SEDIMENT TRANSPORT ANALYSIS
for
SALT RIVER NORTH-BANK LEVEE

Pima Freeway to Alma School Road
Salt River Pima-Maricopa Indian Community

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PRELIMINARY DRAFT
NOT FOR CONSTRUCTION OR DESIGN

SEDIMENT TRANSPORT ANALYSIS for SALT RIVER NORTH-BANK LEVEE

Pima Freeway to Alma School Road
Salt River Pima-Maricopa Indian Community

prepared for:

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1 INTRODUCTION

The purpose of this report is to present the results of a hydraulic, sediment transport, and scour analysis that was performed to provide data for the design of a bank protection system for a proposed levee along the north-bank of the Salt River, between the Pima Freeway Bridge and Alma School Road. This levee system will be located on land owned by the Salt River Pima Maricopa Indian Community (SRPMIC). The study reach is shown in Figure 1.1. Although the exact upstream termination point of the levee is unknown at the present time, the levee will not extend upstream of the Alma School Road Bridge.

The proposed levee system will include a cement-stabilized alluvium (CSA) bank-lining material to prevent an erosion failure resulting from flow in the Salt River.

Specific objectives of this study are to:

1. provide recommended toe-down elevations for the CSA bank protection system.

2. provide recommended top-of-bank elevations that will prevent the CSA system from being overtopped during the 100-year, 10-day flow event in the Salt River.

To be consistent with the previously approved sediment transport and scour analysis that was prepared by Robert L. Ward, P.E. Consulting Engineer for the Red Mountain Freeway bank stabilization system along the south bank of the river, the same engineering methodologies and technical approach have been adopted for this north-bank study. The Ward study is published in the following two documents:

1. **Sediment Transport Analysis, Salt River, Red Mountain Freeway, McKellips Road to Dobson Road**, September 15, 1995.

2. **Sediment Transport Analysis, Salt River, Red Mountain Freeway, Supplement No. 1, McKellips Road to Country Club Drive**, October 3, 1996

The following sections of this report present a technical discussion of the engineering assumptions and methodologies that were used in the sediment transport and scour analysis for the proposed levee. The text for this report follows the same format and is, for the most part, identical to the same text from the 1995-1996 Ward reports. Changes to the text of these previous reports have only been made to reflect specific features associated with the north-bank levee.

Section 4 of this report presents calculation summaries and design recommendations for the proposed levee.

Figure 1.1
Project Location Map

2 HYDRAULIC MODELS (HEC-2)

The HEC-2 models used in this study were based in-part on previous models developed by *Michael Baker, Jr., Inc.* (MBJ), *Simons, Li & Associates, Inc.* (SLA) and new data developed in July 1998 by R. Ward. The MBJ and SLA HEC-2 models were provided to the author of this report by *Wood, Patel & Associates, Inc.* (WPA) for use in the previously referenced 1995-1996 reports for the Red Mountain Freeway. The original HEC-2 modeling was performed by *Michael Baker, Jr., Inc.* (MBJ) in 1994 as part of a floodplain study. SLA reportedly made changes to the MBJ cross-sections downstream of the Pima Freeway bridge (see page 8, April 1994 report referenced below).

Certain revisions were also made to the MBJ files by WPA. WPA indicated that these revised files have been approved by the Arizona Department of Transportation (ADOT) and by the Flood Control District of Maricopa County (FCDMC) for use in this sediment transport and scour analysis. Specific HEC-2 modeling sources used in this current study are identified as follows:

1. McClintock Road (Grade Control No. 5) to upstream side of Pima Freeway bridge uses SLA model BASE.DAT (XSECs 20.5 through 42.1, see **Hydraulic And Sediment Transport Analysis Report, Salt River Bank Protection Design, South Bank Upstream Of Pima Freeway, Bank STA. 33+00 To 73+00**, April 1994).

2. Upstream side of Pima Freeway bridge to Alma School Road uses new cross-sectional geometry developed by R. Ward during July 1998. XSECs 224.33 through 226.32 were manually coded from April 1998 topographic mapping provided by SRPMIC. Cross-sectional geometry for XSECs 226.43 through 226.66 were electronically coded from February 1997 topographic maps provided by *Kimley-Horn & Associates, Inc. (KHA).*

3. All modeling data upstream of the Alma School Road bridge was taken from the MBJ models, with minor modifications as outlined in the previous 1995-1996 Red Mountain Freeway studies.

Topographic maps showing the WPA/MBJ cross-section locations referenced in this report are included as Plates 1, 2, and 3. Plates 4 and 5 present the proposed SRPMIC north-bank levee control-line superimposed on the 1998 topographic mapping provided by SRPMIC. Plate 6 shows a portion of the 1997 Kimley-Horn and Associates topography that was used to code the cross-sectional geometry for XSECs 226.43 through 226.66. The levee control-line on Plates 4 and 5 was provided by Premier Engineering Corporation.

To date, efforts to retrieve copies of the topographic mapping (and HEC-2 cross-section locations) used in the April 1994 SLA study have been unsuccessful. However, Figure 1 of the April 1994 SLA report does show HEC-2 cross-section locations superimposed onto an aerial photograph of the Salt River. The cross-section numbers on this Figure appear to match those in the SLA HEC-2 model (BASE.DAT). Figure 1 from the SLA report is enclosed in this report as Plate 7.

Two HEC-2 models were created for use in this report from the referenced topographic mapping. The first model, SRP1HC2, reflects the actual cross-sectional geometry coded from the topographic maps. The second model, SRP2HC2, reflects minor filling of dry gravel pit excavations at XSECs 225.66, 225.75, 225.94, and 226.03. The reason for filling these pits is discussed in Section 3.3 of this report. Model SRP2HC2 was used for the HEC-2 hydraulic analysis discussed in this report.

3 SEDIMENT TRANSPORT & SCOUR ANALYSIS

A sediment transport analysis was conducted for the proposed levee in order to examine the potential for sediment deposition impacts to the design water surface profile and for potential undercutting of the bank-lining by scour processes. The following sections address the mechanics of both short-term, single-event bed scour and long-term bed-slope adjustments. Section 3.3 discusses the issue of gravel pits being located adjacent to the levee, while water surface profile fluctuations, associated with moveable-bed geometry, are addressed in Section 4.3.

3.1 Scour Analysis (Non-Gravel Pit Environment)

The design of an erosion resistant bank protection system must consider the potential for scour of the channel bed, if the bed is to be left in a natural condition. Failure to do so could lead to the toe of the bank protection material being undercut by scour processes that will be induced by flowing water. Should this situation occur, the bank-lining material may collapse into the scour hole, thus exposing the bank to erosive velocities and possible lateral movement.

Vertical incisement of the channel bed can occur in response to the following six processes:

$$Z_{tot} = Z_{deg} + Z_{ls} + Z_{gs} + Z_{bs} + Z_{i} + Z_{bf} \quad \text{(Equation 3.1)}$$

where Z_{tot} = total vertical adjustment in bed elevation

Z_{deg} = vertical change due to long-term degradation

Z_{ls} = vertical change due to local scour

Z_{gs} = vertical change due to general scour

Z_{bs} = vertical change due to bend scour

Z_{i} = vertical change due to low-flow incisement

Z_{bf} = vertical change due to bed-form troughs

A brief discussion of each of these phenomena, and its applicability to this project, is presented in the following sub-sections.

3.1.1 Long-Term Degradation

Sediment transport analyses need to distinguish between short-term and long-term changes. Short-term changes are event-specific and occur to some extent during each flood hydrograph. Referring to Equation 3.1, examples of short-term changes would be local scour, general scour, bend scour, bedform troughs, and to some extent, low-flow incisement. With the exception of low-flow incisement, any visible signs of these processes may be difficult to detect after the flow has subsided.

Long-term degradation occurs over a long period of time in response to an imbalance between the sediment transport capacity of the channel and the dominant sediment supply to the channel. When such imbalances occur, the channel will naturally adjust its slope to restore equilibrium between the transport capacity and incoming supply of sediment. If the transport capacity of the channel exceeds the sediment supply, the channel will flatten its slope (degrade). However, should the sediment supply exceed the transport capacity of the channel, the channel slope will increase (aggrade) in order to generate higher velocities that are capable of moving the sediment inflows.

Long-term degradation is very difficult to quantify because of the many complex variables that drive this process. Accordingly, numerous assumptions have to be made on the basis of engineering judgment.

Long-term degradation (and/or aggradation) are normally evaluated with an equilibrium slope analysis. Such an analysis requires that a known or assumed scenario of river or watershed changes will occur and be in existence for an adequate time frame for the river system to re-establish equilibrium with such changes.

Since this reach of the Salt River is undergoing active gravel mining, there is no way that a constant set of river system changes can be assumed for conducting an equilibrium slope analysis, i.e., the equilibrium target is changing on a daily basis, and will probably continue to do so for many years to come. Accordingly, an equilibrium slope analysis is not considered practical for this reach of the Salt River.

As a matter of technical interest, the 1994 SLA report did conduct an equilibrium slope and armoring analysis for that reach of the Salt River between McClintock Drive and Alma School Road. This reach includes the SRPMIC north-bank levee alignment being addressed in this current study.

The SLA study published an equilibrium slope of 0.00047 ft/ft, which was pivoted about Grade Control #5, which is located just downstream of McClintock Drive. The SLA report also listed a computed armoring size of 24-mm (0.94"), and an associated armoring depth of 0.3-feet, for the 10-year peak discharge of 95,800 cfs. SLA compared this armoring depth to the theoretical equilibrium slope depth and used the lesser of these two depths to determine the long-term degradation component in Equation 3.1.

For the purpose of continuity with the approved SLA report, the published equilibrium slope of 0.00047 ft/ft, and the Q_{10} armoring depth of 0.3-feet, will also be compared in this report for a prediction of long-term degradation through the current study reach. Since there are no other riverbed "hard-points" between McClintock Drive and Alma School Road, Grade Control #5 will be used as the pivot point for projecting the equilibrium slope to Alma School Road.

3.1.2 Local Scour

Local scour will occur in response to objects being placed in the path of flowing water. The most common form of local scour is that occurring at bridge piers and protruding bridge abutments or spur dikes. This process would be applicable to bridge piers at the Alma School Road crossing of the Salt River. However, since the SRPMIC north-bank levee will terminate downstream of this bridge, the north-bank levee will not be in the pier scour envelope. Accordingly, local scour calculations were not required for this study.

3.1.3 General Scour

This scour process occurs in response to changes in river geometry and/or bed-slope from one reach of a river to the next. As the river cross-section contracts and expands, its flow velocity (and thus sediment transport capacity) will change. General scour will occur when a channel contracts (in the downstream direction) and causes an increase in velocity through the contracted section. The increase in sediment transport capacity through the contracted reach will begin to remove more sediment from the bed of the contracted reach than is being delivered to the contraction by the wider, upstream reach. The result is a lowering (general scour) of the channel bed through the contracted reach. When the channel geometry expands in the downstream direction, the opposite effect can occur, i.e., sediment deposition will take place in the wider channel section. However, sediment deposition can also take place if an artificially constricted channel is subjected to larger sediment inflows than it can transport.

General scour, and/or sediment deposition, is usually quantified with a mobile-boundary sediment routing model, such as HEC-6. Such models are capable of predicting scour and deposition patterns as a function of bed-material size, channel geometry, bed-slope, and changes in discharge that occur during passage of a specific flood hydrograph. Section 3.2 of this report provides a detailed discussion on the sediment routing model that was created to quantify the general scour contribution to the total scour depth for the bank-lining design.

3.1.4 Bend Scour

As the name implies, this process only occurs in the vicinity of channel curvature. For this study, the magnitude of bend scour was completed with the following equation (ADWR, 1985):

$$Z_{bs} = \frac{0.0685 Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right] \quad \text{(Equation 3.2)}$$

where Z_{bs} = depth of bend scour (ft)

V = mean velocity of upstream flow (fps)

Y = maximum depth of upstream flow (ft)

Y_h = hydraulic depth of upstream flow (ft)

S_e = upstream energy slope (ft/ft)

alpha = angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)

Depth and velocity data for the bend scour calculations were taken from HEC-2 File SRP2HC2. Curvature angles were measured from the MBJ topographic mapping and are listed in the scour calculation table in Section 4.2.

Engineering judgment was used to taper-off the bend scour depths through the downstream end of the channel curvature near XSEC 226.03. The length of bend scour decay beyond this cross-section was computed as 1,121-feet. This would place the end of the bend scour component between XSECs 225.75 and 225.85. Accordingly, the bend scour angle of curvature was decreased through these two XSECs to force a gradual reduction in bend scour from 8.03-feet at XSEC 226.03 to 0-feet at XSEC 225.75.

The approximate downstream limit of the bend scour component was computed with Equation 3.3 (ADWR, 1985):

$$X = 2.3 \left(\frac{C}{\sqrt{g}} \right) Y \quad \text{(Equation 3.3)}$$

where X = distance from the end of channel curvature (point of tangency) to the downstream point at which secondary currents have dissipated (ft)

C = Chezy coefficient

Y = maximum depth of flow within the bend (ft)

g = 32.2 feet/second^2

3.1.5 Low-Flow Incisement

Man-made channels with large width to depth ratios are very vulnerable to the formation of low-flow channels. When trapezoidal channels, designed to carry large events such as the 100-year flood, are exposed to smaller, more frequent flows (2- to 5-year floods), the wide channel bottomwidths may cause a shallow sheetflow condition to exist. Rather than transporting small flows in this manner, nature will incise a low-flow section (similar to manmade pilot channels in wide trapezoidal sections) that provides a more hydraulically efficient conveyance for small discharges.

Low-flow channels will meander across the bottom of the larger, parent channel, thus randomly coming into contact with the channel banks. Accordingly, it is important to acknowledge low-flow incisement when computing the total scour depth for bank-lining design.

That reach of the Salt River extending for approximately 1.6 miles upstream from the Pima Freeway bridge has recently been graded to a relatively level bottom. Accordingly, there is potential for low-flow incisement to occur within this reach. This potential has been acknowledged in the scour calculations by including a 1.5-foot low-flow incisement depth in the cross-sections that are located within this region (XSECs 224.33 through 225.85).

Areas upstream of this reach exhibit effects of gravel mining and head-cutting. Accordingly, no practical low-flow incisement depth could be assigned to these areas. The existing head-cut through this upstream region essentially accounts for low-flow incisement.

3.1.6 Bed-Form Troughs

Sand and gravel-bed channels are prone to the development of transitory bedforms, such as dunes and antidunes. Such bedforms create troughs, or depressions, below the natural bed of the channel during the flow event. In order to account for the possibility of these troughs forming adjacent to the toe of the bank, it is prudent to include bedform troughs in the estimate of total scour. Although this reach of the Salt River has a very cobbly bottom, which may tend to inhibit the full development of bed-forms, calculations were performed in order to include this scour component in the toe-down design for the proposed levee embankment.

Based on laboratory flume studies, the maximum depth of antidune troughs (below the existing channel bed) is approximately equal to $\underline{0.0135V^2}$ or one-half the depth of flow, whichever value is less (ADWR 1985).

For lower regime flow, dune heights can be estimated from the following relationship (Simons & Senturk, 1977):

$$\log d = 0.8271 \log A + 0.8901 \quad \text{(Equation 3.4)}$$

where d = mean flow depth (meters)

A = dune height, from trough to crest (meters)

Table 4.1 (in Section 4.2 of this report) presents a quantitative summary of the preceding scour processes and recommended scour depths that should be applied to the bank-lining toe-down design. It should be noted that the total scour depths include a safety factor of 1.5. A minimum scour depth criteria of 10-feet is also applied to all locations.

3.2 Sediment Routing Model (HEC-6)

As discussed in Section 3.1.3, the general scour and sediment deposition process is an event-specific analysis that is most accurately performed with a mobile-boundary sediment routing model. Accordingly, the Corps of Engineers HEC-6 Program, Version 4.1.00, October 1993, was used to analyze the sediment transport performance of this reach of the Salt River.

Due to the split-flow condition in the vicinity of Alma School Road, separate HEC-6 models were created for the main channel and the smaller channel that flows around the south side of the island between McKellips Road and Alma School Road. The model for the south channel was used for the Red Mountain Freeway analysis, but was not used for the proposed north-bank levee, which is the focus of this study.

In addition to cross-sectional geometry, required input data for HEC-6 consists of a flood hydrograph, a sediment supply rating curve, a bed-material gradation, and the selection of a sediment transport equation. HEC-6 uses this information to compute hydraulic data and sediment transport rates for discrete intervals of time throughout the inflow hydrograph. The incoming sediment load is also computed for each hydrograph interval and introduced to the model at the most upstream cross-section.

The difference in sediment inflow and sediment transport is computed for the upstream control section and any imbalance between the two quantities is converted to a sediment volume and distributed within a *"control reach length"* that is a function of adjacent cross-section spacing. If the sediment inflow exceeds the channel transport rate, then sediment deposition occurs and the channel bed is adjusted upward to reflect the excess volume of material. If the reverse condition occurs, then scour will result in a lowering of the bed elevation.

The difference between actual sediment transport rate and incoming sediment load at the first control section becomes the sediment supply to the next downstream control section. This process is repeated until the downstream end of the model is reached. The next interval of the hydrograph is then introduced and the entire calculation sequence is repeated.

The Meyer-Peter and Muller (MPM, 1948) sediment transport equation was used for this study. This equation is recommended for streams with relatively coarse bed-material and very little suspended bed-material load. The cobbly bottom of the Salt River and the sediment trap efficiency of upstream SRP dams would seem to support these assumptions for the study reach addressed in this report. The MPM equation was also used in the sediment routing model prepared by SLA for the adjacent downstream reach of the Salt River, although it was integrated with Einstein's procedure for suspended bed-material load. Einstein's procedure is not an available option in HEC-6.

The following sub-sections discuss specific elements of the input data developed for the HEC-6 models presented in this report.

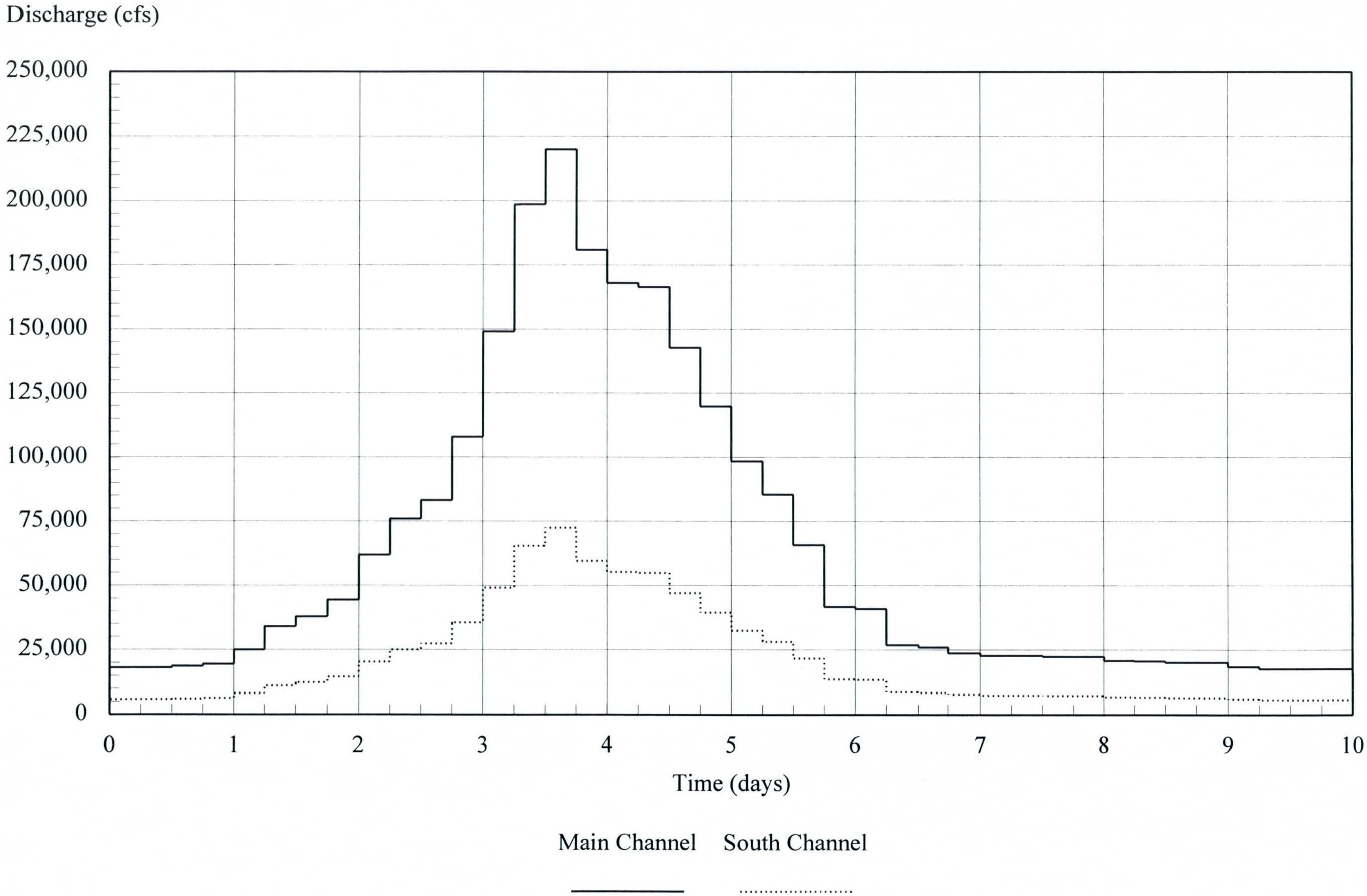
3.2.1 Flood Hydrograph

The hydrograph used for the sediment routing model was identical to that used in the previously referenced 1994 SLA report. The hydrograph coordinates, which were provided to Wood-Patel by SLA, reflect a 100-year, 10-day flood with a peak discharge of 220,000 cfs for the main channel of the Salt River.

The split-flow hydrograph for the south channel (around the Alma School Road island), was created by reducing all the main channel hydrograph ordinates by a ratio of 0.3295. This reduction constant is based on the ratio of the peak south channel discharge to the peak main channel discharge, i.e., 72,500/220,000. The peak south channel discharge was identified from a split-flow analysis performed by Wood-Patel.

Figure 3.1 presents a plot of the main channel and south channel hydrographs that were used with the HEC-6 model. The peak discharges used for the main channel hydrograph

Figure 3.1
100-Year Discretized Hydrograph
Salt River - SRPMIC North-Bank Levee



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were reduced between XSECs 226.13 through 226.89 to reflect the loss of flow through the south channel.

The main channel starting water surface elevations for each interval of the discretized hydrograph were taken from HEC-2 file WSL2 at XSEC 224.33, which is the downstream end of the HEC-6 models prepared for this study. File WSL2 is HEC-2 file SRP1HC2 with all cross-sections eliminated upstream of XSEC 224.33. Multiple profile runs were made for discharges ranging from 17,000 to 237,000 cfs, at 20,000 cfs intervals. The resulting water surface elevations were used to input an elevation/discharge relationship to the HEC-6 model.

3.2.2 Cross-Section Data

HEC-2 file SRP1HC2, previously referenced in Section 2.1 of this report, was used to provide the initial river geometry for the HEC-6 model. The GR data and encroachment stations from this model were visually reviewed with the PLOT2 subroutine in HEC-2 in order to verify that overbank gravel pit areas were not being used in the hydraulic calculations.

In addition to specifying effective flow boundaries for hydraulic calculations, HEC-6 also provides the capability to specify the horizontal limits of the moveable-bed geometry. This is an important feature which allows the user to exclude overbank areas which would not reasonably be expected to contribute to the scour or deposition process in a river.

For this study, moveable-bed limits were based on a visual review of PLOT2 cross-sections. Using this visual illustration of the river geometry, the moveable-bed width was generally set to coincide with the toe of the slope of the main channel bank-lines.

The allowable depth of scour within the moveable-bed width was set at 10-feet, except at grade control structures, which were modeled with a hard bottom.

In addition to cross-sectional geometry, cross-section spacing is also an important parameter in sediment routing calculations. The length of the control volume that HEC-6 uses for sediment transport calculations is defined as the distance between a point located halfway between the current cross-section and the adjacent upstream cross-section and the adjacent downstream cross-section. Irregular cross-section spacing will cause this control section length to vary along the length of the river. Such irregular spacing will result in errors in the bed-level changes that HEC-6 computes for each hydrograph interval. For example, bed-material may be scoured from a control section that is 800-feet long and transported to an adjacent control section that is only 200-feet long. Assuming equal bed-widths and hydraulic parameters within each section, the transported material from the 800-foot section will have a much smaller downstream surface area available for the distribution of any excess sediment. This would result in a larger depth of sediment deposition than would occur if the downstream control section were also 800-feet long.

The cross-section spacing in the MBJ HEC-2 models, provided by Wood-Patel, was found to be fairly uniform in the 500- to 600-foot range. Although there was some irregularity in the cross-section spacing, it was not considered severe enough to cause any major calculation errors. The new cross-sectional geometries coded by R.Ward (for that region downstream of Alma School Road) were spaced at about 500-feet apart.

It should be noted that the bridge cross-sections at Alma School Road were eliminated from the HEC-6 model. These sections were eliminated because of the short cross-section spacing and because HEC-6 cannot accept bridge routines used in HEC-2. XSEC 226.66 was added just downstream of the Alma School bridge location (north channel only) in order to promote uniform cross-section spacing to MBJ XSEC 226.61, which is located just upstream of the Alma School Road bridge.

3.2.3 Bed-Material Gradation

The bed-material gradation used for the HEC-6 model was the same as that used by SLA for the sediment routing model through the adjacent downstream reach of the Salt River. No additional sampling information was available which was considered to be anymore reliable than that used in the 1994 SLA report.

Although *AGRA Earth & Environmental, Inc.* did perform bed-material sampling at four locations within the study reach, the sampling was limited to the existing surface armor layer and was not representative of material below the armor layer. Accordingly, this information was not considered suitable for use in the HEC-6 model.

Table 3.1 summarizes the sediment gradation data taken from the 1994 SLA report. The data in Table 3.1 is plotted in Figure 3.2.

3.2.4 Sediment Supply

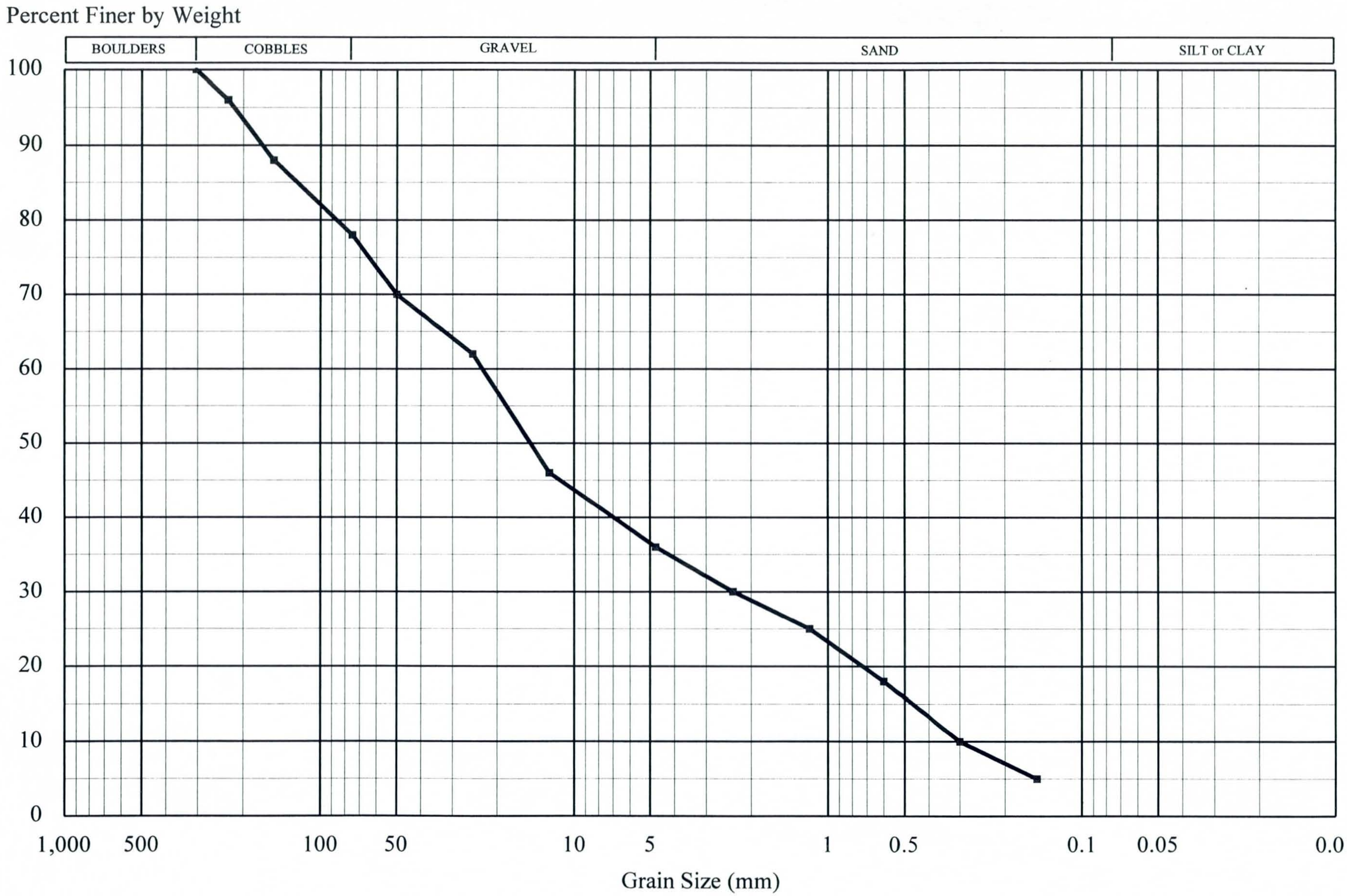
A required input parameter for a sediment routing model is an estimate of the sediment load being supplied to the upstream end of the model.

The sediment load table for the main channel was developed through an iteration process that assumes a cross-section at the upstream end of the model is being supplied sediment at a rate that is in equilibrium with the theoretical transport rate of the cross-section. Using an initial guess of the inflowing sediment load for a specific water discharge, HEC-6 will compute the sediment load, in tons/day, for each size fraction in the given

Figure 3.2

Sediment Gradation For Salt River Bed-Material

SRPMIC North Levee - Pima Freeway Bridge to Alma School Road



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bed-material gradation. This information is then used to compute an updated sediment transport potential for each size fraction. This updated size fraction data is entered on the

Table 3.1
Sediment Gradation For HEC-6 Modeling
Country Club Drive to Evergreen Road
Salt River

Particle Size (mm)	Cumulative Percent Passing (%)
0.15	5.00
0.30	10.00
0.60	18.00
1.18	25.00
2.36	30.00
4.75	36.00
12.50	46.00
25.00	62.00
50.00	70.00
75.00	78.00
152.40	88.00
228.60	96.00
304.80	100.00

LF record and the model is re-run. This iteration process is continued until the computed fraction of the total sediment load for each grain size matches that which is input to the model.

The first step in this iterative process identifies the fraction (or percentage) of each grain size contributing to the total sediment load for a given discharge, e.g., for Q = 25,000 cfs, 2.8% of the total sediment load might be composed of fine gravel (4-8mm), 4.5% of coarse gravel (16-32mm), etc.

Once the transport potential for each sediment size fraction has been determined for a range of water discharges, the total sediment load curve is developed to relate water discharge (cfs) to total sediment discharge (tons/day). In order to estimate the total sediment load curve, different sediment loads (tons/day) were input to the model until a load rate was found which produced very little vertical bed movement (at the upstream end of the model) over a 10-day flow period. The load rate that produced this minimal bed movement was assumed to be in equilibrium with the transport rate at the upstream end of the model. This process was repeated for each water discharge used to define the sediment load curve.

Figure 3.3 illustrates the sediment load relationship that was developed using this procedure. This figure also shows a power regression curve that was fit to the actual data points in an effort to provide a more uniform sediment load relationship at the upper end of the flood hydrograph. Experimental runs with the HEC-6 model indicated that there was very little difference in bed level changes when changing the sediment load table from the actual data points to the regression curve values. Accordingly, the actual computed sediment load data points were used for the final HEC-6 runs, rather than the predicted regression curve values.

Any errors in the upstream sediment load curve are "washed out" within a few cross-sections, as the model becomes controlled by the actual sediment transport rates and sediment movement through the downstream control sections.

It should be noted that the sediment load curve that was developed for the original September 15, 1995 Red Mountain Freeway scour analysis was updated in 1996 as part of the supplemental study **Sediment Transport Analysis, Salt River, Red Mountain Freeway, Supplement No. 1, McKellips Road to Country Club Drive**, Robert L. Ward, P.E., October 3, 1996. This updated sediment load curve was used for the SRPMIC north-bank levee analysis.

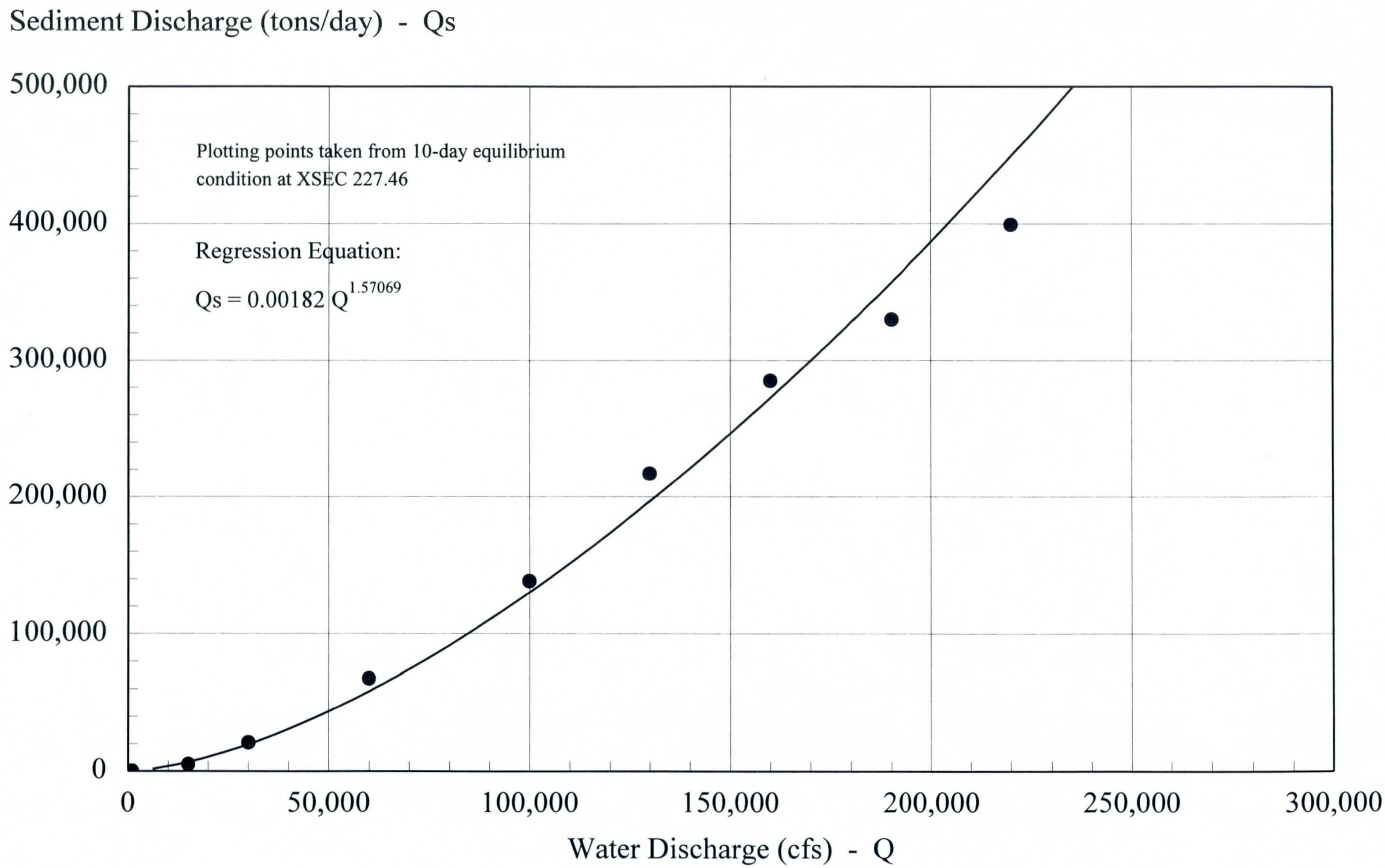
The <u>only change</u> that was made to the original 1995 HEC-6 parameters, in preparing the 1996 supplemental study, was a revision to the sediment supply data that is input at the upstream end of the model. The total sediment load versus water discharge relationship (LT record) was <u>not</u> changed from the previous 1995 study. However, the sediment transport potential for each bed-material grain size (LF records) that would be in transport during various stages of the 100-year, 10-day hydrograph was changed. The LF records tell the HEC-6 model what percentage of the total inflowing sediment load to allocate to each grain size classification.

The calculations for establishing grain size transport potential are dependent on the cross-sectional geometry and hydraulics of the river section that is used for the upstream sediment supply calculation. The September 15, 1995 study used data associated with XSECs 227.46 and 227.56, which are located immediately downstream of the Country Club Drive Bridge. With the easterly extension of the Red Mountain Freeway, the HEC-6 model was extended to Mesa Drive. Accordingly, calculations for grain size transport potential were updated to reflect the geometry and hydraulics of XSECs 229.12 and 229.21, which are located immediately downstream of Mesa Drive. Since this new location exhibits different hydraulic characteristics than that below Country Club Drive,

Figure 3.3

SRPMIC North Levee Along Salt River

Upstream Sediment Load Curve



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the distribution of sediment sizes within the total inflowing sediment load will change. Accordingly, the LF records were updated to reflect this change.

Consideration was also given (in 1996) to updating the total sediment load versus water discharge relationship (LT record) to reflect this new upstream location. However, the initial runs of the model with the original LT record, and the updated LF records, revealed a very stable bottom profile at the upstream end of the model during passage of the 100-year, 10-day hydrograph, e.g., less than 4-inches of vertical bed movement occurred at XSECs 229.12 and 229.21 during the flood. These near-equilibrium starting conditions are justification for accepting the original LT record for this extended HEC-6 analysis.

Since HEC-6 is not capable of processing bridge routines used in the HEC-2 model, the 1996 supplemental report also removed bridge cross-sections at Country Club Drive, i.e., XSECs 227.61, 227.62, 227.63, and 227.64 were deleted from the HEC-6 model.

Except for updating the cross-sectional geometry between the Pima Freeway and Alma School Road bridges, no other changes were made to the HEC-6 input data that was presented in the October 3, 1996 report for the Red Mountain Freeway.

As stated previously, a separate HEC-6 model was created (as part of the 1995 Red Mountain Freeway report) to evaluate that portion of the south channel located between Alma School Road and McKellips Road. It is difficult to identify with any certainty how much of the main channel sediment load would be diverted into the south channel. Accordingly, two scenarios were created in order to examine a probable sediment load envelope for this split-flow location.

As a worst-case condition, the first scenario assumed none of the main channel sediment would enter the south channel. This would create a "clear-water" inflow condition which would be expected to induce the maximum scour profile through the south channel.

The second condition assumed that the sediment concentration in the south channel would be the same as that in the main channel. Under this scenario, the sediment size fractions for the south channel are assumed to be transported in the same ratios (for a given water discharge) as used in the main channel. However, the inflowing sediment load (tons/day) from the main channel to the south channel was reduced by the ratio of the peak discharge in the south channel to that in the main channel, i.e., 72,500/220,000 = 0.3295.

The following section provides a more in-depth discussion of how sediment diversions were handled around the Alma School Road "island".

3.2.5 Special Considerations Near Alma School Road

The sediment routing analysis in the vicinity of the Alma School Road bridge is complicated by the following factors:

1. A large gravel pit is located immediately downstream of the Alma School Road bridge over the south channel (not applicable to SRPMIC north-bank analysis).

2. A split-flow condition occurs around an island at Alma School Road.

3. Concrete grade control structures have been built at both the north and south bridge crossings on Alma School Road to halt headcutting that has occurred in response to downstream gravel mining operations.

Some engineering judgment was required in order to configure the HEC-6 model to address these features without causing unreasonable fluctuations in the hydraulic calculations. These modeling techniques are discussed in the following sub-sections.

3.2.5.1 Split-Flow Analysis

No attempt was made to apply HEC-6 to the large gravel pit that captures the outflow from the south channel. However, the existence of this pit was used to justify an assumption that no sediment flows will enter the main channel from the south channel. This gravel pit is assumed to provide 100-percent trap efficiency for any sediments transported into the pit by flows diverted through the south channel.

This split-flow condition is simulated in the HEC-6 model for the main channel by adding a local inflow point just upstream of XSEC 226.03 and a local diversion point at XSEC 226.89. For the main channel model, the water flow between these two cross-sections is reduced by the amount of water flowing through the south channel. The sediment flow diverted from the main channel at McKellips Road is computed by HEC-6 on the basis of the diverted water discharge and on an assumption of equal sediment concentrations existing in the main channel flow and diverted flow. This diverted sediment load is not allowed to re-enter the model at XSEC 226.03, i.e., it is trapped in the gravel pit. However, the diverted water discharge is returned to the model at XSEC 226.03.

3.2.5.2 Main Channel Headcut

Although the following paragraphs have no impact on the SRPMIC north-bank levee design, they are included in this report for continuity with the previous study for this reach of the Salt River.

As a result of in-stream gravel mining that was initiated downstream of Alma School Road in the mid-1980s, a large headcut has moved up the river-bed and lowered the main channel-bed through the Alma School Road bridge. A concrete grade-control structure has been built at the bridge to prevent any further channel degradation that might jeopardize the stability of the bridge piers.

This grade-control structure creates an abrupt vertical drop in the riverbed profile at the downstream side of the bridge. In accordance with instructions from ADOT (as part of the 1995 Red Mountain Freeway sediment transport analysis), this grade-control structure was assumed to remain intact during the 100-year, 10-day flow event being analyzed in this report.

Since HEC-6 does not have a bridge analysis routine, the Alma School Road HEC-2 bridge coding was not included in the HEC-6 model. An additional cross-section (XSEC 226.66) was inserted in the HEC-6 model, just downstream of the grade control structure, to promote uniform cross-section spacing through the bridge. In order to simulate the effect of the concrete grade control structure on the upstream channel bed-profile, XSEC 226.61 was coded as a "hard bottom" so that no scour could occur at this location. All sections upstream of XSEC 226.61 were left with soft bottoms.

3.3 Gravel Pit Analysis

Numerous remnants of recent in-stream gravel mining are visible through that reach of the Salt River that extends from the Pima Freeway Bridge to Alma School Road. The April 1998 topographic mapping shows several lakes in the riverbed which are assumed to be water-filled gravel pits. This mapping also shows several dry depressions in the riverbed, which would indicate that excavation has previously taken place.

Design criteria for evaluating in-stream gravel pits was previously published in a July 29, 1992 letter from Simons, Li & Associates, Inc. (SLA) to Daniel, Mann, Johnson & Mendenhall (DMJM). The criteria in this letter was approved by the Flood Control District of Maricopa County (FCDMC) via letter dated August 11, 1992 from Donald J. Rerick, to Thomas M. Monchak, DMJM. Both of these letters were included in Appendix IV to the previously referenced 1994 SLA report.

The 1992 letter indicated that scour dimensions associated with in-stream mining would be estimated from relationships published in **"Investigation of Gravel Mining Effects, Salt River Channelization Project At Sky Harbor International Airport"**, Colorado State University (CSU), December 1980.

The three design conditions outlined in the 1992 letter are summarized as follows:

1. If gravel pits are located within 150-feet of the bank, fill will be required and the total scour depth will be the sum of the normal scour depth plus a lateral migration depth component. The toe-down depth will be extended at least 3-feet below the point where the fill meets the existing channel invert.

2. If gravel pits are located between 150 and 300-feet of the bank, no fill will be required and the total scour depth will be the sum of the normal scour depth plus a lateral migration component.

3. If gravel pits are located beyond 300-feet from the bank, the total scour depth will be computed as the normal scour depth. This scenario assumes the bank is not within the scour envelope associated with the gravel pit.

Without knowing the depth of the existing water-filled pits, it is impossible to accurately apply the above criteria to an analysis of the proposed north-bank levee. This issue was discussed with representatives from SRPMIC on July 28, 1998. In order to isolate the proposed levee system from any increased scour potential associated with these pits, SRPMIC agreed to fill the pits to elevations to be specified in this report. The total scour depths in Table 4.1 of this report would then be referenced to the filled elevations of these pits.

Table 3.2 is a summary of the pre- and post-fill elevations for each XSEC through the study reach. The pre-fill elevations are referenced to the 1997-1998 mapping discussed in Section 2 of this report. These pre-fill elevations represent the low point in each cross-section, as read from the topographic mapping. In the case of the water-filled pits, the low-point is equal to the water surface elevation in each pit. In the case of dry pits, the low point is the actual bottom of the pit.

For the water-filled pits, the post-fill elevation is simply equal to the pre-fill elevation of the pit's water surface. In these cases, the pre- and post-fill elevations used in the HEC-2 and HEC-6 models are identical.

Post-fill elevation adjustments were only required at XSECs 225.66, 225.75, 225.94, and 226.03 for the dry pits. The pits at these four locations are small to moderate in size and have no significant impact on the river system hydraulics. The amount of fill recommended at these four locations ranges from 2 to 6-feet.

4 CALCULATION SUMMARY & RECOMMENDATIONS

The preceding sections of this report present discussions of the technical procedures and assumptions that were used to perform the scour analysis for the proposed SRPMIC north-bank levee that will extend from the Pima Freeway Bridge to just west of the Alma School Road

Table 3.2
Summary of Recommended Fill Elevations For Existing Gravel Pits
Proposed SRPMIC North-Bank Levee
Pima Freeway to Alma School Road

Levee Station In Feet	Applicable HEC-2/HEC-6 XSEC	Pre-Fill Thalweg Elevations (ft, MSL)	Post-Fill Thalweg Elevations (ft, MSL)	Difference (ft)	Comments
1,160	224.33	1150	1150	0	Water-filled pit, actual depth unknown
1,670	224.42	1150	1150	0	Water-filled pit, actual depth unknown
2,170	224.52	1150	1150	0	Water-filled pit, actual depth unknown
2,670	224.61	1152	1152	0	Water-filled pit, actual depth unknown
3,170	224.71	1152	1152	0	Water-filled pit, actual depth unknown
3,667	224.80	1152	1152	0	Water-filled pit, actual depth unknown
4,178	224.90	1154	1154	0	No pit
4,627	224.99	1154	1154	0	No pit
4,930	225.09	1152	1152	0	No pit
5,413	225.18	1152	1152	0	No pit
5,898	225.28	1154	1154	0	Water-filled pit, actual depth unknown
6,333	225.37	1154	1154	0	Water-filled pit, actual depth unknown
6,700	225.47	1154	1154	0	Water-filled pit, actual depth unknown
7,180	225.56	1156	1156	0	No pit
7,657	225.66	1150	1152	2	Small depression
8,142	225.75	1150	1152	2	Moderate depression
8,639	225.85	1156	1156	0	Water-filled pit, actual depth unknown
8,978	225.94	1150	1156	6	Moderate depression
9,272	226.03	1154	1156	2	Moderate depression
9,895	226.13	1158	1158	0	Begin headcut
10,404	226.23	1168	1168	0	No pit
10,928	226.32	1170	1170	0	No pit
11,809	226.43	1174	1174	0	No pit
12,468	226.54	1174	1174	0	No pit
13,153	226.66	1172	1172	0	No pit

Note: Pre-fill & post-fill elevations for water-filled pits are based on existing water-level elevations shown on topographic maps.

File: Gravel Pit Fill Summary.xls

Bridge. This final section of the report presents both tabular and graphical summaries of the calculation results and recommendations for the bank-lining toe-down and top of CSA embankment elevations for the levee design.

4.1 Results of HEC-6 Modeling

The HEC-6 output generates a summary of bed-profile and water surface profile changes for each time step at each cross-section. For the 34 time steps and 25 cross-sections used between the Pima Freeway and Alma School Road Bridges, 850 data sets were produced by the HEC-6 model for the 100-year, 10-day flood. Each of these data-sets had to be examined to find maximum and minimum bed profile and water surface profile fluctuations for each cross-section during each of the 34 time steps. This examination process was expedited by importing the HEC-6 output files into an EXCEL spreadsheet, where electronic data scans were performed to find maximum and minimum data points.

A copy of this spreadsheet is enclosed in Appendix A, which is composed of two data sets which show the scour or deposition dimension (feet) at each time step, as well as the adjusted bed profile elevation (feet MSL) for each time step. Summary columns are provided at the end of each data set to summarize the maximum and minimum conditions that occurred at each cross-section during the 10-day flow event. It should be emphasized that the scour and deposition elevations in Appendix A do not reflect the proposed filling of gravel pits at XSECs 225.66, 225.75, 225.94, and 226.03.

Figure 4.1 graphically illustrates the data in Appendix A in the form of bed-profile plots. This Figure shows the initial (pre-flood) bed profile, the maximum scour and deposition profiles that occur during the 10-day flood, and the bed-profile that occurs during the peak discharge of the 100-year, 10-day flood. The "X-axis" in Figure 4.1 reflects an extension of the HEC-6 XSECs into the proposed north-bank levee alignment. As a result, the HEC-6 XSECs are plotted as a function of their intersection points with the north-bank levee stationing. Several of the HEC-6 XSEC points are labeled in Figure 4.1.

Figure 4.2, which is a companion plot to Figure 4.1, shows the actual general scour and deposition depths which were generated by HEC-6. This Figure provides a more clear picture of the magnitude and location of vertical bed movement during the 100-year, 10-day flood. The large scour region that develops between XSECs 226.23 and 226.66 is in response to the steep bed-slope that causes a significant velocity increase through this region. The velocity profile is plotted in Figure 4.3.

Downstream of XSEC 226.23, the bed-slope flattens out and causes a corresponding drop in channel velocity. This drop in velocity accounts for the large sediment deposition between XSECs 226.23 and 225.56.

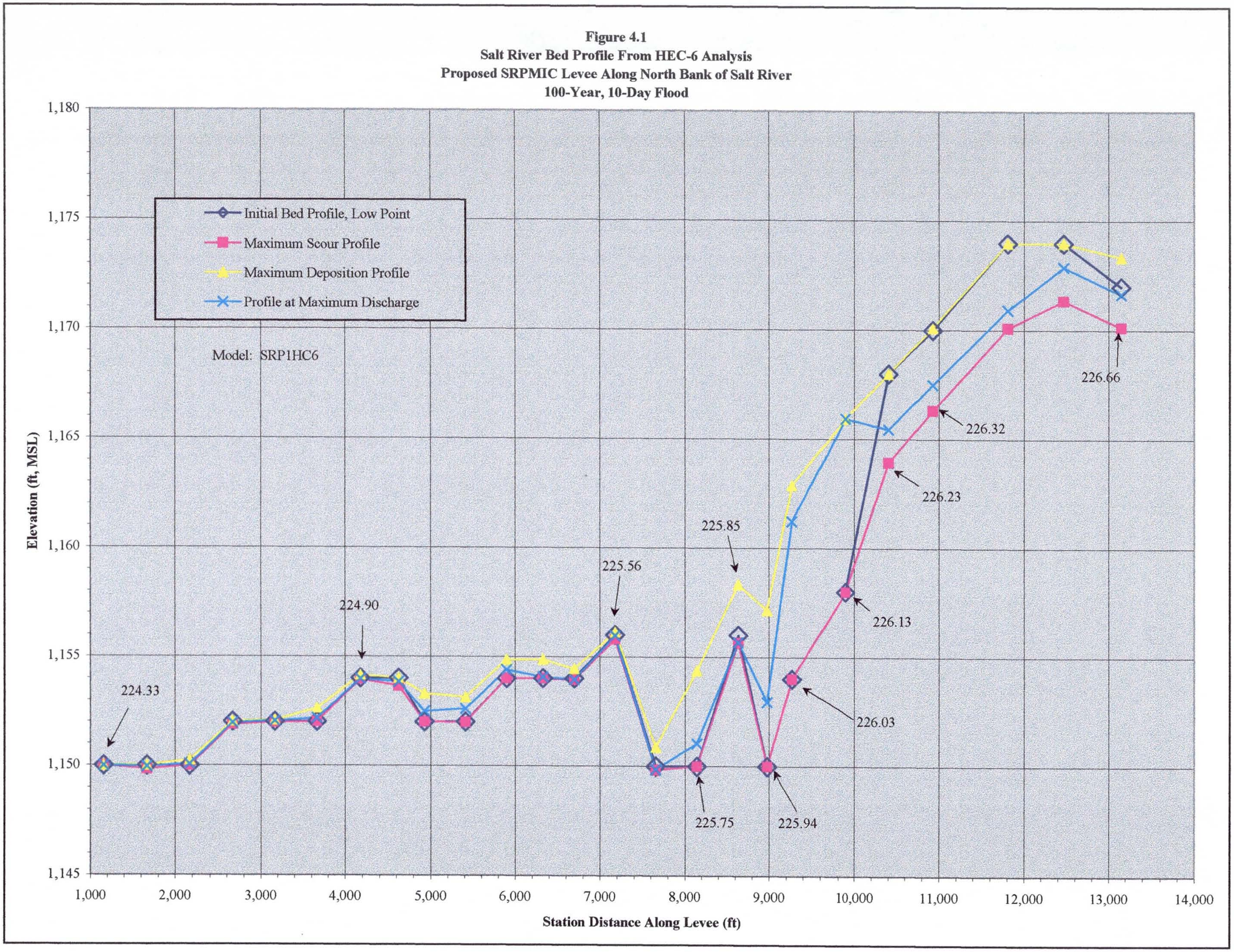


Figure 4.1
Salt River Bed Profile From HEC-6 Analysis
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood
Initial Bed Profile, Low Point
Maximum Scour Profile
Maximum Deposition Profile
Profile at Maximum Discharge
Model: SRP1HC6
Elevation (ft, MSL)
Station Distance Along Levee (ft)
1,180
1,175
1,170
1,165
1,160
1,155
1,150
1,145
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000
224.33
224.90
225.56
225.85
225.75
225.94
226.03
226.13
226.23
226.32
226.66

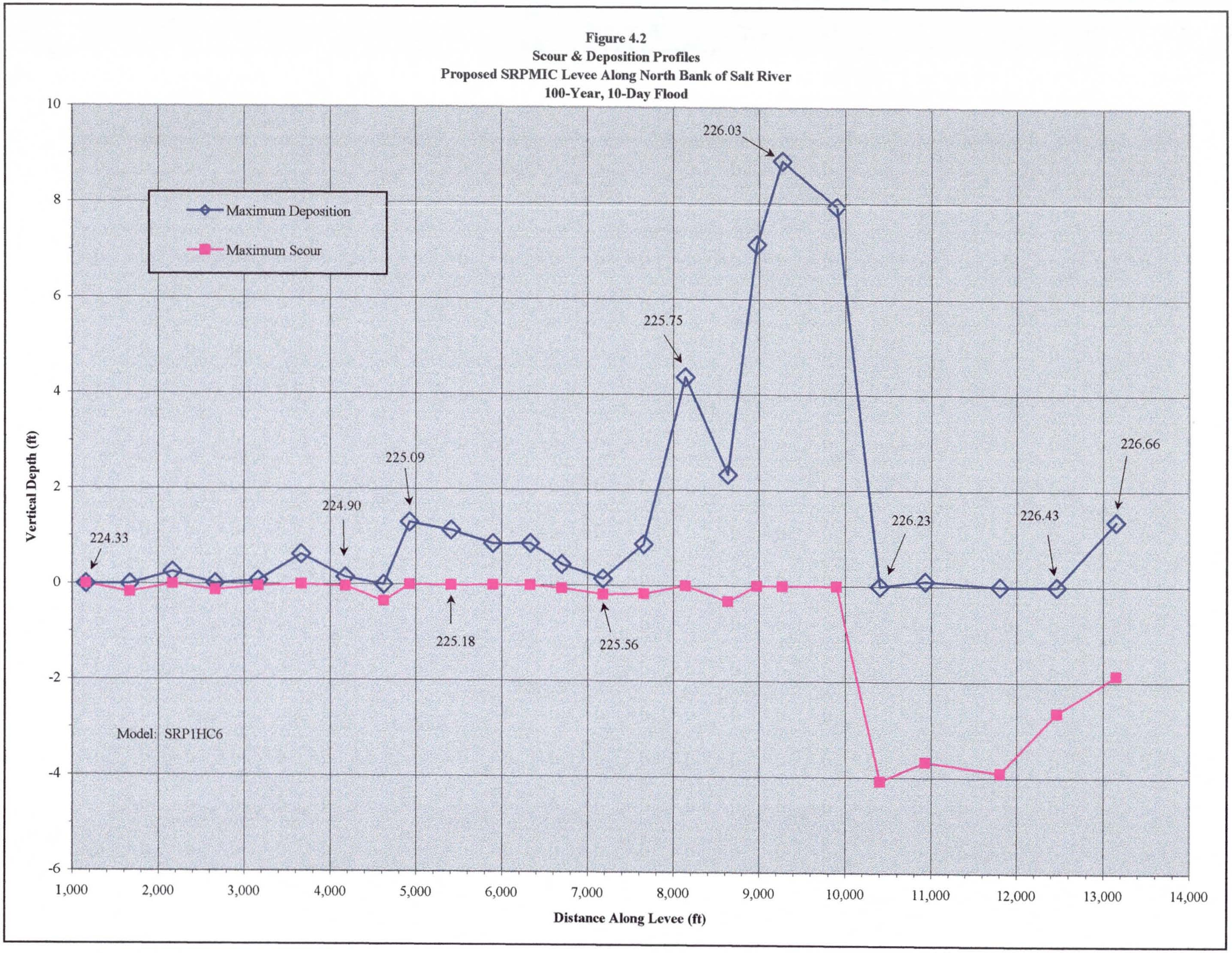
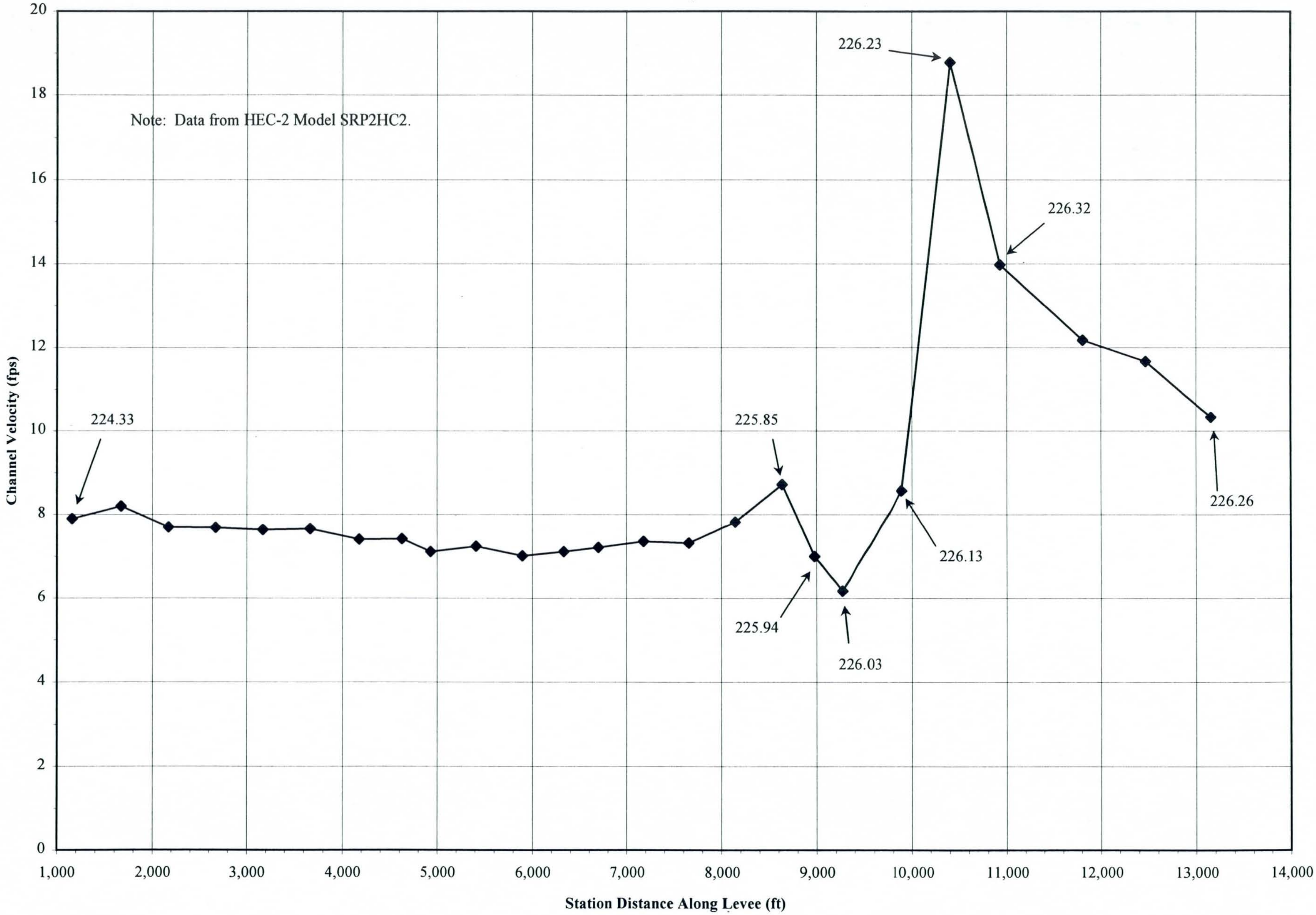


Figure 4.2
Scour & Deposition Profiles
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood
Maximum Deposition
Maximum Scour
Model: SRP1HC6
224.33
224.90
225.09
225.18
225.56
225.75
226.03
226.23
226.43
226.66
Vertical Depth (ft)
Distance Along Levee (ft)
10
8
6
4
2
0
-2
-4
-6
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
11,000
12,000
13,000
14,000

Figure 4.3
Velocity Profile for Peak 100-Year Discharge
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood



The bed-slope and velocity profile downstream from XSEC 225.56 remains relatively constant, which accounts for the minor amounts of vertical bed-movement through this downstream reach.

It should be emphasized that the HEC-6 bed-profiles shown in Figures 4.1 and 4.2 only reflect the general scour/depostion component in Equation 3.1. The remaining scour components in Equation 3.1 must be added to these profiles in order to arrive at the total scour depth.

4.2 Total Scour Summary

Table 4.1 provides a quantitative summary of all applicable scour components for that section of the main channel of the Salt River that lies adjacent to the proposed SRPMIC north-bank levee.

All elevation data listed in Table 4.1 is referenced to the respective topographic mapping that was used for the HEC-2 models described in Section 2 of this report.

The following comments are provided to assist the reader in following the calculation sequence in Table 4.1. A sample calculation sequence is provided in Appendix C.

- All hydraulic data required for calculation of scour components in Table 4.1, other than general scour, were taken from HEC-2 Model SRP2HC2.

- The long-term degradation component was based on the smaller of the equilibrium slope depth or the Q_{10} armoring depth. This is consistent with the 1994 SLA report. Equilibrium slope depths of "zero" indicate that the projected equilibrium slope elevation is at or above the low-point of a particular XSEC.

- The general scour dimensions in Table 4.1 were taken from HEC-6 model SRP1HC6.

- The "Total Computed Scour Depth" is based on Equation 3.1. Local scour is not included because the north-bank levee is not within a scour envelope of bridge piers or spur dikes. Once the proposed north-bank levee is in-place, the existing spur dike at the northeast side of the Pima Road bridge will no longer create a flow contraction that would warrant a local scour analysis.

- A safety factor of 1.50 is applied to the total scour depth to arrive at the "Maximum Scour Depth". This safety factor is based on FCDMC requirements. To provide consistency with the 1994 SLA report, a minimum scour depth of 10-feet is used at all cross-sections.

Table 4.1
Summary of Scour Analysis Calculations - Main Channel
Salt River Pima Maricopa Indian Community
North-Bank Levee Analysis - Salt River
Pima Freeway to Alma School Road

100-Year, 10-Day Flood

XSEC	Minimum Thalweg From SRP1HC2 Model (ft, MSL)	Maximum Flow Depth Between Encroachments (ft)	Channel Velocity (fps)	Water Surface Topwidth Between Effective Flow Boundaries (ft)	Wetted Area (sf)	Hydraulic Depth (ft)	Energy Slope ft/ft)	North Bank Angle of Curvature (alpha) (degrees)	Long-Term Degradation		Maximum General Scour (ft)	Bend Scour (ft)	Dune Troughs (ft)	Anti-dune Troughs (ft)	Low-Flow Incisement (ft)	Total Computed Scour Depth (ft)	Factor of Safety	Maximum Scour Depth With Safety Factor (ft)	Minimum Allowable Scour Depth (ft)	Recommended Toe-Down Elevation (ft, MSL)
									Based On Equil. Slope (ft)	Based On Q_{10} Armor Depth (ft)										
224.33	1150.00	30.74	7.90	993.00	27,856	28.05	0.000419	0	0.00	0.3	0.00	0.00	2.06	0.84	1.50	3.56	1.50	5.34	10.00	1140.00
224.42	1150.00	30.91	8.20	987.00	26,827	27.18	0.000473	0	0.00	0.3	0.17	0.00	2.07	0.91	1.50	3.74	1.50	5.62	10.00	1140.00
224.52	1150.00	31.26	7.70	1012.00	28,588	28.25	0.000396	0	0.00	0.3	0.00	0.00	2.10	0.80	1.50	3.60	1.50	5.40	10.00	1140.00
224.61	1152.00	29.46	7.69	1040.39	28,604	27.49	0.000409	0	1.08	0.3	0.13	0.00	1.96	0.80	1.50	3.89	1.50	5.83	10.00	1142.00
224.71	1152.00	29.68	7.64	1058.51	28,778	27.19	0.000410	0	0.85	0.3	0.04	0.00	1.97	0.79	1.50	3.81	1.50	5.72	10.00	1142.00
224.80	1152.00	29.89	7.66	1080.91	28,717	26.57	0.000424	0	0.61	0.3	0.00	0.00	1.99	0.79	1.50	3.79	1.50	5.69	10.00	1142.00
224.90	1154.00	28.15	7.41	1106.00	29,675	26.83	0.000392	0	2.38	0.3	0.04	0.00	1.85	0.74	1.50	3.69	1.50	5.54	10.00	1144.00
224.99	1154.00	28.35	7.42	1109.54	29,666	26.74	0.000393	0	2.14	0.3	0.35	0.00	1.87	0.74	1.50	4.02	1.50	6.03	10.00	1144.00
225.09	1152.00	30.61	7.11	1163.24	30,932	26.59	0.000364	0	0.00	0.3	0.00	0.00	2.05	0.68	1.50	3.55	1.50	5.32	10.00	1142.00
225.18	1152.00	30.79	7.24	1192.49	30,392	25.49	0.000398	0	0.00	0.3	0.01	0.00	2.06	0.71	1.50	3.57	1.50	5.36	10.00	1142.00
225.28	1154.00	29.03	7.01	1190.60	31,373	26.35	0.000358	0	1.44	0.3	0.00	0.00	1.92	0.66	1.50	3.72	1.50	5.58	10.00	1144.00
225.37	1154.00	29.20	7.11	1188.80	30,961	26.04	0.000374	0	1.20	0.3	0.00	0.00	1.94	0.68	1.50	3.74	1.50	5.60	10.00	1144.00
225.47	1154.00	29.38	7.21	1256.80	30,512	24.28	0.000425	0	0.97	0.3	0.06	0.00	1.95	0.70	1.50	3.81	1.50	5.72	10.00	1144.00
225.56	1156.00	27.58	7.36	1276.58	29,898	23.42	0.000464	0	2.73	0.3	0.19	0.00	1.81	0.73	1.50	3.80	1.50	5.70	10.00	1146.00
225.66	1152.00	33.82	7.32	1262.62	30,063	23.81	0.000451	0	0.00	0.3	0.17	0.00	2.31	0.72	1.50	3.98	1.50	5.97	10.00	1142.00
225.75	1152.00	33.97	7.82	1113.84	28,128	25.25	0.000476	0	0.00	0.3	0.00	0.00	2.33	0.83	1.50	3.83	1.50	5.74	10.00	1142.00
225.85	1156.00	28.08	8.72	1145.33	25,232	22.03	0.000703	22	2.03	0.3	0.33	2.76	1.85	1.03	1.50	6.74	1.50	10.11	10.00	1145.89
225.94	1156.00	34.83	7.00	1273.19	31,448	24.70	0.000383	25	1.79	0.3	0.00	5.36	2.40	0.66	0.00	8.05	1.50	12.08	10.00	1143.92
226.03	1156.00	31.15	6.17	1611.23	35,673	22.14	0.000346	31	1.56	0.3	0.00	8.03	2.09	0.51	0.00	10.43	1.50	15.64	10.00	1140.36
226.13	1158.00	27.00	8.57	830.47	17,218	20.73	0.000751	31	3.32	0.3	0.00	7.37	1.76	0.99	0.00	9.43	1.50	14.14	10.00	1143.86
226.23	1168.00	15.81	18.78	733.11	7,852	10.71	0.008390	31	13.08	0.3	4.07	5.10	0.92	4.76	0.00	14.23	1.50	21.35	10.00	1146.65
226.32	1170.00	19.29	13.98	879.12	10,553	12.00	0.003975	31	14.85	0.3	3.68	5.88	1.17	2.64	0.00	12.50	1.50	18.74	10.00	1151.26
226.43	1174.00	17.87	12.18	882.64	12,106	13.72	0.002527	31	18.58	0.3	3.90	5.30	1.07	2.00	0.00	11.50	1.50	17.25	10.00	1156.75
226.54	1174.00	19.56	11.67	905.60	12,638	13.95	0.002271	18	18.29	0.3	2.65	0.21	1.19	1.84	0.00	5.00	1.50	7.49	10.00	1164.00
226.66	1172.00	23.15	10.33	932.38	14,283	15.32	0.001567	18	16.01	0.3	1.86	0.24	1.46	1.44	0.00	3.86	1.50	5.79	10.00	1162.00

Note: All hydraulic data taken from HEC-2 File: SRP2HC2

General Scour depths taken from HEC-6 File SRP1HC6.

Equilibrium slope of 0.00047 ft/ft & Q10 armor depth of 0.3-ft taken from 1994 SLA report.

Equilibrium pivot point is at Grade-Control #5 (XSEC 20.5), invert elevation =1147.00-ft, MSL

The total scour depth is measured from the low point of the pre-flood channel-bed elevation within the effective flow area of each cross-section.
The thalweg elevations in column 2 of this table reflect the proposed fill to be placed in existing gravel pits. See Section 3.3 of this report for details.

File: SRPMIC North Levee Scour Summary, 1998 Topo.xls

- The "Recommended Toe-Down Elevation" is computed by subtracting the larger of the "Maximum Scour Depth", or 10-feet, from the listed thalweg elevations. The listed thalweg elevations represent "filled" gravel pit conditions as discussed in Section 3.3 of this report.

4.3 Water Surface Profile Summary

In addition to the scour analysis, the HEC-6 model was also used to examine fluctuations in the water surface profile that would occur during the 100-year, 10-day flow event. Appendix B presents a summary of the HEC-6 water surface elevation changes that occur in the main channel during the 100-year, 10-day event. These water surface profile changes reflect both discharge variations and bed-profile movements that are occurring during the flood.

In order to find the maximum water surface profile for the top of the bank-lining design, the maximum HEC-6 profile was compared to the HEC-2 profile, as well as to the profile obtained from routing the 100-year peak discharge through a fixed-bed HEC-6 model, adjusted to the post-flood bed-profile. This latter condition, which was analyzed in order to be consistent with the 1994 SLA study, was simulated by applying a vertical elevation adjustment to the GR records. This elevation adjustment was taken as the cumulative, vertical bed-change dimension from the last hydrograph time step (#34) in the moveable-bed HEC-6 model.

Table 4.2 summarizes the computed water surface elevations for each of these three conditions. All water surface elevations in Table 4.2 include an allowance for superelevation along the north channel bank between XSECs 225.85 through 226.66. Table 4.3 presents a summary of the superelevation calculations that were used in this report.

Superelevation was computed from the following equation (ADWR, 1985).

$$\Delta y_{se} = \frac{V^2}{2g}\frac{W}{r_c}\left[\frac{1}{1-\left(\frac{W}{2r_c}\right)^2}\right] \qquad \text{(Equation 4.1}$$

where delta y_{se} = height of superelevation (ft)

V = mean channel velocity (fps)

W = channel width at water surface (ft)

r_c = radius of channel centerline (ft)

g = acceleration of gravity, 32.2 ft/sec^2

Table 4.2
Summary of Water Surface Profiles
Salt River
100-Year, 10-Day Flood
Proposed SRPMIC North-Bank Levee

Station Distance Along Levee (ft)	Discharge (cfs)	HEC-2 XSEC	Water Surface Profile Elevations (ft, MSL)			Maximum Water Surface Elevation (ft, MSL)
			HEC-2	HEC-6	Post-Flood, Fixed-Bed HEC-6 For Peak Discharge	
1,160	220,000	224.33	1180.74	1181.06	1181.06	1181.06
1,670	220,000	224.42	1180.91	1181.61	1181.61	1181.61
2,170	220,000	224.52	1181.26	1181.82	1181.81	1181.82
2,670	220,000	224.61	1181.46	1181.85	1181.85	1181.85
3,170	220,000	224.71	1181.68	1182.14	1182.13	1182.14
3,667	220,000	224.80	1181.89	1182.26	1182.24	1182.26
4,178	220,000	224.90	1182.15	1182.27	1182.26	1182.27
4,627	220,000	224.99	1182.35	1182.30	1182.30	1182.35
4,930	220,000	225.09	1182.61	1182.75	1182.71	1182.75
5,413	220,000	225.18	1182.79	1182.81	1182.80	1182.81
5,898	220,000	225.28	1183.03	1182.75	1182.73	1183.03
6,333	220,000	225.37	1183.20	1182.89	1182.87	1183.20
6,700	220,000	225.47	1183.38	1183.09	1183.11	1183.38
7,180	220,000	225.56	1183.58	1183.43	1183.50	1183.58
7,657	220,000	225.66	1183.82	1183.58	1183.60	1183.82
8,142	220,000	225.75	1183.97	1183.68	1183.58	1183.97
8,639	220,000	225.85	1184.60	1184.49	1184.66	1184.66
8,978	220,000	225.94	1185.18	1184.89	1185.11	1185.18
9,272	220,000	226.03	1185.55	1185.33	1185.74	1185.74
9,895	147,500	226.13	1185.38	1184.83	1185.68	1185.68
10,404	147,500	226.23	1185.29	1185.97	1186.50	1186.50
10,928	147,500	226.32	1190.28	1187.21	1187.83	1190.28
11,809	147,500	226.43	1192.62	1189.31	1188.86	1192.62
12,468	147,500	226.54	1194.27	1191.58	1190.72	1194.27
13,153	147,500	226.66	1195.72	1193.25	1192.53	1195.72
Model			SRP2HC2	SRP1HC6	SRP1HC6P	

All water surface elevations in this table include superelevation between XSECs 225.85 through 226.66.

File: Sht 4, CWSEL SUMMARY SRPMIC LEVEE, 1998 Topo.xls

Table 4.3
Summary of Superelevation Calculations
Salt River
100-Year, 10-Day Flood
Proposed SRPMIC North Levee

Station Distance Along Levee (ft)	Discharge (cfs)	HEC-2 XSEC	HEC-2 File SRP2HC2			HEC-6 File SRP1HC6			HEC-6 File SRP1HC6P		
			Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)	Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)	Velocity (fps)	Topwidth (ft)	North-Bank Superelevation (ft)
1,160	220,000	224.33			n/a			n/a			n/a
1,670	220,000	224.42			n/a			n/a			n/a
2,170	220,000	224.52			n/a			n/a			n/a
2,670	220,000	224.61			n/a			n/a			n/a
3,170	220,000	224.71			n/a			n/a			n/a
3,667	220,000	224.80			n/a			n/a			n/a
4,178	220,000	224.90			n/a			n/a			n/a
4,627	220,000	224.99			n/a			n/a			n/a
4,930	220,000	225.09			n/a			n/a			n/a
5,413	220,000	225.18			n/a			n/a			n/a
5,898	220,000	225.28			n/a			n/a			n/a
6,333	220,000	225.37			n/a			n/a			n/a
6,700	220,000	225.47			n/a			n/a			n/a
7,180	220,000	225.56			n/a			n/a			n/a
7,657	220,000	225.66			n/a			n/a			n/a
8,142	220,000	225.75			n/a			n/a			n/a
8,639	220,000	225.85	8.72	1,145.33	0.51	8.93	1,238.63	0.58	8.93	1,238.63	0.58
8,978	220,000	225.94	7.00	1,273.19	0.37	8.81	1,266.32	0.58	8.81	1,266.32	0.58
9,272	220,000	226.03	6.17	1,611.23	0.38	8.89	1,574.30	0.76	8.89	1,574.30	0.76
9,895	147,500	226.13	8.57	830.47	0.35	10.32	928.77	0.57	10.32	928.77	0.57
10,404	147,500	226.23	18.78	733.11	1.48	11.38	945.55	0.71	11.38	945.55	0.71
10,928	147,500	226.32	13.98	879.12	0.99	10.82	1,061.60	0.72	10.82	1,061.60	0.72
11,809	147,500	226.43	12.18	882.64	0.75	12.72	879.87	0.82	12.72	879.87	0.82
12,468	147,500	226.54	11.67	905.60	0.71	12.61	902.11	0.83	12.61	902.11	0.83
13,153	147,500	226.66	10.33	932.38	0.57	11.41	922.29	0.69	11.41	922.29	0.69

Note: Radius of curvature = 2,770 feet.

Channel widths and velocities were taken from the HEC-2 and HEC-6 output summaries listed at the top of Table 4.3. The radius of curvature of the channel centerline was measured from 1" = 400' topographic mapping as 2,770-feet.

Figure 4.4 graphically compares the water surface profiles in Table 4.2. Notes on each of these figures identify the model file names that are being plotted.

The maximum water surface elevation (in Table 4.2) that occurred at each XSEC along the north-bank levee was used for the design recommendations presented in the following section. A freeboard elevation of 3.0-feet was added to these maximum water surface elevations in order to establish the recommended top-of-bank elevations. Freeboard is not reflected in the water surface elevations listed in Table 4.2.

4.4 Recommended Elevations For SRPMIC North-Bank Levee Design

The scour and water surface profile data presented in Sections 4.2 and 4.3 have been condensed into summary tables for listing design recommendations for the CSA bank-lining. Table 4.4 summarizes these recommendations.

Design elevations are referenced to HEC-2 cross-section numbers, as well as to the levee control-line stationing. The levee control-line stationing was provided by Premier Engineering Corporation.

The top-of-bank and toe-down elevations from Table 4.3 are plotted in Figure 4.5. The top-of-bank profile in this Figure includes freeboard and superelevation (where applicable).

In preparing this study, it has been assumed that the general river characteristics have not changed in a way (since the preparation of the referenced topographic mapping listed in Section 2 of this report) that would cause any significant alteration to the recommended water surface and scour profiles presented in this report. However, continuation of un-regulated in-stream gravel mining could induce changes to the river system equilibrium that could void the recommendations presented in this report.

Figure 4.4
Water Surface Profile Comparison
Proposed SRPMIC North Bank Levee
100-Year, 10-Day Flood

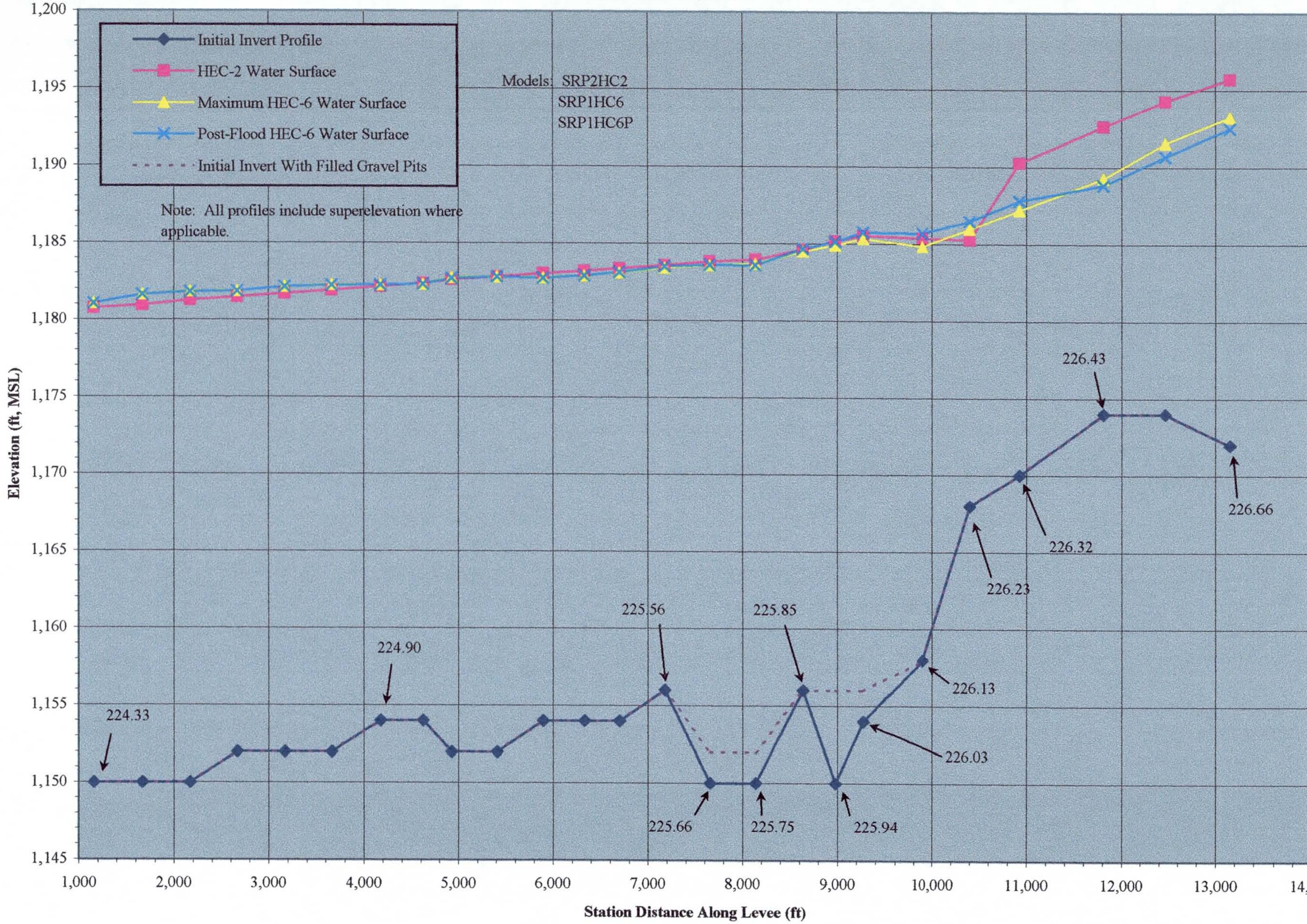


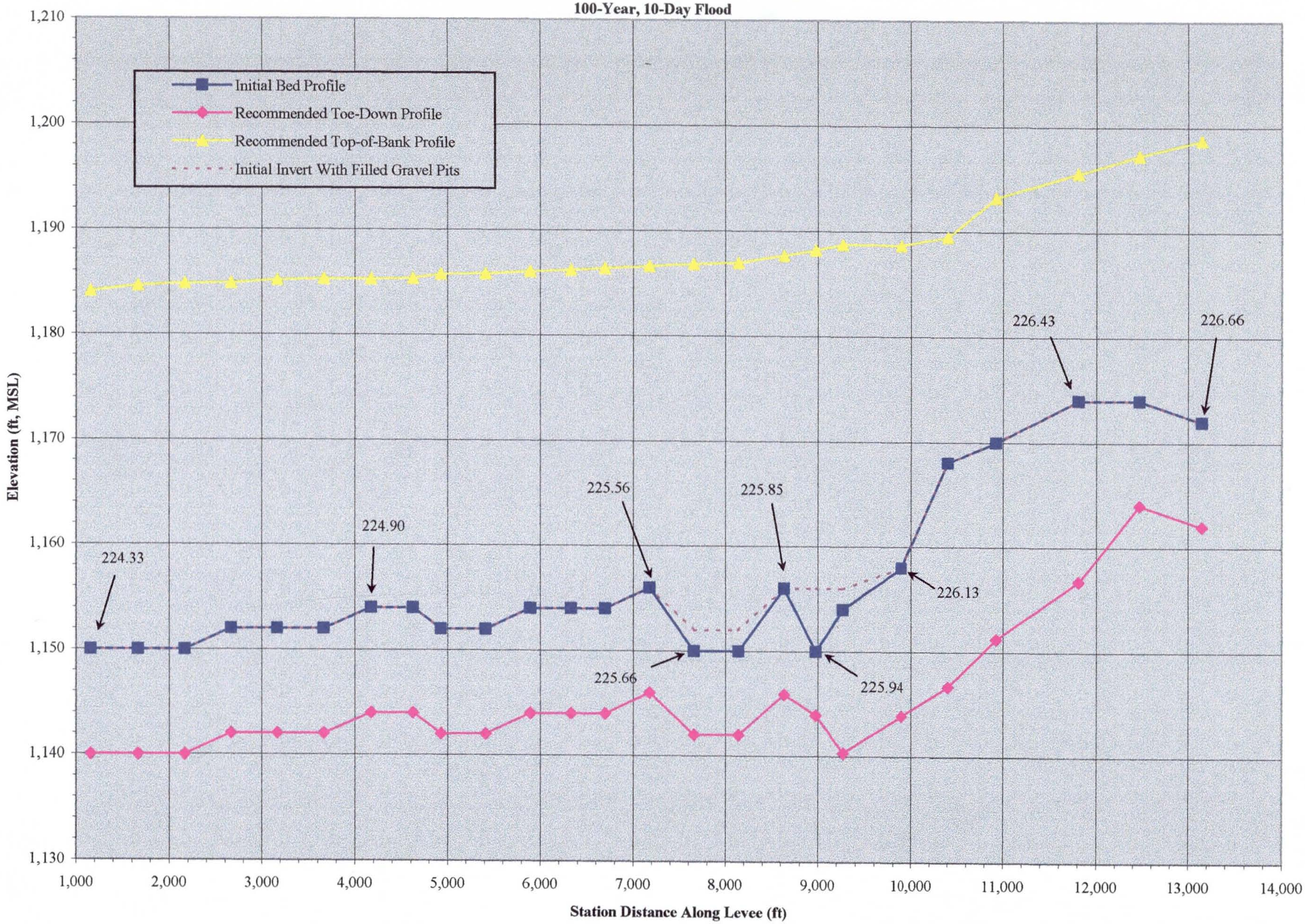
Table 4.4
Summary of Recommended Elevations for CSA Bank-Lining Design
Salt River Maricopa Pima Indian Community
North-Bank Levee Analysis Along Salt River, Pima Freeway Bridge to Alma School Road

100-Year, 10-Day Flood

Levee Station In Feet	Applicable HEC-2/HEC-6 XSEC	Top-of-Bank Design: Maximum 100-Yr Water Surface (ft, MSL)	Top-of-Bank Design: Data Source	Top-of-Bank Design: Superelevation (ft)	Top-of-Bank Design: Freeboard (ft)	South Levee Elev (ft MSL)	Top-of-Bank Design: Recommended Design Elevation (ft, MSL)	Toe-Down Design: Data Source	Toe-Down Design: Recommended Design Elevation (ft, MSL)
1,160	224.33	1181.06	Table 4.2	n/a	3.00		1184.06	Table 4.1	1140.00
1,670	224.42	1181.61		n/a	3.00		1184.61		1140.00
2,170	224.52	1181.82		n/a	3.00		1184.82		1140.00
2,670	224.61	1181.85		n/a	3.00		1184.85		1142.00
3,170	224.71	1182.14		n/a	3.00		1185.14		1142.00
3,667	224.80	1182.26		n/a	3.00		1185.26		1142.00
4,178	224.90	1182.27		n/a	3.00		1185.27		1144.00
4,627	224.99	1182.35		n/a	3.00		1185.35		1144.00
4,930	225.09	1182.75		n/a	3.00	1186.5	1185.75		1142.00
5,413	225.18	1182.81		n/a	3.00	1186.7	1185.81		1142.00
5,898	225.28	1183.03		n/a	3.00	1187.0	1186.03		1144.00
6,333	225.37	1183.20		n/a	3.00		1186.20		1144.00
6,700	225.47	1183.38		n/a	3.00		1186.38		1144.00
7,180	225.56	1183.58		n/a	3.00		1186.58		1146.00
7,657	225.66	1183.82		n/a	3.00		1186.82		1142.00
8,142	225.75	1183.97		n/a	3.00	1190.8	1186.97		1142.00
8,639	225.85	1184.66		(included)	3.00		1187.66		1145.89
8,978	225.94	1185.18		(included)	3.00	1192.1	1188.18		1143.92
9,272	226.03	1185.74		(included)	3.00		1188.74		1140.36
9,895	226.13	1185.68		(included)	3.00		1188.68		1143.86
10,404	226.23	1186.50		(included)	3.00		1189.50		1146.65
10,928	226.32	1190.28		(included)	3.00		1193.28		1151.26
11,809	226.43	1192.62		(included)	3.00		1195.62		1156.75
12,468	226.54	1194.27		(included)	3.00		1197.27		1164.00
13,153	226.66	1195.72		(included)	3.00		1198.72		1162.00

File: SRPMIC LEVEE RECOM, 1998 TOPO.xls

Figure 4.5
Recommended Design Profiles For CSA Bank Lining
Proposed SRPMIC Levee Along North Bank of Salt River
100-Year, 10-Day Flood



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Simons, D.B., & Senturk, F., 1977, *Sediment Transport Technology*

APPENDIX A

HEC-6 General Scour Summary
100-Year, 10-Day Flood
Model SRP1HC6

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

Table A1
Summary of HEC-6 Bed Profile Data
Model SRP1HC6
100-Year, 10-Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River XSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
224.33	0	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00
224.42	500	1150.00	1149.99	1149.99	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.98	1149.97	1149.96	1149.95	1149.94	1149.94	1149.93	1149.92
224.52	1000	1150.00	1150.02	1150.03	1150.03	1150.04	1150.05	1150.06	1150.07	1150.08	1150.08	1150.09	1150.09	1150.09	1150.08	1150.07	1150.06	1150.06	1150.06	1150.06
224.61	1500	1152.00	1152.00	1152.01	1152.01	1152.01	1152.01	1152.01	1152.01	1152.00	1152.00	1151.99	1151.98	1151.97	1151.96	1151.95	1151.94	1151.93	1151.92	1151.90
224.71	2000	1152.00	1152.02	1152.02	1152.03	1152.04	1152.05	1152.05	1152.06	1152.06	1152.07	1152.07	1152.07	1152.06	1152.05	1152.04	1152.02	1152.00	1151.99	1151.98
224.80	2500	1152.00	1152.01	1152.02	1152.02	1152.03	1152.04	1152.05	1152.06	1152.07	1152.08	1152.10	1152.11	1152.12	1152.14	1152.17	1152.20	1152.23	1152.27	1152.31
224.90	3000	1154.00	1154.02	1154.03	1154.04	1154.04	1154.04	1154.04	1154.04	1154.03	1154.02	1154.02	1154.01	1154.00	1153.98	1153.97	1153.97	1153.96	1153.96	1153.96
224.99	3500	1154.00	1153.99	1153.99	1153.98	1153.98	1153.97	1153.97	1153.96	1153.95	1153.94	1153.92	1153.91	1153.89	1153.87	1153.84	1153.81	1153.79	1153.77	1153.74
225.09	4000	1152.00	1152.04	1152.06	1152.07	1152.09	1152.11	1152.14	1152.16	1152.20	1152.24	1152.28	1152.33	1152.38	1152.43	1152.49	1152.54	1152.60	1152.65	1152.71
225.18	4500	1152.00	1151.99	1151.99	1151.99	1151.99	1152.00	1152.02	1152.03	1152.05	1152.09	1152.13	1152.20	1152.30	1152.45	1152.60	1152.71	1152.80	1152.89	1152.97
225.28	5000	1154.00	1154.01	1154.01	1154.01	1154.02	1154.02	1154.02	1154.03	1154.04	1154.06	1154.10	1154.14	1154.20	1154.28	1154.39	1154.50	1154.60	1154.67	1154.72
225.37	5500	1154.00	1154.02	1154.02	1154.01	1154.01	1154.01	1154.01	1154.03	1154.04	1154.05	1154.05	1154.04	1154.04	1154.05	1154.06	1154.10	1154.14	1154.20	1154.30
225.47	6000	1154.00	1154.04	1154.04	1154.06	1154.05	1154.04	1154.03	1154.01	1153.99	1153.97	1153.97	1153.96	1153.96	1153.96	1153.95	1153.95	1153.94	1153.94	1153.94
225.56	6500	1156.00	1155.90	1155.88	1155.84	1155.83	1155.82	1155.82	1155.81	1155.82	1155.83	1155.84	1155.86	1155.90	1155.95	1155.98	1156.00	1156.02	1156.05	1156.07
225.66	7000	1150.00	1149.97	1149.96	1149.95	1149.93	1149.92	1149.90	1149.89	1149.88	1149.88	1149.87	1149.87	1149.87	1149.87	1149.85	1149.85	1149.84	1149.83	1149.83
225.75	7500	1150.00	1150.10	1150.16	1150.20	1150.24	1150.29	1150.35	1150.42	1150.51	1150.60	1150.70	1150.80	1150.89	1150.96	1151.04	1151.18	1151.44	1151.80	1152.30
225.85	8000	1156.00	1155.94	1155.90	1155.87	1155.85	1155.83	1155.80	1155.78	1155.76	1155.74	1155.72	1155.70	1155.69	1155.68	1155.68	1155.67	1155.69	1155.73	1155.95
225.94	8500	1150.00	1150.14	1150.34	1150.60	1150.85	1151.09	1151.32	1151.55	1151.74	1151.93	1152.15	1152.33	1152.48	1152.66	1152.95	1153.64	1154.93	1155.94	1156.83
226.03	8990	1154.00	1156.42	1156.81	1156.90	1157.07	1157.17	1157.29	1157.41	1157.64	1157.99	1158.42	1158.81	1159.39	1160.32	1161.23	1162.89	1162.83	1162.86	1162.47
226.13	9510	1158.00	1159.36	1159.06	1159.16	1159.13	1159.31	1159.41	1159.61	1160.20	1160.81	1161.03	1162.12	1163.83	1164.96	1165.93	1164.90	1165.13	1164.84	1164.53
226.23	10010	1168.00	1163.94	1164.12	1164.00	1163.94	1163.95	1163.93	1163.93	1163.97	1163.99	1163.99	1164.12	1164.75	1165.03	1165.44	1165.31	1165.10	1165.25	1165.23
226.32	10510	1170.00	1170.11	1169.53	1169.29	1168.97	1168.59	1168.45	1168.03	1167.27	1167.40	1167.19	1166.32	1167.00	1167.21	1167.51	1167.17	1167.14	1167.15	1166.93
226.43	11077	1174.00	1173.95	1173.87	1173.74	1173.69	1173.59	1173.45	1173.43	1173.36	1172.44	1172.44	1172.14	1170.10	1171.00	1170.94	1171.07	1170.93	1170.99	1170.69
226.54	11696	1174.00	1173.95	1173.83	1173.78	1173.72	1173.68	1173.61	1173.59	1173.59	1173.59	1173.38	1173.35	1173.31	1171.96	1172.91	1172.85	1172.50	1172.43	1172.11
226.66	12280	1172.00	1172.51	1172.66	1172.83	1172.98	1173.14	1173.27	1173.35	1173.36	1173.24	1172.98	1172.66	1172.84	1173.17	1171.66	1171.81	1171.46	1170.51	1170.47

River XSEC	Time Step 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Maximum Deposition Elevation (ft, MSL)	Maximum Scour Elevation (ft, MSL)
224.33	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00	1150.00
224.42	1149.90	1149.90	1149.89	1149.88	1149.88	1149.87	1149.87	1149.86	1149.86	1149.85	1149.85	1149.85	1149.84	1149.84	1149.84	1149.83	1150.00	1149.83
224.52	1150.06	1150.06	1150.07	1150.07	1150.08	1150.09	1150.10	1150.11	1150.12	1150.13	1150.16	1150.17	1150.20	1150.18	1150.21	1150.25	1150.25	1150.00
224.61	1151.89	1151.88	1151.88	1151.87	1151.87	1151.87	1151.87	1151.87	1151.87	1151.88	1151.88	1151.88	1151.88	1151.88	1151.89	1151.89	1152.01	1151.87
224.71	1151.97	1151.97	1151.96	1151.96	1151.96	1151.96	1151.96	1151.96	1151.96	1151.96	1151.97	1151.97	1151.97	1151.97	1151.97	1151.98	1152.07	1151.96
224.80	1152.35	1152.38	1152.41	1152.43	1152.45	1152.47	1152.48	1152.49	1152.50	1152.53	1152.55	1152.56	1152.60	1152.57	1152.60	1152.62	1152.62	1152.00
224.90	1153.96	1153.96	1153.97	1153.98	1153.98	1153.99	1154.00	1154.01	1154.02	1154.03	1154.05	1154.06	1154.09	1154.07	1154.11	1154.15	1154.15	1153.96
224.99	1153.72	1153.70	1153.69	1153.67	1153.67	1153.66	1153.66	1153.66	1153.66	1153.66	1153.65	1153.65	1153.65	1153.65	1153.65	1153.66	1154.00	1153.65
225.09	1152.76	1152.80	1152.84	1152.89	1152.93	1152.97	1153.01	1153.05	1153.09	1153.15	1153.20	1153.22	1153.27	1153.24	1153.28	1153.30	1153.30	1152.00
225.18	1153.03	1153.08	1153.11	1153.14	1153.14	1153.14	1153.12	1153.09	1153.07	1153.01	1152.97	1152.95	1152.89	1152.93	1152.87	1152.82	1153.14	1151.99
225.28	1154.76	1154.80	1154.82	1154.84	1154.85	1154.86	1154.86	1154.85	1154.85	1154.85	1154.85	1154.84	1154.84	1154.84	1154.83	1154.82	1154.86	1154.00
225.37	1154.39	1154.49	1154.60	1154.70	1154.77	1154.83	1154.86	1154.87	1154.87	1154.84	1154.82	1154.80	1154.78	1154.80	1154.77	1154.76	1154.87	1154.00
225.47	1153.94	1153.95	1153.96	1153.97	1154.01	1154.05	1154.10	1154.15	1154.19	1154.25	1154.29	1154.31	1154.37	1154.33	1154.39	1154.44	1154.44	1153.94
225.56	1156.09	1156.11	1156.13	1156.14	1156.11	1156.07	1156.02	1155.97	1155.92	1155.88	1155.87	1155.87	1155.86	1155.86	1155.85	1155.85	1156.14	1155.81
225.66	1149.84	1149.85	1149.86	1149.89	1149.93	1149.99	1150.05	1150.13	1150.22	1150.38	1150.53	1150.59	1150.74	1150.65	1150.77	1150.86	1150.86	1149.83
225.75	1152.63	1152.81	1153.09	1153.43	1153.76	1153.99	1154.14	1154.23	1154.29	1154.36	1154.37	1154.37	1154.35	1154.36	1154.35	1154.33	1154.37	1150.00
225.85	1156.63	1157.62	1158.15	1158.33	1158.24	1158.15	1158.09	1158.05	1158.03	1157.97	1157.93	1157.92	1157.90	1157.91	1157.89	1157.88	1158.33	1155.67
225.94	1157.14	1156.72	1156.40	1156.13	1155.99	1155.87	1155.78	1155.71	1155.65	1155.57	1155.52	1155.49	1155.46	1155.48	1155.45	1155.42	1157.14	1150.00
226.03	1161.92	1161.59	1161.33	1161.15	1161.03	1160.94	1160.87	1160.83	1160.81	1160.77	1160.74	1160.73	1160.71	1160.73	1160.71	1160.70	1162.89	1154.00
226.13	1164.25	1164.07	1163.98	1163.92	1163.88	1163.87	1163.85	1163.84	1163.84	1163.82	1163.80	1163.80	1163.77	1163.79	1163.76	1163.74	1165.93	1158.00
226.23	1165.13	1165.05	1165.02	1165.00	1165.02	1165.02	1165.04	1165.06	1165.07	1165.07	1165.08	1165.08	1165.09	1165.08	1165.09	1165.11	1168.00	1163.93
226.32	1166.77	1166.75	1166.76	1166.76	1166.78	1166.80	1166.82	1166.83	1166.83	1166.82	1166.82	1166.82	1166.83	1166.82	1166.83	1166.84	1170.11	1166.32
226.43	1170.65	1170.70	1170.73	1170.69	1170.76	1170.73	1170.78	1170.76	1170.77	1170.74	1170.76	1170.76	1170.75	1170.76	1170.75	1170.75	1174.00	1170.10
226.54	1172.02	1171.89	1171.81	1171.80	1171.68	1171.66	1171.56	1171.53	1171.52	1171.49	1171.42	1171.40	1171.38	1171.39	1171.37	1171.35	1174.00	1171.35
226.66	1170.39	1170.37	1170.30	1170.29	1170.29	1170.28	1170.28	1170.27	1170.22	1170.20	1170.19	1170.18	1170.16	1170.17	1170.15	1170.14	1173.36	1170.14

File: HEC6 OUT FOR SRP1HC6.XLS

Table A1
Summary of HEC-6 Bed Profile Data
Model SRP1HC6
100-Year, 10-Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River KSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
224.33	0	1150.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
224.42	500	1150.00	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.03	-0.04	-0.05	-0.06	-0.06	-0.07	-0.08
224.52	1000	1150.00	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.08	0.09	0.09	0.09	0.08	0.07	0.06	0.06	0.06	0.06
224.61	1500	1152.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.06	-0.07	-0.08	-0.10
224.71	2000	1152.00	0.02	0.02	0.03	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.06	0.05	0.04	0.02	0.00	-0.01	-0.02
224.80	2500	1152.00	0.01	0.02	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.17	0.20	0.23	0.27	0.31
224.90	3000	1154.00	0.02	0.03	0.04	0.04	0.04	0.04	0.04	0.03	0.02	0.02	0.01	0.00	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04
224.99	3500	1154.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.05	-0.06	-0.08	-0.09	-0.11	-0.13	-0.16	-0.19	-0.21	-0.23	-0.26
225.09	4000	1152.00	0.04	0.06	0.07	0.09	0.11	0.14	0.16	0.20	0.24	0.28	0.33	0.38	0.43	0.49	0.54	0.60	0.65	0.71
225.18	4500	1152.00	-0.01	-0.01	-0.01	-0.01	0.00	0.02	0.03	0.05	0.09	0.13	0.20	0.30	0.45	0.60	0.71	0.80	0.89	0.97
225.28	5000	1154.00	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.04	0.06	0.10	0.14	0.20	0.28	0.39	0.50	0.60	0.67	0.72
225.37	5500	1154.00	0.02	0.02	0.01	0.01	0.01	0.01	0.03	0.04	0.05	0.05	0.04	0.04	0.05	0.06	0.10	0.14	0.20	0.30
225.47	6000	1154.00	0.04	0.04	0.06	0.05	0.04	0.03	0.01	-0.01	-0.03	-0.03	-0.04	-0.04	-0.04	-0.05	-0.05	-0.06	-0.06	-0.06
225.56	6500	1156.00	-0.10	-0.12	-0.16	-0.17	-0.18	-0.18	-0.19	-0.18	-0.17	-0.16	-0.14	-0.10	-0.05	-0.02	0.00	0.02	0.05	0.07
225.66	7000	1150.00	-0.03	-0.04	-0.05	-0.07	-0.08	-0.10	-0.11	-0.12	-0.12	-0.13	-0.13	-0.13	-0.13	-0.15	-0.15	-0.16	-0.17	-0.17
225.75	7500	1150.00	0.10	0.16	0.20	0.24	0.29	0.35	0.42	0.51	0.60	0.70	0.80	0.89	0.96	1.04	1.18	1.44	1.80	2.30
225.85	8000	1156.00	-0.06	-0.10	-0.13	-0.15	-0.17	-0.20	-0.22	-0.24	-0.26	-0.28	-0.30	-0.31	-0.32	-0.32	-0.33	-0.31	-0.27	-0.05
225.94	8500	1150.00	0.14	0.34	0.60	0.85	1.09	1.32	1.55	1.74	1.93	2.15	2.33	2.48	2.66	2.95	3.64	4.93	5.94	6.83
226.03	8990	1154.00	2.42	2.81	2.90	3.07	3.17	3.29	3.41	3.64	3.99	4.42	4.81	5.39	6.32	7.23	8.89	8.83	8.86	8.47
226.13	9510	1158.00	1.36	1.06	1.16	1.13	1.31	1.41	1.61	2.20	2.81	3.03	4.12	5.83	6.96	7.93	6.90	7.13	6.84	6.53
226.23	10010	1168.00	-4.06	-3.88	-4.00	-4.06	-4.05	-4.07	-4.07	-4.03	-4.01	-4.01	-3.88	-3.25	-2.97	-2.56	-2.69	-2.90	-2.75	-2.77
226.32	10510	1170.00	0.11	-0.47	-0.71	-1.03	-1.41	-1.55	-1.97	-2.73	-2.60	-2.81	-3.68	-3.00	-2.79	-2.49	-2.83	-2.86	-2.85	-3.07
226.43	11077	1174.00	-0.05	-0.13	-0.26	-0.31	-0.41	-0.55	-0.57	-0.64	-1.56	-1.56	-1.86	-3.90	-3.00	-3.06	-2.93	-3.07	-3.01	-3.31
226.54	11696	1174.00	-0.05	-0.17	-0.22	-0.28	-0.32	-0.39	-0.41	-0.41	-0.41	-0.62	-0.65	-0.69	-2.04	-1.09	-1.15	-1.50	-1.57	-1.89
226.66	12280	1172.00	0.51	0.66	0.83	0.98	1.14	1.27	1.35	1.36	1.24	0.98	0.66	0.84	1.17	-0.34	-0.19	-0.54	-1.49	-1.53

River KSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Maximum Deposition (ft)	Maximum Scour (ft)
224.33	0	1150.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
224.42	500	1150.00	-0.1	-0.1	-0.11	-0.12	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.17	0.00	-0.17
224.52	1000	1150.00	0.06	0.06	0.07	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.16	0.17	0.2	0.18	0.21	0.25	0.25	0.00
224.61	1500	1152.00	-0.11	-0.12	-0.12	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13	-0.12	-0.12	-0.12	-0.12	-0.12	-0.11	-0.11	0.01	-0.13
224.71	2000	1152.00	-0.03	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	0.07	-0.04
224.80	2500	1152.00	0.35	0.38	0.41	0.43	0.45	0.47	0.48	0.49	0.50	0.53	0.55	0.56	0.60	0.57	0.60	0.62	0.62	0.00
224.90	3000	1154.00	-0.04	-0.04	-0.03	-0.02	-0.02	-0.01	0.00	0.01	0.02	0.03	0.05	0.06	0.09	0.07	0.11	0.15	0.15	-0.04
224.99	3500	1154.00	-0.28	-0.30	-0.31	-0.33	-0.33	-0.34	-0.34	-0.34	-0.34	-0.34	-0.35	-0.35	-0.35	-0.35	-0.35	-0.34	0.00	-0.35
225.09	4000	1152.00	0.76	0.80	0.84	0.89	0.93	0.97	1.01	1.05	1.09	1.15	1.20	1.22	1.27	1.24	1.28	1.30	1.30	0.00
225.18	4500	1152.00	1.03	1.08	1.11	1.14	1.14	1.14	1.12	1.09	1.07	1.01	0.97	0.95	0.89	0.93	0.87	0.82	1.14	-0.01
225.28	5000	1154.00	0.76	0.80	0.82	0.84	0.85	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.83	0.82	0.86	0.00
225.37	5500	1154.00	0.39	0.49	0.60	0.70	0.77	0.83	0.86	0.87	0.87	0.84	0.82	0.80	0.78	0.80	0.77	0.76	0.87	0.00
225.47	6000	1154.00	-0.06	-0.05	-0.04	-0.03	0.01	0.05	0.10	0.15	0.19	0.25	0.29	0.31	0.37	0.33	0.39	0.44	0.44	-0.06
225.56	6500	1156.00	0.09	0.11	0.13	0.14	0.11	0.07	0.02	-0.03	-0.08	-0.12	-0.13	-0.13	-0.14	-0.14	-0.15	-0.15	0.14	-0.19
225.66	7000	1150.00	-0.16	-0.15	-0.14	-0.11	-0.07	-0.01	0.05	0.13	0.22	0.38	0.53	0.59	0.74	0.65	0.77	0.86	0.86	-0.17
225.75	7500	1150.00	2.63	2.81	3.09	3.43	3.76	3.99	4.14	4.23	4.29	4.36	4.37	4.37	4.35	4.36	4.35	4.33	4.37	0.00
225.85	8000	1156.00	0.63	1.62	2.15	2.33	2.24	2.15	2.09	2.05	2.03	1.97	1.93	1.92	1.90	1.91	1.89	1.88	2.33	-0.33
225.94	8500	1150.00	7.14	6.72	6.40	6.13	5.99	5.87	5.78	5.71	5.65	5.57	5.52	5.49	5.46	5.48	5.45	5.42	7.14	0.00
226.03	8990	1154.00	7.92	7.59	7.33	7.15	7.03	6.94	6.87	6.83	6.81	6.77	6.74	6.73	6.71	6.73	6.71	6.70	8.89	0.00
226.13	9510	1158.00	6.25	6.07	5.98	5.92	5.88	5.87	5.85	5.84	5.84	5.82	5.80	5.80	5.77	5.79	5.76	5.74	7.93	0.00
226.23	10010	1168.00	-2.87	-2.95	-2.98	-3.00	-2.98	-2.98	-2.96	-2.94	-2.93	-2.93	-2.92	-2.92	-2.91	-2.92	-2.91	-2.89	0.00	-4.07
226.32	10510	1170.00	-3.23	-3.25	-3.24	-3.24	-3.22	-3.20	-3.18	-3.17	-3.17	-3.18	-3.18	-3.18	-3.17	-3.18	-3.17	-3.16	0.11	-3.68
226.43	11077	1174.00	-3.35	-3.30	-3.27	-3.31	-3.24	-3.27	-3.22	-3.24	-3.23	-3.26	-3.24	-3.24	-3.25	-3.24	-3.25	-3.25	0.00	-3.90
226.54	11696	1174.00	-1.98	-2.11	-2.19	-2.20	-2.32	-2.34	-2.44	-2.47	-2.48	-2.51	-2.58	-2.60	-2.62	-2.61	-2.63	-2.65	0.00	-2.65
226.66	12280	1172.00	-1.61	-1.63	-1.70	-1.71	-1.71	-1.72	-1.72	-1.73	-1.78	-1.80	-1.81	-1.82	-1.84	-1.83	-1.85	-1.86	1.36	-1.86

File: HEC6 OUT FOR SRP1HC6.XLS

APPENDIX B

HEC-6 Water Surface Profile Summary
100-Year, 10-Day Flood
Model SRP1HC6

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

Table B1
Summary of Maximum Water Surface Profile From HEC-6 Analysis
Model SRP1HC6
100-Year, 10 Day Flood
SRPMIC North Levee Analysis
Pima Freeway to Alma School Road
Salt River - Main Channel

River XSEC	Cumulative Distance (ft)	Initial Bed Profile (ft, MSL)	Time Step 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
224.33	0	1150.00	1159.23	1159.34	1159.48	1160.48	1162.11	1162.77	1163.72	1166.12	1167.85	1168.66	1171.32	1175.22	1179.40	1181.06	1177.97	1176.87	1176.74	1174.66
224.42	500	1150.00	1159.38	1159.49	1159.64	1160.66	1162.31	1162.98	1163.94	1166.38	1168.14	1168.97	1171.68	1175.66	1179.91	1181.61	1178.46	1177.34	1177.21	1175.08
224.52	1000	1150.00	1159.52	1159.63	1159.78	1160.81	1162.46	1163.13	1164.10	1166.55	1168.32	1169.15	1171.86	1175.85	1180.12	1181.82	1178.66	1177.54	1177.40	1175.27
224.61	1500	1152.00	1159.60	1159.71	1159.87	1160.89	1162.54	1163.21	1164.18	1166.63	1168.39	1169.22	1171.92	1175.90	1180.16	1181.85	1178.70	1177.58	1177.45	1175.33
224.71	2000	1152.00	1159.75	1159.87	1160.02	1161.05	1162.70	1163.37	1164.34	1166.81	1168.58	1169.41	1172.13	1176.14	1180.43	1182.14	1178.96	1177.84	1177.70	1175.56
224.80	2500	1152.00	1159.90	1160.01	1160.17	1161.19	1162.82	1163.48	1164.46	1166.92	1168.68	1169.52	1172.24	1176.26	1180.55	1182.26	1179.08	1177.95	1177.81	1175.67
224.90	3000	1154.00	1160.07	1160.19	1160.34	1161.34	1162.95	1163.61	1164.57	1167.01	1168.77	1169.60	1172.30	1176.30	1180.57	1182.27	1179.11	1177.98	1177.85	1175.72
224.99	3500	1154.00	1160.26	1160.38	1160.53	1161.52	1163.10	1163.75	1164.71	1167.12	1168.87	1169.69	1172.39	1176.35	1180.61	1182.30	1179.15	1178.03	1177.90	1175.78
225.09	4000	1152.00	1160.56	1160.67	1160.83	1161.80	1163.37	1164.01	1164.98	1167.41	1169.17	1170.00	1172.72	1176.73	1181.03	1182.75	1179.55	1178.42	1178.28	1176.13
225.18	4500	1152.00	1160.85	1160.96	1161.11	1162.03	1163.55	1164.18	1165.13	1167.54	1169.28	1170.11	1172.81	1176.81	1181.10	1182.81	1179.62	1178.49	1178.35	1176.21
225.28	5000	1154.00	1161.21	1161.31	1161.45	1162.33	1163.78	1164.38	1165.31	1167.66	1169.38	1170.20	1172.86	1176.81	1181.06	1182.75	1179.60	1178.48	1178.35	1176.24
225.37	5500	1154.00	1161.50	1161.61	1161.75	1162.62	1164.05	1164.64	1165.56	1167.88	1169.58	1170.39	1173.04	1176.97	1181.20	1182.89	1179.76	1178.65	1178.52	1176.42
225.47	6000	1154.00	1161.82	1161.93	1162.08	1162.95	1164.36	1164.93	1165.84	1168.13	1169.83	1170.63	1173.26	1177.17	1181.40	1183.09	1179.96	1178.85	1178.72	1176.64
225.56	6500	1156.00	1162.29	1162.40	1162.55	1163.40	1164.77	1165.34	1166.24	1168.49	1170.17	1170.97	1173.58	1177.50	1181.73	1183.43	1180.29	1179.18	1179.04	1176.95
225.66	7000	1150.00	1162.99	1163.05	1163.18	1163.99	1165.29	1165.83	1166.69	1168.84	1170.47	1171.25	1173.83	1177.69	1181.89	1183.58	1180.46	1179.36	1179.23	1177.16
225.75	7500	1150.00	1163.29	1163.36	1163.50	1164.33	1165.65	1166.18	1167.03	1169.14	1170.74	1171.51	1174.05	1177.86	1182.01	1183.68	1180.59	1179.50	1179.36	1177.30
225.85	8000	1156.00	1163.39	1163.48	1163.62	1164.48	1165.85	1166.40	1167.25	1169.37	1170.97	1171.75	1174.29	1178.09	1182.24	1183.91	1180.83	1179.76	1179.64	1177.62
225.94	8500	1150.00	1163.99	1164.08	1164.25	1165.17	1166.56	1167.11	1167.94	1170.01	1171.57	1172.33	1174.81	1178.56	1182.66	1184.31	1181.23	1180.11	1179.93	1177.88
226.03	8990	1154.00	1164.18	1164.31	1164.50	1165.43	1166.86	1167.42	1168.28	1170.39	1171.93	1172.69	1175.15	1178.87	1182.95	1184.57	1181.45	1180.21	1180.27	1178.56
226.13	9510	1158.00	1164.40	1165.77	1166.03	1166.62	1167.81	1168.30	1169.09	1170.98	1172.38	1173.12	1175.43	1178.90	1182.72	1184.26	1181.03	1180.93	1180.90	1179.58
226.23	10010	1168.00	1174.87	1171.21	1171.01	1171.38	1171.87	1172.14	1172.51	1173.43	1174.12	1174.85	1176.42	1179.68	1183.54	1185.26	1183.72	1182.42	1182.56	1181.32
226.32	10510	1170.00	1177.80	1175.52	1175.71	1175.90	1176.58	1176.71	1177.15	1178.10	1178.55	1178.64	1179.45	1181.36	1184.93	1186.49	1185.02	1183.91	1183.87	1182.76
226.43	11077	1174.00	1179.04	1179.25	1178.77	1179.31	1180.15	1180.20	1180.69	1181.68	1181.69	1182.17	1183.32	1184.02	1187.52	1188.49	1187.42	1186.22	1186.09	1185.10
226.54	11696	1174.00	1180.83	1180.86	1180.87	1181.42	1182.50	1182.79	1183.24	1184.57	1185.56	1185.11	1186.52	1188.43	1189.16	1190.75	1189.28	1188.43	1188.20	1187.18
226.66	12280	1172.00	1182.02	1182.14	1182.18	1183.21	1184.55	1184.89	1185.40	1186.63	1187.51	1187.83	1188.91	1190.77	1192.56	1192.40	1191.75	1191.05	1190.66	1189.59

River XSEC	Time Step 19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	Maximum CWSEL Elevation (ft, MSL)	Minimum CWSEL Elevation (ft, MSL)
224.33	1172.50	1170.35	1168.90	1166.60	1163.35	1163.24	1160.82	1160.68	1160.26	1160.08	1160.01	1159.74	1159.70	1159.61	1159.31	1159.16	1181.06	1159.16
224.42	1172.89	1170.69	1169.22	1166.88	1163.57	1163.45	1161.00	1160.86	1160.43	1160.24	1160.18	1159.90	1159.85	1159.76	1159.45	1159.30	1181.61	1159.30
224.52	1173.07	1170.87	1169.39	1167.04	1163.72	1163.60	1161.15	1161.00	1160.58	1160.38	1160.32	1160.04	1159.99	1159.90	1159.59	1159.43	1181.82	1159.43
224.61	1173.13	1170.93	1169.46	1167.12	1163.80	1163.68	1161.24	1161.09	1160.66	1160.47	1160.41	1160.13	1160.08	1159.99	1159.68	1159.52	1181.85	1159.52
224.71	1173.35	1171.13	1169.65	1167.30	1163.96	1163.84	1161.39	1161.23	1160.81	1160.62	1160.55	1160.28	1160.23	1160.13	1159.82	1159.66	1182.14	1159.66
224.80	1173.45	1171.23	1169.76	1167.40	1164.07	1163.95	1161.52	1161.37	1160.95	1160.76	1160.70	1160.43	1160.37	1160.28	1159.97	1159.81	1182.26	1159.81
224.90	1173.51	1171.31	1169.85	1167.51	1164.21	1164.09	1161.71	1161.55	1161.15	1160.96	1160.91	1160.65	1160.60	1160.51	1160.22	1160.06	1182.27	1160.06
224.99	1173.59	1171.40	1169.94	1167.62	1164.34	1164.22	1161.86	1161.71	1161.32	1161.13	1161.08	1160.81	1160.77	1160.68	1160.39	1160.23	1182.30	1160.23
225.09	1173.91	1171.70	1170.23	1167.88	1164.58	1164.46	1162.13	1161.98	1161.59	1161.40	1161.36	1161.10	1161.06	1160.98	1160.70	1160.54	1182.75	1160.54
225.18	1174.00	1171.80	1170.34	1168.02	1164.81	1164.70	1162.53	1162.40	1162.07	1161.91	1161.87	1161.67	1161.63	1161.58	1161.34	1161.23	1182.81	1160.85
225.28	1174.06	1171.90	1170.47	1168.21	1165.13	1165.01	1163.04	1162.90	1162.59	1162.44	1162.38	1162.18	1162.13	1162.08	1161.83	1161.72	1182.75	1161.21
225.37	1174.26	1172.12	1170.71	1168.48	1165.45	1165.34	1163.40	1163.26	1162.95	1162.80	1162.74	1162.52	1162.48	1162.42	1162.16	1162.05	1182.89	1161.50
225.47	1174.49	1172.37	1170.98	1168.78	1165.80	1165.69	1163.76	1163.63	1163.32	1163.16	1163.10	1162.87	1162.82	1162.77	1162.50	1162.38	1183.09	1161.82
225.56	1174.80	1172.68	1171.29	1169.10	1166.15	1166.05	1164.11	1163.98	1163.67	1163.51	1163.46	1163.23	1163.19	1163.14	1162.86	1162.75	1183.43	1162.29
225.66	1175.04	1172.95	1171.59	1169.46	1166.63	1166.52	1164.63	1164.48	1164.17	1164.00	1163.95	1163.72	1163.68	1163.63	1163.36	1163.25	1183.58	1162.99
225.75	1175.19	1173.12	1171.77	1169.69	1166.91	1166.80	1164.95	1164.83	1164.54	1164.39	1164.37	1164.18	1164.15	1164.11	1163.86	1163.76	1183.68	1163.29
225.85	1175.57	1173.54	1172.21	1170.23	1167.58	1167.58	1165.76	1165.67	1165.39	1165.25	1165.24	1165.02	1164.98	1164.92	1164.65	1164.54	1183.91	1163.39
225.94	1175.81	1173.93	1172.98	1171.43	1169.26	1169.15	1167.42	1167.25	1166.95	1166.80	1166.72	1166.50	1166.44	1166.38	1166.13	1166.04	1184.31	1163.99
226.03	1177.06	1175.71	1174.59	1173.01	1170.97	1170.76	1169.28	1169.15	1168.86	1168.72	1168.63	1168.44	1168.40	1168.33	1168.11	1168.05	1184.57	1164.18
226.13	1178.22	1176.76	1175.75	1174.28	1172.45	1172.24	1170.91	1170.86	1170.68	1170.59	1170.45	1170.42	1170.26	1170.23	1170.17	1169.96	1184.26	1164.40
226.23	1180.01	1178.75	1177.94	1176.84	1175.38	1175.30	1174.39	1174.25	1173.99	1173.89	1173.90	1173.69	1173.73	1173.70	1173.42	1173.39	1185.26	1171.01
226.32	1181.44	1180.27	1179.50	1178.37	1176.76	1176.72	1175.46	1175.37	1175.10	1175.00	1174.95	1174.77	1174.79	1174.71	1174.46	1174.36	1186.49	1174.36
226.43	1183.61	1182.29	1181.50	1180.28	1178.51	1178.43	1176.97	1176.88	1176.58	1176.46	1176.40	1176.19	1176.19	1176.10	1175.83	1175.72	1188.49	1175.72
226.54	1185.69	1184.42	1183.66	1182.43	1180.58	1180.52	1178.87	1178.79	1178.51	1178.39	1178.32	1178.14	1178.09	1178.03	1177.83	1177.72	1190.75	1177.72
226.66	1188.17	1186.95	1186.09	1184.85	1183.12	1182.96	1181.38	1181.16	1180.73	1180.49	1180.38	1179.93	1179.82	1179.73	1179.45	1179.29	1192.56	1179.29

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APPENDIX C

Sample Calculations for Scour Analysis
100-Year, 10-Day Flood

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

ROBERT L. WARD, P.E. | Consulting Engineer

Client *Premier Engineering* | Page *1/3*
Project No. *PE-01* | Date *7/31/98*
Project Name *SRPMIC North-Bank Levee* | Computed By *RLW*

Sample Calculations For Scour Analysis

Use XSEC 225.85 From Table 4.1

1. Equilibrium Slope (.00047 ft/ft from SLA report)

Distance from Grade Control No. 5 = 14,840 ft
Elevation of Grade Control No. 5 = 1147.00 ft MSL

Project equilibrium slope @ XSEC 225.85:

$$(14,840)(.00047) + 1147.00 = 1153.97 \text{ ft MSL}$$

Thalweg elevation @ XSEC 225.85 = 1156.00 ft MSL

∴ Equilibrium slope is (1156 − 1153.97) = 2.03 ft below existing thalweg.

Q_{10} armor depth = 0.3-ft from SLA report.

Since 0.3-ft < 2.03-ft, use 0.3-ft as long-term degradation component.

2. Maximum General Scour

A value of -0.33-ft is read from Table A1 (Appendix A) under the "Maximum Scour" column

3. Bend Scour

$$Z_{bs} = \frac{0.0685 Y V^{0.8}}{Y_h^{0.4} S_e^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{\alpha}{2}}{\cos \alpha} \right)^{0.2} - 1 \right]$$

$Y = 28.08'$
$V = 8.72$ fps
$Y_h = 22.03'$
$S_e = .000703$ ft/ft
$\alpha = 22°$

$$Z_{bs} = \frac{(.0685)(28.08)(8.72)^{0.8}}{(22.03)^{0.4}(.000703)^{0.3}} \left[2.1 \left(\frac{\sin^2 \frac{22°}{2}}{\cos 22°} \right)^{0.2} - 1 \right]$$

$$Z_{bs} = (27.8746)(0.09907)$$

$$Z_{bs} = \underline{2.76 \text{ ft}}$$

4. Dune Troughs

$$\log d = 0.8271 \log A + 0.8901$$

d = flow depth (meters) = (28.08)(.305) = 8.5644 meters

$$\log(8.5644) = 0.8271 \log A + 0.8901$$

$$\log A = 0.05150156305$$

$$A = 1.1259 \text{ meters} = 3.6939 \text{ ft}$$

Since "A" is the dune height from trough to crest, 1/2 of this value is the depth below the river-bed.

$$\therefore \tfrac{1}{2} A = \tfrac{1}{2}(3.6939) = \underline{1.85 \text{ ft}}$$

5. Anti-Dune Troughs

$$Z_{bf} = 0.0135\ V^2$$

$$V = 8.72 \text{ fps}$$

$$\therefore Z_{bf} = (0.0135)(8.72)^2$$

$Z_{bf} =$ 1.03', which is < ½ the flow depth

The anti-dune trough depth is less than the dune trough depth. Therefore, the dune trough depth of 1.85' will be used in the total scour calculation.

6. Low-Flow Incisement

For this cross-section, 1.5-ft of low-flow incisement was judgementally selected.

7. Total Computed Scour Depth

0.3	Long-term degradation
0	Local scour
0.33	General scour
2.76	Bend scour
1.85	Bed-form troughs
1.50	Low-flow incisement
Total: 6.74	
× 1.5	Safety Factor
10.11'	Maximum Total Scour Depth

Since 10.11' > 10.00' minimum criteria, use 10.11' of scour.

Scour elevation = 1156.00 − 10.11 = 1145.89-ft MSL.

PLATES

Proposed SRPMIC North-Bank Levee
Salt River
Pima Freeway to Alma School Road

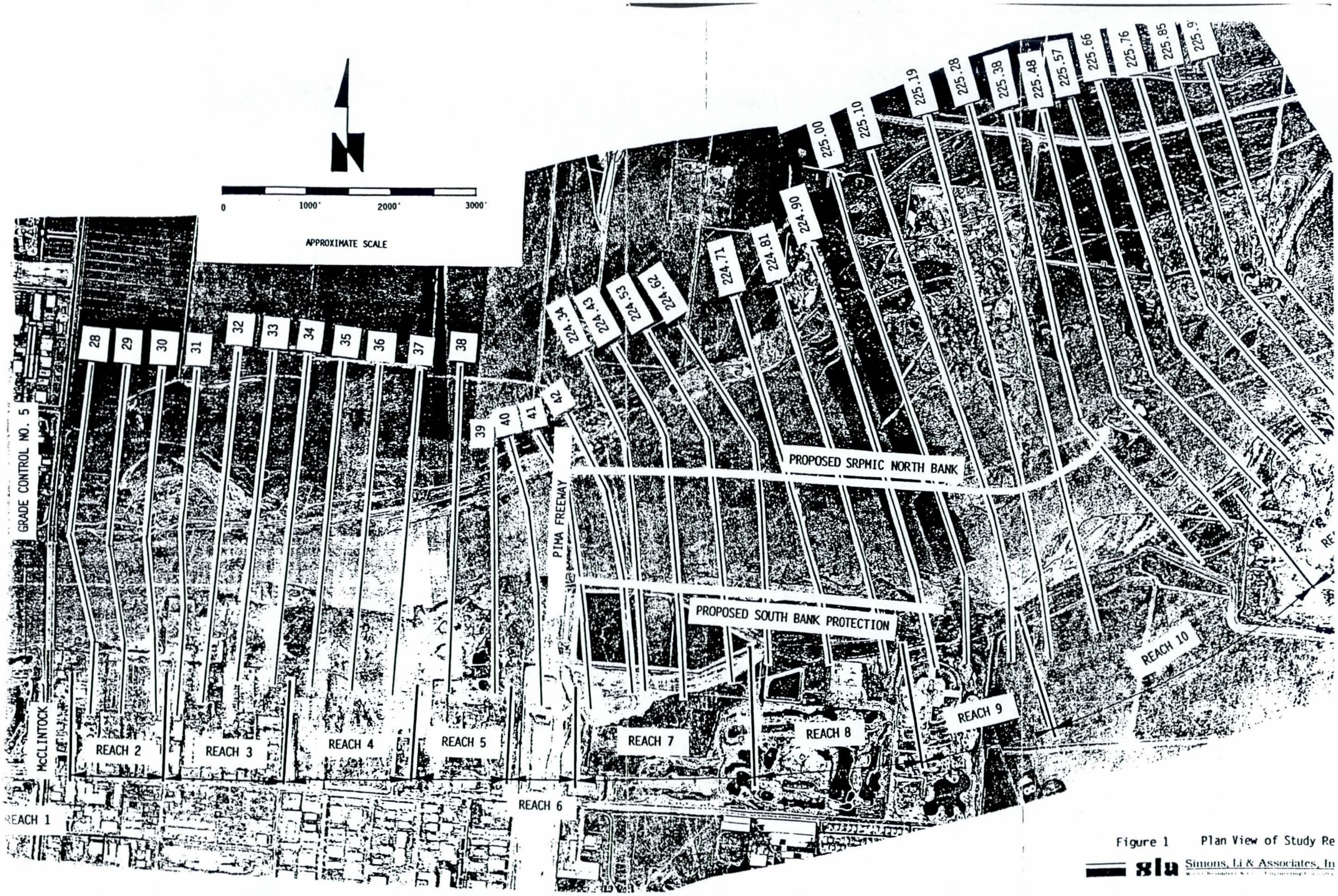
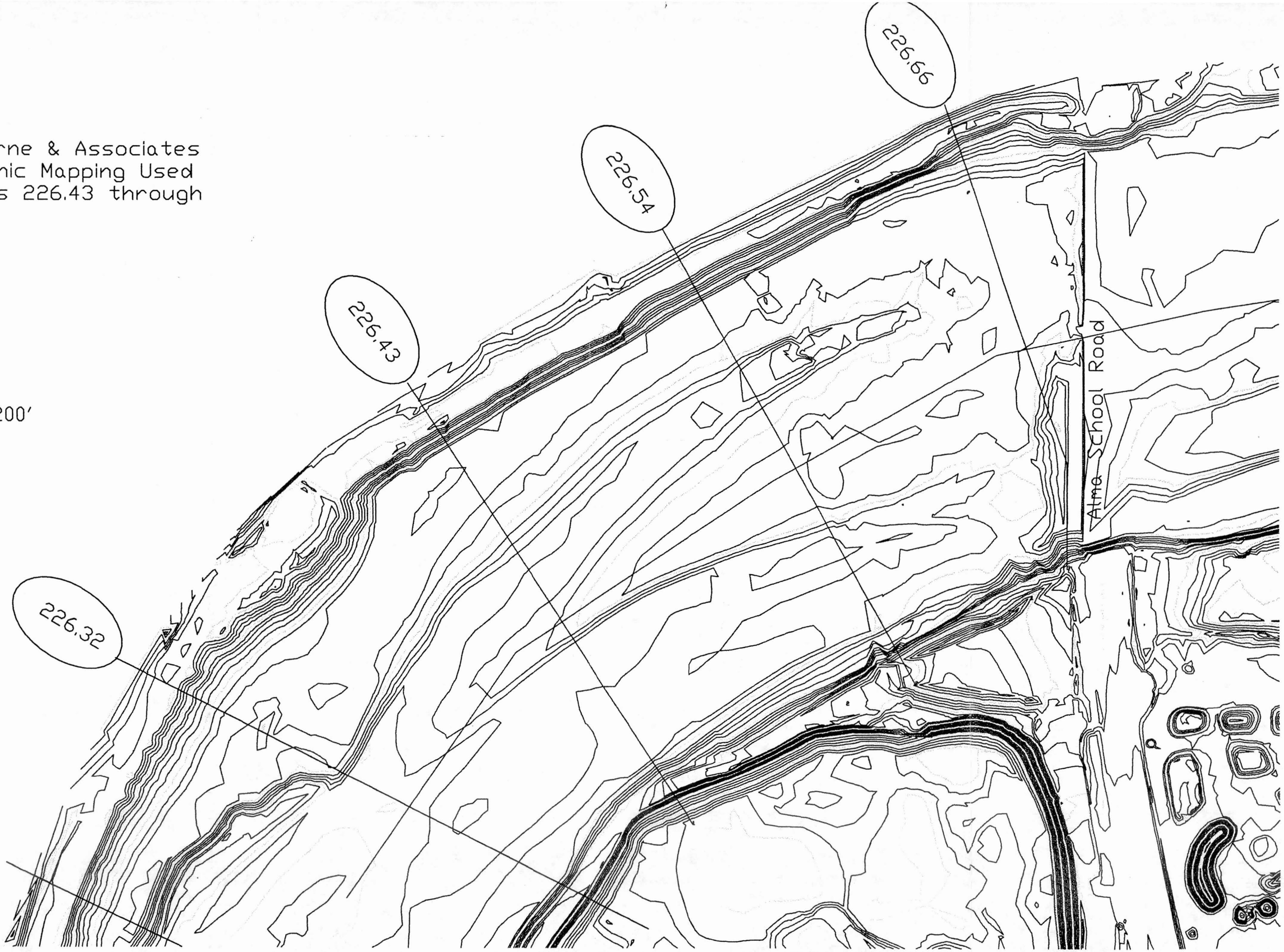


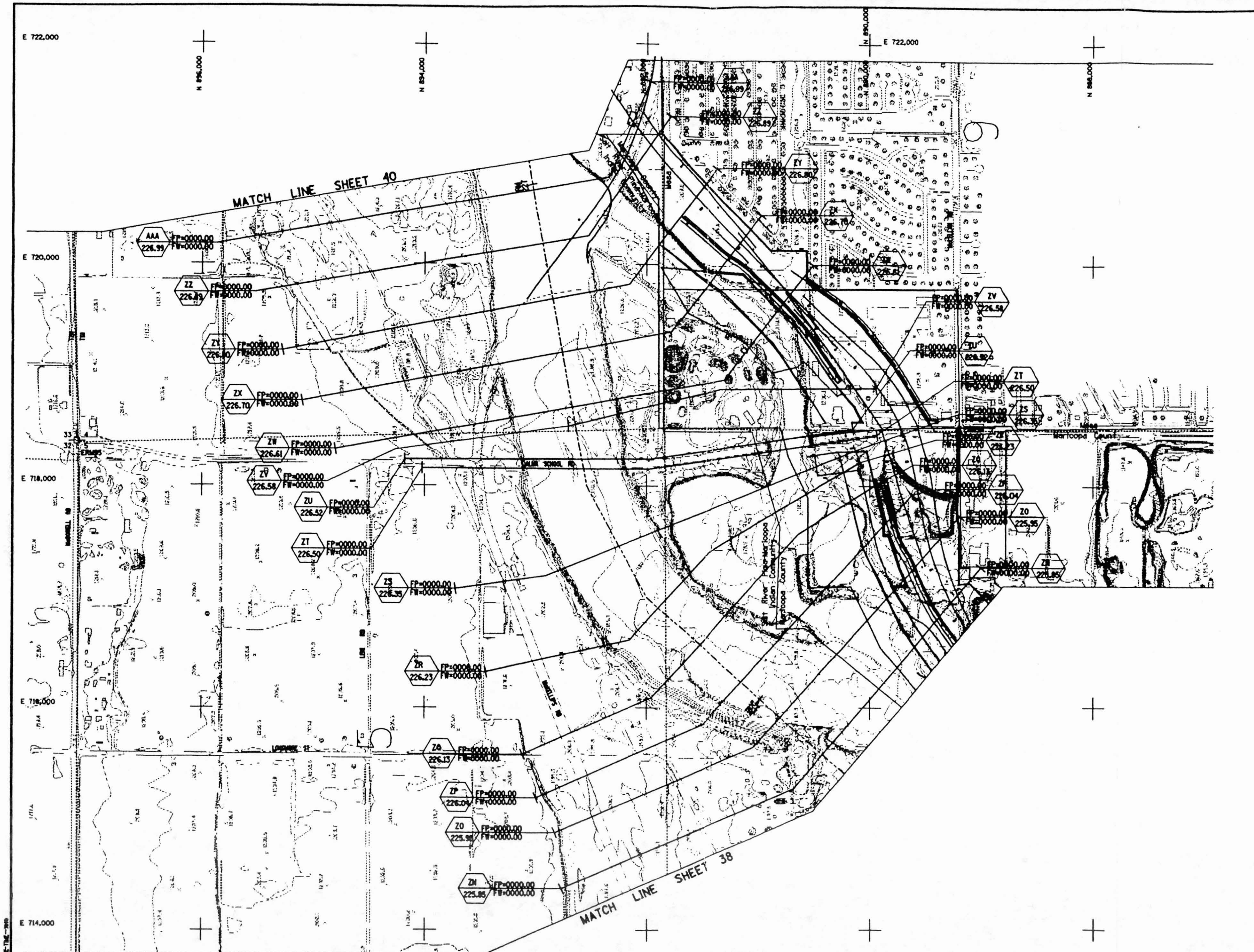
Figure 1 Plan View of Study Re

Simons, Li & Associates, In

Kimley-Horne & Associates
Topographic Mapping Used
For XSECs 226.43 through
226.66

1" = 200'





FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SALT - GILA RIVERS

F.C.D. CONTRACT NO. 90-59 & 92-01

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	RM 12.0 — RM 13.0
STATION 200+00	
CROSS SECTION	FP=100 Yr WSE / FW=Floodway WSE
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
BENCH MARK LOCATION	BM 144 ▲
APPROXIMATE SECTION CORNER	20 21 / 29 28
MAIN CHANNEL LIMITS	

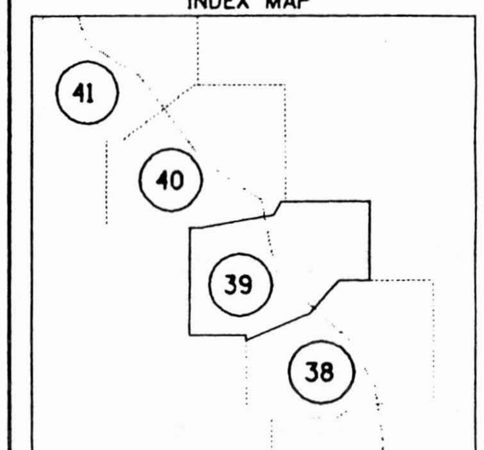
ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1983

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
94	1204.35	A BC in a HH in the intersection of McLellan Rd. and Alma School Rd. This point is the one quarter corner between Sec. 8 and 9 of T 1 N, R 5 E of the G&SRB&M Maricopa County, Arizona.
95	1218.72	A BC in a HH in the intersection of Alma School Rd. and McDowell Rd. This point is the SE corner of Sec. 32, T 2 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.

PRELIMINARY FOR INTERNAL USE ONLY

INDEX MAP



400 0' 400 800
SCALE: 1"= 400'
CONTOUR INTERVAL = 4 FEET

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	RLD	-
DESIGN CHK.	TEK	-
PLANS	SSO	-
PLANS CHK.	RLD/TEK	-

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

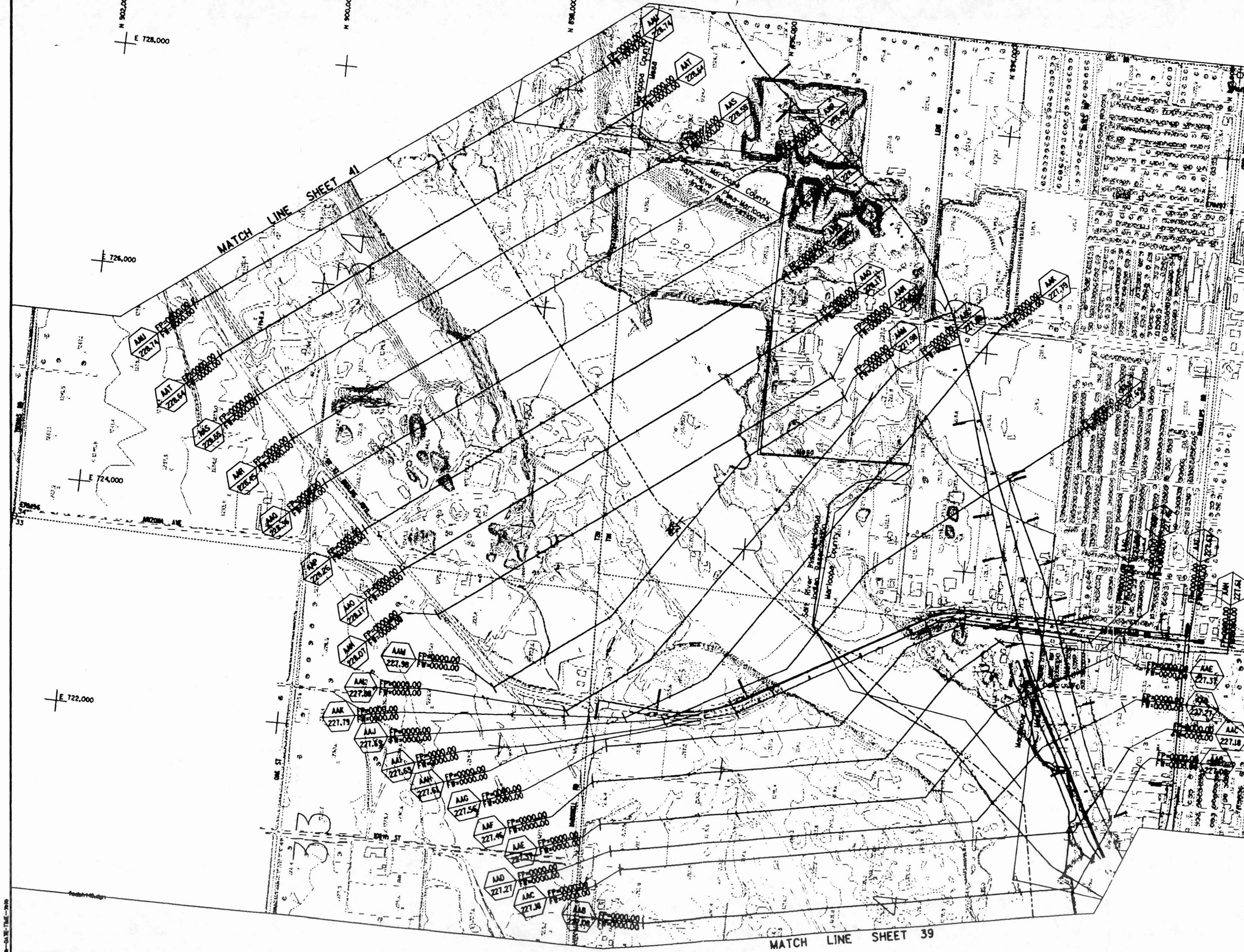
CHIEF ENGINEER AND GENERAL MANAGER

SHEET 39 OF 46

x43e/usr3/fcd/fcdsnt39.dgn

AERIAL MAPPING COMPANY, MCLAUGHLIN KMETZ CO. INC. BAKER ENGINEERS, SURVEYING COMPANY, JAYKIM ENGINEERS & GREINER ENGINEERS.

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS 1"=400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY JAYKIM ENGINEERS & GREINER ENGINEERS



AERIAL MAPPING COMPANY, MCLAUGHLIN/ROBERTS CO. INC. BAKER ENGINEERS.
SURVEYING COMPANY, JAYTON ENGINEERS & GREINER ENGINEERS.
FLIGHT DATES 13 DEC. 1991 ; 13 JAN. 1992 ; 23 JAN. 1992

THIS MAP WAS PREPARED BY PHOTOGRAMMETRIC METHODS TO NATIONAL MAP ACCURACY STANDARDS 1"=400' HORIZONTAL SCALE AND 4' CONTOUR INTERVALS AND BASED ON GROUND CONTROL SURVEY DATA PROVIDED BY JAYTON ENGINEERS & GREINER ENGINEERS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

FLOOD DELINEATION STUDY OF SALT - GILA RIVERS

F.C.D. CONTRACT NO. 90-59 & 92-01

LEGEND

100-YR FLOODPLAIN BOUNDARY	
FLOODWAY BOUNDARY	
HYDRAULIC BASE LINE WITH RIVER MILE	RM 12.0 — RM 13.0
STATION 200+00	
CROSS SECTION	
ELEVATION REFERENCE MARK	ERM3 X
BASE FLOOD ELEVATIONS	1221
ZONE DESIGNATIONS	ZONE AE
CORPORATE LIMITS	Corporate Limits
BENCH MARK LOCATION	BM 144 ▲
APPROXIMATE SECTION CORNER	20 21 / 29 28
MAIN CHANNEL LIMITS	

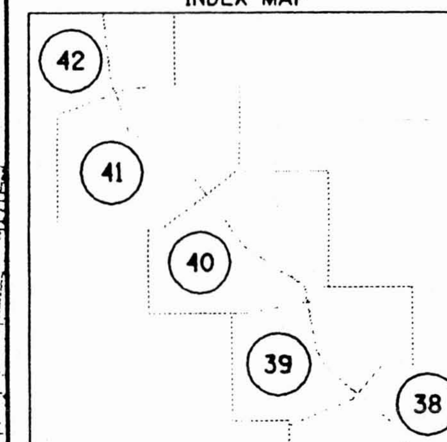
ELEVATION REFERENCE MARKS

NOTE: ALL ELEVATIONS ARE BASED ON NATIONAL GEODETIC VERTICAL DATUM OF 1983

I.D. #	ELEV (FT)	DESCRIPTION/LOCATION
96	1244.28	A BC in a HH in the intersection of Thomas Rd. and Arizona Ave. This point is the NE corner of Sec. 33, T 2 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.
97	1219.19	A BC in a HH in the intersection of Center St. and McKellips Rd. This point is the N quarter corner of Sec. 10, T 1 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.
98	1224.71	A BC in a HH in the intersection of Mesa Dr. and McKellips Rd. This point is the NE corner of Sec. 10, T 1 N, R 5 E of the G&SRB&M, Maricopa County, Arizona.

PRELIMINARY FOR INTERNAL USE ONLY

INDEX MAP



N

400 0' 400 800

SCALE: 1"= 400'

CONTOUR INTERVAL = 4 FEET

MICHAEL BAKER JR INC.

	BY	DATE
DESIGN	RLD	-
DESIGN CHK.	TEK	-
PLANS	SSO	-
PLANS CHK.	RLD/TEK	-

SUBMITTED BY: DATE:

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

RECOMMENDED BY: DATE

APPROVED BY: DATE

CHIEF ENGINEER AND GENERAL MANAGER

SHEET 40 OF 46