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STEWART L. UDALL, *Secretary*

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Thomas B. Nolan, *Director*

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Hydrologic Data Wind River and Fifteen Mile Creek Basins, Wyoming 1947–54

By NORMAN J. KING

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HYDROLOGY OF THE PUBLIC DOMAIN

HYDROLOGIC DATA, WIND RIVER AND FIFTEEN MILE CREEK BASINS, WYOMING, 1947-54

By Norman J. King

ABSTRACT

The collection of hydrologic data, measurement of physiographic features, and the study of drainage-channel characteristics believed to have an influence on erosion and sediment movement were begun in 1946 by the Geological Survey in 13 upland areas in the Wind River and Fifteen Mile Creek basins in Wyoming. The main objectives of these studies were: To obtain information needed to evaluate land-treatment practices under the Soil and Moisture Program of the Department of the Interior, to increase the background of basic data particularly from small drainage basins, and to complement streamflow and sediment investigations on the main streams. Observation procedures in the 13 sample areas, which represent different parts of the basins and tend to show the range of conditions common to the area, involved measurement of local precipitation and its effect on runoff and sediment movement as measured in stock-water and erosion-control reservoirs, instrumental surveys of channels and other topographic features, and examination of the geology and soil conditions of the study areas.

This report, in effect a progress report, contains the data collected during the period 1947–54. Owing to the general lack of high intensity storms and associated runoff within the project areas during that period, the data are insufficient to warrant conclusive interpretations. The report, therefore, is directed to presentation of original data with a description of methods and sufficient background to allow preliminary interpretation of the data presented.

INTRODUCTION

Programs for land treatment have been in operation in the Bighorn River basin, Wyoming, by the Bureau of Land Management and Bureau of Indian Affairs on a small scale for a relatively long period, but impetus was given to these programs about 1950, particularly in Wind River basin, because of the construction of Boysen Reservoir and the emphasis placed on sediment control in the area above the reservoir. Associated with this project was the selection of Wind River basin by the Department of the Interior as a pilot area for conservation practices in the Missouri basin. The expanded program also involved a considerable change in treatment of land in that it called for treatment of an entire drainage basin and emphasized the control of runoff as means of erosion control.

Studies of runoff, erosion, and movement of sediment are being made by the Geological Survey in a number of upland areas in Bighorn River basin, including the basins of Wind River and Fifteen Mile Creek, to obtain information for use in planning the land treatment. Fifteen Mile Creek is a small tributary that enters the Bighorn River at Worland, Wyo. In making these studies, emphasis is placed on the measurement of runoff from small watersheds, the delineation and comparison of the areas of erosion and sources of sediment, determination of the influence of both local and areal factors in the progress of erosion and in the movement of sediment from the upland to the main streams, and evaluation of the effectiveness of measures in abating erosion and improving forage production.

The data contained in this report are the results of observations made during the period 1947–54. They were collected to complement the investigations of streamflow and sediment in the main streams. Stream-gaging was started by the Geological Survey in Bighorn River basin many years ago and has been increased considerably since 1946 as a part of the program connected with the Missouri Basin project. Sediment stations also have been established since 1946 on most of the main streams of the Wind River basin and on several other streams in Bighorn River basin. The results are published in the annual reports of the Geological Survey on surface water supply and on quality of surface water. In addition, a condensation of parts of the study was made by Colby and others.[1] The bulk of the data on upland areas contained in this report, however, are not otherwise available. Although the study units of this report do not include the entire drainage basins of the Wind River and Fifteen Mile Creek they are representative of these basins and tend to show the range of conditions and the factors having the major influence on runoff and sediment yields. As the land-treatment programs progressively involve larger areas, the combined results obtained from the major stream stations and the studies of the smaller units will acquire greater significance in evaluating the effectiveness of the treatment measures. This report contains only the data collected through 1954. The text is limited to descriptions of methods and to the presentation of sufficient background so that the data may be used properly. A few remarks are included on the general trend of results.

Observation procedures in these studies involve: Measurement of precipitation; measurement of runoff and sediment in reservoirs for erosion control and watering stock; instrumental surveys of channels and other topographic features; and examinations of the geology and other characterisitics of the study areas. Because of increasing needs for

[1] Colby, B. R., Hembree, C. H., and Rainwater, F. H., 1956, Sedimentation and chemical quality of surface waters in the Wind River basin, Wyoming: U. S. Geol. Survey Water Supply Paper 1373.

data on runoff, water-stage recorders were installed on several of the large retarding reservoirs built since 1950 by the land agencies. This means of obtaining dependable records of runoff from small watersheds is proving very satisfactory. Such records will aid in progressively refining estimates for proposed similar structures and will add to the general fund of data on runoff from small watersheds, which is in demand for other purposes than land conservation. Another study which has been expanded recently is the observation of inflow, infiltration, and soil moisture in areas of flood-water irrigation by means of range water spreaders.

Although there are no definite distinctions among the types of studies in the several areas, some are chiefly of a general nature concerned with increasing the background of basic data, whereas others are made of an operating project for both the collection of basic data and evaluation of the performance of control structures. Plate 1 is an index map showing the locations of the study areas in the Wind River basin.

OBSERVATIONS IN WIND RIVER BASIN

GRAHAM DRAW

The study of Graham Draw, the first in the program in Wind River basin, was started in 1946 as a comprehensive study of runoff, sediment yields, erosional characteristics, and the factors influencing erosion. The opportunity for measurement of runoff and sediment was provided by a reservoir for watering stock for which, at the time the study was started, the capacity-drainage area ratio was about as large as any that could be adapted for measurement purposes in the Wind River basin. Because of the potential filling of the reservoir by sediment, the Graham Reservoir is not as well suited for future studies as some of the more recently constructed larger reservoirs that have been selected for observation. However, the records obtained in the Graham study are valuable because they are considerably longer than any others available at this time.

DESCRIPTION OF THE AREA

Graham Reservoir, which lies about a mile north of Moneta (See pl. 1), has a catchment area of 3.12 square miles. It is on Graham Draw, a tributary of Poison Creek in the east-central part of the Wind River basin (see pl. 1). A topographic map of the tributary basin is given in plate 2, and an aerial photograph is shown in plate 3*A*.

The basin (see pl. 2) is roughly rectangular and is about 2½ miles long and 1½ miles wide. The maximum relief is about 430 feet. Typical of many basins of this size, the Graham Draw basin contains two more or less distinct units that have contrasting topography and erosional features: A belt of dissected bedrock tableland, buttes, and cliffs along the basin boundaries (pl. 3*B*); and a central area of slight relief, which slopes gradually to the valley of Poison Creek (pl. 4*A*). Runoff from the upper dissected slopes converges into three main forks, called in this study the East, Middle, and West Forks, that have cut meandering channels across the alluvial slope to their junction just above the main reservoir. The channels for the most part are steep-banked gullies, though in some short reaches they are wide and shallow. Flow occurs only in direct response to rainstorms or melting of snow. The annual precipitation in the Graham Draw basin, as determined by records from the nearest Weather Bureau stations and those obtained in this study, averages about 8 inches.

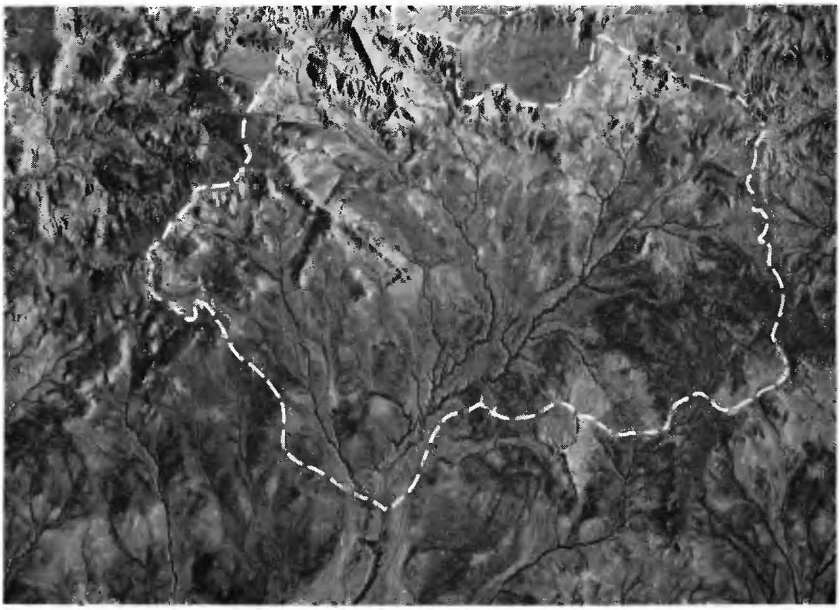
The drainage basin is underlain by the Wind River formation, consisting of shale, siltstone, and sandstone. In the central area, the bedrock is covered by a blanket of alluvium, 5 to 10 feet thick, derived from erosion of the boundary area. Soils in the drainage basin, like many of those on the uplands of the Wind River basin, have not formed a recognizable structure or profile, and, except for being disintegrated and unconsolidated, they are scarcely distinguishable from the underlying rock. Thus they range in character from rather coarse grained and highly permeable types on the areas of sandstone to fine-grained and relatively impermeable types on the areas of shale or of alluvium derived from shale.

Vegetation is generally sparse. Examinations made by the Bureau of Land Management show that the density ranges from less than 1 percent to about 20 percent and averages about 15 percent. The type of vegetation varies with the character of soil and rock and consists mainly of big sage and grass on the sandy or medium-textured soil and of salt sage and brown sage on the fine-textured soil. Because the drainage basin is crossed by a public stock driveway, heavily used in the past, the vegetation probably has been somewhat depleted and, in general, is sparser than that of adjacent areas.

PROCEDURE

The study of Graham Draw at present (1954) includes maintenance of records on three reservoirs—Graham Reservoir on Graham Draw at the lower end of the drainage basin and one reservoir each on the East Fork and West Fork. When the study was started in 1946, only the Graham Reservoir had been built. The West Fork reservoir was built in 1947 and the East Fork reservoir in 1949.

Graham Reservoir, built in 1940, had an initial capacity of 25.6 acre-feet. Its capacity in 1947, when first surveyed in this study, was 19.8 acre-feet. The reservoir has no outlet except an overflow spillway. A low auxiliary dam, which forms a desilting basin in the



A. AERIAL PHOTOGRAPH OF GRAHAM DRAW BASIN

Photograph by Aero Service Corporation.

B. EROSION-MEASUREMENT COURSE IN GRAHAM DRAW BASIN

The barren cliff in the background is typical of the basin boundaries.

channel upstream, is located at the head of the reservoir. The West Fork reservoir had an initial capacity of 3.4 acre-feet and a drainage area of 0.38 square mile. The East Fork reservoir had an initial capacity of 12.3 acre-feet with a drainage area of 0.81 square mile. These two reservoirs likewise have no outlets except overflow spillways.

The reservoirs are equipped with staff gages on which water stages are read. Changes in stage are applied to capacity curves (similar to the one shown in fig. 1 for Graham Reservoir) to compute the amount of runoff from the drainage basin. The sediment level in the reservoirs is determined by surveying along established cross sections, and the volume of sediment is determined by reference to capacity curves.

A system of permanent line transects was established within the drainage basin on which measurements are made periodically to determine the amount of erosion or deposition. These transect lines cross channels and adjacent colluvial slopes in reaches of apparent erosion and constitute a series of cross sections on the main drainage courses by which the erosion and successive movement of sediment can be traced from the head of the drainage basin to the reservoir.

During most of the period of study, three nonrecording precipitation gages were maintained in the drainage basin. In addition, a recording precipitation gage has been maintained since 1950. Gages are kept in operation generally from April to October.

In 1947 observations of vegetation were started with counts along a line transect, 300 feet long, established in the central part of the basin (pl. 4*A*). In 1949, 14 additional sampling plots, distributed a quarter of a mile apart along the legal landlines, were observed. Each plot consists of 4 quadrants, 1-foot square. The vegetation counts were made by the Bureau of Land Management.

RAINFALL AND RUNOFF

During the 8 years of record, flow into the reservoirs has been limited to the period from April through October, and appreciable amounts of inflow have occurred only during the period from June through September. Although winter storms infrequently may cause small flows in the channels, such flows have not reached the reservoirs during the period of observation. Therefore, for this report, precipitation and runoff are considered for only the 7 months, April through October.

Records of seasonal precipitation and runoff for 1947–54 and classification of the daily precipitation for each season are summarized in table 1. Descriptions of reservoirs and runoff for storm events are listed in table 2. Also, the hydrograph in figure 2 shows the precipitation and the fluctuations of the reservoir contents for 1947

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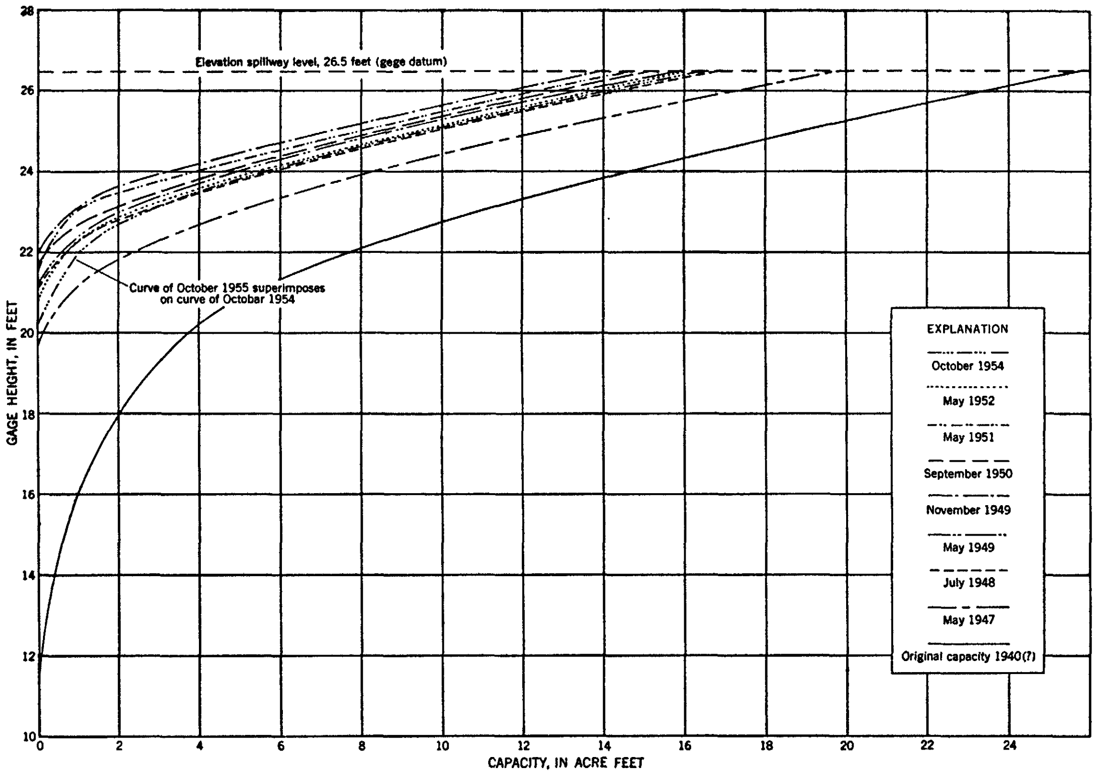

FIGURE 1.—Stage-capacity curves for Graham Reservoir.

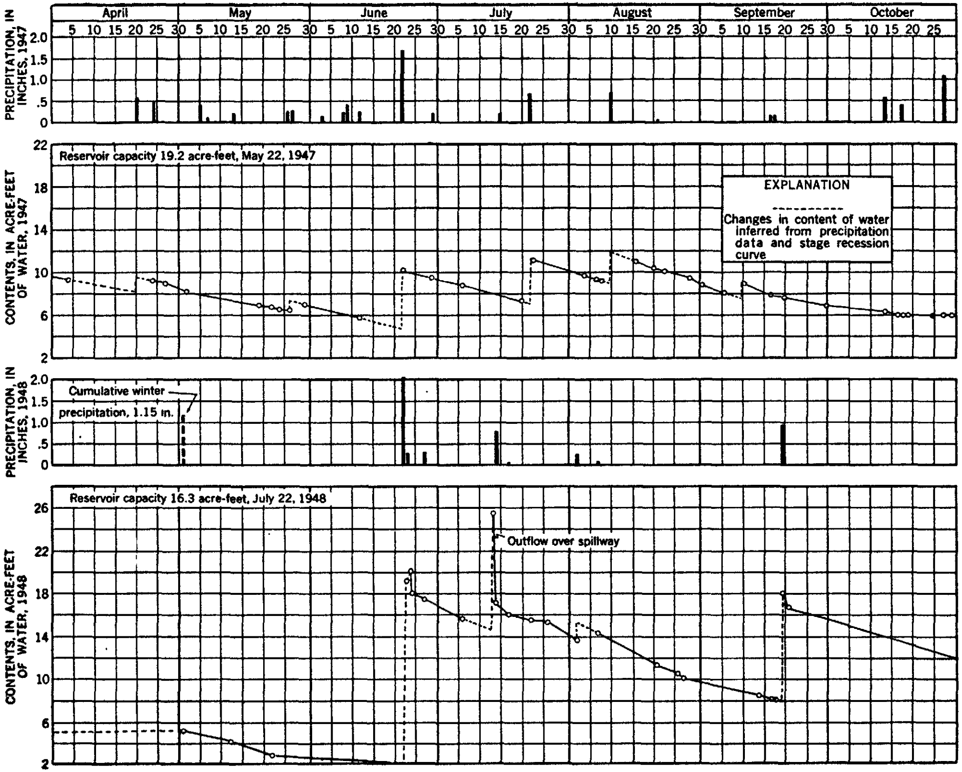

FIGURE 2.—Precipitation and contents of Graham Reservoir, 1947 and 1948.

and 1948 and indicates the relation between rainfall and runoff in the basin.

As shown in table 1, precipitation varies considerably from season to season. Runoff, although consistently representing a small fraction of the seasonal precipitation, does not fluctuate in conformity with the seasonal precipitation but appears to be dependent on the size of the storms and probably even more on short-period intensities within a storm.

SEDIMENT YIELDS

Sediment deposition determined by surveys of the reservoirs are summarized in table 3. Volume is given for the period of observation on Graham Reservoir, 1940–54. The total volume of sediment deposited in Graham Reservoir was measured by probing to determine the original bottom of the reservoir and then computing the difference between the original capacity and the capacity in 1954. In November 1949, the volume of the sediment deposit was the maximum observed; since that time, sediment inflow has been small, and prior deposits have compacted. A profile of the Graham Reservoir, showing the original bottom and successive surfaces of the sediment deposit, is presented in figure 3.

The total volume of sediment for the period 1940–54 is not comparable with those for the shorter periods because it includes some compacted sediment. Also, because the sediment surveys were not made at the same time each year, determination of the annual sediment yield for the periods May 1947 to July 1948 and July 1948 to November 1949 required adjustment for amounts of deposition between observations. The adjustment was made on the basis of the runoff events during these seasons. Despite uncertainties involved in these adjustments, the results show conclusively that

TABLE 1.—*Relation of seasonal and daily precipitation to runoff in Graham Draw basin, April to October, 1947–54*

Year	Total seasonal precipitation (inches)	Number of days in which precipitation exceeded designated amount in inches					Runoff	
		0.25	0.50	1.0	1.5	2.0	Acre-feet per square mile	Inches
1947	9.18	14	6	2	1	0	5.3	0.10
1948	4.64	4	3	1	1	1	[1] 16.9	.32
1949	7.48	10	3	1	1	0	[1] 15.4	.29
1950	4.06	4	1	0	0	0	2.7	.05
1951	3.83	2	0	0	0	0	0	0
1952	4.16	3	1	0	0	0	0	0
1953	2.97	1	0	0	0	0	0	0
1954	2.75	1	1	0	0	0	.2	.004

[1] Includes an estimate of spill from Graham Reservoir.

amounts of sediment fluctuate greatly from year to year and that long-term records are necessary to obtain reliable information for areas like the Graham Draw basin.

TABLE 2.—*Runoff of Graham Draw for the summer seasons, 1947–54*

Graham Reservoir

Location.—Lat 43°10′20″, long 107°43′20″, in SE¼ sec. 14, T. 37 N., R. 91 W., near Moneta, Wyo.

Drainage area.—2.74 square miles (1,760 acres) excluding area upstream from West Fork reservoir; 1.93 square miles (1,240 acres) after construction of East Fork reservoir in May 1949.

Records available.—April to October 1947–54.

Gage.—Staff gage, crest stages observed, gage read once weekly or after storms. Altitude of gage is 5,460 feet (from topographic map).

Remarks.—Records good, except those for spill, which are poor. Capacity (1954) 16.2 acre-feet at spillway level; maximum depth, 6.3 feet.

Storm runoff in Graham Reservoir

Year	Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
		Before inflow	After inflow				
1947	May 27	23.34	23.60	0.9	0.	0.9	0.33
	June 22	22.88	24.40	5.4	0	5.4	1.97
	July 22	23.65	24.70	4.2	0	4.2	1.53
	Aug. 10	24.20	24.85	3.0	0	3.0	1.10
	Sept. 9–10	23.80	24.24	1.4	0	1.4	.51
	Total			14.9	0	14.9	5.4
1948	June 20–23	21.92	26.50	17.0	.8	17.8	6.50
	July 13–14	25.80	26.50	2.6	17.8	20.4	7.45
	Aug. 2	25.95	26.34	1.7	0	1.7	.62
	Sept. 19	24.62	26.50	8.1	1.7	9.8	3.60
	Total			29.4	20.3	49.7	18.2
1949	Apr. 13	24.10	24.48	1.5	0	1.5	.55
	May 22	23.38	23.60	.6	0	.6	.31
	June 4–9	23.25	26.50	13.9	.8	14.7	7.62
	July 9	25.65	26.08	2.2	0	2.2	1.14
	Aug. 9	24.95	26.04	5.1	0	5.1	2.64
	Sept. 2	25.18	25.30	.6	0	.6	.31
	Sept. 4	25.20	25.46	1.1	0	1.1	.57
	Oct. 8	24.13	24.90	2.9	0	2.9	1.52
	Total			27.9	.8	28.7	14.7
1950	May 19	23.42	23.96	1.6	0	1.6	.83
	June 14	23.12	23.66	1.0	0	1.0	.52
	Sept. 20–21	(2)	23.70	2.8	0	2.8	1.45
	Oct. 1	23.60	24.02	1.4	0	1.4	.72
	Total			6.8	0	6.8	3.5
1951	(1)						
1952	(1)						
1953	(1)						
1954	May 1–3	(2)	20.60	.2	0	0.2	0.10
	June 16	(2)	20.55	.2	0	.2	.10
	Total			.4	0	.4	.2

[1] No inflow.
[2] Reservoir was dry.

TABLE 2.—*Runoff of Graham Draw for the summer seasons, 1947–54*—Continued

West Fork reservoir

Location.—Lat 43°10′50″, long 107°43′30″, in NW¼ sec. 14, T. 37 N., R. 91 W., near Moneta, Wyo.

Drainage area.—0.38 square mile (243 acres).

Records available.—April to October 1947–54.

Gage.—Staff gage, crest stages observed, gage read once weekly or after storms. Altitude of gage is 5,515 feet (from topographic map).

Remarks.—Records good except those for spill and estimated inflow which are poor. Capacity (1954) 2.6 acre-feet at spillway level; maximum depth 7.1 feet.

Storm runoff in West Fork reservoir

Year	Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
		Before inflow	After inflow				
1947	May 27	(1)	(1)	0.7	0	0.7	1.84
	June 22	(1)	(1)	.4	0	.4	1.05
	July 22		(1)	.3	0	.3	.79
	Aug. 10		(1)	.3	0	.3	.79
	Total			1.7	0	1.7	4.47
1948	June 20–23	(2)	10.75	1.3	0	1.3	3.42
	July 13–14	9.0	13.1	2.6	(3) .5	3.1	8.16
	Sept. 19	8.2	9.4	.3	0	.3	.79
	Total			4.2	.5	4.7	12.4
1949	June 4–9	(2)	11.0	1.46	0	1.46	3.84
	Aug. 9	6.6	9.9	.80	0	.80	2.11
	Oct. 8	6.9	8.75	.35	0	.35	.92
	Total			2.61	0	2.61	6.87
1950	Sept. 20–21	(2)	8.30	.22	0	.22	.58
1951	(4)						
1952	(4)						
1953	(4)						
1954	June 26	(2)	7.20	.07	0	.07	.18
	Total			.07	0	.07	.18

1 No gage installation; inflow estimated.
2 Reservoir was dry.
3 Spill spread from spillway; did not reach Graham Reservoir.
4 No inflow.

East Fork reservoir

Location.—Lat 43°11′07″, long 107°42′15″, in SE¼ sec. 12, T. 37 N., R. 91 W., near Moneta, Wyo.

Drainage area.—0.81 square mile (518 acres).

Records available.—April to October 1949–54.

Gage.—Staff gage, crest stages observed, gage read once weekly or after storms. Altitude of gage is 5,550 feet (from topographic map).

Remarks.—Records good. Capacity (1954) 11.1 acre-feet at spillway level; maximum depth, 10.0 feet.

TABLE 2.—*Runoff of Graham Draw for the summer seasons, 1947–54*—Continued

East Fork reservoir—Continued

Storm runoff in East Fork reservoir

Year	Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
		Before inflow	After inflow				
1949	June 4–9	0	26.60	7.55	0	7.55	9.32
	July 9	23.65	26.43	3.85	0	3.85	4.76
	Aug. 9	23.18	25.80	3.25	0	3.25	4.01
	Oct. 8	19.70	23.10	2.30	0	2.30	2.84
	Total			16.95	0	16.95	20.9
1950	Sept. 20–21	18.38	21.96	1.1	0	1.1	1.36
	Oct. 1	21.00	21.96	.6	0	.6	.74
	Total			1.7	0	1.7	2.1
1951	(1)						
1952	(1)						
1953	(1)						
1954	June 26	(2)	19.40	.15	0	.15	.19
	Total			.15	0	.15	.19

[1] No inflow.
[2] Reservoir was dry.

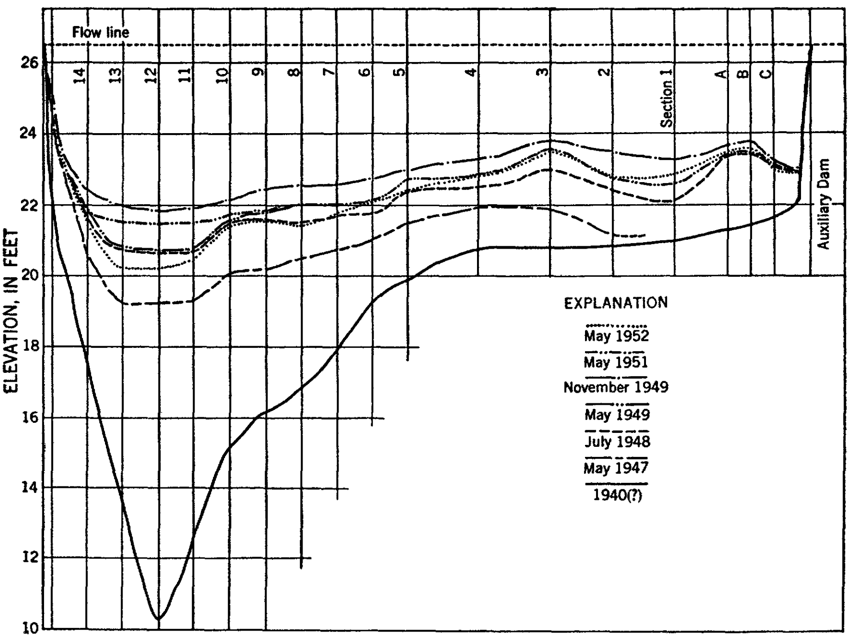

FIGURE 3.—Profile section of Graham Reservoir showing sediment deposition and subsequent compaction.

TABLE 3.—*Sediment deposited in Graham Draw basin, 1940–54*

[Units in acre-feet except as noted]

	Period							Total	
	1940 to May 1947	May 1947 to July 1948	July 1948 to Nov. 1949	Nov. 1949 to Sept. 1950	Sept. 1950 to May 1951	May 1951 to May 1952	May 1952 to Oct. 1954	Nov. 1949 to Oct. 1954	1940 to to Oct. 1954
Compaction	(1)	No	No	Yes	(1)	(2)	Yes	Yes	(1)
Deposit in Graham Reservoir	5.8	2.9	3.1	[2] −1.3	0.5	[2] −1.4	[2] −0.3	[2] −2.5	9.3
Deposit in desilting basin of Graham Reservoir	11.8	3.5	5.1	0	0	0	0	0	20.4
Deposit by overflow from Graham Reservoir		.5	.5	0	0	0	0	0	1.0
Total sediment accumulation at lower end of basin	17.6	6.9	8.7	−1.3	0.5	−1.4	−.3	−2.5	30.7
Deposit in West Fork reservoir		.3	.2	0	0	0	.3	.3	.8
Deposit in East Fork reservoir			.6	0	0	0	.6	.6	1.2
Total sediment in all deposits	17.6	7.2	9.5	−1.3	.5	−1.4	.6	−1.6	32.7
Unit sediment yield of drainage basin (3.12 square miles) per square mile	5.6	2.3	3.1	−.4	.2	−.4	.2	−.5	10.5
Annual unit sediment yield per square mile	.8	1.4	2.3			−.4	.1	−.1	.8

[1] Alternate deposition and compaction during period.
[2] No deposition during period. Figures represent volume decrease in sediment due to compaction.

A. CENTRAL AREA OF GRAHAM DRAW BASIN

View is northward across the 300-foot line transect along which vegetation counts are made by representatives of the Bureau of Land Management.

B. GULLY OF E-K CREEK AT UPPER END OF OBSERVATION POINT

The small tributary entering the main channel near the center of the photograph heads on the barren cliffs of Chugwater formation in the background.

STORAGE RESERVOIR IN COAL DRAW, A HEADWATER TRIBUTARY OF FIVEMILE CREEK

COMPACTION OF SEDIMENT IN THE RESERVOIR

The decrease in volume of the sediment deposit between the observations of November 1949 and October 1954 amounted to 21 percent of the volume in 1949. During most of this period, the reservoir was dry. As indicated by plate 4*A* the compaction was not uniform but differed considerably from place to place. Furthermore, although the compaction was greatest generally where the deposit was thickest, it was not necessarily proportional to the thickness. For example, near the dam where the thickness was 9 feet or more, the compaction amounted to about 15 percent; whereas, near the spillway where the thickness averaged only about 3 feet, the compaction ranged from 22 to 33 percent. The greater compaction presumably was due to the concentration of fine-grained sediment in the spillway area. In contrast, the deposit at the head of the reservoir, where the thickness was about equal to that near the spillway but where coarse-grained material predominated, showed compaction of only 7 to 13 percent.

VEGETATION OBSERVATIONS

To obtain an approximate representation of the vegetative cover on the basin, a vegetation count was made in 1947 by N. A. Smith, range examiner, Bureau of Land Management, along a monumented line transect, 300 feet long, adjacent to the north line of sec. 14, T. 37 N., R. 91 W. (see pl. 2). The original count consisted of an observation continuously along the 300-foot line of the number and type of individual plants, the basal area of individual plants or clumps, and the plant height. However, in order to obtain a sample of wider distribution, a system of 14 sets of 4 quadrats, 1-foot square (see pl. 2 and fig. 4), was established in 1949. Original observations made

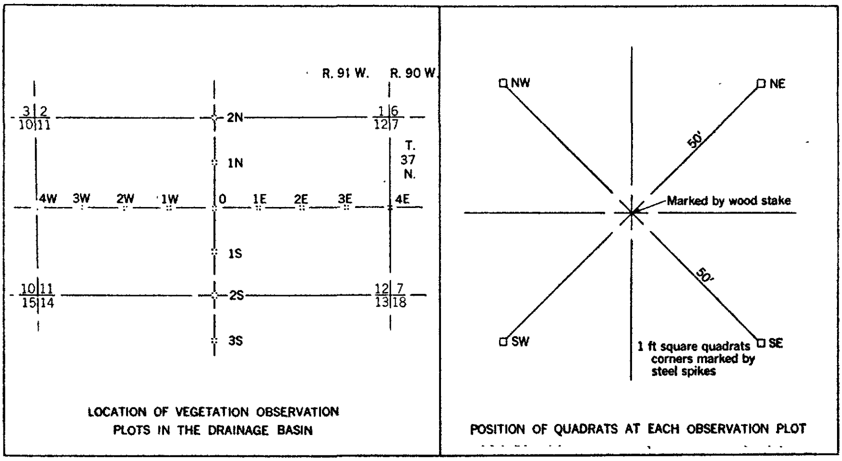

FIGURE 4.—Diagram showing system of vegetation observations in Graham Draw basin.

at these sample points July 7–8, 1949, by W. Townsend, range examiner, Bureau of Land Management, consisted of an estimate of the percentage of ground cover and a precise count and classification of the individual plants in each quadrat.

On October 20, 1954, after 5 years of apparently subnormal rainfall (see table 1) the quadrats were reexamined by R. D. Burr, range conservationist, Bureau of Land Management. It was found that the quadrat method of observation initiated in 1949 had not provided as complete a representation as desired because of the lack of information on consolidation of mature plants. The transect method of observation probably would provide a more realistic representation, at least for the changes in the immediate vicinity of the transect. However, after the examinations of the quadrats were made, time was not available for reexamination of the transect. On the basis of the examinations made in 1954, Mr. Burr summarized his tentative conclusions as follows:

> Assuming our finds will be validated by the transect, the picture of Graham Draw would be a cheerful one. The number of plants of poorer species, particularly blue grama, has materially decreased. On the other hand needle-and-thread grass has increased on many plots, thickspike wheatgrass likewise is found in greater abundance. Certain shrubs have decreased in ground cover while brown sage, a strong favorite of sheep, has increased in number of individuals. Thus the range would be changing into a higher percentage of climax plants.

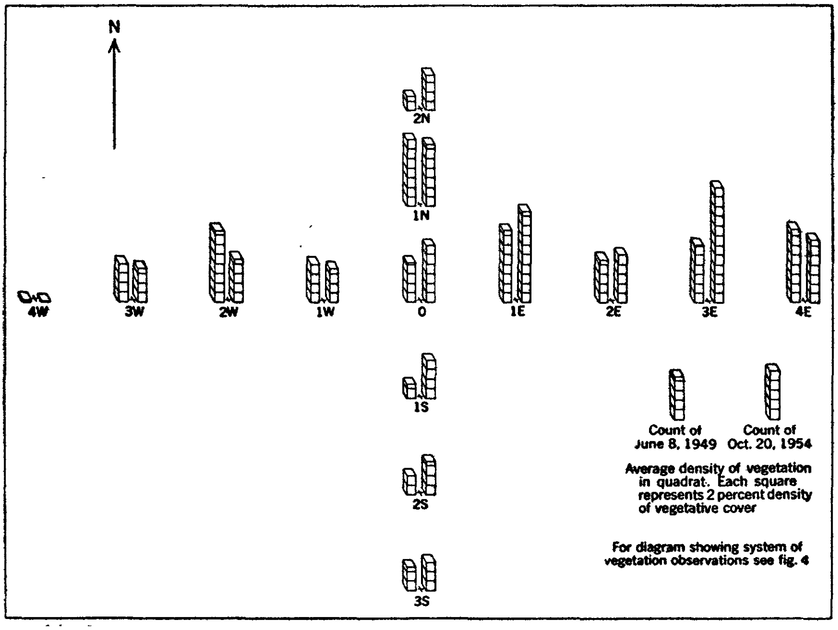

FIGURE 5.—Diagram of vegetation observations in Graham Draw basin showing changes in vegetation density during the 5-year period, 1949–54.

The north-south axis shows a slight gain in density on all plots [see fig. 5]. This would be logical as the soil is light and calculated to react well in a droughty period along the entire line.

The east-west axis likewise shows the influence of favorable soils in droughty periods. The west side, which inclines to the shale and heavier soils has a general decrease in density of the plant cover. The east end, which is characterized by a greater abundance of lighter soils, exhibits an increase in density usually coupled with an increase in individuals higher in position on the scale of plant succession.

MAHONEY DRAW

DESCRIPTION OF THE AREA

To obtain an index of erosion for the more stable upland areas in the southeastern part of the Wind River basin, measurements of runoff and sediment yields to Mahoney Reservoir, which lies about 16 miles south of the settlement of Moneta (see pl. 1) were begun in 1951. The drainage of Mahoney Draw basin, a tributary of Muskrat Creek, differs from the Graham Draw area in having a gently rolling relatively undissected terrain with practically no barren escarpments. A central channel, ranging from 5 to 8 feet wide and 3 to 4 feet deep, extends about 2 miles upstream from the reservoir. For at least three-fourths of its length, this channel has sloping banks and appears to be stabilized. Field observations made in 1951 show that of the 122 miles of channels in the basin 98 percent was stabilized, and about 97 percent had grassed bottoms and sides. The average land slope in the basin is less than 5 percent, and 80 percent of the basin has slopes less than 7 percent.

The drainage basin is underlain by the Mesaverde, Lance, and Fort Union formations, which consist of interbedded shale, siltstone, and sandstone beds, and for the purpose of this study can be considered together as a single lithologic unit. Soils have not developed a recognizable structure or profile, but they are somewhat lighter and more permeable than the soils in the Graham Draw area. As a whole the basin is fairly well vegetated and appears to have moderately low runoff.

In 1951, at the time of the initial reservoir survey, the contributary area was 13.4 square miles. In the spring of 1952, an upstream reservoir was constructed so that the area directly contributing to Mahoney Reservoir was reduced to 9.82 square miles. As the entire area is very uniform in character, this modification should have little effect on the unit sediment yield.

RESULTS OF STUDIES TO 1954

At the time of the initial survey in 1951 the sediment deposit in the reservoir was probed and the volume computed. The average annual amount of sediment from the basin for the period of reservoir operation (1941–51) was about 0.04 acre-foot per square mile.

	Reservoir capacity (acre-feet)
Fall 1941	143.7
June 1951	138.4
October 1954	137.1

Between 1951 and 1954 no summer storms occurred in the basin (see table 4), and runoff occurred only as the result of spring snowmelt. Sediment deposition during the period 1951–54 was negligible with the result that the average annual sediment yield for the period 1941–54 was only 0.03 acre-foot per square mile.

TABLE 4.—*Runoff of Mahoney Draw for the summer seasons, 1952–54*

Mahoney storage reservoir

Location.—Lat 42°55′, long 107°44′, in W½ sec. 15, T. 34 N., R. 91 W., about 16 miles south of Moneta, Wyo.

Drainage area.—9.82 square miles (6,290 acres) excluding area above reservoir upstream.

Records available.—April to October 1952–54.

Gage.—Reference mark. Measurements made to water surface weekly or after storms. Altitude of reference mark is 5,800 feet (from topographic map).

Remarks.—Records good. Capacity (1954) 136 acre-feet at spillway level; maximum depth, 18.4 feet.

Runoff from spring snowmelt in Mahoney reservoir

Year	Month	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
		Before inflow	After inflow				
1952	April	82.10	85.25	1.5	0	1.5	0.15
1953	do	81.80	84.90	1.3	0	1.3	.13
1954	do	81.95	86.0	2.4	0	2.4	.24

SIGNOR DRAW

DESCRIPTION OF THE AREA

The study of Signor Draw is similar in scope to that of Mahoney Draw. Runoff and sediment from a drainage basin of 7.15 square miles located about 22 miles southwest of Moneta (see pl. 1) are measured in a small reservoir for watering stock on Signor Draw. Signor Draw is a tributary of Conant Creek, which in turn discharges into Muskrat Creek.

As a whole, the drainage basin is not unlike that of Mahoney Draw except that the southern part drains the steep north face of Beaver Rim. The average land slope is less than 7 percent, and about 90 percent of the 62 miles of channels in the basin is stabilized with grassed bottoms and sides.

Although the drainage basin is underlain by formations that range from Late Cretaceous through Oligocene in age and include shales, sandstone, and siltstone beds, the effect of the different kinds of bedrock is largely obscured by a generally well developed permeable soil mantle that supports a good vegetative cover. The basin appears, therefore, to have moderately low runoff during storms.

RESULTS OF STUDIES TO 1954

At the time of the initial survey in 1951 the sediment deposit in the reservoir was probed and the volume computed. The average annual sediment yield from the basin for the period of reservoir operation, 1946–51, was 0.04 acre-foot per square mile.

	Reservoir capacity (acre-feet)
August 1946	11. 3
May 1951	9. 8
October 1954	9. 8

Between 1951 and 1954 there was very little runoff in the basin other than that occurring in response to spring snowmelt along Beaver Rim (see table 5). Sediment deposition was negligible thereby reducing the average annual sediment yield for the period 1946–54 to 0.03 acre feet per square mile or about the same as that determined for Mahoney Draw.

TABLE 5.—*Runoff of Signor Draw for the summer seasons, 1952–54*

Signor storage reservoir

Location.—Lat 42°52′, long 107°54′, in NW ¼ sec. 6, T. 33 N., R. 92 W., about 22 miles southwest of Moneta, Wyo.

Drainage area.—7.15 square miles (4,580 acres).

Records available.—April to October 1952–54.

Gage.—Reference mark. Measurements to water surface made weekly or after storms. Altitude of reference mark is 5,930 feet (from topographic map).

Remarks.—Records good. Capacity (1954) 9.83 acre-feet at spillway level; maximum depth, 7.8 feet.

Storm runoff in Signor Reservoir

Year	Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
		Before inflow	After inflow				
1952	(1)						
1953	April [2]	(3)	98. 6	9. 3	0	9. 3	0. 97
1954	April [2]	(3)	96. 3	4. 32	0	4. 32	. 45
	May 30	94. 97	95. 17	. 28	0	. 28	. 03
	June 26	93. 98	94. 30	. 34	0	. 34	. 04
	Total			4. 94	0	4. 94	. 52

[1] No inflow.
[2] Runoff from spring snowmelt during the month.
[3] Reservoir was dry.

MISCELLANEOUS OBSERVATIONS OF GULLYING

Measurements of runoff and sediment in small stock-water reservoirs afford a practical means of correlating rates of upland erosion and sources of sediment with causative and influencing factors in a large part of the upland, but such measurements do not provide an index of the most severe erosion because there are no reservoirs in areas where such erosion occurs. Therefore to obtain information on the progress and the conditions under which the most active erosion takes place, two sample areas in the Wind River basin were selected for observation. Progress of erosion was measured by repeat surveys at appropriate time intervals. Description of the areas and the results of the measurements follow.

E-K CREEK

The E–K Creek observation plot lies about 5 miles north of Arminto near the eastern margin of the Wind River basin (see pl. 1) in NE¼ sec. 13, T. 38 N., R. 87 W., and NW¼ sec. 18, T. 38 N., R. 86 W. In this reach, the valley of E–K Creek is an alluvial flat about half a mile wide bordered by outcrops of the Chugwater formation. The valley fill, which has been derived almost entirely from the siltstone and fine-grained sandstone beds of the Chugwater formation, is typically fine grained and appears to be highly erodible. It is deeply trenched by the main channel of E–K Creek (see pl. 4*B*). Tributary channels crossing the flat and entering the main channel are characteristically narrow with steep banks and an intricate and fretted outline. In their upper reaches they terminate abruptly in vertical headcuts 4 to 17 feet deep and 5 to 40 feet wide. The general aspect of the flat gives the impression that dissection is very active although little definite information could be obtained as to the earlier history of the erosion.

The original survey of the observation plot was made in August 1946. At that same time 3 gully cross sections were established on the main channel at points 3.5, 3.75, and 4.8 miles respectively downstream from the observation plot.

BONNEVILLE

To obtain an index of gully erosion in the Wind River formation and associated colluvial slopes another area was selected for study about 3½ miles east of Bonneville (see pl. 1) in the N½ sec. 16, T. 38 N., R. 93 W. The observation plot lies on the north-facing slope of the low east-west ridge that separates the drainages of Badwater and Poison Creeks and is underlain by a wedge of alluvium and colluvium that thins southward upslope. Derived from weathering of the mudstone, siltstone, and fine-grained sandstone beds of the underlying

Wind River formation, this unconsolidated material is typically fine grained and is dissected to a considerable extent by gullies that terminate upslope in a series of headcuts 3 to 25 feet wide and 3 to 10 feet deep.

As in the E–K Creek area, the appearance of the plot gives the impression of rapid dissection, but again little information could be obtained about its earlier erosional history.

Resurveys of both the E–K Creek and Bonneville plots in August 1954 show only minor differences, which are believed attributable mostly to omissions in the detail of the original surveys; therefore, there has been very little erosion in either of these gullied areas since 1946. Although stability is evident in some places, the plots generally maintain the appearance of recent and active erosion. The observations are significant in that they show the unreliability of inspection as an index to erosion rates.

LOGAN DRAW

DESCRIPTION OF THE PROJECT AND AREA

In 1951 the drainage basin of Logan Draw, a tributary of Conant Creek (see pl. 1) was selected by the Bureau of Land Management as a pilot area for conservation practices on the public domain located in the southeastern part of the Wind River basin. The project was planned for both off-site and on-site benefits, of which the retardation of gully erosion and utilization of water for increasing forage were the main elements. The planned measures included several relatively large retarding reservoirs and range water spreaders for diverting and spreading water.

The drainage basin of Logan Draw, lies immediately west of Signor Draw; it is of rectangular shape, about 17 miles long, 3 to 5 miles wide, and covers an area of 58.8 square miles. The basin is part of a dissected pediment that slopes northward from the steep face of the Beaver Rim. By entrenchment in this pediment, Logan Draw has developed a relatively simple drainage pattern even though the underlying geologic structure is complex. Thus, northward-dipping rock beds are crossed at nearly right angles by the main stem of Logan Draw and the major tributaries, forming a number of desirable reservoir sites whose existence influenced the selection of this basin as a pilot area.

Formations ranging from Cambrian to Late Cretaceous in age and including quartzite, limestone, sandstone, and shale crop out in a crescent-shaped pattern around the base of Rock Creek Mountain, which forms the drainage divide on the southwest. North and eastward from the base of the mountain, the dip of the rock beds decreases abruptly from nearly vertical at the mountain face to less than 10 degrees just south of the East Logan Reservoir (see fig. 6). Northward from this area the basin is underlain by Upper Cretaceous and younger rocks whose dips flatten progressively northward and become nearly horizontal along an east-west synclinal axis across the basin just north of East Logan Reservoir. North of this syncline, along the eastern margin of the basin, formations are locally folded and faulted, but deformation in the northern third of the basin is of little erosional significance. Rocks younger than Cody shale or those strata underlying basins 1–5 (fig. 6) include the Mesaverde, Lance, Fort Union, and Wind River formations that consist for the most part of interbedded sandstone and shale and may be considered a single lithologic unit with similar erosional and runoff characteristics.

PROCEDURE

The 6 retarding reservoirs providing a minimum storage of 1,500 acre-feet and 6 range water spreaders covering an area of approximately 500 acres (see fig. 6) for water-control for the Logan Draw project were completed by the Bureau of Land Management in 1953, and a study of the project was initiated by the Geological Survey. The project offered a valuable opportunity to measure total runoff and sediment yield from a drainage basin of more then 50 square miles. Moreover, observation of the performance of reservoirs, of diversions to range water spreaders, and of the water spreaders themselves would provide the best information obtainable for testing design estimates and for modifying and improving future designs.

The entire basin of Logan Draw has been mapped to show the average land slopes and erosional characteristics of all drainage channels. The results of this study are summarized in table 6 and the erosion characteristics in the upper basin are shown in pl. 5. A network of precipitation gages was established, which includes 3 recording and 2 storage gages. Runoff into Rongis Reservoir is determined on the basis of weekly observations (table 7), and discharge from the reservoir to the water spreader is measured by a canal-gaging station (fig. 6 and table 8). However, in the event of a flood the flow can be diverted back into the main channel, thereby protecting the range water spreader from excessive damage. This diverted flow can be estimated from the records of reservoir contents before and after diversion. Sediment-measurement cross sections have been established for the location of measurements to be made at appropriate intervals.

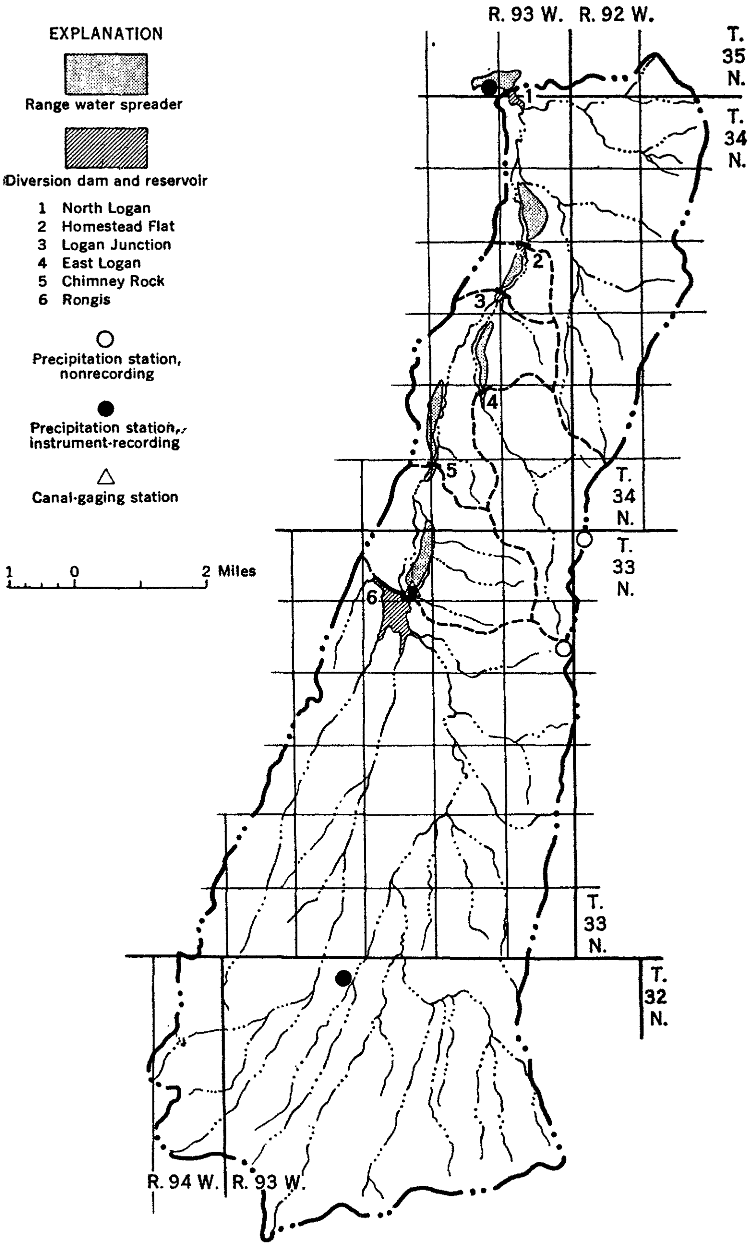

FIGURE 6.—Map of Logan Draw basin showing reservoir sites.

TABLE 6.—*Drainage basin and erosional characteristics of Logan Draw subbasins*

Reservoir drainage basin		Topography							Headcuts		
		Percent of area in range of slope indicated in percent and average distance between channels by groups [1]							Number contributing directly to reservoir	Total number in drainage basin	Number per square mile
No.	Name	0-3	3-5	5-7	7-10	10-20	20-30	30			
1	North Logan	21-5	32-3	21-2	12-1	10-1	1-1	3-1	10	51	5.0
2	Homestead Flat	21-6	23-2	24-1	19-1	4-1	9-1	0	6	14	14.9
3	Logan Junction	30-4	19-2	24-1	13-1	13-1	1-1	0	6	16	5.0
4	East Logan	8-4	35-3	15-2	18-1	17-1	6-1	1-1	25	55	14.9
5	Chimney Rock	51-5	30-3	8-2	1-1	7-1	3-1	0	0	5	1.4
6	Rongis	7-6	7-4	23-2	16-1	16-1	24-1	7-1	24	199	5.4

Reservoir drainage basin		All channels		Grassed channels		Raw channels			
No.	Name	Total length (miles)	Miles per square mile	Total length (miles)	Miles per square mile	Total length (miles)	Miles per square mile	Contributing directly to reservoir (miles)	Miles per square mile
1	North Logan	115.9	11.3	104.1	10.2	11.8	1.2	4.3	0.4
2	Homestead Flat	9.5	10.1	9.4	10.0	.1	.1	0	0
3	Logan Junction	26.1	8.1	22.6	7.0	3.5	1.1	1.3	.4
4	East Logan	48.6	13.1	44.3	12.0	4.3	1.2	1.7	.5
5	Chimney Rock	23.3	6.7	20.8	5.9	2.5	.7	2.5	.7
6	Rongis	256.2	6.9	224.4	6.1	31.8	.9	5.6	.2

Reservoir drainage basin		Basin characteristics						Reservoir characteristics		
					Infiltration			Original capacity		
No.	Name	Area in square miles	Ratio, max. length to maximum width	Vegetative cover	Medium (percent of area)	Low (percent of area)	Very low (percent of area)	Acre-feet	Year of survey	Acre-feet per square mile
1	North Logan	10.25	0.54	Medium	53	33	14	(2)		
2	Homestead Flat	.94	1.43	Medium	43	44	13	(2)		
3	Logan Junction	3.43	.52	Medium	49	37	14	170.0	1956	49.6
4	East Logan	3.70	.46	Medium	43	33	24	16.3	1956	4.41
5	Chimney Rock	3.50	1.33	Medium	81	9	10	65.5	1955	18.7
6	Rongis	37.00	.57	Low	14	39	47	1,012	1952	27.4

[1] Figure preceding hyphen is percent of area with a slope in the range indicated; figure following hyphen is designation of separation of drainage channels by groups as follows:
[2] Surveys to be completed during summer 1957.

Group	*Distance between channels (feet)*
1	>100
2	100–200
3	200–300
4	300–400
5	400–500
6	500–600

RESULTS OF STUDIES, 1952–54

The results of the study from 1952–54 are inconclusive as the only significant runoff (table 7) occurred in response to spring snowmelt. Sediment movement into Rongis Reservoir was negligible, and therefore, no attempt is made at this time to correlate runoff or sediment yield with the precipitation pattern or characteristics of the drainage basin.

Observations on Rongis Reservoir during the first year show that there was considerable seepage under the structure through the old buried sand-filled channel, upon which the dam was built. In 1954 water from spring snowmelt was held in the reservoir to provide late irrigation on the downstream range water spreader (fig. 12). It was observed, however, that 1 to 2 acre-feet of water per day was being lost to underflow and of the 83.6 acre-feet stored in the reservoir (table 7) only 29.4 acre-feet was eventually released to the water spreader (table 8). Thus almost 65 percent of the stored water was lost to evaporation and seepage.

TABLE 7.—*Runoff of Logan Draw for the summer season, 1954*

Rongis retarding reservoir

Location.—Lat 42°51′, long 107°58′, in S½ sec. 3 and N½ sec. 10, T. 33 N., R. 93 W., about 24 miles southwest of Moneta, Wyo.

Drainage area.—37.0 square miles (23,600 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements made to water surface weekly or after storms. Altitude of reference mark is 5,730 feet (from topographic map).

Remarks.—Record good. Capacity (1952) 1,012 acre-feet at spillway level; maximum depth, 29.7 feet.

Storm runoff in Rongis Reservoir for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
April	61.05	65.84	32.0	0	[1] 32.0	0.87
May 1-4	65.11	67.40	26.1	0	[1] 26.1	.71
May 10	67.10	68.22	15.7	0	[1] 15.7	.42
June 26	65.90	66.35	5.0	0	5.0	.14
July 19	63.35	63.84	3.3	0	3.3	.09
August 3	63.05	63.29	1.5	0	1.5	.04
Total			83.6	0	83.6	2.27

[1] Runoff from spring snowmelt.

TABLE 8.—*Runoff of Rongis Canal*

Location.—Lat 42°51′, long 107°58′, in SE¼ sec. 3, T. 33 N., R. 93 W., about 0.1 mile north of Rongis Reservoir on the canal between the reservoir and the waterspreader.

Drainage area.—37.0 square miles above Rongis Reservoir.

Records available.—July to October 1953; May to October 1954.

Gage.—Water-stage recorder.

Remarks.—Records good. Direct flow into canal regulated by gate outlet works on Rongis Reservoir; capacity 1,012 acre-feet. Canal headworks modified (November 1955) from simple concrete stilling basin to gated headworks with drop structure for diverting excess flow back into main channel below reservoir. Canal flow rated at appropriate intervals by current-meter measurements. Records not affected by diversion out of canal.

Runoff released from reservoir in 1954

[S, day subdivided for computation of discharge]

Date	Gage height (feet)	Discharge	
		Cubic feet per second	Acre-feet
Apr. 14	S	0.233	0.46
15	S	.100	.20
16	S	.133	.26
17	S	.067	.13
18	S	.284	.56
19	S	2.295	4.56
May 10	S	.475	.94
11	S	.167	.33
June 10	S	.200	.40
26	S	.708	1.41
27	S	.133	.26
July 22	S	2.210	4.38
23	1.52	5.240	10.39
24	1.38	1.950	3.87
25	S	.030	.06
Aug. 3	S	.400	.79
6	S	.200	.40
Seasonal total			29.40

LOWER FRASER DRAW

DESCRIPTION OF THE AREA

Studies were begun on the Lower Fraser Draw range water spreader in the summer of 1952 when it was observed that a very good flooding had occurred on this project as a result of a rain of about 2.75 inches. Fraser Draw, a tributary of Muskrat Creek, lies about 16 miles south of Moneta (see pl. 1). Of all tributary drainage basins in the Wind River basin it probably offers the most desirable conditions for spreading water. In its lower reaches the main channel borders the southern margin of its valley and is incised about 12 feet below the level of the old flood plain. North of the channel the undissected flood plain averages 500 to 1,000 feet in width, all underlain by medium-textured soils that respond favorably to spreading water.

The present system consists of two water spreaders. The runoff of Fraser Draw above the mouth of Willow Springs Draw is diverted by an upper reservoir to the larger of the two units. Owing to the difficulty of measuring runoff from side slopes and small tributaries that enter the spreader dikes from the north, no attempt has been made to study this part of the system. The lower unit, however, receives practically all of its flow from Willow Springs Draw with direct diversion to the spreader dikes through the spillway of Lower Fraser Reservoir.

The drainage basin above the lower reservoir has an area of 27.45 square miles. A reconnaissance of the basin showed 12 small upstream reservoirs with a total capacity of about 40 acre-feet. The basin is not severely gullied, and the average land slope is estimated to be less than 7 percent. From the size and condition of the main channel, the basin appears to have low runoff. Average annual sediment yield will probably be small and should not exceed 0.3 acre-foot per square mile.

PROCEDURE

The observational network consists of two recording precipitation gages (see pl. 1) and a water-stage gage recorder on the diversion reservoir (see p. 27) that measures flow onto the range water spreader. Reservoir stages below 98.0 feet were determined by weekly measurements. Sediment deposited in the reservoir will be measured at appropriate intervals.

RESULTS OF STUDIES, 1952-54

Results of the studies have been generally inconclusive. With the exception of one run in 1952, the water spreader has received no flow. Moreover, considering the size of the contributing area (27.45 square miles) and the fact that it would take about 130 acre-feet of runoff to fill the reservoirs before any flow could reach the water spreader, it is unlikely that flooding will be frequent or adequate. Nonetheless it is encouraging to note that the increased forage from the one flood irrigation 3 years ago has survived and affords a marked contrast to the unwatered areas.

Runoff of Fraser Draw for the summer season, 1953–54

Lower Fraser diversion reservoir

Location.—Lat 42°55′, long 107°42′, in NE¼ sec. 14, T. 34 N., R. 91 W., about 16 miles south of Moneta, Wyo.

Drainage area.—27.45 square miles (17,590 acres). Runoff partly controlled by 12 small upstream reservoirs having combined capacity of about 40 acre-feet.

Records available.—April to October 1953–54.

Gage.—Reference mark. Measurements to water surface made weekly or after storms. Recording stage gage (Stevens type A–35) measures reservoir stages above 98.0 feet and spill to water spreader. Altitude of reference mark is 5,805 feet (from topographic map).

Remarks.—Record good. Capacity (1954) 90.2 acre-feet at spillway level; maximum depth, 12.6 feet. Entire runoff of main stem of Fraser Draw diverted to upper water spreader immediately upstream from mouth of Willow Springs Draw. No storm runoff. Reservoir dry throughout period of record.

TREE PLANTINGS ALONG CARTER DRAW

DESCRIPTION OF THE PROJECT AND PROCEDURE

The Bureau of Land Management in 1949 and 1950 planted willow, cottonwood, and other cuttings along a typical reach of Carter Draw about 12 miles southeast of Riverton (see pl. 1) to test their effect on bank stabilization. In 1951 observations were begun on the entire reach by the Geological Survey. A planimetric map of the channel and plantings (fig. 7) was made that also shows 40 monumented channel cross sections located at points of most probable change.

These surveys showed that the average channel depth ranged from about 2 to 3 feet. The natural channel gradient including meanders was 0.71 percent or about 38 feet per mile. However, the gradient of the channel as restricted by the plantings was 0.78 percent or about 41 feet per mile. This increase in gradient raises a question as to whether the plantings have the effect of deepening the channel rather than inducing deposition.

RESULTS OF STUDIES, 1951–54

In August 1954 a resurvey of the cross sections revealed no measurable changes. Survival of the plantings was estimated at no more than 5 percent, and those remaining probably will have little effect on controlling flows. Although it may reasonably be concluded that tree plantings have a low survival rate owing mainly to the scarcity of moisture, the effect of plantings on channel stability is still undetermined.

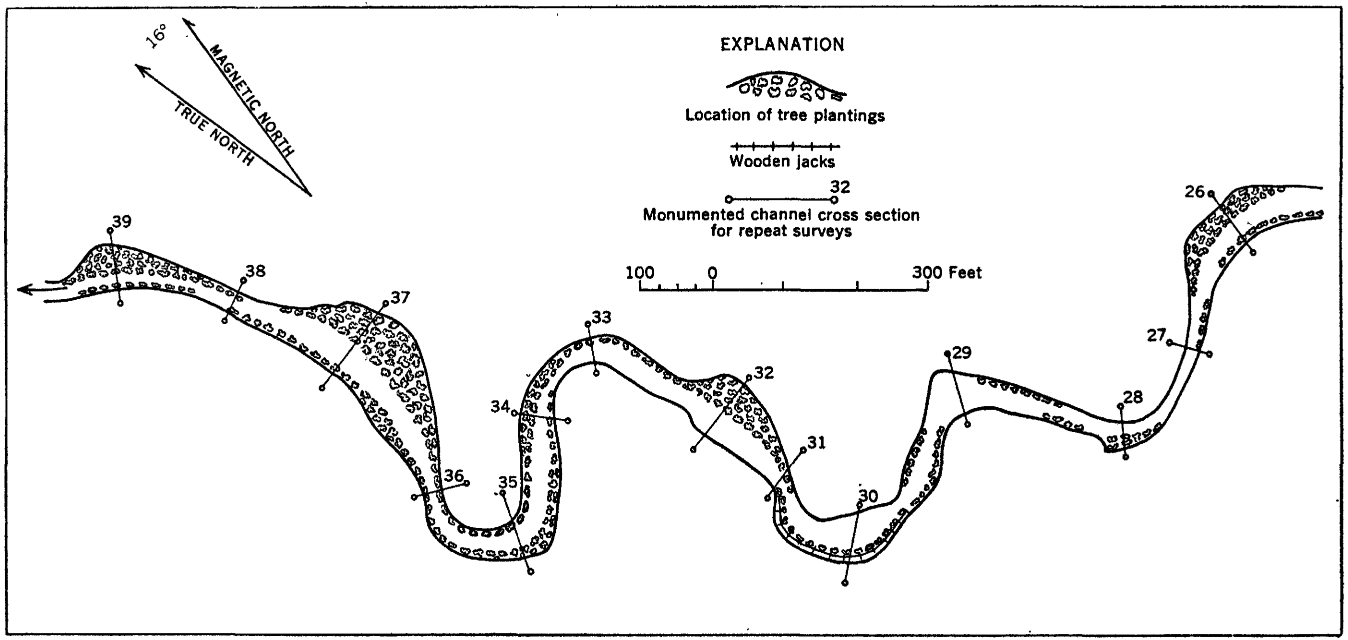

Figure 7.—Map of typical reach of Carter Draw showing tree plantings.

FIVEMILE CREEK

Erosion studies in the Fivemile Creek area in the northwestern part of the Wind River basin (fig. 1) are limited to that part of the basin upstream from the Wyoming Canal on the Wind River Indian Reservation. In this area the major emphasis of the soil and moisture projects of the Bureau of Indian Affairs has been placed on reducing and detaining flood runoff by means of storage and retarding reservoirs (see pl. 6). Owing to steep channel slopes, narrow valleys, and badland topography of much of the range lands there are few opportunities for range water spreading; and the use of water spreaders as a means of applying water on these lands has occupied a minor role in the program.

To evaluate the effectiveness of storage and retarding reservoirs as a means of flood and sediment control, two study areas were selected: Paintpot Draw, representing the areas of highest runoff; and Teapot Draw representing the areas of lowest runoff.

PAINTPOT DRAW

DESCRIPTION OF AREA

Paintpot Draw, one of the headwater tributaries of Fivemile Creek (see pl. 1), drains an area of 5.9 square miles that lies about 22 miles northwest of Pavillion. The drainage basin, although small, has an extremenly complex physiographic development, an understanding of which is helpful to interpret runoff or sediment data.

The basin is underlain by Upper Cretaceous rocks which have been severely folded and faulted to form a feature resembling a giant horseshoe. The open end is on the east and the remaining three sides are ringed by vertical sandstone beds of the Mesaverde formation. The relatively soft Cody shale, which occupied the central part of the structure, was largely removed by differential erosion. Over this eroded surface the younger Wind River formation was deposited. Later, presumably in Pleistocene time, an extensive gravel-capped terrace or pediment surface developed over this part of Wind River basin, extending basinward or southeastward from the Owl Creek and Absaroka Range. Although subsequent erosion destroyed most of this surface and again exposed the older rocks that enclose Paintpot Draw, several gravel-capped remnants are preserved within the margins of the small basin. Where protected by the gravel capping, the soft siltstone and mudstone beds of the Wind River formation are not easily eroded, but where the protective capping has been removed, a badland type of topography exists.

The basin at present, is bounded on the north, west, and south by interbedded sandstone and shale beds of the Mesaverde formation, which constitutes about 25 percent of the area. Pediment remnants

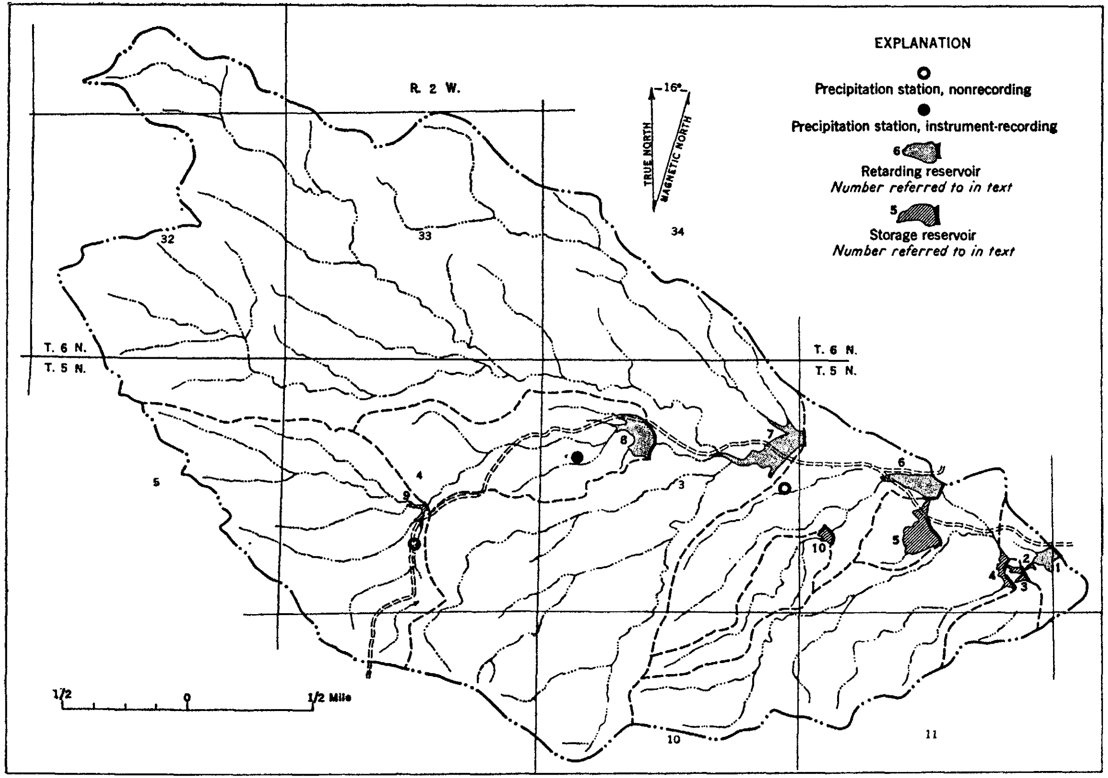

FIGURE 8.—Map of Paintpot Draw showing location of structures for flood and erosion control.

cover about 15 percent of the basin, and the Wind River formation, largely the badlands, occupies the remainder of the basin. Erosion has not yet exposed the underlying Cody shale. Bottomlands are almost nonexistent. The average land slope exceeds 20 percent, and the drainage density is so high that individual channels could not be mapped with the use of available areal photographs. From field observations it was estimated that the total length of channels would exceed 1,000 miles in the basin, whose area is 5.9 square miles. The vegetative cover is very poor except on the pediment remnants, and many of the steeper slopes are almost devoid of any cover. Despite a combination of drainage-basin characteristics that induces maximum runoff, rates of sediment yield may not be as high as in adjoining areas. Steep slopes, although barren of vegetation, are often protected by a veneer of gravel wash that blocks the rills and prevents rapid development of large channels. The larger channels in the basin occur predominantly in coarse gravels. Headcuts are rare. Most of the sediment, therefore, must be derived from sheet erosion associated with formation of badlands.

RESULTS OF STUDIES TO 1954

The flood and erosion control program in Paintpot Draw was completed in the fall of 1953 (see fig. 8 and table 9). Surveys were made of the reservoirs, and weekly observations of water levels in all reservoirs were made during the 1954 summer season (table 10). In addition 1 recording and 2 nonrecording precipitation gages were maintained.

TABLE 9.—*Relations of capacity to area for reservoirs in Paintpot Draw*

Reservoir No.[1]	Drainage area[2] (square miles)	Reservoir storage: When empty		Reservoir storage: Above level of outlet pipe		Diameter of outlet pipe (inches)	Cumulative upstream area[3] (square miles)	Cumulative reservoir storage: When empty		Cumulative reservoir storage: Above level of outlet pipe	
		Acre-feet	Acre-feet per square mile	Acre-feet	Acre-feet per square mile			Acre-feet	Acre-feet per square mile	Acre-feet	Acre-feet per square mile
9	0.640	8.79	13.75			None	0.640	8.79	13.75		
8	.364	45.36	124.61	38.56	105.91	9	1.004	54.15	53.93	38.56	38.41
7	3.57	116.5	32.6	113.3	31.7	18	4.574	170.65	37.31	151.86	33.20
10	.126	8.67	68.81			None	.126	8.67	68.81		
6[4]	.374	43.80	117.11	37.45	100.13	24	5.074	223.12	43.97	189.31	37.31
5	.069	36.25	525.36			None	5.143	259.37	50.43	189.31	36.81
4	.631	5.17	8.19			None	5.774	264.54	45.82	189.31	32.79
3	.065	.62	9.54			None	5.839	265.16	45.41	189.31	32.42
2[5]						None					
1	.067	26.71	398.65	24.43	364.63	18	5.906	291.87	49.42	213.74	36.19

[1] Arranged according to downstream succession.
[2] Below upstream reservoirs.
[3] Includes drainage basins of upstream reservoirs.
[4] Reservoir No. 6 spills into reservoir No. 5, but flow from outlet pipe enters reservoir No. 4 bypassing reservoir No. 5.
[5] Small sediment trap with drainage area cut off by construction of reservoir No. 3.

TABLE 10.—*Runoff of Paintpot Draw for the summer season, 1954*

Reservoir No. 1

Location.—Lat 43°26′, long 108°57′, in SE¼ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.067 square mile (43.2 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,250 feet (from topographic map).

Remarks.—Record good. Capacity (1954) 26.71 acre-feet at spillway level; maximum depth 8.8 feet. No storm runoff. Reservoir dry throughout period of observation.

Reservoir No. 3

Location.—Lat 43°26′, long 108°57′, in SE¼ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.065 square mile (41.3 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,260 feet (from topographic map).

Remarks.—Record good. Capacity (1951) 0.623 acre-feet at spillway level; maximum depth 3.1 feet.

Storm runoff in reservoir No. 3 for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
June 27	Dry	98.71	0.21	0	0.21	3.24
July 17	98.2	99.20	.35	0	.35	5.38
Total			.56	0	.56	8.62

Reservoir No. 4

Location.—Lat 43°26′, long 108°57′, in SE¼ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.631 square mile (404 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,265 feet (from topographic map).

Remarks.—Record good. Capacity (1951) 5.17 acre-feet at spillway level; maximum depth 8.9 feet.

Storm runoff in reservoir No. 4 for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
May 22	106.63	106.90	0.30	0	0.30	0.48
June 27	106.14	106.98	.35	0	.35	.56
July 17	106.48	108.37	[1] 2.57	0	2.57	3.43
Aug. 4	108.02	108.10	.12	0	.12	.19
Total			3.34	0	[1] 3.34	4.66

[1] Includes 0.4 acre-feet from outflow pipe in Reservoir No. 6.

TABLE 10.—*Runoff of Paintpot Draw for the summer season, 1954*—Continued

Reservoir No. 5

Location.—Lat 43°26'00", long 108°57'30", in S½ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.069 square mile (44.1 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,310 feet (from topographic map).

Remarks.—Record good. Capacity (1953) 36.25 acre-feet at spillway level; maximum depth 8.3 feet.

Storm runoff in reservoir No. 5 for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
May 10	92.81	92.99	0.10	0	0.10	1.45
May 22	92.75	93.02	.15	0	.15	2.17
May 30	92.85	93.00	.08	0	.08	1.16
June 27	92.75	92.93	.10	0	.10	1.45
July 17	92.75	93.02	.15	0	.15	2.17
Total			.58	0	.58	8.41

Reservoir No. 6

Location.—Lat 43°26'00", long 108°57'30", in NW¼ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.374 square mile (239 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,330 feet (from topographic map).

Remarks.—Record fair. Capacity (1953) 43.80 acre-feet at spillway level; maximum depth 14.0 feet.

Storm runoff in reservoir No. 6 for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
May 10	91.35	91.77	91.77	3.73	0.65	0	0	0.65	1.74
May 22	91.45	91.93	91.93	4.04	.80	0	0	.80	2.14
May 30	91.72	91.86	91.86	3.88	.18	0	0	.18	.48
June 27	91.12	91.70	91.70	3.60	.85	0	0	.85	2.27
July 17	91.07	93.85	93.80	8.63	[1] 5.52	[2] 0.4	0	5.92	13.9
Aug. 4	93.40	93.51	93.51	7.00	.23	0	0	.23	.62
Total								8.63	21.15

[1] Includes estimated 0.7 acre-feet outflow from pipe in reservoir No. 7.
[2] Estimated from high-water marks.

TABLE 10.—*Runoff of Paintpot Draw for the summer season, 1954*—Continued

Reservoir No. 7

Location.—Lat 43°26′, long 108°58′, in NE¼ sec. 3, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—3.57 square miles (2,285 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,380 feet (from topographic map).

Remarks.—Record fair. Capacity (1952) 116.5 acre-feet at spillway level; maximum depth 25.4 feet.

Storm runoff in reservoir No. 7 for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
May 10	83.21	83.79	83.79	3.3	0.8	0	0	0.6	0.17
May 22	83.58	83.68	83.68	3.2	.1	0	0	.1	.03
May 30	83.54	83.61	83.61	3.1	.1	0	0	.1	.03
June 27	83.22	83.77	83.77	3.3	.6	0	0	.6	.17
July 17	83.32	86.0	85.67	7.2	3.8	[1] 0.7	0	4.5	1.26
Total								5.90	1.65

[1] Estimated from high-water marks.

Reservoir No. 8

Location—Lat 43°26′, long 108°59′, in NW¼ sec. 3, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.

Drainage area.—0.364 square mile (233 acres).

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,430 feet (from topographic map).

Remarks.—Record good. Capacity (1952) 45.36 acre-feet at spillway level; maximum depth 12.2 feet.

Storm runoff in reservoir No. 8 for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
May 10	89.47	89.72	89.72	0.95	0.16	0	0	0.16	0.44
May 17	89.62	89.75	89.75	1.00	.10	0	0	.10	.27
June 27	89.03	89.28	89.28	.67	.17	0	0	.17	.47
July 17	88.67	89.07	89.07	.52	.22	0	0	.22	.60
Total								.65	1.78

TABLE 10.—*Runoff of Paintpot Draw for the summer season, 1954*—Continued

Reservoir No. 9

Location.—Lat 43°26′, long 109°00′, in SE¼ sec. 4, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.
Drainage area.—0.640 square mile (409 acres).
Records available.—April to October 1954.
Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,570 feet (from topographic map).
Remarks.—Record good. Capacity (1952) 8.79 acre-feet at spillway level; maximum depth 17.1 feet.

Storm runoff in reservoir No. 9 for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
May 10	Dry	85.67	0.07	0	0.07	0.11
June 27	Dry	85.50	.06	0	.06	.09
July 17	84.32	91.08	.80	0	.80	1.25
Total			.93	0	.93	1.45

Reservoir No. 10

Location.—Lat 43°26′, long 108°58′, in SW¼ sec. 2, T. 5 N., R. 2 W., near Maverick Spring oil field, Wyoming.
Drainage area.—0.126 square mile (80.9 acres).
Records available.—April to October 1954.
Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 6,370 feet (from topographic map).
Remarks.—Record good. Capacity (1954) 8.67 acre-feet at spillway level; maximum depth 6.4 feet.

Storm runoff in reservoir No. 10 for 1954

Month and day	Water-surface elevation (feet)		Inflow stored (acre-feet)	Spill (acre-feet)	Total inflow (acre-feet)	Inflow (acre-feet per square mile)
	Before inflow	After inflow				
June 27	Dry	94.06	0.06	0	0.06	0.48
July 17	93.74	94.43	.22	0	.22	1.75
Total			.28	0	.28	2.23

The results of the study to date are inconclusive. The total runoff, April to October 1954, was 20.89 acre-feet or an average of 3.54 acre-feet per square mile. Sediment deposition in the various reservoirs was insignificant and did not warrant repeat surveys. The maximum 24-hour rain of the season occurred on July 17 when 0.20 inch fell in 15 minutes. The total summer rainfall was 1.76 inches. From previous observations in this general area, both the rainfall and runoff for 1954 are believed to have been well below normal.

TEAPOT DRAW

DESCRIPTION OF THE AREA

Teapot Draw is a tributary of Fivemile Creek bordering Paintpot Draw on the south (see pl. 1). It has a drainage area of 27.3 square miles, physiographically divided into two nearly equal parts. The upper part of the basin—covering an area of 13.8 square miles lying west of the Maverick Spring road—has a rugged terrain generally similar to that of Paintpot Draw. Runoff from this part is stored in nine storage reservoirs or spread over a flat in the vicinity of the road. No studies have been made of this part of the basin.

The lower part of the basin, directly tributary to the Teapot Reservoir, has an area of 13.5 square miles. In this part, the average slope of the land is less than 5 percent, and a well-developed flood plain extends along the draw for the full length of the drainage area. Although the Teapot channel is intermittently gullied, aggradation is evident along most of the channel. Runoff and sediment yield from this part of the basin are expected to be low. The Teapot Reservoir has a total capacity at spillway level of 246 acre-feet of which 187 acre-feet is above the outlet tube.

RESULTS OF THE STUDY TO 1954

The reservoir was surveyed and a stage-capacity curve prepared; runoff was determined by weekly observations of reservoir stage (see table 11); precipitation was measured in two storage-type gages; and sediment deposition was determined by resurveys on monumented cross sections on the reservoir.

The results to date are inconclusive. During the 1954 season total precipitation of 3.50 inches produced a total runoff of 9.0 acre-feet or 0.67 acre-foot per square mile. The maximum 24-hour rainfall was 0.75 inch, which occurred on July 17. The sediment yield was negligible.

TABLE 11.—*Runoff of Teapot Draw for the summer season, 1954*

Lower Teapot retarding reservoir

Location.—Lat 43°21′, long 108°47′, in SW¼ sec. 32, T. 5 N., R. 1 E., about 10 miles northwest of Pavillion, Wyo.

Drainage area.—13.5 square miles (86,300 acres) uncontrolled.

Records available.—April to October 1954.

Gage.—Reference mark. Measurements to water surface made once weekly or after storms. Altitude of reference mark is 5,740 feet (from topographic map).

Remarks.—Record good. Capacity (1953) 246.2 acre-feet at spillway level; maximum depth 22.7 feet.

Storm runoff in lower Teapot Reservoir for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
May 10	Dry	80.70	80.70	0.4	0.4	0	0	0.4	0.03
June 27	79.28	81.55	81.55	1.2	1.1	0	0	1.1	.08
July 17	80.95	84.40	84.40	8.1	7.5	0	0	7.5	.56
Total								9.0	.67

OBSERVATIONS IN THE FIFTEEN MILE CREEK BASIN

In response to a request by the Bureau of Land Management, studies were begun in a part of Fifteen Mile Creek basin (see fig. 9) to provide hydrologic data that would aid in the design of an effective flood and sediment control program that is planned to eventually cover the entire basin. More specifically, studies were aimed at determining average annual rates of runoff and sediment yield, magnitude and frequency of runoff, the performance of retarding reservoirs as an effective means of flood control, and sediment trap efficiency of retarding reservoirs (sediment loss through drawdown pipes).

BIG GIN BASIN

DESCRIPTION OF THE AREA

Big Gin basin, located about 7 miles northwest of Worland (fig. 9), was selected for study for a number of reasons. The reservoir is the uppermost structure on a small drainage area of 0.942 square mile. This upstream position prevents the complications in making adjustments for the effects of upstream reservoirs. The basin is typical of a large part of the eastern half of the Fifteen Mile Creek basin. Moreover, the reservoir capacity of 99 acre-feet provides a storage of 105 acre-feet per square mile, which should be more than adequate to store the expected 50-year flood. All the sediment will be trapped except for the amount that occasionally will pass through the drawdown pipe. An additional consideration in selecting the reservoir for

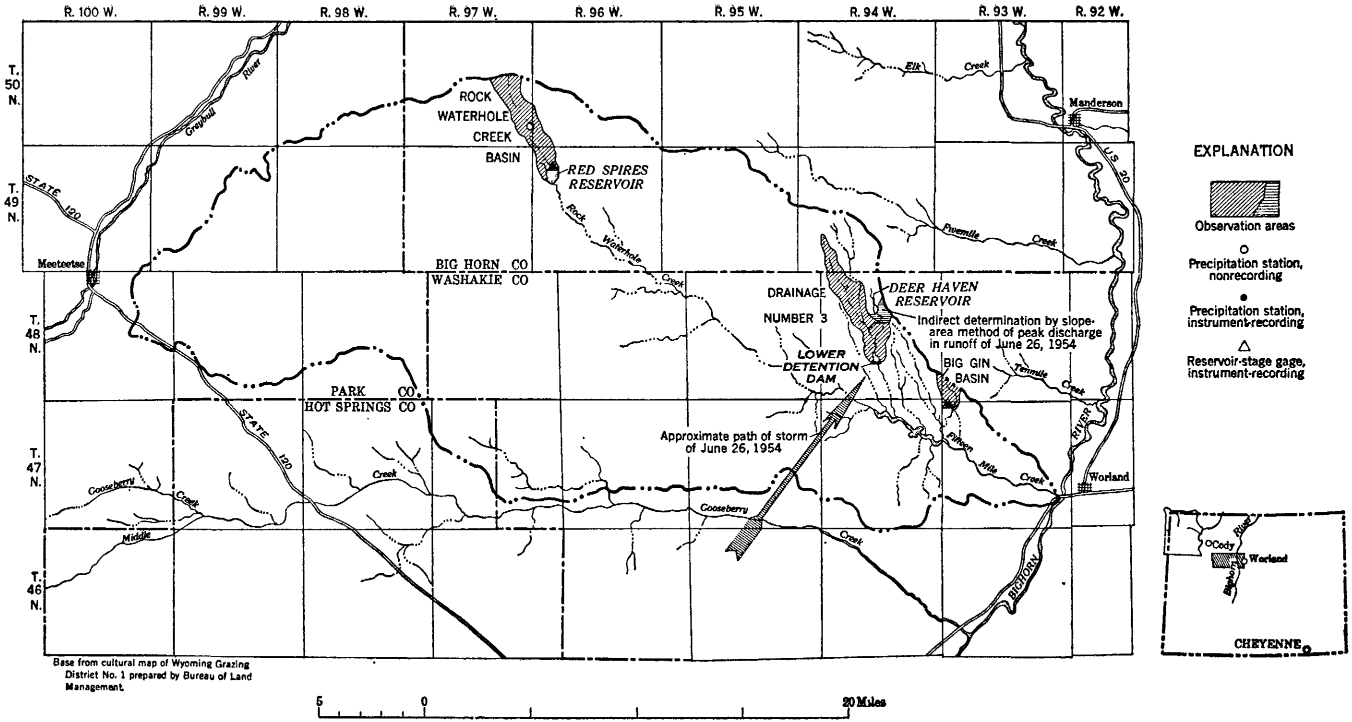

FIGURE 9.—Map of Fifteen Mile Creek basin showing location of study areas.

study was the fact that a vertical sandstone ledge on the west side of the reservoir afforded an excellent gage site.

An attempt was made to map the characteristics of the drainage basin, but the badland topography of the soft mudstone and siltstone beds of the Tatman formation was not discernible on aerial photographs or on the Geological Survey topographic map. It probably suffices to note, however, that approximately 95 percent of the basin is badlands with an average land slope of more than 30 percent. Also, as the vegetative cover is very sparse, all indications are that the basin produces relatively high runoff. Rates of sediment deposition in the reservoir, however, might be somewhat below those generally found in badlands areas, because practically all channels are small and are controlled by bedrock. Headcuts are rare, and in at least one reach above the reservoir the channel appears to be aggrading.

RESULTS OF STUDIES TO 1954

Reservoir stages were measured by a recording gage; precipitation was measured by a tipping-bucket gage attached to the water-stage recorder; and sediment deposition was measured by resurveying the reservoir at appropriate intervals.

Not enough time has elapsed to obtain conclusive results for the study. The total runoff for the 1954 season (table 12) was 4.13 acre-feet. Total summer precipitation was less than 1 inch and the maximum recorded 24-hour rainfall was 0.15 inch. Sediment deposition in the reservoir was negligible.

TABLE 12.—*Runoff of Big Gin basin for the summer season, 1954*

Location.—Lat 44°4′, long 108°5′, in NW¼ sec. 6, T. 47 N., R. 93 W., about 7 miles northwest of Worland, Wyo.

Drainage area.—0.942 square mile (603 acres).

Records available.—April to October 1954.

Gage.—Water-stage recorder (Stevens Type A–35) adjusted to permanent reference mark. Altitude of reference mark is 4,260 feet (from topographic map).

Remarks.—Record good. Capacity (October 1954) 99.35 acre-feet at spillway level; maximum depth, 19.1 feet

Storm runoff in Big Gin Reservoir for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
June 25	83.32	86.20	86.20	3.20	2.60	0	0	2.60	2.76
June 26	86.17	86.25	86.25	3.25	.08	0	0	.08	.08
July 21	85.39	85.94	85.94	2.80	.55	0	0	.55	.58
Aug 25	84.83	85.68	85.68	2.60	.90	0	0	.90	.96
Total								4.13	4.39

ROCK WATERHOLE CREEK BASIN

DESCRIPTION OF THE AREA

Red Spires Reservoir lies in the western part of the Fifteen Mile Creek basin on Rock Waterhole Creek about 28 miles northwest of Worland, Wyo. (see fig. 9). Its drainage area of 5.24 square miles is typical of the southern slope of Tatman Mountain, where badlands formed in essentially flat-lying mudstone and siltstone beds of the Tatman formation are separated from the mountain front by an alluvial slope nearly a mile wide. Although there is assurance of heavy runoff from the poorly vegetated badlands occupying about 80 percent of the basin, the channels are controlled by bedrock and therefore, should not erode easily. The ready source of sediment is in the alluvial slope at the base of Tatman Mountain where many raw headcuts and deeply entrenched gullies indicate high rates of sediment yield.

Two small storage reservoirs in the upper basin have a combined capacity of less than 5 acre-feet and should therefore, have only a minor effect on runoff or sediment yield from the upper basin. As Red Spires Reservoir had a total capacity in 1954 of 193 acre-feet, or a storage of 36.9 acre-feet per square mile, the reservoir probably will spill only in response to the large infrequent floods. The study, therefore, is similar to that made at Big Gin Reservoir with one exception. Sediment deposition in the lower basin is expected to be very high; in fact, sediment has already filled Red Spires Reservoir to the level of the drawdown pipe. Continued observations should provide valuable data on the amount of sediment that will pass through a reservoir with an ungated drawdown pipe and the performance of a retarding reservoir as a means of flood control; for example, will the drawdown pipe continue to function or will it plug once the sediment level in the reservoir is above the pipe intake?

RESULTS OF STUDIES TO 1954

Runoff into the reservoir was measured by a water-stage recorder, and a simultaneous record of precipitation was kept by a tipping-bucket rain gage attached to the recorder. Sediment deposition in the reservoir was measured by resurveys at appropriate intervals. Measurements of sediment loss through the drawdown pipe will be made by systematic sampling of the reservoir inflow and the pipe outflow.

TABLE 13.—*Runoff of Rock Waterhole Creek for the summer season, 1954*

Location.—Lat 44°14′, long 108°26′, in SE¼ sec. 7, T. 49 N., R. 96 W., about 28 miles northwest of Worland, Wyo.

Drainage area.—5.24 square miles (3,354 acres).

Records available.—April to October 1954.

Gage.—Water-stage recorder (Stevens Type A-35) adjusted to permanent reference mark. Altitude of reference mark is 4,720 feet (from topographic map).

Remarks.—Record (May 1–Oct. 31) very good.

Date	Reservoir capacity (acre-feet)	Storage (acre-feet per square mile)
1953	200.4	38.2
May 1, 1954	197.0	37.6
Oct. 31, 1954	193.4	36.9

Storm runoff in Red Spires retarding reservoir for 1954

Month and day	Water-surface elevation (feet)			Maximum storage (acre-feet)	Change in storage (acre-feet)	Outflow		Inflow	
	Before inflow	Maximum stage	After inflow			Pipe (acre-feet)	Spill (acre-feet)	Total (acre-feet)	Acre-feet per square mile
May 2	Dry	82.23	81.34	2.30	2.0	1.90	0	3.90	0.74
May 3	81.25	82.21	81.34	2.30	.1	2.44	0	2.45	.47
May 4	81.34	82.47	81.34	2.40	0	3.85	0	3.85	.73
May 5	81.34	82.17	81.34	2.25	0	2.55	0	2.55	.49
May 26	81.27	81.65	81.34	2.05	.1	.50	0	.60	.11
June 1-2	81.10	81.67	81.34	2.10	.1	.60	0	.70	.13
June 6-7	81.24	82.00	81.34	2.20	.05	1.30	0	1.35	.26
June 26	80.81	82.41	81.34	2.40	.3	2.65	0	2.95	.56
June 27	81.34	82.12	81.34	2.3	0	2.50	0	2.50	.48
July 15	81.19	89.82	81.34	27.5	.1	35.35	0	35.35	6.74
Aug. 5	81.34	83.73	81.34	2.2	0	5.45	0	5.45	1.04
Sept. 5	81.34	82.73	81.34	.7	0	2.18	0	2.18	.42
Sept. 12	81.34	81.70	81.34	.1	0	.50	0	.50	.09
Total								64.33	12.26

The results of the study to date are generally inconclusive. Total seasonal runoff in 1954 was 64.3 acre-feet or 12.26 acre-feet per square mile of which half occurred in response to a single storm (see table 13). Unfortunately no record of precipitation was obtained, as this storm occurred before the tipping-bucket gage was installed. By probing the sediment deposit in the reservoir it was found that a total of 7.05 acre-feet had been deposited in a period of 2 years, an annual rate of 0.67 acre-foot per square mile. No sediment samples have yet been taken on reservoir inflow and pipe discharge.

FLOOD OF JUNE 26, 1954, IN DRAINAGE BASIN NO. 3

In the late afternoon of June 26, 1954, a thunderstorm moving in a northeasterly direction crossed the east-central part of the Fifteen Mile Creek basin causing local runoff that was greater than any previously observed. As the storm, unfortunately, completely missed both of the study basins, it was necessary to make miscellaneous observations within the storm area to obtain data on runoff, peak discharge, and sediment yield.

A reconnaissance of the area showed that the storm center apparently moved northeastward entering drainage basin No. 3 at a point just below Lower Detention Dam (see fig. 9). It then moved diagonally up the basin crossing into Tenmile Creek basin at a point just below Deer Haven Detention Dam. Lower Detention Dam had just been completed and observers report that 3 inches of rain was collected in a can in half an hour. Runoff occurred at an extremely rapid rate, and by evening the reservoir had filled to a stage within 0.6 foot of the spillway. Discharge from outlet pipes in two upstream reservoirs was about equal to discharge from the larger pipe in Lower Detention Reservoir and maintained the reservoir at about a constant stage for a period of 3 days. On the third day, the dam failed, causing a flood in the channel downstream that obliterated any high-water marks left by the flow that came during the storm. In the area above the reservoir no suitable reach for a slope-area determination could be found on the main channel. As an alternative, a slope-area determination was made on a tributary about half a mile downstream from Deer Haven Reservoir. This determination, made by R. C. Culler, hydraulic engineer, and the author, showed that the peak discharge from an area of 0.69 square mile was about 2,600 cfs. However, because the channel conditions were quite unfavorable the calculation may be considerably in error.

A survey of Lower Detention Reservoir showed a total runoff of 234 acre-feet from a contributing area of about 2,600 acres (4.06 square miles) or a runoff of 57.7 acre-feet per square mile.

From the uniform appearance of the sediment deposit in the reservoir it was concluded that little sediment was lost to flushing action when the dam was breached. By probing the deposit, it was found that 12.9 acre-feet of sediment remained in the reservoir which represents a yield of 3.18 acre-feet per square mile in the single flood event. The data for the storm are summarized below.

Hydrologic data on flood of June 26, 1954, in drainage basin No. 3

		Drainage area (square miles)
Precipitation at Lower Detention Dam.	3+ in. in 30 minutes	-------
Peak discharge of unnamed stream	3,800 c. f. s. per square mile	0. 69
Runoff measured at Lower Detention Dam.	57.7 acre-feet per square mile	4. 06
Sediment yield measured at Lower Detention Reservoir.	3.18 acre-feet per square mile	4. 06

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