DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, THOMPSON CREEK NEAR CLARA, MISSISSIPPI

By B. E. Colson, C. O. Ming, and George J. Arcement

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

HYDROLOGIC INVESTIGATIONS ATLAS
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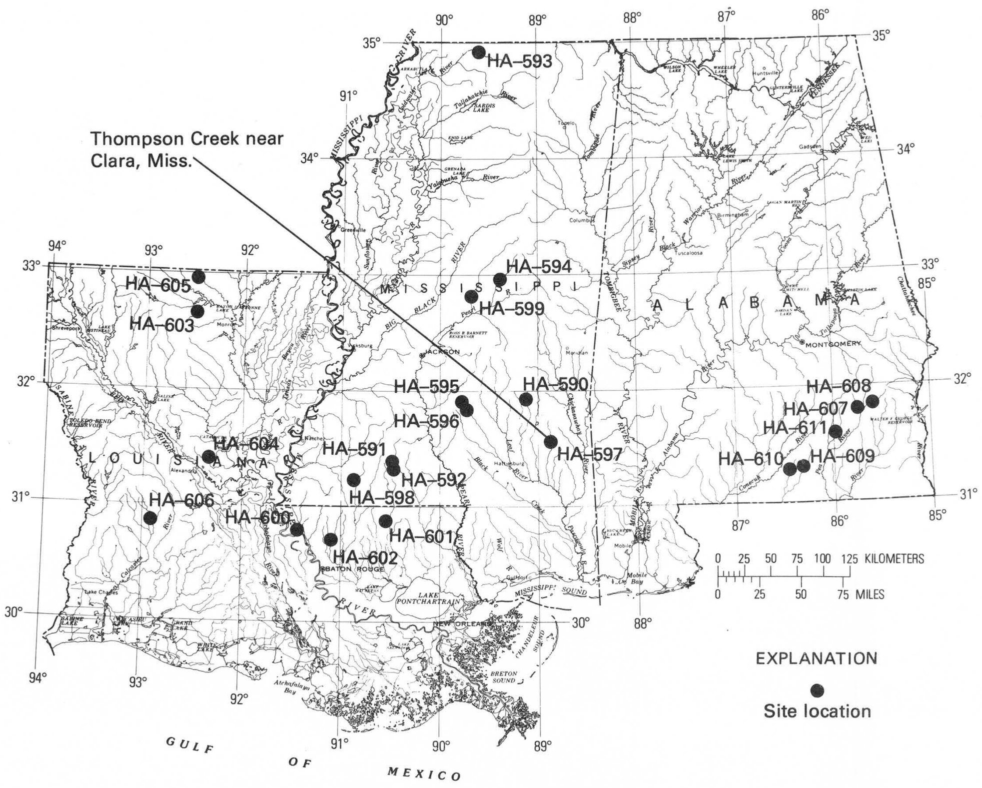

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

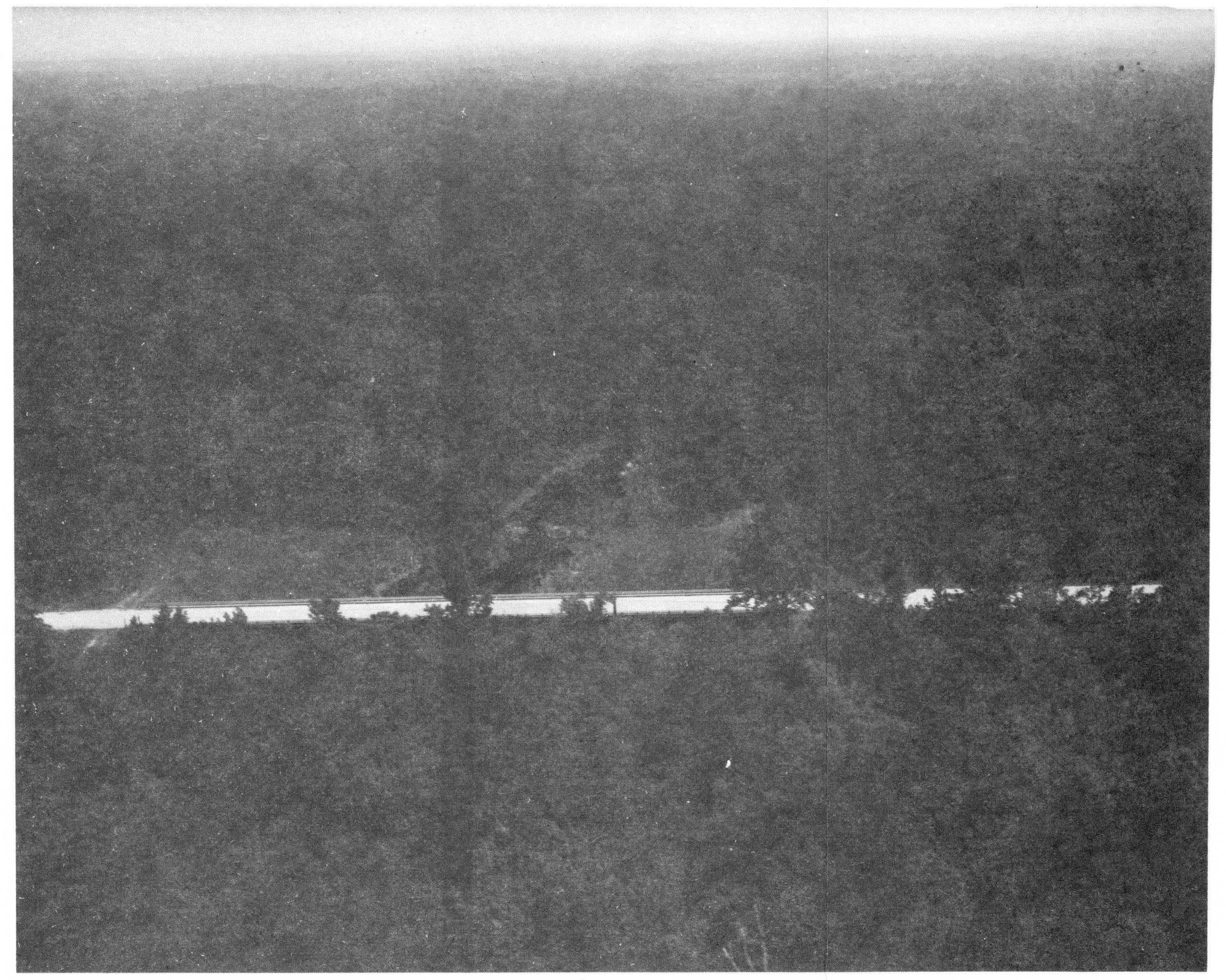

FIGURE 3—AERIAL VIEW LOOKING DOWNSTREAM IN VICINITY OF BRIDGE ON COUNTY ROAD NEAR CLARA, MISSISSIPPI

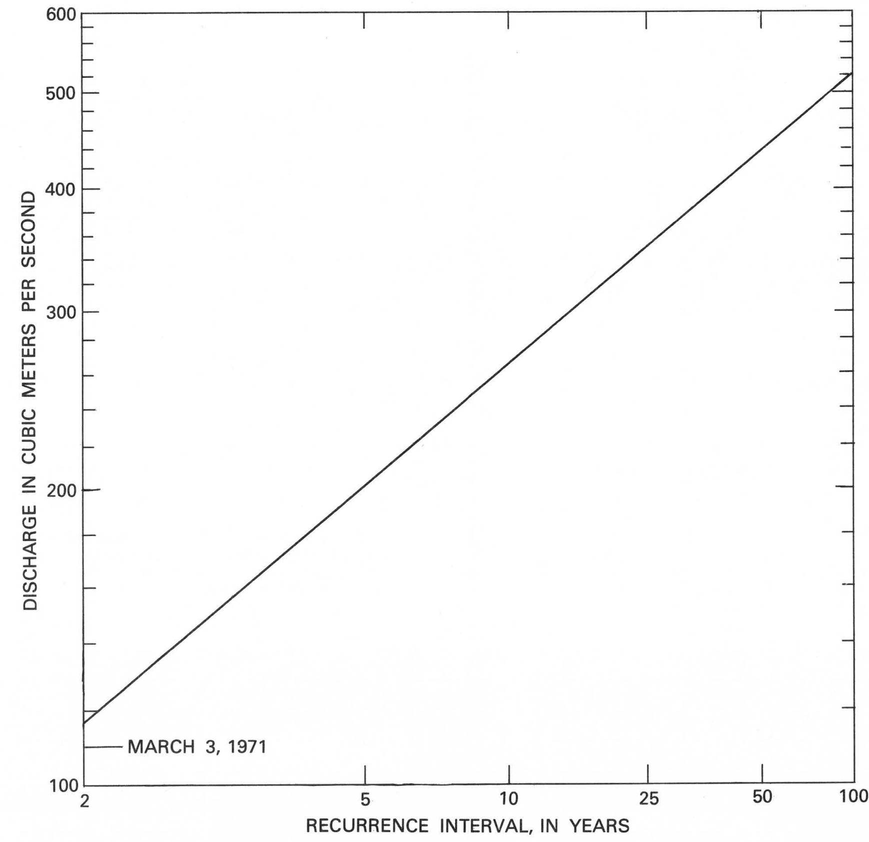

FIGURE 4—FREQUENCY OF FLOODS, THOMPSON CREEK NEAR CLARA, MISSISSIPPI

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, THOMPSON CREEK NEAR CLARA, MISSISSIPPI

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 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 present 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 Thompson Creek near Clara, Miss., one of the 22 sites.

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

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 aligned 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 downstreams 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 pertinent geometry were measured.

MANNING'S ROUGHNESS COEFFICIENT

Schneider and others (1976) used composite Manning's roughness coefficient values *n* where frequent changes in roughness occurred. In their study, composite values of *n* were verified by matching step backwater 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 U.S. 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 are presented graphically. Techniques for deriving flood-frequency relations are those described by the U.S. Water Resources Council (1977), and by (Colson and Hudson, 1976).

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 (m²)	10.76	Square feet (ft²)
	VOLUME	
Cubic meter (m³)	35.31	Cubic feet (ft³)
	VELOCITY	
Meter per second (m/s)	3.281	Feet per second (ft/s)
	FLOW RATE	
Cubic meter per second (m³/s)	35.31	Cubic feet per second (ft³/s)

DATA FOR THOMPSON CREEK NEAR CLARA, MISSISSIPPI

Data for Thompson Creek near Clara, Miss., obtained in a 6-kilometer reach crossed about midway by a county road are presented on three sheets (fig. 2). Sheet 1 presents tables showing cross-section data (table 1) and discharge data (table 2). An aerial view looking downstream in the vicinity of 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 elevation and alinement of the axis. 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 flood. The cross section surveyed at the downstream side of the bridge is tabulated on sheet 1. The cross section shown for velocity distribution was obtained by sounding from the upstream side of the bridge during the discharge measurement.

Data for the flood of March 3, 1971, on Thompson Creek are presented (sheet 3). Ten cross sections were surveyed after this flood (sheet 2).

Manning's roughness coefficient values and the 1971 flood boundaries are shown on sheets 2 and 3.

FLOOD OF MARCH 3, 1971

Peak water-surface elevations, the measured cross section, and velocities for the flood of March 3, 1971, are shown on sheet 3. The flood crested at an elevation of 60.896 meters at the reference point located on the downstream guardrail 60 meters from the left abutment. The measured peak discharge was 108 cubic meters per second (m³/s), at an elevation of 60.875 meters at the reference point (table 2). The recurrence interval of the peak discharge is less than 2 years (Colson and Hudson, 1976). 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 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 Thompson Creek near Clara, Miss. Water depths, velocities, and discharges through bridge openings on Thompson Creek near Clara, Miss., for flood of March 3, 1971, are shown, 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 a graph.

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. A1, 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.

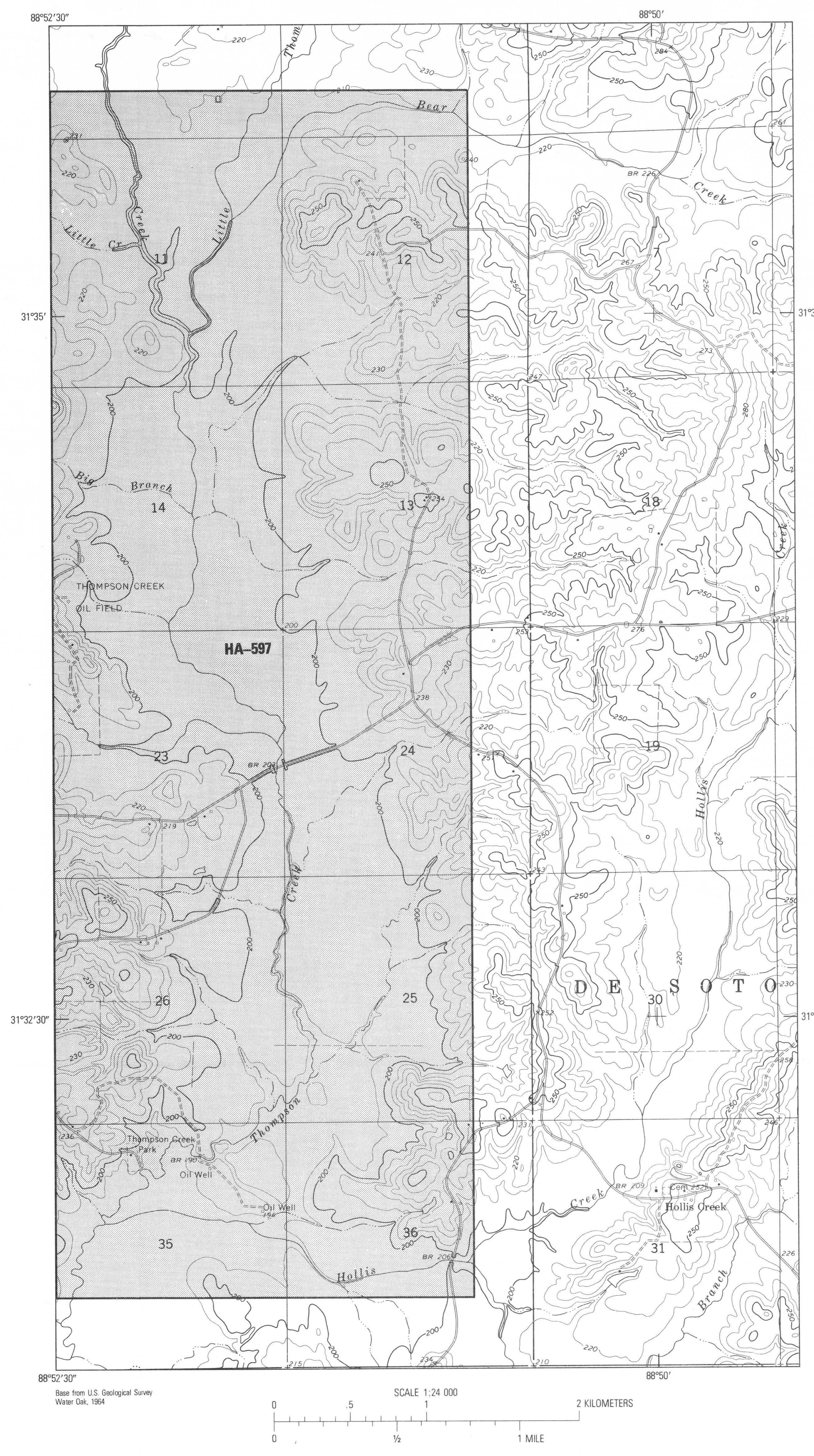

FIGURE 2—INDEX MAP OF STUDY REACH, THOMPSON CREEK NEAR CLARA, MISSISSIPPI

TABLE 1.—VALLEY CROSS-SECTION DATA FOR THOMPSON CREEK NEAR CLARA, MISSISSIPPI. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM).

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	60.50
2	60.23
9	59.47
14	58.70
21	58.80
22	57.49
27	57.49
27	58.64
29	58.83
41	58.58
57	58.49
90	58.64
97	58.86
101	58.80
135	58.37
151	58.40
175	58.31
202	58.31
217	58.34
244	58.28
272	58.19
287	58.16
330	58.16
356	58.09
367	58.13
395	58.28
413	58.19
430	58.19
447	58.28
471	58.28
515	58.19
530	58.13
554	57.94
557	56.14
561	55.23
564	56.14
567	56.91
568	57.21
571	57.24
576	57.06
580	56.63
583	56.42
585	56.48
586	56.30
588	56.88
589	57.67
604	57.94
612	57.45
628	57.58
652	57.76
664	57.91
671	58.13
691	58.28
697	58.25
713	57.88
714	57.85
722	57.27
725	57.58
736	58.00
746	58.43
753	60.23
753	60.93

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	60.35
24	58.73
30	58.55
58	58.40
75	58.28
97	58.40
125	58.37
158	58.40
166	58.34
209	58.40
225	58.22
257	58.22
296	58.22
342	58.25
386	58.25
419	58.25
436	58.22
475	58.31
494	58.16
529	58.25
545	58.28
557	58.83
569	58.70
597	58.37
632	58.34
633	58.46
655	56.02
662	56.54

CROSS SECTION 2 (con't.)

673	56.85
685	54.99
688	57.45
693	57.64
714	57.06
726	56.69
734	58.28
748	58.06
764	57.12
769	58.16
779	57.67
798	58.55
839	58.40
866	58.37
913	58.28
949	57.97
966	58.13
977	58.03
990	57.00
1002	57.73
1038	58.43
1054	58.52
1080	58.98
1103	58.73
1113	58.86
1159	61.36

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	61.69
21	60.08
40	59.59
52	59.56
66	59.53
91	59.53
140	59.41
166	59.44
200	59.19
201	59.07
323	59.07
333	59.04
378	58.98
400	59.01
428	59.10
495	59.19
519	59.19
546	59.25
600	59.22
627	59.22
641	59.22
673	59.22
680	58.49
683	57.85
685	57.97
687	59.19
703	59.31
734	59.53
764	59.16
770	57.70
778	58.37
789	58.95
794	57.88
799	58.55
808	58.83
809	57.85
815	57.06
816	57.79
817	58.58
824	59.04
829	58.70
842	59.44
867	59.38
883	58.95
885	57.91
887	57.79
888	57.55
892	57.42
895	57.79
896	58.19
898	59.22
899	59.22
907	58.09
923	59.25
928	58.73
938	58.55
941	59.01
953	58.31
955	58.52
962	59.22
1017	59.13
1036	59.22
1053	59.07
1067	59.10
1077	59.10
1095	59.74

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	62.03
9	61.14
29	60.14
50	59.80
62	59.77
93	59.83
108	59.77
112	59.80
144	59.80
163	59.71
188	59.68
205	59.62
209	59.71
228	59.59
272	59.59
283	59.50
291	59.56
340	59.56
346	59.56
366	59.68
422	59.10
465	59.62
485	59.59
497	59.56
543	59.34
557	59.62
579	59.80
607	58.28
621	58.28
622	59.41
643	59.71
649	59.56
660	59.47
660	59.47
684	58.70
687	59.47
705	59.01
721	59.83
723	58.03
730	55.29
739	58.31
759	57.94
763	59.19
772	58.58
781	59.83
790	59.50
846	59.28
854	60.53
932	63.19

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	60.84
0	59.56
2	59.41
3	59.71
8	59.80
15	59.83
20	59.53
26	59.34
30	59.77
38	59.98
41	59.80
47	59.28
52	59.68
56	59.83
59	58.09
62	58.40
67	58.58
69	58.13
70	57.15
72	57.00
73	58.13
75	58.67
76	58.89
78	58.37
79	59.19
81	61.57

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	61.54
18	60.75
37	59.74
67	59.80
79	59.74
116	59.89
180	59.98
216	60.11
262	59.98
308	60.11
363	59.89
369	59.65
390	59.65
392	57.82
393	57.58
395	57.00
399	59.65
445	59.65
472	59.95
494	59.95
561	59.92
625	59.86
646	60.11
674	61.42

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	61.42
16	61.42
30	60.93
37	59.83
54	59.83
77	60.17
99	60.02
121	59.83
129	59.92
139	60.38
152	60.32
170	59.98
191	59.98
211	59.98
242	60.11
252	60.26
258	60.32
262	58.22
266	57.06
270	58.22
272	59.59
290	59.65
305	59.80
323	59.71
335	59.65
351	59.68
372	59.56
393	59.28
397	58.86
408	59.65
420	58.98
429	59.59
434	59.71
436	58.19
442	58.19
447	59.38
461	59.50
471	60.08
489	60.02
506	59.98
536	59.98
557	60.02
574	59.98
593	60.02
614	60.08
645	60.05
647	59.86
653	59.89
664	60.14
691	60.47
695	60.29
701	60.29
704	61.02
707	61.42

CROSS SECTION 7

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	62.58
6	61.63
13	60.99
28	60.23
58	59.95
77	59.92
120	59.95
163	60.17
163	57.33
168	56.97
170	59.34
176	59.89
188	59.86
217	60.38
230	59.80
244	60.26
286	60.11
369	60.17
430	60.20
461	60.11
492	60.08
566	59.92
598	60.11
625	59.41
627	58.77
629	59.34
643	59.62
699	59.86
888	60.14
919	60.38
1002	60.62
1066	60.59
1138	60.75
1214	61.36
1225	62.58
1294	64.47

CROSS SECTION 8

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	62.79
0	61.54
30	61.23
97	60.90
167	60.87
210	60.84
230	60.78
287	60.26
294	60.81

CROSS SECTION 8 (con't.)

300	59.62
319	60.59
332	59.80
334	58.89
340	58.70
344	60.90
353	60.90
369	60.78
389	60.66
397	60.26
404	60.90
440	60.90
476	60.78
561	60.75
613	60.66
645	60.66
713	60.62
760	60.72
842	60.66
892	60.41
931	60.59
945	60.53
972	60.66
1041	60.50
1063	60.62
1093	60.56
1113	60.66
1166	60.90
1205	61.17
1258	61.75
1298	62.91

CROSS SECTION 9

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	65.01
3	63.61
15	61.87
45	60.84
62	61.14
157	61.20
218	60.75
254	61.17
341	61.14
414	61.33
441	61.36
498	61.42
535	61.30
569	61.33
582	60.29
590	61.26
599	61.26
610	59.98
620	61.36
696	61.45
715	61.23
781	61.75
785	60.26
786	58.49
794	59.71
795	60.14
796	61.63
809	61.54
844	61.42
846	60.59
848	60.08
851	60.66
852	61.26
884	61.60
961	61.42
1066	61.30
1176	61.36
1280	61.63
1410	62.12
1465	62.42
1503	65.35

CROSS SECTION 10

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	65.26
40	62.27
190	62.18
261	62.00
296	62.09
440	62.09
511	62.30
526	62.09
549	61.94
560	60.66
565	61.54
578	61.30
580	60.02
583	60.20
587	61.72
598	61.97
614	61.84
633	60.53
636	60.69
639	62.09
684	62.09
732	61.97
747	62.03
776	61.81
784	62.03
804	61.84
809	60.62
811	60.11
817	60.08
820	61.14
823	59.59
825	59.50
827	59.68
831	61.11
839	61.45
848	60.62
854	61.36
867	64.62

TABLE 2.—DISCHARGE MEASUREMENT MARCH 3, 1971, THOMPSON CREEK NEAR CLARA, MISSISSIPPI. ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM).

DISCHARGE MEASUREMENT MARCH 3, 1971, THOMPSON CREEK AT COUNTY HIGHWAY NEAR CLARA, MISS. (WATER-SURFACE ELEVATION=60.875 METERS) TOTAL DISCHARGE=108 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
1.2	0.98	0	0.6	0.314
3.4	1.62	0	0.2	0.399
			0.8	0.085
6.4	1.92	0	0.2	0.546
			0.8	0.157
9.4	1.89	0	0.2	0.805
			0.8	0.299
12.5	1.89	0	0.2	0.920
			0.8	0.466
15.5	1.95	0	0.2	1.012
			0.8	0.619
18.6	2.04	0	0.2	1.058
			0.8	0.631
21.6	2.07	0	0.2	1.100
			0.8	0.692
24.7	2.19	0	0.2	1.058
			0.8	0.555
27.7	2.23	0	0.2	1.225
			0.8	0.661
30.8	2.29	0	0.2	1.372
			0.8	1.100
33.8	2.41	8	0.2	1.283
			0.8	0.631
38.9	2.65	11	0.2	1.253
			0.8	0.680
39.9	2.59	14	0.2	1.125
			0.8	0.646
43.0	2.56	11	0.2	0.988
			0.8	0.454
46.0	2.56	11	0.2	0.622
			0.8	0.567
47.5	2.96	8	0.2	0.768
			0.8	0.719
49.1	3.02	8	0.2	0.692
			0.8	0.805
50.6	3.35	11	0.2	0.661
			0.8	0.661
52.1	3.51	11	0.2	0.591
			0.8	0.488
53.6	3.17	8	0.2	0.500
			0.8	0.454
55.2	2.59	8	0.2	0.546
			0.8	0.213
58.2	2.23	8	0.2	0.719
			0.8	0.390
61.3	2.19	8	0.2	0.844
			0.8	0.299
64.3	1.98	8	0.2	0.619
			0.8	0.344
67.4	1.85	0	0.2	0.418
			0.8	0.101
70.4	1.40	0	0.6	0.205
73.2	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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