FLOOD CONTROL INVESTIGATIONS AND INCIDENT POSSIBILITIES OF RURAL ELECTRIFICATION WITH SPECIAL REFERENCE TO THE WASHITA RIVER VALLEY, OKLA.

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UNDER THE direction of the District Engineer of the third Mississippi River District, Vicksburg, Mississippi, the writer reconnoitered the Washita River Valley from Pauls Valley to Clinton, Okla., during the latter part of the summer. The river channel, overflow limits and valley limits were sketched. Data were collected on highwater stage and frequency, and a superficial survey of soil conditions, crops and transportation routes was made together with notes on business and public utility enterprises. About twenty possible storage and detention basins were investigated, the damsites profiled, and capacities roughly estimated.

The reconnaissance was an integral part of the comprehensive investigation being carried out on all tributaries of the Mississippi River, incident to recent federal flood control legislation. The data secured together with that from other investigations are being analyzed, plotted and tabulated by the Corps of Engineers and will be formulated into a report to be transmitted to congress by the Secretary of War.

The following discussion is personal reflection and projection of the writer and in no wise should it be construed as reflecting official mind or attitude of the Engineer Corps.

One cannot traverse the 125 miles of alluvial valley and terraces linking the towns above mentioned without conviction that here is a real and lasting wealth, inexhaustible, except it be by neglect of, and indifference to the great natural force by which it was fostered. Indeed prudent regulation and direction of the forces, which would appear to wreak vengeance on man for his daring infringement of natural heritage, may turn the forces into kindly benefactors and slaves to men.

STORAGE AND DETENTION RESERVOIRS

Employment of storage and detention reservoirs for the purpose of equalizing stream discharge has been long practiced in limited scope. The major burden of current investigations in the Mississippi River Valley is the determination of the efficacy and adaptability of the reservoir method of control for this river.

In order to effectively reduce the flood crest in the lower reaches of this great river, vast areas will be required for impounding basins. Also it is the usual case that natural impounding basins comprise some of the choicest lands in the immediate section of their location. Hence, it is much argued that even though storage capacities of sufficient magnitude to be effectual are available the cost will be prohibitive. In balancing costs of one scheme against those of another, the range and sum-total of benefits should be kept to the fore. Any scheme of spill-ways, by-passes and overflow storage along the stream trunk and lower reaches of the river obviously will require vast areas of medium to high priced lands while the sum-total benefits chargeable to property protection will be meager as compared to like benefits incident to a comprehensive tributary control system. Also the latter system presents industrial and commercial possibilities, in the nature of water power, irrigation and extended navigation, almost wholly foreign to the former scheme.

WASHITA RIVER STUDY

A brief summary projection of the results from the Washita River reconnaissance will serve as an example of tributary control and development. On account of abbreviated and approximate data and dearth of time for research, correlation and comparison, this study will be, necessarily, very superficial and preliminary.

The estimated area of the Washita River drainage shed above Pauls Valley, excepting Rush Creek catchment area, is 5300 square miles. This drainage shed is of the farm leaf type with mean axial length estimated at 200 miles yielding a mean width of 26.5 miles approximately bisected by the river channel. The central fifth of the catchment area would class as flat cultivated surface; the adjacent fifth on either side would class as rolling area mainly cultivated while the outer fifths would be termed hilly, of which about 50% is cultivated and the balance pasture and black-jack brakes.

Storage and detention basin possibilities have been noted, within this catchment area, aggregating a combined capacity of approximately 1,000,000 acre feet storage. Assuming a maximum rainfall of 9 inches in 24 hours with 60% run-off, this system offers potential flood detention for about 60% of the catchment area. However, due to economic considerations and relative basin position on the drainage shed, project surveys, should they be authorized, will not show this high a percentage of control to be feasible.

In the considerations to follow we will assume a feasible storage of 600,000 acre feet capable of being manipulated to control flood crests or rather to control floods so as to eliminate damaging flood crests. On the basis of above calculations upwards of one-third of maximum run-off could be restrained and possibly a large percentage of this restrained water could be gradually released through a period of 30 to 90 days for the purpose of augmenting continuous discharge during periods of slight rainfall.

Table 1 shows monthly rainfall minimums, maximums and means, composite for all stations on the drainage shed in Oklahoma. Inspection of this data indicates that torrential rains may be expected any time and several times during the spring and autumn seasons while none are indicated during the winter and few during the summer seasons.

It would seem permissible, therefore, to assume that all reservoir outlet gates could be adjusted to a certain uniform discharge at or near the first of December and remain so until about the middle of March. The same procedure from July first to the middle of September might be generally effected after a few years of observance and manipulation.

Possibly 10% to 25% of maximum flood requirement capacity should be maintained, generally, throughout the storage system. It is believed that a schedule of storage supply could be worked out to considerably equalize discharge.

Table 2 is a tabulation of the annual rainfall, minimum, maximum and mean for all stations on the drainage shed, in Oklahoma, for which records are available.

TABLE 1
Monthly Rainfall Data
Upper Washita River Drainage Shed
Compiled from U. S. Weather Bureau Reports

	Year	Max.	Min.	Mean*
January	1907	2.47		
	1914		Trace	0.78
February	1911	3.78		
	1916		Trace	0.93
March	1905	3.23		
	1911		0.11	1.52
April	1915	6.32		
	1909		1.00	3.41
May	1902	13.55		
	1916		1.28	4.25
June	1908	9.85		
	1911		0.23	3.52
July	1906	7.92		
	1918		0.77	2.89
August	1920	5.79		
	1922		0.14	2.53
September	1923	8.08		
	1910		0.72	3.16
October	1923	10.67		
	1921		Trace	2.81
November	1909	7.15		
	1904 1921		Trace	1.56
December	1911	4.76		
	1917		Trace	1.18

*Composite mean for all stations of record on Oklahoma area from initiation of records up to and including 1927.
Note: Maximum Sta. Record 17.11 in. at Chickasha, May, 1902.

TABLE 2
Rainfall Data: Upper Washita River Drainage Shed
Compiled from U. S. Weather Bureau Reports

Station	Year	Min.	Max.	Mean	Period	Three Min. Years Year	Rainfall
Anadarko	1896	17.29				1895	24.37
	1898		33.42	24.92	1892-99	1896	17.29
						1897	23.94
Arapaho	1910	14.71				1916	22.32
	1923		41.85	29.00	1894-1927	1917	15.07
						1918	28.55
Carnegie	1917	17.23					
	1923		41.43	29.74	1914-27	1916	25.39
						1917	17.23
						1918	27.07
Cheyenne	1927	19.82					
	1926		30.21	24.71	1924-27	Short	Record
Cloud Chief	1910	9.55				1909	21.04
	1923		40.24	28.74	1901-27	1910	9.55
						1911	26.92
Chickasha	1910	17.27				1909	20.37
	1923		47.27	34.54	1901-27	1910	17.27
						1911	No record
Hammon	1914	15.65				1916	17.44
	1923		46.00	27.10	1913-27	1917	16.61
						1918	31.17
Neola	1910	14.99				1909	21.66
	1908		47.71	29.48	1906-15	1910	14.99
						1911	30.59
Rankin	1910	11.36				1909	25.90
	1906		39.84	25.07	1903-19	1910	11.36
						1911	25.64
Weatherford	1910	16.29				1909	23.08
	1923		41.70	29.13	1901-27	1910	16.29
						1911	27.60
Composite		15.42	40.97	28.24			21.51

TABLE 3

Relation of Run-off to Rainfall for Washita River Drainage Shed above Anadarko
Estimated Drainage Area, 3,500 Sq Mi.
Rainfall data from United States Weather Bureau Reports

Station	Year	Inches Rainfall	Acre ft. Rainfall	Acre ft. Run-off	Percent Run-off	References
Anadarko	1903					U.S.G.S. Water Paper No. 131, p. 189. Note: Missing rainfall record supplied as percentage of mean based on other station records.
Arapaho		21.77				
Cloud Chief		22.03				
Hammon		20.46				
Rankin		19.30				
Texas		19.25				
Mean		20.56	3,849,860	324,600	8.4%	
Anadarko	1904					U.S.G.S. Water Paper No. 131, p. 189. "Note: Discharges for 1902, 1903 and 1904 applied indirectly, taking into account periodic changes in channel between flood crests."
Arapaho		22.22				
Cloud Chief		21.86				
Hammon		18.50				
Rankin		17.85				
Texas		17.85				
Mean		19.66	3,681,335	187,000	5.1%	
Anadarko	1905					
Arapaho		27.88				
Cloud Chief		35.90				U.S.G.S. Water Paper No. 209, p. 72.
Hammon		31.90				
Rankin		30.58				
Texas		30.58				
Mean		31.37	5,874,032	295,000	5.0%	
Anadarko	1906					
Arapaho		40.38				U.S.G.S. Water Paper No. 209, p. 72.
Cloud Chief		40.26				
Hammon		42.16				
Rankin		38.84				
Texas		39.84				
Mean		40.50	7,583,625	279,000	3.7%	
Anadarko	1907					
Arapaho		34.17				U.S.G.S. Water Paper No. 247, p. 107.
Cloud Chief		34.40				
Hammon		33.42				
Rankin		31.52				
Texas		31.52				
Mean		33.00	6,179,250	612,000	9.9%	
Anadarko	1908					U.S.G.S. Water Paper No. 247, p. 107. Note: 1908 Record from Jan. to June inclusive. Discharge for June 302,000 ac. ft.
Arapaho		24.33				
Cloud Chief		21.91				
Hammon		18.00				
Rankin		17.00				
Texas		17.00				
Mean		19.65	3,662,585	516,000	14.1%	

TABLE 4

Relation of run-off to rainfall Verdigris River Drainage Shed above Liberty, Kansas,
Estimated Drainage Area 3067 sq. miles;
Mean annual rainfall of 35.53 inches

Year	Ann. Rainfall Mean all sta's.	Computed Run-off %	Mean of 4 yrs. %	Data Reference
1898	40.50	13.75		20th An. Rep. U. S. G. S.
1901	26.32	9.26		U.S.G.S. Water Paper No. 75
1902	51.18	17.59		U.S.G.S. Water Paper No. 83
1903	40.29	30.16	17.7	U.S.G.S. Water Paper No. 99

Table 3 shows the relation of run-off to rainfall, for a short period and for the upper portion of the catchment area.

Table 4 shows similar data for the upper portion of the Verdigris River drainage shed, here inserted for the purpose of comparison.

Using data from the same source and for the same period as noted in Table 4, the Neosho River drainage shed above Iola, Kansas, comprising an area of 3670 square miles with mean annual rainfall of 37.00 inches yielded a mean run-off of 20.41 percent of the rainfall.

The fallacy of computing run-off as a direct function of rainfall is readily perceived from inspection of Tables 3 and 4. However, this is the only available means of estimating water supply on most of our Oklahoma streams, to date.

Assuming that it may be found possible to equalize the annual discharge of the Washita River through the adjunct of storage, estimates of future discharge will be based on mean three year minimum rainfall composite for all stations (Table 2), and mean percentage of run-off as determined from the full year records in Table 3. We get the following equation:

$$\text{Run-off} = \frac{21.51}{12} \times 5.300 \times 640 \times 0.064$$

$$= 389{,}130 \text{ acre feet.}$$

This is equivalent to a mean discharge of 537 c.f.s.

As there appears to be slight possibility of developing storage to tide over dry years, run off would probably fall below this figure once in ten to fifteen years.

The flow-line elevation of the Washita River is noted as 1466 at the State Highway bridge east of Clinton and at the State Highway bridge about one mile west of Pauls Valley the flow-line elevation is noted as 854, giving a total fall, through this distance, of 612 feet.

The run-off computed above represents the estimated annual discharge at Pauls Valley. Annual discharge at Clinton is estimated at 125,000 acre feet, or 170 c.f.s.

Assuming the Clinton discharge to be utilized throughout the entire stretch and considering wheel efficiency 80%—

$$\text{Max. available H. P.} = \frac{170 \times 612}{11} = 9{,}458.$$

Assuming the run-off from the interim drainage area to operate through one-half the total fall in feet, the additional available horse power would be—

$$\text{H. P.} = \frac{180 \times 306}{11} = 5{,}000.$$

These assumptions allow for no losses due to back water and presume that the tail water elevation of one dam conforms to the headwater elevation of the next. This, of course, will not prove of practical execution. Neither will it be practically possible to maintain the continuous discharge assumed.

However, with a supplementary Diesel or gas engine unit, such as is now being maintained by the plants at Chickasha, Anadarko, and Carnegie, it would appear that an annual hydraulic power approximating the above estimate is possible of economic development.

As a market for this power, possibilities for rural electrification of the valley would offer an interesting study. Any excess or shortage of power could be equalized through a "hook-up" with the Southwestern Light & Power Company's transmission system, which is at present furnishing power to most of the towns and cities within the area.

With the elimination of damaging floods in this and the lower section of the valley and general utilization of electric power on the farms, Washita Valley would become truly a valley of contentment and thrift and a most valuable entity of the state's commonwealth.

I can but call to attention in closing, the possible importance to navigation on Red River, incident to the equalizaion of discharge from this and other important tributaries of the river.

It is believed that possibilities herein discussed argue for further and more detailed investigations of flood-control and power development and utilization possibilities within the Washita Valley.