

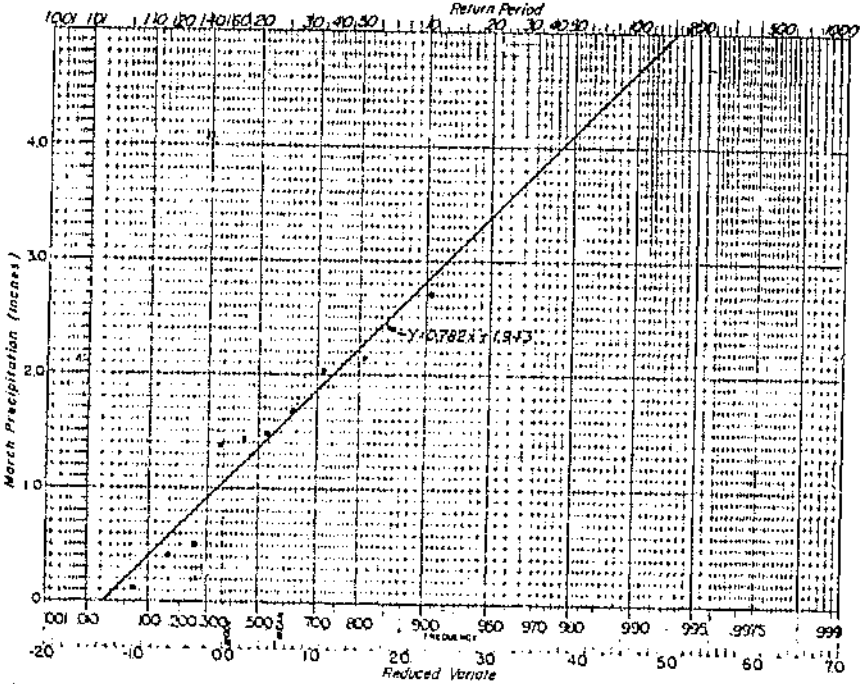


FIGURE 1.—Frequency of amounts of March precipitation at Conservation Experiment Station, Bethany, Mo., 1933-42. [Courtesy of E. J. Gumbel.]

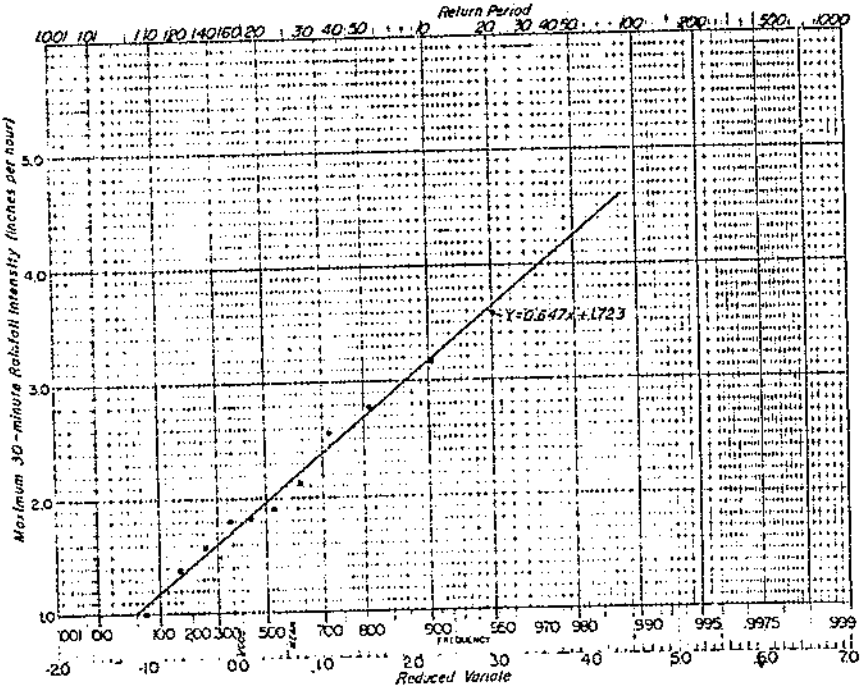


FIGURE 2.—Frequency of maximum 30-minute rainfall intensities at Conservation Experiment Station, Bethany, Mo., 1933-42. [Courtesy of E. J. Gumbel.]

The chart in figure 1 shows the Gumbel method used to estimate the amounts of March precipitation that might be expected for any recurrence interval (years). Figure 2 illustrates the Gumbel method of determining the maximum 30-minute rainfall intensity that might be expected over a period of years. Peak rates of runoff that could be expected for various recurrence intervals were obtained in a similar way.

## CONCLUSIONS

No attempt has been made in this bulletin to adjust experimental data for abnormal weather. The three normalcy tests that have been applied to the precipitation experienced during the period of record should, however, enable the technician to determine whether or not such adjustments are necessary.

A comparison of runoff from small watersheds has shown that the area of the watershed has a marked effect on the peak rate per acre. In general, it may be said that the larger the watershed the smaller will be the peak rate of runoff per acre. This decrease in peak rate per acre with size of watershed is especially rapid for watersheds of less than 100 acres. Direct use of the tabulated peak rates should, therefore, be made only in connection with watersheds that have approximately the same area as those included in the tabulation. Future supplemental studies may be made that will determine the effect of watershed size and thus make possible the extrapolation of the peak rates to larger areas.

# RAINFALL, RUNOFF, AND FREQUENCY TABULATIONS

## Conservation Experiment Station Near Bethany, Mo.

Table 1.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Location | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Bethany, Mo.[1] | 1.20 | 2.32 | 3.00 | 3.88 | 4.53 |
| | St. Joseph, Mo.[2] | .95 | 1.75 | 2.29 | 2.97 | 3.46 |
| February | Bethany, Mo. | .78 | 1.53 | 2.02 | 2.65 | 3.12 |
| | St. Joseph, Mo. | 1.21 | 2.13 | 2.73 | 3.52 | 4.09 |
| March | Bethany, Mo. | 1.34 | 2.22 | 2.79 | 3.51 | 4.08 |
| | St. Joseph, Mo. | 1.89 | 3.25 | 4.14 | 5.30 | 6.15 |
| April | Bethany, Mo. | 2.45 | 3.50 | 4.18 | 5.08 | 5.73 |
| | St. Joseph, Mo. | 2.95 | 4.36 | 5.29 | 6.59 | 7.39 |
| May | Bethany, Mo. | 3.91 | 6.40 | 8.15 | 10.34 | 11.93 |
| | St. Joseph, Mo. | 3.97 | 6.27 | 7.76 | 9.73 | 11.16 |
| June | Bethany, Mo. | 4.15 | 7.51 | 9.75 | 12.96 | 14.78 |
| | St. Joseph, Mo. | 4.87 | 7.66 | 9.48 | 11.87 | 13.41 |
| July | Bethany, Mo. | 1.88 | 3.61 | 4.57 | 5.97 | 6.89 |
| | St. Joseph, Mo. | 3.30 | 5.55 | 6.99 | 8.88 | 10.26 |
| August | Bethany, Mo. | 3.46 | 6.76 | 8.58 | 11.24 | 13.18 |
| | St. Joseph, Mo. | 3.38 | 5.16 | 6.33 | 7.86 | 8.98 |
| September | Bethany, Mo. | 3.63 | 6.67 | 8.66 | 11.26 | 13.16 |
| | St. Joseph, Mo. | 3.56 | 5.76 | 7.10 | 9.08 | 10.45 |
| October | Bethany, Mo. | 2.17 | 4.37 | 5.80 | 7.68 | 9.06 |
| | St. Joseph, Mo. | 2.54 | 4.40 | 5.61 | 7.20 | 8.36 |
| November | Bethany, Mo. | 1.96 | 3.96 | 5.27 | 6.99 | 8.24 |
| | St. Joseph, Mo. | 1.56 | 2.98 | 3.90 | 5.11 | 5.99 |
| December | Bethany, Mo. | 1.00 | 1.65 | 2.07 | 2.63 | 3.03 |
| | St. Joseph, Mo. | .89 | 1.67 | 2.18 | 2.84 | 3.33 |
| Annual | Bethany, Mo. | 29.00 | 34.02 | 37.29 | 41.60 | 44.74 |
| | St. Joseph, Mo. | 32.99 | 40.10 | 44.73 | 50.83 | 55.27 |

[1] Conservation Experiment Station, Bethany, Mo., 1933–42.
[2] U. S. Weather Bureau Station, St. Joseph, Mo., 1875–1939.

Table 2.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Bethany, Mo.[1] (1933–42) | 4.52 | 5.66 | 6.40 | 7.38 | 8.09 |
| St. Joseph, Mo.[2] (1911–35) | 4.87 | 5.88 | 6.56 | 7.43 | 8.09 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Bethany, Mo. (1933–42) | 2.85 | 3.71 | 4.27 | 5.00 | 5.54 |
| St. Joseph, Mo. (1911–35) | 3.41 | 4.20 | 4.69 | 5.31 | 5.81 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Bethany, Mo. (1933–42) | 1.97 | 2.69 | 3.17 | 3.79 | 4.21 |
| St. Joseph, Mo. (1911–35) | 2.37 | 3.15 | 3.66 | 4.33 | 4.82 |

[1] Conservation Experiment Station, Bethany, Mo.
[2] U. S. Weather Bureau Station, St. Joseph, Mo.

TABLE 3.—*Comparison of number of monthly and annual excessive storms at the station, 1933–42, with Yarnell's [1] 30-year average*

| Month | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | 1942 | Total | Average | Yarnell's 30-year average plus 16 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.1 | 0.3 |
| April | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | .1 | .3 |
| May | 3 | 1 | 3 | 0 | 0 | 3 | 0 | 1 | 1 | 2 | 14 | 1.4 | .8 |
| June | 0 | 1 | 4 | 0 | 0 | 0 | 7 | 3 | 2 | 1 | 18 | 1.8 | 2.1 |
| July | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 2 | 0 | 1 | 10 | 1.0 | 1.5 |
| August | 3 | 2 | 0 | 0 | 0 | 4 | 1 | 0 | 1 | 2 | 13 | 1.3 | 1.5 |
| September | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 2 | 9 | .9 | 1.5 |
| October | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 4 | .4 | .3 |
| November | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | .1 | .1 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 9 | 8 | 10 | 1 | 3 | 8 | 10 | 6 | 8 | 8 | 71 | 7.1 | 8.4 |

[1] See literature citation (20).

TABLE 4. *Watershed description [1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| Pa–A | 2.117 | Pasture; continuous bluegrass; terraced | 1934–42 | 0.60 | 1.34 | 1.82 | 2.45 | 2.91 |
| | 2.028 | | | | | | | |
| Pa–B | 16.329 | Pasture; permanent bluegrass | 1933–42 | .81 | 1.76 | 2.37 | 3.19 | 3.78 |
| | 5.583 | | | | | | | |
| Pa–C | 1.974 | Pasture; continuous bluegrass; contour furrowed. | 1936–42 | .48 | 1.05 | 1.42 | 1.91 | 2.26 |
| D–3 | 14.847 | 4-year rotation; cultivated parallel to field boundaries. | 1933–42 | 2.37 | 3.81 | 4.75 | 5.98 | 6.88 |
| | 4.485 | | | | | | | |
| I–38 | 2.112 | 5-year rotation; contour cultivation | 1933–42 | 1.98 | 3.61 | 4.67 | 6.07 | 7.09 |
| H–1 | 2.128 | Crop rotation; strip cropped | 1931–42 | 1.51 | 2.77 | 3.58 | 4.66 | 5.44 |
| D–1 | 7.51 | 4-year rotation; contour cultivation | 1935–42 | 1.61 | 2.96 | 3.83 | 4.98 | 5.82 |
| D–2 | 8.03 | 4-year rotation; terraced | 1935–42 | .86 | 1.87 | 2.53 | 3.46 | 4.01 |

[1] For a more detailed description, see SCS–TP–30 and supplements (*21*, *12*, and *23*).
[2] Period for which frequency studies were made.
[3] Area before Aug. 12, 1938.
[4] Area before Nov. 22, 1935.
[5] Area before May 11, 1934.

## Missouri Valley Loess Conservation Experiment Station, Clarinda, Iowa

TABLE 5.—*Comparisons of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 0.82 | 1.47 | 1.90 | 2.47 | 2.88 |
| | Weather Bureau station [2] | .81 | 1.38 | 1.75 | 2.23 | 2.59 |
| February | Experiment station | .55 | .91 | 1.14 | 1.45 | 1.68 |
| | Weather Bureau station | 1.00 | 1.83 | 2.36 | 3.07 | 3.50 |
| March | Experiment station | 1.10 | 2.11 | 2.77 | 3.64 | 4.28 |
| | Weather Bureau station | 1.49 | 2.40 | 2.90 | 3.76 | 4.33 |
| April | Experiment station | 2.07 | 3.49 | 4.41 | 5.62 | 6.54 |
| | Weather Bureau station | 2.68 | 3.96 | 4.80 | 5.90 | 6.71 |
| May | Experiment station | 3.90 | 6.31 | 7.88 | 9.94 | 11.44 |
| | Weather Bureau station | 4.10 | 6.36 | 7.84 | 9.78 | 11.10 |
| June | Experiment station | 4.70 | 7.96 | 10.05 | 12.70 | 14.70 |
| | Weather Bureau station | 4.02 | 7.17 | 8.76 | 10.90 | 12.40 |
| July | Experiment station | 2.55 | 5.19 | 6.92 | 9.18 | 10.83 |
| | Weather Bureau station | 3.09 | 6.27 | 7.96 | 10.17 | 11.79 |
| August | Experiment station | 2.99 | 4.94 | 6.20 | 7.87 | 9.08 |
| | Weather Bureau station | 3.23 | 5.15 | 6.36 | 7.98 | 9.13 |
| September | Experiment station | 3.05 | 7.41 | 9.07 | 12.04 | 14.81 |
| | Weather Bureau station | 3.34 | 6.04 | 7.80 | 10.12 | 11.81 |
| October | Experiment station | 2.06 | 5.36 | 7.24 | 9.72 | 11.53 |
| | Weather Bureau station | 2.48 | 4.01 | 5.01 | 6.32 | 7.28 |
| November | Experiment station | 1.38 | 2.85 | 3.47 | 4.56 | 5.35 |
| | Weather Bureau station | 1.27 | 2.47 | 3.25 | 4.28 | 5.03 |
| December | Experiment station | .83 | 1.56 | 2.04 | 2.67 | 3.12 |
| | Weather Bureau station | .92 | 1.71 | 2.23 | 2.91 | 3.40 |
| Annual | Experiment station | 28.09 | 35.66 | 40.60 | 47.09 | 51.82 |
| | Weather Bureau station | 31.58 | 37.72 | 41.71 | 46.97 | 50.81 |

[1] Conservation Experiment Station, Clarinda, Iowa, 1934–42.
[2] U. S. Weather Bureau Station, Clarinda, Iowa, 1875–1930.

TABLE 6.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| St. Joseph, Mo.[1] (1911–35) | 4.87 | 5.88 | 6.56 | 7.43 | 8.06 |
| Omaha, Nebr.[2] (1912–35) | 4.14 | 5.12 | 5.76 | 6.60 | 7.20 |
| Average | 4.50 | 5.50 | 6.16 | 7.02 | 7.63 |
| Clarinda, Iowa [3] (1934–41) | 4.90 | 5.92 | 6.52 | 7.31 | 7.89 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| St. Joseph, Mo. (1911–35) | 3.44 | 4.20 | 4.69 | 5.34 | 5.81 |
| Omaha, Nebr. (1912–35) | 2.94 | 3.72 | 4.23 | 4.88 | 5.36 |
| Average | 3.19 | 3.96 | 4.46 | 5.11 | 5.58 |
| Clarinda, Iowa (1934–41) | 3.51 | 4.12 | 4.52 | 5.05 | 5.43 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| St. Joseph, Mo. (1911–35) | 2.37 | 3.15 | 3.66 | 4.33 | 4.82 |
| Omaha, Nebr. (1912–35) | 1.88 | 2.65 | 3.15 | 3.80 | 4.29 |
| Average | 2.12 | 2.90 | 3.40 | 4.06 | 4.56 |
| Clarinda, Iowa (1934–41) | 2.30 | 2.81 | 3.13 | 3.57 | 3.88 |

[1] U. S. Weather Bureau Station, St. Joseph, Mo.
[2] U. S. Weather Bureau Station, Omaha, Nebr.
[3] Conservation Experiment Station, Clarinda, Iowa.

TABLE 7.—*Comparison of number of monthly and annual excessive storms at the station, 1934–41, with Yarnell's [1] 30-year average*

| Month | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | Total | Average | Yarnell's [1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .2 |
| April | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 6 | .8 | .3 |
| May | 2 | 1 | 0 | 3 | 0 | 0 | 0 | 3 | 9 | 1.1 | .8 |
| June | 1 | 2 | 2 | 2 | 1 | 4 | 2 | 3 | 17 | 2.1 | 1.7 |
| July | 1 | 1 | 1 | 4 | 0 | 3 | 6 | 0 | 16 | 2.0 | 1.5 |
| August | 1 | 1 | 0 | 1 | 2 | 0 | 2 | 1 | 8 | 1.0 | 1.4 |
| September | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 3 | 6 | .8 | 1.2 |
| October | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 4 | .5 | .3 |
| November | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .1 |
| December | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | .1 | 0 |
| Annual | 7 | 5 | 7 | 11 | 4 | 7 | 11 | 15 | 67 | 8.4 | 7.5 |

[1] See literature citation (*20*).

TABLE 8.—*Watershed description [1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| V | 3.25 | Unterraced; rotation of corn, corn, oats with seeding of clover and clover. | 1934–41 | 1.19 | 2.60 | 3.68 | 4.97 | 5.91 |
| W | 1.97 | Unterraced; rotation of corn, corn, corn and oats. | 1934–41 | 1.96 | 4.11 | 5.51 | 7.35 | 8.70 |
| X | 1.07 | Terraced; rotation of corn, corn and oats. | 1934–41 | 1.13 | 2.87 | 4.00 | 5.40 | 6.58 |
| Y | 3.25 | Unterraced; rotation of corn, corn, oats with seeding of clover, and clover. | 1934–41 | 1.43 | 3.01 | 4.03 | 5.38 | 6.37 |
| Z | 3.12 | Terraced; rotation of corn, corn, oats with seeding of clover and clover. | 1934–41 | .35 | .82 | 1.13 | 1.53 | 1.82 |

[1] For a more detailed description, see SCS-TP 31 and supplement (*15*, *16*).
[2] Period for which frequency studies were made.

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## Soil Conservation Service Experiments in Cooperation With Kansas Agricultural Experiment Station at Hays, Kans.

Table 9.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 0.38 | 0.98 | 1.37 | 1.89 | 2.26 |
| | Weather Bureau station [2] | .42 | .97 | 1.33 | 1.80 | 2.14 |
| February | Experiment station | .45 | .70 | 1.01 | 1.29 | 1.50 |
| | Weather Bureau station | .60 | 1.44 | 1.93 | 2.58 | 3.05 |
| March | Experiment station | .85 | 2.10 | 2.93 | 4.00 | 4.79 |
| | Weather Bureau station | .80 | 1.70 | 2.38 | 3.20 | 3.80 |
| April | Experiment station | 1.47 | 2.65 | 3.41 | 4.42 | 5.16 |
| | Weather Bureau station | 2.14 | 3.60 | 4.50 | 5.82 | 6.74 |
| May | Experiment station | 3.38 | 5.80 | 7.37 | 9.44 | 10.95 |
| | Weather Bureau station | 3.01 | 4.88 | 6.09 | 7.69 | 8.86 |
| June | Experiment station | 3.39 | 5.74 | 7.28 | 9.30 | 10.77 |
| | Weather Bureau station | 3.25 | 5.25 | 6.65 | 8.27 | 9.52 |
| July | Experiment station | 1.83 | 2.77 | 3.71 | 4.95 | 5.85 |
| | Weather Bureau station | 3.14 | 5.15 | 6.47 | 8.10 | 9.15 |
| August | Experiment station | 2.68 | 3.73 | 4.41 | 5.31 | 6.00 |
| | Weather Bureau station | 2.82 | 4.38 | 5.39 | 6.73 | 7.70 |
| September | Experiment station | 2.20 | 3.77 | 4.79 | 6.13 | 7.11 |
| | Weather Bureau station | 1.94 | 3.36 | 4.29 | 5.51 | 6.40 |
| October | Experiment station | 1.44 | 3.02 | 4.06 | 5.41 | 6.46 |
| | Weather Bureau station | 1.39 | 2.80 | 3.39 | 4.43 | 5.18 |
| November | Experiment station | .99 | 2.17 | 2.94 | 3.95 | 4.69 |
| | Weather Bureau station | .87 | 1.43 | 1.92 | 2.57 | 3.04 |
| December | Experiment station | .39 | .99 | 1.38 | 1.89 | 2.27 |
| | Weather Bureau station | .63 | 1.43 | 1.95 | 2.63 | 3.12 |
| Annual | Experiment station | 19.42 | 25.28 | 29.10 | 34.13 | 37.79 |
| | Weather Bureau station | 22.38 | 27.71 | 31.18 | 35.76 | 39.09 |

[1] Conservation Experiment Station, Hays, Kans., 1930–38.
[2] U. S. Weather Bureau Station, Hays, Kans., 1878–1930.

Table 10.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Concordia, Kans.[1] (1911–35) | 5.03 | 6.30 | 7.14 | 8.21 | 9.05 |
| Dodge City, Kans.[2] (1911–35) | 4.15 | 5.65 | 6.63 | 7.93 | 8.88 |
| Average | 4.59 | 5.98 | 6.88 | 8.08 | 8.96 |
| Hays, Kans.[3] (1930–38) | (4) | (4) | (4) | (4) | (4) |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Concordia, Kans. (1911–35) | 3.47 | 4.50 | 5.17 | 6.06 | 6.71 |
| Dodge City, Kans. (1911–35) | 2.96 | 4.30 | 5.16 | 6.31 | 7.15 |
| Average | 3.21 | 4.40 | 5.16 | 6.18 | 6.93 |
| Hays, Kans. (1930–38) | (4) | (4) | (4) | (4) | (4) |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Concordia, Kans. (1911–35) | 2.20 | 3.20 | 3.75 | 4.51 | 5.10 |
| Dodge City, Kans. (1911–35) | 2.11 | 3.12 | 3.78 | 4.64 | 5.28 |
| Average | 2.20 | 3.16 | 3.78 | 4.59 | 5.19 |
| Hays, Kans. (1930–38) | 2.21 | 3.13 | 3.70 | 4.46 | 5.01 |

[1] U. S. Weather Bureau Station, Concordia, Kans.
[2] U. S. Weather Bureau Station, Dodge City, Kans.
[3] Conservation Experiment Station, Hays, Kans.
[4] Record incomplete.

TABLE 11.—*Comparison of number of monthly and annual excessive storms at the station, 1930–38, with Yarnell's [1] 30-year average*

| Month | 1930 | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | Total | Average | Yarnell's [1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | .1 | 0 |
| April | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | .1 | .2 |
| May | 1 | 0 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 7 | .8 | 1.2 |
| June | 2 | 2 | 4 | 0 | 2 | 2 | 0 | 1 | 0 | 13 | 1.4 | 1.5 |
| July | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 0 | 5 | .6 | 1.4 |
| August | 1 | 1 | 2 | 1 | 2 | 0 | 1 | 1 | 1 | 10 | 1.1 | 1.3 |
| September | 1 | 0 | 3 | 1 | 0 | 2 | 0 | 1 | 1 | 9 | 1.0 | .8 |
| October | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .3 |
| November | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | .1 | .2 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 6 | 4 | 12 | 4 | 4 | 4 | 3 | 5 | 5 | 47 | 5.2 | 6.9 |

[1] See literature citation (*20*).

TABLE 12.—*Watershed description [1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| 2-I | 1.03 | Terraced; rotation of wheat, corn, and barley before 1933; wheat, kafir, and barley 1935 to 1938. | 1930–38 | 1.78 | 3.08 | 3.93 | 5.05 | 5.80 |
| 3-I | .85 | Terraced; rotation of wheat, corn, and barley before 1936; wheat, kafir, and barley 1936 38. | 1930–38 | 1.20 | 2.06 | 2.62 | 3.35 | 3.88 |
| 4-I | .87 | Terraced; rotation of wheat, corn, and barley before 1937; wheat, kafir, and barley 1937 38. | 1930–38 | 1.68 | 2.73 | 3.42 | 4.32 | 4.97 |
| 2-N | 2.81 | Terraced; continuous wheat | 1932–38 | .24 | .48 | .63 | .84 | .99 |
| 3-N | 2.95 | Terraced; continuous wheat | 1931–38 | .26 | .44 | .56 | .71 | .82 |
| 6-I | 2.81 | Unterraced; continuous wheat | 1934–38 | 2.03 | 4.79 | 6.21 | 8.06 | 9.42 |
| 1,61-AG | 1.61 | Native buffalo and gramma grass; grazed. | 1932–38 | 1.38 | 2.06 | 2.51 | 3.10 | 3.52 |

[1] For a more detailed description, see SCS-TP-37 (*6*).
[2] Period for which frequency studies were made.

## Upper Mississippi Valley Conservation Experiment Station Near La Crosse, Wis.

Table 13.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 1.15 | 1.84 | 2.30 | 2.90 | 3.33 |
| | Weather Bureau station [2] | 1.05 | 1.60 | 2.11 | 2.68 | 3.08 |
| February | Experiment station | .88 | 1.40 | 1.90 | 2.43 | 2.81 |
| | Weather Bureau station | 1.02 | 1.72 | 2.18 | 2.78 | 3.21 |
| March | Experiment station | 1.76 | 2.60 | 3.24 | 4.09 | 4.76 |
| | Weather Bureau station | 1.54 | 2.48 | 3.05 | 3.84 | 4.41 |
| April | Experiment station | 2.18 | 3.11 | 3.71 | 4.50 | 5.08 |
| | Weather Bureau station | 2.27 | 3.42 | 4.18 | 5.17 | 5.89 |
| May | Experiment station | 3.78 | 5.62 | 6.82 | 8.39 | 9.54 |
| | Weather Bureau station | 3.45 | 5.25 | 6.42 | 7.96 | 9.08 |
| June | Experiment station | 3.93 | 5.54 | 6.59 | 7.97 | 8.98 |
| | Weather Bureau station | 3.97 | 6.17 | 7.61 | 9.50 | 10.85 |
| July | Experiment station | 3.26 | 5.48 | 6.93 | 8.83 | 10.22 |
| | Weather Bureau station | 3.52 | 5.81 | 7.33 | 9.31 | 10.75 |
| August | Experiment station | 4.05 | 6.55 | 8.18 | 10.32 | 11.88 |
| | Weather Bureau station | 3.28 | 5.26 | 6.55 | 8.24 | 9.48 |
| September | Experiment station | 4.26 | 7.38 | 9.42 | 12.09 | 14.04 |
| | Weather Bureau station | 3.69 | 5.69 | 7.00 | 8.71 | 9.90 |
| October | Experiment station | 2.32 | 3.74 | 4.66 | 5.88 | 6.77 |
| | Weather Bureau station | 2.06 | 3.75 | 4.85 | 6.30 | 7.38 |
| November | Experiment station | 1.84 | 3.25 | 4.17 | 5.38 | 6.28 |
| | Weather Bureau station | 1.44 | 2.50 | 3.10 | 4.10 | 4.78 |
| December | Experiment station | .81 | 1.38 | 1.73 | 2.19 | 2.52 |
| | Weather Bureau station | 1.21 | 1.98 | 2.48 | 3.14 | 3.62 |
| Annual | Experiment station | 31.22 | 37.72 | 41.95 | 47.52 | 51.58 |
| | Weather Bureau station | 30.25 | 35.50 | 39.02 | 43.57 | 46.89 |

[1] Conservation Experiment Station, La Crosse, Wis., 1933–46.
[2] U. S. Weather Bureau Station, La Crosse, Wis., 1875–1930.

Table 14.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Station and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Experiment station [1] (1933–46) | 6.28 | 6.82 | 7.82 | 9.14 | 10.16 |
| Weather Bureau station [2] (1911–35) | 4.88 | 6.16 | 7.09 | 8.09 | 8.89 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Experiment station (1933–46) | 3.32 | 4.51 | 5.28 | 6.30 | 7.04 |
| Weather Bureau station (1911–35) | 3.42 | 4.41 | 5.01 | 5.83 | 6.44 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Experiment station (1933–46) | 2.26 | 2.96 | 3.43 | 4.04 | 4.48 |
| Weather Bureau station (1911–35) | 2.11 | 2.82 | 3.28 | 3.90 | 4.34 |

[1] Conservation Experiment Station, La Crosse, Wis.
[2] U. S. Weather Bureau Station, La Crosse, Wis.

TABLE 15.—*Comparison of number of monthly and annual excessive storms at the station, 1933–47, with Yarnell's [1] 30-year average*

| Month | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 |
|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| April | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 1 |
| May | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 3 |
| June | 2 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 2 |
| July | 4 | 1 | 2 | 0 | 1 | 5 | 0 | 0 | 1 |
| August | 0 | 0 | 3 | 1 | 2 | 2 | 1 | 3 | 0 |
| September | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 2 |
| October | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |
| November | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 6 | 6 | 9 | 6 | 5 | 11 | 2 | 6 | 10 |

| Month | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | Total | Average | Yarnell's [1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 0 | 0 | 1 | 0 | 0 | 1 | .1 | 0 |
| April | 1 | 0 | 0 | 0 | 0 | 1 | 8 | .6 | .1 |
| May | 1 | 1 | 0 | 2 | 0 | 0 | 10 | .7 | .7 |
| June | 5 | 1 | 2 | 0 | 1 | 1 | 20 | 1.3 | 1.4 |
| July | 1 | 0 | 2 | 3 | 1 | 2 | 23 | 1.5 | 1.5 |
| August | 1 | 0 | 2 | 1 | 1 | 1 | 18 | 1.2 | 1.5 |
| September | 4 | 1 | 0 | 1 | 2 | 0 | 10 | 1.1 | .8 |
| October | 1 | 0 | 0 | 0 | 0 | 0 | 5 | .3 | .3 |
| November | 0 | 0 | 0 | 0 | 0 | 0 | 1 | .1 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 14 | 3 | 6 | 8 | 5 | 5 | 102 | 6.8 | 6.3 |

[1] See literature citation (*20*).

TABLE 16.—*Watershed description [1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| UPW | [3] 2.713<br>2.412 | Unterraced; pasture; grazed | 1933–46 | 1.33 | 2.25 | 2.85 | 3.65 | 4.22 |
| UCW | [4] 4.13<br>[5] 2.335<br>2.245 | Unterraced; contour cultivation; rotation of corn, small grain, and hay | 1933–46 | 2.95 | 4.90 | 6.28 | 8.00 | 9.20 |
| CW | 2.705 | Upper portion strip-cropped to rotation of corn, barley, and hay; lower portion, alfalfa. | 1937–47 | 1.58 | 3.30 | 4.43 | 5.90 | 6.98 |

[1] For a more detailed description, see SCS-TP-20 (*9*).
[2] Period for which frequency studies were made.
[3] Area before Nov. 2, 1934.
[4] Area before Mar. 22, 1934.
[5] Area from Mar. 22, 1934, to Apr. 13, 1938.

## CENTRAL PIEDMONT CONSERVATION EXPERIMENT STATION, STATESVILLE, N. C.

TABLE 17.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 5.02 | 9.20 | 12.08 | 15.74 | 18.41 |
| | Weather Bureau station [2] | 3.59 | 5.53 | 6.80 | 8.40 | 9.68 |
| February | Experiment station | 3.36 | 4.90 | 5.91 | 7.25 | 8.10 |
| | Weather Bureau station | 3.74 | 5.60 | 6.81 | 8.40 | 9.56 |
| March | Experiment station | 4.92 | 7.08 | 9.47 | 11.84 | 13.56 |
| | Weather Bureau station | 4.17 | 6.19 | 7.50 | 9.24 | 10.50 |
| April | Experiment station | 3.76 | 5.17 | 6.09 | 7.30 | 8.19 |
| | Weather Bureau station | 3.25 | 4.82 | 5.85 | 7.20 | 8.18 |
| May | Experiment station | 3.14 | 4.98 | 6.18 | 7.76 | 8.91 |
| | Weather Bureau station | 3.28 | 5.03 | 6.18 | 7.66 | 8.78 |
| June | Experiment station | 3.54 | 6.87 | 9.02 | 11.89 | 13.96 |
| | Weather Bureau station | 3.87 | 5.99 | 7.36 | 9.18 | 10.50 |
| July | Experiment station | 6.25 | 9.54 | 11.68 | 14.50 | 16.55 |
| | Weather Bureau station | 5.18 | 7.82 | 9.55 | 11.81 | 13.46 |
| August | Experiment station | 4.98 | 7.69 | 9.40 | 11.79 | 13.48 |
| | Weather Bureau station | 5.14 | 8.19 | 10.18 | 12.70 | 14.70 |
| September | Experiment station | 2.89 | 4.34 | 5.34 | 6.65 | 7.60 |
| | Weather Bureau station | 3.31 | 5.84 | 7.49 | 9.66 | 11.24 |
| October | Experiment station | 5.72 | 7.02 | 9.17 | 12.00 | 14.07 |
| | Weather Bureau station | 3.08 | 5.49 | 7.07 | 9.14 | 10.65 |
| November | Experiment station | 3.13 | 5.18 | 6.52 | 8.27 | 9.55 |
| | Weather Bureau station | 2.39 | 4.02 | 5.00 | 6.49 | 7.51 |
| December | Experiment station | 3.33 | 5.26 | 6.49 | 8.13 | 9.33 |
| | Weather Bureau station | 4.08 | 6.12 | 7.45 | 9.19 | 10.47 |
| Annual | Experiment station | 47.97 | 67.30 | 83.38 | 71.38 | 77.22 |
| | Weather Bureau station | 47.64 | 55.51 | 60.53 | 67.38 | 72.20 |

[1] Conservation Experiment Station, Statesville, N. C., 1933–38.
[2] U. S. Weather Bureau Station, Statesville, N. C., 1901–45.

TABLE 18.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Statesville, N. C.[1] (1933–38) | 4.71 | 5.48 | 5.90 | 6.66 | 7.14 |
| Charlotte, N. C.[2] (1911–35) | 5.13 | 6.61 | 7.57 | 8.82 | 9.74 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Statesville, N. C. (1933–38) | 3.75 | 4.95 | 5.72 | 6.75 | 7.49 |
| Charlotte, N. C. (1911–35) | 3.60 | 4.77 | 5.48 | 6.40 | 7.07 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Statesville, N. C. (1933–38) | 2.86 | 3.74 | 4.31 | 5.06 | 5.61 |
| Charlotte, N. C. (1911–35) | 2.42 | 3.38 | 4.01 | 4.83 | 5.42 |

[1] Conservation Experiment Station, Statesville, N. C.
[2] U. S. Weather Bureau Station, Charlotte, N. C.

TABLE 19.—*Comparison of number of monthly and annual excessive storms at the station, 1933–38, with Yarnell's*[1] *30-year average*

| Month | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | Total | Average | Yarnell's[1] 30-year average plus 16 percent |
|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0.3 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 2 | 0 | 2 | 1 | 0 | 0 | 5 | .8 | .2 |
| April | 0 | 0 | 0 | 2 | 0 | 0 | 2 | .3 | .1 |
| May | 1 | 0 | 0 | 0 | 1 | 2 | 4 | .7 | 1.2 |
| June | 0 | 2 | 0 | 1 | 2 | 5 | 10 | 1.7 | 1.2 |
| July | 1 | 1 | 4 | 0 | 2 | 4 | 12 | 2.0 | 1.2 |
| August | 3 | 4 | 1 | 4 | 4 | 2 | 18 | 3.0 | 2.0 |
| September | 1 | 1 | 0 | 0 | 0 | 0 | 2 | .3 | .7 |
| October | 0 | 1 | 0 | 2 | 2 | 0 | 5 | .8 | .3 |
| November | 0 | 1 | 1 | 0 | 0 | 1 | 3 | .5 | .1 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 8 | 10 | 8 | 11 | 12 | 14 | 63 | 10.4 | 7.0 |

[1] See literature cited (*20*).

TABLE 20.—*Watershed description*[1] *and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record[2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| C–5 | 1.412 | Terraced; oats and lespedeza, 1933 and 1936; cotton, 1934; lespedeza, 1935, 1937, and 1938. | 1933–38 | 1.54 | 2.21 | 2.64 | 3.21 | 3.63 |
| C–6 | 1.632 | ....do | 1933–38 | 1.25 | 1.75 | 2.08 | 2.52 | 2.74 |
| C–7 | 1.790 | ....do | 1933–38 | 1.10 | 1.50 | 1.75 | 2.09 | 2.34 |
| C–8 | 5.123 | Untermeed; oats and lespedeza, 1933; lespedeza, 1934, 1937, and 1938; cotton, winter rye, and vetch, 1935; soybeans; fall oats, 1936. | 1933–38 | 2.74 | 4.65 | 5.89 | 7.53 | 8.72 |
| W–23 | 6.005 | Woods not grazed: shortleaf pine and mixed hardwoods. | 1933–37 | .09 | .16 | .21 | .27 | .31 |

[1] For a more detailed description, see SCS–TP–52 (*8*).
[2] Period for which frequency studies were made.

## Conservation Experiment Station, Tyler, Tex.

TABLE 21.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 3.78 | 6.79 | 8.75 | 11.32 | 13.20 |
| | Weather Bureau station [2] | 3.16 | 5.07 | 6.31 | 7.94 | 9.13 |
| February | Experiment station | 3.39 | 5.52 | 6.90 | 8.72 | 10.05 |
| | Weather Bureau station | 2.96 | 4.68 | 5.81 | 7.29 | 8.37 |
| March | Experiment station | 3.18 | 4.47 | 5.31 | 6.41 | 7.21 |
| | Weather Bureau station | 3.60 | 5.72 | 7.11 | 8.93 | 10.25 |
| April | Experiment station | 3.78 | 4.91 | 5.64 | 6.61 | 7.31 |
| | Weather Bureau station | 4.19 | 6.48 | 7.98 | 9.95 | 11.39 |
| May | Experiment station | 3.69 | 5.70 | 7.40 | 9.54 | 11.27 |
| | Weather Bureau station | 3.82 | 6.57 | 8.36 | 10.71 | 12.43 |
| June | Experiment station | 3.25 | 6.67 | 8.90 | 11.83 | 13.97 |
| | Weather Bureau station | 3.05 | 5.49 | 7.08 | 9.18 | 10.70 |
| July | Experiment station | 3.01 | 4.60 | 5.64 | 7.01 | 8.01 |
| | Weather Bureau station | 3.17 | 5.83 | 7.57 | 9.86 | 11.52 |
| August | Experiment station | 2.39 | 4.18 | 5.35 | 6.88 | 8.00 |
| | Weather Bureau station | 2.05 | 4.21 | 5.62 | 7.48 | 8.84 |
| September | Experiment station | 2.17 | 3.78 | 4.83 | 6.22 | 7.23 |
| | Weather Bureau station | 2.26 | 4.05 | 5.22 | 6.75 | 7.87 |
| October | Experiment station | 2.52 | 4.49 | 5.77 | 7.46 | 8.70 |
| | Weather Bureau station | 2.53 | 4.42 | 5.65 | 7.26 | 8.44 |
| November | Experiment station | 3.80 | 6.24 | 7.84 | 9.93 | 11.46 |
| | Weather Bureau station | 3.14 | 5.65 | 7.29 | 9.45 | 11.02 |
| December | Experiment station | 5.03 | 7.48 | 9.07 | 11.17 | 12.70 |
| | Weather Bureau station | 4.12 | 6.42 | 7.91 | 9.88 | 11.31 |
| Annual | Experiment station | 40.60 | 48.38 | 53.46 | 60.13 | 65.00 |
| | Weather Bureau station | 40.74 | 48.71 | 53.91 | 60.74 | 65.73 |

[1] Conservation Experiment Station, Tyler, Tex., 1931–41.
[2] U. S. Weather Bureau Stations: Tyler, Tex., 1895–1905; omitted 1906–08 (no data); Henderson, Tex., 1909–13; Troup, Tex., 1914–30; Lindale, Tex., 1931–42.

TABLE 22.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Tyler, Tex.[1] (1931–41) | 5.46 | 6.37 | 6.96 | 7.74 | 8.31 |
| Dallas, Tex.[2] (1914–35) | 5.11 | 6.67 | 7.70 | 9.05 | 10.03 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Tyler, Tex. (1931–41) | 3.95 | 4.80 | 5.50 | 6.31 | 6.90 |
| Dallas, Tex. (1914–35) | 3.82 | 4.90 | 5.60 | 6.53 | 7.20 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Tyler, Tex. (1931–41) | 2.78 | 3.35 | 3.73 | 4.21 | 4.57 |
| Dallas, Tex. (1914–35) | 2.85 | 3.61 | 4.08 | 4.73 | 5.18 |

[1] Conservation Experiment Station, Tyler, Tex.
[2] U. S. Weather Bureau Station, Dallas, Tex.

TABLE 23.—*Comparison of number of monthly and annual excessive storms at the station, 1931–41, with Yarnell's [1] 30-year average*

| Month | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | Total | Average | Yarnell's [1] 30-year average plus 16 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 1 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 6 | 0.5 | 0.2 |
| February | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 4 | .4 | .2 |
| March | 0 | 0 | 2 | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 1 | 9 | .8 | .5 |
| April | 0 | 0 | 2 | 2 | 1 | 1 | 3 | 3 | 2 | 2 | 1 | 17 | 1.5 | 1.2 |
| May | 0 | 2 | 3 | 0 | 2 | 1 | 0 | 0 | 2 | 3 | 0 | 13 | 1.2 | 1.0 |
| June | 2 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 2 | 6 | 18 | 1.6 | .8 |
| July | 0 | 2 | 2 | 0 | 3 | 1 | 2 | 0 | 2 | 3 | 2 | 17 | 1.5 | .8 |
| August | 2 | 1 | 3 | 1 | 1 | 0 | 2 | 2 | 0 | 3 | 2 | 17 | 1.5 | .8 |
| September | 0 | 0 | 3 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 1 | 11 | 1.0 | .8 |
| October | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 5 | .4 | .7 |
| November | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 3 | 0 | 0 | 2 | 9 | .8 | .3 |
| December | 2 | 3 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 11 | 1.0 | .6 |
| Annual | 8 | 10 | 17 | 11 | 16 | 7 | 13 | 13 | 10 | 10 | 16 | 137 | 12.2 | 8.0 |

[1] See literature citation (*30*).

TABLE 24.—*Watershed description [1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| 3 | 7.04 | Mixed hardwoods; woods partially grazed 1932–36. | 1933–41 | 0.15 | 0.28 | 0.36 | 0.46 | 0.54 |
| 4 | [3] 6.383<br>[4] 5.747<br>[5] 6.05 | Uncontrolled, contour cultivation; rotation of corn, cotton, and cowpeas with winter cover of oats or vetch. | 1931–41 | 3.85 | 4.86 | 5.60 | 6.45 | 7.10 |
| 5 | [6] 1.73<br>[7] 1.57<br>[8] 2.64 | Strip-cropped, strips equal widths; rotated each year; cotton follows winter crop of vetch turned under; oats follows cotton in the fall and is harvested; stubble stands until fall when vetch is planted. | 1933–40 | 2.48 | 4.38 | 5.63 | 7.26 | 8.46 |

[1] For a more detailed description, see SCS–TP–41 (*19*).
[2] Period for which frequency studies were made.
[3] Area before January 1933.
[4] Area from January 1933 to January 1940.
[5] Area after January 1940.
[6] Area before January 1937.
[7] Area from January 1937 to January 1940.
[8] Area after January 1940.

## NORTHWEST APPALACHIAN CONSERVATION EXPERIMENT STATION, ZANESVILLE, OHIO

TABLE 25.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] | 2.08 | 4.20 | 5.58 | 7.39 | 8.71 |
| | Weather Bureau station [2] | 2.81 | 4.43 | 5.40 | 6.89 | 7.90 |
| February | Experiment station | 2.03 | 3.30 | 4.13 | 5.23 | 6.02 |
| | Weather Bureau station | 2.12 | 3.20 | 4.00 | 4.97 | 5.68 |
| March | Experiment station | 3.52 | 5.94 | 7.52 | 9.60 | 11.12 |
| | Weather Bureau station | 3.21 | 4.77 | 5.80 | 7.14 | 8.12 |
| April | Experiment station | 3.10 | 4.91 | 6.09 | 7.65 | 8.78 |
| | Weather Bureau station | 2.83 | 3.98 | 4.73 | 5.72 | 6.44 |
| May | Experiment station | 3.79 | 5.03 | 6.82 | 8.40 | 9.55 |
| | Weather Bureau station | 3.21 | 4.84 | 6.00 | 7.29 | 8.31 |
| June | Experiment station | 4.71 | 6.84 | 8.23 | 10.05 | 11.38 |
| | Weather Bureau station | 3.50 | 5.17 | 6.20 | 7.70 | 8.74 |
| July | Experiment station | 3.15 | 4.55 | 5.45 | 6.65 | 7.52 |
| | Weather Bureau station | 4.05 | 6.32 | 7.85 | 9.80 | 11.37 |
| August | Experiment station | 3.90 | 5.89 | 7.18 | 8.80 | 10.13 |
| | Weather Bureau station | 3.52 | 5.13 | 6.19 | 7.57 | 8.58 |
| September | Experiment station | 2.83 | 4.61 | 5.77 | 7.29 | 8.41 |
| | Weather Bureau station | 2.54 | 3.80 | 4.75 | 5.99 | 6.90 |
| October | Experiment station | 2.28 | 3.88 | 4.83 | 6.30 | 7.30 |
| | Weather Bureau station | 2.25 | 3.77 | 4.76 | 6.03 | 7.01 |
| November | Experiment station | 2.21 | 3.34 | 4.08 | 5.05 | 5.76 |
| | Weather Bureau station | 2.21 | 3.59 | 4.48 | 5.67 | 6.53 |
| December | Experiment station | 2.15 | 3.19 | 3.87 | 4.76 | 5.41 |
| | Weather Bureau station | 2.70 | 3.88 | 4.60 | 5.56 | 6.25 |
| Annual | Experiment station | 36.91 | 43.42 | 47.67 | 53.28 | 57.33 |
| | Weather Bureau station | 36.40 | 42.84 | 47.04 | 52.58 | 56.59 |

[1] Conservation Experiment Station, Zanesville, Ohio, 1931–45.
[2] U. S. Weather Bureau Station, Zanesville, Ohio, 1893–1937.

TABLE 26.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Zanesville, Ohio [1] (1934–45) | 5.81 | 7.24 | 8.15 | 9.35 | 10.21 |
| Columbus, Ohio [2] (1911–35) | 4.02 | 5.29 | 6.13 | 7.21 | 8.02 |

AVERAGE INTENSITY FOR 15 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Zanesville, Ohio (1934–45) | 3.87 | 5.33 | 6.28 | 7.52 | 8.43 |
| Columbus, Ohio (1911–35) | 2.89 | 3.88 | 4.51 | 5.35 | 5.99 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Zanesville, Ohio (1934–45) | 2.45 | 3.30 | 3.68 | 4.32 | 4.79 |
| Columbus, Ohio (1911–35) | 1.80 | 2.56 | 3.06 | 3.70 | 4.18 |

[1] Conservation Experiment Station, Zanesville, Ohio.
[2] U. S. Weather Bureau Station, Columbus, Ohio.

TABLE 27.—*Comparison of number of monthly and annual excessive storms at the station, 1934–45, with Yarnell's[1] 30-year average*

| Month | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 |
|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| April | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 |
| June | 2 | 2 | 0 | 4 | 3 | 2 | 4 | 2 |
| July | 0 | 2 | 3 | 0 | 0 | 1 | 0 | 4 |
| August | 2 | 1 | 3 | 2 | 1 | 2 | 3 | 2 |
| September | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 |
| October | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 0 |
| November | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 5 | 9 | 8 | 7 | 6 | 7 | 9 | 12 |

| Month | 1942 | 1943 | 1944 | 1945 | Total | Average | Yarnell's[1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| March | 1 | 0 | 0 | 3 | 5 | .4 | .1 |
| April | 0 | 0 | 0 | 1 | 1 | .1 | .1 |
| May | 1 | 0 | 3 | 1 | 9 | .8 | .3 |
| June | 4 | 3 | 4 | 2 | 32 | 2.7 | 1.2 |
| July | 2 | 2 | 1 | 0 | 15 | 1.2 | 1.5 |
| August | 1 | 1 | 2 | 0 | 23 | 1.9 | 1.0 |
| September | 1 | 0 | 0 | 4 | 11 | .9 | .8 |
| October | 0 | 0 | 0 | 0 | 4 | .3 | .3 |
| November | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Annual | 10 | 6 | 10 | 11 | 100 | 8.3 | 5.3 |

[1] See literature citation (20).

TABLE 28.—*Watershed description[1] and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record[2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per sec.* | *Cubic feet per sec.* | *Cubic feet per sec.* | *Cubic feet per sec.* | *Cubic feet per sec.* |
| Cultivated | 2,516 | Rotation of corn, wheat, and meadow; contour cultivation. | 1934–45 | 1.71 | 2.75 | 3.43 | 4.32 | 4.90 |
| Pasture | 3,568 | Grass | 1934–45 | 1.11 | 1.72 | 2.12 | 2.61 | 3.02 |
| Woods | 2,227 | Second-growth hardwoods | 1934–45 | .11 | .27 | .38 | .59 | .62 |

[1] For a more detailed description, see SCS-TP-26 (5).
[2] Period for which frequency studies were made.

## Red Plains Conservation Experiment Station Near Guthrie, Okla.

TABLE 29.—*Comparison of monthly and annual precipitation for various recurrence intervals*

| Month | Station and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|
| | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | | *Inches* | *Inches* | *Inches* | *Inches* | *Inches* |
| January | Experiment station [1] (1931-38) | 1.84 | 2.47 | 3.40 | 4.62 | 5.51 |
| | Weather Bureau station [2] (1893-1937) | 1.91 | 1.99 | 2.63 | 3.46 | 4.08 |
| | Experiment station (1939-47) | .97 | 2.15 | 2.92 | 3.93 | 4.67 |
| February | Experiment station (1931-38) | 1.33 | 2.36 | 3.01 | 3.92 | 4.57 |
| | Weather Bureau station (1893-1937) | 1.07 | 2.11 | 2.79 | 3.69 | 4.31 |
| | Experiment station (1939-47) | 1.27 | 2.30 | 2.97 | 3.84 | 4.48 |
| March | Experiment station (1931-38) | 2.21 | 4.23 | 5.55 | 7.28 | 8.54 |
| | Weather Bureau station (1893-1937) | 1.90 | 3.50 | 4.44 | 5.84 | 6.80 |
| | Experiment station (1939-47) | 1.12 | 2.11 | 2.76 | 3.62 | 4.21 |
| April | Experiment station (1931-38) | 2.30 | 3.73 | 4.66 | 5.80 | 6.78 |
| | Weather Bureau station (1893-1937) | 3.23 | 4.88 | 5.96 | 7.37 | 8.40 |
| | Experiment station (1939-47) | 4.49 | 7.96 | 10.12 | 13.05 | 15.18 |
| May | Experiment station (1931-38) | 3.55 | 5.16 | 6.21 | 7.59 | 8.60 |
| | Weather Bureau station (1893-1937) | 4.40 | 7.30 | 9.19 | 11.67 | 13.49 |
| | Experiment station (1939-47) | 4.66 | 7.74 | 9.81 | 12.54 | 14.53 |
| June | Experiment station (1931-38) | 3.45 | 6.67 | 8.77 | 11.53 | 13.54 |
| | Weather Bureau station (1893-1937) | 3.32 | 5.50 | 6.91 | 8.77 | 10.13 |
| | Experiment station (1939-47) | 3.77 | 6.72 | 8.63 | 11.16 | 13.00 |
| July | Experiment station (1931-38) | 1.49 | 2.56 | 3.22 | 4.18 | 4.90 |
| | Weather Bureau station (1893-1937) | 2.34 | 3.92 | 4.94 | 6.29 | 7.27 |
| | Experiment station (1939-47) | 1.47 | 2.80 | 3.66 | 4.80 | 5.63 |
| August | Experiment station (1931-38) | 3.17 | 5.71 | 7.36 | 9.53 | 11.11 |
| | Weather Bureau station (1893-1937) | 2.68 | 4.83 | 6.23 | 8.07 | 9.41 |
| | Experiment station (1939-47) | 2.22 | 4.14 | 5.38 | 7.03 | 8.23 |
| September | Experiment station (1931-38) | 4.36 | 7.85 | 10.13 | 13.12 | 15.30 |
| | Weather Bureau station (1893-1937) | 3.05 | 5.32 | 6.79 | 8.74 | 10.15 |
| | Experiment station (1939-47) | 3.61 | 7.50 | 10.03 | 13.35 | 15.78 |
| October | Experiment station (1931-38) | 1.71 | 2.62 | 3.21 | 3.98 | 4.55 |
| | Weather Bureau station (1893-1937) | 2.66 | 4.66 | 5.97 | 7.69 | 8.94 |
| | Experiment station (1939-47) | 2.68 | 5.22 | 6.88 | 9.06 | 10.65 |
| November | Experiment station (1931-38) | 2.37 | 5.51 | 7.55 | 10.23 | 12.19 |
| | Weather Bureau station (1893-1937) | 1.91 | 3.80 | 5.03 | 6.65 | 7.83 |
| | Experiment station (1939-47) | 1.60 | 3.61 | 4.93 | 6.65 | 7.91 |
| December | Experiment station (1931-38) | 1.27 | 2.54 | 3.37 | 4.45 | 5.24 |
| | Weather Bureau station (1893-1937) | 1.33 | 2.48 | 3.21 | 4.22 | 4.94 |
| | Experiment station (1939-47) | 1.53 | 2.60 | 3.30 | 4.22 | 4.89 |
| Annual | Experiment station (1931-38) | 28.91 | 34.74 | 38.53 | 43.52 | 47.16 |
| | Weather Bureau station (1893-1937) | 31.06 | 37.85 | 42.27 | 48.09 | 52.33 |
| | Experiment station (1939-47) | 30.25 | 36.30 | 40.25 | 45.43 | 49.22 |

[1] Conservation Experiment Station, Guthrie, Okla.
[2] U. S. Weather Bureau Station, Guthrie, Okla.

TABLE 30.—*Comparison of rainfall intensities for selected time periods and recurrence intervals*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* | *Inches per hour* |
| Guthrie, Okla.[1] (1931-38) | 4.95 | 5.92 | 6.54 | 7.37 | 7.98 |
| Oklahoma City, Okla.[2] (1911-35) | 4.74 | 5.91 | 6.66 | 7.60 | 8.38 |
| Guthrie, Okla. (1939-47) | 5.36 | 6.82 | 7.77 | 9.03 | 9.94 |

[1] Conservation Experiment Station, Guthrie, Okla.
[2] U. S. Weather Bureau Station, Oklahoma City, Okla.

TABLE 30.—*Comparison of rainfall intensities for selected time periods and recurrence intervals—Continued*

AVERAGE INTENSITY FOR 5 MINUTES

| Location and period | Recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|
| | 2 years | 5 years | 10 years | 25 years | 50 years |
| Guthrie, Okla. (1931-38) | 3.47 | 4.19 | 4.66 | 5.28 | 5.73 |
| Oklahoma City, Okla. (1911-35) | 3.61 | 4.54 | 5.10 | 5.88 | 6.44 |
| Guthrie, Okla. (1939-47) | 3.61 | 5.08 | 6.04 | 7.30 | 8.21 |

AVERAGE INTENSITY FOR 30 MINUTES

| | | | | | |
|---|---|---|---|---|---|
| Guthrie, Okla. (1931-38) | 2.58 | 3.34 | 3.83 | 4.48 | 4.95 |
| Oklahoma City, Okla. (1911-35) | 2.48 | 3.46 | 4.08 | 4.92 | 5.53 |
| Guthrie, Okla. (1939-47) | 2.30 | 3.08 | 3.55 | 4.20 | 4.67 |

TABLE 31.—*Comparison of number of monthly and annual excessive storms at the station, 1931–38 and 1939–47, with Yarnell's [1] 30-year average*

| Month | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | Total | Average | Yarnell's [1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 2 | .2 | .1 |
| March | 0 | 0 | 1 | 0 | 3 | 0 | 1 | 0 | 5 | .6 | .3 |
| April | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 6 | .8 | .7 |
| May | 0 | 1 | 1 | 1 | 1 | 3 | 0 | 2 | 9 | 1.1 | 1.0 |
| June | 1 | 4 | 0 | 1 | 3 | 1 | 3 | 2 | 15 | 1.9 | 1.9 |
| July | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 5 | .6 | 1.0 |
| August | 1 | 1 | 2 | 2 | 1 | 0 | 1 | 1 | 9 | 1.1 | 1.0 |
| September | 1 | 0 | 2 | 4 | 1 | 2 | 0 | 3 | 13 | 1.6 | .8 |
| October | 0 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 5 | .6 | .5 |
| November | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | .2 | .4 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .1 |
| Annual | 7 | 10 | 9 | 9 | 11 | 8 | 7 | 10 | 71 | 8.7 | 8.7 |

| Month | 1939 | 1940 | 1941 | 1942 | 1943 | 1944 | 1945 | 1946 | 1947 | Total | Average | Yarnell's [1] 30-year average plus 10 percent |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* | *Number* |
| January | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| February | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .1 |
| March | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .3 |
| April | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 3 | 9 | 1.0 | .7 |
| May | 2 | 2 | 3 | 2 | 3 | 1 | 0 | 2 | 3 | 18 | 2.0 | 1.9 |
| June | 0 | 1 | 1 | 1 | 1 | 0 | 6 | 2 | 0 | 12 | 1.3 | 1.9 |
| July | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 4 | .4 | 1.0 |
| August | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 7 | .8 | 1.0 |
| September | 0 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 5 | .6 | .8 |
| October | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 3 | .3 | .5 |
| November | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 | .2 | .4 |
| December | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .1 |
| Annual | 5 | 6 | 9 | 9 | 4 | 4 | 8 | 8 | 7 | 60 | 6.0 | 8.7 |

[1] See literature citation (*20*).

TABLE 32.—*Watershed description* [1] *and maximum peak rates of runoff per acre for various recurrence intervals*

| Watershed designation | Area | Land use | Period of record [2] | Maximum peak rates of runoff per acre for recurrence interval, 1 year in— | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 2 years | 5 years | 10 years | 25 years | 50 years |
| | *Acres* | | | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* | *Cubic feet per second* |
| No. 1—Ravine A | [3] 35<br>33.35 | Rotation of corn, oats, and cotton [4] | 1931–46 | 1.31 | 2.12 | 2.64 | 3.32 | 3.82 |
| No. 4 Plot L | 5.62 | Native woods and grass; not grazed. | 1931–47 | .15 | .42 | .50 | .82 | .99 |
| No. 2—Plot 13 | [3] 3.61<br>3.21 | Rotation of cotton and cowpeas; unterraced. | 1931–38 | 4.34 | 5.32 | 6.07 | 6.81 | 7.42 |
| No. 3 Plot 15A | 3.13 | Rotation of cotton and cowpeas; terraced. | 1931–38 | 1.63 | 2.45 | 2.99 | 3.70 | 4.21 |
| No. 5—Plot J | 5.28 | Abandoned cropland, gullied; native grasses; not grazed. | 1931–38 | 1.35 | 2.49 | 3.24 | 4.21 | 4.92 |
| No. 6—Terrace 2B. | 5.90 | Rotation of corn, oats, and cotton [4]; terraced. | 1931–38 | 1.90 | 2.35 | 2.69 | 2.94 | 3.18 |
| No. 7—Terrace 3B. | 5.67 | Rotation of corn, oats, and cotton [4]; terraced. | 1931–38 | 1.84 | 2.33 | 2.65 | 3.06 | 3.37 |
| No. 8 Terrace 3C. | 2.85 | Rotation of corn, oats, and cotton [4]; terraced. | 1931–38 | 2.59 | 3.35 | 3.91 | 4.64 | 5.17 |
| No. 9—Terrace 5-C. | 2.58 | Rotation of cotton, oats, and darso; terraced. | 1931–38 | 1.22 | 1.80 | 2.18 | 2.69 | 3.05 |
| No. 10—Terrace 6-E. | 1.20 | Rotation of cotton and cowpeas; terraced. | 1931–38 | 1.42 | 2.03 | 2.43 | 2.96 | 3.34 |
| No. 11—Pasture Plot I. | 2.50 | Native grass; not grazed | 1934–38 | .19 | .40 | .64 | .88 | 1.04 |
| No. 2—Plot 13 | 3.21 | Native grasses; grazed 1941–47 | 1939–47 | 2.46 | 3.57 | 4.20 | 5.24 | 5.93 |
| No. 3 Plot 15A | 3.13 | Native grasses; grazed 1941–47 | 1939–47 | .68 | 1.34 | 1.77 | 2.33 | 2.74 |
| No. 5—Plot J | 5.28 | Abandoned cropland, gullied; native grasses; not grazed. | 1939–47 | 1.16 | 2.15 | 2.80 | 3.64 | 4.26 |
| No. 11—Pasture Plot I. | 2.50 | Native grass; grazed | 1939–47 | .21 | .56 | .77 | 1.05 | 1.25 |
| II | 5.09 | Native grass; grazed | 1939–47 | .22 | .62 | .71 | .97 | 1.15 |
| 1-C | 10.48 | Rotation of oats, cotton, and darso; terraced. | 1939–47 | 1.27 | 2.08 | 2.60 | 3.29 | 3.80 |
| 3-C | 5.62 | Rotation of oats, cotton, and darso; terraced. | 1939–47 | 1.49 | 2.76 | 3.58 | 4.67 | 5.46 |
| III | 9.09 | Native grass; grazed | 1942–47 | 1.02 | 3.40 | 4.47 | 5.79 | 6.75 |
| IV | 13.37 | Native grass; grazed | 1942–47 | 1.30 | 2.01 | 2.42 | 2.95 | 3.34 |
| V | 15.09 | Native grass; grazed | 1942–47 | 1.13 | 1.66 | 2.00 | 2.45 | 2.77 |
| VI | 94.80 | Native grass; grazed | 1942–47 | .56 | 1.08 | 1.42 | 1.90 | 2.19 |

[1] For a more detailed description, see SCS-TP-32 (17).
[2] Period for which frequency studies were made.
[3] Area before January 1939.
[4] Darso replaced corn in the rotation after 1936.
[5] Area before January 1933.

## LITERATURE CITED

(1) BOUST, H. L., MCCALL, A. G., and BELL, F. G.
1945. INVESTIGATIONS IN EROSION CONTROL AND THE RECLAMATION OF ERODED LAND AT THE NORTHWEST APPALACHIAN CONSERVATION EXPERIMENT STATION, ZANESVILLE, OHIO, 1934–42. U. S. Dept. Agr. Tech. Bul. 888, 95 pp., illus.

(2) BOUST, H. L., and WOODBURN, R.
1939. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUNOFF FROM THE WATERSHEDS OF THE NORTH APPALACHIAN CONSERVATION EXPERIMENT STATION, ZANESVILLE, OHIO, 1933–38. Soil Conserv. Serv. TP–26, 25 pp., illus. [Mimeographed.]

(3) BROWNING, G. M., NORTON, R. A., MCCALL, A. G., and BELL, F. G.
1948. INVESTIGATION IN EROSION CONTROL AND THE RECLAMATION OF ERODED LAND AT THE MISSOURI VALLEY LOESS CONSERVATION EXPERIMENT STATION, CLARINDA, IOWA, 1931–42. U. S. Dept. Agr. Tech. Bul. 959, 88 pp., illus.

(4) COPLEY, T. L., FORREST, L. A., MCCALL, A. G., and BELL, F. G.
1944. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE CENTRAL PIEDMONT CONSERVATION EXPERIMENT STATION, STATESVILLE, N. C., 1930–40. U. S. Dept. Agr. Tech. Bul. 873, 66 pp., illus.

(5) DANIEL, H. A., ELWELL, H. M., and COX, M. B.
1943. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE RED PLAINS CONSERVATION EXPERIMENT STATION, GUTHRIE, OKLA., 1930–40. U. S. Dept. Agr. Tech. Bul. 837, 94 pp., illus.

(6) DRAKE, R. R., MICHAEL, S. A., and BAUM, R. O.
1940. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS AND TERRACED AREAS OF THE FORT HAYS CONSERVATION EXPERIMENT STATION, HAYS, KANS., 1930–38. Soil Conserv. Serv. TP–37, 15 pp., illus. [Mimeographed.]

(7) GUMBEL, E. J.
1945. SIMPLIFIED PLOTTING OF STATISTICAL OBSERVATIONS. Trans. Amer. Geo. Union, 26 (1): 69–82, illus.

(8) HARROLD, L. L.
1944. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUNOFF FROM TERRACES C5, C6 AND C7 AND WATERSHEDS C8 AND W23 OF THE CENTRAL PIEDMONT SOIL AND WATER CONSERVATION STATION, STATESVILLE, N. C., 1933–1938. Soil Conserv. Serv. TP–52, 91 pp., illus. [Mimeographed.]

(9) HAYS, O. E., and ATKINSON, H. B.
1939. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE UPPER MISSISSIPPI VALLEY CONSERVATION EXPERIMENT STATION, LA CROSSE, WIS., 1932–38. Soil Conserv. Serv. TP–29, 19 pp., illus. [Mimeographed.]

(10) HAYS, O. E., MCCALL, A. G., and BELL, F. G.
1949. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE UPPER MISSISSIPPI VALLEY CONSERVATION EXPERIMENT STATION, NEAR LA CROSSE, WIS., 1933–43. U. S. Dept. Agr. Tech. Bul. 973, 87 pp., illus.

(11) HILL, H. O., PEEVY, W. J., MCCALL, A. G., and BELL, F. G.
1944. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED LAND AT THE BLACKLAND CONSERVATION EXPERIMENT STATION, TEMPLE, TEX. 1931–41. U. S. Dept. Agr. Tech. Bul. 859, 109 pp., illus.

(12) HORNER, G. M., MCCALL, A. G., and BELL, F. G.
1944. INVESTIGATIONS IN EROSION CONTROL AND THE RECLAMATION OF ERODED LAND AT THE PALOUSE CONSERVATION EXPERIMENT STATION, PULLMAN, WASH. 1931–42. U. S. Dept. Agr. Tech. Bul. 860, 83 pp., illus.

(13) POPE, J. B., ARCHER, J. C., JOHNSON, P. R., and others.
1946. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED SANDY CLAY LANDS OF TEXAS, ARKANSAS, AND LOUISIANA AT THE CONSERVATION EXPERIMENT STATION, TYLER, TEX., 1931–40. U. S. Dept. Agr. Tech. Bul. 916, 76 pp., illus.

(14) POTTER, W. D.
1949. SIMPLIFICATION OF THE GUMBEL METHOD FOR COMPUTING PROBABILITY CURVES. Soil Conserv. Serv. TP–78, 22 pp., illus. [Mimeographed]

(15) SCHOENLEBER, L. H.
1940. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE MISSOURI VALLEY LOESS REGION CONSERVATION EXPERIMENT STATION CLARINDA, IOWA 1934–38. Soil Conserv. Serv. TP–31, 12 pp., illus. [Mimeographed.]

(16) ———
1940. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE MISSOURI VALLEY LOESS REGION CONSERVATION EXPERIMENT STATION CLARINDA, IOWA 1939. Soil Conserv. Serv. TP–31 sup., [no pagination], illus. [Mimeographed]

(17) SLOSSER, J. W.
1940. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE RED PLAINS CONSERVATION EXPERIMENT STATION GUTHRIE, OKLAHOMA 1931–38. Soil Conserv. Serv. TP–32, 40 pp., illus. [Mimeographed.]

(18) SMITH, D. D., WHITT, D. M., ZINGG, A. W., and others.
1945. INVESTIGATIONS IN EROSION CONTROL AND RECLAMATION OF ERODED SHELBY AND RELATED SOILS AT THE CONSERVATION EXPERIMENT STATION BETHANY, MO. 1930–42. U. S. Dept. Agr. Tech. Bul. 883, 175 pp., illus.

(19) WOOD, O. C.
1941. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF DATA FROM THE WATERSHEDS OF THE ARK.-LA.-EAST TEXAS SANDY LANDS CONSERVATION EXPERIMENT STATION TYLER, TEXAS 1931–39. Soil Conserv. Serv. TP–41, 21 pp., illus. [Mimeographed.]

(20) YARNELL, D. L.
1935. RAINFALL INTENSITY-FREQUENCY DATA. U. S. Dept. Agr. Misc. Pub. 204, 68 pp., illus.

(21) ZINGG, A. W.
1941. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE SHELBY LOAM AND RELATED SOILS, CONSERVATION EXPERIMENT STATION, BETHANY, MISSOURI, 1933–1940. Soil Conserv. Serv. TP–39, 25 pp., illus. [Mimeographed.]

(22) ———
1942. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE SHELBY LOAM AND RELATED SOILS CONSERVATION EXPERIMENT STATION BETHANY, MISSOURI 1941. Soil Conserv. Serv. TP–39, Sup. No. 1, [no pagination], illus. [Mimeographed.]

(23) ———
1943. HYDROLOGIC STUDIES—COMPILATION OF RAINFALL AND RUN-OFF FROM THE WATERSHEDS OF THE SHELBY LOAM AND RELATED SOILS CONSERVATION EXPERIMENT STATION BETHANY, MISSOURI 1942. Soil Conserv. Serv. TP–39, Sup. No. 2, [no pagination], illus. [Mimeographed.]

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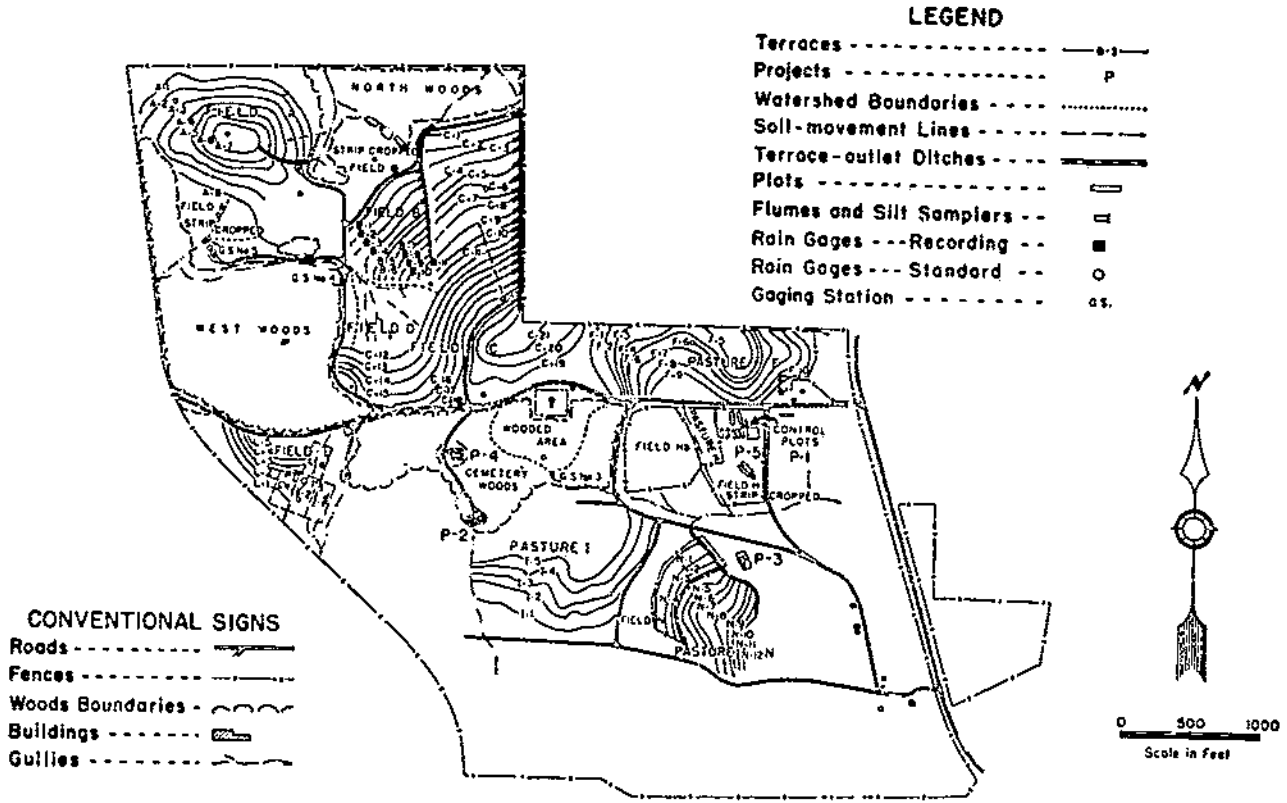
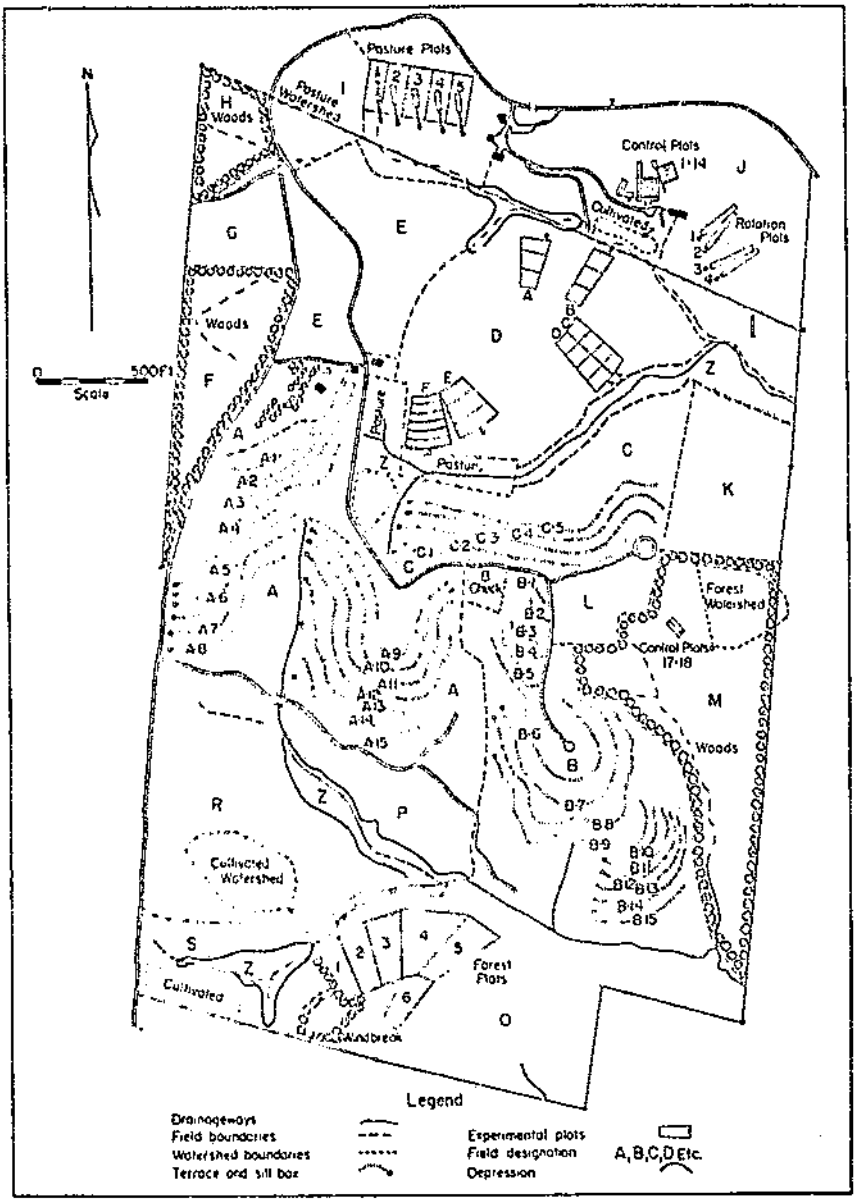
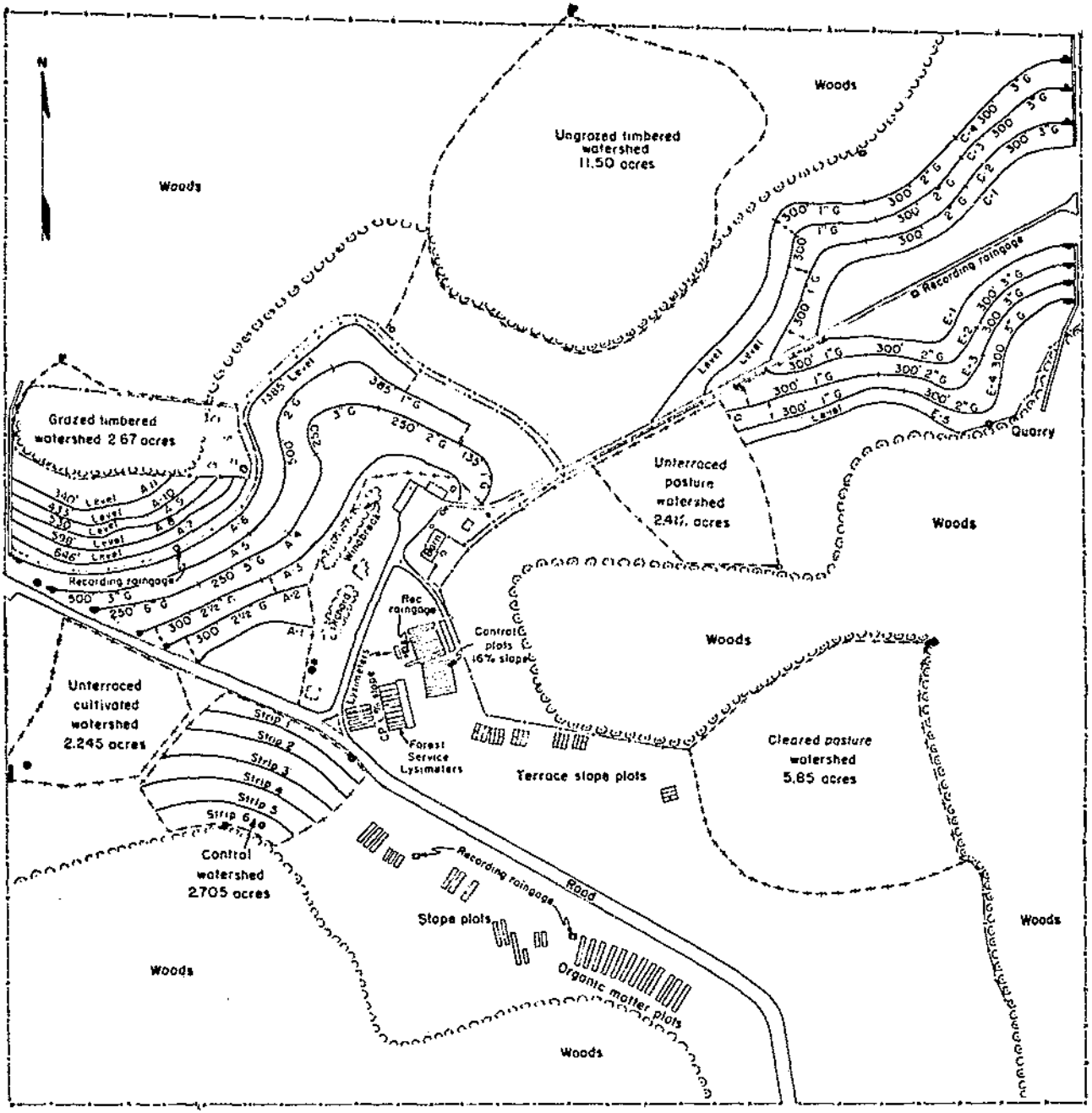


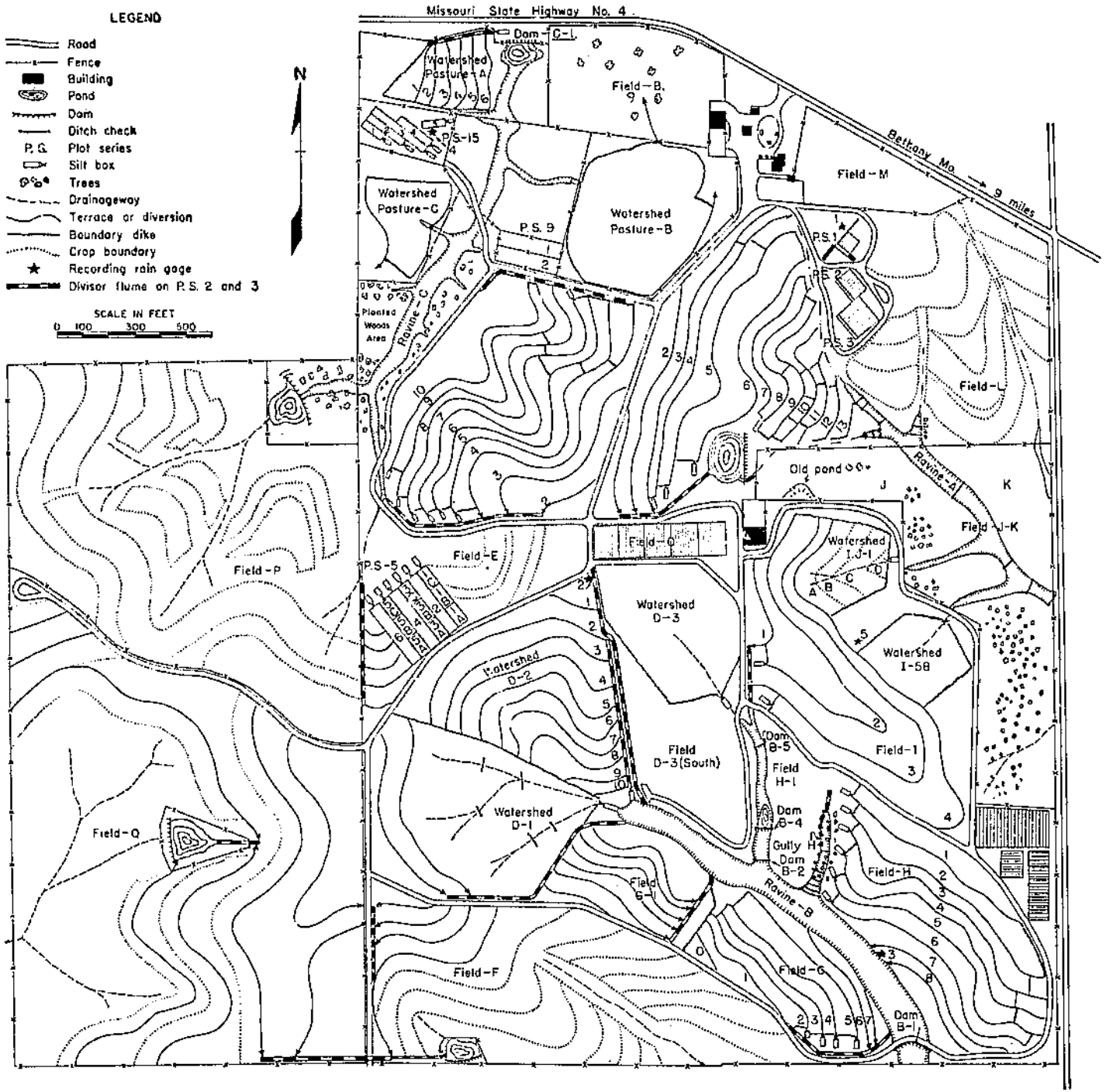

Map of the Conservation Experiment Station and the Texas Agricultural Experiment Substation No. 2, Tyler, Tex., showing fields and experimental areas.



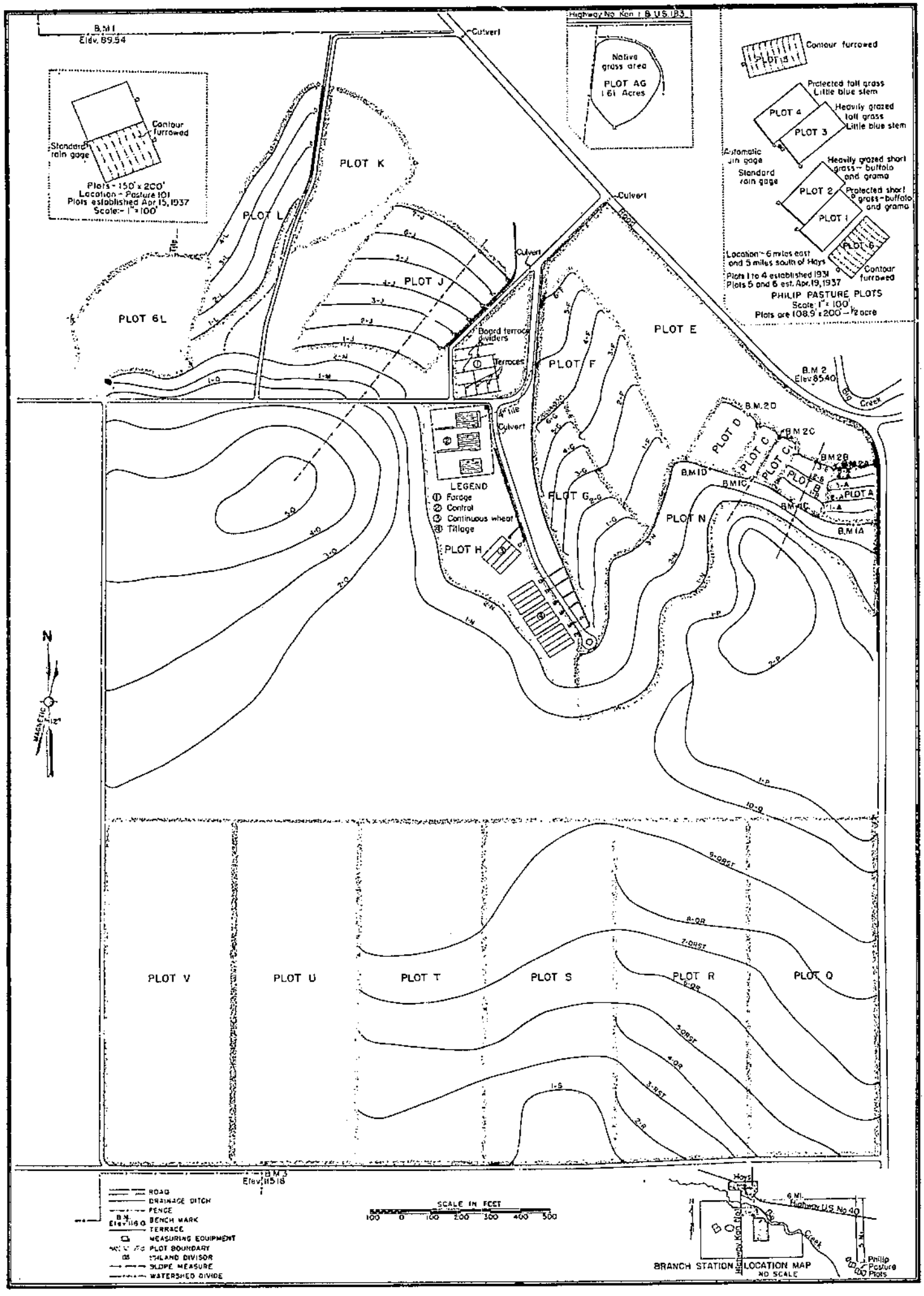

Map of the Northwest Appalachian Conservation Experiment Station, Zanesville, Ohio, showing fields and experimental areas.



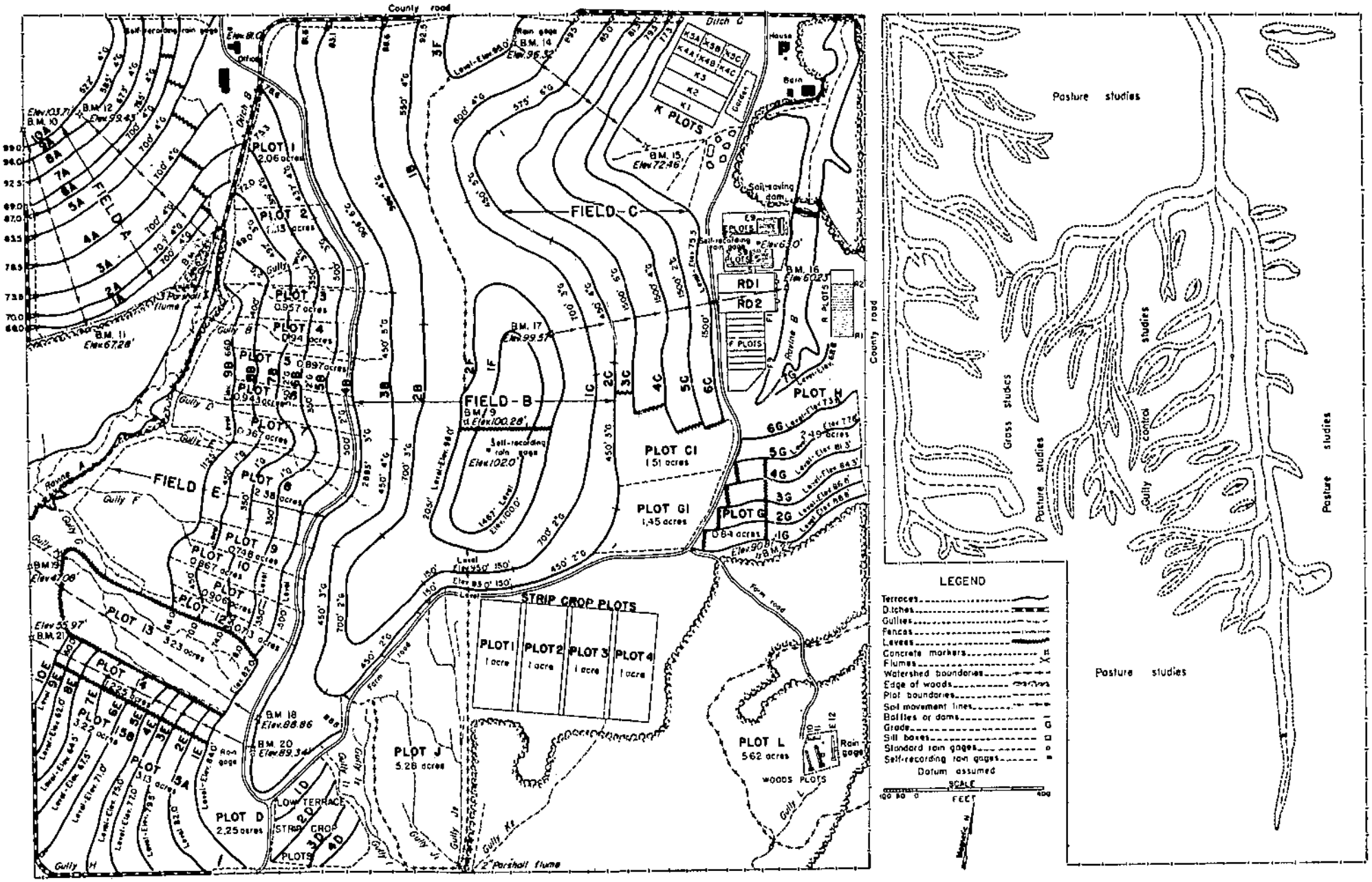

Map of the Upper Mississippi Valley Conservation Experiment Station near La Crosse, Wis., showing fields and experimental areas.



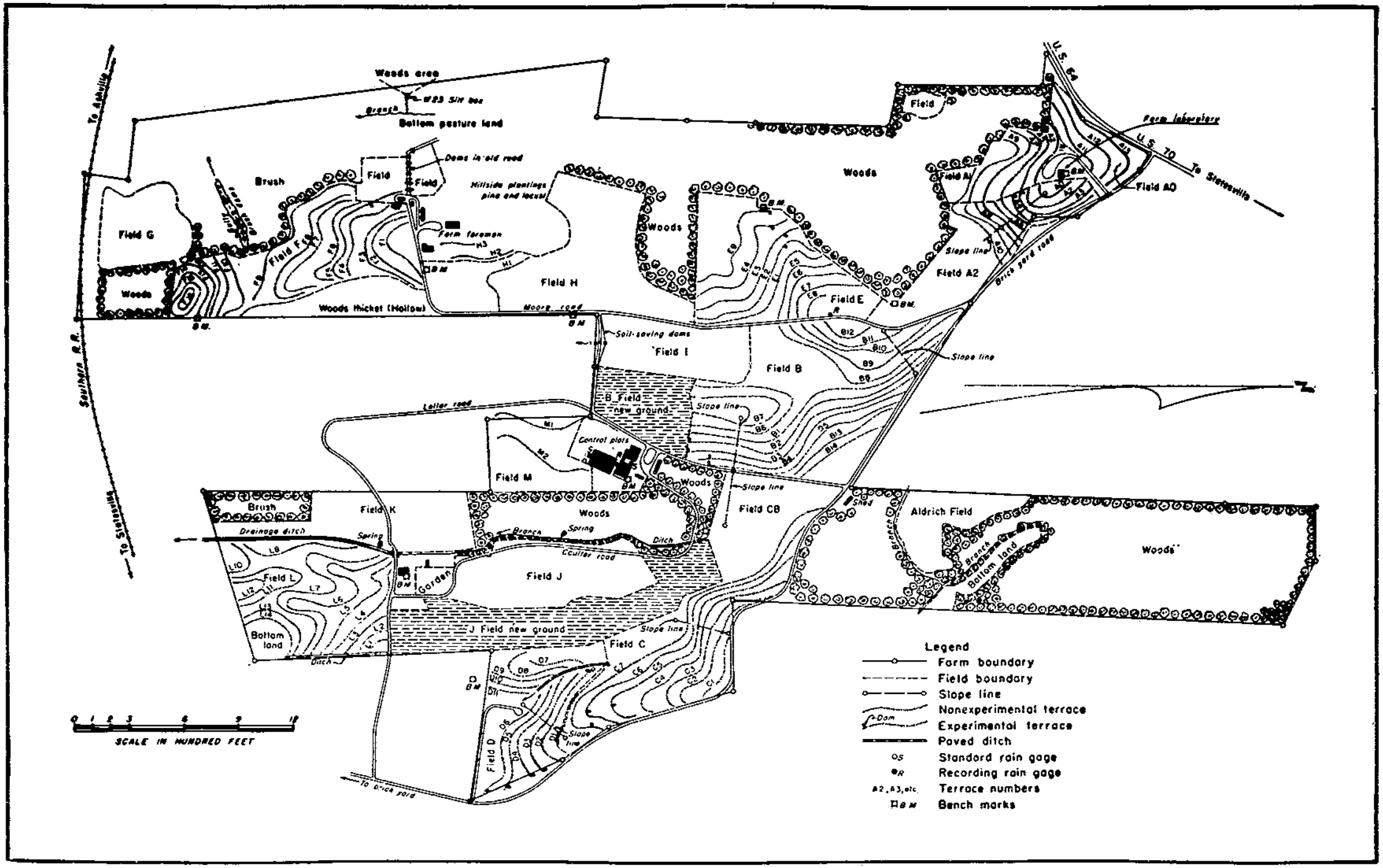

Map of the Conservation Experiment Station near Bethany, Mo., showing fields and experimental areas.



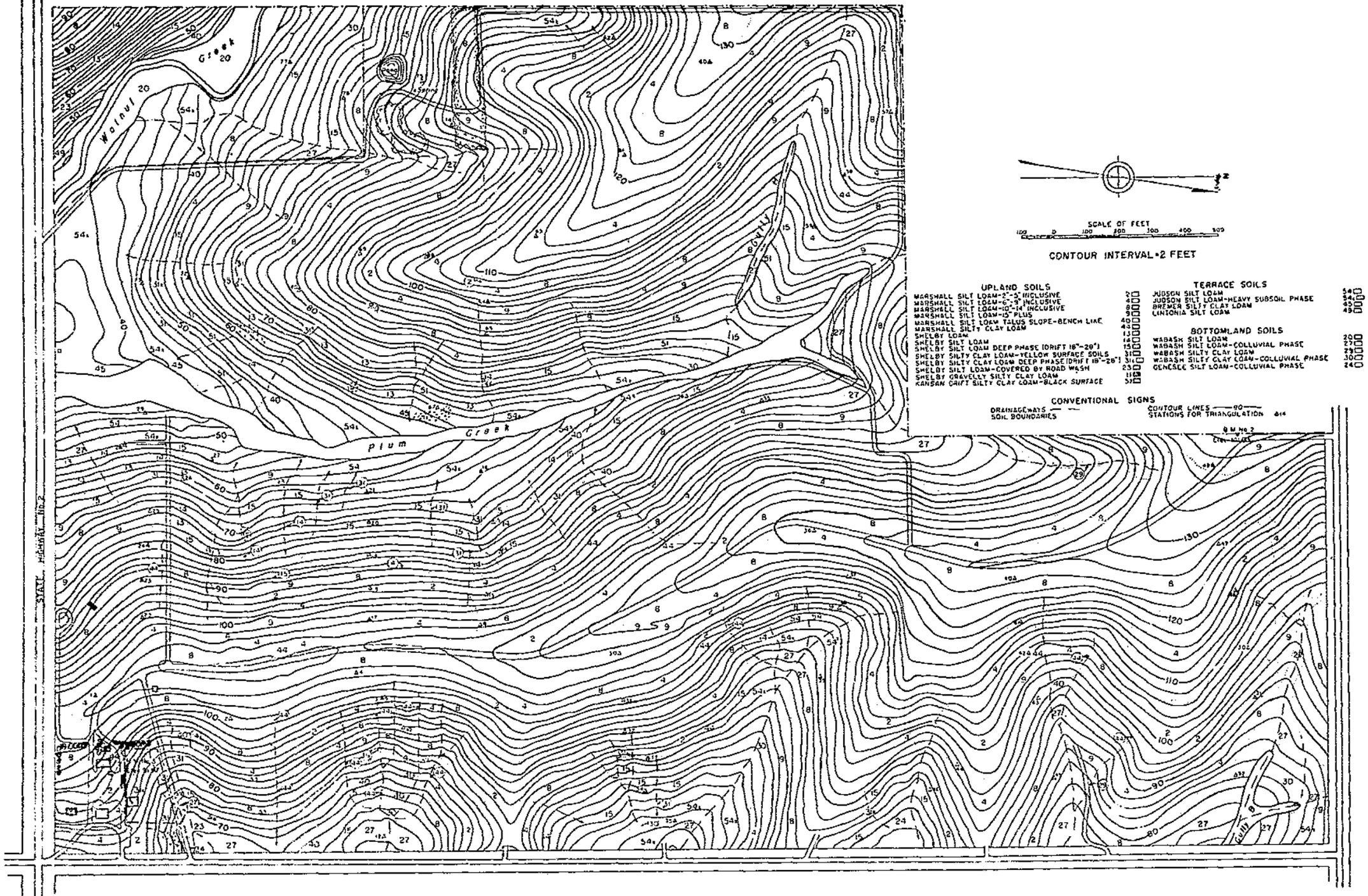

Map of Soil and Water Conservation Project, Kansas Agricultural Experiment Station, Hays, Kans., showing plots.




Map of the Red Plains Conservation Experiment Station near Guthrie, Okla., showing fields and experimental areas.




Map of the Central Piedmont Conservation Experiment Station, Statesville, N. C., showing fields and experimental areas.




Map of the Missouri Valley Loess Conservation Experiment Station, Clarinda, Iowa, showing soils and topography.

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