Improvements can and doubtless will be made. There is need for better figures governing the position of the "locus" than were available in Illinois. Even so, the use of an infiltration-capacity table for the Macoupin Basin furnishes, with little work, runoff-figures which are much more reliable than those heretofore derived from assumed coefficients.

The derived volume of runoff is easily applied to the unit-hydrograph or the rational method for determining the distribution or peak-rates of runoff.

Description of soils and topography of the Macoupin Creek Basin above Kane, Illinois, together with procedure in deriving values of f_{av} from 21 storms, is given in a report of the Illinois State Planning Commission.

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SPRINKLED-PLAT RUNOFF- AND INFILTRATION-EXPERIMENTS ON ARIZONA DESERT-SOILS

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Introduction--The original objectives of sprinkled-plat experiments conducted by the Soil Conservation Experiment Station at Tucson, Arizona, were to determine infiltration-capacities of a number of important soil-types found on range-lands on the watersheds of southern Arizona and to evaluate surface-soil conditions and various types of native plant-covers and their management in terms of their influence on erosion and infiltration. From the beginning of the work it was noted that hydrographs secured lent themselves very well to analysis and showed a good agreement with the analytical treatment of surface-runoff as reported by Dr. R. E. Horton [see 1 of "References" at end of paper].

The experiments reported herein are based on 77 separate applications of controlled amounts and intensities of artificial rain on plats 6 feet by 24 feet in size. Most of these experiments were conducted on sparsely-vegetated or bare soils and the discussion and interpretations will be largely limited to hydrologic relationships and related factors which bear directly on hydrologic phenomena.

Equipment and methods--A sprinkler-system, similar in most respects to the D-1 apparatus designed by the Soil Conservation Service in cooperation with the National Bureau of Standards, Washington, was used in these experiments. The apparatus consists essentially of four stationary 1.5 "Mulsifyre" nozzles mounted on an overhead frame, by which water may be applied at constant rates to a plat 6 feet wide and 24 feet long and to an 18-inch strip adjacent to the sides and upper end of the plat. With two nozzles in operation, water is applied at a rate slightly in excess of three inches per hour and with four nozzles discharging at a rate of approximately six inches per hour. Since slight variations in rate of application, due possibly to changes of temperature, pressure, elevation, or mechanical operation, were noted in calibrating the apparatus, check-runs were made on each site to determine the exact rate of application. This was accomplished by covering a plat with a waterproofed canvas, applying rainfall, and measuring the rate and volume of runoff which is complete and thus equals rainfall. Satisfactory distribution of water is obtained with drop-sizes comparable to actual rainfall. Runoff is measured volumetrically and timed by increments so that rate of runoff may be calculated. For the early experiments the total time of application was largely controlled by the available water-supply and was often limited to one-half hour. In most cases the rate of runoff became constant before the end of a half-hour. The entire sprinkling apparatus and study-plat are enclosed with canvas curtains to provide a shield from winds, which tend to reduce uniformity of application.

The rate and amount of soil-erosion are determined from runoff-samples taken at various intervals throughout the runoff-period. In most of the experiments reported in this paper, soil-losses were due to sheet-erosion and in only a few cases was gully-erosion induced by application of rain. Since the soil-losses were not large in most of the experiments, it is believed that the volume of soil in the runoff did not materially affect the volumetric measurements of the latter.

Characteristics of study-sites and soils--Due to the variety of topography, soil, climate, and plant conditions found in southern Arizona, it is evident that controlled-plat experiments may not include all types of country. Physical limitations made it advisable to conduct the experiments in lower watershed-areas which are or might be included in a soil-and-water conservation-program and for which little information is at present available. Sites chosen are characteristic of millions of acres lying in the semi-desert portions of the watersheds of the Gila, Rio Grande, and lower Colorado rivers. A second series of experiments is being conducted at the present time in areas of the semi-desert grass-land, where ecological relationships between plant-cover, soil-erosion, and infiltration are under study.

After a study site was located, plat-locations were established. Plats were replicated at least twice for each condition to be studied and sometimes more if preliminary studies showed marked variation. Most of the experiments were conducted on soils developed under semi-arid conditions in the vicinities of Safford and Tucson, Arizona. They belong to the reddish brown, Shantung brown, and red desert-groups. Topographically the soils occur on mesas and lower foothill slopes and in alluvial swales or broad valley-bottoms. The latter soils are usually of heavier texture than the former and when unprotected by vegetation tend to puddle and seal over rapidly under the impact of rain-drops and running water. The soils vary from nearly pure sands to clay loams, although the majority of them fall into the sandy and gravelly loam-textures as do the larger areas in the field. Table 1 outlines briefly the field-characteristics of the soils studied.

Results and analysis of experiments: Averages by sites and by runs--The averages for some of the principal factors derived from the experiments are shown in Table 2. The following notes explain the column headings and give briefly the methodology of analysis of hydrologic values. Robert E. Horton has discussed some of these values more fully in a previous publication [1].

Column (3)--Average rain-intensity i in inches per hour is obtained by dividing total rainfall by duration of rain-application in hours. Rain-intensity was maintained sensibly constant throughout each experiment.

Column (4)--Initial infiltration-capacity f_o at beginning of rain or application of water in inches per hour.

Column (5)--Final constant or surface minimum infiltration-capacity f_c in inches per hour.

Column (6)--Time in hours t_c from beginning of rain or application of water at which infiltration-capacity becomes sensibly constant.

Column (7)--The exponent M, which is constant for a given experiment, in the surface-runoff-intensity equation $q_s = K_s\delta^M$; determined from logarithmic platting of q_s in terms of δ_a, where δ is the depth, in inches, of surface-detention along the outlet-end of the plat, and δ_a is the average depth, in inches, of surface-detention on the plat.

Column (8)--Index of turbulence I is given by the equation $I = 3(3.0 - M)/4$; for fully turbulent flow $M = 5/3$ and $I = 1.0$; for laminar flow $M = 3.0$ and $I = 0$. The value of I is an indicator of the fraction of the total volume of surface-runoff in which turbulence occurs. In most cases some of the flow, particularly thin films on slopes of tillage-marks, or part of the flow through depressions, may be laminar, the remaining flow being generally turbulent.

Column (9)--Exponential constant K_f in infiltration-capacity equation.

Column (10)--Coefficient K_a in the surface-runoff equation, expressed in terms of average surface-detention depth δ_a, including depression-storage, or $q_s = K_a\delta_a^M$. The value of K_a is determined directly from logarithmic platting of q_s in terms of δ_a for a value of $\delta_a = 1.0$.

Column (11)--Coefficient K_s of overland flow in terms of depth δ, along outlet-margin. The value of K_s can be derived from K_a [column (10)] and M [column (7)] by using the equation $K_s = [M/(M + 1)]^M K_a$. The coefficient K_s takes into account the effect of the principal variables--slope, roughness, index of turbulence, and length of overland-flow, in relation to surface-runoff, and its value is expressed in terms of these variables by the general equation $K_s = 1020\sqrt{S}/In\,l_o$ where l_o is the length of overland-flow in feet. This equation is not applicable if the flow is not more than one-third turbulent.

Column (12)--Roughness-coefficient n, given by the equation $n = 1020\sqrt{S}/I\,K_s\,l_o$, S being the absolute surface-slope. The difference between slope of the water-surface on the plat and the slope of the plat-surface is usually so slight that the latter is used in the computations.

Column (13)--Mass-erosion expressed in inches depth of soil at volume-weight removed during first 30 minutes of experiment.

Table 1--Field-description of sites and soils studied

Site No.	Soil-type	Surface-soil	Subsoil	Topography and origin	Degree of erosion	Cover
5 6 7	Mohave gravelly sandy loam	Reddish brown, gritty, friable, calcareous	Redder, finer texture, more compact; lime accumulations	Rolling to flat-topped terraces and fans; largely from granite	Slow sheet-erosion; coarse sand and fine gravel-erosion pavement	None, except for very little annual plant-litter
10	Gila fine sandy loam	Light brown to pinkish brown, calcareous, friable	Light-colored, stratified recent stream-deposits	Recent bottom-soils; mixed origin	Severe sheet-erosion "A"-horizon 2 to 4 inches	None
11	Gila fine sandy loam	Light brown to pinkish brown, calcareous, friable	Light-colored, stratified recent stream-deposits	Recent bottom-soils; mixed origin	Sandy overwash; "A"-horizon 6 to 10 inches	Very sparse; few burroweeds present were removed
12	Gila fine sandy loam	Light brown to pinkish brown, calcareous, friable	Light-colored, stratified recent stream-deposits	Recent bottom-soils; mixed origin	No recent erosion "A"-horizon 8 to 10 inches	Very sparse; few burroweeds present were removed
13	Gila silt-loam	Light brown to pinkish brown, calcareous, friable	Light-colored, stratified recent stream-deposits	Recent bottom-soils; mixed origin	No recent erosion	Some annual plants and litter
14	Cajon sand	Light grayish brown, calcareous, coarse	Similar to surface; deep stratified, sandy deposits	Alluvial fans and flood-plains; outwash from granite rocks	No recent erosion	Some filaree and litter
15	Ramona sandy clay-loam	Brown to grayish brown, gritty surface-soil	Heavier moderately compact, grading to gravelly sediments	Upper and lower fans; from granitic materials	Recent overwash; surface badly checked	None
16	Ramona sandy clay-loam	Brown to grayish brown, gritty surface-soil	Heavier moderately compact, grading to gravelly sediments	Upper and lower fans; from granitic materials	Slight erosion, fine gravelly erosion-pavement	Fair cover annual plants and litter
18	Mohave sandy clay-loam	Reddish brown, gritty, friable, calcareous	Redder, finer texture, very compact	Lower fans and terraces, derived from granite	Slight sheet-erosion	Sparse weed-cover
19	Teague stony loam	Grayish brown, calcareous; very rocky	Dark brown calcareous clay-loam, caliche hardpan	Alluvial fans and terraces, derived from basalt	Gravelly erosion-pavement	None
20	White house stony loam	Friable, granular, dull brown	Tough red-clay, cobbly	Upper fans; granite origin	Moderate sheet-erosion; stony pavement	Sparse cover of caliandra and grama grass
21	Sonoita sandy loam	Reddish brown medium to coarse	Compact heavy clay-loam	Alluvial fans; rhyolitic origin	Slight erosion	Sparse cover annual plants; some litter

Table 2--Averages by sites

Site No.	Slope, per cent	i	f_o	f_c	t_c, hour	M	I	K_f	K_a	K_s	n	Mass-erosion, inches
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
						Dry runs						
5	5.3	3.08	4.10	0.92	0.351	1.45	1.16	13.85	118	55	0.164	0.0031
6	8.9	3.09	4.06	1.42	0.468	1.42	1.18	14.10	357	164	0.171	0.0092
7	13.7	3.05	4.78	1.36	0.358	0.84	1.00	19.20	48	24	0.290	0.0060
10	2.0	3.31	10.98	0.63	0.279	1.50	1.13	38.80	520	236	0.039	0.0194
11	2.1	3.25	5.29	0.83	0.688	1.10	1.42	11.20	118	58	0.076	0.0088
12	1.4	3.26	5.22	0.75	0.700	2.12	0.66	14.70	1200	531	0.016	0.0127
13	0.8	3.20	4.30	0.60	0.700	1.70	0.97	5.30	270	101	0.032	0.0118
14	1.3	3.34	(a)	2.22	0.775	(a)	(a)	(a)	(a)	(a)	(a)	0.0019
15	1.3	3.32	8.38	0.28	0.171	1.50	1.12	43.25	40	18	0.266	0.0402
16	2.9	3.36	4.74	1.78	0.476	2.06	0.70	13.75	550	249	0.043	0.0039
18	3.3	3.14	4.22	0.97	0.784	2.09	0.68	9.35	1080	477	0.024	0.0150
19	2.3	3.00	4.27	0.87	0.540	2.05	0.71	11.60	1200	531	0.017	0.0083
20	4.9	3.14	9.52	1.52	0.264	2.44	0.47	28.07	1588	458	0.037	0.0051
21	2.6	3.11	6.78	1.15	0.275	2.02	0.73	25.85	480	257	0.045	0.0100
(1)	(2)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
						Wet runs						
5	5.3	3.10	5.91	0.42	0.160	1.96	0.78	35.65	1296	582	0.092	0.0073
6	8.9	3.12	5.65	0.71	0.188	2.06	0.70	38.05	1125	496	0.136	0.0188
7	13.7	3.05	3.69	0.65	0.200	1.56	1.24	25.20	200	81	0.156	0.0136
10	2.0	3.30	5.74	0.44	0.200	2.00	0.74	44.80	1810	804	0.045	0.0246
11	2.1	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
12	1.4	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
13	0.8	3.16	5.39	0.34	0.458	1.37	1.22	19.60	214	123	0.016	0.0158
14	1.3	3.34	(a)	1.29	0.498	(a)	(a)	(a)	(a)	(a)	(a)	0.0025
15	1.3	3.32	8.94	0.18	0.212	1.68	0.99	40.40	70	32	0.160	0.0336
16	2.9	3.35	6.75	1.05	0.388	2.35	0.48	18.35	1275	554	0.042	0.0054
18	3.3	3.33	5.49	0.69	0.233	2.07	0.70	29.20	1380	611	0.018	0.0095
19	2.3	3.12	5.57	0.62	0.280	2.65	0.26	23.30	2400	1032	0.024	0.0029
20	4.9	3.13	6.59	1.08	0.265	2.52	0.35	27.07	2085	601	0.048	0.0037
21	2.6	3.10	6.80	0.70	0.156	2.11	0.67	45.75	910	402	0.025	0.0075

(a) = Data on the rising side of the hydrographs were not complete enough to solve for values of f_o, K_f, M, etc. (b) = No data.

Since, with a few exceptions, each site represents in general a different soil-type and different cover-condition, it is believed that averages of all the experiments at a given site will show, as far as the number of experiments performed are adequate, true differences due to soil and cover.

An experiment was counted as a dry run if it was the first or initial run on a plat made under existing conditions of field-moisture which for most of the experiments were quite low, surface-soils frequently being nearly in an air-dry condition. A run was designated as a wet run if it followed a dry run usually within 24 hours. In many cases the soils were nearly at field moisture-capacity when the wet run was started.

It will be noted in Table 2 that there were marked differences in the value of the constant infiltration-capacity f_c for both the dry runs and the wet runs at the different sites. In general, there was a different slope at each site, but since infiltration-capacity is but little affected by slope, as shown later, this does not account for the difference. Part of the difference is, however, due to seasonal variations as runs at different sites were made in different months. Aside from this it appears that the differences in f_c at the different sites are chiefly representative of soil- and cover-conditions though the latter factor is of lesser importance since the cover was very sparse on most of the sites studied.

With respect to runoff-characteristics, the runoff-exponent M is generally higher at a given site for wet than for dry runs, seeming to indicate a smoother surface. Indications are that

Table 3--Average of runs

Runs	No. of runs	f_o	f_c	t_c	K_f	M	K_a	I	K_s	n	$\frac{q_e}{(i-f_c)}$	Mass-erosion, inches depth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dry	24	6.25	1.05	0.441	20.83	1.71	534	0.92	237	0.095	1.001	0.0116
Wet	21	6.12	0.64	0.249	31.86	2.02	1036	0.75	455	0.076	1.001	0.0133
Total	45	6.19	0.86	0.352	25.97	1.85	768	0.84	339	0.086	1.001	0.0124

values of the roughness-factor n are generally lower for wet than for dry runs on a given site except where the soil-surface is susceptible to severe checking and cracking between runs such as on sites 10 and 15. Increase of M and decrease of n both correspond to increased facility of runoff. Such differences between wet and dry runs have not heretofore been noticed and are probably due in this case to the effect of the initial wetting on the vegetal cover and on the soil-surface itself.

Since most of the sites had little or no plant-cover, the rate of erosion seems to be a function of other surface-conditions such as soil-puddling and erosion-pavement. Presence of the latter appears to be responsible for low rates of erosion on sites 5, 6, 7, 16, 19, and 20. The effect of slope on erosion is not clearly shown in these experiments since the range of slopes is small except on sites 5, 6, and 7 where the erosion-pavement prevented active soil-removal.

Averages of the principal factors for dry and wet runs and for all runs are shown in Table 3.

A slight reduction in initial infiltration-capacity f_o and a marked reduction in constant infiltration-capacity f_c from dry to wet runs are indicated. The time t_c required for infiltration-capacity to become constant was less for the wet than for the dry runs. The infiltration-capacity constant K_f showed a marked increase from dry to wet runs. The runoff-exponent M showed an increase and the index of turbulence I showed a decrease from dry to wet runs. The runoff on the whole was almost fully turbulent. The roughness-factor n shows a significant decrease from dry to wet runs. Column (11) has been included showing the ratio of runoff-intensity to the constant supply-rate $(i - f_c)$. q_e is the runoff-intensity at the end of the application of water. This should be equal to the supply-rate $(i - f_c)$ with constant infiltration-capacity. It will be noted that the experiments show the ratio of these quantities to be very close to unity in all cases, as it should be in accordance with the infiltration-theory of surface-runoff.

The average infiltration-capacity curves derived from all of the experiments and for wet and dry runs respectively are shown in Figure 1.

Characteristics of hydrographs--The hydrographs for a number of experiments are shown in Figures 2, 3, 4, and 5. These hydrographs cover a variety of examples of different sites with different slopes, soils, and duration of experiments.

All of the infiltration-curves have similar shapes, beginning with high values and declining rapidly for the first ten minutes after which they continue to decline slowly until a nearly constant rate of infiltration is reached. The runoff-curves show distinct waviness in many instances, especially after the flow becomes stable. The presence or absence of waviness does not appear to be closely related to soil-surface or cover-conditions but there is an indication though perhaps not significant of a relation to slope and erosion. The wave-crests vary in time from eight minutes on the steeper slopes to 13 minutes on the flatter slopes.

Relation of slope to infiltration--No consistent variation of the runoff-coefficient K_a (in terms of δ) with increasing slope could be established from these experiments. This was probably due to the fact that the effect of slope is partly masked by seasonal variations but in the main it is due to variations in soil-type, soil-surface, and cover-conditions concomitant with the different slopes. In dealing with natural watersheds, the ecological relationships must be carefully considered. Most individual soil-types do not occur on a wide range of slopes without change, a range of ten per cent being perhaps above the average. Vegetative types likewise vary somewhat with soil-types and topographic aspect.

The infiltration-capacities of soils occurring on low slopes (less than three per cent) in this region seem to be much more variable and, when unprotected by a good vegetative cover, are probably lower than for soils occurring on steeper slopes. This is due to the fact that the flatter areas are subject to alluvial processes of deposition and removal and contain fine sandy,

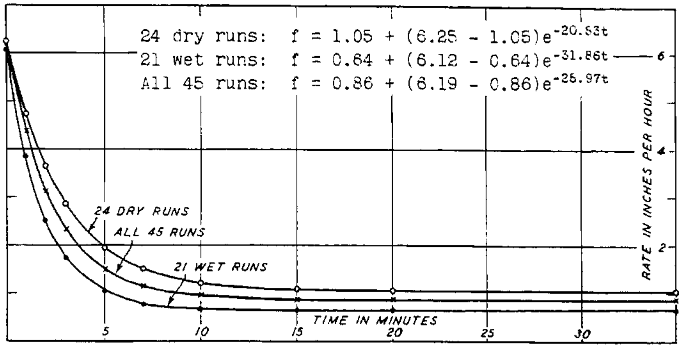
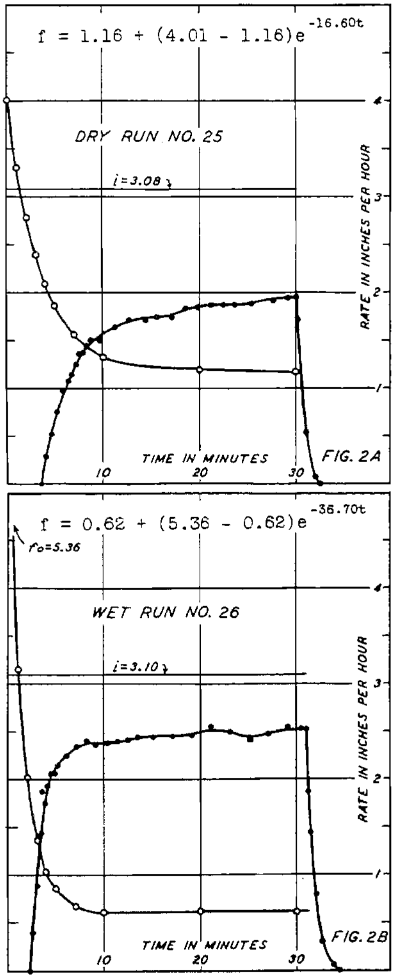


Fig. 1--Average infiltration-capacity curves



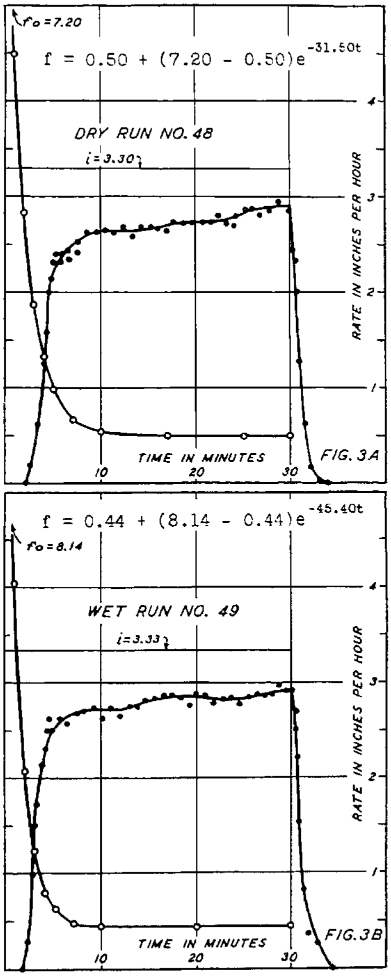


Fig. 2--Hydrographs for Site No. 6 (Tripp Canyon), Plot No. 2 (Soil, Mohave gravelly sandy loam; slope, 8.8 per cent; cover, some annual debris)

Fig. 3--Hydrographs for Site No. 10 (City Farm), Plot No. 1 (Soil, Gila fine sandy loam; slope, 2.0 per cent; cover, none)

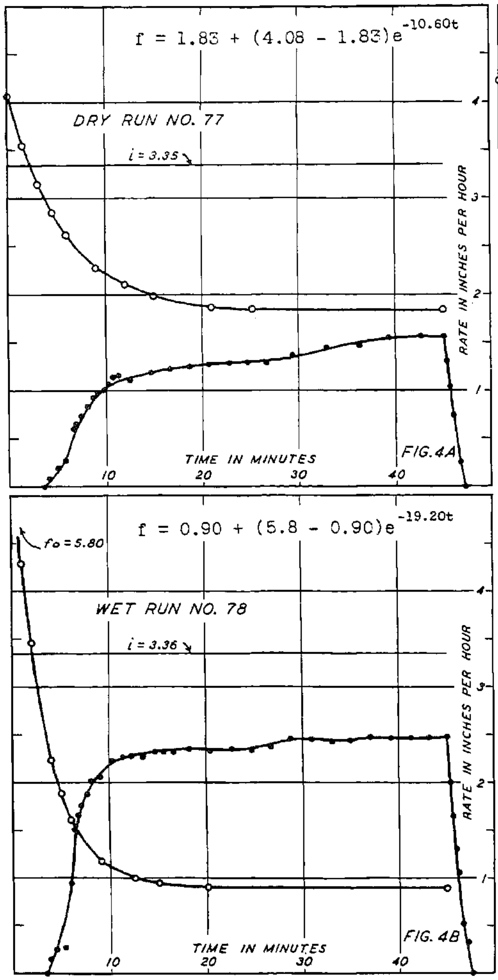


Fig. 4--Hydrographs for Site No. 16 (Beach Ranch), Plot No. 1 (Soil, Ramona sandy loam; slope, 2.9 per cent; cover, fair cover of spring annuals and considerable annual grama litter)

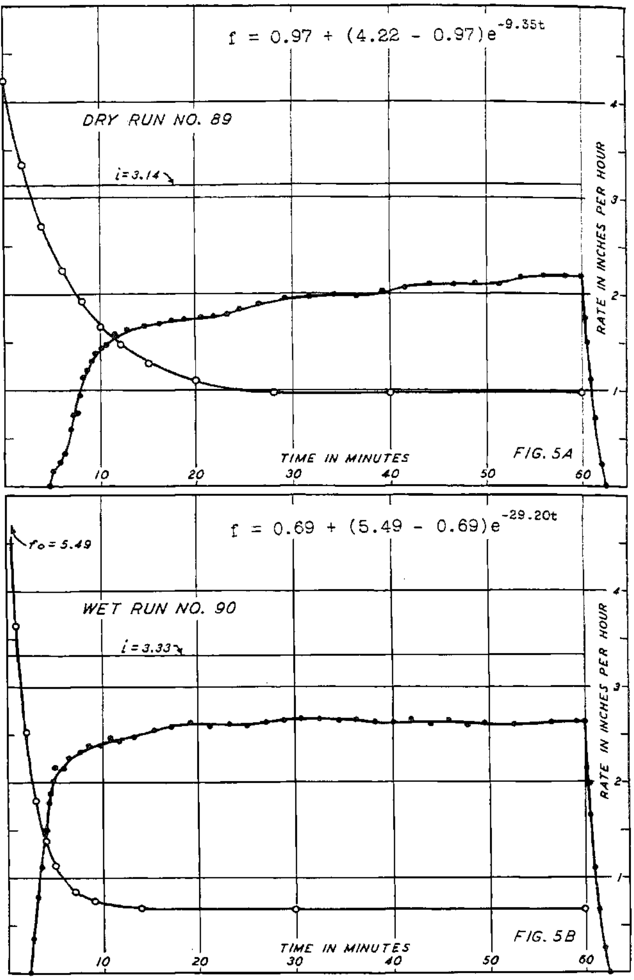


Fig. 5--Hydrographs for Site No. 18 (Artesia), Plot No. 1 (Soil, Mohave sandy clay loam; slope, 3.3 per cent; cover, 19 small burro weeds removed, 28 snake weeds not removed)

silty, and clayey soils which permit ready infiltration of water only when their surfaces are kept in a favorable condition. When a good growth of grass and plant-litter cover these soils, they may have higher infiltration-capacities than adjacent more steeply inclined and also more sparsely vegetated slopes. They may, as areas of natural water spreading, be able to absorb not only most of the rainfall but also considerable runoff from contributing slopes. When the natural balance has been upset, however, and the vegetative cover has deteriorated due to erosion or some other cause, these flat-lying soils often tend to puddle and seal over. Several of the experiments show large variations in infiltration-capacities within a slope-range of one to three per cent on the same general soil-type.

In order to eliminate variables due to soil-type and cover, experimental data for sites 5, 6, and 7 (Table 2) can be best used to note the relationship between slope and infiltration. These three sites in themselves perhaps do not furnish sufficient data to establish conclusively a slope infiltration-relation but they are typical of other experiments conducted recently and not included in this report. These sites having slopes of 5.0, 9.0, and 13.7 per cent are on the same soil-type located within 150 yards of each other on the same exposure, and have nearly the same soil-surface conditions. They are nearly identical from the standpoint of cover, being bare except for very little annual plant-debris and some leaves from surrounding creosote-bushes. No significant relationship between slope and infiltration is evident in these sites nor in other sites not reported in this series of experiments, all tending to bear out the conclusions of other experimenters such as Duley and Hays [2] and Neal [3]. It would thus appear that other factors including cover, soil-surface and profile being equal, no significant correlation exists between slope and infiltration.

The roughness-factor--The roughness-factor n given in Table 2 has the same general meaning as the roughness-factor n in the Manning formula for flow in channels. However, in the latter case the resistance is chiefly that of true boundary-rugosity, while in the case of surface-runoff the resistance due to the surface itself may be relatively small compared with the resistance due to eddies, ineffective slope, and vegetation or other surface-obstructions such as stones and gravel characterizing the erosion-pavement on many of the sites reported in these experiments.

It may be noted that values of n for the greater number of experiments are less than 0.100 and in many cases are less than 0.050 or of the same order as the values of n appurtenant to stream-channels. Where high values of n exist such as those above 0.10, a large amount of resistance is indicated due to causes other than boundary-rugosities. These facts taken together indicate (1) that the true surface- or boundary-resistance due to rugosity on these soils is of the same order as that for natural stream-channels, (2) that the highly increased resistance occurring in a number of cases is due to surface-obstructions which may be either vegetal cover, plant-debris, or stones and gravel. The latter would have the same effect as grass in increasing frictional retardation but in addition would materially reduce the effective cross-section and the result would be a large increase in the value of n, which is computed on the basis of the entire cross-section being effective.

While the particular sites on which these experiments were made had sparse covers of vegetation and in some cases had bare soils, it is apparent that even the limited amount of ephemeral plant-growth together with scattered shrubs furnish debris which may have an important bearing on infiltration and runoff. Vegetal cover and litter may operate to increase the resistance in a variety of ways: (1) By subdividing the flow and greatly increasing the wetted perimeter; (2) by forming complete or partial debris dams on the soil-surface, through which the runoff filters slowly, with greatly increased resistance and loss of effective head or slope. The conditions at some of the sites where these experiments were carried out seem to have been peculiarly adapted to the occurrence of the latter phenomenon. It was noted on many plats that, while little plant-growth and litter were prominent on the surface before the initial run, after an application of three inches of rain, debris-dams were built up in various parts of the plat from plant-material which had originally been scattered on the surface and had been partially incorporated in the surface-soil horizon.

The soil-surface itself when in a dry condition assumes a certain roughness due to trampling effect of either one or a combination of livestock, wildlife or humans, shrinkage during the drying process, as well as other factors. Roughness due to these influences as well as that of scattered plant-materials is somewhat ironed out after an application of rain. The loose plant-debris becomes segregated into rows and dams and the attached material is more or less lined up with the direction of flow down the slope, thus offering less total resistance to runoff. Indications are that the larger depressions which are most evident in observing depression-storage are somewhat filled in with soil during the first application of rain on a plat and are thus less effective during the wet run.

The roughness-factor has an important bearing in relation to runoff-retardation, since high values of the roughness-factor correspond to low values of the runoff-coefficient K_s and low runoff-intensities and increased duration of rain necessary to bring the runoff-intensity up to equality with the supply-rate $(i - f_c)$. In fact, it is through increased resistance to surface-runoff that vegetation acts in part to reduce soil-erosion and promote infiltration. This comes about partly through reduced velocity of overland-flow, partly through increased depth of surface-detention and consequent increased infiltration of water remaining on the ground when rainfall-excess ends.

Seasonal variation of infiltration-capacity--Normal climatic conditions in southern Arizona include two rainy seasons--the summer and winter. The former usually extends from July through September and the latter from December through March. The late spring and fall are very dry especially the spring which during many years is practically rainless. This means that surface-soils of the lower elevations are often nearly in an air-dry condition just preceding the summer rains. Usually the average soil-moisture is maintained at a higher level during the winter rainy season than during the summer since little water is lost as runoff during the low-intensity rains, evaporation is much lower, and plant-growth with resulting transpiration-losses is less active during the winter.

It is not believed that the series of experiments reported in this paper lend themselves well to a study of seasonal variations of infiltration-capacity since experiments were conducted on different sites and soils throughout the year. Later experiments, however, are in progress in which repeat runs are being made on the same site. To date a number of runs have been made on several sites during the summer and again during the winter, the initial soil-moisture being nearly the same, and in most cases the infiltration-capacity is definitely lower during the winter (cooler months) than during the summer (hotter months).

Part of the seasonal variation of f_c is probably due to temperature and part to biological activities within the soil which are influenced by temperature as well as by soil-moisture. Activities of insects and other soil-fauna as well as microbiological activities are largely controlled by soil-moisture conditions as well as temperature. Studies in progress at the University of Arizona indicate that microbiological activity in range-soils is much greater during the hotter than during the cooler periods of the year and also increases during periods of higher soil-moisture.

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A GRAPHICAL METHOD OF ANALYSIS OF SPRINKLED-PLAT HYDROGRAPHS

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The data utilized in developing the following method of analyzing hydrographs of sprinkled plats was secured by an infiltration-study party of the Office of Research of the Soil Conservation Service, under the supervision of G. W. Musgrave. The work was done on the Concho River Watershed, near San Angelo, in West Texas, during the summer and fall of 1939. The data used are those from Type-F rainfall simulator-plats. This infiltrometer is the latest development of the Hydraulic Laboratory of the Soil Conservation Service. Plats were six feet wide and 12 feet long.

The sprinkling apparatus consisted of two spray heads, carrying seven specially designed spray-nozzles each, mounted on either side of the plat. The spray from the nozzles was directed upward and then arched over on the plat and surrounding border-area. The drops of this unit are rather large and fall a distance of about seven feet, having considerable force of impact. Distribution is reported by the Hydraulic Laboratory as being very good. Intensities of rainfall are dependent on the number of nozzles in use, in these studies being approximately 1.65 inches per hour when seven nozzles were in use and 3.30 inches per hour with 14 nozzles operating. Covers, or caps, were available in gangs to permit covering and uncovering nozzles at will, and practically instantaneously.

Other parts of the apparatus included steel border-plates, a tent to protect the spray from wind, a collecting trough and conduit to conduct runoff into buckets, a scales, a stop-watch, sheet-steel intensity-measuring pans, a pump, and a water-tank.

In operation, an intensity-run was first made with the pans covering the plat and conducting all rainfall on the plat into the collecting system, where samples could be collected and weighed for determining intensities. The nozzles were then covered, the pans removed, the nozzles uncovered to start the rainstorm, and the time noted. The time when depression-storage, runoff from the plat, and runoff at the sample tank began were then noted. After runoff started, continuous consecutive samples were collected and weighed. The length of time of samples was varied through the run according to the rate of change in runoff. Where the rate of change was rapid, one-minute samples were obtained. When little or no change was occurring, longer time-intervals were used.

In the particular studies reported herein, rainfall-intensities were changed at intervals