20050042

HYDRAULIC REPORT

Cotton Lane Bridge Channel Design

Goodyear, Arizona

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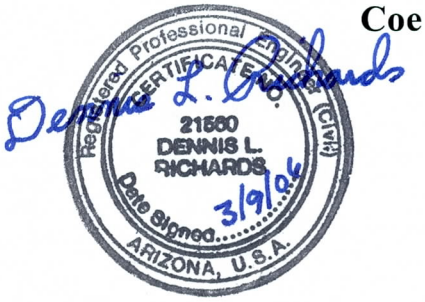

March 7, 2006

R2D River Research and Design, Inc.

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FLOOD CONTROL DISTRICT
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CONTRACTS	
ROUTING	

June 30, 2006

TO: Lynn Thomas
Flood Control District of Maricopa County
1501 W Durango
Phoenix, AZ 8500

SUBJ: CLOMR TDN for Cotton Lane Bridge

I have updated the Cotton Lane CLOMR TDN to incorporate comments from the Flood Control District. We are herewith submitting and update to the TDN and the 95% construction plans. We hope that this is ready for signatures and to be sent to FEMA. I will be out of the office from July 3 until approximately the 26th of July. In the interim if you need anything please call Brian Hensley at CVL. He will be able to provide copies of the grading plans and other offsite documents that may be needed for submittal to FEMA. I should be available by cell and by e-mail although I most likely will not be immediately available and a day or more may pass before I can get back to you on questions or problems.

I know you are aware of the urgency associated with this study and we appreciate the quick reviews we have had in the past.

Please call me at (480) 225-5206 if you have any questions.

Sincerely;

Gary E. Freeman

Cc: Brian Hensley
Bob Wagoner

R2D River Research and Design, Inc.

FAX: (480) 275-5870 **Phone: (480) 275-5077** E-mail: freeman@r2d-eng.com
Website: www.r2d-eng.com

June 13, 2006

Lynn Thomas
Flood Control District of Maricopa County
2801 West Durango St.
Phoenix, AZ 85009

Ms. Thomas:

Please find attached a set of modifications for the Cotton Lane Bridge / King Ranch CLOMR that was submitted on June 8, 2006. The modifications include Appendix E.3 and page 31. The table in Appendix E.3 had not been modified to reflect contraction coefficients of 0.1 at Estrella Parkway Bridge. The last sentence of the first paragraph of page 31 was reworded slightly. Please replace these sections in the four copies of the CLOMR TDN that was submitted.

If you have any questions please call me at (480) 275-5077.

Sincerely;

Gary E. Freeman, PhD, PE
President

ENC: Four (4) sets of changes

1345 E. Spur Ave, Gilbert, AZ 85296

FORWARD

This project was performed under the specific direction of Dr. Gary E. Freeman while he worked at WEST Consultants, Inc. (WEST), Coe & Van Loo Consultants, Inc. (CVL) and River Research & Design, Inc (R2D). The majority of the hydraulic and sediment modeling as well as all of the bridge scour calculations were performed by WEST. The work by WEST subsequent to Dr. Freeman's departure was performed under the general supervision of Dennis Richards. Basic work to determine Manning's n values was performed by Hari Sundararaghavan (formerly of WEST) and Ricardo Aguirre of CVL. The document is sealed by Dr. Freeman and Mr. Richards to cover work performed under their respective supervision. Portions of the intermediate modeling, supervision of plan development, specific project direction, analysis of final data and preparation of the report were performed by R2D as well as coordination of the channel design between MCDOT, FCDMC, Baker Engineering (Cotton Lane Bridge and Road designers) and the developers of King Ranch.

The engineering seals attached hereto represent responsibility for the respective portions of this study and the data presented in this report.

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1 Introduction

1.1 Purpose

The channel design team was tasked by Sontera Partners to design bank protection and evaluate the existing Gila River floodplain and floodway for approximately three miles of riverbank immediately west of the Estrella Parkway Bridge along the north and south side of the river as shown in Figure 1. The channel design team has involved WEST Consultants, Inc. (WEST), Coe & Van Loo Consultants (CVL), and River Research & Design, Inc (R2D). The property on the south side of the river is noted as the King Ranch property while that on the north bank is the Lakin property. The purposes of the study were 1) to support the design of the Cotton Lane Bridge and to shorten the proposed bridge such that it could be economically built and 2) determine how much of the King Ranch property along the river could be developed while recognizing the importance of river geomorphology as well as the function and value of this reach of river. The design of this reach of river has attempted to take into account the environmental importance of this reach of the river while designing a project that will meet the purpose and goals of the Cotton Lane Bridge project and provide the maximum developable lands along the river while not impacting overall river function.

During the preliminary studies associated with the King Ranch project it was noted that the existing floodway crossed a high point of land near the west end of the King Ranch property that did not appear to be a significant contributor to river capacity since it was high in relation to the river and flows appeared to be shallow across the area. This was also true of the portion of the floodway at the north end of the proposed Cotton Lane Bridge on the Lakin Property. These two areas were sufficiently higher and out of the main flow of the river such that it appeared feasible to remove these areas from the floodway to facilitate a shorter bridge as well as future development along the river and still not significantly impact flood heights or river functions.

This report presents the results of the hydraulic, sediment transport, and scour analyses conducted for the design of the channel improvements, bank protection, and floodplain

modifications for the reach of the Gila River between the Estrella Parkway Bridge and approximately the Jackrabbit Road alignment.

An initial analysis was performed which indicated that the rise in water surface elevation due to encroachment for the floodway was significantly less than the 1.0 foot allowed by both FEMA and Maricopa County guidelines. This was determined to be due to the placement of bank stations in the RAS model (following FEMA standards) to represent the wide natural channel of the braided Gila River. Based on the information obtained from a preliminary assessment performed earlier, a more detailed hydraulic analysis was performed to view the impacts of further encroachment of the floodway as well as the impact on sediment transport in the reach. The bank protection was also designed and toe down depths calculated. The details of these analyses are presented in this report.

1.2 Scope

The services performed and documented within this report include:

- **Field Reconnaissance & Data Collection.** Information on field reconnaissance and data collection is presented. Field investigation of the study reach was conducted to obtain required physical data and to identify specific features necessary for hydraulic analysis. Data regarding hydrologic, hydraulic, sediment transport, geomorphologic, and topographic information for the reach of the Gila River from upstream of Estrella Parkway to the Tuthill Bridge were collected and reviewed. This included hydrographs for various flood frequencies within the project reach; historical flow data; sediment size distributions, profile and cross-sectional data; historical aerial photography; previous and/or current floodplain studies showing floodplain and floodway boundaries and sediment transport studies, and information from the current El Rio Watercourse Master Plan (El Rio Study) being developed by the Flood Control District of Maricopa County (FCD).

  Additional field reviews of the project area were conducted to verify collected information, to supplement available data, and to become familiar with the physical environment of the study reach. Observations were made of channel conditions, hydraulic roughness, hydraulic structures, geomorphic characteristics, and sediment

characteristics along the project reach. Sediment gradation data were obtained and analyzed for grain size and sediment type to aid in the determination of sediment transport in the Gila River adjacent to the subject property.

- **Qualitative Geomorphic Analysis** A qualitative analysis of historical changes to river morphology through analysis of available aerial photographs was performed. The recent historical changes to profile gradient, historical channel pattern, flow regime, and bank stability were reviewed if sufficient data existed for each analysis. An evaluation of short and long-term channel stability trends of the river system along the project reach by the application of geomorphic relationships was accomplished. A review of historical aerial photographs was conducted to identify historical banklines, low flow channel locations, sediment aggradation/degradation potential, and to evaluate the potential for lateral migration. Any preliminary information available from the El Rio Water Course Master Plan was reviewed and utilized in the analysis.
- **Hydraulic Analysis.** A preliminary hydraulic analysis of both existing conditions and proposed project conditions (with bank protection) for a reach from Estrella Parkway to the Jackrabbit Road alignment was performed. An existing conditions hydraulic analysis was performed using the topographic information and the HEC-RAS model from the most recent FEMA FIS study (Baker 1999). The results from this model were used to provide velocities and depths for use in conceptual bank protection design calculations and to provide a preliminary view of possible bank alignments.

  A proposed conditions hydraulic model was developed for the proposed bank alignment. An analysis evaluating floodplain impacts both upstream and downstream of the proposed project as well as impacts along the north bank of the Gila River is presented. Several alternatives were analyzed to view river stability and hydraulics. The hydraulic analysis for the selected bank alignment was used to establish the preliminary water-surface elevations, flow velocities, and other hydraulic parameters required for the preliminary bank protection design.

- **Sediment Transport Analysis.** Sediment transport analyses of existing and proposed conditions on the project reach were also conducted. A HEC-6T sediment transport model of the Gila River between Dysart Road and approximately Perryville Road was developed. The model was extended upstream of the proposed project limit to ensure appropriate consideration of upstream sediment supply conditions and also extends downstream to sufficiently define potential downstream impacts of the proposed project. Long-term simulations were performed using a 105-year flood peak simulation for the existing and proposed conditions as developed for the U.S. Army Corps of Engineers study of the Tres Rios project approximately 2 miles upstream from this project. The average bed elevation results were plotted for each decadal sediment transport condition modeled to view intermediate stability trends. An analysis of long term scour potential is presented based on the results from the sediment transport model.
- **Scour and Lateral Migration Analysis.** Scour depths for the various scour components was estimated to establish the toe-down depths for the 100-year (design) event using the hydraulic and sediment transport parameters established above. The scour analysis considered contributions from each of the following components: local scour; aggradation/degradation; general scour; bedforms, low-flow incisement, and bend scour. The total scour depth, which is the sum of the individual scour components, is determined and the toe-down depth for the bank protection was established from the total scour depth.
- **Design of Bank Protection.** Bank protection is designed to resist forces associated with the 100 year design event. Data inputs were obtained from the sediment and hydraulic models to design and size protection to insure erosion will not occur during the 100 year event. Bank protection toe-down depth calculations were performed and these scour calculations consider the probable 100-year flood event and 105-year long-term bed profile to determine the maximum toe-down depth.

1.3 Study Area

The approximately 5-mile long study reach of the Gila River is located in Goodyear, Arizona immediately downstream from the Estella Parkway Bridge. The area modeled in both hydraulic

and sediment transport models extends approximately from the Agua Fria River confluence downstream to west of Tuthill Road. Figure 1 shows the project vicinity and Figure 2 shows the aerial photograph and the location of the King Ranch and Lakin Properties. The Agua Fria River is the first major tributary (not analyzed in this study) of Gila River below its confluence with the Salt River in Phoenix.

The Gila River consists of a heavily braided system with three bridges at Bullard Avenue, Estrella Parkway and Tuthill Road in the study reach. The Bullard Avenue Bridge and Estrella Parkway Bridge are located approximately 4 miles and 5 miles downstream from the Salt-Gila confluence, respectively. The condition of the vegetation in the channel and floodplain has a high spatial variability, ranging from non-existent to extremely dense over very short distances.

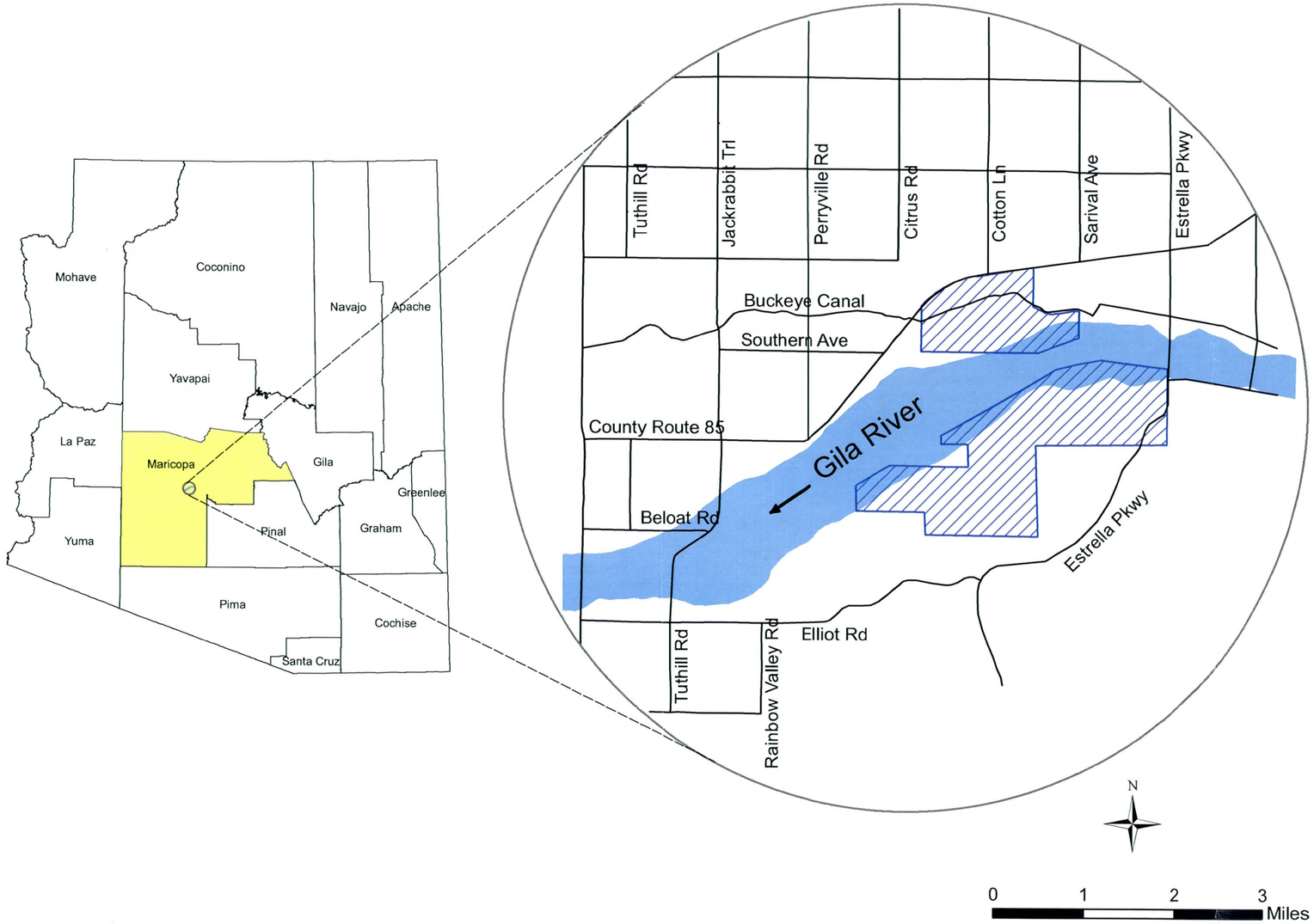


Figure 1. Project Vicinity Map

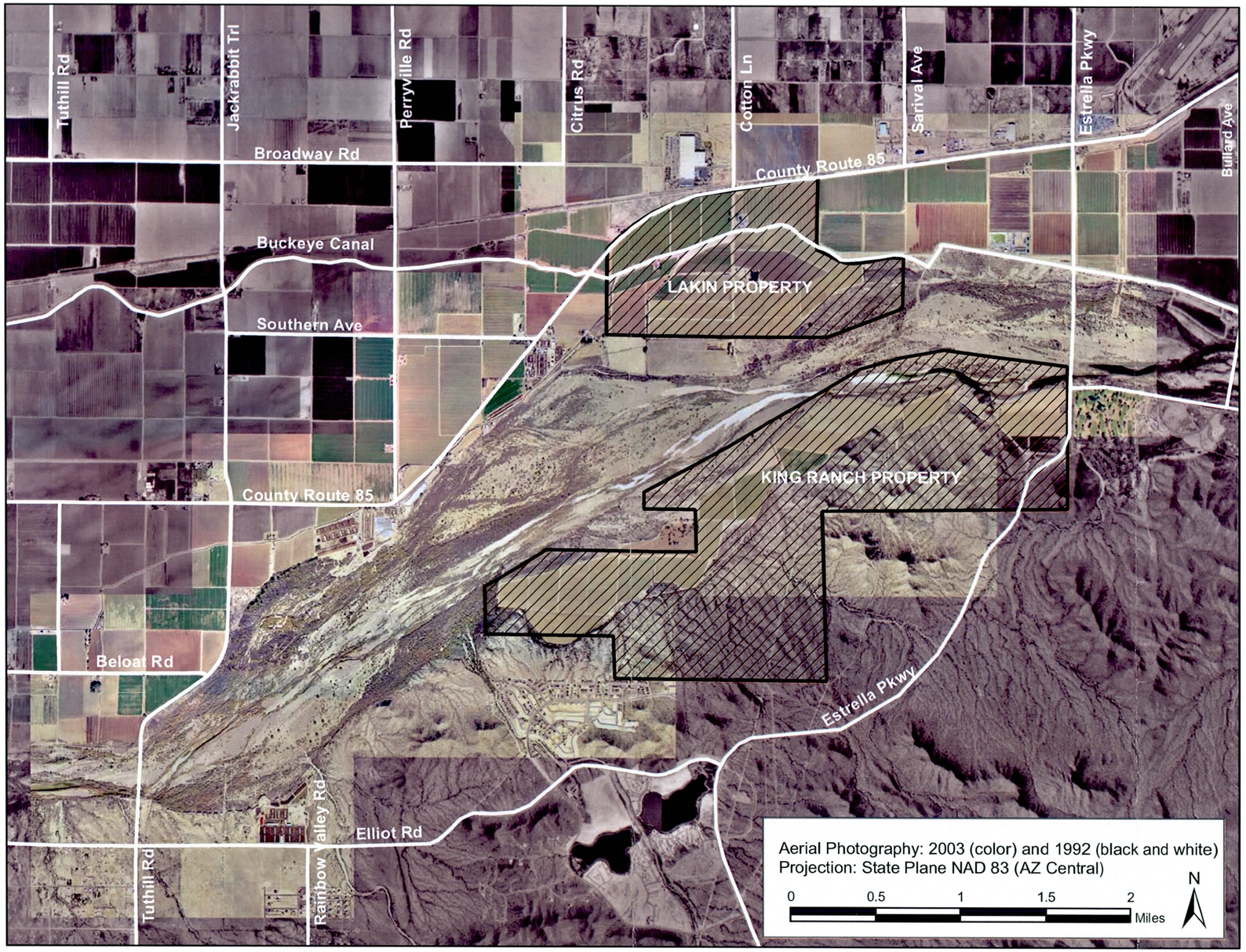


Figure 2. Area Map Showing Project Location and Surrounding Features

2 Field Reconnaissance and Data Collection

2.1 Field Reconnaissance

Members of the design team visited the project site and viewed the approximate alignment of the proposed bank protection. It was noted that the bank is, for the most part, on the inside of a bend but that the river is currently flowing immediately adjacent to the bank along the eastern portion of the property. The main channel then moves a short distance from the high terrace but stays on the south side of the broad channel area until it leaves the western end of the property. The high terraces consisted of material that has been deposited by the river during larger flood events and is mostly farmed at present. The river in this reach has a well defined low flow channel that primarily is composed of a gravel or cobble bed. APPENDIX A contains the photographs of the project area taken during the site visits.

The project team also met with representatives of Stantec, Inc. (Stantec) regarding the ongoing El Rio Watercourse Master Plan on the Gila River from the Bullard Avenue Bridge to State Road 85. This coordination effort was required to insure that plans for the King Ranch reach of the river fit with the recommendations for the overall El Rio Watercourse Master Plan being developed by the Flood Control District of Maricopa County. Close coordination has been maintained between the design team and Stantec. Hydraulic and sediment models have been closely coordinated between this design and the El Rio Watercourse Master Plan.

2.2 Data Collection

Data have been collected from a number of sources but the obtaining and blending of existing and new topographic data has presented several challenges throughout the project.

2.2.1 Topography Sources

Topography for the overbank areas with a one-foot contour interval was provided by Coe & Van Loo Consultants, Inc. (CVL). Initially this topography covered only the south portion of the river and floodplain. These data were spliced into existing four-foot contour interval data that was used for the original FIS study and used for the preliminary modeling. Further discussion of the topography and splicing process is given later in this report. Subsequent to early studies additional new topography (including both 1 ft and 2 ft contour data) was obtained for the remainder of the river and for Lakin property in the north overbank. This confirmed observations made based on the partial river topography obtained earlier that the channel had eroded subsequent to the 1993 topography. This will also be discussed in more detail later in the report.

Four sources of topographic information were used for the RMA2, HEC-RAS, and HEC-6T models:

- **Flood Insurance Study** (as ArcView GIS coverages obtained from FCD): This consists of topography flown on February 6, 1993 (main channel and part of the adjacent overbanks), and topography flown on November 14, 1991 (the remainder of the mapping). This topography covers the entire study area. The contour interval is four feet. Spot elevations are also part of this data set.
- **Topography flown in 2003** (as ArcView GIS coverages obtained from Coe and Van Loo): This topography covers the main channel and the left descending overbank for about a 4 mile river reach, as well as covering King Ranch itself. The contour interval is one foot.
- **A field survey conducted on February 6, 2004** (a set of points, each with latitude and longitude, and elevation): This survey consists of spot elevations in the main channel at 4 cross-sections downstream of the 2003 aerial-topography, as well as spot elevations at a few other locations.
- **Additional aerial photography flown in 2004** This survey covers the northern half of the river as well as the active river channel west of King Ranch to near the Jackrabbit Road alignment. The majority of this topography has a 2 foot contour

interval. Areas covered by the 1 ft and 2 ft contour data flown in 2003 and 2004 are shown in Figure 3.

Figure 3 shows the locations of recent topographic and elevation data. All the available topographic data were combined to provide a single coverage of topographic information. The details of the methodology adopted to arrive at a combined topographic coverage are presented in Section 3.

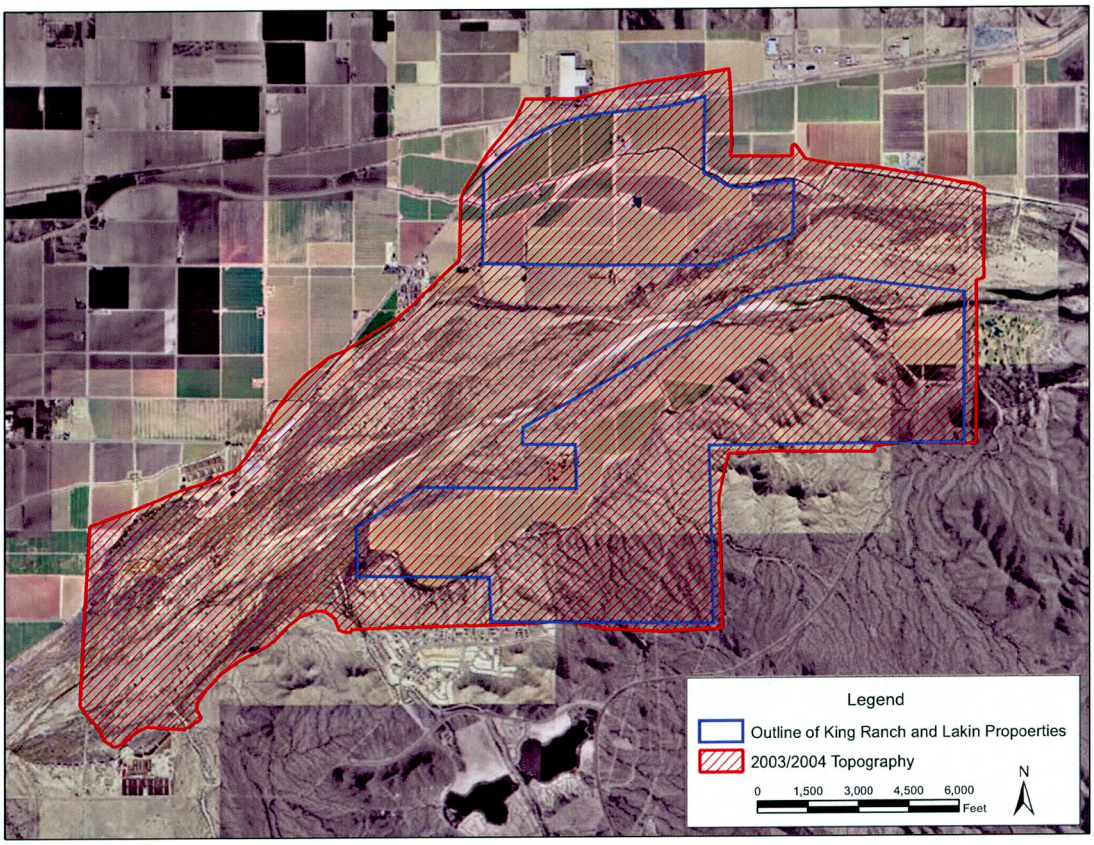


Figure 3. Updated Topography for King Ranch flown in 2003 and 2004

2.2.2 Sediment Data

The sediment gradation data was obtained from the geotechnical evaluation performed by Western Technologies Inc (Western Technologies, Inc., 2003), data obtained by Stantec

as a part of the El Rio Watercourse Master Plan and supplemented by data obtained by WEST.

2.2.3 Hydrology Data

The peak discharges for the 5, 10, 20, 50, 100 and 500 year flood events were obtained from the report by US Army Corps of Engineers on the Gila River Basin (US Army Corps of Engineers, 1996). The values of the peak discharges are presented later in Table 2. These peak discharges were used in the steady-state hydraulic models.

To evaluate the long term effects of sediment transport, a 105 year record of flood hydrographs was used. These records were obtained from a recent study (WEST 2004) for the Tres Rios study area which is the reach of the Gila River immediately upstream from the area being studied here. The reach considered in Tres Rios study involved the Gila River upstream of the Bullard Avenue Bridge to the Salt and Gila River confluence. That study also included portions of the Salt and Gila Rivers upstream of the Salt-Gila confluence. The long-term hydrographs for this study were obtained by combining the hydrographs for Salt and Gila rivers used in the Tres Rios Preliminary Engineering Design (PED) study. This hydrology was developed by the U.S. Army Corps of Engineers for the Tres Rios Study.

3 Analysis of Topography and Preparation for Use

When the new topography was compared with that obtained from 1993 it was apparent that there were significant differences between the two sets of data. The principle difference between the topography from the Flood Insurance Study and the recent aerial and field surveys is that the main channel, which is about 800 to 1000 feet wide, is about 6 to 8 feet higher in the Flood Insurance Study. This was determined to be primarily due to water that was in the channel on the date the Flood Insurance Study topography was flown on February 6, 1993.

The horizontal datum of the Flood Insurance Study topography is Arizona State Plane Central, NAD83, International Feet. The vertical datum of the study appears to be NGVD 1929. This observation is based on a comparison of the 1 ft contours with the contours from the FEMA study where the aerial (1-ft) contours are within 1 foot of NGVD 1929. The topography flown in 2003 is slightly shifted from Arizona Central State Plane Coordinate system, NAD 83, and has a vertical datum of NGVD 1929.

3.1 Rectification of Contours and Mapping

The 2003 contours were not originally rectified to Arizona State Plane Central, the coordinate system of the FIS maps. The 2003 contours were shifted to the state plane coordinate system by visually aligning features, principally hilltops, with the FIS topography. The net shift for the 2003 contours was south by 104.65 feet and west by 65.37 feet, resulting in a straight line shift of 123.39 feet. This shift brought the various hilltops and other features (about a dozen in all) to within 10-12 feet of each corresponding feature in the FIS topography. Subsequently conversions were calculated by MCDOT for translation from the Arizona State Plane Coordinate System, NAD 83 to the coordinate system provided by CVL. This conversion was done as a part of the MCDOT Cotton Lane Bridge Project. These data are presented in Table 1.

Table 1 . Coordinate Transformation for CVL to State Plane Coordinate System.

Project Name: **Cotton Lane Project**
MCDOT Project #: **40069083 (TT180)**

From	NAD 83 State Plane Coordinates (AZ Central Zone, International Feet)
To	The Cotton Lane Project Coordinate System
Step 1:	Scale using 1.000116259 about 0.00 N, 0.00 E
Step 2:	Translate Northing by +4.876 ift
Step 3:	Translate Easting by +3.048 ift
Step 4:	Rotate (-)0^00'00.184476" about 315297.818 N, 543277.093 E

From	The Cotton Lane Project Coordinate System
To	NAD 83 State Plane Coordinates (AZ Central Zone, International Feet)
Step 1:	Rotate (+)0^00'00.184476" about 315297.818 N, 543277.093 E
Step 2:	Translate Northing by -4.876 ift
Step 3:	Translate Easting by -3.048 ift
Step 4:	Scale using 0.999883778 about 0.00 N, 0.00 E

3.2 Topography for the Hydraulic Models

The hydraulic models require elevation and location data for both the one-dimensional and two-dimensional models. The RMA2 model requires a topographic model in the form of a TIN (triangulated irregular network). The TIN was developed by combining elevation information from:

- The 2003 topography.
- The 2004 topography for the north channel and Lakin property
- The FIS topography and spot elevations, which were used for all regions without new topography

The cross-sections for the HEC-RAS and HEC6-T models were cut from the TIN developed for both the HEC-RAS and RMA-2 models using HEC-GeoRAS.

The most upstream cross-section that uses the topography flown in 2003 and 2004 is 194.21 which is immediately upstream of the Estrella Parkway Bridge. The most downstream section where the 2004 topography covers the entire active channel is cross-

section 188.81. The next cross-section downstream would have included only a portion of the new topography and was therefore taken from the Baker FIS model. The remaining cross-sections used in the model upstream from 194.21 and downstream from 188.81 were also taken directly from the Michael Baker FIS Study.

3.3 Overview of Existing Topography near King Ranch

3.3.1 Flood Insurance Study Topography

The Flood Insurance Study (FIS) for the Gila River was prepared by Michael Baker Corporation in 1999. According to the Technical Documentation Notebook from the study (Salt/Gila Flood Delineation Study, May 1999), the topography for the Gila River near King Ranch is based on a 1991 survey and a 1993 re-survey which re-mapped the main portion of the channel after the January 1993 floods. The contour interval for the FIS topography is 4 feet.

Electronic files from the Michael Baker FIS indicate that the aerial re-survey over the main channel near King Ranch was flown on February 6, 1993. The United States Geological Survey (USGS) data show a discharge of 13,200 cfs for that day at the Estrella Parkway gage. A stage and flow measurement, taken the next day, by the USGS recorded a flow of 13,300 cfs and indicates a water depth of just over 7 feet at the gage. Therefore, it is concluded that the contours in the main channel show the water surface instead of the ground which accounts for most, if not all, of the 6' to 8' difference in surveyed elevation data.

3.3.2 1990 Topography

Topography from the White Tanks-Agua Fria ADMS (another FCD study that covered the area) was also obtained in GIS format. In the area near King Ranch, the contours were flown on February 10 and February 15, 1990. The contour interval is 4 feet, and the topography also covers the entire study area.

3.3.3 2003 Topography

In conjunction with the proposed development of King Ranch, an aerial survey was commissioned by Sontera Partners in 2003 with additional mapping obtained in 2004. The extents of the aerial survey, as well as the floodway and floodplain limits from the 1999 Michael Baker study are shown in Figure 4. The 2003 topography covers primarily the King Ranch property and extends to just north of the main channel of the river, which is about 800-1000 feet wide. The 2004 topography covers the balance of the channel and much of the north floodplain as shown in Figure 4.

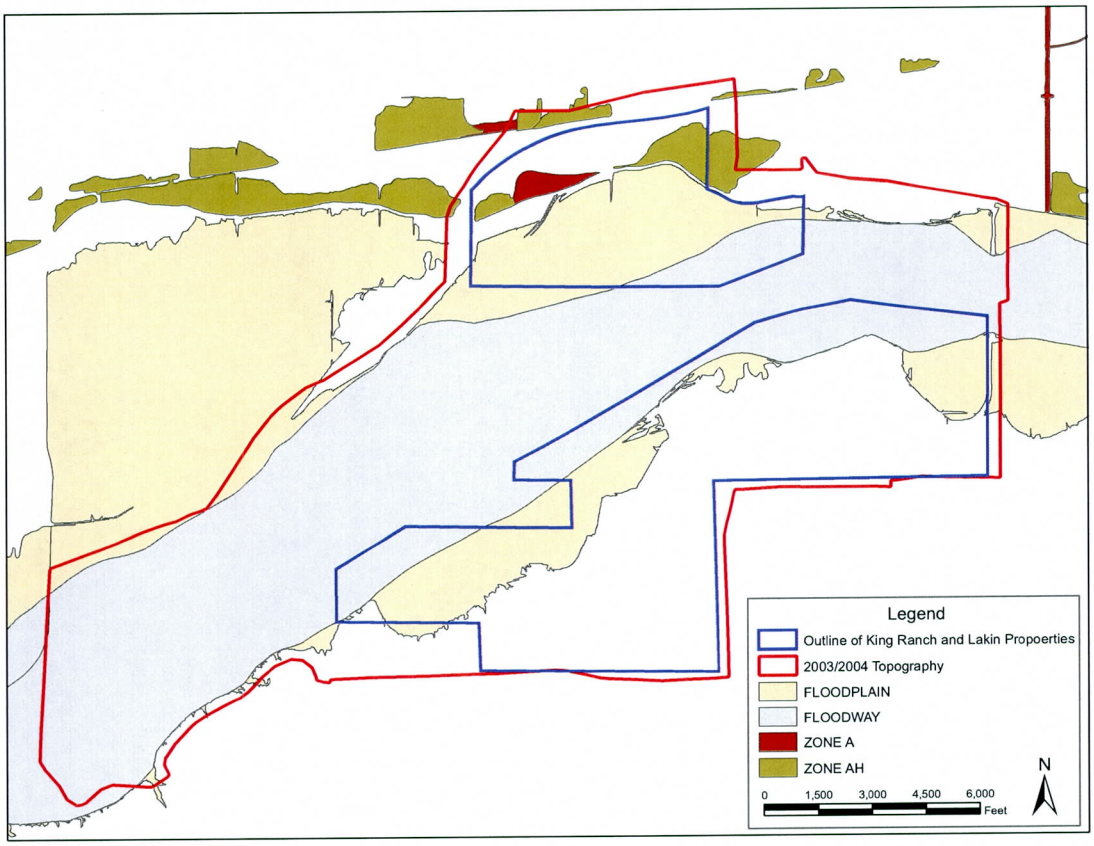


Figure 4. The Floodplain, Floodway, and Limits of the 2003-2004 new Topography.

3.3.4 2004 Topography

The topography obtained in 2004 was designed to supplement that obtained in 2003 and allow modeling of the full width of the Gila River with new topography. This was due in part to the changes noted between the 1993 and 2003 topography where they overlaid. Based on the review of data available prior to the 2004 mapping, it became apparent that the topography needed to cover the entire river to allow accurate modeling. This is discussed in more detail below.

3.3.5 February 1990 versus 2003 Topography

The most notable difference between these two topographies is the scour that has occurred western portion of the main channel. For the western two miles of the Gila River north of King Ranch, there has been about 10 feet of scour with significantly more in some places. For the reach upstream of this, adjacent to the eastern portion of King Ranch, the main channel has also scoured, but less than the reach to the west.

3.3.6 1993 (FIS) Topography versus 2003 topography

It appears that the 1993 topography is not as accurate for the low flow channel in this river reach due to approximately 13,000 cfs flowing in the river on the day the topography was flown—leading to contours in the main channel that show the water surface elevation and not the ground elevation. The eastern portion of the main channel, typically about 800 to 1,000 feet wide, is about 6 to 8 feet higher in the FIS topography than the 2003 topography.

A hydraulic simulation of the 13,200 cfs discharge was run in a preliminary HEC-RAS hydraulic model developed using the 2003 topography. The water surface elevations from this model (flowing about 6-10 feet deep) were typically within two feet of the 1993 contours of the channel bottom. Thus it appears that most of the difference in channel elevation between the 2003 and FIS topography is due to water in the channel or erosion that took place after the 1993 topography was obtained. Considering that scour took

place between 1993 and 2003, it is also likely that some of the channel elevation difference is due to scour between February 6, 1993 and the date of the new topography in 2003.

Figure 5 shows a sample cross-section based on each of the topographies. The cross-section shown by the pink colored line is based on the 2003 topography while the cross-section shown by the black line is based on the FIS topography.

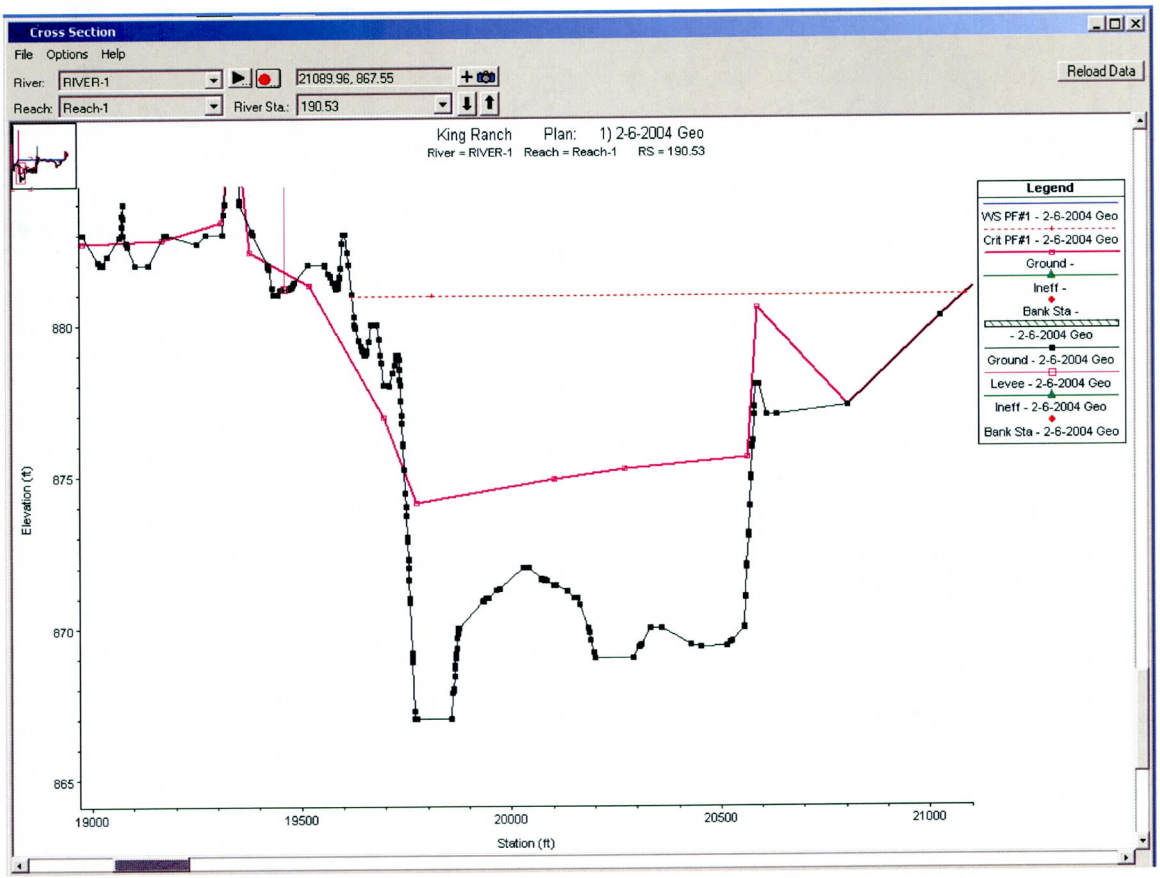


Figure 5. Typical Cross-section Detail for Main Channel. 2003 Topography shown in Black, FIS Topography shown in Magenta (with fewer points).

Figure 6 shows hydrographs of the two significant events that occurred on the Gila River in this time period. The dark vertical line indicates 2/6/1993, the date the FIS topography

was flown in the main channel. Given that sediment transport tends to increase exponentially with discharge, the majority of sediment transport in the period between 1990 and the date of the 1993 topography likely occurred before 2/6/1993. It should be noted that the flood peak from the Upper Gila River of approximately 75,000 cfs occurred subsequent to the 1993 topography of the channel section. From the topography obtained in 2004 it is apparent that this event caused significant additional scour near the west end of the project reach with elevation differences of up to 16' being noted between the two topographies. A significant portion of this scour was apparently caused by flows subsequent to the January 1993 flood event. The changes, however, appear to be primarily limited to the main low flow channels with little change noted in the overbanks.

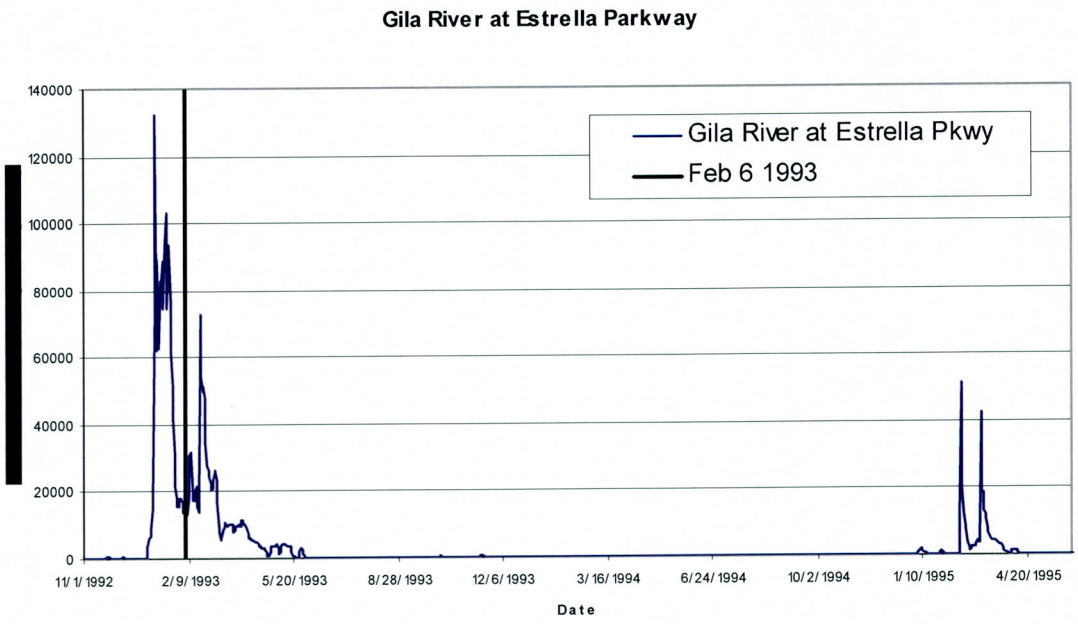


Figure 6. Daily average flows, Gila River at Estrella Parkway. Cause of Possible Changes in the Right Overbank

Comparisons were made for limited areas of the right overbank using topography in the FIS study from February 6, 1993 being combined with topography from December 14, 1991 for the analysis. Comparison of the part of the right overbank that appears in the February 6, 1993 topography to the February 1990 topography shows some areas with

aggradation, others with scour, but little net change overall. Comparison of the 12/14/1991 topography in the right overbank also shows some areas with deposition, some smaller areas with scour, and the majority of the area with little net change. This analysis was not extended to the 2004 data since it was not necessary once the full topography for the river was obtained. These data have all been provided to the Flood Control District of Maricopa County to facilitate any future analysis.

4 Qualitative Geomorphic Analysis

The primary goal of the geomorphic analysis is to identify historical behavior of the Gila River adjacent to King Ranch Property through collection and review of historical aerial photographs and the application of geomorphic relationships. The principle objective is to evaluate lateral channel migration and historical banklines as well as low flow channel locations and sediment aggradation/degradation potential. The geomorphic aspects of the site were reviewed using historical photos and current site constraints.

4.1 Historical Migrations

WEST obtained historical aerial photographs of the project reach for the years 1937, 1958, 1977 and 1992. The photographs were used in ArcView GIS environment to delineate the historical bank locations and study lateral migration of the study reach. The historical aerial photographs with the banklines are presented in APPENDIX B. The historical movements of the banklines indicate that the channel has encountered resistance to movement in the southern bank. Along the northern bank (not adjacent to King Ranch Property), the channel appears stable except in the reach between Citrus Road and Sarival Road. In this region, significant southern movements have occurred in the past but little movement has occurred since 1972. The reach shows sufficient movement that bank protection should be used on all banks where development occurs.

5 Hydraulic Analysis

5.1 HEC-RAS Model development

A HEC-RAS model was developed for the river between Bullard Road and approximately two miles downstream of the Tuthill Bridge. This section includes a brief discussion on the development of the HEC-RAS model and assumptions used in developing the model including peak discharges, n values and other variables. Existing and proposed condition HEC-RAS model results are presented in APPENDIX C and APPENDIX D, respectively.

5.1.1 Peak Discharges

The peak discharges used in the hydraulic analysis of all the conditions modeled were developed by the U.S. Army Corps of Engineers (1996) and are listed in Table 2.

Table 2. Peak Discharge Values Used in Hydraulic Models

River ID	River Station (miles)	Discharge (cfs)				
		5-Year	10-Year	20-Year	50-Year	100-Year
Gila River	195.75	23,500	57,000	92,000	185,000	227,000

5.1.2 Effective Model

The current effective FIS model, which was obtained from the FCDMC, was developed in HEC-2 and required slight updates to run in HEC-RAS. Only minor modifications at bridges were required to adapt the model to the HEC-RAS model. Results compared extremely favorably with those from the current FEMA work maps (also provided by FCDMC). Differences between the two data sets were insignificant. The model was then updated with the new topography obtained in this study and run with all other values the same. This resulted in a major change in water surface elevations for the 100 year flood

event with some areas experiencing greater than a 4 ft reduction in flood elevations due to the changes in the topography in the reach. This model was then updated to include new Manning's n values and ineffective flow areas to match the current conditions along the river. These changes are discussed below.

5.1.3 Development of Updated Mannings n Values

The Mannings n values determine the resistance to the flow in the hydraulic models. The Mannings n values for the initial HEC-RAS model were chosen based on the information provided in the HEC-RAS model used in the Michael Baker FIS study. The validity of these values were checked to a limited extent but the Baker values were used for preliminary modeling since they were not too dissimilar to values used for the upstream Tres Rios study which was completed in 2004 (WEST 2004).

Manning's n values for the final models were developed based field visits and recent (2004) aerial photos provided by Maricopa County. The photographs taken during the field visits are presented in APPENDIX A.

The Manning's n-values used in the HEC-RAS model for the proposed King Ranch / Cotton Lane Bridge & Channel project have been determined by applying two methodologies found in the following reports:

"Roughness Coefficients for Channels in Arizona" (Aldridge and Garrett, 1973)

"Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona" (Thomsen and Hjalmarson, 1991)

"Verification of Roughness Coefficients for Selected Natural and Constructed Stream Channels in Arizona" (Phillips and Ingersoll, 1998)

5.1.3.1 Method 1: BASE "n" VALUES AND ADJUSTMENT FACTORS

The first methodology, which is addressed in the first two reports, is modified from the Chow (1959) approach of establishing a base n-value, which is a function of the stream bed material type and then applying adjustment factors that characterizes the stream irregularity, cross-sectional variations, obstructions, amount of vegetation, and degree of meandering. The consistency throughout all three of these reports indicates that the subsequent two reports (Thomsen and Hjalmarson) and (Phillips and Ingersoll) have been developed based on the Aldridge and Garrett report. The added benefit from the subsequent two reports comes in the form of additional field studies, which have provided more sample n-values from a greater and more diverse set of streams throughout Arizona. The method in the third report, however; is to determine the n-value by analyzing the flow in a channel during a flow event and then calculating a resulting n-value. Although this report was considered to be a second phase follow-up to Thomsen and Hjalmarson (1991), data were not available for this methodology in this reach of the Gila River.

The first methodology consists of the following equation used to determine a Manning's n-value:

$n = (n_b + n_1 + n_2 + n_3)m,$

where,

n_b = base value of n for a straight uniform channel defined by the stream bed material.

n_1 = adjustment factor for surface irregularity

n_2 = adjustment factor for obstructions

n_3 = adjustment factor for vegetation

m = adjustment factor for meandering

Table 2 in "Roughness Coefficients for Channels in Arizona" (Aldridge and Garrett, 1973) provides n-value adjustment factors with their corresponding example descriptions for surface irregularity, obstructions, vegetation, and meandering. Table 1 of the Aldridge and Garrett report provides a list of channel materials and their corresponding n_b values defined by Chow (1959) and defined by Benson and Dalrymple (1967). The difference between Chow and Benson and Dalrymple is that the Chow n_b values characterize the smoothest reach attainable for a given bed material while the Benson and Dalrymple n_b values characterize conditions that are closer to average. Therefore, the Benson and Dalrymple n_b values are assumed to be more representative of natural conditions, and used for this analysis with the adjustment factors from Table 2 of the Aldridge and Garrett report.

The reach of the Gila River that is adjacent to the proposed King Ranch project primarily consists of material ranging from sands to fine gravels. There are, however, randomly distributed areas of bed load that include material up to cobble size material. The selected base n-value for this reach of the Gila River is $n_b = 0.028$, which is the same base n_b value selected by Thomsen and Hjalmarson during their study of the Gila River 1,000 feet upstream from the Bullard Avenue Bridge. This value also agrees well with the value obtained using the Limerinos Equation for the bare bed (USACE 1991). Based on a D_{84} of 30 mm the Limerinos Equation gives a Manning's n value of 0.026.

The vegetation component is then added to the base n_b value to determine the overall n-values for low density, medium density, and high density. Surface irregularities, meandering, and obstructions are considered to be negligible in this reach. Values presented in Thomsen and Hjalmarson (1991) for only the vegetation portion of the equation are presented in Table 3.

Table 3. Description of Vegetation Densities and Associated n Value Adjustment Factors from Thomsen and Hjalmarson, 1991.

Vegetation	Manning's n Value Adjustment	Example
Small	0.002 to 0.010	Dense growth of flexible turf grass, such as Bermuda, or weeds where the average depth of flow is at least 2x the height of the vegetation; supple tree seedlings such as willow, cottonwood, arrow weed, or salt cedar where the average depth of flow is at least 3x the height of the vegetation.
Medium	0.010-0.025	Grass or weeds where the average depth of flow is from one to two times the height of the vegetation; moderately dense stemmy grass, weeds or tree seedlings where the average depth of flow is from 1x to 2x the height of the vegetation; moderately dense brush, similar to 1 to 2 year sold saltcedar in the dormant season, along the banks and no significant vegetation along the channel bottoms where the hydraulic radius exceeds 2 feet
Large	0.025-0.050	Turf grass or weeds where the average depth to flow is about equal to the height of vegetation; small trees intergrown with some weeds and brush where the hydraulic radius exceeds 2 feet.
Very Large	0.050-0.100	Turf grass or weeds where the average depth of flow is less than half the height of vegetation; small bushy trees intergrown with weeds along the side slopes o[r] dense cattails growing along channel bottom; trees intergrown with weeds and brush.

5.1.3.2 METHOD 2 – "n" Values Based on Predominant Vegetation

The second methodology for determining a stream n-value is vegetation dependent, and is addressed in "Roughness Coefficients for Channels in Arizona" (Aldridge and Garrett, 1973). If vegetation is the primary factor that affects the n-value, then the n-value is

determined by the vegetation rather then by the stream bed material and adjustment factors. This consideration is usually consistent in floodplains or areas of the channel that are rarely flooded.

Research conducted by the U.S. Army Corps of Engineers tends to verify the validity of this approach finding that when vegetation was significant the roughness of the bed had little influence on the total n value and could be neglected (Freeman et. al., 2000). The Corps study found that roughness was dependent on flow properties – i.e. depth and velocity – as well as plant characteristics such as stiffness, density and size. This methodology has not been applied to the current study although in earlier studies by WEST, the value for very dense salt cedar communities was estimated to be near 0.200, which is the value determined by the other researchers cited in this analysis.

Table 3 in "Roughness Coefficients for Channels in Arizona" (Aldridge and Garrett, 1973) provides composite n-values for several degrees of vegetal cover in floodplains as well as in different types of constructed channels and provides the basis for this method.

5.1.3.3 Procedure for Determining the King Ranch Project n Values

Since the proposed Cotton Lane Project requires that a floodplain be delineated, the n-values have been determined by considering both the adjustment factor methodology as well as the vegetation dependent methodology. To apply these guidelines, aerial photography was first used to delineate land use polygons in ArcGIS 9. The study area was classified into eight land use types in which each type was assigned an n-value. Similar to the Thomsen and Hjalmarson report, which uses the adjustment factor methodology, the photographs show that the dominant factors are bed surface material and vegetation with negligible adjustments for surface irregularities and obstructions. However, an argument can also be made for considering the vegetation as the primary factor.

Table 5 catalogs the photographs and describes the land use where the photographs were taken. Table 4 lists the land use type, description, and the assigned n-value.

Following the process of estimating the n-values from the aerial photography, a site visit was conducted to confirm the n-value of each land use type. During the field investigation, the above described methodologies were applied to determine if the estimated n-values were appropriate or if they required modification. Also, the field investigation allowed for an evaluation of the shape of the land use polygons delineated on the aerial photography.

Photographs were taken of the main channel and floodplain areas as a record of the field investigation. The photographs are included in APPENDIX A. The main channel and floodplain areas consisted of the very low, low, medium, medium-high and high density vegetation land use types, which was the focus of this investigation. The general layout of the ArcMap shapefiles is shown in Figure 7. A range of photographs were referenced to (Global Positioning System) GPS points as shown on the aerial photograph in Figure 8 and Figure 9 which also shows the selected n values for the main portion of the study area. Similar to the Thomsen and Hjalmarson report, which uses the adjustment factor methodology, the photographs show that the dominant factors are bed surface material and vegetation with negligible adjustments for surface irregularities and obstructions.

Table 5 catalogs the photographs and describes the land use where the photographs were taken while the location waypoints are shown in Figure 8.

Table 4. Assignment of Manning's n Values based on Land Use Type and Vegetation Density

Land Use	Description	n-value
Agricultural	Farmland	0.05
Mountain	Foothills	0.05
Residential	Low Density Industrial and Residential Development – No block walls.	0.04
Very Low Density Vegetation	Open channels with predominately bare bed material	0.03
Low Density Vegetation	Little significant vegetation in site	0.04
Medium Density Vegetation	Significant brush / trees but most of area still conveys flow during flood flows.	0.06
Medium-High Density Vegetation	70% of area or greater covered by dense woody vegetation but open paths exist through area for flows and can walk through most areas sometimes parting the vegetation. Flow depth approximately equal to or up to 2x the height of plants.	0.12
High Density Vegetation	Dense bushy willow, mesquite, and salt cedar (all vegetation in full foliage). Difficult if not impossible to walk through vegetation without either cutting or forcing vegetation out of way. Few, if any direct flow paths through area. Vegetation height is approximately equal to or greater than flow depth.	0.20

Table 5. List of Photographs and Locations with Description of Land Use and Vegetation Density

GPS Point	Photograph Numbers	Land Use Description
10	#4293 - #4296	Very low density vegetation located on the Gila River floodplain. High grass mixed in with light brush and trees. Maximum tree height is approximately 12 feet. Most of this material would either lay flat or be removed during high flows. 100 flood depths are approximately 10 ft in this area. Area could be classed as low density if more extensive.
11, 12, 14, 15, 16, 17	#4298 - #4305 #4306 - #4313	Pictures show both the density of the vegetation and the bed material along the Gila River main channel. If vegetation were more extensive this area would be classified as low density vegetation with light brush and trees. The bed material is mostly made up of coarse sand with random areas of cobble size bed load throughout the main channel. This vegetated area is relatively small and is neglected in comparison with large open areas. Maximum tree height is approximately 15 ft.
18	#4314 - #4320	Interface between farmland and very low density vegetation on the Gila River floodplain. Previously tilled farmland shows mostly tall weeds and some bare top soil
19	#4321 - #4336	Interface between very low density vegetation and low density vegetation. Low density vegetation located on the Gila River floodplain, and on the banks of the main channel. High grass mixed in with light brush and trees. Maximum tree height is approximately 12 feet. Very low density vegetation example photograph #4323 is of the Gila River main channel, and very low density vegetation example photograph #4329 is of the Gila River floodplain.
20	#4337 – 4358	Low density vegetation located near the Gila River main channel and floodplain. Bed material consists of mostly silty-clay with some random areas of cobble size bed load. Maximum tree height is approximately 15 feet. While some pockets of denser vegetation exist, overall this area is still open and does not have significant vegetation to hinder flows.

21	#4359 - #4361	Interface between very low density, low density and medium high density vegetation showing a prevalent area of cobble size bed load on the banks of the main channel. The medium high density vegetation is shown in the background beyond the bed material in photographs #4359 and #4360. Photograph # 4361 is looking up the cobble bed at an open area which has been classified low density for this study.
22, 24, 25	#4365 - #4381	Very low density vegetation located near the Gila River main channel. Bed material consists of mostly coarse sand and gravel with some random areas of cobble size bed load.
27, 28, 29	#4382 - #4391	Interface between medium density vegetation and farmland on the Gila River Flood plain showing existing rip-rap protection. Classed as medium density due to numerous flow paths through the vegetated area.
Pictures at Bullard Ave	#4392 - #4411	Photographs show same general vegetation distribution as shown in "Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona" (Thomsen and Hjalmarson, 1991)

Table 6 compares results from the methodologies used to determine n-values as well as those actually used for the proposed Cotton Lane project. Mothod 1 is n-values determined by bed material and adjustment factors, and Method 2 is n-values determined by predominant vegetation.

Table 6. Comparison of Manning's n Values Developed by Methods Used in Analysis.

Vegetation Land Use Type	Method 1 (add nb = 0.028) Base n + Adjustment Factors		Method 2 Vegetation Based Values Aldridge & Garrett, 1973		Cotton Lane
	Description	N	Description	n	n
Very Low Density	Dense growth of flexible turf grass (n = 0.002)	0.03	Cleared land with tree stumps, no sprouts (0.030-0.050)	0.03	0.03
Low Density	Occasional trees with some brush (n=0.010)	0.04	Scattered brush, heavy weeds (0.035-0.070)	0.05	0.04
Medium Density	Small trees intergrown with some weeds and brush where hydraulic radius is greater than 2 feet (n = 0.030)	0.06	Light brush and trees, in summer (0.04-0.08)	0.06	0.06
Medium High Density	Trees intergrown with weeds and brush (n = 0.100)	0.128	Heavy stand of timber, few down trees, little undergrowth, with stage reaching branches (0.08-0.16)	0.10	0.12
Very High Density			Dense willow, mesquite, and salt cedar (0.100-0.200)	0.20	0.20
Agricultural	Farmland		Cultivated areas (0.020-0.100)	0.04	0.05
Mountain					0.05
Residential					0.04

It should be noted that the 0.12 or medium-high density classification was added to this analysis since it was thought that the jump from 0.06 to 0.20 was too abrupt and an additional level was needed for vegetation that was dense but not so dense as to be nearly impenetrable by both water and man.

5.1.3.4 Future Conditions n Value Analysis

Post-Construction. Immediately after construction the channel and disturbed areas will consist primarily of unvegetated bed material with some vegetation in the main channel threads that have not been disturbed. This material should still be similar to the samples previously taken. The D_{84}, D_{50} and D_{16} are approximately 30 mm, 6 mm, and 0.4 mm, respectively (see later section on bed material analysis). Using the Limerinos Equation gives a Manning's n value of 0.026 which agrees with the 0.028 value used upstream by Aldridge and Garrett above the Bullard Avenue Bridge. This should serve as the lower limit and was used in the sediment models to predict the worst case scour depths.

Post-Construction with Vegetation. Subsequent to construction vegetation can be expected to grow in some portions of the channel. The amount and density of the vegetation will depend on the depth to water and other growing conditions in the reach of the river near the King Ranch. The existing vegetation is modeled using Manning's n values ranging from 0.03 to 0.20. It is unlikely that the entire channel will grow to a density sufficient for an n value of 0.2 0.20 although this is possible if plenty of water is available for the growth of salt cedar or other similar vegetation as is the case in the Gila River just upstream of the Gila – Salt River confluence.

Currently the most vegetated portions of the channel (near the Perryville Alignment – See Figure 1) contain a channel approximately 1300-1500' ft in total width that are relatively unvegetated (n = 0.03). The balance of the channel is much more vegetated and covers approximately 2,000 ft of the existing channel width. This would indicate that based on existing conditions the most vegetated area in this reach approximately 40% of the channel width has light vegetation while the remainder of the channel consists of medium to high density vegetation.

Given the past history of the channel it appears that during large event the river opens up a bare channel approximately 1500 ft in width to facilitate large flows. This should be expected to continue in the future. It is possible, however, that the channel could

experience significant growth. A valid assumption would be that a 1500 ft corridor could be expected to either be open or to be opened during the rising stages of the flood. The worst case scenario would be that the balance of the channel was choked with salt cedar and passing little flow. A more realistic estimate may be that 35% (or a minimum of 1500' which ever is greater) is relatively open with an n value of 0.03, 20% of the channel is vegetated such that the n value is 0.06, 20% of the channel has an n value of 0.12, and the balance is choked with salt cedar with an n value of 0.20.

The worst case would be a condition with the channel choked with salt cedar except for the 1500 ft channel that was opened during the event. These values could be used as an estimate of the worst case for hydraulics in order to view the impacts of vegetation without a maintenance plan.

The proposed conditions with vegetation model are based on the n values developed for existing conditions since approximately 12 years have passed since the 1993 flood event with no maintenance of vegetation. These values were adjusted upwards by 10%, 20% and 30% to view the sensitivity of the model to increases in Manning's n values. The conditions described in the previous paragraphs were not modeled but could be to view the impacts of a "worst case" scenario with no vegetative maintenance in support of maintenance provisions for the 404 permit. It was noted that high n values, i.e. no maintenance for long periods of time, could raise water surface elevations 4 to 5 ft in this reach of the river.

5.1.3.5 Summary of n Value Selection

Fortunately, one of the locations studied in "Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona" (Thomsen and Hjalmarson, 1991) is the Gila River, approximately 1000 feet upstream of the Bullard Avenue Bridge, and approximately 1 mile upstream from the proposed Cotton Lane project study area. The adjustment factors assessed by Thomsen and Hjalmarson at this cross-section were confirmed during the CVL field investigation and

therefore it was concluded that the n-values found in that report could be used as guideline values for the proposed King Ranch floodplain study.

After extensive review it is felt that the n-values determined for the proposed Cotton Lane project are appropriate for use in this reach of the river. The five levels of vegetation density have been the focus of the analysis since those are the land use areas that make up the majority of the Gila River along the proposed King Ranch project. Both methods facilitated an approach to determine an n-value. The n-values determined for low density and medium density by both methods result in approximately the same values. The n-value determined for high density by both methods did result in different values of which the most conservative was chosen. Photographs from the Bullard Avenue Bridge were taken to compare against the photographs found in "Estimated Manning's Roughness Coefficients for Stream Channels and Flood Plains in Maricopa County, Arizona" (Thomsen and Hjalmarson, 1991). The set of photographs provided in this report and the Thomsen and Hjalmarson (1991) report illustrate that the flow patterns and levels of vegetation are generally the same along that reach of the Gila River. The research performed in the Thomsen and Hjalmarson report provided an n-value determination based on depth of flow, while the n-value determination for the proposed King Ranch Project was for a floodplain delineation based on the 100-year storm event.

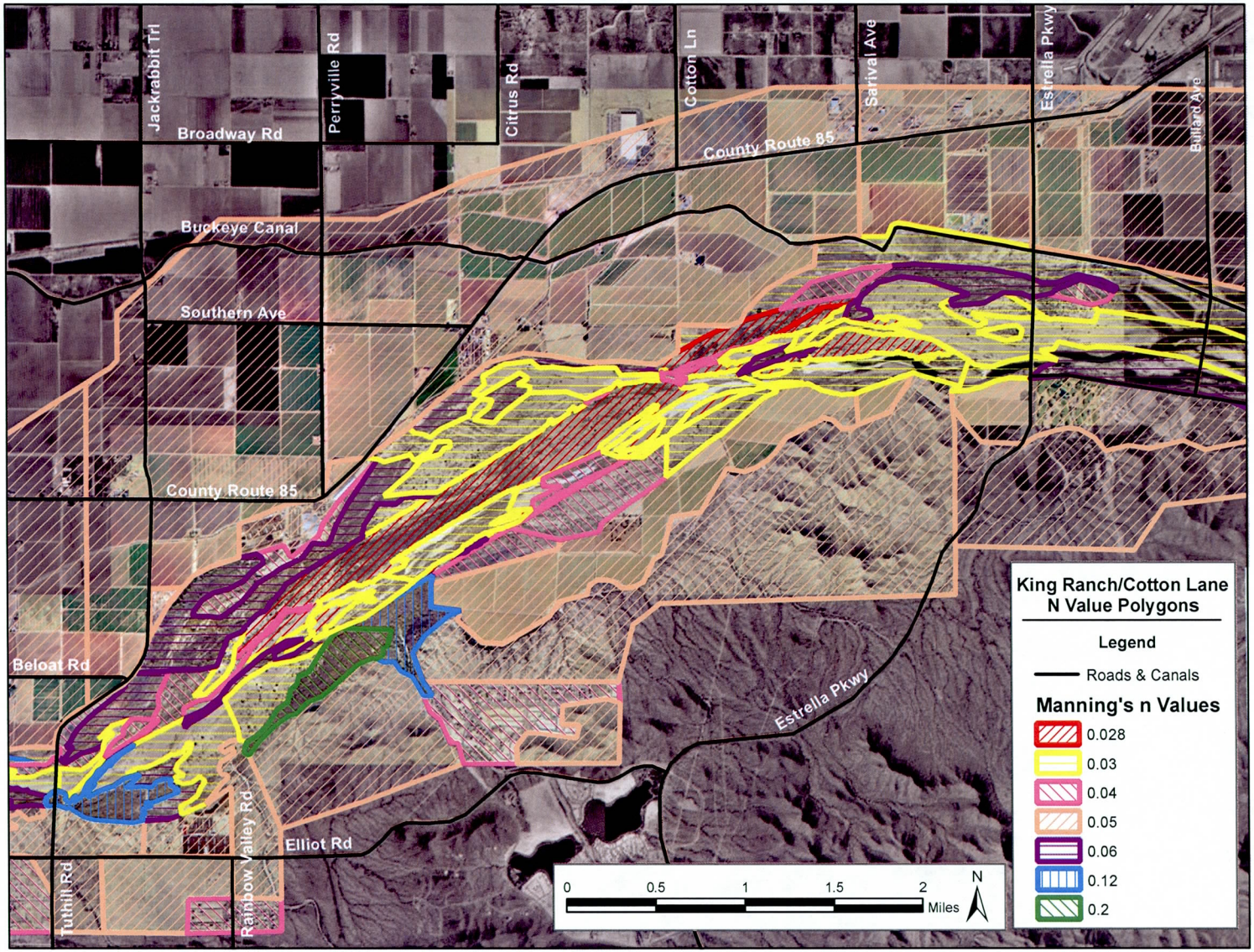


Figure 7. Overview of Selected Manning's n Values for the Cotton Lane Bridge Study Reach.

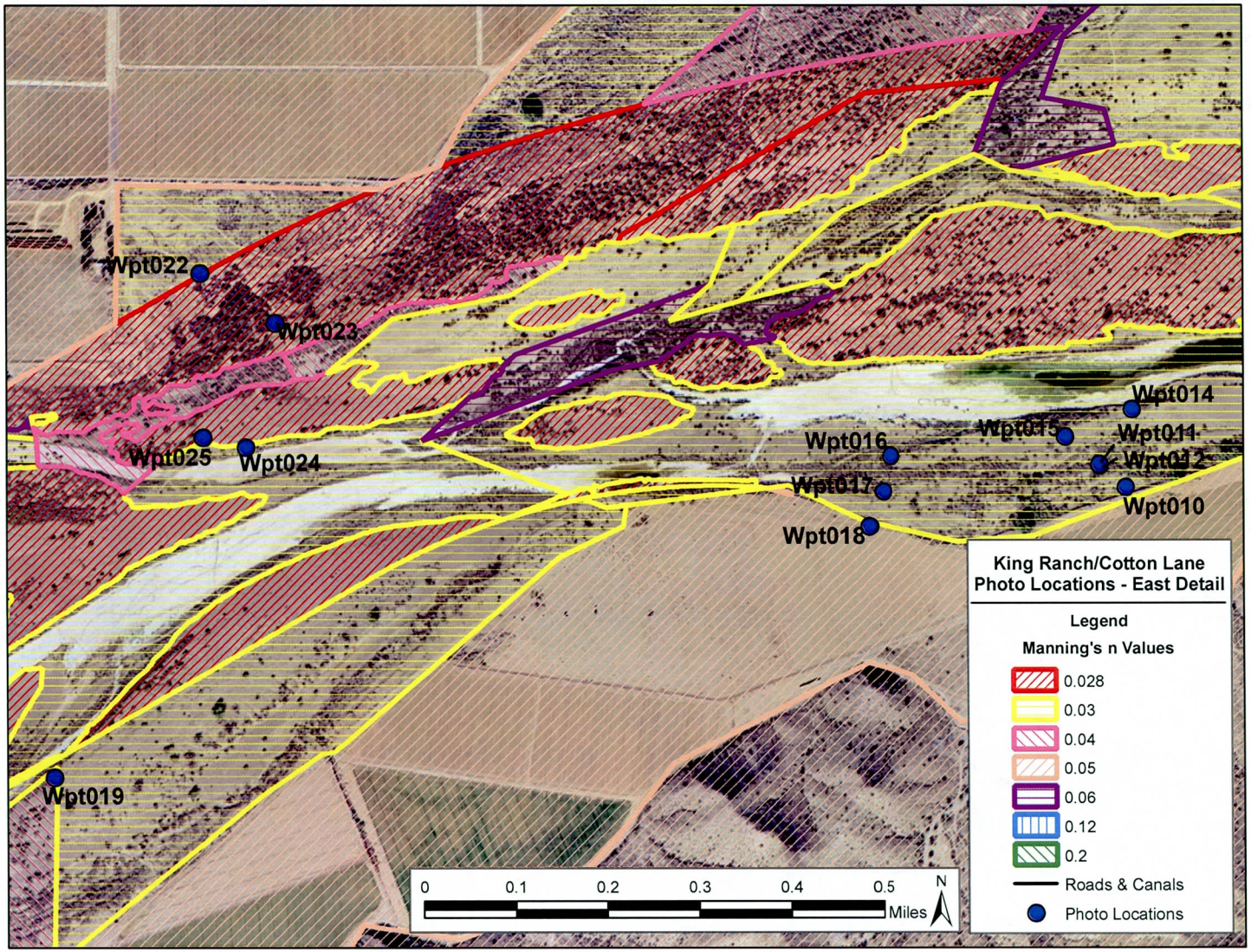


Figure 8. Cotton Lane Field Photo Locations and Associated n Values.

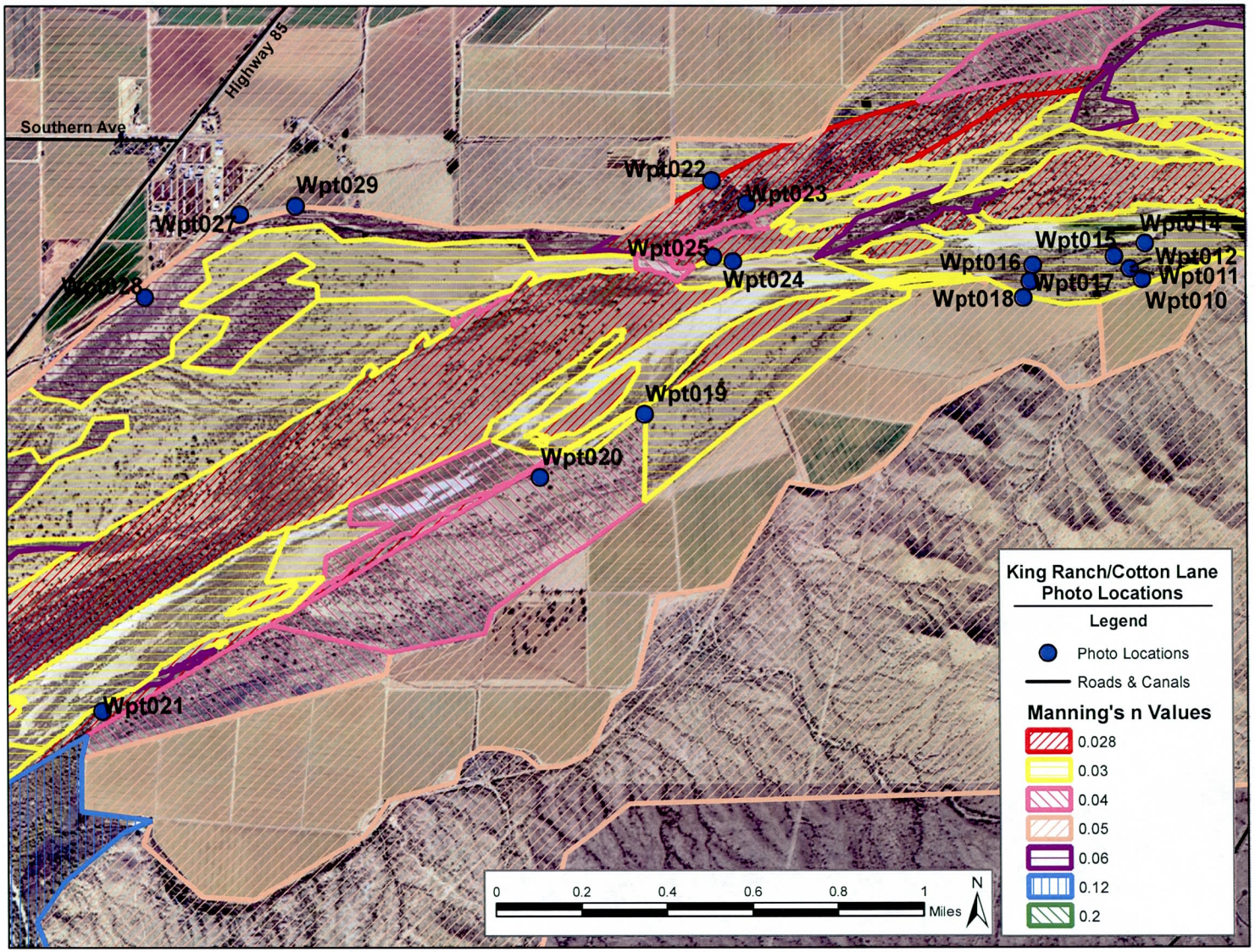


Figure 9. Cotton Lane Field Photo Locations for Central Portion of Study Area.

5.1.4 Model geometry

The HEC-RAS model was developed to adequately describe the study reach. The upstream most cross-section in the model is 195.75 while the last downstream cross-section is located at 186.87. The topography needed for the generation of the cross-section shapes were obtained using procedures described in Section 3. New geometry was incorporated for the channel and overbanks where new topography was available between cross-sections 188.69 and 194.21. The remaining cross-sections were used as obtained from the Michael Baker FIS study. Figure 10 shows the locations of the cross-section stations as used in the HEC-RAS and HEC6-T models for the proposed conditions with the Cotton Lane Bridge in place as well as the original FIS cross-sections.

During the design portion of the project it was determined that the cross-section alignment should be slightly modified to better represent the flows in the proposed channel as well as for existing conditions. The modifications were made based on the results of the two dimensional model as well as the proposed channel conditions and the new cross-sections adequately represent flow for both the existing and proposed conditions model. The hydraulic baseline was also slightly modified to stay within the new channel. This resulted in a river mile difference of approximately 0.01 miles for the realigned cross-sections and at the upstream end of the modified reach. While the cross-sections are at the same location as the original FIS cross-sections where they cross the baseline, the alignment across the channel has been modified to place the cross-sections at more of a right angle to the flow. The Baker cross-sections were aligned to account for significant flows over the right descending (north) bank and into the farm areas. With the topography changes and proposed channel modifications we did not see the overbank flow occurring to the north and thus the cross-section need to be adjusted to better represent flow in this reach of the river. The original and modified cross-sections are shown in Figure 10.

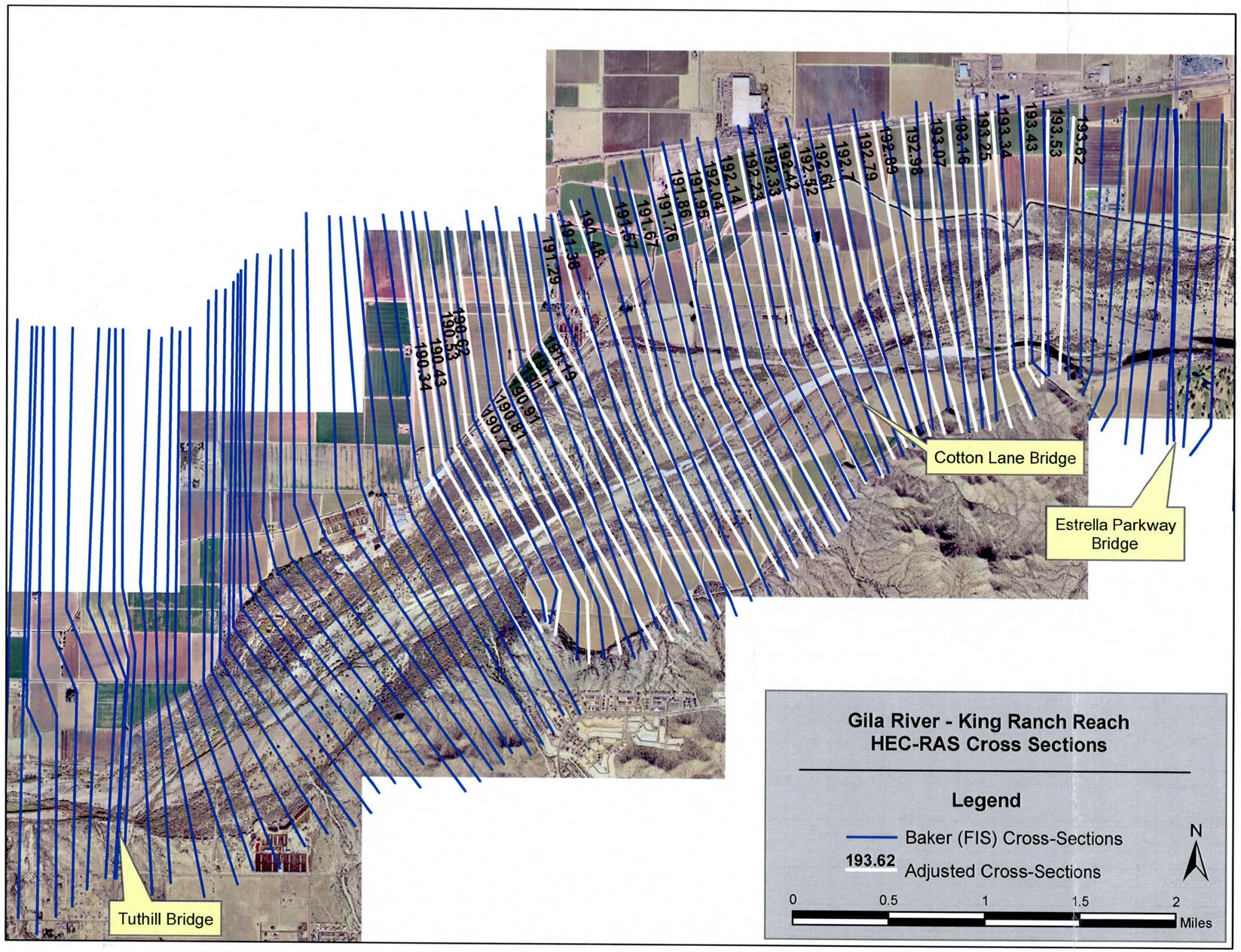


Figure 10. Cross-section cutlines used in HEC-RAS/HEC6-T models

5.1.5 Ineffective flow areas

The ineffective flow areas were prescribed based on the model used in Baker FIS study. The appropriateness of the ineffective flow areas to the model developed in this study was verified during this process and adjusted as necessary to represent any changes since the Baker modeling was performed. All cross-sections were inspected for ineffective flow areas. A maximum of 4:1 expansion was maintained in developing these areas, where necessary.

5.1.6 Contraction and Expansion coefficients

The contraction and expansion coefficients of 0.5 and 0.3 respectively were used near the bridges to accommodate the hydraulic losses that occur due to the presence of the bridges.

5.1.7 Bank Station Locations

Two sets of channel banks stations were developed. One set identified the banks of the main channel as defined for FEMA studies and one set was narrower and used to predict sediment transport. It has been found that active sediment transport does not occur over the entire width of a very wide channel such as the Gila River but in a much narrower width of the channel. The channel banks for the hydraulic and FEMA studies were placed close if not at the same locations of the Baker study except in areas where the banks or ineffective flow areas were changed due to the construction of banks and related channel features.

Channel bank stations for the sediment modeling were identified based on a regime equation proposed by Blench (1970). In general, the channel-forming discharge for a river system such as the Gila River is responsible for the bulk of sediment transport. For this study, the 10-year discharge (57,000) was used as the channel-forming discharge and channel width (distance between bank stations) was based on this value. The application of this modeling approach helps to maintain channel velocities which better ensure that sediment transport is maintained throughout the study reach.

Most regime formulations include three relations that yield values of the channel width, depth, and slope as functions of the water discharge and bed material size. Some of the more refined

equations also take into account bank cohesiveness, sediment discharge or concentration, and fluid viscosity. The regime equation used in this study is that of Blench (1970) where the channel width, *w*, is given by

$$w = \sqrt{\frac{F_b Q}{F_s}}$$

where F_b is the so-called bed factor and is defined as the product of *g* (gravitational acceleration) and the Froude number squared, $F_s = 0.10$ for friable banks, and Q is the water discharge (Vanoni, 1975). Based on average Froude number from initial HEC-RAS modeling results, the regime low-flow channel widths were calculated to be approximately 1200 ft for the Gila River.

Stantec in the El Rio Study estimates that sediment transport occurs over a width of approximately 1500 ft in this portion of the Gila River. Based on these findings the value channel banks were placed approximately 1200-1500 feet apart for the sediment modeling through this reach. In braided or very wide sections (such as west of Cotton Lane Bridge) the bank stations were widened slightly to include the main portion of the channel.

5.2 Existing Conditions Hydraulic Model

The change in the topography in this reach of the Gila River has caused a significant change in the floodplain and floodway elevations in this reach of the river. The differences between the existing FIS water surface elevations and those obtained after replacing the FIS bed elevations with those obtained during this study are shown in Figure 11. The exiting conditions HEC-RAS model data is included in APPENDIX C and the model is included on the enclosed CD.

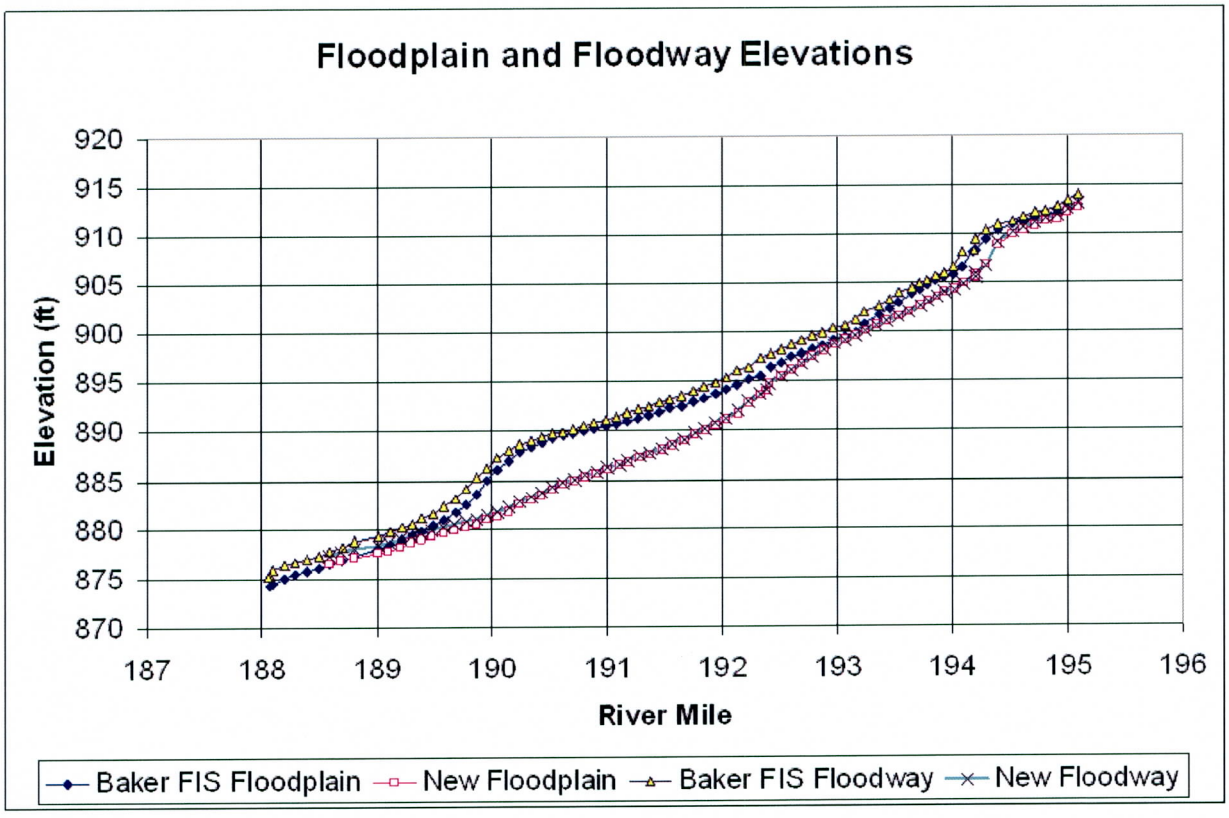


Figure 11. Floodway and Floodplain Elevations from Baker (1999) Study and Current Modeling

Figure 12 shows the water surface elevation profiles for the 5, 10, 20, 50 and 100 year events. The results show fairly uniform variation of the water surface profiles for all the flow events considered in this study. The rapid changes in the channel bottom due to the splicing of the new topography tend to influence the 5-year event the most with the 100 year event being impacted the least.

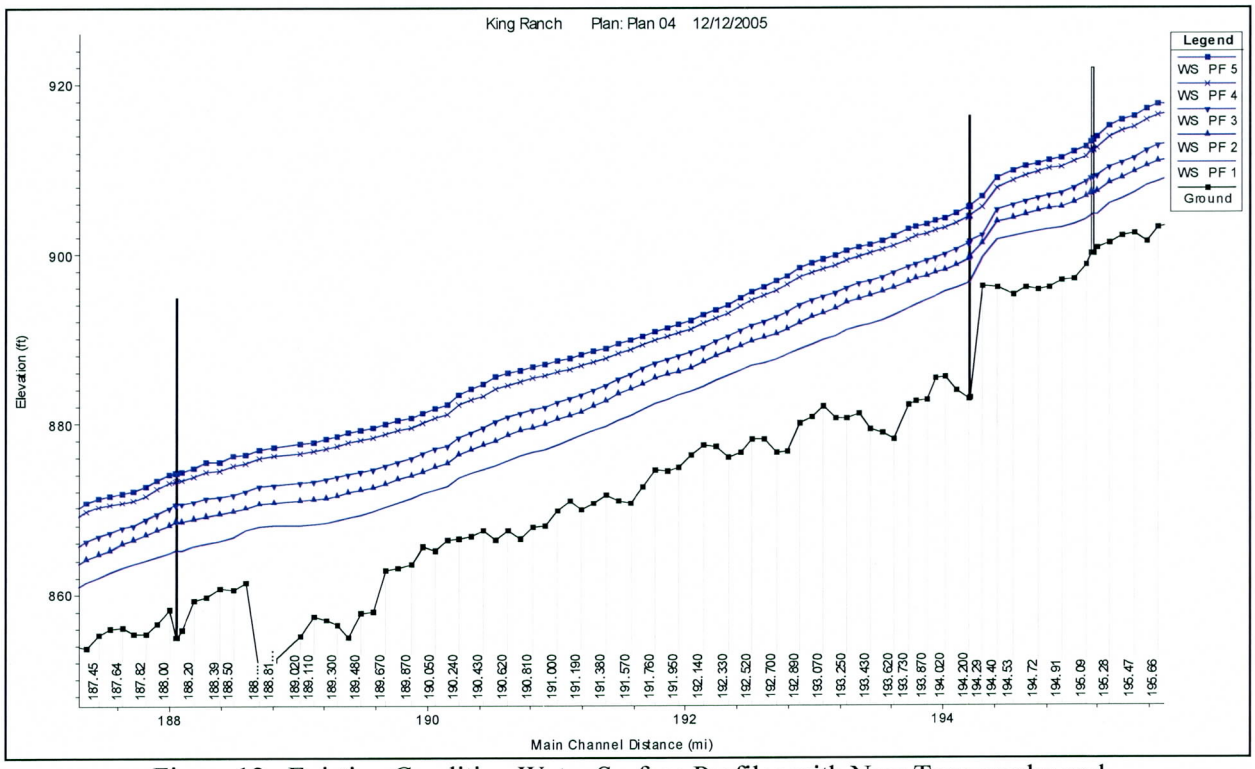


Figure 12. Existing Condition Water Surface Profiles with New Topography and Without Project.

The rapid change in thalweg elevation near the right side of Figure 12 (approximately cross-section 194.2) is located at the Estrella Parkway Bridge where new topography is blended with the older topography. This is most likely due to the transition from channel bed in the new topography to the water surface as the channel low point as described in the earlier section describing the topography. The new topography that was subsequently obtained provided new topography across the entire river upstream of the bridge and allowed the confirmation that the change is an artifact of the topography rather than a change in bed elevations for existing conditions. The same phenomenon also occurs towards the lower end of the model where bed elevations transition back into water surface elevations for the 13,000 cfs flow. The downstream transition occurs between cross-sections 188.59 and 188.69. The difference in thalweg elevations is shown in Figure 13. The maximum difference is in excess of 16 ft while the average difference is 7.8 ft.

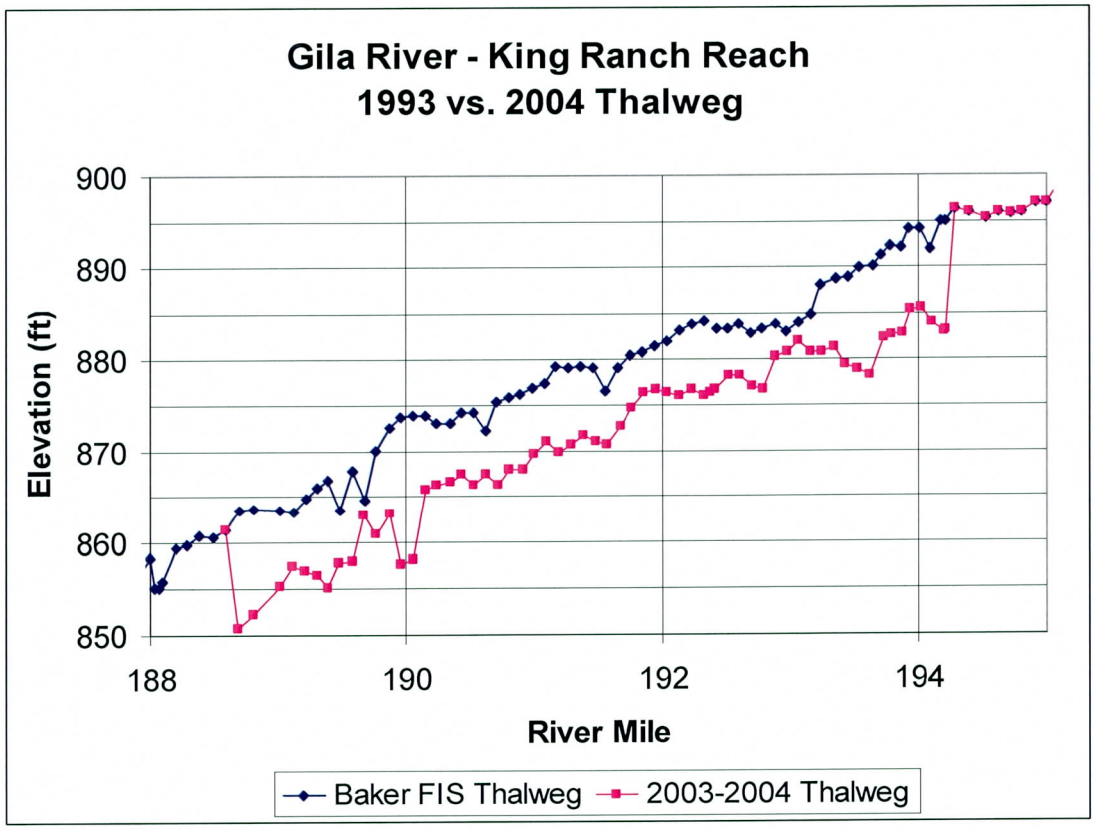


Figure 13. Difference in Thalweg Elevations between 1993 and 2003/2004 Surveys.

5.3 Proposed Conditions Hydraulic Analysis

The proposed conditions hydraulics model is based on the existing conditions hydraulics with the proposed channel and bank alignments incorporated to reflect the proposed conditions. Manning's n values were used as described above. The proposed conditions are modeled from a new TIN of the ground surface with the channel and bank elevations in place. The area behind the banks was modeled as a flat fill with a minimum elevation of 1.0 ft above the 100 year water surface elevation. On site plans will further define these elevations and the elevations will meet both FEMA and FCDMC criteria for design. Since the area will be significantly above the 100 year floodplain it was not felt that it was necessary to be extremely accurate in these areas prior to final modeling. Ineffective flow areas were developed based on the new bank lines and flow limits. No large differences are noted between the floodway and floodplain elevations due to the

incised nature of the natural channel and the encroachment of the bank protection in the reach. The results of the hydraulics simulation are presented in Figure 14. The proposed condition HEC-RAS model results are included in APPENDIX D.

It can be noted that there is a large difference between the exiting and proposed floodplain elevations in this reach. The majority of this difference is due to the change in topography subsequent to the 1993 FIS model as well as the impact of the 13,000 cfs flow in the channel at the time the topography was flow in 1993. The channel improvements in this reach further reduce the water surface elevations where the channel bars are being lowered. It should be remembered that proposed conditions are being modeled with the existing vegetation having regrown in the channel rather than the new constructed bare channel being used for modeling purposes. The layout as modeled is shown in Figure 15.

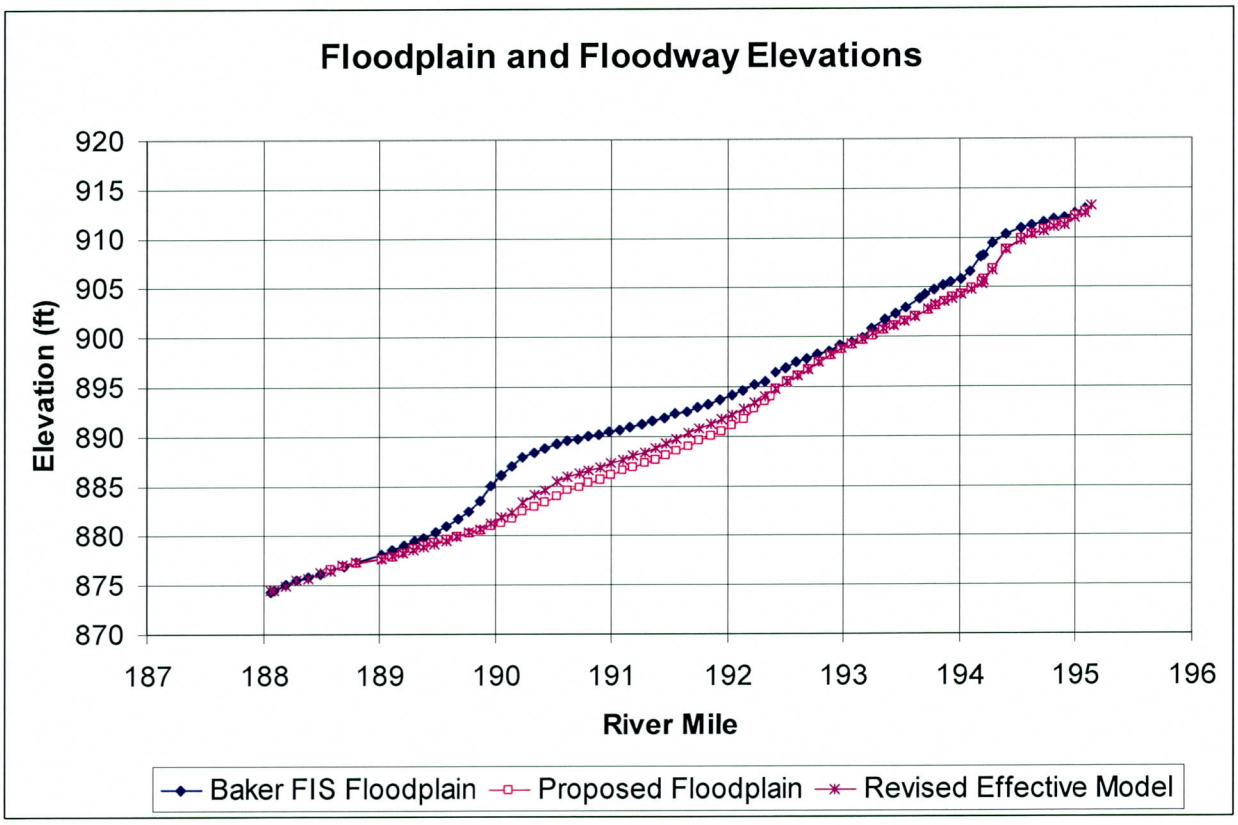


Figure 14. Comparison of Floodplain Elevations for Baker FIS, the Revised Effective and Proposed Conditions Models

The depth of cut and the location of the excavation for the proposed condition are shown in Figure 16. It can be noted from the figure that the low flow channels are not impacted by the excavation and that most of the excavation is obtained from the area west of the Cotton Lane Bridge.

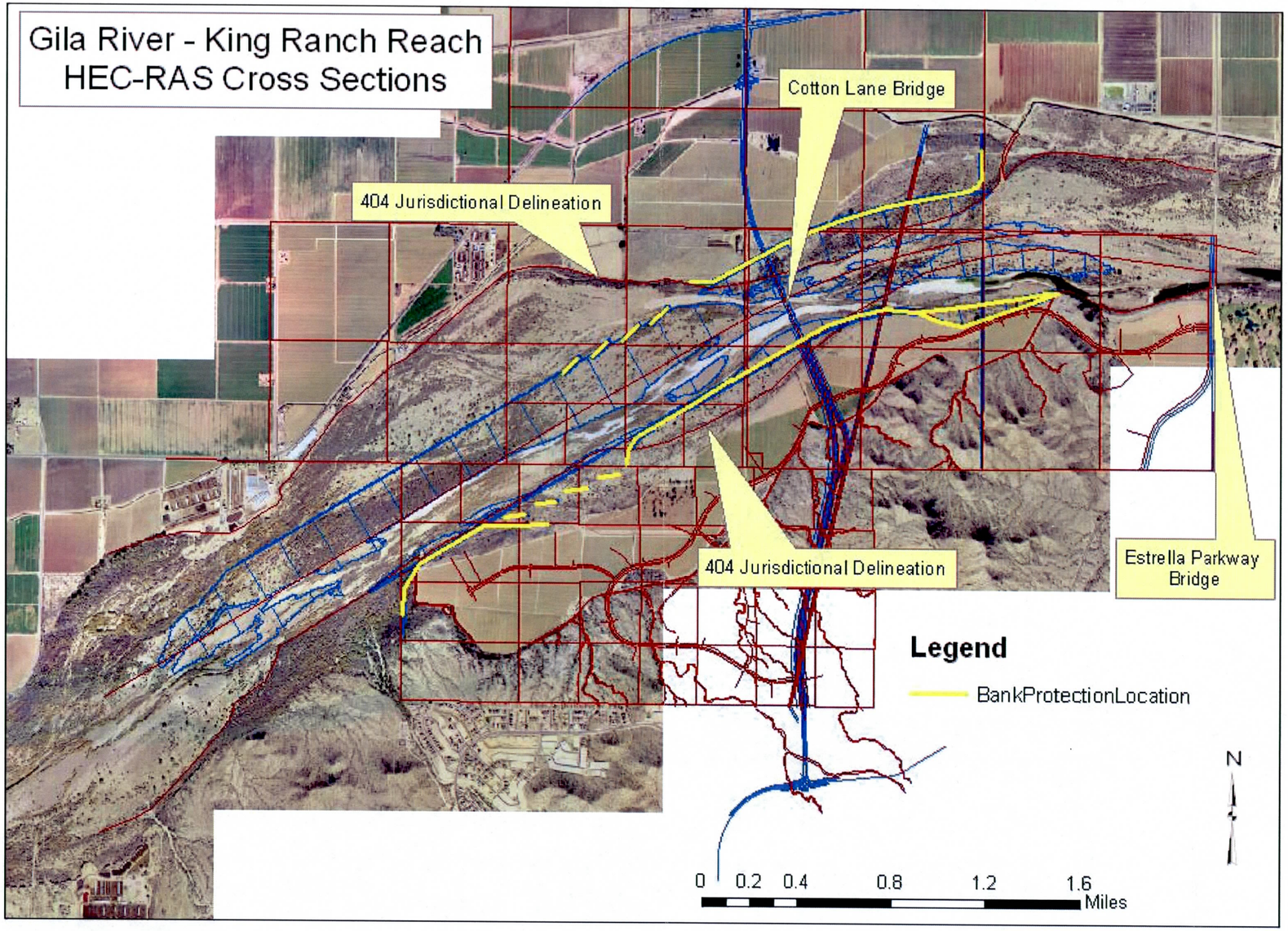


Figure 15. Aerial of King Ranch area showing Cotton Lane Alignment, property boundaries and proposed bank lines in yellow. Proposed cut areas shown in blue.

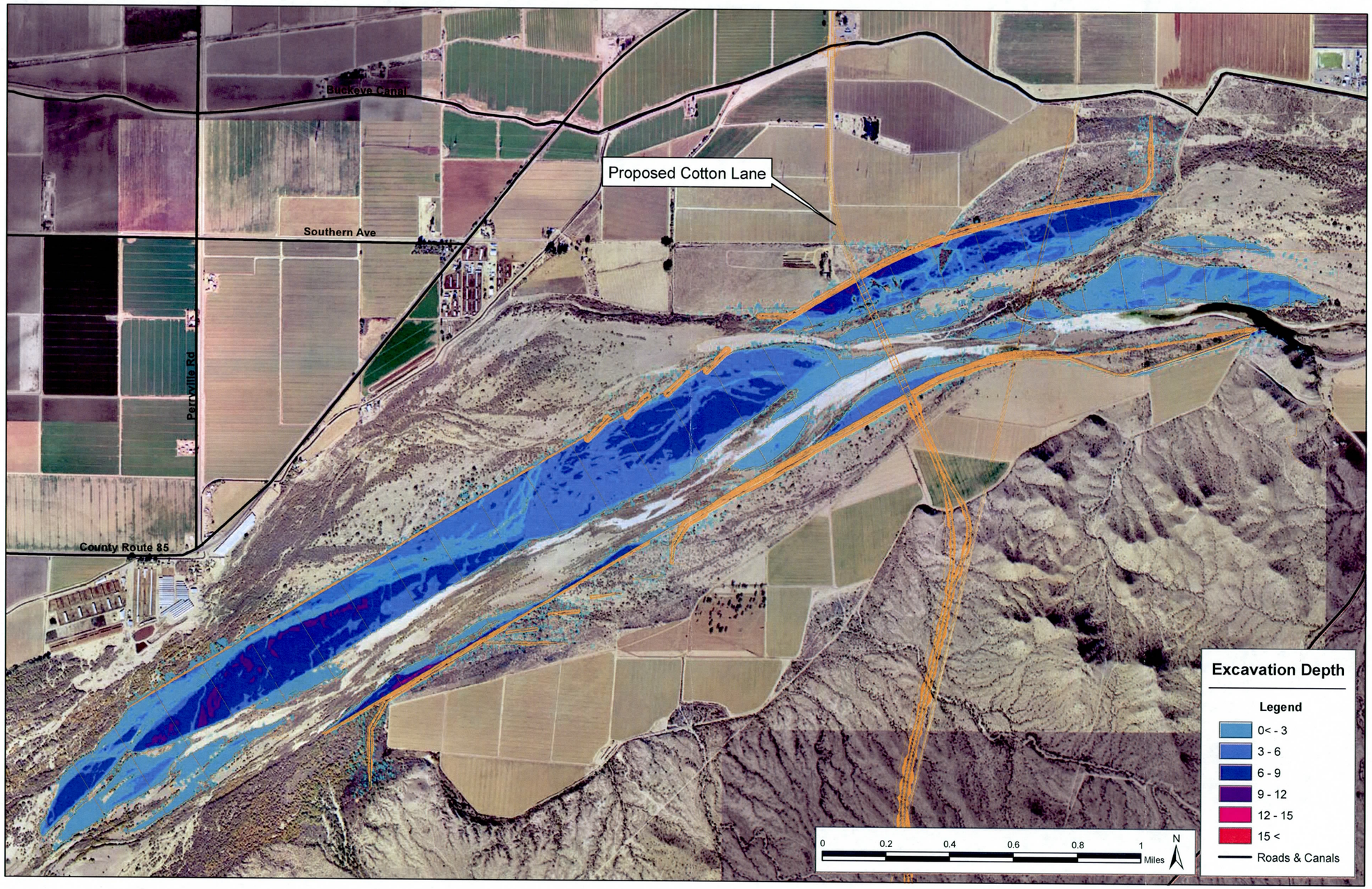


Figure 16. Depth of cut for Cotton Lane Bridge Channel Improvements.

6 Two Dimensional Modeling

A steady state two-dimensional RMA-2 model was developed and run for the 100-year discharge of 227,000 cfs. The hydraulic model begins at Bullard Avenue Bridge downstream of Salt-Agua Fria confluence and ends about one-half mile below the Tuthill Bridge.

6.1 RMA2 Model Development

6.1.1 Construction of Hydraulic Model Geometry

The two-dimensional RMA2 model was developed using version 8.1 of the Surface water Modeling System (SMS). SMS was used to develop the finite element mesh as well as to prepare input data and visualize the results. Node elevations were obtained from topographic data developed in ArcView version 3.2a. The preliminary existing and proposed conditions Manning's *n* values were closely approximated to those in the FEMA HEC-RAS model provided by the Flood Control District of Maricopa County (FCDMC). The Manning's n values used in the development of two-dimensional model for existing conditions were the same as used for the HEC-RAS models. The extension of the model reach upstream and downstream of the King Ranch Property were necessary to insure that model boundary conditions do not influence the flows near the Property. The mesh was developed with element size and type corresponding to the river morphology.

6.1.2 Topographic / Bathymetric Data

The FEMA topographic data was obtained from the FCDMC for areas that were not re-mapped in this project as described previously. The same data was used for both the one- and two-dimensional modeling. Since the new mapping did not contain any water when flown in 2003 and 2004 no bathymetric data were necessary for the design reach.

6.1.3 Model Boundary Conditions

A single discharge of 227,000 cfs was simulated. The downstream water surface elevation (869.09 ft) was set based on the FEMA HEC-RAS steady state model. The existing and proposed conditions model boundary follow the corresponding floodplain limits except at the lower end of the model where wetting and drying caused elements to dry based on the new topographic information. The proposed condition floodway is encroached adjacent to the King Ranch and Lakin Properties to represent the proposed banks associated with the Cotton Lane Bridge project. The mesh elements on the Property were turned off (i.e. inactive) for the proposed condition. The upstream boundary for both the existing and the proposed conditions was defined by the opening between the abutments of the Bullard Avenue Bridge.

6.1.4 RMA2 Model Analysis

The existing condition steady state run shows the majority of flood velocities on the King Ranch Property are substantially less than 2.0 ft/sec while those on the Lakin Property (Figure 17 and Figure 19) have velocity below about 3.0 feet/sec for the majority of the area. The flow depths for existing conditions are shown in Figure 18 and Figure 20.

Figure 21 shows the comparison of water surface elevations between the RMA-2 and HEC-RAS models through the Cotton Lane Bridge reach. Figure 21 shows the agreement in water surface elevation along the channel centerline for HEC-RAS and RMA-2 for both existing and proposed conditions.

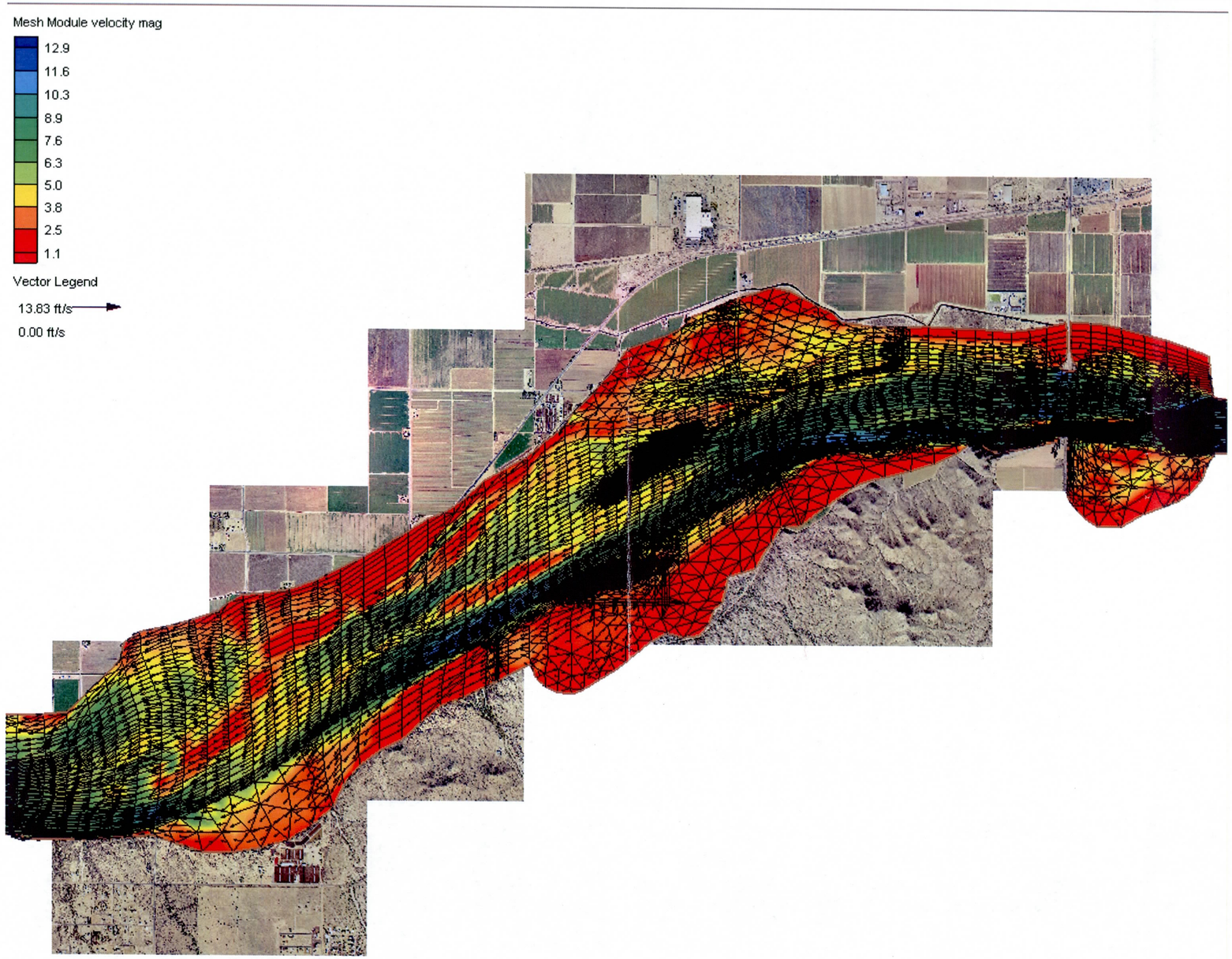


Figure 17. Two-dimensional Velocity Distribution for Existing Conditions with new Topography.

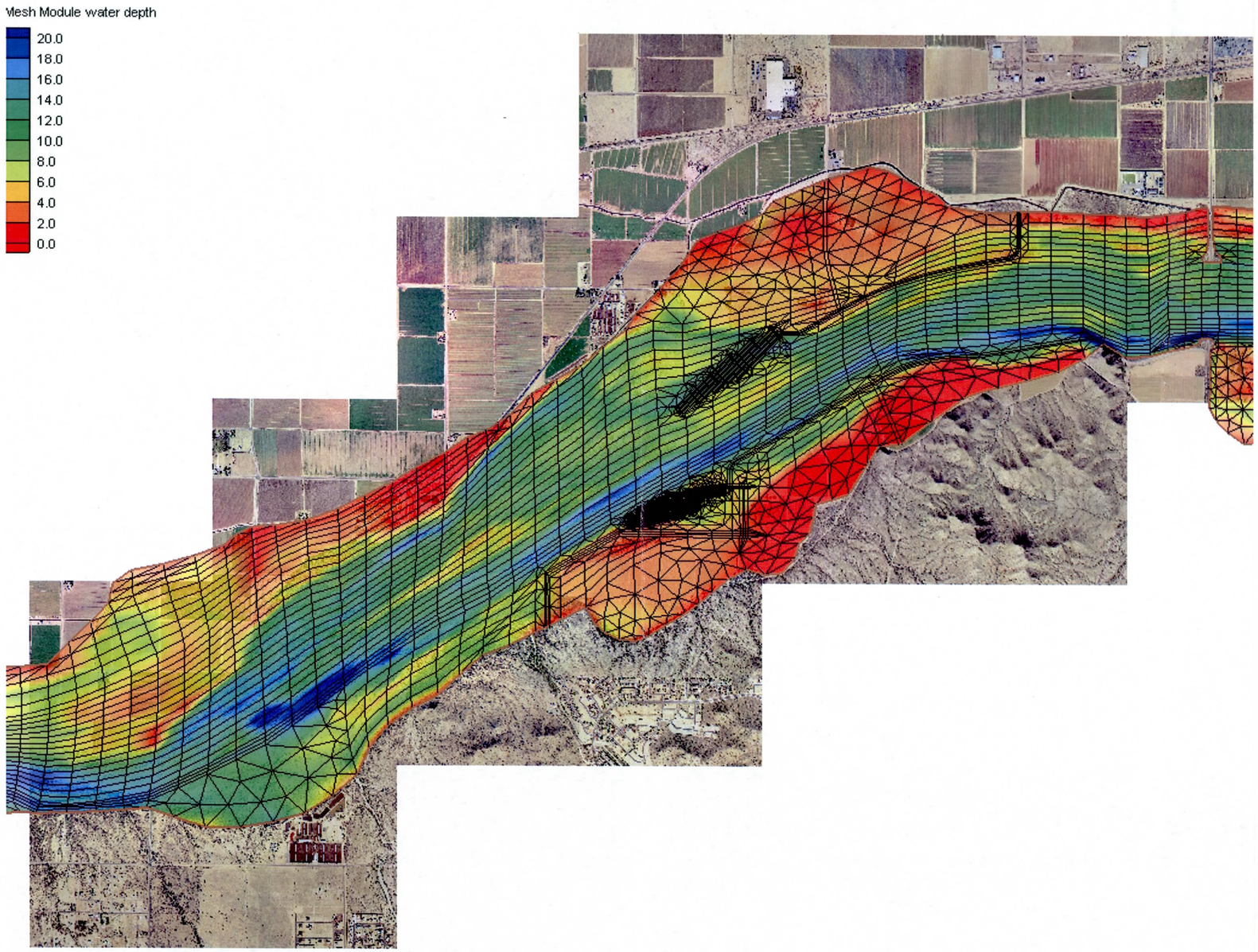


Figure 18. Water Depths for Existing Conditions from RMA-2 Model.

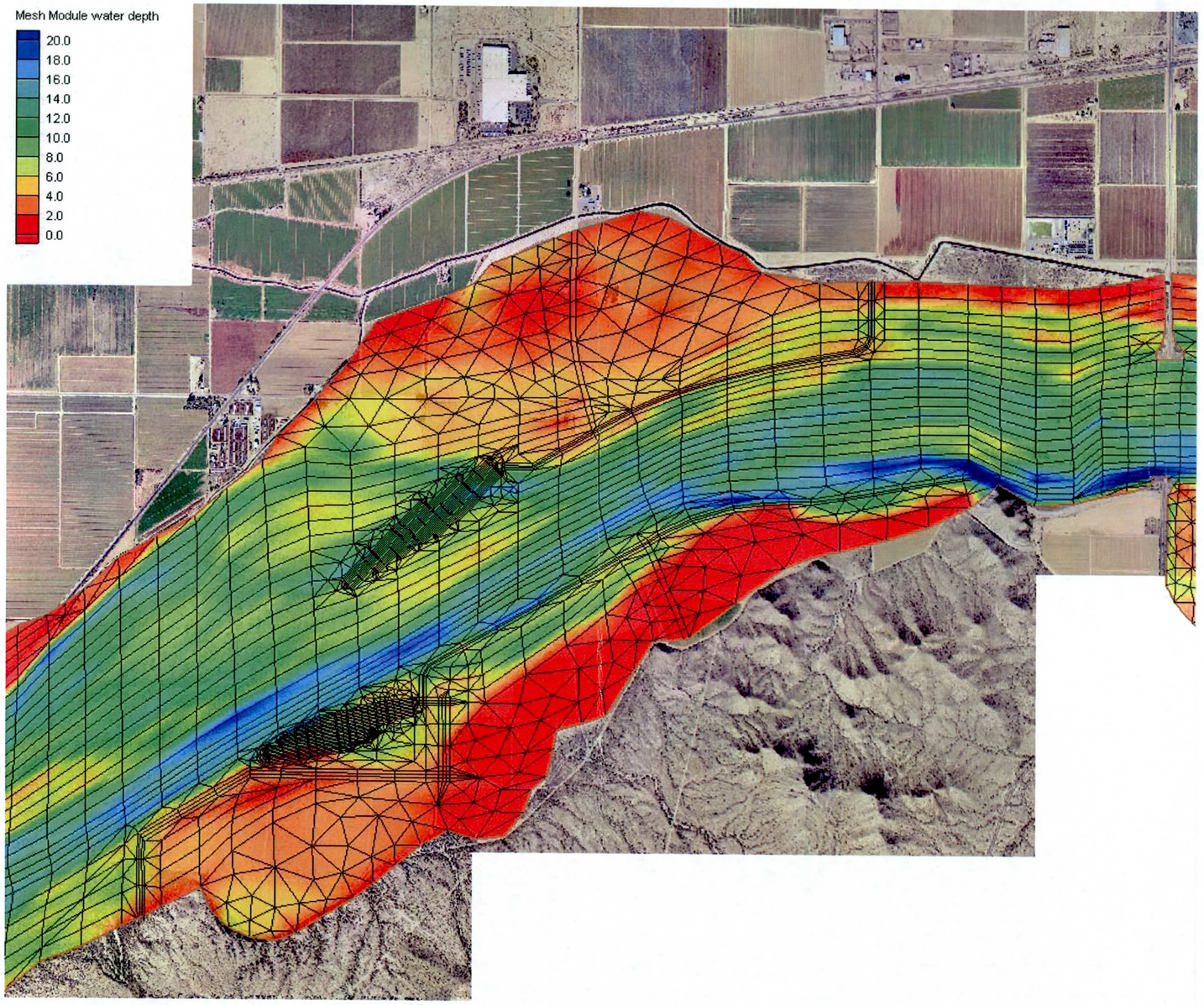


Figure 19. Existing Condition Water Depths for Existing Conditions for Cotton Lane Bridge Reach. (Q = 227,000 cfs)

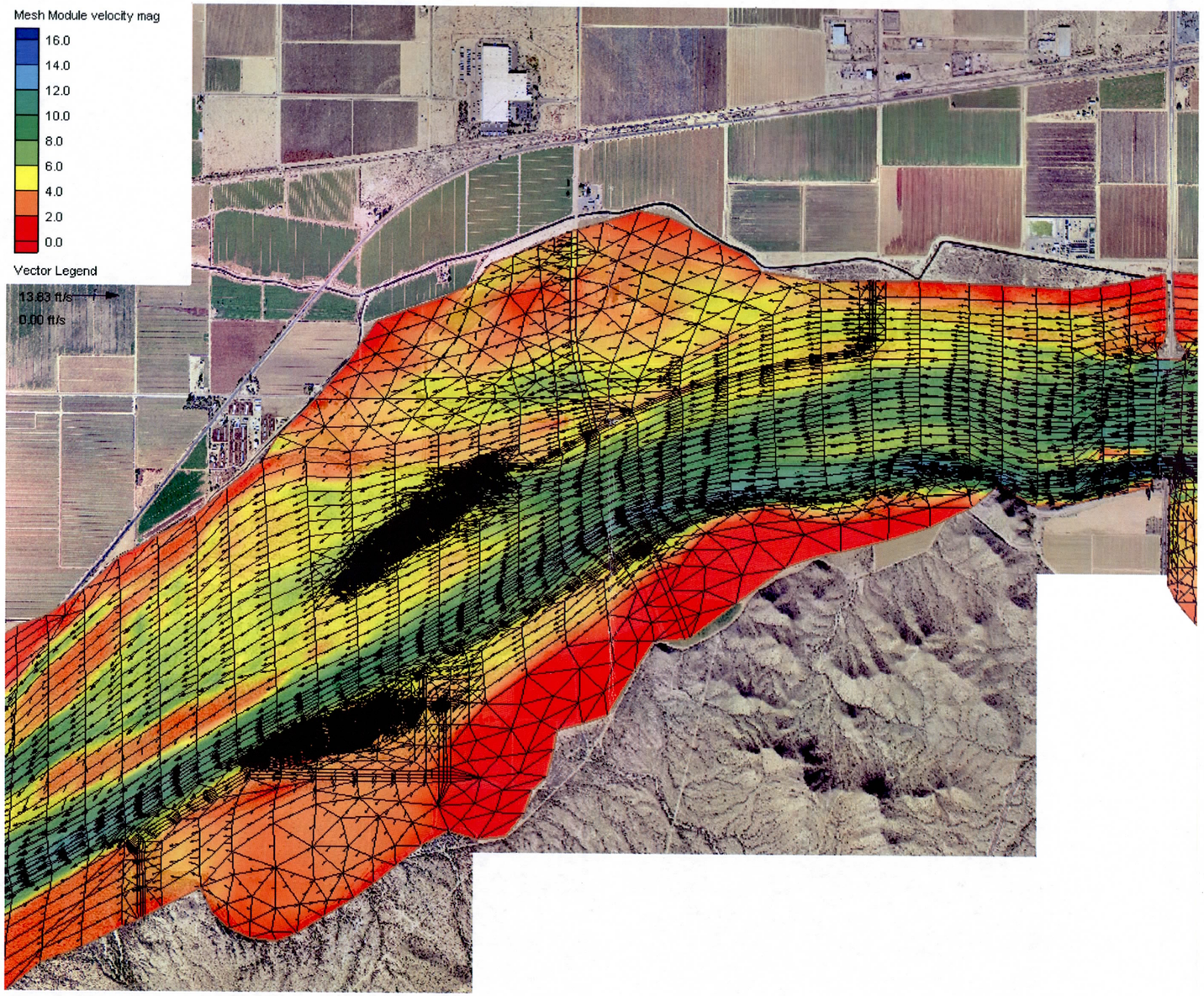


Figure 20. Existing Condition Velocities for the Cotton Lane Reach Showing Flow Area Across Lower Portion of King Ranch Property and Lakin Properties (Q = 227,000 cfs)

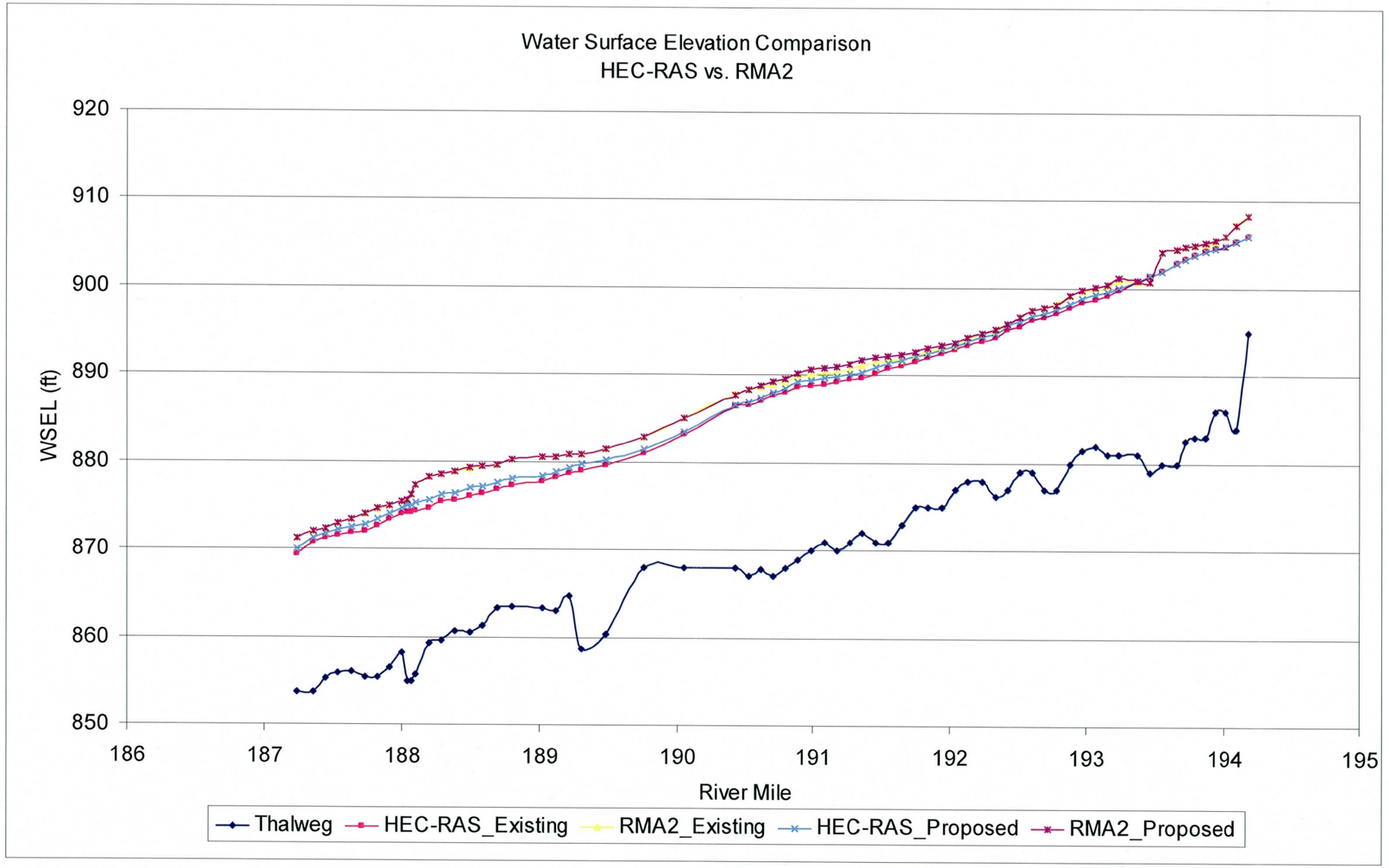


Figure 21. Comparison of RMA-2 Water Surface Elevations for Reach with those from Baker floodplain delineation model.

6.2 Cotton Lane Bridge with Bridge and 2000 Foot Channel

The RMA-2 model was also run for the proposed conditions with a 2000 ft base width channel and a 2067 ft Cotton Lane Bridge. The bridge was modeled with both abutments being inline with the banks both upstream and downstream from the bridge as shown in Figure 15. The velocity results for the two-dimensional model are shown in Figure 22for the entire project and in Figure 23 for the areas with the bridge and bank protection. The water depths are shown in Figure 24.

The results show that the project does concentrate flow through the bridge to some extent but flow velocities are still in the 8 ft/sec range as compared with approximately 7.5 ft /sec for existing conditions. The concentration of flow through the bridge will also tend to keep the bridge free from sedimentation that would reduce capacity.

A number of other bridge openings were evaluated using the HEC-RAS model. While the bridge could be lengthened, it a longer bridge does not significantly reduce the velocities through the bridge and may lead to increased sedimentation in the bridge opening and increase the tendency for the river to meander and attack the banks in this reach.

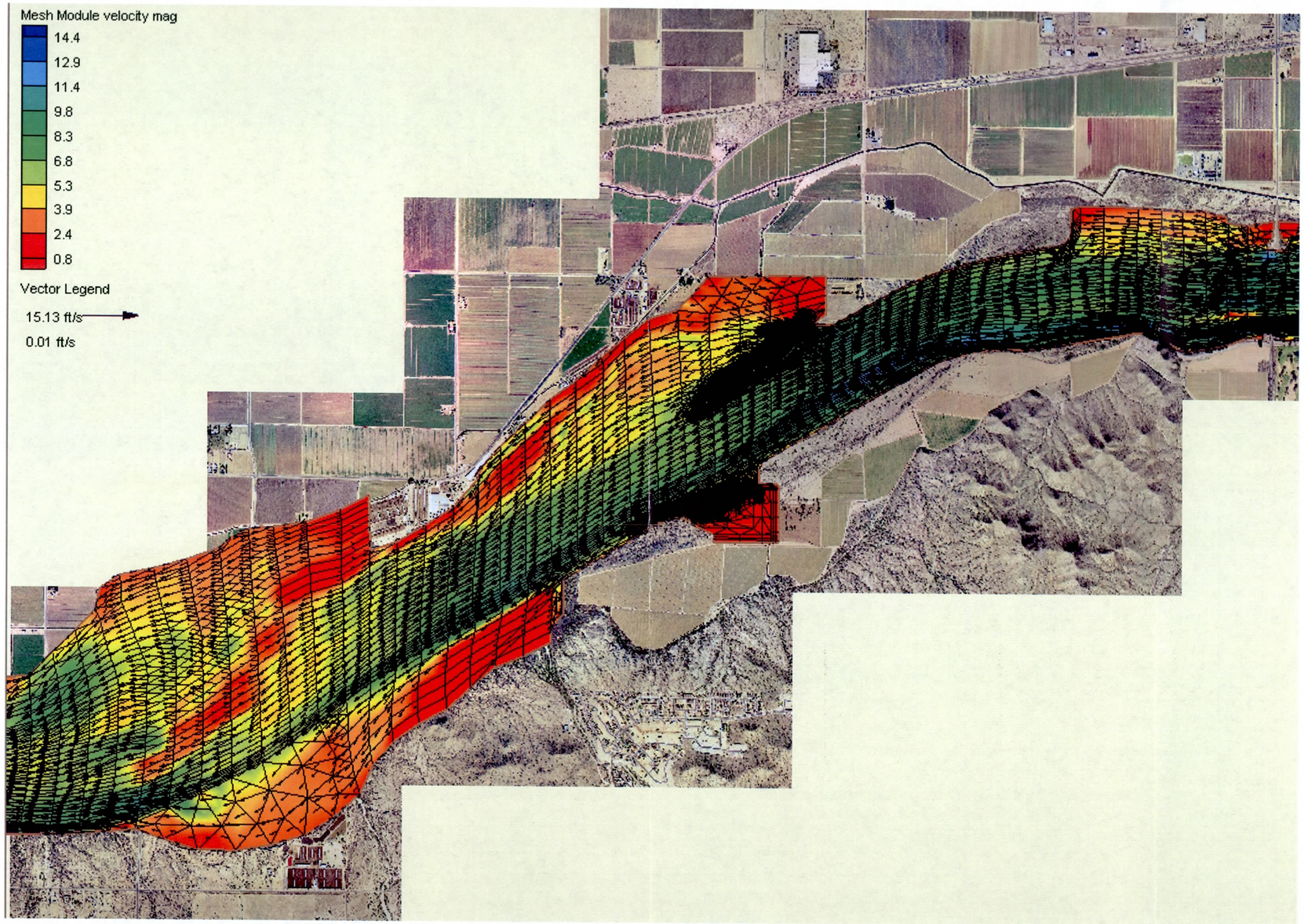


Figure 22. Flow Velocities for Proposed Conditions for Cotton Lane Bridge Reach (Q = 227,000 cfs)

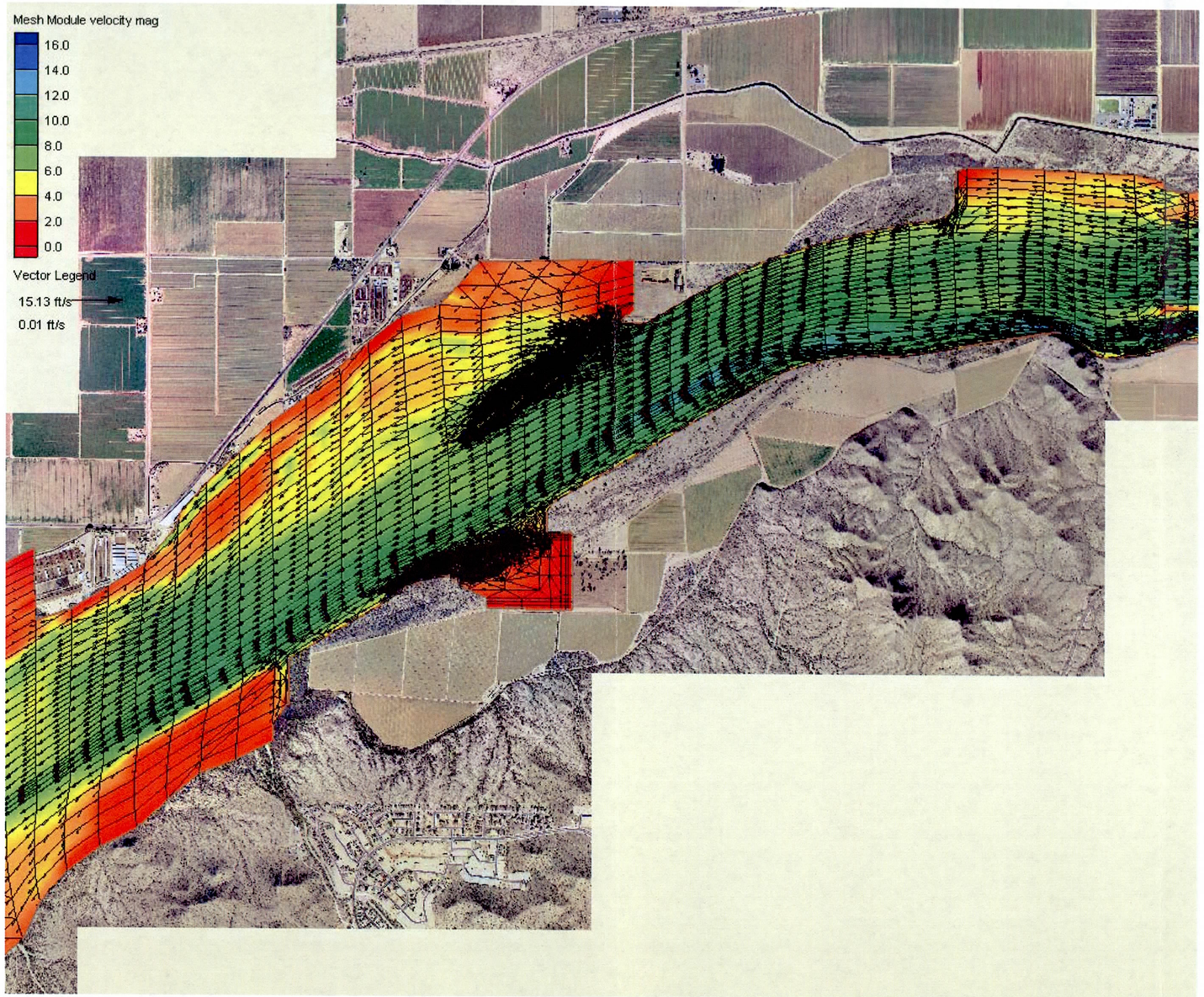


Figure 23. Velocity for Reach with Channel Modifications (Proposed Conditions Q = 227,000 cfs). Some shallow areas turned off for Sediment Transport Stability.

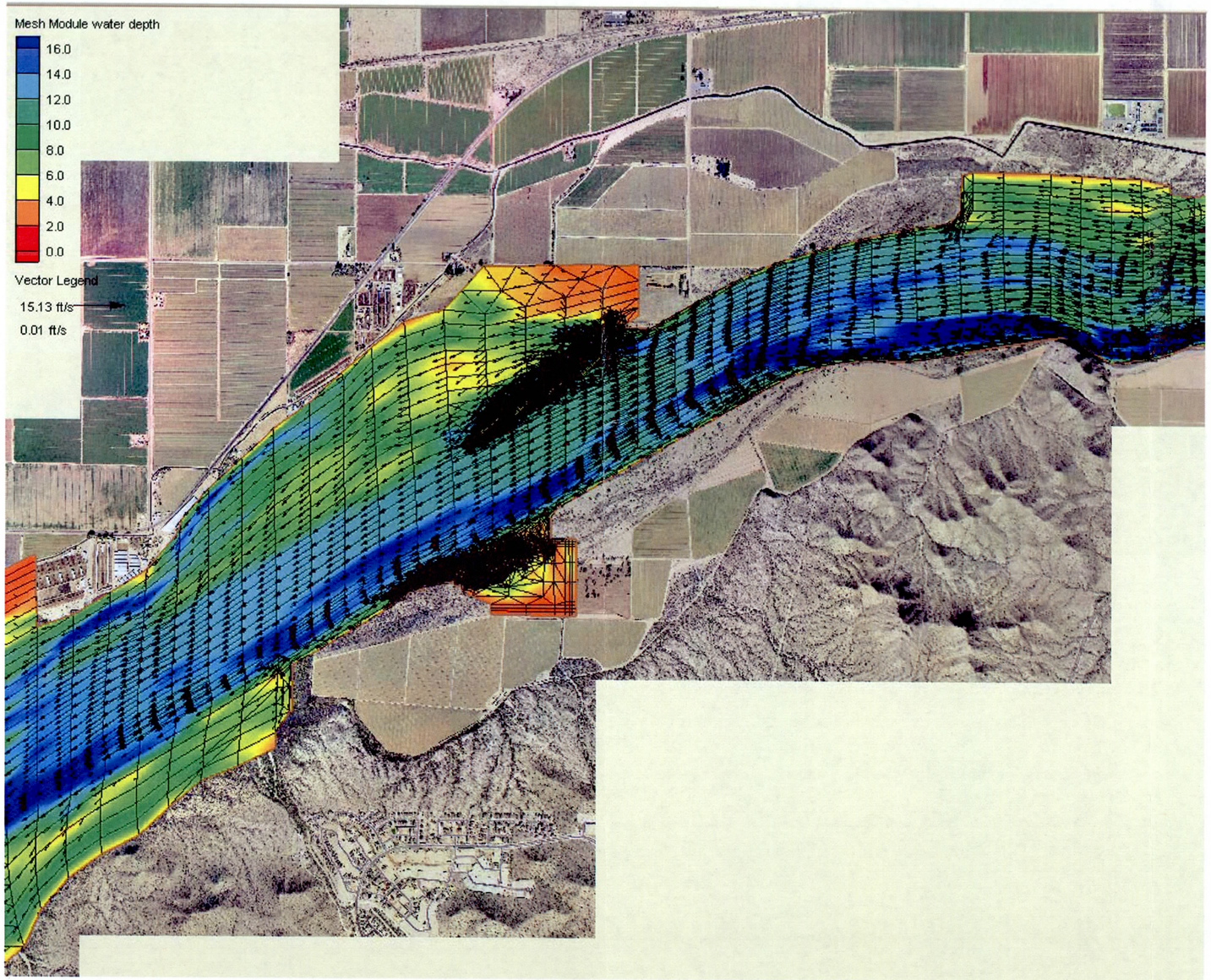


Figure 24. Water Depths for Proposed Conditions for Cotton Lane Bridge Reach. Some Shallow Areas Removed or Deepened Slightly for Sediment Model Stability.

7 Geotechnical Investigation and Sediment Characteristics

Soil and bed material samples were taken by Western Technologies for Cavalier Development the predecessor to Sonterra Partners as well as for prior studies for bridges at the current Cotton Lane Alignment. The sediment sample data were obtained from various sources and are presented in Figure 25. These samples indicate that this reach of the river is predominately a gravel bed system while the Gila River below Tuthill Road behaves as a sand bed river system (Stantec - El Rio Study). The bold lines in Figure 25 show the samples that have been taken to be most representative of the Gila River in the Cotton Lane Bridge Reach. Further discussion on incorporation of these data in HEC6-T sediment transport model is presented in Section 7.1.1.

7.1 Sediment Data

The decisive factor in selecting the proper sediment transport function was based on available bed gradation and maximum grain size. Bed material in the project location is comprised of significant quantities of both sand and gravel, making it necessary to use an appropriate transport function. A combination of the Toffaleti and Meyer-Peter and Muller (TMPM) (US Army 1989) transport functions was used in the study. This combination accounts for sand and gravel, giving a higher, realistic measure of total sediment concentration (and thus total sediment load). Based on field observations, to facilitate modeling and to represent larger diameter cobbles noted in the bed, a maximum grain size of 200mm was used in the final sediment transport runs in HEC-6T. Additional transport equations were also used as a sensitivity analysis and results were not significantly different in terms of final bed configuration for the reach even though transport rates varied through the models.

7.1.1 Bed Sediment Characteristics

The available sediment gradation data is presented in Figure 25 and includes data from Western Technologies, Stantec and WEST. Most of the sediment data that shows a predominance of sand as shown in Figure 25 are taken from the overbank regions but the channel data agrees well with

most of the data provided by Stantec and that obtained by WEST and other sources. Upon careful investigation and comparing the sediment gradation curves with the sediment data from the Tres Rios PED study (located upstream of this study reach), it was concluded that samples from location 21 and 24 (Shown as TR Stations in Figure 25) along with those obtained by WEST and Stantec showing significant gravel adequately represents the conditions in the channel. Therefore, the data from Stantec locations 3, 4, and 9 were used in conjunction with samples obtained by WEST and Western Technologies in the development HEC6-T sediment transport model.

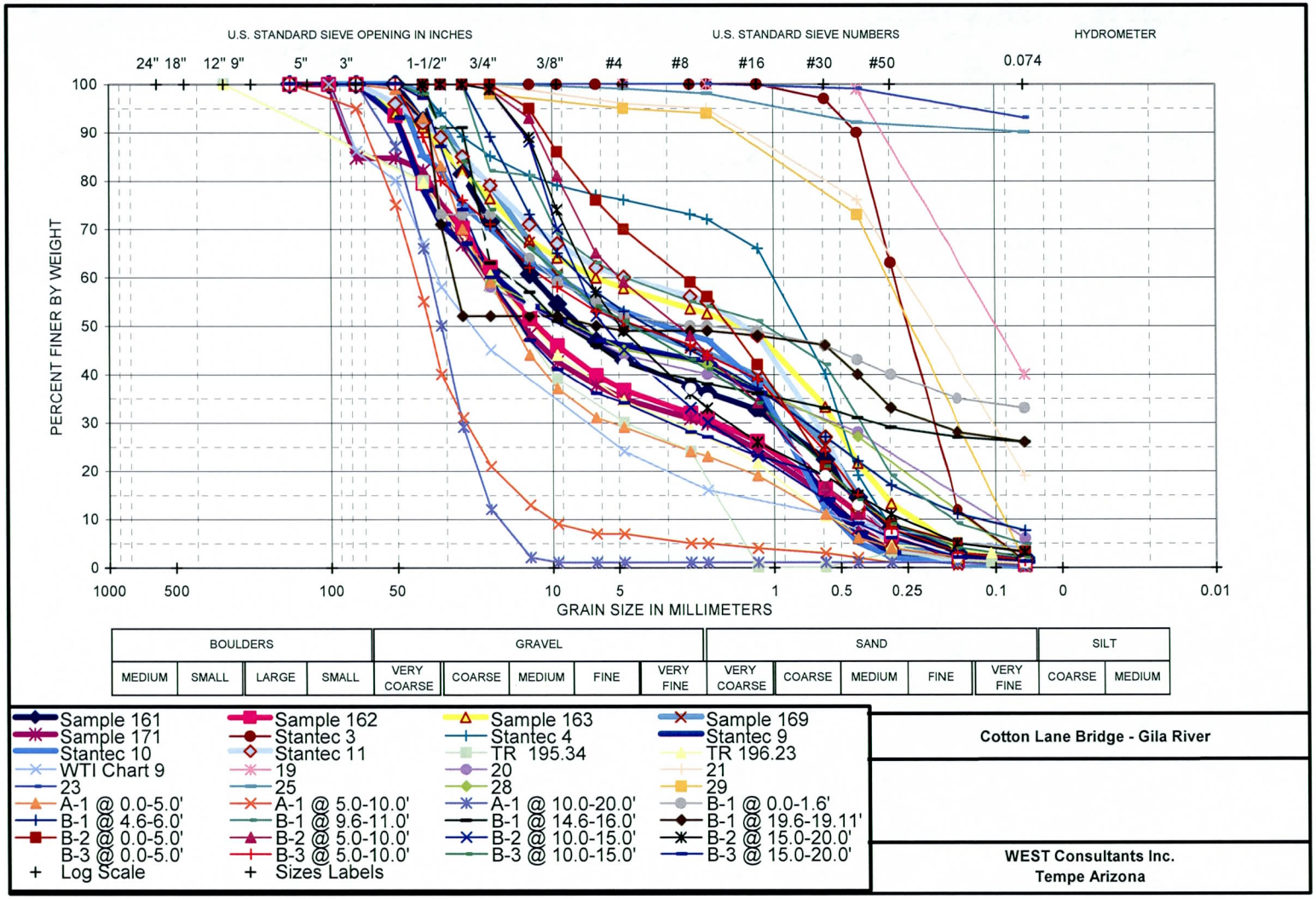


Figure 25. Available Bed Sediment Gradation Data for Gila River Adjacent to King Ranch.

7.1.2 Inflowing Sediment Load

The sediment transport model cannot be directly calibrated to historical conditions because detailed historical bed elevation data are not readily available. The HEC-6T model requires input of the bed material load at the upstream limit of the project reach for the entire range of discharges. For this purpose, the HEC6-T model developed for the Tres Rios PED Study was used was initially used.

The Tres Rios model considers the reach immediately upstream of the study reach. Therefore, the outflowing sediment load from the Tres Rios model was originally used as the inflowing sediment load for the model developed in this study. A 30 day steady state simulation of the Tres Rios PED model was performed for a range of discharges to generate the inflowing sediment load table. The values obtained in this manner are input into the present HEC-6T model at the upstream most cross-section located at 195.75. The sediment inflow for the Tres Rios model was also compared with the outflowing sediment load for the Tres Rio Oeste model located immediately upstream from the Tres Rios Study area.

After review by Stantec and the FCD, and in conjunction with Mr. Tony Thomas (the original developer of HEC-6) it was suggested that using a higher inflowing concentration with more of the wash load accounted for in the load curve would be more accurate. The wash load was high enough to impact the transport of bed material due to the increased density of the water and sediment mixture. A sensitivity analysis was performed which indicated that this reach of the river is not overly sensitive to changes made to the inputs of sediment transport models. Large changes in inputs resulted in relatively minor changes in bed elevation with changes in final bed elevations on the order of 1-2 ft after a 105 year simulation. This was deemed to be relatively minor for the Cotton Lane Bridge reach of the Gila River. Final modeling used an inflowing sediment load that was acceptable for both the El Rio and King Ranch studies.

8 Sediment Transport Analysis

8.1 HEC-RAS Model Conversion

8.1.1 Model Geometry

The geometry of the HEC-RAS hydraulic model was converted into a text file with the format required by the HEC-6T program. Roughness coefficients (Manning's n) in the cross-sections of the river models were varied with depth. After running the 5-, 20- and 100-year flood events in HEC-RAS, the profile output tables were used to extract conveyance weighted Manning's n values for the channel, the left and the right overbanks for the different discharges. The modified data was then entered into the HEC-6T input file using NV records. A default value of 0.065 was used to fill blanks when the conveyance in an overbank area was zero. The result was a configuration of roughness coefficients changing vertically by discharge rather than horizontally by distance as in the HEC-RAS models.

Using normal flow considerations, an elevation-discharge Rating Curve was developed at the downstream boundary of the Gila River (cross-section 186.87) for starting water surface elevations. The rating curve at this point was generated for discharges ranging from 0-292,500 cfs, at 7500 cfs increments for a bed slope of 0.002 ft/ft which is shown in Figure 26.

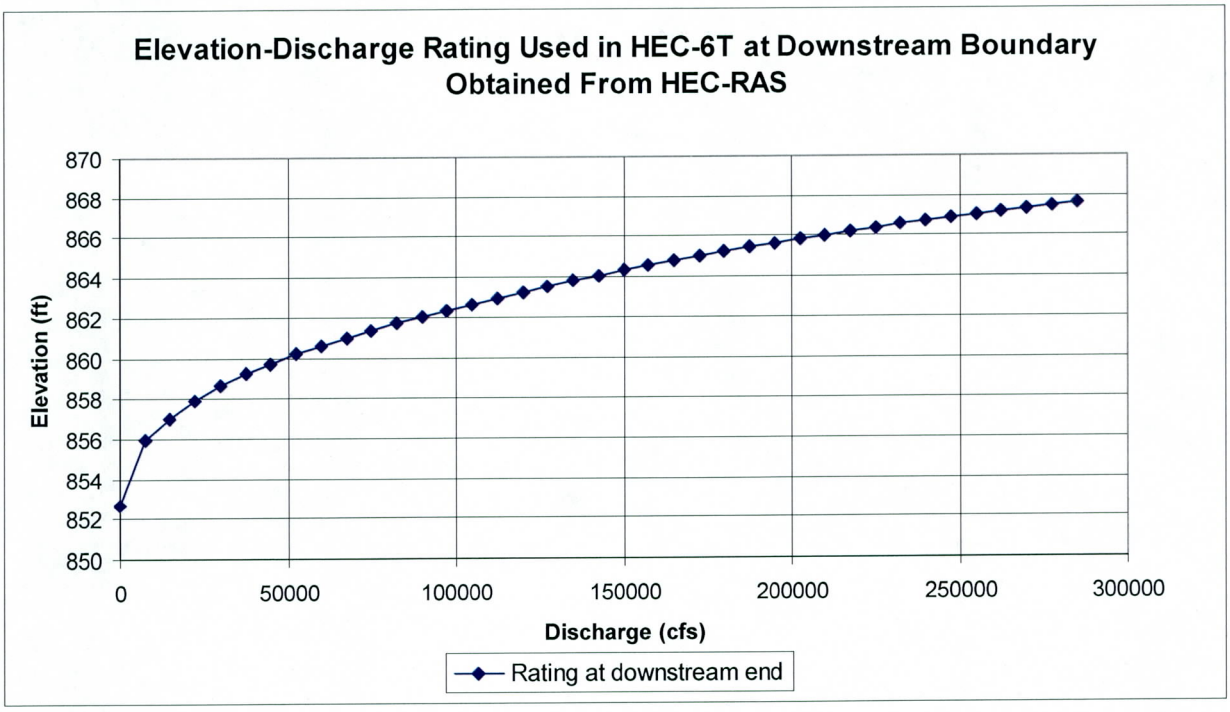


Figure 26. Downstream WSE Boundary Condition for HEC-6T Model.

8.1.2 Fixed Bed Model Calibration

Initially, the HEC-6T model was calibrated with a fixed bed using the 5-, 20- and 100-year flows, and the resulting water surface profiles were compared to the HEC-RAS Existing Conditions results. Adjustments of Manning's n were performed for calibration purposes for all cross-sections beginning with the downstream section in the Gila reach. These adjustments were performed to reach agreement between the HEC-RAS and HEC-6T water surface elevations and channel velocities within a difference of 0.1 for both parameters. Hydraulic comparison between HEC-RAS and HEC-6T models are presented in APPENDIX E.

8.1.3 Movable Bed and Erosion Limits

In general, sediment dynamics tend to be more significant within the active channel, where the bed can either degrade or aggrade in response to erosion or deposition. The overbank areas tend to be more stable and normally are free of erosion, but can experience deposition. HD records were used to specify a bed sediment depth of 25 feet for all cross-sections. Movable bed limits were identified at the boundary of the main channel in HD records (the narrower set of bank

stations as described in the Hydraulics section). The movable bed limits extend beyond the 5-year low flow channel (regime channel) and the defined bank stations. During high flows, significant deposition and scour was expected to occur within the movable bed limits but not expected to extend to the overbank areas.

Average bed elevations were generated using a 50-year flow applied to the model for a few seconds. This allowed wetting of the movable bed cross-sections and provide average elevation across the cross-section while not allowing enough transport to distort the model calculations. This process allows the comparison of different model results without the plotting of each individual cross-section.

8.2 Hydrologic Data

A 105-year (1889-1993) series of hydrographs at the Salt-Gila confluence consisting of historical flows was developed by WEST for the Tres Rios PED study as discussed previously. Further details are presented in Section 2.2.3.

8.3 Computation Options in HEC-6T

The supercritical option ($SCRT card) was turned off in the HEC-6T model to prevent supercritical velocities, which could produce unrealistic scour depths, from being used in the sediment transport calculations.

The $SMOOTH command was also used to prevent the cross-section geometry from becoming irregular (i.e., having spurious spikes) during the simulation. The command instructs HEC-6T to test the slope across the movable bed versus the angle of repose for sand. An angle of repose is calculated between each set of coordinates using the initial cross-section stations and elevations. The HEC-6T program assumes the bed material to be sand and assigns a value of 0.3 as the angle of repose. When the calculated values are larger than 0.3, the computed angle of repose is used to calculate the slope between cross-section stations. This results in more uniform cross-sections while not impacting the average bed elevations.

8.4 Existing Conditions Sediment Results

The HEC-6T model simulation was performed for 105 years with two major events of 1891 and 1993. Figure 27 shows the impact of the project on the stability of the Gila River. As can be noted the reach appears to be somewhat erosional under existing conditions but relatively stable under proposed conditions. Appendix F contains the sediment Transport HEC-6T model results.

In Figure 28, the results of the simulation for existing conditions are presented which show that the channel is subject to very little change due to sedimentation under the WEST inflowing load and a slightly different inflowing load gradation. This again indicates a general stability of the reach in response to major floods. It can also be noted that after a relatively minor initial adjustment the bed is stable for the entire range of events in the historical record after 1891.

Several feet of erosion can be noted at the upstream portion of the model (cross-section 194.5) at the Estrella Parkway Bridge but is due to the change in topography sources. It should be remembered that this area is where the topography changes from the channel bed to the top of the 13,000 cfs water surface elevation. This change in topography accounts for the erosion noted in the models at the location of the Estrella Parkway Bridge. It is expected that this project will have no impact on erosion at Estrella Parkway since any channel modifications are relatively distant from the bridge.

An apparent accumulation occurs at Station 190.5 in Figure 28 and Figure 29. It must be noted that the original topography data ended near this station and the downstream cross-sections use the old data (top of water surface) from the FIS study. In the later data shown in Figure 27 (whose results are based on additional downstream topography) it can be noted that this deposition is eliminated. This indicates that this deposition is indeed the result of the model adjusting itself to the discrepancies between the two sets of topographic data.

8.5 Two-dimensional Sediment Model Results

Two-dimensional model results show deposition in the off channel areas where velocities reduce as well as in the main channel downstream of the proposed Cotton Lane Bridge. The results of the two dimensional sediment transport model are shown in Figure 31 and Figure 33.. It can be

seen that the results are not that dissimilar between the existing and proposed conditions. There is a slight reduction in the depth of sediment deposition in the north portion of the excavation area just west of the north vane dikes. No other significant differences can be noted between the two figures.

8.6 Proposed Conditions Sediment Results

The proposed conditions HEC6-T model was developed using the existing conditions model as the base and by incorporating the new bank alignment as encroachments using the X3 cards for the north and south banks, adding the Cotton Lane Bridge, and the inclusion of a 2000 ft wide channel. These results are presented in Figures 27 and 29 and again show stability for the design channel through this reach. The models all indicate that deposition can be expected outside the main channel for both existing and plan conditions. The average bed elevations, however, do not change significantly indicating the main channel of the river will remain relatively stable.

The two-dimensional results are shown in Figure 31 and Figure 33.. It can be seen that under existing conditions (Figure 31) that more sediment is deposited in the excavated portion of the main channel just west of the vane dikes than in the proposed condition model. The two-dimensional model does not account for bed load transport so deposition rates will be higher than those indicated in the model results.

From the results it can be seen that the area near the bridge is kept clear of deposition while the area to the north and west away from the bridge tend to fill slightly along with areas where velocities reduce. Some slight deposition is noted in the main channel but not enough to cause problems with water surface elevations. These results are based on a fine to medium sand size and a 60 hour simulation at the 100 year peak. While this does not address the full hydrograph, the currently released version of SED2D as released by the Army Corps of Engineers does not readily allow dynamic modeling of the hydrograph due to problems with wetting and drying in the sediment transport model. The two dimensional model shows deposition in the west end of the excavation area – perhaps indicating that this area of the channel is slightly over excavated in the existing plan. This excavation will tend to act as a sediment trap for flood events and will reduce sediment delivery downstream where the channel is even more depositional. Some of

this change may be due to removal of vegetation in the excavation area and the more uniform flow through the excavated area. It is likely that the river will recover somewhat by the deposition of bars in the excavated area if sufficient sediment is present. Given the amount of sand and gravel mining upstream from the site it is likely that sediment transport will be reduced from the natural conditions – especially on the Salt and Agua Fria Rivers. Sediment transport from the upper Gila (above the Salt River confluence) is primarily fine sediments due to dense areas of salt cedar. These sediments will tend to move past the King Ranch / Cotton Lane reach and continue far downstream from the area.

The proposed design does, however, reduce scour along the north bank of the river west of Cotton Lane Bridge. As can be noted in Figures 30 and 31 the amount of red (no deposition) along the BID canal is reduced under the proposed conditions.

The HEC-6T model was also run for proposed conditions with an 0.028 n value wherever excavation is planned to occur. The remaining n values were not changed since they represent existing conditions and are not expected to change. The model results show some slight differences including slightly more deposition in the downstream cut area from River Mile 189.5 to about River Mile 191.0 as shown in Figure 32..

Based on the sediment transport results it appears that the river will reform the bars in the most downstream reach of the excavation area but the water surfaces will remain within approximately 1.0 ft of those calculated for both existing conditions as well as the proposed conditions models. The channel between the Cotton Lane Bridge and River Mile 189.0 should be monitored after large events to insure that deposition in this reach does not seriously impact flood elevations. While the models predict stability in this reach it is possible that deposition could occur due to debris jams or other obstructions that have not been modeled in this study.

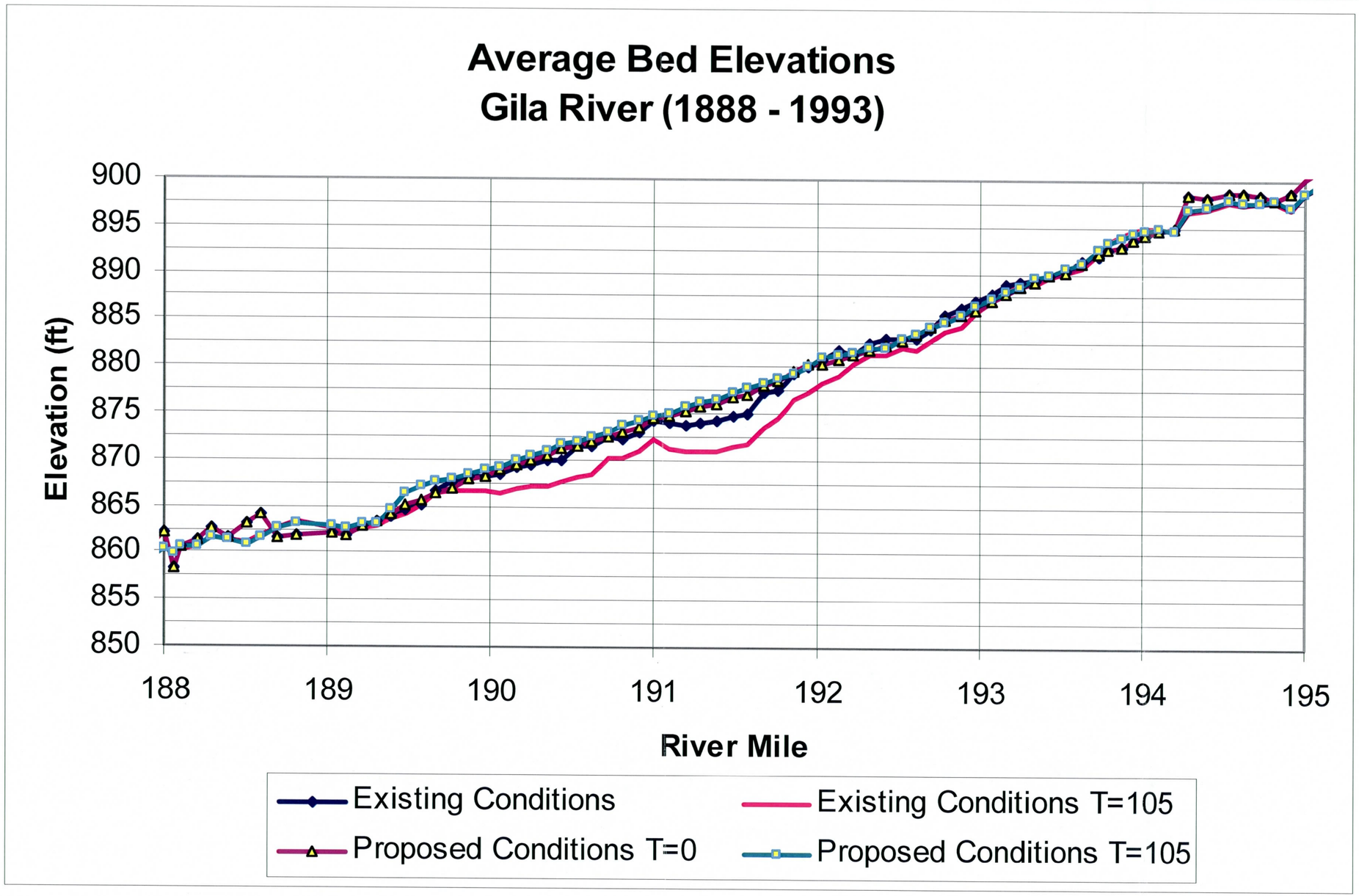


Figure 27. Average Bed Elevations for 105 Simulation of Historical Peak Flows on the Gila River at Cotton Lane Bridge

King Ranch
Average Bed Elevations for the 105-Year Simulation (1898-1993)
Existing Conditions

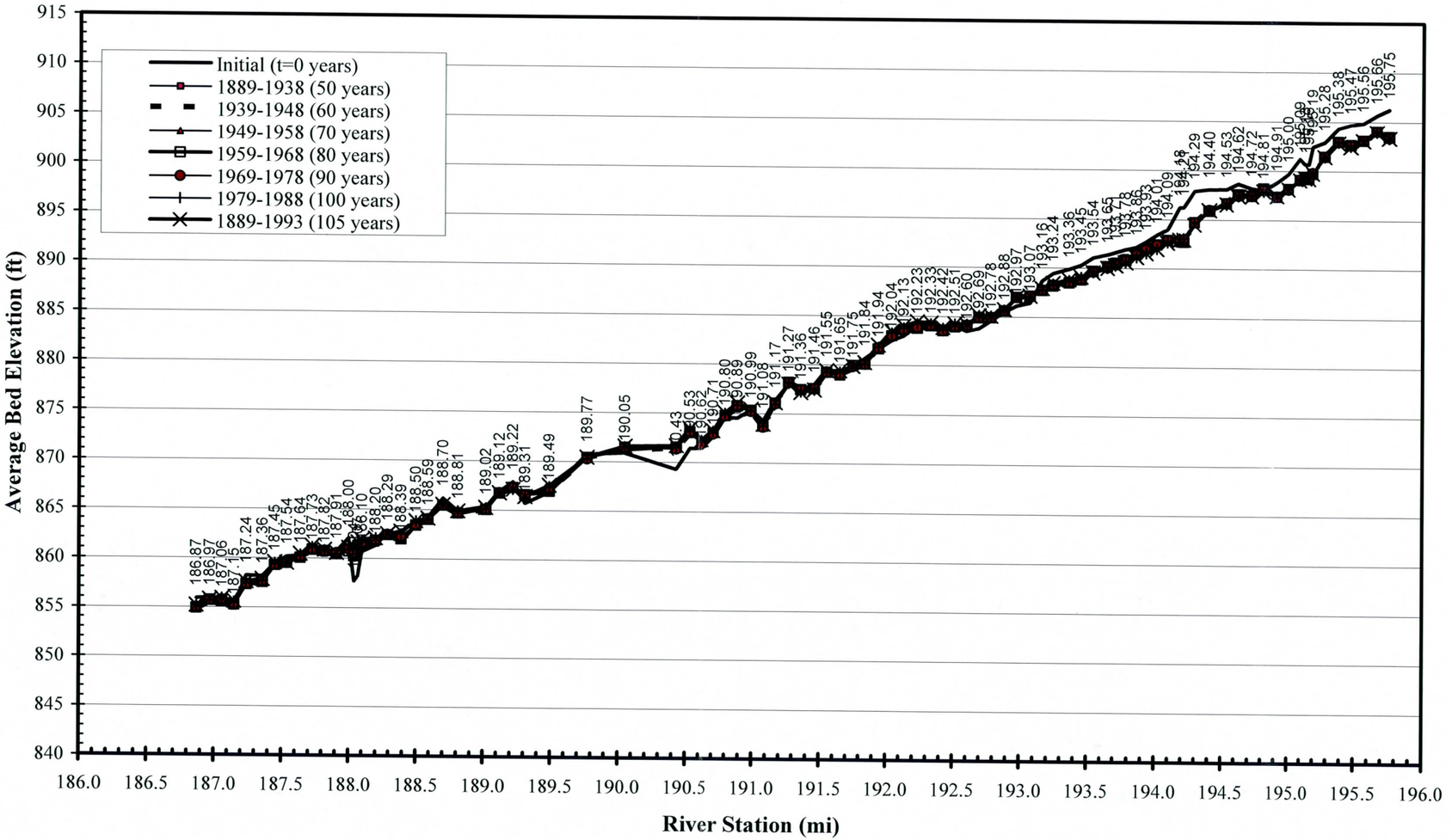


Figure 28. Average Bed Elevation Comparison After 105 Years for Existing conditions

King Ranch
Average Bed Elevations for the 105-Year Simulation (1898-1993)
Alternate Bank Alignment with 2000 ft Channel, 4ft higher

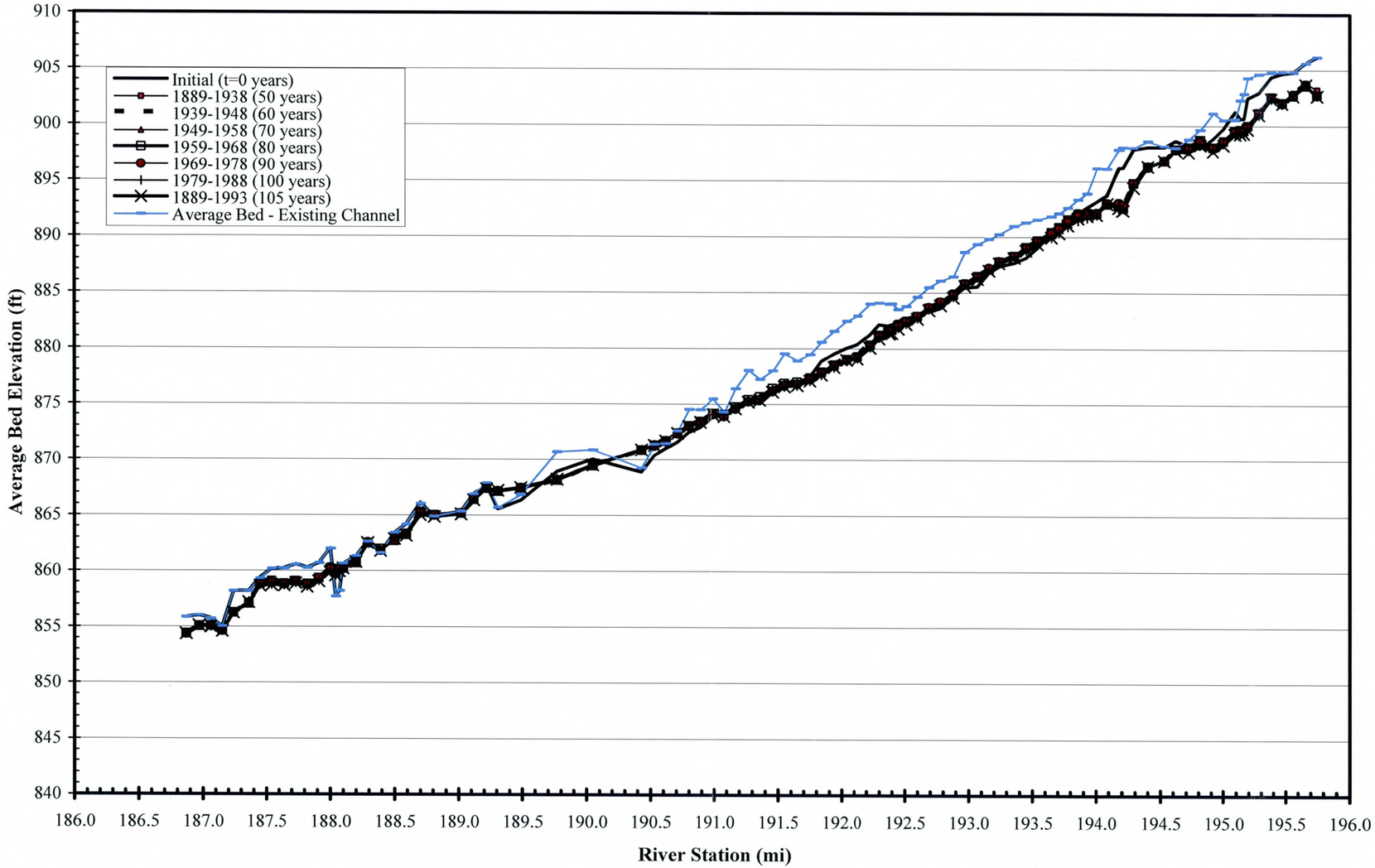


Figure 29. Average Bed Elevation Comparison After 105 Years for Proposed conditions

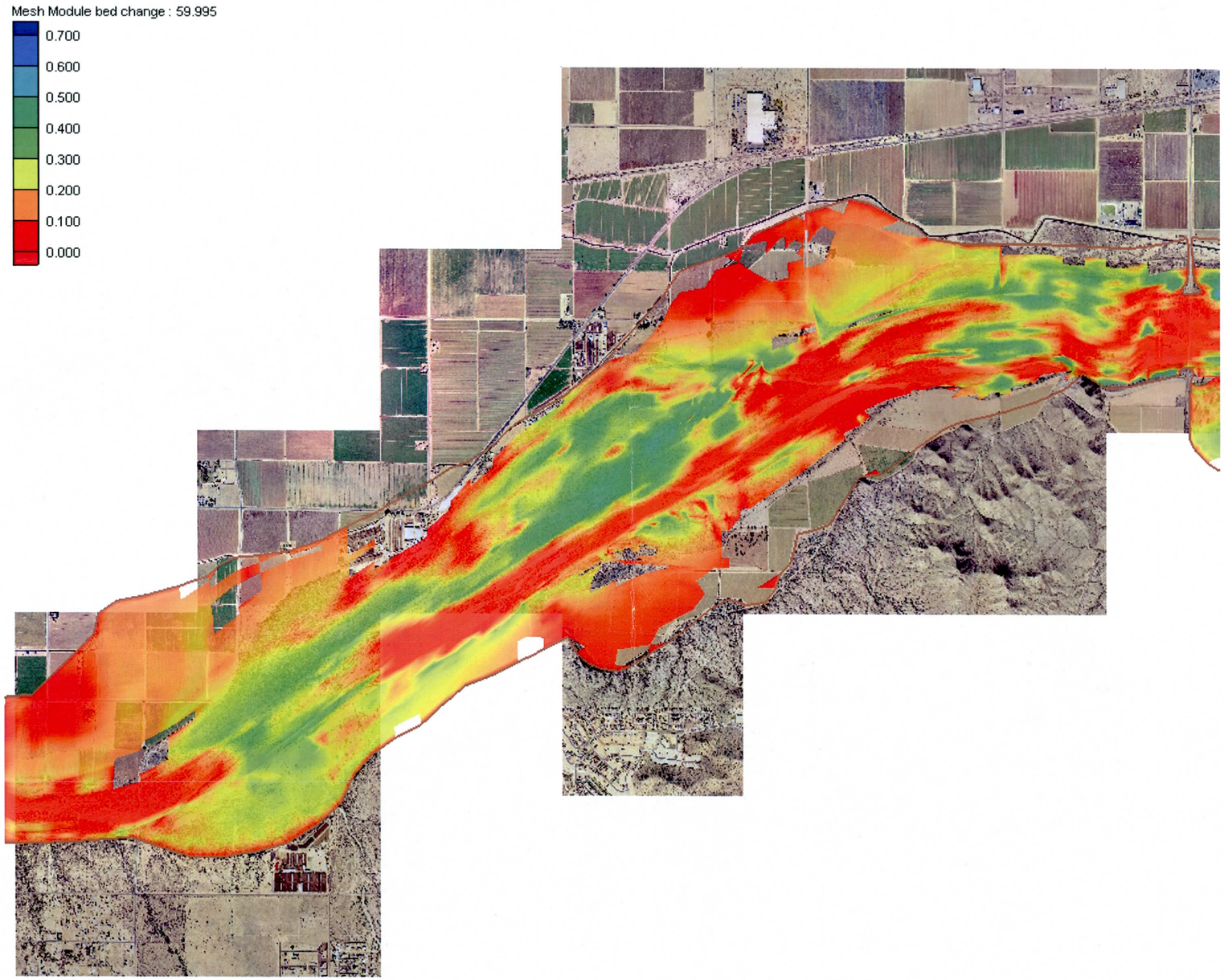


Figure 30. Sediment Transport for Existing Conditions for Medium-Fine Sand after 60 Hours at 227,000 cfs (100 Year Flood).

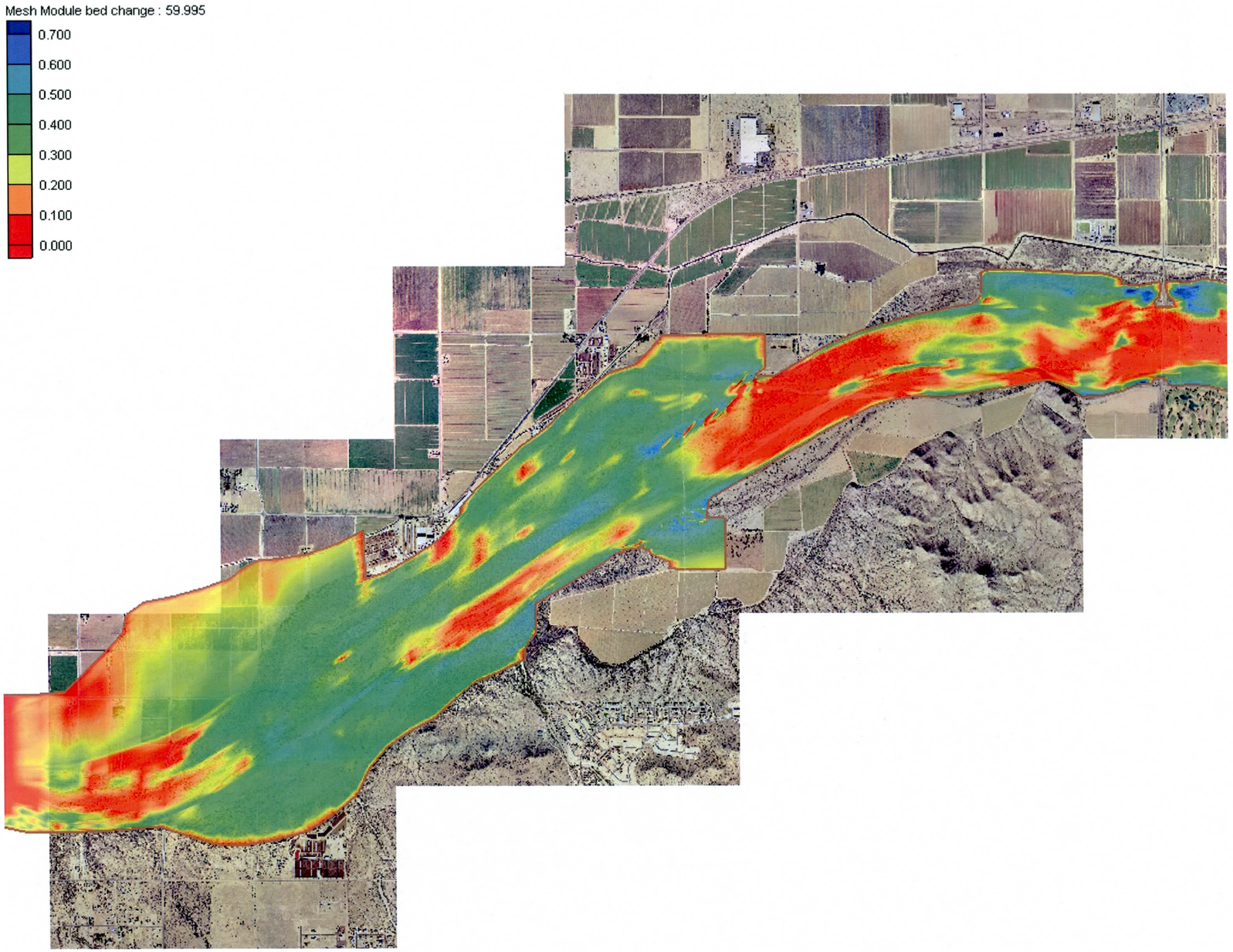


Figure 31. Bed Change- Proposed Conditions for Medium-Fine Sand after 60 Hours of 100 Year Peak Flow for Cotton Lane Bridge Reach.

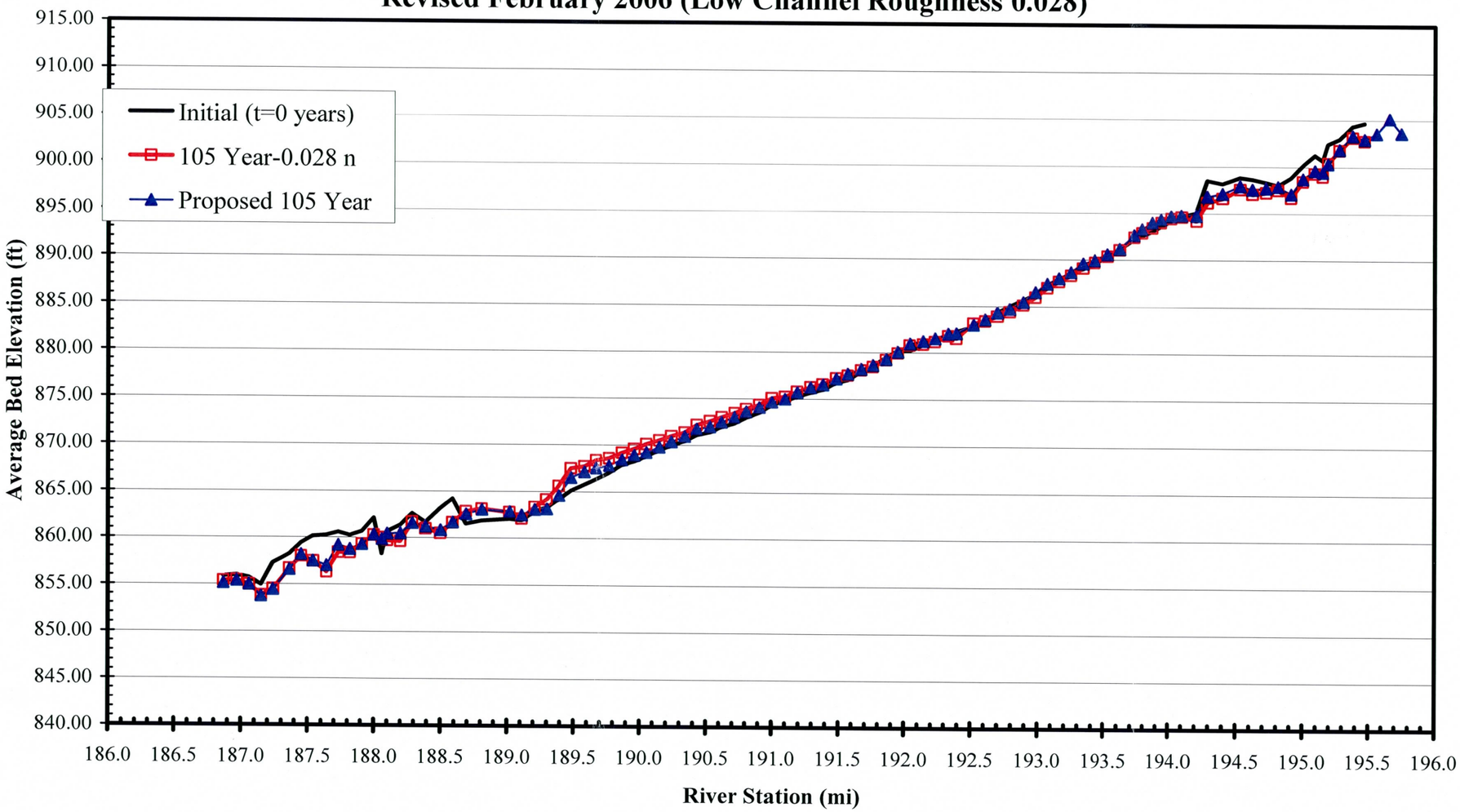


Figure 32. Impact of Low Manning's n Value for Disturbed Sections of Channel.

9 Bank Protection and Bridge Scour Analysis

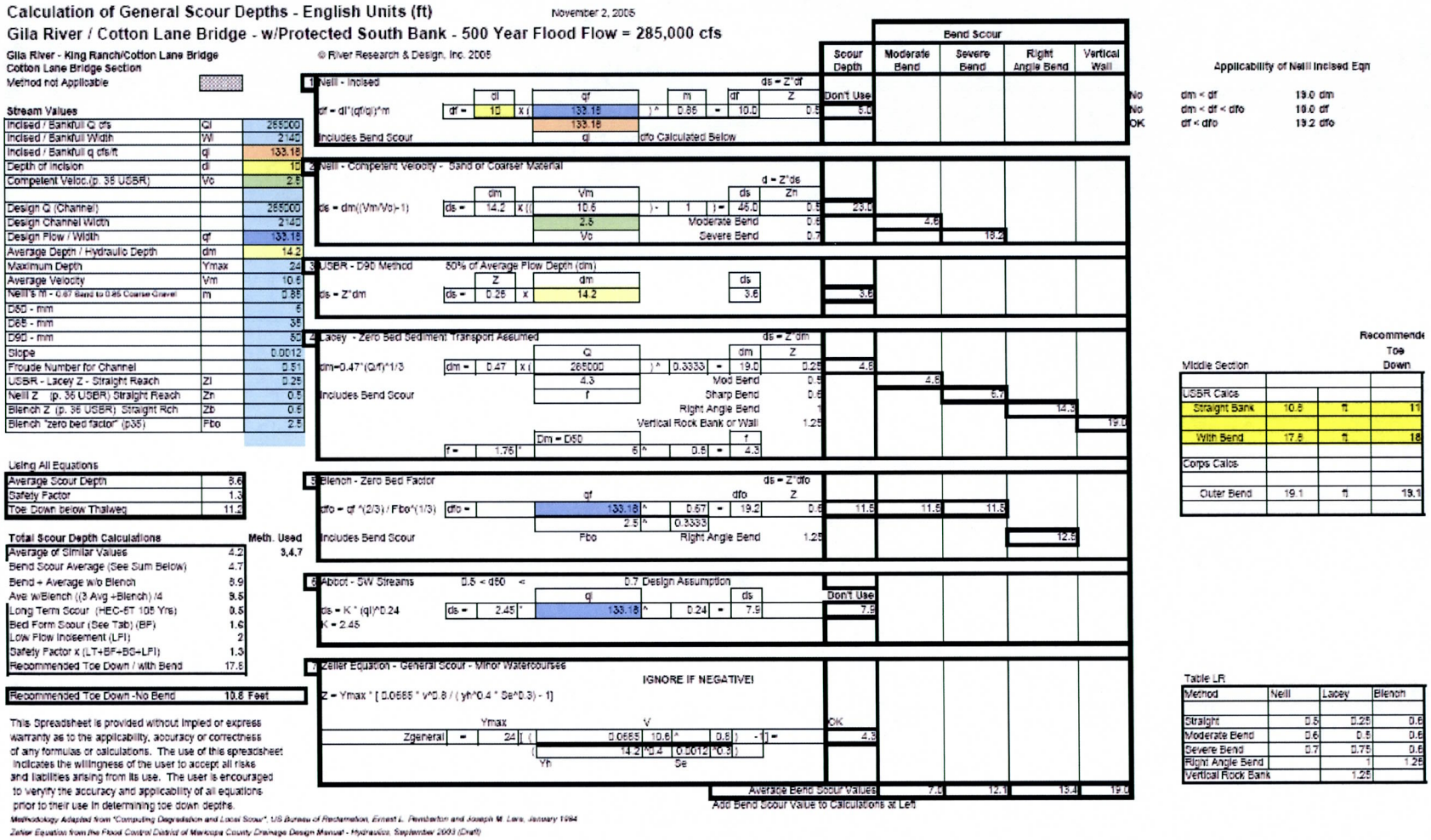
The potential scour along the banks and at the bridge piers were analyzed based on standard practices. These analyses are presented below. Toe-down and bridge scour calculations are presented in APPENDIX G.

9.1 Scour Protection and Toe Down for Bank Protection

The bank protection was analyzed based on methodology presented in Pemberton and Laura 1984 which corresponds closely with the requirements of the Flood Control District of Maricopa County. The reach was divided into three sections for analysis based on the hydraulics of each reach. The most upstream reach bank protection, where protection runs on both banks (both upstream and downstream of the Cotton Lane Bridge or from cross-section 192.14 to cross-section 193.16) was calculated separately due to higher velocities. The second section, from the end of the bank protection along the north bank to the break in bank protection along the south bank, was a second section, labeled in

Figure 33. as middle section, was also calculated separately due to lowered velocities and the last section is that portion of the protection at the west end of the project southwest of the mitigation lands. The toe down depths below the river thalweg were respectively: 11 and 18 ft for inside and outside of the bend in the upper or higher velocity section, 10 and 15 for the middle section and 7 and 12 ft for the lower section. It should be noted that other than the vane dikes on the north bank no protection is planned for the middle and lower sections along the north bank. The values were calculated simply as a reference.

Based on the river morphology and the possibility of future river improvements on the north bank it was determined that toe down should not be reduced below 15 ft below the existing thalweg for any of the sections in this reach. Since the low flow channel is braided and may migrate north or south in the future, it is recommended that protection be provided which include toe down for bend scour on both the north and south banks in the middle and lower section s of this project.



Final Design Calculations - Section 1 (Bridge Section)

Figure 33. Toe Down Calculations for Bank Protection – Section 1 (Bridge Section).

9.2 Bridge Scour Analysis

The expected scour for the bridge piers was calculated by WEST Consultants and was estimated to be 23.1 feet for a pier diameter of 5 ft for the 100 year event and 24.7 ft for the 500 year event. The abutment scour was calculated to be 7.3 ft for the 100 year flood and 27.3 ft for the 500 year flood. Since the abutment is in line with the bank protection the scour for the bridge is not expected to be 50 to 100% higher than for the unprotected bank on both sides given the wide bridge opening and the distance to the first set of piers. The toe down for the banks were used in the development of plans for protection under the bridge. The full calculations are contained in APPENDIX G Section 1.

10 Conclusions

Extensive modeling and analysis has been performed over a period of two years to develop and select the current bank alignment and channel design for the Cotton Lane Project. This analysis has been careful to consider the environmental, hydraulic, geomorphic and sediment transport aspects of the proposed design. The final design will meet the goals of the project while providing a stable river section and additional habitat through mitigation activities. Care has been exercised to include environmental aspects of design including leaving the low flow channels in place and untouched in an effort to reduce impacts to the existing desirable vegetation along the low flow channels.

11 References

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N Value References

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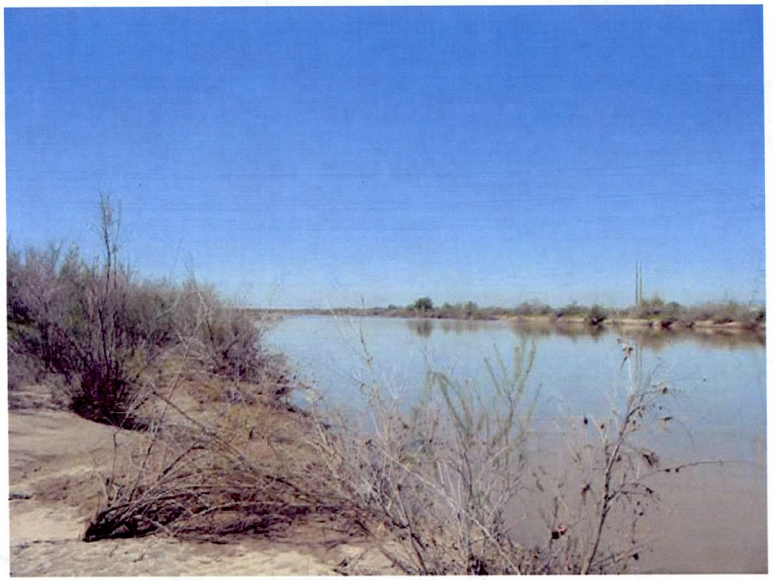
APPENDIX A

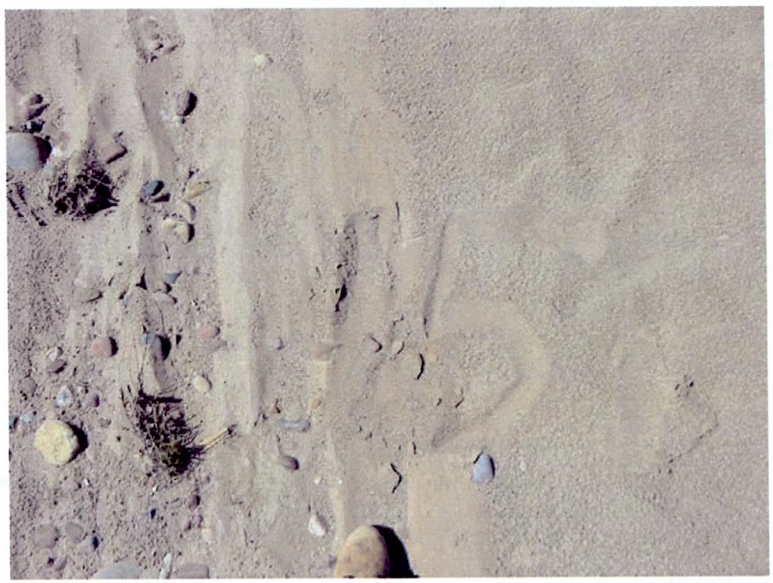
Field Photographs and Logs Report
Manning's n Value Field Assessments

Photos Waypoint 10 – South Overbank – Photos IMG_4293-4296 (L-R by Row) Very Low Density n=0.03 due to small area of shrubs

Waypoints 11-15 – Overbank Area Subject to Flow in 2005 (Photos IMG_4299-4301) n = 0.03 Very Low Density due to small area of shrubs.

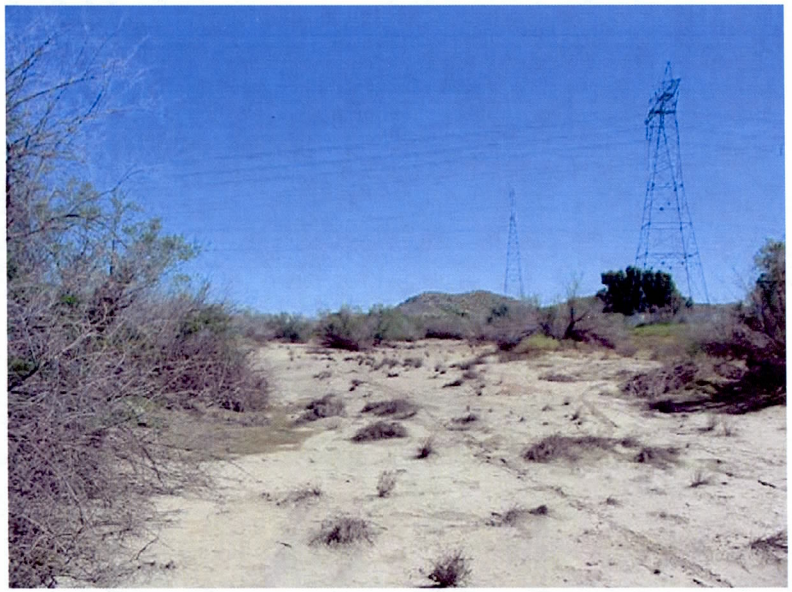


Waypoint 15 – Gila River – IMG_4302-4305 – n = 0.03



Waypoint 16 – Gila River Channel – Very Low Density Vegetation – IMG_4306-4309- n = 0.03

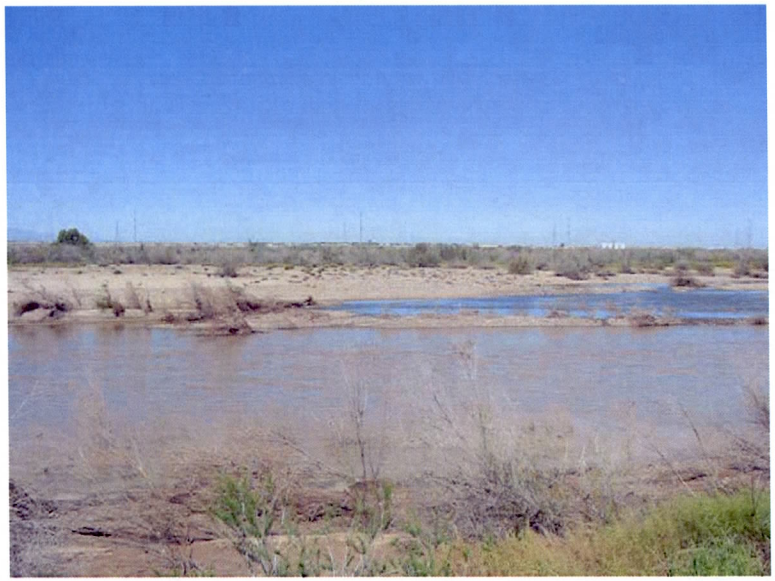
Waypoint 17 – Gila River Channel – IMG_4310-4313 Very Low Density – n = 0.03 due to limited area of vegetation

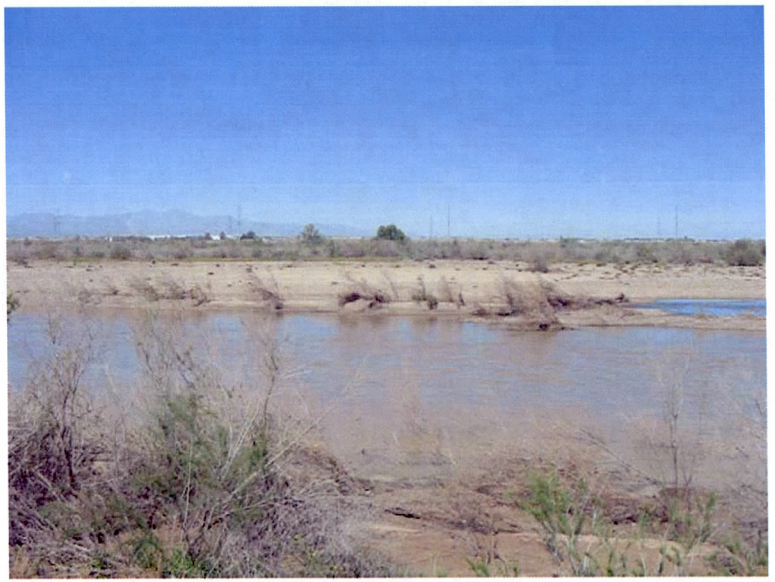


Waypoint 18 – Photos IMG_4314-4317 – Very Low Density / Farmland Interface – n = 0.03 – riverward area

Waypoint 18 – IMG_4318-4320 – n = 0.05 – assume crops during flood for worst case

Waypoint 19 – Very Low Density – IMG_4321-4324 – n = 0.03 upstream and north

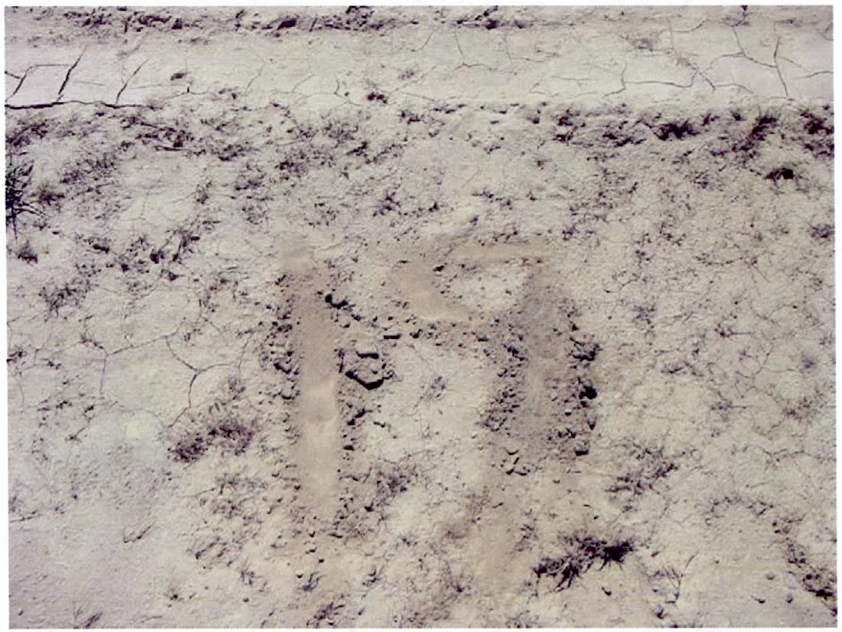




Waypoint 19 – IMG_4325-4328 Low Density – n = 0.03 northwest except lower right – n = 0.04

Waypoint 19 – IMG_4329-4332 – Very Low and Low Density Interface note higher density in distance n = 0.03 to 0.04

Waypoint 19 – Interface Between Very Low and Low Vegetation – IMG_4333-4336 n = 0.04



Waypoint 19-20 Photos 4337-4340 Low Density Vegetation – n = 0.04

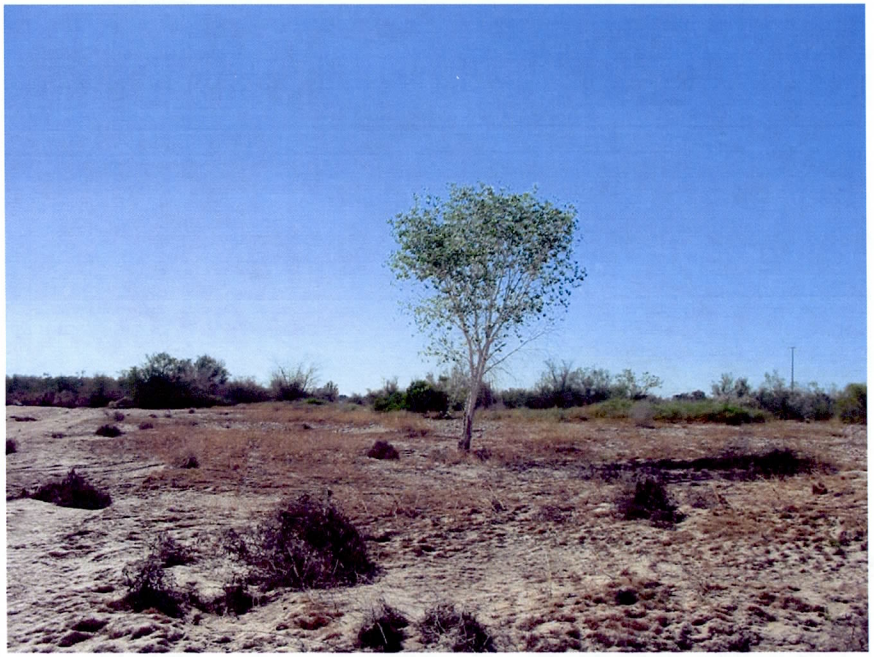
Waypoint 19-20 Photos 4341-4344 – Low Density Vegetation – n = 0.04

Waypoint 20 – Photos 4345-4347, 4349 Low Density Vegetation – n = 0.04

Waypoint 20 Photos 4350-4353 – Low Density Vegetation - n = 0.04

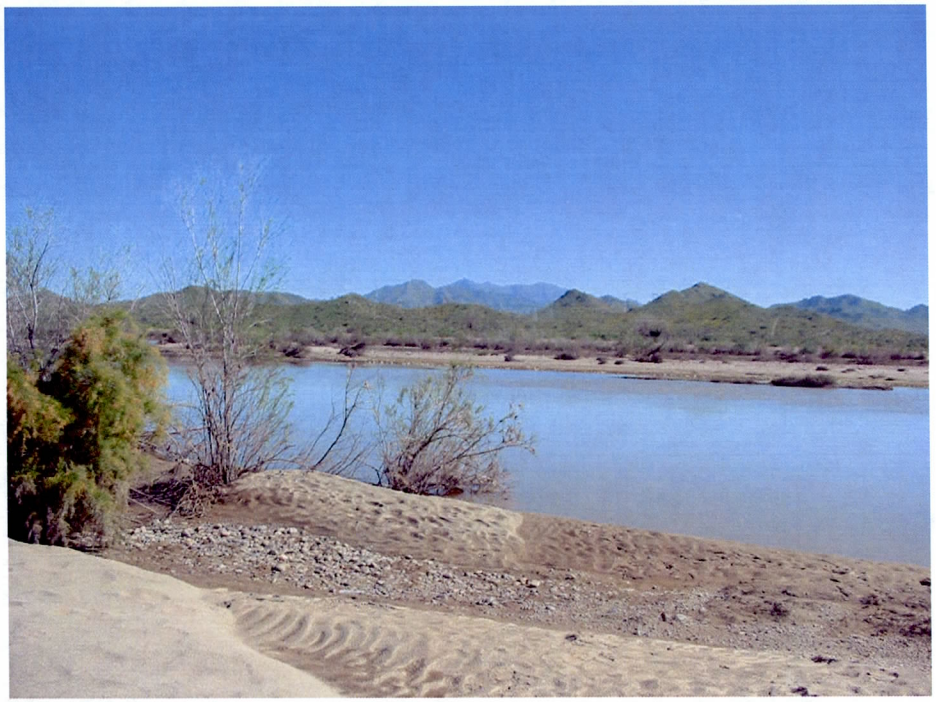
Waypoint 20 – Photos 4354-4357 – Boundary of Low Density Vegetation – n = 0.04

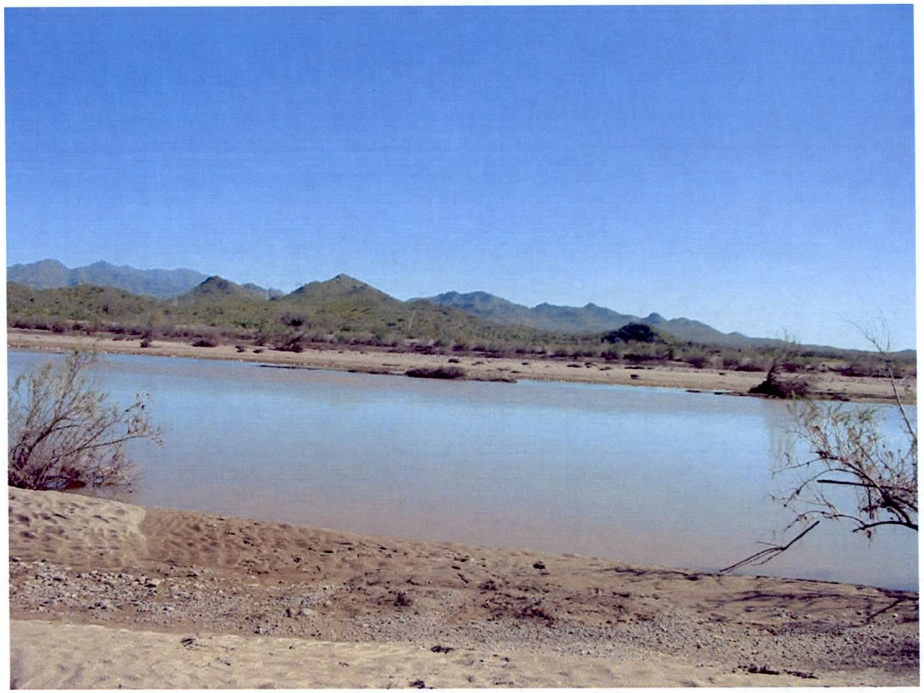
Waypoint 21 – Photo 4358-4361 Medium High Vegetation Density – n = 0.12 (background upper right and lower left)



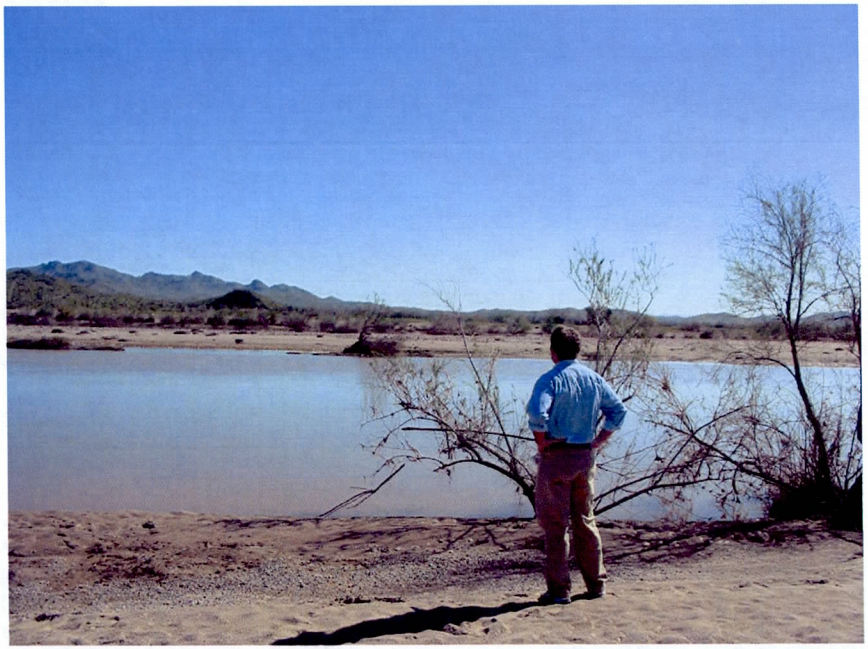
Waypoint 24 Photos 4365-4368 – Very Low Density Vegetation – n = 0.03

Waypoint 24 Photos 4369-4372 Very Low Density Vegetation n = 0.03



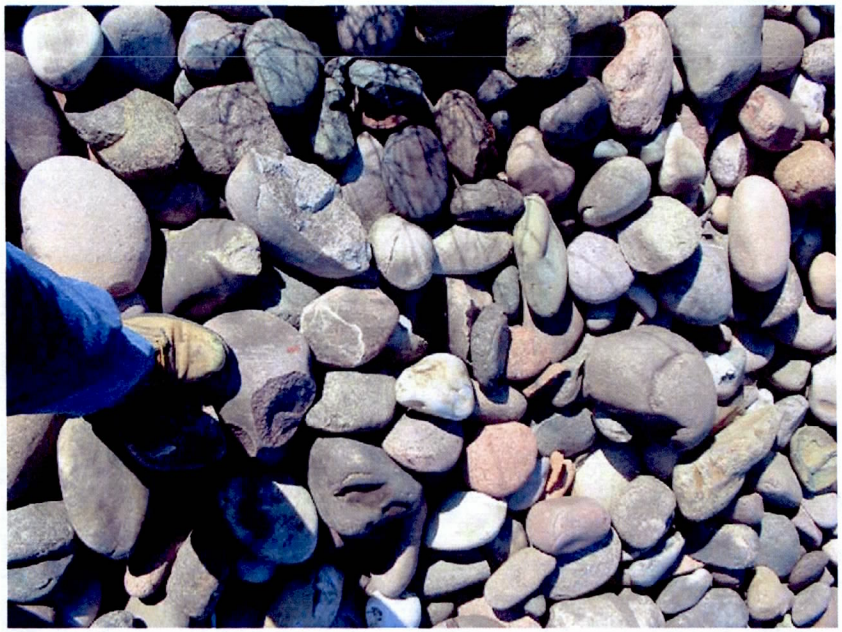


Waypoint 24 – Photos 4373-4376 – Main Channel – Very Low Density Vegetation - n = 0.03



Waypoint 24 – Photos 4377-4380 Very Low Density – n = 0.03

Waypoint 28 – Photos 4383-4385 Protected north bank with Medium Dense Vegetation to left in channel – n = 0.06



Waypoint 27 - Photo 4386-4389 – Protected north bank with medium dense vegetation across channel - n = 0.06

Waypoint 29 – Photos 4390-4391 East end of protected north bank – medium dense vegetation in channel – n = 0.06

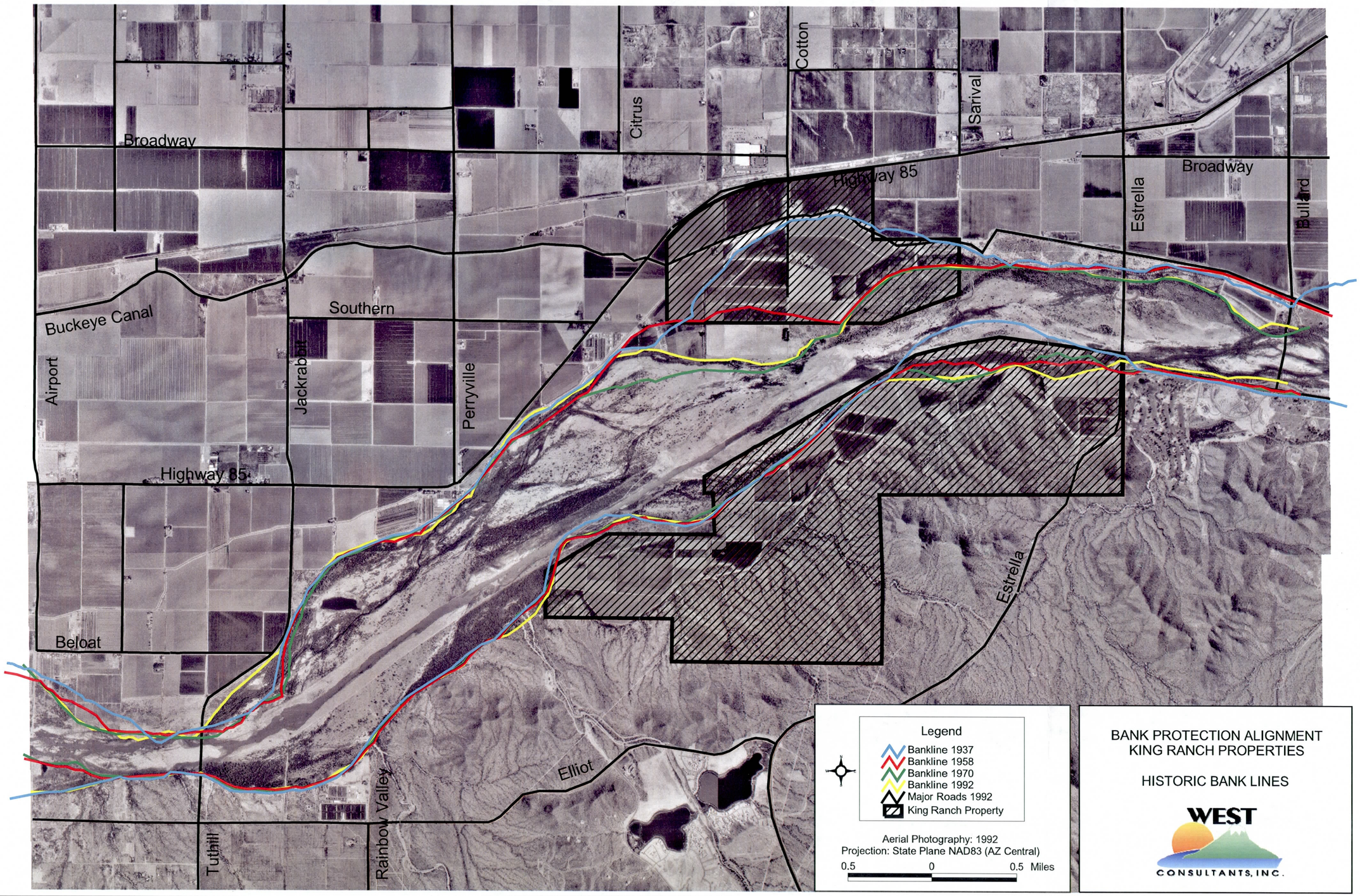
Channel at Bullard Avenue Looking Upstream (East) – Medium Vegetation Density (n = 0.06) Photos 4394-4397

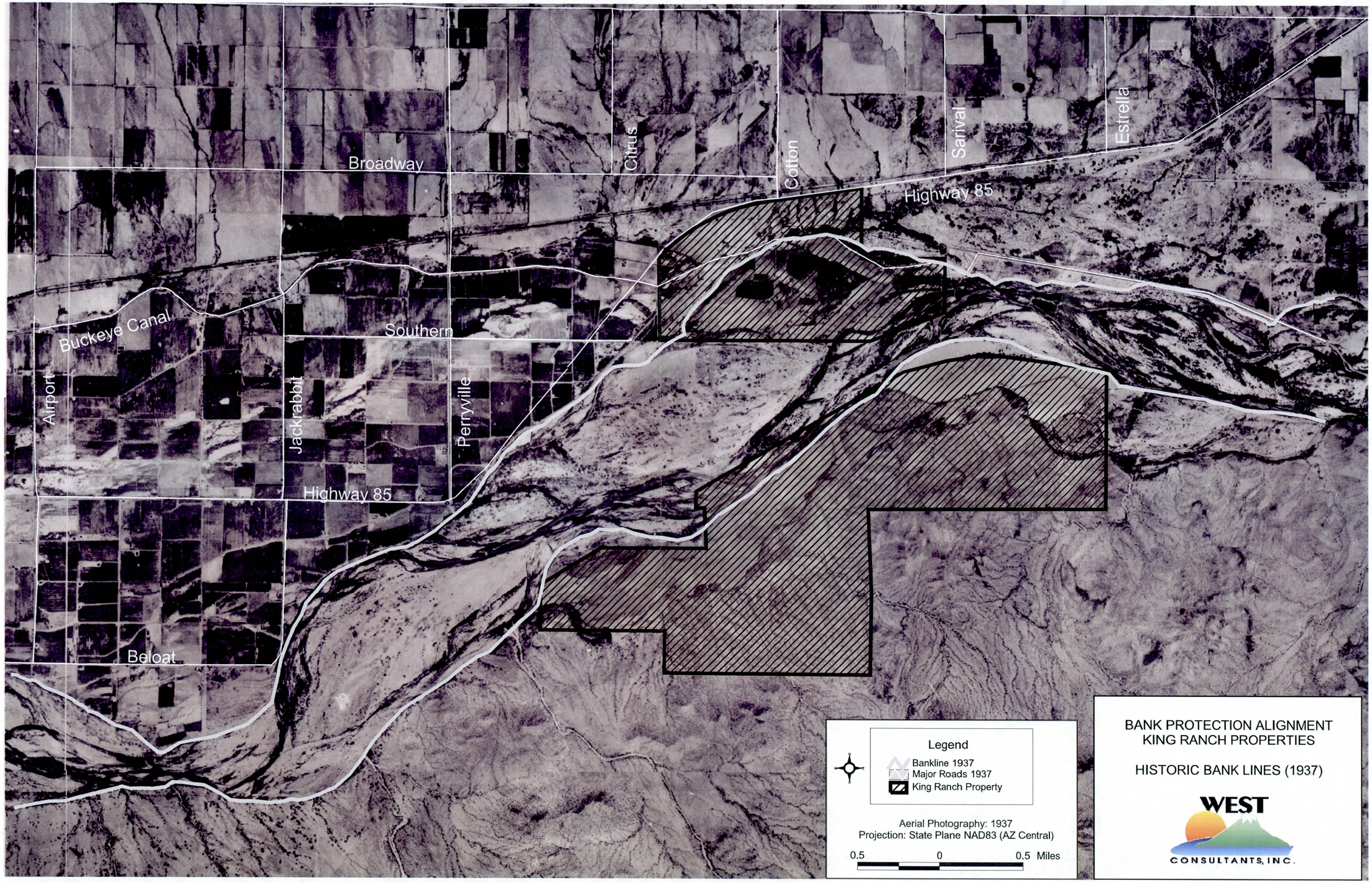
Looking Upstream from Center of Bullard Ave Bridge (From North to East) - Low Density Vegetation (n = 0.03)

Bullard Avenue Bridge – looking east to south – Low density vegetation (n = 0.03) Photos 4403-4406

APPENDIX B

HISTORIC AERIAL PHOTOS AND BANK LINES


Broadway
Citrus
Cotton
Sarival
Highway 85
Broadway
Estrella
Bullard
Buckeye Canal
Southern
Airport
Jackrabbit
Perryville
Highway 85
Beloat
Estrella
Elliot
Tuthill
Rainbow Valley
Legend
Bankline 1937
Bankline 1958
Bankline 1970
Bankline 1992
Major Roads 1992
King Ranch Property
Aerial Photography: 1992
Projection: State Plane NAD83 (AZ Central)
0.5 0 0.5 Miles
BANK PROTECTION ALIGNMENT
KING RANCH PROPERTIES
HISTORIC BANK LINES
WEST
CONSULTANTS, INC.


Broadway
Citrus
Cotton
Sarival
Estrella
Highway 85
Buckeye Canal
Southern
Airport
Jackrabbit
Perryville
Highway 85
Beloat
Legend
Bankline 1937
Major Roads 1937
King Ranch Property
Aerial Photography: 1937
Projection: State Plane NAD83 (AZ Central)
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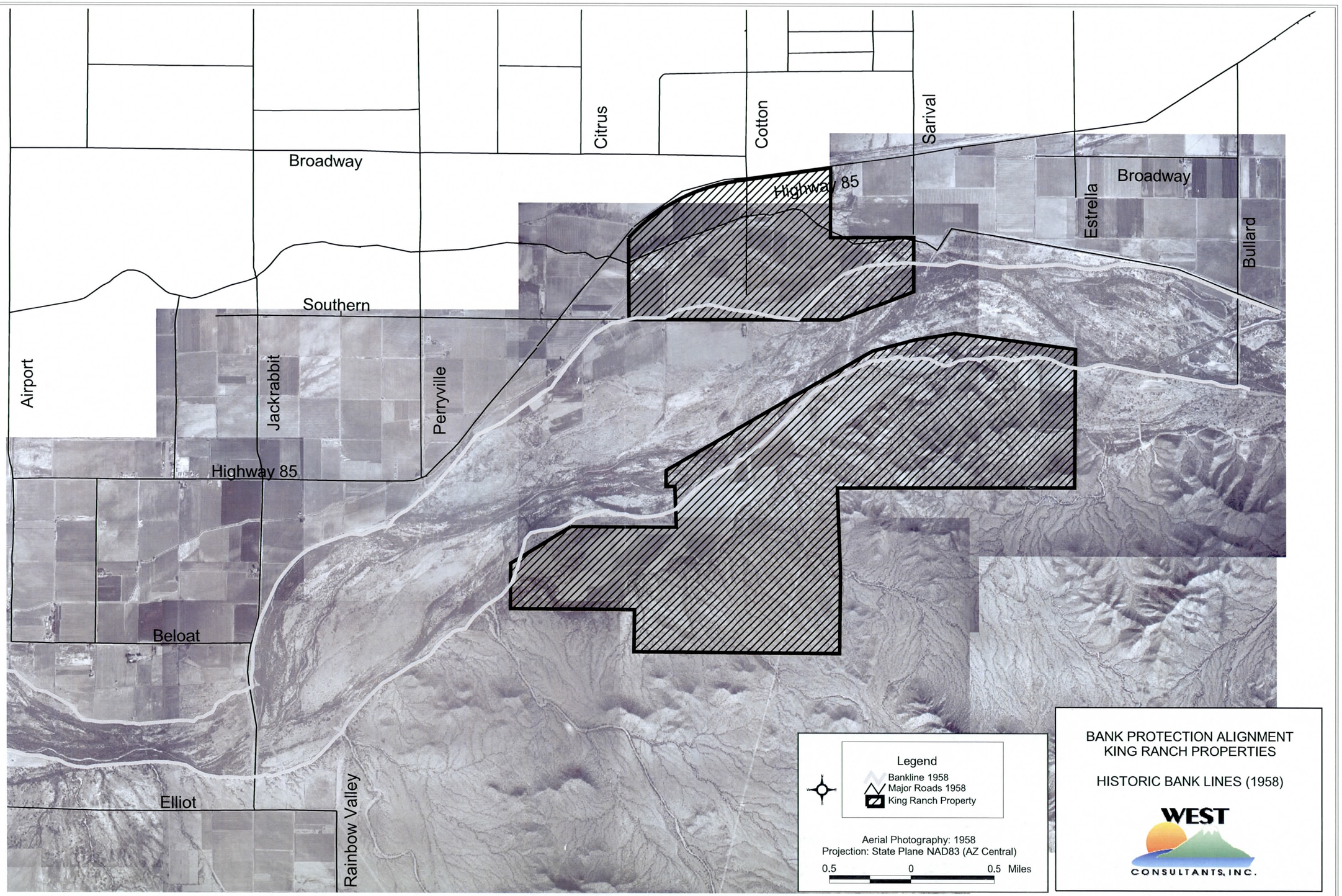
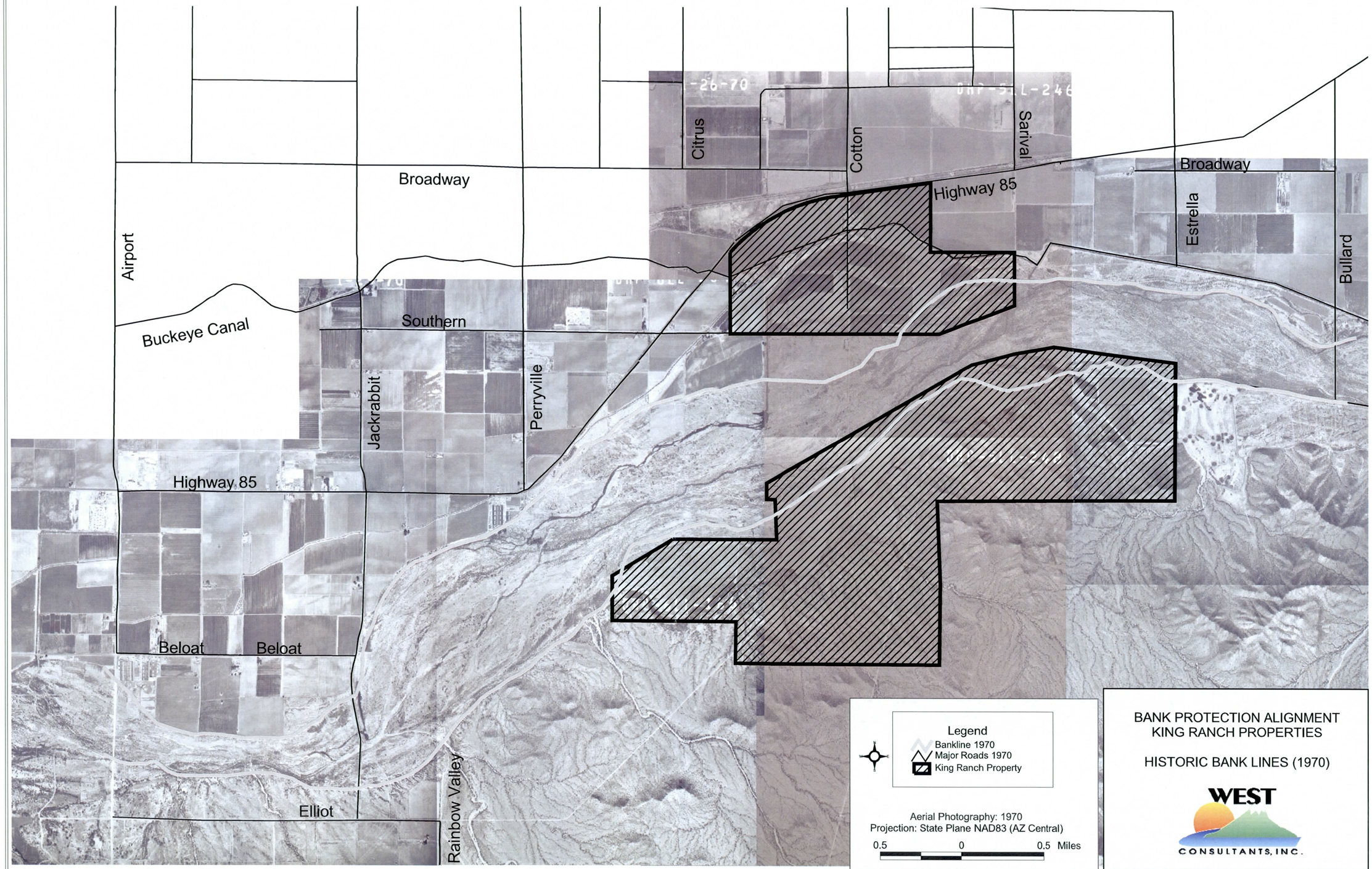
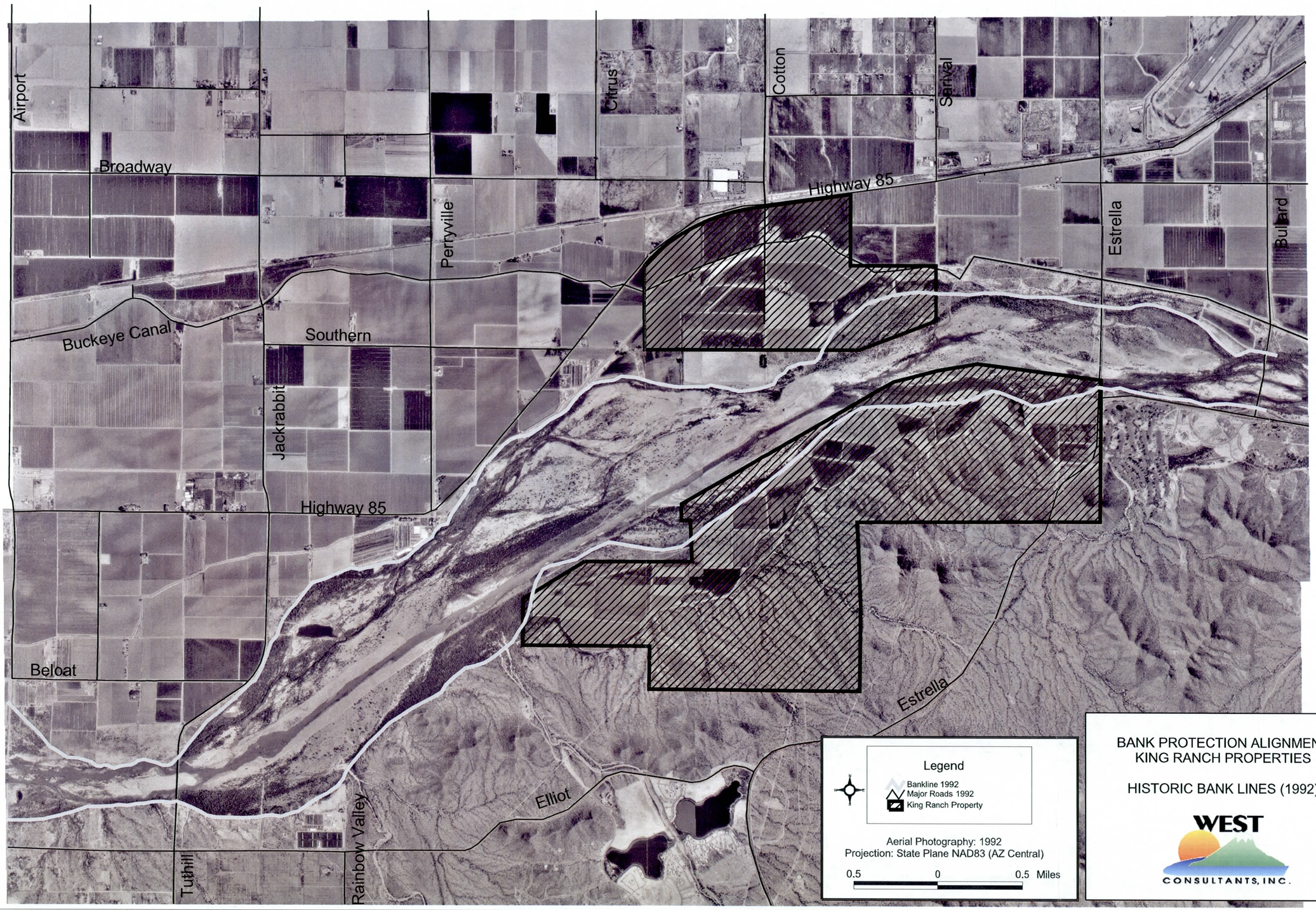
BANK PROTECTION ALIGNMENT
KING RANCH PROPERTIES
HISTORIC BANK LINES (1937)
WEST
CONSULTANTS, INC.


Broadway
Citrus
Cotton
Sarival
Highway 85
Broadway
Estrella
Bullard
Southern
Airport
Jackrabbit
Perryville
Highway 85
Beloat
Elliot
Rainbow Valley
Legend
Bankline 1958
Major Roads 1958
King Ranch Property
Aerial Photography: 1958
Projection: State Plane NAD83 (AZ Central)
0.5 0 0.5 Miles
BANK PROTECTION ALIGNMENT
KING RANCH PROPERTIES
HISTORIC BANK LINES (1958)
WEST
CONSULTANTS, INC.


Broadway
Airport
Buckeye Canal
Southern
Citrus
Cotton
Sarival
Broadway
Estrella
Bullard
Highway 85
Perryville
Jackrabbit
Highway 85
Beloat
Beloat
Elliot
Rainbow Valley
Legend
Bankline 1970
Major Roads 1970
King Ranch Property
Aerial Photography: 1970
Projection: State Plane NAD83 (AZ Central)
0.5 0 0.5 Miles
BANK PROTECTION ALIGNMENT
KING RANCH PROPERTIES
HISTORIC BANK LINES (1970)
WEST
CONSULTANTS, INC.



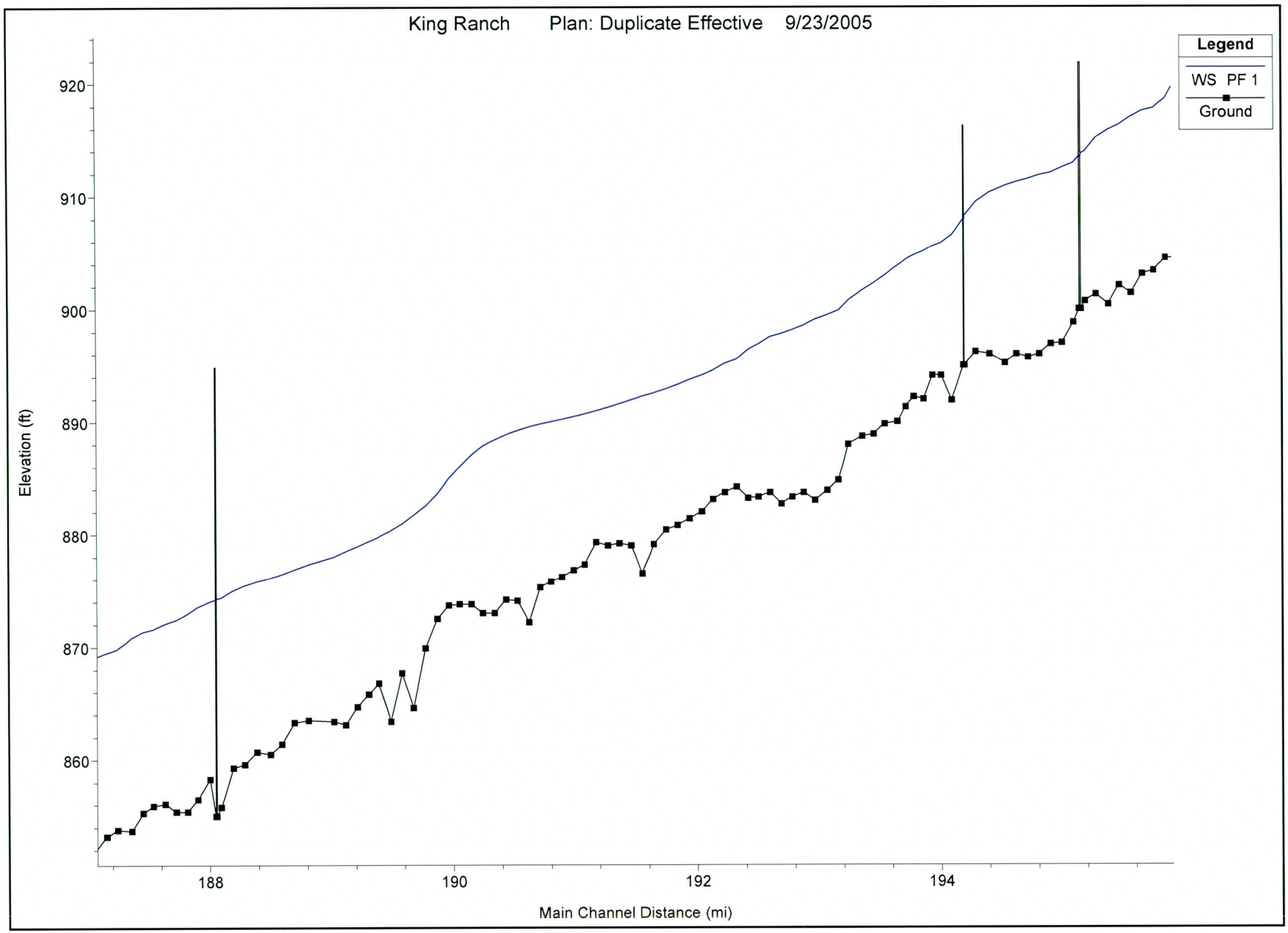
BANK PROTECTION ALIGNMENT
KING RANCH PROPERTIES

HISTORIC BANK LINES (1992)

WEST CONSULTANTS, INC.

APPENDIX C

Existing Condition HEC-RAS Model Results


King Ranch Plan: Duplicate Effective 9/23/2005
Legend
WS PF 1
Ground
920
910
900
890
880
870
860
Elevation (ft)
188
190
192
194
Main Channel Distance (mi)

HEC-RAS River: Gila Reach: 1 Profile: PF 1

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)	
1	195.85	Dupe Effec	227000.00	904.50	918.65	915.94	920.75	0.002203	12.26	23405.03	5287.65	0.60
1	195.75	Dupe Effec	227000.00	903.40	917.78	914.96	919.54	0.002135	11.17	22887.90	4484.18	0.58
1	195.75	EC FIS	227000.00	903.40	917.73	914.96	919.51	0.002168	11.22	22774.02	4473.94	0.59
1	195.66	Dupe Effec	227000.00	903.10	917.53	912.70	918.56	0.001143	8.42	28865.96	4371.39	0.43
1	195.66	EC FIS	227000.00	903.10	917.47	912.70	918.52	0.001162	8.46	28722.96	4347.24	0.43
1	195.56	Dupe Effec	227000.00	901.40	917.01	911.75	917.98	0.001135	8.07	28976.41	4114.54	0.42
1	195.56	EC FIS	227000.00	901.40	916.94	911.75	917.93	0.001156	8.12	28810.95	4106.66	0.42
1	195.47	Dupe Effec	227000.00	902.10	916.29	911.88	917.34	0.001347	8.36	28071.92	4377.25	0.45
1	195.47	EC FIS	227000.00	902.10	916.20	911.88	917.27	0.001385	8.43	27821.90	4362.31	0.45
1	195.38	Dupe Effec	227000.00	900.40	915.84	910.84	916.73	0.001064	7.74	31256.28	4074.60	0.40
1	195.38	EC FIS	227000.00	900.40	915.74	910.84	916.64	0.001098	7.82	30931.73	4013.89	0.41
1	195.28	Dupe Effec	227000.00	901.30	915.12	910.16	916.13	0.001069	8.27	29946.91	5149.13	0.42
1	195.28	EC FIS	227000.00	901.30	914.99	910.16	916.02	0.001115	8.39	29505.45	5073.02	0.43
1	195.19	Dupe Effec	227000.00	900.70	913.93	910.33	915.43	0.001746	10.13	24088.51	4217.69	0.53
1	195.19	EC FIS	227000.00	900.70	913.69	910.33	915.28	0.001884	10.39	23450.08	4198.92	0.55
1	195.16	Dupe Effec	227000.00	900.00	913.71	908.68	915.12	0.001320	9.62	24361.72	2345.16	0.47
1	195.16	EC FIS	227000.00	900.00	913.48	908.68	914.95	0.001407	9.81	23853.05	2341.51	0.48
1	195.145		Bridge									
1	195.13	Dupe Effec	227000.00	900.00	913.49	908.68	914.95	0.001400	9.80	23908.85	2250.79	0.48
1	195.13	EC FIS	227000.00	900.00	913.23	908.68	914.76	0.001503	10.02	23350.55	2237.84	0.50
1	195.09	Dupe Effec	227000.00	898.80	912.92	909.24	914.55	0.001800	10.41	23264.79	3870.46	0.54
1	195.09	EC FIS	227000.00	898.80	912.58	909.24	914.32	0.001998	10.76	22308.36	3660.31	0.56
1	195	Dupe Effec	227000.00	897.00	912.50	908.48	913.63	0.001335	8.77	28262.35	4603.73	0.46
1	195	EC FIS	227000.00	897.00	912.06	908.48	913.29	0.001537	9.17	26698.18	4368.53	0.49
1	194.91	Dupe Effec	227000.00	896.90	912.04	907.63	912.96	0.001156	7.95	31220.91	5049.35	0.43
1	194.91	EC FIS	227000.00	896.90	911.44	907.63	912.52	0.001442	8.55	28714.85	4973.81	0.47
1	194.81	Dupe Effec	227000.00	896.00	911.83	905.84	912.45	0.000657	6.51	38052.68	5295.65	0.33
1	194.81	EC FIS	227000.00	896.00	911.17	905.84	911.89	0.000815	7.00	35160.22	5168.10	0.37
1	194.72	Dupe Effec	227000.00	895.70	911.49	905.79	912.12	0.000721	6.53	37296.60	5052.78	0.34
1	194.72	EC FIS	227000.00	895.70	910.73	905.79	911.47	0.000923	7.07	34273.66	4730.49	0.38
1	194.62	Dupe Effec	227000.00	896.00	911.22	905.58	911.75	0.000632	6.02	39329.16	5483.94	0.32
1	194.62	EC FIS	227000.00	896.00	910.35	905.58	911.00	0.000856	6.66	35706.64	5298.42	0.36
1	194.53	Dupe Effec	227000.00	895.20	910.88	905.21	911.43	0.000668	6.07	39262.35	6542.52	0.32
1	194.53	EC FIS	227000.00	895.20	909.84	905.21	910.54	0.000963	6.86	34624.42	5589.16	0.38
1	194.4	Dupe Effec	227000.00	896.00	910.30	904.77	910.94	0.000737	6.63	36874.39	6723.06	0.34
1	194.4	EC FIS	227000.00	896.00	908.87	904.77	909.78	0.001211	7.81	31032.90	5846.11	0.43
1	194.29	Dupe Effec	227000.00	896.20	909.44	904.97	910.32	0.001109	7.68	30593.88	5971.78	0.41
1	194.29	EC FIS	227000.00	896.20	906.89	904.97	908.48	0.002842	10.31	22847.51	5100.20	0.64
1	194.21	Dupe Effec	227000.00	895.00	908.21	903.83	909.56	0.001488	9.33	24317.26	2140.38	0.49
1	194.21	EC FIS	227000.00	883.10	905.94	902.06	907.43	0.001619	9.79	23180.12	2986.14	0.52
1	194.200	EC FIS	227000.00	882.97	905.65		907.20	0.001733	10.00	22708.96	2490.10	0.54
1	194.195		Bridge									
1	194.18	Dupe Effec	227000.00	895.00	907.96	903.83	909.38	0.001600	9.54	23788.79	2138.48	0.50
1	194.100	EC FIS	227000.00	883.87	905.03		906.30	0.001487	9.03	25152.53	4416.15	0.50
1	194.09	Dupe Effec	227000.00	891.90	906.48	904.28	908.19	0.002976	10.48	21660.59	5496.29	0.64
1	194.020	EC FIS	227000.00	885.49	904.53		905.60	0.001304	8.31	27334.51	4385.17	0.46
1	194.01	Dupe Effec	227000.00	894.10	905.82	902.59	906.93	0.001899	8.45	26850.71	5422.52	0.50
1	193.940	EC FIS	227000.00	885.38	904.24		905.09	0.001055	7.43	30577.74	4824.95	0.40

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	193.93	Dupe Effec	227000.00	894.10	905.53	901.12	906.28	0.001111	6.96	32682.98	4960.39	0.40
1	193.870	EC FIS	227000.00	882.80	903.85		904.60	0.001395	6.92	32789.38	4442.61	0.38
1	193.86	Dupe Effec	227000.00	892.00	905.11	900.74	905.85	0.001114	6.93	32753.66	4575.13	0.40
1	193.790	EC FIS	227000.00	882.55	903.30		903.99	0.001356	6.68	34001.67	4084.62	0.37
1	193.78	Dupe Effec	227000.00	892.20	904.75	899.63	905.37	0.000970	6.33	35874.07	4101.57	0.35
1	193.730	EC FIS	227000.00	882.18	902.84		903.59	0.000969	6.98	32547.95	3422.17	0.40
1	193.71	Dupe Effec	227000.00	891.30	904.30	899.46	905.00	0.001157	6.69	33916.43	3491.22	0.38
1	193.65	Dupe Effec	227000.00	890.00	903.80	899.09	904.56	0.001228	7.01	32396.55	3334.06	0.39
1	193.620	EC FIS	227000.00	878.21	902.08		902.97	0.001205	7.58	29961.99	3219.71	0.43
1	193.54	Dupe Effec	227000.00	889.80	902.93	898.88	903.82	0.001382	7.60	29965.48	3343.41	0.44
1	193.530	EC FIS	227000.00	878.96	901.54		902.39	0.001126	7.39	30800.24	3345.84	0.42
1	193.45	Dupe Effec	227000.00	888.90	902.25	898.15	903.10	0.001620	7.43	30532.05	3530.86	0.43
1	193.430	EC FIS	227000.00	879.37	901.12		901.85	0.000961	6.90	33034.87	3717.42	0.39
1	193.36	Dupe Effec	227000.00	888.70	901.61	897.59	902.41	0.001162	7.17	32169.06	3878.69	0.42
1	193.340	EC FIS	227000.00	881.18	900.74		901.40	0.000849	6.56	34799.45	3882.87	0.37
1	193.250	EC FIS	227000.00	880.67	900.31		900.94	0.001057	6.43	35769.75	4130.63	0.37
1	193.24	Dupe Effec	227000.00	888.00	900.72	897.06	901.57	0.001645	7.39	31095.88	4150.34	0.46
1	193.16	Dupe Effec	227000.00	884.80	899.83	896.56	900.78	0.002012	7.81	29367.20	4179.14	0.50
1	193.16	EC FIS	227000.00	880.66	899.78		900.46	0.000935	6.65	34684.11	4280.19	0.40
1	193.07	Dupe Effec	227000.00	883.90	899.45	893.82	900.06	0.000903	6.25	36849.99	4364.17	0.36
1	193.07	EC FIS	227000.00	881.99	899.39		900.02	0.000833	6.41	36599.66	4501.91	0.38
1	192.980	EC FIS	227000.00	880.71	898.94		899.60	0.000904	6.55	36477.48	4492.52	0.37
1	192.97	Dupe Effec	227000.00	883.00	899.04	893.61	899.58	0.000806	5.98	38933.65	5020.35	0.33
1	192.890	EC FIS	227000.00	880.09	898.26		899.03	0.001424	7.17	34862.68	5006.47	0.41
1	192.88	Dupe Effec	227000.00	883.70	898.53	893.47	899.15	0.000925	6.43	37040.51	5456.69	0.35
1	192.790	EC FIS	227000.00	876.81	897.40		898.32	0.001389	7.93	33573.02	5336.40	0.45
1	192.78	Dupe Effec	227000.00	883.30	898.14	892.61	898.73	0.000708	6.41	38896.72	6211.90	0.34
1	192.700	EC FIS	227000.00	876.64	896.74		897.64	0.001333	7.98	35145.32	5682.11	0.43
1	192.69	Dupe Effec	227000.00	882.70	897.80	892.37	898.38	0.000677	6.53	39839.13	6880.82	0.33
1	192.610	EC FIS	227000.00	878.15	896.15		897.03	0.001154	8.00	35546.89	5872.80	0.42
1	192.6	Dupe Effec	227000.00	883.70	897.49	892.80	897.99	0.000799	6.06	40747.94	6443.18	0.32
1	192.520	EC FIS	227000.00	878.23	895.53		896.44	0.001148	8.05	34239.52	6077.61	0.42
1	192.51	Dupe Effec	227000.00	883.30	896.86	893.05	897.54	0.000955	7.21	36499.05	7531.22	0.39
1	192.42	Dupe Effec	227000.00	883.20	896.36	892.68	897.03	0.001202	7.18	36197.95	7133.54	0.40
1	192.42	EC FIS	227000.00	876.63	894.89		895.82	0.001336	8.28	32561.57	5843.05	0.45
1	192.33	Dupe Effec	227000.00	884.20	895.51	892.70	896.37	0.001428	8.10	33196.96	6171.26	0.47
1	192.33	EC FIS	227000.00	876.06	893.94		895.05	0.001690	8.81	30701.01	6006.68	0.50
1	192.23	Dupe Effec	227000.00	883.70	895.12	891.34	895.67	0.001029	6.25	38851.23	6812.14	0.36
1	192.23	EC FIS	227000.00	876.72	893.34		894.21	0.001422	7.75	34065.29	5915.17	0.44
1	192.140	EC FIS	227000.00	875.94	892.70		893.51	0.001371	7.46	35753.43	6577.71	0.44
1	192.13	Dupe Effec	227000.00	883.10	894.53	891.11	895.04	0.001305	5.62	39743.45	7677.65	0.34

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (Continued)

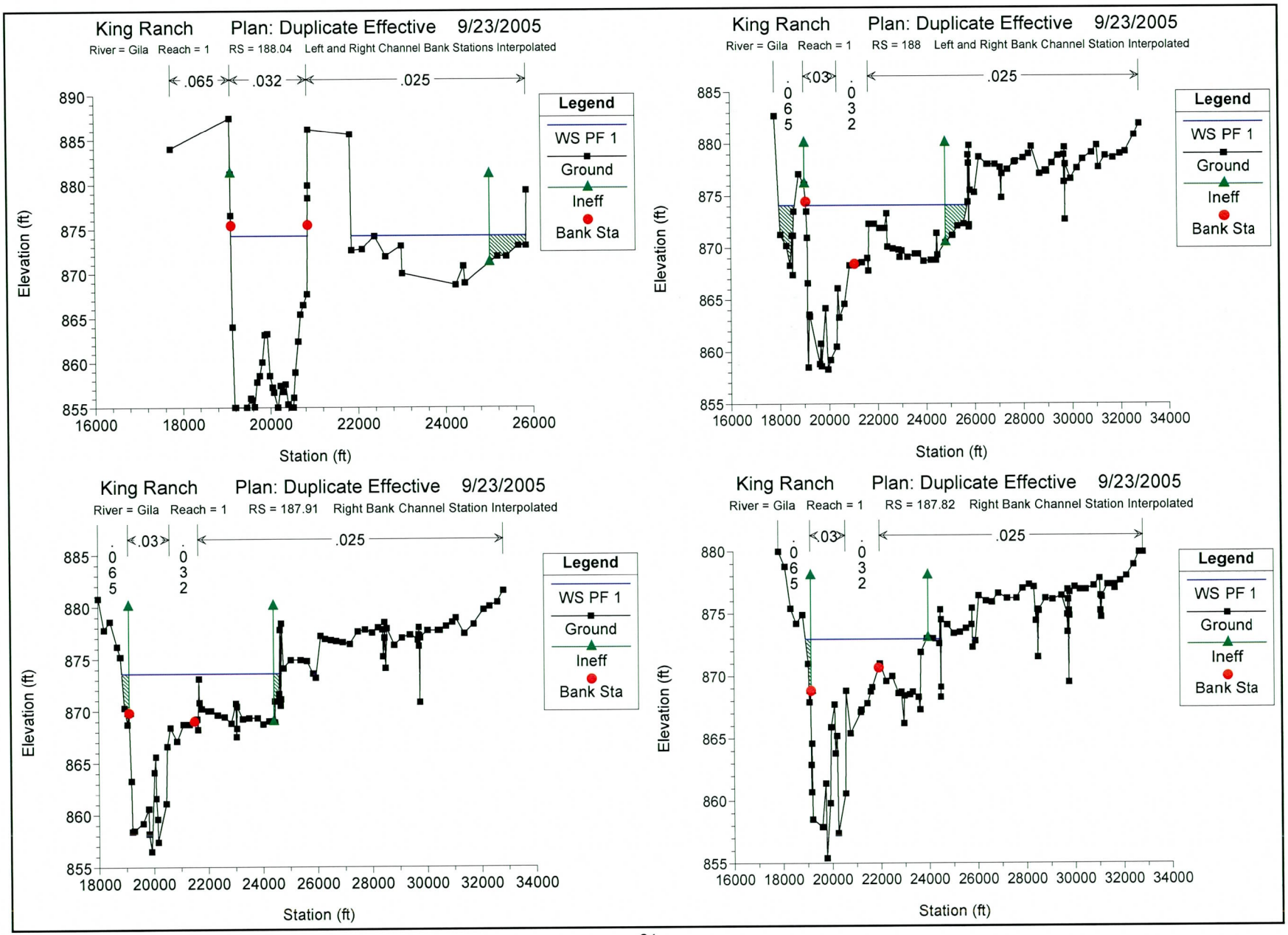
Reach	River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	192.04	Dupe Effec	227000.00	882.00	894.07	890.72	894.52	0.000824	5.59	42424.03	7766.74	0.34
1	192.04	EC FIS	227000.00	876.36	892.15		892.84	0.001184	6.87	38705.71	6340.30	0.41
1	191.950	EC FIS	227000.00	874.98	891.68		892.27	0.000992	6.35	40579.67	6286.37	0.38
1	191.94	Dupe Effec	227000.00	881.40	893.70	889.79	894.09	0.000797	5.07	45584.10	7948.92	0.30
1	191.860	EC FIS	227000.00	874.43	891.23		891.77	0.000956	6.01	41392.52	6194.40	0.36
1	191.84	Dupe Effec	227000.00	880.80	893.24		893.64	0.000911	5.26	45223.06	7847.64	0.32
1	191.760	EC FIS	227000.00	874.62	890.77		891.25	0.001023	5.75	43691.46	6618.45	0.35
1	191.75	Dupe Effec	227000.00	880.40	892.86	888.67	893.19	0.000796	4.82	49970.53	8659.98	0.29
1	191.670	EC FIS	227000.00	872.60	890.21		890.70	0.001196	5.76	42353.34	6318.40	0.36
1	191.65	Dupe Effec	227000.00	879.10	892.50	887.65	892.80	0.000606	4.57	53249.00	9077.19	0.27
1	191.570	EC FIS	227000.00	870.63	889.70		890.12	0.001047	5.33	44937.55	6254.95	0.34
1	191.55	Dupe Effec	227000.00	876.50	892.22	887.42	892.50	0.000677	4.39	54705.82	9150.76	0.26
1	191.480	EC FIS	227000.00	870.93	889.22		889.61	0.000939	5.10	45899.68	7187.75	0.32
1	191.46	Dupe Effec	227000.00	879.00	891.88	887.33	892.16	0.000657	4.34	53804.05	8798.20	0.27
1	191.380	EC FIS	227000.00	871.69	888.72		889.13	0.000974	5.18	44881.15	6649.49	0.34
1	191.36	Dupe Effec	227000.00	879.20	891.53	887.22	891.80	0.000745	4.16	54771.66	9220.32	0.26
1	191.290	EC FIS	227000.00	870.63	888.28		888.67	0.000858	4.99	46526.23	7388.01	0.31
1	191.27	Dupe Effec	227000.00	879.00	891.23	886.23	891.46	0.000570	3.81	59113.20	9572.63	0.23
1	191.190	EC FIS	227000.00	869.78	887.86		888.26	0.000787	5.05	46198.18	7861.27	0.30
1	191.17	Dupe Effec	227000.00	879.30	890.94	885.71	891.18	0.000553	3.96	58001.98	9540.22	0.23
1	191.100	EC FIS	227000.00	870.88	887.51		887.91	0.000629	5.09	46885.33	7293.46	0.29
1	191.08	Dupe Effec	227000.00	877.30	890.65	885.43	890.90	0.000536	4.07	57635.00	9711.45	0.23
1	191.000	EC FIS	227000.00	869.64	887.13		887.57	0.000686	5.41	44628.57	7582.72	0.31
1	190.99	Dupe Effec	227000.00	876.80	890.40	884.28	890.66	0.000469	4.20	57790.23	7494.27	0.23
1	190.910	EC FIS	227000.00	867.98	886.72		887.20	0.000782	5.65	43346.07	7999.37	0.32
1	190.89	Dupe Effec	227000.00	876.20	890.18	883.88	890.41	0.000487	4.04	58720.39	10378.21	0.22
1	190.810	EC FIS	227000.00	867.86	886.37		886.84	0.000669	5.59	44158.22	8364.90	0.31
1	190.8	Dupe Effec	227000.00	875.80	889.97	883.73	890.20	0.000447	3.90	60413.32	11719.18	0.21
1	190.720	EC FIS	227000.00	866.30	886.05		886.50	0.000661	5.50	45458.39	8348.21	0.30
1	190.71	Dupe Effec	227000.00	875.30	889.76	883.41	889.98	0.000456	3.86	61067.79	11919.51	0.21
1	190.62	Dupe Effec	227000.00	872.20	889.50	882.54	889.75	0.000472	3.97	57867.10	11205.91	0.20
1	190.62	EC FIS	227000.00	867.37	885.69		886.15	0.000739	5.55	44852.69	7726.17	0.30
1	190.53	Dupe Effec	227000.00	874.10	889.20	882.19	889.47	0.000687	4.22	54383.10	11111.69	0.22
1	190.53	EC FIS	227000.00	866.16	885.12		885.61	0.001724	5.68	42071.69	6517.66	0.32
1	190.43	Dupe Effec	227000.00	874.20	888.82	881.51	889.12	0.000750	4.47	54839.95	11248.10	0.23
1	190.43	EC FIS	227000.00	867.42	884.46		884.98	0.000953	5.82	40797.63	5841.82	0.33
1	190.34	Dupe Effec	227000.00	873.00	888.35	881.37	888.65	0.001233	4.39	52085.64	11643.56	0.24
1	190.34	EC FIS	227000.00	866.61	884.00		884.46	0.001034	5.43	41834.49	5720.86	0.32
1	190.24	Dupe Effec	227000.00	873.00	887.82	880.86	888.13	0.000861	4.46	51604.94	11847.98	0.24
1	190.24	EC FIS	227000.00	866.29	883.45		883.89	0.001198	5.36	42387.94	5596.41	0.31
1	190.15	Dupe Effec	227000.00	873.80	887.01	882.20	887.50	0.002000	5.62	41355.20	12521.23	0.34
1	190.15	EC FIS	227000.00	865.74	882.61		883.22	0.001518	6.24	36446.58	5097.66	0.38

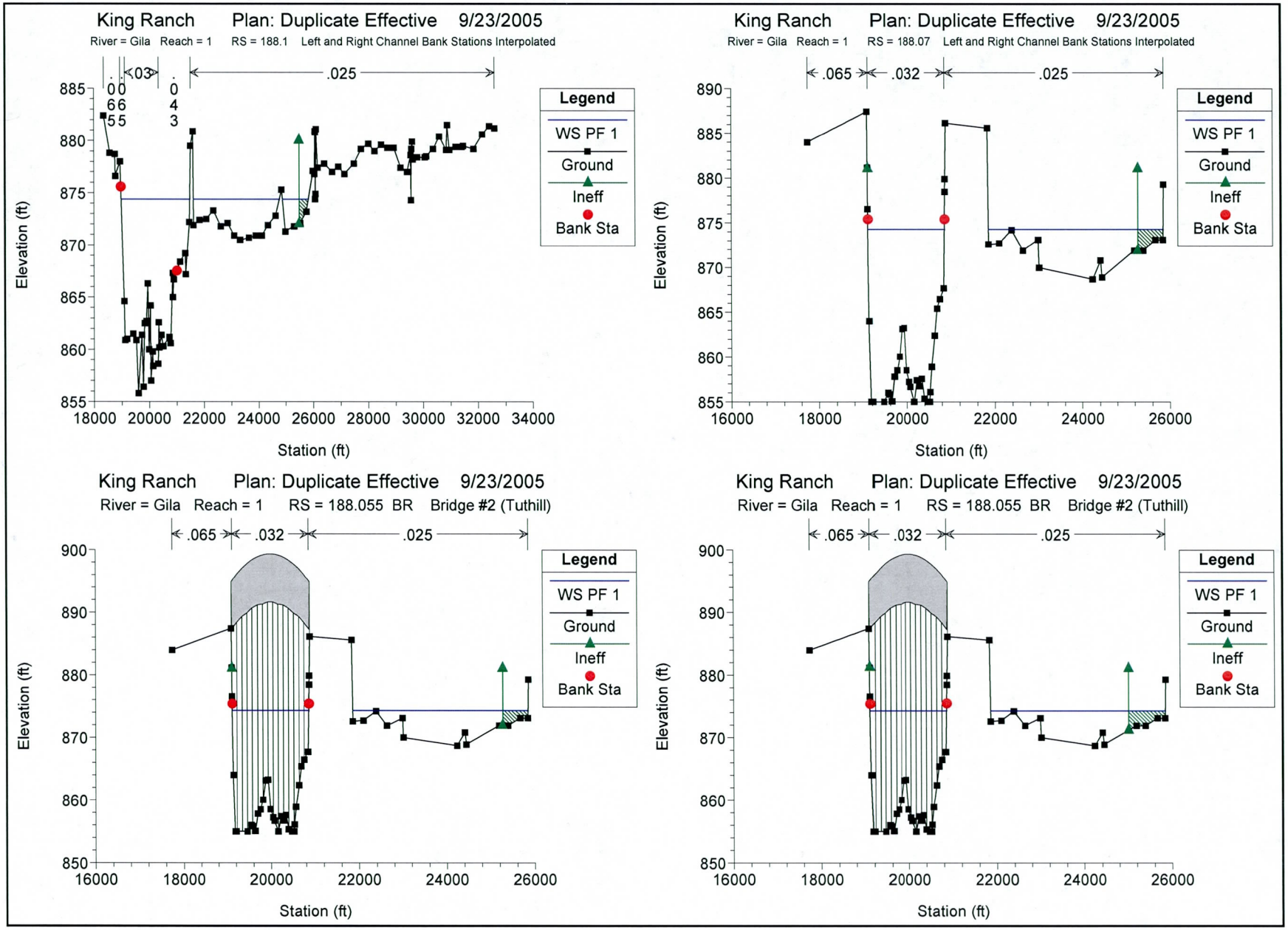
HEC-RAS River: Gila Reach: 1 Profile: PF 1 (Continued)

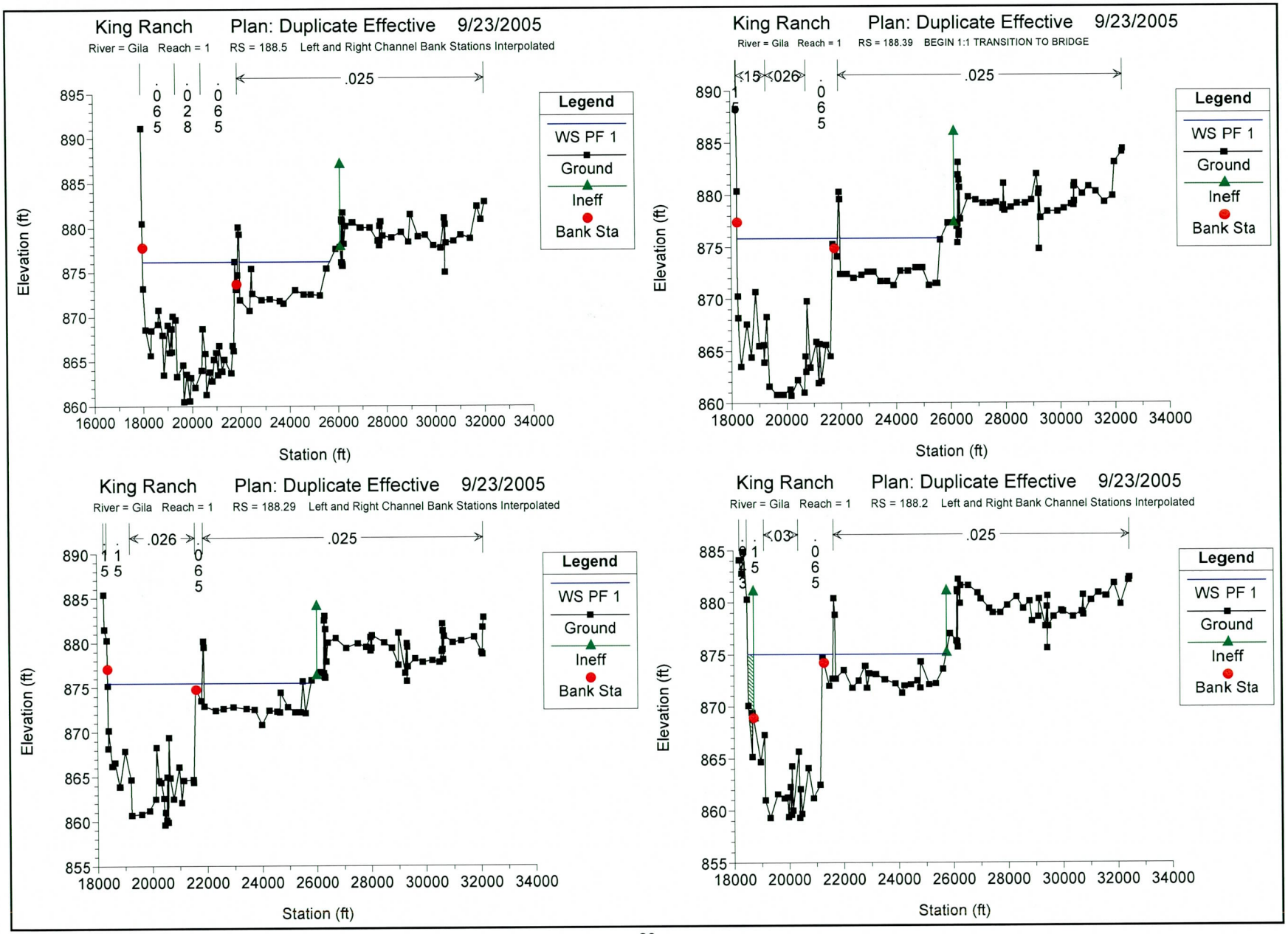
Reach	River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	190.05	Dupe Effec	227000.00	873.80	885.99	881.79	886.56	0.001708	6.12	37817.95	12160.34	0.38
1	190.05	EC FIS	227000.00	858.06	882.07		882.52	0.001089	5.38	42196.50	5755.81	0.30
1	189.96	Dupe Effec	227000.00	873.70	884.93	881.25	885.56	0.002540	6.41	35768.85	11879.18	0.40
1	189.96	EC FIS	227000.00	857.56	881.52		881.98	0.001179	5.43	41782.05	5173.45	0.30
1	189.87	Dupe Effec	227000.00	872.50	883.54	880.41	884.24	0.002852	6.75	33882.41	11839.84	0.44
1	189.87	EC FIS	227000.00	862.94	880.98		881.41	0.001119	5.28	43407.35	9106.03	0.30
1	189.77	Dupe Effec	227000.00	869.90	882.48	878.25	882.95	0.001848	5.49	41247.31	12202.15	0.34
1	189.77	EC FIS	227000.00	860.75	880.56		880.89	0.000778	4.64	50356.75	10644.73	0.25
1	189.68	Dupe Effec	227000.00	864.60	881.65	877.27	882.10	0.001501	5.42	42378.98	12293.09	0.33
1	189.670	EC FIS	227000.00	862.77	880.16		880.48	0.000779	4.56	51568.92	10427.07	0.25
1	189.58	Dupe Effec	227000.00	867.70	880.91	876.36	881.36	0.001514	5.53	42682.80	11905.50	0.34
1	189.58	EC FIS	227000.00	857.92	879.80		880.11	0.000701	4.53	52684.95	9175.34	0.24
1	189.49	Dupe Effec	227000.00	863.40	880.32	875.29	880.70	0.001081	5.10	47016.49	10728.38	0.31
1	189.480	EC FIS	227000.00	857.85	879.48		879.77	0.000636	4.42	54786.62	8934.14	0.23
1	189.39	Dupe Effec	227000.00	866.80	879.75	874.86	880.15	0.001145	5.29	46038.21	10705.65	0.32
1	189.39	EC FIS	227000.00	855.02	879.18		879.47	0.000545	4.45	55398.39	9977.68	0.23
1	189.31	Dupe Effec	227000.00	865.80	879.34	874.20	879.70	0.001026	5.02	48027.75	10326.30	0.30
1	189.300	EC FIS	227000.00	856.36	878.90		879.21	0.000638	4.59	54138.75	9775.70	0.24
1	189.22	Dupe Effec	227000.00	864.70	878.92	874.04	879.26	0.001017	4.89	48879.11	9433.39	0.29
1	189.210	EC FIS	227000.00	856.97	878.54		878.80	0.001059	4.32	56990.95	9083.98	0.23
1	189.12	Dupe Effec	227000.00	863.10	878.47	873.77	878.81	0.001015	4.97	49123.61	9037.20	0.30
1	189.110	EC FIS	227000.00	857.40	877.99		878.25	0.001099	4.28	57377.02	8474.79	0.22
1	189.02	Dupe Effec	227000.00	863.40	878.00	873.67	878.37	0.000958	5.15	49359.91	9413.65	0.32
1	189.02	EC FIS	227000.00	855.16	877.62		877.89	0.000495	4.30	58870.63	8955.39	0.23
1	188.81	Dupe Effec	227000.00	863.50	877.31	871.67	877.60	0.000604	4.41	53904.10	8506.25	0.25
1	188.81	EC FIS	227000.00	852.24	877.19		877.43	0.000348	4.09	62725.53	8318.66	0.20
1	188.7	Dupe Effec	227000.00	863.30	876.86	872.22	877.19	0.000909	4.79	49805.93	8743.50	0.28
1	188.690	EC FIS	227000.00	850.62	876.87		877.15	0.000700	4.35	59160.10	8930.40	0.21
1	188.59	Dupe Effec	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.59	EC FIS	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.5	Dupe Effec	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.5	EC FIS	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.39	Dupe Effec	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.39	EC FIS	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.29	Dupe Effec	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.29	EC FIS	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.2	Dupe Effec	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41666.16	7148.81	0.31
1	188.2	EC FIS	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41665.74	7148.81	0.31
1	188.1	Dupe Effec	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37966.03	6595.49	0.36
1	188.1	EC FIS	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37965.66	6595.48	0.36
1	188.07	Dupe Effec	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39209.29	5733.80	0.31
1	188.07	EC FIS	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39208.98	5733.80	0.31
1	188.055		Bridge									
1	188.04	Dupe Effec	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38249.08	5733.34	0.31
1	188.04	EC FIS	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38248.79	5733.34	0.31
1	188	Dupe Effec	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.52	7288.17	0.39
1	188	EC FIS	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.17	7288.16	0.39

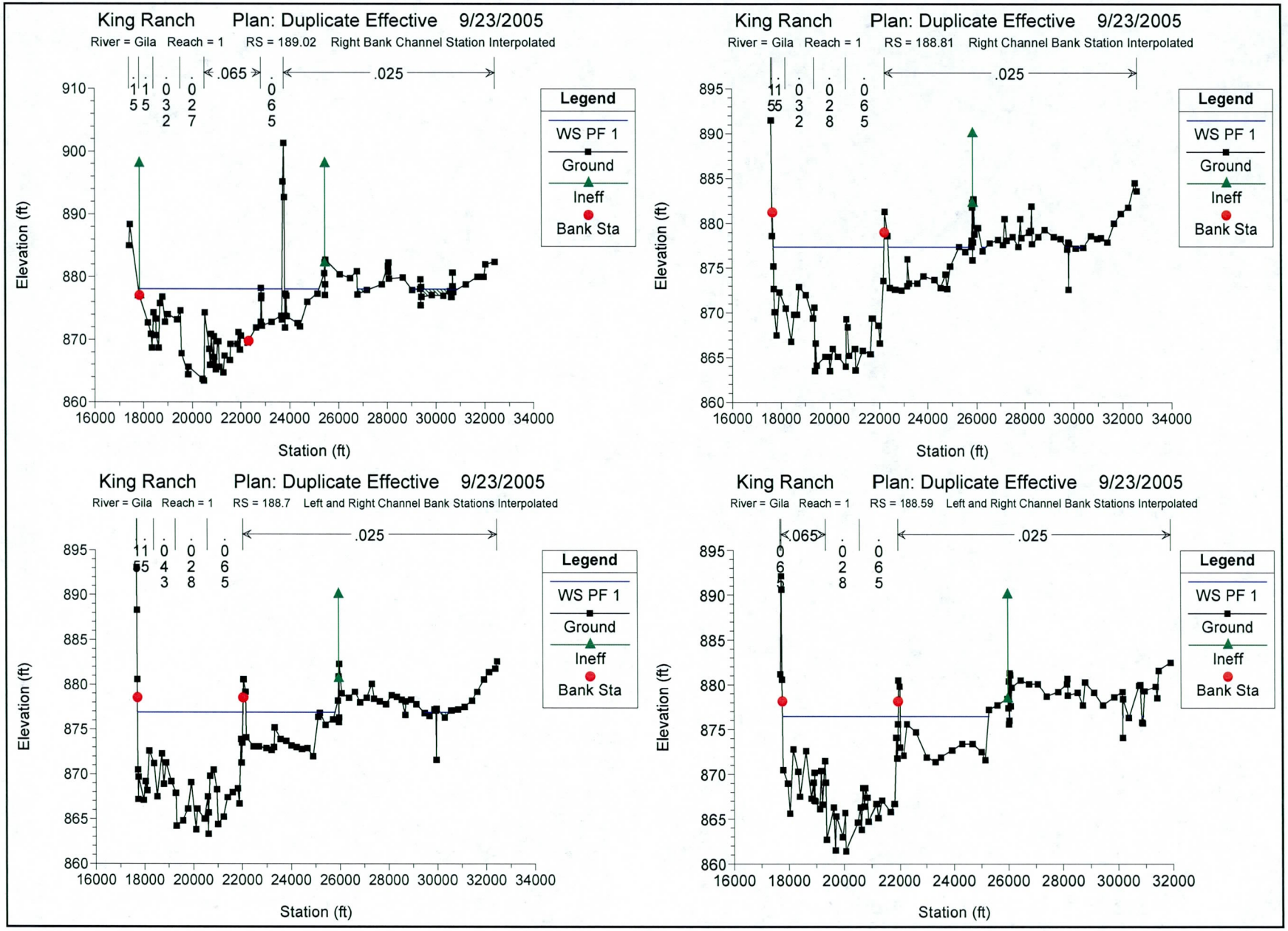
HEC-RAS River: Gila Reach: 1 Profile: PF 1 (Continued)

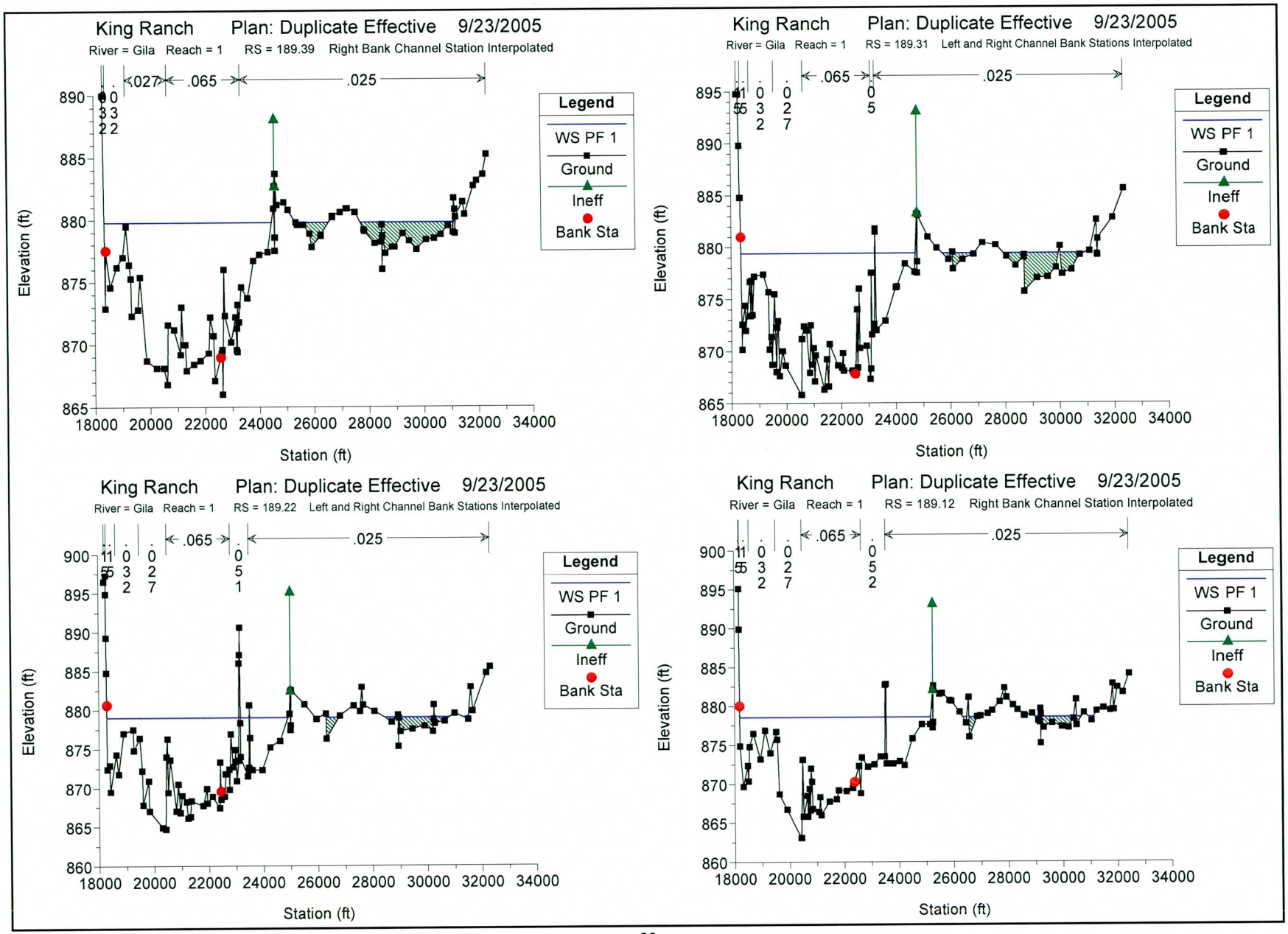
Reach	River Sta	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	187.91	Dupe Effec	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35901.30	5898.49	0.40
1	187.91	EC FIS	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35900.98	5898.48	0.40
1	187.82	Dupe Effec	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32039.06	5367.22	0.46
1	187.82	EC FIS	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32038.47	5367.10	0.46
1	187.73	Dupe Effec	227000.00	855.40	872.38	869.18	873.23	0.001124	7.74	32553.39	7780.66	0.45
1	187.73	EC FIS	227000.00	855.40	872.38	869.18	873.23	0.001125	7.74	32552.54	7779.96	0.45
1	187.64	Dupe Effec	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36451.52	8098.67	0.38
1	187.64	EC FIS	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36450.42	8097.85	0.38
1	187.54	Dupe Effec	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33186.02	8488.08	0.42
1	187.54	EC FIS	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33184.70	8486.68	0.42
1	187.45	Dupe Effec	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38833.45	9340.20	0.36
1	187.45	EC FIS	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38831.71	9337.40	0.36
1	187.36	Dupe Effec	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36029.66	9688.99	0.38
1	187.36	EC FIS	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36027.79	9688.24	0.38
1	187.24	Dupe Effec	227000.00	853.80	869.81	866.24	870.85	0.001547	8.48	30575.30	8205.17	0.47
1	187.24	EC FIS	227000.00	853.80	869.81	866.24	870.85	0.001548	8.48	30572.47	8203.42	0.47
1	187.15	Dupe Effec	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36063.86	8795.17	0.38
1	187.15	EC FIS	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36060.30	8790.41	0.38
1	187.06	Dupe Effec	227000.00	851.90	869.09	864.37	869.69	0.000821	6.34	37397.82	8895.22	0.35
1	187.06	EC FIS	227000.00	851.90	869.09	864.37	869.68	0.000821	6.34	37393.59	8893.03	0.35
1	186.97	Dupe Effec	227000.00	851.90	868.75	864.00	869.29	0.000764	5.98	38636.68	9764.51	0.35
1	186.97	EC FIS	227000.00	851.90	868.75	864.00	869.29	0.000764	5.99	38631.88	9763.17	0.35
1	186.87	Dupe Effec	227000.00	852.60	868.18	863.60	868.83	0.001044	6.65	35925.27	11028.66	0.38
1	186.87	EC FIS	227000.00	852.60	868.18	863.60	868.83	0.001045	6.65	35918.05	11022.50	0.38
1	186.78	Dupe Effec	227000.00	851.70	867.28	863.40	868.16	0.001739	7.64	35624.27	10624.28	0.45

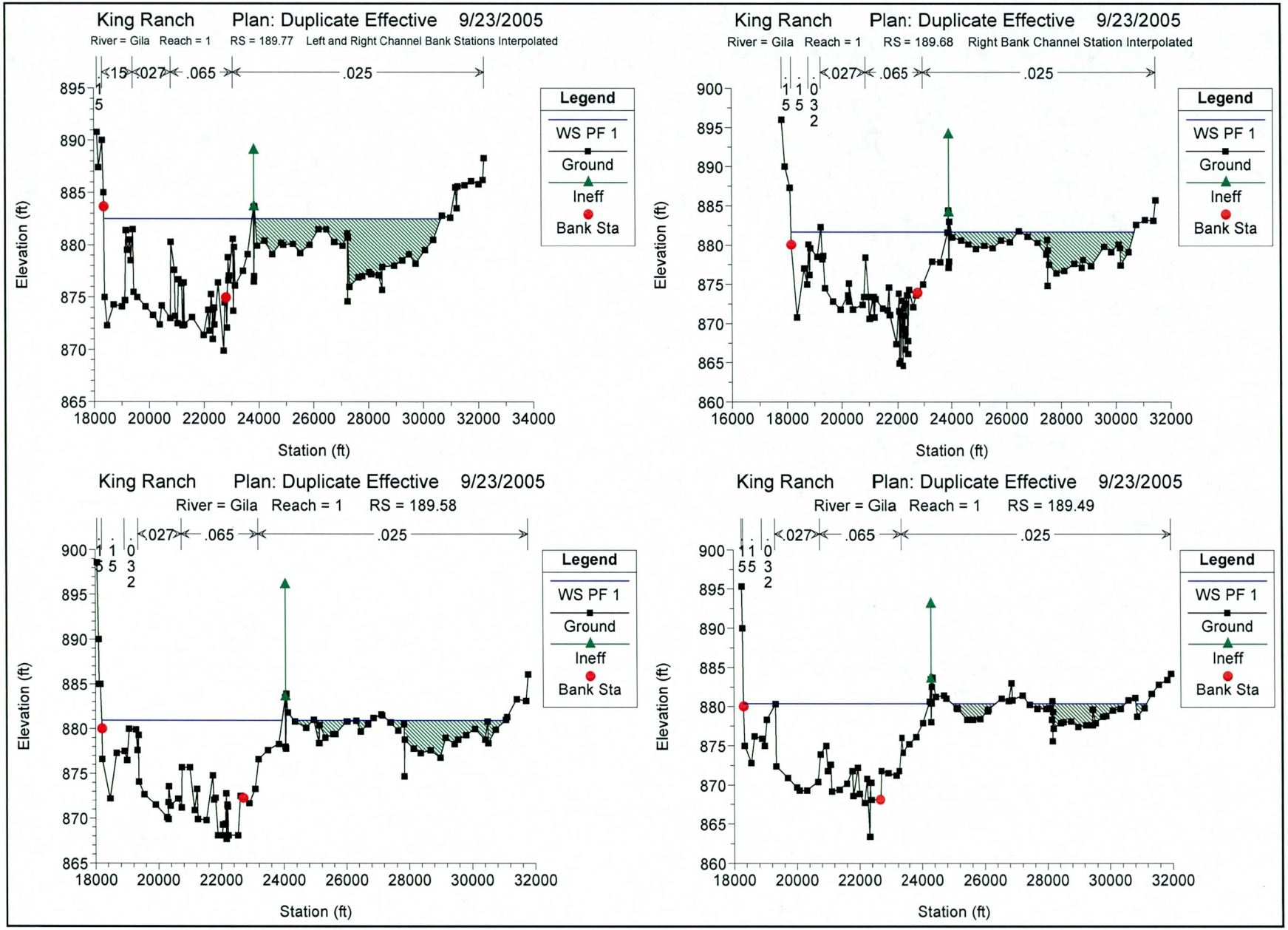

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.04 Left and Right Channel Bank Stations Interpolated
.065
.032
.025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188 Left and Right Bank Channel Station Interpolated
.065
.03
.032
.025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.91 Right Bank Channel Station Interpolated
.065
.03
.032
.025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.82 Right Bank Channel Station Interpolated
.065
.03
.032
.025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta

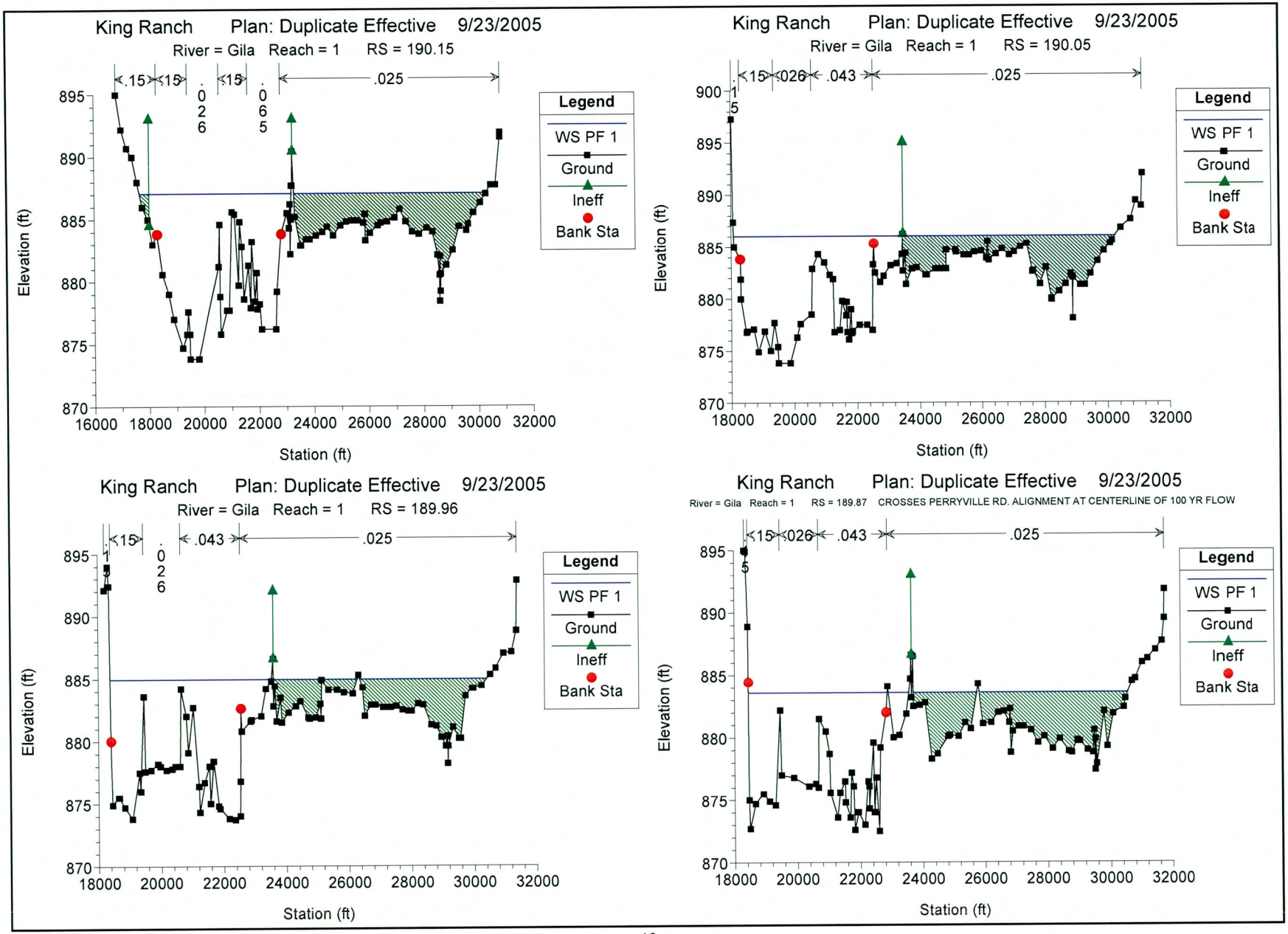

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.1 Left and Right Channel Bank Stations Interpolated
.065
.066
.055
.03
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.07 Left and Right Channel Bank Stations Interpolated
.065
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
.065
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
.065
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

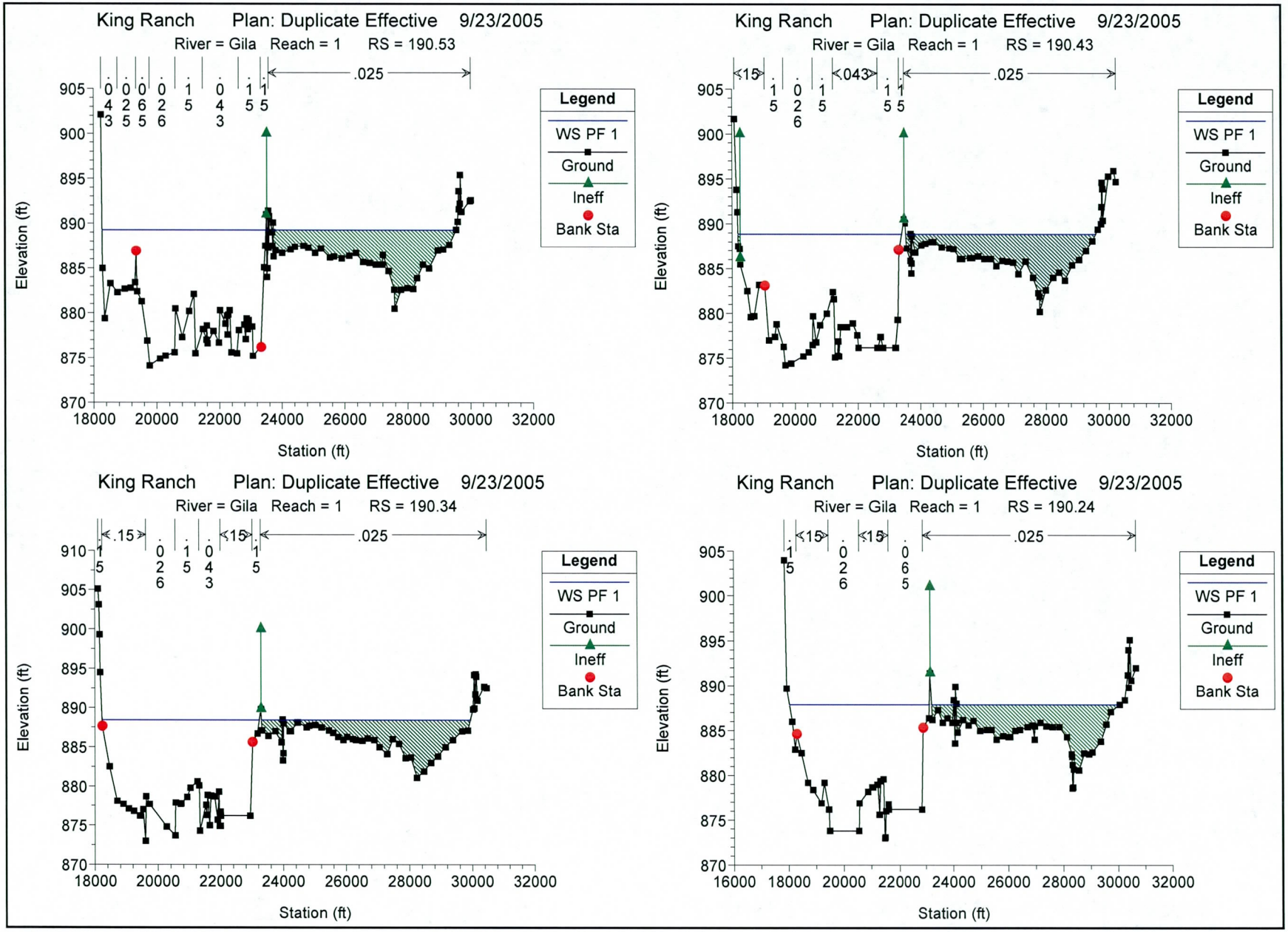

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.5 Left and Right Channel Bank Stations Interpolated
.065 .028 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.39 BEGIN 1:1 TRANSITION TO BRIDGE
.15 .026 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.29 Left and Right Channel Bank Stations Interpolated
.115 .026 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.2 Left and Right Bank Channel Stations Interpolated
.115 .03 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

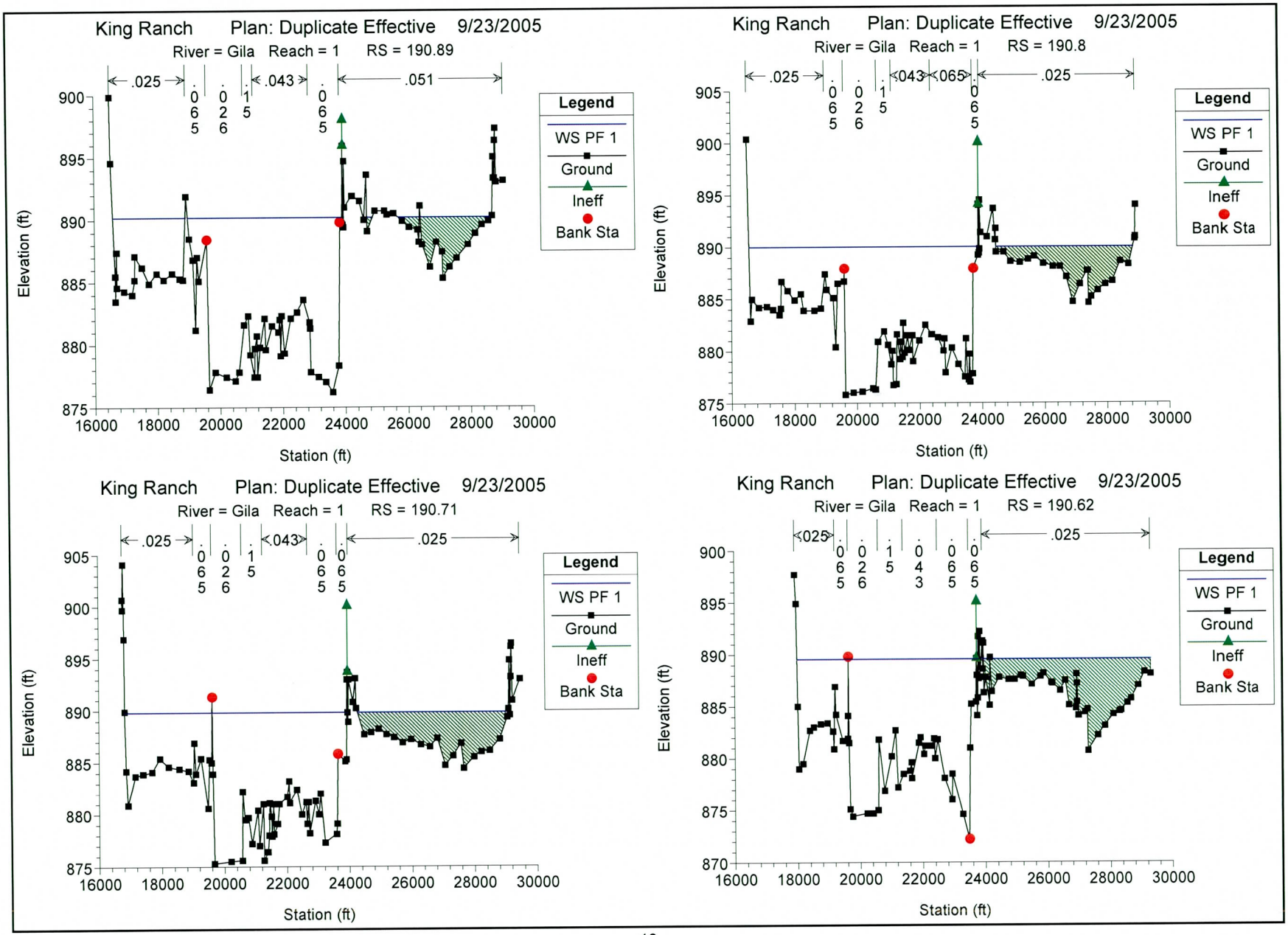

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.02 Right Bank Channel Station Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.81 Right Channel Bank Station Interpolated
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.7 Left and Right Channel Bank Stations Interpolated
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 188.59 Left and Right Channel Bank Stations Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

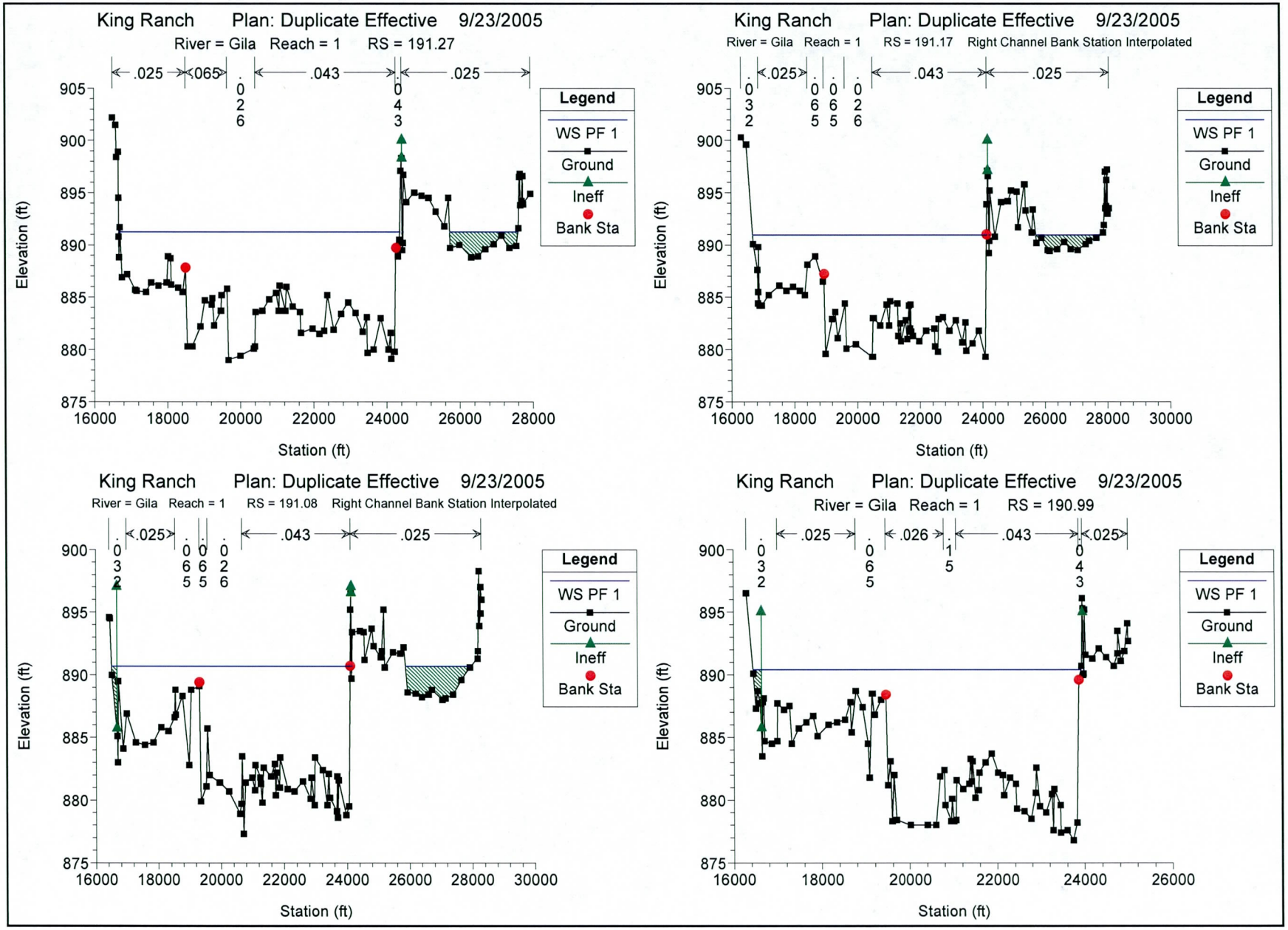

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.39 Right Bank Channel Station Interpolated
.027
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.31 Left and Right Channel Bank Stations Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.22 Left and Right Channel Bank Stations Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.12 Right Bank Channel Station Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

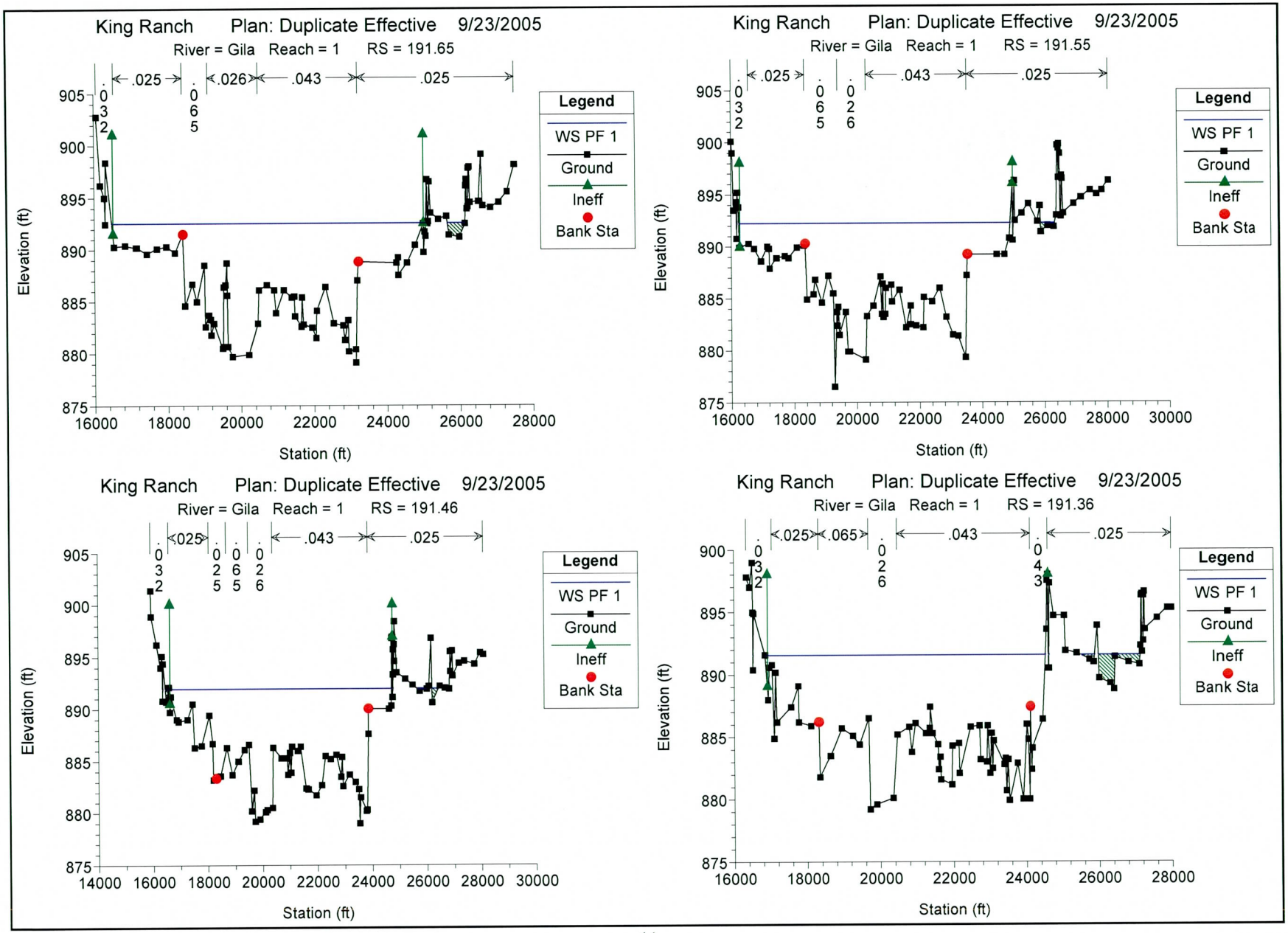

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.77 Left and Right Channel Bank Stations Interpolated
.15 .027 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.68 Right Bank Channel Station Interpolated
.115 .032 .027 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.58
.115 .032 .027 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.49
.1155 .032 .027 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

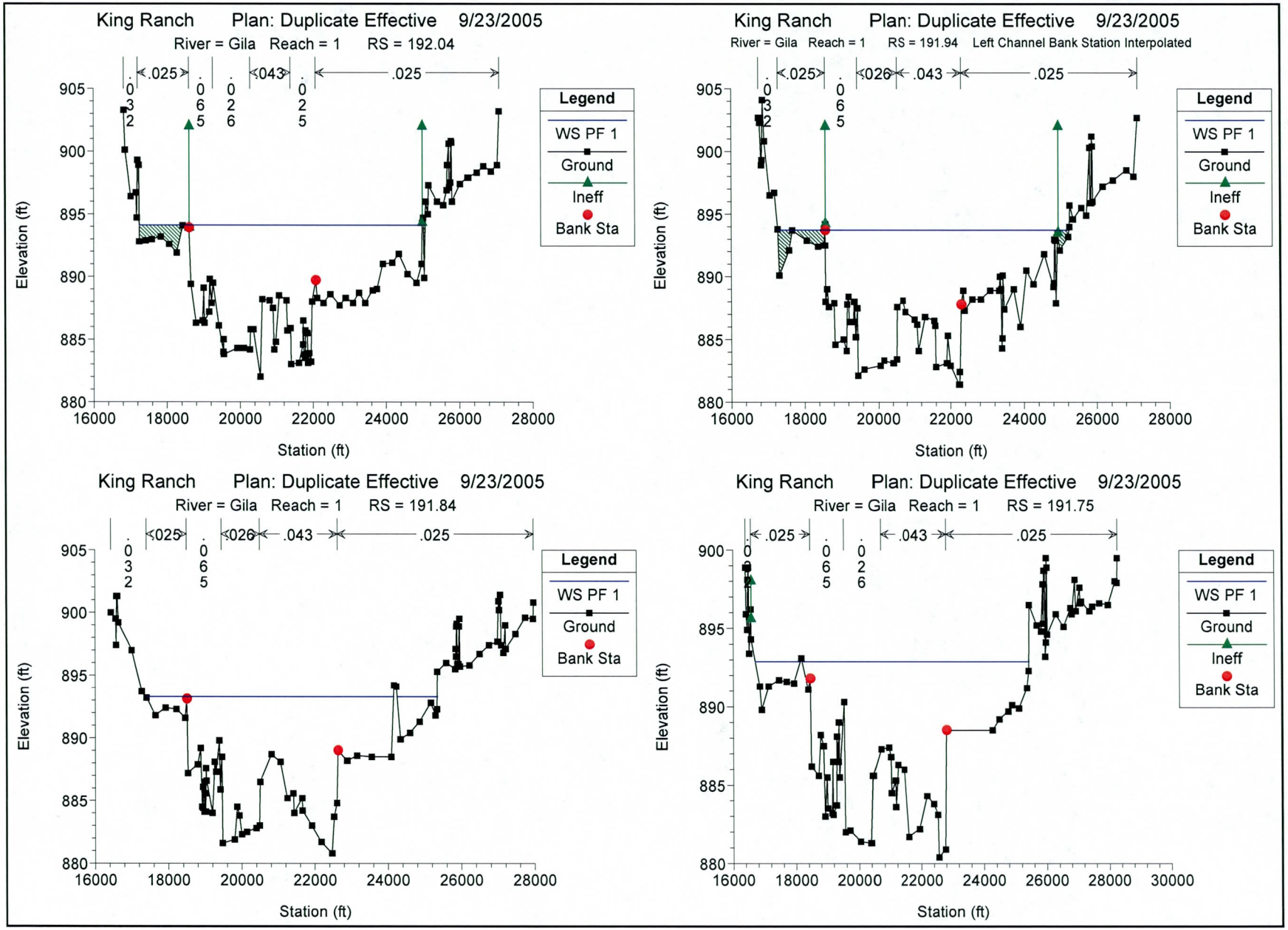

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.15
.15 .15 .026 .15 .065 .025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.05
.15 .026 .043 .025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.96
.15 .026 .043 .025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 189.87 CROSSES PERRYVILLE RD. ALIGNMENT AT CENTERLINE OF 100 YR FLOW
.15 .026 .043 .025
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.53
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.43
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.34
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.24
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.89
.025 .043 .051
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.8
.025 .043 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.71
.025 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.62
.025 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.27
.025 .065 .026 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.17 Right Channel Bank Station Interpolated
.032 .025 .065 .065 .026 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.08 Right Channel Bank Station Interpolated
.032 .025 .065 .065 .026 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 190.99
.032 .025 .065 .026 .15 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.65
.025 .026 .043 .025
.032 .065
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.55
.025 .043 .025
.032 .065 .026
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.46
.025 .043 .025
.032 .025 .065 .026
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.36
.025 .065 .043 .025
.032 .026 .043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.04
.025
.043
.025
.032
.065
.026
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.94 Left Channel Bank Station Interpolated
.025
.026
.043
.025
.032
.065
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.84
.025
.026
.043
.025
.032
.065
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 191.75
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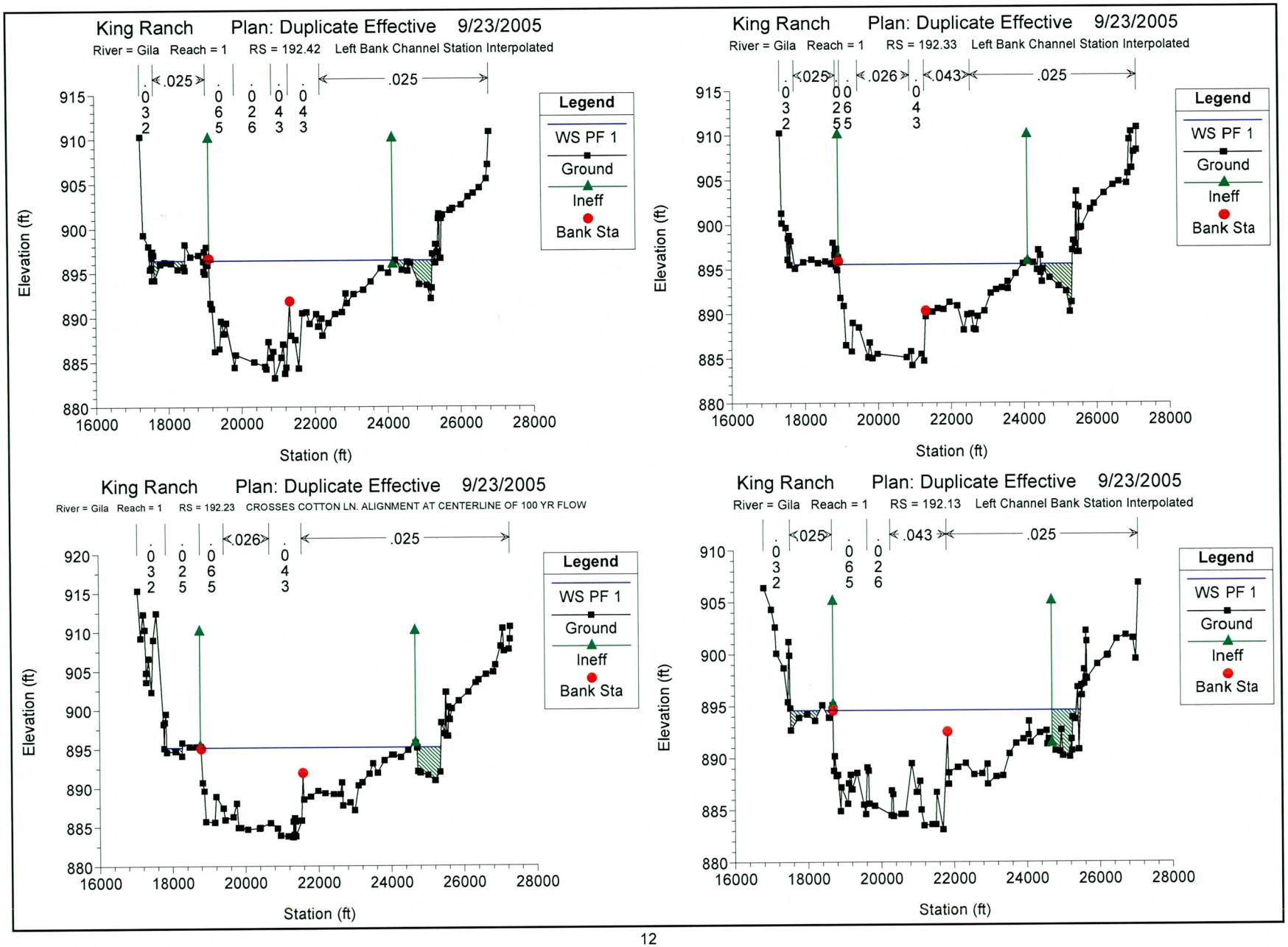
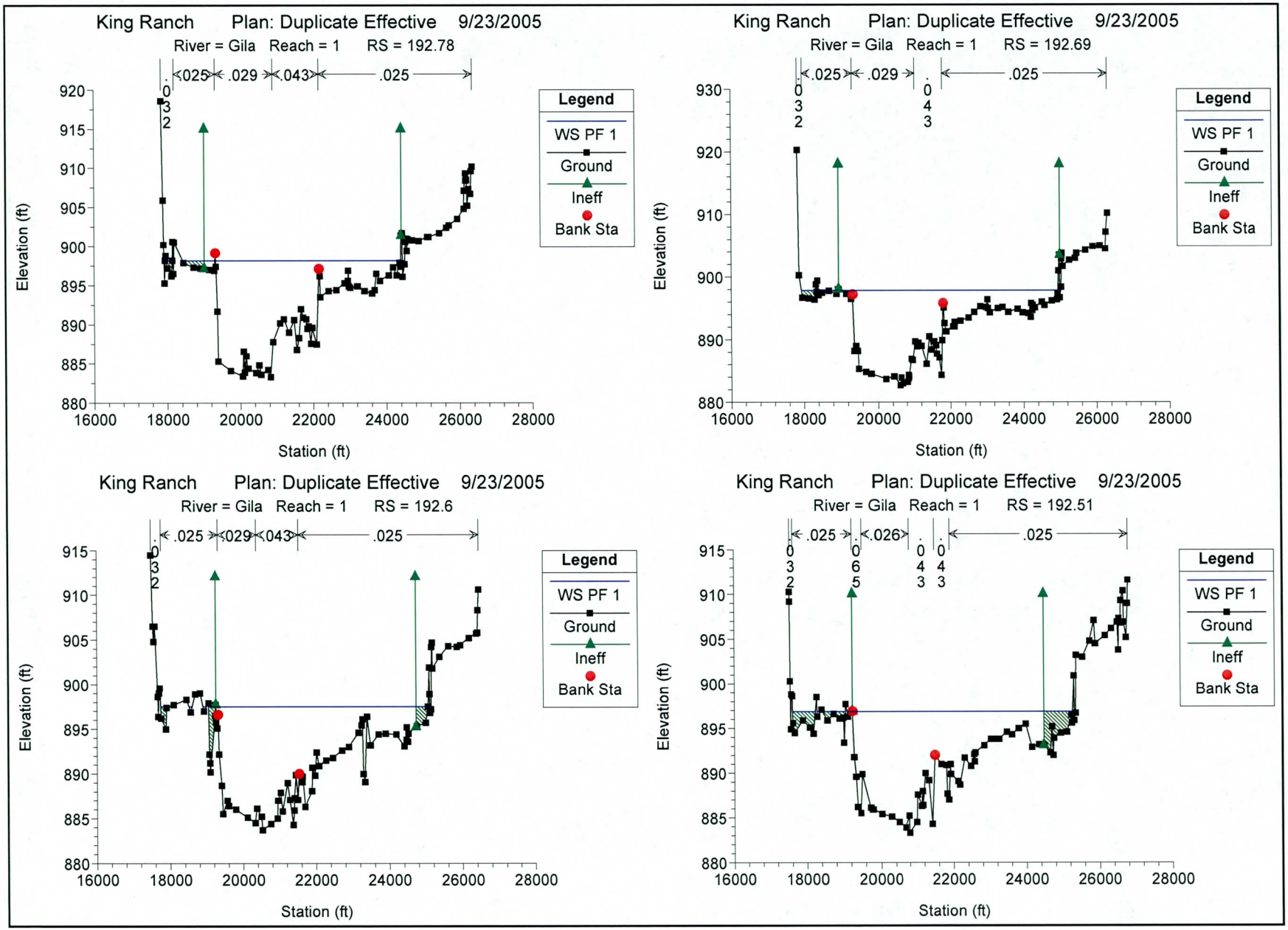
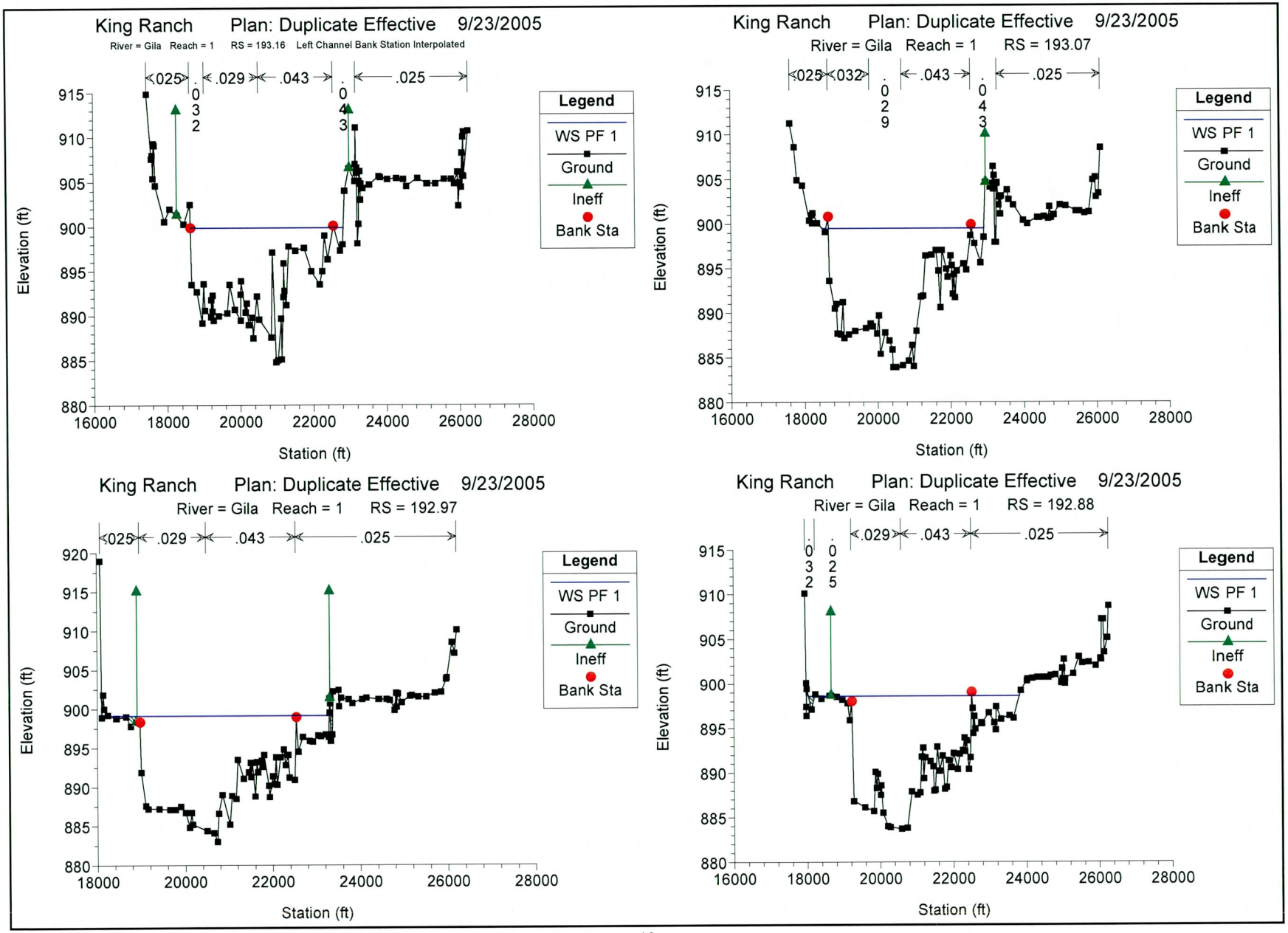
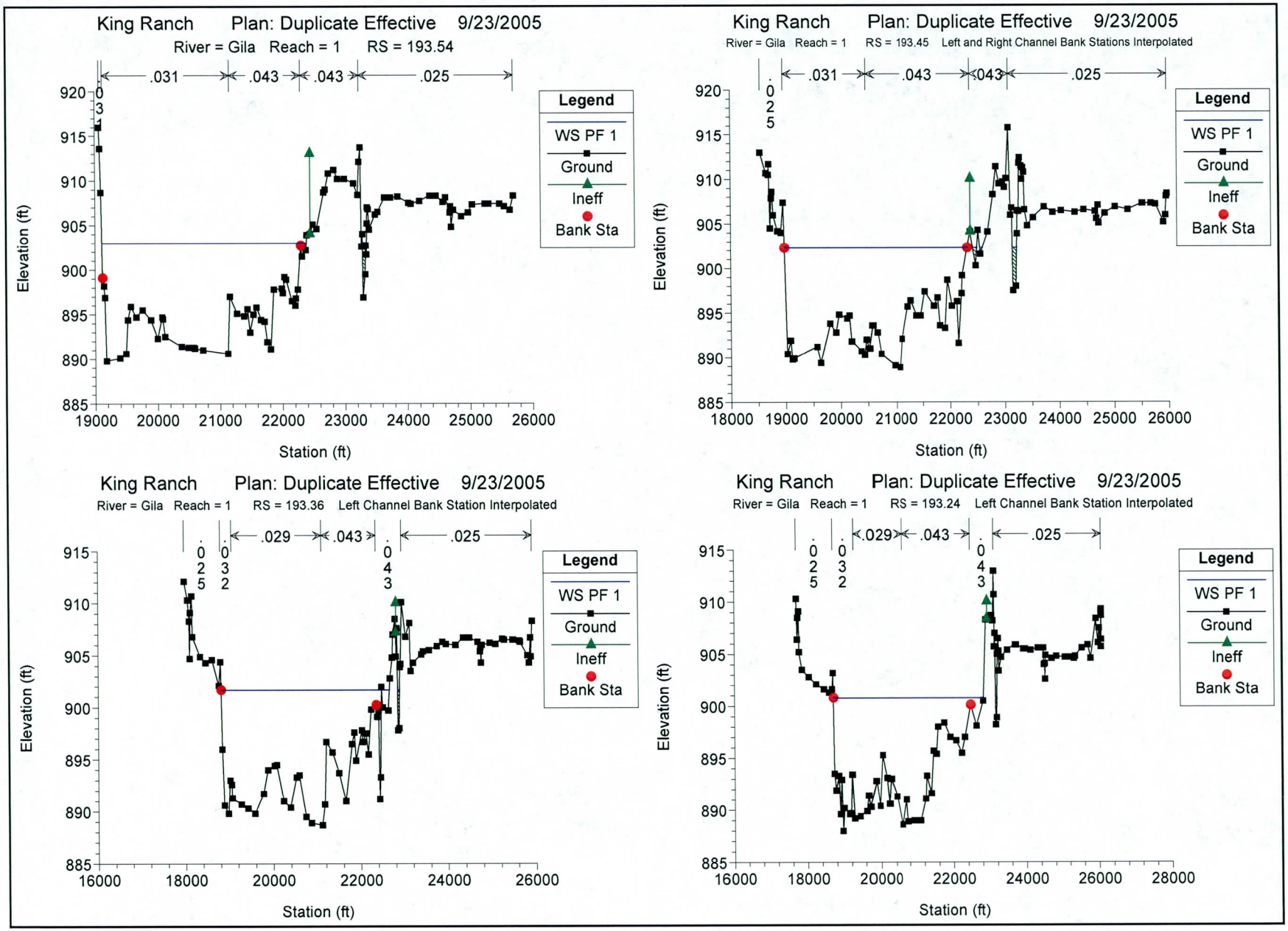
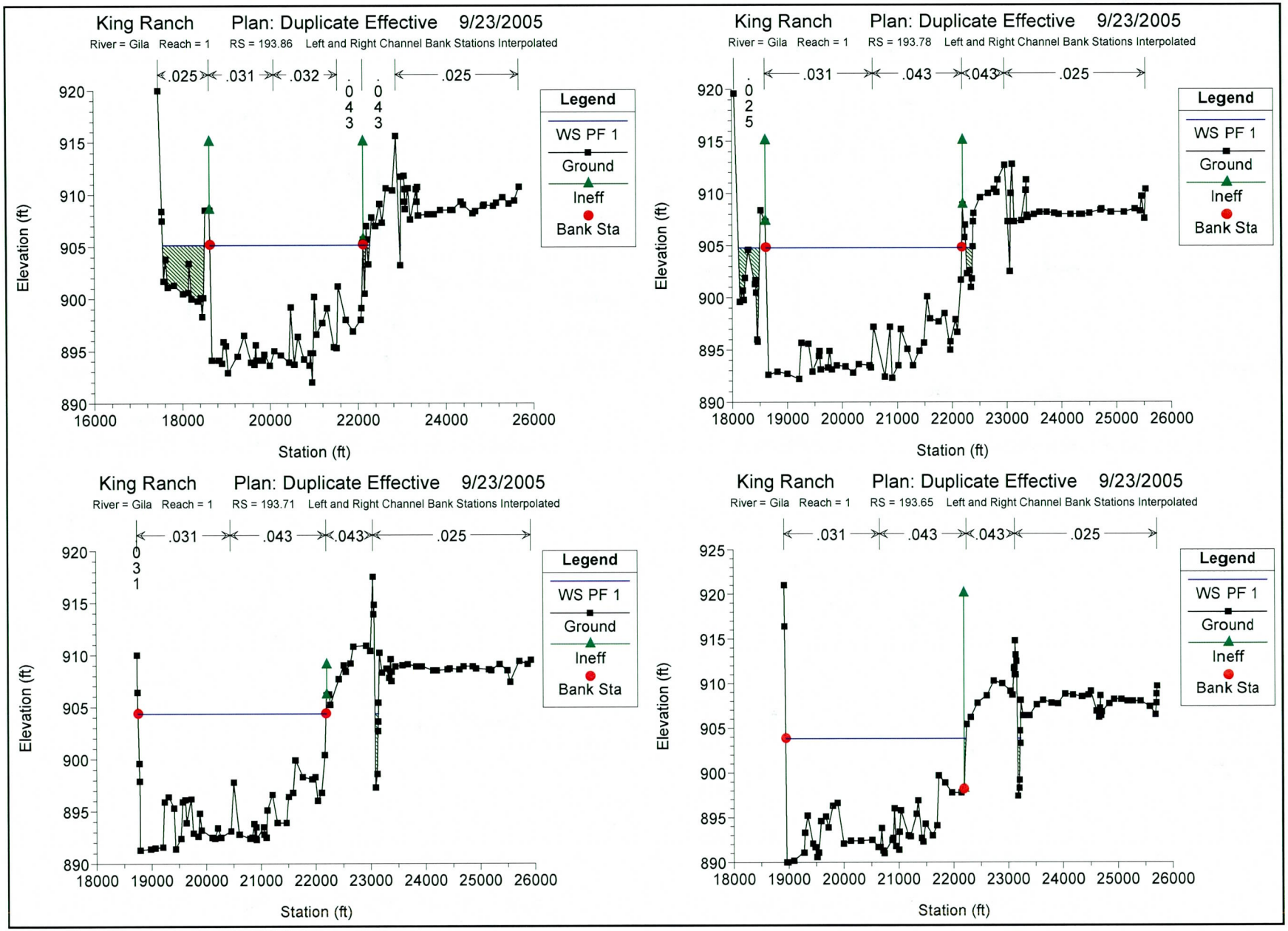
.043
.025
.065
.026
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

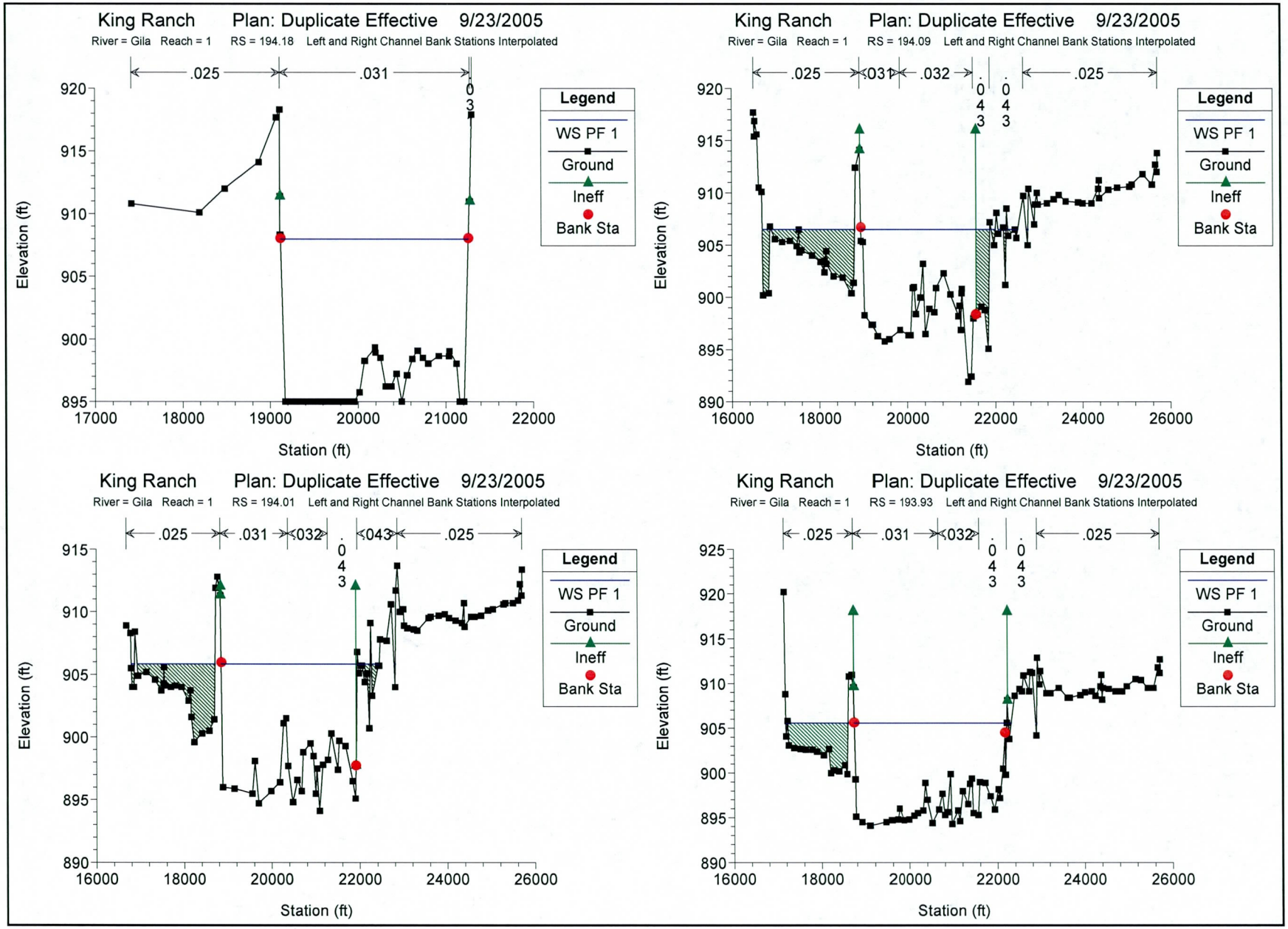

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.42 Left Bank Channel Station Interpolated
.025
.025
.032
.065
.026
.043
.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.33 Left Bank Channel Station Interpolated
.025
.026
.043
.025
.032
.026
.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.23 CROSSES COTTON LN. ALIGNMENT AT CENTERLINE OF 100 YR FLOW
.026
.025
.032
.025
.065
.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.13 Left Channel Bank Station Interpolated
.025
.043
.025
.032
.065
.026
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

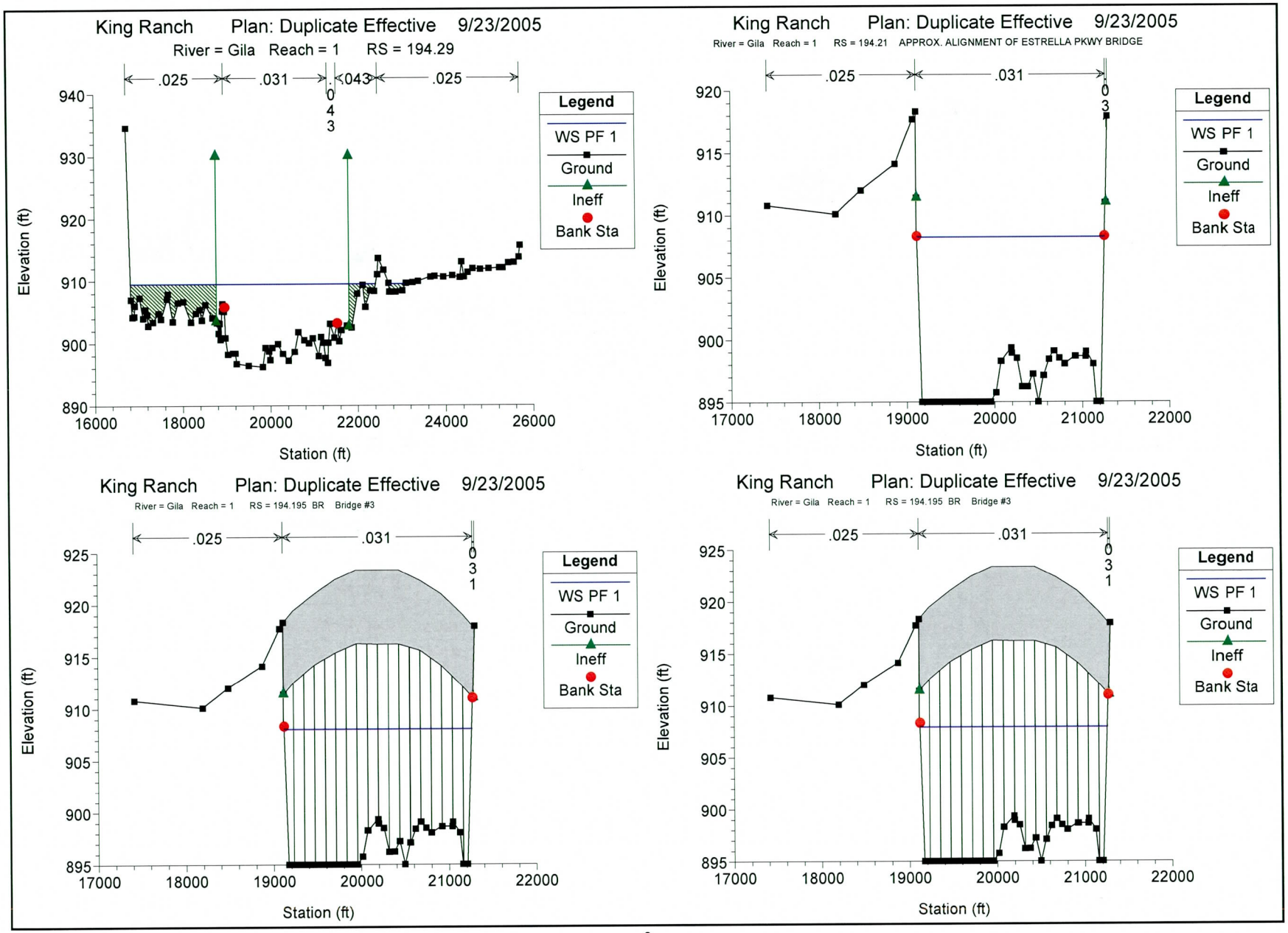

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.78
.025 .029 .043 .025
0 3 2
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.69
.025 .029 .025
0 3 2
0 4 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.6
.025 .029 .043 .025
0 3 2
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.51
.025 .026 .025
0 3 2
0 6 5
0 4 3
0 4 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

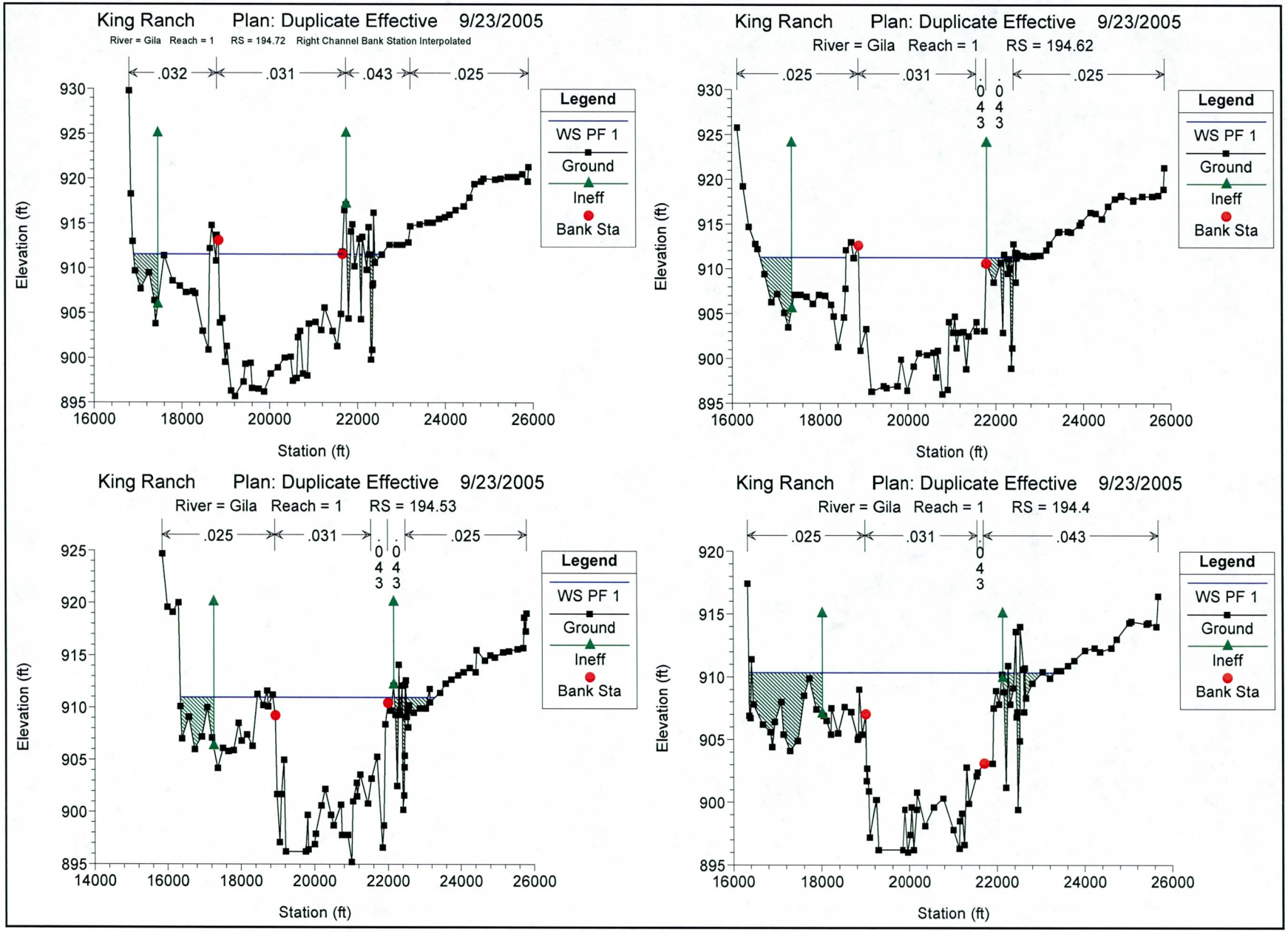

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.16 Left Channel Bank Station Interpolated
.025 .032 .029 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.07
.025 .032 .029 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.97
.025 .029 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 192.88
.032 .025 .029 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

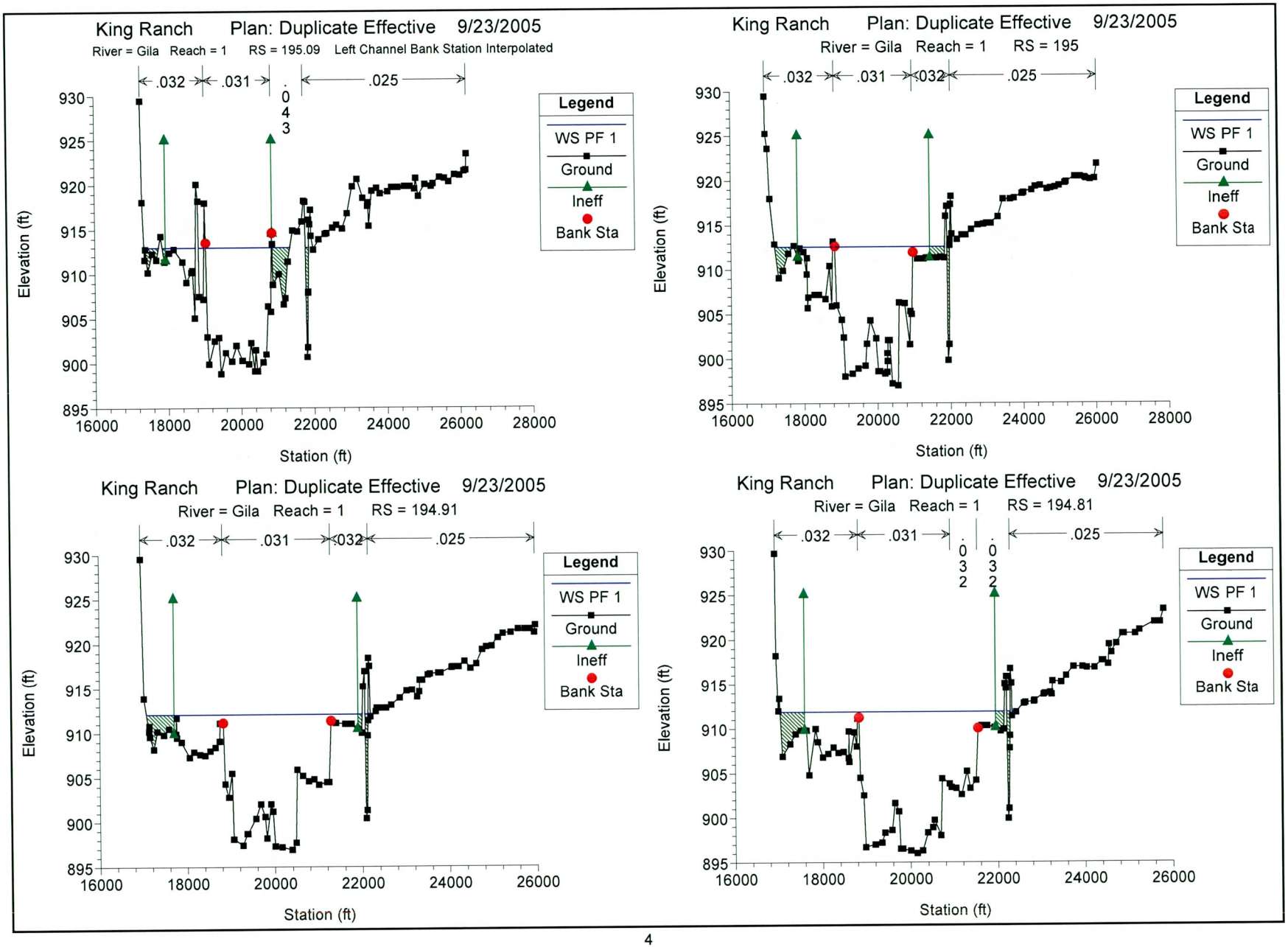

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.54
.031 .043 .043 .025
0 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.45 Left and Right Channel Bank Stations Interpolated
.031 .043 .043 .025
. 0 2 5
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.36 Left Channel Bank Station Interpolated
.029 .043 .025
. 0 2 5
. 0 3 2
. 0 4 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.24 Left Channel Bank Station Interpolated
.029 .043 .025
. 0 2 5
. 0 3 2
. 0 4 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

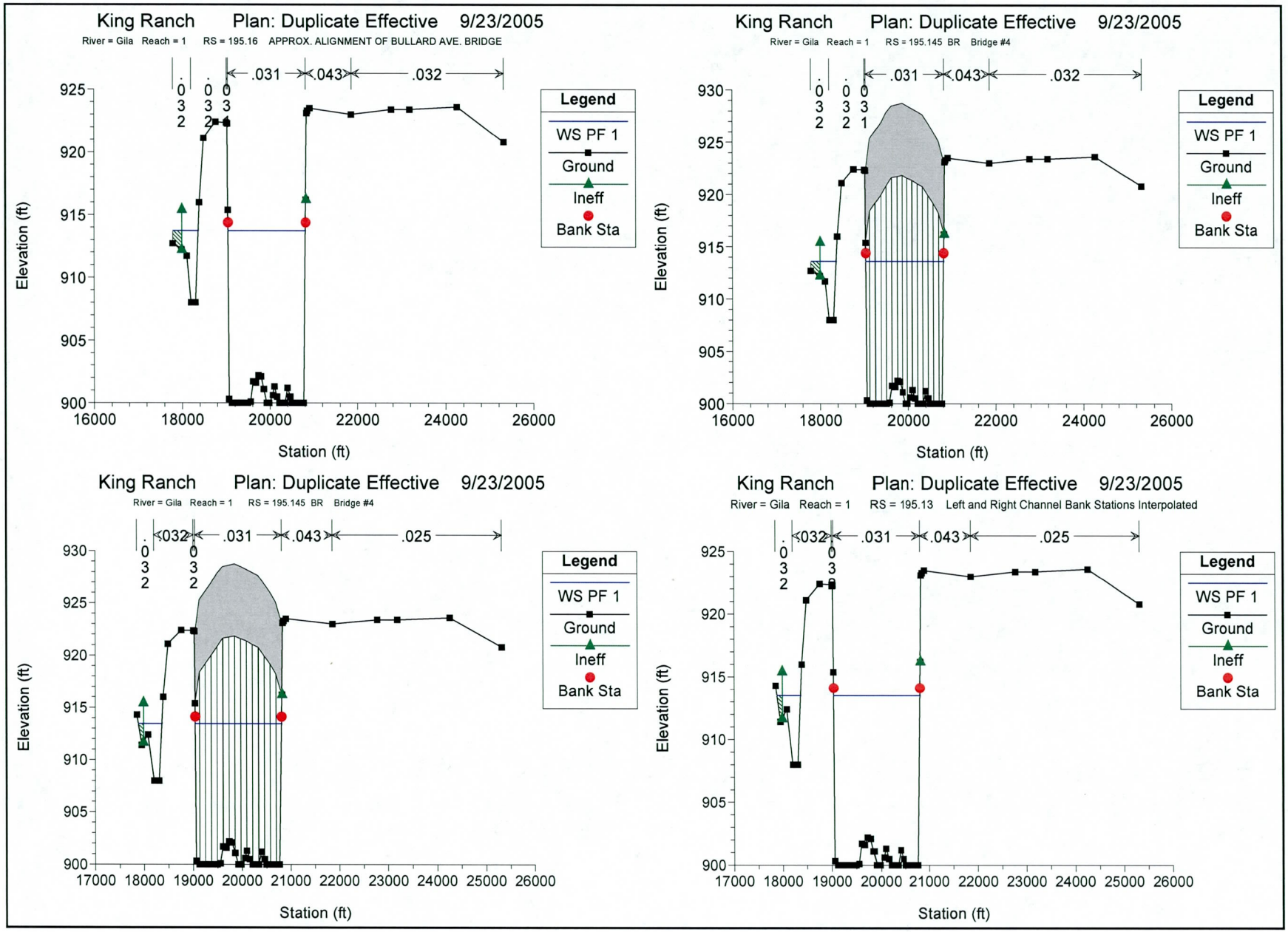

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.86 Left and Right Channel Bank Stations Interpolated
.025 .031 .032 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.78 Left and Right Channel Bank Stations Interpolated
.025 .031 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.71 Left and Right Channel Bank Stations Interpolated
.031 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.65 Left and Right Channel Bank Stations Interpolated
.031 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

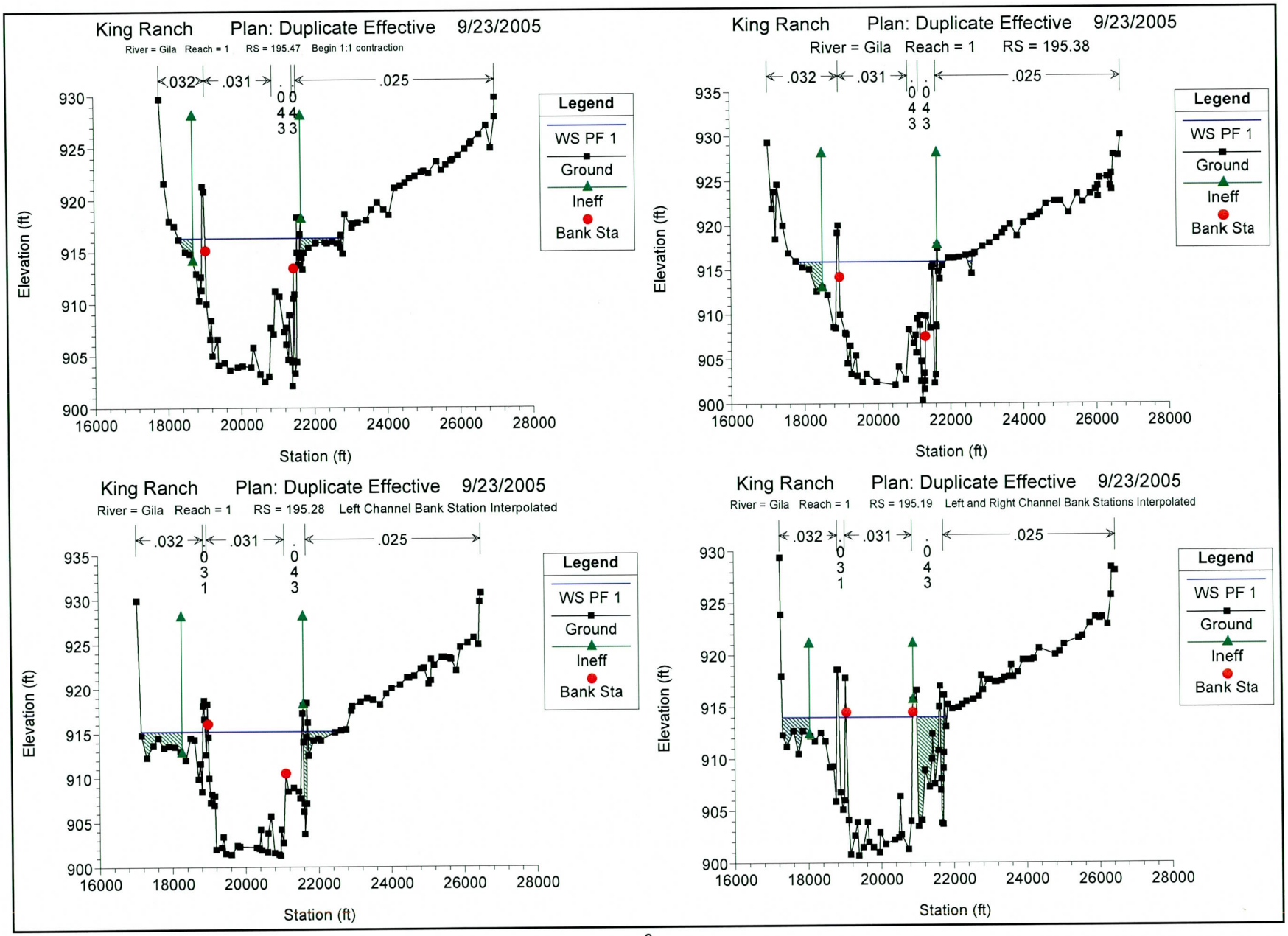

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.18 Left and Right Channel Bank Stations Interpolated
.025
.031
.03
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.09 Left and Right Channel Bank Stations Interpolated
.025
.031
.032
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.01 Left and Right Channel Bank Stations Interpolated
.025
.031
.032
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 193.93 Left and Right Channel Bank Stations Interpolated
.025
.031
.032
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

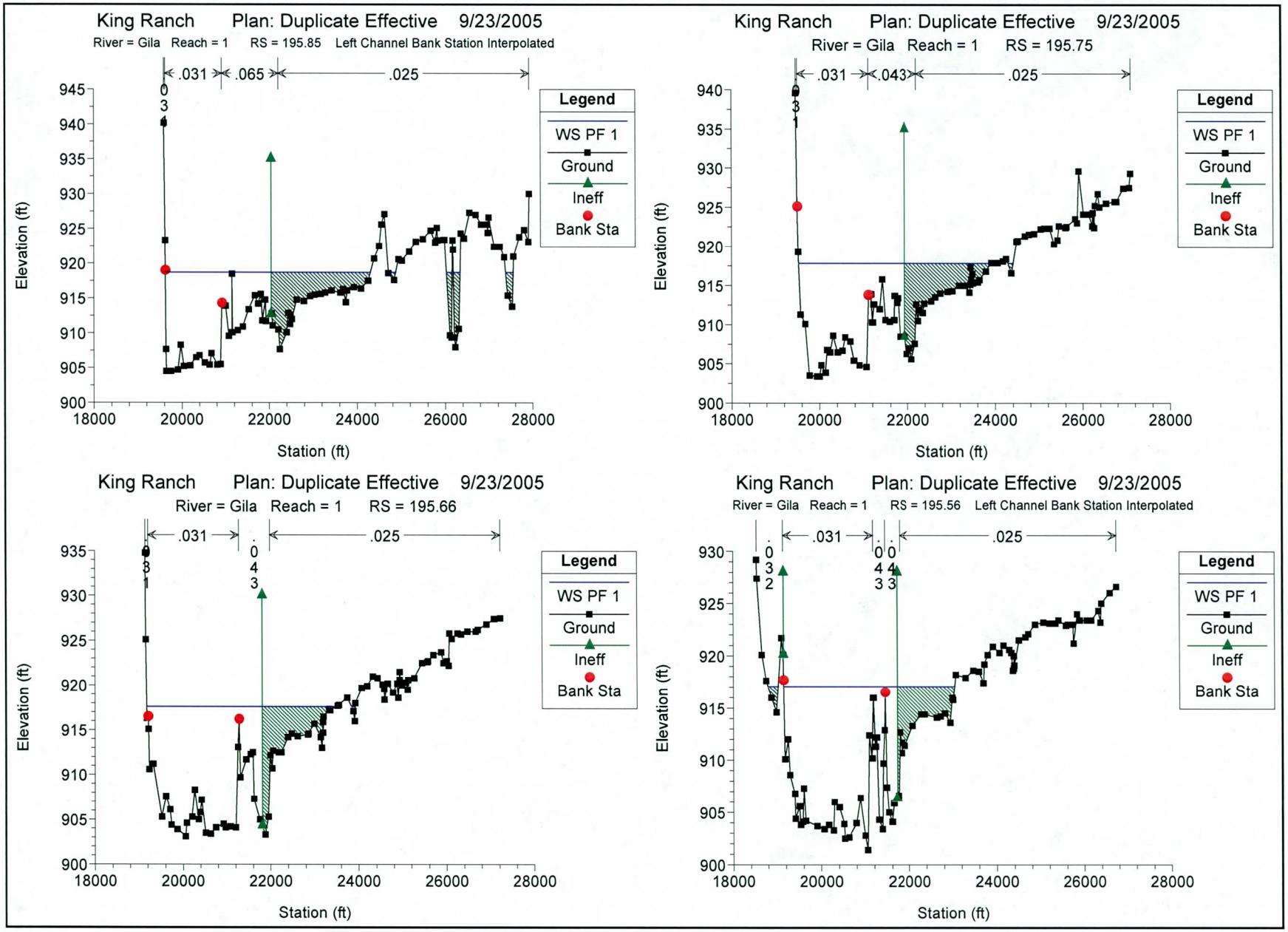

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.29
.025
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.21 APPROX. ALIGNMENT OF ESTRELLA PKWY BRIDGE
.025
.031
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.195 BR Bridge #3
.025
.031
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.195 BR Bridge #3
.025
.031
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

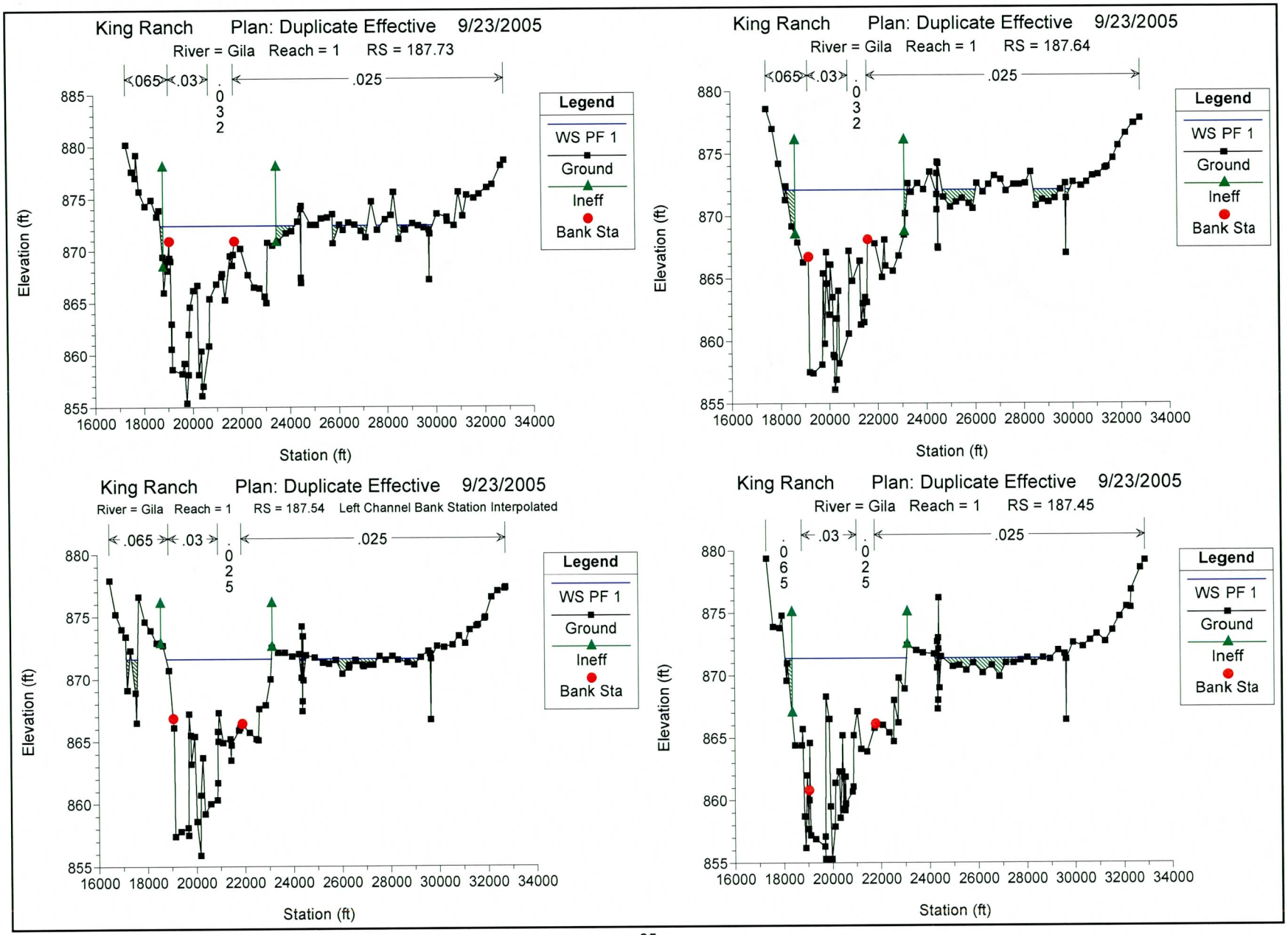

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.72 Right Channel Bank Station Interpolated
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.62
.025
.031
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.53
.025
.031
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.4
.025
.031
.043
.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

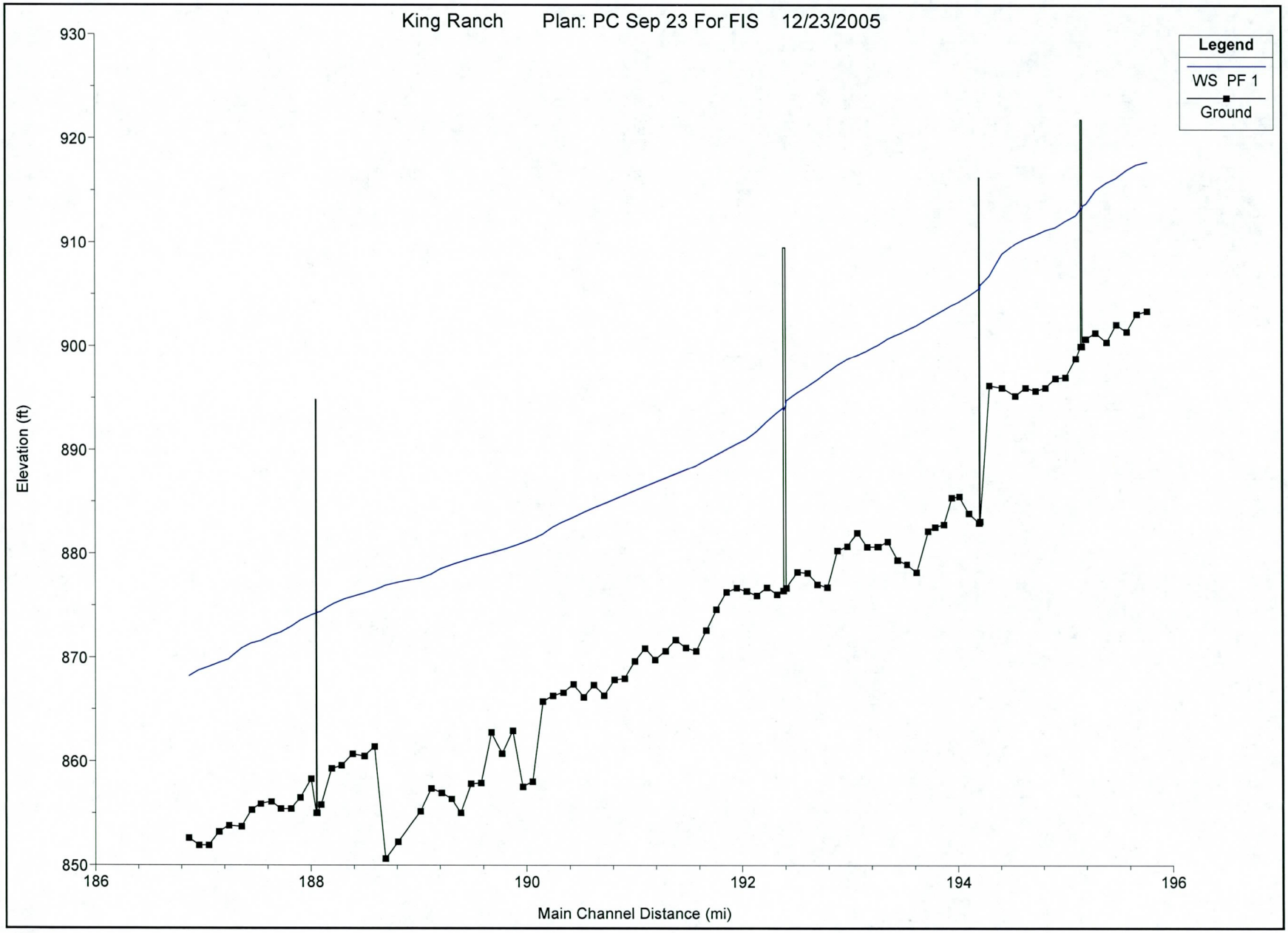

King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.09 Left Channel Bank Station Interpolated
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195
.032
.031
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.91
.032
.031
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 194.81
.032
.031
.032
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.16 APPROX. ALIGNMENT OF BULLARD AVE. BRIDGE
.031
.043
.032
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.145 BR Bridge #4
.031
.043
.032
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.145 BR Bridge #4
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.13 Left and Right Channel Bank Stations Interpolated
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.47 Begin 1:1 contraction
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.38
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.28 Left Channel Bank Station Interpolated
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.19 Left and Right Channel Bank Stations Interpolated
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.85 Left Channel Bank Station Interpolated
.031 .065 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.75
.031 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.66
.031 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 195.56 Left Channel Bank Station Interpolated
.031 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.73
.065
.03
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.64
.065
.03
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.54 Left Channel Bank Station Interpolated
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: Duplicate Effective 9/23/2005
River = Gila Reach = 1 RS = 187.45
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

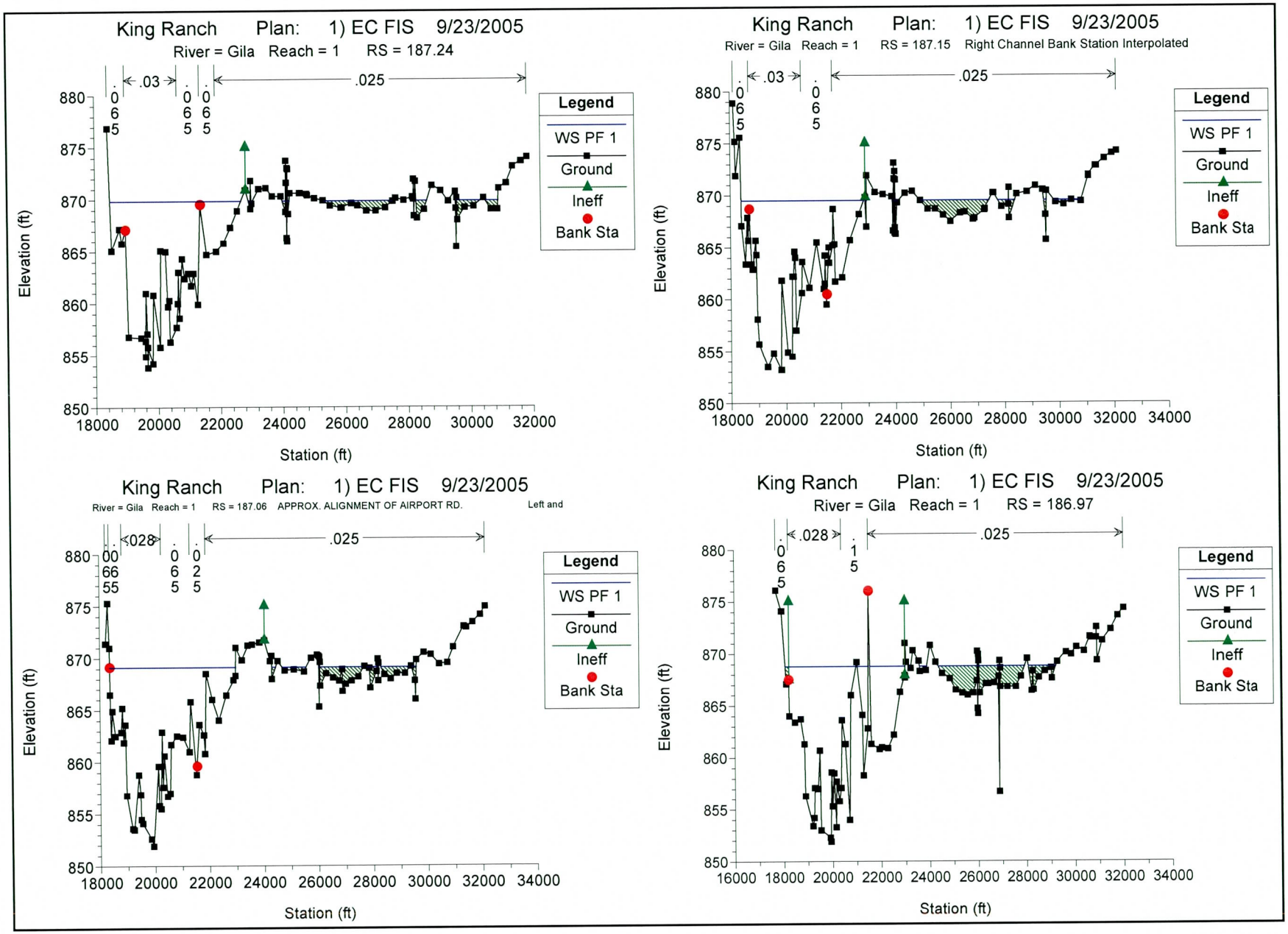

King Ranch Plan: PC Sep 23 For FIS 12/23/2005
Legend
WS PF 1
Ground
Elevation (ft)
930
920
910
900
890
880
870
860
850
186
188
190
192
194
196
Main Channel Distance (mi)

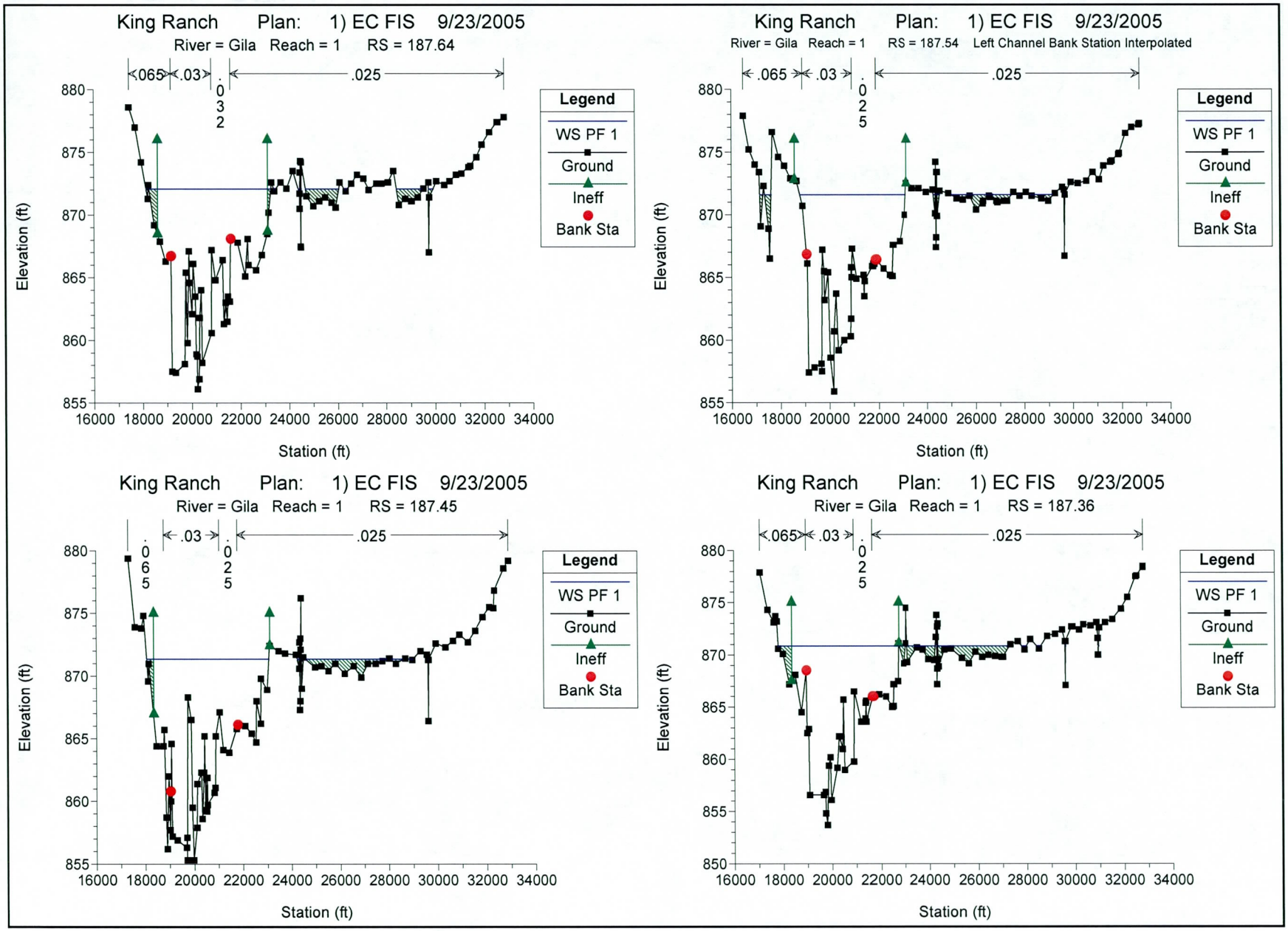
HEC-RAS Plan: PC Sep 23FIS River: Gila Reach: 1 Profile: PF 1

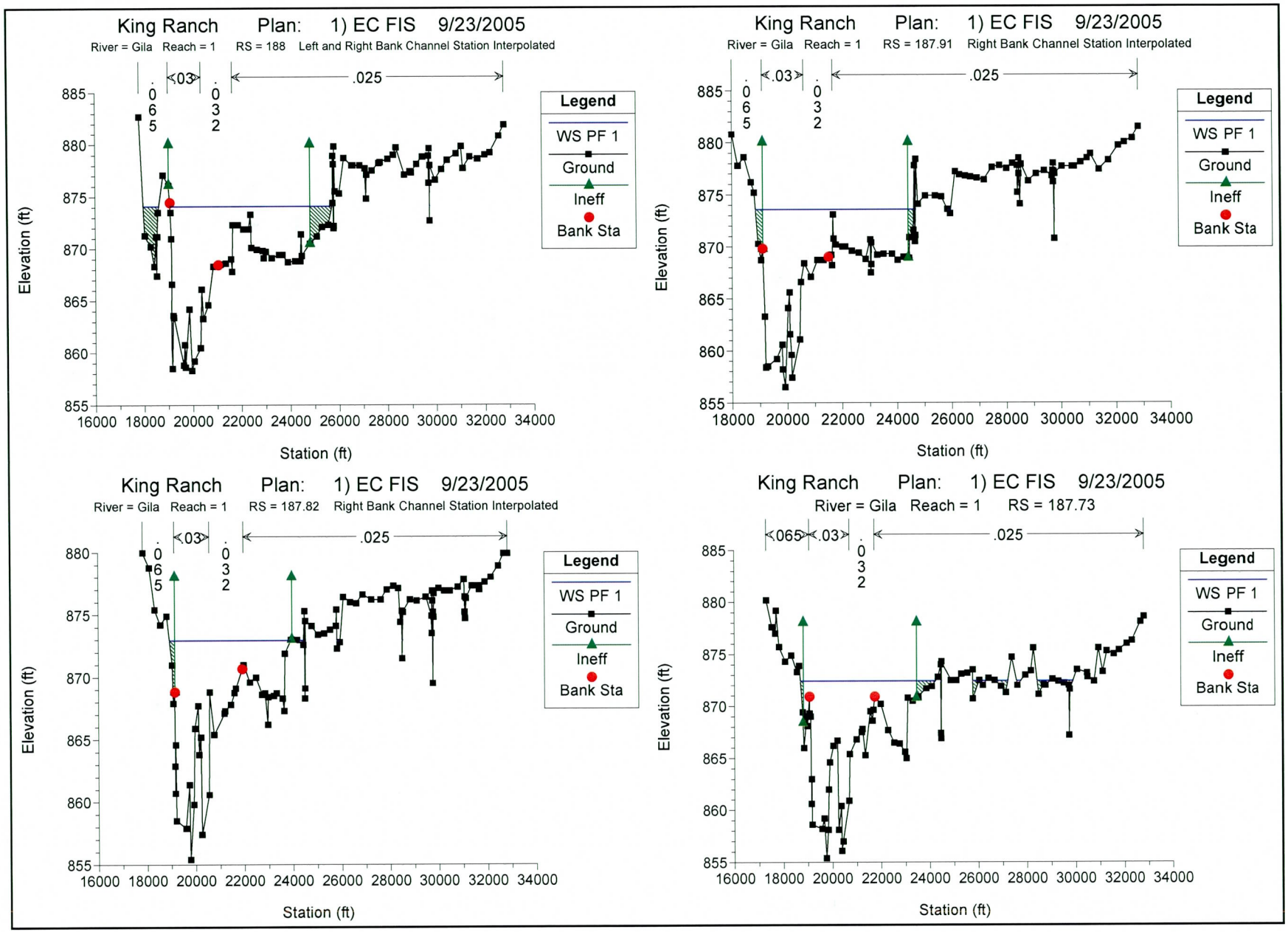
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	195.75	227000.00	903.40	917.73	914.96	919.51	0.002169	11.22	22772.56	4473.81	0.59
1	195.66	227000.00	903.10	917.47	912.70	918.52	0.001162	8.46	28721.20	4346.95	0.43
1	195.56	227000.00	901.40	916.94	911.75	917.93	0.001156	8.12	28808.92	4106.57	0.42
1	195.47	227000.00	902.10	916.20	911.88	917.27	0.001385	8.43	27818.78	4362.12	0.45
1	195.38	227000.00	900.40	915.74	910.84	916.64	0.001099	7.82	30927.77	4013.15	0.41
1	195.28	227000.00	901.30	914.98	910.16	916.02	0.001115	8.39	29500.01	5072.21	0.43
1	195.19	227000.00	900.70	913.69	910.33	915.28	0.001885	10.39	23441.89	4198.68	0.55
1	195.16	227000.00	900.00	913.47	908.68	914.94	0.001408	9.82	23846.52	2341.47	0.48
1	195.15	Bridge									
1	195.13	227000.00	900.00	913.23	908.68	914.76	0.001505	10.02	23343.48	2237.68	0.50
1	195.09	227000.00	898.80	912.57	909.24	914.32	0.002001	10.76	22295.60	3657.03	0.57
1	195.00	227000.00	897.00	912.05	908.48	913.29	0.001540	9.18	26677.16	4364.90	0.49
1	194.91	227000.00	896.90	911.43	907.63	912.51	0.001446	8.56	28678.78	4973.37	0.47
1	194.81	227000.00	896.00	911.16	905.84	911.88	0.000818	7.00	35118.84	5164.81	0.37
1	194.72	227000.00	895.70	910.72	905.79	911.46	0.000927	7.08	34228.88	4725.84	0.38
1	194.62	227000.00	896.00	910.33	905.58	910.99	0.000861	6.67	35650.48	5294.07	0.36
1	194.53	227000.00	895.20	909.82	905.21	910.53	0.000969	6.88	34552.08	5571.63	0.38
1	194.40	227000.00	896.00	908.84	904.77	909.76	0.001223	7.83	30923.65	5830.38	0.43
1	194.29	227000.00	896.20	906.78	904.97	908.42	0.002971	10.46	22532.17	5071.73	0.65
1	194.210	227000.00	883.10	905.79	902.06	907.32	0.001693	9.93	22868.46	2976.98	0.53
1	194.205	Bridge									
1	194.200	227000.00	882.97	905.48		907.08	0.001824	10.15	22353.69	2116.92	0.55
1	194.100	227000.00	883.87	904.80		906.13	0.001606	9.24	24571.75	3012.59	0.51
1	194.020	227000.00	885.49	904.24		905.37	0.001434	8.56	26556.24	3197.07	0.48
1	193.940	227000.00	885.38	903.91		904.82	0.001169	7.67	29611.59	3505.83	0.42
1	193.870	227000.00	882.80	903.46		904.27	0.001587	7.20	31550.00	3568.25	0.40
1	193.790	227000.00	882.55	902.98		903.72	0.000970	6.91	32937.20	3711.83	0.39
1	193.730	227000.00	882.18	902.61		903.38	0.000987	7.04	32287.59	3421.02	0.40
1	193.620	227000.00	878.21	901.95		902.79	0.001085	7.37	30819.18	3218.51	0.42
1	193.530	227000.00	878.96	901.50		902.27	0.000946	7.06	32250.77	3319.89	0.39
1	193.430	227000.00	879.37	901.09		901.82	0.000883	6.84	33220.23	3567.46	0.38
1	193.340	227000.00	881.18	900.67		901.41	0.000818	6.94	32725.29	3675.98	0.37
1	193.250	227000.00	880.67	900.05		900.93	0.001184	7.54	30125.74	2637.27	0.39
1	193.160	227000.00	880.66	899.50		900.42	0.000962	7.71	29438.91	2539.47	0.40
1	193.070	227000.00	881.99	899.09		899.96	0.000879	7.50	30259.65	2538.06	0.38
1	192.980	227000.00	880.71	898.69		899.52	0.000903	7.27	31204.00	2521.58	0.36
1	192.890	227000.00	880.29	898.09		899.02	0.001051	7.74	29339.27	2381.74	0.39
1	192.790	227000.00	876.74	897.41		898.44	0.001307	8.16	27818.78	2263.91	0.41
1	192.700	227000.00	877.01	896.69		897.78	0.001373	8.40	27026.35	2195.03	0.42
1	192.610	227000.00	878.15	896.07		897.17	0.001202	8.42	26963.21	2156.23	0.42
1	192.520	227000.00	878.23	895.44		896.56	0.001205	8.51	26673.10	2133.77	0.42
1	192.41	227000.00	876.67	894.67	889.51	895.88	0.001300	8.82	25746.52	2147.83	0.45
1	192.39	Bridge									
1	192.38	227000.00	876.41	893.99		895.29	0.001444	9.16	24768.88	2144.68	0.47
1	192.330	227000.00	876.06	893.53		894.84	0.001469	9.20	24681.97	2851.61	0.48
1	192.230	227000.00	876.72	892.69	888.24	894.05	0.001744	9.34	24315.51	3055.77	0.49
1	192.140	227000.00	875.94	891.73		893.14	0.001884	9.54	23785.56	3299.12	0.51
1	192.040	227000.00	876.36	891.00		892.24	0.001575	9.03	26257.72	3669.92	0.48
1	191.950	227000.00	876.68	890.50		891.46	0.001251	8.00	29521.80	3987.04	0.44
1	191.860	227000.00	876.27	890.03		890.84	0.001064	7.36	32021.15	4303.79	0.41
1	191.760	227000.00	874.62	889.48		890.28	0.001142	7.28	32455.70	4513.80	0.42
1	191.670	227000.00	872.60	888.93		889.67	0.001218	7.06	33519.43	5157.87	0.41
1	191.570	227000.00	870.63	888.43		889.07	0.001075	6.53	36236.30	5062.61	0.39
1	191.480	227000.00	870.93	888.02		888.54	0.000901	5.90	39492.37	5916.39	0.35
1	191.380	227000.00	871.69	887.61		888.10	0.000833	5.67	41063.20	6346.76	0.34
1	191.290	227000.00	870.63	887.22		887.67	0.000836	5.43	42431.91	5889.11	0.32
1	191.190	227000.00	869.78	886.80		887.24	0.000855	5.42	42801.48	5257.53	0.31
1	191.100	227000.00	870.88	886.42		886.86	0.000696	5.38	43056.66	4758.53	0.30
1	191.000	227000.00	869.64	886.03		886.50	0.000742	5.49	41384.86	4474.24	0.31
1	190.910	227000.00	867.98	885.57		886.09	0.000893	5.76	39431.41	4804.60	0.33
1	190.810	227000.00	867.86	885.15		885.66	0.000807	5.70	39801.43	4655.92	0.32
1	190.720	227000.00	866.30	884.77		885.25	0.000788	5.61	40458.98	4939.51	0.31
1	190.620	227000.00	867.37	884.36		884.85	0.000843	5.59	40795.71	5064.83	0.31
1	190.530	227000.00	866.16	883.93		884.41	0.000910	5.56	40806.98	4525.62	0.30
1	190.430	227000.00	867.42	883.45		883.95	0.000916	5.68	39976.21	4134.25	0.30
1	190.340	227000.00	866.61	883.02		883.47	0.000934	5.40	42025.91	5012.53	0.29
1	190.240	227000.00	866.29	882.51		882.96	0.001073	5.38	42199.64	5160.74	0.28
1	190.150	227000.00	865.74	881.83		882.38	0.001281	5.92	38347.65	4696.69	0.33
1	190.050	227000.00	858.06	881.37		881.81	0.000873	5.34	42476.54	5338.90	0.28
1	189.960	227000.00	857.56	880.99		881.41	0.000778	5.22	43450.05	4807.29	0.28
1	189.870	227000.00	862.94	880.64		881.02	0.000761	4.95	46199.33	8377.52	0.27
1	189.770	227000.00	860.75	880.34		880.64	0.000606	4.42	52822.17	10330.71	0.23
1	189.670	227000.00	862.77	880.02		880.32	0.000633	4.43	53087.27	10078.49	0.23
1	189.580	227000.00	857.92	879.73		880.02	0.000564	4.33	55074.63	9079.53	0.23

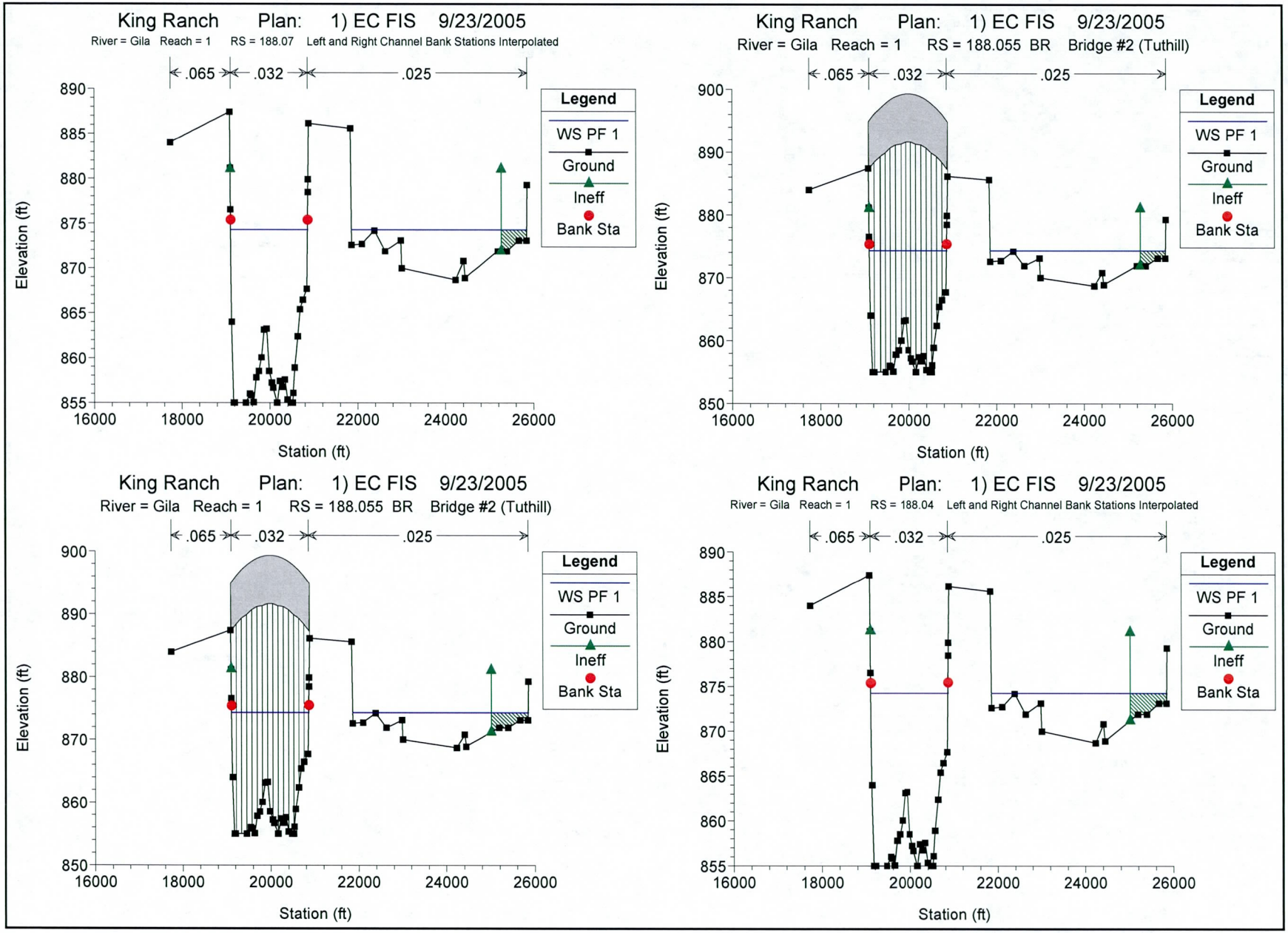
HEC-RAS Plan: PC Sep 23FIS River: Gila Reach: 1 Profile: PF 1 (Continued)

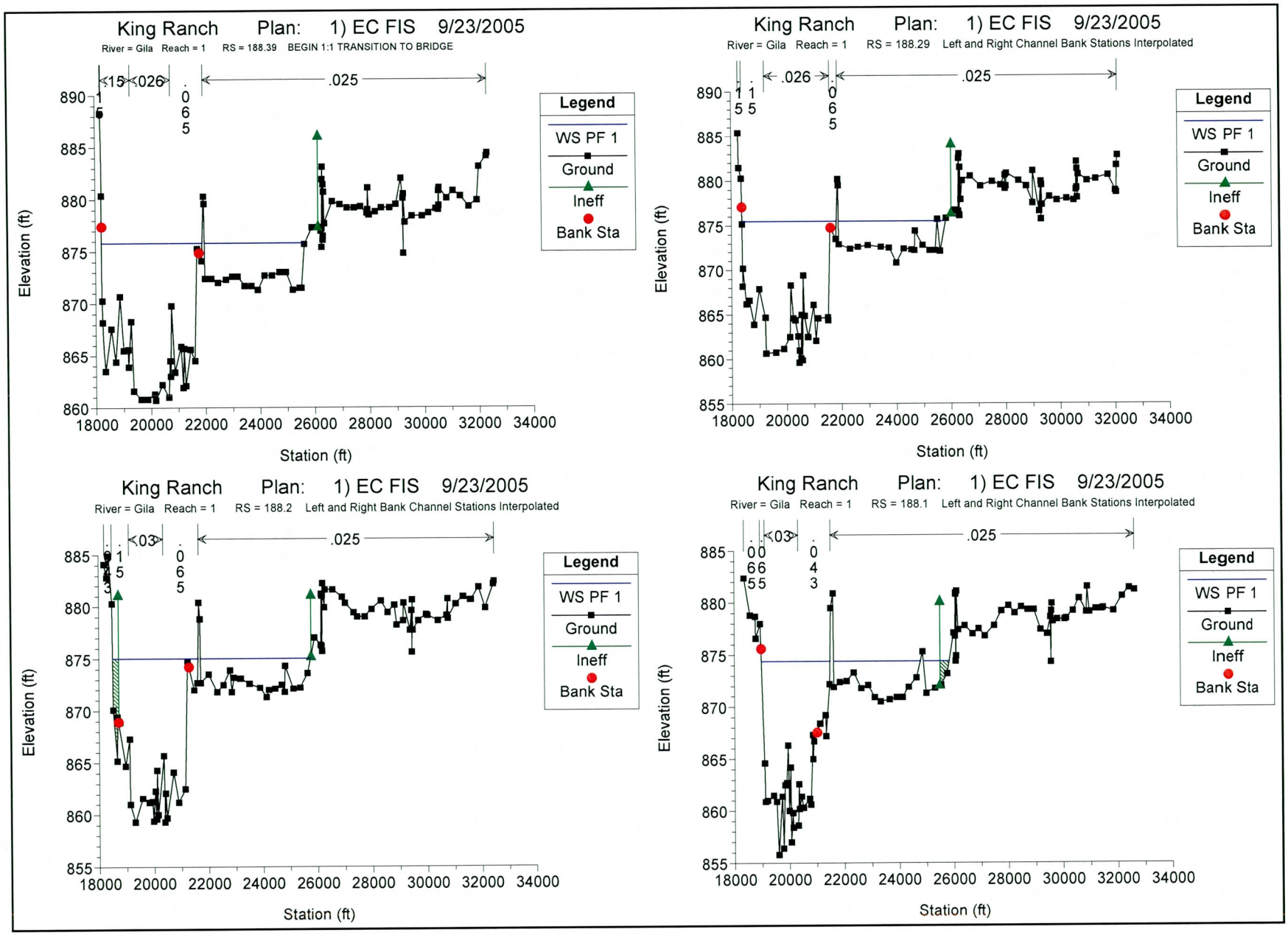
Reach	River Sta	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
		(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	189.480	227000.00	857.85	879.47		879.74	0.000533	4.24	57076.95	8915.03	0.22
1	189.390	227000.00	855.02	879.18		879.47	0.000528	4.42	55806.66	9978.30	0.23
1	189.300	227000.00	856.36	878.90		879.21	0.000638	4.59	54138.75	9775.70	0.24
1	189.210	227000.00	856.97	878.54		878.80	0.001059	4.32	56990.93	9083.98	0.23
1	189.110	227000.00	857.40	877.99		878.25	0.001099	4.28	57377.02	8474.79	0.22
1	189.020	227000.00	855.16	877.62		877.89	0.000495	4.30	58870.63	8955.39	0.23
1	188.810	227000.00	852.24	877.19		877.43	0.000348	4.09	62725.53	8318.66	0.20
1	188.690	227000.00	850.62	876.87		877.15	0.000699	4.35	59160.61	8930.40	0.21
1	188.59	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.5	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.39	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.29	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.2	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41665.74	7148.81	0.31
1	188.1	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37965.66	6595.48	0.36
1	188.07	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39208.98	5733.80	0.31
1	188.055	Bridge									
1	188.04	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38248.79	5733.34	0.31
1	188	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.17	7288.16	0.39
1	187.91	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35900.98	5898.48	0.40
1	187.82	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32038.47	5367.10	0.46
1	187.73	227000.00	855.40	872.38	869.18	873.23	0.001125	7.74	32552.54	7779.96	0.45
1	187.64	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36450.42	8097.85	0.38
1	187.54	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33184.70	8486.68	0.42
1	187.45	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38831.71	9337.40	0.36
1	187.36	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36027.79	9688.24	0.38
1	187.24	227000.00	853.80	869.81	866.24	870.85	0.001548	8.48	30572.47	8203.42	0.47
1	187.15	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36060.30	8790.41	0.38
1	187.06	227000.00	851.90	869.09	864.37	869.68	0.000821	6.34	37393.59	8893.03	0.35
1	186.97	227000.00	851.90	868.75	864.00	869.29	0.000764	5.99	38631.88	9763.17	0.35
1	186.87	227000.00	852.60	868.18	863.60	868.83	0.001045	6.65	35918.05	11022.50	0.38


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.24
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.15 Right Channel Bank Station Interpolated
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.06 APPROX. ALIGNMENT OF AIRPORT RD. Left and
.028
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 186.97
.028
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.64
.065
.03
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.54 Left Channel Bank Station Interpolated
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.45
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.36
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188 Left and Right Bank Channel Station Interpolated
.065
.03
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.91 Right Bank Channel Station Interpolated
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.82 Right Bank Channel Station Interpolated
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.73
.065


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.07 Left and Right Channel Bank Stations Interpolated
.065
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.04 Left and Right Channel Bank Stations Interpolated


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.39 BEGIN 1:1 TRANSITION TO BRIDGE
.026
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.29 Left and Right Channel Bank Stations Interpolated
.026
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.2 Left and Right Bank Channel Stations Interpolated
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.1 Left and Right Channel Bank Stations Interpolated
.03
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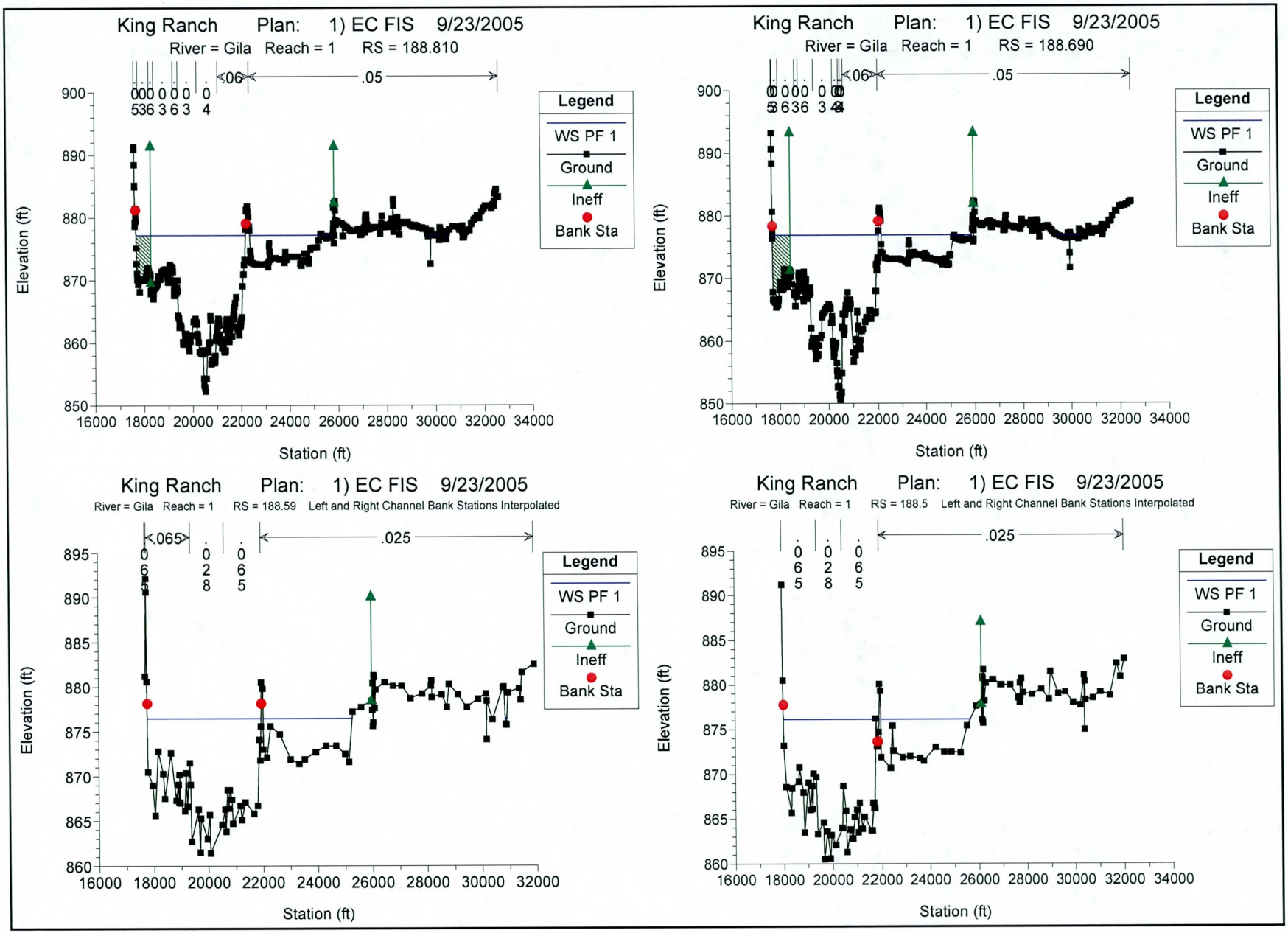
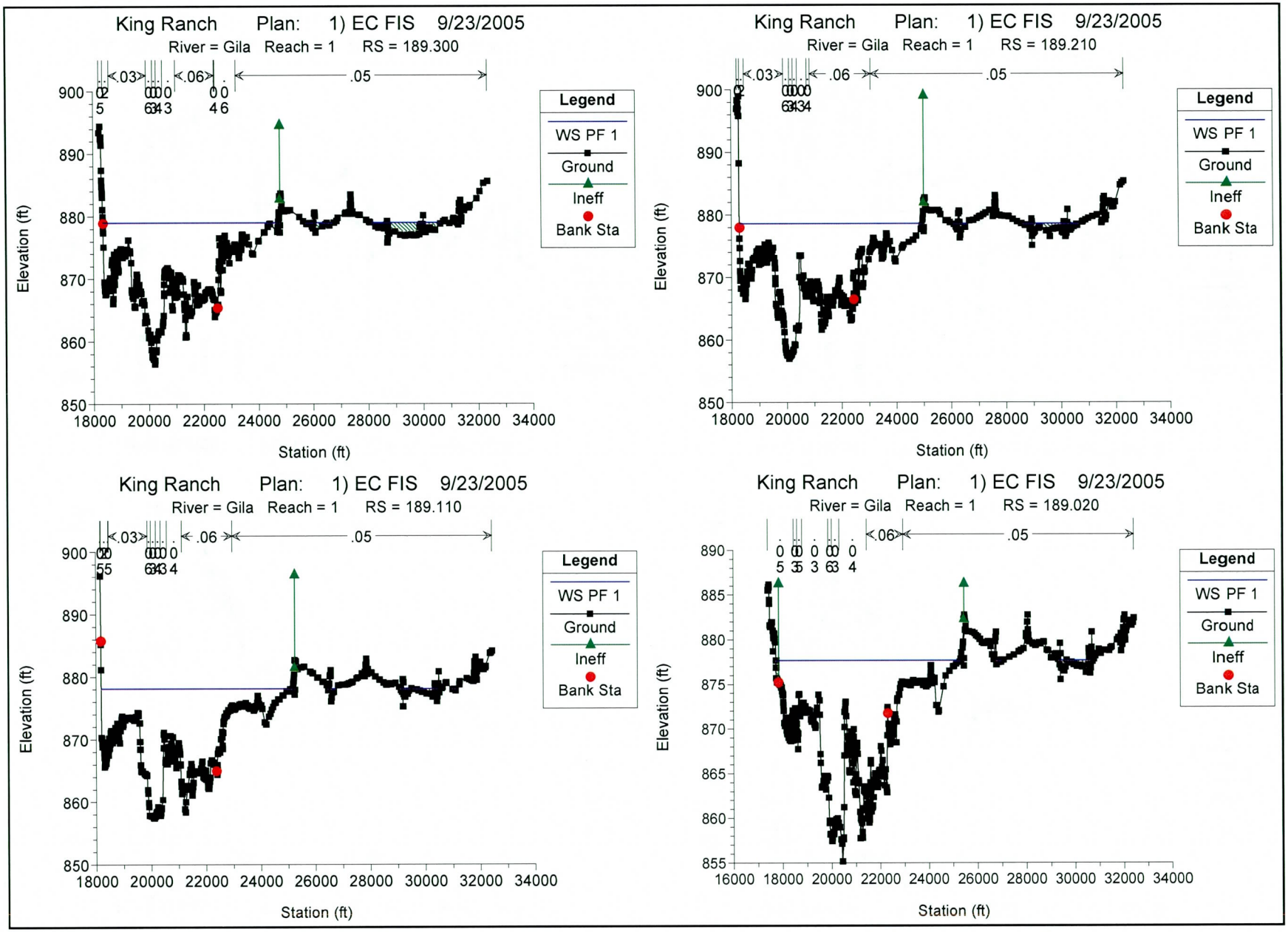
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.810
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.690
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.59 Left and Right Channel Bank Stations Interpolated
.065
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.5 Left and Right Channel Bank Stations Interpolated
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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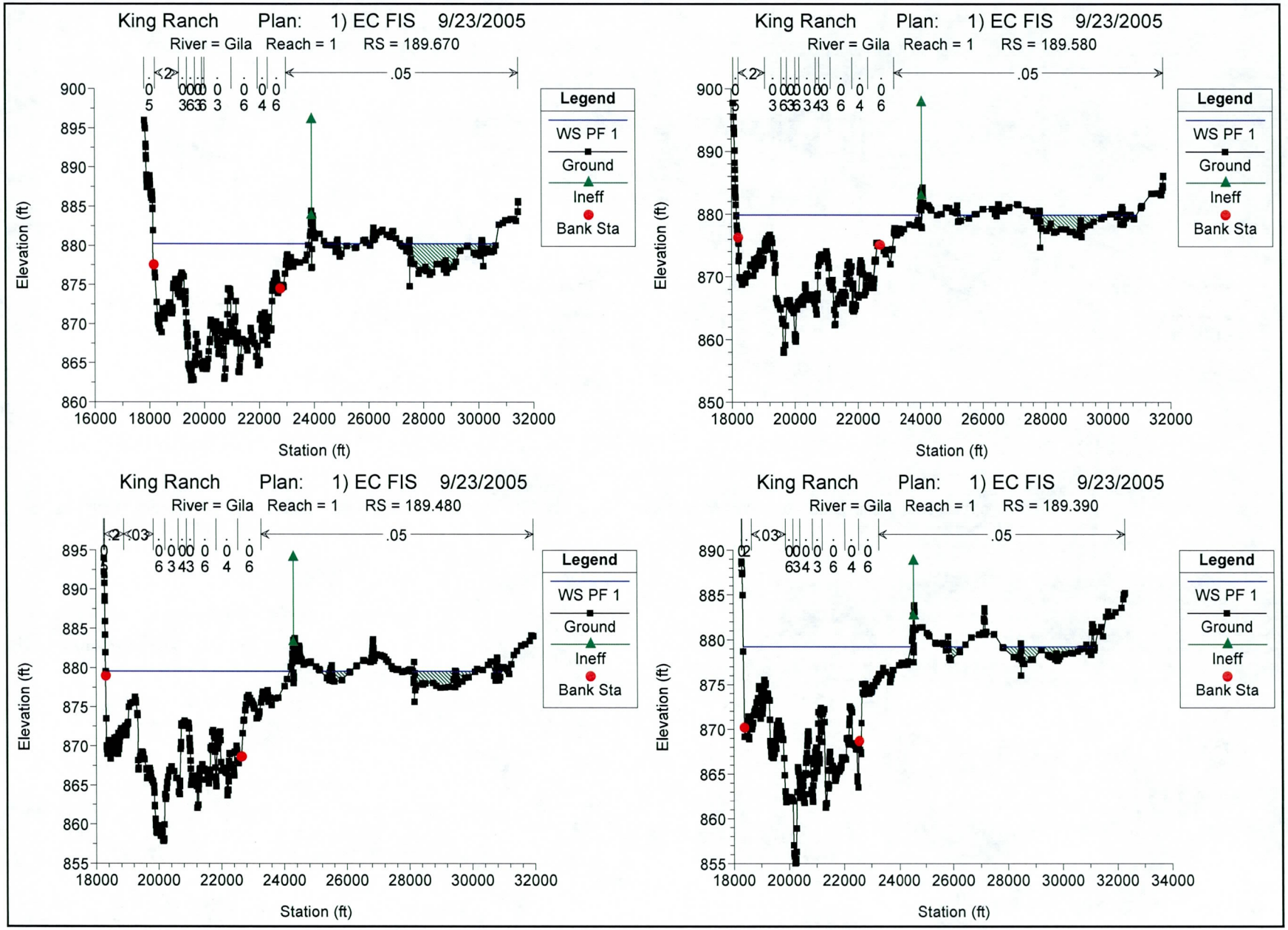
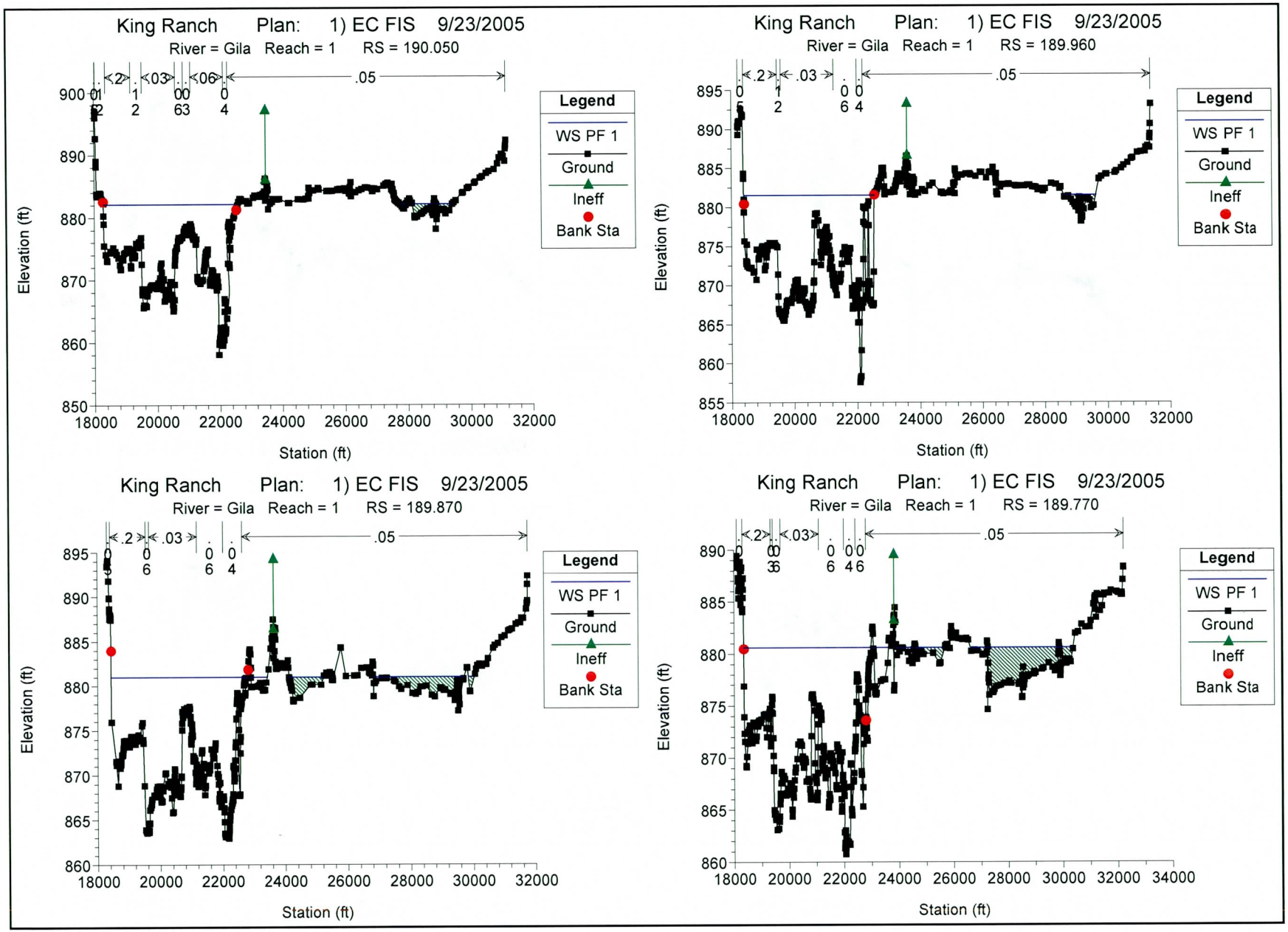
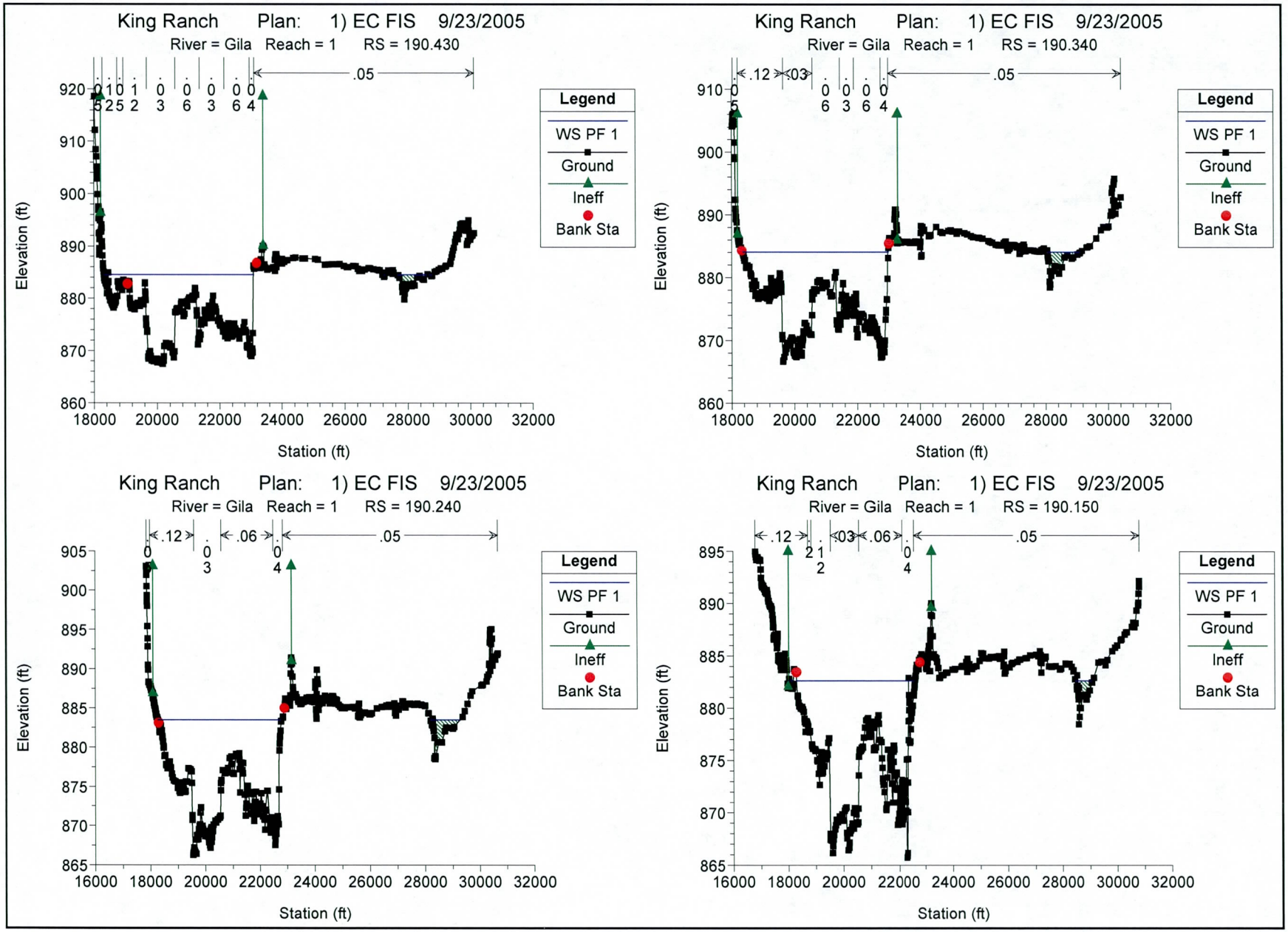
River = Gila Reach = 1 RS = 189.300
.03
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.210
.03
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.110
.03
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.020
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.670
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.580
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.480
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.390
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.050
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.960
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.870
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.770
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.430
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.340
.12
.03
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.240
.12
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.150
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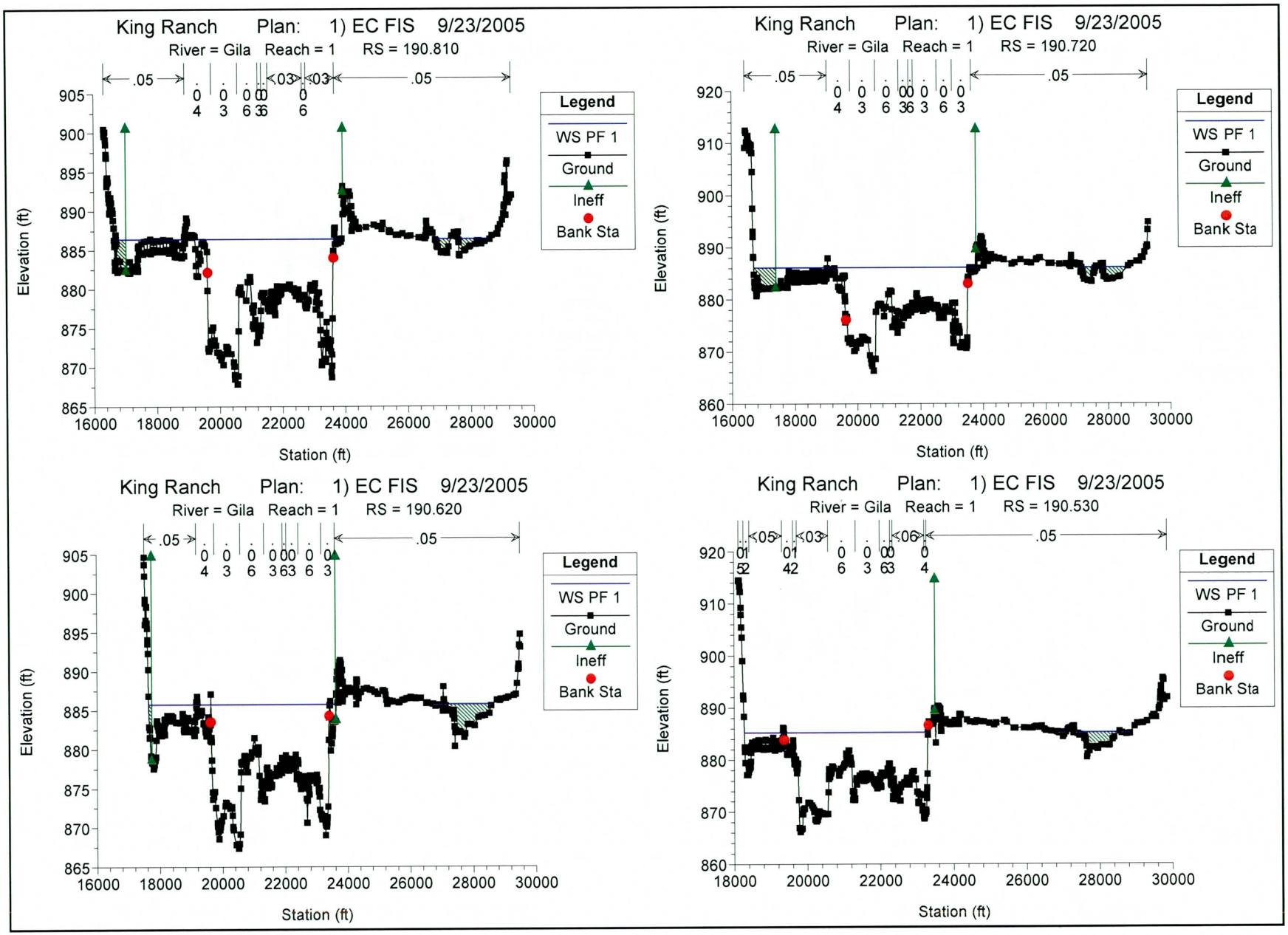
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.810
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.03
.03
.05
Legend
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Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.720
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.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.620
.05
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.530
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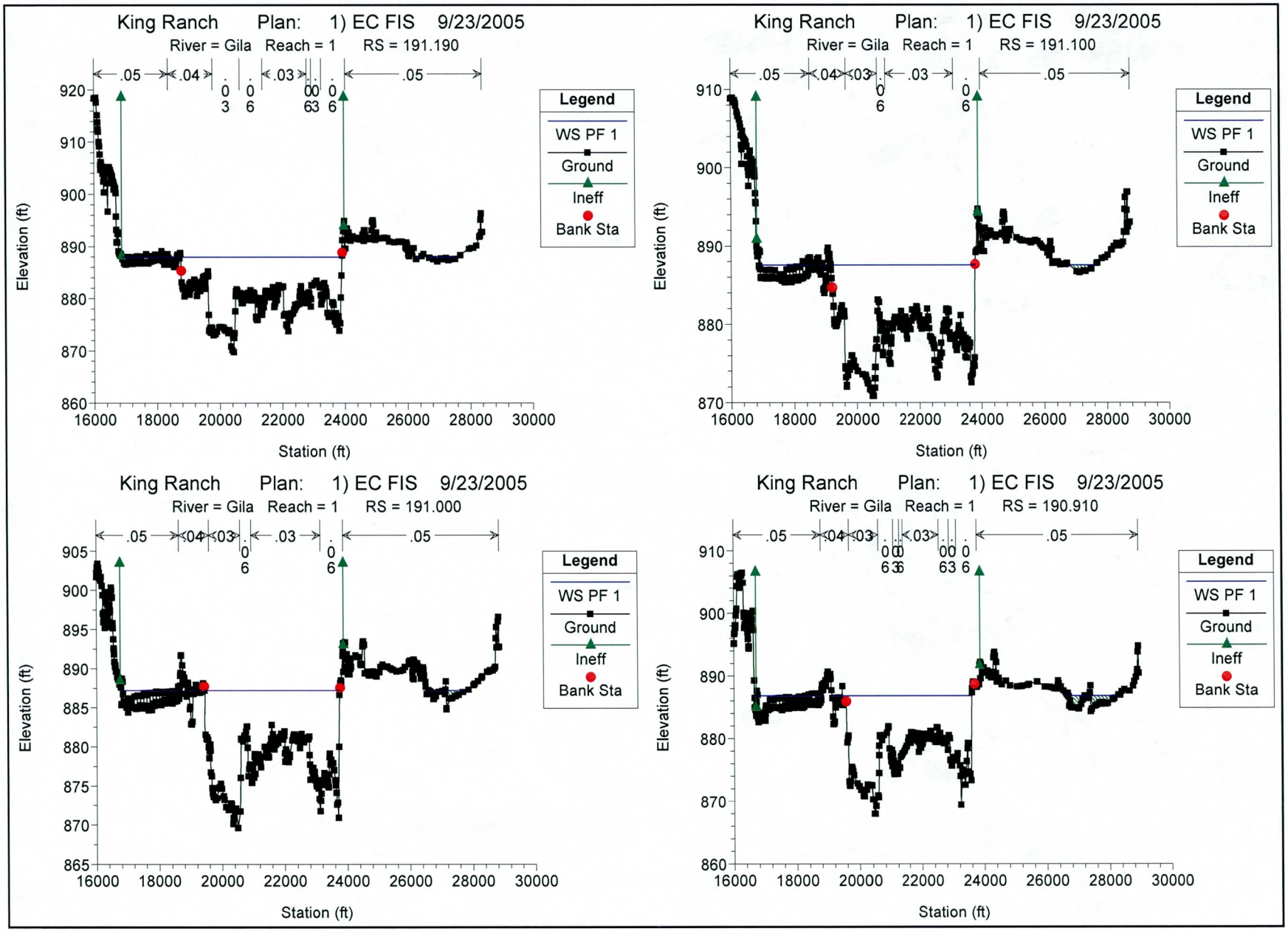
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.190
.05 .04 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.100
.05 .04 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.000
.05 .04 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.910
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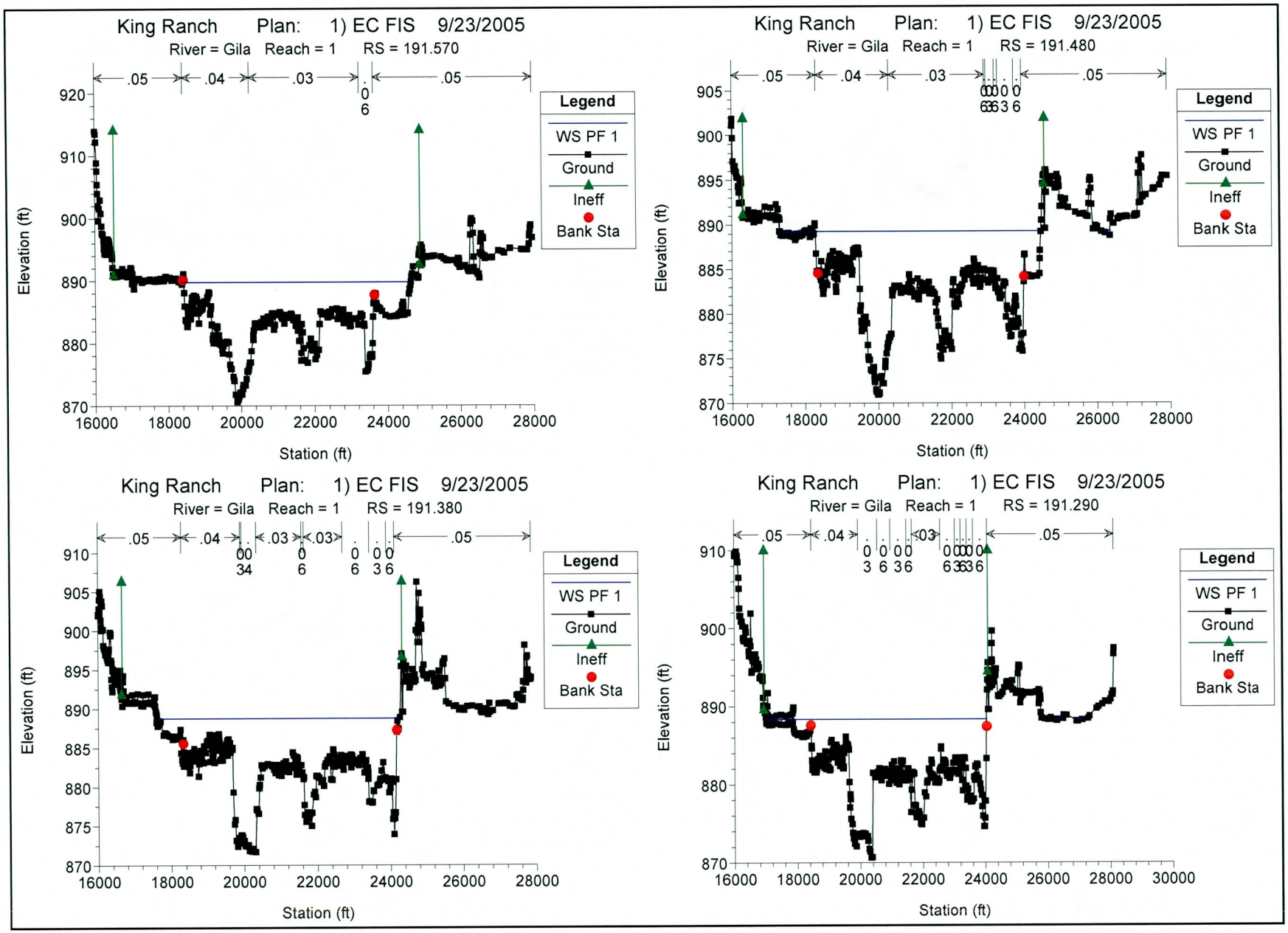
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.570
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.480
.05 .04 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.380
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.290
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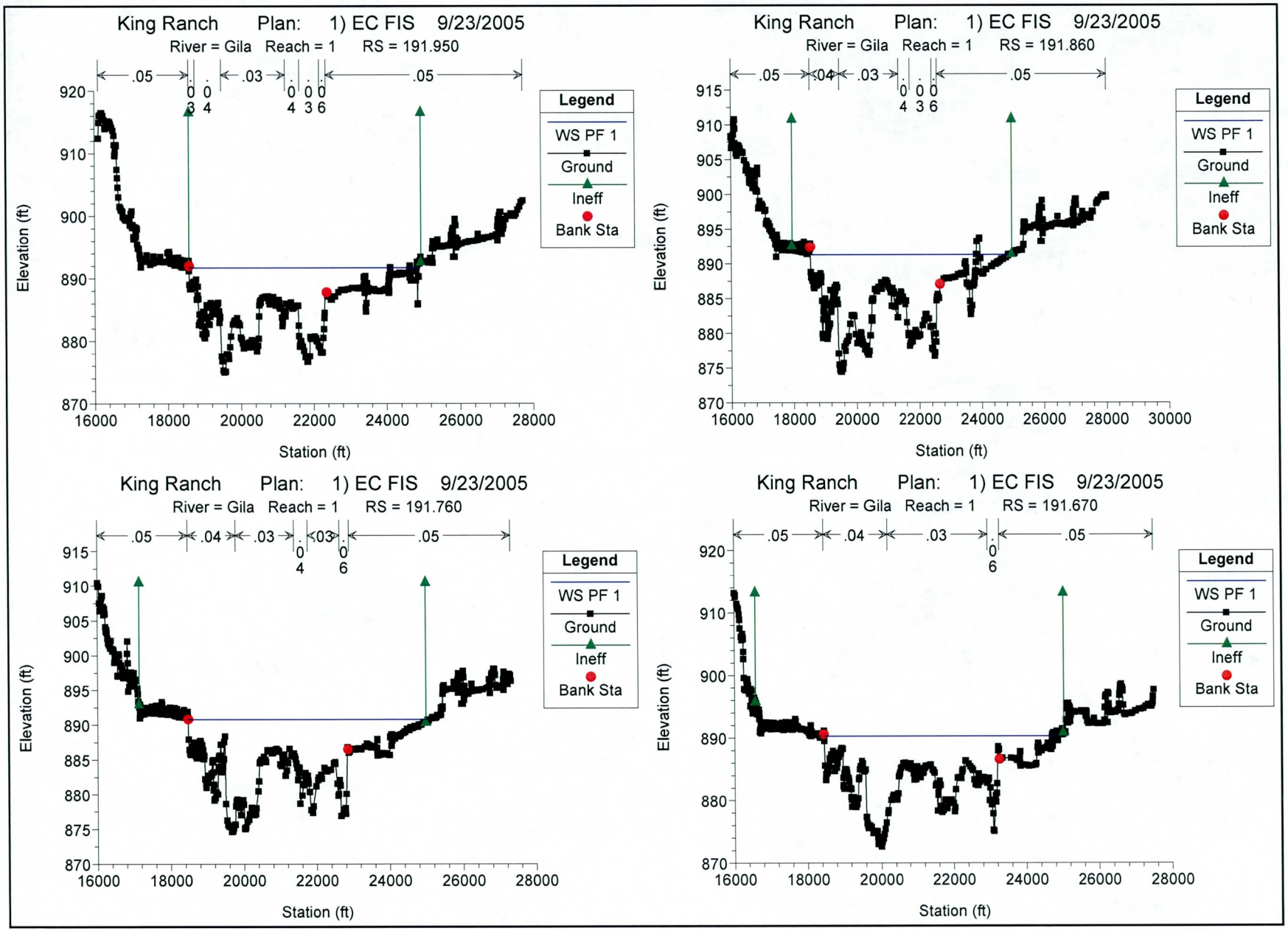
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 191.950
.05 .03 .05
0 0 0 0 0 0
3 4 4 3 6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.860
.05 .04 .03 .05
0 0 0
4 3 6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.760
.05 .04 .03 .03 .05
0 0
4 6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.670
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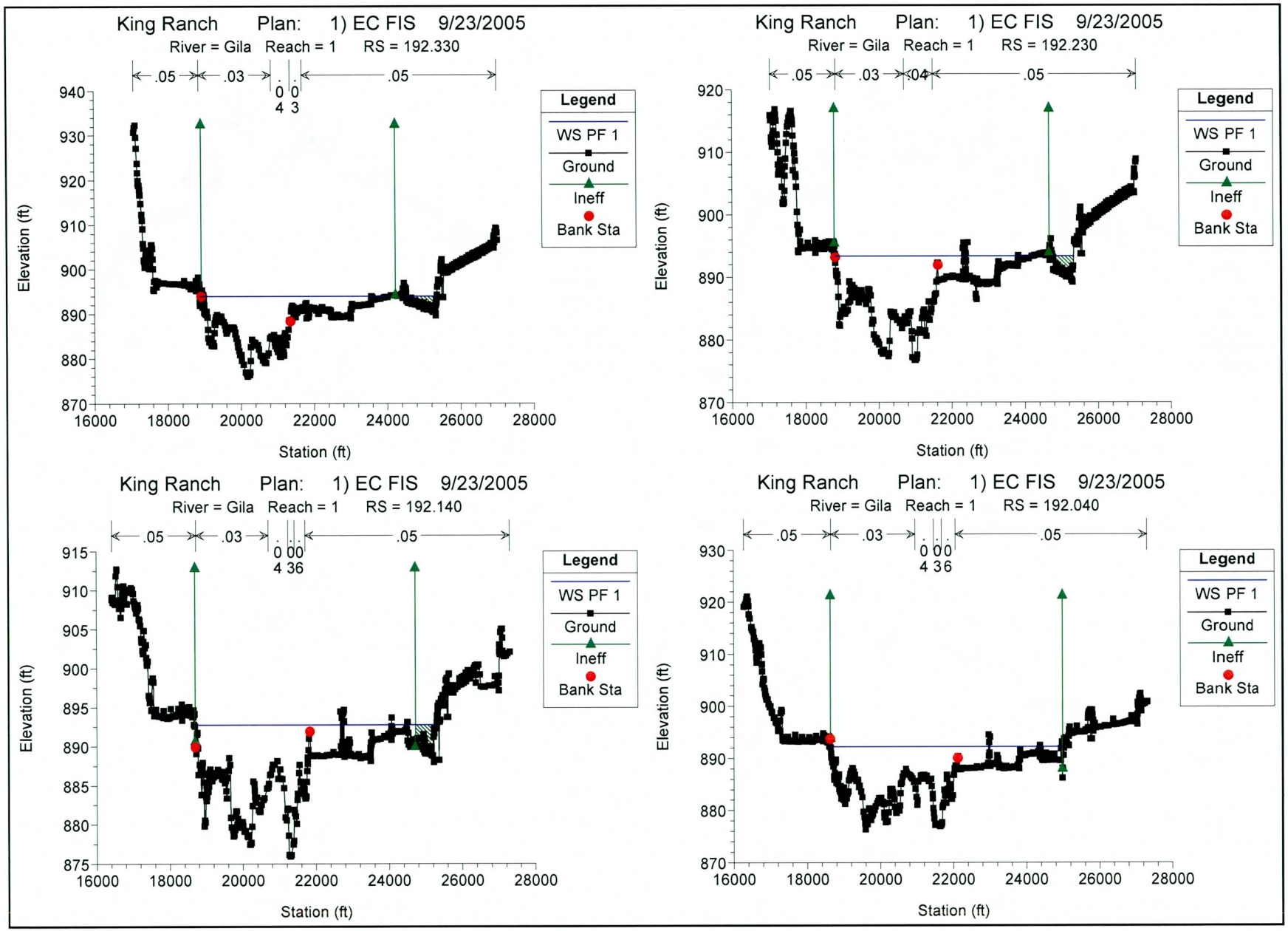
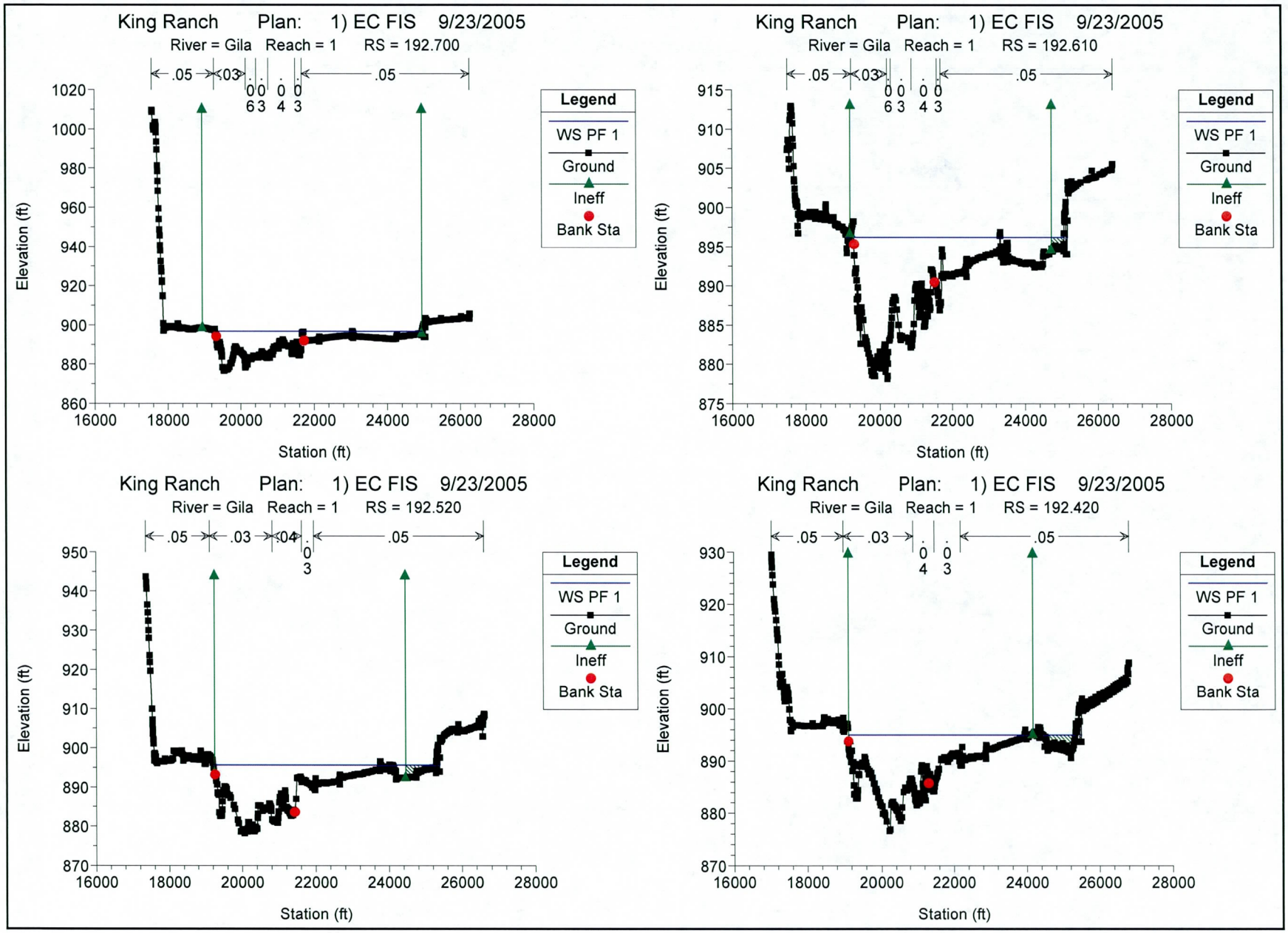
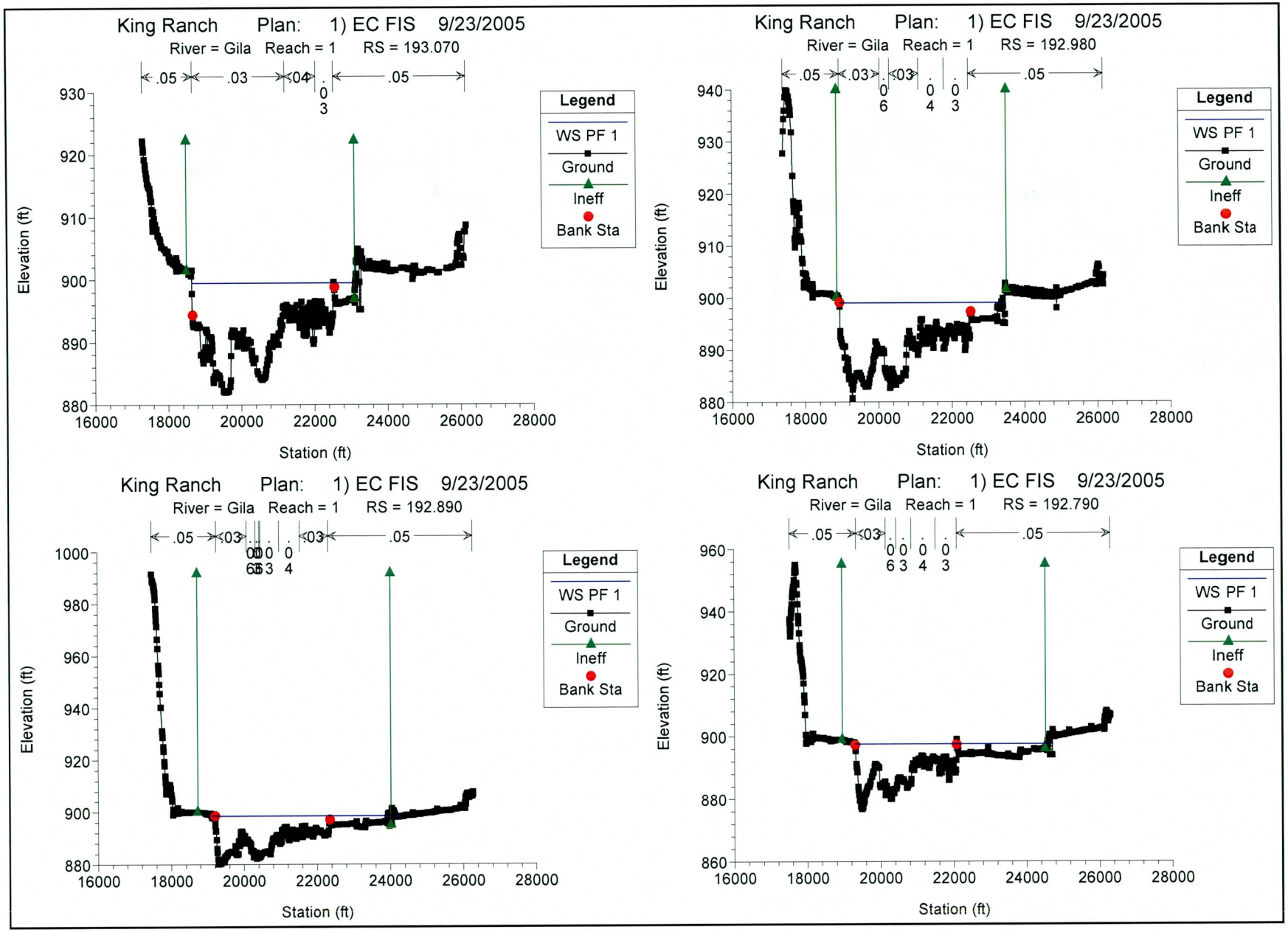
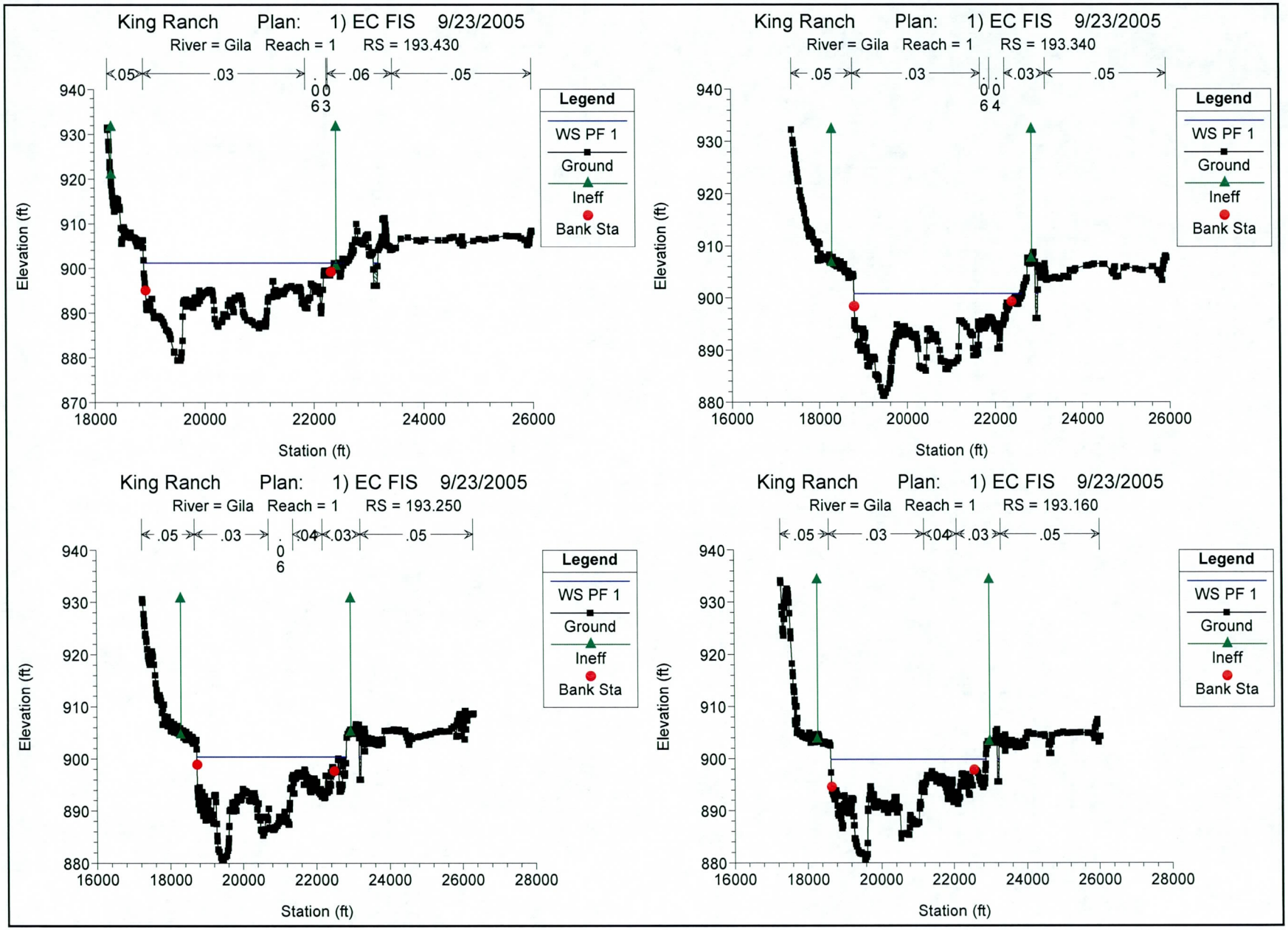
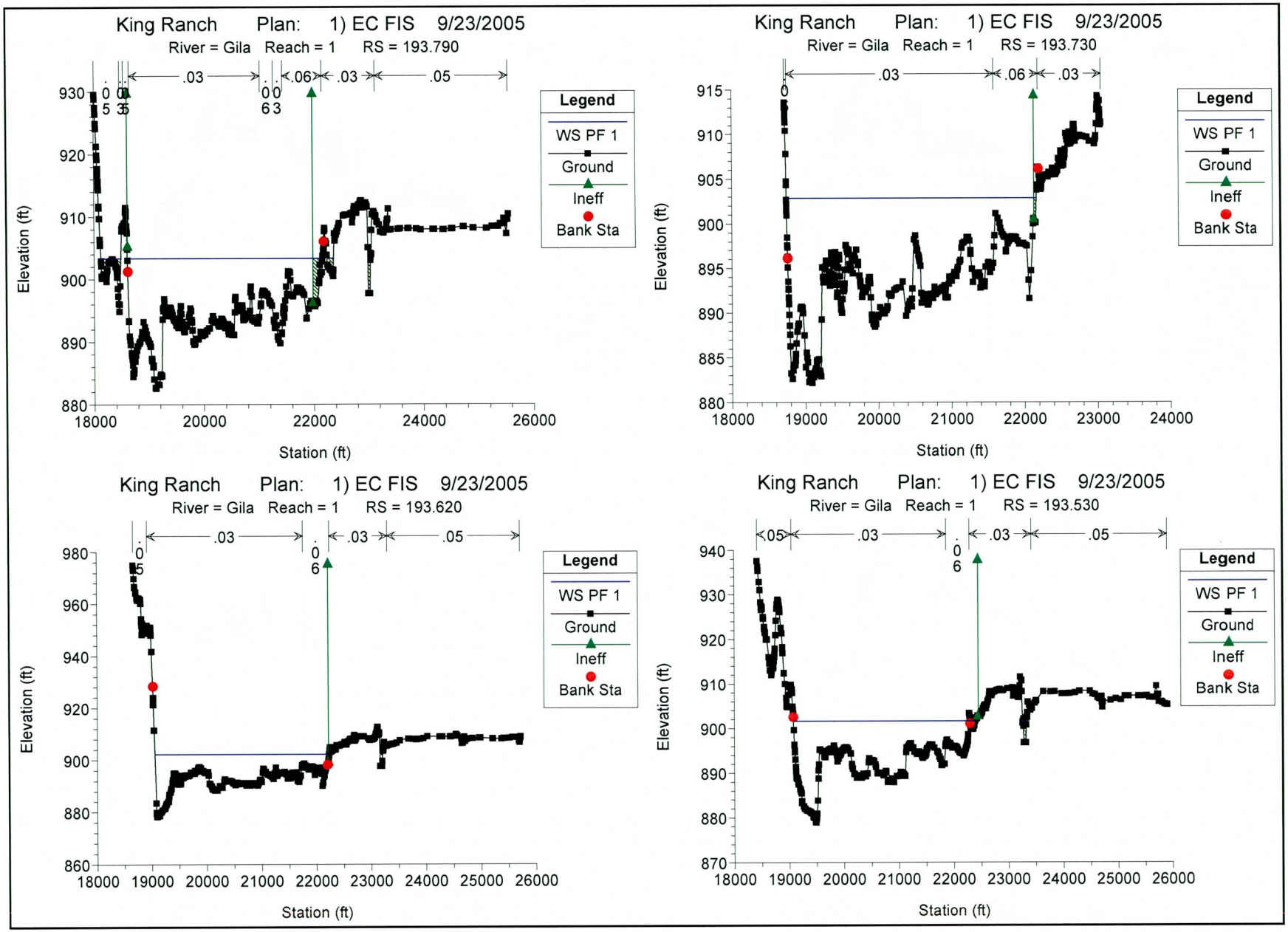
0
6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

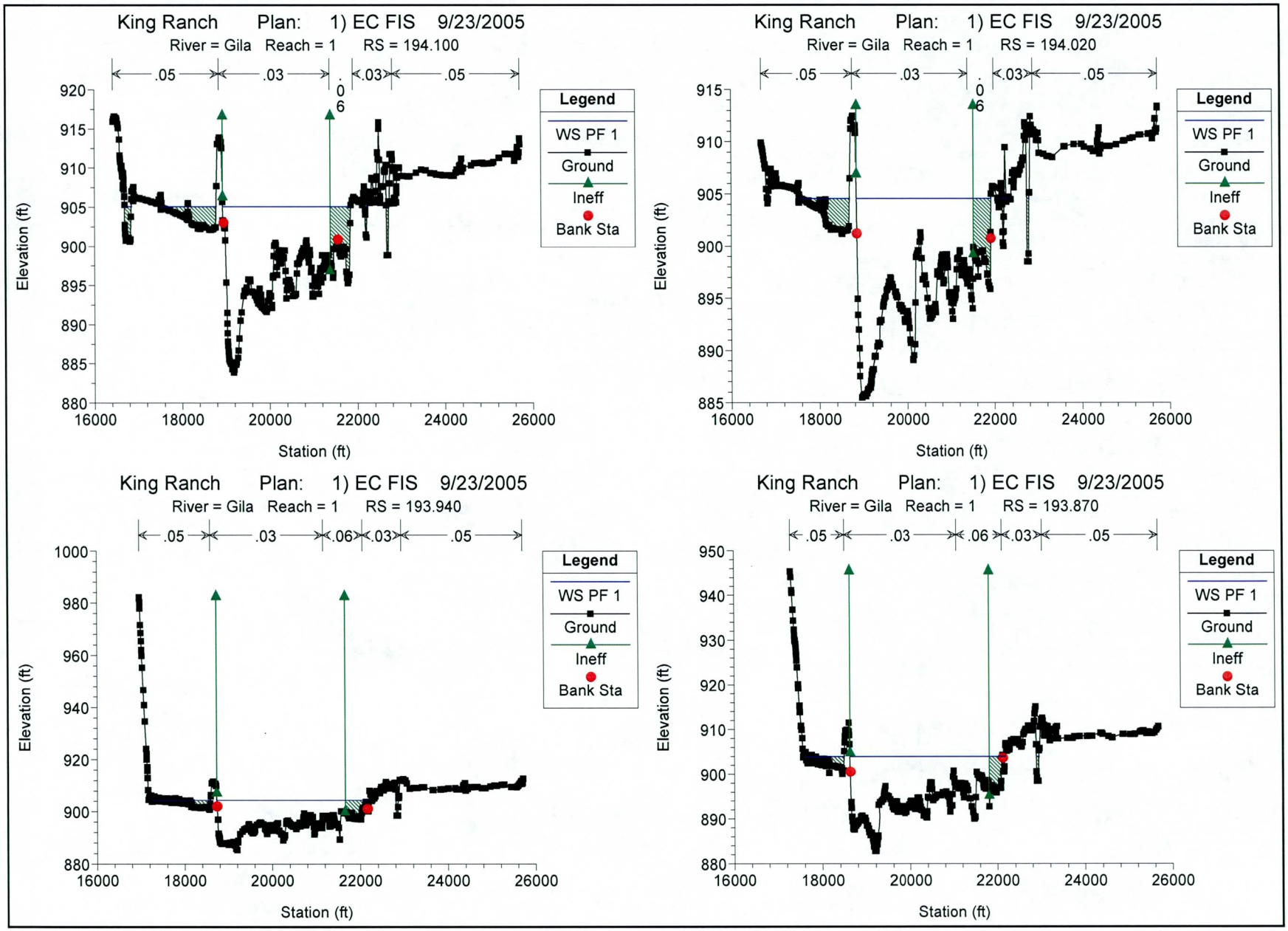

King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.330
.05 .03 .05
0 0
4 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
940 930 920 910 900 890 880 870
16000 18000 20000 22000 24000 26000 28000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.230
.05 .03 .04 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
920 910 900 890 880 870
16000 18000 20000 22000 24000 26000 28000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.140
.05 .03 .05
0 00
4 36
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
915 910 905 900 895 890 885 880 875
16000 18000 20000 22000 24000 26000 28000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.040
.05 .03 .05
0 00
4 36
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
930 920 910 900 890 880 870
16000 18000 20000 22000 24000 26000 28000
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.700
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.610
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.520
.05 .03 .04 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.420
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.070
.05 .03 .04 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.980
.05 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.890
.05 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.790
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.430
.05 .03 .00 .06 .05
.00 6 3
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
940 930 920 910 900 890 880 870
18000 20000 22000 24000 26000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.340
.05 .03 .00 .03 .05
.00 6 4
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
940 930 920 910 900 890 880
16000 18000 20000 22000 24000 26000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.250
.05 .03 .0 .04 .03 .05
0 6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
940 930 920 910 900 890 880
16000 18000 20000 22000 24000 26000 28000
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.160
.05 .03 .04 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
940 930 920 910 900 890 880
16000 18000 20000 22000 24000 26000 28000
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.790
.03 .06 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.730
.03 .06 .03
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.620
.03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.530
.05 .03 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.100
.05 .03 .06 .03 .05
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.020
.05 .03 .06 .03 .05
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.940
.05 .03 .06 .03 .05
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Ineff
Bank Sta
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.870
.05 .03 .06 .03 .05
Elevation (ft)
Station (ft)
Legend
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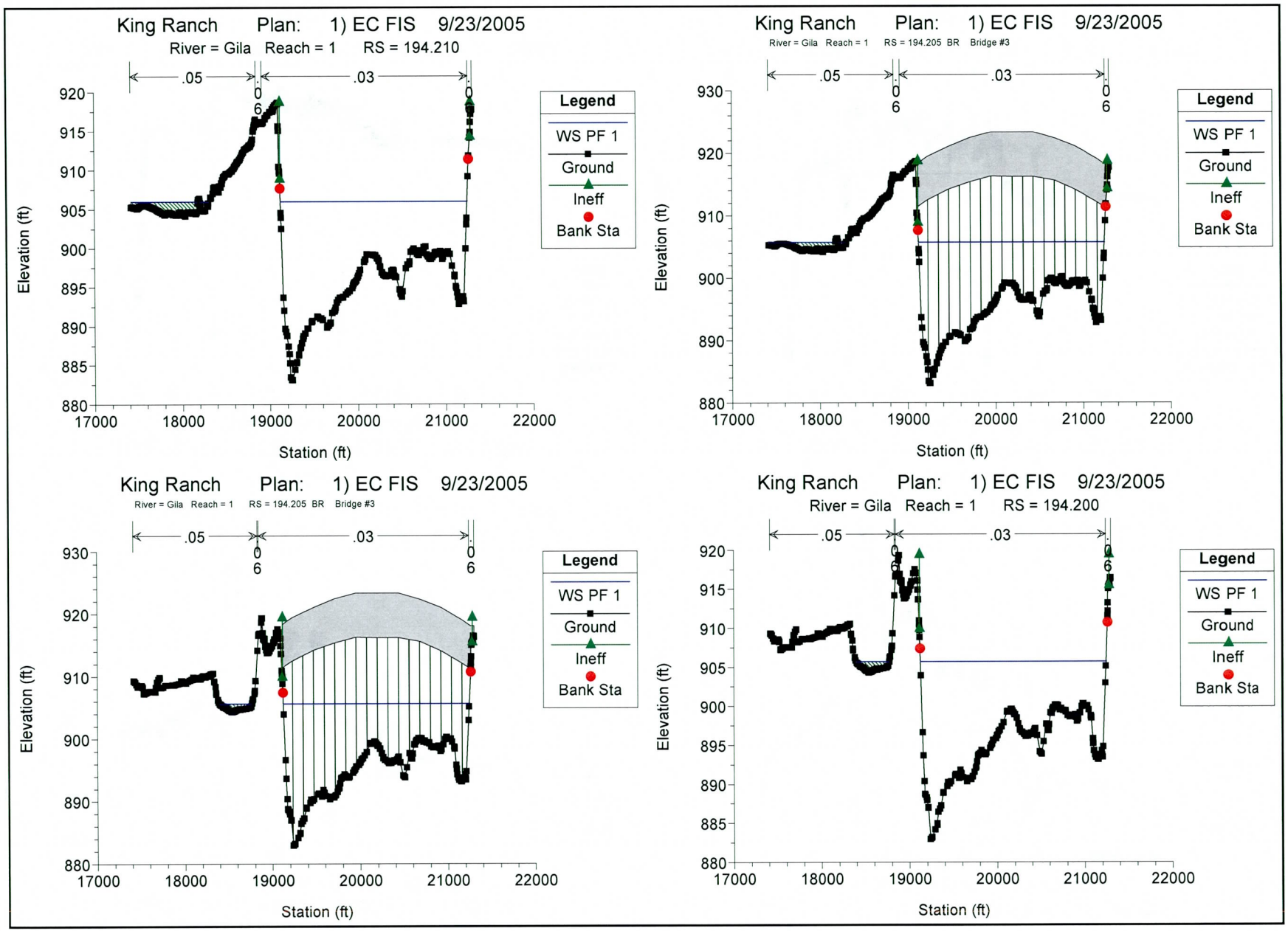
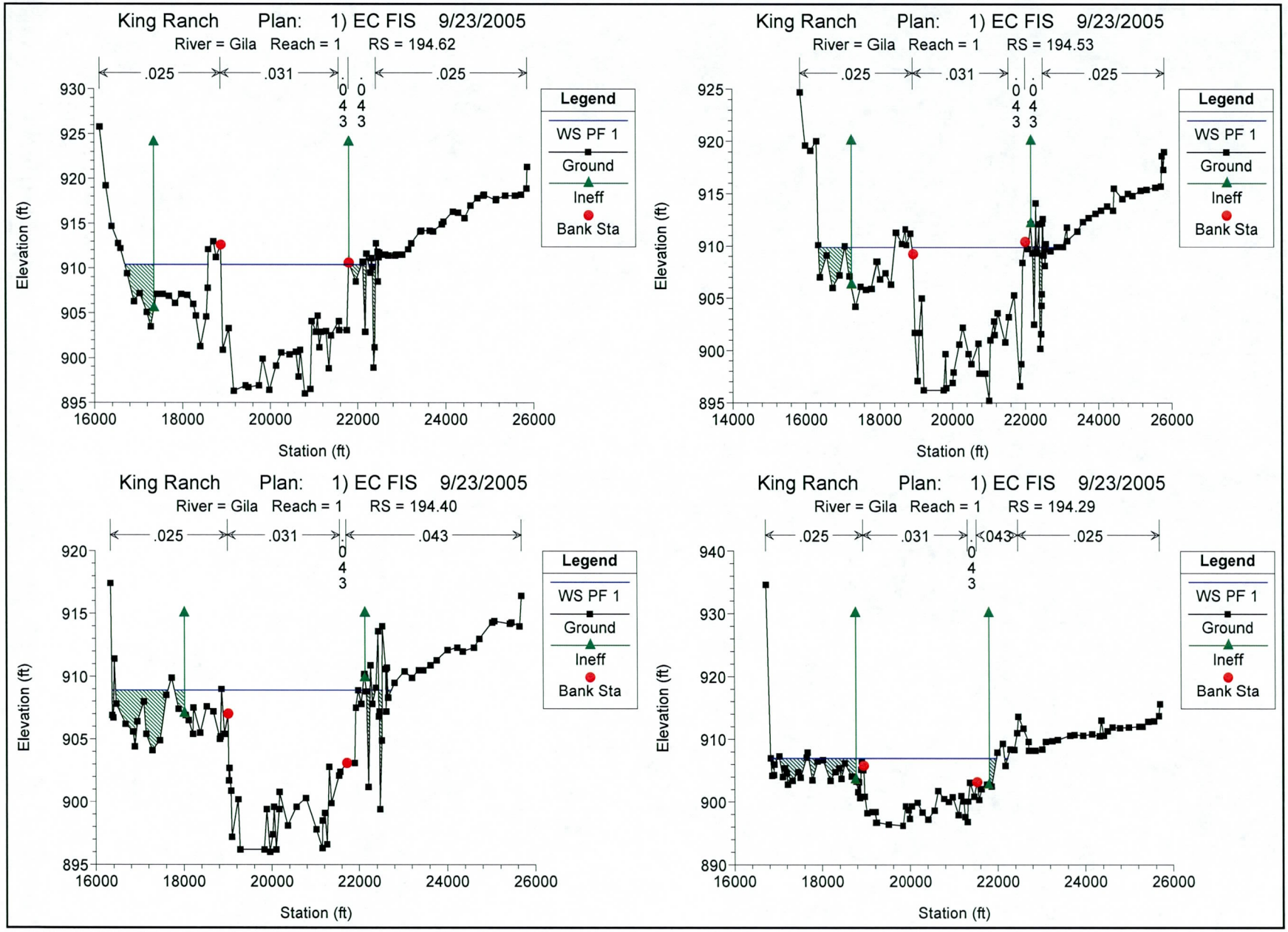
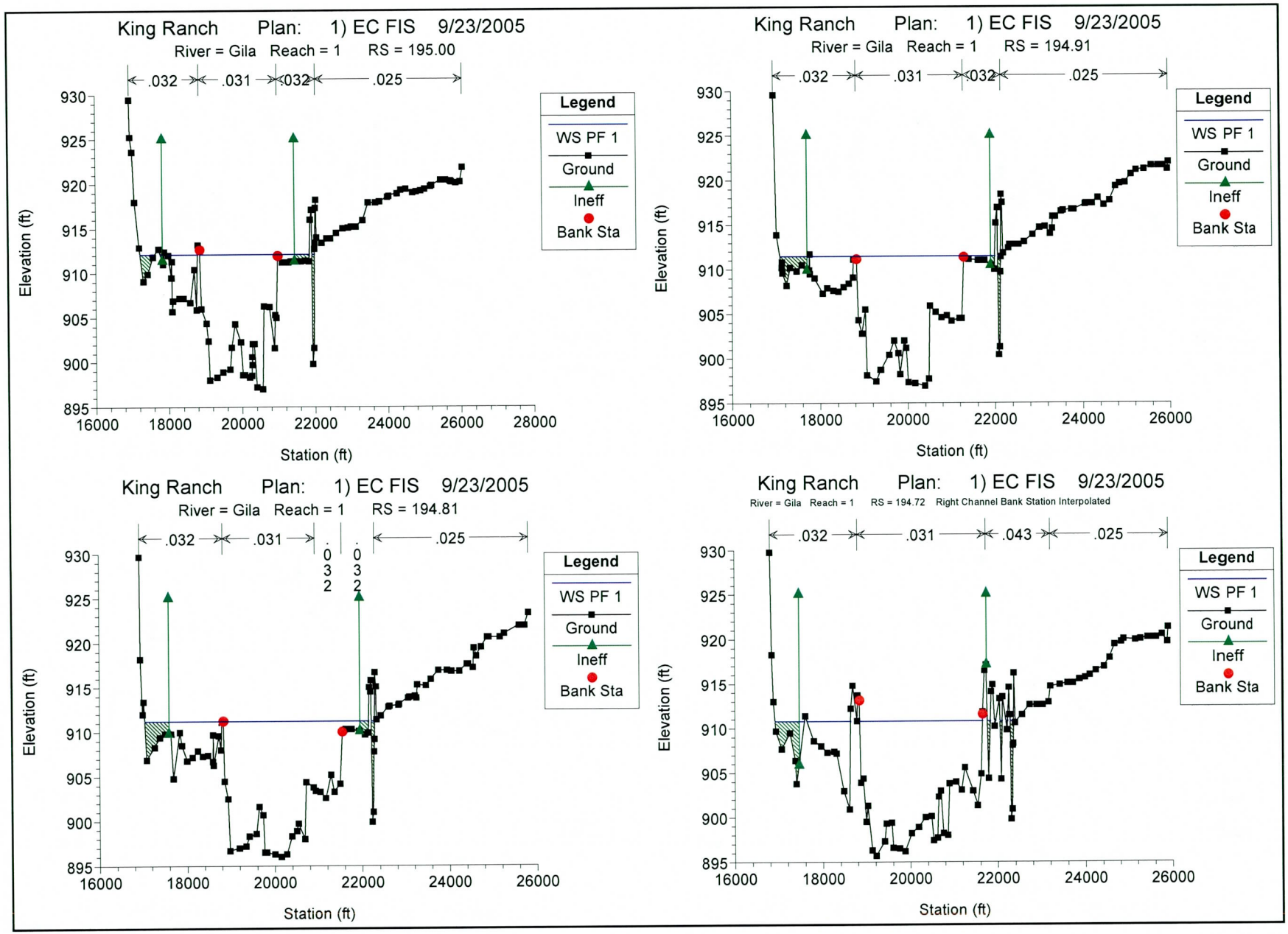
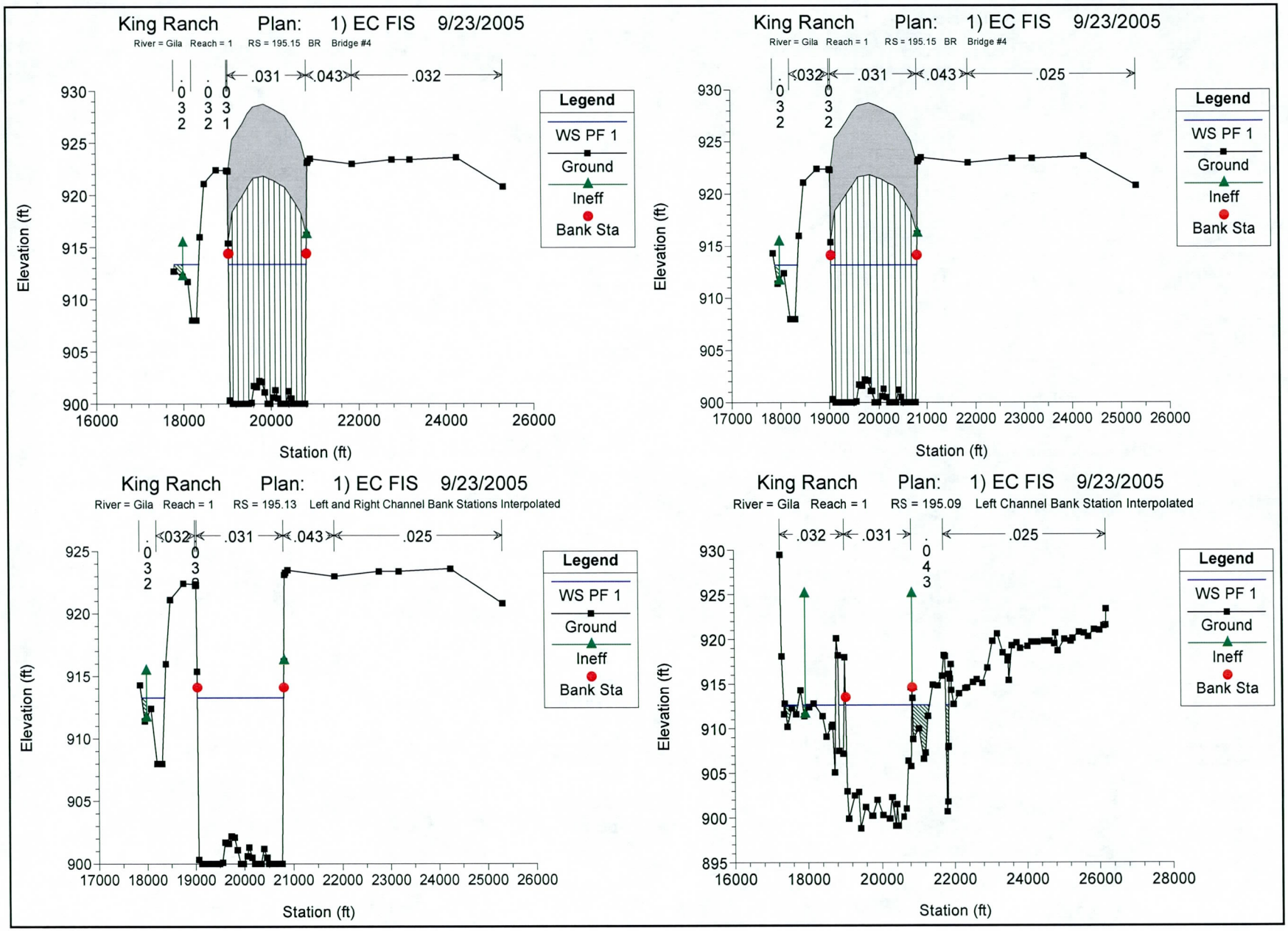
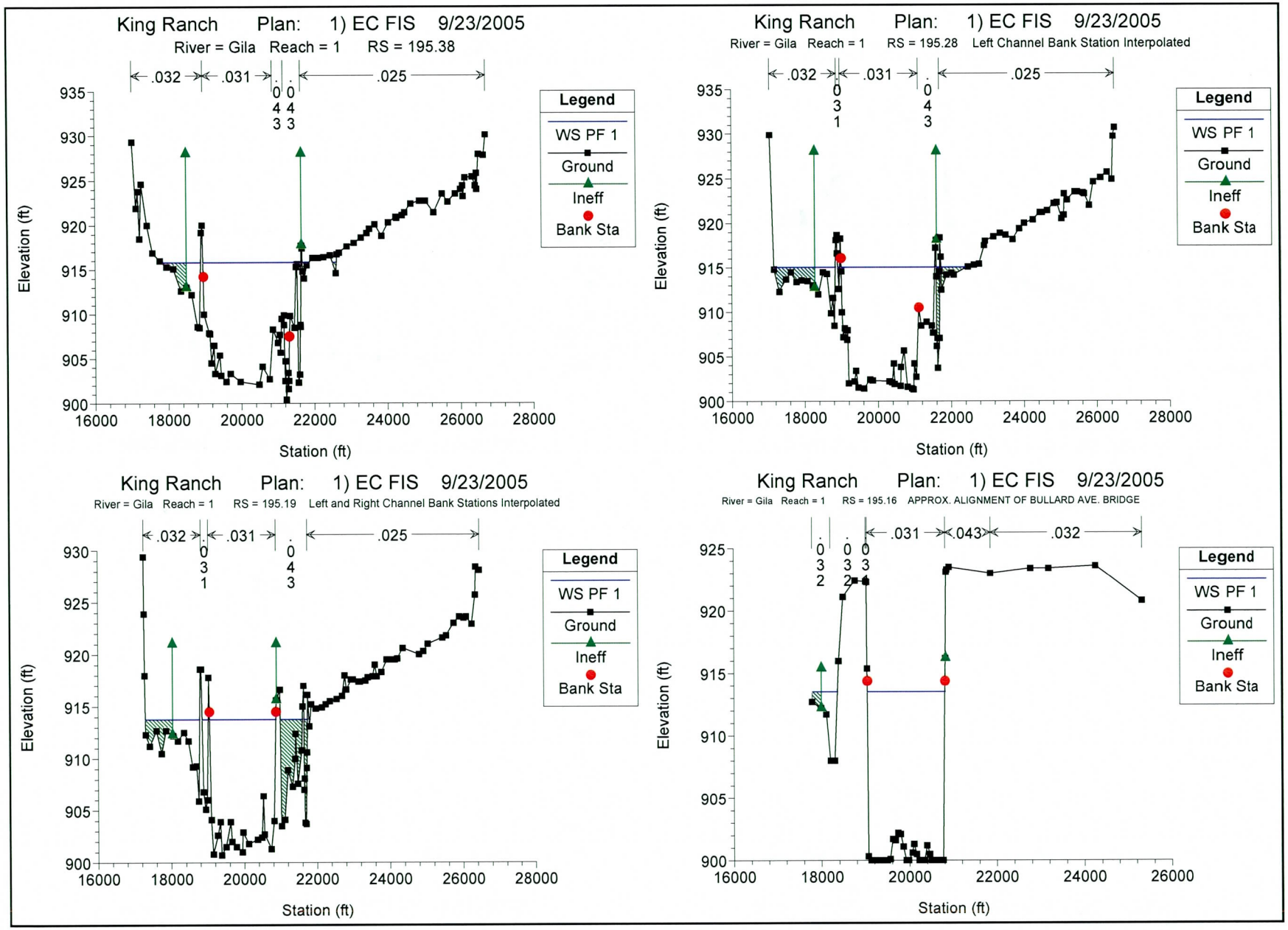
Ground
Ineff
Bank Sta

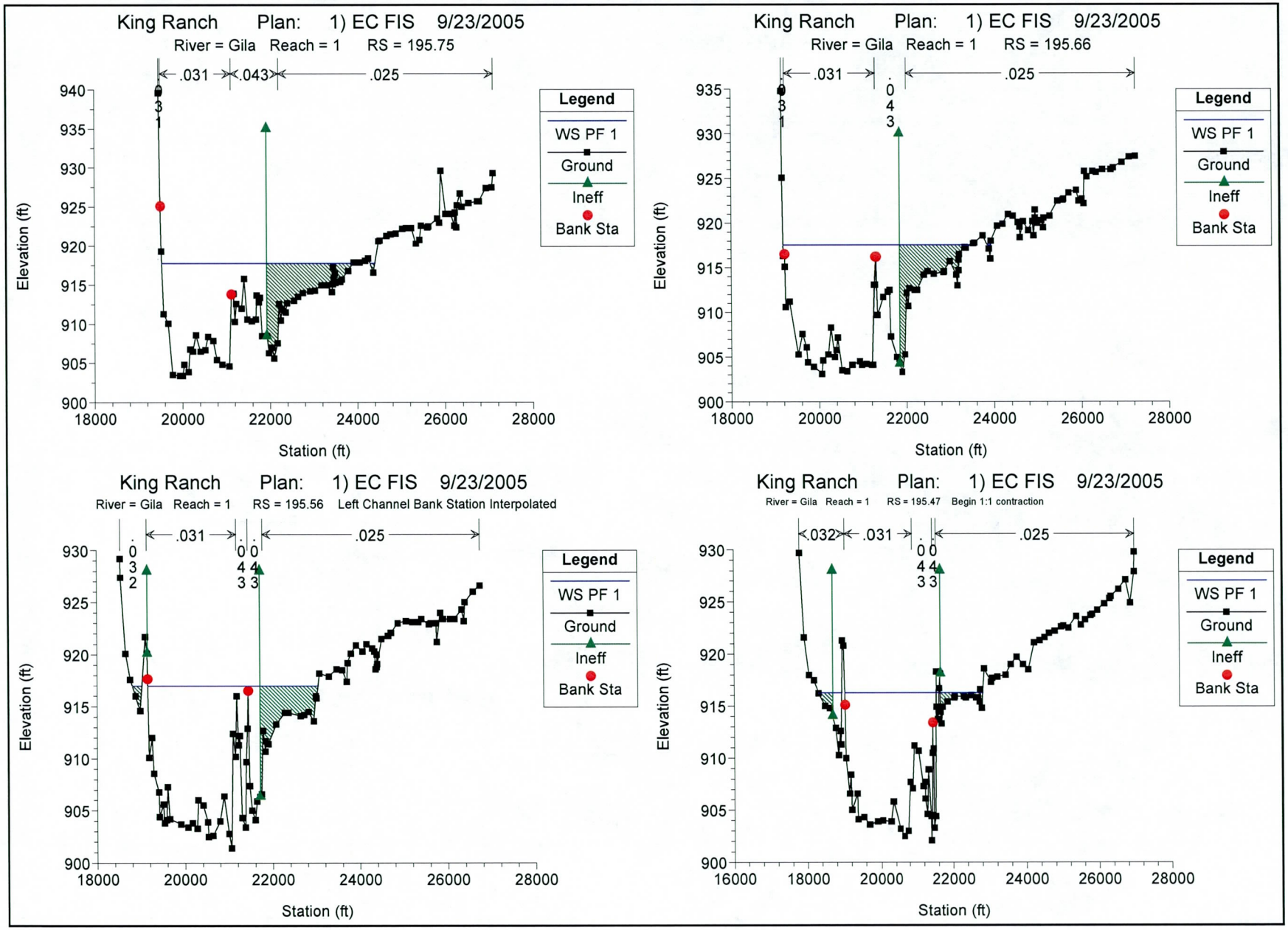

King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.210
.05
.03
0
6
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.205 BR Bridge #3
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.205 BR Bridge #3
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.200

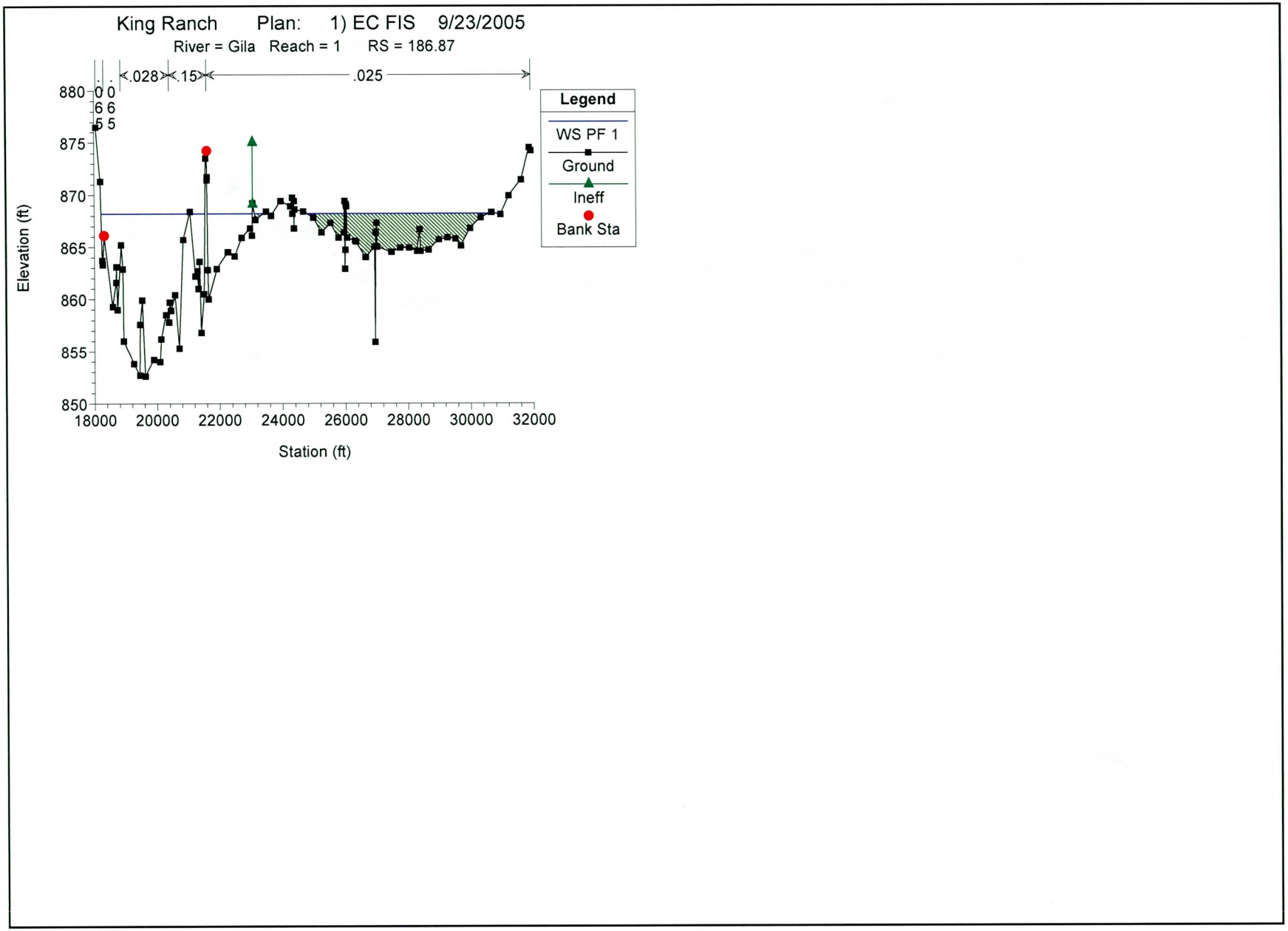

King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.62
.025
.031
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.53
.025
.031
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.40
.025
.031
.043
.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.29
.025
.031
.043
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.00
.032 .031 .032 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.91
.032 .031 .032 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.81
.032 .031 .032 .032 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.72 Right Channel Bank Station Interpolated
.032 .031 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.15 BR Bridge #4
.031
.043
.032
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.15 BR Bridge #4
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.13 Left and Right Channel Bank Stations Interpolated
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.09 Left Channel Bank Station Interpolated
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

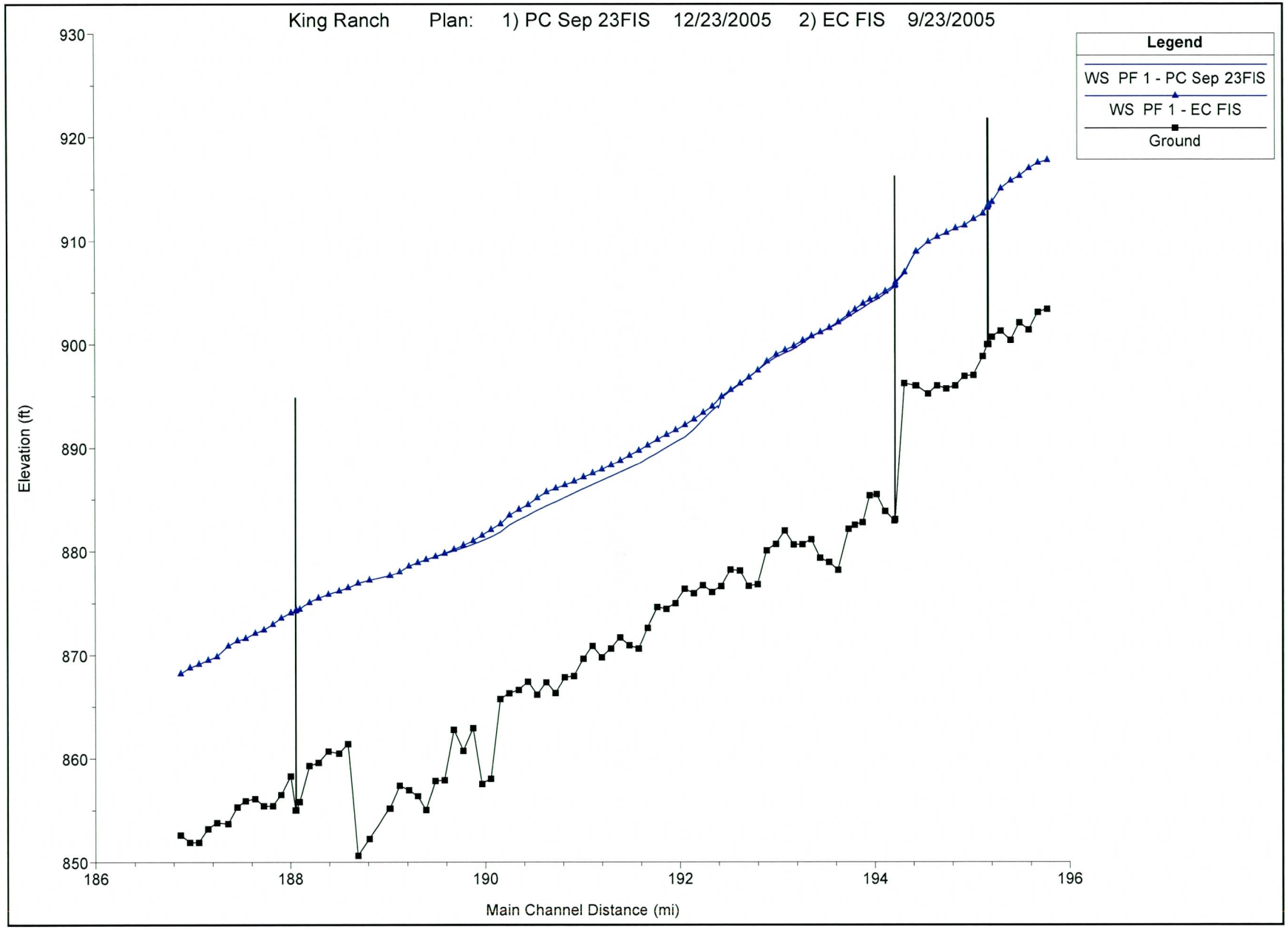

King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.38
.032
.031
.025
0.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.28 Left Channel Bank Station Interpolated
.032
.031
.025
0.031
0.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.19 Left and Right Channel Bank Stations Interpolated
.032
.031
.025
0.031
0.043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.16 APPROX. ALIGNMENT OF BULLARD AVE. BRIDGE
.031
.043
.032
0.032
0.032
0.032
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.75
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.66
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.56 Left Channel Bank Station Interpolated
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.47 Begin 1:1 contraction
.032
.031
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 186.87
.028
.15
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
880
875
870
865
860
855
850
18000
20000
22000
24000
26000
28000
30000
32000

APPENDIX D

Proposed Conditions HEC-RAS Model Results

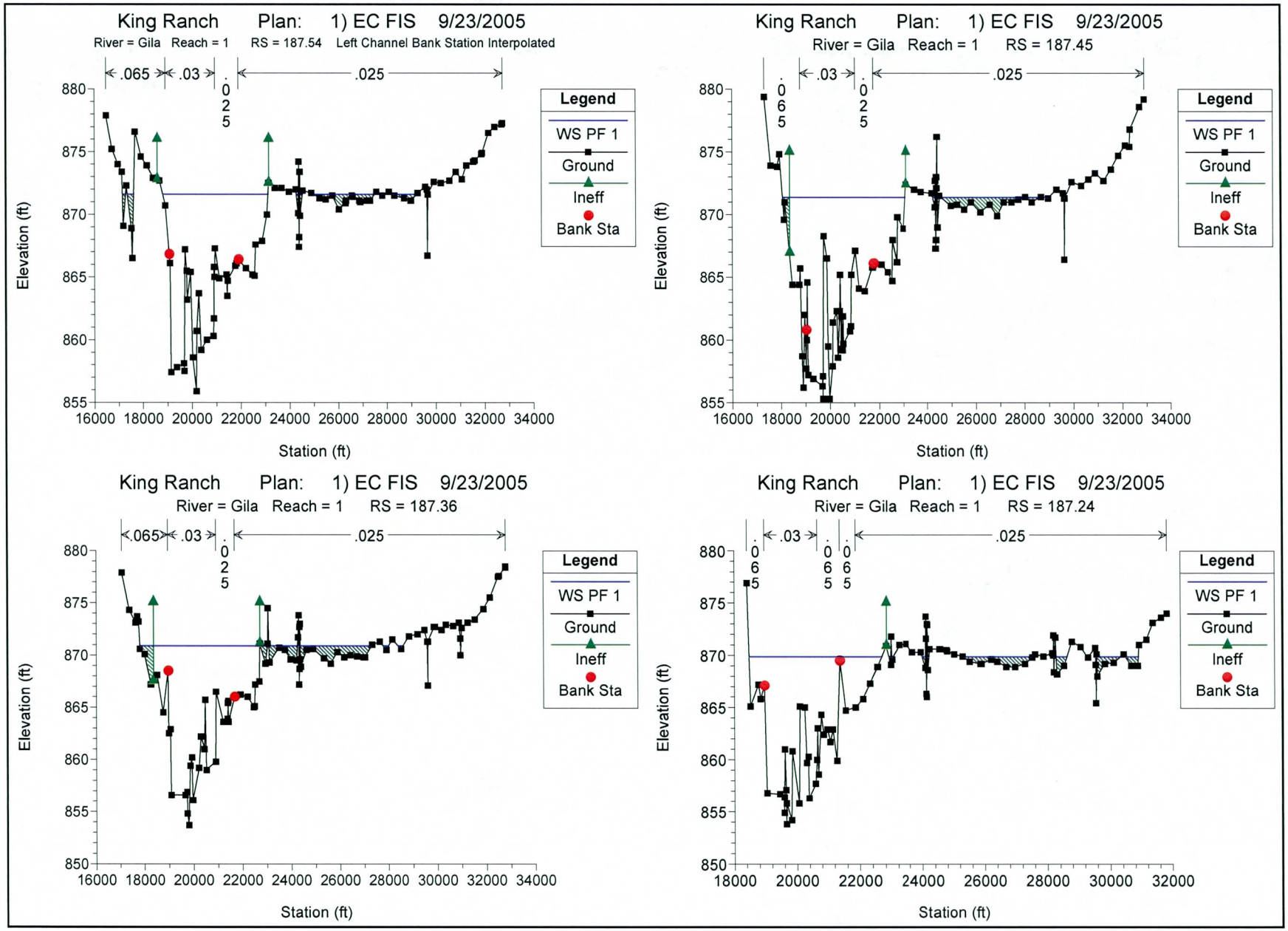

King Ranch Plan: 1) PC Sep 23FIS 12/23/2005 2) EC FIS 9/23/2005
Legend
WS PF 1 - PC Sep 23FIS
WS PF 1 - EC FIS
Ground
Elevation (ft)
930
920
910
900
890
880
870
860
850
186
188
190
192
194
196
Main Channel Distance (mi)

HEC-RAS Plan: PC Sep 23FIS River: Gila Reach: 1 Profile: PF 1

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)	
1	195.75	227000.00	903.40	917.73	914.96	919.51	0.002169	11.22	22772.56	4473.81	0.59
1	195.66	227000.00	903.10	917.47	912.70	918.52	0.001162	8.46	28721.20	4346.95	0.43
1	195.56	227000.00	901.40	916.94	911.75	917.93	0.001156	8.12	28808.92	4106.57	0.42
1	195.47	227000.00	902.10	916.20	911.88	917.27	0.001385	8.43	27818.78	4362.12	0.45
1	195.38	227000.00	900.40	915.74	910.84	916.64	0.001099	7.82	30927.77	4013.15	0.41
1	195.28	227000.00	901.30	914.98	910.16	916.02	0.001115	8.39	29500.01	5072.21	0.43
1	195.19	227000.00	900.70	913.69	910.33	915.28	0.001885	10.39	23441.89	4198.68	0.55
1	195.16	227000.00	900.00	913.47	908.68	914.94	0.001408	9.82	23846.52	2341.47	0.48
1	195.15	Bridge									
1	195.13	227000.00	900.00	913.23	908.68	914.76	0.001505	10.02	23343.48	2237.68	0.50
1	195.09	227000.00	898.80	912.57	909.24	914.32	0.002001	10.76	22295.60	3657.03	0.57
1	195.00	227000.00	897.00	912.05	908.48	913.29	0.001540	9.18	26677.16	4364.90	0.49
1	194.91	227000.00	896.90	911.43	907.63	912.51	0.001446	8.56	28678.78	4973.37	0.47
1	194.81	227000.00	896.00	911.16	905.84	911.88	0.000818	7.00	35118.84	5164.81	0.37
1	194.72	227000.00	895.70	910.72	905.79	911.46	0.000927	7.08	34228.88	4725.84	0.38
1	194.62	227000.00	896.00	910.33	905.58	910.99	0.000861	6.67	35650.48	5294.07	0.36
1	194.53	227000.00	895.20	909.82	905.21	910.53	0.000969	6.88	34552.08	5571.63	0.38
1	194.40	227000.00	896.00	908.84	904.77	909.76	0.001223	7.83	30923.65	5830.38	0.43
1	194.29	227000.00	896.20	906.78	904.97	908.42	0.002971	10.46	22532.17	5071.73	0.65
1	194.210	227000.00	883.10	905.79	902.06	907.32	0.001693	9.93	22868.46	2976.98	0.53
1	194.205	Bridge									
1	194.200	227000.00	882.97	905.48		907.08	0.001824	10.15	22353.69	2116.92	0.55
1	194.100	227000.00	883.87	904.80		906.13	0.001606	9.24	24571.75	3012.59	0.51
1	194.020	227000.00	885.49	904.24		905.37	0.001434	8.56	26556.24	3197.07	0.48
1	193.940	227000.00	885.38	903.91		904.82	0.001169	7.67	29611.59	3505.83	0.42
1	193.870	227000.00	882.80	903.46		904.27	0.001587	7.20	31550.00	3568.25	0.40
1	193.790	227000.00	882.55	902.98		903.72	0.000970	6.91	32937.20	3711.83	0.39
1	193.730	227000.00	882.18	902.61		903.38	0.000987	7.04	32287.59	3421.02	0.40
1	193.620	227000.00	878.21	901.95		902.79	0.001085	7.37	30819.18	3218.51	0.42
1	193.530	227000.00	878.96	901.50		902.27	0.000946	7.06	32250.77	3319.89	0.39
1	193.430	227000.00	879.37	901.09		901.82	0.000883	6.84	33220.23	3567.46	0.38
1	193.340	227000.00	881.18	900.67		901.41	0.000818	6.94	32725.29	3675.98	0.37
1	193.250	227000.00	880.67	900.05		900.93	0.001184	7.54	30125.74	2637.27	0.39
1	193.160	227000.00	880.66	899.50		900.42	0.000962	7.71	29438.91	2539.47	0.40
1	193.070	227000.00	881.99	899.09		899.96	0.000879	7.50	30259.65	2538.06	0.38
1	192.980	227000.00	880.71	898.69		899.52	0.000903	7.27	31204.00	2521.58	0.36
1	192.890	227000.00	880.29	898.09		899.02	0.001051	7.74	29339.27	2381.74	0.39
1	192.790	227000.00	876.74	897.41		898.44	0.001307	8.16	27818.78	2263.91	0.41
1	192.700	227000.00	877.01	896.69		897.78	0.001373	8.40	27026.35	2195.03	0.42
1	192.610	227000.00	878.15	896.07		897.17	0.001202	8.42	26963.21	2156.23	0.42
1	192.520	227000.00	878.23	895.44		896.56	0.001205	8.51	26673.10	2133.77	0.42
1	192.41	227000.00	876.67	894.67	889.51	895.88	0.001300	8.82	25746.52	2147.83	0.45
1	192.39	Bridge									
1	192.38	227000.00	876.41	893.99		895.29	0.001444	9.16	24768.88	2144.68	0.47
1	192.330	227000.00	876.06	893.53		894.84	0.001469	9.20	24681.97	2851.61	0.48
1	192.230	227000.00	876.72	892.69	888.24	894.05	0.001744	9.34	24315.51	3055.77	0.49
1	192.140	227000.00	875.94	891.73		893.14	0.001884	9.54	23785.56	3299.12	0.51
1	192.040	227000.00	876.36	891.00		892.24	0.001575	9.03	26257.72	3669.92	0.48
1	191.950	227000.00	876.68	890.50		891.46	0.001251	8.00	29521.80	3987.04	0.44
1	191.860	227000.00	876.27	890.03		890.84	0.001064	7.36	32021.15	4303.79	0.41
1	191.760	227000.00	874.62	889.48		890.28	0.001142	7.28	32455.70	4513.80	0.42
1	191.670	227000.00	872.60	888.93		889.67	0.001218	7.06	33519.43	5157.87	0.41
1	191.570	227000.00	870.63	888.43		889.07	0.001075	6.53	36236.30	5062.61	0.39
1	191.480	227000.00	870.93	888.02		888.54	0.000901	5.90	39492.37	5916.39	0.35
1	191.380	227000.00	871.69	887.61		888.10	0.000833	5.67	41063.20	6346.76	0.34
1	191.290	227000.00	870.63	887.22		887.67	0.000836	5.43	42431.91	5889.11	0.32
1	191.190	227000.00	869.78	886.80		887.24	0.000855	5.42	42801.48	5257.53	0.31
1	191.100	227000.00	870.88	886.42		886.86	0.000696	5.38	43056.66	4758.53	0.30
1	191.000	227000.00	869.64	886.03		886.50	0.000742	5.49	41384.86	4474.24	0.31
1	190.910	227000.00	867.98	885.57		886.09	0.000893	5.76	39431.41	4804.60	0.33
1	190.810	227000.00	867.86	885.15		885.66	0.000807	5.70	39801.43	4655.92	0.32
1	190.720	227000.00	866.30	884.77		885.25	0.000788	5.61	40458.98	4939.51	0.31
1	190.620	227000.00	867.37	884.36		884.85	0.000843	5.59	40795.71	5064.83	0.31
1	190.530	227000.00	866.16	883.93		884.41	0.000910	5.56	40806.98	4525.62	0.30
1	190.430	227000.00	867.42	883.45		883.95	0.000916	5.68	39976.21	4134.25	0.30
1	190.340	227000.00	866.61	883.02		883.47	0.000934	5.40	42025.91	5012.53	0.29
1	190.240	227000.00	866.29	882.51		882.96	0.001073	5.38	42199.64	5160.74	0.28
1	190.150	227000.00	865.74	881.83		882.38	0.001281	5.92	38347.65	4696.69	0.33
1	190.050	227000.00	858.06	881.37		881.81	0.000873	5.34	42476.54	5338.90	0.28
1	189.960	227000.00	857.56	880.99		881.41	0.000778	5.22	43450.05	4807.29	0.28
1	189.870	227000.00	862.94	880.64		881.02	0.000761	4.95	46199.33	8377.52	0.27
1	189.770	227000.00	860.75	880.34		880.64	0.000606	4.42	52822.17	10330.71	0.23
1	189.670	227000.00	862.77	880.02		880.32	0.000633	4.43	53087.27	10078.49	0.23
1	189.580	227000.00	857.92	879.73		880.02	0.000564	4.33	55074.63	9079.53	0.23

HEC-RAS Plan: PC Sep 23FIS River: Gila Reach: 1 Profile: PF 1 (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)	
1	189.480	227000.00	857.85	879.47		879.74	0.000533	4.24	57076.95	8915.03	0.22
1	189.390	227000.00	855.02	879.18		879.47	0.000528	4.42	55806.66	9978.30	0.23
1	189.300	227000.00	856.36	878.90		879.21	0.000638	4.59	54138.75	9775.70	0.24
1	189.210	227000.00	856.97	878.54		878.80	0.001059	4.32	56990.93	9083.98	0.23
1	189.110	227000.00	857.40	877.99		878.25	0.001099	4.28	57377.02	8474.79	0.22
1	189.020	227000.00	855.16	877.62		877.89	0.000495	4.30	58870.63	8955.39	0.23
1	188.810	227000.00	852.24	877.19		877.43	0.000348	4.09	62725.53	8318.66	0.20
1	188.690	227000.00	850.62	876.87		877.15	0.000699	4.35	59160.61	8930.40	0.21
1	188.59	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.5	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.39	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.29	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.2	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41665.74	7148.81	0.31
1	188.1	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37965.66	6595.48	0.36
1	188.07	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39208.98	5733.80	0.31
1	188.055	Bridge									
1	188.04	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38248.79	5733.34	0.31
1	188	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.17	7288.16	0.39
1	187.91	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35900.98	5898.48	0.40
1	187.82	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32038.47	5367.10	0.46
1	187.73	227000.00	855.40	872.38	869.18	873.23	0.001125	7.74	32552.54	7779.96	0.45
1	187.64	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36450.42	8097.85	0.38
1	187.54	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33184.70	8486.68	0.42
1	187.45	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38831.71	9337.40	0.36
1	187.36	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36027.79	9688.24	0.38
1	187.24	227000.00	853.80	869.81	866.24	870.85	0.001548	8.48	30572.47	8203.42	0.47
1	187.15	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36060.30	8790.41	0.38
1	187.06	227000.00	851.90	869.09	864.37	869.68	0.000821	6.34	37393.59	8893.03	0.35
1	186.97	227000.00	851.90	868.75	864.00	869.29	0.000764	5.99	38631.88	9763.17	0.35
1	186.87	227000.00	852.60	868.18	863.60	868.83	0.001045	6.65	35918.05	11022.50	0.38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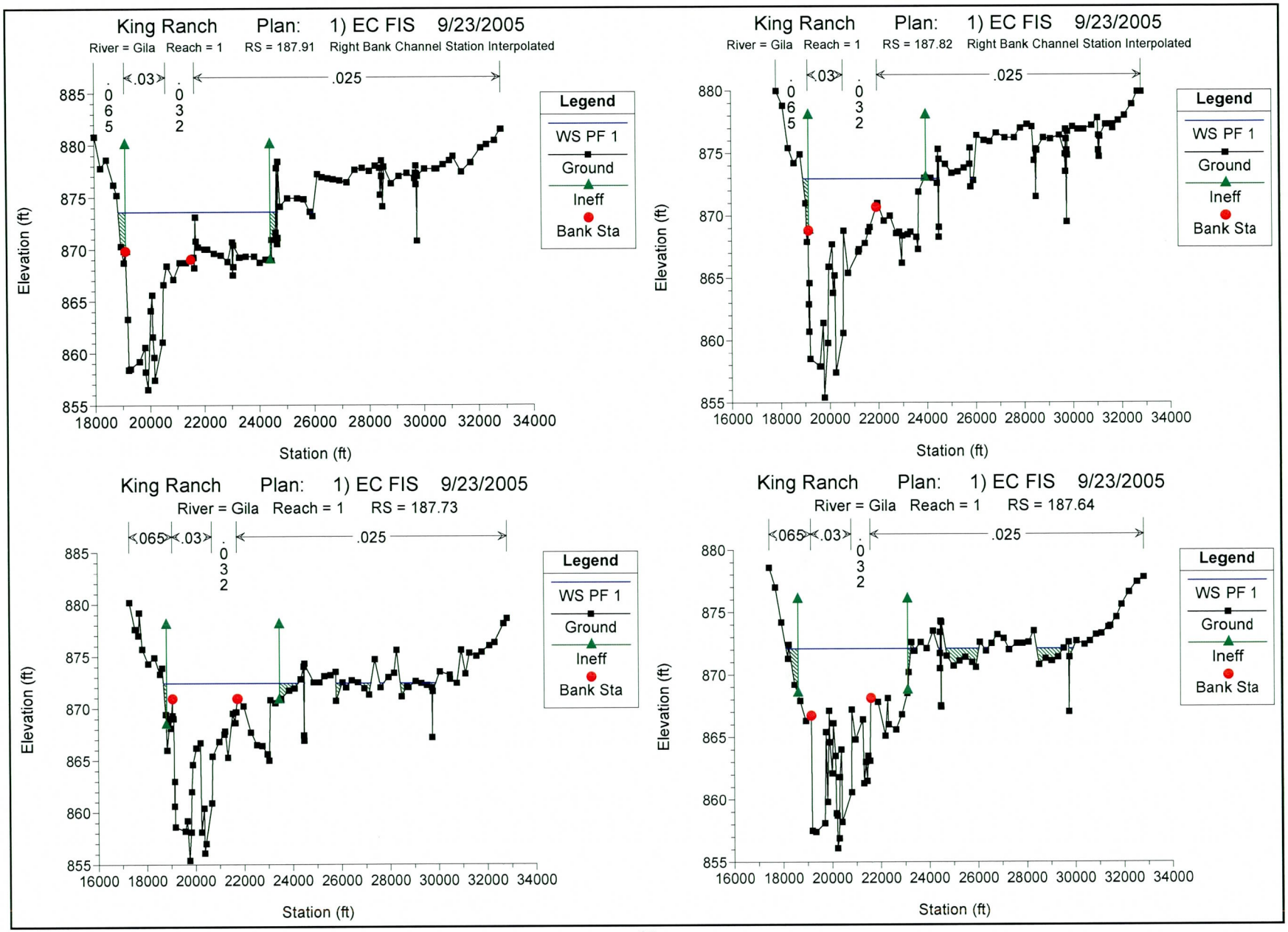
River = Gila Reach = 1 RS = 187.54 Left Channel Bank Station Interpolated
.065
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.45
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.36
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.24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WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.82 Right Bank Channel Station Interpolated
.065
.03
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.73
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.03
.032
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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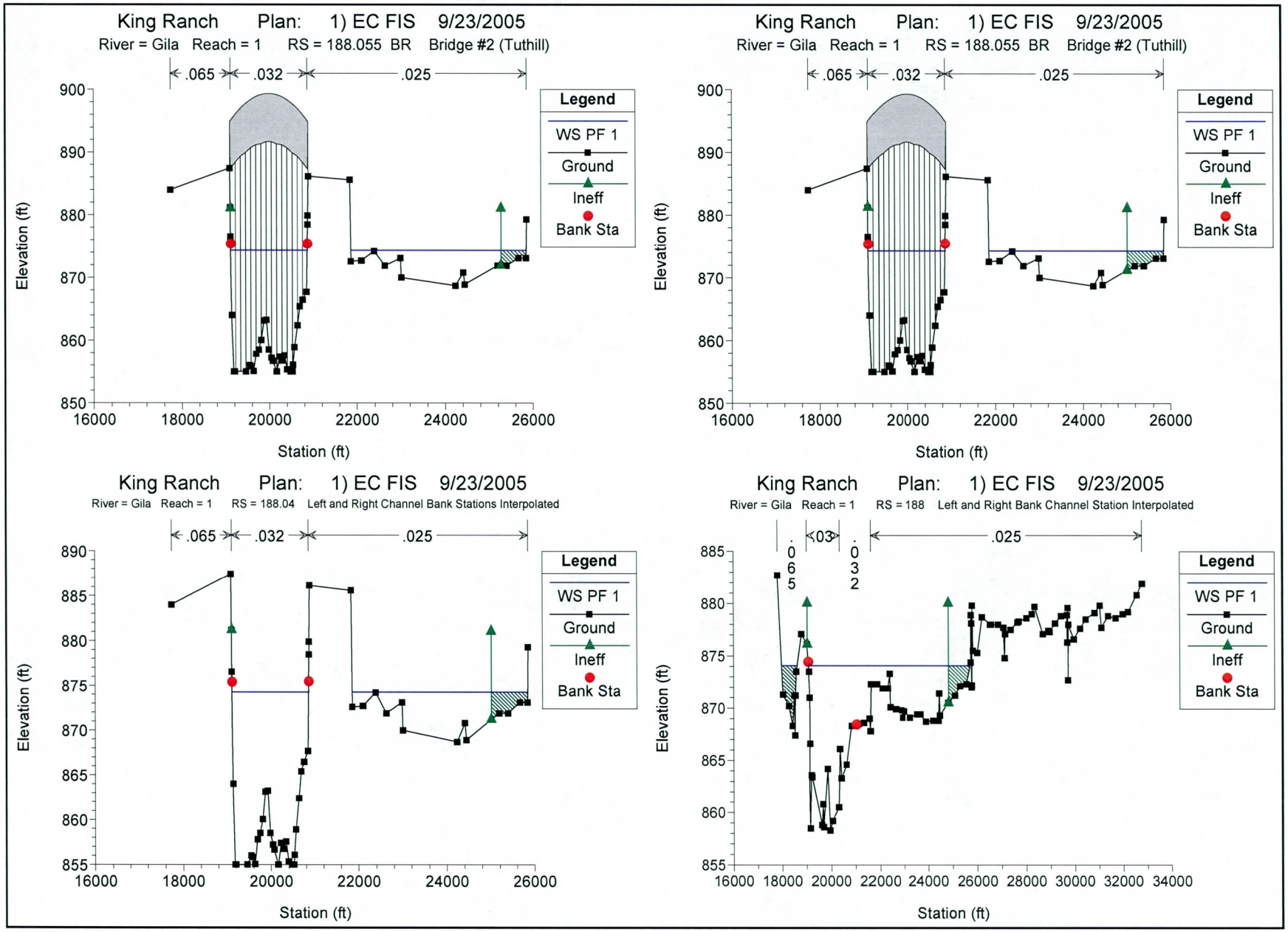
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
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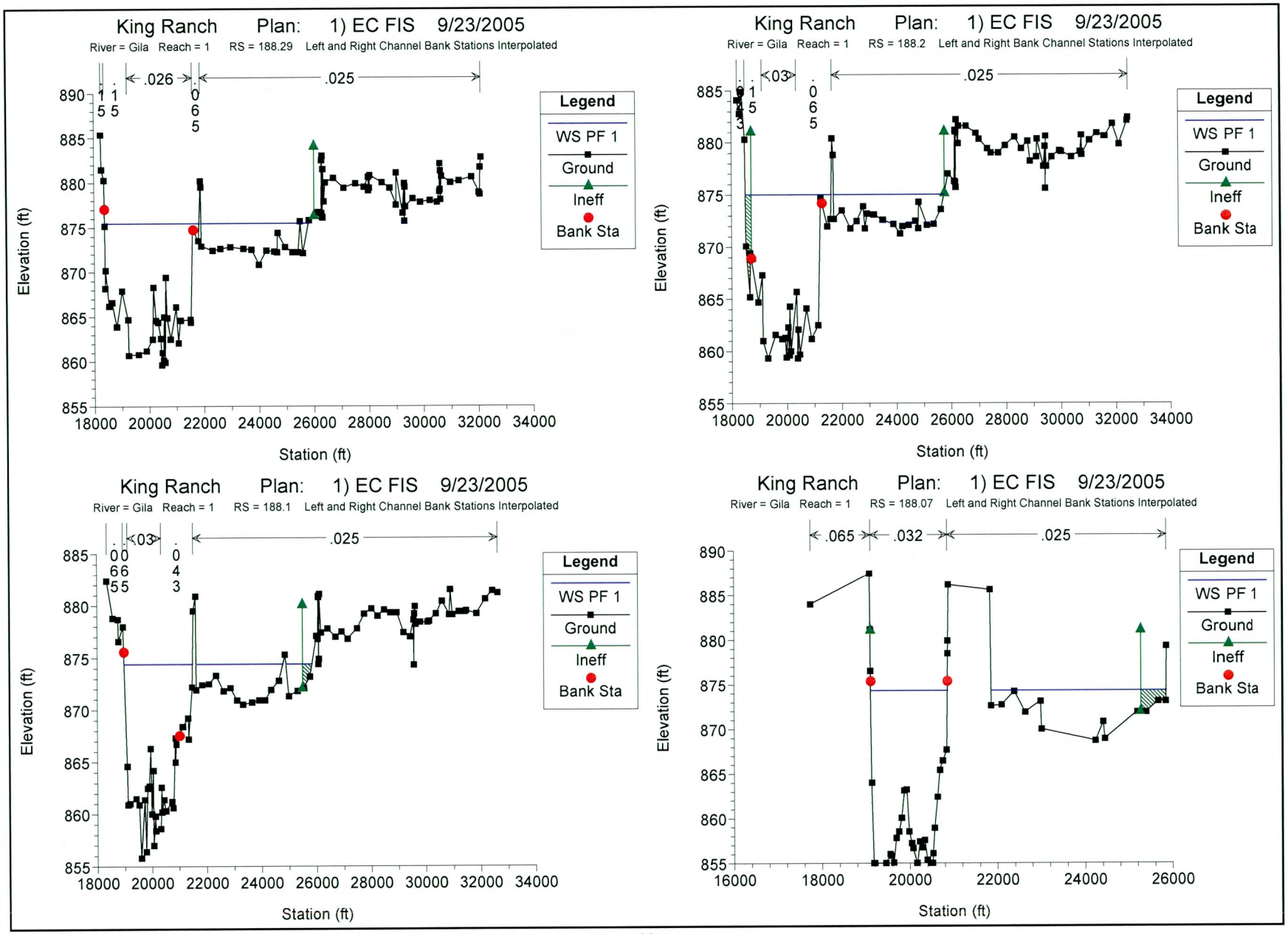
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.055 BR Bridge #2 (Tuthill)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.04 Left and Right Channel Bank Stations Interpolated
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188 Left and Right Bank Channel Station Interpolated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River = Gila Reach = 1 RS = 188.29 Left and Right Channel Bank Stations Interpolated
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.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.2 Left and Right Bank Channel Stations Interpolated
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.1 Left and Right Channel Bank Stations Interpolated
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.07 Left and Right Channel Bank Stations Interpolated
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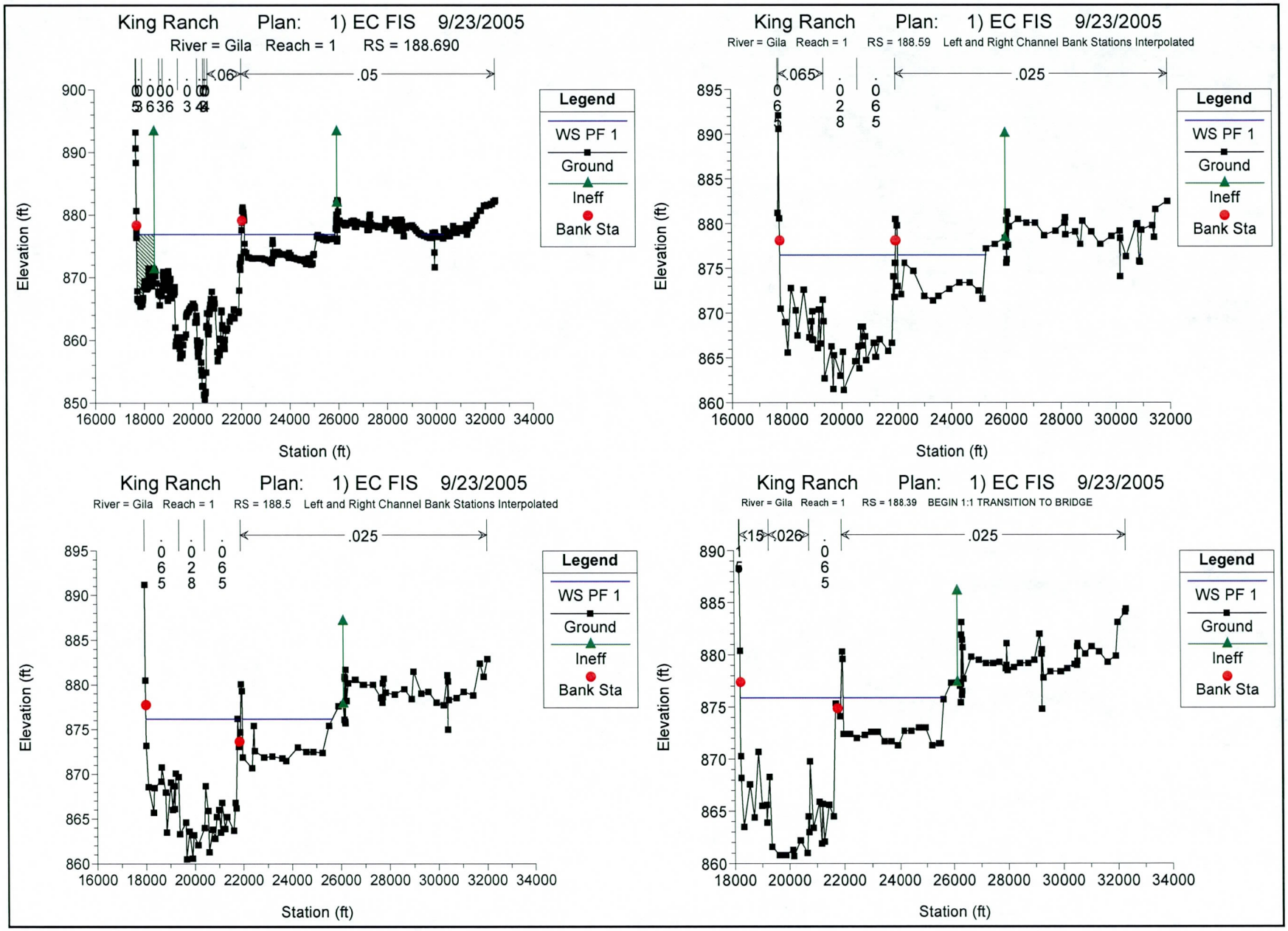
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.690
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.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.59 Left and Right Channel Bank Stations Interpolated
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.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.5 Left and Right Channel Bank Stations Interpolated
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.39 BEGIN 1:1 TRANSITION TO BRIDGE
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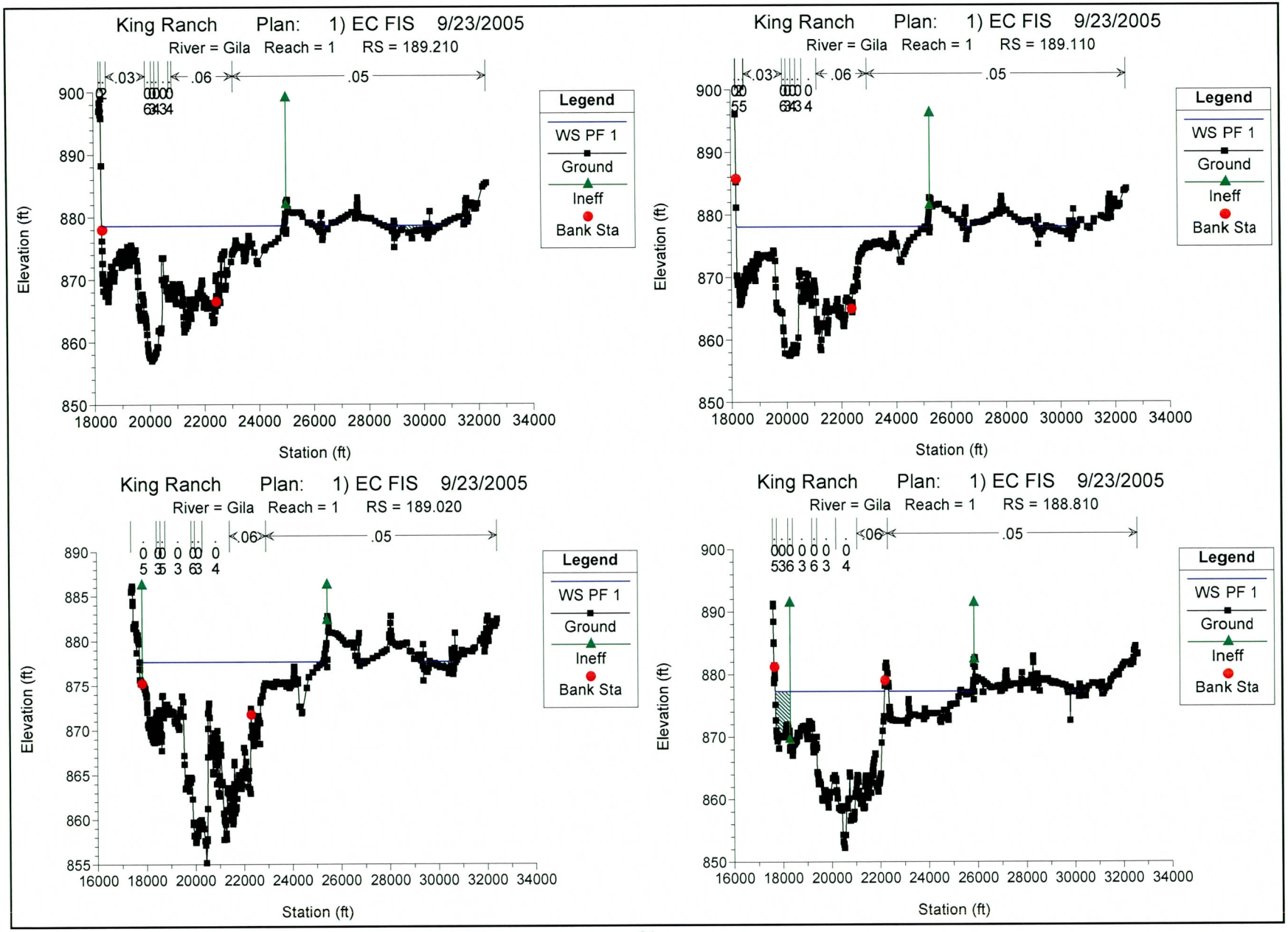
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 189.210
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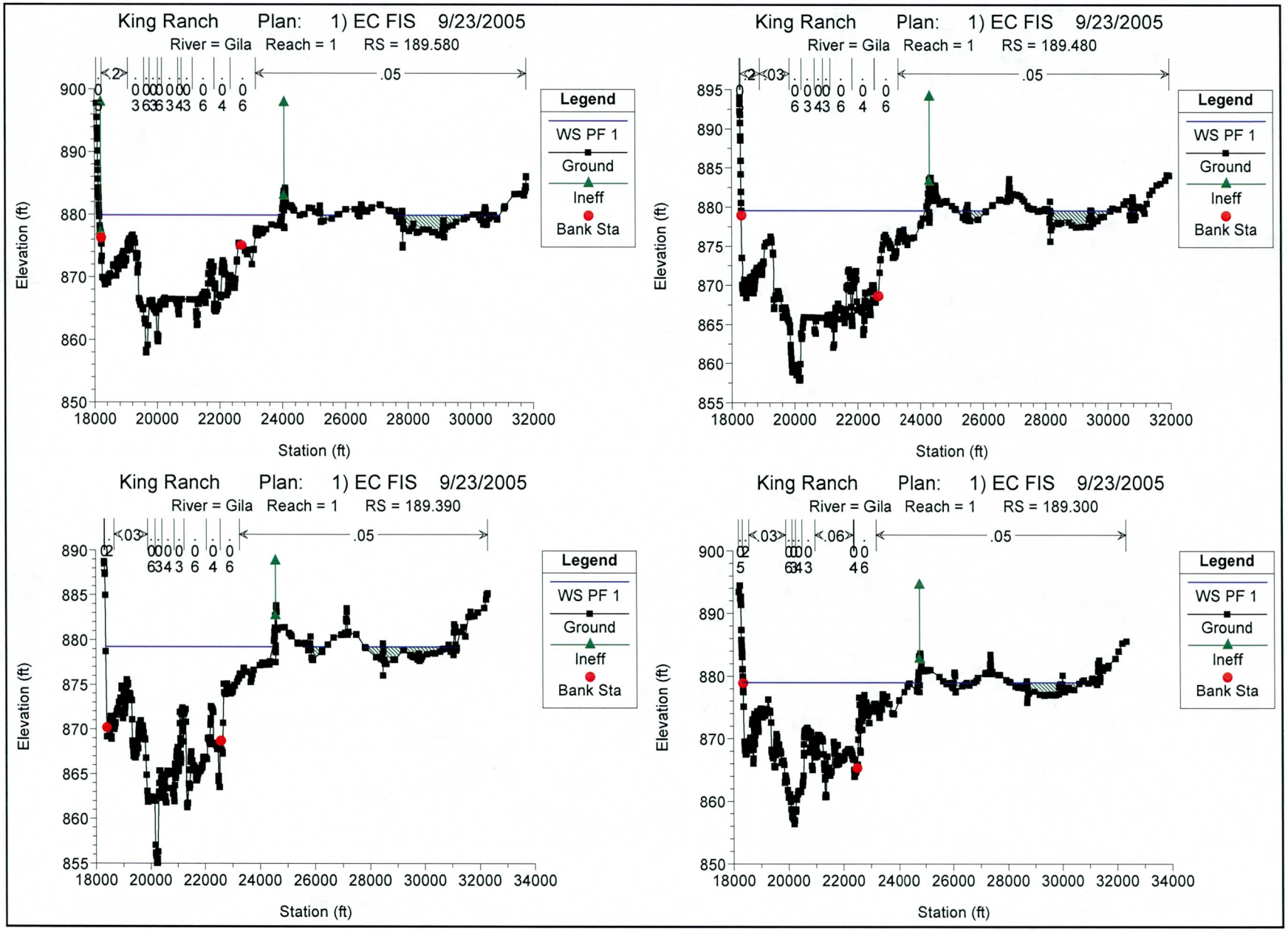
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.110
.03
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.020
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 188.810
.06
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 189.580
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.480
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.390
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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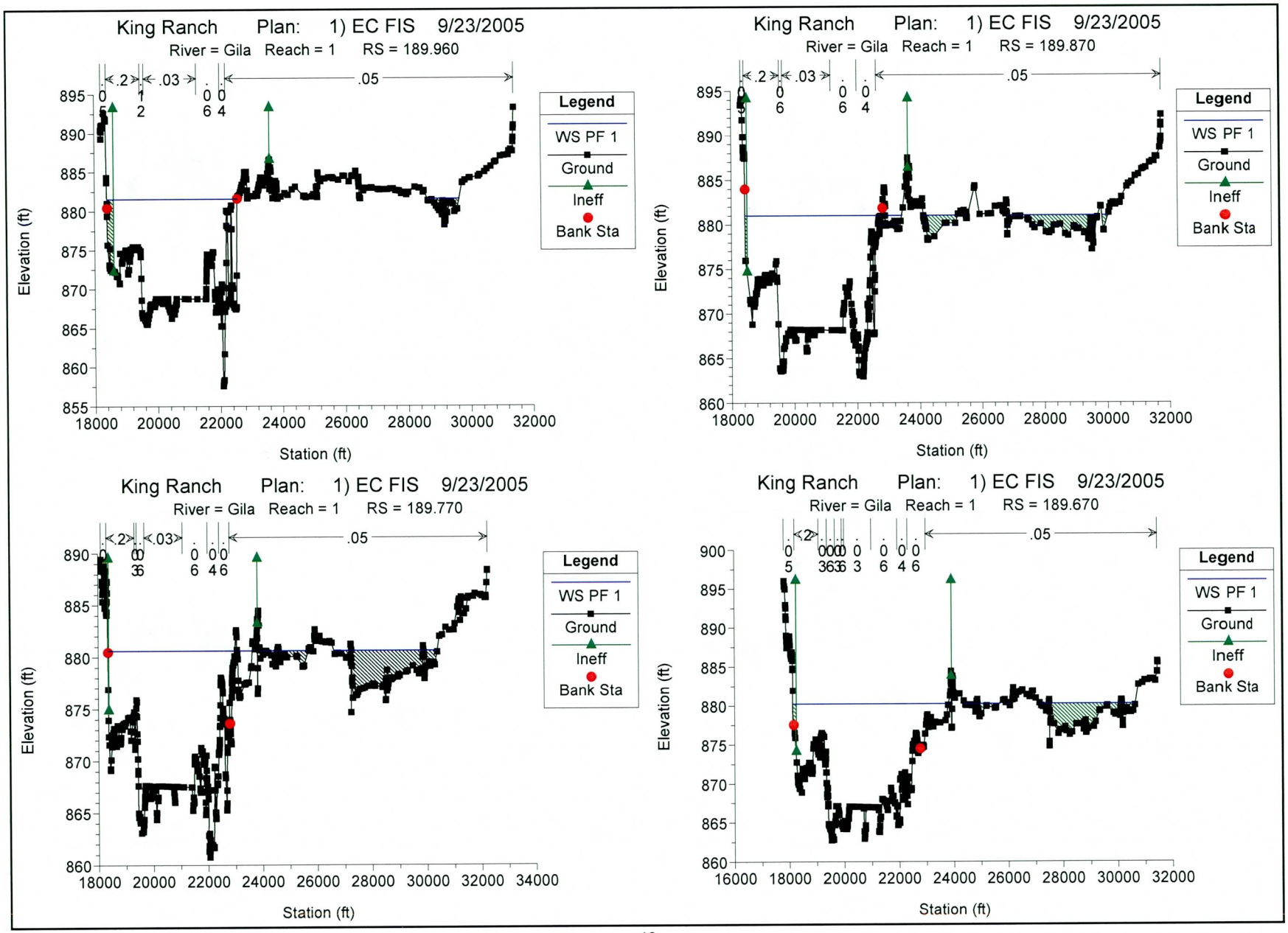
Bank Sta
Elevation (ft)
Station (ft)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King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 189.770
King Ranch Plan: 1) EC FIS 9/23/2005
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Legend
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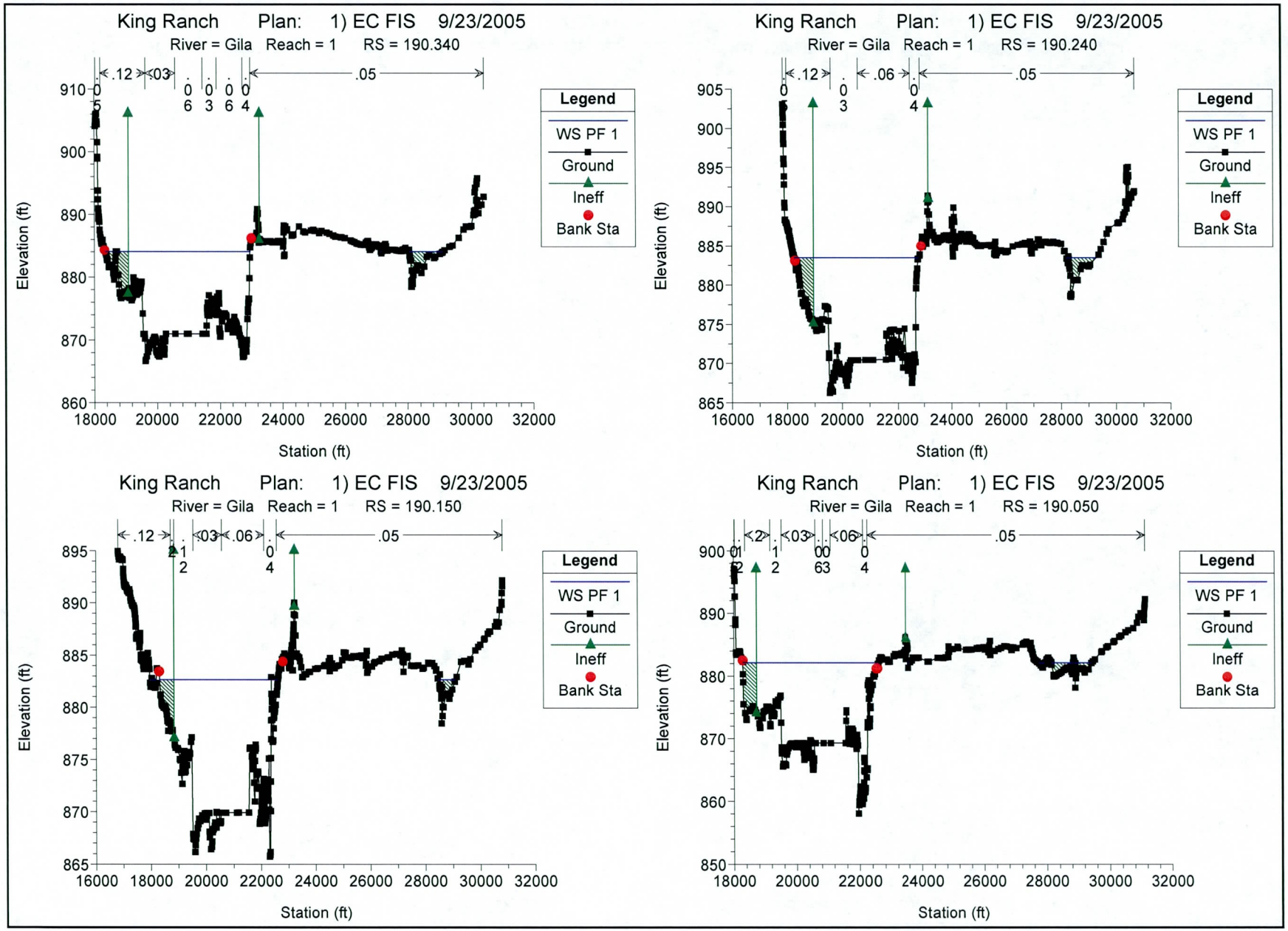
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.340
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Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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Ground
Ineff
Bank Sta
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Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.150
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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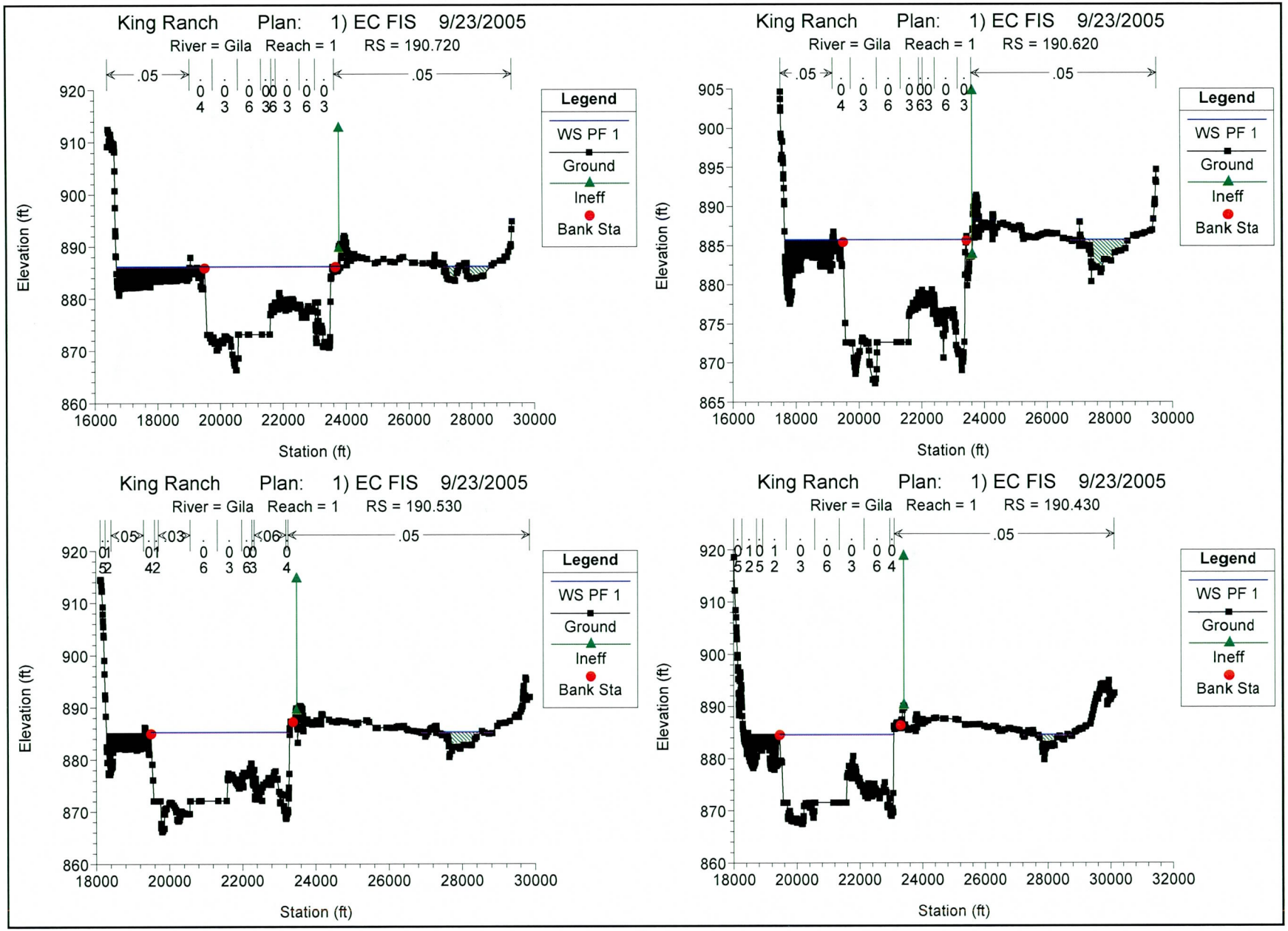
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Ineff
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Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.620
.05
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.530
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.05
.06
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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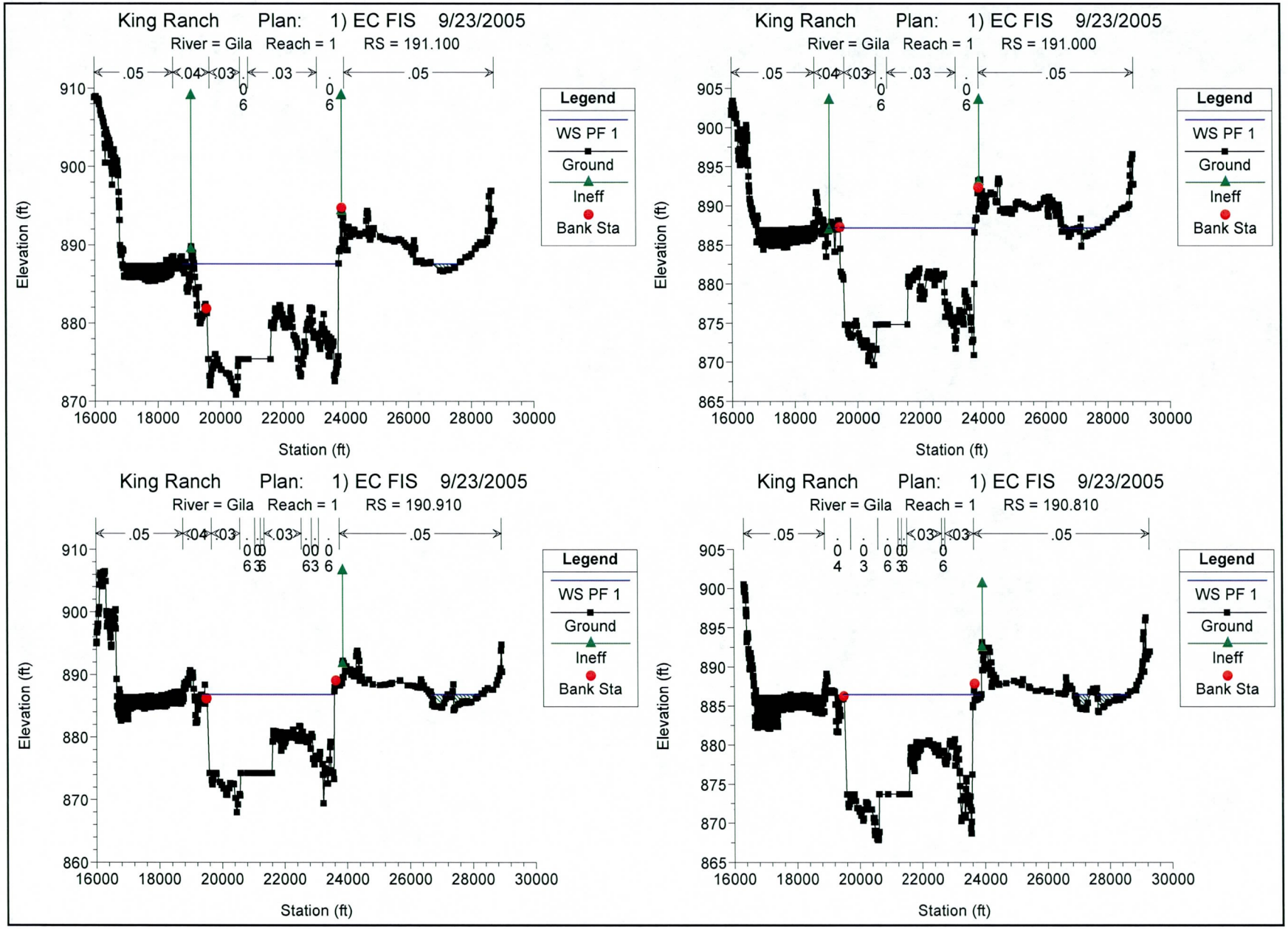
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.000
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 190.910
King Ranch Plan: 1) EC FIS 9/23/2005
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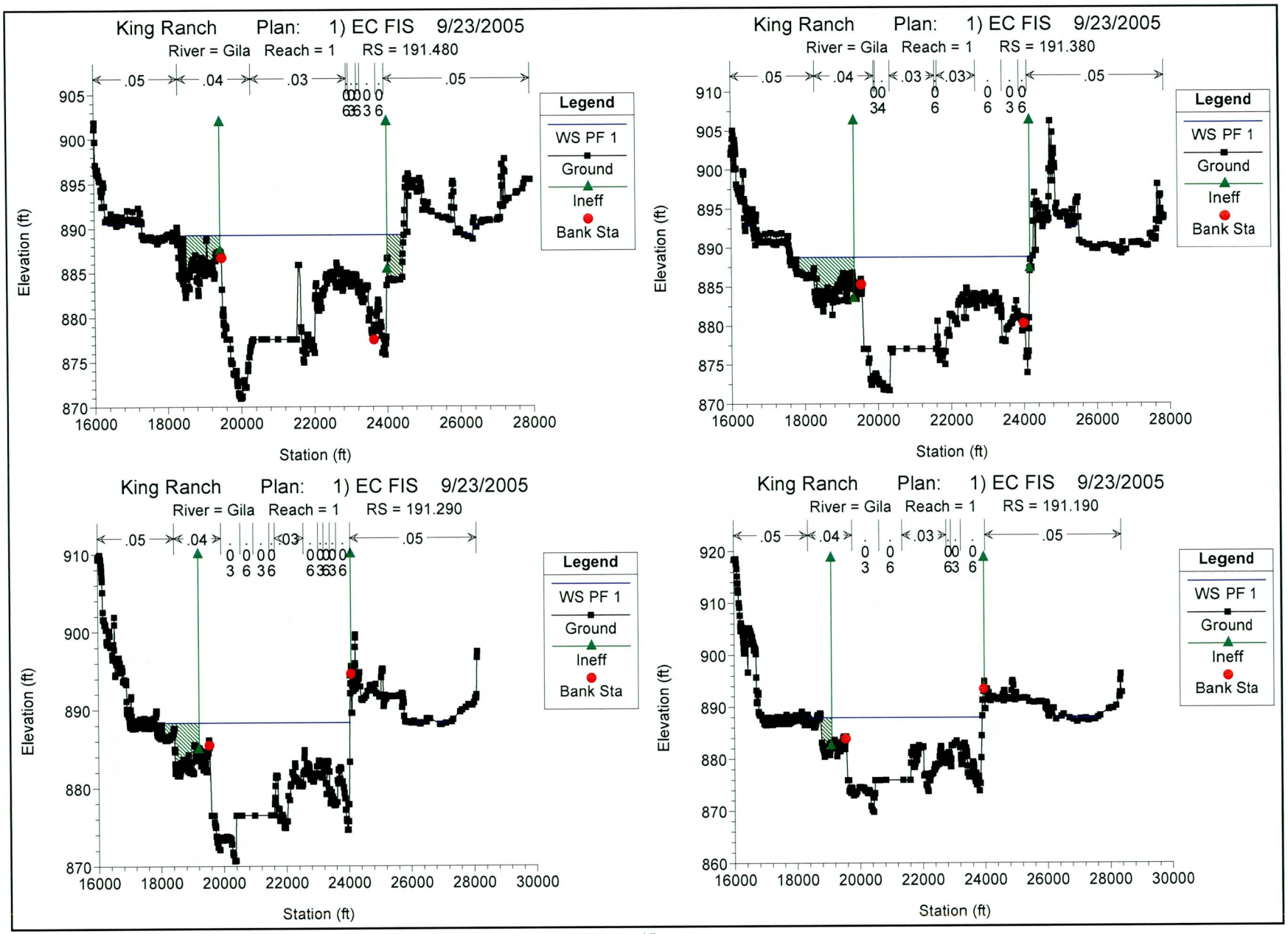
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.480
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Legend
WS PF 1
Ground
Ineff
Bank Sta
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Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.380
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.290
.05 .04 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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Legend
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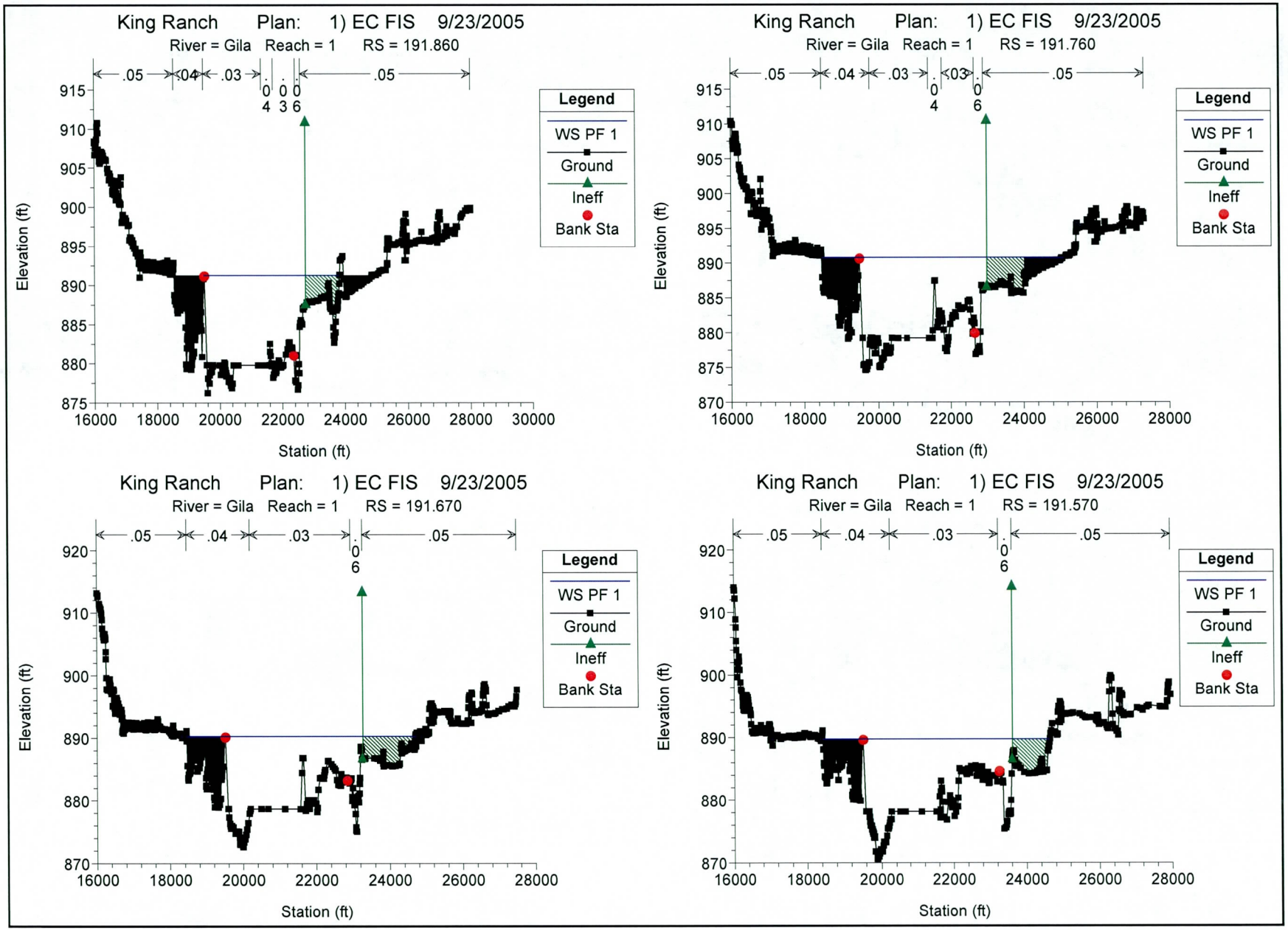
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 191.860
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Legend
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Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.760
.05 .04 .03 .04 .03 .06 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 191.670
.05 .04 .03 .06 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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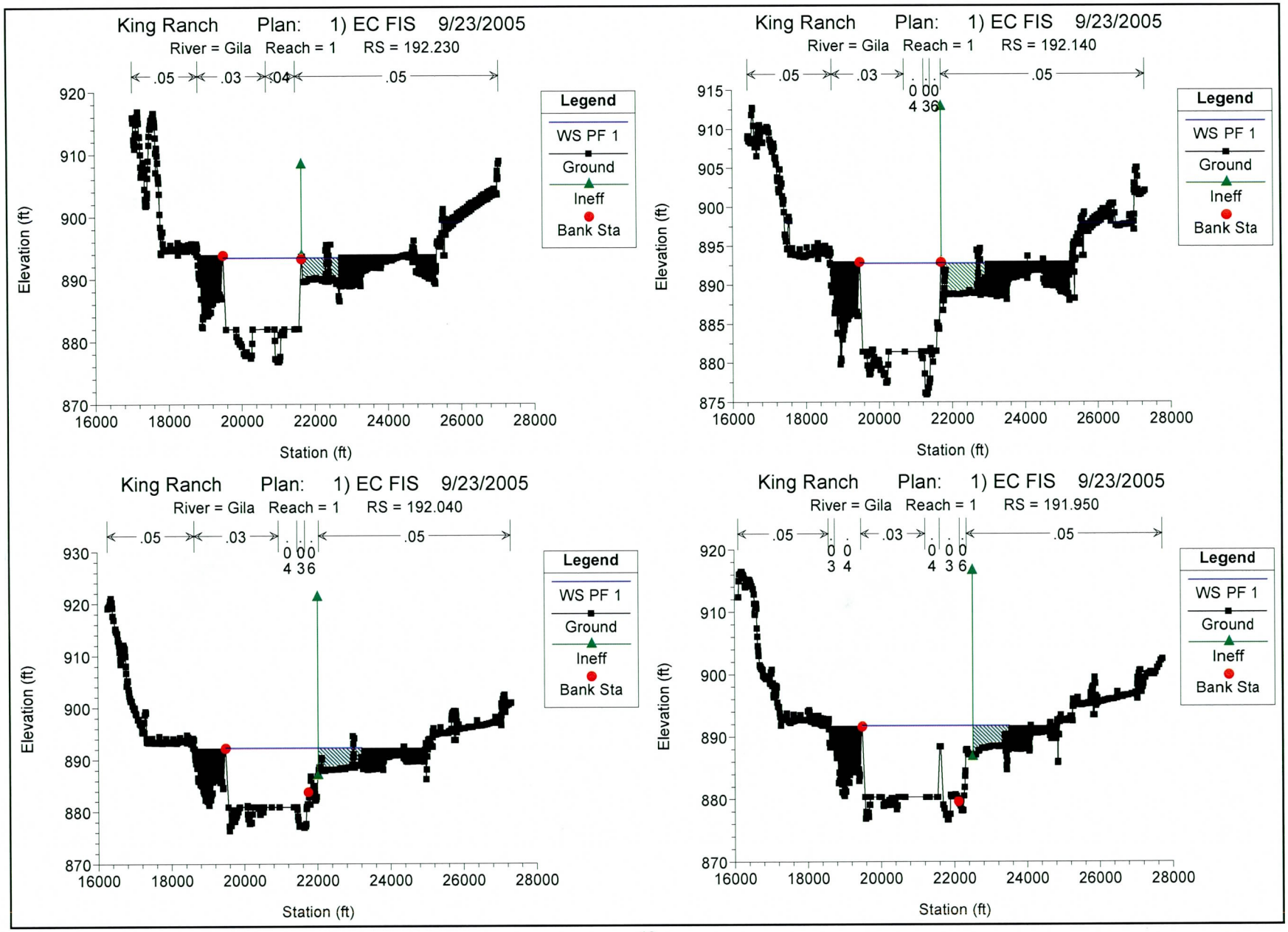
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Ground
Ineff
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Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.140
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.040
.05 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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Legend
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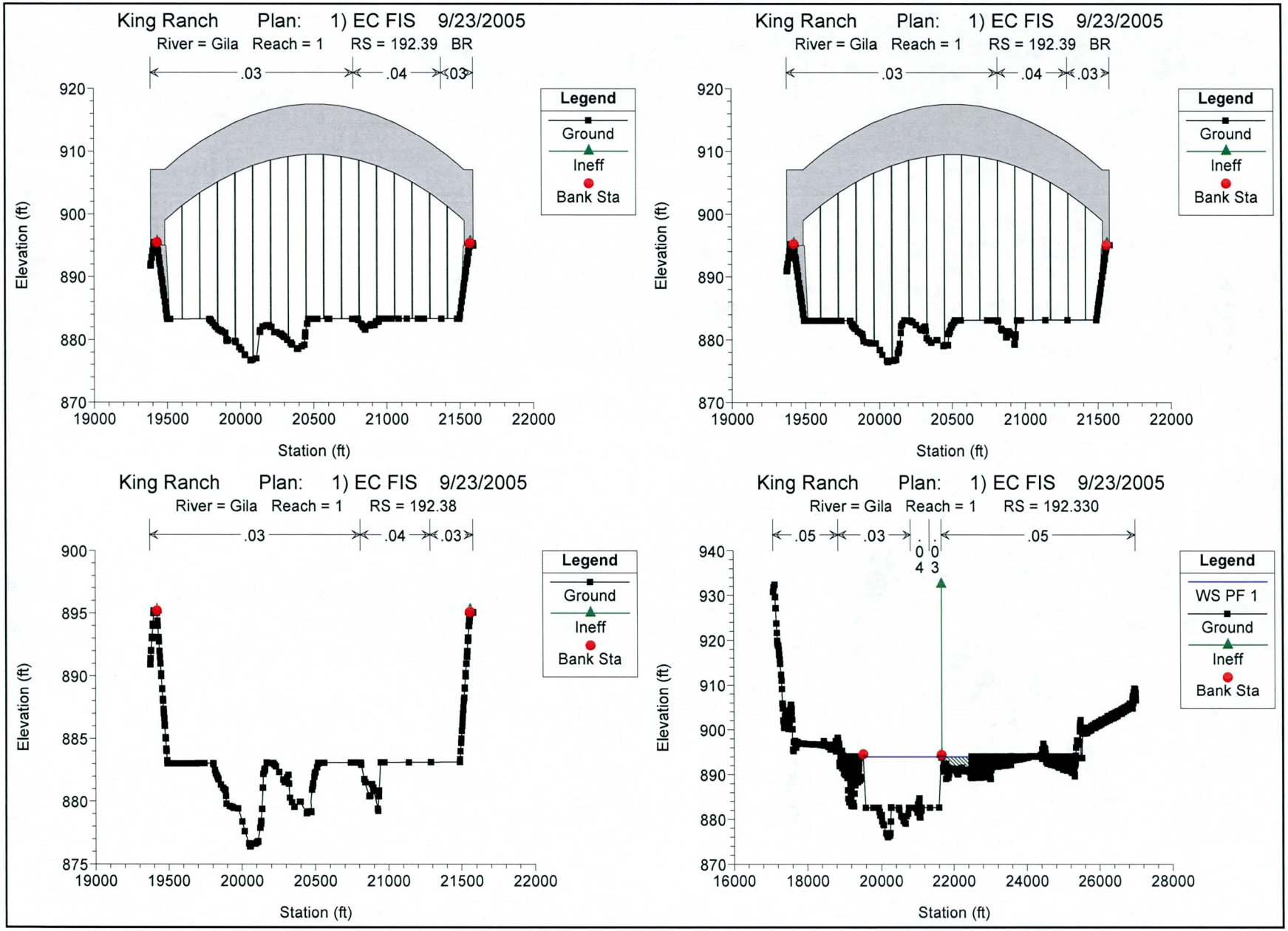
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 192.39 BR
.03
.04
.03
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.38
King Ranch Plan: 1) EC FIS 9/23/2005
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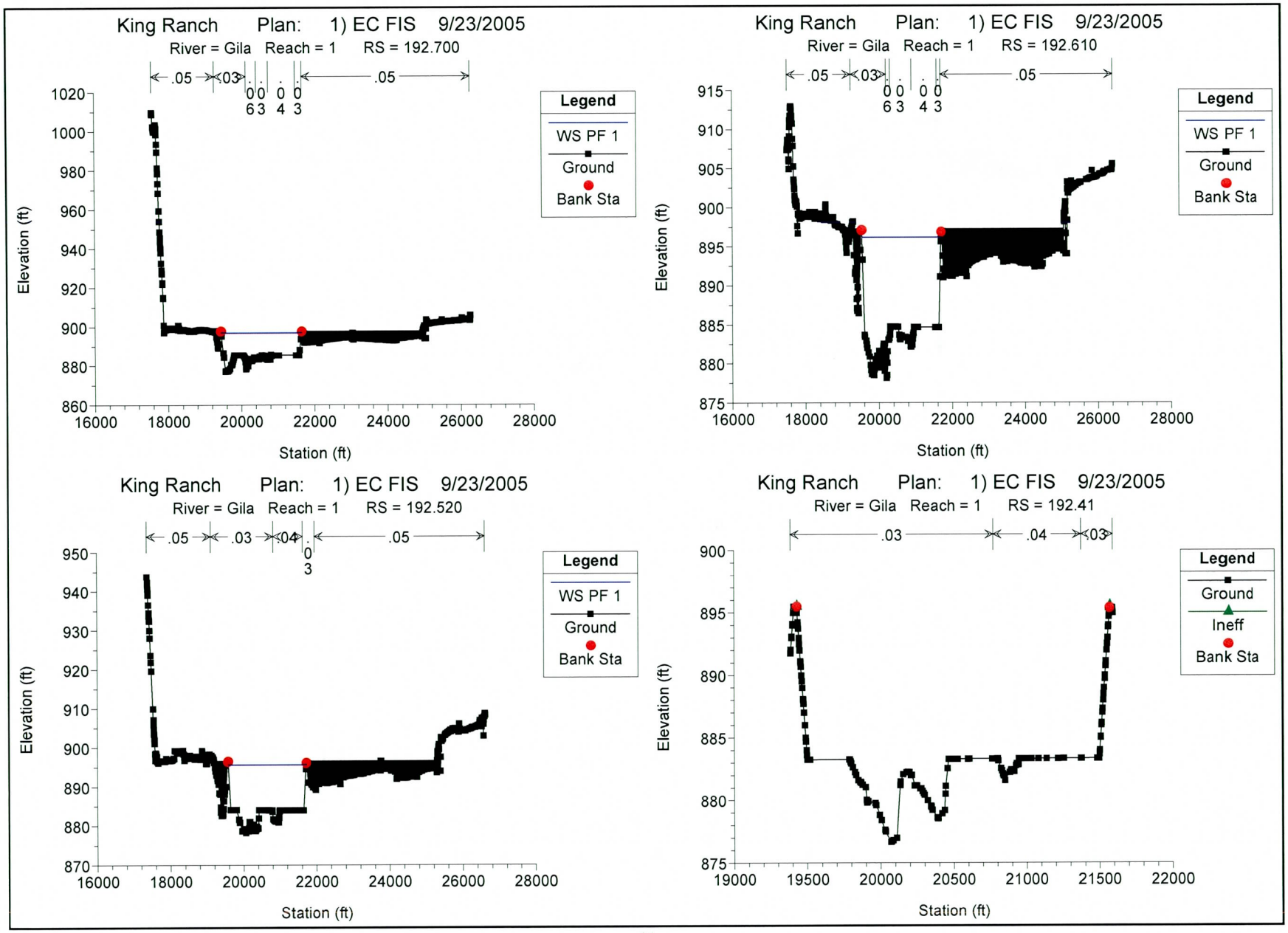
.05
.03
.05
WS PF 1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River = Gila Reach = 1 RS = 192.700
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Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.610
.05 .03 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.520
.05 .03 .04 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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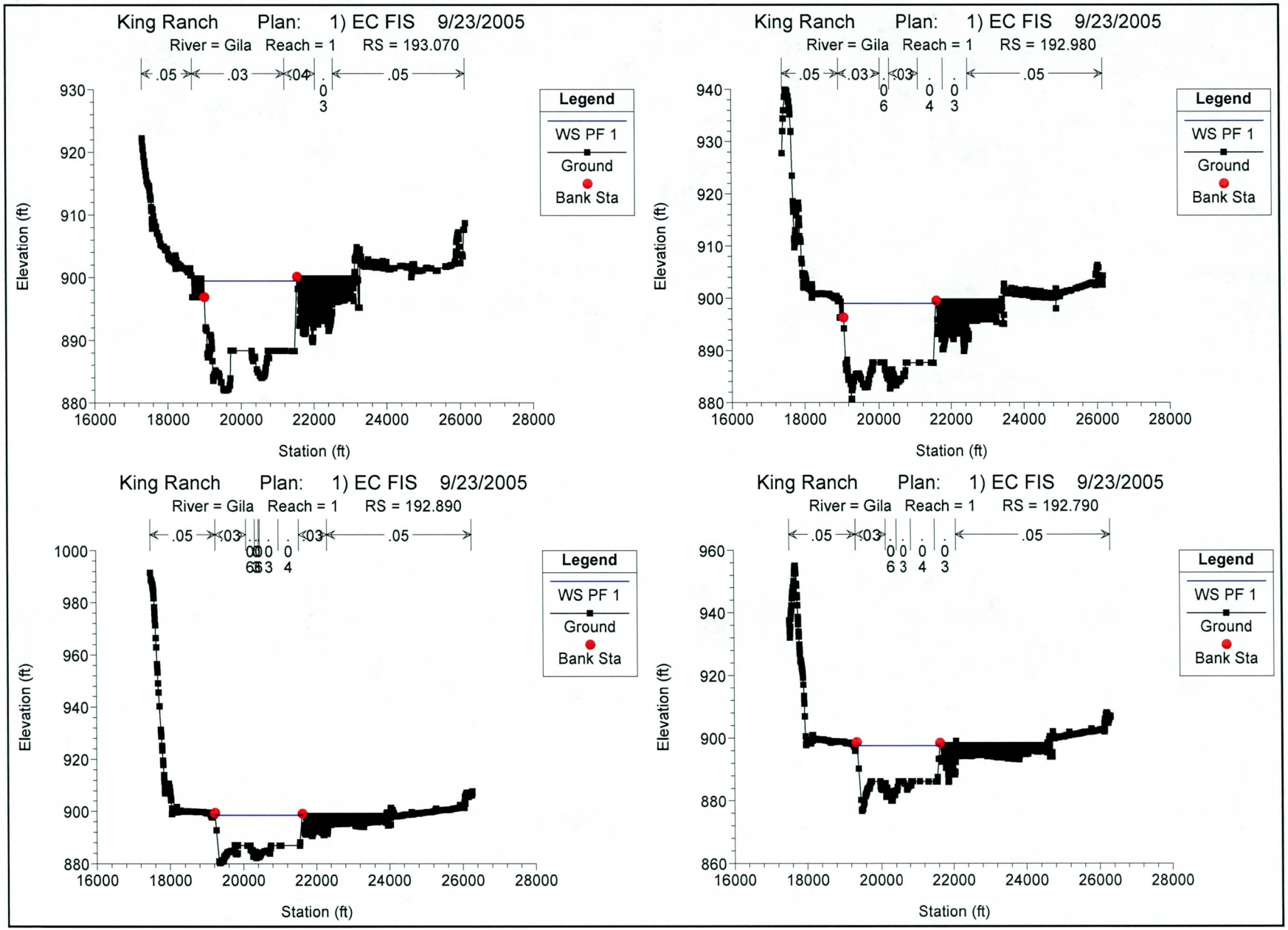
.03 .04 .03
Legend
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 193.070
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Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.980
.05 .03 .03 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.890
.05 .03 .03 .05
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 192.790
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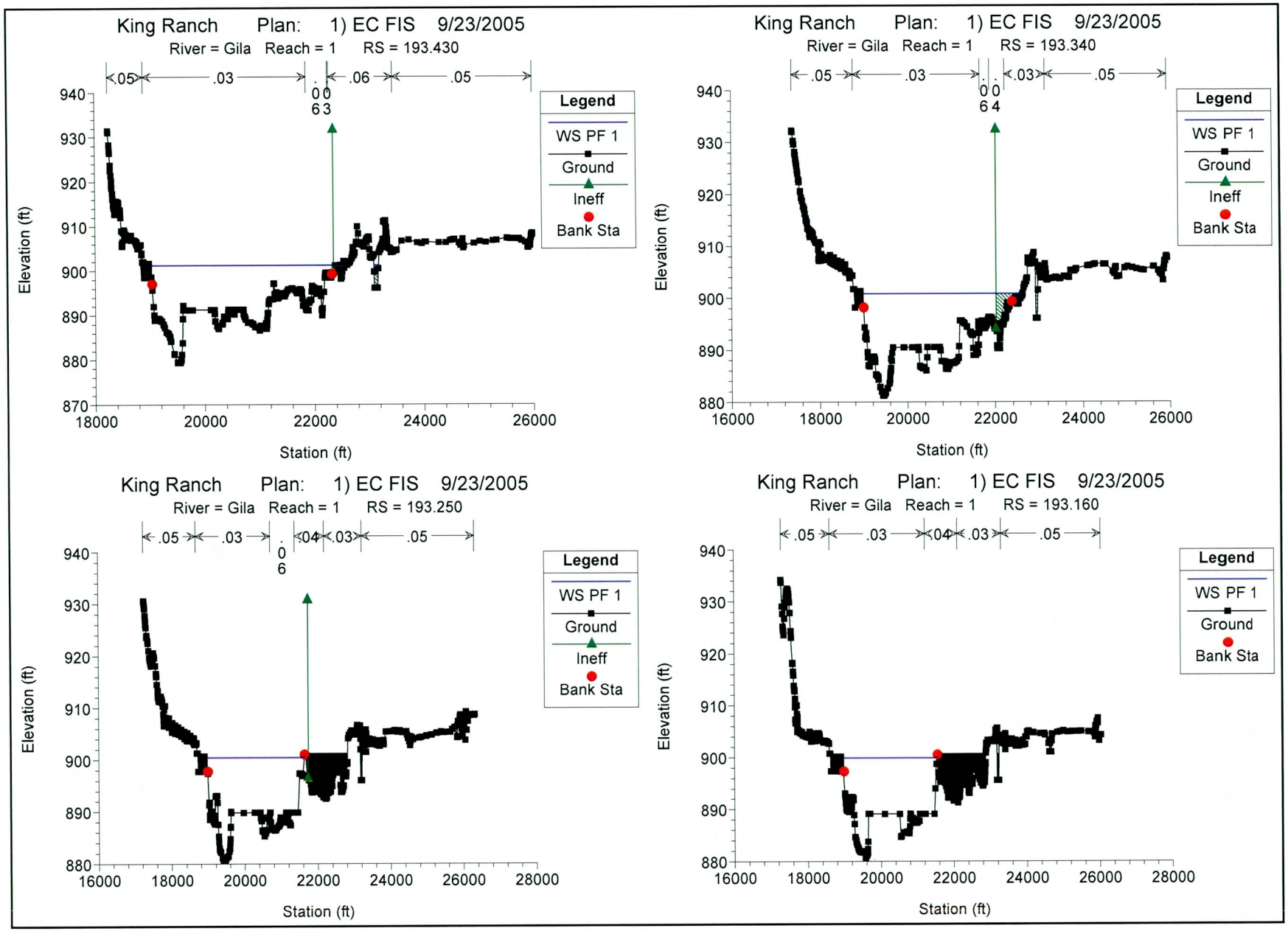
Legend
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 193.430
.05 .03 .00 .06 .05
63
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.340
.05 .03 .00 .03 .05
64
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.250
.05 .03 .06 .04 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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Legend
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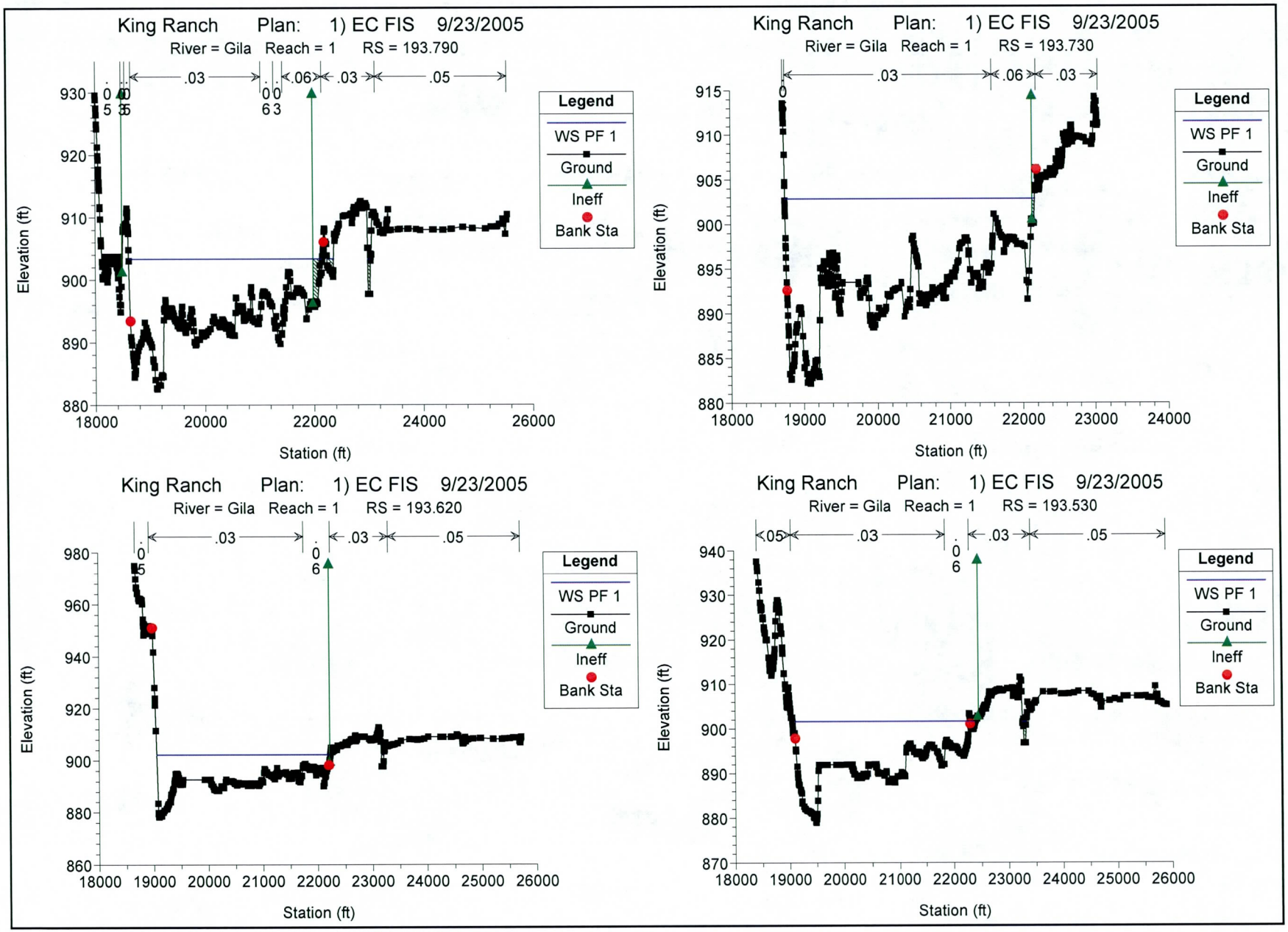
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 193.790
.03
.06
.03
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.730
.03
.06
.03
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.620
.03
.03
.05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.530
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.03
.03
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Legend
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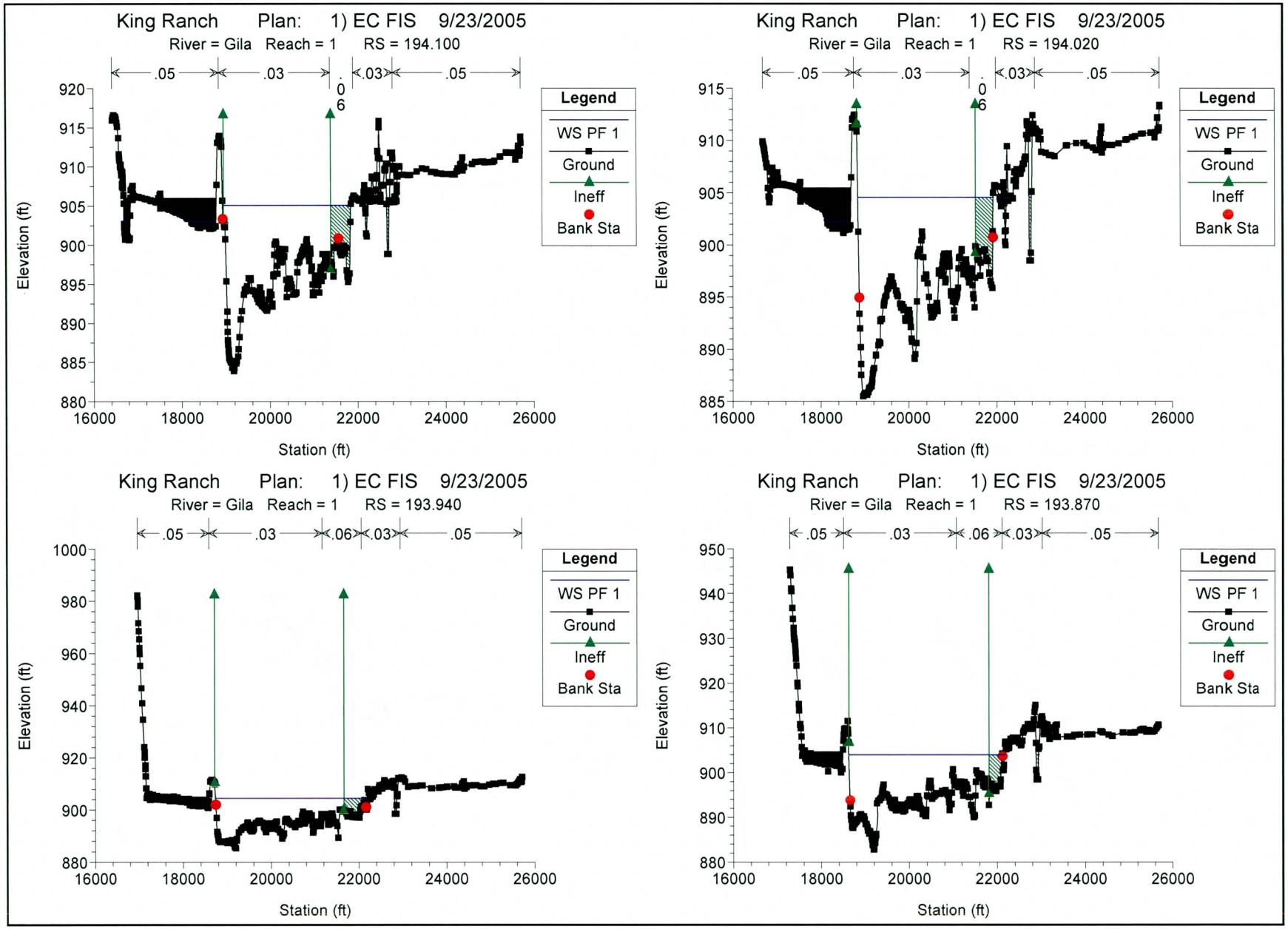
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.100
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Legend
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Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.020
.05 .03 .06 .03 .05
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 193.940
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Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
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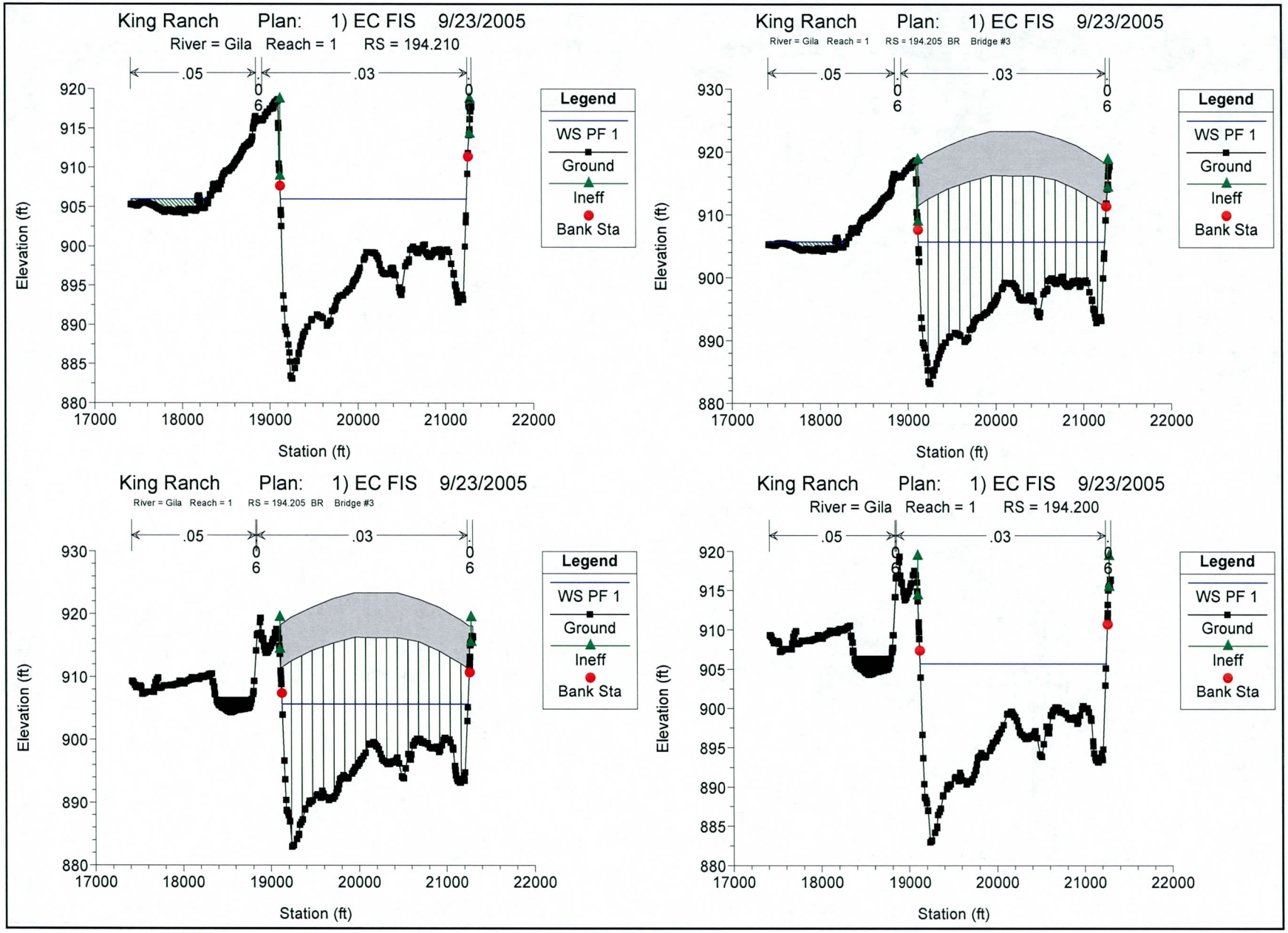
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 194.210
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.03
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Ineff
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Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.205 BR Bridge #3
.05
.03
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.205 BR Bridge #3
.05
.03
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.200
.05
.03
Legend
WS PF 1
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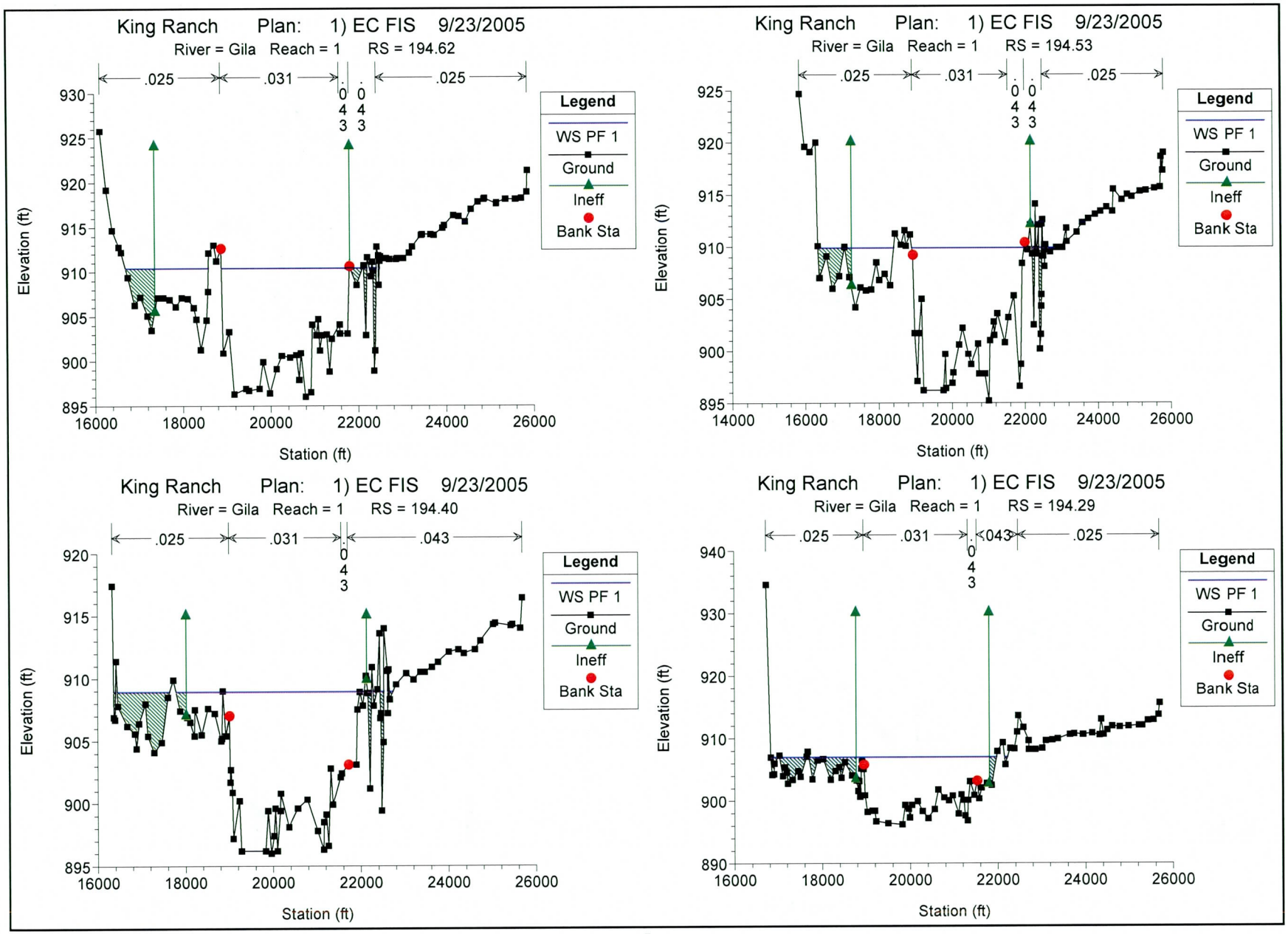
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 194.62
.025 .031 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.53
.025 .031 .043 .043 .025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.40
.025 .031 .043 .043
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.29
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Legend
WS PF 1
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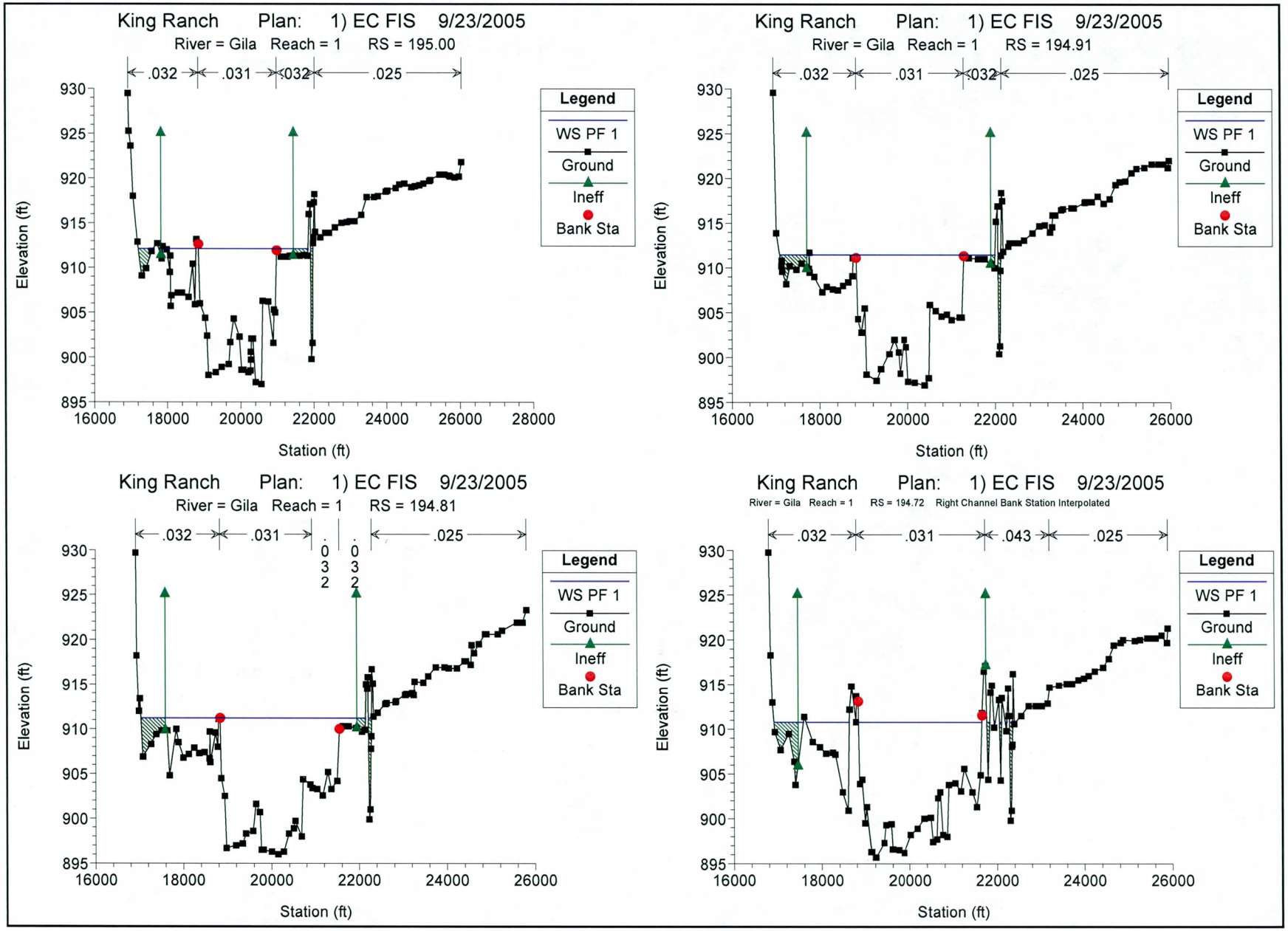
Ineff
Bank Sta
Elevation (ft)
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.00
.032
.031
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.91
.032
.031
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.81
.032
.031
.032
.032
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 194.72 Right Channel Bank Station Interpolated
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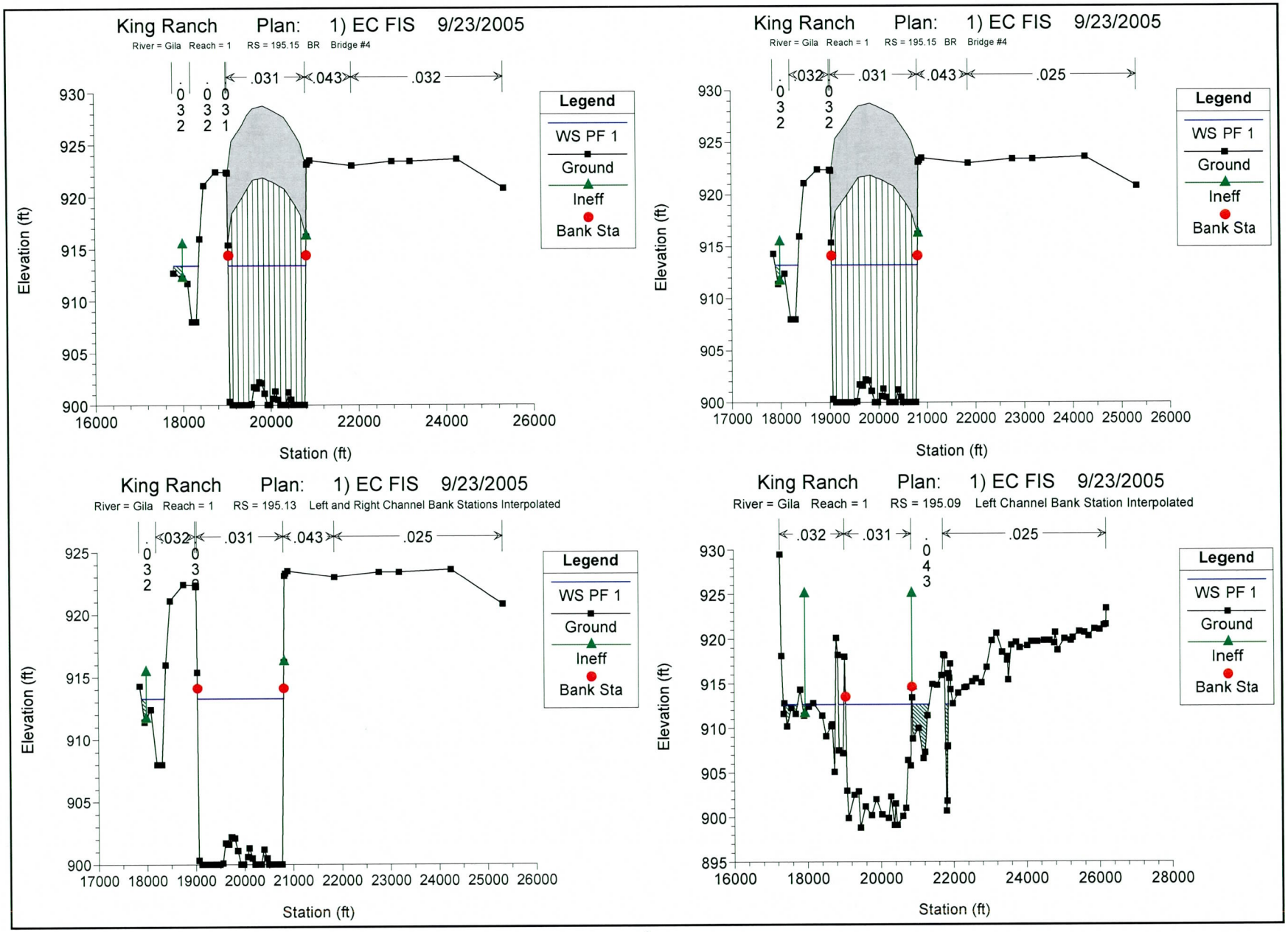
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 195.15 BR Bridge #4
.031
.043
.032
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.15 BR Bridge #4
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.13 Left and Right Channel Bank Stations Interpolated
.032
.031
.043
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.09 Left Channel Bank Station Interpolated
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.025
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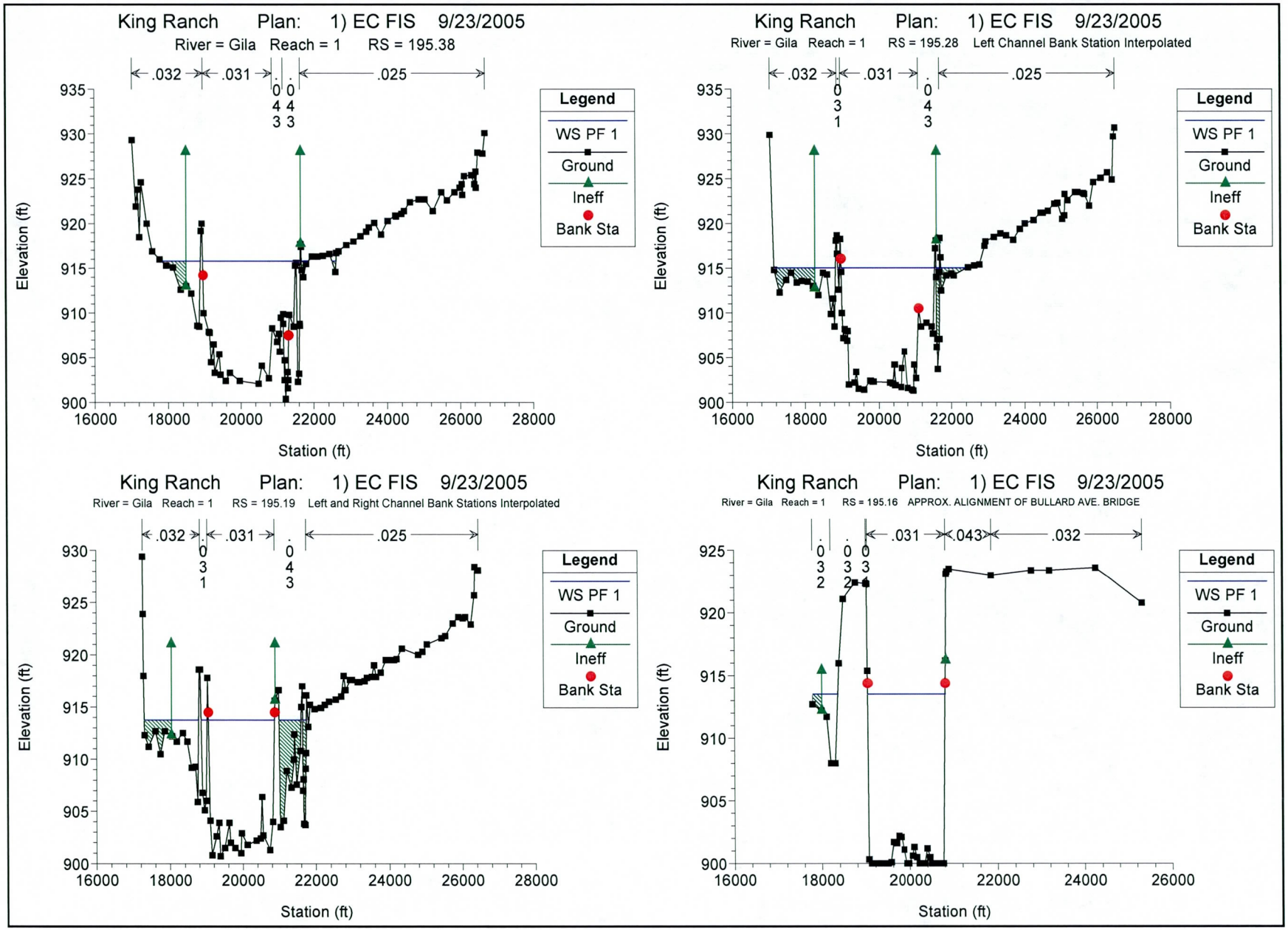
Ineff
Bank Sta
Elevation (ft)
Station (ft)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River = Gila Reach = 1 RS = 195.38
.032
.031
.025
0433
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.28 Left Channel Bank Station Interpolated
.032
.031
.025
0431
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.19 Left and Right Channel Bank Stations Interpolated
.032
.031
.025
0431
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 195.16 APPROX. ALIGNMENT OF BULLARD AVE. BRIDGE
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.032
0323
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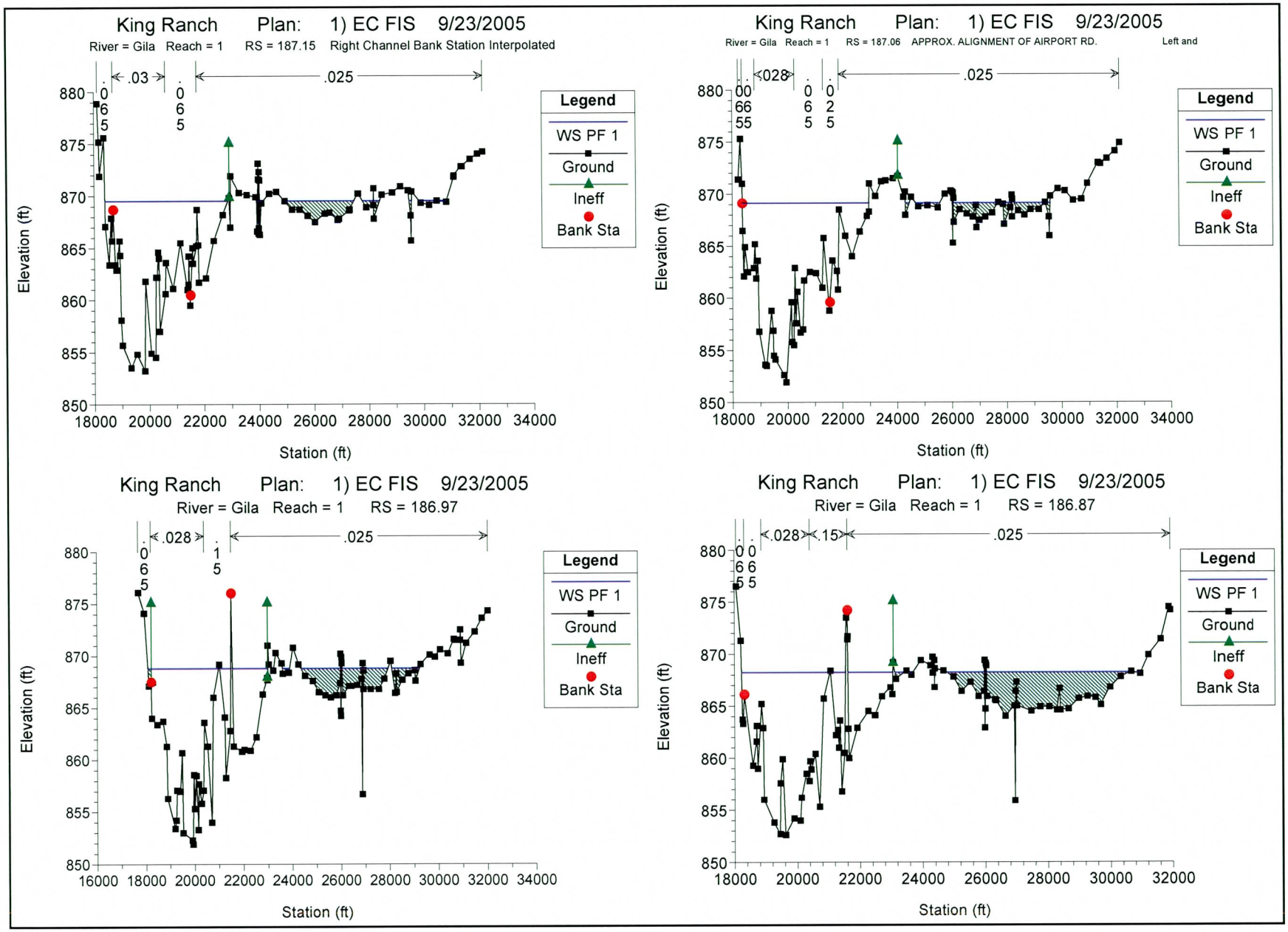
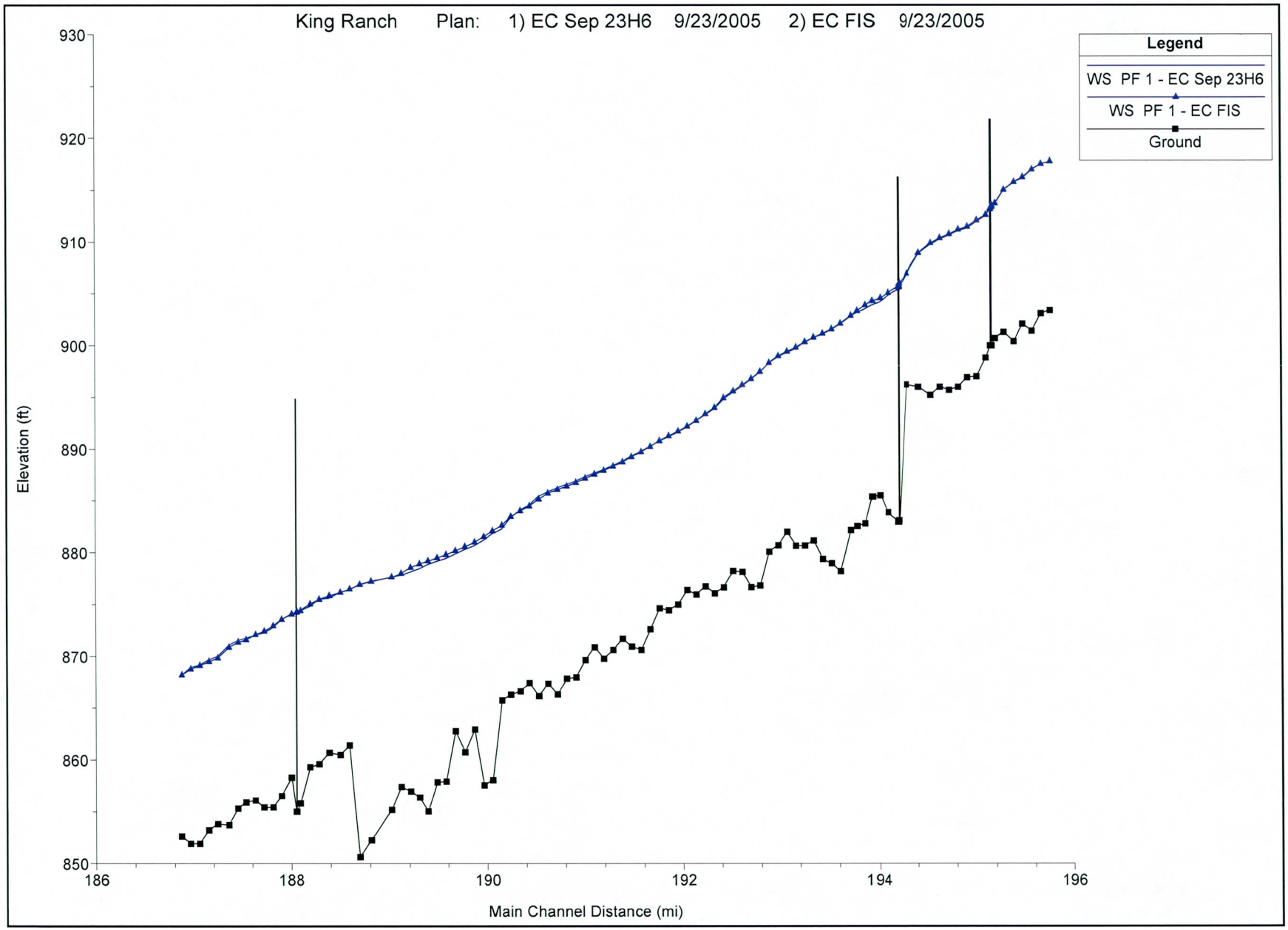
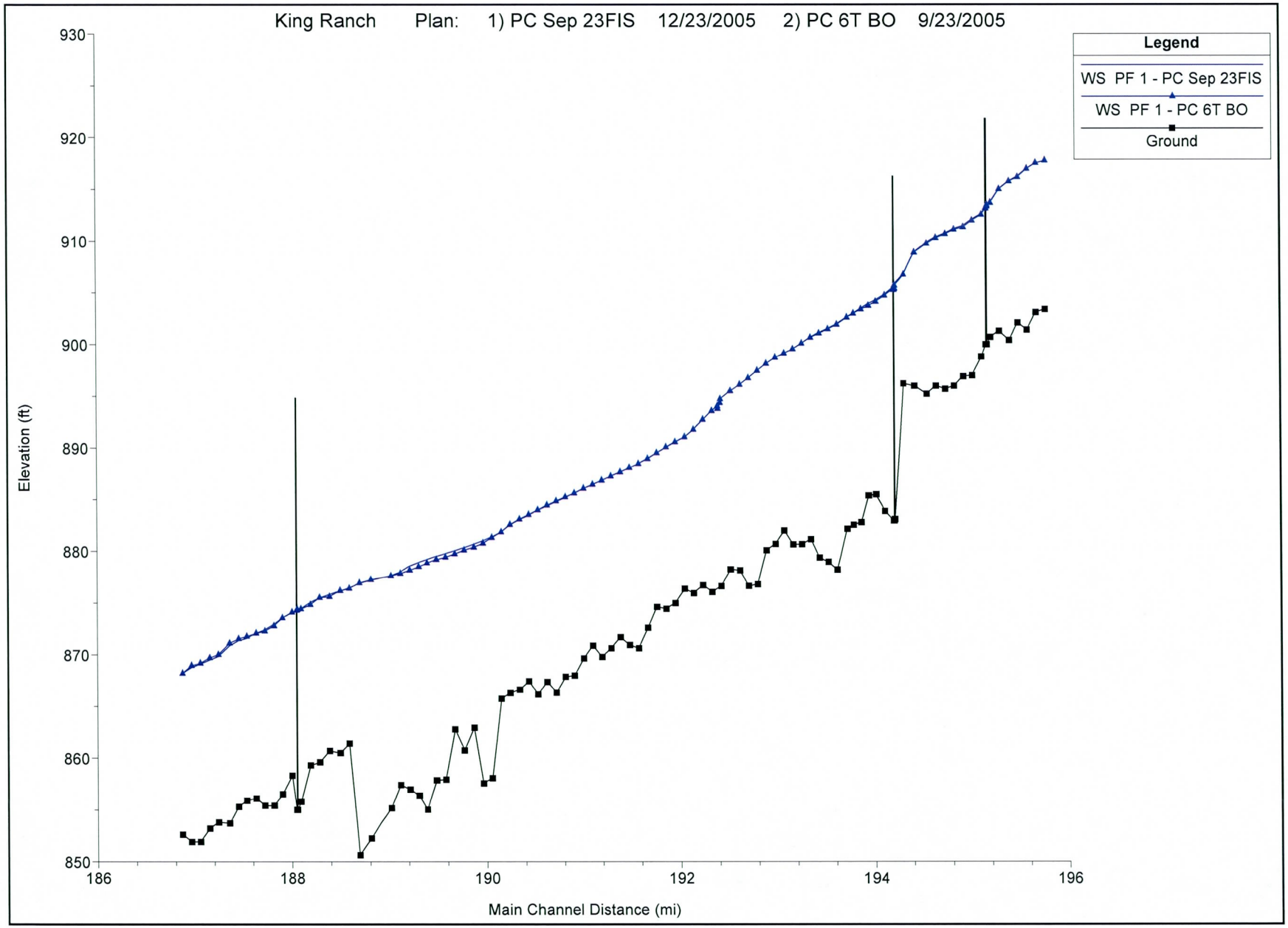
Station (ft)


King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.15 Right Channel Bank Station Interpolated
.03
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 187.06 APPROX. ALIGNMENT OF AIRPORT RD. Left and
.028
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 186.97
.028
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
King Ranch Plan: 1) EC FIS 9/23/2005
River = Gila Reach = 1 RS = 186.87
.028
.15
.025
Legend
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

APPENDIX E

Hydraulic Comparison Between HEC-RAS and HEC-6T Models


King Ranch Plan: 1) EC Sep 23H6 9/23/2005 2) EC FIS 9/23/2005
Legend
WS PF 1 - EC Sep 23H6
WS PF 1 - EC FIS
Ground
Elevation (ft)
930
920
910
900
890
880
870
860
850
186
188
190
192
194
196
Main Channel Distance (mi)


King Ranch Plan: 1) PC Sep 23FIS 12/23/2005 2) PC 6T BO 9/23/2005
Legend
WS PF 1 - PC Sep 23FIS
WS PF 1 - PC 6T BO
Ground
Elevation (ft)
930
920
910
900
890
880
870
860
850
186
188
190
192
194
196
Main Channel Distance (mi)

HEC-RAS River: Gila Reach: 1 Profile: PF 1

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)	
1	195.75	PC Sep 23FIS	227000.00	903.40	917.73	914.96	919.51	0.002169	11.22	22772.56	4473.81	0.59
1	195.75	PC 6T BO	227000.00	903.40	917.73	914.94	919.53	0.002135	11.28	22776.49	4474.16	0.59
1	195.75	EC FIS	227000.00	903.40	917.73	914.96	919.51	0.002168	11.22	22774.02	4473.94	0.59
1	195.75	EC Sep 23H6	227000.00	903.40	917.73	914.94	919.53	0.002135	11.28	22776.79	4474.19	0.59
1	195.66	PC Sep 23FIS	227000.00	903.10	917.47	912.70	918.52	0.001162	8.46	28721.20	4346.95	0.43
1	195.66	PC 6T BO	227000.00	903.10	917.50	912.70	918.54	0.001154	8.44	28780.09	4356.89	0.43
1	195.66	EC FIS	227000.00	903.10	917.47	912.70	918.52	0.001162	8.46	28722.96	4347.24	0.43
1	195.66	EC Sep 23H6	227000.00	903.10	917.50	912.70	918.54	0.001154	8.44	28780.41	4356.95	0.43
1	195.56	PC Sep 23FIS	227000.00	901.40	916.94	911.75	917.93	0.001156	8.12	28808.92	4106.57	0.42
1	195.56	PC 6T BO	227000.00	901.40	916.93	911.75	917.97	0.001140	8.52	28779.63	4105.17	0.43
1	195.56	EC FIS	227000.00	901.40	916.94	911.75	917.93	0.001156	8.12	28810.95	4106.66	0.42
1	195.56	EC Sep 23H6	227000.00	901.40	916.93	911.75	917.97	0.001140	8.52	28780.10	4105.19	0.43
1	195.47	PC Sep 23FIS	227000.00	902.10	916.20	911.88	917.27	0.001385	8.43	27818.78	4362.12	0.45
1	195.47	PC 6T BO	227000.00	902.50	916.13	912.09	917.30	0.001409	9.13	27615.53	4346.23	0.48
1	195.47	EC FIS	227000.00	902.10	916.20	911.88	917.27	0.001385	8.43	27821.90	4362.31	0.45
1	195.47	EC Sep 23H6	227000.00	902.50	916.13	912.09	917.30	0.001409	9.13	27616.23	4346.28	0.48
1	195.38	PC Sep 23FIS	227000.00	900.40	915.74	910.84	916.64	0.001099	7.82	30927.77	4013.15	0.41
1	195.38	PC 6T BO	227000.00	902.10	915.71	910.93	916.63	0.001119	8.01	30836.39	3996.05	0.42
1	195.38	EC FIS	227000.00	900.40	915.74	910.84	916.64	0.001098	7.82	30931.73	4013.89	0.41
1	195.38	EC Sep 23H6	227000.00	902.10	915.71	910.93	916.63	0.001119	8.01	30837.33	3996.23	0.42
1	195.28	PC Sep 23FIS	227000.00	901.30	914.98	910.16	916.02	0.001115	8.39	29500.01	5072.21	0.43
1	195.28	PC 6T BO	227000.00	901.30	914.96	910.16	916.00	0.001124	8.41	29416.04	5059.71	0.43
1	195.28	EC FIS	227000.00	901.30	914.99	910.16	916.02	0.001115	8.39	29505.45	5073.02	0.43
1	195.28	EC Sep 23H6	227000.00	901.30	914.96	910.16	916.00	0.001124	8.41	29417.21	5059.88	0.43
1	195.19	PC Sep 23FIS	227000.00	900.70	913.69	910.33	915.28	0.001885	10.39	23441.89	4198.68	0.55
1	195.19	PC 6T BO	227000.00	900.70	913.65	910.29	915.25	0.001914	10.44	23315.99	4194.98	0.55
1	195.19	EC FIS	227000.00	900.70	913.69	910.33	915.28	0.001884	10.39	23450.08	4198.92	0.55
1	195.19	EC Sep 23H6	227000.00	900.70	913.65	910.29	915.25	0.001914	10.44	23317.83	4195.04	0.55
1	195.16	PC Sep 23FIS	227000.00	900.00	913.47	908.68	914.94	0.001408	9.82	23846.52	2341.47	0.48
1	195.16	PC 6T BO	227000.00	900.00	913.43	908.68	914.91	0.001426	9.86	23746.12	2340.75	0.49
1	195.16	EC FIS	227000.00	900.00	913.48	908.68	914.95	0.001407	9.81	23853.05	2341.51	0.48
1	195.16	EC Sep 23H6	227000.00	900.00	913.43	908.68	914.91	0.001425	9.86	23747.55	2340.76	0.49
1	195.15		Bridge									
1	195.13	PC Sep 23FIS	227000.00	900.00	913.23	908.68	914.76	0.001505	10.02	23343.48	2237.68	0.50
1	195.13	PC 6T BO	227000.00	900.00	913.18	908.68	914.72	0.001526	10.07	23232.44	2235.10	0.50
1	195.13	EC FIS	227000.00	900.00	913.23	908.68	914.76	0.001503	10.02	23350.55	2237.84	0.50
1	195.13	EC Sep 23H6	227000.00	900.00	913.18	908.68	914.72	0.001526	10.07	23233.88	2235.14	0.50
1	195.09	PC Sep 23FIS	227000.00	898.80	912.57	909.24	914.32	0.002001	10.76	22295.60	3657.03	0.57
1	195.09	PC 6T BO	227000.00	898.80	912.50	909.24	914.27	0.002049	10.84	22098.15	3605.73	0.57
1	195.09	EC FIS	227000.00	898.80	912.58	909.24	914.32	0.001998	10.76	22308.36	3660.31	0.56
1	195.09	EC Sep 23H6	227000.00	898.80	912.50	909.24	914.27	0.002048	10.84	22100.89	3606.45	0.57
1	195.00	PC Sep 23FIS	227000.00	897.00	912.05	908.48	913.29	0.001540	9.18	26677.16	4364.90	0.49
1	195.00	PC 6T BO	227000.00	897.00	911.92	908.67	913.26	0.001512	9.86	26243.03	4308.62	0.50
1	195.00	EC FIS	227000.00	897.00	912.06	908.48	913.29	0.001537	9.17	26698.18	4368.53	0.49
1	195.00	EC Sep 23H6	227000.00	897.00	911.92	908.67	913.26	0.001511	9.86	26248.04	4309.13	0.50
1	194.91	PC Sep 23FIS	227000.00	896.90	911.43	907.63	912.51	0.001446	8.56	28678.78	4973.37	0.47
1	194.91	PC 6T BO	227000.00	896.90	911.29	908.07	912.50	0.001396	9.60	28071.99	4956.83	0.48
1	194.91	EC FIS	227000.00	896.90	911.44	907.63	912.52	0.001442	8.55	28714.85	4973.81	0.47
1	194.91	EC Sep 23H6	227000.00	896.90	911.29	908.07	912.50	0.001395	9.60	28080.67	4958.19	0.48
1	194.81	PC Sep 23FIS	227000.00	896.00	911.16	905.84	911.88	0.000818	7.00	35118.84	5164.81	0.37
1	194.81	PC 6T BO	227000.00	896.00	911.06	906.00	911.85	0.000819	7.60	34715.30	5144.55	0.37
1	194.81	EC FIS	227000.00	896.00	911.17	905.84	911.89	0.000815	7.00	35160.22	5168.10	0.37
1	194.81	EC Sep 23H6	227000.00	896.00	911.06	906.00	911.85	0.000819	7.60	34725.07	5144.61	0.37
1	194.72	PC Sep 23FIS	227000.00	895.70	910.72	905.79	911.46	0.000927	7.08	34228.88	4725.84	0.38
1	194.72	PC 6T BO	227000.00	895.70	910.63	906.01	911.43	0.000899	7.70	33873.27	4688.81	0.39
1	194.72	EC FIS	227000.00	895.70	910.73	905.79	911.47	0.000923	7.07	34273.66	4730.49	0.38
1	194.72	EC Sep 23H6	227000.00	895.70	910.63	906.01	911.43	0.000898	7.70	33883.77	4689.90	0.38
1	194.62	PC Sep 23FIS	227000.00	896.00	910.33	905.58	910.99	0.000861	6.67	35650.48	5294.07	0.36
1	194.62	PC 6T BO	227000.00	896.00	910.25	905.80	910.95	0.000865	7.22	35313.54	5267.94	0.37
1	194.62	EC FIS	227000.00	896.00	910.35	905.58	911.00	0.000856	6.66	35706.64	5298.42	0.36
1	194.62	EC Sep 23H6	227000.00	896.00	910.26	905.80	910.95	0.000864	7.21	35326.69	5268.96	0.37
1	194.53	PC Sep 23FIS	227000.00	895.20	909.82	905.21	910.53	0.000969	6.88	34552.08	5571.63	0.38

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	194.53	PC 6T BO	227000.00	895.20	909.70	905.49	910.48	0.000984	7.71	34038.44	5446.68	0.40
1	194.53	EC FIS	227000.00	895.20	909.84	905.21	910.54	0.000963	6.86	34624.42	5589.16	0.38
1	194.53	EC Sep 23H6	227000.00	895.20	909.71	905.49	910.48	0.000983	7.70	34055.42	5450.82	0.40
1	194.40	PC Sep 23FIS	227000.00	896.00	908.84	904.77	909.76	0.001223	7.83	30923.65	5830.38	0.43
1	194.40	PC 6T BO	227000.00	896.00	908.83	904.80	909.74	0.001223	8.15	30890.23	5825.56	0.44
1	194.40	EC FIS	227000.00	896.00	908.87	904.77	909.78	0.001211	7.81	31032.90	5846.11	0.43
1	194.40	EC Sep 23H6	227000.00	896.00	908.84	904.80	909.74	0.001221	8.15	30915.23	5829.16	0.44
1	194.29	PC Sep 23FIS	227000.00	896.20	906.78	904.97	908.42	0.002971	10.46	22532.17	5071.73	0.65
1	194.29	PC 6T BO	227000.00	896.20	906.70	905.07	908.41	0.003037	11.25	22289.00	5049.77	0.67
1	194.29	EC FIS	227000.00	896.20	906.89	904.97	908.48	0.002842	10.31	22847.51	5100.20	0.64
1	194.29	EC Sep 23H6	227000.00	896.20	906.73	905.07	908.43	0.002999	11.21	22377.46	5057.76	0.66
1	194.210	PC Sep 23FIS	227000.00	883.10	905.79	902.06	907.32	0.001693	9.93	22868.46	2976.98	0.53
1	194.210	PC 6T BO	227000.00	883.10	905.65	902.27	907.27	0.001709	10.59	22551.76	2971.15	0.54
1	194.210	EC FIS	227000.00	883.10	905.94	902.06	907.43	0.001619	9.79	23180.12	2986.14	0.52
1	194.210	EC Sep 23H6	227000.00	883.10	905.69	902.27	907.30	0.001687	10.55	22642.48	2972.65	0.54
1	194.205		Bridge									
1	194.200	PC Sep 23FIS	227000.00	882.97	905.48		907.08	0.001824	10.15	22353.69	2116.92	0.55
1	194.200	PC 6T BO	227000.00	882.97	905.32		907.03	0.001842	10.86	22008.01	2115.94	0.56
1	194.200	EC FIS	227000.00	882.97	905.65		907.20	0.001733	10.00	22708.96	2490.10	0.54
1	194.200	EC Sep 23H6	227000.00	882.97	905.37		907.06	0.001812	10.81	22119.87	2459.99	0.56
1	194.100	PC Sep 23FIS	227000.00	883.87	904.80		906.13	0.001606	9.24	24571.75	3012.59	0.51
1	194.100	PC 6T BO	227000.00	883.87	904.69		906.07	0.001642	9.67	24292.94	3010.23	0.52
1	194.100	EC FIS	227000.00	883.87	905.03		906.30	0.001487	9.03	25152.53	4416.15	0.50
1	194.100	EC Sep 23H6	227000.00	883.87	904.76		906.15	0.001571	10.01	24492.62	4308.31	0.52
1	194.020	PC Sep 23FIS	227000.00	885.49	904.24		905.37	0.001434	8.56	26556.24	3197.07	0.48
1	194.020	PC 6T BO	227000.00	885.49	904.08		905.30	0.001491	9.01	26148.44	3186.01	0.50
1	194.020	EC FIS	227000.00	885.49	904.53		905.60	0.001304	8.31	27334.51	4385.17	0.46
1	194.020	EC Sep 23H6	227000.00	885.49	904.20		905.42	0.001392	9.53	26463.45	4109.35	0.49
1	193.940	PC Sep 23FIS	227000.00	885.38	903.91		904.82	0.001169	7.67	29611.59	3505.83	0.42
1	193.940	PC 6T BO	227000.00	885.38	903.69		904.73	0.001251	8.30	28995.57	3501.17	0.45
1	193.940	EC FIS	227000.00	885.38	904.24		905.09	0.001055	7.43	30577.74	4824.95	0.40
1	193.940	EC Sep 23H6	227000.00	885.38	903.86		904.88	0.001156	8.77	29479.39	4533.61	0.45
1	193.870	PC Sep 23FIS	227000.00	882.80	903.46		904.27	0.001587	7.20	31550.00	3568.25	0.40
1	193.870	PC 6T BO	227000.00	882.80	903.36		904.22	0.001115	7.51	31233.98	3566.45	0.41
1	193.870	EC FIS	227000.00	882.80	903.85		904.60	0.001395	6.92	32789.38	4442.61	0.38
1	193.870	EC Sep 23H6	227000.00	882.80	903.49		904.43	0.001045	8.36	31641.58	4419.43	0.43
1	193.790	PC Sep 23FIS	227000.00	882.55	902.98		903.72	0.000970	6.91	32937.20	3711.83	0.39
1	193.790	PC 6T BO	227000.00	882.55	902.95		903.76	0.000979	7.29	32840.93	3711.24	0.40
1	193.790	EC FIS	227000.00	882.55	903.30		903.99	0.001356	6.68	34001.67	4084.62	0.37
1	193.790	EC Sep 23H6	227000.00	882.55	903.16		903.96	0.000903	7.70	33551.39	4061.50	0.39
1	193.730	PC Sep 23FIS	227000.00	882.18	902.61		903.38	0.000987	7.04	32287.59	3421.02	0.40
1	193.730	PC 6T BO	227000.00	882.18	902.56		903.41	0.001005	7.49	32108.37	3420.69	0.41
1	193.730	EC FIS	227000.00	882.18	902.84		903.59	0.000969	6.98	32547.95	3422.17	0.40
1	193.730	EC Sep 23H6	227000.00	882.18	902.80		903.62	0.000960	7.90	32416.21	3421.99	0.41
1	193.620	PC Sep 23FIS	227000.00	878.21	901.95		902.79	0.001085	7.37	30819.18	3218.51	0.42
1	193.620	PC 6T BO	227000.00	878.21	901.89		902.81	0.001097	7.93	30628.41	3217.95	0.43
1	193.620	EC FIS	227000.00	878.21	902.08		902.97	0.001205	7.58	29961.99	3219.71	0.43
1	193.620	EC Sep 23H6	227000.00	878.21	902.03		903.02	0.001185	8.50	29823.10	3219.31	0.45
1	193.530	PC Sep 23FIS	227000.00	878.96	901.50		902.27	0.000946	7.06	32250.77	3319.89	0.39
1	193.530	PC 6T BO	227000.00	878.96	901.44		902.29	0.000952	7.59	32053.98	3316.90	0.40
1	193.530	EC FIS	227000.00	878.96	901.54		902.39	0.001126	7.39	30800.24	3345.84	0.42
1	193.530	EC Sep 23H6	227000.00	878.96	901.50		902.44	0.001094	8.22	30651.30	3343.44	0.43
1	193.430	PC Sep 23FIS	227000.00	879.37	901.09		901.82	0.000883	6.84	33220.23	3567.46	0.38
1	193.430	PC 6T BO	227000.00	879.37	901.02		901.83	0.000885	7.39	32989.24	3556.44	0.39
1	193.430	EC FIS	227000.00	879.37	901.12		901.85	0.000961	6.90	33034.87	3717.42	0.39
1	193.430	EC Sep 23H6	227000.00	879.37	901.08		901.91	0.000929	7.67	32919.06	3712.15	0.40
1	193.340	PC Sep 23FIS	227000.00	881.18	900.67		901.41	0.000818	6.94	32725.29	3675.98	0.37
1	193.340	PC 6T BO	227000.00	881.18	900.62		901.41	0.000826	7.28	32579.64	3674.04	0.38
1	193.340	EC FIS	227000.00	881.18	900.74		901.40	0.000849	6.56	34799.45	3882.87	0.37
1	193.340	EC Sep 23H6	227000.00	881.18	900.72		901.45	0.000838	7.28	34732.05	3882.15	0.38
1	193.250	PC Sep 23FIS	227000.00	880.67	900.05		900.93	0.001184	7.54	30125.74	2637.27	0.39
1	193.250	PC 6T BO	227000.00	880.67	900.05		900.93	0.001184	7.54	30124.93	2637.27	0.39

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	193.250	EC FIS	227000.00	880.67	900.31		900.94	0.001057	6.43	35769.75	4130.63	0.37
1	193.250	EC Sep 23H6	227000.00	880.67	900.27		900.99	0.001055	7.16	35616.82	4130.28	0.37
1	193.160	PC Sep 23FIS	227000.00	880.66	899.50		900.42	0.000962	7.71	29438.91	2539.47	0.40
1	193.160	PC 6T BO	227000.00	880.66	899.50		900.42	0.000962	7.71	29438.13	2539.47	0.40
1	193.160	EC FIS	227000.00	880.66	899.78		900.46	0.000935	6.65	34684.11	4280.19	0.40
1	193.160	EC Sep 23H6	227000.00	880.66	899.69		900.49	0.000960	7.61	34306.89	4279.47	0.40
1	193.070	PC Sep 23FIS	227000.00	881.99	899.09		899.96	0.000879	7.50	30259.65	2538.06	0.38
1	193.070	PC 6T BO	227000.00	881.99	899.09		899.96	0.000880	7.50	30258.88	2538.06	0.38
1	193.070	EC FIS	227000.00	881.99	899.39		900.02	0.000833	6.41	36599.66	4501.91	0.38
1	193.070	EC Sep 23H6	227000.00	881.99	899.29		900.03	0.000841	7.39	36177.60	4498.06	0.38
1	192.980	PC Sep 23FIS	227000.00	880.71	898.69		899.52	0.000903	7.27	31204.00	2521.58	0.36
1	192.980	PC 6T BO	227000.00	880.71	898.69		899.52	0.000903	7.27	31203.08	2521.57	0.36
1	192.980	EC FIS	227000.00	880.71	898.94		899.60	0.000904	6.55	36477.48	4492.52	0.37
1	192.980	EC Sep 23H6	227000.00	880.71	898.85		899.59	0.000925	7.43	36064.98	4484.21	0.38
1	192.890	PC Sep 23FIS	227000.00	880.29	898.09		899.02	0.001051	7.74	29339.27	2381.74	0.39
1	192.890	PC 6T BO	227000.00	880.29	898.09		899.02	0.001051	7.74	29338.25	2381.73	0.39
1	192.890	EC FIS	227000.00	880.09	898.26		899.03	0.001424	7.17	34862.68	5006.47	0.41
1	192.890	EC Sep 23H6	227000.00	880.09	898.25		899.04	0.001311	7.80	34779.32	4991.29	0.40
1	192.790	PC Sep 23FIS	227000.00	876.74	897.41		898.44	0.001307	8.16	27818.78	2263.91	0.41
1	192.790	PC 6T BO	227000.00	876.74	897.41		898.44	0.001308	8.16	27817.68	2263.90	0.41
1	192.790	EC FIS	227000.00	876.81	897.40		898.32	0.001389	7.93	33573.02	5336.40	0.45
1	192.790	EC Sep 23H6	227000.00	876.81	897.37		898.34	0.001406	8.65	33393.38	5332.65	0.44
1	192.700	PC Sep 23FIS	227000.00	877.01	896.69		897.78	0.001373	8.40	27026.35	2195.03	0.42
1	192.700	PC 6T BO	227000.00	877.01	896.69		897.78	0.001373	8.40	27024.88	2195.02	0.42
1	192.700	EC FIS	227000.00	876.64	896.74		897.64	0.001333	7.98	35145.32	5682.11	0.43
1	192.700	EC Sep 23H6	227000.00	876.64	896.69		897.63	0.001340	8.60	34871.12	5678.73	0.43
1	192.610	PC Sep 23FIS	227000.00	878.15	896.07		897.17	0.001202	8.42	26963.21	2156.23	0.42
1	192.610	PC 6T BO	227000.00	878.15	896.07		897.17	0.001202	8.42	26961.37	2156.22	0.42
1	192.610	EC FIS	227000.00	878.15	896.15		897.03	0.001154	8.00	35546.89	5872.80	0.42
1	192.610	EC Sep 23H6	227000.00	878.15	896.02		897.01	0.001176	8.79	34842.66	5858.10	0.44
1	192.520	PC Sep 23FIS	227000.00	878.23	895.44		896.56	0.001205	8.51	26673.10	2133.77	0.42
1	192.520	PC 6T BO	227000.00	878.23	895.44		896.56	0.001206	8.51	26671.02	2133.75	0.42
1	192.520	EC FIS	227000.00	878.23	895.53		896.44	0.001148	8.05	34239.52	6077.61	0.42
1	192.520	EC Sep 23H6	227000.00	878.23	895.44		896.39	0.001183	8.51	33758.52	6068.56	0.44
1	192.420	EC FIS	227000.00	876.63	894.89		895.82	0.001336	8.28	32561.57	5843.05	0.45
1	192.420	EC Sep 23H6	227000.00	876.63	894.76		895.75	0.001387	8.81	31924.71	5802.94	0.48
1	192.41	PC Sep 23FIS	227000.00	876.67	894.67	889.51	895.88	0.001300	8.82	25746.52	2147.83	0.45
1	192.41	PC 6T BO	227000.00	876.67	894.67	889.51	895.88	0.001300	8.82	25743.79	2147.81	0.45
1	192.39		Bridge									
1	192.38	PC Sep 23FIS	227000.00	876.41	893.99		895.29	0.001444	9.16	24768.88	2144.68	0.47
1	192.38	PC 6T BO	227000.00	876.41	893.98		895.29	0.001444	9.17	24765.90	2144.65	0.47
1	192.330	PC Sep 23FIS	227000.00	876.06	893.53		894.84	0.001469	9.20	24681.97	2851.61	0.48
1	192.330	PC 6T BO	227000.00	876.06	893.53		894.84	0.001469	9.20	24678.46	2851.58	0.48
1	192.330	EC FIS	227000.00	876.06	893.94		895.05	0.001690	8.81	30701.01	6006.68	0.50
1	192.330	EC Sep 23H6	227000.00	876.06	893.87		894.97	0.001690	9.32	30386.83	5980.11	0.52
1	192.230	PC Sep 23FIS	227000.00	876.72	892.69	888.24	894.05	0.001744	9.34	24315.51	3055.77	0.49
1	192.230	PC 6T BO	227000.00	876.72	892.69	888.24	894.04	0.001745	9.34	24310.57	3055.67	0.49
1	192.230	EC FIS	227000.00	876.72	893.34		894.21	0.001422	7.75	34065.29	5915.17	0.44
1	192.230	EC Sep 23H6	227000.00	877.34	893.26		894.11	0.001449	8.46	33666.63	5889.02	0.48
1	192.140	PC Sep 23FIS	227000.00	875.94	891.73		893.14	0.001884	9.54	23785.56	3299.12	0.51
1	192.140	PC 6T BO	227000.00	875.94	891.73		893.14	0.001886	9.55	23777.89	3298.85	0.51
1	192.140	EC FIS	227000.00	875.94	892.70		893.51	0.001371	7.46	35753.43	6577.71	0.44
1	192.140	EC Sep 23H6	227000.00	877.45	892.70		893.43	0.001355	8.26	35712.30	6577.14	0.47
1	192.040	PC Sep 23FIS	227000.00	876.36	891.00		892.24	0.001575	9.03	26257.72	3669.92	0.48
1	192.040	PC 6T BO	227000.00	876.36	891.00		892.23	0.001578	9.04	26246.03	3669.81	0.48
1	192.040	EC FIS	227000.00	876.36	892.15		892.84	0.001184	6.87	38705.71	6340.30	0.41
1	192.040	EC Sep 23H6	227000.00	876.36	892.09		892.73	0.001193	7.72	38277.35	6334.28	0.44
1	191.950	PC Sep 23FIS	227000.00	876.68	890.50		891.46	0.001251	8.00	29521.80	3987.04	0.44
1	191.950	PC 6T BO	227000.00	876.68	890.52		891.44	0.001242	7.92	29583.38	3987.18	0.44
1	191.950	EC FIS	227000.00	874.98	891.68		892.27	0.000992	6.35	40579.67	6286.37	0.38
1	191.950	EC Sep 23H6	227000.00	874.98	891.62		892.17	0.000951	6.87	40229.84	6282.90	0.38

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	191.860	PC Sep 23FIS	227000.00	876.27	890.03		890.84	0.001064	7.36	32021.15	4303.79	0.41
1	191.860	PC 6T BO	227000.00	876.27	890.04		890.83	0.001060	7.47	32057.07	4305.34	0.41
1	191.860	EC FIS	227000.00	874.43	891.23		891.77	0.000956	6.01	41392.52	6194.40	0.36
1	191.860	EC Sep 23H6	227000.00	874.43	891.16		891.71	0.000890	6.90	41010.50	6190.12	0.37
1	191.760	PC Sep 23FIS	227000.00	874.62	889.48		890.28	0.001142	7.28	32455.70	4513.80	0.42
1	191.760	PC 6T BO	227000.00	874.62	889.47		890.27	0.001147	7.66	32410.56	4513.71	0.42
1	191.760	EC FIS	227000.00	874.62	890.77		891.25	0.001023	5.75	43691.46	6618.45	0.35
1	191.760	EC Sep 23H6	227000.00	874.62	890.74		891.23	0.000931	6.67	43525.91	6607.69	0.35
1	191.670	PC Sep 23FIS	227000.00	872.60	888.93		889.67	0.001218	7.06	33519.43	5157.87	0.41
1	191.670	PC 6T BO	227000.00	872.60	888.90		889.68	0.001172	7.58	33422.16	5155.82	0.40
1	191.670	EC FIS	227000.00	872.60	890.21		890.70	0.001196	5.76	42353.34	6318.40	0.36
1	191.670	EC Sep 23H6	227000.00	872.60	890.23		890.71	0.001105	6.35	42501.93	6327.41	0.34
1	191.570	PC Sep 23FIS	227000.00	870.63	888.43		889.07	0.001075	6.53	36236.30	5062.61	0.39
1	191.570	PC 6T BO	227000.00	870.63	888.43		889.10	0.001014	7.12	36222.60	5062.52	0.37
1	191.570	EC FIS	227000.00	870.63	889.70		890.12	0.001047	5.33	44937.55	6254.95	0.34
1	191.570	EC Sep 23H6	227000.00	870.63	889.76		890.18	0.000944	5.93	45309.59	6261.80	0.32
1	191.480	PC Sep 23FIS	227000.00	870.93	888.02		888.54	0.000901	5.90	39492.37	5916.39	0.35
1	191.480	PC 6T BO	227000.00	870.93	888.04		888.59	0.000866	6.48	39575.34	5916.94	0.34
1	191.480	EC FIS	227000.00	870.93	889.22		889.61	0.000939	5.10	45899.68	7187.75	0.32
1	191.480	EC Sep 23H6	227000.00	870.93	889.31		889.72	0.000814	5.77	46570.23	7316.52	0.30
1	191.380	PC Sep 23FIS	227000.00	871.69	887.61		888.10	0.000833	5.67	41063.20	6346.76	0.34
1	191.380	PC 6T BO	227000.00	871.69	887.60		888.14	0.000835	6.51	41045.57	6346.56	0.34
1	191.380	EC FIS	227000.00	871.69	888.72		889.13	0.000974	5.18	44881.15	6649.49	0.34
1	191.380	EC Sep 23H6	227000.00	871.69	888.80		889.26	0.000910	6.47	45413.78	6653.39	0.34
1	191.290	PC Sep 23FIS	227000.00	870.63	887.22		887.67	0.000836	5.43	42431.91	5889.11	0.32
1	191.290	PC 6T BO	227000.00	870.63	887.22		887.71	0.000834	6.21	42447.83	5889.19	0.32
1	191.290	EC FIS	227000.00	870.63	888.28		888.67	0.000858	4.99	46526.23	7388.01	0.31
1	191.290	EC Sep 23H6	227000.00	870.63	888.40		888.82	0.000785	6.26	47335.19	7908.86	0.33
1	191.190	PC Sep 23FIS	227000.00	869.78	886.80		887.24	0.000855	5.42	42801.48	5257.53	0.31
1	191.190	PC 6T BO	227000.00	869.78	886.81		887.29	0.000846	6.12	42852.37	5258.71	0.32
1	191.190	EC FIS	227000.00	869.78	887.86		888.26	0.000787	5.05	46198.18	7861.27	0.30
1	191.190	EC Sep 23H6	227000.00	869.78	887.97		888.44	0.000744	6.82	46928.63	7990.77	0.34
1	191.100	PC Sep 23FIS	227000.00	870.88	886.42		886.86	0.000696	5.38	43056.66	4758.53	0.30
1	191.100	PC 6T BO	227000.00	870.88	886.41		886.91	0.000683	6.26	43050.18	4758.35	0.32
1	191.100	EC FIS	227000.00	870.88	887.51		887.91	0.000629	5.09	46885.33	7293.46	0.29
1	191.100	EC Sep 23H6	227000.00	870.88	887.65		888.10	0.000597	6.71	47784.98	7488.59	0.33
1	191.000	PC Sep 23FIS	227000.00	869.64	886.03		886.50	0.000742	5.49	41384.86	4474.24	0.31
1	191.000	PC 6T BO	227000.00	869.64	886.03		886.55	0.000720	6.37	41393.07	4474.50	0.33
1	191.000	EC FIS	227000.00	869.64	887.13		887.57	0.000686	5.41	44628.57	7582.72	0.31
1	191.000	EC Sep 23H6	227000.00	869.64	887.30		887.79	0.000644	6.66	45773.65	7833.69	0.34
1	190.910	PC Sep 23FIS	227000.00	867.98	885.57		886.09	0.000893	5.76	39431.41	4804.60	0.33
1	190.910	PC 6T BO	227000.00	867.98	885.57		886.15	0.000876	6.66	39425.93	4802.12	0.34
1	190.910	EC FIS	227000.00	867.98	886.72		887.20	0.000782	5.65	43346.07	7999.37	0.32
1	190.910	EC Sep 23H6	227000.00	867.98	886.88		887.43	0.000740	7.21	44405.28	8111.70	0.36
1	190.810	PC Sep 23FIS	227000.00	867.86	885.15		885.66	0.000807	5.70	39801.43	4655.92	0.32
1	190.810	PC 6T BO	227000.00	867.86	885.21		885.71	0.000790	5.96	40015.12	4682.28	0.30
1	190.810	EC FIS	227000.00	867.86	886.37		886.84	0.000669	5.59	44158.22	8364.90	0.31
1	190.810	EC Sep 23H6	227000.00	867.86	886.58		887.07	0.000638	6.60	45581.19	8577.27	0.33
1	190.720	PC Sep 23FIS	227000.00	866.30	884.77		885.25	0.000788	5.61	40458.98	4939.51	0.31
1	190.720	PC 6T BO	227000.00	866.30	884.82		885.32	0.000774	6.05	40666.63	4950.84	0.30
1	190.720	EC FIS	227000.00	866.30	886.05		886.50	0.000661	5.50	45458.39	8348.21	0.30
1	190.720	EC Sep 23H6	227000.00	866.30	886.24		886.75	0.000647	6.97	46710.03	8449.06	0.33
1	190.620	PC Sep 23FIS	227000.00	867.37	884.36		884.85	0.000843	5.59	40795.71	5064.83	0.31
1	190.620	PC 6T BO	227000.00	867.37	884.41		884.92	0.000823	6.18	40994.84	5092.32	0.31
1	190.620	EC FIS	227000.00	867.37	885.69		886.15	0.000739	5.55	44852.69	7726.17	0.30
1	190.620	EC Sep 23H6	227000.00	867.37	885.85		886.40	0.000744	7.54	45757.68	7892.40	0.35
1	190.530	PC Sep 23FIS	227000.00	866.16	883.93		884.41	0.000910	5.56	40806.98	4525.62	0.30
1	190.530	PC 6T BO	227000.00	866.16	883.95		884.49	0.000898	6.42	40882.07	4528.97	0.32
1	190.530	EC FIS	227000.00	866.16	885.12		885.61	0.001724	5.68	42071.69	6517.66	0.32
1	190.530	EC Sep 23H6	227000.00	866.16	885.41		885.92	0.001192	6.84	43518.32	6915.32	0.32
1	190.430	PC Sep 23FIS	227000.00	867.42	883.45		883.95	0.000916	5.68	39976.21	4134.25	0.30
1	190.430	PC 6T BO	227000.00	867.42	883.50		884.04	0.000892	6.35	40160.65	4140.19	0.32

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	190.430	EC FIS	227000.00	867.42	884.46		884.98	0.000953	5.82	40797.63	5841.82	0.33
1	190.430	EC Sep 23H6	227000.00	867.42	884.56		885.36	0.000924	8.91	41301.73	5958.01	0.41
1	190.340	PC Sep 23FIS	227000.00	866.61	883.02		883.47	0.000934	5.40	42025.91	5012.53	0.29
1	190.340	PC 6T BO	227000.00	866.61	883.06		883.58	0.000916	6.28	42180.88	5036.51	0.31
1	190.340	EC FIS	227000.00	866.61	884.00		884.46	0.001034	5.43	41834.49	5720.86	0.32
1	190.340	EC Sep 23H6	227000.00	866.61	884.09		884.88	0.001003	8.82	42233.14	5758.72	0.41
1	190.240	PC Sep 23FIS	227000.00	866.29	882.51		882.96	0.001073	5.38	42199.64	5160.74	0.28
1	190.240	PC 6T BO	227000.00	866.29	882.54		883.09	0.001058	6.44	42320.40	5192.61	0.32
1	190.240	EC FIS	227000.00	866.29	883.45		883.89	0.001198	5.36	42387.94	5596.41	0.31
1	190.240	EC Sep 23H6	227000.00	866.42	883.39		884.32	0.001213	9.54	42104.66	5558.32	0.45
1	190.150	PC Sep 23FIS	227000.00	865.74	881.83		882.38	0.001281	5.92	38347.65	4696.69	0.33
1	190.150	PC 6T BO	227000.00	866.17	881.83		882.51	0.001239	7.05	38326.79	4695.35	0.35
1	190.150	EC FIS	227000.00	865.74	882.61		883.22	0.001518	6.24	36446.58	5097.66	0.38
1	190.150	EC Sep 23H6	227000.00	866.17	882.25		883.58	0.001643	10.89	34861.54	4928.88	0.53
1	190.050	PC Sep 23FIS	227000.00	858.06	881.37		881.81	0.000873	5.34	42476.54	5338.90	0.28
1	190.050	PC 6T BO	227000.00	865.09	881.29		881.84	0.001197	6.23	42167.19	5237.43	0.31
1	190.050	EC FIS	227000.00	858.06	882.07		882.52	0.001089	5.38	42196.50	5755.81	0.30
1	190.050	EC Sep 23H6	227000.00	865.09	881.83		882.66	0.001354	8.80	41156.96	5630.64	0.43
1	189.960	PC Sep 23FIS	227000.00	857.56	880.99		881.41	0.000778	5.22	43450.05	4807.29	0.28
1	189.960	PC 6T BO	227000.00	865.52	880.74		881.35	0.000829	6.78	42453.79	4696.73	0.34
1	189.960	EC FIS	227000.00	857.56	881.52		881.98	0.001179	5.43	41782.05	5173.45	0.30
1	189.960	EC Sep 23H6	227000.00	865.52	881.19		882.03	0.001198	8.74	40415.55	4962.42	0.43
1	189.870	PC Sep 23FIS	227000.00	862.94	880.64		881.02	0.000761	4.95	46199.33	8377.52	0.27
1	189.870	PC 6T BO	227000.00	863.56	880.37		880.93	0.000821	6.49	44888.45	8052.21	0.32
1	189.870	EC FIS	227000.00	862.94	880.98		881.41	0.001119	5.28	43407.35	9106.03	0.30
1	189.870	EC Sep 23H6	227000.00	863.56	880.66		881.40	0.001172	8.15	41901.85	8411.87	0.40
1	189.770	PC Sep 23FIS	227000.00	860.75	880.34		880.64	0.000606	4.42	52822.17	10330.71	0.23
1	189.770	PC 6T BO	227000.00	863.09	880.07		880.49	0.000652	5.70	51430.65	9607.12	0.28
1	189.770	EC FIS	227000.00	860.75	880.56		880.89	0.000778	4.64	50356.75	10644.73	0.25
1	189.770	EC Sep 23H6	227000.00	863.09	880.29		880.78	0.000832	6.83	48974.23	10100.06	0.34
1	189.670	PC Sep 23FIS	227000.00	862.77	880.02		880.32	0.000633	4.43	53087.27	10078.49	0.23
1	189.670	PC 6T BO	227000.00	862.77	879.70		880.14	0.000691	5.79	51323.83	9130.15	0.28
1	189.670	EC FIS	227000.00	862.77	880.16		880.48	0.000779	4.56	51568.92	10427.07	0.25
1	189.670	EC Sep 23H6	227000.00	862.77	879.86		880.34	0.000853	6.82	49845.09	9567.20	0.33
1	189.580	PC Sep 23FIS	227000.00	857.92	879.73		880.02	0.000564	4.33	55074.63	9079.53	0.23
1	189.580	PC 6T BO	227000.00	857.92	879.39		879.80	0.000604	5.66	53103.90	8601.23	0.27
1	189.580	EC FIS	227000.00	857.92	879.80		880.11	0.000701	4.53	52684.95	9175.34	0.24
1	189.580	EC Sep 23H6	227000.00	857.92	879.44		879.93	0.000764	6.85	50599.52	8663.33	0.32
1	189.480	PC Sep 23FIS	227000.00	857.85	879.47		879.74	0.000533	4.24	57076.95	8915.03	0.22
1	189.480	PC 6T BO	227000.00	857.85	879.16		879.49	0.000572	5.15	55251.21	8518.20	0.24
1	189.480	EC FIS	227000.00	857.85	879.48		879.77	0.000636	4.42	54786.62	8934.14	0.23
1	189.480	EC Sep 23H6	227000.00	857.85	879.16		879.53	0.000685	6.00	52933.98	8521.84	0.28
1	189.390	PC Sep 23FIS	227000.00	855.02	879.18		879.47	0.000528	4.42	55806.66	9978.30	0.23
1	189.390	PC 6T BO	227000.00	855.02	878.84		879.19	0.000580	5.65	53712.08	9274.02	0.27
1	189.390	EC FIS	227000.00	855.02	879.18		879.47	0.000545	4.45	55398.39	9977.68	0.23
1	189.390	EC Sep 23H6	227000.00	855.02	878.86		879.20	0.000596	5.82	53439.81	9327.41	0.27
1	189.300	PC Sep 23FIS	227000.00	856.36	878.90		879.21	0.000638	4.59	54138.75	9775.70	0.24
1	189.300	PC 6T BO	227000.00	856.36	878.48		878.90	0.000718	6.67	51478.68	8707.20	0.30
1	189.300	EC FIS	227000.00	856.36	878.90		879.21	0.000638	4.59	54138.75	9775.70	0.24
1	189.300	EC Sep 23H6	227000.00	856.36	878.48		878.90	0.000718	6.67	51478.68	8707.20	0.30
1	189.210	PC Sep 23FIS	227000.00	856.97	878.54		878.80	0.001059	4.32	56990.93	9083.98	0.23
1	189.210	PC 6T BO	227000.00	856.97	878.14		878.55	0.000723	6.72	54389.00	8515.41	0.31
1	189.210	EC FIS	227000.00	856.97	878.54		878.80	0.001059	4.32	56990.95	9083.98	0.23
1	189.210	EC Sep 23H6	227000.00	856.97	878.14		878.55	0.000723	6.72	54389.01	8515.41	0.31
1	189.110	PC Sep 23FIS	227000.00	857.40	877.99		878.25	0.001099	4.28	57377.02	8474.79	0.22
1	189.110	PC 6T BO	227000.00	857.40	877.82		878.21	0.000599	6.67	56229.93	7988.05	0.30
1	189.110	EC FIS	227000.00	857.40	877.99		878.25	0.001099	4.28	57377.02	8474.79	0.22
1	189.110	EC Sep 23H6	227000.00	857.40	877.82		878.21	0.000599	6.67	56229.93	7988.05	0.30
1	189.020	PC Sep 23FIS	227000.00	855.16	877.62		877.89	0.000495	4.30	58870.63	8955.39	0.23
1	189.020	PC 6T BO	227000.00	855.16	877.59		877.92	0.000498	6.05	58645.43	8919.88	0.27
1	189.020	EC FIS	227000.00	855.16	877.62		877.89	0.000495	4.30	58870.63	8955.39	0.23
1	189.020	EC Sep 23H6	227000.00	855.16	877.59		877.92	0.000498	6.05	58645.43	8919.88	0.27

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	188.810	PC Sep 23FIS	227000.00	852.24	877.19		877.43	0.000348	4.09	62725.53	8318.66	0.20
1	188.810	PC 6T BO	227000.00	852.24	877.22		877.49	0.000344	5.11	62963.75	8402.89	0.23
1	188.810	EC FIS	227000.00	852.24	877.19		877.43	0.000348	4.09	62725.53	8318.66	0.20
1	188.810	EC Sep 23H6	227000.00	852.24	877.22		877.49	0.000344	5.11	62963.75	8402.89	0.23
1	188.690	PC Sep 23FIS	227000.00	850.62	876.87		877.15	0.000699	4.35	59160.61	8930.40	0.21
1	188.690	PC 6T BO	227000.00	850.62	876.91		877.27	0.000470	5.75	59425.62	8962.16	0.26
1	188.690	EC FIS	227000.00	850.62	876.87		877.15	0.000700	4.35	59160.10	8930.40	0.21
1	188.690	EC Sep 23H6	227000.00	850.62	876.91		877.27	0.000470	5.75	59425.11	8962.16	0.26
1	188.59	PC Sep 23FIS	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.59	PC 6T BO	227000.00	861.40	876.39	872.50	876.94	0.000783	7.55	50471.11	7515.48	0.38
1	188.59	EC FIS	227000.00	861.40	876.44	871.17	876.76	0.000765	4.67	50873.55	7530.72	0.27
1	188.59	EC Sep 23H6	227000.00	861.40	876.39	872.50	876.94	0.000783	7.55	50471.11	7515.48	0.38
1	188.5	PC Sep 23FIS	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.5	PC 6T BO	227000.00	860.50	876.16	871.16	876.56	0.000671	6.27	53720.96	7608.25	0.31
1	188.5	EC FIS	227000.00	860.50	876.12	870.33	876.40	0.000690	4.44	53393.40	7597.74	0.24
1	188.5	EC Sep 23H6	227000.00	860.50	876.16	871.16	876.56	0.000671	6.27	53720.96	7608.25	0.31
1	188.39	PC Sep 23FIS	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.39	PC 6T BO	227000.00	860.70	875.57	870.07	876.24	0.000539	7.68	52290.72	7319.79	0.36
1	188.39	EC FIS	227000.00	860.70	875.81	868.98	876.11	0.000487	4.58	54047.77	7353.55	0.24
1	188.39	EC Sep 23H6	227000.00	860.70	875.57	870.07	876.24	0.000539	7.68	52290.72	7319.79	0.36
1	188.29	PC Sep 23FIS	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.29	PC 6T BO	227000.00	859.60	875.49	869.66	875.95	0.000460	6.33	48201.63	7331.62	0.31
1	188.29	EC FIS	227000.00	859.60	875.45	869.32	875.86	0.000472	5.41	47908.43	7326.69	0.28
1	188.29	EC Sep 23H6	227000.00	859.60	875.49	869.66	875.95	0.000460	6.33	48201.63	7331.62	0.31
1	188.2	PC Sep 23FIS	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41665.74	7148.81	0.31
1	188.2	PC 6T BO	227000.00	859.30	874.80	869.20	875.62	0.001079	8.14	40224.15	7130.31	0.39
1	188.2	EC FIS	227000.00	859.30	875.00	868.81	875.54	0.000962	6.21	41665.74	7148.81	0.31
1	188.2	EC Sep 23H6	227000.00	859.30	874.80	869.20	875.62	0.001079	8.14	40224.15	7130.31	0.39
1	188.1	PC Sep 23FIS	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37965.66	6595.48	0.36
1	188.1	PC 6T BO	227000.00	855.80	874.39	868.83	875.13	0.000845	7.52	38156.50	6601.86	0.36
1	188.1	EC FIS	227000.00	855.80	874.36	868.84	875.07	0.000862	7.28	37965.66	6595.48	0.36
1	188.1	EC Sep 23H6	227000.00	855.80	874.39	868.83	875.13	0.000845	7.52	38156.50	6601.86	0.36
1	188.07	PC Sep 23FIS	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39208.98	5733.80	0.31
1	188.07	PC 6T BO	227000.00	855.00	874.33	866.20	874.97	0.000541	6.88	39506.41	5734.27	0.30
1	188.07	EC FIS	227000.00	855.00	874.27	866.15	874.91	0.000558	6.89	39208.98	5733.80	0.31
1	188.07	EC Sep 23H6	227000.00	855.00	874.33	866.20	874.97	0.000541	6.88	39506.41	5734.27	0.30
1	188.055		Bridge									
1	188.04	PC Sep 23FIS	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38248.79	5733.34	0.31
1	188.04	PC 6T BO	227000.00	855.00	874.26	866.20	874.93	0.000548	7.05	38497.46	5733.75	0.31
1	188.04	EC FIS	227000.00	855.00	874.21	866.15	874.88	0.000577	6.99	38248.79	5733.34	0.31
1	188.04	EC Sep 23H6	227000.00	855.00	874.26	866.20	874.93	0.000548	7.05	38497.46	5733.75	0.31
1	188	PC Sep 23FIS	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.17	7288.16	0.39
1	188	PC 6T BO	227000.00	858.30	874.08	871.15	874.76	0.000816	7.46	37849.55	7298.07	0.38
1	188	EC FIS	227000.00	858.30	874.03	871.10	874.70	0.000857	7.29	37571.17	7288.16	0.39
1	188	EC Sep 23H6	227000.00	858.30	874.08	871.15	874.76	0.000816	7.46	37849.55	7298.07	0.38
1	187.91	PC Sep 23FIS	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35900.98	5898.48	0.40
1	187.91	PC 6T BO	227000.00	856.50	873.52	871.03	874.30	0.000876	8.03	35824.71	5893.88	0.39
1	187.91	EC FIS	227000.00	856.50	873.54	870.77	874.24	0.000870	7.26	35900.98	5898.48	0.40
1	187.91	EC Sep 23H6	227000.00	856.50	873.52	871.03	874.30	0.000876	8.03	35824.71	5893.88	0.39
1	187.82	PC Sep 23FIS	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32038.47	5367.10	0.46
1	187.82	PC 6T BO	227000.00	855.40	872.75	870.36	873.79	0.001200	9.18	31291.89	5199.19	0.46
1	187.82	EC FIS	227000.00	855.40	872.91	870.06	873.76	0.001124	7.77	32038.47	5367.10	0.46
1	187.82	EC Sep 23H6	227000.00	855.40	872.75	870.36	873.79	0.001200	9.18	31291.89	5199.19	0.46
1	187.73	PC Sep 23FIS	227000.00	855.40	872.38	869.18	873.23	0.001125	7.74	32552.54	7779.96	0.45
1	187.73	PC 6T BO	227000.00	855.40	872.25	869.29	873.22	0.001188	8.76	31932.69	7262.81	0.45
1	187.73	EC FIS	227000.00	855.40	872.38	869.18	873.23	0.001125	7.74	32552.54	7779.96	0.45
1	187.73	EC Sep 23H6	227000.00	855.40	872.25	869.29	873.22	0.001188	8.76	31932.69	7262.81	0.45
1	187.64	PC Sep 23FIS	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36450.42	8097.85	0.38
1	187.64	PC 6T BO	227000.00	856.10	872.05	868.33	872.74	0.000852	7.48	36373.52	8040.36	0.38
1	187.64	EC FIS	227000.00	856.10	872.07	868.39	872.75	0.000847	6.99	36450.42	8097.85	0.38
1	187.64	EC Sep 23H6	227000.00	856.10	872.05	868.33	872.74	0.000852	7.48	36373.52	8040.36	0.38
1	187.54	PC Sep 23FIS	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33184.70	8486.68	0.42

HEC-RAS River: Gila Reach: 1 Profile: PF 1 (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)	
1	187.54	PC 6T BO	227000.00	855.90	871.75	868.05	872.47	0.000877	7.49	33948.21	9383.39	0.39
1	187.54	EC FIS	227000.00	855.90	871.57	867.67	872.34	0.000939	7.28	33184.70	8486.68	0.42
1	187.54	EC Sep 23H6	227000.00	855.90	871.75	868.05	872.47	0.000877	7.49	33948.21	9383.39	0.39
1	187.45	PC Sep 23FIS	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38831.71	9337.40	0.36
1	187.45	PC 6T BO	227000.00	855.30	871.52	867.30	872.10	0.000672	6.75	39644.56	9916.62	0.34
1	187.45	EC FIS	227000.00	855.30	871.35	867.00	871.92	0.000722	6.45	38831.71	9337.40	0.36
1	187.45	EC Sep 23H6	227000.00	855.30	871.52	867.30	872.10	0.000672	6.75	39644.56	9916.62	0.34
1	187.36	PC Sep 23FIS	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36027.79	9688.24	0.38
1	187.36	PC 6T BO	227000.00	853.70	871.08	866.67	871.75	0.000699	7.19	37132.52	10200.43	0.35
1	187.36	EC FIS	227000.00	853.70	870.83	866.53	871.53	0.000766	6.99	36027.79	9688.24	0.38
1	187.36	EC Sep 23H6	227000.00	853.70	871.08	866.67	871.75	0.000699	7.19	37132.52	10200.43	0.35
1	187.24	PC Sep 23FIS	227000.00	853.80	869.81	866.24	870.85	0.001548	8.48	30572.47	8203.42	0.47
1	187.24	PC 6T BO	227000.00	853.80	869.99	866.47	871.09	0.001451	9.72	31336.92	8958.63	0.50
1	187.24	EC FIS	227000.00	853.80	869.81	866.24	870.85	0.001548	8.48	30572.47	8203.42	0.47
1	187.24	EC Sep 23H6	227000.00	853.80	869.99	866.47	871.09	0.001451	9.72	31336.92	8958.63	0.50
1	187.15	PC Sep 23FIS	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36060.30	8790.41	0.38
1	187.15	PC 6T BO	227000.00	853.20	869.67	865.32	870.45	0.000853	8.66	36942.07	9252.69	0.40
1	187.15	EC FIS	227000.00	853.20	869.48	864.95	870.16	0.000967	6.90	36060.30	8790.41	0.38
1	187.15	EC Sep 23H6	227000.00	853.20	869.67	865.32	870.45	0.000853	8.66	36942.07	9252.69	0.40
1	187.06	PC Sep 23FIS	227000.00	851.90	869.09	864.37	869.68	0.000821	6.34	37393.59	8893.03	0.35
1	187.06	PC 6T BO	227000.00	851.90	869.16	865.01	870.03	0.000803	8.48	37708.88	9056.41	0.41
1	187.06	EC FIS	227000.00	851.90	869.09	864.37	869.68	0.000821	6.34	37393.59	8893.03	0.35
1	187.06	EC Sep 23H6	227000.00	851.90	869.16	865.01	870.03	0.000803	8.48	37708.88	9056.41	0.41
1	186.97	PC Sep 23FIS	227000.00	851.90	868.75	864.00	869.29	0.000764	5.99	38631.88	9763.17	0.35
1	186.97	PC 6T BO	227000.00	851.90	868.93	864.35	869.62	0.000666	7.54	39482.95	10000.20	0.37
1	186.97	EC FIS	227000.00	851.90	868.75	864.00	869.29	0.000764	5.99	38631.88	9763.17	0.35
1	186.97	EC Sep 23H6	227000.00	851.90	868.93	864.35	869.62	0.000666	7.54	39482.95	10000.20	0.37
1	186.87	PC Sep 23FIS	227000.00	852.60	868.18	863.60	868.83	0.001045	6.65	35918.05	11022.50	0.38
1	186.87	PC 6T BO	227000.00	852.60	868.18	864.16	869.18	0.001044	8.76	35918.05	11022.50	0.44
1	186.87	EC FIS	227000.00	852.60	868.18	863.60	868.83	0.001045	6.65	35918.05	11022.50	0.38
1	186.87	EC Sep 23H6	227000.00	852.60	868.18	864.16	869.18	0.001044	8.76	35918.05	11022.50	0.44

APPENDIX F

Sediment Transport HEC-6T Model Results

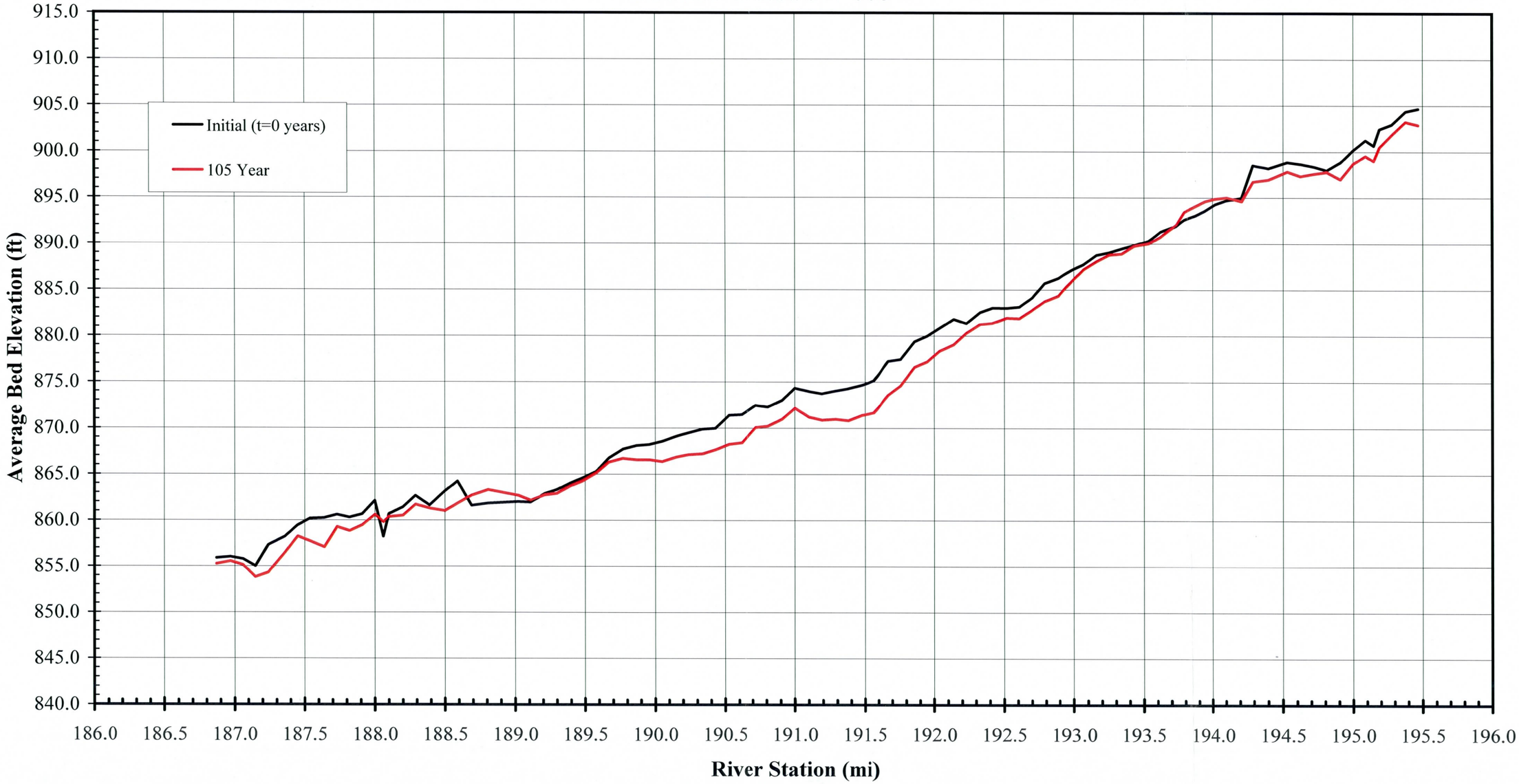
APPENDIX F

SECTION 1

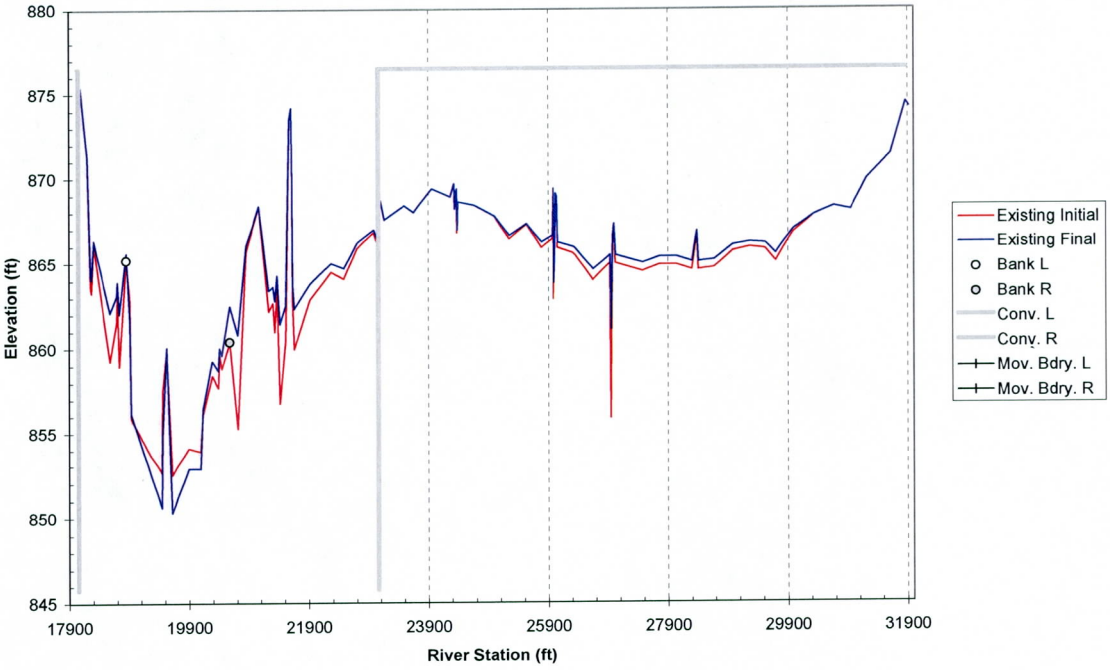
Sediment Transport HEC-6T Model Results

EXISTING CONDITIONS

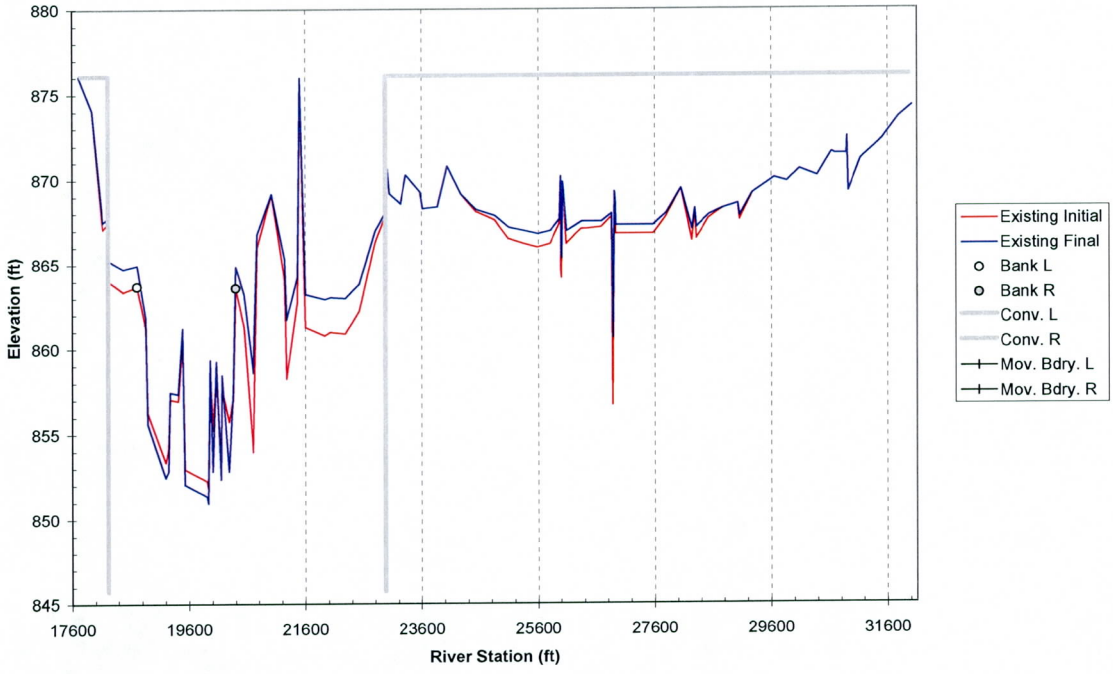
King Ranch
Average Bed Elevations for the 105-Year Simulation (1898-1993)
Existing Conditions with New Topography, Stantec Sediment Load, and WEST Gradation
Revised October 2005



Cross Section 186.87



Cross Section 186.97



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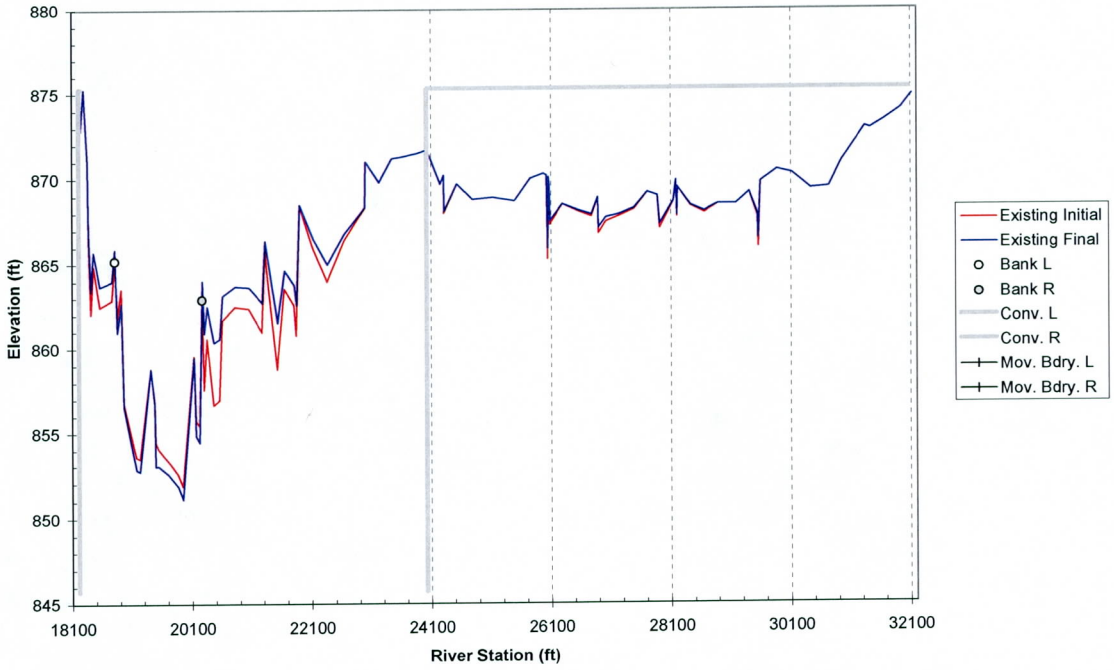

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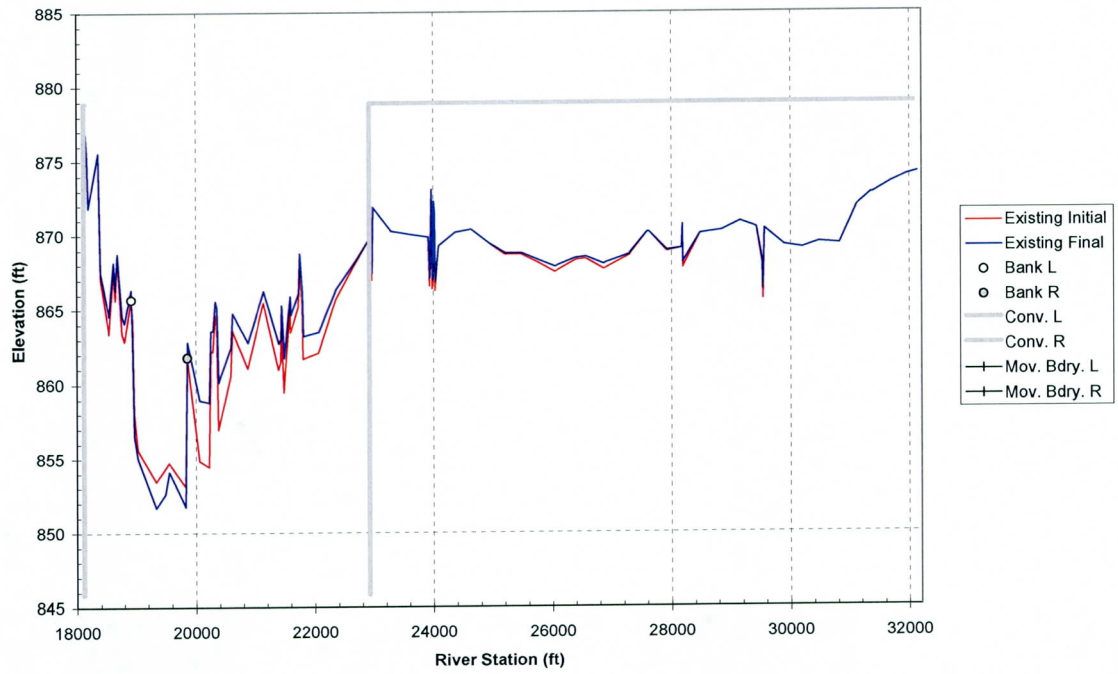

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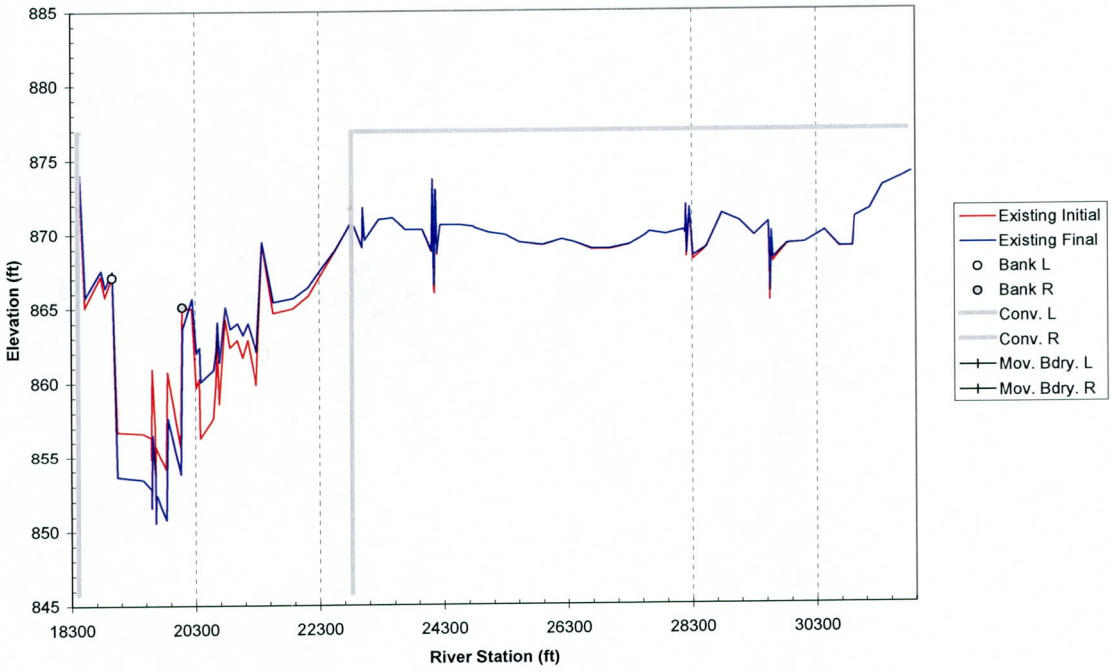

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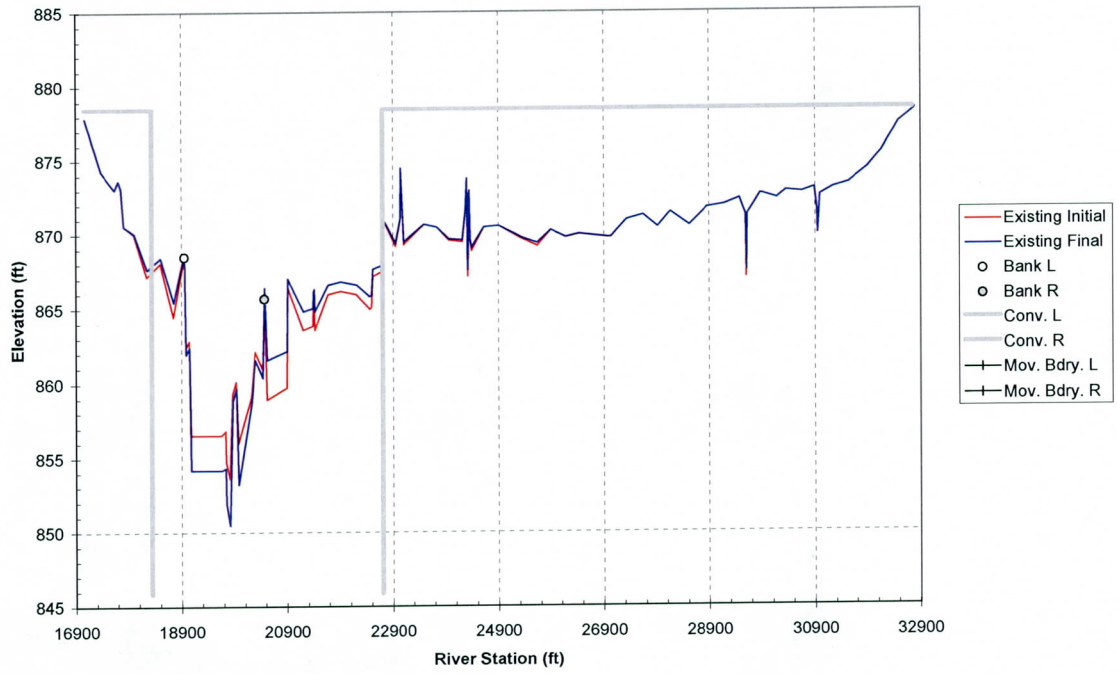

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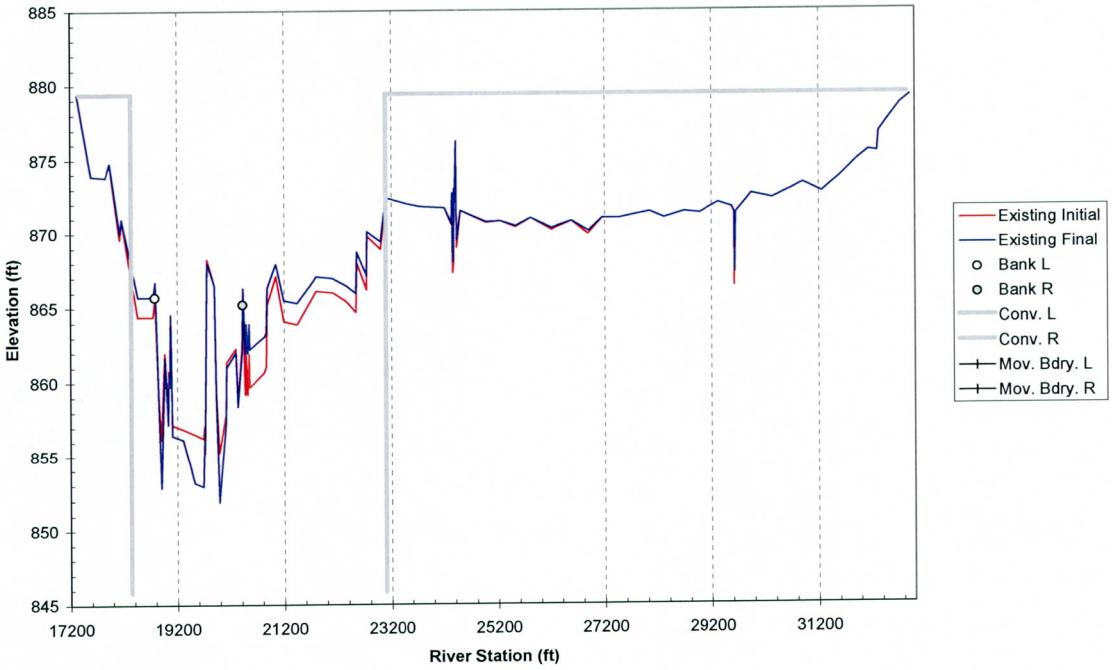

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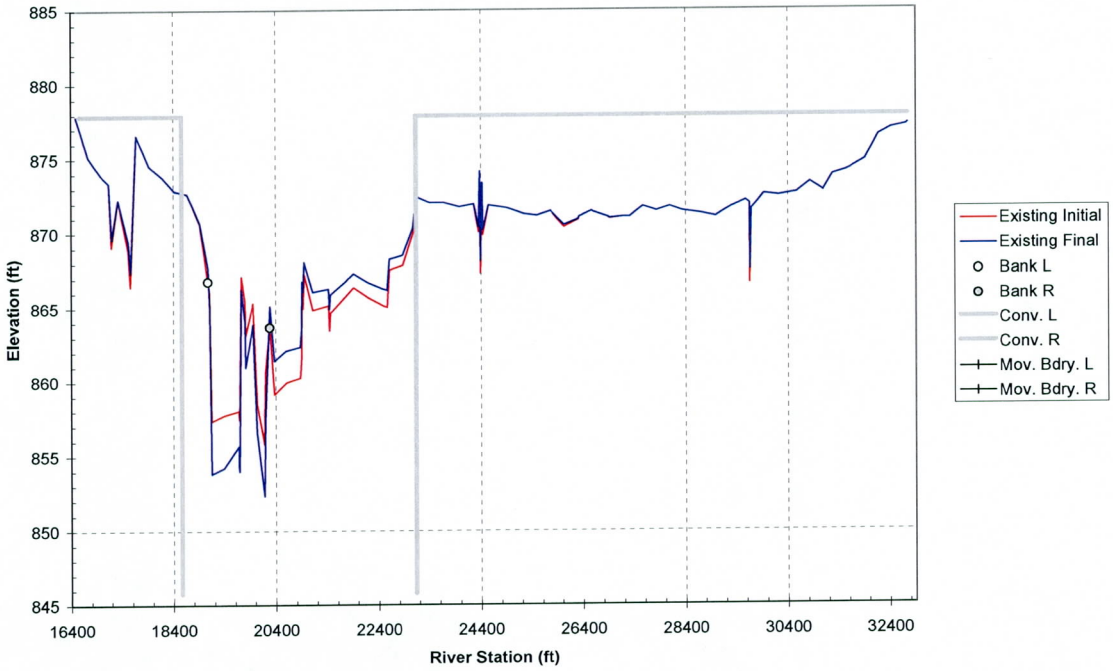

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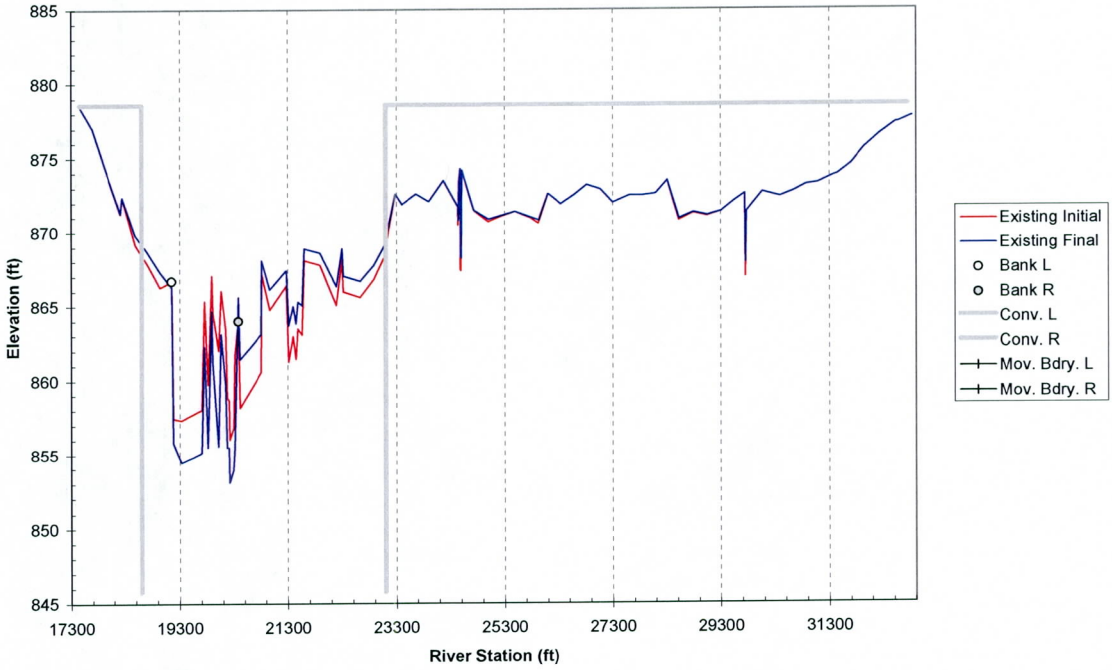

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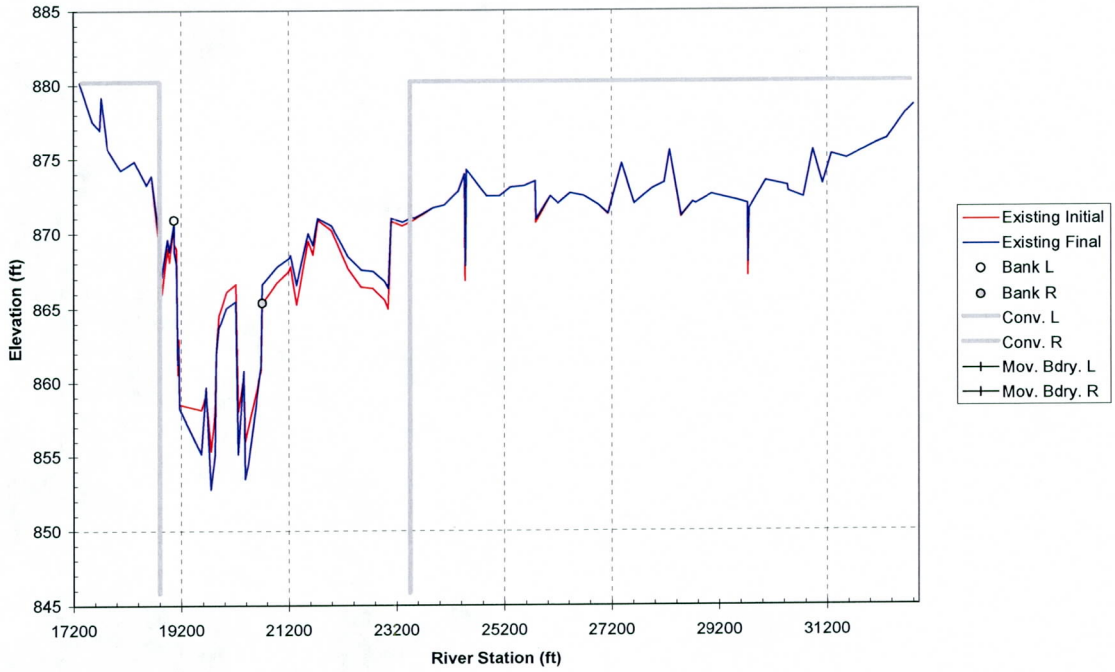

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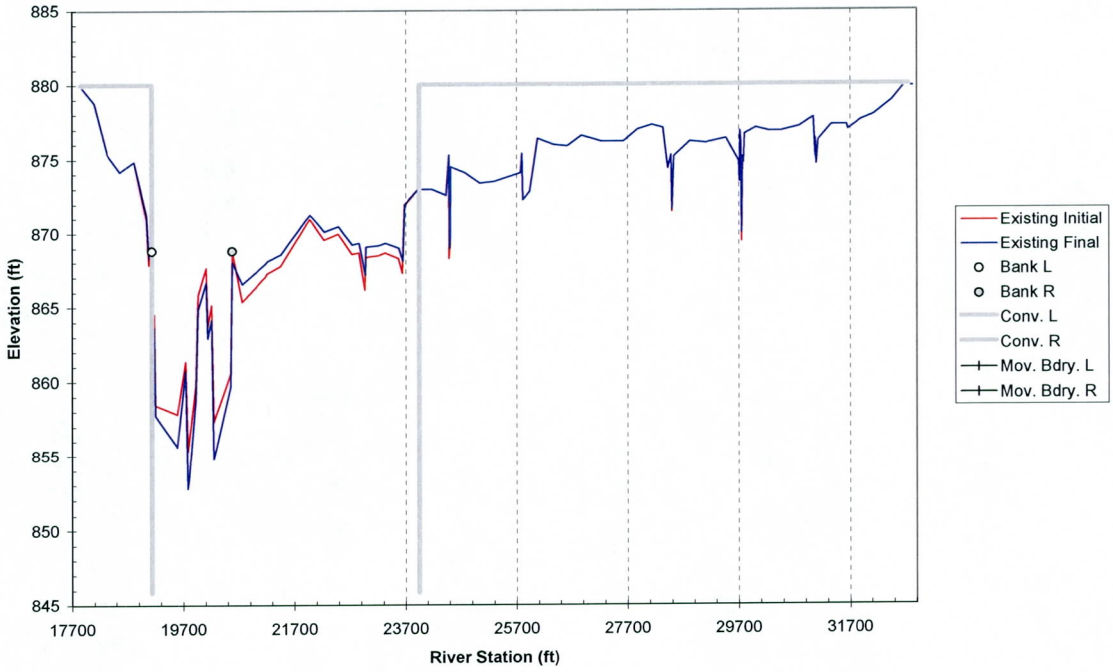

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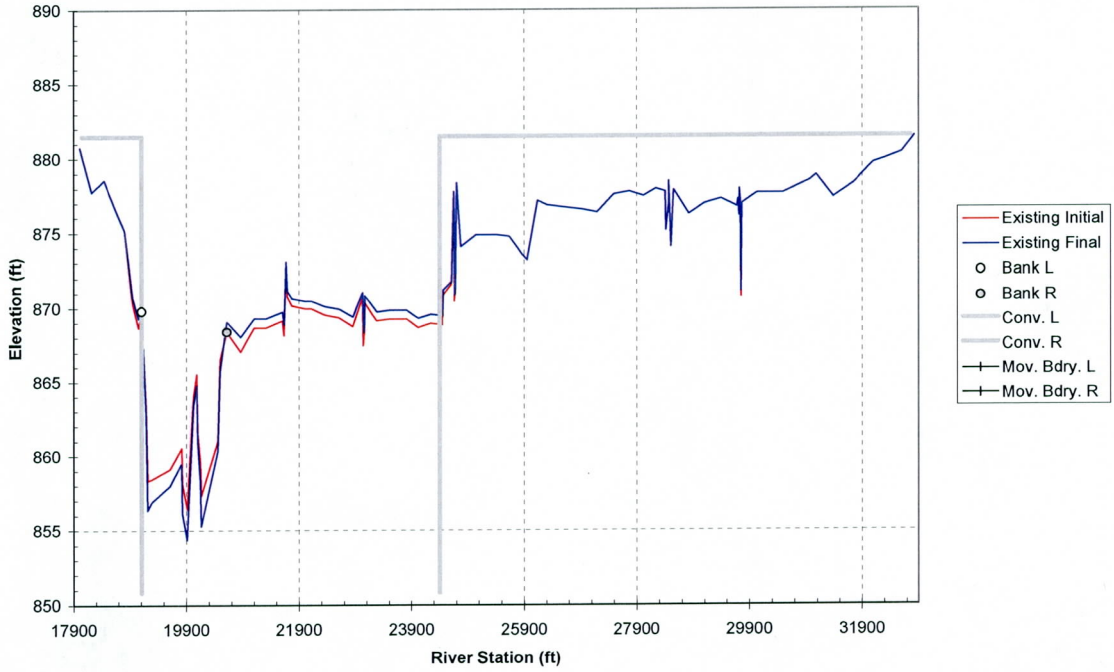

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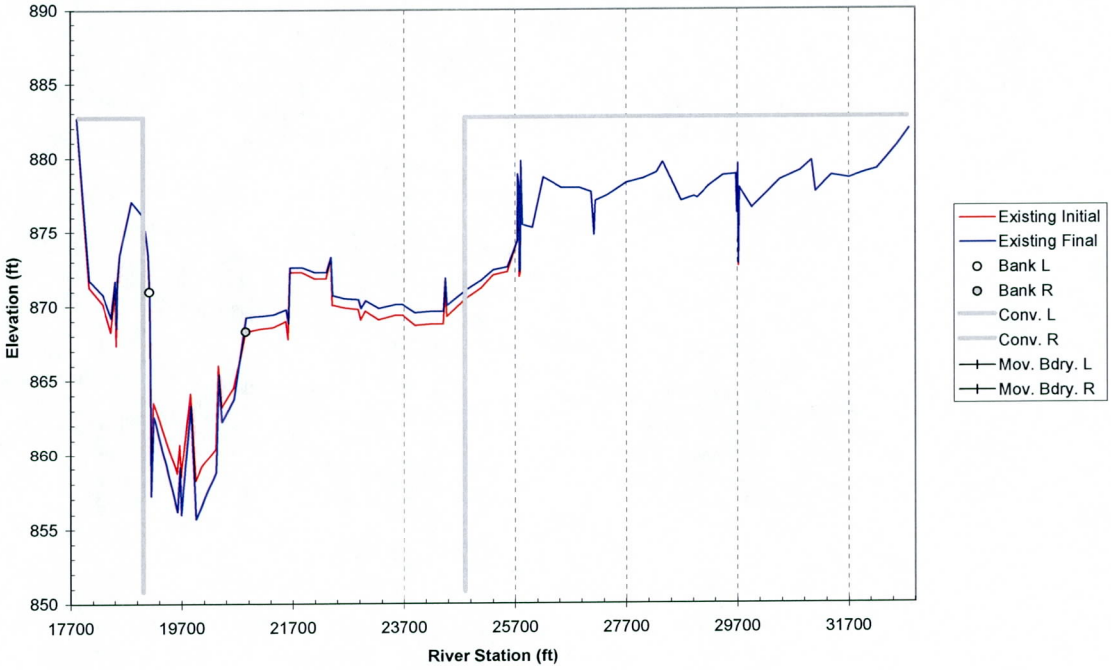

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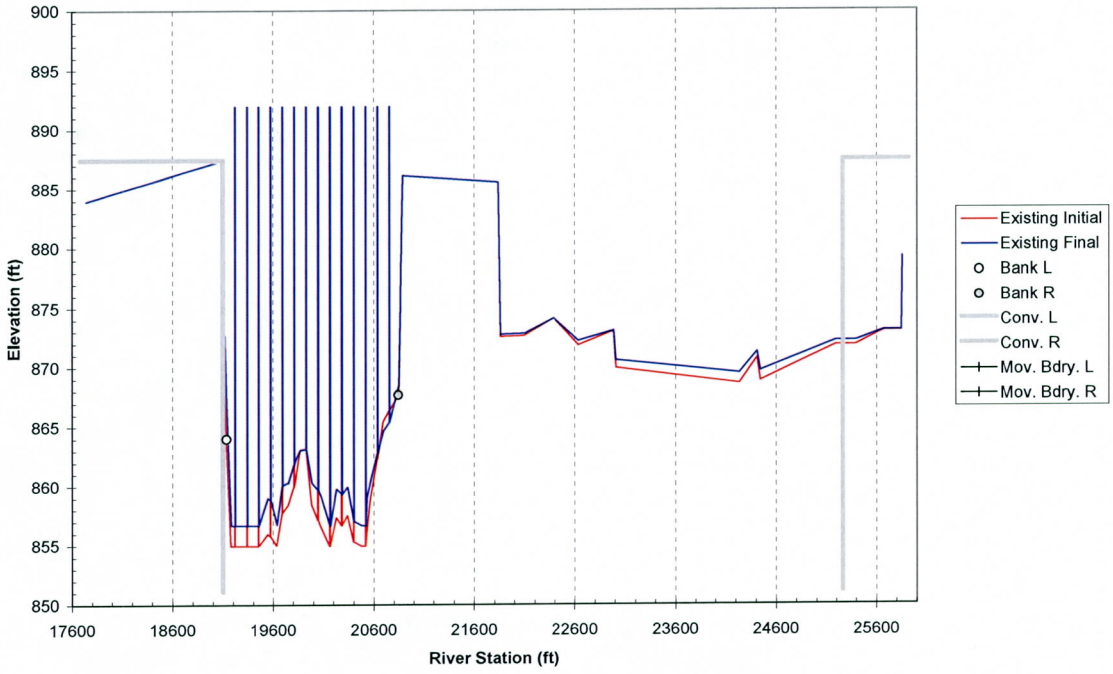

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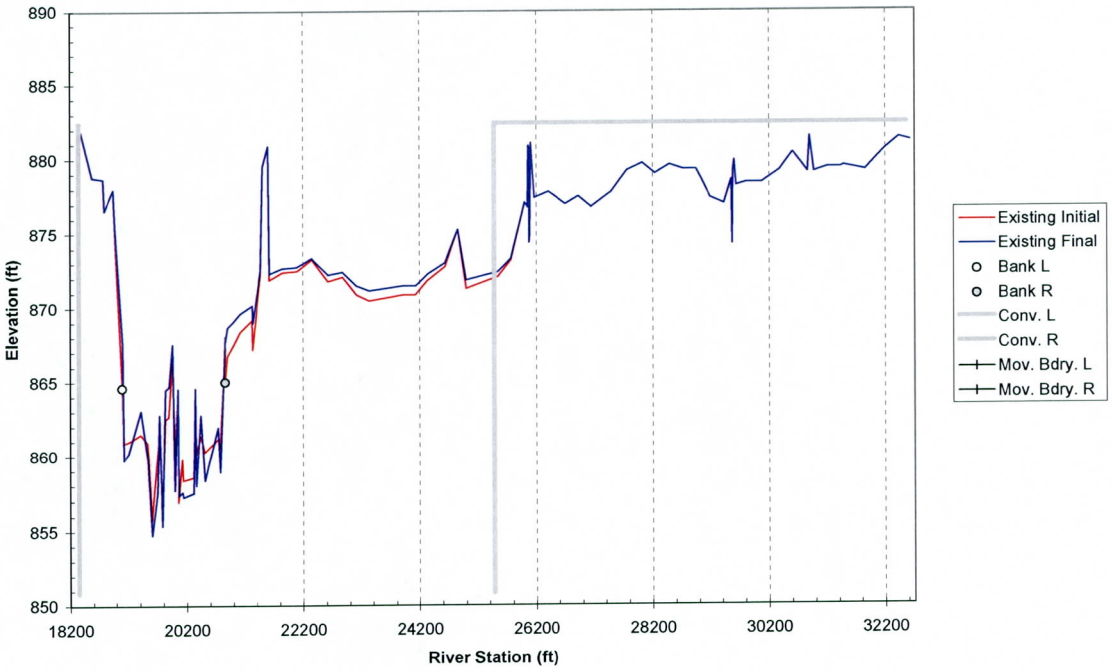

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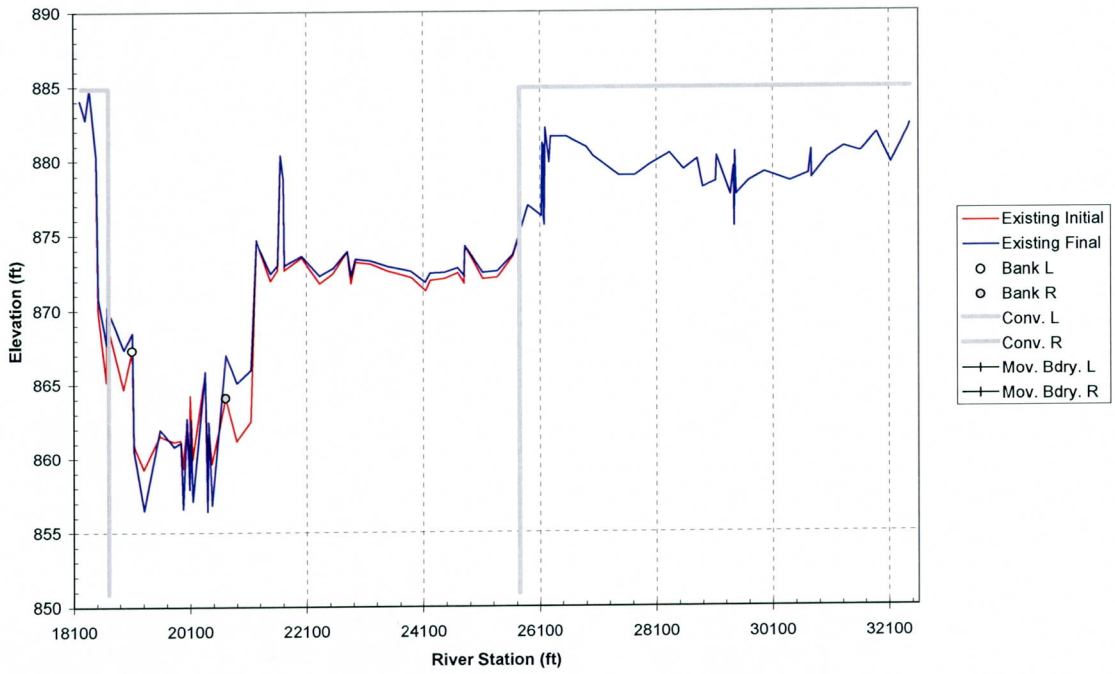

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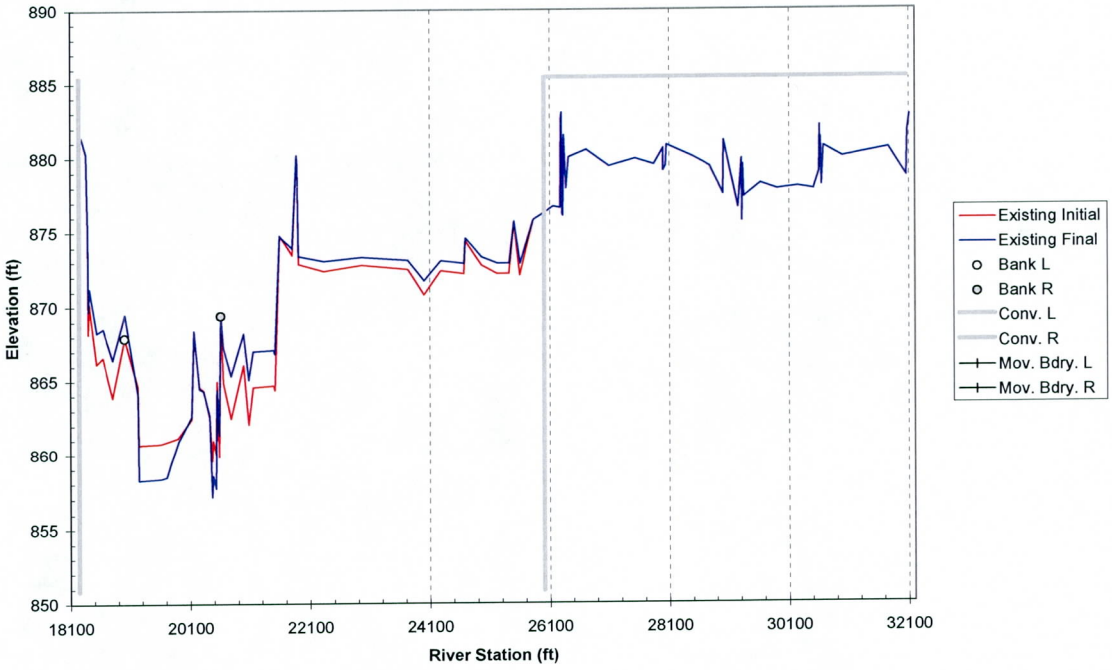

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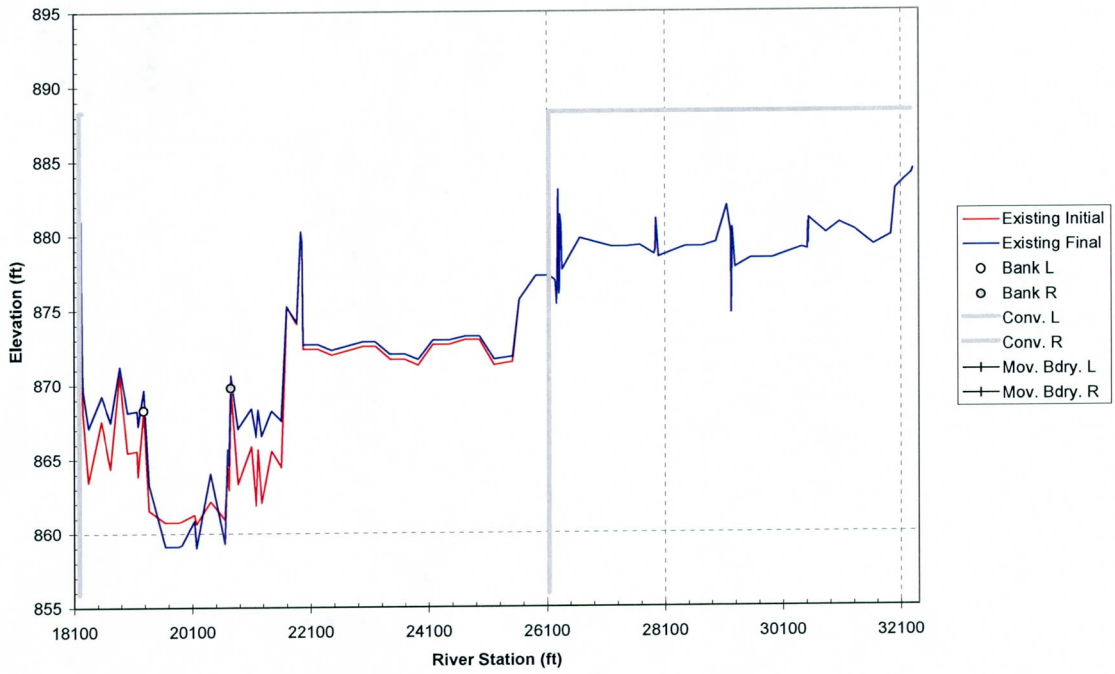

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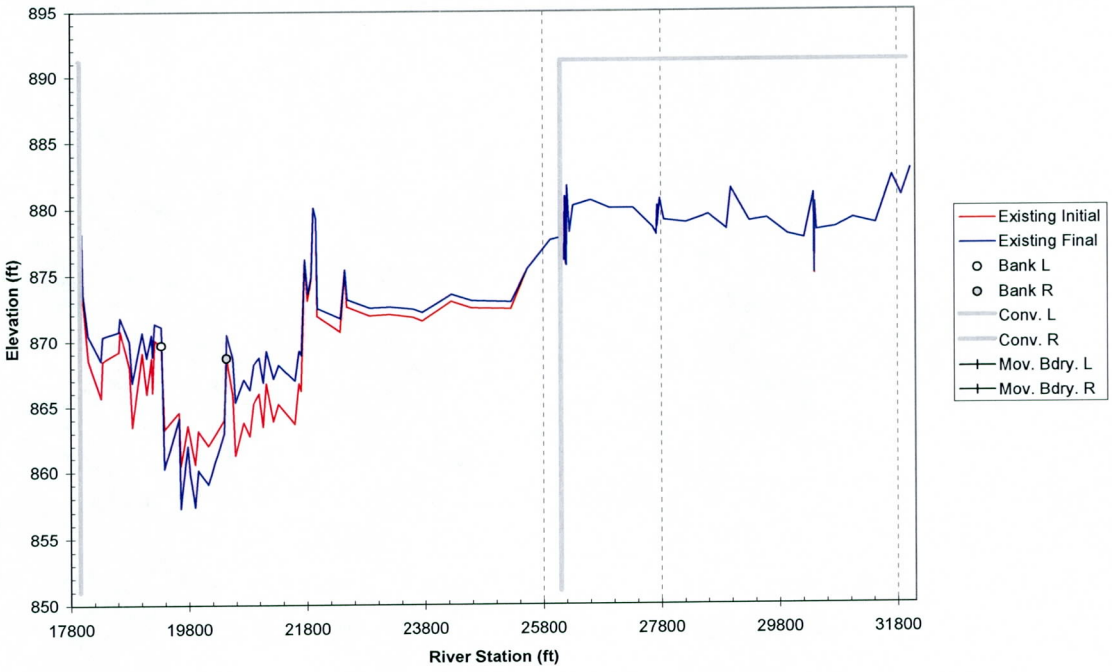

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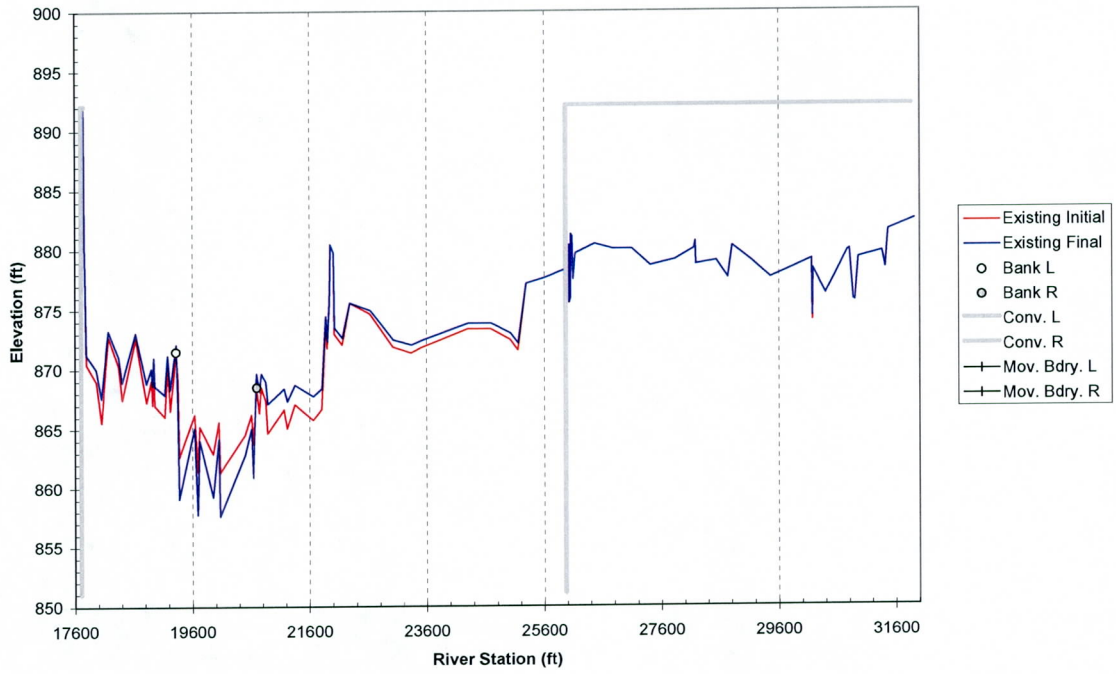

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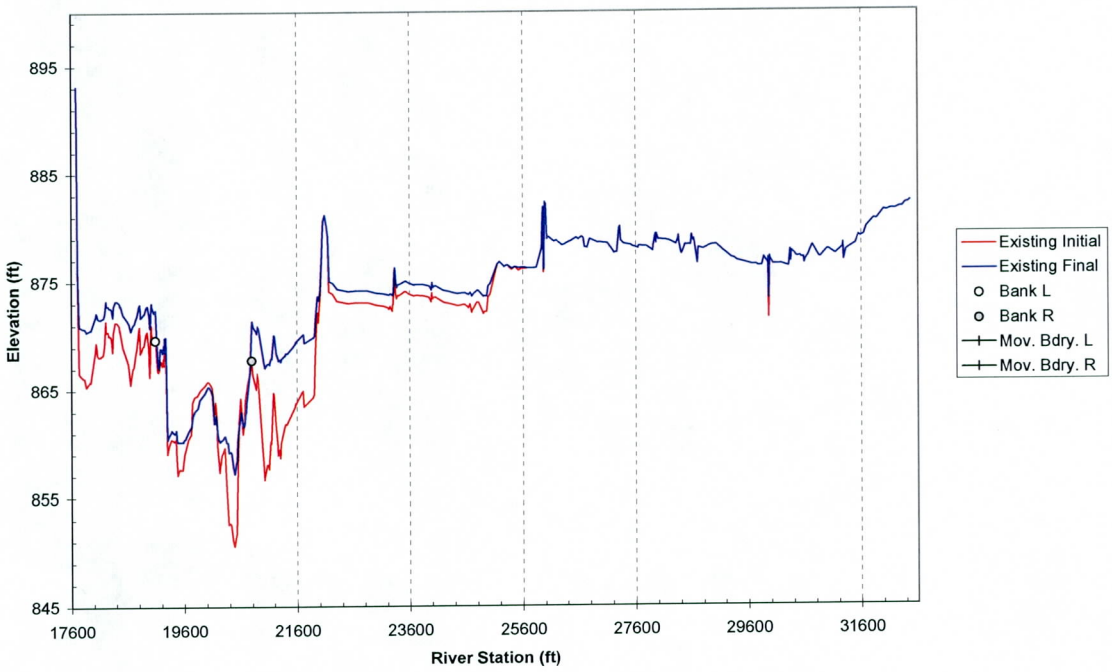

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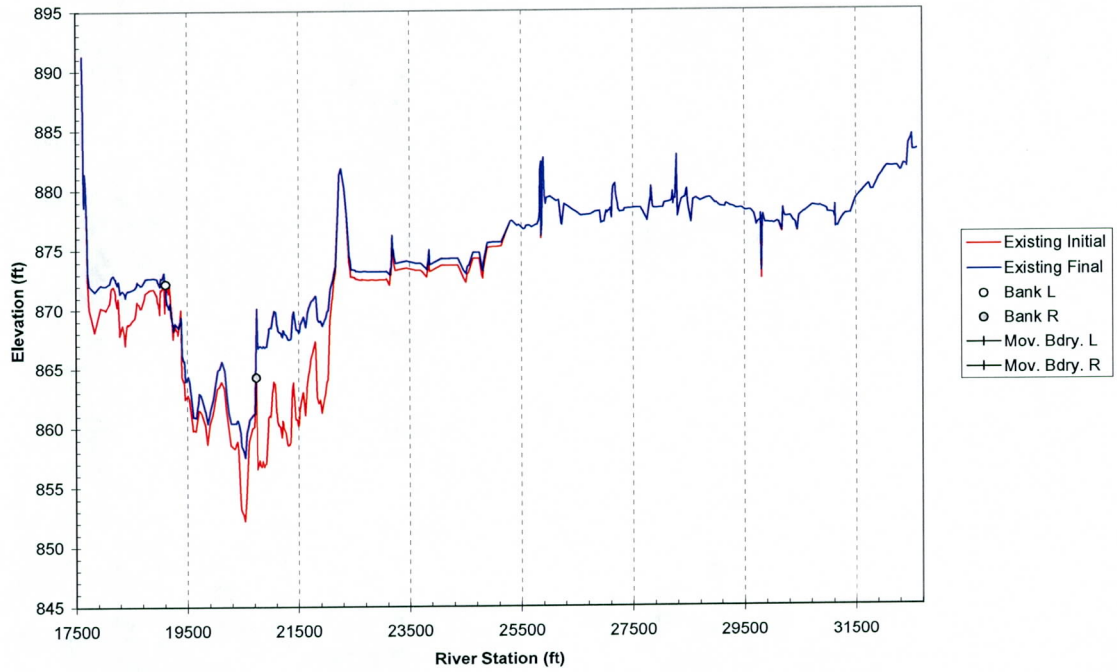

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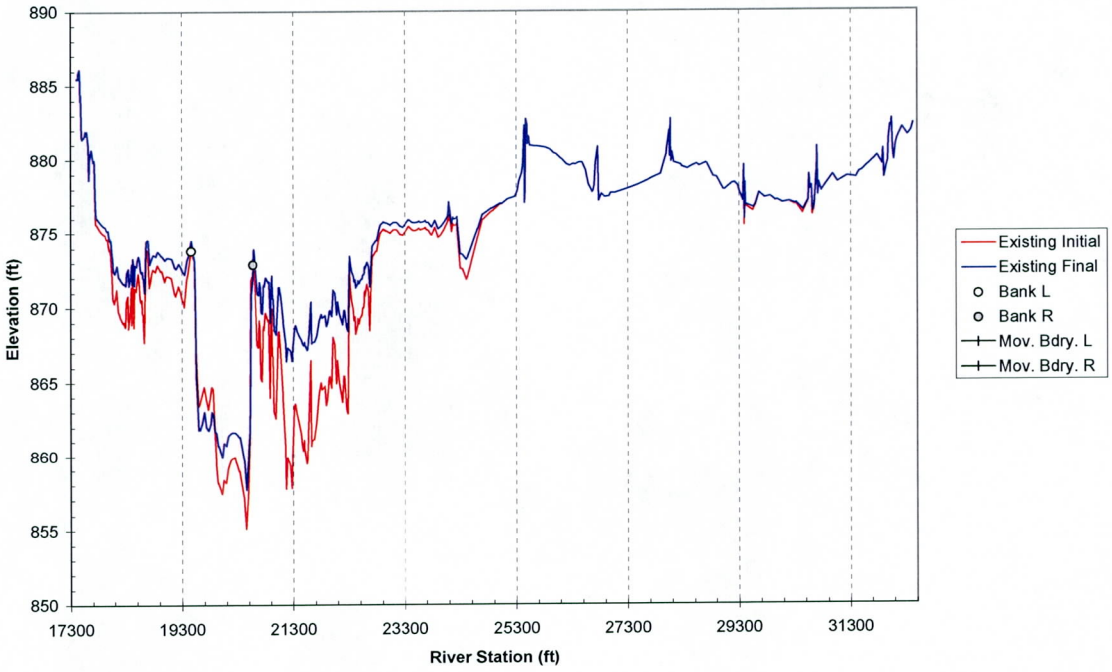

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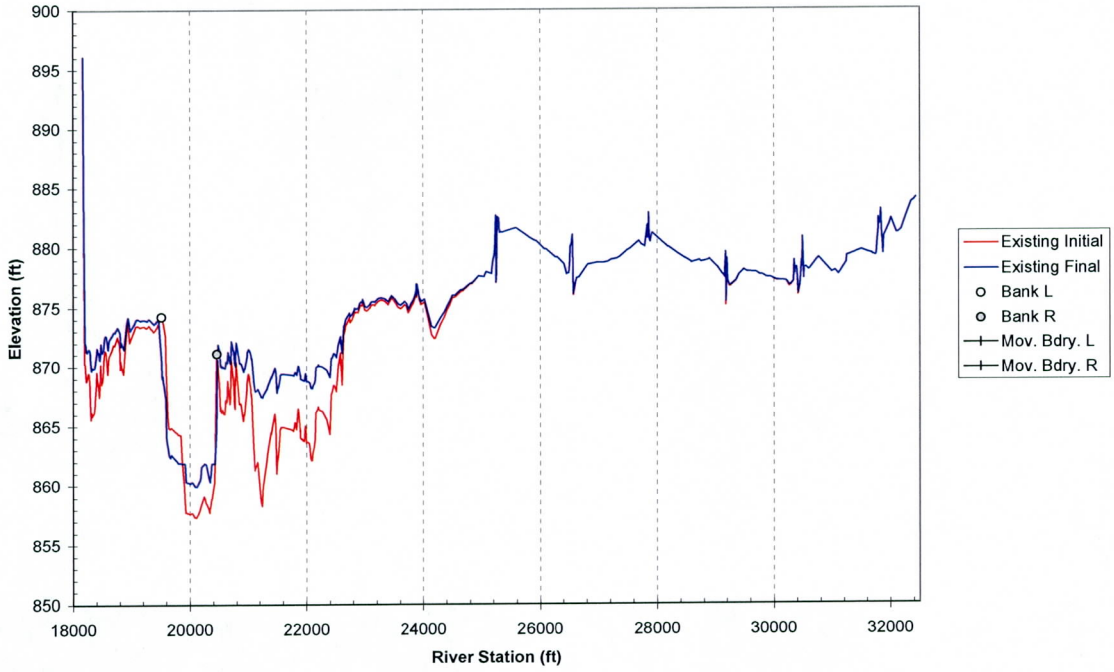

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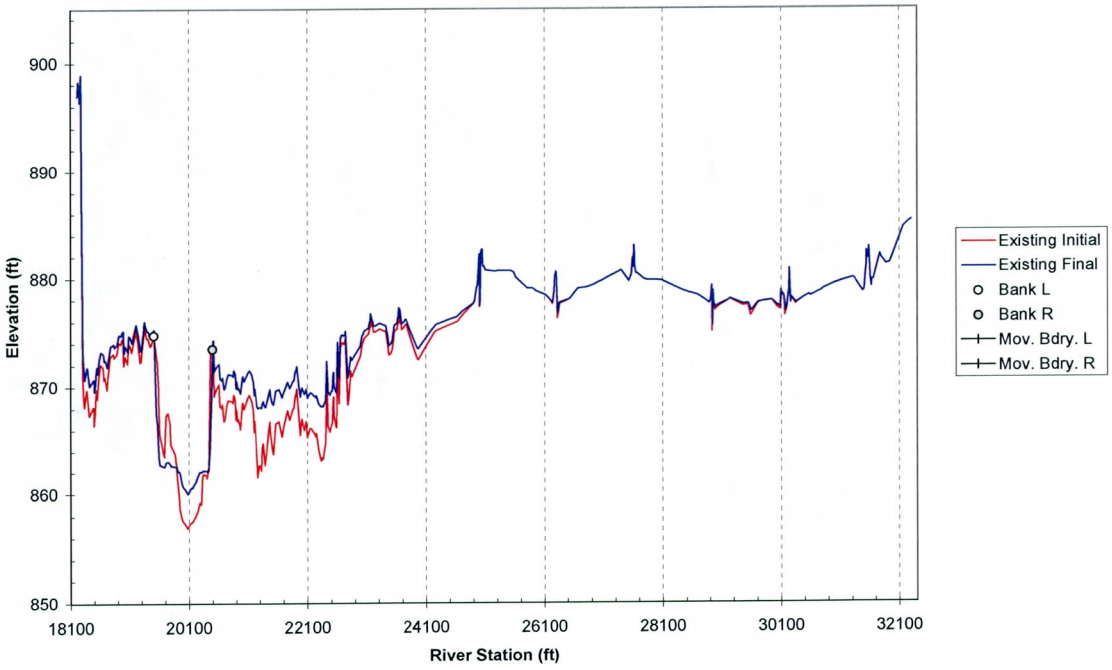

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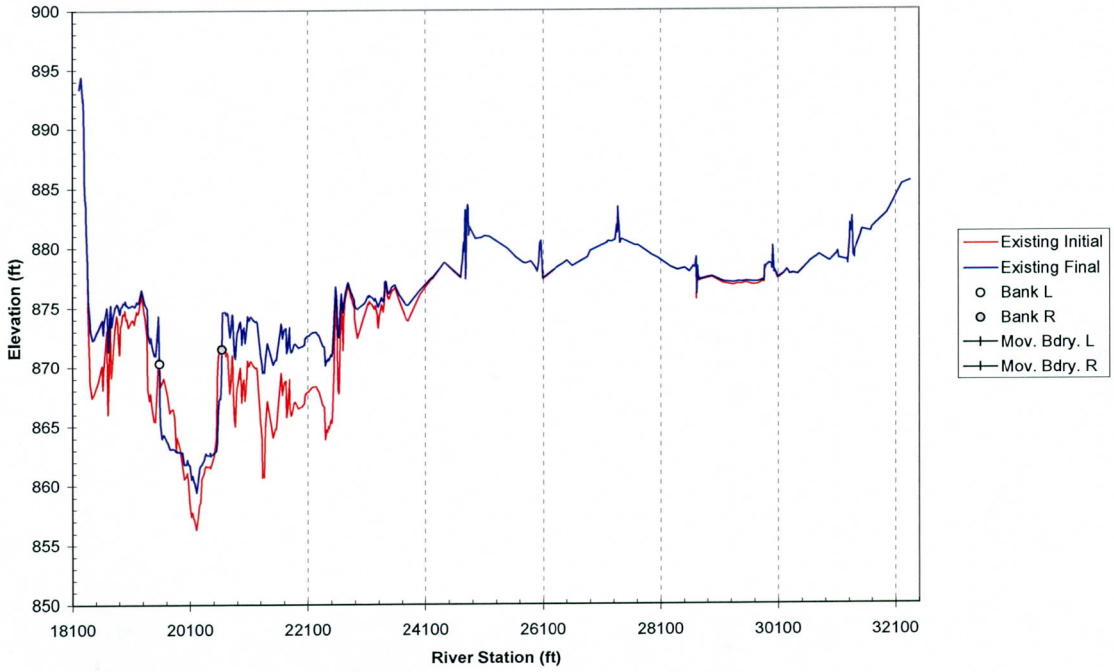

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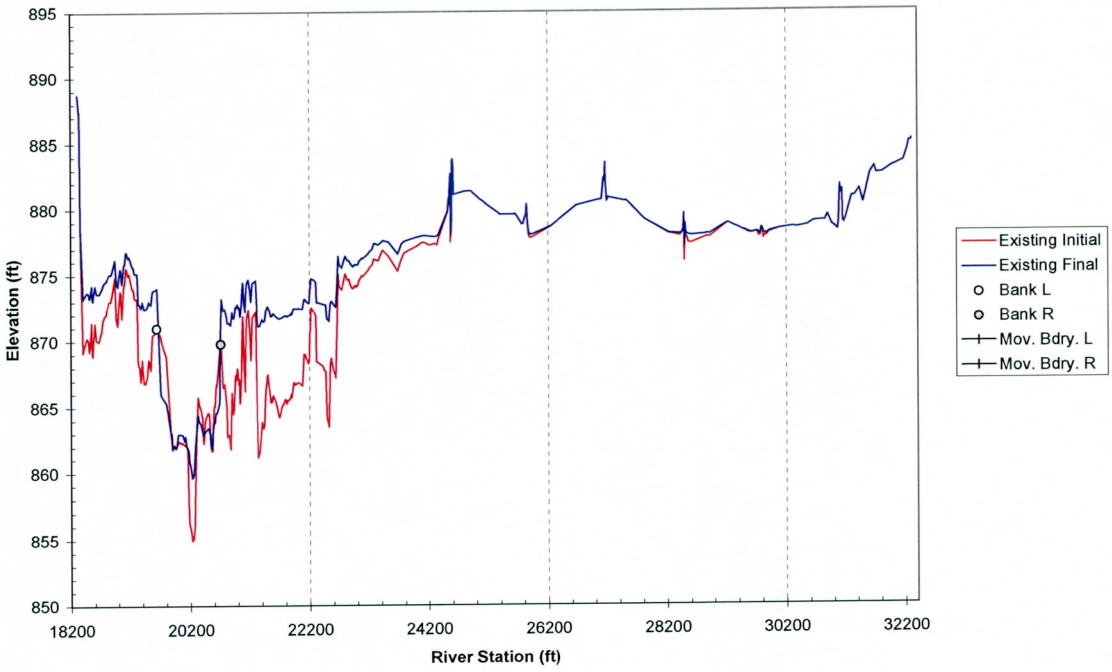

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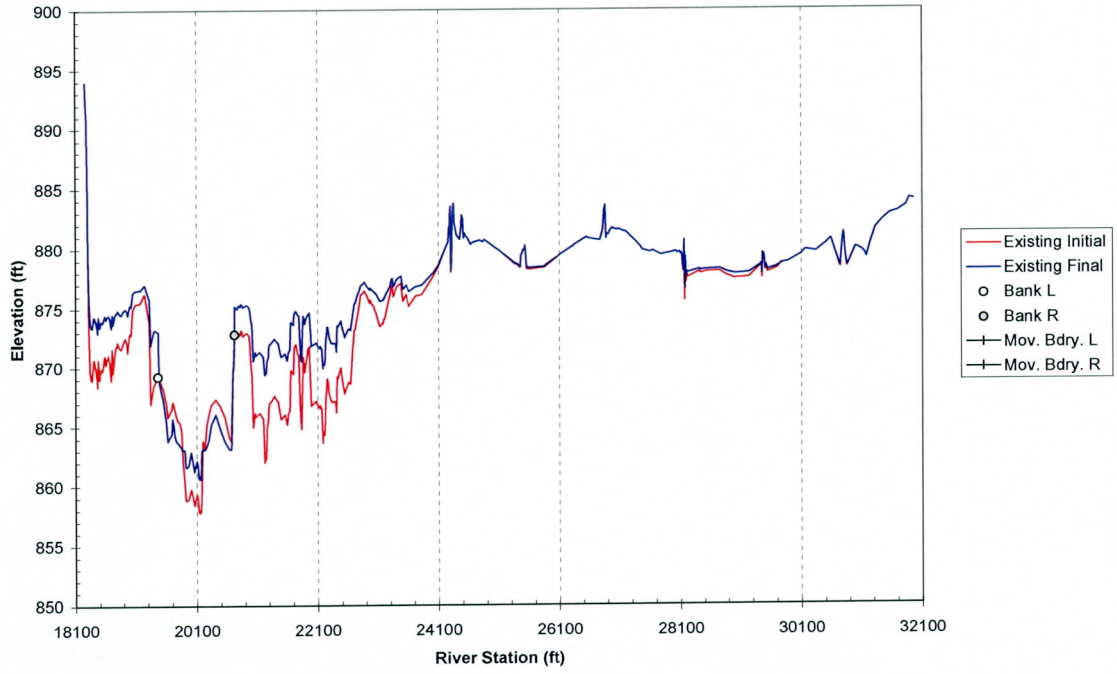

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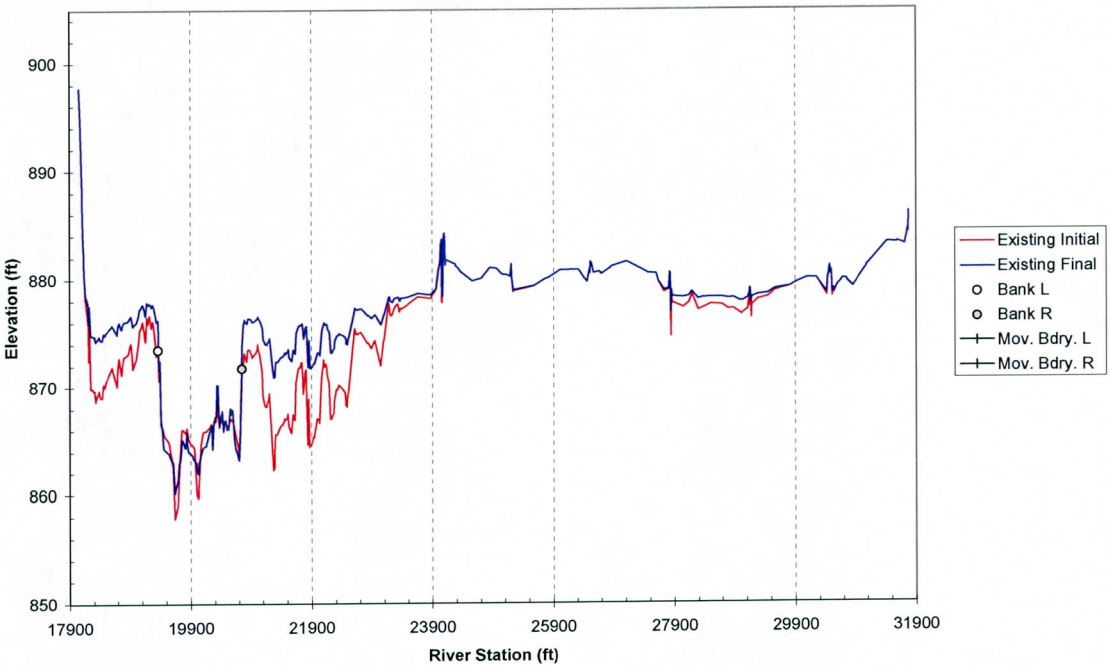

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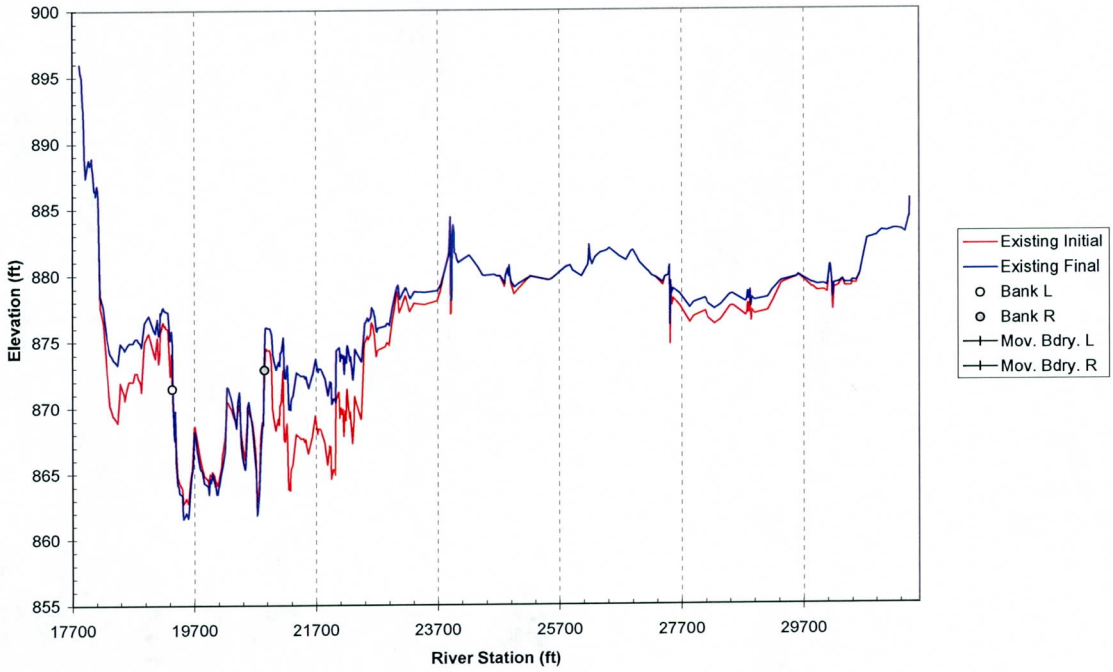

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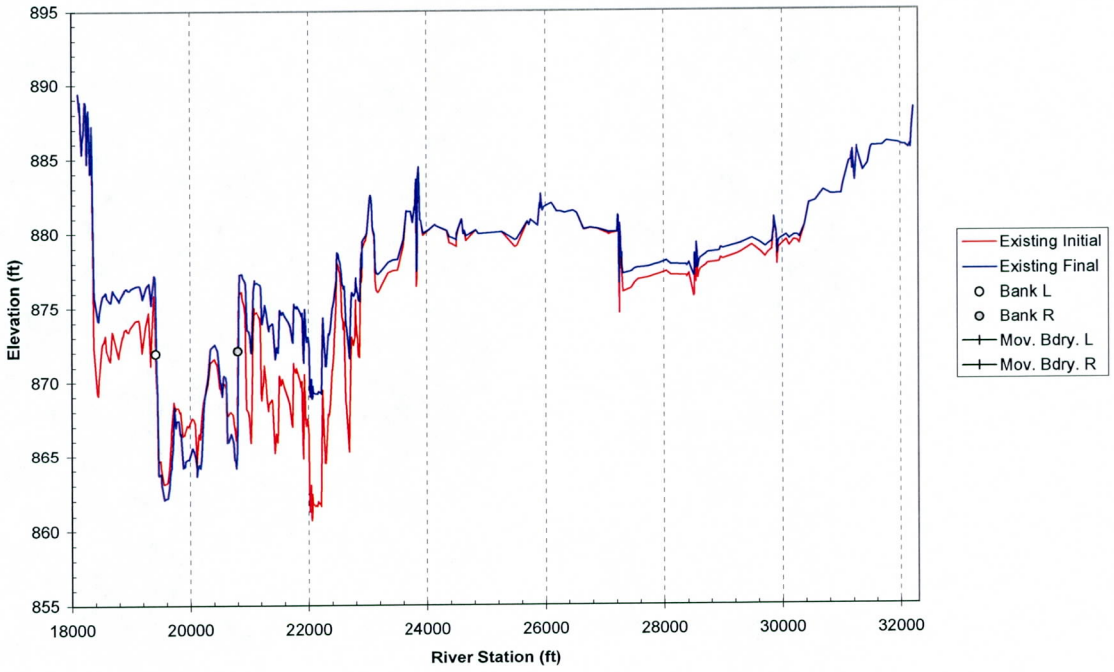

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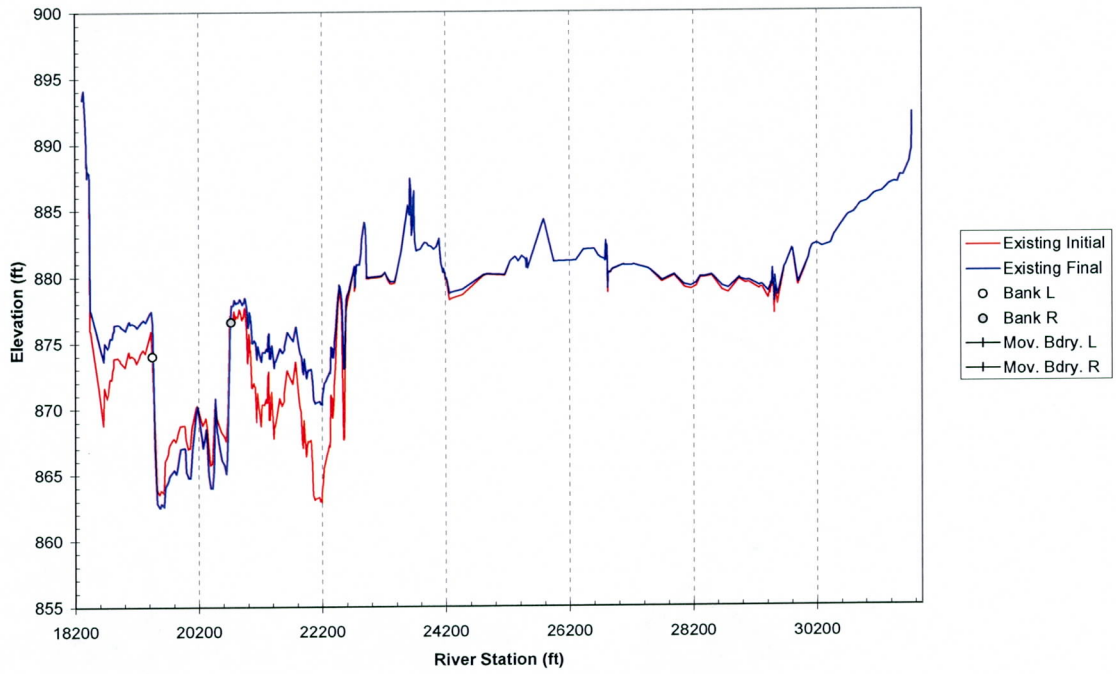

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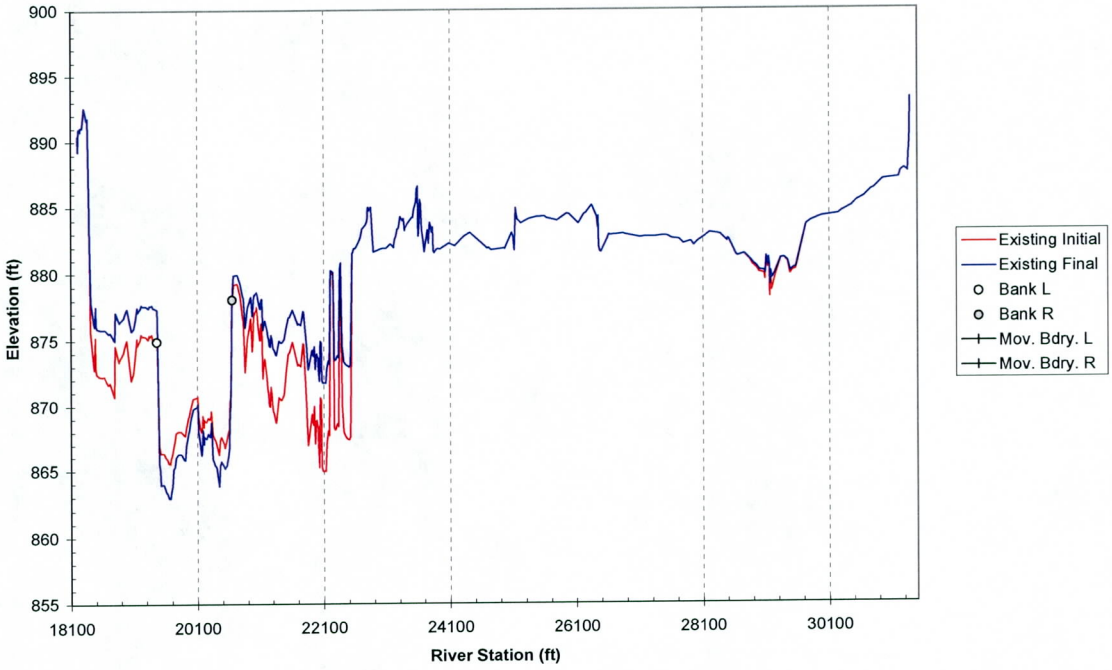

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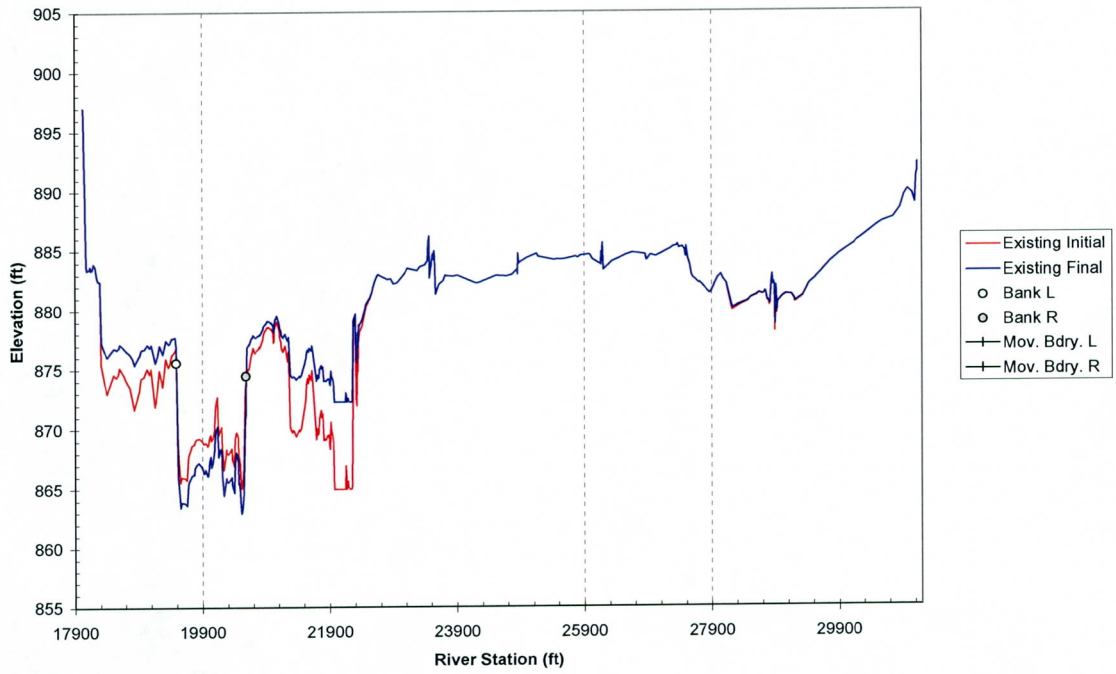

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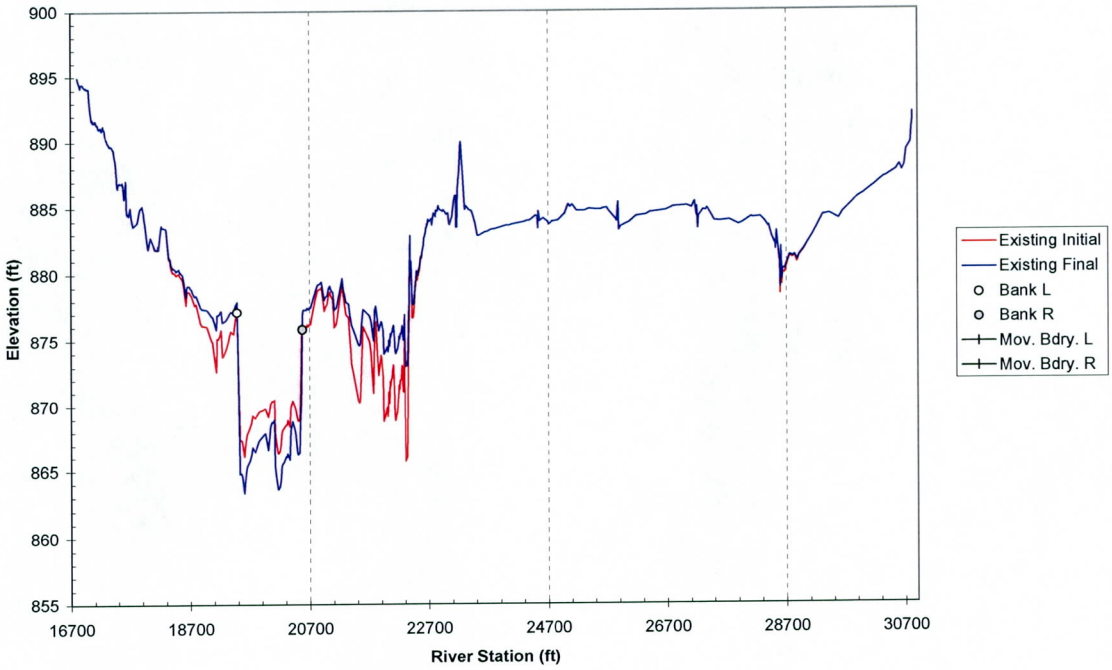

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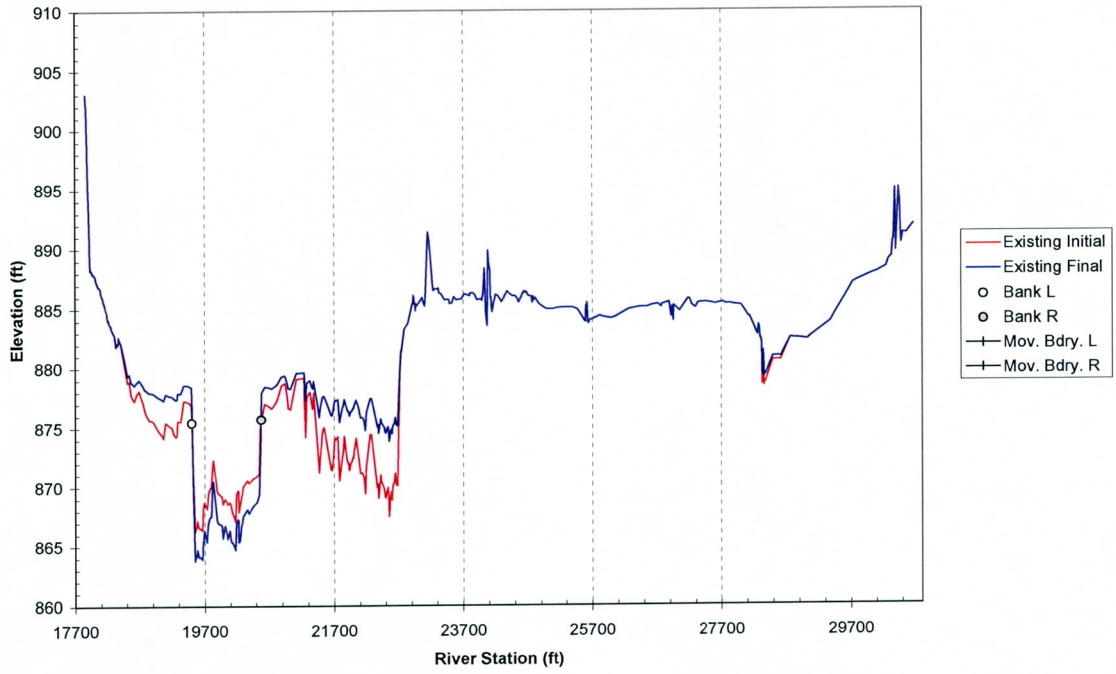

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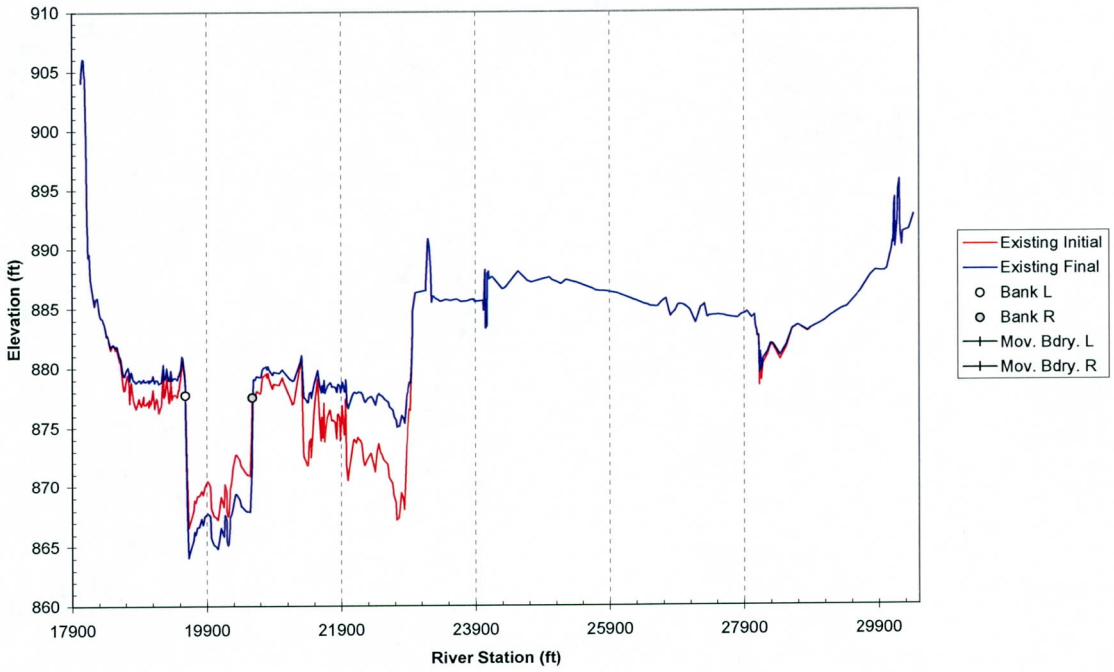

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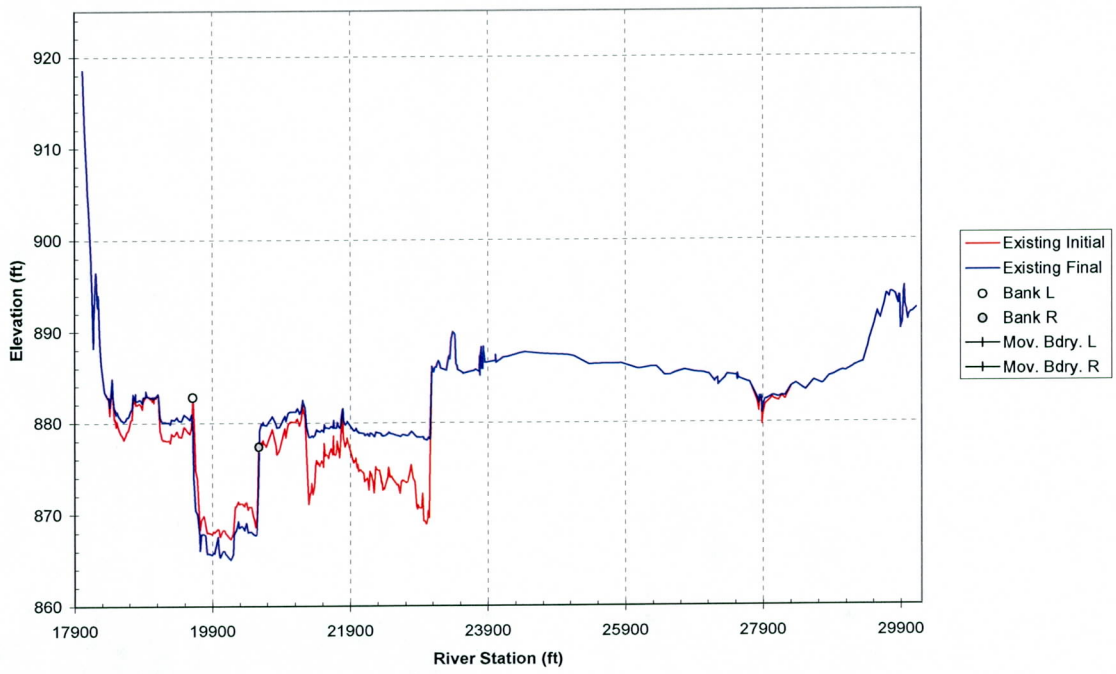

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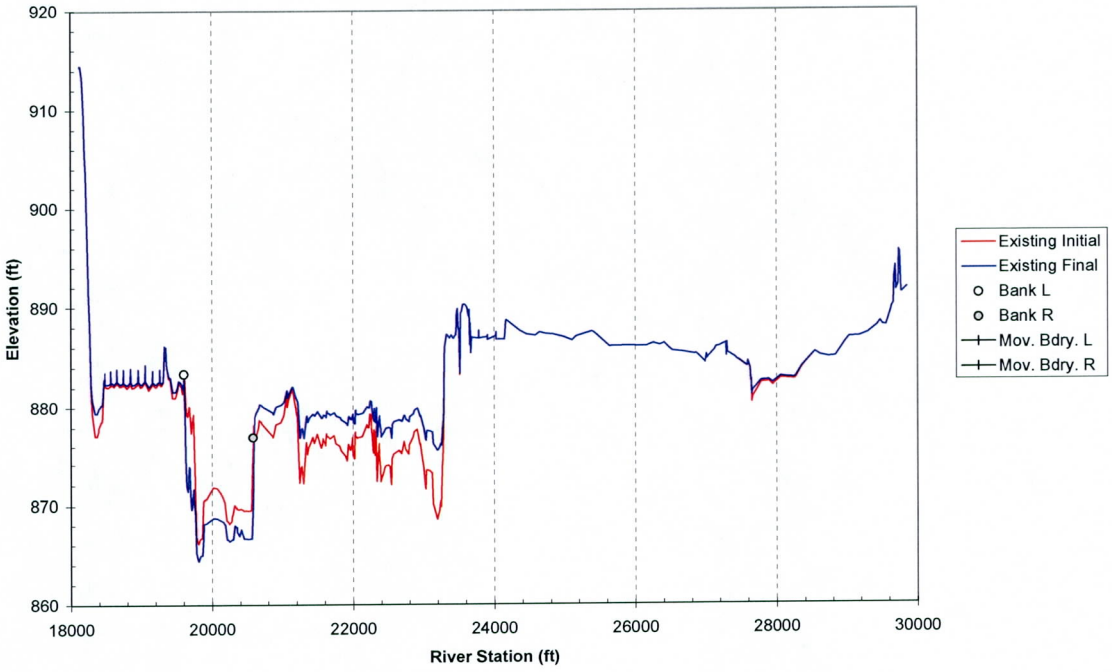

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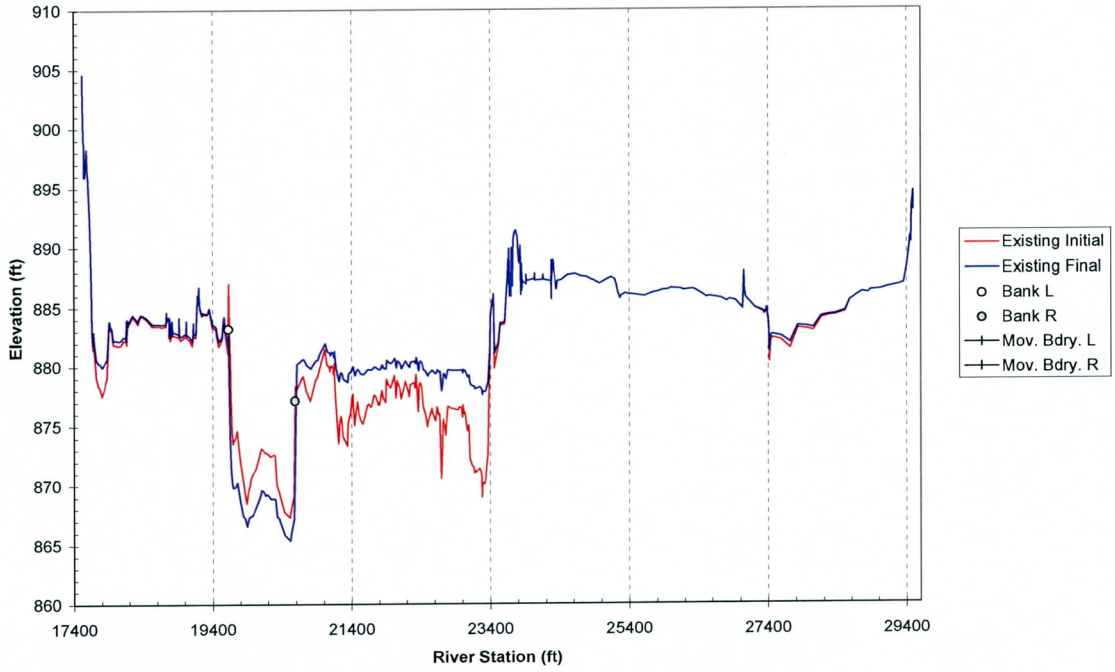

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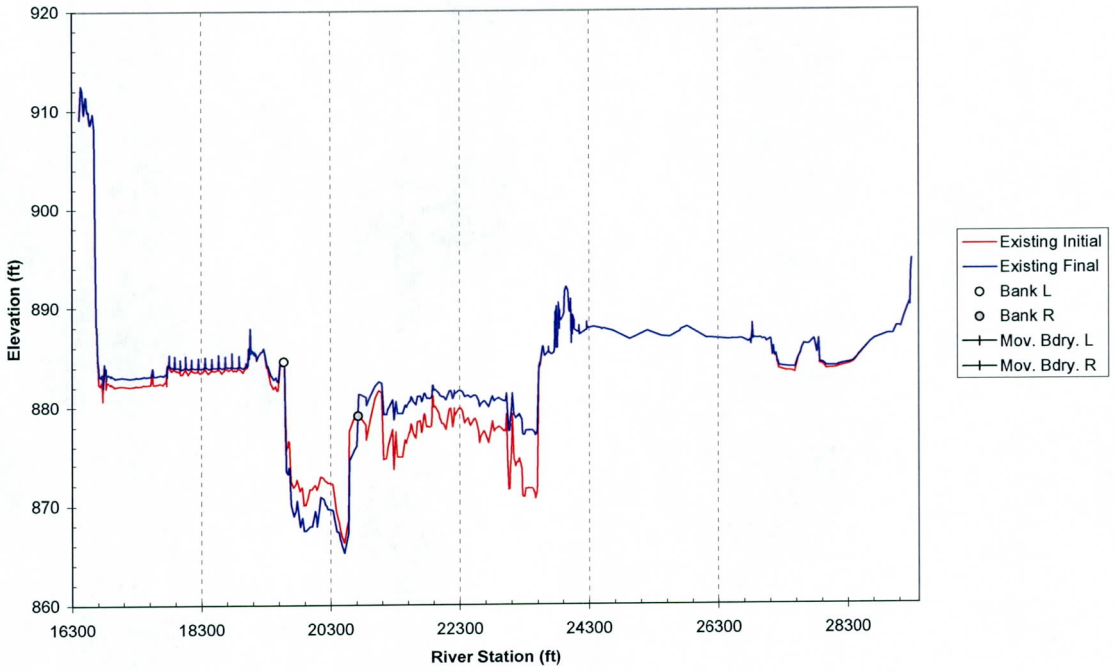

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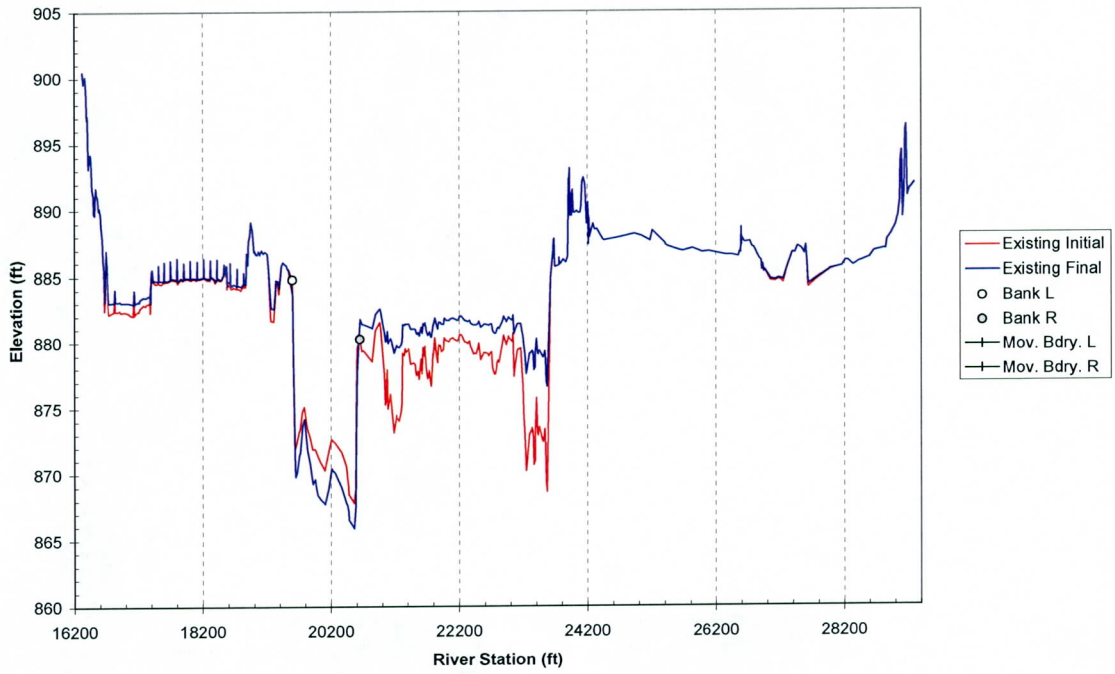

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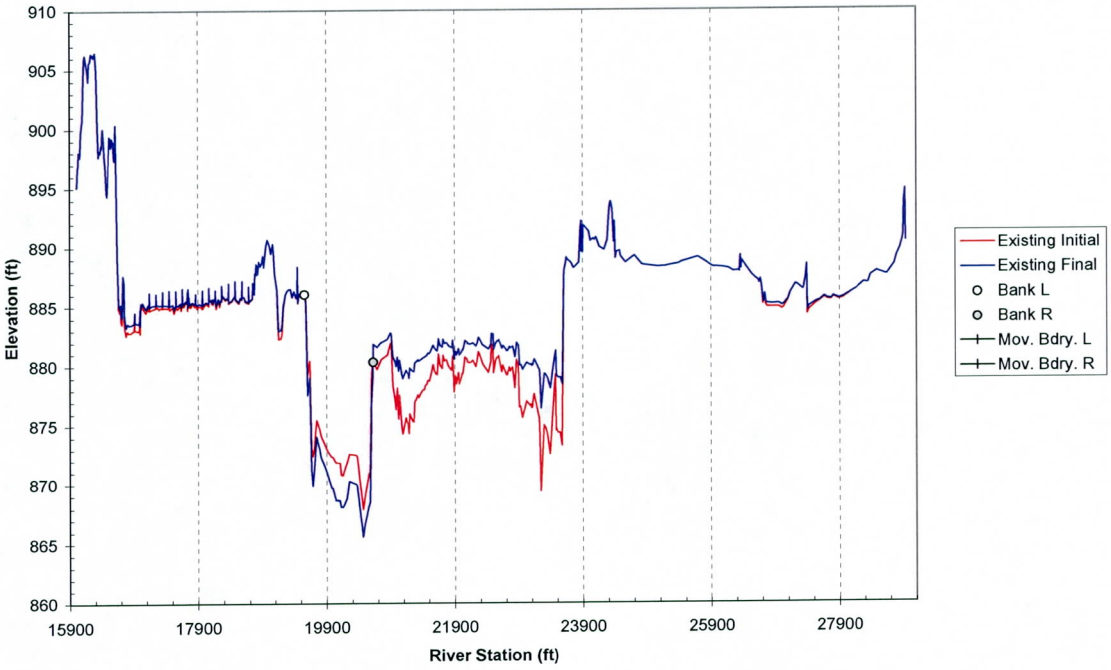

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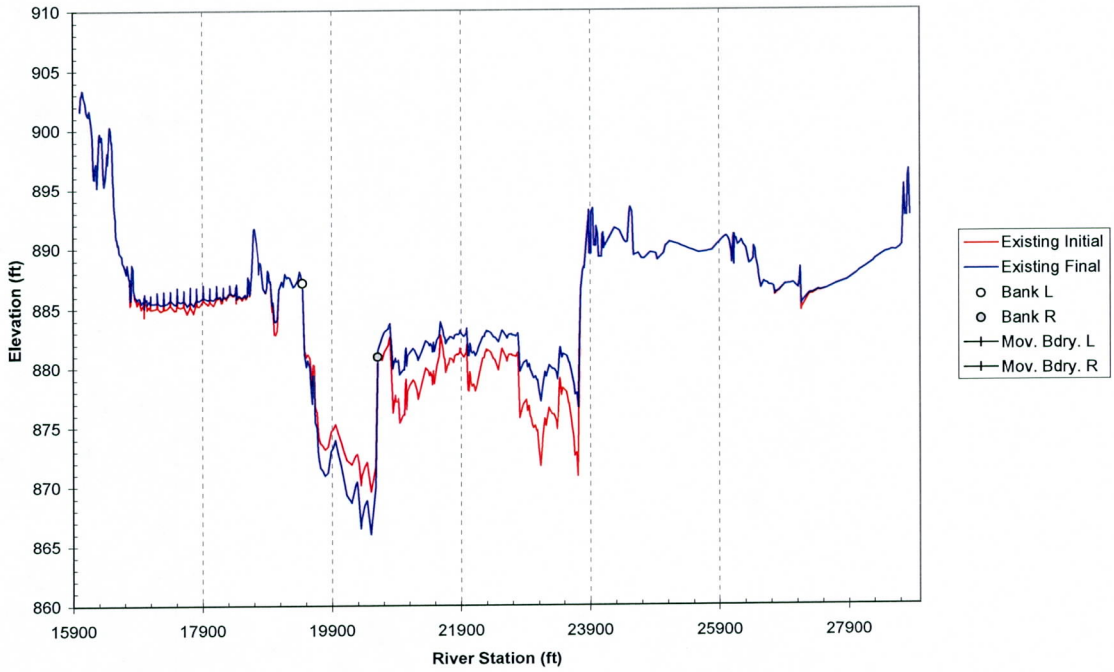

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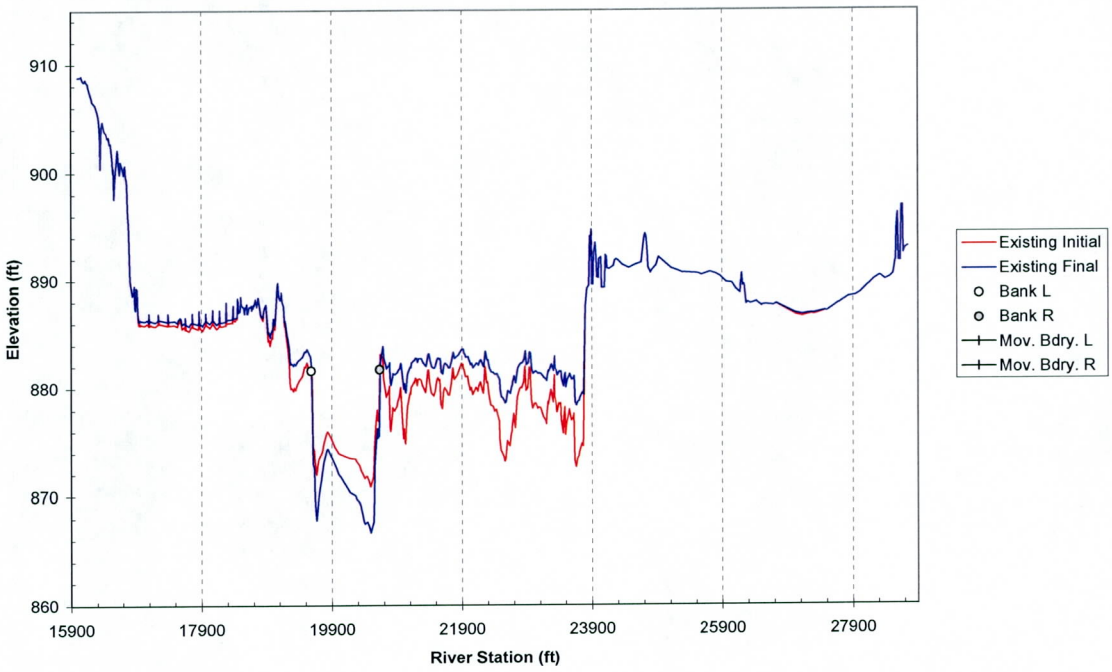

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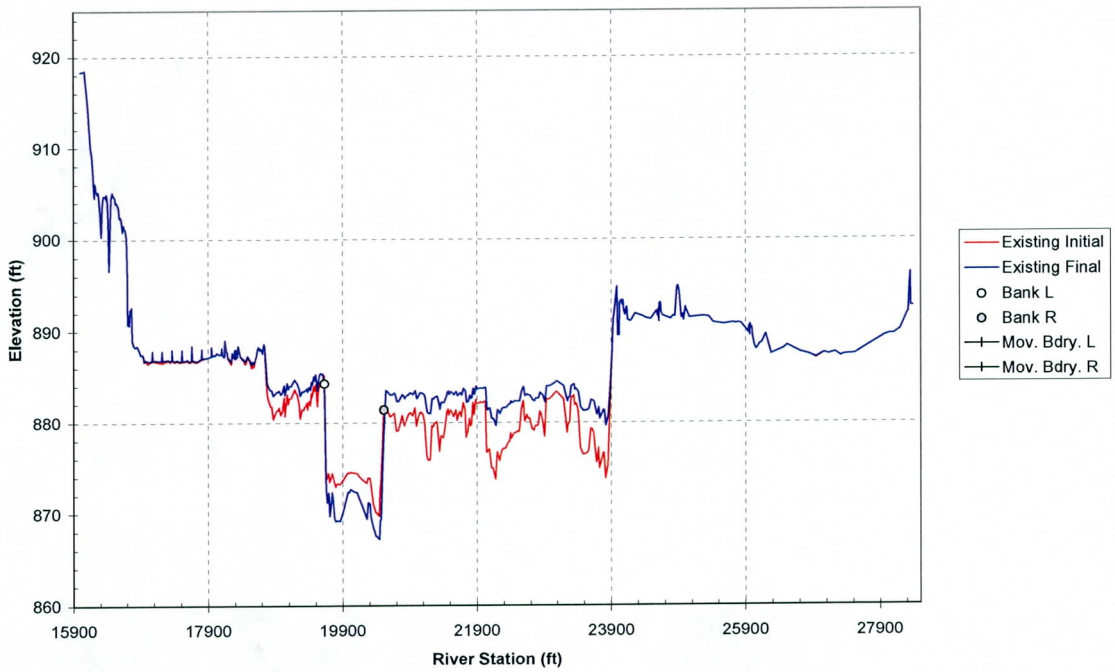

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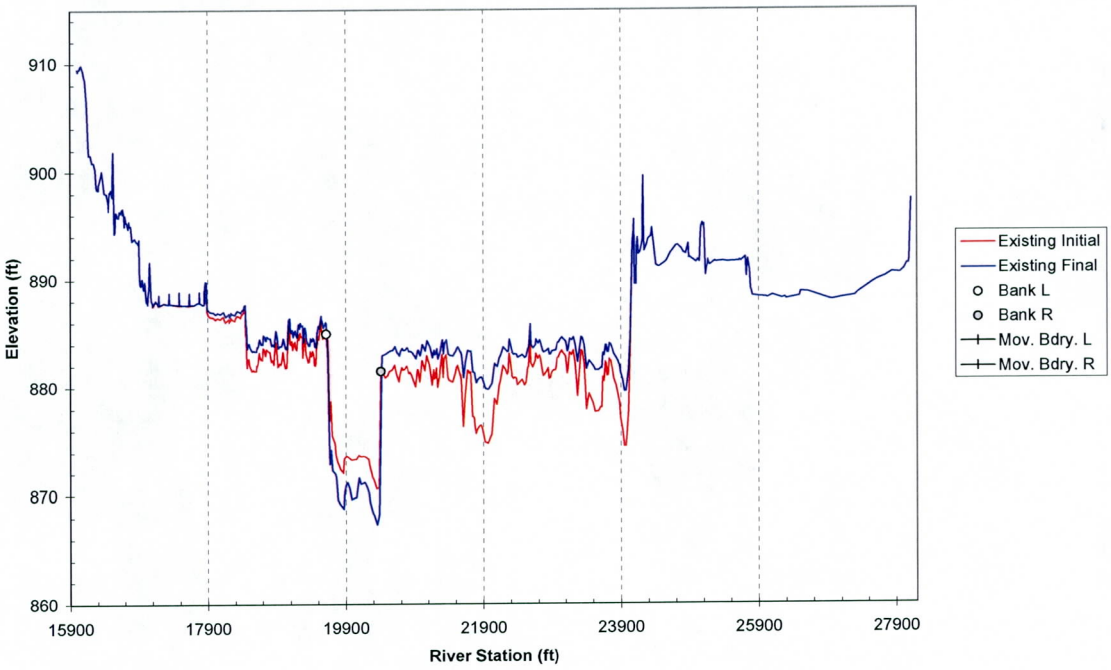

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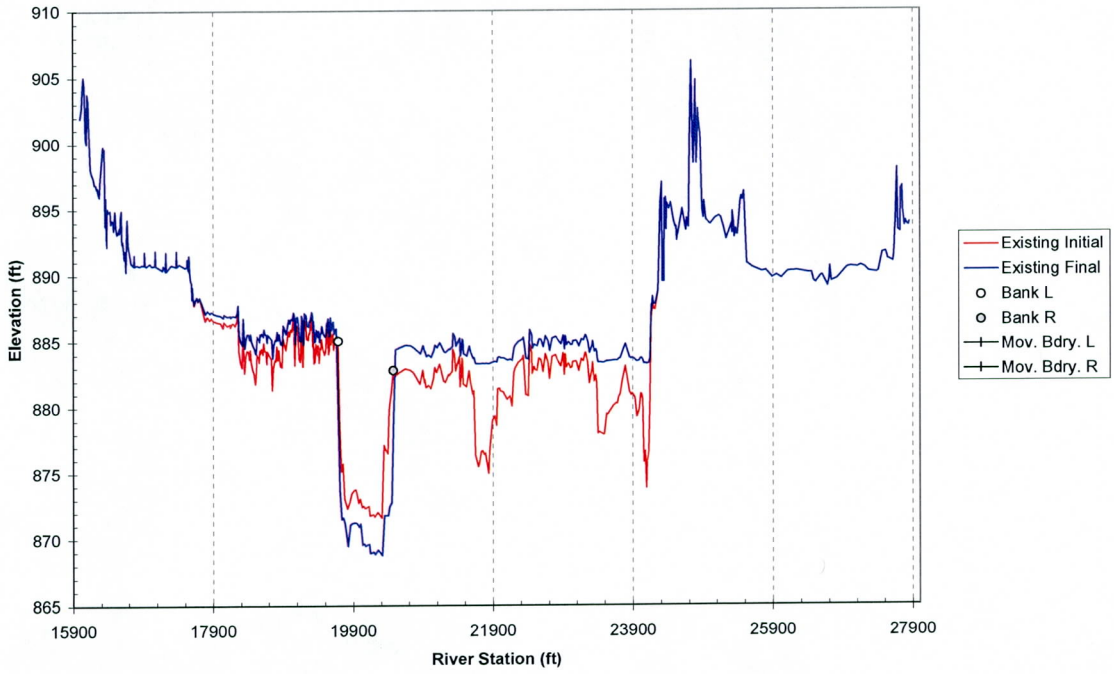

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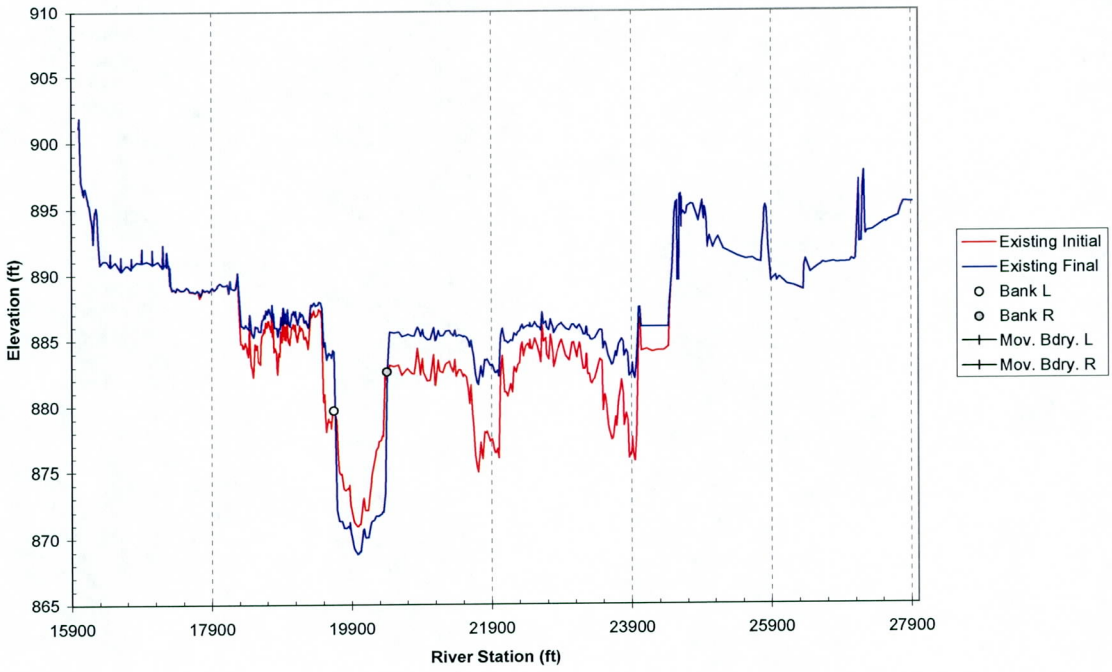

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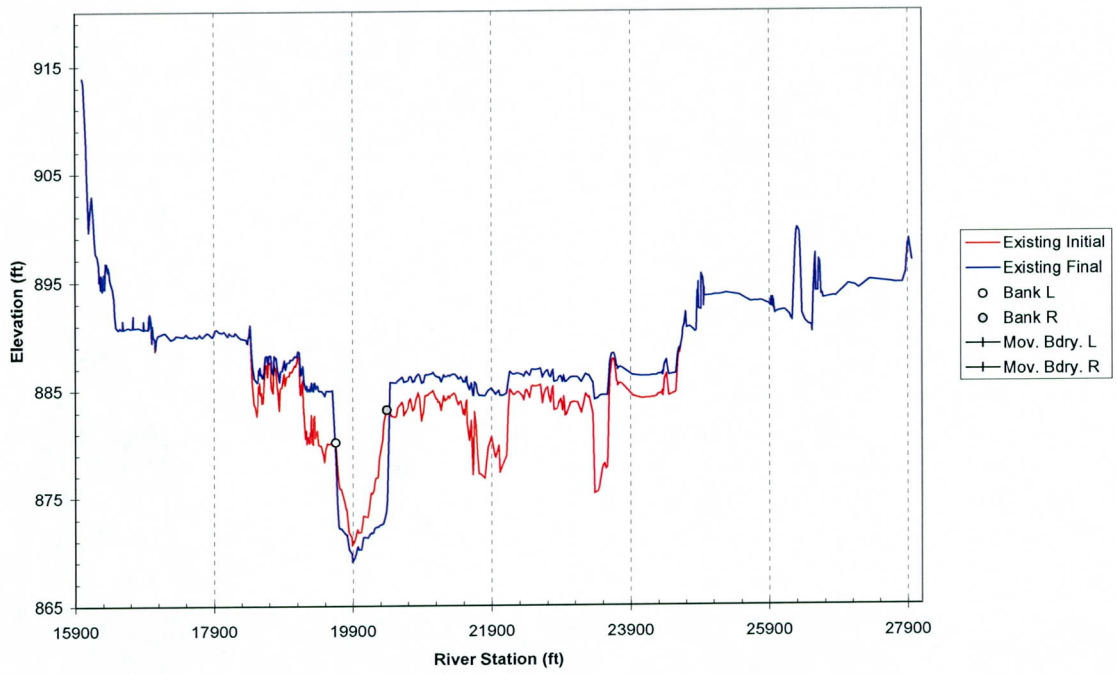

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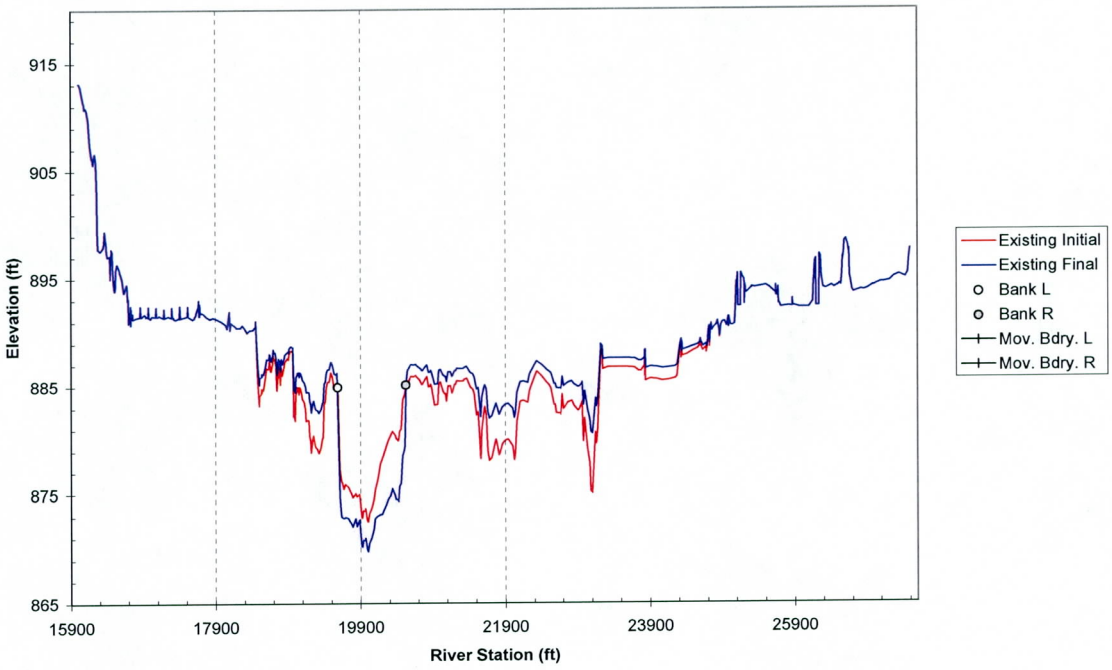

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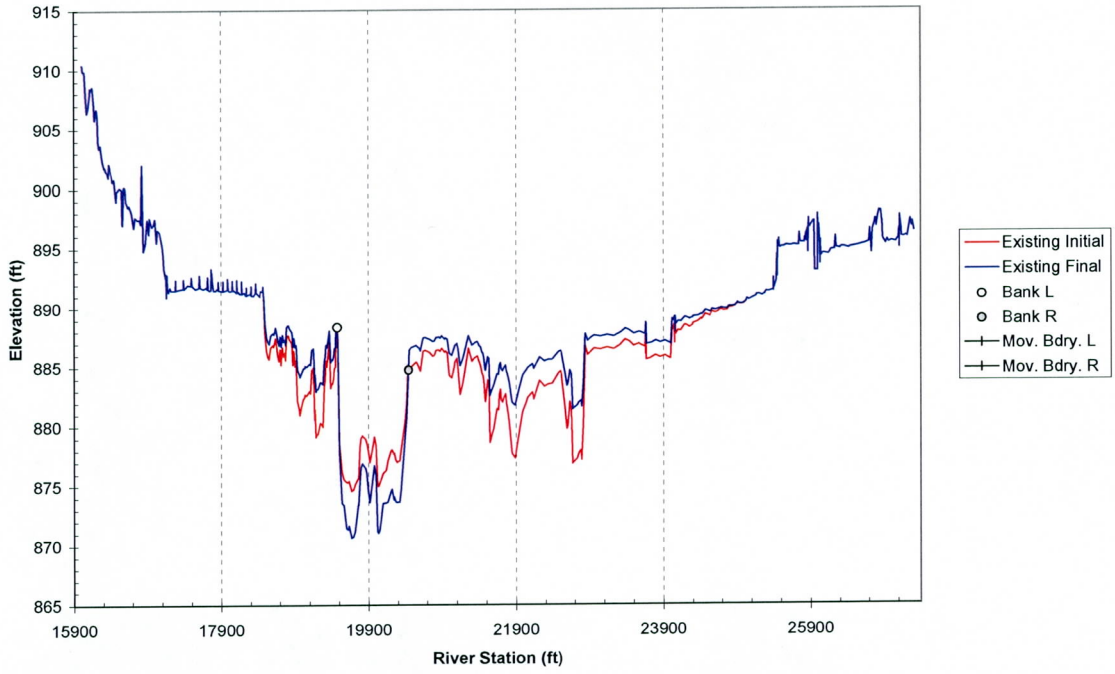

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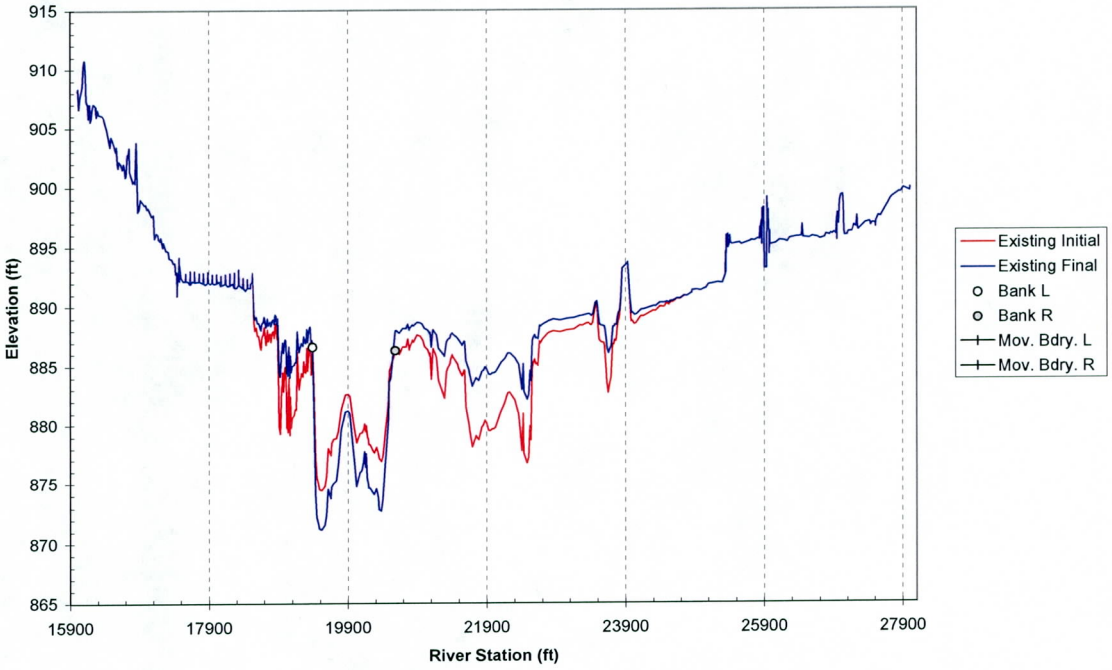

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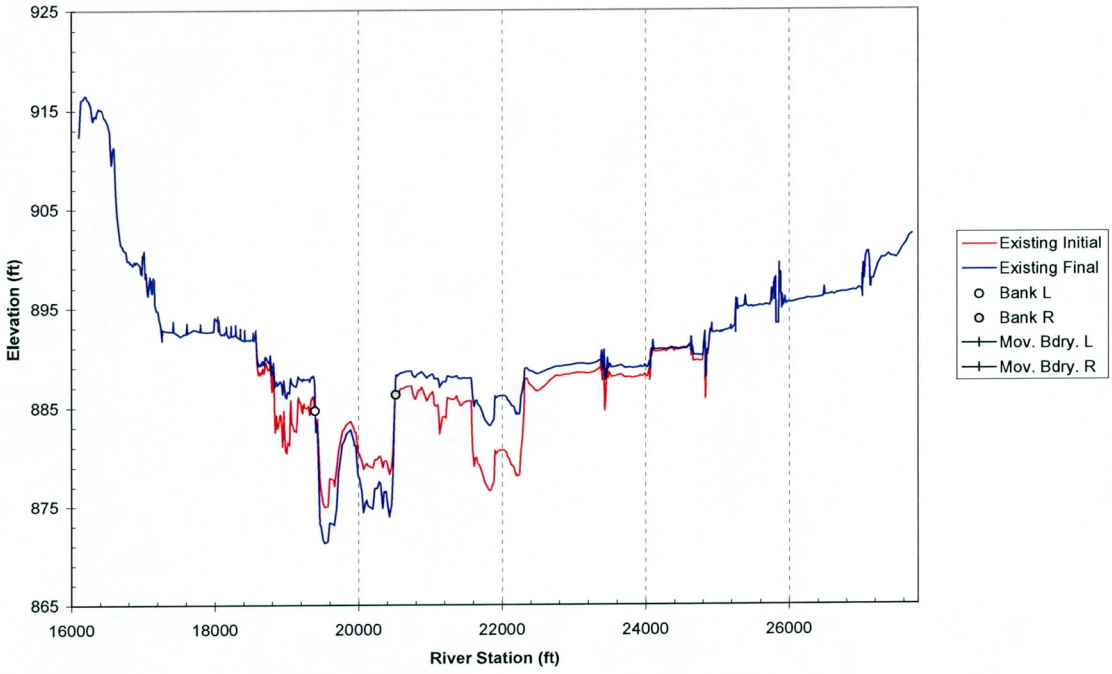

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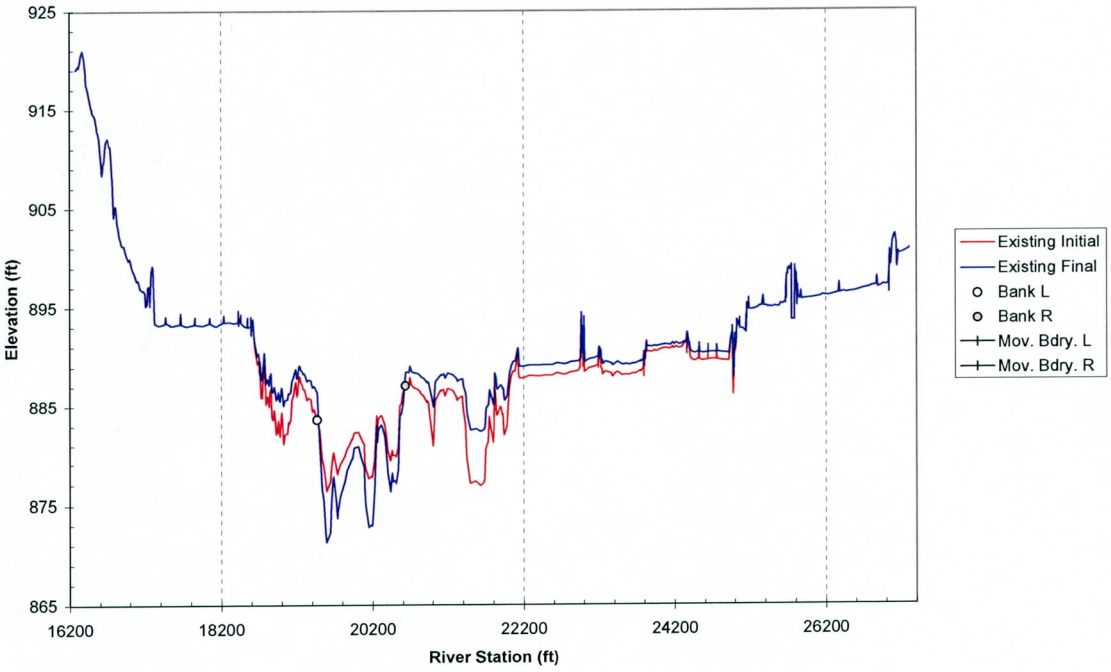

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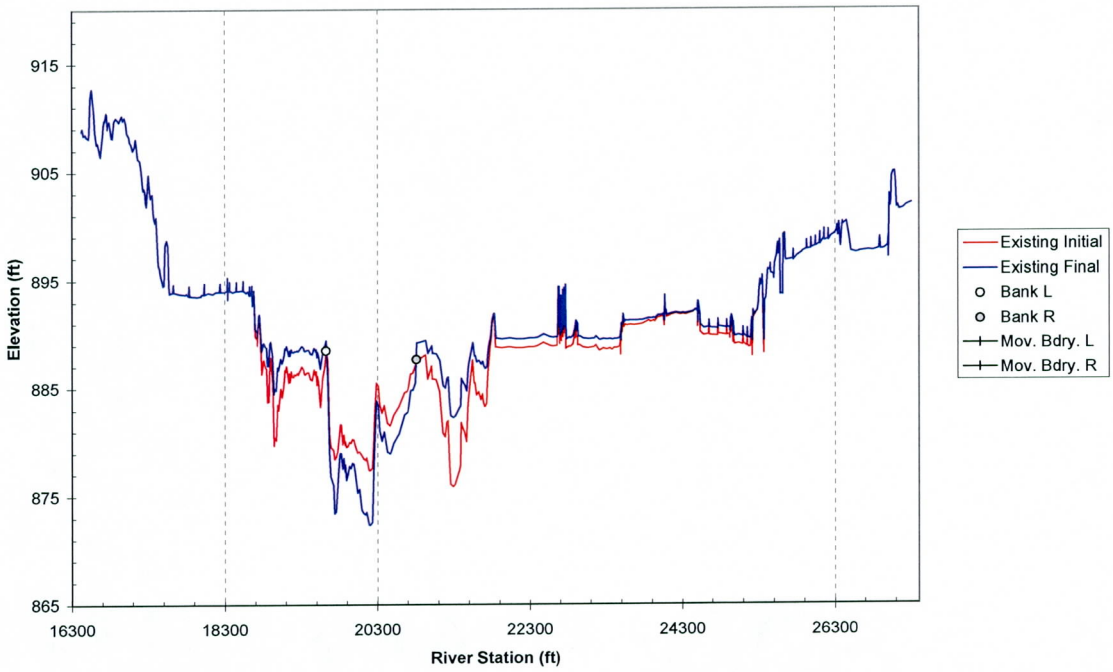

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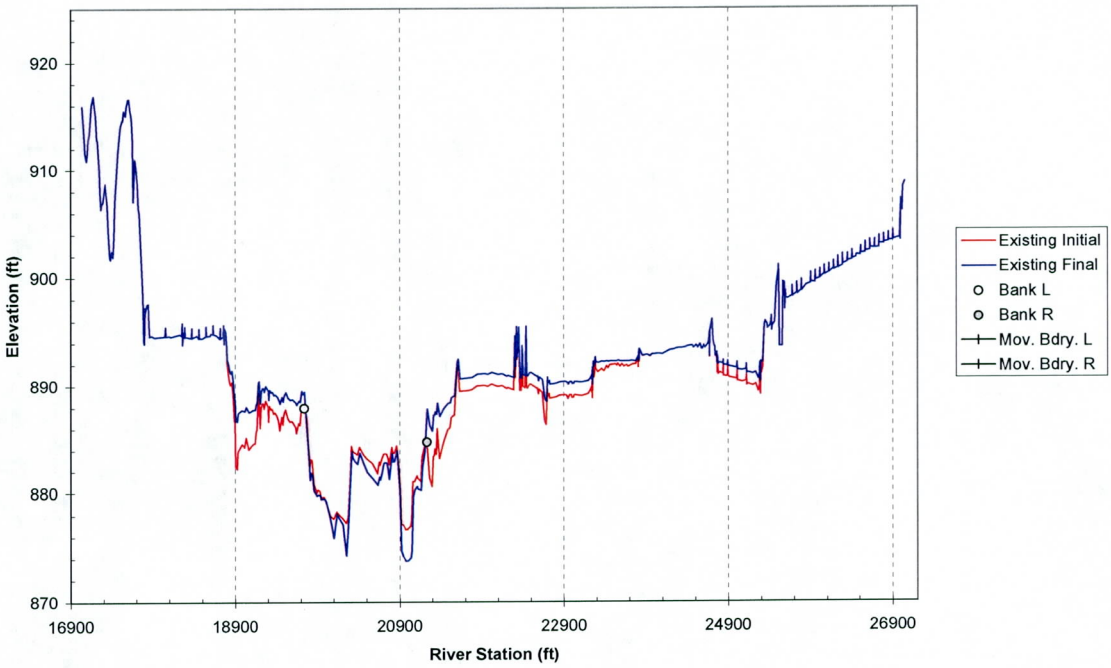

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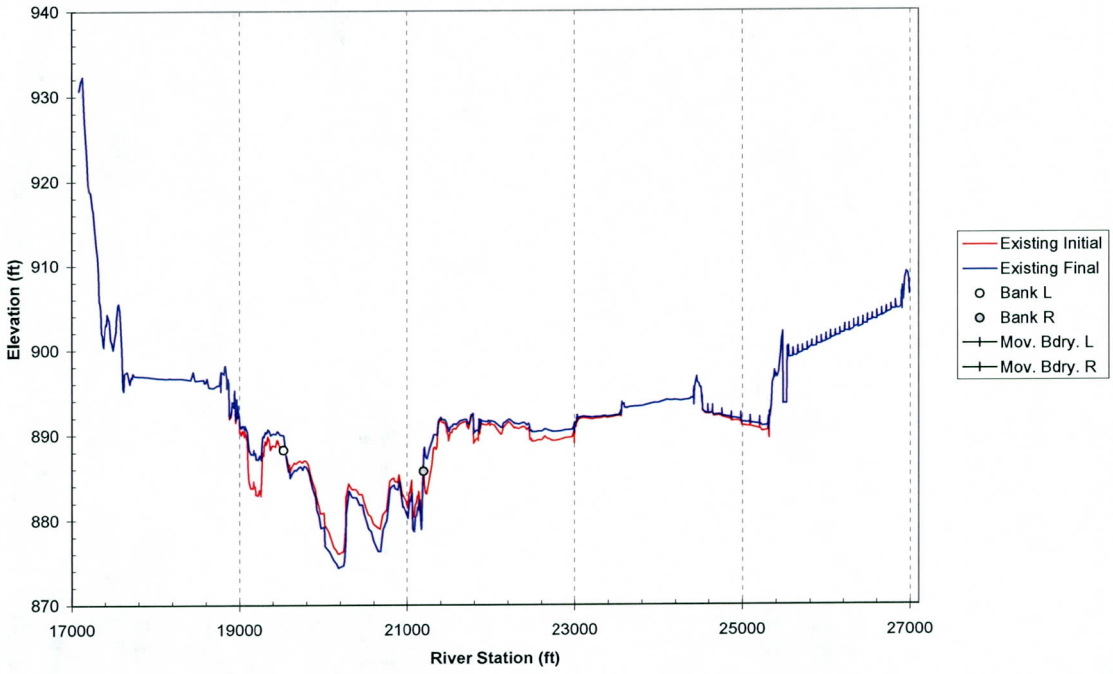

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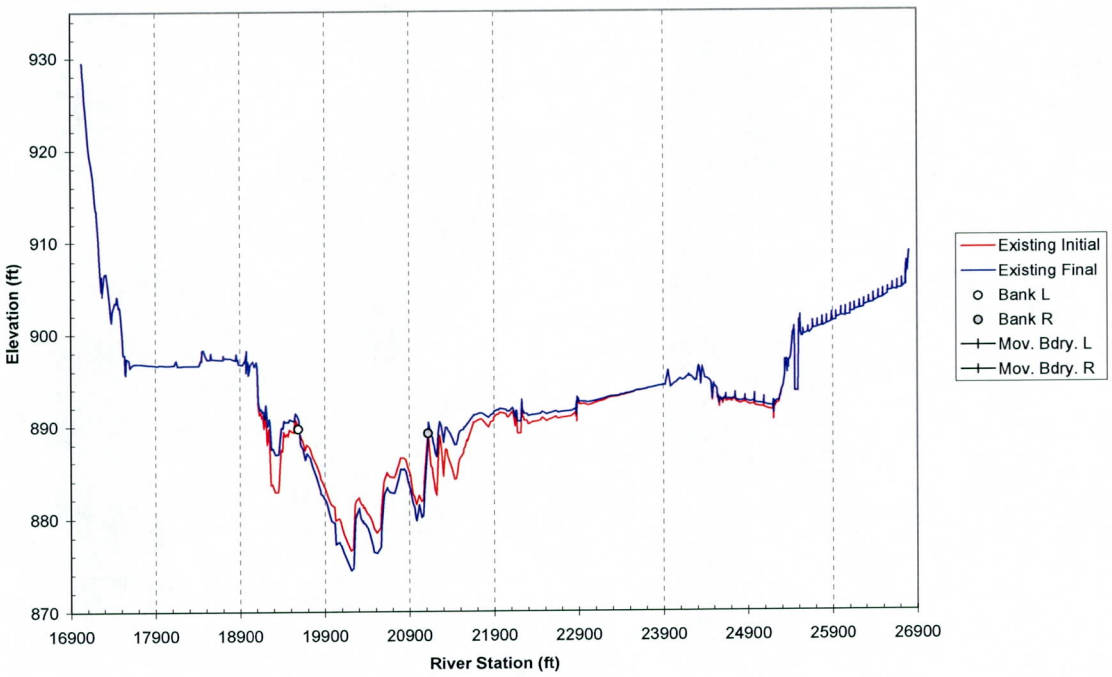

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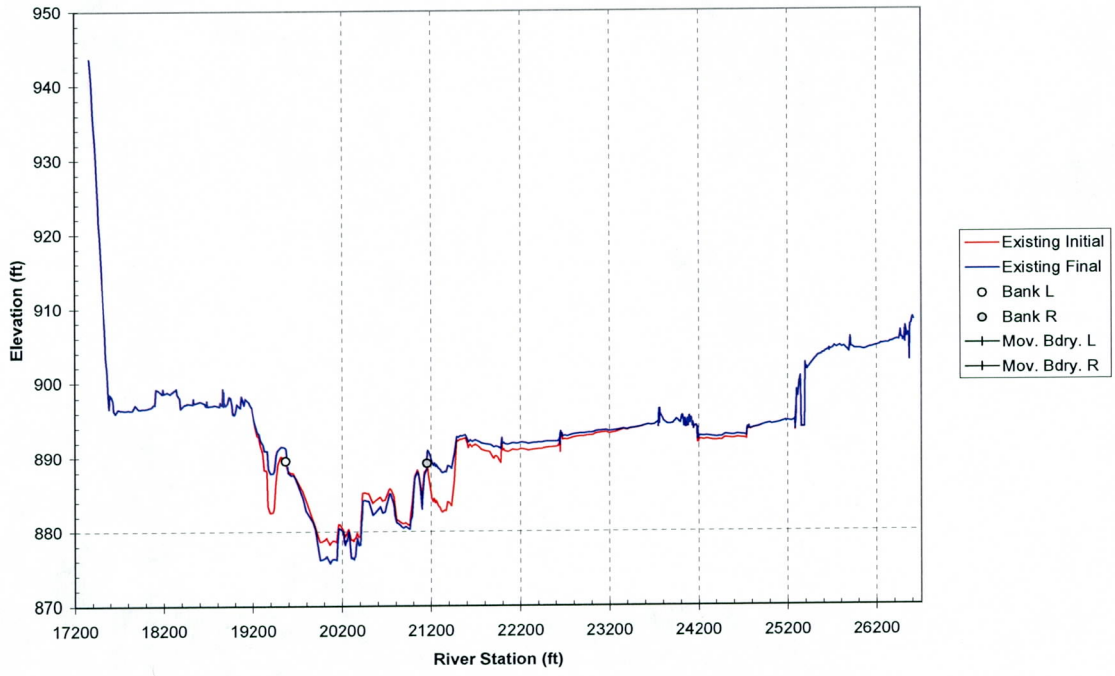

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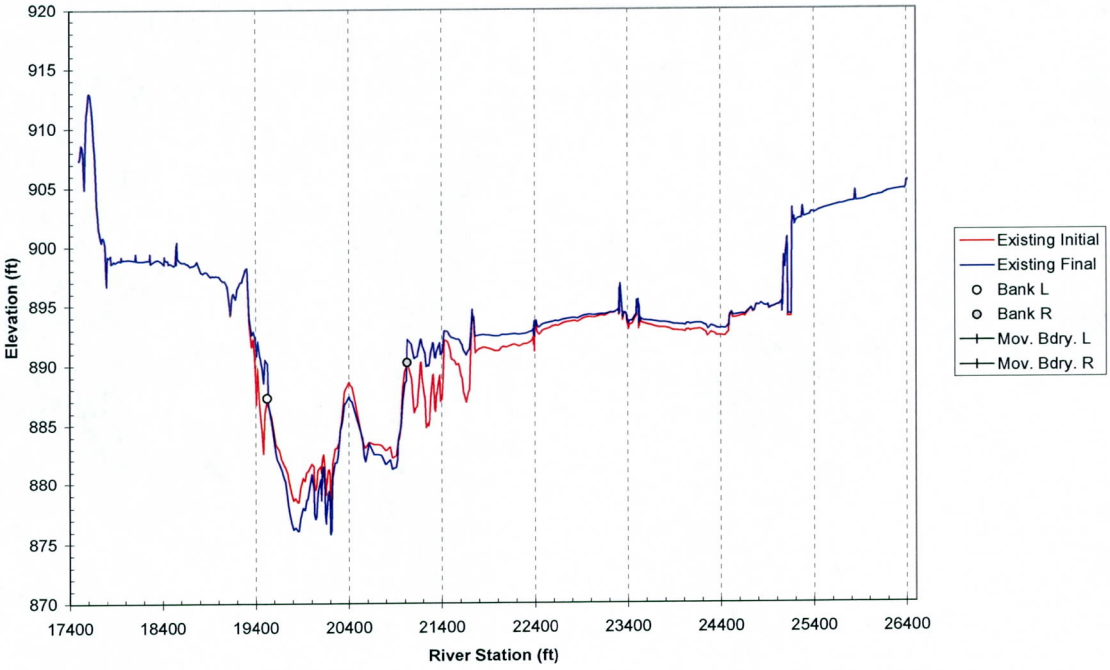

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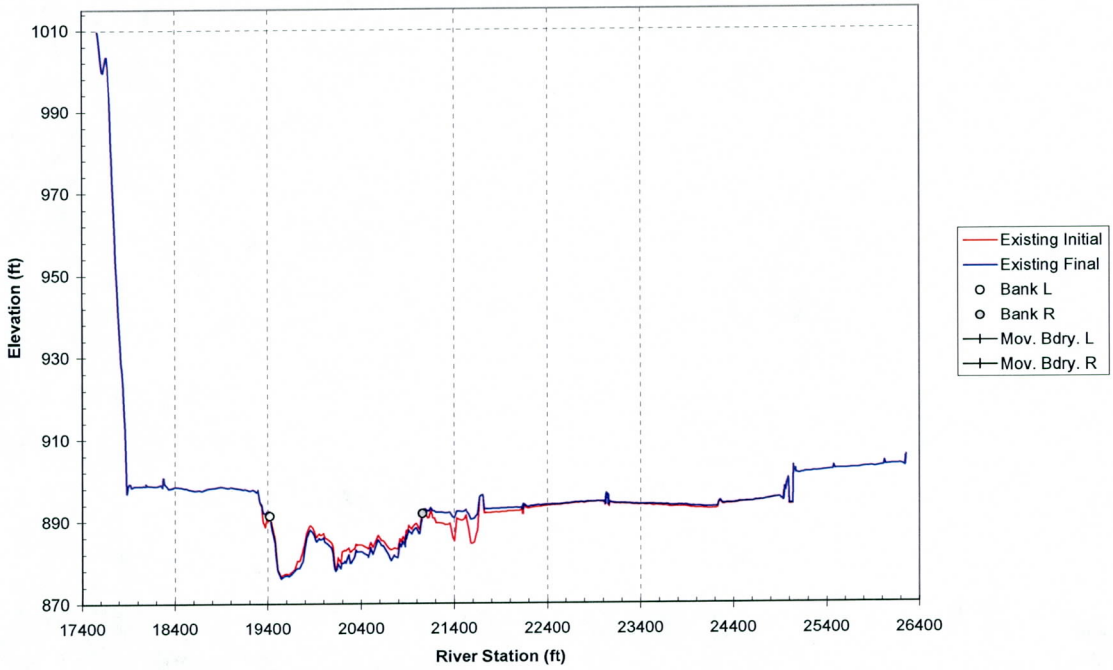

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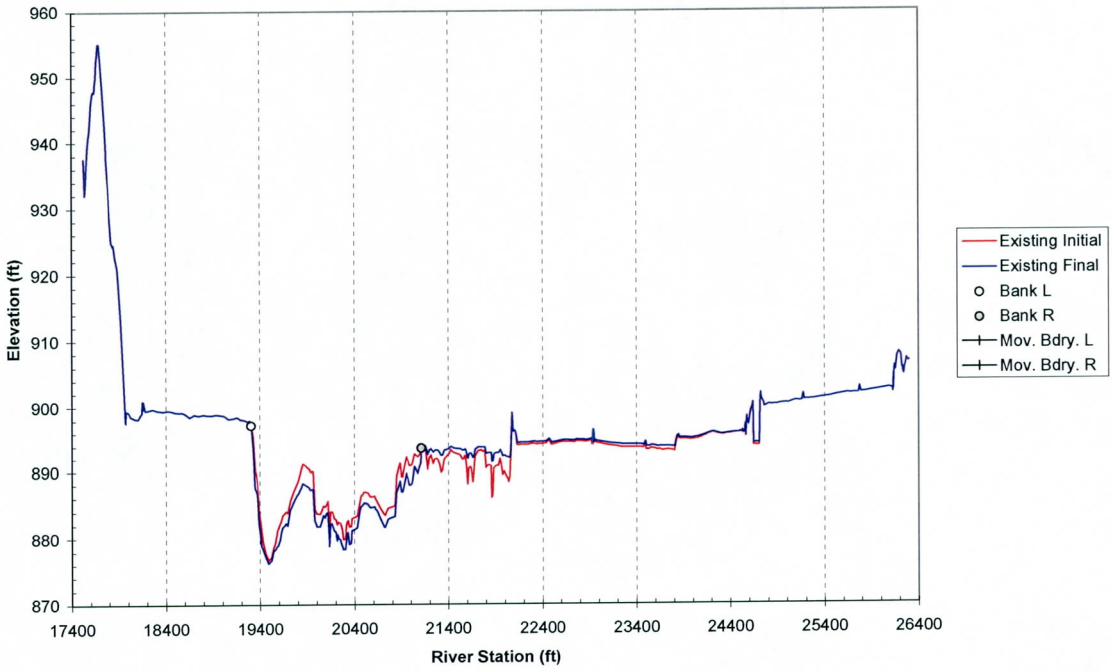

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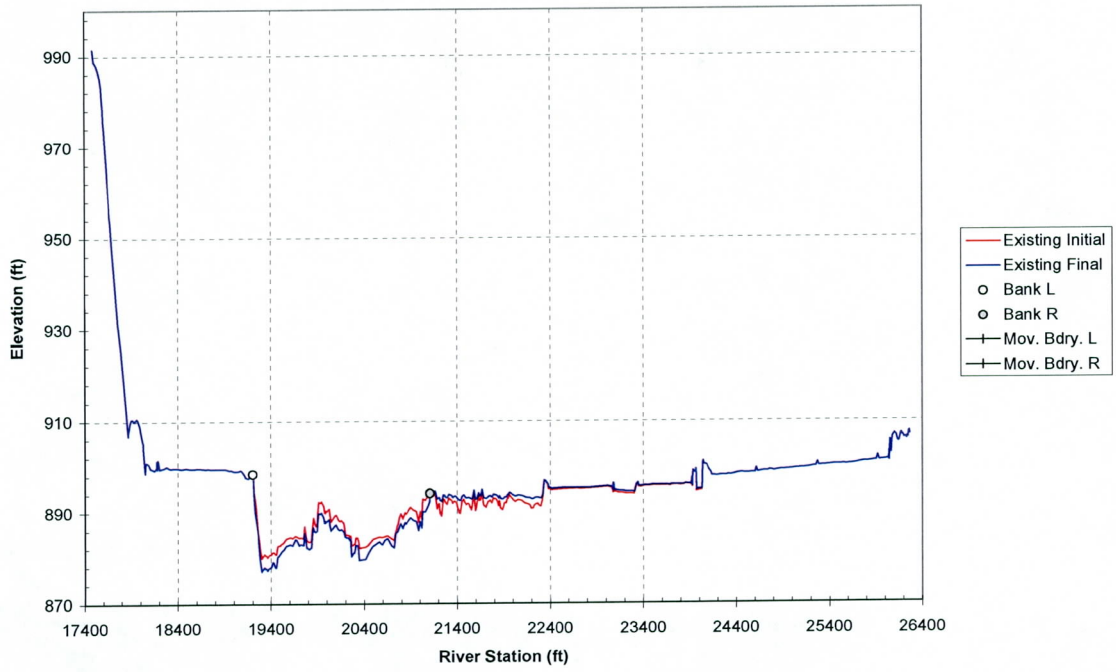

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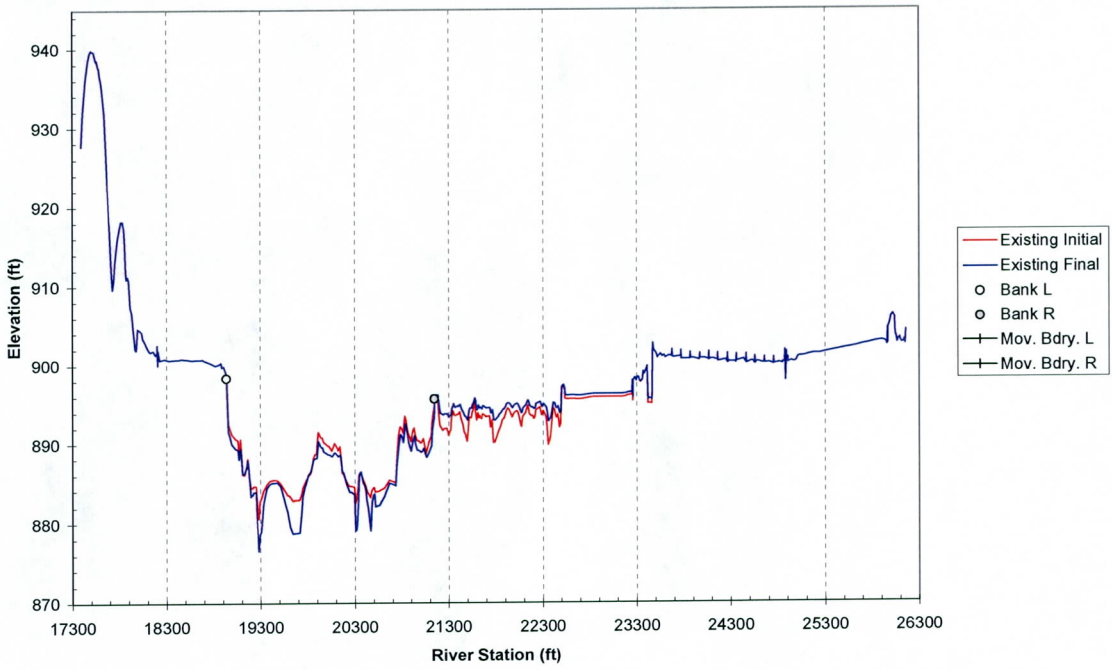

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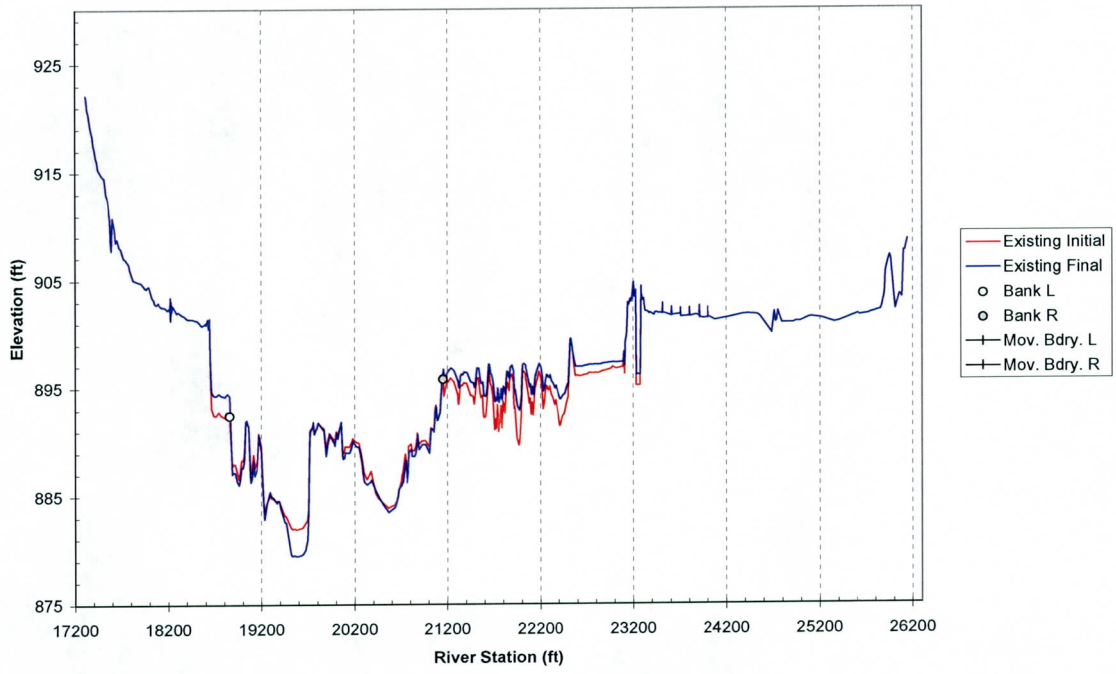

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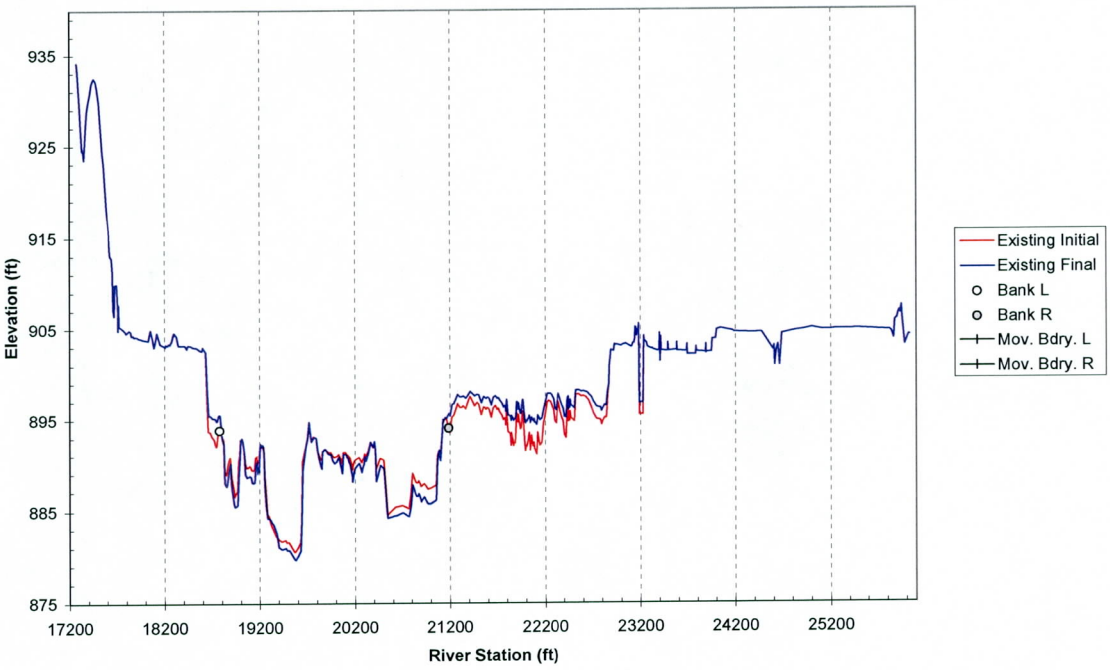

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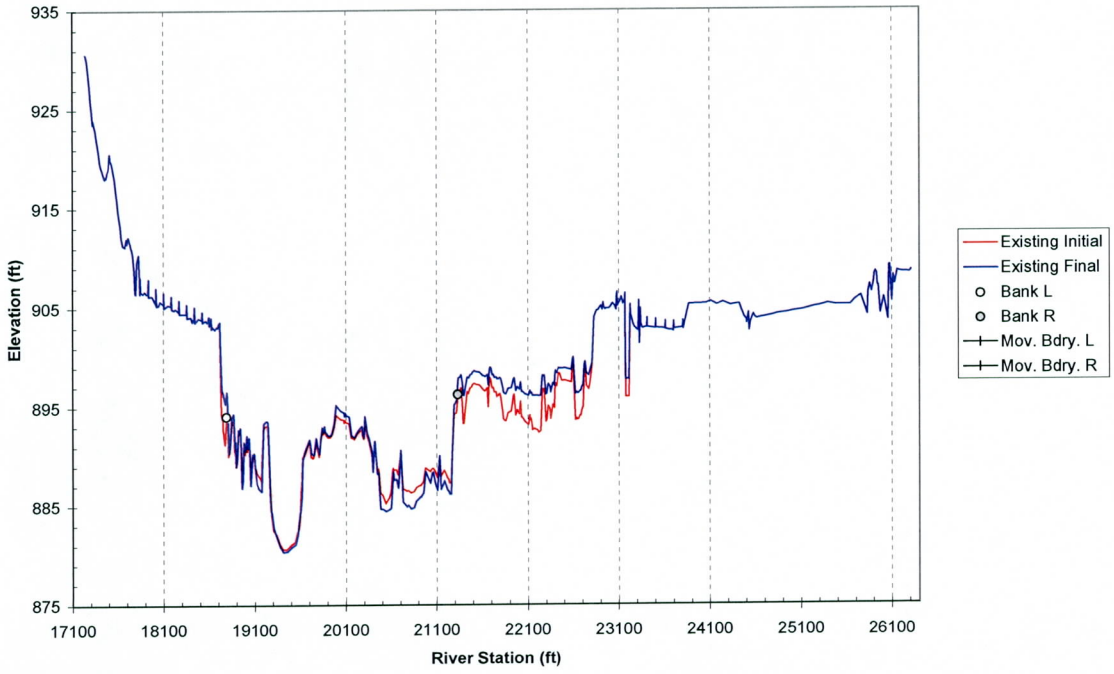

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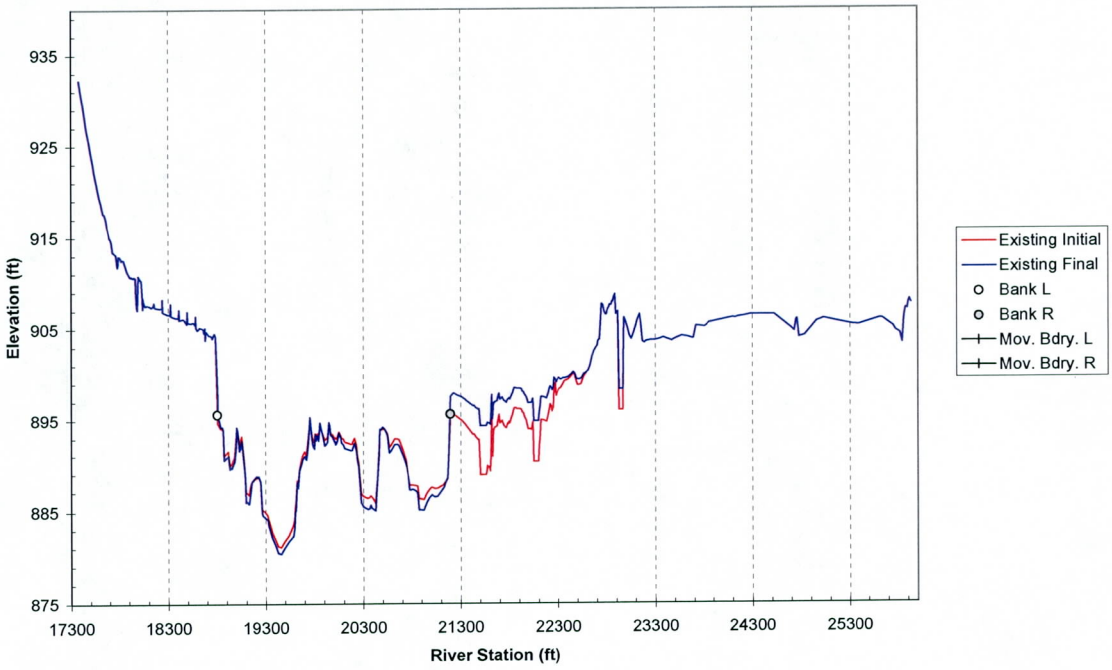

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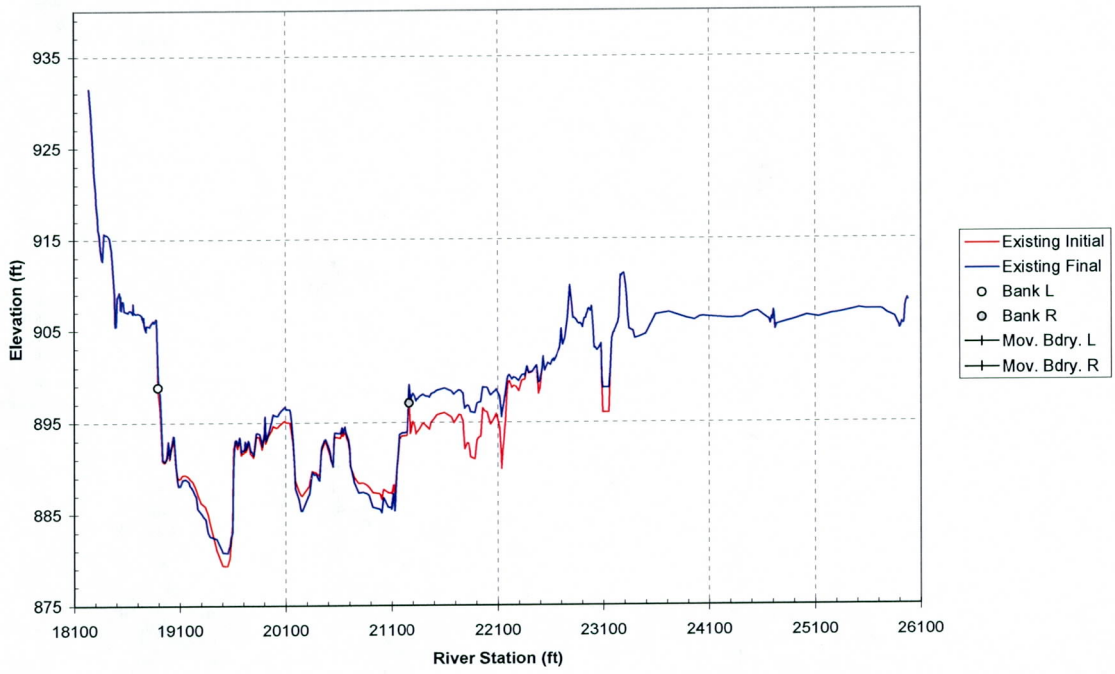

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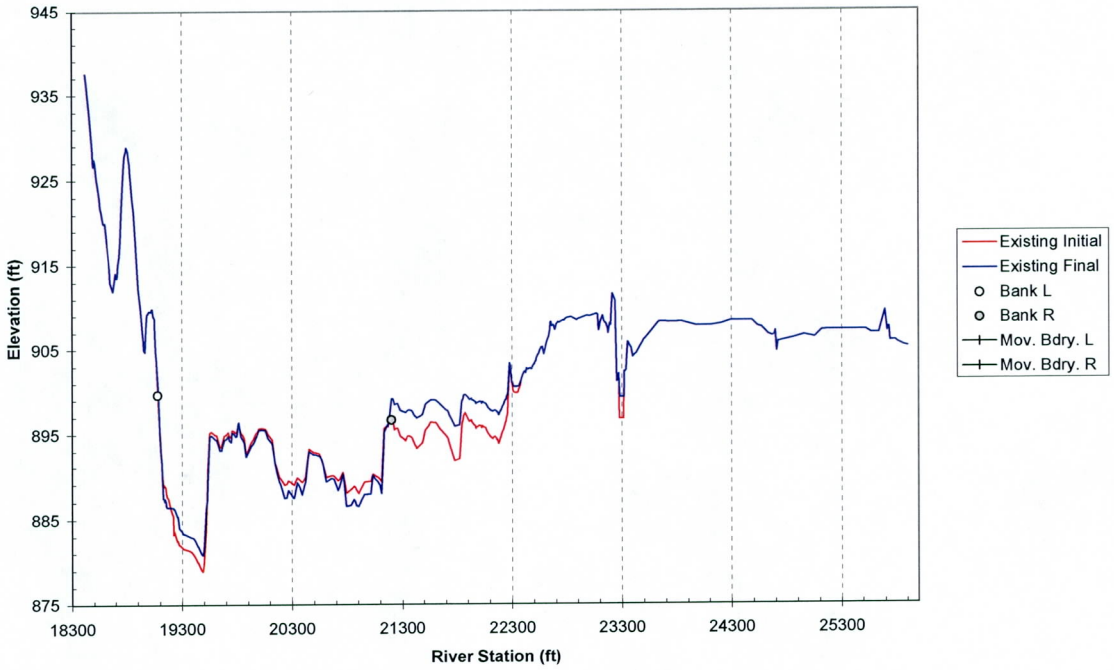

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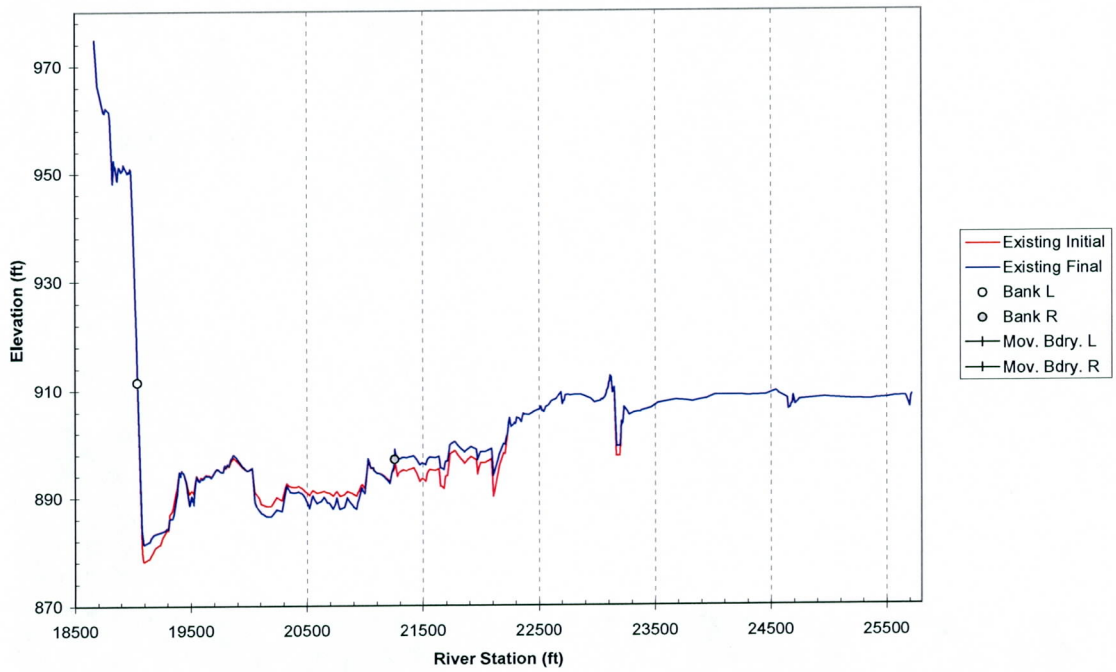

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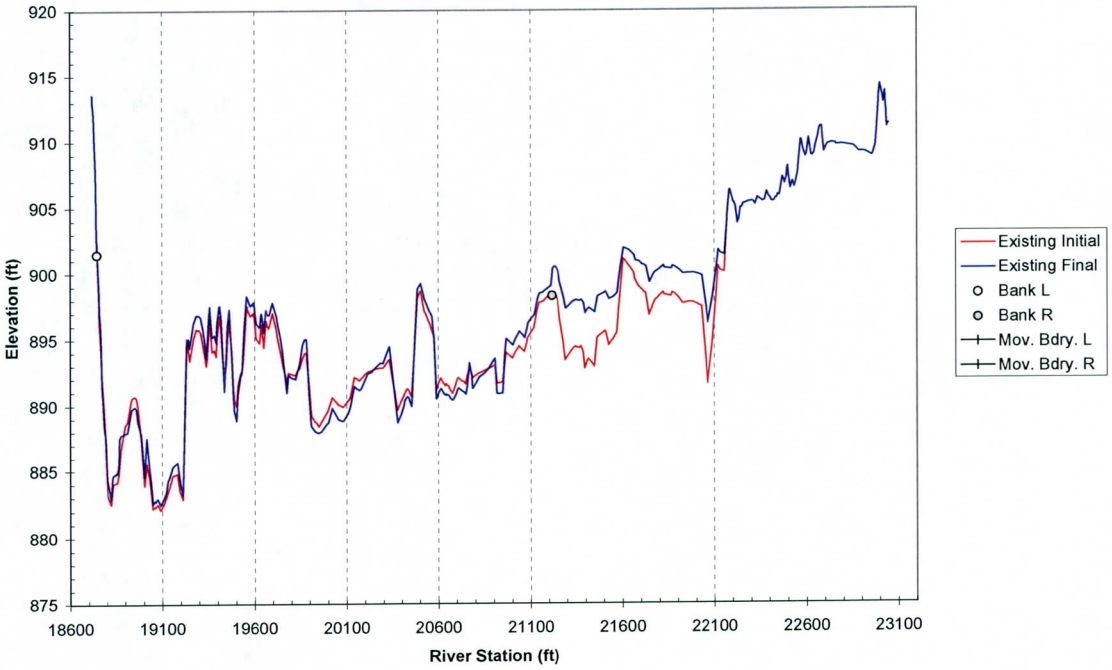

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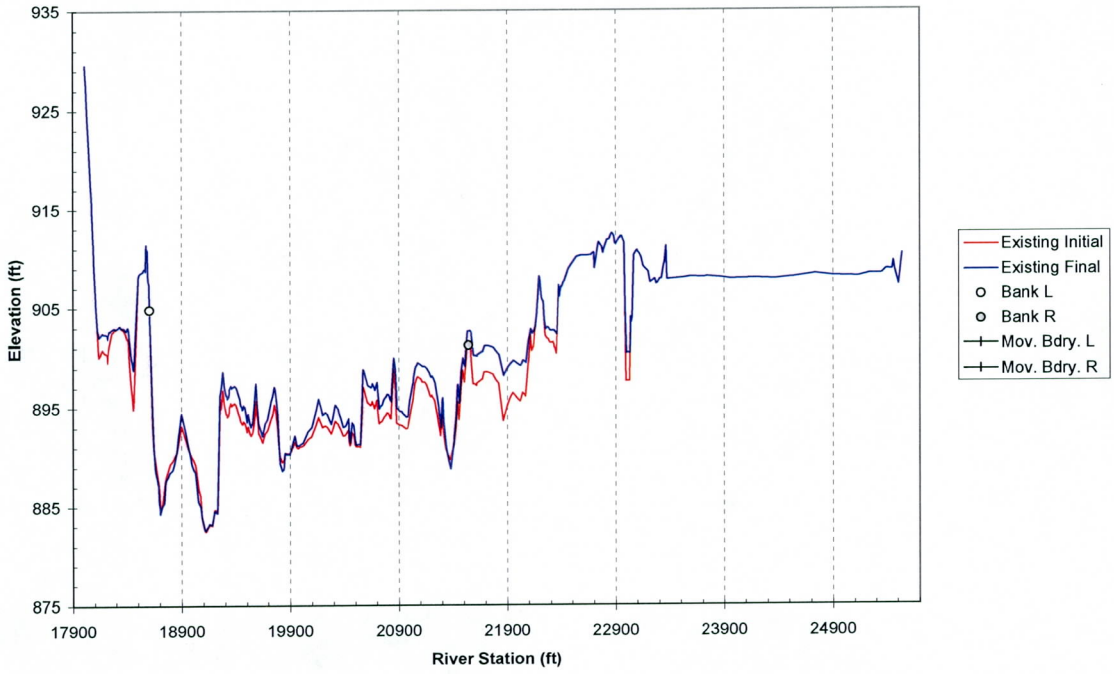

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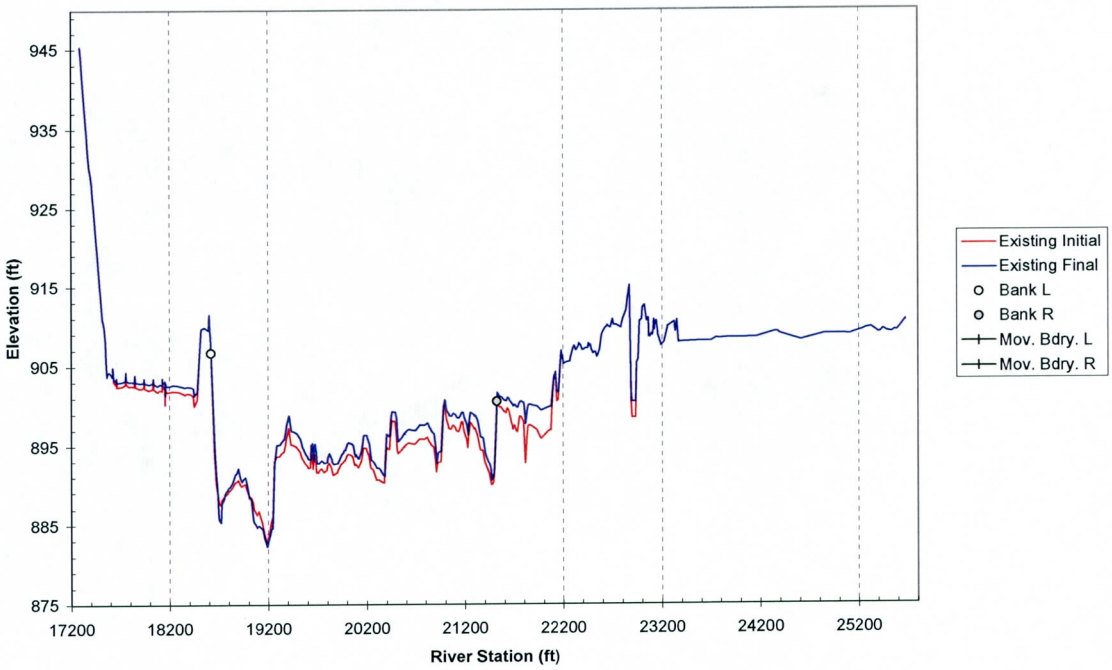

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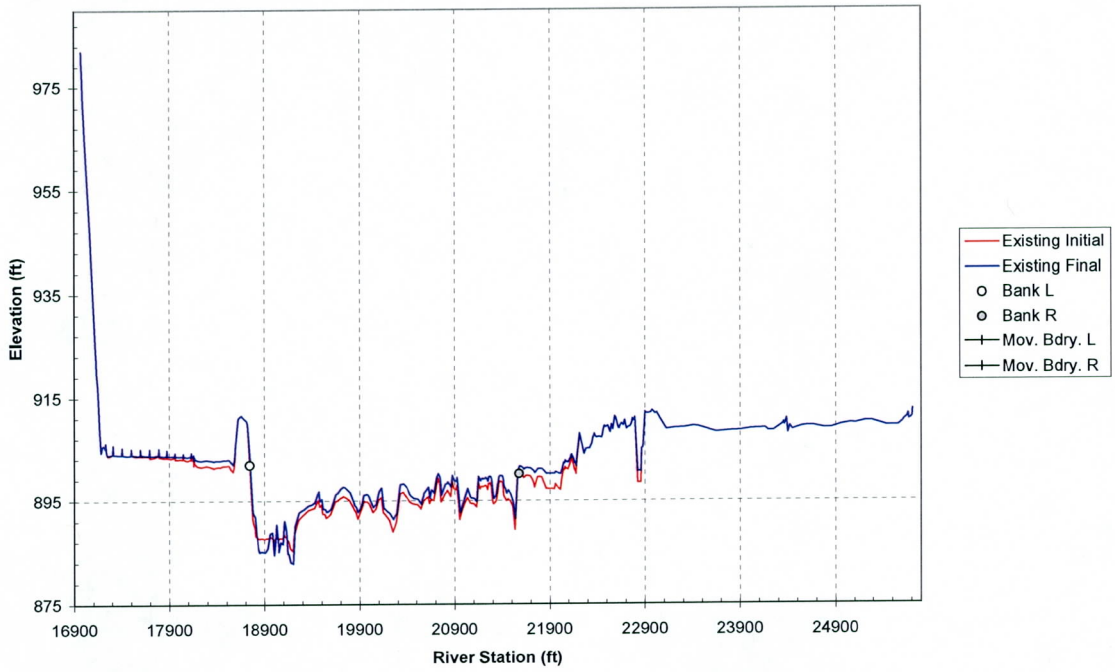

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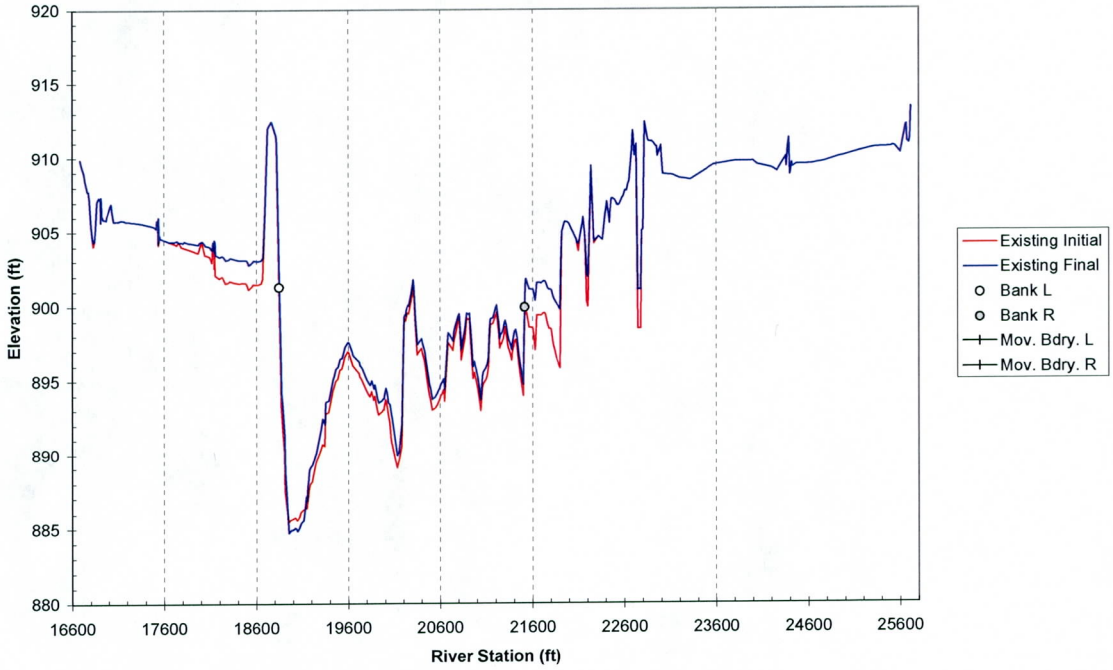

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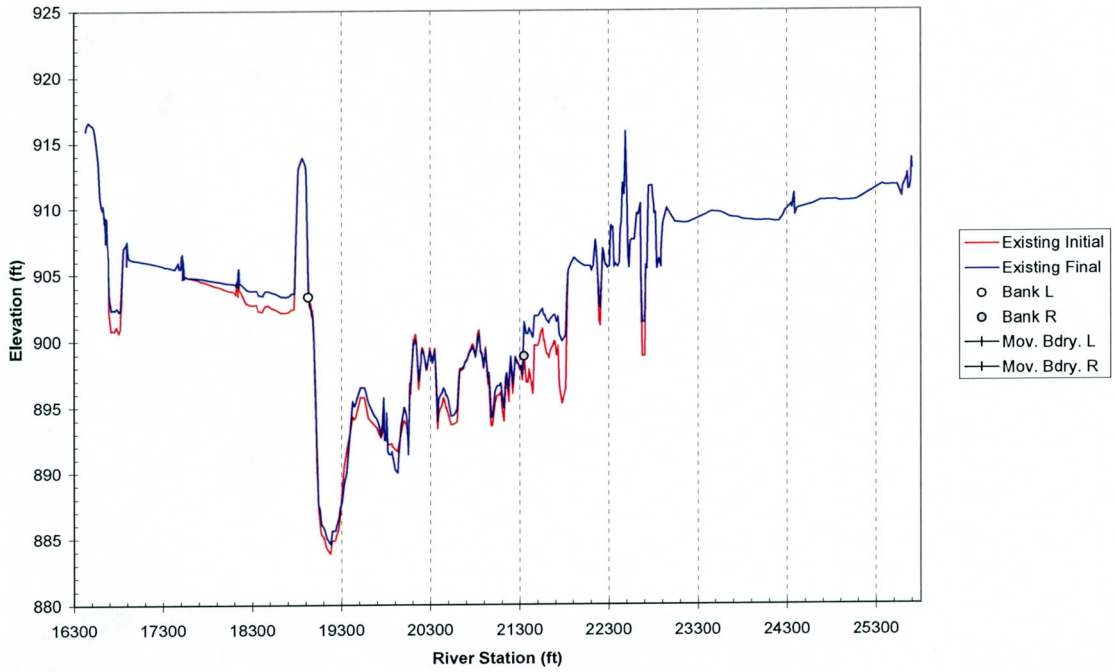

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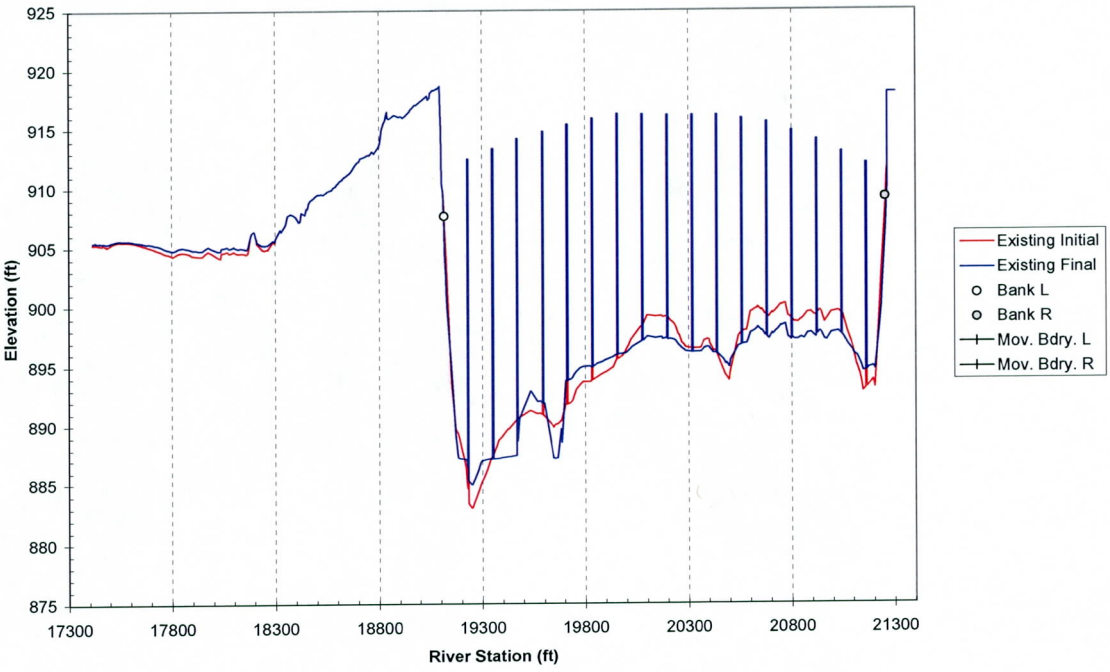

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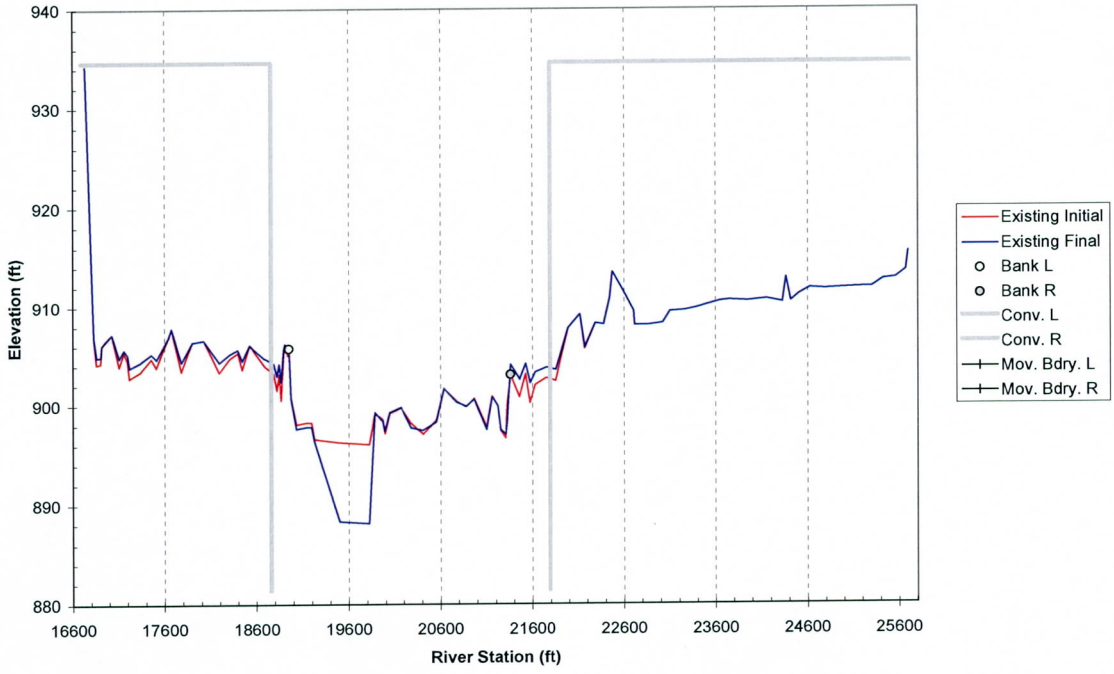

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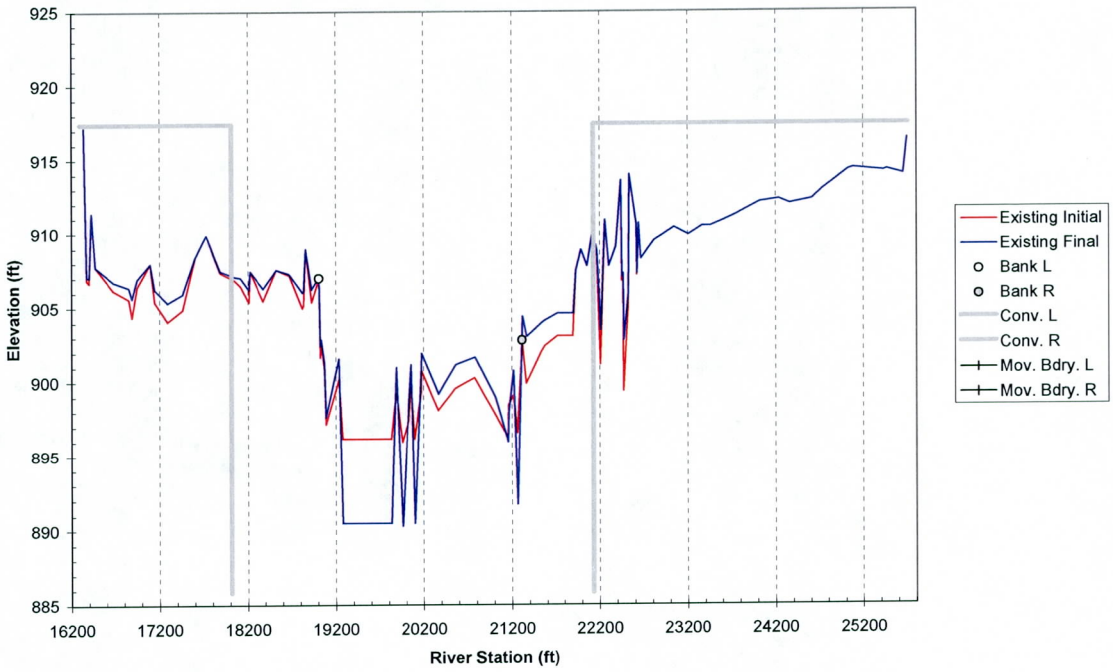

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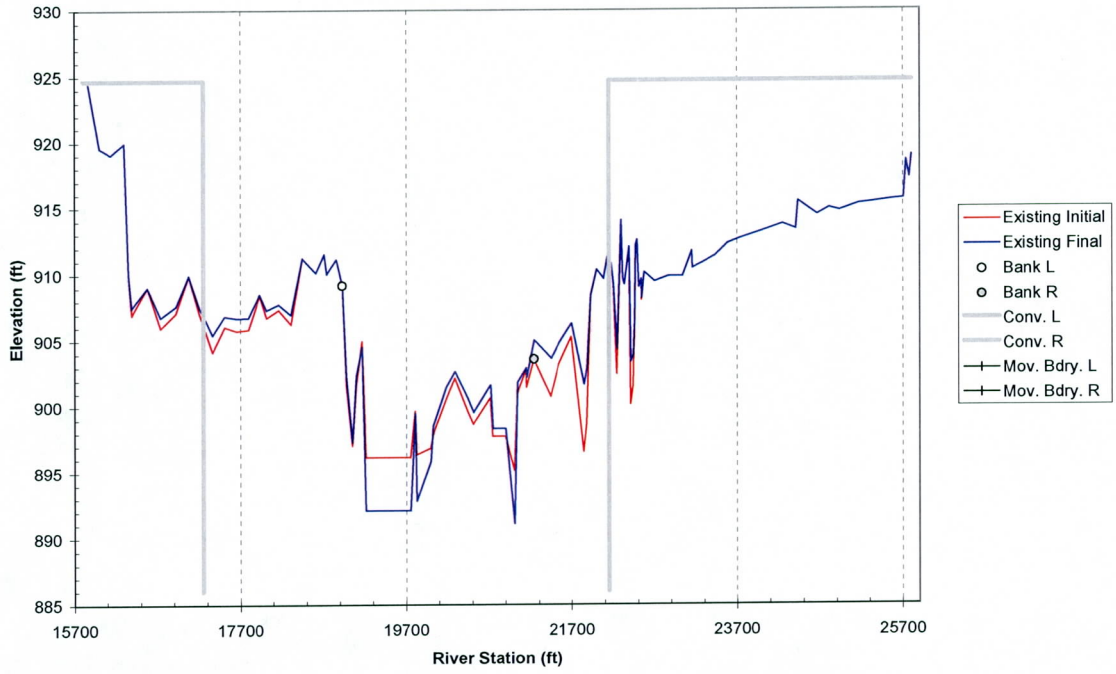

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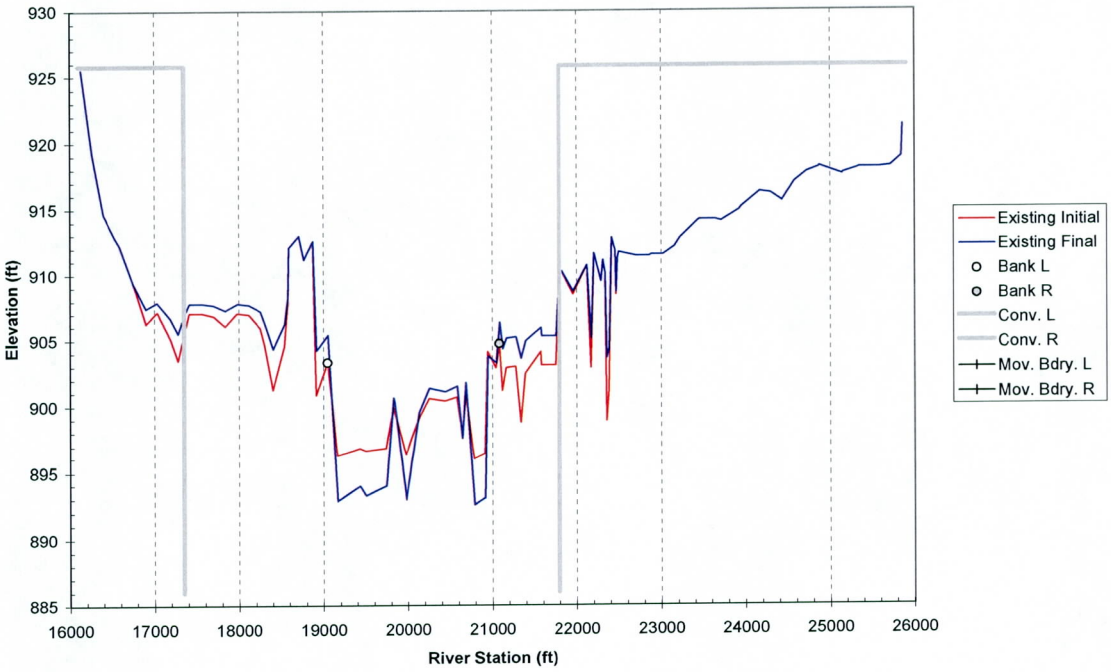

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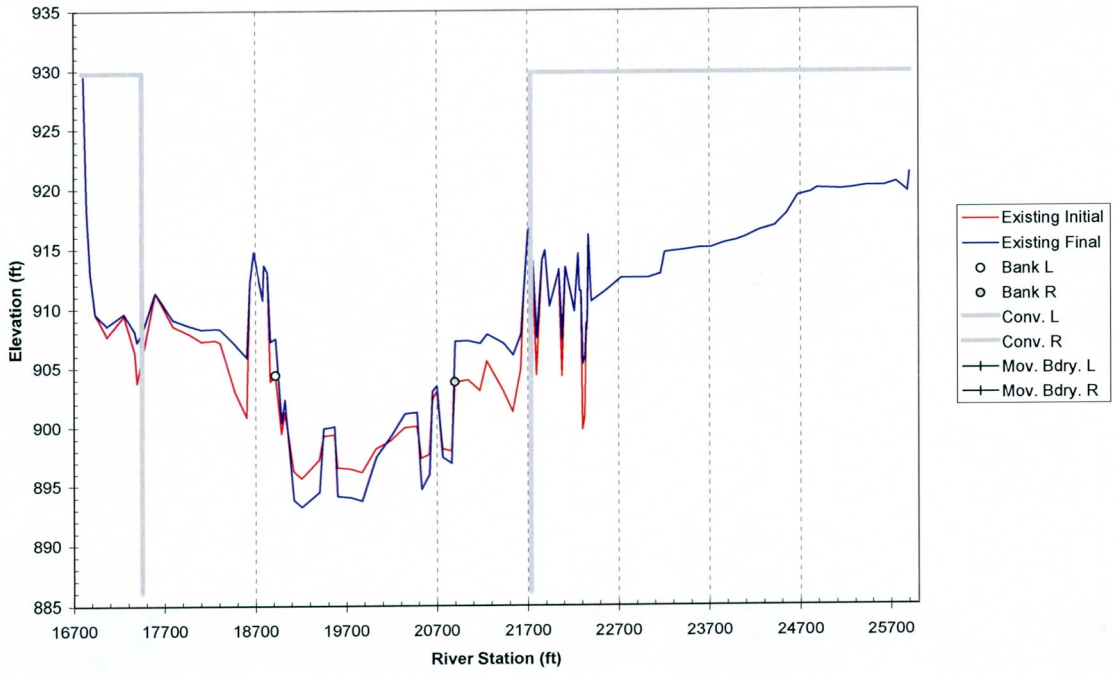

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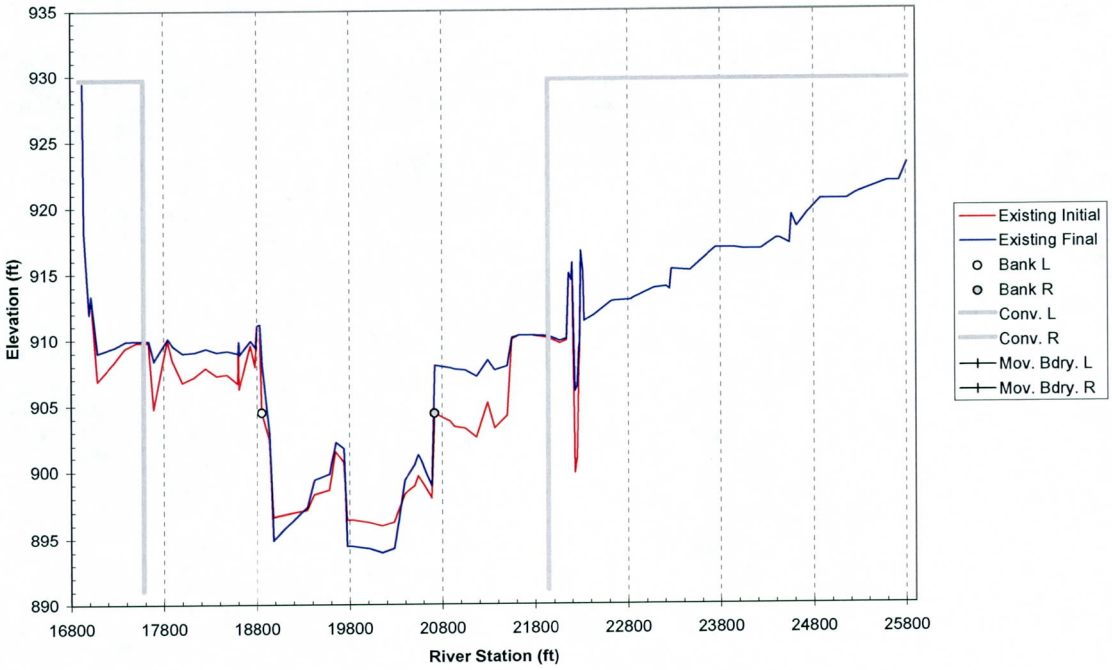

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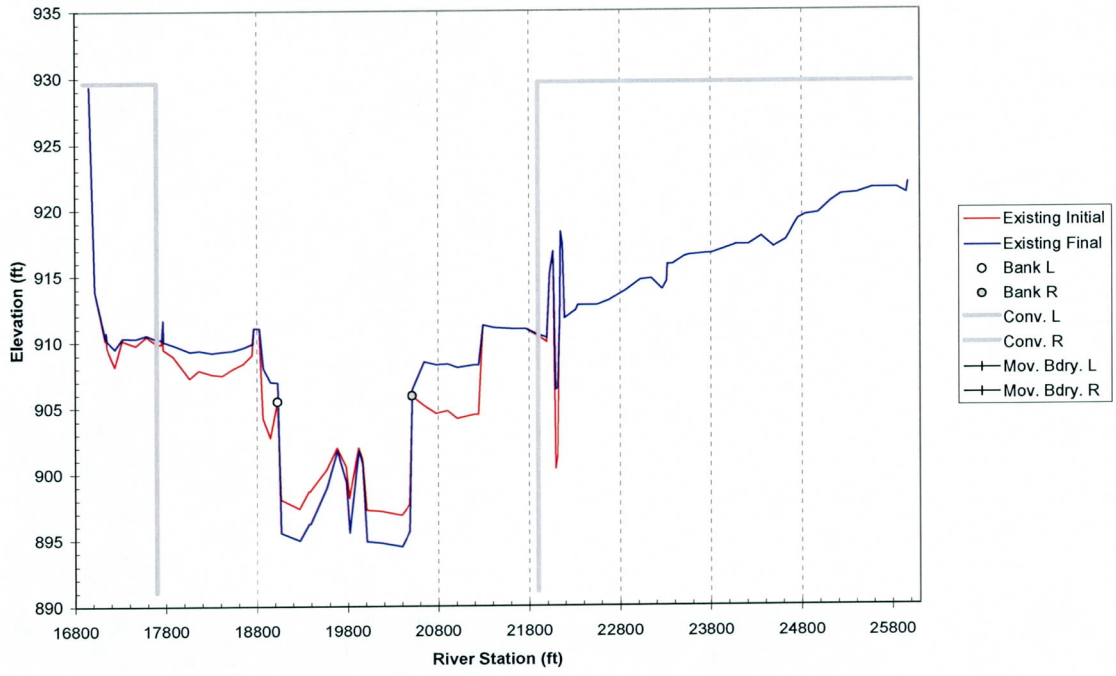

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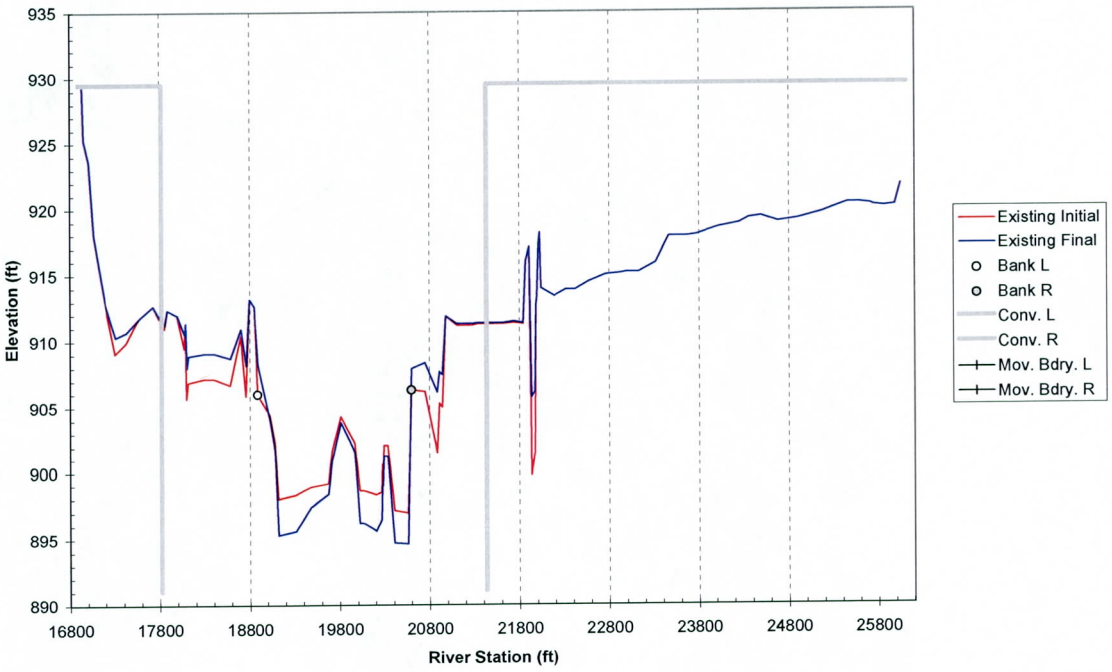

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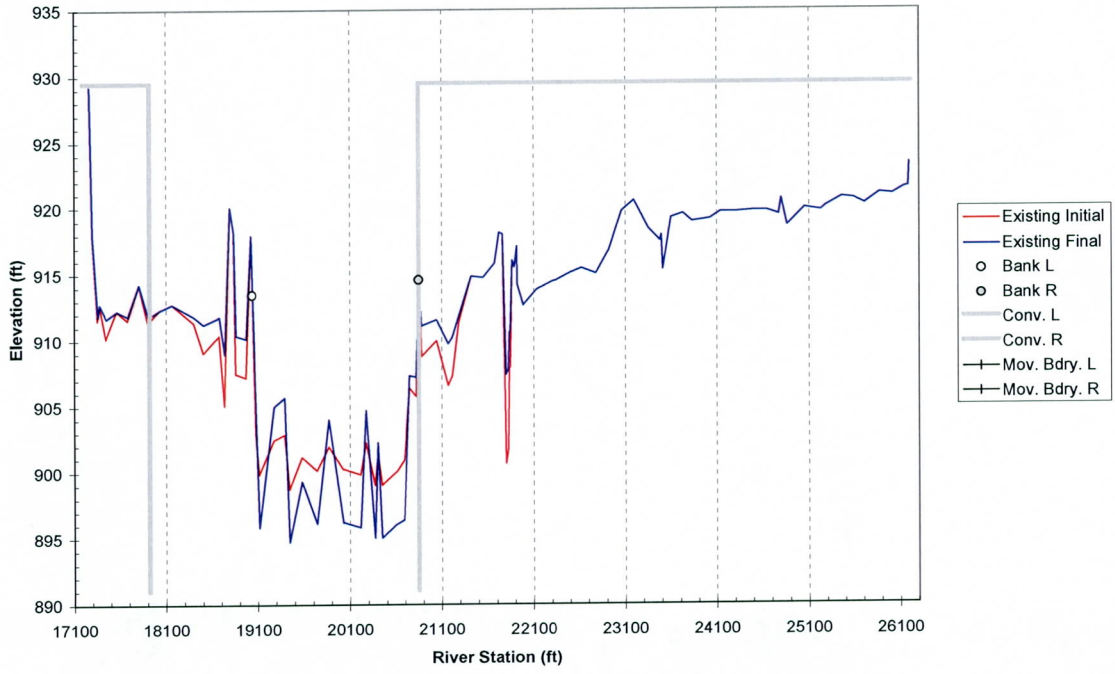

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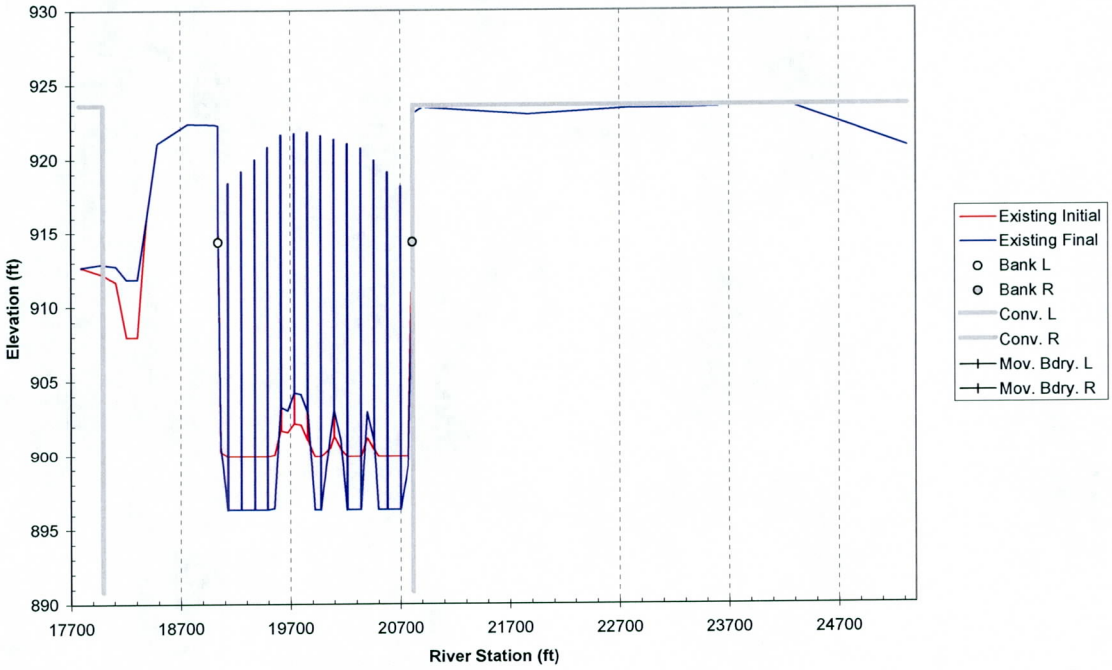

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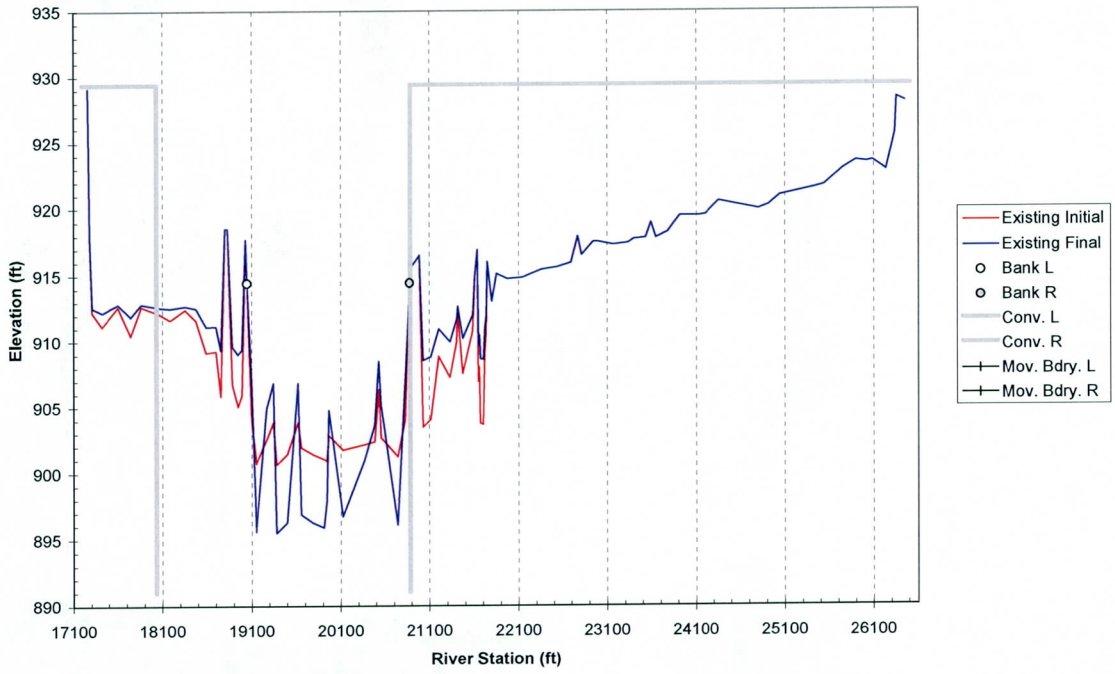

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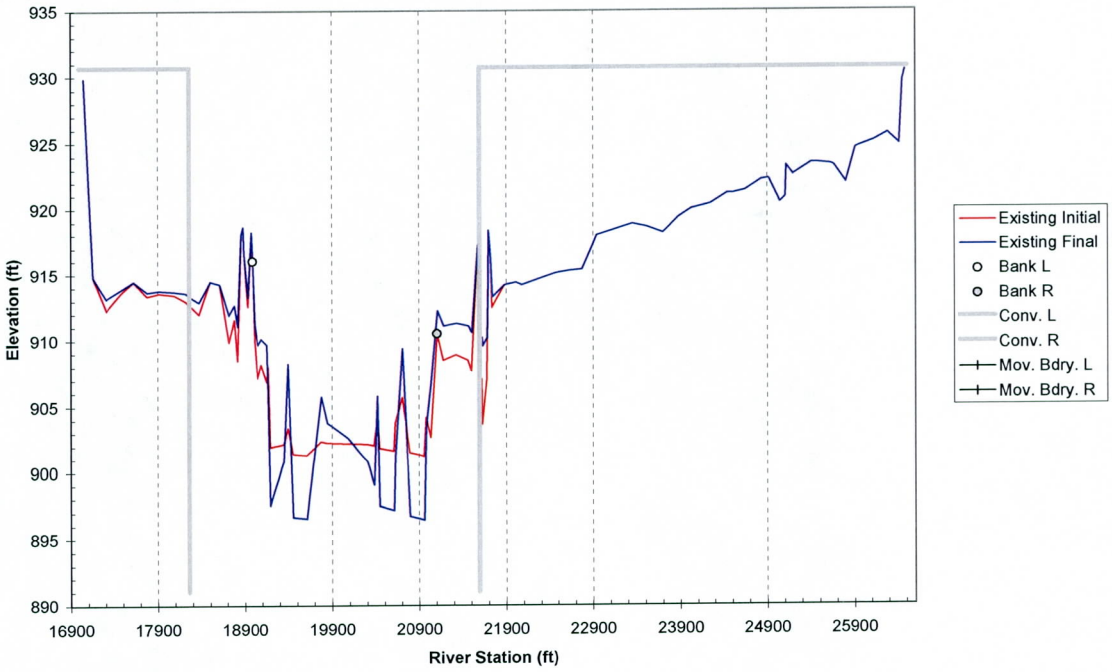

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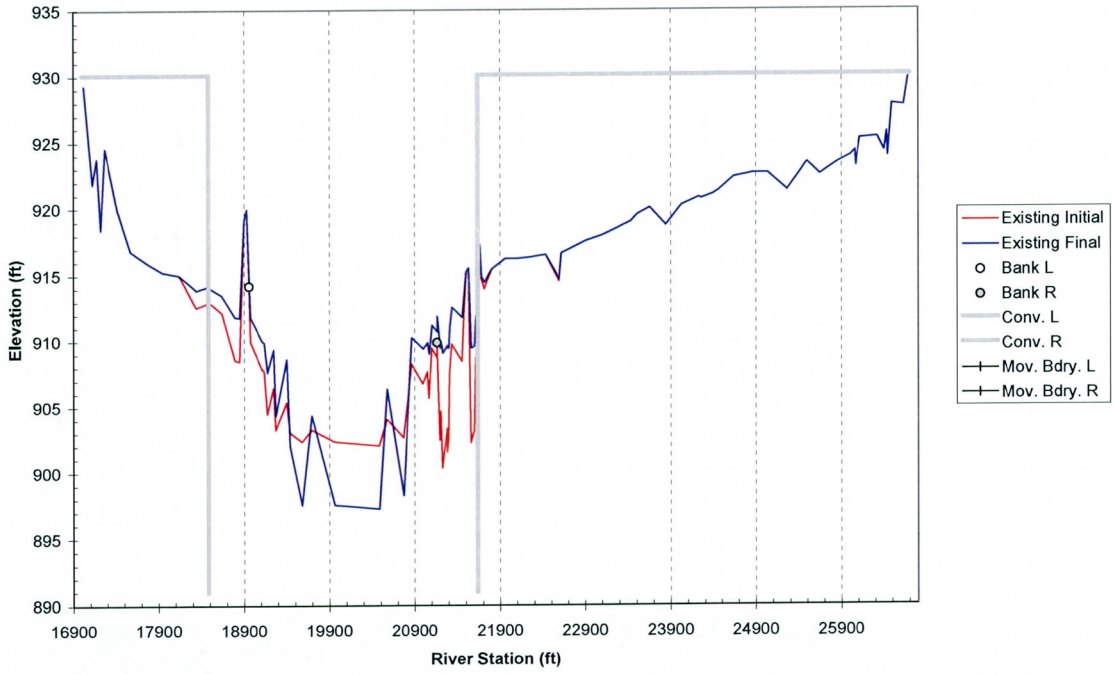

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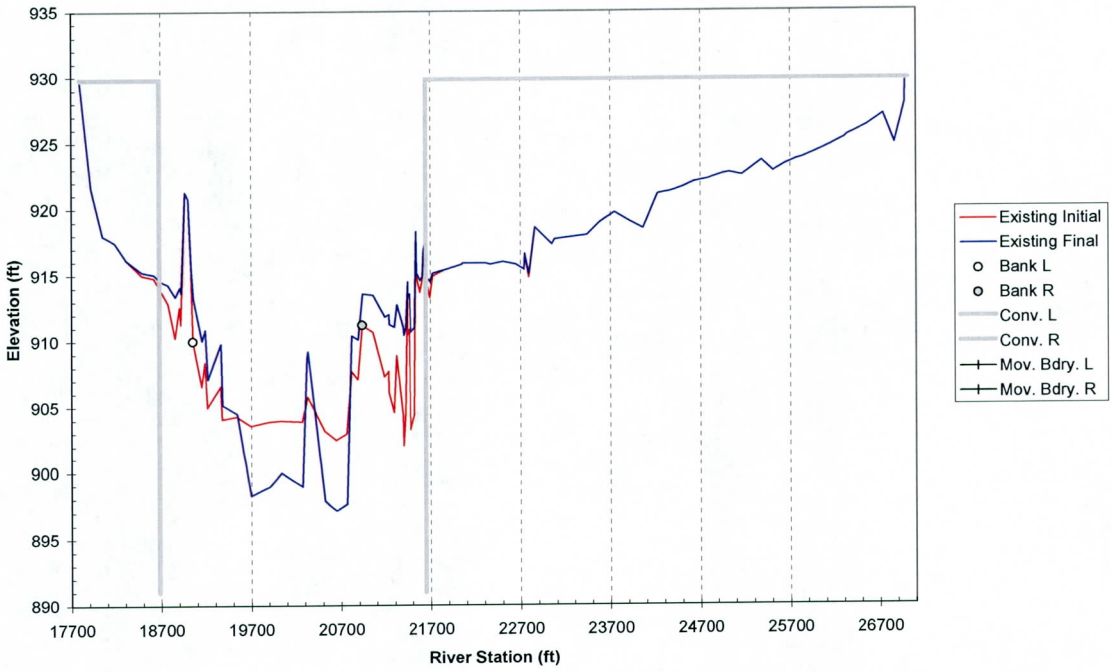

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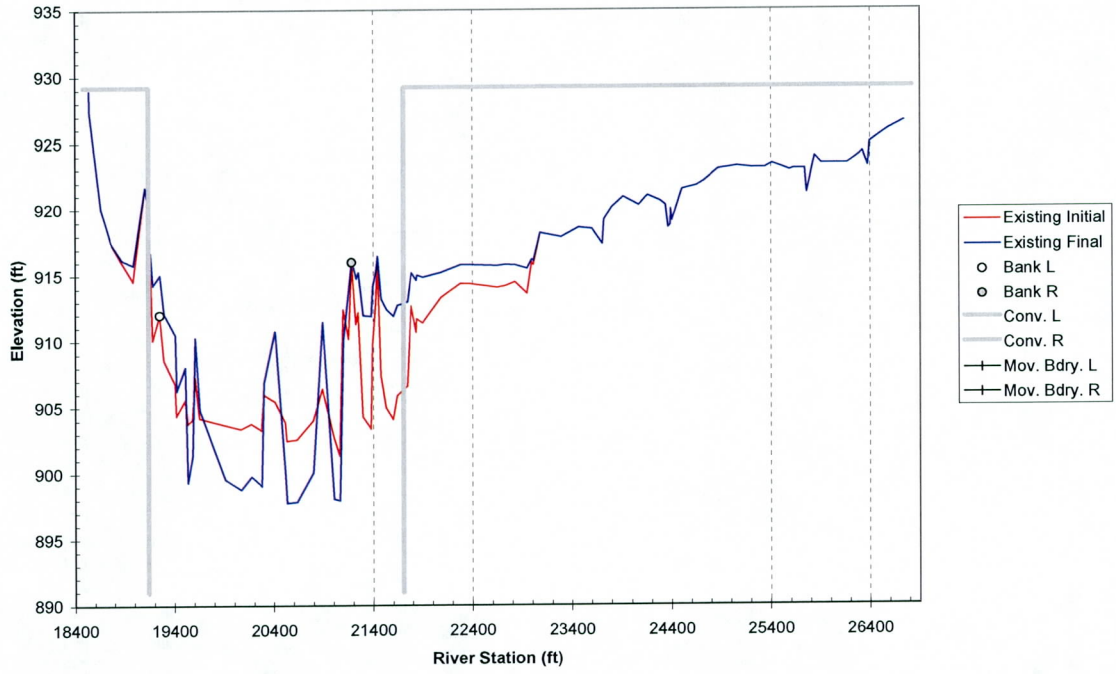

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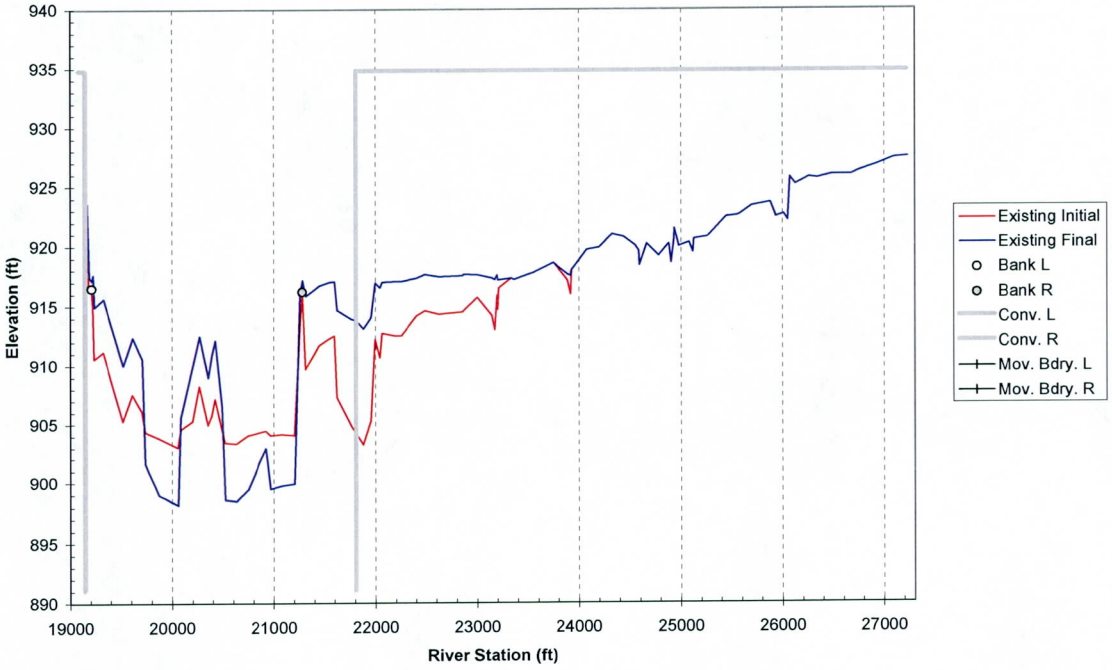

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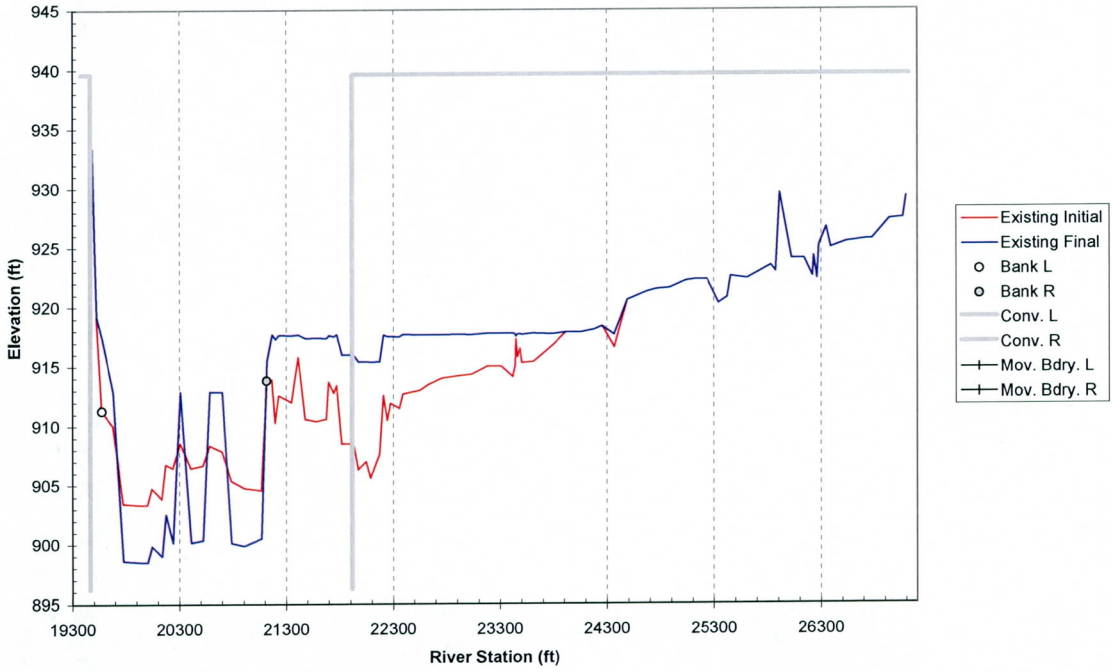


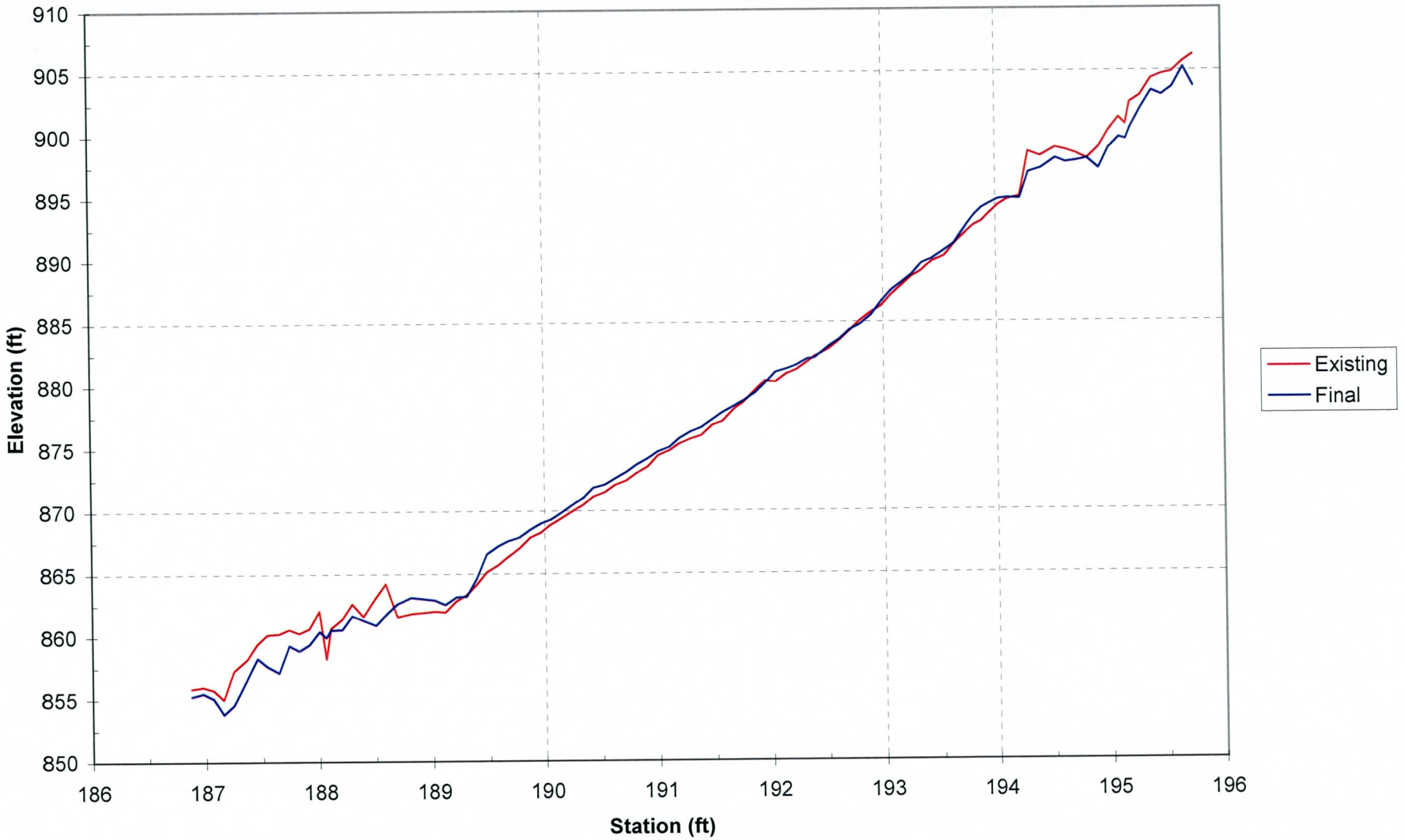
APPENDIX F

SECTION 2

Sediment Transport HEC-6T Model Results

PROPOSED CONDITIONS

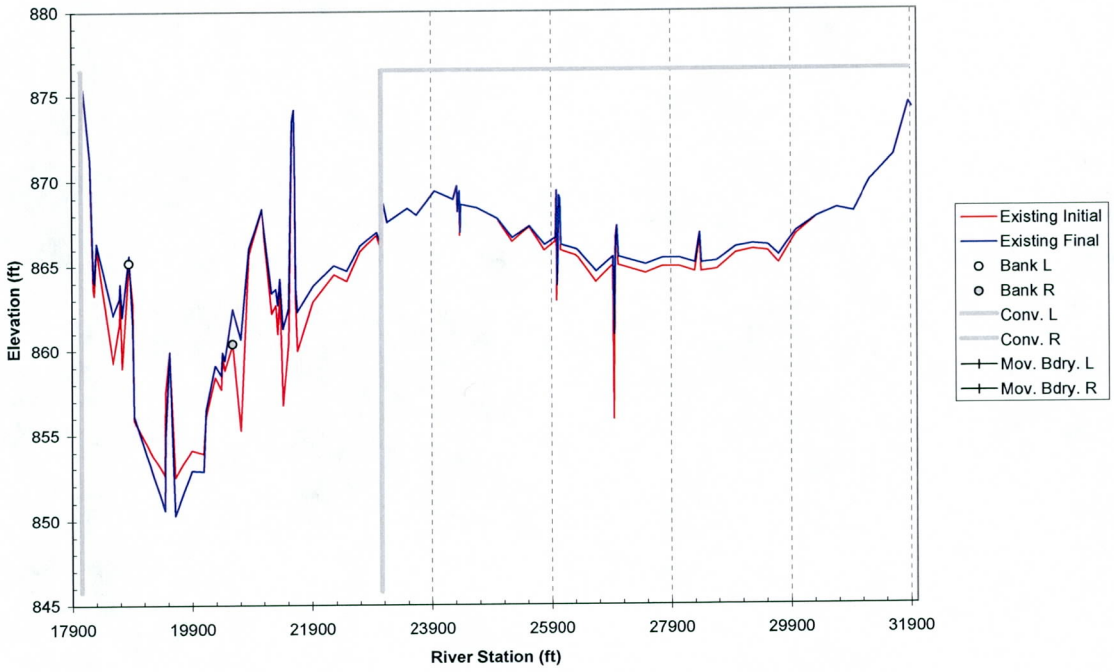
Bed Profile



105 Year Sediment Run

Proposed Conditions

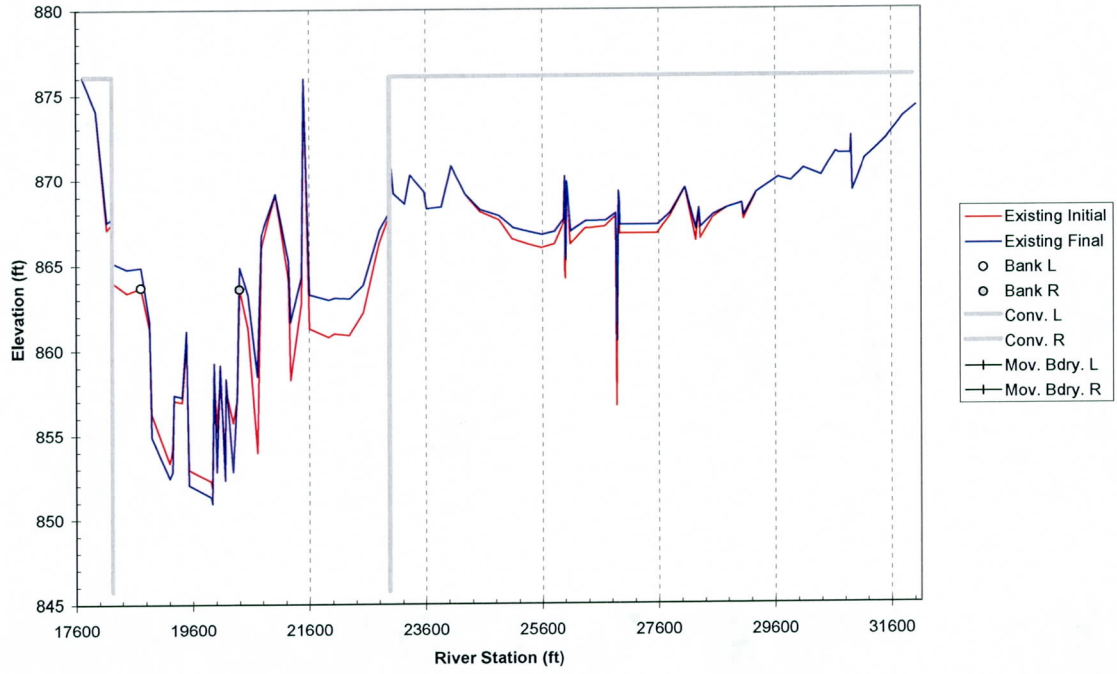
Cross Section 186.87



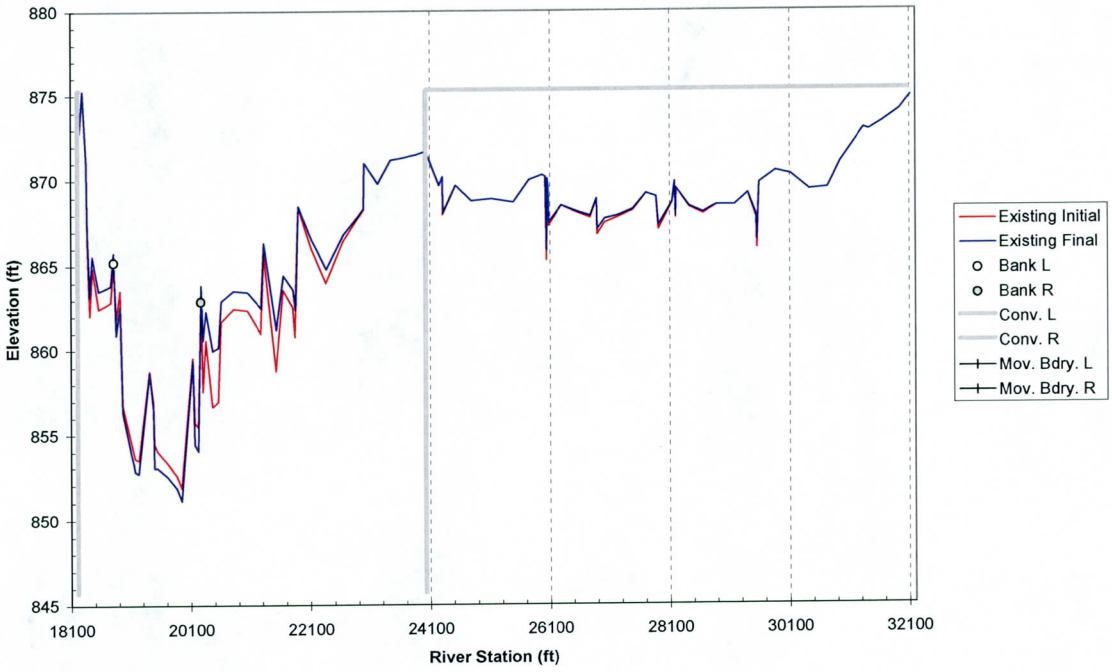
105 Year Run

Proposed Conditions

Cross Section 186.97



Cross Section 187.06



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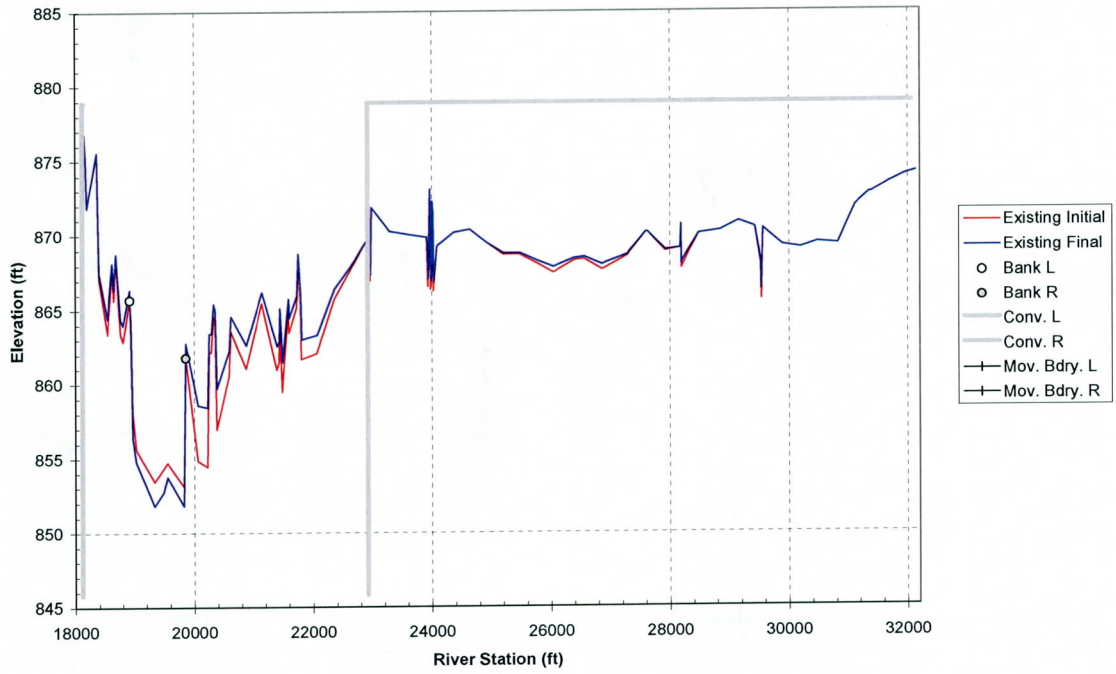

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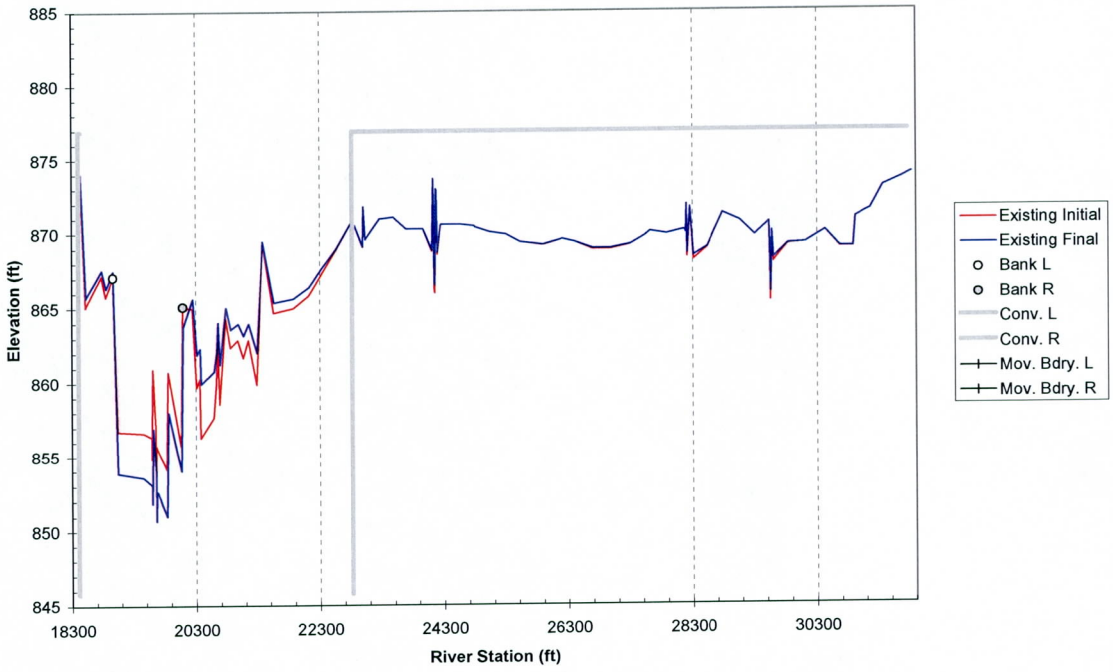

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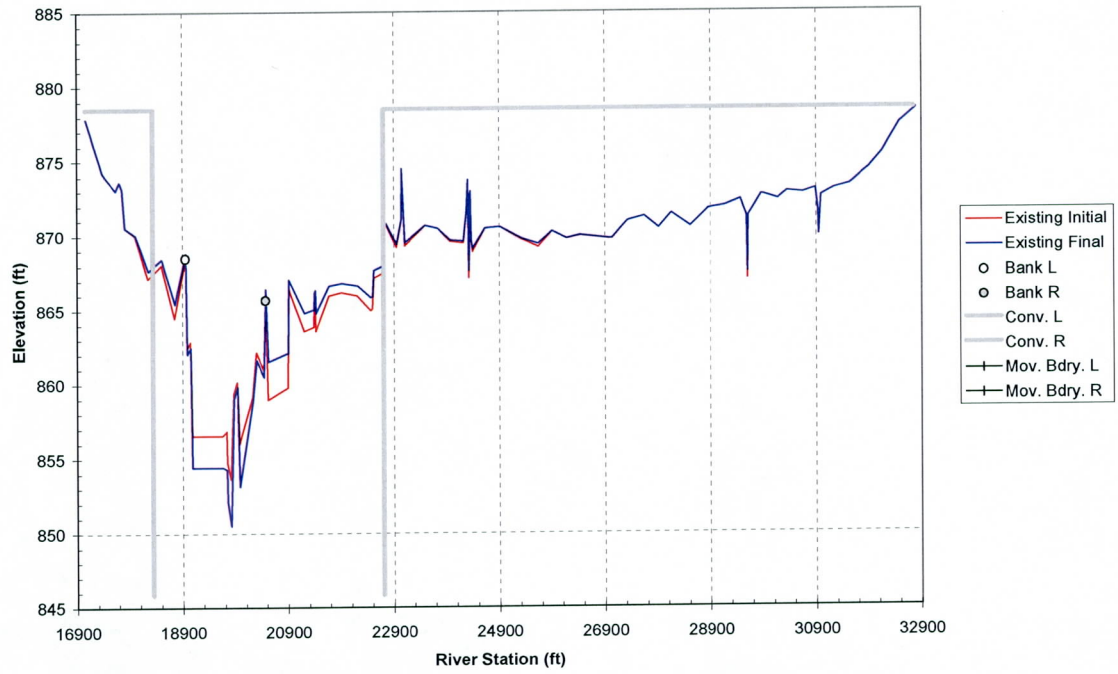

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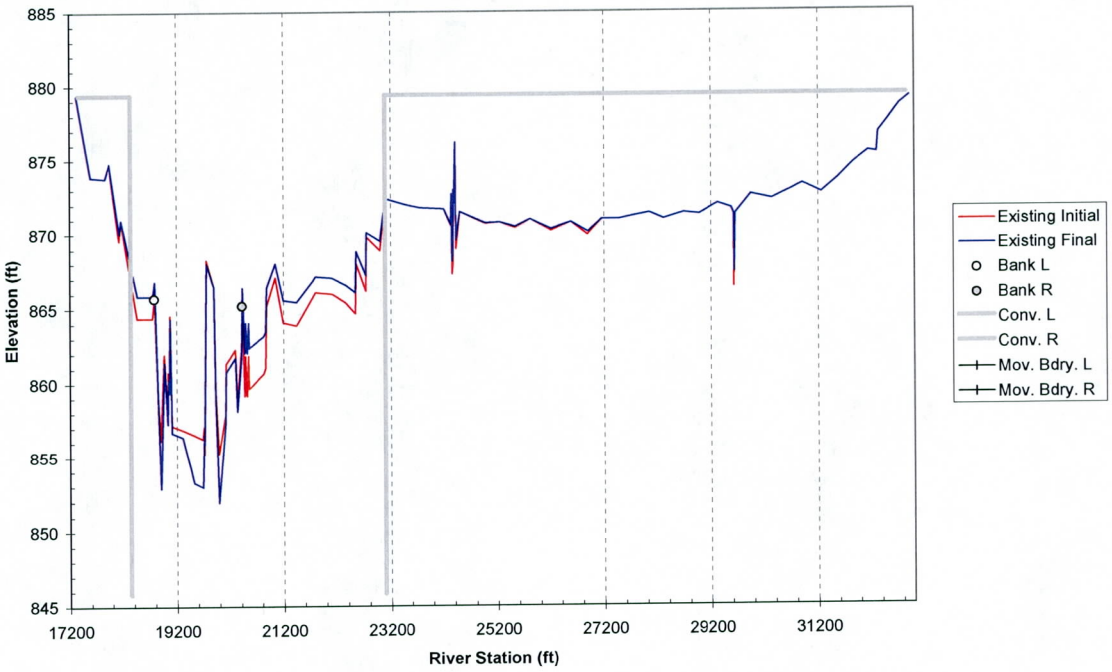

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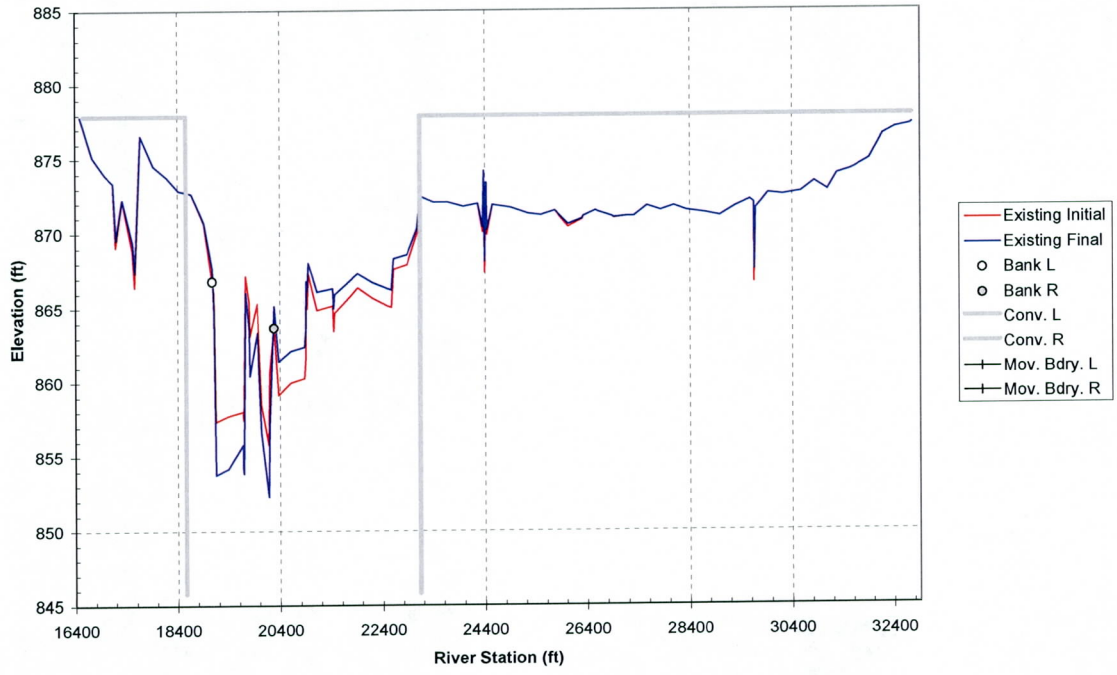

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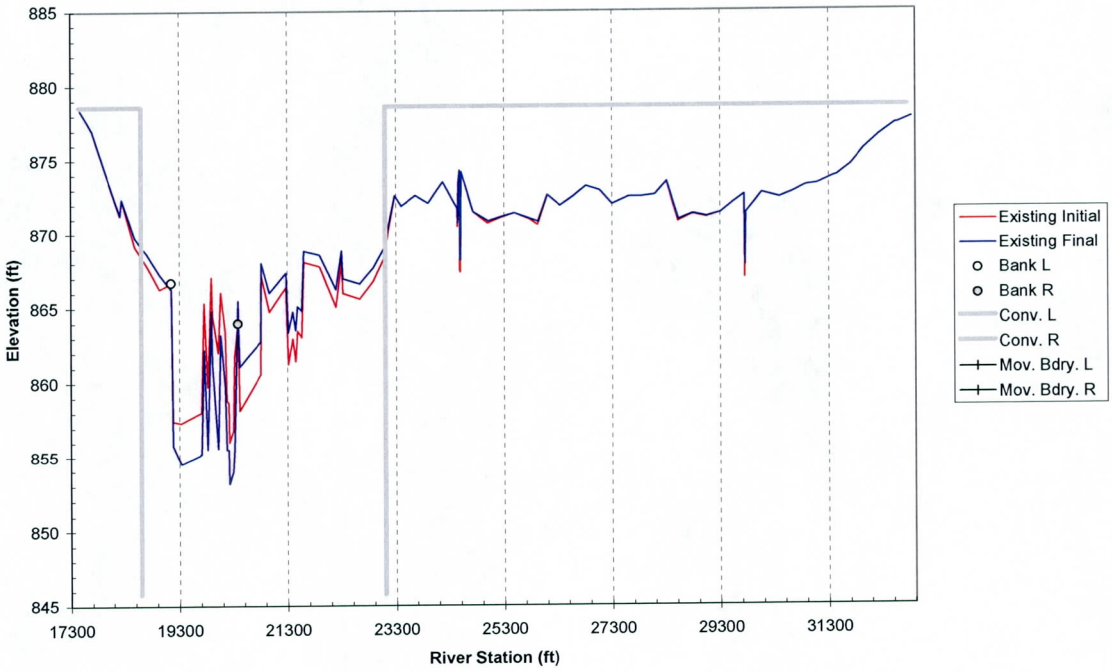

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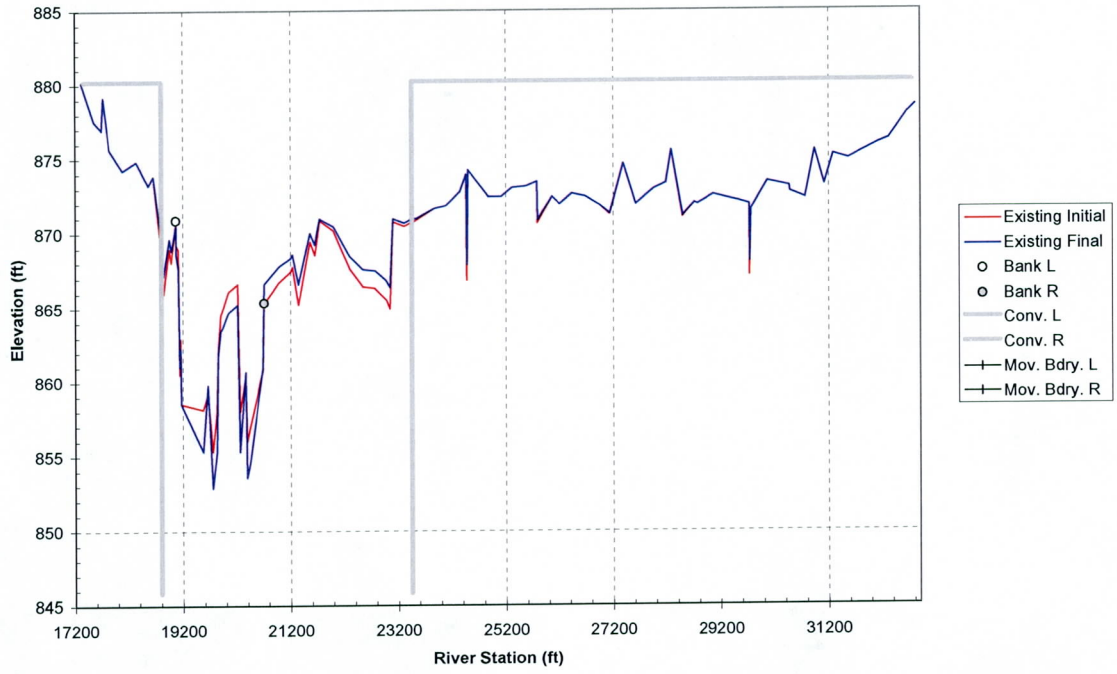
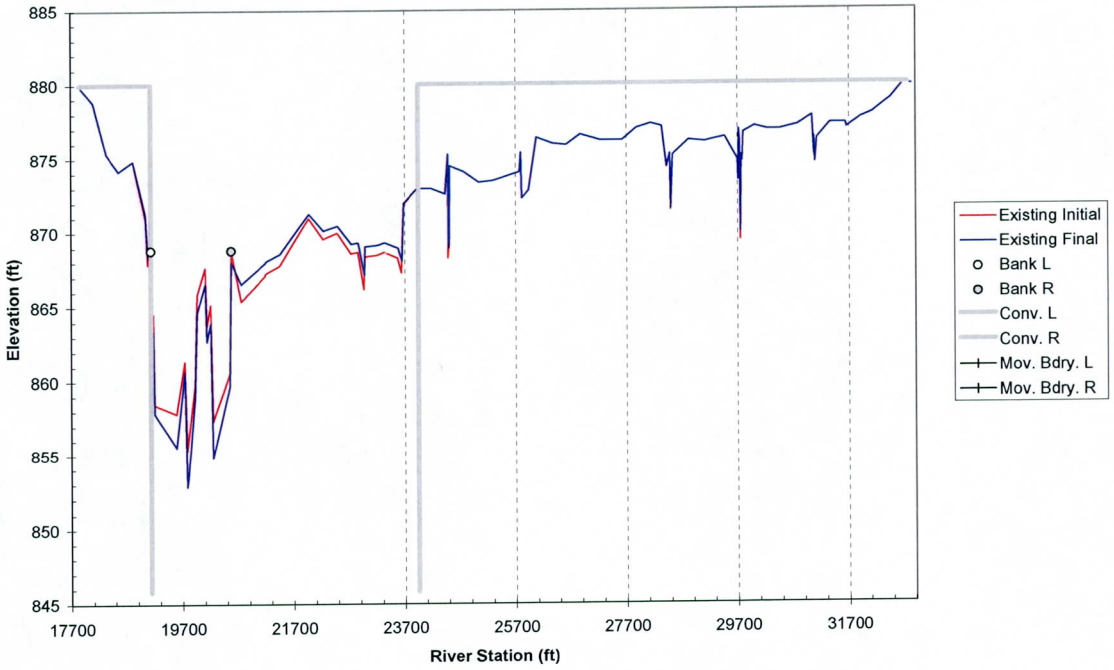


Cross Section 187.82



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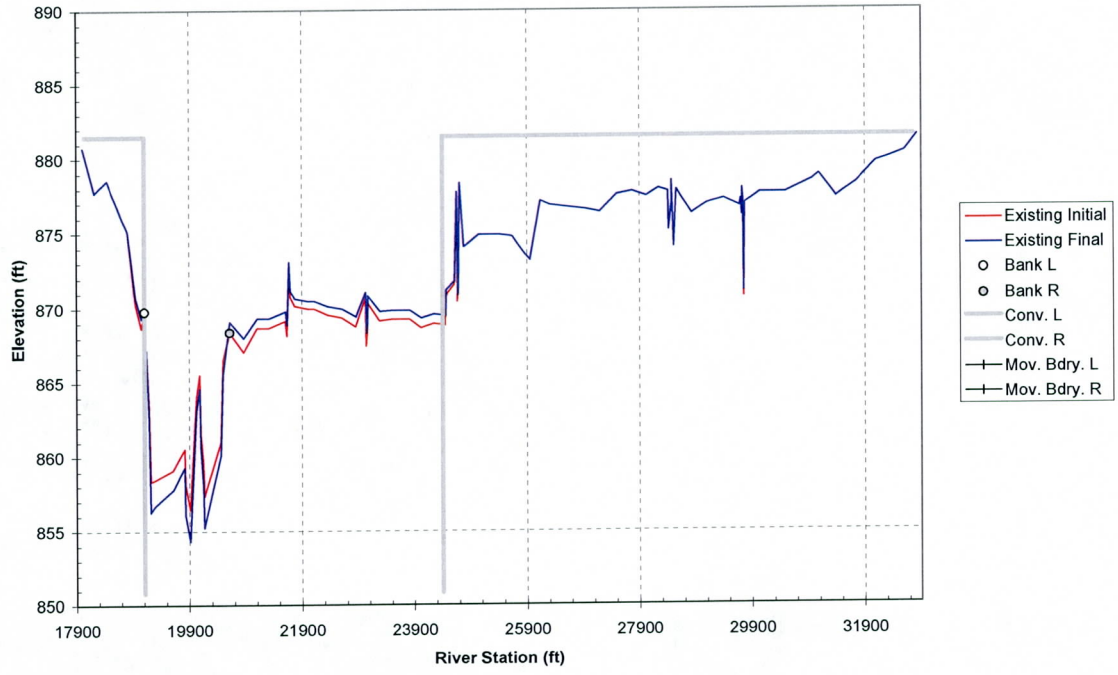

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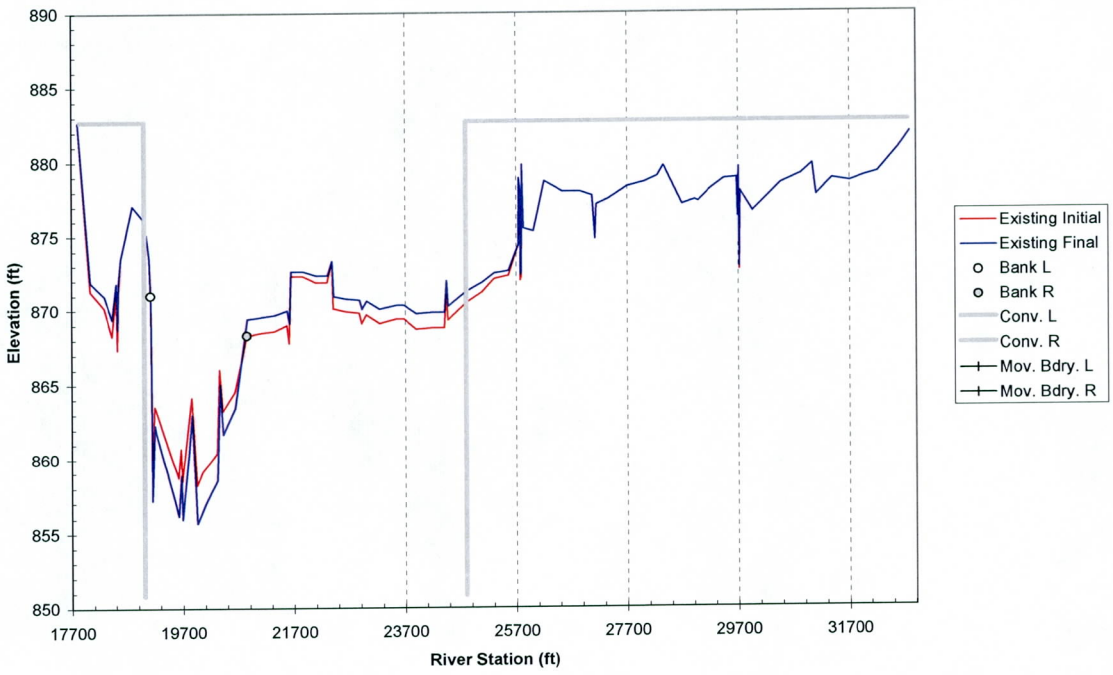

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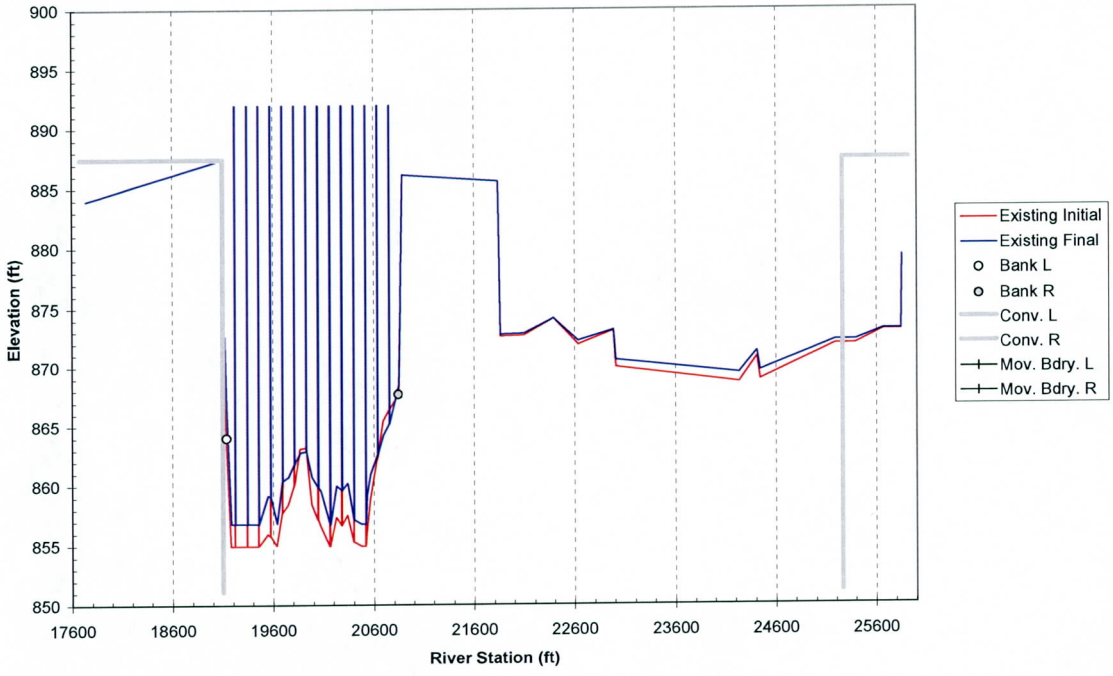
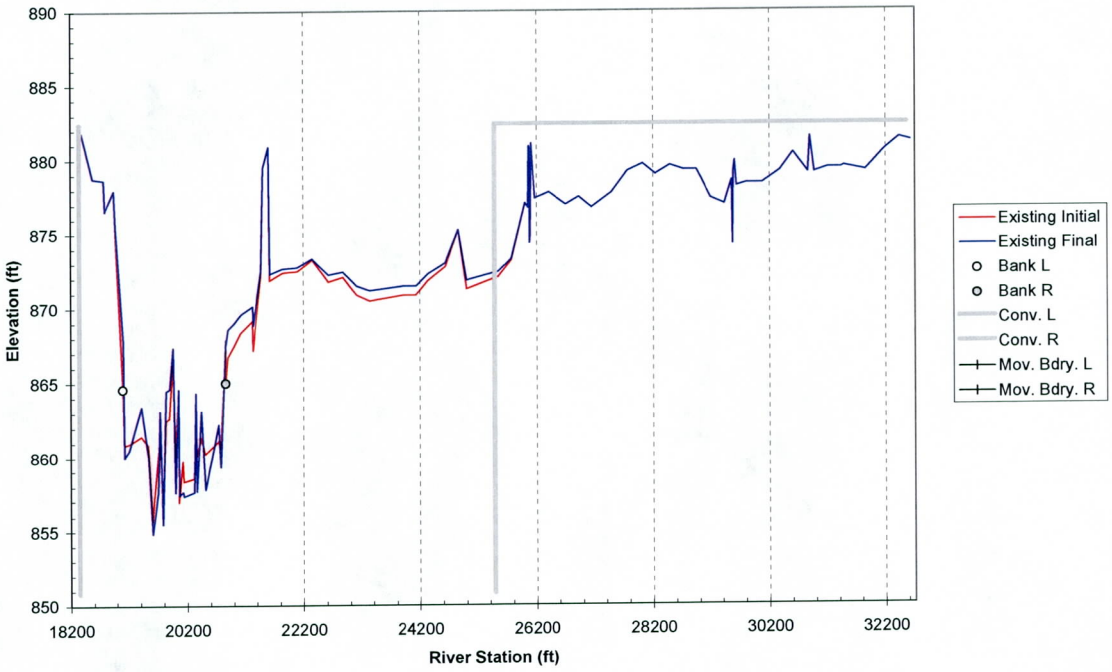


Cross Section 188.10



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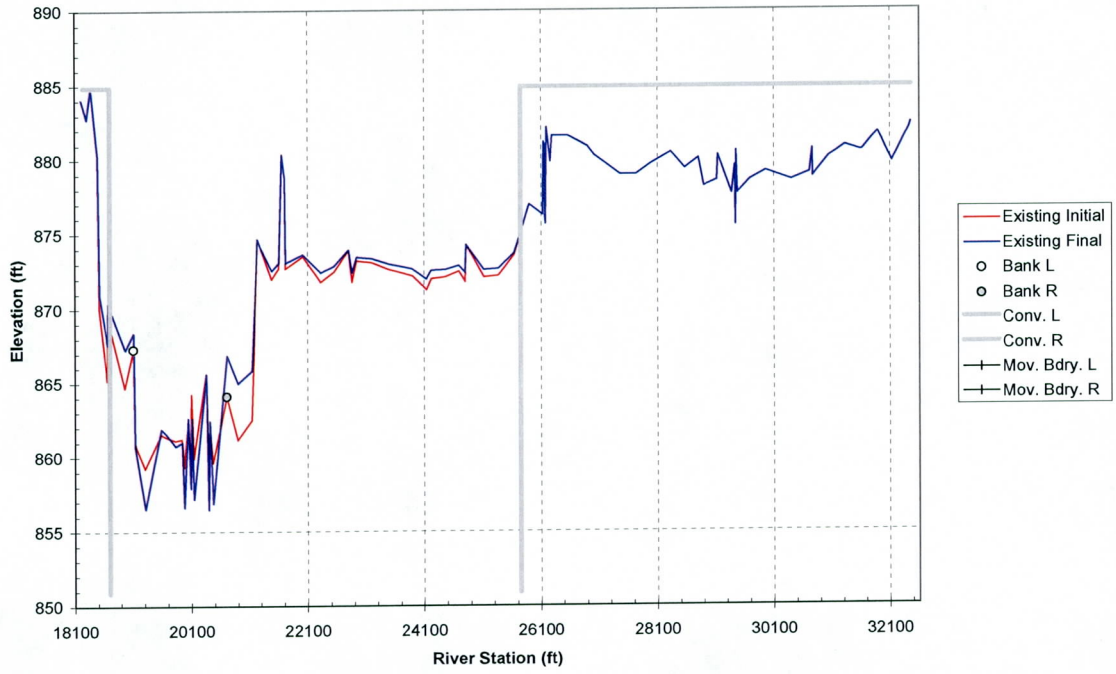

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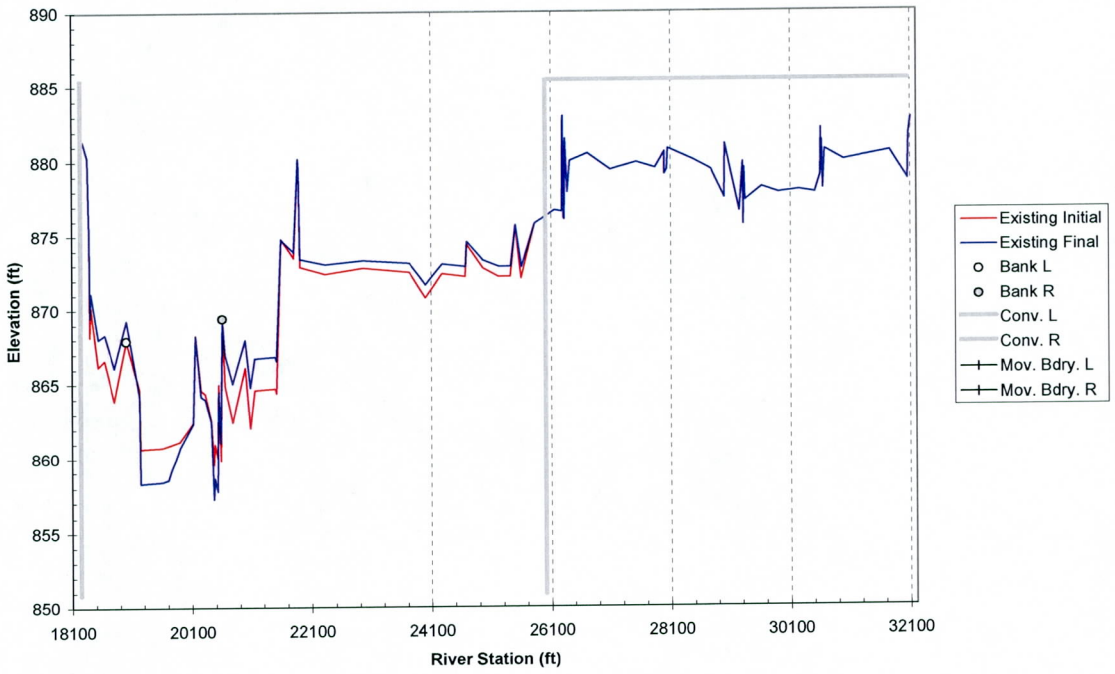

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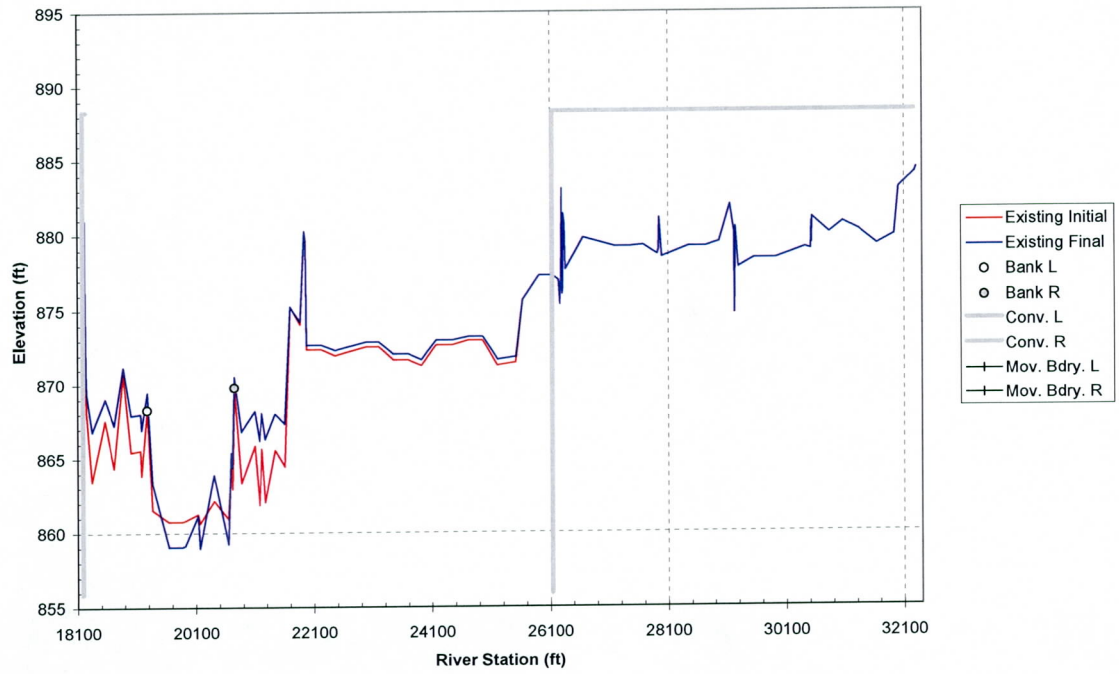

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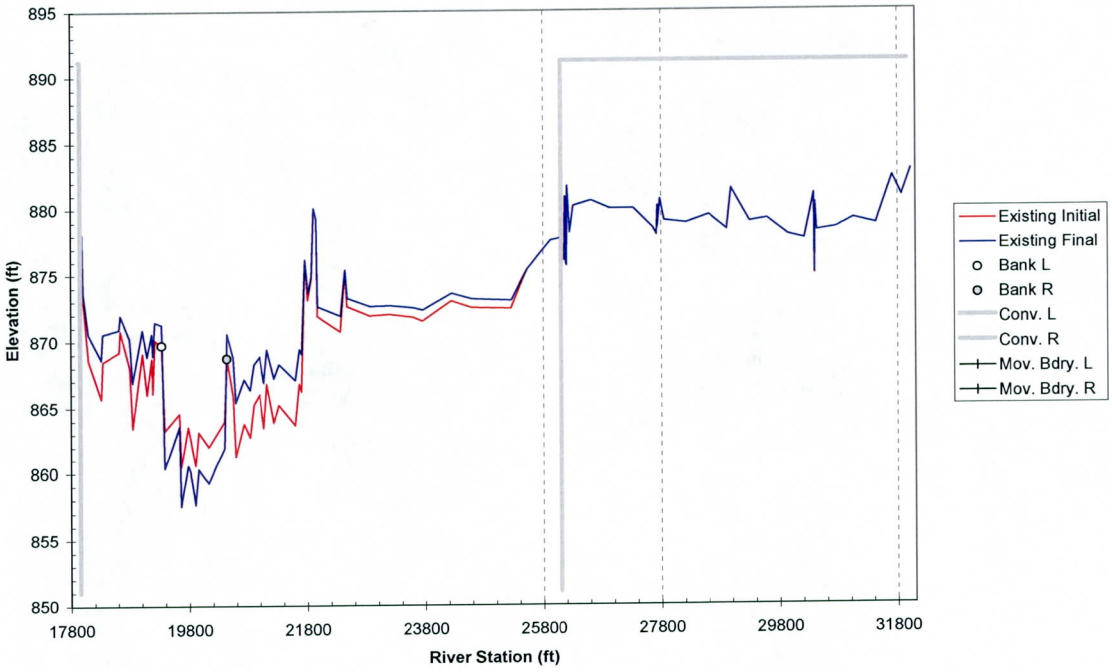

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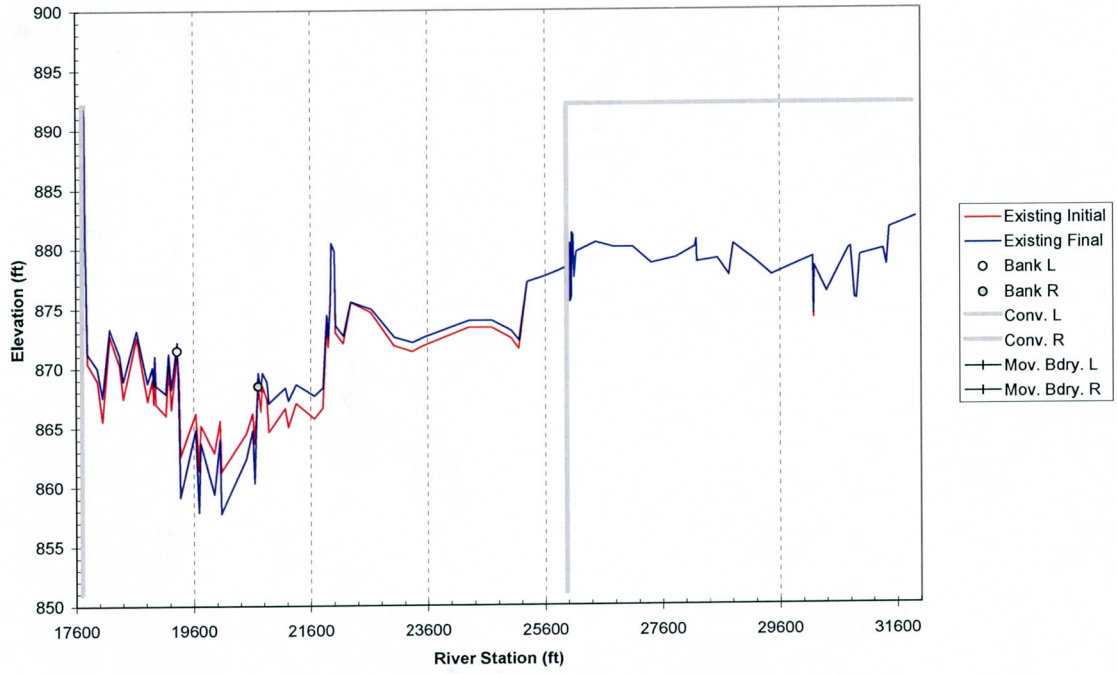

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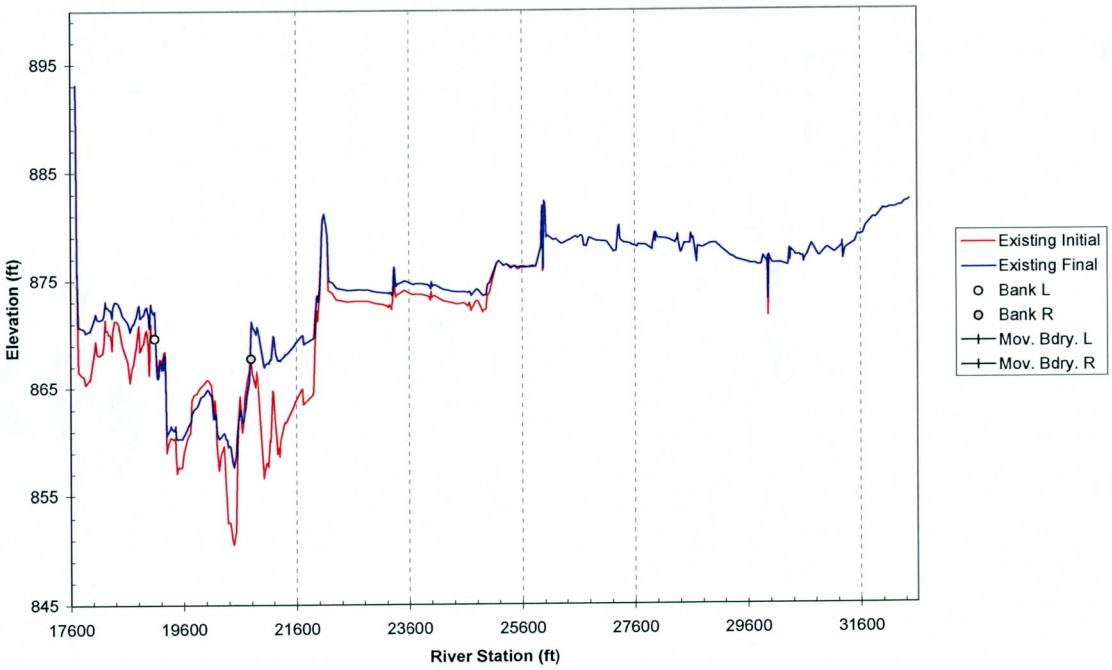

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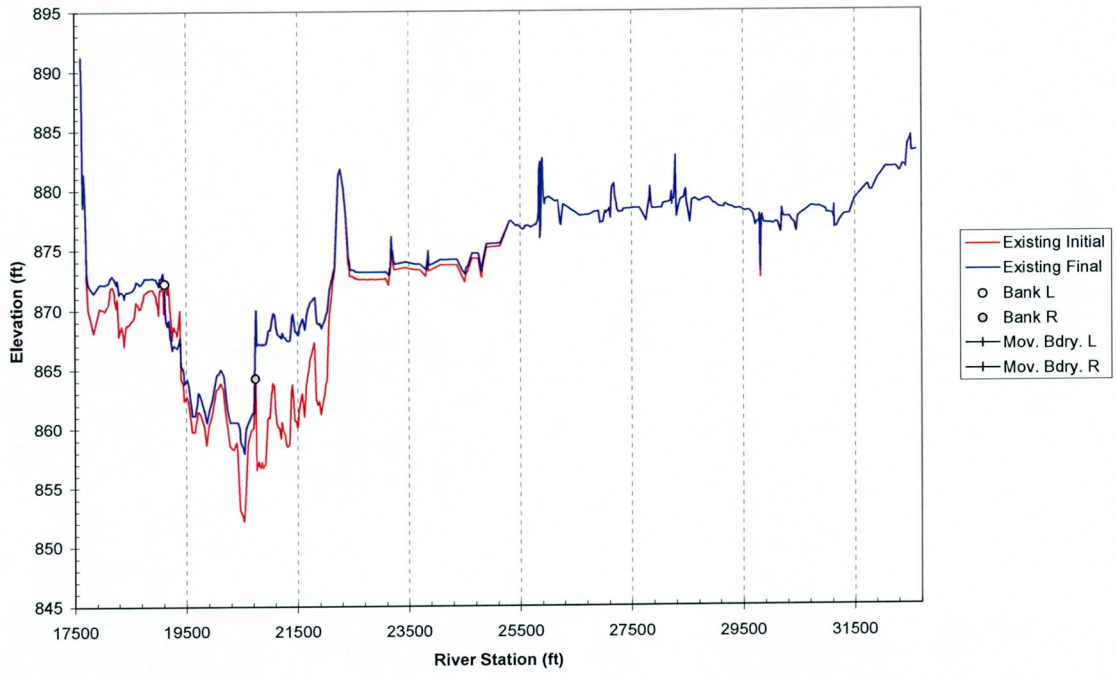

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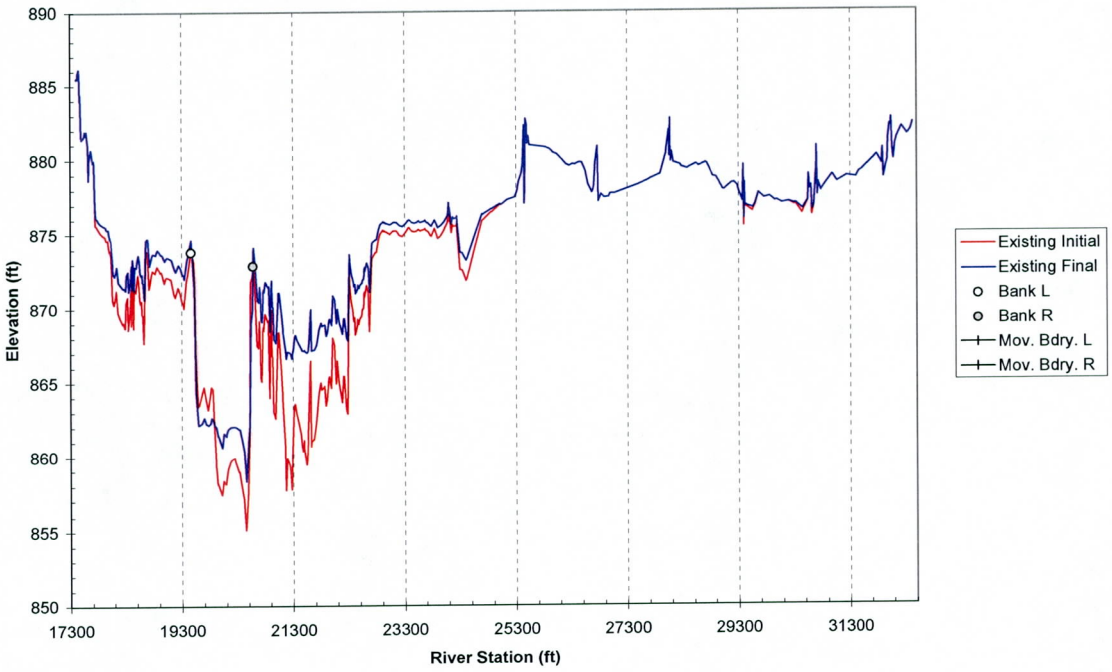

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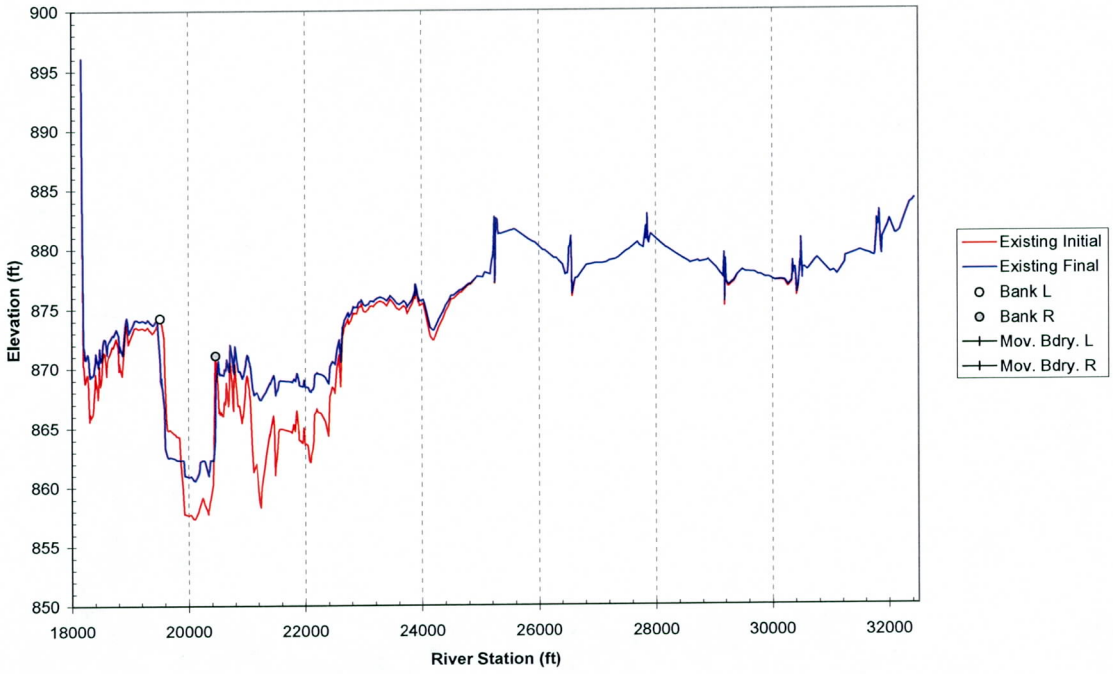

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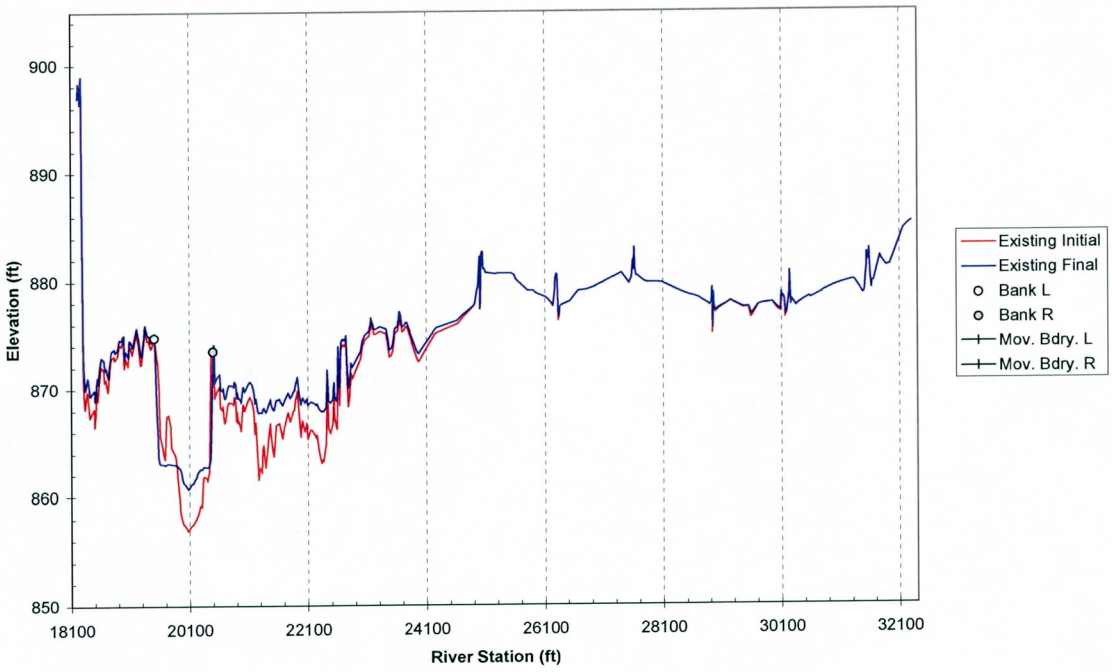

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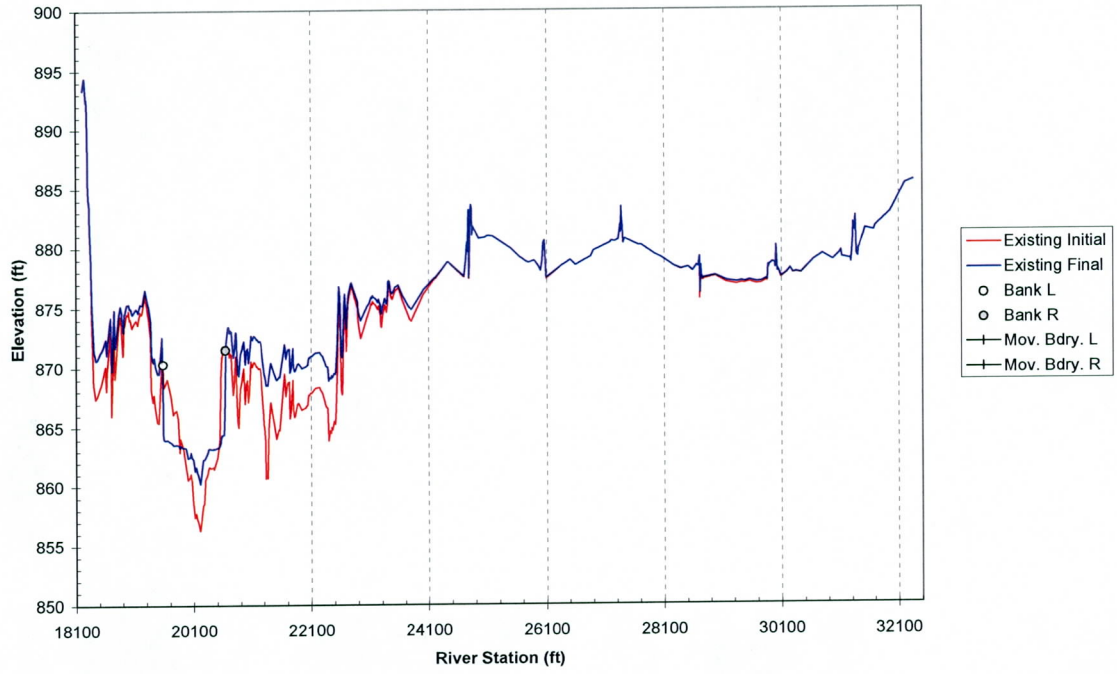

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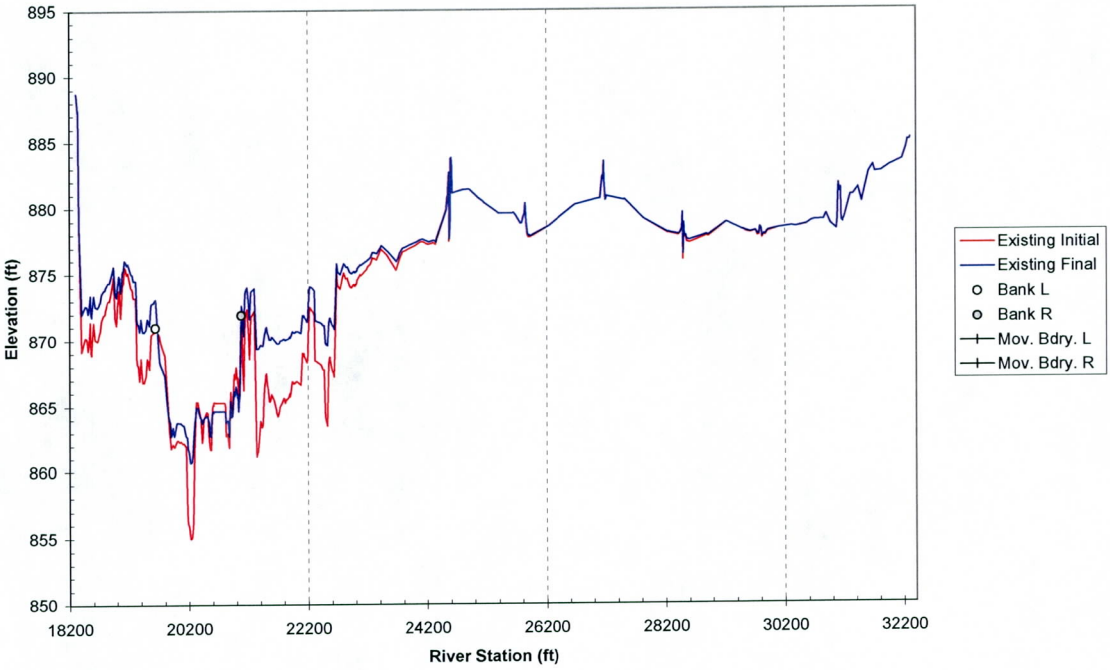

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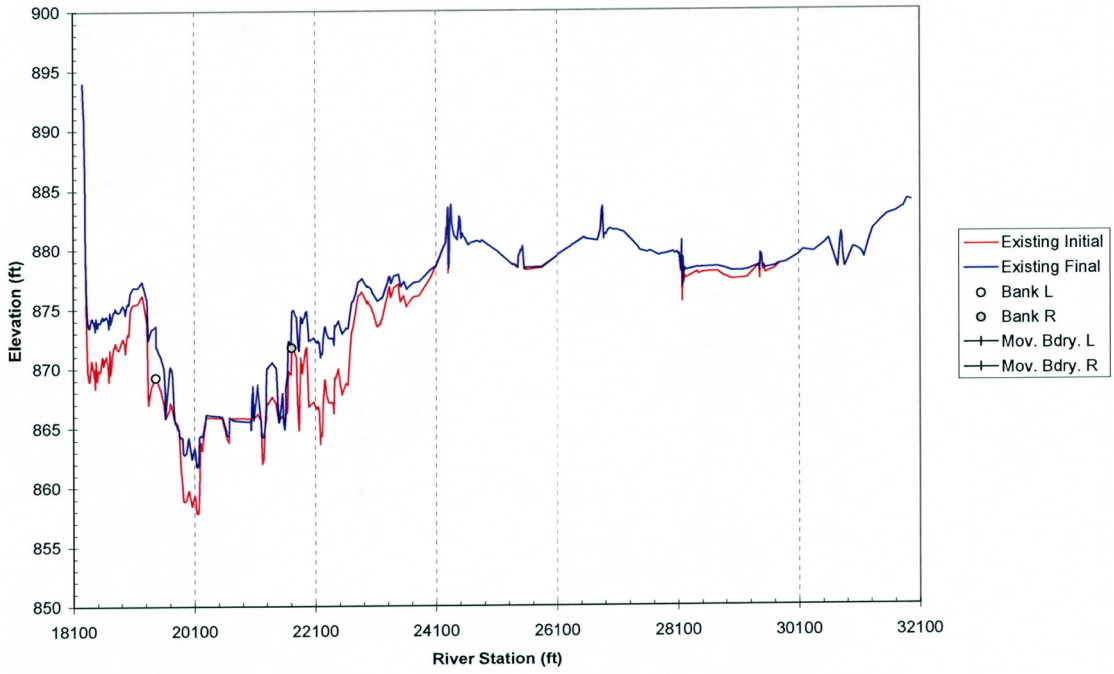

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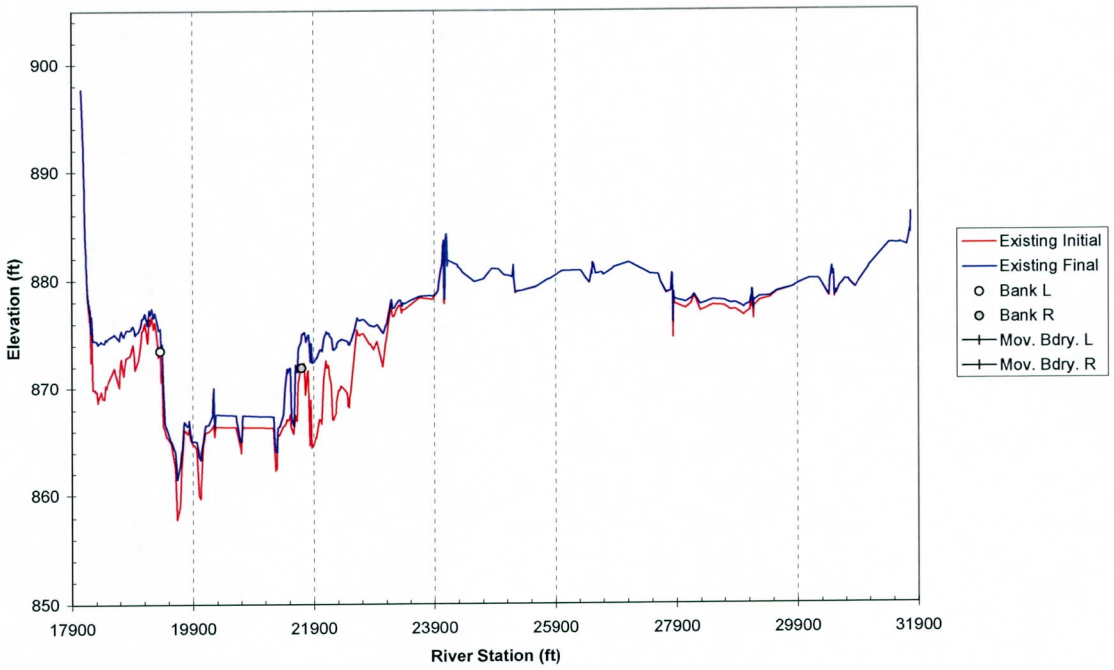

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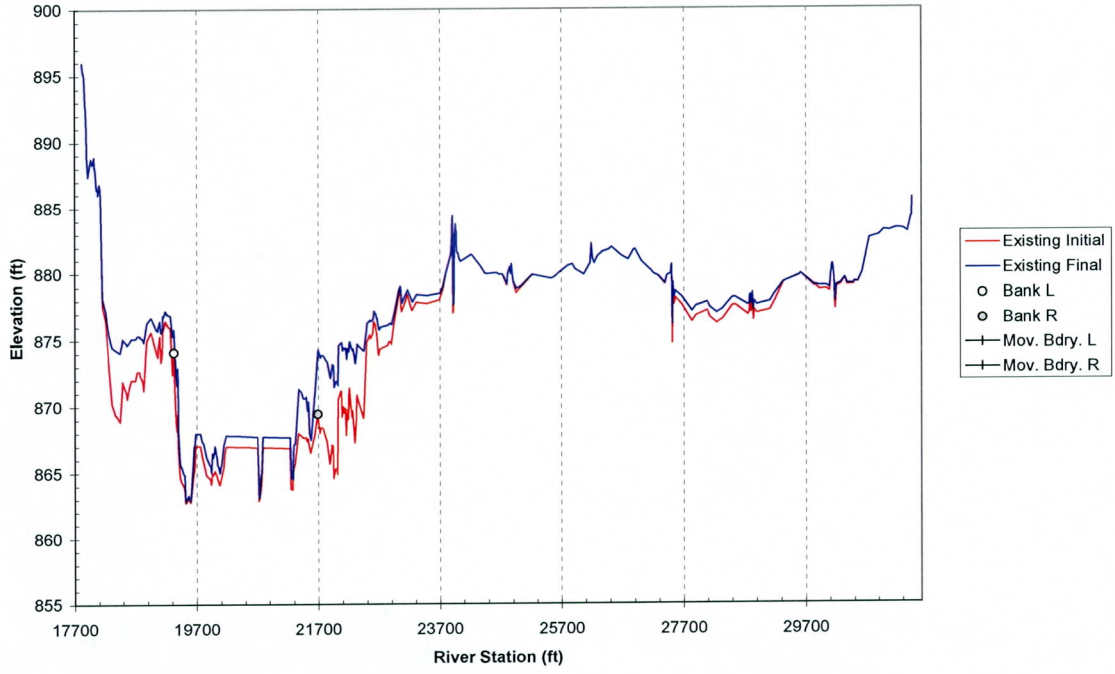

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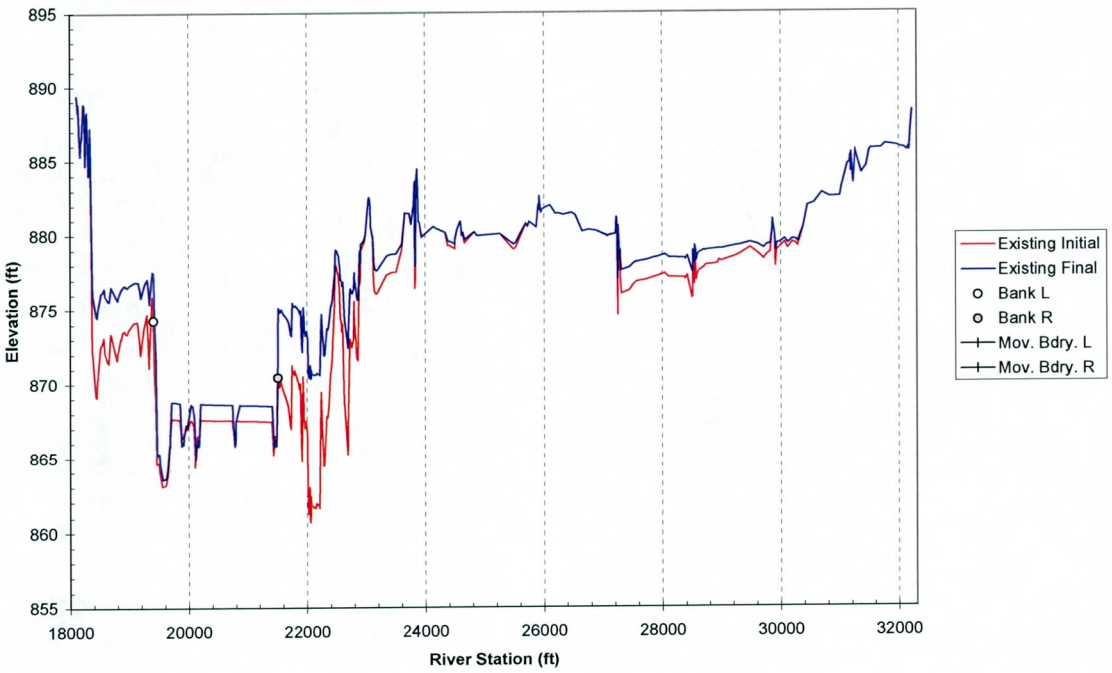

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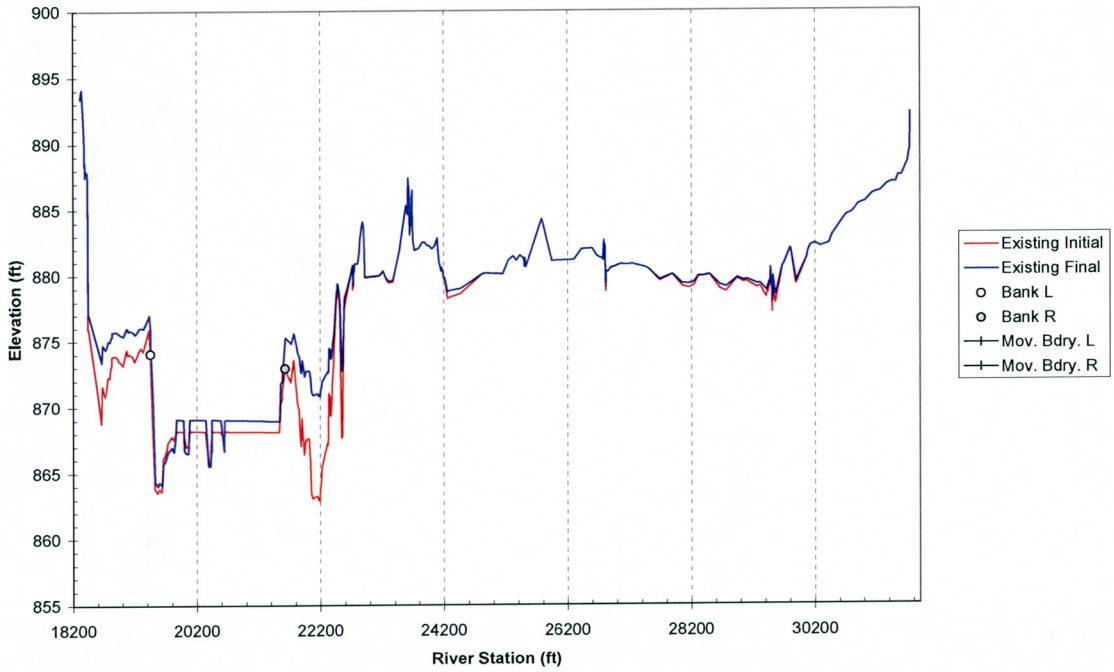

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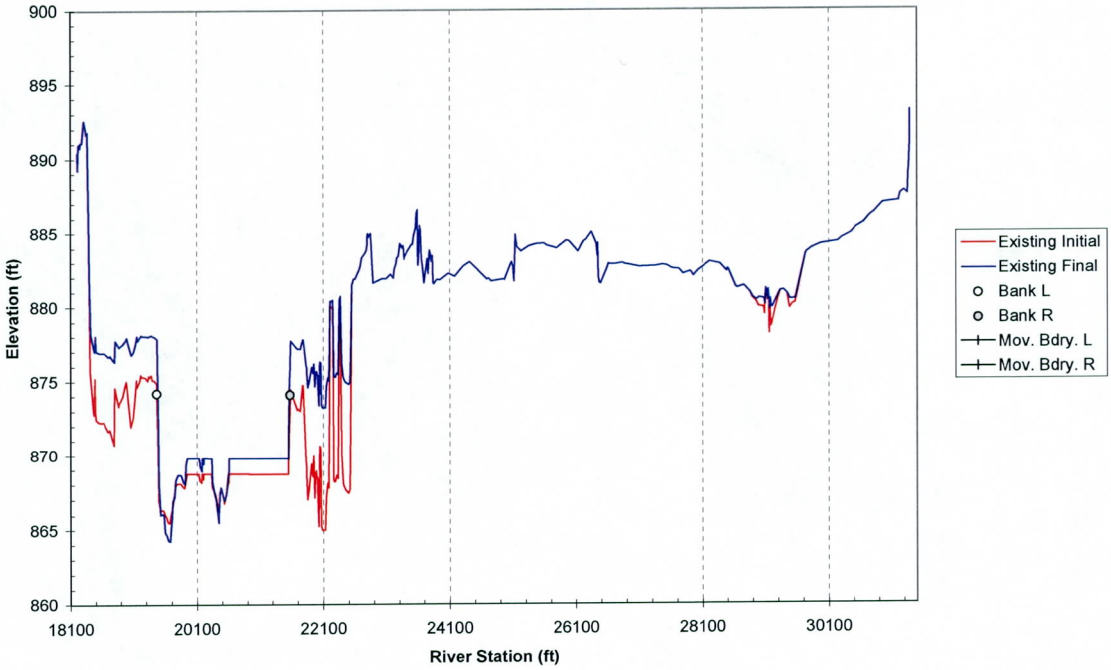

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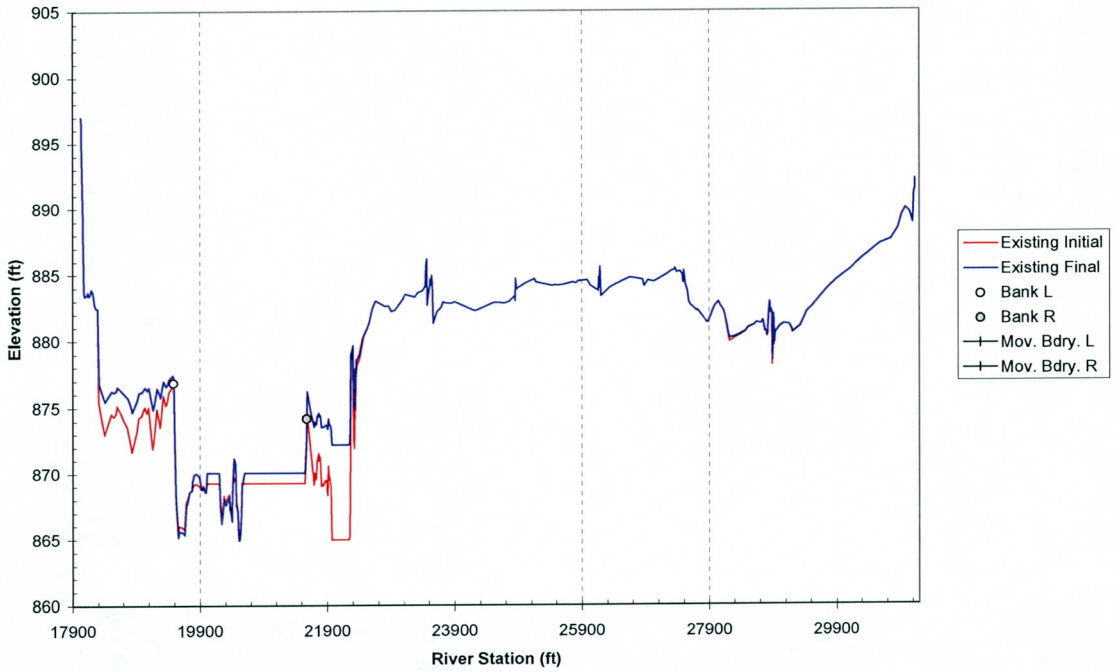

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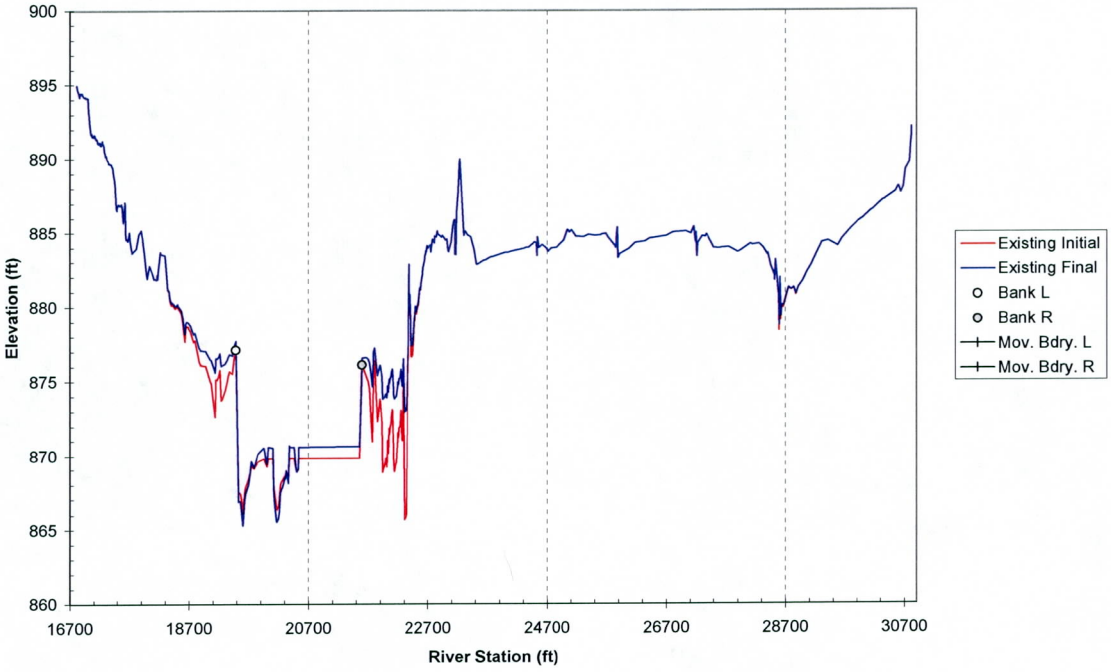

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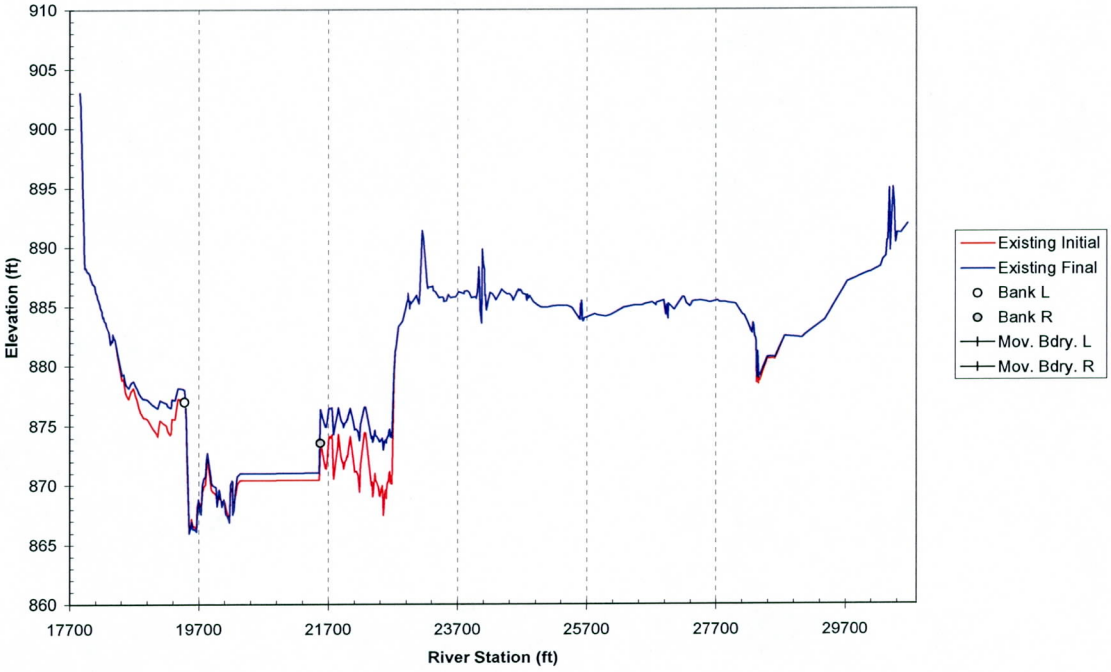

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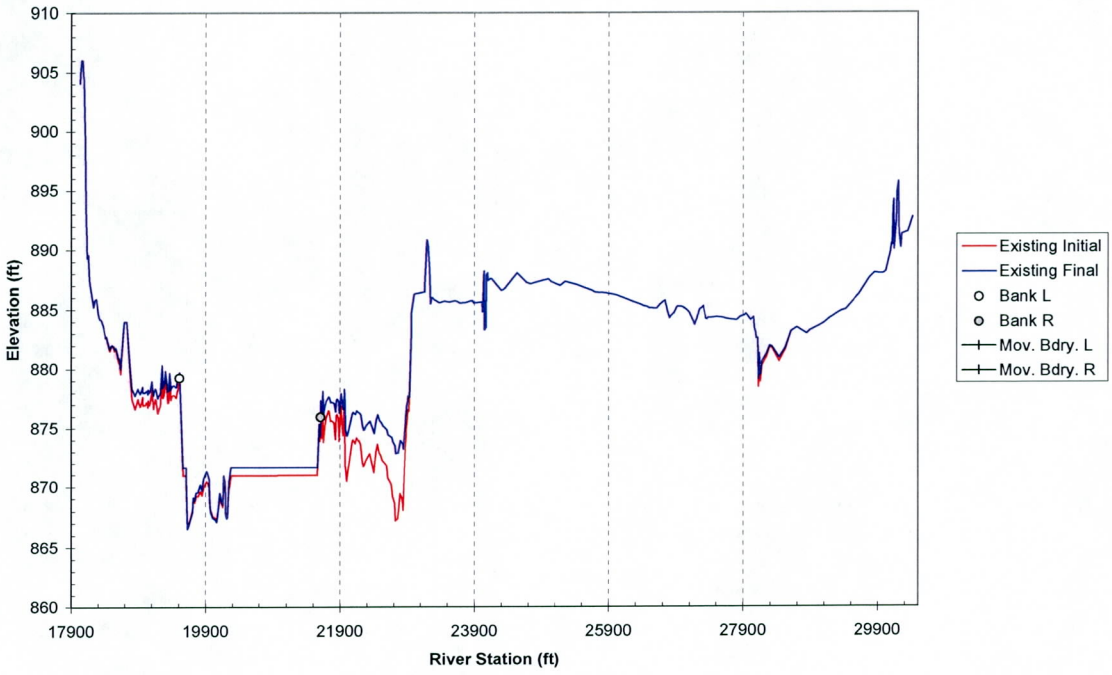

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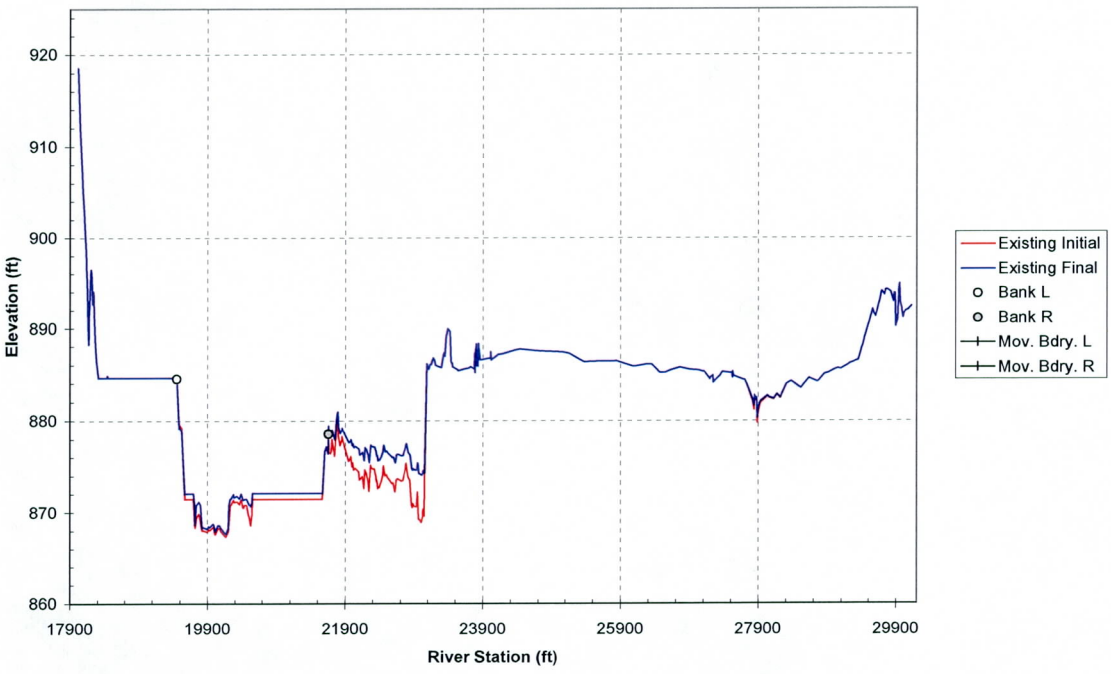

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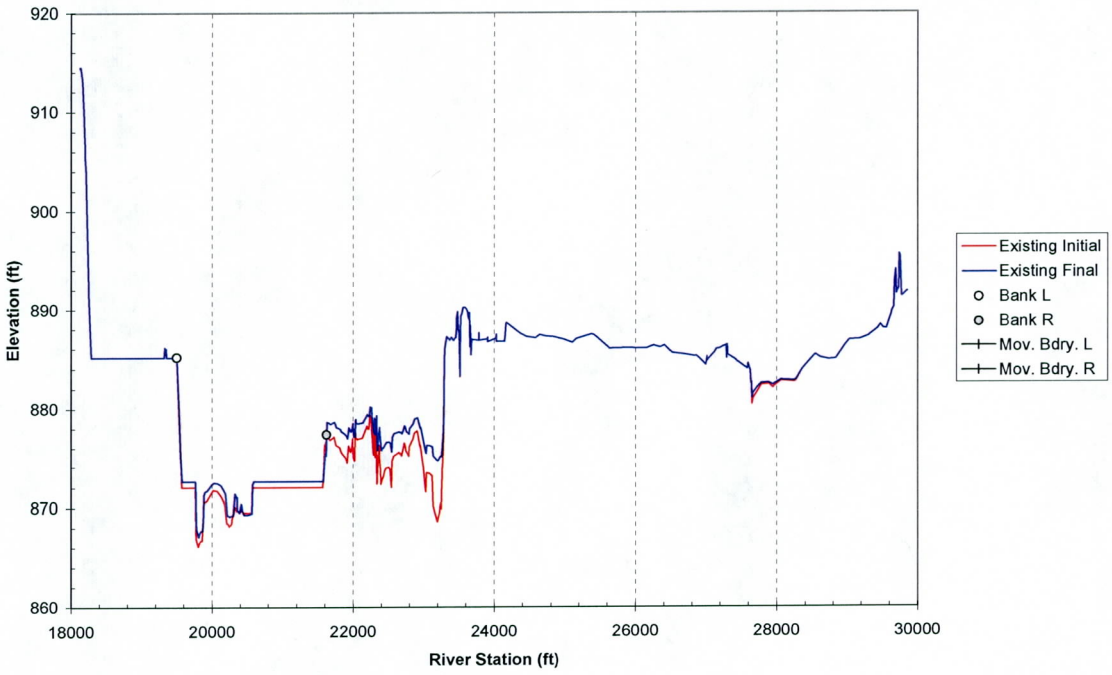

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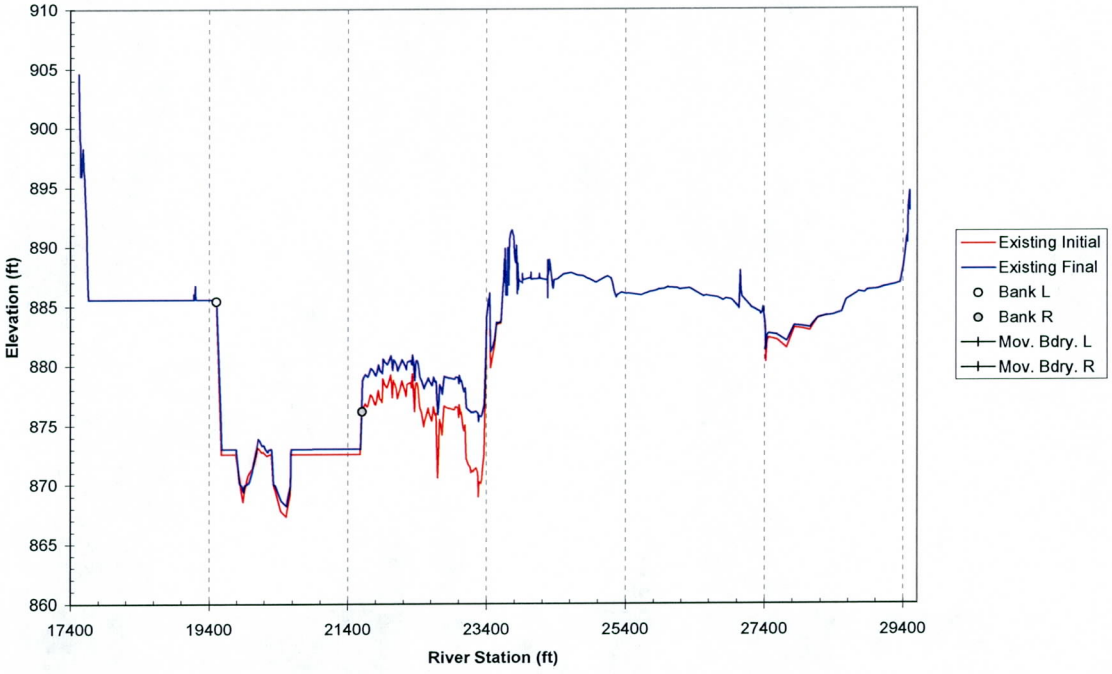

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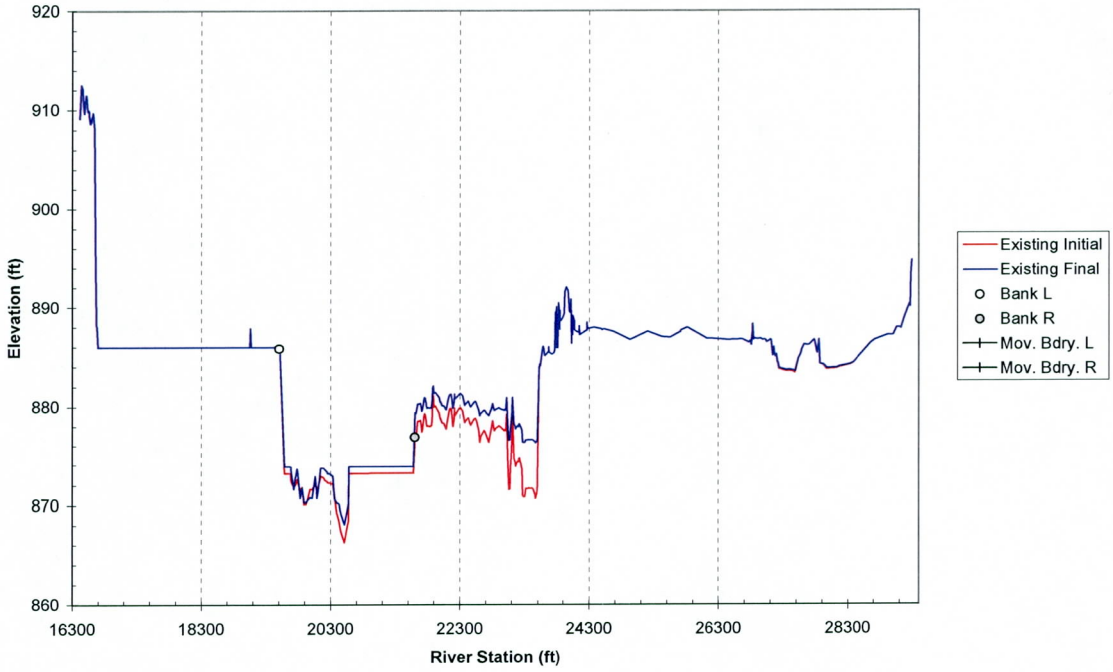

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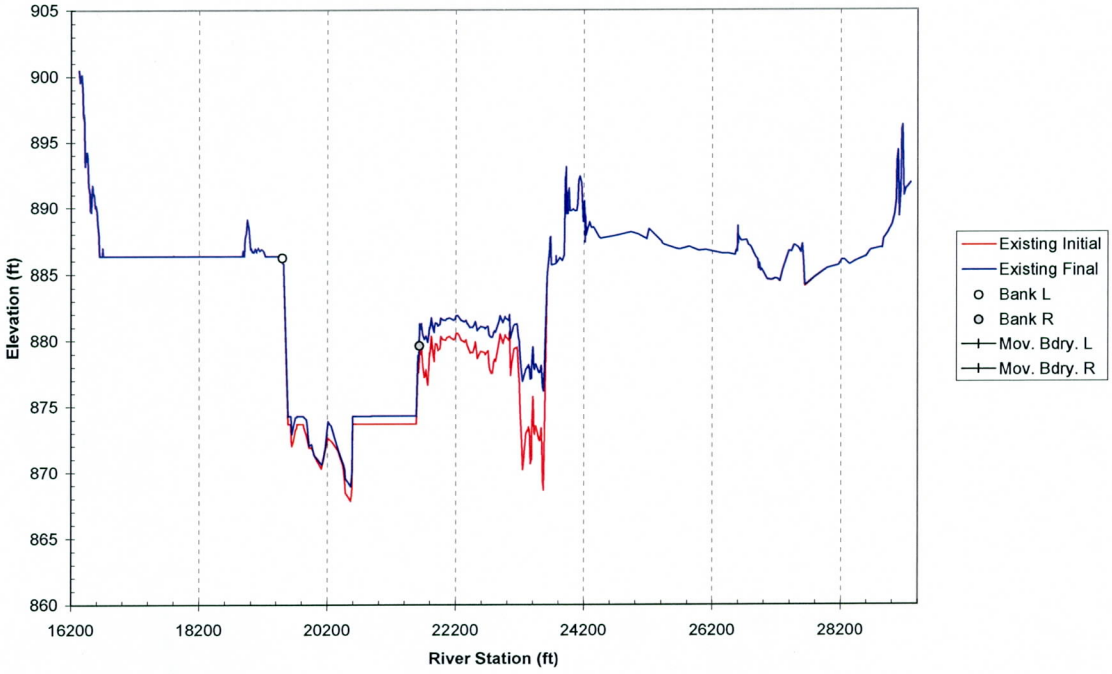

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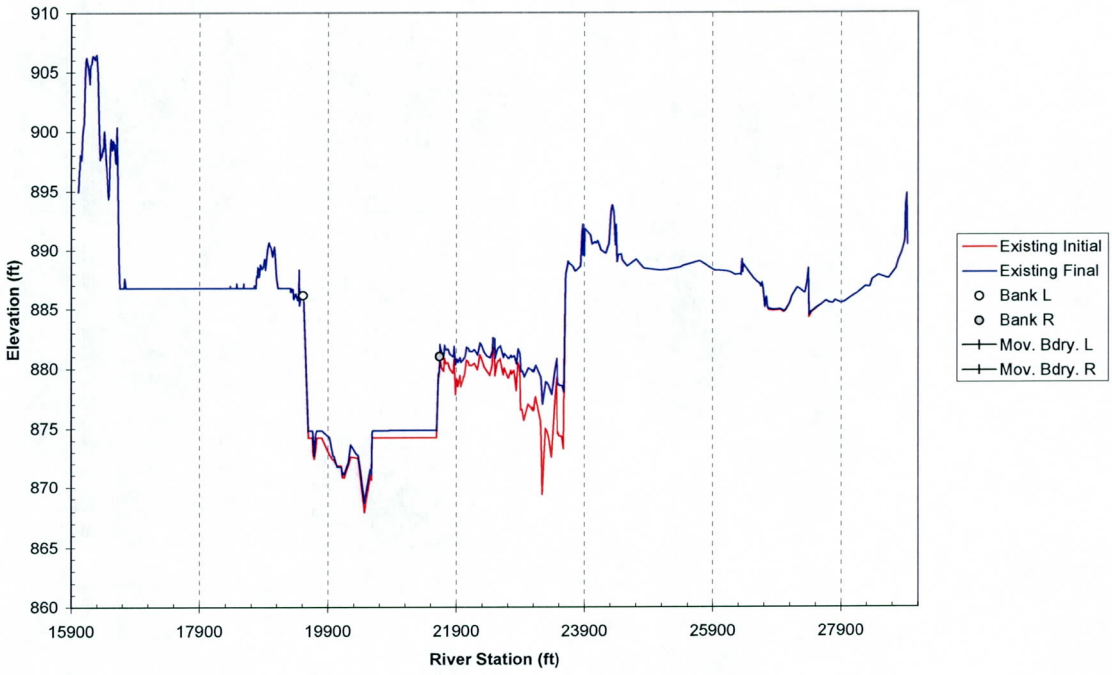

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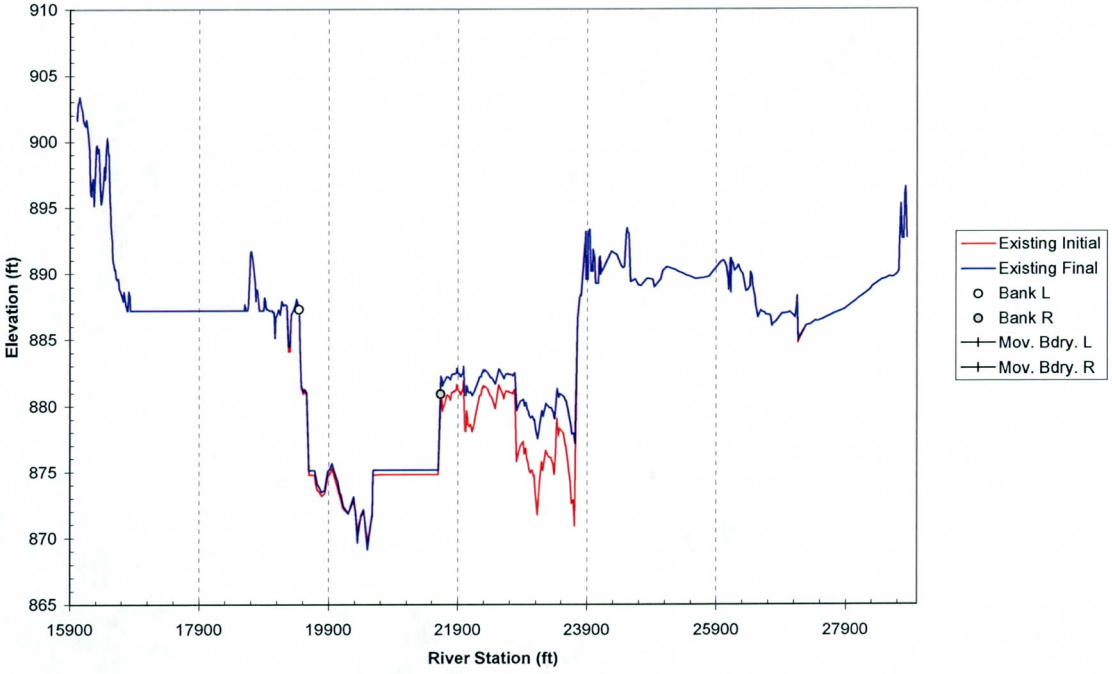

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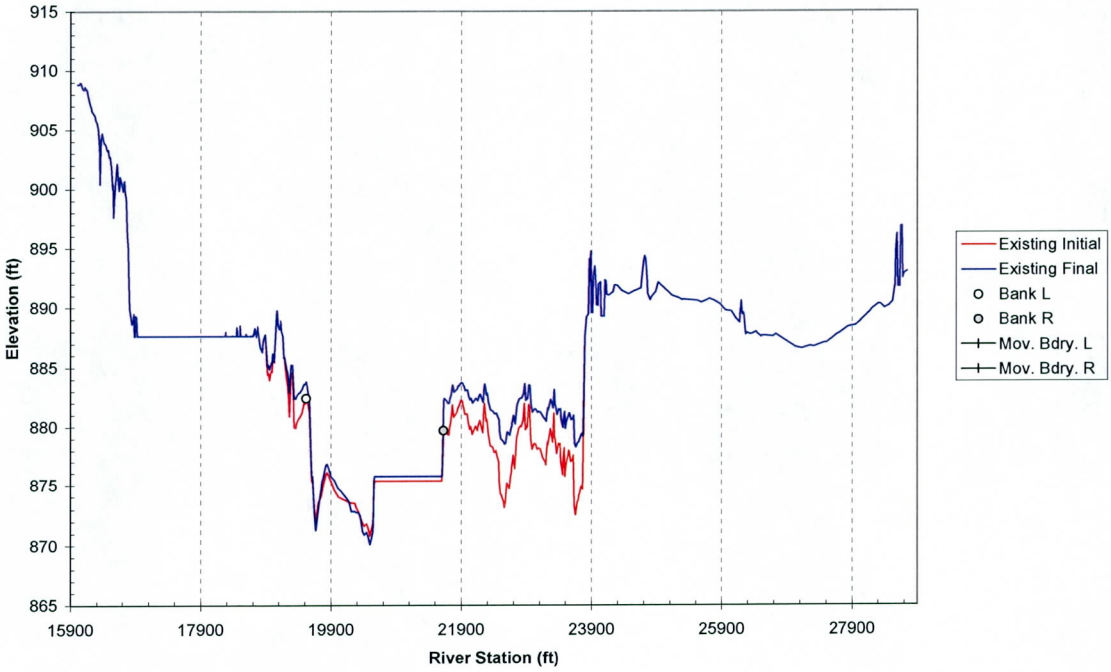

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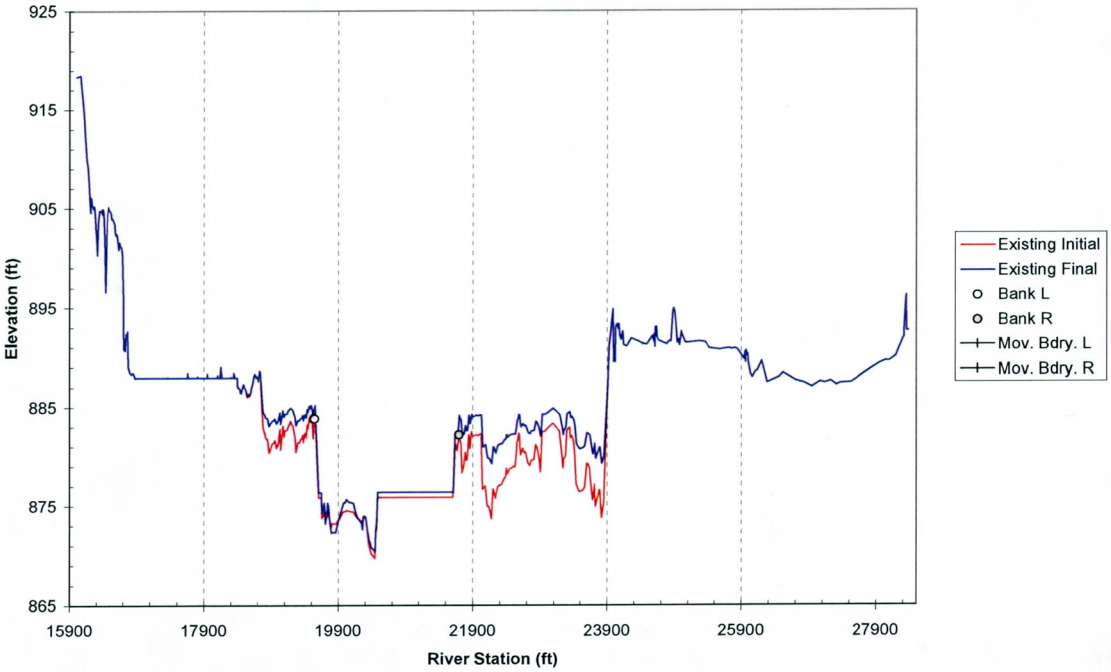

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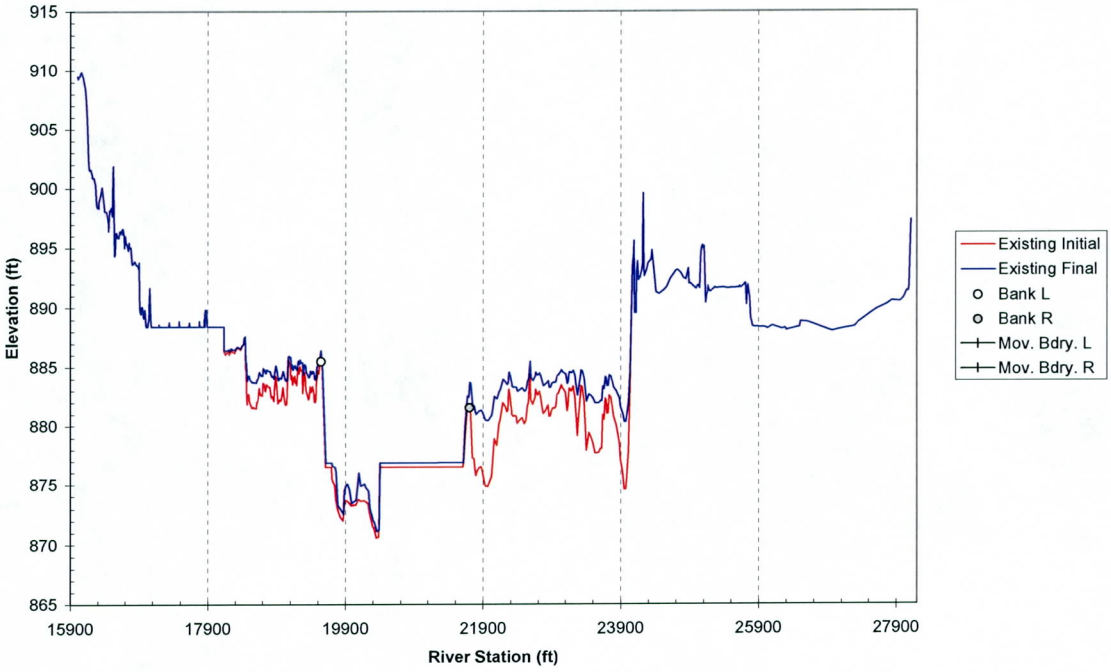

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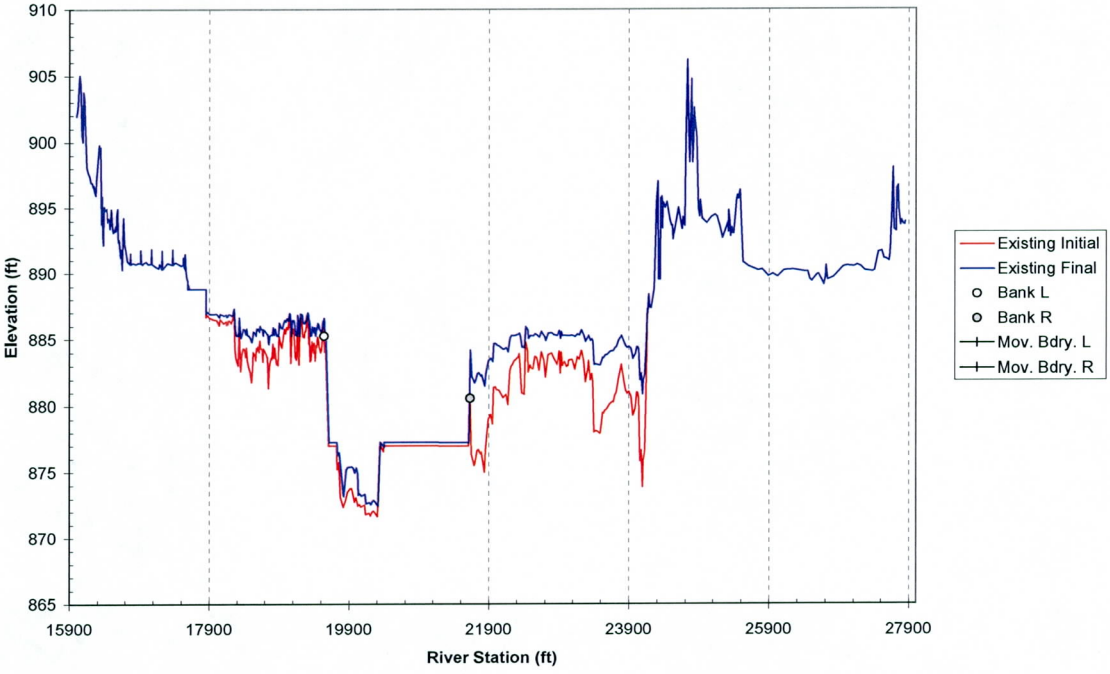

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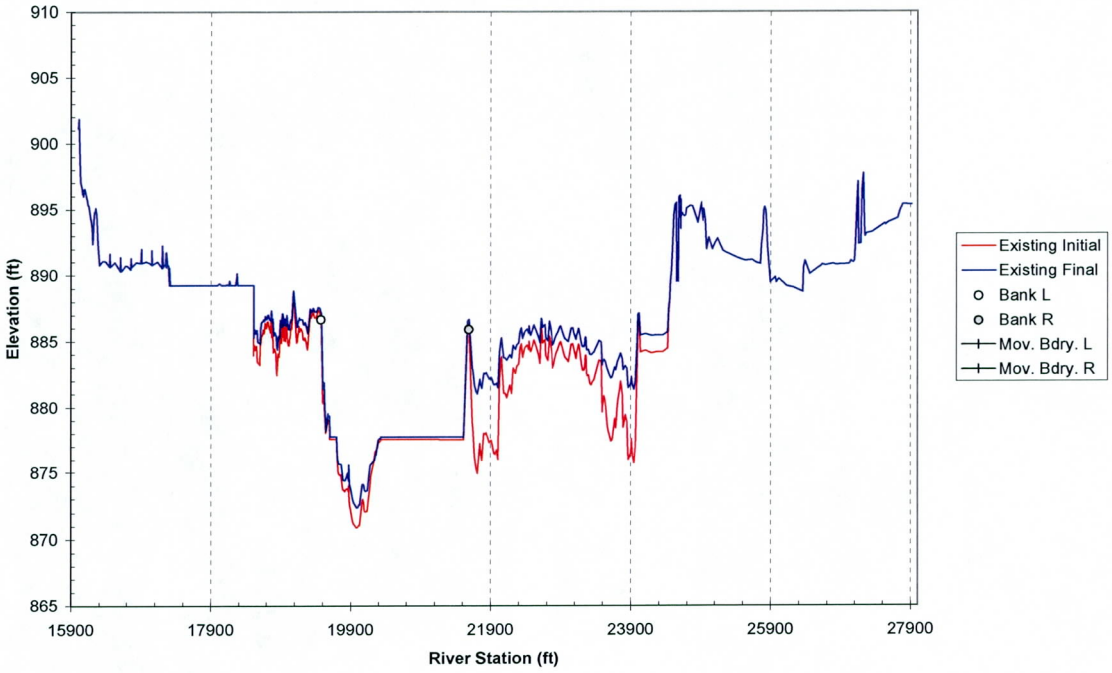

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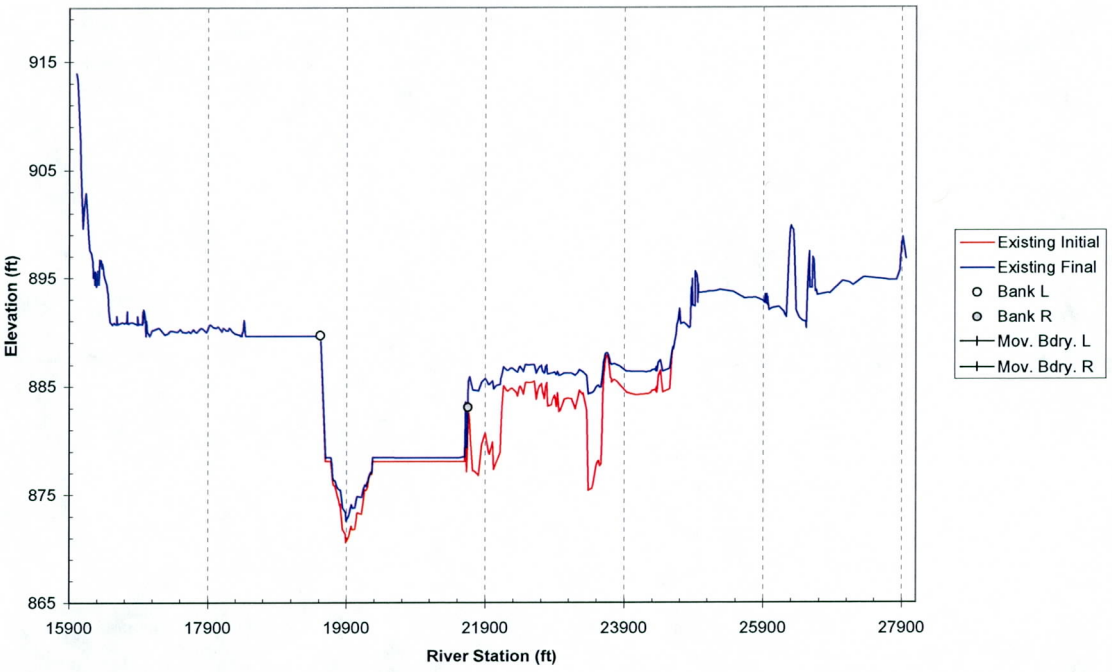

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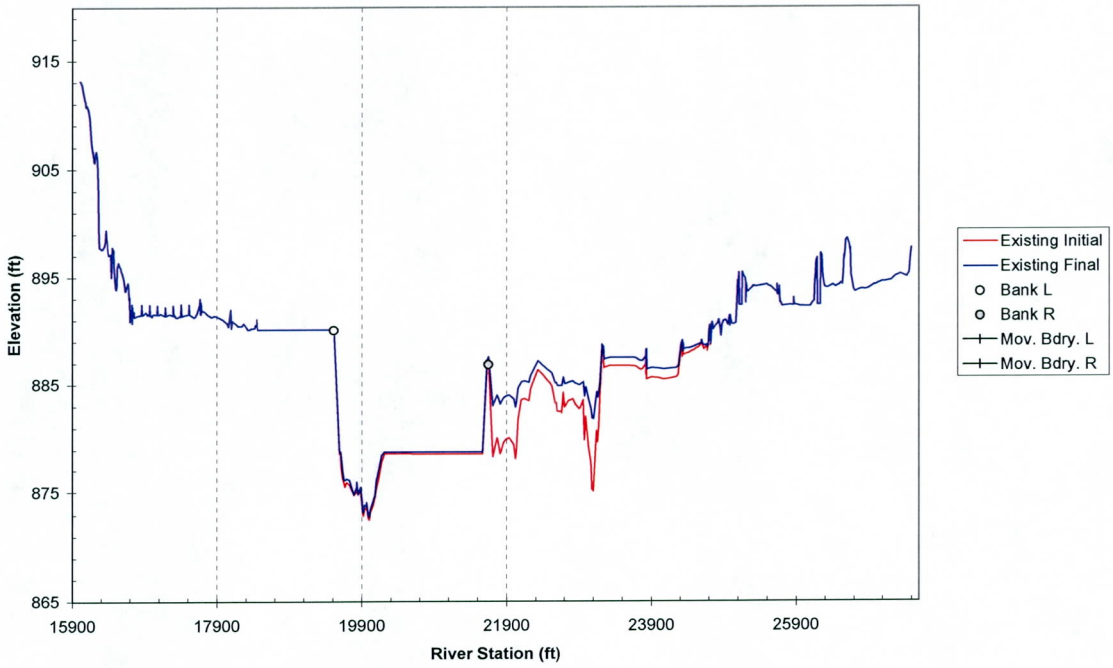

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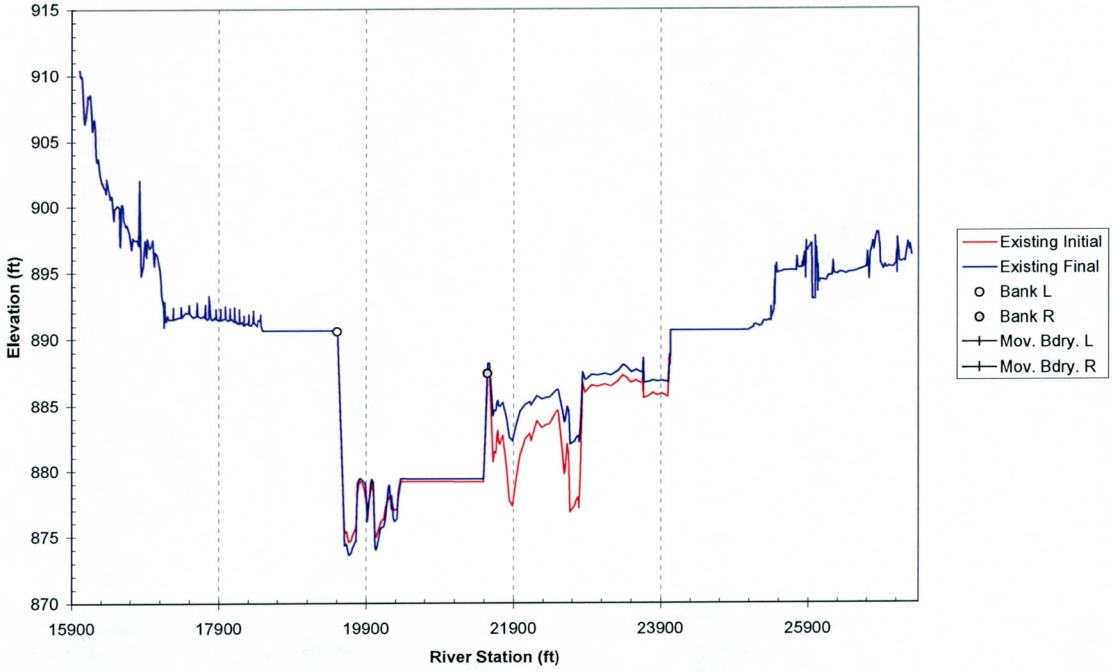

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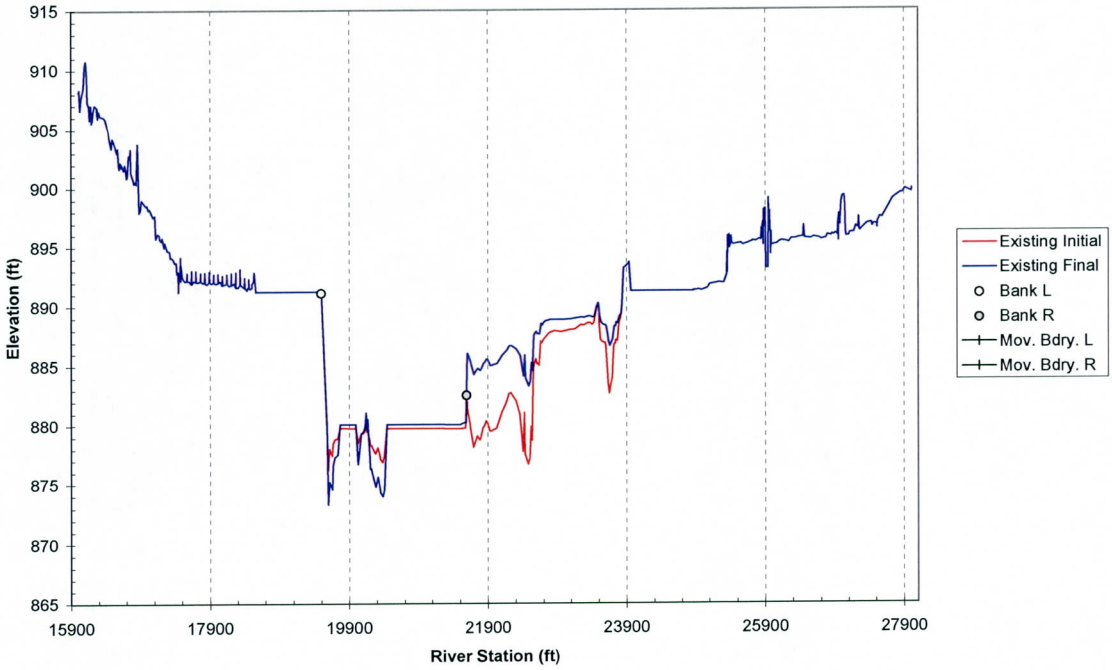

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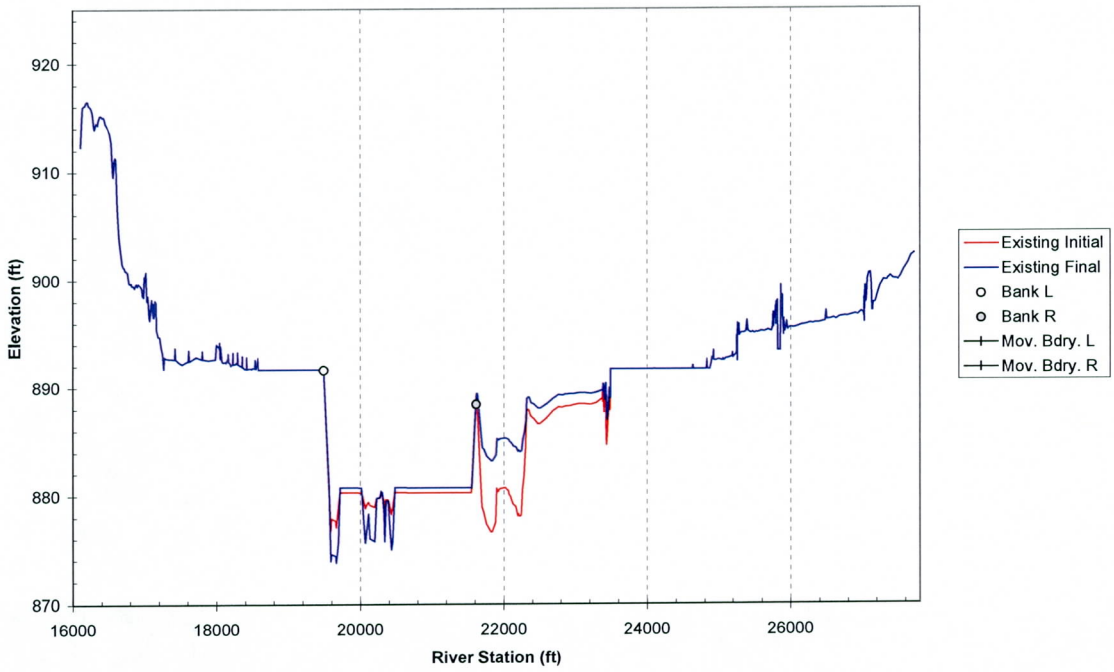

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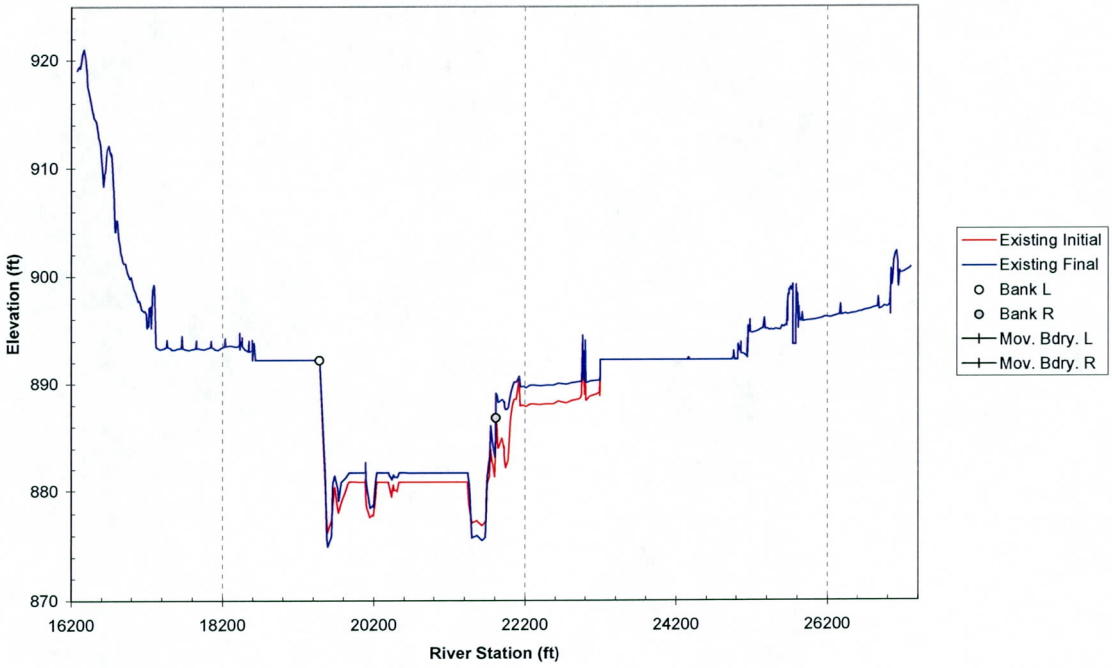

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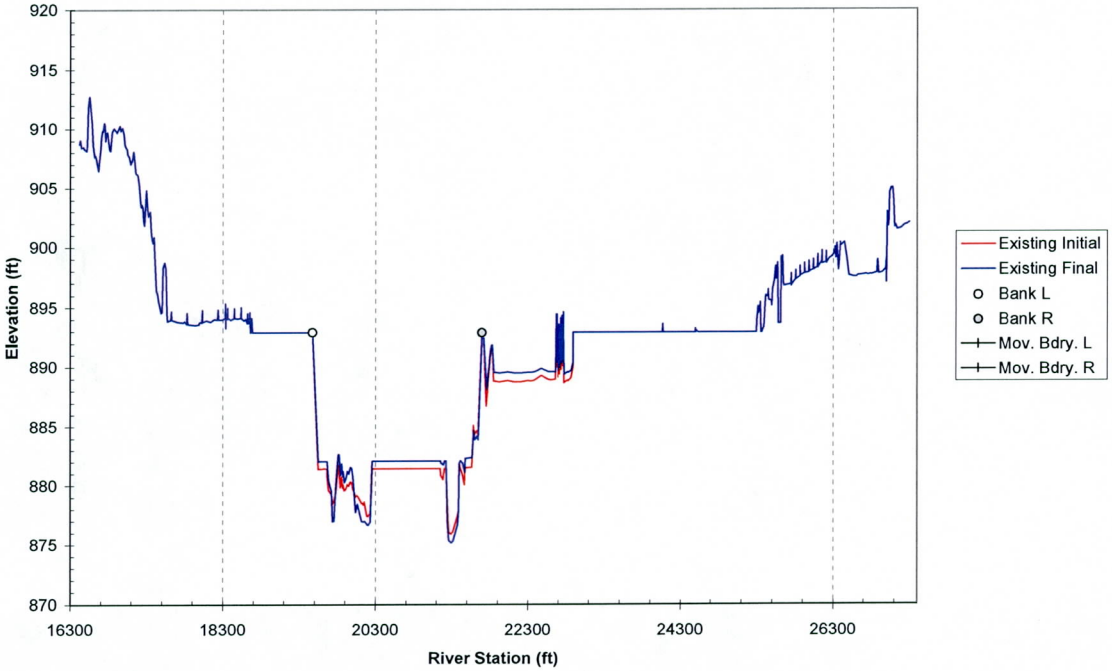

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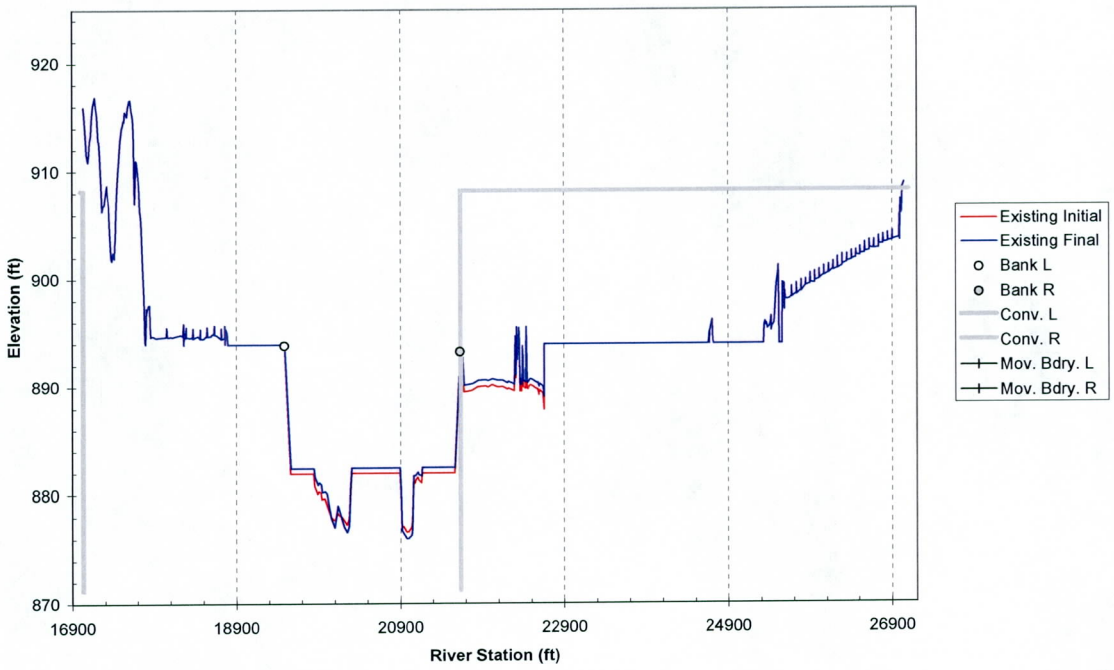

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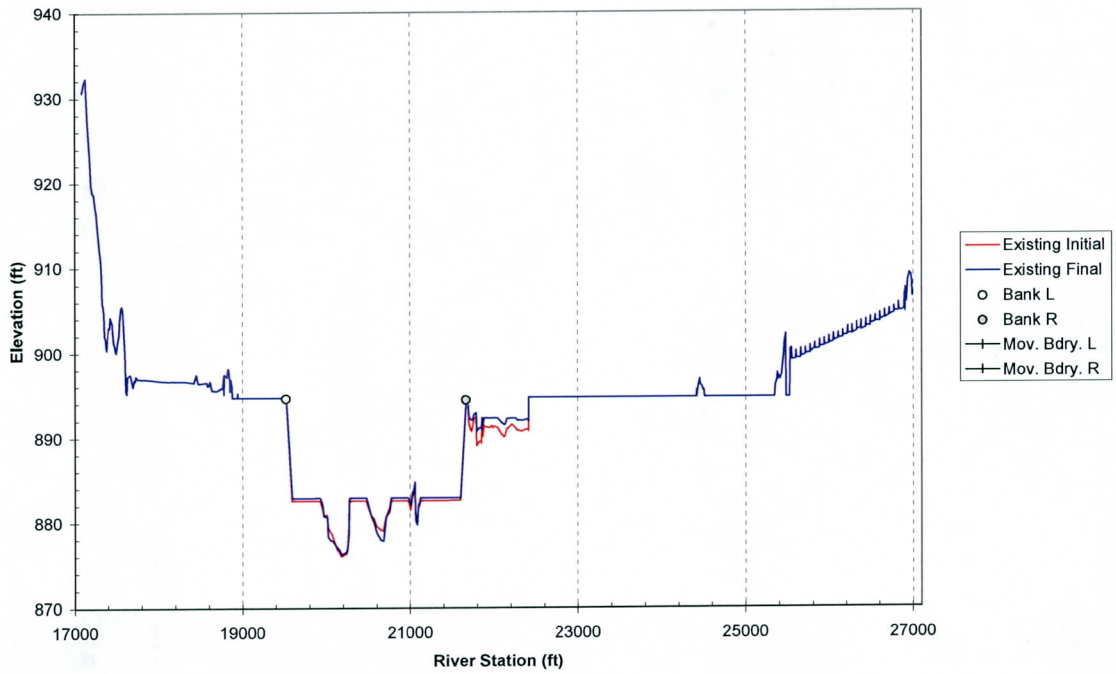

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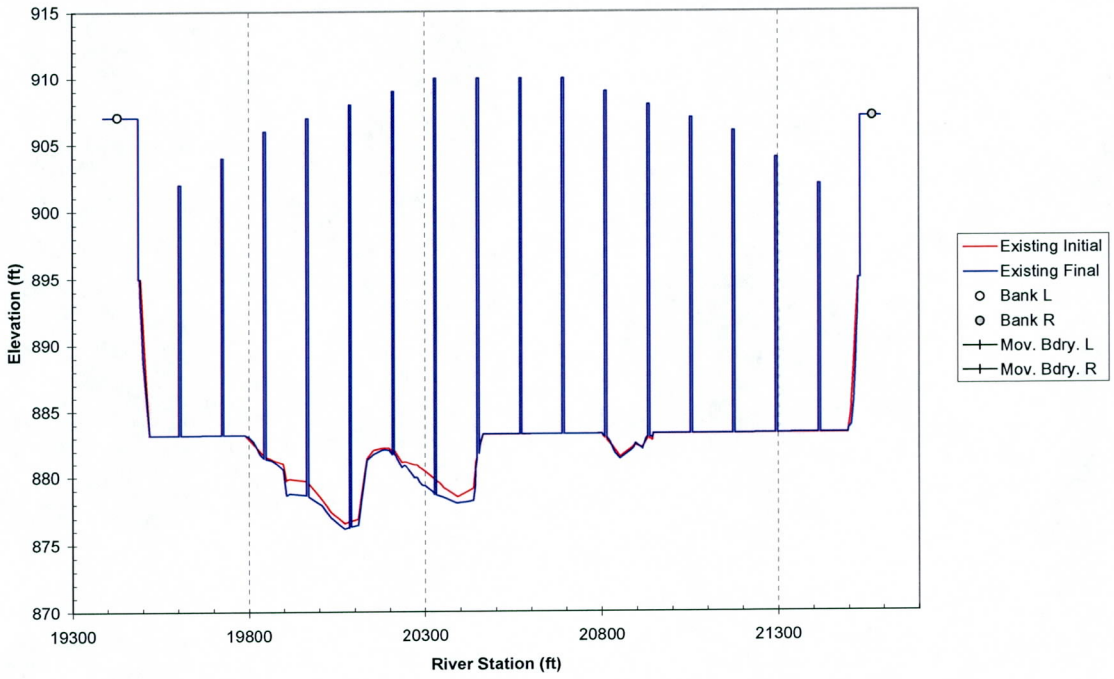

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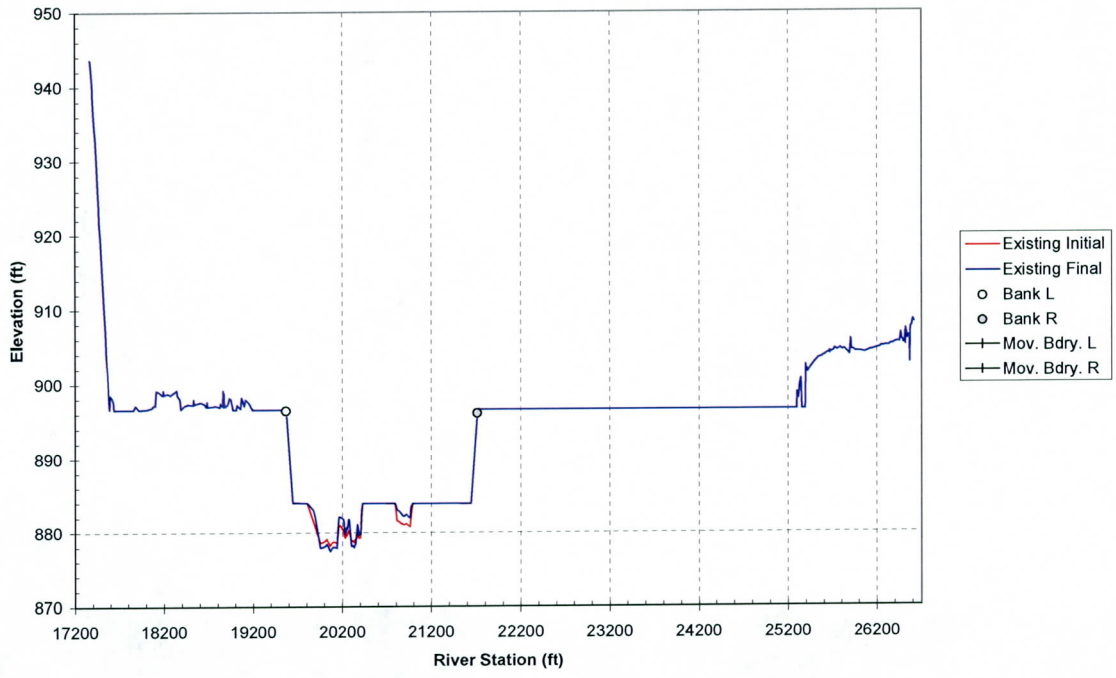

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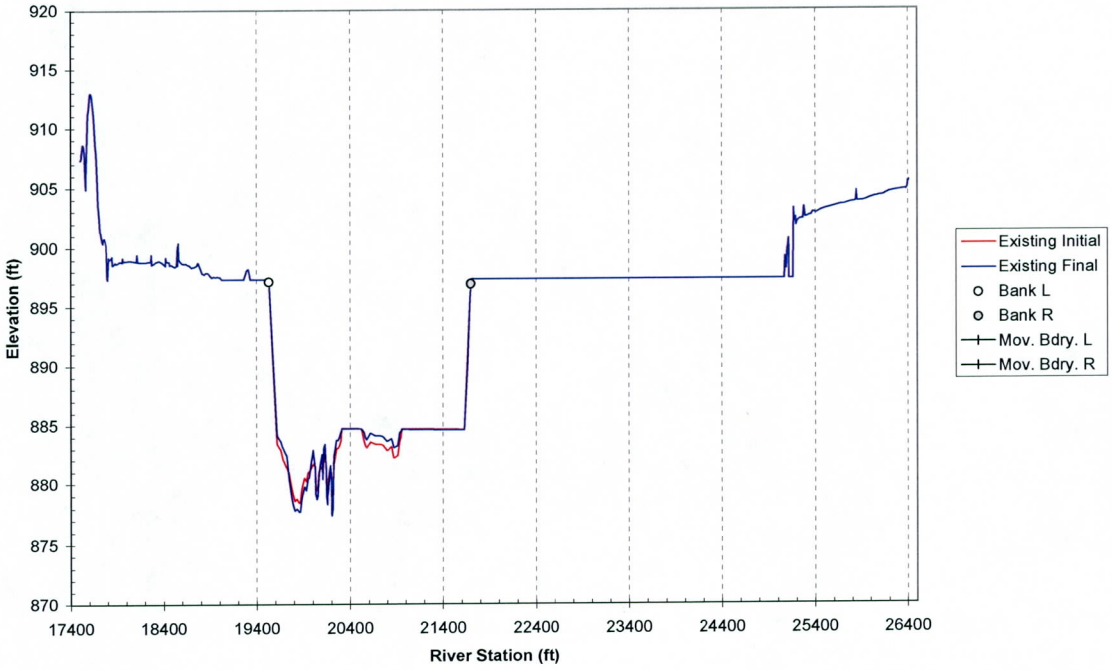

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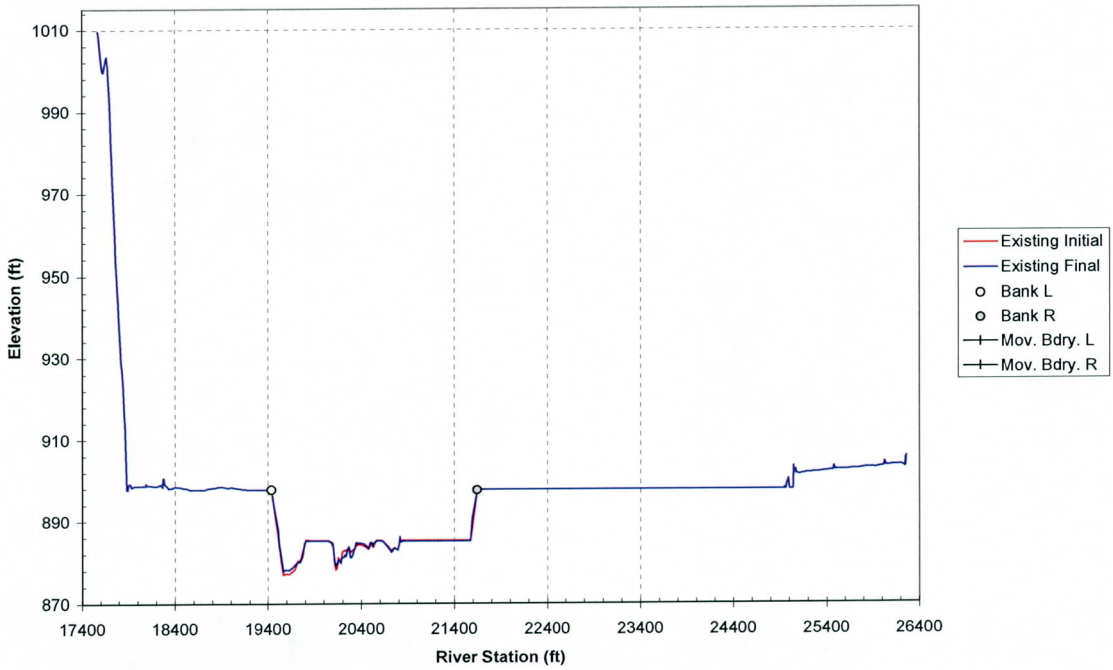

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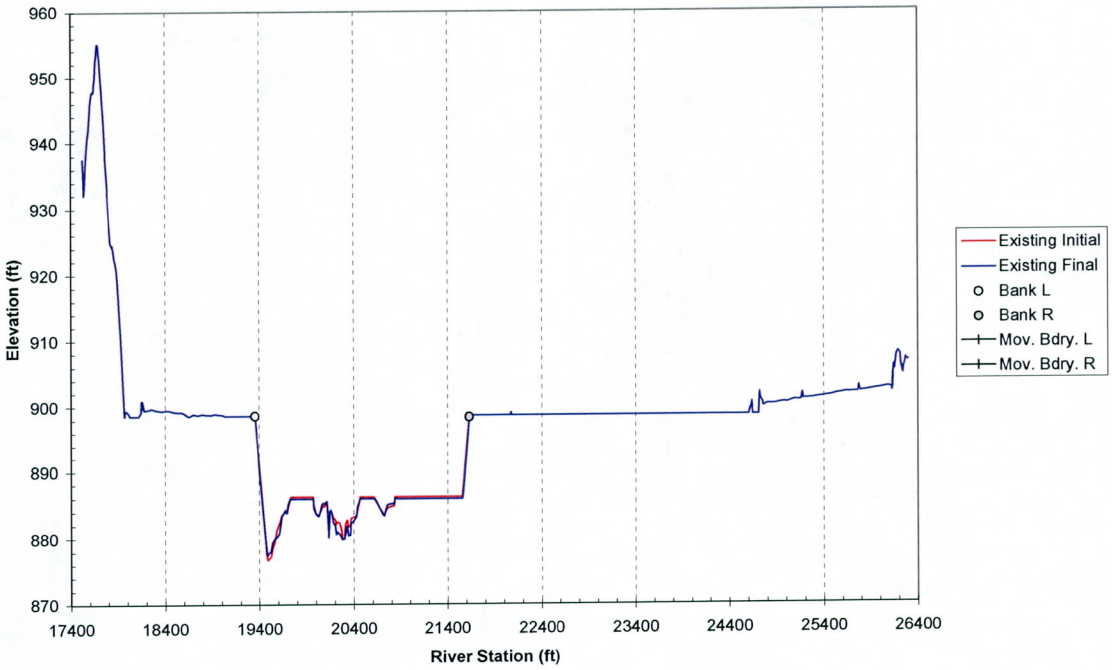

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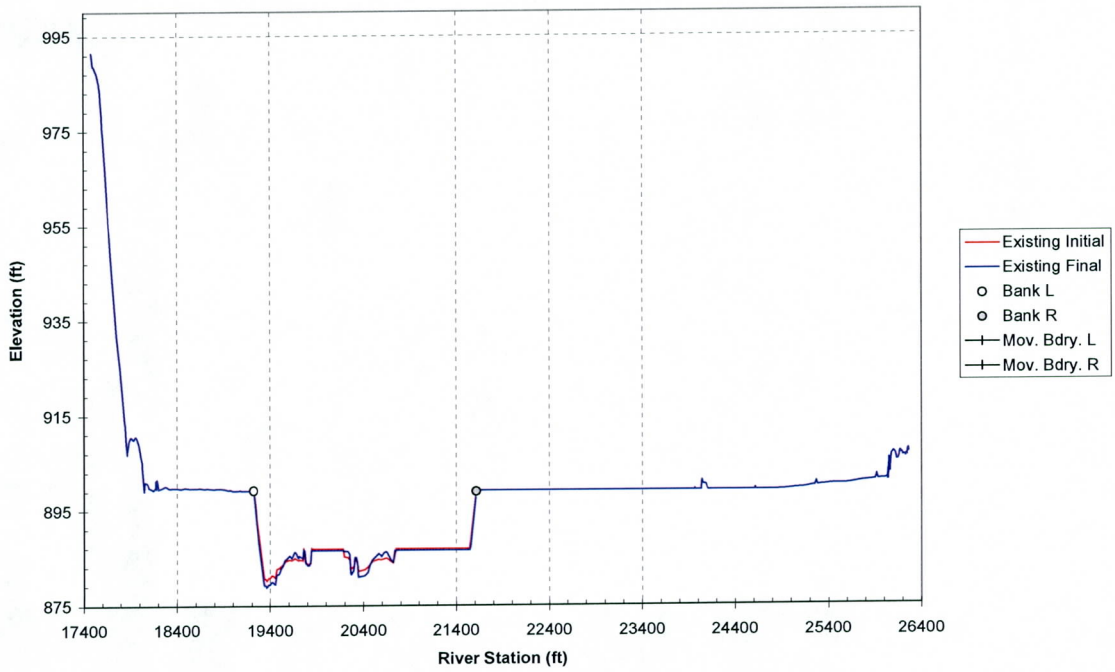

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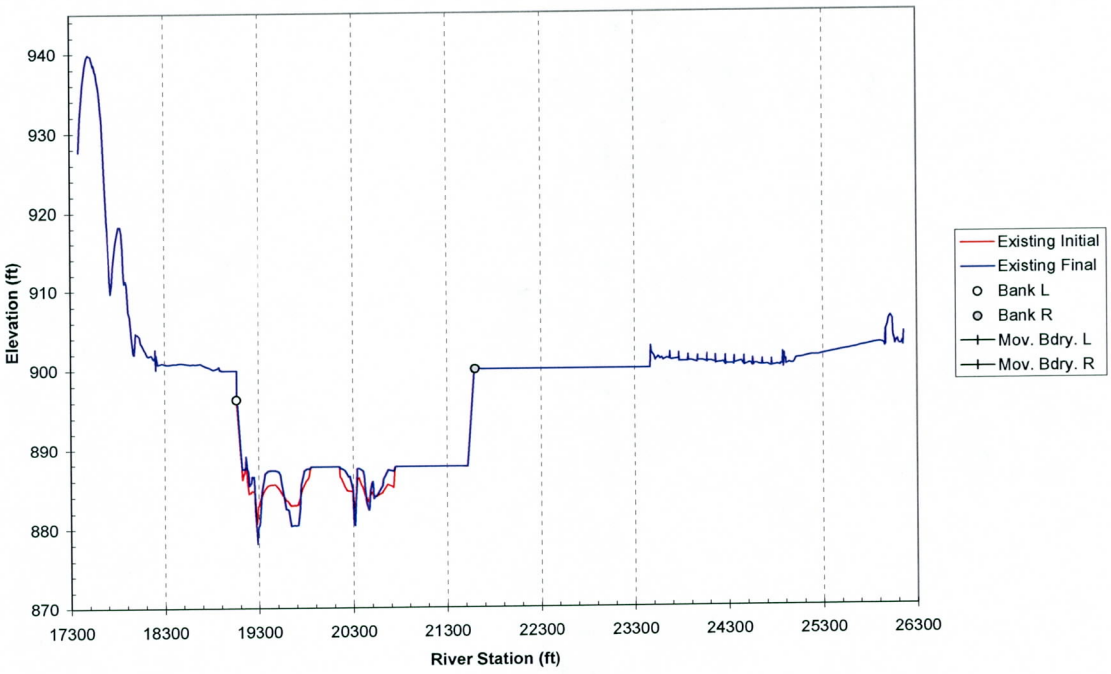

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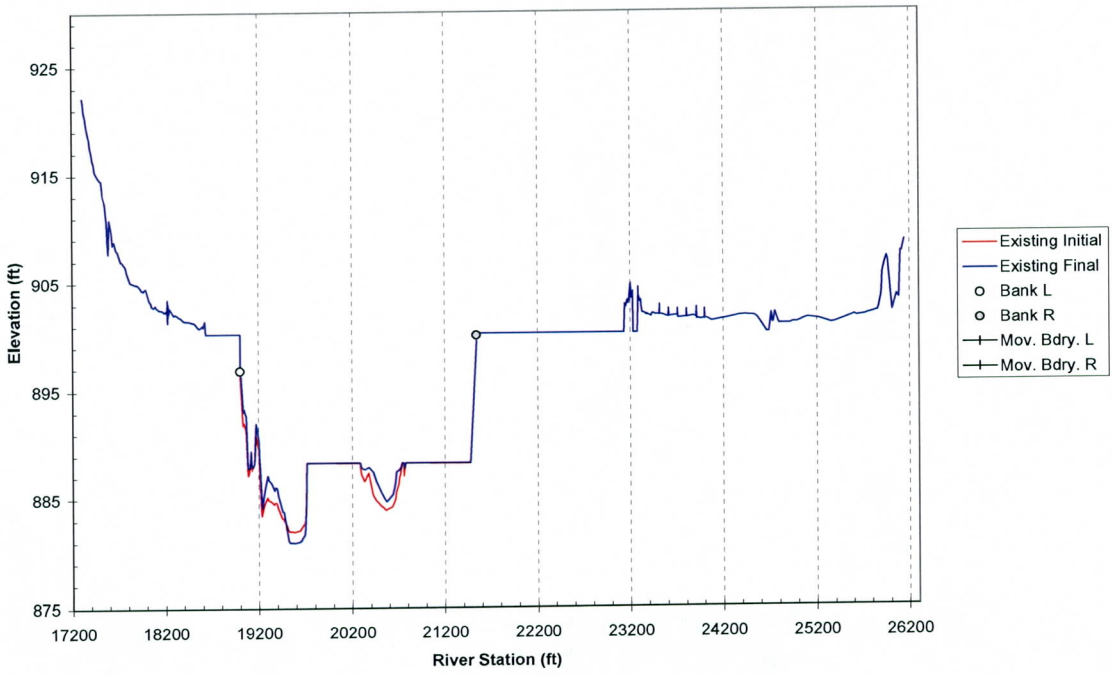

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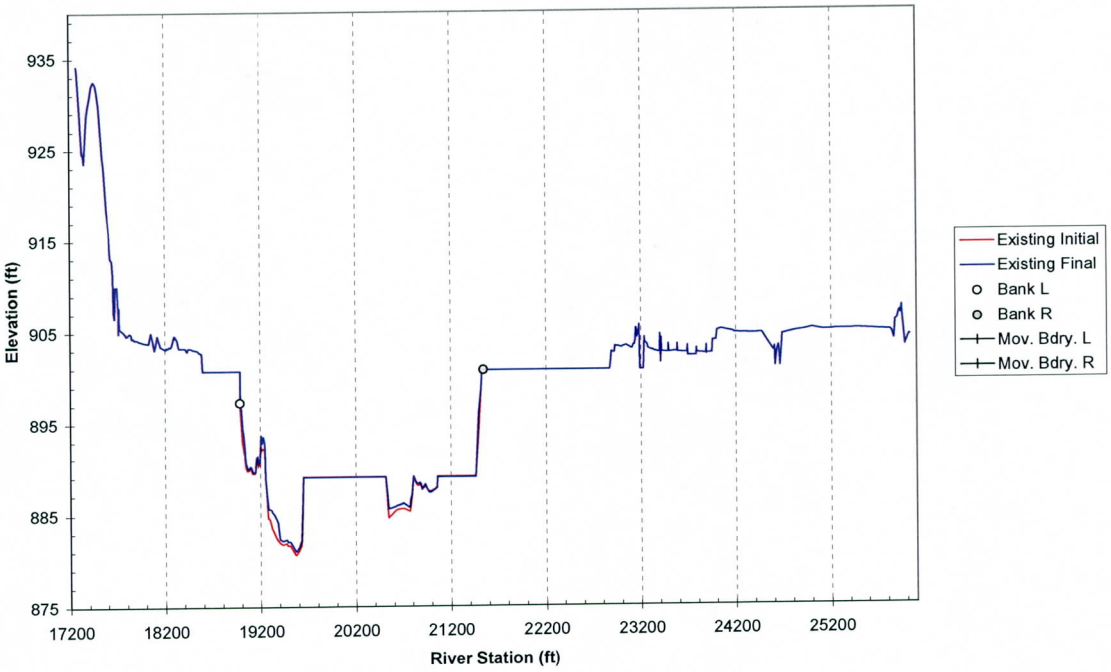

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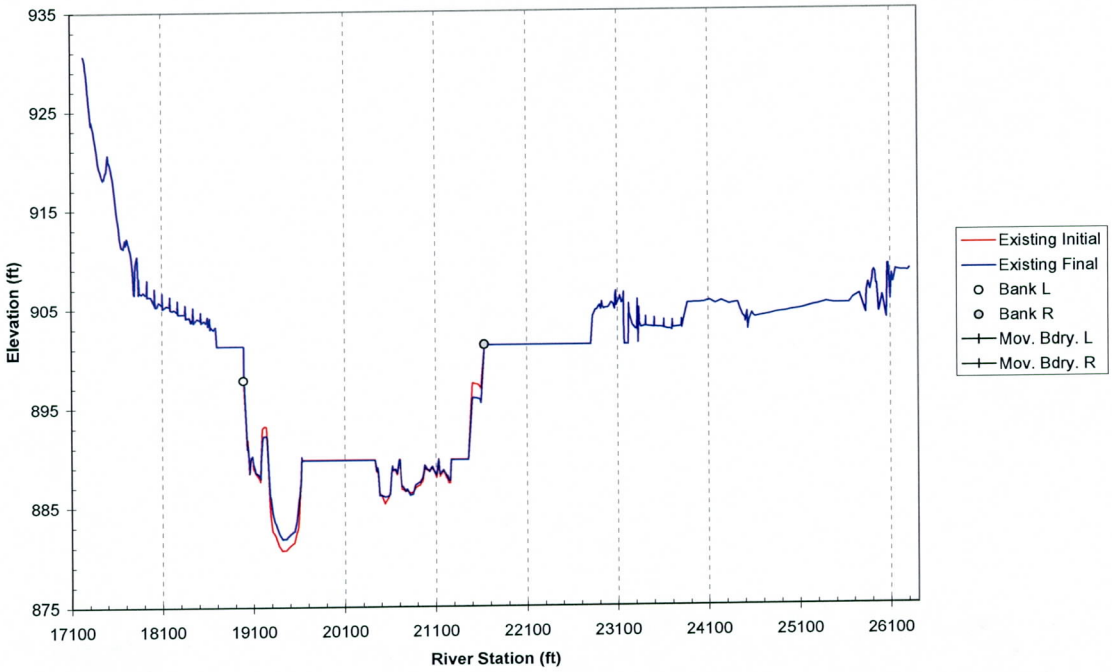

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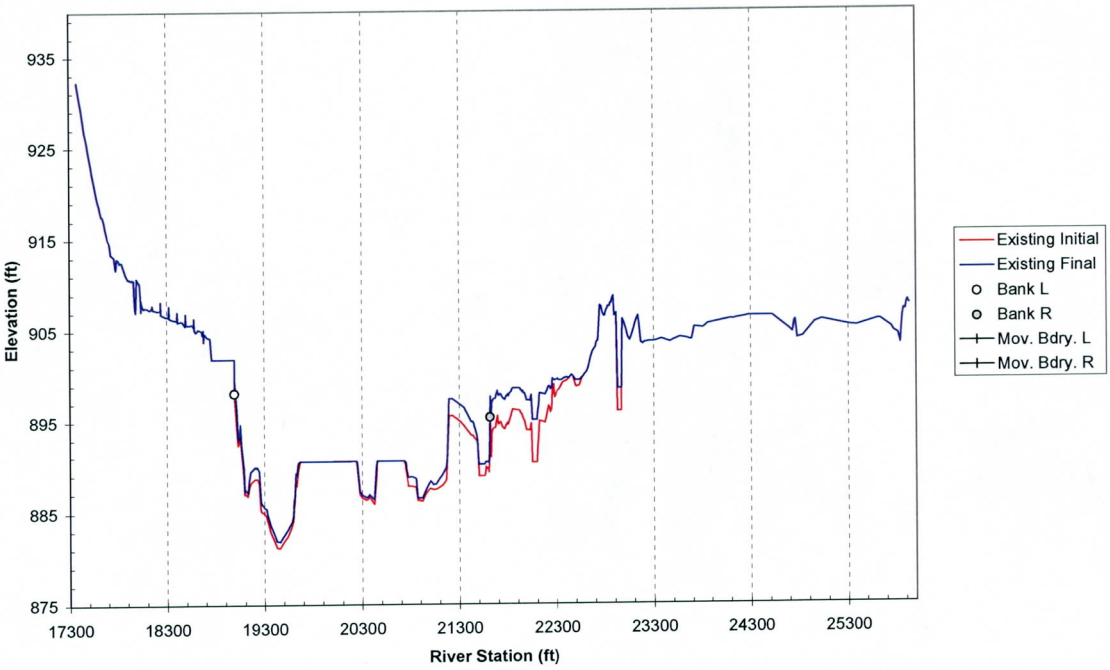

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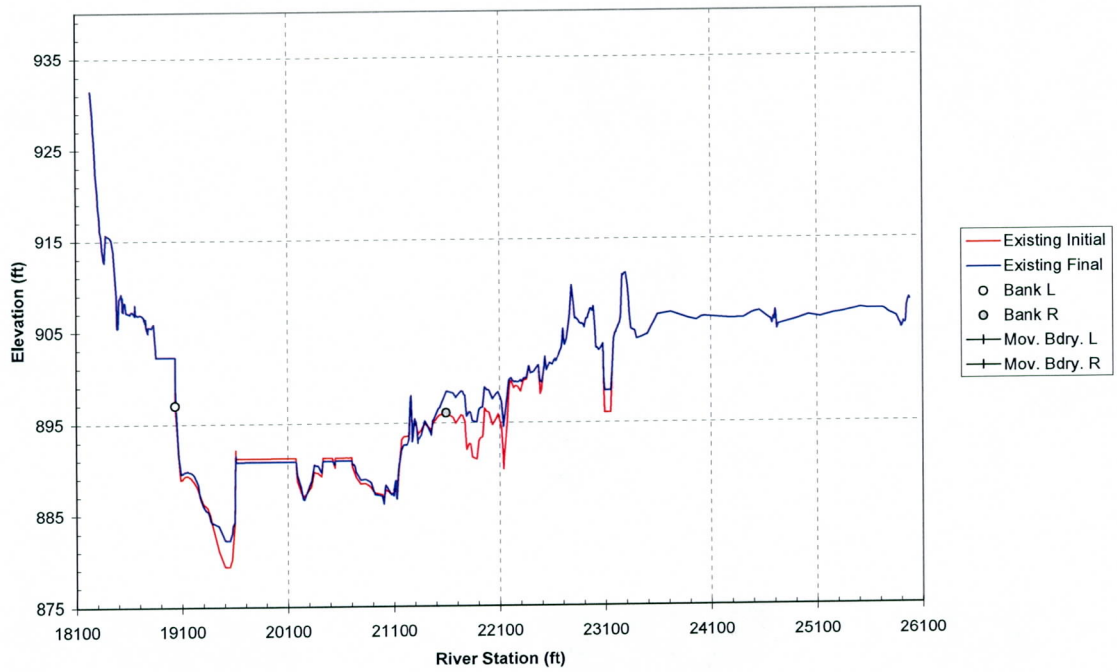

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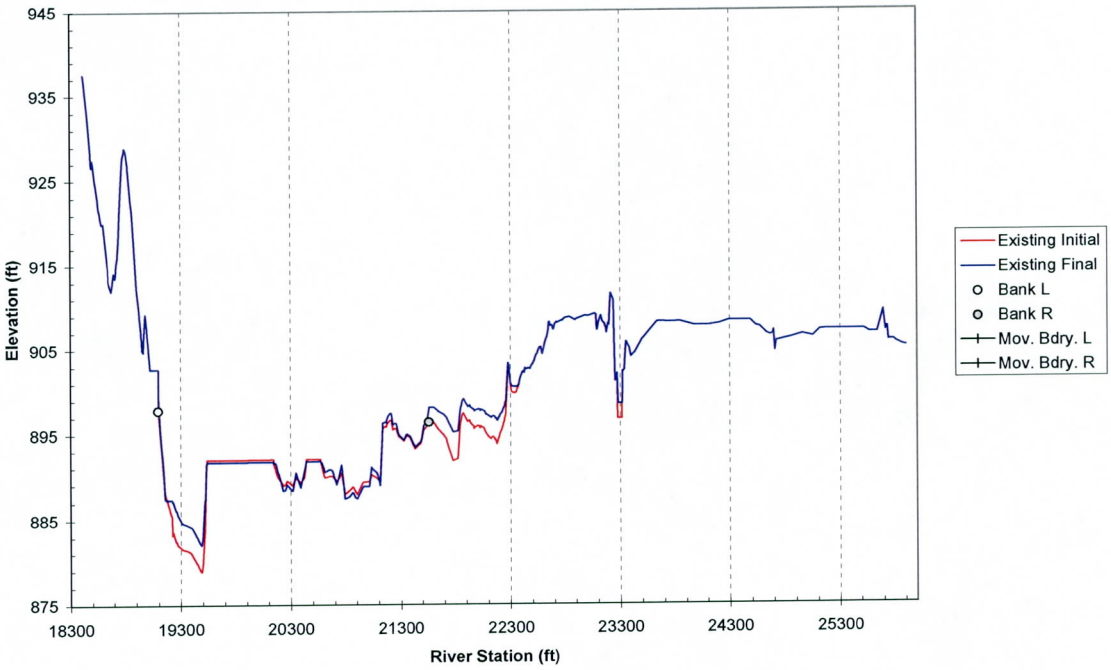

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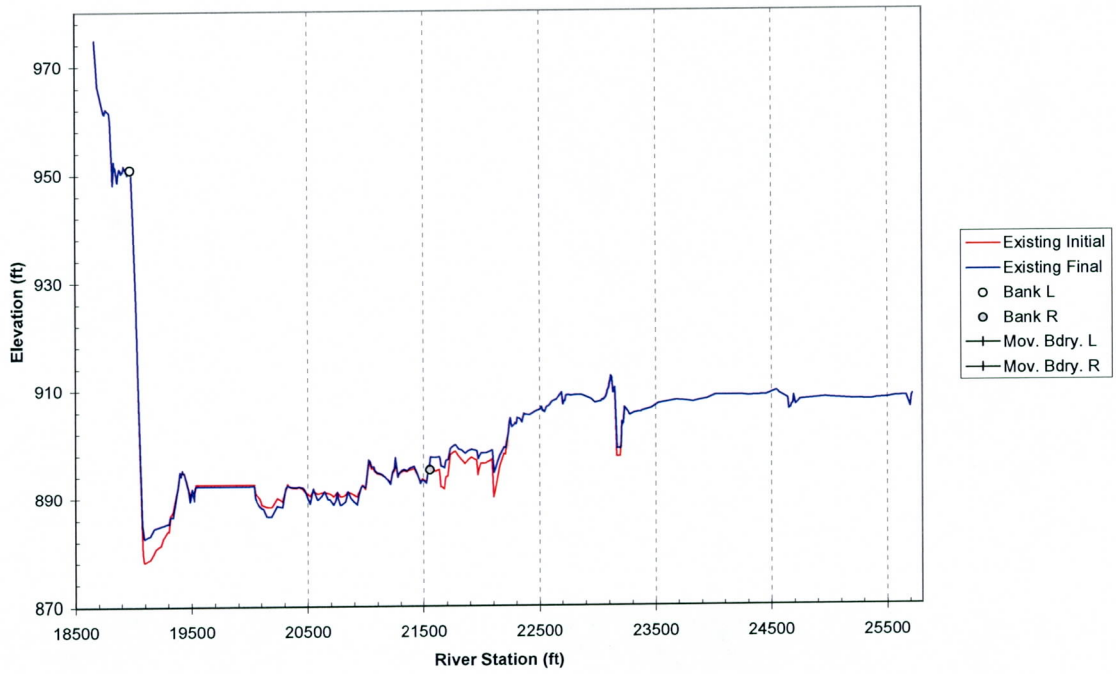

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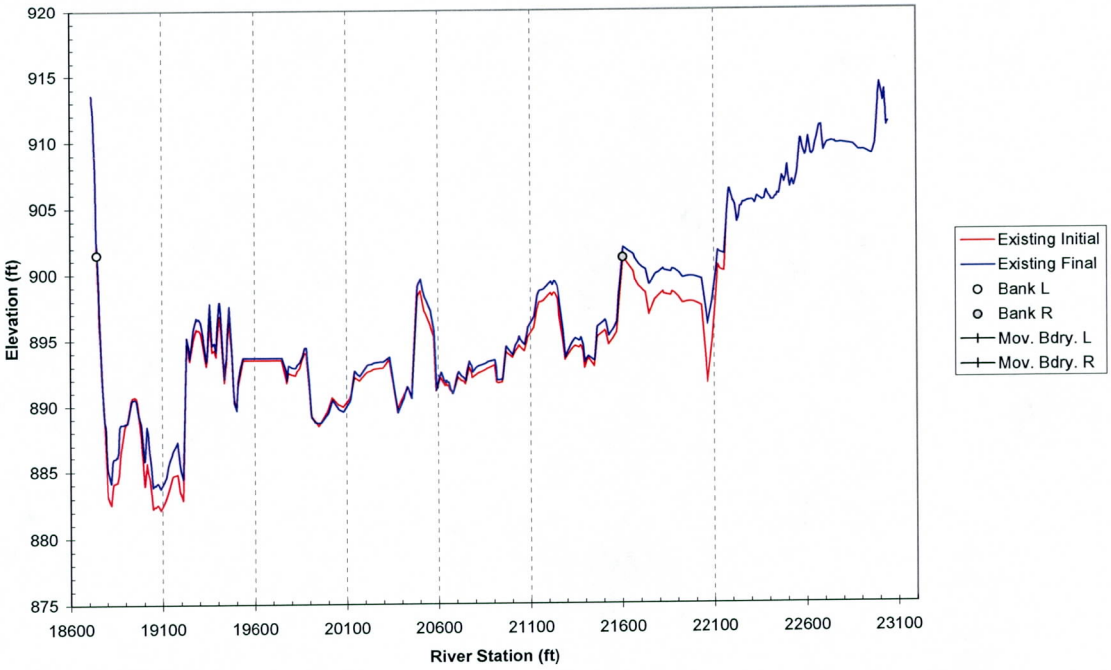

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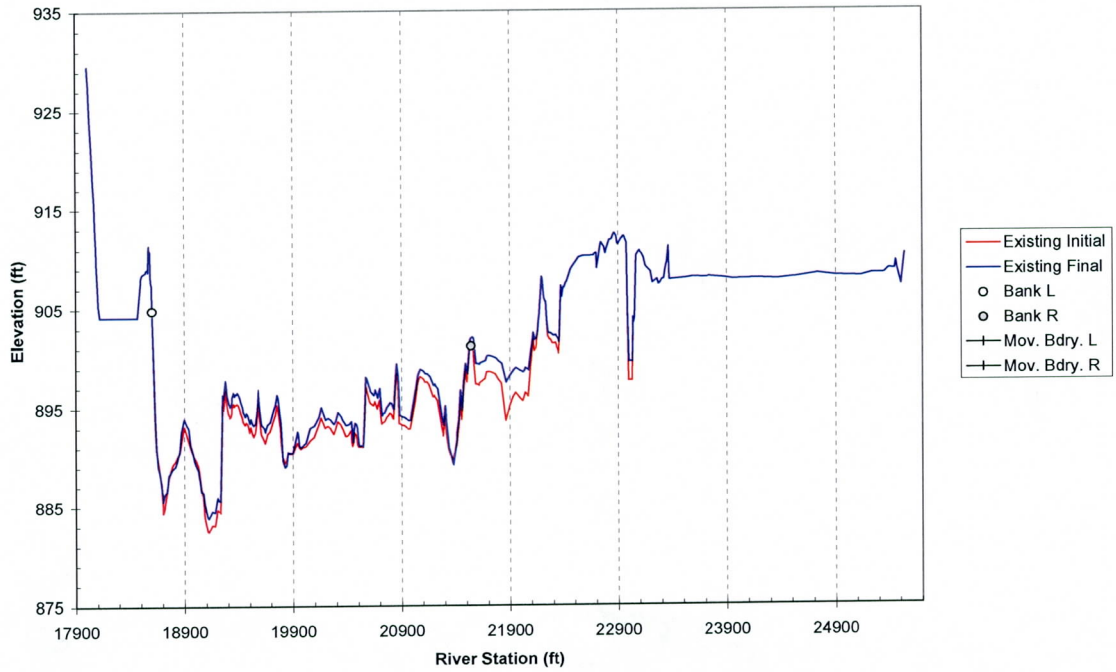

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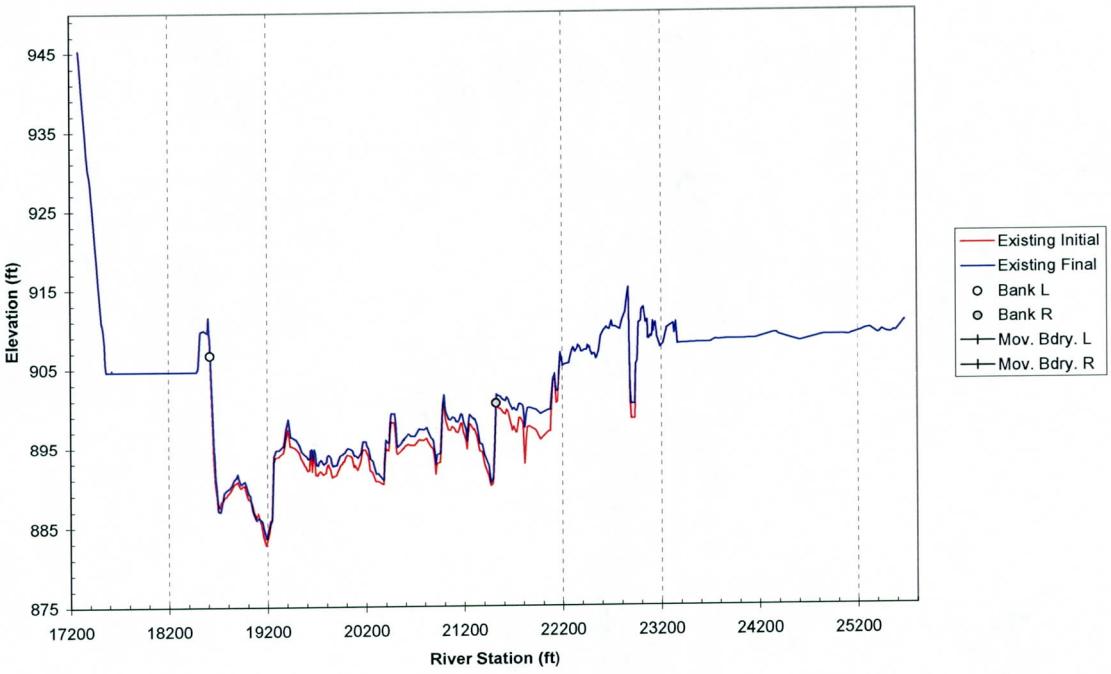
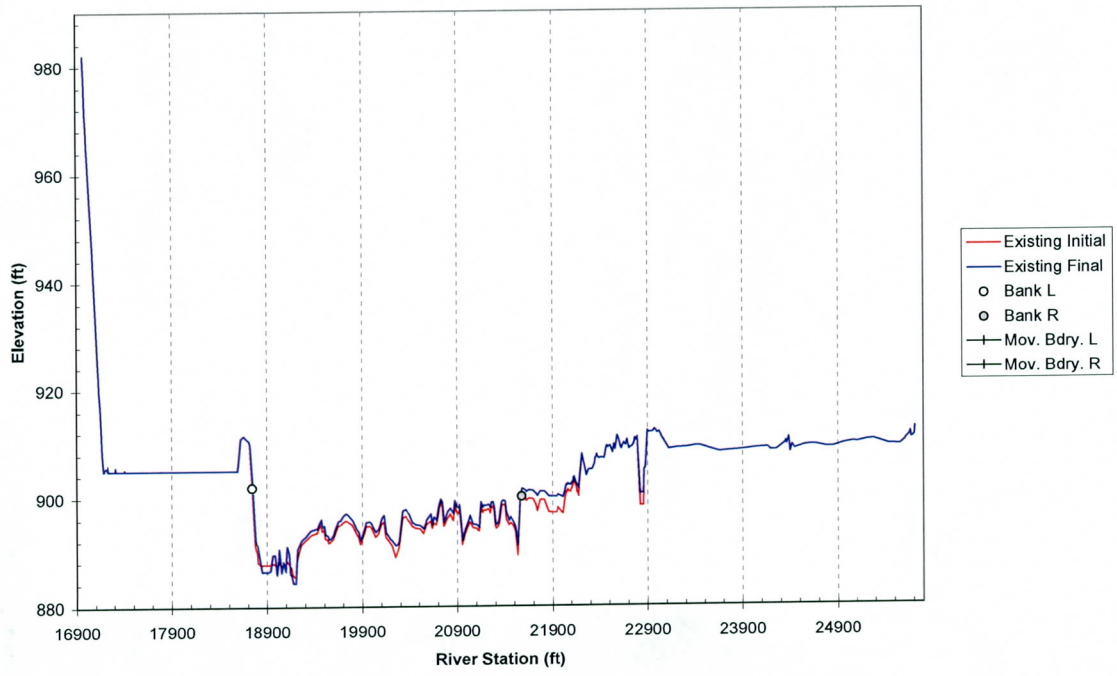
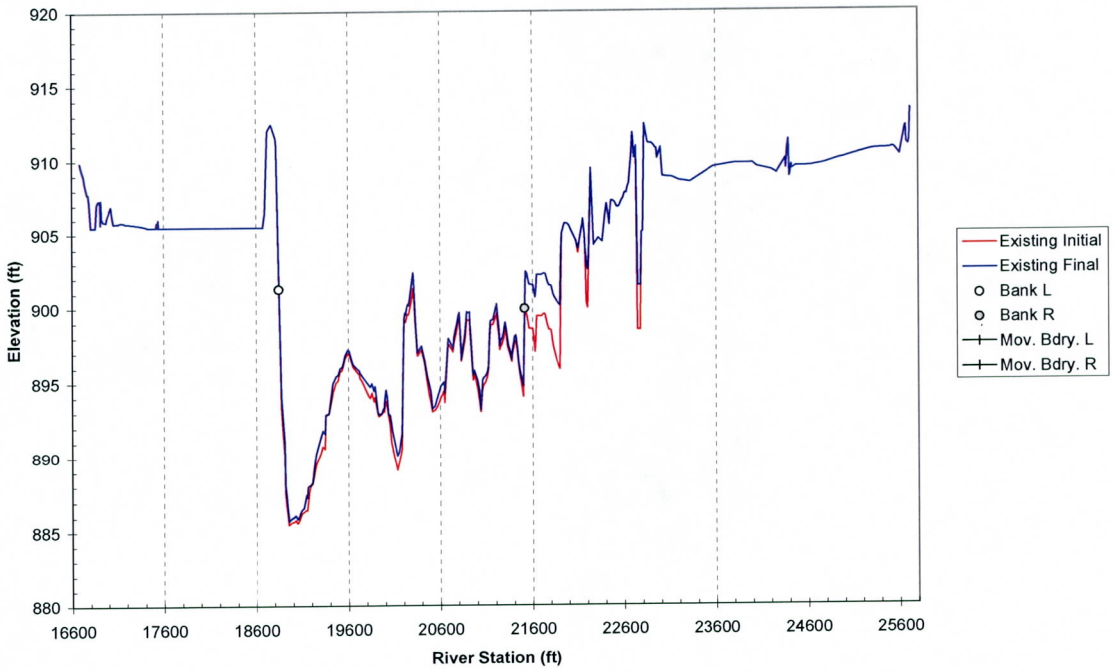


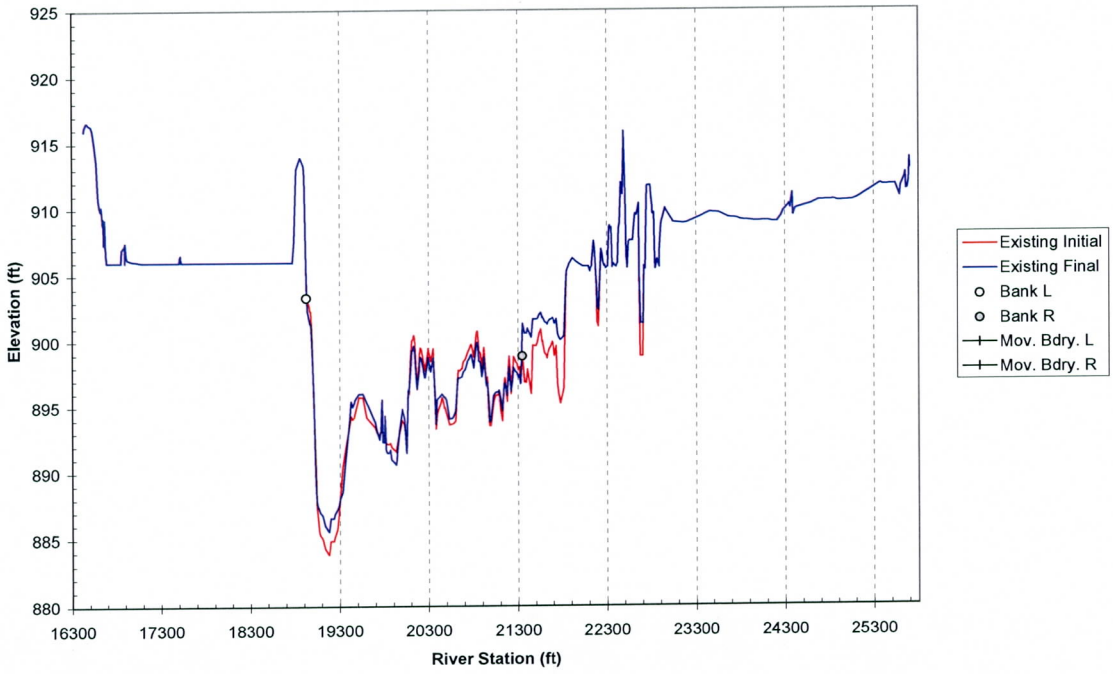
Cross Section 193.94



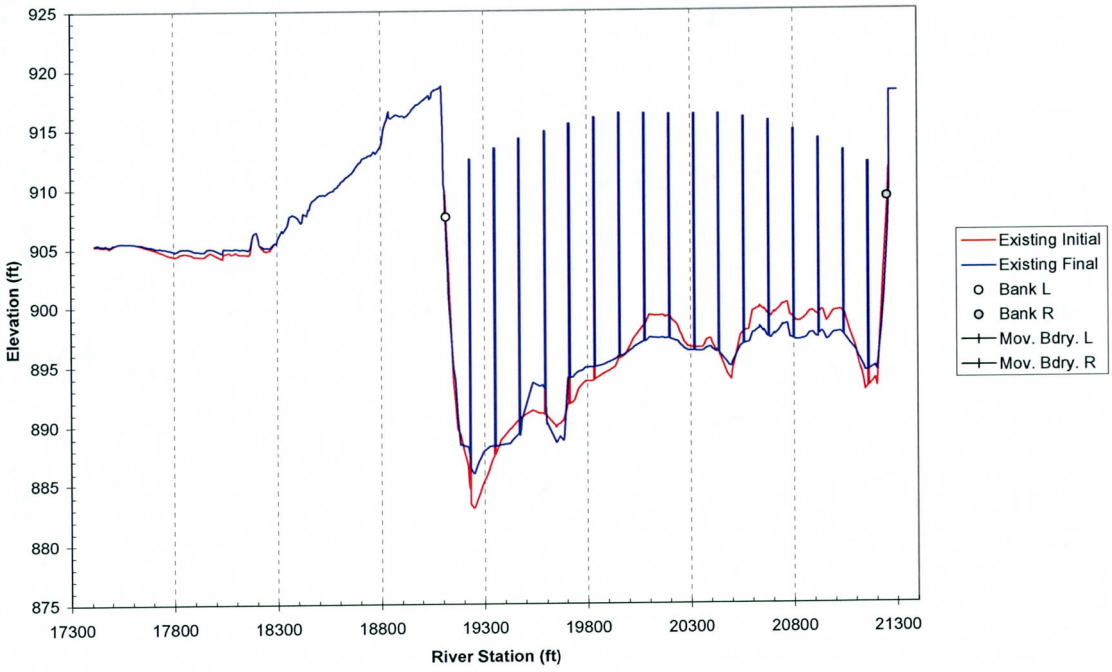
Cross Section 194.02



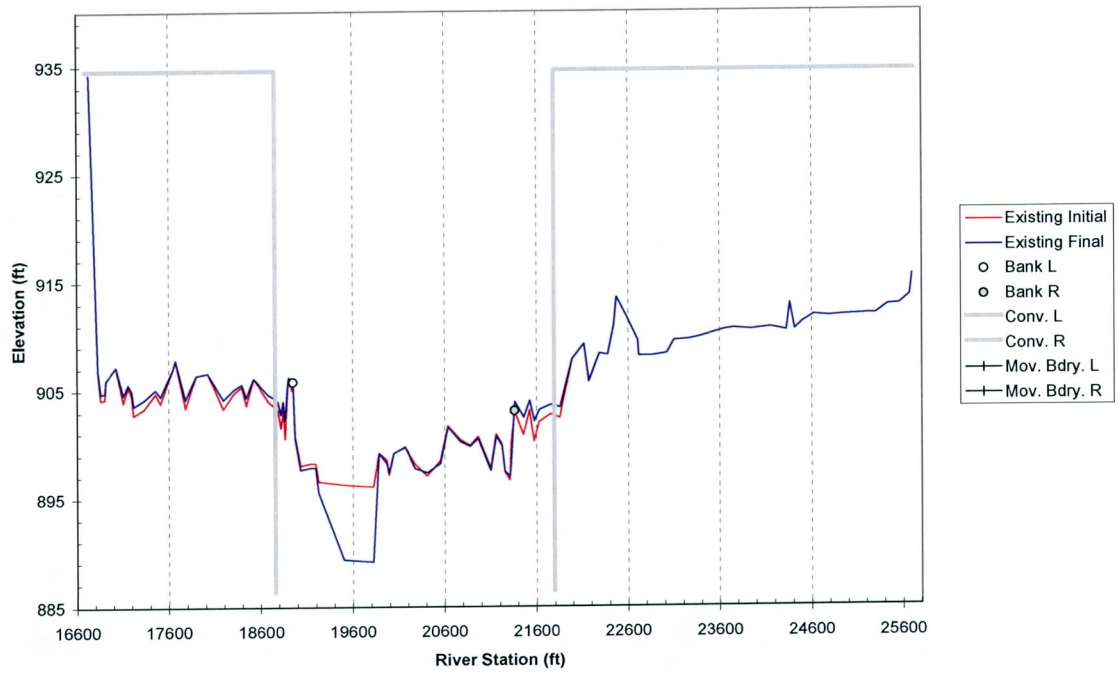
Cross Section 194.1



Cross Section 194.21



Cross Section 194.29



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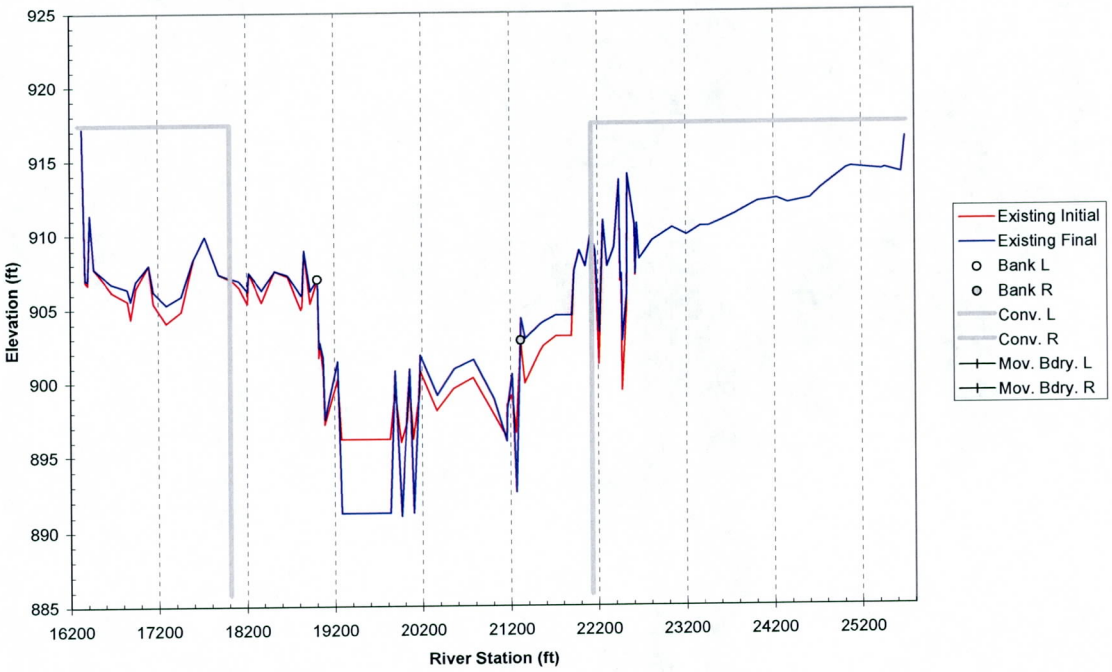

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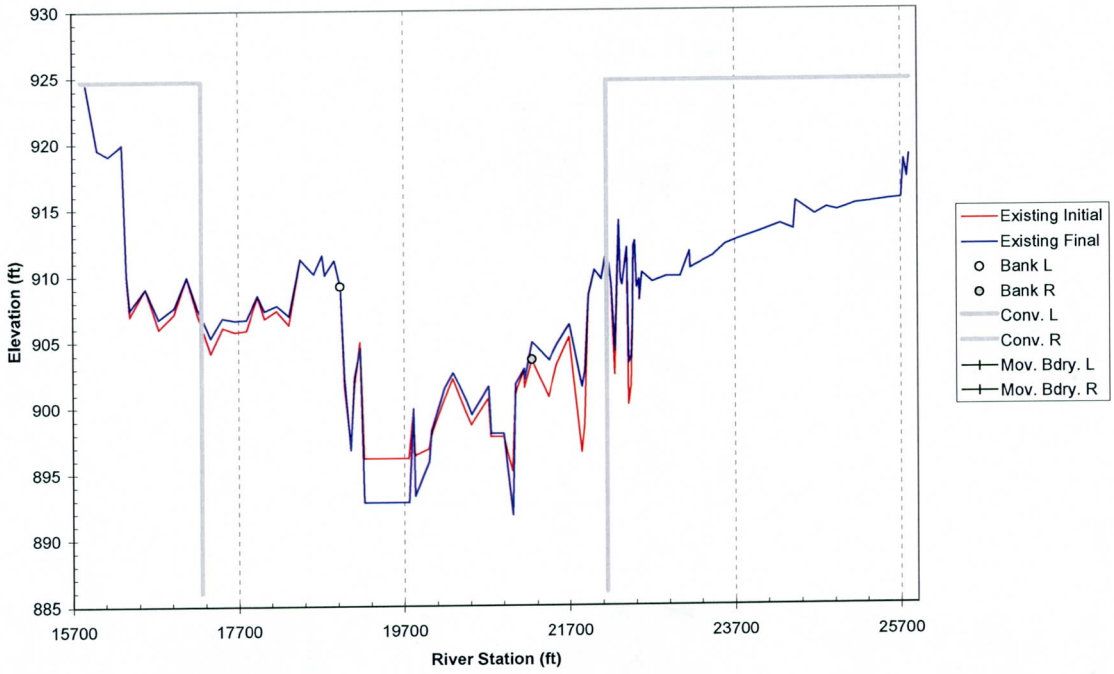
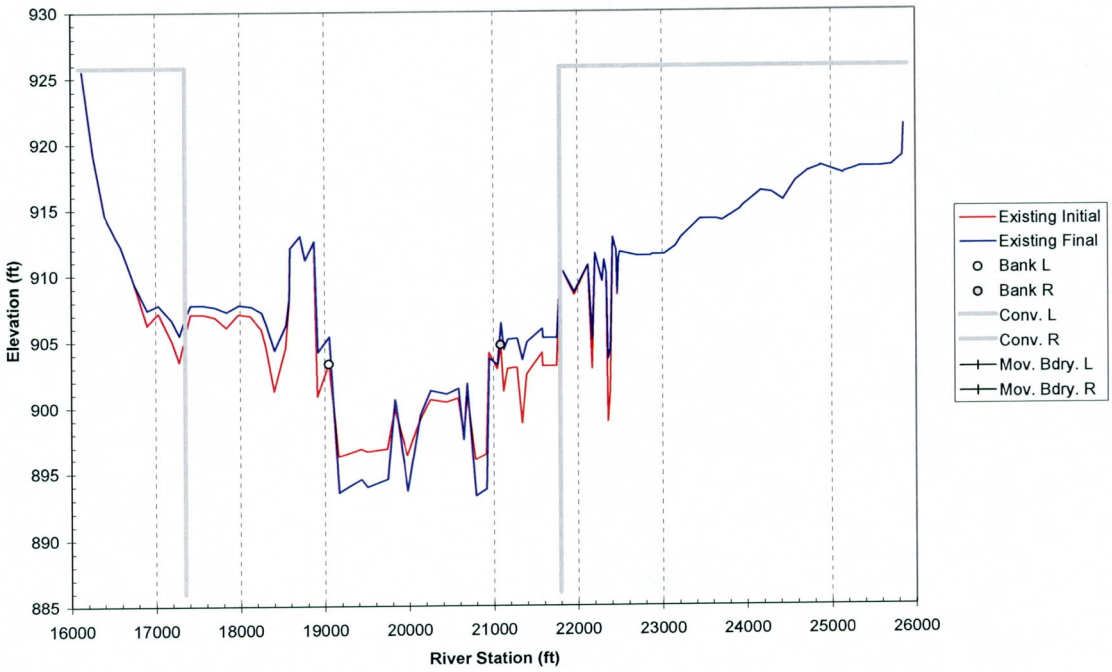
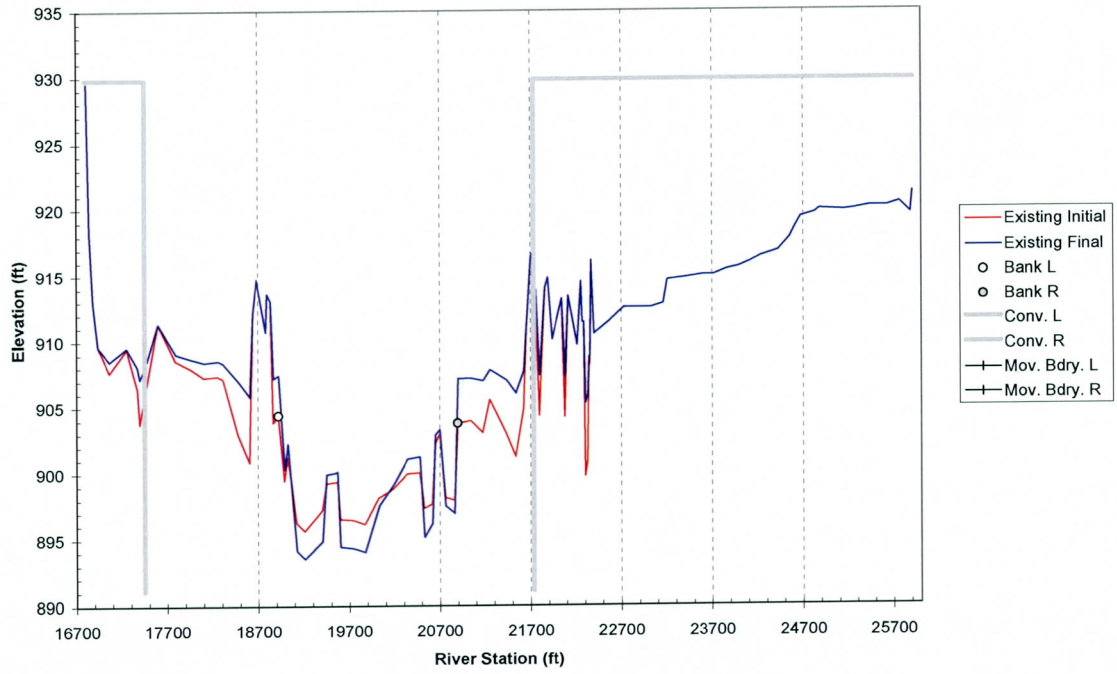


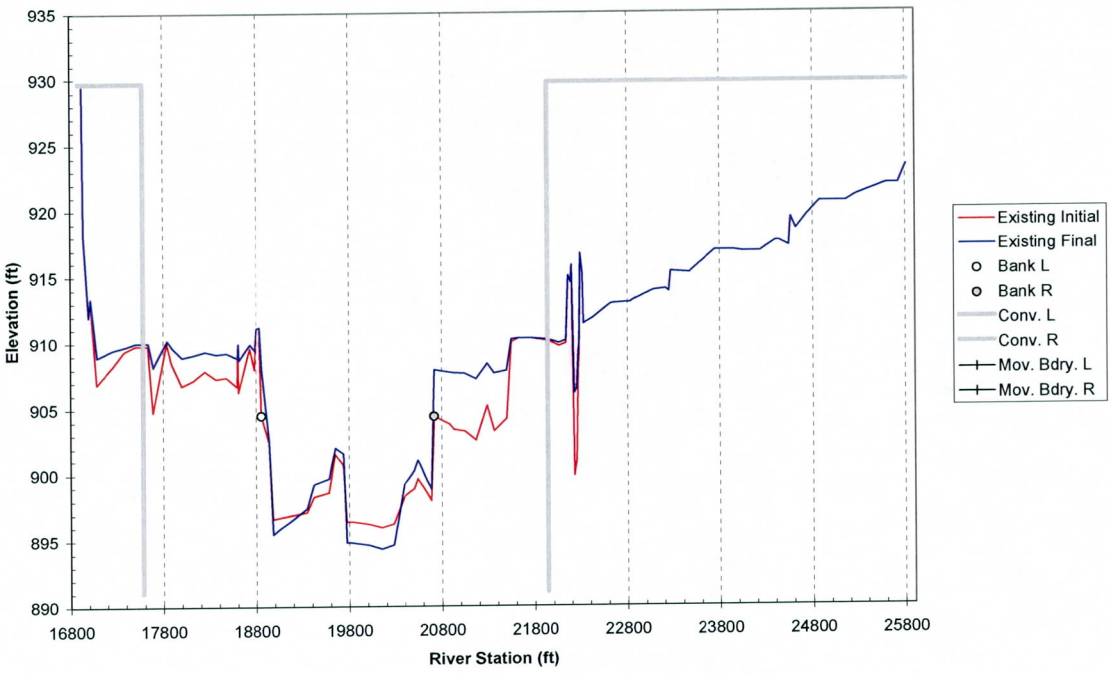
Cross Section 194.62



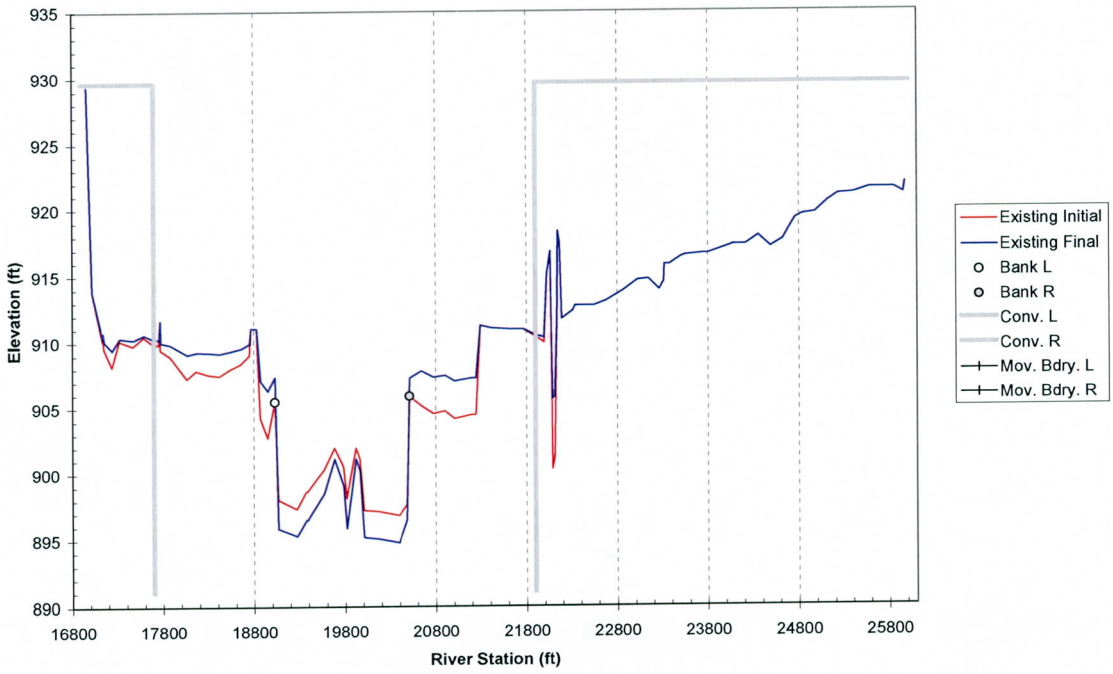
Cross Section 194.72



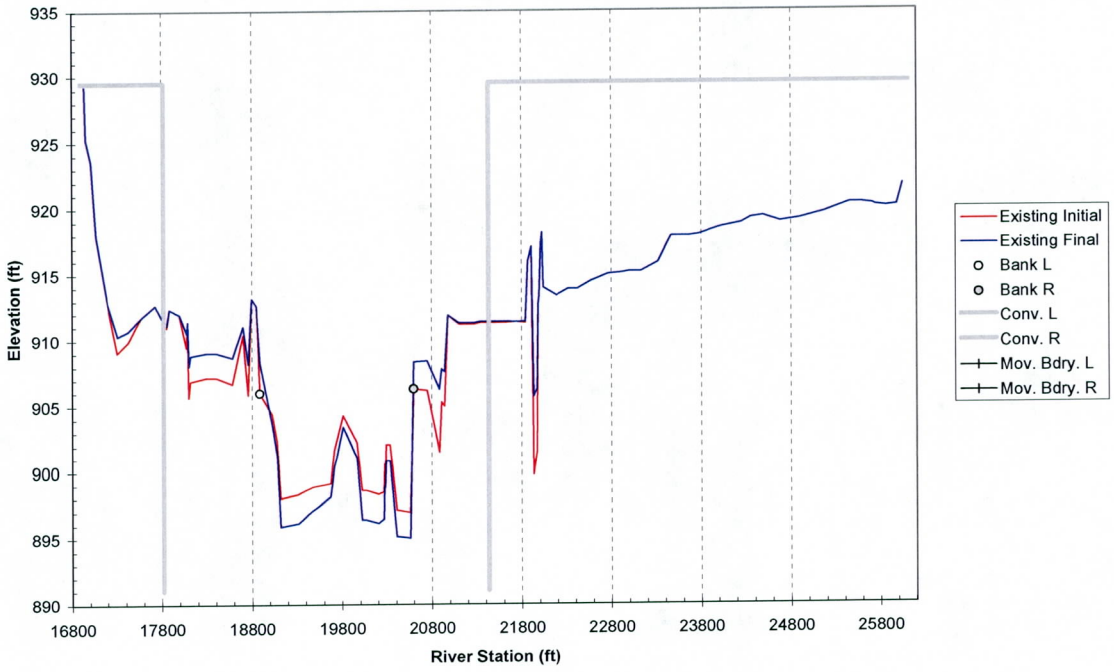
Cross Section 194.81



Cross Section 194.91



Cross Section 195.00



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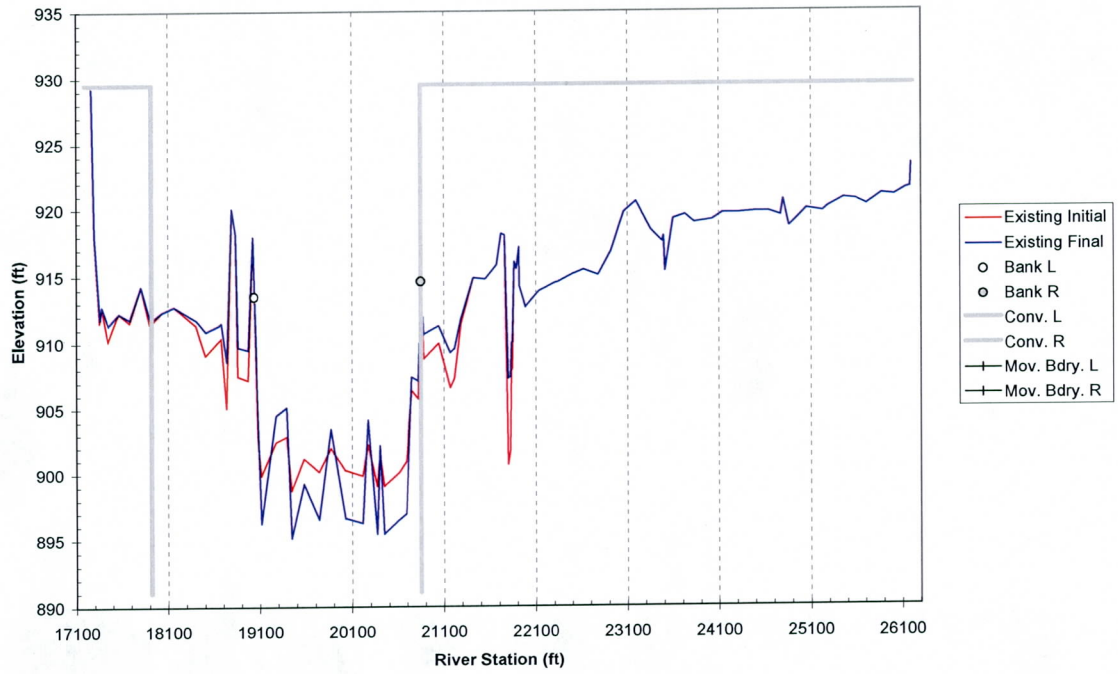
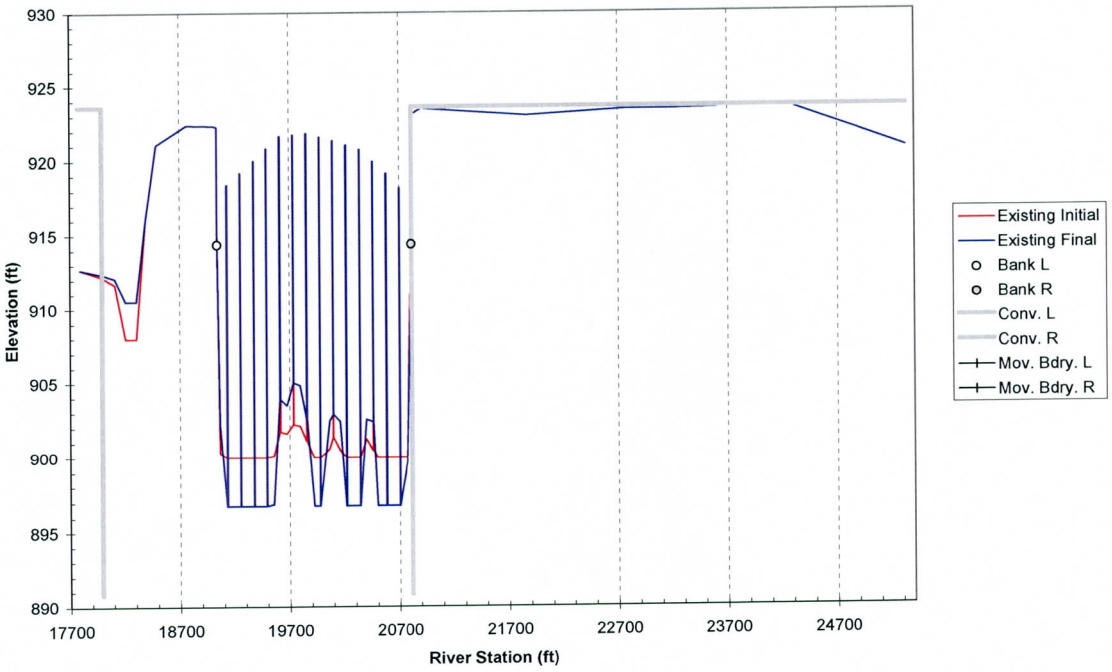
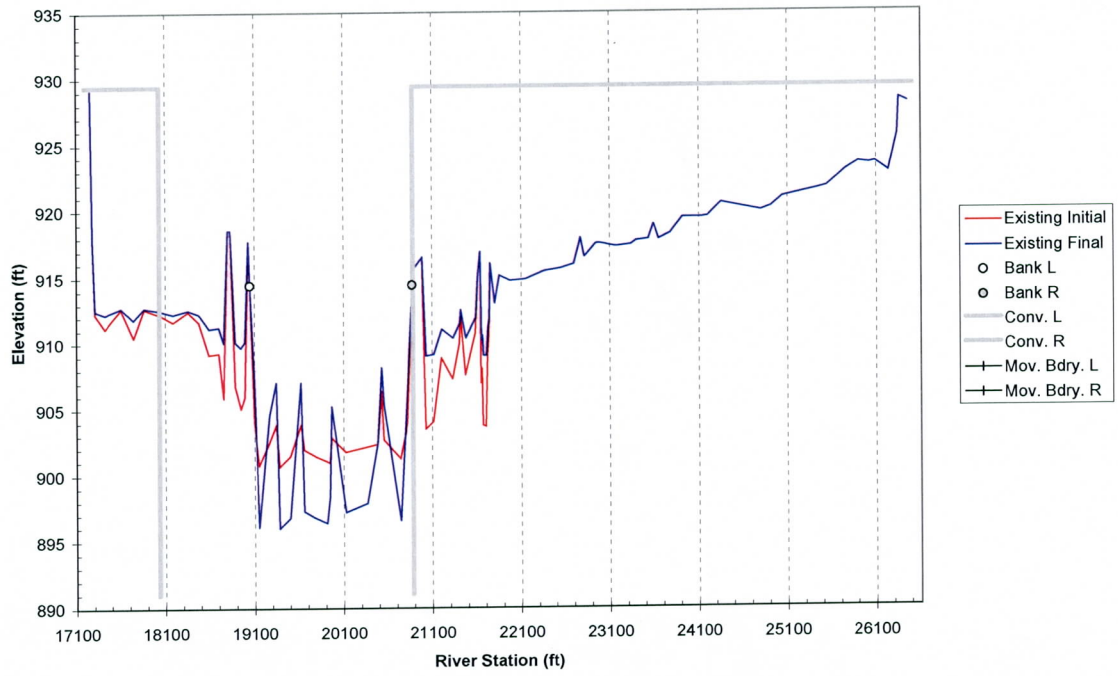


Cross Section 195.15



Cross Section 195.19



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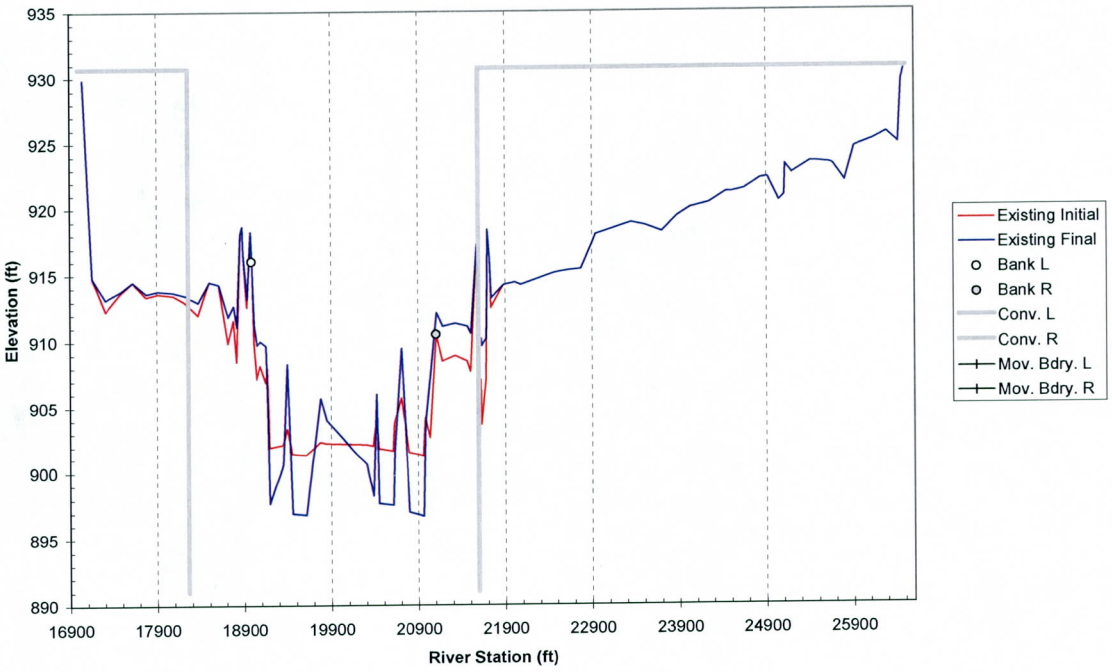
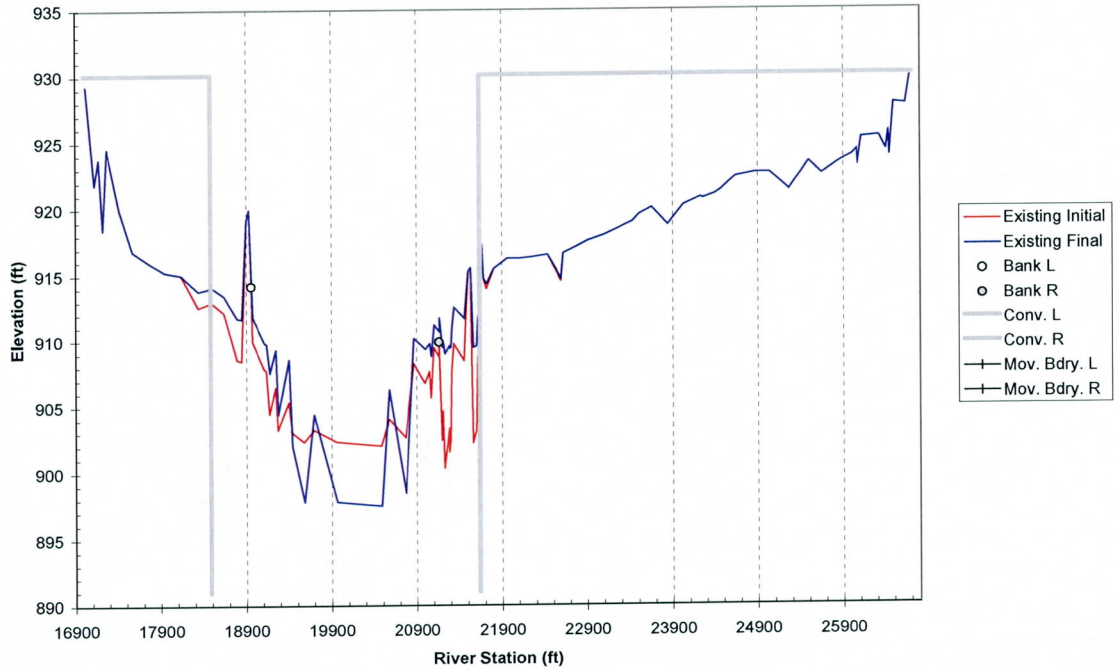


Cross Section 195.38



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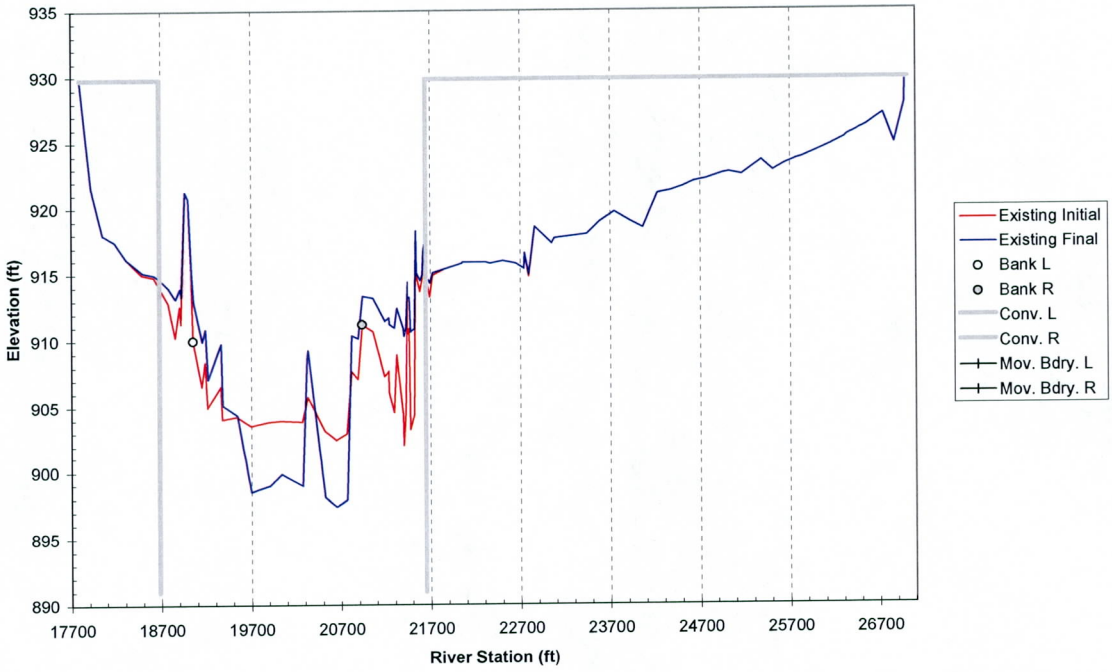

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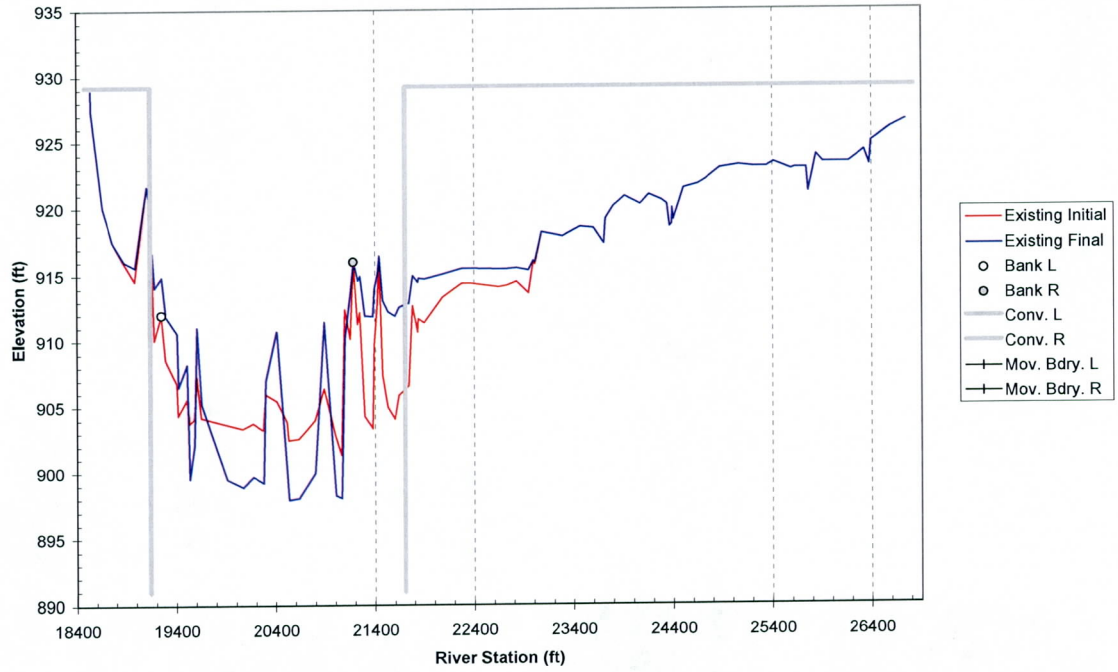

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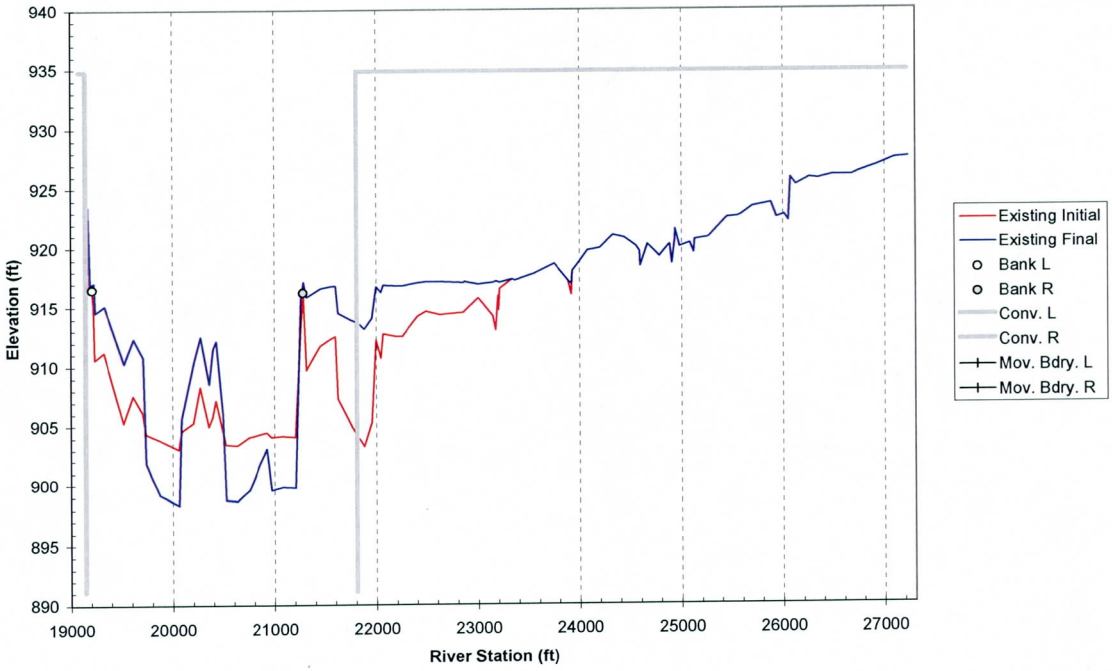

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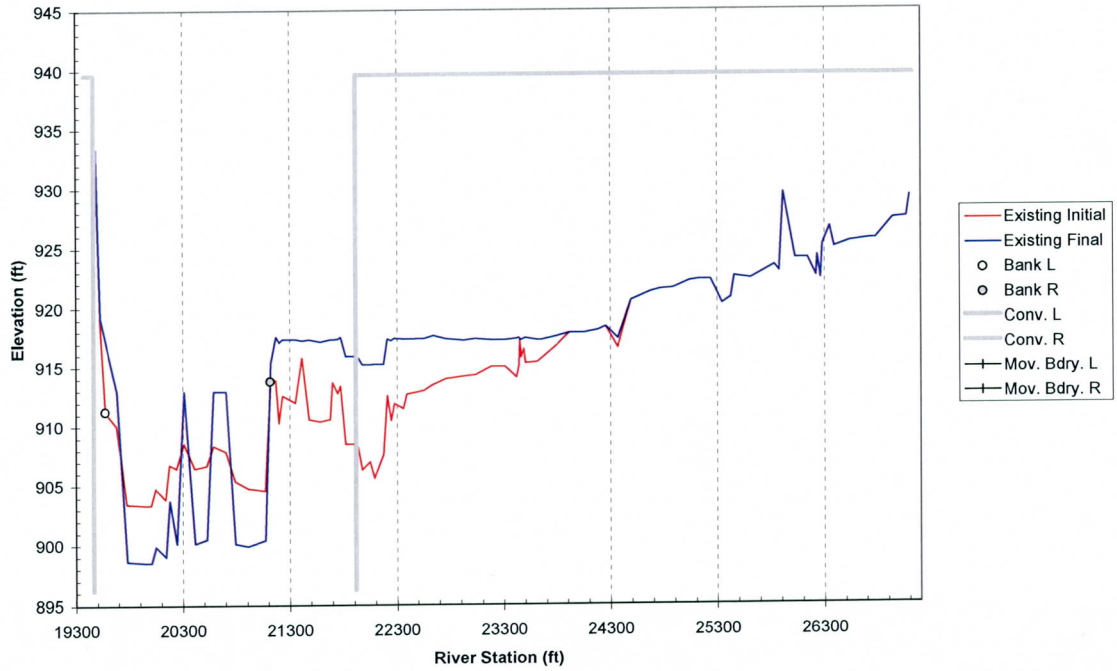

APPENDIX G

Toe-Down and Bridge Scour Calculations

APPENDIX G

SECTION I

Scour Calculations for Bank Protection

Calculation of General Scour Depths - English Units (ft)

November 2, 2005

Gila River / Cotton Lane Bridge - w/Protected South Bank - 500 Year Flood Flow = 285,000 cfs

Gila River - King Ranch/Cotton Lane Bridge
Cotton Lane Bridge Section
Method not Applicable

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Stream Values

Incised / Bankfull Q cfs	Qi	285000
Incised / Bankfull Width	Wi	2140
Incised / Bankfull q cfs/ft	qi	133.18
Depth of Incision	di	10
Competent Veloc.(p. 38 USBR)	Vc	2.5
Design Q (Channel)		285000
Design Channel Width		2140
Design Flow / Width	qf	133.18
Average Depth / Hydraulic Depth	dm	14.2
Maximum Depth	Ymax	24
Average Velocity	Vm	10.6
Neill's m - 0.67 Sand to 0.85 Coarse Gravel	m	0.85
D50 - mm		6
D85 - mm		35
D90 - mm		50
Slope		0.0012
Froude Number for Channel		0.51
USBR - Lacey Z - Straight Reach	Zl	0.25
Neill Z (p. 36 USBR) Straight Reach	Zn	0.5
Blench Z (p. 36 USBR) Straight Rch	Zb	0.6
Blench "zero bed factor" (p35)	Fbo	2.5

Using All Equations

Average Scour Depth	8.6
Safety Factor	1.3
Toe Down below Thalweg	11.2

Total Scour Depth Calculations		Meth. Used
Average of Similar Values	4.2	3,4,7
Bend Scour Average (See Sum Below)	4.7	
Bend + Average w/o Blench	8.9	
Ave w/Blench ((3 Avg +Blench) /4	**9.5**	
Long Term Scour (HEC-6T 105 Yrs)	**0.5**	
Bed Form Scour (See Tab) (BF)	**1.6**	
Low Flow Incisement (LFI)	**2**	
Safety Factor x (LT+BF+BS+LFI)	**1.3**	
Recommended Toe Down / with Bend	17.8	

Recommended Toe Down -No Bend	**10.8 Feet**

This Spreadsheet is provided without impled or express warranty as to the applicability, accuracy or correctness of any formulas or calculations. The use of this spreadsheet indicates the willingness of the user to accept all risks and liabilities arising from its use. The user is encouraged to veryify the accuracy and applicability of all equations prior to their use in determining toe down depths.

Methodology Adapted from "Computing Degradation and Local Scour", US Bureau of Reclamation, Ernest L. Pemberton and Joseph M. Lara, January 1984
Zeller Equation from the Flood Control District of Maricopa County Drainage Design Manual - Hydraulics, September 2003 (Draft)

		Scour Depth	Bend Scour: Moderate Bend	Severe Bend	Right Angle Bend	Vertical Wall
1	Neill - Incised: df = di*(qf/qi)^m; df = 10 x (133.18 / 133.18 qi) ^ 0.85 = 10.0 ds = Z*df Z = 0.5; Includes Bend Scour; dfo Calculated Below	Don't Use 5.0				
2	Neill - Competent Velocity - Sand or Coarser Material: ds = dm((Vm/Vc)-1); ds = 14.2 x ((10.6 / 2.5 Vc) - 1) = 46.0 d = Z*ds Z = 0.5	23.0	Moderate Bend 0.6 → 4.6	Severe Bend 0.7 → 18.2		
3	USBR - D90 Method: ds = Z*dm; 50% of Average Flow Depth (dm); ds = 0.25 x 14.2 = 3.6	3.6				
4	Lacey - Zero Bed Sediment Transport Assumed: dm=0.47*(Q/f)^1/3; dm = 0.47 x (285000 / 4.3 f) ^ 0.3333 = 19.0 ds = Z*dm Z = 0.25; Includes Bend Scour; f = 1.76 * Dm = D50 6 ^ 0.5 = 4.3	4.8	Mod Bend 0.5 → 4.8	Sharp Bend 0.6 → 6.7	Right Angle Bend 1 → 14.3	Vertical Rock Bank or Wall 1.25 → 19.0
5	Blench - Zero Bed Factor: dfo = qf ^(2/3) / Fbo^(1/3); dfo = 133.18 ^ 0.67 = 19.2 ds = Z*dfo Z = 0.6; Includes Bend Scour; 2.5 ^ 0.3333 Fbo	11.5	11.5	11.5	Right Angle Bend 1.25 → 12.5	
6	Abbot - SW Streams: 0.5 < d50 < 0.7 Design Assumption; ds = K * (qi)^0.24; ds = 2.45 * 133.18 ^ 0.24 = 7.9; K = 2.45	Don't Use 7.9				
7	Zeller Equation - General Scour - Minor Watercourses: IGNORE IF NEGATIVE! Z = Ymax * [0.0685 * v^0.8 / (yh^0.4 * Se^0.3) - 1]; Zgeneral = 24 [(0.0685 10.6 ^ 0.8) -1] = 4.3 (Ymax, V, Yh, Se)	OK				
		Average Bend Scour Values	7.0	12.1	13.4	19.0

Add Bend Scour Value to Calculations at Left

Applicability of Neill Incised Eqn

No	dm < df	19.0 dm
No	dm < df < dfo	10.0 df
OK	df < dfo	19.2 dfo

Middle Section			Recommend Toe Down
USBR Calcs			
Straight Bank	10.8	ft	11
With Bend	17.8	ft	18
Corps Calcs			
Outer Bend	19.1	ft	19.1

Table LR

Method	Neill	Lacey	Blench
Straight	0.5	0.25	0.6
Moderate Bend	0.6	0.5	0.6
Severe Bend	0.7	0.75	0.6
Right Angle Bend		1	1.25
Vertical Rock Bank		1.25	

Final Design Calculations - Section 1 (Bridge Section)

Bend Scour Calculations

Thorne Equation

Depth of flow upstream of bend	y1, Du	14.2
Radius of Curvature	Rc	4210
Width of Flow (Top Width)	W	2140

ds / y1 = 1.07 - log (Rc/W-2) Limits **for 2 < Rc/W < 22**

$$ds = \frac{y1}{14.2} \left(1.07 - \log \left(\frac{Rc}{W} \frac{4210}{2140} - 2 \right) \right) = \textbf{No Value}$$

Rc/W = **1.97** **Not Valid**

Maynord Equation

Active Flow Width Wa 2100

dmb/du = 1.8-0.051*(Rc/W)+0.0084(W/Du) Limits **1.5 < Rc/Wa < 10** **2.00** **20 < Wa/Du < 125** **147.89** **Overbank < 20% Total Depth**

$$dmb = \frac{14.2}{Du} \left(1.8 - 0.0051 * \left(\frac{Rc}{W} \frac{4210}{2100} \right) + 0.00840 * \frac{W}{14.2} \frac{2100}{24} \right) = \frac{\textbf{43.05}}{19.05}$$

Max Wat Depth
Max Depth
Scour Depth
Don't Use

Final Design Calculations - Section 1 (Bridge Section)

Bend Scour Summary	Moderate	Severe	Right Angle	Vertical Wall
Neill	**4.6**	18.2		
Lacey	**4.8**	6.7	14.3	19.0
Blench	**11.5**	11.5	12.5	
Thorne				
Maynord	**19.05**			
Average	**4.7**			

Avg Scour	4.2
Avg +Bend Scour	8.9
Blench Zero Bed Scour	11.5
Average - Weighted (3 Avg : Ble	**9.53**

King Ranch - Cotton Lane Bridge - Near Bridge Reach
Bedform Scour Depths

Zbedform = 0.5 Dh

Hydraulic Depth	14
Froude Number	0.54

Simons and Senturk (1992)

Dune Height (Dh) **Applicable when Fr <1.0**

Dh = 0.066 * Yh^1.21

		Yh			
Dh =	0.066		14 ^ 1.21	=	**1.6**

Antidune Height **Applicable when Fr > 0.7**

Dh = 0.28 * pi * Yh * Fr^2

Dh =	0.28	3.14	14 *	0.54 ^2	=	**3.6**

Bedform Height	**1.6**	**Fr =**	**0.54**

Based on Methodology Presented in Flood Control District of Maricopa County Drainage Design Manual, September 2003 (Draft)

Calculation of General Scour Depths - English Units (ft)

November 2, 2005

Gila River / Cotton Lane Bridge - w/Protected South Bank - 500 Year Flood Flow = 285,000 cfs

Gila River - King Ranch/Cotton Lane Bridge
Cotton Lane Bridge Section
Method not Applicable

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Stream Values

Incised / Bankfull Q cfs	Qi	285000
Incised / Bankfull Width	Wi	3150
Incised / Bankfull q cfs/ft	qi	90.48
Depth of Incision	di	10
Competent Veloc.(p. 38 USBR)	Vc	2.5
Design Q (Channel)		285000
Design Channel Width		3150
Design Flow / Width	qf	90.48
Average Depth / Hydraulic Depth	dm	11
Maximum Depth	Ymax	19.26
Average Velocity	Vm	8.8
Radius of Curvature	Rc	4210
Neill's m - 0.67 Sand to 0.85 Coarse Gravel	m	0.85
D50 - mm		6
D85 - mm		35
D90 - mm		50
Slope		0.0012
Froude Number for Channel		0.44
USBR - Lacey Z - Straight Reach	Zl	0.25
Neill Z (p. 36 USBR) Straight Reach	Zn	0.5
Blench Z (p. 36 USBR) Straight Rch	Zb	0.6
Blench "zero bed factor" (p35)	Fbo	2.5

Using All Equations

Average Scour Depth	6.4
Safety Factor	1.3
Toe Down below Thalweg	8.3

Total Scour Depth Calculations		Meth. Used
Average of Similar Values	3.3	3,4,7
Bend Scour Average (See Sum Below)	3.8	
Bend + Average w/o Blench	7.1	
Ave w/Blench ((3 Avg +Blench) /4	**7.5**	
Long Term Scour (HEC-6T 105 Yrs)	**0.5**	
Bed Form Scour (See Tab) (BF)	**1.2**	
Low Flow Incisement (LFI)	**2**	
Safety Factor x (LT+BF+BS+LFI)	**1.3**	
Recommended Toe Down / with Bend	**14.6**	

Recommended Toe Down -No Bend	**9.1 Feet**

This Spreadsheet is provided without impled or express warranty as to the applicability, accuracy or correctness of any formulas or calculations. The use of this spreadsheet indicates the willingness of the user to accept all risks and liabilities arising from its use. The user is encouraged to veryify the accuracy and applicability of all equations prior to their use in determining toe down depths.

Methodology Adapted from "Computing Degradation and Local Scour", US Bureau of Reclamation, Ernest L. Pemberton and Joseph M. Lara, January 1984
Zeller Equation from the Flood Control District of Maricopa County Drainage Design Manual - Hydraulics, September 2003 (Draft)

		Scour Depth	Bend Scour: Moderate Bend	Severe Bend	Right Angle Bend	Vertical Wall
1	Neill - Incised: df = di*(qf/qi)^m — di = 10, qf = 90.48, m = 0.85, df = 10.0, Z = 0.5; qi = 90.48; Includes Bend Scour; dfo Calculated Below	5.0				
2	Neill - Competent Velocity - Sand or Coarser Material: ds = dm((Vm/Vc)-1) — dm = 11, Vm = 8.8, Vc = 2.5; d = Z*ds	13.9	2.8	5.5		
3	USBR - D90 Method: ds = Z*dm — 50% of Average Flow Depth (dm); Z = 0.25, dm = 11	2.8				
4	Lacey - Zero Bed Sediment Transport Assumed: dm=0.47*(Q/f)^1/3 — Q = 285000, f = 4.3; Includes Bend Scour; Mod Bend 0.5, Sharp Bend 0.6, Right Angle Bend 1, Vertical Rock Bank or Wall 1.25; Dm = D50 = 6, f = 4.3	4.8	4.8	6.7	14.3	19.0
5	Blench - Zero Bed Factor: dfo = qf ^(2/3) / Fbo^(1/3) — qf = 90.48, dfo = 14.8, Z = 0.6; Fbo = 2.5; Includes Bend Scour; Right Angle Bend 1.25	8.9	8.9	8.9	9.7	
6	Abbot - SW Streams: ds = K * (qi)^0.24 — 0.5 < d50 < 0.7 Design Assumption; qi = 90.48, ds = 7.2; K = 2.45	Don't Use 7.2				
7	Zeller Equation - General Scour - Minor Watercourses: Z = Ymax * [0.0685 * v^0.8 / (yh^0.4 * Se^0.3) - 1] — IGNORE IF NEGATIVE! — Ymax = 19.26, V = 8.8, Yh = 11, Se = 0.0012; Zgeneral = 2.4	OK 2.4				
	Average Bend Scour Values		5.5	7.0	12.0	19.0

Add Bend Scour Value to Calculations at Left

Applicability of Neill Incised Eqn

No	dm < df	19.0 dm
No	dm < df < dfo	10.0 df
OK	df < dfo	14.8 dfo

Middle Section			Recommede Toe Down
USBR Calcs			
Straight Bank	9.1	ft	**10**
With Bend	14.6	ft	**15**
Corps Calcs			
Outer Bend	18.1	ft	**18.1**

Table LR

Method	Neill	Lacey	Blench
Straight	0.5	0.25	0.6
Moderate Bend	0.6	0.5	0.6
Severe Bend	0.7	0.75	0.6
Right Angle Bend		1	1.25
Vertical Rock Bank		1.25	

Final Design Calculations - Section 3 (Downstream Section)

Bend Scour Calculations

Thorne Equation

				Limits										
Depth of flow upstream of bend	y1, Du	11	ds / y1 = 1.07 - log (Rc/W-2)	**for 2 < Rc/W < 22**										
Radius of Curvature	Rc	4210		y1						Rc				
Width of Flow (Top Width)	W	3150	ds =	11	(	1.07	- log (	4210	-2	) =	**No Value**			
								3150						
								W						
			Rc/W =			**1.34**					**Not Valid**			

Maynord Equation

						2.00		**190.91**						
Active Flow Width	Wa	2100	dmb/du = 1.8-0.051*(Rc/W)+0.0084(W/Du)		Limits	**1.5 < Rc/Wa < 10**		**20 < Wa/Du < 125**		**Overbank < 20% Total Depth**				
						Rc				W				
			dmb =	11	1.8 -	0.0051 * (	4210)	+	0.00840 *	2100) =	**37.33**	Max Wat Depth		
							2100			11	19.26	Max Depth		
							W			Du	18.07	Scour Depth		
											Don't Use			

Final Design Calculations - Section 3 (Downstream Section)

Bend Scour Summary	Moderate	Severe	Right Angle	Vertical Wall
Neill	2.8	5.5		
Lacey	4.8	6.7	14.3	19.0
Blench	8.9	8.9	9.7	
Thorne				
Maynord	18.07			
Average	3.8			

Avg Scour	3.3
Avg +Bend Scour	7.1
Blench Zero Bed Scour	8.9
Average - Weighted (3 Avg : Blen	7.52

King Ranch - Cotton Lane Bridge - Near Bridge Reach
Bedform Scour Depths

Zbedform = 0.5 Dh

Hydraulic Depth	11
Froude Number	0.44

Simons and Senturk (1992)

Dune Height (Dh) **Applicable when Fr <1.0**

Dh = 0.066 * Yh^1.21

		Yh			
Dh =	0.066		11 ^ 1.21	=	**1.2**

Antidune Height **Applicable when Fr > 0.7**

Dh = 0.28 * pi * Yh * Fr^2

Dh =	0.28	3.14	11 *	0.44 ^2	=	**1.9**

Bedform Height	**1.2**	**Fr =**	**0.44**

Based on Methodology Presented in Flood Control District of Maricopa County Drainage Design Manual, September 2003 (Draft)

Calculation of General Scour Depths - English Units (ft)

November 2, 2005

Gila River / Cotton Lane Bridge - w/Protected South Bank - 500 Year Flood Flow = 285,000 cfs

Gila River - King Ranch/Cotton Lane Bridge
Cotton Lane Bridge Section
Method not Applicable

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Stream Values

Incised / Bankfull Q cfs	Qi	285000
Incised / Bankfull Width	Wi	4150
Incised / Bankfull q cfs/ft	qi	68.67
Depth of Incision	di	10
Competent Veloc.(p. 38 USBR)	Vc	2.5
Design Q (Channel)		285000
Design Channel Width		4150
Design Flow / Width	qf	68.67
Average Depth / Hydraulic Depth	dm	12.6
Maximum Depth	Ymax	20.1
Average Velocity	Vm	6.3
Radius of Curvature	Rc	4210
Neill's m - 0.67 Sand to 0.85 Coarse Gravel	m	0.85
D50 - mm		6
D85 - mm		35
D90 - mm		50
Slope		0.0012
Froude Number for Channel		0.35
USBR - Lacey Z - Straight Reach	Zl	0.25
Neill Z (p. 36 USBR) Straight Reach	Zn	0.5
Blench Z (p. 36 USBR) Straight Rch	Zb	0.6
Blench "zero bed factor" (p35)	Fbo	2.5

Using All Equations

Average Scour Depth	4.7
Safety Factor	1.3
Toe Down below Thalweg	6.1

Total Scour Depth Calculations

		Meth. Used
Average of Similar Values	1.4	3,4,7
Bend Scour Average (See Sum Below)	3.3	
Bend + Average w/o Blench	4.7	
Ave w/Blench ((3 Avg +Blench) /4	5.4	
Long Term Scour (HEC-6T 105 Yrs)	0.5	
Bed Form Scour (See Tab) (BF)	1.4	
Low Flow Incisement (LFI)	2	
Safety Factor x (LT+BF+BS+LFI)	1.3	
Recommended Toe Down / with Bend	12.1	

Recommended Toe Down -No Bend	6.9 Feet

This Spreadsheet is provided without impled or express warranty as to the applicability, accuracy or correctness of any formulas or calculations. The use of this spreadsheet indicates the willingness of the user to accept all risks and liabilities arising from its use. The user is encouraged to veryify the accuracy and applicability of all equations prior to their use in determining toe down depths.

Methodology Adapted from "Computing Degradation and Local Scour", US Bureau of Reclamation, Ernest L. Pemberton and Joseph M. Lara, January 1984
Zeller Equation from the Flood Control District of Maricopa County Drainage Design Manual - Hydraulics, September 2003 (Draft)

	Scour Depth	Bend Scour: Moderate Bend	Bend Scour: Severe Bend	Bend Scour: Right Angle Bend	Bend Scour: Vertical Wall
1 Neill - Incised: df = di*(qf/qi)^m; ds = Z*df; di = 10, qf = 68.67, m = 0.85, df = 10.0, Z = 0.5	Don't Use				
Includes Bend Scour: qf = 68.67, qi = 68.67, dfo Calculated Below	5.0				
2 Neill - Competent Velocity - Sand or Coarser Material: ds = dm((Vm/Vc)-1); d = Z*ds; dm = 12.6, Vm = 6.3, Vc = 2.5, ds = 19.2	9.6				
Moderate Bend Z = 0.6		1.9			
Severe Bend Z = 0.7			3.8		
3 USBR - D90 Method: 50% of Average Flow Depth (dm); ds = Z*dm; Z = 0.25, dm = 12.6, ds = 3.2	3.2				
4 Lacey - Zero Bed Sediment Transport Assumed: dm=0.47*(Q/f)^1/3; ds = Z*dm; Q = 285000, dm = 19.0, Z = 0.25	4.8				
Includes Bend Scour: f = 4.3, Dm = D50 = 6, f = 4.3					
Mod Bend Z = 0.5		4.8			
Sharp Bend Z = 0.6			6.7		
Right Angle Bend Z = 1				14.3	
Vertical Rock Bank or Wall Z = 1.25					19.0
5 Blench - Zero Bed Factor: dfo = qf ^(2/3) / Fbo^(1/3); ds = Z*dfo; qf = 68.67, dfo = 12.4, Z = 0.6	7.4	7.4	7.4		
Includes Bend Scour: Fbo = 2.5^0.3333; Right Angle Bend Z = 1.25				8.0	
6 Abbot - SW Streams: 0.5 < d50 < 0.7 Design Assumption; ds = K * (qi)^0.24; K = 2.45; qi = 68.67, ds = 6.8	Don't Use				
	6.8				
7 Zeller Equation - General Scour - Minor Watercourses: IGNORE IF NEGATIVE! Z = Ymax * [0.0685 * v^0.8 / (yh^0.4 * Se^0.3) - 1]	Don't Use				
Zgeneral = 20.1 [(0.0685 * 6.3^0.8) / (12.6^0.4 * 0.0012^0.3) - 1] =	-3.7				
Average Bend Scour Values		4.7	6.0	11.1	19.0

Add Bend Scour Value to Calculations at Left

Applicability of Neill Incised Eqn

No	dm < df	19.0 dm
No	dm < df < dfo	10.0 df
OK	df < dfo	12.4 dfo

Middle Section			Recommede Toe Down
USBR Calcs			
Straight Bank	6.9	ft	7
With Bend	12.1	ft	12
Corps Calcs			
Outer Bend	20.1	ft	20.1

Table LR

Method	Neill	Lacey	Blench
Straight	0.5	0.25	0.6
Moderate Bend	0.6	0.5	0.6
Severe Bend	0.7	0.75	0.6
Right Angle Bend		1	1.25
Vertical Rock Bank		1.25	

Final Design Calculations - Section 3 (Downstream Section)

Bend Scour Calculations

Thorne Equation

Depth of flow upstream of bend	y1, Du	12.6	ds / y1 = 1.07 - log (Rc/W-2)	Limits **for 2 < Rc/W < 22**	
Radius of Curvature	Rc	4210			
Width of Flow (Top Width)	W	4150	ds =	12.6 (1.07 - log (4210 / 4150 - 2) =	**No Value**
			Rc/W =	**1.01**	**Not Valid**

Maynord Equation

Active Flow Width	Wa	2100	dmb/du = 1.8-0.051*(Rc/W)+0.0084(W/Du)		**2.00**	**166.67**	**Overbank < 20% Total Depth**
				Limits	**1.5 < Rc/Wa < 10**	**20 < Wa/Du < 125**	
			dmb =	12.6 (1.8 - 0.0051 * (Rc/W 4210 / 2100) + 0.00840 * Wa/Du 2100 / 12.6) =			**40.19** Max Wat Depth
							20.1 Max Depth
				Du			20.09 Scour Depth
							Don't Use

Final Design Calculations - Section 3 (Downstream Section)

Bend Scour Summary	Moderate	Severe	Right Angle	Vertical Wall
Neill	1.9	3.8		
Lacey	4.8	6.7	14.3	19.0
Blench	7.4	7.4	8.0	
Thorne				
Maynord	20.09			
Average	3.3			

Avg Scour	1.4
Avg +Bend Scour	4.7
Blench Zero Bed Scour	7.4
Average - Weighted (3 Avg : Blen	5.40

King Ranch - Cotton Lane Bridge - Near Bridge Reach
Bedform Scour Depths

Zbedform = 0.5 Dh

Hydraulic Depth	12.6
Froude Number	0.35

Simons and Senturk (1992)

Dune Height (Dh) **Applicable when Fr <1.0**

Dh = 0.066 * Yh^1.21

		Yh			
Dh =	0.066		12.6 ^ 1.21	=	**1.4**

Antidune Height **Applicable when Fr > 0.7**

Dh = 0.28 * pi * Yh * Fr^2

Dh =	0.28	3.14	12.6 *	0.35 ^2	=	**1.4**

Bedform Height	**1.4**	**Fr =**	**0.35**

Based on Methodology Presented in Flood Control District of Maricopa County Drainage Design Manual, September 2003 (Draft)

Gila River - Plan E Revised - 500 Yr Flood.
November 2005
HEC-RAS Plan: PC Sep 23FIS River: Gila Reach: 1 Profile: PF 3

	Reach	River Sta	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 # C	Hydr Depth (ft)	Hydr Depth (ft)	Top W Act (ft)	Max Chl D
	1	194.205 Bridge														
	1	194.2	285000	882.97	906.95		908.89	0.001885	11.19	25459.92	2550.71	0.57	11.98	11.98	2125.7	23.98
	1	194.1	285000	883.87	906.33		907.9	0.001586	10.08	28277.39	5559.99	0.52	11.61	11.61	2436.32	22.46
	1	194.02	285000	885.49	905.81		907.15	0.00139	9.28	30766.13	5226.65	0.48	11.57	11.5	2644.4	20.32
	1	193.94	285000	885.38	905.52		906.59	0.001145	8.31	34324.23	5006.54	0.43	11.79	11.75	2909.57	20.14
	1	193.87	285000	882.8	905.12		906.05	0.001497	7.75	36816	4545.16	0.4	11.63	11.57	3150.9	22.32
	1	193.79	285000	882.55	904.68		905.52	0.00093	7.39	38658.17	4141.68	0.38	11.51	11.42	3345.8	22.13
	1	193.73	285000	882.18	904.33		905.2	0.000925	7.49	38104.97	3443.67	0.39	11.3	11.26	3355.9	22.15
	1	193.62	285000	878.21	903.69		904.65	0.001012	7.85	36331.5	3264.64	0.41	11.51	11.49	3151.33	25.48
	1	193.53	285000	878.96	903.29		904.16	0.000883	7.51	38190.7	3566.06	0.38	11.85	11.19	3192.51	24.33
	1	193.43	285000	879.37	902.91		903.73	0.00082	7.27	39335.38	3929.94	0.37	11.94	11.28	3279.34	23.54
	1	193.34	285000	881.18	902.49		903.35	0.000781	7.45	38367.59	3965.29	0.37	12.64	11.75	3024.61	21.31
	1	193.25	285000	880.67	901.85		902.88	0.00116	8.17	35084.95	4174.42	0.4	13.17	11.53	2646.72	21.18
Section 1	1	193.16	285000	880.66	901.3		902.38	0.00094	8.35	35009.75	4348.24	0.4	13.29	8.05	2560.82	20.64
Channelized	1	193.07	285000	881.99	900.9		901.93	0.000864	8.15	36023.93	4637.62	0.39	13.71	7.77	2544.07	18.91
Both Banks Protected	1	192.98	285000	880.71	900.51		901.48	0.000905	7.93	37117.31	5357	0.37	14.09	6.93	2540.93	19.8
	1	192.89	285000	880.29	899.89		900.99	0.001053	8.43	35664.28	6674.7	0.4	14.05	5.34	2394.17	19.6
	1	192.79	285000	876.74	899.18		900.4	0.001311	8.9	33806.68	6254.89	0.42	13.98	5.4	2278.46	22.44
	1	192.7	285000	877.01	898.43		899.74	0.001391	9.19	32844.68	6436.42	0.43	13.99	5.1	2207.02	21.42
	1	192.61	285000	878.15	897.79		899.11	0.001236	9.25	32545.24	6224.38	0.43	14.16	5.23	2167.2	19.64
	1	192.52	285000	878.23	897.13		898.48	0.001245	9.37	32240.34	6795.08	0.44	14.13	4.74	2143.68	18.9
	1	192.41	285000	876.67	896.29	890.71	897.77	0.001357	9.76	29209.63	2204.05	0.47	13.65	13.65	2139.45	19.62
	1	192.39 Bridge														
	1	192.38	285000	876.41	895.54		897.14	0.001512	10.15	28085.31	2206.06	0.49	13.12	13.12	2140.03	19.13
	1	192.33	285000	876.06	895.06		896.67	0.001543	10.19	28132.19	6428.79	0.5	13.03	10.08	2144.5	19
	1	192.23	285000	876.72	894.15	889.42	895.83	0.001854	10.38	27587.12	6487.64	0.51	12.81	9.67	2141.48	17.43
	1	192.14	285000	875.94	893.11		894.86	0.002017	10.61	26952.9	6609.17	0.54	12.1	8.94	2219	17.17
	1	192.04	285000	876.36	892.36		893.89	0.001674	10.04	29792.95	6355.34	0.51	12.12	8.81	2263.77	16
							Average	0.001253	8.95	33110.61	5147.51	0.43	13.21	8.81	2445.99	20.00
							Maximum	0.002017	10.61	39335.38	6795.08	0.54	14.16	13.65	3279.34	24.33
	1	191.95	285000	876.68	891.88		893.05	0.001291	8.82	33810.89	6420.45	0.46	11.61	8.36	2622.25	15.2
Section 2	1	191.86	285000	876.27	891.42		892.4	0.001094	8.11	36660.7	6363.85	0.42	11.57	8.71	2856.23	15.15
South Bank Protected	1	191.76	285000	874.62	890.87		891.83	0.001152	7.96	37451.74	6651.48	0.42	10.91	8.31	3151.44	16.25
North Vane Dikes	1	191.67	285000	872.6	890.34		891.22	0.001184	7.65	39014.68	6420.8	0.41	10.56	7.93	3339.64	17.74
	1	191.57	285000	870.63	889.89		890.63	0.001027	7.04	42423.86	6391.86	0.39	10.34	7.91	3727.86	19.26
							Average	0.00115	7.92	37872.37	6449.69	0.42	11.00	8.24	3139.48	16.72
							Maximum	0.001291	8.82	42423.86	6651.48	0.46	11.61	8.71	3727.86	19.26
	1	191.48	285000	870.93	889.52		890.12	0.000845	6.32	46340.6	7446.21	0.35	10.18	10.16	4150.39	18.59
	1	191.38	285000	871.69	889.14		889.69	0.000791	6.03	48449.29	6663.63	0.33	10.29	10.06	4449.45	17.45
Section 3	1	191.29	285000	870.63	888.77		889.29	0.000801	5.8	49947.94	8401.37	0.31	10.72	10.33	4504.12	18.14
South Bank Protected	1	191.19	285000	869.78	888.37		888.88	0.000808	5.78	50406.51	8476.95	0.31	10.94	10.44	4365.07	18.59
No North Bank Protection	1	191.1	285000	870.88	888.01		888.52	0.000665	5.78	50427.06	8220.22	0.3	11.35	10.83	4250.77	17.13
	1	191	285000	869.64	887.63		888.17	0.000712	5.91	48419.43	8072.9	0.31	11.14	10.68	4326.42	17.99
	1	190.91	285000	867.98	887.18		887.77	0.000866	6.18	47014.09	8299.44	0.33	11.21	7.13	4103.33	19.2
	1	190.81	285000	867.86	886.78		887.36	0.000781	6.12	47641.38	9047.51	0.32	11.2	6.83	4152.44	18.92
	1	190.72	285000	866.3	886.39		886.96	0.000795	6.03	48288.79	8556.91	0.32	11.33	6.83	4159.65	20.09
	1	190.62	285000	867.37	885.99		886.55	0.000839	6.04	48109.66	8218.28	0.31	11.93	8.1	3926.04	18.62
	1	190.53	285000	866.16	885.54		886.11	0.000923	6.07	47338.04	7090.65	0.3	12.37	9.48	3793.62	19.38
	1	190.43	285000	867.42	885.04		885.64	0.00094	6.23	46129.33	6310.11	0.31	12.61	9.66	3628.52	17.62
							Average	0.000814	6.02	48209.34	7900.35	0.32	11.27	9.21	4150.82	18.48
							Maximum	0.00094	6.32	50427.06	9047.51	0.35	12.61	10.83	4504.12	20.09
	1	190.34	285000	866.61	884.6		885.15	0.000964	5.92	48171.08	6764.22	0.3	12.41	12.41	3880.81	17.99
	1	190.24	285000	866.29	884.07		884.61	0.001141	5.91	48191.84	5950.51	0.3	12.34	12.34	3904.81	17.78
	1	190.15	285000	865.74	883.35		884	0.001325	6.46	44097.48	5613.15	0.34	11.54	11.54	3820.09	17.61
	1	190.05	285000	858.06	882.86		883.4	0.000947	5.91	48333.04	7341.68	0.29	12.59	11.42	3826.25	24.8
	1	189.96	285000	857.56	882.45		882.97	0.000843	5.79	49427.69	7126.96	0.29	12.45	11.24	3952.74	24.89
	1	189.87	285000	862.94	882.09		882.54	0.000816	5.45	53193.15	10760.92	0.28	12.01	10.82	4335.58	19.15
	1	189.77	285000	860.75	881.76		882.13	0.000662	4.9	60267.97	11776.35	0.24	12.83	11.21	4436.27	21.01
	1	189.67	285000	862.77	881.42		881.78	0.000683	4.89	60876.72	11924.29	0.24	12.54	10.83	4528.26	18.65
	1	189.58	285000	857.92	881.11		881.45	0.00061	4.79	63041.16	12180.79	0.24	12.7	10.83	4501.2	23.19
	1	189.48	285000	857.85	880.82		881.15	0.000577	4.72	65064.32	11928.34	0.23	13.23	10.92	4337.8	22.97
	1	189.39	285000	855.02	880.51		880.86	0.000567	4.9	63969.32	11652.14	0.24	13.1	10.36	4168.8	25.49
	1	189.3	285000	856.36	880.21		880.58	0.000673	5.05	62535.04	11741.26	0.25	12.61	9.75	4154.65	23.85
	1	189.21	285000	856.97	879.84		880.16	0.001084	4.71	65697.61	11730.48	0.24	12.39	9.83	4152.28	22.87
	1	189.11	285000	857.4	879.28		879.59	0.001142	4.67	66399.91	10916.54	0.23	12.84	9.46	4187.36	21.88
	1	189.02	285000	855.16	878.88		879.2	0.00053	4.73	68349.99	11405.26	0.24	12.37	9.06	4481.6	23.72
	1	188.81	285000	852.24	878.4		878.7	0.0004	4.61	71633.28	10995.28	0.21	14.51	9.69	3921.52	26.16
	1	188.69	285000	850.62	878.06		878.38	0.000769	4.82	67863.42	10804.6	0.22	14.48	9.19	3610.57	27.44
	1	188.59	285000	861.4	877.62	872.18	877.98	0.000761	4.93	59724.52	8123.13	0.27	10.71	7.74	4171.73	16.22
	1	188.5	285000	860.5	877.31	871.19	877.63	0.00068	4.67	62556.46	7877.07	0.24	11.51	8.01	3842.39	16.81
	1	188.39	285000	860.7	877.01	869.89	877.34	0.000506	4.9	62954.61	7632.77	0.24	12.75	8.32	3539.36	16.31
	1	188.29	285000	859.6	876.64	870.23	877.09	0.000482	5.79	56778.91	7763.01	0.29	12.53	7.51	3227.37	17.04
	1	188.2	285000	859.3	876.23	869.87	876.78	0.000926	6.42	50199.21	7274.42	0.31	13.41	7.2	2580	16.93
	1	188.1	285000	855.8	875.61	870.18	876.34	0.000838	7.58	45843.45	6832.04	0.36	13.92	7.18	2030.88	19.81
	1	188.07	285000	855	875.46	867.78	876.19	0.000599	7.48	45362.71	5743.58	0.32	16.93	8.79	1751.18	20.46
	1	188.055 Bridge														

APPENDIX G

SECTION II

Toe Down Depths and Related Plots

Calculated Toe Down, Turn Down and Top of Bank Elevations
King Ranch / Cotton Lane Bridge Channel

Minimum Design Toe Down Elevation

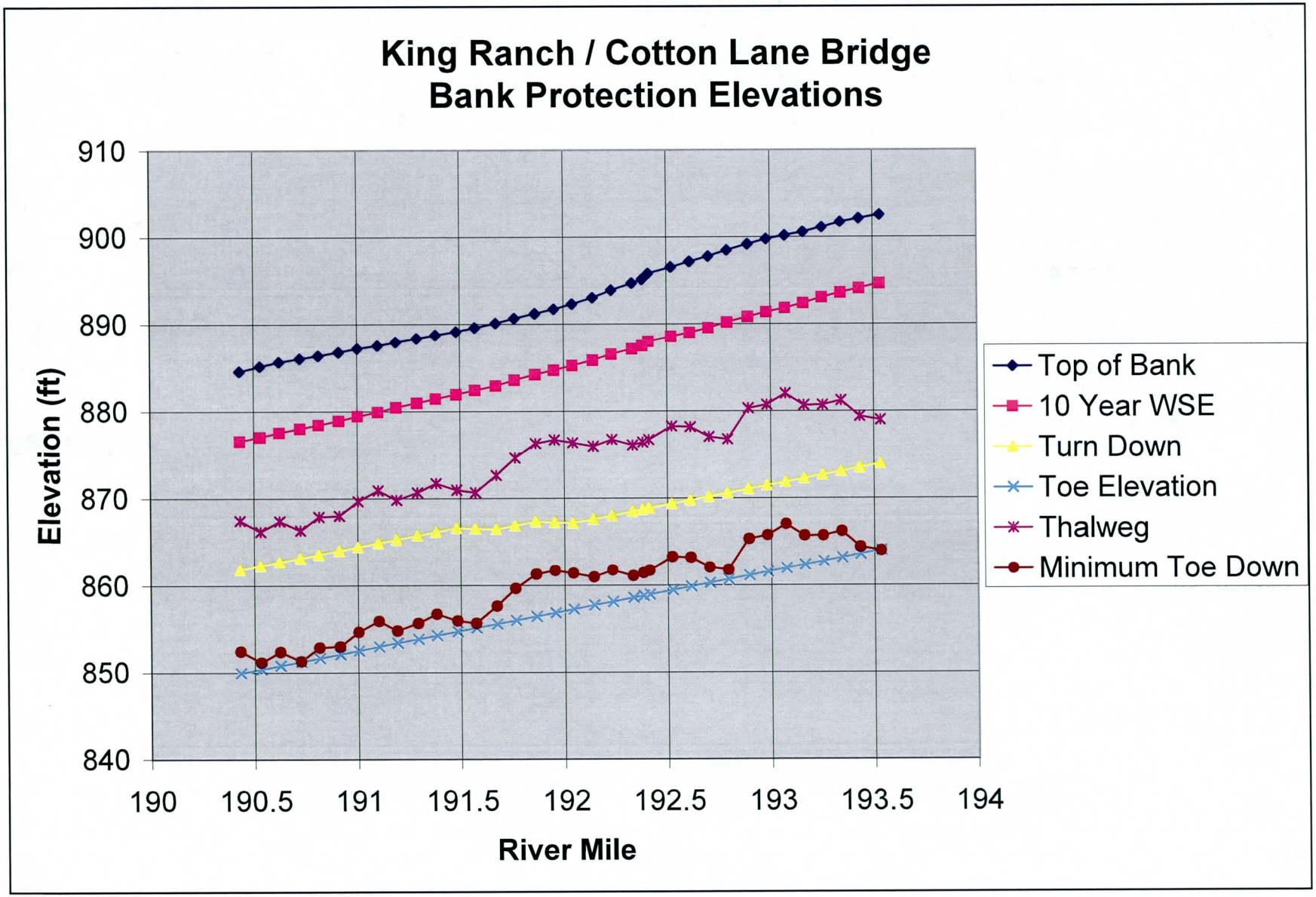
Toe Down Line Formula
Y = ax+b
4.555172 Slope (a)
-17.6 Intercept (b)
x in river miles

Formula
Y = 4.555172(x)-17.6

		River Mile	Thalweg Elevation	Minimum Top of Bank Elevation	Top of Hard Protection (10 Yr WSE)	Distance Top Bank to Top of Hard Bank	South Bank Toe Down Elevations: South Bank	South Turn Down Elevation	Distance to Toe frm Turndown	Distance to Turndn from Top	Total Horizontal Distance	North Bank Toe Down Elevations: North Bank	North Turn Down Elevation	Distanct to Top Hard Bank	Total Distance to Toe	Extra Toe Down
Estrella Parkway Bridge		194.205	Bridge													
		194.2	882.97	906.49	899.5											
		194.1	883.87	905.82	898.79											
		194.02	885.49	905.25	898.15											
		193.94	885.38	904.92	897.69											
		193.87	882.8	904.47	897.18											
		193.79	882.55	903.99	896.63											
		193.73	882.18	903.62	896.22											
		193.62	878.21	902.95	895.31											
		193.53	878.96	902.51	894.63	47.3	864.0	874.0	20.0	171.3	191.3	857.0	869.0	201.3	225.3	0.0
Calculated Value		193.43	879.37	902.1	894.07	48.2	863.5	873.5	20.0	171.6	191.6	856.5	868.5	201.6	225.6	0.9
11 ft Inside		193.34	881.18	901.68	893.58	48.6	863.1	873.1	20.0	171.5	191.5	856.1	868.1	201.5	225.5	3.1
Bend	Toe Down	193.25	880.67	901.07	893.04	48.2	862.7	872.7	20.0	170.3	190.3	855.7	867.7	200.3	224.3	3.0
Inside	**15**	193.16	880.66	900.51	892.37	48.8	862.3	872.3	20.0	169.4	189.4	855.3	867.3	199.4	223.4	3.4
Outside	18	193.07	881.99	900.11	891.82	49.7	861.9	871.9	20.0	169.5	189.5	854.9	866.9	199.5	223.5	5.1
		192.98	880.71	899.72	891.35	50.2	861.5	871.5	20.0	169.6	189.6	854.5	866.5	199.6	223.6	4.3
		192.89	880.29	899.12	890.8	49.9	861.0	871.0	20.0	168.4	188.4	854.0	866.0	198.4	222.4	4.2
		192.79	876.74	898.44	890.17	49.6	860.6	870.6	20.0	167.1	187.1	853.6	865.6	197.1	221.1	1.1
Section 1		192.7	877.01	897.73	889.52	49.3	860.2	870.2	20.0	165.3	185.3	853.2	865.2	195.3	219.3	1.8
		192.61	878.15	897.13	889	48.8	859.8	869.8	20.0	164.1	184.1	852.8	864.8	194.1	218.1	3.4
		192.52	878.23	896.51	888.53	47.9	859.4	869.4	20.0	162.9	182.9	852.4	864.4	192.9	216.9	3.9
		192.41	876.67	895.77	887.97	46.8	858.9	868.9	20.0	161.5	181.5	851.9	863.9	191.5	215.5	2.8
Cotton Lane Bridge		192.39														
		192.38	876.41	895.1	887.48	45.7	858.7	868.7	20.0	158.3	178.3	851.7	863.7	188.3	212.3	2.7
		192.33	876.06	894.67	887.12	45.3	858.5	868.5	20.0	157.0	177.0	851.5	863.5	187.0	211.0	2.6
		192.23	876.72	893.88	886.51	44.2	858.0	868.0	20.0	155.0	175.0	851.0	863.0	185.0	209.0	3.7
		192.14	875.94	893.01	885.82	43.1	857.6	867.6	20.0	152.3	172.3	850.6	862.6	182.3	206.3	3.3
		192.04	876.36	892.28	885.22	42.4	857.2	867.2	20.0	150.6	170.6	850.2	862.2	180.6	204.6	4.2
Section 2		191.95	876.68	891.7	884.69	42.1	856.8	867.3	21.0	146.6	167.6	849.8				4.9
Bend	Toe Down	191.86	876.27	891.19	884.18	42.1	856.4	867.4	22.0	143.0	165.0	849.4				4.9
Inside	**15**	191.76	874.62	890.66	883.55	42.7	855.9	866.9	22.0	142.6	164.6	848.9				3.7
Outside	15	191.67	872.6	890.1	882.9	43.2	855.5	866.5	22.0	141.7	163.7	848.5				2.1
		191.57	870.63	889.58	882.39	43.1	855.0	866.5	23.0	138.3	161.3	848.0				0.6
		191.48	870.93	889.13	881.92	43.3	854.6	866.6	24.0	135.0	159.0					1.3
Bend	Toe Down	191.38	871.69	888.73	881.42	43.9	854.2	866.2	24.0	135.4	159.4					2.5
Inside	**15**	191.29	870.63	888.36	880.94	44.5	853.8	865.8	24.0	135.6	159.6					1.9
Outside	15	191.19	869.78	887.93	880.44	44.9	853.3	865.3	24.0	135.8	159.8					1.5
		191.1	870.88	887.55	879.91	45.8	852.9	864.9	24.0	135.9	159.9					3.0
Section 3		191	869.64	887.2	879.43	46.6	852.4	864.4	24.0	136.6	160.6					2.2
		190.91	867.98	886.78	878.91	47.2	852.0	864.0	24.0	136.5	160.5					1.0
		190.81	867.86	886.39	878.43	47.8	851.6	863.6	24.0	136.9	160.9					1.3
		190.72	866.3	886.04	878	48.2	851.2	863.2	24.0	137.3	161.3					0.1
		190.62	867.37	885.67	877.54	48.8	850.7	862.7	24.0	137.8	161.8					1.7
		190.53	866.16	885.17	877.04	48.8	850.3	862.3	24.0	137.2	161.2					0.9
		190.43	867.42	884.59	876.55	48.2	849.8	861.8	24.0	136.5	160.5					2.6
Tuthill Rd. Bridge		188.055	Bridge													

Gila River Bank Protection Design - King Ranch / Cotton Lane Bridge

Toe Down for Vane Dikes			
		Toe Elevations	
North Bank	Top Elev	Upstream	Downstream
1N (upstrm)	885.0	850	849.5
2N	884.0	849.0	848.5
3N	883.5	848.5	848.0
4N (dnstrm)	883.0	848.0	847.5
South Bank			
1N (upstrm)	885.5	853.5	853.0
2N (dnstrm)	885.0	853.0	852.5


King Ranch / Cotton Lane Bridge
Bank Protection Elevations
Elevation (ft)
910
900
890
880
870
860
850
840
190
190.5
191
191.5
192
192.5
193
193.5
194
River Mile
Top of Bank
10 Year WSE
Turn Down
Toe Elevation
Thalweg
Minimum Toe Down

APPENDIX G

SECTION III

Bridge Scour Calculations

Scour Summary of Calculations
Leo Kreymborg, P.E. / WEST Consultants, Inc.
16-Feb-06

Pier Scour (5 foot columns)	100-year	500-year	Notes
General Scour	1.1	1.6	Both are Zeller General Scour at 192.41 from n=0.025 in channel model
Long Term Scour	1.5	1.5	
30% factor of safety on subtotal	0.8	0.9	
Subtotal	3.4	4.0	
Local Pier Scour	19.7	20.7	
Total Scour	23.1	24.7	

Left and Right Abutment Scour	100-year	500-year	Notes
General Scour	1.1	*see note below	Zeller General Scour at 192.41 from n=0.025 in channel model
Long Term Scour	1.5	*see note below	
Dune Scour	3	*see note below	1/6 of Maximum Depth at 192.41
Factor of Safety, 30%	1.7	*see note below	
Total Scour	7.3	27.3	*for 500-year flood, use pier scour calculation for 5-foot piers

Bedforms per Engelund and Hansen:
V/U* is about 9-10 at all cross sections upstream of the bridge
Froude numbers less than 1
>> Predicts Dunes

Simons & Richardson
Stream Power is well within the antidunes and flat bed range (high stream power)

Assuming AntiDunes:

Bedform scour = 1/2 * ha = 0.027 V^2 /2

500-year pier scour

y_1	19.6	Flow depth directly upstream of pier	from cross-section 192.41 Channel Maximum Depth (n=0.025 in channel model)
K_1	1.1	Correction Factor for pier nose shape	Square Nose Including Debris, Table 6.1 HEC-18
K_2	1.0	Correction Factor for angle of attack	0 angle of attack, Table 6.2
K_3	1.1	Correction Factor for bed condition	Table 6.3 Plane bed and antidune flow
K_4	1.0	Correction Factor for armoring	Several samples do not have D95 > 20mm, so no armoring is assumed
a	9.0	Pier width (5 feet + 4 feet debris)	8 feet
Fr_1	0.47	Froude number directly upstream of pier	from cross-section 192.42, Channel Froude number
V_1	9.77	Mean channel velocity (not used)	Channel velocity from 192.42
g	32.2	(not used)	

$y_s = a * 2.0 * K_1 * K_2 * K_3 * K_4 * (y_1/a)^{0.35} * Fr_1^{0.43}$

$y_s = 20.67115$

HEC-RAS Plan: PC Dec 23 Fo River: Gila Reach: 1 Profile: PF 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	Top Wdth Act (ft)	Hydr Depth C (ft)	Q Channel (cfs)	Vel Total (ft/s)
1	195.75	PF 1	227000	903.4	917.73	914.96	919.51	0.002169	11.22	22772.56	4473.81	0.59	2385.78	11.28	200864.1	9.97
1	195.66	PF 1	227000	903.1	917.47	912.7	918.52	0.001162	8.46	28721.2	4346.95	0.43	2629.43	11.8	206966	7.9
1	195.56	PF 1	227000	901.4	916.94	911.75	917.93	0.001156	8.12	28808.92	4106.57	0.42	2552.51	11.36	211032.3	7.88
1	195.47	PF 1	227000	902.1	916.2	911.88	917.27	0.001385	8.43	27818.78	4362.12	0.45	2841.88	10.74	217811.1	8.16
1	195.38	PF 1	227000	900.4	915.74	910.84	916.64	0.001099	7.82	30927.77	4013.15	0.41	3087.24	11.47	210836.9	7.34
1	195.28	PF 1	227000	901.3	914.98	910.16	916.02	0.001115	8.39	29500.01	5072.21	0.43	3185.12	12.01	213024.5	7.69
1	195.19	PF 1	227000	900.7	913.69	910.33	915.28	0.001885	10.39	23441.89	4198.68	0.55	2736.38	11.17	211490.3	9.68
1	195.16	PF 1	227000	900	913.47	908.68	914.94	0.001408	9.82	23846.52	2341.47	0.48	2139.47	12.8	221999.3	9.52
1	195.15	Bridge														
1	195.13	PF 1	227000	900	913.23	908.68	914.76	0.001505	10.02	23343.48	2237.68	0.5	2145.68	12.56	222302.9	9.72
1	195.09	PF 1	227000	898.8	912.57	909.24	914.32	0.002001	10.76	22295.6	3657.03	0.57	2679.17	11.26	218873.1	10.18
1	195	PF 1	227000	897	912.05	908.48	913.29	0.00154	9.18	26677.16	4364.9	0.49	3441.75	10.8	210851	8.51
1	194.91	PF 1	227000	896.9	911.43	907.63	912.51	0.001446	8.56	28678.78	4973.37	0.47	4192.33	10.19	214162.6	7.92
1	194.81	PF 1	227000	896	911.16	905.84	911.88	0.000818	7	35118.84	5164.81	0.37	4345.47	11.26	213966.1	6.46
1	194.72	PF 1	227000	895.7	910.72	905.79	911.46	0.000927	7.08	34228.88	4725.84	0.38	3923.08	10.69	212469.8	6.63
1	194.62	PF 1	227000	896	910.33	905.58	910.99	0.000861	6.67	35650.48	5294.07	0.36	4144.93	10.4	202090.1	6.37
1	194.53	PF 1	227000	895.2	909.82	905.21	910.53	0.000969	6.88	34552.08	5571.63	0.38	4246.03	10.06	210976.8	6.57
1	194.4	PF 1	227000	896	908.84	904.77	909.76	0.001223	7.83	30923.65	5830.38	0.43	4056.79	10.13	214997.4	7.34
1	194.29	PF 1	227000	896.2	906.78	904.97	908.42	0.002971	10.46	22531.8	5071.7	0.65	3032	8.03	216170	10.07
1	194.21	PF 1	227000	883.1	905.79	902.06	907.32	0.001693	9.93	22867.95	2976.97	0.53	2120.93	10.78	227000	9.93
1	194.205	Bridge														
1	194.2	PF 1	227000	882.97	905.48	901.99	907.08	0.001824	10.16	22353.18	2116.92	0.55	2116.92	10.56	227000	10.16
1	194.1	PF 1	227000	883.87	904.8	901.11	906.13	0.001606	9.24	24570.85	3012.59	0.51	2436.32	10.09	227000	9.24
1	194.02	PF 1	227000	885.49	904.24	900.31	905.37	0.001434	8.57	26554.93	3196.98	0.48	2671.71	9.99	226367.4	8.55
1	193.94	PF 1	227000	885.38	903.9	899.37	904.82	0.00117	7.67	29609.81	3505.83	0.42	2915.68	10.17	226990.1	7.67
1	193.87	PF 1	227000	882.8	903.46	898.79	904.26	0.001587	7.2	31547.68	3568.24	0.4	3176.56	9.97	226333.1	7.2
1	193.79	PF 1	227000	882.55	902.98	898.24	903.72	0.00097	6.91	32934.32	3711.81	0.39	3369.75	9.81	226712.6	6.89
1	193.73	PF 1	227000	882.18	902.61	897.91	903.38	0.000988	7.04	32284.29	3421.02	0.4	3382.87	9.58	226311.5	7.03
1	193.62	PF 1	227000	878.21	901.95	897.52	902.79	0.001086	7.37	30815.13	3218.5	0.42	3160.37	9.77	226925.2	7.37
1	193.53	PF 1	227000	878.96	901.5	896.73	902.27	0.000947	7.06	32245.8	3319.81	0.39	3264.37	10.12	226799.4	7.04
1	193.43	PF 1	227000	879.37	901.09	896	901.82	0.000883	6.84	33214.39	3567.18	0.38	3302.23	10.12	226965.2	6.83
1	193.34	PF 1	227000	881.18	900.66	895.22	901.41	0.000818	6.94	32719.01	3675.9	0.37	3024.61	10.82	227000	6.94
1	193.25	PF 1	227000	880.67	900.05	894.46	900.93	0.001184	7.54	30119.3	2637.25	0.39	2637.25	11.42	227000	7.54
1	193.16	PF 1	227000	880.66	899.49	894.1	900.42	0.000963	7.71	29431.47	2539.45	0.4	2539.45	11.59	227000	7.71
1	193.07	PF 1	227000	881.99	899.09	893.35	899.96	0.00088	7.5	30251.29	2538.04	0.38	2538.04	11.92	227000	7.5
1	192.98	PF 1	227000	880.71	898.69	892.51	899.51	0.000904	7.28	31194.61	2521.56	0.36	2521.56	12.37	227000	7.28
1	192.89	PF 1	227000	880.29	898.09	892.18	899.02	0.001052	7.74	29328.8	2381.69	0.39	2381.69	12.31	227000	7.74
1	192.79	PF 1	227000	876.74	897.4	891.75	898.44	0.001309	8.16	27806.49	2263.84	0.41	2263.84	12.28	227000	8.16
1	192.7	PF 1	227000	877.01	896.68	891.15	897.78	0.001376	8.4	27011.34	2194.95	0.42	2194.95	12.31	227000	8.4
1	192.61	PF 1	227000	878.15	896.06	890.41	897.16	0.001204	8.42	26945.32	2156.14	0.42	2156.14	12.5	227000	8.42
1	192.52	PF 1	227000	878.23	895.43	889.84	896.55	0.001209	8.52	26651.48	2133.65	0.42	2133.65	12.49	227000	8.52
1	192.41	PF 1	227000	876.67	894.66	889.51	895.87	0.001304	8.83	25718.7	2147.6	0.45	2130.3	12.07	227000	8.83
1	192.39	Bridge														
1	192.38	PF 1	227000	876.41	893.99	889.28	895.29	0.001444	9.16	24768.88	2144.68	0.47	2126.25	11.65	227000	9.16

Q contracted / Qus	Width US / Contracted Width	Vstar	Vstar / omega	Y2 / Y1	Contract Scour	
0.88486388	1.2281249	0.8875897	1.1272389	1.0270244		
0.91174449	1.3535483	0.6644648	0.8438703	1.1213696		
0.92965771	1.3139523	0.6502734	0.8258473	1.1187661		
0.95952026	1.4629109	0.6920779	0.8789389	1.2312813		
0.92879692	1.5892146	0.6371013	0.8091187	1.2625842		
0.93843392	1.6396001	0.6566544	0.8339511	1.2995061		
0.93167533	1.4086028	0.8233987	1.0457164	1.1718716		
0.97797048	1.1013322	0.7617882	0.967471	1.0436035		
#VALUE!	0	0	0	#VALUE!		
0.97930793	1.1045289	0.7801732	0.9908199	1.0467666		
0.96419868	1.3791529	0.8517667	1.0817438	1.1906398		
0.92885903	1.7717052	0.7318131	0.9294026	1.3536268		
0.94344758	2.1580803	0.6888096	0.8747882	1.5564414		
0.94258194	2.236912	0.5445952	0.6916359	1.5913405		
0.93599031	2.0194788	0.5648806	0.7173984	1.4815919		
0.89026476	2.1336803	0.5369653	0.6819459	1.4701901		
0.92941322	2.1857234	0.560259	0.7115289	1.5491425		
0.94712511	2.0883086	0.6316055	0.802139	1.5291367		
0.95229075	1.5607787	0.87647	1.1131168	1.2750903		
1	1.0917884	0.7665947	0.9735752	1.0578123		
#VALUE!	0	0	0	#VALUE!		
1	1.0897242	0.7875394	1.0001751	1.0565319		
1	1.2541413	0.7223477	0.9173816	1.1559572		
0.99721322	1.3753127	0.6791806	0.8625593	1.2233144		
0.99995639	1.5009008	0.6189867	0.7861132	1.2967285		
0.99706211	1.6351937	0.7137793	0.9064998	1.3664352		
0.99873392	1.7346419	0.5535391	0.7029947	1.4210936	13.940928	
0.99696696	1.7413956	0.5520637	0.7011209	1.4224716	13.627278	
0.99967048	1.6268596	0.5845076	0.7423246	1.3650274	13.336318	
0.9991163	1.6803955	0.5555117	0.7054998	1.392946	14.096613	
0.9998467	1.6998847	0.5364121	0.6812433	1.4041431	14.209929	
1	1.5569746	0.5338487	0.6779879	1.3275784	14.364398	
1	1.3575738	0.6598373	0.8379933	1.2160981	13.88784	
1	1.3072294	0.5994912	0.7613538	1.1870395	13.757787	
1	1.3065036	0.5811756	0.7380931	1.1866176	14.144482	
1	1.2980202	0.6000632	0.7620803	1.1816807	14.61739	
1	1.2260195	0.6457506	0.8201033	1.1393006	**14.02479**	fully expanded section
1	1.165354	0.7194439	0.9136938	1.1028921	13.543515	
1	1.1298916	0.7385267	0.9379289	1.0812934	13.310721	
1	1.1099134	0.6961394	0.884097	1.069018	13.362725	
1	1.0983363	0.6973042	0.8855764	1.0618682	13.262734	
1	1.0966118	0.7119023	0.9041159	1.0608009	12.803866	
#VALUE!	0	0	0	#VALUE!	#VALUE!	
1	1.094527	0.6526183	0.8288253	1.0595097		

100-year Pier Scour

y_1	17.99	Flow depth directly upstream of pier	from cross-section 192.41 Channel Maximum Depth (n=0.025 in channel model)
K_1	1.1	Correction Factor for pier nose shape, including debris	Square Nose Including Debris, Table 6.1 HEC-18
K_2	1.0	Correction Factor for angle of attack	0 degree angle of attack, Table 6.2
K_3	1.1	Correction Factor for bed condition	Table 6.3 Plane bed and antidune flow
K_4	1.0	Correction Factor for armoring	Several samples do not have D95 > 20mm, so no armoring is assumed
a	9.0	Pier width (5 feet + 4 feet debris)	8 feet
Fr_1	0.45	Froude number directly upstream of pier	from cross-section 192.41, Channel Froude number (n=0.025 model)
V_1	8.85	Mean channel velocity (not used)	Channel velocity from 192.41 (n=0.025 in channel model)
g	32.2	(not used)	

$y_s = a * 2.0 * K_1 * K_2 * K_3 * K_4 * (y_1/a)^{0.35} * Fr_1^{0.43}$

$y_s = 19.68862$

King Ranch Bank Protection Design Antidune and Zeller Scour by Cross-Section
Leo R. Kreymborg, PE
March 2005
U.S. Units
Using n=0.025 in Channel

100-yr

XS Id Number	Design Q cfs	Thalweg Elevation	Average (Mean) Velocity, ft/s	Channel Velocity, ft/s	Antidune scour = 1/2 * 0.027 * V^2 (using Channel Velocity), feet	or Dune Scour = 1/6 Max Depth	Hydraulic Depth, ft	Maximum Depth, ft	Energy Slope	Zeller General Scour, feet	Shear Velocity, ft / s	V/Shear Velocity
195.66	285000	903.1	8.7	9.32	**1.172642**	**2.651667**	12.44	15.91	0.001197	**1.0**	0.692445	12.56418
195.56	285000	901.4	8.72	8.98	**1.088645**	**2.841667**	12.77	17.05	0.001207	**0.8**	0.704494	12.37769
195.47	285000	902.1	8.85	9.17	**1.1352**	**2.605**	11.16	15.63	0.001387	**1.2**	0.70599	12.5356
195.38	285000	900.4	7.97	8.51	**0.977671**	**2.815**	11.51	16.89	0.001105	**0.8**	0.639951	12.45408
195.28	285000	901.3	8.28	9.12	**1.122854**	**2.536667**	10.63	15.22	0.001127	**1.6**	0.621093	13.33134
195.19	285000	900.7	10.4	11.25	**1.708594**	**2.405**	9.9	14.43	0.001891	**2.4**	0.77641	13.39498
195.16	285000	900	10.69	11.08	**1.657346**	**2.463333**	12.34	14.78	0.00158	**2.3**	0.792345	13.49161
195.15	Bridge	0	0	0	**0**	**0**	0	0	0	**#DIV/0!**	0	#DIV/0!
195.13	285000	900	10.95	11.35	**1.739104**	**2.411667**	12.02	14.47	0.001705	**2.4**	0.812348	13.47944
195.09	285000	898.8	11.02	11.89	**1.908523**	**2.508333**	9.19	15.05	0.00213	**3.3**	0.793918	13.88053
195	285000	897	9.06	10	**1.35**	**2.731667**	8.71	16.39	0.001568	**2.7**	0.663147	13.66212
194.91	285000	896.9	8.21	9.07	**1.110576**	**2.66**	8.27	15.96	0.001362	**2.4**	0.60224	13.63245
194.81	285000	896	6.88	7.54	**0.767497**	**2.768333**	9.51	16.61	0.000815	**1.7**	0.499571	13.77182
194.72	285000	895.7	7.13	7.66	**0.792121**	**2.743333**	9.88	16.46	0.000921	**1.2**	0.541298	13.17205
194.62	285000	896	6.82	7.1	**0.680535**	**2.633333**	9.89	15.8	0.000824	**1.1**	0.512259	13.31357
194.53	285000	895.2	6.89	7.33	**0.72534**	**2.686667**	8.52	16.12	0.000926	**1.7**	0.504026	13.66992
194.4	285000	896	7.65	8.25	**0.918844**	**2.398333**	9.05	14.39	0.001128	**1.5**	0.573333	13.34304
194.29	285000	896.2	10.27	10.64	**1.52833**	**2.05**	9.15	12.3	0.002399	**1.4**	0.840724	12.21566
194.21	285000	883.1	10.91	10.91	**1.606879**	**4.036667**	12.26	24.22	0.001723	**3.6**	0.824738	13.22845
194.205	Bridge	0	0	0	0	**0**	0	0	0	**#DIV/0!**	0	#DIV/0!
194.2	285000	882.97	11.19	11.19	**1.690417**	**3.995**	11.98	23.97	0.001886	**3.6**	0.852957	13.11907
194.1	285000	883.87	10.08	10.08	**1.371686**	**3.741667**	11.61	22.45	0.001586	**2.9**	0.770009	13.09076
194.02	285000	885.49	9.26	9.29	**1.165105**	**3.386667**	11.49	20.32	0.001391	**2.1**	0.717384	12.90802
193.94	285000	885.38	8.3	8.31	**0.932257**	**3.356667**	11.75	20.14	0.001145	**1.2**	0.658187	12.61039
193.87	285000	882.8	7.74	7.75	**0.810844**	**3.72**	11.57	22.32	0.001498	**-1.6**	0.747051	10.36073
193.79	285000	882.55	7.37	7.39	**0.737263**	**3.686667**	11.42	22.12	0.00093	**0.8**	0.584793	12.60274
193.73	285000	882.18	7.48	7.49	**0.757351**	**3.691667**	11.26	22.15	0.000926	**1.3**	0.579432	12.90919
193.62	285000	878.21	7.85	7.85	**0.831904**	**4.246667**	11.49	25.48	0.001013	**1.6**	0.612199	12.82263
193.53	285000	878.96	7.46	7.51	**0.761401**	**4.053333**	11.19	24.32	0.000883	**1.8**	0.564057	13.2256
193.43	285000	879.37	7.25	7.28	**0.715478**	**3.923333**	11.28	23.54	0.00082	**1.6**	0.545745	13.2846
193.34	285000	881.18	7.43	7.45	**0.749284**	**3.55**	11.75	21.3	0.000781	**1.9**	0.543591	13.66836
193.25	285000	880.67	8.13	8.17	**0.90111**	**3.528333**	11.53	21.17	0.001161	**1.0**	0.656536	12.38317
193.16	285000	880.66	8.14	8.35	**0.941254**	**3.438333**	8.05	20.63	0.000941	**5.9**	0.493879	16.48176
193.07	285000	881.99	7.92	8.15	**0.896704**	**3.151667**	7.77	18.91	0.000866	**5.9**	0.465476	17.01484
192.98	285000	880.71	7.68	7.94	**0.851089**	**3.298333**	6.93	19.79	0.000906	**6.3**	0.449633	17.08058

XS Id Number	Design Q cfs	Thalweg Elevation	Average (Mean) Velocity, ft/s	Channel Velocity, ft/s	**Antidune scour = 1/2 * 0.027 * V^2 (using Channel Velocity), feet**	**or Dune Scour = 1/6 Max Depth**	Hydraulic Depth, ft	Maximum Depth, ft	Energy Slope	**Zeller General Scour, feet**	Shear Velocity, ft / s	V/Shear Velocity
192.89	285000	880.29	8	8.44	**0.961654**	**3.265**	5.36	19.59	0.001055	**8.7**	0.426714	18.74793
192.79	285000	876.74	8.44	8.91	**1.071739**	**3.738333**	5.4	22.43	0.001314	**9.1**	0.477994	17.65712
192.7	285000	877.01	8.7	9.2	**1.14264**	**3.568333**	5.1	21.41	0.001395	**9.6**	0.47863	18.17687
192.61	285000	878.15	8.78	9.26	**1.157593**	**3.27**	5.22	19.62	0.00124	**9.8**	0.456535	19.23182
192.52	285000	878.23	8.87	9.38	**1.187789**	**3.146667**	4.74	18.88	0.001251	**10.7**	0.436964	20.29915
192.41	285000	876.67	9.77	9.77	**1.288614**	**3.266667**	13.63	19.6	0.001364	**1.6**	0.773719	12.62733
192.39	Bridge	0	0	0	**0**	**0**	0	0	0	**#DIV/0!**	0	#DIV/0!
192.38	285000	876.41	10.15	10.15	**1.390804**	**3.188333**	13.12	19.13	0.001512	**1.8**	0.799228	12.69975
192.33	285000	876.06	10.13	10.19	**1.401787**	**3.166667**	10.08	19	0.001543	**4.0**	0.707687	14.31424
192.23	285000	876.72	10.33	10.38	**1.454549**	**2.905**	9.67	17.43	0.001854	**3.2**	0.759794	13.59578
192.14	285000	875.94	10.57	10.61	**1.519723**	**2.861667**	8.94	17.17	0.002017	**3.6**	0.761991	13.87156
192.04	285000	876.36	9.57	10.04	**1.360822**	**2.666667**	8.81	16	0.001674	**3.0**	0.689118	13.88732
191.95	285000	876.68	8.43	8.82	**1.050197**	**2.533333**	8.36	15.2	0.001291	**2.8**	0.589514	14.29991
191.86	285000	876.27	7.77	8.11	**0.887923**	**2.525**	8.71	15.15	0.001094	**2.3**	0.553918	14.02734

HEC-RAS Plan: PC Dec 23 Fo River: Gila Reach: 1 Profile: PF 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	Top Wdth Act (ft)	Hydr Depth C (ft)	Q Channel (cfs)	Vel Total (ft/s)	Q contracted / Qus	Width US / Contracted Width	Vstar	Vstar / omega	Y2 / Y1	Contract Scour
1	195.75	PF 1	227000	903.4	917.73	914.96	919.51	0.002169	11.22	22772.56	4473.81	0.59	2385.78	11.28	200864.1	9.97	0.88486388	1.2281249	0.8875897	1.1272389	1.0270244	
1	195.66	PF 1	227000	903.1	917.47	912.7	918.52	0.001162	8.46	28721.2	4346.95	0.43	2629.43	11.8	206966	7.9	0.91174449	1.3535483	0.6644648	0.8438703	1.1213696	
1	195.56	PF 1	227000	901.4	916.94	911.75	917.93	0.001156	8.12	28808.92	4106.57	0.42	2552.51	11.36	211032.3	7.88	0.92965771	1.3139523	0.6502734	0.8258473	1.1187661	
1	195.47	PF 1	227000	902.1	916.2	911.88	917.27	0.001385	8.43	27818.78	4362.12	0.45	2841.88	10.74	217811.1	8.16	0.95952026	1.4629109	0.6920779	0.8789389	1.2312813	
1	195.38	PF 1	227000	900.4	915.74	910.84	916.64	0.001099	7.82	30927.77	4013.15	0.41	3087.24	11.47	210836.9	7.34	0.92879692	1.5892146	0.6371013	0.8091187	1.2625842	
1	195.28	PF 1	227000	901.3	914.98	910.16	916.02	0.001115	8.39	29500.01	5072.21	0.43	3185.12	12.01	213024.5	7.69	0.93843392	1.6396001	0.6566544	0.8339511	1.2995061	
1	195.19	PF 1	227000	900.7	913.69	910.33	915.28	0.001885	10.39	23441.89	4198.68	0.55	2736.38	11.17	211490.3	9.68	0.93167533	1.4086028	0.8233987	1.0457164	1.1718716	
1	195.16	PF 1	227000	900	913.47	908.68	914.94	0.001408	9.82	23846.52	2341.47	0.48	2139.47	12.8	221999.3	9.52	0.97797048	1.1013322	0.7617882	0.967471	1.0436035	
1	195.15		Bridge														#VALUE!	0	0	0	#VALUE!	
1	195.13	PF 1	227000	900	913.23	908.68	914.76	0.001505	10.02	23343.48	2237.68	0.5	2145.68	12.56	222302.9	9.72	0.97930793	1.1045289	0.7801732	0.9908199	1.0467666	
1	195.09	PF 1	227000	898.8	912.57	909.24	914.32	0.002001	10.76	22295.6	3657.03	0.57	2679.17	11.26	218873.1	10.18	0.96419868	1.3791529	0.8517667	1.0817438	1.1906398	
1	195	PF 1	227000	897	912.05	908.48	913.29	0.00154	9.18	26677.16	4364.9	0.49	3441.75	10.8	210851	8.51	0.92885903	1.7717052	0.7318131	0.9294026	1.3536268	
1	194.91	PF 1	227000	896.9	911.43	907.63	912.51	0.001446	8.56	28678.78	4973.37	0.47	4192.33	10.19	214162.6	7.92	0.94344758	2.1580803	0.6888096	0.8747882	1.5564414	
1	194.81	PF 1	227000	896	911.16	905.84	911.88	0.000818	7	35118.84	5164.81	0.37	4345.47	11.26	213966.1	6.46	0.94258194	2.236912	0.5445952	0.6916359	1.5913405	
1	194.72	PF 1	227000	895.7	910.72	905.79	911.46	0.000927	7.08	34228.88	4725.84	0.38	3923.08	10.69	212469.8	6.63	0.93599031	2.0194788	0.5648806	0.7173984	1.4815919	
1	194.62	PF 1	227000	896	910.33	905.58	910.99	0.000861	6.67	35650.48	5294.07	0.36	4144.93	10.4	202090.1	6.37	0.89026476	2.1336803	0.5369653	0.6819459	1.4701901	
1	194.53	PF 1	227000	895.2	909.82	905.21	910.53	0.000969	6.88	34552.08	5571.63	0.38	4246.03	10.06	210976.8	6.57	0.92941322	2.1857234	0.560259	0.7115289	1.5491425	
1	194.4	PF 1	227000	896	908.84	904.77	909.76	0.001223	7.83	30923.65	5830.38	0.43	4056.79	10.13	214997.4	7.34	0.94712511	2.0883086	0.6316055	0.802139	1.5291367	
1	194.29	PF 1	227000	896.2	906.78	904.97	908.42	0.002971	10.46	22531.8	5071.7	0.65	3032	8.03	216170	10.07	0.95229075	1.5607787	0.87647	1.1131168	1.2750903	
1	194.21	PF 1	227000	883.1	905.79	902.06	907.32	0.001693	9.93	22867.95	2976.97	0.53	2120.93	10.78	227000	9.93	1	1.0917884	0.7665947	0.9735752	1.0578123	
1	194.205		Bridge														#VALUE!	0	0	0	#VALUE!	
1	194.2	PF 1	227000	882.97	905.48	901.99	907.08	0.001824	10.16	22353.18	2116.92	0.55	2116.92	10.56	227000	10.16	1	1.0897242	0.7875394	1.0001751	1.0565319	
1	194.1	PF 1	227000	883.87	904.8	901.11	906.13	0.001606	9.24	24570.85	3012.59	0.51	2436.32	10.09	227000	9.24	1	1.2541413	0.7223477	0.9173816	1.1559572	
1	194.02	PF 1	227000	885.49	904.24	900.31	905.37	0.001434	8.57	26554.93	3196.98	0.48	2671.71	9.99	226367.4	8.55	0.99721322	1.3753127	0.6791806	0.8625593	1.2233144	
1	193.94	PF 1	227000	885.38	903.9	899.37	904.82	0.00117	7.67	29609.81	3505.83	0.42	2915.68	10.17	226990.1	7.67	0.99995639	1.5009008	0.6189867	0.7861132	1.2967285	
1	193.87	PF 1	227000	882.8	903.46	898.79	904.26	0.001587	7.2	31547.68	3568.24	0.4	3176.56	9.97	226333.1	7.2	0.99706211	1.6351937	0.7137793	0.9064998	1.3664352	
1	193.79	PF 1	227000	882.55	902.98	898.24	903.72	0.00097	6.91	32934.32	3711.81	0.39	3369.75	9.81	226712.6	6.89	0.99873392	1.7346419	0.5535391	0.7029947	1.4210936	13.940928
1	193.73	PF 1	227000	882.18	902.61	897.91	903.38	0.000988	7.04	32284.29	3421.02	0.4	3382.87	9.58	226311.5	7.03	0.99696696	1.7413956	0.5520637	0.7011209	1.4224716	13.627278
1	193.62	PF 1	227000	878.21	901.95	897.52	902.79	0.001086	7.37	30815.13	3218.5	0.42	3160.37	9.77	226925.2	7.37	0.99967048	1.6268596	0.5845076	0.7423246	1.3650274	13.336318
1	193.53	PF 1	227000	878.96	901.5	896.73	902.27	0.000947	7.06	32245.8	3319.81	0.39	3264.37	10.12	226799.4	7.04	0.9991163	1.6803955	0.5555117	0.7054998	1.392946	14.096613
1	193.43	PF 1	227000	879.37	901.09	896	901.82	0.000883	6.84	33214.39	3567.18	0.38	3302.23	10.12	226965.2	6.83	0.9998467	1.6998847	0.5364121	0.6812433	1.4041431	14.209929
1	193.34	PF 1	227000	881.18	900.66	895.22	901.41	0.000818	6.94	32719.01	3675.9	0.37	3024.61	10.82	227000	6.94	1	1.5569746	0.5338487	0.6779879	1.3275784	14.364398
1	193.25	PF 1	227000	880.67	900.05	894.46	900.93	0.001184	7.54	30119.3	2637.25	0.39	2637.25	11.42	227000	7.54	1	1.3575738	0.6598373	0.8379933	1.2160981	13.88784
1	193.16	PF 1	227000	880.66	899.49	894.1	900.42	0.000963	7.71	29431.47	2539.45	0.4	2539.45	11.59	227000	7.71	1	1.3072294	0.5994912	0.7613538	1.1870395	13.757787
1	193.07	PF 1	227000	881.99	899.09	893.35	899.96	0.00088	7.5	30251.29	2538.04	0.38	2538.04	11.92	227000	7.5	1	1.3065036	0.5811756	0.7380931	1.1866176	14.144482
1	192.98	PF 1	227000	880.71	898.69	892.51	899.51	0.000904	7.28	31194.61	2521.56	0.36	2521.56	12.37	227000	7.28	1	1.2980202	0.6000632	0.7620803	1.1816807	14.61739
1	192.89	PF 1	227000	880.29	898.09	892.18	899.02	0.001052	7.74	29328.8	2381.69	0.39	2381.69	12.31	227000	7.74	1	1.2260195	0.6457506	0.8201033	1.1393006	**14.02479** fully expanded section
1	192.79	PF 1	227000	876.74	897.4	891.75	898.44	0.001309	8.16	27806.49	2263.84	0.41	2263.84	12.28	227000	8.16	1	1.165354	0.7194439	0.9136938	1.1028921	13.543515
1	192.7	PF 1	227000	877.01	896.68	891.15	897.78	0.001376	8.4	27011.34	2194.95	0.42	2194.95	12.31	227000	8.4	1	1.1298916	0.7385267	0.9379289	1.0812934	13.310721
1	192.61	PF 1	227000	878.15	896.06	890.41	897.16	0.001204	8.42	26945.32	2156.14	0.42	2156.14	12.5	227000	8.42	1	1.1099134	0.6961394	0.884097	1.069018	13.362725
1	192.52	PF 1	227000	878.23	895.43	889.84	896.55	0.001209	8.52	26651.48	2133.65	0.42	2133.65	12.49	227000	8.52	1	1.0983363	0.6973042	0.8855764	1.0618682	13.262734
1	192.41	PF 1	227000	876.67	894.66	889.51	895.87	0.001304	8.83	25718.7	2147.6	0.45	2130.3	12.07	227000	8.83	1	1.0966118	0.7119023	0.9041159	1.0608009	12.803866
1	192.39		Bridge														#VALUE!	0	0	0	#VALUE!	#VALUE!
1	192.38	PF 1	227000	876.41	893.99	889.28	895.29	0.001444	9.16	24768.88	2144.68	0.47	2126.25	11.65	227000	9.16	1	1.094527	0.6526183	0.8288253	1.0595097	

HEC-RAS Plan: 500 River: Gila Reach: 1 Profile: PF 2

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	Top W Act Chan (ft)	Hydr Depth C (ft)	Q Channel (cfs)	Vel Total (ft/s)	Q contracted / Qus	Width US / Contracted Width	Vstar	Vstar / omega	Y2 / Y1	Contract Scour
1	195.75	PF 2	285000	903.4	919.23	916.23	921.31	0.002183	12.19	26351.4	4924.38	0.6	1595.74	12.71	247182.6	10.82	0.86730737	0.821437	0.9452084	1.2004147	0.780428	
1	195.66	PF 2	285000	903.1	919.01	913.79	920.27	0.001197	9.32	32767.61	4880.69	0.45	2073.4	13.33	257626.4	8.7	0.90395228	1.0673215	0.7167869	0.9103194	0.956135	
1	195.56	PF 2	285000	901.4	918.46	912.86	919.66	0.001207	8.98	32677.69	4722.96	0.44	2290.11	12.86	264634.3	8.72	0.9285414	1.178877	0.7069717	0.8978541	1.042656	
1	195.47	PF 2	285000	902.1	917.73	912.97	919	0.001387	9.17	32208.62	4782.64	0.46	2404.9	12.27	270749.9	8.85	0.94999965	1.2379673	0.7402671	0.9401392	1.097083	
1	195.38	PF 2	285000	900.4	917.29	911.9	918.35	0.001105	8.51	35739.95	5176.57	0.42	2349.2	13.03	260401	7.97	0.91368772	1.2092947	0.6808968	0.8647389	1.045246	
1	195.28	PF 2	285000	901.3	916.52	911.34	917.72	0.001127	9.12	34433.62	5585.72	0.44	2122.2	13.5	261212.1	8.28	0.91653368	1.0924422	0.6999335	0.8889155	0.982044	
1	195.19	PF 2	285000	900.7	915.13	911.6	916.97	0.001891	11.25	27401.89	4662.44	0.56	1829.96	12.56	258615.5	10.4	0.90742281	0.9420062	0.8745175	1.1106373	0.885587	
1	195.16	PF 2	285000	900	914.78	910.07	916.64	0.00158	11.08	26655.65	2361.5	0.52	1771.38	14.07	276196.6	10.69	0.96911088	0.911851	0.8460646	1.0745021	0.917638	
1	195.15		Bridge														#VALUE!	0	0	0	#VALUE!	
1	195.13	PF 2	285000	900	914.47	910.07	916.42	0.001705	11.35	26026.33	2293.77	0.54	1770.09	13.77	276625.1	10.95	0.97061439	0.911187	0.869475	1.1042332	0.91843	
1	195.09	PF 2	285000	898.8	913.85	910.68	915.94	0.00213	11.89	25859.03	4167.66	0.59	1813.31	12.49	269293.7	11.02	0.94489018	0.9334353	0.925548	1.175446	0.911491	
1	195	PF 2	285000	897	913.39	909.61	914.84	0.001568	10	31466.13	4754.31	0.51	2131.4	12.12	258522.2	9.06	0.90709544	1.097178	0.7822621	0.9934728	0.976068	
1	194.91	PF 2	285000	896.9	912.86	908.97	914.05	0.001362	9.07	34695.16	5423.32	0.47	2456.9	11.62	258892.9	8.21	0.90839614	1.2647353	0.7138707	0.9066158	1.070325	
1	194.81	PF 2	285000	896	912.61	906.86	913.43	0.000815	7.54	41450.94	5467.51	0.37	2713.6	12.71	260100.7	6.88	0.91263404	1.3968764	0.5775366	0.7334715	1.145169	
1	194.72	PF 2	285000	895.7	912.16	906.75	913.01	0.000921	7.66	39980.25	5288.26	0.39	2817.28	12.09	260859.6	7.13	0.91529684	1.4502476	0.598785	0.7604569	1.175915	
1	194.62	PF 2	285000	896	911.8	906.56	912.54	0.000824	7.1	41768.54	6208.24	0.36	2919.26	11.84	245475.3	6.82	0.86131684	1.5027437	0.5604894	0.7118215	1.14191	
1	194.53	PF 2	285000	895.2	911.32	906.31	912.1	0.000926	7.33	41335.92	6899.02	0.38	3069	11.49	258257.6	6.89	0.90616702	1.5798252	0.5853201	0.7433565	1.231491	
1	194.4	PF 2	285000	896	910.39	905.76	911.38	0.001128	8.25	37235.14	6804.04	0.43	2708.2	11.68	260864.5	7.65	0.91531404	1.3940966	0.6513342	0.8271945	1.146588	
1	194.29	PF 2	285000	896.2	908.5	905.94	910.2	0.002399	10.64	27745.09	5791.22	0.6	2574.6	9.75	267201.9	10.27	0.93755053	1.3253235	0.8678514	1.1021713	1.133135	
1	194.21	PF 2	285000	883.1	907.32	903.22	909.17	0.001723	10.91	26119.85	3081.5	0.55	2130.02	12.26	285000	10.91	1	1.0964677	0.8247376	1.0474168	1.060712	
1	194.205		Bridge														#VALUE!	0	0	0	#VALUE!	
1	194.2	PF 2	285000	882.97	906.94	903.13	908.89	0.001886	11.19	25458.62	2550.68	0.57	2125.7	11.98	285000	11.19	1	1.0942439	0.8529571	1.0832555	1.059334	
1	194.1	PF 2	285000	883.87	906.32	902.19	907.9	0.001586	10.08	28275.45	5559.86	0.52	2436.32	11.61	285000	10.08	1	1.2541413	0.7700087	0.9779111	1.155957	
1	194.02	PF 2	285000	885.49	905.81	901.37	907.15	0.001391	9.29	30763.51	5225.42	0.48	2644.4	11.57	284052.9	9.26	0.99667684	1.3612544	0.7198768	0.9142435	1.214736	
1	193.94	PF 2	285000	885.38	905.52	900.42	906.59	0.001145	8.31	34321.03	5006.42	0.43	2909.57	11.79	284952.2	8.3	0.99983228	1.4977556	0.6593068	0.8373197	1.294851	
1	193.87	PF 2	285000	882.8	905.12	899.77	906.05	0.001498	7.75	36811.93	4545.14	0.4	3150.9	11.63	284011.5	7.74	0.99653158	1.6219847	0.748986	0.9512122	1.358741	
1	193.79	PF 2	285000	882.55	904.67	899.18	905.52	0.00093	7.39	38653.2	4141.65	0.38	3345.8	11.5	284554.3	7.37	0.99843614	1.7223132	0.5868381	0.7452844	1.41426	16.26399
1	193.73	PF 2	285000	882.18	904.33	899	905.2	0.000926	7.49	38099.38	3443.62	0.39	3355.9	11.3	283976.9	7.48	0.99641018	1.7275123	0.5804605	0.7371848	1.414526	15.98414
1	193.62	PF 2	285000	878.21	903.69	898.49	904.65	0.001013	7.85	36325.12	3264.48	0.41	3151.32	11.51	284859	7.85	0.99950526	1.6222009	0.6127317	0.7781692	1.362331	15.68043
1	193.53	PF 2	285000	878.96	903.28	897.67	904.16	0.000883	7.51	38182.8	3565.95	0.38	3192.48	11.84	284126.3	7.46	0.99693439	1.6433888	0.5802086	0.7368649	1.370664	16.22866
1	193.43	PF 2	285000	879.37	902.91	896.98	903.73	0.00082	7.28	39326.24	3929.49	0.37	3279.34	11.94	284783.9	7.25	0.99924175	1.6881016	0.5614835	0.7130841	1.397181	16.68234
1	193.34	PF 2	285000	881.18	902.48	896.34	903.35	0.000781	7.45	38358.04	3965.18	0.37	3024.61	12.64	284876.4	7.43	0.99956632	1.5569746	0.5638025	0.7160292	1.327085	16.77435
1	193.25	PF 2	285000	880.67	901.84	895.53	902.88	0.001161	8.17	35074.37	4174.37	0.4	2646.72	13.17	284775.9	8.13	0.99921368	1.3624487	0.7016765	0.8911292	1.218069	16.04198
1	193.16	PF 2	285000	880.66	901.29	895.15	902.37	0.000941	8.35	34991.17	4348.05	0.4	2560.82	13.29	284104.5	8.14	0.99685789	1.31823	0.6345783	0.8059145	1.190208	15.81786
1	193.07	PF 2	285000	881.99	900.9	894.42	901.92	0.000866	8.15	36001.57	4635.16	0.39	2544.07	13.7	284107	7.92	0.99686667	1.3096076	0.6180835	0.7849661	1.185229	16.23763
1	192.98	PF 2	285000	880.71	900.5	893.58	901.48	0.000906	7.94	37088.23	5350.97	0.37	2540.93	14.08	284048.6	7.68	0.99666175	1.3079913	0.6409046	0.8139488	1.184084	16.6719
1	192.89	PF 2	285000	880.29	899.88	893.28	900.98	0.001055	8.44	35619.55	6649.44	0.4	2394.17	14.04	283621.6	8	0.99516351	1.2324438	0.6906177	0.8770845	1.138377	15.98282
1	192.79	PF 2	285000	876.74	899.17	892.9	900.4	0.001314	8.91	33753.24	6252.33	0.42	2278.46	13.97	283599.3	8.44	0.99508526	1.1728799	0.7688185	0.9763995	1.102778	15.40581
1	192.7	PF 2	285000	877.01	898.42	892.33	899.73	0.001395	9.2	32773.25	6424.19	0.43	2207.02	13.98	283669.6	8.7	0.99533193	1.1361048	0.7924441	1.006404	1.080752	15.10891
1	192.61	PF 2	285000	878.15	897.77	891.6	899.1	0.00124	9.26	32458.67	6217.34	0.43	2167.2	14.14	283842.9	8.78	0.99594	1.1156068	0.7513867	0.9542611	1.068791	15.1127
1	192.52	PF 2	285000	878.23	897.11	891.04	898.47	0.001251	9.38	32119.81	6774.55	0.44	2143.68	14.11	283802.1	8.87	0.99579684	1.1034994	0.753911	0.957467	1.061222	14.97384
1	192.41	PF 2	285000	876.67	896.27	890.71	897.75	0.001364	9.77	29164.19	2204.05	0.47	2139.45	13.63	285000	9.77	1	1.1013219	0.7737186	0.9826226	1.063715	**14.49843**
1	192.39		Bridge														#VALUE!	0	0	0	#VALUE!	#VALUE!
1	192.38	PF 2	285000	876.41	895.54	890.48	897.14	0.001512	10.15	28085.31	2206.06	0.49	2140.03	13.12	285000	10.15	1	1.1016205	0.7029701	0.892772	1.063899	

HEC-RAS Plan: 500 River: Gila Reach: 1 Profile: PF 2

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 # C	Vel Total (ft/s)	Max Chl D	Hydr Depth (ft)
1	195.75	PF 2	285000	903.4	919.23	916.23	921.31	0.002183	12.19	26351.4	4924.38	0.6	10.82	15.83	11
1	195.66	PF 2	285000	903.1	919.01	913.79	920.27	0.001197	9.32	32767.61	4880.69	0.45	8.7	15.91	12.44
1	195.56	PF 2	285000	901.4	918.46	912.86	919.66	0.001207	8.98	32677.69	4722.96	0.44	8.72	17.05	12.77
1	195.47	PF 2	285000	902.1	917.73	912.97	919	0.001387	9.17	32208.62	4782.64	0.46	8.85	15.63	11.16
1	195.38	PF 2	285000	900.4	917.29	911.9	918.35	0.001105	8.51	35739.95	5176.57	0.42	7.97	16.89	11.51
1	195.28	PF 2	285000	901.3	916.52	911.34	917.72	0.001127	9.12	34433.62	5585.72	0.44	8.28	15.22	10.63
1	195.19	PF 2	285000	900.7	915.13	911.6	916.97	0.001891	11.25	27401.89	4662.44	0.56	10.4	14.43	9.9
1	195.16	PF 2	285000	900	914.78	910.07	916.64	0.00158	11.08	26655.65	2361.5	0.52	10.69	14.78	12.34
1	195.15		Bridge												
1	195.13	PF 2	285000	900	914.47	910.07	916.42	0.001705	11.35	26026.33	2293.77	0.54	10.95	14.47	12.02
1	195.09	PF 2	285000	898.8	913.85	910.68	915.94	0.00213	11.89	25859.03	4167.66	0.59	11.02	15.05	9.19
1	195	PF 2	285000	897	913.39	909.61	914.84	0.001568	10	31466.13	4754.31	0.51	9.06	16.39	8.71
1	194.91	PF 2	285000	896.9	912.86	908.97	914.05	0.001362	9.07	34695.16	5423.32	0.47	8.21	15.96	8.27
1	194.81	PF 2	285000	896	912.61	906.86	913.43	0.000815	7.54	41450.94	5467.51	0.37	6.88	16.61	9.51
1	194.72	PF 2	285000	895.7	912.16	906.75	913.01	0.000921	7.66	39980.25	5288.26	0.39	7.13	16.46	9.88
1	194.62	PF 2	285000	896	911.8	906.56	912.54	0.000824	7.1	41768.54	6208.24	0.36	6.82	15.8	9.89
1	194.53	PF 2	285000	895.2	911.32	906.31	912.1	0.000926	7.33	41335.92	6899.02	0.38	6.89	16.12	8.52
1	194.4	PF 2	285000	896	910.39	905.76	911.38	0.001128	8.25	37235.14	6804.04	0.43	7.65	14.39	9.05
1	194.29	PF 2	285000	896.2	908.5	905.94	910.2	0.002399	10.64	27745.09	5791.22	0.6	10.27	12.3	9.15
1	194.21	PF 2	285000	883.1	907.32	903.22	909.17	0.001723	10.91	26119.85	3081.5	0.55	10.91	24.22	12.26
1	194.205		Bridge												
1	194.2	PF 2	285000	882.97	906.94	903.13	908.89	0.001886	11.19	25458.62	2550.68	0.57	11.19	23.97	11.98
1	194.1	PF 2	285000	883.87	906.32	902.19	907.9	0.001586	10.08	28275.45	5559.86	0.52	10.08	22.45	11.61
1	194.02	PF 2	285000	885.49	905.81	901.37	907.15	0.001391	9.29	30763.51	5225.42	0.48	9.26	20.32	11.49
1	193.94	PF 2	285000	885.38	905.52	900.42	906.59	0.001145	8.31	34321.03	5006.42	0.43	8.3	20.14	11.75
1	193.87	PF 2	285000	882.8	905.12	899.77	906.05	0.001498	7.75	36811.93	4545.14	0.4	7.74	22.32	11.57
1	193.79	PF 2	285000	882.55	904.67	899.18	905.52	0.00093	7.39	38653.2	4141.65	0.38	7.37	22.12	11.42
1	193.73	PF 2	285000	882.18	904.33	899	905.2	0.000926	7.49	38099.38	3443.62	0.39	7.48	22.15	11.26
1	193.62	PF 2	285000	878.21	903.69	898.49	904.65	0.001013	7.85	36325.12	3264.48	0.41	7.85	25.48	11.49
1	193.53	PF 2	285000	878.96	903.28	897.67	904.16	0.000883	7.51	38182.8	3565.95	0.38	7.46	24.32	11.19
1	193.43	PF 2	285000	879.37	902.91	896.98	903.73	0.00082	7.28	39326.24	3929.49	0.37	7.25	23.54	11.28
1	193.34	PF 2	285000	881.18	902.48	896.34	903.35	0.000781	7.45	38358.04	3965.18	0.37	7.43	21.3	11.75
1	193.25	PF 2	285000	880.67	901.84	895.53	902.88	0.001161	8.17	35074.37	4174.37	0.4	8.13	21.17	11.53
1	193.16	PF 2	285000	880.66	901.29	895.15	902.37	0.000941	8.35	34991.17	4348.05	0.4	8.14	20.63	8.05
1	193.07	PF 2	285000	881.99	900.9	894.42	901.92	0.000866	8.15	36001.57	4635.16	0.39	7.92	18.91	7.77
1	192.98	PF 2	285000	880.71	900.5	893.58	901.48	0.000906	7.94	37088.23	5350.97	0.37	7.68	19.79	6.93
1	192.89	PF 2	285000	880.29	899.88	893.28	900.98	0.001055	8.44	35619.55	6649.44	0.4	8	19.59	5.36
1	192.79	PF 2	285000	876.74	899.17	892.9	900.4	0.001314	8.91	33753.24	6252.33	0.42	8.44	22.43	5.4
1	192.7	PF 2	285000	877.01	898.42	892.33	899.73	0.001395	9.2	32773.25	6424.19	0.43	8.7	21.41	5.1
1	192.61	PF 2	285000	878.15	897.77	891.6	899.1	0.00124	9.26	32458.67	6217.34	0.43	8.78	19.62	5.22
1	192.52	PF 2	285000	878.23	897.11	891.04	898.47	0.001251	9.38	32119.81	6774.55	0.44	8.87	18.88	4.74
1	192.41	PF 2	285000	876.67	896.27	890.71	897.75	0.001364	9.77	29164.19	2204.05	0.47	9.77	19.6	13.63
1	192.39		Bridge												
1	192.38	PF 2	285000	876.41	895.54	890.48	897.14	0.001512	10.15	28085.31	2206.06	0.49	10.15	19.13	13.12
1	192.33	PF 2	285000	876.06	895.06	890.09	896.67	0.001543	10.19	28132.19	6428.79	0.5	10.13	19	10.08
1	192.23	PF 2	285000	876.72	894.15	889.42	895.83	0.001854	10.38	27587.12	6487.64	0.51	10.33	17.43	9.67
1	192.14	PF 2	285000	875.94	893.11	888.92	894.86	0.002017	10.61	26952.9	6609.17	0.54	10.57	17.17	8.94
1	192.04	PF 2	285000	876.36	892.36	888.05	893.89	0.001674	10.04	29792.95	6355.34	0.51	9.57	16	8.81
1	191.95	PF 2	285000	876.68	891.88	887.04	893.05	0.001291	8.82	33810.89	6420.45	0.46	8.43	15.2	8.36
1	191.86	PF 2	285000	876.27	891.42	886.27	892.4	0.001094	8.11	36660.7	6363.85	0.42	7.77	15.15	8.71
1	191.76	PF 2	285000	874.62	890.87	885.97	891.83	0.001152	7.96	37451.74	6651.48	0.42	7.61	16.25	8.31
1	191.67	PF 2	285000	872.6	890.34	885.5	891.22	0.001184	7.65	39014.68	6420.8	0.41	7.3	17.74	7.93
1	191.57	PF 2	285000	870.63	889.89	884.65	890.63	0.001027	7.04	42423.86	6391.86	0.39	6.72	19.26	7.91
1	191.48	PF 2	285000	870.93	889.52	883.95	890.12	0.000845	6.32	46340.6	7446.21	0.35	6.15	18.59	10.16
1	191.38	PF 2	285000	871.69	889.14	883.68	889.69	0.000791	6.03	48449.29	6663.63	0.33	5.88	17.45	10.06
1	191.29	PF 2	285000	870.63	888.77	882.88	889.29	0.000801	5.8	49947.94	8401.37	0.31	5.71	18.14	10.33
1	191.19	PF 2	285000	869.78	888.37	882.34	888.88	0.000808	5.78	50406.51	8476.95	0.31	5.65	18.59	10.44
1	191.1	PF 2	285000	870.88	888.01	881.81	888.52	0.000665	5.78	50427.06	8220.22	0.3	5.65	17.13	10.83
1	191	PF 2	285000	869.64	887.63	881.5	888.17	0.000712	5.91	48419.43	8072.9	0.31	5.89	17.99	10.68
1	190.91	PF 2	285000	867.98	887.18	881.18	887.77	0.000866	6.18	47014.09	8299.44	0.33	6.06	19.2	7.13
1	190.81	PF 2	285000	867.86	886.78	880.72	887.36	0.000781	6.12	47641.38	9047.51	0.32	5.98	18.92	6.83
1	190.72	PF 2	285000	866.3	886.39	879.99	886.96	0.000795	6.03	48288.79	8556.91	0.32	5.9	20.09	6.83
1	190.62	PF 2	285000	867.37	885.99	879.42	886.55	0.000839	6.04	48109.66	8218.28	0.31	5.92	18.62	8.1
1	190.53	PF 2	285000	866.16	885.54	878.7	886.11	0.000923	6.07	47338.04	7090.65	0.3	6.02	19.38	9.48
1	190.43	PF 2	285000	867.42	885.04	878.03	885.64	0.00094	6.23	46129.33	6310.11	0.31	6.18	17.62	9.66
1	190.34	PF 2	285000	866.61	884.6	877.44	885.15	0.000964	5.92	48171.08	6764.22	0.3	5.92	17.99	12.41
1	190.24	PF 2	285000	866.29	884.07	876.85	884.61	0.001141	5.91	48191.84	5950.51	0.3	5.91	17.78	12.34
1	190.15	PF 2	285000	865.74	883.35	877.02	884	0.001325	6.46	44097.48	5613.15	0.34	6.46	17.61	11.54
1	190.05	PF 2	285000	858.06	882.86	875.34	883.4	0.000947	5.91	48333.04	7341.68	0.29	5.9	24.8	11.42
1	189.96	PF 2	285000	857.56	882.45	875.21	882.97	0.000843	5.79	49427.69	7126.96	0.29	5.77	24.89	11.24
1	189.87	PF 2	285000	862.94	882.09	874.63	882.54	0.000816	5.45	53193.15	10760.92	0.28	5.36	19.15	10.82
1	189.77	PF 2	285000	860.75	881.76	873.68	882.13	0.000662	4.9	60267.97	11776.35	0.24	4.73	21.01	11.21
1	189.67	PF 2	285000	862.77	881.42	873.27	881.78	0.000683	4.89	60876.72	11924.29	0.24	4.68	18.65	10.83
1	189.58	PF 2	285000	857.92	881.11	872.91	881.45	0.00061	4.79	63041.16	12180.79	0.24	4.52	23.19	10.83
1	189.48	PF 2	285000	857.85	880.82	872.32	881.15	0.000577	4.72	65064.32	11928.34	0.23	4.38	22.97	10.92
1	189.39	PF 2	285000	855.02	880.51	872.22	880.86	0.000567	4.9	63969.32	11652.14	0.24	4.46	25.49	10.36
1	189.3	PF 2	285000	856.36	880.21	872.32	880.58	0.000673	5.05	62535.04	11741.26	0.25	4.56	23.85	9.75
1	189.21	PF 2	285000	856.97	879.84	871.82	880.16	0.001084	4.71	65697.61	11730.48	0.24	4.34	22.87	9.83
1	189.11	PF 2	285000	857.4	879.28	870.72	879.59	0.001142	4.67	66399.91	10916.54	0.23	4.29	21.88	9.46
1	189.02	PF 2	285000	855.16	878.88	870.24	879.2	0.00053	4.73	68349.99	11405.26	0.24	4.17	23.72	9.06
1	188.81	PF 2	285000	852.24	878.4	867.92	878.7	0.0004	4.61	71633.28	10995.28	0.21	3.98	26.16	9.69
1	188.69	PF 2	285000	850.62	878.06	868.85	878.38	0.000769	4.82	67863.42	10804.6	0.22	4.2	27.44	9.19
1	188.59	PF 2	285000	861.4	877.62	872.18	877.98	0.000761	4.93	59724.52	8123.13	0.27	4.77	16.22	7.74
1	188.5	PF 2	285000	860.5	877.31	871.19	877.63	0.00068	4.67	62556.46	7877.07	0.24	4.56	16.81	8.01
1	188.39	PF 2	285000	860.7	877.01	869.89	877.34	0.000506	4.9	62954.61	7632.77	0.24	4.53	16.31	8.32
1	188.29	PF 2	285000	859.6	876.64	870.23	877.09	0.000482	5.79	56778.91	7763.01	0.29	5.02	17.04	7.51
1	188.2	PF 2	285000	859.3	876.23	869.87	876.78	0.000926	6.42	50199.21	7274.42	0.31	5.68	16.93	7.2
1	188.1	PF 2	285000	855.8	875.61	870.18	876.34	0.000838	7.58	45843.45	6832.04	0.36	6.22	19.81	7.18
1	188.07	PF 2	285000	855	875.46	867.78	876.19	0.000599	7.48	45362.71	5743.58	0.32	6.28	20.46	8.79
1	188.055		Bridge												
1	188.04	PF 2	285000	855	875.38	867.78	876.15	0.000629	7.64	43967.65	5742.91	0.33	6.48	20.38	8.98
1	188	PF 2	285000	858.3	875.24	871.93	875.95	0.000824	7.58	44471.4	7474.65	0.38	6.41	16.94	7.72
1	187.91	PF 2	285000	856.5	874.73	871.61	875.5	0.000856	7.64	42196.75	6471.21	0.4	6.75	18.23	7.97
1	187.82	PF 2	285000	855.4	874.06	871.08	875.02	0.001129	8.27	37593.64	6821.18	0.46	7.58	18.66	7.81
1	187.73	PF 2	285000	855.4	873.53	870.08	874.49	0.001138	8.29	37860.42	11667.01	0.45	7.53	18.13	8.14
1	187.64	PF 2	285000	856.1	873.18	869.27	874	0.000898	7.66	41476.67	12484.15	0.4	6.87	17.08	9.22
1	187.54	PF 2	285000	855.9	872.66	868.91	873.58	0.00099	8	37948.14	12280.36	0.43	7.51	16.76	8.49
1	187.45	PF 2	285000	855.3	872.43	867.83	873.13	0.000775	7.14	43958.21	12079.62	0.38	6.48	17.13	9.25
1	187.36	PF 2	285000	853.7	871.82	867.63	872.7	0.000863	7.85	40344.73	11226.59	0.41	7.06	18.12	9.24
1	187.24	PF 2	285000	853.8	870.53	867.46	871.89	0.0019	9.76	33645.57	10865.03	0.52	8.47	16.73	7.82
1	187.15	PF 2	285000	853.2	870.11	865.93	871.03	0.001231	8.03	38916.36	10384.26	0.43	7.32	16.91	8.59
1	187.06	PF 2	285000	851.9	869.6	865.34	870.42	0.001094	7.48	39716.29	9866.36	0.41	7.18	17.7	8.58
1	186.97	PF 2	285000	851.9	869.11	864.8	869.88	0.001063	7.17	40294.99	10225.24	0.41	7.07	17.21	8.62
1	186.87	PF 2	285000	852.6	868.18	864.91	869.2	0.001647	8.35	35918.05	11022.5	0.48	7.93	15.58	7.59

APPENDIX H

Comments and Responses

Flood Control District of Maricopa County

Environmental Protection Agency

R2D River Research and Design, Inc.

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Website: www.r2d-eng.com

February 21, 2006

John Hathaway, P.E.
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Phoenix, AZ 85009

Response to Comments of December 13, 2005

The following comments were received on December 14, 2005. Our responses are listed below each comment.

SUBJECT OF COMMENTS: Gila River Improvements for the Cotton Lane Bridge produced by CVL. Dropped off by R2D in November 2005. Production percentage unknown as is the production date.

I have finished my review of the above referenced plans and I have the following comments. The FCD should receive written responses from the consultant for each of the comments as given below.

1. **The plans as submitted should have a design percentage (70%, 90%) and a date they were produced.**

   The plans have been updated to show percentage as well as a production date. This submittal is at the 90% level.

2. **The most current hydraulic model I have for the Cotton Lane Bridge is dated September 23, 2005. The FCD needs the most up to date hydraulic and sediment models for the Cotton Lane Bridge Project.**

   The September 23, 2005 model is still valid. For the FIS CLOMR submittal some of the cross sections have been removed from both the upstream and downstream end of the model hydraulic models for the CLOMR. These cross sections are retained for the sediment transport models.

3. **A CLOMR may take a long time to get through FEMA. Has CVL or Gary Freeman of R2D submitted a CLOMR to FEMA for this project?**

   The CLOMR has been on hold awaiting the approval of the mass grading plan for King Ranch by the City of Goodyear. This has been approved and the CLOMR will submitted in the near future.

4. **The FCD needs scour calculations for bank protection toe downs, abutment protection and pier depths.**

These calculations are included in the Hydraulic Report dated February 2006.

5. **Sheet 5, at station 882+00, area marked as an excavation area should be marked as an area to remain undisturbed.**

This area has been updated on the plans and areas to remain undisturbed have been better noted on the plans.

6. **Sheet 5, why is the 48" pipe in the river, it appears to not be needed?**

This was to pass small nuisance flows that may occur in the river. On review it was felt that if water is present in the river it may not be possible to continue excavation due to high ground water. The haul roads have been marked as contractor discretion with boundaries of where they can be placed and how wide an area can be disturbed. If the contractor desires culverts he can put them in as a part of his contract.

7. **Most if not all the sheets show the proposed floodplain and floodway lines. These should be cleaned up. They now appear as jagged lines.**

These lines have been cleaned up and smoothed out.

8. **Why is a haul road being placed in the river as indicated on several design sheets? Is this a 404 requirement to minimize river damage?**

The haul roads are identified to limit the amount of 404 disturbance in the river.

9. **Sheet 6, how does the soil cement protection terminate at station 887+00 for the 6:1 channel cut?**

The bank at station 887+00 has no protection. It is an excavation line only. The protection turns back at station 895+00 and follows the fill area to the south. This areas has been clearly marked as excavation only and the toes of the bank protection has been drawn on the plans.

10. **Sheet 6, what is the slope of the bank that is trending in a southerly direction?**

This is the line of the bank protection. The bank will be protected past an on site drainage channel that will exit the development south of the turn back. This is shown on the 90% plans.

11. **Does the slope commented on in comment 10 above have slope protection of any type?**

Yes – see responses for comments 9 and 10 above.

12. Sheet 7, station 922+00 there is a significant discontinuity in the 6:1 slope width. There should be some sort of protection for the wider width, were it abuts the shorter 6:1 slope width. Please provide a detail on how this will be done.

The previous plans did not show the toe of the bank – only the portion of the bank above ground. The 90% plans show the toes of the banks and the protection extending to the protection depth.

13. Sheet 7, there is a levee type structure from station 917+00 to 930+00. Is this structure needed and how will it be protected? In several locations it appears that tie-backs will be installed on level ground, is this?

The protection and alignment have been modified in this area to better represent the existing ground elevations. The bank protection has been moved away from the King Ranch property line to allow El Rio park features such as viewing platforms and trail areas to be constructed on the Game & Fish property as a part of the mitigation for the channel project. Details of the mitigation plans will be developed by others.

14. Sheet 7, the vane dikes should be cleaned up, they are irregular in shape.

The vane dikes have only shown the above ground portion which was minimal for some of the dikes. The number of dikes has been reduced and adjusted to provide protection against the river thalweg moving into the mitigation area while not eliminating flow into the area altogether. The toe down for the vane dikes is now also shown on the plans.

15. The design sheets should extend further to the south to encompass the spread of the floodplain into the Game and Fish property.

A new sheet (7A) has been added to show this area on the plans. Fill will be placed along the boundary of the Game and Fish property as shown on the separate King Ranch grading plans. The floodplain line in this area is based on the fill shown in those plans.

16. Sheet 8, station 950+00, the 6:1 slope doesn't exist at this location, yet the existing contours appear to be relatively flat. This area should be cleaned up.

The inside contours have been removed from the plans to allow for the fill behind the banks planned by King Ranch. This may have caused some confusion for review. Any cleanup and revisions have been performed in this area.

17. Sheet 8 should have a reference to where fill will be placed for the King Ranch Development. All sheets that show an area of fill should have this reference.

This reference has been added to the plans.

18. Sheet 8, why is the 48" pipe located in the design at station 977+00?

This was for minor flows. This has now been left to contractor discretion. See Comment # 6

19. Sheet 9, why is the 48" pipe located in the design at station 1003+00.

See response to Comment # 18 and Comment # 6.

20. Sheet 9, are the diagonal structures centered on station 1000+00 an access road? If so, they should be labeled as such and a detail provided for their construction.

The diagonal features are the service road and trails passing under the bridge. These currently go to the elevation of the design cut and could serve as access roads. A better detail has been included in the plans. These details are being coordinated between the Baker bridge plans and the CVL channel plans.

21. Sheet 10, station 1009+00 to 1025+00 shows a slope on the backside of the fill area while the cross section on sheet 24 for station 1010+00 indicates fill is to be placed in this area and will not have a slope. Consultant should clarify the design scenario before the project proceeds.

The contours for the back of the bank have been removed. This area will be filled as shown in the cross sections.

22. Sheet 10, a 60-inch gas line is shown to underlie the project. The depth to the line should be indicated on these plans.

The potholes have been shown as well as the depths. It appears that the gas line may have to be relocated for a portion of the project. This is currently being investigated.

23. The cross section for station 1035+00 on sheet 10 does not have the appropriate cross section on sheet 24. The cross section ends short of the second slope depicted on the south side of the sheet.

This cross section has been lengthened to show the second bank. The low area is a mitigation area that is expected to be some type of fish ponds for native fish.

24. Sheet 10, what is the 30-foot ROW easement for? If it is for SRP please indicate as such.

The easements have been updated to show labels for each easement shown on the plans in this area.

25. Sheet 11, what is the slope of the south most bank on this sheet?

This has not fully been determined but will be in the 4:1 to 6:1 range.

26. The cross section on sheet 24 for station 1050+00 on sheet 11 does not represent the construction effectively. The south most slope is missing from the cross section.

This cross section has been extended to show the second slope.

27. Sheet 11, how does the fill of the 6:1 slope terminate and how does the soil cement terminate at the end station of 1063+00? Plans should include details so the soil cement will not be undermined at its end.

The slope will tie back smoothly into the rock outcrop. It is expected that the bank will warp to a steeper profile as it approaches the rock outcrop. This detail needs to finalized.

28. Sheet 14, the side marked as sheet 13 should be sheet 11, the side marked as sheet 11 should be sheet 15 and the east side of the sheet should be marked sheet 13.

This has been corrected on the current set of plans.

29. Sheet 14, does the 6:1 slope have soil cement protection?

The bank will be protected for a significant portion of its length although not the full length. We expect approximately one-half of the length to be protected with soil cement. The current set of plans show protection the full length of the embankment to insure sufficient funding for the protection desired during cost estimation.

30. Sheet 14, the haul road at station 1050+00 does not have a pipe installed.

A pipe was not expected to be needed in this location but one can be installed at the contractor's discretion.

31. Sheet 15, the plan view of this sheet is not depicted accurately on sheet 24. The cross sections for the stations depict a down slope on the north side of the 6:1 slope. Which is correct.

The area behind the bank will be filled so the plan sheet was correct. This has been corrected for the cross sections in this area.

32. Sheet 15, the cross section cut E25 is orientated in the wrong direction for the cross section depicted on sheet 25. E25 also need to go through a tie-back.

This has been corrected in the current set of plans.

33. Sheet 16, construction notes 7 and 8 do not match the items on this sheet. They should be floodplain and floodway.

This has been corrected.

34. Sheet 16, what are the items centered on station 1000+00. They appear to be access roads. If so, they should be labeled and have a detail of their construction.

The Cotton Lane Bridge is centered on station 1000+00. This has been called out in the plans.

35. Sheet 16, the area north of the 6:1 slope is a fill area in the hydraulic model of September 23 but is drawn as a levee/spur dike on your plans. Which is correct?

The area west of the Cotton Lane Bridge will remain floodplain due to flooding from downstream around the end of the protection. The area to the east is slated for fill (including the FCDMC property just to the east of Cotton Lane).

36. Sheet 17, the top of the soil cement protection appears to travel up the 6:1 slope, I don't know if this is correct or not.

This area has been clarified to label areas of excavation only.

37. **Sheet 17, the vane dikes are irregular in shape, they should be symmetrical.**

Only the above ground portion of the dikes was shown on previous plans. Toe downs are now shown based on a dike slope of 3:1. The protection will go completely around the dikes.

38. Sheet 18, the vane dikes are irregular in shape.

See response to Comment # 37 above.

39. Sheet 18, the call out for the vane dike typical is incorrect. It should be called out on sheet 25.

This call out has been corrected.

40. Sheet 18 and 19. The top of the soil cement protection is coincident with the 10-year water surface elevation but I can't tell where the soil cement starts and stops in the design. The soil cement appears to go right through the van dikes. Consultant should be more clear on where the soil cement is to be placed.

There is not soil cement protection in this area. This is a natural bank that is expected to erode and fill over time as the river adjusts to the changes associated with the Cotton Lane Bridge and upstream impacts.

41. Several of the cross sections on sheets 23 and 24 depict a levee scenario. Is this really occurring and if so the FEMA freeboard requirement will have to be adhered to.

The only area where the bank will serve a purpose similar to a levee is immediately west of the Cotton Lane Bridge. The area behind the bank will remain in the floodplain so the dike is not serving as a levee but only as a guidebank to help water pass through the bridge smoothly. This bank could be extended in the future along the floodway line to remove the state land parcel from the floodplain.

42. Several cross section depict the 100-year water surface overtopping the fill area. This should be corrected.

These have been corrected. This was an artifact of the original design of allowing the fish ponds to become inundated during the 100 year flood. These cross sections have been corrected. The only cross sections that should show water behind the banks are 985+00 to 995+00. There are several additional cross sections that show vane dikes but these are noted on the cross sections.

43. Sheet 25. What is the toe down on the vane dikes?

The toe down for the vane dikes are the same as used for the associated banks in this area. Since the dikes are angled maximum erosion should occur off the downstream end and slightly downstream from the dike. It is expected that they will act more as banks than as mid-channel obstructions.

44. Sheet 25. One side of the vane dike appears to be compacted soil and the other soil cement. Consultant should clarify the design of the vane dike.

The vane dikes consist of soil cement entirely around the dike.

45. Sheet 25. Toe down of the soil cement is depicted to be 10 feet plus an unspecified depth. The preliminary toe down calculations provided by R2D dated June 15, 2005 indicated a toe down of 14.2 feet. This value is in line with what Stantec calculated for the El Rio WMP in stretches of the river not effected by the bridge hydraulics. Stantec had significant values for total scour upstream of the bridges in the El Rio Project. The depicted design toe down on this sheet should be more definitive. The FCD should have in its possession the final design values for toe down protection.

The new values are included on a table in the plans as well as in the hydraulic report. The values of 15 ft for the south bank and 18 ft for the north bank have been used throughout the design. The areas west of the Cotton Lane Bridge reach could have lower toe down values but given the braided nature of the stream it was determined that the toe down should not be reduced below 15 ft for either bank. See Appendix G in the Hydraulic Report for the calculations by reach.

46. Sheet 25. What are the tie-backs constructed of and why are they even needed? Consultant should discuss the need for tie-backs in the design.

The tie backs are constructed of soil cement. They are to protect against the river getting behind the solid soil cement protection during large flood events. This keeps the river flowing on the right side of the protection. Numerous failures have occurred due

to flow getting behind toe protection or low bank protection. This design allows vegetation of the upper bank while providing hard protection for the lower banks.

47. Sheet 25. It appears that the cross section D-9 may not be accurately depicting the plan view of the bridge abutment and road. Consultant should investigate the plan view and redraw the cross section if needed.

This cross section was incorrectly drawn. This has been redrawn and now better represents the cross section at the bridge abutment.

River Research and Design, Inc.

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February 22, 2006

John Hathaway, P.E.
David Degerness, P.E.
Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

RE: Comments from May 23, 2005 reiteration of Earlier Comments

We have added to previous answers on the questions that were highlighted in red. New comments are shown in italics. If you have any questions please let me know.

Gary E. Freeman, PhD, PE

1345 E. Spur Ave, Gilbert, AZ 85296

Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: March 8, 2005

To: John Hathaway, P.E., Project Manager, Planning Branch, Project Planning and Management Division

From: David Degerness, P.E., Civil Engineer, Hydrology and Hydraulics Branch, Engineering Division

Subject: Review Comments on Preliminary King Ranch/Cotton Lane Bridge HEC6T Models dated February 28, 2005 and HEC-RAS Models dated February 7, 2005 by WEST Consultants.

Background

On December 8th, 2004 the Flood Control District provided comments to WEST Consultants on sediment transport models (HEC6T) and hydraulic models (HEC-RAS). On December 28th, 2004 Stantec Consultants provided comments to WEST Consultants on sediment transport models (HEC6T). Stantec is the consultant to the FCD on the El Rio Watercourse Master Plan. On December 30th, 2004 WEST Consultants provided a response letter to address both FCD comments and Stantec comments. Since this point, WEST Consultants has been trying to resolve the outstanding comments and update their models using new mapping data. On February 16th, 2005 a meeting was held at the FCD to help WEST Consultants expedite the production of the sediment transport models and hydraulic models. The FCD received updated HEC6T models on February 28th, 2005.

Sediment Transport Comments Summary

The FCD has reviewed the updated HEC6T models and verified that the main issues are resolved. It was verified that the channel trap efficiency for the proposed condition is the same as that for the existing condition. It was also verified that the downstream channel invert for the proposed condition is the same as that for the existing condition. Because WEST is still verifying the cross section accuracy and CVL is considering lowering the channel an additional 2 feet, we tentatively approve the models. In addition, since HEC6T is a 1D model for long term channel bed aggradation/degradation and it does not address the channel meandering process, erosion protection should be provided for channel banks and bridges. A channel maintenance document needs to be developed which specifically defines maintenance responsibility and the responsible parties. The responsibility may include, but not limited to, (1) sediment aggradation/degradation that occurs in the project reach during and after flood events; (2) channel bank erosion in project reach during and after storm events; (3) vegetation replanting in the project reach after flood events; (4)

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vegetation trimming and removal for overgrowth which will reduce the channel capacity; and (5) emergency action plan.

We agree that this needs to be done but this is involves extensive discussions between FCDMC and the City of Goodyear. We can work up the parts of the agreement that need to be there from the engineering standpoint but the politics needs to be worked out between the sponsors of the project. This appears to be happening at the current time.

The following is a list of all previous comments and the outstanding issues related to mapping and HEC-RAS modeling.

December 8, 2004 Flood Control District Comments and Resolutions

1. Page 1 of the report mentions that the rise in water surface elevation due to encroachment for the floodway was significantly less than the 1.0 foot allowed by FEMA and Maricopa County. This occurred because the encroachments couldn't be placed within the bank stations on any cross section. This is a FEMA requirement. Suggest further clarification in this paragraph if this technical fact is used.

FCD: WEST agreed to include encroachments that are in accordance with FEMA

This was clarified in the February version of the Hydraulic Report.

2. The n-values proposed for the King Ranch model are the same as the effective FEMA model produced by Baker. Will n-values for the proposed conditions be the same or similar to the existing hydraulic model?

WEST previous response: The final design will likely incorporate various levels of vegetation and environmental enhancement. We anticipate that the final design models will include three levels of n values. A base condition without vegetation which will be the worst case for sediment transport, an intermediate condition representing either soon after planting or a few years after planting (depending on the amount and types of vegetation and expected growth), and a high n value condition which would represent something that could be expected under full growth conditions (the worst case for hydraulics). The n-values from the Baker model were left in the model simply to provide some roughness for the concept model that was based on a condition that existed historically. It allows comparison with the Baker results without the added complication of changed n values.

The models used for the analysis of alternatives will use either current or expected condition n values as appropriate.

FCD: WEST agreed to update the final models using high and low n-values.

Hydraulics have been run using both high and low n-values. High n values cause a significant rise in flood elevations. It is recommended that vegetation maintenance programs be set up and extremely dense salt cedar vegetation be removed and prevented from re-establishing to the extent possible. Lower n values have been evaluated in the hydraulic model with no extreme differences noted.

3. How was the downstream boundary condition for the HEC-RAS model was obtained? It should be 868.18 ft which comes from the effective FEMA model at 186.87.

WEST previous response: The value was obtained from the FEMA model but appears to be in error. The value will be changed in future models. The difference in water surface elevation caused by this change becomes negligible downstream from Tuthill Bridge in the current models and thus does not impact water surface elevations or flows through the area of interest.

FCD: WEST agreed to update the final models.

4. Will a new floodway be prepared for the proposed project?

WEST previous response: Yes.

FCD: WEST agreed to update the final models.

The final models include the new floodway and floodplain. Digital data is on the accompanying CD and will be submitted with the CLOMR in the near future.

5. The GIS exhibits have two south bank alignments, a proposed and an alternative. The proposed is the one in the HEC-RAS model. Is the alternate still under consideration? If not, then it should be removed from the exhibit.

FCD: WEST agreed to update the final report.

The report has been updated to present only the desired bank alternative for the King Ranch property.

6. Significant differences exist in the upstream and downstream thalweg elevations where the King Ranch project ties into the effective FEMA model elevations. Since the proposed channel starts and ends at the two abrupt grade changes, we suggest more mapping or cross section surveys be performed to extend the RAS / HEC-6T modeling areas 500 feet upstream and downstream of the abrupt grade changes.

WEST previous response: Mapping currently underway should extend the upstream boundary slightly and expected modifications to the channel template will move the excavated channel some distance downstream from the Estrella Parkway Bridge (perhaps 1,500 to 3,000 ft). The lower end of the mapping should extend beyond the end of the excavated channel as well. If not additional surveys may be needed to meet the 500 ft request and additional surveying will be performed as necessary.

FCD: This issue has not been resolved from observation of the most recent HEC-RAS models dated February 7th, 2005.

The changes in channel geometry were moved downstream away from the channel to eliminate any effects at the change in topography. This change can be seen in model results and is evidenced by the need to carry the FIS model upstream to Bullard bridge before a tie in could be obtained. Results in the immediate vicinity of these areas are questionable but the modeling shows that even with the changes no long term impacts are expected.

7. WEST provided FCDMC a color exhibit showing the excavation for the proposed channel. What was used as the basis for this exhibit? Was it the difference between the Baker model / mapping and the WEST proposed channel or was it the difference between the WEST existing conditions model/new mapping and the WEST proposed channel? Provide more explanation on the exhibit.

FCD: WEST agreed to update the final report.

The excavation exhibit is based on the differences between existing and proposed conditions. These are based on the same topographic data to insure accuracy of estimates and any associated modeling.

8. Exhibits should show the proposed bridge in place so the proper placement of cross sections upstream and downstream of the bridge can be checked.

FCD: WEST agreed to update the final report.

9. The King Ranch incoming sediment load on the QS records from the HEC-6T model does not match the output from the Tres Rios models as provided by WEST Consultants in an e-mail dated December 2, 2004.

FCD: this issue has been resolved.

10. The Corps is changing the proposed plan for Tres Rios by removing several ponds and adding a channel to the project. This will affect the hydraulics and sediment transport within the King Ranch project. The Corps new modeling efforts should be reflected within the King Ranch design.

FCD: this issue has been resolved since the sediment gage data is being used.

11. Section 7.1.2 of the draft report describes a 30 day simulation that was run for the Tres Rios HEC-6T model that is used to obtain the inflowing sediment load for the King Ranch project. It appears that significantly more time was modeled within the Tres Rios models. Please clarify this section with increased methodology description and an example of the output data from the HEC-6T model that is used as input for the King Ranch HEC-6T model.

FCD: this issue has been resolved since the sediment gage data is being used.

12. The 1-foot mapping for the main channel and south side of the King Ranch Gila River portion has an horizontal shift problem. Based on WEST Consultants, they have corrected it in the HEC-RAS and HEC-6T modeling. FCDMC spot-checked three HEC-RAS cross-sections and found the elevations match both the MCDOT's survey data near Cotton Lane and FCDMC's own survey data. Once the mapping for the north side of the river is finished

and incorporated into the rest of the mapping, a detailed QA/QC/verification must be performed by WEST Consultants about the final digital terrain data for HEC-RAS and HEC-6T modeling by using RTK/GPS cross section survey on a number of representative locations along the river.

FCD: there are some zero values in the contour data. WEST has been looking into this problem. FCD received the topography on March 8th, 2005 and will look into this problem too. FCD is still waiting for CVL to provide some documentation for verification of the HEC-RAS cross sections.

December 28, 2004 comments by Stantec and Resolutions

1. WEST recently used an average inflowing sediment load rating curve. Why is an average curve used? We are interested in using a curve based on the best available data (USGS).

FCD: this issue has been resolved. WEST used the El Rio sediment inflow data which was developed from the USGS gage data at Gillespie Dam by Stantec.

2. Movable bed limits are an important factor in modeling the Gila River. It is our opinion that the river experiences erosion (degradation/scour) in the "cleared" channel and fill (aggradation) in the vegetated floodplain. How does the WEST model incorporate that condition in the model?

FCD: this issue has been resolved. WEST used HE records in the revised models.

3. The WEST model results need to be compared to the available USGS sediment data.

FCD: this issue has been resolved. WEST used the El Rio sediment inflow data which was developed from the USGS gage data at Gillespie Dam by Stantec.

4. It appears that the current modeling shows the river degrading in the upper reach containing the bridge. That needs to be addressed.

WEST previous response: It is not clear which bridge is referenced but it is assumed that this refers to the Estrella Parkway Bridge. The model currently shows degradation at the Estrella Parkway Bridge that is most likely due to a change in the channel topography. The topography upstream from Estrella Parkway contains a flow of approximately 13,000 cfs while the topography below the bridge has no flow in the channel. The new topography should extend further above the bridge and the model behavior at this location will be further evaluated to see if the reach is truly degradational or if the erosion is simply a product of the pre-existing topography containing a flow of 13,000 cfs above the bridge while the topography below the bridge shows the bed of the channel. The new topography will allow the determination of whether the erosion is the result of the hydraulics of the reach or simply the splicing of topography. No conclusion can be made until the new topography is incorporated into the HEC-6T model.

FCD: this issue needs to be addressed by WEST.

The incorporation of the data in the HEC-6T model show no upstream or downstream impacts from the change in topography. There are some local changes for a cross section or two while the model adjusts to the abrupt change in topography but rest of the model is stable and shows no impacts upstream or downstream of the abrupt change in bed elevations.

5. The WEST model uses a long hydrologic record (most of which is irrelevant to sediment transport) and it contains all of the Baker model cross sections. That results in long run times and extraneous output. For example, the WEST model (10 miles long) takes an hour or so to run while the Stantec model (20 miles long) runs in a few minutes. Excess output makes analysis tedious and greatly complicates inspection of results. Simplification is this regard would facilitate review.

FCD: this issue has been resolved. WEST will keep their hydrologic records in the models which are from the Corps of Engineers. Although Stantec recently raised some questions about the data as compared with gage data, it will not change the sediment transport results significantly. In addition, the gage data is 30 miles downstream of the project. The FCD decided to let WEST keep their data.

6. We don't understand the geometry changes to the proposed condition model.

WEST previous response: The channel cross section was cut so that if the existing bed was higher than the channel elevation the material was removed. If the existing bed is lower than the channel cut the existing bed was left. A comparison of the two bed elevations is shown below for one cross section slightly downstream from the Cotton Lane Bridge.

Further elaboration on this comment indicated that the question revolved about differing numbers of points on the north (right descending) overbank. This can also be seen in the figure below. The existing condition HEC-RAS cross section has significantly fewer points than the cross section with the channel in place. This is due to the re-cutting of the cross section from the topography after the channel cut was inserted into the topography. The north end of both cross sections come from the same topography as shown in the figure below with the existing conditions having significantly fewer points when compared to the with-channel cross section. Both cross sections represent the same surface however as can also be seen in the figure.

FCD: this issue has been resolved.

7. We do not have the necessary information at this time to reach a conclusion as to whether input to the WEST model is compatible to the El Rio modeling.

WEST previous response: WEST has provided all of our data and models to Stantec for analysis and review. Given the above discussion and the additional data and models provided, it is our hope that Stantec can determine that the two approaches to input data, modeling, and analysis yield basically the same results when used in the WEST model. From the analysis and comparisons we have performed it appears that the changes in inflowing load, the transport function used, and the bed material in the ranges used in both the Stantec and WEST models produce essentially identical

results. While some differences of opinion may exist in such areas as whether to use the total load including fines or just the bed load portion of the sediment inflow, it appears in this case that they involve more differing approaches to modeling than disagreements regarding the data or results. While under specific circumstances one approach may be superior to the other, both appear to be acceptable approaches and both yield similar results in this situation.

FCD: this issue has been resolved.

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Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: September 8, 2005

To: John Hathaway, P.E.

From: David Degerness, P.E.

Subject: Proposed Condition HEC-RAS Model of the King Ranch/Cotton Lane Bridge Area of the Gila River submitted August 17, 2005.

I have finished my review of the above referenced model and I have the following comments.

1. Investigation of the n-values used in both the HEC-RAS model and the HEC6T model reveal that for the most part the n-values used in the HEC6T model are lower than the new n-values used in this submittal of the HEC-RAS model. This may not be a bad thing in that the lower n-values in the sediment transport model lead to more erosion and will provide a conservative value for bank protection in the project vicinity.

The n values used in the HEC-6T model will vary from the RAS models as the HEC-6T model is adjusted to give the same flow characteristics – i.e. depth and velocity – rather than the same n value. This is due to differences in the way the n values are composited between the two models. The models yield similar results for velocity and head as shown in Appendix E of the Hydraulic Report dated February 2006.

2. A left levee and right levee are used in the model. The left levee should represent fill on the King Ranch Property. The right levee should represent a spur dike that is protecting the upstream and downstream side of the north bridge abutment. The 40% plans as submitted up to this point have not included the spur dike design and the fill on the south side of the river on the King Ranch property is designed as a levee. Future submittals of the plans should include design of the spur dike and appropriate fill elevation for the King Ranch Development.

This has been corrected in the models submitted after mid-September.

3. Significant river invert differences still exist tying the Cotton Lane Project into the effective FEMA model.

This has been rectified in the latest models (September 23, 2005 or later). The models tie in to the FEMA water surface elevations and both the floodplain and floodway tie in smoothly to the exiting lines.

4. The FCD is still waiting on the item-to-item response to our March 8, 2005 and April 28, 2005 comments.

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These have been address and are included in Appendix H of the Hydraulic Report.

5. The 500-year flood event has not been modeled within this latest hydraulic submittal.

The 500 year flood has been run but no floodplain has been delineated nor will a 500 year floodplain be determined.

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June 15, 2005

RESPONSE TO COMMENTS BY DAVE DEGERNESS REGARDING SCOUR CALCULATIONS FOR GILA RIVER CHANNEL

TO: Dave Degerness – FCD

1. Blench's Zero Bed Factor is given as 8.5 for a D_{50} of 6mm. I obtain a zero bed factor of 2.5 for the given D_{50} of 6mm. Using the value of 2.5 in the scour equation produces a scour depth of 9.75 feet instead of the given 6.7 feet. Consultant should investigate the zero bed factor and explain how 8.5 was obtained. If necessary, recalculate total scour.

The Blench Zero Bed Factor should indeed be 2.5. This was apparently changed in error during earlier sensitivity analysis. This was modified in the spreadsheet and the scour depths recalculated. This resulted in a scour depth of 10.0 ft which was very similar to that calculated by the Lacey methodology and indicating that Lacey may not be out of the range. Lacey's equation was thus incorporated into the average which resulted in a preliminary total scour depth of 16 feet. These values will be compared with values obtained from the Corps calculations method which will also include bend scour.

2. The spreadsheet has the average depth being the same as the hydraulic depth. Hydraulic depth is the flow area divided by the top width. What is the definition for average depth? Are they equivalent? I would use the maximum channel depth for these calculations.

The hydraulic depth for this series of calculations was based on the hydraulic depth of the channel rather than the entire floodplain which would likely be too shallow of a depth given the very wide top width and shallow floodplain. Since the formula was developed based on an "average depth" it was felt that the hydraulic depth of the channel will be closer than the maximum depth. The only formula that this information is used in is the USBR method which uses half the "mean" depth.

3. Why wasn't bend scour calculated? Will you use Zeller's Bend Scour formula to compute bend scour?

Bend scour will be calculated for the outer bank using a number of methods including Zeller's formula, methods developed by the U.S. Army Corps of Engineers, and possibly other methods. This calculation was a preliminary set to give an idea of the approximate depth of scour for this stretch of the Gila River.

4. Scour calculations should also be computed for the 500-year event. The bank protection and toe down should be designed for this event.

Scour calculations have been redone for the 500-event and are attached.

Again the numbers provided were PRELIMINARY calculations for use in the 404 application rather than final numbers for final review. Final values will be provided later in the process when designs are more finalized. If you have any questions please call me.

/s/

Gary E. Freeman, PhD, PE
President

Cc: Brian Bombardier – Baker
Denny Grigg - MCDOT

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May 12, 2005

Response to Flood Control District Comments for Initial 40% Plan Submittal.

1. **How does this project relate to the entire Gila River? When I look at the plans I can't tell where I am in relation to the full width of the Gila. I would like to see the entire width of the river on the plans, if possible.**

The plans have been modified and an overview sheet added to better show the entire river channel. Separate plans (or sheets) showing the existing and proposed FEMA floodplains will be prepared for future submittals.

2. **The plans need to show the existing floodplain and floodway as well as the proposed floodplain and floodway. This should include the north and south extent of each, not just in the project vicinity on the south bank of the river.**

Plans showing these will be prepared for later submittal.

3. **The proposed downstream and upstream water surface elevations must tie into the current FEMA water surface elevations. This should be shown on the plans for the project.**

This will also be shown on the floodplain plans.

4. **Indicate on the plans what the stippled areas are. It should be called out as a construction note or written in the areas themselves that these are areas to be graded at the indicated slope.**

This has been addressed on the revised 40% plans.

5. **How can we be assured that the areas indicated for grading would actually be those areas graded in the field?**

The areas will either be staked or GPS excavators will be used to insure correct grades. Alternate HEC-RAS cross sections will be surveyed as a part of the LOMR process to show correct excavation elevations.

6. **The cross section cuts indicated in plan view are to be viewed in a downstream direction. The cross sections themselves starting on sheet 9 are being viewed in an upstream direction.**

This has been corrected on the revised plans.

7. **Label the hydraulic cross sections on the plans.**

Cross Sections will be labeled in future submittals.

8. **As I viewed the WSEL's in an upstream direction they became more and more different from the WSEL's in the HEC-RAS model of February 7, 2005 as done by WEST Consultants.**

The WSEL's should match from the bridge upstream. The WSEL's downstream of the bridge may be higher than those in the latest WEST model. This was done to insure any use of the WSEL's for design on King Ranch was not too low since the final FEMA modeling has not yet been performed. Two-dimensional modeling of area is also planned.

9. **The water surface profile should be drawn with the river bottom profile on the bottom of each sheet.**

The water surface profile was added to the profiles at the bottom of the sheets.

10. **The word jurisdictional is misspelled on each sheet in the construction notes section.**

This was corrected.

11. **The word floodway is misspelled on each sheet in the construction notes section.**

This was corrected on the new submittal.

12. **Construction note 14, replace the words low flow with the words river bottom. There is no low flow channel component to this project.**

This will be corrected in the next plan submittal.

13. **Sheet 3 of 11. What is meant by the "1000' FLOODWAY" in the middle of the sheet? Will this be the new floodway with the project in place? This should be removed from the sheet. This can be avoided by showing the entire floodplain and floodway as remarked in comment #2.**

This was removed from the sheet. This originally referred to FCD's 1000 ft clearing easement/right of way.

14. **Sheet 3 of 11. How will the 6:1 slope be terminated on the left side of the sheet?**

The protection will turn back at a 30 degree angle from the bank and then turn back along the property line. This is not depicted correctly on the 40% plans as submitted. The slope of the

protection may increase to 2:1 where buried in the bank along the property line away from the river.

15. Sheet 3 of 11. Where does the 6:1 slope go that leaves the sheet running in a southwesterly direction?

This ties back to high ground. This will be the protected portion of the bank while the slope running west along the river will not be protected beyond the King Ranch property line and any adjoining slope easements.

16. Do we need to see all the elevations on the 6:1 slope? Perhaps just the top and lower elevations should be shown.

The 5 ft contours have been plotted and intermediate contours removed.

17. Sheet 3 of 11. What is the dark line indicating that ties into the quarter section line?

A series of quarter section lines were plotted on the original set of plans. These lines have been removed to avoid confusion.

18. Consideration of groundwater should be included in the design and construction of the project. The groundwater table is very shallow. It may have an impact on the channel excavation but will certainly cause some difficulties on the channel bank protection construction and stability.

This has been discussed with the construction managers for the project and, while not shown on the plans, is being considered. Either thickened toes or dewatering will be considered to aid in the construction in areas of high ground water.

19. Bank protection and toe downs need to be specified on the plans.

Specific areas may not have been adequately noted on the current set of plans but will be clearly noted on future sets. The areas being considered for bank protection are from the rock outcrop at the west end of the existing levee at the east end of the King Ranch property to the west end of the project along the south bank and from the floodplain line at the east edge of the Laken property to just west of the Cotton Lane Bridge along the north bank.

20. Consultant needs to submit scour calculations and riprap sizing calculations for review.

These calculations will be submitted in the near future. Current sizing is based on initial evaluation and sizing planned for the Tres Rios project area.

21. Sheet 3 of 11. The "F" cut line is on top of the match sheet line. I would like to see it on either sheet 3 or sheet 4, not on the cut line.

We have moved all of the cut lines away from the match sheet line.

22. Sheet 4 of 11. There is a line that runs parallel to a line indicated with construction note #4. What is this line?

These are part of the section and quarter section lines. They have been removed in the latest set of plans.

23. Sheet 4 of 11. What do you mean by 404 washes? Please clarify the plan view and the construction note. Why is there a jurisdictional waterway and 404 wash on the plans? Is the jurisdictional waterway depicting the floodplain? Please clarify.

The plans have been modified to show only Jurisdictional Water Ways. This could probably be modified to indicate Limits of Jurisdictional Waters or Jurisdictional Delineation of Waters of US.

24. Sheet 4 of 11. What is the line at the bottom of the sheet just below the 6:1 slope?

This was likely quarter section lines and has been removed in the current set of plans.

25. Consultant needs to submit bridge scour calculations and abutment construction details.

Preliminary calculations have been submitted to Baker Engineering as well as to FCD.

26. A channel maintenance document needs to be developed which specifically defines maintenance responsibility and the responsible parties. The responsibility may include, but not limited to, (1) sediment aggradation/degradation that occurs in the project reach during and after flood events; (2) channel bank erosion in project reach during and after storm events; (3) vegetation replanting in the project reach after flood events; (4) vegetation trimming and removal for overgrowth which will reduce the channel capacity; and (5) emergency action plan.

This is being discussed by the various partners at this time.

27. Sheet 5 of 11. How does the 6:1 channel side slope tie into the bridge abutment that has a 2:1 slope?

The slope varies as it approaches the bridge so as to tie in smoothly through the bridge. It is anticipated that the slope will gradually vary from 6:1 to 2:1 with some type of trail bench under the bridge.

28. Sheet 5 of 11. The hydraulic section upstream of the bridge has an elevation of 894.97 feet. This is 0.7 feet higher than the latest model I have from WEST Consultants.

The water surface elevation should match the WEST Consultant model at this time.

29. There should be protection for the 6:1 dirt channel bank. During a flood event the 6:1 channel bank will be eroded.

It is anticipated that the north channel bank will erode to some extent during large floods. Some protection is being considered for the portion of the channel just downstream of the bridge and west of the north channel branch but no plans are available at this time since only concepts have been discussed.

30. Sheet 5 of 11. How does the 6:1 slope terminate at the center of the sheet?

The slope was terminated in this reach in error. The slope will continue past the mitigation site and tie in at the rock outcrop as shown on sheet 7. Further details will be developed with more detailed plans for the next submittal.

31. Sheet 5 of 11. Does the gas line exist now where the gas line easement is show? If the line exists now it should be shown on the plans as well as the easement.

We are currently potholing the gas line and will show it on future plans. The easement is shown on current plans to the extent that it has been identified.

32. Sheet 5 of 11. Do we know the depth to the gas line? Its depth is not indicated on cross section J on sheet 10 nor is its depth indicated on sheet 5.

We are currently potholing the line and will have elevations in the near future.

33. Sheet 5 of 11. Is it a wise idea to be doing the excavation on top of the gas line? Shouldn't the river bottom in the vicinity of the gas line be left alone?

Once the depth of the gas line is known we can better determine relocation needs and areas that can be left unexcavated. The area over the gas line planned for excavation has been reduced to the extent possible.

34. Sheet 5 of 11. Cross section I needs to be extended to the north to cover the extent of the work.

This cross section has been extended.

35. Sheet 5 of 11. Cross section J needs to be extended to the north to cover the extent of the work.

This cross section has also been extended.

36. Sheet 6 of 11. Cross section L needs to be extended to the north to cover the extent of the work.

The cross section has been extended.

37. Sheet 6 of 11. What is the line running through the middle of the sheet? It is not labeled.

This is the King Ranch Property Boundary and will be labeled in future submittals.

38. Sheet 7 of 11. Culverts not located at bottom of the washes as is indicated in the profile view.

The road plans are very preliminary. Future submittals will place the culverts correctly in the washes.

39. FCD needs drainage calculations for culvert design of culverts seen on sheet 7.

These will be provided in future submittals as the drainage report becomes available.

40. Sheet 8 of 11. The line indicated as the floodplain is really the floodway.

This has been corrected .

41. Sheet 8 of 11. This sheet shows the floodway leaving at the top of the sheet. This floodway needs to be chased down or continued on another sheet in the plan set.

This will be shown on separate drawings showing the floodplains more accurately.

42. The FCD would like to see the onsite drainage plans for King Ranch as soon as they become available. This relates to out letting of flows into the Gila River. How will this be accomplished and where will this be accomplished?

Currently plans call for reconnecting the hillside washes with the river across the existing farm land but the alignment has not been finalized. These plans will be provided as soon as possible. Much of the water will be delivered to the Game and Fish managed property on the south bank of the river for mitigation purposes.

43. Sheet 8 of 11. The water surface of 895.30 feet given at the bottom of the sheet does not match what is in the latest HEC-RAS model.

This has been corrected.

44. In the current 40% plans there is no protection for the north channel bank (2000' channel). During a flood event it is likely that the north channel bank will be eroded and meandering will take place.

The bank near the bridge and along the bridge will be protected. The bank further west will likely not be protected except just downstream of the north channel branch.

45. The 6:1 channel bank slope and the 2:1 riprap underneath are outside the King Ranch property line. Some of them are on FCD land. This must be addressed because of maintenance and liability issues.

This has been discussed and since the project is a MCDOT project it was felt that the bank should be on FCD property rather than private property. Further discussions may be needed at high levels.

46. Provide turn back for bank armor at each end of project instead of the straight terminus that is drawn on plans now.

The armor will initially turn back at 30 degrees or less from flow and then tie back into the bank at least a distance equal to the flow depth plus the anticipated scour depths.

47. The Gila River will tend to meander toward the north bank upstream of the bridge abutment. Extra protection should be provided.

This will be taken into account in the design of the north bank armoring.

48. BLM land is on the south bank of the river, north of a portion of the King Ranch development. This area may be subject to the river meandering process and flood inundation. On the plan it shows that this portion of the river will have the 6:1 channel slope. Will the 2:1 riprap be constructed underneath this bank? If yes, then this channel protection will become a levee unless fill is placed on the BLM land. If not, will protection be provided at the King Ranch property boundary further to the south? If the channel protection will be provided at the King Ranch property boundary, an equivalent amount of protection should be provided for this bank as compared to the other banks. This is due to the meandering process and possible attack on this area by the low flow channel

Protection design will take this into account. At the moment some type of porous protection is anticipated that will keep the main river channel out of the area while allow flow to enter. This will likely require some protection along the north portion of the King Ranch property but would not cut off flows from entering the area. The designers are considering several options and are continuing to consider how to accomplish this design. A possibility would be to use a series of dikes angled at 15 degrees from parallel to the flow. Further analysis would be required as well as extensive coordination with FCD prior to designing this type of feature.

49. WEST Consultants should update the November 2004 report entitled, "Bank Protection and Alignment, King Ranch Properties."

This report will be updated in the near future as new modeling and information becomes available. The updated report will include work performed by CVL and River Research & Design and WEST so that the entire project will be reported in a single document.

The following comments were provided by Mr. Gary Shapiro, Civil Engineering Technician, Civil Engineering Branch, Engineering Division.

1. Address floodplain limits before and after.

This will be addressed as the FEMA modeling is completed and plans presented.

2. Address how swales are handled and outlet to the Gila River.

Drainage will enter the river through lowered sections of the bank protection. Entering flows during periods of low or no flows in the Gila river will be safely dropped into the river to avoid damage to bank protection works.

3. **Address groundwater table.**

We are aware that ground water is high in the area and are considering how to construct protection with the high groundwater.

4. **Address scour at bridge toe down protection for abutments.**

Scour at the bridge abutments should be the same as for bank protection upstream and downstream of the abutment since the bank alignment will be smooth through the bridge.

5. **Keep bank armoring and bank slope within property line and indicate type of armoring.**

See comments above regarding property lines and armoring.

6. **Provide turn back for bank armor at ends of project.**

See above comments. Bank armor will be turned back and tied back.

7. **Show profile or depth of gas line.**

This is being done and will be shown on future submittals.

If you have any further questions please feel free to call me at (480) 225-5206.

Sincerely;

/s/

Gary E. Freeman, Ph.D., PE
President

Cotton Lane at the Gila River
USACE Application No. 2004-01247-SDM

Responses to Additional Information Request from EPA (August 22, 2005)

For your reference, the EPA questions posed on August 22, 2005 are outlined in **bold** and our responses are provided in *italics*. Please note that many of these responses were prepared by Dr. Gary E. Freeman, P.E. (River Research & Design, Inc.) who is an authority on flood control and stream/river dynamics issues and is the principal designer for the proposed channel improvements. Dr. Freeman spent seven years with the U.S. Army Corps of Engineers Waterways Experiment Station studying and applying both sediment transport and hydraulic models to rivers across the United States. He also served on the Scientific Assessment and Strategy Team (SAST) for the White House study of the 1993 Mississippi and Missouri River Flood.

1. **What is bankfull width of the Gila River? It appears that bankfull width may change along the 5-mile stretch proposed for channelization. Can the bankfull width be reported at small intervals along the 5-mile stretch?**

The bankfull width is extremely difficult to determine for intermittent streams in the southwestern United States. Since we are leaving the low flow channels as is in the system, the widths for very low flows should not change significantly. The US Army Corps of Engineers (Corps) has estimated the 5-year event at 23,500 cubic feet/second (cfs) and the 10-year event at 57,000 cfs for this reach of the Gila River in their 1996 report for Roosevelt Dam. This flow rate this past spring is thus similar to the 5-year event. This flow wetted a substantial portion of bottom of the River and should have been above bankfull stage, but the Corps did not estimate events smaller than the 5 year for the Gila River in this reach. Since bankfull width is often associated with annual or 2-year events, it will, however, be wide and vary significantly – especially given the braided nature of the low flow channels in this reach. The excavation of the channel may widen the bankfull widths initially, but the river can be expected to again develop any bankfull indicators as time passes. Given the high sediment load it is anticipated that any disruption of the bankfull indicators will quickly be eliminated by the river.

In summary, the bankfull width has not been determined as a part of this study. Since the design did not use methods based on bankfull width, it was not determined nor analyzed. This design was based on river geomorphology developed as a part of the El Rio Vision, as well as, modeling and other methods currently being used across the nation and the southwest United States. It is expected that bankfull width for the channel forming events will not vary significantly between the existing and proposed conditions.

2. **The 404 application materials explain that the design width of the Gila River is proposed for 2000 feet. The section of the Gila River between Perryville Road and Cotton Lane seems to be much wider than 2000 feet. Looking at the 404 delineation boundary and the scale, the widest section seems to be approximately 1 mile wide. What is the over all change in channel width proposed for the 2000-foot wide channel?**

The 2000-foot channel refers to the base of the channel design width. Please refer to Exhibits 8, 9 and 10, as well as, Permit Exhibit N and the typical existing section for the proposed channel, in the application package.

The excavation footprint is based on a 2000 ft base width plus side slopes at 6H:1V. Even though the channel base width is only 2000 feet, the design for the area west of the Cotton Lane Bridge will allow flow to overtop the north bank of the channel and continue to flow in the northern portion of the existing channel as it now does. Most of the areas downstream from Cotton Lane are much wider than the 2000-foot channel under existing conditions and will continue to be wider. The section you note between the Perryville Road Alignment and Cotton Lane is just such a section. While we are excavating a 2000 ft channel section we are not cutting off flow to the existing north braid of the low flow channel that runs along the north bank of the channel. We have designed and continue to design our bank protection and river training structures to avoid cutting off this braid of the channel. In this area the two low flow channels are approximately one mile apart with a significant mound of deposited material in the center of the channel – a portion of which we are proposing to remove.

3. **What is the difference in area between the pre-project condition CWA jurisdictional area) and the proposed 2000-foot wide channel for the 5-mile Gila River segment?**

There will be a net 7-acre increase in waters of the U.S. as a result of the proposed project. Approximately 2,106 acres of jurisdictional area will be present in the post-project condition. The current approved jurisdictional determination is approximately 2,099 acres in size. Please refer to the cover letter in the Section 404 application package, as well as, Exhibit 8 of the Draft Environmental Assessment. Approximately 1,258 acres of waters of the U.S. will be avoided by the proposed project.

4. **Generally, when a channel is narrowed, water velocity increases. The HECRAS model results do not show a change in water velocity, although the channel appears to be substantially narrowed. This result seems counter intuitive, can you explain why water velocity will not increase even though the channel will be narrowed?**

The vast majority of the flow is currently carried in the main channel. With this project we are encroaching into the river slightly along the southern bank (as evidenced by the loss of waters of the United States along the south bank) but increasing the flow area along the north bank by excavation of significant volumes of material from areas that are outside the waters of the US. The overbank flows, while extending far from the channel in the floodplain maps, are only 2-3 feet deep and do not convey large volumes of water. Thus the combination of shallow floodplain flows in the overbank and excavation along the north bank result in very little change in velocities or water surface elevations in the reach near Cotton Lane for the 100- year flood.

5. **As stated above, the Gila River channel is very wide in some segments, what type of flood (100yr, 110yr, 200yr, 500 yr?) would it take to cover the area within CWA jurisdiction?**

The 100-year flood currently covers all of the area inside the CWA jurisdiction. Smaller floods may also cover the entire area but this has not been investigated. This will continue to be the case after the project is complete since we are not cutting off flow to any areas inside the CWA jurisdiction other than those along the south bank that are shown in the application.

Please refer to the attached exhibit that provides a comparison between the existing 100-year floodplain and the anticipated 500-year floodplain in the proposed condition.

6. **In the 200-year event, would water velocity increase in the proposed channel? Would stage increase? If so, by how much for both? What about the 500-year event?**

Model results show that for the 500- year flood the change in WSE (Water Surface Elevation) is on the order of one foot or less with the proposed conditions being lower than the existing conditions with the exception of immediately upstream of the Cotton lane bridge where an increase of 0.6 ft. This lowering of WSE for the proposed conditions is also true of the 200-year flood but changes are less noticeable with only a 0.2 ft rise upstream of the bridge.

The maximum lowering of the WSE is 1.5 feet for the 500-year flood just east of the Perryville Alignment. For the 200 year flood the maximum lowering is also approximately 1.5 feet slightly further east than the maximum lowering for the 500-year flood.

Velocity changes are more significant with the proposed condition lowering velocities downstream of the Cotton Lane Bridge. The lower velocities better transition into the downstream velocities and are more uniform for the proposed conditions. This is true for both the 200 and 500 year flows as shown in the attached table. Changes in both WSE and velocities are shown in the table.

Please refer to the attached exhibit that provides a comparison between the existing 100-year floodplain and the anticipated 500-year floodplain in the proposed condition.

7. **Can the proposed channel handle the 200-year event without having water velocity increase? If water velocity increases in the 200-year event, how does this impact sediment transport?**

The sediment impacts have been analyzed for the preliminary model of the proposed condition. It showed itself to be stable for the changes we evaluated. Numerous sensitivity analyses were performed to determine if the reach was stable. These included differing inflowing sediment loads and particle sizes, differing loading curves (amounts of each grain size) and differing flow rates. Additional sediment transport modeling is anticipated to meet requirements of FEMA and the Flood Control District of Maricopa County (FCDMC) for channel stability. Modeling performed to date shows a stable channel for the 105 year adjusted historical record that is available. Additional modeling in anticipated using both one- and two-dimensional models but the design appears to be stable for both hydraulics and sediment transport.

8. **As water moves from the non-armored portion of the Gila River to the channelized portion, water velocity is likely to increase due to the removal of friction forces along the stream banks. It is very common to see headward erosion of the softer bank material that migrates upstream from the transition point between soft earthen banks and hard concrete banks. How will this problem be avoided?**

The velocity is not expected to increase significantly when it leaves the bank protected areas. This type of erosion normally occurs where turbulence is generated in the transition from protected area to natural areas. To help avoid this problem, the ends of the bank protection are designed so as to have a 30 degree turnback (i.e. angled away from the river at a 30 degree angle) that has been shown to allow the water to smoothly move away from the bank protection and not cause turbulence and eddies that are responsible for erosion of natural bank material immediately downstream of protected areas. This will also help to keep the higher velocities away from the natural banks immediately downstream of the protected areas.

Further, the bank protection is anticipated to be hardened up to approximately the WSE of the 10-year flood (toe protection) with the upper bank being vegetated to protect the bank material

with tie backs from the toe protection to the top bank to insure the river does not get behind the toe protection. The design has attempted to take into account experience from the protection of both large and small rivers throughout the United States. Methods currently being taught in the American Society of Civil Engineers (ASCE) Stream Investigation, Stabilization and Restoration Course taught by Mr. David L. Derrick (USACE-ERDC) and Dr. Gary E. Freeman are being incorporated into the design.

9. **Similarly, water exiting the armored (riprap/soil cement) channel moving into the earthen channel will commonly erode the banks composed of softer earthen material due to an increase in velocity of water while it moves through the armored channel. Over time, bank stability can be compromised to the point of failure at which point we see a proposal for more fill to stabilize the banks. How will this problem be avoided?**

Only the toes of the banks will be hardened. The channel bottom is designed to be natural and can adjust to varying flows. Thus the flow will not see much hard protection and will primarily see natural bank material or similar vegetation. See also the response to Question 8 above.

The protection will be installed to a depth below the anticipated scour depth so any scour should be contained within the protected banks. From the sediment modeling it is anticipated that the reach will be stable and not need additional fill in the future. If the river degrades due to upstream impacts that remove the sediment inflow it is possible that some fill may be needed in the future but that is not anticipated at this time. Current designs have accounted for the scour involved in the proposed river modifications.

10. **Conventional flood control project such as straightening and lining channels are designed to move floodwaters out of the local area as quickly as possible. Often this has the result of transporting more water downstream, faster, increasing the severity of floods to downstream lands because the local area can no longer store and absorb the flood water. In fact, this is the point of removing adjacent lands from the floodplain for development. What kind of information can be provided to show that this problem/phenomenon can be avoided in this case?**

The removal of large areas from the floodplain can create problems for downstream property owners. This project does not straighten the channel but rather improves the existing channel while allowing the water to spread across the channel area. We are removing some of the overbank areas from the floodplain but the areas are, for the most part, shallow flooded areas that do not store a large volume of water in relation to the flood hydrograph. Experience from the 1993 Mississippi and Missouri River floods indicate that while this phenomenon is important (and significant) on a scale of 100's of miles of river the impact of individual projects such as this are almost impossible to determine. Given the shallow flooding in this area it is likely that impacts will be very small if not negligible.

One of the reasons that the channel base was set at 2,000 ft was to insure that the river was not over encroached in this area. The desire was to set the river such that it still had room to "be a river" while recovering some of the lands in the floodplains. The current design appeared to be a good balance between river function and flood protection. It was desired to leave the river more natural than is found in the Rio Salado reach of the Salt River just upstream. This design incorporates existing low flow channels and a wide natural channel that can adjust and shift within the protected banks over time. This should yield a more natural system than many of the earlier projects.

11. There may be a typo or discrepancy about the amount of excavation proposed for the preferred alternative. On page 7 of the Alternatives Analysis (Engineering Form 4345 Continuation Sheet Cotton Lane Bridge at Gila), the document reports that 4.3 million cubic yards of material will be excavated from the channel. In Block 21 of the actual Engineering Form 4345 (just following page 13 of the Request for Individual Permit), a number of 3.52 million cubic yards is reported for "channel excavation". The difference is approximately 800,000 cubic yards. Which of the numbers is correct? If they are both correct and the 3.5 million CY is within CWA jurisdiction, and the additional 800K CY is outside CWA jurisdiction, can I see a map showing the excavated areas and the CWA JD boundary so I understand where it is coming from?

We are reinvestigating the amount of cubic yards proposed and will provide the results to you shortly.

12. Where could I get a copy of the El Rio Vision?

The El Rio Vision is still in its draft form and is unpublished data. The El Rio Vision, in its generalities, can be found at the following web pages:

http://www.fcd.maricopa.gov/projects/ElRio/default.asp
http://www.fcd.maricopa.gov/projects/ElRio/StudyArea.asp
http://www.fcd.maricopa.gov/projects/ElRio/Benefits.asp
http://www.fcd.maricopa.gov/Neighborhood/ProjectDetails.asp?wPROJECT=29

Two public meetings are scheduled for September 13 and 15, 2005 to outline the status of the project. We plan on having a representative at this meeting to get any more detailed information on schedule, status of the data collection, etc. and can provide this information to you, if interested.

13. What are the estimated impacts to waters of the United States for the related housing developments (e.g., King Ranch)?

Even though the proposed project is to facilitate development by removing areas from the floodplain, the development project associated with King Ranch is a separate and unique project and could be constructed without the proposed project (with appropriate authorization from the USACE). The King Ranch project is still in the planning and development phases and will most likely be processed by Mr. Ron Fowler with the USACE – Arizona Regulatory Office.

14. Has the project team evaluated widening and improving existing Gila River roads and bridge crossings to provide the transportation access needed by the increased development in the area and the City of Goodyear?

The widening and improvement to existing Gila River roads (Tuthill Road/Jackrabbit Trail, Estrella Parkway and the Bullard Avenue Bridge) have been evaluated in various planning and transportation studies conducted by others since the 1980s. The Cotton Lane Bridge alignment was evaluated as recently as March 2004, as part of the "Corridor Improvement Study for SR 303L Between Riggs Road and MC 85" project and the preferred alternative is the current alignment within the proposed project study area; the Corridor Study continued much farther south of the proposed project study area. The Cotton Lane Bridge is needed in addition to the widening of these bridges in order to accommodate future growth and traffic demands. These

roadways will inevitably be widened, modified or relocated in order to accommodate these demands.

15. Have set back levees been evaluated for flood control purposes?

Given the shallow floodplains in the area and the ability of the Gila River to move within its floodplain, coupled with the extremely high land values in the area, set back levees were not evaluated in detail for the proposed channel improvements as they did not meet the entire purpose and need of the project. The alternative analysis provided in the application does have an alternative (Alternative 2), which provides for a levee system to be primarily installed in non-jurisdictional areas parallel to the Gila River. This alternative would affect approximately 12 acres of waters of the U.S., but not provide (1) flood protection and control needed to eliminate the Buckeye breakout noted, (2) would have an increased public cost (no private investment), (3) potentially cause internal drainage problems behind the levee system and (4) increase the WSE during a 100-year event.

Set back levees, such as those evaluated for the Tres Rios project just upstream also complicate the design and installation of bank protection since the protection likely needs to extend to the same depth. This requires significantly more excavation and very nearly the same disturbance of riparian habitat. Since flows on the floodplains are very shallow even for the 100-year flood, the Gila River does not get onto its floodplains except in very large events – probably on the order of 25 to 50 year events. The river's floodplains are mostly contained within what has been classified as "Waters of the US" according to the Corps delineation of those waters. As such, the current design could be considered to be set back levees when compared with earlier river designs that attempted to narrow the river to the maximum extent possible. The current design was developed to maintain as much existing habitat and river complexity as possible while meeting the flood control purposes and allowing the construction of a reasonable length bridge across the river.

16. Another potential typo/discrepancy. On page 13 of the EA, the cost of mitigation for the preferred project is estimated at 8 million, and channel improvements at $30 million. On page 7 of the Alternatives Analysis (Engineering Form 4345 Continuation Sheet Cotton Lane Bridge at Gila), mitigation is estimated to be $11 million and channel improvements at $30 million. Which figure is the correct one for estimated mitigation costs?

There is a mistake in the application. Based on best estimates, the cost should be a maximum of $12 million at current costs. This actually could range from $7 to $12 million depending on various factors, including land costs, construction costs, etc. We will use $12 million, as this is the most conservative number. We apologize for any inconveniences this may have caused.

17. The 404 application materials explain that the low flow channels will not be impacted. In the western portion of the project where the Gila River is very wide (between Perryville Road and Cotton Lane), it appears that a channel will be cut off and filled. Is this channel not a low flow channel?

The only area being filled is the area along the south bank of the river just west of the Cotton Lane Bridge. This area is not a low flow channel since the channel is cut off at the east end by a relatively high bar. Some portions of this channel are low and upon initial evaluation could appear to be low flow channels. Upon closer evaluation this channel is a chute for higher flows rather than a low flow channel. There is a very small area of the low flow channel along the

proposed south bank west of Cotton Lane that may be slightly shifted to the north to improve the exiting south bank alignment. This area is included in the 86± acres of loss of waters of the US as shown in the application but accounts for only a few acres of the total. This is the only place that the low flow channels are affected other than for temporary crossings as outlined in the application package.

The area of low flow channels along the north bank will not be filled or cut off from the river. A series of vane dikes are proposed along the north bank just west of the Cotton Lane Bridge to insure the river makes the turn to the southwest and does not erode a new channel to the north and endanger improvements to the west including irrigation canals and highways. These vane dikes will not, however, cut off flow from the area behind them. They are designed to allow flow into the area to the north and west while encouraging the river's main channel to make the turn to the southwest. Care has been exercised in the current design to avoid the low flow channels and the elevation of the channel cut designed so as to not impact flows into the existing low flow channels.

18. How large is the CWA jurisdictional stream area that will be cut off by the channelization project? Will this area receive water from the Gila after the project? Will it function as a river? Is this area counted as an indirect impact of the proposed project?

The only areas to be removed from the Gila River are the areas along the south bank that are shown in the application. All of the other CWA jurisdictional areas within the project boundary will remain a part of the river with characteristics either similar to or improved from existing conditions. The only change anticipated at this point is the area east of Cotton Lane Bridge proposed to be used for rearing ponds for endangered species. This area was proposed to have 50-year flood protection but it appears that this fish pond area east of Cotton Lane Bridge will need to be protected from the 100-year flood to address concerns over the release of endangered species during high flows as raised by other landowners and water users along the lower Gila River. Other than these two areas that are both discussed in the application all other portions of the CWA jurisdictional area will continue to function as river. Post-project conditions will result in a CWA jurisdictional area that functions similarly from a hydraulic standpoint, but improved considerably from a habitat standpoint. The CWA jurisdictional area will still function as a River. This concern with the release of endangered species is currently being addressed as a part of on going design efforts.

Please remember that the only sources of water within this reach of the Gila River is from the effluent from the 91st Street Wastewater Treatment Plant and rainfall events. No groundwater upwelling is anticipated as a result of the channel improvements proposed.