D R A F T

16 March 1945

Subject: Mississippi River Flood Discharge Capacity

To: The Division Engineer, U. M. V. D., St. Louis, Missouri

1. Authority.- This report is submitted in compliance with letter dated 24 July 1944, from the Division Engineer, U. M. V. D., in which it was requested that an investigation be made to determine the reasons for the apparent reduction of the carrying capacity of the Mississippi River floodway between St. Louis, Missouri and the mouth of the Ohio River.

2. Scope of Report.- The purpose of this investigation is to determine the relative floodway capacity of the Mississippi River for the years 1908, 1927 and 1944 by a comparison of the effect of progressive modification of the flood plain accomplished by the construction of flood control and channel regulating works. These three years were chosen because they represented the termination of three different phases in construction of regulating works and levees. Up to 1908 the amount of levees and regulating works built was small. Between 1908 and 1927 construction of regulating works had increased and practically all present levees were in place. Between 1927 and 1944 the major portion of regulating works had been constructed and the project depth had been changed (in 1927) from 8 feet to 9 feet. It became apparent after analyzing the purely physical changes that had occurred in the floodway, that it would be advisable to investigate the accuracy of methods with which discharges were measured during the last several years as compared to those used in earlier periods. Data and results pertaining to this investigation are contained in the latter part of this report.

3. Location.- Three reaches of the Mississippi River, each 20 miles in length, where there had been constructed a considerable amount of flood

control projects and channel regulating works, were investigated. The reaches in upstream order are, No. 1, that portion of the river between Commerce, Missouri (mile 40*) and Poe Landing (mile 60); No. 2, from near foot of Crain Island (mile 105) to Little Rock Landing (mile 125); and No. 3, from Chesley Island (mile 160) to St. Louis Eads Bridge (mile 180).

4. Types of Regulating Works.- Open river regulating works can be classified into two types according to the purpose for which they are built. The purpose of one type such as bank protection is to stabilize the banks of the river while the purpose of the other type dikes, is to change the physical features of the river, for example, build new banks, and shift and confine the channel. This report is concerned with the type of regulating work that would change the physical features of the floodway or channel, therefore, hereinafter, the term regulating works may be considered to refer to dikes unless otherwise stated.

5. Description, Reach No. 1.- The Mississippi River from St. Louis to the mouth of the Ohio River flows generally in a southerly direction although in the lower reaches between Cape Girardeau, Mo. and Cairo, Ill., there are several sharp bends and two or three long sweeping bends. In an upstream direction from Commerce, Reach No. 1 turns sharply westward at Grays Point, mile 46, then makes a long sweeping bend to the east before continuing northward at mile 60 (Sheets 8-11, Alluvial Valley Maps, Appendix B). A comparatively moderate amount of regulating works had been constructed in this reach by 1908 and no levees had been constructed on either side of the river.

* Mileage given herein is above Mouth of Ohio River.

6. Between 1908 and 1927 very little additional regulating works were constructed in Reach No. 1; however, a small amount of bank protection was placed including some by local interests. By 1927 three levee districts had been organized and levees constructed in Reach No. 1 on the left bank. These were the East Cape Girardeau and Clear Creek drainage and levee district, the North Alexander County drainage and levee district and the Clear Creek drainage and levee district. In addition about 1912?, the St. Francis outlet for Mississippi River flood waters was closed by the construction of the Little River diversion channel with its bordering levees, on right bank about 2½ miles downstream from Cape Girardeau, Missouri.

7. Most of the regulating works in Reach No. 1 were constructed during the period 1927 to 1944 and were mainly in the form of dikes and revetment. The majority of the work was placed along the left bank of the river, the right bank hugging the bluff through a greater portion of the reach. No additional levees were constructed during the period. Regulating works existing at the present time are shown on survey sheets 15-22, appendix B.

8. Description, Reach No. 2.- In this reach going upstream, the river between banks contains two fairly sharp bends, the first at mile 117 towards the west and the second at mile 121 to the north (Sheets 21-25, Alluvial Valley Maps, appendix B). A moderate amount of regulating works were constructed during the period prior to 1908. Practically all the works were placed in two localities, Crain Island mile 105-106 and in the vicinity of Ste. Genevieve, mile 120-125. There were no levees constructed along the main channel of the river up to 1908; however, a levee had been built along the south side of the lower end of the old river channel behind Kaskaskia Island,

that is the upper flank of Perry County District No. 1.

9. Between 1908 and 1927 a small amount of additional regulating work was constructed. The greater portion of the work was placed at the two localities mentioned in preceding paragraph. Four levee districts were organized and their levees built, all on the right bank, by 1927; the Perry County drainage and levee districts Nos 1, 2 and 3, the Kaskaskia Island drainage and levee district and the Ste. Genevieve levee district No. 1.

10. A considerable amount of regulating works was built in this reach during the period 1927 to 1944. A small percentage was placed along the left bank which runs along the bluff line through almost the entire reach, the right bank receiving the larger percentage of the work. The levee districts that existed in 1927 protected land on the right bank almost throughout the entire length of the reach, consequently no new districts needed to be organized. On survey sheets 40-47, appendix B are shown regulating works that exist at the present time.

11. Description, Reach No. 3.- Reach No. 3 is practically a straight reach of river (sheets 33-35 and sheets 37-38, Alluvial Valley Maps, appendix B). Since the upper half of the reach is coincident with the lower half of St. Louis harbor, there existed in 1908 a considerable amount of regulating works. Records of this office show that for this important reach, regulating works by the United States were begun about 1880; a large amount of work having been done by local interests between 1838, when two dikes were built by the U. S. (R. E. Lee), and 1880. Three levees of varying importance existed in Reach No. 3 in 1908, all on left bank. The Columbia drainage and levee district (mile 160 to 165.5); a small levee miles 168.6-169.5, which later became a portion of the Wilson and Wenkel drainage and

levee district; and a levee (miles 171.9 to 172.2) protecting the towns of the East Carondelet and Prairie du Pont from overflow of the Prairie du Pont Creek. The levee of the East Side Levee and Sanitary District in this reach in 1908 extended from mile 180 downstream to mile 172.

12. A comparatively small additional amount of regulating works were check board maps constructed in Reach No. 3 from 1908 to 1927. There existed in 1927 the Columbia drainage and levee district, the Wilson and Wenkel drainage and levee district, the Prairie du Pont drainage and levee district and the East Side levee and Sanitary district which had been extended somewhat to protect land further downstream in Reach No. 3. All levees were on the left bank, the right bank being adjacent to bluffs or high ground.

13. Only a moderate amount of additional regulating works was placed in Reach No. 3 during the period 1927 to 1944, this reach being reasonably well stabilized. No additional levees were needed as land along the left bank throughout almost the entire reach was protected by levees that existed in 1927. The existing regulating works are shown on Survey sheets 60-67, Appendix B.

14. In tabular form below are given the quantities of regulating works of both types constructed in the three reaches for the three periods.

Reach No. 1, mile 40-60

	Before 1908	1908-1927, incl.	1928-1944, incl.
Dikes, lin. ft.	20,700	533	51,600
Mattress, lin. ft.*	19,450	5,100	44,800
Paving sq. ft.	688,900	366,500	2,059,100

Reach No. 2, mile 105-125

	Before 1908	1908-1927, incl.	1928-1944, incl.
Dikes, lin. ft.	36,800	16,950	82,700
Mattress, lin. ft.*	48,050	15,300	24,050
Paving, sq. ft.	2,849,500	1,507,600	1,447,450

Reach No. 3, mile 160 to 180

	Before 1908	1908-1927,incl.	1928-1944,incl.
Dikes, lin. ft.	180,150	11,650	23,000
Mattress, lin. ft.*	53,900	1,100	8,050
Paving, sq. ft.	2,167,800	130,050	463,650

* Linear feet along bank line.

15. The following tabulation shows the lengths (miles) of river front levee that existed at the end of each period for the three reaches of river.

	1908	1927	1944
Reach No. 1	0.	16	16
Reach No. 2	0	11	11
Reach No. 3	11.0	14	14

16. Data used.- For the purpose of determining the effect of flood control projects and regulating works on the Mississippi River floodway, cross-sections were plotted for each mile in each of the three reaches for the years 1908, 1927 and 1944. Cross-sections were plotted "bluff to bluff" and levees controlling width of floodway are shown. A typical cross-section in each reach is given on plates 1, 2 and 3 of this report and their location is shown on sheets 11, 24 and 34, Alluvial Valley Maps, Appendix B.

17. The 1908 cross-sections were plotted from the "1908 Board Survey" charts. The 1927 cross-sections were plotted using the 1927 low water survey charts for the channel section and the 1940 Alluvial Valley Maps for overbank section. The 1944 cross-sections were plotted using the 1944 low water survey charts for the channel section and the 1940 Alluvial Valley Maps for overbank.

18. For the purpose of comparing the physical changes in the entire floodway section accomplished by construction of levees and channel regulating works, area curves were constructed in accordance with the width of floodway as determined by the bluffs or confining levees. The areas were

taken bluff to bluff where no levees existed, bluff to levees where there were levees on only one bank and levee to levee when the latter condition prevailed.

19. For comparison of available floodway areas, particularly those of 1927 and 1944 when the same levees existed in both years it was believed advisable to assume the levees in each case to be built to contain flow of 50-year frequency. Investigations indicated that levees existing in 1908 were of insufficient height and section to have more than a negligible effect on large flood flows.

20. Comparative areas of the entire floodway section under the elevation of the 50-year flood profile were obtained for each mile in the reach and the average areas for each of the three reaches were computed. Area curves for entire typical floodway section are shown on plates 1, 2 and 3. The results are given in the three tables below:

REACH NO. I

Section Mile	Mile 40-60, Incl. Area in 1,000 sq. ft. 1908	1927	1944
40	149	149	139
41	157	147	149
42	172	166	155
43	155	139	125
44	133	136	124
45	136	111	111
46	183	128	132
47	350	141	131
48	578	219	215
49	736	306	313
50	684	276	269
51	710	190	170
52	732	164	156
53	772	162	180
54	661	155	169
55	679	213	212
56	712	378	378
57	646	378	378
58	677	393	393
59	555	336	323
60	656	317	292

Average	487	219	215

REACH NO. II

Section Mile	Mile 105-125, Incl. Area in 1,000 sq. ft. 1908	1927	1944
105	560	265	285
106	645	340	353
107	627	317	327
108	558	177	169
109	587	125	131
110	546	175	175
111	623	231	236
112	683	377	378
113	665	352	332
114	630	298	295
115	628	365	388
116	535	435	413
117	890	890	840
118	704	486	509
119	722	420	401
120	653	447	458
121	646	625	598
122	596	566	542
123	534	525	506
124	521	397	454
125	393	359	376
Average	616	389	388

REACH NO. III

Section Mile	Mile 160-180, Incl. Area in 1,000 sq. ft. 1908	1927	1944
160	512	226	204
161	626	253	245
162	466	150	142
163	442	214	213
164	385	198	198
165	361	167	159
166	343	173	193
167	316	302	298
168	344	304	315
169	314	171	145
170	315	351	327
171	444	409	398
172	291	377	374
173	411	153	170
174	331	154	168

REACH NO. III (Cont'd)

Mile 160-180, Incl.
Area in 1,000 sq. ft.

Section Mile	1908	1927	1944
175	392	184	187
176	580	142	139
177	500	144	132
178	512	144	136
179	618	129	133
180	240	114	106
Average	416	212	209

Analysis of the above tabulated data leads to the conclusion that the construction of levees in the Mississippi River flood plain during the period 1908-1927 has been the main factor in reducing floodway area to approximately 54% of the 1908 area. Between 1927 and 1944 when no additional levees were constructed and when, at the same time about half of all regulating works were built, the floodway area remained practically constant being reduced only an additional $\frac{1}{2}$ of 1%.

21. An investigation was next made of changes in the condition of the main channel only, which changes were caused mainly by construction of regulating works. At each section for each year chosen for study, the areas up to the lowest high bank elevation that existed during each respective year was obtained and the average area thereof computed for each reach. Area curves for typical main channel section only are shown on plate 4. The results for mean of all sections are tabulated below:

	Reach No. 1	Reach No. 2	Reach No. 3
	Area, sq. ft.	Area, sq. ft.	Area, sq. ft.
1908	99,000	89,000	87,000
1927	87,000	98,000	90,000
1944	86,000	83,000	89,000

22. Attention is here invited to the fact that the lowest respective high bank elevation to which the areas were taken in the above computations were not at a common elevation in all three years. This was due to the fact that in some cases the banks had been built up in the later years by the regulating works, indicating an improvement in channel conditions due to the regulating works.

23. Areas were also taken at the lowest high bank elevation common to all three years and the average areas for each reach computed. The results are listed below:

	Reach No. 1	Reach No. 2	Reach No. 3
	Area, sq. ft.	Area, sq. ft.	Area, sq. ft.
1908	96,000	74,000	80,000
1927	78,000	78,000	80,000
1944	79,000	76,000	78,000

24. Improvement in channel conditions, mentioned in paragraph 22 as the result of constructing regulating works was determined by a comparison of the mean depths derived for each reach by dividing the areas of each section at bankfull by the bankfull width. Below are listed the mean depths in feet for the three reaches at both bankfull elevation and lowest bankfull elevation for the three years 1908, 1927 and 1944.

Mean depths at bankfull elevation

	Reach 40-60	Reach 105-125	Reach 160-180
1908	27.5	25.7	29.4
1927	30.9	28.2	31.8
1944	29.8	29.0	32.1

Mean depths at lowest bankfull elevation

	Reach 40-60	Reach 105-125	Reach 160-180
1908	27.1	23.4	28.2
1927	28.4	25.4	29.0
1944	29.9	26.5	30.4

25. The with-in banks cross sectional area, regardless of the elevation of the banks for all three years, has been generally reduced due to regulating works which narrowed the channel. However, as could be expected, the narrowing of the channel caused scour and the mean depth progressively improved.

26. It should be remembered that grades of most of the levees were not as high in 1927 as at the present time and that flood heights were probably reduced considerably by storage in the districts, after the levees broke. In recent years the more efficient flood-fighting organization is, to a great extent, responsible for holding flood flows to a higher elevation which consequently denied storage to the flow almost up to the peak. Analysis of the data contained in the preceding paragraphs indicates that the apparent reduction in the carrying capacity of the Mississippi River floodway between St. Louis and the mouth of the Ohio River from 1927 to 1944 was not caused by a physical reduction of available floodway section. A possible solution is that the apparent reduction in floodway capacity is due mainly to the improvement in the present method of measuring stream flow over the method used in earlier years. A comparison of methods was made the results of which are given in the following paragraphs.

27. Description.- Discharge measurements within the limits of the St. Louis Missouri Engineer district have been secured as early as 1866. The earlier measurements were taken by the City of St. Louis, Mississippi River Commission and the Engineer Department. The majority of the earlier measurements were obtained thru the use of floats. Various methods were used to determine discharge viz rod floats, surface floats, surface and

sub-surface floats, ice cakes and meters. Float measurements were usually made by timing the floats from ranges laid out about 400 feet above and 400 feet below the main discharge range. Rod floats consisted of a series of poles in sections of various lengths which were fastened together to give a length about equal to the depth of water and on the top of which was connected a flag and on the bottom end a weight sufficient to keep the rod in a vertical position. Surface floats as the name implies floated upon the surface of the water and were usually spheroid in construction containing a small flag on top. Double floats consisted of two floats connected together by an adjustable line one float riding on the surface and the other float submerged at any desired depth.

28. Data used.- Prior to March 1933 discharge measurements were obtained for use in the U. S. Engineer Department by field discharge parties of the U. S. Engineer Department, St. Louis, Missouri at St. Louis, Chester, Cape Girardeau and Thebes. Subsequent to March 1933 in accordance with a cooperative stream gauging agreement between the U. S. E. D. and the U. S. G. S. regular measurements were obtained by the U. S. G. S. although at times the U. S. E. D. also sent discharge parties into this field to measure stream flow. This was particularly the case when flood conditons prevailed, consequently, simultaneous measurements were obtained at St. Louis, Cape Girardeau and Thebes. These simultaneous measurements afford the opportunity to compare the methods used by each agency.

29. Comparison of methods.- It is proposed to show by analysis of discharge measurements taken by the U. S. G. S. and the U. S. E. D. that the present method and equipment for measuring stream flow used by the U. S. G. S. results in a smaller amount of measured discharge than resulted from former methods and equipment used by the U. S. E. D. Measurements by the U. S. G. S. are made from the downstream side of bridges using small type

Price current meters, Columbus type sounding weight and fine wire sounding lines. A wind and wet line correction to soundings is applied to depths. Measurements by the U. S. E. D. were made from a launch, barge or boat. All meter measurements were taken with the large Price current meter attached either singly or doubly to a rod, with large flat iron weight at the bottom. Soundings were taken with a sounding lead attached to rope sounding line. It is believed advisable and reasonable in view of the years chosen for the physical analysis of the carrying capacity of the floodway, to compare the results of discharge measurements taken in 1927 with those taken in 1943 and 1944. The 1943 and 1944 discharge measurements were taken by the U. S. G. S. using the best of modern equipment, while the 1927 discharge measurements were taken by the U. S. E. D. using double floats. Results of discharge measurements made by the various methods are given in the following table:

Table

Year	St. Louis			Chester			Cape Girardeau		
	Date	Stage (Feet)	Discharge (1000 cfs)	Date	Stage (Feet)	Discharge (1000 cfs)	Date	Stage	Discharge (M cfs)
1903				6/11	32.8	906(RF)	6/14	36.5(a)	1,014(M)
				6/13	33.4	900(RF)	6/15	36.4(a)	1,009(M)
1922	4/20	33.9	762(F)				4/20	37.9(a)	977(F)
							4/21	37.8(a)	888(2M)
1926				10/7	28.4	687(R)			
				10/8	28.6	736(M)			
1927	4/24	35.6	870(F)	4/27	34.3	1,060(RF)			
				4/27	34.2	971(RF)			
1929	4/28	34.6	669(2M)				4/28	36.3(a)	745(F)
	4/29	33.8	676(F)				5/22	37.4(a)	736(M)
1935	6/7	33.3	649(M)	6/8	32.8	697(2M)	6/10	36.3	633(M)
1942	6/30	34.4	663(M)	7/2	33.6	583(M)	7/3	36.4(a)	611(M)
1943	5/24	38.9	835(M)	5/23	37.9	837(M)(b)	5/28	41.9(a)	867(M)
1944	4/30	39.1	844(M)	5/2	37.4	837(M)	5/7	40.4(a)	798(M)

(a) Measurements at Thebes.
(b) Flow through levee break not measured.
F - Double floats
RF - Rod floats
M - One meter
2M - Two meters

30. The process of analysis used was as follows:

A comparison was made of the results of discharge measurements taken by the U. S. E. D. using the old type Price current meter as compared to results obtained from measurements taken by the U. S. E. D. using double floats, the method used in 1927. The U. S. E. D. current meter discharges were then in turn compared with the discharges resulting from measurements made by the U. S. G. S. with present-day equipment. In this manner, through the common criterion, the U. S. E. D. meter measurements, a comparison could be made between the 1927 float measurements taken by U. S. E. D. and the 1943 and 1944 meter measurements taken by U. S. G. S.

31. Plate No. 5 shows rating curves obtained by plotting the results of discharge measurements taken at St. Louis by the U. S. E. D. using double floats and Price current meters. Listed below are the comparison of discharges at various gauge heights obtained by both methods:

Results of Discharge Measurements

Gauge Height Feet	Floats c. f. s.	Meters c.f.s.	Difference percent
20			
20	334,000	316,000	6
22	379,000	356,000	6
24	429,000	397,000	8
26	485,000	442,000	10
28	546,000	491,000	11
30	612,000	543,000	13
32	684,000	597,000	15

Results of Discharge Measurements (Cont'd)

Gauge Height Feet	Floats c.f.s.	Meters c.f.s.	Difference percent
34	762,000	655,000	16
36	844,000	718,000	18
38	936,000	789,000	19
39	996,000	830,000	20

32. The 1927 discharge measurements, by the U. S. E. D., were made with double floats; therefore, this report is not particularly concerned with rod float measurements but it was believed to be of passing interest, since this method of measuring discharge was mentioned in paragraph 27. Plate 6 shows rating curves derived by plotting the results of discharge measurements taken at Chester, Illinois in 1926, 1927 and 1930, by the U. S. E. D. using rod floats and Price current meters. At higher stages, at this particular station, discharges computed from rod float measurements are less than those computed from measurements taken with Price current meters.

33. On plate 7 is a rating curve derived from plotting results of discharge measurements taken by the U. S. G. S. during the period June 1933 - June 1935 from the Municipal Bridge at St. Louis and the upper portion of a rating curve drawn through points obtained from U. S. E. D. measurements which were made approximately 2.7 miles downstream from the Municipal Bridge during the period August 1934 - July 1935. A reasonably reliable relationship can be obtained by the comparison of these two curves as the discharges from which they were derived were measured during the same period of time, a number of them being simultaneous measurements. Below in the first table is given the percentage of difference in the discharges read from the rating curves and in the second table is given the percentage of difference in

simultaneously measured discharges. Correspondence and pictures regarding experimental simultaneous discharge measurements of the Mississippi River at St. Louis, Missouri made by the U. S. E. D. in conjunction with the U. S. G. S. is contained in Appendix A.

Discharges from Rating Curves

Stage, Feet above m.s.l.	U.S.G.S. Discharge 1000c.f.s.	U.S.E.D. Discharge 1000c.f.s.	Difference Referred to U.S.G.S. percent
406	415	424	≠ 2
408	465	474	≠ 2
410	518	540	≠ 4
412	578	620	≠ 7
414	642	716	≠ 12
416	710	832	≠ 17
419	840	1,060	≠ 26

Simultaneous Measurements

Date	U.S.G.S. Measurement c.f.s.	U.S.E.D. Measurement c.f.s.	Difference Referred to U.S.G.S Percent
June 3	495	545	10
4	520	563	8
6	633	678	7
8	641	716	12
10	612	648	6
11	607	636	5
13	546	561	3
17	406	470	12
22	417	463	11
25	460	497	8
28	369	397	8

34. The relationship between the results of discharge measurements taken by the U.S.G.S. and the U.S.E.D. at Cape Girardeau, Missouri and

Thebes, Illinois are shown on plate 8. The U.S.G.S. rating curve was derived from measurements taken at Cape Girardeau from March 1933 to June 1935 while the U.S.E.D. rating curve was obtained from measurements taken at Thebes, approximately 8½ miles downstream, during the period June 1933 - June 1935. The rating curves are in the form of one foot fall curves to account for the backwater effect of the Ohio River on flows at Cape Girardeau and Thebes. Attention is invited to the fact that flows at Thebes are at times also affected by discharge from the Little River Diversion Channel which enters the Mississippi River approximately 5 miles upstream. A number of simultaneous measurements were obtained by the U.S.G.S. measuring at Cape Girardeau and the U.S.E.D. at Thebes and some simultaneous measurements were made by both agencies at Cape Girardeau during the period 1933 - 1939, Plate 9. The results of these measurements and their respective percentages of difference is given in the two tables below.

Cape Girardeau and Thebes Measurements

Date	U.S.G.S. Cape Girardeau Disch. 1000 c.f.s.	U.S.E.D. Thebes Discharge 1000 c.f.s.	Difference referred to U.S.G.S. Disch. Percent
March 21	263	278	6
28	247	254	3
		248	0
April 3	238	250	5
9	229	237	4
		235	3
19	251	261	4
		260	4
June 7	574	584	2
8	605	600	-1
10	633	637	1
11	604	654	8
12	595	636	7
14	575	653	14
17	524	571	9

Cape Girardeau Measurements

Date	U.S.G.S. Discharge 1000 c.f.s.	U.S.E.D. Discharge 1000 c.f.s.	Difference referred to U.S.G.S. Percent
March 14	375	435	16
May 18	385	346	-10
22	392	413	5
June 21	471	522	11
25	493	557	13
July 1	451	490	9

In the table below are the comparative discharges and their respective percentage of difference as taken from the two rating curves.

Discharges from Rating Curves (one foot fall)

Stage at Cape Girardeau	U.S.G.S. Discharge 1000 c.f.s.	U.S.E.D. Discharge 1000 c.f.s.	Difference referred to U.S.G.S.
316	41	66	61
320	76	95	25
324	109	127	17
328	145	162	12
332	183	202	10
336	224	248	11
340	268	297	11

35. None of the data, from which the tables and curves heretofore mentioned were derived, were of such magnitude as to determine the upper portions of the curves except the latest U.S.G.S. rating curve at St. Louis. In order to determine the relationship of discharge measurements taken by the U.S.G.S. and the U.S.E.D. at stages approximately equal to those of the 1943 and 1944 floods the curves were extrapolated on semi-logarithmic graph paper.

36. Summary.- The reduction in floodway capacity of the Mississippi River between St. Louis, Missouri and the mouth of the Ohio River during the period 1908-1927 was due mainly to the construction of levees which

reduced the available floodway section to approximately 54% of floodway area available in 1908. During the period 1927-1943 the available floodway section was reduced an additional ½ of 1% due mainly to construction of regulating works in riverbed.

37. In the table below is shown the relative results of discharge measurements taken at various stations on the Mississippi referred to U.S.E.D. meter measurements.

	U.S.G.S. Meters	U.S.E.D. Rod Floats	U.S.E.D. Double Floats	U.S.E.D. Meters	Percent
St. Louis 1935	840,000			1,060,000	21
Chester 1926-27		1,184,000		1,396,000	15
St. Louis 1927-30			996,000	830,000	-20
Cape-Thebes 1935*	360,000			391,000	16
Cape-Cape 1935*	360,000			474,000	

* 1 Foot Fall curve values

38. Conclusion.- In view of the fact that the physical reduction in floodway capacity, after flood control projects were established and regulating works constructed, was practically negligible and in view of the fact that the U.S.G.S. used modern and improved equipment to measure stream flow and that there would be a natural tendency towards improvement of method with the acquisition of experience it is believed that the U.S.G.S. discharge measurements more nearly represent the actual amount of stream flow. Therefore, the reduction in floodway capacity was not an actual physical reduction but an apparent reduction caused by a discrepancy in the accuracy of measuring streamflow by older methods and equipment.