TECHNICAL REPORT H-68-7

NAVIGATION CONDITIONS IN FORT SMITH REACH, ARKANSAS RIVER

Hydraulic Model Investigation

by

J. J. Franco

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September 1968

Sponsored by

U. S. Army Engineer District
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FOREWORD

The model investigation reported herein was authorized by the Office, Chief of Engineers, in 4th indorsement dated 12 April 1965 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 Division of the U. S. Army Engineer Waterways Experiment Station during the period August 1965 to September 1966.

During the course of the model study, Mr. E. B. Madden of the Southwestern Division, Messrs. T. Schmidgall, J. T. Clements, Jr., and C. W. Shelton of the Little Rock District, and Messrs. E. E. Hudson, Jr., A. M. Smith, Dwayne Helmberger, and G. W. Kelly of the Tulsa District visited the Waterways Experiment Station 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 Mr. E. P. Fortson, Jr., Chief of the Hydraulics Division, and under the direct supervision of Mr. J. J. Franco, Chief of the Waterways Branch. The engineer in immediate charge of the model was Mr. L. J. Shows, assisted by Messrs. A. M. Gill and Lloyd Woods. This report was prepared by Messrs. Franco and Shows.

Directors of the Waterways Experiment Station during the course of the investigation and the preparation and publication of this report were COL John R. Oswalt, Jr., CE, and COL Levi A. Brown, CE. Technical Director was Mr. J. B. Tiffany.

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
inches	2.54	centimeters
feet	0.3048	meters
miles	1.609344	kilometers
feet per second	0.3048	meters per second
cubic feet per second	0.0283168	cubic meters per second

SUMMARY

The Fort Smith reach of the Arkansas River, located in the Lock and Dam No. 13 pool, includes the mouth of the Poteau River and is crossed by two bridges 850 ft apart. An undistorted 1:120-scale, semifixed-bed model reproducing approximately 4 miles of the Arkansas River and adjacent overbank and the lower 2 miles of the Poteau River was used to determine the regulating structures and modifications required to develop a channel of project dimensions, and the modifications required to the existing bridges to provide satisfactory navigation conditions through the reach. Results of the investigation indicate that:

a. The bridge spans should be modified to provide additional clearance and the navigation channel through the bridges should be maintained along the right bank.

b. Normal flow from the Poteau River would have little effect on navigation through the bridges downstream. Overflow from the Arkansas River into the Poteau River channel combined with Poteau River flow could produce serious crosscurrents at the mouth of the Poteau River and would tend to increase shoaling at that point.

c. Modifications would be required in the regulating structures along the right bank just upstream of the mouth of the Poteau River and along the left bank to develop satisfactory channel dimensions through the reach.

Fig. 1. Vicinity map

NAVIGATION CONDITIONS IN FORT SMITH REACH

ARKANSAS RIVER

Hydraulic Model Investigation

PART I: INTRODUCTION

Location and Description of Prototype

1. The Arkansas River is considered a navigable stream from its mouth to the mouth of the Verdigris River (fig. 1). In this section, the slope of the stream averages 0.9 ft per mile* above Little Rock, 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 the vicinity of Pine Bluff, mile 111. During periods of low water, the controlling depth of the Arkansas River from its mouth to Little Rock is about 2 ft, and from Little Rock to the mouth of the Verdigris River, about 1 ft. 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.

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 (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.

Present Plan of Development

3. The Arkansas River multipurpose project provides for improvement

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

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, Okla., 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 by 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 on the Arkansas River and in the Arkansas Post Canal, and 83 by 600 ft on the Verdigris River. A minimum channel width of 150 ft is proposed for the Verdigris River section, 250 ft for the Arkansas and White River 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.

Fort Smith Reach

5. The Fort Smith reach of the Arkansas River, which is in the pool of Lock and Dam No. 13, extends from a short distance downstream to a short distance upstream of Fort Smith, Ark., about 362 miles above the mouth and includes the mouth of the Poteau River, a tributary of the Arkansas River. Normal upper pool elevation based on Lock and Dam No. 13 is 392.0*. Two bridges 800 ft apart (Missouri Pacific Railroad bridge and Highway 64 Bridge) cross the reach at Fort Smith, Ark. The Missouri Pacific Bridge has a swing span and limited width on either side of the

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

pivot pier which will have to be replaced. The U. S. Highway 64 Bridge will also have to be modified to provide the necessary clearance for navigation. Even with the raising of pool 13, depths through the reach would be generally less than project depth.

Need for and Purpose of Model Study

6. The improvement of the Fort Smith 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. The reach was complicated by flow from the Poteau River entering the main stream just above two bridges. An analytical solution to the problem would be extremely complex and uncertain; therefore, a hydraulic semifixed-bed model was considered necessary to determine the following:

- a. Regulating structures required to develop a channel of project dimensions.
- b. Best location for navigation spans on the two existing bridges.
- c. Effects of flow from the Poteau River on navigation through the bridges.
- d. Remedial works that might be required to overcome any adverse conditions noted during the course of the investigation.

Description

7. The model reproduced about 4 miles of the Arkansas River in the vicinity of Fort Smith, Ark., beginning just downstream of river mile 363 and extending downstream of river mile 361, including about 2 miles of the Poteau River and adjacent overbank areas (plate 1). The model was of the semifixed-bed type with the overbank areas molded in sand-cement mortar to sheet metal templates (fig. 2). Except in the upper reach of

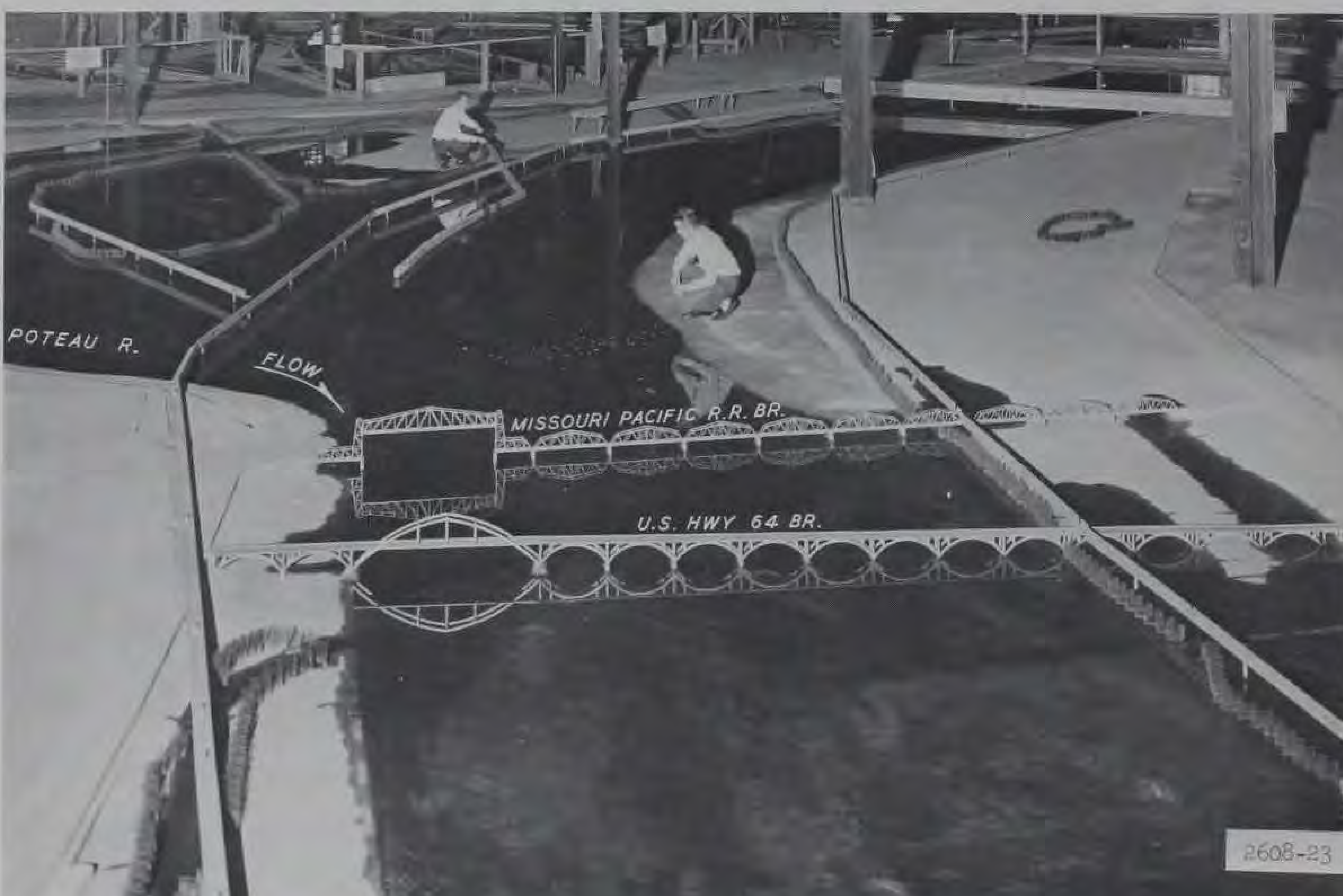


Fig. 2. The model

the model the Arkansas River channel was molded in sand to facilitate the adjustment of the channel configuration based on conditions that could be expected to develop with various improvement plans. Provisions for modification of the dikes and the revetment were included in the form of concrete blocks and pea gravel. The two bridges that span the Arkansas

River in the Fort Smith reach area were fabricated of sheet metal and assembled on a base plate.

8. The model was molded to conform to a special hydrographic and topographic survey made in July 1965 except that a 300-ft-wide dredged channel with bottom elevation of 380.0 was included in the model as shown in plate 2. Sufficient overbank area was included in the model to permit the study of flows up to the maximum navigable flow for this reach (total 250,000 cfs) except along the right overbank upstream of the Poteau River.

9. Water was supplied to the model by a comprehensive water-supply system and was measured at the upper end of the Arkansas River channel by means of a venturi meter and at the upper end of the Poteau River channel by means of a 3-in. Van Leer weir. Water-surface elevations were measured by means of 13 piezometers located in the model channel (plate 1) and connected to a centrally located gage pit.

10. Velocities and current direction were determined in the model by means of wooden cylindrical floats weighted on one end to simulate the maximum permissible draft for loaded barges using the waterway (8 ft prototype). A model towboat and tow (fig. 3) were used to determine and demonstrate the effects of currents on tows passing near the mouth of the Poteau River and negotiating the reach that contains the two bridges. The towboat was propelled by two small electric motors operating from batteries located in the tow; the rudders and speed were remote-controlled. The towboat could be operated in forward or reverse speed, and the power was adjusted by means of a rheostat to a maximum speed comparable to that of the towboats that travel the Arkansas River.

Fig. 3. Remote-controlled towboat and tow

Scale Relations

11. The model was constructed to an undistorted linear scale of 1:120, model to prototype, to accurately reproduce velocities, cross-currents, and eddies that would affect navigation. Other scale ratios resulting from the linear scale ratios were: area, 1:14,400; velocity and time, 1:10.95; and discharge, 1:157,743. Measurements of discharge, water-surface elevations, and current velocities and directions can be transferred quantitatively from model to prototype equivalents by use of these scale relations.

Model Adjustment

12. Inclusion of the proposed 300-ft-wide dredged channel in the initial model construction precluded adjustment of the model to the existing prototype conditions. This type of adjustment was not considered necessary since the proposed improvements would involve considerable change from existing conditions. Adjustment of the channel bed was based on a study of currents. Water-surface elevations obtained with the adjusted channel bed check closely with the computed profiles furnished by the Little Rock District for flows ranging from 30,000 to 250,000 cfs below the mouth of the Poteau River (table 1 and plate 3). Folded strips of 8-mesh screen wire were placed in areas covered by vegetation as indicated by aerial photographs to obtain the higher roughness values along the overbank. The adjustment was considered satisfactory since any errors in the simulation of prototype roughness would produce no significant effect on water-surface elevations or on velocities within the short reach reproduced in the model.

PART III: TESTS AND RESULTS

Test Procedure

13. Tests were concerned primarily with the study of currents and velocities, the behavior of the model tow, the effects of various flows from the Poteau River on navigation, and the development of channel configurations with the various plans tested.

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 ends of the Arkansas and Poteau River channels and manipulating the tailgate until the computed tailwater elevation for that flow was obtained at the lower end of the model. With the exception of special tests, the flow from the Poteau River was assumed to be 3 percent of the total river flow. The flows used during most of the tests were as follows:

- a. Total flow of 150,000 cfs with tailwater at el 402.9. 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.
- b. Total flow of 250,000 cfs with tailwater at el 407.2. This represents the approximate maximum flow at which Lock 13 will be usable and will be equaled or exceeded about 9 percent of the time.

15. Velocities were determined by timing the travel of the floats described in paragraph 10, over a measured distance; current directions were ascertained by plotting the paths of the floats with respect to ranges established for that purpose. In plots of currents in turbulent areas or where crosscurrents existed, only the main trends are shown in the interest of clarity.

16. The model towboat and tow were observed to determine the effects

of currents on their behavior and the maneuvering required to overcome the effects of adverse currents, particularly on the tow approaching the reach near the mouth of the Poteau River and through the bridge spans.

Base Test

Description

17. The base test was conducted with 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 (fig. 4).

Fig. 4. Features of base test along upper reach of model

Also, the portion of the right bank riverward of the trench-filled revetment downstream of the bridges was removed. The conditions in the model for this test are shown in plates 1 and 2.

18. This test was conducted to obtain basic data with the existing structures and with proposed dredging and to determine modifications

required to provide satisfactory navigation conditions through the reach.

Results

19. Water-surface elevations for flows ranging from 30,000 to 250,000 cfs are shown in table 1. The water-surface profiles obtained during this test were generally in reasonably close agreement with those computed, except with low flows in the upper reach of the model (plate 3). The difference between the water-surface elevations in the model and those computed for the upper reach is attributed mostly to the difference in the dredged channel which did not extend into the fixed portion of the model channel.

20. Current directions and velocities obtained during this test indicate that high velocity currents would tend to move along the left side of the dredged channel below the left bank dikes (plates 4 and 5). Also, the crossing from the left to right side would occur some distance downstream of the crossing indicated by the dredged channel. Because of the tendency mentioned, velocities along the left bank upstream of the bridges would be sufficient to erode the bank during the higher flows.

21. With the total flow of 150,000 cfs, velocities in the Poteau River channel were low, generally less than 1.0 fps except near its mouth where velocities increased to 1.6 to 2.6 fps. The increase in velocity at the mouth was caused by flow from the Arkansas River over the right bank dikes. There was little disturbance in flow at the confluence of the Arkansas and Poteau Rivers. However, observation of bottom currents indicated some tendency for shoaling along the point in the right bank just downstream of the mouth of the Poteau River. With the 250,000-cfs flow, there was considerable flow from the Arkansas River channel over the right overbank and structures toward and into the Poteau River channel. The alignment of currents in the channel approaching the Missouri Pacific Railroad bridge was affected by the combined overflow from the Arkansas River and normal flow from the Poteau River channel, and downbound tows would experience some difficulty in maintaining proper alignment for passage through the right bridge span.

22. The results of the base test indicated that there would be a tendency for the channel to follow along the left bank dikes upstream of

the bridges. The dredged channel as installed for this test would tend to shoal on the right side and scour along the left side opposite dikes 364.6 and 364.3L. Velocities also indicate that some deepening of the channel can be expected during the higher flows. Because of the tendency for flow to spread toward the left side of the channel from just above the two bridges, velocities along the right side in the channel through the bridges and downstream would tend to be lower than in the reach upstream. Navigation conditions through the bridges would tend to be hazardous because of the alignment of currents just upstream of the bridges, the limited width of clear spans, and the limited distance between bridges. Navigation would also be affected by flow over the right bank dikes upstream of the mouth of the Poteau River returning to the main channel through the Poteau River channel.

Plan A

Description

23. Plan A (plate 6) was the same as the base test except that:

a. Dikes 364.1L through 363.4L were installed on the left bank downstream of existing structures with crest elevation of 398 (fig. 5a).

b. Stone-fill revetment 364.3L was extended downstream along the ends of dikes 364.1L and 363.8L to a point about 200 ft downstream of the latter dike.

c. The alignment of the dredged channel was modified to follow along the revetment as extended.

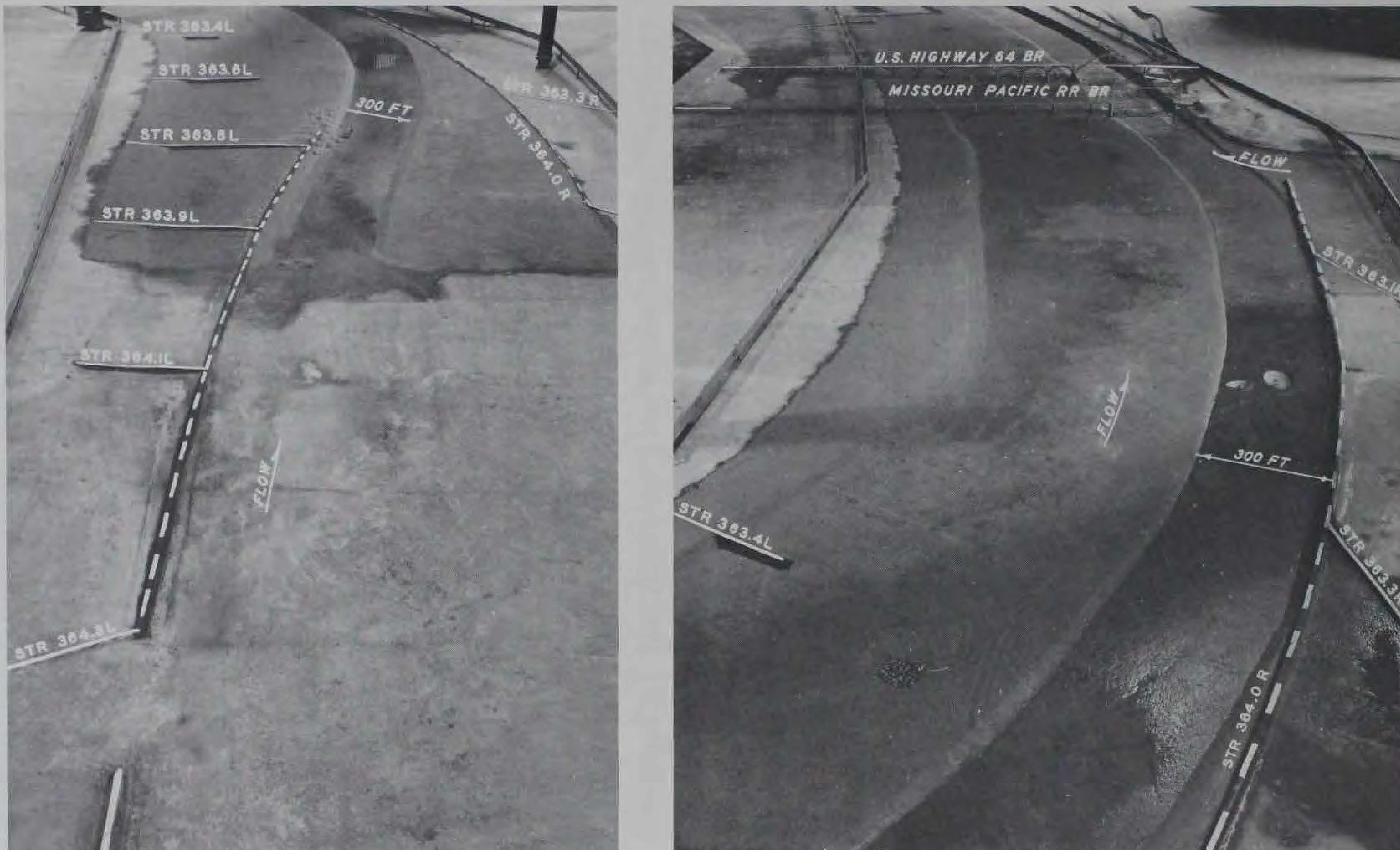
d. The swing span on the Missouri Pacific Railroad bridge was replaced with a 340-ft lift span and the pivot pier was eliminated (see fig. 2, page 4).

e. The two arch spans of the Highway 64 Bridge over the navigation channel were replaced with a single overhead arch span (fig. 2 and fig. 5b).

Results

24. The modifications included in this plan had little effect on water-surface elevations except for lowering of from 0.1 to 0.2 ft in the reach upstream of the bridges (table 2).

25. Velocities of currents in the dredged channel along the left



a. Upstream view showing location of new dikes 364.1L through 363.4L

b. Reach above bridges

Fig. 5. Plan A

bank dikes as extended were higher than those of the base test, and direction of currents was more in line with the dredged channel (plates 7 and 8). The velocity of currents along the left bank was considerably less than that of the base test except in the reach immediately upstream of the railroad bridge. Because of the greater concentration of flow along the right side downstream of the left bank dikes, velocities were somewhat higher in the navigation channel than were obtained in the previous test. Because of the alignment of the right bank revetment upstream of the mouth of the Poteau River and the greater concentration of flow along that side, the impingement of currents on the point on the right bank at the mouth of the Poteau River was increased, particularly with the 150,000-cfs flow. With the 250,000-cfs flow, discharge increased over the right bank dikes upstream of the mouth of the Poteau River. Currents resulting from the combined overflow from the Arkansas River and normal flow from the Poteau River had a greater effect on the alignment of currents in the navigation channel just upstream of the railroad bridge. Because of the effect of currents from the Poteau River, velocities were somewhat lower within the navigation channel than along the left side.

26. The extension of the left bank dike system improved conditions in the crossing toward the right bank dikes upstream of the bridge. Tows navigating the reach between the crossing and the mouth of the Poteau River would tend to be moved toward and against the right bank dikes. Navigation conditions through the bridges were improved considerably by the increase in the navigable spans of the two bridges. Tows would experience some difficulty in maintaining alignment just upstream of the railroad bridge because of the crosscurrents produced by flow from the Poteau River channel moving into the main channel at the mouth of the Poteau River. Because of the relatively flat bend and the effect of flow from the Poteau River channel, the high velocity flow tended to move away from the right bank.

Plan A-1

Description

27. Plan A-1 was the same as plan A except as follows (plate 9):

- a. Dikes 363.6L and 363.4L were lengthened about 200 ft, reducing the channel control width to about 800 ft.
- b. Lower portion of revetment 364.0R near the mouth of the Poteau River was shifted riverward to line up with the right bankline downstream of the mouth of the Poteau River.

Results

28. The results of tests of this plan, shown in table 3 and plates 10 and 11, indicate that the changes included in plan A-1 were not sufficient to have any material effect on water-surface profiles.

29. The extension of the left bank dikes produced some improvement on the alignment of currents and increased velocities in the dredged channel downstream (plates 10 and 11). The attack on the left bank downstream of the dikes was reduced but velocities of currents in the channel along the right bank were not affected appreciably. Modification of the stone-fill revetment on the right side of the channel upstream of the mouth of the Poteau River improved the alignment of currents and velocities along the right bank. However, because of the increase in flow over the revetment toward the Poteau River side, the crosscurrents near the mouth of the Poteau River were not eliminated.

30. The modification of plan A-1 would tend to improve the development of a satisfactory channel through the reach, particularly in the crossing toward the right bank at about mile 363 and along the right bank downstream of the mouth of the Poteau River. Because of the increase in flow over the revetment toward the Poteau River, tows would experience somewhat greater difficulties in keeping away from the revetment, particularly during the higher stages.

Plans A-2 and A-3

Description

31. Plans A-2 and A-3 were the same as plan A-1 except for the following:

- a. Plan A-2. Dike 363.3R was raised to about el 410.0 from its river end to high ground (about 1400 ft landward).
- b. Plan A-3. Same as plan A-2 except that dike 363.1R was raised to el 410.0 from its river end to high ground (about 1850 ft landward). These plans were designed to eliminate

flow over the stone-fill revetment toward the Poteau River channel.

Results

32. The results of tests of plans A-2 and A-3, shown in table 3 and plates 12-15, indicate that raising the dikes along the right bank without modification of the bed would raise stages in the reach upstream and increase water-surface slopes and velocities in the reach downstream of the raised dikes.

33. Raising the right bank dikes increased velocities along the left side of the channel, particularly just upstream of the Missouri Pacific Railroad bridge. With dike 363.3R raised (plan A-2), flow over the stone-fill revetment was not completely eliminated with the 250,000-cfs flow. Tows moving close along the lower reach of the revetment would tend to be forced against and over the revetment. With both dikes 363.3R and 363.1R raised (plan A-3) there was little or no flow over the revetment, downstream of the dikes, and navigation conditions along the revetment and through the bridge spans were improved.

34. The results of tests of plans A-2 and A-3 indicated that flow from the Poteau River under normal conditions would have little or no effect on navigation conditions near the mouth and through the bridges. Eliminating most of the flow from the Arkansas River into the Poteau River would eliminate crosscurrents near the mouth of the Poteau River, increase channel depths in the reach, and eliminate the hazardous navigation conditions along the stone-fill revetment. With each of these plans (A-2 and A-3) there would be some flow across the overbank landward of the raised dikes. Because of the difference in water-surface elevation between the Arkansas River channel and the Poteau River, erosion of the overbank landward of the raised dikes could occur during high flows.

Plans B and B-1

Description

35. The features of plan B, shown in plate 16, included the following:

a. Dike 363.3R was raised as in plan A-2 and revetment between dikes 363.3R and 363.1R was raised to about el 410.0.

b. Channel downstream of the Poteau River was contracted to 900 ft in width by the installation of three dikes along the left bank and extension of the length of dike 361.3L about 370 ft riverward.

36. This plan was developed to reduce flow over the right bank revetment toward the Poteau River at less cost than raising dike 363.1R (plan A-3) and to reduce velocities along the left bank and dispersion of flow along the left side of the channel in the reach downstream of the mouth of the Poteau River.

37. Plan B-1 was the same as plan B except that the stone-fill revetment near the mouth of the Poteau River was extended downstream about 360 ft, maintaining an alignment with the right bank downstream of the mouth of the Poteau River.

Results

38. Results of this test with changes incorporated indicate an increase in water-surface elevation of from 0.3 to 0.4 ft above that obtained with plan A-3 with no change in the channel bed (table 4). The flow over the overbank toward the Poteau River was reduced by the raising of the revetment between dikes 363.3R and 363.1R, even with the raised water-surface elevation in the reach.

39. The modification along the right bank revetment produced little change in the alignment of currents and velocities in the dredged channel upstream of the Poteau River (plates 17 and 18). Some of the flow over the right bank revetment upstream of the raised dike moved riverward along the dike causing some disturbance at its river end. The disturbance, which did not appear to be sufficient to affect navigation but could cause some local scour near the end of the dike, could be minimized with a short spur dike placed on the upstream side of the main dike a short distance landward of the end of the dike.

40. The dikes along the left bank reduced the dispersion of flow to the left side of the channel and produced a more uniform distribution of velocities across the channel. There was little change in velocities along the left bank upstream of the dikes.

41. Extending the right bank revetment downstream near the mouth

of the Poteau River (plan B-1) had little effect on currents in the reach (plates 19 and 20).

Plans B-2 and B-3

Description

42. Plan B-2 was the same as plan B-1 except that dike 363.3R was raised to about el 410.0 along its entire length. With the dike extended and raised, all overflow toward the Poteau River channel was eliminated for flows up to about 250,000 cfs.

43. Plan B-3 was the same as plan B-2 except that the stone-fill revetment along the right side of the channel was extended downstream about 360 ft at the existing elevation maintaining an alignment with the right bank downstream of the mouth of the Poteau River (same as with plan B-1).

Results

44. Elimination of flow over the overbank with plan B-2 produced an increase in water-surface elevations of 0.1 to 0.3 ft in the upper reach of the model (table 4) with some lowering of stages downstream. Some increase in velocities in the dredged channel was noted, caused principally by the increase in flow in the main channel (plate 21). The velocities of currents from the Poteau River were reduced to less than 0.5 fps.

45. Extending the stone-fill revetment along the right side of the channel downstream (plan B-3) had little effect on stages and current direction and velocities in the main channel (plate 22). With the extended revetment, flow from the Poteau River was concentrated along the right bank, and the velocity of currents from the Poteau River was increased.

Special Tests

46. Special tests were conducted to demonstrate the effects of unusual flow distribution between the Arkansas and Poteau Rivers on navigation through the bridges. Flows demonstrated were as follows:

Discharge, cfs		
Arkansas River	Poteau River	Total
80,000	20,000	100,000
30,000	30,000	60,000
None	30,000	30,000

Since the combination of flows listed above would occur rarely, if ever, no data were obtained except to observe the effect of currents on the movement of the model tow. Results of this demonstration indicated that increasing the flow from the Poteau River in proportion to the total river flow would tend to produce currents which could affect navigation. Except with no flow in the Arkansas River, flow from the Poteau River had only a local effect on currents in the navigation channel. With no flow in the Arkansas River, currents from the Poteau River moved across the entire channel and would thus tend to move a tow out of the channel. The effects of these currents could be overcome without serious difficulty by directing the heads of tows toward the mouth of the Poteau River when moving through this reach.

PART IV: DISCUSSION OF RESULTS AND CONCLUSIONS

Results

47. The results of this investigation were based on conditions existing in the prototype at the time of the July 1965 survey with a 300-ft-wide dredged channel, 12 ft below normal pool. During the investigation some modifications were made to the bed of the model and in the alignment of the dredged channel based on a study of currents and velocities. Since it is extremely difficult to determine with any degree of accuracy the effects of changes on channel configurations and since channel configurations developed would depend to a considerable extent on flow conditions, the channel bed was modified to reflect major trends only. During the tests of the final plans in which velocities and water-surface slopes indicated that some deepening and changes in channel width could be expected, the changes were not made in the interest of economy since indications were that navigation conditions would not be materially affected. In these cases, water-surface elevations resulting from the installation of improvements would be somewhat higher than could be expected in the prototype under normal conditions.

48. Evaluation of navigation conditions was based principally upon a study of current directions and velocities as indicated by wooden floats submerged to a depth of 8 ft (prototype) and a study of the effects of these currents on the behavior of the model tow. In evaluating test results, it should be borne in mind that small changes in the direction of flow or in velocities are not necessarily changes 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. Current directions shown in the plates were obtained with wooden floats and should be indicative of currents that will affect tows.

49. It should also be considered that because of the limited overbank area reproduced to the right of the channel, only a portion of the overflow area upstream of the mouth of the Poteau River was included in

the model. No adjustments were made in the discharge to compensate for the overbank area not reproduced. This limitation would affect only flows overtopping the right bank.

Conclusions

50. The following conclusions and indications were developed from the results of this investigation:

- a. With existing structures in the Fort Smith reach, channel dimensions would tend to be less than required for navigation. With the construction and operation of Lock and Dam No. 13, the tendency for shoaling in the reach would be increased because of the reduction in velocities during most of the controlled flows.
- b. Navigation conditions would tend to be hazardous through the reach upstream of the Poteau River because of flow over the right stone-fill revetment, which would tend to move tows against and over the revetment, and in the reach downstream of the Poteau River because of the limited width of bridge spans and the effect of flow through the Poteau River channel.
- c. Under normal conditions, flow from the Poteau River would not be sufficient to affect navigation. Overflow from the Arkansas River moving over the right stone-fill revetment and into the Poteau River channel during high flows would tend to produce crosscurrents at the mouth of the Poteau River and cause shoaling near the junction of the right bank of the Poteau and Arkansas Rivers. A high flow in the Poteau River of 20,000 to 30,000 cfs with little flow in the Arkansas River would produce currents across the navigation channel which could be hazardous to navigation.
- d. Development of channel depths over the crossing toward the right bank between miles 363 and 364 would require the downstream extension of the left stone-fill revetment and the installation of additional dikes as in plan A-1.
- e. Raising the right stone-fill revetment between dikes 363.3R and 363.1R and the raising of dike 363.3R from its river end to high ground to above the maximum navigable flow would eliminate the danger of tows being moved against and over the revetment, improve current alignment and depths along the revetment downstream, and reduce the effect of flow from the Poteau River on navigation through the bridges.

f. Moving the lower end of the stone-fill revetment above the mouth of the Poteau riverward to line up with the right bank downstream of the mouth of the Poteau River would eliminate the impingement of currents on the point in the right bank at the confluence of the Poteau and Arkansas Rivers, improve the alignment of currents in the reach, and reduce the tendency for shoaling at that point.

g. Dikes would be required along the left bank from just above the bridges to a point downstream at least as far as dike 361.3L to reduce the tendency for flow to move toward the left side of the channel and reduce velocities in the channel along the right bank.

Table 1

Water-Surface Elevations, Base Test

Gage No.	Total Discharge in 1000 cfs*						
	30	40	50	100	150	200	250
1	393.4	395.3	396.9	402.0	405.7	408.5	410.8
2	392.8	394.8	296.4	401.7	405.1	407.7	410.0
3	392.4	394.4	496.1	401.3	404.6	407.2	409.3
4	392.3	394.4	396.0	401.1	404.4	406.9	409.0
5	392.2	394.3	395.9	401.0	404.1	406.7	408.7
6	392.1	394.2	395.8	400.8	403.8	406.2	408.1
7	392.0	394.0	395.6	400.6	403.5	405.9	407.8
8	392.0	394.0	395.6	400.6	403.5	405.9	407.8
9	391.8	393.8	395.4	400.4	403.2	405.7	407.5
10	391.5	393.7	395.2	400.1	402.9	405.4	407.2
A**	392.2	394.3	395.8	401.1	404.3	407.0	409.2
B**	392.1	394.2	395.8	401.1	404.3	407.0	409.2
C**	392.1	394.2	395.8	401.1	404.2	406.9	409.0

Note: Elevations are in feet referred to mean sea level.
* Discharge below mouth of Poteau River. Discharge of Poteau River maintained at 3 percent of total.
** Gages located in Poteau River.

Table 2

Water-Surface Elevations, Plan A

Gage No.	Total Discharge in 1000 cfs* 30	40	50	100	150	200	250
1	393.2	395.1	396.7	402.0	405.5	408.4	410.6
2	392.7	394.6	396.2	401.8	405.0	407.7	409.8
3	392.4	394.4	396.0	401.4	404.5	407.2	409.3
4	392.4	394.4	396.0	401.1	404.3	406.8	408.9
5	392.3	394.3	395.8	401.0	404.1	406.5	408.6
6	392.2	394.2	395.7	400.8	403.8	406.2	408.1
7	392.0	394.1	395.6	400.7	403.5	405.9	407.8
8	392.0	394.0	395.6	400.6	403.5	405.9	407.8
9	391.8	393.8	395.4	400.3	403.2	405.6	407.4
10	391.5	393.7	395.2	400.1	402.9	405.4	407.2
A**	392.1	394.2	395.8	401.0	404.3	406.9	409.2
B**	392.1	394.2	395.8	401.0	404.3	406.9	409.1
C**	392.1	394.2	395.8	401.0	404.2	406.8	408.9

Note: Elevations are in feet referred to mean sea level.

* Discharge below mouth of Poteau River. Discharge of Poteau River maintained at 3 percent of total.

** Gages located in Poteau River.

Table 3

Water-Surface Elevations, Plans A-1, A-2, and A-3

Gage No.	Plan A-1 150	Plan A-1 250	Plan A-2 150	Plan A-2 250	Plan A-3 150	Plan A-3 250
	Total Discharge in 1000 cfs*					
1	405.6	410.6	405.8	411.3	406.0	411.4
2	405.1	409.8	405.4	410.6	405.5	410.7
3	404.4	409.3	404.7	410.0	404.8	410.1
4	404.2	408.9	404.3	409.1	404.3	409.2
5	403.9	408.6	404.0	408.6	403.9	408.5
6	403.7	408.1	403.8	408.3	403.7	408.2
7	403.5	407.8	403.6	408.0	403.6	408.0
8	403.5	407.8	403.5	407.9	403.5	407.9
9	403.2	407.4	403.2	407.6	403.2	407.6
10	402.9	407.2	402.9	407.2	402.9	407.2
A**	404.3	409.2	404.3	409.3	404.2	409.1
B**	404.3	409.1	404.3	409.3	404.1	409.1
C**	404.2	409.1	404.3	409.3	404.1	408.9

Note: Elevations are in feet referred to mean sea level.
* Discharge below mouth of Poteau River. Discharge of Poteau River maintained at 3 percent of total.
** Gages located in Poteau River.

Table 4

Water-Surface Elevations, Plans B and B-2

Gage No.	Total Discharge in 1000 cfs* Plan B 150	Plan B 250	Plan B-2 250
1	406.4	411.7	412.0
2	405.9	411.0	411.3
3	405.2	410.5	410.6
4	404.6	409.4	409.1
5	404.2	408.9	408.6
6	404.1	408.6	408.5
7	403.9	408.4	408.3
8	403.8	408.3	408.2
9	403.3	407.8	407.7
10	402.9	407.2	407.2
A**	404.4	409.5	409.1
B**	404.4	409.4	409.0
C**	404.4	409.3	409.0

Note: Elevations are in feet referred to mean sea level.
* Discharge below mouth of Poteau River. Discharge of Poteau River maintained at 3 percent of total.
** Gages located in Poteau River.

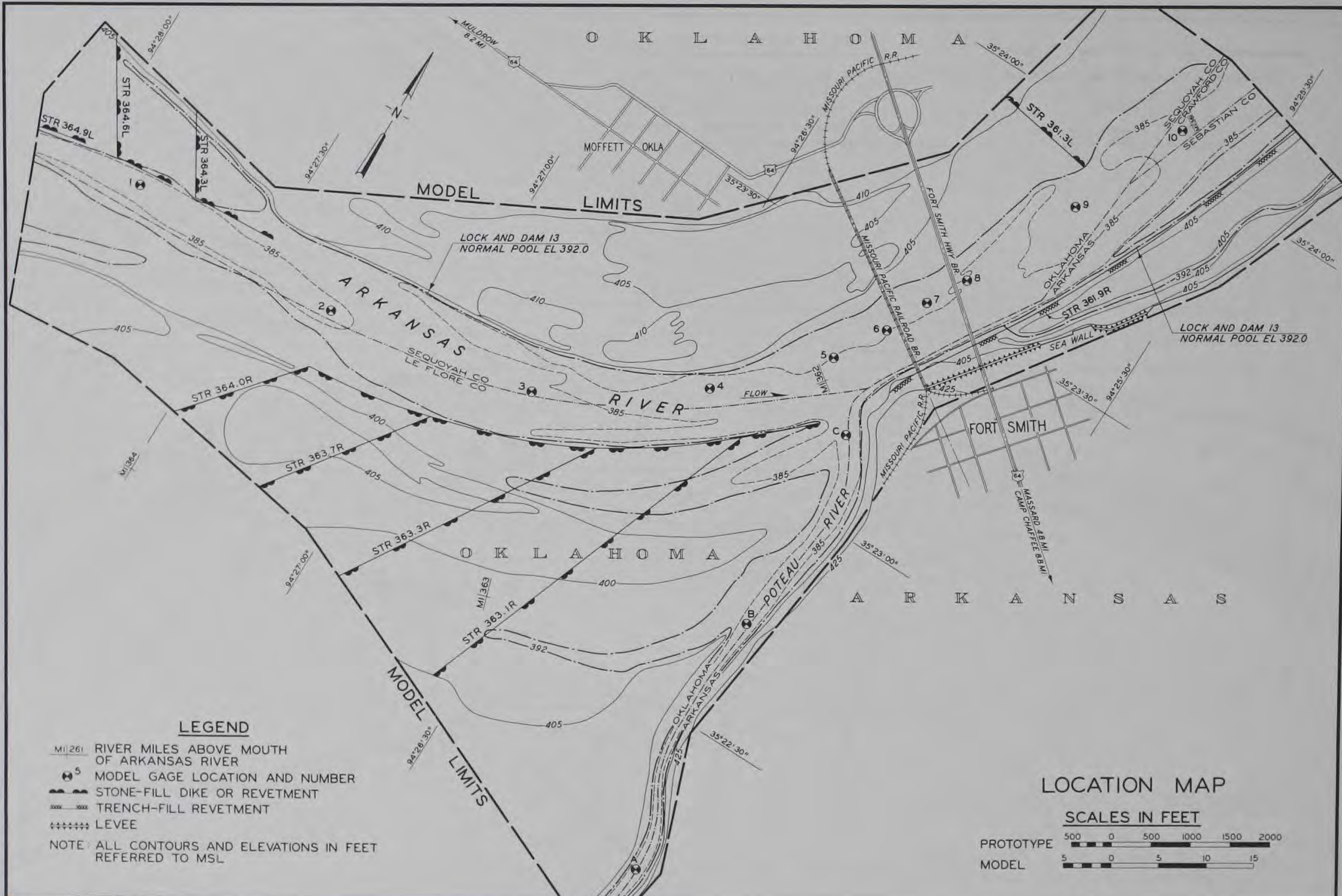


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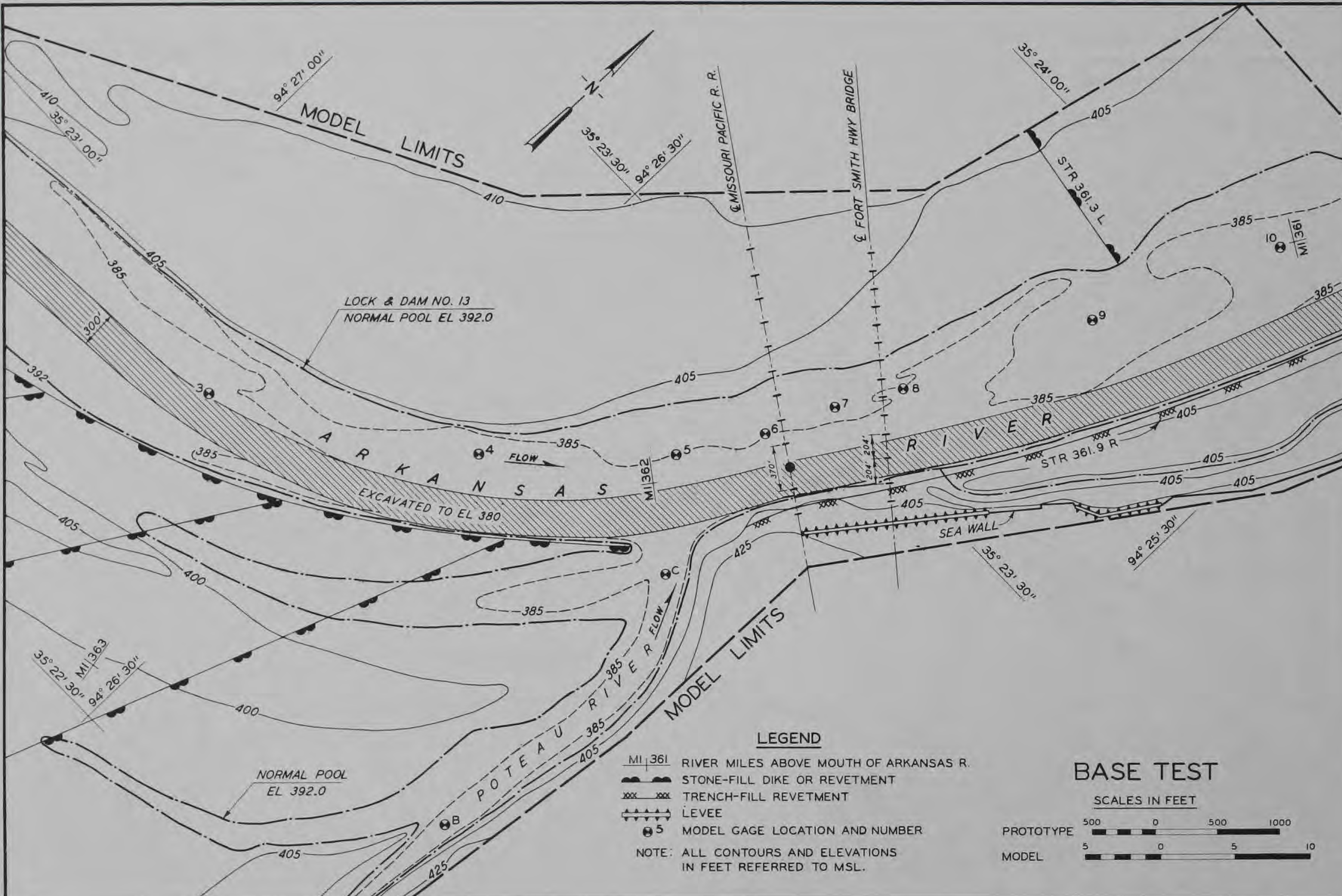
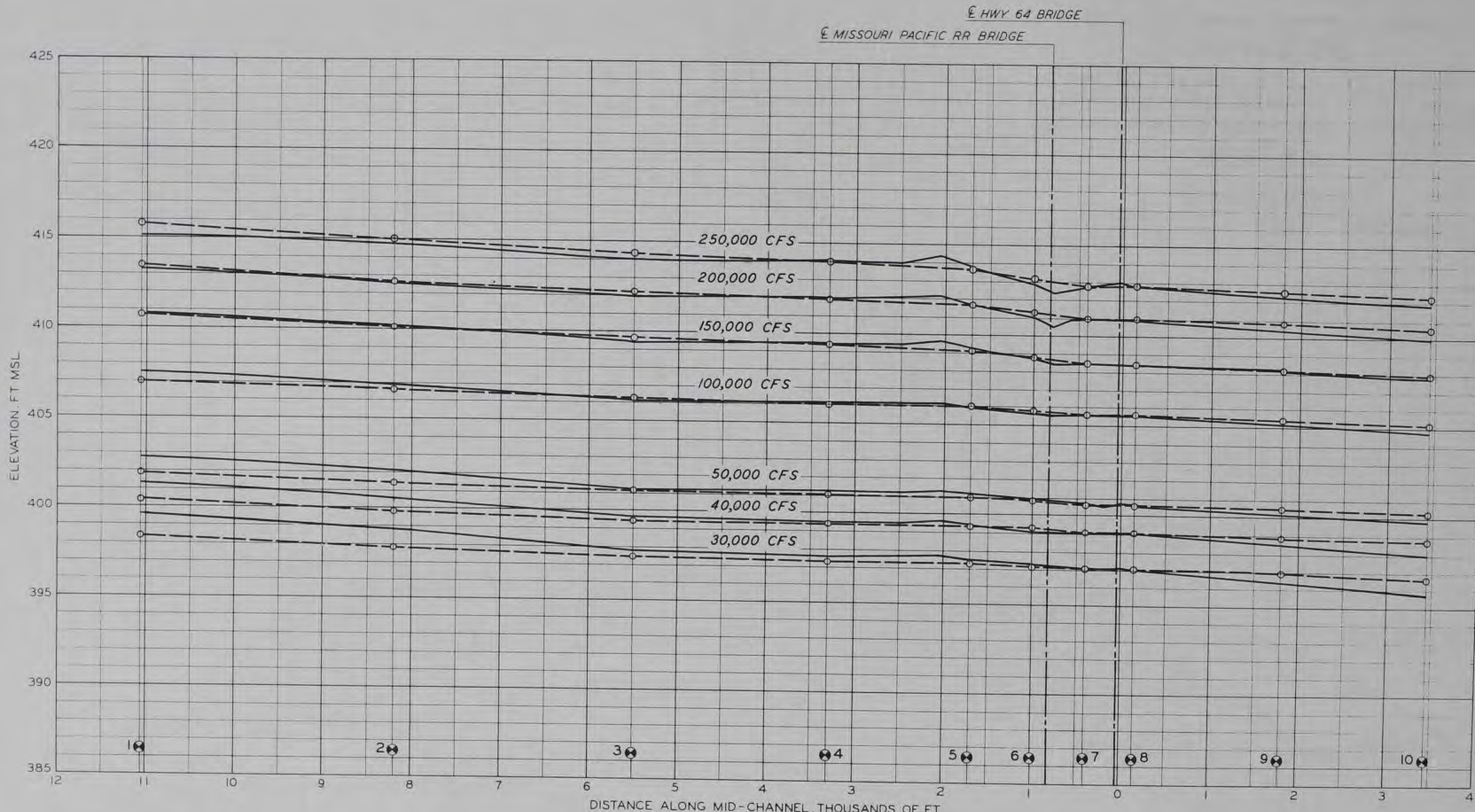
PLATE 1

PLATE 2



MODEL LIMITS
N
94° 27' 00"
35° 23' 00"
35° 23' 30"
94° 26' 30"
35° 24' 00"
℄ MISSOURI PACIFIC R. R.
℄ FORT SMITH HWY BRIDGE
STR 361.3 L
MI 361
MI 362
MI 363
LOCK & DAM NO. 13
NORMAL POOL EL 392.0
ARKANSAS RIVER
FLOW
EXCAVATED TO EL 380
300'
370'
204'
STR 361.9 R
SEA WALL
35° 23' 30"
94° 25' 30"
35° 22' 30"
94° 26' 30"
POTEAU RIVER
NORMAL POOL
EL 392.0
410
405
400
392
385
425
LEGEND
MI 361 RIVER MILES ABOVE MOUTH OF ARKANSAS R.
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
5 MODEL GAGE LOCATION AND NUMBER
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
BASE TEST
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



LEGEND

COMPUTED

MODEL

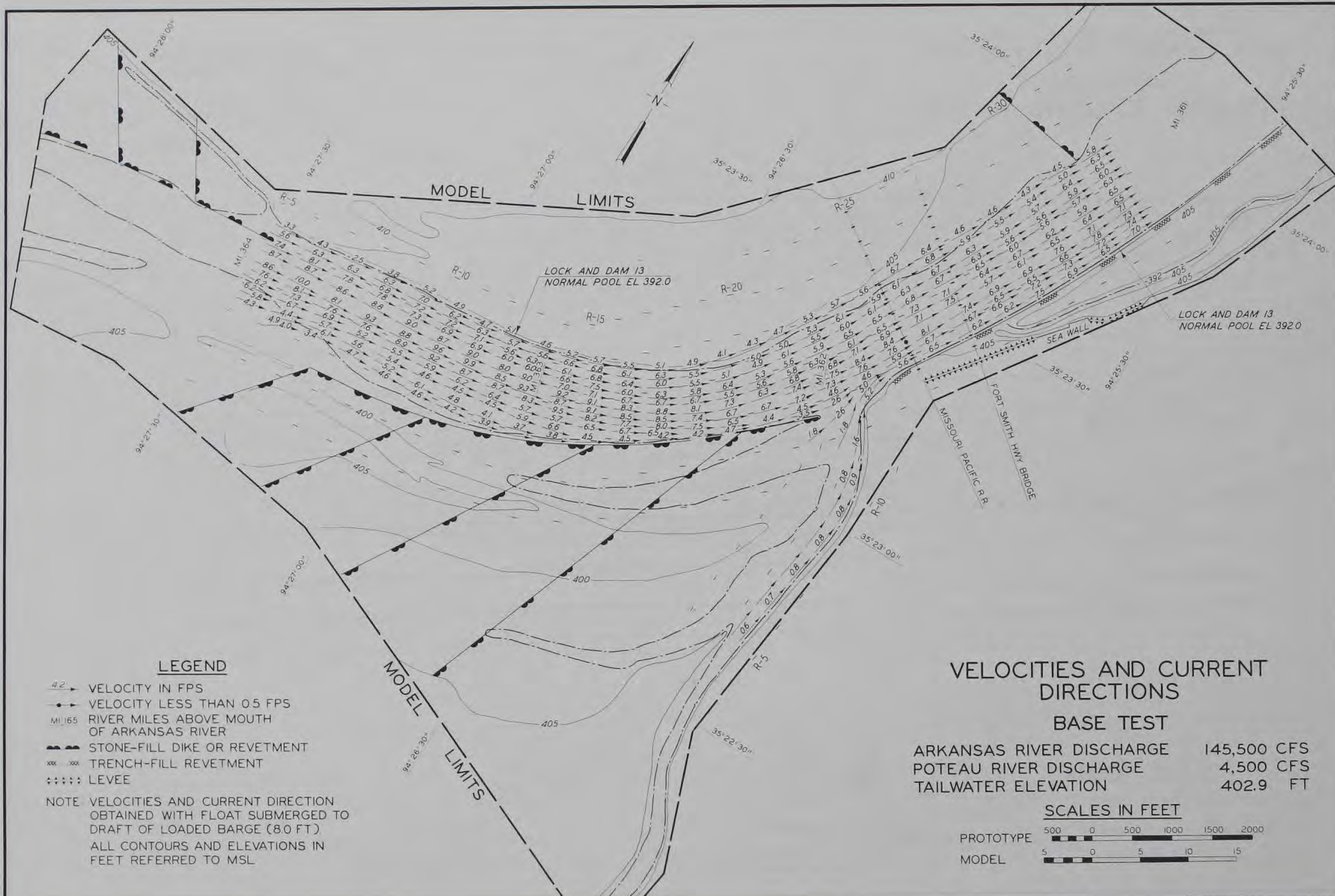
NOTE: DISCHARGES ARE TOTALS BELOW MOUTH OF POTEAU RIVER.

WATER-SURFACE PROFILES

BASE TEST

DISCHARGES: 30,000, 40,000, 50,000, 100,000, 150,000, 200,000 AND 250,000 CFS

PLATE 3



VELOCITIES AND CURRENT DIRECTIONS

BASE TEST

ARKANSAS RIVER DISCHARGE	145,500 CFS
POTEAU RIVER DISCHARGE	4,500 CFS
TAILWATER ELEVATION	402.9 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15

LEGEND

- 4.2 VELOCITY IN FPS
- VELOCITY LESS THAN 0.5 FPS
- MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
- STONE-FILL DIKE OR REVETMENT
- TRENCH-FILL REVETMENT
- LEVEE

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).

ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL

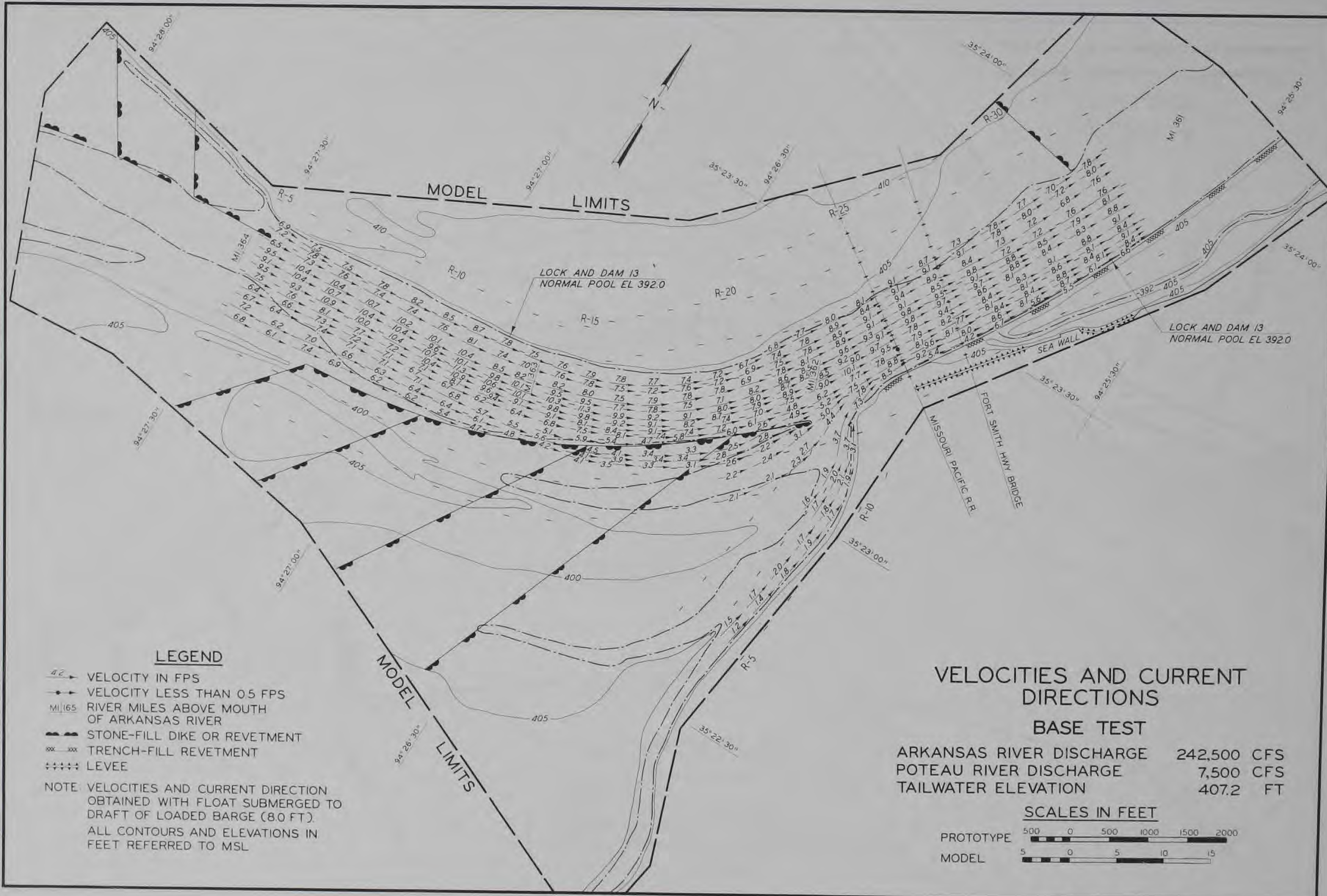
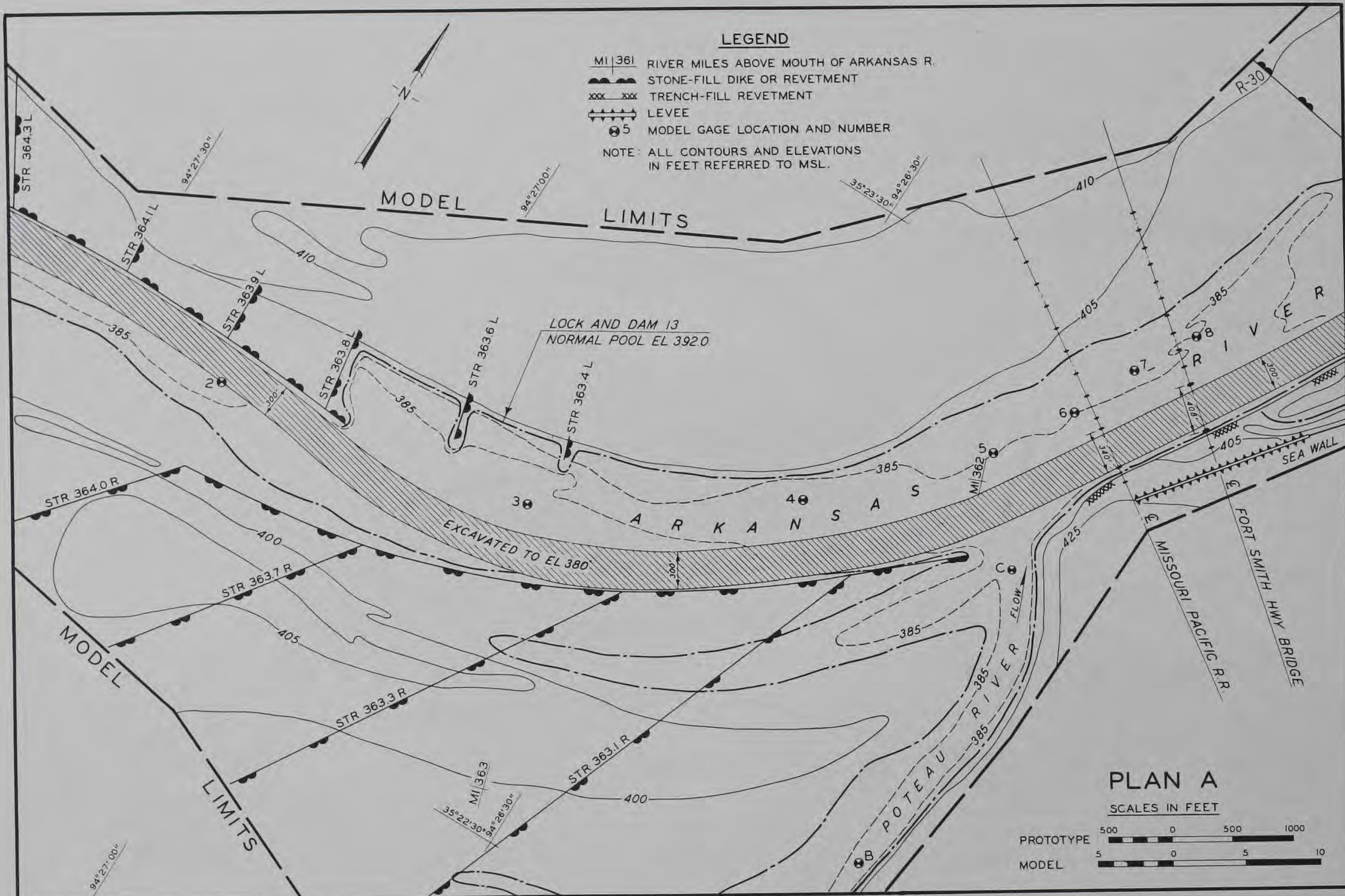

MODEL LIMITS
N
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 362
MI 361
LEGEND
VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
VELOCITIES AND CURRENT DIRECTIONS
BASE TEST
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

PLATE 5


LEGEND
MI 361 RIVER MILES ABOVE MOUTH OF ARKANSAS R.
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
5 MODEL GAGE LOCATION AND NUMBER
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
N
MODEL LIMITS
MODEL LIMITS
94°27'30"
94°27'00"
35°23'30"
94°26'30"
35°22'30"
94°26'30"
94°27'00"
R-30
STR 364.3 L
STR 364.1 L
STR 363.9 L
STR 363.8 L
STR 363.6 L
STR 363.4 L
STR 364.0 R
STR 363.7 R
STR 363.3 R
STR 363.1 R
LOCK AND DAM 13
NORMAL POOL EL 392.0
EXCAVATED TO EL 380'
ARKANSAS RIVER
POTEAU RIVER
FLOW
MI 362
MI 363
410
405
400
385
425
300'
340'
406'
2
3
4
5
6
7
8
B
C
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10

PLAN A

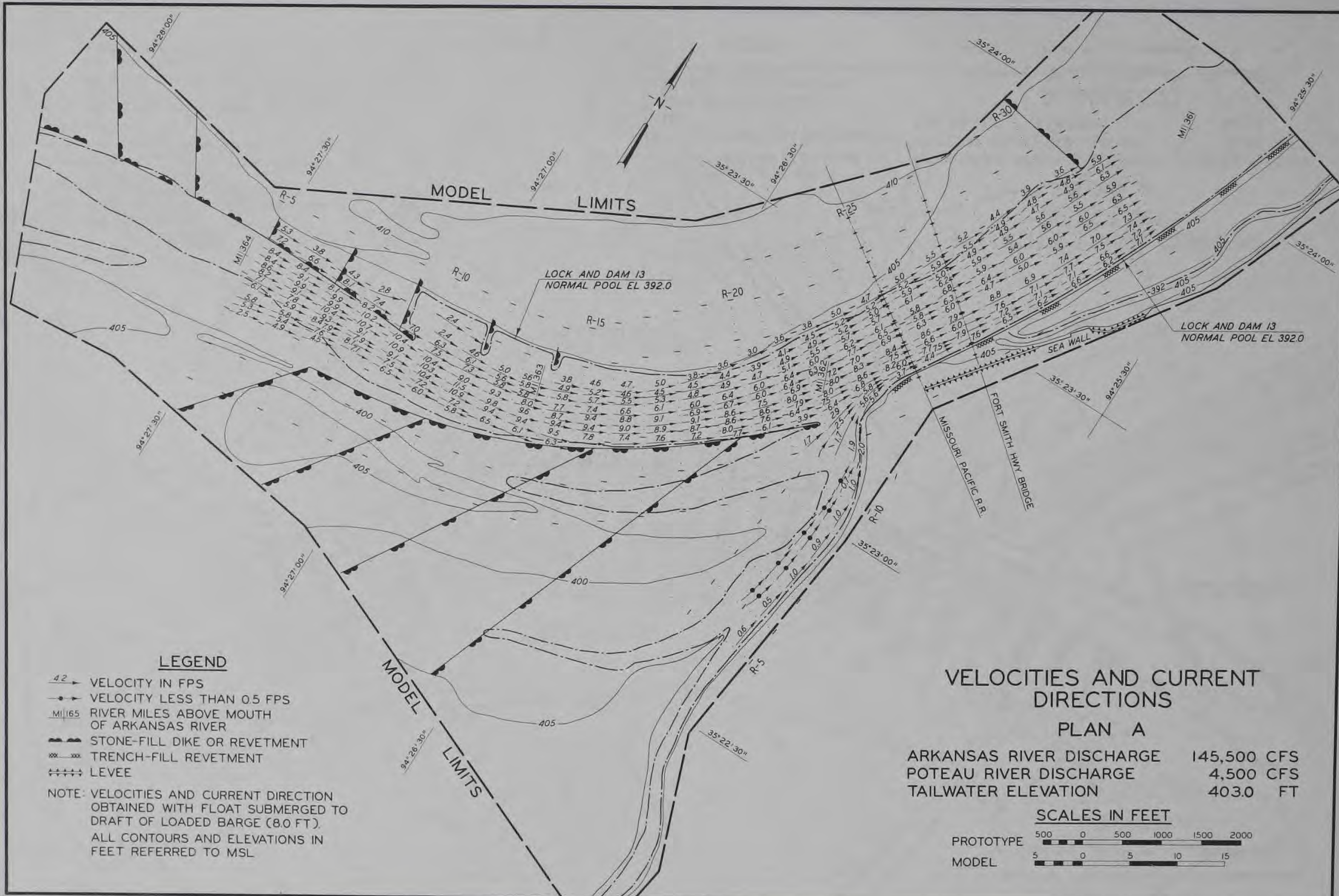
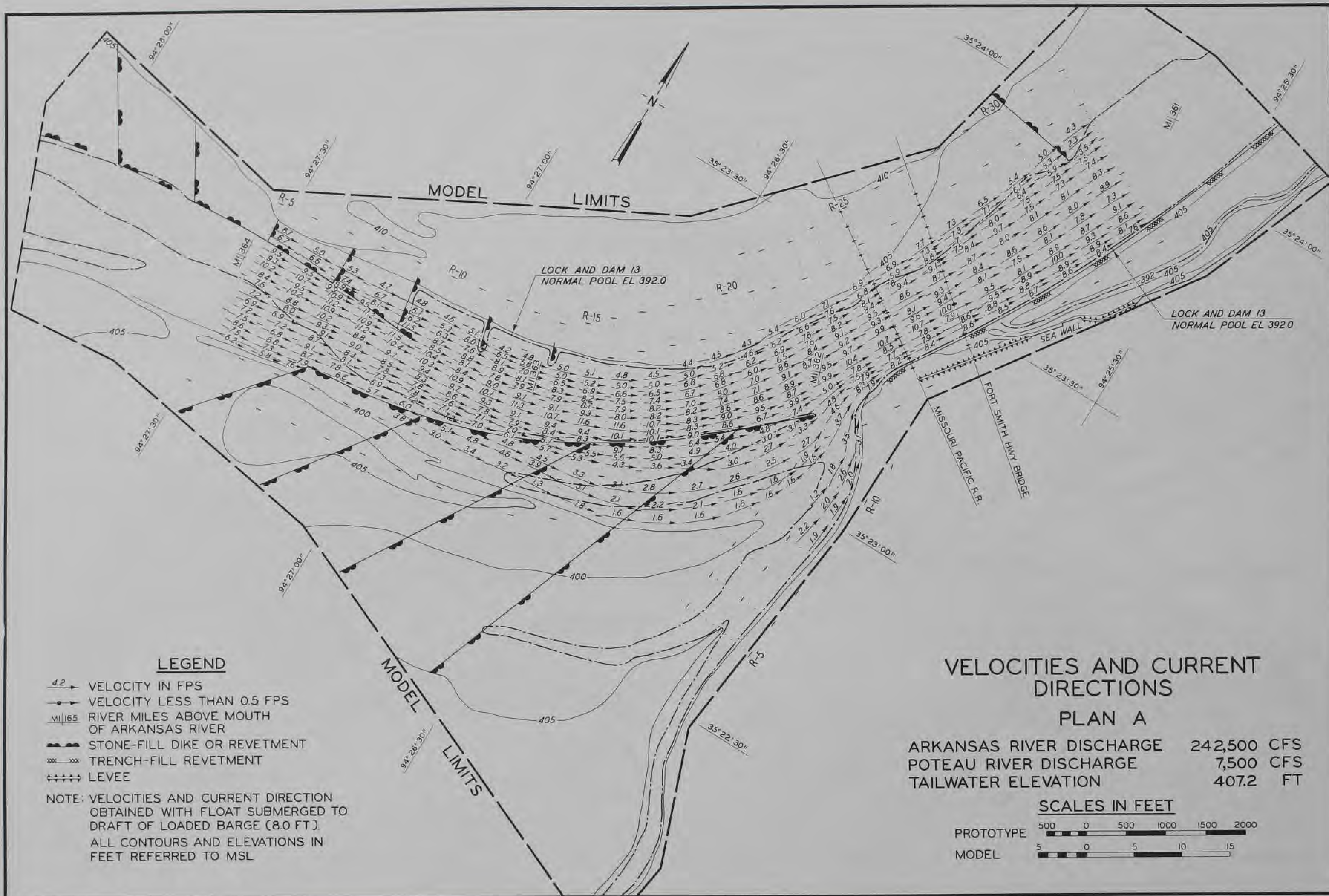
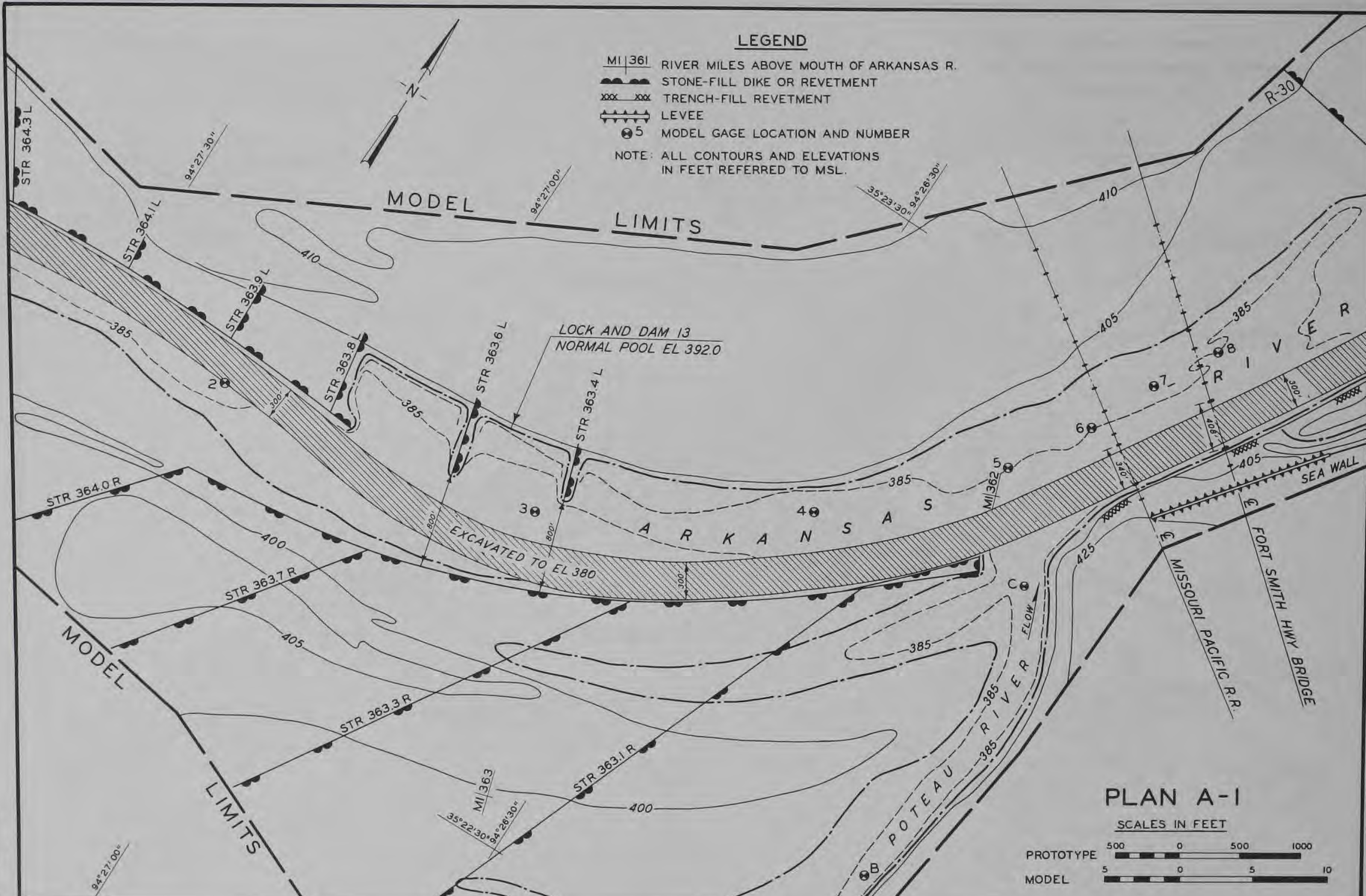

MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 363
MI 362
MI 361
R-5
R-10
R-15
R-20
R-25
R-30
94°28'00"
94°27'30"
94°27'00"
94°26'30"
94°25'30"
35°24'00"
35°23'30"
35°23'00"
35°22'30"
N
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
ARKANSAS RIVER DISCHARGE 145,500 CFS
POTEAU RIVER DISCHARGE 4,500 CFS
TAILWATER ELEVATION 403.0 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

PLATE 7

PLATE 8

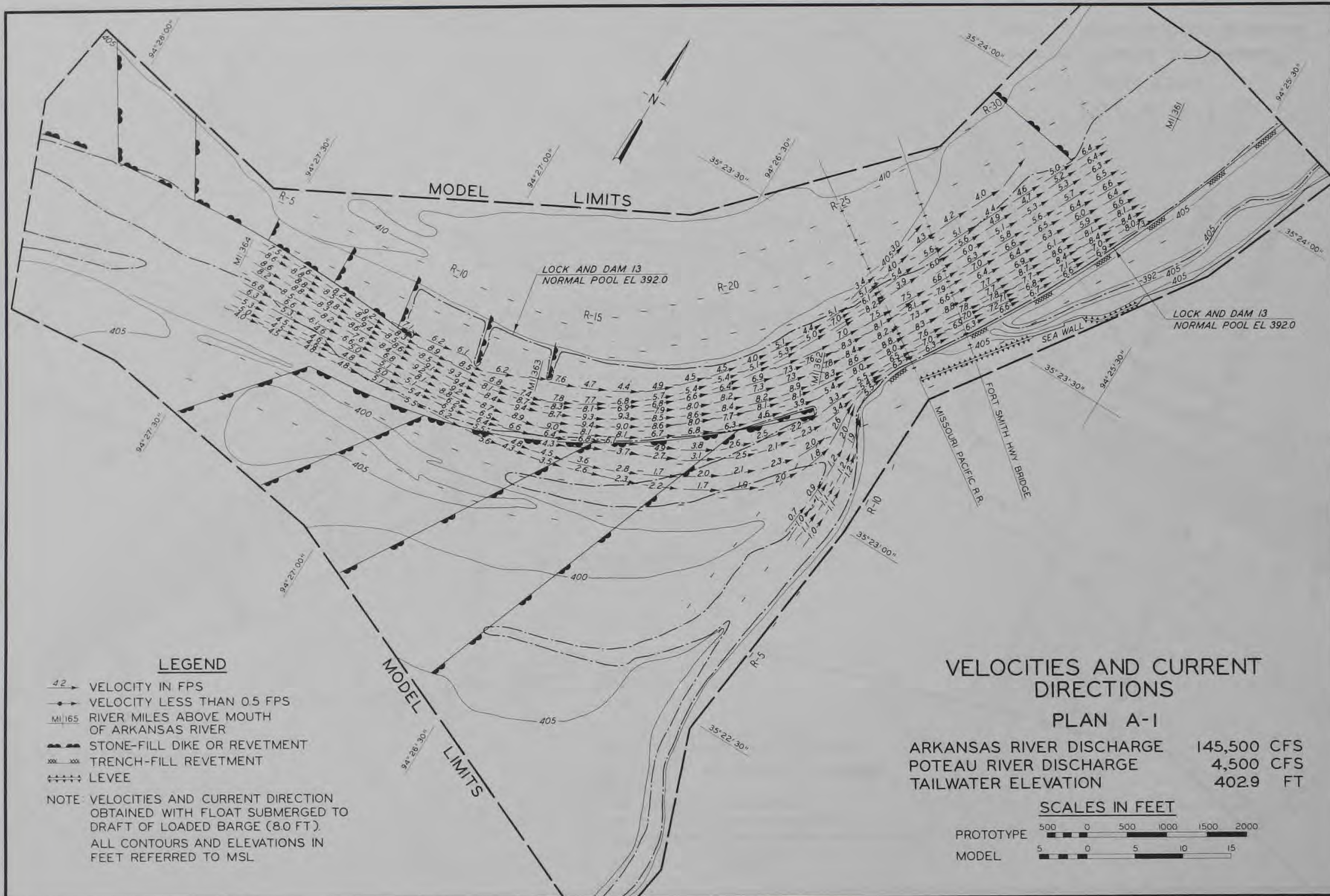


MODEL LIMITS
MODEL LIMITS
N
LOCK AND DAM 13
NORMAL POOL EL 392.0
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
FORT SMITH HWY BRIDGE
MISSOURI PACIFIC R.R.
MI 364
MI 362
MI 361
R-5
R-10
R-15
R-20
R-25
R-30
94°28'00"
94°27'30"
94°27'00"
94°26'30"
94°25'30"
35°24'00"
35°23'30"
35°23'00"
35°22'30"
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
VELOCITIES AND CURRENT DIRECTIONS
PLAN A
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15



PLAN A-1

PLATE 9



LEGEND

- 4.2 → VELOCITY IN FPS
- —•→ VELOCITY LESS THAN 0.5 FPS
- MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
- STONE-FILL DIKE OR REVETMENT
- TRENCH-FILL REVETMENT
- LEVEE

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).

ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL

VELOCITIES AND CURRENT DIRECTIONS

PLAN A-1

ARKANSAS RIVER DISCHARGE	145,500 CFS
POTEAU RIVER DISCHARGE	4,500 CFS
TAILWATER ELEVATION	402.9 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15

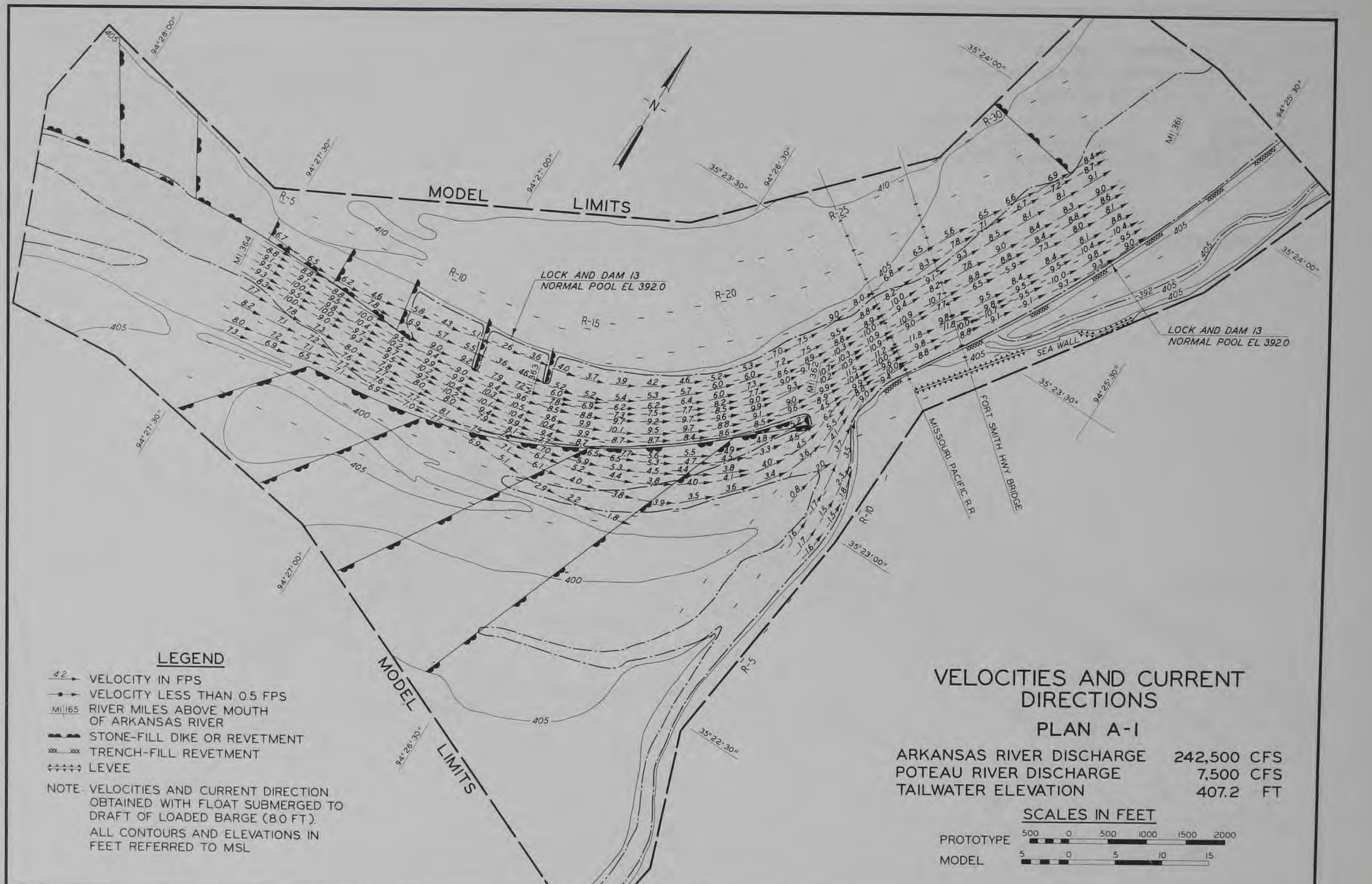
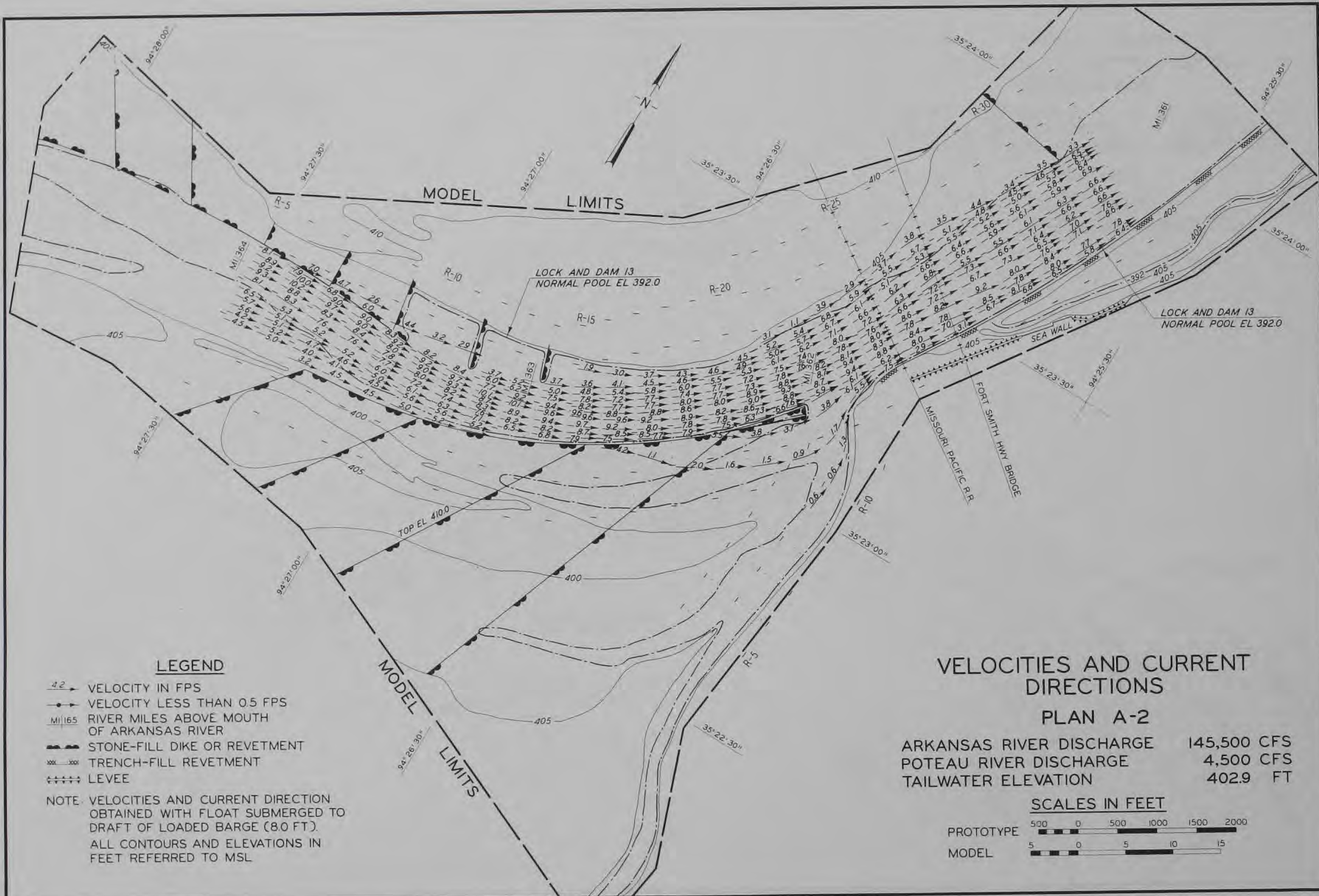

MODEL LIMITS
MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 363
MI 362
MI 361
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-1
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

PLATE 11

PLATE 12


MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
TOP EL 410.0
MI 364
MI 363
MI 362
MI 361
LEGEND
VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT.).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-2
ARKANSAS RIVER DISCHARGE 145,500 CFS
POTEAU RIVER DISCHARGE 4,500 CFS
TAILWATER ELEVATION 402.9 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

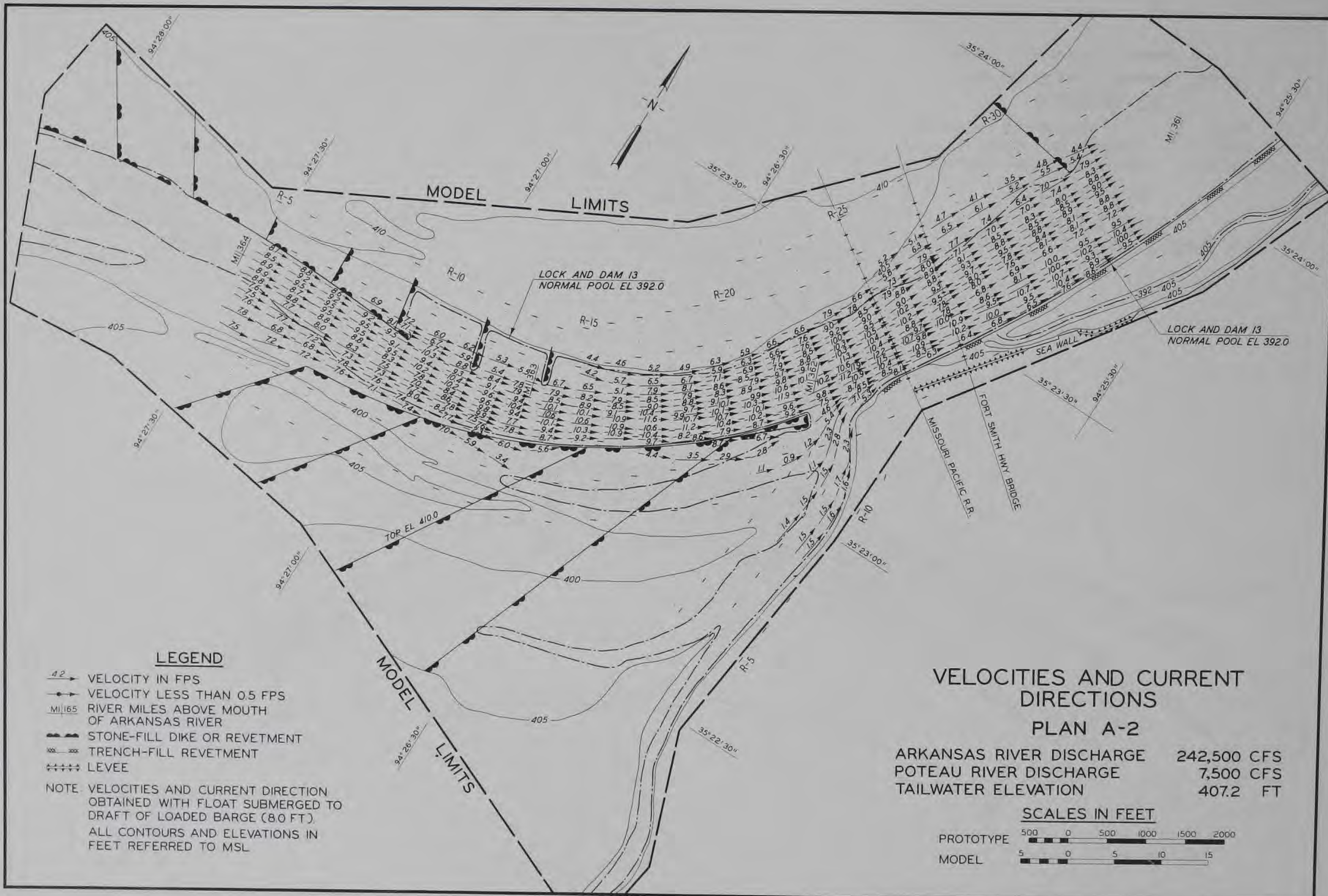
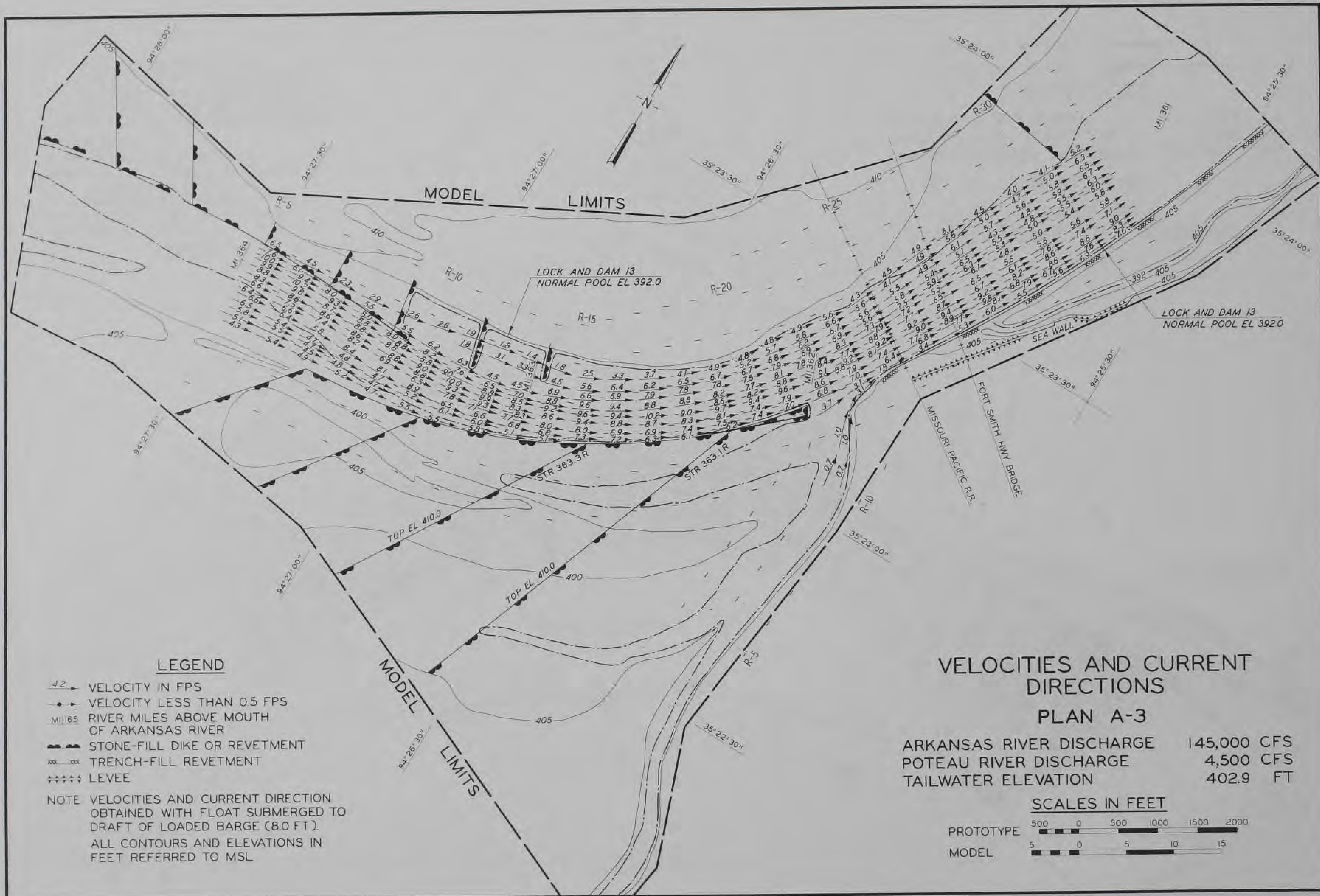

MODEL LIMITS
N
LOCK AND DAM 13
NORMAL POOL EL 392.0
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
TOP EL 410.0
MODEL LIMITS
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-2
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

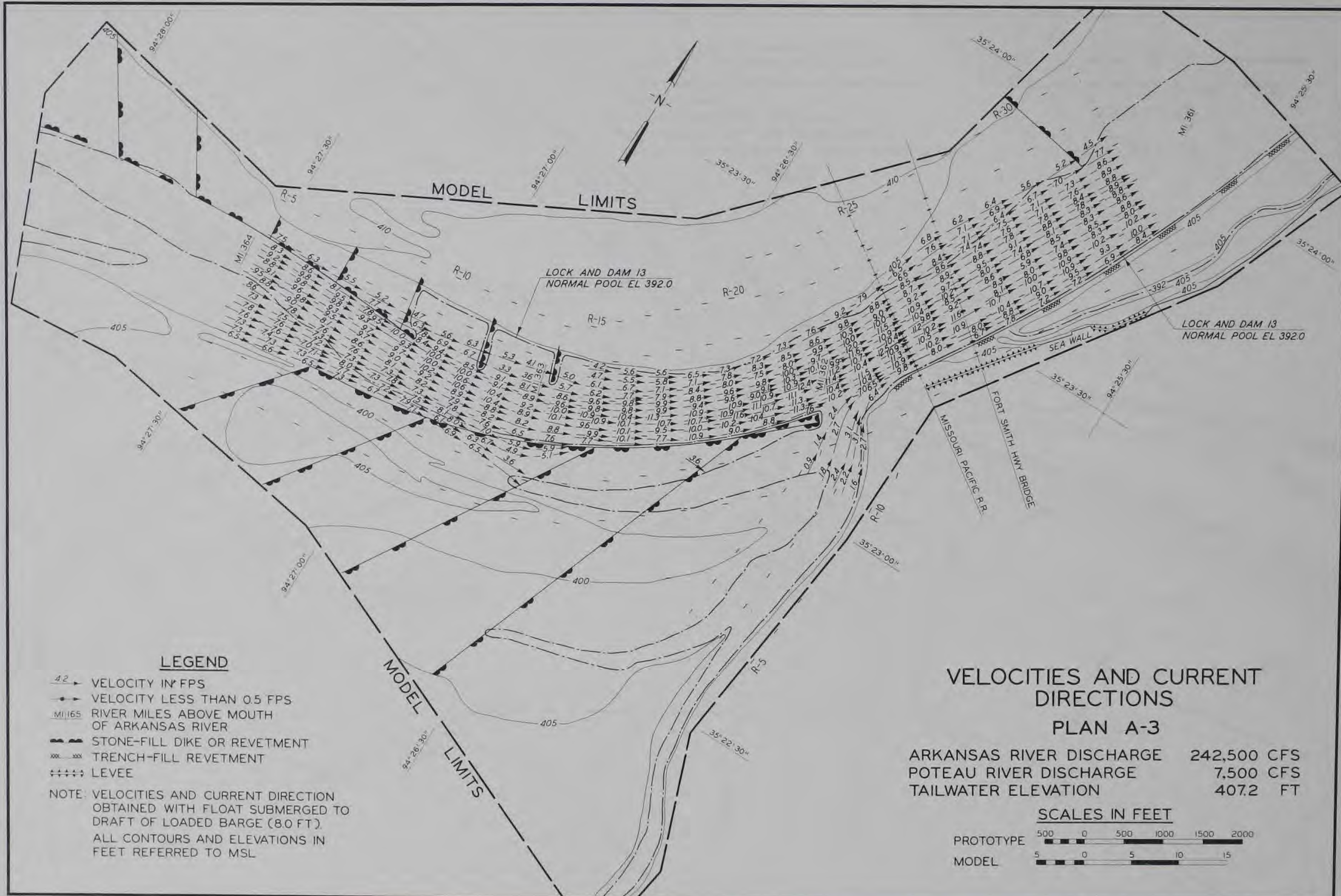
PLATE 13



VELOCITIES AND CURRENT DIRECTIONS

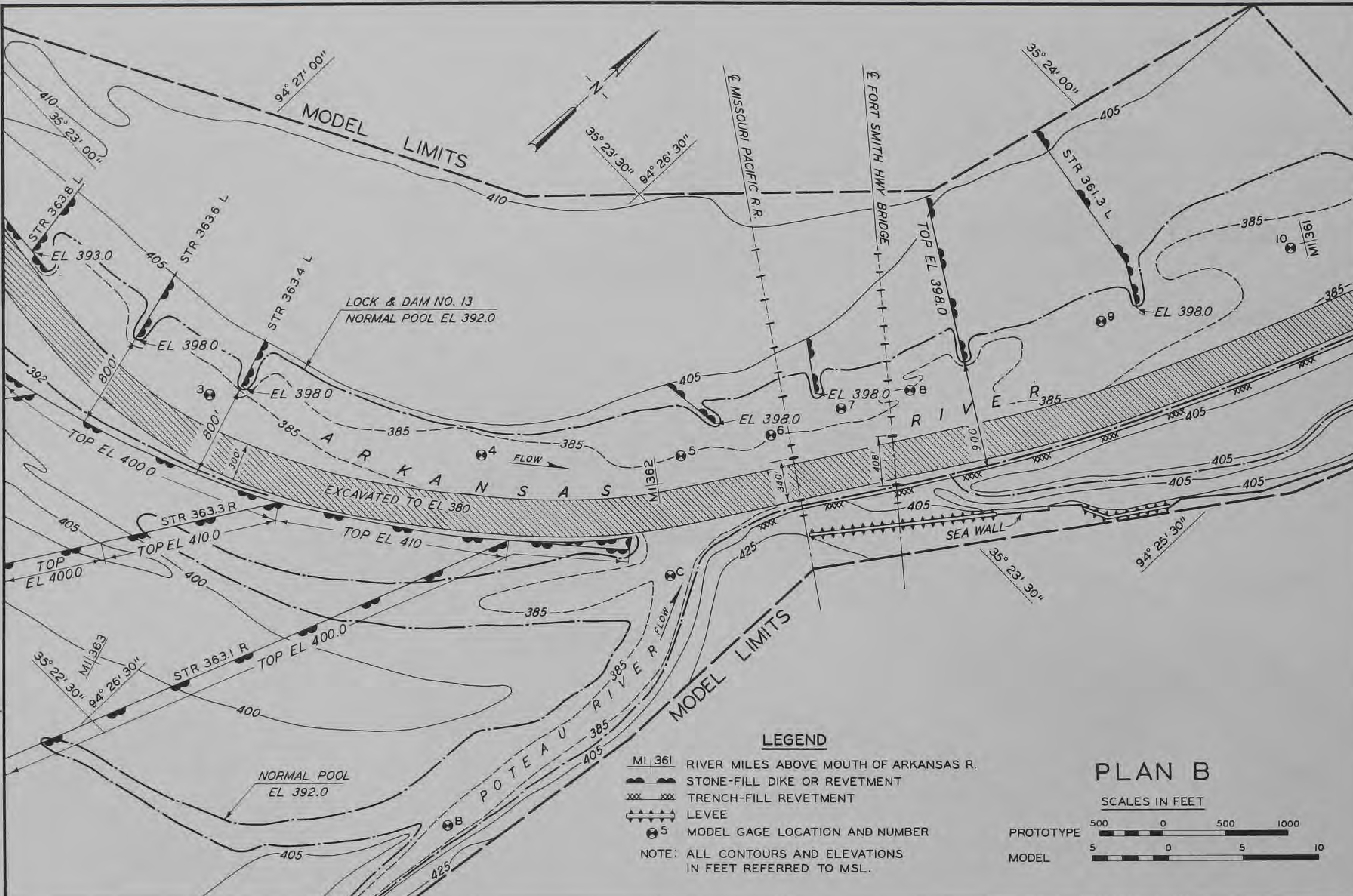
PLAN A-3

ARKANSAS RIVER DISCHARGE	145,000 CFS
POTEAU RIVER DISCHARGE	4,500 CFS
TAILWATER ELEVATION	402.9 FT

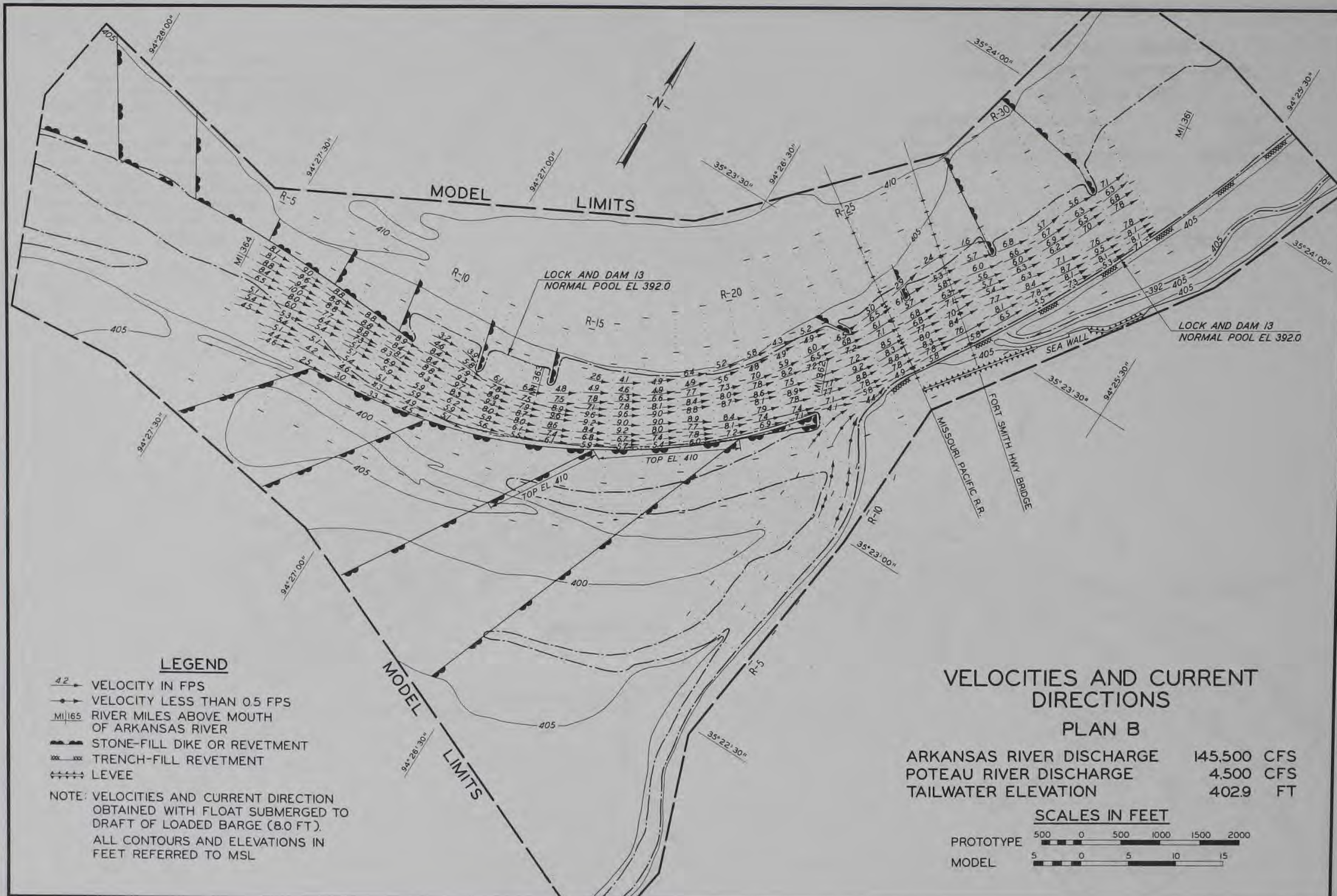


MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 363
MI 362
MI 361
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN A-3
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

PLATE 15



MODEL LIMITS
N
94° 27' 00"
35° 23' 00"
35° 23' 30"
94° 26' 30"
℄ MISSOURI PACIFIC R.R.
℄ FORT SMITH HWY BRIDGE
35° 24' 00"
STR 363.8 L
STR 363.6 L
STR 363.4 L
STR 361.3 L
EL 393.0
EL 398.0
TOP EL 398.0
LOCK & DAM NO. 13
NORMAL POOL EL 392.0
800'
300'
340'
408'
900'
A R K A N S A S
R I V E R
FLOW
EXCAVATED TO EL 380
TOP EL 400.0
STR 363.3 R
TOP EL 410.0
TOP EL 410
TOP EL 400.0
SEA WALL
94° 25' 30"
35° 23' 30"
MI 361
MI 362
MI 363
STR 363.1 R
35° 22' 30"
94° 26' 30"
P O T E A U R I V E R
NORMAL POOL
EL 392.0
410
405
400
392
385
425
LEGEND
MI 361 RIVER MILES ABOVE MOUTH OF ARKANSAS R.
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
5 MODEL GAGE LOCATION AND NUMBER
NOTE: ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
PLAN B
SCALES IN FEET
PROTOTYPE 500 0 500 1000
MODEL 5 0 5 10



LEGEND

- 4.2 VELOCITY IN FPS
- VELOCITY LESS THAN 0.5 FPS
- MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
- STONE-FILL DIKE OR REVETMENT
- TRENCH-FILL REVETMENT
- LEVEE

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.

VELOCITIES AND CURRENT DIRECTIONS

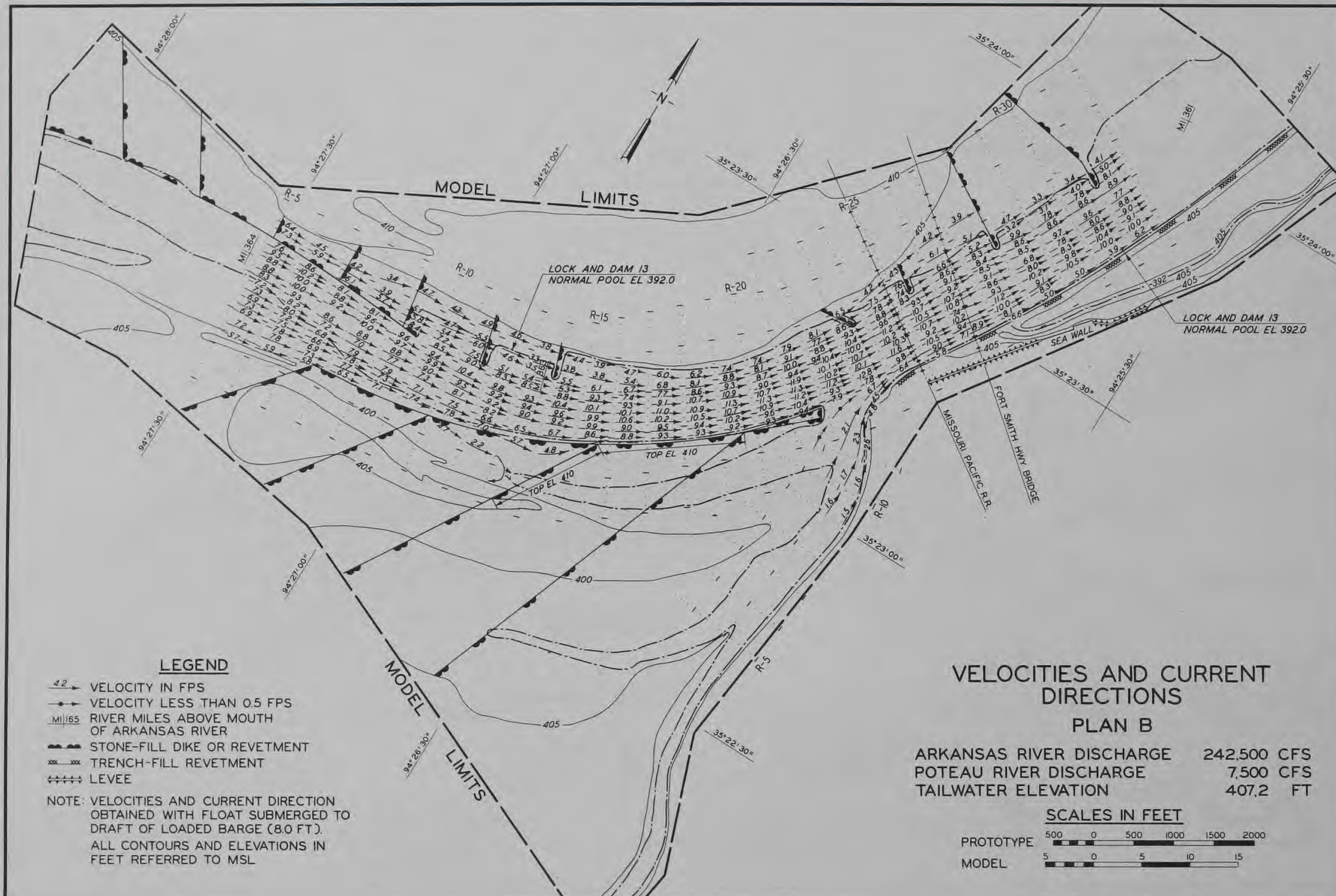
PLAN B

ARKANSAS RIVER DISCHARGE	145,500	CFS
POTEAU RIVER DISCHARGE	4,500	CFS
TAILWATER ELEVATION	402.9	FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15



VELOCITIES AND CURRENT DIRECTIONS
PLAN B
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
MODEL LIMITS
MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
TOP EL 410
TOP EL 410
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 361
N
R-5
R-10
R-15
R-20
R-25
R-30
R-10
R-5
94°28'00"
94°27'30"
94°27'00"
94°26'30"
94°25'30"
94°27'30"
94°27'00"
94°26'30"
94°25'30"
35°24'00"
35°23'30"
35°24'00"
35°23'30"
35°23'00"
35°22'30"

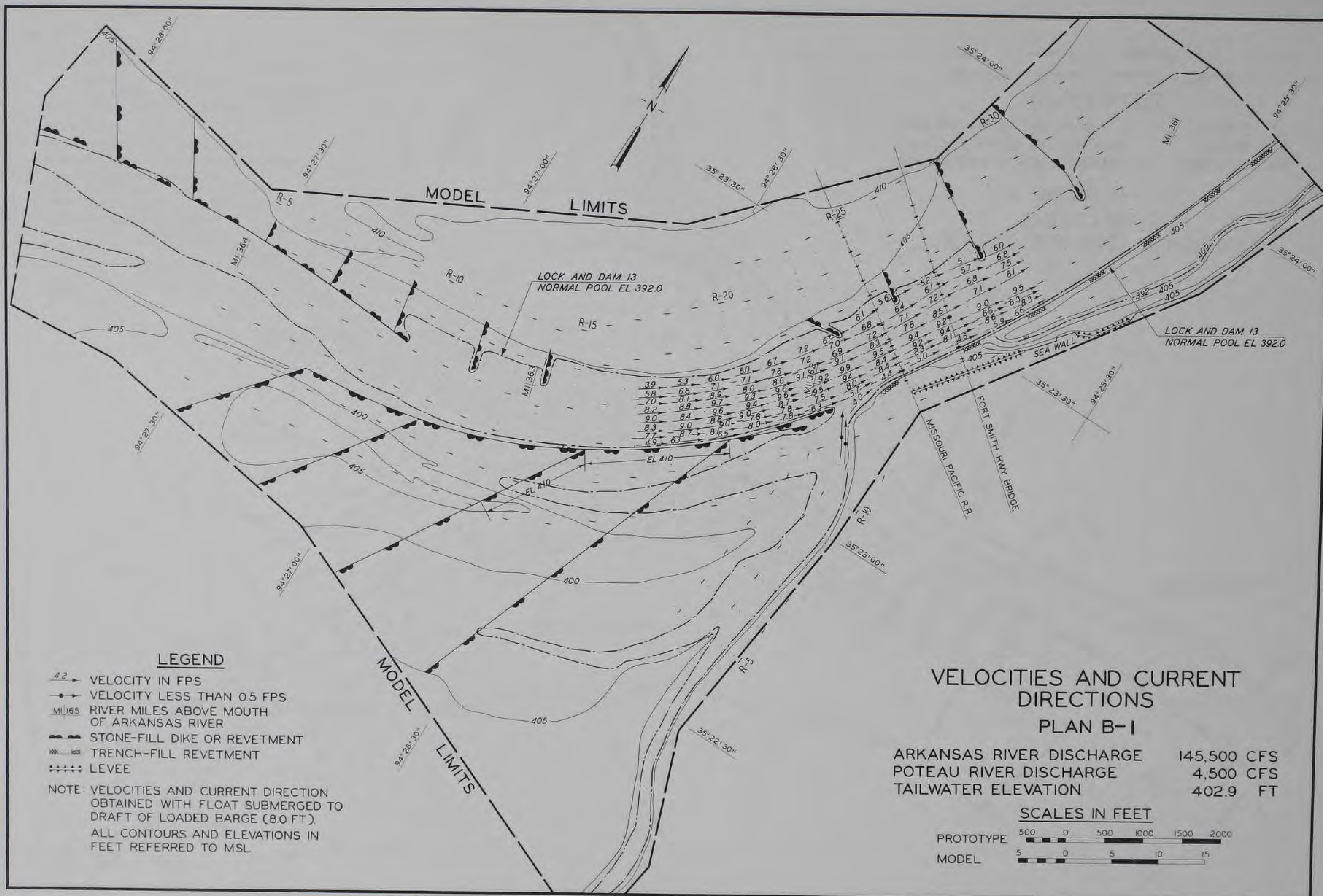
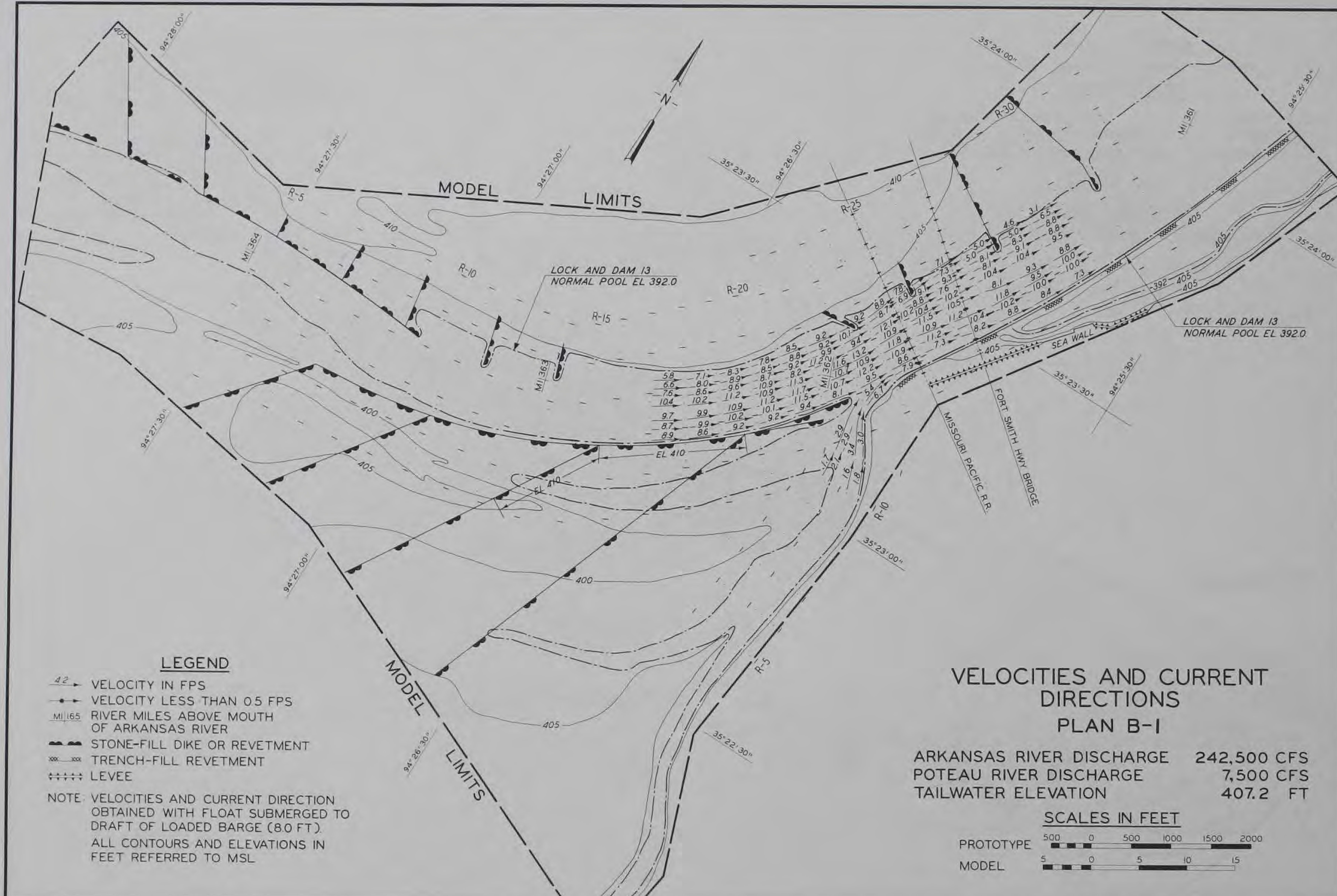

MODEL LIMITS
N
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
EL 410
R-5
R-10
R-15
R-20
R-25
R-30
MI 364
MI 363
MI 362
MI 361
94°28'00"
94°27'30"
94°27'00"
94°26'30"
94°25'30"
35°24'00"
35°23'30"
35°23'00"
35°22'30"
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-1
ARKANSAS RIVER DISCHARGE 145,500 CFS
POTEAU RIVER DISCHARGE 4,500 CFS
TAILWATER ELEVATION 402.9 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

PLATE 19



LEGEND

- 4.2 VELOCITY IN FPS
- VELOCITY LESS THAN 0.5 FPS
- MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
- STONE-FILL DIKE OR REVETMENT
- TRENCH-FILL REVETMENT
- LEVEE

NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.

VELOCITIES AND CURRENT DIRECTIONS

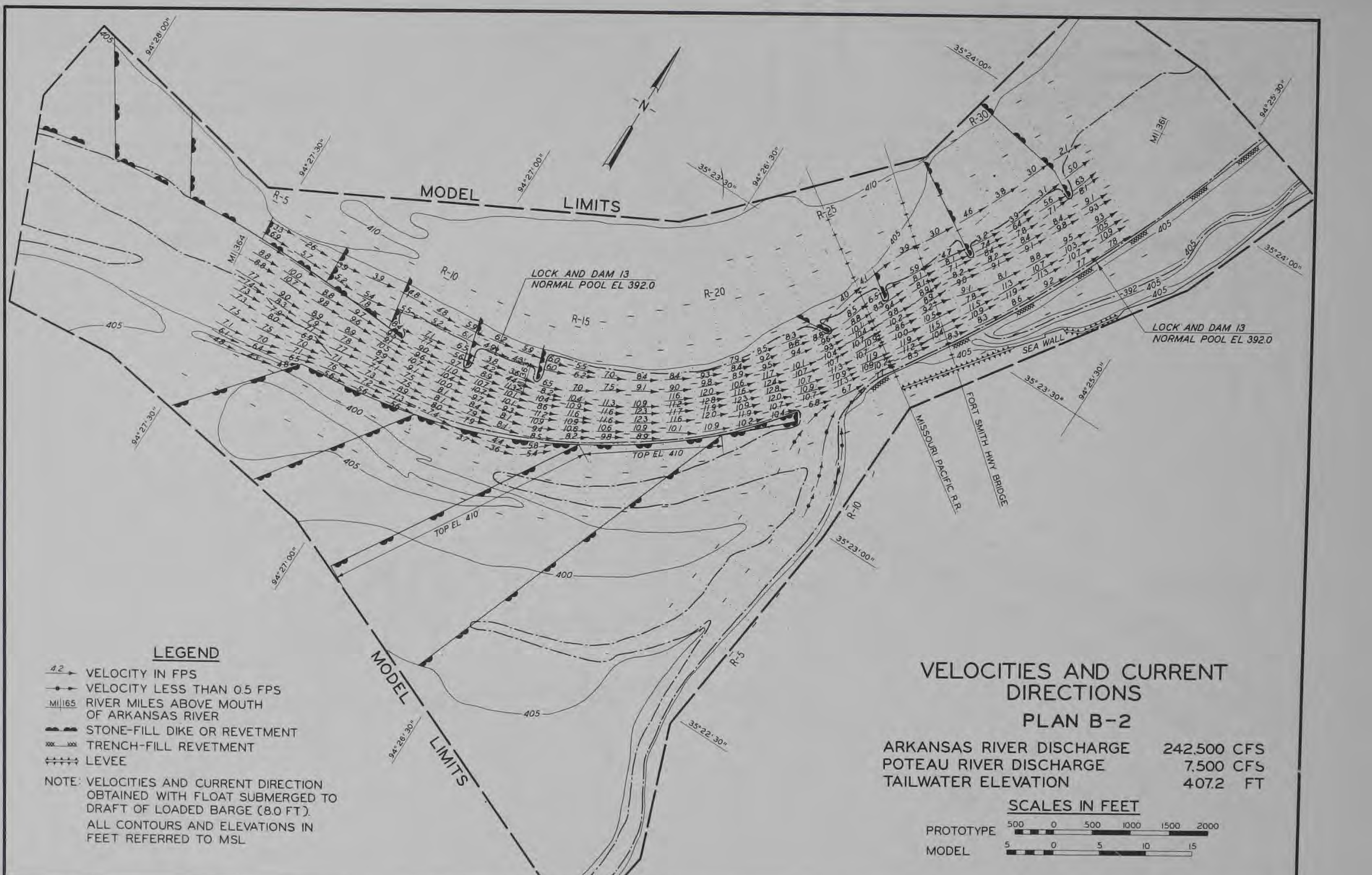
PLAN B-1

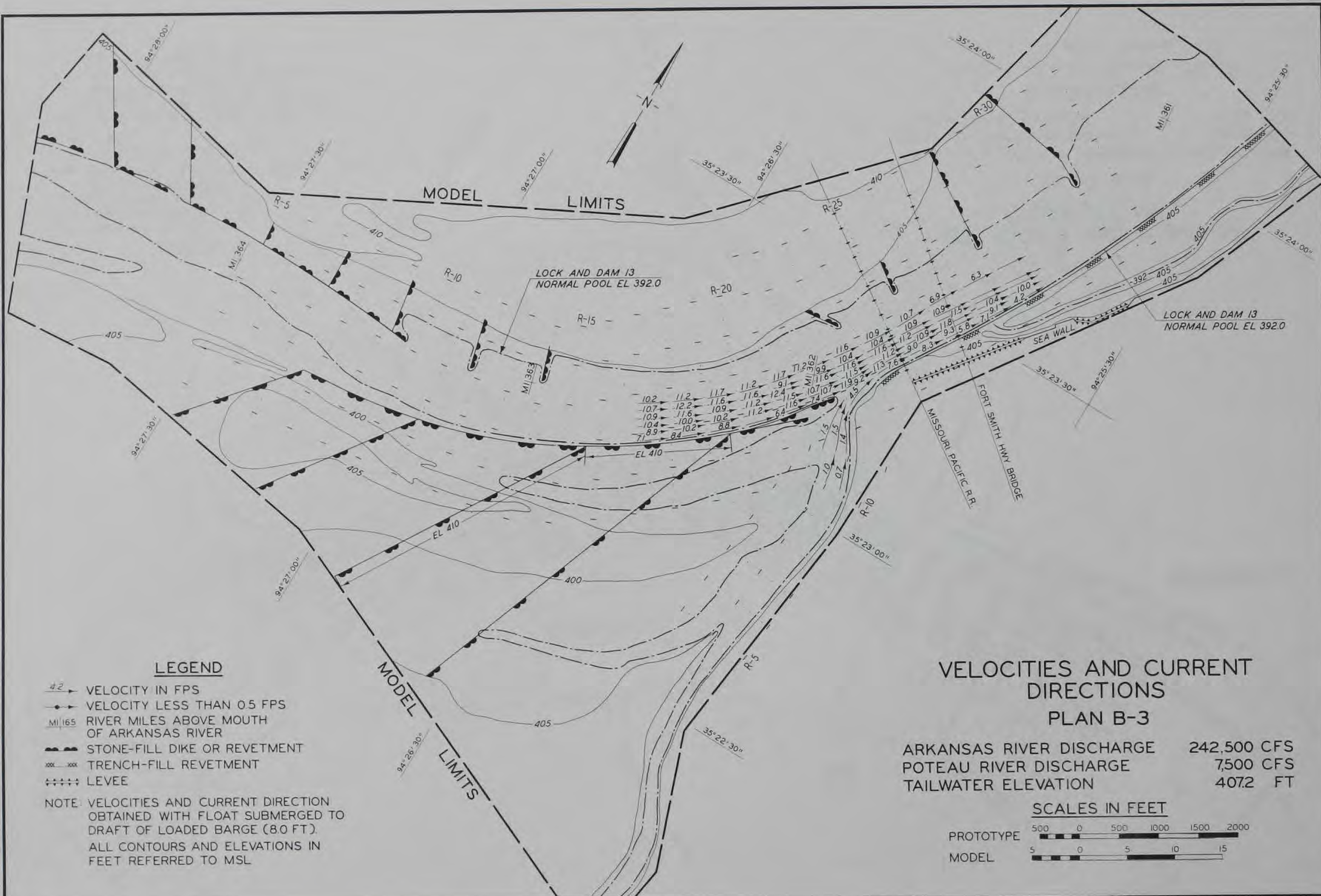
ARKANSAS RIVER DISCHARGE	242,500 CFS
POTEAU RIVER DISCHARGE	7,500 CFS
TAILWATER ELEVATION	407.2 FT

SCALES IN FEET

PROTOTYPE 500 0 500 1000 1500 2000

MODEL 5 0 5 10 15


MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
TOP EL 410
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-2
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15


MODEL LIMITS
LOCK AND DAM 13
NORMAL POOL EL 392.0
SEA WALL
MISSOURI PACIFIC R.R.
FORT SMITH HWY BRIDGE
MI 364
MI 363
MI 362
MI 361
EL 410
LEGEND
4.2 VELOCITY IN FPS
VELOCITY LESS THAN 0.5 FPS
MI 165 RIVER MILES ABOVE MOUTH OF ARKANSAS RIVER
STONE-FILL DIKE OR REVETMENT
TRENCH-FILL REVETMENT
LEVEE
NOTE: VELOCITIES AND CURRENT DIRECTION OBTAINED WITH FLOAT SUBMERGED TO DRAFT OF LOADED BARGE (8.0 FT).
ALL CONTOURS AND ELEVATIONS IN FEET REFERRED TO MSL.
VELOCITIES AND CURRENT DIRECTIONS
PLAN B-3
ARKANSAS RIVER DISCHARGE 242,500 CFS
POTEAU RIVER DISCHARGE 7,500 CFS
TAILWATER ELEVATION 407.2 FT
SCALES IN FEET
PROTOTYPE 500 0 500 1000 1500 2000
MODEL 5 0 5 10 15

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11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	U. S. Army Engineer District Little Rock, Arkansas

13. ABSTRACT

The Fort Smith reach of the Arkansas River, located in the Lock and Dam No. 13 pool, includes the mouth of the Poteau River and is crossed by two bridges 850 ft apart. An undistorted 1:120-scale, semifixed-bed model reproducing approximately 4 miles of the Arkansas River and adjacent overbank and the lower 2 miles of the Poteau River was used to determine the regulating structures and modifications required to develop a channel of project dimensions, and the modifications required to the existing bridges to provide satisfactory navigation conditions through the reach. Results of the investigation indicate that: (1) The bridge spans should be modified to provide additional clearance and the navigation channel through the bridges should be maintained along the right bank. (2) Normal flow from the Poteau River would have little effect on navigation through the bridges downstream. Overflow from the Arkansas River into the Poteau River channel combined with Poteau River flow could produce serious crosscurrents at the mouth of the Poteau River and would tend to increase shoaling at that point. (3) Modifications would be required in the regulating structures along the right bank just upstream of the mouth of the Poteau River and along the left bank to develop satisfactory channel dimensions through the reach.

Unclassified
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
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Fort Smith Reach, Arkansas River						
Hydraulic models						
Navigation conditions						
Poteau River						

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