DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, BUCKHORN CREEK NEAR SHILOH, ALABAMA

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Prepared in cooperation with the
DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
and the
ALABAMA STATE HIGHWAY DEPARTMENT

HYDROLOGIC INVESTIGATIONS ATLAS
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INTRODUCTION

New techniques for predicting water-surface profiles, needed in the design of economical, structurally sound, and environmentally compatible stream crossings, are under investigation. The investigation has accelerated with the advent of digital computers capable of analyzing large quantities of data. Among the techniques is the development of two-dimensional (2–D) digital models. Field data are essential for development and evaluation of these techniques for predicting water-surface profiles. This atlas is one of a series that provide a wide range of field data.

Since 1969 the U.S. Geological Survey has been collecting backwater data where wide, densely vegetated flood plains are crossed by highway embankments and single-opening bridges. This work was done in cooperation with the Federal Highway Administration Department of Transportation, the Alabama State Highway Department, the Louisiana Department of Transportation and Development, and the Mississippi State Highway Department. The objective of this cooperative project is to present the data in a format conducive to the development of improved models for predicting hydraulic responses of flow at highway crossings of streams in complex hydrologic and geographic settings.

Backwater data were obtained at 22 sites for 35 floods; that is, 11 sites had 1 flood each; 9 sites, 2 floods each; and 2 sites, 3 floods each. Analysis of data (Schneider and others, 1976) showed that backwater and discharge at these sites computed by methods presently in use, would be inaccurate. The floodflow data are unique in the range and detail in which information was collected and provide a base for evaluating digital models relating to open-channel flow.

The data sites (fig. 1) are listed below. This atlas shows flood data obtained on Buckhorn Creek near Shiloh, Ala., one of 22 sites plotted in figure 1:

HYDROLOGIC INVESTIGATIONS ATLAS NUMBER

ALABAMA

Buckhorn Creek near Shiloh HA–607
Pea Creek near Louisville 608*
Poley Creek near Sanford 609
Yellow River near Sanford 610*
Whitewater Creek near Tarentum 611

LOUISIANA

Alexander Creek near St. Francisville HA–600*
Beaver Creek near Kentwood 601*
Comite River near Olive Branch 602
Cypress Creek near Downsville 603*
Flagon Bayou near Libuse 604
Little Bayou de Loutre near Truxno 605*
Tenmile Creek near Elizabeth 606*

MISSISSIPPI

Bogue Chitto near Johnston Station HA–591
Bogue Chitto near Summit 592
Coldwater River near Red Banks 593*
Lobutcha Creek at Zama 594
Okatoma Creek east of Magee 595
Okatoma Creek near Magee 596
Tallahala Creek at Waldrup 590
Thompson Creek near Clara 597*
West Fork Amite River near Liberty 598*
Yockanookany River near Thomastown 599*

* In press

DESCRIPTION OF DATA

TYPE OF DATA

Data collected at all study sites consist of (1) depths, velocities, and discharges measured through the bridge openings, and (2) peak water-surface elevations along the highway embankment and along cross sections. A minimum of seven valley cross sections were surveyed at approximately one valley-width intervals in the vicinity of the bridge at each site. Locations of the cross sections were alined perpendicularly to the assumed direction of flow. Cross sections were extended to intersect the edge of the valley at equal water-surface elevations. Surveying procedures described in the U.S. Geological Survey Techniques of Water-Resources Investigations series (Matthai, 1967; Benson and Dalrymple, 1967) were followed.

HIGH-WATER MARKS

Water-surface elevations were determined from high-water marks identified along the cross sections and the edges of the valley after each flood. During peak discharge measurements, water-surface elevations were marked with standard surveying stakes along the upstream and downstream sides of the highway embankment. For some floods additional high-water marks were identified in the valley adjacent to the bridge to define in detail the water surface in the approach and exit reaches.

BRIDGE GEOMETRY

Detailed bridge geometry was obtained at each site. The bridge cross section was surveyed at the most contracted section. Piers, spur dikes, wingwalls, abutment slopes, and other petinent geometry were measured.

MANNING'S ROUGHNESS COEFFICIENT

Schneider and others (1976) used composite Manning's roughness coefficient values of *n* where frequent changes in roughness occurred. In their study, composite values of *n* were verified by matching step back-water computations of the water surface with actual water-surface profiles for measured discharges. The range of *n* values used in this report is based on values used by Schneider and others (1976). Roughness varies from open fields to dense forests.

Roughness values or ranges of roughness values in different parts of the flood plain are shown on the maps. The values shown are based on water depth. The high value is the value where water depth is less than 0.6 meter and the low value applies where water depth is greater than 1.0 meter. A linear relation of roughness to water depth is assumed for water depths between 0.6 and 1.0 meter.

PRESENTATION OF DATA

The data are presented on topographic maps enlarged from standard 1:24,000 (or 1:62,500) scale Geological Survey topographic maps which comply with National Map Accuracy Standards. Accuracy limitations of the base maps are retained in the enlargements. Although positions may be scaled closely on the enlargements, they are not defined with greater accuracy than positions on the base maps.

Ground elevations are placed adjacent to solid squares. Elevations of floodmarks are indicated by numerical values adjacent to solid triangles. Floodmark elevations for separate floods are shown on separate sheets. Bridge geometry and road-embankment dimensions are shown with brief notations of pier spacing and configuration.

In addition to the data points shown on the maps, discharge measurements of selected floods, plots of cross sections, and velocity distribution diagrams are shown. Cross-section elevations are tabulated to define stream channels and flood-plain features in greater detail. Each cross section is referred to a zero station established at the extreme left edge (facing downstream) of the valley.

DATUM

All elevations presented in this report are referred to National Geodetic Vertical Datum of 1929 (NGVD).

FLOOD FREQUENCY

Flood-frequency relations derived using techniques described in "Floods in Alabama" (Hains, 1973) are presented graphically.

INTERNATIONAL SYSTEM OF UNITS (SI)

The International System of Units (SI) is used throughout this report. All data were measured in the U.S. customary units and converted to SI units. Ground elevations which were originally determined to the nearest tenth of a foot are rounded to the nearest 0.01 meter. Water-surface elevations which were surveyed to hundredths of a foot are rounded to millimeters. The same criteria apply to all other dimensions, except contour elevations which are shown to the nearest tenth of a meter.

The following factors may be used to convert SI units to the U.S. customary units:

MULTIPLY SI UNITS	*BY*	*TO OBTAIN U.S. CUSTOMARY UNITS*
	LENGTH	
Meter (m)	3.281	Feet (ft)
	AREA	
Square meter (m^2)	10.76	Square feet (ft^2)
	VOLUME	
Cubic meter (m^3)	35.31	Cubic feet (ft^3)
	VELOCITY	
Meter per second (m/s)	3.281	Feet per second (ft/s)
	FLOW RATE	
Cubic meter per second (m^3/s)	35.31	Cubic feet per second (ft^3/s)

DATA FOR BUCKHORN CREEK NEAR SHILOH, ALABAMA

Data for Buckhorn Creek near Shiloh, Ala., obtained in a 3-kilometer reach crossed about midway by State Highway 130, are presented on four sheets (fig. 2). Sheet 1 contains tables showing cross-section data (table 1) and discharge data (table 2). An aerial view of the reach upstream from the bridge is shown in figure 3. Relative magnitudes of the floods are shown on the frequency curve (fig. 4).

The locations of representative ground elevations are shown on sheet 2. These are points of significant changes in cross-section elevations and alinement of the axis. Stationing along cross sections was projected along straight lines perpendicular to the flow. Plots of the cross sections are graphic presentations of the tabular data.

Bridge geometry and road embankments are shown on sheet 2 as they existed at the time of the floods. The cross section surveyed at the downstream side of the bridge is tabulated. The cross section shown for velocity distribution was obtained by sounding from the upstream side of the bridge during the discharge measurement.

Data for two floods on Buckhorn Creek are presented. The first flood occurred March 2, 1972. Nine valley cross sections were surveyed after this flood (sheet 3). A second flood occurred on December 21, 1972 (sheet 4). The stability of the stage-discharge relation indicates that no significant changes have occurred in the flood plain downstream from the bridge. Valley cross sections as surveyed are considered valid for both floods.

Manning's roughness coefficient values and the 1972 flood boundaries are shown on sheets 2–4.

FLOOD OF MARCH 2, 1972

Peak water-surface elevations, measured cross section, and velocities for the flood of March 2, 1972, are shown on sheet 3. The flood crested at an elevation of 97.385 meters at the reference point located on the downstream guardrail 67 meters from the left abutment. The crest was determined from high-water marks located at each bridge abutment. The peak discharge was 63.7 cubic meters per second, from a stage-discharge relation developed for the site. The discharge was measured three times on the recession with 55.8, 43.0, and 25.3 cubic meters per second at elevations of 97.350, 97.106, and 96.847 meters, respectively (table 2). The recurrence interval of the peak discharge is 6 years (Haines, 1973). See figure 4.

FLOOD OF DECEMBER 21, 1972

Peak water-surface elevations for the flood of December 21, 1972, are shown on sheet 4. The flood crested at an elevation of 97.917 meters at the reference point located on the downstream guardrail. The peak discharge was 118 cubic meters per second. A discharge of 117 cubic meters per second was measured at an elevation of 97.914 meters, 0.003 meters below the crest elevation (table 2). The measured cross section and velocity distribution are shown on sheet 4. The recurrence interval of the peak discharge is 28 years (Haines, 1973). See figure 4.

SUMMARY

Floodflow data that will provide a base for evaluating digital models relating to open-channel flow were obtained at 22 sites on streams in Alabama, Louisiana, and Mississippi. Thirty-five floods were measured. Analysis of the data indicated that backwater and discharges computed by standard indirect methods currently in use would be inaccurate where densely vegetated flood plains are crossed by highway embankments and single-opening bridges. This atlas presents flood information at the site on Buckhorn Creek near Shiloh, Ala. Water depths, velocities, and discharges through bridge openings on Buckhorn Creek near Shiloh, Ala., for floods of March 2, 1972, and December 21, 1972 were measured, together with peak water-surface elevations along embankments and along cross sections. Manning's roughness coefficient values in different parts of the flood plain are shown on maps, and flood-frequency relations are shown on graphs.

ADDITIONAL INFORMATION

Other information pertaining to floods in Alabama, Louisiana, and Mississippi may be obtained at the offices of the U.S. Geological Survey listed below:

U.S. Geological Survey
Room 202, Oil and Gas Board Building (P.O. Box V)
University, Alabama 35486

U.S. Geological Survey
6554 Florida Boulevard (P.O. Box 66492)
Baton Rouge, Louisiana 70896

U.S. Geological Survey
430 Bounds Street
Jackson, Mississippi 39206

SELECTED REFERENCES

Barnes, H. H., Jr., 1967, Roughness characteristics of natural channels: U.S. Geol. Survey Water Supply Paper 1849, 213 p.

Benson, M. A., and Dalrymple, T., 1967, General field and office procedures for indirect discharge measurements: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. Al, 30 p.

Bradley, J. N., 1970, Hydraulics of bridge waterways: Federal Highway Admin., Hydraulic Design Ser. No. 1, 111 p.

Colson, B. E., and Hudson, J. W., 1976, Flood frequency of Mississippi streams: Mississippi State Highway Dept., 34 p.

Hains, C. F., 1973, Floods in Alabama, magnitude and frequency: Alabama Highway Dept., 37 p.

Hedman, E. R., 1964, Effects of spur dikes on flow through constrictions: Am. Soc. Civil Engineers Proc., Jour. Hydraulics Div., v. 91, no. HY4, July 1965, p. 155–165.

Matthai, H. F., 1967, Measurement of peak discharge at width contractions by indirect methods: U.S. Geol. Survey Techniques Water-Resources Inv., book 3, chap. A4, 44 p.

Neely, B. L., Jr., 1976, Floods in Louisiana, magnitude and frequency, 3d ed.: Louisiana Dept. Highways, 340 p.

Schneider, V. R., Board, J. W., Colson, B. E., Lee, F. N., and Druffel, L., 1976, Computation of backwater and discharge at width constrictions of heavily vegetated flood plains: U.S. Geol. Survey Water-Resources Inv. 76–129, 64 p.

U.S. Water Resources Council, 1977, Guidelines for determining flood flow frequency: Washington, D.C., U.S. Water Resources Council Bull. 17A, 163 p.

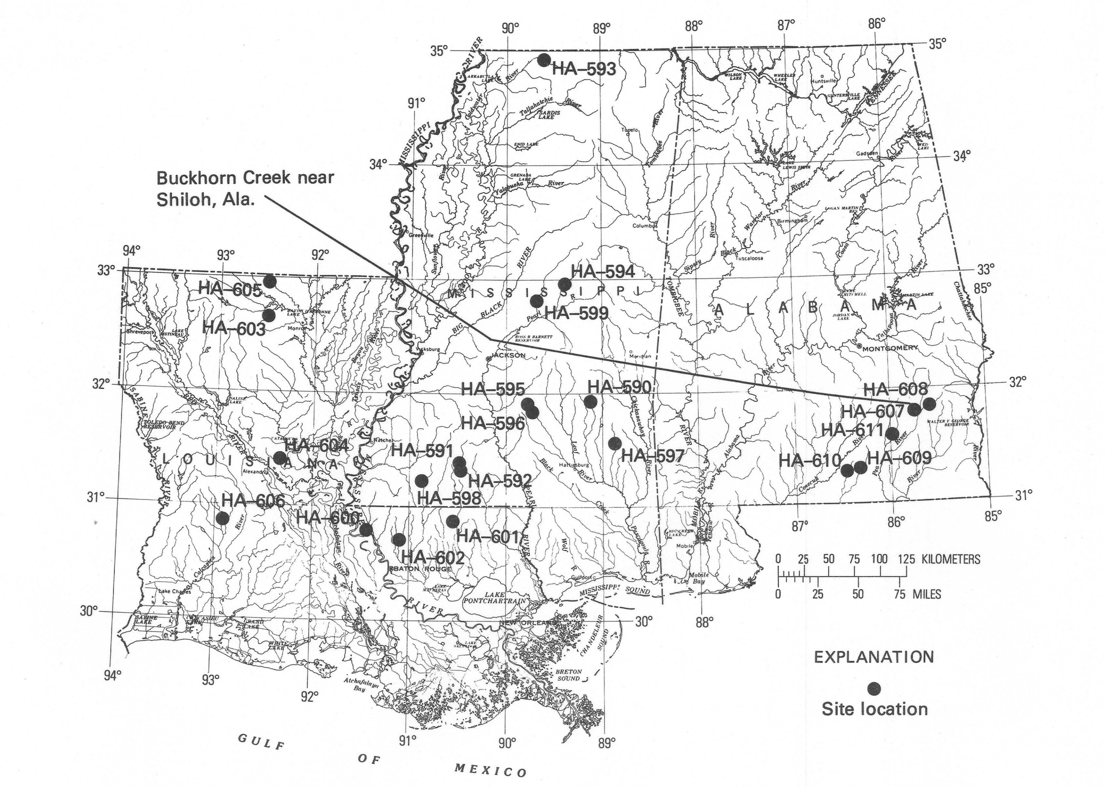

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

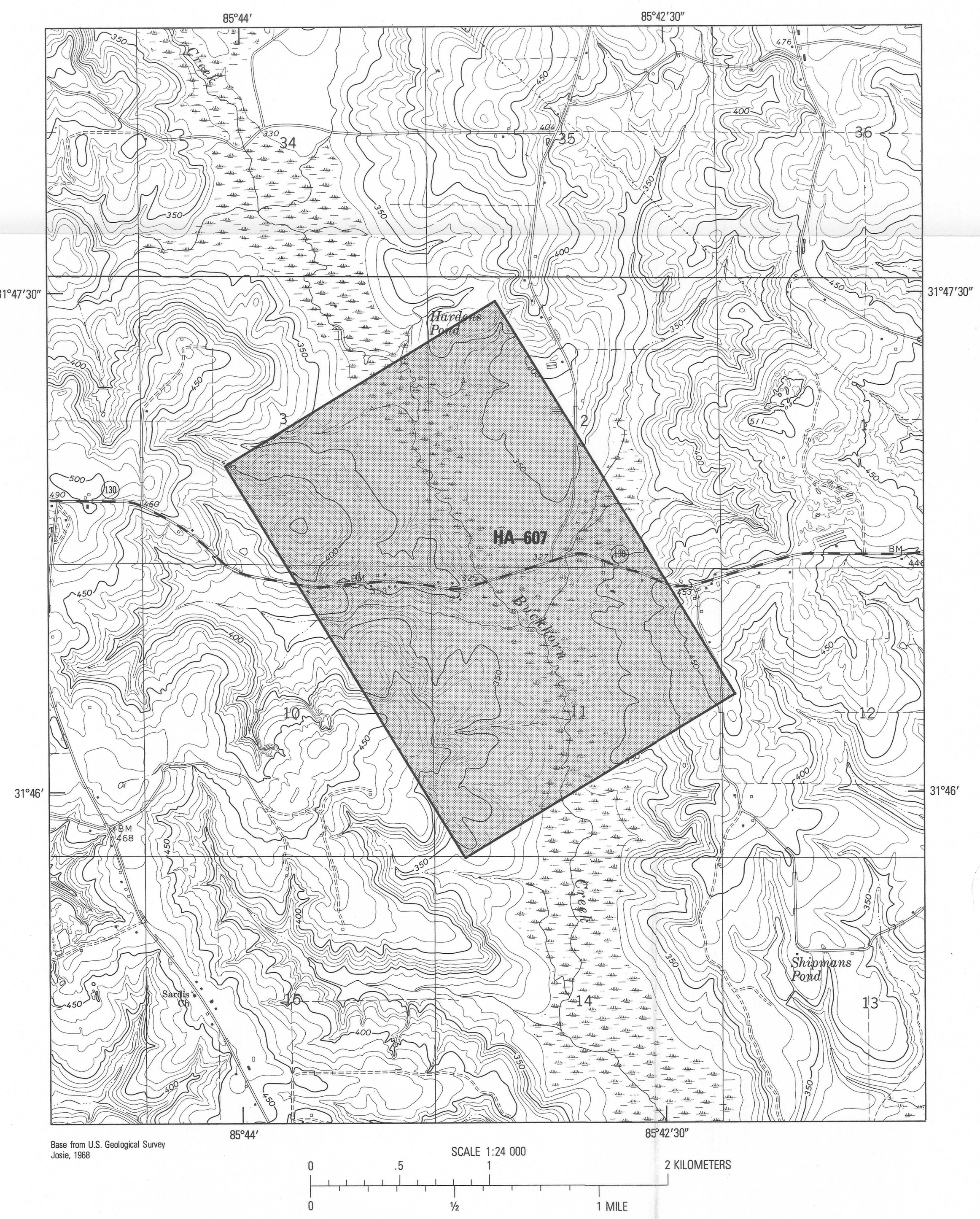

FIGURE 2.—INDEX MAP SHOWING STUDY REACH, BUCKHORN CREEK NEAR SHILOH, ALABAMA

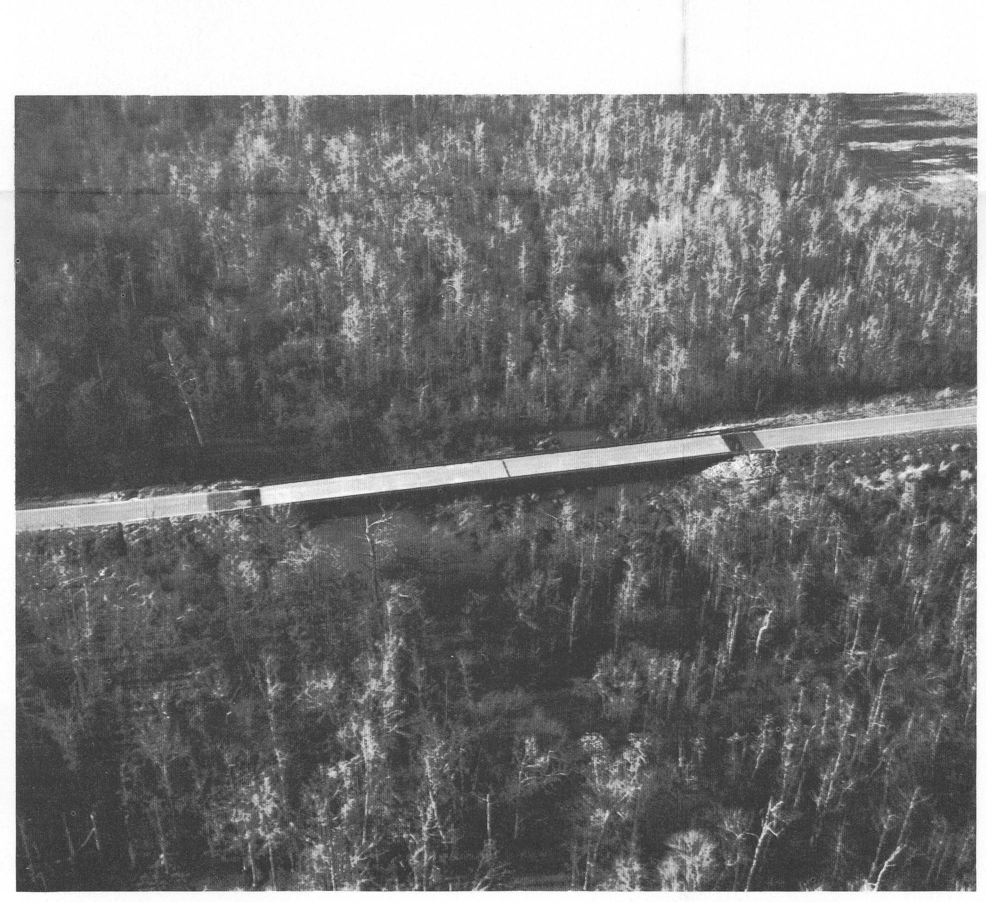

FIGURE 3—AERIAL VIEW LOOKING UPSTREAM AT BRIDGE ON STATE HIGHWAY 130, BUCKHORN CREEK NEAR SHILOH, ALABAMA

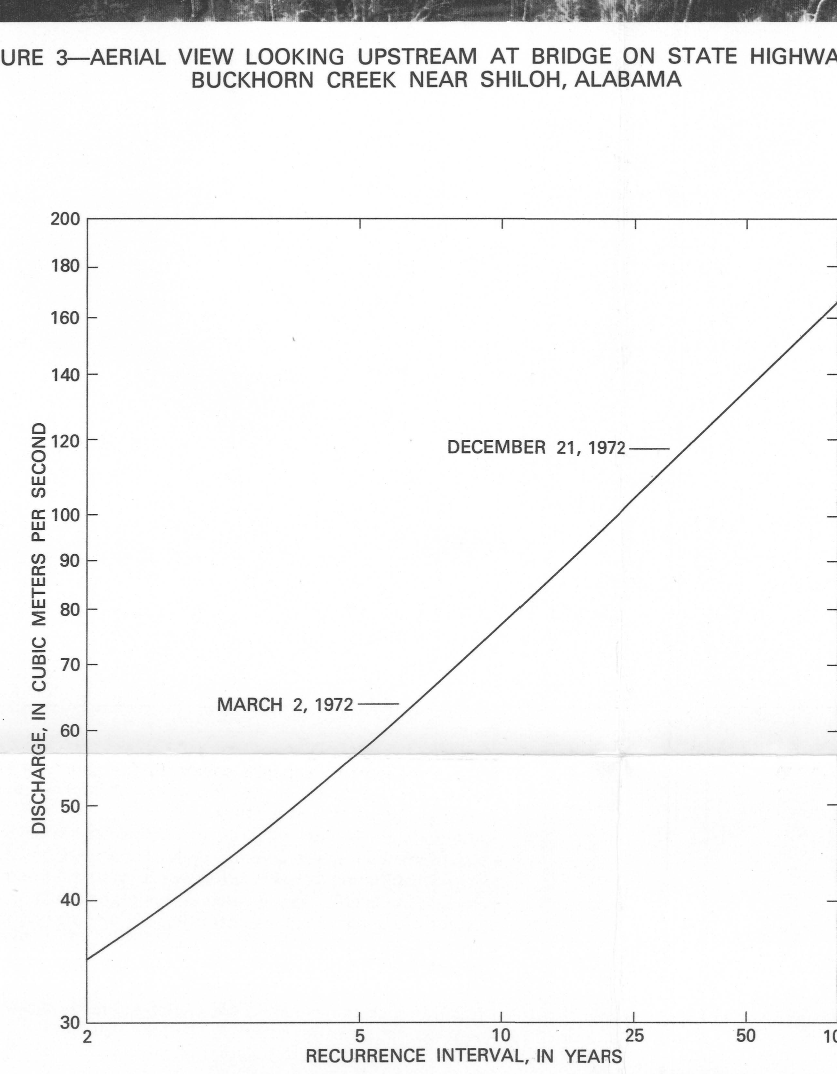

FIGURE 4—FREQUENCY OF FLOODS, BUCKHORN CREEK NEAR SHILOH, ALABAMA

TABLE 1—VALLEY CROSS SECTION DATA FOR BUCKHORN CREEK NEAR SHILOH, ALABAMA. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM).

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	97.24
3	96.81
6	95.93
24	95.08
29	94.80
37	94.44
40	94.71
50	94.83
70	94.89
76	94.95
82	94.19
88	94.47
90	94.92
113	95.05
119	95.14
155	95.29
157	94.65
162	93.70
163	93.86
166	93.83
168	93.89
169	94.62
174	94.98
192	95.11
209	94.59
213	94.44
221	94.62
224	94.98
244	94.92
291	94.92
299	95.11
305	95.35
308	95.93
311	97.06
315	97.67
322	98.79

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	97.55
8	97.48
26	96.78
30	96.39
34	96.26
46	95.84
67	95.53
81	95.81
99	95.26
101	94.95
104	94.56
107	94.95
120	95.17
123	94.95
126	94.31
130	94.95
139	95.41
145	95.35
154	95.02
158	94.68
165	94.56
169	94.98
175	95.26
189	95.29
190	94.98
192	94.50
198	94.59
203	94.59
206	94.95
207	95.35
213	95.38
229	95.59
242	95.66
253	95.81
268	96.17
283	96.26
288	96.66
299	97.27
312	98.46

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	98.15
5	97.45
11	96.72
15	96.02
55	95.96
85	95.78
108	95.90
134	95.78
152	95.72
160	95.84
192	95.90
207	95.62
223	95.93
238	95.78
241	95.05
244	94.28
245	94.80
247	95.26
248	95.17
250	95.78
251	95.93
265	95.90
280	95.99
299	95.90
314	95.75
323	95.93
332	95.99
343	96.72
347	97.03
351	97.39
357	98.76

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	98.55
9	97.82
15	97.30
24	97.09
27	97.03
37	96.90
73	96.23
116	96.23
158	96.33
168	96.11
195	96.08
198	96.02
206	95.05
209	95.08
215	95.99
226	96.14
238	96.02
244	94.19
247	95.08
248	95.47
251	96.05
258	96.14
276	96.20
299	96.20
311	96.30
323	97.09
329	97.33
347	97.36
363	97.00
363	96.63
366	97.42

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	98.55
12	97.82
15	97.30
21	97.21
30	97.03
34	97.00
37	96.90
107	97.15
169	96.63
184	96.63
186	96.81
189	96.84
192	96.72
194	96.54
210	96.69
229	96.69
238	96.20
245	96.08
250	96.17
256	96.17
262	96.11
274	95.81
280	96.20
294	96.02
299	95.08
306	94.77
308	95.41
320	96.33
340	96.51
347	96.20
352	95.90
364	96.20
369	96.36
372	96.30
390	96.51
411	96.57
418	96.60
421	96.94
424	96.90
425	97.06
427	97.21
428	97.45
433	98.31
447	103.03

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	97.79
3	97.45
5	96.87
7	96.45
9	96.14
12	96.02
21	96.05
30	96.08
37	96.14
43	96.11
49	96.17
55	96.05
57	95.81
59	95.81
61	95.56
63	95.08
64	94.56
66	94.38
67	93.98
69	93.77
70	94.74
72	95.08
73	95.93
74	96.26
75	96.45
76	96.97
78	97.45
78	97.51

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	98.76
12	98.03
23	97.55
27	97.30
34	97.24
43	96.30
52	96.54
104	96.63
126	96.39
134	96.08
143	96.48
152	96.33
154	96.11
157	96.36
159	96.30
171	96.30
177	96.26
190	95.81
197	95.29
201	96.11
216	96.45
226	95.78
230	96.26
233	95.53
235	95.53
244	96.30
253	96.42
277	97.03
283	97.55
287	98.00
299	99.16

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	99.19
18	97.85
21	97.79
23	97.61
27	96.84
34	96.69
38	96.57
41	96.23
44	95.50
46	95.90
51	96.78
66	95.87
71	96.14
94	96.48
97	96.08
99	95.72
101	95.87
101	96.14
109	96.20
121	95.62
122	95.81
123	96.02
125	96.69
134	96.78
146	96.63
149	96.39
152	96.60
165	96.57
202	97.33
210	97.85
218	98.34
244	101.63

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	100.90
24	99.07
26	98.61
27	98.09
30	97.61
37	97.03
53	97.33
55	97.06
58	96.45
59	96.14
61	96.42
62	96.48
66	97.06
79	97.24
98	97.12
104	97.03
107	96.72
114	96.69
117	97.03
123	97.15
135	97.09
146	96.90
165	97.06
176	97.09
177	96.57
178	96.57
180	97.21
180	96.97
184	97.15
201	96.97
226	96.60
226	96.81
227	97.00
236	97.00
249	97.03
271	97.00
293	97.00
294	96.81
296	96.69
299	97.15
320	97.24
344	96.81
354	96.94
367	97.18
373	98.09
378	98.79
393	100.11

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	99.68
8	98.58
9	98.37
12	97.73
71	97.39
120	97.51
126	97.51
186	97.55
241	97.58
290	97.88
328	98.22
344	98.37
370	98.55
396	98.61
427	98.92
433	99.22

TABLE 2—DISCHARGE MEASUREMENTS MARCH 2, MARCH 3, AND DECEMBER 21, 1972, BUCKHORN CREEK NEAR SHILOH, ALABAMA. ZERO STATION IS AT THE LEFT EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM)

DISCHARGE MEASUREMENT OF MARCH 2, 1972 BUCKHORN CREEK NEAR SHILOH, ALABAMA (WATER-SURFACE ELEVATION=97.350 METERS) TOTAL DISCHARGE=55.8 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
3.7	0.0	0	0.0	0.0
6.1	0.64	180	0.6	0.091
9.1	1.22	31	0.2	1.305
			0.8	0.893
12.2	1.31	29	0.2	0.713
			0.8	0.238
15.2	1.77	23	0.2	0.713
			0.8	0.134
18.3	2.19	11	0.2	0.274
			0.8	0.332
21.3	1.95	0	0.2	0.640
			0.8	0.393
24.4	1.62	0	0.2	0.625
			0.8	0.561
27.4	1.34	0	0.6	0.527
30.5	1.22	0	0.6	0.625
33.5	1.22	0	0.6	0.573
36.6	1.19	0	0.6	0.317
39.6	1.16	0	0.6	0.152
42.7	1.19	0	0.6	0.411
45.7	1.28	0	0.6	0.262
48.8	1.10	0	0.6	0.134
51.8	1.19	0	0.6	0.131
54.9	1.31	0	0.6	0.332
57.9	1.49	0	0.2	0.655
			0.8	0.360
61.0	1.65	0	0.2	0.671
			0.8	0.262
64.0	2.59	0	0.2	0.613
			0.8	0.713
65.5	3.02	0	0.2	0.613
			0.8	0.424
67.1	3.38	0	0.2	0.856
			0.8	0.817
68.6	3.51	11	0.2	1.006
			0.8	0.936
70.1	2.26	23	0.2	0.799
			0.8	1.006
71.6	2.13	31	0.2	0.762
			0.8	0.728
73.2	1.43	31	0.2	0.686
			0.8	0.573
74.7	0.91	36	0.6	0.875
77.1	0.0	0	0.0	0.0

DISCHARGE MEASUREMENT OF MARCH 2, 1972 BUCKHORN CREEK NEAR SHILOH, ALABAMA (WATER-SURFACE ELEVATION=97.106 METERS) TOTAL DISCHARGE=43.0 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
4.6	0.0	0	0.0	0.0
9.1	0.88	31	0.6	1.116
12.2	1.07	29	0.6	0.341
15.2	1.43	23	0.2	0.323
			0.8	0.128
18.3	1.83	11	0.2	0.384
			0.8	0.323
21.3	1.68	0	0.2	0.613
			0.8	0.472
24.4	1.37	0	0.6	0.600
27.4	1.07	0	0.6	0.539
30.5	0.91	0	0.6	0.613
33.5	0.91	0	0.6	0.628
36.6	0.85	0	0.6	0.506
39.6	0.91	0	0.6	0.482
42.7	0.94	0	0.6	0.643
45.7	0.94	0	0.6	0.451
48.8	0.85	0	0.6	0.162
51.8	0.91	0	0.6	0.311
54.9	1.04	11	0.6	0.347
57.9	1.22	25	0.2	0.482
			0.8	0.472
61.0	1.37	25	0.2	0.494
			0.8	0.482
62.5	1.68	31	0.2	0.674
			0.8	0.561
64.0	2.44	36	0.2	0.674
			0.8	0.573
65.5	2.87	36	0.2	0.820
			0.8	0.552
67.1	2.99	36	0.2	0.780
			0.8	0.658
68.6	2.96	36	0.2	0.658
			0.8	0.658
70.1	1.62	28	0.2	0.658
			0.8	0.747
73.2	0.91	0	0.6	0.600
76.2	0.0	0	0.0	0.0

DISCHARGE MEASUREMENT OF MARCH 3, 1972 BUCKHORN CREEK NEAR SHILOH, ALABAMA (WATER-SURFACE ELEVATION=96.847 METERS) TOTAL DISCHARGE=25.3 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
5.2	0.0	0	0.0	0.0
9.1	0.73	31	0.6	0.613
12.2	0.76	29	0.6	0.235
15.2	1.22	23	0.6	0.104
18.3	1.65	11	0.2	0.268
			0.8	0.219
21.3	1.37	0	0.2	0.384
			0.8	0.259
24.4	1.10	0	0.6	0.393
27.4	0.85	0	0.6	0.442
30.5	0.70	0	0.6	0.347
33.5	0.70	0	0.6	0.460
36.6	0.61	0	0.6	0.323
39.6	0.67	0	0.6	0.165
42.7	0.73	0	0.6	0.341
45.7	0.73	0	0.6	0.192
48.8	0.61	0	0.6	0.155
51.8	0.61	0	0.6	0.140
54.9	0.76	11	0.6	0.256
57.9	0.98	25	0.6	0.384
61.0	1.22	25	0.2	0.561
			0.8	0.402
62.5	1.55	31	0.2	0.628
			0.8	0.472
64.0	2.29	36	0.2	0.561
			0.8	0.433
65.5	2.59	36	0.2	0.506
			0.8	0.393
67.1	2.83	36	0.2	0.482
			0.8	0.451
68.6	2.90	36	0.2	0.494
			0.8	0.530
70.1	1.52	28	0.2	0.518
			0.8	0.573
71.6	1.58	11	0.2	0.539
			0.8	0.585
73.2	0.91	8	0.6	0.643
75.6	0.0	0	0.0	0.0

DISCHARGE MEASUREMENT OF DECEMBER 21, 1972 BUCKHORN CREEK NEAR SHILOH, ALABAMA (WATER-SURFACE ELEVATION=97.914 METERS) TOTAL DISCHARGE=117 CUBIC METERS PER SECOND

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
0.0	0.0	0	0.0	0.0
1.5	0.15	0	0.6	0.671
3.0	0.30	0	0.6	2.012
4.6	0.85	0	0.6	2.012
6.1	1.22	0	0.6	1.564
7.6	1.52	0	0.6	1.753
9.1	1.83	19	0.2	1.253
			0.8	1.122
12.2	1.86	16	0.2	0.805
			0.8	0.631
15.2	2.41	11	0.2	0.844
			0.8	0.378
18.3	2.77	0	0.2	0.646
			0.8	0.604
21.3	2.44	0	0.2	0.604
			0.8	0.567
24.4	2.10	0	0.2	0.735
			0.8	0.408
27.4	1.92	0	0.2	0.719
			0.8	0.579
30.5	1.74	0	0.2	0.844
			0.8	0.378
33.5	1.74	0	0.2	0.677
			0.8	0.661
36.6	1.65	0	0.2	0.963
			0.8	0.445
39.6	1.71	0	0.2	0.677
			0.8	0.509
42.7	1.77	0	0.2	0.677
			0.8	0.515
45.7	1.80	0	0.2	0.485
			0.8	0.287
48.8	1.68	0	0.2	0.533
			0.8	0.256
51.8	1.71	0	0.2	0.567
			0.8	0.305
54.9	1.80	0	0.2	0.311
			0.8	0.509
57.9	2.01	0	0.2	0.805
			0.8	0.677
61.0	2.29	0	0.2	0.899
			0.8	0.396
64.0	3.14	0	0.2	0.786
			0.8	1.170
65.5	3.54	0	0.2	0.844
			0.8	1.122
67.1	3.78	0	0.2	1.012
			0.8	1.253
68.6	3.99	0	0.2	1.170
			0.8	1.253
70.1	2.53	11	0.2	1.170
			0.8	1.430
73.2	2.16	11	0.2	1.283
			0.8	1.012
74.7	1.65	19	0.2	1.430
			0.8	1.100
76.2	0.79	0	0.6	0.0
78.0	0.0	0	0.0	0.0

[1] Observation depth is the ratio of the velocity-observation depth to the total depth at the station.

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