BRIDGE HYDRAULICS REPORT

S.H. 96A (4th Street) Over the Arkansas River

Prepared for

Figg Bridge Engineers, Inc.
and
Colorado Department of Transportation – Region 2

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Background

The Colorado Department of Transportation (CDOT) intends to replace the State Highway 96A (4th Street) bridge over the Arkansas River in Pueblo, Colorado. Ayres Associates is a member of the design team led by Figg Bridge Engineers. Ayres Associates submitted a Floodplain and Drainage Assessment Report (FDAR) for the project in December 2001 (Ayres Associates 2001) and submitted a Preliminary Bridge Hydraulics Report for the project in May 2003 (Ayres Associates 2003). In January 2006 the design team began the final design of the project. Ayres Associates has performed studies regarding the hydrology, river floodplain hydraulics and design hydraulics in support of the final design effort. This report documents those studies.

1.2 Site Location

The project site is located on S.H. 96A, or 4th Street, near Pueblo's Central Business District. The route crosses over the Arkansas River and an extensive rail yard facility between the intersections with Abriendo Avenue and Midtown Circle Drive. **Figure 1.1** is a site location map.

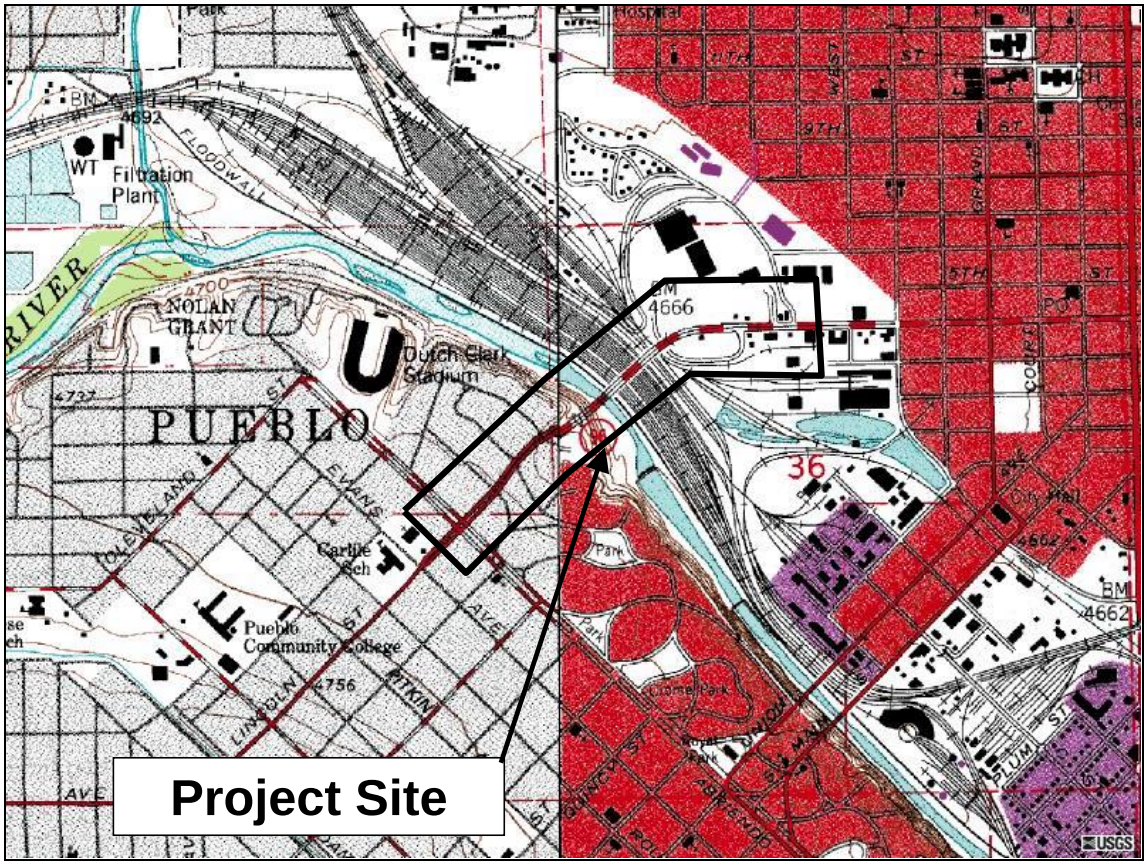

Figure 1.1. Site location map (excerpt from USGS 7.5-minute quadrangle).

2. HYDROLOGY

2.1 Drainage Basin Description

The Arkansas River drains a watershed of approximately 4,790 square miles at the project site. The watershed ranges in elevation from over 14,300 feet at the continental divide to about 4,650 feet at the project site. Pueblo Reservoir, constructed in 1976, provides storage for water conservation and for flood control upstream of the project site. The U.S. Bureau of Reclamation (USBR) owns and operates the reservoir. Operational rules limit the discharge rate for releases into the Arkansas River downstream. By these operational rules, the maximum release discharge would be approximately 6,000 cfs for reservoir inflow floods up to and including the 500-year flood.

There is limited drainage area tributary to the Arkansas River between Pueblo Reservoir and the bridge site, with major contributions from Goodnight Arroyo and Wildhorse Dry Creek. Because of the regulation afforded by Pueblo Reservoir, local inflows are the predominant source of flood flows in the Arkansas River at the bridge site. Goodnight Arroyo flows into the Arkansas River from the south (right) side, with an approximate tributary area of 6 square miles. Wildhorse Dry Creek flows into the Arkansas River from the north (left) side, with an approximate tributary area of 87 square miles. Flood flows typically occur as a result of intense thunderstorms. Flood durations in Wildhorse Dry Creek are typically 20 hours or less. A map of the Goodnight Arroyo and Wildhorse Dry Creek drainage basins, taken from a U.S. Army Corps of Engineers Floodplain Information Report (USACE 1969) is included in **Appendix A**.

2.2 River Channel and Floodplain

The Arkansas River reach of interest for this study runs from the confluence with Wildhorse Dry Creek to a diversion structure roughly 800 feet downstream of the bridge site. This reach was channelized by the construction of a floodwall in 1924 following the devastating 1921 Pueblo flood. The concrete-lined floodwall forms the left limit of the floodplain and protects the downtown area of Pueblo from flooding due to the Arkansas River. The right limit of the floodplain through the study reach is comprised of a natural bluff that runs parallel to the low flow channel. Between these two constraints the floodplain cross section has relatively flat cross slopes. A low-flow channel occupies the leftmost one-third to one-half of the floodplain width. **Figure 2.1** shows a typical cross section in the study reach. **Figure 2.2** is a summary of the geomorphic characteristics of the study reach. In Figure 2.2, the chapter and section references in the first column refer to the Federal Highway Administration document HEC-20 "Stream Stability at Highway Structures" (Lagasse et al. 2001).

The low flow channel bed consists mainly of gravel and cobble material. Vegetation in the floodplain is characterized by grasses near the channel while weeds and bare soil cover the right overbank area downstream of the bridge. Upstream of the bridge, willows and small trees line the right overbank causing an increase in roughness.

According to the Flood Insurance Study prepared by the Federal Emergency Management Agency (FEMA 1986) the floodplain contained by the floodwall is capable of carrying a discharge of over 100,000 cfs. Pueblo Reservoir's construction in the 1970s, however, decreased the flood flows in the channel to a point where the capacity is not likely to be exceeded. Information from the FIS and from the Bureau of Reclamation suggests that the capacity of the floodwall at the bridge project site far exceeds the capacity required for the 100- or 500-year flood, when the effects of Pueblo Dam are considered.

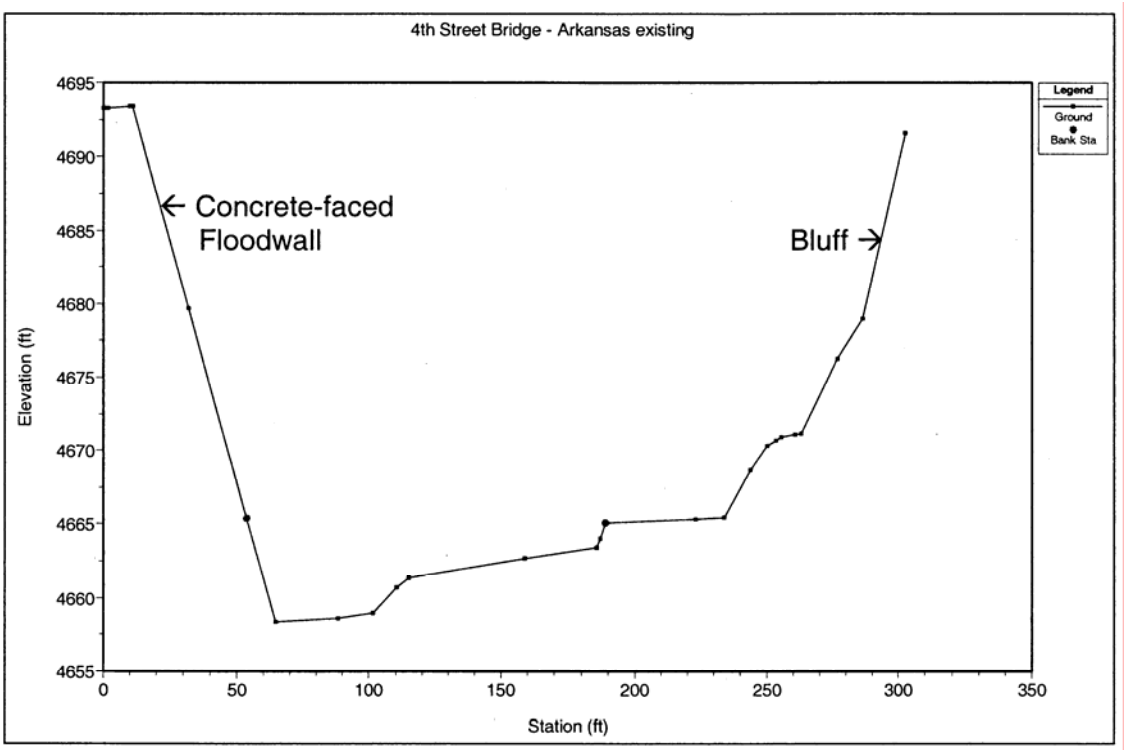

Figure 2.1. Cross section (looking downstream) of Arkansas River near S.H. 96A.

2.3 Flood History

Several major floods have afflicted Pueblo throughout its history. Large floods are known to have occurred in the study reach in 1864, 1893, 1894, and 1921 (the flood of record). The 1921 flood occurred in early June and was caused by intense thunderstorms in the foothill region to the west. Some of the floodwaters came from Wildhorse Dry Creek, which saw an estimated peak discharge rate of 24,000 cfs. The Arkansas River discharge peaked at 103,000 cfs. Accounts of the 1921 flood indicate that the Arkansas River, Fountain Creek, and Wildhorse Dry Creek all reached flood stage at different times during the event.

2.4 Hydrologic Study Approach

Flows in the study reach of the Arkansas River come from three main sources: Goodnight Arroyo and Wildhorse Dry Creek, which are unregulated, and the Arkansas above Wildhorse Dry Creek, which is regulated by Pueblo Reservoir. The operation rules for Pueblo Reservoir prevent large flood discharge releases from the dam. According to a discharge summary table provided by the USBR (see Appendix A) the extent of flood control provided by Pueblo Reservoir depends on the hydrologic method used. All but two of the seven methods, however, support that the reservoir releases a maximum of 6,000 cfs until at least the 500-year event. The local inflows, therefore, provide the dominant portion of peak flows in the Arkansas River through the study reach.

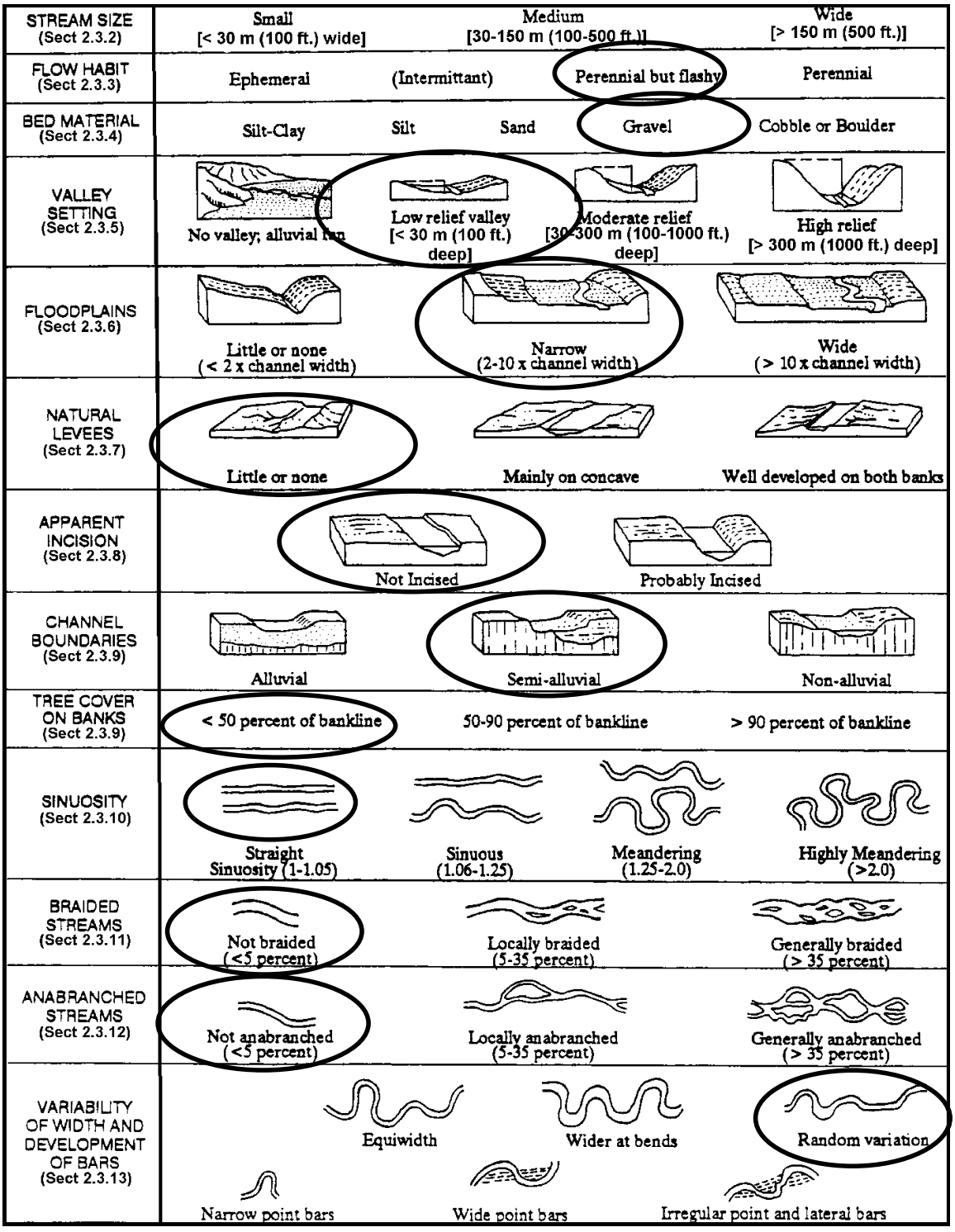

Figure 2.2. Summary of study reach geomorphic characteristics.

2.4.1 FEMA FIS Hydrology

The USACE Flood Plain Information Report (USACE 1969) presented peak discharge rates of 19,600 cfs for the Intermediate Regional Flood (equivalent to the 100-year flood) and 49,500 cfs for the Standard Project Flood (larger than the 500-year flood). The 100- and 500-year flows listed in the FEMA FIS for Wildhorse Dry Creek are 19,500 and 39,500 cfs, respectively. For the reach of interest on the Arkansas, the FEMA FIS uses a peak discharge rate of 20,000 cfs for the 100-year flood and 40,000 cfs for the 500-year flood. In setting these peak discharge rates, the FIS essentially assumes that the maximum 6,000 cfs release from Pueblo Reservoir would not occur at the same time as the peak Wildhorse Dry Creek discharge. In September 2001 the USACE published an Environmental Assessment report (USACE 2001) for a fisheries restoration project on the Arkansas River between Pueblo Reservoir and Fountain Creek. The hydrologic analysis for that effort adopted the 100- and 500-year flows from the FEMA FIS.

2.4.2 Hydrologic Method Comparison

The hydrologic study approach for the S.H. 96A bridge replacement project was to check the FEMA peak discharge rates against other established hydrology methods. The flood frequency relationship reported in the FEMA FIS for Wildhorse Dry Creek was checked using four methods including:

- Colorado Department of Natural Resources Technical Manual 1, "Manual for Estimating Flood Characteristics of Natural-Flow Streams in Colorado" (McCain and Jarrett 1976)
- USGS Water Resources Investigations Report 99-4190, "Analysis of the Magnitude and Frequency of Floods in Colorado" (Vaill 1999)
- USGS Water Resources Investigations Report 87-4094, "Techniques for Estimating Regional Flood Characteristics of Small Rural Watersheds in the Plains Region of Eastern Colorado" (Livingston et al. 1987)
- Natural Resources Conservation Service TR-55, "Urban Hydrology for Small Watersheds" (NRCS 1986)

The first three of these methods are regional regression equations that use the drainage basin area to compute various recurrence interval peak discharges. The fourth is a well-established methodology for small watersheds based on the principles of the NRCS National Engineering Handbook 4. Equations and calculations for each of the four check methods are presented in Appendix A. To aid in providing input to the four check methods, the drainage basin for Wildhorse Dry Creek was delineated digitally on georeferenced USGS quadrangle maps. The drainage basin area was found to be about 87 square miles.

2.4.3 City of Pueblo Modeling Comparison

In addition to comparing peak discharge rates against common methodologies, recent rainfall-runoff modeling performed for the City of Pueblo's Master Drainage Plan (Sellards and Grigg 2006) has been completed for both Goodnight Arroyo and Wildhorse Dry Creek. The hydrologic analysis was performed using SCS hydrologic methods with the SCS Type IIa rainfall distribution. The storm hydrographs for both watersheds were provided by the study subcontractor, Northstar Engineering. The digital hydrographs for Goodnight Arroyo and Wildhorse Dry Creek were added to form a combined storm hydrograph.

The operating rules for Pueblo Reservoir are designed to limit the river discharge to 6,000 cfs at the USGS Avondale gage, downstream of the confluence with Fountain Creek, east of Pueblo. The reservoir releases are reduced as flows on Fountain Creek increase. Based on conversations with the Bureau of Reclamation, the reservoir releases may not be adjusted immediately for locally contributed flows between the reservoir and the Avondale gage. Consequently, an assumed 6,000 base flow release from Pueblo Reservoir was added to the digital storm hydrographs for Goodnight Arroyo and Wildhorse Dry Creek to obtain a cumulative storm discharge.

The hydrologic and hydraulic floodplain modeling performed by Northstar Engineering for Wildhorse Dry Creek assumed that all of the 100- and 500-year storm runoff would be confined to the channel and be conveyed to the Arkansas River. However, Ayres Associates review of the floodplain mapping for Wildhorse Dry Creek showed the potential for a portion of the 500-year to be conveyed around the levee/floodwall and flow through the rail yards. Approximately 3,600 feet upstream of the Arkansas River confluence, a lateral channel enters Wildhorse Dry Creek from the east (in line with 15th Street). At this location, the 500-year floodplain is shown to extend up to 1,000 feet east of the Wildhorse Dry Creek channel. The south bank elevation of the lateral channel is approximately equal to the 500-year water surface elevation in the Creek. Therefore, it is supposed that the left overbank portion of the 500-year discharge (east of Lowell Avenue) could overtop the lateral channel south bank, and be conveyed to the rail yard. The hydraulic modeling for Wildhorse Dry Creek was not made available to Ayres Associates, so a conservative estimate was made that half of the difference between the 100- and 500-year discharges would be conveyed to the rail yard. The 100-year discharge in Wildhorse Dry Creek is 8,885 cfs; the 500-year discharge is 14,452 cfs. Half of the difference is approximately 2,800 cfs, which has been adopted as the 500-year discharge rate for the rail yard area.

2.4.4 Selection of Design Flow Rates

The values determined by Technical Manual 1 method differed only slightly from the FEMA FIS discharges while the other four methods were above and below the FEMA FIS values as shown in **Figure 2.3**.

For compliance with the City of Pueblo and FEMA floodplain development regulations, the evaluation of river hydraulics for water surface elevation profiles should be performed using the FEMA FIS discharges. The City Pueblo and Pueblo County are in the process of preparing revised hydrology and floodplain delineations that would be based on the City of Pueblo Master Plan hydrology in the study area, but the formal submittal of this work has been delayed beyond 2006. Also, conversations with the FEMA study contractor have indicated that changes to the FEMA FIS discharges this reach of the Arkansas River are not anticipated. Consequently, the values published in the current FEMA FIS will be used for the evaluation of river water surface profiles, and floodplain development regulation compliance.

For the hydraulic design of the bridge – including scour evaluation and design of erosion countermeasures - the design discharge was taken from the City of Pueblo rainfall-runoff modeling for the Master Plan study, combined with releases from Pueblo Reservoir. It is desired to base the hydraulic design calculations on the most defensible hydrologic modeling. The City's rainfall-runoff modeling was performed to a much more detailed level, that when combined with reservoir releases represents the most detailed evaluation of the tributary watershed. The addition of a full 6,000 cfs release from Pueblo Reservoir builds some additional conservatism. **Table 2.1** and **Figure 2.4** summarize the flood-frequency relationship adopted for this study.

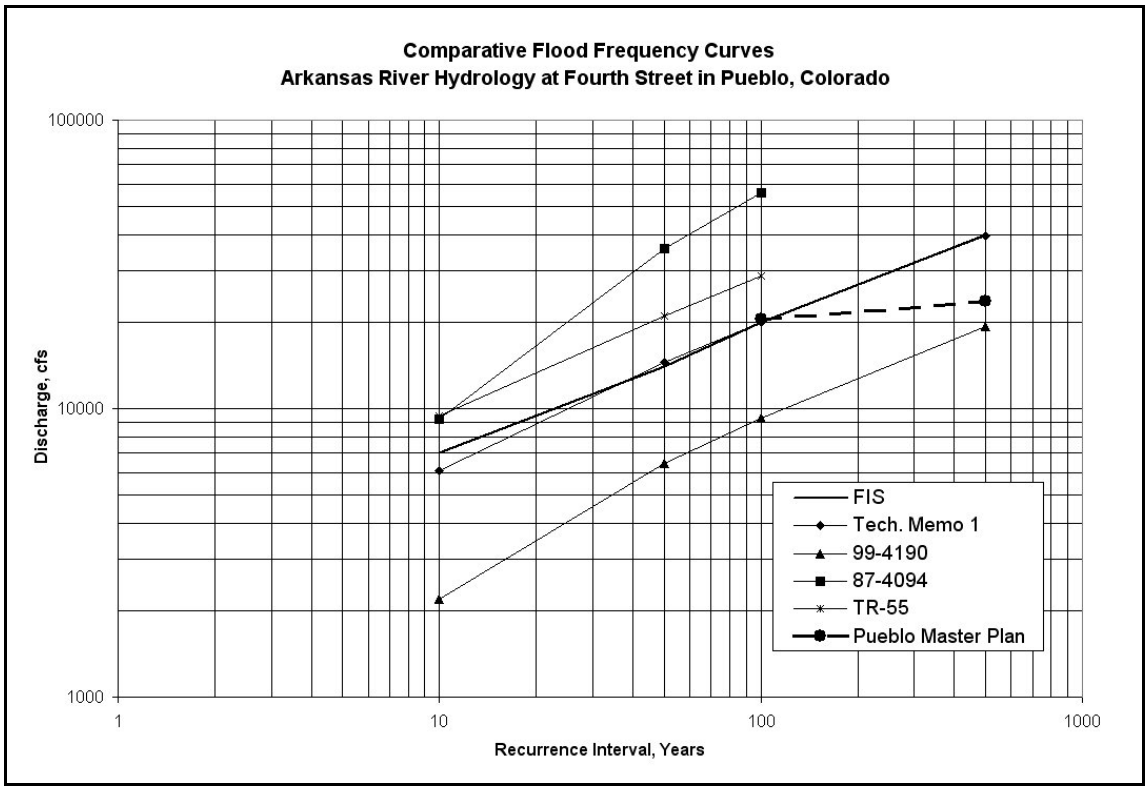

Figure 2.3. Comparison of flood-frequency curves from FEMA and four other methods.

Table 2.1. Flood-Frequency Relationship.			
Recurrence Interval (yrs)	Arkansas River Peak Discharge (cfs)		Rail yard Discharge (cfs)
	General Modeling and FEMA compliance	Hydraulic Design and Analysis	Hydraulic Design and Analysis
10	7,000	N/A	N/A
50	14,000	N/A	N/A
100	20,000	20,500	N/A
500	40,000	24,500	2,800

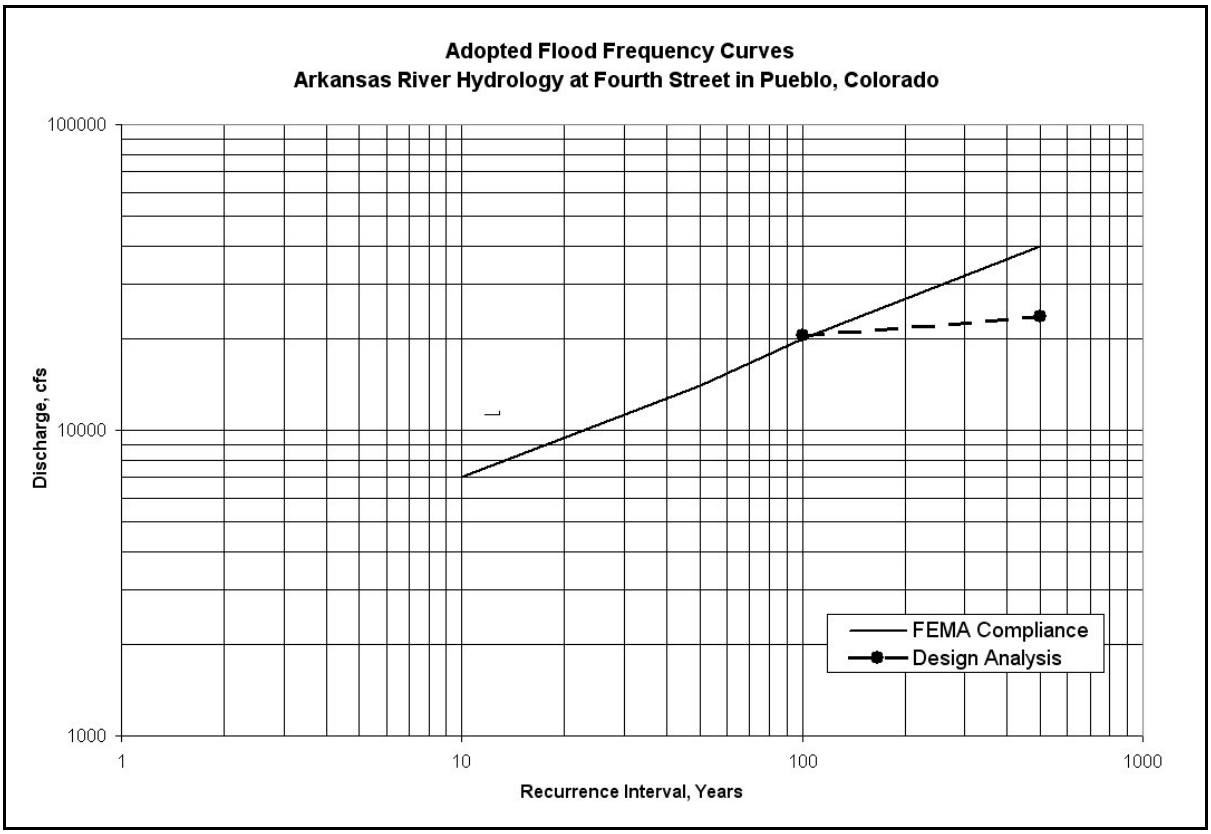

Figure 2.4. Adopted flood-frequency curves.

3. DESIGN CRITERIA

The design of the proposed replacement bridge must comply with certain regulations and criteria. This chapter explains the various hydraulics-related criteria pertinent to this project.

3.1 Design Frequency and Freeboard

According to CDOT standard criteria, adequate vertical freeboard height must be provided between the water surface elevation for the design flood event and the low chord of the structure. The required freeboard height is a function of the peak discharge rate and velocity. If the 500-year flood were selected as the design event for this project, the computed freeboard criteria would be about 4.5 feet. The computed 500-year water surface elevation is more than 17 feet below the top of the floodwall. The lowest low chord elevation of the proposed bridge over the river is above the top of the floodwall. The proposed design, therefore, provides ample freeboard even for a 500-year design frequency.

3.2 FEMA Regulatory Compliance

The Arkansas River reach of interest is designated by FEMA as an approximate Zone A flood hazard area. The Zone A designation means that it is within the 100-year floodplain but no detailed hydraulic study was performed for that reach. Because no detailed study was performed, there is no regulatory floodway in the study reach.

Because the location of the project is in a Zone A flood hazard area without a regulatory floodway, FEMA and City of Pueblo floodplain compliance requires that the proposed bridge would cause no more than a 1.0 foot rise in the 100-year water surface profile over natural (no-bridge) conditions.

3.3 Designing the Bridge to Resist Scour

Scour criteria have been derived from the Federal Highway Administration document HEC-18, "Evaluating Scour at Bridges," and the CDOT Drainage Design Manual (2004). The bridge should be designed to withstand and accommodate the predicted scour depth from a 100-year flood. This means that the design should meet all appropriate structural and geotechnical safety factors after the removal of the streambed material to the predicted scour depth. The designers should consider the increased unsupported length of the piers and foundations. The lateral force exerted on the piers by the high-velocity flow should also be considered. The bridge is designed to prevent failure of the structure (with all safety factors at least equal to 1.0) under the predicted 500-year scour conditions.

3.4 Minimizing Impacts on Channel Stability

The replacement structure should not decrease the overall channel stability in the subject river reach. Adverse impacts to the stability of the floodwall must be avoided.

4. RIVER HYDRAULIC ANALYSIS

Steady-state hydraulic analyses of the Arkansas River in the project area were performed using HEC-RAS v3.1.3, a 1-dimensional hydraulic simulation program developed and maintained by the Hydrologic Engineering Center of the U.S. Army Corps of Engineers. HEC-RAS was also used to perform a hydraulic analysis of the UPRR & BNSF rail yards to assess the 500-year event scour potential at the rail yard piers.

4.1 Existing Bridge

The existing S.H. 96A (4th Street) Bridge, which spans the Arkansas River, and Union Pacific (UPRR) and Burlington Northern Santa Fe (BNSF) rail yards is approximately 1,070 feet long. The bridge also spans the Arkansas River floodwall that separates the River from the two rail yards. Where the bridge crosses the floodwall, the low chord is about 5 feet above the top of the floodwall. The west abutment of the bridge is located on top of a natural bluff that defines the right bank of the Arkansas River floodplain. The road elevation at the west abutment location at the top of the bluff is approximately 4717 feet. The east abutment of the bridge is located on fill at the east edge of the UPRR & BNSF rail yards. The road elevation at the east abutment is approximately 4693 feet. The existing structure in the Arkansas River floodplain (between the floodwall and the bluff) is a single, 3 foot-wide vertical wall pier with a triangular shaped nose. **Figure 4.1** is a photograph taken from upstream of the bridge looking downstream from the top of the floodwall. An aerial photo of the bridge and surrounding area is shown in **Figure 4.2**. Five piers are located in the two rail yards that occupy most of the 726 feet between the floodwall and the left abutment. The rail yard piers are 5-column bents that have 3 feet by 4 feet bent caps.

Figure 4.1. Looking downstream at existing S.H. 96A bridge over Arkansas River.

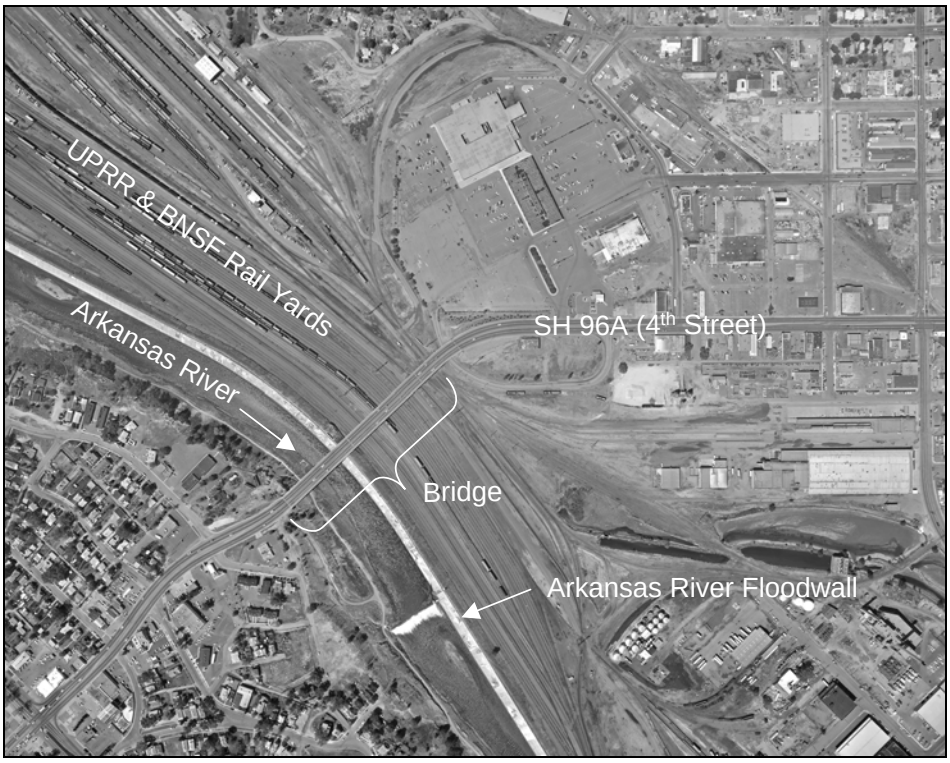

Figure 4.2. Aerial photograph of existing bridge and surrounding area. Arkansas River flows from left to right in the photograph.

4.1.1 Flow Patterns

As discussed previously, the predominant portion of the flow in the Arkansas River during the 100- and 500-year events comes from Wildhorse Dry Creek. Wildhorse Dry Creek has a levee on its left (east) bank ties into the Arkansas River floodwall, which begins at the confluence.

The existing floodplain at the bridge location has a low flow channel approximately 132 feet wide beginning on the left side at the toe of the floodwall and a right overbank area that is approximately 91 feet wide from the main channel to the toe of the bluff on the west side. The USACE Arkansas River Fisheries Habitat Restoration (FHR) project (USACE 2003) had only a minor impact on the present conditions in the project area, which have been incorporated into the current hydraulic modeling.

4.1.2 Hydraulic Modeling Approach

Ayres Associates developed a hydraulic model of the Arkansas River from approximately 1,200 feet downstream of the existing bridge to approximately 1,000 feet upstream. The downstream limit of the model is approximately 300 feet downstream of the Historic Arkansas River of Pueblo (HARP) diversion structure and is located at the crest of Drop #2 from the Arkansas River FHR Project. This location of the downstream starting water surface elevation allowed the analysis to assure that a reasonable variation in tailwater depths below the HARP diversion structure would have a minimal impact on model results at the bridge. The downstream water surface elevation (WSEL) or boundary condition was set for each modeled discharge by HEC-RAS as the critical depth.

The geometry for the model cross sections in both the Arkansas River and the rail yards was developed in Microstation from topographic mapping supplied by Abel Engineering, Inc. The mapping included channel bathymetry for the low flow channel and incorporates the FHR project construction. Model cross sections were placed at locations to represent changes in roughness, channel width, depth, and variations in overbank configuration likely to impact hydraulic properties at the bridge. Cross section locations are displayed over an aerial photo in **Figure 4.3**. Reach lengths between cross sections and overbank elevations were also obtained from the project topographic mapping in Microstation. Channel lengths were measured along the channel thalweg, and overbank reach lengths were measured from the appropriate overbank center of conveyance at each cross section.

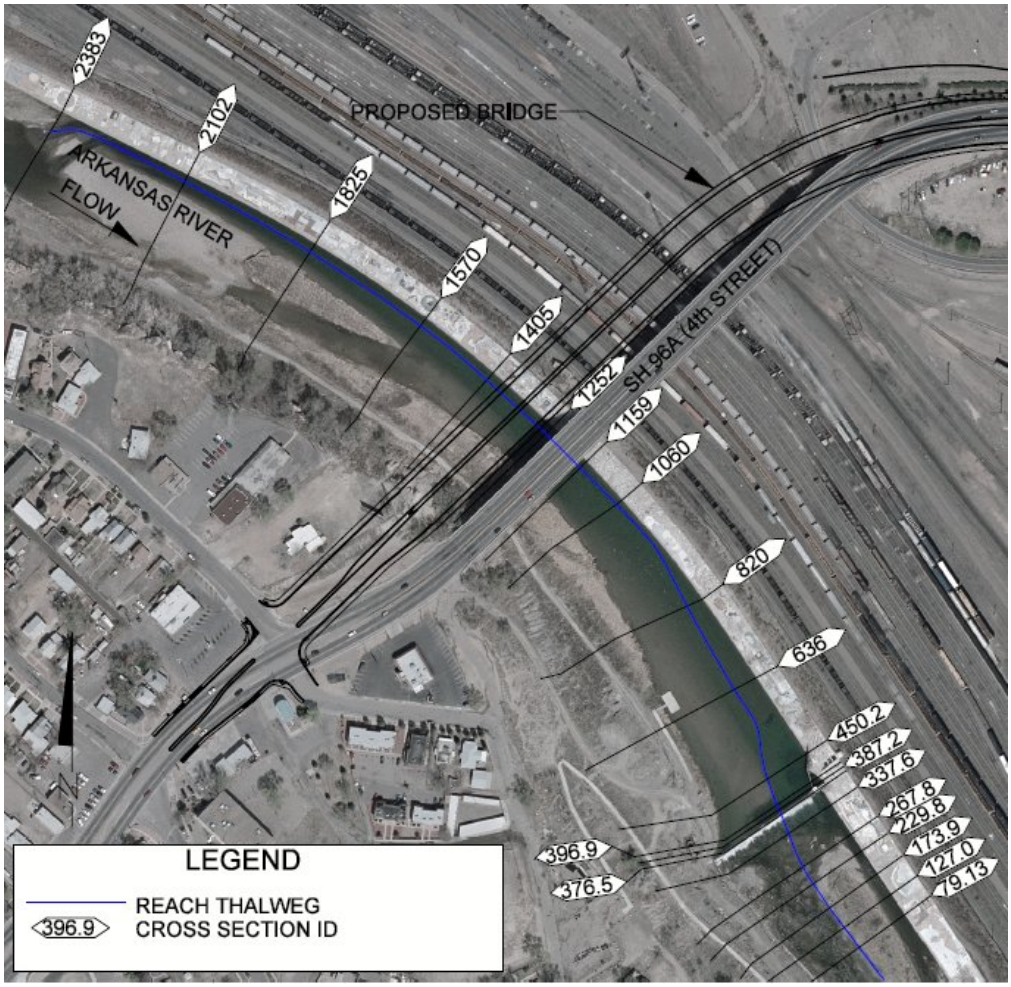

Figure 4.3. HEC-RAS model cross section locations.

Channel and overbank roughness estimates were based on field investigation and photographs taken on the January 24, 2006 site visit and results from a grain roughness analysis using Strickler (1923) and Limerinos (1970). Manning's roughness coefficient values for the main channel were set between 0.021 and 0.027, while the overbanks included roughness values for the concrete floodwall of 0.014, 0.035 in grassy areas, and 0.06 in moderately vegetated areas of willows and shrubs and 0.08-0.1 for mature tree covered areas upstream of the bridge.

The modeling for the analysis of the natural, existing, and proposed bridge were performed for the 10-, 50-, 100, and 500-year FEMA flow rates to verify compliance with both FEMA and City of Pueblo floodplain regulations. For the hydraulic design and evaluation of the bridge structure, scour depth, and bluff slope erosion protection, the 100- and 500-year design flow rates were modeled.

4.1.3 Hydraulic Performance of Existing Bridge

Appendix B contains cross section plots and a detailed table of results from the existing conditions HEC-RAS models. **Table 4.1** summarizes the results of the hydraulic analysis of existing conditions for the FEMA discharge rates. The water surface elevations in Table 4.1 were taken from River Station 1253, which is a cross section located about 15 feet upstream of the existing bridge. The velocity values were taken from the cross section just inside the bridge at the upstream face. The existing conditions model was prepared not only to assess the impacts of proposed design, but to determine the impacts that the existing bridge has over the natural (no-bridge) conditions. Water surface elevations immediately upstream of the bridge, at river station 1253, for the FEMA 100-year discharge were 4670.99 and 4672.12 feet for the natural and existing conditions, respectively. The model results indicate a water surface elevation increase of 1.13 feet upstream of the bridge, which is not within established criteria. **Figure 4.4** displays a water surface profile plot for 100-year FEMA flows representing existing conditions and no-bridge conditions. The flow passes through critical depth over the crest of the diversion structure in all of the floods that were modeled.

Table 4.1. Summary of Results from HEC-RAS Model of Existing Conditions at RS 1253.

Recurrence Interval (yrs)	WSEL at RS 1253 (ft-NAVD)	Main Channel Avenue Velocity at Bridge (fps)	Right Overbank Velocity at Bridge Pier (fps)
10	4668.24	7.19	5.16
50	4670.61	10.47	8.26
100	4672.12	12.64	10.36
500	4676.49	17.14	14.97

4.2 Proposed Bridge

4.2.1 Alternative Selection

Alternative bridge designs and configurations were not considered in the final phase of this project. In the preliminary phase of this project three separate layout options were analyzed, with respect to hydraulic conditions and scour depth, and based upon that analysis the Long Span Layout 3 was chosen as the preferred alternative (Ayres Associates 2003).

Hydraulically, the Long Span 3 option was desirable because it only places one pier in the Arkansas River floodplain and that pier is located in the right overbank where velocities are substantially lower than in the main channel. These lower velocities produce less scour and allow for simpler water control operations during construction.

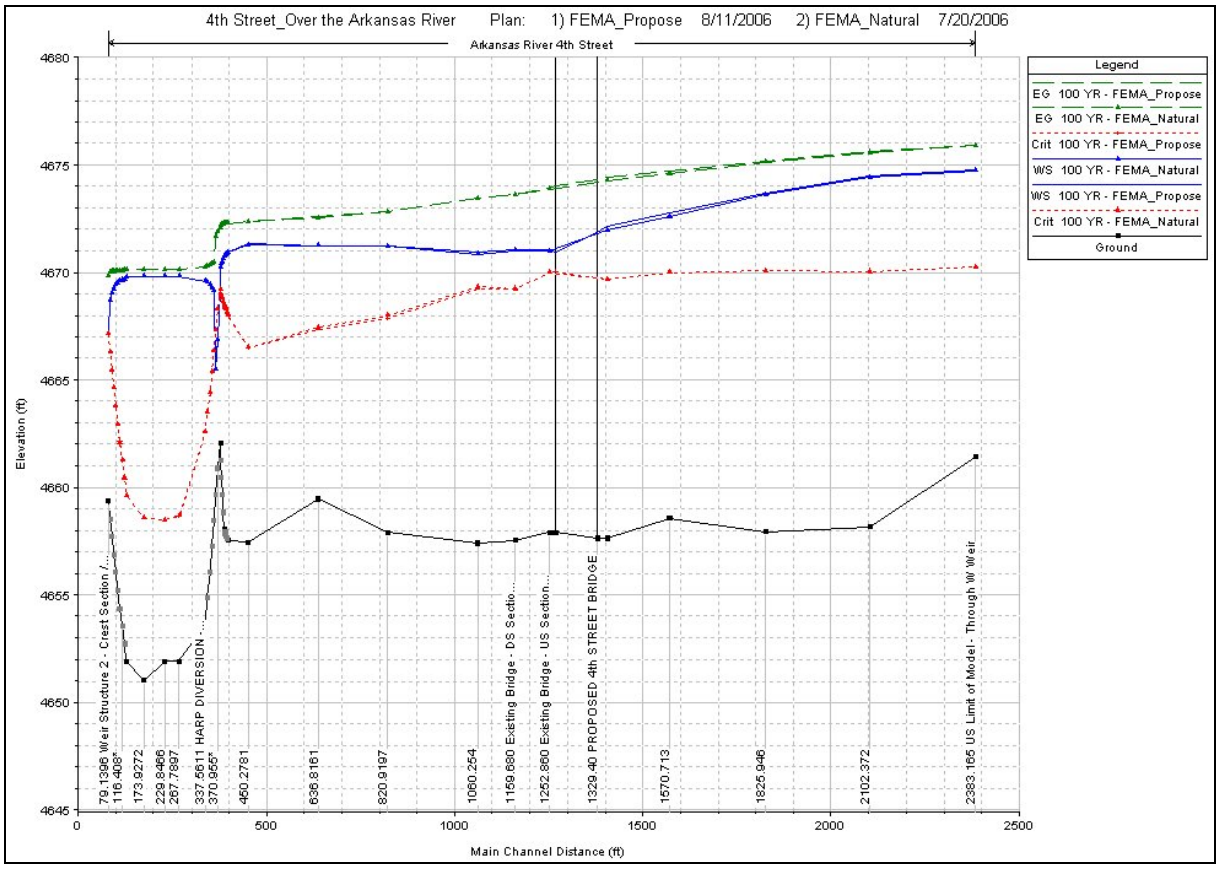

Figure 4.4. Comparison of the No-Bridge and Existing Condition Water Surface Profiles for the 100-year FEMA discharge.

4.2.2 Proposed Bridge Geometry

As shown in Figure 4.3, the proposed bridge will have parallel east- and west-bound bridges located immediately west of the existing bridge. Each bridge will be 54 feet wide, and carry two lanes of traffic and a sidewalk. The total bridge length will be 1,137 feet with 5 spans. A single pier for each bridge (Pier 2) will be located in the Arkansas River floodplain between the bluff and floodwall, but is located outside of the river channel on the overbank. Pier 3 will be located immediately east of, and on the back side of the floodwall, and will be dry for the 500-year event. Piers 4 and 5 span a minor channel in the rail yard area that would convey runoff that would circumvent the Wildhorse Dry Creek levee. The piers are each rectangular with a width of 3.83 feet. Flow patterns for the proposed condition will be essentially the same as for existing conditions.

4.2.3 Hydraulic Modeling Approach

The proposed condition was modeled in HEC-RAS to determine and compare its impacts on the water surface elevations for the FEMA discharges, and to provide hydraulic design information for the bridge used for the structural design of the bridge, computing maximum scour depths, and design of bluff slope protection.

The hydraulic modeling approach for proposed condition is essentially the same as discussed for existing conditions except for changes in bridge geometry. Those changes in bridge geometry included removing the existing bridge from the model and entering new bridge structure elements for the proposed bridge layout. As shown in Figure 4.3, the proposed bridge is modeled between cross sections 1252 and 1405.

4.2.4 Hydraulic Performance of Proposed Conditions

Appendix B contains cross section plots and a detailed table of results from the proposed condition HEC-RAS model. **Table 4.2** summarizes the results of the hydraulic analysis of the proposed conditions. **Figure 4.5** displays a water surface profile plot for 100-year FEMA flows representing no-bridge and proposed conditions. **Appendix E** contains a copy of the complete Bridge Hydraulics Information Sheet for proposed conditions

Table 4.2. Summary of Results from HEC-RAS Model of Proposed Conditions at RS 1406.

Recurrence Interval (yrs)	Proposed Water Surface Elevation at RS 1406 (ft-NAVD)	Main Channel Average Velocity at Bridge (fps)	Right Overbank Velocity at Bridge Pier 2 (fps)
10	4668.10	7.24	1.98
50	4670.48	10.61	3.16
100	4672.15	12.58	4.17
500	4677.00	16.50	6.29

4.2.5 Comparison of Water Surface Profiles for FEMA Compliance

The results of the HEC-RAS hydraulic model for the 100-year event FEMA discharge indicate that the proposed condition would result in a lower flood profile compared to the existing condition. The proposed condition flood profile would be slightly higher than the natural condition (a maximum rise of 0.2 feet), but would be below the allowable rise of 1.0 feet in a Zone A floodplain. A comparison of the water surface profiles is provided in **Table 4.3**.

Table 4.3. Comparison of Water Surface Profiles on the Arkansas River at the 4th Street No-Bridge for the, Existing, and Proposed Conditions.

Cross Section	100-year FEMA discharge WSEL (ft-NAVD)			Difference in WSEL (ft)	
	No Bridge	Existing Bridge	Proposed Bridge	Proposed – No Bridge	Proposed – Existing
Crest of HARP Diversion Weir					
338	4669.6	4669.6	4669.6	0.0	0.0
450	4671.3	4671.3	4671.3	0.0	0.0
637	4671.2	4671.2	4671.2	0.0	0.0
821	4671.2	4671.2	4671.2	0.0	0.0
1060	4670.9	4670.9	4670.9	0.0	0.0
1160	4671.0	4671.0	4671.0	0.0	0.0
Existing Bridge					
1253	4671.0	4672.1	4671.0	0.0	-1.1
Proposed Bridge					
1406	4671.9	4672.6	4672.1	0.2	-0.5
1570	4672.6	4673.1	4672.7	0.1	-0.4
1826	4673.6	4673.9	4673.7	0.1	-0.2
2102	4674.4	4674.6	4674.5	0.1	-0.1
2383	4674.7	4674.9	4674.8	0.1	-0.1

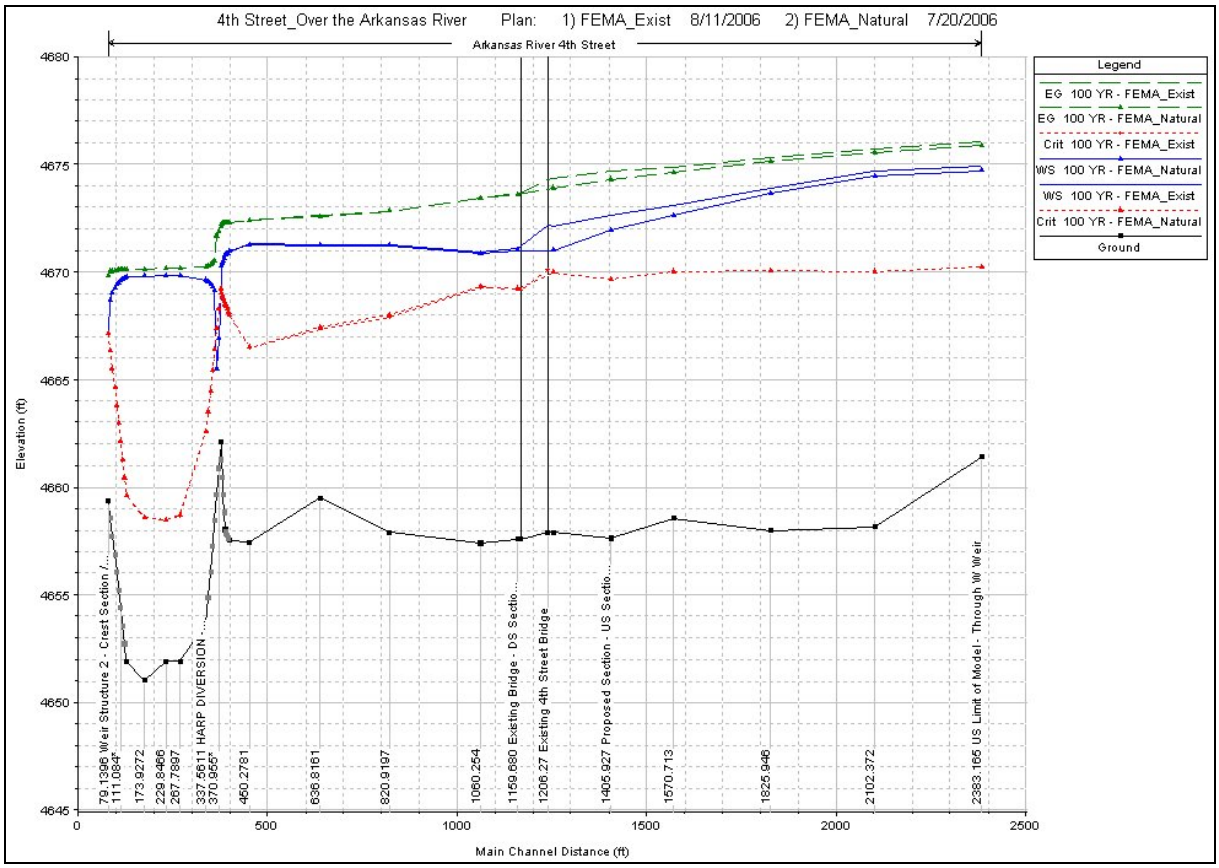

Figure 4.5. Comparison of the No-Bridge and Proposed Condition Water Surface Profiles for the 100-year FEMA discharge.

5. STABILITY AND SCOUR ASSESSMENT

5.1 Channel Description

A description of the channel, including geomorphic factors, is provided in Section 2.2 and Figure 2.2. The low-flow channel bed material is comprised of coarse gravel and small cobbles. A concrete-lined floodwall is at the left bank of the low-flow channel and forms the left limit of the floodplain. The right overbank is mostly vegetated with grasses and weeds. A tall, steep, natural bluff forms the right floodplain limit.

The rail yard area east of the floodwall potentially conveys a flow of about 2,800 cfs that could bypass the east Wildhorse Dry Creek levee in a 500-year flood. Much of the rail yard area is covered with railroad tracks. The proposed piers in the rail yard will be placed between tracks in areas of bare earth. The left edge of active flow in the rail yard will be defined by a small rise of existing high ground between the loop ramp road and the rail yard. The right edge is defined by the back side of the Arkansas River floodwall.

5.2 Scour Assessment

Ayres Associates conducted a full scour assessment of the proposed design, which has only one pier in the Arkansas River floodplain, and two piers subject to 500-year flows in the rail yard. The following sections discuss the potential scour components and Ayres' approach to assessing the scour potential.

5.2.1 Degradation Potential

Degradation is a vertical lowering of the channel bed that takes place over a long segment of the channel and over a long time frame. Where degradation is occurring, it can be discerned by such observations as multiple terraces within the flood plain, eroded, vertical or oversteepened banks along the low-flow channel and a lowering trend in the bed elevations reported in recent bridge inspections.

The subject reach of the Arkansas River does not show signs of degradation. The diversion structure downstream acts as a grade control structure, and appears to have prevented any degradational trend in the reach since its construction. The potential for degradation in the project reach is low as long as the diversion structure remains in place and functional.

Field photographs from the construction of the concrete weir structure indicate that it was founded on piles. Therefore, that structure is unlikely to fail as a result of a single flood. A scour-resistant claystone shale bedrock horizon exists a few feet below the surface. The presence of the bedrock suggests that even if the diversion structure did fail during a flood, it is unlikely that the resulting headcut could migrate the entire distance from the structure to the bridge (over 800 feet) during the same event. Therefore, the risk of a headcut threatening the bridge because of a failure of the downstream diversion structure is low.

5.2.2 Lateral Migration Potential

Lateral migration is the side-to-side movement of the main channel within a floodplain. It can cause piers that were originally outside the main channel to be captured within the main channel and subject them to higher flow velocities and angles of attack. Lateral migration can also undermine abutments.

Examination of maps, aerial photographs and ground photographs dating from about 1990 to 2001 show no evidence of low-flow channel migration in the project reach. The low-flow channel appears to have remained in the same position within the floodplain over that eleven year time span. In addition, the completed USACE Fisheries Habitat Restoration Project has not appeared to have impacted the low flow channel alignment significantly.

5.2.3 Contraction Scour

Contraction scour is a general lowering of the streambed within the bridge opening waterway. It usually occurs over most or the entire bridge opening. Contraction scour is the result of constrictions in the floodplain flow area caused by the bridge structure and roadway embankments. In the case of the proposed design, minor flow area constriction is caused by the placement of a pier in the floodplain and by the fact that the flow is locally shallower in the bridge waterway than just upstream.

The contraction scour calculations were performed in accordance with the Federal Highway Administration document HEC-18, "Evaluating Scour at Bridges" (Richardson et al. 2001). Ayres used discharge rates of 20,500 and 23,500 cfs, respectively for the 100- and 500-year scour calculations.

The 100- and 500-year flow velocities exceed the critical velocity for entraining sediment across the entire flow width in the project reach. As a result of the high velocities, live-bed contraction scour is expected across the entire bridge waterway. In live-bed contraction scour, sediment is transported into the bridge waterway by the upstream flow and the scour results from an excessive sediment transport capacity within the bridge waterway. The computed contraction scour depths for the proposed design are 0.9 feet in the 100-year flood and 1.1 feet in the 500-year flood.

5.2.4 Abutment Scour

Abutment scour is localized, deep erosion that occurs at bridge abutments. It is caused by the redirection of flow that is exerted by road embankments and the abutment itself. In this case no abutment scour is expected because the left edge of the floodplain is the floodwall, with no bridge abutment, and the right abutment will be located on top of the bluff and will not obstruct the flow.

5.2.5 Pier Scour

Pier scour is localized, deep erosion that occurs at bridge piers. High velocity flow against a pier causes an intense, horseshoe-shaped, horizontal vortex at the upstream end of the pier and along both sides. A vertical vortex forms just downstream in the wake of the pier. The horseshoe vortex and wake vortex exert erosive power on the stream bottom at the base of the pier. The depth of pier scour is affected by:

- Velocity and depth of the flow
- Width of the pier
- Shape of the pier
- Attack angle of the flow in relation to the axis of the pier
- Length of the pier if the flow is not aligned with the pier
- Competence of the streambed material to resist scour

Ayres made the pier scour calculations in accordance with HEC-18. The velocity and depth of flow came directly from the HEC-RAS model results. The geometric characteristics and shape of the piers were derived from the design information supplied by Figg Bridge Engineers. Ayres assumed the flow to be aligned with the pier axes because of the relatively straight and uniform planform of the channel and floodplain. The channel is in a mild bend at the bridge site, but the degree of curvature is not so great as to cause the flow to attack the pier at a bad angle.

Ayres computed the pier scour from the 100- and 500-year events for piers in the Arkansas River floodplain. The roughly 2,800 cfs that bypasses the Wildhorse Dry Creek levee in a 500-year flood could cause scour at the piers in the rail yard area. Ayres therefore computed 500-year pier scour values for those piers. The computed pier scour at the single river pier in the proposed design was 9.5 and 10.2 feet, respectively for the 100- and 500-year floods.

5.2.6 Total Potential Scour

Table 5.1 summarizes the potential scour computed for the proposed design. The lone pier in the Arkansas River floodplain is designated pier 2. This summary does not account for the effects of scour-resistant bedrock, which is discussed in the next section. The detailed scour calculations are included in **Appendix C**.

Table 5.1. Scour Summary for Proposed Design.

Pier	Streambed Elevation (ft-NAVD)	Degradation (ft)	Contraction Scour (ft)	Pier Scour (ft)	Total Scour (ft)	Potential Post-Scour Elevation (ft-NAVD)
100-year Event						
2	4665.3	0.0	0.9	9.5	10.4	4654.9
500-year Event						
2	4665.3	0.0	1.1	10.2	11.3	4654.0

5.2.7 Scour Resistance of the Underlying Bedrock

A horizon of claystone shale bedrock exists roughly 8 feet beneath ground at the location of the proposed pier location, with competent bedrock at a depth of 10 feet. This bedrock material resists scour, but is known to be erodible under certain conditions. Annandale (1999) describes a methodology for estimating the depth of scour in erodible bedrock, as a percentage of the unimpeded scour computed by standard HEC-18 methods. The use of this method requires the prior evaluation of the Erodibility Index, as described in the NRCS National Engineering Handbook (NRCS 1997). West & Associates examined the claystone shale material at surface exposures and at a sample obtained from a geotechnical boring in order to evaluate the Erodibility Index, a dimensionless parameter. As a result of this investigation, West & Associates reported a range of possible values for the Erodibility Index from 89 to 151.

Ayres Associates applied the Annandale procedure, using the low end of the range of the Erodibility Index (the highest erodibility in the range) determined by West & Associates. This calculation predicts that the scour will not extend below the bedrock horizon. **Table 5.2** summarizes the post-scour elevations modified to account for the scour-resistant bedrock.

Table 5.2. Scour Summary - Proposed Design Considering Scour - Resistant Bedrock.				
Pier	Streambed Elevation (ft-NAVD)	Potential Post-Scour Elevation (ft-NAVD)	Approximate Bedrock Elevation (ft-NAVD)	Adopted Post-Scour Elevation (ft-NAVD)
100-year Event				
2	4665.3	4654.9	4655.5	4655.5
500-year Event				
2	4665.3	4654.0	4655.5	4655.5

5.2.8 Rail Yard Pier Scour

The roughly 2,800 cfs that could bypass the east Wildhorse Dry Creek levee in the 500-year flood could potentially cause local scour at the two piers in the rail yard. No flow from Wildhorse Dry Creek is expected in the rail yard in the 100-year event. Ayres computed the 500-year potential scour at the rail yard piers. **Table 5.3** summarizes the computed 500-year scour depth. Pier 4 is located approximately 375 feet northeast of the back slope of the floodwall. Pier 5 is the next pier to the east, located in an open strip of the yard and approximately 150 feet southwest of
the proposed east abutment.

Table 5.3. Scour Summary for Rail Yard Piers.					
Pier	Streambed Elevation (ft-NAVD)	Contraction Scour (ft)	Pier Scour (ft)	Total Scour (ft)	Potential Post-Scour Elevation (ft-NAVD)
500-year Event					
4	4667.4	0.0	3.8	3.8	4663.6
5	4666.9	0.0	5.5	5.5	4661.4

5.3 Foundation and Countermeasure Recommendations

The foundations of the new piers should be designed to withstand and accommodate the predicted scour. The design should meet all appropriate geotechnical and structural safety factors assuming that the 100-year scour has occurred. The design should prevent failure of the bridge, with safety factors set greater than or equal to 1.0, assuming the 500-year scour has occurred.

The left limit of the Arkansas River is the concrete-lined floodwall. Erosion or scour countermeasures are not required at that location in conjunction with the proposed design.

The right limit is the natural bluff. The slope of the bluff below the proposed abutment and at the location of the existing bridge will be regraded at a 2h:1v slope, with no significant change to the location of the existing bluff toe as part of the project. Under proposed design, the toe of the bluff will not be subjected to any higher velocity or shear stress than under existing conditions. The design of the bluff slope protection is controlled by the slope height/length and steepness, rather than velocity and shear stress from the river flows. At a minimum, the bluff slope will be protected by a 6-inch D_{50} riprap or a permanent turf reinforcing mat (TRM) planted with native grasses. Calculations for the design of the bluff slope countermeasures are provided in **Appendix D.**

6. REFERENCES

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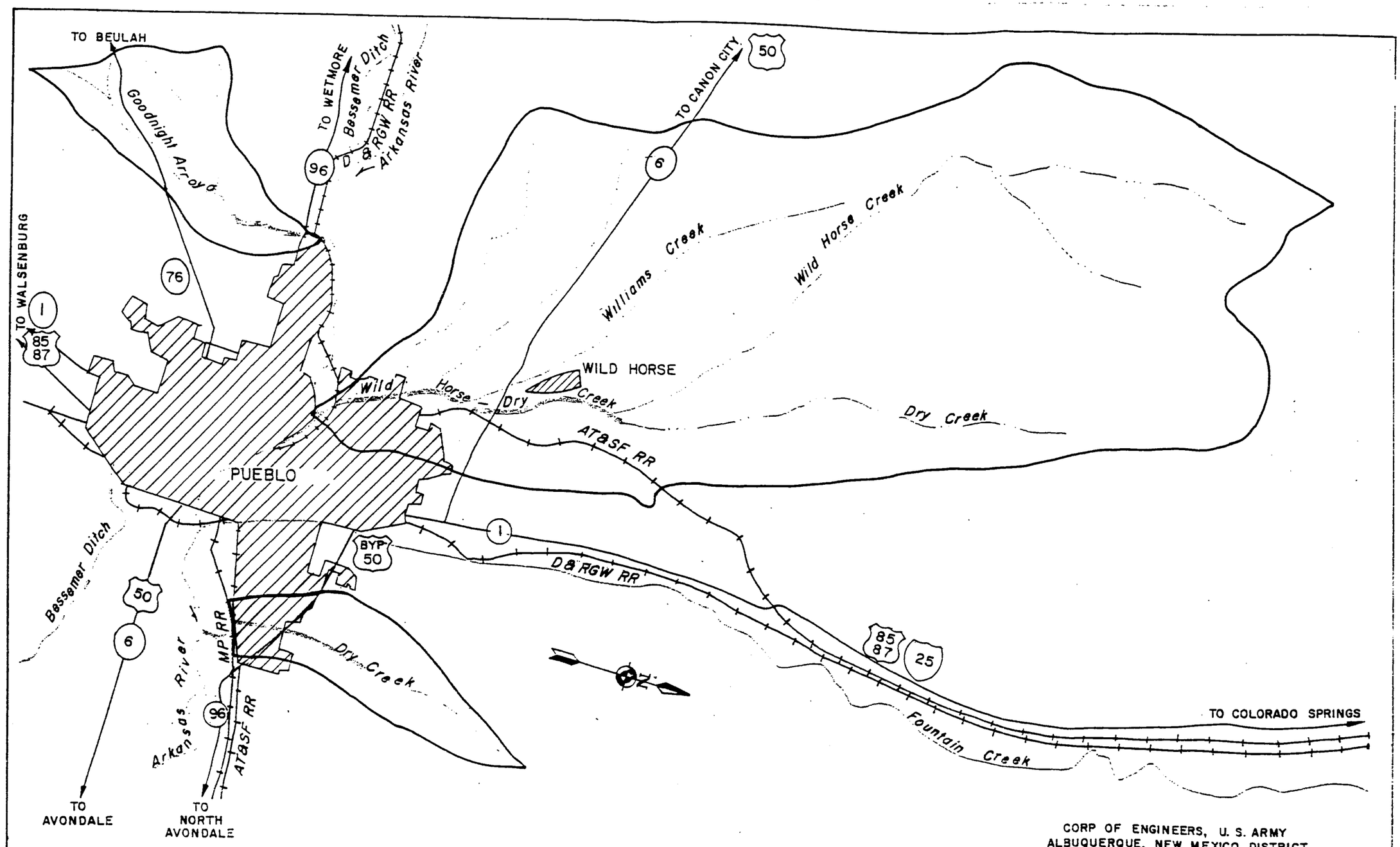
APPENDIX A
Hydrology Documentation



CORP OF ENGINEERS, U. S. ARMY
ALBUQUERQUE, NEW MEXICO DISTRICT

GOODNIGHT ARROYO, WILDHORSE-DRY CREEK, DRY CREEK WATERSHED

VICINITY OF PUEBLO, COLORADO

SCALE 0 1 2 3 4 MILES

APRIL 1969

PLATE 1

WILD HORSE-DRY CREEK FLOOD FREQUENCY VERIFICATION

Pueblo, CO FIS (1986) Discharge Data

Recurrence Interval Years	Peak Discharge, Q cfs
10	5700
50	14000
100	19500
500	39500

DISCHARGES COMPUTED USING REGIONAL REGRESSION EQUATIONS

TECHNICAL MEMORANDUM NO. 1

Basin Area = 87.3 mi^2 Δ Elev. = 1320 ft

S_b = 62.0 ft/mi Dist. = 21.31 mi = 112498 ft

Rf = 1302 ft

Recurrence Interval Years	Peak Discharge, Q cfs
10	6101
50	14502
100	19989
500	39784

Note: The area and distance were obtained by digitizing the drainage basin area, and the longest flow line through the basin off of a 1:250,000 scale contour map into MicroStation. The MicroStation file is named "w.h.basin".

USGS 99-4190, PLAINS REGION

Recurrence Interval Years	Peak Discharge, Q cfs
10	2179
50	6435
100	9289
500	19314

USGS Water-Resources Investigations Report 87-4094

Recurrence Interval Years	log(Q)	Peak Discharge, Q cfs
10	3.96	9195
50	4.55	35834
100	4.75	56106
500	-	-

Hydrology for Small Watersheds (TR-55) Calculations

Q = runoff (in)
P = rainfall (in) (from NOAA Atlas 2)
S = potential maximum retention after runoff begins (in)
Cn = curve number

Assume soil type =	B			
Cover type =	Brush			
Hydrologic condition =	Poor			
Cn =	67	(from Table 2-2c)		
Estimated Impervious Area =	10499269	ft^2 =	0.38	mi^2
% Impervious Area =	0.43			
Unadjusted Cn =	67			
S (in) =	4.93			

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)}$$

Recurrance Interval	Rainfall 24 hr. (in)	Runoff (Q) (in)
10	3	0.5850
50	4	1.1448
100	4.5	1.4638

Time of Concentration

T_t (hr) = travel time
T_c = time of concentration
L (ft) = flow length
V (ft/s) = average velocity
P_2 (in)= 2-yr, 24 hour rainfall
s (ft/ft) = slope of hydraulic grade line (land slope)
n = Manning's roughness coefficient
r = hydraulic radius (ft) and is equal to a/p_w
a (ft^2) = cross sectional flow area
p_w (ft) = wetted perimeter

Sheet Flow

n =	0.13	(natural) Table 3-1
P_2 (in) =	2	
s (ft/ft) =	0.040	
L (ft) =	200	
Tt =	$\frac{0.007(nL)^{0.8}}{(P_2)^{0.5}s^{0.4}k}$	
Tt (hr) =	0.2431	

Shallow Concentration Flow

L (ft) =	200	
V (ft/s) =	1.63	(from fig. 3-1)
Tt =	$\frac{L}{3600V}$	
Tt (hr)	0.034	

Channel Flow

L (ft) =	112498	
V (ft/s) =	20	(from April 1969 Pueblo Flood Plain Information, p. 45, Table 10)
Tt =	$\frac{L}{3600V}$	
Tt (hr)	1.562	

T_c (hr) = 1.84

Peak Discharge Computations

Rainfall Distribution Type = II
Cn = 67
I_a (in) = 0.985
Peak Discharge = q_p (cfs)= $q_u * A * Q * F_p$

Recurrance Interval (years)	24 hr. Rainfall (in)	I_a/P	q_u (csm/in) Table 4-II	Runoff (Q) (in)	F_p (pond and swamp adjuster)	Peak Discharge (q_p) (cfs)
10	3	0.33	185	0.58	1	9449
50	4	0.25	210	1.14	1	20989
100	4.5	0.22	225	1.46	1	28755

Pueblo Dam Maximum Flood Discharge (cfs) - Using Various Flood Frequency Studies

Frequency (years)	Projected Site Specific Data	1997 Hydrographs Modified Using Paleo Rain Storm	1997 Hydrographs Modified Using Paleo Rain-on-Snow	1921 Flood Modified Using Paleo Rain Storm	GEV Balanced Hydrographs	GEV Adjusted to Wakeby Volume	1997 Hydrographs
10	6,000	6,000	6,000	6,000	6,000	6,000	6,000
12	6,000	6,000	6,000	6,000	6,000	6,000	6,000
15	6,000	6,000	6,000	6,000	6,000	6,000	6,000
20	6,000	6,000	6,000	6,000	6,000	6,000	6,000
30	6,000	6,000	6,000	6,000	6,000	6,000	6,000
50	6,000	6,000	6,000	6,000	6,000	6,000	6,000
100	6,000	6,000	6,000	6,000	16,583	6,000	6,000
200		6,000	6,000	6,000	23,053	8,607	6,000
500		6,000	6,000	6,000	33,171	21,146	6,000
1,000		14,294	6,000	6,000	41,601	27,316	6,000
2,000		30,650	6,000	6,000	51,040	32,961	6,000
5,000		52,836	6,863	6,000	64,534	41,496	7,814
10,000	25,275	69,256	9,515	7,369	75,250	49,379	11,560
20,000		84,383	14,494	21,272	86,819	58,115	18,880
50,000		102,424	20,916	52,114	102,535	71,918	30,642
100,000		115,044	25,616	82,032	115,291	83,762	42,034
200,000		126,376	30,064	116,201	128,413	96,862	57,105
500,000		140,901	35,224	168,872	147,299	116,700	86,317
1,000,000		150,608	38,948	211,063	162,046	133,837	120,432

Note: None of the methods shown are approved for use. .
The minimum flow of 6,000 cfs is actually the maximum controlled discharge based on safe downstream channel capacity. Actual flows could be lower.

Table 2. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Arkansas River	4,790.00[1]	7,000	14,000	20,000	40,000[2]
Above Santa Fe Avenue	4,790.00[1]	7,000	14,000	20,000	41,000[2]
Above Mouth of Fountain Creek	5,717.00[1]	20,000	48,000	67,000	140,000
Downstream from Fountain Creek					
Fountain Creek					
3,500 Feet Upstream from State Highway 47	917.00	18,500	45,000	64,000[3]	130,000[4]
Downstream of 8th Street	920.00	18,500	45,000	58,000[3]	99,000[4]
At Mouth	927.00	18,500	45,000	64,000	99,000
Fountain Creek East Bank Overflow Downstream	N/A[5]	N/A[6]	N/A[6]	6,000	N/A[7]
University Park Tributary					
1,930 Feet Upstream from Jerry Murphy Road	0.89	450	1,010	1,370	4,100
At Jerry Murphy Road	1.25	610	1,430	1,970	6,100
Wild Horse-Dry Creek	74.58	5,600	13,400	18,500	37,500
2,980 Feet Upstream from 24th Street					
Downstream of Denver & Rio Grande Western Railroad	86.80	5,700	14,000	19,500	39,500

1 4,670 square miles controlled by Pueblo Dam at River Mile 1,293.7
2 Occurs when storm is centered over Fountain Creek and split flows from Fountain Creek are flowing into the Arkansas River above the mouth of Fountain Creek.
3 Discharge in Main Channel only
4 Decrease in discharge due to loss to West Bank Overflow
5 Split flow area-see Fountain Creek above
6 No 10- or 500-year overflow into East Bank area
7 East Bank area considered in Main Channel analysis for 500-year flood

EXCERPT FROM FEMA FIS - CITY OF PUEBLO, 1986

EXCERPT FROM USACE, 1969. "FLOODPLAIN INFORMATION - GOODNIGHT ARROYO, DRY CREEK & WILD HORSE CREEK," PUEBLO, CO.

discharge and stage data, past floods cannot be compared with the Intermediate Regional Floods on the study reaches.

Peak discharges of the Intermediate Regional Floods on Wild Horse-Dry Creek, Dry Creek, and Goodnight Arroyo at specified river mile locations are shown in Table 7. The maximum known floods that have occurred on watersheds comparable with the study areas and within the geographical region are listed in Table 8.

TABLE 7

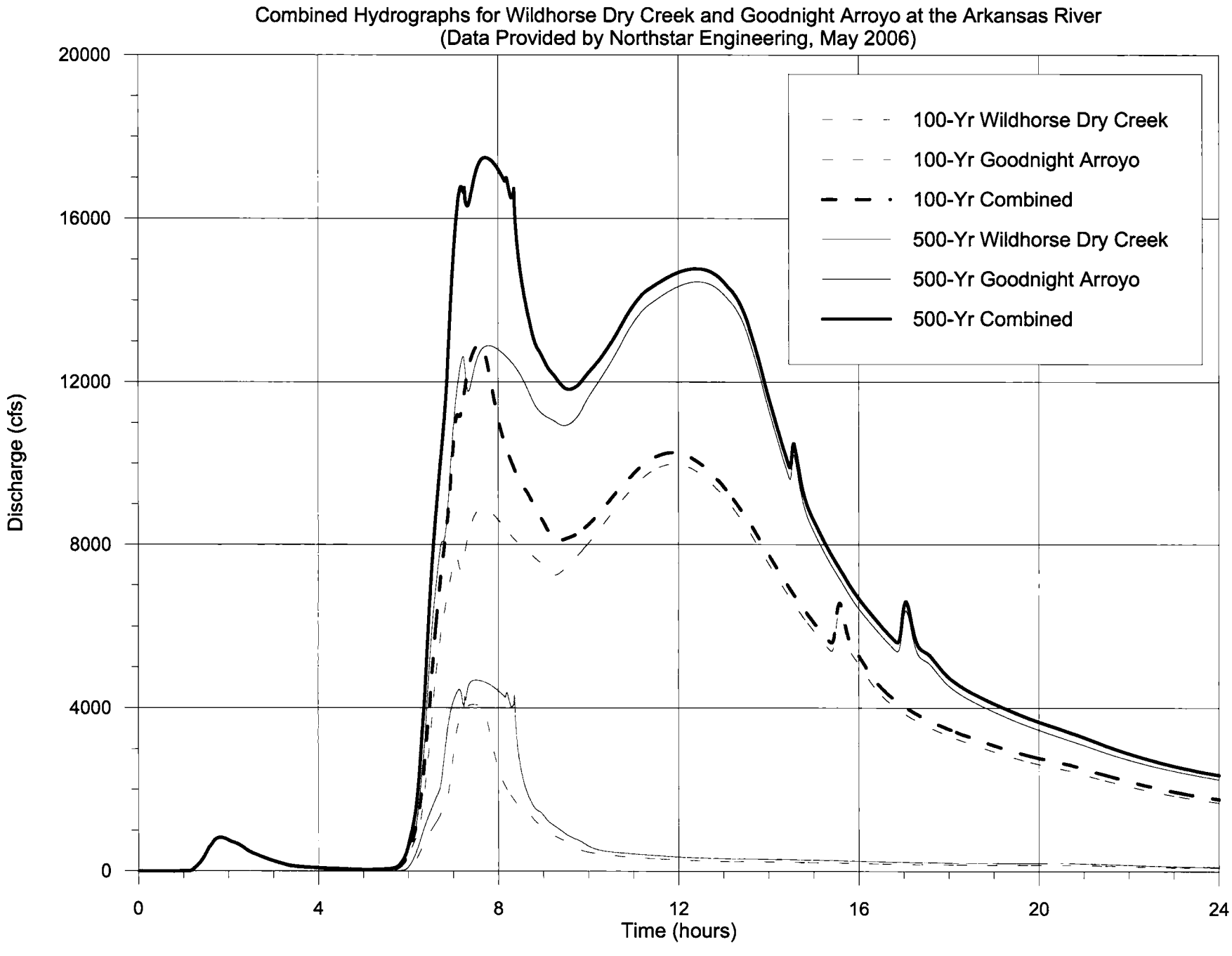
INTERMEDIATE REGIONAL FLOOD

PEAK DISCHARGES

Stream	Location	Mile Above Mouth	Drainage Area sq. miles	Discharge c.f.s.
Wild Horse-Dry Creek	D. & R.G.W. bridge	0.33	82.8	19,600
	0.75 miles below U.S. Highway 50	2.55	69.6	19,000
Dry Creek	Mouth	0.07	5.4	2,900
	About 0.10 mile upstream of U.S. Hwy. 50 Bypass	1.63	4.1	2,750
Goodnight Arroyo	Mouth	0.00	5.9	3,100
	0.40 miles upstream of Red Creek Road	2.07	5.1	3,000

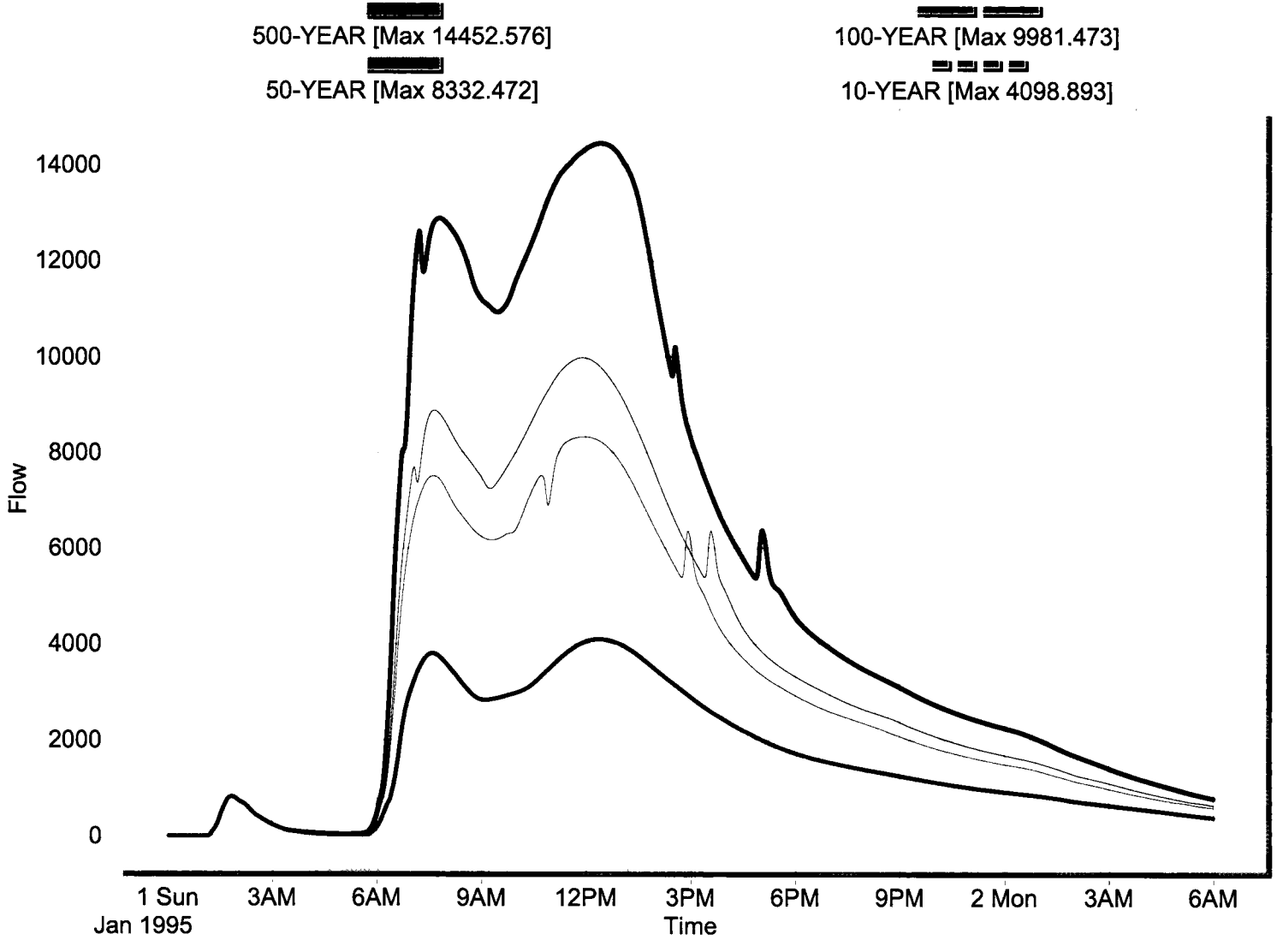
Determination of Standard Project Flood

Only in rare instances has a specific stream experienced the largest flood that is potentially possible. Severe as the maximum known flood may have been on any given stream, it is generally accepted that a larger flood will sooner or later occur. The Corps of Engineers, in cooperation with the Weather Bureau, has made comprehensive studies and investigations based on the vast records of experienced storms and floods and has evolved generalized procedures


Combined Hydrographs for Wildhorse Dry Creek and Goodnight Arroyo at the Arkansas River
(Data Provided by Northstar Engineering, May 2006)
Discharge (cfs)
20000
16000
12000
8000
4000
0
0
4
8
12
16
20
24
Time (hours)
100-Yr Wildhorse Dry Creek
100-Yr Goodnight Arroyo
100-Yr Combined
500-Yr Wildhorse Dry Creek
500-Yr Goodnight Arroyo
500-Yr Combined

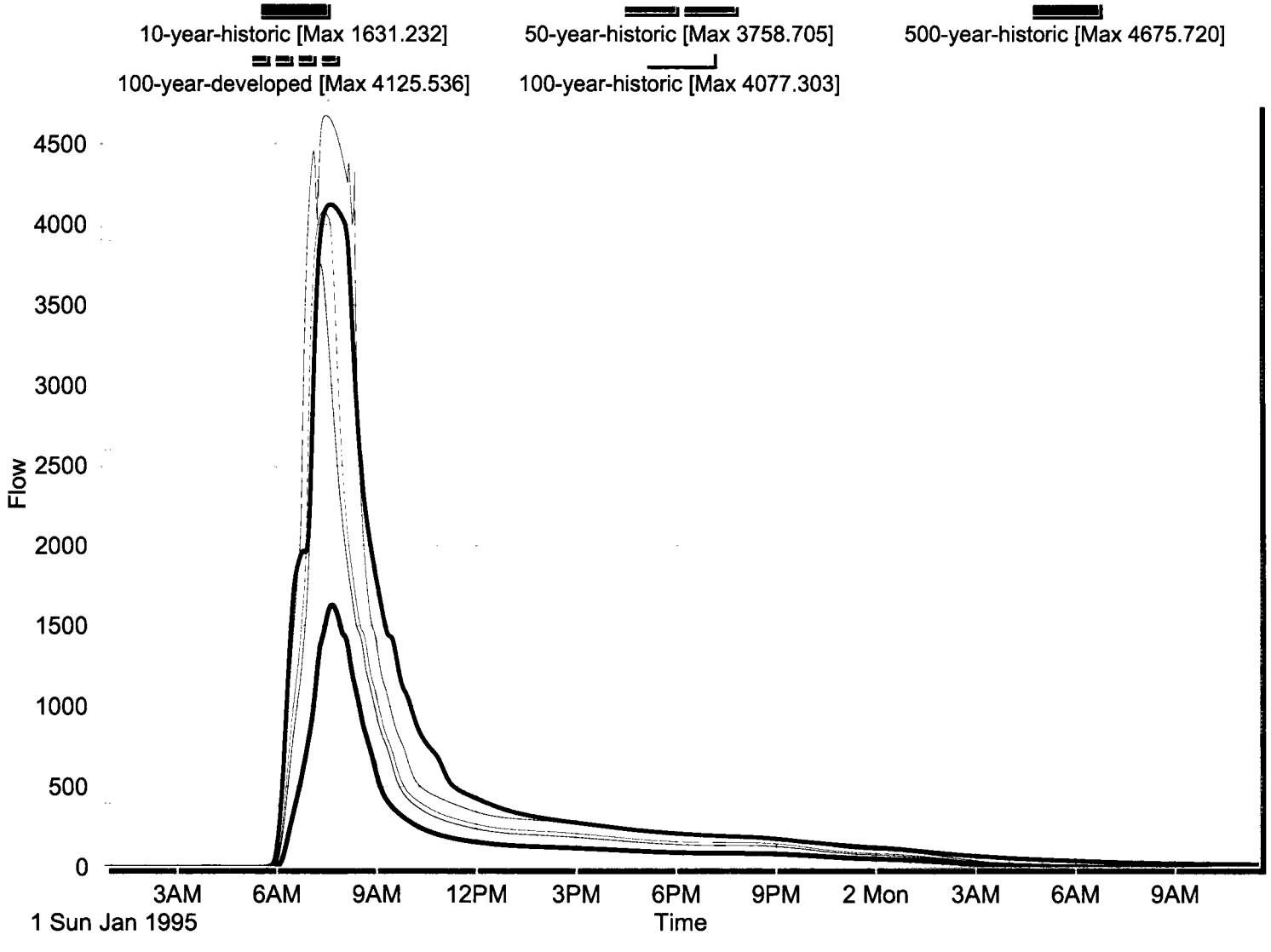
Wildhorse Dry Creek at the Arkansas River

Conduit L170 from N147 to D60



Goodnight Arroyo at the Arkansas River

Conduit L58 from N28 to N6



APPENDIX B
HEC-RAS Input and Output

Proposed Design
100- and 500-year Discharges.

HEC-RAS Plan: Design_Prop River: Arkansas River Reach: 4th Street

Reach	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)	
4th Street	79.1396	20500.00	4659.37	4667.2280	4667.2280	4669.9760	0.006055	13.30	1542.07	286.76	1.01
4th Street	79.1396	23500.00	4659.37	4667.7520	4667.7520	4670.7510	0.005849	13.90	1692.74	288.38	1.00
4th Street	84.4637*	20500.00	4658.54	4668.8140	4666.4100	4670.1340	0.001766	9.23	2230.71	290.29	0.58
4th Street	84.4637*	23500.00	4658.54	4669.4300	4666.9260	4670.9180	0.001803	9.80	2410.16	292.16	0.59
4th Street	89.7878*	20500.00	4657.71	4669.1650	4665.5450	4670.1730	0.001038	8.08	2556.91	290.31	0.47
4th Street	89.7878*	23500.00	4657.71	4669.8080	4666.0820	4670.9590	0.001084	8.64	2744.33	292.60	0.49
4th Street	95.1119*	20500.00	4656.88	4669.3750	4664.7070	4670.1960	0.000728	7.29	2839.27	290.84	0.40
4th Street	95.1119*	23500.00	4656.88	4670.0380	4665.2500	4670.9850	0.000773	7.84	3032.87	293.53	0.42
4th Street	100.436*	20500.00	4656.05	4669.5200	4663.8800	4670.2120	0.000541	6.70	3099.38	292.46	0.35
4th Street	100.436*	23500.00	4656.05	4670.1980	4664.4210	4671.0020	0.000583	7.23	3298.70	295.73	0.37
4th Street	105.760*	20500.00	4655.22	4669.6230	4663.0330	4670.2240	0.000389	6.26	3348.07	295.96	0.31
4th Street	105.760*	23500.00	4655.22	4670.3130	4663.5980	4671.0150	0.000424	6.77	3553.02	298.21	0.33
4th Street	111.084*	20500.00	4654.39	4669.7080	4662.1960	4670.2330	0.000308	5.86	3593.62	296.94	0.28
4th Street	111.084*	23500.00	4654.39	4670.4080	4662.7580	4671.0260	0.000340	6.36	3802.34	299.24	0.30
4th Street	116.408*	20500.00	4653.56	4669.7760	4661.3620	4670.2410	0.000248	5.52	3833.05	297.59	0.26
4th Street	116.408*	23500.00	4653.56	4670.4850	4661.9280	4671.0340	0.000276	6.01	4044.85	299.86	0.27
4th Street	121.732*	20500.00	4652.73	4669.8300	4660.5510	4670.2470	0.000190	5.24	4067.39	297.91	0.24
4th Street	121.732*	23500.00	4652.73	4670.5460	4661.1100	4671.0410	0.000213	5.72	4281.42	300.09	0.25
4th Street	127.0565	20500.00	4651.90	4669.8760	4659.6940	4670.2520	0.000159	4.99	4297.52	297.93	0.22
4th Street	127.0565	23500.00	4651.90	4670.5980	4660.2930	4671.0470	0.000179	5.46	4513.44	300.06	0.23
4th Street	173.9272	20500.00	4651.04	4669.9360	4658.6870	4670.2630	0.000130	4.66	4601.32	302.96	0.20
4th Street	173.9272	23500.00	4651.04	4670.6670	4659.2570	4671.0600	0.000148	5.11	4823.74	305.19	0.21
4th Street	229.8466	20500.00	4651.93	4669.9560	4658.5590	4670.2710	0.000124	4.57	4677.23	308.03	0.19
4th Street	229.8466	23500.00	4651.93	4670.6910	4659.1370	4671.0690	0.000141	5.00	4904.57	310.27	0.21
4th Street	267.7897	20500.00	4651.93	4669.9550	4658.7530	4670.2780	0.000128	4.62	4640.28	313.20	0.20
4th Street	267.7897	23500.00	4651.93	4670.6910	4659.3280	4671.0780	0.000145	5.06	4871.68	315.74	0.21
4th Street	337.5611	20500.00	4653.66	4669.7360	4662.6720	4670.3940	0.000432	6.64	3306.51	300.08	0.32
4th Street	337.5611	23500.00	4653.66	4670.4410	4663.3120	4671.2080	0.000473	7.18	3519.79	304.51	0.33
4th Street	343.126*	20500.00	4654.86	4669.6580	4663.6460	4670.4320	0.000554	7.21	3057.43	297.66	0.35
4th Street	343.126*	23500.00	4654.86	4670.3540	4664.2250	4671.2500	0.000600	7.77	3266.47	302.35	0.37
4th Street	348.692*	20500.00	4656.06	4669.5570	4664.4970	4670.4800	0.000774	7.88	2802.04	295.04	0.40
4th Street	348.692*	23500.00	4656.06	4670.2440	4665.1740	4671.3030	0.000828	8.46	3006.45	300.03	0.42
4th Street	354.258*	20500.00	4657.26	4669.4160	4665.5070	4670.5480	0.001072	8.75	2535.20	292.18	0.47
4th Street	354.258*	23500.00	4657.26	4670.0900	4666.1750	4671.3760	0.001129	9.35	2734.14	297.45	0.49
4th Street	359.824*	20500.00	4658.47	4669.2450	4666.4870	4670.6310	0.001494	9.72	2260.65	289.04	0.55
4th Street	359.824*	23500.00	4658.47	4669.9130	4667.1110	4671.4630	0.001539	10.31	2455.46	294.69	0.56
4th Street	365.390*	20500.00	4659.67	4665.5520	4667.4420	4671.8020	0.015350	20.25	1048.79	245.22	1.58
4th Street	365.390*	23500.00	4659.67	4666.0870	4668.0550	4672.6310	0.014172	20.79	1182.26	252.32	1.54
4th Street	370.955*	20500.00	4660.87	4666.9720	4668.3830	4671.9980	0.011348	18.38	1189.52	259.86	1.38
4th Street	370.955*	23500.00	4660.87	4667.5070	4668.9770	4672.8230	0.010695	18.97	1330.18	265.81	1.36
4th Street	376.5217	20500.00	4662.07	4669.3050	4669.3050	4672.2420	0.003954	14.33	1603.30	285.32	0.97
4th Street	376.5217	23500.00	4662.07	4669.8860	4669.8860	4673.0700	0.003868	14.98	1771.00	291.88	0.97
4th Street	378.663*	20500.00	4661.26	4670.4310	4669.1130	4672.3500	0.002692	11.66	1963.33	296.64	0.71
4th Street	378.663*	23500.00	4661.26	4671.1280	4669.6970	4673.1900	0.002615	12.13	2172.11	301.68	0.71
4th Street	380.805*	20500.00	4660.45	4670.5320	4668.9880	4672.3650	0.002397	11.36	2024.48	297.65	0.68
4th Street	380.805*	23500.00	4660.45	4671.2150	4669.6010	4673.2020	0.002365	11.86	2229.30	302.31	0.68
4th Street	382.946*	20500.00	4659.65	4670.6170	4668.8780	4672.3770	0.002206	11.18	2081.09	297.98	0.65
4th Street	382.946*	23500.00	4659.65	4671.2930	4669.4910	4673.2130	0.002207	11.73	2284.08	302.63	0.66

HEC-RAS Plan: Design_Prop River: Arkansas River Reach: 4th Street (Continued)

Reach	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)	
4th Street	385.088*	20500.00	4658.84	4670.7590	4668.7050	4672.3940	0.001950	10.78	2155.29	298.83	0.62
4th Street	385.088*	23500.00	4658.84	4671.4390	4669.3250	4673.2310	0.001964	11.33	2359.98	303.42	0.63
4th Street	387.2300	20500.00	4658.03	4670.8870	4668.5600	4672.4090	0.001751	10.39	2225.10	299.53	0.59
4th Street	387.2300	23500.00	4658.03	4671.5690	4669.1280	4673.2470	0.001776	10.94	2430.98	304.10	0.60
4th Street	389.163*	20500.00	4657.93	4670.9120	4668.5040	4672.4140	0.001683	10.24	2232.55	299.53	0.58
4th Street	389.163*	23500.00	4657.93	4671.5920	4669.0790	4673.2520	0.001712	10.79	2437.92	304.19	0.59
4th Street	391.097*	20500.00	4657.83	4670.9360	4668.4290	4672.4190	0.001634	10.13	2241.84	298.88	0.57
4th Street	391.097*	23500.00	4657.83	4671.6120	4669.0530	4673.2570	0.001668	10.70	2446.19	304.31	0.58
4th Street	393.031*	20500.00	4657.74	4670.9600	4668.3930	4672.4240	0.001592	10.05	2253.39	298.23	0.56
4th Street	393.031*	23500.00	4657.74	4671.6340	4668.9890	4673.2610	0.001631	10.63	2456.98	304.40	0.58
4th Street	394.965*	20500.00	4657.64	4670.9910	4668.3030	4672.4290	0.001548	9.94	2268.49	297.31	0.55
4th Street	394.965*	23500.00	4657.64	4671.6620	4668.9080	4673.2670	0.001594	10.53	2470.94	304.52	0.57
4th Street	396.8996	20500.00	4657.54	4671.0320	4668.1600	4672.4360	0.001528	9.79	2289.20	296.74	0.54
4th Street	396.8996	23500.00	4657.54	4671.7030	4668.7820	4673.2720	0.001584	10.39	2491.39	304.73	0.56
4th Street	450.2781	20500.00	4657.45	4671.4260	4666.5830	4672.5140	0.000561	8.45	2541.67	264.06	0.44
4th Street	450.2781	23500.00	4657.45	4672.0880	4667.2350	4673.3530	0.000608	9.12	2719.22	271.86	0.46
4th Street	636.8161	20500.00	4659.48	4671.3590	4667.4600	4672.7290	0.000912	9.46	2261.71	252.41	0.51
4th Street	636.8161	23500.00	4659.48	4672.0070	4668.1580	4673.5900	0.000979	10.19	2427.81	260.63	0.53
4th Street	820.9197	20500.00	4657.89	4671.3570	4667.9970	4672.9920	0.001082	10.54	2158.14	248.97	0.55
4th Street	820.9197	23500.00	4657.89	4671.9970	4668.6700	4673.8750	0.001163	11.33	2319.53	255.13	0.58
4th Street	1060.254	20500.00	4657.42	4671.0070	4669.4010	4673.6120	0.001849	13.64	1809.24	219.32	0.72
4th Street	1060.254	23500.00	4657.42	4671.5330	4670.1860	4674.5840	0.002050	14.81	1925.88	224.69	0.76
4th Street	1159.680	20500.00	4657.56	4671.1680	4669.2920	4673.7900	0.001749	13.84	1852.64	225.47	0.70
4th Street	1159.680	23500.00	4657.56	4671.8180	4670.5300	4674.7810	0.001864	14.80	2000.12	228.38	0.73
4th Street	1252.860	20500.00	4657.91	4671.1450	4670.1180	4674.0870	0.002727	14.41	1729.25	220.77	0.77
4th Street	1252.860	23500.00	4657.91	4671.7670	4670.8950	4675.1090	0.002903	15.42	1867.54	223.82	0.80
4th Street	1329.40	Bridge									
4th Street	1405.927	20500.00	4657.64	4672.2950	4669.7280	4674.5790	0.001742	12.70	1950.86	220.72	0.65
4th Street	1405.927	23500.00	4657.64	4673.1860	4670.9560	4675.6780	0.001740	13.33	2148.81	223.81	0.66
4th Street	1570.713	20500.00	4658.55	4672.8970	4670.1280	4674.8720	0.001479	11.60	2054.07	234.94	0.61
4th Street	1570.713	23500.00	4658.55	4673.8310	4670.9120	4675.9710	0.001450	12.12	2275.71	239.61	0.62
4th Street	1825.946	20500.00	4657.96	4673.8600	4670.2080	4675.3740	0.002210	9.74	2144.74	230.18	0.52
4th Street	1825.946	23500.00	4657.96	4674.8080	4670.8980	4676.4670	0.002164	10.19	2366.69	238.25	0.52
4th Street	2102.372	20500.00	4658.15	4674.6410	4670.1250	4675.8010	0.000983	8.65	2411.68	233.15	0.45
4th Street	2102.372	23500.00	4658.15	4675.6040	4670.7840	4676.8910	0.000977	9.11	2645.16	255.20	0.46
4th Street	2383.165	20500.00	4661.43	4674.9410	4670.3000	4676.1040	0.001189	8.74	2485.70	245.65	0.45
4th Street	2383.165	23500.00	4661.43	4675.9070	4670.9730	4677.1920	0.001183	9.19	2725.93	251.58	0.45

100-year FEMA Discharges
Comparison of Natural, Existing and Proposed Conditions.

HEC-RAS River: Arkansas River Reach: 4th Street Profile: 100 YR

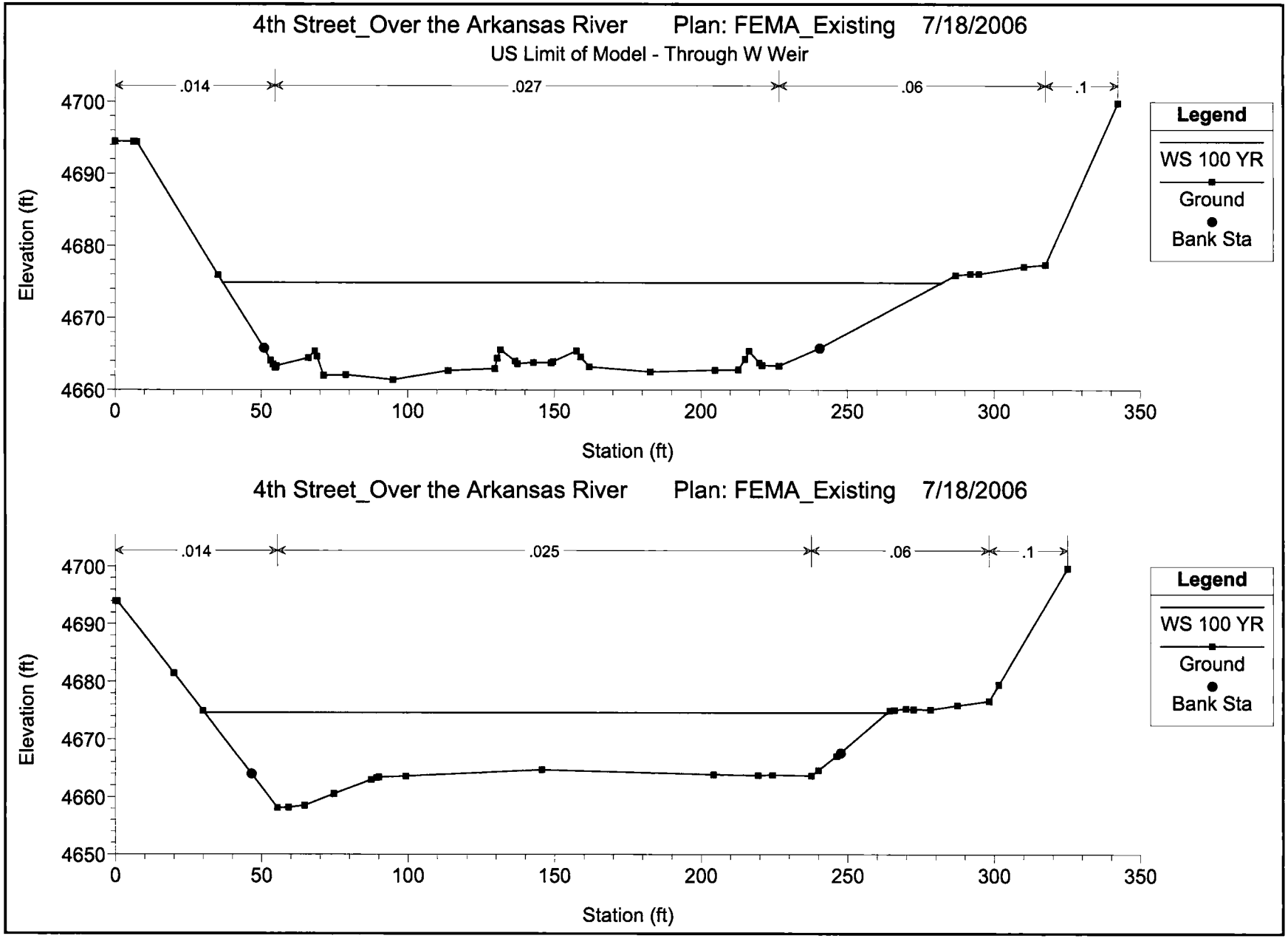
Reach	River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
4th Street	79.1396	FEMA_Natural	20000.00	4659.37	4667.1380	4667.1380	4669.8420	0.006096	13.20	1516.18	286.48	1.01
4th Street	79.1396	FEMA_Exist	20000.00	4659.37	4667.1380	4667.1380	4669.8420	0.006096	13.20	1516.18	286.48	1.01
4th Street	79.1396	FEMA_Propose	20000.00	4659.37	4667.1380	4667.1380	4669.8420	0.006096	13.20	1516.18	286.48	1.01
4th Street	84.4637*	FEMA_Natural	20000.00	4658.54	4668.6960	4666.3080	4669.9980	0.001753	9.18	2196.57	289.92	0.58
4th Street	84.4637*	FEMA_Exist	20000.00	4658.54	4668.7080	4666.3010	4670.0000	0.001759	9.13	2199.82	289.96	0.58
4th Street	84.4637*	FEMA_Propose	20000.00	4658.54	4668.7080	4666.3010	4670.0000	0.001759	9.13	2199.82	289.96	0.58
4th Street	89.7878*	FEMA_Natural	20000.00	4657.71	4669.0450	4665.4610	4670.0360	0.001023	8.02	2522.20	289.90	0.47
4th Street	89.7878*	FEMA_Exist	20000.00	4657.71	4669.0530	4665.4560	4670.0370	0.001030	7.98	2524.61	289.93	0.47
4th Street	89.7878*	FEMA_Propose	20000.00	4657.71	4669.0530	4665.4560	4670.0370	0.001030	7.98	2524.61	289.93	0.47
4th Street	95.1119*	FEMA_Natural	20000.00	4656.88	4669.2540	4664.6200	4670.0590	0.000715	7.23	2803.94	290.36	0.40
4th Street	95.1119*	FEMA_Exist	20000.00	4656.88	4669.2610	4664.6110	4670.0600	0.000720	7.20	2805.93	290.39	0.40
4th Street	95.1119*	FEMA_Propose	20000.00	4656.88	4669.2610	4664.6110	4670.0600	0.000720	7.20	2805.93	290.39	0.40
4th Street	100.436*	FEMA_Natural	20000.00	4656.05	4669.3940	4663.7850	4670.0750	0.000529	6.66	3062.43	291.85	0.35
4th Street	100.436*	FEMA_Exist	20000.00	4656.05	4669.4030	4663.7710	4670.0760	0.000533	6.61	3065.14	291.90	0.35
4th Street	100.436*	FEMA_Propose	20000.00	4656.05	4669.4030	4663.7710	4670.0760	0.000533	6.61	3065.14	291.90	0.35
4th Street	105.760*	FEMA_Natural	20000.00	4655.22	4669.4990	4662.9510	4670.0870	0.000382	6.20	3311.25	295.32	0.31
4th Street	105.760*	FEMA_Exist	20000.00	4655.22	4669.5040	4662.9400	4670.0870	0.000383	6.17	3312.83	295.36	0.31
4th Street	105.760*	FEMA_Propose	20000.00	4655.22	4669.5040	4662.9400	4670.0870	0.000383	6.17	3312.83	295.36	0.31
4th Street	111.084*	FEMA_Natural	20000.00	4654.39	4669.5830	4662.1130	4670.0960	0.000302	5.81	3556.39	296.53	0.28
4th Street	111.084*	FEMA_Exist	20000.00	4654.39	4669.5870	4662.1170	4670.0970	0.000303	5.77	3557.69	296.55	0.28
4th Street	111.084*	FEMA_Propose	20000.00	4654.39	4669.5870	4662.1170	4670.0970	0.000303	5.77	3557.69	296.55	0.28
4th Street	116.408*	FEMA_Natural	20000.00	4653.56	4669.6490	4661.2770	4670.1040	0.000242	5.47	3795.44	297.19	0.26
4th Street	116.408*	FEMA_Exist	20000.00	4653.56	4669.6530	4661.2760	4670.1040	0.000243	5.44	3796.61	297.20	0.25
4th Street	116.408*	FEMA_Propose	20000.00	4653.56	4669.6530	4661.2760	4670.1040	0.000243	5.44	3796.61	297.20	0.25
4th Street	121.732*	FEMA_Natural	20000.00	4652.73	4669.7020	4660.4530	4670.1090	0.000185	5.19	4029.31	297.52	0.23
4th Street	121.732*	FEMA_Exist	20000.00	4652.73	4669.7060	4660.4400	4670.1100	0.000186	5.16	4030.47	297.53	0.23
4th Street	121.732*	FEMA_Propose	20000.00	4652.73	4669.7060	4660.4400	4670.1100	0.000186	5.16	4030.47	297.53	0.23
4th Street	127.0565	FEMA_Natural	20000.00	4651.90	4669.7540	4659.5950	4670.1150	0.000157	4.88	4261.17	297.57	0.21
4th Street	127.0565	FEMA_Exist	20000.00	4651.90	4669.7510	4659.6000	4670.1150	0.000155	4.91	4260.30	297.56	0.22
4th Street	127.0565	FEMA_Propose	20000.00	4651.90	4669.7510	4659.6000	4670.1150	0.000155	4.91	4260.30	297.56	0.22
4th Street	173.9272	FEMA_Natural	20000.00	4651.04	4669.8130	4658.5900	4670.1260	0.000129	4.54	4564.07	302.58	0.19
4th Street	173.9272	FEMA_Exist	20000.00	4651.04	4669.8090	4658.5790	4670.1260	0.000127	4.58	4563.03	302.57	0.19
4th Street	173.9272	FEMA_Propose	20000.00	4651.04	4669.8090	4658.5790	4670.1260	0.000127	4.58	4563.03	302.57	0.19
4th Street	229.8466	FEMA_Natural	20000.00	4651.93	4669.8290	4658.4670	4670.1340	0.000122	4.48	4638.30	307.64	0.19
4th Street	229.8466	FEMA_Exist	20000.00	4651.93	4669.8290	4658.4680	4670.1340	0.000121	4.49	4638.15	307.64	0.19
4th Street	229.8466	FEMA_Propose	20000.00	4651.93	4669.8290	4658.4680	4670.1340	0.000121	4.49	4638.15	307.64	0.19
4th Street	267.7897	FEMA_Natural	20000.00	4651.93	4669.8330	4658.6950	4670.1390	0.000123	4.63	4602.09	312.78	0.20
4th Street	267.7897	FEMA_Exist	20000.00	4651.93	4669.8280	4658.6580	4670.1410	0.000125	4.54	4600.54	312.77	0.19
4th Street	267.7897	FEMA_Propose	20000.00	4651.93	4669.8280	4658.6580	4670.1410	0.000125	4.54	4600.54	312.77	0.19
4th Street	337.5611	FEMA_Natural	20000.00	4653.66	4669.6150	4662.5790	4670.2540	0.000424	6.57	3270.22	299.32	0.31
4th Street	337.5611	FEMA_Exist	20000.00	4653.66	4669.6140	4662.5660	4670.2540	0.000425	6.54	3269.92	299.31	0.31
4th Street	337.5611	FEMA_Propose	20000.00	4653.66	4669.6140	4662.5660	4670.2540	0.000425	6.54	3269.92	299.31	0.31
4th Street	343.126*	FEMA_Natural	20000.00	4654.86	4669.5380	4663.4810	4670.2910	0.000544	7.14	3021.87	296.86	0.35
4th Street	343.126*	FEMA_Exist	20000.00	4654.86	4669.5370	4663.4700	4670.2910	0.000545	7.11	3021.58	296.85	0.35
4th Street	343.126*	FEMA_Propose	20000.00	4654.86	4669.5370	4663.4700	4670.2910	0.000545	7.11	3021.58	296.85	0.35
4th Street	348.692*	FEMA_Natural	20000.00	4656.06	4669.4320	4664.4300	4670.3420	0.000760	7.85	2765.07	294.13	0.40
4th Street	348.692*	FEMA_Exist	20000.00	4656.06	4669.4380	4664.3930	4670.3380	0.000764	7.78	2766.94	294.18	0.40
4th Street	348.692*	FEMA_Propose	20000.00	4656.06	4669.4380	4664.3930	4670.3380	0.000764	7.78	2766.94	294.18	0.40
4th Street	354.258*	FEMA_Natural	20000.00	4657.26	4669.2900	4665.4150	4670.4090	0.001056	8.73	2498.45	291.20	0.47
4th Street	354.258*	FEMA_Exist	20000.00	4657.26	4669.2980	4665.3950	4670.4050	0.001061	8.64	2501.01	291.27	0.47
4th Street	354.258*	FEMA_Propose	20000.00	4657.26	4669.2980	4665.3950	4670.4050	0.001061	8.64	2501.01	291.27	0.47
4th Street	359.824*	FEMA_Natural	20000.00	4658.47	4669.1290	4666.3960	4670.4880	0.001483	9.66	2227.26	288.05	0.55
4th Street	359.824*	FEMA_Exist	20000.00	4658.47	4669.1290	4666.3800	4670.4870	0.001486	9.62	2227.26	288.05	0.55
4th Street	359.824*	FEMA_Propose	20000.00	4658.47	4669.1290	4666.3800	4670.4870	0.001486	9.62	2227.26	288.05	0.55
4th Street	365.390*	FEMA_Natural	20000.00	4659.67	4665.4710	4667.3280	4671.6530	0.015380	20.19	1028.98	243.52	1.58
4th Street	365.390*	FEMA_Exist	20000.00	4659.67	4665.4580	4667.3250	4671.6590	0.015591	20.15	1025.89	243.25	1.59
4th Street	365.390*	FEMA_Propose	20000.00	4659.67	4665.4580	4667.3250	4671.6590	0.015591	20.15	1025.89	243.25	1.59
4th Street	370.955*	FEMA_Natural	20000.00	4660.87	4666.8850	4668.2820	4671.8480	0.011405	18.33	1166.98	258.90	1.38
4th Street	370.955*	FEMA_Exist	20000.00	4660.87	4666.8790	4668.2910	4671.8550	0.011474	18.27	1165.59	258.84	1.38
4th Street	370.955*	FEMA_Propose	20000.00	4660.87	4666.8790	4668.2910	4671.8550	0.011474	18.27	1165.59	258.84	1.38

HEC-RAS River: Arkansas River Reach: 4th Street Profile: 100 YR (Continued)

Reach	River Sta	Plan	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)	
4th Street	376.5217	FEMA_Natural	20000.00	4662.07	4669.1980	4669.1980	4672.0910	0.004016	14.13	1572.87	284.11	0.96
4th Street	376.5217	FEMA_Exist	20000.00	4662.07	4669.1990	4669.1990	4672.0990	0.003983	14.24	1573.00	284.12	0.97
4th Street	376.5217	FEMA_Propose	20000.00	4662.07	4669.1990	4669.1990	4672.0990	0.003983	14.24	1573.00	284.12	0.97
4th Street	378.663*	FEMA_Natural	20000.00	4661.26	4670.2840	4669.0160	4672.1960	0.002737	11.65	1919.85	295.05	0.72
4th Street	378.663*	FEMA_Exist	20000.00	4661.26	4670.3160	4669.0120	4672.2070	0.002698	11.57	1929.36	295.47	0.71
4th Street	378.663*	FEMA_Propose	20000.00	4661.26	4670.3160	4669.0120	4672.2070	0.002698	11.57	1929.36	295.47	0.71
4th Street	380.805*	FEMA_Natural	20000.00	4660.45	4670.4020	4668.9020	4672.2120	0.002410	11.30	1985.76	296.37	0.68
4th Street	380.805*	FEMA_Exist	20000.00	4660.45	4670.4180	4668.8850	4672.2210	0.002397	11.26	1990.67	296.60	0.68
4th Street	380.805*	FEMA_Propose	20000.00	4660.45	4670.4180	4668.8850	4672.2210	0.002397	11.26	1990.67	296.60	0.68
4th Street	382.946*	FEMA_Natural	20000.00	4659.65	4670.4910	4668.8000	4672.2250	0.002212	11.11	2043.48	296.59	0.65
4th Street	382.946*	FEMA_Exist	20000.00	4659.65	4670.5050	4668.7790	4672.2330	0.002201	11.07	2047.68	296.80	0.65
4th Street	382.946*	FEMA_Propose	20000.00	4659.65	4670.5050	4668.7790	4672.2330	0.002201	11.07	2047.68	296.80	0.65
4th Street	385.088*	FEMA_Natural	20000.00	4658.84	4670.6330	4668.6420	4672.2420	0.001950	10.71	2117.56	297.63	0.62
4th Street	385.088*	FEMA_Exist	20000.00	4658.84	4670.6460	4668.6070	4672.2500	0.001943	10.67	2121.34	297.86	0.62
4th Street	385.088*	FEMA_Propose	20000.00	4658.84	4670.6460	4668.6070	4672.2500	0.001943	10.67	2121.34	297.86	0.62
4th Street	387.2300	FEMA_Natural	20000.00	4658.03	4670.7670	4668.4440	4672.2570	0.001749	10.25	2189.31	298.56	0.58
4th Street	387.2300	FEMA_Exist	20000.00	4658.03	4670.7710	4668.4700	4672.2660	0.001745	10.28	2190.63	298.65	0.58
4th Street	387.2300	FEMA_Propose	20000.00	4658.03	4670.7710	4668.4700	4672.2660	0.001745	10.28	2190.63	298.65	0.58
4th Street	389.163*	FEMA_Natural	20000.00	4657.93	4670.7950	4668.3900	4672.2630	0.001677	10.09	2197.54	297.76	0.57
4th Street	389.163*	FEMA_Exist	20000.00	4657.93	4670.8000	4668.3990	4672.2710	0.001673	10.13	2199.00	297.83	0.57
4th Street	389.163*	FEMA_Propose	20000.00	4657.93	4670.8000	4668.3990	4672.2710	0.001673	10.13	2199.00	297.83	0.57
4th Street	391.097*	FEMA_Natural	20000.00	4657.83	4670.8180	4668.3480	4672.2680	0.001627	9.99	2206.92	297.12	0.57
4th Street	391.097*	FEMA_Exist	20000.00	4657.83	4670.8230	4668.3570	4672.2760	0.001623	10.02	2208.37	297.19	0.57
4th Street	391.097*	FEMA_Propose	20000.00	4657.83	4670.8230	4668.3570	4672.2760	0.001623	10.02	2208.37	297.19	0.57
4th Street	393.031*	FEMA_Natural	20000.00	4657.74	4670.8440	4668.2810	4672.2730	0.001583	9.90	2218.85	296.31	0.56
4th Street	393.031*	FEMA_Exist	20000.00	4657.74	4670.8480	4668.3130	4672.2810	0.001580	9.93	2220.15	296.38	0.56
4th Street	393.031*	FEMA_Propose	20000.00	4657.74	4670.8480	4668.3130	4672.2810	0.001580	9.93	2220.15	296.38	0.56
4th Street	394.965*	FEMA_Natural	20000.00	4657.64	4670.8730	4668.1110	4672.2780	0.001536	9.80	2233.61	295.60	0.55
4th Street	394.965*	FEMA_Exist	20000.00	4657.64	4670.8780	4668.1330	4672.2860	0.001537	9.83	2235.05	295.67	0.55
4th Street	394.965*	FEMA_Propose	20000.00	4657.64	4670.8780	4668.1330	4672.2860	0.001537	9.83	2235.05	295.67	0.55
4th Street	396.8996	FEMA_Natural	20000.00	4657.54	4670.9360	4667.9890	4672.2870	0.001514	9.53	2260.57	295.44	0.54
4th Street	396.8996	FEMA_Exist	20000.00	4657.54	4670.9180	4668.0380	4672.2920	0.001516	9.68	2255.38	295.21	0.54
4th Street	396.8996	FEMA_Propose	20000.00	4657.54	4670.9180	4668.0380	4672.2920	0.001516	9.68	2255.38	295.21	0.54
4th Street	450.2781	FEMA_Natural	20000.00	4657.45	4671.2810	4666.5030	4672.3590	0.000535	8.48	2503.63	262.29	0.44
4th Street	450.2781	FEMA_Exist	20000.00	4657.45	4671.3120	4666.4640	4672.3700	0.000553	8.33	2511.58	262.67	0.43
4th Street	450.2781	FEMA_Propose	20000.00	4657.45	4671.3120	4666.4640	4672.3700	0.000553	8.33	2511.58	262.67	0.43
4th Street	636.8161	FEMA_Natural	20000.00	4659.48	4671.2270	4667.4340	4672.5610	0.000867	9.64	2228.29	250.80	0.51
4th Street	636.8161	FEMA_Exist	20000.00	4659.48	4671.2480	4667.3510	4672.5820	0.000900	9.34	2233.57	251.05	0.50
4th Street	636.8161	FEMA_Propose	20000.00	4659.48	4671.2480	4667.3510	4672.5820	0.000900	9.34	2233.57	251.05	0.50
4th Street	820.9197	FEMA_Natural	20000.00	4657.89	4671.2190	4667.9980	4672.8130	0.001024	11.00	2123.75	247.04	0.56
4th Street	820.9197	FEMA_Exist	20000.00	4657.89	4671.2480	4667.8740	4672.8390	0.001067	10.40	2130.87	247.44	0.55
4th Street	820.9197	FEMA_Propose	20000.00	4657.89	4671.2480	4667.8740	4672.8390	0.001067	10.40	2130.87	247.44	0.55
4th Street	1060.254	FEMA_Natural	20000.00	4657.42	4670.8540	4669.3170	4673.4170	0.001840	13.71	1775.71	218.08	0.71
4th Street	1060.254	FEMA_Exist	20000.00	4657.42	4670.9120	4669.2560	4673.4460	0.001816	13.44	1788.50	218.55	0.71
4th Street	1060.254	FEMA_Propose	20000.00	4657.42	4670.9120	4669.2560	4673.4460	0.001816	13.44	1788.50	218.55	0.71
4th Street	1159.680	FEMA_Natural	20000.00	4657.56	4671.0030	4669.2330	4673.5990	0.001759	13.75	1815.49	224.73	0.70
4th Street	1159.680	FEMA_Exist	20000.00	4657.56	4671.0660	4669.2330	4673.6230	0.001722	13.66	1829.55	225.01	0.70
4th Street	1159.680	FEMA_Propose	20000.00	4657.56	4671.0660	4669.2330	4673.6230	0.001722	13.66	1829.55	225.01	0.70
4th Street	1252.860	FEMA_Natural	20000.00	4657.91	4670.9850	4669.9930	4673.8960	0.002745	14.31	1694.07	219.98	0.77
4th Street	1252.860	FEMA_Exist	20000.00	4657.91	4672.1230	4669.9930	4674.3580	0.001873	12.64	1947.63	225.57	0.65
4th Street	1252.860	FEMA_Propose	20000.00	4657.91	4671.0460	4669.9930	4673.9140	0.002686	14.21	1707.61	220.29	0.76
4th Street	1405.927	FEMA_Natural	20000.00	4657.64	4671.9430	4669.6740	4674.2920	0.001860	12.86	1873.26	219.49	0.67
4th Street	1405.927	FEMA_Exist	20000.00	4657.64	4672.5920	4669.6740	4674.6320	0.001510	12.02	2016.53	221.75	0.61
4th Street	1405.927	FEMA_Propose	20000.00	4657.64	4672.1470	4669.6740	4674.3930	0.001739	12.58	1918.25	220.20	0.65
4th Street	1570.713	FEMA_Natural	20000.00	4658.55	4672.5980	4670.0000	4674.6040	0.001554	11.68	1984.09	233.44	0.63
4th Street	1570.713	FEMA_Exist	20000.00	4658.55	4673.0780	4670.0000	4674.8860	0.001328	11.11	2096.60	235.84	0.58
4th Street	1570.713	FEMA_Propose	20000.00	4658.55	4672.7400	4670.0000	4674.6840	0.001482	11.50	2017.20	234.15	0.61
4th Street	1825.946	FEMA_Natural	20000.00	4657.96	4673.6150	4670.0780	4675.1280	0.002279	9.74	2088.57	228.11	0.53
4th Street	1825.946	FEMA_Exist	20000.00	4657.96	4673.9170	4670.0780	4675.3420	0.002066	9.45	2157.79	230.66	0.50
4th Street	1825.946	FEMA_Propose	20000.00	4657.96	4673.6990	4670.0780	4675.1880	0.002217	9.66	2107.87	228.82	0.52

HEC-RAS River: Arkansas River Reach: 4th Street Profile: 100 YR (Continued)

Reach	River Sta	Plan	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)	
4th Street	2102.372	FEMA_Natural	20000.00	4658.15	4674.4130	4670.0170	4675.5650	0.001004	8.62	2358.62	232.28	0.46
4th Street	2102.372	FEMA_Exist	20000.00	4658.15	4674.6390	4670.0170	4675.7440	0.000936	8.44	2411.23	233.14	0.44
4th Street	2102.372	FEMA_Propose	20000.00	4658.15	4674.4750	4670.0170	4675.6150	0.000984	8.57	2373.14	232.52	0.45
4th Street	2383.165	FEMA_Natural	20000.00	4661.43	4674.7200	4670.2610	4675.8750	0.001209	8.70	2431.63	244.30	0.45
4th Street	2383.165	FEMA_Exist	20000.00	4661.43	4674.9230	4670.2610	4676.0340	0.001138	8.54	2481.26	245.54	0.44
4th Street	2383.165	FEMA_Propose	20000.00	4661.43	4674.7760	4670.2610	4675.9180	0.001189	8.66	2445.24	244.64	0.45


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
US Limit of Model - Through W Weir
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4670
4660
Elevation (ft)
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100
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200
250
300
350
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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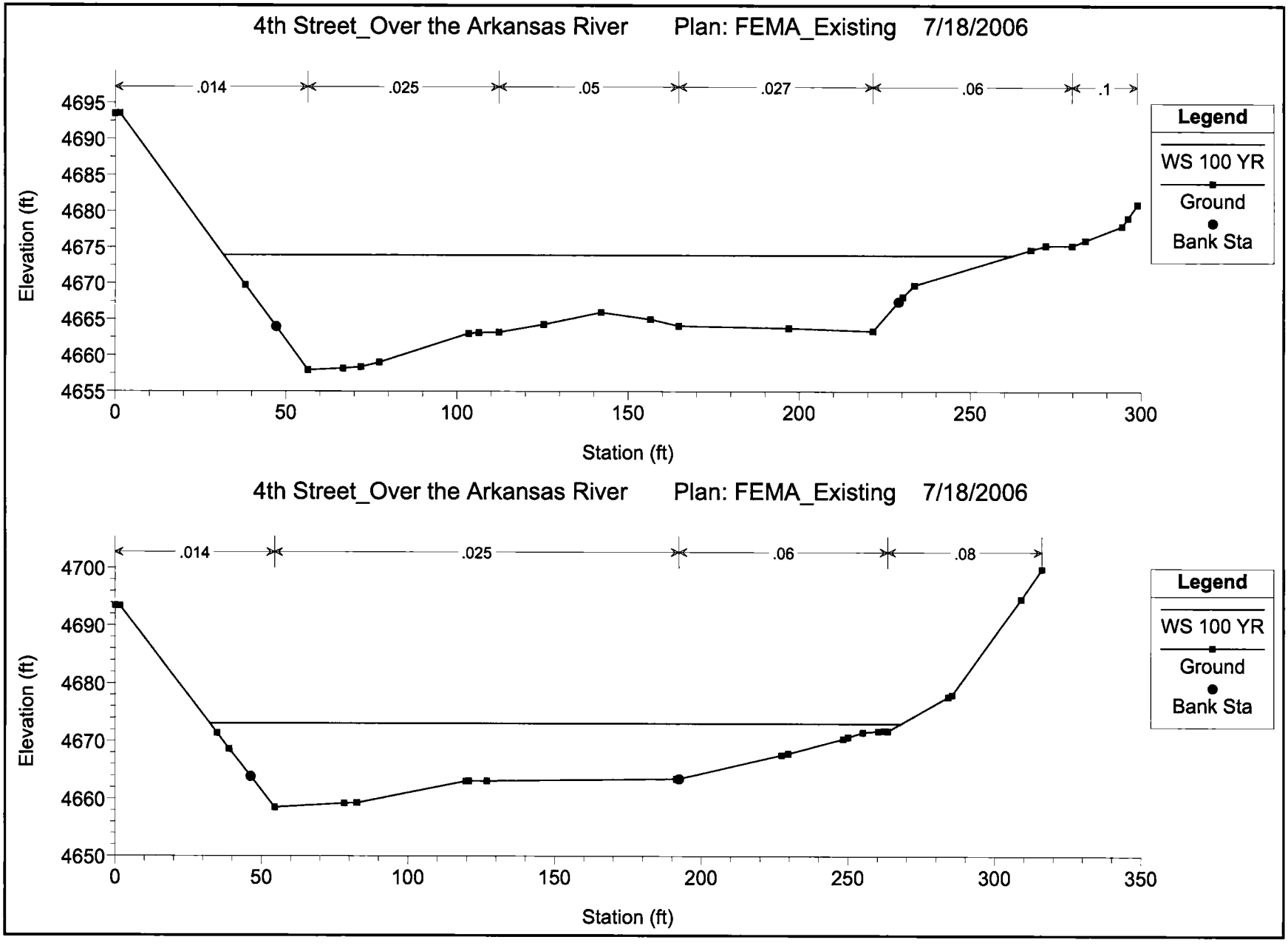
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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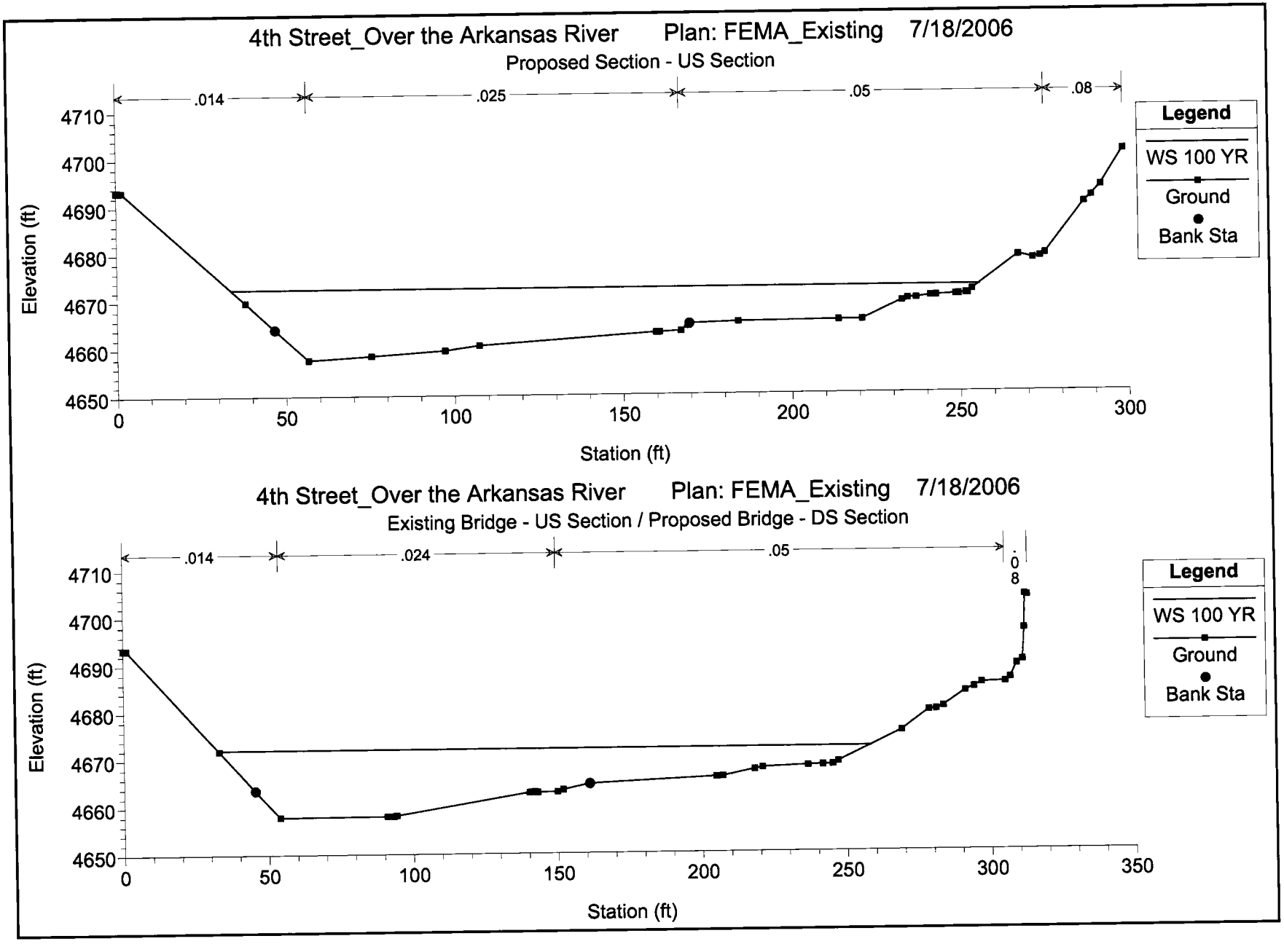
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Proposed Section - US Section
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Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
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Station (ft)
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Existing Bridge - US Section / Proposed Bridge - DS Section
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Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
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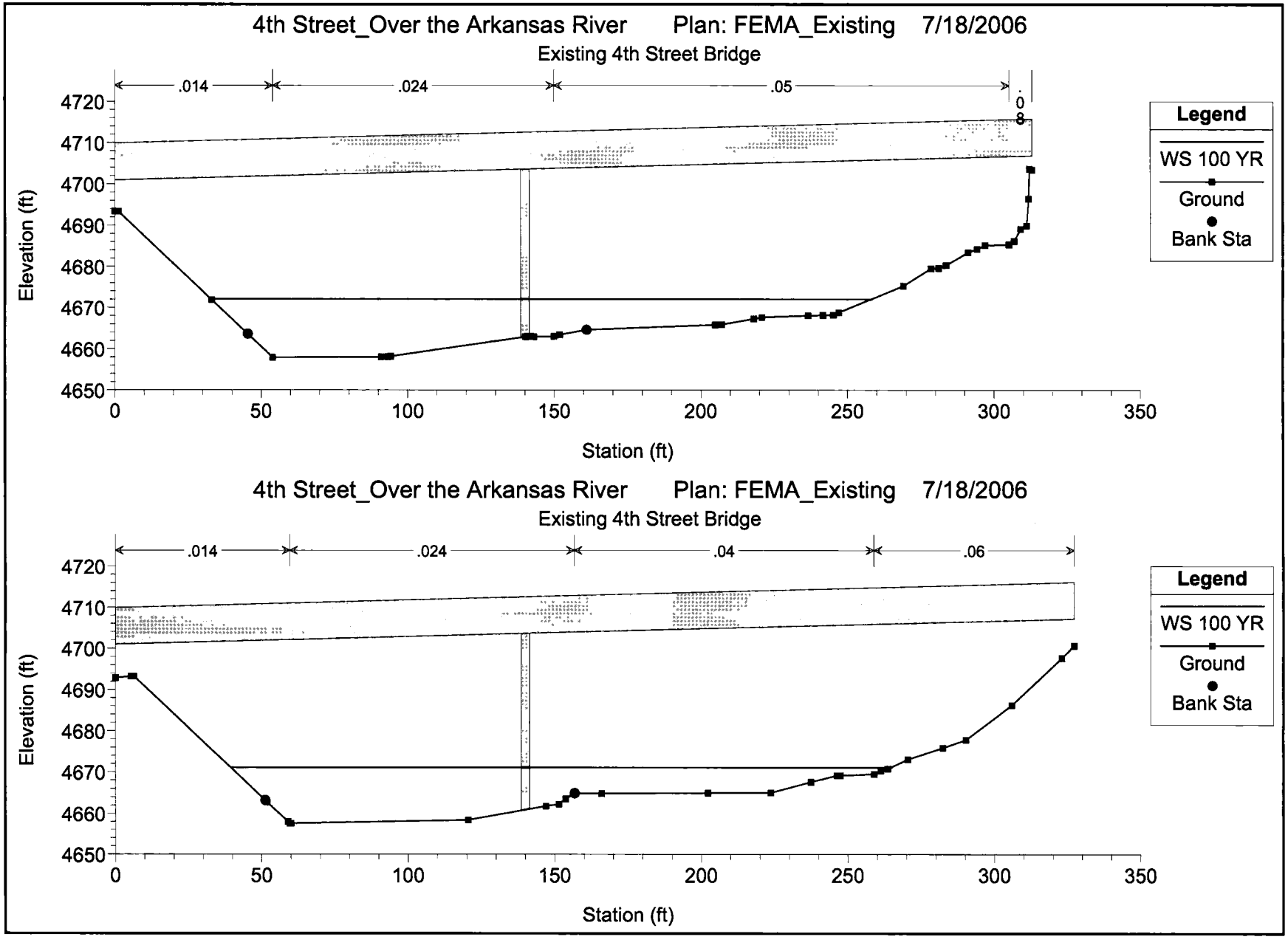
Station (ft)


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Existing 4th Street Bridge
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Elevation (ft)
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Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Existing 4th Street Bridge
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Elevation (ft)
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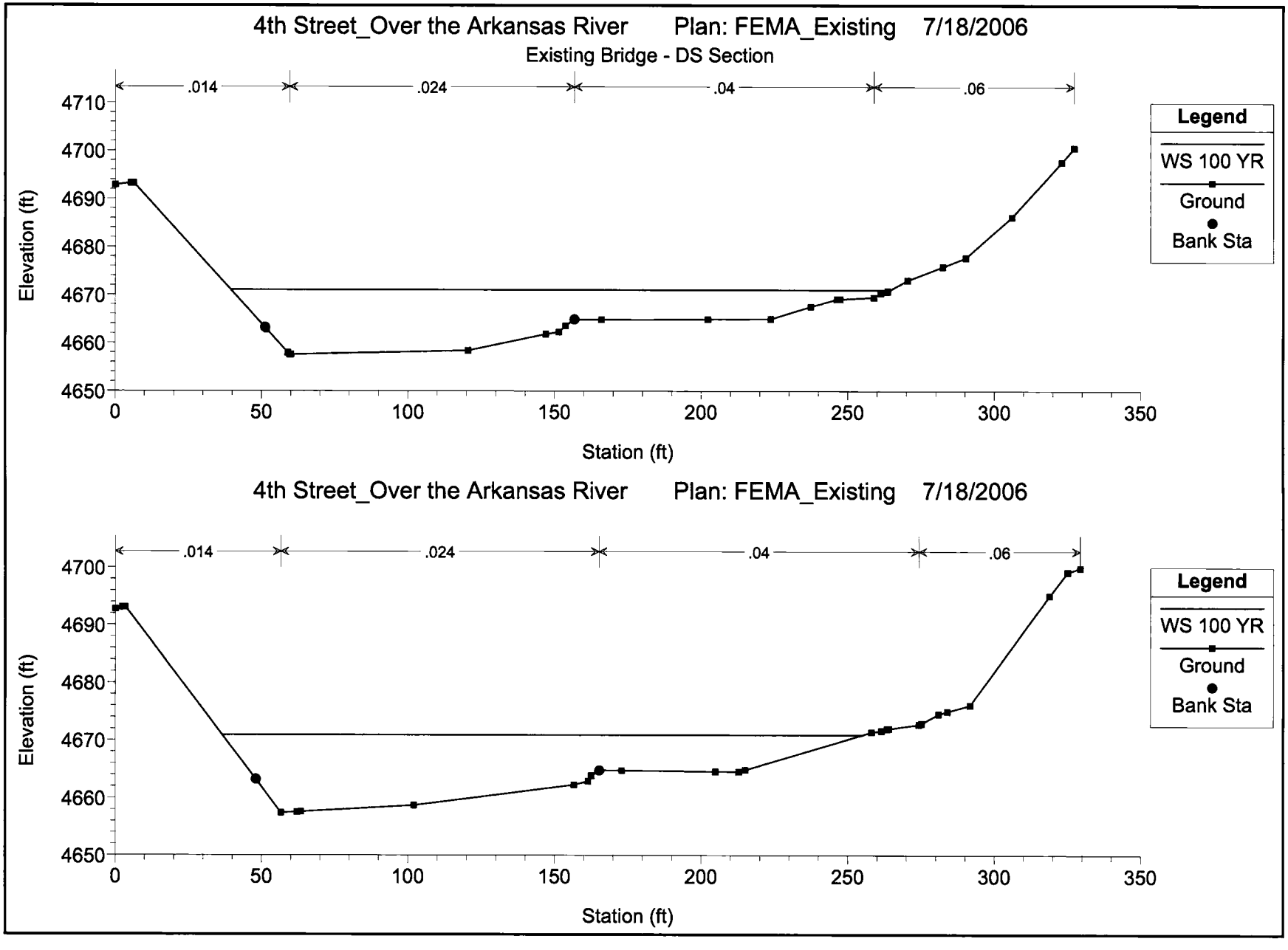
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Existing Bridge - DS Section
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Elevation (ft)
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Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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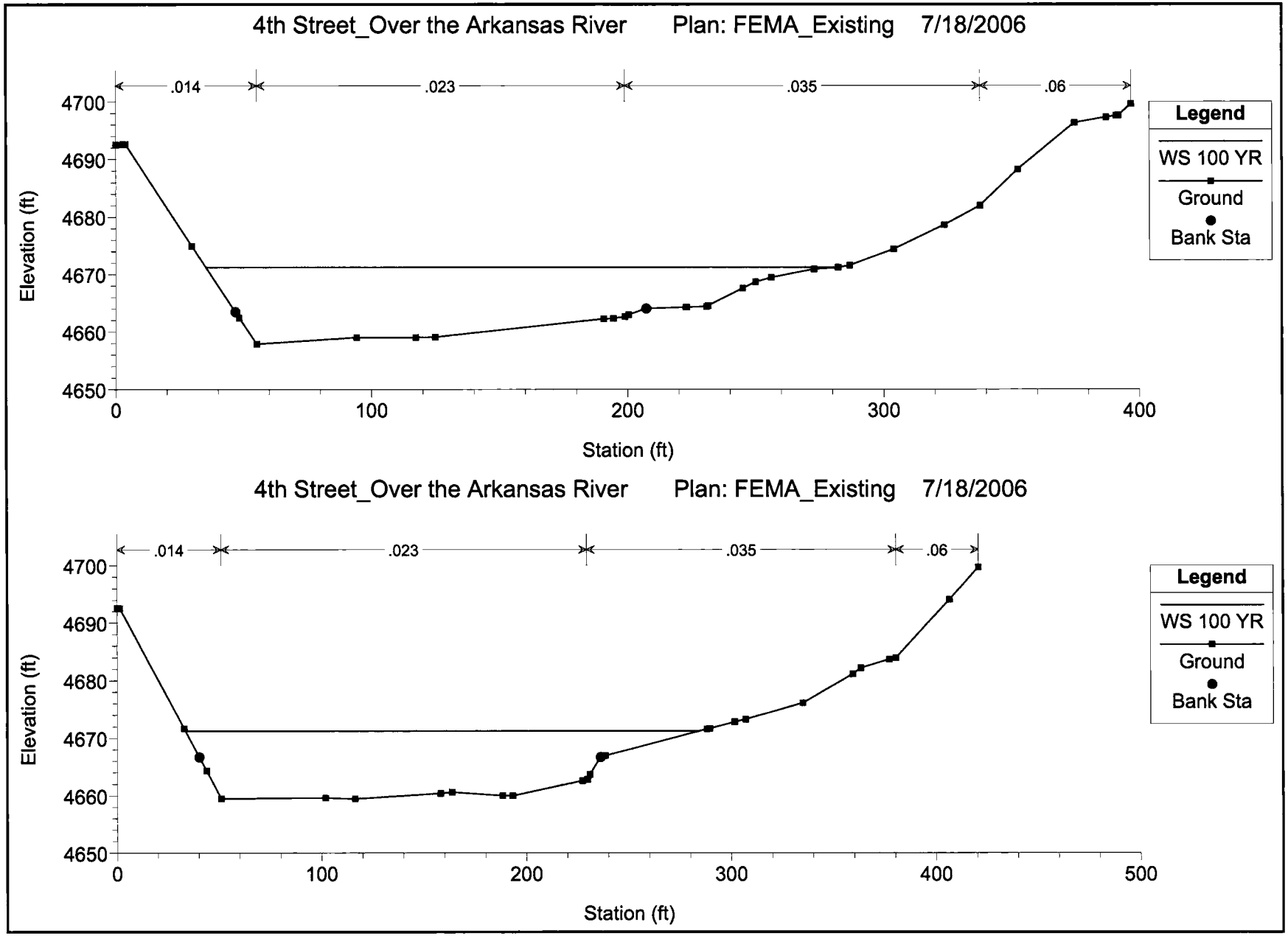
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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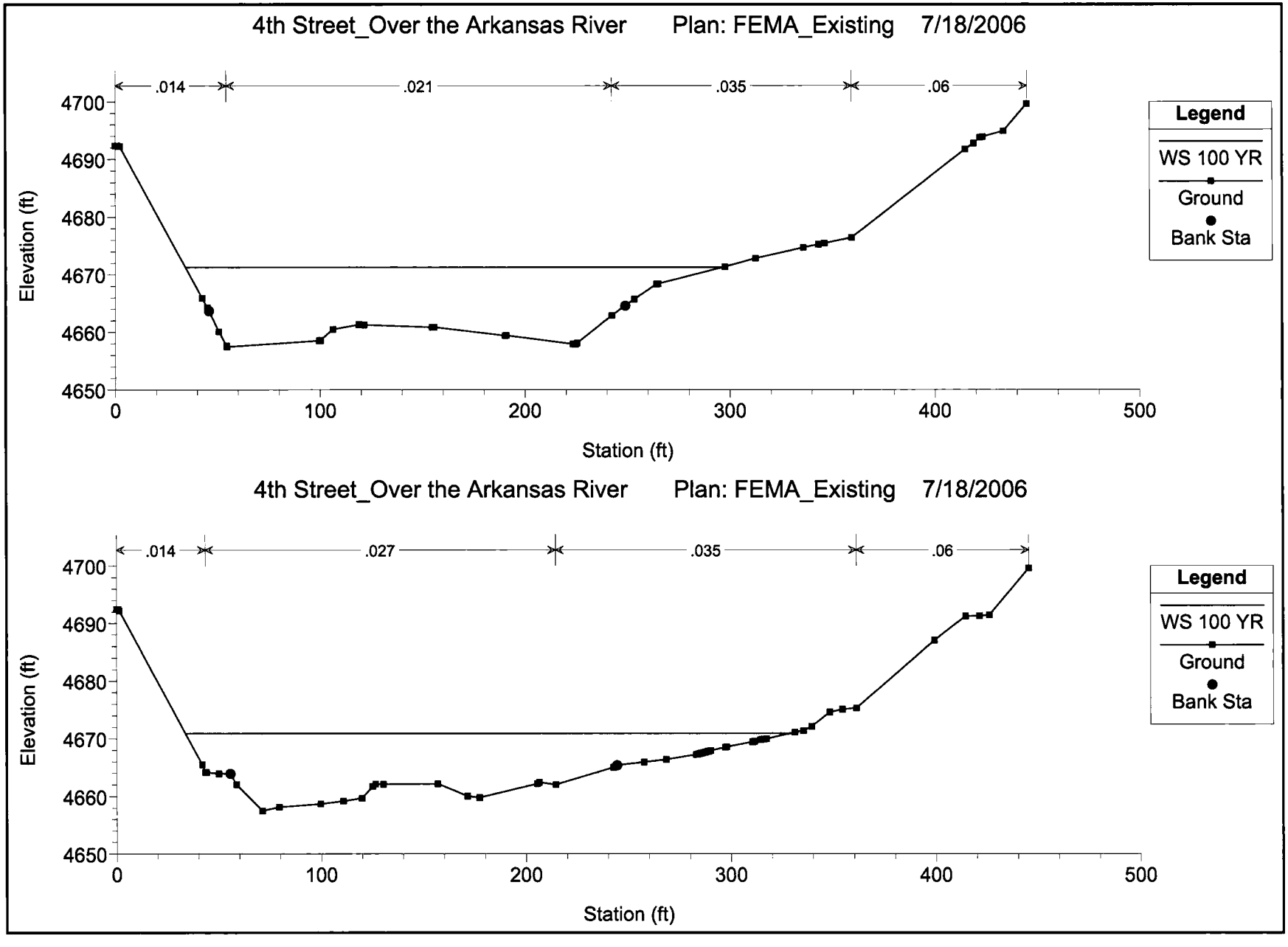
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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Elevation (ft)
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400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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4670
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4650
Elevation (ft)
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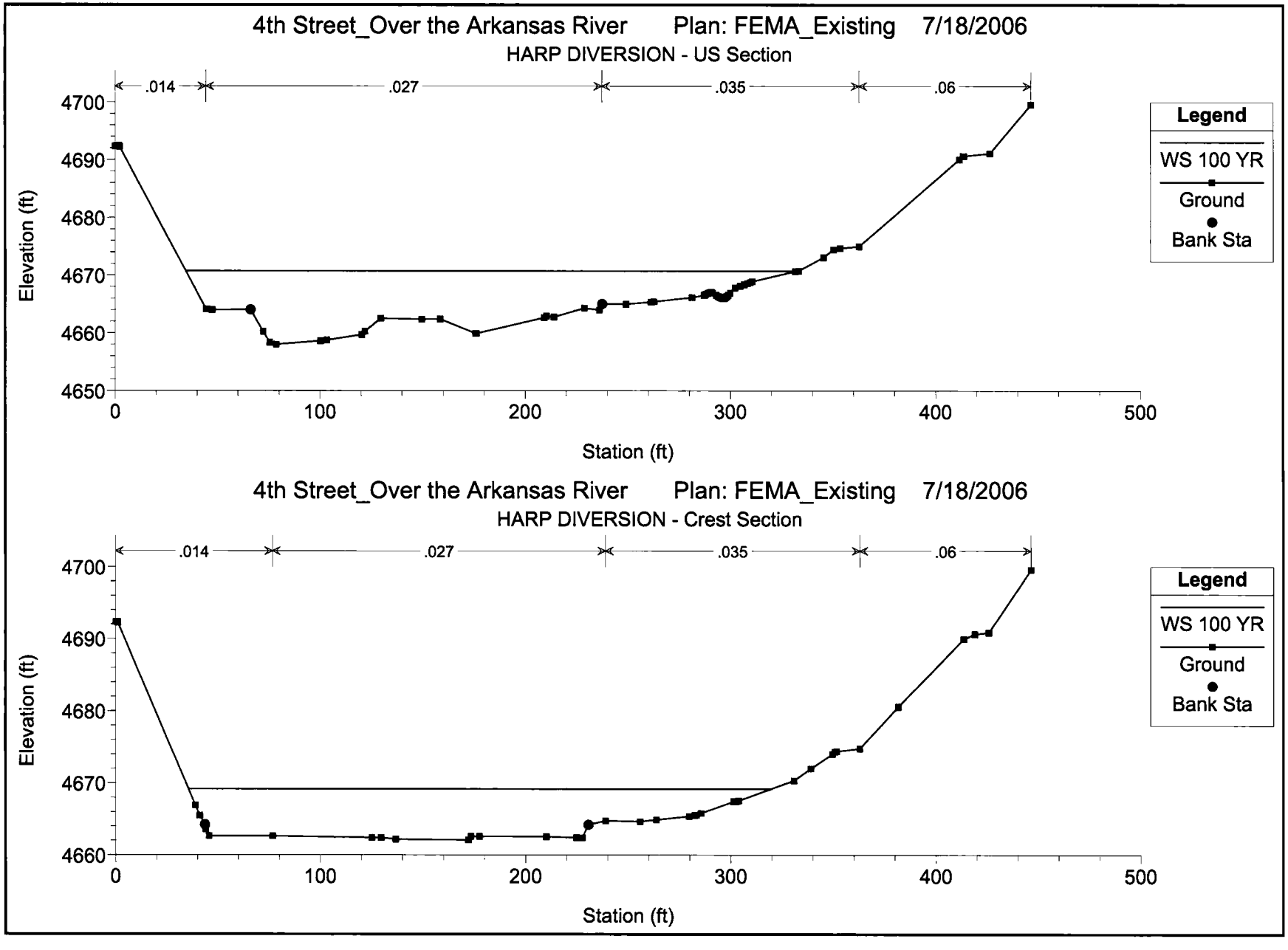
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
HARP DIVERSION - US Section
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4690
4680
4670
4660
4650
Elevation (ft)
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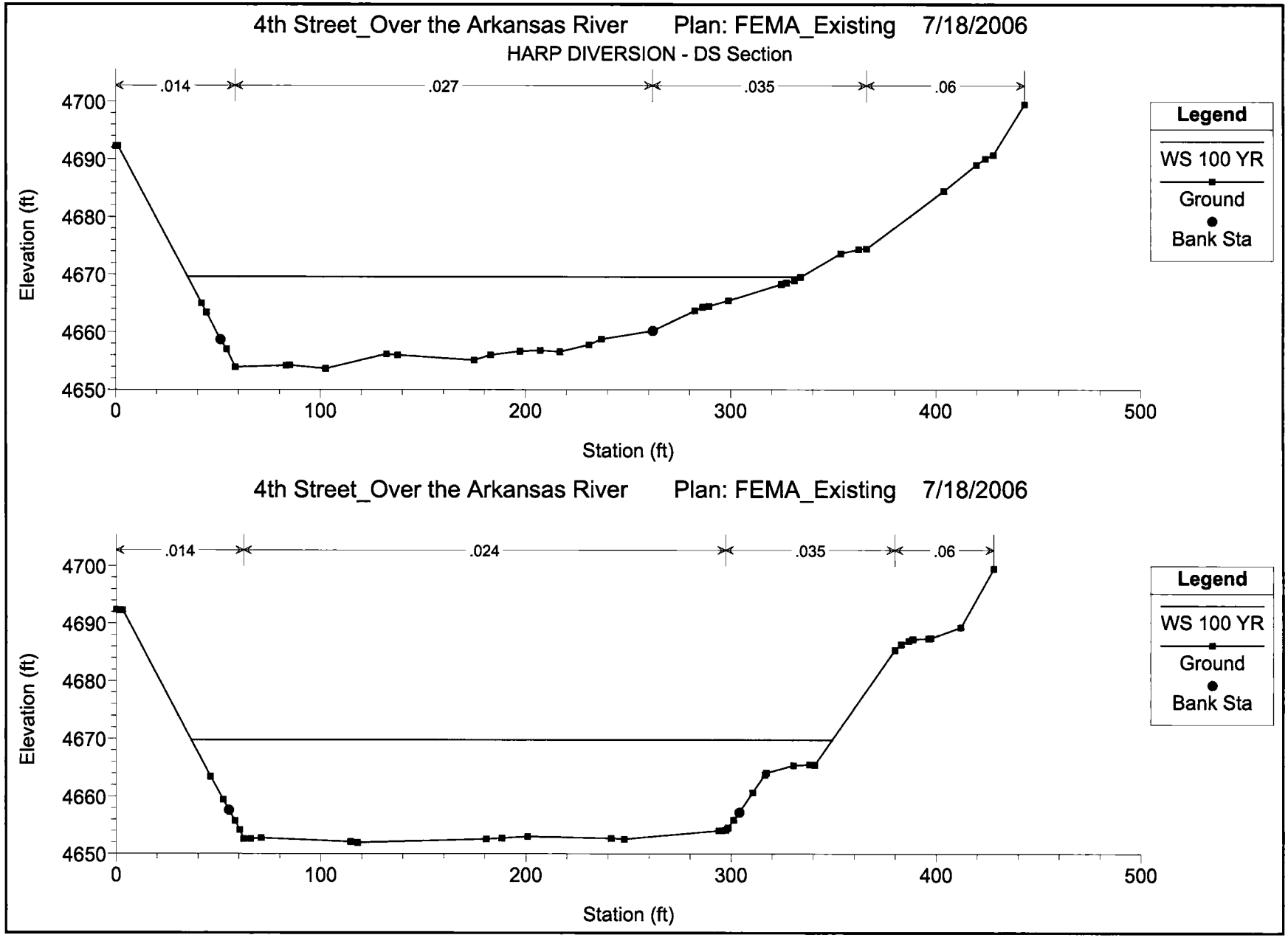
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
HARP DIVERSION - Crest Section
.014
.027
.035
.06
4700
4690
4680
4670
4660
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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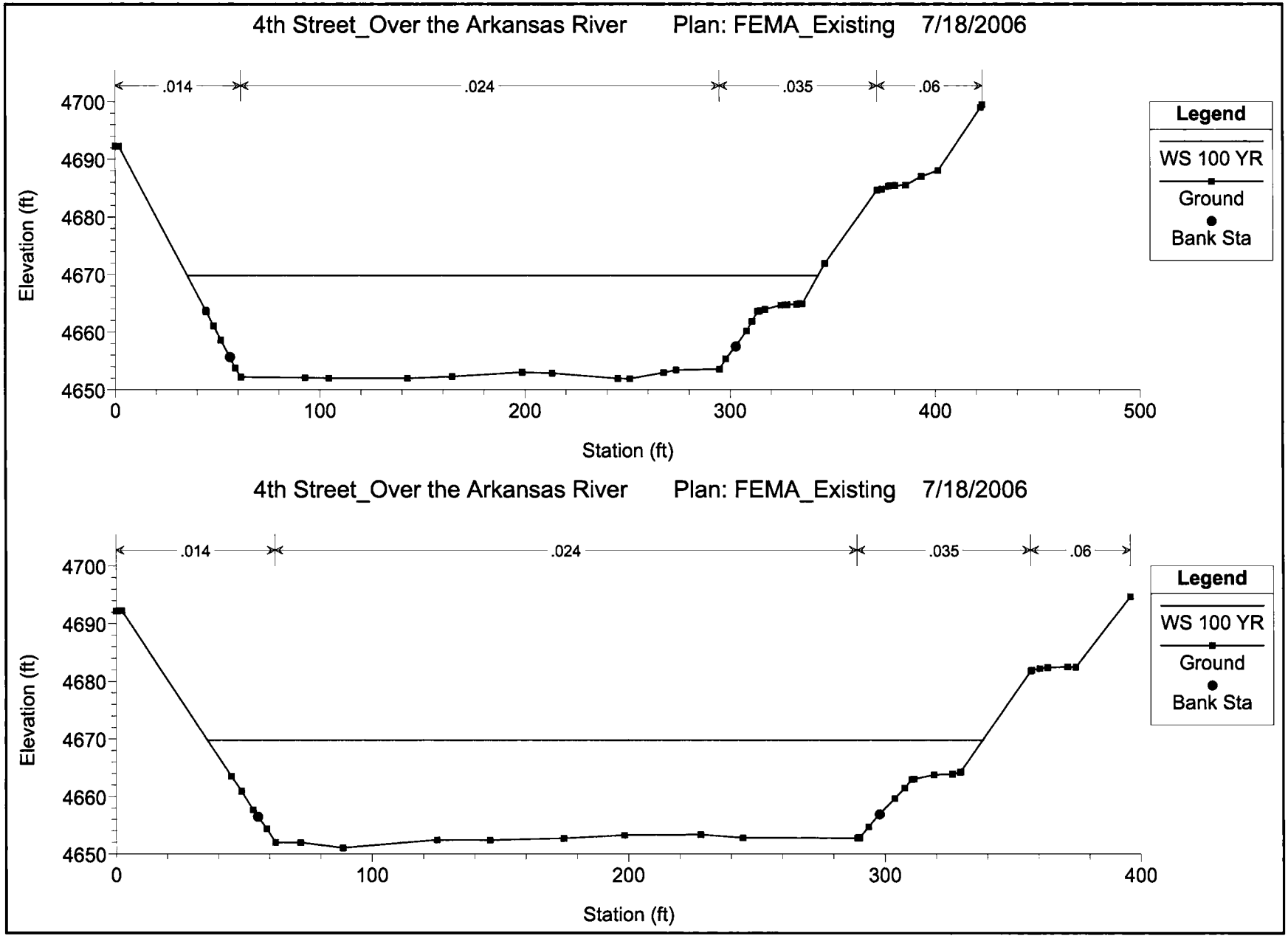
HARP DIVERSION - DS Section
.014
.027
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
.014
.024
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
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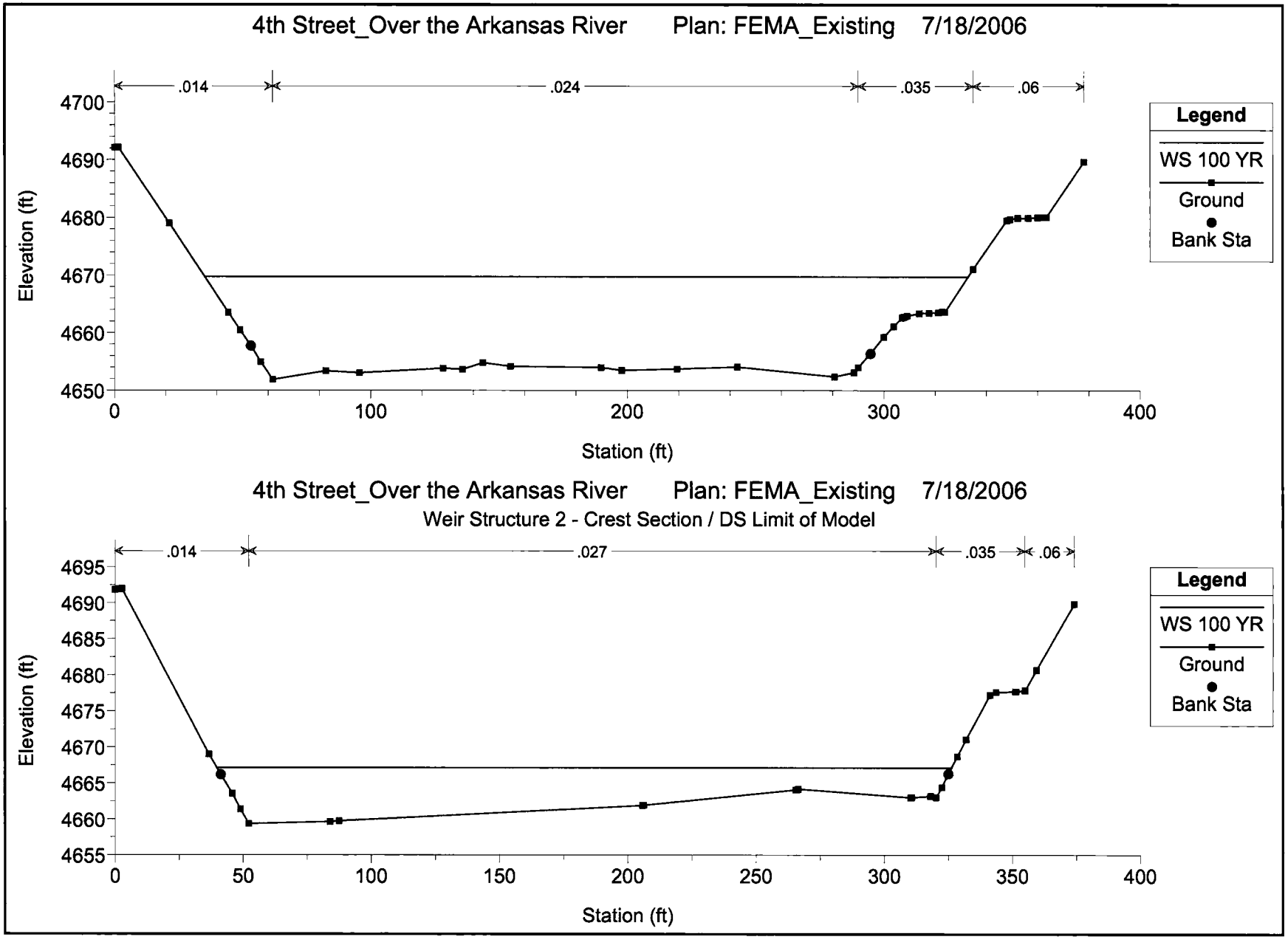
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
.014
.024
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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.014
.024
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Existing 7/18/2006
Weir Structure 2 - Crest Section / DS Limit of Model
.014
.027
.035
.06
4695
4690
4685
4680
4675
4670
4665
4660
4655
Elevation (ft)
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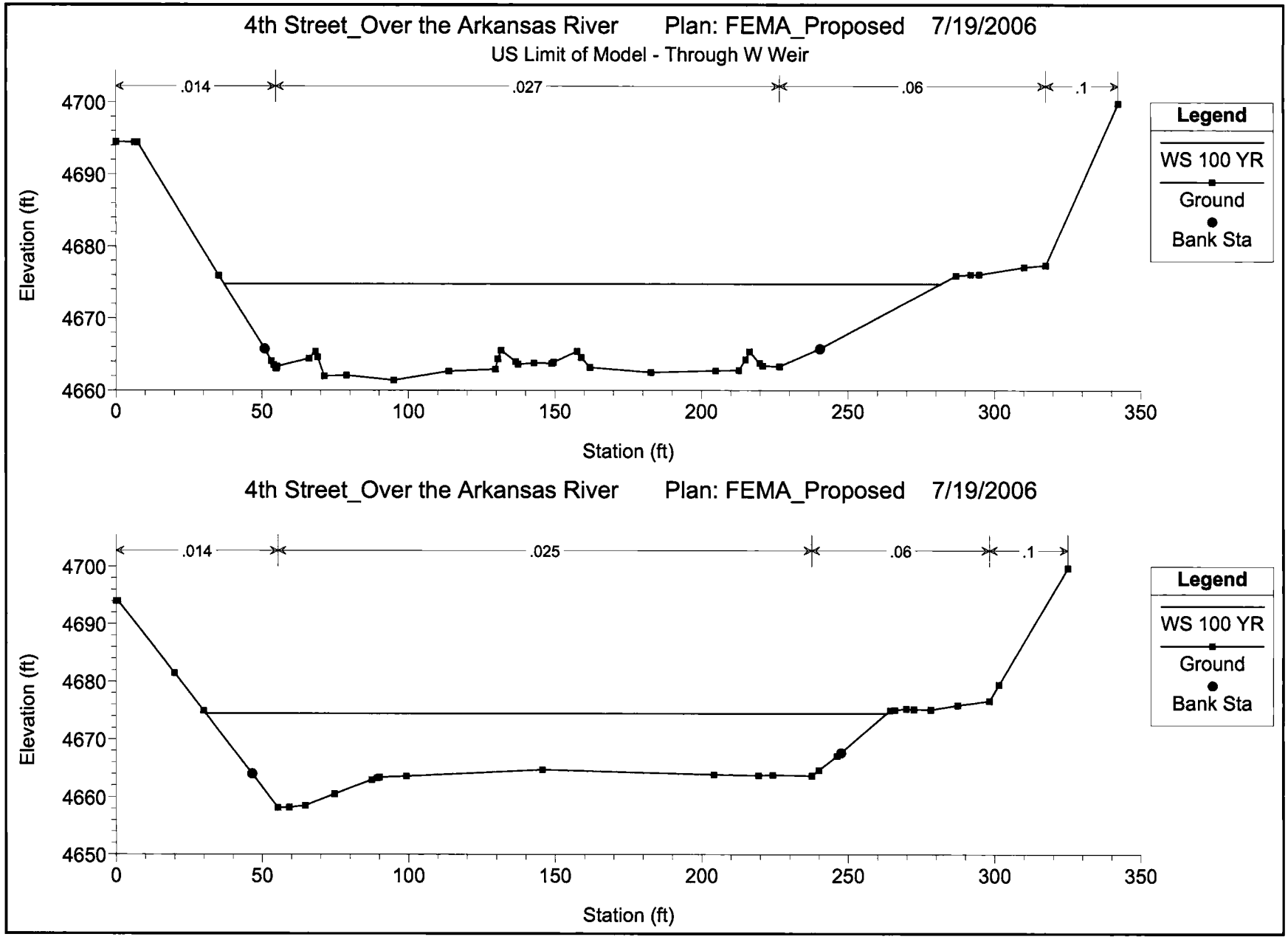
50
100
150
200
250
300
350
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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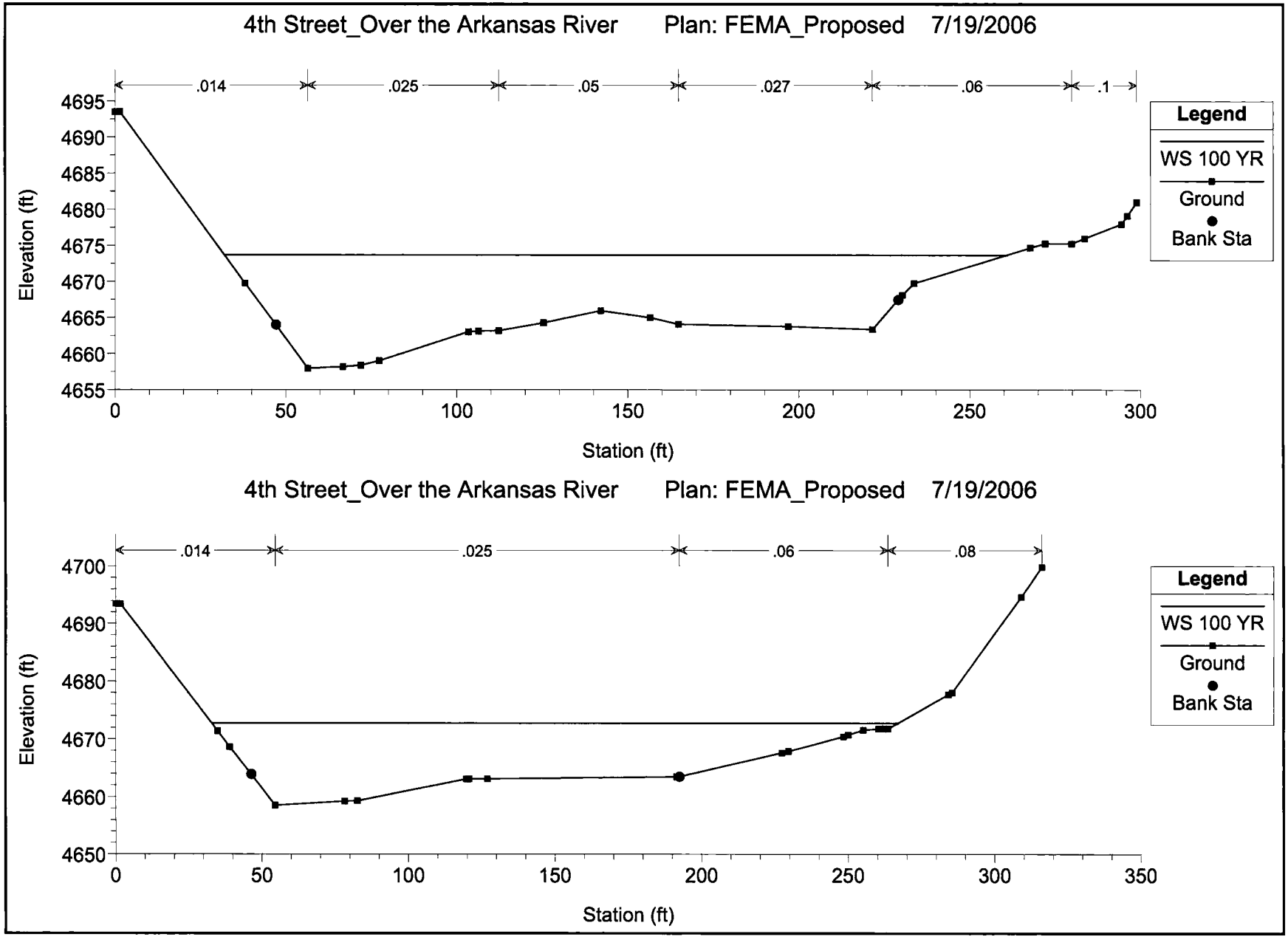
US Limit of Model - Through W Weir
.014
.027
.06
.1
Elevation (ft)
4700
4690
4680
4670
4660
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.025
.06
.1
Elevation (ft)
4700
4690
4680
4670
4660
4650
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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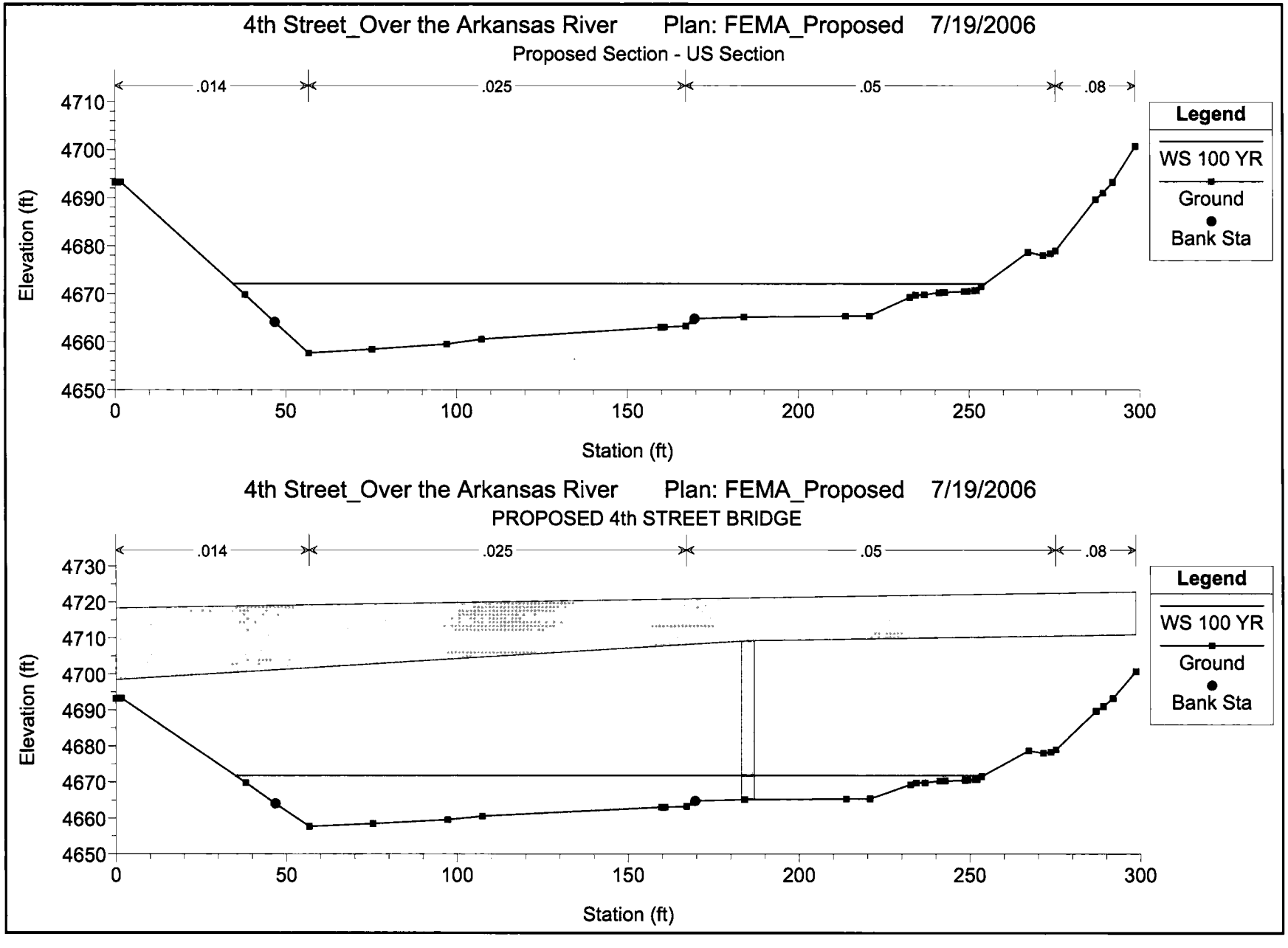
.014
.025
.05
.027
.06
.1
Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.025
.06
.08
Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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Proposed Section - US Section
.014
.025
.05
.08
Elevation (ft)
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4700
4690
4680
4670
4660
4650
0
50
100
150
200
250
300
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
PROPOSED 4th STREET BRIDGE
.014
.025
.05
.08
Elevation (ft)
4730
4720
4710
4700
4690
4680
4670
4660
4650
0
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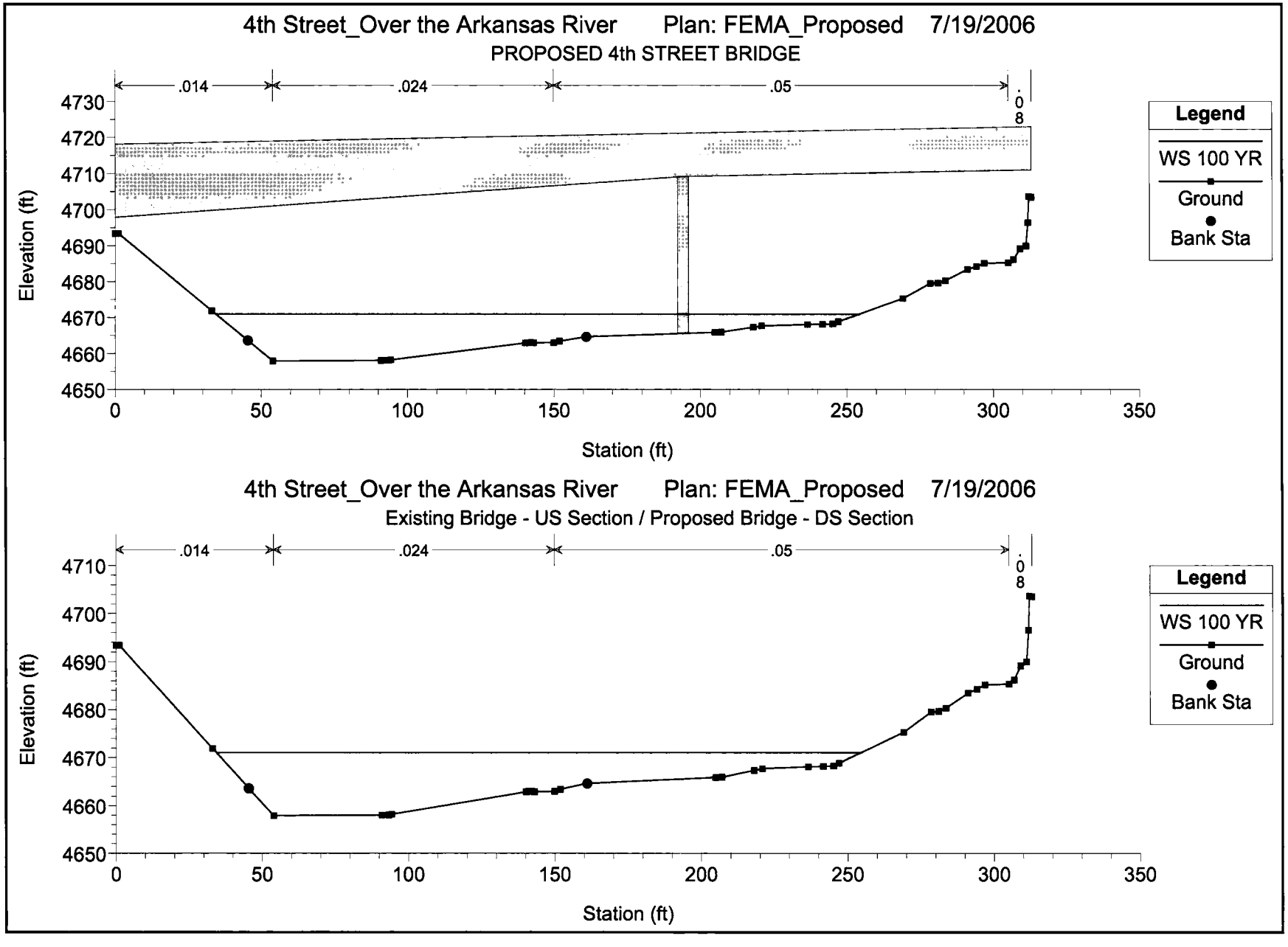
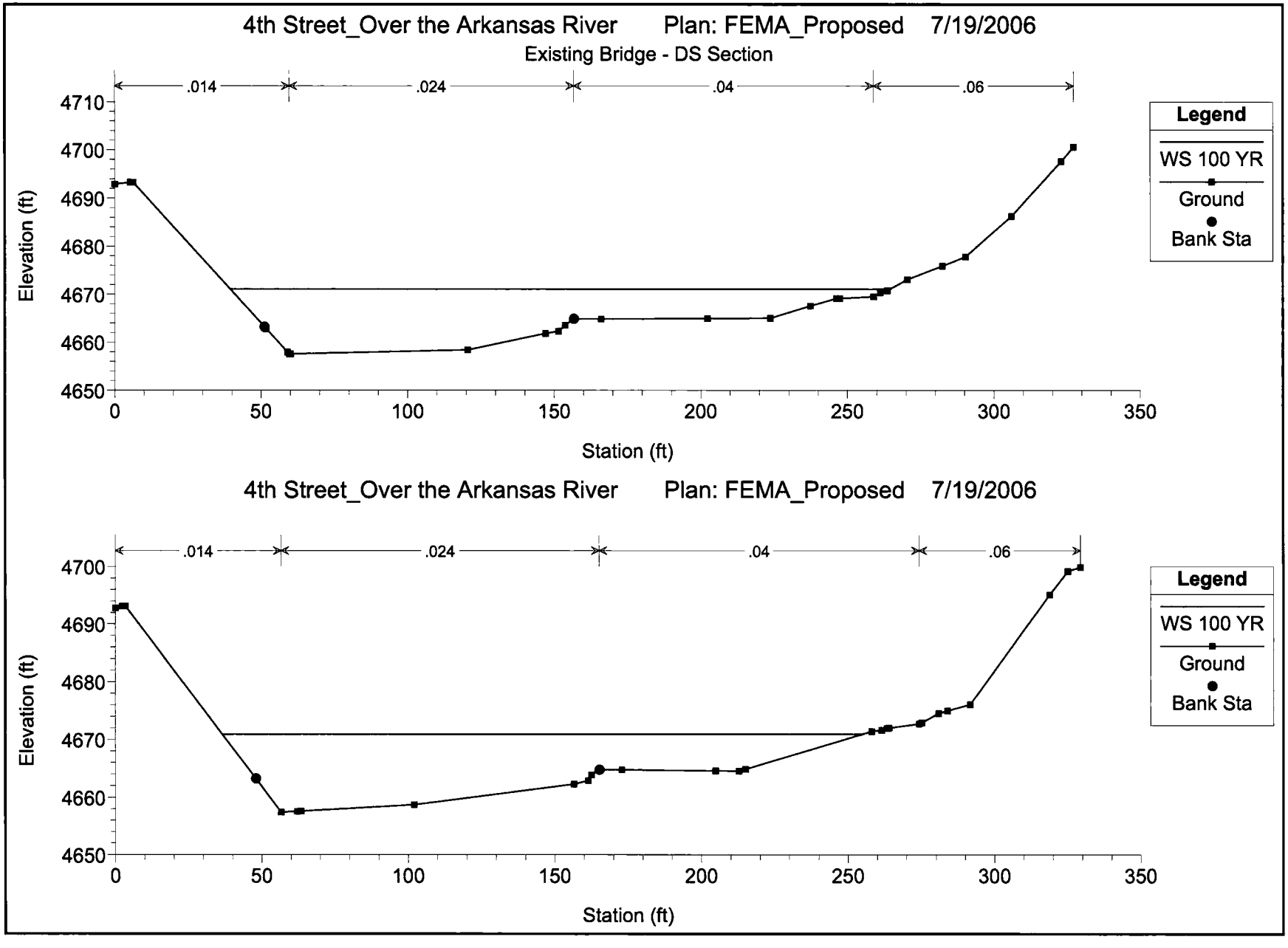
100
150
200
250
300
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
PROPOSED 4th STREET BRIDGE
.014
.024
.05
.08
Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
Existing Bridge - US Section / Proposed Bridge - DS Section
.014
.024
.05
.08
Legend
WS 100 YR
Ground
Bank Sta
Elevation (ft)
Station (ft)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Existing Bridge - DS Section
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.024
.04
.06
Elevation (ft)
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4700
4690
4680
4670
4660
4650
0
50
100
150
200
250
300
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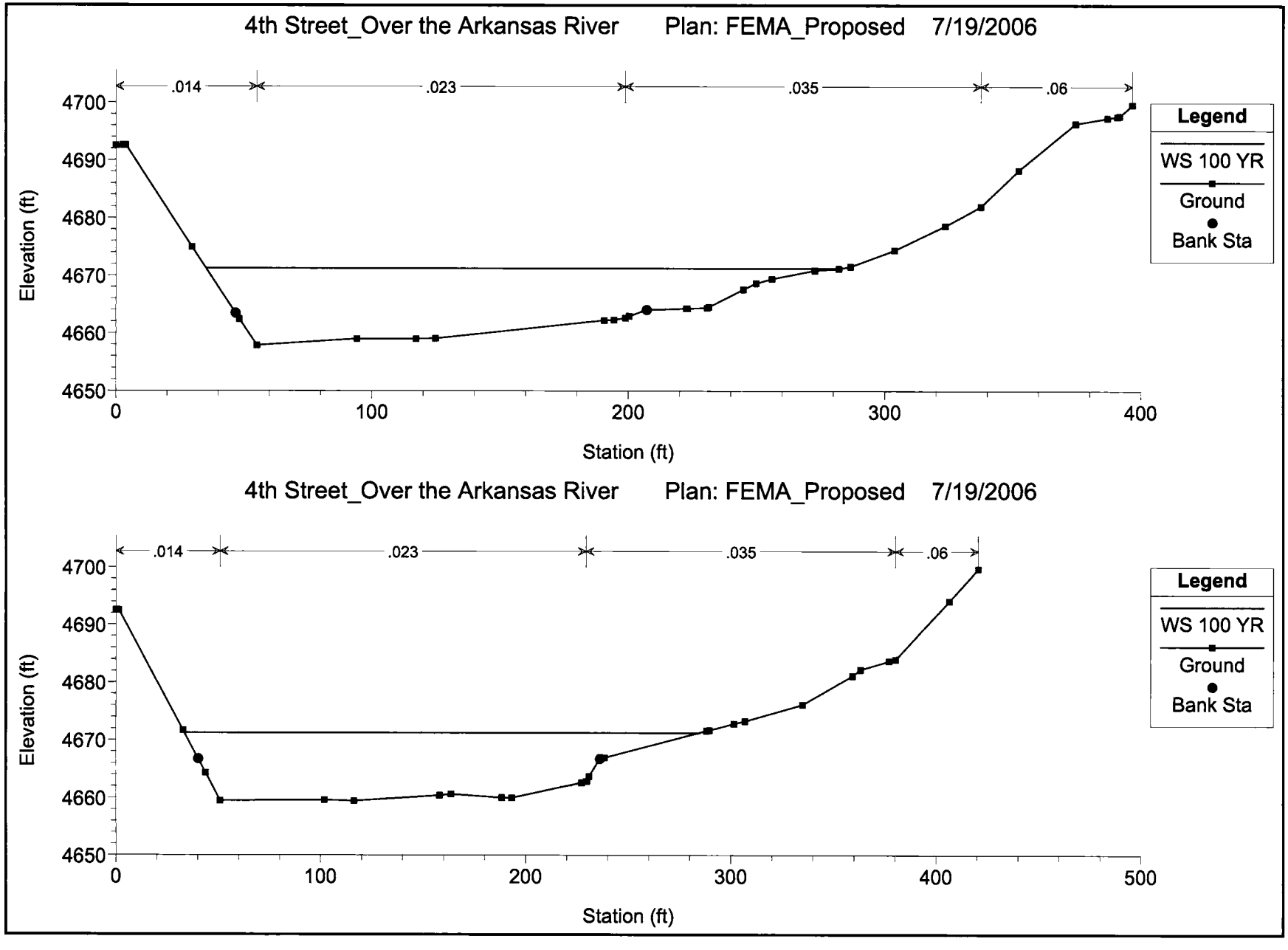
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.024
.04
.06
Elevation (ft)
4700
4690
4680
4670
4660
4650
0
50
100
150
200
250
300
350
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
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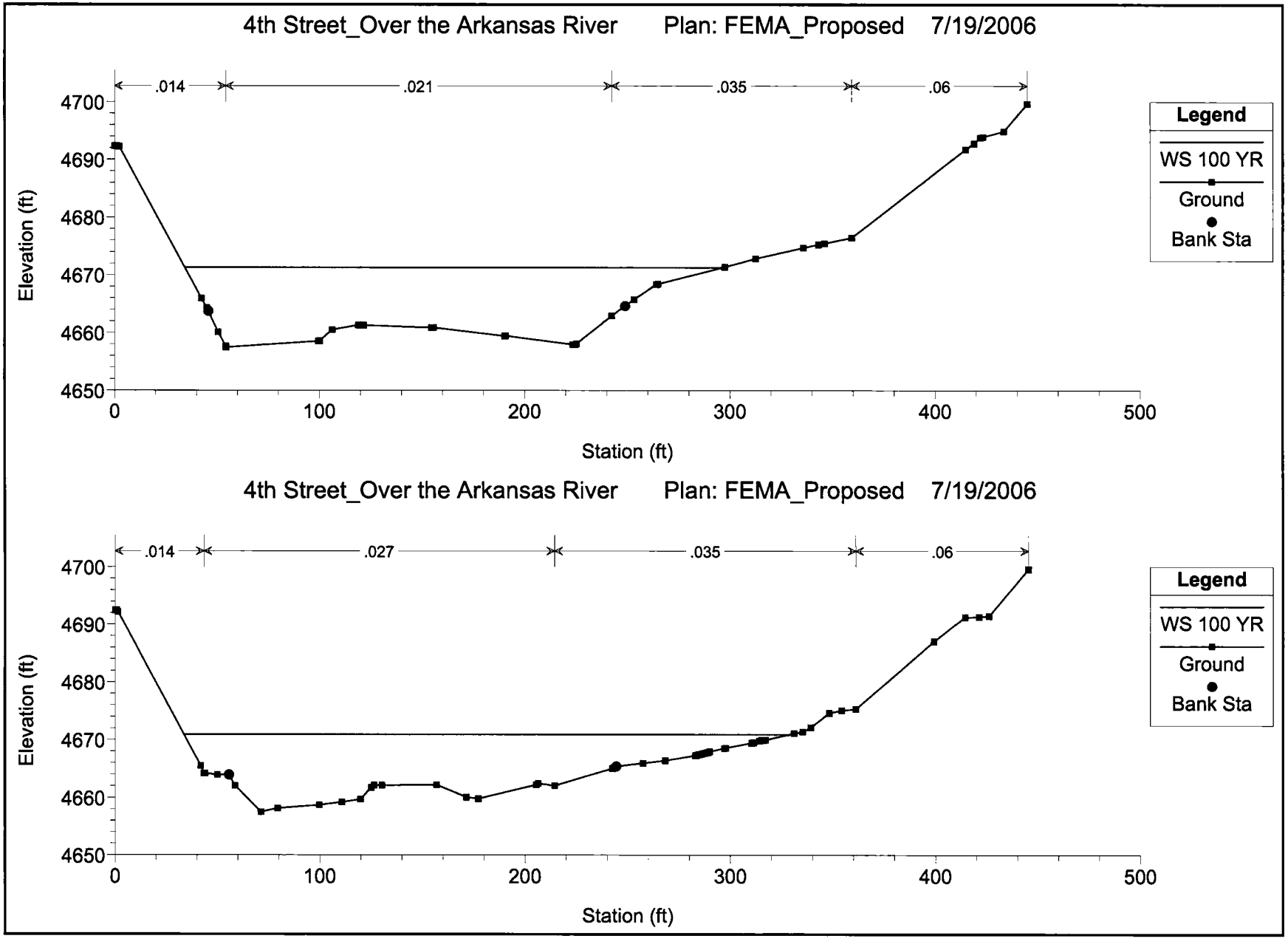
.023
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.023
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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.035
.06
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4680
4670
4660
4650
Elevation (ft)
0
100
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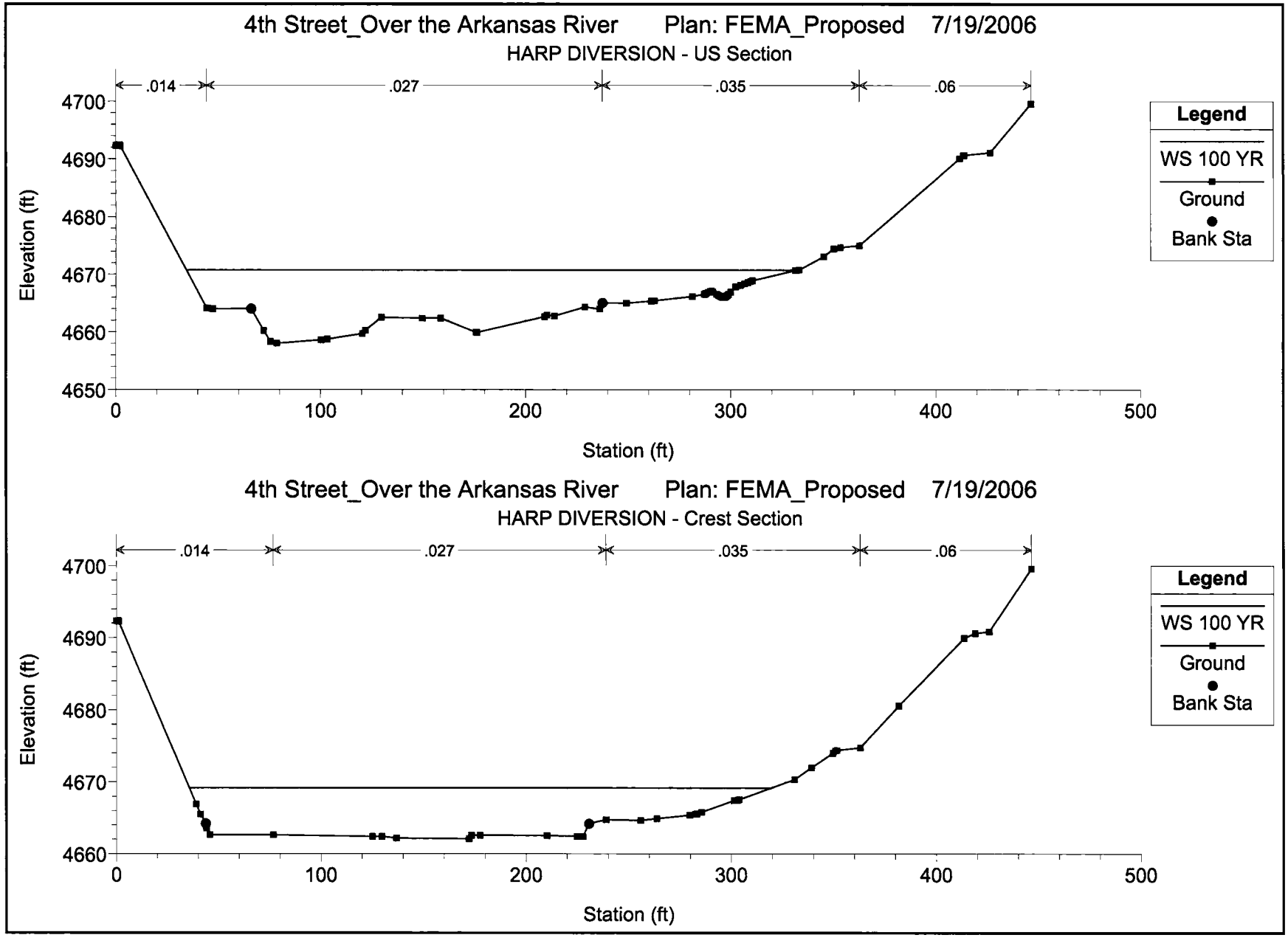
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.027
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
HARP DIVERSION - US Section
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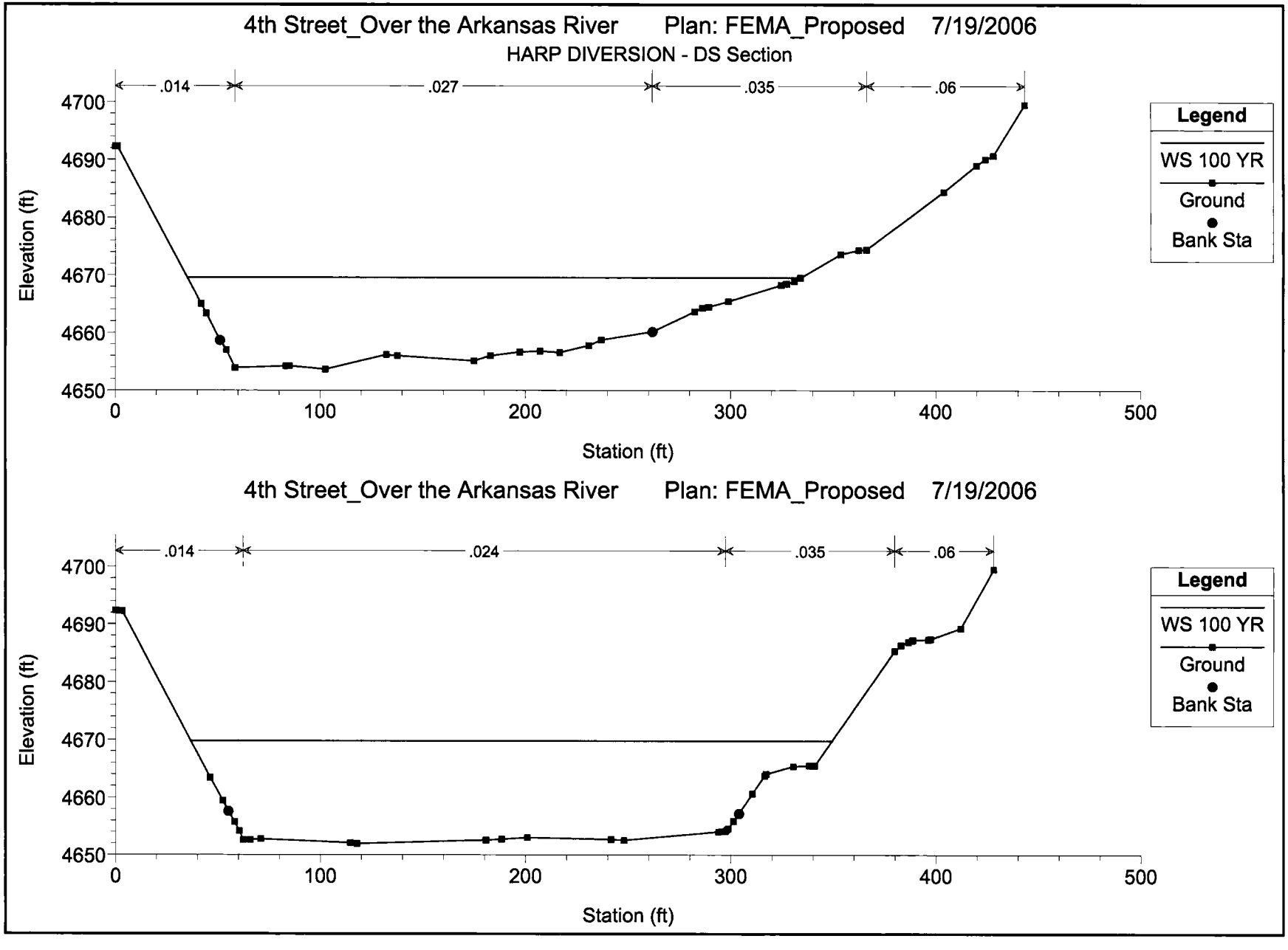
.027
.035
.06
4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
HARP DIVERSION - Crest Section
.014
.027
.035
.06
4700
4690
4680
4670
4660
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta


4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
HARP DIVERSION - DS Section
.014
.027
.035
.06
Elevation (ft)
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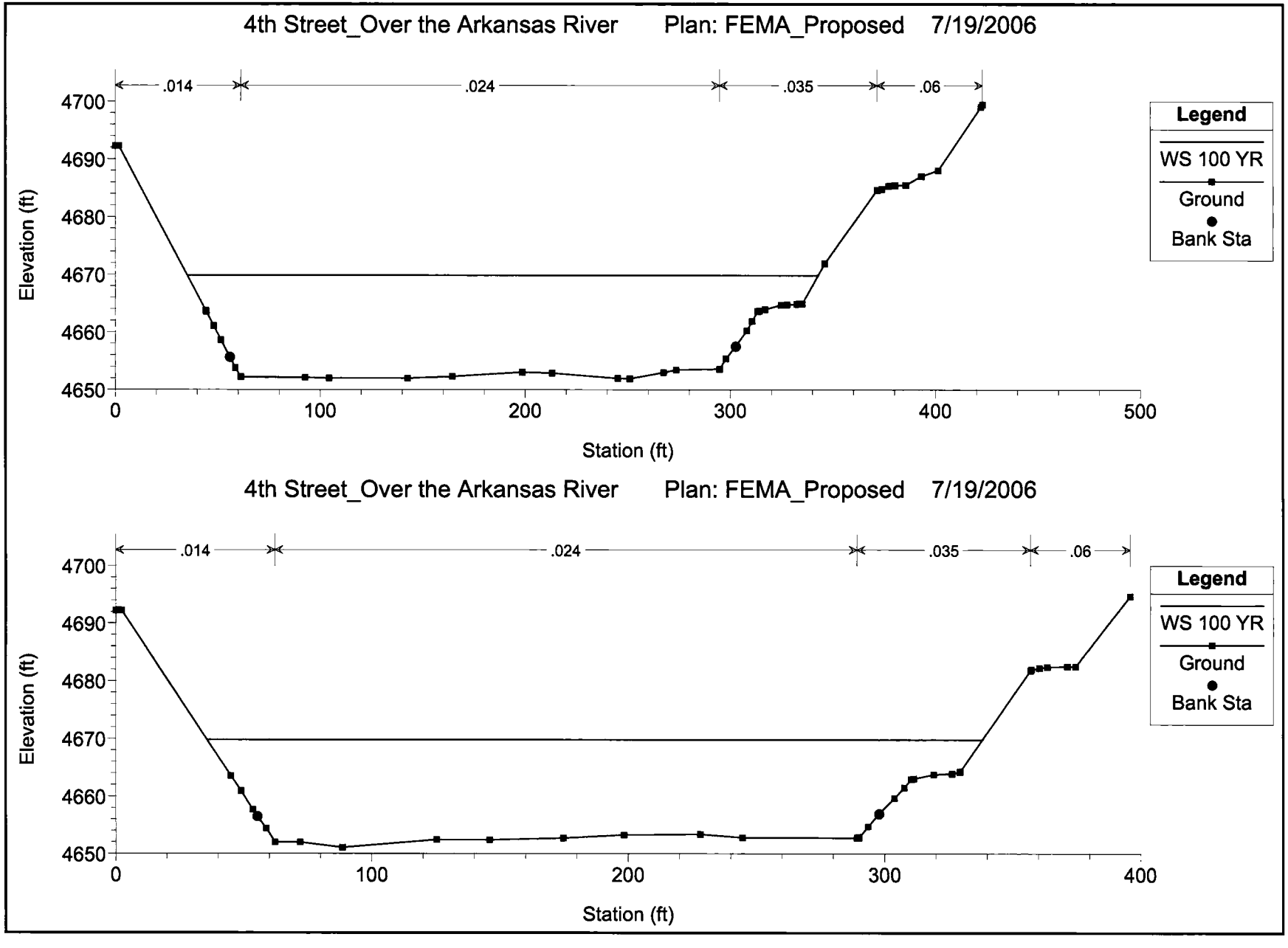
4690
4680
4670
4660
4650
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.024
.035
.06
Elevation (ft)
4700
4690
4680
4670
4660
4650
0
100
200
300
400
500
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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4700
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4680
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Elevation (ft)
0
100
200
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Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
.014
.024
.035
.06
4700
4690
4680
4670
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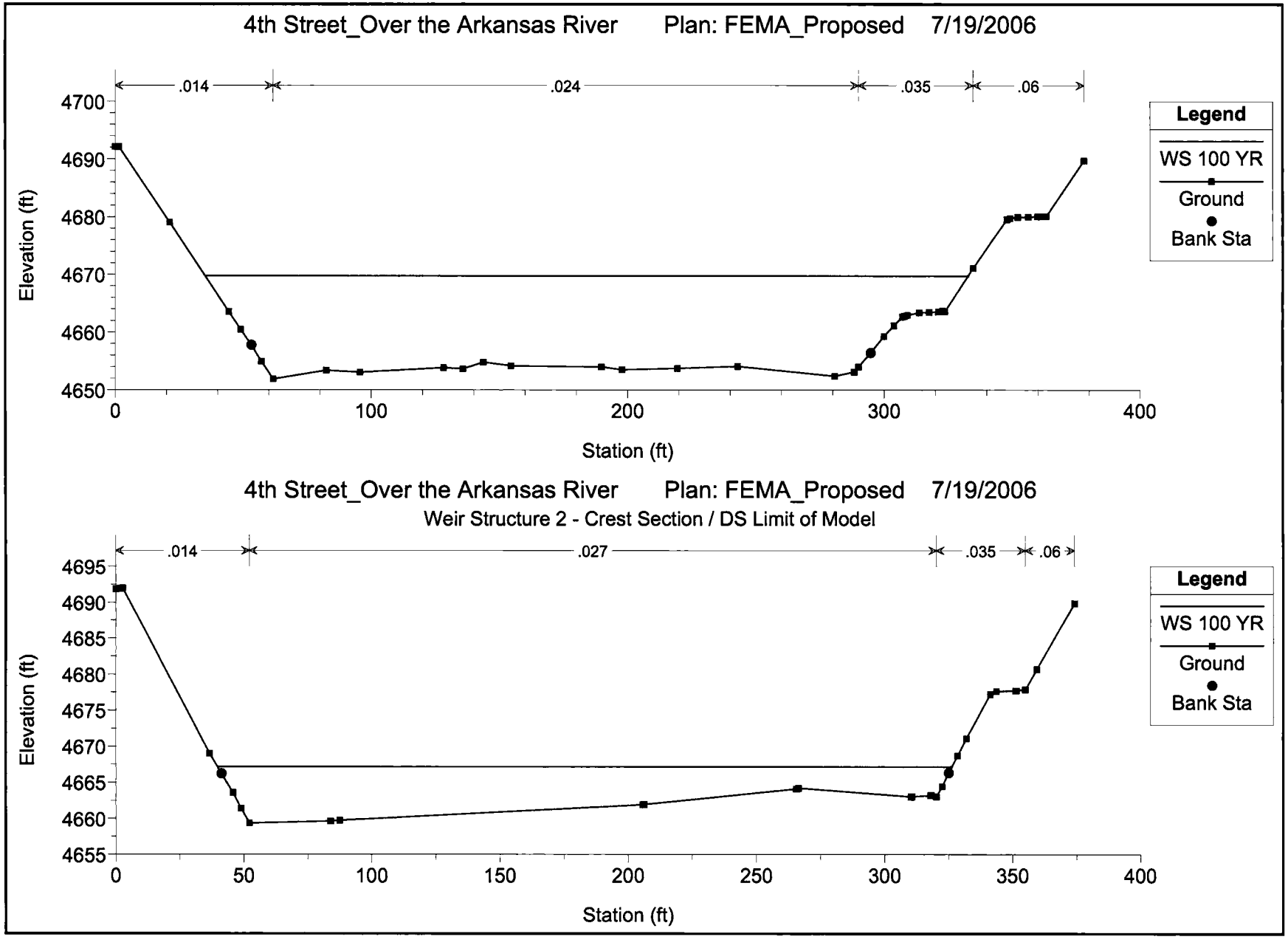
4650
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta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.024
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4700
4690
4680
4670
4660
4650
Elevation (ft)
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta
4th Street_Over the Arkansas River Plan: FEMA_Proposed 7/19/2006
Weir Structure 2 - Crest Section / DS Limit of Model
.014
.027
.035
.06
4695
4690
4685
4680
4675
4670
4665
4660
4655
Elevation (ft)
0
50
100
150
200
250
300
350
400
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta

HEC-RAS Version 3.1.3 May 2005
U.S. Army Corp of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
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PROJECT DATA
Project Title: 4th Street_Over the Arkansas River
Project File : Arkansas.prj
Run Date and Time: 7/19/2006 9:36:58 AM

Project in English units

Project Description:
SH 96A (4th Street) Over the Akansas River Hydraulic Analysis

****

PLAN DATA

Plan Title: FEMA_Proposed
Plan File : s:\32-1066.01_4thStreet\Scour\RAS\Arkansas.p12

Geometry Title: Proposed Conditions
Geometry File : s:\32-1066.01_4thStreet\Scour\RAS\Arkansas.g12

Flow Title : FEMA Flows
Flow File : s:\32-1066.01_4thStreet\Scour\RAS\Arkansas.f04

Plan Summary Information:

Number of:	Cross Sections	= 42	Multiple Openings	=	0
	Culverts	= 0	Inline Structures	=	0
	Bridges	= 1	Lateral Structures	=	0

Computational Information

Water surface calculation tolerance	= 0.001
Critical depth calculation tolerance	= 0.001
Maximum number of iterations	= 30
Maximum difference tolerance	= 0.3
Flow tolerance factor	= 0.001

Computation Options

Critical depth computed at all cross sections	
Conveyance Calculation Method:	At breaks in n values only
Friction Slope Method:	Average Conveyance
Computational Flow Regime:	Mixed Flow

****

FLOW DATA

Flow Title: FEMA Flows
Flow File : s:\32-1066.01_4thStreet\Scour\RAS\Arkansas.f04

Flow Data (cfs)

River	Reach	RS	10 YR	50 YR	100 YR	500 YR
Arkansas River	4th Street	2383.165	7000	14000	20000	40000

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Arkansas River	4th Street	10 YR	Normal S = 0.002	Critical
Arkansas River	4th Street	50 YR	Normal S = 0.002	Critical
Arkansas River	4th Street	100 YR	Normal S = 0.002	Critical
Arkansas River	4th Street	500 YR	Normal S = 0.002	Critical

GEOMETRY DATA

Geometry Title: Proposed Conditions
Geometry File : s:\32-1066.01_4thStreet\Scour\RAS\Arkansas.g12

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 2383.165

INPUT
Description: US Limit of Model - Through W Weir
Station Elevation Data num= 44

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4694.47	6.28	4694.44	6.76	4694.42	7.39	4694.4	35.15	4675.94
50.88	4665.79	53.15	4664.09	53.97	4663.55	54.65	4663.1	54.93	4663.1
55.16	4663.32	66.03	4664.44	68.23	4665.39	68.98	4664.64	71.26	4662.01
78.84	4662.1	94.96	4661.43	113.79	4662.68	129.71	4662.95	130.5	4664.38
131.65	4665.56	136.57	4664.01	137.43	4663.63	142.85	4663.81	148.92	4663.76
149.55	4663.93	157.53	4665.41	158.92	4664.59	161.96	4663.19	182.7	4662.52
204.84	4662.74	212.72	4662.8	215.01	4664.25	216.38	4665.39	219.86	4663.77
220.86	4663.41	226.6	4663.32	240.36	4665.78	286.79	4675.91	291.87	4676.09
294.74	4676.08	310.1	4677.09	317.45	4677.36	342.26	4699.8		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	54.65	.027	226.6	.06	317.45	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
50.88	240.36	270.73	280.79	284.47	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4675.92	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.14	Wt. n-Val.	0.014	0.030	0.060
W.S. Elev (ft)	4674.78	Reach Len. (ft)	270.73	280.79	284.47
Crit W.S. (ft)	4670.26	Flow Area (sq ft)	62.57	2197.21	185.46
E.G. Slope (ft/ft)	*0.001189	Area (sq ft)	62.57	2197.21	185.46
Q Total (cfs)	*20000.00	Flow (cfs)	555.17	*19019.92	424.90
Top Width (ft)	244.64	Top Width (ft)	13.93	189.48	41.23
Vel Total (ft/s)	8.18	Avg. Vel. (ft/s)	8.87	8.66	2.29
Max Chl Dpth (ft)	13.35	Hydr. Depth (ft)	4.49	11.60	4.50
Conv. Total (cfs)	*580031.6	Conv. (cfs)	16100.9	*551607.8	12322.9
Length Wtd. (ft)	280.51	Wetted Per. (ft)	16.57	196.09	42.20
Min Ch El (ft)	4661.43	Shear (lb/sq ft)	0.28	0.83	0.33
Alpha	1.10	Stream Power (lb/ft s)	2.49	7.20	0.75
Frctn Loss (ft)	0.30	Cum Volume (acre-ft)	3.22	107.77	12.07
C & E Loss (ft)	0.00	Cum SA (acres)	0.70	9.17	2.88

Warning: The parabolic search method failed to converge on critical depth. The program will try the cross section slice/secant method to find critical depth.
Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	35.62	40.70	14.38	4.54	4.46	0.07	1.21	3.17
2	LOB	40.70	45.79	146.79	20.66	6.06	0.73	4.06	7.10
3	LOB	45.79	50.88	394.00	37.37	6.06	1.97	7.34	10.54
4	Chan	50.88	69.83	1865.99	201.49	20.91	9.33	10.63	9.26
5	Chan	69.83	88.78	2248.85	241.52	19.71	11.24	12.75	9.31
6	Chan	88.78	107.72	2388.70	246.67	18.98	11.94	13.02	9.68
7	Chan	107.72	126.67	2111.76	229.01	18.96	10.56	12.09	9.22
8	Chan	126.67	145.62	1660.53	204.97	20.61	8.30	10.82	8.10
9	Chan	145.62	164.57	1657.82	200.85	19.64	8.29	10.60	8.25
10	Chan	164.57	183.52	2080.12	226.91	18.96	10.40	11.98	9.17
11	Chan	183.52	202.46	2132.48	230.28	18.95	10.66	12.15	9.26
12	Chan	202.46	221.41	1830.54	215.58	20.20	9.15	11.38	8.49
13	Chan	221.41	240.36	1043.13	199.93	19.17	5.22	10.55	5.22
14	ROB	240.36	250.55	227.14	80.34	10.43	1.14	7.88	2.83
15	ROB	250.55	260.74	130.77	57.69	10.43	0.65	5.66	2.27
16	ROB	260.74	270.93	56.94	35.03	10.43	0.28	3.44	1.63
17	ROB	270.93	281.12	10.06	12.38	10.43	0.05	1.21	0.81
18	ROB	281.12	291.31	0.00	0.02	0.48	0.00	0.05	0.10

Warning: The parabolic search method failed to converge on critical depth. The program will try the cross section slice/secant method to find critical depth.
Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 2102.372

INPUT
Description:
Station Elevation Data num= 30

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4694.02	.62	4694	19.97	4681.5	29.91	4674.94	46.5	4664.01
55.4	4658.15	59.25	4658.21	64.69	4658.54	74.67	4660.53	87.44	4662.95
89.27	4663.29	90.04	4663.38	99.25	4663.57	145.65	4664.68	204.17	4663.84
219.4	4663.7	224.27	4663.77	237.54	4663.63	239.99	4664.6	246.14	4667.05
247.48	4667.63	264.29	4674.98	265.92	4675.07	269.81	4675.27	272.43	4675.18
278.14	4675.14	287.39	4675.86	298.19	4676.61	301.47	4679.44	324.97	4699.66

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	55.4	.025	237.54	.06	298.19	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
46.5	247.48	280.47	276.43	253.06	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4675.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.14	Wt. n-Val.	0.014	0.027	0.060
W.S. Elev (ft)	4674.48	Reach Len. (ft)	280.47	276.43	253.06
Crit W.S. (ft)	4670.02	Flow Area (sq ft)	83.12	2236.44	53.58
E.G. Slope (ft/ft)	*0.000984	Area (sq ft)	83.12	2236.44	53.58
Q Total (cfs)	*20000.00	Flow (cfs)	739.81	*19170.99	89.20
Top Width (ft)	232.52	Top Width (ft)	15.88	200.98	15.66
Vel Total (ft/s)	8.43	Avg. Vel. (ft/s)	8.90	8.57	1.66
Max Chl Dpth (ft)	16.33	Hydr. Depth (ft)	5.23	11.13	3.42
Conv. Total (cfs)	*637426.1	Conv. (cfs)	23578.8	*611004.3	2843.0
Length Wtd. (ft)	276.45	Wetted Per. (ft)	19.02	204.01	17.09
Min Ch El (ft)	4658.15	Shear (lb/sq ft)	0.27	0.67	0.19
Alpha	1.03	Stream Power (lb/ft s)	2.39	5.78	0.32
Frctn Loss (ft)	0.39	Cum Volume (acre-ft)	2.77	93.48	11.29
C & E Loss (ft)	0.03	Cum SA (acres)	0.61	7.92	2.70

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	27.90	32.55	2.29	1.23	2.32	0.01	0.64	1.86
2	LOB	32.55	37.20	65.20	13.05	5.57	0.33	2.81	5.00
3	LOB	37.20	41.85	223.08	27.29	5.57	1.12	5.87	8.17
4	LOB	41.85	46.50	449.23	41.54	5.57	2.25	8.93	10.81
5	Chan	46.50	66.60	3710.44	299.58	21.90	18.55	14.91	12.39
6	Chan	66.60	86.70	2576.28	273.06	20.47	12.88	13.59	9.43
7	Chan	86.70	106.79	1828.29	220.88	20.15	9.14	10.99	8.28
8	Chan	106.79	126.89	1692.79	210.71	20.10	8.46	10.48	8.03
9	Chan	126.89	146.99	1565.84	201.08	20.10	7.83	10.00	7.79
10	Chan	146.99	167.09	1553.85	200.14	20.10	7.77	9.96	7.76
11	Chan	167.09	187.19	1629.68	205.95	20.10	8.15	10.25	7.91
12	Chan	187.19	207.28	1706.59	211.72	20.10	8.53	10.53	8.06
13	Chan	207.28	227.38	1758.27	215.54	20.10	8.79	10.72	8.16
14	Chan	227.38	247.48	1148.97	197.76	20.87	5.74	9.84	5.81
15	ROB	247.48	255.23	76.41	39.92	8.46	0.38	5.15	1.91
16	ROB	255.23	262.98	12.79	13.66	8.46	0.06	1.76	0.94
17	ROB	262.98	270.73	0.00	0.01	0.17	0.00	0.03	0.07

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1825.946

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4693.51	.29	4693.52	1.39	4693.55	38.06	4669.77	47.1	4664.01
56.46	4657.96	66.74	4658.19	71.96	4658.4	77.33	4659.03	103.43	4663.03
106.41	4663.13	112.29	4663.2	125.36	4664.29	142.09	4665.95	156.56	4665
164.82	4664.09	196.94	4663.78	221.52	4663.37	229	4667.47	230.23	4668.14
233.64	4669.76	267.66	4674.69	272	4675.27	279.76	4675.26	283.58	4675.98
294.34	4677.99	296.06	4679.13	298.82	4681				

Manning's n Values num= 6

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	56.46	.025	112.29	.05	164.82	.027	221.52	.06
279.76	.1								

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
47.1	229	258.34	255.23	247.86	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4675.19	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.49	Wt. n-Val.	0.014	0.035	0.060
W.S. Elev (ft)	4673.70	Reach Len. (ft)	258.34	255.23	247.86
Crit W.S. (ft)	4670.08	Flow Area (sq ft)	73.46	1957.42	76.99
E.G. Slope (ft/ft)	0.002217	Area (sq ft)	73.46	1957.42	76.99
Q Total (cfs)	20000.00	Flow (cfs)	939.54	18901.41	159.06
Top Width (ft)	228.82	Top Width (ft)	15.10	181.90	31.82
Vel Total (ft/s)	9.49	Avg. Vel. (ft/s)	12.79	9.66	2.07
Max Chl Dpth (ft)	15.74	Hydr. Depth (ft)	4.87	10.76	2.42
Conv. Total (cfs)	424788.8	Conv. (cfs)	19955.2	401455.3	3378.3
Length Wtd. (ft)	255.14	Wetted Per. (ft)	17.94	185.30	32.64
Min Ch El (ft)	4657.96	Shear (lb/sq ft)	0.57	1.46	0.33
Alpha	1.06	Stream Power (lb/ft s)	7.25	14.12	0.67
Frctn Loss (ft)	0.46	Cum Volume (acre-ft)	2.26	80.17	10.91
C & E Loss (ft)	0.05	Cum SA (acres)	0.51	6.70	2.56

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	28.26	32.97	0.53	0.30	1.16	0.00	0.31	1.75
2	LOB	32.97	37.68	64.24	10.15	5.61	0.32	2.16	6.33
3	LOB	37.68	42.39	278.52	24.43	5.59	1.39	5.19	11.40
4	LOB	42.39	47.10	596.26	38.57	5.58	2.98	8.19	15.46
5	Chan	47.10	65.29	4084.58	257.11	19.98	20.42	14.13	15.89
6	Chan	65.29	83.48	3517.51	270.71	18.30	17.59	14.88	12.99
7	Chan	83.48	101.67	2562.55	224.34	18.40	12.81	12.33	11.42
8	Chan	101.67	119.86	1559.91	189.69	18.24	7.80	10.43	8.22
9	Chan	119.86	138.05	767.03	164.42	18.27	3.84	9.04	4.66
10	Chan	138.05	156.24	646.83	148.34	18.24	3.23	8.15	4.36
11	Chan	156.24	174.43	1208.13	171.19	18.24	6.04	9.41	7.06
12	Chan	174.43	192.62	1627.25	178.08	18.19	8.14	9.79	9.14
13	Chan	192.62	210.81	1686.47	181.95	18.19	8.43	10.00	9.27
14	Chan	210.81	229.00	1241.14	171.60	19.24	6.21	9.43	7.23
15	ROB	229.00	235.98	83.31	32.27	7.54	0.42	4.62	2.58
16	ROB	235.98	242.96	44.62	21.60	7.05	0.22	3.09	2.07
17	ROB	242.96	249.95	23.06	14.54	7.05	0.12	2.08	1.59
18	ROB	249.95	256.93	7.61	7.47	7.05	0.04	1.07	1.02
19	ROB	256.93	263.91	0.46	1.10	3.94	0.00	0.28	0.42

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1570.713

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

0	4693.48	.52	4693.49	1.18	4693.45	1.53	4693.44	34.85	4671.38
38.96	4668.64	46.3	4663.87	54.51	4658.55	78.27	4659.25	82.58	4659.3
119.77	4663.03	120.66	4663.05	126.9	4663.06	191.5	4663.43	192.36	4663.44
227.38	4667.58	229.64	4667.85	248.39	4670.4	250.05	4670.71	255.07	4671.53
260.37	4671.76	262.57	4671.81	263.56	4671.77	284.13	4677.66	285.42	4678.02
309.03	4694.61	316.1	4699.81						

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	54.51	.025	192.36	.06	263.56	.08

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
46.3	192.36	168.43	164.79	138.09	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4674.68	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.94	Wt. n-Val.	0.014	0.024	0.060
W.S. Elev (ft)	4672.74	Reach Len. (ft)	168.43	164.79	138.09
Crit W.S. (ft)	4670.00	Flow Area (sq ft)	60.21	1602.42	354.56
E.G. Slope (ft/ft)	*0.001482	Area (sq ft)	60.21	1602.42	354.56
Q Total (cfs)	*20000.00	Flow (cfs)	591.42	*18434.54	974.05
Top Width (ft)	234.15	Top Width (ft)	13.50	146.06	74.59
Vel Total (ft/s)	9.91	Avg. Vel. (ft/s)	9.82	11.50	2.75
Max Chl Dpth (ft)	14.19	Hydr. Depth (ft)	4.46	10.97	4.75
Conv. Total (cfs)	*519501.0	Conv. (cfs)	15362.1	*478838.0	25300.9
Length Wtd. (ft)	163.10	Wetted Per. (ft)	16.16	147.83	75.26
Min Ch El (ft)	4658.55	Shear (lb/sq ft)	0.34	1.00	0.44
Alpha	1.27	Stream Power (lb/ft s)	3.39	11.54	1.20
Frctn Loss (ft)	0.26	Cum Volume (acre-ft)	1.87	69.74	9.68
C & E Loss (ft)	0.03	Cum SA (acres)	0.42	5.74	2.26

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	32.41	37.04	23.23	5.97	5.10	0.12	1.41	3.89
2	LOB	37.04	41.67	166.59	20.14	5.54	0.83	4.35	8.27
3	LOB	41.67	46.30	401.60	34.10	5.52	2.01	7.37	11.78
4	Chan	46.30	60.91	2874.54	184.82	16.18	14.37	12.65	15.55
5	Chan	60.91	75.51	2572.10	201.36	14.61	12.86	13.79	12.77
6	Chan	75.51	90.12	2409.79	193.81	14.65	12.05	13.27	12.43
7	Chan	90.12	104.72	2021.20	174.57	14.68	10.11	11.95	11.58
8	Chan	104.72	119.33	1625.36	153.17	14.68	8.13	10.49	10.61
9	Chan	119.33	133.94	1425.74	141.31	14.61	7.13	9.67	10.09
10	Chan	133.94	148.54	1406.90	140.18	14.61	7.03	9.60	10.04
11	Chan	148.54	163.15	1386.56	138.96	14.61	6.93	9.51	9.98
12	Chan	163.15	177.75	1366.28	137.74	14.61	6.83	9.43	9.92
13	Chan	177.75	192.36	1346.07	136.51	14.61	6.73	9.35	9.86
14	ROB	192.36	204.73	366.42	106.02	12.46	1.83	8.57	3.46
15	ROB	204.73	217.11	268.20	87.92	12.46	1.34	7.11	3.05
16	ROB	217.11	229.48	182.63	69.82	12.46	0.91	5.64	2.62
17	ROB	229.48	241.86	105.80	50.36	12.49	0.53	4.07	2.10
18	ROB	241.86	254.23	41.80	28.88	12.52	0.21	2.33	1.45
19	ROB	254.23	266.60	9.20	11.54	12.51	0.05	0.93	0.80
20	ROB	266.60	278.98	0.00	0.02	0.36	0.00	0.05	0.08

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1405.927

INPUT
Description: Proposed Section - US Section
Station Elevation Data num= 37

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4693.22	.52	4693.24	.88	4693.26	1.64	4693.29	38.06	4669.8
46.71	4664.1	56.68	4657.64	75.3	4658.43	97.2	4659.52	107.33	4660.53
159.69	4663.03	160.17	4662.97	160.82	4663.06	167.06	4663.27	169.07	4664.43
169.53	4664.83	184.05	4665.15	213.79	4665.35	220.75	4665.39	232.57	4669.27
234.27	4669.73	236.84	4669.8	241.11	4670.25	242.71	4670.31	248.53	4670.5
249.35	4670.53	251.54	4670.72	252.07	4670.74	253.4	4671.51	267.16	4678.68
271.51	4678.01	273.69	4678.34	275.17	4678.94	286.91	4689.67	289.08	4691.01
291.9	4693.23	298.6	4700.74						

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	56.68	.025	167.06	.05	275.17	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

Left	Right	Left	Channel	Right	Coeff Contr.	Expan.
46.71	169.53	155.9	153.07	139.36	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4674.39	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.25	Wt. n-Val.	0.014	0.025	0.050
W.S. Elev (ft)	4672.15	Reach Len. (ft)	26.00	26.00	26.00
Crit W.S. (ft)	4669.67	Flow Area (sq ft)	49.23	1415.86	453.16
E.G. Slope (ft/ft)	*0.001739	Area (sq ft)	49.23	1415.86	453.16
Q Total (cfs)	*20000.00	Flow (cfs)	488.02	*17813.68	1698.30
Top Width (ft)	220.20	Top Width (ft)	12.29	122.82	85.09
Vel Total (ft/s)	10.43	Avg. Vel. (ft/s)	9.91	12.58	3.75
Max Chl Dpth (ft)	14.51	Hydr. Depth (ft)	4.01	11.53	5.33
Conv. Total (cfs)	*479568.4	Conv. (cfs)	11702.0	*427143.9	40722.5
Length Wtd. (ft)	26.00	Wetted Per. (ft)	14.69	125.36	86.18
Min Ch El (ft)	4657.64	Shear (lb/sq ft)	0.36	1.23	0.57
Alpha	1.33	Stream Power (lb/ft s)	3.61	15.43	2.14
Frctn Loss (ft)	0.05	Cum Volume (acre-ft)	1.66	64.03	8.40
C & E Loss (ft)	0.03	Cum SA (acres)	0.37	5.23	2.01

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	32.70	37.37	9.15	2.80	3.51	0.05	0.95	3.26
2	LOB	37.37	42.04	122.64	16.03	5.59	0.61	3.43	7.65
3	LOB	42.04	46.71	356.23	30.40	5.59	1.78	6.51	11.72
4	Chan	46.71	58.99	2572.04	145.86	14.19	12.86	11.88	17.63
5	Chan	58.99	71.27	2382.84	173.77	12.29	11.91	14.15	13.71
6	Chan	71.27	83.56	2232.48	167.12	12.30	11.16	13.61	13.36
7	Chan	83.56	95.84	2069.02	159.68	12.30	10.35	13.00	12.96
8	Chan	95.84	108.12	1844.16	149.21	12.33	9.22	12.15	12.36
9	Chan	108.12	120.40	1634.76	138.63	12.30	8.17	11.29	11.79
10	Chan	120.40	132.68	1495.67	131.42	12.30	7.48	10.70	11.38
11	Chan	132.68	144.97	1361.56	124.22	12.30	6.81	10.11	10.96
12	Chan	144.97	157.25	1232.55	117.02	12.30	6.16	9.53	10.53
13	Chan	157.25	169.53	988.60	108.92	12.76	4.94	8.87	9.08
14	ROB	169.53	182.44	386.31	92.61	12.91	1.93	7.18	4.17
15	ROB	182.44	195.34	367.80	89.92	12.91	1.84	6.97	4.09
16	ROB	195.34	208.25	360.05	88.77	12.91	1.80	6.88	4.06
17	ROB	208.25	221.16	352.13	87.65	12.93	1.76	6.79	4.02
18	ROB	221.16	234.07	172.44	58.21	13.56	0.86	4.51	2.96
19	ROB	234.07	246.97	47.05	26.21	12.94	0.24	2.03	1.80
20	ROB	246.97	259.88	12.52	9.78	8.02	0.06	1.28	1.28

Note: Manning's n values were composited to a single value in the main channel.

BRIDGE

RIVER: Arkansas River
REACH: 4th Street RS: 1329.40

INPUT
Description: PROPOSED 4th STREET BRIDGE

(FROM PLANS DATED 6-05-03)

PIERS
SKEWED 4.095 DEGREES TO THE FLOW
Distance from Upstream XS = 26
Deck/Roadway Width = 112
Weir Coefficient = 2.6
Bridge Pier Skew = 4.095
Upstream Deck/Roadway Coordinates
num= 3

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-48.6	4717.59	4695.59	185	4721.18	4709.18	345	4723.51	4711.51

Upstream Bridge Cross Section Data
Station Elevation Data num= 37

```
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*********************************************************************************
       0 4693.22      .52 4693.24      .88 4693.26     1.64 4693.29    38.06  4669.8
   46.71  4664.1    56.68 4657.64     75.3 4658.43     97.2 4659.52   107.33 4660.53
  159.69 4663.03   160.17 4662.97   160.82 4663.06   167.06 4663.27   169.07 4664.43
  169.53 4664.83   184.05 4665.15   213.79 4665.35   220.75 4665.39   232.57 4669.27
  234.27 4669.73   236.84  4669.8   241.11 4670.25   242.71 4670.31   248.53  4670.5
  249.35 4670.53   251.54 4670.72   252.07 4670.74    253.4 4671.51   267.16 4678.68
  271.51 4678.01   273.69 4678.34   275.17 4678.94   286.91 4689.67   289.08 4691.01
   291.9 4693.23    298.6 4700.74

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************************
       0    .014   56.68    .025  167.06     .05  275.17     .08

Bank Sta: Left   Right    Coeff Contr.   Expan.
         46.71  169.53             .1       .3

Downstream  Deck/Roadway Coordinates
    num=       3
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
*************************************************************************
   -38.9 4717.59 4695.59     194 4721.18 4709.18     345 4723.51 4711.51

Downstream Bridge Cross Section Data
Station Elevation Data    num=      40
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*********************************************************************************
       0 4693.35      .27 4693.35     1.16 4693.36    33.05 4671.89    45.37 4663.65
   45.38 4663.64    53.94 4657.91    90.94 4658.04    93.24 4658.08    94.25 4658.21
  140.23 4662.92   140.94 4662.99   142.07 4663.04   143.02 4662.93   149.88 4663.02
  151.83 4663.42   160.96 4664.63   204.88 4665.85   207.08 4665.91   218.05  4667.3
  220.82 4667.67   236.53 4668.07   241.61 4668.15   245.06 4668.22   245.23 4668.25
  246.99 4668.82   269.06 4675.28    278.5 4679.51   281.08 4679.64   283.59 4680.28
  291.14 4683.41   294.19 4684.24   296.92 4685.15   305.06  4685.3   306.84 4686.17
  309.06 4689.11   311.14 4689.91   311.76 4696.46   312.07 4703.68   312.94 4703.46

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
*************************************************************
       0    .014   53.94    .024  149.88     .05  305.06     .08

Bank Sta: Left   Right    Coeff Contr.   Expan.
         45.38  160.96             .1       .3

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .95
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  1

Pier Data
Pier Station     Upstream=     185    Downstream=     194
Upstream     num=       2
    Width   Elev    Width   Elev
*********************************
   3.833       0   3.833    4710
Downstream     num=       2
    Width   Elev    Width   Elev
*********************************
   3.833       0   3.833    4710

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
       Momentum               Cd   =       2
Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the upstream end
       Criteria to check for pressure flow = Upstream energy grade line
```

BRIDGE OUTPUT Profile #100 YR

E.G. US. (ft)	4674.39	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	4672.15	E.G. Elev (ft)	4674.32	4674.01
Q Total (cfs)	20000.00	W.S. Elev (ft)	4671.82	4670.94
Q Bridge (cfs)	20000.00	Crit W.S. (ft)	4669.73	4670.03
Q Weir (cfs)		Max Chl Dpth (ft)	14.18	13.03
Weir Sta Lft (ft)		Vel Total (ft/s)	10.99	12.02
Weir Sta Rgt (ft)		Flow Area (sq ft)	1819.90	1663.62
Weir Submerg		Froude # Chl	0.69	0.79
Weir Max Depth (ft)		Specif Force (cu ft)	16938.93	16522.87
Min El Weir Flow (ft)	4718.35	Hydr Depth (ft)	8.46	7.70
Min El Prs (ft)	4710.83	W.P. Total (ft)	234.40	231.59
Delta EG (ft)	0.48	Conv. Total (cfs)	444950.4	407002.8
Delta WS (ft)	1.10	Top Width (ft)	215.22	215.93
BR Open Area (sq ft)	11029.16	Frctn Loss (ft)	0.25	0.04
BR Open Vel (ft/s)	12.02	C & E Loss (ft)	0.06	0.06
Coef of Q		Shear Total (lb/sq ft)	0.98	1.08
Br Sel Method	Energy only	Power Total (lb/ft s)	10.76	13.02

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Note: Manning's n values were composited to a single value in the main channel.
Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1252.860

INPUT
Description: Existing Bridge - US Section / Proposed Bridge - DS Section
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4693.35	.27	4693.35	1.16	4693.36	33.05	4671.89	45.37	4663.65
45.38	4663.64	53.94	4657.91	90.94	4658.04	93.24	4658.08	94.25	4658.21
140.23	4662.92	140.94	4662.99	142.07	4663.04	143.02	4662.93	149.88	4663.02
151.83	4663.42	160.96	4664.63	204.88	4665.85	207.08	4665.91	218.05	4667.3
220.82	4667.67	236.53	4668.07	241.61	4668.15	245.06	4668.22	245.23	4668.25
246.99	4668.82	269.06	4675.28	278.5	4679.51	281.08	4679.64	283.59	4680.28
291.14	4683.41	294.19	4684.24	296.92	4685.15	305.06	4685.3	306.84	4686.17
309.06	4689.11	311.14	4689.91	311.76	4696.46	312.07	4703.68	312.94	4703.46

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	53.94	.024	149.88	.05	305.06	.08

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
45.38 160.96 93.11 93.18 93.67 .1 .3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4673.91	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.87	Wt. n-Val.	0.014	0.026	0.050
W.S. Elev (ft)	4671.05	Reach Len. (ft)	93.11	93.18	93.67
Crit W.S. (ft)	4669.99	Flow Area (sq ft)	40.97	1253.61	413.03
E.G. Slope (ft/ft)	0.002686	Area (sq ft)	40.97	1253.61	413.03
Q Total (cfs)	20000.00	Flow (cfs)	476.74	17818.83	1704.43
Top Width (ft)	220.29	Top Width (ft)	11.07	115.58	93.64
Vel Total (ft/s)	11.71	Avg. Vel. (ft/s)	11.64	14.21	4.13
Max Chl Dpth (ft)	13.14	Hydr. Depth (ft)	3.70	10.85	4.41
Conv. Total (cfs)	385882.3	Conv. (cfs)	9198.2	343798.5	32885.6
Length Wtd. (ft)	93.23	Wetted Per. (ft)	13.32	117.70	94.19
Min Ch El (ft)	4657.91	Shear (lb/sq ft)	0.52	1.79	0.74
Alpha	1.35	Stream Power (lb/ft s)	6.00	25.39	3.03
Frctn Loss (ft)	0.20	Cum Volume (acre-ft)	1.51	59.40	7.00
C & E Loss (ft)	0.09	Cum SA (acres)	0.33	4.81	1.71

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	31.77	36.30	4.23	1.33	2.40	0.02	0.67	3.19
2	LOB	36.30	40.84	108.68	12.93	5.46	0.54	2.85	8.40
3	LOB	40.84	45.38	363.83	26.71	5.46	1.82	5.89	13.62

4	Chan	45.38	56.94	2391.38	127.29	13.30	11.96	11.01	18.79
5	Chan	56.94	68.50	2372.63	151.47	11.56	11.86	13.11	15.66
6	Chan	68.50	80.05	2360.42	151.00	11.56	11.80	13.06	15.63
7	Chan	80.05	91.61	2348.14	150.53	11.56	11.74	13.02	15.60
8	Chan	91.61	103.17	2188.76	144.59	11.61	10.94	12.51	15.14
9	Chan	103.17	114.73	1855.30	130.96	11.62	9.28	11.33	14.17
10	Chan	114.73	126.29	1543.56	117.28	11.62	7.72	10.15	13.16
11	Chan	126.29	137.84	1255.24	103.59	11.62	6.28	8.96	12.12
12	Chan	137.84	149.40	1063.94	93.69	11.58	5.32	8.11	11.36
13	Chan	149.40	160.96	439.43	83.21	11.68	2.20	7.20	5.28
14	ROB	160.96	176.16	457.59	94.31	15.20	2.29	6.21	4.85
15	ROB	176.16	191.36	406.89	87.89	15.20	2.03	5.78	4.63
16	ROB	191.36	206.55	358.60	81.48	15.20	1.79	5.36	4.40
17	ROB	206.55	221.75	241.36	64.43	15.31	1.21	4.24	3.75
18	ROB	221.75	236.95	148.55	48.01	15.20	0.74	3.16	3.09
19	ROB	236.95	252.15	90.83	36.03	15.51	0.45	2.37	2.52
20	ROB	252.15	267.35	0.62	0.88	2.55	0.00	0.36	0.71

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1159.680

INPUT
Description: Existing Bridge - DS Section
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.89	5.34	4693.28	6.29	4693.26	51.14	4663.22	51.73	4662.83
58.98	4657.98	59.62	4657.56	60.03	4657.56	120.53	4658.41	147.03	4661.83
151.49	4662.29	153.75	4663.56	156.7	4664.89	166.01	4664.84	202.27	4664.95
202.28	4664.95	223.71	4665.01	237.4	4667.58	246.28	4669.15	247.36	4669.15
258.88	4669.5	261.22	4670.37	263.61	4670.79	270.39	4673.06	282.41	4675.9
290.24	4677.79	305.92	4686.21	322.98	4697.64	327.21	4700.61		

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	59.62	.024	156.7	.04	258.88	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
51.14	156.7	102.01	99.43	70.76	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4673.62	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.56	Wt. n-Val.	0.014	0.023	0.040
W.S. Elev (ft)	4671.07	Reach Len. (ft)	102.01	99.43	70.76
Crit W.S. (ft)	4669.23	Flow Area (sq ft)	45.95	1256.28	527.32
E.G. Slope (ft/ft)	*0.001722	Area (sq ft)	45.95	1256.28	527.32
Q Total (cfs)	*20000.00	Flow (cfs)	444.94	*17160.24	2394.82
Top Width (ft)	225.01	Top Width (ft)	11.71	105.56	107.73
Vel Total (ft/s)	10.93	Avg. Vel. (ft/s)	9.68	13.66	4.54
Max Chl Dpth (ft)	13.51	Hydr. Depth (ft)	3.92	11.90	4.89
Conv. Total (cfs)	*481925.4	Conv. (cfs)	10721.5	*413497.8	57706.1
Length Wtd. (ft)	96.36	Wetted Per. (ft)	14.10	108.14	108.35
Min Ch El (ft)	4657.56	Shear (lb/sq ft)	0.35	1.25	0.52
Alpha	1.38	Stream Power (lb/ft s)	3.39	17.06	2.38
Frctn Loss (ft)	0.17	Cum Volume (acre-ft)	1.41	56.72	5.99
C & E Loss (ft)	0.01	Cum SA (acres)	0.31	4.57	1.49

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	35.80	40.91	1.56	0.74	1.79	0.01	0.50	2.11
2	LOB	40.91	46.03	90.37	13.85	6.16	0.45	2.71	6.53
3	LOB	46.03	51.14	353.01	31.36	6.16	1.77	6.13	11.26
4	Chan	51.14	61.70	2073.46	118.56	12.27	10.37	11.23	17.49
5	Chan	61.70	72.25	2008.81	141.54	10.56	10.04	13.41	14.19
6	Chan	72.25	82.81	1971.94	139.97	10.56	9.86	13.26	14.09
7	Chan	82.81	93.36	1935.35	138.41	10.56	9.68	13.11	13.98
8	Chan	93.36	103.92	1898.97	136.84	10.56	9.49	12.96	13.88
9	Chan	103.92	114.48	1862.87	135.27	10.56	9.31	12.81	13.77
10	Chan	114.48	125.03	1796.43	132.54	10.59	8.98	12.56	13.55
11	Chan	125.03	135.59	1523.08	120.27	10.64	7.62	11.39	12.66

* 12	* Chan	* 135.59	* 146.14	* 1231.83 *	105.89 *	10.64 *	6.16 *	10.03 *	11.63 *
* 13	* Chan	* 146.14	* 156.70	* 857.54 *	86.98 *	11.21 *	4.29 *	8.24 *	9.86 *
* 14	* ROB	* 156.70	* 173.75	* 520.79 *	105.84 *	17.05 *	2.60 *	6.21 *	4.92 *
* 15	* ROB	* 173.75	* 190.80	* 516.53 *	105.32 *	17.05 *	2.58 *	6.18 *	4.90 *
* 16	* ROB	* 190.80	* 207.85	* 509.35 *	104.43 *	17.05 *	2.55 *	6.12 *	4.88 *
* 17	* ROB	* 207.85	* 224.90	* 501.19 *	103.48 *	17.07 *	2.51 *	6.07 *	4.84 *
* 18	* ROB	* 224.90	* 241.96	* 272.64 *	72.26 *	17.34 *	1.36 *	4.24 *	3.77 *
* 19	* ROB	* 241.96	* 259.01	* 71.57 *	32.26 *	17.13 *	0.36 *	1.89 *	2.22 *
* 20	* ROB	* 259.01	* 276.06	* 2.74 *	3.73 *	5.66 *	0.01 *	0.69 *	0.74 *

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 1060.254

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.78	2.32	4693.11	3.41	4693.11	47.99	4663.21	56.65	4657.42
62.15	4657.58	63.42	4657.62	102.01	4658.73	156.62	4662.24	161.43	4662.87
162.5	4663.83	165.18	4664.74	172.88	4664.73	204.85	4664.55	212.84	4664.5
215.06	4664.82	258.13	4671.38	261.49	4671.62	263.35	4671.95	264.01	4671.99
274.28	4672.72	275.16	4672.9	280.95	4674.54	283.93	4674.96	291.71	4676.04
318.83	4695.09	325.04	4699.18	329.34	4699.87				

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	56.65	.024	165.18	.04	274.28	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
47.99	165.18	247.27	239.33 200.98	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

* E.G. Elev (ft)	* 4673.45	* Element	* Left OB	* Channel	* Right OB *
* Vel Head (ft)	* 2.53	* Wt. n-Val.	* 0.014	* 0.023	* 0.040 *
* W.S. Elev (ft)	* 4670.91	* Reach Len. (ft)	* 247.27	* 239.33	* 200.98 *
* Crit W.S. (ft)	* 4669.26	* Flow Area (sq ft)	* 44.22	* 1309.43	* 434.84 *
* E.G. Slope (ft/ft)	*0.001816	* Area (sq ft)	* 44.22	* 1309.43	* 434.84 *
* Q Total (cfs)	*20000.00	* Flow (cfs)	* 434.25	*17603.51	* 1962.24 *
* Top Width (ft)	* 218.55	* Top Width (ft)	* 11.48	* 117.19	* 89.88 *
* Vel Total (ft/s)	* 11.18	* Avg. Vel. (ft/s)	* 9.82	* 13.44	* 4.51 *
* Max Chl Dpth (ft)	* 13.49	* Hydr. Depth (ft)	* 3.85	* 11.17	* 4.84 *
* Conv. Total (cfs)	*469283.9	* Conv. (cfs)	* 10189.3	*413052.3	* 46042.3 *
* Length Wtd. (ft)	* 236.67	* Wetted Per. (ft)	* 13.83	* 119.64	* 90.36 *
* Min Ch El (ft)	* 4657.42	* Shear (lb/sq ft)	* 0.36	* 1.24	* 0.55 *
* Alpha	* 1.30	* Stream Power (lb/ft s)	* 3.56	* 16.68	* 2.46 *
* Frctn Loss (ft)	* 0.32	* Cum Volume (acre-ft)	* 1.31	* 53.79	* 5.21 *
* C & E Loss (ft)	* 0.28	* Cum SA (acres)	* 0.28	* 4.32	* 1.33 *

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

*	* Pos	* Left Sta (ft)	* Right Sta (ft)	* Flow (cfs)	* Area (sq ft)	* W.P. (ft)	* Percent Conv	* Hydr Depth(ft)	* Velocity (ft/s) *
* 1	* LOB	* 33.59	* 38.39	* 3.02	* 1.19	* 2.27	* 0.02	* 0.63	* 2.53 *
* 2	* LOB	* 38.39	* 43.19	* 95.86	* 13.79	* 5.78	* 0.48	* 2.87	* 6.95 *
* 3	* LOB	* 43.19	* 47.99	* 335.36	* 29.24	* 5.78	* 1.68	* 6.09	* 11.47 *
* 4	* Chan	* 47.99	* 59.71	* 2326.75	* 132.91	* 13.48	* 11.63	* 11.34	* 17.51 *
* 5	* Chan	* 59.71	* 71.43	* 2232.87	* 155.06	* 11.72	* 11.16	* 13.23	* 14.40 *
* 6	* Chan	* 71.43	* 83.15	* 2138.59	* 151.09	* 11.72	* 10.69	* 12.89	* 14.15 *
* 7	* Chan	* 83.15	* 94.87	* 2046.27	* 147.15	* 11.72	* 10.23	* 12.56	* 13.91 *
* 8	* Chan	* 94.87	* 106.59	* 1946.26	* 142.82	* 11.73	* 9.73	* 12.19	* 13.63 *
* 9	* Chan	* 106.59	* 118.30	* 1768.52	* 134.90	* 11.74	* 8.84	* 11.51	* 13.11 *
* 10	* Chan	* 118.30	* 130.02	* 1579.84	* 126.07	* 11.74	* 7.90	* 10.76	* 12.53 *
* 11	* Chan	* 130.02	* 141.74	* 1399.84	* 117.25	* 11.74	* 7.00	* 10.00	* 11.94 *
* 12	* Chan	* 141.74	* 153.46	* 1228.65	* 108.42	* 11.74	* 6.14	* 9.25	* 11.33 *
* 13	* Chan	* 153.46	* 165.18	* 935.95	* 93.76	* 12.28	* 4.68	* 8.00	* 9.98 *
* 14	* ROB	* 165.18	* 181.60	* 494.58	* 101.66	* 16.42	* 2.47	* 6.19	* 4.86 *
* 15	* ROB	* 181.60	* 198.01	* 505.91	* 103.05	* 16.42	* 2.53	* 6.28	* 4.91 *
* 16	* ROB	* 198.01	* 214.43	* 516.70	* 104.41	* 16.43	* 2.58	* 6.36	* 4.95 *
* 17	* ROB	* 214.43	* 230.84	* 336.56	* 81.06	* 16.60	* 1.68	* 4.94	* 4.15 *

* 18	* ROB	* 230.84	* 247.26	* 103.79	* 40.02	* 16.61	* 0.52	* 2.44	* 2.59 *
* 19	* ROB	* 247.26	* 263.68	* 4.69	* 4.63	* 7.89	* 0.02	* 0.59	* 1.01 *

Warning: The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 820.9197

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.54	2.74	4692.62	3.44	4692.6	3.81	4692.61	29.72	4674.94
46.73	4663.47	48.27	4662.44	55.13	4657.89	94.15	4659.02	117.26	4659.01
124.86	4659.08	190.61	4662.25	194.39	4662.3	198.9	4662.63	200.31	4662.97
207.17	4664.05	222.67	4664.27	223.04	4664.28	230.74	4664.4	231.42	4664.55
244.87	4667.61	249.88	4668.68	256.01	4669.45	272.75	4670.91	282.17	4671.21
286.64	4671.57	303.85	4674.42	323.64	4678.64	337.57	4682	352.3	4688.28
374.53	4696.35	386.92	4697.31	390.81	4697.57	391.73	4697.64	396.68	4699.61

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	55.13	.023	198.9	.035	337.57	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
46.73	207.17	186.08	184.1	189.52	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

* E.G. Elev (ft)	* 4672.84	* Element	* Left OB	* Channel * Right OB *
* Vel Head (ft)	* 1.59	* Wt. n-Val.	* 0.014	* 0.023 * 0.035 *
* W.S. Elev (ft)	* 4671.25	* Reach Len. (ft)	* 186.08	* 184.10 * 189.52 *
* Crit W.S. (ft)	* 4667.87	* Flow Area (sq ft)	* 44.85	* 1797.71 * 288.30 *
* E.G. Slope (ft/ft)	*0.001067	* Area (sq ft)	* 44.85	* 1797.71 * 288.30 *
* Q Total (cfs)	*20000.00	* Flow (cfs)	* 339.38	*18688.64 * 971.98 *
* Top Width (ft)	* 247.44	* Top Width (ft)	* 11.53	* 160.44 * 75.47 *
* Vel Total (ft/s)	* 9.39	* Avg. Vel. (ft/s)	* 7.57	* 10.40 * 3.37 *
* Max Chl Dpth (ft)	* 13.36	* Hydr. Depth (ft)	* 3.89	* 11.20 * 3.82 *
* Conv. Total (cfs)	*612272.3	* Conv. (cfs)	* 10389.6	*572126.9 * 29755.8 *
* Length Wtd. (ft)	* 184.28	* Wetted Per. (ft)	* 13.91	* 162.35 * 76.06 *
* Min Ch El (ft)	* 4657.89	* Shear (lb/sq ft)	* 0.21	* 0.74 * 0.25 *
* Alpha	* 1.16	* Stream Power (lb/ft s)	* 1.63	* 7.67 * 0.85 *
* Frctn Loss (ft)	* 0.18	* Cum Volume (acre-ft)	* 1.05	* 45.25 * 3.54 *
* C & E Loss (ft)	* 0.08	* Cum SA (acres)	* 0.22	* 3.56 * 0.95 *

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

*	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
* 1	* LOB	* 32.71	* 37.38	* 3.46	* 1.61	* 2.64	* 0.02	* 0.74	* 2.15 *
* 2	* LOB	* 37.38	* 42.06	* 78.82	* 14.26	* 5.64	* 0.39	* 3.05	* 5.53 *
* 3	* LOB	* 42.06	* 46.73	* 257.11	* 28.98	* 5.64	* 1.29	* 6.20	* 8.87 *
* 4	* Chan	* 46.73	* 62.77	* 2417.24	* 190.06	* 17.73	* 12.09	* 11.85	* 12.72 *
* 5	* Chan	* 62.77	* 78.82	* 2315.27	* 207.03	* 16.05	* 11.58	* 12.90	* 11.18 *
* 6	* Chan	* 78.82	* 94.86	* 2178.16	* 199.58	* 16.05	* 10.89	* 12.44	* 10.91 *
* 7	* Chan	* 94.86	* 110.91	* 2118.31	* 196.24	* 16.04	* 10.59	* 12.23	* 10.79 *
* 8	* Chan	* 110.91	* 126.95	* 2110.40	* 195.81	* 16.05	* 10.55	* 12.20	* 10.78 *
* 9	* Chan	* 126.95	* 142.99	* 1960.01	* 187.39	* 16.06	* 9.80	* 11.68	* 10.46 *
* 10	* Chan	* 142.99	* 159.04	* 1748.44	* 174.98	* 16.06	* 8.74	* 10.91	* 9.99 *
* 11	* Chan	* 159.04	* 175.08	* 1546.71	* 162.57	* 16.06	* 7.73	* 10.13	* 9.51 *
* 12	* Chan	* 175.08	* 191.13	* 1355.09	* 150.17	* 16.06	* 6.78	* 9.36	* 9.02 *
* 13	* Chan	* 191.13	* 207.17	* 939.00	* 133.88	* 16.18	* 4.70	* 8.34	* 7.01 *
* 14	* ROB	* 207.17	* 226.12	* 534.90	* 133.83	* 18.95	* 2.67	* 7.06	* 4.00 *
* 15	* ROB	* 226.12	* 245.07	* 361.71	* 106.64	* 19.32	* 1.81	* 5.63	* 3.39 *
* 16	* ROB	* 245.07	* 264.02	* 70.40	* 39.79	* 19.14	* 0.35	* 2.10	* 1.77 *
* 17	* ROB	* 264.02	* 282.97	* 4.98	* 8.04	* 18.65	* 0.02	* 0.43	* 0.62 *

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 636.8161

INPUT
Description:
Station Elevation Data num= 31

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.55	.18	4692.57	.65	4692.56	1.31	4692.54	32.79	4671.69
40.09	4666.69	43.75	4664.32	50.92	4659.51	101.88	4659.63	116.3	4659.48
158.04	4660.42	163.58	4660.63	188.38	4660.03	193.28	4660.01	227.22	4662.57
229.43	4662.79	229.84	4662.83	230.9	4663.68	236.1	4666.71	238.42	4666.93
288.14	4671.59	289.55	4671.69	301.53	4672.81	306.92	4673.27	334.96	4676.1
359.28	4681.13	363.18	4682.2	377.08	4683.67	380.33	4683.95	406.5	4694.07
420.65	4699.69								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	50.92	.023	229.43	.035	380.33	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
40.09	236.1	172.75	186.53	169.25	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4672.58	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.33	Wt. n-Val.	0.014	0.023	0.035
W.S. Elev (ft)	4671.25	Reach Len. (ft)	172.75	186.53	169.25
Crit W.S. (ft)	4667.35	Flow Area (sq ft)	15.16	2108.69	109.72
E.G. Slope (ft/ft)	0.000900	Area (sq ft)	15.16	2108.69	109.72
Q Total (cfs)	20000.00	Flow (cfs)	73.54	19686.01	240.45
Top Width (ft)	251.05	Top Width (ft)	6.65	196.01	48.39
Vel Total (ft/s)	8.95	Avg. Vel. (ft/s)	4.85	9.34	2.19
Max Chl Dpth (ft)	11.77	Hydr. Depth (ft)	2.28	10.76	2.27
Conv. Total (cfs)	666748.5	Conv. (cfs)	2451.6	656280.8	8016.1
Length Wtd. (ft)	186.22	Wetted Per. (ft)	8.07	199.42	48.60
Min Ch El (ft)	4659.48	Shear (lb/sq ft)	0.11	0.59	0.13
Alpha	1.07	Stream Power (lb/ft s)	0.51	5.55	0.28
Frctn Loss (ft)	0.13	Cum Volume (acre-ft)	0.93	37.00	2.68
C & E Loss (ft)	0.08	Cum SA (acres)	0.18	2.80	0.68

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	32.07	36.08	5.52	2.40	3.21	0.03	0.91	2.30
2	LOB	36.08	40.09	68.01	12.77	4.86	0.34	3.18	5.33
3	Chan	40.09	59.69	1973.22	190.80	21.77	9.87	9.73	10.34
4	Chan	59.69	79.29	2223.91	229.22	19.60	11.12	11.69	9.70
5	Chan	79.29	98.89	2209.23	228.31	19.60	11.05	11.65	9.68
6	Chan	98.89	118.49	2221.68	229.08	19.60	11.11	11.69	9.70
7	Chan	118.49	138.10	2161.61	225.36	19.61	10.81	11.50	9.59
8	Chan	138.10	157.70	2025.07	216.71	19.61	10.13	11.06	9.34
9	Chan	157.70	177.30	1937.45	211.05	19.61	9.69	10.77	9.18
10	Chan	177.30	196.90	2044.92	218.02	19.61	10.22	11.12	9.38
11	Chan	196.90	216.50	1774.87	200.43	19.66	8.87	10.23	8.86
12	Chan	216.50	236.10	1114.05	159.71	20.76	5.57	8.15	6.98
13	ROB	236.10	254.56	175.38	67.73	18.54	0.88	3.67	2.59
14	ROB	254.56	273.01	60.63	35.81	18.54	0.30	1.94	1.69
15	ROB	273.01	291.47	4.44	6.17	11.53	0.02	0.54	0.72

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 450.2781

INPUT
Description:
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.35	.99	4692.34	1.56	4692.25	2.18	4692.25	42.36	4665.93
44.9	4664.26	45.65	4663.71	50.53	4660.09	54.28	4657.65	54.35	4657.45
99.47	4658.52	100.1	4658.59	106.23	4660.5	118.91	4661.31	121.51	4661.27

```
  154.61 4660.86  155.51 4660.89  190.24 4659.39  190.78 4659.43  223.31 4657.95
  224.53  4657.9  225.27 4658.09  242.34  4662.9   248.8  4664.6  248.85 4664.61
  253.21 4665.75  264.03 4668.34  264.82 4668.41  297.46 4671.37  312.42 4672.83
  335.65 4674.69  343.05 4675.26  346.08 4675.44  359.28 4676.44  414.74 4691.74
  418.88 4692.76  421.91 4693.77  423.26  4693.9  433.38 4694.89  444.84 4699.64

Manning's n Values        num=       4
     Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
*********************************************************
       0    .014   54.28    .021  242.34    .035  359.28     .06

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         45.65   248.8             49.75   53.37   54.23             .1       .3

CROSS SECTION OUTPUT  Profile #100 YR
*************************************************************************************************
* E.G. Elev (ft)         * 4672.37  * Element                * Left OB *  Channel * Right OB *
* Vel Head (ft)          *    1.06  * Wt. n-Val.            *   0.014  *   0.021  *   0.035  *
* W.S. Elev (ft)         * 4671.31  * Reach Len. (ft)       *   49.75  *   53.37  *   54.23  *
* Crit W.S. (ft)         * 4666.46  * Flow Area (sq ft)     *   43.39  * 2346.22  *  121.97  *
* E.G. Slope (ft/ft)     *0.000553  * Area (sq ft)          *   43.39  * 2346.22  *  121.97  *
* Q Total (cfs)          *20000.00  * Flow (cfs)            *  232.47  *19542.71  *  224.81  *
* Top Width (ft)         *  262.67  * Top Width (ft)        *   11.51  *  203.15  *   48.01  *
* Vel Total (ft/s)       *    7.96  * Avg. Vel. (ft/s)      *    5.36  *    8.33  *    1.84  *
* Max Chl Dpth (ft)      *   13.86  * Hydr. Depth (ft)      *    3.77  *   11.55  *    2.54  *
* Conv. Total (cfs)      *850686.6  * Conv. (cfs)           *  9888.1  *831236.2  *  9562.3  *
* Length Wtd. (ft)       *   53.29  * Wetted Per. (ft)      *   13.79  *  206.53  *   48.60  *
* Min Ch El (ft)         * 4657.45  * Shear (lb/sq ft)      *    0.11  *    0.39  *    0.09  *
* Alpha                  *    1.07  * Stream Power (lb/ft s) *    0.58  *    3.27  *    0.16  *
* Frctn Loss (ft)        *    0.05  * Cum Volume (acre-ft)  *    0.81  *   27.46  *    2.23  *
* C & E Loss (ft)        *    0.03  * Cum SA (acres)        *    0.14  *    1.95  *    0.49  *
*************************************************************************************************

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than
         0.7 or greater than 1.4.  This may indicate the need for additional cross sections.
Note:    Manning's n values were composited to a single value in the main channel.

  Profile #100 YR
*************************************************************************************************************************
*          * Pos      * Left Sta  * Right Sta *     Flow *     Area *     W.P. *  Percent *     Hydr * Velocity *
*          *          *  (ft)     *  (ft)     *    (cfs) *  (sq ft) *     (ft) *     Conv *Depth(ft) *    (ft/s) *
* 1        * LOB      * 31.96     * 36.52     *     2.97 *     1.85 *     2.84 *     0.01 *     0.78 *     1.61 *
* 2        * LOB      * 36.52     * 41.09     *    55.77 *    13.93 *     5.46 *     0.28 *     3.05 *     4.00 *
* 3        * LOB      * 41.09     * 45.65     *   173.73 *    27.61 *     5.49 *     0.87 *     6.05 *     6.29 *
* 4        * Chan     * 45.65     * 65.97     *  2426.24 *   252.95 *    22.38 *    12.13 *    12.45 *     9.59 *
* 5        * Chan     * 65.97     * 86.28     *  2462.43 *   271.10 *    20.32 *    12.31 *    13.34 *     9.08 *
* 6        * Chan     * 86.28     * 106.60    *  2200.77 *   254.89 *    20.61 *    11.00 *    12.55 *     8.63 *
* 7        * Chan     * 106.60    * 126.91    *  1588.31 *   208.47 *    20.34 *     7.94 *    10.26 *     7.62 *
* 8        * Chan     * 126.91    * 147.23    *  1582.45 *   207.91 *    20.32 *     7.91 *    10.23 *     7.61 *
* 9        * Chan     * 147.23    * 167.54    *  1669.37 *   214.74 *    20.33 *     8.35 *    10.57 *     7.77 *
* 10       * Chan     * 167.54    * 187.86    *  1887.38 *   231.18 *    20.33 *     9.44 *    11.38 *     8.16 *
* 11       * Chan     * 187.86    * 208.17    *  2124.90 *   248.23 *    20.34 *    10.62 *    12.22 *     8.56 *
* 12       * Chan     * 208.17    * 228.49    *  2348.17 *   264.31 *    20.48 *    11.74 *    13.01 *     8.88 *
* 13       * Chan     * 228.49    * 248.80    *  1252.71 *   192.44 *    21.07 *     6.26 *     9.47 *     6.51 *
* 14       * ROB      * 248.80    * 268.40    *   184.70 *    85.37 *    20.08 *     0.92 *     4.35 *     2.16 *
* 15       * ROB      * 268.40    * 288.01    *    38.53 *    33.08 *    19.68 *     0.19 *     1.69 *     1.17 *
* 16       * ROB      * 288.01    * 307.61    *     1.57 *     3.52 *     8.84 *     0.01 *     0.40 *     0.45 *
*************************************************************************************************************************

Warning: The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than
         0.7 or greater than 1.4.  This may indicate the need for additional cross sections.
Note:    Manning's n values were composited to a single value in the main channel.

CROSS SECTION


RIVER: Arkansas River
REACH: 4th Street         RS: 396.8996

INPUT
Description:
Station Elevation Data    num=      63
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
*************************************************************************
       0 4692.47     .61 4692.48     .75 4692.49    1.34 4692.21   41.85 4665.48
   43.43 4664.16   43.71 4664.15   43.94 4664.14   49.95 4663.93   55.51 4663.93
   58.58 4662.04   71.24 4657.54   79.45 4658.18   99.71 4658.73   110.7 4659.22
  119.85 4659.73  125.03 4661.71  126.49 4662.13   130.3  4662.1  156.86 4662.17
   171.4 4660.08  177.22 4659.83  205.39 4662.17  206.37 4662.41  214.44 4662.05
  242.48 4664.99  243.36 4665.16  244.24 4665.37  257.49 4665.91   268.3 4666.36
  282.93 4667.24  283.39 4667.28   283.9 4667.33  284.44 4667.38  285.01 4667.43
   285.6 4667.49  286.21 4667.54  286.82  4667.6  287.42 4667.65     288 4667.71
  288.56 4667.76  289.08 4667.82  289.55 4667.87  289.97 4667.93  297.08  4668.5
```

297.79	4668.58	310.45	4669.43	311.36	4669.51	314.17	4669.78	315.07	4669.87
316.17	4669.9	317.17	4669.94	331.1	4671.11	335.25	4671.34	339.29	4672.11
348.12	4674.59	354.24	4675.06	361.1	4675.28	399.16	4687	414.4	4691.23
421.2	4691.27	425.99	4691.44	445.25	4699.59				

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	43.43	.027	214.44	.035	361.1	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
55.51	244.24	1.92	2.06	2.68	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4672.29	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.37	Wt. n-Val.	0.023	0.028	0.035
W.S. Elev (ft)	4670.92	Reach Len. (ft)	1.92	2.06	2.68
Crit W.S. (ft)	4668.04	Flow Area (sq ft)	115.71	1875.37	264.30
E.G. Slope (ft/ft)	*0.001516	Area (sq ft)	115.71	1875.37	264.30
Q Total (cfs)	*20000.00	Flow (cfs)	907.15	*18160.49	932.37
Top Width (ft)	295.21	Top Width (ft)	21.90	188.73	84.58
Vel Total (ft/s)	8.87	Avg. Vel. (ft/s)	7.84	9.68	3.53
Max Chl Dpth (ft)	13.38	Hydr. Depth (ft)	5.28	9.94	3.12
Conv. Total (cfs)	*513656.3	Conv. (cfs)	23298.1	*466412.4	23945.8
Length Wtd. (ft)	2.08	Wetted Per. (ft)	24.02	191.01	84.78
Min Ch El (ft)	4657.54	Shear (lb/sq ft)	0.46	0.93	0.30
Alpha	1.13	Stream Power (lb/ft s)	3.57	9.00	1.04
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)	0.72	24.87	1.99
C & E Loss (ft)	0.00	Cum SA (acres)	0.12	1.71	0.41

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	33.31	38.86	46.28	9.09	6.29	0.23	1.73	5.09
2	LOB	38.86	44.41	281.98	29.58	6.62	1.41	5.33	9.53
3	LOB	44.41	49.96	286.01	38.25	5.55	1.43	6.89	7.48
4	LOB	49.96	55.51	292.86	38.79	5.55	1.46	6.99	7.55
5	Chan	55.51	74.38	2073.95	206.90	20.19	10.37	10.96	10.02
6	Chan	74.38	93.26	2753.75	238.82	18.89	13.77	12.65	11.53
7	Chan	93.26	112.13	2533.45	227.14	18.89	12.67	12.04	11.15
8	Chan	112.13	131.00	1915.08	193.73	19.31	9.58	10.27	9.89
9	Chan	131.00	149.88	1501.82	165.92	18.87	7.51	8.79	9.05
10	Chan	149.88	168.75	1639.30	175.32	19.00	8.20	9.29	9.35
11	Chan	168.75	187.62	2094.72	202.87	18.94	10.47	10.75	10.33
12	Chan	187.62	206.49	1684.21	178.07	18.96	8.42	9.44	9.46
13	Chan	206.49	225.37	1226.55	159.70	18.94	6.13	8.46	7.68
14	Chan	225.37	244.24	737.68	126.91	19.01	3.69	6.72	5.81
15	ROB	244.24	264.34	439.18	103.26	20.12	2.20	5.14	4.25
16	ROB	264.34	284.44	311.56	84.07	20.14	1.56	4.18	3.71
17	ROB	284.44	304.54	145.56	53.29	20.17	0.73	2.65	2.73
18	ROB	304.54	324.64	35.72	22.94	20.16	0.18	1.14	1.56
19	ROB	324.64	344.75	0.33	0.73	4.19	0.00	0.18	0.45

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 387.2300

INPUT
Description: HARP DIVERSION - US Section
Station Elevation Data num= 77

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.33	.82	4692.39	1.36	4692.4	1.82	4692.42	2.21	4692.24
44.38	4664.12	44.93	4664.1	44.95	4664.1	47.16	4664.02	47.37	4664.01
66.09	4664.04	72.2	4660.23	75.44	4658.34	78.66	4658.03	100.18	4658.62
103.25	4658.75	120.36	4659.71	121.86	4660.28	129.67	4662.51	149.64	4662.38
158.58	4662.4	175.78	4659.93	176.25	4659.91	209.25	4662.65	210.39	4662.93
214.04	4662.76	228.86	4664.31	236.12	4663.99	237.41	4665.07	249.12	4665
261.28	4665.38	262.74	4665.43	281.25	4666.17	287.09	4666.56	287.3	4666.62
287.59	4666.68	287.98	4666.75	289.1	4666.93	289.87	4667.03	290.58	4667.12
291.27	4666.97	293.14	4666.57	294.11	4666.36	294.71	4666.24	295.14	4666.17
295.46	4666.11	295.71	4666.08	295.92	4666.05	296.11	4666.03	296.27	4666.02
296.72	4666.02	296.87	4666.03	297.02	4666.04	297.24	4666.09	297.49	4666.15
297.79	4666.23	298.21	4666.36	298.82	4666.56	299.88	4666.95	302.24	4667.85
302.32	4667.86	304.71	4668.14	306.68	4668.39	308.3	4668.6	309.59	4668.78

310.62 4668.93 331.56 4670.69 333.21 4670.78 345.33 4673.11 350.13 4674.46
353.45 4674.71 362.67 4675.01 411.57 4690.09 413.44 4690.64 413.75 4690.68
426.46 4691.12 446.41 4699.58

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	44.38	.027	237.41	.035	362.67	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
66.09	237.41	1.93	2.14	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4672.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	1.49	Wt. n-Val.	0.024	0.027	0.035
W.S. Elev (ft)	4670.77	Reach Len. (ft)	1.93	2.14	2.35
Crit W.S. (ft)	4668.47	Flow Area (sq ft)	179.52	1648.50	362.61
E.G. Slope (ft/ft)	*0.001745	Area (sq ft)	179.52	1648.50	362.61
Q Total (cfs)	*20000.00	Flow (cfs)	1490.17	*16953.53	1556.31
Top Width (ft)	298.65	Top Width (ft)	31.68	171.32	95.65
Vel Total (ft/s)	9.13	Avg. Vel. (ft/s)	8.30	10.28	4.29
Max Chl Dpth (ft)	12.74	Hydr. Depth (ft)	5.67	9.62	3.79
Conv. Total (cfs)	*478835.5	Conv. (cfs)	35677.2	*405897.5	37260.7
Length Wtd. (ft)	2.14	Wetted Per. (ft)	33.70	174.20	96.30
Min Ch El (ft)	4658.03	Shear (lb/sq ft)	0.58	1.03	0.41
Alpha	1.15	Stream Power (lb/ft s)	4.82	10.60	1.76
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)	0.69	24.46	1.89
C & E Loss (ft)	0.01	Cum SA (acres)	0.12	1.67	0.38

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	33.05	39.65	50.93	9.19	6.31	0.25	1.75	5.54
2	LOB	39.65	46.26	370.44	36.58	7.56	1.85	5.53	10.13
3	LOB	46.26	52.87	356.96	44.64	6.61	1.78	6.75	8.00
4	LOB	52.87	59.48	356.39	44.59	6.61	1.78	6.75	7.99
5	LOB	59.48	66.09	355.45	44.52	6.61	1.78	6.74	7.98
6	Chan	66.09	83.22	1982.74	188.36	18.75	9.91	10.99	10.53
7	Chan	83.22	100.35	2566.23	212.12	17.14	12.83	12.38	12.10
8	Chan	100.35	117.49	2333.42	200.44	17.16	11.67	11.70	11.64
9	Chan	117.49	134.62	1617.86	162.38	17.55	8.09	9.48	9.96
10	Chan	134.62	151.75	1330.81	143.03	17.13	6.65	8.35	9.30
11	Chan	151.75	168.88	1452.32	151.09	17.24	7.26	8.82	9.61
12	Chan	168.88	186.01	1918.56	178.56	17.24	9.59	10.42	10.74
13	Chan	186.01	203.15	1600.77	160.01	17.19	8.00	9.34	10.00
14	Chan	203.15	220.28	1235.64	137.09	17.22	6.18	8.00	9.01
15	Chan	220.28	237.41	915.17	115.43	17.58	4.58	6.74	7.93
16	ROB	237.41	258.31	590.70	118.90	20.90	2.95	5.69	4.97
17	ROB	258.31	279.21	491.78	106.54	20.92	2.46	5.10	4.62
18	ROB	279.21	300.11	365.87	89.75	21.23	1.83	4.29	4.08
19	ROB	300.11	321.01	102.73	41.82	21.16	0.51	2.00	2.46
20	ROB	321.01	341.91	5.23	5.60	12.09	0.03	0.46	0.93

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 376.5217

INPUT
Description: HARP DIVERSION - Crest Section
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.33	.84	4692.36	1.05	4692.26	38.98	4666.95	41.12	4665.53
43.61	4664.26	44	4663.59	44.01	4663.58	45.66	4662.65	76.64	4662.61
125.09	4662.4	129.65	4662.4	136.71	4662.17	172.15	4662.07	173.28	4662.56
177.5	4662.57	210.14	4662.53	224.75	4662.4	227.71	4662.38	230.57	4664.22
238.99	4664.76	255.82	4664.66	263.75	4664.91	263.76	4664.91	279.75	4665.4
282.51	4665.54	283.19	4665.58	285.51	4665.83	301.42	4667.47	302.57	4667.49
303.15	4667.51	303.87	4667.58	330.81	4670.33	339.05	4671.98	349.5	4673.98
350.75	4674.34	351.61	4674.4	362.9	4674.78	381.69	4680.57	413.51	4689.93
418.9	4690.6	425.78	4690.84	446.38	4699.59				

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	76.64	.027	238.99	.035	362.9	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
43.61	230.57	5.43	5.57	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4672.10	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.90	Wt. n-Val.	0.014	0.023	0.033
W.S. Elev (ft)	4669.20	Reach Len. (ft)	5.43	5.57	6.31
Crit W.S. (ft)	4669.20	Flow Area (sq ft)	20.84	1258.86	293.30
E.G. Slope (ft/ft)	*0.003983	Area (sq ft)	20.84	1258.86	293.30
Q Total (cfs)	*20000.00	Flow (cfs)	237.03	*17921.30	1841.67
Top Width (ft)	284.12	Top Width (ft)	8.00	186.96	89.16
Vel Total (ft/s)	12.71	Avg. Vel. (ft/s)	11.38	14.24	6.28
Max Chl Dpth (ft)	7.13	Hydr. Depth (ft)	2.60	6.73	3.29
Conv. Total (cfs)	*316920.3	Conv. (cfs)	3756.0	*283981.1	29183.2
Length Wtd. (ft)	5.62	Wetted Per. (ft)	9.41	188.24	89.37
Min Ch El (ft)	4662.07	Shear (lb/sq ft)	0.55	1.66	0.82
Alpha	1.16	Stream Power (lb/ft s)	6.26	23.67	5.12
Frctn Loss (ft)	0.03	Cum Volume (acre-ft)	0.67	24.08	1.79
C & E Loss (ft)	0.00	Cum SA (acres)	0.11	1.62	0.35

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	34.89	39.25	26.01	4.42	4.37	0.13	1.21	5.89
2	LOB	39.25	43.61	211.03	16.42	5.04	1.06	3.77	12.85
3	Chan	43.61	62.31	2764.64	121.34	19.33	13.82	6.49	22.78
4	Chan	62.31	81.00	2568.67	123.09	18.70	12.84	6.58	20.87
5	Chan	81.00	99.70	1525.72	124.30	18.70	7.63	6.65	12.27
6	Chan	99.70	118.39	1556.85	125.81	18.70	7.78	6.73	12.37
7	Chan	118.39	137.09	1600.17	127.91	18.70	8.00	6.84	12.51
8	Chan	137.09	155.79	1684.83	131.92	18.70	8.42	7.06	12.77
9	Chan	155.79	174.48	1681.14	132.03	18.80	8.41	7.06	12.73
10	Chan	174.48	193.18	1521.53	124.09	18.70	7.61	6.64	12.26
11	Chan	193.18	211.87	1530.21	124.52	18.70	7.65	6.66	12.29
12	Chan	211.87	230.57	1487.57	123.83	19.24	7.44	6.62	12.01
13	ROB	230.57	252.15	750.03	98.58	21.60	3.75	4.57	7.61
14	ROB	252.15	273.73	605.73	92.90	21.59	3.03	4.30	6.52
15	ROB	273.73	295.31	398.59	72.36	21.65	1.99	3.35	5.51
16	ROB	295.31	316.89	87.03	29.05	21.68	0.44	1.35	3.00
17	ROB	316.89	338.48	0.28	0.41	2.85	0.00	0.14	0.68

Warning: The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.
Warning: During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 267.7897

INPUT
Description:
Station Elevation Data num= 46

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.4	1.88	4692.3	2.07	4692.31	3.18	4692.3	46.18	4663.43
46.2	4663.42	52.42	4659.48	55.07	4657.63	58.15	4655.77	60.35	4654.18
62.35	4652.56	65.74	4652.6	70.88	4652.74	114.52	4652.06	117.89	4651.93
180.67	4652.54	188.31	4652.72	200.82	4652.97	241.63	4652.66	247.91	4652.53
294.05	4654.02	295.46	4654.06	297.39	4654.11	298.13	4654.39	298.69	4654.59
301.32	4655.9	303.96	4657.23	310.57	4660.68	316.51	4663.71	316.53	4663.72
317.15	4664.04	317.26	4664.05	330.47	4665.34	338.2	4665.48	338.35	4665.51
340.85	4665.46	379.86	4685.35	382.93	4686.34	386.58	4686.91	388.35	4687.18

388.76 4687.24 396.29 4687.34 396.77 4687.35 397.4 4687.4 412.05 4689.27
428.15 4699.52

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	62.35	.024	297.39	.035	379.86	.06

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
55.07 303.96 37.84 37.94 39.53 .1 .3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4670.14	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.31	Wt. n-Val.	0.014	0.024	0.035
W.S. Elev (ft)	4669.83	Reach Len. (ft)	37.84	37.94	39.53
Crit W.S. (ft)	4658.66	Flow Area (sq ft)	112.60	4234.10	253.84
E.G. Slope (ft/ft)	0.000125	Area (sq ft)	112.60	4234.10	253.84
Q Total (cfs)	20000.00	Flow (cfs)	395.80	19239.52	364.68
Top Width (ft)	312.77	Top Width (ft)	18.42	248.89	45.46
Vel Total (ft/s)	4.35	Avg. Vel. (ft/s)	3.52	4.54	1.44
Max Chl Dpth (ft)	17.90	Hydr. Depth (ft)	6.11	17.01	5.58
Conv. Total (cfs)	1788310.0	Conv. (cfs)	35390.8	1720312.0	32608.0
Length Wtd. (ft)	37.97	Wetted Per. (ft)	22.10	251.25	48.23
Min Ch El (ft)	4651.93	Shear (lb/sq ft)	0.04	0.13	0.04
Alpha	1.07	Stream Power (lb/ft s)	0.14	0.60	0.06
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)	0.47	16.71	0.94
C & E Loss (ft)	0.00	Cum SA (acres)	0.08	1.08	0.16

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	33.04	38.55	0.80	1.21	2.29	0.00	0.64	0.66
2	LOB	38.55	44.06	32.87	17.20	6.63	0.16	3.12	1.91
3	LOB	44.06	49.56	120.51	37.34	6.56	0.60	6.78	3.23
4	LOB	49.56	55.07	241.61	56.85	6.61	1.21	10.32	4.25
5	Chan	55.07	79.96	2024.16	408.47	26.50	10.12	16.41	4.96
6	Chan	79.96	104.85	1991.38	433.65	24.89	9.96	17.42	4.59
7	Chan	104.85	129.74	2060.09	442.57	24.89	10.30	17.78	4.65
8	Chan	129.74	154.63	2037.12	439.59	24.89	10.19	17.66	4.63
9	Chan	154.63	179.52	1990.87	433.57	24.89	9.95	17.42	4.59
10	Chan	179.52	204.40	1920.17	424.29	24.89	9.60	17.05	4.53
11	Chan	204.40	229.29	1907.71	422.61	24.89	9.54	16.98	4.51
12	Chan	229.29	254.18	1942.97	427.31	24.89	9.71	17.17	4.55
13	Chan	254.18	279.07	1853.87	415.49	24.90	9.27	16.69	4.46
14	Chan	279.07	303.96	1511.20	386.55	25.61	7.56	15.53	3.91
15	ROB	303.96	316.38	205.68	116.41	13.98	1.03	9.37	1.77
16	ROB	316.38	328.80	84.49	65.42	12.57	0.42	5.27	1.29
17	ROB	328.80	341.22	63.34	54.87	12.48	0.32	4.42	1.15
18	ROB	341.22	353.64	11.16	17.14	9.20	0.06	2.09	0.65

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 229.8466

INPUT
Description:
Station Elevation Data num= 46

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.26	.55	4692.29	.98	4692.29	1.68	4692.28	44.13	4663.76
44.44	4663.55	48.02	4661.07	51.54	4658.62	55.95	4655.64	58.59	4653.78
61.3	4652.22	92.63	4652.1	104.32	4652.01	142.64	4651.98	164.45	4652.29
198.57	4653.04	213.2	4652.87	245.17	4651.97	250.97	4651.93	267.51	4652.98
273.56	4653.44	294.71	4653.57	297.8	4655.37	302.57	4657.5	307.93	4660.21
310.57	4661.87	313.31	4663.59	314.16	4663.67	316.9	4663.92	324.74	4664.68
327.67	4664.75	332.31	4664.83	333.53	4664.94	335.03	4664.89	345.99	4671.91
371.48	4684.64	373.77	4684.82	376.99	4685.33	377.57	4685.42	380.31	4685.47
385.48	4685.52	393.01	4687.04	393.29	4687.04	401.35	4688.06	422.16	4699.03
422.89	4699.46								

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val

```
       0    .014    61.3    .024  294.71    .035  371.48     .06

 Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          55.95  302.57             51.83   55.92   58.62             .1       .3

 CROSS SECTION OUTPUT  Profile #100 YR
 ********************************************************************************************
 * E.G. Elev (ft)         * 4670.13  * Element               *  Left OB *  Channel * Right OB *
 * Vel Head (ft)          *    0.31  * Wt. n-Val.            *   0.014  *   0.024  *   0.035  *
 * W.S. Elev (ft)         * 4669.83  * Reach Len. (ft)       *   51.83  *   55.92  *   58.62  *
 * Crit W.S. (ft)         * 4658.47  * Flow Area (sq ft)     *  147.38  * 4253.35  *  237.42  *
 * E.G. Slope (ft/ft)     *0.000121  * Area (sq ft)          *  147.38  * 4253.35  *  237.42  *
 * Q Total (cfs)          *20000.00  * Flow (cfs)           *  559.00  *19095.74  *  345.26  *
 * Top Width (ft)         *  307.64  * Top Width (ft)       *   20.85  *  246.62  *   40.17  *
 * Vel Total (ft/s)       *    4.31  * Avg. Vel. (ft/s)     *    3.79  *    4.49  *    1.45  *
 * Max Chl Dpth (ft)      *   17.90  * Hydr. Depth (ft)     *    7.07  *   17.25  *    5.91  *
 * Conv. Total (cfs)      *1815685.0  * Conv. (cfs)          * 50748.3  *1733593.0  * 31344.1  *
 * Length Wtd. (ft)       *   55.87  * Wetted Per. (ft)     *   25.22  *  248.64  *   43.30  *
 * Min Ch El (ft)         * 4651.93  * Shear (lb/sq ft)     *    0.04  *    0.13  *    0.04  *
 * Alpha                  *    1.06  * Stream Power (lb/ft s) *  0.17  *    0.58  *    0.06  *
 * Frctn Loss (ft)        *    0.01  * Cum Volume (acre-ft)  *    0.36  *   13.02  *    0.72  *
 * C & E Loss (ft)        *    0.00  * Cum SA (acres)       *    0.06  *    0.86  *    0.12  *
 ********************************************************************************************

 Note:    Manning's n values were composited to a single value in the main channel.

   Profile #100 YR
 ********************************************************************************************************************
 *          * Pos      * Left Sta  * Right Sta *     Flow *     Area *     W.P. *  Percent *     Hydr * Velocity *
 *          *          * (ft)      * (ft)      *    (cfs) *  (sq ft) *     (ft) *     Conv *Depth(ft) *    (ft/s) *
 * 1        * LOB      * 33.57     * 39.17     *     5.99 *     5.56 *     4.90 *     0.03 *     1.37 *     1.08 *
 * 2        * LOB      * 39.17     * 44.76     *    62.60 *    25.81 *     6.75 *     0.31 *     4.61 *     2.43 *
 * 3        * LOB      * 44.76     * 50.36     *   170.25 *    47.22 *     6.81 *     0.85 *     8.44 *     3.61 *
 * 4        * LOB      * 50.36     * 55.95     *   320.14 *    68.79 *     6.77 *     1.60 *    12.30 *     4.65 *
 * 5        * Chan     * 55.95     * 80.61     *  2105.78 *   426.29 *    25.67 *    10.53 *    17.29 *     4.94 *
 * 6        * Chan     * 80.61     * 105.27    *  1996.78 *   437.56 *    24.66 *     9.98 *    17.74 *     4.56 *
 * 7        * Chan     * 105.27    * 129.94    *  2013.16 *   439.71 *    24.66 *    10.07 *    17.83 *     4.58 *
 * 8        * Chan     * 129.94    * 154.60    *  2008.51 *   439.11 *    24.66 *    10.04 *    17.80 *     4.57 *
 * 9        * Chan     * 154.60    * 179.26    *  1945.53 *   430.82 *    24.67 *     9.73 *    17.47 *     4.52 *
 * 10       * Chan     * 179.26    * 203.92    *  1852.24 *   418.30 *    24.67 *     9.26 *    16.96 *     4.43 *
 * 11       * Chan     * 203.92    * 228.58    *  1872.56 *   421.06 *    24.67 *     9.36 *    17.07 *     4.45 *
 * 12       * Chan     * 228.58    * 253.25    *  1988.87 *   436.60 *    24.67 *     9.94 *    17.70 *     4.56 *
 * 13       * Chan     * 253.25    * 277.91    *  1851.85 *   418.53 *    24.71 *     9.26 *    16.97 *     4.42 *
 * 14       * Chan     * 277.91    * 302.57    *  1460.48 *   385.39 *    25.60 *     7.30 *    15.63 *     3.79 *
 * 15       * ROB      * 302.57    * 314.60    *   188.54 *   109.45 *    13.66 *     0.94 *     9.10 *     1.72 *
 * 16       * ROB      * 314.60    * 326.63    *    90.01 *    66.87 *    12.08 *     0.45 *     5.56 *     1.35 *
 * 17       * ROB      * 326.63    * 338.67    *    64.27 *    55.78 *    12.72 *     0.32 *     4.64 *     1.15 *
 * 18       * ROB      * 338.67    * 350.70    *     2.43 *     5.32 *     4.84 *     0.01 *     1.30 *     0.46 *
 ********************************************************************************************************************

 Note:    Manning's n values were composited to a single value in the main channel.

 CROSS SECTION


 RIVER: Arkansas River
 REACH: 4th Street         RS: 173.9272

 INPUT
 Description:
 Station Elevation Data    num=      43
      Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
 ********************************************************************************
        0  4692.2    1.04 4692.26    2.04 4692.25    2.21 4692.25   44.98 4663.53
    48.99 4660.94   53.57 4657.69   55.33  4656.5   58.85 4654.38   62.18 4651.98
    72.06 4651.94   88.58 4651.04  125.26 4652.39  145.98 4652.36  174.72 4652.66
   198.39 4653.23  228.12 4653.33  244.54 4652.77  289.24 4652.72   289.6 4652.75
   289.77 4652.87  289.97  4652.8  290.09 4652.75  293.57 4654.71   297.8 4656.96
   303.79 4659.68  307.67 4661.47  310.39 4662.92   311.4 4663.02  319.14 4663.73
    326.3 4663.89  326.36 4663.89  329.36 4664.15  329.55 4664.27  356.93  4681.8
   357.27 4681.97  360.43 4682.22  363.49 4682.41  363.57 4682.42  371.29 4682.51
   371.37 4682.52  374.57 4682.47  395.91 4694.69

 Manning's n Values        num=       4
      Sta   n Val     Sta   n Val     Sta   n Val     Sta   n Val
 ************************************************************
        0    .014   62.18    .024  289.24    .035  356.93     .06

 Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          55.33   297.8             47.69   46.87      46             .1       .3

 CROSS SECTION OUTPUT  Profile #100 YR
 ********************************************************************************************
```

* E.G. Elev (ft)	* 4670.13	* Element	* Left OB	* Channel	* Right OB *
* Vel Head (ft)	* 0.32	* Wt. n-Val.	* 0.014	* 0.024	* 0.035 *
* W.S. Elev (ft)	* 4669.81	* Reach Len. (ft)	* 47.69	* 46.87	* 46.00 *
* Crit W.S. (ft)	* 4658.58	* Flow Area (sq ft)	* 130.17	* 4165.10	* 267.76 *
* E.G. Slope (ft/ft)	*0.000127	* Area (sq ft)	* 130.17	* 4165.10	* 267.76 *
* Q Total (cfs)	*20000.00	* Flow (cfs)	* 484.12	*19084.85	* 431.04 *
* Top Width (ft)	* 302.57	* Top Width (ft)	* 19.70	* 242.47	* 40.40 *
* Vel Total (ft/s)	* 4.38	* Avg. Vel. (ft/s)	* 3.72	* 4.58	* 1.61 *
* Max Chl Dpth (ft)	* 18.77	* Hydr. Depth (ft)	* 6.61	* 17.18	* 6.63 *
* Conv. Total (cfs)	*1772931.0	* Conv. (cfs)	* 42915.4	*1691806.0	* 38209.8 *
* Length Wtd. (ft)	* 46.87	* Wetted Per. (ft)	* 23.78	* 245.04	* 43.45 *
* Min Ch El (ft)	* 4651.04	* Shear (lb/sq ft)	* 0.04	* 0.14	* 0.05 *
* Alpha	* 1.06	* Stream Power (lb/ft s)	* 0.16	* 0.62	* 0.08 *
* Frctn Loss (ft)	* 0.01	* Cum Volume (acre-ft)	* 0.20	* 7.61	* 0.38 *
* C & E Loss (ft)	* 0.00	* Cum SA (acres)	* 0.03	* 0.55	* 0.06 *

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	33.20	38.73	2.99	3.23	3.74	0.01	1.04	0.93
2	LOB	38.73	44.26	48.98	21.80	6.66	0.24	3.94	2.25
3	LOB	44.26	49.80	147.12	42.08	6.63	0.74	7.61	3.50
4	LOB	49.80	55.33	285.03	63.05	6.75	1.43	11.40	4.52
5	Chan	55.33	79.58	2154.25	418.17	25.62	10.77	17.25	5.15
6	Chan	79.58	103.82	2152.82	448.61	24.27	10.76	18.50	4.80
7	Chan	103.82	128.07	2012.93	430.82	24.26	10.06	17.77	4.67
8	Chan	128.07	152.32	1950.43	422.64	24.25	9.75	17.43	4.61
9	Chan	152.32	176.57	1917.73	418.39	24.25	9.59	17.26	4.58
10	Chan	176.57	200.81	1836.67	407.72	24.25	9.18	16.82	4.50
11	Chan	200.81	225.06	1785.36	400.80	24.25	8.93	16.53	4.45
12	Chan	225.06	249.31	1830.10	406.86	24.26	9.15	16.78	4.50
13	Chan	249.31	273.55	1881.39	413.60	24.25	9.41	17.06	4.55
14	Chan	273.55	297.80	1563.16	397.48	25.38	7.82	16.39	3.93
15	ROB	297.80	307.61	206.57	104.15	10.79	1.03	10.62	1.98
16	ROB	307.61	317.42	103.57	67.33	10.21	0.52	6.86	1.54
17	ROB	317.42	327.23	85.32	59.02	9.82	0.43	6.02	1.45
18	ROB	327.23	337.04	35.50	36.83	11.26	0.18	3.75	0.96
19	ROB	337.04	346.86	0.09	0.43	1.37	0.00	0.37	0.20

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 127.0565

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4692.11	.26	4692.12	1.06	4692.12	1.41	4692.14	21.3	4679.06
44.39	4663.55	48.99	4660.48	53.22	4657.76	57.09	4654.97	61.74	4651.9
82.47	4653.39	95.63	4653.07	128.25	4653.84	135.77	4653.65	143.72	4654.79
154.5	4654.18	189.81	4653.97	197.81	4653.5	219.39	4653.73	242.84	4654.07
280.72	4652.39	288.33	4653.13	290.02	4654	294.69	4656.42	299.91	4659.28
303.79	4661.14	307.12	4662.69	307.94	4662.8	309.03	4662.96	313.72	4663.39
317.58	4663.47	321.16	4663.56	322.79	4663.7	323.78	4663.61	334.73	4671.13
347.92	4679.56	349.14	4679.77	352.14	4679.98	356.21	4680	359.91	4680.07
361.76	4680.13	363.31	4680.12	378.01	4689.71				

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	61.74	.024	290.02	.035	334.73	.06

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
53.22	294.69	5.21	5.32	5.28	.1	.3

CROSS SECTION OUTPUT Profile #100 YR

* E.G. Elev (ft)	* 4670.12	* Element	* Left OB	* Channel	* Right OB *
* Vel Head (ft)	* 0.36	* Wt. n-Val.	* 0.014	* 0.024	* 0.035 *
* W.S. Elev (ft)	* 4669.75	* Reach Len. (ft)	* 5.21	* 5.32	* 5.28 *
* Crit W.S. (ft)	* 4659.60	* Flow Area (sq ft)	* 109.18	* 3891.62	* 259.50 *
* E.G. Slope (ft/ft)	*0.000155	* Area (sq ft)	* 109.18	* 3891.62	* 259.50 *
* Q Total (cfs)	*20000.00	* Flow (cfs)	* 424.53	*19109.07	* 466.39 *

Top Width (ft)	297.56	Top Width (ft)	18.06	241.47	38.03			
Vel Total (ft/s)	4.69	Avg. Vel. (ft/s)	3.89	4.91	1.80			
Max Chl Dpth (ft)	17.85	Hydr. Depth (ft)	6.04	16.12	6.82			
Conv. Total (cfs)	1603884.0	Conv. (cfs)	34045.0	1532437.0	37402.1			
Length Wtd. (ft)	5.32	Wetted Per. (ft)	21.68	244.35	41.49			
Min Ch El (ft)	4651.90	Shear (lb/sq ft)	0.05	0.15	0.06			
Alpha	1.06	Stream Power (lb/ft s)	0.19	0.76	0.11			
Frctn Loss (ft)	0.00	Cum Volume (acre-ft)	0.06	3.28	0.10			
C & E Loss (ft)	0.00	Cum SA (acres)	0.01	0.29	0.02			

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	LOB	31.93	37.25	1.16	1.48	2.52	0.01	0.70	0.79
2	LOB	37.25	42.58	36.64	17.00	6.41	0.18	3.20	2.15
3	LOB	42.58	47.90	128.04	36.00	6.40	0.64	6.77	3.56
4	LOB	47.90	53.22	258.69	54.70	6.34	1.29	10.28	4.73
5	Chan	53.22	77.37	2266.65	397.85	26.01	11.33	16.48	5.70
6	Chan	77.37	101.51	1977.69	399.59	24.17	9.89	16.55	4.95
7	Chan	101.51	125.66	1920.76	392.57	24.15	9.60	16.26	4.89
8	Chan	125.66	149.81	1793.09	377.24	24.24	8.97	15.62	4.75
9	Chan	149.81	173.96	1791.41	376.49	24.15	8.96	15.59	4.76
10	Chan	173.96	198.10	1837.63	382.33	24.16	9.19	15.83	4.81
11	Chan	198.10	222.25	1893.79	389.22	24.15	9.47	16.12	4.87
12	Chan	222.25	246.40	1835.46	382.00	24.15	9.18	15.82	4.80
13	Chan	246.40	270.54	1942.93	395.39	24.17	9.71	16.37	4.91
14	Chan	270.54	294.69	1849.68	398.95	24.99	9.25	16.52	4.64
15	ROB	294.69	303.02	203.95	92.39	9.40	1.02	11.09	2.21
16	ROB	303.02	311.35	108.63	61.62	8.79	0.54	7.40	1.76
17	ROB	311.35	319.69	87.14	52.88	8.34	0.44	6.35	1.65
18	ROB	319.69	328.02	62.25	45.02	9.25	0.31	5.40	1.38
19	ROB	328.02	336.35	4.43	7.60	5.71	0.02	1.62	0.58

Note: Manning's n values were composited to a single value in the main channel.

CROSS SECTION

RIVER: Arkansas River
REACH: 4th Street RS: 79.1396

INPUT
Description: Weir Structure 2 - Crest Section / DS Limit of Model
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	4691.86	1.54	4691.94	1.79	4691.94	2.66	4691.98	36.65	4669.01
41.23	4666.19	45.82	4663.59	48.99	4661.42	52.25	4659.37	83.93	4659.65
87.49	4659.75	205.73	4661.94	206.24	4661.96	265.53	4664.08	266.42	4664.15
266.48	4664.2	310.33	4663.03	310.74	4663.04	318	4663.21	318.2	4663.23
320.21	4663.05	322.47	4664.44	324.93	4666.3	328.46	4668.69	331.94	4671.08
341.22	4677.2	343.61	4677.6	351.09	4677.7	351.41	4677.71	354.84	4677.85
354.98	4677.86	359.34	4680.67	374.12	4689.83				

Manning's n Values num= 4

Sta	n Val	Sta	n Val	Sta	n Val	Sta	n Val
0	.014	52.25	.027	320.21	.035	354.84	.06

Bank Sta: Left 41.23 Right 324.93 Lengths: Left Channel 0 Right 0 Coeff Contr. .1 Expan. .3

CROSS SECTION OUTPUT Profile #100 YR

E.G. Elev (ft)	4669.84	Element	Left OB	Channel	Right OB
Vel Head (ft)	2.70	Wt. n-Val.	0.014	0.027	0.035
W.S. Elev (ft)	4667.14	Reach Len. (ft)			
Crit W.S. (ft)	4667.14	Flow Area (sq ft)	0.73	1514.93	0.52
E.G. Slope (ft/ft)	0.006096	Area (sq ft)	0.73	1514.93	0.52
Q Total (cfs)	20000.00	Flow (cfs)	3.30	19995.85	0.85
Top Width (ft)	286.48	Top Width (ft)	1.54	283.70	1.24
Vel Total (ft/s)	13.19	Avg. Vel. (ft/s)	4.53	13.20	1.64
Max Chl Dpth (ft)	7.77	Hydr. Depth (ft)	0.47	5.34	0.42
Conv. Total (cfs)	256162.7	Conv. (cfs)	42.3	256109.5	10.9
Length Wtd. (ft)		Wetted Per. (ft)	1.81	286.77	1.49
Min Ch El (ft)	4659.37	Shear (lb/sq ft)	0.15	2.01	0.13
Alpha	1.00	Stream Power (lb/ft s)	0.69	26.54	0.22

* Frctn Loss (ft)	*	* Cum Volume (acre-ft)	*	*	*	*
* C & E Loss (ft)	*	* Cum SA (acres)	*	*	*	*

Note: Manning's n values were composited to a single value in the main channel.

Profile #100 YR

*	* Pos	* Left Sta (ft)	* Right Sta (ft)	* Flow (cfs)	* Area (sq ft)	* W.P. (ft)	* Percent Conv	* Hydr Depth(ft)	* Velocity (ft/s)
* 1	* LOB	* 37.11	* 41.23	* 3.30	* 0.73	* 1.81	* 0.02	* 0.47	* 4.53 *
* 2	* Chan	* 41.23	* 69.60	* 2981.37	* 180.42	* 30.32	* 14.91	* 6.36	* 16.52 *
* 3	* Chan	* 69.60	* 97.97	* 3269.07	* 211.09	* 28.37	* 16.35	* 7.44	* 15.49 *
* 4	* Chan	* 97.97	* 126.34	* 2904.20	* 196.62	* 28.37	* 14.52	* 6.93	* 14.77 *
* 5	* Chan	* 126.34	* 154.71	* 2546.62	* 181.72	* 28.37	* 12.73	* 6.41	* 14.01 *
* 6	* Chan	* 154.71	* 183.08	* 2208.09	* 166.81	* 28.37	* 11.04	* 5.88	* 13.24 *
* 7	* Chan	* 183.08	* 211.45	* 1882.98	* 151.62	* 28.38	* 9.41	* 5.34	* 12.42 *
* 8	* Chan	* 211.45	* 239.82	* 1405.17	* 127.21	* 28.39	* 7.03	* 4.48	* 11.05 *
* 9	* Chan	* 239.82	* 268.19	* 914.81	* 98.36	* 28.41	* 4.57	* 3.47	* 9.30 *
* 10	* Chan	* 268.19	* 296.56	* 869.46	* 95.37	* 28.38	* 4.35	* 3.36	* 9.12 *
* 11	* Chan	* 296.56	* 324.93	* 1014.08	* 105.68	* 29.40	* 5.07	* 3.73	* 9.60 *
* 12	* ROB	* 324.93	* 329.85	* 0.85	* 0.52	* 1.49	* 0.00	* 0.42	* 1.64 *

Note: Manning's n values were composited to a single value in the main channel.

SUMMARY OF MANNING'S N VALUES

River:Arkansas River

* Reach	* River Sta.	* n1	* n2	* n3	* n4	* n5	* n6	*
*4th Street	* 2383.165	* .014*	.027*	.06*	.1*	*	*	
*4th Street	* 2102.372	* .014*	.025*	.06*	.1*	*	*	
*4th Street	* 1825.946	* .014*	.025*	.05*	.027*	.06*	.1*	
*4th Street	* 1570.713	* .014*	.025*	.06*	.08*	*	*	
*4th Street	* 1405.927	* .014*	.025*	.05*	.08*	*	*	
*4th Street	* 1329.40	*Bridge *	*	*	*	*	*	
*4th Street	* 1252.860	* .014*	.024*	.05*	.08*	*	*	
*4th Street	* 1159.680	* .014*	.024*	.04*	.06*	*	*	
*4th Street	* 1060.254	* .014*	.024*	.04*	.06*	*	*	
*4th Street	* 820.9197	* .014*	.023*	.035*	.06*	*	*	
*4th Street	* 636.8161	* .014*	.023*	.035*	.06*	*	*	
*4th Street	* 450.2781	* .014*	.021*	.035*	.06*	*	*	
*4th Street	* 396.8996	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 394.965*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 393.031*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 391.097*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 389.163*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 387.2300	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 385.088*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 382.946*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 380.805*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 378.663*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 376.5217	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 370.955*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 365.390*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 359.824*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 354.258*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 348.692*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 343.126*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 337.5611	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 267.7897	* .014*	.024*	.035*	.06*	*	*	
*4th Street	* 229.8466	* .014*	.024*	.035*	.06*	*	*	
*4th Street	* 173.9272	* .014*	.024*	.035*	.06*	*	*	
*4th Street	* 127.0565	* .014*	.024*	.035*	.06*	*	*	
*4th Street	* 121.732*	* .014*	.024*	.035*	.06*	*	*	
*4th Street	* 116.408*	* .014*	.025*	.035*	.06*	*	*	
*4th Street	* 111.084*	* .014*	.025*	.035*	.06*	*	*	
*4th Street	* 105.760*	* .014*	.025*	.035*	.06*	*	*	
*4th Street	* 100.436*	* .014*	.026*	.035*	.06*	*	*	
*4th Street	* 95.1119*	* .014*	.026*	.035*	.06*	*	*	
*4th Street	* 89.7878*	* .014*	.026*	.035*	.06*	*	*	
*4th Street	* 84.4637*	* .014*	.027*	.035*	.06*	*	*	
*4th Street	* 79.1396	* .014*	.027*	.035*	.06*	*	*	

SUMMARY OF REACH LENGTHS

River: Arkansas River

Reach	River Sta.	Left	Channel	Right
4th Street	2383.165	270.73	280.79	284.47
4th Street	2102.372	280.47	276.43	253.06
4th Street	1825.946	258.34	255.23	247.86
4th Street	1570.713	168.43	164.79	138.09
4th Street	1405.927	155.9	153.07	139.36
4th Street	1329.40	Bridge		
4th Street	1252.860	93.11	93.18	93.67
4th Street	1159.680	102.01	99.43	70.76
4th Street	1060.254	247.27	239.33	200.98
4th Street	820.9197	186.08	184.1	189.52
4th Street	636.8161	172.75	186.53	169.25
4th Street	450.2781	49.75	53.37	54.23
4th Street	396.8996	1.92	2.06	2.68
4th Street	394.965	1.92	2.06	2.68
4th Street	393.031	1.92	2.06	2.68
4th Street	391.097	1.92	2.06	2.68
4th Street	389.163	1.92	2.06	2.68
4th Street	387.2300	1.93	2.14	2.35
4th Street	385.088	1.93	2.14	2.35
4th Street	382.946	1.93	2.14	2.35
4th Street	380.805	1.93	2.14	2.35
4th Street	378.663	1.93	2.14	2.35
4th Street	376.5217	5.43	5.57	6.31
4th Street	370.955	5.43	5.57	6.31
4th Street	365.390	5.43	5.57	6.31
4th Street	359.824	5.43	5.57	6.31
4th Street	354.258	5.43	5.57	6.31
4th Street	348.692	5.43	5.57	6.31
4th Street	343.126	5.43	5.57	6.31
4th Street	337.5611	68.48	69.77	93.21
4th Street	267.7897	37.84	37.94	39.53
4th Street	229.8466	51.83	55.92	58.62
4th Street	173.9272	47.69	46.87	46
4th Street	127.0565	5.21	5.32	5.28
4th Street	121.732	5.21	5.32	5.28
4th Street	116.408	5.21	5.32	5.28
4th Street	111.084	5.21	5.32	5.28
4th Street	105.760	5.21	5.32	5.28
4th Street	100.436	5.21	5.32	5.28
4th Street	95.1119	5.21	5.32	5.28
4th Street	89.7878	5.21	5.32	5.28
4th Street	84.4637	5.21	5.32	5.28
4th Street	79.1396	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Arkansas River

Reach	River Sta.	Contr.	Expan.
4th Street	2383.165	.1	.3
4th Street	2102.372	.1	.3
4th Street	1825.946	.1	.3
4th Street	1570.713	.1	.3
4th Street	1405.927	.1	.3
4th Street	1329.40 Bridge		
4th Street	1252.860	.1	.3
4th Street	1159.680	.1	.3
4th Street	1060.254	.1	.3
4th Street	820.9197	.1	.3
4th Street	636.8161	.1	.3
4th Street	450.2781	.1	.3
4th Street	396.8996	.1	.3
4th Street	394.965**	.1	.3
4th Street	393.031**	.1	.3
4th Street	391.097**	.1	.3
4th Street	389.163**	.1	.3
4th Street	387.2300*	.1	.3
4th Street	385.088**	.1	.3
4th Street	382.946**	.1	.3
4th Street	380.805**	.1	.3
4th Street	378.663**	.1	.3
4th Street	376.5217*	.1	.3
4th Street	370.955**	.1	.3
4th Street	365.390**	.1	.3
4th Street	359.824**	.1	.3

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*4th Street      *    354.258**       .1*       .3*
*4th Street      *    348.692**       .1*       .3*
*4th Street      *    343.126**       .1*       .3*
*4th Street      *    337.5611*       .1*       .3*
*4th Street      *    267.7897*       .1*       .3*
*4th Street      *    229.8466*       .1*       .3*
*4th Street      *    173.9272*       .1*       .3*
*4th Street      *    127.0565*       .1*       .3*
*4th Street      *    121.732**       .1*       .3*
*4th Street      *    116.408**       .1*       .3*
*4th Street      *    111.084**       .1*       .3*
*4th Street      *    105.760**       .1*       .3*
*4th Street      *    100.436**       .1*       .3*
*4th Street      *    95.1119**       .1*       .3*
*4th Street      *    89.7878**       .1*       .3*
*4th Street      *    84.4637**       .1*       .3*
*4th Street      *    79.1396 *       .1*       .3*
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Profile Output Table - Standard Table 1

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
4th Street	2383.165	100 YR	20000.00	4661.43	4674.78	4670.26	4675.92	0.001189	8.66	2445.24	244.64	0.45
4th Street	2102.372	100 YR	20000.00	4658.15	4674.48	4670.02	4675.62	0.000984	8.57	2373.14	232.52	0.45
4th Street	1825.946	100 YR	20000.00	4657.96	4673.70	4670.08	4675.19	0.002217	9.66	2107.87	228.82	0.52
4th Street	1570.713	100 YR	20000.00	4658.55	4672.74	4670.00	4674.68	0.001482	11.50	2017.20	234.15	0.61
4th Street	1405.927	100 YR	20000.00	4657.64	4672.15	4669.67	4674.39	0.001739	12.58	1918.25	220.20	0.65
4th Street	1329.40		Bridge									
4th Street	1252.860	100 YR	20000.00	4657.91	4671.05	4669.99	4673.91	0.002686	14.21	1707.61	220.29	0.76
4th Street	1159.680	100 YR	20000.00	4657.56	4671.07	4669.23	4673.62	0.001722	13.66	1829.55	225.01	0.70
4th Street	1060.254	100 YR	20000.00	4657.42	4670.91	4669.26	4673.45	0.001816	13.44	1788.50	218.55	0.71
4th Street	820.9197	100 YR	20000.00	4657.89	4671.25	4667.87	4672.84	0.001067	10.40	2130.87	247.44	0.55
4th Street	636.8161	100 YR	20000.00	4659.48	4671.25	4667.35	4672.58	0.000900	9.34	2233.57	251.05	0.50
4th Street	450.2781	100 YR	20000.00	4657.45	4671.31	4666.46	4672.37	0.000553	8.33	2511.58	262.67	0.43
4th Street	396.8996	100 YR	20000.00	4657.54	4670.92	4668.04	4672.29	0.001516	9.68	2255.38	295.21	0.54
4th Street	387.2300	100 YR	20000.00	4658.03	4670.77	4668.47	4672.27	0.001745	10.28	2190.63	298.65	0.58
4th Street	376.5217	100 YR	20000.00	4662.07	4669.20	4669.20	4672.10	0.003983	14.24	1573.00	284.12	0.97
4th Street	337.5611	100 YR	20000.00	4653.66	4669.61	4662.57	4670.25	0.000425	6.54	3269.92	299.31	0.31
4th Street	267.7897	100 YR	20000.00	4651.93	4669.83	4658.66	4670.14	0.000125	4.54	4600.54	312.77	0.19
4th Street	229.8466	100 YR	20000.00	4651.93	4669.83	4658.47	4670.13	0.000121	4.49	4638.15	307.64	0.19
4th Street	173.9272	100 YR	20000.00	4651.04	4669.81	4658.58	4670.13	0.000127	4.58	4563.03	302.57	0.19
4th Street	127.0565	100 YR	20000.00	4651.90	4669.75	4659.60	4670.12	0.000155	4.91	4260.30	297.56	0.22
4th Street	79.1396	100 YR	20000.00	4659.37	4667.14	4667.14	4669.84	0.006096	13.20	1516.18	286.48	1.01

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
4th Street	2383.165	100 YR	4675.92	4674.78	1.14	0.30	0.00	555.17	19019.92	424.90	244.64
4th Street	2102.372	100 YR	4675.62	4674.48	1.14	0.39	0.03	739.81	19170.99	89.20	232.52
4th Street	1825.946	100 YR	4675.19	4673.70	1.49	0.46	0.05	939.54	18901.41	159.06	228.82
4th Street	1570.713	100 YR	4674.68	4672.74	1.94	0.26	0.03	591.42	18434.54	974.05	234.15
4th Street	1405.927	100 YR	4674.39	4672.15	2.25	0.05	0.03	488.02	17813.68	1698.30	220.20
4th Street	1329.40		Bridge								
4th Street	1252.860	100 YR	4673.91	4671.05	2.87	0.20	0.09	476.74	17818.83	1704.43	220.29
4th Street	1159.680	100 YR	4673.62	4671.07	2.56	0.17	0.01	444.94	17160.24	2394.82	225.01
4th Street	1060.254	100 YR	4673.45	4670.91	2.53	0.32	0.28	434.25	17603.51	1962.24	218.55
4th Street	820.9197	100 YR	4672.84	4671.25	1.59	0.18	0.08	339.38	18688.64	971.98	247.44
4th Street	636.8161	100 YR	4672.58	4671.25	1.33	0.13	0.08	73.54	19686.01	240.45	251.05
4th Street	450.2781	100 YR	4672.37	4671.31	1.06	0.05	0.03	232.47	19542.71	224.81	262.67
4th Street	396.8996	100 YR	4672.29	4670.92	1.37	0.00	0.00	907.15	18160.49	932.37	295.21
4th Street	387.2300	100 YR	4672.27	4670.77	1.49	0.00	0.01	1490.17	16953.53	1556.31	298.65
4th Street	376.5217	100 YR	4672.10	4669.20	2.90	0.03	0.00	237.03	17921.30	1841.67	284.12
4th Street	337.5611	100 YR	4670.25	4669.61	0.64	0.01	0.10	515.45	18746.42	738.13	299.31
4th Street	267.7897	100 YR	4670.14	4669.83	0.31	0.00	0.00	395.80	19239.52	364.68	312.77
4th Street	229.8466	100 YR	4670.13	4669.83	0.31	0.01	0.00	559.00	19095.74	345.26	307.64
4th Street	173.9272	100 YR	4670.13	4669.81	0.32	0.01	0.00	484.12	19084.85	431.04	302.57
4th Street	127.0565	100 YR	4670.12	4669.75	0.36	0.00	0.00	424.53	19109.07	466.39	297.56
4th Street	79.1396	100 YR	4669.84	4667.14	2.70			3.30	19995.85	0.85	286.48

Profile Output Table - Six XS Bridge

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Crit W.S. (ft)	Frctn Loss (ft)	C & E Loss (ft)	Top Width (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Vel Chnl (ft/s)
4th Street	1570.713	100 YR	4674.68	4672.74	4670.00	0.26	0.03	234.15	591.42	18434.54	974.05	11.50
4th Street	1405.927	100 YR	4674.39	4672.15	4669.67	0.05	0.03	220.20	488.02	17813.68	1698.30	12.58
4th Street	1329.40 BR U	100 YR	4674.32	4671.82	4669.73	0.25	0.06	215.22	470.01	18137.54	1392.45	13.19
4th Street	1329.40 BR D	100 YR	4674.01	4670.94	4670.03	0.04	0.06	215.93	434.95	18163.18	1401.87	14.63
4th Street	1252.860	100 YR	4673.91	4671.05	4669.99	0.20	0.09	220.29	476.74	17818.83	1704.43	14.21
4th Street	1159.680	100 YR	4673.62	4671.07	4669.23	0.17	0.01	225.01	444.94	17160.24	2394.82	13.66

APPENDIX C
Detailed Scour Calculations

100-YR SCOUR SUMMARY
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

Pier/Bent	Groundline Elevation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour (ft)	Scour Elevation (ft)
2	4965.3	0.9	9.5	10.4	4954.9

500-YR SCOUR SUMMARY
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

Pier/Bent	Groundline Elevation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour (ft)	Scour Elevation (ft)
2	4965.3	1.1	10.2	11.3	4954.0

NOTES:
These tables present ultimate potential scour depths for the associated hydraulic events. A soil horizon exists beneath the bridge which may be resistant to scour, the predicted scour depths, therefore, could be reduced to reflect the competence of the material.

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

SCOUR MODE COMPUTATION
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

The following computations are made using Laursen's Equation (Equation 15 in HEC-18):

$$V_c = Ku \times Y_1^{1/6} \times D_{50}^{1/3}$$

100-YR DISCHARGE
MAIN CHANNEL SCOUR MODE

APPROACH SECTION MAIN CHANNEL AREA (ft^2), A_1	=	1,625
APPROACH SECTION MAIN CHANNEL WIDTH (ft), W_1	=	146
APPROACH SECTION AVERAGE CHANNEL DEPTH (ft), $Y_1 = A_1/W_1$	=	11.13
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.023000
Ku		11.17
BED TRANSPORT CRITICAL VELOCITY (fps), V_c	=	4.75
DISCHARGE IN APPROACH CHANNEL (cfs), Q_1	=	18,856
MEAN VELOCITY IN APPROACH CHANNEL (fps), V_m	=	11.60
MAIN CHANNEL SCOUR MODE	=	**LIVE-BED**

500-YR DISCHARGE
MAIN CHANNEL SCOUR MODE

APPROACH SECTION MAIN CHANNEL AREA (ft^2), A_1	=	1,762
APPROACH SECTION MAIN CHANNEL WIDTH (ft), W_1	=	146
APPROACH SECTION AVERAGE CHANNEL DEPTH (ft), $Y_1 = A_1/W_1$	=	12.06
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.023000
Ku		11.17
BED TRANSPORT CRITICAL VELOCITY (fps), V_c	=	4.81
DISCHARGE IN APPROACH CHANNEL (cfs), Q_1	=	21,357
MEAN VELOCITY IN APPROACH CHANNEL (fps), V_m	=	12.12
MAIN CHANNEL SCOUR MODE	=	**LIVE-BED**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

CONTRACTION SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s=Y_2-Y_0$$

$$Y_2=((Q_2/Q_1)^{6/7}((W_1/W_2)^{k_1}))*Y_1$$

100-YR DISCHARGE
Main Channel
LIVE-BED CONTRACTION SCOUR COMPUTATIONS

ENERGY SLOPE	=	1.48E-03
ω FALL VELOCITY (fps)	=	1.30
AVERAGE UPSTREAM CHANNEL DEPTH (ft), $Y_1 = A_1/W_1$	=	11.13
g GRAVITATIONAL ACCELERATION (ft/sqsec)	=	32.20
V^* SHEAR VELOCITY IN UPSTREAM SECTION (fps)	=	0.73
V^*/ω	=	0.56
k_1 HEC-18	=	0.64
DISCHARGE IN UPSTREAM CHANNEL (cfs), Q_1	=	18,856
DISCHARGE IN CONTRACTED SECTION (cfs), Q_2	=	18,552
WIDTH OF UPSTREAM CHANNEL SECTION (ft), W_1	=	146.1
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (ft), W_2	=	123.0
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.023000
COMPUTED WATER DEPTH OF CONTRACTED SECTION (ft), Y_2	=	12.25
AVERAGE WATER DEPTH AT BRIDGE(ft), Y_0	=	11.33
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION, Y_S	**=**	**0.9**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

CONTRACTION SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s=Y_2-Y_0$$

$$Y_2=((Q_2/Q_1)^{6/7}((W_1/W_2)^{k_1}))*Y_1$$

500-YR DISCHARGE
Main Channel
LIVE-BED CONTRACTION SCOUR COMPUTATIONS

ENERGY SLOPE	=	1.45E-03
ω FALL VELOCITY (fps)	=	1.30
AVERAGE UPSTREAM CHANNEL DEPTH (ft), $Y_1 = A_1/W_1$	=	12.06
g GRAVITATIONAL ACCELERATION (ft/sqsec)	=	32.20
V^* SHEAR VELOCITY IN UPSTREAM SECTION (fps)	=	0.75
V^*/ω	=	0.58
k_1 SEE HEC-18	=	0.64
DISCHARGE IN UPSTREAM CHANNEL (cfs), Q_1	=	21,357
DISCHARGE IN CONTRACTED SECTION (cfs), Q_2	=	21,010
WIDTH OF UPSTREAM CHANNEL SECTION (ft), W_1	=	146.1
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (ft), W_2	=	123.0
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.023000
COMPUTED WATER DEPTH OF CONTRACTED SECTION (ft), Y_2	=	13.28
AVERAGE WATER DEPTH AT BRIDGE(ft), Y_0	=	12.15
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION, Y_S	=	**1.1**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CJD	Date:	8/4/06

100-YR
LOCAL PIER SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

CASE 2 COMPLEX PIERS SCOUR ANALYSIS FOR 100-YR

Reference for methodology: HEC-18 4th Edition Chapter 6

PIER COMPONENT

Bent Number	**Pier 2**
Station	**21+43**
V_1: velocity (fps)	4.26
Y_1: depth (ft)	7.46
ATTACK ANGLE, (degrees)	0
h_1: pier stem height above bed (ft)	-2.00
Individual Pier Width (ft)	3.50
a: projected pier width (ft)	3.50
L: pier length (ft)	17.25
f: pier setback from edge of pile cap (ft)	2.38
Pier Nose Shape (S=SQUARE, C = CIRCULAR)	S
K_1: shape coefficient	1.10
K_2: angle coefficient	1.00
K_3: bed condition coefficient	1.10
K_{hpier}: weighting factor for pier component	0.62
g: gravitational constant (ft/sec^2)	32.20
Fr: Froude number	0.27
Pier Component of Local Scour Depth, Y_{spier} (ft)	**3.9**

CAP COMPONENT (Case 2)

Bent Number	**Pier 2**
V_2: velocity (fps)	2.80
Y_2: depth (ft)	11.36
ATTACK ANGLE, (degrees)	0
h_{opc}: pre-scour pile cap bottom height above the bed (ft)	-8.00
D_{50} (ft)	0.0230
Ks (ft)	0.0345
Ku critical velocity transport coefficient	11.17
Vc critical transport velocity (fps)	4.76
Y_f: distance from bed to top of footing (ft)	1.90
V_f: ave velocity in the flow zone below the top of the footing (fps)	2.19
a_{pc}: pile cap width (ft)	6.00
L_{pc}: pile cap length (ft)	22.00
Cap Nose Shape (S=SQUARE, C = CIRCULAR)	S
K_1: shape coefficient	1.10
K_2: angle coefficient	1.00
K_3: bed condition coefficient	1.10
K_w: wide pier adjustment factor	1.00
Fr: Froude number	0.28
Cap Component of Local Scour Depth, Y_{spc} (m)	**5.6**

LOCAL SCOUR DEPTH = $Y_{spier} + Y_{spc}$	**9.5**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

500-YR
LOCAL PIER SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

CASE 2 COMPLEX PIERS SCOUR ANALYSIS FOR 500-YR

Reference for methodology: HEC-18 4th Edition Chapter 6

PIER COMPONENT

Bent Number	**Pier 2**
Station	**21+43**
V_1: velocity (fps)	4.65
Y_1: depth (ft)	8.36
ATTACK ANGLE, (degrees)	0
h_1: pier stem height above bed (ft)	-2.00
Individual Pier Width (ft)	3.50
a: projected pier width (ft)	3.50
L: pier length (ft)	17.25
f: pier setback from edge of pile cap (ft)	2.38
Pier Nose Shape (S=SQUARE, C = CIRCULAR)	S
K_1: shape coefficient	1.10
K_2: angle coefficient	1.00
K_3: bed condition coefficient	1.10
K_{hpier}: weighting factor for pier component	0.62
g: gravitational constant (ft/sec^2)	32.20
Fr: Froude number	0.28
Pier Component of Local Scour Depth, Y_{spier} (ft)	**4.2**

CAP COMPONENT (Case 2)

Bent Number	**Pier 2**
V_2: velocity (fps)	3.10
Y_2: depth (ft)	12.56
ATTACK ANGLE, (degrees)	0
h_{opc}: pre-scour pile cap bottom height above the bed (ft)	-8.00
D_{50} (ft)	0.0230
Ks (ft)	0.0345
Ku critical velocity transport coefficient	11.17
Vc critical transport velocity (fps)	4.84
Y_f: distance from bed to top of footing (ft)	2.20
V_f: ave velocity in the flow zone below the top of the footing (fps)	2.44
a_{pc}: pile cap width (ft)	6.00
L_{pc}: pile cap length (ft)	22.00
Cap Nose Shape (S=SQUARE, C = CIRCULAR)	S
K_1: shape coefficient	1.10
K_2: angle coefficient	1.00
K_3: bed condition coefficient	1.10
K_w: wide pier adjustment factor	1.00
Fr: Froude number	0.29
Cap Component of Local Scour Depth, Y_{spc} (m)	**6.0**

LOCAL SCOUR DEPTH = $Y_{spier} + Y_{spc}$	**10.2**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

100-YR DISCHARGE BEDROCK SCOUR ESTIMATE - ERODIBILITY INDEX METHOD FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

The following computations are made using the Erodibility Index Method as described in HEC-18 & "Estimation of Bridge Pier Scour Using the Erodibility Index Method." by George W. Annandale, P.E.

HEC-18 Scour Depth, y_s =	10.4	ft
Stream Power Upstream =	10.1	ft-lbs/s/ft^2
Ground Elevation =	4665.3	ft
Bedrock Elevation =	4655.5	ft

TABLE OF VALUES FOR PIER 2

Stream Power Amplification Ratio	Stream Power ft-lbs/s/ft^2	Relative Scour Percent	Ultimate Scour Elevation ft	*Stream Power Rqd for Scour ft-lbs/s/ft^2
13.5	136.5	5%	4664.78	N/A
10.7	108.0	10%	4664.26	N/A
7.9	79.5	20%	4663.22	N/A
6.2	62.8	30%	4662.18	N/A
5.0	51.0	40%	4661.14	N/A
4.1	41.8	50%	4660.10	N/A
3.4	34.3	60%	4659.06	N/A
2.8	28.0	70%	4658.02	N/A
2.2	22.5	80%	4656.98	N/A
1.7	17.7	90%	4655.94	N/A
1.3	13.3	100%	4654.90	1919

Ultimate Scour Depth Interpolated from Above Values =	**4655.5**	**ft**
Scour Depth in Bedrock =	0.0	ft

* Stream Power Required for Scour is assumed to be the same at all elevations because the sample examined by Michael W. West & Associates, Inc. to determine the erodibility index was taken at one elevation.

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

500 ~~100~~-YR DISCHARGE BEDROCK SCOUR ESTIMATE - ERODIBILITY INDEX METHOD FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER

PUEBLO, COLORADO

7-21-2006

The following computations are made using the Erodibility Index Method as described in HEC-18 & "Estimation of Bridge Pier Scour Using the Erodibility Index Method." by George W. Annandale, P.E.

HEC-18 Scour Depth, y_s =	11.3	ft
Stream Power Upstream =	11.4	ft-lbs/s/ft^2
Ground Elevation =	4665.3	ft
Bedrock Elevation =	4655.5	ft

TABLE OF VALUES FOR PIER 2

Stream Power Amplification Ratio	Stream Power ft-lbs/s/ft^2	Relative Scour Percent	Ultimate Scour Elevation ft	*Stream Power Rqd for Scour ft-lbs/s/ft^2
13.5	154.2	5%	4664.74	N/A
10.7	122.0	10%	4664.17	N/A
7.9	89.8	20%	4663.04	N/A
6.2	71.0	30%	4661.91	N/A
5.0	57.6	40%	4660.78	N/A
4.1	47.2	50%	4659.65	N/A
3.4	38.8	60%	4658.52	N/A
2.8	31.6	70%	4657.39	N/A
2.2	25.4	80%	4656.26	N/A
1.7	19.9	90%	4655.13	N/A
1.3	15.0	100%	4654.00	1919

Ultimate Scour Depth Interpolated from Above Values =	**4655.5**	**ft**
Scour Depth in Bedrock =	0.0	ft

* Stream Power Required for Scour is assumed to be the same at all elevations because the sample examined by Michael W. West & Associates, Inc. to determine the erodibility index was taken at one elevation.

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

500-YR SCOUR SUMMARY
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER & RAILYARD

PUEBLO, COLORADO
RAILYARD PIERS

7-21-2006

Pier/Bent	Groundline Elevation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Scour (ft)	Scour Elevation (ft)
4	4667.4	0.0	3.8	3.8	4663.6
5	4666.9	0.0	5.5	5.5	4661.4

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

SCOUR MODE COMPUTATION
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER & RAILYARD

PUEBLO, COLORADO
RAILYARD PIERS

7-21-2006

The following computations are made using Laursen's Equation (Equation 15 in HEC-18):

$$V_c = Ku \times Y_1^{1/6} \times D_{50}^{1/3}$$

500-YR DISCHARGE
MAIN CHANNEL SCOUR MODE

APPROACH SECTION MAIN CHANNEL AREA (ft^2), A_1	=	1,168
APPROACH SECTION MAIN CHANNEL WIDTH (ft), W_1	=	355
APPROACH SECTION AVERAGE CHANNEL DEPTH (ft), $Y_1 = A_1/W_1$	=	3.29
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.003281
Ku		11.17
BED TRANSPORT CRITICAL VELOCITY (fps), V_c	=	2.024
DISCHARGE IN APPROACH CHANNEL (cfs), Q_1	=	2,361
MEAN VELOCITY IN APPROACH CHANNEL (fps), V_m	=	2.022
MAIN CHANNEL SCOUR MODE	=	**CLEAR-WATER**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

CONTRACTION SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER & RAILYARD

PUEBLO, COLORADO
RAILYARD PIERS

7-21-2006

The following computations are made using the HEC-18 equation for Clear Water Contraction Scour:

Scour Depth, $Y_s=Y_2-Y_1$

where:

$$Y_2= (+Q^2/(Ku*(1.25*D_{50})^{(2/3)}*W^2))^{(3/7)}$$

500-YR DISCHARGE
Left Overbank
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (cfs), Q	=	99
WIDTH OF CONTRACTED SECTION (ft), W	=	92.4
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.003281
Ku, CLEAR WATER CONTRACTION SCOUR COEFFICIENT	=	130
COMPUTED DEPTH OF CONTRACTED SECTION (ft), Y_2	=	0.64
AVERAGE FLOOD PLAIN DEPTH (ft), Y_1	=	0.82
DEPTH OF CONTRACTION SCOUR (ft), Y_s	=	**-0.2**

500-YR DISCHARGE
Main Channel
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (cfs), Q	=	99
WIDTH OF CONTRACTED SECTION (ft), W	=	92.4
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.003281
Ku, CLEAR WATER CONTRACTION SCOUR COEFFICIENT	=	130
COMPUTED DEPTH OF CONTRACTED SECTION (ft), Y_2	=	0.64
AVERAGE FLOOD PLAIN DEPTH (ft), Y_1	=	2.98
DEPTH OF CONTRACTION SCOUR (ft), Y_s	=	**-2.3**

500-YR DISCHARGE
Right Overbank
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (cfs), Q	=	142
WIDTH OF CONTRACTED SECTION (ft), W	=	331.3
MEDIAN GRAIN SIZE (ft), D_{50}	=	0.003281
Ku, CLEAR WATER CONTRACTION SCOUR COEFFICIENT	=	130
COMPUTED DEPTH OF CONTRACTED SECTION (ft), Y_2	=	0.29
AVERAGE FLOOD PLAIN DEPTH (ft), Y_1	=	0.48
DEPTH OF CONTRACTION SCOUR (ft), Y_s	=	**-0.2**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

500-YR
LOCAL PIER SCOUR COMPUTATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER & RAILYARD

PUEBLO, COLORADO
RAILYARD PIERS

7-21-2006

CASE 2 COMPLEX PIERS SCOUR ANALYSIS FOR 500-YR

Reference for methodology: HEC-18 4th Edition Chapter 6

PIER COMPONENT

Bent Number	**Pier 4**	**Pier 5**
Station	**27+52**	**29+81**
V_1: velocity (fps)	1.91	2.18
Y_1: depth (ft)	1.86	2.38
ATTACK ANGLE, (degrees)	0	0
h_1: pier stem height above bed (ft)	-2.00	-2.00
Individual Pier Width (ft)	7.08	3.50
a: projected pier width (ft)	7.08	3.50
L: pier length (ft)	17.25	17.25
f: pier setback from edge of pile cap (ft)	8.38	2.38
Pier Nose Shape (S=SQUARE, C = CIRCULAR)	S	S
K_1: shape coefficient	1.10	1.10
K_2: angle coefficient	1.00	1.00
K_3: bed condition coefficient	1.10	1.10
K_{hpier}: weighting factor for pier component	0.43	0.62
g: gravitational constant (ft/sec^2)	32.20	32.20
Fr: Froude number	0.25	0.25
Pier Component of Local Scour Depth, Y_{spier} (ft)	**2.5**	**2.5**

CAP COMPONENT (Case 2)

Bent Number	**Pier 4**	**Pier 5**
V_2: velocity (fps)	0.81	1.06
Y_2: depth (ft)	4.36	4.88
ATTACK ANGLE, (degrees)	0	0
h_{opc}: pre-scour pile cap bottom height above the bed (ft)	-11.00	-8.00
D_{50} (ft)	0.0033	0.0033
Ks (ft)	0.0049	0.0049
Ku critical velocity transport coefficient	11.17	11.17
Vc critical transport velocity (fps)	2.12	2.16
Y_f: distance from bed to top of footing (ft)	0.50	0.50
V_f: ave velocity in the flow zone below the top of the footing (fps)	0.62	0.80
a_{pc}: pile cap width (ft)	9.00	6.00
L_{pc}: pile cap length (ft)	34.00	22.00
Cap Nose Shape (S=SQUARE, C = CIRCULAR)	S	S
K_1: shape coefficient	1.10	1.10
K_2: angle coefficient	1.00	1.00
K_3: bed condition coefficient	1.10	1.10
K_w: wide pier adjustment factor	0.35	1.00
Fr: Froude number	0.16	0.20
Cap Component of Local Scour Depth, Y_{spc} (m)	**1.3**	**3.0**

LOCAL SCOUR DEPTH = Y_{spier} + Y_{spc}	**3.8**	**5.5**

Calc. By:	RLE	Date:	7-21-2006
Check By:	CLD	Date:	8/4/06

APPENDIX D
Bluff Slope Countermeasure Design Calculations

RIPRAP SIZE CALCULATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER
500-YR
PUEBLO, COLORADO
RIGHT OVERBANK BLUFF SLOPE

8/4/06

The following computations are made using the CDOT Drainage Design Manual equation for Riprap size determination

$$D_{50} = \left(0.00594 C V_a^3\right) / \left(d_{avg}^{0.5} K_1^{1.5}\right)$$

$$K_1 = \left[1 - \left(\sin^2\theta / \sin^2\phi\right)\right]^{0.5}$$

$$C = \left(1.61 SF^{1.5}\right) / \left(S_s - 1\right)^{1.5}$$

RIPRAP SIZE CALCULATIONS

V_a AVERAGE MAIN CHANNEL VELOCITY (ft/s)	=	6.23
d_a AVERAGE MAIN CHANNEL FLOW DEPTH (ft)	=	4.15
θ BANK ANGLE TO THE HORIZONTAL (deg)	=	26.57
ϕ MATERIAL ANGLE OF REPOSE (deg)	=	39.00
S_s MATERIAL SPECIFIC GRAVITY	=	2.65
SF STABILITY FACTOR	=	2.12
K_1	=	0.70
C CORRECTION FACTOR	=	2.34
MEDIAN GRAIN SIZE (ft), D50	=	0.50

Calc. By:	RLE	Date:	8/4/06
Check By:	CLD	Date:	8/4/06

TURF REINFORCEMENT MAT DESIGN CALCULATIONS
FOR S.H. 96A (4th St.) OVER ARKANSAS RIVER
500-YR
PUEBLO, COLORADO
RIGHT OVERBANK BLUFF SLOPE

8/11/06

The following computations are made using FHWA HEC-15 Design of Roadside Channels with Flexible Linings

$\tau = \gamma \cdot R \cdot S$
which is simplified to
$\tau = \gamma \cdot Y \cdot S$
where:

τ is the boudary shear stress (lb/sf)

γ is the unit weight of water (62.4 lb/cf)
Y is the depth of water (at the toe of slope)
S is the energy gradient (ft/ft)

CHANNEL HYDRAULIC DESIGN PARAMETERS
HEC-RAS MODEL XS 1253

V CHANNEL VELOCITY AT BLUFF TOE (ft/s)	=	3.50
Y FLOW DEPTH AT BLUFF TOE (ft)	=	3.65
S ENERGY GRADIENT (ft/ft)	=	0.0029

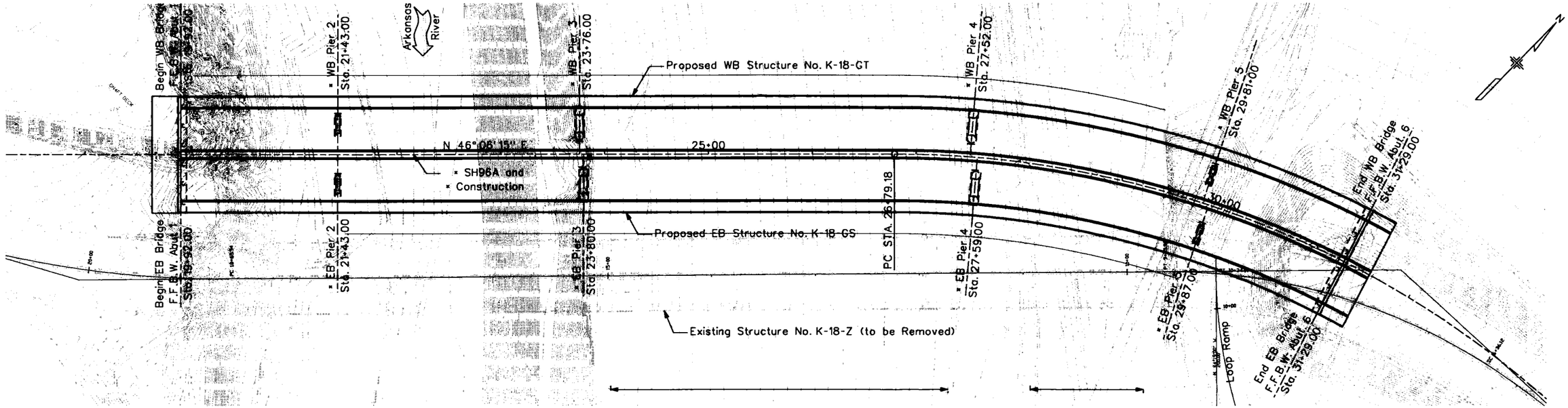
SHEAR STRESS CALCULATION

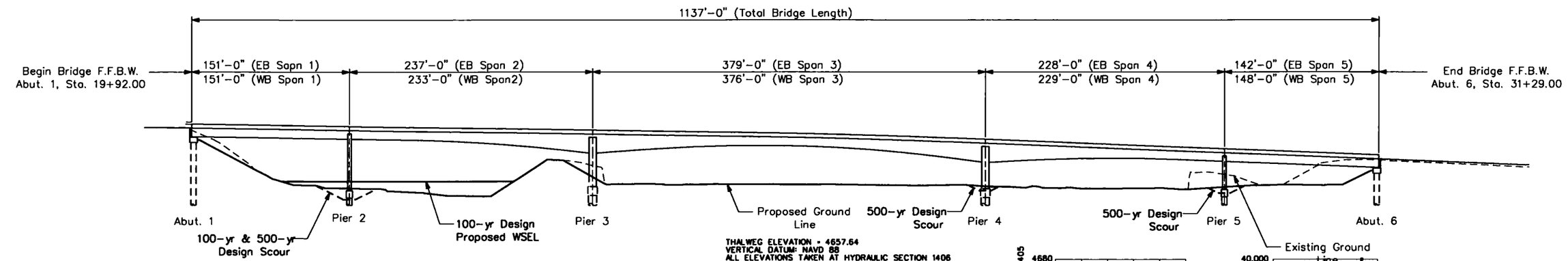
τ SHEAR STRESS (lb/sf)	=	**0.66**

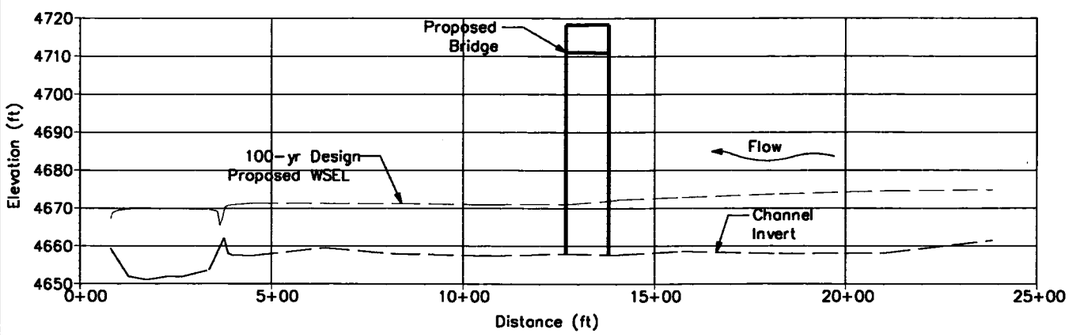
Conclusion - For disturbed bluff slopes (not protected by riprap), a permanent Turf Reinforcement Mat will be required with a permissable shear stress greater than **0.66** lb/sf, based on testing according to ASTM D6460, for non-vegetated conditions.

Calc. By:	CLD	Date:	8/11/06
Check By:		Date:	8/11/06

APPENDIX E
Bridge Hydraulic Information Sheet







CHANNEL PROFILE

THALWEG ELEVATION = 4657.64
VERTICAL DATUM: NAVD 88
ALL ELEVATIONS TAKEN AT HYDRAULIC SECTION 1406

HYDRAULIC DATA

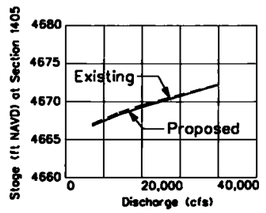
ARKANSAS RIVER DRAINAGE AREA	= 4,790 SQ-MI (REGULATED)
WILDHORSE CREEK DRAINAGE AREA	= 87 SQ-MI (UNREGULATED)
AVERAGE CHANNEL SLOPE	= 0.1%
MANNING'S 'N' CHANNEL	= 0.021 - 0.027
OVERBANK	= 0.014 (CONCRETE)
	= 0.035 - 0.100 (VEGETATED)

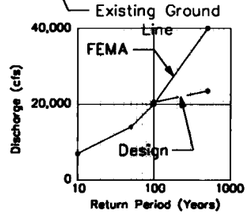
DEBRIS: ■ BRUSH ■ LOGS □ ICE □ _____
DESIGN FLOW: 20,500 CFS (100-YEAR)
SOURCE OF HYDROLOGY: PUEBLO STORMWATER MASTER BASIN PLANNING STUDY

COMPARISON OF HYDRAULICS AT APPROACH SECTION 1406

	AVERAGE VELOCITY (FT/S)	FREEBOARD (FT)	WSEL (FT, NAVD)
EXISTING	10.04	30.77	4672.71
PROPOSED	10.51	34.35	4672.30

RECURRENCE INTERVAL (YEARS)	DISCHARGE (CFS)	EXISTING STAGE (FT)	PROPOSED STAGE (FT)
10 FEMA	7,000	4668.46	4668.10
50 FEMA	14,000	4670.95	4670.48
100 FEMA	20,000	4672.59	4672.15
500 FEMA	40,000	4677.14	4677.00
100 DESIGN	20,500	4672.71	4672.30
500 DESIGN	23,500	4673.44	4673.19





PRELIMINARY
SUBJECT TO REVISION

GEOTECHNICAL DATA
BOTTOM MATERIAL: □ COHESIVE ■ NON-COHESIVE
BOTTOM MATERIAL PARTICLE SIZE: □ CLAY □ SILT □ SAND ■ GRAVEL ■ COBBLES □ _____
STREAM PLANFORM: ■ STRAIGHT □ MEANDERING □ BRAIDED
CHANNEL STABILITY: ■ STABLE □ AGGRADING □ DEGRADING
ICE: □ YES ■ NO □ UNKNOWN

NOTES:
1. Hydraulic RS 1406 is located 26 ft upstream of the proposed upstream bridge face.
2. EB denotes eastbound, WB denotes westbound.
3. Span lengths measured along * SH96A and * construction.

Quantities	INITIAL	DATE
Quantities By	XXX	MM/YY
Checked By	XXX	MM/YY
Detail		
Detailed By	XXX	MM/YY
Checked By	XXX	MM/YY
Design		
Designed By	XXX	MM/YY
Checked By	XXX	MM/YY

Print Date: 8/11/2006
Drawing File Name: CDOT BHIS.dgn
Horiz. Scale: 1:100 Vert. Scale: As Noted
Unit Information Unit Leader Initials

AYRES ASSOCIATES
3665 JFK PARKWAY BUILDING 2, SUITE 200 FORT COLLINS, CO 80525 Phone: (970) 223-5556 Fax: (970) 223-5578

R-X

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation
DOT DEPARTMENT OF TRANSPORTATION
902 Erie Avenue
Pueblo, CO 81001
Phone: 719-546-5438 FAX: 719-546-5702
Region 2 KSR

As Constructed
No Revisions:
Revised:
Void:

BRIDGE HYDRAULIC DATA SHEET

Designer:	L. Embertson	Structure Numbers	K-18-GS (EB)
Detailer:	C. Kulick		K-18-GT (WB)
Sheet Subset:	BRIDGE	Subset Sheets:	XXX of XXX

Project No./Code
BR 0961-008
13141
Sheet Number XXX