

**HYDRAULIC MODEL OF THE RIO GRANDE AND FLOODWAYS
WITHIN THE
LOWER RIO GRANDE FLOOD CONTROL PROJECT**



JUNE 2003

Prepared by:

INTERNATIONAL BOUNDARY AND WATER COMMISSION
UNITED STATES AND MEXICO
UNITED STATES SECTION

**HYDRAULIC MODEL OF THE RIO GRANDE AND FLOODWAYS
WITHIN THE
LOWER RIO GRANDE FLOOD CONTROL PROJECT**

TABLE OF CONTENTS

A. INTRODUCTION	1
B. PURPOSE OF THE STUDY	2
C. PRESENT OPERATION OF THE LRGFCP	
1. DEVELOPMENT OF THE PROJECT	3
2. DISTRIBUTION OF DESIGN FLOOD FLOW	4
D. OVERVIEW OF THE 1992 HYDRAULIC MODEL	
1. EVENTS LEADING TO THE STUDY	6
2. DESCRIPTION OF THE 1992 MODEL	7
3. CONCLUSIONS FROM THE 1992 MODEL	7
E. THE 2003 HYDRAULIC MODEL	
1. BACKGROUND	8
2. DESCRIPTION OF THE 2003 MODEL	8
3. MODEL RUNS	9
4. RESULTS	10
5. CONCLUSIONS	11

LIST OF TABLES

TABLE 1	HYDRAULIC MODEL RUN RESULTS FOR RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE	13
TABLE 2	HYDRAULIC MODEL RUN RESULTS FOR MAIN AND NORTH FLOODWAYS	19
TABLE 3	HYDRAULIC MODEL RUN RESULTS FOR ARROYO COLORADO	26

LIST OF FIGURES

FIGURE 1	LOWER RIO GRANDE VALLEY	5
FIGURE 2	FLOOD PROFILE ON THE RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY	32
FIGURE 3	FLOOD PROFILE ON THE U.S. MAIN AND NORTH FLOODWAYS OF THE RIO GRANDE RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY	33
FIGURE 4	FLOOD PROFILE ON THE ARROYO COLORADO FLOODWAY OF THE RIO GRANDE RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY	34
FIGURE 5	RIO GRANDE LEVEE ELEVATIONS WITH RESPECT TO WATER SURFACE ELEVATIONS	35
FIGURE 6	MAIN AND NORTH FLOODWAY LEVEE ELEVATIONS WITH RESPECT TO WATER SURFACE ELEVATIONS	36
FIGURE 7	ARROYO COLORADO LEVEE OR HIGH BANK ELEVATIONS WITH RESPECT TO WATER SURFACE ELEVATIONS	37
FIGURE 8	FLOOD PROFILES ON THE RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY	38

HYDRAULIC MODEL OF THE RIO GRANDE AND FLOODWAYS WITHIN THE LOWER RIO GRANDE FLOOD CONTROL PROJECT

A. INTRODUCTION

The present report deals with a hydraulic modeling study of the Lower Rio Grande Flood Control Project (LRGFCP) under the occurrence of the design flood flows in the river channel and its floodways within the United States. A similar study was conducted and a report entitled “Status of Conveying Capacity of the Lower Rio Grande Flood Control Project” issued in 1992. Since then, changes have occurred in land use and agricultural practices within the LRGFCP, and additional structures have been constructed, creating influences on the flow that were not present for the 1992 study. Also, additional geometrical data have been collected, and software capabilities have been enhanced, adding reliability to the results of the hydraulic model. The reader is directed to the 1992 report cited above for a comprehensive coverage of the history, physical characteristics, and development of the LRGFCP.

B. PURPOSE OF THE STUDY

The purpose of the present study is to determine the capability of the LRGFCP to convey the design flood flows, under existing vegetation conditions, at water surface elevations that will not encroach on the proposed 3 ft freeboard for the Rio Grande levees and 2 ft. freeboard for the floodway levees. The occurrence of such encroachment at any point would indicate a diminished capability of the LRGFCP to provide adequate flood protection at that point.

C. PRESENT OPERATION OF THE LRGFCP

1. DEVELOPMENT OF THE PROJECT

The LRGFCP was constructed under an agreement between the United States and Mexico concluded in 1932. Under that agreement, the two countries adopted a flood control plan for the lower Rio Grande prepared by the International Boundary Commission (IBC), and by which each Government committed to construct river levees and off-river floodways in its territory based on a design flood of 187,000 cubic feet per second (cfs) (5,300 cubic meters per second (cms)) at Peñitas. Later the 1944 Water Treaty renamed the IBC as the International Boundary and Water Commission (IBWC), and assigned to it the construction and operation and maintenance of flood control works in the Rio Grande/Rio Bravo. The 1944 Water Treaty also removed a prohibition for construction of dams on the Rio Grande. Pursuant to this action, the IBWC, under Minute No. 196 signed in December 1950, constructed the Anzalduas Dam diversion structure upstream of the Hidalgo/Reynosa area.

In 1967, the LRGFCP was subjected to a flood flow of 220,000 cfs (6,230 cms) at Rio Grande City, resulting from rainfall associated with Hurricane Beulah. Due to extensive flooding from this event, in 1970 the United States and Mexico, in Minute No. 238, agreed to construct improvements to the project on the basis of a design flood of 250,000 cfs (7,080 cms) at Rio Grande City. These included improvements to the interior floodway system in each country, clearing of the river channel in the Brownsville/Matamoros area, and construction of the Retamal Dam diversion structure. After construction of these various stages of improvements, at present the project consists of the following features:

- \$ The reach of the Rio Grande from just upstream of Peñitas at River Mile 186 to downstream of Brownsville at River Mile 28, including levees on both sides of the river and two diversion dams, the Anzalduas Dam at River Mile 169.4 and the Retamal Dam at River Mile 129.22.
- \$ In the United States, the Main Floodway from just upstream of Anzalduas Dam to the vicinity of Mercedes where it branches off into the North Floodway and the Arroyo Colorado, both of which end at the Gulf of Mexico.
- \$ In Mexico, the Mexican Floodway from just upstream of Retamal Dam to the Gulf of Mexico.

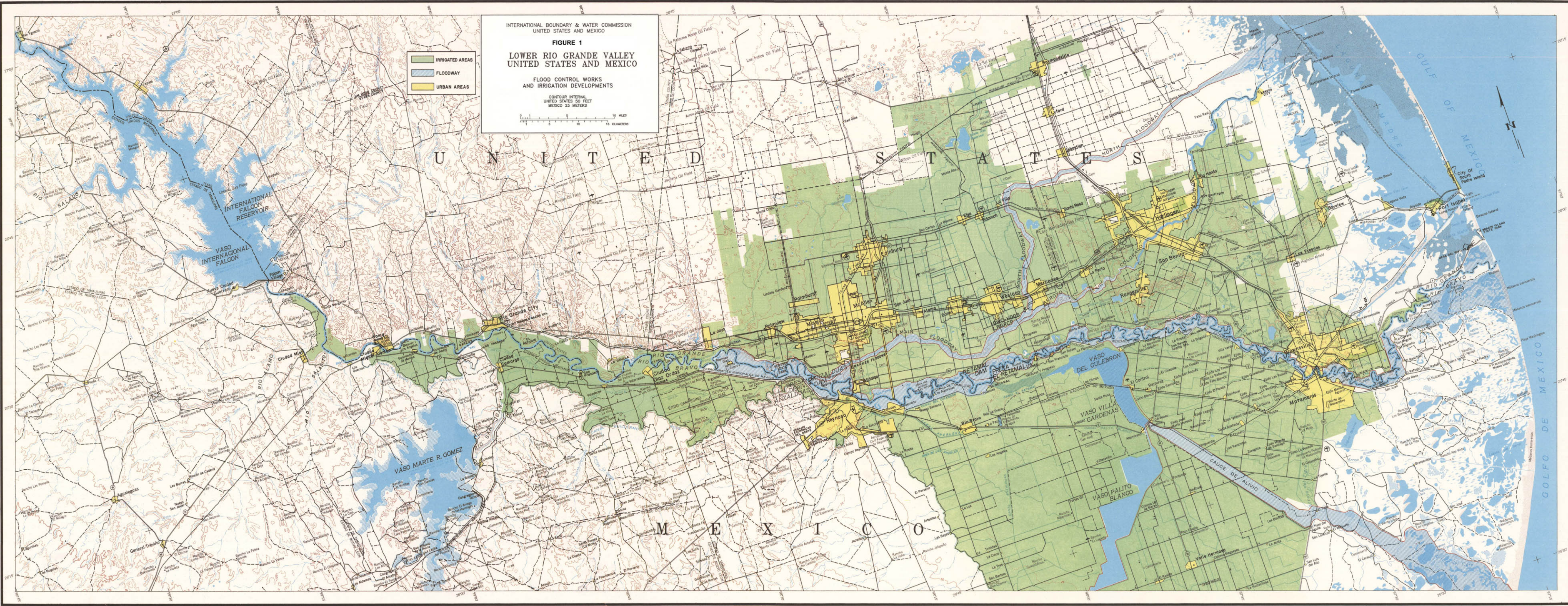
A map of the LRGFC including the features described above and other upstream features is shown in Figure 1.

2. DISTRIBUTION OF DESIGN FLOOD FLOW

As mentioned previously, in Minute No. 238, the IBWC adopted a design flood of 250,000 cfs (7,080 cms) at Rio Grande City. This design flood was used as the basis for design of the proposed improvements and is the basis for operation of the flood control works in accordance with the distribution of flows agreed in Minute No. 238 by the Governments of the United States and Mexico, and which is as follows:

\$	Rio Grande at Rio Grande City	250,000 cfs	7,080 cms
\$	Reduction of flow due to channel storage between Rio Grande City and Peñitas	15,000 cfs	430 cms
\$	Rio Grande at Peñitas	235,000 cfs	6,650 cms
\$	Diversion to the Main Floodway in the United States	105,000 cfs	2,970 cms
\$	Rio Grande at Hidalgo/Reynosa	130,000 cfs	3,680 cms
\$	Reduction of flow due to channel storage between Hidalgo/Reynosa and above Retamal Dam	5,000 cfs	140 cms
\$	Diversion to the Mexican Floodway	105,000 cfs	2,970 cms
\$	Rio Grande at Brownsville/Matamoros	20,000 cfs	570 cms

Details on operation of the off-river floodway system in each country are not part of Minute No. 238. In the United States, it is proposed that the flow of 105,000 cfs (2,970 cms) diverted into the Main Floodway be distributed as 84,000 cfs (2,380 cms) to the North Floodway and 21,000 cfs (590 cms) to the Arroyo Colorado.



INTERNATIONAL BOUNDARY & WATER COMMISSION
UNITED STATES AND MEXICO

FIGURE 1
LOWER RIO GRANDE VALLEY
UNITED STATES AND MEXICO

FLOOD CONTROL WORKS
AND IRRIGATION DEVELOPMENTS

CONTOUR INTERVAL
UNITED STATES 50 FEET
MEXICO 25 METERS

0 5 10 15 MILES
0 5 10 15 KILOMETERS

- IRRIGATED AREAS
- FLOODWAY
- URBAN AREAS

D. OVERVIEW OF THE 1992 HYDRAULIC MODEL

1. EVENTS LEADING TO THE STUDY

During September and October 1958, flood flows occurred in the LRGFCP with a peak discharge of 104,000 cfs (2,945 cms) at Rio Grande City that caused extensive damage to farming areas in the Lower Rio Grande Valley. It became obvious that the flood conveyance capacity of the LRGFCP had been reduced and was inadequate. It was determined that the reduction in capacity was mainly due to the growth of vegetation in the channel and floodplain. Also, review of channel configurations indicated that their geometry had been changed resulting in reduced conveyance capacity.

To restore the conveyance capacity of the LRGFCP, the Governments of the United States and Mexico agreed in Minute No. 212, signed in December 1961, to a vegetation clearing program in both countries. The agreement was to clear vegetation from the edge of the water to the top of the channel bank or to a point 330 feet (100 meters) from the edge of the water, whichever was the shorter distance. This clearing would extend along the banks of the Rio Grande channel from Anzalduas Dam to below Brownsville/Matamoros. Clearing work as agreed in Minute No. 212 was started in 1962 and completed before the 1967 flood season. Later, the vegetation management practice in the United States was changed to clearing vegetation from selected banks in a 34.5 mile (55.5 kilometer) reach from upstream of Brownsville to downstream of this area.

In November 1989, the U.S. Section of the IBWC (USIBWC) was sued in connection with its vegetation management practices, in a civil action in which the plaintiffs alleged violations by USIBWC of the Endangered Species Act and the National Environmental Policy Act. As a result of this action, the Court issued a Consent Decree requiring USIBWC to enter into formal consultation with the U.S. Fish and Wildlife Service (USFWS). The Consent Decree also required USIBWC to prepare an Environmental Impact Statement (EIS) that would specifically address vegetation maintenance practices in the LRGFCP.

In late 1990 USIBWC initiated the Section 7 consultation process, whereby USIBWC was directed to prepare a Biological Assessment for vegetation clearing activities. In early 1993, USIBWC submitted the Biological Assessment to USFWS, and discussions between the two agencies followed to agree on a vegetation management plan. In mid-1993, USFWS issued a Biological Opinion that called for the creation of a 33 ft. (10 meters) wide, heavily vegetated wildlife travel corridor, adjacent to a 75 ft. (23 meters) strip of land in which USIBWC would be

allowed to mow, and which would be next to the water edge, in the reach of the Rio Grande from River Mile 28 to River Mile 62.5. It was in connection with the determination of the effects of this vegetation management plan on flood flows that the 1992 study was prepared.

2. DESCRIPTION OF THE 1992 MODEL

The 1992 hydraulic modeling study of flood flows in the LRGFCP was prepared with the Hydrologic Engineering Center HEC-2 software. The study contains two models, both for the same design flood of 250,000 cfs (7,080 cms) at Rio Grande City and with identical geometrical data, but with different roughness coefficients in areas where vegetation management would be different. One model is based on vegetation existing in 1988, and calibrated to the Hurricane Gilbert flows in the Rio Grande. The second model is based on a full growth vegetation condition, i.e., including full vegetation in a 33 ft. (10 meters) wildlife travel corridor, as indicated in the USFWS Biological Opinion.

3. CONCLUSIONS FROM THE 1992 MODEL

The general conclusion reached from the 1992 modeling study was that the LRGFCP is not capable of providing adequate design flood protection. It is noted here, in order to give a more complete sense of this conclusion, that approximately 70% of the length of the United States river levee provides adequate design flood protection against levee overtopping, in that there is no encroachment of the 3 ft. (0.9 meters) freeboard.

Other conclusions reached from the 1992 model are:

- \$ The United States river levee will be overtopped at spot locations from just upstream of Hidalgo/Reynosa Bridge # 1 to downstream of the Santa Ana Refuge.
- \$ About 30 noncontiguous miles (48 kilometers) of the United States levee have less than the recommended 3 ft. (0.9 meters) of freeboard.
- \$ The river levee in Mexico is overtopped in at least 35 noncontiguous miles (56 kilometers), including reaches in areas adjacent to Reynosa and Matamoros.

E. THE 2003 HYDRAULIC MODEL

1. BACKGROUND

As stated previously, the Consent Decree issued pursuant to the 1989 civil action suit against USIBWC stipulated that the USIBWC should prepare an EIS specifically addressing its vegetation maintenance activities in the LRGFCP. To this end, the USIBWC entered into an agreement with the U.S. Army Corps of Engineers (USACOE) for them to prepare the required EIS. At present, a draft EIS has been delivered to and reviewed by the USIBWC. Preparation of the final EIS is awaiting resolution of various issues.

As part of the studies needed for the EIS, a hydraulic modeling study was conducted in which several alternatives were considered for vegetation management. A HEC-2 model of the Rio Grande within the LRGFCP was run for each of the alternatives, with cross section geometry and flows being identical for all the alternatives. Cross section geometry data were taken from the 1992 model, except in a reach 10.2 miles (16.4 kilometers) long in the Brownsville/Matamoros area where the United States and Mexico agreed to move the levees in and establish a Restricted Use Zone (RUZ) for the floodplains on both sides of the Rio Grande. Also, the Los Tomates and Pharr bridges, which had not been built at the time the 1992 model study was conducted, were added. Roughness coefficient values in each alternative were assigned in accordance with the current or planned vegetation management scheme, as applicable. For alternatives that involved current vegetation conditions, aerial photography of the LRGFCP taken in 1996 and 1999 was used to assess vegetation density and height.

A Hydraulic Modeling Report was delivered by USACOE to USIBWC in October 2001 containing descriptions of the various alternatives and results of the modeling study. The different alternatives were assessed in terms of the effects of the vegetation maintenance scheme on water surface elevations. Water surface profiles were compared to top of levee profiles to assess the severity of overtopping in terms of length of levee overtopped and average height of overtopping.

2. DESCRIPTION OF THE 2003 MODEL

The 2003 LRGFCP hydraulic model is based on the geometrical cross section data used in the 1992 model for the channel of the Rio Grande and the floodways in the United States. The Rio Grande data are modified from the 1992 model for the RUZ and additional bridges described earlier, and to include data for 24 additional new cross sections that were recently surveyed. The

locations of the cross sections from the 1992 model and the new cross sections for the Rio Grande, the Main and North Floodways and the Arroyo Colorado are shown in Appendix A, Appendix B and Appendix C, respectively. For the Rio Grande component, the 2003 model uses roughness coefficient values as determined for the EIS Hydraulic Modeling Report alternative referred to as the Current Maintenance - A model alternative. This is a model with roughness coefficient values determined from presently existing vegetation, and a plan to control vegetation growth in areas of the floodplain outside of the wildlife travel corridor. As mentioned earlier, aerial photography taken in 1996 and 1999 was used to assess existing vegetation conditions. For the off-river floodways in the United States, roughness coefficient values are identical to those in the 1992 model. Geometrical data for all cross sections, roughness coefficient values, and geometrical and modeling approach data for bridges and in-line weirs are given in the appendices.

Flood flows in the 2003 model for all components of the project are as per the IBWC Minute No. 238 agreed flow distribution. The actual flow distribution of flows may be affected by existing friction and structural controls, as well as by any future changes in these. Determination of any deviations from the Minute No. 238 flow distribution and any proposed improvements that would minimize these deviations are not within the scope of the present study.

The 2003 model was prepared using the recent Hydrologic Engineering Center HEC-RAS software, version 3.0. Since the model for the Current Maintenance - A alternative is in HEC-2, it was necessary to go through a data conversion process, which is performed within the HEC-RAS program. Bridge data needed to be manually input to be properly interpreted in the HEC-RAS format. Also, Anzalduas Dam and Retamal Dam were manually converted from the bridge designation in HEC-2 to an in-line weir designation in HEC-RAS. For the off-river floodways, the data were converted directly from the 1992 model to the HEC-RAS format. For these components, it was also necessary to edit the bridge data manually for proper inclusion in the HEC-RAS model.

3. MODEL RUNS

The present modeling consisted of one model run for each of the LRGFCP components, i.e., the Rio Grande, the Main and North Floodways as one continuous conveyance, and the Arroyo Colorado as a branch of the Main Floodway. The vegetation condition in all components is as presently existing, with additional vegetation growth expected only in the wildlife travel corridor between River Mile 28 and River Mile 62.5 of the Rio Grande. As mentioned previously, the flows used for each component are as specified in IBWC Minute No. 238.

4. RESULTS

Results found from the HEC-RAS model runs are shown in Table 1 for the Rio Grande, Table 2 for the Main and North Floodways, and Table 3 for the Arroyo Colorado. The water surface elevation profiles are graphically shown and compared to the top of levee or high bank profiles in Figure 2 for the Rio Grande, Figure 3 for the Main and North Floodways, and Figure 4 for the Arroyo Colorado. From the graphical presentations, it can be established that the water surface profiles overtop the levee or high bank profiles of all three components at various points along each profile.

For a better graphical depiction of levee overtopping or encroachment on freeboard in the Rio Grande and the floodways, the difference between the top of levee elevation or high bank elevation and the water surface elevation was calculated at each cross section and plotted as (Levee or High Bank Elevation - Water Surface Elevation) vs. channel distance. The plots are shown in Figure 5 for the Rio Grande, Figure 6 for the Main and North Floodways, and Figure 7 for the Arroyo Colorado. It can be readily determined that any point that plots below the 0 line indicates a point of levee or high bank overtopping, and any point that plots below the +3 ft. (+0.9 meters) line in the Rio Grande graph and the +2ft. line in the Main and North Floodways graph indicates a point of encroachment of the proposed 3 ft. (0.9 meters) freeboard for the Rio Grande and 2 ft. freeboard for the floodways.

A comparison was also made between the resulting water surface profile from the HEC-RAS 2003 model and the profiles from the HEC-2 1992 models with 1988 vegetation and with vegetation at mature growth in the full length of the project. Graphical results are presented as water surface profiles from each model in Figure 8. It may be seen that in the lower reach of the Rio Grande between River Mile 28 and River Mile 62.5 the 1992 model with vegetation at mature growth yields higher water surface elevations than the 2003 model. This is attributable to the present condition of vegetation in this reach, as considered in the 2003 model, which is not at mature growth. Upstream of River Mile 62.5, the differences in these two profiles become smaller, since present vegetation is mostly near mature growth. The profile for the 1992 model with 1988 vegetation is between one and two feet lower than the 2003 model profile, except for a reach between River Miles 48 and 62. Also, differences in water surface elevations are introduced at the Retamal and Anzalduas dams. These result from the improved weir modeling techniques available in the HEC-RAS software.

5. CONCLUSIONS

From a point of view of flood risk generated from encroachment on the recommended 3ft. (0.9 meters) levee freeboard in the Rio Grande, it is concluded that in general the LRGFCP does not provide adequate flood risk protection along its full length for the 100-year flood of 250,000 cfs (7,080 cms) at Rio Grande City. Close examination of the results presented as noted above indicates the following:

- \$ In the Rio Grande, the United States levee would be overtopped along 38 river miles (61 river kilometers). This overtopping would occur in about two thirds of the levee length upstream of Anzalduas Dam, and in most of the length downstream of Anzalduas Dam to the Santa Ana National Wildlife Refuge.
- \$ In the Rio Grande, the United States levee would be subject to encroachment of the proposed 3 ft. (0.9 meters) freeboard along 64 river miles (103 river kilometers). This encroachment would occur mostly between Peñitas and the Santa Ana National Wildlife Refuge, about 6 miles (10 kilometers) between the Los Indios Bridge and above Brownsville, and 2 miles (3 kilometers) of the Amigoland levee in Brownsville.
- \$ In the Rio Grande, the Mexican levee would be overtopped along 57 river miles (92 river kilometers). The overtopping would occur along 38 river miles (61 river kilometers) between Peñitas and Retamal Dam and 19 river miles (31 river kilometers) between the Los Indios Bridge and above Matamoros.
- \$ In the Rio Grande, the Mexican levee would be subject to encroachment of a 3 ft. (0.9 meters) freeboard along 110 river miles (177 river kilometers). This encroachment would occur from Peñitas to below Retamal Dam, except for short distances in between, and from above Los Indios Bridge to Matamoros.
- \$ In the Main and North Floodways, the left levee would be overtopped along 1 mile (1.6 kilometers), and encroachment on the 2 ft. (0.6 meters) freeboard would occur along 10 miles (16 kilometers).
- \$ In the Main and North Floodways, the right levee would be overtopped along 1 mile (1.6 kilometers), and encroachment on the 2 ft. (0.6 meters) freeboard would occur along 14 miles (23 kilometers).

From examination of the Rio Grande profile and the Main Floodway profile in the vicinity of the Banker Weir, it is also concluded that under the design flood, the diversion into the Main Floodway will be more than the 105,000 cfs (2,970 cms) stipulated in IBWC Minute No. 238. Improvements that may be proposed to control the amount of flow into the Main Floodway would require further study.

For flows into the Mexican Floodway, study of the water surface profile along the floodway resulting from a diversion of 105,000 cfs (2,970 cms) would be required before a conclusion can be reached on whether or not this would be the actual diverted flow under the design flood.

TABLE 1
HYDRAULIC MODEL RUN RESULTS FOR
RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
186	235000	86.30	134.37			0.000061	4.42	176597	10519	0.13
184	235000	87.00	133.87			0.000115	5.78	141934	10727	0.17
182.4	235000	79.50	133.04		133.18	0.000061	5.72	206859	15361	0.16
180.3	235000	87.40	131.95		132.28	0.000112	7.37	144918	9709	0.21
178.5	235000	87.00	130.71		131.04	0.000122	7.43	157801	11045	0.22
176.8	235000	89.20	129.39		129.90	0.000184	8.12	138303	8702	0.25
174.6	235000	86.50	128.00		(ft)	0.000098	8.55	162410	10078	0.25
171.8	235000	75.60	126.92		134.47	0.000142	6.09	118054	8410	0.18
170.5	235000	74.60	123.32		134.04	0.000436	15.24	70671	4870	0.47
170.02	235000	90.00	121.71		124.45	0.000277	15.62	74840	4865	0.49
169.83	130000	90.00	122.40		123.78	0.000174	11.15	68748	4500	0.35
169.14	130000	85.00	122.51	97.41	123.19	0.000042	6.61	19751	624	0.19
169.13	Inline Weir									
169.12	130000	72.50	122.51		122.89	0.000017	4.96	26193	524	0.12
169.1	130000	84.00	122.42		122.87	0.000027	5.41	24026	659	0.16
168.85	130000	72.00	122.24		122.80	0.000360	6.11	25423	1070	0.17
168.3	130000	75.70	121.01		121.36	0.000613	5.22	41066	2238	0.16
167.4	130000	74.50	119.19		119.45	0.000169	5.12	85618	8740	0.15
166.6	130000	71.70	118.81		118.90	0.000073	3.97	163080	12700	0.11
161.4	130000	70.50	117.49		117.59	0.000093	3.74	150236	14947	0.11
157.15	130000	70.00	113.49		114.20	0.000230	7.53	36055	2402	0.22
156.93	125000	57.50	112.90	81.16	113.75	0.000180	7.51	19299	541	0.19
156.915	Bridge									
156.9	125000	57.50	112.40		113.22	0.000179	7.43	19029	541	0.19
156.87	125000	61.40	112.44	80.46	113.13	0.000083	7.01	24704	820	0.18
156.855	Bridge									
156.84	125000	61.40	112.34		113.07	0.000088	7.17	24621	820	0.18
156.6	125000	61.30	112.25		112.91	0.000194	7.15	28470	2183	0.19
155.7	125000	69.00	111.88		112.04	0.000152	4.58	75870	7548	0.14
155.01	125000	67.30	110.96		111.17	0.000442	4.75	52391	4518	0.16
154.6	125000	56.00	109.52		110.07	0.000376	6.15	27510	1354	0.18
153.85	125000	66.80	107.96		108.52	0.000608	6.96	35912	3718	0.23
153.36	125000	67.30	107.40		107.51	0.000172	4.01	102662	14344	0.13

RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
152.53	125000	67.00	106.70		106.76	0.000171	125000	67.00	106.70	
151.7	125000	65.40	106.01		106.07	0.000134	3.26	123108	14131	0.11
151.27	125000	66.24	105.76	90.14	105.79	0.000061	2.33	136258	14891	0.08
151.255	Bridge									
151.25	125000	66.24	105.75		105.78	0.000057	2.25	136118	14891	0.08
151.24	125000	66.24	105.75		105.78	0.000061	2.33	136072	14891	0.08
150.31	125000	65.00	105.32		105.37	0.000146	3.14	130193	17215	0.11
147.68	125000	60.40	104.45		104.49	0.000142	2.39	135289	15507	0.09
145	125000	61.20	102.81		102.86	0.000088	3.14	148495	14110	0.10
144.55	125000	59.00	102.62		102.66	0.000088	2.95	146419	14238	0.09
142.5	125000	57.30	101.33		101.43	0.000178	4.28	143818	13900	0.14
140.74	125000	58.10	100.06		100.10	0.000068	3.15	143291	13786	0.10
139.85	125000	60.00	99.34		99.53	0.000152	5.24	96286	11871	0.16
139.01	125000	59.80	98.83		98.90	0.000119	3.36	93649	10391	0.11
137.71	125000	57.00	98.04		98.09	0.000124	2.99	101177	10188	0.10
135	125000	58.30	96.23		96.30	0.000113	3.70	103660	10240	0.12
132.75	125000	53.90	94.28		94.56	0.000185	6.50	88900	8687	0.20
131.35	125000	55.60	92.88		93.01	0.000211	4.81	86016	8598	0.15
130.51	125000	55.50	91.70		92.01	0.000243	6.27	51218	4416	0.20
129.3	20000	55.50	91.65		91.66	0.000008	1.02	44678	4170	0.03
129.23	20000	55.50	91.55		91.62	0.000039	2.20	9118	309	0.07
129.22	20000	55.50	91.55		91.62	0.000039	2.20	9117	309	0.07
129.216	20000	56.00	90.84	68.27	91.55	0.000096	6.86	3083	162	0.20
129.215	Inline Weir									
129.214	20000	56.00	84.12		85.29	0.000180	8.67	2306	82	0.29
129.213	20000	56.00	82.81		85.06	0.001012	12.03	1662	62	0.41
129.212	20000	56.00	82.78		85.03	0.001015	12.05	1660	62	0.41
129.211	20000	56.00	83.83		83.97	0.000016	3.05	6556	299	0.11
129.21	20000	56.00	83.84		83.95	0.000013	2.73	7338	327	0.10
129.2	20000	55.40	83.83		83.94	0.000175	2.67	8269	776	0.11
129.03	20000	54.20	83.63		83.72	0.000196	2.54	8534	1400	0.11
127.7	20000	50.30	82.67		82.71	0.000093	1.84	23139	6875	0.08
126.7	20000	51.30	82.06		82.14	0.000183	2.59	21128	9461	0.11
125	20000	50.60	80.86		80.97	0.000102	2.86	15509	5309	0.10
123.8	20000	50.10	79.89		79.99	0.000132	2.65	11641	2551	0.10

RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
122.5	20000	52.30	79.06		79.20	0.000100	3.05	7778	577	0.11
121.46	20000	45.80	78.66		78.81	0.000117	3.38	9381	1062	0.12
120.7	20000	51.20	78.23		78.34	0.000129	2.67	8691	844	0.11
120.62	20000	46.90	78.14	58.49	78.27	0.000151	2.91	7432	615	0.11
120.605	Bridge									
120.59	20000	46.90	78.13		78.26	0.000151	2.91	7427	615	0.11
120.5	20000	50.20	78.07		78.17	0.000096	2.61	10958	1286	0.10
120.38	20000	52.00	77.75		77.81	0.000081	2.33	23457	3648	0.09
117.87	20000	49.70	76.61		76.71	0.000114	2.87	21571	5098	0.11
117.2	20000	47.20	76.10		76.24	0.000141	3.09	12093	3842	0.12
116.5	20000	47.90	75.73		75.91	0.000113	3.42	8744	1576	0.13
116.1	20000	46.20	75.49		75.62	0.000124	2.97	7602	478	0.12
115.7	20000	48.50	75.24		75.39	0.000111	3.23	8022	1346	0.12
115	20000	36.50	74.73		74.88	0.000162	3.24	8864	1477	0.12
114.8	20000	47.30	74.47		74.63	0.000121	3.34	9649	1578	0.13
114.65	20000	42.90	74.44		74.53	0.000107	2.53	12265	2287	0.10
114.1	20000	42.40	73.85		73.92	0.000185	2.28	19451	9145	0.10
112.2	20000	41.20	72.40		72.51	0.000119	2.96	18765	6639	0.11
111.5	20000	37.90	71.77		71.95	0.000165	3.49	7810	1733	0.13
110.7	20000	43.10	71.12		71.30	0.000151	3.47	7991	3006	0.13
109.5	20000	41.10	70.43		70.54	0.000097	2.76	10359	3034	0.10
109.2	20000	40.10	70.22		70.32	0.000192	2.62	10617	2871	0.11
109.1	20000	37.00	70.17		70.23	0.000099	2.40	16938	3357	0.09
108.5	20000	39.30	69.86		69.94	0.000115	2.59	18478	6296	0.10
107.6	20000	38.00	69.09		69.15	0.000149	2.23	21388	7941	0.09
106.4	20000	35.40	68.19		68.26	0.000181	2.45	18722	7953	0.10
105.3	20000	24.90	67.10		67.26	0.000165	3.39	8064	999	0.12
103.1	20000	36.50	65.86		65.92	0.000089	2.39	29499	9322	0.09
100.1	20000	36.80	64.40		64.52	0.000108	3.11	17552	7629	0.12
99.51	20000	36.00	64.05		64.14	0.000130	2.82	15639	4327	0.11
99.4	20000	31.20	63.98		64.03	0.000090	1.93	17229	3940	0.07
97.5	20000	26.40	62.74		62.86	0.000201	2.97	10169	4290	0.11
96.82	20000	31.07	62.19	41.44	62.24	0.000155	2.11	19632	5959	0.09
96.805	Bridge									
96.80	20000	31.07	62.09		62.14	0.000163	2.16	19013	5932	0.09

RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
94.05	20000	28.00	61.58		61.66	0.000137	2.67	16869	4358	0.10
93.81	20000	28.30	61.34		61.44	0.000208	2.72	14210	4600	0.11
93.8	20000	33.81	61.26		61.40	0.000263	3.31	11300	4106	0.13
93.5	20000	27.10	60.94		61.05	0.000192	2.98	13742	4270	0.11
90.5	20000	27.40	58.60		58.70	0.000130	2.93	24623	7241	0.10
87.7	20000	20.90	57.55		57.58	0.000048	1.77	31198	7981	0.06
86.6	20000	22.90	57.23		57.25	0.000121	1.47	28086	7041	0.07
84	20000	21.50	55.68		55.77	0.000181	2.86	18968	7029	0.11
82	20000	15.40	54.41		54.44	0.000085	1.74	27376	8725	0.07
81.5	20000	22.80	54.23		54.28	0.000078	2.26	27050	8602	0.08
79.8	20000	21.30	53.42		53.46	0.000117	2.09	22079	6273	0.09
78.5	20000	15.90	52.63		52.67	0.000151	2.03	20964	6880	0.09
74.5	20000	17.10	50.84		50.88	0.000067	2.06	26323	6180	0.07
73.8	20000	15.00	50.33		50.50	0.000226	3.50	8651	1933	0.13
72.9	20000	14.50	49.67		49.71	0.000124	1.83	21624	5790	0.08
72.2	20000	11.10	49.08		49.21	0.000150	3.34	13038	3727	0.12
70.7	20000	16.00	48.13		48.21	0.000094	2.74	13534	1962	0.10
70.5	20000	12.70	47.97		48.09	0.000157	3.22	12062	2320	0.12
70.2	20000	15.80	47.81		47.89	0.000101	2.84	18317	4390	0.10
67.4	20000	16.20	45.32		45.46	0.000226	3.11	7790	6659	0.13
67.25	20000	13.50	45.07		45.30	0.000188	3.95	6485	6939	0.14
64.7	20000	12.00	43.51		43.62	0.000122	3.11	16450	5891	0.11
63.8	20000	8.20	43.17		43.22	0.000075	2.40	23764	4195	0.09
62.5	20000	10.60	42.59		42.76	0.000078	3.57	10956	3009	0.13
61.3	20000	3.40	42.01		42.09	0.000187	2.39	15814	4190	0.10
59.9	20000	9.50	40.91		41.09	0.000094	3.58	9243	2741	0.13
59	20000	4.50	40.52		40.65	0.000076	3.38	14760	3863	0.12
58.8	20000	7.00	40.48		40.56	0.000052	2.65	17709	3543	0.10
58.3	20000	6.00	40.19		40.36	0.000112	3.30	6369	406	0.13
57.7	20000	3.10	39.96		40.09	0.000065	3.10	10272	1516	0.11
56.9	20000	7.90	39.64		39.75	0.000106	2.83	10849	1542	0.12
56.7	20000	6.20	39.33		39.48	0.000175	3.15	6353	431	0.14
56.1	20000	10.00	38.59		38.79	0.000336	3.53	5668	441	0.17
55.5	20000	1.30	37.58		37.90	0.000264	4.52	4429	244	0.19
55.25	20000	3.30	37.30		37.54	0.000143	4.08	5637	446	0.15

RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
55.23	20000	0.20	37.32	15.07	37.50	0.000104	3.49	6340	430	0.13
55.215	Bridge									
55.21	20000	0.20	37.26		37.44	0.000105	3.50	6314	426	0.13
55.2	20000	0.20	37.25		37.44	0.000105	3.50	6313	426	0.13
54.5	20000	-1.10	36.99		37.10	0.000074	3.21	9038	720	0.11
54.49	20000	5.30	36.89	18.98	37.09	0.000108	3.85	6616	486	0.14
54.475	Bridge									
54.47	20000	5.30	36.85		37.05	0.000108	3.86	6595	486	0.14
54.46	20000	5.30	36.84		37.04	0.000109	3.86	6590	485	0.14
54.45	20000	1.00	36.83	17.18	37.04	0.000097	3.86	6169	366	0.14
54.435	Bridge									
54.43	20000	1.00	36.77		36.98	0.000098	3.87	6148	366	0.14
54.42	20000	1.00	36.77		36.98	0.000098	3.88	6146	366	0.14
54.4	20000	0.00	36.75		36.95	0.000122	3.65	5955	394	0.14
54	20000	4.30	36.41		36.65	0.000106	4.19	6309	679	0.14
52.4	20000	-0.40	35.69		35.81	0.000092	3.11	11290	1520	0.12
51.6	20000	5.00	35.16		35.32	0.000140	3.42	10465	2573	0.14
51.42	20000	5.24	35.14	14.14	35.17	0.000037	1.70	20997	3930	0.07
51.405	Bridge									
51.40	20000	5.24	35.13		35.16	0.000037	1.70	20955	3929	0.07
50.8	20000	2.30	34.94		34.99	0.000091	2.22	18756	4998	0.10
49.6	20000	-1.60	34.52		34.59	0.000068	2.38	19288	5458	0.10
48.4	20000	1.00	33.89		34.00	0.000112	2.91	13509	3663	0.12
47.9	20000	5.60	33.66		33.81	0.000112	3.23	10019	2309	0.13
47.8	20000	9.40	33.62		33.78	0.000171	3.37	9485	2300	0.15
47.7	20000	0.10	33.52		33.67	0.000127	3.22	9754	2295	0.13
47.4	20000	-3.30	33.19		33.28	0.000058	2.42	13036	3360	0.11
46.8	20000	-2.80	32.94		33.04	0.000127	2.73	11957	3327	0.12
46.4	20000	-0.80	32.44		32.60	0.000211	3.33	8412	2293	0.15
45	20000	-9.80	31.55		31.65	0.000092	2.53	8935	2464	0.11
44	20000	-3.70	30.87		31.07	0.000154	3.73	9885	5451	0.15
42.4	20000	-4.00	29.42		29.65	0.000183	3.92	5526	1066	0.16
40.3	20000	-5.90	27.53		27.64	0.000187	2.84	12411	8246	0.12
38.9	20000	-7.80	26.51		26.64	0.000097	3.07	7994	674	0.12
36.3	20000	-6.80	24.98		25.20	0.000113	3.87	5976	566	0.15

RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)		(ft/ft)	(ft/s)	(sq ft)	(ft)	
34	20000	-7.80	23.19		23.39	0.000209	3.58	5590	386	0.17
31.2	20000	-8.60	20.59		20.91	0.000144	4.65	4782	397	0.18
28	20000	-6.30	18.09	3.36	18.46	0.000150	4.90	4274	288	0.20

TABLE 2
HYDRAULIC MODEL RUN RESULTS FOR
MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
139.03	105000	100.00	119.21	108.22	119.91	0.000686	6.72	15627	852	0.28
139.015	Inline Weir									
139	105000	100.00	118.69		119.44	0.000752	6.91	15186	850	0.29
138	105000	100.10	118.58	108.63	119.26	0.000801	6.63	15849	996	0.29
137	105000	99.90	118.33		118.94	0.000708	6.25	16791	1051	0.28
136	105000	100.00	118.02		118.52	0.000580	5.70	18415	1140	0.25
135	105000	100.30	117.39		117.92	0.000635	5.82	18036	1158	0.26
134	105000	99.70	116.81		117.30	0.000594	5.64	18630	1196	0.25
133	105000	99.40	116.25		116.70	0.000577	5.44	19308	1279	0.25
132	105000	98.30	113.83		114.25	0.000564	5.17	20327	1430	0.24
131	105000	98.00	113.37		113.83	0.000620	5.40	19432	1372	0.25
130	105000	92.50	113.02	104.32	113.29	0.000389	4.86	25595	1937	0.20
129	105000	91.00	112.78	102.73	112.89	0.000161	3.02	39682	2974	0.13
128	105000	90.00	112.41		112.60	0.000317	4.26	30861	2691	0.18
127	105000	91.40	111.97	103.10	112.17	0.000287	3.99	30005	2308	0.17
126	105000	86.80	111.44	99.95	111.57	0.000146	3.14	36800	2329	0.13
125	105000	85.50	111.00	96.37	111.10	0.000100	2.67	41761	2431	0.10
124	105000	89.50	110.43		110.70	0.000342	5.08	26045	1908	0.20
123.03	105000	85.80	109.85		110.26	0.000825	6.93	20824	2065	0.29
123.02	105000	85.80	109.84	103.66	110.26	0.000923	5.63	20374	2065	0.20
123.015	Bridge									
123.01	105000	85.80	109.77		110.19	0.000945	5.69	20213	2061	0.21
123	105000	85.80	109.76		110.18	0.000846	7.00	20647	2061	0.30
122.03	105000	85.90	109.83	101.24	110.07	0.000323	5.00	27537	2046	0.19
122.02	105000	85.90	109.83	101.22	110.07	0.000323	5.00	27536	2046	0.19
122.015	Bridge									
122.01	105000	85.90	109.77		110.00	0.000328	5.03	27403	2045	0.19
122	105000	85.90	109.77	101.24	110.00	0.000329	5.03	27400	2045	0.19
121	105000	84.50	109.09		109.35	0.000372	5.35	26227	2018	0.20
120.03	105000	81.80	108.01		108.27	0.000342	5.36	26442	1930	0.20
120.02	105000	81.80	108.01	99.53	108.27	0.000342	5.36	26441	1930	0.20
120.015	Bridge									
120.01	105000	81.80	107.96	99.53	108.22	0.000346	5.38	26346	1930	0.20
120	105000	81.80	107.96		108.22	0.000347	5.38	26343	1930	0.20

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
119	105000	82.40	107.05	97.21	107.26	0.000270	4.38	28854	1993	0.17
118.03	105000	83.90	106.98	97.53	107.20	0.000318	4.43	27694	2021	0.16
118.02	105000	83.90	106.97	97.53	107.20	0.000318	4.43	27684	2021	0.16
118.015	Bridge									
118.01	105000	83.90	106.97	97.53	107.20	0.000318	4.44	27674	2021	0.16
118	105000	83.90	106.97	97.53	107.20	0.000318	4.44	27674	2021	0.16
117.03	105000	83.00	105.89	97.86	106.18	0.000480	5.23	24357	1990	0.19
117.02	105000	83.00	105.89	97.86	106.18	0.000481	5.24	24349	1990	0.19
117.015	Bridge									
117.01	105000	83.00	105.85	97.86	106.15	0.000484	5.25	24285	1989	0.19
117	105000	83.00	105.85	97.86	106.15	0.000484	5.25	24285	1989	0.19
116.03	105000	69.90	104.10		104.60	0.000565	7.71	22102	2072	0.26
116.02	105000	69.90	104.10	97.82	104.60	0.000565	7.71	22101	2072	0.26
116.015	Bridge									
116.01	105000	69.90	104.00		104.51	0.000580	7.79	21893	2068	0.27
116	105000	69.90	104.00		104.51	0.000580	7.79	21893	2068	0.27
115.03	105000	75.70	102.11		102.42	0.000554	5.79	24729	2377	0.24
115.02	105000	75.70	102.11	96.11	102.42	0.000554	5.79	24728	2377	0.24
115.015	Bridge									
115.01	105000	75.70	102.08		102.39	0.000559	5.81	24655	2376	0.24
115	105000	75.70	102.08		102.38	0.000560	5.82	24647	2376	0.24
114	105000	66.70	101.16		101.57	0.000450	6.58	23957	2130	0.23
113.03	105000	68.40	100.23		100.48	0.000475	5.94	27716	2820	0.22
113.02	105000	68.40	100.23	93.54	100.48	0.000475	5.94	27711	2820	0.22
113.015	Bridge									
113.01	105000	68.40	100.19		100.44	0.000480	5.97	27608	2816	0.22
113	105000	68.40	100.19		100.44	0.000480	5.97	27606	2816	0.22
112	105000	68.90	100.03	92.70	100.14	0.000176	3.54	41883	3779	0.14
111	105000	69.40	99.03		99.21	0.000332	5.00	32338	3182	0.19
110	105000	69.80	97.99	92.20	98.06	0.000132	3.23	48443	4339	0.12
109.03	105000	68.40	97.42		97.56	0.000249	4.57	37291	3673	0.17
109.02	105000	68.40	97.42	90.93	97.56	0.000249	4.57	37291	3673	0.17
109.015	Bridge									
109.01	105000	68.40	97.40	90.90	97.54	0.000251	4.58	37221	3672	0.17
109	105000	68.40	97.40	90.90	97.54	0.000251	4.58	37217	3672	0.17
108.03	105000	66.40	96.75	88.33	96.81	0.000109	2.29	55093	5076	0.10

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
108.02	105000	66.40	96.75	88.38	96.81	0.000109	2.29	55092	5076	0.10
108.015	Bridge									
108.01	105000	66.40	96.75	88.34	96.81	0.000109	2.29	55087	5076	0.10
108	105000	66.40	96.75	88.35	96.81	0.000109	2.29	55085	5076	0.10
107.03	105000	67.80	96.05	87.67	96.16	0.000185	3.77	40688	3574	0.14
107.02	105000	67.80	96.05	87.67	96.16	0.000185	3.77	40686	3574	0.14
107.015	Bridge									
107.01	105000	67.80	96.05	87.67	96.15	0.000185	3.77	40680	3573	0.14
107	105000	67.80	96.05	87.67	96.15	0.000185	3.77	40679	3573	0.14
106	105000	64.00	95.57		95.73	0.000220	4.21	33211	2438	0.16
105	105000	63.70	94.60		94.75	0.000214	4.53	35351	2802	0.15
104	105000	64.00	93.55	85.22	93.72	0.000247	4.65	32327	2505	0.17
103	105000	60.30	92.74		92.83	0.000133	3.58	44795	3545	0.12
102.03	105000	59.00	92.07		92.19	0.000182	4.08	38981	3195	0.14
102.02	105000	59.00	92.07	83.45	92.19	0.000182	4.08	38971	3194	0.14
102.015	Bridge									
102.01	105000	59.00	92.06		92.18	0.000183	4.09	38942	3194	0.14
102	105000	59.00	92.06		92.18	0.000183	4.09	38942	3194	0.14
101	105000	57.20	90.62	83.79	90.83	0.000322	5.89	30163	2601	0.19
100	105000	60.10	89.49		90.10	0.000894	9.46	17980	1559	0.32
99	105000	57.10	89.26	81.74	89.74	0.000571	6.71	20024	1469	0.26
98	105000	54.10	87.52		87.80	0.000432	5.59	25846	2198	0.21
97.03	105000	52.00	86.88		87.21	0.000541	6.69	24953	2476	0.24
97.02	105000	52.00	86.88	81.47	87.21	0.000541	6.69	24952	2476	0.24
97.015	Bridge									
97.01	105000	52.00	86.83		87.16	0.000550	6.73	24829	2474	0.25
97	105000	52.00	86.82		87.16	0.000550	6.73	24824	2474	0.25
96	105000	52.30	86.29		86.49	0.000339	4.81	30978	2888	0.19
95	105000	51.00	84.24		84.53	0.000460	5.83	27065	2781	0.23
94	105000	49.80	83.45		83.62	0.000355	4.80	34127	3913	0.20
93	105000	49.30	81.94		82.27	0.000735	6.76	27352	4245	0.28
92	105000	48.00	80.93	75.23	81.02	0.000178	3.53	47666	5338	0.14
91	105000	50.20	80.30	72.24	80.39	0.000150	3.14	46477	4348	0.13
90	105000	50.60	79.62		79.76	0.000156	3.85	37278	2597	0.14
89.03	105000	47.50	79.32	69.30	79.42	0.000119	3.23	43663	3151	0.12
89.015	Bridge									

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
89	105000	47.50	79.32		79.42	0.000119	3.23	43652	3151	0.12
88	105000	49.00	78.86	69.07	78.99	0.000170	3.56	40529	3706	0.14
87	105000	49.40	78.38		78.64	0.000299	4.70	28924	2522	0.19
86	105000	47.60	77.68		77.87	0.000182	4.19	35203	3194	0.15
85.03	105000	46.70	77.04		77.20	0.000140	4.29	34850	2522	0.15
85.02	105000	46.70	77.04	67.27	77.20	0.000140	4.29	34846	2522	0.15
85.015	Bridge									
85.01	105000	46.70	77.04		77.20	0.000141	4.30	34835	2522	0.15
85	84000	46.70	77.08		77.18	0.000089	3.42	34939	2523	0.12
84	84000	51.40	77.06	65.53	77.17	0.000087	3.34	33410	2154	0.12
83	84000	49.60	76.78		76.96	0.000116	3.86	26807	1639	0.14
82	84000	45.10	76.69	55.89	76.74	0.000028	2.08	57430	3928	0.07
81	84000	46.80	76.52		76.63	0.000073	3.33	34988	2260	0.11
80	84000	47.50	76.15	63.30	76.36	0.000147	4.60	24047	1463	0.16
79	84000	48.00	75.93	66.92	76.06	0.000111	3.83	32028	2415	0.13
78	84000	60.60	75.83	67.20	75.96	0.000167	3.34	29180	2441	0.15
77.03	84000	46.80	75.75	67.21	75.85	0.000106	3.75	34485	2739	0.13
77.02	84000	46.80	75.75	67.23	75.85	0.000106	3.75	34485	2739	0.13
77.015	Bridge									
77.01	84000	46.80	75.73	67.21	75.84	0.000106	3.75	34447	2739	0.13
77	84000	46.80	75.73	67.21	75.84	0.000106	3.75	34447	2739	0.13
76	84000	50.00	75.62	62.97	75.68	0.000055	2.60	42258	2676	0.09
75	84000	53.00	75.58	62.39	75.65	0.000061	2.42	40168	2543	0.10
74.03	84000	52.90	75.23	62.34	75.39	0.000139	3.82	25843	1565	0.15
74.015	Bridge									
74	84000	52.90	74.94		75.11	0.000147	3.90	25389	1563	0.15
73.03	84000	53.40	74.91	61.35	75.07	0.000118	3.50	26518	1474	0.13
73.015	Bridge									
73	84000	53.40	74.67		74.83	0.000123	3.55	26158	1471	0.14
72.03	84000	49.10	74.61		74.75	0.000106	3.64	28320	1606	0.13
72.02	84000	49.10	74.61	61.06	74.74	0.000106	3.64	28313	1606	0.13
72.015	Bridge									
72.01	84000	49.10	74.58		74.72	0.000107	3.64	28275	1606	0.13
72	84000	49.10	74.58		74.72	0.000107	3.64	28275	1606	0.13
71	84000	49.20	74.37	61.51	74.42	0.000048	2.24	46980	3148	0.09
70	84000	48.50	74.23	60.44	74.31	0.000065	2.59	38073	2323	0.10

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
69	84000	48.10	74.14		74.18	0.000029	1.86	55703	3468	0.07
68	84000	51.30	74.05		74.12	0.000057	2.52	38711	2226	0.09
67	84000	50.00	73.87		74.02	0.000094	3.28	27938	1468	0.12
66	84000	48.70	73.43	58.84	73.59	0.000125	3.75	28735	2184	0.14
65	84000	46.70	72.75		73.20	0.000273	5.40	15568	724	0.21
64	84000	46.70	72.78	58.25	72.90	0.000093	3.29	33997	2583	0.12
63	84000	52.00	72.78	60.56	72.86	0.000090	2.88	36697	2748	0.12
62.03	84000	50.30	72.47	63.88	72.57	0.000137	3.30	32855	2825	0.14
62.02	84000	50.30	72.47	63.90	72.57	0.000137	3.30	32842	2825	0.14
62.015	Bridge									
62.01	84000	50.30	72.46	63.88	72.56	0.000137	3.30	32827	2825	0.14
62	84000	50.30	72.46	63.85	72.56	0.000137	3.30	32826	2825	0.14
61	84000	50.00	71.99	60.47	72.18	0.000187	4.36	24006	1620	0.17
60	84000	48.80	71.17		71.33	0.000156	3.97	25653	1676	0.15
59.03	84000	47.50	69.97	62.32	70.23	0.000373	5.42	20717	1897	0.21
59.02	84000	47.50	69.97	62.35	70.23	0.000373	5.42	20716	1897	0.21
59.015	Bridge									
59.01	84000	47.50	69.97	62.32	70.23	0.000373	5.42	20711	1896	0.21
59	84000	47.50	69.97	62.32	70.23	0.000373	5.43	20709	1896	0.21
58	84000	46.80	69.67		69.79	0.000150	3.41	31014	2659	0.15
57	84000	44.60	68.84		69.06	0.000272	4.50	22508	1853	0.19
56	84000	45.60	67.53		67.80	0.000364	4.86	20710	1872	0.22
55.03	84000	44.20	67.23		67.33	0.000130	2.97	33595	2856	0.11
55.02	84000	44.20	67.23	58.49	67.33	0.000130	2.96	33597	2856	0.11
55.015	Bridge									
55.01	84000	44.20	67.23		67.33	0.000130	2.96	33594	2856	0.11
55	84000	44.20	67.23		67.33	0.000130	2.97	33589	2856	0.11
54	84000	43.90	66.67		66.90	0.000270	5.24	22138	1766	0.20
53.03	84000	41.60	65.15		65.35	0.000277	4.72	24205	2268	0.18
53.02	84000	41.60	65.15	58.22	65.35	0.000277	4.71	24205	2268	0.18
53.015	Bridge									
53.01	84000	41.60	65.15		65.34	0.000277	4.71	24200	2268	0.18
53	84000	41.60	65.15		65.34	0.000277	4.72	24197	2268	0.18
52	84000	42.10	64.75	55.57	64.89	0.000161	3.91	28262	2187	0.15
51.03	84000	40.50	63.74		63.95	0.000350	5.12	24419	2813	0.22
51.02	84000	40.50	63.74	58.32	63.95	0.000350	5.12	24409	2813	0.22

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
51.015	Bridge									
51.01	84000	40.50	63.71		63.92	0.000353	5.14	24329	2811	0.22
51	84000	40.50	63.71		63.92	0.000354	5.15	24320	2811	0.22
50.03	84000	39.60	62.78	57.42	63.20	0.000569	7.60	16940	1626	0.29
50	84000	39.60	62.77	57.42	63.19	0.000572	7.61	16917	1625	0.29
49	84000	38.80	61.84	55.86	61.97	0.000214	3.91	29791	3160	0.17
48.03	84000	36.10	61.41		61.48	0.000099	2.46	39955	3625	0.11
48.02	84000	36.10	61.41	53.00	61.48	0.000099	2.46	39958	3625	0.11
48.015	Bridge									
48.01	84000	36.10	61.41		61.48	0.000099	2.46	39951	3625	0.11
48	84000	36.10	61.41		61.48	0.000099	2.46	39945	3625	0.11
47	84000	38.30	61.28		61.34	0.000087	2.38	42683	3870	0.11
46	84000	37.00	61.03		61.15	0.000193	3.57	29879	2932	0.16
45	84000	36.00	59.85		59.98	0.000188	3.79	29536	2781	0.16
44.03	84000	33.50	58.84		58.96	0.000170	3.67	31059	2940	0.15
44.02	84000	33.50	58.84	51.17	58.96	0.000170	3.67	31038	2939	0.15
44.015	Bridge									
44.01	84000	33.50	58.82		58.94	0.000171	3.68	30995	2938	0.15
44	84000	33.50	58.82		58.94	0.000171	3.68	30995	2938	0.15
43	84000	34.60	57.48	50.56	58.03	0.000645	7.66	14362	1141	0.29
42	84000	37.90	57.01	50.73	57.75	0.000865	8.61	12415	998	0.36
41	84000	28.20	56.83		57.50	0.000609	8.62	13780	1044	0.31
40	84000	26.60	56.38	49.21	56.53	0.000201	4.01	27942	2609	0.17
39	84000	26.00	54.80		54.99	0.000281	4.89	25912	2814	0.20
38	84000	25.00	54.45	48.51	54.67	0.000288	5.76	24024	2339	0.20
37.03	84000	24.40	54.39		54.64	0.000336	6.00	22533	2249	0.22
37.02	84000	24.40	54.39	48.53	54.64	0.000336	6.00	22532	2249	0.22
37.015	Bridge									
37.01	84000	24.40	54.36		54.61	0.000339	6.02	22453	2248	0.22
37	84000	24.40	54.35		54.61	0.000339	6.02	22451	2248	0.22
36	84000	26.10	53.98		54.28	0.000398	5.97	20235	1926	0.23
35	84000	25.90	53.61	46.44	53.77	0.000207	4.16	27347	2485	0.17
34	84000	25.90	52.94		53.18	0.000337	5.37	23059	2425	0.22
33	84000	24.50	51.92		52.12	0.000259	4.69	24594	2279	0.19
32	84000	25.30	50.12		50.28	0.000235	4.59	26673	2567	0.18
31.03	84000	21.50	49.97	44.53	50.19	0.000343	5.21	23644	2552	0.22

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
31.015	Bridge									
31	84000	21.50	49.67		49.91	0.000380	5.43	22891	2552	0.23
30.03	84000	24.40	49.58		49.86	0.000456	6.76	21362	2480	0.26
30.02	84000	24.40	49.58	44.97	49.86	0.000457	6.77	21409	2499	0.26
30.015	Bridge									
30.01	84000	24.40	49.47		49.76	0.000475	6.88	21135	2495	0.26
30	84000	24.40	49.47		49.76	0.000475	6.88	21086	2477	0.26
29.03	84000	25.00	49.15		49.56	0.000735	7.31	18410	2565	0.32
29.02	84000	25.00	49.15	45.84	49.56	0.000735	7.31	18408	2565	0.32
29.015	Bridge									
29.01	84000	25.00	49.06		49.48	0.000764	7.43	18169	2560	0.32
29	84000	25.00	49.06		49.48	0.000764	7.43	18167	2560	0.32
28	84000	20.40	49.00		49.30	0.000385	6.46	22309	2570	0.24
27	84000	16.60	46.14		46.41	0.000394	6.01	22049	2481	0.24
26	84000	17.00	45.17	40.60	45.39	0.000330	5.85	24755	2862	0.22
25.03	84000	15.70	43.57		43.77	0.000371	5.73	24198	2817	0.21
25.02	84000	15.70	43.57	38.52	43.77	0.000371	5.73	24197	2817	0.21
25.015	Bridge									
25.01	84000	15.70	43.54		43.74	0.000374	5.75	24130	2816	0.21
25	84000	15.70	43.54		43.74	0.000374	5.75	24130	2816	0.21
24	84000	15.20	42.47	37.26	42.66	0.000309	5.09	25118	2742	0.20
23	84000	12.00	40.54	34.08	40.70	0.000222	4.35	27252	2612	0.18
22	84000	13.70	39.15		39.34	0.000289	4.78	26380	3008	0.20
21.03	84000	14.00	39.04		39.27	0.000394	5.56	23619	2872	0.23
21.02	84000	14.00	39.04	34.23	39.27	0.000394	5.56	23618	2872	0.23
21.015	Bridge									
21.01	84000	14.00	39.01		39.24	0.000399	5.59	23515	2869	0.23
21	84000	14.00	39.01		39.24	0.000399	5.59	23515	2869	0.23
20	84000	11.40	37.99		38.18	0.000295	5.05	25099	2635	0.20
19	84000	7.50	36.64		36.84	0.000281	5.58	25291	2654	0.20
18.03	84000	8.10	36.35		36.79	0.000719	7.63	18197	2469	0.31
18.02	84000	8.10	36.35	32.77	36.79	0.000720	7.63	18195	2469	0.31
18.015	Bridge									
18.01	84000	8.10	36.25		36.70	0.000749	7.75	17943	2465	0.32
18	84000	8.10	36.25		36.70	0.000749	7.75	17943	2465	0.32
17	84000	10.00	35.01		35.14	0.000178	3.95	30174	2801	0.16

MAIN AND NORTH FLOODWAYS

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
16	84000	8.90	34.08	28.38	34.23	0.000266	4.34	27495	3020	0.19
15	84000	9.50	32.93		33.10	0.000292	4.76	26648	3042	0.20
14	84000	8.00	31.51	26.30	31.70	0.000285	5.11	25096	2565	0.20
13	84000	5.50	30.17		30.35	0.000265	4.44	25446	2492	0.19
12	84000	7.30	28.79		28.92	0.000174	3.88	29570	2614	0.16
11.03	84000	7.40	28.68		28.89	0.000340	5.35	23400	2445	0.22
11.02	84000	7.40	28.67	22.61	28.89	0.000341	5.35	23382	2445	0.22
11.015	Bridge									
11.01	84000	7.40	28.65		28.87	0.000343	5.37	23328	2444	0.22
11	84000	7.40	28.65		28.87	0.000343	5.37	23328	2444	0.22
10	84000	4.20	26.09		26.26	0.000252	4.58	25448	2365	0.18
9	84000	2.10	24.74		24.93	0.000329	5.29	24593	2682	0.21
8	84000	1.20	22.96	17.00	23.20	0.000376	5.35	21906	2192	0.22
7.03	84000	1.60	22.90		23.16	0.000437	5.40	20611	2098	0.22
7.02	84000	1.60	22.90	17.09	23.16	0.000437	5.40	20605	2098	0.22
7.015	Bridge									
7.01	84000	1.60	22.89		23.16	0.000438	5.40	20593	2098	0.22
7	84000	1.60	22.89		23.15	0.000438	5.40	20590	2098	0.22
6	84000	1.90	22.40	16.87	22.78	0.000600	6.58	17170	1695	0.28
5.1	84000	1.00	22.11		22.29	0.000288	4.62	25053	2505	0.19
5	84000	1.70	20.90		21.07	0.000299	4.61	25071	2585	0.20
4	84000	0.80	20.68		20.90	0.000409	5.38	22792	2591	0.23
3	84000	0.00	20.63	15.20	20.82	0.000344	5.01	24333	2676	0.21
2	84000	3.60	19.66	12.01	19.74	0.000125	2.79	36861	3529	0.13
1	84000	1.10	19.03	12.23	19.09	0.000117	2.35	41613	4542	0.12

**TABLE 3
HYDRAULIC MODEL RUN RESULTS FOR
ARROYO COLORADO**

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
139	21000	64.30	77.90		78.04	0.000837	3.02	6959	636	0.16
138	21000	64.60	77.36		77.53	0.001064	3.32	6319	598	0.18
137	21000	65.50	76.15		76.38	0.001708	3.85	5461	593	0.22
136	21000	64.00	74.41		74.67	0.002417	4.09	5140	661	0.26
135	21000	65.20	73.68		73.96	0.002840	4.24	4955	682	0.28
134	21000	48.20	73.05		73.50	0.000523	6.36	6066	708	0.27
133	21000	48.60	71.64		72.36	0.000866	8.76	5558	738	0.35
132	21000	47.60	69.92		70.87	0.001181	10.02	5008	739	0.40
131	21000	48.50	69.26		69.60	0.000419	5.91	7837	1049	0.24
130	21000	49.00	68.08		68.51	0.000798	7.62	7640	1276	0.32
129	21000	49.00	67.92		67.99	0.000227	4.07	15919	2319	0.17
128	21000	48.40	67.86		67.91	0.000135	2.77	15049	2405	0.13
127	21000	47.90	67.78		67.83	0.000131	2.74	15728	2266	0.13
126	21000	47.80	67.66		67.75	0.000229	4.13	13447	2253	0.18
125	21000	48.10	67.46		67.59	0.000315	4.21	12789	2245	0.20
124	21000	46.90	67.32		67.43	0.000277	3.97	13644	2298	0.19
123	21000	46.40	67.15		67.27	0.000265	3.91	13462	2359	0.19
122	21000	45.80	67.01		67.12	0.000267	3.85	13911	2424	0.18
121	21000	46.90	66.81		66.94	0.000334	4.39	13063	2454	0.21
120	21000	47.30	66.66		66.78	0.000315	4.14	12933	2375	0.20
119	21000	44.80	66.55		66.65	0.000233	3.93	13999	1974	0.17
118	21000	46.40	66.39		66.52	0.000284	4.35	12126	1672	0.19
117	21000	48.60	65.94		66.24	0.000601	6.29	7881	1070	0.28
116	21000	47.70	65.15		65.82	0.001063	8.04	5008	661	0.37
115	21000	49.40	64.51		65.59	0.001534	9.44	3678	513	0.44
114	21000	51.80	64.58		65.32	0.001175	7.96	4161	489	0.39
113	21000	43.40	64.80		65.06	0.000218	4.56	9944	2499	0.18
112	21000	37.00	64.70		64.89	0.000364	5.62	12440	2378	0.20
111	21000	37.00	64.70	56.96	64.89	0.000364	5.62	12438	2378	0.20
110.5	Bridge									
110	21000	37.00	64.08		64.66	0.000822	8.32	5713	668	0.29
109	21000	37.00	64.08		64.66	0.000822	8.32	5713	668	0.29
108	21000	44.20	60.70		62.25	0.002260	11.94	4429	1340	0.54
107	21000	25.40	61.17		61.73	0.000351	6.68	6785	1352	0.22

ARROYO COLORADO

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
106	21000	37.20	60.33		61.37	0.000951	9.74	5999	1519	0.37
105	21000	25.40	60.56		61.12	0.000340	6.76	7423	1501	0.22
104	21000	28.20	59.81		60.61	0.000498	8.24	6985	1802	0.28
103	21000	28.20	59.40	46.37	60.51	0.000628	9.17	3360	1529	0.31
102	21000	28.20	59.40	46.37	60.50	0.000629	9.17	3359	1529	0.31
101.5	Bridge									
101	21000	28.20	59.26	46.37	60.38	0.000641	9.22	3329	1511	0.31
100	21000	28.20	59.26	46.37	60.38	0.000641	9.22	3329	1511	0.31
99	21000	27.70	59.13		59.74	0.000362	7.18	7190	1752	0.24
98	21000	28.80	58.67		59.12	0.000329	6.28	9975	2971	0.22
97	21000	28.00	58.52		58.78	0.000242	5.56	12584	2277	0.19
96	21000	26.30	57.44	46.32	57.97	0.000447	7.41	9979	2603	0.25
95	21000	25.80	55.94	43.01	56.19	0.000218	4.79	13439	5589	0.18
94	21000	24.90	54.90		55.30	0.000254	5.92	9918	3089	0.20
93	21000	24.40	54.30	53.20	54.68	0.000309	6.33	10894	2837	0.21
92	21000	24.10	53.93		54.06	0.000109	3.84	13744	1483	0.13
91	21000	22.40	53.76		53.88	0.000128	4.16	10907	661	0.14
90	21000	22.40	53.76	39.45	53.88	0.000128	4.16	10907	661	0.14
89.5	Bridge									
89	21000	22.40	53.74		53.86	0.000129	4.17	10889	661	0.14
88	21000	22.40	53.74		53.86	0.000129	4.17	10889	661	0.14
87	21000	21.50	53.18		53.50	0.000263	5.95	10359	1579	0.20
86	21000	22.20	52.34		52.75	0.000308	6.44	8525	1449	0.22
85	21000	21.90	52.04		52.40	0.000259	5.97	8928	1454	0.20
84	21000	20.90	50.48	36.79	51.26	0.000478	7.96	6406	1496	0.27
83	21000	19.30	50.31		50.69	0.000221	5.56	5543	311	0.19
82	21000	19.60	49.99	35.03	50.34	0.000251	5.85	5756	686	0.20
81	21000	19.60	49.99	35.03	50.34	0.000251	5.85	5756	686	0.20
80.5	Bridge									
80	21000	19.60	49.92	35.03	50.28	0.000253	5.87	5736	672	0.20
79	21000	19.60	49.92	35.03	50.28	0.000253	5.87	5736	671	0.20
78	21000	19.20	49.73		49.99	0.000237	5.73	8596	761	0.19
77	21000	18.00	49.22		49.40	0.000138	4.27	12335	1776	0.15
76	21000	17.50	47.91	34.96	48.60	0.000483	8.19	6069	852	0.27
75	21000	15.70	46.78		47.28	0.000348	6.90	6725	884	0.23
74	21000	15.00	45.35	31.46	45.88	0.000357	7.00	5138	329	0.24

ARROYO COLORADO

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
73	21000	14.70	44.25		44.67	0.000358	6.67	6787	657	0.23
72	21000	14.30	44.20		44.45	0.000165	4.73	7710	771	0.16
71	21000	12.40	43.68	31.01	44.04	0.000272	5.83	6272	627	0.20
70	21000	12.40	43.47		43.71	0.000224	5.32	9577	1042	0.18
69	21000	12.40	43.47	29.74	43.71	0.000224	5.32	9576	1042	0.18
68.5	Bridge									
68	21000	12.40	43.39		43.64	0.000228	5.36	9497	1039	0.18
67	21000	12.40	43.39		43.64	0.000228	5.36	9495	1039	0.18
66	21000	11.80	42.83		43.05	0.000142	4.42	8373	677	0.15
65	21000	11.00	42.10		42.62	0.000376	7.23	4981	287	0.24
64	21000	11.10	41.31		41.94	0.000457	7.89	4844	326	0.26
63	21000	10.60	41.11		41.32	0.000140	4.42	7811	465	0.15
62	21000	8.20	40.69		40.95	0.000198	5.18	7727	565	0.17
61	21000	8.50	40.18		40.60	0.000336	6.53	6606	599	0.22
60	21000	7.50	39.69		40.16	0.000292	6.23	5688	475	0.21
59	21000	7.80	39.59		39.75	0.000187	4.79	10281	849	0.15
58	21000	7.80	39.59	26.25	39.74	0.000187	4.79	10280	849	0.15
57.5	Bridge									
57	21000	7.80	39.55		39.71	0.000188	4.80	10247	847	0.15
56	21000	7.80	39.55		39.71	0.000188	4.80	10247	847	0.15
55	21000	6.30	38.35		39.02	0.000478	7.90	4645	322	0.26
54	21000	5.60	37.89		38.21	0.000229	5.47	6331	388	0.19
53	21000	3.60	36.73		37.07	0.000213	5.50	5946	326	0.18
52	21000	2.80	36.25		36.43	0.000164	4.77	8941	577	0.15
51	21000	2.50	34.87		35.36	0.000292	6.64	5128	275	0.22
50	21000	1.60	34.58		34.97	0.000223	5.78	5858	365	0.19
49	21000	1.40	33.90		34.21	0.000212	5.62	6372	327	0.18
48	21000	1.30	33.82		33.93	0.000098	3.84	10771	601	0.12
47	21000	0.40	33.40		33.76	0.000254	6.18	5834	271	0.20
46	21000	0.40	33.39	16.74	33.75	0.000254	6.18	5832	271	0.20
45.5	Bridge									
45	21000	0.40	33.36		33.72	0.000255	6.19	5823	271	0.20
44	21000	0.40	33.35		33.71	0.000256	6.19	5820	271	0.20
43	21000	0.40	33.34		33.70	0.000256	6.19	5818	271	0.20
42	21000	0.40	33.34	16.74	33.70	0.000256	6.19	5818	271	0.20
41.5	Bridge									

ARROYO COLORADO

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
41	21000	0.40	33.24		33.60	0.000259	6.22	5790	271	0.20
40	21000	0.40	33.23		33.59	0.000260	6.22	5788	271	0.20
39	21000	0.40	33.22		33.59	0.000260	6.22	5786	271	0.20
38	21000	0.40	33.21	16.74	33.58	0.000260	6.23	5784	271	0.20
37.5	Bridge									
37	21000	0.40	33.18		33.55	0.000261	6.23	5775	271	0.20
36	21000	0.40	33.18		33.55	0.000261	6.23	5775	271	0.20
35	21000	-0.10	33.05		33.14	0.000072	3.32	12485	739	0.11
34	21000	0.80	32.59		32.95	0.000233	6.02	6135	336	0.19
33	21000	-0.10	31.65		32.23	0.000322	7.13	4901	289	0.23
32	21000	-1.90	31.39		31.59	0.000155	4.80	8037	437	0.15
31	21000	-1.90	31.39	13.98	31.59	0.000155	4.80	8037	437	0.15
30.5	Bridge									
30	21000	-1.90	31.33		31.53	0.000157	4.82	8011	436	0.16
29	21000	-1.90	31.33		31.53	0.000157	4.82	8011	436	0.16
28	21000	-2.50	31.13		31.35	0.000179	5.30	7873	444	0.17
27	21000	-2.60	30.99		31.21	0.000158	4.99	7582	382	0.16
26	21000	-2.60	30.99	14.71	31.21	0.000158	4.99	7582	382	0.16
25.5	Bridge									
25	21000	-2.60	30.91		31.13	0.000160	5.01	7551	382	0.16
24	21000	-2.60	30.91		31.13	0.000160	5.01	7551	382	0.16
23	21000	-1.30	30.40		30.87	0.000268	6.54	10902	674	0.21
22	21000	-3.50	29.60		30.42	0.000460	8.09	6801	452	0.27
21	21000	-1.50	29.76		30.16	0.000180	5.43	8614	496	0.17
20	21000	-2.80	29.09		29.72	0.000344	7.22	8736	610	0.23
19	21000	-4.10	29.00		29.38	0.000250	6.12	13920	995	0.20
18	21000	-4.10	29.00	13.52	29.38	0.000250	6.12	13920	995	0.20
17.5	Bridge									
17	21000	-4.10	28.91		29.29	0.000254	6.15	13828	994	0.20
16	21000	-4.10	28.91		29.29	0.000254	6.15	13828	994	0.20
15	21000	-5.70	27.34		28.59	0.000629	9.68	6676	868	0.31
14	21000	-4.70	26.91		27.53	0.000345	6.86	8227	782	0.23
13	21000	-6.70	26.88		27.11	0.000196	5.30	17359	1028	0.17
12	21000	-5.80	26.17		26.82	0.000357	7.08	7689	617	0.24
11	21000	-9.00	25.08		25.82	0.000429	7.75	7150	451	0.26
10	21000	-6.30	23.27		24.33	0.000646	9.43	6062	384	0.32

ARROYO COLORADO

River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
9	21000	-3.50	21.93		22.42	0.000315	6.04	6908	411	0.22
8	21000	-13.00	20.39		20.85	0.000295	6.05	9092	677	0.21
7	21000	-6.80	17.64		18.83	0.000803	9.42	4253	247	0.35
6	21000	-4.50	14.86	7.25	16.03	0.001146	8.75	3010	320	0.38
5.5	Bridge									
5	21000	-4.50	14.64		15.85	0.001201	8.88	2941	315	0.39
4	21000	-6.30	14.23		15.03	0.000692	7.32	3866	288	0.31
3	21000	-6.30	14.23	5.33	15.02	0.000692	7.32	3866	288	0.31
2.5	Bridge									
2	21000	-6.30	14.17		14.97	0.000700	7.35	3849	288	0.31
1	21000	-6.30	14.17	5.32	14.97	0.000700	7.35	3849	288	0.31

**FLOOD PROFILE ON THE RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE
RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY**

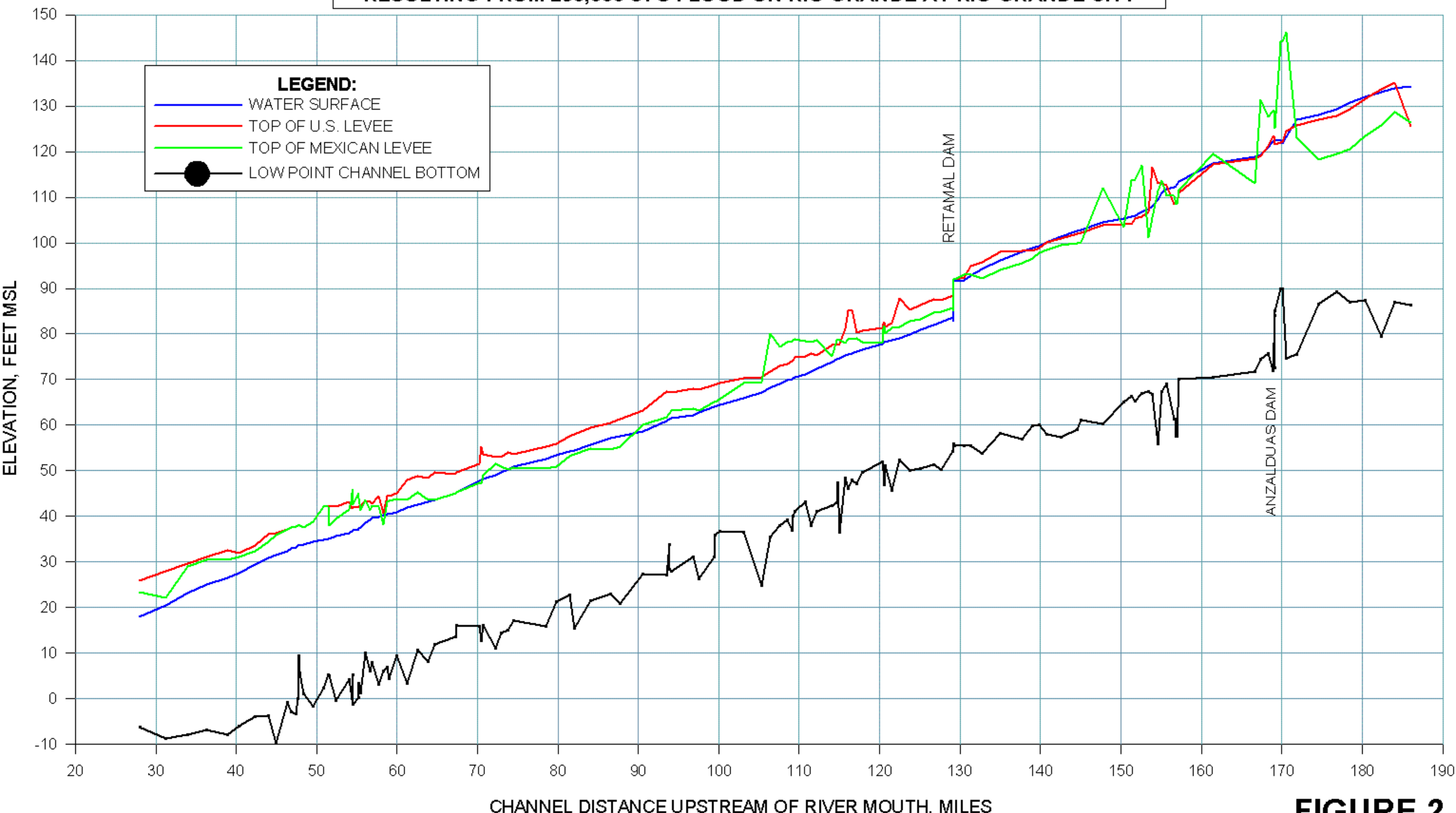


FIGURE 2

**FLOOD PROFILE ON THE U.S. MAIN AND NORTH FLOODWAYS OF THE RIO GRANDE
RESULTING FROM A 250,000 CFS FLOOD ON THE RIO GRANDE AT RIO GRANDE CITY**

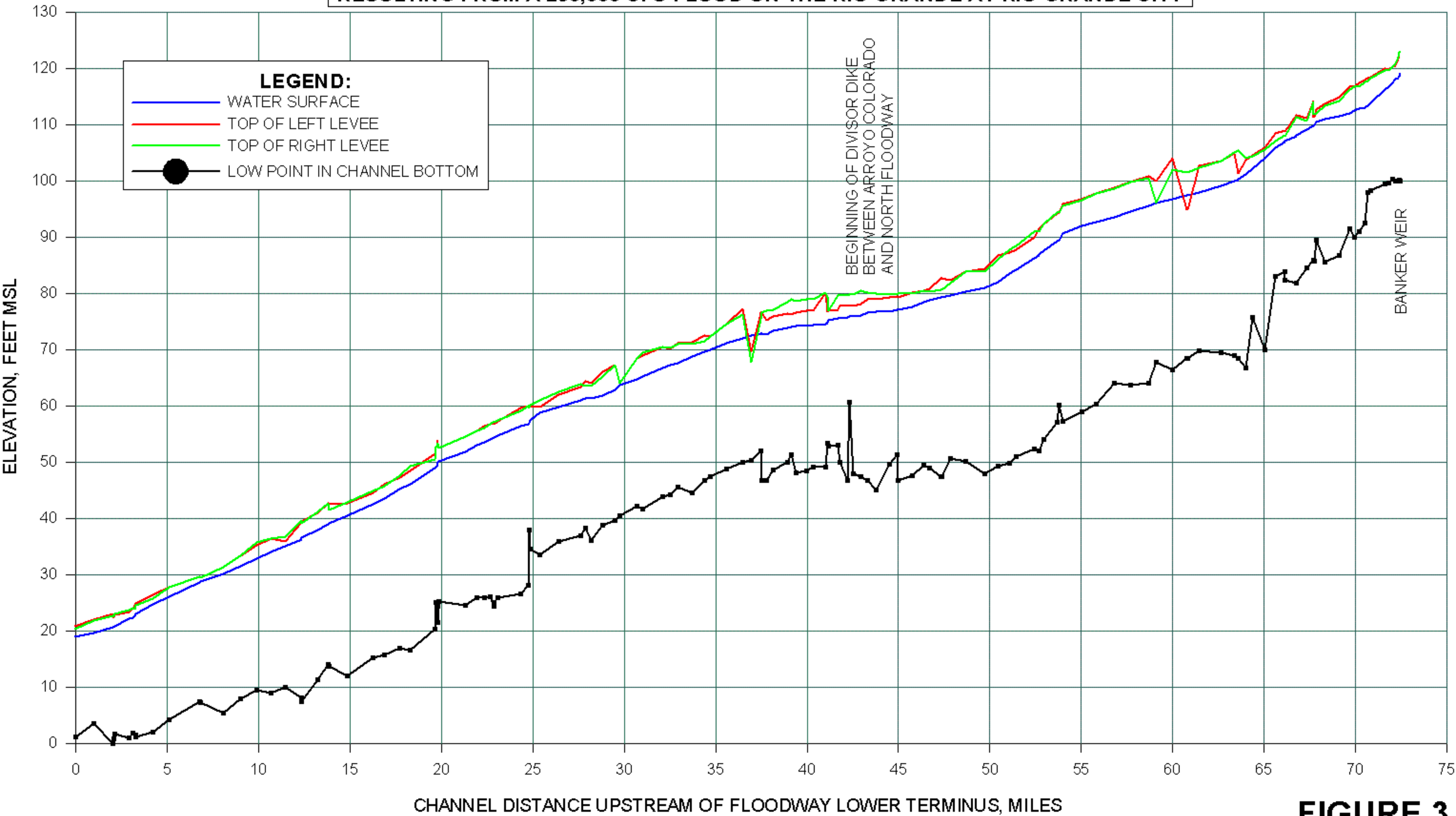


FIGURE 3

**FLOOD PROFILE ON THE ARROYO COLORADO FLOODWAY OF THE RIO GRANDE
RESULTING FROM A 250,000 CFS FLOOD ON THE RIO GRANDE AT RIO GRANDE CITY**

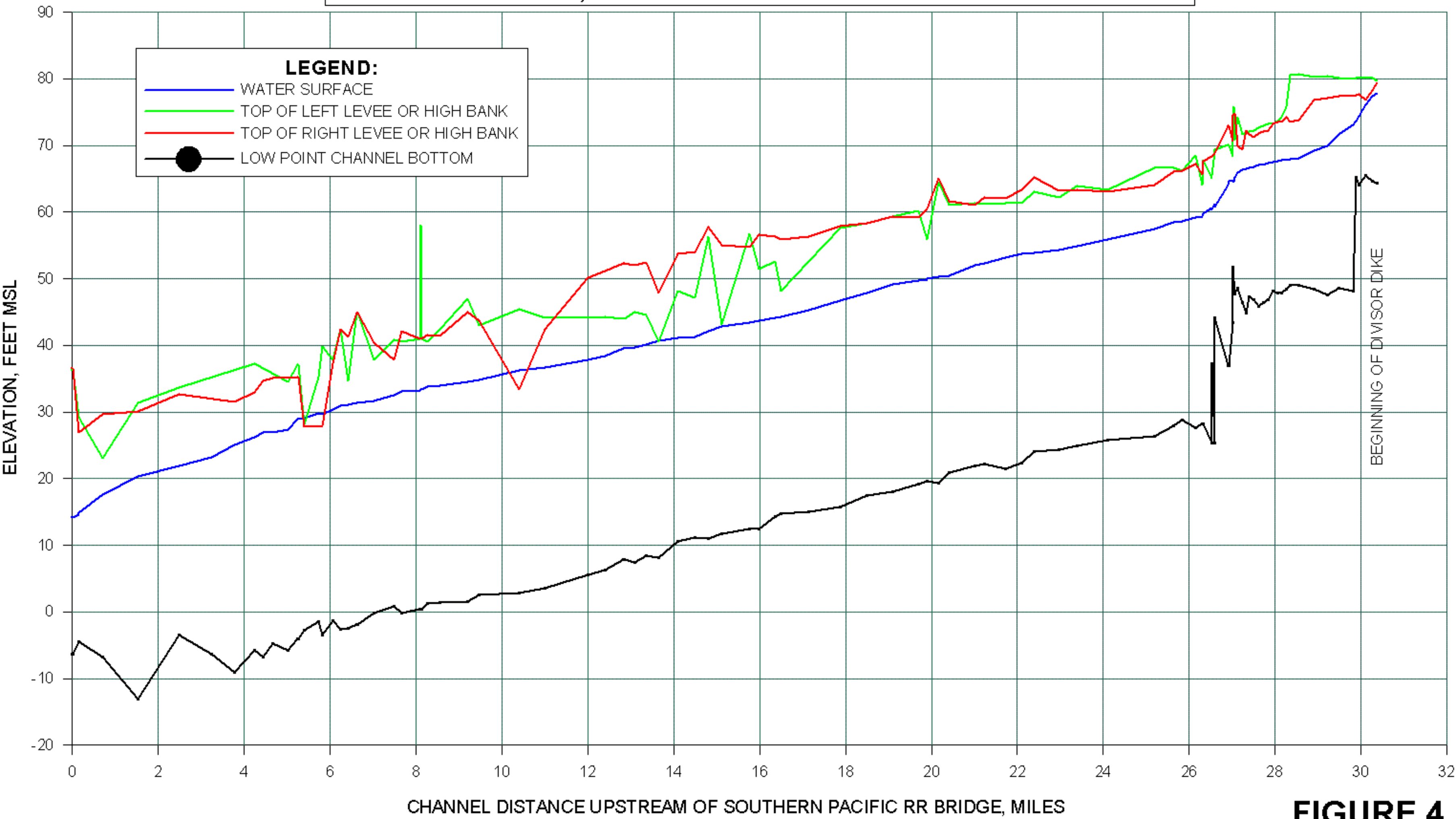


FIGURE 4

LOWER RIO GRANDE FLOOD CONTROL PROJECT RIO GRANDE LEVEES

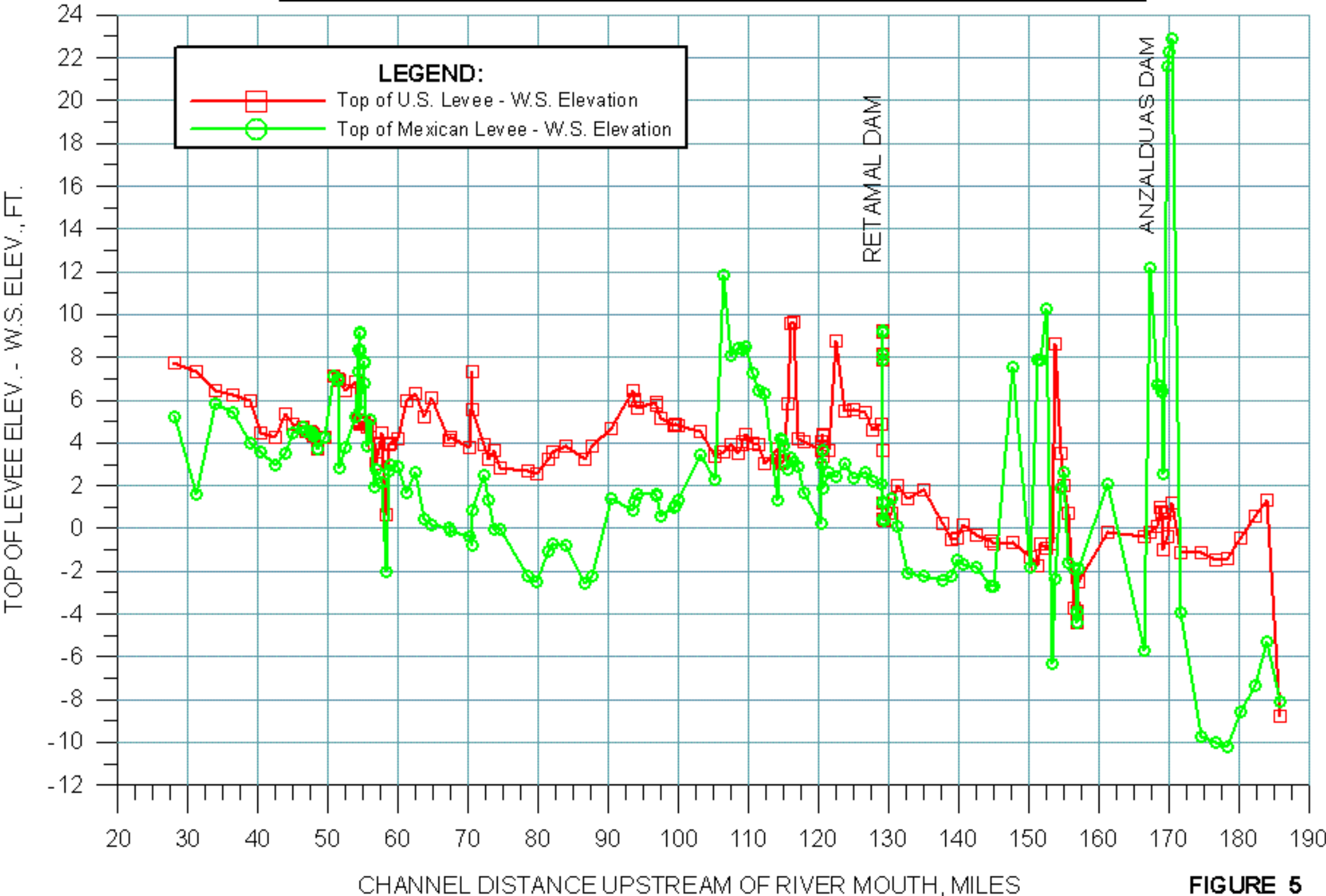


FIGURE 5

LOWER RIO GRANDE FLOOD CONTROL PROJECT MAIN AND NORTH FLOODWAY LEVEES

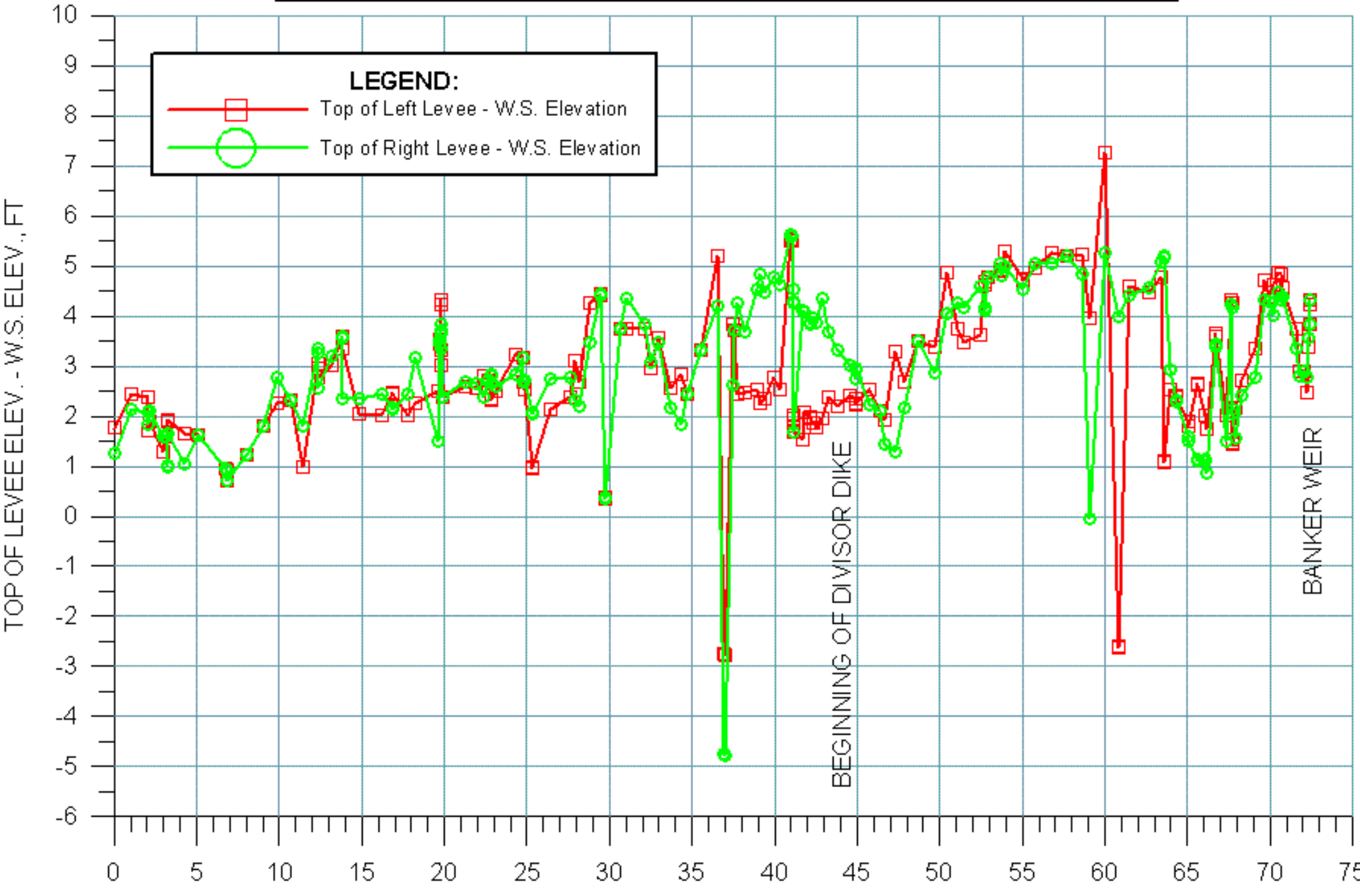
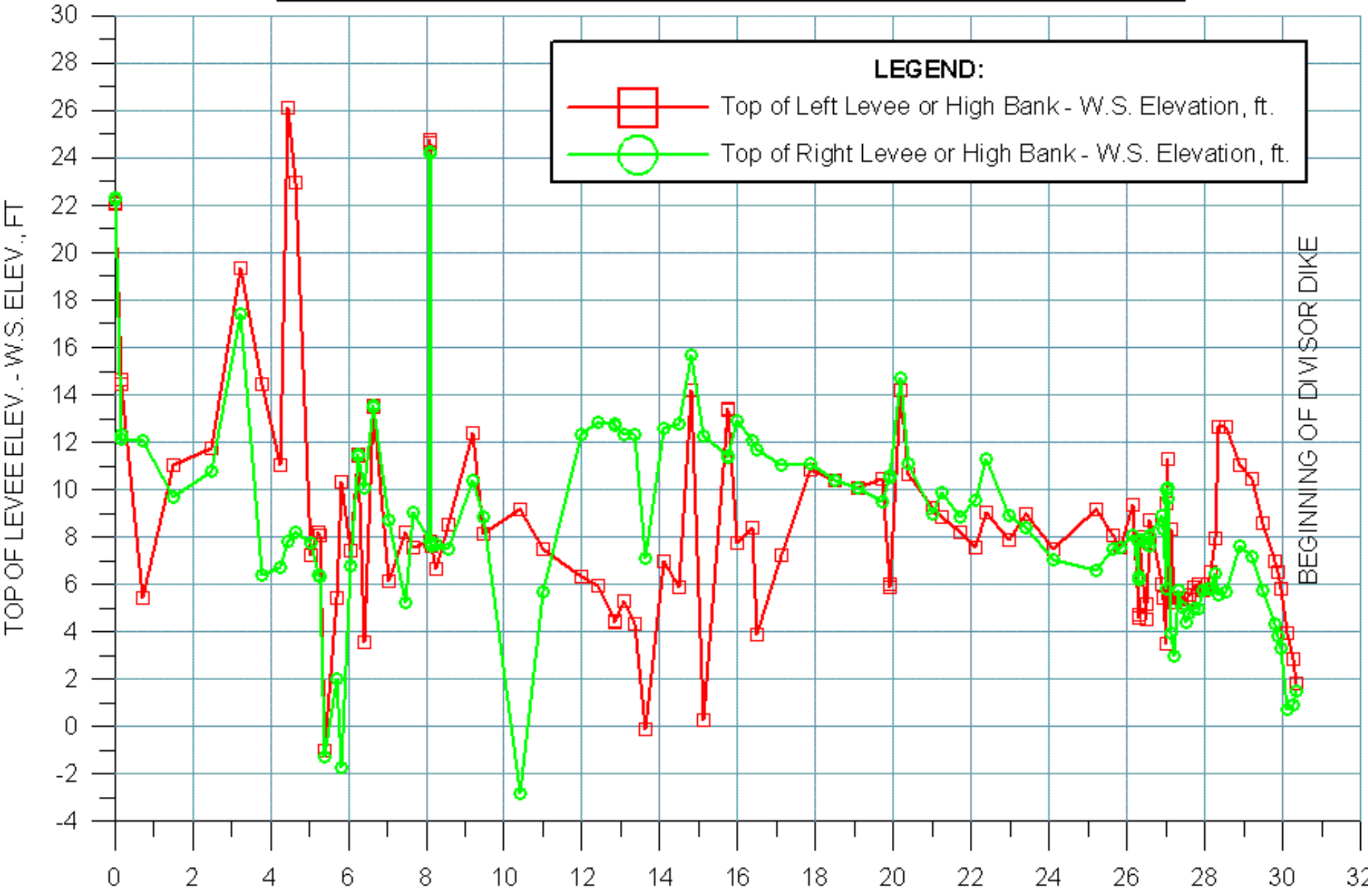


FIGURE 6

LOWER RIO GRANDE FLOOD CONTROL PROJECT ARROYO COLORADO LEVELS OR HIGH BANKS



CHANNEL DISTANCE UPSTREAM OF SOUTHERN PACIFIC RR BRIDGE, MILES

FIGURE 7

**FLOOD PROFILE ON THE RIO GRANDE FROM PEÑITAS TO BELOW BROWNSVILLE
RESULTING FROM 250,000 CFS FLOOD ON RIO GRANDE AT RIO GRANDE CITY**

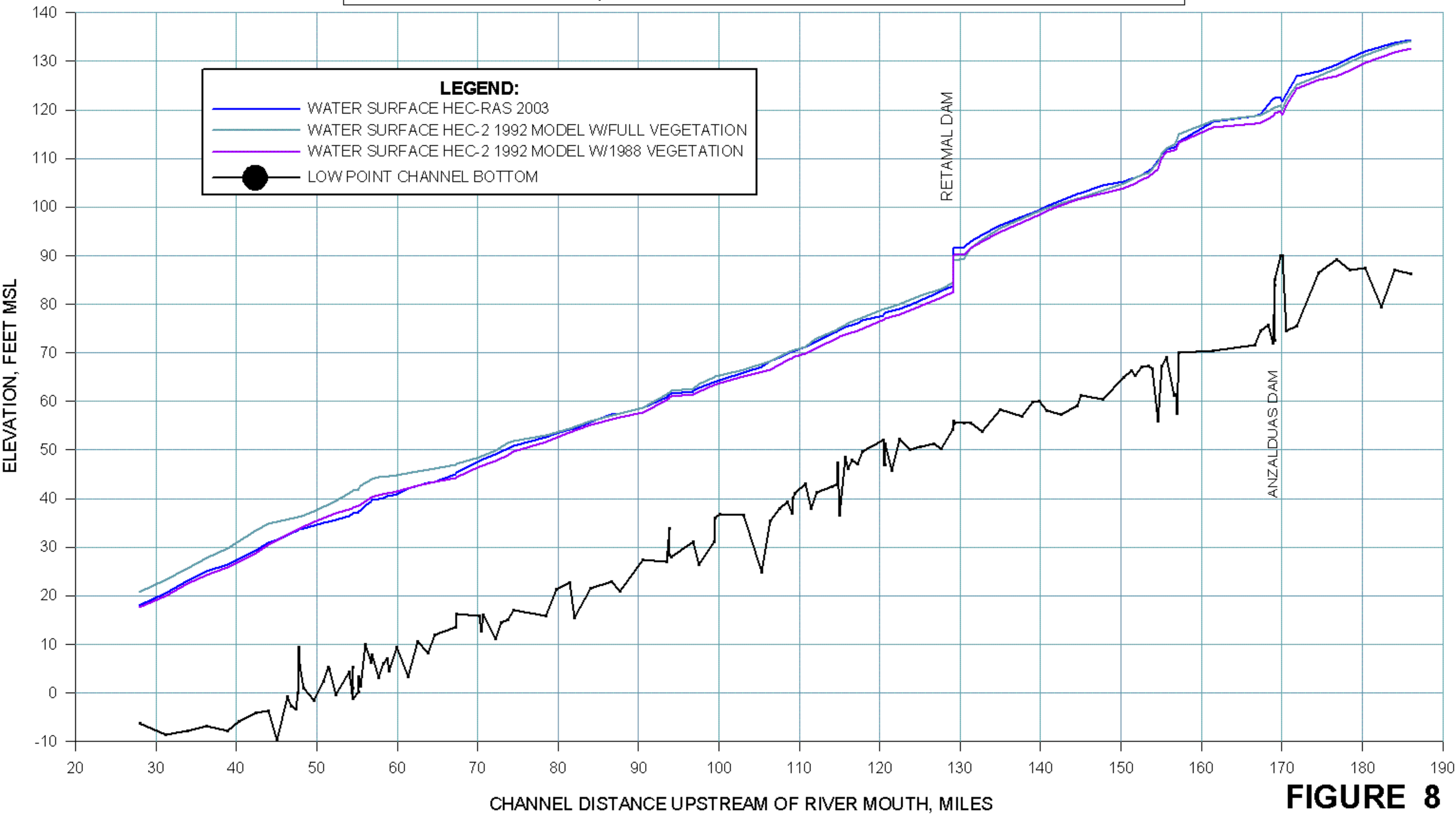


FIGURE 8