ATLAS HA-605

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS, LITTLE BAYOU DE LOUTER NEAR TRUXNO, LOUISIANA

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Prepared in cooperation with the
DEPARTMENT OF TRANSPORTATION
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and the
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HYDROLOGIC INVESTIGATIONS ATLAS
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BACKWATER AT BRIDGES AND DENSELY WOODED FLOOD PLAINS LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA

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 Little Bayou de Loutre near Truxno, La., 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 eight 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 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 Neely (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 (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 LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA

Data for Little Bayou de Loutre near Truxno, La., obtained in a 2-kilometer reach crossed about midway by a parish road, are presented on three sheets. Sheet 1 contains tables showing cross-section data (table 1) and discharge data (table 2). A vicinity map showing the location of the site is shown in figure 2. An aerial view of the reach in the vicinity of the bridge is shown in figure 3. Relative magnitude of the flood is 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 axis. Stationing along cross sections was projected along straight lines perpendicular to the flow. Plots of the cross sections are graphic representations 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 downstream side of the bridge during the discharge measurement.

Data for the flood of April 22, 1974, are presented. Six valley cross sections were surveyed after this flood (sheet 2).

Manning's roughness coefficient values and the 1974 flood boundaries are shown on sheets 2 and 3.

FLOOD OF APRIL 22, 1974

Peak water-surface elevations, measured cross section, and velocities for the flood of April 22, 1974, are shown on sheet 3. The flood crested at an elevation of 38.225 meters at the reference point located on the downstream guardrail 25 meters from the left abutment. The peak discharge was 119 cubic meters per second, from a stage-discharge relation developed for the site. A discharge of 116 cubic meters per second (table 2) was measured at an elevation of 38.191 meters, 0.034 meters below the crest. The measured cross section and velocity distribution are shown on sheet 3. The recurrence interval of the peak discharge is 25 years (Neely, 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 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 Little Bayou de Loutre near Truxno, La. Water depths, velocities, and discharges through bridge openings for the flood of April 22, 1974, on Little Bayou de Loutre near Truxno, La., were measured, together with peak water surface elevations along embankments and along cross sections. Manning's roughness coefficients 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.

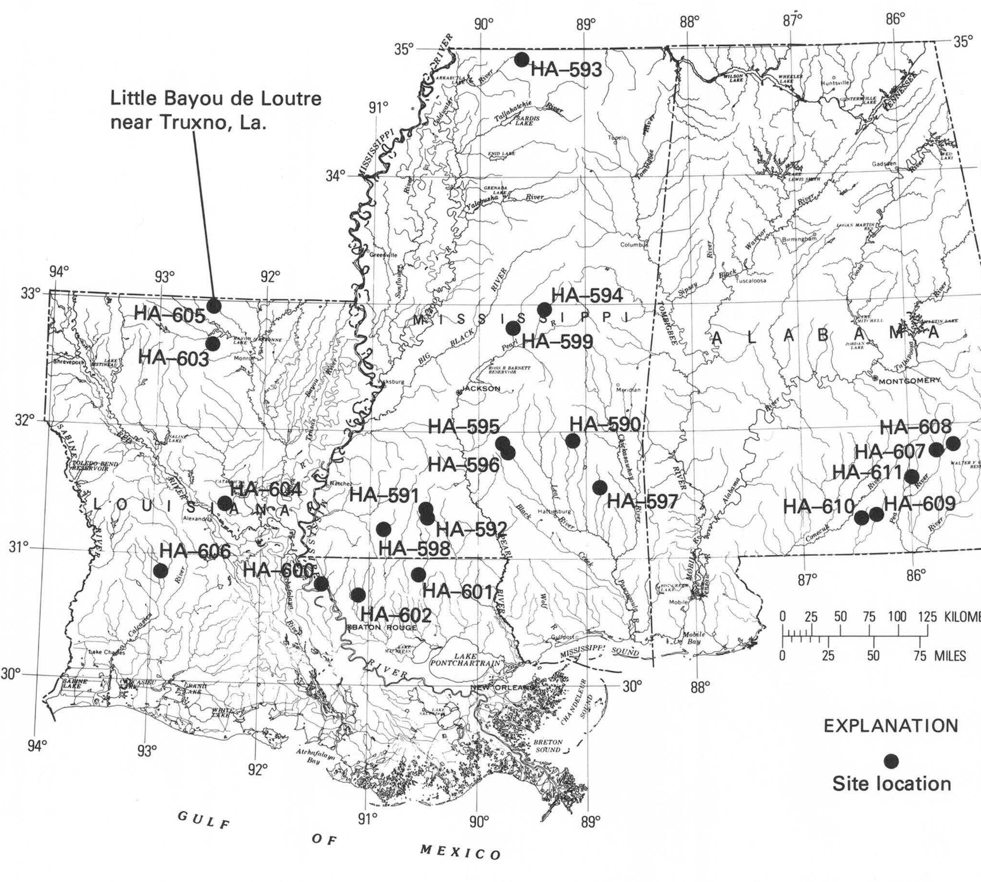

FIGURE 1.—INDEX MAP OF STUDY SITES IN THE BRIDGE BACKWATER INVESTIGATION PROJECT, ALABAMA, LOUISIANA, AND MISSISSIPPI.

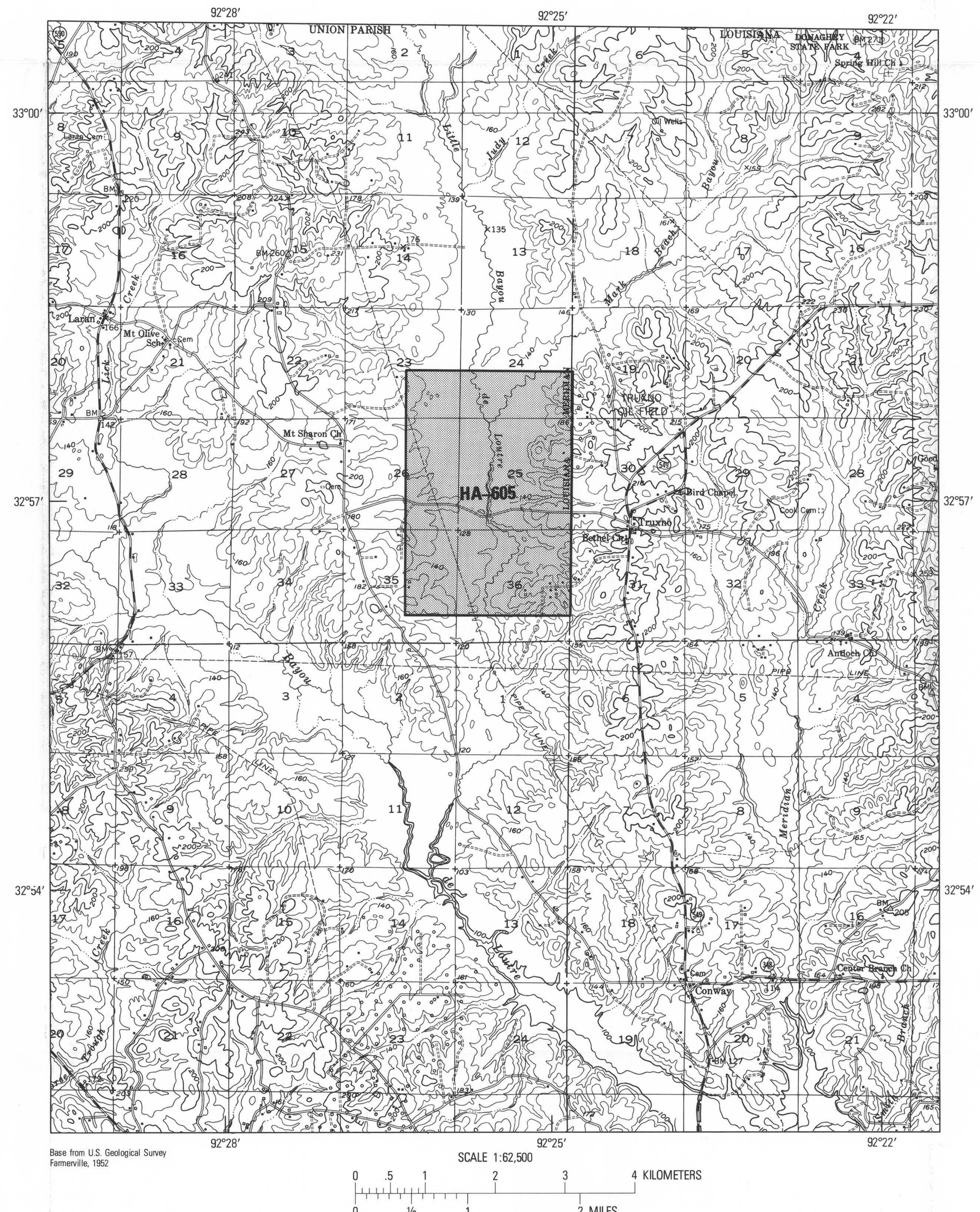

FIGURE 2—INDEX MAP SHOWING STUDY REACH, LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA

FIGURE 3—AERIAL VIEW LOOKING EASTWARD AT BRIDGE ON PARISH ROAD NEAR TRUXNO, LOUISIANA

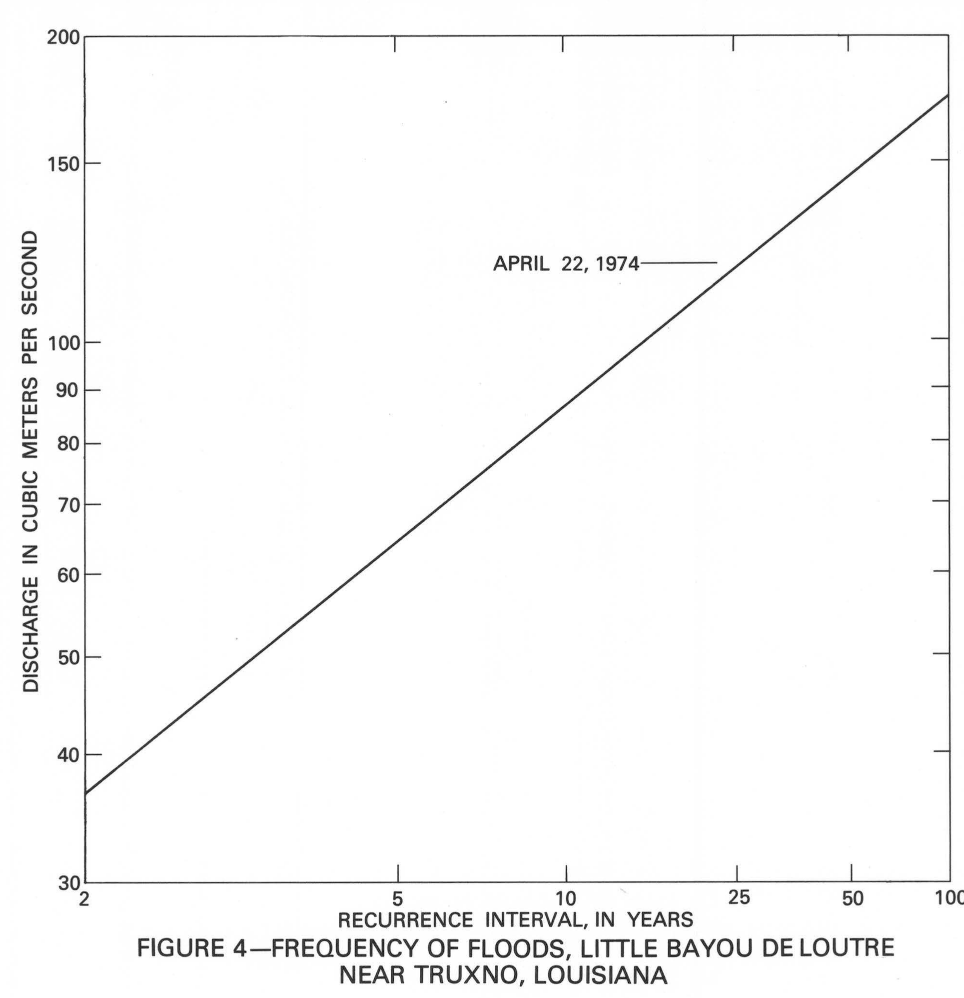

FIGURE 4—FREQUENCY OF FLOODS, LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA

TABLE 1—VALLEY CROSS-SECTION DATA FOR LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA. ZERO STATION IS AT THE LEFT EDGE OF THE VALLEY (FACING DOWNSTREAM)

CROSS SECTION 1

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	37.83
18	36.72
26	35.59
59	35.83
67	35.07
69	35.92
103	35.65
121	35.62
148	36.11
153	35.86
158	36.02
161	35.44
166	35.47
166	35.80
177	35.47
201	36.90
211	35.65
237	36.17
240	35.89
248	36.02
250	36.56
352	37.02
355	35.41
372	35.80
374	35.04
379	35.16
380	36.47
382	36.66
417	36.59
445	36.53
474	37.08
491	37.63
526	36.50
560	36.59
588	36.62
610	37.63
650	37.39
658	38.06
687	38.61
705	39.12

CROSS SECTION 2

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	39.03
8	37.14
17	36.50
34	35.95
65	36.41
77	35.89
83	35.95
94	35.98
99	36.05
103	36.20
108	36.20
113	35.62
126	36.14
134	36.29
147	36.11
154	36.26
155	36.35
165	36.05
177	35.31
195	35.95
201	36.29
209	36.38
215	36.20
222	35.16
237	35.68
250	35.95
261	36.17
264	36.41
268	36.56
271	36.72
284	37.26
286	37.66
289	37.72

CROSS SECTION 3

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	38.00
1	37.14
34	36.72
56	36.62
73	36.66
96	36.69
136	36.47
143	36.47
154	36.62
187	36.69
209	36.44
212	36.56
216	36.41
219	36.05
221	35.56
222	34.86
224	34.49
226	34.86
227	35.56
228	36.56
252	36.29
272	36.53
311	36.72
337	36.72
364	36.72
389	37.02
417	37.17
437	37.20
457	37.30
460	37.45
465	38.19

CROSS SECTION 4

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	38.71
4	37.42
58	36.81
137	36.62
163	36.78

CROSS SECTION 4 (Cont.)

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
169	36.75
203	36.56
222	35.56
222	36.20
237	36.72
241	36.72
246	36.66
279	36.53
291	36.47
308	36.50
323	36.41
338	36.29
355	36.41
360	36.35
370	36.53
389	36.90
399	38.59

CROSS SECTION 5

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	39.03
2	36.84
8	36.87
11	36.93
49	36.96
59	37.05
60	35.95
66	35.04
69	35.95
73	35.04
88	36.99
103	36.99
126	37.02
141	37.11
191	36.87
201	36.87
208	36.53
211	35.92
217	35.98
220	36.72
228	37.66
235	38.15
239	38.27
245	38.48
252	37.17
258	37.20
264	37.51
267	38.27
269	38.82

CROSS SECTION 6

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	39.01
5	38.03
117	37.69
132	37.81
171	37.66
176	37.66
193	37.63
197	37.60
206	37.63
239	37.48
273	37.60
292	37.33
301	37.11
317	37.51
339	37.63
344	37.17
360	37.14
369	37.48
404	37.66
415	37.60
425	37.69
427	36.11
437	36.53
440	37.54
458	37.20
468	37.33
480	36.56
489	37.36
522	37.54
529	36.93
532	36.90
552	37.33
559	37.66
568	37.75
593	37.57
610	37.66
623	37.81
642	37.72
658	37.72
674	38.03
698	39.04

BRIDGE SECTION

STATION (METERS)	GROUND SURFACE ELEVATION (METERS)
0	37.45
2	37.42
3	36.90
5	36.38
6	35.95
8	35.74
9	35.25
11	34.86
12	35.19
14	35.98
15	35.98
17	35.65
18	35.53
20	35.53
21	35.31
23	35.10
24	35.10
26	35.22
27	35.44
29	35.68
30	36.05
32	36.44
34	36.72
35	36.96
36	37.14

TABLE 2—DISCHARGE MEASUREMENT APRIL 4, 1974, LITTLE BAYOU DE LOUTRE NEAR TRUXNO, LOUISIANA. (WATER SURFACE ELEVATION=38.191 METERS. TOTAL DISCHARGE=116 CUBIC METERS PER SECOND). ZERO STATION IS AT THE EDGE OF THE LEFT ABUTMENT (FACING DOWNSTREAM)

STATION (METERS)	DEPTH (METERS)	ANGLE (DEGREES)	OBSERVATION DEPTH[1]	VELOCITY (METERS PER SECOND)
0.0	0.34	0	0.6	0.503
1.5	0.67	0	0.6	0.728
2.7	1.04	0	0.6	0.625
4.0	1.37	0	0.6	0.853
5.2	1.98	0	0.6	1.234
6.4	2.19	0	0.6	2.167
7.6	2.53	0	0.6	2.213
8.8	2.87	0	0.6	2.121
10.1	3.23	0	0.6	1.305
11.3	3.57	0	0.6	1.512
12.5	3.05	0	0.6	1.134
13.7	2.32	0	0.6	0.835
14.9	2.29	0	0.6	1.256
16.2	2.35	0	0.6	1.332
17.4	2.53	0	0.6	1.000
18.6	2.59	0	0.6	1.332
19.8	2.65	0	0.6	1.113
21.0	3.17	0	0.6	1.338
22.3	3.17	0	0.6	0.872
23.5	3.29	0	0.6	1.585
24.7	3.05	0	0.6	1.512
25.9	2.87	0	0.6	1.417
27.4	2.74	0	0.6	1.661
29.0	2.44	0	0.6	2.076
30.5	2.10	0	0.6	1.661
32.0	1.58	0	0.6	1.512
33.5	1.43	0	0.6	1.158
35.1	1.04	0	0.6	0.796
36.0	0.55	0	0.6	0.448

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

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For sale by Branch of Distribution, U.S. Geological Survey 1200 South Eads Street, Arlington, VA 22202 and Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225