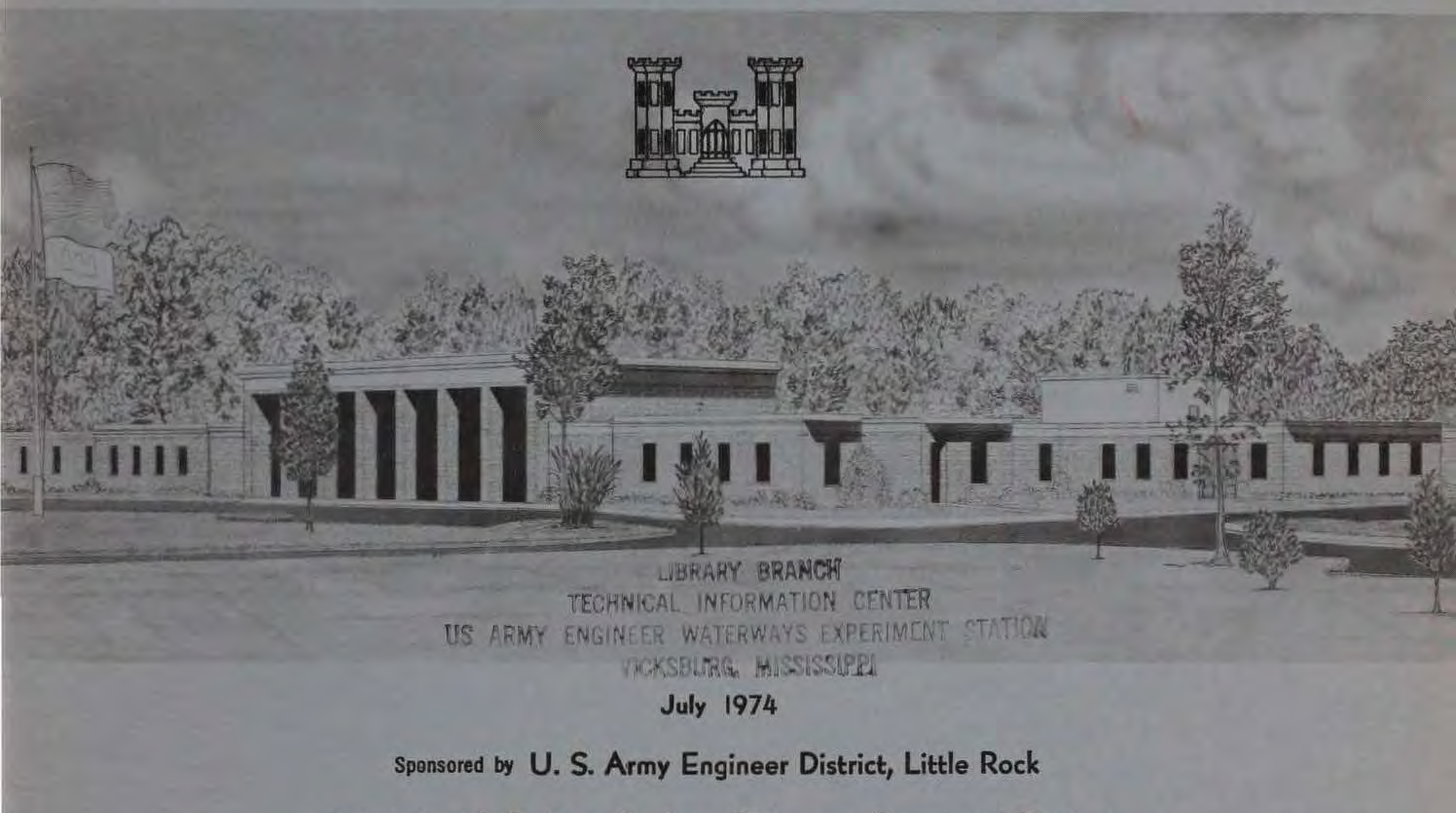
TECHNICAL REPORT H-74-7

VAN BUREN REACH, ARKANSAS RIVER NAVIGATION PROJECT

Hydraulic Model Investigation

by

L. J. Shows, J. J. Franco



July 1974

Sponsored by U. S. Army Engineer District, Little Rock

Conducted by U. S. Army Engineer Waterways Experiment Station
Hydraulics Laboratory
Vicksburg, Mississippi

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ARMY-MRC VICKSBURG, MISS.

FOREWORD

The model investigation reported herein was authorized by the Office, Chief of Engineers, in a 2d Indorsement dated 23 March 1966 to the Division Engineer, U. S. Army Engineer Division, Southwestern. The study was conducted for the U. S. Army Engineer District, Little Rock, in the Hydraulics Laboratory of the U. S. Army Engineer Waterways Experiment Station (WES) during the period April 1966 to October 1969.

During the course of the model study, Mr. J. P. Davis of the Office, Chief of Engineers; Mr. E. B. Madden of the Southwestern Division; and Messrs. Tasso Schmidgall, J. T. Clements, Jr., W. A. Thomas, C. W. Shelton, M. G. Wilbur, Jr., and D. R. Rippey of the Little Rock District visited WES at different times to observe special model tests and to discuss test results. The Little Rock District was kept informed of the progress of the study through monthly progress reports and special reports at the end of each test.

The investigation was performed under the general supervision of Messrs. E. P. Fortson, Jr. (retired), Chief of the Hydraulics Laboratory; H. B. Simmons, present Chief of the Hydraulics Laboratory; F. A. Herrmann, Jr., present Assistant Chief of the Hydraulics Laboratory; and under the direct supervision of Messrs. J. J. Franco (retired), Chief of the Waterways Division, and J. E. Glover, present Chief of the Waterways Division. The engineer in immediate charge of the model study was Mr. L. J. Shows, Chief of the Navigation Branch, assisted by Messrs. Lloyd Woods and R. T. Wooley. This report was prepared by Messrs. Shows and Franco.

Directors of WES during the course of this investigation and the preparation and publication of this report were COL J. R. Oswalt, Jr., CE, COL L. A. Brown, CE, BG E. D. Peixotto, CE, and COL G. H. Hilt, CE. Technical Directors were Messrs. J. B. Tiffany and F. R. Brown.

CONTENTS

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
miles (U. S. statute)	1.609344	kilometers
feet per second	0.3048	meters per second
cubic feet per second	0.02831685	cubic meters per second

SUMMARY

The Van Buren reach of the Arkansas River is in Lock and Dam No. 13 pool near Van Buren, Ark., about river mile 353. The reach is characterized by three relatively flat bends and is crossed by three existing or proposed bridges. The location of the navigation spans of the two existing bridges could cause considerable difficulties in navigating the reach and in maintaining a channel of adequate dimensions based on the alignment of the navigation spans. A hydraulic model reproducing about 4 miles of the Arkansas River including the three bridges was constructed to an undistorted scale of 1:120. Originally the model was of the semifixed-bed type for the navigation studies. It was later converted to the movable-bed type and used to determine (a) the best location for a navigable channel; (b) the modifications required to the two existing bridges; (c) adequacy of the proposed structures in the development of a satisfactory channel; and (d) modifications needed to improve navigation conditions and channel depths through the reach. The investigation revealed the following:

a. The channel had a natural tendency to develop in a sinuous alignment with the channel crossing first toward the right bank and then back toward the left bank. Following the natural tendency of the river would produce conditions hazardous for navigation, particularly during the higher flows, because of the location of the two existing bridges with respect to the navigation span of the I-540 bridge under construction.

b. The best alignment for the channel insofar as navigation is concerned is along the left or convex side of the bend, eliminating the two crossings.

c. Development of a channel along the left side would require considerable contraction and training structures to offset the strong tendency toward shoaling along that side.

d. A system of vane dikes could be developed which would practically eliminate the need for maintenance dredging.

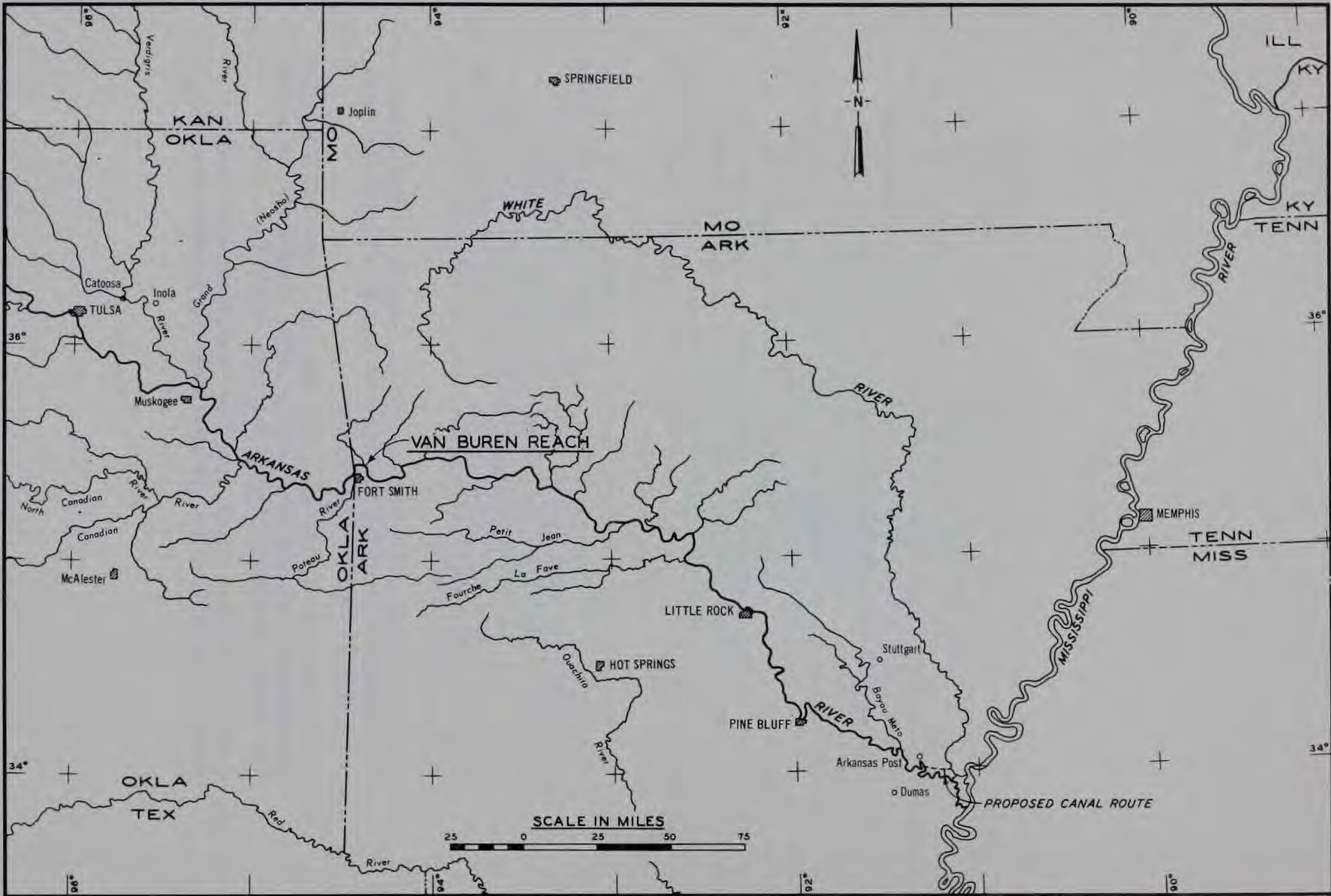

Fig. 1. Vicinity map

VAN BUREN REACH

ARKANSAS RIVER NAVIGATION PROJECT

Hydraulic Model Investigation

PART I: INTRODUCTION

Present Development Plan for the Arkansas River

1. The Arkansas River is considered to be navigable from its mouth on the Mississippi River to the mouth of the Verdigris River (fig. 1). In this section, the slope of the river averages 0.9 ft* per mile above Little Rock, Ark., and 0.7 ft per mile between Little Rock and the Mississippi River. Water-surface elevations and slopes in the lower river are affected by backwater from the Mississippi; at times these effects extend as far upstream as Pine Bluff, Ark. (river mile 111). Before the present development plan for the Arkansas River was authorized, Federal improvements on the river had consisted of snagging and dredging operations and construction of contraction works, revetments, and levees. With these improvements, the controlling depths of the Arkansas River during low water were only about 2 ft from its mouth to Little Rock and about 1 ft from Little Rock to the mouth of the Verdigris River.

2. The Arkansas River carries a large sediment load with a large fluctuation from year to year in the volume of sediment flow. The riverbed above Little Rock is composed of sand and gravel overlying rock to depths of from a few feet to about 30 ft, while downstream from Little Rock bedrock is at greater depths. The predominant bed material is medium sand (grain size 0.25 to 0.50 mm). In general, the bed material becomes finer in a downstream direction and coarser with depth below the bed surface.

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* A table of factors for converting British units of measurement to metric units is presented on page vii.

3. The Arkansas River multipurpose project provides for improvement of the Arkansas River and its tributaries in Arkansas and Oklahoma by construction of coordinated developments to serve navigation, produce hydroelectric power, afford additional flood control, and provide related benefits such as public facilities for recreation and conservation of fish and wildlife.

4. The navigation feature of the project provides for a 9-ft-deep channel from Catoosa, Oklahoma, on the Verdigris River, 52 miles downstream to the Arkansas River at mile 458, thence down the Arkansas River to Arkansas Post, about 46 miles above its mouth. From this point the Arkansas Post Canal will connect the Arkansas River with the White River; the navigation channel will then continue down the White River for about 10 miles to its junction with the Mississippi River. The 9-ft-deep channel will be provided with a system of locks and dams, some of which will be used for both navigation and hydroelectric power production. Lock chambers will be 110 by 600 ft with a minimum channel width of 150 ft proposed for the Verdigris River section, 250 ft for the Arkansas and White Rivers sections, and 300 ft for the Arkansas Post Canal. Bank stabilization and channel rectification works such as training dikes, cutoffs, and revetments are included in the multipurpose plan as part of the proposed overall development of the Arkansas River.

The Van Buren Reach

5. The Van Buren reach of the Arkansas River, which is in the pool of Lock and Dam No. 13, extends from a short distance upstream to a short distance downstream of Van Buren, Ark., about 353 miles above the mouth of the Arkansas River (1940 survey). Normal pool elevation of this reach is 392.0 ft* based on the elevation of the upper pool of Lock and Dam No. 13. At the time that the model study was undertaken, there were two existing bridges across the river in this reach about 2000 ft apart, and a third bridge was scheduled for construction about

* All elevations (el) cited herein are in feet referred to mean sea level.

4200 ft downstream of the lower bridge. One bridge, the St. Louis-San Francisco Railroad bridge, had a swing span located on the left side of the river, and the other, the U. S. Highways 64 and 71 bridge, had a lift span located near midchannel. The bridge that will carry Interstate Highway 540 was designed with a fixed navigation span along the left bank of the river (see fig. 2). The alignment of the spans of the existing bridges, the limited width of the spans, and inadequate channel depths cause problems to navigation in this reach.

Fig. 2. General view of the model showing navigation spans of existing bridges and of the proposed I-540 bridge

Need for and Purpose of Model Study

6. The improvement of the Van Buren reach of the Arkansas River involved the development of regulating structures that would provide the required channel depths through the reach without producing currents hazardous to navigation. As stated previously, navigation of the reach

was complicated by the alignment of the channel, which was unstable; the locations of the spans of the two existing bridges that were about 2000 ft apart; and the location of the proposed span for the new bridge about 4200 ft downstream. The problem involved the development of an adequate and stable channel and a relocation of the bridge spans that would be satisfactory for navigation. Because of the complex nature of flow in natural streams in general and of the conditions in the Van Buren reach in particular, an analytical analysis of the problem to determine conditions that could be reasonably expected from a particular plan of improvement would be extremely difficult and inconclusive. Therefore, a hydraulic model investigation of the reach was considered necessary and was used for the following purposes:

- a. To determine the alignment and velocity of currents through the reach with Lock and Dam No. 13 in operation.
- b. To determine the best location for the bridge spans from a navigation standpoint and for the development of an adequate channel.
- c. To design a plan of regulating and training structures required to develop and maintain a channel of adequate dimensions based on the alignment and location of the bridge spans.
- d. To determine navigation conditions as affected by the regulating and training structures.
- e. To demonstrate the conditions resulting from the proposed design for those concerned with planning, design, and operation of the project.

PART II: THE MODEL

Description

7. The model (fig. 3) reproduced about 4 miles of the Arkansas River beginning just downstream of river mile 356 (about 11,000 ft upstream of the St. Louis-San Francisco Railroad bridge) and extending to just downstream of river mile 352 (about 5,000 ft downstream of the location for the proposed I-540 bridge). The lower end of the model was about 6 miles upstream of Lock and Dam No. 13. Originally the model was of the semifixed-bed type constructed to an undistorted scale of 1:120; later it was converted to a movable-bed type. The banks and overbank areas of the model in its original condition were molded in sand-cement mortar to sheet metal templets. The channel, except for a short reach at each end, was molded in sand to facilitate adjustment of channel

Fig. 3. General view of model with conditions existing in the prototype at the time of the October 1966 survey

configuration based on conditions that could be expected to develop with various proposed improvement plans. The overbank portion of the model was molded to conform to hydrographic and topographic surveys dated February 1963 and October 1966; the channel bed was molded to a special survey made in April 1966. Sufficient overbank area was included in the model to permit the study of flows up to the maximum navigable flow for this reach (250,000 cfs), with the height of the model perimeter wall sufficient to confine a maximum flow of 300,000 cfs. The bridges, including the proposed I-540 bridge, were fabricated of sheet metal and assembled on a base plate.

Appurtenances

8. Water was supplied to the model by a 10-cfs, axial-flow pump operating in a circulating system and was measured by means of a venturi meter. Water-surface elevations were measured by 11 piezometer gages located in the model channel and run to a centrally located gage pit (fig. 4). Stages were controlled by introducing the desired discharge at the upper end of the model and controlling the tailwater elevations by means of a tailgate at the lower end of the model.

9. A model tow and towboat were used to determine the effects of currents on navigation moving through this reach of the river and through the bridges. The towboat was propelled by two small electric motors operating from batteries installed in the tow; the rudders and speed were remote-controlled. The towboat could be operated in forward or reverse, and power was adjusted by means of a rheostat to a maximum speed comparable to that of towboats normally plying the Arkansas waterways.

Scale Relations

10. The model was built to an undistorted scale of 1:120, model to prototype, to obtain accurate reproduction of velocities, cross-currents, and eddies that would affect navigation. Other scale ratios

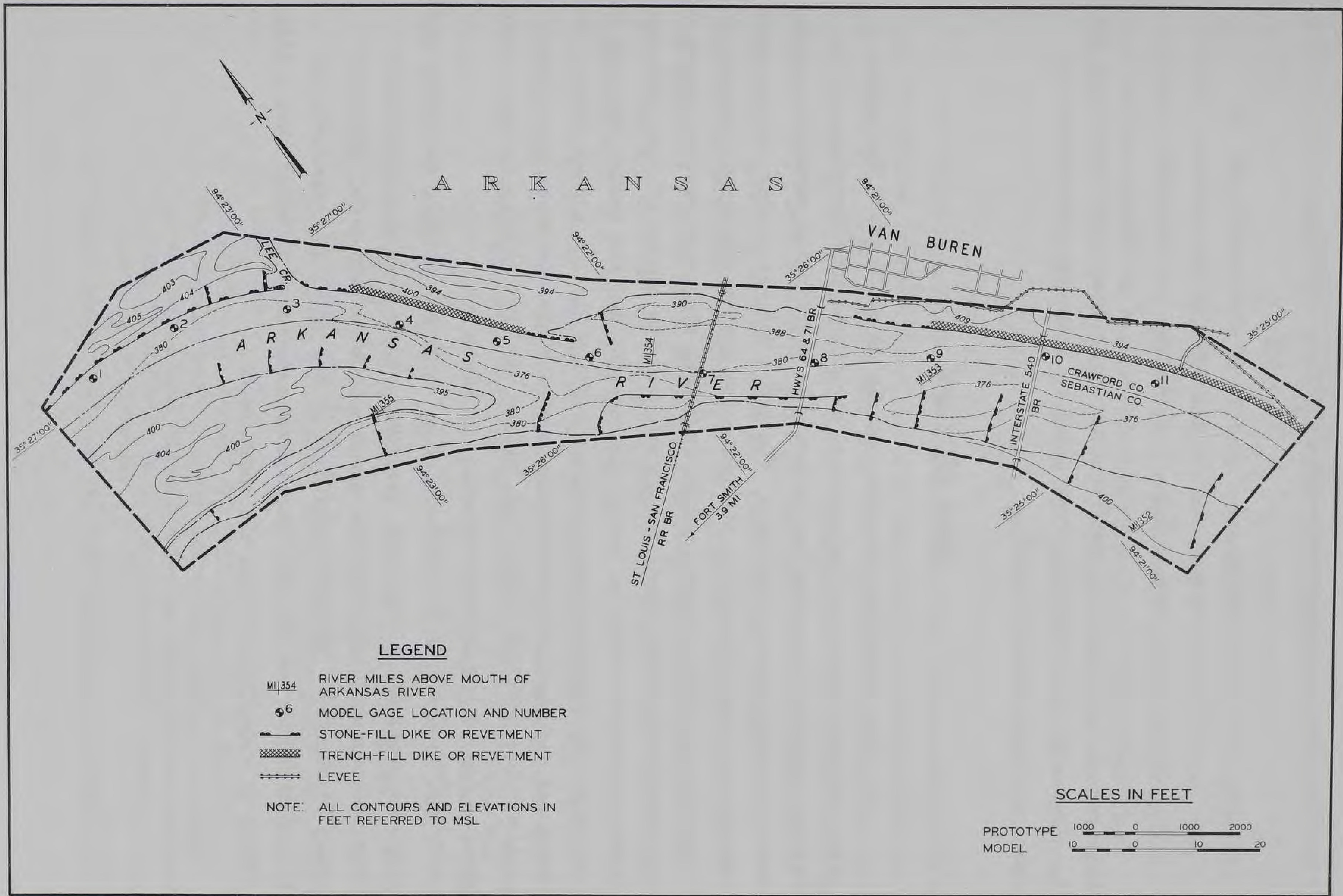


Fig. 4. Site map

resulting from the linear scale ratio were as follows:

Area	1:14,400
Velocity	1:10.95
Time	1:10.95
Discharge	1:157,743

Measurements of discharge, water-surface elevations, and velocities are transferrable quantitatively from model to prototype equivalents by means of these scale relations.

Model Adjustment

11. The adjustment procedure consisted of checking the model prior to installation of the proposed structures or alteration of the bridges spanning the reach for accuracy in reproducing prototype roughness and water-surface profiles. The model bed was molded in sand that corresponded very closely to the prototype channel roughness (Manning's n of about 0.023). Folded strips of 8-mesh wire were used to obtain the high roughness values along the overbanks. The amount of wire used was based on interpretation of aerial photographs and the amount required to reproduce the computed water-surface profiles for the higher flows. The model was adjusted using the rating curve at the Van Buren gage (model gage 8) revised 3 June 1966. The results of this adjustment with flows from 50,000 to 300,000 cfs are shown in plate 1.

12. These results indicate close agreement between the model and computed profiles, except that the model stages were somewhat higher than the computed stages in the upper reaches of the model with the lower discharges. Further adjustment of the model to compensate for this difference was not considered necessary since it would have little effect on velocities within the short reach.

PART III: SEMIFIXED-BED TESTS AND RESULTS

13. The first series of tests were concerned primarily with the study of currents and velocities, the behavior of the model tow, the effects of various bank and channel stabilization plans on navigation, and the development of channel configurations with the various plans tested.

Test Procedure

14. Tests consisted of reproducing selected, representative flows and determining current velocities and directions and their effects on the model tow. Some adjustments were made in the configuration of the channel bed based on an evaluation of currents with the conditions being tested. All flows were reproduced as constant flows and permitted to stabilize before data were recorded. Each flow was reproduced by introducing the proper discharge at the upper end of the model and manipulating the tailgate until the computed tailwater elevation for that flow was obtained at the lower end of the model. The flows used during most of the tests were as follows:

- a. Total flow of 72,000 cfs with the tailwater at el 388.2. This represents flow conditions at the time prototype current velocities and directions were taken in April 1966. To determine the accuracy of the model in reproducing prototype current direction and velocity data before Dam No. 13 was in place, this flow condition was reproduced for base tests only.
- b. Total flow of 72,000 cfs with tailwater at el 392.0. This represents the same flow as in subparagraph a above but with conditions that would exist after Lock and Dam No. 13 would be in operation. Results obtained with this flow condition are comparable for all plans tested except the base tests.
- c. Total flow of 150,000 cfs with tailwater at el 394.7. This represents the approximate maximum flow at which normal upper pool elevation can be maintained at Lock and Dam No. 13 and will be equaled or exceeded about 40 percent of the time.
- d. Total flow of 250,000 cfs with tailwater at el 400.4.

This represents the approximate maximum flow at which Lock 13 will be usable and will be equalled or exceeded about 9 percent of the time.

15. Current directions were determined by plotting the paths of wooden floats with respect to ranges established for that purpose; floats were submerged to a depth equivalent to an 8-ft draft of a loaded barge. Velocities were measured by timing the travel of the floats over known distances. No data were obtained using the model tow other than observations to determine the effects of currents on the behavior of the tow and the maneuvering required to overcome the effects of adverse currents, particularly in the approaches to the bridges.

16. Most of the modifications were developed during preliminary tests. Data obtained during these tests were sufficient only to assist in the adjustment of the channel configuration and to determine the adequacy of the proposed change. Results of these preliminary tests are not included in this report.

Base Tests

Description

17. The base tests were conducted using the channel as modified during the adjustment of the model and with the regulating structures existing in the prototype at the time of the survey for model design. The conditions in the model for this test are shown in fig. 5. Tests were conducted using these conditions to determine the natural trends within the Van Buren reach and to provide a basis for determining the effectiveness of various improvement plans developed from the trends indicated.

Results

18. Water-surface elevations for flows ranging from 50,000 to 300,000 cfs obtained during these tests are shown in table 1. Plots of the water-surface profiles based on the gage readings were generally in close agreement with the average computed elevations for this reach of the river (plate 1). The total drop through this reach (gages 1

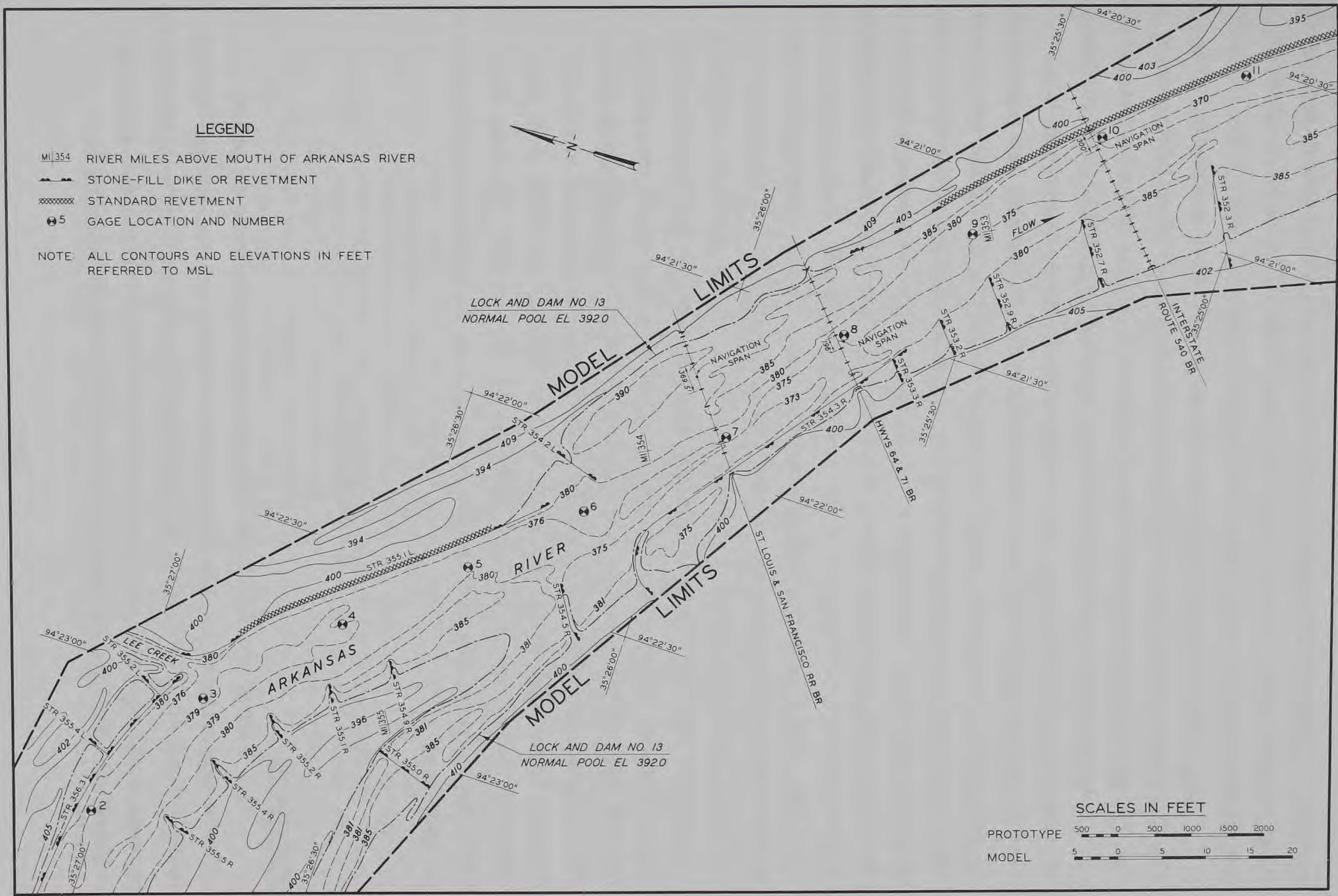


Fig. 5. Base test

through 11) ranged from about 4.2 to 5.2 ft with the greatest drop occurring between gages 3 and 4 with the lower flows (50,000 to 150,000 cfs) and between gages 6 and 7 with the higher flows (200,000 to 300,000 cfs).

19. Results shown in plates 2-4 indicated that a crossing from the left bank toward the right bank would tend to develop upstream of the railroad bridge at about mile 354.2 and from the right bank toward the left bank upstream of the I-540 bridge at about mile 353. The currents in general paralleled the left bank revetment in the upper and lower reaches of the model and the right bank revetment through the midreach of the model. The flow pattern and velocities for the 72,000-cfs flow shown in plate 2 closely reproduced the prototype field data furnished by the Little Rock District for a comparable flow. Maximum velocities resulting from the three flows tested ranged from about 7.0 fps for the 72,000-cfs flow to about 10.0 fps for the 250,000-cfs flow.

20. These results indicate that because of the alignment of the bridge spans of the existing bridges with respect to the alignment of currents, navigation conditions through the bridges would be extremely hazardous. The difficulty for navigation is further increased by the short distance between the two bridges, which would limit maneuvering between the bridges, and by the limited width of the navigation spans. The results also indicate that the general tendency is for the main channel to develop along the right bank at the bridges but that the crossing toward the right bank upstream of the bridges and from the right bank toward the left bank downstream of the bridges would tend to be unstable.

Plans A and A-1

Description

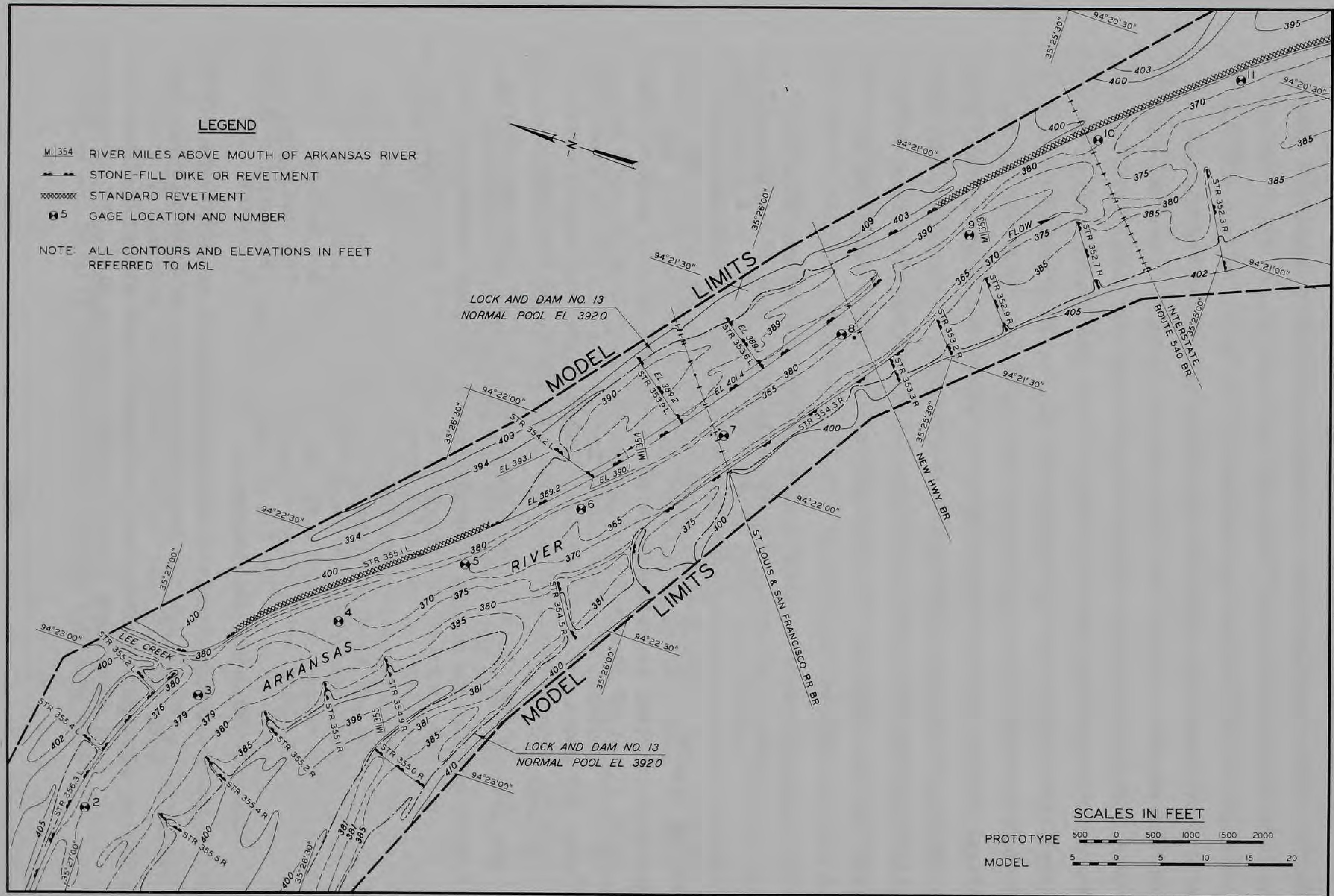
21. Plan A was developed during preliminary tests in which efforts were made to follow the natural tendency of the stream in this reach. Accordingly, tests were conducted to determine if a satisfactory channel could be developed along the right bank near the two existing bridges with navigation spans placed on that side. Results of

preliminary tests indicated that it would be easier to develop a channel of adequate dimensions on that side but that tows would experience considerable difficulty in passing through the two upper bridges and then crossing over toward the left bank and becoming aligned for passage through the proposed span of the I-540 bridge. Also, it was determined that because of the alignment of the channel and the tendency for a sandbar to develop along the right bank at the I-540 bridge site, it would not be practical for the navigation span of that bridge to be moved from the left bank. Because of the conditions noted during the preliminary tests, it was decided that the navigation channel would have to be developed along the left end of the two existing bridges, and the training structures and navigation spans of the two bridges were to be designed for that purpose. The features of this plan designated as plan A were as follows (fig. 6):

a. The control width of the channel was reduced to about 850 ft by means of a rock-fill revetment along the left bank between about miles 354.4 and 353.3 (just downstream of the new Highways 64 and 71 bridge). This revetment was a continuation of revetment 355.1L and included a modification of dike 354.2L and new dikes 353.9L and 353.6L extending from the revetment to high ground. The top of the revetment was at el 389.2 to about 1300 ft upstream of the railroad bridge and at el 401.4 from that point to the lower end. Dikes 353.9L and 353.6L had crest elevations of 389.2 and 389.1, respectively.

b. The existing U. S. Highways 64 and 71 bridge was removed from the model since it was scheduled for replacement by a new bridge located a short distance downstream. The piers of the navigation span of the new bridge were installed in the model before the start of the test with the navigation span located along the left side (along the proposed new revetment); the navigation span of the railroad bridge was modified and also placed along the revetment in line with the span of the new bridge. Both of these bridges had navigation spans with horizontal clearances of 300 ft, the same as that proposed for the I-540 bridge downstream.

c. Protection cells with a top elevation of 405.0 were placed on the riverward piers of the navigation spans of both the railroad bridge and the new Highways 64 and 71 bridge. Cells 25 ft in diameter were placed upstream and downstream of the railroad bridge pier, and a 42-ft-diam pier was placed on the upstream side of the highway



LEGEND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
5 GAGE LOCATION AND NUMBER
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0
ARKANSAS RIVER
LEE CREEK
FLOW
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
STR 355.1 L
STR 354.2 L
STR 353.9 L
STR 353.6 L
STR 355.2 L
STR 355.4 L
STR 356.3 L
STR 354.5 R
STR 354.9 R
STR 355.1 R
STR 355.2 R
STR 355.0 R
STR 355.4 R
STR 355.5 R
STR 354.3 R
STR 353.3 R
STR 353.2 R
STR 352.9 R
STR 352.7 R
STR 352.3 R
EL 389.2
EL 393.1
EL 390.1
EL 389.2
EL 389.1
EL 401.4
MI 353
MI 354
MI 355
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

Fig. 6. Plan A

bridge pier. Protection cells were not planned for the I-540 bridge span.

d. Before taking any data using this plan, some adjustments were made in the channel bed configuration based on changes indicated by currents affected by the proposed plan. The adjustments were not carried out to any degree of refinement since the purpose of the test was to determine the general adequacy of the plan and its effects on navigation conditions.

22. Plan A-1 was the same as plan A except for modification of the proposed rock-fill revetment along the left side of the channel. This modification involved realigning the revetment to form a straight line between the bridges, raising the high portion of the revetment to el 405.0 (about 1 ft above the maximum navigable flow line), and removing the portion of the revetment downstream of a point about 50 ft downstream of the new highway bridge.

23. Operation of the model and design of the improvement plans were based on conditions that could be expected with Lock and Dam No. 13 completed and in operation. The tailwater elevation for all flows substantially less than 150,000 cfs had to be raised, based on the backwater effect caused by controlling the pool at the dam. The results of tests with the 72,000-cfs flows, therefore, would not be comparable with conditions obtained during the base test with the same flow.

Results

24. Water-surface elevations obtained during tests of plans A and A-1 are shown in table 2. These results indicate some differences in water-surface elevation from those obtained with the base test (table 1). Gage readings with the 250,000-cfs flow for plans A and A-1 were somewhat higher than those for the base test (0.2 to 0.5 ft) in the reach upstream of the bridges and somewhat lower (0.3 to 0.6 ft) between the railroad and the I-540 bridge with little or no change downstream. There was little difference between the water-surface elevations of plans A and A-1 except that plan A-1 stages upstream of the bridges were slightly lower than those for plan A and downstream slightly higher. It should be considered that the differences noted are not of any particular significance since the water-surface elevations would depend to a large extent

on the degree of adjustment of the channel bed based on the changes produced by the plans.

25. Currents within the navigation channel using plan A were generally parallel to the left bank revetment for the 72,000- and 150,00-cfs flows (plates 5 and 6). Maximum velocities within the navigation channel based on the bed conditions imposed on the model for the two flows were about 5.6 and 8.8 fps, respectively. With the 250,000-cfs flow, currents approaching the new Highways 64 and 71 bridge moved away from the revetment at a slight angle to the channel alignment with velocities as high as 12.4 fps (plate 7). This was attributed to flow moving over the low section of the left bank revetment and reentering the channel just upstream of the bridge. Although navigation conditions were considerably better than could be developed with the channel along the right bank revetment, some difficulty could be experienced by downbound tows because of the alignment of the currents during high flows and the limited distance between the two upper bridges.

26. Changes in the alignment of the revetment in plan A-1 improved navigation conditions with the lower flows (plates 8 and 9). The modification of the left bank revetment in plan A-1 also reduced the amount of overbank flow that would reenter the channel, and the alignment of currents approaching the new Highways 64 and 71 bridge with the 250,000-cfs flow was improved (plate 10). Maximum velocities within the navigation channel along the revetment were reduced somewhat with the 72,000- and 250,000-cfs flows and increased with the 150,000-cfs flow. However, the primary reason for the reduction in current velocities with the 72,000-cfs flow was the 4.2-ft increase in tailwater elevation created when Lock and Dam No. 13 was constructed. Because of the reduction of flow along the left overbank, navigation conditions for downbound tows approaching the I-540 bridge were improved for the higher flows.

Plans B and B-1

Description

27. Observations and results of tests of plans A and A-1

indicated that shoaling might occur in the channel upstream of the bridges and in the reach between the Highways 64 and 71 bridge and the I-540 bridge. This prediction was based on the alignment and dispersion of currents and the channel width, which was considerably greater than the control width of the channel between the left and right bank revetments. Accordingly, plans B and B-1 were designed to improve channel depths through the reaches mentioned without adversely affecting navigation conditions. Plan B was the same as plan A-1 except for the following (fig. 7):

a. The channel in the upper reach was contracted by extending the river ends of dikes 355.4R through 354.5R and the addition of dike 354.7R. The river end of the new dike was placed at el 389.5. The control channel width with these modifications varied from 875 ft to 1000 ft within the reach affected.

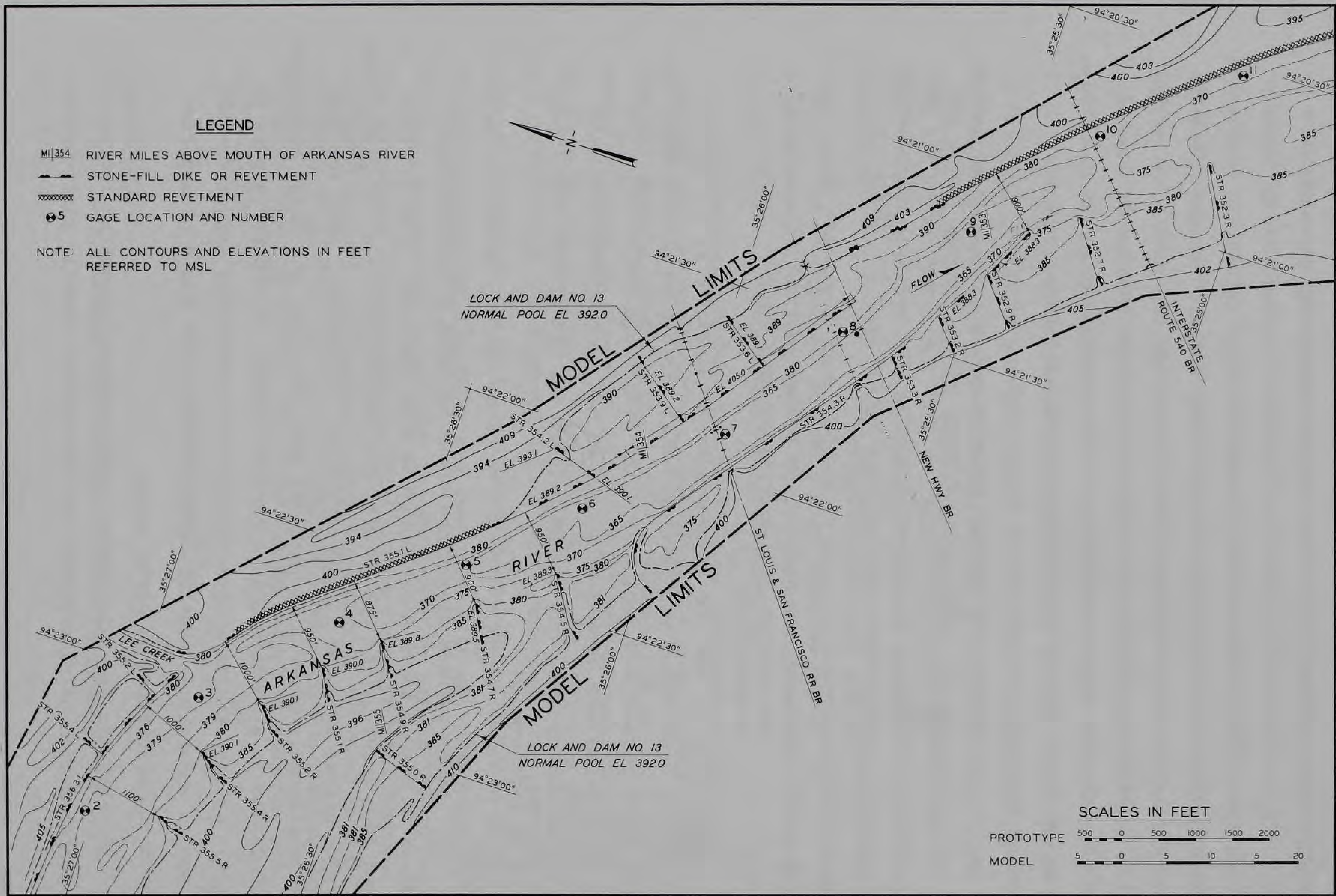
b. L-head sections were added to dikes 353.2R and 352.9R between the new highway bridge and the I-540 bridge. The lengths of the sections were 450 and 810 ft, respectively.

28. Plan B-1 was the same as plan B except that the channel width in the upper reach was further reduced to 850 ft by extending all of the dikes between and including dikes 355.5R and 354.5R (fig. 8). Some adjustments were made in the channel bed to compensate for the additional contraction, but the adjustment was not carried out to any degree of refinement.

Results

29. Water-surface elevations shown in table 3 indicate some increase in stages above those obtained with plan A-1. The increase varied from about 0.1 to 0.3 ft with the 250,000-cfs flow for plan B and somewhat higher with the 150,000-cfs flow. In general, gage readings were considerably lower with plan B-1 than with plan B. These elevations would depend to a considerable extent on changes in channel depths as affected by the changes in plan and in flow conditions and, therefore, are not an accurate indication of the results that could be expected with the modifications of these plans.

30. Results shown in plates 11-16 indicate a general increase in the concentration of flow within the navigation channel, particularly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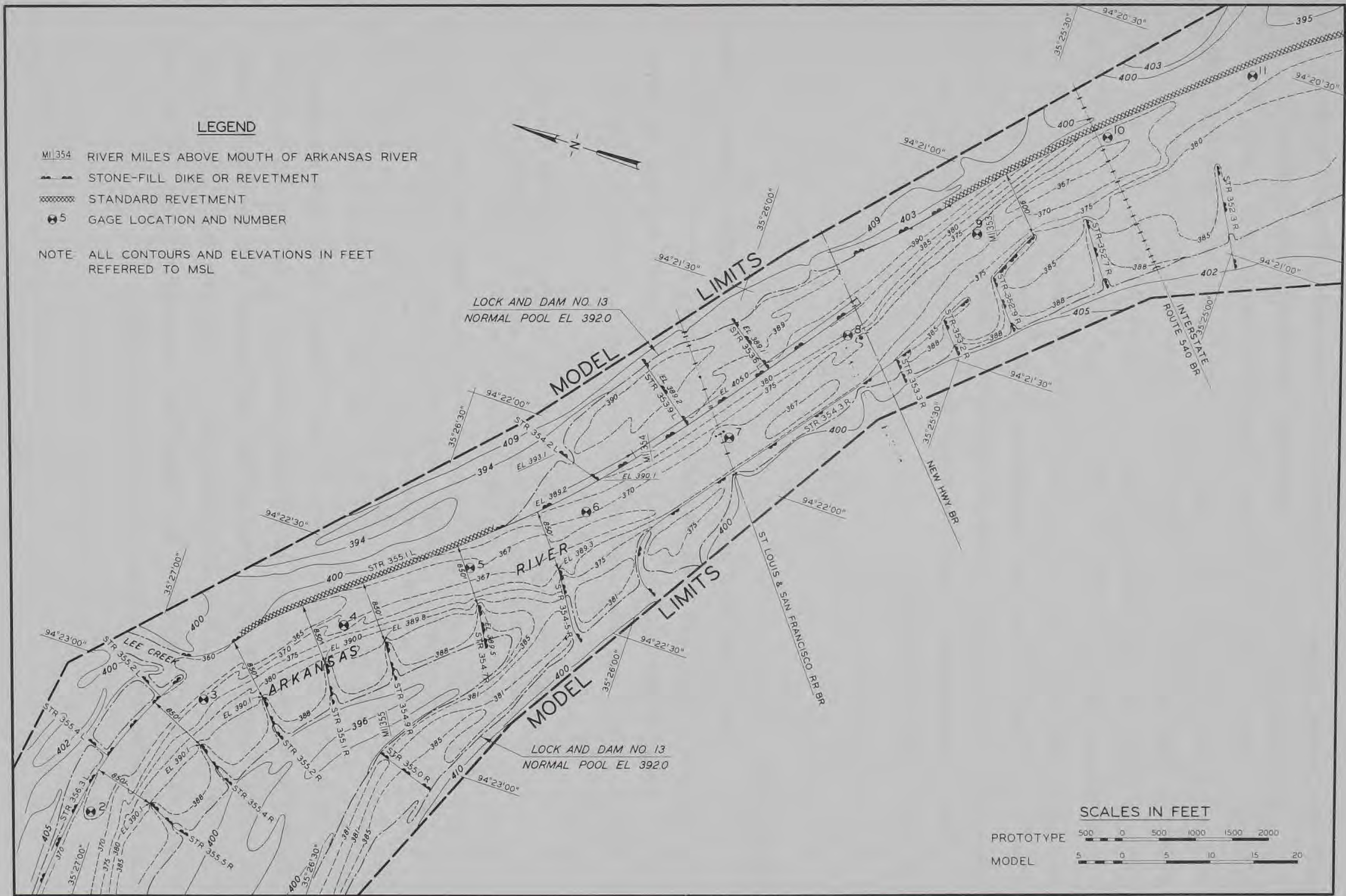
ARKANSAS RIVER
LEE CREEK
FLOW
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

Fig. 7. Plan B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SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

Fig. 8. Plan B-1

with the higher flows. The alignment of currents through the reach was good and should present no difficulties for navigation through the bridges. Although there was some increase in velocities within the navigation channel, the velocities along the right bank revetment were generally higher than those within some reaches of the navigation channel along the left bank revetment. Because of this condition and the crossing upstream of the bridges, a large proportion of the sediment load tended to move toward the navigation channel. The heavy movement of sediment within the navigation channel could reduce depths to less than that required for navigation with a normal pool, particularly if there is appreciable scouring along the right bank revetment on the opposite side of the river.

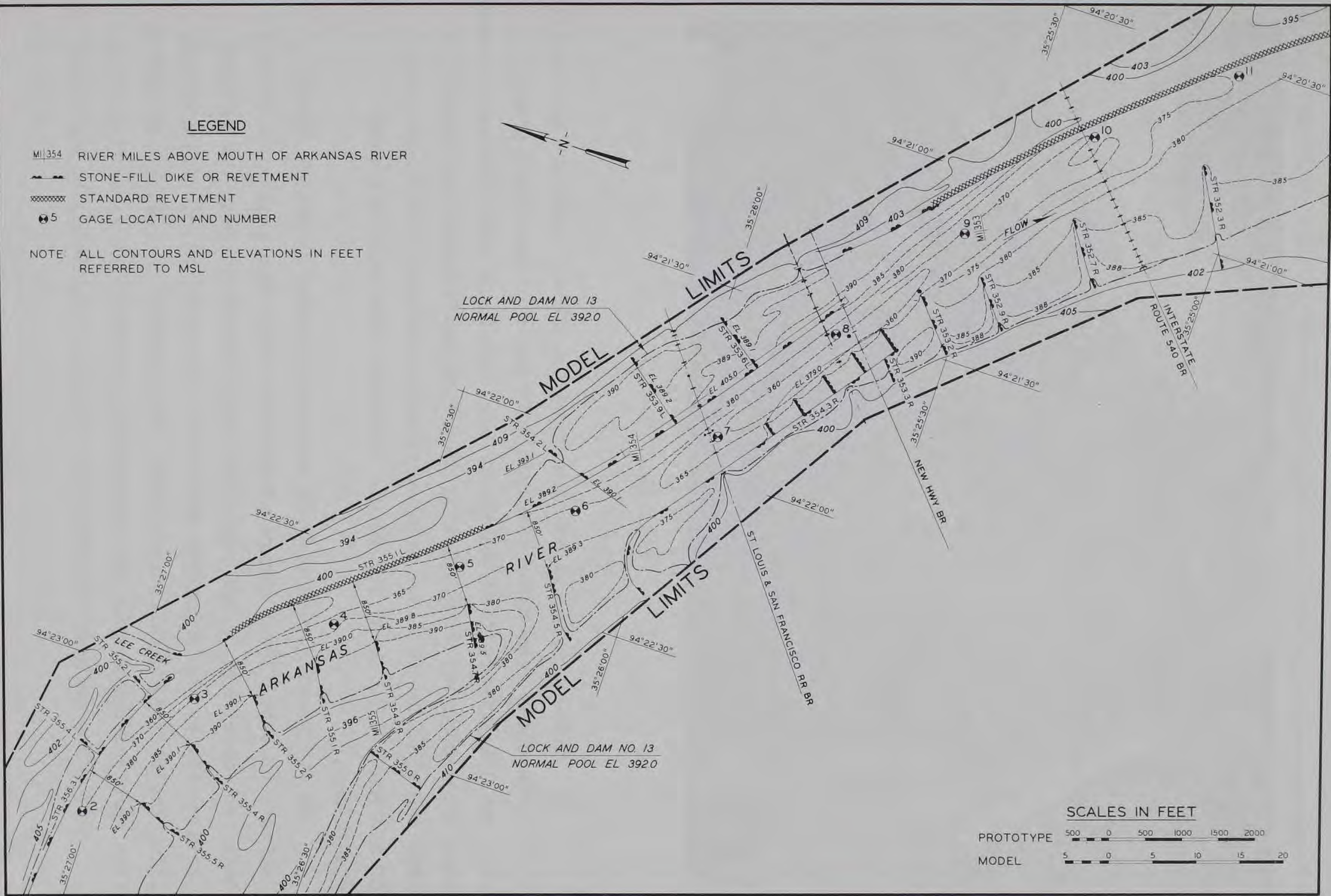
Plans C and C-1

Description

31. Plans C and C-1 were developed to reduce the tendency toward shoaling along the left bank revetment and toward scouring along the right bank revetment in the vicinity of the railroad and new highway bridges. Plan C was the same as plan B-1 except for the following (fig. 9):

- a. The proposed L-head sections on dikes 353.2R and 352.9R were removed, and dike 353.2R was lengthened about 350 ft with the top of the extension at el 379.0.
- b. Five submerged dikes were placed normal to the right bank revetment (354.3R) with their tops at el 379.0. Beginning at the downstream end of the revetment and moving upstream, the dikes were spaced 500 ft apart with lengths of 350, 330, 280, 240, and 190 ft, respectively.

32. Plan C-1 was the same as plan C except that the submerged dike farthest upstream was lengthened from 190 ft to 240 ft, and two additional submerged dikes were added upstream of the railroad bridge (fig. 10). The new dikes were each 240 ft long with an elevation of 379.0 and located normal to the right bank revetment about 100 ft and 1100 ft, respectively, above the railroad bridge.



LEGEND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
5 GAGE LOCATION AND NUMBER
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0
ARKANSAS RIVER
LEE CREEK
FLOW
INTERSTATE ROUTE 540 BR
NEW HWY BR
ST LOUIS & SAN FRANCISCO RR BR
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

Fig. 9. Plan C

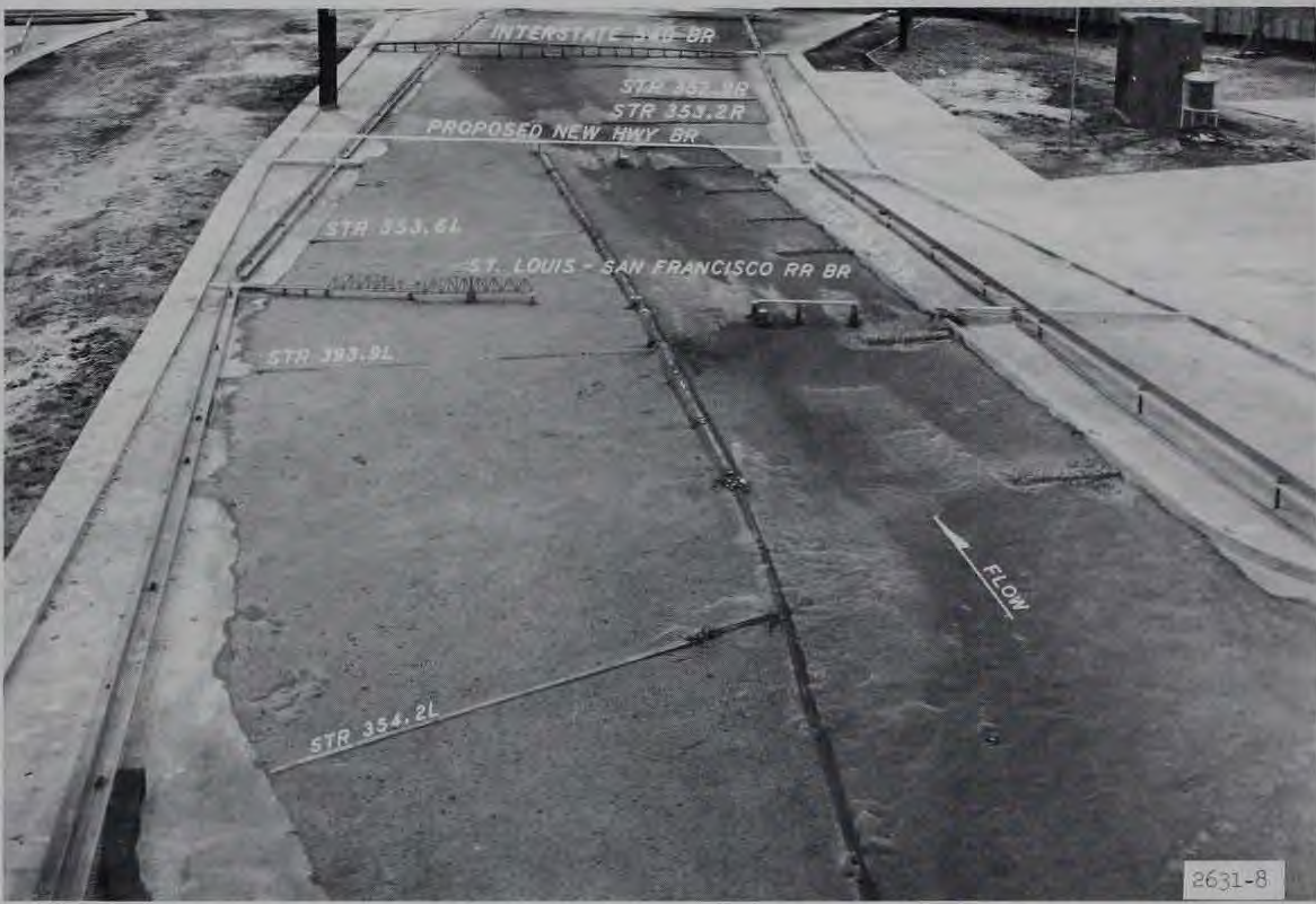


Fig. 10. Plan C-1

Results

33. Water-surface elevations shown in table 4 indicate no significant differences from those obtained with tests of the other plans. With the 150,000-cfs flow, water-surface elevations were generally lower than those observed with existing prototype conditions (base test). With the 250,000-cfs flow, water-surface elevations in the upper reach of the model were about 0.1 to 0.4 ft higher than with the base conditions.

34. Current directions and velocities shown in plates 17-22 indicate no significant change within the navigation channel along the left bank revetment. Flow along the right bank revetment was reduced considerably by the submerged dikes with the increase occurring mostly along the channel ends of the dikes. In general, no navigation difficulties were indicated with the conditions observed with plans C and C-1.

35. The natural tendency for a channel to develop in the reach is

along the right bank on the concave side of the bend. This tendency could not be developed because of the locations of the existing and proposed bridges and the limited distance between bridges. Location of the channel along the convex side of the bend would provide satisfactory navigation conditions but could cause some problems in developing and maintaining a channel of adequate depth. Results of the completed tests indicate velocities to be relatively high within the navigation channel but somewhat lower than those along the right side and along the ends of the submerged dikes. There was also an indication that there would be a heavier concentration of sediment moving on the navigation channel side of the bend. Because of the uncertainties indicated, it was considered desirable to conduct a generalized movable-bed model study of the reach to determine the adequacy of the structures developed in the preceding tests and to determine any modifications that might be necessary to reduce maintenance.

PART IV: MOVABLE-BED TESTS AND RESULTS

Model Conversion

36. In order to conduct the movable-bed study as mentioned in paragraph 35, the model had to be modified and adjusted to reproduce the movement of sediment generally similar to that occurring in the prototype. The modification involved the replacement of the semifixed material with crushed coal having a specific gravity of 1.30 and a mean grain diameter of about 4 mm. Since the model was not specifically designed for the movable-bed study, it was constructed without distortion of the linear scales and without supplementary slope, which are usually required in studies of this type. Supplementary slope was added to the movable-bed portion of the model by adjustment of the curb rails located along each side of the channel and used for the establishment of the model grade. A sediment trap was also provided at the lower end of the model where extruded material could accumulate and be measured to determine the amount discharged for any period.

Model Adjustment

Procedure

37. Although the model was not specifically designed for a movable-bed study and the data available from the prototype were not sufficient to support a movable-bed verification of the conventional type, it was essential that the model be adjusted to reproduce channel configurations generally representative of those to be expected in the Arkansas River under similar conditions. Accordingly, before any movable-bed tests were undertaken, a series of adjustment tests was conducted during which progressive changes were made in the rate of introducing bed material and in discharge and time scales until the movement of bed material during each stage and the configuration of the bed as developed were reasonably representative of conditions in the prototype.

38. The adjustment tests were started with the bed of the model molded to the configurations indicated by the prototype survey of April 1966 (fig. 11) and operated by reproducing the stage hydrograph recorded in the prototype for the period 6 July 1965 to 18 April 1966 which preceded the prototype survey (fig. 12). Water-surface elevations were based on the computed rating curve for mile 353.4 (without Lock and Dam No. 13) and referred to stages at the Van Buren gage (fig. 13).

Results

39. The results obtained at the end of the fifth adjustment test were considered to be sufficiently adequate for the purpose of the investigation. The model bed configurations shown in fig. 14 indicate that the general trends were reproduced in the model with some differences in bed elevations between the model and those shown by the prototype survey, which should be considered in the evaluation of test results. In general, the model indicated a greater tendency for shoaling along the left bank revetment at about mile 354.7 and along the left side of the channel between the railroad bridge and the Highways 64 and 71 bridge. The crossing to the right bank at about mile 354.2 was somewhat farther downstream in the model, and depths along the right bank revetment between the two bridges were somewhat greater than indicated by the prototype surveys. These differences are not considered of major significance and are attributed to the adjustment of the model, which was not carried out to any degree of refinement in respect to scale effect and possible differences in bed conditions between model and prototype. The results indicate that the scale relationships developed were reasonably adequate except that the rate of bed feed into the model might have been higher than required. Since the differences noted between the model and prototype were on the conservative side insofar as the development of the navigation channel was concerned and the effectiveness of the improvement plans would be based on the results of a base test, further adjustment of the model was not considered necessary. The sediment discharge relation and the discharge scale relation developed during the adjustment were used in subsequent movable-bed tests.

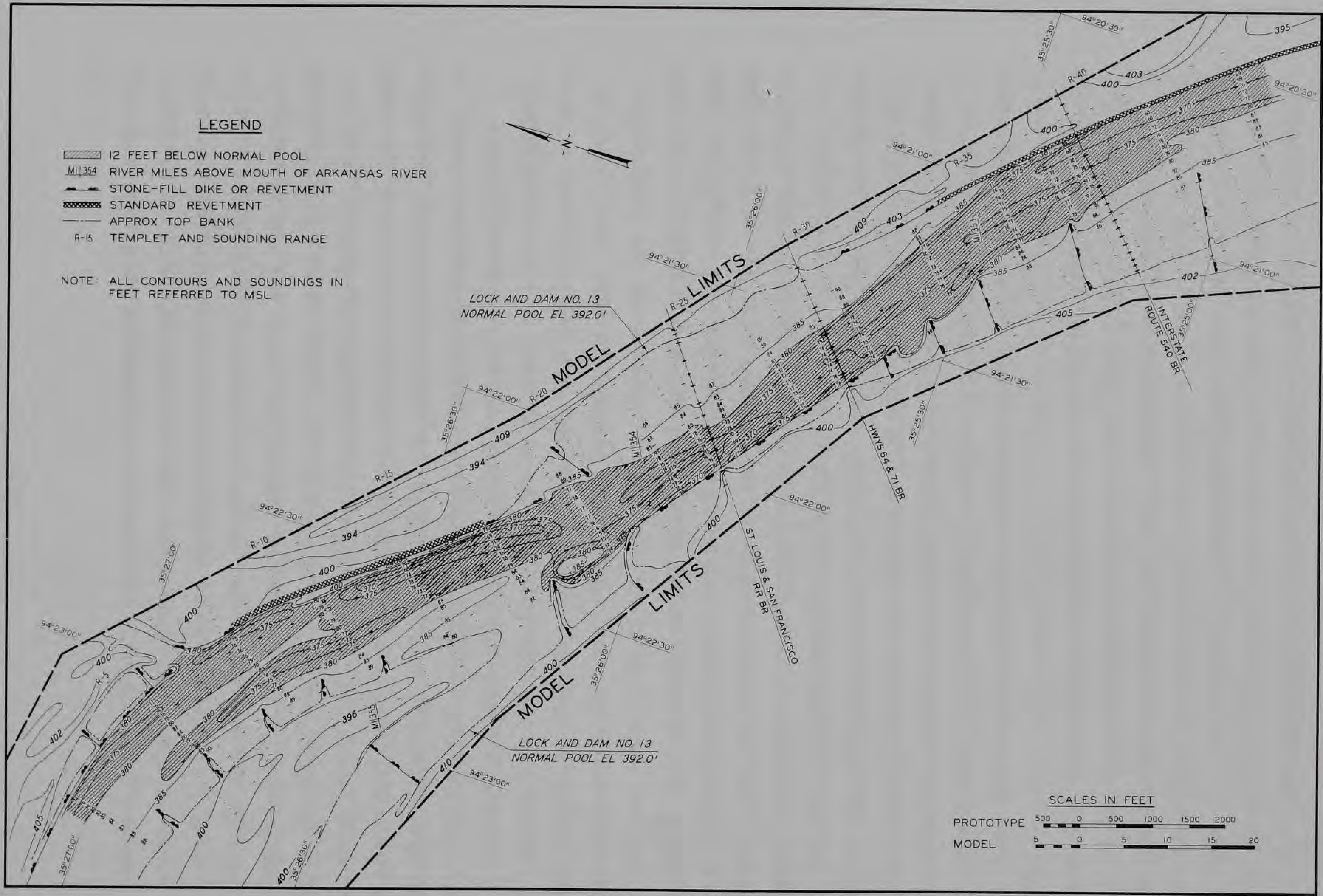


Fig. 11. Channel configuration, prototype survey of 1966

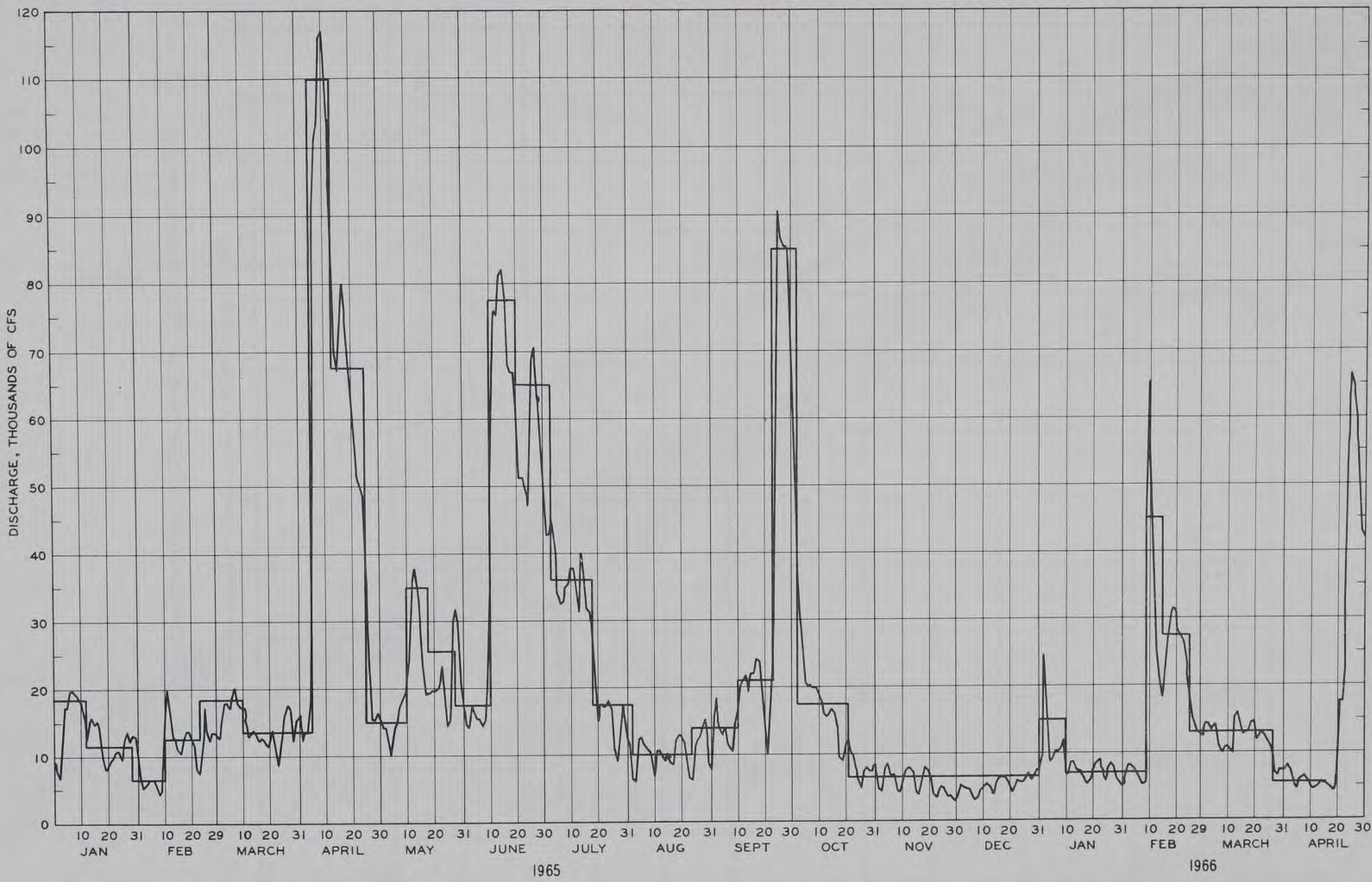


Fig. 12. Discharge verification hydrograph, 1965 and 1966

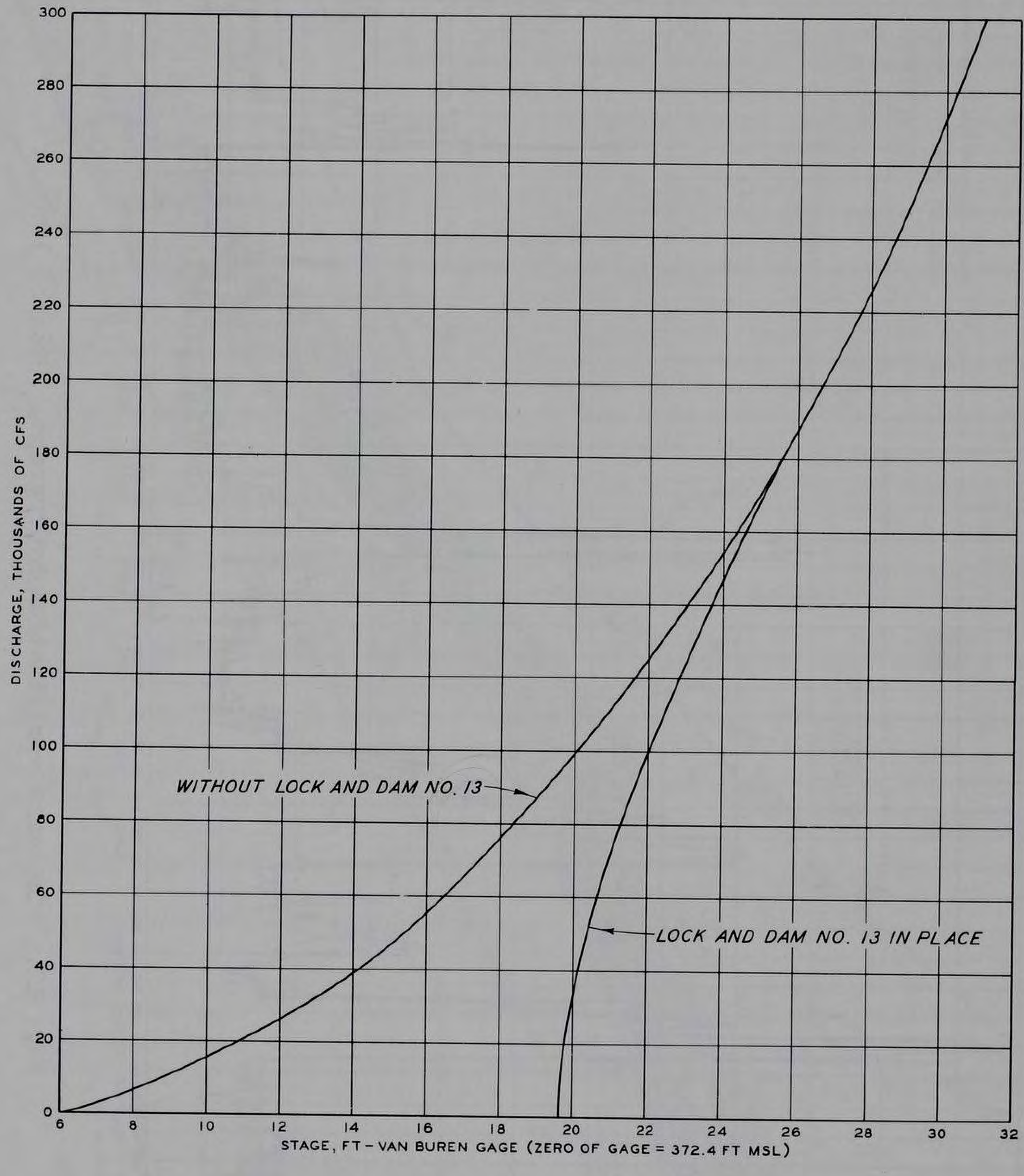


Fig. 13. Stage-discharge curve for Van Buren gage

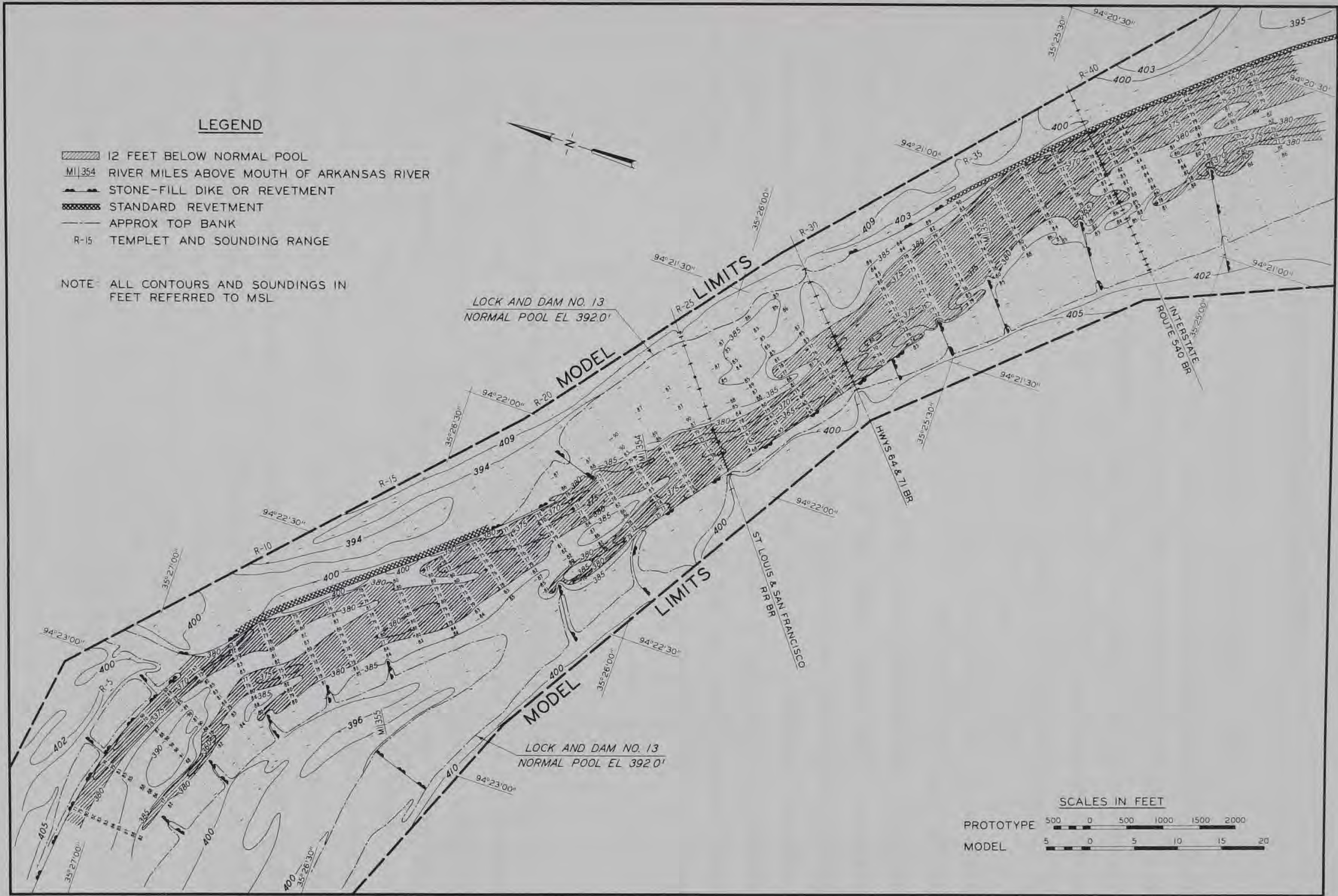


Fig. 14. Channel configuration adjustment test

Testing of Improvement Plans

40. The results of the semifixed-bed study indicated that satisfactory navigation conditions could be developed through the reach with the channel along the proposed left bank revetment. This portion of the investigation was concerned with the development and maintenance of a channel along that side of the river and with modifications that might be required to improve channel conditions and minimize maintenance.

41. Each test consisted of a series of "runs" with each run consisting of the reproduction of an annual hydrograph considered typical of flow conditions within the Van Buren reach of the Arkansas River using the scale relations developed during the adjustment. The hydrograph used for these tests was that recorded in the prototype during the period 1 July 1959 to 30 June 1960 (fig. 15) except that it was modified based on the effects of Lock and Dam No. 13. Tests of each plan were started with the bed of the model as obtained in the preceding test with modifications based on the improvement plan to be tested. Plans tested with the movable-bed model are designated by the subscript "m."

Base Test

42. Before the study of proposed improvements was undertaken, a base test was conducted. The purpose of this test was to determine the ultimate channel configuration that could be expected with the selected hydrograph and the effect of Lock and Dam No. 13. The results of this test would also be used as a basis for determining the effects of the proposed improvements. The bed of the model at the start of this test was the same as that obtained at the end of the adjustment test (fig. 14). The bridges and channel stabilization and training structures were the same as those existing in the prototype at the time of the October 1966 prototype survey.

43. The bed configurations developed during the base test are shown in plate 23. These results indicate that the tendency for the channel to develop along the right bank in the reach of the railroad and

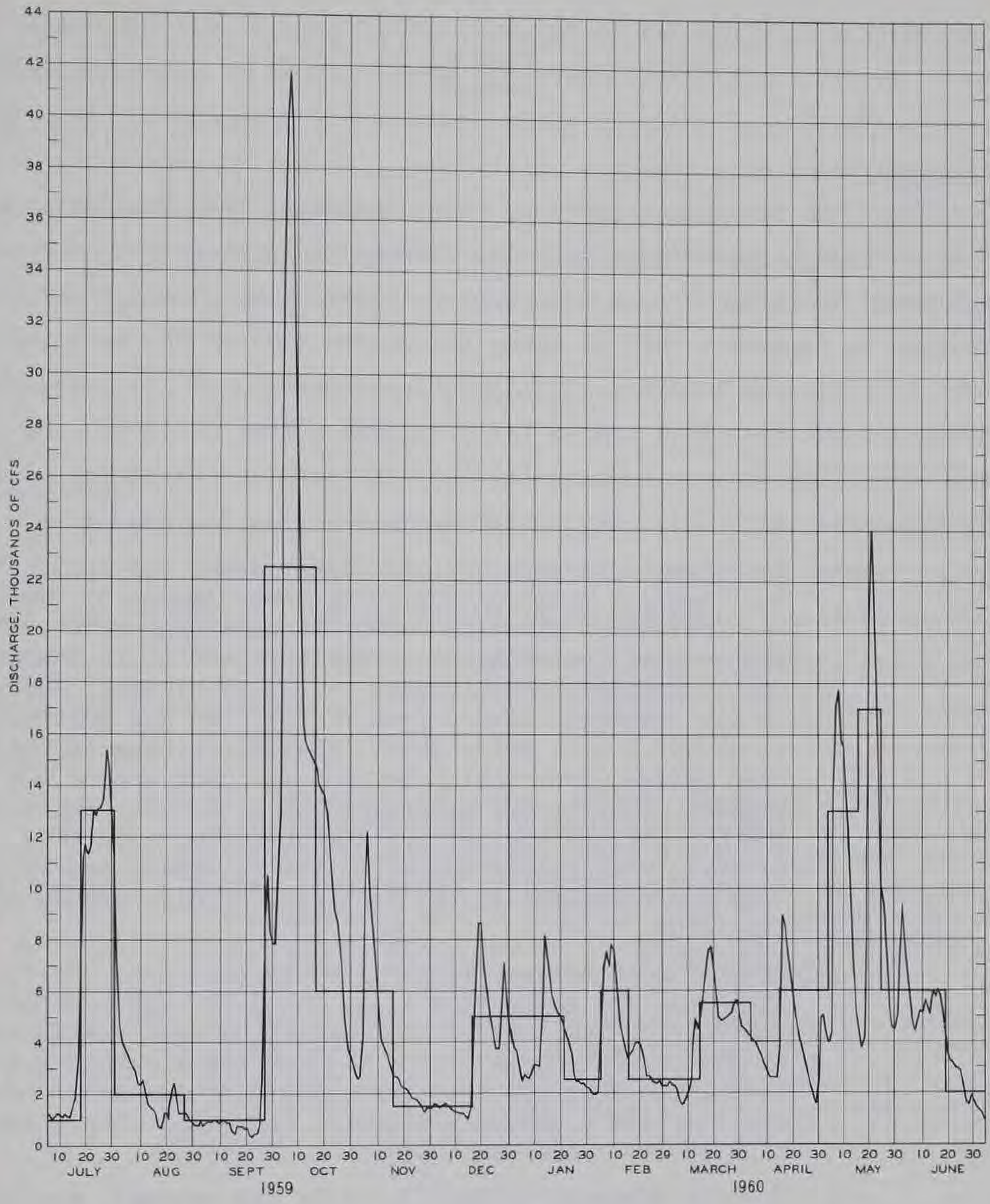


Fig. 15. Discharge hydrograph, 1959 and 1960

Highways 64 and 71 bridges would continue after the completion of Lock and Dam No. 13. Except for some decrease in shoaling along the left bank revetment at about mile 354.8 and an increase in the size of the sandbar along the convex side of the channel in the reach near the existing bridges, conditions were generally the same as those indicated in the adjustment tests and by the 1966 prototype survey.

Plan A_m

Description

44. The results of previous tests indicated that navigation conditions through the bridges with the channel along the right bank revetment would be difficult and hazardous. Accordingly, plan A_m was designed to develop a channel along the convex side of the bend where there is a natural tendency for a sandbar to develop as indicated by the results of the base test and by the prototype survey of 1966. The features of this plan were essentially the same as plan A-1 of the semifixed-bed tests (fig. 6) and included the following (plate 24):

a. The channel through the existing bridges was contracted to a control width of 850 ft by installation of the left bank revetment (355.1L) which extended from about 2500 ft upstream of the railroad bridge to about 50 ft downstream of the proposed new Highways 64 and 71 bridge. The top of the revetment sloped from el 389.2 at the upstream end to el 405.0 at a point about 1250 ft upstream of the railroad bridge; from that point to the lower end of the revetment, the top was maintained at el 405.0. The dikes 353.6L, 353.9L, 354.1L, and 354.3L having a crest el of 389.2 were placed normal to the revetment and extended from the revetment to the left bank or high ground on that side.

b. The railroad bridge was modified to provide a 300-ft lift span for navigation along the left bank revetment. The pier on the left of the navigation span was located in the revetment, while the pier on the right of the navigation span was protected by 25-ft-diam cells on the upstream and downstream sides of the pier. Top elevation of the cells was 405.0.

c. The old Highways 64 and 71 bridge was removed, and piers for the navigation span of the proposed new bridge were installed generally parallel to the old bridge and about 300 ft downstream. The navigation span for the new bridge had a clear width of 300 ft and was located along the left bank revetment with the left pier within the revetment. The right pier of the navigation span was protected by a 42-ft-diam cell with a top elevation of 405.0 on its upstream side.

Results

45. The results of tests of plan A_m (plate 24) indicate that the

tendency for the channel in the vicinity of the railroad and the new highway bridges to develop along the right bank would continue. There was some reduction of the shoaling along the left bank revetment, particularly upstream of the railroad bridge, compared with that obtained in the base test; but depths would be less than adequate for navigation without considerable maintenance dredging. Depths along the right bank revetment were somewhat greater than in the base test.

Plan B_m

Description

46. This plan was designed to eliminate or reduce insofar as practical the amount of shoaling within the navigation channel along the left bank revetment. Before the start of the test of this plan, the channel along the left bank revetment was dredged to 12 ft below normal pool, and the following modifications (similar to the original plan B-1, fig. 8) were included:

- a. The six existing dikes (355.5R through 354.5R) were extended riverward to provide a channel width of 850 ft between the ends of the dikes and the left bank revetment. The crests of the dike extensions were sloped from the ends of the existing dikes to el 390.1 for the upper three dikes and to el 390.0, 389.8, and 389.3, respectively, for the remaining three dikes.
- b. A dike (354.7R) was added downstream of the right bank dikes mentioned in subparagraph a above. The dike was generally normal to the currents and about 600 ft long with a top elevation of 389.5 at the river end and 394.5 at its landward end.

Results

47. The results of tests of this plan shown in plate 25 indicate little change in the channel in the upper reach except for a slight decrease in the channel width just upstream of the mouth of Lee Creek (mile 355.4). There was a considerable reduction in the amount of shoaling (about 75 percent) along the left bank revetment in the vicinity of the railroad and new highway bridges. Depths of at least 11 ft below normal pool elevations were obtained in the navigation channel

upstream of the railroad bridge and for a short distance just downstream. Shoaling to less than project depth occurred from that point to about 2000 ft downstream of the new highway bridge.

Plans C_m and C_m-1

Description

48. Plans C_m and C_m-1 were designed to reduce velocities along the right bank revetment in the vicinity of the two upstream bridges and increase flow along the opposite side through the navigation channel, particularly below the railroad bridge. Plan C_m was the same as plan B_m except for the addition of five submerged dikes along the right bank revetment which were the same as those in plan C (fig. 9). These dikes, which had a crest elevation of 379.0, were spaced about 500 ft apart with lengths of 190, 240, 280, 330, and 350 ft, respectively, starting with the upstream dike.

49. Plan C_m-1 was the same as plan C_m except for the following (see plan C-1, fig. 10):

a. Dike 353.2R, just downstream of the right bank revetment, was extended riverward about 350 ft with a crest elevation of 379.0.

b. The length of the submerged dike farthest upstream in plan C_m (just downstream of the railroad bridge) was increased to 240 ft.

c. Two additional submerged dikes were installed about 100 and 1100 ft, respectively, upstream of the railroad bridge. These dikes were each 240 ft long with crest elevations of 379.0.

Results

50. The results of tests of plan C_m shown in plate 26 indicate a decrease in the shoaling just upstream and downstream of the new highway bridge and an increase in the shoaling of the navigation channel just upstream and downstream of the railroad bridge, compared with plan B_m. The amount of material deposited in the channel in the vicinity of the bridges was about the same as with plan B_m, but the maximum elevation of the shoal was somewhat lower.

51. Conditions with plan C_m-1 were considerably better than with Plan C_m as shown in plate 27. Channel depths of at least 11 ft below normal pool were maintained throughout the model reach except for a small area close to the left bank revetment about 2500 ft upstream of the railroad bridge (mile 354.3). This shoaling was attributed to surface flow moving over the top of the revetment causing some of the sediment to be deposited because of loss of energy.

Plans D_m and D_m-1

Description

52. Plan D_m was developed in an effort to reduce or eliminate the shoaling along the upstream end of the left bank revetment in the vicinity of mile 354.3 by diverting sediment toward the right side of the channel and increasing the concentration of flow along the left side. Accordingly, this plan was the same as plan C_m-1 except for the installation of two vane dikes as shown in fig. 16. These dikes were each 700 ft long, placed at a slight angle to the current and spaced about 450 ft apart with crests at el 400.0. The vane dikes were located along the right side of the channel between dikes 354.9R and 354.5R and were at least 400 ft riverward of the left bank revetment. The design and location of these dikes were based on the results of preliminary tests in which the movement of currents and sediment was observed with representative flows.

53. Plan D_m-1 was the same as plan D_m except that the low section of the left bank revetment in the vicinity of the shoal area near mile 354.3 was raised to reduce the amount of flow over the top of the revetment. The section of the revetment was raised to el 405.0, the same as the portion of the revetment downstream.

Results

54. Results of tests of plan D_m, shown in plate 28, indicate that some sediment was diverted toward the right side of the channel by the vane dikes, but the effect was not sufficient to eliminate the shoaling along the navigation channel upstream of the railroad bridge.

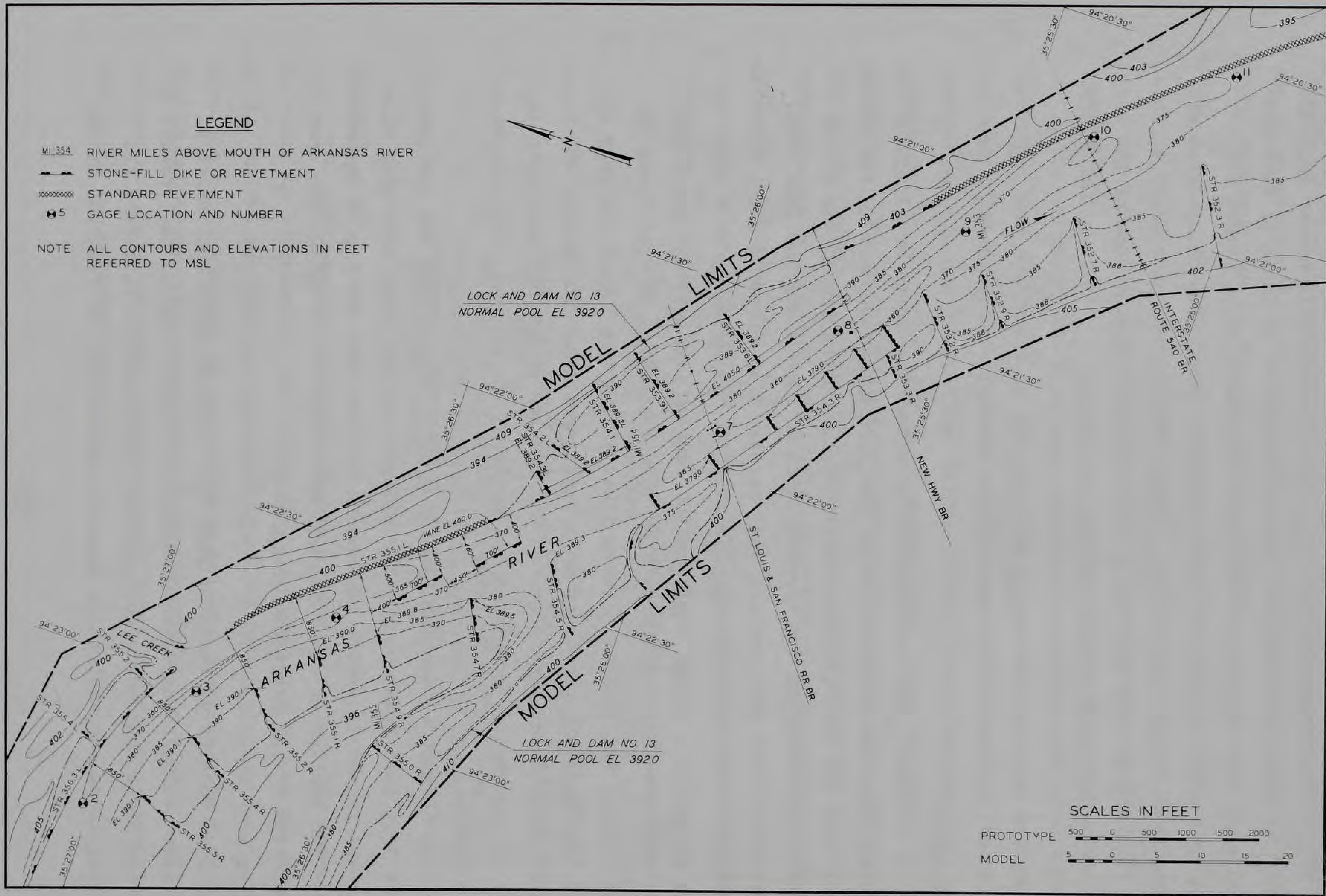


Fig. 16. Plan D_m

There was a considerable increase in channel depths downstream of the bridge, but the shoal completely blocked the channel upstream. There also appeared to be a considerable increase in flow over the low section of the left bank revetment which produced an increase in the shoaling of the channel in that vicinity.

55. Raising the low section of the left bank revetment in plan D_m-1 reduced but did not eliminate the shoaling upstream of the railroad bridge (plate 29). Shoaling continued landward of the vane dikes, but apparently the amount of sediment diverted was not sufficient to have any appreciable effect on shoaling in the navigation channel downstream.

Plan E_m

Description

56. The features of plan E_m were developed during a series of preliminary tests of plans with and without vane dikes and with various modifications of the vane dike system. The features of this plan were the same as plan D_m-1 with the following modifications (fig. 17):

- a. A third vane dike was added downstream of the second vane dike from upstream. This dike was 700 ft long with a crest elevation of 400.0, and its upstream end was 450 ft downstream of the end of the second dike.
- b. Flow between the upper end of the first vane dike and dike 354.9R was reduced by a dike connecting their ends with a crest at el 389.8.
- c. Flow between the upper end of the second vane dike and dike 354.7R was reduced by a dike connecting their ends with a crest at el 384.8.

Results

57. Results of tests of plan E_m (plate 30) indicate that there was a considerable reduction of shoaling in the navigation channel compared with conditions obtained with plan D_m. Depths obtained at the end of run 2 were at least 10 ft below normal pool elevation. The tendency for shoaling along the navigation channel was not eliminated, but it should be considered that during the adjustment and base tests the

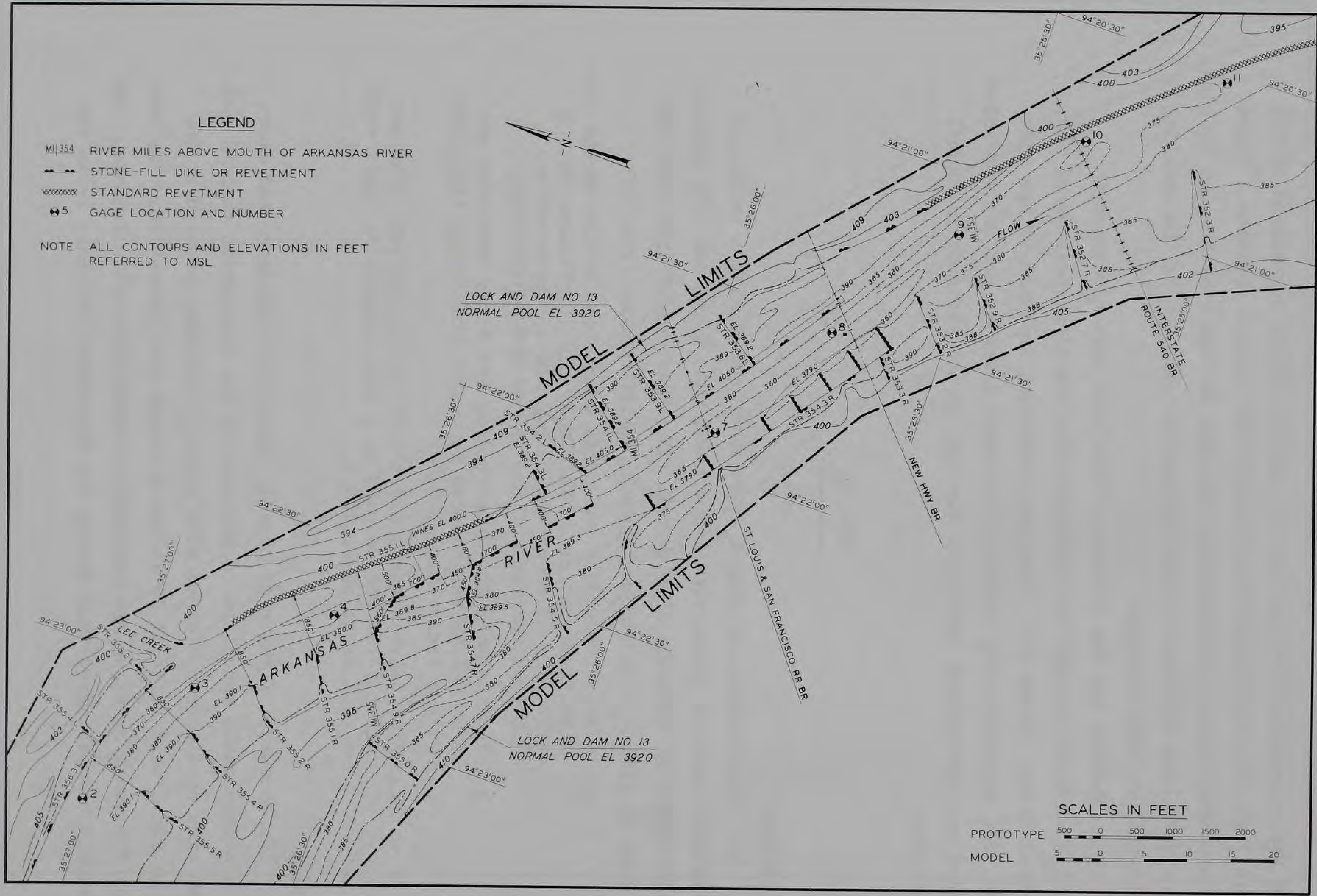


Fig. 17. Plan E_m

tendency to shoal was somewhat greater in the model than in the prototype under similar conditions. Results also indicate an increase in the tendency for shoaling landward of the vane dikes, which should contribute to the long-term development of the channel along the left bank revetment.

PART V: EVALUATION OF RESULTS AND CONCLUSIONS

Limitations of Model Results

58. In evaluating the results of tests of channel regulating works, it should be considered that the conventional process of verifying a movable-bed model was precluded in this case by the lack of necessary recorded data for the reach of the Arkansas River reproduced. The scale ratios established, therefore, can be considered to approximate only in a general way the relations between the model and various reaches of the prototype. The time scale in particular was by necessity established somewhat arbitrarily; and although it was used as a basis for reproducing the discharge hydrograph (figs. 12 and 15), it should not be considered an accurate indication of the time required in the prototype for model-predicted developments to occur under similar conditions.

59. Developments in the movable-bed model occurred mostly as a result of bed movement. Although some of the coal forming the bed of the model channel was thrown into suspension during the higher stages, the model did not even roughly simulate the effects of suspended sediment in a river of this type.

60. In evaluating the results of tests of various plans, consideration must also be given to the fact that some tests were continued until the model reached stability while others were conducted only until the general effects of the plan being tested were indicated. All movable-bed tests were conducted using the hydrograph shown in fig. 15, which was considered as typical of flow conditions in the reach of the river under study. Prolonged periods of unusually low or high water could produce results somewhat different from those expected with a normal-flow hydrograph. Since information concerning the composition of the bed in this reach of the river was not available, it was assumed that the material in the bed consisted of sand without consideration of any bedrock or coarse material which could affect channel development.

61. It is believed that, in spite of the above-mentioned

limitations, the model adjustment resulted in the development of operating techniques and scale ratios sufficiently accurate to permit satisfactory reproduction of the characteristics of the Arkansas River. The reliability and usefulness of the results of tests of improvement plans are further supported by utilization of the base test. This test was conducted with all channel stabilization works in the Arkansas River prior to April 1966 included in the model. In sections where revetments and dikes were installed, the banks riverward of the revetments were removed, the bed of the model was molded to typical sections, and the areas between the dikes were filled to the tops of the dikes (the ultimate conditions expected). By using the base test results as a basis for evaluating the results of the tests of other plans, it is possible to obtain an indication of the relative effectiveness of the various plans as well as general indications of the type of effects that they will produce.

62. The analysis of the results of navigation tests is based principally upon a study of current directions and velocities and the effects of these currents on the behavior of the model tow. The current directions and velocities were indicated by wooden floats submerged to a depth of 8 ft (prototype scale). In evaluating test results, it should be borne in mind that small changes in the direction of flow or in velocities are not necessarily produced by a change in plan, since several floats introduced at the same point under the same flow conditions may follow different paths or move at different velocities, or both, because of pulsating currents and eddies.

Summary of Results and Conclusions

63. The results of the investigation and the conclusions and indications developed during the investigation are summarized as follows:

- a. The channel had a natural tendency to develop in a somewhat sinuous alignment, crossing from the bend along the left bank toward the right bank at about mile 354.2 and then crossing back toward the left bank at about mile 353.0. A navigation channel following the natural tendency would have been easier to develop and maintain.

b. Because of the location of the navigation span of the I-540 bridge with respect to the navigation spans of the two bridges upstream, tows would experience considerable difficulty in passing through the two upper bridges with spans along the right bank and then crossing toward the left bank and becoming aligned for passage through the lower bridge, particularly during the higher flows. Since the location of the I-540 bridge was fixed and it would not have been practical to change the navigation span because of the large sandbar opposite the left bank, navigation conditions would be considerably improved by developing a channel along the left side through the two upper bridges.

c. With the navigation channel along the left side, two crossings would be eliminated; but there would a strong tendency for shoaling within the channel. Raising of the pool with the operation of Lock and Dam No. 13 would have little effect on the shoaling tendency. Submerged dikes along the right bank would tend to reduce velocity of currents on that side of the channel and reduce shoaling along the left side.

d. Development of a navigation channel along the left side in the vicinity of the two upper bridges would require considerable contraction and training structures to offset the natural tendency for high velocity currents to move toward the right side. A rock-fill revetment would have to be provided along the left side of the channel with baffle dikes between the revetment and the left bank to reduce or eliminate flow moving landward of the revetment. The revetment would have to be sufficiently high to prevent loss of surface flow, which would leave the heavily sediment-laden bottom currents within the navigation channel.

e. Installation of the left bank revetment with a top elevation of 405.0 with submerged dikes along the right bank and extension of the right bank dikes upstream and downstream as included in plan C_m-1 should produce an adequate channel under most conditions with some maintenance dredging.

f. Maintenance dredging could be practically eliminated with a system of vane dikes such as that developed in plan E_m.

Table 1

Water-Surface Elevations, Base Test

Gage No.	Water-Surface Elevation, ft msl Q, cfs 50,000	Q, cfs 72,000	Q, cfs 100,000	Q, cfs 150,000	Q, cfs 200,000	Q, cfs 250,000	Q, cfs 300,000
1	391.2	393.4	395.9	399.6	402.4	404.6	406.8
2	390.9	393.1	395.7	399.2	402.1	404.4	406.6
3	390.4	392.6	395.2	399.1	401.9	404.2	406.4
4	389.5	391.7	394.4	398.1	401.1	403.6	405.9
5	389.1	391.3	394.1	397.8	400.7	403.2	405.5
6	388.9	391.0	393.7	397.5	400.5	403.0	405.3
7	388.2	390.3	392.8	396.6	399.6	402.0	404.1
8*	387.9	389.9	392.5	396.1	399.1	401.5	403.5
9	387.4	389.2	392.0	395.6	398.7	401.0	403.2
10	386.9	388.6	391.4	395.1	398.2	400.6	402.8
11	386.6	388.2	391.0	394.7	397.9	400.4	402.5

* Control gage (based on rating curve at the Van Buren gage, revised 3 June 1966).

Table 2

Water-Surface Elevations

Plans A and A-1

Gage No.	Water-Surface Elevation, ft msl — Plan A — Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000	Plan A-1 — Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000
1	394.2	399.3	404.9	394.3	399.3	404.9
2	394.0	399.1	404.8	394.1	399.1	404.8
3	393.7	398.6	404.4	393.7	398.5	404.3
4	393.5	398.1	404.0	393.4	397.9	403.8
5	393.3	397.8	403.7	393.3	397.7	403.6
6	393.2	397.6	403.4	393.1	397.4	403.3
7	392.8	396.4	401.6	392.8	396.4	401.7
8	392.6	395.7	400.9	392.6	395.9	401.2
9	392.4	395.2	400.7	392.3	395.5	401.0
10	392.3	395.2	400.7	392.2	395.3	400.8
11*	392.0	394.7	400.4	392.0	394.7	400.4

* Control gage.

Table 3

Water-Surface Elevations

Plans B and B-1

Gage No.	Water-Surface Elevation, ft msl					
	Plan B			Plan B-1		
	Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000	Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000
1	394.6	399.8	405.1	394.1	399.3	404.9
2	394.4	399.6	405.0	394.0	399.2	404.8
3	394.0	399.1	404.6	393.7	398.7	404.3
4	393.7	398.4	404.1	393.4	398.0	403.8
5	393.5	398.0	403.8	393.4	397.9	403.7
6	393.4	397.8	403.4	393.2	397.5	403.2
7	393.0	396.8	402.0	392.9	396.6	401.8
8	392.8	396.3	401.5	392.6	395.8	401.0
9	392.4	395.5	401.0	392.4	395.4	400.9
10	392.3	395.2	400.7	392.3	395.4	400.9
11*	392.0	394.7	400.4	392.0	394.7	400.4

* Control gage.

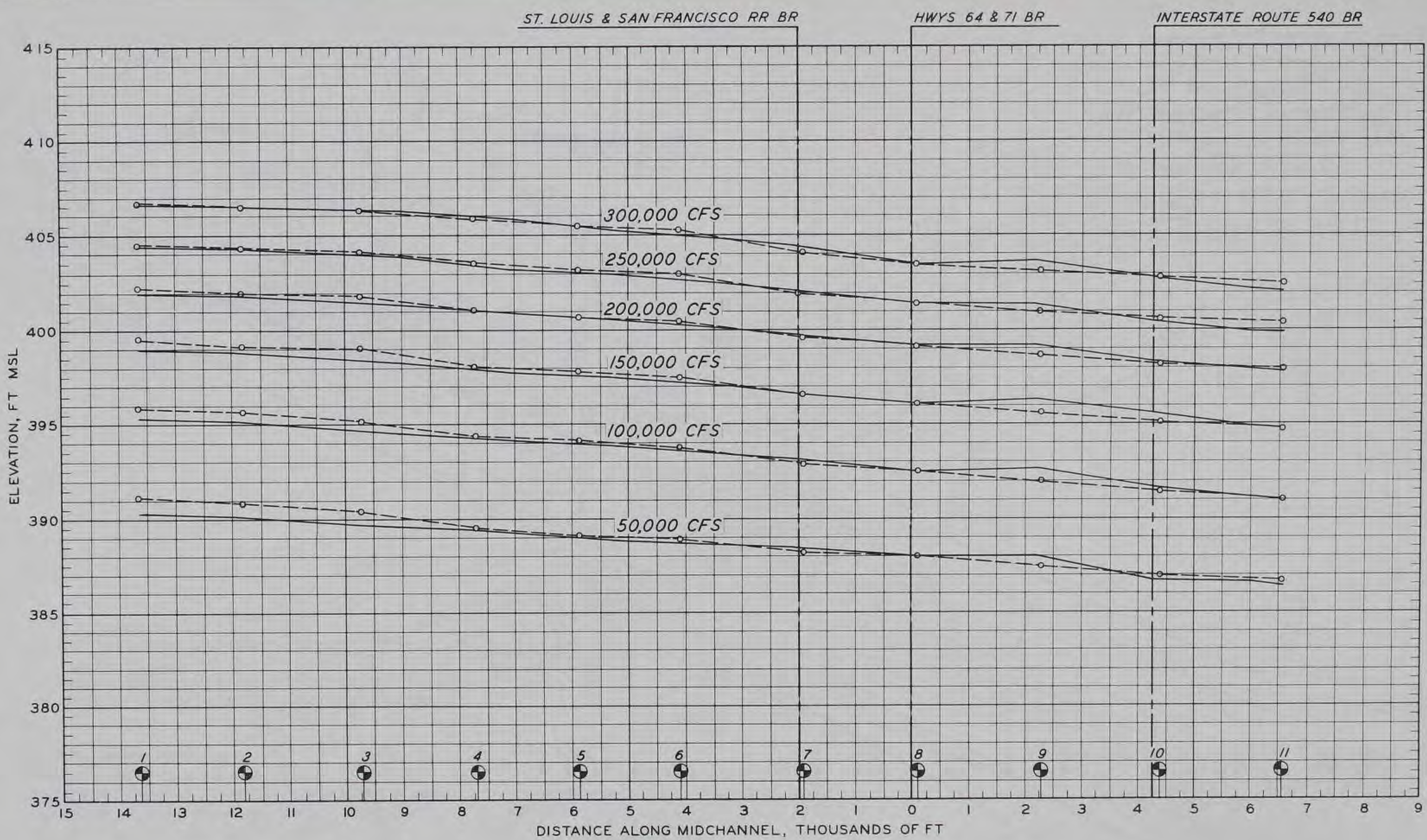
Table 4

Water-Surface Elevations

Plans C and C-1

Gage No.	Water-Surface Elevation, ft msl					
	Plan C			Plan C-1		
	Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000	Q, cfs 72,000	Q, cfs 150,000	Q, cfs 250,000
1	394.2	399.4	405.0	394.3	399.5	405.1
2	393.9	399.1	404.8	394.0	399.2	404.9
3	393.4	398.5	404.3	393.5	398.6	404.5
4	393.2	397.5	403.6	393.3	397.7	403.7
5	393.1	397.4	403.5	393.2	397.5	403.5
6	393.0	397.2	403.2	393.1	397.4	403.3
7	392.8	396.5	402.0	392.8	396.4	401.9
8	392.6	395.9	401.4	392.6	395.9	401.4
9	392.3	395.4	401.0	392.4	395.4	401.0
10	392.3	395.2	400.7	392.3	395.2	400.7
11*	392.0	394.7	400.4	392.0	394.7	400.4

* Control gage.



LEGEND

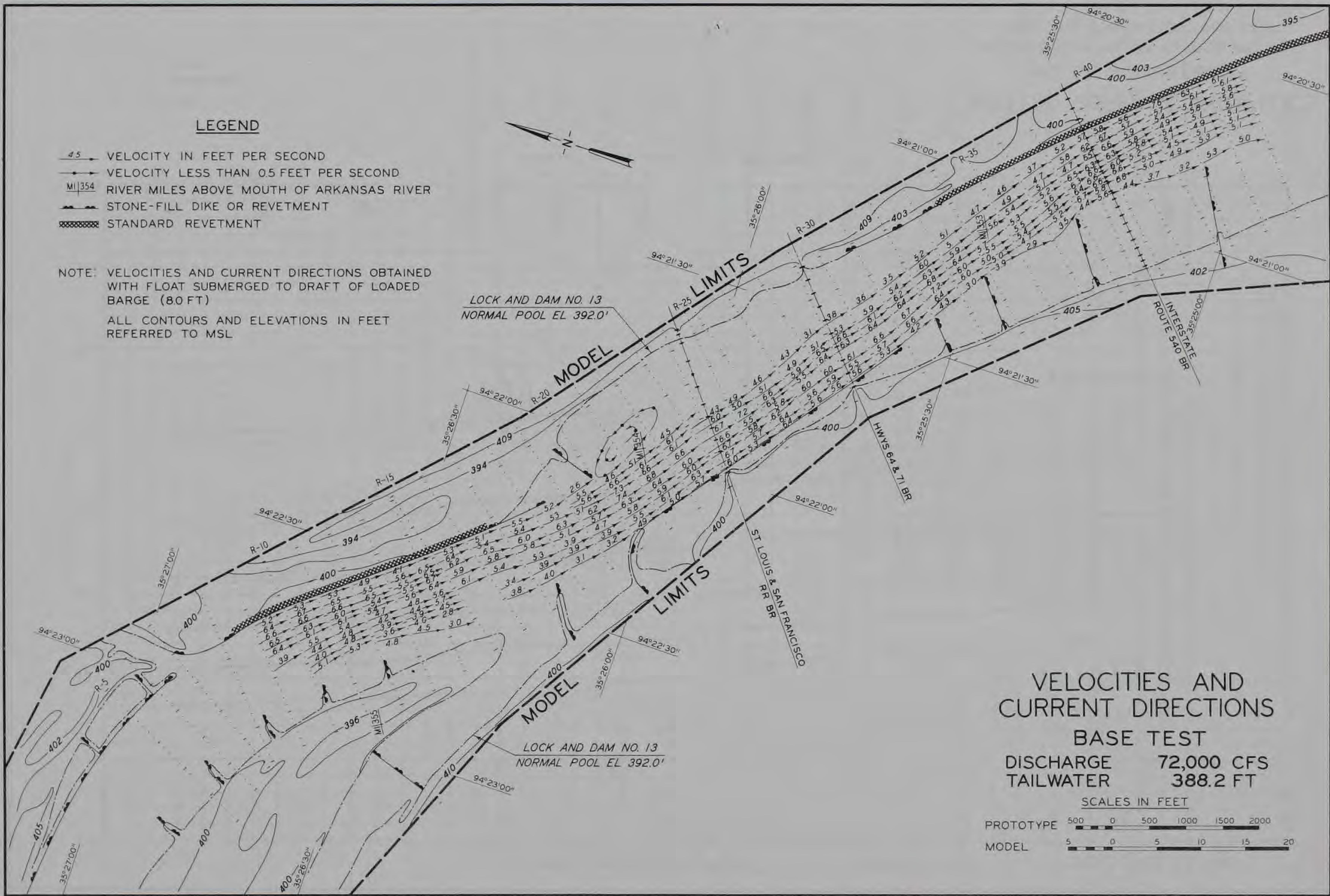
——— COMPUTED
o---o MODEL

WATER–SURFACE PROFILES

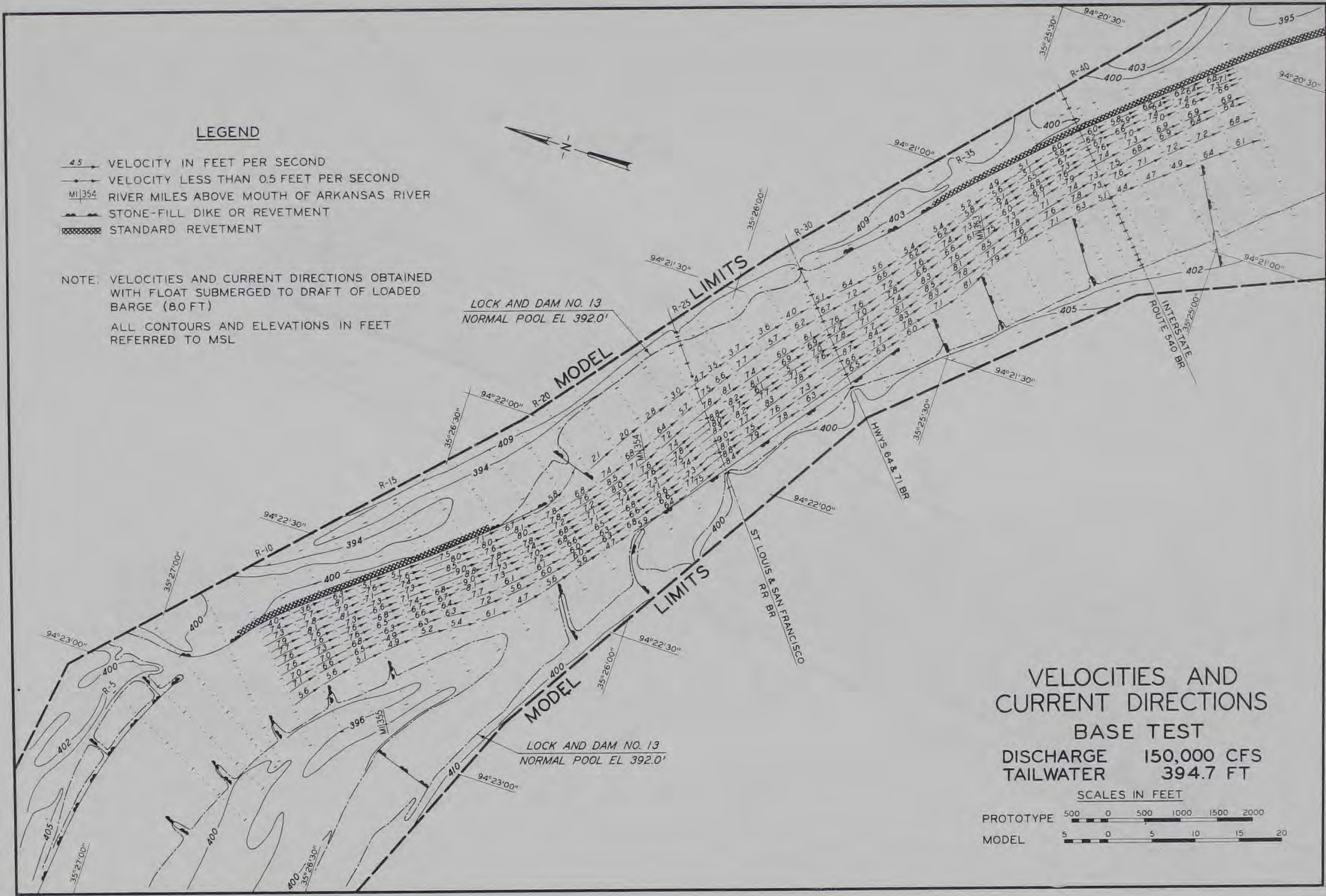
MODEL ADJUSTMENT

DISCHARGES: 50,000, 100,000, 150,000, 200,000, 250,000, 300,000 CFS

PLATE 2



LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
INTERSTATE ROUTE 540 BR
HWYS 64 & 71 BR
ST LOUIS & SAN FRANCISCO RR BR
MI 353
MI 354
MI 355
VELOCITIES AND CURRENT DIRECTIONS
BASE TEST
DISCHARGE 72,000 CFS
TAILWATER 388.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
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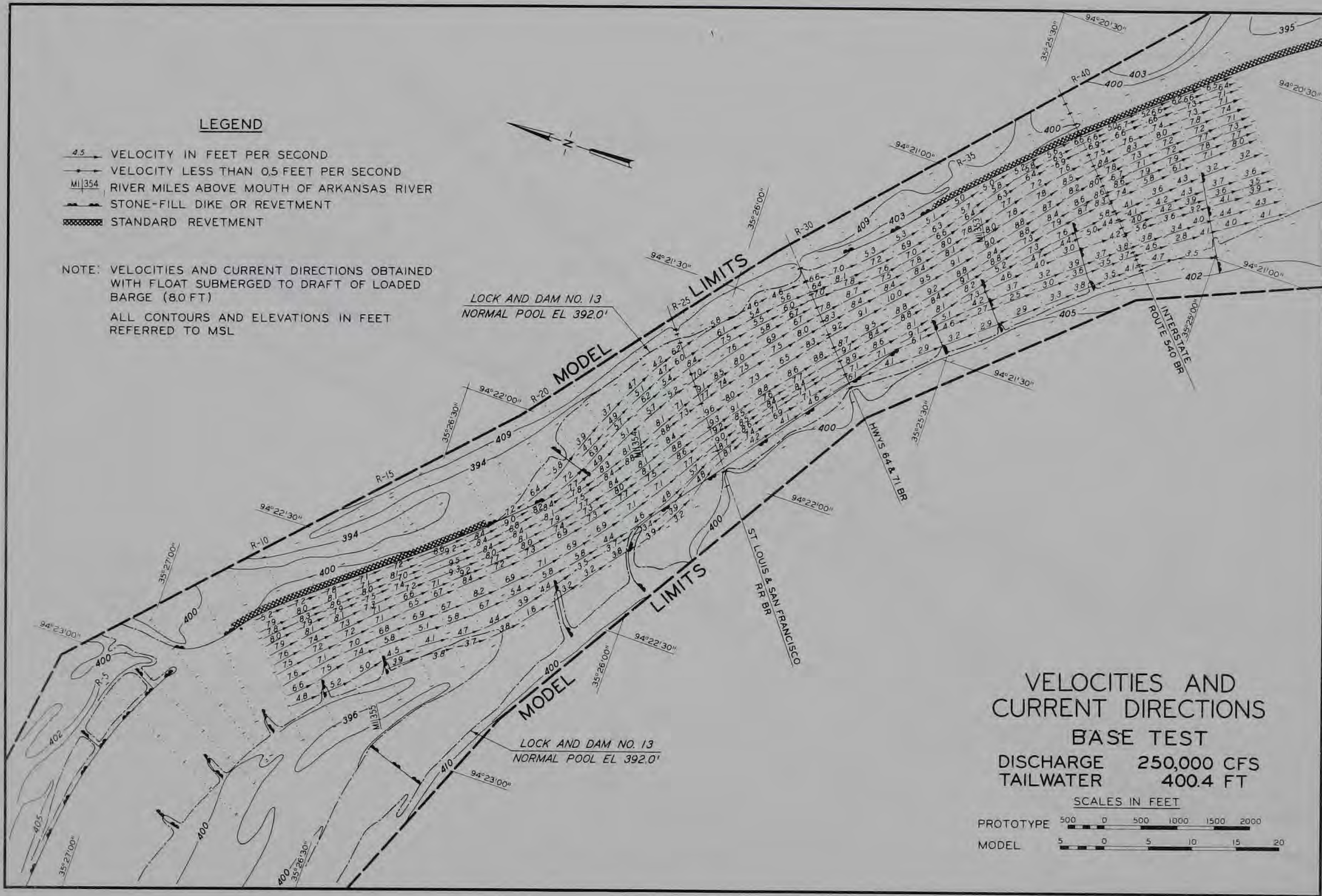
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
HWYS 64 & 71 BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
BASE TEST
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 3

PLATE 4



LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
HWYS 64 & 71 BR
ST LOUIS & SAN FRANCISCO RR BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
BASE TEST
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

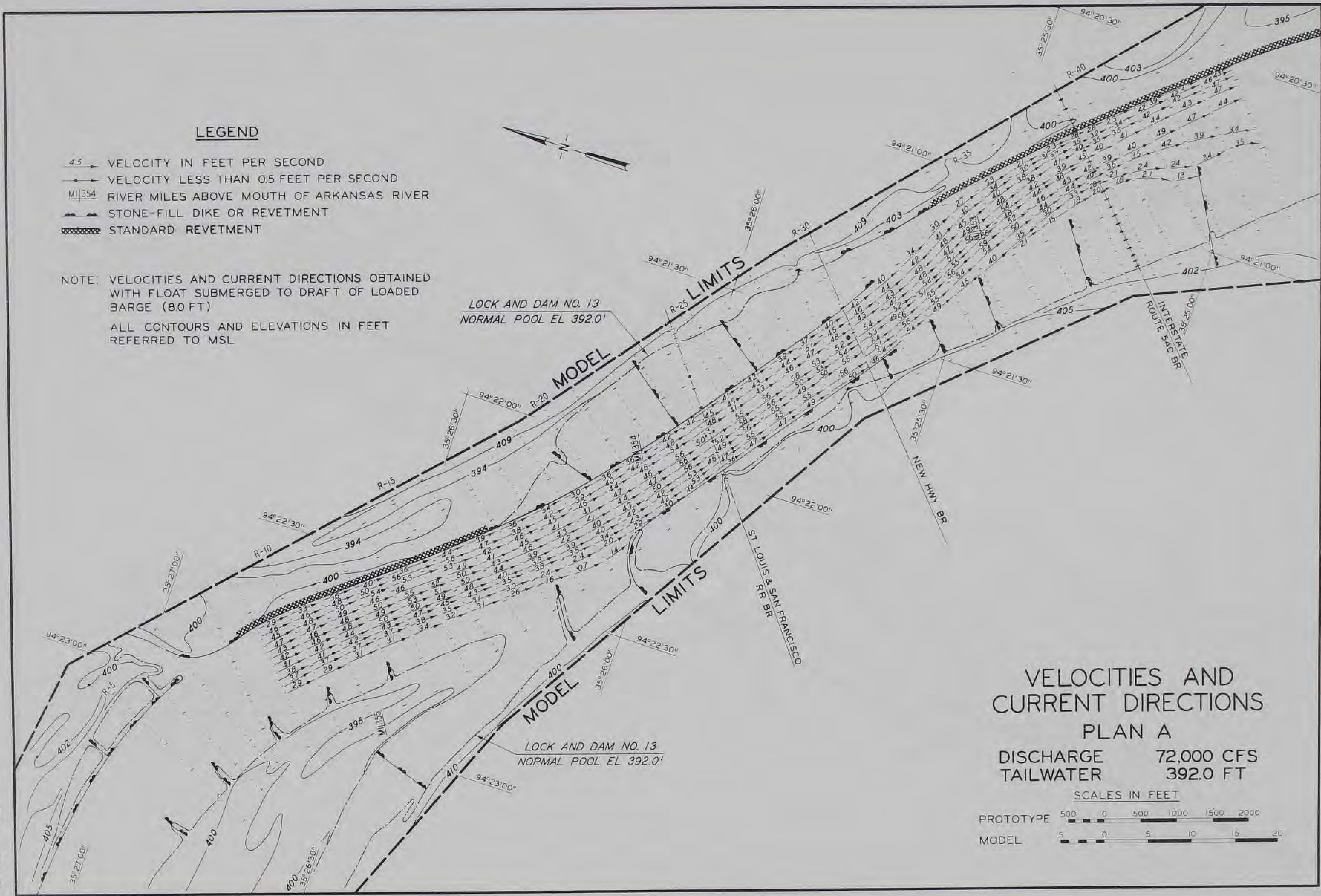
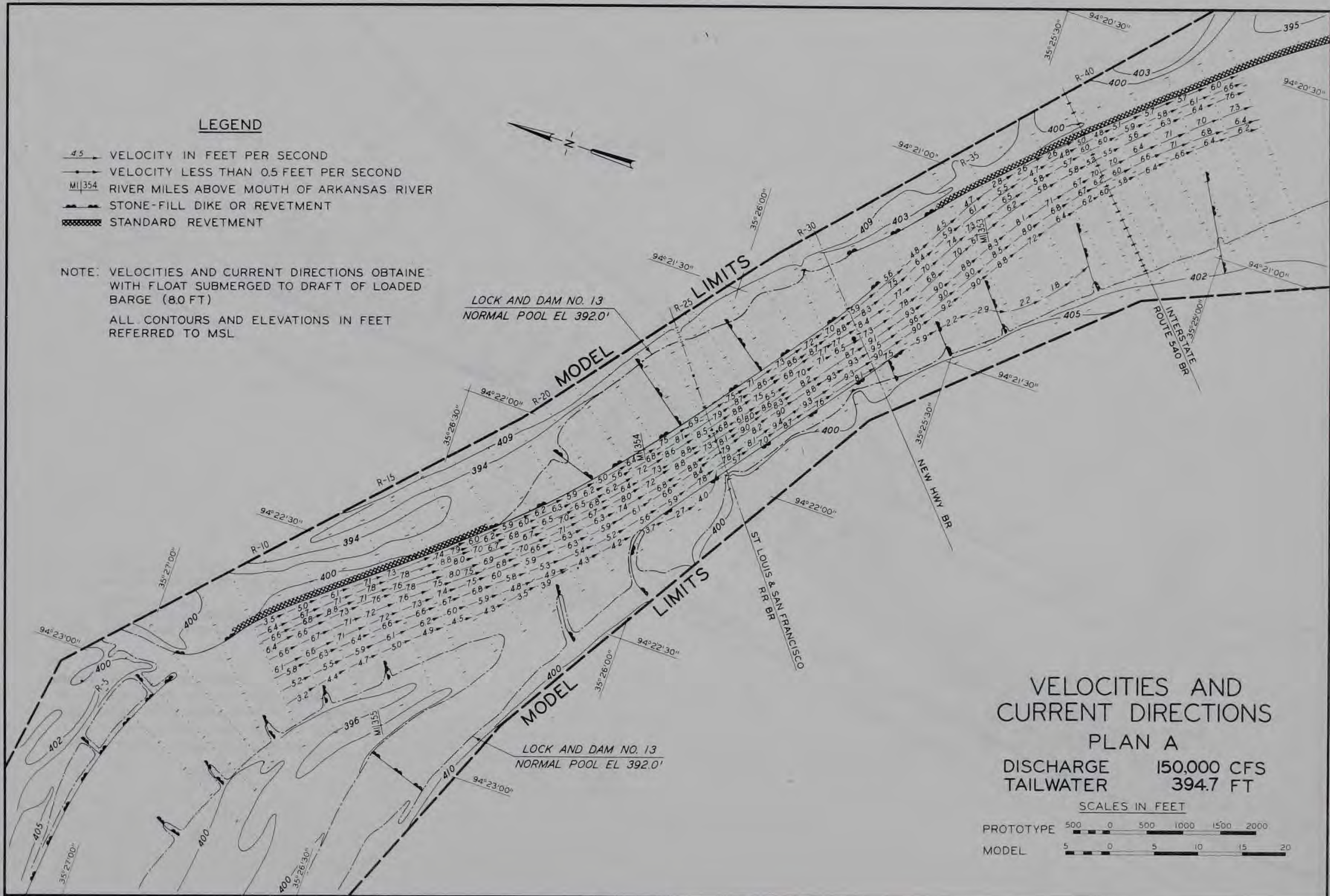
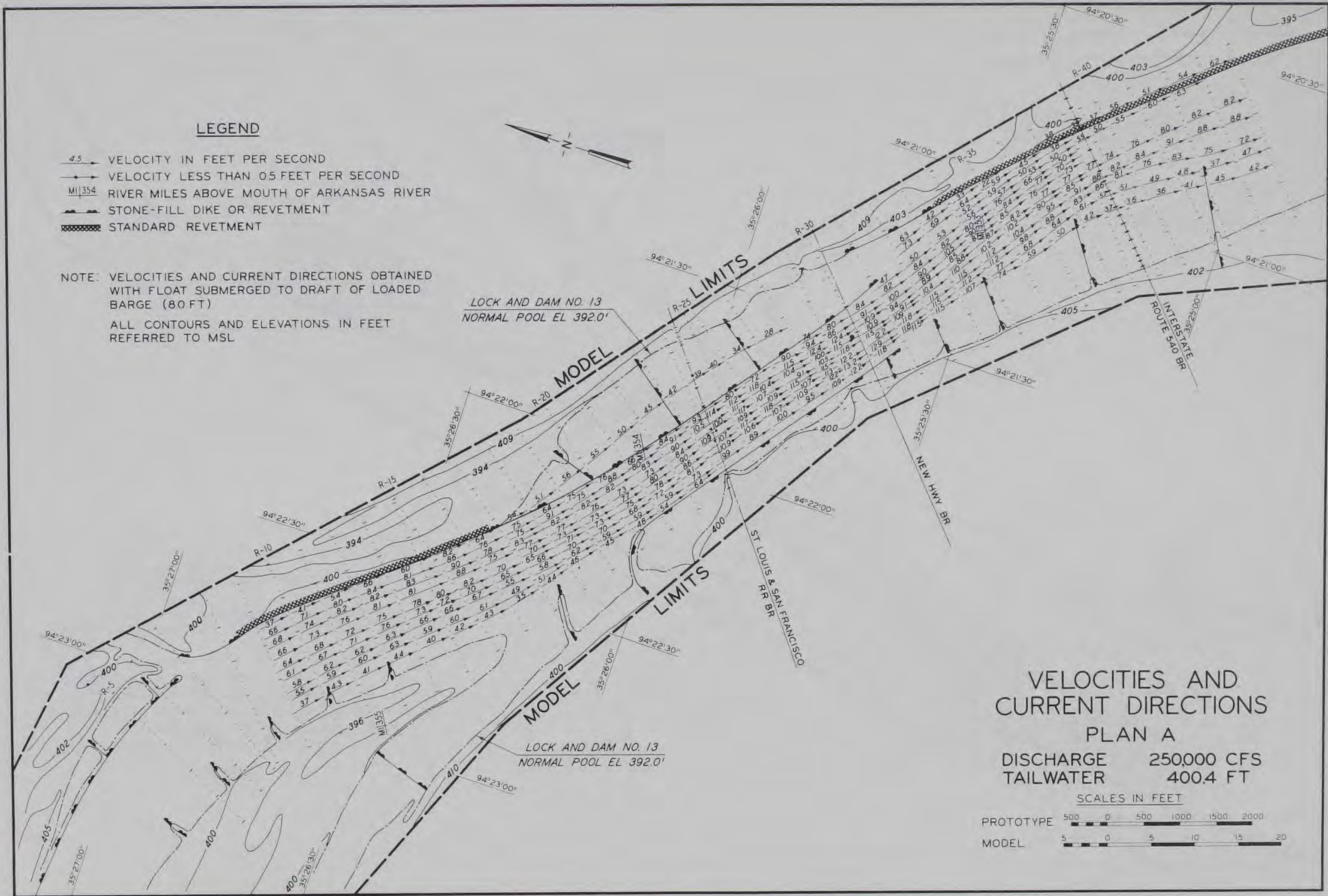

LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
DISCHARGE 72,000 CFS
TAILWATER 392.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 5

PLATE 6


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINE WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
N
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 353
MI 354
MI 355
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
94°20'30"
94°21'00"
94°21'30"
94°22'00"
94°22'30"
94°23'00"
35°25'00"
35°25'30"
35°26'00"
35°26'30"
35°27'00"
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20



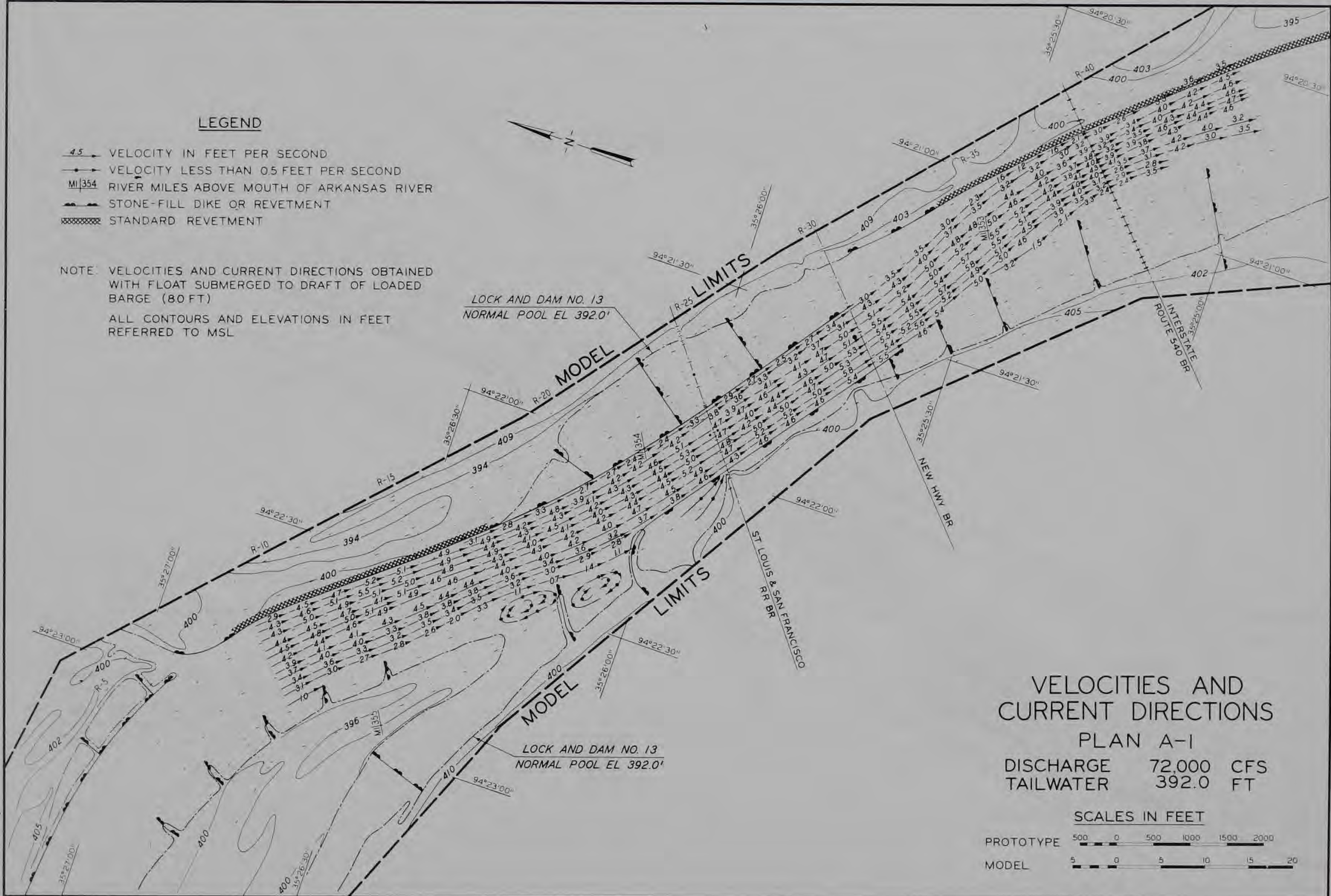
VELOCITIES AND CURRENT DIRECTIONS

PLAN A

DISCHARGE 250,000 CFS

TAILWATER 400.4 FT

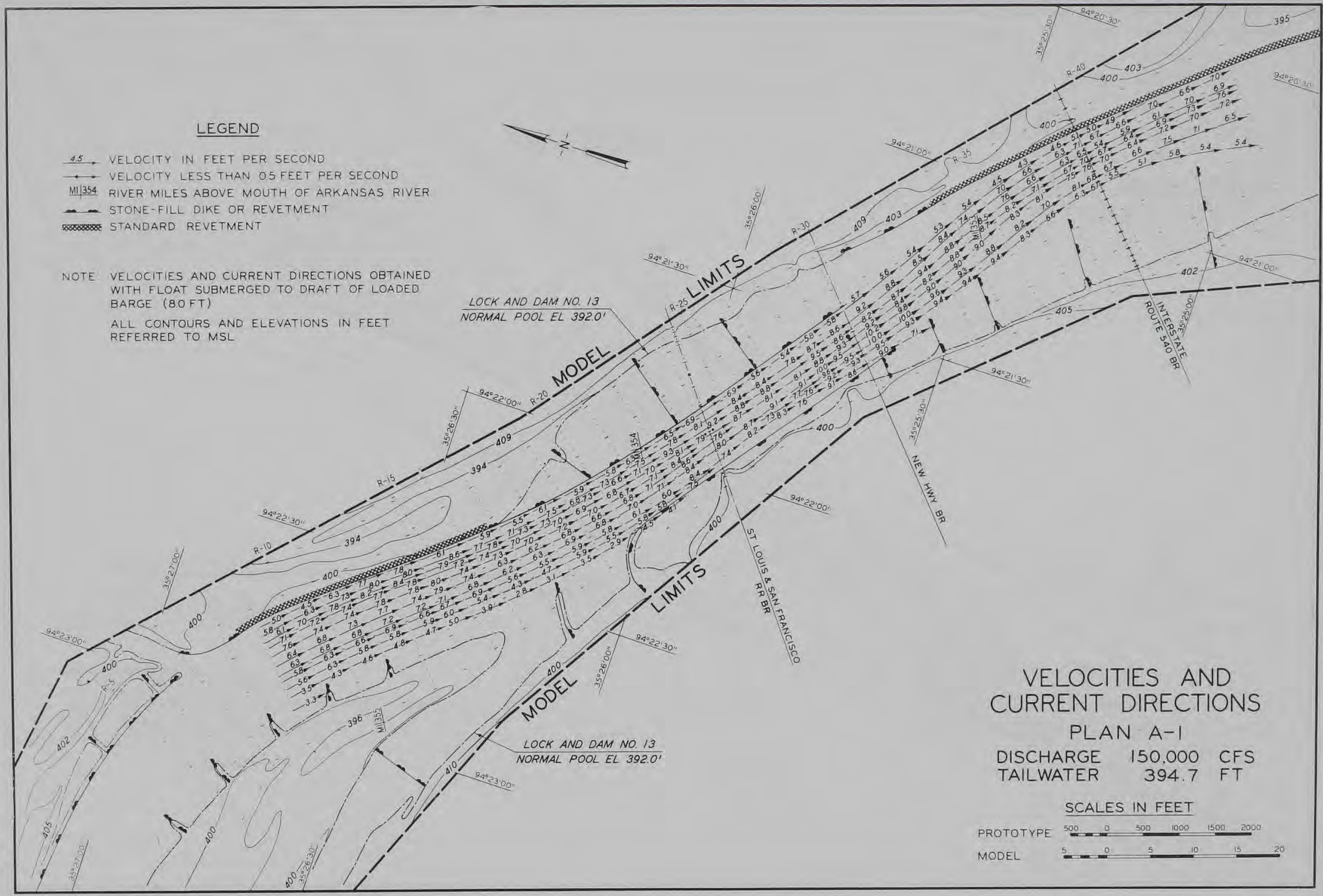
PLATE 7



VELOCITIES AND CURRENT DIRECTIONS

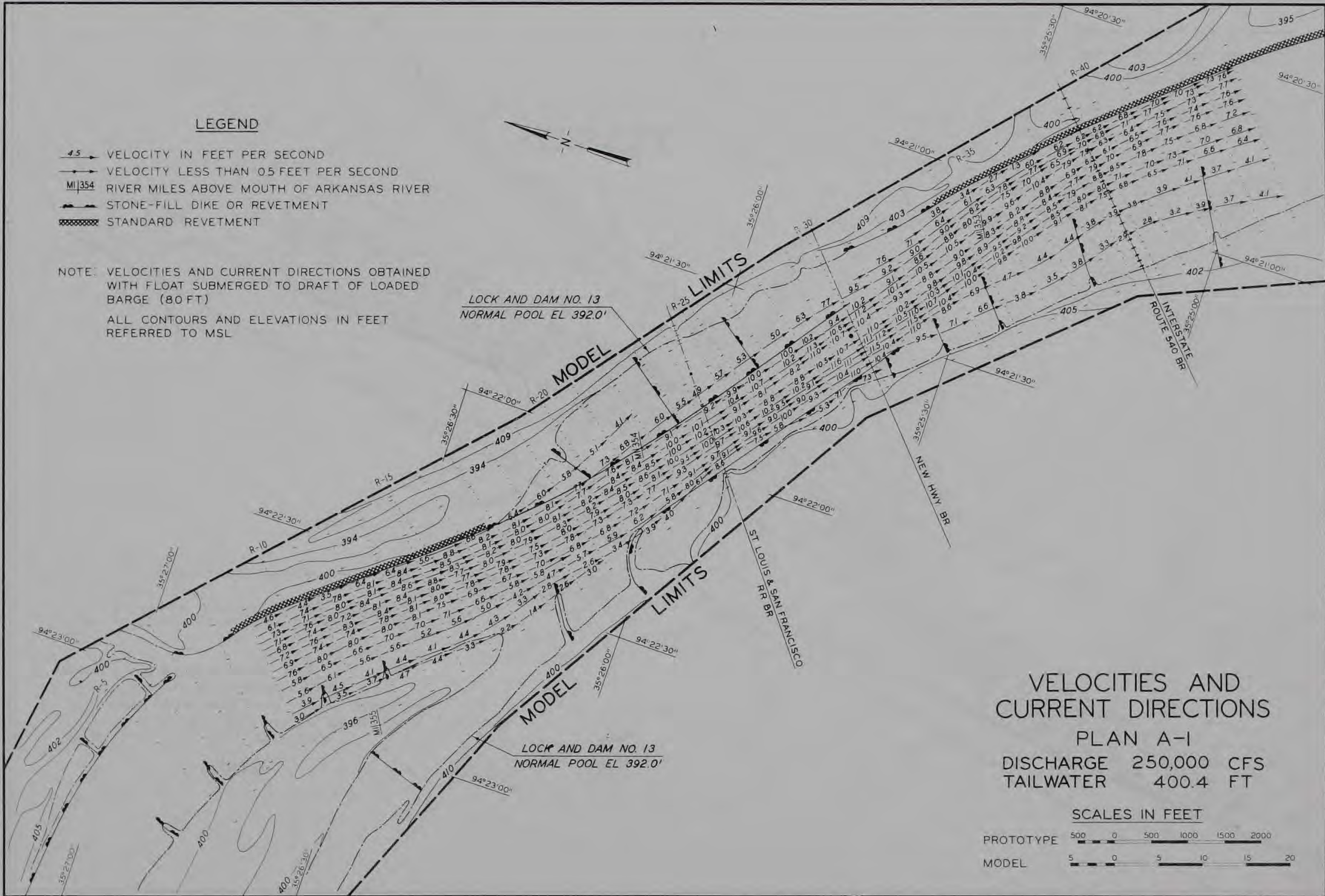
PLAN A-1

DISCHARGE 72,000 CFS
TAILWATER 392.0 FT



LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-1
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 9


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 353
MI 354
MI 355
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-1
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

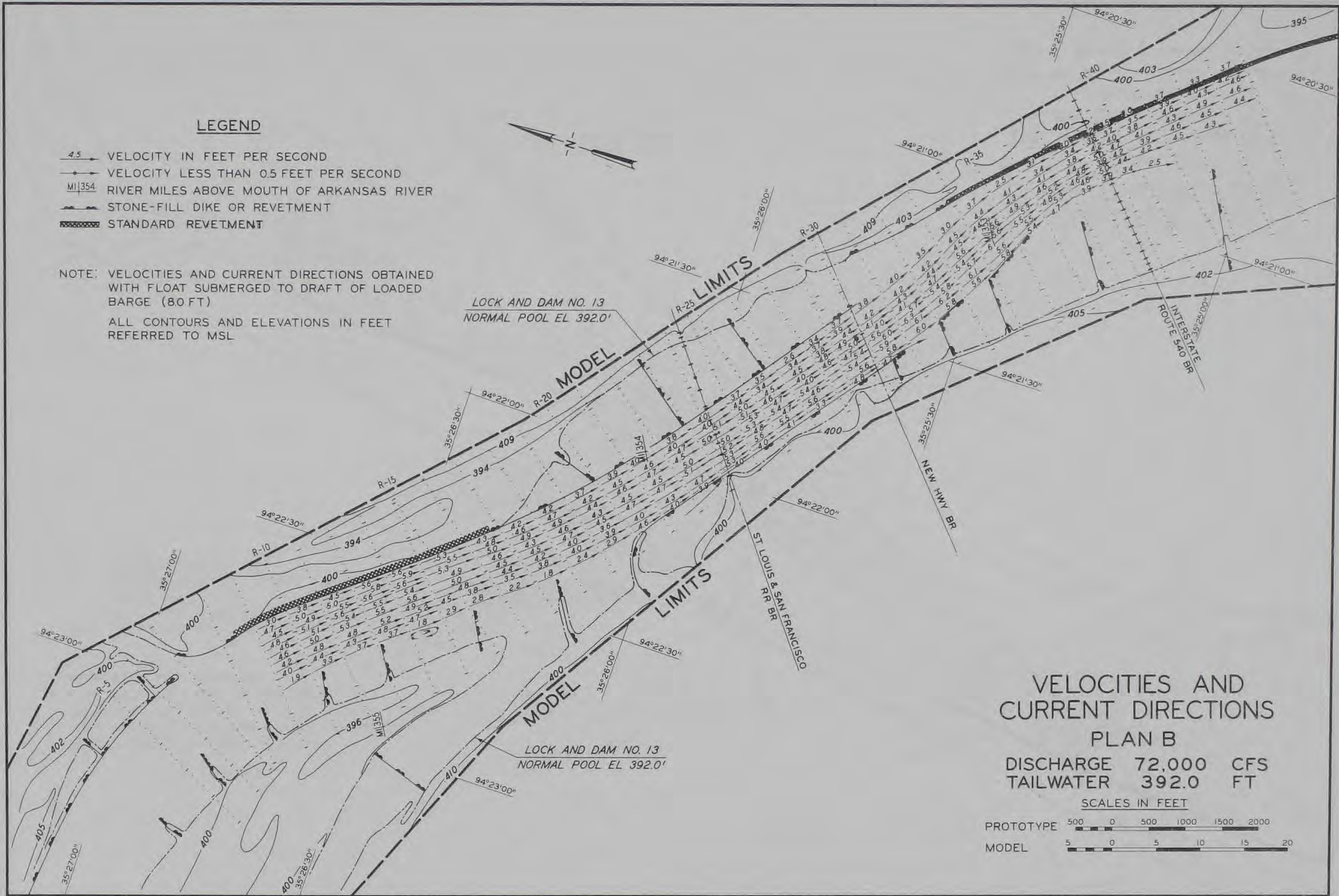
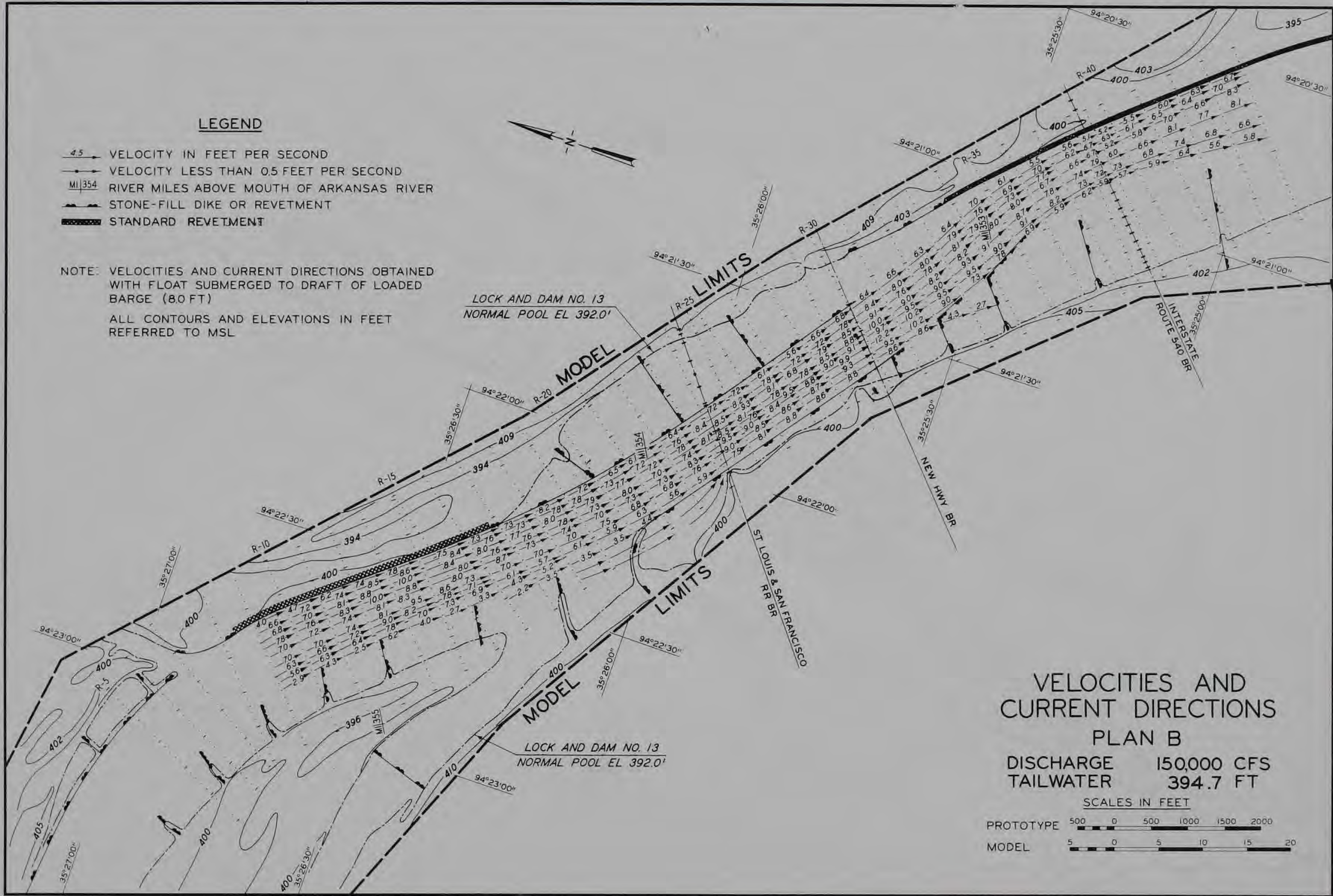
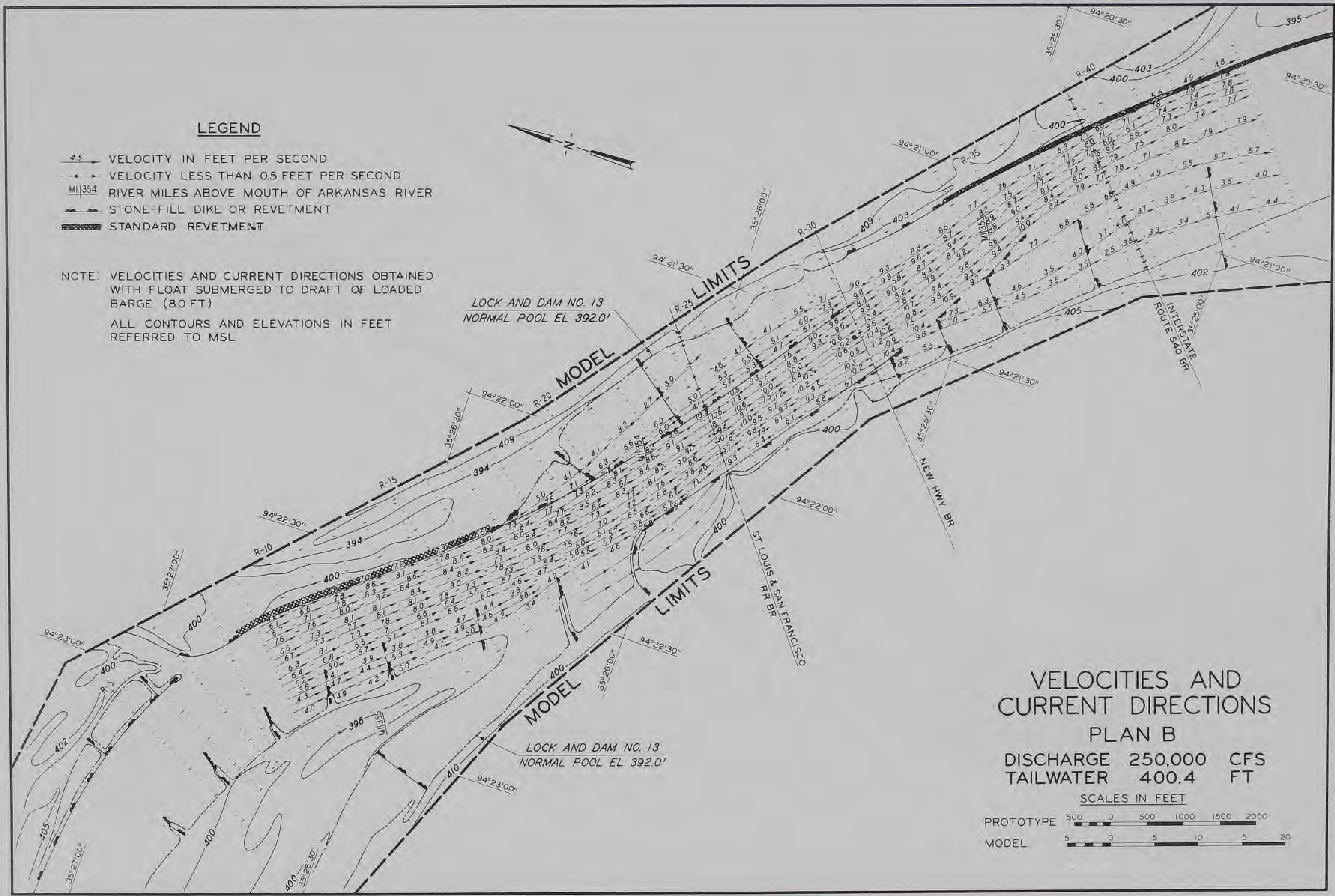

LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN B
DISCHARGE 72,000 CFS
TAILWATER 392.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 11


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
NEW HWY BR
ST LOUIS & SAN FRANCISCO RR BR
INTERSTATE ROUTE 540 BR
MI 353
MI 354
MI 355
VELOCITIES AND CURRENT DIRECTIONS
PLAN B
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
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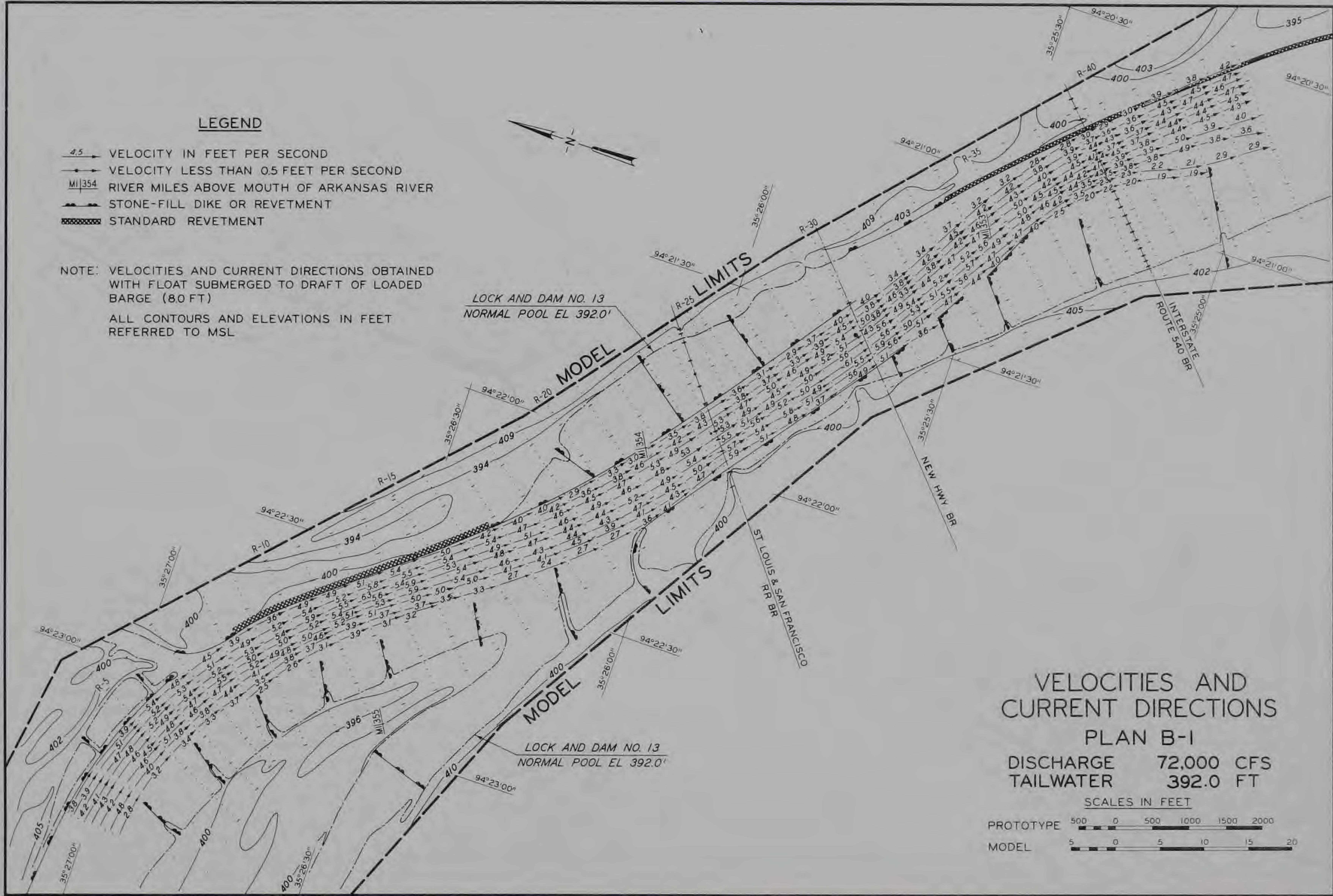
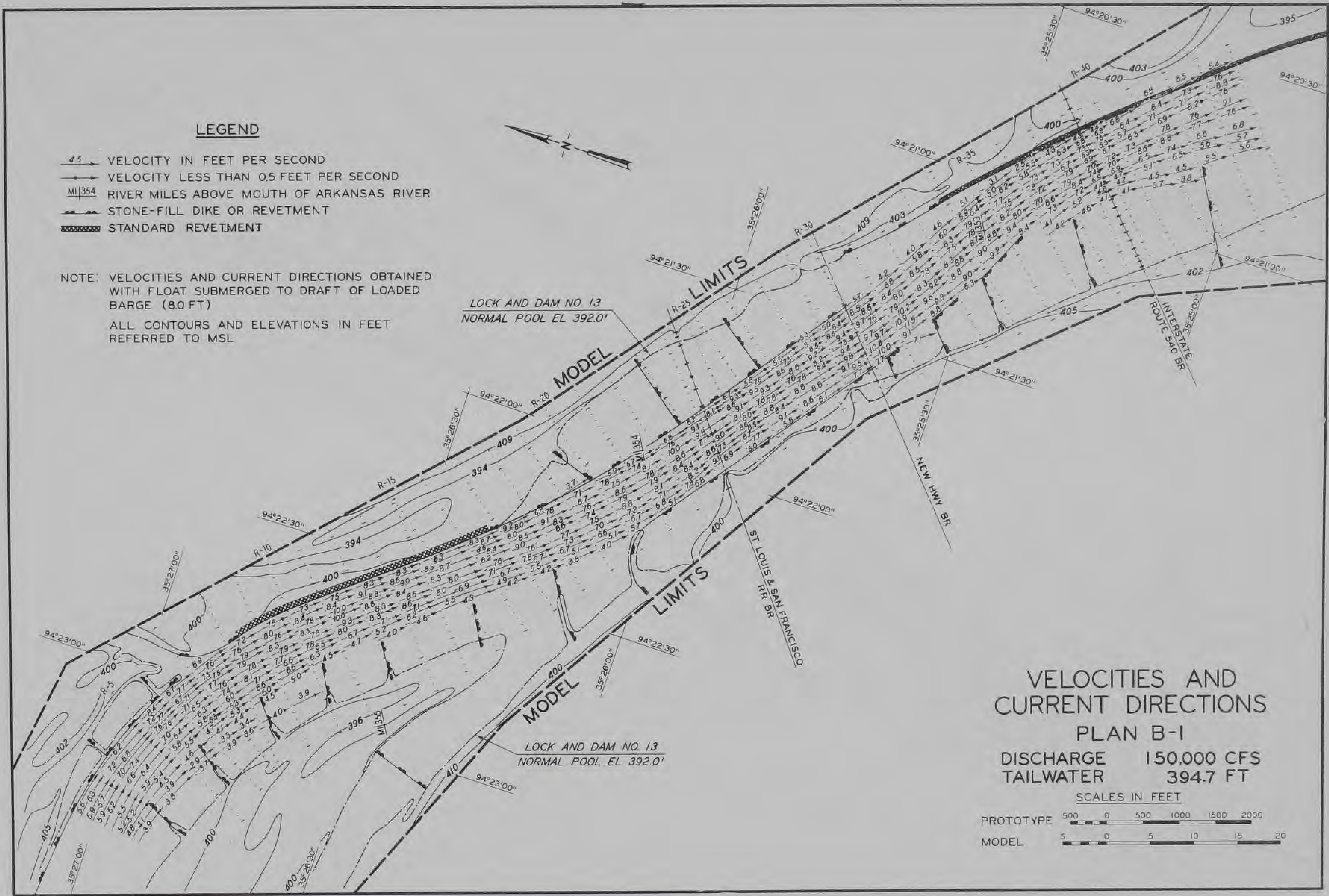
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
MI 353
VELOCITIES AND
CURRENT DIRECTIONS
PLAN B
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 13


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-1
DISCHARGE 72,000 CFS
TAILWATER 392.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20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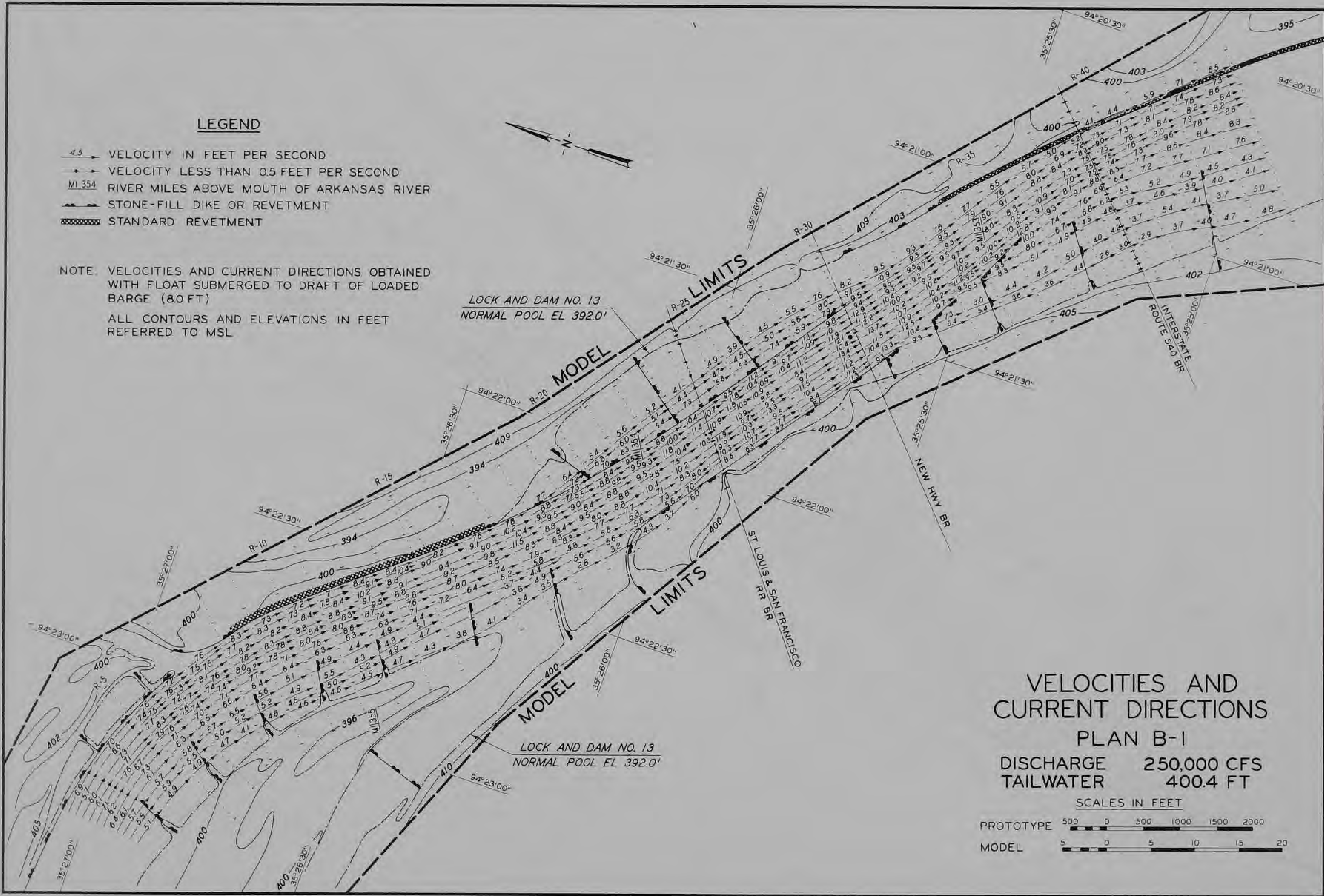
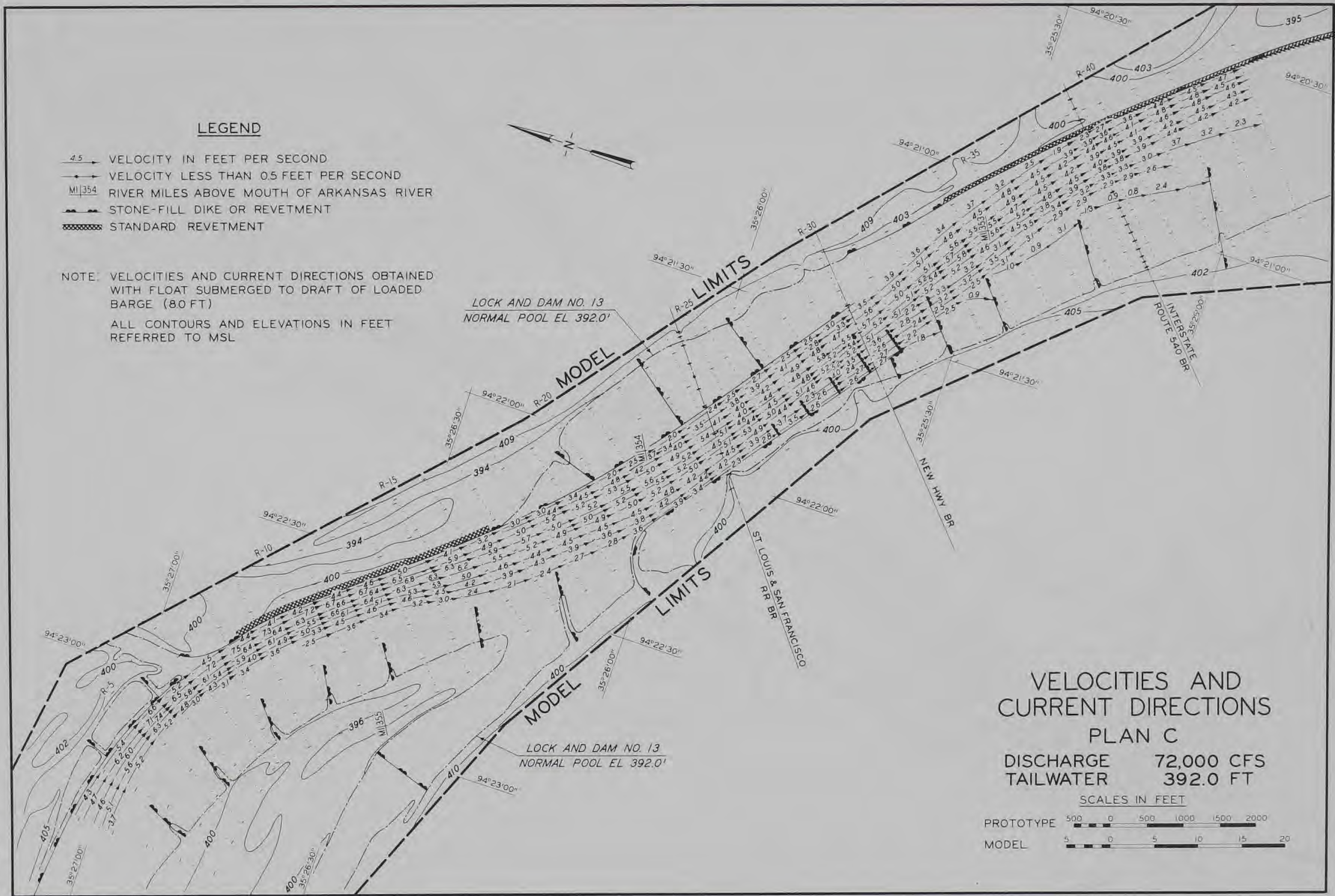
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-1
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 16


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE. VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
NEW HWY BR
ST LOUIS & SAN FRANCISCO RR BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
MI 353
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
94°20'30"
94°21'00"
94°21'30"
94°22'00"
94°22'30"
94°23'00"
35°25'00"
35°25'30"
35°26'00"
35°26'30"
35°27'00"
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-1
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
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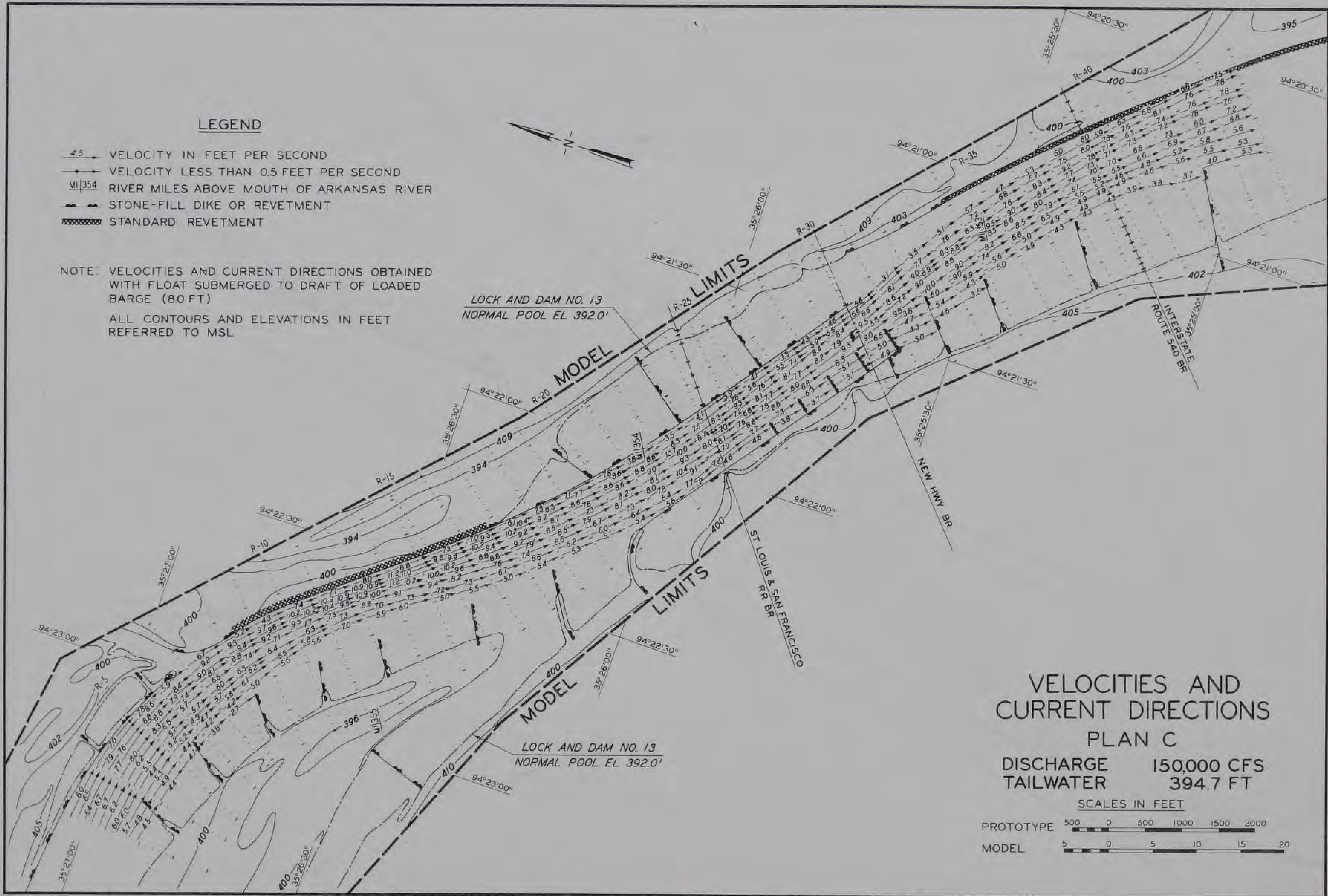
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
MI 353
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
94°23'00"
94°22'30"
94°22'00"
94°21'30"
94°21'00"
94°20'30"
35°27'00"
35°26'30"
35°26'00"
35°25'30"
35°25'00"
VELOCITIES AND CURRENT DIRECTIONS
PLAN C
DISCHARGE 72,000 CFS
TAILWATER 392.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

PLATE 17

PLATE 18


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
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STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
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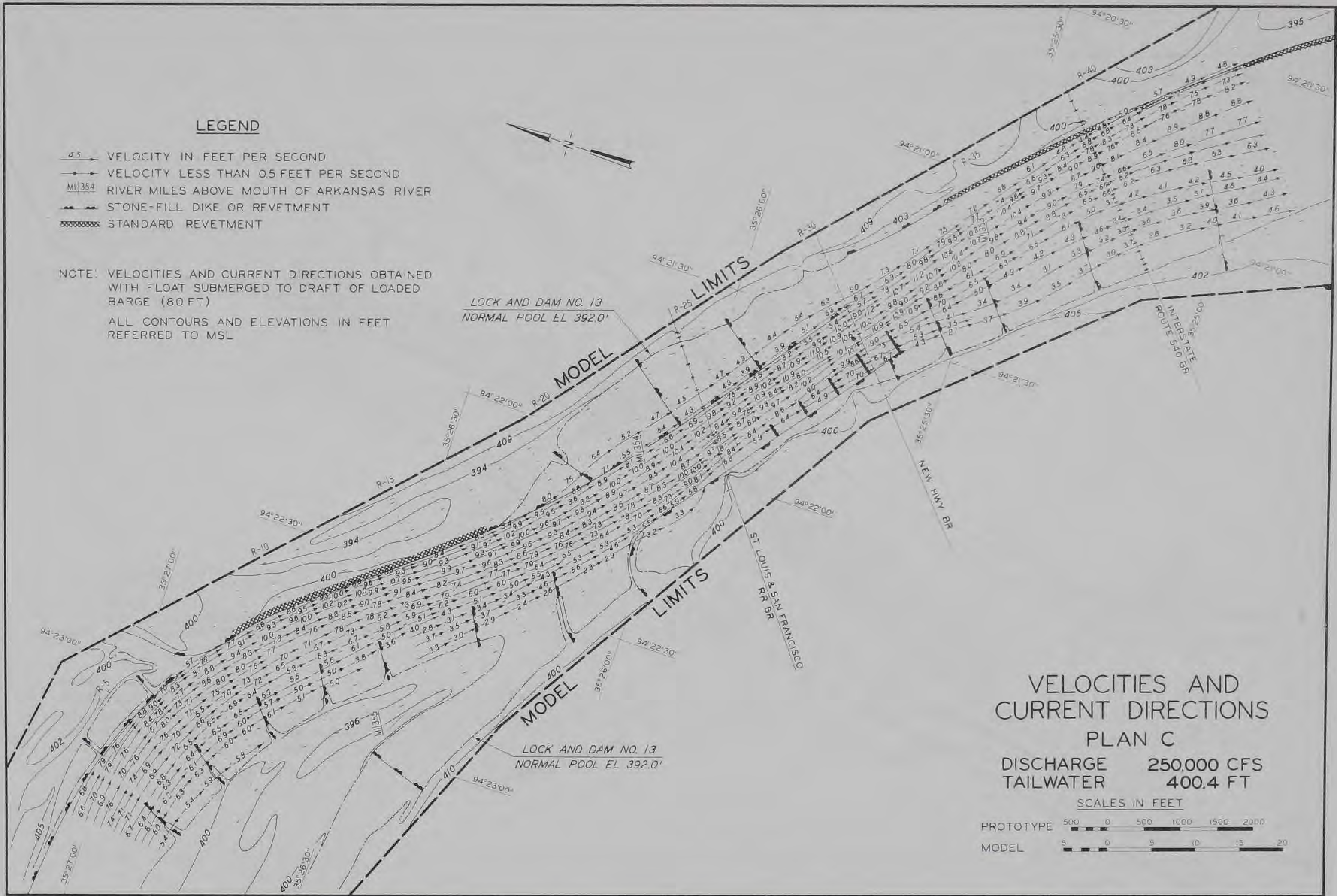
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN C
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20


LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
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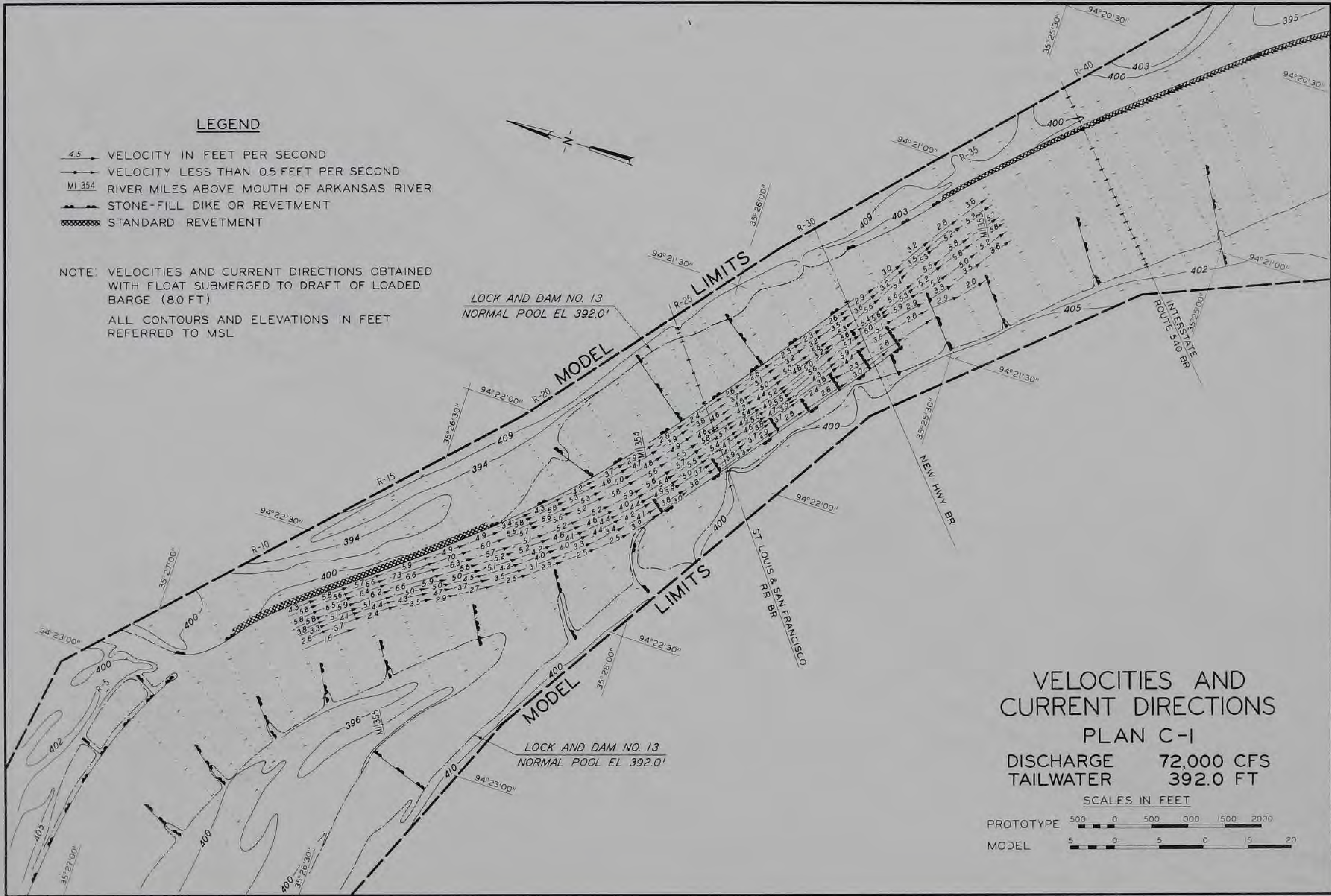
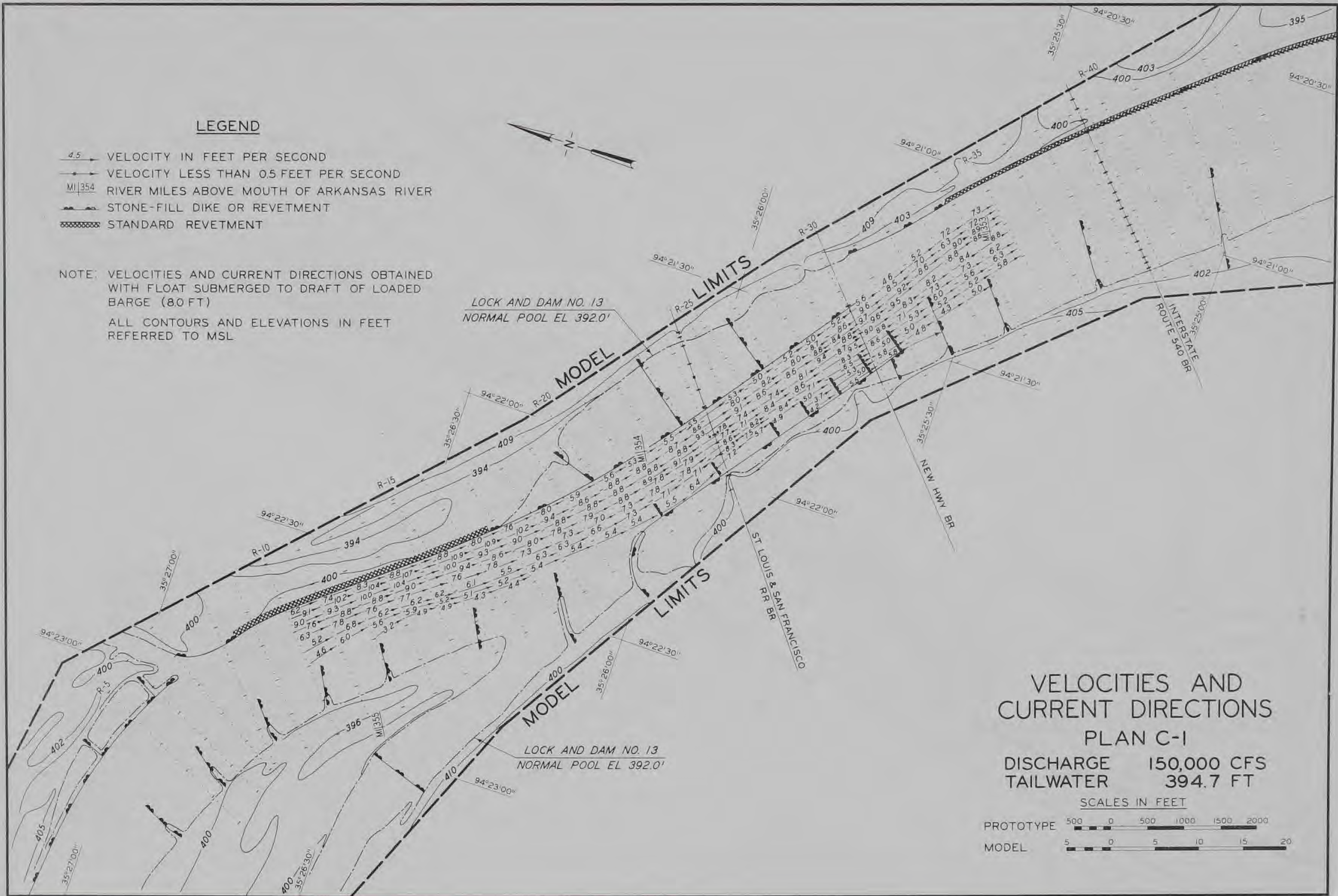
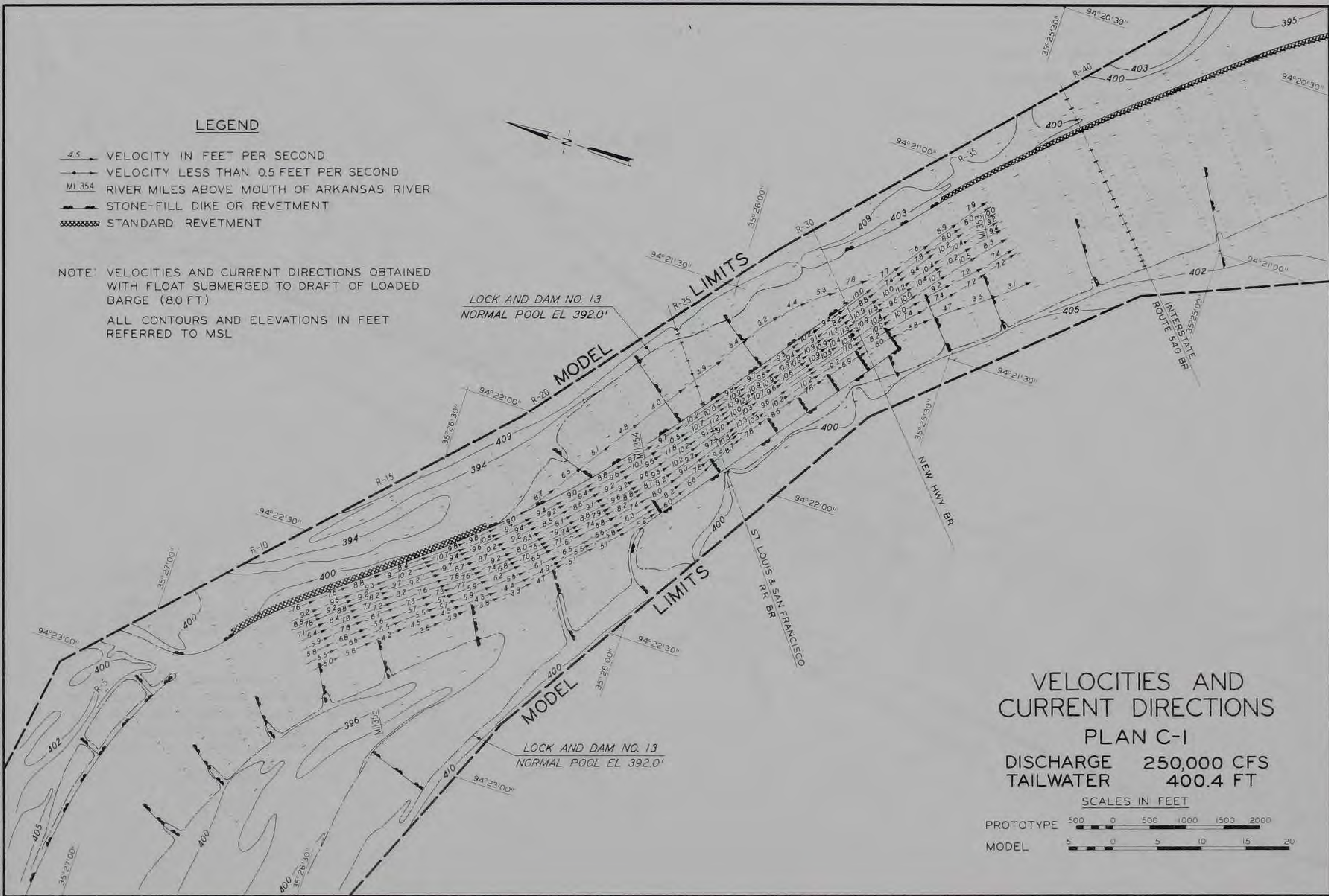
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN C
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

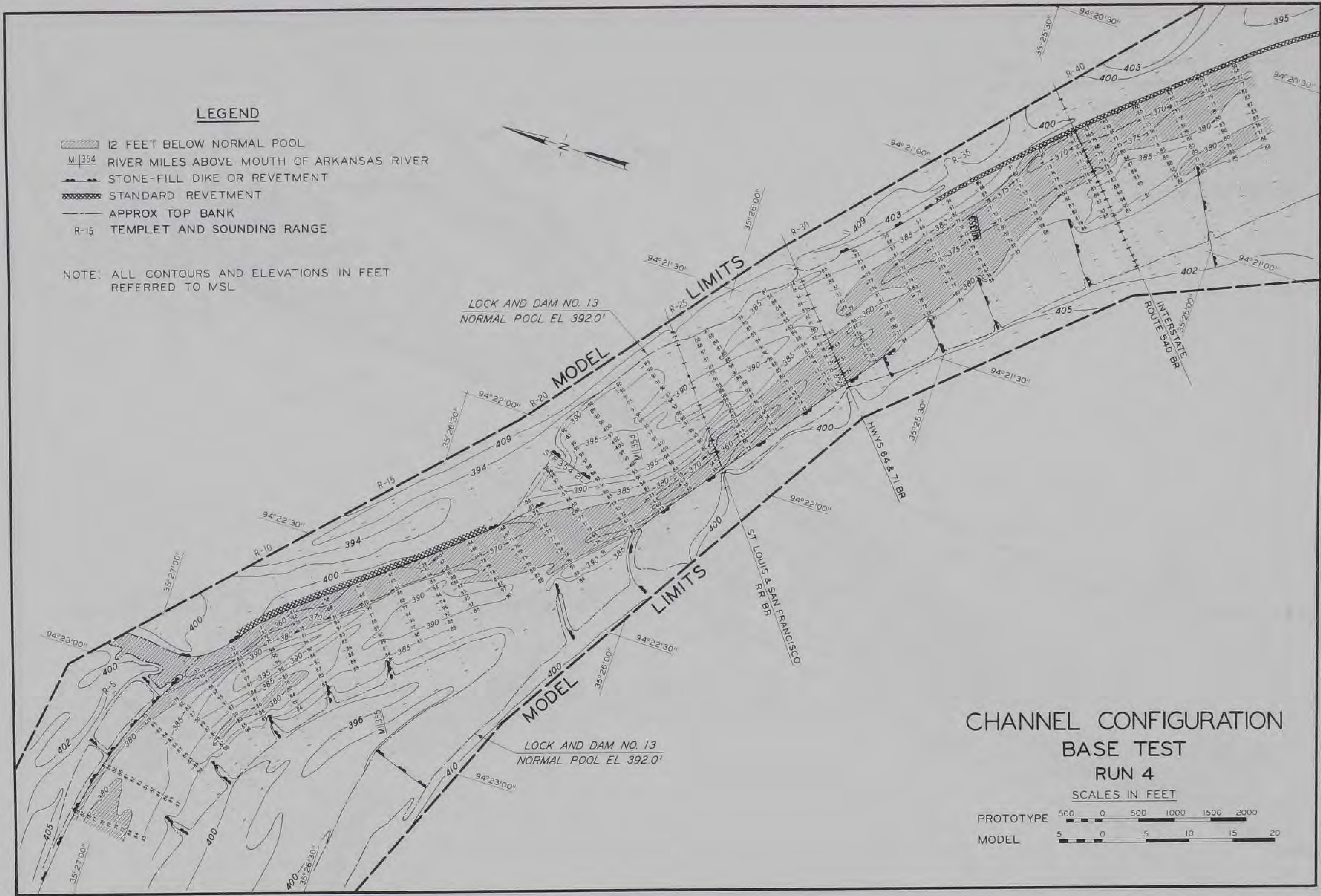
PLATE 20



LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VELOCITIES AND CURRENT DIRECTIONS
PLAN C-1
DISCHARGE 72,000 CFS
TAILWATER 392.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

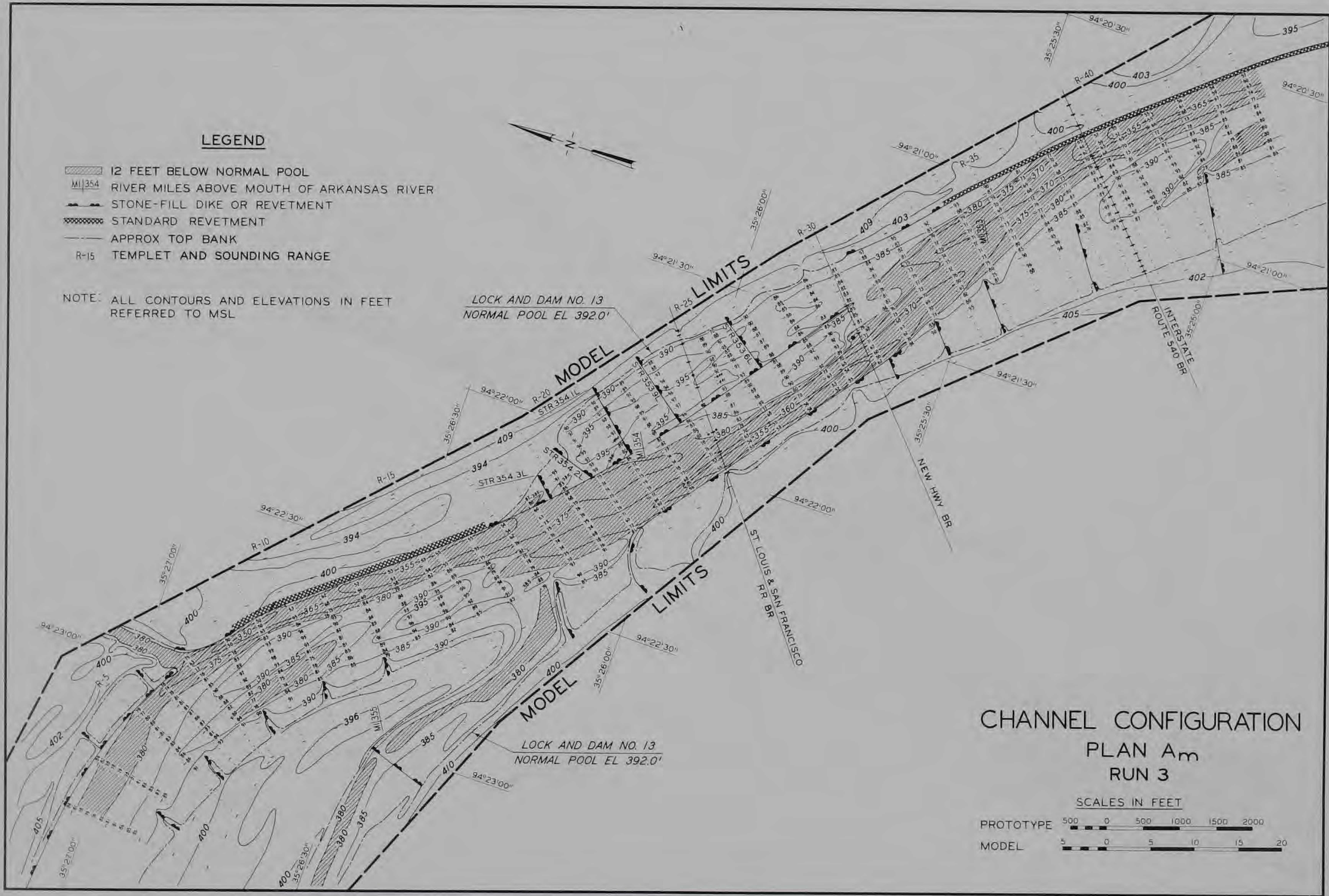

LEGEND
4.5 VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
MI 353
VELOCITIES AND CURRENT DIRECTIONS
PLAN C-1
DISCHARGE 150,000 CFS
TAILWATER 394.7 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

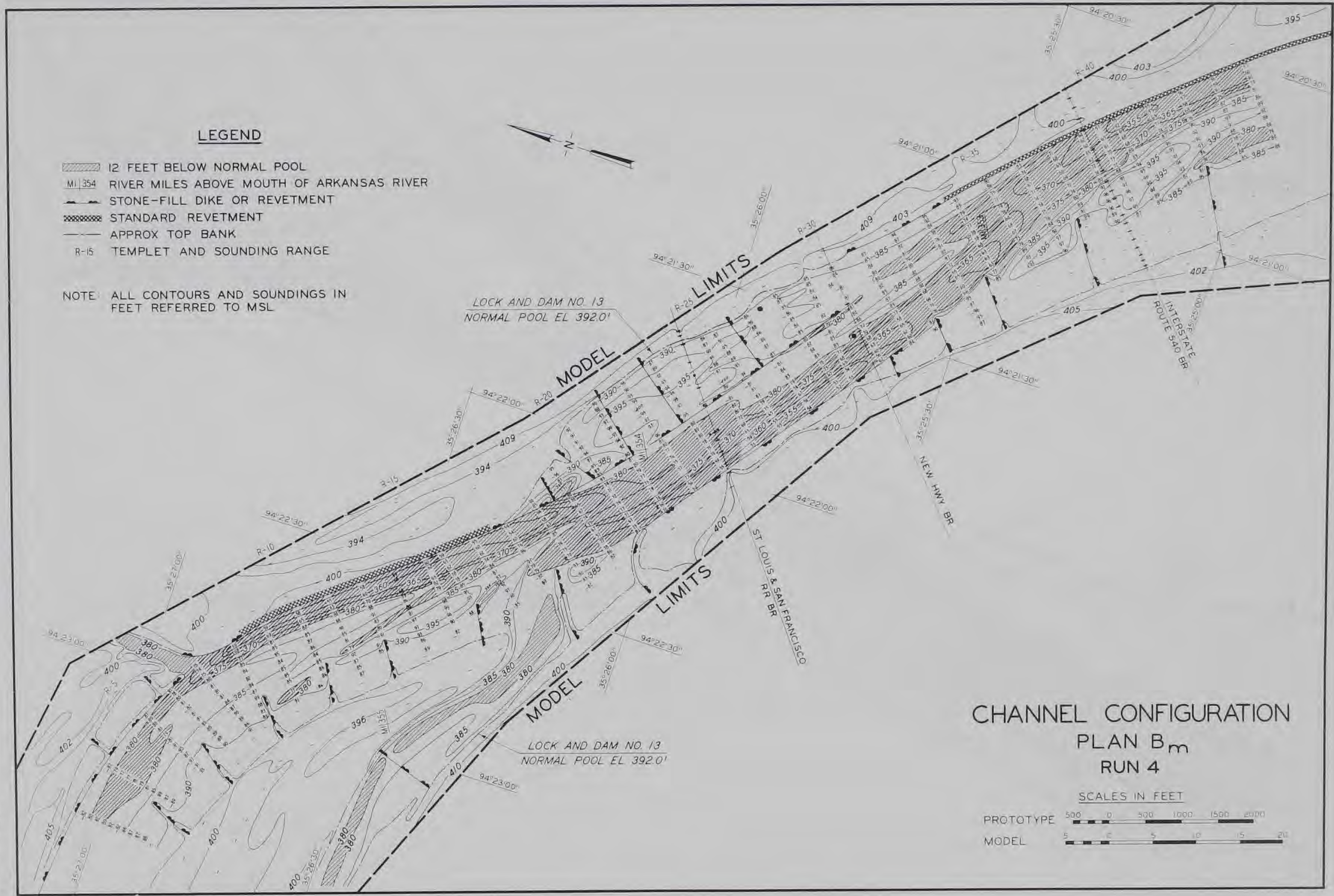

LEGEND
VELOCITY IN FEET PER SECOND
VELOCITY LESS THAN 0.5 FEET PER SECOND
RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
NOTE: VELOCITIES AND CURRENT DIRECTIONS OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT)
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
NEW HWY BR
INTERSTATE ROUTE 540 BR
ST LOUIS & SAN FRANCISCO RR BR
MI 354
MI 353
MI 355
VELOCITIES AND CURRENT DIRECTIONS
PLAN C-1
DISCHARGE 250,000 CFS
TAILWATER 400.4 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20



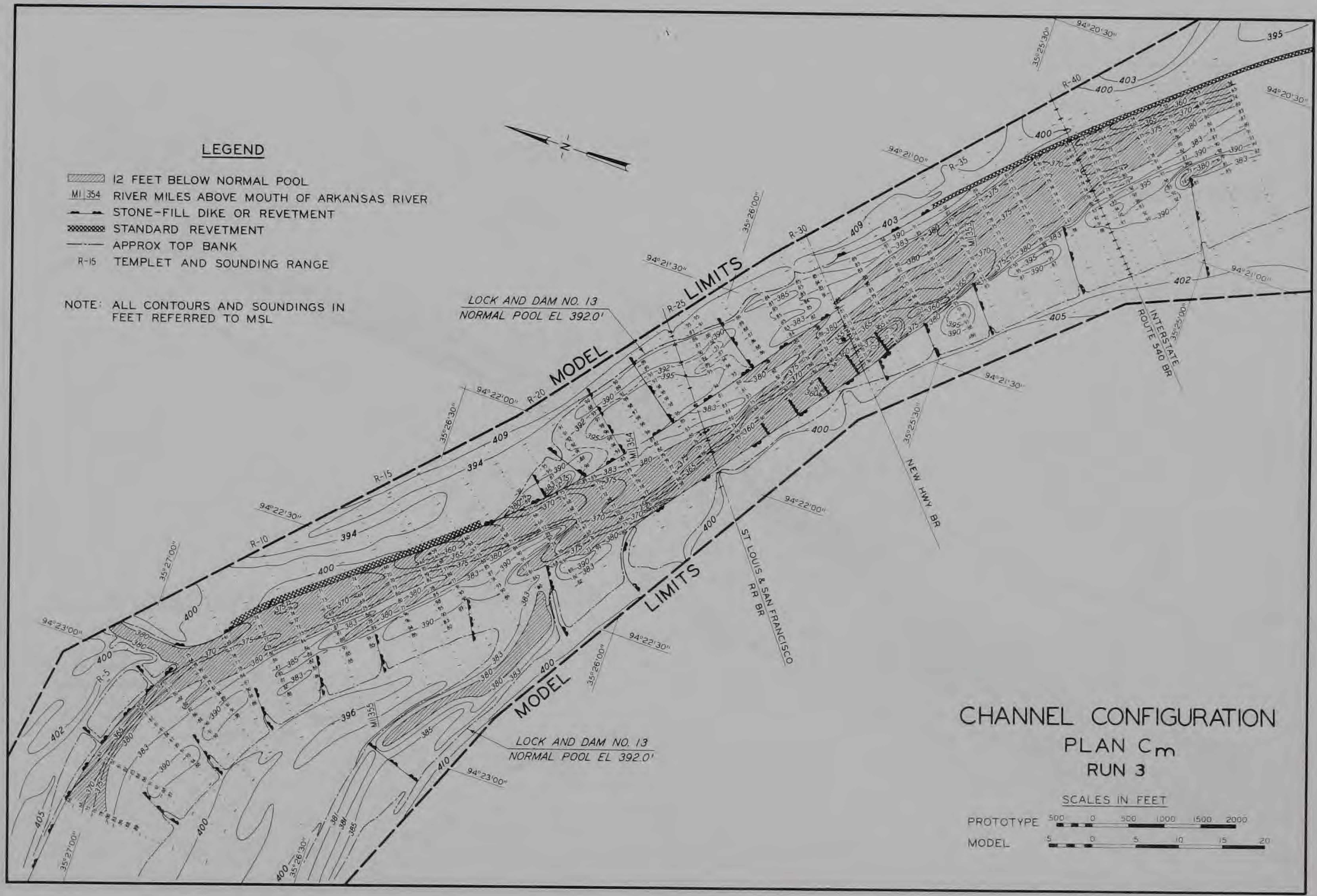
CHANNEL CONFIGURATION
BASE TEST
RUN 4

SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20


LEGEND
12 FEET BELOW NORMAL POOL
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
APPROX TOP BANK
R-15 TEMPLET AND SOUNDING RANGE
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
STR 354.1L
STR 354.2L
STR 354.3L
STR 353.6L
MI 354
MI 355
N
CHANNEL CONFIGURATION
PLAN Am
RUN 3
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20



CHANNEL CONFIGURATION
PLAN B_m
RUN 4



CHANNEL CONFIGURATION
PLAN C_m
RUN 3

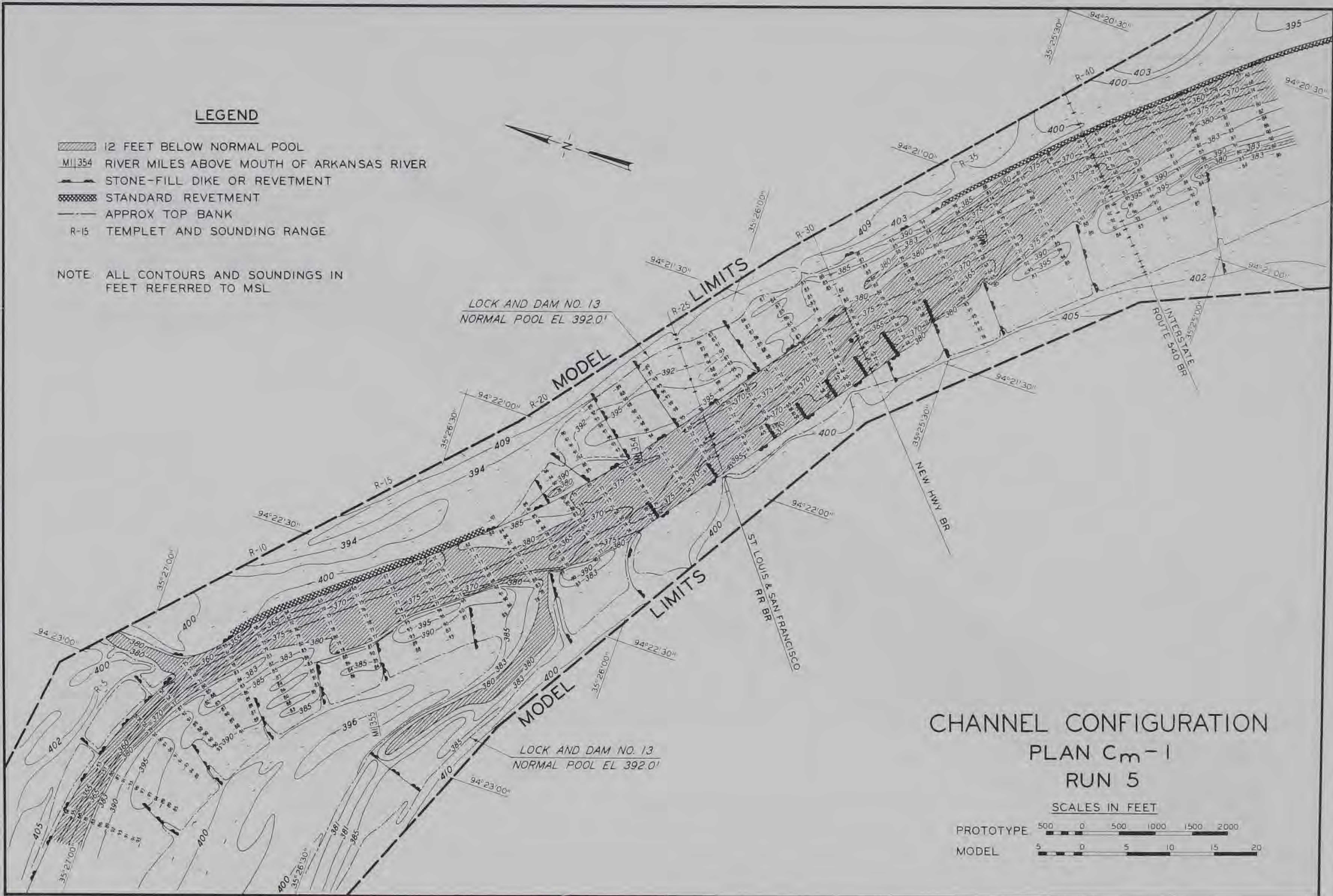
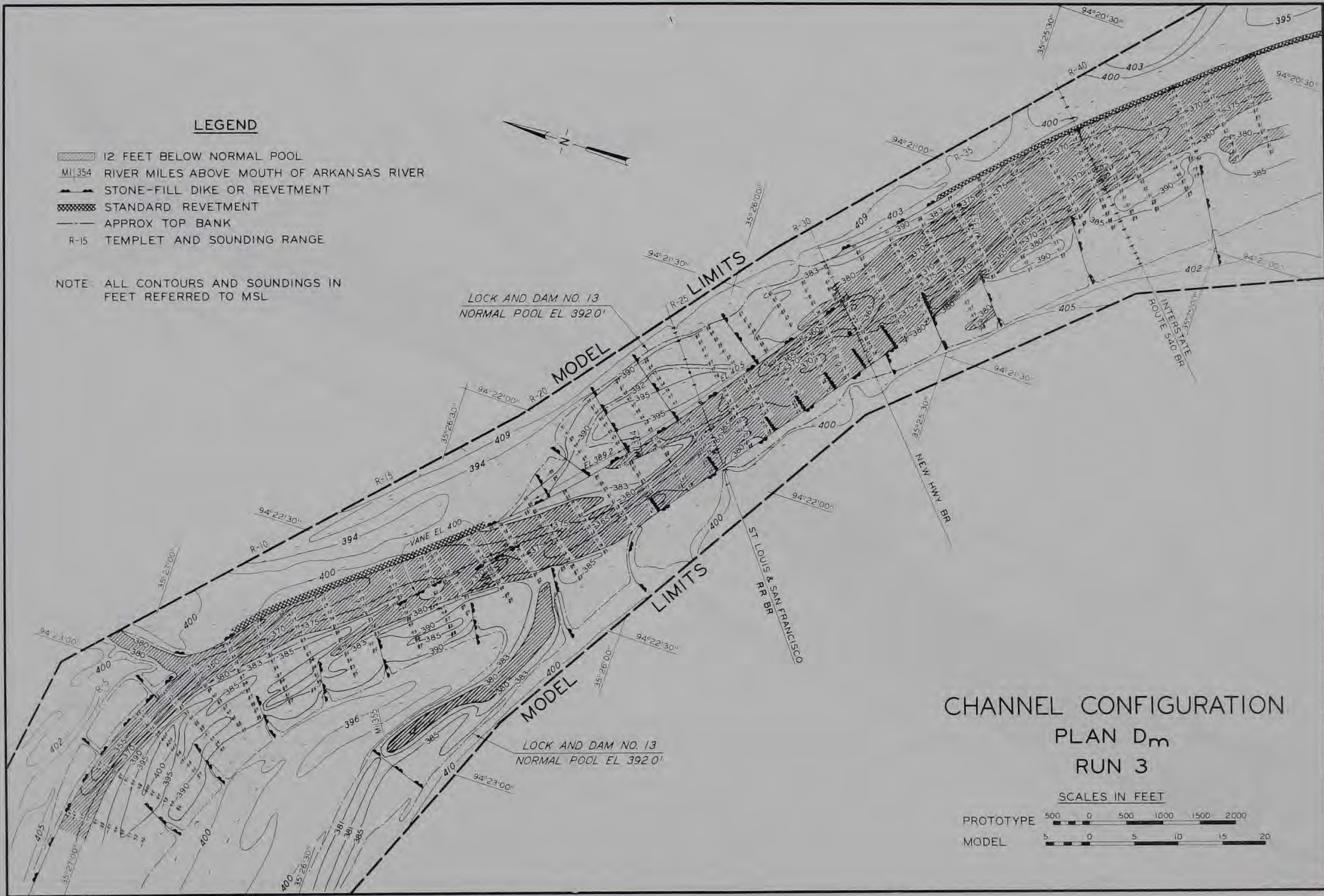
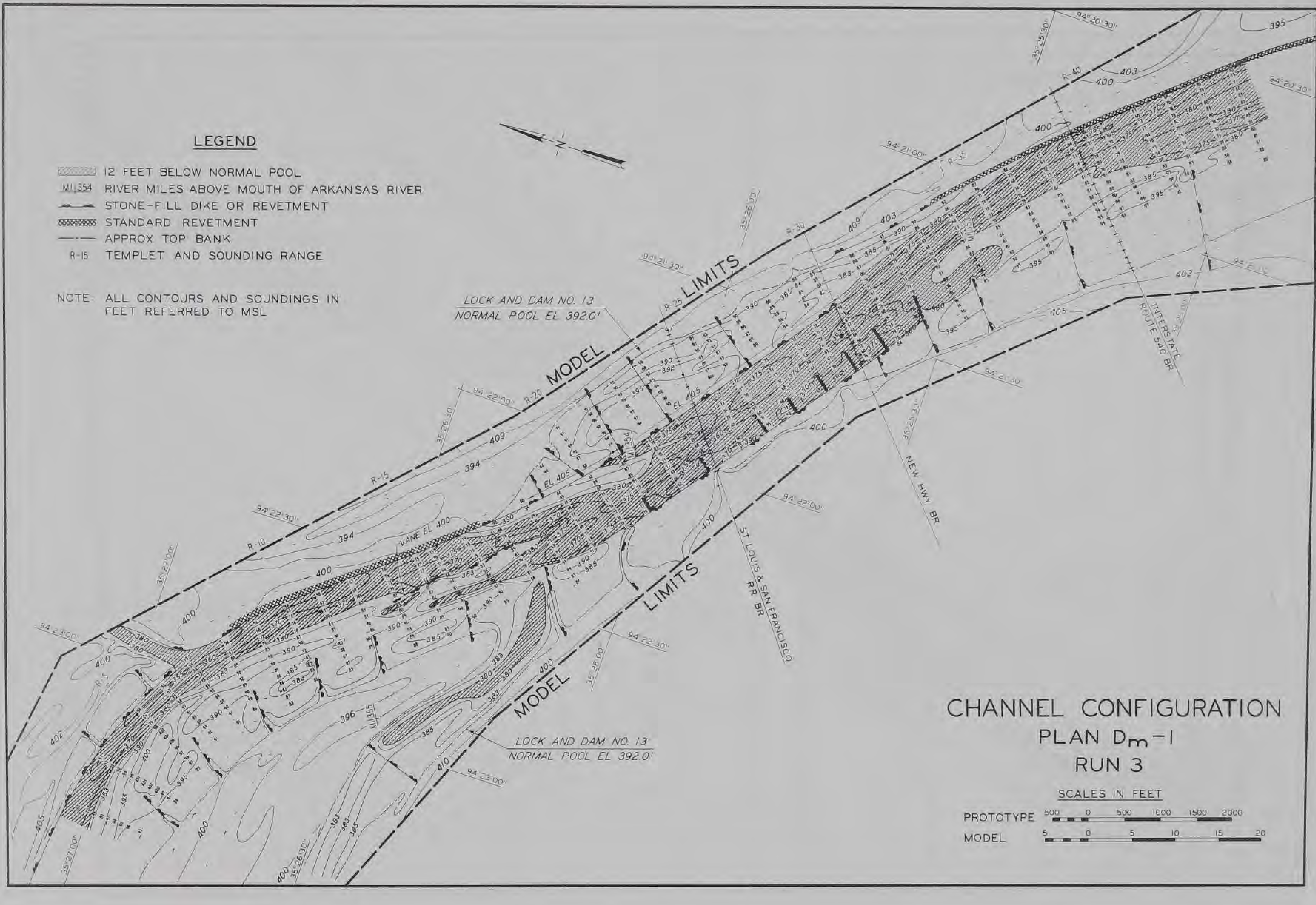

LEGEND
12 FEET BELOW NORMAL POOL
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
APPROX TOP BANK
R-15 TEMPLET AND SOUNDING RANGE
NOTE: ALL CONTOURS AND SOUNDINGS IN FEET REFERRED TO MSL
N
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
MI 354
MI 355
CHANNEL CONFIGURATION
PLAN Cm-1
RUN 5
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

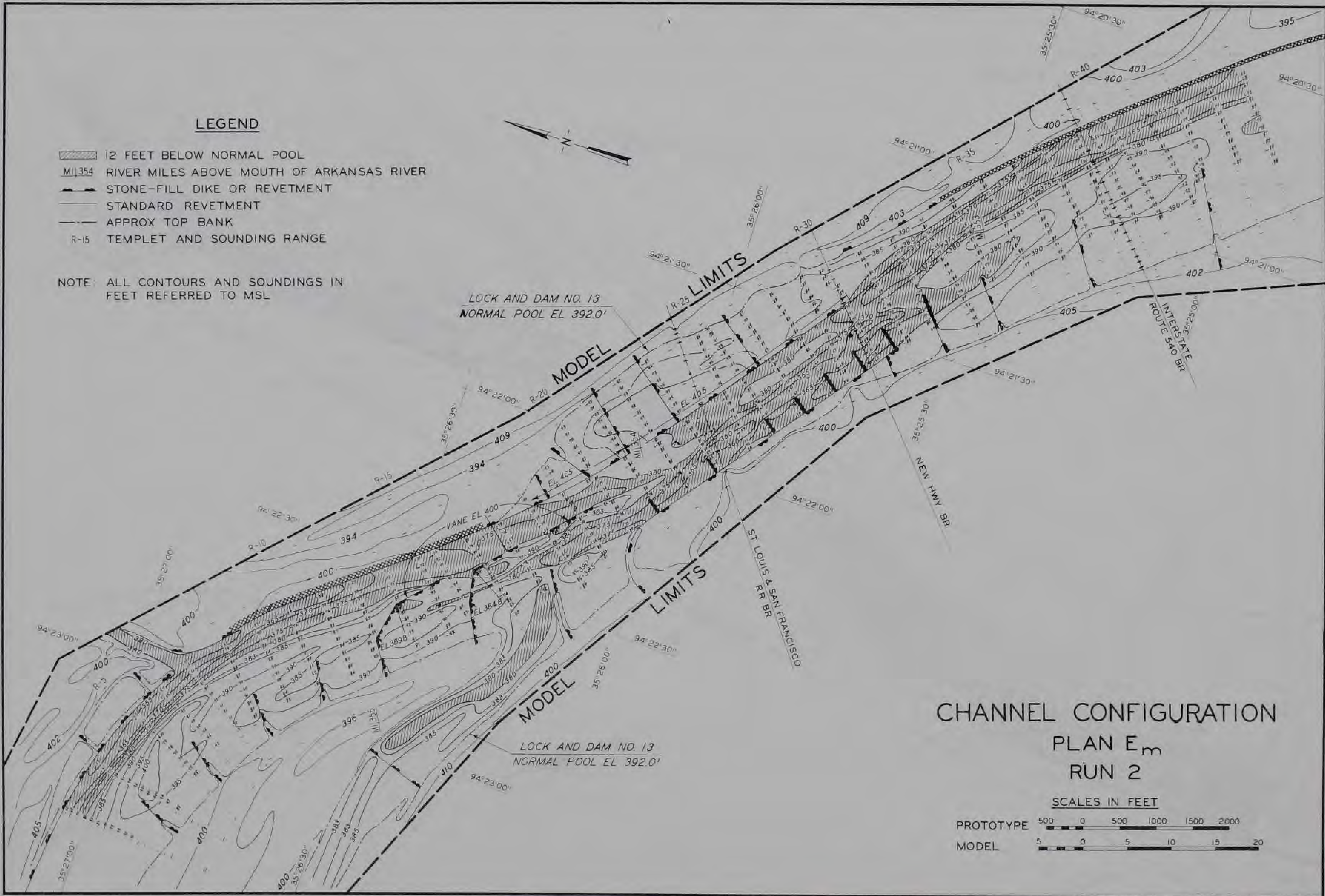
PLATE 27


LEGEND
12 FEET BELOW NORMAL POOL
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
APPROX TOP BANK
R-15 TEMPLET AND SOUNDING RANGE
NOTE: ALL CONTOURS AND SOUNDINGS IN FEET REFERRED TO MSL
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
MODEL LIMITS
ST LOUIS & SAN FRANCISCO RR BR
NEW HWY BR
INTERSTATE ROUTE 540 BR
VANE EL 400
CHANNEL CONFIGURATION
PLAN Dm
RUN 3
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20



CHANNEL CONFIGURATION
PLAN D_m-1
RUN 3

PLATE 29


LEGEND
12 FEET BELOW NORMAL POOL
MI 354 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
STANDARD REVETMENT
APPROX TOP BANK
R-15 TEMPLET AND SOUNDING RANGE
NOTE: ALL CONTOURS AND SOUNDINGS IN FEET REFERRED TO MSL
N
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
LOCK AND DAM NO. 13
NORMAL POOL EL 392.0'
INTERSTATE ROUTE 540 BR
NEW HWY BR
ST LOUIS & SAN FRANCISCO RR BR
VANE EL 400
EL 405
EL 405
EL 384.8
EL 389.8
MI 354
MI 355
R-5
R-10
R-15
R-20
R-25
R-30
R-35
R-40
94°20'30"
94°21'00"
94°21'30"
94°22'00"
94°22'30"
94°23'00"
35°25'00"
35°25'30"
35°26'00"
35°26'30"
35°27'00"
CHANNEL CONFIGURATION
PLAN E_m
RUN 2
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15 20

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Security Classification

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13. ABSTRACT

The Van Buren reach of the Arkansas River is in Lock and Dam No. 13 pool near Van Buren, Ark., about river mile 353. The reach is characterized by three relatively flat bends and is crossed by three existing or proposed bridges. The location of the navigation spans of the two existing bridges could cause considerable difficulties in navigating the reach and in maintaining a channel of adequate dimensions based on the alignment of the navigation spans. A hydraulic model reproducing about 4 miles of the Arkansas River including the three bridges was constructed to an undistorted scale of 1:120. Originally the model was of the semifixed-bed type for the navigation studies. It was later converted to the movable-bed type and used to determine (a) the best location for a navigable channel; (b) the modifications required to the two existing bridges; (c) adequacy of the proposed structures in the development of a satisfactory channel; and (d) modifications needed to improve navigation conditions and channel depths through the reach. The investigation revealed the following: (a) The channel had a natural tendency to develop in a sinuous alignment with the channel crossing first toward the right bank and then back toward the left bank. Following the natural tendency of the river would produce conditions hazardous for navigation, particularly during the higher flows, because of the location of the two existing bridges with respect to the navigation span of the I-540 bridge under construction. (b) The best alignment for the channel insofar as navigation is concerned is along the left or convex side of the bend, eliminating the two crossings. (c) Development of a channel along the left side would require considerable contraction and training structures to offset the strong tendency toward shoaling along that side. (d) A system of vane dikes could be developed which would practically eliminate the need for maintenance dredging.

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Hydraulic models						
Navigation conditions						
Van Buren reach, Arkansas River						

Unclassified

Security Classification