Technical Data Notebook (TDN)

Salt River Channelization
Floodplain Delineation Study
Southern Pacific Railroad Salt River Bridge
to McClintock Drive Bridge

Project No. 906345B
Salt River Flood Plain Revisions

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prepared for

Rio Salado Task Force
City of Tempe
Tempe, Arizona

by

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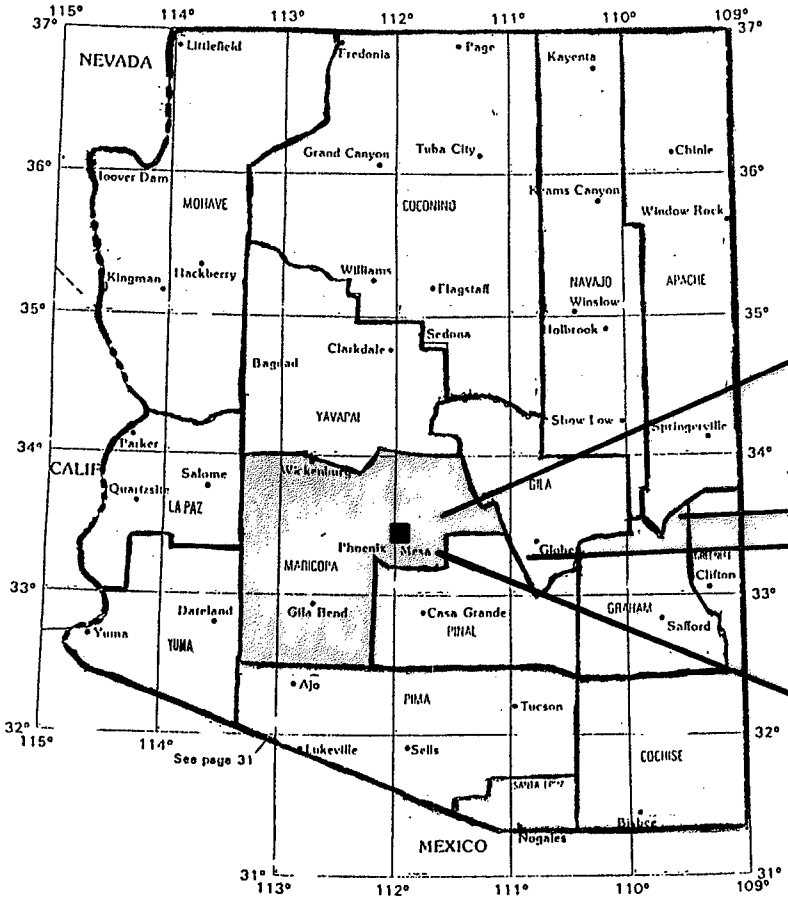
I. INTRODUCTION

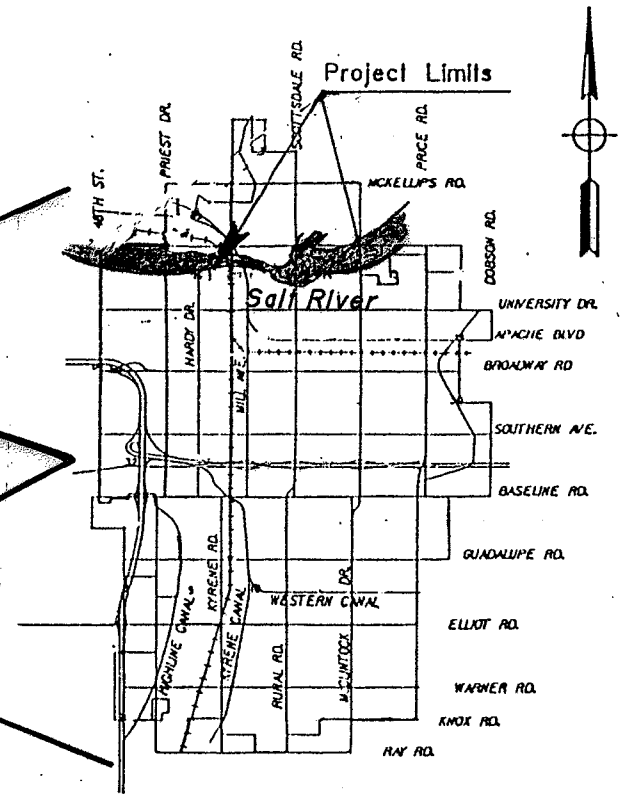
1.1 Purpose

The purpose of this report is to document the changes in the Salt River channel alignment, profile and section which have been constructed and are planned through the community of Tempe, Arizona (see Figure 1). This report covers the second phase of river channel improvements which were designed by the City of Tempe and constructed by the Arizona Department of Transportation (ADOT) in conjunction with the construction of the East Papago Freeway (Loop 202). The Tempe segment of construction begins 1.71 miles east of the jurisdictional boundary between the communities of Tempe and Phoenix. These river channel improvements, together with the first phase of construction are part of the general plan for river corridor improvements, known as Tempe Rio Salado, which covers the entire reach of the Salt River through Tempe. Tempe retained CRSS Civil Engineers, Inc., to design the second phase of channelization of the Salt River to the McClintock Drive bridge, which is located one-quarter mile west of the eastern City limit.

Separate letters of map revision have been prepared for each design reach of the Salt River due to the staging of construction and the various differences in design criteria and methods adopted by the City of Tempe and ADOT. Channel construction on the first phase (ADOT reach) began July 1989 and was substantially completed in March 1991. Channel construction for the second phase (Tempe reach) began December 1990 and is scheduled to be completed in July 1994. Design criteria for both reaches were set to conform to FEMA requirements for channels with levees and additional requirements for channel capacity and scour as recommended by the Maricopa County Flood Control District.



ARIZONA



TEMPE

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PROJECT VICINITY MAP
FIGURE I

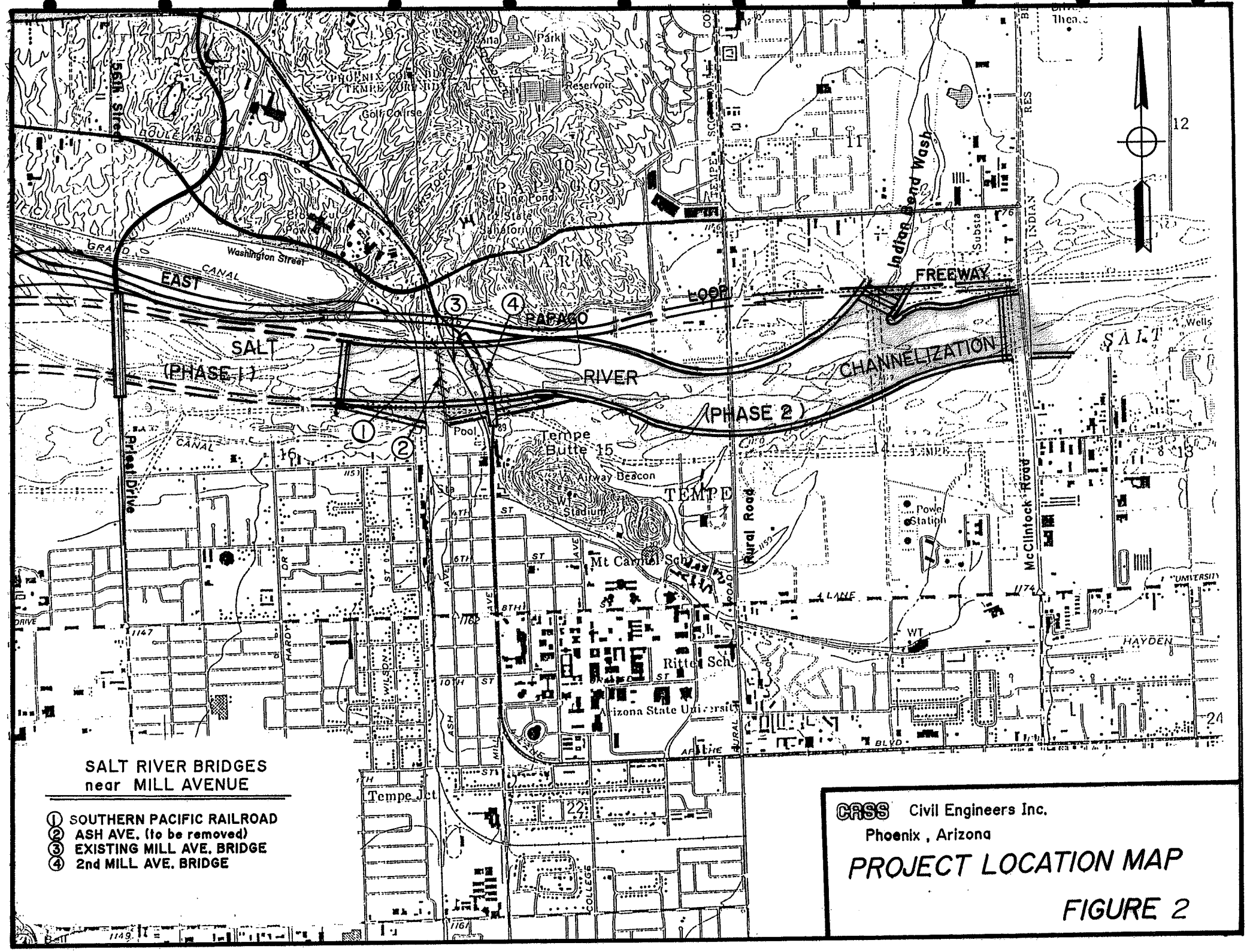
1.2 Background

The planning for the Tempe Rio Salado project began in 1976 with in initiation of the "Tempe Rio Salado Design Study" which provided an overview of channel improvements and alternative landuses for the Salt River corridor within Tempe. This conceptual phase was extended in 1978 with the completion of the "Tempe Rio Salado Master Plan Study". Based on this study the Tempe City Council adopted a plan alternative and created an overlay zoning district. In 1980 the Tempe Rio Salado Commission was created to review building permits within the overlay district. In 1981 plans for the Rio Salado Concept were proposed for the entire Salt River corridor within metropolitan Phoenix. However, in 1987 the funding of this larger project was rejected by Maricopa County voters. In 1988 the Tempe Rio Salado Master Plan was updated and plans were made to coordinate the initial phases of channel construction with construction of the East Papago Freeway. In March 1988, the Tempe City Council approved an update to the Tempe Rio Salado Master Plan.

The Tempe Rio Salado project includes approximately 6.5 miles of channel improvements for the Salt River. The Tempe Rio Salado Salt River channelization is being completed in two phases. The first phase includes the Salt River reach from 48th Street to a location 1,500 feet west of the Southern Pacific Railroad Salt River bridge. Design and construction of this phase was completed by the Arizona Department of Transportation together with the construction of the East Papago Freeway. A portion of the freeway was located on land which was removed from the Salt River floodplain by channel construction. The second phase (see Location Map, Figure 2) extends the channelization of the Salt River to the McClintock Drive bridge, just east of the eastern boundary of Tempe. The design of this phase was completed by the City of Tempe and the Flood Control District of Maricopa County. Construction funding was provided by the Flood Control District of Maricopa County and the Arizona Department of Transportation.

The basic purpose of the project is to construct a bank-stabilized floodway capable of controlling flooding and erosion along the Salt River within the City of Tempe. Additional in-channel uses that are foreseen in the Rio Salado Masterplan include, recreation (hiking and biking trails) and improvement of riparian habitat (replanting of

bank terrace areas and establishment of a low-flow riparian strand). These additional uses are planned to be compatible with the overall hydraulic performance of the floodway as proposed in this analysis. The reestablishment of riparian habitat complies with stipulations that are part of the Section 404 permit issued by the U.S. Army Corps of Engineers for the project.


SALT RIVER BRIDGES
near MILL AVENUE
① SOUTHERN PACIFIC RAILROAD
② ASH AVE. (to be removed)
③ EXISTING MILL AVE. BRIDGE
④ 2nd MILL AVE. BRIDGE
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Phoenix, Arizona
PROJECT LOCATION MAP
FIGURE 2
SALT
(PHASE 1)
RIVER
CHANNELIZATION
(PHASE 2)
EAST
LOOP
FREEWAY
PAPAGO
PARK
Indian Bend Wash
Washington Street
56th Street
Priest Drive
Rural Road
McClintock Road
Tempe Butte
Airway Beacon
TEMPE
Mt Carmel Sch
Ritter Sch
Arizona State University
Tempe Jct
Golf Course
Reservoir
Pool
Stadium
Power Station
Substa
Wells
HAYDEN
BOULEVARD
GRAND
CANAL
LAKE
BLVD
COLLEGE
ASH
MILL
WILSON
HARDY
DRIVE
UNIVERSITY
INDIAN
RES
TEMPE
SCOTTSDALE
12
11
10
9
16
15
14
13
22
24

II. GENERAL DOCUMENTATION AND CORRESPONDENCE

The following documentation is submitted (see Appendix A) for the change in base flood elevation:

(a) Project plans, certified by a registered professional engineer in the State of Arizona, dated May 1, 1989.

(b) Public notice of intent to revise the floodway and notification of affected property owners and jurisdictions.

(c) Letter notifying the Arizona Department of Water Resources of the floodway revision.

(d)

III. MAPPING AND SURVEY INFORMATION

The project is located in the Tempe 7.5 minute quadrangle. Aerial mapping of topographic and planimetric features for the Salt River floodplain was conducted by McLain Harbers Co., Inc. for the City of Tempe in December of 1988. Topographic mapping consists of a digital elevation model and a series of digital planimetric models. Previous topographic mapping for ADOT freeway plans was based on aerial mappings conducted by Kenney Aerial Mapping, Inc., dated March thru April 1987. The Tempe survey used vertical and horizontal control established by ADOT for the East Papago Freeway corridor. The control is based on the 1929 vertical datum.

The current floodplain delineation for the Salt River (FEMA 1984) is based on mapping conducted by the Corps of Engineers in 1983. At the time of the Corps aerial survey, the flood control channel to the west of Tempe and south of the Sky Harbor International Airport was under construction. The floodplain delineation was therefore based on design plans for that channelization. In 1987, Maricopa County compiled more recent mapping (including the ADOT aerial survey) and conducted an updated delineation of the Salt River floodplain (Burgess & Niple, 1987). For this study the ADOT maps were also used to provide topographic information on the final configuration of the Sky Harbor Salt River channelization. The tie to the established FIS water surface elevation was made downstream of Sky Harbor Airport at the 1-10 Salt River bridge (COE Cross-section 16.927).

The accuracy of the Tempe digital models is such that at least 90 percent of all well-defined planimetric features are within 1/100 inch of true horizontal position (±5.0 feet). Vertical accuracy is such that 90 percent of the points are within 0.5 feet. This accuracy was sufficient to produce flood plain contour maps at the scale of 1"=200' with 2-foot contour intervals.

IV. HYDROLOGIC ANALYSIS

The basis for the current hydrology on the Salt River is the report of May 1982, "Gila River and Tributaries, Central Arizona Water Control Study, Hydrology" by the Los Angeles District, U.S. Army Corps of Engineers. That report (referred to herein as the "CAWCS Hydrology") provides the hydrology (discharge/frequency) for the existing conditions on the Salt River. This hydrology was adopted for the Flood Insurance Study and is the hydrology used for all channel improvements to the Salt River in the City of Tempe. For the Tempe reach of the Salt River, the CAWCS study provides the following discharge/frequency relationship at the Mill Avenue bridge:

Table 1
Discharge/Frequency Salt River at Mill Avenue Bridge*

Frequency	Discharge
5	40,000
10	93,000
20	135,000
50	160,000
100	215,000
200	275,000
500	330,000

*from Table 1, LA ACE (1988)

The Corps of Engineers has set a Standard Project Flood discharge of 296,000 cfs for the Salt River at Mill Avenue. Because of the elevation of existing bridge low cords (primarily at Rural Road), the maximum design discharge was set equal to the maximum capacity of the Salt River at the minimum low chord elevation. A study of channel profile and cross section was conducted to determine this maximum discharge which was found to be 250,000 cfs. Design criteria were developed based on both the water-surface profile due to the maximum discharge and the 100-year flood.

The CAWCS hydrology routed Granite Reef hydrographs through the downstream reaches of the Salt River. Tributary inflows are not included in the reach from Granite Reef Dam to the I-10 Salt River bridge, and the hydrograph peak gradually attenuates as it moves through this reach presumably due to floodplain storage alone. The flood hydrographs, routed to Tempe's jurisdictional boundary, are used as the basis for design following the recommendation of the Flood Control District of Maricopa County (Johnson to Bond, November 1991).

To complete the discussion of available hydrology on the Salt River, the following facts should also be noted:

1. Operationally, nearly all low flows on the Salt River are diverted or stored when possible. For the period between 1941 and 1966, there was zero discharge to the Salt River channel below Granite Reef Dam. According to the CAWCS hydrology, such a period of zero flow should be extremely rare. However, periods of low or no-flow are common, indicating that flood discharges for more frequent floods (25 years and less) are overestimated.

2. CAWCS hydrology was revised (LACOE, 1988) following the rejection of Plan 6 of the Central Arizona Project. This plan called for the construction of an additional dam on the Verde River called Cliff Dam. The subsequent hydrology is based on Plan 9, which provides for the modification of Roosevelt Dam on the Salt River for dam safety and flood control. This plan will not be operational until 1995, therefore this revised hydrology was not incorporated into the channel improvements for the Salt River in Tempe.

V. HYDRAULIC ANALYSIS

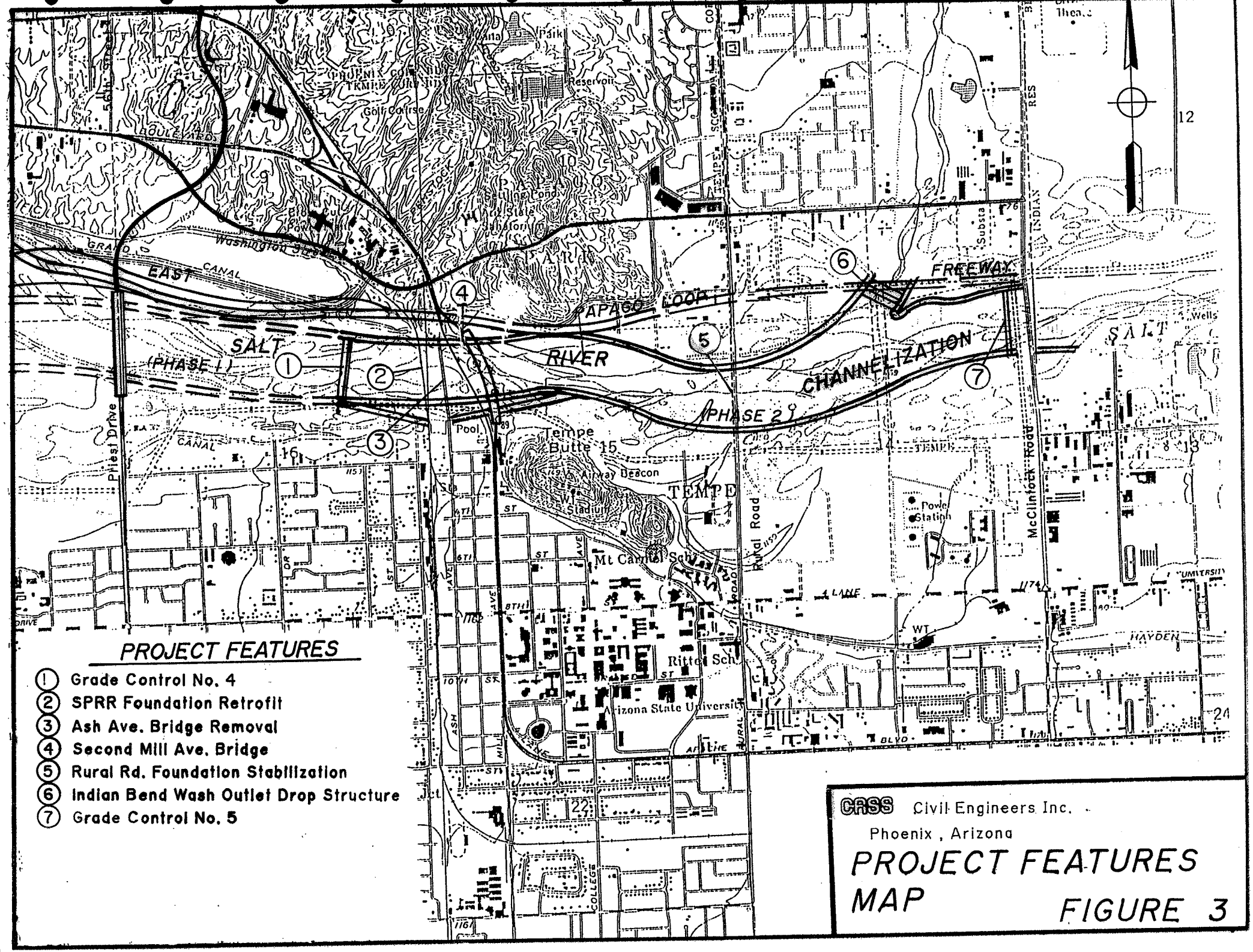
5.1 Description of Changed Hydraulic Conditions

The Tempe Rio Salado Salt River channelization provides a stabilized channel section which follows the natural river alignment for the reach in Tempe. The channel profile is set at a milder grade than the existing profile to accommodate the anticipated amount of long-term degradation in the river channel. The design features for the channelization include levee embankments, bank protection, grade-control and drop structures, penetrations for tributary drainage, and stabilization of bridge foundations.

5.1.1 River Alignment

The river alignment was selected to conform to the dominant geomorphic features of the natural Salt River channel. In addition, the channel alignment addressed the location of various bridges and existing developments adjacent to the Salt River. Public utilities were relocated as necessary to accommodate the channel alignment. Because of the large size of the Salt River, channel bends were set at a gradual rate of curvature. For the planned channel width of about 1000 feet, the minimum radius of curvature for the main channel was set at approximately one mile, or greater than a one-degree curve (see Figure 3).

Historically, the Salt River east of the Tempe Buttes was a braided, gravel bed channel that had wide and relatively shallow cross section. Today, the upper reach of the Salt River, east of Country Club Road, is the only remaining reach of the original braided channel of the Salt River. In a braided channel, the individual braids are quite sinuous and tend to meander and intertwine. The reach of the Salt River through Tempe had several additional fluvial features associated with the outcropping of bed rock in the river channel near the Tempe Buttes. This outcrop resulted in a meandering channel for about one mile upstream of the rock outcrop which was referred to as the Indian Bends. This meandering channel alignment occurred due to the reduction in channel grade and the deposition of sediments caused by the natural floodplain constriction at the buttes. Further upstream, the confluence of the Indian Bend Wash with the Salt River imparts a prominent bend to the Salt River channel between Rural Road and McClintock Drive.


PROJECT FEATURES
1 Grade Control No. 4
2 SPRR Foundation Retrofit
3 Ash Ave. Bridge Removal
4 Second Mill Ave. Bridge
5 Rural Rd. Foundation Stabilization
6 Indian Bend Wash Outlet Drop Structure
7 Grade Control No. 5
SALT
(PHASE I)
RIVER
CHANNELIZATION
PHASE 2
EAST
CANAL
PAPAGO
LOOP
FREEWAY
Tempe Butte
Airway Beacon
TEMPE
Mt Carmel Sch
Ritter Sch
Arizona State University
Rural Road
McClintock Road
Priest Drive
Pool
Golf Course
Reservoir
Power Station
HAYDEN
CRSS Civil Engineers Inc.
Phoenix, Arizona
PROJECT FEATURES MAP
FIGURE 3

This bend occurs in response to flow from Indian Bend Wash and sediment deposition that deflected the main channel of the Salt River toward its south channel bank.

The levee alignments are constrained by the location of existing bridges. The study reach originally had five bridges, including: Southern Pacific Railroad, Ash Avenue, Mill Avenue, Rural Road and McClintock Drive bridges. However, the Ash Avenue bridge was demolished during the course of the channel design due to its deteriorated condition. Two new bridges are to be constructed within the study reach, the first is the East Papago Freeway over Indian Bend Wash; and second Mill Avenue bridge to replace the north bound at-grade river crossing. The levee alignments have been set to provide a guide the flow efficiently to each bridge opening. Because of the severe skew of the existing Mill Avenue bridge, a separate study of levee alignments and flow conditions was conducted during the concept design phase for the project (CRSS Commercial Group, Inc. 1989).

5.1.2 Channel Profile

The channel profile was set to meet two objectives: (1) reduce flood elevations; and (2) provide a stable channel invert that is not subject to substantial aggradation or degradation. To accommodate a milder channel grade, drop structures were added at Indian Bend Wash and at McClintock Drive (see Figure 3). The deepening of the channel thalweg increased the capacity of the floodway, which reduced the stage in the remaining floodplain.

Since the prevailing grade of the Salt River throughout the City of Tempe is about 0.016 feet/foot (about eight feet per mile), a potential consequence of a reduced channel gradient is deposition of sediment. However, the possibility of significant sediment deposition in the Tempe reach is low because of the large volume of sand and gravel production in the upper reaches of the Salt River at this time. Also there is a substantial storage of sediments in the series of upper basin dams on the Salt and Verde Rivers. Given the present condition of sediment supply on the Salt River, the channel is actually sediment-deficient, and the river reach has generally degraded during recent floods. Reduction of the river grade in this reach will therefore arrest the scouring process and provide a more stable river reach.

5.1.3 Channel Section

The river cross section provides conveyance for the design flood discharge through the reach with approximately the same hydraulic characteristics (velocity and flow depth) as the existing channel. The section includes stabilized channel banks to control any lateral erosion during major flood flows. Hydraulic features of the cross section include a low-flow channel capable of conveying minor Salt River Project spills, a main floodway with the capacity for the maximum discharge and intermediate terraces set near the elevation of the ten-year flood for re-establishment of riparian vegetation and habitat areas (see Figure 4).

The channel section varies in the reach from Mill Avenue to McClintock Drive. The basic requirements of hydraulic capacity and channel stability are met at each section with the enhancements that have been made being geared toward the planned recreational and land use development in the Rio Salado corridor.

5.2 Hydraulic Analysis

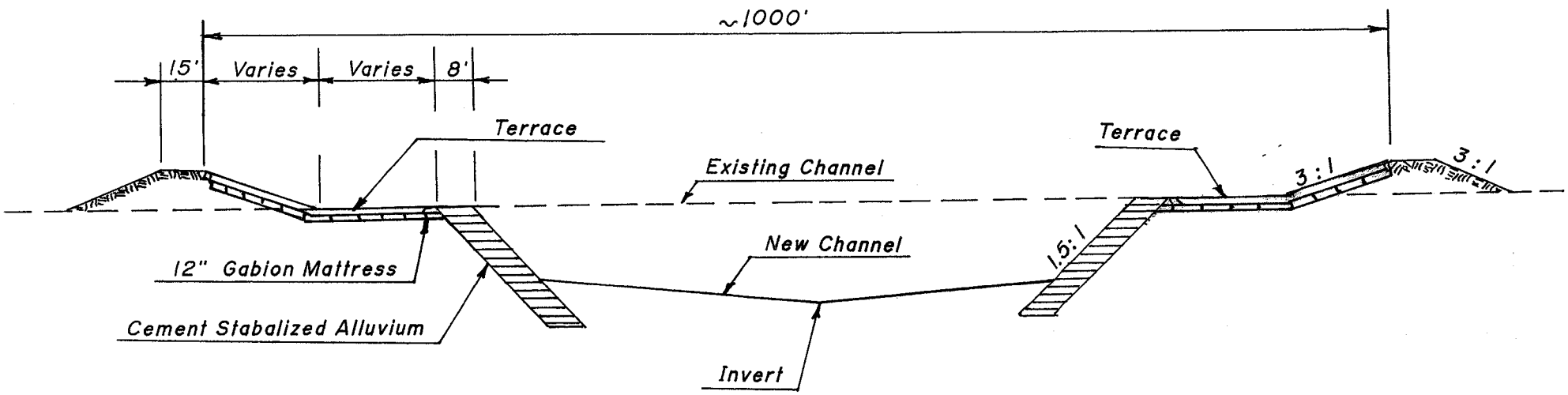
Hydraulic Analysis for the Salt River channelization was conducted using the Corps of Engineers program HEC-2. Water surface elevations and hydraulic conditions were computed for the 10-, 50-, 100-year, the Maximum Design Flood, and the Standard Project Flood. Computer printouts for these flood events are given in Appendix B-2.

5.3 Data on Design for River Structures

The channelization includes bank protection and grade control structures for the purpose of stabilizing the channelized reach of the Salt River. The new channel is also crossed at three locations by new bridges.

5.3.1 Bank Protection

The bank protection used for the channelization is a composite system of cement stabilized alluvium (CSA) and gabion slope mattress (see Figure 5). The composite system was chosen because it provided a combination of performance capabilities that were needed to meet design objectives for the project. These objectives included:



TYPICAL CHANNEL SECTION

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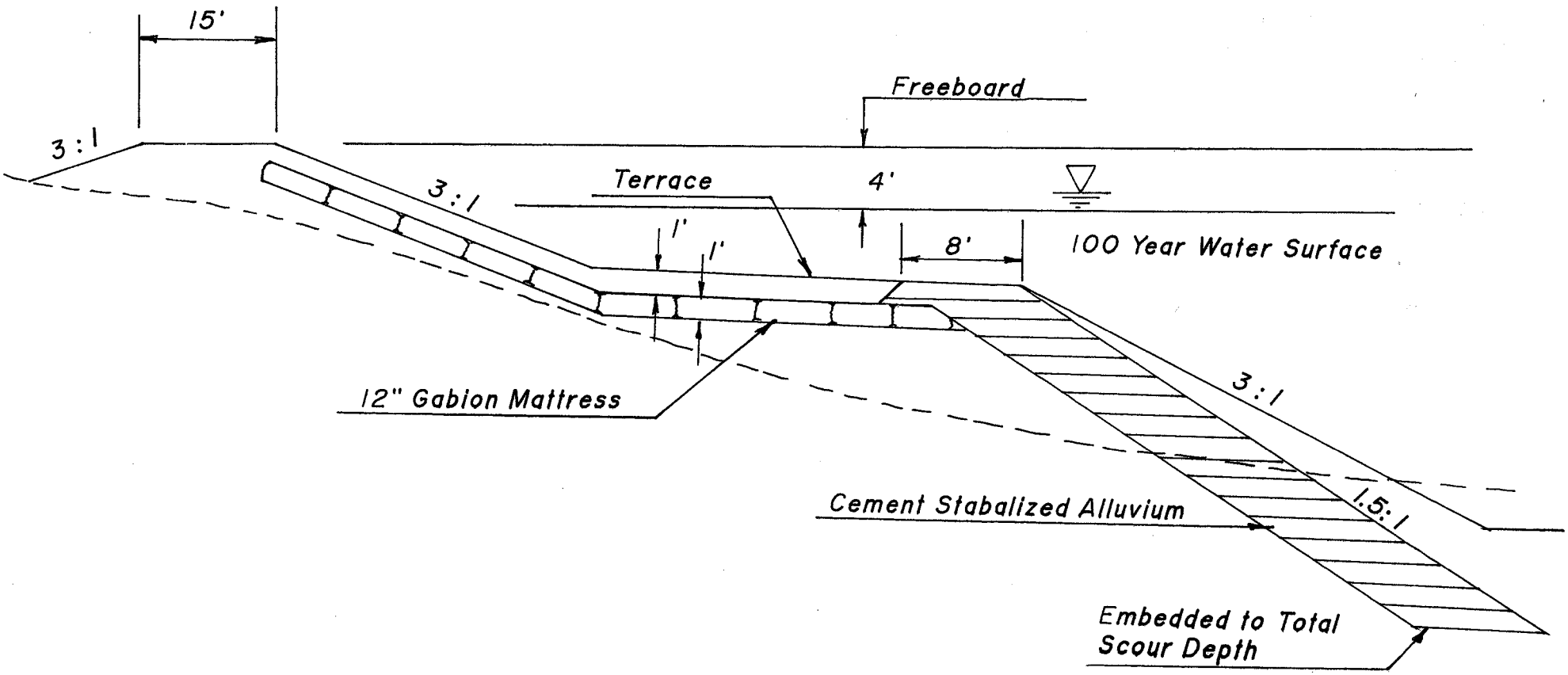
CHANNEL SECTION

FIGURE 4



CHANNEL BANK PROTECTION SYSTEM

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Phoenix , Arizona

BANK PROTECTION

FIGURE 5

channel stability during extreme flood events, the ability to re-establish types of vegetation native to this riparian environment, and an acceptable aesthetic quality. Regarding the first objective, soil cement bank stabilization has achieved a very good performance record for protecting river banks in Arizona during severe floods. The successful performance has been attributed to the large mass of the protection which is stable even if overtopped.

Because the gradation of the in-situ aggregates of the Salt River channel is much coarser than the recommended gradation limits for soil cement. To utilize the available aggregates, the mix design was modified to accommodate gravel sizes and a reduced-fraction of fine material. The mix design was closer to that of roller-compacted concrete but without strict controls on the gradation of the aggregates in the mix. The resulting mix design was termed "cement stabilized alluvium" (CSA) to set the material apart from more commonly used soil-cement and roller-compacted mix designs. The CSA protection extends from mid-bank to the toedown depth for maximum scour protection. The toedown profile was computed based on scour calculations which considered potential erosion due to local scour and sediment transport (see Chapter VI).

While CSA provides a very durable form of bank protection, it is relatively impermeable and can limit the re-establishment of vegetation on the banks of the channel. To mitigate this condition, the CSA protection was covered with native alluvial material on a 3:1 slope. The upper portion of the bank and the channel terrace was then stabilized with gabion slope mattress placed on a 3:1 slope. The gabion slope mattress was also covered with a 1.0 foot thickness of alluvial material. Overall the bank protection system will permit selective revegetation of the channel banks consistent with the requirements for wildlife and habitat restoration. The alluvial cover over the CSA and gabion slope mattress bank protection is considered to be sacrificial, but is included in the channel section for hydraulic calculations of the water surface profile.

Overall the general concept for the bank protection system allowed a variety of channel bank sections to be developed for the project. The channel section typically incorporates a small terrace at the elevation of the top of the CSA for use as a path or level area. Conceptual plans for channel landscaping call for an increased density of planting on the terrace and upper portion of the channel bank. The bank protection

system affords the opportunity to revegetate and landscape the channel banks in accordance with various aesthetic objectives.

The hydraulic design of the bank protection system was based on establishing an adequate toedown depth for the CSA portion of the bank, and to provide an adequate factor of safety against shear force acting on the gabion slope mattress. The bank protection system design was evaluated based on a factor of safety of 1.5 for the 100-year flood, and a factor of safety of 1.3 for the Maximum Design Flood with the more severe condition governing the design. In general, the 100-year flood conditions controlled the design. Computations for bank protection system stability are provided in Appendix B-3.

5.3.2 Grade Control Structures

Grade control structures are provided in the channel profile at the Indian Bend Wash outlet and downstream of McClintock Drive. These structures are designed to maintain the channel profile upstream of the control for the design life of the channel. Because the channel profile accounts for the general deficit of sediment supplied to this reach of the Salt River, a drop occurs at each control structure. Energy from each drop, in turn, is dissipated in stilling basins at the base of each drop. The design of the grade control structure was based on the anticipated depth of general scour in the channel. The stability of the structure was then evaluated to ensure that it had an adequate factor of safety against sliding and overturning. Computations which check the adequacy of the grade control stability are found in Appendix B-3.

5.3.3 Bridges

There are five crossing of the Salt River by bridges in the study reach. With the exception of the old Mill Avenue bridge, hydraulic conditions at the bridges were determined using the Special Bridge routines provided in HEC-2. The original Mill Avenue crossing of the Salt River was constructed c. 1930 and has an arched superstructure, supported by large piers. The superstructure is partially submerged at high stage which creates an unusual variation in bridge waterway area. For this reason the older bridge was modeled outside HEC-2 routines. Estimates of energy loss through the old Mill Avenue Bridge for a set of discharges were calculated using methods give by Bradley (FHWA, 1978).

The study reach contains a new bridge crossing located immediately upstream of the old Mill Avenue bridge called the Second Mill Avenue bridge. This is a flush haunched box girder. The alignment of the bridge curves as it crosses the Salt River, giving a variation in pier skew from 0- to 15-degrees.

The foundations of two existing bridges on the Salt River, the Southern Pacific Railroad bridge and the Rural Road bridge were retrofitted to protect against an increase in total scour depths. Embedment of the pier foundations was evaluated based on the estimated total scour (local pier scour and long-term scour) and existing foundation conditions. Pier scour computations are provided in Appendix B-3.

The most upstream bridge in the study reach is the McClintock Drive crossing of the Salt River. The bridge is located 150 feet upsteam of Grade Control Structure No. 5. The grade control structure maintains stream bed profile in the vicinity of the McClintock Drive bridge, providing protection for both the bridge foundation and utilities adjacent to the bridge.

5.3.4 Maintenance Considerations

A continuous maintenance road is located at the top of the channel bank which can be accessed from existing major streets in the river corridor. Access to the channel bed from the top of the channel banks is provided on both the south and the north side of the channel at roughly one-half mile intervals. By intergovernmental agreement the Flood Control District of Maricopa County will inspect channel structures (bank protection and grade control structures) at regular intervals. The FCD will also remove excess vegetation and debris from the channel as necessary. The bridge structures are maintained by the Southern Pacific Transportation Company and the City of Tempe (Mill Avenue, Rural Road, McClintock Drive) and Arizona Department of Transportation (East Papago Freeway).

5.4 Data on Design for Levee System

The channelization provides a channel section that is generally narrower than the existing banks of the Salt River. Therefore the new bank alignments are within the old

channel and are constructed as levees. The area outside the channel limits generally consists of remnant portions of the Salt River channel. The top-of-levee is located at an elevation similar to the elevation of the previous Salt River banks plus about four feet of freeboard. The Rio Salado masterplan calls for the eventual infilling of the Salt River channel that is outside the new channel limits. Until such time as the infilling is accomplished, no development is planned within the remnant channel areas behind the north and south channel levees other than the freeway and roadway construction. The profiles of the East Papago Freeway mainline and ramps have been set at or above the levee profile. The Rio Salado Parkway is located on the sourth channel terrace from about Farmer Road to Mill Avenue. The parkway profile is at about the 10-year flood elevation. Design criteria for the levees require that for the levees remain stable without additional infilling behind the levee embankment.

5.4.1 Freeboard

The channel section provides at least 4.0 feet of freeboard above the profile of the 100-year flood and at least 1.0 feet of freeboard above the Maximum Design Flood.

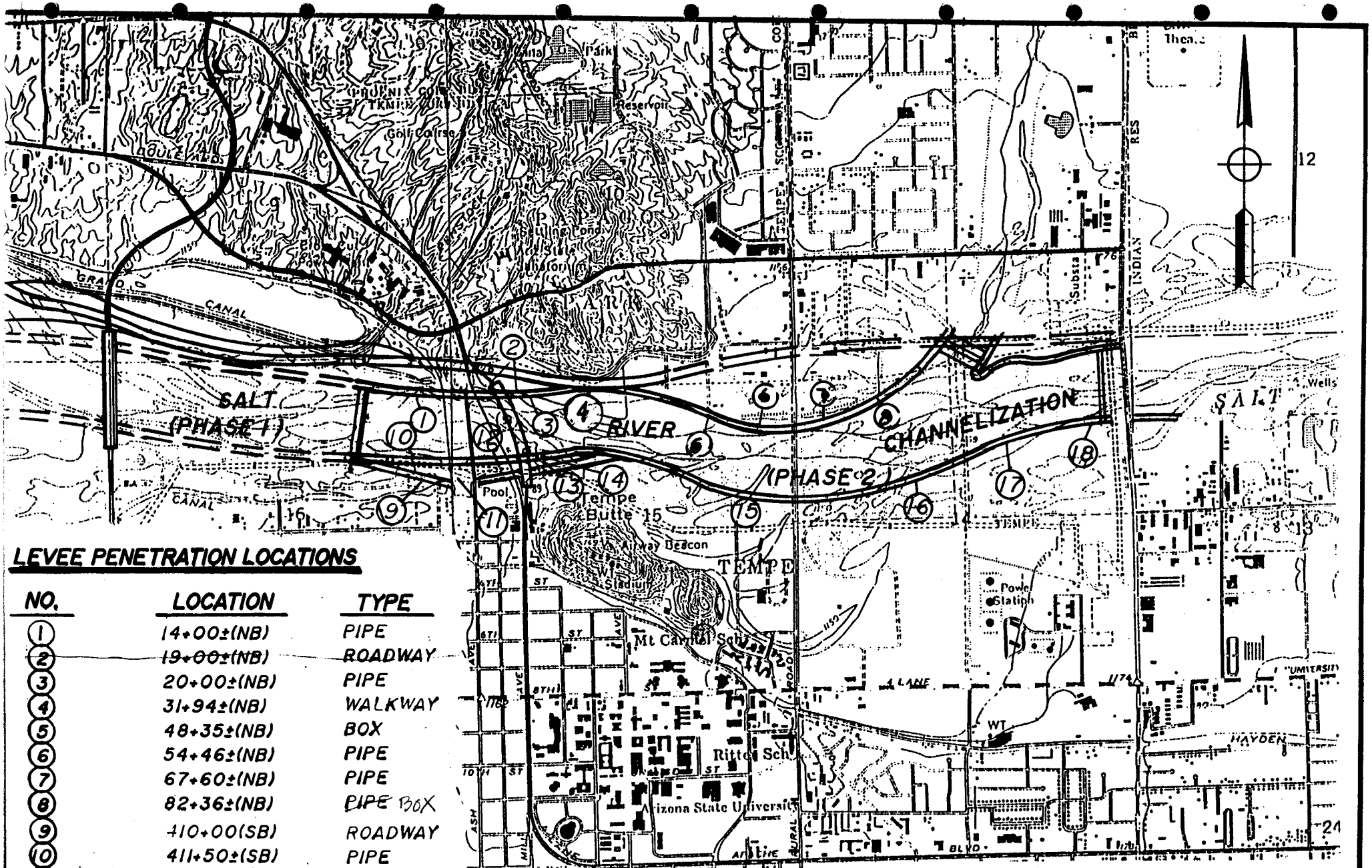
5.4.2 Closures

The channel levees are penetrated at eighteen locations for storm drainage outfalls and roadways (see Figure 6). The largest drainage outfalls are two cell 8'x8' (span vs. rise) reinforced concrete box culvert at Station 48+35 and 82+36 on the north bank. Most drainage outfalls with a potential for backflow have flap gate outlets. Four drainage outlets are not gated. For three of these drains the 100-year flood stage is contained within the tributary system (closed conduit or channel banks). One box culvert penetration for the north levee at station 82+36 will be allowed to backflow onto undeveloped property west of College Avenue. This area of shallow flooding will be eliminated by future development of this property by grading to an elevation above the elevation of the 100-year flood elevation.

The Rio Salado Parkway and northbound Mill Avenue roadways both penetrate the levee embankments. The Rio Salado Parkway penetrations are permanent features of the levee design. The profile of this road at the point of levee penetration is set above the elevation of 100-year water surface elevation so that flood water is contained by the levee and roadway embankments. Between the levee penetrations, Rio Salado Parkway

is located on a terraced area of channel which is set at the elevation of the 10-year flood stage. The northbound Mill Avenue, is constructed as a temporary at-grade crossing of the Salt River. The levee penetration is located in the upper half of the levee embankment above the elevation of the CSA hard bank protection. This temporary penetration will be closed during construction of the Second Mill Avenue bridge which is scheduled for completion in 1993.

Table 2 summarizes basic design data for each levee penetration as identified in Figure 6. The elevations for drainage structure invert, top of levee, 100-year water surface, and manhole rim or tributary bank are given.



LEVEE PENETRATION LOCATIONS

NO.	LOCATION	TYPE
1	14+00±(NB)	PIPE
2	19+00±(NB)	ROADWAY
3	20+00±(NB)	PIPE
4	31+94±(NB)	WALKWAY
5	48+35±(NB)	BOX
6	54+46±(NB)	PIPE
7	67+60±(NB)	PIPE
8	82+36±(NB)	~~PIPE~~ BOX
9	410+00(SB)	ROADWAY
10	411+50±(SB)	PIPE
11	416+00±(SB)	ROADWAY
12	417+50±(SB)	PIPE
13	425+00±(SB)	ROADWAY
14	426+50±(SB)	PIPE
15	465+00±(SB)	PIPE
16	482+00±(SB)	PIPE
17	501+50±(SB)	PIPE
18	522+31±(SB)	PIPE

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Phoenix, Arizona

LEVEE PENETRATION MAP

FIGURE 6

Table 2

Levee Penetration Design Data

ID Number	Struc. Type	Invert/Profile Elevation	Water Surface Elevation	Top of Levee Elevation	MH Rim Elevation
1	pipe	1138.0	1154.0	1158.10	1158.0
2	road	(removed)			
3	pipe	1139.6	1156.1	1160.80	1160.0 (f)
4	bridge	1158.0	1157.8	1162.04	na
5	box	1138.4	1159.2	1163.74	1158.0 (b)
6	pipe	1144.0	1160.0	1164.37	1160.5 (f)
7	pipe	1140.8	1161.8	1165.74	1157.5(f)
8	box	1145.5	1163.8	1167.77	1168.0 (b)
9	road	1154.2	1152.0	1157.00	na
10	pipe	1135.0	1152.4	1156.83	1146.0 (f)
11	road	1158.0	1156.3	1160.50	na
12	pipe	1135.0	1156.3	1160.50	1142.6 (f)
13	road	(removed)			
14	pipe	1140.0	1156.8	1161.36	1152.8 (f)
15	pipe	1144.2	1161.4	1165.50	1159.2 (f)
16	pipe	1144.0	1163.1	1167.36	1155.9 (f)
17	pipe	1147.4	1164.3	1169.40	1151.4 (f)
18	pipe	1154.0	1166.2	1173.80	1172.0

(f) - flap gate at outlet

(b) - tributary channel bank elevation

Note: The at-grade crossing of the Salt River (ID 2 & 13) was removed following the completion of the Second Mill Avenue Bridge.

5.4.3 Embankment Protection

The levee embankments are protected by a combination of cement stabilized alluvium, CSA (see section 5.3.1). As shown in the typical section for the levee, the gabion slope mattress is placed behind the CSA protection. Gabion buttresses are provided at 300-foot intervals to ensure overall stability should a portion of the slope mattress be eroded. The CSA protection is toed down to below the estimated cumulative scour depth. Levee section details and computations bank protection size are provided in Appendix B4.

5.4.4 Stability

The levees for the Salt River channelization are formed from non-cohesive, coarse alluvial sediments found in the bed of the river channel. Angle of repose for this material is approximately 40 degrees. The slope of the levee embankment is 18.4-degrees (3:1 channel side slope), which provides a factor of safety for slope stability. The relatively impermeable zone created by the CSA protection will retard drawdown in the otherwise very permeable material which composes the levee embankment. The CSA embedment likewise creates a relatively long flow path for water draining from the saturated embankment. The stability of the embankment was therefore calculated based on drawdown during the recession period of the 100-year flood hydrograph. This computation showed an acceptable factor of safety against sliding and overturning of the embankment. The possibility of a land-side failure due to a prolonged impoundment of water behind the levee was also evaluated and found to have an acceptable factor of safety.

5.4.5 Settlement

The levee embankment is founded on the sediments of the Salt River, compacted to 95-percent of maximum density. The Salt River sediments consist of coarse sand, gravel and cobbles. Compression of this material due to the load of the levee embankment is anticipated to be small.

5.4.6 Interior Drainage

As presented in the discussion of levee closures, areas adjacent to the levee are for the most part slightly below the elevation of the 100-year flood elevation. To prevent backflow during flood stage in the Salt River flap gates are provided on the culvert outlets. The one exception is land adjacent to the north levee and west of College Avenue. For this area shallow flooding will occur during the 100-year flood. At the present time this land is undeveloped and flood risk is minimal. The property has been identified for more intense development and will eventually be regraded to an elevation above the 100-year flood elevation.

5.4.7 Operations

There are no active operations planned for the levees or at levee penetrations during flood events.

5.4.8 Maintenance

The Flood Control District of Maricopa County has agreed to provide maintenance of channel levees for this reach of the Salt River within the jurisdiction of the Cities of Tempe and Phoenix. Any supplemental structures or landscaping of the channel will be maintained by each respective jurisdiction. Maintenance activities are expected to include the removal of debris and excess vegetation from the channel, and the inspection of embankments and embankment protection. Each jurisdiction will be responsible for maintenance of its own drainage system which outfalls to the Salt River.

VI. EROSION/SEDIMENT TRANSPORT

A river mechanics analysis was conducted by CRSS to identify the size and type of stabilization specified for the levee and banks of the channelized Salt River, and to determine local scour at bridge piers and grade control structures. The analysis was also conducted to quantify the upstream and downstream impacts of the project and the need, if any, for mitigation measures in these reaches. The channel design criteria are set to provide sufficient channel capacity for the Standard Project Flood and embedment for bank stabilization (i.e. toedown) below the scour depth associated with that flood.

6.1 Scour Methodology

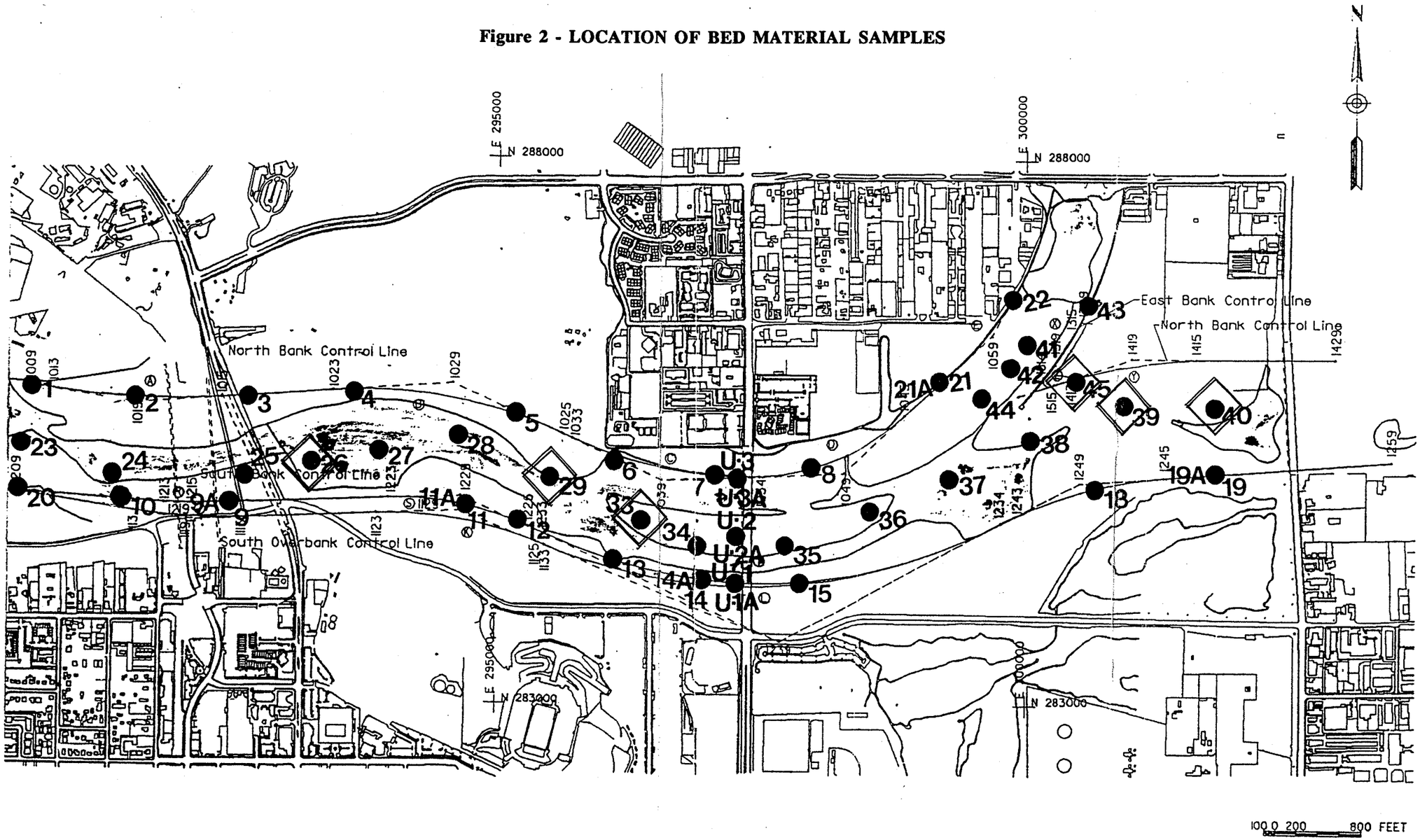
The river scour was checked using U.S. Bureau of Reclamation procedures (USBR, 1977) for degradation in a gravel bed channel. Supplemental analyses were performed for types of local scour at bridge piers, grade control structures, and scour due to phenomenon such as channel bends and bedform movement. The methods for estimating local effects in the river channel were based on the manual developed for the Arizona Department of Water Resources (SLA, 1985) entitled "Design Manual for Engineering Analysis of Fluvial Systems".

6.2 Sediment Data

The sampling of channel bed material was conducted at 21 locations (Thomas-Hartig & Associates, Feb 1990). Laboratory analysis of the proportion of the material which was less than six inches in diameter was conducted. To estimate the fraction of oversized material, supplemental, large volume samples were taken at six of the 21 locations. Figure 7 shows the location of field exploration sites.

The design gradation was developed by plotting the measured gradation for 12 samples along the existing channel alignment (samples: 24, 25, 26, 27, 28, 29, 33, 35, 38, 39, 40, and 45). This includes the six large volume samples for which the full distribution of sizes were measured (samples: 26, 29, 33, 39, 40 and 45). The fraction of oversized sediments (sizes greater than 3 inches) for sites without large volume sampling, was

Figure 2 - LOCATION OF BED MATERIAL SAMPLES



Field Exploration Location

Location with large volume sample of oversized material

Figure 7

Site Plan **LOCATION OF BED MATERIAL SAMPLES**

Project No. 89-0919

THOMAS-HARTIG & ASSOCIATES, INC.

made visually. The visual estimate was corrected based on a comparison of the visual estimated to measured value. The correction was found to decrease the percentage of oversized material by 15 percent.

No trend in the gradation of channel sediments along the channel alignment was found. The average sediment size was found to be in the range of 10 mm to 50 mm regardless of the location or depth at which a sample was taken. Based on this analysis a worst case design gradation was developed for scour estimation by determining a 90 percent confidence curve based on the representative measured samples.

6.3 Results

The results of the scour analysis were tabulated for the design reach. The general trend of the channelized profile is degradation.

The long-term stability of the Salt River channel occurs due to the eventual armoring of the channel bed by the coarse fraction of the sediment gradation. In order to provide a conservative estimate of the long-term stability of the channel, it was specified that three layers of coarse clasts would need develop to fully armor the reach. This allows for several cycles of armoring where channel bed might be altered by subsequent regrading in the channel by human activity.

VII. REFERENCES

Bradley, Joseph N., 1978, "Hydraulics of Bridge Waterways", Hydraulic Design Series No.1, U.S. Department of Transportation, Federal Highway Administration.

Burgess & Niple, "Salt River Flood Delineation Study", 1987.

Federal Emergency Management Agency, "Flood Insurance Study of Maricopa County Streams", 1984.

John Carollo Engineers, "Draft Environmental Assessment for State Route 202, East Papago Freeway", for Arizona Department of Transportation, 1987.

Simons, Li & Associates, Inc., "Concept Hydraulic Design Salt River Channelization, East Papago Freeway,Ó prepared for Daniel, Mann, Johnson & Mendenhall, May 1988.

Simons, Li & Associates, Inc., "Design Manual for Engineering Analysis of Fluvial Systems,Ó prepared for Arizona Department of Water Resources, March 1985.

Simons, Li & Associates, Inc., "River Mechanics and Floodplain Analysis of the Salt River for the East Papago and Hohokam Freeway Alignments", submitted to John Carollo Engineers for Arizona Department of Transportation, May 1987.

Simons, Li & Associates, Inc., "East Papago and Hohokam Freeway Location Study and Preliminary Design Technical Series, Technical Memorandum No. 14: Off Site Hydrology, and Technical Memorandum No. 15: Off Site Drainage Design", June 1987.

U.S. Army Corps of Engineers, "Gila River and Tributaries, Central Arizona Water Control Study, Hydrology", Los Angeles District, May 1982.

U.S. Army Corps of Engineers, "Study for Flood Control Alternatives to Cliff Dam", Los Angeles District, October 1988.

U.S. Bureau of Reclamation, Design of Small Dams, 1977 (Appendix H, Sedimentation).

Appendix A

Documentation and Correspondence

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
Fax (602) 506-4601

D. E. Sagramoso, P.E., Chief Engineer and General Manager

BOARD OF DIRECTORS
P. Ben Arredondo
Betsey Bayless
James D. Bruner
Carole Carpenter
Tom Freestone

Mr. James E. Bond
City of Tempe
Public Works Department
P.O. Box 5002
31 East Fifth Street
Tempe, Arizona 85280

Re: Channelization of Salt River
Letter of Map Revision
C.O.T. Project No. 906345 B

Dear Mr. Bond:

Following research of our files and documentation published by the Corps of Engineers, we offer the following information regarding the 100-year peak discharges for the Salt River.

Salt River Current Peak Discharges (*)
(Maricopa County Flood Insurance Study)

LOCATION	100-YEAR PEAK DISCHARGES (cfs)
At Price Road Alignment	220,000
Downstream Side of Price Road Alignment	215,000
At Southern Pacific Railroad Bridge	215,000
Downstream Side of Southern Pacific Railroad Bridge	210,000
At Hohokam Expressway	210,000
Downstream of Hohokam Expressway	205,000
At 24th Street	205,000

(*) Used as input data to HEC-2 for flood insurance study analysis.

For future consideration the following table provides a comparison of flows at specific locations for present and future conditions with Plan 9 (565,000 acre feet of flood control storage on the Salt River at modified Roosevelt Dam).

Salt River 100-Year Peak Discharges (cfs)

LOCATION	CURRENT(1)	FUTURE(2)	FUTURE WITH FUTURE LAND USE CONDITIONS(3)
At Gilbert Road	230,000	170,000	170,000
At Tempe Bridge	215,000	166,000	166,000
At Central Ave.	200,000	164,000	165,000

(1) FEMA used in Maricopa County Flood Insurance Study.

(2) As established by the Corps of Engineers for 1988 land use conditions and Plan 9 outflow from Bureau of Reclamation reservoirs.

(3) As established by the Corps of Engineers for future land use conditions (channelization) and Plan 9 outflow from Bureau of Reclamation reservoirs.

If you have any questions, please call me at 506-1501.

Sincerely,

David R. Johnson
Chief, Hydrology Division

Copy to: Paul Kienow, P.E., City of Phoenix

JUN 30 1992

Date: 6-29-92 Township 1N Section 13

To: CRSS CIVIL ENGINEERS, INC.
4041 N. CENTRAL AVE., SUITE 650
PHOENIX, AZ. 85012-3306
ATTN. GEORGE COTTON

Re: Project - SALT RIVER LOMR
Address - E. OF McCLINTOCK
Proj. # - 9063458

To Whom it May Concern:

We are forwarding the following:

- [ ] Check prints with comments for incorporation into your design.
- [ ] Approved tracings.
- [ ] ____ Quit Claim Deed(s); ____ Easement(s); ____ Ratification(s)
- [x] COPY OF I.G.A. REGARDING EXTENSION OF CHANNELIZATION E. OF McCLINTOCK.

Please process as follows:

- [ ] Make necessary changes and resubmit two sets of prints for additional checking.
- [ ] Make necessary changes and submit original tracings and two sets of prints for approval.
- [ ] Have signed by authorized person(s), notarized and return.
- [x] FOR INCLUSION IN REQUEST FOR C.L.O.M.R. FOR UPPER REACH OF SALT RIVER.

Very truly yours,

Lee M. Quaas, P.E.
City Engineer

By [signature]

FLOOD CONTROL DISTRICT
of
Maricopa County

2801 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 506-1501
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D. E. Sagramoso, P.E., Chief Engineer and General Manager

BOARD OF DIRECTORS

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James D. Bruner
Carole Carpenter
Tom Freestone

February 21, 1992

Mr. Steve Nielsen
City of Tempe
P.O. Box 5002
31 East Fifth Street
Tempe, Arizona 85280

SUBJECT: Letter of Intent for Salt River South Bank Stabilization

Dear Mr. ~~Nielsen~~ Steve:

Enclosed is a conformed copy of the Letter of Intent for the Salt River South Bank Stabilization.

Your assistance in finalizing this document is greatly appreciated.

Sincerely,

Richard G. Perreault
Chief, Planning Branch

Enclosure

FEB
CITY OF TEMPE
ENGINEERING

LETTER OF INTENT

SALT RIVER SOUTH BANK STABILIZATION

The Arizona Department of Transportation (ADOT) has been closely coordinating with the City of Tempe and the Flood Control District of Maricopa County (FCDMC) for the design and construction of the East Papago Freeway. Cooperative agreements have been implemented and the majority of the freeway and associated Salt River Channelization features, west of the Indian Bend Wash Outlet Channel, have been constructed or will be completed in the near future. The challenge that now requires all of our efforts involves that portion of the freeway east of McClintock Drive, lying predominantly outside of Tempe corporate boundaries.

During the last year, ADOT has negotiated an "Agreement and Covenant Not to Sue" (Region 9 Docket No. 91-23) with the Environmental Protection Agency (EPA) that allows ADOT to construct the freeway through the South Indian Bend Wash Superfund Site without incurring future liability beyond the freeway rights-of-way. In accordance with guidance and direction from EPA, ADOT has applied for a Section 404 Permit with the U.S. Army Corps of Engineers (COE). The permit application included 100-year level protection for the north and south river banks east of the Price Road alignment; 10-year protection along the north bank between Price Road and McClintock Drive, and no protection to the south bank west of the Pima/Red Mountain Freeway Traffic Interchange (T.I.) to McClintock Drive. Tempe and the FCDMC have provided written responses to the COE expressing concerns that the proposed construction does not provide any protection to approximately 4000 linear feet of the south bank and does not preclude the potential of a 100-year flood from overtopping McClintock Drive.

ADOT, the City of Tempe, and the FCDMC agree to work together to resolve the concerns for construction in the Salt River east of McClintock Drive and agree to support the timely construction of the East Papago Freeway to the Pima/Red Mountain T.I. An agreed upon goal of the three parties is the construction of 100-year protection for the north and south banks between McClintock Drive and the T.I. (See Exhibit "A", attached hereto and made a part hereof). The parties understand that ADOT's participation in this effort is subject to the EPA's written concurrence, and that ADOT's liability will be no greater than that specified in the "Covenant Not to Sue", and the parties agree to aggressively pursue such concurrence. The parties further acknowledge that participation by the FCDMC and the City of Tempe will be subject to ratification and agreement by the FCDMC Board of Directors and the Tempe City Council, respectively.

ADOT, at its own expense, has conducted extensive geotechnical testing and analyses of an alignment along the south bank that would be sufficient to construct 10-year level flood protection. In order to be able to construct 100-year level protection, additional geotechnical testing and environmental investigation is necessary. ADOT is willing to have this additional work performed under its direction. The terms included in this Letter of Intent define general provisions and responsibilities that the parties agree to in order to conduct the additional testing and analysis. An Intergovernmental Agreement shall be negotiated which defines the specific responsibilities of each party when the results of the additional testing and analysis have been reviewed. The present estimated costs of the approximately 4000 linear feet of 10-year to 100-year flood protection range from $3.8 million to $14.0 million.

TERMS OF THE LETTER OF INTENT:

1. ADOT will:

   a. Have additional geotechnical testing and environmental investigations performed which will provide the necessary information required to construct increased south bank flood protection from the 10-year to the 100-year level of protection. ADOT agrees to pay for up to one-third of the costs associated with the additional testing, which shall be deducted from ADOT's maximum $2.5 million commitment for south bank protection.

   b. Design the bank protection using criteria as shown on Exhibit "B", attached hereto and made a part hereof. The desired level of protection is 100-year; however, ADOT will design and construct a minimum of 10-year level of protection with 100-year toe-down protection, should higher levels of protection be impossible due to landfill considerations. The design shall include such features as necessary to create conditions such that the 100-year flood will not overtop McClintock Drive.

   c. Fund up to one-third of the additional testing costs, and the costs to acquire rights-of-way, design and construct the south bank protection subsequent to the date of this letter in an amount not to exceed $2.5 million.

   d. Construct the south bank protection with the earliest ADOT project possible, preferably with the adjacent south bank protection and/or the north bank protection.

   e. Acquire all necessary rights-of-way to construct the south bank protection and for operation and maintenance of the completed bank protection, provided that such purchases are covered under the provisions of the "Covenant Not to Sue". After construction has been accepted by the FCDMC, ADOT shall grant access to the FCDMC for operation and maintenance purposes. EPA cooperation shall be solicited such that the FCDMC will assume no responsibility for any existing contamination under the provisions of EPA's "Covenant Not to Sue".

   f. Coordinate with and seek the approval for all design and construction plans for all proposed channel/bank protection work with the jurisdiction having floodplain regulatory responsibility.

   g. Pay for the design and construction of the north bank levee between McClintock Drive and Loop 101L to the 100-year flood level of protection, when and if the corresponding south bank improvements are constructed. Costs for the design and construction of the north bank to the 100-year level of protection are in addition to ADOT's $2.5 million commitment for the south bank work.

2. The FCDMC staff will recommend to its Board of Directors the following. The FCDMC will:

   a. Support ADOT's Section 404 Permit Application based on ADOT's intentions stated above. The FCDMC will work closely with ADOT and the City of Tempe to achieve the desired 100-year level of protection for the Salt River east of McClintock Drive.

b. Reimburse ADOT for up to one-third of the additional costs incurred by ADOT for the additional geotechnical testing and environmental investigation necessary to increase the south bank protection from 10-year to 100-year.

c. Review, comment on and have right of approval on flood control features to be operated and maintained by FCDMC. The flood control features will be designed and constructed using FCDMC-provided criteria, as shown in Exhibit "B", attached hereto and made a part hereof, with the understanding that certain portions of the bank protection between McClintock Drive and Loop 101L may only be constructed to approximately the 10-year flood frequency elevation. The FCDMC will assist ADOT in the creation of conditions such that the 100-year flood will not overtop McClintock Drive.

d. Accept the operation and maintenance responsibility for flood control features constructed using FCDMC criteria between McClintock Drive and Dobson Road upon acceptance of easements or permits provided by ADOT or others that are clear of EPA Superfund liability.

e. Jointly cost-share with ADOT in the construction of 100-year protection for the approximately 4000 linear feet of south bank east of McClintock Drive. It is understood that ADOT's maximum commitment is $2.5 million. FCDMC cost-share may be as much as $11.0 million. If less than 100-year level of protection is the only feasible option, the FCDMC will match up to ADOT's maximum cost-share of $2.5 million for 10-year level of protection. Higher levels of protection will be paid for by FCDMC to a maximum commitment of $11.0 million.

f. Not hold ADOT or Tempe responsible for any future flood control operation and maintenance costs associated with the south bank protection or enhancements between McClintock Drive and Loop 101L once FCDMC has accepted operation and maintenance access.

g. Assist the City of Tempe in its application to the Federal Emergency Management Agency for revising the floodplain delineations of the Salt River through Tempe.

3. The staff of the City of Tempe will recommend to the City Council the following. Tempe will:

a. Support ADOT's Section 404 Permit Application based on ADOT's intentions, stated above.

b. Tempe's sole contribution towards the undertaking described in this LOI and any related obligations or requirements will be $250,000 to be used by ADOT for the additional geotechnical testing and environmental investigation necessary to increase the south bank protection from 10-year to 100-year.

c. Have the right to review and comment on all geotechnical testing results, environmental investigations and flood control features that could impact the Salt River Floodplain within the City. Tempe agrees to closely coordinate with ADOT and the FCDMC and shall provide any technical or environmental data that it has developed to the two entities.

This LOI will be incorporated into an Intergovernmental Agreement (IGA), ADOT File No. JPA 91-117, to be negotiated once conditions, costs, and design constraints are better defined, and the FCDMC staff and the City of Tempe staff will recommend to the Board of Directors and the City Council, respectively, that such an agreement be approved if it is consistent with this Letter of Intent. After this LOI is signed, ADOT will proceed with preliminary plans for geotechnical, and environmental investigations, concurrent with the preparation of an IGA. ADOT shall proceed and conduct the field investigation once all the parties have signed an IGA committing funds for the field investigation. The parties agree and understand that a second future IGA will be more comprehensive, and that in the event of conflict between the LOI and IGA, the terms of the IGA executed by the Board of Directors and the City Council will control.

I concur with the terms stated above in this Letter of Intent.

2/20/92	Gary R Brown, Acting City Manager 2/20/
Gary Robinson, P.E. Date	Terry L. Zerkle Date
State Engineer	City Manager
Arizona Department of Transportation	City of Tempe

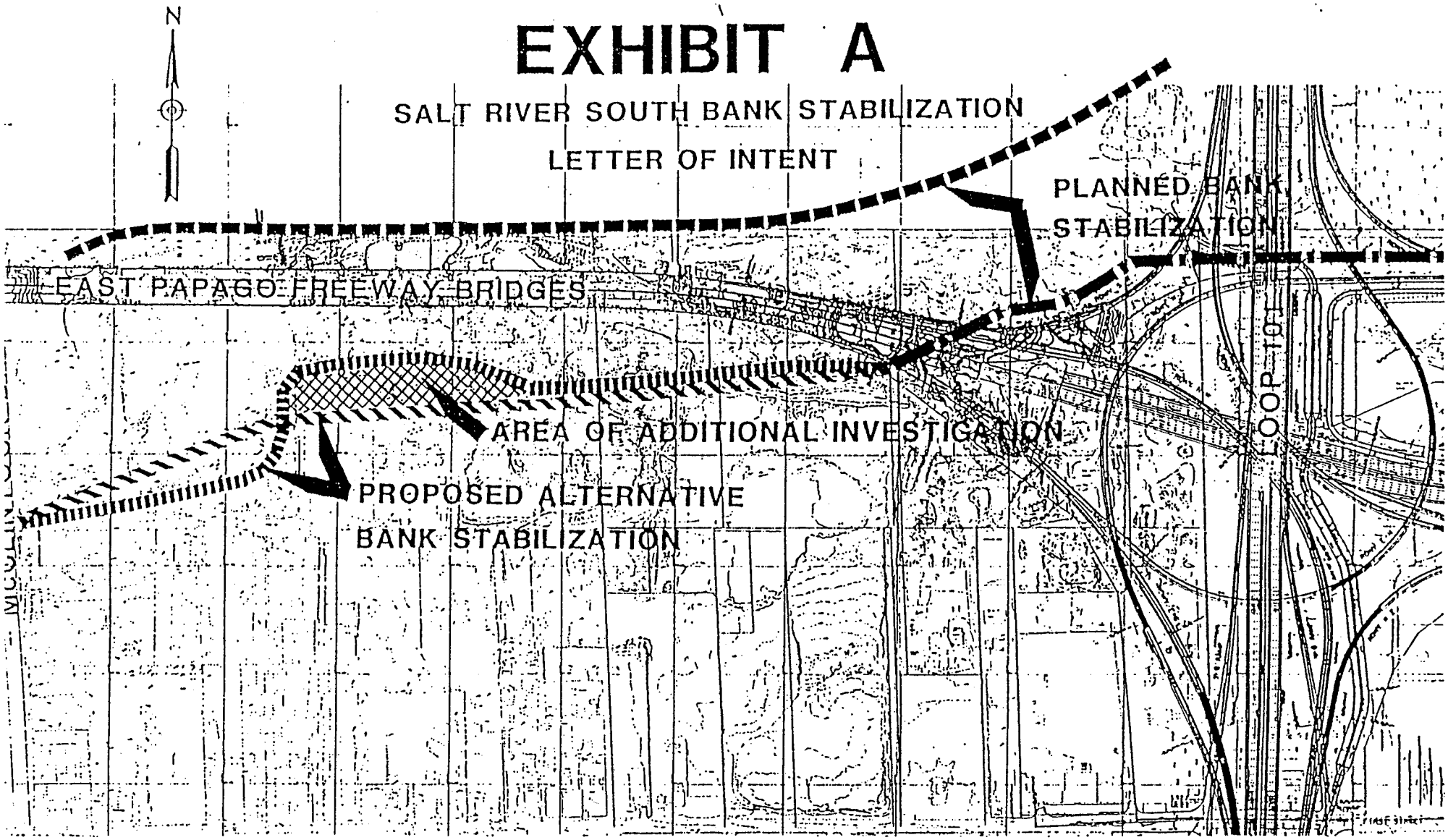
2-18-92

Stanley L. Smith, Jr., P.E. Date
Acting Chief Engineer and General Manager
Flood Control District of Maricopa County

EXHIBIT A

SALT RIVER SOUTH BANK STABILIZATION

LETTER OF INTENT



EGEND

ROPOSED ALTERNATIVE SALT RIVER BANK STABILIZATION)

10 YEAR PROTECTION

100 YEAR PROTECTION

LEGEND

(PLANNED SALT RIVER BANK STABILIZATION)

10 YEAR PROTECTION

100 YEAR PROTECTION

1/28/92

ATTACHMENT A

ANALYTICAL APPROACH FOR DETERMINING REQUIRED TOE DEPTHS FOR BANK PROTECTION ALONG SALT RIVER UPSTREAM OF McCLINTOCK DRIVE

The following analytical approach shall be utilized for determining required toe depths for bank protection along the Salt River upstream of McClintock Drive:

1. Contraction Scour (includes General Scour), in the vicinity of bridge crossings and river sections that have been contracted due to landfill encroachment shall be computed by methods described in Federal Highway Administration, FHWA, Hydraulic Engineering Circular Nos. 18 and 20, and other publications deemed appropriate for the 100-year frequency peak flow of 215,000/220,000 cfs. General scour for uncontracted reaches, is to be quantified by computer models for flows representing a hydrological history, as described in Item 3 below, and must be supplemented with hand calculations. For hand calculations, the 100-year frequency peak flow of 215,000/220,000 cfs is to be used.

2. Bed-form Scour, due to the passage of dunes or anti-dunes, shall be computed from analytical relationships developed by investigators such as Yalin and Kennedy, as described in textbooks on sediment/transport technology. The maximum hydraulic parameters associated with the passage of a 100-year frequency peak will be used to establish the quantitative values for this scour component.

3. Long-term Aggradation/Degradation shall be computed by using either the concept of equilibrium slope or the concept of streambed armoring, depending upon which approach controls the long-term channel profile of the Salt River upstream of McClintock Drive. The equilibrium-slope concept shall utilize a sediment/transport relationship which incorporates the D_{50} and gradation of the streambed sediments. The streambed-armoring concept shall utilize the critical-tractive-stress approach and the representative (armor) particle size. A series of flood frequency hydrographs from 10 to 100-year, should be used to represent the hydrologic history that the structure may experience in its life as a basis for determining these long-term trends. The "dominant" discharge will be the 10-year frequency discharge.

4. Once the scour components are quantified, as described in Items 1 through 3, they will be added together (i.e., as if they each act independently) to inherently incorporate a factor of safety of 1.2 to 1.3 in the estimate of Total Scour. This

value for the summed Total Scour will then be multiplied by an appropriate factor (approximately 1.3) to assure a final minimum factor of safety of 1.5 in accordance with Item 18 of Exhibit B.

5. Finally, the bank-protection toe depth shall be based on the scour depth established in Item 4 and shall everywhere be measured from the low-flow thalweg invert elevation in accordance with Item 13 of Exhibit B.

Any sediment analysis will have to consider the sediment load entering the study reach. If the hydraulic parameters are known upstream, flow depth, velocity and tractive shear, and the gradation of the streambed can be determined upstream, a practical estimate of the sediment load entering the study reach can be made.

Coding files as well as model documentation are to be made available to the District for review.

EXHIBIT B

SALT RIVER CHANNEL DESIGN CRITERIA
UPSTREAM OF McCLINTOCK DRIVE

1. All geotechnical test results must be provided for District review. Gradation data should be available that is representative of the full depth of the moveable bed in this reach. The District's rule of thumb for bore hole/test pit intervals is one per 500 lineal feet. If an armoring analysis is to be presented for review, gradation test results for the channel bed samples should include the percentages of the 3 inch plus material encountered.

2. The geotechnical exploration must determine if landfill deposits are present within the channel alignment, and if so, their impacts on channel design and costs.

3. If the existing gravel pits are to be filled, gradation specs will be needed for the material that is to be placed in the moveable bed zone.

4. The channel should be designed with capacity for the current 100-year frequency peak flow with three feet of freeboard. The 100-year peak flow rate for this reach is 215,000 cfs. (This rate is 220,000 cfs upstream of Price Road). The freeboard requirement will provide a capacity in the channel approaching that of the Standard Project Flood peak flow with Modified Roosevelt Dam improvements in place and result in a consistent design with channelization immediately downstream. If design for 215,000 cfs is achievable only through unacceptably large impacts to known landfill wastes, the reach between McClintock Drive and the Pima Freeway is to be designed for, as a minimum, a flow rate that is necessary to contain a 10-year frequency flow along the south bank, and that precludes the 100-year frequency flow from overtopping McClintock Drive.

5. Tributary (side) drainage to the Salt River channel must be addressed consistent with ADOT criteria which state that the more severe of the following two conditions govern; (1) 100-year frequency peak in the main channel with 10-year frequency peak tributary drainage or (2) 10-year frequency peak in the main channel with 100-year frequency peak tributary drainage.

6. Consideration must be given to the upstream river and floodplain conditions and how those conditions may impact the proposed channel. Existing and potential material extraction and landfill operations must be addressed in this context. Overbank flooding upstream of the channelization must be analyzed to ensure that those flows enter and are contained within the improved channel.

7. Maintenance access and channel invert access ramps must be incorporated into the design.

8. The design and analysis will address the potential impacts of known future modifications that may be proposed by the City of Tempe and/or the Salt River Indian Community.

9. The location of cross sections used in the water surface profile calculations must be provided on a scaled map. Computer files must also be provided such that velocity, depth, HGL and EGL can be verified for each cross section.

10. The final plans shall include profiles showing the top of levee protection, HGL, invert, and the low chords for all bridges.

11. The scour analysis should be performed using an analytical approach, based on the velocity associated with the 100-year frequency peak flow of 215,000/220,000 cfs, the depth of the thalweg, and the D_{50} of the channel bed materials.

12. Degradation and aggradation analyses should include factors for dunes and antidunes.

13. The depth of scour, measured from the low-flow thalweg invert elevation, should be used to determine the toe-down elevations for bank protection and grade control structures based on the 100-year frequency peak flow of 215,000/220,000 cfs.

14. Local scour calculations shall be provided for District review if structures that are to be maintained by the District are affected by scour. These calculations are to be tabulated at all critical design locations and presented with a map showing the locations.

15. Levee slope stability analysis calculations must be submitted for District review. The analysis should consider pore pressures caused by rapid draw down.

16. All calculations performed in the design of riprap and filter materials for slope stabilization must be provided for District review.

17. All calculations should be independently checked by a person at least as competent as the designer before submitting them to the District. Both the designer and checker must initial and date each page of calculations that is submitted.

18. Minimum factors of safety for the project should be 1.5 based on the 100-year frequency peak flow of 215,000/220,000 cfs. If a tractive shear approach is used, the safety factor should be applied to the calculated tractive shear.

Appendix B

Water Surface Profile Computations

1. **Effective Model:**
   ADOT channelization
2. **Post-Design Model:**
   Rio Salado modifications
3. **Rating Curve Development**
   Analysis of Existing Mill Ave. Bridge

Appendix B

Water Surface Profile Computations

1. **Effective Model:**
   ADOT channelization
2. **Post-Design Model:**
   Rio Salado modifications
3. **Rating Curve Development**
   Analysis of Existing Mill Ave. Bridge

1. Effective Model:

The effective model is executed in three reaches. The downstream reach consists of the model per the approved Conditional Letter of Map Revision (Case No.: 92-09-071R) Locke to Mitchell, November 6, 1992. Stationing for this model is based on the channel control line per the Arizona Department of Transportation construction plans.

The next two upstream reaches are based on the effective model as per the Flood Insurance Study, Maricopa County, Arizona, Forth Revision (September 4, 1993). The middle reach (the first reach upstream of the CLOMR) represent the reach that is change by river channelization. This reach extends from the Southern Pacific Railroad to McClintock Drive (River Mile 21.725 to 23.667). The most upstream reach extends from McClintock Drive to Country Club Road (River Mile 23.667 to 25.194).

Below Project Model
(File Name: RSSRP1.DTA)

==========
B O S S H E C - 2 (tm)
==========

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PROJECT DESCRIPTION :

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River
DESCRIPTION : 100 Year Floodplain with Levees
ENGINEER :
DATE OF RUN : 11/09/1993
TIME OF RUN : 3:36 pm

T1 Channelized Salt River
T2 City of Tempe File Name: RSSRP1.HC2
T3 100 Year Floodplain with Levees

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0.0	0	0.0	90000.0	112.21	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

USER-DEFINED SUMMARY TABLES (J3) :
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38 42 39 43 1 3 25 4 5

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

-10 -10

NC 0.050 0.050 0.035 0.1 0.3
Begin ADOT Channelization
Begin ADOT Channelization

X1	10035	12	10020.0	11105.0	0.0	0.0	0.0	1.0	0.0	0
GR	125.0	10000.	125.0	10010.	122.00	10020.	105.00	10056.	104.00	10340.
GR	100.00	10356.	97.20	10540.	100.00	10750.	105.00	10770.	105.00	11050.
GR	125.0	11105.	125.0	11150.						
X1	10200	11	10025.0	11100.0	165.0	165.0	165.0	1.0	0.0	0
GR	122.00	10000.	123.00	10025.	105.00	10065.	104.00	10355.	100.00	10365.
GR	98.10	10548.	100.00	10758.	105.00	10775.	105.00	11060.	123.00	11100.
GR	123.00	11150.								
X1	10400	11	10035.0	11103.0	200.0	200.0	200.0	1.0	0.0	0
GR	122.00	10000.	122.00	10035.	105.00	10070.	105.00	10353.	100.00	10385.
GR	98.10	10548.	100.00	10758.	105.00	10775.	105.00	11060.	123.00	11103.
GR	123.00	11140.								
X1	10600	11	10025.0	11100.0	200.0	200.0	200.0	1.0	0.0	0
GR	123.00	10000.	123.00	10025.	105.00	10068.	105.00	10362.	100.00	10392.
GR	98.50	10544.	100.00	10760.	105.00	10775.	106.00	11050.	124.00	11100.

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GR   124.00     11130.

X1    10800        11   10030.0   11100.0     200.0     200.0     200.0       1.0       0.0         0
GR   123.00     10000.    123.00    10030.    105.00    10067.    106.00     10380.    100.00     10400.
GR    99.00     10540.    101.00    10780.    106.00    10800.    107.00     11060.    124.00     11100.
GR   124.00     11145.

X1    11000        11   10022.0   11095.0     200.0     200.0     200.0       1.0       0.0         0
GR   123.00     10000.    123.00    10022.    105.00    10065.    106.00     10392.    101.00     10418.
GR    99.50     10538.    101.00    10810.    106.00    10830.    107.00     11060.    124.00     11095.
GR   125.00     11195.

X1    11200        12   10030.0   11100.0     200.0     200.0     200.0       1.0       0.0         0
GR   123.00     10000.    123.00    10030.    106.00    10064.    106.00     10413.    100.00     10425.
GR   100.00     10538.    100.00    10815.    103.00    10821.    106.00     10875.    107.00     11055.
GR   126.00     11100.    126.00    11160.

X1    11400        11   10030.0   11113.0     200.0     200.0     200.0       1.0       0.0         0
GR   124.00     10000.    124.00    10030.    107.00    10064.    103.40     10405.    100.40     10411.
GR   100.40     10810.    103.40    10816.    108.00    10925.    108.00     11060.    126.00     11113.
GR   128.00     11195.

X1    11600        12   10030.0   11122.0     200.0     200.0     200.0       1.0       0.0         0
GR   124.00     10000.    124.00    10030.    108.00    10065.    103.90     10399.    100.90     10405.
GR   100.90     10805.    103.90    10811.    103.90    11060.    116.50     11080.    116.50     11089.
GR   127.50     11122.    127.50    11133.

X1    11800        12   10035.0   11130.0     200.0     200.0     200.0       1.0       0.0         0
GR   125.50     10000.    125.00    10035.    110.00    10075.    104.40     10386.    101.40     10392.
GR   101.40     10792.    104.40    10798.    104.40    11071.    116.90     11089.    116.90     11097.
GR   127.90     11130.    127.90    11141.

X1    12000        12   10035.0   11130.0     200.0     200.0     200.0       1.0       0.0         0
GR   127.60     10000.    127.00    10035.    110.00    10070.    104.80     10364.    101.80     10370.
GR   101.80     10770.    104.80    10776.    104.80    11070.    117.40     11089.    117.40     11097.
GR   128.40     11130.    128.40    11140.

X1    12100        12   10035.0   11125.0     100.0     100.0     100.0       1.0       0.0         0
GR   127.80     10000.    127.00    10035.    110.50    10070.    105.10     10347.    102.10     10353.
GR   102.10     10753.    105.10    10759.    105.10    11065.    117.60     11084.    117.60     11092.
GR   128.60     11125.    128.60    11136.

X1    12200        12   10032.0   11123.0     100.0     100.0     100.0       1.0       0.0         0
GR   128.00     10000.    126.00    10032.    110.00    10082.    105.30     10334.    102.30     10340.
GR   102.30     10740.    105.30    10746.    105.30    11063.    117.80     11082.    117.80     11090.
GR   128.80     11123.    128.80    11134.

X1    12400        12   10047.0   11109.0     200.0     200.0     200.0       1.0       0.0         0
GR   129.30     10000.    129.00    10047.    111.00    10085.    105.80     10308.    102.80     10314.
GR   102.80     10714.    105.80    10720.    105.80    11049.    118.20     11068.    118.20     11076.
GR   129.20     11109.    129.20    11119.
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X1    12600        14   10033.0   11097.0     200.0     200.0     200.0       1.0       0.0         0
GR   130.00     10000.    130.00    10033.    118.60     10078.    118.60    10086.    106.20     10105.
GR   106.20     10281.    103.20    10287.    103.20     10687.    106.20    10693.    106.20     11038.
GR   118.60     11056.    118.60    11064.    129.60     11097.    129.60    11108.

X1    12800        14   10055.0   11130.0     200.0     200.0     200.0       1.0       0.0         0
GR   130.40     10000.    131.00    10055.    119.10     10108.    119.10    10116.    106.70     10135.
GR   106.70     10284.    103.70    10290.    103.70     10690.    106.70    10696.    106.70     11071.
GR   119.10     11089.    119.10    11097.    130.00     11130.    130.00    11141.

X1    13000        14   10059.0   11115.0     200.0     200.0     200.0       1.0       0.0         0
GR   132.00     10000.    131.00    10059.    119.40     10087.    119.40    10095.    107.20     10113.
GR   107.20     10244.    104.20    10250.    104.20     10650.    107.20    10656.    107.20     11055.
GR   119.50     11074.    119.50    11082.    130.50     11115.    130.50    11126.

X1    13200        14   10040.0   11092.0     200.0     200.0     200.0       1.0       0.0         0
GR   131.00     10000.    130.00    10040.    119.90     10064.    119.90    10072.    107.70     10090.
GR   107.70     10194.    104.70    10200.    104.70     10600.    107.70    10606.    107.70     11032.
GR   119.90     11051.    119.90    11059.    130.90     11092.    130.90    11102.

X1    13400        14   10040.0   11092.0     200.0     200.0     200.0       1.0       0.0         0
GR   131.00     10000.    130.00    10040.    120.30     10064.    120.30    10072.    108.10     10090.
GR   108.10     10172.    105.10    10178.    105.10     10578.    108.10    10584.    108.10     11032.
GR   120.30     11051.    120.30    11059.    131.30     11092.    131.30    11102.

X1    13600        14   10042.0   11087.0     200.0     200.0     200.0       1.0       0.0         0
GR   132.00     10000.    130.00    10042.    120.80     10067.    120.80    10075.    108.60     10093.
GR   108.60     10144.    105.60    10150.    105.60     10550.    108.60    10556.    108.60     11027.
GR   120.80     11046.    120.80    11054.    131.80     11087.    131.80    11097.

X1    13800        14   10035.0   11081.0     200.0     200.0     200.0       1.0       0.0         0
GR   132.50     10000.    130.00    10035.    121.20     10055.    121.20    10063.    109.10     10081.
GR   109.10     10114.    106.10    10120.    106.10     10520.    109.10    10526.    109.10     11022.
GR   121.20     11040.    121.20    11048.    132.20     11081.    132.20    11092.

X1    14000        14   10033.0   11085.0     200.0     200.0     200.0       1.0       0.0         0
GR   132.00     10000.    130.00    10033.    121.60     10049.    121.60    10057.    109.50     10075.
GR   109.50     10096.    106.50    10102.    106.50     10502.    109.50    10508.    109.50     11026.
GR   121.60     11044.    121.60    11052.    132.60     11085.    132.60    11096.

X1    14200        14   10011.0   11093.0     200.0     200.0     200.0       1.0       0.0         0
GR   133.00     10000.    133.00    10011.    122.00     10044.    122.00    10052.    110.00     10070.
GR   110.00     10091.    107.00    10097.    107.00     10497.    110.00    10503.    110.00     11034.
GR   122.00     11052.    122.00    11060.    133.00     11093.    133.00    11104.

NC      0.0       0.0       0.0       0.3       0.5
  Grade Control Str. No. 2
Grade Control Str. No. 2

X1    14400        13   10027.0   11093.0     200.0     200.0     200.0       1.0       0.0         0
GR   133.50     10000.    133.50    10027.    133.50     10035.    110.50    10070.    110.50     10086.
GR   107.50     10092.    107.50    10492.    110.50     10498.    110.50    11034.    122.50     11052.
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GR   122.50     11060.     133.50     11093.     133.50     11104.

NC    0.050      0.050      0.035       0.3        0.5
  SR 153 Bridge (D/S limit)
SR 153 Bridge (D/S limit)

X1    14665         10    10036.0    11068.0      265.0      265.0      265.0        1.0        0.0          0
X3        0        0.0        0.0    10036.0      147.0    11068.0      147.0        0.0        0.0
GR   134.10     10000.     134.10     10036.     111.20     10070.     111.20     10092.     108.20      10098.
GR   108.20     10498.     111.20     10504.     111.20     11034.     134.10     11068.     134.10      11103.
  SR 153 Bridge (U/S limit)

SR 153 Bridge (U/S limit)

X1    14785         12    10011.0    11068.0      120.0      120.0      120.0        1.0        0.0          0
GR   134.30     10000.     134.30     10011.     123.30     10044.     123.30     10052.     111.40      10070.
GR   111.40     10092.     108.40     10098.     108.40     10498.     111.40     10504.     111.40      11034.
GR   134.30     11068.     134.30     11103.

NC      0.0        0.0        0.0        0.1        0.3
X1    15000         14    10011.0    11091.0      215.0      215.0      215.0        1.0        0.0          0
GR   134.70     10000.     134.70     10011.     123.70     10044.     123.70     10052.     111.90      10070.
GR   111.90     10091.     108.90     10097.     108.90     10497.     111.90     10503.     111.90      11033.
GR   123.70     11050.     123.70     11058.     134.70     11091.     134.70     11102.

NC    0.050      0.050      0.035        0.1        0.3
X1    15200         14    10011.0    11091.0      200.0      200.0      200.0        1.0        0.0          0
GR   135.20     10000.     135.20     10011.     124.20     10044.     124.20     10052.     112.40      10070.
GR   112.40     10091.     109.40     10097.     109.40     10497.     112.40     10503.     112.40      11033.
GR   124.20     11050.     124.20     11058.     135.20     11091.     135.20     11102.

X1    15400         12    10035.0    11091.0      200.0      200.0      200.0        1.0        0.0          0
GR   135.60     10000.     135.60     10035.     112.80     10069.     112.80     10091.     109.80      10097.
GR   109.80     10497.     112.80     10503.     112.80     11033.     124.60     11051.     124.60      11059.
GR   135.60     11091.     135.60     11102.

NC    0.050      0.050      0.035        0.3        0.5
QT        4    92000.0   157000.0   210000.0   250000.0
  SR 143 Bridge (D/S limit)
SR 143 Bridge (D/S limit)

X1    15586         12    10035.0    11091.0      186.0      186.0      186.0        1.0        0.0          0
X3        0        0.0        0.0    10035.0      145.4    11091.0      145.4        0.0        0.0
GR   136.00     10000.     136.00     10035.     113.30     10069.     113.30     10091.     110.30      10097.
GR   110.30     10497.     113.30     10503.     113.30     11033.     125.00     11051.     125.00      11059.
GR   136.00     11091.     136.00     11102.

SB     1.05       1.56        2.6      200.0      963.0       48.0    26680.0        1.5     110.50      110.30
  SR 143 Bridge (U/S limit)
SR 143 Bridge (U/S limit)

X1    15710         12    10011.0    11066.0      124.0      124.0      124.0        1.0        0.0          0
```

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X2      0.0       0.0         1     137.0     145.4       0.0         0      2.00       0.0
GR   136.10     10000.    136.20   10011.    125.20   10044.    125.20    10052.    113.60    10070.
GR   113.60     10091.    110.60   10097.    110.60   10497.    113.60    10503.    113.60    11032.
GR   136.20     11066.    136.20   11102.

NC      0.0       0.0       0.0       0.1       0.3
X1    16000        16   10011.0   11084.0     290.0     290.0     290.0       1.0       0.0         0
GR   136.90     10000.    136.90   10011.    125.90   10044.    125.90    10052.    114.30    10078.
GR   114.30     10089.    111.30   10095.    111.30   10495.    114.30    10501.    114.30    11032.
GR   125.90     11050.    125.90   11058.    122.90   11062.    122.90    11063.    136.90    11084.
GR   136.90     11098.

NC    0.035     0.035     0.035       0.1       0.3
X1    16200        15   10020.0   11096.0     200.0     200.0     200.0       1.0       0.0         0
GR   137.30     10000.    137.30   10012.    137.30   10020.    114.70    10081.    114.70    10109.
GR   111.70     10115.    111.70   10515.    114.70   10521.    114.70    11043.    126.30    11061.
GR   126.30     11069.    123.30   11073.    123.30   11074.    137.30    11096.    137.30    11109.

X1    16400        16   10011.0   11083.0     200.0     200.0     200.0       1.0       0.0         0
GR   137.70     10000.    137.70   10011.    126.70   10044.    126.70    10052.    115.20    10069.
GR   115.20     10102.    112.20   10108.    112.20   10508.    115.20    10514.    115.20    11031.
GR   126.70     11049.    126.70   11057.    123.70   11061.    123.70    11062.    138.30    11083.
GR   138.30     11098.

X1    16600        16   10011.0   11085.0     200.0     200.0     200.0       1.0       0.0         0
GR   138.10     10000.    138.10   10011.    127.10   10043.    127.10    10051.    115.70    10069.
GR   115.70     10124.    112.70   10130.    112.70   10530.    115.70    10536.    115.70    11033.
GR   127.10     11050.    127.10   11058.    124.10   11063.    124.10    11064.    138.70    11085.
GR   138.70     11099.

X1    16800        16   10010.0   11087.0     200.0     200.0     200.0       1.0       0.0         0
GR   138.60     10000.    138.60   10010.    127.60   10043.    127.60    10051.    116.20    10069.
GR   116.20     10157.    113.20   10163.    113.20   10563.    116.20    10569.    116.20    11035.
GR   127.60     11052.    127.60   11060.    124.60   11065.    124.60    11066.    139.20    11087.
GR   139.20     11101.

X1    17000        16   10011.0   11089.0     200.0     200.0     200.0       1.0       0.0         0
GR   139.00     10000.    139.00   10011.    128.00   10044.    128.00    10052.    116.60    10069.
GR   116.60     10205.    113.60   10211.    113.60   10611.    116.60    10617.    116.60    11037.
GR   128.00     11054.    128.00   11062.    125.00   11067.    125.00    11068.    139.60    11089.
GR   139.60     11103.

X1    17200        16   10011.0   11089.0     200.0     200.0     200.0       1.0       0.0         0
GR   139.40     10000.    139.40   10011.    128.40   10044.    128.40    10052.    117.10    10069.
GR   117.10     10263.    114.10   10269.    114.10   10669.    117.10    10675.    117.10    11037.
GR   128.40     11054.    128.40   11062.    125.40   11067.    125.40    11068.    140.00    11089.
GR   140.00     11103.

X1    17400        12   10010.0   11088.0     200.0     200.0     200.0       1.0       0.0         0
GR   139.80     10000.    139.80   10010.    128.80   10043.    128.80    10051.    117.60    10068.
GR   117.60     10322.    114.60   10328.    114.60   10728.    117.60    10734.    117.60    11036.
GR   140.40     11088.    140.40   11102.
```

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X1    17600       12   10011.0   11070.0     200.0     200.0     200.0       1.0       0.0         0
GR   140.30    10000.    140.30    10011.    129.30    10044.    129.30    10052.    118.00     10069.
GR   118.00    10382.    115.00    10388.    115.00    10788.    118.00    10794.    118.00     11035.
GR   140.90    11070.    140.90    11084.

X1    17800       12   10011.0   11067.0     200.0     200.0     200.0       1.0       0.0         0
GR   140.70    10000.    140.70    10011.    129.70    10044.    129.70    10052.    118.50     10068.
GR   118.50    10431.    115.50    10437.    115.50    10837.    118.50    10843.    118.50     11033.
GR   141.30    11067.    141.30    11081.

X1    18000       12   10011.0   11065.0     200.0     200.0     200.0       1.0       0.0         0
GR   141.00    10000.    141.00    10011.    130.10    10044.    130.10    10052.    119.00     10069.
GR   119.00    10485.    116.00    10491.    116.00    10891.    119.00    10897.    119.00     11031.
GR   141.70    11065.    141.70    11079.

X1    18200       12   10011.0   11061.0     200.0     200.0     200.0       1.0       0.0         0
GR   141.50    10000.    141.50    10011.    130.50    10044.    130.50    10052.    119.50     10069.
GR   119.50    10528.    116.50    10534.    116.50    10934.    119.50    10940.    119.50     11027.
GR   142.10    11061.    142.10    11075.

X1    18400       10   10015.0   11080.0     200.0     200.0     200.0       1.0       0.0         0
GR   142.00    10000.    142.00    10015.    119.90    10077.    119.90    10567.    116.90     10573.
GR   116.90    10973.    119.90    10979.    119.90    11032.    142.60    11080.    142.60     11090.

X1    18600       10   10018.0   11050.0     200.0     200.0     200.0       1.0       0.0         0
GR   142.40    10000.    142.40    10018.    120.40    10067.    120.40    10576.    117.40     10582.
GR   117.40    10982.    120.40    10988.    120.40    11016.    143.00    11050.    143.00     11063.

X1    18800       12   10011.0   11046.0     200.0     200.0     200.0       1.0       0.0         0
GR   142.80    10000.    142.80    10011.    131.80    10044.    131.80    10052.    120.90     10069.
GR   120.90    10587.    117.90    10593.    117.90    10993.    120.90    10999.    120.90     11012.
GR   143.40    11046.    143.40    11060.

X1    19000       12   10011.0   11039.0     200.0     200.0     200.0       1.0       0.0         0
GR   143.20    10000.    143.20    10011.    132.20    10044.    132.20    10052.    121.30     10069.
GR   121.30    10586.    118.30    10592.    118.30    10992.    121.30    10998.    121.30     11005.
GR   143.80    11039.    143.80    11053.

X1    19200       12   10011.0   11031.0     200.0     200.0     200.0       1.0       0.0         0
GR   143.70    10000.    143.70    10011.    132.70    10044.    132.70    10052.    121.80     10068.
GR   121.80    10574.    118.80    10580.    118.80    10980.    121.80    10986.    121.80     10998.
GR   144.30    11031.    144.30    11045.

X1    19400       12   10011.0   11023.0     200.0     200.0     200.0       1.0       0.0         0
GR   144.10    10000.    144.10    10011.    133.10    10044.    133.10    10052.    122.30     10068.
GR   122.30    10555.    119.30    10561.    119.30    10961.    122.30    10967.    122.30     10989.
GR   144.70    11023.    144.70    11037.

X1    19600       12   10011.0   11014.0     200.0     200.0     200.0       1.0       0.0         0
GR   144.50    10000.    144.50    10011.    133.50    10044.    133.50    10052.    122.80     10068.
GR   122.80    10516.    119.80    10522.    119.80    10922.    122.80    10928.    122.80     10980.
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GR   145.10     11014.     145.10     11028.

X1    19800        12    10011.0    11005.0      200.0      200.0      200.0        1.0        0.0          0
GR   145.00     10000.     145.00     10011.     134.00     10044.     134.00     10052.     123.20     10068.
GR   123.20     10480.     120.20     10486.     120.20     10886.     123.20     10892.     123.20     10972.
GR   145.60     11005.     145.60     11019.

X1    20000        12    10010.0    10994.0      200.0      200.0      200.0        1.0        0.0          0
GR   145.60     10000.     145.60     10010.     134.60     10043.     134.60     10051.     123.70     10068.
GR   123.70     10435.     120.70     10441.     120.70     10841.     123.70     10847.     123.70     10961.
GR   145.60     10994.     145.60     11008.

X1    20200        12    10011.0    10987.0      200.0      200.0      200.0        1.0        0.0          0
GR   146.10     10000.     146.10     10011.     135.10     10044.     135.10     10052.     124.20     10068.
GR   124.20     10382.     121.20     10388.     121.20     10788.     124.20     10794.     124.20     10951.
GR   146.10     10987.     146.10     11000.

X1    20400        10    10020.0    10987.0      200.0      200.0      200.0        1.0        0.0          0
GR   146.60     10000.     146.60     10020.     124.60     10066.     124.60     10325.     121.60     10331.
GR   121.60     10731.     124.60     10737.     124.60     10938.     146.60     10987.     146.60     11000.

X1    20600        12    10010.0    10965.0      200.0      200.0      200.0        1.0        0.0          0
GR   147.10     10000.     147.10     10010.     136.10     10043.     136.10     10051.     125.10     10068.
GR   125.10     10276.     122.10     10282.     122.10     10682.     125.10     10688.     125.10     10932.
GR   147.10     10965.     147.10     10979.

X1    20782        14    10012.0    10988.0      178.0      178.0      178.0        1.0        0.0          0
GR   147.67     10000.     147.67     10012.     136.66     10045.     136.66     10053.     125.56     10069.
GR   125.56     10230.     122.50     10236.     122.50     10636.     125.56     10642.     125.56     10931.
GR   136.66     10947.     136.66     10955.     147.67     10988.     147.67     10999.
  Grade Control Str. No. 3

Grade Control Str. No. 3

X1    20800        14    10012.0    10988.0       18.0       18.0       18.0        1.0        0.0          0
GR   147.70     10000.     147.70     10012.     136.69     10045.     136.69     10053.     125.59     10069.
GR   125.59     10230.     122.53     10236.     122.53     10636.     125.59     10642.     125.59     10931.
GR   136.69     10947.     136.69     10955.     147.70     10988.     147.70     10999.

X1    21000        10    10032.0    10964.0      200.0      200.0      200.0        1.0        0.0          0
GR   148.20     10000.     148.20     10032.     125.94     10069.     125.94     10190.     122.86     10196.
GR   122.86     10596.     125.94     10602.     125.94     10931.     148.20     10964.     148.20     10999.

NC    0.050      0.050      0.035        0.3        0.5
  Priest Bridge (D/S)
Priest Bridge (D/S)

X1    21050        10    10032.0    10964.0       50.0       50.0       50.0        1.0        0.0          0
X3       10       0.0        0.0        0.0        0.0        0.0        0.0      157.0      157.0
GR    148.3   10000.0      148.3    10032.0      126.2    10069.0      126.2    10190.0      123.2    10196.0
GR    123.2   10596.0      126.2    10602.0      126.2    10931.0      148.3    10964.0      148.8    10999.0
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NC      0.0       0.0       0.0       0.1       0.3
SB     1.05      1.56       2.6    1000.0     861.8      42.0   24080.0       1.5     123.4     123.2
  Priest Bridge (U/S)
Priest Bridge (U/S)

X1    21150        10   10032.0   10964.0     100.0     100.0     100.0       1.0       0.0         0
X2      0.0       0.0         1     150.0     157.0       0.0         0       2.0       0.0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0     157.0     157.0
GR    148.5   10000.0     148.5   10032.0     126.4   10069.0     126.4   10190.0     123.4   10196.0
GR    123.4   10596.0     126.4   10602.0     126.4   10931.0     148.5   10964.0     148.5   10999.0

X1    21200        10   10035.0   10965.0      50.0      50.0      50.0       1.0       0.0         0
GR   148.90    10000.    148.90    10035.    126.20    10069.    126.20    10160.    123.19    10166.
GR   123.19    10566.    126.20    10572.    126.20    10931.    148.90    10965.    148.90    11000.

X1    21400        14   10011.0   10991.0     200.0     200.0     200.0       1.0       0.0         0
GR   149.60    10000.    149.60    10011.    137.86    10045.    137.86    10053.    126.56    10070.
GR   126.56    10133.    123.52    10139.    123.52    10539.    126.56    10545.    126.56    10932.
GR   137.86    10949.    137.86    10957.    149.60    10991.    149.60    11002.

X1    21600        10   10013.0   11006.0     200.0     200.0     200.0       1.0       0.0         0
GR   150.00    10000.    150.00    10013.    126.91    10078.    126.91    10119.    123.85    10125.
GR   123.85    10525.    126.91    10531.    126.91    10940.    150.50    11006.    150.50    11017.

X1    21800        14   10011.0   10991.0     200.0     200.0     200.0       1.0       0.0         0
GR   150.50    10000.    150.50    10011.    138.47    10045.    138.47    10053.    127.17    10070.
GR   127.17    10101.    124.18    10107.    124.18    10507.    127.17    10513.    127.17    10932.
GR   138.47    10949.    138.47    10957.    150.50    10991.    150.50    11002.

X1    22000        14   10011.0   10991.0     200.0     200.0     200.0       1.0       0.0         0
GR   151.00    10000.    151.00    10011.    138.82    10045.    138.82    10053.    127.52    10070.
GR   127.52    10104.    124.51    10110.    124.51    10510.    127.52    10516.    127.52    10932.
GR   138.82    10949.    138.82    10957.    151.00    10991.    151.00    11002.

X1    22200        14   10010.0   10990.0     200.0     200.0     200.0       1.0       0.0         0
GR   151.40    10000.    151.40    10010.    139.08    10044.    139.08    10052.    127.88    10069.
GR   127.88    10123.    124.84    10129.    124.84    10529.    127.88    10535.    127.88    10931.
GR   139.08    10948.    139.08    10956.    151.40    10990.    151.40    11000.

X1    22400        14   10010.0   10990.0     200.0     200.0     200.0       1.0       0.0         0
GR   151.90    10000.    151.90    10010.    139.44    10044.    139.44    10052.    128.24    10069.
GR   128.24    10160.    125.18    10166.    125.18    10566.    128.24    10572.    128.24    10931.
GR   139.44    10948.    139.44    10956.    151.90    10990.    151.90    11000.

X1    22600        14   10010.0   10990.0     200.0     200.0     200.0       1.0       0.0         0
GR   152.30    10000.    152.30    10010.    139.69    10044.    139.69    10052.    128.49    10069.
GR   128.49    10205.    125.51    10211.    125.51    10611.    128.49    10617.    128.49    10931.
GR   139.69    10948.    139.69    10956.    152.30    10990.    152.30    11000.

X1    22800        14   10010.0   10990.0     200.0     200.0     200.0       1.0       0.0         0
GR   152.80    10000.    152.80    10010.    140.05    10044.    140.05    10052.    128.85    10069.
GR   128.85    10260.    125.84    10266.    125.84    10666.    128.85    10672.    128.85    10931.
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GR   140.05    10948.    140.05    10956.    152.80    10990.    152.80    11000.

X1    23000       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   153.20    10000.    153.20    10011.    140.30    10045.    140.30    10053.    129.20     10069.
GR   129.20    10325.    126.70    10331.    126.70    10731.    129.20    10737.    129.20     10931.
GR   140.30    10947.    140.30    10955.    153.20    10989.    153.20    11000.

X1    23200       14   10010.0   10990.0     200.0     200.0     200.0       1.0       0.0         0
GR   153.70    10000.    153.70    10010.    140.66    10044.    140.66    10052.    129.46     10069.
GR   129.46    10390.    126.50    10396.    126.50    10796.    129.46    10802.    129.46     10931.
GR   140.66    10948.    140.66    10956.    153.70    10990.    153.70    11000.

X1    23400       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   154.10    10000.    154.10    10011.    140.92    10045.    140.92    10053.    129.82     10069.
GR   129.82    10440.    126.83    10446.    126.83    10846.    129.82    10852.    129.82     10931.
GR   140.92    10947.    140.92    10955.    154.10    10989.    154.10    11000.

X1    23600       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   154.60    10000.    154.60    10011.    141.27    10045.    141.27    10053.    130.17     10069.
GR   130.17    10480.    127.16    10486.    127.16    10886.    130.17    10892.    130.17     10931.
GR   141.27    10947.    141.27    10955.    154.60    10989.    154.60    11000.

X1    23800       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   155.00    10000.    155.00    10011.    141.53    10045.    141.53    10053.    130.53     10069.
GR   130.53    10500.    127.46    10506.    127.46    10906.    130.53    10912.    130.53     10931.
GR   141.53    10947.    141.53    10955.    155.00    10989.    155.00    11000.

X1    24000       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   155.50    10000.    155.50    10011.    141.88    10045.    141.88    10053.    130.40     10069.
GR   130.40    10510.    127.82    10516.    127.82    10916.    130.40    10922.    130.40     10931.
GR   141.88    10947.    141.88    10955.    155.50    10989.    155.50    11000.

X1    24200       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   155.90    10000.    155.90    10011.    142.14    10045.    142.14    10053.    130.40     10069.
GR   130.40    10507.    128.15    10513.    128.15    10913.    130.40    10919.    130.40     10931.
GR   142.14    10947.    142.14    10955.    155.90    10989.    155.90    11000.

X1    24400       10   10014.0   10981.0     200.0     200.0     200.0       1.0       0.0         0
GR   156.40    10000.    156.40    10014.    130.40    10066.    130.40    10487.    128.48     10493.
GR   128.48    10893.    130.40    10899.    130.40    10928.    156.40    10981.    156.40     10994.

X1    24600       10   10010.0   11004.0     200.0     200.0     200.0       1.0       0.0         0
GR   156.80    10000.    156.80    10010.    130.40    10076.    130.40    10465.    128.81     10471.
GR   128.81    10871.    130.40    10877.    130.40    10938.    156.80    11004.    156.80     11019.

X1    24800       14   10011.0   10989.0     200.0     200.0     200.0       1.0       0.0         0
GR   157.30    10000.    157.30    10011.    143.11    10045.    143.11    10053.    130.40     10069.
GR   130.40    10410.    129.14    10416.    129.14    10816.    130.40    10822.    130.40     10931.
GR   143.11    10947.    143.11    10955.    157.30    10989.    157.30    11000.

NC     0.05     0.05     0.035       0.0       0.0
 GCS #4
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GCS #4

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X1    24955       12     581.5    1500.0     155.0     155.0     155.0       1.0       0.0         0
X3        0      0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   154.75   505.00    154.60    520.00    142.10    557.50    141.86    581.50    132.40    609.88
GR   129.40  1022.00    132.40   1454.70    147.50   1500.00    147.65   1515.00    147.50   1517.00
GR   157.70  1548.00    157.85   1563.00

X1    25115       13     598.50   1500.00     120.0     200.0     160.0       1.0       0.0         0
GR   154.91   522.00    154.91    573.00    142.40    574.50    142.40    598.50    132.53    626.94
GR   129.61  1082.00    132.61   1454.55    147.83   1500.00    147.83   1515.00    145.83   1521.00
GR   145.83  1568.00    155.04   1594.00    155.04   1609.00

X1    25315       13     611.50   1500.00     200.0     200.0     200.0       1.0       0.0         0
GR   155.41   535.00    155.41    550.00    142.90    587.50    142.90    611.50    132.74    640.63
GR   129.82  1141.00    132.82   1454.34    148.17   1500.00    148.32   1515.00    146.17   1521.00
GR   146.17  1611.00    155.44   1639.00    155.44   1654.00

X1    25515       13     621.50   1515.00     200.0     200.0     200.0       1.0       0.0         0
GR   155.91   545.00    155.91    560.00    143.40    597.50    143.40    621.50    132.96    651.29
GR   130.03  1190.00    133.03   1413.59    148.50   1460.00    148.50   1515.00    146.50   1521.00
GR   146.50  1660.00    155.83   1686.00    155.83   1701.00

X1    25715       13     629.50   1500.00     200.0     200.0     200.0       1.0       0.0         0
GR   156.41   553.00    156.41    568.00    143.90    605.50    143.66    629.50    133.50    659.98
GR   130.24  1225.00    133.50   1454.01    148.83   1500.00    148.83   1515.00    146.83   1521.00
GR   147.73  1701.83    156.22   1730.00    156.22   1745.00

X1    25915       13     627.50   1500.00     200.0     200.0     200.0       1.0       0.0         0
GR   156.91   551.00    156.91    566.00    144.40    603.50    144.40    627.50    133.38    658.64
GR   130.45  1247.00    133.45   1453.86    149.17   1500.00    149.17   1515.00    147.17   1521.00
GR   148.31  1748.00    156.63   1777.00    156.63   1792.00

X1    26115       13     623.50   1500.00     200.0     200.0     200.0       1.0       0.0         0
GR   157.41   547.00    157.41    562.00    144.90    599.50    144.90    623.50    133.60    655.15
GR   130.66  1255.00    133.66   1453.65    149.50   1500.00    149.50   1515.00    147.50   1521.00
GR   148.88  1796.00    157.04   1822.00    157.04   1837.00

X1    26273       13     611.43   1500.00     115.0     200.0     158.0       1.0       0.0         0
GR   157.69   535.31    157.69    550.24    145.19    587.55    145.19    611.43    133.72    643.13
GR   130.86  1243.75    133.86   1452.09    149.83   1500.00    149.83   1507.43    147.83   1513.40
GR   149.42  1830.74    157.47   1859.66    157.47   1874.58

NC      0.0       0.0       0.0       0.3       0.5
  SPRR Bridge (D/S) (COE Sta. 21.659)
SPRR Bridge (D/S) (COE Sta. 21.659)

X1    26395       13     599.49   1420.00      85.0     160.0     122.0       1.0       0.0         0
GR   157.90   523.37    157.90    538.30    145.40    575.61    145.40    599.49    133.81    630.71
GR   131.03   1233.8    134.03   1371.79    150.10   1420.00    150.10   1515.00    148.10   1521.00
GR   149.93  1886.52    157.79   1911.32    157.79   1926.32
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QT       4   93000.0  160000.0  215000.0  250000.0
SB    1.48      1.56      2.67    1388.0     816.0      72.0   29800.0      10.7    131.58    131.55
X1   26413        13    598.49   1420.00      15.0      20.0      18.0       1.0       0.0         0
X2     0.0       0.0         1     161.0     165.0       0.0         0       2.0       0.0
GR  158.94    522.38    157.94    537.30    145.44    574.61    145.44    598.49    133.83    629.75
GR  131.05   1232.81    134.05   1371.76    150.13   1420.00    150.13   1515.00    148.13   1521.00
GR  149.96   1886.52    157.79   1911.40    157.79   1926.32

NC    0.05      0.05     0.035       0.1       0.3
X1   26737        13    9290.0   10830.0     335.0     315.0     324.0       1.0       0.0         0
GR   167.0    9290.0     150.0    9370.0     145.0    9500.0     140.0    9620.0     140.0    9820.0
GR   137.7    9960.0     135.6   10120.0     135.6   10360.0     140.0   10550.0     145.0   10680.0
GR   150.0   10750.0     170.0   10830.0     175.0   10850.0
T1     Channelized Salt River
T2     City of Tempe   File Name: RSSRP1.HC2
T3     100 Year Floodplain with Levees
```

JOB PARAMETERS :

```
J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q        WSEL    FQ

      0       3       0       0     0.0       0      0.0  155000.0  116.42

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

     2       0      0.0     0.0     0.0     0.0     0.0    -6.0     0.0

T1     Channelized Salt River
T2     City of Tempe   File Name: RSSRP1.HC2
T3     100 Year Floodplain with Levees
```

JOB PARAMETERS :

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J1  ICHECK   INQ     NINV    IDIR    STRT    METRIC  HVINS   Q        WSEL    FQ

      0       4       0       0     0.0       0      0.0  205000.0  119.15

J2  NPROF    IPLOT   PRFVS   XSECV   XSECH   FN      ALLDC   IBW     CHNIM   ITRACE

     3       0      0.0     0.0     0.0     0.0     0.0    -6.0     0.0

T1     Channelized Salt River
T2     City of Tempe   File Name: RSSRP1.HC2
T3     100 Year Floodplain with Levees
```

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	5	0	0	0.0	0	0.0	250000.0	120.10	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

SUMMARY PRINTOUT : City of Tempe File Name: RSSRP1.HC2
100 Year Floodplain with Levees
Channelized Salt River

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
10035.000	97.20	.00	90000.00	112.21	113.45	10054.86	1029.10	21.39
10035.000	97.20	.00	155000.00	116.42	118.21	14430.49	1049.59	19.57
10035.000	97.20	.00	205000.00	119.15	121.33	17314.01	1062.88	18.99
10035.000	97.20	.00	250000.00	120.10	122.99	18325.94	1067.50	23.52
10200.000	98.10	165.00	90000.00	112.60	113.80	10249.65	1028.79	20.07
10200.000	98.10	165.00	155000.00	116.78	118.53	14583.33	1047.35	18.86
10200.000	98.10	165.00	205000.00	119.49	121.64	17445.05	1059.42	18.46
10200.000	98.10	165.00	250000.00	120.57	123.38	18582.19	1064.18	22.39
10400.000	98.10	200.00	90000.00	113.04	114.19	10445.51	1025.76	18.77
10400.000	98.10	200.00	155000.00	117.19	118.91	14738.65	1044.21	18.13
10400.000	98.10	200.00	205000.00	119.89	122.01	17581.09	1056.25	17.91
10400.000	98.10	200.00	250000.00	121.09	123.82	18844.26	1061.55	21.29
10600.000	98.50	200.00	90000.00	113.43	114.56	10529.44	1022.77	18.19

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
10600.000	98.50	200.00	155000.00	117.56	119.27	14797.08	1044.11	17.88
10600.000	98.50	200.00	205000.00	120.27	122.36	17635.34	1058.06	17.75
10600.000	98.50	200.00	250000.00	121.56	124.25	19019.84	1064.80	20.71
10800.000	99.00	200.00	90000.00	113.78	114.95	10342.26	1026.99	19.44
10800.000	99.00	200.00	155000.00	117.90	119.65	14612.39	1045.16	18.69
10800.000	99.00	200.00	205000.00	120.60	122.74	17447.15	1057.05	18.40
10800.000	99.00	200.00	250000.00	121.96	124.68	18889.04	1063.04	21.18
11000.000	99.50	200.00	90000.00	114.24	115.33	10775.06	1031.99	17.06
11000.000	99.50	200.00	155000.00	118.37	120.01	15072.15	1050.35	16.96
11000.000	99.50	200.00	205000.00	121.07	123.10	17927.51	1062.37	16.92
11000.000	99.50	200.00	250000.00	122.54	125.10	19492.41	1068.90	19.20
11200.000	100.00	200.00	90000.00	114.63	115.66	11093.79	1026.35	15.39
11200.000	100.00	200.00	155000.00	118.77	120.35	15372.93	1044.40	15.78
11200.000	100.00	200.00	205000.00	121.47	123.44	18212.69	1056.21	15.95
11200.000	100.00	200.00	250000.00	123.01	125.48	19846.06	1092.92	17.98
11400.000	100.40	200.00	90000.00	114.99	115.96	11408.64	1032.56	14.11
11400.000	100.40	200.00	155000.00	119.15	120.66	15751.05	1053.15	14.69
11400.000	100.40	200.00	205000.00	121.88	123.76	18637.09	1066.61	14.94
11400.000	100.40	200.00	250000.00	123.50	125.83	20370.96	1074.62	16.69
11600.000	100.90	200.00	90000.00	115.36	116.22	12102.62	1029.30	11.57
11600.000	100.90	200.00	155000.00	119.57	120.94	16504.87	1058.54	12.69
11600.000	100.90	200.00	205000.00	122.32	124.05	19433.69	1072.80	13.12
11600.000	100.90	200.00	250000.00	124.02	126.17	21262.50	1111.56	14.63
11800.000	101.40	200.00	90000.00	115.56	116.49	11589.90	1026.88	13.31
11800.000	101.40	200.00	155000.00	119.78	121.24	15991.26	1056.71	14.06
11800.000	101.40	200.00	205000.00	122.53	124.35	18920.24	1072.30	14.33
11800.000	101.40	200.00	250000.00	124.25	126.50	20775.39	1082.06	15.80
12000.000	101.80	200.00	90000.00	115.82	116.76	11593.87	1028.58	13.33
12000.000	101.80	200.00	155000.00	120.06	121.52	16013.19	1055.66	13.98
12000.000	101.80	200.00	205000.00	122.82	124.64	18943.85	1069.61	14.23
12000.000	101.80	200.00	250000.00	124.58	126.82	20845.83	1078.57	15.57
12100.000	102.10	100.00	90000.00	115.93	116.91	11371.39	1023.00	14.11
12100.000	102.10	100.00	155000.00	120.17	121.67	15765.97	1050.24	14.62
12100.000	102.10	100.00	205000.00	122.93	124.80	18679.20	1064.35	14.81
12100.000	102.10	100.00	250000.00	124.70	126.99	20570.82	1073.42	16.16

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
12200.000	102.30	100.00	90000.00	116.07	117.05	11339.05	1016.35	14.12
12200.000	102.30	100.00	155000.00	120.31	121.82	15719.75	1047.79	14.71
12200.000	102.30	100.00	205000.00	123.07	124.95	18632.40	1064.68	14.93
12200.000	102.30	100.00	250000.00	124.86	127.16	20540.62	1075.60	16.27
12400.000	102.80	200.00	90000.00	116.31	117.37	10885.31	991.32	15.66
12400.000	102.80	200.00	155000.00	120.54	122.17	15130.70	1018.15	16.09
12400.000	102.80	200.00	205000.00	123.28	125.31	17941.23	1032.16	16.26
12400.000	102.80	200.00	250000.00	125.07	127.55	19799.89	1041.33	17.63
12600.000	103.20	200.00	90000.00	116.66	117.67	11140.38	964.21	14.01
12600.000	103.20	200.00	155000.00	120.89	122.48	15291.32	1001.90	15.25
12600.000	103.20	200.00	205000.00	123.63	125.63	18063.14	1020.94	15.71
12600.000	103.20	200.00	250000.00	125.46	127.90	19941.97	1033.65	17.08
12800.000	103.70	200.00	90000.00	116.92	117.97	10942.73	966.50	14.91
12800.000	103.70	200.00	155000.00	121.17	122.81	15121.54	1004.52	15.88
12800.000	103.70	200.00	205000.00	123.92	125.96	17912.60	1025.10	16.24
12800.000	103.70	200.00	250000.00	125.79	128.25	19844.48	1039.10	17.48
13000.000	104.20	200.00	90000.00	117.21	118.29	10800.94	972.24	15.69
13000.000	104.20	200.00	155000.00	121.48	123.13	15020.75	1005.99	16.27
13000.000	104.20	200.00	205000.00	124.24	126.29	17816.38	1020.92	16.45
13000.000	104.20	200.00	250000.00	126.12	128.61	19748.20	1031.12	17.60
13200.000	104.70	200.00	90000.00	117.50	118.62	10605.45	971.75	16.67
13200.000	104.70	200.00	155000.00	121.78	123.48	14817.25	1005.11	17.00
13200.000	104.70	200.00	205000.00	124.54	126.64	17607.76	1019.93	17.08
13200.000	104.70	200.00	250000.00	126.44	128.98	19563.48	1030.19	18.13
13400.000	105.10	200.00	90000.00	117.83	118.97	10525.74	971.50	17.08
13400.000	105.10	200.00	155000.00	122.11	123.83	14749.72	1004.93	17.26
13400.000	105.10	200.00	205000.00	124.87	126.99	17542.72	1020.03	17.29
13400.000	105.10	200.00	250000.00	126.80	129.35	19521.56	1030.59	18.27
13600.000	105.60	200.00	90000.00	118.14	119.34	10270.37	962.95	18.32
13600.000	105.60	200.00	155000.00	122.42	124.21	14441.21	996.24	18.30
13600.000	105.60	200.00	205000.00	125.17	127.37	17202.11	1011.96	18.27
13600.000	105.60	200.00	250000.00	127.11	129.75	19182.56	1023.09	19.18
13800.000	106.10	200.00	90000.00	118.50	119.71	10193.08	968.96	18.94
13800.000	106.10	200.00	155000.00	122.78	124.58	14389.22	1001.29	18.65
13800.000	106.10	200.00	205000.00	125.53	127.74	17162.28	1015.79	18.50
13800.000	106.10	200.00	250000.00	127.49	130.14	19168.81	1026.15	19.31

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
14000.000	106.50	200.00	90000.00	118.91	120.09	10294.07	978.98	18.58
14000.000	106.50	200.00	155000.00	123.19	124.95	14540.44	1010.78	18.24
14000.000	106.50	200.00	205000.00	125.94	128.11	17345.37	1024.30	18.06
14000.000	106.50	200.00	250000.00	127.95	130.52	19406.12	1034.12	18.73
14200.000	107.00	200.00	90000.00	119.28	120.47	10293.66	991.84	18.91
14200.000	107.00	200.00	155000.00	123.57	125.32	14594.88	1025.36	18.35
14200.000	107.00	200.00	205000.00	126.34	128.48	17464.47	1042.02	18.05
14200.000	107.00	200.00	250000.00	128.37	130.90	19600.17	1054.25	18.57
14400.000	107.50	200.00	90000.00	119.65	120.87	10170.07	991.66	19.68
14400.000	107.50	200.00	155000.00	123.92	125.71	14446.46	1014.71	18.73
14400.000	107.50	200.00	205000.00	126.68	128.87	17252.69	1027.14	18.45
14400.000	107.50	200.00	250000.00	128.72	131.31	19360.15	1036.38	18.94
14665.000	108.20	265.00	90000.00	120.17	121.43	9977.16	990.61	20.94
14665.000	108.20	265.00	155000.00	124.40	126.24	14205.11	1003.21	19.52
14665.000	108.20	265.00	205000.00	127.13	129.40	16956.32	1011.32	19.17
14665.000	108.20	265.00	250000.00	129.18	131.86	19034.03	1017.40	19.58
14785.000	108.40	120.00	90000.00	120.44	121.68	10053.59	991.09	20.43
14785.000	108.40	120.00	155000.00	124.65	126.48	14266.89	1013.73	19.50
14785.000	108.40	120.00	205000.00	127.41	129.64	17077.15	1026.08	19.07
14785.000	108.40	120.00	250000.00	129.48	132.11	19218.63	1035.40	19.38
15000.000	108.90	215.00	90000.00	120.87	122.13	9982.36	989.63	20.88
15000.000	108.90	215.00	155000.00	125.06	126.92	14182.78	1022.22	20.11
15000.000	108.90	215.00	205000.00	127.81	130.06	17013.39	1038.70	19.61
15000.000	108.90	215.00	250000.00	129.90	132.53	19192.53	1051.21	19.84
15200.000	109.40	200.00	90000.00	121.28	122.56	9889.52	989.35	21.53
15200.000	109.40	200.00	155000.00	125.45	127.33	14062.23	1021.51	20.67
15200.000	109.40	200.00	205000.00	128.18	130.47	16881.46	1037.94	20.10
15200.000	109.40	200.00	250000.00	130.28	132.95	19069.56	1050.51	20.25
15400.000	109.80	200.00	90000.00	121.72	122.99	9925.10	990.87	21.32
15400.000	109.80	200.00	155000.00	125.86	127.74	14070.26	1013.12	20.41
15400.000	109.80	200.00	205000.00	128.58	130.88	16847.52	1025.11	19.92
15400.000	109.80	200.00	250000.00	130.67	133.35	19008.72	1034.34	20.07
15586.000	110.30	186.00	92000.00	122.08	123.45	9803.24	990.67	23.20
15586.000	110.30	186.00	157000.00	126.21	128.18	13922.36	1012.84	21.67
15586.000	110.30	186.00	210000.00	128.88	131.35	16643.55	1024.61	21.75
15586.000	110.30	186.00	250000.00	131.03	133.75	18865.46	1034.12	20.58

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
15710.000	110.60	124.00	92000.00	122.31	123.70	9714.04	988.62	23.85
15710.000	110.60	124.00	157000.00	126.55	128.52	13941.48	1011.52	21.54
15710.000	110.60	124.00	210000.00	129.33	131.76	16768.83	1024.03	21.20
15710.000	110.60	124.00	250000.00	131.51	134.20	19022.06	1033.90	20.01
16000.000	111.30	290.00	92000.00	123.00	124.41	9654.83	988.24	24.31
16000.000	111.30	290.00	157000.00	127.17	129.16	13862.67	1029.23	22.48
16000.000	111.30	290.00	210000.00	129.94	132.39	16735.23	1041.72	21.85
16000.000	111.30	290.00	250000.00	132.10	134.79	18991.19	1051.42	20.59
16200.000	111.70	200.00	92000.00	123.54	124.88	9889.66	1001.28	22.82
16200.000	111.70	200.00	157000.00	127.68	129.61	14106.40	1034.93	21.36
16200.000	111.70	200.00	210000.00	130.45	132.82	16985.12	1046.74	20.92
16200.000	111.70	200.00	250000.00	132.57	135.20	19216.77	1055.81	19.90
16400.000	112.20	200.00	92000.00	123.98	125.36	9784.49	990.51	23.35
16400.000	112.20	200.00	157000.00	128.08	130.06	13913.71	1028.44	22.22
16400.000	112.20	200.00	210000.00	130.83	133.27	16757.54	1040.64	21.76
16400.000	112.20	200.00	250000.00	132.93	135.63	18947.81	1049.95	20.74
16600.000	112.70	200.00	92000.00	124.45	125.83	9765.26	992.91	23.58
16600.000	112.70	200.00	157000.00	128.52	130.51	13880.90	1031.47	22.47
16600.000	112.70	200.00	210000.00	131.26	133.71	16723.38	1043.39	21.97
16600.000	112.70	200.00	250000.00	133.33	136.05	18897.72	1052.41	20.98
16800.000	113.20	200.00	92000.00	124.92	126.30	9755.89	994.75	23.71
16800.000	113.20	200.00	157000.00	128.97	130.96	13856.48	1033.39	22.66
16800.000	113.20	200.00	210000.00	131.70	134.15	16693.41	1045.50	22.16
16800.000	113.20	200.00	250000.00	133.74	136.48	18848.27	1054.61	21.22
17000.000	113.60	200.00	92000.00	125.42	126.77	9872.65	996.61	22.85
17000.000	113.60	200.00	157000.00	129.45	131.41	13956.87	1034.74	22.16
17000.000	113.60	200.00	210000.00	132.16	134.59	16784.68	1046.80	21.80
17000.000	113.60	200.00	250000.00	134.18	136.90	18896.88	1055.71	21.08
17200.000	114.10	200.00	92000.00	125.87	127.23	9833.49	996.91	23.17
17200.000	114.10	200.00	157000.00	129.88	131.86	13902.07	1034.93	22.46
17200.000	114.10	200.00	210000.00	132.59	135.04	16721.03	1046.95	22.08
17200.000	114.10	200.00	250000.00	134.59	137.33	18826.02	1055.83	21.34
17400.000	114.60	200.00	92000.00	126.34	127.70	9816.33	1001.17	23.40
17400.000	114.60	200.00	157000.00	130.32	132.31	13861.18	1026.62	22.35
17400.000	114.60	200.00	210000.00	133.02	135.49	16646.86	1040.85	22.15
17400.000	114.60	200.00	250000.00	135.00	137.77	18723.94	1051.33	21.51

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2

PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
17600.000	115.00	200.00	92000.00	126.81	128.16	9836.91	992.69	23.00
17600.000	115.00	200.00	157000.00	130.76	132.77	13809.60	1014.91	22.33
17600.000	115.00	200.00	210000.00	133.44	135.94	16539.32	1027.01	22.28
17600.000	115.00	200.00	250000.00	135.40	138.22	18560.89	1035.89	21.77
17800.000	115.50	200.00	92000.00	127.26	128.63	9792.58	990.60	23.29
17800.000	115.50	200.00	157000.00	131.19	133.22	13721.85	1012.43	22.74
17800.000	115.50	200.00	210000.00	133.87	136.40	16448.45	1024.46	22.62
17800.000	115.50	200.00	250000.00	135.81	138.66	18451.93	1033.21	22.13
18000.000	116.00	200.00	92000.00	127.72	129.11	9724.18	988.42	23.76
18000.000	116.00	200.00	157000.00	131.63	133.69	13635.92	1010.60	23.16
18000.000	116.00	200.00	210000.00	134.30	136.87	16349.03	1022.68	23.02
18000.000	116.00	200.00	250000.00	136.24	139.12	18335.71	1031.43	22.54
18200.000	116.50	200.00	92000.00	128.18	129.59	9655.19	984.50	24.20
18200.000	116.50	200.00	157000.00	132.08	134.17	13530.56	1006.69	23.64
18200.000	116.50	200.00	210000.00	134.74	137.34	16230.69	1018.70	23.46
18200.000	116.50	200.00	250000.00	136.66	139.59	18179.90	1027.28	23.06
18400.000	116.90	200.00	92000.00	128.71	130.07	9821.01	998.34	23.24
18400.000	116.90	200.00	157000.00	132.62	134.64	13759.73	1017.56	22.61
18400.000	116.90	200.00	210000.00	135.29	137.81	16502.89	1030.74	22.47
18400.000	116.90	200.00	250000.00	137.22	140.05	18493.19	1040.20	22.08
18600.000	117.40	200.00	92000.00	129.15	130.56	9664.36	981.65	24.01
18600.000	117.40	200.00	157000.00	133.02	135.12	13491.91	996.10	23.51
18600.000	117.40	200.00	210000.00	135.68	138.30	16150.13	1006.00	23.44
18600.000	117.40	200.00	250000.00	137.57	140.55	18065.59	1013.08	23.11
18800.000	117.90	200.00	92000.00	129.61	131.05	9559.92	969.78	24.52
18800.000	117.90	200.00	157000.00	133.46	135.62	13332.58	992.02	24.35
18800.000	117.90	200.00	210000.00	136.11	138.80	15964.27	1003.92	24.32
18800.000	117.90	200.00	250000.00	138.00	141.04	17866.62	1012.43	23.97
19000.000	118.30	200.00	92000.00	130.10	131.54	9572.51	963.02	24.19
19000.000	118.30	200.00	157000.00	133.94	136.10	13312.40	985.33	24.26
19000.000	118.30	200.00	210000.00	136.59	139.29	15935.11	997.26	24.25
19000.000	118.30	200.00	250000.00	138.47	141.52	17818.10	1005.75	23.98
19200.000	118.80	200.00	92000.00	130.58	132.03	9501.24	955.78	24.56
19200.000	118.80	200.00	157000.00	134.41	136.61	13191.83	977.61	24.75
19200.000	118.80	200.00	210000.00	137.04	139.79	15784.13	989.39	24.78
19200.000	118.80	200.00	250000.00	138.91	142.03	17634.90	997.71	24.57

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
19400.000	119.30	200.00	92000.00	131.05	132.54	9399.91	947.27	25.15
19400.000	119.30	200.00	157000.00	134.88	137.12	13053.71	969.41	25.35
19400.000	119.30	200.00	210000.00	137.50	140.31	15616.78	981.29	25.39
19400.000	119.30	200.00	250000.00	139.35	142.55	17441.41	989.65	25.21
19600.000	119.80	200.00	92000.00	131.54	133.06	9312.94	938.42	25.62
19600.000	119.80	200.00	157000.00	135.36	137.65	12936.18	960.77	25.81
19600.000	119.80	200.00	210000.00	137.98	140.84	15457.26	972.57	25.97
19600.000	119.80	200.00	250000.00	139.82	143.08	17254.86	980.89	25.82
19800.000	120.20	200.00	92000.00	132.06	133.56	9332.33	930.14	25.15
19800.000	120.20	200.00	157000.00	135.87	138.16	12926.35	952.27	25.58
19800.000	120.20	200.00	210000.00	138.49	141.36	15436.44	963.99	25.79
19800.000	120.20	200.00	250000.00	140.32	143.60	17214.97	972.21	25.73
20000.000	120.70	200.00	92000.00	132.54	134.08	9232.40	920.11	25.70
20000.000	120.70	200.00	157000.00	136.35	138.69	12776.02	942.31	26.23
20000.000	120.70	200.00	210000.00	138.96	141.91	15252.74	954.08	26.47
20000.000	120.70	200.00	250000.00	140.78	144.14	16999.27	962.30	26.46
20200.000	121.20	200.00	92000.00	133.04	134.61	9153.47	910.54	26.08
20200.000	121.20	200.00	157000.00	136.85	139.24	12650.46	933.03	26.75
20200.000	121.20	200.00	210000.00	139.45	142.46	15099.58	945.14	27.03
20200.000	121.20	200.00	250000.00	141.27	144.70	16823.19	953.57	27.06
20400.000	121.60	200.00	92000.00	133.58	135.13	9222.65	910.78	25.39
20400.000	121.60	200.00	157000.00	137.41	139.77	12743.54	927.32	25.84
20400.000	121.60	200.00	210000.00	140.02	142.99	15180.24	938.60	26.26
20400.000	121.60	200.00	250000.00	141.83	145.24	16886.80	946.42	26.40
20600.000	122.10	200.00	92000.00	134.06	135.65	9081.97	891.29	26.03
20600.000	122.10	200.00	157000.00	137.88	140.32	12525.39	913.51	26.90
20600.000	122.10	200.00	210000.00	140.49	143.56	14920.86	925.24	27.36
20600.000	122.10	200.00	250000.00	142.29	145.81	16596.23	933.35	27.54
20782.000	122.50	178.00	92000.00	134.52	136.12	9079.72	887.82	25.93
20782.000	122.50	178.00	157000.00	138.37	140.80	12554.99	920.26	26.95
20782.000	122.50	178.00	210000.00	141.01	144.05	15001.94	936.07	27.27
20782.000	122.50	178.00	250000.00	142.84	146.31	16722.03	947.02	27.36
20800.000	122.53	18.00	92000.00	134.58	136.16	9098.36	887.88	25.75
20800.000	122.53	18.00	157000.00	138.43	140.85	12571.95	920.37	26.84
20800.000	122.53	18.00	210000.00	141.07	144.10	15019.85	936.18	27.17
20800.000	122.53	18.00	250000.00	142.89	146.36	16740.33	947.13	27.26

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
21000.000	122.86	200.00	92000.00	135.16	136.67	9328.00	890.98	23.80
21000.000	122.86	200.00	157000.00	139.04	141.37	12812.95	903.20	24.58
21000.000	122.86	200.00	210000.00	141.67	144.63	15195.05	911.45	25.26
21000.000	122.86	200.00	250000.00	143.47	146.89	16842.24	917.12	25.65
21050.000	123.20	50.00	92000.00	135.25	136.82	9147.46	890.66	25.38
21050.000	123.20	50.00	157000.00	139.13	141.53	12630.45	902.96	25.76
21050.000	123.20	50.00	210000.00	141.76	144.80	15012.68	911.28	26.29
21050.000	123.20	50.00	250000.00	143.56	147.06	16660.03	916.99	26.59
21150.000	123.40	100.00	92000.00	135.53	137.07	9215.63	890.90	24.77
21150.000	123.40	100.00	157000.00	139.60	141.91	12872.62	903.81	24.22
21150.000	123.40	100.00	210000.00	142.39	145.27	15404.56	912.64	24.18
21150.000	123.40	100.00	250000.00	144.31	147.60	17165.05	918.73	24.14
21200.000	123.19	50.00	92000.00	135.78	137.20	9617.45	890.70	21.50
21200.000	123.19	50.00	157000.00	139.87	142.04	13286.84	902.96	21.79
21200.000	123.19	50.00	210000.00	142.67	145.40	15826.36	911.34	22.08
21200.000	123.19	50.00	250000.00	144.60	147.74	17589.74	917.12	22.22
21400.000	123.52	200.00	92000.00	136.24	137.63	9721.32	891.13	20.76
21400.000	123.52	200.00	157000.00	140.37	142.48	13473.98	926.54	21.49
21400.000	123.52	200.00	210000.00	143.22	145.85	16141.89	943.07	21.59
21400.000	123.52	200.00	250000.00	145.20	148.19	18015.91	954.51	21.57
21600.000	123.85	200.00	92000.00	136.71	138.04	9963.09	917.03	19.79
21600.000	123.85	200.00	157000.00	140.91	142.90	13861.07	940.58	19.87
21600.000	123.85	200.00	210000.00	143.80	146.28	16597.92	956.78	19.97
21600.000	123.85	200.00	250000.00	145.79	148.62	18516.68	967.97	19.98
21800.000	124.18	200.00	92000.00	137.10	138.43	9920.18	891.87	19.43
21800.000	124.18	200.00	157000.00	141.29	143.31	13737.13	927.92	20.19
21800.000	124.18	200.00	210000.00	144.16	146.70	16430.36	944.18	20.38
21800.000	124.18	200.00	250000.00	146.15	149.04	18317.40	955.41	20.44
22000.000	124.51	200.00	92000.00	137.50	138.82	9965.91	892.00	19.14
22000.000	124.51	200.00	157000.00	141.71	143.72	13814.75	928.14	19.83
22000.000	124.51	200.00	210000.00	144.60	147.11	16515.67	944.25	20.04
22000.000	124.51	200.00	250000.00	146.59	149.45	18405.50	955.36	20.12
22200.000	124.84	200.00	92000.00	137.89	139.20	10008.42	892.37	18.88
22200.000	124.84	200.00	157000.00	142.12	144.11	13874.02	928.76	19.56
22200.000	124.84	200.00	210000.00	145.02	147.51	16581.66	944.71	19.79
22200.000	124.84	200.00	250000.00	147.01	149.85	18487.87	955.79	19.83

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
22400.000	125.18	200.00	92000.00	138.27	139.58	10040.58	892.45	18.68
22400.000	125.18	200.00	157000.00	142.53	144.50	13919.75	928.79	19.35
22400.000	125.18	200.00	210000.00	145.43	147.90	16639.09	944.64	19.56
22400.000	125.18	200.00	250000.00	147.42	150.25	18536.66	955.54	19.65
22600.000	125.51	200.00	92000.00	138.67	139.95	10131.76	892.87	18.14
22600.000	125.51	200.00	157000.00	142.95	144.89	14056.75	929.58	18.75
22600.000	125.51	200.00	210000.00	145.86	148.29	16785.85	945.28	19.01
22600.000	125.51	200.00	250000.00	147.86	150.64	18688.17	956.07	19.14
22800.000	125.84	200.00	92000.00	139.04	140.31	10160.07	892.92	17.97
22800.000	125.84	200.00	157000.00	143.33	145.26	14088.07	929.50	18.61
22800.000	125.84	200.00	210000.00	146.25	148.67	16821.11	945.05	18.87
22800.000	125.84	200.00	250000.00	148.26	151.02	18725.05	955.74	19.01
23000.000	126.70	200.00	92000.00	139.37	140.70	9928.73	891.31	19.35
23000.000	126.70	200.00	157000.00	143.67	145.66	13857.52	927.77	19.61
23000.000	126.70	200.00	210000.00	146.59	149.08	16588.52	943.15	19.72
23000.000	126.70	200.00	250000.00	148.59	151.43	18489.85	953.72	19.77
23200.000	126.50	200.00	92000.00	139.84	141.07	10311.64	893.51	17.12
23200.000	126.50	200.00	157000.00	144.17	146.05	14281.77	930.31	17.80
23200.000	126.50	200.00	210000.00	147.11	149.47	17037.10	945.63	18.11
23200.000	126.50	200.00	250000.00	149.13	151.83	18953.85	956.14	18.27
23400.000	126.83	200.00	92000.00	140.18	141.42	10297.04	891.86	17.17
23400.000	126.83	200.00	157000.00	144.53	146.40	14286.13	928.67	17.75
23400.000	126.83	200.00	210000.00	147.47	149.83	17041.11	943.85	18.05
23400.000	126.83	200.00	250000.00	149.49	152.19	18956.49	954.26	18.22
23600.000	127.16	200.00	92000.00	140.52	141.76	10299.76	891.84	17.15
23600.000	127.16	200.00	157000.00	144.88	146.76	14290.18	928.44	17.73
23600.000	127.16	200.00	210000.00	147.84	150.19	17050.82	943.48	18.01
23600.000	127.16	200.00	250000.00	149.86	152.56	18968.85	953.80	18.17
23800.000	127.46	200.00	92000.00	140.87	142.10	10311.47	892.07	17.09
23800.000	127.46	200.00	157000.00	145.25	147.11	14314.86	928.73	17.64
23800.000	127.46	200.00	210000.00	148.20	150.55	17083.13	943.65	17.90
23800.000	127.46	200.00	250000.00	150.23	152.92	19005.33	953.88	18.06
24000.000	127.82	200.00	92000.00	141.26	142.44	10576.13	892.28	15.72
24000.000	127.82	200.00	157000.00	145.67	147.46	14610.62	928.92	16.48
24000.000	127.82	200.00	210000.00	148.64	150.91	17396.92	943.77	16.86
24000.000	127.82	200.00	250000.00	150.68	153.28	19330.07	953.95	17.07

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
24200.000	128.15	200.00	92000.00	141.61	142.75	10738.20	892.53	14.95
24200.000	128.15	200.00	157000.00	146.04	147.79	14811.80	929.29	15.76
24200.000	128.15	200.00	210000.00	149.04	151.24	17613.84	944.08	16.18
24200.000	128.15	200.00	250000.00	151.08	153.62	19556.64	954.19	16.43
24400.000	128.48	200.00	92000.00	141.96	143.04	11014.09	908.68	14.02
24400.000	128.48	200.00	157000.00	146.42	148.10	15109.87	926.71	14.65
24400.000	128.48	200.00	210000.00	149.43	151.56	17914.25	938.85	15.15
24400.000	128.48	200.00	250000.00	151.48	153.95	19850.95	947.14	15.45
24600.000	128.81	200.00	92000.00	142.28	143.32	11239.63	921.40	13.33
24600.000	128.81	200.00	157000.00	146.79	148.39	15443.02	943.94	13.93
24600.000	128.81	200.00	210000.00	149.83	151.87	18340.54	959.16	14.38
24600.000	128.81	200.00	250000.00	151.91	154.26	20348.71	969.57	14.63
24800.000	129.14	200.00	92000.00	142.54	143.59	11166.57	892.58	13.13
24800.000	129.14	200.00	157000.00	147.05	148.68	15289.86	928.86	14.18
24800.000	129.14	200.00	210000.00	150.09	152.17	18140.85	943.46	14.67
24800.000	129.14	200.00	250000.00	152.17	154.57	20114.50	953.43	14.96
24955.000	129.40	155.00	92000.00	142.63	143.89	10238.04	929.47	17.78
24955.000	129.40	155.00	157000.00	147.14	148.99	14492.70	956.55	17.03
24955.000	129.40	155.00	210000.00	150.19	152.48	17479.69	991.93	16.73
24955.000	129.40	155.00	250000.00	152.27	154.88	19559.09	1004.51	16.57
25115.000	129.61	160.00	92000.00	142.89	144.19	10084.98	910.79	18.20
25115.000	129.61	160.00	157000.00	147.37	149.28	14294.78	980.80	17.55
25115.000	129.61	160.00	210000.00	150.41	152.77	17326.29	1007.40	17.25
25115.000	129.61	160.00	250000.00	152.49	155.17	19429.34	1013.52	17.04
25315.000	129.82	200.00	92000.00	143.25	144.55	10056.43	898.92	18.01
25315.000	129.82	200.00	157000.00	147.71	149.64	14274.79	1024.55	17.66
25315.000	129.82	200.00	210000.00	150.75	153.12	17461.17	1060.88	17.27
25315.000	129.82	200.00	250000.00	152.84	155.51	19678.32	1073.38	17.02
25515.000	130.03	200.00	92000.00	143.52	144.98	9483.18	847.90	20.21
25515.000	130.03	200.00	157000.00	147.91	150.09	13463.16	1021.36	20.15
25515.000	130.03	200.00	210000.00	150.96	153.56	16758.54	1097.61	20.58
25515.000	130.03	200.00	250000.00	153.06	155.93	19072.04	1109.73	19.74
25715.000	130.24	200.00	92000.00	144.06	145.37	10022.65	880.69	17.71
25715.000	130.24	200.00	157000.00	148.54	150.49	14256.31	1096.15	17.60
25715.000	130.24	200.00	210000.00	151.59	153.96	17680.87	1132.20	17.10
25715.000	130.24	200.00	250000.00	153.67	156.32	20049.85	1145.34	16.79

PROJECT TITLE : City of Tempe File Name: RSSRP1.HC2
PROJECT NUMBER : Channelized Salt River 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
25915.000	130.45	200.00	92000.00	144.49	145.72	10346.83	883.03	15.98
25915.000	130.45	200.00	157000.00	148.98	150.84	14661.46	1144.45	16.24
25915.000	130.45	200.00	210000.00	152.05	154.30	18251.56	1180.47	15.86
25915.000	130.45	200.00	250000.00	154.15	156.66	20740.48	1194.06	15.58
26115.000	130.66	200.00	92000.00	144.84	146.03	10496.06	862.65	15.32
26115.000	130.66	200.00	157000.00	149.36	151.17	14890.96	1195.51	15.62
26115.000	130.66	200.00	210000.00	152.44	154.62	18655.49	1230.45	15.22
26115.000	130.66	200.00	250000.00	154.55	156.97	21267.70	1243.51	14.91
26273.000	130.86	158.00	92000.00	145.14	146.27	10747.74	874.34	14.41
26273.000	130.86	158.00	157000.00	149.68	151.41	15231.08	1249.21	14.77
26273.000	130.86	158.00	210000.00	152.78	154.86	19164.66	1277.95	14.38
26273.000	130.86	158.00	250000.00	154.91	157.21	21897.59	1291.93	14.06
26395.000	131.03	122.00	92000.00	145.22	146.58	9831.64	805.37	17.39
26395.000	131.03	122.00	157000.00	149.71	151.79	13870.26	1181.52	17.97
26395.000	131.03	122.00	210000.00	152.79	155.25	17936.19	1341.98	17.30
26395.000	131.03	122.00	250000.00	154.92	157.58	20806.45	1355.05	16.65
26413.000	131.05	18.00	93000.00	145.79	147.05	10294.41	833.39	15.37
26413.000	131.05	18.00	160000.00	150.60	152.51	14996.77	1329.34	15.55
26413.000	131.05	18.00	215000.00	153.82	156.08	19306.34	1349.17	15.00
26413.000	131.05	18.00	250000.00	156.00	158.35	22266.47	1362.62	13.87
* 26737.000	135.60	324.00	93000.00	146.28	147.94	8994.03	1231.36	41.86
26737.000	135.60	324.00	160000.00	151.60	153.14	16065.96	1393.93	21.15
26737.000	135.60	324.00	215000.00	155.00	156.65	20859.47	1423.56	16.46
26737.000	135.60	324.00	250000.00	157.18	158.87	23992.06	1442.59	14.21

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 26737, profile 1, conveyance change outside acceptable range.

1 Warning and status message(s) generated

END OF OUTPUT

Project Model Baseline
(File Name: SRBASE3.DTA)

==========
B O S S H E C - 2 (tm)
==========

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Version : 3.00
Serial Number : 0010149.250

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PROJECT DESCRIPTION :

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984
DESCRIPTION : 100-YEAR FLOODPLAIN
ENGINEER : U.S. Army Corps of Engineers
DATE OF RUN : 11/10/1993
TIME OF RUN : 5:11 pm

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

T1 SALT RIVER FLOOD INSUR. STUDY 1983-1984
T2 CORP OF ENGINEERS DATA
T3 100-YEAR FLOODPLAIN

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0.0	0	0.0	93000.0	1146.28	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

USER-DEFINED SUMMARY TABLES (J3) :
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38 42 39 43 1 3 25 4 5

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

-10 -10

NC	0.05	0.05	0.035	0.1	0.3					
X1	21.725	13	9290.0	10830.0	0.0	0.0	0.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	1163.0	1163.0	
GR	1167.0	9290.0	1150.0	9370.0	1145.0	9500.0	1140.0	9620.0	1140.0	9820.0
GR	1137.7	9960.0	1135.6	10120.0	1135.6	10360.0	1140.0	10550.0	1145.0	10680.0
GR	1150.0	10750.0	1170.0	10830.0	1175.0	10850.0				

Mill Avenue Bridge

Mill Avenue Bridge

X1	21.795	14	9300.0	11090.0	560.0	110.0	370.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	1169.0	1169.0	
GR	1174.0	9300.0	1155.0	9370.0	1150.0	9400.0	1145.0	9480.0	1140.0	9580.0
GR	1135.7	9860.0	1135.7	10300.0	1140.0	10550.0	1145.0	10650.0	1150.0	10750.0
GR	1155.0	10830.0	1160.0	10880.0	1170.0	11000.0	1175.0	11090.0		
SB	1.05	1.18	2.5	0.0	1460.0	63.0	44704.0	0.0	1137.0	1136.8
X1	21.809	0	0.0	0.0	70.0	70.0	70.0	1.0	0.0	0
X2	0.0	0.0	1	1169.0	1175.0	0.0	0	0.0	0.0	
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	1175.0	1175.0	
BT	-2	9300.0	1175.0	0.0	11090.0	1175.0	0.0			

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

NC	0.04	0.04	0.03	0.1	0.3					
X1	21.837	15	9400.0	10900.0	100.0	200.0	150.0	1.0	0.0	0
X3	10	0.0	0.0	9400.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	8850.0	1160.0	9000.0	1155.0	9070.0	1150.0	9400.0	1145.0	9520.0
GR	1142.5	9660.0	1136.0	9810.0	1136.0	10380.0	1140.0	10530.0	1150.0	10600.0
GR	1155.0	10710.0	1155.0	10900.0	1151.0	11150.0	1160.0	11200.0	1175.0	11250.0
NC	0.0	0.0	0.0	0.1	0.3					
X1	21.937	18	9350.0	10480.0	330.0	860.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1175.0	8560.0	1170.0	8720.0	1165.0	8770.0	1160.0	8950.0	1159.5	9020.0
GR	1155.0	9040.0	1150.0	9350.0	1145.0	9570.0	1140.0	9650.0	1138.0	9670.0
GR	1138.0	9740.0	1145.0	9800.0	1138.0	9870.0	1138.0	10470.0	1155.0	10480.0
GR	1156.0	11130.0	1162.0	11160.0	1175.0	11220.0				
X1	22.037	19	9210.0	10540.0	470.0	565.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1175.0	8570.0	1165.0	8800.0	1155.0	9100.0	1152.0	9150.0	1155.0	9210.0
GR	1150.0	9330.0	1145.0	9460.0	1140.0	9550.0	1145.0	9720.0	1150.0	9770.0
GR	1139.0	9850.0	1139.0	10270.0	1140.0	10290.0	1140.0	10480.0	1145.0	10520.0
GR	1155.0	10540.0	1155.0	10920.0	1162.0	10930.0	1175.0	11050.0		
X1	22.137	17	9150.0	10550.0	510.0	540.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	8820.0	1161.0	9150.0	1150.0	9210.0	1145.0	9270.0	1141.0	9400.0
GR	1145.0	9520.0	1145.0	9680.0	1155.0	9730.0	1145.0	9790.0	1140.0	9830.0
GR	1140.0	10230.0	1143.0	10400.0	1145.0	10520.0	1155.0	10550.0	1155.0	11000.0
GR	1160.0	11020.0	1175.0	11150.0						
X1	22.237	15	8880.0	10550.0	520.0	535.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	8770.0	1161.0	8880.0	1150.0	8990.0	1145.0	9030.0	1145.0	9500.0
GR	1150.0	9590.0	1157.0	9630.0	1141.0	9750.0	1141.0	10350.0	1141.0	10370.0
GR	1155.0	10550.0	1150.0	10970.0	1155.0	11300.0	1160.0	11340.0	1175.0	11520.0
X1	22.337	18	8950.0	10520.0	520.0	540.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	8530.0	1160.0	8790.0	1155.0	8950.0	1150.0	9020.0	1147.0	9300.0
GR	1145.0	9480.0	1150.0	9530.0	1157.0	9590.0	1150.0	9640.0	1145.0	9690.0
GR	1142.0	9720.0	1142.0	10350.0	1150.0	10410.0	1155.0	10520.0	1156.5	10890.0
GR	1157.0	11250.0	1160.0	11320.0	1175.0	11520.0				
X1	22.437	14	8970.0	10370.0	550.0	500.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	8290.0	1160.0	8700.0	1155.0	8970.0	1150.0	9000.0	1149.0	9370.0
GR	1150.0	9520.0	1157.0	9590.0	1145.0	9670.0	1143.0	9710.0	1143.0	10320.0
GR	1160.0	10370.0	1161.5	10630.0	1160.0	11520.0	1165.0	11670.0		
X1	22.537	25	8880.0	10420.0	540.0	510.0	528.0	1.0	0.0	0
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1165.0	7050.0	1160.0	7150.0	1159.0	7380.0	1160.0	7600.0	1160.0	7900.0
GR	1159.0	8110.0	1160.0	8430.0	1161.0	8700.0	1160.0	8880.0	1155.0	9000.0

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GR   1150.0    9020.0    1150.0    9270.0    1149.0    9350.0    1150.0    9430.0    1155.0    9580.0
GR   1158.0    9650.0    1150.0    9760.0    1144.0    9800.0    1144.0   10360.0    1160.0   10420.0
GR   1156.5   10800.0    1158.0   11370.0    1158.5   11930.0    1160.0   12300.0    1165.0   12350.0

NC      0.0       0.0       0.0       0.3       0.5
X1   22.637        20    8990.0   10500.0     510.0     540.0     528.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1165.0    6300.0    1161.0    6870.0    1161.5    7280.0    1160.0    8450.0    1161.5    8720.0
GR   1160.0    8850.0    1155.0    8990.0    1150.0    9100.0    1146.0    9250.0    1150.0    9340.0
GR   1150.0    9650.0    1145.0    9850.0    1145.0   10370.0    1155.0   10430.0    1158.0   10500.0
GR   1162.0   11450.0    1160.0   11620.0    1160.0   12230.0    1165.0   12480.0    1170.0   12570.0
  Rural Road Bridge

Rural Road Bridge

X1   22.662        16    9050.0   10480.0     130.0     130.0     130.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0    1165.0    1165.0
GR   1165.0    6770.0    1164.0    6930.0    1163.5    7490.0    1162.5    8000.0    1160.9    8560.0
GR   1165.0    8850.0    1172.0    9050.0    1145.5    9145.0    1145.5   10398.0    1172.0   10480.0
GR   1165.0   10690.0    1160.0   10950.0    1160.0   11340.0    1162.0   11590.0    1162.0   12300.0
GR   1165.0   12640.0

SB      1.2       1.6       2.5       0.0    1253.0     100.0   24000.0      0.45    1145.5    1145.4
X1   22.681         0       0.0       0.0     100.0     100.0     100.0       1.0       0.0         0
X2      0.0       0.0         1    1165.0    1163.0       0.0         0       0.0       0.0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0    1160.9    1160.9
BT      -16    6770.0    1165.0       0.0    6930.0    1164.0       0.0    7490.0    1163.5       0.0
BT             8000.0    1162.5       0.0    8560.0    1160.9       0.0    8850.0    1165.0       0.0
BT             9050.0    1172.0       0.0    9051.0    1172.0    1165.0   10480.0    1172.0    1165.0
BT            10481.0    1172.0       0.0   10690.0    1165.0       0.0   10950.0    1160.0       0.0
BT            11340.0    1160.0       0.0   11590.0    1162.0       0.0   12300.0    1162.0       0.0
BT            12640.0    1165.0       0.0

X1   22.799        27    9050.0   10655.0     640.0     590.0     625.0       1.0       0.0         0
GR   1165.0    6760.0    1161.5    7440.0    1161.5    7441.0    1161.5    7442.0    1161.5    7443.0
GR   1162.5    8755.0    1160.0    8880.0    1160.5    8930.0    1160.0    9000.0    1160.0    9050.0
GR   1155.0    9065.0    1152.5    9330.0    1150.0    9500.0    1146.0    9620.0    1146.0   10430.0
GR   1150.0   10470.0    1160.0   10500.0    1162.5   10655.0    1160.0   10900.0    1157.0   10930.0
GR   1160.0   10950.0    1163.0   11450.0    1165.0   11750.0    1168.0   12200.0    1168.0   12650.0
GR   1170.0   12690.0    1173.5   12950.0

NC     0.05      0.05     0.035       0.1       0.3
X1   23.000        27    8725.0   10920.0    1040.0    1065.0    1060.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1167.0    8500.0    1167.0    8501.0    1167.0    8502.0    1167.0    8503.0    1167.0    8504.0
GR   1165.0    8725.0    1164.0    8780.0    1160.0    8850.0    1160.0    9050.0    1155.0    9060.0
GR   1150.0    9110.0    1150.0    9295.0    1150.0    9490.0    1155.0    9940.0    1150.0   10045.0
GR   1147.0   10330.0    1150.0   10355.0    1155.0   10445.0    1155.0   10765.0    1160.0   10795.0
GR   1165.0   10820.0    1167.0   10920.0    1167.0   11260.0    1165.0   11500.0    1168.0   12040.0
GR   1170.0   12350.0    1174.0   12820.0

X1   23.199        22    9270.0   10810.0    1040.0    1060.0    1050.0       1.0       0.0         0
```

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

```
X3      10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR  1167.0    8660.0    1165.0    8810.0    1164.0    8975.0    1165.0    9040.0    1165.0    9270.0
GR  1160.0    9320.0    1155.0    9340.0    1150.0    9380.0    1150.0    9480.0    1155.0    9660.0
GR  1155.0    9965.0    1153.0   10265.0    1155.0   10580.0    1160.0   10660.0    1165.0   10690.0
GR  1170.0   10810.0    1170.0   12000.0    1173.0   12250.0    1170.0   12460.0    1170.0   12550.0
GR  1175.0   12620.0    1178.0   12705.0

X1  23.398       27    9315.0   10770.0    1175.0     915.0    1052.0       1.0       0.0       0
X3      10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR  1171.0    8500.0    1170.0    8600.0    1170.0    9315.0    1165.0    9400.0    1160.0    9470.0
GR  1151.0    9610.0    1151.0    9810.0    1155.0    9925.0    1155.0   10130.0    1157.0   10290.0
GR  1155.0   10470.0    1155.0   10690.0    1160.0   10750.0    1165.0   10770.0    1165.0   10860.0
GR  1160.0   10920.0    1165.0   10955.0    1166.5   11050.0    1165.0   11130.0    1165.0   11190.0
GR  1170.0   11270.0    1173.0   11300.0    1170.0   11330.0    1171.0   11660.0    1173.0   11955.0
GR  1175.0   12235.0    1177.0   12410.0

X1  23.597       26    8920.0   11050.0    1047.0    1052.0    1050.0       1.0       0.0       0
X3      10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR  1172.0    8245.0    1170.0    8580.0    1170.0    8775.0    1174.5    8920.0    1170.0    9005.0
GR  1165.0    9025.0    1165.0    9180.0    1166.0    9360.0    1165.0    9550.0    1160.0    9620.0
GR  1155.0    9640.0    1152.0    9710.0    1152.0   10135.0    1155.0   10260.0    1160.0   10390.0
GR  1162.0   10595.0    1164.5   10800.0    1165.0   10950.0    1170.0   11040.0    1173.0   11050.0
GR  1170.0   11060.0    1170.0   11450.0    1173.0   11790.0    1175.0   12050.0    1175.0   12310.0
GR  1176.0   12365.0
  McClintock Drive Bridge

McClintock Drive Bridge

X1  23.649        8    9320.0   10510.0     200.0     340.0     270.0       1.0       0.0       0
X3      10       0.0       0.0       0.0       0.0       0.0       0.0    1175.0    1175.0
GR  1173.0    8200.0    1170.0    8640.0    1182.0    9320.0    1150.0    9410.0    1150.0   10420.0
GR  1182.0   10510.0    1170.0   11370.0    1175.0   11970.0

SB    1.05       1.6       2.5       0.0    1044.0      90.0   25600.0       2.5    1150.1    1150.0
X1  23.658        0       0.0       0.0      45.0      45.0      45.0       1.0       0.0       0
X2     0.0       0.0         1    1175.0    1170.0       0.0         0       0.0       0.0
X3      10       0.0       0.0       0.0       0.0       0.0       0.0    1182.0    1182.0
BT      -7    8200.0    1173.0       0.0    8640.0    1170.0       0.0    9320.0    1182.0       0.0
BT            9320.0    1182.0    1175.0   10510.0    1182.0    1175.0   11370.0    1170.0       0.0
BT           11970.0    1175.0       0.0

X1  23.667        6    9320.0   10510.0      45.0      45.0      45.0       1.0       0.0       0
X3      10       0.0       0.0       0.0       0.0       0.0       0.0    1175.0    1175.0
GR  1173.0    8200.0    1170.0    8640.0    1182.0    9320.0    1150.1    9410.0    1150.1   10420.0
GR  1182.0   10510.0
T1     SALT RIVER FLOOD INSUR. STUDY 1983-1984
T2     CORP OF ENGINEERS DATA
T3     100-YEAR FLOODPLAIN
```

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0	0	0.0	160000.0	1151.60	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

T1 SALT RIVER FLOOD INSUR. STUDY 1983-1984
T2 CORP OF ENGINEERS DATA
T3 100-YEAR FLOODPLAIN

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	0.0	0	0.0	215000.0	1155.00	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

T1 SALT RIVER FLOOD INSUR. STUDY 1983-1984
T2 CORP OF ENGINEERS DATA
T3 100-YEAR FLOODPLAIN

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	5	0	0	0.0	0	0.0	250000.0	1157.18	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

SUMMARY PRINTOUT : CORP OF ENGINEERS DATA
100-YEAR FLOODPLAIN
SALT RIVER FLOOD INSUR. STUDY 1983-1984

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
21.725	1135.60	.00	93000.00	1146.28	1147.94	8989.22	1231.20	41.93
21.725	1135.60	.00	160000.00	1151.60	1153.14	16065.13	1393.93	21.15
21.725	1135.60	.00	215000.00	1155.00	1156.65	20854.84	1423.53	16.47
21.725	1135.60	.00	250000.00	1157.18	1158.87	23978.90	1442.51	14.24
* 21.795	1135.70	370.00	93000.00	1148.02	1148.94	12076.00	1278.63	16.49
21.795	1135.70	370.00	160000.00	1152.61	1153.80	18287.16	1407.53	13.91
21.795	1135.70	370.00	215000.00	1155.84	1157.21	22945.44	1471.57	12.52
21.795	1135.70	370.00	250000.00	1157.93	1159.36	26047.91	1500.14	11.38
21.809	1135.70	70.00	93000.00	1148.12	1149.02	12211.22	1282.43	15.95
21.809	1135.70	70.00	160000.00	1152.74	1153.91	18468.96	1410.37	13.50
21.809	1135.70	70.00	215000.00	1155.99	1157.33	23156.83	1473.53	12.16
21.809	1135.70	70.00	250000.00	1158.08	1159.49	26266.71	1502.13	11.09
21.837	1136.00	150.00	93000.00	1148.18	1149.33	10784.21	1143.56	15.23
21.837	1136.00	150.00	160000.00	1152.71	1154.21	16245.16	1259.53	13.12
21.837	1136.00	150.00	215000.00	1155.97	1157.61	21466.15	1777.63	13.19
21.837	1136.00	150.00	250000.00	1158.10	1159.71	25261.20	1789.46	10.85
21.937	1138.00	528.00	93000.00	1148.88	1150.43	9328.14	1077.33	22.99
21.937	1138.00	528.00	160000.00	1153.19	1155.15	14476.07	1326.95	17.91
21.937	1138.00	528.00	215000.00	1156.36	1158.49	19497.57	2097.85	14.73
21.937	1138.00	528.00	250000.00	1158.40	1160.47	23790.97	2117.09	12.49
22.037	1139.00	528.00	93000.00	1150.29	1151.57	10251.95	1207.71	19.43
22.037	1139.00	528.00	160000.00	1154.42	1156.08	15458.65	1315.03	16.40
22.037	1139.00	528.00	215000.00	1157.48	1159.26	21003.32	1898.08	13.30
22.037	1139.00	528.00	250000.00	1159.32	1161.13	24543.43	1955.82	11.73
22.137	1140.00	528.00	93000.00	1151.44	1152.52	11194.44	1298.10	15.95

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
22.137	1140.00	528.00	160000.00	1155.45	1156.90	16754.94	1821.54	13.77
22.137	1140.00	528.00	215000.00	1158.34	1159.94	22055.55	1848.85	11.84
22.137	1140.00	528.00	250000.00	1160.07	1161.74	25268.64	1865.54	10.87
22.237	1141.00	528.00	93000.00	1152.45	1153.29	12625.53	1491.59	12.84
22.237	1141.00	528.00	160000.00	1156.63	1157.55	22274.20	2384.55	9.41
22.237	1141.00	528.00	215000.00	1159.56	1160.51	29342.40	2442.07	7.65
22.237	1141.00	528.00	250000.00	1161.29	1162.26	33608.43	2483.60	6.90
22.337	1142.00	528.00	93000.00	1153.09	1154.19	11065.81	1439.75	19.01
22.337	1142.00	528.00	160000.00	1156.94	1158.30	17492.23	2316.67	15.16
22.337	1142.00	528.00	215000.00	1159.74	1161.14	24313.87	2515.44	11.82
22.337	1142.00	528.00	250000.00	1161.44	1162.83	28680.28	2623.88	10.25
22.437	1143.00	528.00	93000.00	1154.04	1155.36	10079.23	1327.38	23.32
22.437	1143.00	528.00	160000.00	1157.56	1159.34	15066.48	1531.13	19.97
22.437	1143.00	528.00	215000.00	1160.02	1162.10	19010.00	1690.92	17.92
22.437	1143.00	528.00	250000.00	1161.57	1163.73	22677.53	2996.01	16.25
22.537	1144.00	528.00	93000.00	1155.26	1156.67	9775.98	1307.09	25.29
22.537	1144.00	528.00	160000.00	1158.65	1160.52	14562.10	1502.46	23.88
22.537	1144.00	528.00	215000.00	1161.70	1162.99	29171.19	5200.99	13.28
22.537	1144.00	528.00	250000.00	1163.47	1164.49	38389.40	5253.89	9.55
* 22.637	1145.00	528.00	93000.00	1156.94	1157.69	13390.97	1539.45	10.61
* 22.637	1145.00	528.00	160000.00	1160.45	1161.55	20131.18	3365.93	10.28
22.637	1145.00	528.00	215000.00	1162.37	1163.61	29440.18	5674.50	10.12
22.637	1145.00	528.00	250000.00	1163.90	1164.99	38314.86	5967.97	8.33
22.662	1145.50	130.00	93000.00	1157.26	1157.84	15198.29	1331.55	5.96
22.662	1145.50	130.00	160000.00	1160.67	1161.68	19773.14	1354.31	7.51
22.662	1145.50	130.00	215000.00	1162.39	1163.85	22111.23	1365.79	9.45
22.662	1145.50	130.00	250000.00	1163.72	1165.41	23939.78	1374.70	9.90
22.681	1145.50	100.00	93000.00	1157.38	1157.95	15360.56	1332.37	5.76
22.681	1145.50	100.00	160000.00	1160.91	1161.89	20538.46	1913.87	7.08
22.681	1145.50	100.00	215000.00	1162.74	1164.06	25593.40	3762.46	8.44
22.681	1145.50	100.00	250000.00	1164.02	1165.41	31053.57	5016.89	8.43
22.799	1146.00	625.00	93000.00	1157.76	1158.51	13351.10	1449.04	10.15
22.799	1146.00	625.00	160000.00	1161.38	1162.50	19280.56	2186.54	10.66
22.799	1146.00	625.00	215000.00	1163.33	1164.68	26306.96	4416.50	11.38
22.799	1146.00	625.00	250000.00	1164.72	1166.02	32767.81	4894.30	10.09

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
23.000	1147.00	1060.00	93000.00	1159.19	1160.00	12868.91	1738.53	20.11
23.000	1147.00	1060.00	160000.00	1162.92	1163.90	20053.16	2010.70	16.48
23.000	1147.00	1060.00	215000.00	1164.91	1166.15	24111.21	2089.51	16.95
23.000	1147.00	1060.00	250000.00	1166.04	1167.42	26565.15	2261.71	17.32
23.199	1150.00	1050.00	93000.00	1161.48	1162.79	10120.19	1363.73	32.40
23.199	1150.00	1050.00	160000.00	1164.58	1166.49	14423.57	1413.32	30.88
23.199	1150.00	1050.00	215000.00	1166.50	1168.86	18058.65	2028.37	31.82
23.199	1150.00	1050.00	250000.00	1167.60	1170.19	20349.03	2092.51	31.93
* 23.398	1151.00	1052.00	93000.00	1164.29	1165.15	12525.89	1357.21	15.81
23.398	1151.00	1052.00	160000.00	1167.61	1168.89	18391.48	1876.23	16.70
23.398	1151.00	1052.00	215000.00	1169.78	1171.35	22544.02	1947.90	17.24
23.398	1151.00	1052.00	250000.00	1170.97	1172.69	25759.57	3105.66	17.34
23.597	1152.00	1050.00	93000.00	1166.36	1167.19	12731.10	1954.85	24.36
23.597	1152.00	1050.00	160000.00	1169.70	1170.76	19393.85	2028.45	18.63
23.597	1152.00	1050.00	215000.00	1171.93	1173.18	23976.17	2077.98	17.13
23.597	1152.00	1050.00	250000.00	1173.19	1174.49	28430.68	2869.40	16.12
* 23.649	1150.00	270.00	93000.00	1167.02	1167.43	17999.96	1105.71	3.61
23.649	1150.00	270.00	160000.00	1170.18	1171.04	21525.42	1123.50	6.03
* 23.649	1150.00	270.00	215000.00	1172.22	1173.49	23832.86	1135.00	7.86
23.649	1150.00	270.00	250000.00	1173.34	1174.88	25106.47	1141.29	9.01
23.658	1150.00	45.00	93000.00	1167.07	1167.48	18055.56	1105.99	3.58
23.658	1150.00	45.00	160000.00	1170.42	1171.26	21804.68	1124.90	5.78
23.658	1150.00	45.00	215000.00	1172.50	1173.73	24152.85	1136.58	7.53
23.658	1150.00	45.00	250000.00	1173.85	1175.32	25703.92	1144.23	8.36
23.667	1150.10	45.00	93000.00	1167.08	1167.50	17965.52	1105.82	3.64
23.667	1150.10	45.00	160000.00	1170.45	1171.29	21723.34	1124.83	5.86
23.667	1150.10	45.00	215000.00	1172.53	1173.76	24076.55	1136.58	7.61
23.667	1150.10	45.00	250000.00	1173.89	1175.36	25629.17	1144.26	8.44

PROJECT TITLE : CORP OF ENGINEERS DATA
PROJECT NUMBER : SALT RIVER FLOOD INSUR. STUDY 1983-1984 11/10/1993

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 21.795, profile 1, conveyance change outside acceptable range.

Section 22.637, profile 1, conveyance change outside acceptable range.

Section 22.637, profile 2, conveyance change outside acceptable range.

Section 23.398, profile 1, conveyance change outside acceptable range.

Section 23.649, profile 1, conveyance change outside acceptable range.

Section 23.649, profile 2, conveyance change outside acceptable range.

Section 23.649, profile 3, conveyance change outside acceptable range.

7 Warning and status message(s) generated

END OF OUTPUT

Above Project Baseline
(File Name: SRBASE4.DTA)

==========
B O S S H E C - 2 (tm)
==========

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PROJECT DESCRIPTION :

PROJECT TITLE : AUGUST 1982 ADOT TOPO BASE MAP
PROJECT NUMBER : SALT RIVER FLOOD INSURANCE STUDY
DESCRIPTION : HAYDEN ROAD TO COUNTRY CLUB ROAD
ENGINEER :
DATE OF RUN : 10/28/1993
TIME OF RUN : 7:24 pm

```
T1      SALT RIVER FLOOD INSURANCE STUDY
T2      AUGUST 1982  ADOT TOPO BASE MAP
T3      HAYDEN ROAD TO COUNTRY CLUB ROAD
```

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0.0	0	0.0	93000.0	1167.08	
J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

USER-DEFINED SUMMARY TABLES (J3) :

38 42 39 43 1 3 25 4 5

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

-10 -10

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NC    0.045     0.045     0.035       0.1       0.3
  Hayden Road Bridge U/S line
Hayden Road Bridge U/S line

X1   23.667         6    9320.0   10510.0       0.0       0.0       0.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0   1159.07   1171.79
GR    1173.0    8200.0    1170.0    8640.0    1182.0    9320.0    1150.1    9410.0    1150.1    10420.0
GR    1182.0   10510.0

X1   23.797        21    9190.0   10790.0     860.0     560.0     690.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR    1175.0    8295.0    1171.5    8760.0    1173.0    9190.0    1170.0    9450.0    1165.0     9470.0
GR    1160.0    9590.0    1155.0    9620.0    1154.0    9980.0    1152.0   10210.0    1155.0    10370.0
GR    1160.0   10520.0    1165.0   10640.0    1170.0   10715.0    1174.0   10790.0    1170.0    10850.0
GR    1170.0   11320.0    1171.0   11390.0    1170.0   11450.0    1170.0   11590.0    1171.0    11770.0
GR    1174.0   11880.0

X1   23.997        25    9760.0   10610.0    1085.0    1040.0    1060.0       1.0       0.0
GR    1180.0    8380.0    1181.0    8430.0    1180.0    8560.0    1179.0    8720.0    1180.0     9000.0
GR    1181.0    9070.0    1180.0    9130.0    1180.0    9430.0    1185.0    9455.0    1180.0     9490.0
GR    1175.0    9760.0    1170.0    9815.0    1155.0    9955.0    1154.0   10005.0    1154.0    10475.0
GR    1155.0   10475.0    1175.0   10525.0    1175.0   10610.0    1171.0   11230.0    1170.0    11460.0
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GR   1168.0    11525.0    1170.0    11590.0    1175.0    11620.0    1173.5    11950.0    1175.0    12250.0

NC      0.05       0.05     0.035       0.0       0.0
X1    24.196         18    9675.0    10910.0     815.0     1045.0    1050.0        1.0       0.0
X3        10        0.0       0.0       0.0       0.0        0.0       0.0        0.0       0.0
GR   1180.0     8155.0    1180.0     8340.0    1183.5     8530.0    1175.0     8580.0    1175.0     9545.0
GR   1178.5     9675.0    1175.0     9790.0    1155.0     9835.0    1155.0    10030.0    1160.0    10270.0
GR   1165.0    10350.0    1170.0    10440.0    1170.0    10600.0    1174.0    10910.0    1175.0    11140.0
GR   1177.0    11360.0    1178.0    11640.0    1180.0    12170.0

X1    24.396         13    9010.0    10665.0    1090.0     1040.0    1055.0        1.0       0.0
X3        10        0.0       0.0       0.0       0.0        0.0       0.0        0.0       0.0
GR   1184.0     9010.0    1180.0     9150.0    1175.0     9270.0    1158.0     9430.0    1158.0    10200.0
GR   1165.0    10275.0    1165.0    10340.0    1170.0    10400.0    1175.0    10640.0    1179.0    10665.0
GR   1175.0    10710.0    1180.0    11050.0    1181.5    11470.0

QT         4    95000.0   163000.0   220000.0   250000.0
  Price Road Extension
Price Road Extension

X1    24.595         16    8985.0    11005.0    1025.0     1070.0    1052.0        1.0       0.0
X3        10        0.0       0.0       0.0       0.0        0.0       0.0        0.0       0.0
GR   1185.0     8790.0    1180.0     8855.0    1180.0     8985.0    1175.0     9090.0    1175.0     9170.0
GR   1170.0     9245.0    1165.0     9300.0    1161.0     9340.0    1161.0     9970.0    1163.0    10030.0
GR   1161.0    10110.0    1161.0    10630.0    1170.0    10660.0    1175.0    11005.0    1180.0    11155.0
GR   1183.0    11300.0

X1    24.795         16    9770.0    11530.0    1060.0      630.0    1055.0        1.0       0.0
X3        10        0.0       0.0       0.0       0.0        0.0       0.0        0.0       0.0
GR   1184.0     8890.0    1180.0     9095.0    1180.0     9740.0    1183.0     9755.0    1180.0     9770.0
GR   1165.0     9810.0    1165.0     9900.0    1171.6     9910.0    1165.0     9970.0    1164.0    10000.0
GR   1164.0    11045.0    1165.0    11105.0    1170.0    11120.0    1175.0    11510.0    1180.0    11530.0
GR   1184.0    11840.0

X1    24.995         28    9605.0    11850.0    1065.0     1135.0    1055.0        1.0       0.0
X3        10        0.0       0.0       0.0       0.0        0.0       0.0        0.0       0.0
GR   1186.0     8250.0    1184.0     8570.0    1184.0     8571.0    1184.0     8572.0    1184.0     8573.0
GR   1180.0     8705.0    1179.0     9605.0    1175.0     9630.0    1167.0     9650.0    1167.0     9745.0
GR   1170.0     9755.0    1170.0     9945.0    1167.0     9980.0    1167.0    10260.0    1170.0    10280.0
GR   1173.0    10350.0    1170.0    10385.0    1167.0    10395.0    1167.0    11060.0    1170.0    11070.0
GR   1170.0    11380.0    1171.0    11430.0    1169.0    11580.0    1170.0    11640.0    1175.0    11665.0
GR   1180.0    11850.0    1185.0    11860.0    1186.0    11940.0

X1    25.194         25    9330.0    12245.0    1070.0      870.0    1050.0        1.0       0.0
GR   1185.0     8895.0    1175.0     8910.0    1175.0     9270.0    1180.0     9300.0    1184.0     9330.0
GR   1180.0     9355.0    1175.0     9370.0    1175.0     9460.0    1178.0     9640.0    1175.0     9820.0
GR   1170.0     9890.0    1170.0    10250.0    1175.0    10385.0    1180.0    10400.0    1184.0    10435.0
GR   1180.0    10500.0    1175.0    10670.0    1177.0    10890.0    1180.0    11095.0    1180.0    11475.0
GR   1177.0    11650.0    1175.0    11920.0    1176.8    12115.0    1175.0    12215.0    1185.0    12245.0
T1      SALT RIVER FLOOD INSURANCE STUDY
T2      AUGUST 1982  ADOT TOPO BASE MAP
T3      HAYDEN ROAD TO COUNTRY CLUB ROAD
```

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0	0	0.0	160000.0	1170.45	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	0.0	0	0.0	215000.0	1172.53	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	5	0	0	0.0	0	0.0	250000.0	1173.89	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

SUMMARY PRINTOUT : AUGUST 1982 ADOT TOPO BASE MAP
HAYDEN ROAD TO COUNTRY CLUB ROAD
SALT RIVER FLOOD INSURANCE STUDY

	Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
	23.667	1150.10	.00	93000.00	1167.08	1167.50	17963.23	1105.81	3.64
	23.667	1150.10	.00	160000.00	1170.45	1171.29	21742.43	1216.32	5.86
	23.667	1150.10	.00	215000.00	1172.53	1173.76	24724.55	1651.00	7.57
	23.667	1150.10	.00	250000.00	1173.89	1175.33	27105.06	1804.67	8.28
*	23.797	1152.00	690.00	93000.00	1167.23	1168.03	12989.43	1212.42	12.05
*	23.797	1152.00	690.00	160000.00	1170.74	1172.05	17380.32	1342.84	15.49
*	23.797	1152.00	690.00	215000.00	1173.02	1174.68	21197.45	2213.18	19.28
	23.797	1152.00	690.00	250000.00	1174.67	1176.08	29558.33	3539.67	15.28
	23.997	1154.00	1060.00	93000.00	1168.20	1170.11	8392.87	689.38	23.91
*	23.997	1154.00	1060.00	160000.00	1171.65	1174.95	11446.31	1190.56	32.49
	23.997	1154.00	1060.00	215000.00	1174.10	1178.04	14965.11	1871.17	34.71
*	23.997	1154.00	1060.00	250000.00	1175.16	1179.47	17296.68	2498.91	42.03
	24.196	1155.00	1050.00	93000.00	1171.28	1173.33	8087.80	900.56	39.51
	24.196	1155.00	1050.00	160000.00	1176.17	1178.38	13747.16	1517.13	30.87
	24.196	1155.00	1050.00	215000.00	1179.28	1181.04	24130.94	3427.69	21.18
*	24.196	1155.00	1050.00	250000.00	1180.82	1182.47	29773.36	3853.89	18.04
*	24.396	1158.00	1055.00	93000.00	1174.36	1174.86	16292.39	1333.04	6.43
*	24.396	1158.00	1055.00	160000.00	1179.13	1179.87	23755.21	1820.00	6.87
*	24.396	1158.00	1055.00	215000.00	1181.46	1182.42	28472.63	2358.62	8.01
*	24.396	1158.00	1055.00	250000.00	1182.70	1183.80	31468.71	2414.78	8.67
	24.595	1161.00	1052.00	95000.00	1175.14	1175.48	20424.81	1922.37	5.13
	24.595	1161.00	1052.00	163000.00	1180.01	1180.47	30392.30	2300.86	4.46
	24.595	1161.00	1052.00	220000.00	1182.50	1183.10	36301.36	2453.33	4.79
	24.595	1161.00	1052.00	250000.00	1183.85	1184.51	39659.04	2495.09	4.77
	24.795	1164.00	1055.00	95000.00	1175.73	1176.26	16293.31	1731.54	9.53

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
24.795	1164.00	1055.00	163000.00	1180.45	1181.13	24833.04	2466.89	7.32
24.795	1164.00	1055.00	220000.00	1182.94	1183.79	31421.15	2813.14	7.45
24.795	1164.00	1055.00	250000.00	1184.29	1185.19	35317.39	2950.00	7.21
24.995	1167.00	1055.00	95000.00	1176.85	1177.33	17018.46	2114.85	10.75
24.995	1167.00	1055.00	163000.00	1181.36	1181.91	28671.60	3192.73	7.21
24.995	1167.00	1055.00	220000.00	1183.93	1184.55	36971.10	3282.45	6.53
24.995	1167.00	1055.00	250000.00	1185.27	1185.92	41505.59	3513.87	6.11
* 25.194	1170.00	1050.00	95000.00	1178.65	1180.30	9384.63	2551.58	109.00
* 25.194	1170.00	1050.00	163000.00	1182.45	1183.41	20933.72	3278.63	30.88
* 25.194	1170.00	1050.00	220000.00	1184.83	1185.75	28824.64	3349.22	19.88
* 25.194	1170.00	1050.00	250000.00	1186.07	1186.99	32998.17	3350.00	16.38

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 23.797, profile 1, conveyance change outside acceptable range.

Section 23.797, profile 2, conveyance change outside acceptable range.

Section 23.797, profile 3, conveyance change outside acceptable range.

Section 23.997, profile 2, conveyance change outside acceptable range.

Section 23.997, profile 4, conveyance change outside acceptable range.

Section 24.196, profile 4, conveyance change outside acceptable range.

Section 24.396, profile 1, conveyance change outside acceptable range.

Section 24.396, profile 2, conveyance change outside acceptable range.

Section 24.396, profile 3, conveyance change outside acceptable range.

Section 24.396, profile 4, conveyance change outside acceptable range.

Section 25.194, profile 1, conveyance change outside acceptable range.

Section 25.194, profile 2, conveyance change outside acceptable range.

Section 25.194, profile 3, conveyance change outside acceptable range.

Section 25.194, profile 4, conveyance change outside acceptable range.

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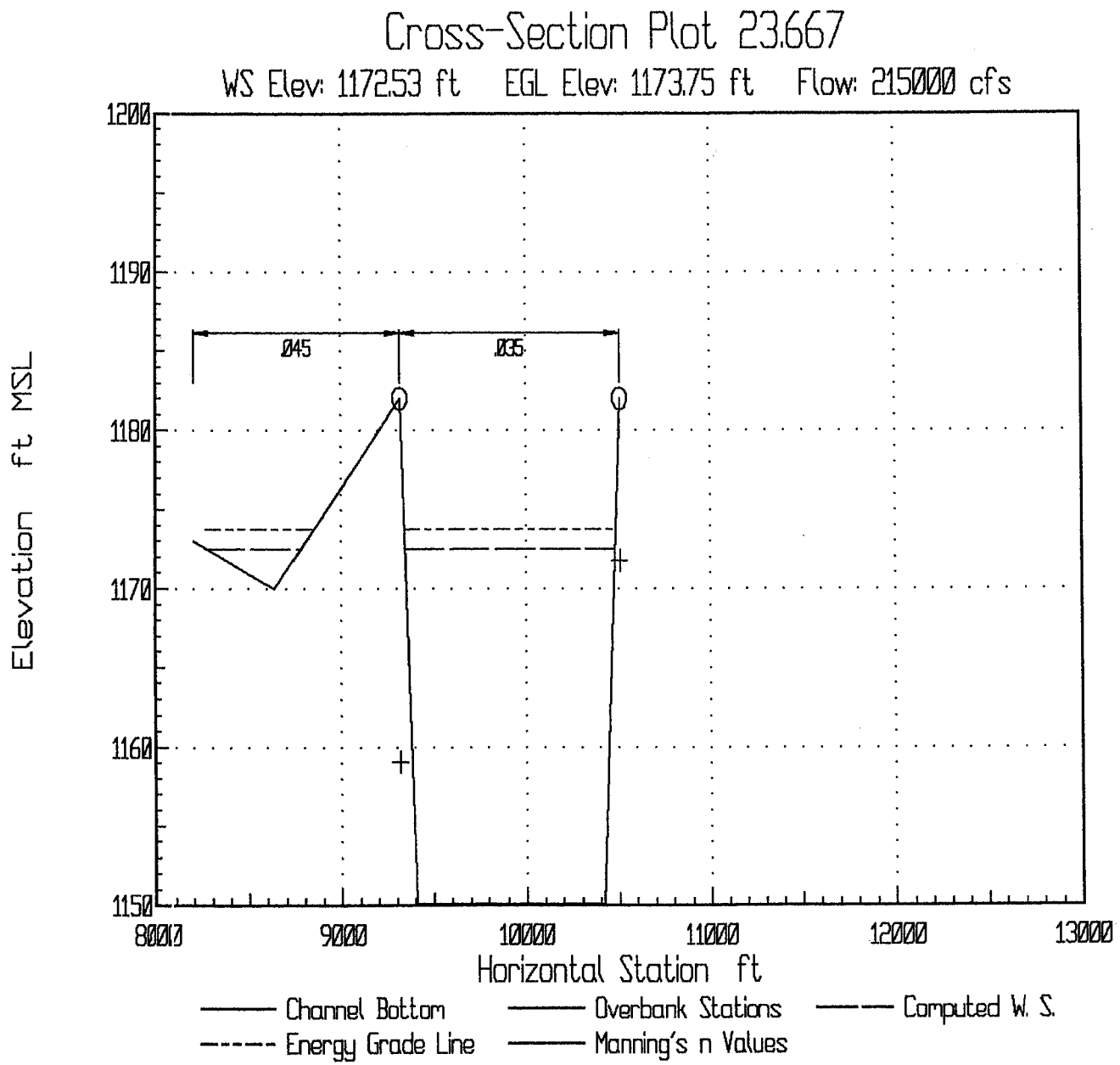
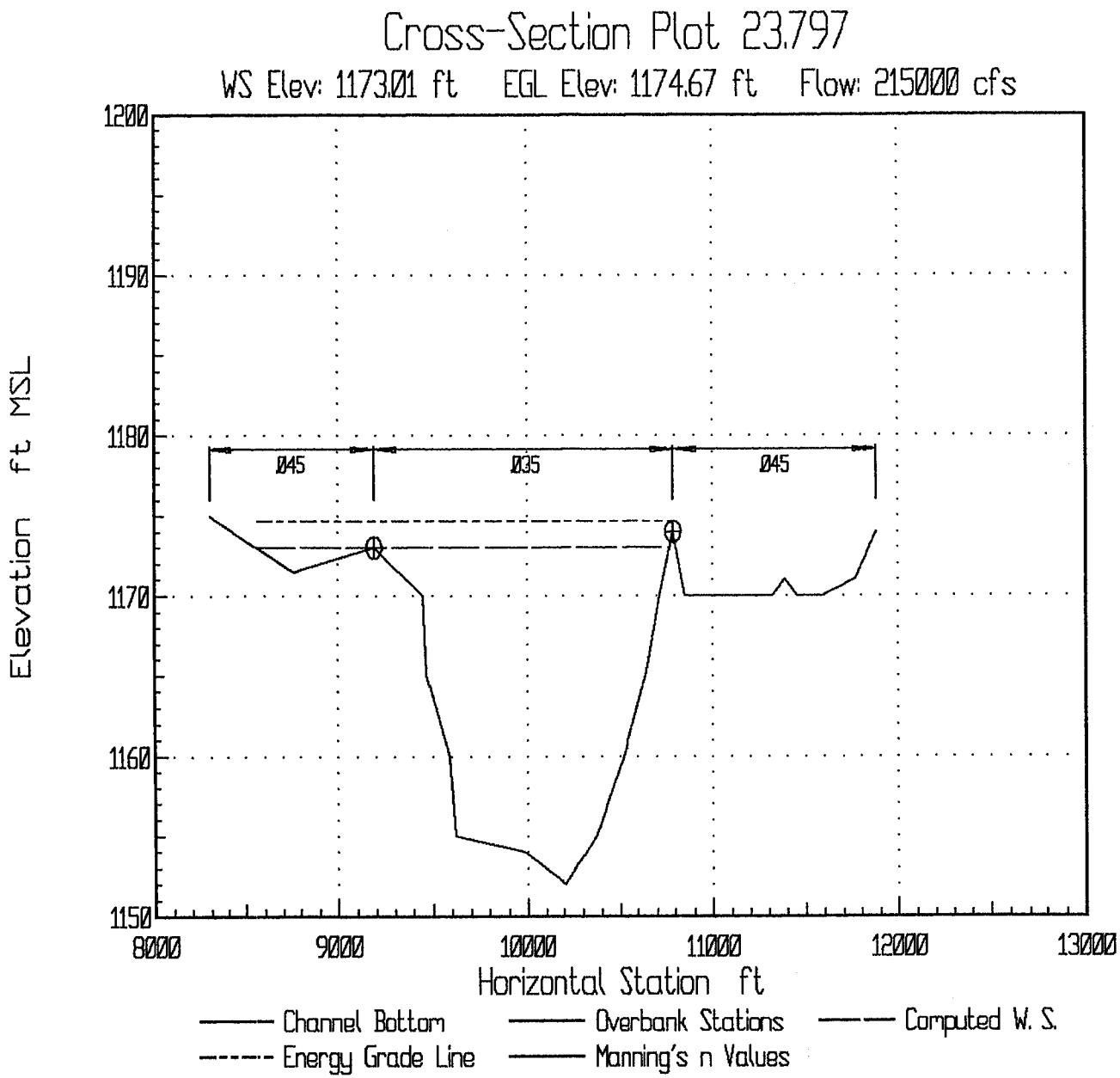
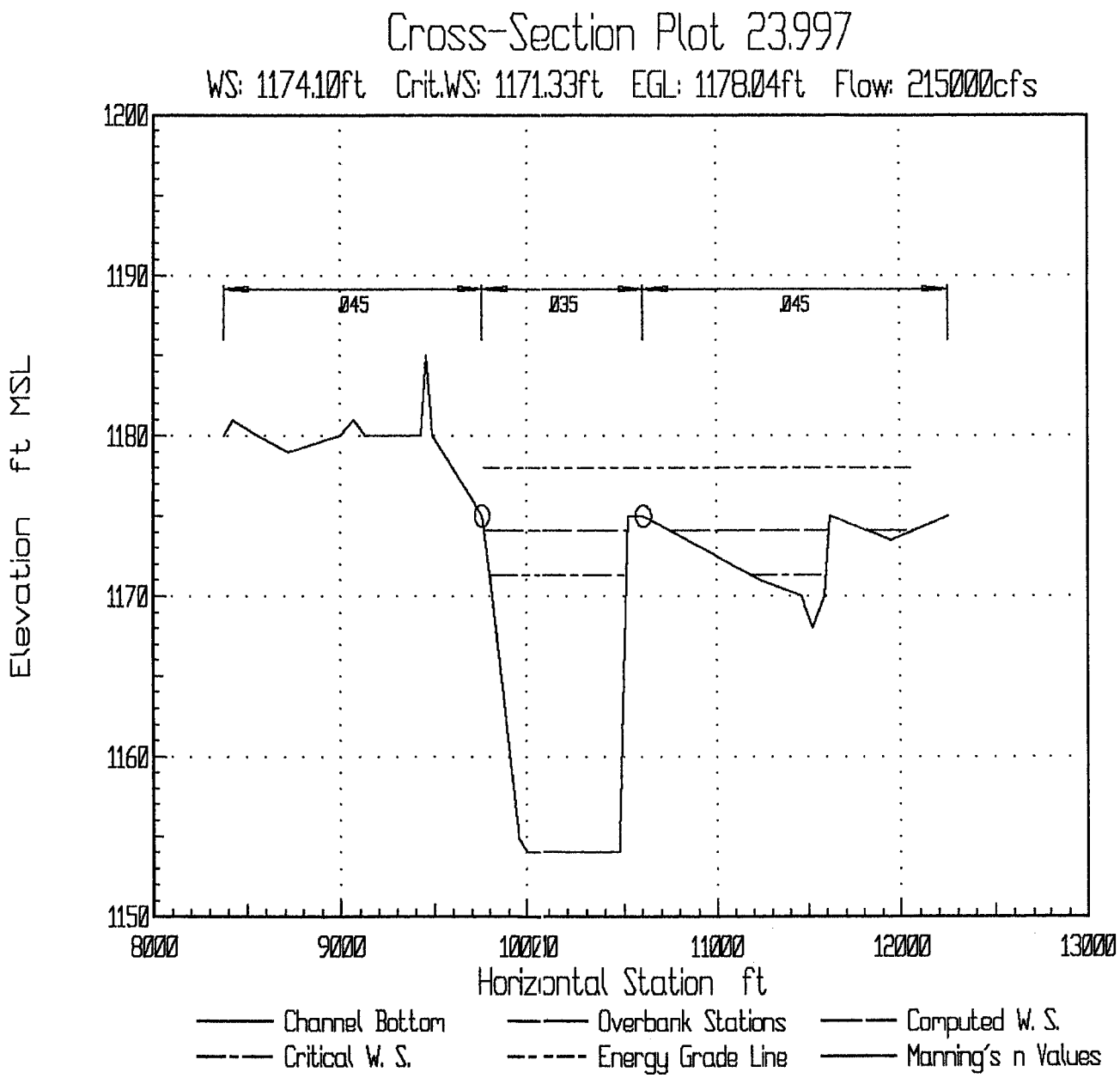
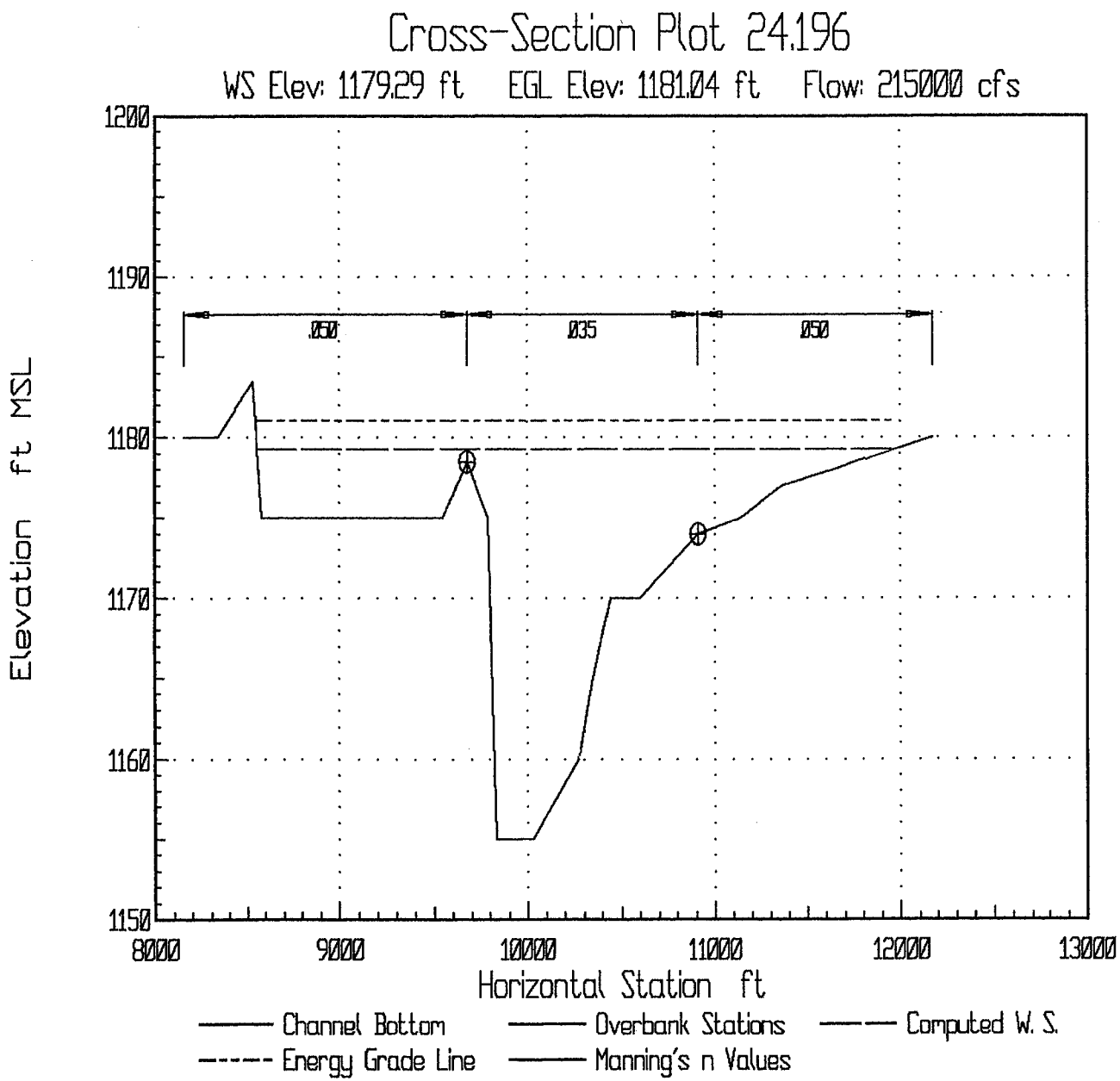
14 Warning and status message(s) generated

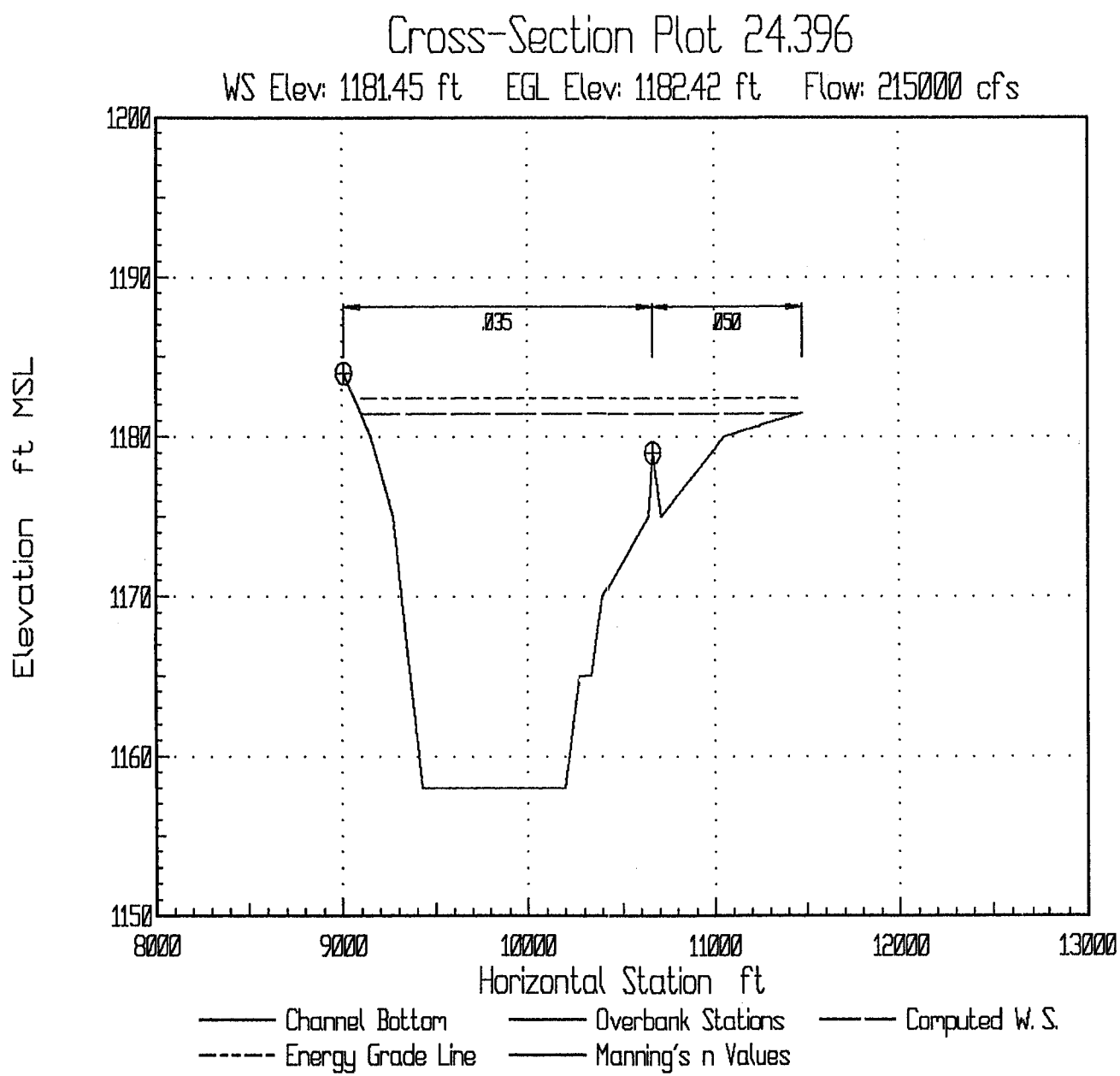
END OF OUTPUT

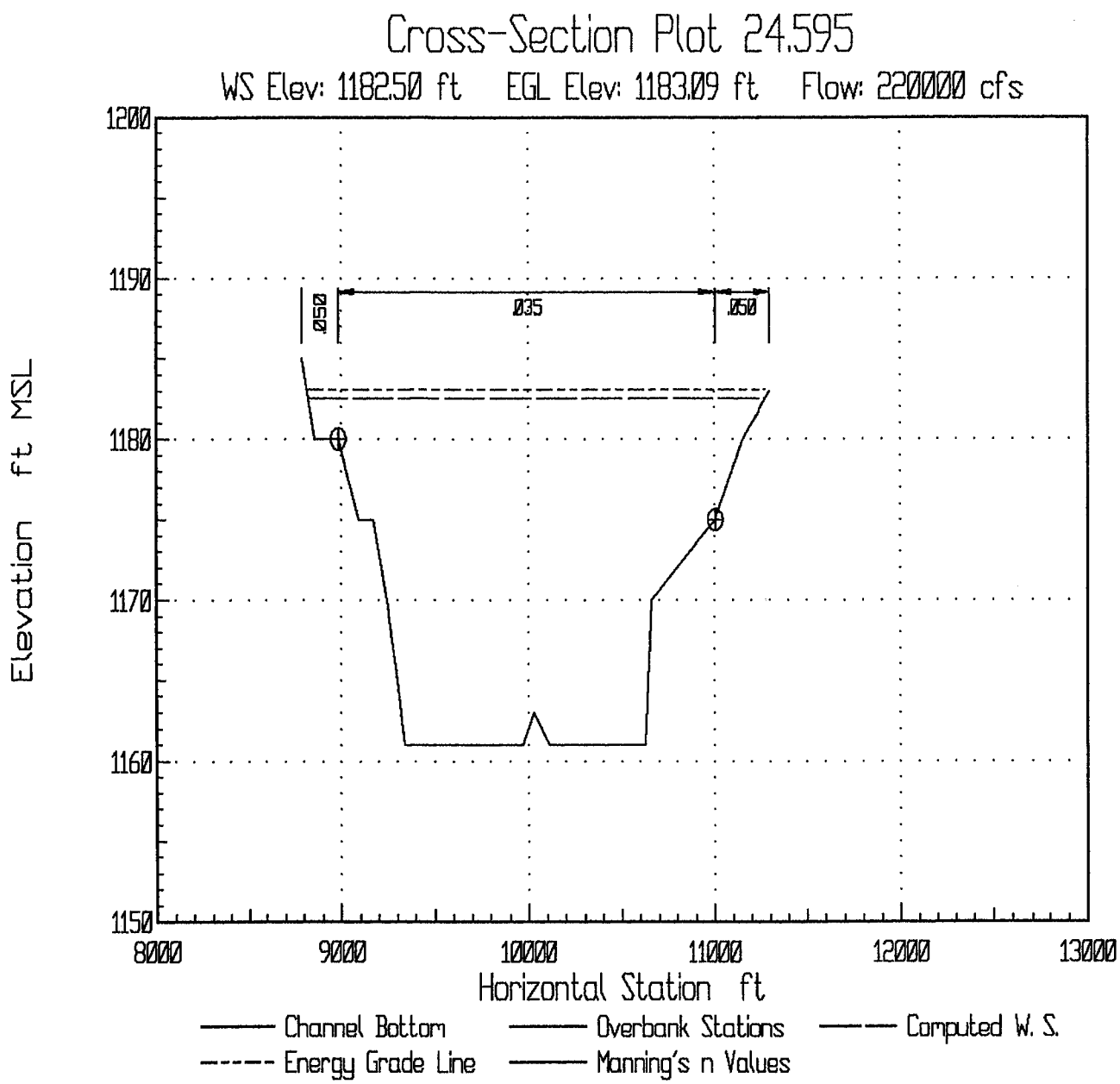

Cross-Section Plot 23.667
WS Elev: 1172.53 ft EGL Elev: 1173.75 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
045
035
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

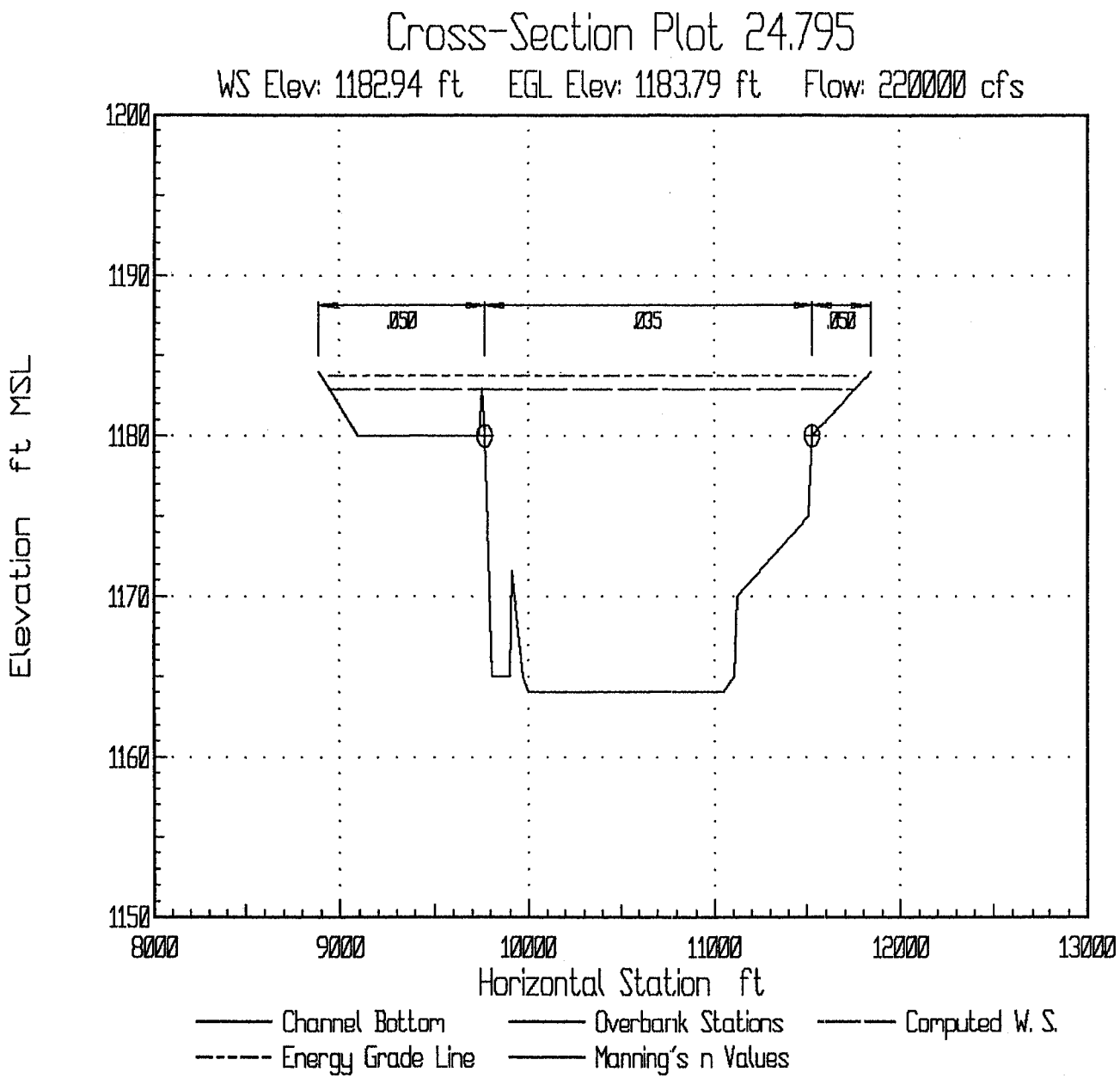

Cross-Section Plot 23.797
WS Elev: 1173.01 ft EGL Elev: 1174.67 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
045
035
045
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

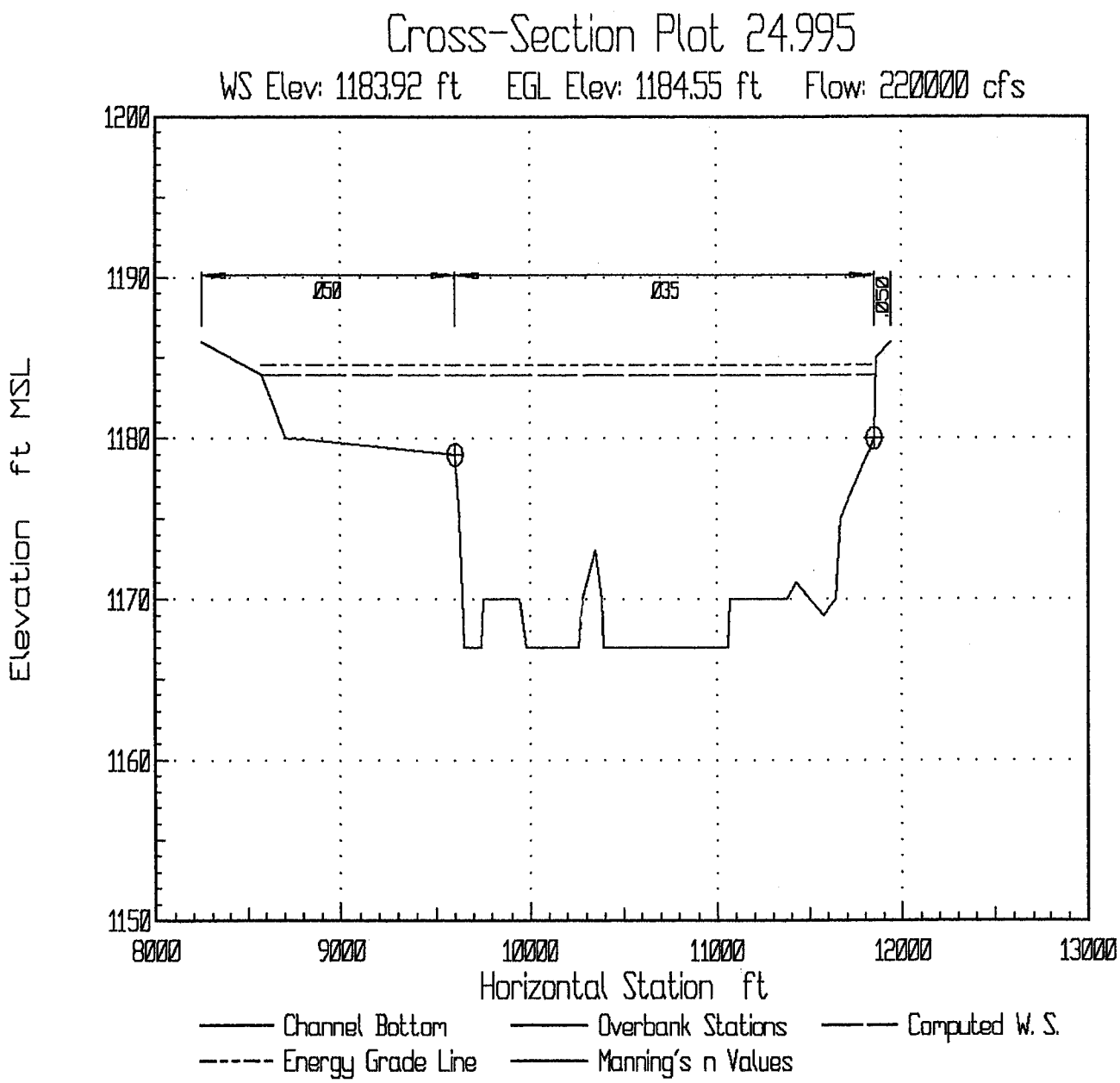

Cross-Section Plot 23.997
WS: 1174.10ft Crit.WS: 1171.33ft EGL: 1178.04ft Flow: 215000cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
045
035
045
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Critical W. S.
Energy Grade Line
Manning's n Values

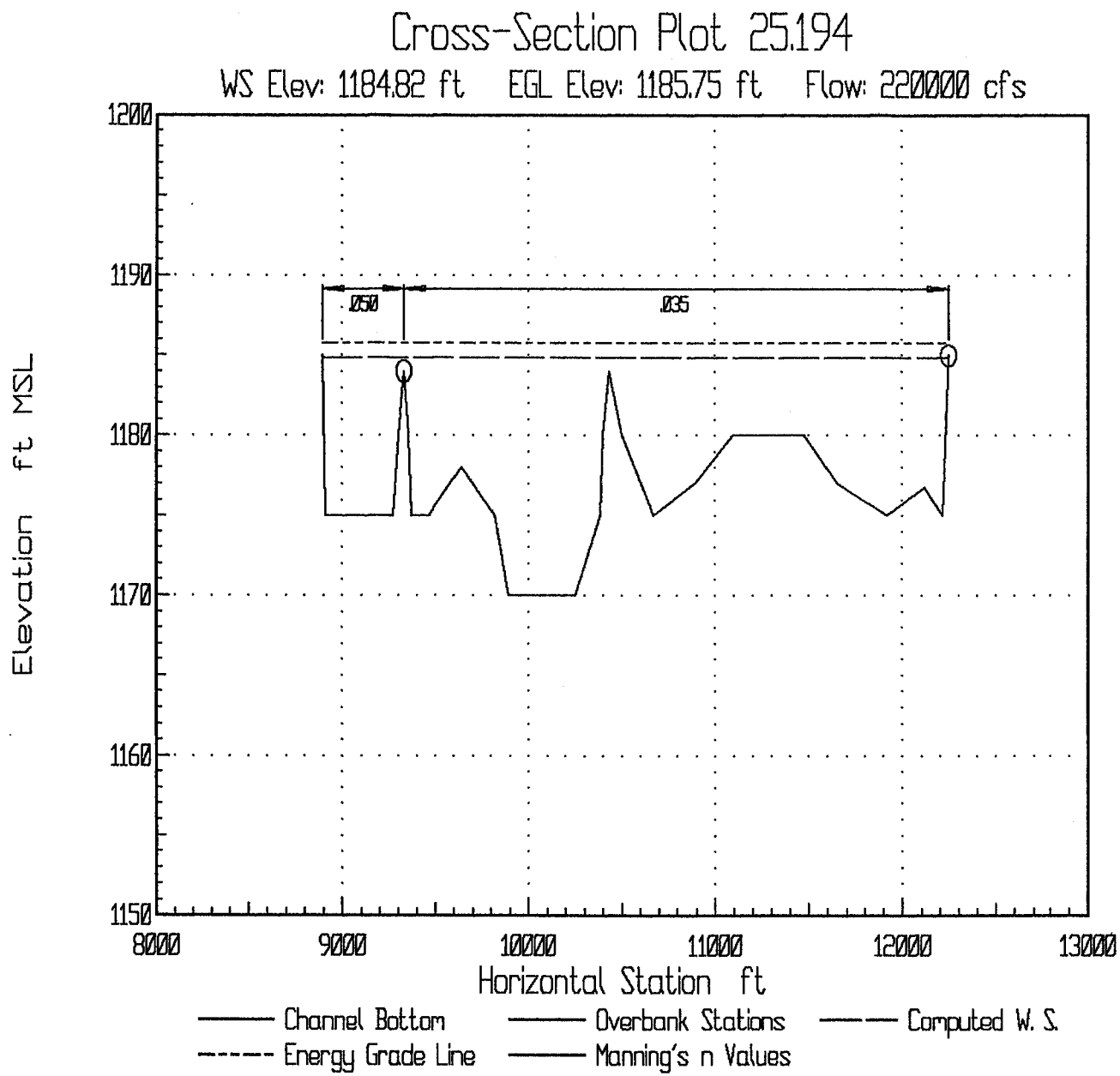

Cross-Section Plot 24.196
WS Elev: 1179.29 ft EGL Elev: 1181.04 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
.050
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.396
WS Elev: 1181.45 ft EGL Elev: 1182.42 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
035
050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W.S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.595
WS Elev: 1182.50 ft EGL Elev: 1183.09 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
.050
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.795
WS Elev: 1182.94 ft EGL Elev: 1183.79 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
.050
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.995
WS Elev: 1183.92 ft EGL Elev: 1184.55 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
050
035
050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 25.194
WS Elev: 1184.82 ft EGL Elev: 1185.75 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
Elevation ft MSL
050
035
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

2. Post-Project Model:

The post-project model is also executed in three reaches. The downstream reach is identical to that of the effective model. The middle reach is the project model. The reach extends from Grade Control Structure No. 4 (located 1500 feet west of the Southern Pacific Railroad Bridge, River Mile 21.399) to 445 feet east of the McClintock Drive Bridge (River Mile 23.751). The model for the project reach overlaps the previous CLOMR reach downstream and provides the identical hydraulic results. The purpose of including the overlap is to provide model information that is identical to the limits of the construction documents for this phase of channelization.

The reach upstream of the project reach is taken from the effective model and extends from McClintock Drive to Country Club Road (River Mile 23.667 to 25.194).

Project Model
(File Name: RSSRP2.DTA)

==========
B O S S H E C - 2 (tm)
==========

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Version : 3.00
Serial Number : 0010149.250

Licensed to CRSS Civil Engineers, Inc.

PROGRAM ORIGIN :

Boss Hec-2 (tm) is an enhanced version of the U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-2 program for water-surface profile computations. Program based upon the September 1990 version, updated on August 1991.

DISCLAIMER :

Boss Hec-2 (tm) is a complex program which requires engineering expertise to use correctly. Boss Corporation assumes absolutely no responsibility for the correct use of this program. All results obtained should be carefully examined by an experienced professional engineer to determine if they are reasonable and accurate.

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PROJECT DESCRIPTION :

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL
DESCRIPTION : GC#4 TO MCCLINTOCK DRIVE
ENGINEER :
DATE OF RUN : 11/09/1993
TIME OF RUN : 4:04 pm

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

T1 CHANNELIZED SALT RIVER CRSS CIVIL
T2 CITY OF TEMPE FILE NAME: RSSP2.HC2
T3 GC#4 TO MCCLINTOCK DRIVE

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0.0	0	0.0	92000.0	1142.63	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

USER-DEFINED SUMMARY TABLES (J3) :
---

38 42 39 43 1 3 25 4 5

REQUESTED CROSS-SECTION PRINTOUTS (J5) :

-10 -10

NC 0.050 0.050 0.035 0.1 0.3
Grade Control Str. No. 4
Grade Control Str. No. 4

X1	21.399	12	581.5	1500.00	0.0	0.0	0.0	1.0	0.0	0
GR	1154.7	505.00	1154.60	520.00	1142.10	557.50	1141.86	581.5	1132.40	609.88
GR	1129.4	1022.00	1132.40	1454.7	1147.50	1500.00	1147.65	1515.00	1147.50	1517.00
GR	1157.7	1548.00	1157.85	1563.00						
X1	21.429	13	598.50	1500.00	120.0	200.0	160.0	1.0	0.0	0
GR	1154.9	522.00	1154.91	573.00	1142.40	574.50	1142.40	598.50	1132.53	626.94
GR	1129.6	1082.00	1132.61	1454.55	1147.83	1500.00	1147.83	1515.00	1145.83	1521.00
GR	1145.8	1568.00	1155.04	1594.00	1155.04	1609.00				
X1	21.467	13	611.50	1500.00	200.0	200.0	200.0	1.0	0.0	0
GR	1155.4	535.00	1155.41	550.00	1142.90	587.50	1142.90	611.50	1132.74	640.63
GR	1129.8	1141.00	1132.82	1454.34	1148.17	1500.00	1148.32	1515.00	1146.17	1521.00
GR	1146.1	1611.00	1155.44	1639.00	1155.44	1654.00				
X1	21.505	13	621.50	1515.00	200.0	200.0	200.0	1.0	0.0	0
GR	1155.9	545.00	1155.91	560.00	1143.40	597.50	1143.40	621.50	1132.96	651.29
GR	1130.0	1190.00	1133.03	1413.59	1148.50	1460.00	1148.50	1515.00	1146.50	1521.00

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

```
GR   1146.5    1660.00    1155.83    1686.00    1155.83    1701.00

X1   21.543        13     629.50    1500.00      200.0      200.0      200.0        1.0        0.0          0
GR   1156.4    553.00    1156.41     568.00    1143.90     605.50    1143.66     629.50    1133.50     659.98
GR   1130.2   1225.00    1133.50    1454.01    1148.83    1500.00    1148.83    1515.00    1146.83    1521.00
GR   1147.7   1701.83    1156.22    1730.00    1156.22    1745.00

X1   21.581        13     627.50    1500.00      200.0      200.0      200.0        1.0        0.0          0
GR   1156.9    551.00    1156.91     566.00    1144.40     603.50    1144.40     627.50    1133.38     658.64
GR   1130.4   1247.00    1133.45    1453.86    1149.17    1500.00    1149.17    1515.00    1147.17    1521.00
GR   1148.3   1748.00    1156.63    1777.00    1156.63    1792.00

X1   21.619        13     623.50    1500.00      200.0      200.0      200.0        1.0        0.0          0
GR   1157.4    547.00    1157.41     562.00    1144.90     599.50    1144.90     623.50    1133.60     655.15
GR   1130.6   1255.00    1133.66    1453.65    1149.50    1500.00    1149.50    1515.00    1147.50    1521.00
GR   1148.8   1796.00    1157.04    1822.00    1157.04    1837.00

X1   21.649        13     611.43    1500.00      115.0      200.0      158.0        1.0        0.0          0
GR   1157.6    535.31    1157.69     550.24    1145.19     587.55    1145.19     611.43    1133.72     643.13
GR   1130.8   1243.75    1133.86    1452.09    1149.83    1500.00    1149.83    1507.43    1147.83    1513.40
GR   1149.4   1830.74    1157.47    1859.66    1157.47    1874.58

NC     0.0       0.0        0.0        0.3        0.5
X1   21.672        13     599.49    1420.00       85.0      160.0      122.0        1.0        0.0          0
GR   1157.9    523.37    1157.90     538.30    1145.40     575.61    1145.40     599.49    1133.81     630.71
GR   1131.0    1233.8    1134.03    1371.79    1150.10    1420.00    1150.10    1515.00    1148.10    1521.00
GR   1149.9   1886.52    1157.79    1911.32    1157.79    1926.32

QT       4   93000.0   160000.0   215000.0   250000.0
SB    1.48      1.56       2.67     1388.0      816.0       72.0    29800.0       10.7    1131.58    1131.55
  SPRR bridge U/S
SPRR bridge U/S

X1   21.675        13     598.49    1420.00       15.0       20.0       18.0        1.0        0.0          0
X2     0.0       0.0          1     1161.0     1165.0        0.0          0        2.0        0.0
GR   1158.9    522.38    1157.94     537.30    1145.44     574.61    1145.44     598.49    1133.83     629.75
GR   1131.0   1232.81    1134.05    1371.76    1150.13    1420.00    1150.13    1515.00    1148.13    1521.00
GR   1149.9   1886.52    1157.79    1911.40    1157.79    1926.32

NC     0.0       0.0        0.0        0.1        0.3
X1   21.704        13     602.29    1500.00      155.0      150.0      152.0        1.0        0.0          0
GR   1158.3    525.95    1158.33     540.92    1145.83     578.34    1145.83     602.29    1133.99     634.21
GR   1131.2   1229.54    1134.21    1450.17    1150.38    1500.00    1150.38    1515.00    1148.57    1521.00
GR   1150.0   1790.00    1160.04    1880.00    1160.04    2050.00
  Old Ash Bridge alignment

Old Ash Bridge alignment

X1   21.737        13     602.90    1500.00      180.0      165.0      172.0        1.0        0.0          0
GR   1158.9    526.47    1158.99     541.46    1146.49     578.42    1146.49     602.90    1134.19     636.64
GR   1131.3   1218.78    1134.38    1450.88    1150.66    1500.00    1150.66    1515.00    1148.66    1521.00
GR   1149.5   1698.30    1160.47    1726.27    1160.47    1741.26
```

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X1   21.771        13     557.48   1500.00       90.0      275.0      182.0        1.0        0.0          0
GR   1159.4    483.50    1159.48    498.01    1146.98     534.27    1146.98     557.48    1134.28     590.08
GR   1131.6   1142.03    1134.67   1450.65    1151.12    1500.00    1151.12    1515.00    1149.12    1521.00
GR   1149.8   1658.02    1160.79   1688.10    1160.79    1702.60

X1   21.798        13     522.05   1371.00       50.0      230.0      140.0        1.0        0.0          0
GR   1159.7    405.82    1159.76    419.53    1147.26     453.80    1147.26     522.05    1134.34     551.50
GR   1131.9   1031.91    1134.91   1327.70    1151.50    1371.00    1151.50    1386.00    1149.50    1392.00
GR   1150.1   1511.75    1160.90   1541.00    1160.90    1556.00
  Mill Avenue bridge

Mill Avenue bridge

X1   21.809        13     530.00   1501.65       60.0       60.0       60.0        1.0        0.0          0
RC        7   40000.0    1141.84   93000.0    1147.51   135000.0    1151.04   160000.0    1152.84   215000.0
RC   1156.1  250000.0    1158.80  296000.0    1162.00
X2      0.0       0.0          0       0.0       0.0        0.0          0        0.0        0.0
GR   1160.0    402.16    1160.09    415.87    1147.59     450.15    1147.59     530.00    1134.40     560.00
GR   1131.9   1021.85    1134.97   1327.65    1151.62    1370.00    1151.62    1385.00    1149.62    1391.00
GR   1150.1   1501.65    1161.06   1530.00    1161.06    1545.00

NC    0.035     0.035        0.0       0.0       0.0
X1   21.843        13     587.86   1428.00      230.0      140.0      185.0        1.0        0.0          0
GR   1160.9    442.68    1160.90    456.96    1148.40     492.66    1148.40     587.86    1134.65     620.48
GR   1132.1   1024.35    1135.12   1382.59    1151.88    1428.00    1151.88    1442.28    1149.88    1447.99
GR   1150.3   1550.00    1161.16   1580.32    1161.16    1594.60

SB     1.11      1.56       2.67    1040.0      760.0       85.0    30000.0        5.2    1132.12    1132.22
  Second Mill Avenue bridge
Second Mill Avenue bridge

X1   21.851        13     587.86   1428.00       45.0       45.0       45.0        1.0        0.0          0
X2      0.0       0.0          1   1172.51    1176.14        0.0          0        2.0        0.0
GR   1160.9    442.68    1160.90    456.96    1148.40     492.66    1148.40     587.86    1134.65     620.48
GR   1132.1   1024.35    1135.12   1382.59    1151.88    1428.00    1151.88    1442.28    1149.88    1447.99
GR   1150.3   1550.00    1161.22   1580.32    1161.22    1594.60

X1   21.879        13     648.59   1491.00      255.0       55.0      155.0        1.0        0.0          0
GR   1161.2    497.00    1161.22    511.91    1148.72     549.19    1148.72     648.59    1134.97     683.18
GR   1132.2   1034.75    1135.22   1443.40    1152.08    1491.00    1152.08    1505.91    1150.08    1511.87
GR   1150.5   1601.21    1161.29   1631.00    1161.29    1646.00

X1   21.908        13     654.50   1500.00      220.0      100.0      160.0        1.0        0.0          0
GR   1161.4    502.00    1161.44    517.00    1148.94     554.50    1148.94     654.50    1135.20     689.57
GR   1132.3    999.00    1135.33   1451.97    1152.27    1500.00    1152.27    1515.00    1150.27    1521.00
GR   1150.6   1598.00    1161.57   1628.00    1161.57    1643.00

X1   21.945        13     657.50    1500.0      200.0      200.0      200.0        1.0        0.0          0
GR   1161.6    505.00    1161.65    520.00    1149.15     557.50    1149.15     657.50    1135.42     692.39
GR   1132.5    952.00    1135.54   1451.64    1152.65    1500.00    1152.65    1515.00    1150.65    1521.00
GR   1150.9   1580.00    1161.84   1610.00    1161.84    1625.00
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PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
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X1   21.981      11    658.06   1500.0     200.0     200.0     200.0      1.0       0.0         0
GR   1161.8   514.00   1161.86   529.00   1149.37    566.50   1149.37   658.06   1135.63    692.98
GR   1132.7   920.00   1135.75  1462.92   1148.11   1500.00   1148.91  1580.00   1162.11   1619.60
GR   1162.1  1634.60

X1   22.018      11    656.17  1500.00     200.0     200.0     200.0      1.0       0.0         0
GR   1162.0   529.00   1162.07   544.00   1149.57    581.50   1149.57   656.17   1135.85    691.45
GR   1132.9   902.00   1135.96  1466.01   1148.32   1500.00   1149.12  1580.00   1162.32   1619.60
GR   1162.3  1634.60

X1   22.057      11    658.78  1500.00     230.0     200.0     215.0      1.0       0.0         0
GR   1162.3   557.00   1162.31   572.00   1149.81    609.50   1149.81   658.78   1136.09    699.94
GR   1133.1   894.00   1136.17  1462.89   1148.54   1500.00   1149.34  1580.00   1162.53   1619.57
GR   1162.5  1634.57

X1   22.099      11    661.39  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1162.5   568.00   1162.58   583.00   1150.49    619.27   1150.08   661.39   1136.37    697.57
GR   1133.3   892.00   1136.37  1462.86   1148.75   1500.00   1149.55  1580.00   1162.74   1619.57
GR   1162.7  1634.57

X1   22.140      11    671.78  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1162.8   596.00   1162.85   611.00   1150.59    647.78   1150.35   671.78   1136.65    712.88
GR   1133.5   895.00   1136.58  1462.86   1148.96   1500.00   1149.76  1580.00   1162.95   1639.57
GR   1162.9  1654.57

X1   22.182      11    673.78  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1163.1   598.00   1163.12   613.00   1150.86    649.78   1150.62   673.78   1136.93    714.85
GR   1133.7   900.00   1136.79  1462.83   1149.18   1500.00   1149.24  1580.00   1163.16   1621.76
GR   1163.1  1636.76

X1   22.224      11    690.78  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1163.3   615.00   1163.39   630.00   1151.13    666.78   1150.89   690.78   1137.20    731.85
GR   1134.0   908.00   1137.00  1462.83   1149.39   1500.00   1150.19  1580.00   1163.37   1619.54
GR   1163.3  1634.54

X1   22.266      11    689.78  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1163.6   614.00   1163.66   629.00   1151.40    665.78   1151.16   689.78   1137.48    730.82
GR   1134.2   919.00   1137.21  1462.83   1149.60   1500.00   1150.40  1580.00   1163.58   1619.54
GR   1163.5  1634.54

X1   22.308      11    682.78  1500.00     260.0     200.0     230.0      1.0       0.0         0
GR   1163.9   607.00   1163.93   622.00   1151.67    658.78   1151.43   682.78   1137.76    723.79
GR   1134.4   931.00   1137.42  1462.80   1149.82   1500.00   1150.62  1580.00   1163.79   1619.51
GR   1163.7  1634.51

X1   22.345      11    670.78  1500.00     210.0     200.0     205.0      1.0       0.0         0
GR   1164.1   595.00   1164.15   610.00   1151.89    646.78   1151.65   670.78   1137.99    711.76
GR   1134.6   951.00   1137.63  1462.80   1150.03   1500.00   1150.83  1580.00   1164.00   1619.51
GR   1164.0  1634.51

X1   22.380      11    661.78  1500.00     175.0     200.0     188.0      1.0       0.0         0
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GR   1164.3    586.00   1164.33    601.00   1152.07    637.78   1151.83    661.78   1138.17    702.76
GR   1134.8    981.00   1137.84   1462.80   1150.24   1500.00   1151.04   1580.00   1164.21   1619.51
GR   1164.2   1634.51

X1   22.412        11    654.78   1500.00     160.0     200.0     180.0       1.0       0.0         0
GR   1164.5    579.00   1164.50    594.00   1152.24    630.78   1152.00    654.78   1138.34    695.76
GR   1135.0   1020.00   1138.05   1467.87   1150.46   1500.00   1151.26   1580.00   1164.42   1619.48
GR   1164.4   1634.48

X1   22.445        11    645.78   1500.00     160.0     200.0     180.0       1.0       0.0         0
GR   1164.6    570.00   1164.67    585.00   1152.41    621.78   1152.17    645.78   1138.52    686.73
GR   1135.2   1065.00   1138.26   1462.77   1150.67   1500.00   1151.47   1580.00   1164.63   1619.48
GR   1164.6   1634.48

X1   22.478        11    638.78   1500.00     165.0     200.0     182.0       1.0       0.0         0
GR   1164.8    563.00   1164.84    578.00   1152.58    614.78   1152.34    638.78   1138.69    679.73
GR   1135.4   1121.00   1138.47   1462.77   1150.88   1500.00   1151.68   1580.00   1164.84   1619.48
GR   1164.8   1634.48

X1   22.512        11    629.78   1500.00     170.0     200.0     185.0       1.0       0.0         0
GR   1165.0    554.00   1165.01    569.00   1152.75    605.78   1152.51    629.78   1138.87    670.70
GR   1135.6   1180.00   1138.68   1462.77   1151.09   1500.00   1151.89   1580.00   1165.05   1619.48
GR   1165.0   1634.48

X1   22.545        11    620.78   1500.00     160.0     200.0     180.0       1.0       0.0         0
GR   1165.1    545.00   1165.18    560.00   1152.92    596.78   1152.68    620.78   1139.04    661.70
GR   1135.8   1230.00   1138.89   1462.74   1151.31   1500.00   1152.11   1580.00   1165.26   1619.45
GR   1165.2   1634.45

X1   22.578        11    612.78   1500.00     160.0     200.0     180.0       1.0       0.0         0
GR   1165.3    537.00   1165.34    552.00   1153.08    588.78   1152.84    612.78   1139.22    647.88
GR   1136.0   1270.00   1139.09   1462.71   1151.52   1500.00   1152.32   1580.00   1165.47   1619.45
GR   1165.4   1634.45

X1   22.610        11    604.78   1500.00     160.0     200.0     180.0       1.0       0.0         0
GR   1165.5    529.00   1165.51    544.00   1153.25    580.78   1153.01    604.78   1139.39    645.64
GR   1136.3   1300.00   1139.30   1462.71   1151.73   1500.00   1152.53   1580.00   1165.51   1618.94
GR   1165.5   1633.94

X1   22.644        11    597.78   1500.00     170.0     200.0     185.0       1.0       0.0         0
GR   1165.6    522.00   1165.69    537.00   1153.43    573.78   1153.19    597.78   1139.57    638.64
GR   1136.5   1318.00   1139.51   1462.68   1151.95   1500.00   1152.75   1580.00   1165.89   1619.42
GR   1165.8   1634.42

X1   22.664        11    590.78   1500.00      85.0     130.0     108.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1165.7    515.00   1165.78    530.00   1153.52    566.78   1153.28    590.78   1139.66    631.64
GR   1136.6   1322.00   1139.65   1462.68   1152.09   1500.00   1152.89   1580.00   1166.03   1619.42
GR   1166.0   1634.42

SB     1.05      1.56      2.63       0.0     831.0      54.0   34820.0       5.0   1136.75   1136.65
  Rural Road bridge
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Rural Road bridge

X1	22.681	21	589.78	1500.00	85.0	100.0	92.0	1.0	0.0	0
X2	0.0	0.0	1	1172.28	1176.98	0.0	0	2.0	0.0	
BT	-12	514.00	1176.98	1165.86	524.00	1177.02	1169.35	645.00	1178.49	1170.82
BT		766.00	1179.49	1171.79	887.00	1179.95	1172.28	1008.00	1179.95	1172.28
BT		1129.00	1179.46	1171.79	1250.00	1178.49	1170.82	1371.00	1177.02	1169.35
BT		1492.00	1175.07	1167.40	1612.00	1172.65	1164.98	1619.42	1172.50	1166.13
GR	1165.8	514.00	1165.78	524.00	1165.86	529.00	1153.60	565.78	1153.36	589.78
GR	1139.7	630.61	1139.69	645.00	1139.17	766.00	1138.64	887.00	1138.12	1008.00
GR	1137.6	1129.00	1137.07	1250.00	1136.75	1325.00	1137.76	1371.00	1139.75	1462.68
GR	1149.5	1492.00	1152.19	1500.00	1152.99	1580.00	1163.66	1612.00	1166.13	1619.42
GR	1166.1	1634.42								
X1	22.710	11	581.78	1500.00	150.0	170.0	160.0	1.0	0.0	0
GR	1166.0	506.00	1166.03	521.00	1153.77	557.78	1153.53	581.78	1139.91	622.64
GR	1136.9	1321.00	1139.93	1462.68	1152.37	1500.00	1152.86	1549.00	1166.31	1589.35
GR	1166.3	1604.35								
X1	22.742	11	571.78	1500.00	160.0	200.0	180.0	1.0	0.0	0
GR	1166.2	496.00	1166.26	511.00	1154.00	547.78	1153.76	571.78	1140.12	612.70
GR	1137.1	1315.00	1140.14	1462.65	1152.59	1500.00	1152.83	1524.00	1166.52	1565.07
GR	1166.5	1580.07								
X1	22.775	11	556.78	1500.00	160.0	200.0	180.0	1.0	0.0	0
GR	1166.4	481.00	1166.49	496.00	1154.23	532.78	1153.99	556.78	1140.33	597.76
GR	1137.3	1279.00	1140.35	1462.65	1152.80	1500.00	1153.04	1524.00	1166.73	1565.07
GR	1166.7	1580.07								
X1	22.808	11	532.75	1500.00	160.0	200.0	180.0	1.0	0.0	0
GR	1166.7	457.00	1166.71	472.00	1154.46	508.75	1154.22	532.75	1140.54	573.79
GR	1137.5	1241.00	1140.56	1462.65	1153.01	1500.00	1153.25	1524.00	1166.94	1565.07
GR	1166.9	1580.07								
X1	22.841	11	506.78	1500.00	165.0	200.0	182.0	1.0	0.0	0
GR	1166.9	431.00	1166.95	446.00	1154.69	482.78	1154.45	506.78	1140.76	547.85
GR	1137.7	1194.00	1140.77	1462.62	1153.23	1500.00	1153.47	1524.00	1167.15	1565.04
GR	1167.1	1580.04								
X1	22.874	11	471.78	1500.00	160.0	200.0	180.0	1.0	0.0	0
GR	1167.1	396.00	1167.18	411.00	1154.92	447.78	1154.68	471.78	1140.97	512.91
GR	1137.9	1136.00	1140.98	1462.62	1153.44	1500.00	1153.68	1524.00	1167.36	1565.04
GR	1167.3	1580.04								
X1	22.907	11	435.78	1500.00	160.0	200.0	180.0	1.0	0.0	0
GR	1167.4	360.00	1167.41	375.00	1155.15	411.78	1154.91	435.78	1141.19	476.94
GR	1138.1	1088.00	1141.19	1462.62	1153.65	1500.00	1153.89	1524.00	1167.57	1565.04
GR	1167.5	1580.04								
X1	22.940	11	388.78	1500.00	165.0	200.0	182.0	1.0	0.0	0
GR	1167.6	313.00	1167.64	328.00	1155.38	364.78	1155.14	388.78	1141.39	430.03
GR	1138.4	1040.00	1141.40	1462.59	1153.87	1500.00	1154.11	1524.00	1167.78	1565.01

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GR   1167.7    1580.01

X1   22.973        11     322.78   1500.00      160.0      200.0      180.0        1.0        0.0          0
GR   1167.8    247.00    1167.87    262.00    1155.61     298.78    1155.37     322.78    1141.60     364.09
GR   1138.6   1008.00    1141.60   1462.56    1154.08    1500.00    1154.32    1524.00    1167.99    1565.01
GR   1167.9   1580.01

X1   23.005        12     265.78   1500.00      155.0      200.0      178.0        1.0        0.0          0
GR   1168.0    190.00    1168.07    205.00    1155.81     241.00    1155.57     265.78    1149.50     284.00
GR   1141.8    307.09    1138.81    980.00    1141.81    1462.56    1154.29    1500.00    1154.53    1524.00
GR   1168.2   1561.01    1168.20   1576.01

X1   23.038        11     215.78   1500.00      155.0      200.0      178.0        1.0        0.0          0
GR   1168.2    140.00    1168.24    155.00    1155.98     191.78    1157.74     215.78    1142.01     262.97
GR   1139.0    960.00    1142.02   1459.53    1155.51    1500.00    1155.75    1524.00    1168.41    1561.98
GR   1168.4   1576.98

X1   23.070        12     168.75   1500.00      155.0      200.0      178.0        1.0        0.0          0
GR   1168.4     93.00    1168.41    108.00    1156.16     144.75    1155.92     168.75    1142.21     185.88
GR   1141.9    282.00    1139.23    948.00    1142.23    1471.62    1154.72    1500.00    1154.96    1524.00
GR   1168.6   1561.05    1168.62   1576.05

X1   23.109        12     150.00   1500.00      225.0      200.0      212.0        1.0        0.0          0
GR   1168.6     33.00    1168.66     48.00    1156.41     84.75    1156.17     150.00    1142.51     190.98
GR   1142.1    319.00    1139.44    939.00    1142.44    1462.53    1154.93    1500.00    1155.17    1524.00
GR   1168.8   1564.98    1168.83   1579.98

X1   23.153         9      20.00   1500.00      290.0      200.0      245.0        1.0        0.0          0
GR   1156.4     20.00    1142.89     60.80    1141.79     353.00    1139.65     920.00    1142.65    1462.50
GR   1155.1   1500.00    1155.39   1524.00    1169.04    1564.95    1169.04    1579.95

X1   23.200         7     350.00   1500.00      310.0      200.0      255.0        1.0        0.0          0
GR   1142.5    350.00    1139.86    885.00    1142.86    1462.50    1155.36    1500.00    1155.60    1524.00
GR   1169.2   1564.95    1169.25   1579.95

X1   23.252        11     484.41   1500.00      370.0      200.0      285.0        1.0        0.0          0
GR   1169.4    407.91    1169.42    422.91    1156.92     460.41    1156.68     484.41    1143.15     525.00
GR   1140.0    853.00    1143.07   1462.50    1155.57    1500.00    1155.81    1524.00    1169.46    1564.95
GR   1169.4   1579.95

X1   23.293        11     535.50   1500.00      260.0      200.0      230.0        1.0        0.0          0
GR   1169.6    459.00    1169.62    474.00    1157.12     511.50    1156.88     535.50    1143.15     576.69
GR   1140.2    828.00    1143.28   1462.47    1155.79    1500.00    1156.03    1524.00    1169.67    1564.92
GR   1169.6   1579.92

X1   23.334        11     531.50   1500.00      250.0      200.0      225.0        1.0        0.0          0
GR   1169.8    455.00    1169.87    470.00    1157.37     507.50    1157.13     531.50    1143.40     572.69
GR   1140.4    810.00    1143.49   1462.47    1156.00    1500.00    1156.14    1514.40    1169.88    1555.62
GR   1169.8   1570.62

X1   23.375        10     473.50   1500.00      250.0      200.0      225.0        1.0        0.0          0
GR   1170.1    397.00    1170.12    412.00    1157.62     449.50    1157.38     473.50    1143.65     514.69
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GR   1140.7    795.00   1143.70   1462.02   1156.36   1500.00   1170.09   1541.19   1170.09   1556.19

X1   23.417         9    590.50   1500.00     255.0     200.0     228.0       1.0       0.0         0
GR   1170.3    514.00   1170.37    529.00   1157.87    566.50   1157.63    590.50   1143.91    631.66
GR   1140.9    790.00   1143.91   1420.83   1170.30   1500.00   1170.30   1515.00

X1   23.456         9    606.50   1500.00     225.0     200.0     212.0       1.0       0.0         0
GR   1170.6    530.00   1170.60    545.00   1158.10    582.50   1157.86    606.50   1144.13    647.69
GR   1141.1    790.00   1144.12   1420.83   1170.51   1500.00   1170.51   1515.00

X1   23.492         9    584.50   1500.00     200.0     200.0     200.0       1.0       0.0         0
GR   1170.8    508.00   1170.80    523.00   1158.30    560.50   1158.06    584.50   1144.33    625.69
GR   1141.3    800.00   1144.32   1420.77   1170.73   1500.00   1170.73   1515.00

X1   23.529         9    529.50   1500.00     205.0     200.0     202.0       1.0       0.0         0
GR   1171.0    453.00   1171.00    468.00   1158.50    505.50   1158.26    529.50   1144.54    570.66
GR   1141.5    820.00   1144.53   1420.77   1170.94   1500.00   1170.94   1515.00

X1   23.566         9    474.50   1500.00     210.0     200.0     205.0       1.0       0.0         0
GR   1171.2    398.00   1171.21    413.00   1158.71    450.50   1158.47    474.50   1144.75    515.66
GR   1141.7    854.00   1144.74   1420.77   1171.15   1500.00   1171.15   1515.00

X1   23.601         9    446.50   1500.00     180.0     200.0     190.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1171.3    370.00   1171.39    385.00   1158.89    422.50   1158.65    446.50   1144.95    487.60
GR   1141.9    525.00   1144.95   1420.74   1171.37   1500.00   1171.37   1515.00

X1   23.610         9    446.22   1485.00      57.0      42.0      50.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1171.4    370.00   1171.45    385.00   1158.95    422.50   1158.71    446.22   1144.98    487.69
GR   1142.0    926.50   1145.00   1405.77   1171.41   1485.00   1171.41   1500.00
  Grade Control Str. No. 5

Grade Control Str. No. 5

X1   23.611         9    443.50   1485.00       8.0       8.0       8.0       1.0       0.0         0
GR   1171.4    367.00   1171.46    382.00   1158.96    419.50   1158.72    443.50   1150.00    469.66
GR   1147.0    926.50   1150.00   1420.74   1171.42   1485.00   1171.42   1500.00

X1   23.639         9    441.50   1460.00     155.0     150.0     152.0       1.0       0.0         0
GR   1171.6    365.00   1171.61    380.00   1159.11    417.50   1158.87    441.50   1150.16    467.63
GR   1147.1    941.00   1150.15   1395.71   1171.58   1460.00   1171.58   1475.00

X1   23.651         9    441.50   1460.00      65.0      65.0      65.0       1.0       0.0         0
X3       10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1171.6    365.00   1171.68    380.00   1159.18    417.50   1158.94    441.50   1150.22    490.27
GR   1147.2    952.00   1150.22   1395.71   1171.65   1460.00   1171.65   1475.00

SB      1.05      1.56      2.63       0.0     798.0      66.0   24246.0       6.3   1147.31   1147.22
  McClintock Drive Bridge
McClintock Drive Bridge
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PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

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X1   23.667      20     441.5   1460.00     90.0     90.0     90.0      1.0      0.0        0
X2     0.0     0.0         1   1180.61   1181.8      0.0        0      2.0      0.0
X3      10     0.0       0.0       0.0      0.0      0.0      0.0      0.0      0.0
BT     -11  316.00   1181.80   1174.13   436.00  1184.23  1176.56   554.00  1185.93  1178.26
BT          672.00   1187.37   1179.70   790.00  1188.15  1180.48   908.00  1188.28  1180.61
BT         1026.00   1188.15   1180.48  1144.00  1187.37  1179.70  1262.00  1185.93  1178.26
BT         1380.00   1184.23   1176.56  1500.00  1181.80  1174.13
GR   1174.1  316.00   1171.77    371.00  1171.77   386.00  1159.27   423.50  1159.10   436.00
GR   1159.0  441.50   1150.31    500.09  1149.97   554.00  1149.22   672.00  1148.48   790.00
GR   1147.7  908.00   1147.31    975.00  1147.64  1026.00  1148.42  1144.00  1149.19  1262.00
GR   1149.9 1380.00   1150.31   1433.31  1171.75  1460.00  1171.75  1475.00  1174.13  1500.00

X1   23.676       9    436.50   1465.00     45.0     45.0     45.0      1.0      0.0        0
GR   1171.8  360.00   1171.81    375.00  1159.31   412.50  1159.07   436.50  1150.36   464.22
GR   1147.3  983.00   1150.35   1400.68  1171.79  1465.00  1171.79  1480.00

X1   23.713      10    415.00   1500.00    200.0    200.0    200.0      1.0      0.0        0
X3       0     0.0       0.0       0.0      0.0      0.0      0.0      0.0      0.0
GR   1170.0  240.00   1168.00    272.00  1166.00   317.00  1164.00   348.00  1162.00   388.00
GR   1159.2  415.00   1150.56    441.13  1147.55   985.00  1150.55  1435.62  1172.01  1500.00

X1   23.751       8    402.00   1500.00    200.0    200.0    200.0      1.0      0.0        0
X3       0     0.0       0.0       0.0      0.0      0.0      0.0      0.0      0.0
GR   1172.0  242.00   1166.00    280.00  1164.00   377.00  1159.47   402.00  1150.76   428.13
GR   1147.7 1017.00   1150.75   1359.75  1170.00  1500.00
T1      CHANNELIZED SALT RIVER      CRSS CIVIL
T2      CITY OF TEMPE     FILE NAME: RSSP2.HC2
T3      GC#4 TO MCCLINTOCK DRIVE
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JOB PARAMETERS :

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J1  ICHECK    INQ      NINV     IDIR     STRT   METRIC    HVINS     Q        WSEL      FQ

       0        3         0        0      0.0        0      0.0  157000.0   1147.14

J2  NPROF    IPLOT     PRFVS    XSECV    XSECH     FN    ALLDC     IBW      CHNIM   ITRACE

      2        0       0.0      0.0      0.0    0.0      0.0    -6.0       0.0

T1      CHANNELIZED SALT RIVER      CRSS CIVIL
T2      CITY OF TEMPE     FILE NAME: RSSP2.HC2
T3      GC#4 TO MCCLINTOCK DRIVE
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PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	0.0	0	0.0	210000.0	1150.19	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

T1 CHANNELIZED SALT RIVER CRSS CIVIL
T2 CITY OF TEMPE FILE NAME: RSSP2.HC2
T3 GC#4 TO MCCLINTOCK DRIVE

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	5	0	0	0.0	0	0.0	250000.0	1152.27	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	0	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

SUMMARY PRINTOUT : CITY OF TEMPE FILE NAME: RSSP2.HC2
---------- GC#4 TO MCCLINTOCK DRIVE
CHANNELIZED SALT RIVER CRSS CIVIL

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
21.399	1129.40	.00	92000.00	1142.63	1143.89	10238.81	929.48	17.77
21.399	1129.40	.00	157000.00	1147.14	1148.99	14491.80	956.54	17.03
21.399	1129.40	.00	210000.00	1150.19	1152.48	17481.68	991.95	16.73
21.399	1129.40	.00	250000.00	1152.27	1154.88	19558.07	1004.51	16.58
21.429	1129.60	160.00	92000.00	1142.89	1144.18	10098.24	910.82	18.13
21.429	1129.60	160.00	157000.00	1147.37	1149.28	14289.89	980.79	17.57
21.429	1129.60	160.00	210000.00	1150.42	1152.77	17334.46	1007.45	17.22
21.429	1129.60	160.00	250000.00	1152.49	1155.16	19434.65	1013.55	17.03
21.467	1129.80	200.00	92000.00	1143.25	1144.55	10066.01	898.93	17.95
21.467	1129.80	200.00	157000.00	1147.71	1149.64	14290.72	1024.78	17.61
21.467	1129.80	200.00	210000.00	1150.75	1153.12	17476.12	1061.00	17.23
21.467	1129.80	200.00	250000.00	1152.84	1155.51	19690.55	1073.44	16.99
21.505	1130.00	200.00	92000.00	1143.52	1144.98	9494.33	847.90	20.13
21.505	1130.00	200.00	157000.00	1147.91	1150.09	13475.63	1021.37	20.09
21.505	1130.00	200.00	210000.00	1150.97	1153.56	16773.53	1097.63	20.52
21.505	1130.00	200.00	250000.00	1153.06	1155.93	19085.45	1109.74	19.69
21.543	1130.20	200.00	92000.00	1144.06	1145.37	10037.31	880.68	17.63
21.543	1130.20	200.00	157000.00	1148.54	1150.49	14275.26	1096.25	17.53
21.543	1130.20	200.00	210000.00	1151.59	1153.96	17702.94	1132.27	17.04
21.543	1130.20	200.00	250000.00	1153.67	1156.32	20071.93	1145.39	16.73
21.581	1130.40	200.00	92000.00	1144.49	1145.71	10364.06	883.01	15.89
21.581	1130.40	200.00	157000.00	1148.98	1150.84	14681.85	1144.48	16.17
21.581	1130.40	200.00	210000.00	1152.05	1154.30	18275.02	1180.51	15.79
21.581	1130.40	200.00	250000.00	1154.15	1156.65	20763.09	1194.08	15.53
21.619	1130.60	200.00	92000.00	1144.84	1146.02	10516.18	862.63	15.22

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
21.619	1130.60	200.00	157000.00	1149.35	1151.16	14925.33	1195.74	15.53
21.619	1130.60	200.00	210000.00	1152.44	1154.62	18695.21	1230.61	15.13
21.619	1130.60	200.00	250000.00	1154.55	1156.97	21306.83	1243.60	14.83
21.649	1130.80	158.00	92000.00	1145.13	1146.26	10766.40	874.30	14.33
21.649	1130.80	158.00	157000.00	1149.68	1151.40	15253.36	1249.23	14.70
21.649	1130.80	158.00	210000.00	1152.78	1154.86	19191.05	1277.98	14.31
21.649	1130.80	158.00	250000.00	1154.91	1157.21	21923.80	1291.95	14.00
21.672	1131.00	122.00	92000.00	1145.21	1146.57	9836.04	805.32	17.36
21.672	1131.00	122.00	157000.00	1149.70	1151.78	13878.68	1185.61	17.94
21.672	1131.00	122.00	210000.00	1152.79	1155.24	17949.16	1342.03	17.27
21.672	1131.00	122.00	250000.00	1154.91	1157.58	20819.28	1355.07	16.62
21.675	1131.00	18.00	93000.00	1145.78	1147.04	10305.54	833.33	15.31
21.675	1131.00	18.00	160000.00	1150.59	1152.50	15016.94	1329.47	15.50
21.675	1131.00	18.00	215000.00	1153.81	1156.07	19329.78	1349.23	14.95
21.675	1131.00	18.00	250000.00	1155.99	1158.34	22290.09	1362.63	13.83
21.704	1131.20	152.00	93000.00	1146.27	1147.27	11569.64	910.30	11.74
21.704	1131.20	152.00	160000.00	1151.23	1152.75	16717.90	1238.89	11.82
21.704	1131.20	152.00	215000.00	1154.45	1156.31	20766.11	1277.36	11.81
21.704	1131.20	152.00	250000.00	1156.57	1158.56	23496.38	1302.67	11.29
21.737	1131.30	172.00	93000.00	1146.47	1147.47	11582.86	884.42	11.66
21.737	1131.30	172.00	160000.00	1151.43	1152.95	16608.11	1139.43	11.79
21.737	1131.30	172.00	215000.00	1154.63	1156.52	20277.47	1157.02	11.96
21.737	1131.30	172.00	250000.00	1156.72	1158.78	22704.35	1168.52	11.58
21.771	1131.60	182.00	93000.00	1146.79	1147.68	12282.44	929.06	10.24
21.771	1131.60	182.00	160000.00	1151.81	1153.17	17482.94	1143.29	10.36
21.771	1131.60	182.00	215000.00	1155.04	1156.75	21203.59	1161.49	10.57
21.771	1131.60	182.00	250000.00	1157.13	1159.00	23637.23	1173.25	10.31
21.798	1131.90	140.00	93000.00	1146.79	1147.92	10883.24	835.56	13.32
21.798	1131.90	140.00	160000.00	1151.73	1153.44	15628.87	1074.61	13.45
21.798	1131.90	140.00	215000.00	1154.91	1157.04	19072.83	1091.94	13.64
21.798	1131.90	140.00	250000.00	1156.97	1159.30	21334.26	1103.17	13.24
21.809	1131.90	60.00	93000.00	1147.51	1148.56	11331.75	829.36	11.53
21.809	1131.90	60.00	160000.00	1152.84	1154.33	16615.49	1072.99	12.72
21.809	1131.90	60.00	215000.00	1156.10	1157.94	20141.75	1090.36	12.47
21.809	1131.90	60.00	250000.00	1158.80	1160.70	23105.22	1104.75	10.92

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
21.843	1132.10	185.00	93000.00	1147.72	1148.77	11262.63	827.23	11.73
21.843	1132.10	185.00	160000.00	1153.03	1154.56	16511.99	1078.18	11.32
21.843	1132.10	185.00	215000.00	1156.28	1158.18	20049.90	1096.55	11.47
21.843	1132.10	185.00	250000.00	1158.96	1160.91	23010.23	1111.70	10.20
21.851	1132.10	45.00	93000.00	1148.00	1149.02	11501.26	828.70	10.96
21.851	1132.10	45.00	160000.00	1153.45	1154.91	16966.61	1080.51	10.45
21.851	1132.10	45.00	215000.00	1156.81	1158.60	20633.32	1099.46	10.52
21.851	1132.10	45.00	250000.00	1159.48	1161.33	23579.74	1114.45	9.47
21.879	1132.20	155.00	93000.00	1148.17	1149.19	11500.90	830.04	10.98
21.879	1132.20	155.00	160000.00	1153.61	1155.07	16932.16	1075.24	10.49
21.879	1132.20	155.00	215000.00	1156.97	1158.77	20577.90	1094.54	10.57
21.879	1132.20	155.00	250000.00	1159.62	1161.48	23490.90	1109.72	9.54
21.908	1132.30	160.00	93000.00	1148.36	1149.36	11566.75	832.91	10.82
21.908	1132.30	160.00	160000.00	1153.79	1155.24	16957.63	1066.71	10.42
21.908	1132.30	160.00	215000.00	1157.15	1158.94	20578.23	1086.00	10.51
21.908	1132.30	160.00	250000.00	1159.77	1161.63	23449.40	1101.05	9.53
21.945	1132.50	200.00	93000.00	1148.57	1149.58	11529.94	829.54	10.88
21.945	1132.50	200.00	160000.00	1153.98	1155.45	16821.50	1045.50	10.54
21.945	1132.50	200.00	215000.00	1157.34	1159.16	20351.95	1064.71	10.70
21.945	1132.50	200.00	250000.00	1159.93	1161.84	23130.75	1079.59	9.77
21.981	1132.70	200.00	93000.00	1148.83	1149.80	11757.86	912.12	10.44
21.981	1132.70	200.00	160000.00	1154.27	1155.66	17305.03	1044.30	9.83
21.981	1132.70	200.00	215000.00	1157.64	1159.38	20860.72	1064.54	10.00
21.981	1132.70	200.00	250000.00	1160.21	1162.04	23610.95	1079.93	9.22
22.018	1132.90	200.00	93000.00	1149.04	1150.01	11810.96	914.35	10.32
22.018	1132.90	200.00	160000.00	1154.47	1155.86	17276.96	1029.28	9.79
22.018	1132.90	200.00	215000.00	1157.84	1159.58	20779.69	1049.50	10.01
22.018	1132.90	200.00	250000.00	1160.38	1162.23	23470.92	1064.77	9.27
22.057	1133.10	215.00	93000.00	1149.26	1150.24	11708.92	911.65	10.57
22.057	1133.10	215.00	160000.00	1154.66	1156.09	16993.82	1000.98	10.11
22.057	1133.10	215.00	215000.00	1158.02	1159.82	20392.96	1021.15	10.36
22.057	1133.10	215.00	250000.00	1160.54	1162.45	22984.45	1036.27	9.65
22.099	1133.30	230.00	93000.00	1149.50	1150.48	11732.19	911.61	10.46
22.099	1133.30	230.00	160000.00	1154.88	1156.32	16946.68	989.91	10.09
22.099	1133.30	230.00	215000.00	1158.25	1160.06	20314.41	1010.12	10.37
22.099	1133.30	230.00	250000.00	1160.75	1162.68	22860.71	1025.13	9.70

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
22.140	1133.50	230.00	93000.00	1149.72	1150.73	11559.57	903.81	10.81
22.140	1133.50	230.00	160000.00	1155.08	1156.57	16621.56	969.74	10.51
22.140	1133.50	230.00	215000.00	1158.44	1160.32	19921.08	994.98	10.81
22.140	1133.50	230.00	250000.00	1160.92	1162.93	22407.53	1013.59	10.14
22.182	1133.70	230.00	93000.00	1149.97	1150.98	11576.87	906.46	10.81
22.182	1133.70	230.00	160000.00	1155.32	1156.81	16619.10	961.84	10.50
22.182	1133.70	230.00	215000.00	1158.69	1160.57	19890.01	982.03	10.80
22.182	1133.70	230.00	250000.00	1161.14	1163.17	22324.53	996.79	10.17
22.224	1134.00	230.00	93000.00	1150.19	1151.25	11266.74	887.13	11.42
22.224	1134.00	230.00	160000.00	1155.52	1157.08	16180.28	942.36	11.13
22.224	1134.00	230.00	215000.00	1158.87	1160.86	19376.92	962.49	11.44
22.224	1134.00	230.00	250000.00	1161.31	1163.44	21737.96	977.10	10.79
22.266	1134.20	230.00	93000.00	1150.46	1151.52	11322.39	888.27	11.27
22.266	1134.20	230.00	160000.00	1155.78	1157.34	16235.62	943.46	11.02
22.266	1134.20	230.00	215000.00	1159.15	1161.12	19457.95	963.73	11.30
22.266	1134.20	230.00	250000.00	1161.57	1163.69	21792.27	978.16	10.72
22.308	1134.40	230.00	93000.00	1150.75	1151.77	11493.42	895.58	10.86
22.308	1134.40	230.00	160000.00	1156.08	1157.59	16452.75	950.81	10.66
22.308	1134.40	230.00	215000.00	1159.46	1161.38	19706.20	971.12	10.96
22.308	1134.40	230.00	250000.00	1161.86	1163.94	22056.36	985.53	10.41
22.345	1134.60	205.00	93000.00	1151.01	1152.00	11711.52	907.84	10.41
22.345	1134.60	205.00	160000.00	1156.35	1157.81	16751.41	963.16	10.23
22.345	1134.60	205.00	215000.00	1159.76	1161.61	20069.02	983.61	10.50
22.345	1134.60	205.00	250000.00	1162.15	1164.15	22440.04	997.97	10.00
22.380	1134.80	188.00	93000.00	1151.23	1152.19	11846.07	916.92	10.16
22.380	1134.80	188.00	160000.00	1156.58	1158.01	16955.16	972.36	9.96
22.380	1134.80	188.00	215000.00	1160.00	1161.80	20320.26	992.91	10.21
22.380	1134.80	188.00	250000.00	1162.39	1164.34	22706.53	1007.23	9.74
22.412	1135.00	180.00	93000.00	1151.44	1152.37	11999.27	924.05	9.85
22.412	1135.00	180.00	160000.00	1156.79	1158.19	17142.29	979.46	9.71
22.412	1135.00	180.00	215000.00	1160.23	1161.99	20545.37	1000.09	9.94
22.412	1135.00	180.00	250000.00	1162.61	1164.52	22940.85	1014.36	9.51
22.445	1135.20	180.00	93000.00	1151.62	1152.55	12069.57	932.99	9.79
22.445	1135.20	180.00	160000.00	1156.99	1158.36	17278.56	988.51	9.57
22.445	1135.20	180.00	215000.00	1160.44	1162.17	20727.42	1009.23	9.78
22.445	1135.20	180.00	250000.00	1162.81	1164.69	23138.88	1023.46	9.36

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
22.478	1135.40	182.00	93000.00	1151.82	1152.73	12165.28	940.02	9.63
22.478	1135.40	182.00	160000.00	1157.19	1158.54	17415.03	995.55	9.42
22.478	1135.40	182.00	215000.00	1160.65	1162.35	20899.36	1016.33	9.60
22.478	1135.40	182.00	250000.00	1163.02	1164.87	23321.27	1030.53	9.20
22.512	1135.60	185.00	93000.00	1152.01	1152.91	12290.95	949.05	9.44
22.512	1135.60	185.00	160000.00	1157.39	1158.71	17598.55	1004.64	9.22
22.512	1135.60	185.00	215000.00	1160.87	1162.53	21127.11	1025.49	9.38
22.512	1135.60	185.00	250000.00	1163.23	1165.04	23564.98	1039.66	9.00
22.545	1135.80	180.00	93000.00	1152.20	1153.08	12414.20	958.01	9.25
22.545	1135.80	180.00	160000.00	1157.58	1158.88	17775.55	1013.63	9.03
22.545	1135.80	180.00	215000.00	1161.07	1162.70	21348.12	1034.56	9.17
22.545	1135.80	180.00	250000.00	1163.43	1165.20	23802.01	1048.69	8.81
22.578	1136.00	180.00	93000.00	1152.39	1153.24	12583.05	966.28	8.95
22.578	1136.00	180.00	160000.00	1157.78	1159.04	17984.15	1021.68	8.78
22.578	1136.00	180.00	215000.00	1161.28	1162.87	21595.89	1042.67	8.93
22.578	1136.00	180.00	250000.00	1163.63	1165.36	24064.52	1056.78	8.59
22.610	1136.30	180.00	93000.00	1152.55	1153.41	12583.54	973.93	9.04
22.610	1136.30	180.00	160000.00	1157.94	1159.20	18023.27	1029.50	8.81
22.610	1136.30	180.00	215000.00	1161.45	1163.03	21665.33	1050.51	8.93
22.610	1136.30	180.00	250000.00	1163.80	1165.52	24151.36	1064.62	8.57
22.644	1136.50	185.00	93000.00	1152.73	1153.57	12661.46	978.46	8.94
22.644	1136.50	185.00	160000.00	1158.12	1159.37	18142.87	1036.36	8.70
22.644	1136.50	185.00	215000.00	1161.64	1163.20	21835.90	1057.52	8.78
22.644	1136.50	185.00	250000.00	1163.98	1165.68	24329.24	1071.57	8.44
22.664	1136.60	108.00	93000.00	1152.84	1153.67	12770.72	982.54	8.78
22.664	1136.60	108.00	160000.00	1158.24	1159.46	18308.37	1043.43	8.52
22.664	1136.60	108.00	215000.00	1161.76	1163.29	22021.30	1064.57	8.61
22.664	1136.60	108.00	250000.00	1164.10	1165.77	24529.17	1078.61	8.29
22.681	1136.75	92.00	93000.00	1152.94	1153.77	12776.53	984.32	8.78
22.681	1136.75	92.00	160000.00	1158.39	1159.60	18365.67	1044.79	8.45
22.681	1136.75	92.00	215000.00	1161.96	1163.47	22129.04	1066.18	8.49
22.681	1136.75	92.00	250000.00	1164.31	1165.96	24656.37	1080.31	8.17
22.710	1136.90	160.00	93000.00	1153.10	1153.91	12877.91	966.59	8.64
22.710	1136.90	160.00	160000.00	1158.53	1159.74	18334.01	1022.49	8.40
22.710	1136.90	160.00	215000.00	1162.09	1163.61	22019.03	1043.89	8.49
22.710	1136.90	160.00	250000.00	1164.43	1166.10	24483.02	1057.95	8.20

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
22.742	1137.10	180.00	93000.00	1153.27	1154.07	12980.89	952.01	8.51
22.742	1137.10	180.00	160000.00	1158.69	1159.89	18341.60	1007.82	8.34
22.742	1137.10	180.00	215000.00	1162.24	1163.76	21966.76	1029.18	8.47
22.742	1137.10	180.00	250000.00	1164.58	1166.25	24389.64	1043.20	8.21
22.775	1137.30	180.00	93000.00	1153.44	1154.22	13178.54	966.80	8.26
22.775	1137.30	180.00	160000.00	1158.88	1160.04	18631.55	1022.68	8.08
22.775	1137.30	180.00	215000.00	1162.44	1163.92	22315.98	1044.07	8.20
22.775	1137.30	180.00	250000.00	1164.78	1166.40	24769.82	1058.08	7.95
22.808	1137.50	180.00	93000.00	1153.63	1154.37	13509.88	990.63	7.86
22.808	1137.50	180.00	160000.00	1159.08	1160.19	19111.79	1046.63	7.66
22.808	1137.50	180.00	215000.00	1162.67	1164.07	22903.64	1068.14	7.76
22.808	1137.50	180.00	250000.00	1165.01	1166.55	25416.84	1082.17	7.53
22.841	1137.70	182.00	93000.00	1153.81	1154.51	13857.93	1016.32	7.48
22.841	1137.70	182.00	160000.00	1159.28	1160.33	19618.45	1072.43	7.26
22.841	1137.70	182.00	215000.00	1162.89	1164.21	23525.14	1094.07	7.34
22.841	1137.70	182.00	250000.00	1165.23	1166.69	26102.48	1108.12	7.12
22.874	1137.90	180.00	93000.00	1153.99	1154.65	14341.62	1051.09	6.98
22.874	1137.90	180.00	160000.00	1159.49	1160.46	20317.33	1107.34	6.76
22.874	1137.90	180.00	215000.00	1163.12	1164.35	24375.69	1129.12	6.81
22.874	1137.90	180.00	250000.00	1165.46	1166.82	27042.59	1143.20	6.61
22.907	1138.10	180.00	93000.00	1154.16	1154.77	14820.44	1086.78	6.55
22.907	1138.10	180.00	160000.00	1159.68	1160.59	21014.52	1143.15	6.31
22.907	1138.10	180.00	215000.00	1163.33	1164.47	25227.16	1165.05	6.34
22.907	1138.10	180.00	250000.00	1165.68	1166.94	27985.03	1179.17	6.15
22.940	1138.40	182.00	93000.00	1154.32	1154.89	15406.86	1133.42	6.09
22.940	1138.40	182.00	160000.00	1159.86	1160.71	21885.33	1189.94	5.83
22.940	1138.40	182.00	215000.00	1163.54	1164.59	26296.41	1211.98	5.83
22.940	1138.40	182.00	250000.00	1165.90	1167.06	29173.97	1226.14	5.65
22.973	1138.60	180.00	93000.00	1154.50	1155.00	16319.38	1199.13	5.43
22.973	1138.60	180.00	160000.00	1160.07	1160.81	23198.21	1255.83	5.17
22.973	1138.60	180.00	215000.00	1163.77	1164.71	27885.77	1278.03	5.16
22.973	1138.60	180.00	250000.00	1166.14	1167.17	30931.85	1292.25	5.00
23.005	1138.81	178.00	93000.00	1154.64	1155.10	17055.18	1255.70	4.99
23.005	1138.81	178.00	160000.00	1160.23	1160.91	24272.67	1311.39	4.72
23.005	1138.81	178.00	215000.00	1163.95	1164.80	29188.58	1332.38	4.70
23.005	1138.81	178.00	250000.00	1166.32	1167.26	32371.52	1345.79	4.56

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
23.038	1139.00	178.00	93000.00	1154.75	1155.19	17527.95	1272.96	4.75
23.038	1139.00	178.00	160000.00	1160.35	1160.99	24963.78	1359.13	4.50
23.038	1139.00	178.00	215000.00	1164.08	1164.89	30078.25	1381.52	4.46
23.038	1139.00	178.00	250000.00	1166.46	1167.35	33384.13	1395.81	4.31
23.070	1139.23	178.00	93000.00	1154.88	1155.27	18454.18	1345.58	4.26
23.070	1139.23	178.00	160000.00	1160.49	1161.08	26241.28	1407.28	4.02
23.070	1139.23	178.00	215000.00	1164.24	1164.97	31553.00	1428.69	4.00
23.070	1139.23	178.00	250000.00	1166.62	1167.43	34976.17	1442.32	3.88
23.109	1139.44	212.00	93000.00	1154.96	1155.37	18241.61	1350.59	4.48
23.109	1139.44	212.00	160000.00	1160.58	1161.16	26297.77	1468.05	4.13
23.109	1139.44	212.00	215000.00	1164.33	1165.06	31837.89	1490.54	4.04
23.109	1139.44	212.00	250000.00	1166.72	1167.51	35413.79	1504.88	3.89
23.153	1139.65	245.00	93000.00	1155.14	1155.47	19961.49	1479.16	3.75
23.153	1139.65	245.00	160000.00	1160.77	1161.26	28476.20	1520.15	3.48
23.153	1139.65	245.00	215000.00	1164.54	1165.16	34227.19	1531.45	3.44
23.153	1139.65	245.00	250000.00	1166.93	1167.61	37896.89	1538.62	3.34
23.200	1139.86	255.00	93000.00	1155.11	1155.66	15615.18	1149.24	6.17
23.200	1139.86	255.00	160000.00	1160.66	1161.47	22163.45	1189.24	5.83
23.200	1139.86	255.00	215000.00	1164.37	1165.39	26594.72	1200.40	5.83
23.200	1139.86	255.00	250000.00	1166.73	1167.86	29432.06	1207.50	5.67
23.252	1140.00	285.00	93000.00	1155.16	1155.93	13199.68	1009.82	8.99
23.252	1140.00	285.00	160000.00	1160.65	1161.76	19031.96	1089.28	8.22
23.252	1140.00	285.00	215000.00	1164.32	1165.69	23069.54	1111.30	8.01
23.252	1140.00	285.00	250000.00	1166.65	1168.16	25680.87	1125.31	7.69
23.293	1140.20	230.00	93000.00	1155.32	1156.18	12493.33	958.46	10.07
23.293	1140.20	230.00	160000.00	1160.75	1162.00	17981.11	1037.57	9.28
23.293	1140.20	230.00	215000.00	1164.40	1165.94	21800.22	1059.43	9.05
23.293	1140.20	230.00	250000.00	1166.71	1168.40	24270.64	1073.33	8.69
23.334	1140.40	225.00	93000.00	1155.55	1156.41	12560.35	962.44	9.95
23.334	1140.40	225.00	160000.00	1160.97	1162.21	18003.60	1032.12	9.24
23.334	1140.40	225.00	215000.00	1164.60	1166.14	21795.78	1053.94	9.03
23.334	1140.40	225.00	250000.00	1166.91	1168.59	24243.84	1067.78	8.69
23.375	1140.70	225.00	93000.00	1155.88	1156.63	13412.04	1020.55	8.64
23.375	1140.70	225.00	160000.00	1161.32	1162.42	19147.77	1076.51	8.04
23.375	1140.70	225.00	215000.00	1164.99	1166.35	23130.56	1098.48	7.89
23.375	1140.70	225.00	250000.00	1167.30	1168.79	25685.88	1112.35	7.62

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

	Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
	23.417	1140.90	228.00	93000.00	1155.87	1156.97	11057.37	860.94	13.12
	23.417	1140.90	228.00	160000.00	1161.19	1162.80	15804.16	916.15	12.43
	23.417	1140.90	228.00	215000.00	1164.77	1166.76	19122.29	937.63	12.27
	23.417	1140.90	228.00	250000.00	1167.04	1169.21	21263.52	951.24	11.87
	23.456	1141.10	212.00	93000.00	1156.13	1157.26	10884.52	845.17	13.50
	23.456	1141.10	212.00	160000.00	1161.42	1163.08	15511.08	900.13	12.92
	23.456	1141.10	212.00	215000.00	1164.99	1167.04	18768.59	921.59	12.75
	23.456	1141.10	212.00	250000.00	1167.24	1169.49	20866.83	935.15	12.35
	23.492	1141.30	200.00	93000.00	1156.48	1157.53	11310.98	868.01	12.30
	23.492	1141.30	200.00	160000.00	1161.80	1163.34	16094.99	923.19	11.82
	23.492	1141.30	200.00	215000.00	1165.39	1167.30	19446.60	944.72	11.72
	23.492	1141.30	200.00	250000.00	1167.64	1169.75	21591.74	958.25	11.39
	23.529	1141.50	202.00	93000.00	1156.87	1157.77	12237.98	924.15	10.28
	23.529	1141.50	202.00	160000.00	1162.26	1163.58	17391.01	979.73	9.90
	23.529	1141.50	202.00	215000.00	1165.90	1167.55	21001.29	1001.60	9.82
	23.529	1141.50	202.00	250000.00	1168.18	1169.99	23294.49	1015.24	9.56
	23.566	1141.70	205.00	93000.00	1157.20	1157.98	13114.83	979.83	8.82
	23.566	1141.70	205.00	160000.00	1162.63	1163.79	18623.11	1035.72	8.50
	23.566	1141.70	205.00	215000.00	1166.32	1167.75	22482.84	1057.84	8.42
	23.566	1141.70	205.00	250000.00	1168.61	1170.19	24921.73	1071.58	8.21
	23.601	1141.90	190.00	93000.00	1157.41	1158.15	13515.77	1007.90	8.29
	23.601	1141.90	190.00	160000.00	1162.86	1163.95	19197.25	1063.90	7.96
	23.601	1141.90	190.00	215000.00	1166.57	1167.92	23179.48	1086.13	7.88
	23.601	1141.90	190.00	250000.00	1168.86	1170.35	25688.94	1099.90	7.69
	23.610	1142.00	50.00	93000.00	1157.43	1158.20	13261.32	992.99	8.66
	23.610	1142.00	50.00	160000.00	1162.88	1164.00	18848.96	1048.68	8.30
	23.610	1142.00	50.00	215000.00	1166.57	1167.97	22767.86	1070.86	8.21
	23.610	1142.00	50.00	250000.00	1168.87	1170.41	25238.30	1084.62	8.01
*	23.611	1147.00	8.00	93000.00	1156.35	1158.68	7589.34	989.19	55.20
*	23.611	1147.00	8.00	160000.00	1162.14	1164.33	13497.84	1047.24	25.26
*	23.611	1147.00	8.00	215000.00	1165.90	1168.27	17479.44	1069.80	19.85
*	23.611	1147.00	8.00	250000.00	1168.24	1170.69	19990.84	1083.80	17.46
	23.639	1147.10	152.00	93000.00	1157.52	1159.42	8413.87	972.26	38.27
	23.639	1147.10	152.00	160000.00	1162.50	1164.73	13414.78	1025.44	25.06
	23.639	1147.10	152.00	215000.00	1166.15	1168.60	17200.68	1047.35	20.35
	23.639	1147.10	152.00	250000.00	1168.44	1170.99	19600.26	1061.01	18.12

PROJECT TITLE : CITY OF TEMPE FILE NAME: RSSP2.HC2
PROJECT NUMBER : CHANNELIZED SALT RIVER CRSS CIVIL 11/09/1993

Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
23.651	1147.20	65.00	93000.00	1157.79	1159.67	8470.99	970.52	37.30
23.651	1147.20	65.00	160000.00	1162.65	1164.89	13360.47	1025.96	25.41
23.651	1147.20	65.00	215000.00	1166.27	1168.74	17112.48	1047.68	20.70
23.651	1147.20	65.00	250000.00	1168.54	1171.11	19504.63	1061.29	18.41
23.667	1147.31	90.00	93000.00	1158.46	1160.02	9283.11	998.35	28.60
23.667	1147.31	90.00	160000.00	1163.32	1165.28	14258.90	1038.14	20.92
23.667	1147.31	90.00	215000.00	1166.93	1169.15	18033.34	1053.46	17.61
23.667	1147.31	90.00	250000.00	1169.18	1171.53	20415.42	1063.02	15.93
23.676	1147.30	45.00	93000.00	1158.62	1160.15	9378.64	987.54	27.22
23.676	1147.30	45.00	160000.00	1163.42	1165.38	14290.61	1039.73	20.69
23.676	1147.30	45.00	215000.00	1167.01	1169.23	18063.03	1061.27	17.60
23.676	1147.30	45.00	250000.00	1169.26	1171.60	20457.55	1074.73	15.98
23.713	1147.55	200.00	93000.00	1159.44	1160.64	10572.00	1049.65	19.75
23.713	1147.55	200.00	160000.00	1164.14	1165.78	15670.22	1130.66	16.43
23.713	1147.55	200.00	215000.00	1167.72	1169.58	19844.38	1208.91	14.24
23.713	1147.55	200.00	250000.00	1169.98	1171.93	22623.81	1253.57	12.92
23.751	1147.70	200.00	93000.00	1159.80	1161.07	10270.46	1025.51	21.08
23.751	1147.70	200.00	160000.00	1164.41	1166.16	15140.29	1102.31	18.10
23.751	1147.70	200.00	215000.00	1167.94	1169.91	19302.30	1217.35	15.77
23.751	1147.70	200.00	250000.00	1170.18	1172.23	22054.97	1246.46	14.28

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 23.611, profile 1, conveyance change outside acceptable range.

Section 23.611, profile 2, conveyance change outside acceptable range.

Section 23.611, profile 3, conveyance change outside acceptable range.

Section 23.611, profile 4, conveyance change outside acceptable range.

4 Warning and status message(s) generated

END OF OUTPUT

Above Project Model
(File Name: SRBASE4P.DTA)

==========
B O S S H E C - 2 (tm)
==========

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Version : 3.00
Serial Number : 0010149.250

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PROGRAM ORIGIN :

Boss Hec-2 (tm) is an enhanced version of the U.S. Army Corps of Engineers Hydrologic Engineering Center HEC-2 program for water-surface profile computations. Program based upon the September 1990 version, updated on August 1991.

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PROJECT DESCRIPTION :

PROJECT TITLE : AUGUST 1982 ADOT TOPO BASE MAP
PROJECT NUMBER : SALT RIVER FLOOD INSURANCE STUDY
DESCRIPTION : HAYDEN ROAD TO COUNTRY CLUB ROAD
ENGINEER :
DATE OF RUN : 11/11/1993
TIME OF RUN : 3:14 pm

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	2	0	0	0.0	0	0.0	93000.0	1158.46	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	1	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

USER-DEFINED SUMMARY TABLES (J3) :

38 42 39 43 1 3 25 4 5

NC 0.045 0.045 0.035 0.1 0.3
Hayden Road Bridge U/S line
Hayden Road Bridge U/S line

X1	23.667	9	9973.0	11001.0	0.0	0.0	0.0	1.0	0.0	
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	1159.07	1171.79	
GR	1171.8	9896.0	1171.81	9911.0	1159.31	9948.0	1159.07	9973.0	1150.36	10000.0
GR	1147.3	10519.0	1150.35	10937.0	1171.79	11001.0	1171.79	11016.0		
X1	23.713	10	9430.0	10515.0	245.0	245.0	245.0	1.0	0.0	
X3	0	0.0	0.0	0.0	0.0	0.0	0.0	1159.27	1172.01	
GR	1170.0	9255.0	1168.0	9287.0	1166.0	9332.0	1164.0	9363.0	1162.0	9403.0
GR	1159.2	9430.0	1150.56	9456.0	1147.55	10000.0	1150.55	10451.0	1172.01	10515.0
X1	23.751	8	9385.0	10483.0	200.0	200.0	200.0	1.0	0.0	
X3	0	0.0	0.0	0.0	0.0	0.0	0.0	1159.47	1170.0	
GR	1172.0	9225.0	1166.0	9263.0	1164.0	9360.0	1159.47	9385.0	1150.76	9411.0
GR	1147.7	10000.0	1150.75	10343.0	1170.0	10483.0				
X1	23.797	21	9190.0	10790.0	415.0	125.0	245.0	1.0	0.0	
X3	10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
GR	1175.0	8295.0	1171.5	8760.0	1173.0	9190.0	1170.0	9450.0	1165.0	9470.0
GR	1160.0	9590.0	1155.0	9620.0	1154.0	9980.0	1152.0	10210.0	1155.0	10370.0
GR	1160.0	10520.0	1165.0	10640.0	1170.0	10715.0	1174.0	10790.0	1170.0	10850.0
GR	1170.0	11320.0	1171.0	11390.0	1170.0	11450.0	1170.0	11590.0	1171.0	11770.0
GR	1174.0	11880.0								
X1	23.997	25	9760.0	10610.0	1085.0	1040.0	1060.0	1.0	0.0	

```
GR   1180.0    8380.0    1181.0    8430.0    1180.0    8560.0    1179.0    8720.0    1180.0    9000.0
GR   1181.0    9070.0    1180.0    9130.0    1180.0    9430.0    1185.0    9455.0    1180.0    9490.0
GR   1175.0    9760.0    1170.0    9815.0    1155.0    9955.0    1154.0   10005.0    1154.0   10475.0
GR   1155.0   10475.0    1175.0   10525.0    1175.0   10610.0    1171.0   11230.0    1170.0   11460.0
GR   1168.0   11525.0    1170.0   11590.0    1175.0   11620.0    1173.5   11950.0    1175.0   12250.0

NC      0.05      0.05     0.035       0.0       0.0
X1    24.196        18    9675.0   10910.0     815.0    1045.0    1050.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1180.0    8155.0    1180.0    8340.0    1183.5    8530.0    1175.0    8580.0    1175.0    9545.0
GR   1178.5    9675.0    1175.0    9790.0    1155.0    9835.0    1155.0   10030.0    1160.0   10270.0
GR   1165.0   10350.0    1170.0   10440.0    1170.0   10600.0    1174.0   10910.0    1175.0   11140.0
GR   1177.0   11360.0    1178.0   11640.0    1180.0   12170.0

X1    24.396        13    9010.0   10665.0    1090.0    1040.0    1055.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1184.0    9010.0    1180.0    9150.0    1175.0    9270.0    1158.0    9430.0    1158.0   10200.0
GR   1165.0   10275.0    1165.0   10340.0    1170.0   10400.0    1175.0   10640.0    1179.0   10665.0
GR   1175.0   10710.0    1180.0   11050.0    1181.5   11470.0

QT         4   95000.0  163000.0  220000.0  250000.0
  Price Road Extension
Price Road Extension

X1    24.595        16    8985.0   11005.0    1025.0    1070.0    1052.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1185.0    8790.0    1180.0    8855.0    1180.0    8985.0    1175.0    9090.0    1175.0    9170.0
GR   1170.0    9245.0    1165.0    9300.0    1161.0    9340.0    1161.0    9970.0    1163.0   10030.0
GR   1161.0   10110.0    1161.0   10630.0    1170.0   10660.0    1175.0   11005.0    1180.0   11155.0
GR   1183.0   11300.0

X1    24.795        16    9770.0   11530.0    1060.0     630.0    1055.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1184.0    8890.0    1180.0    9095.0    1180.0    9740.0    1183.0    9755.0    1180.0    9770.0
GR   1165.0    9810.0    1165.0    9900.0    1171.6    9910.0    1165.0    9970.0    1164.0   10000.0
GR   1164.0   11045.0    1165.0   11105.0    1170.0   11120.0    1175.0   11510.0    1180.0   11530.0
GR   1184.0   11840.0

X1    24.995        28    9605.0   11850.0    1065.0    1135.0    1055.0       1.0       0.0
X3        10       0.0       0.0       0.0       0.0       0.0       0.0       0.0       0.0
GR   1186.0    8250.0    1184.0    8570.0    1184.0    8571.0    1184.0    8572.0    1184.0    8573.0
GR   1180.0    8705.0    1179.0    9605.0    1175.0    9630.0    1167.0    9650.0    1167.0    9745.0
GR   1170.0    9755.0    1170.0    9945.0    1167.0    9980.0    1167.0   10260.0    1170.0   10280.0
GR   1173.0   10350.0    1170.0   10385.0    1167.0   10395.0    1167.0   11060.0    1170.0   11070.0
GR   1170.0   11380.0    1171.0   11430.0    1169.0   11580.0    1170.0   11640.0    1175.0   11665.0
GR   1180.0   11850.0    1185.0   11860.0    1186.0   11940.0

X1    25.194        25    9330.0   12245.0    1070.0     870.0    1050.0       1.0       0.0
GR   1185.0    8895.0    1175.0    8910.0    1175.0    9270.0    1180.0    9300.0    1184.0    9330.0
GR   1180.0    9355.0    1175.0    9370.0    1175.0    9460.0    1178.0    9640.0    1175.0    9820.0
GR   1170.0    9890.0    1170.0   10250.0    1175.0   10385.0    1180.0   10400.0    1184.0   10435.0
GR   1180.0   10500.0    1175.0   10670.0    1177.0   10890.0    1180.0   11095.0    1180.0   11475.0
```

GR 1177.0 11650.0 1175.0 11920.0 1176.8 12115.0 1175.0 12215.0 1185.0 12245.0
STATUS: Analyzing profile 1.

Contraction Coefficient (CCHV) .100

Expansion Coefficient (CEHV) .300

STATUS: Analyzing cross-section reach 23.667.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1159.07
Right Overbank Elevation (ft, RBEL) 1171.79

Hayden Road Bridge U/S line

Cross Section Number SECNO	Left Overbank Manning XNL	Channel Manning n XNCH	Right Overbank Manning XNR	Flow Depth DEPTH (ft)	Water Surface Elevation CWSEL (ft MSL)	Critical W. S. Elevation CRIWS (ft MSL)	Known W. S. Elevation WSELK (ft MSL)
Energy Gradient SLOPE (ft/ft)	Left Overbank Length XLOBL (ft)	Channel Length XLCH (ft)	Right Overbank Length XLOBR (ft)	Energy Gradient Elevation EG (ft MSL)	Weighted Velocity Head HV (ft)	Friction Energy Loss HL (ft)	Other Energy Loss OLOSS (ft)
Cummul-ative Volume VOL (acre-ft)	Left Overbank Area ALOB (sq ft)	Channel Area ACH (sq ft)	Right Overbank Area AROB (sq ft)	Bridge Deck Area CORAR (sq ft)	Left Bank Elevation LTBNK (ft MSL)	Right Bank Elevation RTBNK (ft MSL)	Number of Balance Trials ITRIAL
Total Flow Q (cfs)	Left Overbank Flow QLOB (cfs)	Channel Flow QCH (cfs)	Right Overbank Flow QROB (cfs)	Computed W. S. Top Width TOPWD (ft)	Left W. S. Station SSTA (ft)	Right W. S. Station ENDST (ft)	Number of Crit Dpth Trials IDC
Flow Travel Time TIME (hrs)	Left Overbank Velocity VLOB (ft/s)	Channel Mean Velocity VCH (ft/s)	Right Overbank Velocity VROB (ft/s)	Length Weighted Manning n WTN	Cummul. Surface Area TWA (acres)	Minimum C. S. Elevation ELMIN (ft MSL)	Number of Other Trials ICONT
23.667	.000	.035	.000	11.16	1158.46	.00	1158.46
.002871	0	0	0	1160.04	1.58	.00	.00
.00	0	9225	0	.00	1159.07	1171.79	0
93000	0	92999	0	986.3	9974.89	10961.21	0
.00	.00	10.08	.00	.000	.0	1147.30	0

STATUS: Analyzing cross-section reach 23.713.

23.713	.045	.035	.000	11.90	1159.45	.00	.00
.001965	245	245	245	1160.65	1.20	.58	.04
55.72	0	10589	0	.00	1159.20	1172.01	2
93000	0	92999	0	1050.0	9427.53	10477.56	0
.01	.37	8.78	.00	.000	5.7	1147.55	0

STATUS: Analyzing cross-section reach 23.751.

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.751	.045	.035	.000	12.11	1159.81	.00	.00
.002099	200	200	200	1161.08	1.27	.41	.02
103.64	0	10283	0	.00	1159.47	1170.00	2
93000	0	92999	0	1025.8	9383.12	10408.90	0
.01	.46	9.04	.00	.000	10.5	1147.70	0

STATUS: Analyzing cross-section reach 23.797.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3685) 20 trials attempted in balancing assumed water surface elevation (WSEL) and computed water surface elevation (CWSEL).

WARNING: (3693) It is probable that critical depth has been crossed.

WARNING: (3720) Critical depth has been assumed.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1173.00
Right Overbank Elevation (ft, RBEL) 1174.00

23.797	.000	.035	.000	9.38	1161.38	1161.38	.00
.009785	415	245	125	1164.65	3.27	.96	.60
150.58	0	6405	0	.00	1173.00	1174.00	20
93000	0	93000	0	996.1	9556.97	10553.03	15
.02	.00	14.52	.00	.000	16.2	1152.00	0

STATUS: Analyzing cross-section reach 23.997.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 1.89

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.997	.000	.035	.000	13.65	1167.65	.00	.00
.002740	1085	1060	1040	1169.74	2.09	4.97	.12
326.15	0	8024	0	.00	1175.00	1175.00	3
93000	0	93000	0	669.8	9836.87	10506.64	0
.04	.00	11.59	.00	.000	36.5	1154.00	0

STATUS: Analyzing cross-section reach 24.196.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1178.50
Right Overbank Elevation (ft, RBEL) 1174.00

24.196	.000	.035	.000	16.11	1171.11	.00	.00
.004120	815	1050	1045	1173.24	2.13	3.49	.01
518.55	0	7939	0	.00	1178.50	1174.00	4
93000	0	93000	0	887.3	9798.75	10686.09	0
.07	.00	11.71	.00	.000	55.2	1155.00	0

STATUS: Analyzing cross-section reach 24.396.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 2.52

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1184.00
Right Overbank Elevation (ft, RBEL) 1179.00

24.396	.000	.035	.000	16.30	1174.30	.00	.00
.000651	1090	1055	1040	1174.81	.51	1.41	.16
811.06	0	16215	0	.00	1184.00	1179.00	2
93000	0	93000	0	1329.7	9276.60	10606.32	0
.12	.00	5.74	.00	.000	82.1	1158.00	0

STATUS: Analyzing cross-section reach 24.595.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1180.00
Right Overbank Elevation (ft, RBEL) 1175.00

Price Road Extension

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
24.595	.000	.035	.050	14.10	1175.10	.00	.00
.000520	1025	1052	1070	1175.44	.34	.61	.02
1252.41	0	20334	0	.00	1180.00	1175.00	2
95000	0	94999	0	1920.0	9087.95	11007.92	0
.18	.00	4.67	.09	.000	121.3	1161.00	0

STATUS: Analyzing cross-section reach 24.795.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1180.00
Right Overbank Elevation (ft, RBEL) 1180.00

24.795	.000	.035	.000	11.69	1175.69	.00	.00
.000966	1060	1055	630	1176.22	.53	.73	.06
1695.16	0	16226	0	.00	1180.00	1180.00	2
95000	0	95000	0	1731.3	9781.49	11512.77	0
.23	.00	5.85	.00	.000	165.5	1164.00	0

STATUS: Analyzing cross-section reach 24.995.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1179.00
Right Overbank Elevation (ft, RBEL) 1180.00

24.995	.000	.035	.000	9.82	1176.82	.00	.00
.001085	1065	1055	1135	1177.31	.49	1.08	.00
2097.12	0	16966	0	.00	1179.00	1180.00	2
95000	0	95000	0	2113.8	9618.61	11732.41	0
.28	.00	5.60	.00	.000	212.1	1167.00	0

STATUS: Analyzing cross-section reach 25.194.

STATUS: (3265) Divided flow.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .31

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
25.194	.050	.035	.000	8.64	1178.64	.00	.00
.010937	1070	1050	870	1180.30	1.66	2.64	.35
2414.90	1358	8015	0	.00	1184.00	1185.00	4
95000	9842	85157	0	2550.8	8904.55	12225.91	0
.31	7.25	10.62	.00	.000	268.4	1170.00	0

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	3	0	0	0.0	0	0.0	160000.0	1163.32	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	2	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

STATUS: Analyzing profile 2.

Contraction Coefficient (CCHV) .100

Expansion Coefficient (CEHV) .300

STATUS: Analyzing cross-section reach 23.667.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1159.07
Right Overbank Elevation (ft, RBEL) 1171.79

Hayden Road Bridge U/S line

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.667	.045	.035	.000	16.02	1163.32	.00	1163.32
.002121	0	0	0	1165.31	1.99	.00	.00
.00	127	14062	0	.00	1159.07	1171.79	0
160000	459	159540	0	1039.6	9936.13	10975.72	0
.00	3.62	11.35	.00	.000	.0	1147.30	0

STATUS: Analyzing cross-section reach 23.713.

23.713	.045	.035	.000	16.62	1164.17	.00	.00
.001633	245	245	245	1165.80	1.63	.45	.04
84.08	143	15565	0	.00	1159.20	1172.01	2
160000	370	159629	0	1131.4	9360.28	10491.63	0
.01	2.57	10.26	.00	.000	6.1	1147.55	0

STATUS: Analyzing cross-section reach 23.751.

23.751	.045	.035	.000	16.74	1164.44	.00	.00
.001798	200	200	200	1166.18	1.74	.34	.03
154.98	72	15103	0	.00	1159.47	1170.00	2
160000	184	159815	0	1104.0	9338.57	10442.58	0
.01	2.55	10.58	.00	.000	11.2	1147.70	0

STATUS: Analyzing cross-section reach 23.797.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3685) 20 trials attempted in balancing assumed water surface elevation (WSEL) and computed water surface elevation (CWSEL).

WARNING: (3693) It is probable that critical depth has been crossed.

WARNING: (3720) Critical depth has been assumed.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL)	1173.00
Right Overbank Elevation (ft, RBEL)	1174.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.797	.000	.035	.000	12.40	1164.40	1164.40	.00
.008891	415	245	125	1168.68	4.28	.84	.76
224.91	0	9639	0	.00	1173.00	1174.00	20
160000	0	160000	0	1141.3	9484.33	10625.67	19
.02	.00	16.60	.00	.000	17.6	1152.00	0

STATUS: Analyzing cross-section reach 23.997.

STATUS: (3265) Divided flow.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 1.53

23.997	.000	.035	.045	16.93	1170.93	.00	.00
.003798	1085	1060	1040	1174.63	3.70	5.89	.06
471.51	0	10280	353	.00	1175.00	1175.00	2
160000	0	159083	916	1059.6	9804.77	11595.58	0
.04	.00	15.47	2.60	.000	44.3	1154.00	0

STATUS: Analyzing cross-section reach 24.196.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1178.50
Right Overbank Elevation (ft, RBEL) 1174.00

24.196	.000	.035	.050	21.15	1176.15	.00	.00
.003097	815	1050	1045	1178.37	2.22	3.59	.15
765.09	0	13273	455	.00	1178.50	1174.00	2
160000	0	159031	968	1515.4	9751.95	11267.38	0
.06	.00	11.98	2.13	.000	75.3	1155.00	0

STATUS: Analyzing cross-section reach 24.396.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 2.12

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1184.00
Right Overbank Elevation (ft, RBEL) 1179.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
24.396	.000	.035	.050	21.12	1179.12	.00	.00
.000688	1090	1055	1040	1179.86	.74	1.34	.15
1218.59	0	23063	672	.00	1184.00	1179.00	2
160000	0	159149	850	1819.1	9171.11	10990.18	0
.10	.00	6.90	1.27	.000	115.6	1158.00	0

STATUS: Analyzing cross-section reach 24.595.

24.595	.050	.035	.050	19.01	1180.01	.00	.00
.000447	1025	1052	1070	1180.46	.45	.58	.03
1872.21	0	29997	375	.00	1180.00	1175.00	2
163000	0	162564	435	2300.4	8854.92	11155.30	0
.16	.02	5.42	1.16	.000	165.4	1161.00	0

STATUS: Analyzing cross-section reach 24.795.

STATUS: (3265) Divided flow.

24.795	.050	.035	.050	16.44	1180.44	.00	.00
.000734	1060	1055	630	1181.12	.68	.59	.07
2538.71	289	24519	7	.00	1180.00	1180.00	2
163000	133	162864	2	2466.0	9072.48	11564.05	0
.20	.46	6.64	.29	.000	222.3	1164.00	0

STATUS: Analyzing cross-section reach 24.995.

24.995	.050	.035	.050	14.36	1181.36	.00	.00
.000722	1065	1055	1135	1181.91	.55	.77	.01
3186.45	1702	26949	1	.00	1179.00	1180.00	2
163000	2036	160961	1	3192.5	8660.18	11852.72	0
.25	1.20	5.97	.57	.000	291.0	1167.00	0

STATUS: Analyzing cross-section reach 25.194.

STATUS: (3265) Divided flow.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .48

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
25.194	.050	.035	.000	12.45	1182.45	.00	.00
.003094	1070	1050	870	1183.41	.96	1.38	.12
3785.02	2894	18027	0	.00	1184.00	1185.00	2
163000	17810	145189	0	3278.5	8898.82	12237.35	0
.29	6.15	8.05	.00	.000	369.3	1170.00	0

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	4	0	0	0.0	0	0.0	215000.0	1166.93	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	3	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

STATUS: Analyzing profile 3.

Contraction Coefficient (CCHV) .100

Expansion Coefficient (CEHV) .300

STATUS: Analyzing cross-section reach 23.667.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1159.07
Right Overbank Elevation (ft, RBEL) 1171.79

Hayden Road Bridge U/S line

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.667	.045	.035	.000	19.63	1166.93	.00	1166.93
.001793	0	0	0	1169.18	2.25	.00	.00
.00	279	17701	0	.00	1159.07	1171.79	0
215000	1341	213658	0	1061.0	9925.44	10986.49	0
.00	4.80	12.07	.00	.000	.0	1147.30	0

STATUS: Analyzing cross-section reach 23.713.

23.713	.045	.035	.000	20.19	1167.74	.00	.00
.001424	245	245	245	1169.61	1.87	.39	.04
106.46	501	19372	0	.00	1159.20	1172.01	2
215000	1802	213197	0	1209.5	9292.76	10502.28	0
.01	3.59	11.00	.00	.000	6.4	1147.55	0

STATUS: Analyzing cross-section reach 23.751.

23.751	.045	.035	.000	20.27	1167.97	.00	.00
.001576	200	200	200	1169.94	1.97	.30	.03
196.47	455	18876	0	.00	1159.47	1170.00	2
215000	1478	213521	0	1217.7	9250.55	10468.21	0
.01	3.24	11.31	.00	.000	12.0	1147.70	0

STATUS: Analyzing cross-section reach 23.797.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .47

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1173.00
Right Overbank Elevation (ft, RBEL) 1174.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.797	.000	.035	.000	14.89	1166.89	.00	.00
.007094	415	245	125	1171.42	4.53	.72	.77
287.13	0	12592	0	.00	1173.00	1174.00	3
215000	0	215000	0	1206.2	9462.38	10668.57	0
.02	.00	17.07	.00	.000	19.0	1152.00	0

STATUS: Analyzing cross-section reach 23.997.

STATUS: (3265) Divided flow.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

23.997	.000	.035	.045	18.61	1172.61	1171.33	.00
.004764	1085	1060	1040	1177.69	5.08	6.10	.17
594.34	0	11498	1180	.00	1175.00	1175.00	4
215000	0	210187	4812	1359.2	9786.21	11605.70	11
.03	.00	18.28	4.08	.000	50.1	1154.00	0

STATUS: Analyzing cross-section reach 24.196.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 1.53

24.196	.050	.035	.050	24.42	1179.42	.00	.00
.002037	815	1050	1045	1181.13	1.71	3.10	.34
1030.37	4667	17209	2685	.00	1178.50	1174.00	3
215000	16420	190508	8071	3461.6	8554.01	12015.63	0
.06	3.52	11.07	3.00	.000	105.1	1155.00	0

STATUS: Analyzing cross-section reach 24.396.

STATUS: (3280) For cross-section 24.40, ends have been extended vertically .02 feet in order to calculate the hydraulic cross-section properties.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 1.60

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1184.00
Right Overbank Elevation (ft, RBEL) 1179.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
24.396	.000	.035	.050	23.51	1181.51	.00	.00
.000793	1090	1055	1040	1182.47	.96	1.27	.07
1675.46	0	26726	1891	.00	1184.00	1179.00	2
215000	0	211422	3577	2373.1	9096.89	11470.00	0
.10	.00	7.91	1.89	.000	175.9	1158.00	0

STATUS: Analyzing cross-section reach 24.595.

24.595	.050	.035	.050	21.55	1182.55	.00	.00
.000475	1025	1052	1070	1183.14	.59	.63	.04
2461.25	373	35130	913	.00	1180.00	1175.00	2
220000	431	218006	1561	2456.2	8821.89	11278.11	0
.14	1.16	6.21	1.71	.000	234.4	1161.00	0

STATUS: Analyzing cross-section reach 24.795.

STATUS: (3265) Divided flow.

24.795	.050	.035	.050	18.98	1182.98	.00	.00
.000738	1060	1055	630	1183.83	.85	.62	.08
3278.22	2197	28999	345	.00	1180.00	1180.00	2
220000	3509	216126	363	2819.1	8942.04	11761.30	0
.18	1.60	7.45	1.05	.000	295.8	1164.00	0

STATUS: Analyzing cross-section reach 24.995.

24.995	.050	.035	.050	16.96	1183.96	.00	.00
.000647	1065	1055	1135	1184.58	.62	.73	.02
4110.32	4273	32792	15	.00	1179.00	1180.00	2
220000	8537	211445	17	3283.6	8574.28	11857.92	0
.23	2.00	6.45	1.11	.000	370.2	1167.00	0

STATUS: Analyzing cross-section reach 25.194.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .57

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
25.194	.050	.035	.000	14.85	1184.85	.00	.00
.001968	1070	1050	870	1185.77	.92	1.10	.09
4907.55	3926	24984	0	.00	1184.00	1185.00	2
220000	23060	196939	0	3349.3	8895.22	12244.56	0
.27	5.87	7.88	.00	.000	450.4	1170.00	0

T1 SALT RIVER FLOOD INSURANCE STUDY
T2 AUGUST 1982 ADOT TOPO BASE MAP
T3 HAYDEN ROAD TO COUNTRY CLUB ROAD

JOB PARAMETERS :

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
	0	5	0	0	0.0	0	0.0	250000.0	1169.18	

J2	NPROF	IPLOT	PRFVS	XSECV	XSECH	FN	ALLDC	IBW	CHNIM	ITRACE
	15	1	0.0	0.0	0.0	0.0	0.0	-6.0	0.0	

STATUS: Analyzing profile 4.

Contraction Coefficient (CCHV) .100

Expansion Coefficient (CEHV) .300

STATUS: Analyzing cross-section reach 23.667.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1159.07
Right Overbank Elevation (ft, RBEL) 1171.79

Hayden Road Bridge U/S line

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.667	.045	.035	.000	21.88	1169.18	.00	1169.18
.001625	0	0	0	1171.55	2.37	.00	.00
.00	393	19989	0	.00	1159.07	1171.79	0
250000	2078	247921	0	1074.4	9918.79	10993.21	0
.00	5.28	12.40	.00	.000	.0	1147.30	0

STATUS: Analyzing cross-section reach 23.713.

23.713	.045	.035	.000	22.43	1169.98	.00	.00
.001300	245	245	245	1171.95	1.97	.35	.04
120.98	853	21782	0	.00	1159.20	1172.01	2
250000	3456	246543	0	1253.7	9255.25	10508.96	0
.01	4.05	11.32	.00	.000	6.5	1147.55	0

STATUS: Analyzing cross-section reach 23.751.

STATUS: (3280) For cross-section 23.75, ends have been extended vertically .19 feet in order to calculate the hydraulic cross-section properties.

23.751	.045	.035	.000	22.49	1170.19	.00	.00
.001435	200	200	200	1172.25	2.06	.27	.03
223.61	769	21298	0	.00	1159.47	1170.00	2
250000	3083	246916	0	1246.5	9236.49	10483.00	0
.01	4.01	11.59	.00	.000	12.3	1147.70	0

STATUS: Analyzing cross-section reach 23.797.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .55

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1173.00
Right Overbank Elevation (ft, RBEL) 1174.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
23.797	.000	.035	.000	17.49	1169.49	.00	.00
.004773	415	245	125	1173.39	3.90	.59	.55
331.54	0	15777	0	.00	1173.00	1174.00	3
250000	0	250000	0	1255.3	9452.03	10707.38	0
.02	.00	15.85	.00	.000	19.6	1152.00	0

STATUS: Analyzing cross-section reach 23.997.

STATUS: (3265) Divided flow.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

23.997	.000	.035	.045	19.41	1173.41	1173.26	.00
.005441	1085	1060	1040	1179.42	6.01	5.39	.63
691.10	0	12081	1725	.00	1175.00	1175.00	4
250000	0	241572	8427	1497.1	9777.52	11610.45	11
.03	.00	20.00	4.88	.000	52.9	1154.00	0

STATUS: Analyzing cross-section reach 24.196.

STATUS: (3265) Divided flow.

STATUS: (3280) For cross-section 24.20, ends have been extended vertically 1.17 feet in order to calculate the hydraulic cross-section properties.

STATUS: (3301) The velocity head difference for current and previous cross-sections exceeded the allowable specified by HVINS.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) 1.83

24.196	.050	.035	.050	26.18	1181.18	.00	.00
.001630	815	1050	1045	1182.69	1.52	2.82	.45
1213.68	6897	19376	4852	.00	1178.50	1174.00	3
250000	26508	207631	15860	3875.0	8155.00	12170.00	0
.06	3.84	10.72	9.27	.000	113.8	1155.00	0

STATUS: Analyzing cross-section reach 24.396.

STATUS: (3280) For cross-section 24.40, ends have been extended vertically 1.37 feet in order to calculate the hydraulic cross-section properties.

STATUS: (3495) Overbank area assumed noneffective.

Left Overbank Elevation (ft, XLBEL) 1184.00
Right Overbank Elevation (ft, RBEL) 1179.00

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
24.396	.000	.035	.050	24.87	1182.87	.00	.00
.000843	1090	1055	1040	1183.94	1.07	1.20	.04
1977.82	0	28877	2979	.00	1184.00	1179.00	3
250000	0	243168	6831	2420.4	9049.60	11470.00	0
.10	.00	8.42	2.29	.000	190.3	1158.00	0

STATUS: Analyzing cross-section reach 24.595.

STATUS: (3280) For cross-section 24.59, ends have been extended vertically .99 feet in order to calculate the hydraulic cross-section properties.

24.595	.050	.035	.050	22.99	1183.99	.00	.00
.000466	1025	1052	1070	1184.63	.64	.64	.04
2846.10	621	38036	1333	.00	1180.00	1175.00	2
250000	939	246468	2591	2496.8	8803.18	11300.00	0
.14	1.51	6.48	1.94	.000	249.8	1161.00	0

STATUS: Analyzing cross-section reach 24.795.

STATUS: (3280) For cross-section 24.80, ends have been extended vertically .41 feet in order to calculate the hydraulic cross-section properties.

24.795	.050	.035	.050	20.41	1184.41	.00	.00
.000703	1060	1055	630	1185.30	.89	.60	.07
3752.52	3424	31506	746	.00	1180.00	1180.00	2
250000	6861	242082	1056	2950.0	8890.00	11840.00	0
.18	2.00	7.68	1.41	.000	312.9	1164.00	0

STATUS: Analyzing cross-section reach 24.995.

SECNO	XNL	XNCH	XNR	DEPTH	CWSEL	CRIWS	WSELK
SLOPE	XLOBL	XLCH	XLOBR	EG	HV	HL	OLOSS
VOL	ALOB	ACH	AROB	CORAR	LTBNK	RTBNK	ITRIAL
Q	QLOB	QCH	QROB	TOPWD	SSTA	ENDST	IDC
TIME	VLOB	VCH	VROB	WTN	TWA	ELMIN	ICONT
24.995	.050	.035	.050	18.36	1185.36	.00	.00
.000597	1065	1055	1135	1186.01	.64	.68	.02
4693.20	5875	35944	33	.00	1179.00	1180.00	2
250000	13282	236676	40	3537.6	8351.62	11889.19	0
.23	2.26	6.58	1.18	.000	392.0	1167.00	0

STATUS: Analyzing cross-section reach 25.194.

STATUS: (3280) For cross-section 25.19, ends have been extended vertically 1.15 feet in order to calculate the hydraulic cross-section properties.

WARNING: (3302) Conveyance change is outside of acceptable range.

Upstream to Downstream Conveyance Ratio (KRATIO) .61

25.194	.050	.035	.000	16.15	1186.15	.00	.00
.001596	1070	1050	870	1187.05	.90	.97	.08
5600.82	4491	28770	0	.00	1184.00	1185.00	2
250000	25770	224229	0	3350.0	8895.00	12245.00	0
.27	5.74	7.79	.00	.000	475.3	1170.00	0

SPECIAL NOTE :

An asterisk (*) to the left of the cross-section number indicates a special note is present in the SUMMARY OF WARNING AND STATUS MESSAGES section.

SUMMARY PRINTOUT : AUGUST 1982 ADOT TOPO BASE MAP
HAYDEN ROAD TO COUNTRY CLUB ROAD
SALT RIVER FLOOD INSURANCE STUDY

	Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
	23.667	1147.30	.00	93000.00	1158.46	1160.04	9225.21	986.32	28.71
	23.667	1147.30	.00	160000.00	1163.32	1165.31	14189.61	1039.58	21.21
	23.667	1147.30	.00	215000.00	1166.93	1169.18	17981.36	1061.05	17.93
	23.667	1147.30	.00	250000.00	1169.18	1171.55	20383.77	1074.42	16.25
	23.713	1147.55	245.00	93000.00	1159.45	1160.65	10589.33	1050.04	19.65
	23.713	1147.55	245.00	160000.00	1164.17	1165.80	15709.32	1131.35	16.33
	23.713	1147.55	245.00	215000.00	1167.74	1169.61	19874.86	1209.51	14.24
	23.713	1147.55	245.00	250000.00	1169.98	1171.95	22635.60	1253.70	13.00
	23.751	1147.70	200.00	93000.00	1159.81	1161.08	10283.98	1025.78	20.99
	23.751	1147.70	200.00	160000.00	1164.44	1166.18	15175.83	1104.01	17.98
	23.751	1147.70	200.00	215000.00	1167.97	1169.94	19331.84	1217.66	15.76
	23.751	1147.70	200.00	250000.00	1170.19	1172.25	22068.12	1246.51	14.35
*	23.797	1152.00	245.00	93000.00	1161.38	1164.65	6405.46	996.06	97.85
*	23.797	1152.00	245.00	160000.00	1164.40	1168.68	9639.87	1141.34	88.91
*	23.797	1152.00	245.00	215000.00	1166.89	1171.42	12592.63	1206.18	70.94
*	23.797	1152.00	245.00	250000.00	1169.49	1173.39	15777.26	1255.35	47.73
*	23.997	1154.00	1060.00	93000.00	1167.65	1169.74	8024.48	669.77	27.40
*	23.997	1154.00	1060.00	160000.00	1170.93	1174.63	10633.91	1059.58	37.98
	23.997	1154.00	1060.00	215000.00	1172.61	1177.69	12678.73	1359.24	47.64
	23.997	1154.00	1060.00	250000.00	1173.41	1179.42	13807.22	1497.12	54.41
	24.196	1155.00	1050.00	93000.00	1171.11	1173.24	7939.61	887.34	41.20
	24.196	1155.00	1050.00	160000.00	1176.15	1178.37	13729.02	1515.42	30.97
*	24.196	1155.00	1050.00	215000.00	1179.42	1181.13	24562.36	3461.62	20.37
*	24.196	1155.00	1050.00	250000.00	1181.18	1182.69	31127.23	3874.97	16.30
*	24.396	1158.00	1055.00	93000.00	1174.30	1174.81	16215.36	1329.72	6.51

	Cross-Section Number SECNO	Minimum C. S. Elevation (ft MSL) ELMIN	Channel Reach Length (ft) XLCH	Discharge Flow (cfs) Q	Computed W. S. Elevation (ft MSL) CWSEL	Energy Gradient Elevation (ft MSL) EG	Cross-Section Area (sq ft) AREA	Water Surface Top Width (ft) TOPWID	Energy Gradient Slope * 10,000 10K*S
*	24.396	1158.00	1055.00	160000.00	1179.12	1179.86	23736.56	1819.06	6.88
*	24.396	1158.00	1055.00	215000.00	1181.51	1182.47	28618.01	2373.11	7.93
	24.396	1158.00	1055.00	250000.00	1182.87	1183.94	31856.49	2420.40	8.43
	24.595	1161.00	1052.00	95000.00	1175.10	1175.44	20334.29	1919.97	5.20
	24.595	1161.00	1052.00	163000.00	1180.01	1180.46	30374.32	2300.38	4.47
	24.595	1161.00	1052.00	220000.00	1182.55	1183.14	36417.33	2456.22	4.75
	24.595	1161.00	1052.00	250000.00	1183.99	1184.63	39991.14	2496.82	4.66
	24.795	1164.00	1055.00	95000.00	1175.69	1176.22	16226.95	1731.28	9.66
	24.795	1164.00	1055.00	163000.00	1180.44	1181.12	24816.48	2465.96	7.34
	24.795	1164.00	1055.00	220000.00	1182.98	1183.83	31542.15	2819.10	7.38
	24.795	1164.00	1055.00	250000.00	1184.41	1185.30	35678.22	2950.00	7.03
	24.995	1167.00	1055.00	95000.00	1176.82	1177.31	16966.59	2113.79	10.85
	24.995	1167.00	1055.00	163000.00	1181.36	1181.91	28653.67	3192.54	7.22
	24.995	1167.00	1055.00	220000.00	1183.96	1184.58	37082.50	3283.64	6.47
	24.995	1167.00	1055.00	250000.00	1185.36	1186.01	41853.77	3537.57	5.97
*	25.194	1170.00	1050.00	95000.00	1178.64	1180.30	9374.05	2550.84	109.37
*	25.194	1170.00	1050.00	163000.00	1182.45	1183.41	20922.91	3278.49	30.94
*	25.194	1170.00	1050.00	220000.00	1184.85	1185.77	28910.91	3349.34	19.68
*	25.194	1170.00	1050.00	250000.00	1186.15	1187.05	33261.12	3350.00	15.96

SUMMARY OF WARNING AND STATUS MESSAGES :

Section 23.797, profile 1, critical depth assumed.

Section 23.797, profile 1, probable minimum specific energy.

Section 23.797, profile 1, 20 trials attempted to balance water surface elevation.

Section 23.797, profile 2, critical depth assumed.

Section 23.797, profile 2, probable minimum specific energy.

Section 23.797, profile 2, 20 trials attempted to balance water surface elevation.

Section 23.797, profile 3, conveyance change outside acceptable range.

Section 23.797, profile 4, conveyance change outside acceptable range.

Section 23.997, profile 1, conveyance change outside acceptable range.

Section 23.997, profile 2, conveyance change outside acceptable range.

Section 24.196, profile 3, conveyance change outside acceptable range.

Section 24.196, profile 4, conveyance change outside acceptable range.

Section 24.396, profile 1, conveyance change outside acceptable range.

Section 24.396, profile 2, conveyance change outside acceptable range.

Section 24.396, profile 3, conveyance change outside acceptable range.

Section 25.194, profile 1, conveyance change outside acceptable range.

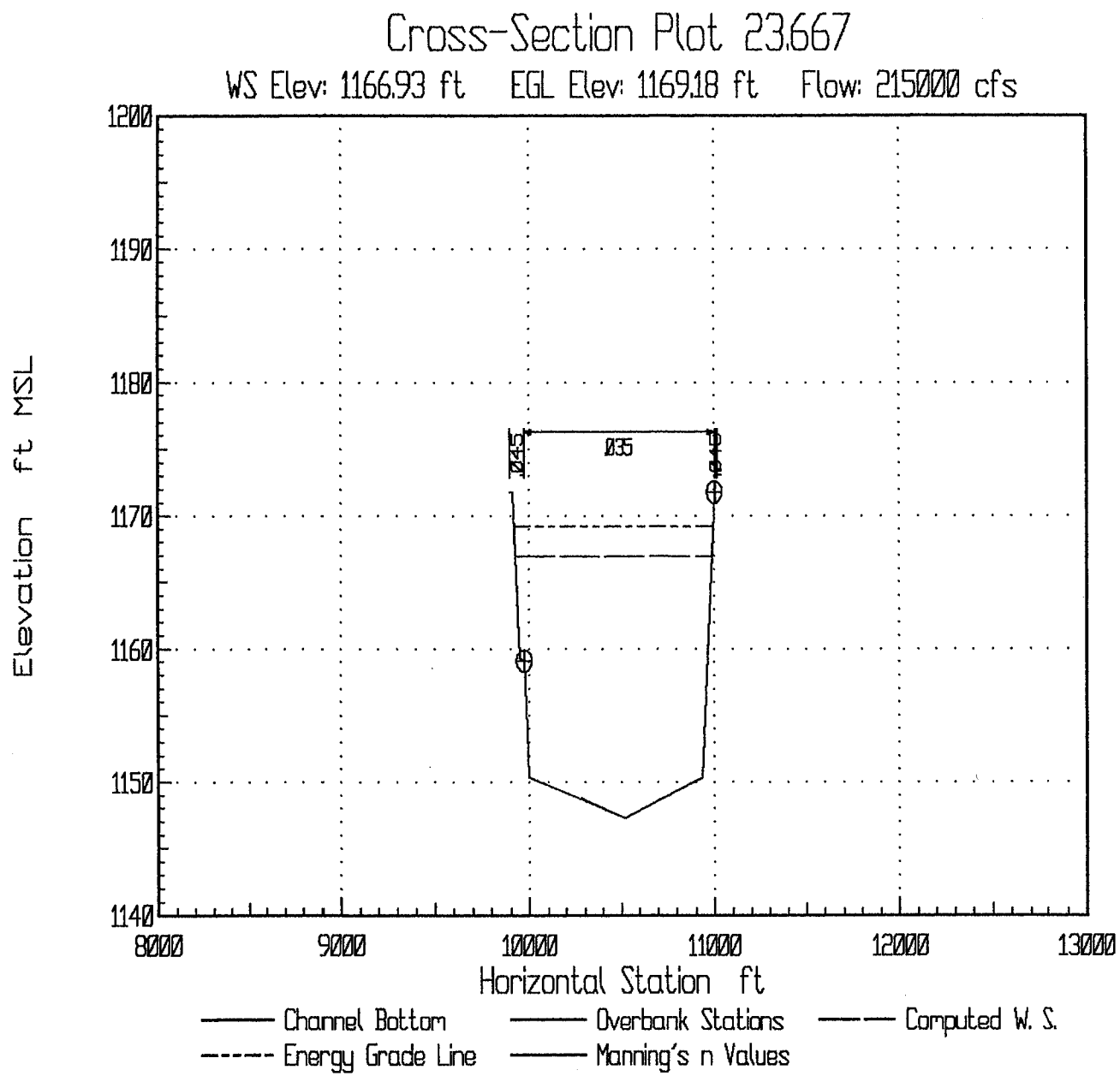
Section 25.194, profile 2, conveyance change outside acceptable range.

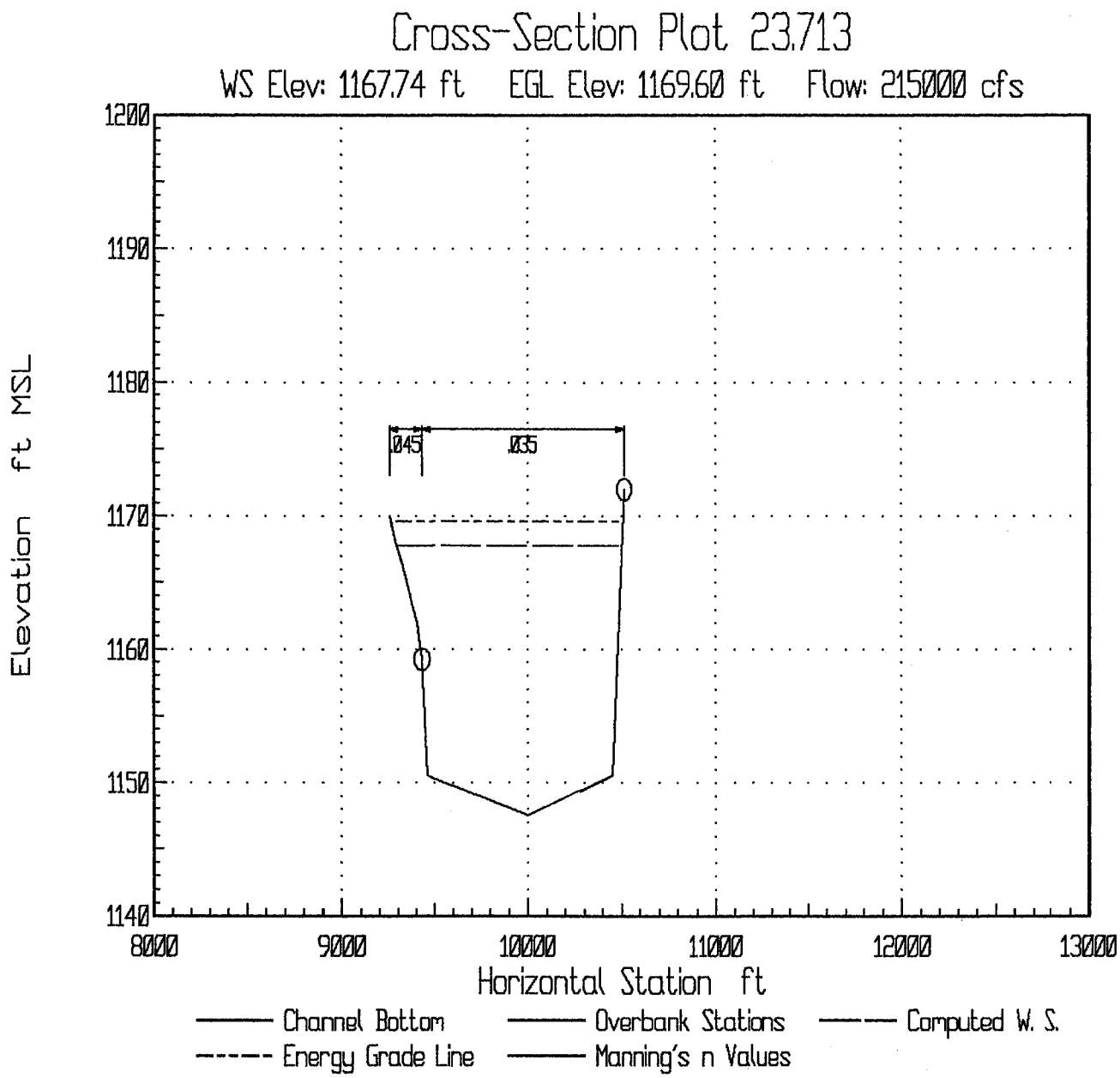
Section 25.194, profile 3, conveyance change outside acceptable range.

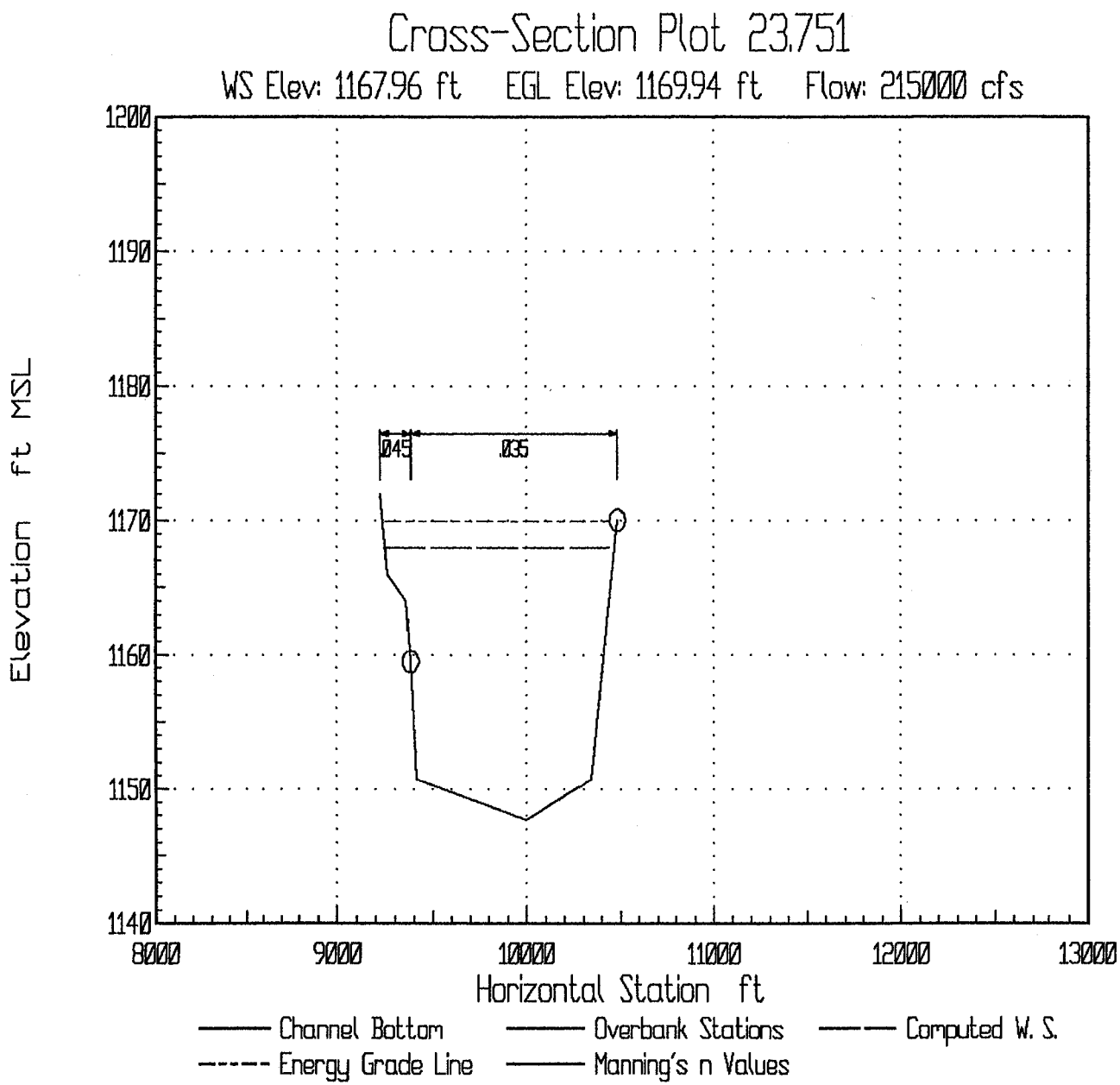
Section 25.194, profile 4, conveyance change outside acceptable range.

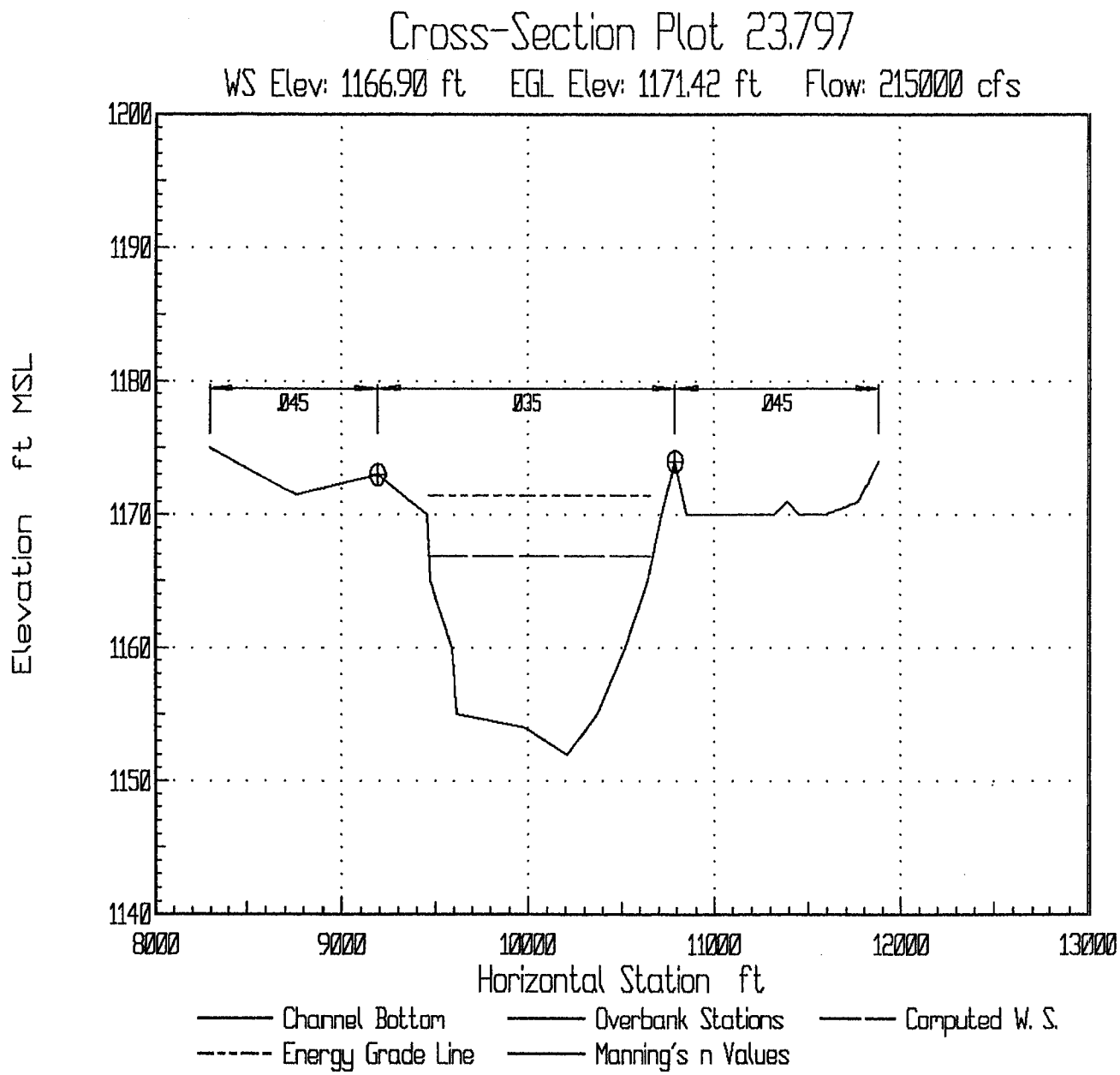
19 Warning and status message(s) generated

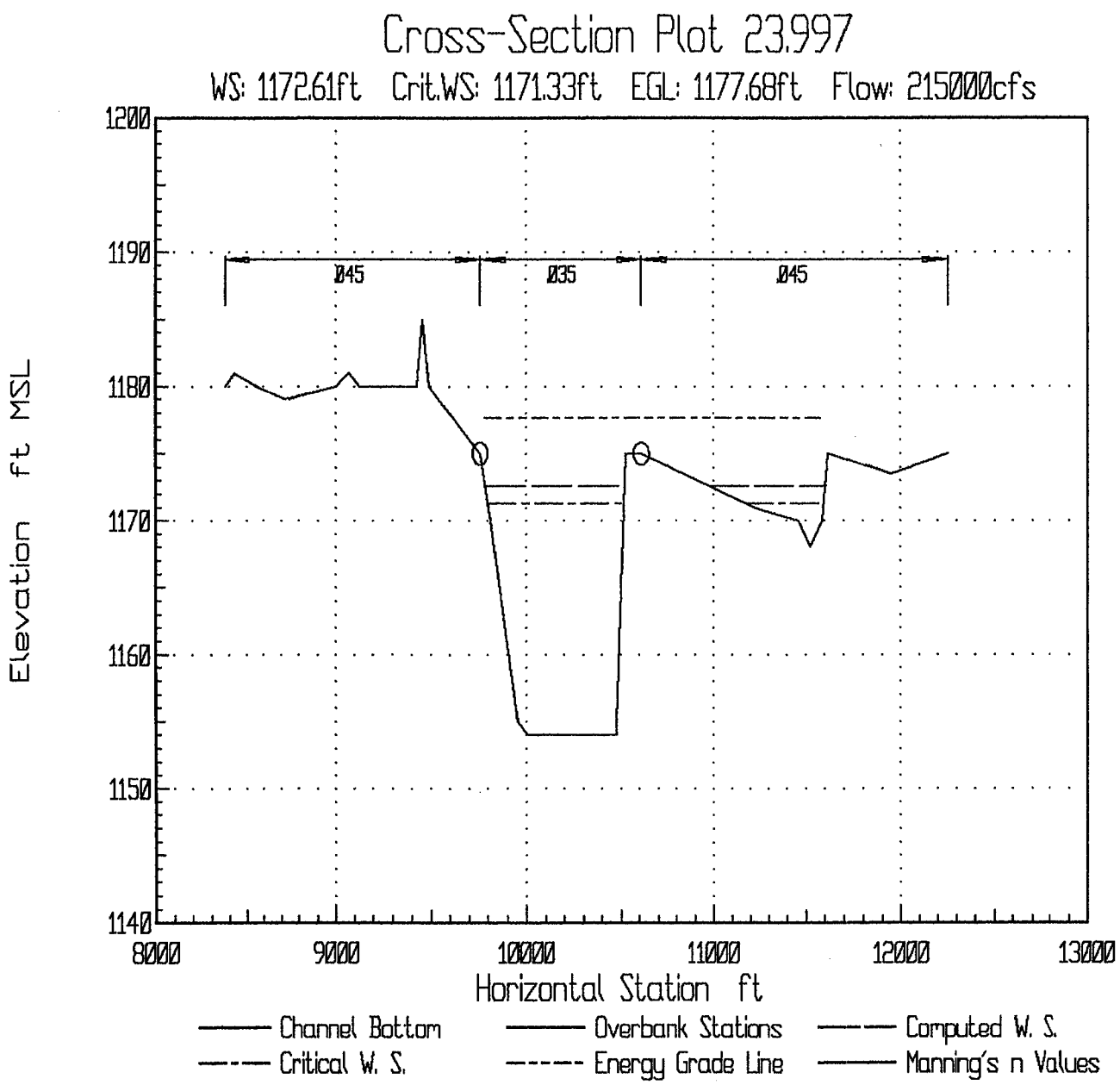
END OF OUTPUT

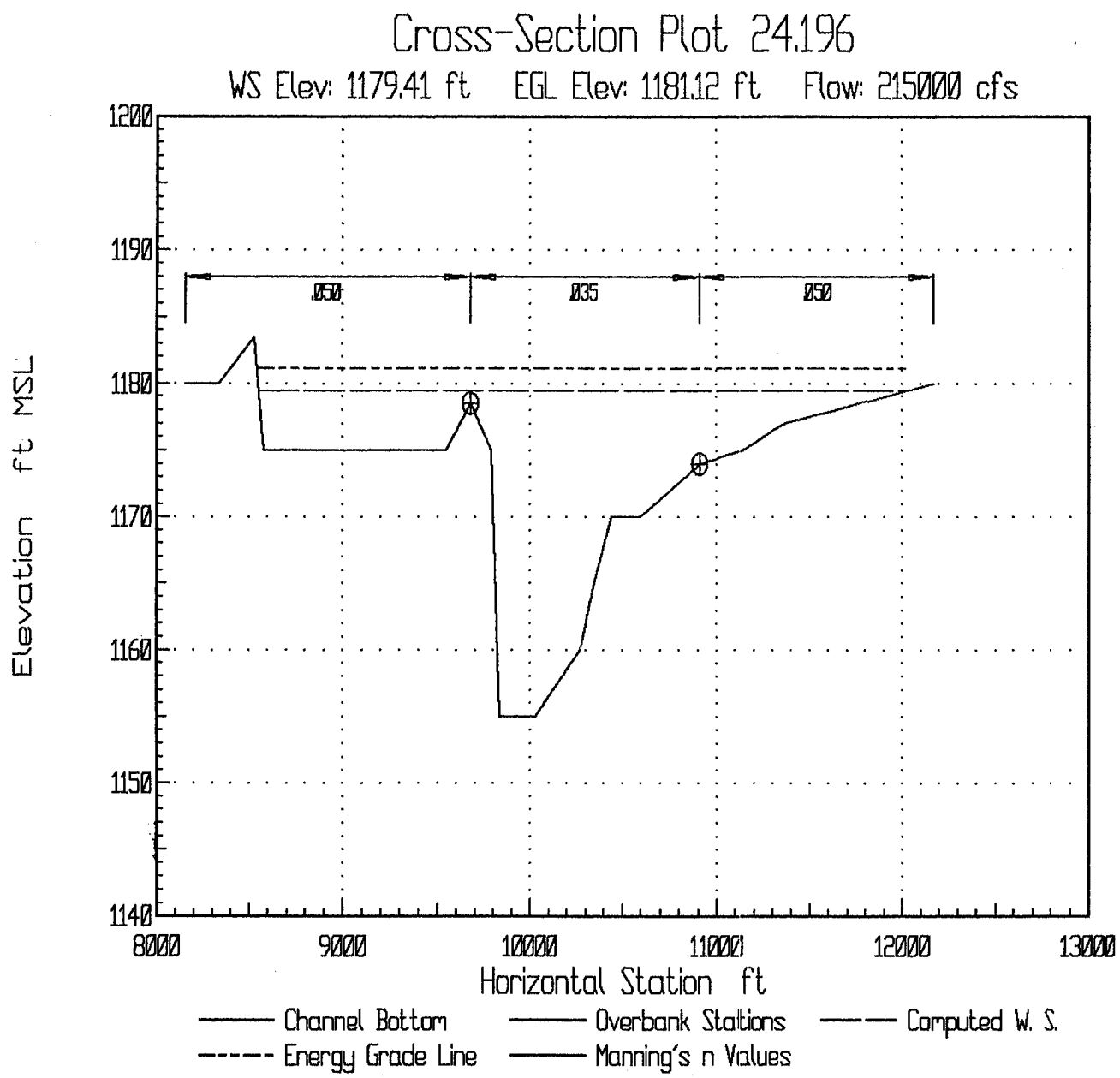

Cross-Section Plot 23.667
WS Elev: 1166.93 ft EGL Elev: 1169.18 ft Flow: 215000 cfs
Elevation ft MSL
1200
1190
1180
1170
1160
1150
1140
8000
9000
10000
11000
12000
13000
Horizontal Station ft
035
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

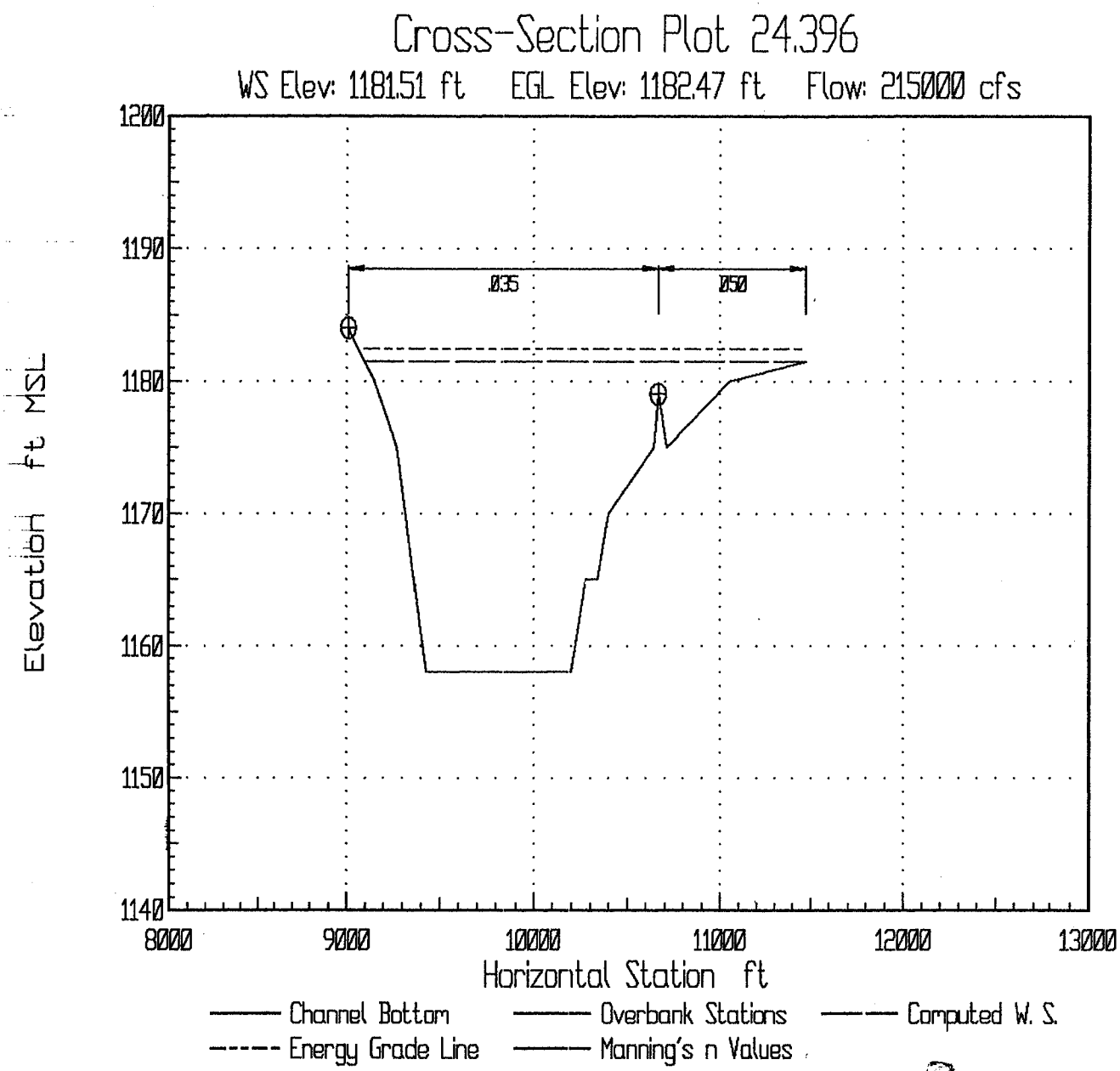

Cross-Section Plot 23.713
WS Elev: 1167.74 ft EGL Elev: 1169.60 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.045
.035
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

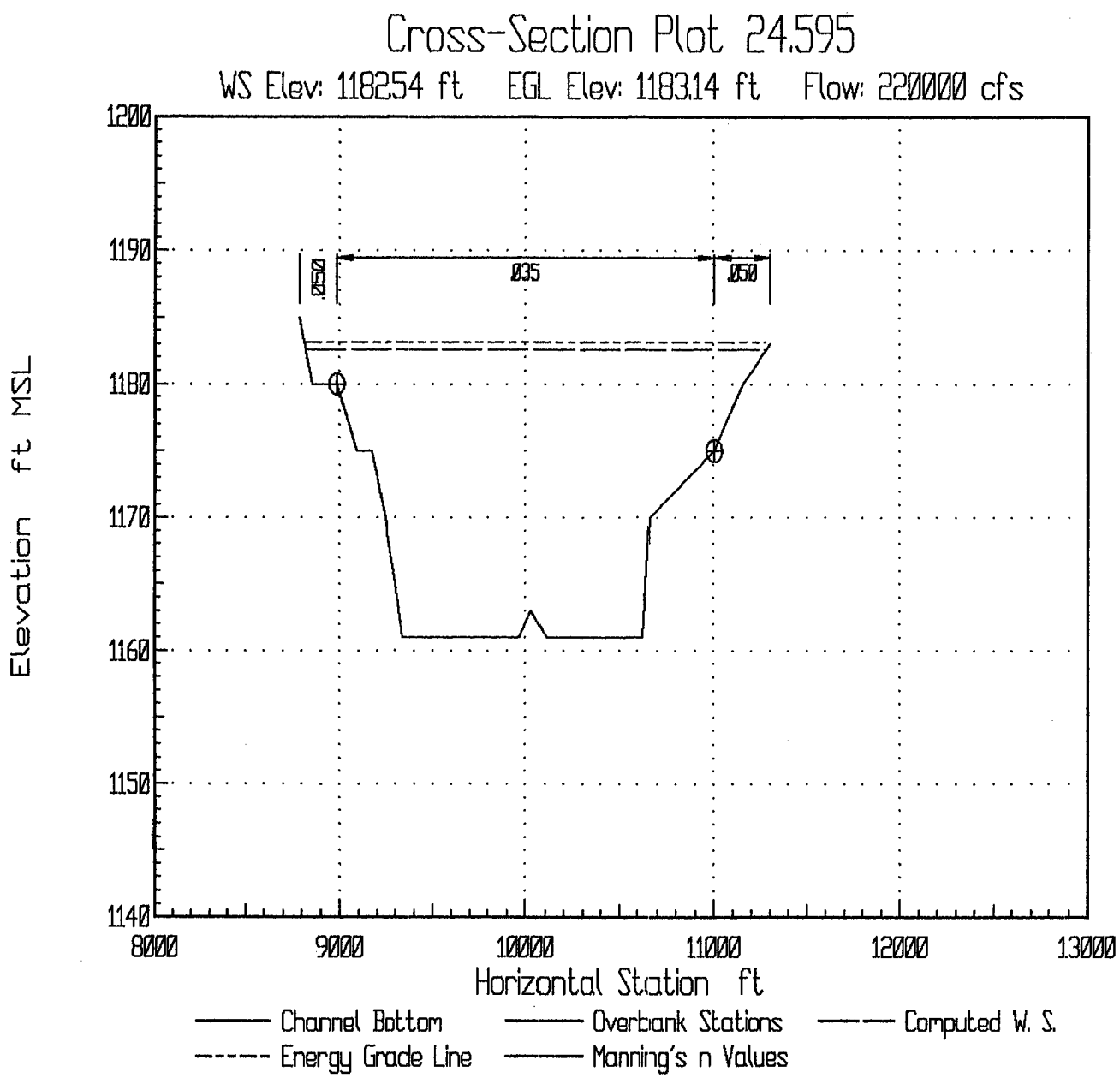

Cross-Section Plot 23.751
WS Elev: 1167.96 ft EGL Elev: 1169.94 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.045
.035
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

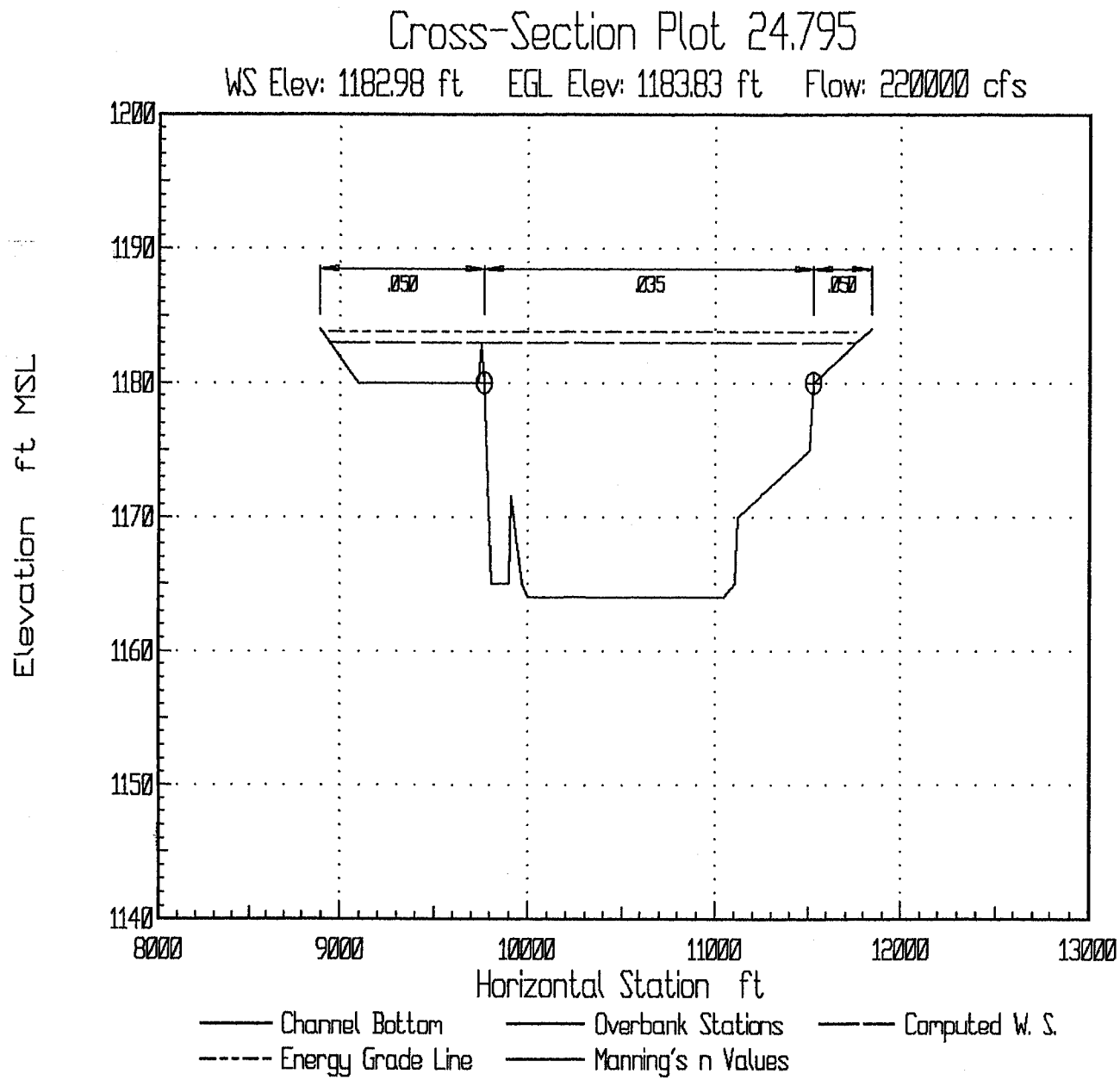

Cross-Section Plot 23.797
WS Elev: 1166.90 ft EGL Elev: 1171.42 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
045
035
045
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

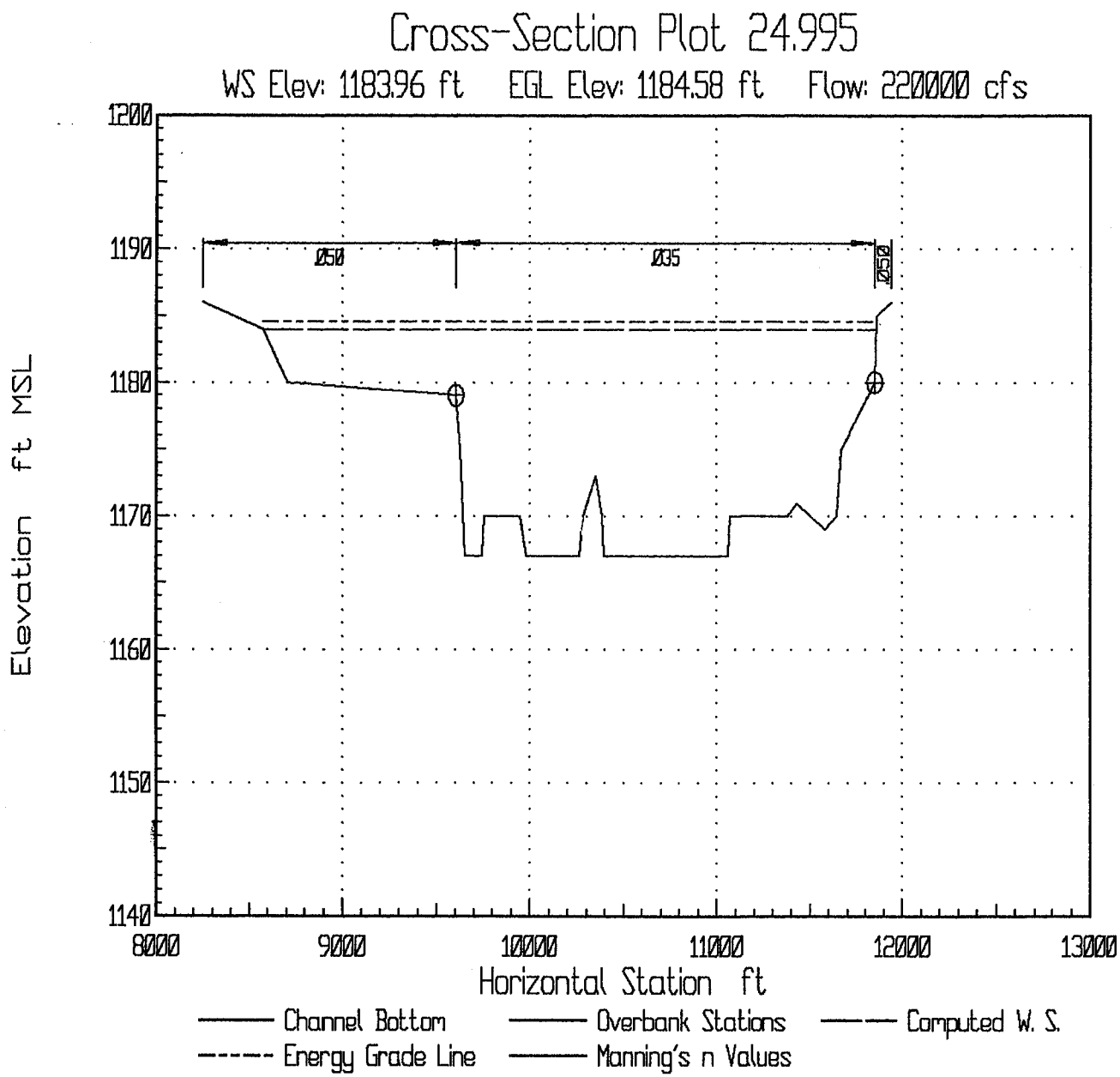

Cross-Section Plot 23.997
WS: 1172.61ft Crit.WS: 1171.33ft EGL: 1177.68ft Flow: 215000cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
045
035
045
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Critical W. S.
Energy Grade Line
Manning's n Values

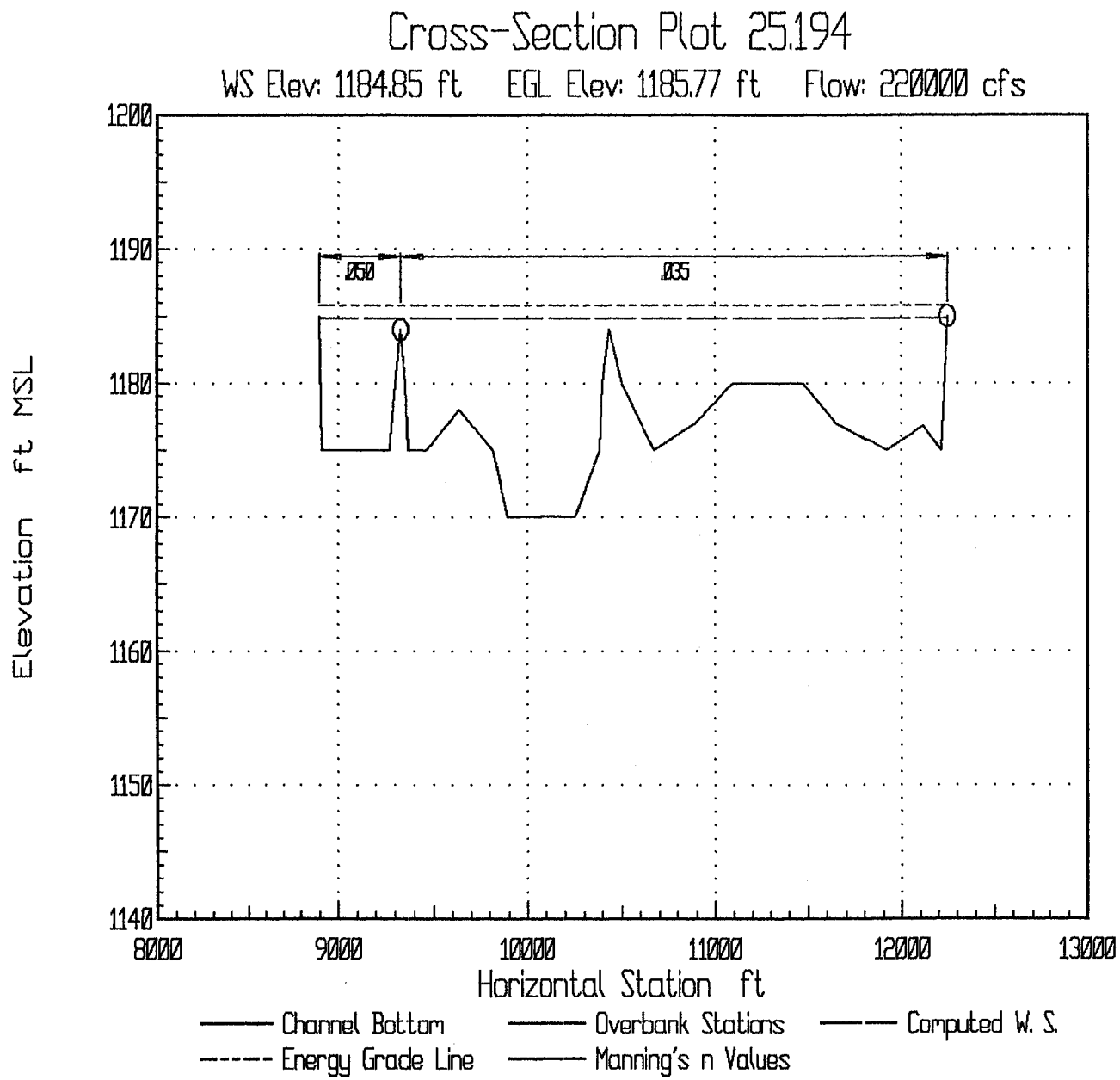

Cross-Section Plot 24.196
WS Elev: 1179.41 ft EGL Elev: 1181.12 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.050
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.396
WS Elev: 1181.51 ft EGL Elev: 1182.47 ft Flow: 215000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.595
WS Elev: 118254 ft EGL Elev: 118314 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.050
035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.795
WS Elev: 1182.98 ft EGL Elev: 1183.83 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.050
.035
.050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 24.995
WS Elev: 1183.96 ft EGL Elev: 1184.58 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
050
035
050
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values


Cross-Section Plot 25.194
WS Elev: 1184.85 ft EGL Elev: 1185.77 ft Flow: 220000 cfs
1200
1190
1180
1170
1160
1150
1140
Elevation ft MSL
.050
.035
8000
9000
10000
11000
12000
13000
Horizontal Station ft
Channel Bottom
Overbank Stations
Computed W. S.
Energy Grade Line
Manning's n Values

3. Rating Curve Development

Analysis of Existing Mill Ave. Bridge

CRS SIRRINE	PROJECT: Rio Salado	JOB NO.		NO. 1
	CLIENT: City of Tempe	DESIGNED BY: GKC	DATE: 1/13/90	OF 11
	SUBJECT: Bridge Backwater	CHECKED BY: JFM	DATE: 2/5/90	

Summary

Discharge	Location: SPRR.	Ash	Mill	Rural
40,000	0.11	0.18	0.31	0.06
80,000	0.21	0.33	0.57	0.10
120,000	0.28	0.39	0.81	0.14
160,000	0.26	0.48	1.01	0.19
215,000	0.38	0.52	1.16	0.21
250,000	0.42	0.66	2.05	0.28

CRS SIRRINE	PROJECT: Rio Salado	JOB NO.		NO. 2
	CLIENT: City of Tempe	DESIGNED BY: OKL	DATE: 1/13/90	OF 11
	SUBJECT: Bridge Bkwt. Q=40,000	CHECKED BY: JFM	DATE: 2/5/90	

Location	Sec No	Area	Obst Area	J	K
SPRR	15.60	6841	404	0.059	0.14
Ash	19.20	6887	556	0.081	0.22
Mill	24.50	6906	979	0.142	0.40
Rural	70.50	7987	351	0.044	0.105

Location	h_v	K	Δh_1	TW	Δh_2	Loss
SPRR	0.53	0.14	0.096	849	0.016	0.11
Ash	0.53	0.22	0.15	852	0.025	0.18
Mill	0.52	0.40	0.27	834	0.042	0.31
Rural	0.39	0.105	0.053	921	0.006	0.06

$$\Delta h_1 = 1.3 h_v K$$

$$\Delta h_2 = 1.3 h_v \left[1 - (Area/(Area + \Delta h_1 TW))^2\right]$$

SPRR

$$A_p = 6(8)(39.84 - 31.43)$$
$$= 404$$

Ash

$$A_p = 1282(40.26 - 32.81)/17.19$$
$$= 556$$

Mill:

$$A_p = \text{Wall} + \text{Pier}$$

$$\text{Wall} = 2(40.67 - 32.2)/6.8 + 4(40.67 - 32.2)/3.1$$
$$= 728$$

$$\text{Pier} = 527(40.67 - 32.2)/17.8$$
$$= 251$$

$$A_p = 979$$

Rural:

$$A_p = 8 \times 5 \times (46.2 - 37.42)$$
$$= 351$$

CRS SIRRINE	PROJECT: Rio Salado	JOB NO.		NO. 4
	CLIENT: City of Tempe	DESIGNED BY: GKC	DATE: 1/13/90	OF 11
	SUBJECT: Porridge Bkwt. Q = 89,000	CHECKED BY: JFM	DATE: 2/5/90	

Location	Sec No	Area	Obst Area	J	K
SPRR	15.60	10303	596	0.058	0.14
Ash	19.20	10496	858	0.082	0.22
Mill	24.50	10341	1449	0.140	0.40
Rural	70.50	12307	536	0.044	0.105

Location	h_v	K	Δh_1	TW	Δh_2	Loss
SPRR	0.94	0.14	0.17	882	0.035	0.21
Ash	0.92	0.22	0.26	1187	0.067	0.33
Mill	0.93	0.40	0.48	854	0.090	0.57
Rural	0.66	0.105	0.09	951	0.012	0.10

$$\Delta h_1 = 1.3 K h_v$$

$$\Delta h_2 = 1.3 h_v [1 - (Area/(Area + \Delta h_1 TW))^2]$$

$$Loss = \Delta h_1 + \Delta h_2$$

*

SPRR:

$A_p = 6(8)(43.84 - 31.43)$

$= 596$

Ash:

$A_p = 1282(44.31 - 32.81)/17.19$

$= 858$

Mill:

$A_p = \text{Wall} + \text{Pier} + \text{Super}$

$\text{Wall} = 2(44.74 - 32.2) + 16.8 +$
$4(44.74 - 32.2) + 13.1$

$= 1078$

$\text{Pier} = 527(44.74 - 32.2)/17.8$

$= 371$

$\text{Super} = 0$

$A_p = 1449$

Rural:

$A_p = 8 \times 5(50.81 - 37.42)$

$= 536$

CRS SIRRINE	PROJECT: Rio Salado	JOB NO.		NO. 6
	CLIENT: City of Tempe	DESIGNED BY: GKC	DATE: 1/13/90	OF 11
	SUBJECT: Bridge Bkwt. Q=120,000	CHECKED BY: JFM	DATE: 2/5/90	

Location	SecNo	Area	Obst Area	J	K
SPRR	15.60	14397	822	0.057	0.14
Ash	19.20	14297	1095	0.077	0.20
Mill	24.50	13520	1848	0.137	0.39
Rural	70.50	15676	676	0.043	0.105

Location	h_v	K	Δh_1	TW	Δh_2	Loss
SPRR	1.21	0.14	0.22	1311	0.061	0.28
Ash	1.19	0.20	0.31	1204	0.078	0.39
Mill	1.29	0.39	0.65	1044	0.156	0.81
Rural	0.91	0.105	0.12	974	0.017	0.14

$$\Delta h_1 = K h_v 1.3$$

$$\Delta h_2 = 1.3\, h_v \left[1 - (\text{Area}/(\text{Area} - \Delta h_1 TW))^2\right]$$

$$\text{Loss} = \Delta h_1 + \Delta h_2$$

* SPRR:

$$A_p = 14(1)(47.04-44) + 2(5)(47.04-44) + 6(8)(47.04-31.43)$$
$$= 42.56 + 30.40 + 749.28$$
$$= 822.24$$

Ash: $A_p = 1282(47.49-32.81)/17.19$
$= 1095$

Mill:

A_p = Wall + Pier + Super

Wall = $(47.86-45) * 13.1 + 2(47.86-32.2) * 16.8 + 4(47.86-32.2) * 13.1$
$= 1384$

Pier = $527(47.86-32.2)/17.8$
$= 464$

Super = 0

$A_p = 1848$

Rural:

$A_p = 8 \times 5 \times (54.31-37.42)$
$= 676$

CRS SIRRINE	PROJECT: Rio Salado	JOB NO. 12101N	NO. 8 / 11
	CLIENT: City of Tempe	DESIGNED BY GKC / DATE 1/13/90	
	SUBJECT: Bridge Bk wt. Q = 160,000	CHECKED BY JFM / DATE 2/5/90	

Location	Sec No	Area	Obstr Area *	J	K
SPRR	15.60	18016	1020	0.057	0.14
Ash	19.20	17557	1282	0.073	0.195
Mill	24.50	16297	2206	0.135	0.39
Rural	70.50	18565	794	0.043	0.105

Location	h_v	K	Δh_1	TW	Δh_2	Loss
SPRR	1.40	0.14	0.25	1332	0.065	0.26
Ash	1.43	0.195	0.36	1218	0.089	0.48
Mill	1.60	0.39	0.81	1060	0.203	1.01
Rural	1.15	0.105	0.16	992	0.025	0.19

$$\Delta h_1 = K h_v 1.3$$

$$\Delta h_2 = 1.3\, h_v \left[1 - (\text{Area}/(\text{Area} - \Delta h_1 TW))^2\right]$$

$$\text{Loss} = \Delta h_1 + \Delta h_2$$

*

SPRR:

$$A_p = 14(1)(49.78 - 44.00) + 2(5)(49.78 - 44.00) + 6(8)(49.78 - 31.43)$$
$$= 80.92 + 57.8 + 880.8$$
$$= 1019.52$$

Ash:

$$A_p = 1282$$

Mill:

$$A_p = \text{Wall} + \text{Pier} + \text{Superstructure}$$

$$\text{Wall} = (50.50 - 45) \times 13.1 + 2(50.50 - 32.2) \times 16.8 + 4(50.50 - 32.2)\,13.1$$
$$= 1645.85$$

$$\text{Pier} = 527$$

$$\text{Super} = 0.5(4 * 7.5 + 2 * 12) + 7(0.86)$$
$$= 33.02$$

$$A_p = 2205.87$$

Rural:

$$A_p = 8 \times 5(57.26 - 37.42)$$
$$= 793.60$$

CRSS	PROJECT: Rio Salado	JOB NO. R101N	NO. 10
CRS SIRRINE	CLIENT: City of Tempe	DESIGNED BY GKC / DATE 1/13/90	OF 11
	SUBJECT: Bridge Bk wt. Q = 215,000	CHECKED BY JFM / DATE 5 FEB 90	

Location	Sec No	Area	Obstr.* Area	J	K
SPRR	15.60	22,503	1256	0.056	0.14
Ash	19.20	22,312	1674	0.075	0.20
Mill	24.50	21,405	3239	0.151	0.435
Rural	70.50	22,659	956	0.042	0.10

* SPRR

$$A_p = 14(1)(53.10 - 44.00) + 2(5)(53.10 - 44.00) + 6(8)(53.10 - 31.43)$$

$$= 124.4 + 91.0 + 1040.2$$

$$= 1255.6$$

Ash

$$A_p = 1282 + 8(49)$$

$$= 1674$$

Mill

$$A_p = \text{Wall} + \text{Pier} + \text{Superstr}$$

$$\text{Wall} = (55.2 - 45.0)13.1 + 2(55.2 - 32.2)16.8 + 4(55.2 - 32.2)13.1$$

$$= 2112$$

$$\text{Pier} = 7.4(50 - 45) + 2 \times 15.0(50 - 32.2) + 4 \times 8.2(50 - 32.2)$$

$$= 527$$

$$\text{Super} = 5.2(4 * 7.5 + 2 * 12) + 7(45.6)$$

$$= 600$$

$$A_p = 3239$$

Location	h_v	K	Δh_1	Δh_2	Loss	TW
SPRR	1.63	0.14	0.30	0.075	0.38	1361
Ash	1.61	0.20	0.42	0.095	0.52	1244
Mill	1.69	0.435	0.96	0.201	1.16	1096
Rural	1.40	0.10	0.18	0.029	0.21	1019

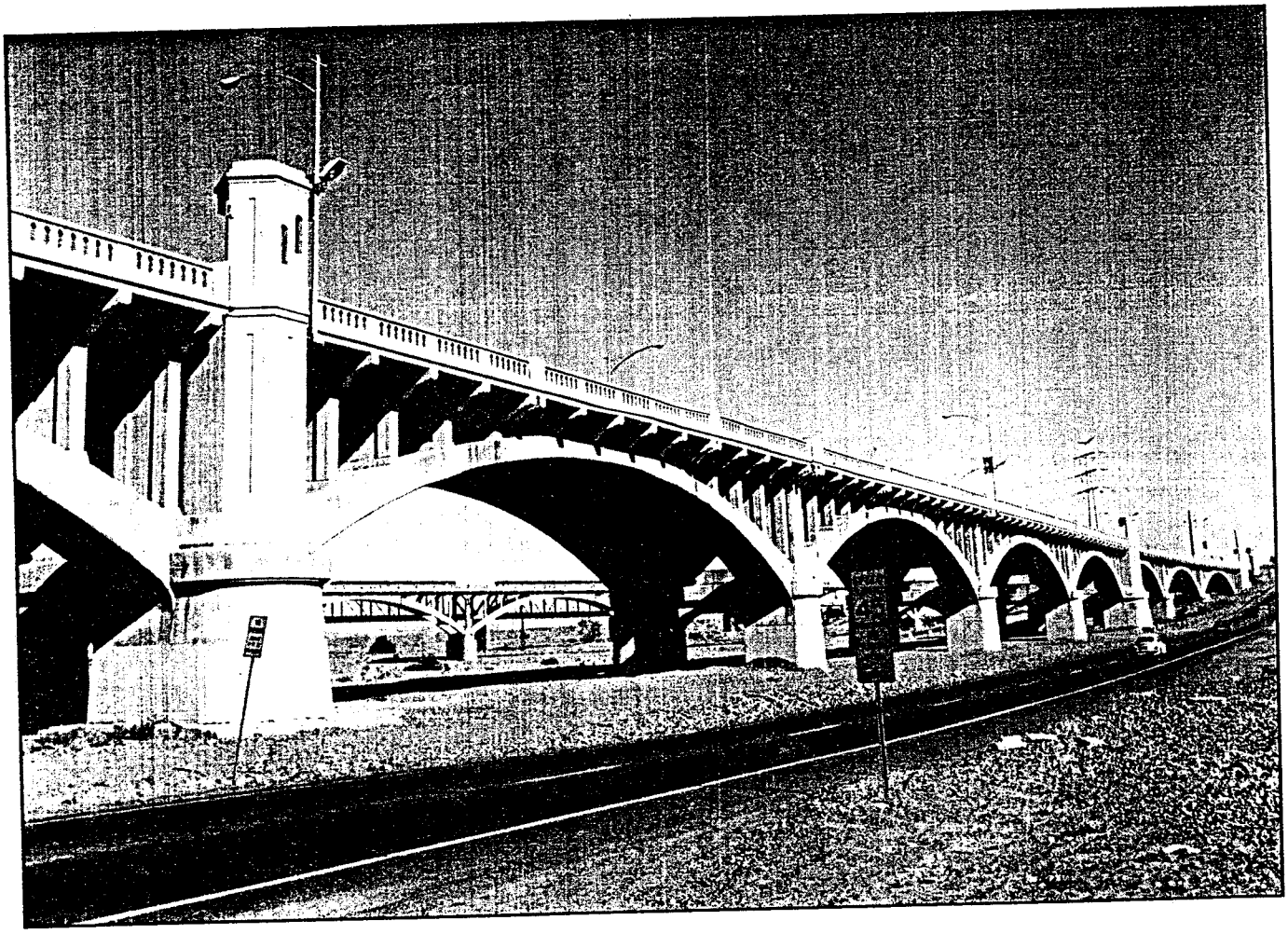
where $\Delta h_1 = h_v K 1.3$

$$\Delta h_2 = 1.3\left[1 - (\text{Area}/(\text{Area} + \Delta h_1 TW))^2\right] h_v$$

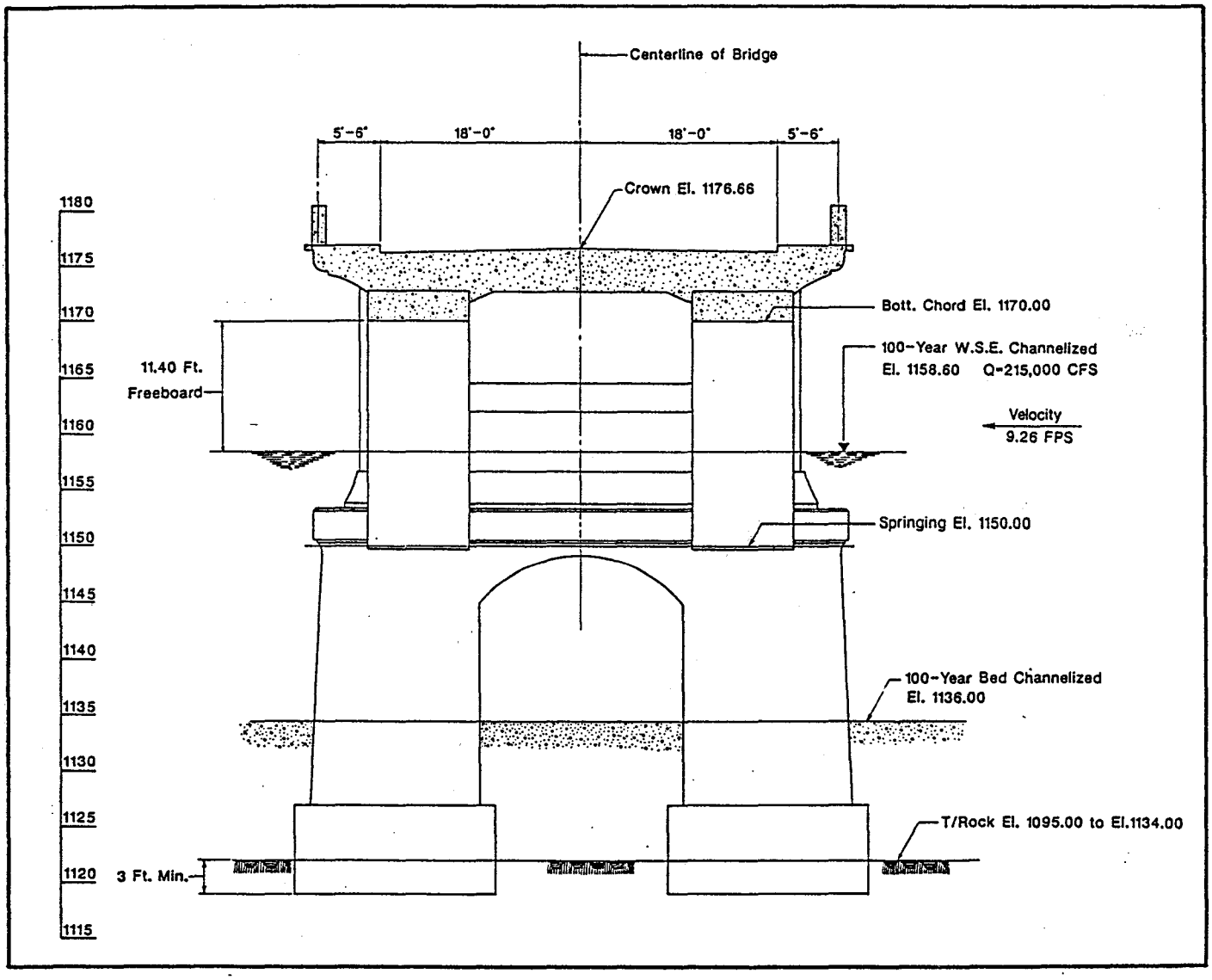
$$\text{Loss} = \Delta h_1 + \Delta h_2$$

Rural Obstruction

$$A_p = 8 \times 5(61.33 - 37.42) = 956.4$$



Mill Avenue Bridge



CROSS SECTION OF MILL AVENUE BRIDGE

Existing Mill Ave Bridge

Narrative: Calculation is based on abnormal stage with backwater from the SPRR and Ash Ave bridges. The bridge substructure is a wall-type pier that is skewed to the direction of flow. A portion of the bridge superstructure in addition to the piers abstructs the flow. Channelization removes piers 2 and 10 from the flow and places pier 3 on the south overbank terrace.

Flow Conditions:

$Q = 250{,}000$ cfs

WSEL = 1155.90

A_{n2} =	428	LOB
	19,630	CH
	1,820	ROB
	21,878	

V_{n2} = 11.42 fps (average)

4.64	LOB
11.99	CH
5.42	ROB

h_e = 1158.04 − 1155.90 = 2.14

M = 1.0 ; No flow contraction

assume $\alpha_1 = \alpha_2 = 1.3$; Large River compound section

Skew = 15° ;

Pier Loss Coef:

Terrace Elev. 1145.0
Average channel bed 1132.18
1 pier on terrace
6 piers in channel

$$A_p = (55.90-45.00)(13.1) + 7.4(50-45) + \quad \text{No. 2}$$
$$(55.90-32.18)(16.8) + 15.0(50-32.18) + \quad \text{No. 3 *}$$
$$(55.90-32.18)(13.1) + 8.2(50-32.18) + \quad \text{No. 4}$$
$$(55.90-32.18)(13.1) + 8.2(50-32.18) + \quad \text{No. 5}$$
$$(55.90-32.18)(13.1) + 8.2(50-32.18) + \quad \text{No. 6}$$
$$(55.90-32.18)(16.8) + 15.0(50-32.18) + \quad \text{No. 7 *}$$
$$(55.90-32.18)(13.1) + 8.2(50-32.18) + \quad \text{No. 8}$$

superstructure → $+ 5.9(7.5+12+7.5+7.5+7.5+12+7.5) + 7(58.8)$

$$= \underset{\text{wall}}{2182.7} + \underset{\text{pier}}{1156.1} + \underset{\text{arch}}{362.9} + 411.6 = 4113.3$$

$$J = A_p / A_{n2} = 4113/21878$$
$$= 0.188$$

$$\Delta K_p = 0.56$$

Loss:

$$h_1 = \Delta K_p \alpha_2 h_e + \alpha_1 \left[(A_{n2}/A_{n4})^2 - (A_{n2}/A_{n1})^2 \right] h_e$$
$$= 0.56(1.3)2.14 + \alpha_1 [\quad] h_e$$
$$= 1.56 + 1.3\left[1 - (21878/(21878+1.56\cdot 1190))^2\right]2.14$$
$$= 1.56 + 1.3(0.15)2.14$$
$$= 1.98$$

$h_f = 0.07$ (Friction loss from Sec 24.0 to 24.5)

$$h_\ell = h_1 + h_f$$
$$h_\ell = 1.98 + 0.07 = 2.05$$

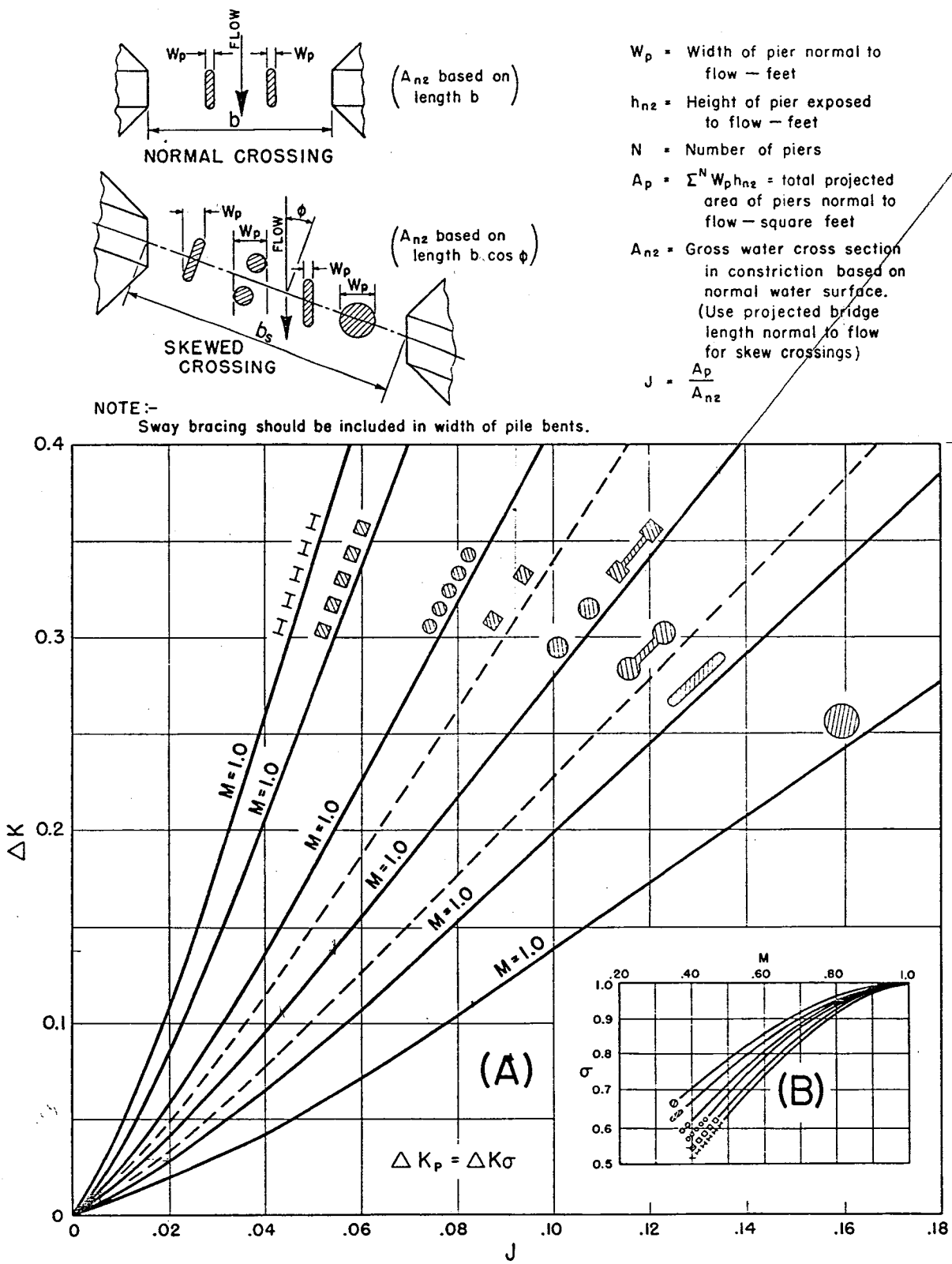


Figure 7.—Incremental backwater coefficient for piers.

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****************************************************
*  WATER SURFACE PROFILES                          *
*  VERSION OF NOVEMBER 1976                        *
*  UPDATED MAY 1984                                *
*  IBM-PC-XT VERSION AUGUST 1985                   *
*  RUN DATE  01-31-90   TIME  18:27:46               *
****************************************************
```

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*************************************
*  U.S. ARMY CORPS OF ENGINEERS     *
*  THE HYDROLOGIC ENGINEERING CENTER *
*  609 SECOND STREET, SUITE D       *
*  DAVIS, CALIFORNIA 95616          *
  *  (916) 440-2105 (FTS) 448-2105
*************************************
```

```
X     X  XXXXXXX   XXXXX             XXXXX
X     X  X        X     X           X     X
X     X  X        X                       X
XXXXXXX  XXXX     X         XXXXX    XXXXX
X     X  X        X                 X
X     X  X        X     X           X
X     X  XXXXXXX   XXXXX            XXXXXXX
```

THIS RUN EXECUTED 01-31-90

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
**************************************************


C
T1             CRSS COMMERCIAL GROUP, INC.
T2      RIO SALADO * HEC2 * GRADE CONTROL STRUCTURE No. 3 TO HAYDEN ROAD
T3      JANUARY 25, 1990        FILE:TEST.DAT         Q = 250,000 CFS

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC   HVINS    Q        WSEL     FQ

     -10.       2.       0.       0.   .000000     .00       .0       0.   142.880    .000

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW      CHNIM    ITRACE

    -1.000     .000   -1.000     .000     .000     .000   -1.000     .000     .000     .000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38.000    1.000    8.000   13.000   14.000   15.000   55.000   26.000   56.000    3.000

J5  LPRNT    NUMSEC                  ********REQUESTED SECTION NUMBERS********

   -10.000  -10.000     .000     .000     .000     .000     .000     .000     .000     .000
```

THIS RUN EXECUTED 01-31-90

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**************************************************
  HEC2 RELEASE DATED NOV 76 UPDATED MAY  1984
  ERROR CORR -  01,02,03,04,05,06
  MODIFICATION -  50,51,52,53,54,55,56
  IBM-PC-XT VERSION AUGUST 1985
**************************************************
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

JANUARY 25, 1990

SUMMARY PRINTOUT

SECNO	CWSEL	DEPTH	QLOB	QCH	QROB	VLOB	VCH	VROB	EG
20782.000	142.88	20.38	.00	250000.00	.00	.00	14.91	.00	146.33
20800.000	142.94	20.41	.00	250000.00	.00	.00	14.90	.00	146.38
21000.000	143.50	20.64	.00	250000.00	.00	.00	14.81	.00	146.91
21200.000	144.12	20.93	.00	250000.00	.00	.00	14.58	.00	147.42
21400.000	144.78	21.26	.00	250000.00	.00	.00	14.19	.00	147.91
21600.000	145.43	21.58	.00	250000.00	.00	.00	13.76	.00	148.37
21800.000	145.82	21.64	.00	250000.00	.00	.00	13.89	.00	148.81
22000.000	146.29	21.78	.00	250000.00	.00	.00	13.79	.00	149.25
22200.000	146.75	21.91	.00	250000.00	.00	.00	13.71	.00	149.67
22400.000	147.19	22.01	.00	250000.00	.00	.00	13.66	.00	150.08
22600.000	147.65	22.14	.00	250000.00	.00	.00	13.52	.00	150.49
22800.000	148.06	22.22	.00	250000.00	.00	.00	13.49	.00	150.89
23000.000	148.41	21.71	.00	250000.00	.00	.00	13.65	.00	151.31
23200.000	148.97	22.47	.00	250000.00	.00	.00	13.30	.00	151.71
23400.000	149.34	22.51	.00	250000.00	.00	.00	13.29	.00	152.09
23600.000	149.72	22.56	.00	250000.00	.00	.00	13.27	.00	152.46
23800.000	150.11	22.65	.00	250000.00	.00	.00	13.23	.00	152.83

	SECND	CWSEL	DEPTH	QLOB	QCH	QROB	VLOB	VCH	VROB	EG
	24000.000	150.57	22.75	.00	250000.00	.00	.00	13.00	.00	153.20
	24200.000	150.98	22.83	.00	250000.00	.00	.00	12.85	.00	153.54
	24400.000	151.39	22.91	.00	250000.00	.00	.00	12.65	.00	153.88
	24600.000	151.83	23.02	.00	250000.00	.00	.00	12.34	.00	154.19
	24800.000	152.09	22.95	.00	250000.00	.00	.00	12.48	.00	154.51
	.000	152.39	22.99	552.66	249447.30	.08	3.21	12.34	.34	154.75
	2.000	152.69	23.12	2470.69	244805.20	2724.11	4.36	12.25	5.11	154.98
	4.000	152.86	23.08	1988.19	242888.30	5123.47	4.57	12.70	4.94	155.31
	6.000	153.16	23.16	2124.96	240447.10	7427.92	4.65	12.75	5.12	155.60
	8.000	153.50	23.29	2708.08	238052.90	9239.00	4.50	12.68	5.11	155.90
	10.000	153.88	23.46	2757.95	236743.90	10498.18	4.52	12.47	5.00	156.19
	12.000	154.47	23.83	2502.56	229582.50	17914.91	4.06	11.76	5.27	156.48
	14.000	154.79	23.99	2133.21	226738.30	21128.54	4.04	11.46	5.32	156.67
	15.400	155.03	24.13	2393.88	224823.00	22783.19	3.94	11.12	5.26	156.80
*	15.600	155.43	24.50	2503.21	224026.30	23470.52	3.90	10.90	5.22	157.13
	17.500	155.59	24.47	2272.44	227483.20	20244.32	4.11	10.90	5.22	157.31
	19.000	155.69	24.40	2155.42	229290.00	18554.60	4.54	11.20	5.41	157.51
	19.200	155.71	24.40	2162.24	229234.70	18603.03	4.54	11.19	5.42	157.53
	21.500	155.72	24.24	2413.32	231545.30	16041.34	4.68	11.86	5.63	157.78
	24.000	155.83	24.20	1966.11	238250.40	9783.46	4.64	12.00	5.41	157.98
	24.500	155.90	24.22	1984.97	238152.40	9862.65	4.64	11.99	5.42	158.04
	26.000	156.09	24.19	2138.93	239091.60	8769.49	4.85	12.18	5.61	158.31
	27.000	156.14	24.03	7624.19	234079.80	8295.96	5.95	13.11	6.01	158.68
	28.000	156.37	24.10	7914.11	235071.90	7014.03	6.00	13.06	5.72	158.90
	30.000	156.72	24.23	8241.02	233821.00	7938.04	6.03	12.94	5.87	159.19
	32.000	156.91	24.21	7629.93	234510.10	7859.93	5.91	13.31	5.78	159.52

0.07

Mill Ave.

SECNO	CWSEL	DEPTH	QLOB	QCH	QROB	VLOB	VCH	VROB	EG
34.000	157.23	24.32	7872.59	234413.20	7714.26	5.99	13.25	5.79	159.82
36.000	157.59	24.46	6802.45	235941.10	7256.49	5.89	13.06	6.02	160.12
38.000	157.90	24.54	3127.80	239567.30	7304.85	5.49	12.98	5.82	160.43
40.000	158.15	24.55	2430.21	242368.40	5201.36	5.16	13.17	5.17	160.78
42.000	158.34	24.49	2643.38	239641.00	7715.68	5.47	13.83	5.72	161.20
44.000	158.79	24.70	2778.22	240314.80	6906.96	5.52	13.59	5.58	161.56
46.000	159.20	24.86	3014.69	238822.60	8162.73	5.30	13.48	5.62	161.91
48.000	159.53	24.94	2703.12	240694.50	6602.35	5.22	13.47	5.61	162.26
50.000	160.02	25.21	2783.37	240448.80	6767.87	5.26	13.02	5.37	162.57
52.000	160.61	25.60	2811.87	243663.40	3524.69	4.95	12.09	4.39	162.83
54.000	161.05	25.85	.93	246665.50	3333.51	.56	11.42	4.34	163.06
56.000	161.28	25.88	1.57	246496.50	3501.92	.64	11.32	4.37	163.25
58.000	161.42	25.83	1.75	243860.10	6138.17	.67	11.59	4.91	163.47
60.000	161.81	26.03	2.64	247427.50	2569.91	.72	11.00	4.60	163.67
62.000	162.00	26.03	3.42	247364.40	2632.14	.76	10.94	4.59	163.84
64.000	162.21	26.05	4.44	247297.80	2697.80	.81	10.83	4.59	164.01
66.000	162.41	26.05	5.58	247236.30	2758.09	.85	10.73	4.57	164.18
68.000	162.63	26.07	7.92	247586.40	2405.66	.92	10.61	4.43	164.36
69.500	162.85	26.19	.44	249999.60	.00	.43	10.20	.00	164.46
70.500	162.90	26.14	.52	249999.50	.00	.46	10.30	.00	164.55
72.000	163.00	26.08	.76	249984.50	14.72	.50	10.46	1.05	164.70
74.000	163.06	25.87	.93	249976.20	22.91	.55	10.93	1.18	164.92
76.000	163.19	25.63	.00	249980.20	19.85	.00	11.17	1.20	165.13
78.000	163.25	25.31	1.34	249816.10	182.56	.67	11.80	2.25	165.41
80.000	163.89	25.57	2.97	249960.10	36.87	.74	10.62	1.33	165.64
82.000	164.18	25.48	.00	249966.10	33.88	.01	10.24	1.29	165.81

SECND	CWSEL	DEPTH	QLOB	QCH	QROB	VLOB	VCH	VROB	EG
84.000	164.41	25.33	.07	249958.30	41.64	.27	10.01	1.34	165.97
86.000	164.71	25.25	45.45	249909.10	45.45	1.32	9.56	1.32	166.13
88.000	164.98	25.14	.67	249951.20	48.13	.44	9.12	1.30	166.27
90.000	165.19	24.97	.00	250000.00	.00	.00	8.80	.00	166.40
92.000	165.34	24.74	.00	250000.00	.00	.00	8.71	.00	166.52
94.000	165.41	24.43	.00	250000.00	.00	.00	8.94	.00	166.65
96.000	165.48	24.12	.00	250000.00	.00	.00	9.34	.00	166.83
98.000	165.55	23.82	.00	250000.00	.00	.00	9.78	.00	167.03
100.000	165.59	23.48	.00	250000.00	.00	.00	10.53	.00	167.31
102.000	165.66	23.17	.00	250000.00	.00	.00	11.34	.00	167.66
104.000	165.80	22.93	.00	249899.10	100.86	.00	11.88	2.00	167.99
106.000	166.12	22.87	6.85	249877.00	116.19	1.02	11.86	2.07	168.30
108.000	166.56	22.93	10.97	249853.90	135.16	1.12	11.50	2.10	168.61
110.000	166.71	22.70	.35	249846.70	152.96	.50	12.13	2.26	169.00
112.000	166.86	22.47	.60	249828.50	170.91	.59	12.73	2.42	169.37
114.000	167.24	22.47	1.76	249802.60	195.62	.77	12.59	2.49	169.70
116.000	167.78	22.63	4.85	249815.30	179.85	.94	12.01	2.38	170.02
118.000	168.28	22.75	7.28	249791.80	200.91	1.01	11.42	2.34	170.31
120.000	168.64	22.73	10.42	249921.50	68.09	1.09	11.15	1.69	170.57
120.500	168.69	22.69	11.11	249918.20	70.69	1.11	11.16	1.71	170.63
122.000	168.87	22.59	11.77	249909.80	78.47	1.14	11.19	1.76	170.81
122.650	169.07	22.66	13.84	249899.90	86.28	1.18	11.15	1.80	171.00
123.550	169.26	22.68	16.23	249888.70	95.06	1.23	11.14	1.84	171.18
124.000	169.47	22.81	19.03	249876.30	104.65	1.27	11.06	1.87	171.37

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado
Structure: Mill Avenue
Live Load Per Square Foot:

Job No.: 12131N
Date: 1/15/90
Computed By: GKC
Working Stress:
JFM 1/19/90

Mill Avenue Bridge

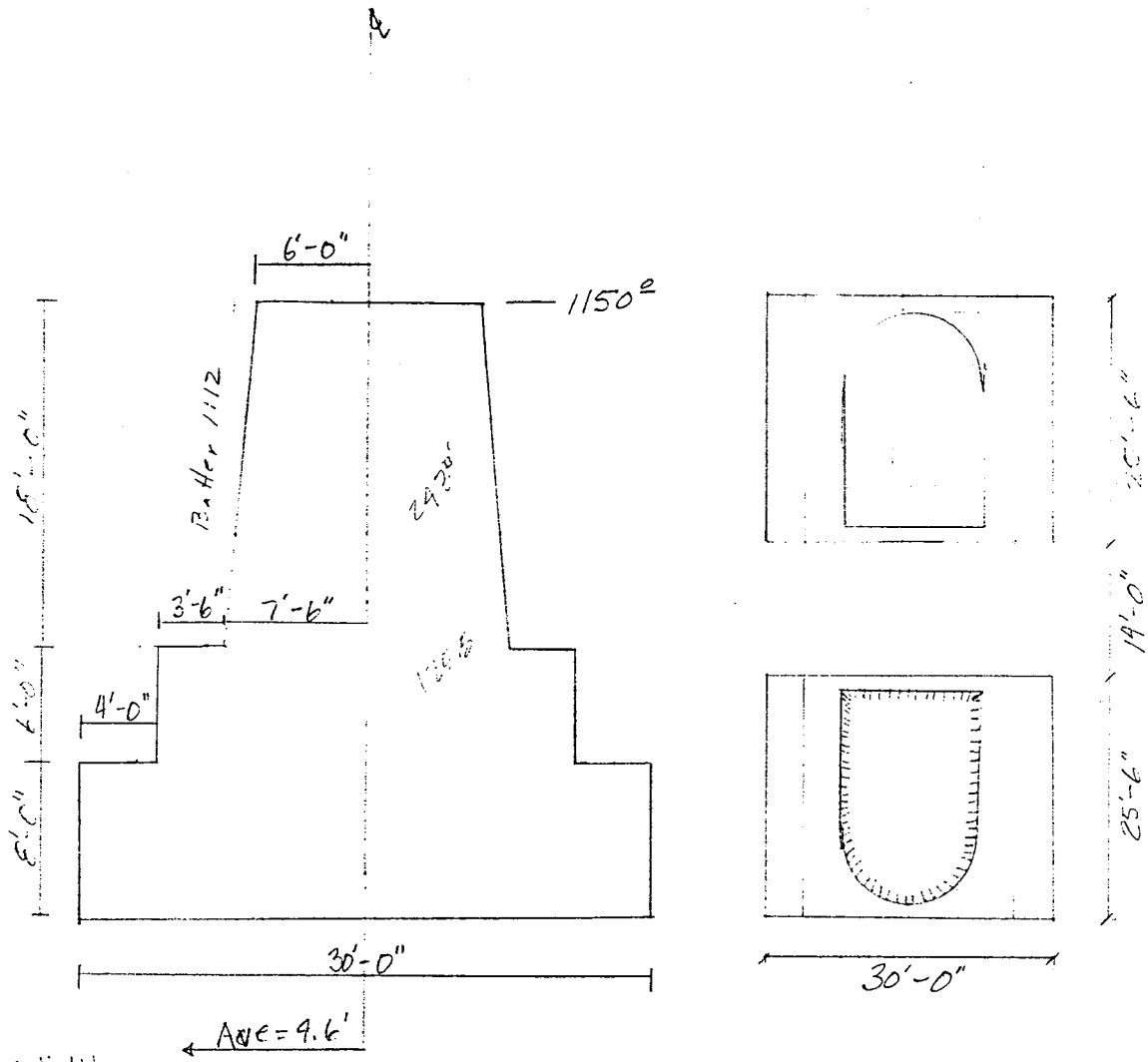
Location	Orig Plan Station	Span Length	Pier ⊙ Width	Foundation Footing Base*	Foundation Footing Top
No 1 South Abut	10+33.46	149.75	12.0	1114.80	1124.00
No 2 Inter. Pier	11+83.21	147.50	7.5	1117.00	1126.34
No. 3 Pier	13+30.71	149.75	7.5	1119.00	1128.00
No. 4 Abut Pier	14+80.46	149.75	12.0	1124.90	1138.00
No. 5 Inter. Pier	16+30.21	149.50	7.5	1120.75	1129.00
No 6 Pier	17+77.71	150.50	7.5	1120.30	[illegible]
No 7 Pier	19+25.21	149.75	7.5	[illegible]	[illegible]
No 8 Abut Pier	20+74.96	149.75	12.0	[illegible]	[illegible]
No 9 Inter. Pier	22+24.71	147.50	7.5	1133.00	[illegible]
No 10 Pier	23+72.21	149.75	7.5	1119.40	[illegible]
No 11 North Abut	25+21.96		12.0	1134.04	--
		1488.50			

* Piers extend 3 feet into solid rock.

⊙ At spring line

Channel Invert

CRS SIRRINE	PROJECT: Rio Salado	JOB NO. 5401M	NO. 2
	CLIENT: Mill Avenue Bridge	DESIGNED BY GKC / DATE 1/15/90	OF 5
	SUBJECT: Abutment Pier	CHECKED BY JFM / DATE 1/19/90	



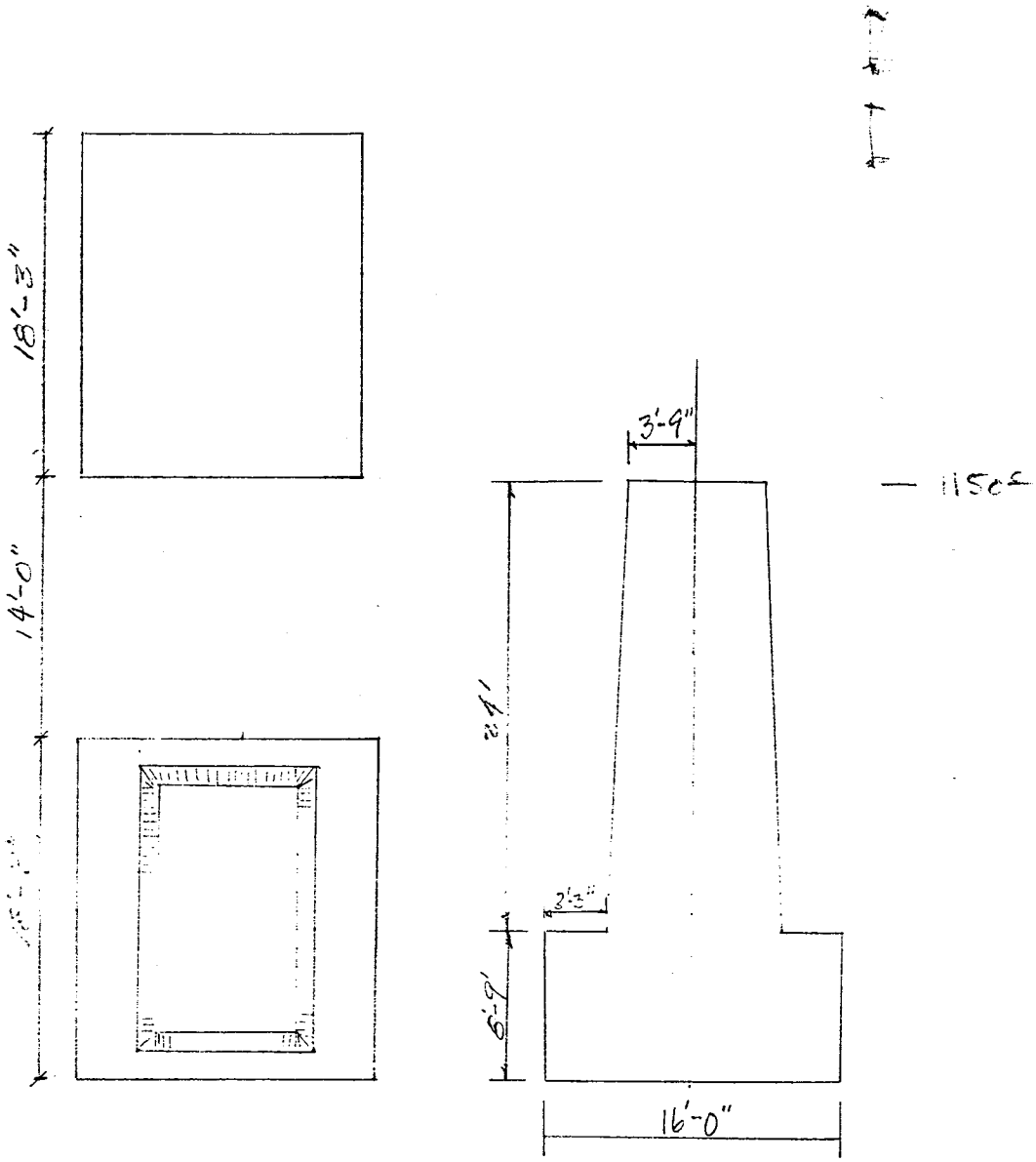
Ave Pier Width

$$\frac{(6+7.5)/2 * 18 + 11 * 6 + 15 * 8}{32} = 9.61$$

Length

32'-6"

CRS SIRRINE	PROJECT: Rio Salado	JOB NO. [illegible]	NO. 3
	CLIENT: Mill Avenue Bridge	DESIGNED BY: GKC / DATE: [illegible]	
	SUBJECT: Intermediate Pier	CHECKED BY: JFM / DATE: 1/19/90	OF 5



Ave Pier Width

$$\frac{4.25 \times 24 + 8 \times 8.75}{32} = 5.38$$

Length

25'-3"

CRSS

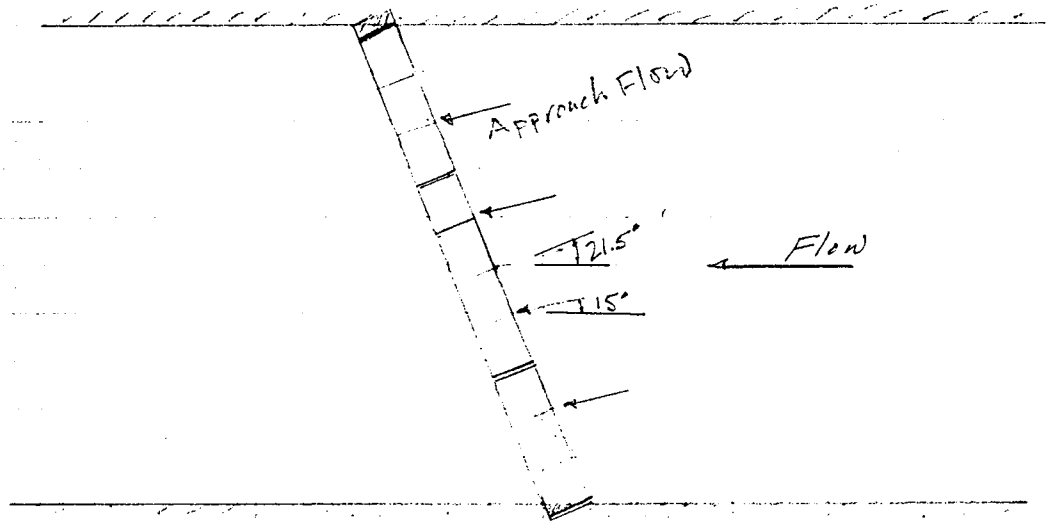
CRS SIRRINE

DESIGN SHEET

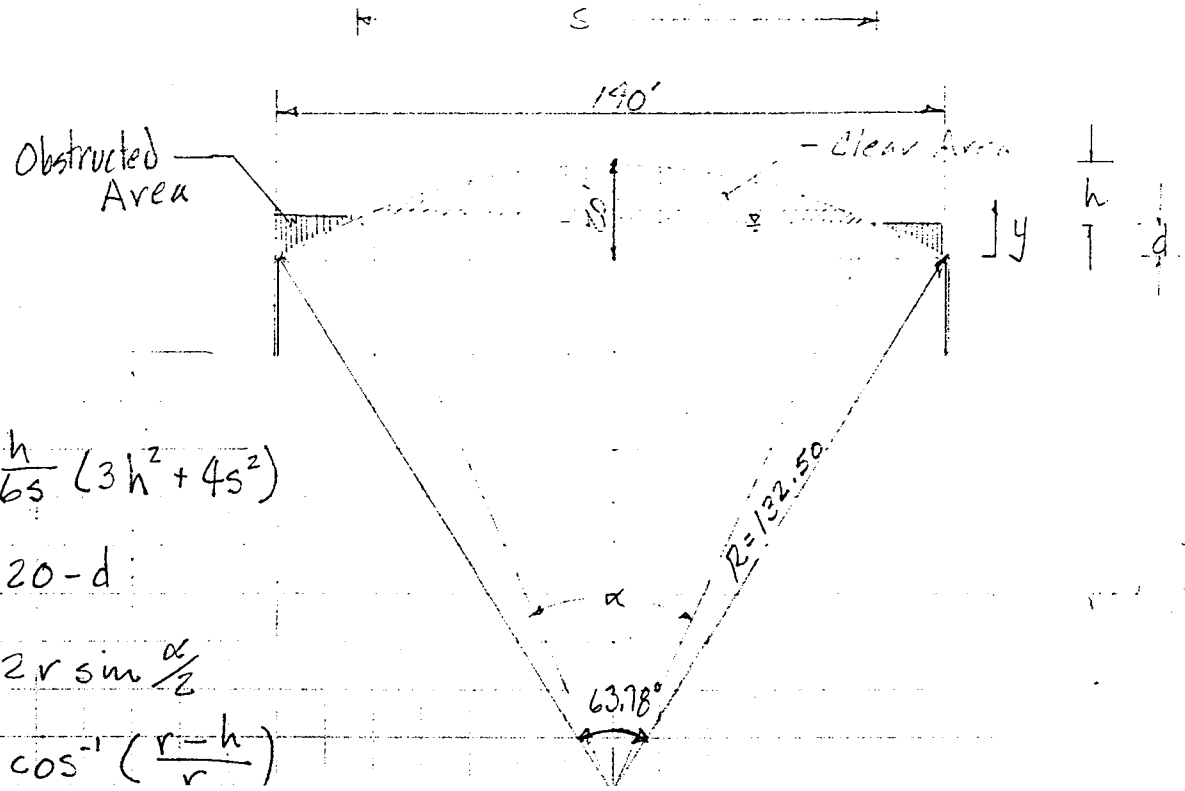
Job Second Mill Ave Fr. Job No. 1210 E.R. Date 1/12/90
Structure Computed By C.K.C.
Live Load Per Square Foot Working Stress
JFM 1/19/90

Computation of Mill Ave Waterway Area

Plan



Typical Span



$$\text{Area} = \frac{h}{6s}(3h^2 + 4s^2)$$

$$h = 20 - d$$

$$s = 2r\sin\frac{\alpha}{2}$$

$$\alpha = 2\cos^{-1}\left(\frac{r-h}{r}\right)$$

EKC 1/12/90 5/5

JPM 1/19/90

SPAN = 140.00 FT
RISE = 20.00 FT
AREA = 1895.24 SQ FT
RADIUS = 132.50 FT

FLOW DEPTH	CLEAR	CLEAR SPAN	CLEAR AREA	WETTED AREA	WITH 15° SKEW
0.00	20.00	140.00	1895.24	0.00	0.0
1.00	19.00	136.73	1757.04	138.20	133.5
2.00	18.00	133.36	1622.15	273.09	263.8
3.00	17.00	129.86	1490.68	404.56	390.8
4.00	16.00	126.24	1362.76	532.48	514.3
5.00	15.00	122.47	1238.52	656.71	634.3
6.00	14.00	118.56	1118.11	777.12	750.6
7.00	13.00	114.47	1001.69	893.55	863.1
8.00	12.00	110.20	889.44	1005.80	971.5
9.00	11.00	105.72	781.55	1113.69	1075.7
10.00	10.00	101.00	678.25	1216.99	1175.5
11.00	9.00	96.00	579.80	1315.44	1270.6
12.00	8.00	90.69	486.48	1408.76	1360.8
13.00	7.00	84.99	398.66	1496.58	1445.6
14.00	6.00	78.84	316.74	1578.50	1524.7
15.00	5.00	72.11	241.24	1654.00	[illegible]
16.00	4.00	64.62	172.82	1722.42	[illegible]
17.00	3.00	56.07	112.38	1782.85	[illegible]
18.00	2.00	45.87	61.25	1833.99	[illegible]
19.00	1.00	32.50	21.68	1873.56	1809.7
20.00	0.00	0.00	0.00	1895.24	1830.7

Appendix C

Hydraulic Structure Computations

1. Drop Structure Stability Analysis
2. Levee Stability Analysis
3. Toedown Scour Analysis
4. General Scour Analysis
5. Local Scour Analysis
6. Bank Protection Design

1. Drop Structure Stability Analysis

INDEX OF INDIAN BEND WASH DROP STRUCTURE CALCS

Set #1: Rating curves for drops

Set #2: Stilling basin size computations

Set #3: Static uplift pressures/creep ratio

Set #4: Dynamic uplift pressure

Set #5: Weep hole spacing determination

Set #6: Drop structure stability computations

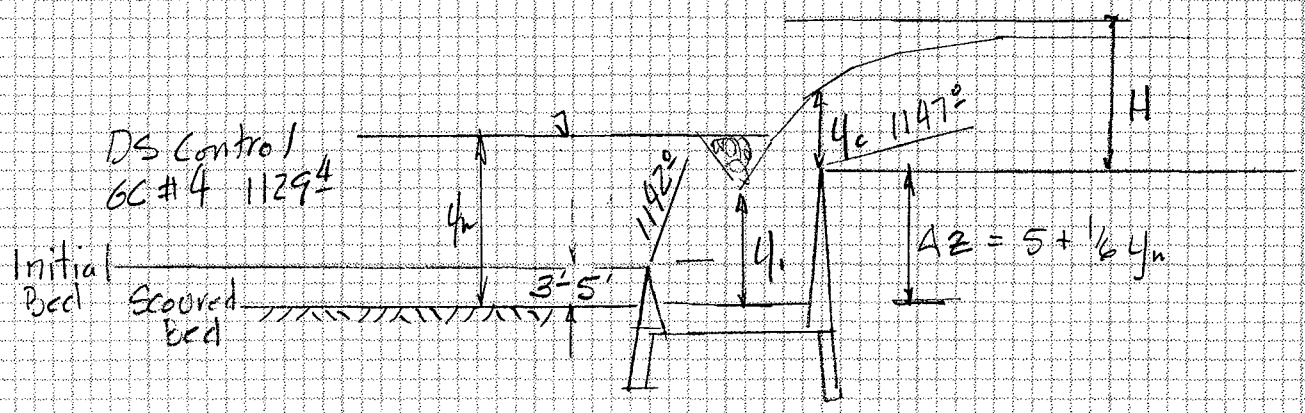
Set #7: Local scour from IBW Bridge Piers

Set #8: Residual drop scour computation

Registered Professional Engineer (Civil)
CERTIFICATE NO. 20207
GEORGE K. COTTON
Date Signed 11/15/90
ARIZONA, U.S.A.

PROJECT	Rio Salado Channel	JOB NO	12101N	NO. 1
CLIENT	Tempe	DESIGNED BY GKC	DATE 8/27/90	OF 5
SUBJECT	Grade Control No. 5 McClintock Drive Structure	CHECKED BY JFM	DATE 8/29/90	

A. Hydraulic Conditions



Reach length = 11,800' $n = 0.035$

Crest width = 950'

D/S channel S_o = 0.0814% for y_s = 3'

D/S channel S_o = 0.0644% for y_s = 5'

Q	q	y_{n3}	y_{n5}	y_c	H	σ_3	σ_5
1,000	1.1	0.94	1.01	0.33	0.50	0.27*	0.18*
5,000	5.3	2.42	2.60	0.96	1.44	0.70*	0.40*
10,000	10.5	3.65	3.91	1.51	2.27	0.69*	0.54*
20,000	21.1	5.55	5.95	2.40	3.60	(d) 0.83*/0.48	0.69*
40,000	42.1	8.39	9.00	3.80	5.70	0.61	(d) 0.84*/0.5
60,000	63.2	10.71	11.49	4.99	7.49	0.69	0.66
80,000	84.2	12.72	13.65	6.04	9.06	0.75	0.72
100,000	105.3	14.55	15.61	7.01	10.51	0.79	0.76
120,000	126.3	16.22	17.41	7.91	11.87	(d) 0.86	0.80

where $H = \frac{3}{2} y_c$

$\sigma = y_n / (H + (8 \text{ or } 10))$

* hydraulic drop below end sill

(d) hydraulic drop submerged

B. Stilling Basin Size

$Q = 120{,}000$ cfs is the maximum unsubmerged flow that will occur at GC #5. At discharges greater than this, the drop will become a vertical expansion of the flow.

Dimensions:

$$L_d = 4.30\, y_c^{0.09}\, \Delta z^{0.91}$$
$$= 4.30\,(7.91)^{0.09}\,(5 + \tfrac{1}{6}\,13.0)^{0.91}$$
$$= 31.1$$

$$y_1 = 0.54\, y_c^{1.275} / \Delta z^{0.275}$$
$$= 0.54\,(7.91)^{1.275} / (5 + \tfrac{1}{6}\,13.0)^{0.275}$$
$$= 4.4$$

$$L_j = 6.9\,(13.0 - 4.4)$$
$$= 59.5$$

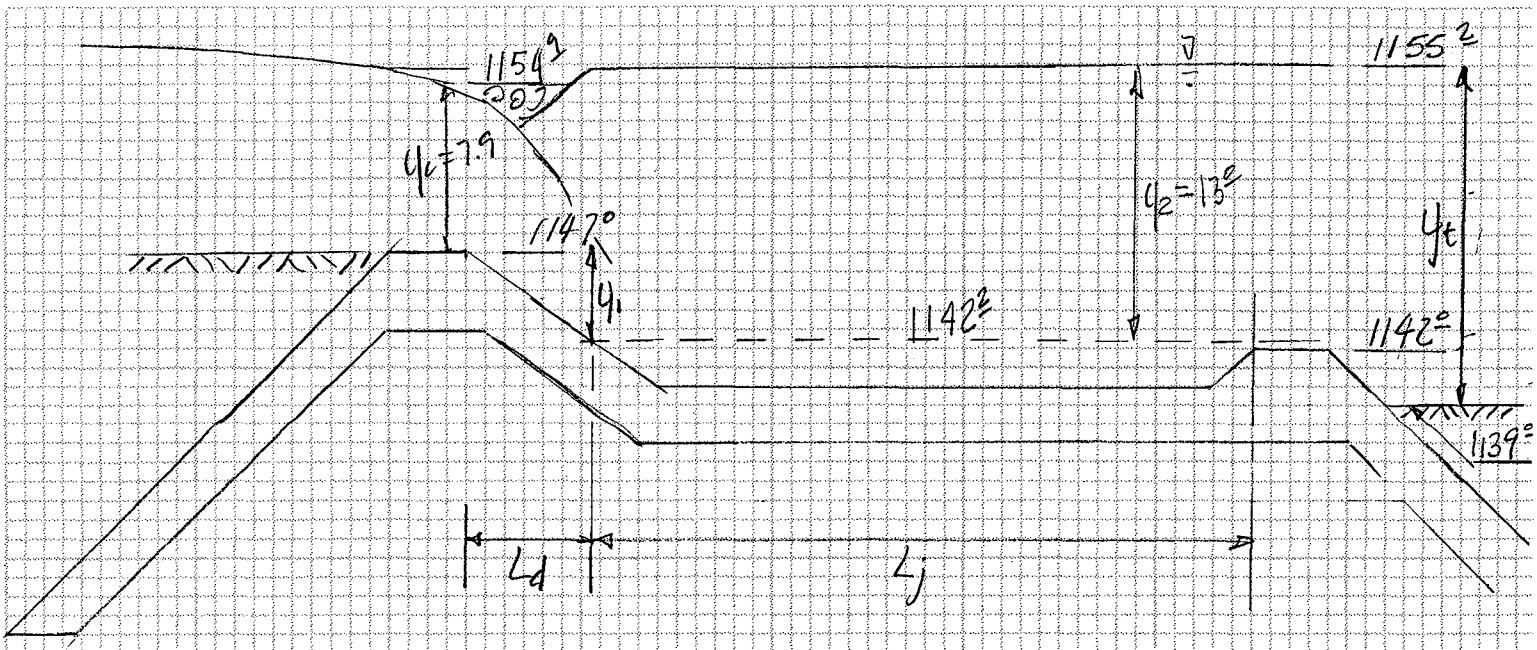
$$F_1 = q/\sqrt{g y_1^3} =$$
$$= 126.3/\sqrt{32.2 \times 4.4^3}$$
$$= 2.41$$

$$y_2 = (y_1/2)\left(\sqrt{1 + 8F_1^2} - 1\right)$$
$$= 13.0'$$

$$\frac{y_{TW}}{y_2} = \frac{16.2}{13.0} = 1.25$$

$$\frac{y_{TW}}{y_1} = \frac{16.2}{4.4} = 3.7$$

CRSS	PROJECT: Rio Salado Channel	JOB NO: R10 IN	NO. 3
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 8/28/90	OF 5
	SUBJECT: GC #5	CHECKED BY: JFM / DATE: 8/29/90	



① Since the drop has a high submergence at this discharge the jump will actually begin on the drop slope.

② The drop length L_d is much shorter than given by the previous equation. Following Elevatorski's procedure

$$L_d = 1.5(1147.0 - (1139.0 + y_t - y_2))$$
$$= 1.5(1147.0 - (1139.0 + 16.2 - 13))$$
$$= 7.2$$

<u>Total Basin Length</u>

$$L_t = L_d + L_j$$
$$= 59.5 + 7.2$$
$$= 66.7'$$

CRSS	PROJECT: Rio Salado Channel	JOB NO: R101N	NO. 4
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 8/28/90	
	SUBJECT: GC #5	CHECKED BY: JFM / DATE: 8/29/90	OF 5

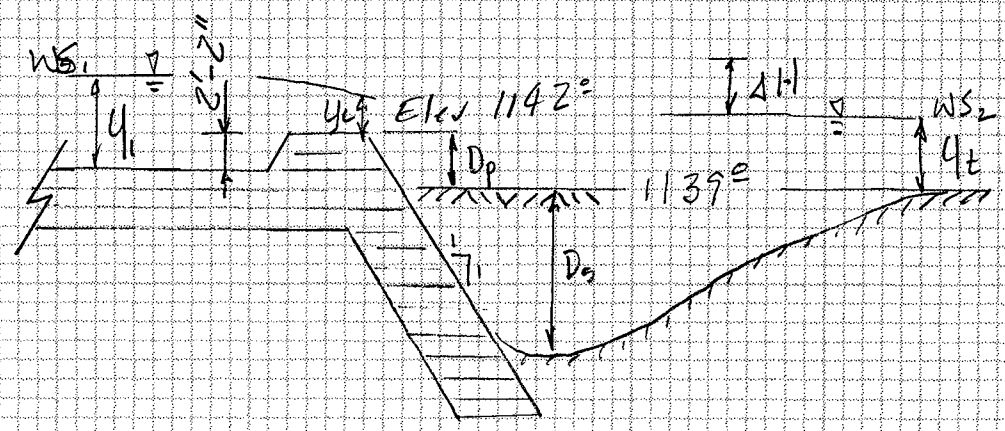
For other discharges*

Q	y_1	y_2	TW	L_j	L_d	L_t
120,000	4.4	13.0	16.2	59.3	7.2	66.7
100,000	3.8	11.8	14.6	55.4	7.8	63.2
80,000	3.1	10.5	12.7	50.7	8.6	59.3
60,000	2.4	8.9	10.7	44.9	9.4	54.3
40,000	1.7	7.2	8.4	37.7	10.2	47.9
20,000	1.0	4.9	5.6	27.3	11.0	38.3

* $\Delta Z_0 = 7.2$ for other Q's

PROJECT	Rio Salado Channel	JOB NO	R10IN	NO.	5
CLIENT	Tempe	DESIGNED BY	GKC	DATE	8/28/90
SUBJECT	GC #5	CHECKED BY	JFM	DATE	8/29/90
				OF	5

C. Scour Below End Sill



Q	q	WS_1	WS_2	ΔH^*	y_t	y_1	S_r^*
1000	1.1	1142.5	1139.9	2.6	0.9	0.5	-
5000	5.3	1143.4	1141.4	2.0	2.4	1.4	-
10000	10.5	1144.3	1142.7	1.6	3.7	2.3	0.30
20000	21.1	1145.6	1144.6	1.0	5.6	3.6	0.72
40000	42.1	1147.7	1147.4	0.3	8.4	5.7	0.95

$\Delta H = WS_1 - WS_2$; $S_r = (y_t - D_p)/y_1$

where $D_p = 3.0'$

$$D_s = 1.36\, y_c\, (\Delta H / y_t)^{0.158}\, S_r^{-0.134}$$

Q	y_c	$\Delta H/y_t$	D_s
1000	0.33	2.89	—
5000	0.96	0.83	—
10000	1.51	0.43	2.11
20000	2.40	0.18	2.60
40000	3.80	0.04	3.13

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HYDRAULIC ENERGY DISSIPATORS

EDWARD A. ELEVATORSKI
Head, Hydraulics Laboratory and
Assistant Professor of Civil Engineering
University of Arizona

McGRAW-HILL BOOK COMPANY, INC.
NEW YORK TORONTO LONDON
1959

By increasing the tailwater depth, it is possible for the designer to move the front of the hydraulic jump up on the sloping apron. There are, in general, three types of jump formations that can occur on a sloping floor. These are shown in Fig. 6-1*a*, *b*, and *c*.

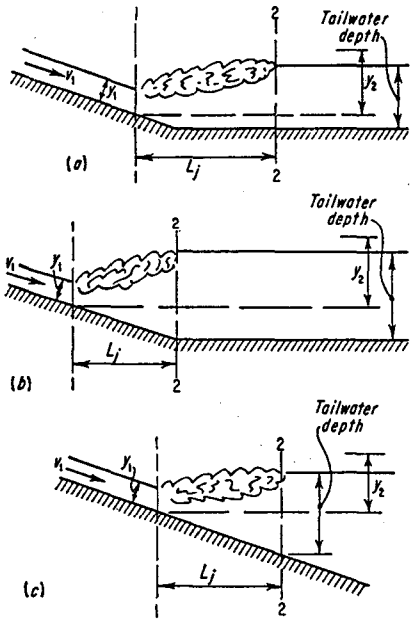


FIG. 6-1. Occurrence of the hydraulic jump on a sloping apron: (a) case I, (b) case II, (c) case III.

The different formations of the hydraulic jump depend primarily upon where the terminus of the jump falls. As shown in Fig. 6-1*a*, case I prevails when the toe of the hydraulic jump forms on the slope, while the terminus, or end, of the jump occurs on the horizontal apron.

In case II, illustrated by Fig. 6-1*b*, the toe of the hydraulic jump occurs on the slope as in case I, but the end of the jump occurs at the junction of the slope and the horizontal apron.

As shown in Fig. 6-1*c*, case III prevails when the hydraulic jump forms entirely on the sloping apron. Cases II and III are practically the same, and further analysis will be made only of cases I and III.

It will be noted that case II is virtually that of the hydraulic jump formed on a horizontal apron, operating with excessive tailwater. As the tailwater is further increased, the formation of the hydraulic jump can be changed progressively from case I to case II and finally to case III.

If the tailwater depth is increased by a vertical element Δy, the front of the hydraulic jump does not rise an equal amount vertically. Instead, the jump profile undergoes an immediate change as the slope becomes part of the stilling basin, as illustrated by Fig. 6-2.

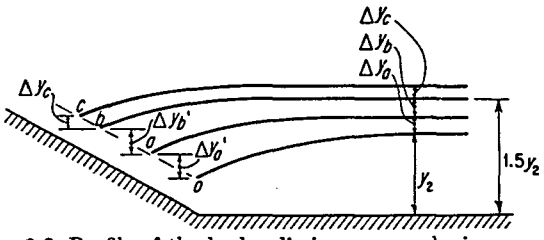


FIG. 6-2. Profile of the hydraulic jump on a sloping apron.

For an increase in tailwater d
on the slope to point *a*, or mov
several times Δy_a. The same e
front of the hydraulic jump is n
of tailwater depth produce the s
will continue until the tailwater
greater than this amount, the
tailwater depth Δy_c moves the fr
equal vertical distance Δy_c.

6-2. Historical Résumé. The
tion of the hydraulic jump was f
of the Miami Conservancy Distr
Riegel were principally interest
apron upon the design of the G

In 1927, Ellms[5] conducted se
4 feet long, whose slope could
Several erroneous results were o
section of the flume he used was
Also, Ellms neglected to compen
bottom of the flume and to ma
flume.

An analysis was attempted
apron-floor pressure under the h
profile from the beginning to th
made in a glass-walled flume 2.5
tigations were made on slopes of
tunately, Yarnell's work was int

In 1935, Rindlaub[9] conducted
of California hydraulic laborato
walled flume 3 ft deep and 0.5
four slopes of 8.2, 12.5, 24.2, and
made on the slope of 12.5°. In
the pressure component on the
term, which can be determin
external forces.

Experiments in a rectangular
14 were performed in 1936 at
Matzke.[1] In order to compensa
floor, a dimensionless cubic equ
be dependent upon the shape
investigated were very small, a
made from the results.

During 1941, Puls[8] presented

For an increase in tailwater depth Δy_a, the front of the jump moves up on the slope to point a, or moves a vertical distance $\Delta y'_a$, which may be several times Δy_a. The same effect occurs to a lesser degree when the front of the hydraulic jump is moved to point b. Additional increments of tailwater depth produce the same effect, only to a lesser degree. This will continue until the tailwater approaches $1.5y_2$. For tailwater depths greater than this amount, the relation is geometric, and an increase in tailwater depth Δy_c moves the front of the hydraulic jump on the slope an equal vertical distance Δy_c.

6-2. Historical Résumé. The effect of a sloping floor upon the formation of the hydraulic jump was first studied in 1917 by Beebe and Riegel[2] of the Miami Conservancy District, located in Dayton, Ohio. Beebe and Riegel were principally interested in studying the effect of a stepped apron upon the design of the Germantown Dam outlet works.

In 1927, Ellms[5] conducted several experiments in a rectangular flume 4 feet long, whose slope could be varied from approximately 9 to 17°. Several erroneous results were obtained by Ellms because the horizontal section of the flume he used was too small to contain the hydraulic jump. Also, Ellms neglected to compensate for the pressure force exerted on the bottom of the flume and to make allowances for the flaring sides of the flume.

An analysis was attempted by Yarnell, in 1934, to determine the apron-floor pressure under the hydraulic jump by assuming a straight-line profile from the beginning to the end of the jump. Over 600 tests were made in a glass-walled flume 2.5 ft wide, 3 ft deep, and 30 ft long. Investigations were made on slopes of 1 on 6, 1 on 3, 1 on 2, and 1 on 1. Unfortunately, Yarnell's work was interrupted by his death.

In 1935, Rindlaub[9] conducted a series of experiments at the University of California hydraulic laboratory. Experiments were made in a glass-walled flume 3 ft deep and 0.5 ft wide. Investigations were made on four slopes of 8.2, 12.5, 24.2, and 30°, with most of the experiments being made on the slope of 12.5°. In his analysis, Rindlaub compensated for the pressure component on the sloping floor by including a dimensionless term, which can be determined experimentally, to account for any external forces.

Experiments in a rectangular channel having a maximum slope of 1 on 14 were performed in 1936 at Columbia University by Bakhmeteff and Matzke.[1] In order to compensate for the weight of the jump on a sloping floor, a dimensionless cubic equation was developed which was found to be dependent upon the shape of the jump. Unfortunately, the slopes investigated were very small, and consequently no generalization can be made from the results.

During 1941, Puls[8] presented a method of routing stream flow through

CRS SIRRINE	PROJECT: Rio Salado Channel	JOB NO. R101N	NO. 1
	CLIENT: Tempe	DESIGNED BY GKC / DATE 8/28/90	OF 1
	SUBJECT: McClintock Grade Control	CHECKED BY JFM / DATE 8/29/90	

Slab Thickness

A. Local uplift on slab

$$\tau_{max} = 2.0 \frac{n^2}{2.21} 62.4 \cdot d_a^{-1/3} V_a^2$$

use $n = 0.024$

$V_a = 28.7$

$d_a = 4.4$

$$\tau_{max} = 2.0 \frac{(0.024)^2}{2.21} 62.4 (4.4)^{-1/3} (28.7)^2$$

$= 16.4$ psf

B. Slab Thickness

For SF = 1.5

$\tau_c = 4.1\ S$ (150 lb/ft³ density)

where S = slab thickness

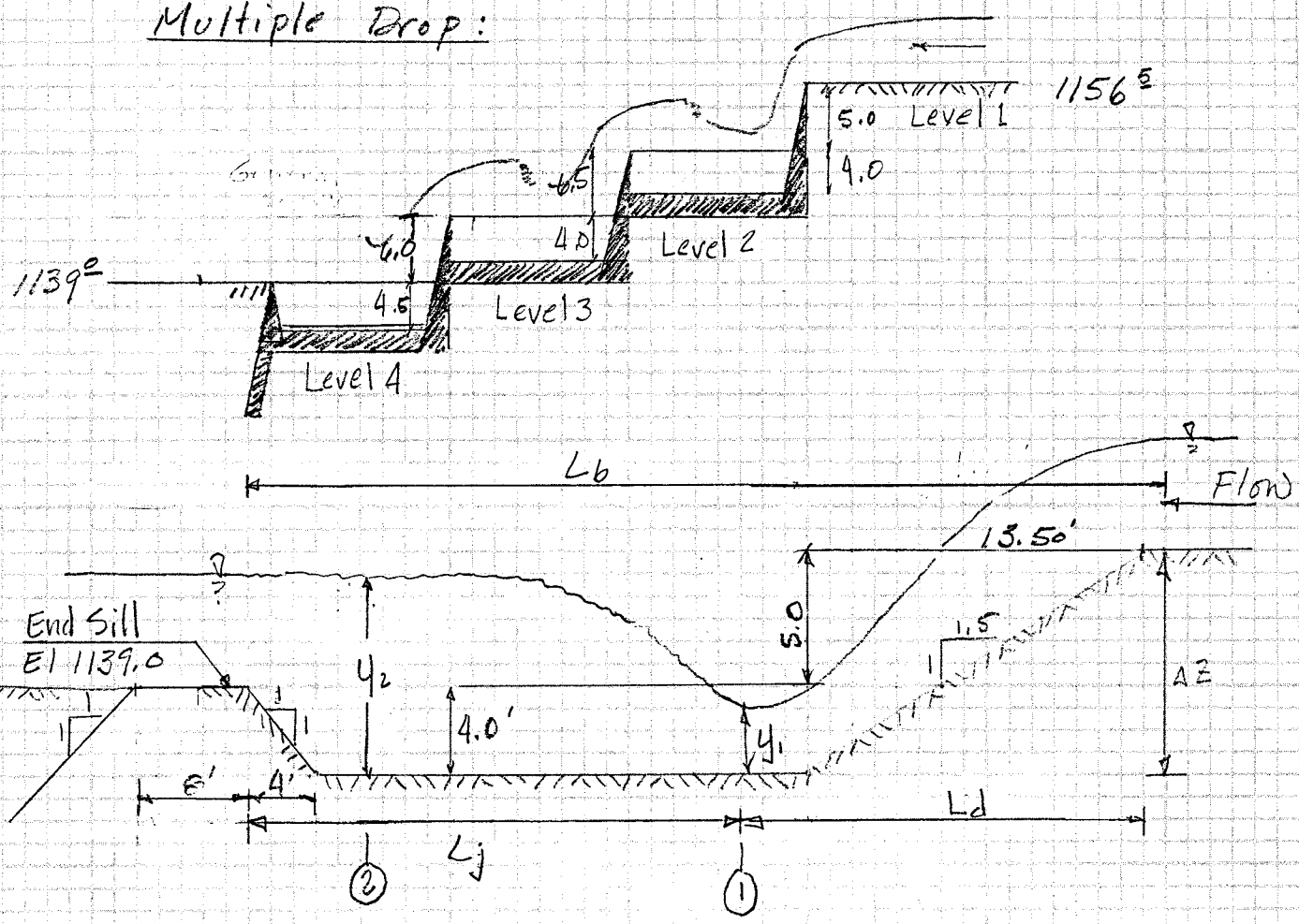
$S = SF(\tau_{max}/4.1)$

$= 1.5(16.4/4.1)$

$= 6.0$ ft

Use 6.0 ft slab thickness

Multiple Drop:



Hydraulic Conditions: Level 1

Design Discharge, $Q_d = 63{,}000$ cfs
Axis Length, $L_a = 621.5$ ft
Unit discharge, $q = 101.4$ cfs/ft

Approach flow conditions

$y_c = 8.3$ ft
$V_c = 14.8$ fps
$H_c = 11.7$ ft

Conditions at base of drop

$$y_1 = 0.54\,(y_c/\Delta Z)^{0.275}\,y_c$$

$$L_d = 4.30\,(y_c/\Delta Z)^{0.09}\,\Delta Z$$

for $y_c = 8.3'$ $\Delta Z = 9.0$

$$y_1 = 0.54(8.3/9.0)^{0.275}\, 8.3 = 4.4'$$

$$L_d = 4.30(8.3/9.0)^{0.09}\, 9.0 = 38.4$$

$$V_1 = 101.4/4.4 = 23.1 \text{ fps}$$

Sequent Depth:

$$y_2 = \tfrac{1}{2}\left(\sqrt{1+8F_b^2} - 1\right) y_1 \qquad \text{where } F = \frac{V_1}{\sqrt{32.2\, y_1}}$$

$$y_2 = \tfrac{1}{2}\left(\sqrt{1+8(1.94)^2} - 1\right) 4.4$$

$$= 10.1$$

For USBR Type III Stilling Basin $(2.5 < F < 4.5)$

$$h_2 = 1.25\, y_1$$
$$= 1.25(4.4)$$
$$= 5.5'$$

$$L_j = 4.24\, y_2$$
$$= 4.24(10.1)$$
$$= 42.8'$$

From Henderson:

$$L_j = 6.9(y_2 - y_1)$$
$$= 6.9(10.1 - 4.4)$$
$$L_j = 39.3$$

(See attached chart from Design of Small Dams).

Total basin length Level 2

$$L_b = L_d + L_j = 38 + 40 = 78'$$

CRSS	PROJECT: Rio Salado Channelization	JOB NO: R101N	NO. 3
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 11/1/90	
	SUBJECT: IBW Drop Structure	CHECKED BY: JFM / DATE: 11/2/90	OF 4

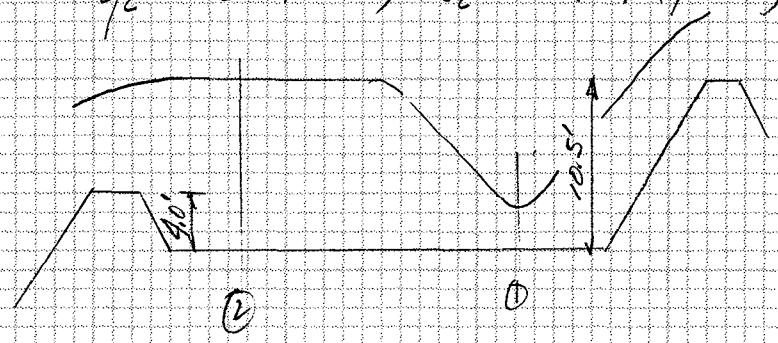
Level 2 Crest:

Design Q = 63000 cfs

Axis Length = 605 ft

Unit discharge = 104.1 cfs/ft

y_c = 8.4' ; V_c = 14.9 fps ; H_c = 11.9 ft



$y_1 = 0.54(y_c/\Delta Z_0)^{0.275}\, y_c$

$= 0.54(8.4/10.5)^{0.275}\, 8.4$

$= 4.3'$

$L_d = 4.3(y_c/\Delta Z_0)^{0.09}\, \Delta Z_0$

$= 4.3(8.4/10.5)^{0.09}\, 10.5$

$= 44.3'$

$y_2 = 1.66(y_c/\Delta Z_0)^{0.81}\, \Delta Z_0$

$= 1.66(8.4/10.5)^{0.81}\, 10.5$

$= 14.6$

$L_j = 6.9(y_2 - y_1)$

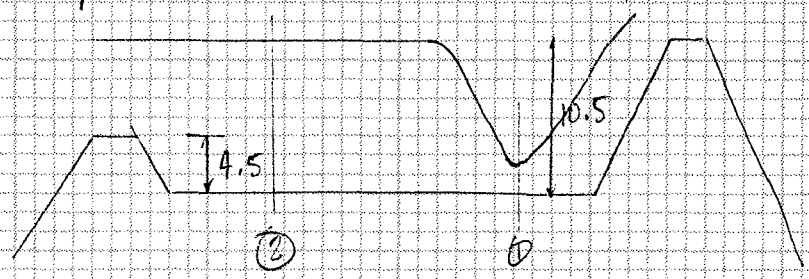
$= 6.9(14.6 - 4.3)$

$= 71.1$

$L_b = L_d + L_j = 44.3 + 71.1 = 115.4'$

Level 3 Crest:

Design Q = 63,000 cfs
Axis Length = 612.2 ft
Unit Discharge = 102.9 cfs/ft
y_c = 8.9 ft; V_c = 14.9 fps; H_c = 12.4 ft.



$y_1 = 0.54(8.9/10.5)^{0.275}\ 8.9$
$= 4.6$

$y_2 = 1.66(8.9/10.5)^{0.81}\ 10.5$
$= 15.3$

$L_d = 4.3(8.9/10.5)^{0.09}\ 10.5$
$= 44.5$

$L_j = 6.9(15.3 - 4.6)$
$= 73.8$

$L_b = 44.5 + 73.8$
$= 118.3$

with experiment is remarkably good considering the approximations that must be inherent in this formulation of the problem.

This analysis by White is commended to the reader as a good example of the way in which skilful formulation and a grasp of fundamentals can yield surprisingly exact solutions of problems which may at first glance appear intractable by theoretical methods. The details can be worked out by the reader as an exercise (Probs. 6.10 and 6.11).

The Drop Structure

Figure 6-17 shows that the energy loss E_L at the base of an overfall may be 50 percent or more of the initial energy, referred to the basin floor as datum. If, as in Fig. 6-16, there is a hydraulic jump downstream of section 1 dissipating further energy, the energy loss in the entire "drop structure" may be very substantial. The loss due to the hydraulic jump is readily calculated (Prob. 6.12) in terms of the parameters of Fig. 6-17, and a curve is plotted on that figure displaced to the left of the E_1/y_c curve by the amount E_J/y_c, where E_J is the loss in the jump. This left-hand curve then indicates the remaining specific energy E_2 downstream of the jump. It is seen that the ratio E_2/y_c does not vary greatly with $\Delta z_0/y_c$; this suggests that a value of 2.5 for E_2/y_c may form a satisfactory basis for a preliminary design (Probs. 6.13 and 6.14).

Rand [25] assembled the results of experimental measurements made by himself, by Moore [24], and others, and from them obtained the following exponential equations, which fit the data with errors of 5 percent or less:

$$\frac{y_1}{\Delta z_0} = 0.54\left(\frac{y_c}{\Delta z_0}\right)^{1.275} \tag{6-37a}$$

or

$$\frac{y_1}{y_c} = 0.54\left(\frac{y_c}{\Delta z_0}\right)^{0.275} \tag{6-37b}$$

$$\frac{y_2}{\Delta z_0} = 1.66\left(\frac{y_c}{\Delta z_0}\right)^{0.81} \tag{6-38}$$

$$\frac{L_d}{\Delta z_0} = 4.30\left(\frac{y_c}{\Delta z_0}\right)^{0.09} \tag{6-39}$$

$$L_j = 6.9(y_2 - y_1) \tag{6-40}$$

where L_d and L_j are the horizontal distances covered by the jet and the hydraulic jump respectively, as shown in Fig. 6-16. With the help of these equations the designer can proportion the simple drop structure completely. The upward step of $y_2/6$ at the end of the structure, shown in Fig. 6-16, is a standard design feature which helps to localize the jump immediately below the overfall.

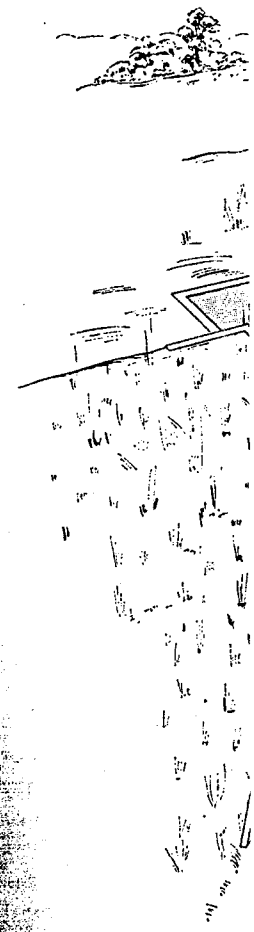


Figure 6-18. *Th*

It has been assume
of the overfall is critic
of the drop structure,
nel to be laid on a r
occur, leading to sup
the jet shape and beh
The drop structure
and is the simplest
practice; e.g., a basin
would indicate, emb
as in Sec. 6.7. A c
Fig. 6-18, which has

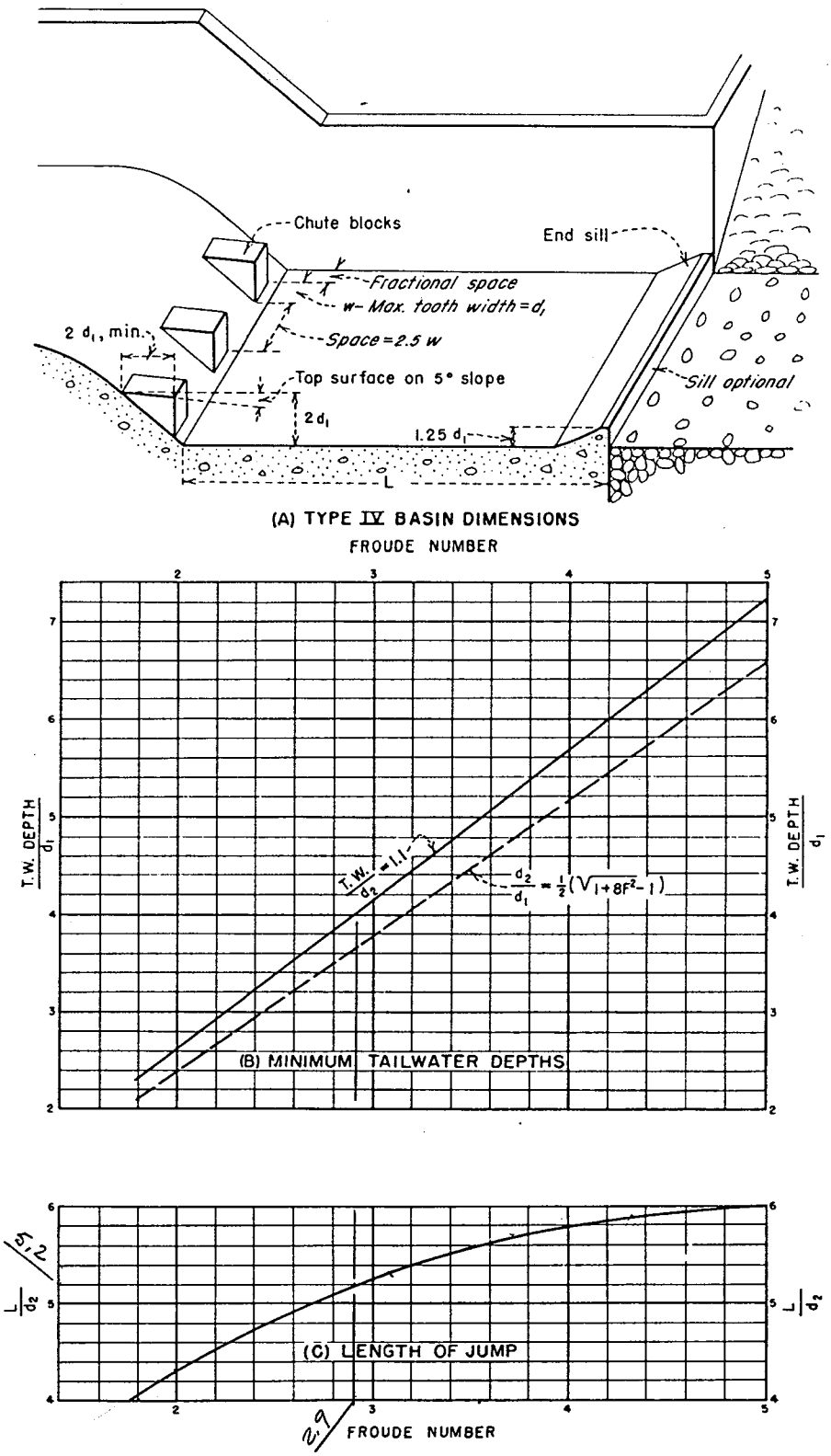
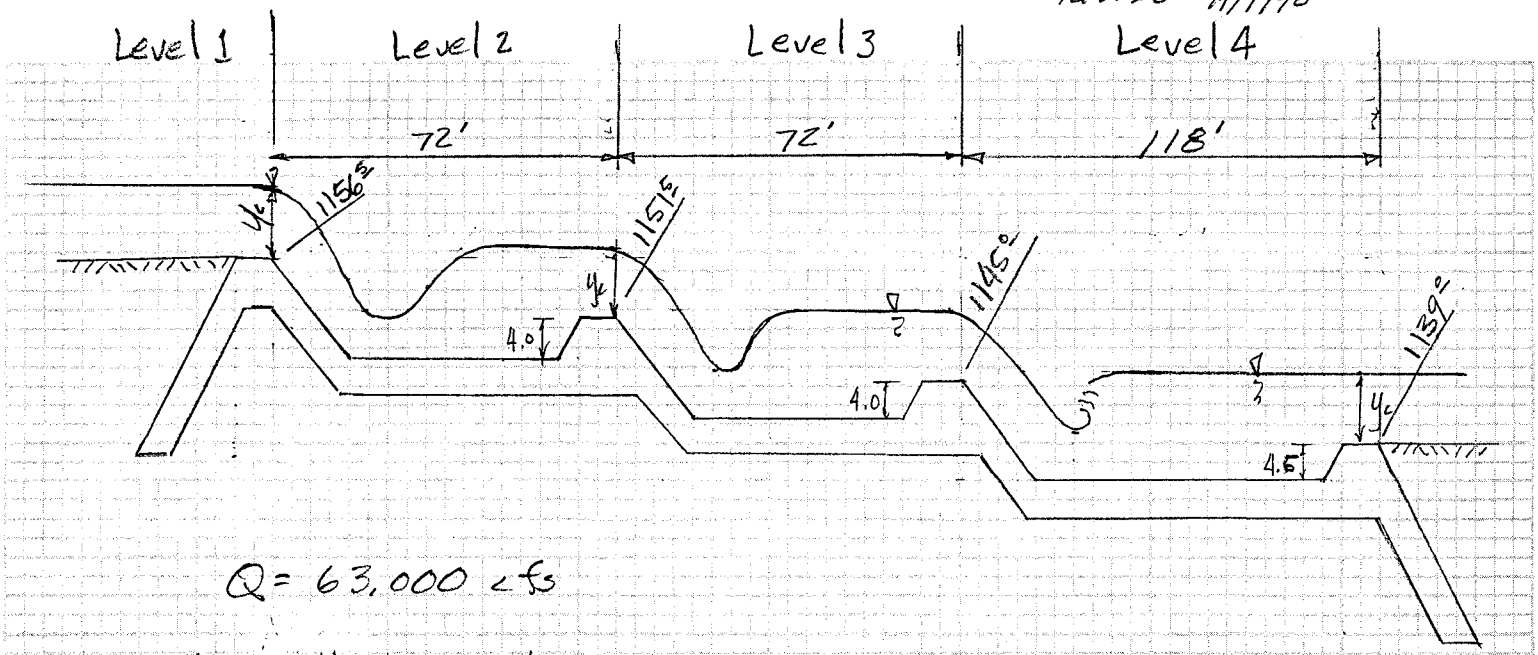


Figure 265. **Stilling basin characteristics for Froude numbers between 2.5 and 4.5. 288—D—2425.**

CRS SIRRINE	PROJECT: 12 Salado Channelization	JOB NO. 12101N	NO. 1 / 3
	CLIENT: City of Tempe	DESIGNED BY: GKC / DATE: 5/18/90	
	SUBJECT: IBW Drop WSP	CHECKED BY: JFM / DATE: 5/18/90	
		Revised 11/1/90	



Q = 63,000 cfs

Level	Crest Elev	Crest Length	q_{max}	y_c	Δz_o	WSEL
I	1156.5	621.5	135.7	8.3	—	1164.8
II	1151.5	605.0	138.2	8.4	9.0	1159.9
III	1145.0	555.5	150.7	8.9	10.5	1153.9
IV	1139.0	537.5	153.2	9.0	10.0	1148.0

Basin	y_1	V_1	F_1	y_2
I-II	4.4	30.8	2.6	10.1
II-III	4.3	32.1	2.7	14.6
III-IV	4.6	32.8	2.7	15.3

[Ref: Henderson, 1966 "Open Channel Flow" Chapter 6, pg 200]

CRSS			
PROJECT: Rio Salado	JOB NO: R10N		NO. 2
CLIENT: Tempe	DESIGNED BY: GKC	DATE: 5/25/90	OF 3
SUBJECT: Critical Depths IBW Drop	CHECKED BY: JFM	DATE: 5/18/90	
	Revised	11/1/90	

Crest Section Level 1

Sta	Elev
0.0	1170.0
15.75	1159.5
326.50	1156.5
637.25	1159.5
653.0	1170.0

Q	y_c	Area	TopWid	Vel
63,000	8.3	4268	637.4	14.8

$q_{max} = 135.7$

where $q_{max} = \sqrt{y_c^3 g}$

Crest Section Level 2

Sta	Elev
8.0	1170.0
23.25	1154.5
325.75	1151.5
628.25	1154.5
651.0	1170.0

Q	y_c	Area	TopWid	Vel
63,000	8.4	4216	621	14.9

$q_{max} = 138.2$

Crest Section Level 3

Sta	Elev
0.0	1170.0
23.25	1154.5
38.25	1154.5
48.0	1148.0
325.75	1145.0
603.50	1148.0
613.25	1154.5
628.25	1154.5
651.50	1170.0

Q	y_c	Area	TopWid	Vel
63,000	8.9	4219.6	612.2	14.9

$q_{max} = 150.7$

PROJECT	Rio Salado	JOB NO	R101N	NO.	3
CLIENT	Tempe	DESIGNED BY	GKC	DATE	5/25/90
SUBJECT	IBW Drop Rating	CHECKED BY	JFM	DATE	5/25/90
				OF	3

Elev	Depth	Area	TopWid	Q_c
1157.5	1.0	103.6	207.2	416
58.5	2.0	414.3	414.3	2351
59.5	3.0	932.3	621.5	6474
60.5	4.0	1555.3	624.5	13917
61.5	5.0	2181.3	627.5	23059
62.5	6.0	2810.3	630.5	33641
63.5	7.0	3442.3	633.5	45497
64.5	8.0	4077.3	636.5	58512
64.8	8.3	4265.0	637.4	63000

$$Q_c = \sqrt{g}\, A^{3/2} / T^{1/2}$$

Design Discharges:

Q	Elev	Design Event
30,000	1162.2	100-yr
43,000	1163.3	Bankfull
51,000	1163.9	Super Flood
63,000	1164.8	SPF

Coincident Stage: Salt Riv/IBW

Salt / IBW	10-year	100-yr	Qmax
100-yr			
Bank			
Super			
SPF			

CRS SIRRINE	PROJECT: Ri Salado Channelization	JOB NO. R101N	NO. 1
	CLIENT: Tempe	DESIGNED BY GRC / DATE 5/27/90	OF 1
	SUBJECT: IBW Drop structure	CHECKED BY JFM / DATE 7/30/90	

A. Dynamic Uplift Force on Slab

Assume that $\Delta P_{max} \propto \tau_{max}$ where τ_{max} is the shear force on the stilling basin and ΔP_{max} is the differential pressure to uplift the slab.

$$\tau_{max} = 2.0 \frac{n^2}{2.21} 62.4 * d_a^{-1/3} V_a^2$$

assume $n = 0.024$

For stilling basins

$V_a = 30.8 - 32.8$ fps

Basin	q_{max}	y_1	V_1
2	135.7	4.4	30.8
3	138.2	4.3	32.1
4	150.7	4.6	32.8

$$\tau_{max} = 2 \frac{(0.024)^2}{2.21} 62.4 (4.6)^{-1/3} (32.8)^2$$

$$= 21.0 \text{ lb/ft}^2$$

B. Slab Thickness

For $SF = 1.3$

$\tau_c = 4.1 S$ (150 lb/ft³ density)

where S = slab thickness

$$S = SF(\tau_{max}/4.1)$$

$$= 1.3(21.0/4.1) = 6.7 \text{ ft}$$

Use 6.75' slab thickness (9-9" lifts)

Rio Salado Channelization
IBW Drop Structure
Seepage and Uplift Computation:
Lane's Weighted Creep Method

Job No.:
Dgn. By: GKC Date: 09/21/90
Chk. By: JFM Date: 9/24/90

Path	Dir	Length (ft)	Cumm Length (ft)	Weight Factor	Eff Length (ft)	Frac Length	Uplift Head Low (ft)	Uplift Head High (ft)
2-3	V	22.00	22.00	2.00	14.67	0.08	16.11	25.11
3-4	H	8.00	30.00	1.00	17.33	0.09	15.86	24.86
4-5	V	17.00	47.00	2.00	28.67	0.15	14.79	23.79
5-6	H	4.00	51.00	1.00	30.00	0.16	14.66	23.66
6-7	V	22.25	73.25	2.00	44.83	0.24	13.26	22.26
7-8	V	4.50	77.75	3.00	49.33	0.27	12.84	21.84
8-9	H	8.00	85.75	1.00	52.00	0.28	12.58	21.58
9-10	V	4.50	90.25	3.00	56.50	0.31	12.16	21.16
10-11	H	56.50	146.75	1.00	75.33	0.41	10.38	19.38
11-12	H	9.75	156.50	1.00	78.58	0.42	10.07	19.07
12-13	V	4.50	161.00	3.00	83.08	0.45	9.64	18.64
13-14	H	8.00	169.00	1.00	85.75	0.46	9.39	18.39
14-15	V	4.50	173.50	3.00	90.25	0.49	8.97	17.97
15-16	H	54.25	227.75	1.00	108.33	0.59	7.26	16.26
16-17	H	9.75	237.50	1.00	111.58	0.60	6.95	15.95
17-18	V	4.50	242.00	3.00	116.08	0.63	6.52	15.52
18-19	H	8.00	250.00	1.00	118.75	0.64	6.27	15.27
19-20	V	4.50	254.50	3.00	123.25	0.67	5.85	14.85
20-21	H	95.50	350.00	1.00	155.08	0.84	2.84	11.84
21-22	V	15.00	365.00	2.00	165.08	0.89	1.89	10.89
22-23	H	8.00	373.00	1.00	167.75	0.91	1.64	10.64
23-24	V	26.00	399.00	2.00	185.08	1.00	0.00	9.00

High Stage:
Upper = 1164.80 △1
Lower = 1148.00
Creep ratio = 11.02

Low Stage:
Upper = 1156.50 △1
Lower = 1139.00
Creep ratio = 10.58

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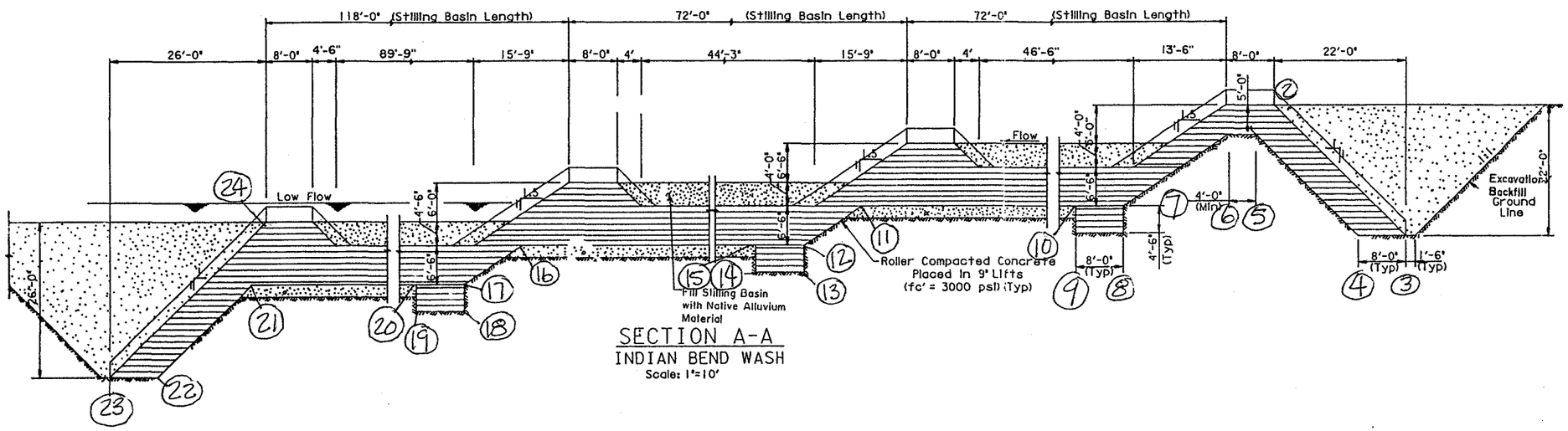
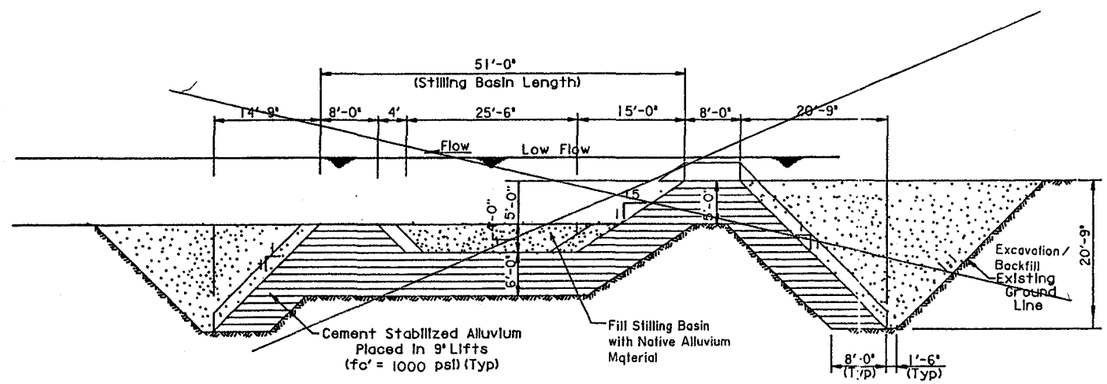
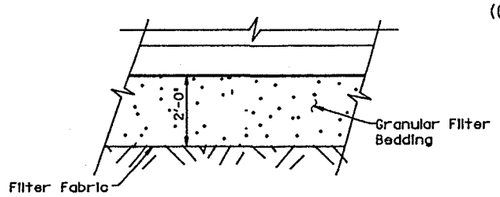
△1 revised 11/1/90 to conform to final structure dimensions and stage/discharge relationship



SECTION A-A
INDIAN BEND WASH
Scale: 1"=10'



SECTION A-A
McCLINTOCK DR.
(GRADE CONTROL No. 5)
Scale: 1"=10'



FILTER DRAIN DETAIL

APPROXIMATE QUANITIES

IBW

Roller Compacted Concrete	55,000 CY
Granular Filter Bedding	9,000 CY
Filter Fabric	13,600 CY
Structural Backfill	26,150 CY
Structural Excavation	452,800 CY

McClintock

Cement Stabalized Alluvium	21,435 CY
Structural Backfill	24,400 CY
Structural Excavation	42,400 CY

CONSTRUCTION NOTES

-For McClintock Structure Additional Details Refer to Sht No. 573

-For Indian Bend Wash Structure Additional Details Refer to Sht No. 572

-All Work shall be done According to the Arizona Department of Transportation "Standard Specifications For Road and Bridge Construction." 1987 Edition Amended By Special Provisions.

Design:

In Accordance with ACI 318-83 and Arizona Department of Transportation Highway Division, Structures Section Drainage Manual, Edition August 1987.

Design Loads:

-Cement Stabilized Alluvium - 140 pcf
-Dry Alluvium - 110 pcf
-Hydraulic Uplift (Dynamic) - 21.2 psf
-Design Flow Velocity - 30fps

Materials:

-Cement Stabilized Alluvium - fc' = 1000 psi (7 days)
-Roller Compacted Concrete - fc' = 3000 psi (28 days)

-Granular Filter Bedding (1)
-Filter Fabric (2)

Miscellaneous:

-All Dimensions Shown on the Plans are Measured Horizontally or Vertically Unless Otherwise Noted.

(1) GRADING

Sieve Size	Percent by Weight passing Sieve
3"	100%
2"	70-85%
1"	40-60%
0.5"	8-15%
#200	0-5%

(2) Min Permeability 6.2×10^{-4} ft/sec
Max AOS 0.6
Type: Mirafi 140N
Typar 3401
Trivera Spunbound 1112
or Approved Equal

NO.	DATE	DESCRIPTION	APPROVAL
3			
2			
1			

REVISIONS

CRSS, INC.
PHOENIX, ARIZONA

RIO SALADO
CHANNEL DESIGN

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA

DESIGNED: JV
DRAWN: CRS
APPROVED: GKC
SCALE: NOTED

GRADE CONTROL STRUCTURES
CROSS SECTIONS & DETAILS

DATE 8 1-90
PROJECT NO. 876191
SHT 574 OF 585
CH-7.3

① The weep holes drain water that is dammed behind the drop. From the Lane's weighted creep analysis it was found that the largest uplift pressure will exist in the lowest stilling basin of the structure. The average uplift head on the slab is 8.9 feet. The average path length to the lower basin is 123 feet. Assuming that the weep holes will reduce the pressure head on the lower basin to zero, the ground water gradient is

$$i = (18.0 + 4.5)/123 \quad \text{(where 4.5 is the end sill height)}$$
$$= 0.183$$

The drainage path is through the existing fine sand material with a hydraulic conductivity of 3×10^{-3} cm/sec (from Morris & Johnson). or 9.8×10^{-5} ft/sec.

② Weep hole discharge

$$Q = k i A$$

for weep holes on 12' spacing

$$A = 144 \text{ sq. ft}$$

$$Q = 9.8 \times 10^{-5} (0.183)\, 144$$
$$= 2.5 \times 10^{-3} \text{ cfs/hole}$$

③ The influence of a single weep hole will extend radially from the hole. For a single hole

$$Q_e = k i A_e$$
$$= k i \pi r_e^2$$

where r_e = effective draw down radius

$$Q_e = 9.8 \times 10^{-5} (0.183) \pi r_e^2$$
$$= 1.8 \times 10^{-5} \pi r_e^2$$

④ For a radial drain

$$Q = \frac{\pi k h_e^2}{\ln(r_e/r_w)}$$

where r_e = weep hole radius (1")

⑤ Combining 3 & 4 gives

$$k i \pi r_e^2 = \frac{\pi k h_e^2}{\ln(r_e/r_w)}$$

$$r_e^2 \ln(r_e/r_w) = h_e^2/i$$

⑥ For $h_e = 8.9'$ $\quad i = 0.183$

$r_w = 0.083'$

$$r_e^2 \ln(r_e/0.083) - 432.8 = 0$$

$r_e = 9.5'$

(7) At a radius of 6' the effective draw down can be found from eq. 4.

$$h = \left(\frac{Q \ln(r/r_w)}{\pi k}\right)^{1/2}$$

$$h = \left[\frac{2.5\times10^{-3}(\ln(6/0.083))}{\pi\ 9.8\times10^{-5}}\right]^{1/2}$$

$$= 5.9'$$

(8) By adding a granular filter layer the drawdown can be locally increased. For gravel, $k = 0.4$ cm/sec or 0.13×10^{-1} ft/sec.

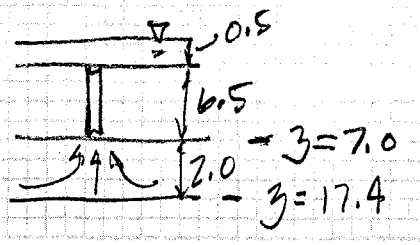
$$h = \left[\frac{2.5\times10^{-3}(\ln(6/.083))}{\pi\ 0.013}\right]^{1/2}$$

$$= 0.51$$

This is a 94% reduction in uplift pressure head.

(9) For a 2' thick granular bedding layer, the ground water gradient is

$$i = 10.4/2 = 5.2$$



(10) This gives an apparent velocity of for the granular layer of

$$V = ki$$
$$= 0.013(5.2) = 0.068$$

which is much larger than the velocity in the surrounding fine sand material.

(11) check Reynold No.

$$Re = \frac{q\bar{d}}{\nu} \quad \text{where} \quad \bar{d} = \sqrt{0.6k}$$
$$= 0.09' \sim 1''$$
$$\bar{d} \approx D_{50} \checkmark$$

$$= \frac{(2.5\times10^{-3}/144)\,0.09}{1\times10^{-5}}$$

$$= 0.16 \checkmark$$

For Darcy law to be valid $Re < 1$

(12) Velocity in weep hole

$$V = 2.5\times10^{-3}/\pi(0.083)^2$$

$$= 0.12 \text{ fps} \checkmark$$

Fall velocity of a 1/4" ϕ stone is about 0.9 fps

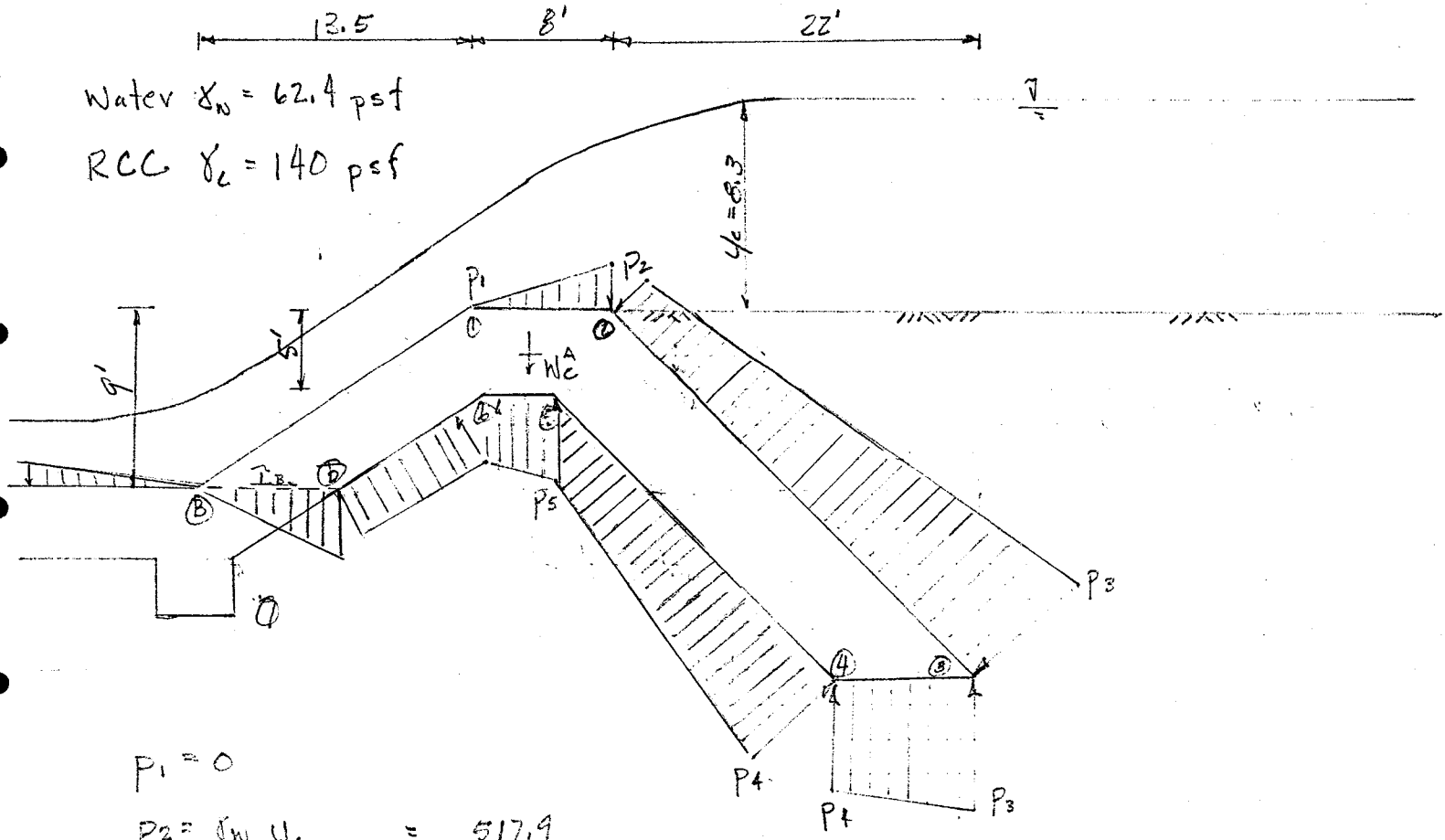
CRSS

CRS SIRRINE

DESIGN SHEET

Job: RIO SALADO CHANNEL DGN
Structure: INDIAN BEND WASH DROP
Live Load Per Square Foot: _____

Job No.: R101N Date: 10/15/90
Computed By: JFM GKC 11/5/90
Working Stress: _____



$P_1 = 0$

$P_2 = \gamma_w y_c = 517.9$

$P_3^* = \gamma_w 25.11 = 1566.9$

$P_4 = \gamma_w 24.86 = 1551.3$

$P_5 = \gamma_w 23.79 = 1489.5$

$P_6 = \gamma_w 23.66 = 1476.4$

$P_7 = \gamma_w 22.26 = 1389.0$

$P_b = 1443.1$

*Note: See computation of uplift pressures by weighted Creep Method.

Assumptions:

- Uplift pressures based on weighted creep methodology
- No scour in the approach reach
- Zero pressure on spillway face
- Friction factor $\mu = \tan(40°) = 0.84$
- Cracks in planes A'-A & B-B
- Sliding resisted: 20% Concrete Shear, 80% Friction Shear
- Calculations don't reflect weep-hole drains for pressure relief

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By JFM
Live Load Per Square Foot _____ Working Stress GKC 11/5/90

Moment Around B : Full Section

Forces:

$F_{1-2} = (0 + 0.518)/2 * 8 = 2.07$; $F^V_{1-2} = -2.07$; $F^H_{1-2} = 0.0$

$F_{2-3} = (0.518 + 1.567)/2 * 31.1 = 32.4$; $F^V_{2-3} = -22.9$; $F^H_{2-3} = -22.9$

$F_{3-4} = (1.567 + 1.551)/2 * 8 = 12.5$; $F^V_{3-4} = 12.5$; $F^H_{3-4} = 0.0$

$F_{4-5} = (1.551 + 1.485)/2 * 24.0 = 36.4$; $F^V_{4-5} = 25.8$; $F^H_{4-5} = 25.8$

$F_{5-6} = (1.485 + 1.476)/2 * 4.5 = 6.66$; $F^V_{5-6} = 6.66$; $F^H_{5-6} = 0.0$

$F_{6-b} = (1.476 + 1.443)/2 * 7.2 = 10.5$; $F^V_{6-B} = 5.83$; $F^H_{6-B} = -8.74$

$F_{b-B} = (1.443 + 0)/2 * 8 = 5.77$; $F^V_{b-B} = 5.77$; $F^H_{b-B} = 0.0$

$W_c = (4*8 + 14.3*5 + 17*8)/40 = 33.5$; $F_c^V = -33.5$; $F_c^H = 0.0$

Moment Arms:

Force	X	Y
F_{1-2}	18.83	—
F_{2-3}	34.34	-3.84
F_{3-4}	39.51	—
F_{4-5}	27.05	-4.55
F_{5-6}	16.25	—
F_{6-B}	11.0	2.0
F_{b-B}	3.33	—
W_c	23.60	—

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By GKC/JFM
Live Load Per Square Foot _____ Working Stress GKC 11/5/90

Sliding:

$\tau_S = 0.95\sqrt{3000}\ 8\ (12^2) = 59.9$

$\tau_f = 0.5(1.91) = 0.96$

$\tau_B = 0.8(0.96) + 0.2(59.9) = 12.75$

$SF = \dfrac{12.75 + 25.8}{22.9 + 8.74} = 1.2$

Overturning:

$\Sigma M_J = 18.83(2.07) + 34.34(22.9) + 23.6(33.5) + 3.84(22.9)$

$= 1704$ k-ft

$\Sigma M_J = 39.51(12.5) + 27.05(25.8) + 16.25(6.66) +$

$11.0(5.83) + 4.55(25.8) + 2.0(8.74) + 3.33(5.77)$

$= 1518$ k-ft

$SF = \dfrac{\Sigma M_J}{\Sigma M_J} = \dfrac{1704}{1518} = 1.1$

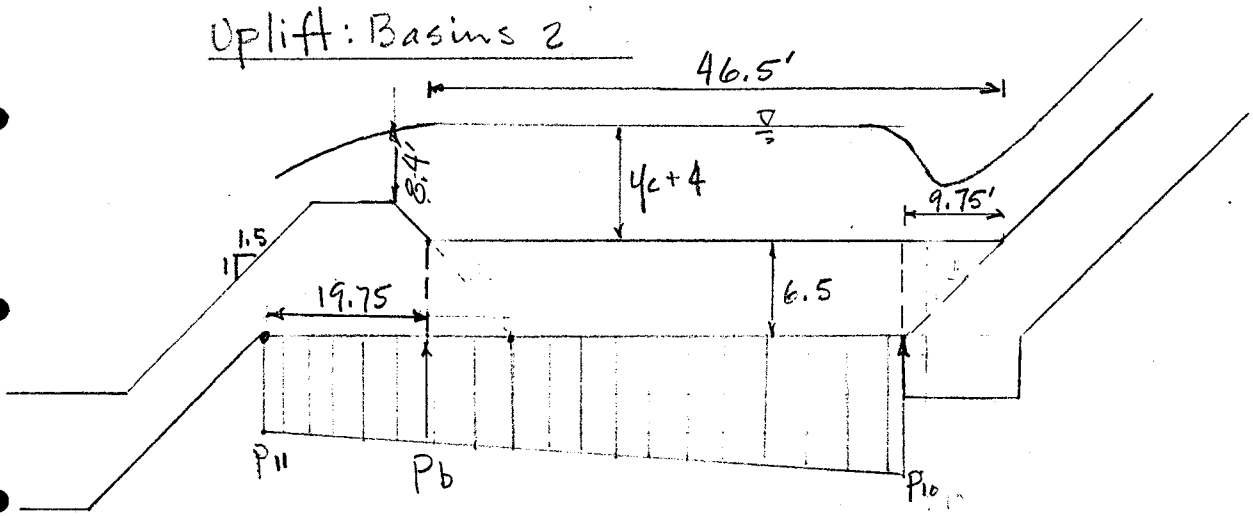
CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By VFM
Live Load Per Square Foot _____ Working Stress ~~GKC 11/5/90~~

Uplift: Basins 2



For basin 2:

Wet: $P_{10} = 21.2$ Dry: $P_{10} = 12.2$

$P_{11} = 19.4$ $P_{11} = 10.4$

$P_b = 20.0$ $P_b = 11.0$

$F^{u}_{10-b} = (21.2 + 20.0)/2 * 62.4 * 36.8 = 47.3\ k$ (wet)
$(12.2 + 11.0)/2 * 62.4 * 36.8 = 26.6\ k$ (dry)

$F^{d}_{10-b} = 12.4 * 62.4 * 36.8 = 28.5\ k$ (wet)
$= 0.0\ k$ (dry)

$W_c = 36.8 * 6.5 * 140 = 33.5\ k$ wet/dry

$SF_w = \frac{28.5 + 33.5}{47.3} = 1.4$ wet

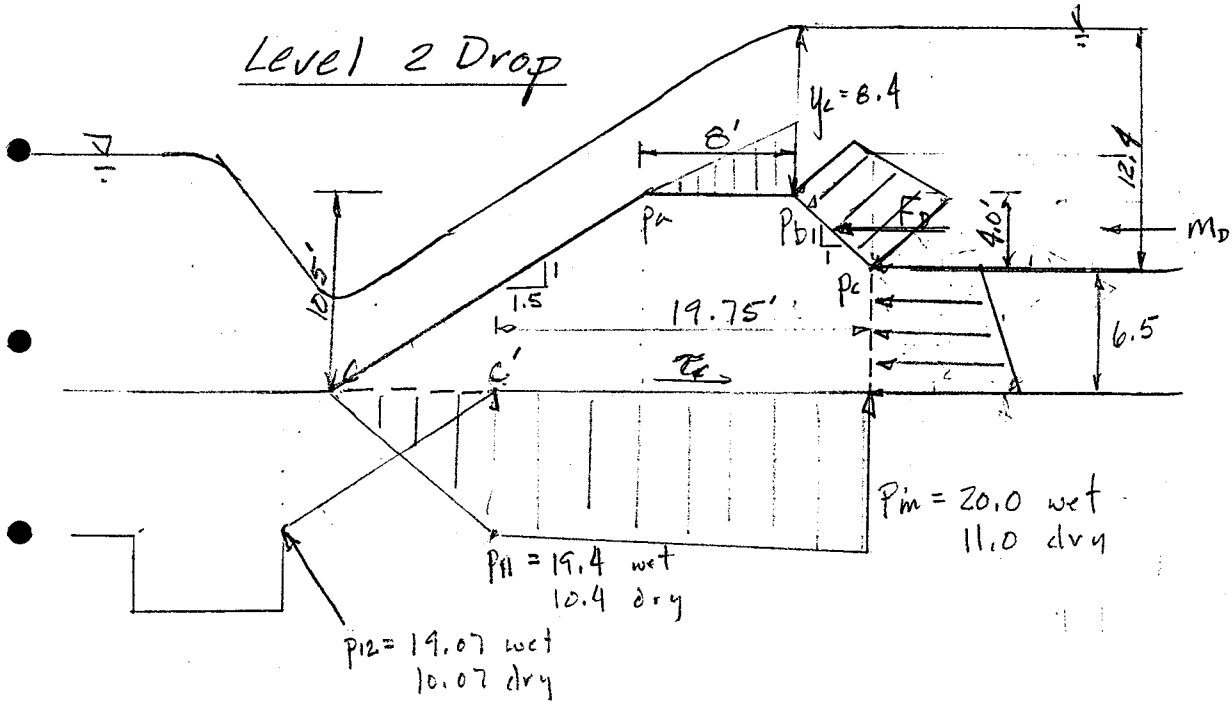
$SF_D = \frac{33.5}{26.6} = 1.3$ dry

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By JFM
Live Load Per Square Foot _____ Working Stress _____ GKC 11/6/90



$p_a = 0$

$p_b = 8.4 \times \gamma_w = 0.524$ ksf

$p_c = 12.4 \times \gamma_w = 0.774$ ksf

$p_m = 20.0 \times \gamma_w = 1.248$ k (wet)
$11.0 \times \gamma_w = 0.686$ k (dry)

$p_{11} = 19.4\ \gamma_w = 1.211$ k (wet)
$10.4\ \gamma_w = 0.649$ k (dry)

$p_{12} = 19.1\ \gamma_w = 1.192$ k (wet)
$10.1\ \gamma_w = 0.630$ k (dry)

$m_D = C_D\ \frac{1}{2} \rho V_0^2 = 1.5 \times (\frac{1}{2} \times 1.94 \times 11.2^2) = 0.18$ ksf

$C_D = 1.5$ for triangle. see Morris & Wiggert "Applied Hydraulic in Engineering" pg 93
See Table on Sheet 10/10.

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By JFM
Live Load Per Square Foot _____ Working Stress _____ 6/KC 11/5/90

For Section c-c'

$F_{a-b} = (0+0.524)/2 * 8 = 2.10$; $F^V_{a-b} = 2.10$; $F^H_{a-b} = 0.0$

$F_{b-c} = (0.524+0.774)/2 * 5.66 = 3.67$; $F^V_{b-c} = 2.60$; $F^H_{b-c} = -2.60$

$F_{c-m} = (0.774+1.248)/2 * 6.5 = 6.57$; $F^V_{c-m} = 0.0$; $F^H_{c-m} = -6.57$

$F_{m-11} = (1.248+1.211)/2 * 19.8 = 24.3$; $F^V_{m-11} = -24.3$; $F^H_{m-11} = 0.0$

$F_{11-c} = (1.211+0)/2 * 8 = 4.84$; $F^V_{11-c} = -4.83$; $F^H_{11-c} = 0.0$

$\tau_c = 0.8(0.5*3.67)+0.2(60) = 13.47$; $F^V_\tau = 0.0$; $F^H_\tau = 13.47$

$W_c = 200.7 * 140 = 28.1$; $F^V_c = 28.1$; $F^H_c = 0.0$

$F_D = 0.18 * 4 = 0.72$; $F^V_D = 0.0$; $F^H_D = -0.72$

Force	Moment Arm X	Y
F_{a-b}	21.1	—
F_{b-c}	25.9	8.37
F_{c-m}	—	3.00
F_{m-11}	17.9	—
F_{11-c}	5.33	—
W_c	17.0	—
F_D	—	8.5

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By JFM GKC 11/5/90
Live Load Per Square Foot _____ Working Stress _____

SF Overturning : Moment about C

$$\Sigma M) = 2.10(21.1) + 2.60(25.9) + 28.1(17.0)$$
$$= 589.4$$

$$\Sigma M) = 24.3(17.9) + 2.60(8.37) + 6.57(3.00) + 0.72(8.5) + 4.83(5.33)$$
$$= 508.3$$

$$\frac{\Sigma M)}{\Sigma M)} = \frac{589.4}{508.3} = 1.2$$

SF Sliding.

$$SF = \frac{13.47}{2.60 + 6.57 + 0.72} = 1.4$$

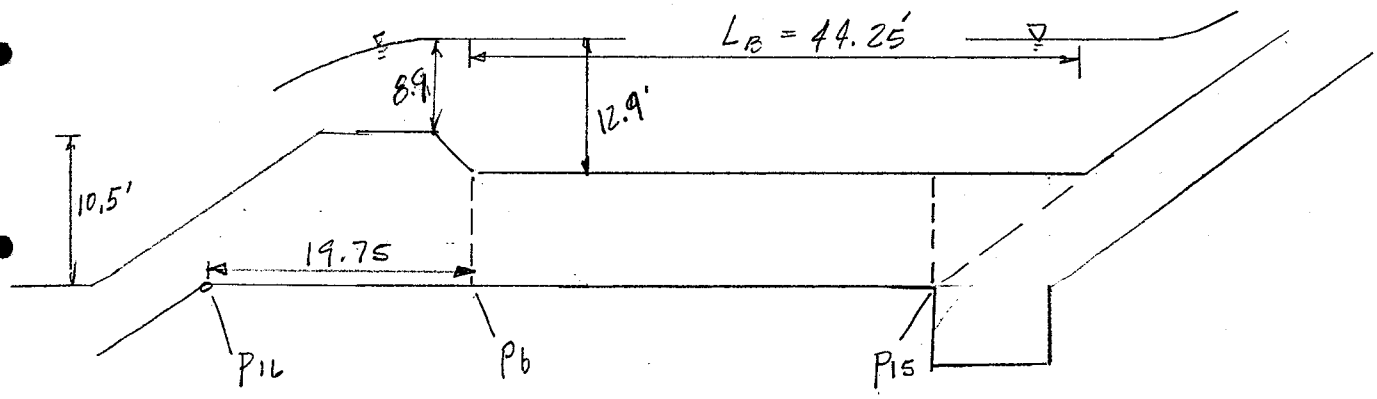
CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By VFM
Live Load Per Square Foot _____ Working Stress ~~6/LC~~ 11/5/90

Level 3 Basin



Wet: $P_{15} = 18.0$ Dry: $P_{15} = 9.0$

$P_{1L} = 16.3$ $P_{1L} = 7.3$

$P_b = 16.9$ $P_b = 7.9$

$F^U_{15-b} = (18.0 + 16.9)/2 * 62.4 * 37.75 = 41.1$ kips (wet)

$(9.0 + 7.9)/2 * 62.4 * 37.75 = 19.9$ kips (dry)

$F^D_{15-b} = (12.9 * 62.4) * 37.75 = 30.4$ kips (wet)

$= 0.0$ kips (dry)

$W_c = 37.75 * 6.5 * 140 = 34.4$ kips (wet/dry)

$SF_w = \frac{34.4 + 30.4}{41.1} = 1.6$ wet

$SF_D = \frac{34.4}{19.9} = 1.7$ (dry)

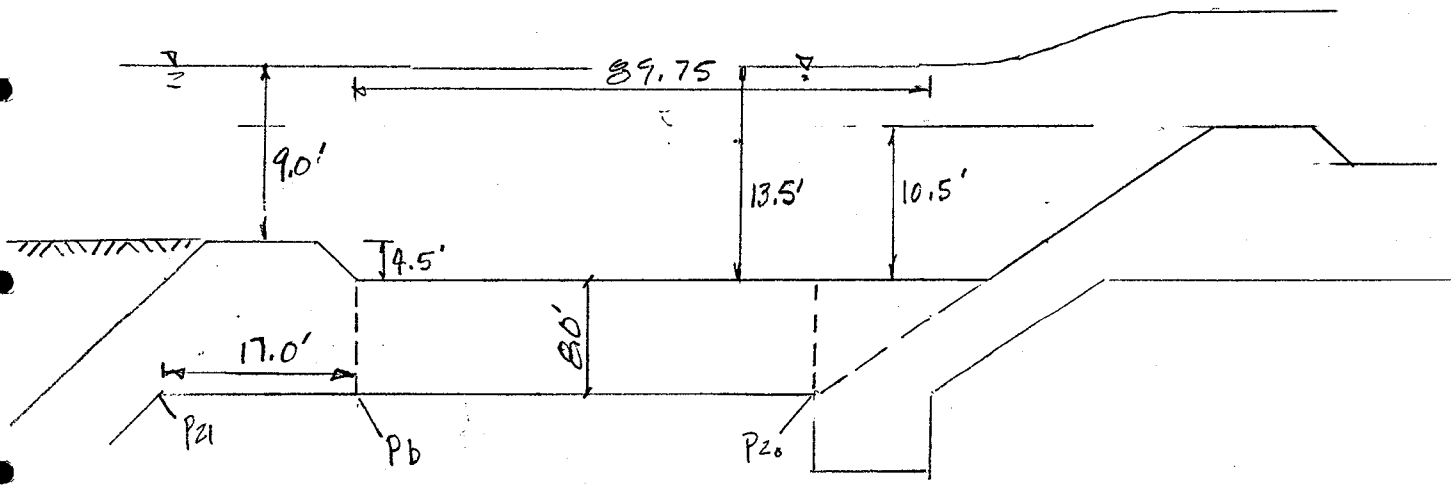
CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90
Structure _____ Computed By JFM
Live Load Per Square Foot _____ Working Stress GKC 11/5/90

Level 4 Basin



Wet: $P_{20} = 14.9$ Dry: $P_{20} = 5.9$

$P_{21} = 11.8$ $P_{21} = 2.8$

$P_b = 12.4$ $P_b = 3.4$

$$F^{U}_{20-b} = \begin{cases} (14.9 + 12.4)/2 * 62.4 * 77.8 = 66.3 \text{ kips (wet)} \\ (5.9 + 3.4)/2 * 62.4 * 77.8 = 22.6 \text{ kips (dry)} \end{cases}$$

$$F^{D}_{20-b} = (13.5 * 62.4) * 77.8 = 65.5 \text{ kips (wet)}$$
$$= 0. \text{ kips (dry)}$$

$$W_c = 77.8 * 8 * 140 = 87.1 \text{ kips (wet/dry)}$$

$$SF_W = \frac{65.5 + 87.1}{66.3} = 2.3 \text{ (wet)}$$

$$SF_D = \frac{87.1}{22.6} = 3.9 \text{ (dry)}$$

CRSS

CRS SIRRINE

10/10

DESIGN SHEET

Job _____ Job No. _____ Date 10/15/90 JFM

Computed By _____ GKC 11/5/90

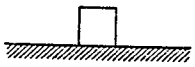
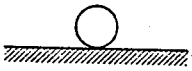
Spot Roughness	Type of Element	C_D
Sphere		0.5
Hemisphere		0.4
Cube		1.5
Cone		0.5
Strip Roughnesses		
Rectangular		1.9
Circular		1.2
Elliptical		0.5
Semi-circular		0.9
Triangular		1.5 ← Use
Depression Roughnesses		
Rectangular slot		1.0
Hemispherical pit		0.2

Fig. 3–11. Drag coefficients for roughness elements.

curves, define the entire transition from smooth flow to normal turbulent flow for corrugated surfaces. As noted before, this includes a segment of semi-smooth flow as well as the hyperturbulent regime proper.

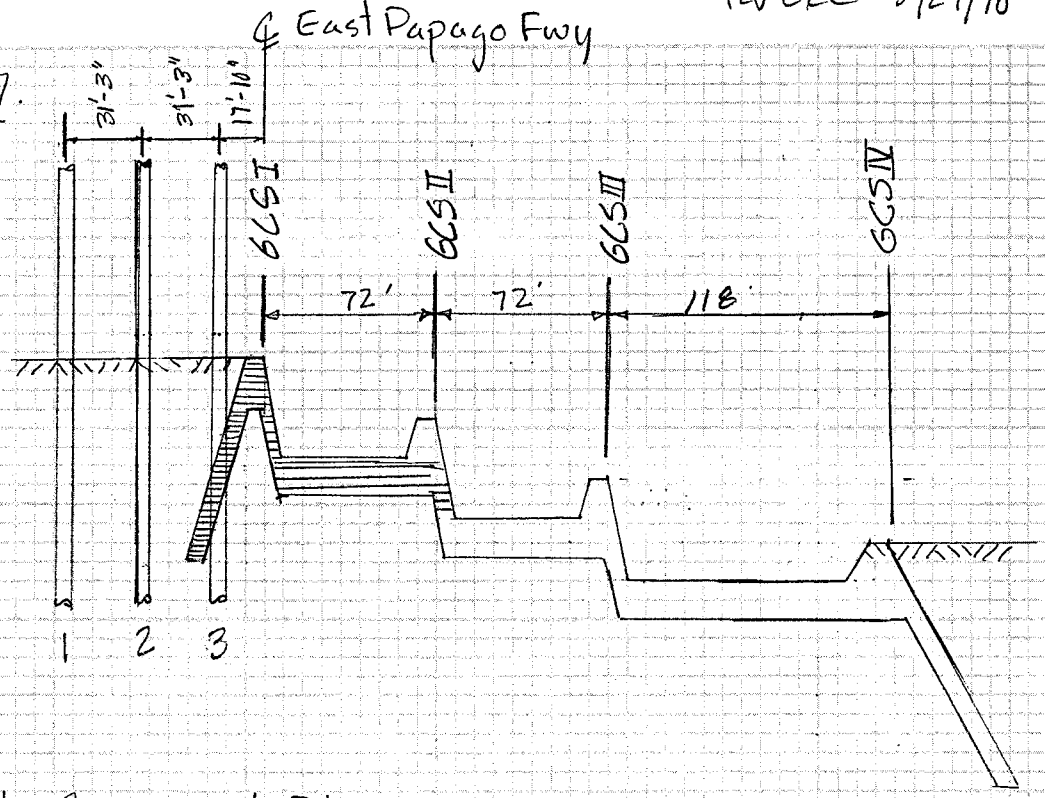
Similar families of experimental curves are plotted on Figs. 3–14 and 3–15, for sharp-edged strip roughnesses and uniform spot roughnesses, respectively. The latter are identical with the Nikuradse test curves on uniform sand-coated surfaces, since the sand-grain diameter and roughness spacing are identical in this case.

Morris & Wiggert, Applied Hydraulics in Engineering

CRS SIRRINE	PROJECT: R. Salado Channel	JOB NO.: R101N	NO. 1
	CLIENT: City of Tempe	DESIGNED BY: GKC / DATE: 5/17/90	
	SUBJECT: Local Scour IBW Drop	CHECKED BY: JFM / DATE: 5/18/90	OF 10

rev GKC 5/27/90

Pier No 7.



Local Scour at Piers:

CSU equation $d_s/y = 2.0\, K_1 K_2 (b/y)^{0.65} F_r^{0.43}$

$b = 6'$ Max debris size $= 10'$

Use $b_{eff} = 10'$

for round piers $K_1 = K_2 = 1.0$

$y_c = \left[\frac{(Q/T)^2}{g}\right]^{1/3}$ $Q = 63{,}000$ cfs

$T = 602'$

$y_c = \left[\frac{(63000/602)^2}{32.2}\right]^{1/3} = 6.98$ ✓

Assume that the flow is at critical vel. through all the piers.

$d_s = 2.0(1.0)(1.0)(10/7.0)^{0.65}(1.0)^{0.65}(7.0)$

$d_s = 17.7'$

CRS SIRRINE	PROJECT: Rio Salado Channel	JOB NO. R101N	NO. 2
	CLIENT: City of Tempe	DESIGNED BY GKC / DATE 5/18/90	OF 10
	SUBJECT: IBW Drop - Local Scour	CHECKED BY JFM / DATE 5/18/90	

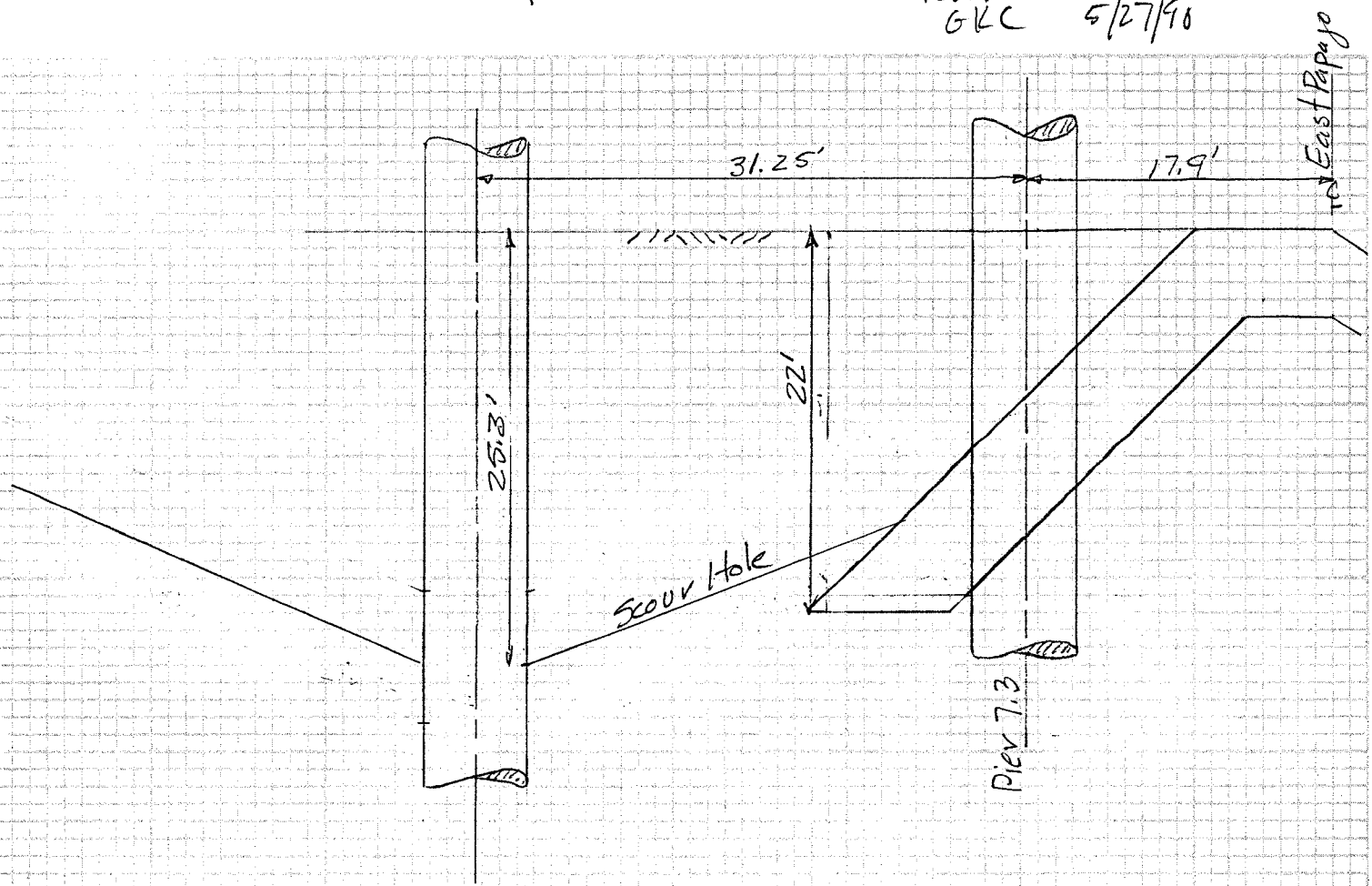
rev GKC 5/27/90

Total Pier Scour

$$d_{pt} = 1.3 \times 1.1 \times 17.7$$

$$= 25.3'$$

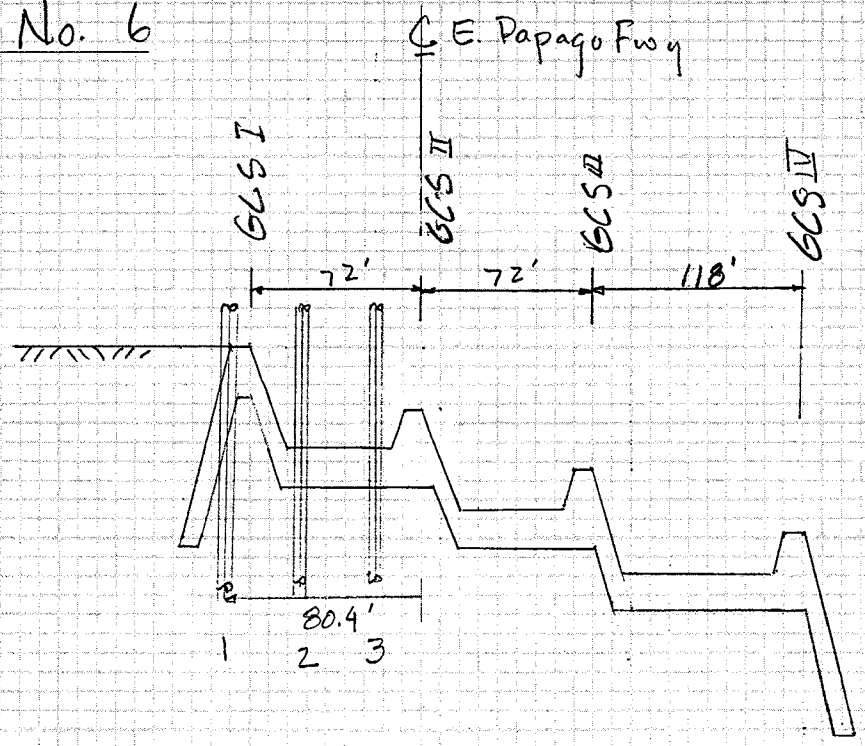
CRS SIRRINE	PROJECT: Ri Salado Channel	JOB NO. R101N		NO. 3
	CLIENT: City of Tempe	DESIGNED BY GKC	DATE 5/18/90	OF 10
	SUBJECT: IBW Drop - Local Scour	CHECKED BY JFM	DATE 5/18/90	
		REVISED GKC	5/27/90	

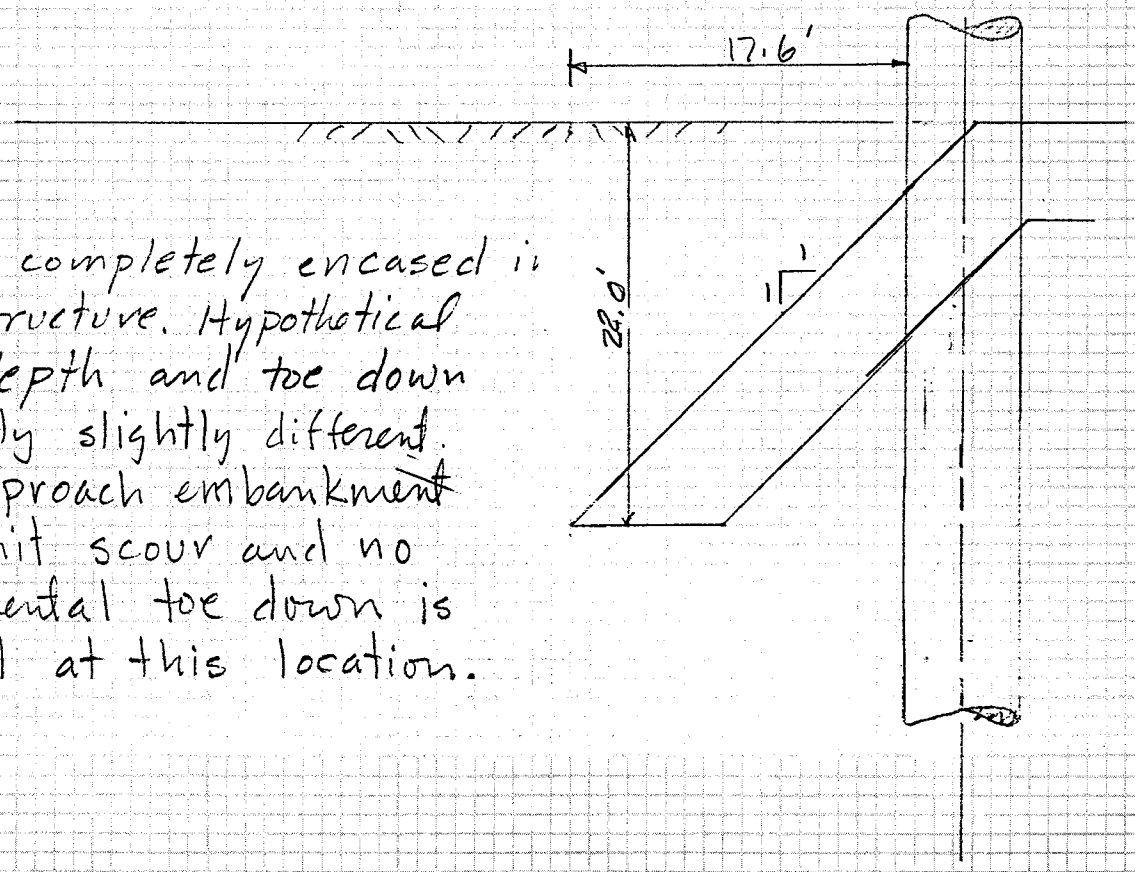


Section Along Pier 7

CRS SIRRINE	PROJECT: Ri Salado	JOB NO.: R101N	NO. 4 / 10
	CLIENT: Tempe	DESIGNED BY: GKC — DATE: 5/18/90	
	SUBJECT: IBW Drop Local Scour	CHECKED BY: JFM — DATE: 5/18/90	
		revised GKC 5/27/90	

Pier No. 6





Note:
Pier is completely encased in drop structure. Hypothetical scour depth and toe down are only slightly different. Drop approach embankment will limit scour and no supplemental toe down is required at this location.

CRSS	PROJECT: Rio Salado	JOB NO. R101N	NO. 5
CRS SIRRINE	CLIENT: Tempe	DESIGNED BY GKC / DATE 5/18/90	OF 10
	SUBJECT: IBW Drop Local Scour	CHECKED BY JFM / DATE 5/18/90	
		revised GKC 5/27/90	

Local Scour at Piers
Downstream of Level IV

Velocity at base of drop III

$V_b = 22.5$ fps $\quad y_b = 5.17'$

Critical Depth

$q = Q/T$

$= 63{,}000/537.5$

$= 117.2$ cfs/ft

$y_c = (q^2/g)^{1/3}$

$= (117.2^2/32.2)^{1/3}$

$= 7.53$

Design Velocity

$V_2 = q_2/y_2$

$= 117.2/7.53$

$= 15.6$ fps

Local Scour, CSU equation

$d_s = 2.0\, K_1 K_2 (b/y)^{0.65} F^{0.43}\, y$

$= 2.0(1.0)(1.0)(10/7.53)^{0.65}(1.0)^{0.43}\, 7.53$

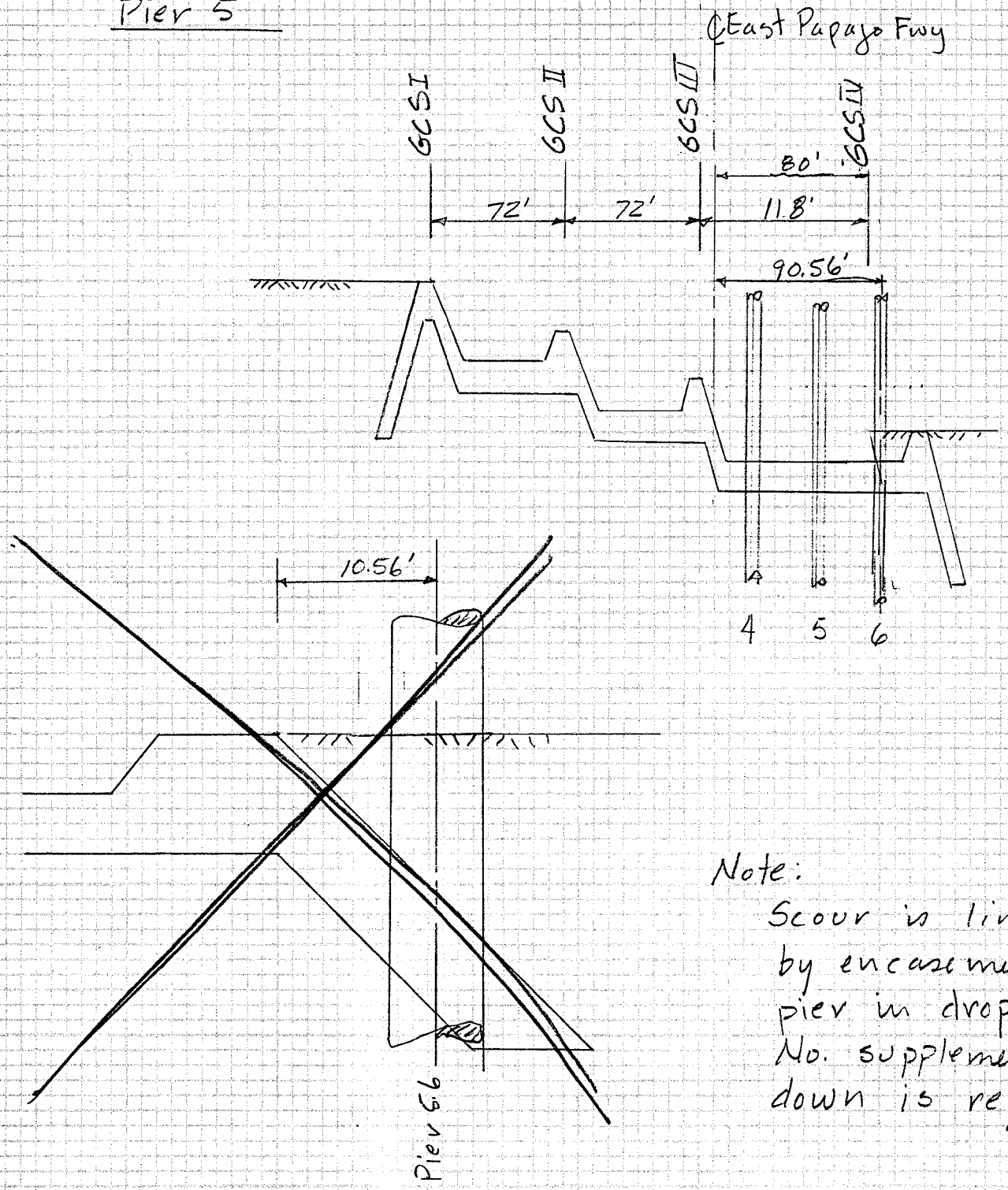
$= 18.1$ ✓

Total Pier Scour

$d_{pf} = 1.3 \times 1.1 \times 18.1 = 25.9$ ✓

CRSS	PROJECT: R. Salado	JOB NO.: R10 1N	NO. 5
CRS SIRRINE	CLIENT: City of Tempe	DESIGNED BY: GKC / DATE: 5/18/90	OF 10
	SUBJECT: Local Scour IBW Drop	CHECKED BY: JFM, revised GKC / DATE: 5/18/90, 5/27/90	

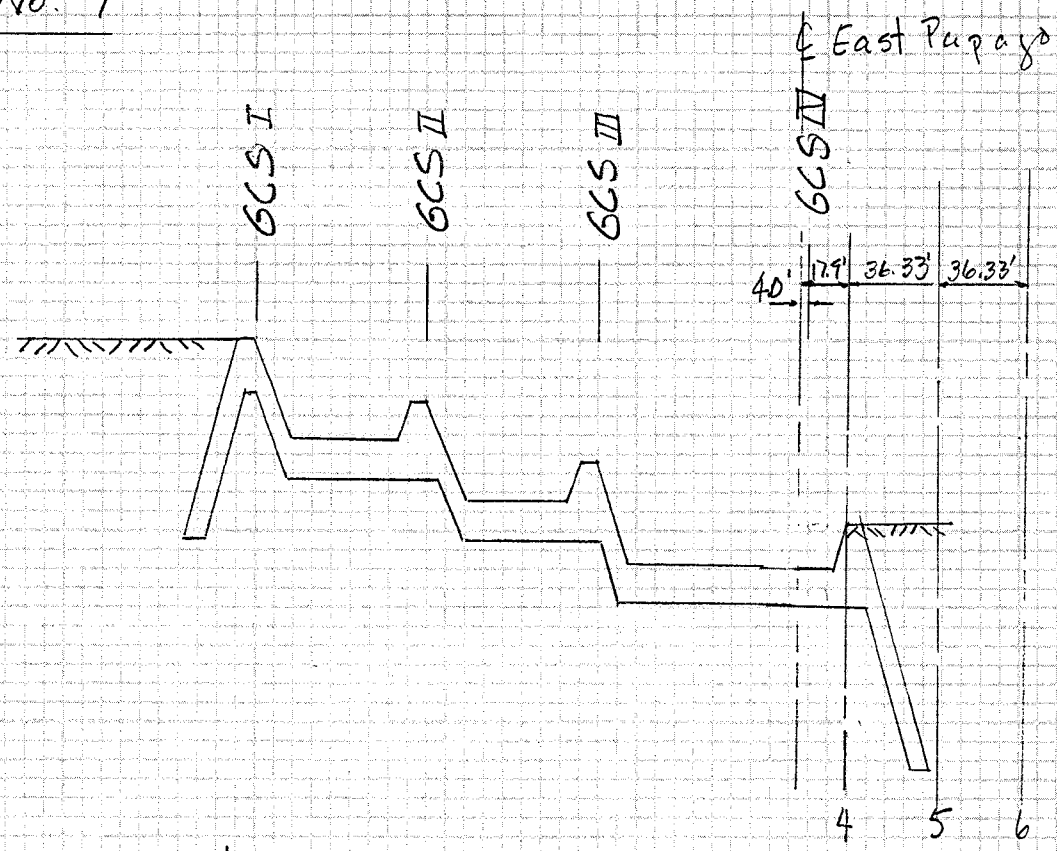
Pier 5

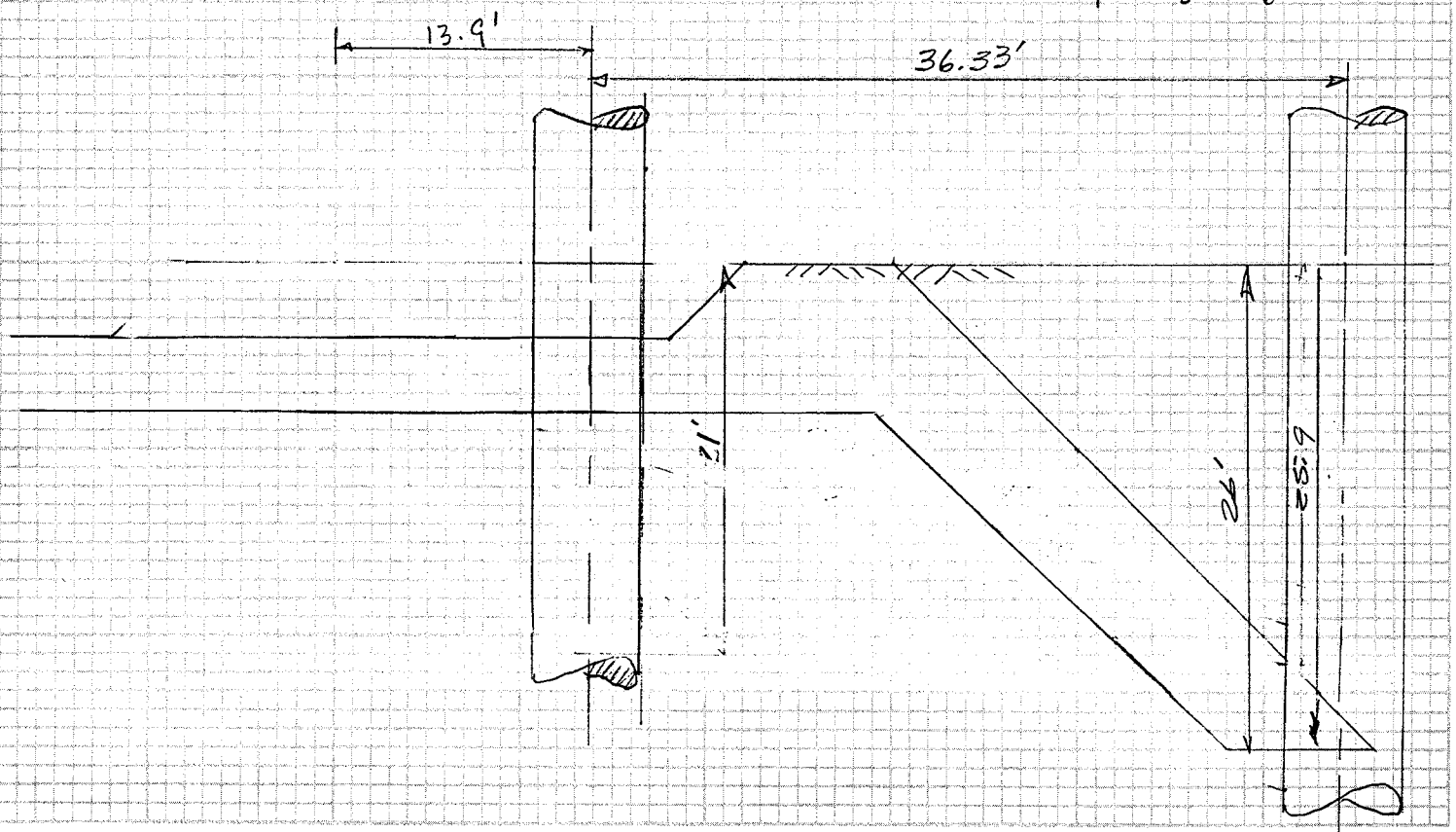


Note:
Scour is limited by encasement of pier in drop structure. No supplemental toe down is required.

CRS SIRRINE	PROJECT: R. Salado	JOB NO.: R101N	NO. 7 / 10
	CLIENT: City of Tempe	DESIGNED BY: GKC — DATE: 5/18/90	
	SUBJECT: Local Scour IBW Drop	CHECKED BY: JFM, revised GKC — DATE: 5/18/90, 5/21/90	

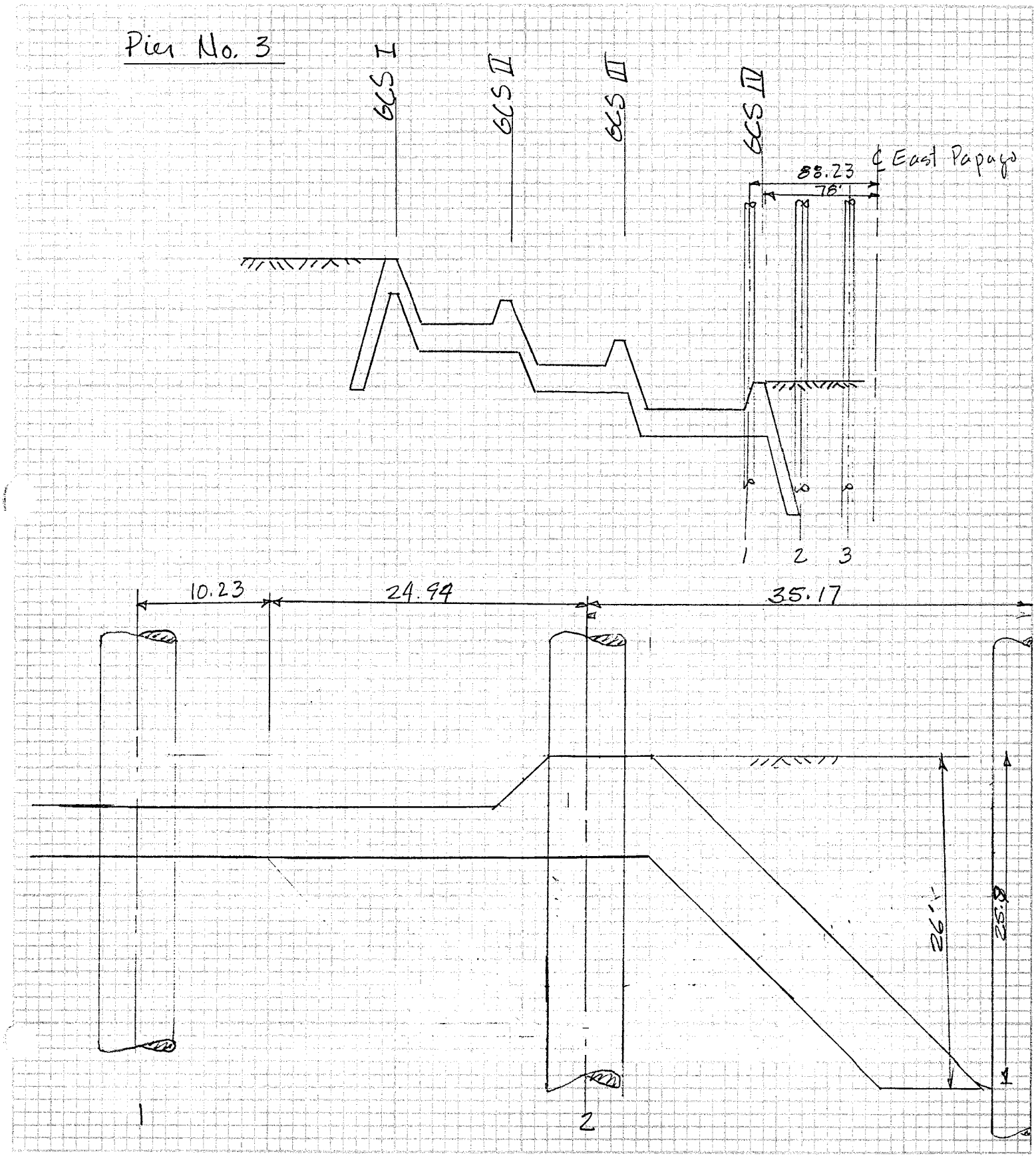
Pier No. 4





CRSS	PROJECT: Rio Salado Channelization	JOB NO.: R101N	NO. 8
CRS SIRRINE	CLIENT: City of Tempe	DESIGNED BY: GKC / DATE: 5/18/90	OF 10
	SUBJECT: Local Scour IBW Drop	CHECKED BY: JFM / DATE: 5/18/90	
		revised GKC 5/27/90	

Pier No. 3



Pier No 2.

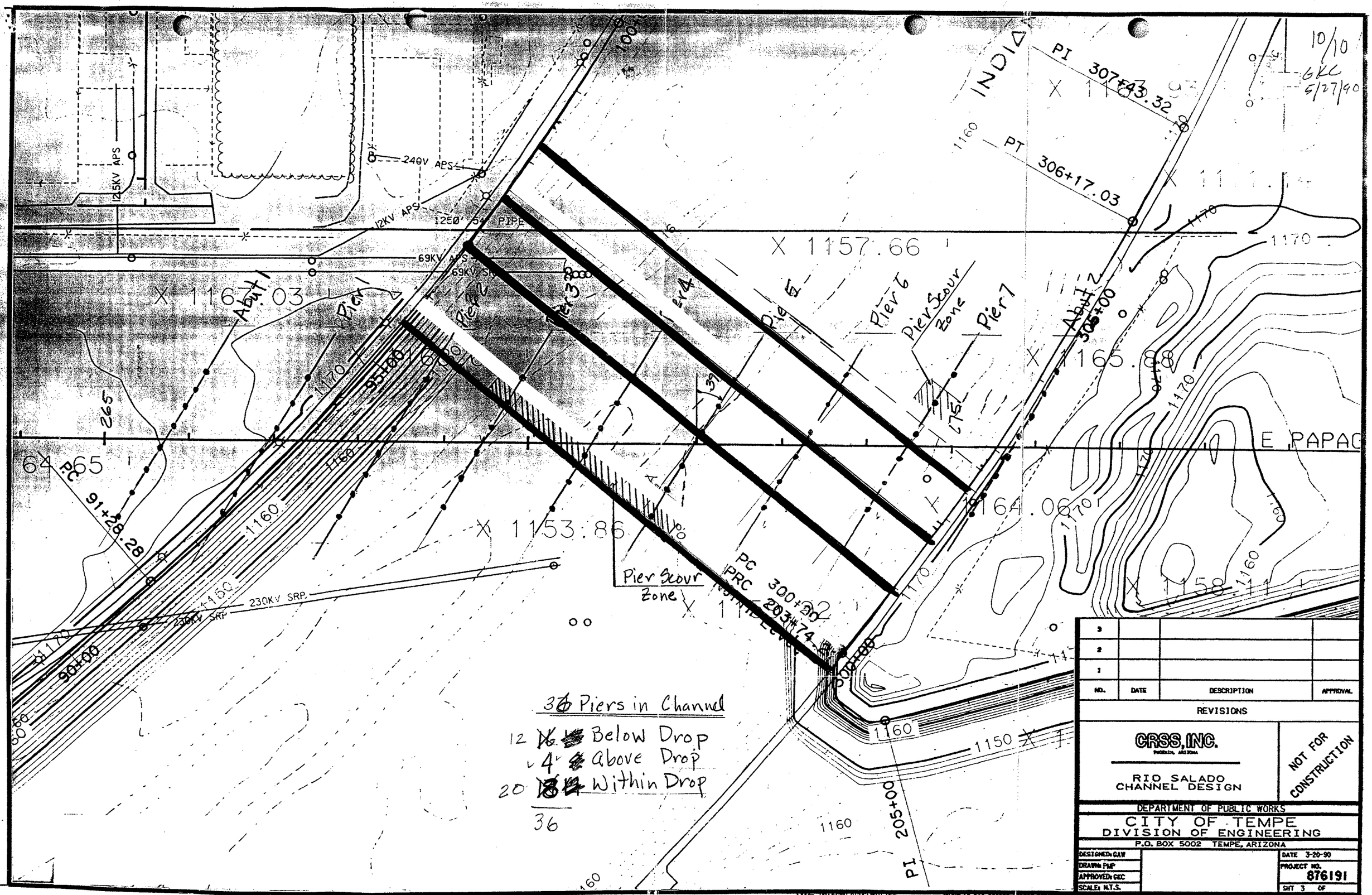
Pier 2.1 (most upstream pier) is 35 ft downstream of Str 4. The local scour hole will be at 13.2 ft below the crest of Str 4., i.e. local scour from pier No 2 will not effect on IBW structure.

Pier No 1

Pier 1 is located on the west bank of IBW and is unaffected by flow in either IBW or the Salt River.

Abutments 1 & 2

Both abutments are located on the banks of IBW and are unaffected by flows in either IBW or the Salt River.



NO.	DATE	DESCRIPTION	APPROVAL
3			
2			
1			

REVISIONS

CRSS, INC.
PHOENIX, ARIZONA

RIO SALADO
CHANNEL DESIGN

NOT FOR CONSTRUCTION

DEPARTMENT OF PUBLIC WORKS
CITY OF TEMPE
DIVISION OF ENGINEERING
P.O. BOX 5002 TEMPE, ARIZONA

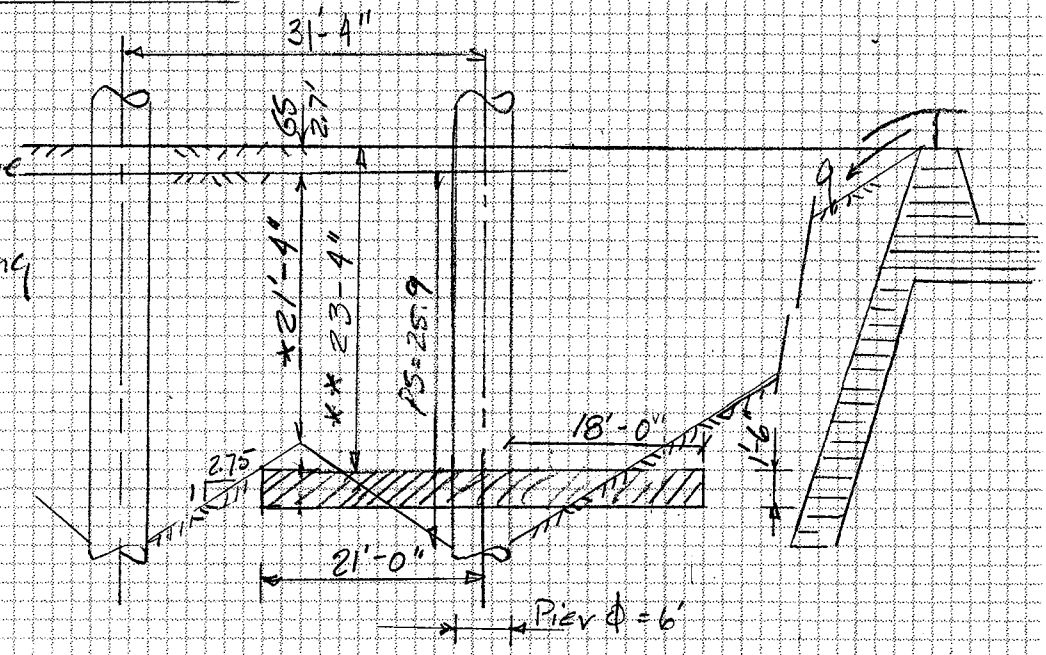
DESIGNED: GAW		DATE 3-20-90
DRAWN: PMP		PROJECT NO. 876191
APPROVED: GKC		
SCALE: N.T.S.		SHT 3 OF

CRSS	PROJECT: Rio Salado Channel	JOB NO: R101N	NO. 1
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 8/27/90	
	SUBJECT: IBW Bridge Pier Protection	CHECKED BY: JFM / DATE: 8/29/90	OF 2

Flow at Gabion

Assume:
- Uniform flow
- down hole side slope

Note:
- * Depth to overlapping pier scour
- ** Depth to gabion below adjacent pier scour



$$\tau_{max} = \gamma d S$$
$$= 62.4 (0.15) 0.34$$
$$= 3.2 \text{ psf}$$

$$\tau_c = 4.83 D_G$$

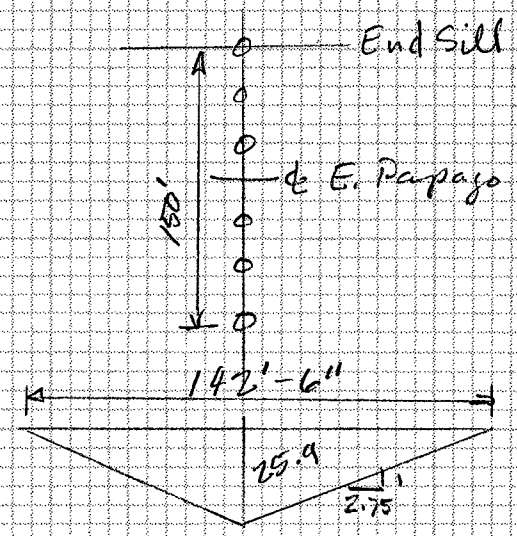
$$SF = \frac{\tau_c}{\tau_{max}} \quad ; \quad SF = 1.5$$

$$D_G = \frac{1.5 \times 3.2}{4.8}$$
$$= 1.0'$$

Fill Gradation: $D_{50} = 6''$
$D_{min} = 3''$
$D_{max} = 12''$

CRSS	PROJECT: Rio Salado Channel	JOB NO: R101N	NO. 2
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 8/27/90	OF 2
	SUBJECT: IBW Bridge Pier Protection	CHECKED BY: JFM / DATE: 8/29/90	

Scour Hole Volume



$$\forall_s = \tfrac{1}{2}(142.5)(25.9)(150) + \tfrac{1}{2}\,\frac{71.25^2\,\pi\,25.9}{3}$$

$$= 345\,650 \text{ cf}$$

$$= 7.9 \text{ acre-ft.}$$

Time to fill

1 cfs/ft

$$t_f = \frac{\forall_s}{Q} = \frac{345650}{142.5}\,\frac{1}{60}$$

$$= 40 \text{ min}$$

10 cfs/ft

$$t_f = \frac{\forall_s}{Q} = \frac{345650}{1425}\,\frac{1}{60}$$

$$= 4 \text{ min}$$

Assume critical depth at end sill

$$y_c = (q^2/g)^{1/3}$$

for

q	y_c	H
1	0.31	0.47
10	1.96	2.19

for side slope of scour hole

$$S = \sin(\operatorname{atan}(1/2.75)) = 0.34$$

$$q = \frac{1.49}{n}\,y^{5/3}\,S^{1/2}$$

$$y = \left(\frac{q\,n}{1.49\,S^{1/2}}\right)^{0.6} \quad ; \; n = 0.035$$

q	y_n	y_c	E	τ_o
1	0.15	6.9	0.89	3.18
10	0.58	17.3	5.23	12.3

Flow from end sill down scour hole will accelerate to normal depth

For $q = 1$ cfs the scour hole will be filled to 5' depth in $\frac{1}{33}\,t_f$ or 1.2 min

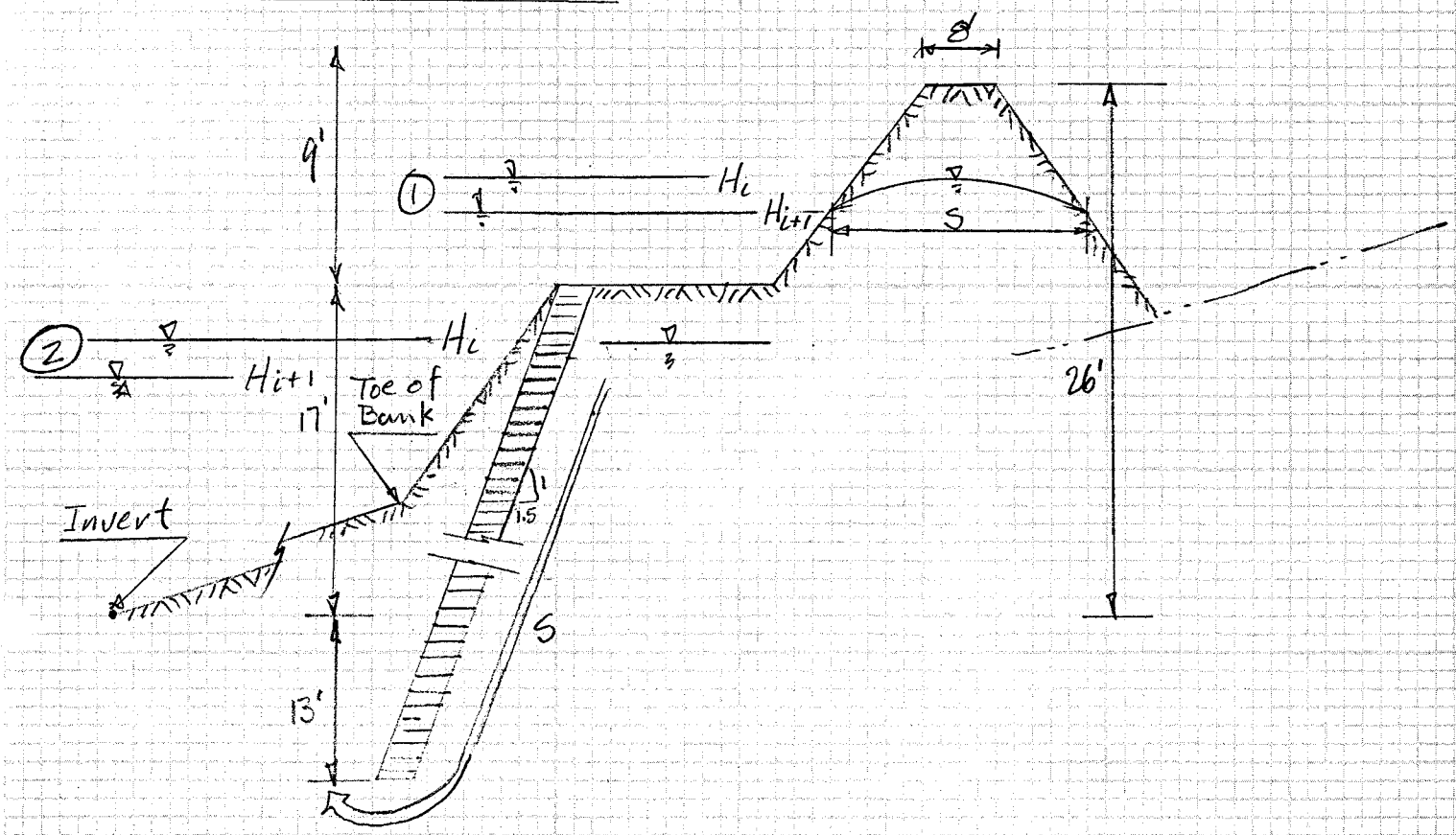
Since this depth is sufficient to dissipate energy and flow duration is brief, assume

$$\tau_{max} = \tau_{(1\,cfs)}$$

2. Levee Stability Analysis

CRS SIRRINE	PROJECT: Rio Salado	JOB NO.: R101N	NO. 1 / 3
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 8/24/90	
	SUBJECT: Bank stability	CHECKED BY: JEM / DATE: 8/29/90	

Definition sketch



① Case I: Water surface is above hard bank and drains laterally through levee banks.

② Case II: Water surface is below hard bank and drains to channel from beneith the hard bank.

For case I : $S = [3(26 - y_{i+1}) + 4]2 = 164 - 6y_{i+1}$

For case II : $S = 1.8y_i + 8 + 13 = 21 + 1.8y_i$

Draw Down Rate

Case I: This is similar to a condition of parallel drains where

$$S^2 = \frac{4kH}{v}(2d+H)$$

solving for unit inflow rate

$$v = \frac{4kH}{S^2}(2d+H)$$

For a large depth to aquiclude the effective depth to a barrier layer, d, is about

$$d = \frac{S}{12.5} + 3$$

Case II: The unit inflow rate is simply

$$v = ki$$

where $i = \Delta h / S$

where S is the path length through the embankment.

Conductivity

For coarse sand $k = 0.052$ cm/s
For gravel $k = 0.403$ cm/s

The outer envelope for Salt River bed material which describes the finest gradation of material gives $D_{50} = 10$ mm
This is medium to fine gravel use

$$k = \sqrt{0.052 \times 0.403} = 0.14 \text{ cm/sec}$$

CRS SIRRINE	PROJECT: Rio Salado	JOB NO. R101N		NO. 3
	CLIENT: Tempe	DESIGNED BY GKC	DATE 8/24/90	OF 3
	SUBJECT: Bank Stability	CHECKED BY JFM	DATE 8/29/90	

Spread Sheet Equations

2/7 $$y = \left[\frac{qn}{1.49\, S^{1/2}}\right]^{0.6}$$

where $n = 0.035$; $S = 0.105\%$

$$y = 0.82\, q^{0.6}$$

3/7 $$\Delta h = y_{i+1} - y_i$$

4/7 if $\Delta h < 0$

if $y_{i+1} > 17$

$S = 164 - 6\, y_{i+1}$

if $y_{i+1} < 17$

$S = 21. + 1.8\, y_i$

else no computation

5/7 if $\Delta h < 0$

if $y_{i+1} > 17$

$V = 4kH(1/6.25*S + 6/S^2 + H)$

if $y_{i+1} < 17$

$V = k\,\Delta h / S$

6/7 $$\Delta h_d = V * (6 * 3600)$$

$$= 21{,}600\, V$$

7/7 if $\Delta h < h_d$ then "drains" else "pools"

23-Aug-90 DATE

Job: R401N Date
Calc by: GRC 8/24/90
Checked by: JFM 8/29/90
Dwg Chk:

Salt River Flood Hydrographs
Location: Granite Reef Dam

Discharge Hydrograph:

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	0.0	0.0	0.0	0.0	0.0
6	6540.0	10085.0	14090.0	14514.4	15015.0
12	13080.0	20170.0	28180.0	29028.8	30030.0
18	13530.0	20670.0	28960.0	29582.4	30310.0
24	14720.0	21630.0	30610.0	31441.8	32420.0
30	11530.0	24110.0	33230.0	34062.8	35040.0
36	10610.0	36000.0	37970.0	38740.4	39640.0
42	13040.0	37000.0	39260.0	39838.5	40510.0
48	13040.0	40870.0	43350.0	43970.3	44690.0
54	24780.0	41610.0	45140.0	45742.1	46440.0
60	28140.0	43170.0	46420.0	47003.8	47680.0
66	27020.0	46060.0	48580.0	51231.9	54440.0
72	42960.0	66880.0	70790.0	74650.4	79320.0
78	76320.0	101060.0	109820.0	114787.7	120740.0
84	112760.0	142850.0	158560.0	165853.8	174600.0
90	150000.0	174000.0	193000.0	203500.2	216200.0
96	106700.0	122240.0	133610.0	227000.0	274000.0
102	96610.0	104490.0	113520.0	150000.0	248630.0
108	101910.0	108170.0	116280.0	128500.0	215540.0
114	84710.0	88210.0	122490.0	137689.4	157380.0
120	67420.0	70650.0	100190.0	110313.6	123140.0
126	49490.0	52440.0	81930.0	88292.5	96170.0
132	42990.0	45610.0	72060.0	77366.4	83910.0
138	42990.0	44590.0	69480.0	73193.3	77680.0
144	40940.0	44260.0	65920.0	68302.2	71130.0
150	40940.0	44030.0	64300.0	65955.7	67900.0
156	39550.0	42370.0	46830.0	47257.1	47750.0
162	39550.0	41300.0	44880.0	45394.7	45990.0
168	38470.0	41300.0	41010.0	41712.5	42530.0
174	38060.0	40270.0	40120.0	41227.3	42530.0
180	38060.0	40270.0	40120.0	41227.3	42530.0
186	38060.0	40110.0	39650.0	40969.0	42530.0
192	38060.0	38820.0	39650.0	40393.4	41260.0
198	37290.0	37520.0	39370.0	39709.0	40100.0
204	37290.0	37520.0	39370.0	39709.0	40100.0
210	37290.0	37220.0	39370.0	39709.0	40100.0
216	36580.0	36440.0	39370.0	39709.0	40100.0
222	38580.0	36440.0	38240.0	39042.4	39980.0
228	36030.0	36120.0	37870.0	38338.1	38880.0
234	35180.0	35550.0	37870.0	38338.1	38880.0
240	35180.0	35550.0	37870.0	38338.1	38880.0

23-Aug-90 DATE

Job: 210/N Date
Calc by: GKC 8/24/90
Checked by: JFM 8/29/90
Dwg Chk:

Salt River Flood Hydrographs
Location: Granite Reef Dam

Stage Hydrograph:

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	0.0	0.0	0.0	0.0	0.0
6	2.5	3.3	4.0	4.1	4.2
12	3.9	5.0	6.1	6.2	6.3
18	3.9	5.1	6.2	6.3	6.4
24	4.1	5.2	6.4	6.5	6.6
30	3.6	5.6	6.7	6.8	7.0
36	3.4	7.1	7.3	7.4	7.5
42	3.8	7.2	7.5	7.5	7.6
48	3.8	7.6	7.9	8.0	8.1
54	5.7	7.7	8.1	8.2	8.2
60	6.1	7.9	8.2	8.3	8.4
66	6.0	8.2	8.5	8.7	9.1
72	7.9	10.3	10.6	11.0	11.4
78	11.1	13.2	13.8	14.2	14.6
84	14.0	16.2	17.2	17.7	18.3
90	16.7	18.2	19.4	20.0	20.8
96	13.6	14.7	15.5	21.4	23.9
102	12.8	13.4	14.1	16.7	22.6
108	13.2	13.7	14.3	15.2	20.7
114	11.8	12.1	14.8	15.8	17.2
120	10.3	10.6	13.1	13.9	14.8
126	8.6	8.9	11.6	12.1	12.8
132	7.9	8.2	10.7	11.2	11.8
138	7.9	8.0	10.5	10.8	11.2
144	7.6	8.0	10.2	10.4	10.7
150	7.6	8.0	10.0	10.2	10.4
156	7.5	7.8	8.3	8.3	8.4
162	7.5	7.7	8.1	8.1	8.2
168	7.4	7.7	7.7	7.7	7.8
174	7.3	7.6	7.6	7.7	7.8
180	7.3	7.6	7.6	7.7	7.8
186	7.3	7.6	7.5	7.7	7.8
192	7.3	7.4	7.5	7.6	7.7
198	7.2	7.3	7.5	7.5	7.6
204	7.2	7.3	7.5	7.5	7.6
210	7.2	7.2	7.5	7.5	7.6
216	7.1	7.1	7.5	7.5	7.6
222	7.4	7.1	7.3	7.4	7.5
228	7.1	7.1	7.3	7.4	7.4
234	7.0	7.0	7.3	7.4	7.4
240	7.0	7.0	7.3	7.4	7.4

where $\text{stage} = \left(\frac{qn}{1.49 S^{1/2}}\right)^{0.6}$

$n = 0.035$

$S = 0.105\%$

23-Aug-90 DATE

Job: R101N Date
Calc by: GLC 8/24/90
Checked by: JFM 8/29/90
Dwg Chk:

Salt River Flood Hydrographs
Location: Granite Reef Dam

Stage Fall (ft):

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	--	--	--	--	--
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	0.6	NA	NA	NA	NA
36	0.2	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	0.1	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	3.1	3.5	3.8	NA	NA
102	0.8	1.3	1.4	4.7	1.4
108	NA	NA	NA	1.5	1.9
114	1.4	1.6	NA	NA	3.6
120	1.5	1.5	1.7	2.0	2.3
126	1.7	1.7	1.5	1.7	2.0
132	0.7	0.7	0.9	0.9	1.0
138	NA	0.1	0.2	0.4	0.5
144	0.2	0.0	0.3	0.4	0.6
150	NA	0.0	0.2	0.2	0.3
156	0.2	0.2	1.7	1.8	2.0
162	NA	0.1	0.2	0.2	0.2
168	0.1	NA	0.4	0.4	0.4
174	0.0	0.1	0.1	0.1	NA
180	NA	NA	NA	NA	NA
186	NA	0.0	0.1	0.0	NA
192	NA	0.1	NA	0.1	0.1
198	0.1	0.1	0.0	0.1	0.1
204	NA	NA	NA	NA	NA
210	NA	0.0	NA	NA	NA
216	0.1	0.1	NA	NA	NA
222	NA	NA	0.1	0.1	0.0
228	0.3	0.0	0.0	0.1	0.1
234	0.1	0.1	NA	NA	NA
240	NA	NA	NA	NA	NA

where fall = $stage_{i+1} - stage_i$

if fall < 0 then na (not computed)

24-Aug-90 DATE

Salt River Flood Hydrographs
Location: Granite Reef Dam

Job: 1201N Date
Calc by: GLC 8/24/90
Checked by: JFM 8/29/90
Dwg Chk:

Drainage Path Length:

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	--	--	--	--	--
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	28.5	NA	NA	NA	NA
36	27.4	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	32.0	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	51.0	53.8	55.9	NA	NA
102	45.5	47.5	49.0	59.5	28.6
108	NA	NA	NA	51.0	39.7
114	44.8	45.7	NA	NA	61.1
120	42.3	42.8	47.6	49.5	51.9
126	39.6	40.1	44.5	45.9	47.7
132	36.4	37.0	41.9	42.8	44.0
138	NA	35.7	40.3	41.2	42.2
144	35.2	35.5	39.9	40.5	41.2
150	NA	35.4	39.3	39.7	40.2
156	34.8	35.4	39.0	39.3	39.6
162	NA	35.1	35.9	36.0	36.1
168	34.5	NA	35.5	35.6	35.8
174	34.3	34.8	34.8	34.9	NA
180	NA	NA	NA	NA	NA
186	NA	34.6	34.6	34.8	NA
192	NA	34.6	NA	34.8	35.1
198	34.2	34.3	34.5	34.7	34.8
204	NA	NA	NA	NA	NA
210	NA	34.1	NA	NA	NA
216	34.0	34.0	NA	NA	NA
222	NA	NA	34.4	34.5	34.6
228	34.3	33.8	34.2	34.4	34.6
234	33.7	33.8	NA	NA	NA
240	NA	NA	NA	NA	NA

Job: 610N
Calc by: GKC
Date: 8/24/90
Checked by: JFM
Date: 8/29/90
Dwg Chk:

Draw Down Rate (ft/sec):

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	--	--	--	--	--
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	-9.12E-05	NA	NA	NA	NA
36	-2.92E-05	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	-2.11E-05	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	-2.78E-04	-2.97E-04	-3.16E-04	NA	NA
102	-7.96E-05	-1.28E-04	-1.36E-04	-3.64E-04	-3.41E-02
108	NA	NA	NA	-1.33E-04	-6.35E-02
114	-1.43E-04	-1.59E-04	NA	NA	-2.34E-01
120	-1.65E-04	-1.62E-04	-1.62E-04	-1.83E-04	-2.08E-04
126	-2.03E-04	-1.99E-04	-1.54E-04	-1.74E-04	-1.97E-04
132	-8.77E-05	-8.87E-05	-9.44E-05	-9.93E-05	-1.05E-04
138	NA	-1.42E-05	-2.65E-05	-4.10E-05	-5.80E-05
144	-2.98E-05	-4.64E-06	-3.76E-05	-5.00E-05	-6.45E-05
150	NA	-3.25E-06	-1.76E-05	-2.50E-05	-3.35E-05
156	-2.08E-05	-2.37E-05	-2.05E-04	-2.16E-04	-2.29E-04
162	NA	-1.56E-05	-2.67E-05	-2.54E-05	-2.38E-05
168	-1.65E-05	NA	-5.51E-05	-5.20E-05	-4.84E-05
174	-6.34E-06	-1.53E-05	-1.32E-05	-7.13E-06	NA
180	NA	NA	NA	NA	NA
186	NA	-2.40E-06	-7.08E-06	-3.82E-06	NA
192	NA	-1.95E-05	NA	-8.56E-06	-1.85E-05
198	-1.20E-05	-2.01E-05	-4.24E-06	-1.03E-05	-1.72E-05
204	NA	NA	NA	NA	NA
210	NA	-4.71E-06	NA	NA	NA
216	-1.12E-05	-1.23E-05	NA	NA	NA
222	NA	NA	-1.73E-05	-1.01E-05	-1.80E-06
228	-3.98E-05	-5.12E-06	-5.74E-06	-1.08E-05	-1.67E-05
234	-1.37E-05	-9.18E-06	NA	NA	NA
240	NA	NA	NA	NA	NA

24-Aug-90 DATE

Job: 1210/N
Calc by: GKC
Date: 8/24/90
Checked by: JFM
Dwg Chk: 8/29/90

Draw Down Fall (ft):

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	--	--	--	--	--
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	-2.0	NA	NA	NA	NA
36	-0.6	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	-0.5	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	-6.0	-6.4	-6.8	NA	NA
102	-1.7	-2.8	-2.9	-7.9	-736.5
108	NA	NA	NA	-2.9	-1371.1
114	-3.1	-3.4	NA	NA	-5049.4
120	-3.6	-3.5	-3.5	-4.0	-4.5
126	-4.4	-4.3	-3.3	-3.7	-4.3
132	-1.9	-1.9	-2.0	-2.1	-2.3
138	NA	-0.3	-0.6	-0.9	-1.3
144	-0.6	-0.1	-0.8	-1.1	-1.4
150	NA	-0.1	-0.4	-0.5	-0.7
156	-0.4	-0.5	-4.4	-4.7	-4.9
162	NA	-0.3	-0.6	-0.5	-0.5
168	-0.4	NA	-1.2	-1.1	-1.0
174	-0.1	-0.3	-0.3	-0.2	NA
180	NA	NA	NA	NA	NA
186	NA	-0.1	-0.2	-0.1	NA
192	NA	-0.4	NA	-0.2	-0.4
198	-0.3	-0.4	-0.1	-0.2	-0.4
204	NA	NA	NA	NA	NA
210	NA	-0.1	NA	NA	NA
216	-0.2	-0.3	NA	NA	NA
222	NA	NA	-0.4	-0.2	-0.0
228	-0.9	-0.1	-0.1	-0.2	-0.4
234	-0.3	-0.2	NA	NA	NA
240	NA	NA	NA	NA	NA

24-Aug-90 DATE

Job: 140/N
Date
Calc by: GKC 8/24/90
Checked by: JFM 8/29/90
Dwg Chk:

Draw Down Check:

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0					
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	drains	NA	NA	NA	NA
36	drains	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	drains	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	drains	drains	drains	NA	NA
102	drains	drains	drains	drains	drains
108	NA	NA	NA	drains	drains
114	drains	drains	NA	NA	drains
120	drains	drains	drains	drains	drains
126	drains	drains	drains	drains	drains
132	drains	drains	drains	drains	drains
138	NA	drains	drains	drains	drains
144	drains	drains	drains	drains	drains
150	NA	drains	drains	drains	drains
156	drains	drains	drains	drains	drains
162	NA	drains	drains	drains	drains
168	drains	NA	drains	drains	drains
174	drains	drains	drains	drains	NA
180	NA	NA	NA	NA	NA
186	NA	drains	drains	drains	NA
192	NA	drains	NA	drains	drains
198	drains	drains	drains	drains	drains
204	NA	NA	NA	NA	NA
210	NA	drains	NA	NA	NA
216	drains	drains	NA	NA	NA
222	NA	NA	drains	drains	drains
228	drains	drains	drains	drains	drains
234	drains	drains	NA	NA	NA
240	NA	NA	NA	NA	NA

24-Aug-90 DATE

Worst Case
Use lowest possible
conductivity

5/7

Job: R101N Date
Calc by: GKC 8/29/90
Checked by: JFM 8/29/90
Dwg Chk:

Draw Down Rate (ft/sec):

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	---	---	---	---	---
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	-3.37E-05	NA	NA	NA	NA
36	-1.08E-05	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	-7.81E-06	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	-1.03E-04	-1.10E-04	-1.17E-04	NA	NA
102	-2.94E-05	-4.74E-05	-5.03E-05	-1.34E-04	-1.26E-02
108	NA	NA	NA	-4.92E-05	-2.35E-02
114	-5.27E-05	-5.88E-05	NA	NA	-8.64E-02
120	-6.09E-05	-6.00E-05	-5.99E-05	-6.77E-05	-7.69E-05
126	-7.50E-05	-7.37E-05	-5.68E-05	-6.41E-05	-7.28E-05
132	-3.24E-05	-3.28E-05	-3.49E-05	-3.67E-05	-3.88E-05
138	NA	-5.24E-06	-9.79E-06	-1.51E-05	-2.14E-05
144	-1.10E-05	-1.71E-06	-1.39E-05	-1.85E-05	-2.38E-05
150	NA	-1.20E-06	-6.52E-06	-9.24E-06	-1.24E-05
156	-7.67E-06	-8.75E-06	-7.56E-05	-7.98E-05	-8.46E-05
162	NA	-5.77E-06	-9.88E-06	-9.38E-06	-8.80E-06
168	-6.08E-06	NA	-2.04E-05	-1.92E-05	-1.79E-05
174	-2.34E-06	-5.64E-06	-4.89E-06	-2.63E-06	NA
180	NA	NA	NA	NA	NA
186	NA	-8.87E-07	-2.62E-06	-1.41E-06	NA
192	NA	-7.21E-06	NA	-3.16E-06	-6.83E-06
198	-4.44E-06	-7.42E-06	-1.57E-06	-3.80E-06	-6.36E-06
204	NA	NA	NA	NA	NA
210	NA	-1.74E-06	NA	NA	NA
216	-4.14E-06	-4.56E-06	NA	NA	NA
222	NA	NA	-6.39E-06	-3.74E-06	-6.67E-07
228	-1.47E-05	-1.89E-06	-2.12E-06	-3.99E-06	-6.15E-06
234	-5.07E-06	-3.39E-06	NA	NA	NA
240	NA	NA	NA	NA	NA

for K = 0.05 cm/sec
for coarse sand

24-Aug-90 DATE

Job: 2101N	Date
Calc by: GKC	8/24/90
Checked by: JFM	8/29/90
Dwg Chk:	

Draw Down Fall (ft):

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0	---	---	---	---	---
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	-0.7	NA	NA	NA	NA
36	-0.2	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	-0.2	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	-2.2 +0.4	-2.4 1.1	-2.5 1.3	NA	NA
102	-0.6	-1.0 0.3	-1.1 0.3	-2.9 1.8	-272.2
108	NA	NA	NA	-1.1 0.4	-506.7
114	-1.1 +0.3	-1.3 0.3	NA	NA	-1866.1
120	-1.3 +0.2	-1.3 0.2	-1.3 0.4	-1.5 0.5	-1.7 0.6
126	-1.6 +0.1	-1.6 0.1	-1.2 0.3	-1.4 0.3	-1.6 0.4
132	-0.7	-0.7	-0.8 0.1	-0.8 0.1	-0.8 0.2
138	NA	-0.1	-0.2	-0.3 0.1	-0.5 0
144	-0.2	-0.0	-0.3	-0.4	-0.5 0.3
150	NA	-0.0	-0.1	-0.2	-0.3 0.
156	-0.2	-0.2	-1.6	-1.7	-1.8 0.2
162	NA	-0.1	-0.2	-0.2	-0.2 0
168	-0.1	NA	-0.4	-0.4	-0.4 0
174	-0.1	-0.1	-0.1	-0.1	NA
180	NA	NA	NA	NA	NA
186	NA	-0.0	-0.1	-0.0	NA
192	NA	-0.2	NA	-0.1	-0.1
198	-0.1	-0.2	-0.0	-0.1	-0.1
204	NA	NA	NA	NA	NA
210	NA	-0.0	NA	NA	NA
216	-0.1	-0.1	NA	NA	NA
222	NA	NA	-0.1	-0.1	-0.0
228	-0.3	-0.0	-0.0	-0.1	-0.1
234	-0.1	-0.1	NA	NA	NA
240	NA	NA	NA	NA	NA
max dh	1.7	2.0	2.4	3.2	1.7

24-Aug-90 DATE

7/7

Job: 1210N
Date
Calc by: GKC 8/29/90
Checked by: JFM 8/29/90
Dwg Chk:

Draw Down Check:

Time	50-yr	100-yr	200-yr	300-yr	500-yr
0					
6	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	NA
18	NA	NA	NA	NA	NA
24	NA	NA	NA	NA	NA
30	drains	NA	NA	NA	NA
36	drains	NA	NA	NA	NA
42	NA	NA	NA	NA	NA
48	NA	NA	NA	NA	NA
54	NA	NA	NA	NA	NA
60	NA	NA	NA	NA	NA
66	drains	NA	NA	NA	NA
72	NA	NA	NA	NA	NA
78	NA	NA	NA	NA	NA
84	NA	NA	NA	NA	NA
90	NA	NA	NA	NA	NA
96	pools	pools	pools	NA	NA
102	pools	pools	pools	pools	drains
108	NA	NA	NA	pools	drains
114	pools	pools	NA	NA	drains
120	pools	pools	pools	pools	pools
126	pools	pools	pools	pools	pools
132	drains	pools	pools	pools	pools
138	NA	drains	pools	pools	pools
144	drains	drains	pools	pools	pools
150	NA	drains	pools	pools	pools
156	drains	drains	pools	pools	pools
162	NA	drains	drains	drains	drains
168	drains	NA	drains	drains	drains
174	drains	drains	drains	drains	NA
180	NA	NA	NA	NA	NA
186	NA	drains	drains	drains	NA
192	NA	drains	NA	drains	drains
198	drains	drains	drains	drains	drains
204	NA	NA	NA	NA	NA
210	NA	drains	NA	NA	NA
216	drains	drains	NA	NA	NA
222	NA	NA	drains	drains	drains
228	drains	drains	drains	drains	drains
234	drains	drains	NA	NA	NA
240	NA	NA	NA	NA	NA

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Soil Engineering

Fourth Edition

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Iowa State University

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1817

proximately inverse to D^2. Then the flow per unit area is

$$nq = \frac{Q}{A} = C_1 D^2 i \frac{\gamma_w}{\eta} = ki$$

or

$$k = C_1 D^2 \frac{\gamma_w}{\eta} \tag{11.6a}$$

where C_1 is a constant and k is the coefficient of hydraulic conductivity of the soil.

Since the capillary diameter D is not known and is not readily measured, empirical investigations have for the most part attempted to relate fluid flow characteristics of soils to their particle size and void ratio. An empirical equation by Hazen (*4*) is

$$k = C_2 D_{10}^2 \tag{11.7}$$

where D_{10} is the soil effective size, $C_2 = 100$, and k is in centimeters per second. This of course does not account for variability in void ratio or influences from other grain sizes, and is unreliable for prediction. Other studies have shown that as an approximation with particle size constant,

$$k = C_3 \left(\frac{e^3}{1 + e} \right) \tag{11.8}$$

where C_3 is a constant and e is the void ratio. Thus the coefficient of hydraulic conductivity increases roughly as the square of both the particle size and the void ratio.

Typical ranges of k values are indicated in Table 11.1. Metric units in wide use are centimeters per second, and because of the extended range of values, the coefficient frequently is given in terms of the exponent, a permeability coefficient of "minus 1" signifying 10^{-1} cm/s. There are numerous types of problems in connection with engineering projects which require knowledge of the hydraulic conductivity characteristics of the soil involved, such as computations of seepage through earth dams and levees and losses from irrigation ditches. Estimates of pumpage-capacity requirements for dewatering cofferdams or excavations below a water table are familiar examples of such problems. The spacing and depth of underdrains for lowering the water table under a road or runway in order to improve subgrade stability

TABLE 11.1 Hydraulic Conductivity Values

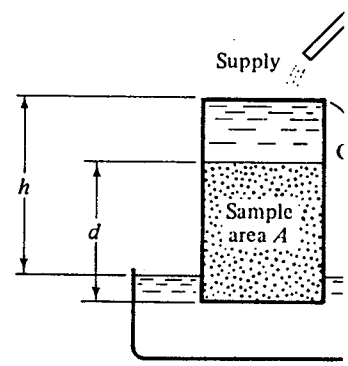
Range	k (cm/s)	Soils
Very high	$>10^{0}$ (>1.0)	Clean gravel
High	10^{-1}–10^{0}	Gravel, clean coarse sand
Medium	10^{-3}–10^{-1}	Graded sand, fine sand
Low	10^{-5}–10^{-3}	Silty sand, silt
Very low	10^{-7}–10^{-5}	Dense silt, clayey silt
Practically impermeable	$<10^{-7}$	Clay, silty clay

or for draining waterloggec
which the conductivity of tl
of settlement of a structure
rate at which water moves

Several methods of me
able. Some methods involv
turbed samples, and others
of the soil in place below a
tages that are important in d
most feasible and appropri
chosen. For example, in stu
would be appropriate to mal
to be used which would be c
structure. On the other han
appropriate in the case of st
In every case, the objectiv
soil in its natural or norma
possible. Furthermore, soil
spect to flow; that is, the co
differ considerably from th
exists, it may be necessary

11.8. LABORATORY TES APPARATUS

A laboratory test that is pa
cient of hydraulic conducti
which the hydraulic gradier
A typical arrangement of a



Grad

Figure 11.4 Constant-head
conductivity of coarse-graine

GEOHYDROLOGY

ROGER J. M. De WIEST

Freeman Fellow ASCE
Professor of Hydraulics and Hydrology
Princeton University

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e solution, namely, $x_1 = 1, x_2 = -1$,

$$Cd^2\gamma/\mu \tag{4.18}$$

, K, such as effective permeability [5], eepage coefficient [7], and hydraulic nductivity, in view of the analogy with ie gaining widespread use. It is used insic permeability for

$$= Cd^2 \tag{4.19}$$

naracteristic of the medium alone, and

$$= k\frac{\gamma}{\mu} \tag{4.18*}$$

; the dimensions of a velocity. It may of consistent units, generally different oil mechanics, petroleum engineering, it to continent (Europe, the United ter-gram-second units are universally n this country are carried out with K in).

petroleum engineering, has been pre- ic permeability k because of an incom- ideed, for horizontal flow, Darcy's law

$$= -(k/\mu)(dp/dl)$$

in absolute value,

$$= \frac{\mu(Q/A)}{dp/dl} \tag{4.20}$$

f defined as

$$\frac{\text{ntipoise} \times 1\ \text{cm}^3/\text{sec}}{1\ \text{cm}^2}$$

. atmosphere/cm

of $[L]^2$. It may be expressed as such by

poise = 0.01 dyne sec/cm^2

132 × 10^6 dynes/cm^2

Table 4.1 Average Values of K and k

Soil Class	K cm/sec	K darcys	K gpd/ft^2
Gravel	1——10^2	10^3——10^5	10^4——10^6
Clean sands (good aquifers)	10^{-3}——1	1——10^3	10——10^4
Clayey sands, fine sands (poor aquifers)	10^{-6}——10^{-3}	10^{-3}——1	10^{-2}——10

This leads to

$$1 \text{ darcy} = 0.987 \times 10^{-8}\ \text{cm}^2$$

or

$$1 \text{ darcy} = 1.062 \times 10^{-11}\ \text{ft}^2$$

Because Eq. 4.18 may be written as

$$K = kg/\nu \tag{4.21}$$

in which $\nu = \mu/\rho$ is the kinematic viscosity of the fluid, and ρ is the density of the fluid. It is easy to convert from darcy units to gpd/ft^2. The knowledge of the temperature of the fluid makes it possible to read ν from tables of physical properties of fluids [11]. The U.S. Geological Survey uses the meinzer unit to measure the hydraulic conductivity, honoring the late Dr. O. E. Meinzer. The meinzer unit is defined as the flow of water in gallons per day through a cross-sectional area of 1 square foot under a hydraulic gradient of one at a temperature of 60°F.

A second coefficient, the field coefficient of hydraulic conductivity, is also used by the Water Resources Division of the Geological Survey.

Table 4.2 Representative Values for k and K

Geologic Classification		Darcys (k)	Meinzers (K)
Argillaceous limestone	2% porosity	1.0 × 10^{-4}	1.80 × 10^{-3}
Limestone	16% porosity	1.4 × 10^{-1}	2.50
Sandstone, silty	12% porosity	2.6 × 10^{-3}	4.74 × 10^{-2}
Sandstone, coarse	12% porosity	1.1	19.90
Sandstone	29% porosity	2.4	43.60
Very fine sand	well sorted	9.9	18.00 × 10
Medium sand	very well sorted	2.6 × 10^2	4.60 × 10^3
Coarse sand	very well sorted	3.1 × 10^3	5.80 × 10^4
Gravel	very well sorted	4.3 × 10^4	7.88 × 10^5
Montmorillonite clay		10^{-5}	10^{-4}
Kaolinite clay		10^{-3}	10^{-2}

For the clays only the order of magnitude is indicated.

K ≐ hydraulic conductivity

k ≐ permeability

GROUND-WATER HYDROLOGY AND HYDRAULICS

by
David B. McWhorter
and
Daniel K. Sunada

Water Resources Publications
P. O. Box 303
Fort Collins, Colorado 80522 USA

Table 3-1 contains values of hydraulic conductivity to water for several different porous materials. It is striking to note that the hydraulic conductivity of materials with which the hydrologist must deal range over 9 orders of magnitude.

Table 3-1. Hydraulic Conductivity of Porous Materials (Adapted from Morris & Johnson, 1967)

Material	No. of Analyses	Range cm/s	Arithmetic Mean cm/s
Igneous Rocks			
Weathered granite	7	$(3.3 - 52) \times 10^{-4}$	1.65×10^{-3}
Weathered gabbro	4	$(0.5 - 3.8) \times 10^{-4}$	1.89×10^{-4}
Basalt	93	$(0.2 - 4250) \times 10^{-8}$	9.45×10^{-6}
Sedimentary Materials			
Sandstone (fine)	20	$(0.5 - 2270) \times 10^{-6}$	3.31×10^{-4}
Siltstone	8	$(0.1 - 142) \times 10^{-8}$	1.9×10^{-7}
Sand (fine)	159	$(0.2 - 189) \times 10^{-4}$	2.88×10^{-3}
Sand (med.)	255	$(0.9 - 567) \times 10^{-4}$	1.42×10^{-2}
Sand (coarse)	158	$(0.9 - 6610) \times 10^{-4}$	5.20×10^{-2}
Gravel	40	$(0.3 - 31.2) \times 10^{-1}$	4.03×10^{-1}
Silt	39	$(0.09 - 7090) \times 10^{-7}$	2.83×10^{-5}
Clay	19	$(0.1 - 47) \times 10^{-8}$	9×10^{-8}
Metamorphic Rocks			
Schist	17	$(0.002 - 1130) \times 10^{-6}$	1.9×10^{-4}

3.2 NON-HOMOGENIETY AND ANISOTROPY

Non-homogeneous Aquifers

An aquifer is said to be *homogeneous* with respect to hydraulic conductivity if K is not a function of the space coordinates. If $K = K(x,y,z)$ the aquifer is *non-homogeneous*. Rarely is an aquifer actually homogeneous, but the practical and financial difficulties of establishing the function $K = K(x,y,z)$ in the field are substantial. Flow nets, a method of analysis to be discussed in Chapter IV, is one method by which non-homogeniety can be deduced quantitatively. Nevertheless, the hydrologist is often obliged to assign a constant value to K in full realization that doing so is only an approximation.

No modification of Darcy's Law is required for flow in non-homogeneous aquifers. Both Eqs. 3-10 and 3-20 apply because

$K = K(x,y,z)$ remains a scalar,
with, but opposite in sense to,
head just as in the case of cor
homogeniety that must be dealt
of the aquifer. The hydraulic
within individual stratum but c
Such an aquifer can be regardec
with discontinuities in K at th
layers.

Treatment of block-wise hc
plished by defining a piezometr
which K is constant. For examp
and b in which the hydraulic cc
the piezometric heads are h_a ar
the two regions is denoted by c
velocity $\vec{q}_a$ at any point on C

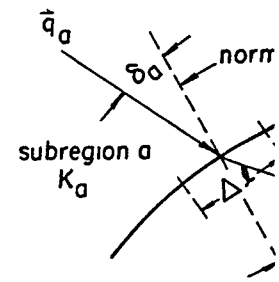


Figure 3-8. Refraction of the
between different

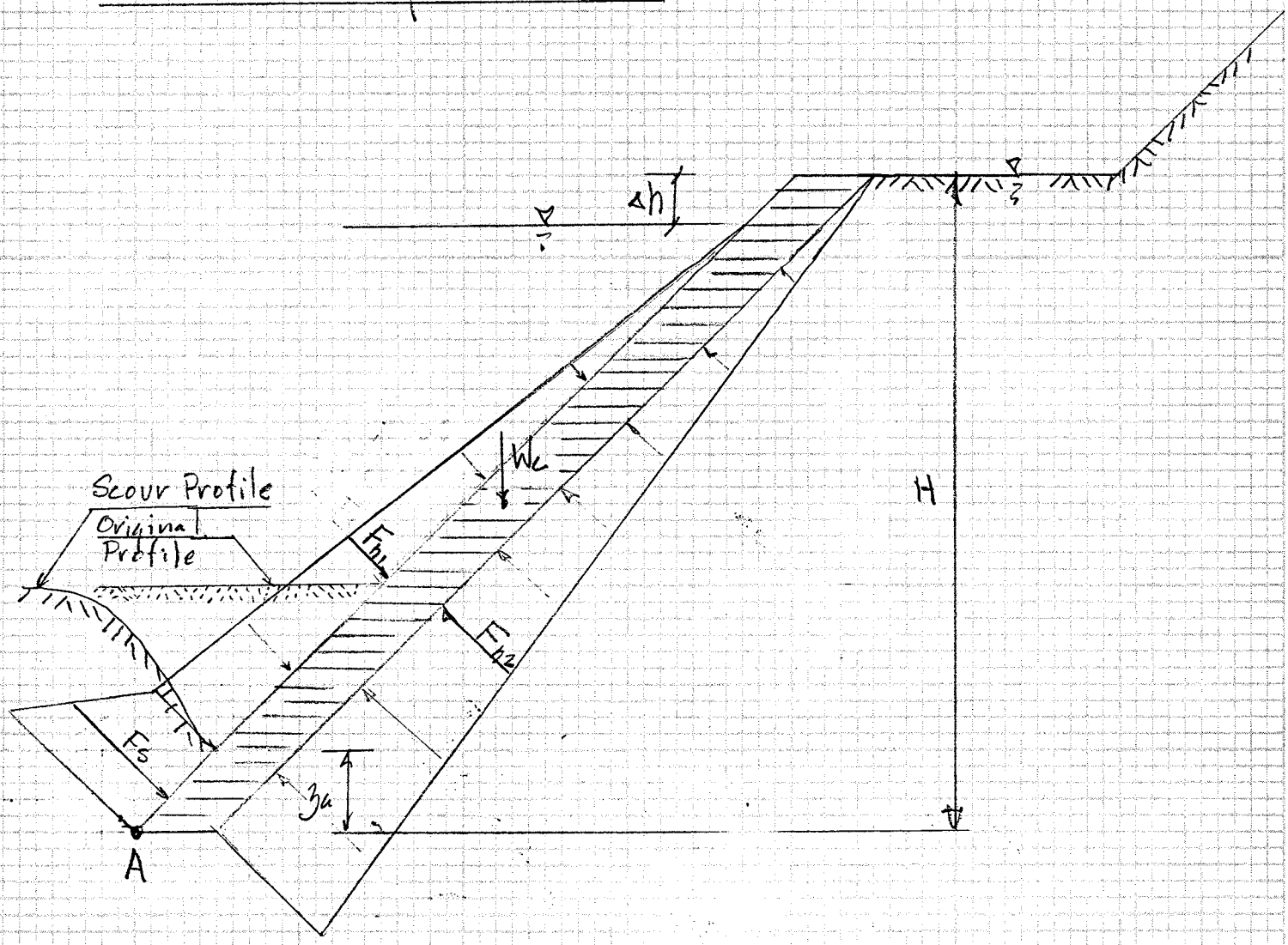
q_{an} normal to C and one tangen
depth into the paper through a
is the coordinate measured tan
can be similarly decomposed.
ment $\Delta\ell$ must be the same regar
used to calculate it, the conc
$\vec{q}_a$ and $\vec{q}_b$ normal to C must be

$$q_a \cos \delta_a =$$

The fact that $(p/\rho g)_a = ($
means that $h_a = h_b$ on C. Ther

CRSS	PROJECT: Rio Salado Channel	JOB NO. R101N	NO. 1
CRS SIRRINE	CLIENT: Tempe	DESIGNED BY GKC / DATE 6/24/90	OF 5
	SUBJECT: Bank Stability	CHECKED BY JV / DATE 8/29/90	

Overturning Condition



where H : bank protection height
Δh : drawdown depth
y_a : toe embedment depth
F_{h1} : hydrostatic force at center of pressure
F_{h2} : uplift force at center of pressure
F_s : soil pressure force at center of pressure

Forces:

Pressure (acting normal to submerge surface)

$$F_{h1} = \gamma_w (H - \Delta h - z_a)^2 / (2 \cos\theta)$$

$$F_{h2} = \gamma_w H^2 / (2 \cos\theta)$$

$$F_s = \tfrac{1}{2} (2 \gamma_w (H - \Delta h - z_a) + U_s z_a) z_a / \cos\theta$$

$$= \gamma_w (H - \Delta h + (\tfrac{1}{2} U_s / \gamma_w - 1) z_a) z_a / \cos\theta$$

Body (acting vertically)

$$W_{cy} = 8 (H * \gamma_c - (H - \tfrac{1}{2} \Delta h) \gamma_w)$$

Component Forces

$$F_{h1x} = \gamma_w (H - \Delta h - z_a)^2 / 2$$

$$F_{h1y} = \gamma_w (H - \Delta h - z_a)^2 \tan\theta / 2$$

$$F_{h2x} = \gamma_w H^2 / 2$$

$$F_{h2y} = \gamma_w H^2 \tan\theta / 2$$

$$F_{sx} = \gamma_w (H - \Delta h + (\tfrac{1}{2} U_s / \gamma_w - 1) z_a) z_a$$

$$F_{sx} = \gamma_w (H - \Delta h + (\tfrac{1}{2} U_s / \gamma_w - 1) z_a) z_a \tan\theta$$

CRS SIRRINE	PROJECT: Rio Salado Channel	JOB NO: R40IN	NO. 3
	CLIENT: Tempe	DESIGNED BY: GLC, DATE: 8/24/90	OF 5
	SUBJECT: Bank Stability	CHECKED BY: JV, DATE: 8/29/90	

Moments

$$d_{h1x} = z_a + \tfrac{1}{3}(H - \Delta h - z_a)$$

$$d_{h1y} = d_{h1x} \tan\theta$$

$$d_{h2x} = \tfrac{1}{3} H$$

$$d_{h2y} = 8 + d_{h2x} \tan\theta$$

$$d_{sx} = \tfrac{1}{3} z_a \left[\frac{(\gamma_w (H - \Delta h) + U_s z_a) + 2\gamma_w (H - \Delta h)}{(\gamma_w (H - \Delta h) + U_s z_a) + \gamma_w (H - \Delta h)} \right]$$

$$d_{sy} = d_{sx} \tan\theta$$

$$d_{cy} = 4 + \tfrac{3}{2} \tfrac{1}{2} H = 4 + \tfrac{3}{4} H$$

For: $H = 30'$ $H_o = 17'$

$z_a = \frac{1}{3}(H - H_o) = \frac{1}{3}(30-17) = 4.3'$

$\Delta h = 3.2'$

$\gamma_w = 62.4$ pcf

$\gamma_c = 150$ pcf

$\gamma_s = 180$ pcf

$F_{h1x} = 62.4(30 - 3.2 - 4.3)^2/2 = 15.8$ kips

$F_{h1y} = 1.5(F_{h1x}) = 23.7$ kips

$F_{h2x} = 62.4(30)^2/2 = 28.1$ kips

$F_{h2y} = 1.5(F_{h2x}) = 42.1$ kips

$F_{sx} = 62.4(30 - 3.2 + (\frac{1}{2}(180/62.4 - 1)4.3)4.3$

$= 7.7$ kips

$F_{sy} = 1.5(F_{sx}) = 11.6$ kips

$W_c = 8(150-62)(30 - \frac{1}{2}3.2) + \frac{1}{2}(50 \times 3.2) = 21.9$ kip

$d_{h1x} = 4.3 + \frac{1}{3}(30 - 3.2 - 4.3) = 11.8'$

$d_{h1y} = 1.5\, d_{h1x} = 17.7'$

$d_{h2x} = \frac{1}{3}(30) = 10.0'$

$d_{h2y} = 8 + 1.5\, d_{h2x} = 23.0'$

$$d_{sx} = \frac{1}{3}4.3\left[\frac{62.4(30-3.2) + 180 \times 4.3 + 2 \times 62.4(30-3.2)}{62.4(30-3.2) + 180 \times 4.3 + 62.4(30-3.2)}\right]$$

$= 2.0$

$d_{sy} = 1.5\, d_{sx} = 3.0$

$$SF = \frac{(F_{h1x} d_{h1x} + F_{h2x} d_{h2x} + F_{sx} d_{sx} + F_{sy} d_{sy} + W_{cy} d_{cy})}{(F_{h2x} d_{h2x} + F_{h2y} d_{h2y})}$$

$$= \frac{(15.8(11.8) + 23.7(17.7) + 7.7(2.9) + 11.6(3.0) + 21.9(26.5)}{(28.1(10.0) + 42.1(23.0))}$$

$$= \frac{1236.5}{1249.3}$$

$$= 0.99$$

<u>For Sliding:</u>

$$SF = \frac{F_{h1x} + F_{sx} + \tan\phi\, W_c}{F_{h2x}}$$

$$= \frac{28.1 + 7.7 + 0.7(21.9)}{28.1}$$

$$= 1.82$$

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk: VV 8/29/90

H =	30.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	3.2 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	15.7	d1x	11.8
Fh1y	23.5	d1y	17.7
Fh2x	27.9	d2x	10.0
Fh2y	41.9	d2y	23.0
Fsx	7.7	dsx	2.0
Fsy	11.5	dsy	3.0
Wc	21.9	dc	26.5

Factor of Safety:
Overturning:
SF = 0.99

Sliding:
SF = 1.82

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk:

H =	30.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	3.2 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	15.7	d1x	11.8
Fh1y	19.6	d1y	14.8
Fh2x	27.9	d2x	10.0
Fh2y	34.9	d2y	20.5
Fsx	7.7	dsx	2.0
Fsy	9.6	dsy	2.5
Wc	21.9	dc	26.5

Factor of Safety:
Overturning:
SF = 1.10

Sliding:
SF = 1.82

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIDIN
Dgn: GKC 29-Aug-90
Chk: JV 8/29/90

H =	25.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	3.2 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	9.5	d1x	10.1
Fh1y	14.2	d1y	15.2
Fh2x	19.4	d2x	8.3
Fh2y	29.1	d2y	20.5
Fsx	6.3	dsx	2.0
Fsy	9.5	dsy	3.0
Wc	18.4	dc	22.8

Factor of Safety:
Overturning:
SF = 1.02

Sliding:
SF = 1.99

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIDIN
Dgn: GKC 29-Aug-90
Chk:

H =	25.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	3.2 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	9.5	d1x	10.1
Fh1y	11.9	d1y	12.7
Fh2x	19.4	d2x	8.3
Fh2y	24.2	d2y	18.4
Fsx	6.3	dsx	2.0
Fsy	7.9	dsy	2.5
Wc	18.4	dc	22.8

Factor of Safety:
Overturning:
SF = 1.15

Sliding:
SF = 1.99

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk: VV 8/28/90

H =	20.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	3.2 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	4.8	d1x	8.5
Fh1y	7.3	d1y	12.7
Fh2x	12.4	d2x	6.7
Fh2y	18.6	d2y	18.0
Fsx	5.0	dsx	2.0
Fsy	7.5	dsy	2.9
Wc	14.9	dc	19.0

Factor of Safety:
Overturning:
SF = 1.07

Sliding:
SF = 2.24

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk:

H =	20.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	3.2 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	4.3 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	4.8	d1x	8.5
Fh1y	6.1	d1y	10.6
Fh2x	12.4	d2x	6.7
Fh2y	15.5	d2y	16.3
Fsx	5.0	dsx	2.0
Fsy	6.2	dsy	2.4
Wc	14.9	dc	19.0

Factor of Safety:
Overturning:
SF = 1.23

Sliding:
SF = 2.24

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk: JV 8/29/90

H =	30.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	0.0 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	27.9	d1x	10.0
Fh1y	41.9	d1y	15.0
Fh2x	27.9	d2x	10.0
Fh2y	41.9	d2y	23.0
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	21.1	dc	26.5

Factor of Safety:
Overturning:
SF = 1.18

Sliding:
SF = 1.53

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk:

H =	30.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	0.0 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	27.9	d1x	10.0
Fh1y	34.9	d1y	12.5
Fh2x	27.9	d2x	10.0
Fh2y	34.9	d2y	20.5
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	21.1	dc	26.5

Factor of Safety:
Overturning:
SF = 1.28

Sliding:
SF = 1.53

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk: ✓✓ 8/29/90

H =	25.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	0.0 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	19.4	d1x	8.3
Fh1y	29.1	d1y	12.5
Fh2x	19.4	d2x	8.3
Fh2y	29.1	d2y	20.5
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	17.6	dc	22.8

Factor of Safety:
Overturning:
SF = 1.22

Sliding:
SF = 1.64

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk:

H =	25.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	0.0 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	19.4	d1x	8.3
Fh1y	24.2	d1y	10.4
Fh2x	19.4	d2x	8.3
Fh2y	24.2	d2y	18.4
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	17.6	dc	22.8

Factor of Safety:
Overturning:
SF = 1.34

Sliding:
SF = 1.64

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk: JV 8/29/90

H =	20.0 '	Uw =	62.0 pcf	Z =	1.50
dh =	0.0 '	Uc =	150.0 pcf	Az =	33.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	12.4	d1x	6.7
Fh1y	18.6	d1y	10.0
Fh2x	12.4	d2x	6.7
Fh2y	18.6	d2y	18.0
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	14.1	dc	19.0

Factor of Safety:
Overturning:
SF = 1.28

Sliding:
SF = 1.79

Rio Salado Channel
City of Tempe
Bank Stability Computation

Proj: RIOIN
Dgn: GKC 29-Aug-90
Chk:

H =	20.0 '	Uw =	62.0 pcf	Z =	1.25
dh =	0.0 '	Uc =	150.0 pcf	Az =	38.7 degrees
za =	0.0 '	Us =	180.0 pcf	Tc =	8.0

Force:	kips	Moment:	ft
Fh1x	12.4	d1x	6.7
Fh1y	15.5	d1y	8.3
Fh2x	12.4	d2x	6.7
Fh2y	15.5	d2y	16.3
Fsx	0.0	dsx	0.0
Fsy	0.0	dsy	0.0
Wc	14.1	dc	19.0

Factor of Safety:
Overturning:
SF = 1.43

Sliding:
SF = 1.79

THOMAS-HARTIG & ASSOCIATES, INC.

Geotechnical, Materials Testing, and Environmental Consultants

7031 West Oakland Street • Chandler, Arizona 85226

Chandler: Phone (602) 961-1169, Fax (602) 940-0952 • Phoenix: Phone (602) 437-5450

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Judith A. McBee
Dale V. Bedenkop, P.E.
John C. Patton
Kenneth D. Walsh, P.E.

19 March 1992

City of Tempe
Engineering Department
P.O. Box 5002
31 East 5th Street
Tempe, Arizona 85281

Attention: Jim Bond

Project: Rio Salado Improvements
Salt River Channelization
Hohokam (University - Sky Harbor)
Tempe, Arizona

Project No. 89-0919
Supplement No. 1

In accordance with your request, this firm has estimated settlements for typical levee sections along the project. Settlements were estimated using an elastic solution for determining displacement under a strip load on the surface of an elastic layer overlying a rigid base. A modulus of elasticity of 20,000 psi was assumed for the Salt River deposits beneath the levees based upon settlement data for caisson foundations obtained during the Papago Load Test. The caissons were embedded in materials similar to the natural deposits beneath the levees. The settlement estimates ranged between approximately 0.3 and 1.2 inches for the seven sections evaluated. Due to the granular nature of the Salt River deposits above the bedrock level, settlements would have occurred rapidly (elastically) after levee construction and should now be essentially complete.

Settlement calculations and levee cross sections are attached for the seven typical locations evaluated. Please call if we may be of further assistance.

Respectfully submitted,

THOMAS-HARTIG & ASSOCIATES, INC.

By: _____ Reviewed by: _____

John P. Boyd, P.E. Kenneth L. Ricker, P.E.

/dh

Copies to: Addressee (3).

Thomas-Hartig & Assoc, Inc.
2720 S. Hardy Drive
Tempe, Arizona 85282

PROJECT NO. 89-0919 COMPUTED BY JMB DATE 3-18-92
SUBJECT Settlements CHECKED BY _____ DATE _____

Sta. 125+00 N. Dike

Use $\gamma \approx 145$ pcf total
Use $\mu = 0.30$
Use $E = 20{,}000$ psi (Range 14,000 to 31,500 psi at $\delta = 1''$ Papago load test).

Rock depth = 60' = h

At Sta 125 use 2 equiv rectangles

① $(151+87)\times 1/2 = 119'$ @ $14' \times 0.145 = 2.03$ ksf

② $(80+14)\times 1/2 = 47'$ @ $11' \times 0.145 = 1.60$ ksf

Where: $I\Delta z ① = 1.1$ and $I\Delta z ② = 0.93$

$$\delta = \frac{4\, q① \cdot h}{\pi E} \cdot I\Delta z① + \frac{4\, q② \cdot h \cdot I\Delta z②}{\pi E}$$

$$= \frac{4h}{\pi E}\left(q① \cdot I\Delta z① + q② \cdot I\Delta z②\right)$$

$$= \frac{4 \times 60}{\pi \cdot 20{,}000 \times 144}\left(2030 \cdot 1.1 + 1600 \cdot 0.93\right) = 0.099'$$

→ $\delta = \underline{1.2''} \pm$

Sta. 144+00 So. Dike

Use $h = 60'$

① $53'$ @ $14' \times 0.145 = 2.03$ ksf

$I\Delta z① = 1.0$

$$\delta = \frac{4 \times 60}{\pi \cdot 20{,}000 \times 144}\left(2030 \cdot 1.0\right) = 0.054'$$

→ $\delta = \underline{0.6''} \pm$

Thomas-Hartig & Assoc, Inc.
2720 S. Hardy Drive
Tempe, Arizona 85282

PROJECT NO. 89 0919 COMPUTED BY JB DATE 3-18-92
SUBJECT Settlements CHECKED BY _____ DATE _____

Sta. 154+00 No. Dike
Use $h = 60$ feet
① 33' @ 7' × 0.145 = 1.02 ksf

$I\Delta z$ ① = 0.87

$$\delta = \frac{4 \times 60}{\pi \times 20{,}000 \times 144}(1020 \times 0.87) = 0.024'$$

→ $\delta = \underline{0.3''\ \pm}$

Sta. 160+00 South Dike
Use $h = 60$ ft.

① (136 + 86) × ½ = 111' @ 11' × 0.145 = 1.60 ksf
② (78 + 14) × ½ = 46 @ 11' @ 0.145 = 1.60 ksf

$I\Delta z$ ① = 1.1 $I\Delta z$ ② = 0.93

$$\delta = \frac{4 \cdot 60}{\pi \cdot 20{,}000 \cdot 144}(1600 \times 1.1 + 1600 \times 0.93) = 0.086'$$

→ $\delta = \underline{1.0''\ \pm}$

Sta. 191+00 No. Dike
① 48 @ 16' × 0.145 = 2.32 ksf.
Use $h = 50'$
$I\Delta z$ ① = 1.02

$$\delta = \frac{4 \cdot 50}{\pi \cdot 20{,}000 \cdot 144}(2320 \times 1.02) = 0.052'$$

→ $\delta = \underline{0.6''\ \pm}$

Thomas-Hartig & Assoc, Inc.
2720 S. Hardy Drive
Tempe, Arizona 85282

PROJECT NO. 89-0919 COMPUTED BY JRB DATE 3-18-92
SUBJECT Settlements CHECKED BY _____ DATE _____

Sta 230 So. Dike

Use $h = 50'$

① $(144 + 85) \times \frac{1}{2} = 115$ @ $12' \times 0.145 = 1.74$ ksf

② $(77 + 11) \times \frac{1}{2} = 44$ @ $11' \times 0.145 = 1.60$ ksf

$I\Delta z_{①} = 1.12$ $I\Delta z_{②} = 1.0$

$$\delta = \frac{4 \cdot 50}{\pi \cdot 20{,}000 \cdot 144} (1740 \times 1.12 + 1600 \times 1.0) = 0.078'$$

→ $\delta = \underline{\underline{0.9''}} \pm$

Sta. 248+00 N Dike

Use $h = 40'$

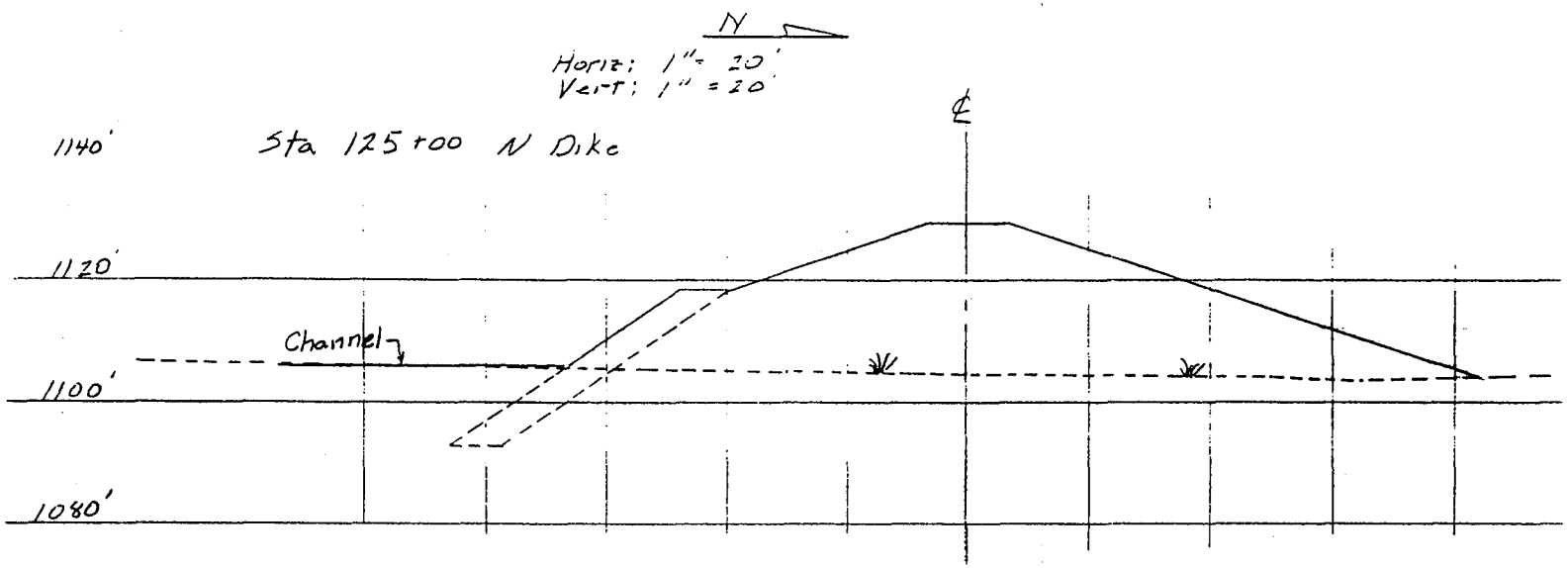
① $(122 + 85) \times \frac{1}{2} = 104$ @ $10' \times 0.145 = 1.45$ ksf

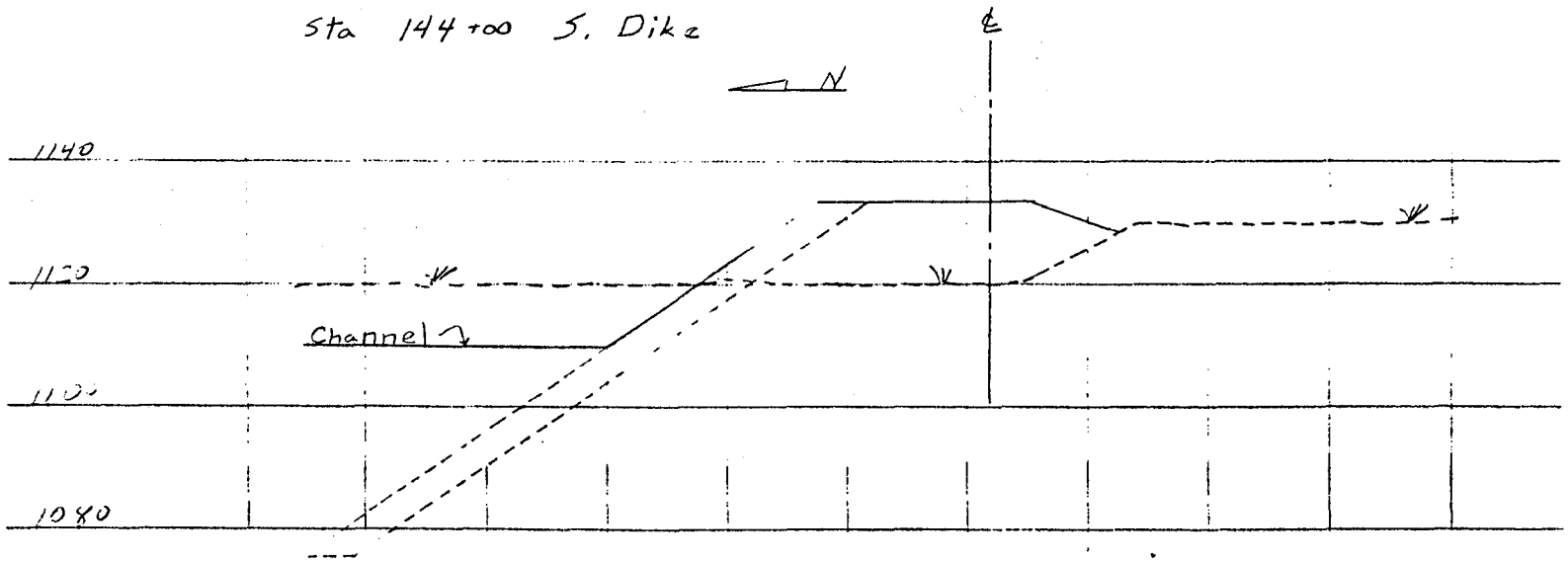
② $(77 + 11) \times \frac{1}{2} = 44$ @ $11' \times 0.145 = 1.60$ ksf

$I\Delta z_{①} = 1.1$ $I\Delta z_{②} = 1.08$

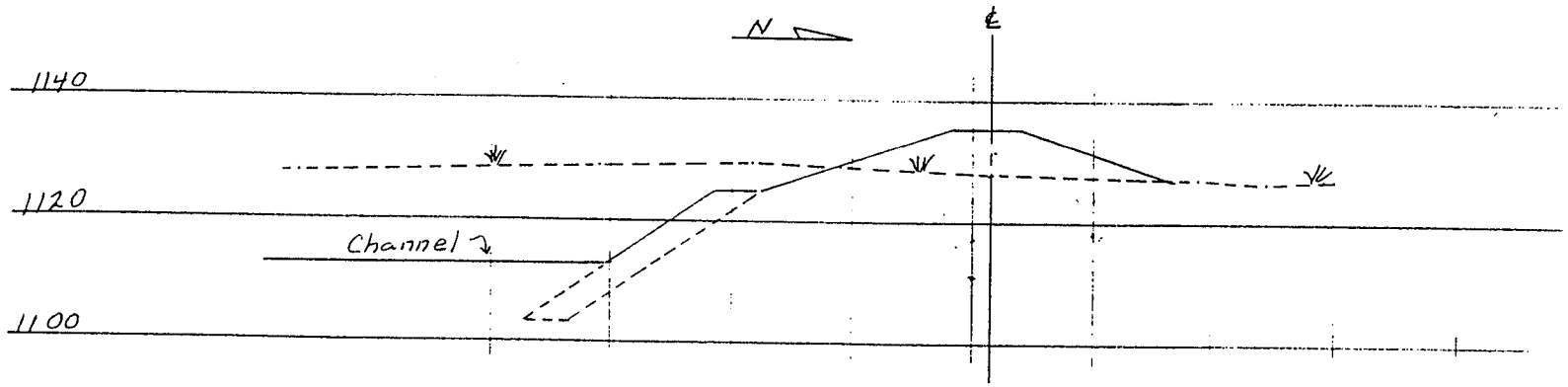
$$\delta = \frac{4 \cdot 40}{\pi \times 20{,}000 \cdot 144} (1450 \times 1.1 + 1600 \times 1.08) = 0.059'$$

→ $\delta = \underline{\underline{0.7''}} \pm$

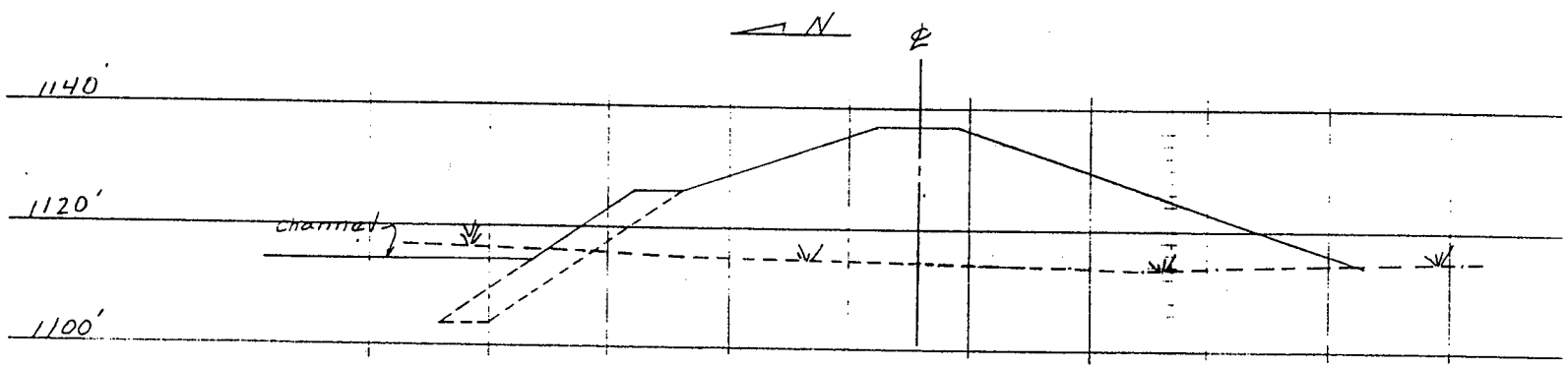

N
Horiz: 1" = 20'
Vert: 1" = 20'
1140'
Sta 125+00 N Dike
1120'
Channel
1100'
1080'


Sta 144+00 S. Dike
N
1140
Channel
1080

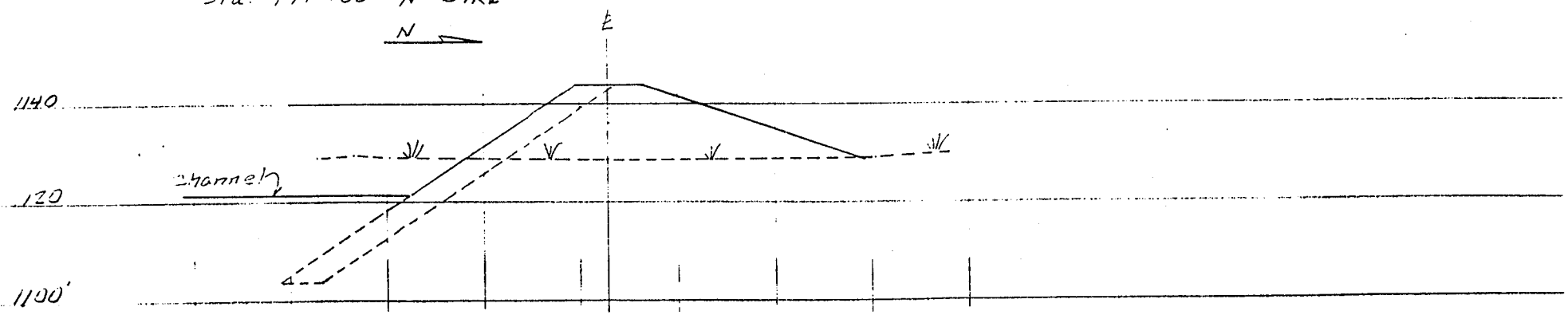
Sta. 154+00 N Dike



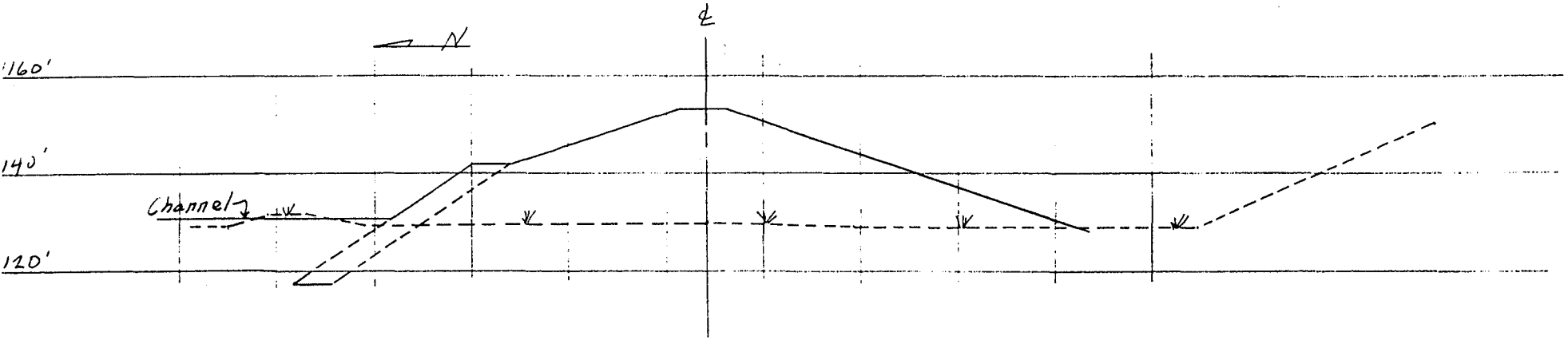
Sta. -160+00 S Dike



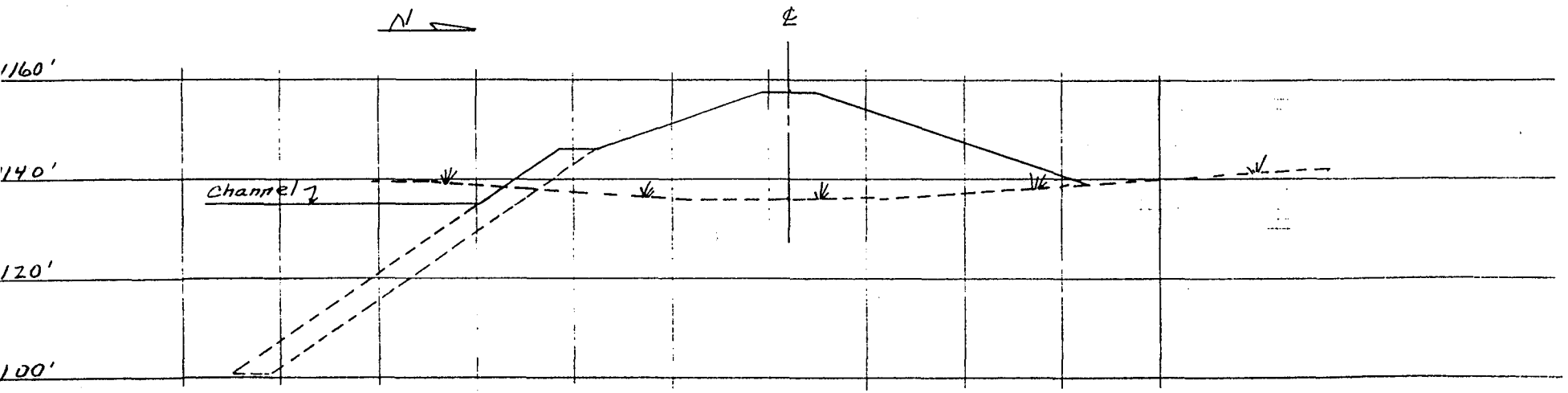
Sta. 191+00 N Dike



Sta. 230+00 S Dike



Sta 248+00 N Dike



REPORT FOR
GEOTECHNICAL ENGINEERING SERVICES
SLOPE STABILITY EVALUATION
SALT RIVER CHANNELIZATION
40TH STREET TO MILL AVENUE
TEMPE, ARIZONA

Submitted To:

City of Tempe
Public Works Department
P.O. Box 5002
Tempe, Arizona 85280

Project No. 92-0933

10 August 1992

THOMAS-HARTIG & ASSOCIATES, INC.

Geotechnical, Materials Testing, and Environmental Consultants

7031 West Oakland Street • Chandler, Arizona 85226

Chandler: Phone (602) 961-1169, Fax (602) 940-0952 • Phoenix: Phone (602) 437-5450

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Dale V. Bedenkop, P.E.
John C. Patton
Kenneth D. Walsh, P.E.

City of Tempe
Public Works Department
P.O. Box 5002
Tempe, Arizona 85280

10 August 1992

Attention: James E. Bond, Senior Civil Engineer

Subject: Report for Geotechnical Engineering Services
Slope Stability Evaluation
Salt River Channelization
40th Street to Mill Avenue
Tempe, Arizona

Project No. 92-0933

In accordance with your authorization, this firm has performed slope stability analyses for selected levee sections along this reach of the Salt River. Stability of the levee on the landside where adjacent ground is below the 100-year flood stage was evaluated. Locations with the most elevation differential between the top of the levee and ground level on the landside were analyzed for the north and south levees of the two projects to determine safety factors at the 100-year flood stage. These locations were:

- North Levee, Sta. 125, Project 866025
- South Levee, Sta. 230, Project 866025
- North Overbank Levee, Sta. 2, Project 876191
- South Overbank Levee, Sta. 606, Project 876191

These sections were evaluated both for a hypothetically limiting condition of minimum stability with a phreatic surface in the levee at the 100-year flood level (analogous to an instantaneous total draw down of a submerged slope) and for steady state seepage through the embankments passing just below the landside toe of the levee slope (the more likely condition for a permeable, granular embankment on an underlying granular base deposit after prolonged water impoundment). Minimum factors of safety between 1.4 and 1.5 were calculated for the four sections analyzed for the hypothetically limiting condition analogous to instantaneous drawdown of a submerged slope. The actual safety factors at the 100-year flood stage will be larger

as demonstrated by the minimum factors of safety of 2.3 or higher calculated for the several sections with steady state seepage assumed below the toe of the embankment. Prolonged water impoundment in the channel at the 100-year flood level would be necessary to develop such steady state seepage; thus, we conclude a factor of safety on the order of 2.3 or even higher would be maintained during the actual duration of the 100-year flood.

Copies of the stability analyses by the TSTAB computer program are attached. Please call if we may be of further assistance.

Respectfully submitted,

THOMAS-HARTIG & ASSOCIATES, INC.

By: _____ Reviewed by: _____

John P. Boyd, P.E. Kenneth L. Ricker, P.E.

/bc

Copies to: Addressee (5)

APPENDIX A
Slope Stability Analyses

```
*********************************************
* ***************************************** *
* *                                       * *
* *    ---------------------------------  * *
* *     TSTAB  slope stability analysis   * *
* *        Revision 2.40 - 02/12/85       * *
* *    ---------------------------------  * *
* *                                       * *
* *    TAGA Engineering Software Services * *
* *           Berkeley, California        * *
* *                                       * *
* *   IBM PC & 8086/8088 MS-DOS Version by * *
* *                                       * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington        * *
* *                                       * *
* *      copyright (c) 1983, 1984 TAGA    * *
* *      copyright (c) 1983, 1984 DPMS    * *
* *                                       * *
* ***************************************** *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 125,N. DIKE,TRY 1,TOE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  0
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    2
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                    =        .000
      ATMOSPHERIC PRESSURE                   =        .000
      UNIT WEIGHT OF WATER                   =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

 SEARCH STARTS AT CENTER ( 119.0,  46.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES PASS THROUGH THE POINT ( 117.0, 106.0)
```

GEOMETRY

SECTIONS	.00	40.00	58.00	118.00	150.00
T. CRACKS	80.00	80.00	86.00	106.00	106.00
W IN CRACK	80.00	80.00	86.00	106.00	106.00
BOUNDARY 1	80.00	80.00	86.00	106.00	106.00
BOUNDARY 2	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	58.00	118.00	150.00
Y-COORDINATE OF PHREATIC SURFACE	86.00	86.00	86.00	106.00	106.00

1

****
RESULTS
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	106.0	60.0	119.0	46.0	1.474
2	106.1	60.1	113.0	46.0	1.523
3	106.0	66.0	119.0	40.0	1.474
4	106.5	60.5	125.0	46.0	1.841
5	106.0	54.0	119.0	52.0	1.474
6	106.0	60.0	116.0	46.0	1.495
7	106.0	63.0	119.0	43.0	1.474
8	106.2	60.2	122.0	46.0	1.510
9	106.0	57.0	119.0	49.0	1.474
10	106.0	63.0	116.0	43.0	1.494
11	106.2	63.2	122.0	43.0	1.502
12	106.2	57.2	122.0	49.0	1.521
13	106.0	57.0	116.0	49.0	1.496

F.S. MINIMUM= 1.474 FOR THE CIRCLE OF CENTER (119.0, 46.0)

Opened plot file: srslope.P01
Saved plot file: srslope.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

1.5

1.5 1.5

1.5

00000

00000

```
OOOOO
    OOOOOO
      OOOOOOOOO
           OOXXOOOOO
             OOXXXXXOOOOO
               OOXXXXXXXXXOOOOO
                 OOOOOXXXXXXXXXOOOOO
                      OOXXXXXXXXXXXXOOOOO
                        OOOOOXXXXXXXXXXXXOOOOO
                             OOOOXXXXXXXXXXXXXXOOOOO
                                 OOOOOXXXXXXXXXXXXXXOOOOO
                                      OOOOOXXXXXXXXXXXXXXOOOOO
                                           OOOOOOOXXXXXXXXXXXXOOOOO
                                                   OOOOOOOOOOOOXXXXOOOOO
                                                              OOOOOOOOO
```

```
-------------------------------------------
Execution complete, time =    54.49 seconds
-------------------------------------------
```

```
*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 125,N. DIKE,TRY 2,TOE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  0
      NUMBER OF VERTICAL SECTIONS                        4
      NUMBER OF SOIL LAYER BOUNDARIES                    2
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                    =        .000
      ATMOSPHERIC PRESSURE                   =        .000
      UNIT WEIGHT OF WATER                   =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK =       62.400

 SEARCH STARTS AT CENTER ( 113.0,  34.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES PASS THROUGH THE POINT ( 117.0, 106.0)
```

GEOMETRY

SECTIONS	.00	40.00	118.00	150.00
T. CRACKS	80.00	80.00	106.00	106.00
W IN CRACK	80.00	80.00	106.00	106.00
BOUNDARY 1	80.00	80.00	106.00	106.00
BOUNDARY 2	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	118.00	150.00
Y-COORDINATE OF PHREATIC SURFACE	80.00	80.00	106.00	106.00

1

****
RESULTS
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	106.1	72.1	113.0	34.0	1.515
2	106.7	72.7	107.0	34.0	1.568
3	106.1	78.1	113.0	28.0	1.512
4	106.0	72.0	119.0	34.0	1.474
5	106.1	66.1	113.0	40.0	1.518
6	106.0	72.0	116.0	34.0	1.492
7	106.0	75.0	119.0	31.0	1.474
8	106.2	72.2	122.0	34.0	1.486
9	106.0	69.0	119.0	37.0	1.474
10	106.0	69.0	116.0	37.0	1.493
11	106.2	69.2	122.0	37.0	1.490
12	106.0	66.0	119.0	40.0	1.474
13	106.0	66.0	116.0	40.0	1.494
14	106.2	66.2	122.0	40.0	1.495
15	106.0	63.0	119.0	43.0	1.474
16	106.0	63.0	116.0	43.0	1.494
17	106.2	63.2	122.0	43.0	1.502
18	106.0	60.0	119.0	46.0	1.474
19	106.0	60.0	116.0	46.0	1.495
20	106.2	60.2	122.0	46.0	1.510
21	106.0	57.0	119.0	49.0	1.474
22	106.0	63.0	116.0	43.0	1.494
23	106.2	63.2	122.0	43.0	1.502
24	106.2	57.2	122.0	49.0	1.521
25	106.0	57.0	116.0	49.0	1.496

F.S. MINIMUM= 1.474 FOR THE CIRCLE OF CENTER (119.0, 46.0)

```
Opened plot file: srslope1.P01
Saved plot file:  srslope1.P01

1
*******************************
 LOCATION OF CRITICAL CIRCLE
*******************************

                                                    1.5

                                          1.6       1.5   1.5

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                                                    OOOOOXXXXXXXXXXXXXOOOOO
                                                         OOOOOOOXXXXXXXXXXXOOOOO
                                                                 OOOOOOOOOOOOOXXOOOOO
                                                                              OOOOOOO

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 Execution complete, time =    85.63 seconds
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*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
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```

```
*******************************************************************
  92-0933,STA. 125,N. DIKE,TRY 3,TOE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
CONTROL DATA,
     AUTOMATIC SEARCH FOR CRITICAL CIRCLE
     NUMBER OF DEPTH LIMITING TANGENTS                  0
     NUMBER OF VERTICAL SECTIONS                        5
     NUMBER OF SOIL LAYER BOUNDARIES                    2
     NUMBER OF POINTS DEFINING COHESION PROFILE         0
     NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
     NUMBER OF BOUNDARY LINE LOADS                      0
     NUMBER OF BOUNDARY PRESSURE LOADS                  0

     SEISMIC COEFFICIENT                    =       .000
     ATMOSPHERIC PRESSURE                   =       .000
     UNIT WEIGHT OF WATER                   =     62.400
     UNIT WEIGHT OF WATER IN TENSION CRACK  =     62.400

SEARCH STARTS AT CENTER ( 119.0,  46.0),WITH FINAL GRID OF  3.0

ALL CIRCLES PASS THROUGH THE POINT ( 117.0, 106.0)
```

GEOMETRY

SECTIONS	.00	40.00	58.00	118.00	200.00
T. CRACKS	80.00	80.00	86.00	106.00	106.00
W IN CRACK	80.00	80.00	86.00	106.00	106.00
BOUNDARY 1	80.00	80.00	86.00	106.00	106.00
BOUNDARY 2	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	58.00	118.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	86.00	93.00	97.00	110.00	126.00

1

****
RESULTS
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	106.0	60.0	119.0	46.0	2.723
2	106.1	60.1	113.0	46.0	2.802
3	106.0	66.0	119.0	40.0	2.723
4	106.5	60.5	125.0	46.0	3.369
5	106.0	54.0	119.0	52.0	2.723
6	106.0	60.0	116.0	46.0	2.757
7	106.0	63.0	119.0	43.0	2.723
8	106.2	60.2	122.0	46.0	2.788
9	106.0	57.0	119.0	49.0	2.723
10	106.0	63.0	116.0	43.0	2.756
11	106.2	63.2	122.0	43.0	2.773
12	106.2	57.2	122.0	49.0	2.807
13	106.0	57.0	116.0	49.0	2.759

F.S. MINIMUM= 2.723 FOR THE CIRCLE OF CENTER (119.0, 46.0)

Opened plot file: srslope2.P01
Saved plot file: srslope2.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

2.8

2.8 2.8

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Execution complete, time =    53.66 seconds
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*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 125,N. DIKE,TRY 4,BASE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  3
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    3
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                  =        .000
      ATMOSPHERIC PRESSURE                 =        .000
      UNIT WEIGHT OF WATER                 =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

 SEARCH STARTS AT CENTER ( 100.0,  46.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES TANGENT TO DEPTH, 107.0, 112.0, 117.0,
```

GEOMETRY

SECTIONS	.00	40.00	58.00	118.00	200.00
T. CRACKS	80.00	80.00	86.00	106.00	106.00
W IN CRACK	80.00	80.00	86.00	106.00	106.00
BOUNDARY 1	80.00	80.00	86.00	106.00	106.00
BOUNDARY 2	106.00	106.00	106.00	106.00	106.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	58.00	118.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	86.00	93.00	97.00	110.00	126.00

1

****
RESULTS
****

****
DEPTH LIMITING TANGENT NO. 1 AT Y = 107.00
****

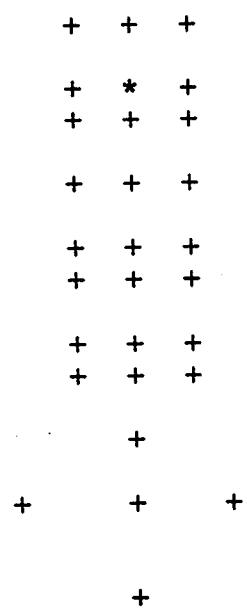
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	107.0	61.0	100.0	46.0	2.652
2	107.0	61.0	94.0	46.0	2.659
3	107.0	67.0	100.0	40.0	2.630
4	107.0	61.0	106.0	46.0	2.668
5	107.0	55.0	100.0	52.0	2.680
6	107.0	67.0	97.0	40.0	2.628
7	107.0	70.0	100.0	37.0	2.621
8	107.0	67.0	103.0	40.0	2.639
9	107.0	64.0	100.0	43.0	2.641
10	107.0	70.0	97.0	37.0	2.617
11	107.0	73.0	100.0	34.0	2.612
12	107.0	70.0	103.0	37.0	2.631
13	107.0	73.0	97.0	34.0	2.607
14	107.0	76.0	100.0	31.0	2.604
15	107.0	73.0	103.0	34.0	2.623
16	107.0	76.0	97.0	31.0	2.599
17	107.0	79.0	100.0	28.0	2.597
18	107.0	76.0	103.0	31.0	2.616

19	107.0	79.0	97.0	28.0	2.598
20	107.0	82.0	100.0	25.0	2.591
21	107.0	79.0	103.0	28.0	2.610
22	107.0	82.0	97.0	25.0	2.601
23	107.0	85.0	100.0	22.0	2.591
24	107.0	82.0	103.0	25.0	2.604
25	107.0	85.0	97.0	22.0	2.607
26	107.0	88.0	100.0	19.0	2.594
27	107.0	85.0	103.0	22.0	2.599
28	107.0	88.0	97.0	19.0	2.617
29	107.0	88.0	103.0	19.0	2.594
30	107.0	82.0	103.0	25.0	2.604
31	107.0	82.0	97.0	25.0	2.601

F.S. MINIMUM= 2.591 FOR THE CIRCLE OF CENTER (100.0, 22.0)

Opened plot file: srslope3.P01
Saved plot file: srslope3.P01

1
****
LOCATION OF CRITICAL CIRCLE
****



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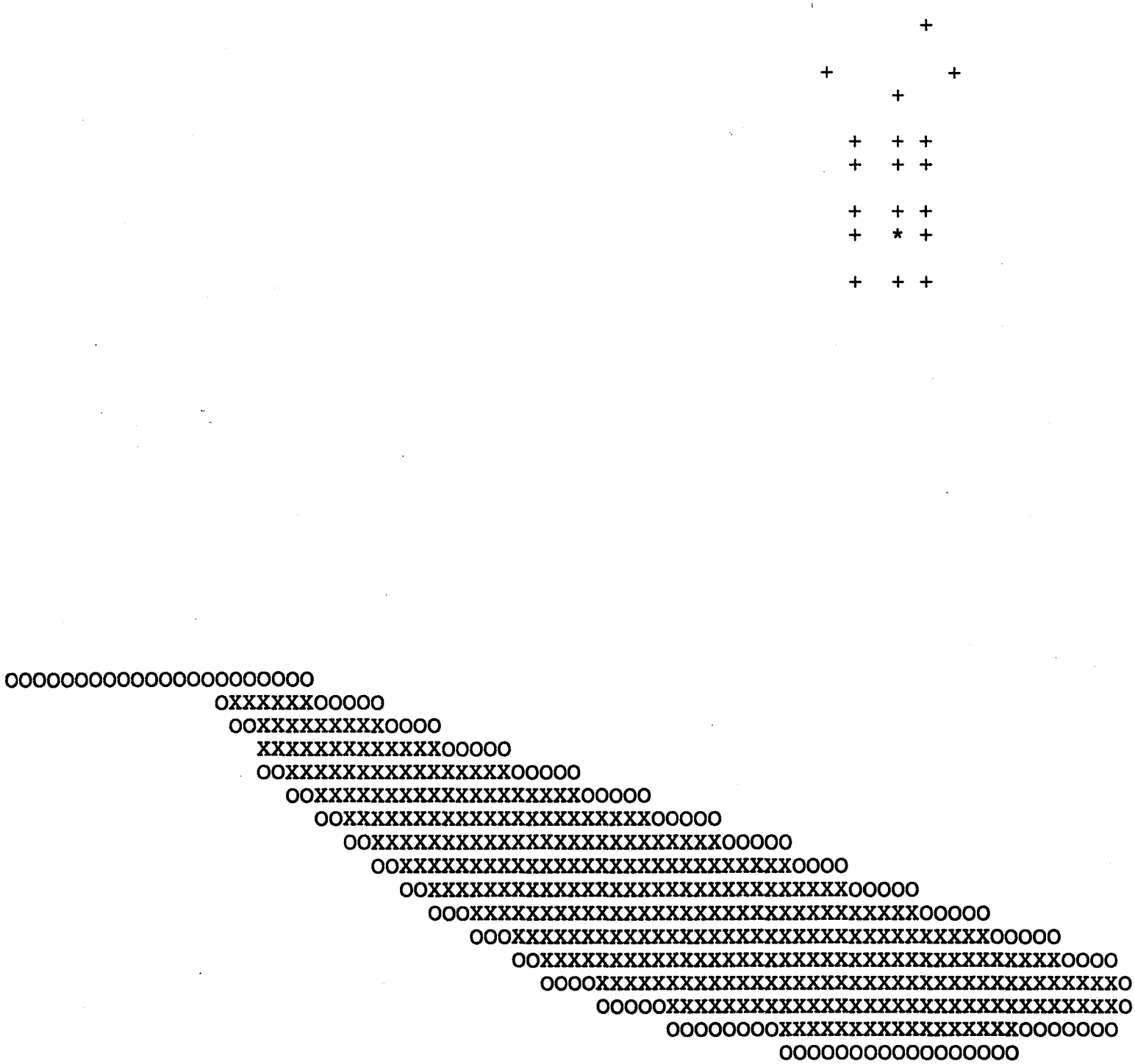
1
**************************************************
  DEPTH LIMITING TANGENT NO.  2  AT Y =   112.00
**************************************************
```

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	112.0	90.0	100.0	22.0	2.383
2	112.0	87.0	91.0	25.0	2.442
3	112.0	93.0	97.0	19.0	2.406
4	112.0	87.0	103.0	25.0	2.388
5	112.0	81.0	97.0	31.0	2.356
6	112.0	81.0	94.0	31.0	2.375
7	112.0	84.0	97.0	28.0	2.365
8	112.0	81.0	100.0	31.0	2.354
9	112.0	78.0	97.0	34.0	2.347
10	112.0	78.0	94.0	34.0	2.366
11	112.0	78.0	100.0	34.0	2.350
12	112.0	75.0	97.0	37.0	2.341
13	112.0	75.0	94.0	37.0	2.357
14	112.0	75.0	100.0	37.0	2.349
15	112.0	72.0	97.0	40.0	2.339
16	112.0	72.0	94.0	40.0	2.352
17	112.0	72.0	100.0	40.0	2.353
18	112.0	69.0	97.0	43.0	2.341
19	112.0	75.0	94.0	37.0	2.357
20	112.0	75.0	100.0	37.0	2.349
21	112.0	69.0	100.0	43.0	2.359
22	112.0	69.0	94.0	43.0	2.351

```
F.S. MINIMUM= 2.339 FOR THE CIRCLE OF CENTER (  97.0,  40.0)

Opened plot file: srslope3.P02
Saved plot file:  srslope3.P02

1
*******************************
  LOCATION OF CRITICAL CIRCLE
*******************************
```



1

****
DEPTH LIMITING TANGENT NO. 3 AT Y = 117.00
****

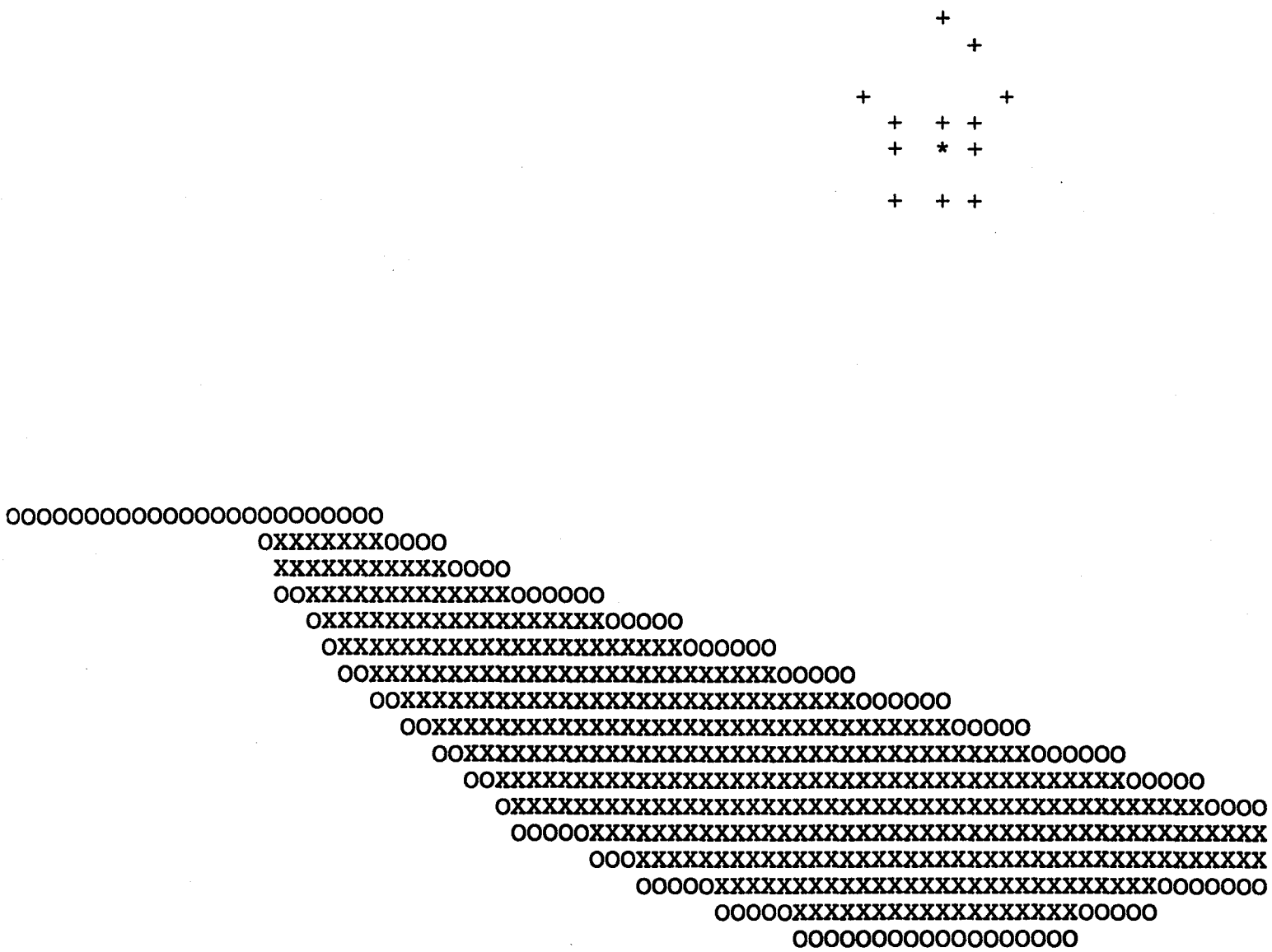
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	117.0	77.0	97.0	40.0	2.379
2	117.0	74.0	88.0	43.0	2.421
3	117.0	80.0	94.0	37.0	2.387
4	117.0	74.0	100.0	43.0	2.399
5	117.0	68.0	94.0	49.0	2.366

6	117.0	68.0	91.0	49.0	2.379
7	117.0	71.0	94.0	46.0	2.367
8	117.0	68.0	97.0	49.0	2.375
9	117.0	65.0	94.0	52.0	2.370
10	117.0	71.0	91.0	46.0	2.381
11	117.0	71.0	97.0	46.0	2.372
12	117.0	65.0	97.0	52.0	2.383
13	117.0	65.0	91.0	52.0	2.382

F.S. MINIMUM= 2.366 FOR THE CIRCLE OF CENTER (94.0, 49.0)

Opened plot file: srslope3.P03
Saved plot file: srslope3.P03

1
****
LOCATION OF CRITICAL CIRCLE
****



Execution complete, time = 186.70 seconds

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*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
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```

```
*****************************************************************
  92-0933,STA. 125,N. DIKE,TRY 4A, BASE
*****************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  3
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    3
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                  =        .000
      ATMOSPHERIC PRESSURE                 =        .000
      UNIT WEIGHT OF WATER                 =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

 SEARCH STARTS AT CENTER ( 100.0,  46.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES TANGENT TO DEPTH, 107.0, 112.0, 117.0,
```

GEOMETRY

SECTIONS	.00	40.00	58.00	118.00	200.00
T. CRACKS	80.00	80.00	86.00	106.00	106.00
W IN CRACK	80.00	80.00	86.00	106.00	106.00
BOUNDARY 1	80.00	80.00	86.00	106.00	106.00
BOUNDARY 2	106.00	106.00	106.00	106.00	106.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	58.00	118.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	86.00	86.00	86.00	106.00	106.00

1

****
RESULTS
****

****
DEPTH LIMITING TANGENT NO. 1 AT Y = 107.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	107.0	61.0	100.0	46.0	1.530
2	107.0	61.0	94.0	46.0	1.617
3	107.0	67.0	100.0	40.0	1.535
4	107.0	61.0	106.0	46.0	1.476
5	107.0	55.0	100.0	52.0	1.535
6	107.0	61.0	103.0	46.0	1.498
7	107.0	64.0	106.0	43.0	1.473
8	107.0	61.0	109.0	46.0	1.459
9	107.0	58.0	106.0	49.0	1.478
10	107.0	64.0	109.0	43.0	1.458
11	107.0	61.0	112.0	46.0	1.454
12	107.0	58.0	109.0	49.0	1.459
13	107.0	64.0	112.0	43.0	1.454
14	107.0	61.0	115.0	46.0	1.466
15	107.0	58.0	112.0	49.0	1.453
16	107.0	58.0	109.0	49.0	1.459
17	107.0	58.0	115.0	49.0	1.465
18	107.0	55.0	112.0	52.0	1.453

19	107.0	55.0	109.0	52.0	1.460
20	107.0	55.0	115.0	52.0	1.465
21	107.0	52.0	112.0	55.0	1.452
22	107.0	52.0	109.0	55.0	1.461
23	107.0	52.0	115.0	55.0	1.465
24	107.0	49.0	112.0	58.0	1.452
25	107.0	49.0	109.0	58.0	1.463
26	107.0	49.0	115.0	58.0	1.465
27	107.0	46.0	112.0	61.0	1.452
28	107.0	46.0	109.0	61.0	1.466
29	107.0	46.0	115.0	61.0	1.465
30	107.0	43.0	112.0	64.0	1.452
31	107.0	49.0	109.0	58.0	1.463
32	107.0	49.0	115.0	58.0	1.465
33	107.0	43.0	115.0	64.0	1.466
34	107.0	43.0	109.0	64.0	1.469

F.S. MINIMUM= 1.452 FOR THE CIRCLE OF CENTER (112.0, 61.0)

Opened plot file: srslope4.P01
Saved plot file: srslope4.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

```
                                        1.5

                                                1.5  1.5  1.5

                              1.6       1.5  1.5  1.5  1.5  1.5  1.5

                                                1.5  1.5  1.5  1.5

                                        1.5            1.5  1.5  1.5

                                                       1.5  1.5  1.5

                                                       1.5  1.5  1.5

                                                       1.5  1*5  1.5

                                                       1.5  1.5  1.5
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```
**************************************************
  DEPTH LIMITING TANGENT NO.  2  AT Y =   112.00
**************************************************
```

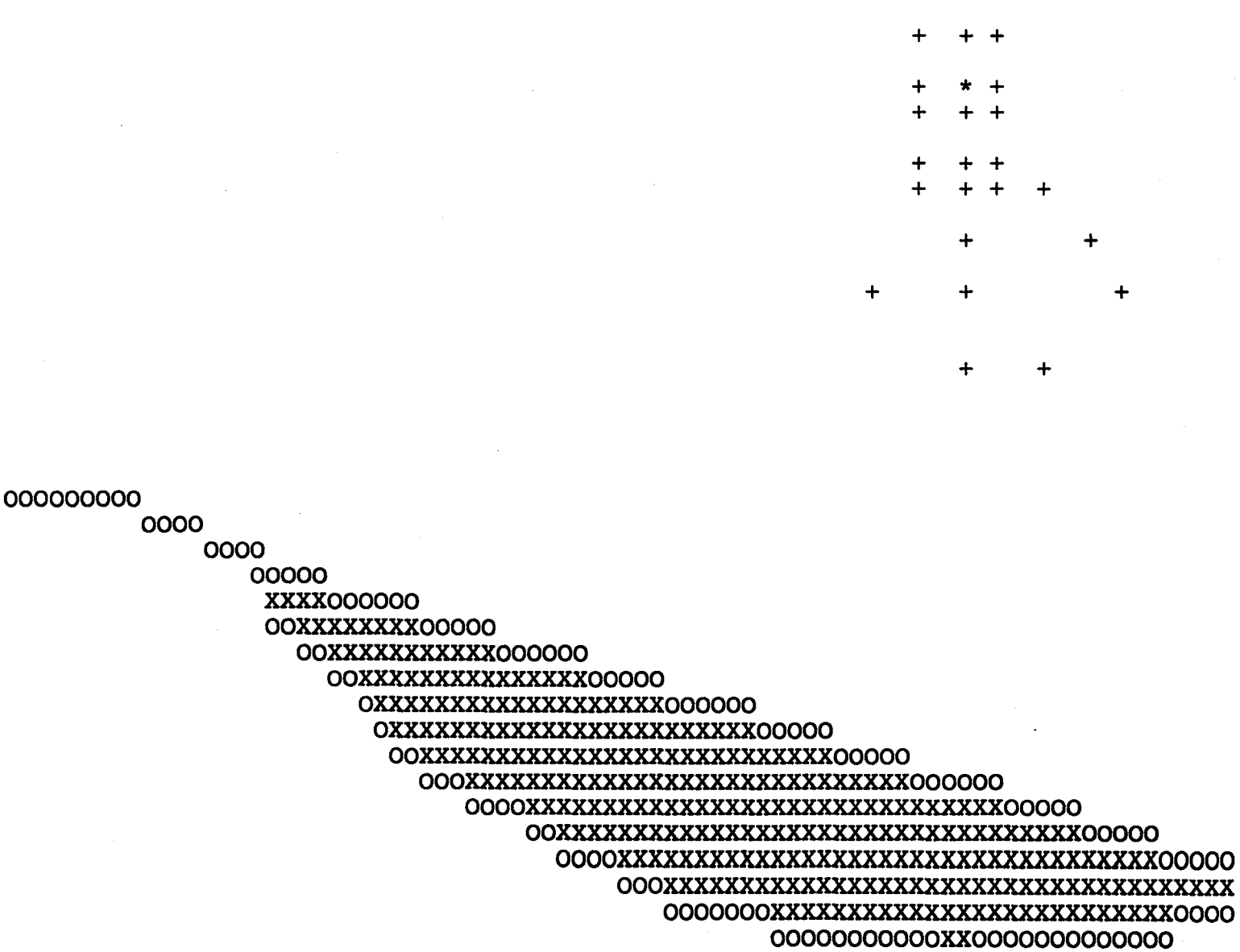
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	112.0	51.0	112.0	61.0	1.692
2	112.0	48.0	103.0	64.0	1.586
3	112.0	54.0	109.0	58.0	1.618
4	112.0	48.0	115.0	64.0	1.811
5	112.0	42.0	109.0	70.0	1.668
6	112.0	48.0	97.0	64.0	1.614
7	112.0	54.0	103.0	58.0	1.564
8	112.0	42.0	103.0	70.0	1.619
9	112.0	54.0	100.0	58.0	1.567
10	112.0	57.0	103.0	55.0	1.558
11	112.0	54.0	106.0	58.0	1.581
12	112.0	51.0	103.0	61.0	1.574
13	112.0	57.0	100.0	55.0	1.560

14	112.0	60.0	103.0	52.0	1.553
15	112.0	57.0	106.0	55.0	1.573
16	112.0	60.0	100.0	52.0	1.557
17	112.0	63.0	103.0	49.0	1.551
18	112.0	60.0	106.0	52.0	1.567
19	112.0	63.0	100.0	49.0	1.557
20	112.0	66.0	103.0	46.0	1.551
21	112.0	63.0	106.0	49.0	1.563
22	112.0	66.0	100.0	46.0	1.557
23	112.0	66.0	106.0	46.0	1.560
24	112.0	60.0	106.0	52.0	1.567
25	112.0	60.0	100.0	52.0	1.557

F.S. MINIMUM= 1.551 FOR THE CIRCLE OF CENTER (103.0, 49.0)

Opened plot file: srslope4.P02
Saved plot file: srslope4.P02

1
****
LOCATION OF CRITICAL CIRCLE
****



OO

1
****
DEPTH LIMITING TANGENT NO. 3 AT Y = 117.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	117.0	68.0	103.0	49.0	1.744
2	117.0	65.0	94.0	52.0	1.741
3	117.0	71.0	100.0	46.0	1.726
4	117.0	65.0	106.0	52.0	1.783
5	117.0	59.0	100.0	58.0	1.747
6	117.0	71.0	97.0	46.0	1.729
7	117.0	74.0	100.0	43.0	1.728
8	117.0	71.0	103.0	46.0	1.740
9	117.0	68.0	100.0	49.0	1.727
10	117.0	74.0	97.0	43.0	1.735
11	117.0	74.0	103.0	43.0	1.738
12	117.0	68.0	103.0	49.0	1.744
13	117.0	68.0	97.0	49.0	1.726

F.S. MINIMUM= 1.726 FOR THE CIRCLE OF CENTER (100.0, 46.0)

Opened plot file: srslope4.P03
Saved plot file: srslope4.P03

1
****
LOCATION OF CRITICAL CIRCLE
****

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                                                    + + +
                                                    + * +

                                                    + + +
                                                +         +

                                                      +
```

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OOOOOOOOOOOOOOOOOOOOOOO
                XXXXXXXOOOOOO
                OXXXXXXXXXXXXOOOOO
                 OOXXXXXXXXXXXXXXXOOOOO
                   OOXXXXXXXXXXXXXXXXXXOOOO
                     OXXXXXXXXXXXXXXXXXXXXXOOOOO
                      OXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                       OOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
```

```
OOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
  OOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
    OOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOO
      OOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOO
        OOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
          OOOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOO
                OOOOOXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXOOOOOO
                     OOOOOOOOXXXXXXXXXXXXXXXXXXXXXXXXOOOOOOOOOOOO
                              OOOOOOO
```

```
-------------------------------------------
Execution complete, time =   204.71 seconds
-------------------------------------------
```

```
*********************************************
* ***************************************** *
* *                                       * *
* *    ---------------------------------  * *
* *     TSTAB  slope stability analysis   * *
* *        Revision 2.40 - 02/12/85       * *
* *    ---------------------------------  * *
* *                                       * *
* *    TAGA Engineering Software Services * *
* *           Berkeley, California        * *
* *                                       * *
* *   IBM PC & 8086/8088 MS-DOS Version by * *
* *                                       * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington        * *
* *                                       * *
* *      copyright (c) 1983, 1984 TAGA    * *
* *      copyright (c) 1983, 1984 DPMS    * *
* *                                       * *
* ***************************************** *
*********************************************
```

```
*****************************************************************
  92-0933,STA. 230,s. DIKE,TRY 5,TOE
*****************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  0
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    2
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                    =        .000
      ATMOSPHERIC PRESSURE                   =        .000
      UNIT WEIGHT OF WATER                   =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

 SEARCH STARTS AT CENTER ( 115.0,  46.0),WITH FINAL GRID OF  2.0

 ALL CIRCLES PASS THROUGH THE POINT ( 114.0, 105.0)
```

GEOMETRY

SECTIONS	.00	40.00	61.00	115.00	150.00
T. CRACKS	80.00	80.00	87.00	105.00	105.00
W IN CRACK	80.00	80.00	87.00	105.00	105.00
BOUNDARY 1	80.00	80.00	87.00	105.00	105.00
BOUNDARY 2	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	61.00	115.00	150.00
Y-COORDINATE OF PHREATIC SURFACE	87.00	87.00	87.00	105.00	105.00

1

****
RESULTS
****

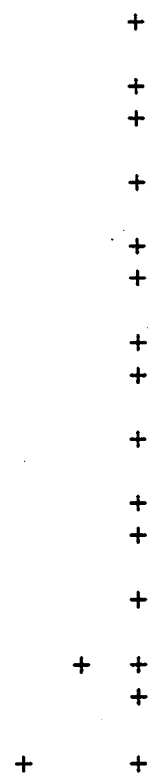
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	105.0	59.0	115.0	46.0	1.479
2	105.1	59.1	111.0	46.0	1.514
3	105.0	63.0	115.0	42.0	1.479
4	105.2	59.2	119.0	46.0	1.513
5	105.0	55.0	115.0	50.0	1.479
6	105.0	63.0	113.0	42.0	1.494
7	105.0	65.0	115.0	40.0	1.479
8	105.1	63.1	117.0	42.0	1.473
9	105.0	61.0	115.0	44.0	1.479
10	105.1	65.1	117.0	40.0	1.472
11	105.2	63.2	119.0	42.0	1.502
12	105.1	61.1	117.0	44.0	1.473
13	105.0	65.0	115.0	40.0	1.479
14	105.1	67.1	117.0	38.0	1.472
15	105.2	65.2	119.0	40.0	1.497
16	105.0	67.0	115.0	38.0	1.479
17	105.1	69.1	117.0	36.0	1.472
18	105.2	67.2	119.0	38.0	1.493
19	105.0	69.0	115.0	36.0	1.479
20	105.1	71.1	117.0	34.0	1.472
21	105.2	69.2	119.0	36.0	1.490
22	105.0	71.0	115.0	34.0	1.479
23	105.1	73.1	117.0	32.0	1.471
24	105.2	71.2	119.0	34.0	1.487
25	105.0	73.0	115.0	32.0	1.479
26	105.1	75.1	117.0	30.0	1.471
27	105.2	73.2	119.0	32.0	1.485

28	105.0	75.0	115.0	30.0	1.479
29	105.1	77.1	117.0	28.0	1.471
30	105.2	75.2	119.0	30.0	1.483
31	105.0	77.0	115.0	28.0	1.479
32	105.1	79.1	117.0	26.0	1.471
33	105.2	77.2	119.0	28.0	1.481
34	105.0	79.0	115.0	26.0	1.479
35	105.1	81.1	117.0	24.0	1.471
36	105.2	79.2	119.0	26.0	1.479
37	105.0	81.0	115.0	24.0	1.479
38	105.1	83.1	117.0	22.0	1.471
39	105.2	81.2	119.0	24.0	1.478
40	105.0	83.0	115.0	22.0	1.479
41	105.1	85.1	117.0	20.0	1.471
42	105.2	83.2	119.0	22.0	1.477
43	105.0	85.0	115.0	20.0	1.479
44	105.1	87.1	117.0	18.0	1.471
45	105.1	85.1	119.0	20.0	1.476
46	105.0	87.0	115.0	18.0	1.479
47	105.1	87.1	119.0	18.0	1.475
48	105.2	83.2	119.0	22.0	1.477
49	105.0	83.0	115.0	22.0	1.479

F.S. MINIMUM= 1.471 FOR THE CIRCLE OF CENTER (117.0, 20.0)

Opened plot file: srslope4.P01
Saved plot file: srslope4.P01

1
****
LOCATION OF CRITICAL CIRCLE
****



```
OOOOO
     OOOOO
          OOOOO
               OOOOOO
                 OOXXOOOOO
                   OOOXXXXOOOOO
                      OOOOXXXXXOOOOO
                           OOXXXXXXXXOOOOO
                             OOXXXXXXXXXXXXOOOOO
                               OOOOOXXXXXXXXXXXXOOOOO
                                     OOXXXXXXXXXXXXXXXOOOOO
                                       OOOOOXXXXXXXXXXXXXXXOOOOO
                                             OOOOOXXXXXXXXXXXXXXXOOOOO
                                                   OOOOOXXXXXXXXXXXXXXXOOOOO
                                                         OOOOOOOXXXXXXXXXXXXXXOOOOO
                                                                 OOOOOOOOOOXXXXXXXXXOOOO
                                                                            OOOOOOOOOOOO
```

```
-------------------------------------------
Execution complete, time =   135.67 seconds
-------------------------------------------
```

```
*********************************************
* ***************************************** *
* *                                       * *
* *    ---------------------------------  * *
* *     TSTAB  slope stability analysis   * *
* *        Revision 2.40 - 02/12/85       * *
* *    ---------------------------------  * *
* *                                       * *
* *    TAGA Engineering Software Services * *
* *           Berkeley, California        * *
* *                                       * *
* *   IBM PC & 8086/8088 MS-DOS Version by * *
* *                                       * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington        * *
* *                                       * *
* *      copyright (c) 1983, 1984 TAGA    * *
* *      copyright (c) 1983, 1984 DPMS    * *
* *                                       * *
* ***************************************** *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 230 S. DIKE,TRY 6,BASE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  3
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    3
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                    =        .000
      ATMOSPHERIC PRESSURE                   =        .000
      UNIT WEIGHT OF WATER                   =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

 SEARCH STARTS AT CENTER ( 100.0,  46.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES TANGENT TO DEPTH, 106.0, 111.0, 116.0,
```

GEOMETRY

SECTIONS	.00	40.00	61.00	115.00	200.00
T. CRACKS	80.00	80.00	87.00	105.00	105.00
W IN CRACK	80.00	80.00	87.00	105.00	105.00
BOUNDARY 1	80.00	80.00	87.00	105.00	105.00
BOUNDARY 2	105.00	105.00	105.00	105.00	105.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	61.00	115.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	87.00	87.00	87.00	105.00	105.00

1

****
RESULTS
****

****
DEPTH LIMITING TANGENT NO. 1 AT Y = 106.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	106.0	60.0	100.0	46.0	1.514
2	106.0	60.0	94.0	46.0	1.609
3	106.0	66.0	100.0	40.0	1.525
4	106.0	60.0	106.0	46.0	1.459
5	106.0	54.0	100.0	52.0	1.512
6	106.0	60.0	103.0	46.0	1.480
7	106.0	63.0	106.0	43.0	1.458
8	106.0	60.0	109.0	46.0	1.454
9	106.0	57.0	106.0	49.0	1.459
10	106.0	63.0	109.0	43.0	1.454
11	106.0	60.0	112.0	46.0	1.466
12	106.0	57.0	109.0	49.0	1.453
13	106.0	57.0	106.0	49.0	1.459
14	106.0	57.0	112.0	49.0	1.465
15	106.0	54.0	109.0	52.0	1.453
16	106.0	54.0	106.0	52.0	1.460
17	106.0	54.0	112.0	52.0	1.465
18	106.0	51.0	109.0	55.0	1.452

19	106.0	51.0	106.0	55.0	1.462
20	106.0	51.0	112.0	55.0	1.465
21	106.0	48.0	109.0	58.0	1.452
22	106.0	48.0	106.0	58.0	1.464
23	106.0	48.0	112.0	58.0	1.465
24	106.0	45.0	109.0	61.0	1.452
25	106.0	51.0	106.0	55.0	1.462
26	106.0	51.0	112.0	55.0	1.465
27	106.0	45.0	112.0	61.0	1.465
28	106.0	45.0	106.0	61.0	1.467

F.S. MINIMUM= 1.452 FOR THE CIRCLE OF CENTER (109.0, 58.0)

Opened plot file: srslope5.P01
Saved plot file: srslope5.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

```
                                                1.5

                                                        1.5  1.5

                                    1.6         1.5  1.5  1.5  1.5  1.5

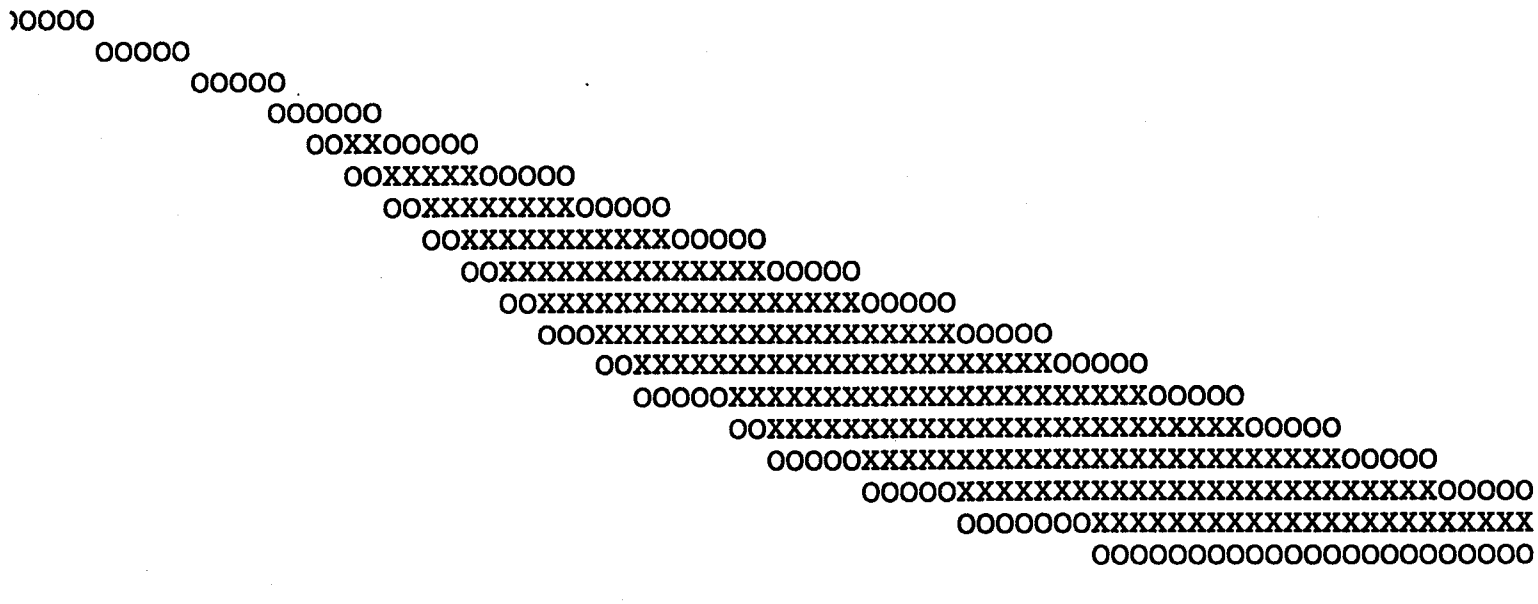
                                                        1.5  1.5  1.5

                                                1.5     1.5  1.5  1.5

                                                        1.5  1.5  1.5

                                                        1.5  1*5  1.5

                                                        1.5  1.5  1.5
```



1

****
DEPTH LIMITING TANGENT NO. 2 AT Y = 111.00
****

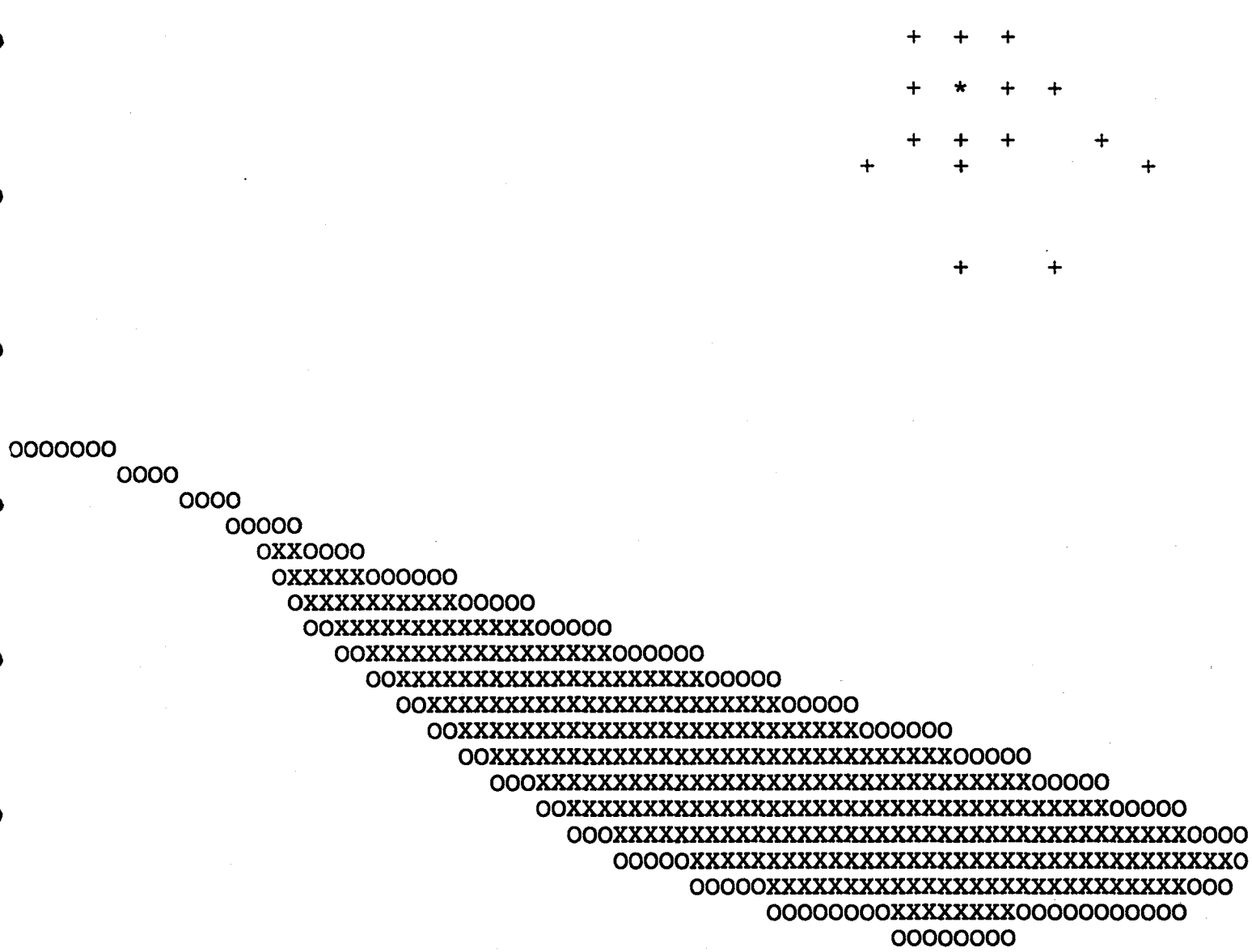
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	111.0	53.0	109.0	58.0	1.684
2	111.0	50.0	100.0	61.0	1.583
3	111.0	56.0	106.0	55.0	1.613
4	111.0	50.0	112.0	61.0	1.798
5	111.0	44.0	106.0	67.0	1.657
6	111.0	50.0	94.0	61.0	1.624
7	111.0	56.0	100.0	55.0	1.574
8	111.0	44.0	100.0	67.0	1.607
9	111.0	56.0	97.0	55.0	1.585
10	111.0	59.0	100.0	52.0	1.574
11	111.0	56.0	103.0	55.0	1.582
12	111.0	53.0	100.0	58.0	1.576
13	111.0	59.0	97.0	52.0	1.584
14	111.0	59.0	103.0	52.0	1.579
15	111.0	53.0	103.0	58.0	1.587
16	111.0	53.0	97.0	58.0	1.588

F.S. MINIMUM= 1.574 FOR THE CIRCLE OF CENTER (100.0, 55.0)

Opened plot file: srslope5.P02
Saved plot file: srslope5.P02

1

```
*******************************
  LOCATION OF CRITICAL CIRCLE
*******************************
```



1

```
*************************************************
  DEPTH LIMITING TANGENT NO.  3  AT Y =   116.00
*************************************************
```

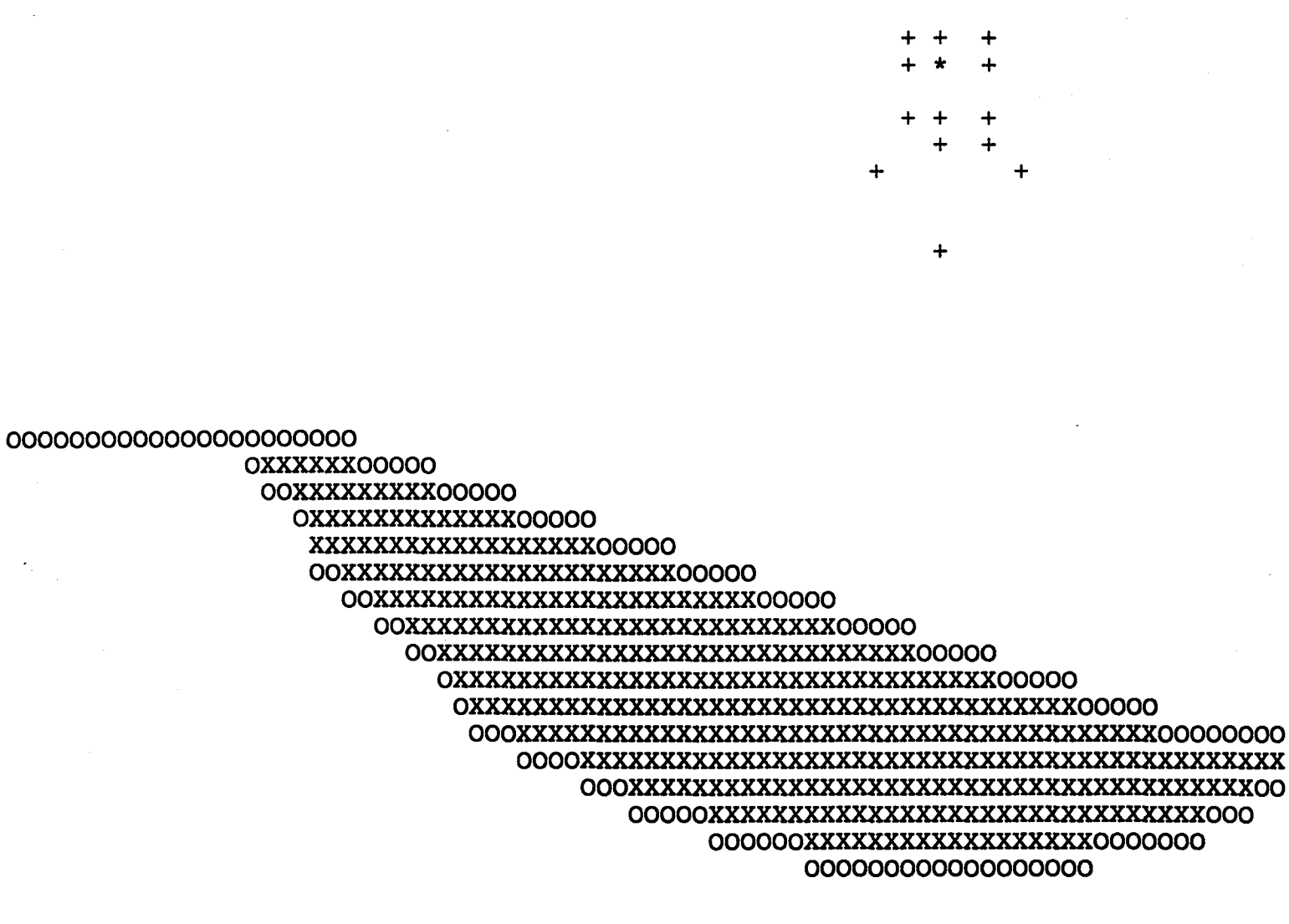
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	116.0	61.0	100.0	55.0	1.783
2	116.0	58.0	91.0	58.0	1.792
3	116.0	64.0	97.0	52.0	1.763
4	116.0	58.0	103.0	58.0	1.825
5	116.0	52.0	97.0	64.0	1.799
6	116.0	64.0	94.0	52.0	1.768
7	116.0	67.0	97.0	49.0	1.762
8	116.0	64.0	100.0	52.0	1.777

9	116.0	61.0	97.0	55.0	1.767
10	116.0	67.0	94.0	49.0	1.771
11	116.0	70.0	97.0	46.0	1.766
12	116.0	67.0	100.0	49.0	1.773
13	116.0	70.0	94.0	46.0	1.778
14	116.0	70.0	100.0	46.0	1.773
15	116.0	64.0	100.0	52.0	1.777
16	116.0	64.0	94.0	52.0	1.768

F.S. MINIMUM= 1.762 FOR THE CIRCLE OF CENTER (97.0, 49.0)

Opened plot file: srslope5.P03
Saved plot file: srslope5.P03

1
****
LOCATION OF CRITICAL CIRCLE
****



Execution complete, time = 180.93 seconds

```
*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 230 S. DIKE,TRY 7 TOE
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  0
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    3
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                    =        .000
      ATMOSPHERIC PRESSURE                   =        .000
      UNIT WEIGHT OF WATER                   =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

 SEARCH STARTS AT CENTER ( 117.0,  20.0),WITH FINAL GRID OF  2.0

 ALL CIRCLES PASS THROUGH THE POINT ( 114.0, 105.0)
```

GEOMETRY

SECTIONS	.00	40.00	61.00	115.00	200.00
T. CRACKS	80.00	80.00	87.00	105.00	105.00
W IN CRACK	80.00	80.00	87.00	105.00	105.00
BOUNDARY 1	80.00	80.00	87.00	105.00	105.00
BOUNDARY 2	105.00	105.00	105.00	105.00	105.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	61.00	115.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	87.00	87.00	87.00	105.00	105.00

1

****
RESULTS
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	105.1	85.1	117.0	20.0	1.470
2	105.0	85.0	113.0	20.0	1.487
3	105.1	89.1	117.0	16.0	1.470
4	105.3	85.3	121.0	20.0	1.494
5	105.1	81.1	117.0	24.0	1.470
6	105.0	81.0	115.0	24.0	1.478
7	105.1	83.1	117.0	22.0	1.470
8	105.2	81.2	119.0	24.0	1.472
9	105.1	79.1	117.0	26.0	1.470
10	105.0	79.0	115.0	26.0	1.478
11	105.2	79.2	119.0	26.0	1.473
12	105.1	77.1	117.0	28.0	1.470
13	105.0	77.0	115.0	28.0	1.478
14	105.2	77.2	119.0	28.0	1.474
15	105.1	75.1	117.0	30.0	1.469
16	105.0	75.0	115.0	30.0	1.478
17	105.2	75.2	119.0	30.0	1.475
18	105.1	73.1	117.0	32.0	1.469
19	105.0	73.0	115.0	32.0	1.478
20	105.2	73.2	119.0	32.0	1.476
21	105.1	71.1	117.0	34.0	1.469
22	105.0	71.0	115.0	34.0	1.478
23	105.2	71.2	119.0	34.0	1.478
24	105.1	69.1	117.0	36.0	1.469
25	105.0	73.0	115.0	32.0	1.478

26	105.2	73.2	119.0	32.0	1.476
27	105.2	69.2	119.0	36.0	1.480
28	105.0	69.0	115.0	36.0	1.478

F.S. MINIMUM= 1.469 FOR THE CIRCLE OF CENTER (117.0, 34.0)

Opened plot file: srslope6.P01
Saved plot file: srslope6.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

```
OOOOOO
      OOOOO
            OOOOO
                OOOOOOO
                  OOOOOOOOOO
                        OOXXXOOOOOO
                          OOXXXXXXXOOOOO
                            OOXXXXXXXXXXOOOOO
                              OOOOOXXXXXXXXXXOOOOO
                                    OOXXXXXXXXXXXXXOOOOO
                                      OOOOOXXXXXXXXXXXXXOOOOOO
                                           OOOOXXXXXXXXXXXXXXXOOOOO
                                               OOOOOXXXXXXXXXXXXXXXOOOOO
                                                    OOOOOOOOXXXXXXXXXXXXXOOOOO
                                                              OOOOOOOXXXXXXXXXXXOOOOO
                                                                      OOOOOOOOOOOOOOOOO
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-----------------------------------------
Execution complete, time =   100.62 seconds
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*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 2,8,&11 N. Overbank, Toe, Try 8
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
CONTROL DATA,
     AUTOMATIC SEARCH FOR CRITICAL CIRCLE
     NUMBER OF DEPTH LIMITING TANGENTS                    0
     NUMBER OF VERTICAL SECTIONS                          5
     NUMBER OF SOIL LAYER BOUNDARIES                      2
     NUMBER OF POINTS DEFINING COHESION PROFILE           0
     NUMBER OF CURVES DEFINING COHESION ANISOTROPY        0
     NUMBER OF BOUNDARY LINE LOADS                        0
     NUMBER OF BOUNDARY PRESSURE LOADS                    0

     SEISMIC COEFFICIENT                    =        .000
     ATMOSPHERIC PRESSURE                   =        .000
     UNIT WEIGHT OF WATER                   =      62.400
     UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

SEARCH STARTS AT CENTER (  91.0,  50.0),WITH FINAL GRID OF  2.0

ALL CIRCLES PASS THROUGH THE POINT (  90.0,  97.0)
```

GEOMETRY

SECTIONS	.00	40.00	55.00	91.00	150.00
T. CRACKS	80.00	80.00	85.00	97.00	97.00
W IN CRACK	80.00	80.00	85.00	97.00	97.00
BOUNDARY 1	80.00	80.00	85.00	97.00	97.00
BOUNDARY 2	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	55.00	91.00	150.00
Y-COORDINATE OF PHREATIC SURFACE	85.00	85.00	85.00	97.00	97.00

1

****
RESULTS
****

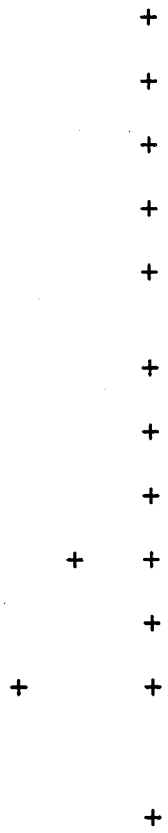
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	97.0	47.0	91.0	50.0	1.479
2	97.1	47.1	87.0	50.0	1.523
3	97.0	51.0	91.0	46.0	1.479
4	97.3	47.3	95.0	50.0	1.588
5	97.0	43.0	91.0	54.0	1.479
6	97.0	51.0	89.0	46.0	1.498
7	97.0	53.0	91.0	44.0	1.479
8	97.1	51.1	93.0	46.0	1.477
9	97.0	49.0	91.0	48.0	1.479
10	97.1	53.1	93.0	44.0	1.476
11	97.2	51.2	95.0	46.0	1.553
12	97.1	49.1	93.0	48.0	1.479
13	97.0	53.0	91.0	44.0	1.479
14	97.1	55.1	93.0	42.0	1.475
15	97.2	53.2	95.0	44.0	1.540
16	97.0	55.0	91.0	42.0	1.479
17	97.1	57.1	93.0	40.0	1.474
18	97.2	55.2	95.0	42.0	1.529
19	97.0	57.0	91.0	40.0	1.479
20	97.1	59.1	93.0	38.0	1.474
21	97.2	57.2	95.0	40.0	1.521
22	97.0	59.0	91.0	38.0	1.479
23	97.1	61.1	93.0	36.0	1.473
24	97.2	59.2	95.0	38.0	1.513
25	97.0	61.0	91.0	36.0	1.480
26	97.1	63.1	93.0	34.0	1.473
27	97.2	61.2	95.0	36.0	1.507

28	97.0	63.0	91.0	34.0	1.483
29	97.1	65.1	93.0	32.0	1.472
30	97.2	63.2	95.0	34.0	1.502
31	97.0	65.0	91.0	32.0	1.489
32	97.1	67.1	93.0	30.0	1.473
33	97.2	65.2	95.0	32.0	1.497
34	97.0	67.0	91.0	30.0	1.498
35	97.2	67.2	95.0	30.0	1.493
36	97.2	63.2	95.0	34.0	1.502
37	97.0	63.0	91.0	34.0	1.483

F.S. MINIMUM= 1.472 FOR THE CIRCLE OF CENTER (93.0, 32.0)

Opened plot file: srslope7.P01
Saved plot file: srslope7.P01

1
****
LOCATION OF CRITICAL CIRCLE
****



```
OOOOO
     OOOO
          OOOO
               OOOOO
                  OOOOOOO
                    OOOXXOOOOO
                       OOXXXXXOOOOO
                         OOOOXXXXXXOOOOO
                              OOXXXXXXXXXXOOOOO
                                OOOOOXXXXXXXXXXOOOOO
                                      OOXXXXXXXXXXXXXOOOOO
                                        OOOOOXXXXXXXXXXXXXOOOOO
                                              OOOOOXXXXXXXXXXXXXOOOOO
                                                    OOOOOXXXXXXXXXXXXXOOOOO
                                                          OOOOOOOXXXXXXXXXXXOOOOO
                                                                  OOOOOOOOOOXXXXXOOOO
                                                                              OOOOOOOOOOOO
```

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Execution complete, time =   111.22 seconds
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*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*****************************************************************
  92-0933,STA. 606 S. Overbank, Toe, Try 9
*****************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
CONTROL DATA,
     AUTOMATIC SEARCH FOR CRITICAL CIRCLE
     NUMBER OF DEPTH LIMITING TANGENTS                  0
     NUMBER OF VERTICAL SECTIONS                        5
     NUMBER OF SOIL LAYER BOUNDARIES                    2
     NUMBER OF POINTS DEFINING COHESION PROFILE         0
     NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
     NUMBER OF BOUNDARY LINE LOADS                      0
     NUMBER OF BOUNDARY PRESSURE LOADS                  0

     SEISMIC COEFFICIENT                    =       .000
     ATMOSPHERIC PRESSURE                   =       .000
     UNIT WEIGHT OF WATER                   =     62.400
     UNIT WEIGHT OF WATER IN TENSION CRACK  =     62.400

SEARCH STARTS AT CENTER (  84.0,  35.0),WITH FINAL GRID OF  2.0

ALL CIRCLES PASS THROUGH THE POINT (  81.0,  94.0)
```

GEOMETRY

SECTIONS	.00	40.00	52.00	82.00	150.00
T. CRACKS	80.00	80.00	84.00	94.00	94.00
W IN CRACK	80.00	80.00	84.00	94.00	94.00
BOUNDARY 1	80.00	80.00	84.00	94.00	94.00
BOUNDARY 2	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	52.00	82.00	150.00
Y-COORDINATE OF PHREATIC SURFACE	84.00	84.00	84.00	94.00	94.00

1

****
RESULTS
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	94.1	59.1	84.0	35.0	1.480
2	94.0	59.0	80.0	35.0	1.577
3	94.1	63.1	84.0	31.0	1.499
4	94.4	59.4	88.0	35.0	1.683
5	94.1	55.1	84.0	39.0	1.475
6	94.0	55.0	82.0	39.0	1.494
7	94.1	57.1	84.0	37.0	1.476
8	94.2	55.2	86.0	39.0	1.529
9	94.1	53.1	84.0	41.0	1.476
10	94.0	57.0	82.0	37.0	1.504
11	94.2	57.2	86.0	37.0	1.521
12	94.2	53.2	86.0	41.0	1.540
13	94.0	53.0	82.0	41.0	1.485

F.S. MINIMUM= 1.475 FOR THE CIRCLE OF CENTER (84.0, 39.0)

Opened plot file: srslope8.P01
Saved plot file: srslope8.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

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OOOOO
     OOOO
          OOOO
               OOOOOO
                  OOXOOOOO
                    OOOOOXOOOOO
                          OOXXXXOOOOO
                            OOXXXXXXXOOOOO
                              OOOOOXXXXXXXOOOOOO
                                    OOXXXXXXXXXXXXOOOOO
                                      OOOOOXXXXXXXXXXXXOOOOO
                                            OOOOXXXXXXXXXXXXXXOOOOO
                                                OOOOOXXXXXXXXXXXXXXOOOOO
                                                      OOOOOOOOXXXXXXXXXXOOOOO
                                                               OOOOOOOXXXXXXXXOOOOO
                                                                       OOOOOOOOOOOOOOOOO
```

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-----------------------------------------
Execution complete, time =    59.38 seconds
-----------------------------------------
```

```
*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 2,8,&11 N. Overbank, Base, Try 10
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
 CONTROL DATA,
      AUTOMATIC SEARCH FOR CRITICAL CIRCLE
      NUMBER OF DEPTH LIMITING TANGENTS                  3
      NUMBER OF VERTICAL SECTIONS                        5
      NUMBER OF SOIL LAYER BOUNDARIES                    3
      NUMBER OF POINTS DEFINING COHESION PROFILE         0
      NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
      NUMBER OF BOUNDARY LINE LOADS                      0
      NUMBER OF BOUNDARY PRESSURE LOADS                  0

      SEISMIC COEFFICIENT                  =        .000
      ATMOSPHERIC PRESSURE                 =        .000
      UNIT WEIGHT OF WATER                 =      62.400
      UNIT WEIGHT OF WATER IN TENSION CRACK =     62.400

 SEARCH STARTS AT CENTER (  85.0,  55.0),WITH FINAL GRID OF  3.0

 ALL CIRCLES TANGENT TO DEPTH,  98.0, 103.0, 108.0,
```

GEOMETRY

SECTIONS	.00	40.00	55.00	91.00	200.00
T. CRACKS	80.00	80.00	85.00	97.00	105.00
W IN CRACK	80.00	80.00	85.00	97.00	105.00
BOUNDARY 1	80.00	80.00	85.00	97.00	105.00
BOUNDARY 2	97.00	97.00	97.00	97.00	105.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	55.00	91.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	85.00	85.00	85.00	97.00	97.00

1

****
RESULTS
****

****
DEPTH LIMITING TANGENT NO. 1 AT Y = 98.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	98.0	43.0	85.0	55.0	1.447
2	98.0	43.0	79.0	55.0	1.555
3	98.0	49.0	85.0	49.0	1.462
4	98.0	43.0	91.0	55.0	1.433
5	98.0	37.0	85.0	61.0	1.448
6	98.0	43.0	88.0	55.0	1.432
7	98.0	46.0	91.0	52.0	1.433
8	98.0	43.0	94.0	55.0	1.448
9	98.0	40.0	91.0	58.0	1.433
10	98.0	43.0	85.0	55.0	1.447
11	98.0	46.0	88.0	52.0	1.433
12	98.0	40.0	88.0	58.0	1.432
13	98.0	40.0	85.0	58.0	1.446
14	98.0	40.0	91.0	58.0	1.433
15	98.0	37.0	88.0	61.0	1.432
16	98.0	37.0	85.0	61.0	1.448
17	98.0	37.0	91.0	61.0	1.434
18	98.0	34.0	88.0	64.0	1.432

19	98.0	40.0	85.0	58.0	1.446
20	98.0	40.0	91.0	58.0	1.433
21	98.0	34.0	91.0	64.0	1.435
22	98.0	34.0	85.0	64.0	1.451

F.S. MINIMUM= 1.432 FOR THE CIRCLE OF CENTER (88.0, 61.0)

Opened plot file: srslope8.P01
Saved plot file: srslope8.P01

****
LOCATION OF CRITICAL CIRCLE
****

	1.5		
		1.4	1.4
1.6	1.4	1.4	1.4
	1.4	1.4	1.4
	1.4	1*4	1.4
	1.5	1.4	1.4

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)OOOOOO
      OOOOO
           OOOOO
              OOOOOOO
                OOXXXOOOOO
                  OOXXXXXXOOOOO
                    OOXXXXXXXXXOOOOO
                      OOXXXXXXXXXXXXOOOOOO
                        OOOOOXXXXXXXXXXXXXXOOOOO
                              OOXXXXXXXXXXXXXXXXXXOOOOO
                                OOXXXXXXXXXXXXXXXXXXXXXOOOOO
                                  OOXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                    OOOOOXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                          OOOOOXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                                OOOOOXXXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                                      OOOOOOOXXXXXXXXXXXXXXXXXXXXXXXOOO
                                                            OOOOOOOOOOOOOOOOOOOOOOOOOOO

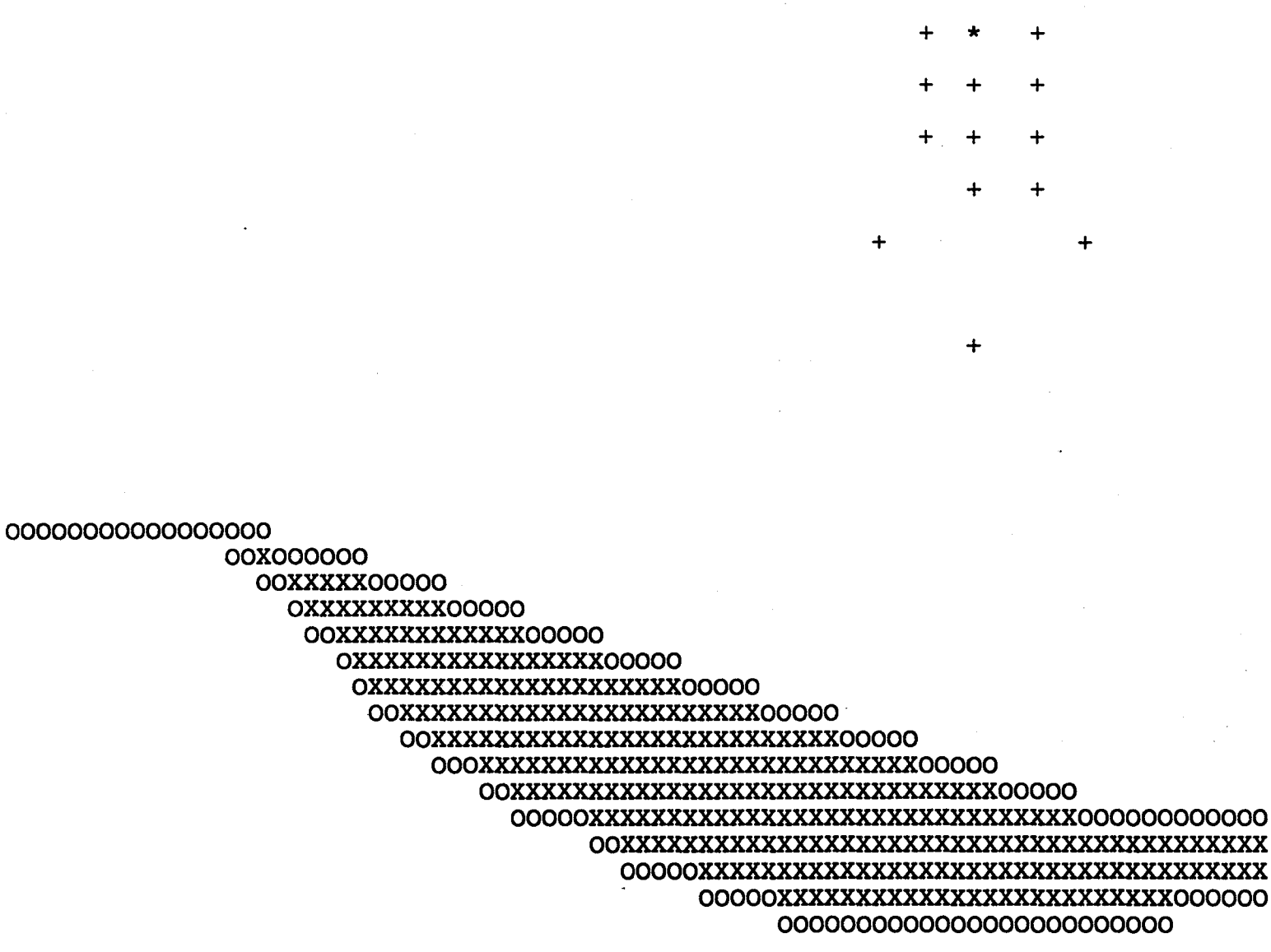
 1
 ***************************************************
   DEPTH LIMITING TANGENT NO.  2  AT Y =   103.00
 ***************************************************
```

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	103.0	42.0	88.0	61.0	1.636
2	103.0	39.0	79.0	64.0	1.647
3	103.0	45.0	85.0	58.0	1.607
4	103.0	39.0	91.0	64.0	1.722
5	103.0	33.0	85.0	70.0	1.676
6	103.0	45.0	82.0	58.0	1.614
7	103.0	48.0	85.0	55.0	1.603
8	103.0	45.0	88.0	58.0	1.621
9	103.0	42.0	85.0	61.0	1.614
10	103.0	48.0	82.0	55.0	1.614
11	103.0	51.0	85.0	52.0	1.602
12	103.0	48.0	88.0	55.0	1.611
13	103.0	51.0	82.0	52.0	1.616
14	103.0	54.0	85.0	49.0	1.605
15	103.0	51.0	88.0	52.0	1.607
16	103.0	54.0	82.0	49.0	1.624
17	103.0	54.0	88.0	49.0	1.604
18	103.0	48.0	88.0	55.0	1.611
19	103.0	48.0	82.0	55.0	1.614

```
F.S. MINIMUM= 1.602 FOR THE CIRCLE OF CENTER (  85.0,  52.0)

Opened plot file: srslope8.P02
Saved plot file:  srslope8.P02

 1
 ********************************
   LOCATION OF CRITICAL CIRCLE
 ********************************
```



1

****
DEPTH LIMITING TANGENT NO. 3 AT Y = 108.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	108.0	56.0	85.0	52.0	1.832
2	108.0	53.0	76.0	55.0	1.918
3	108.0	59.0	82.0	49.0	1.854
4	108.0	53.0	88.0	55.0	1.855
5	108.0	47.0	82.0	61.0	1.857
6	108.0	53.0	79.0	55.0	1.871
7	108.0	50.0	82.0	58.0	1.846
8	108.0	56.0	79.0	52.0	1.879
9	108.0	56.0	85.0	52.0	1.832
10	108.0	50.0	85.0	58.0	1.849

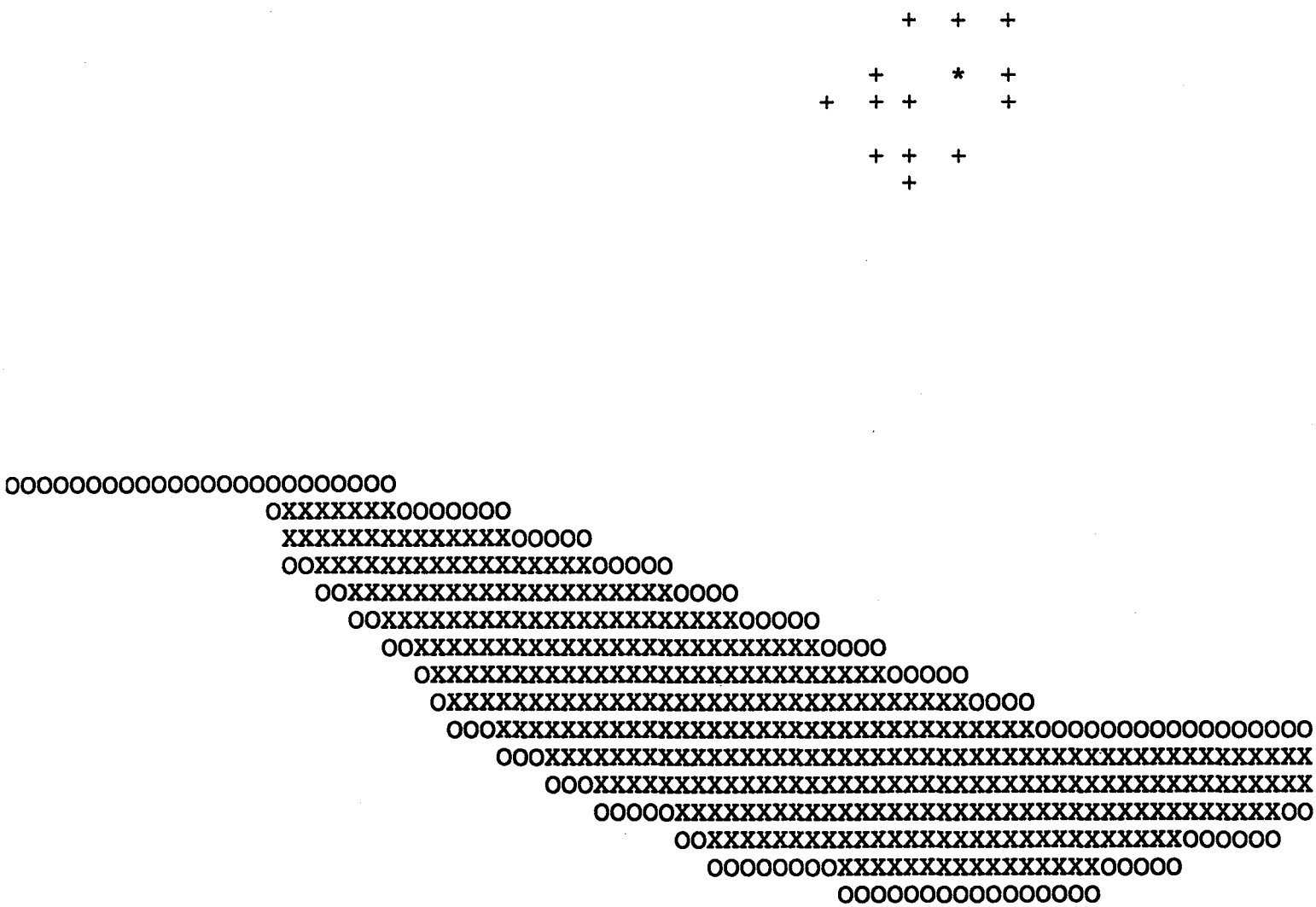
11	108.0	50.0	79.0	58.0	1.868
12	108.0	59.0	85.0	49.0	1.834
13	108.0	56.0	88.0	52.0	1.841
14	108.0	59.0	82.0	49.0	1.854
15	108.0	59.0	88.0	49.0	1.832
16	108.0	53.0	88.0	55.0	1.855
17	108.0	53.0	82.0	55.0	1.844

F.S. MINIMUM= 1.832 FOR THE CIRCLE OF CENTER (85.0, 52.0)

Opened plot file: srslope8.P03
Saved plot file: srslope8.P03

1

```
*******************************
  LOCATION OF CRITICAL CIRCLE
*******************************
```



```
----------------------------------------
Execution complete, time =   171.15 seconds
----------------------------------------
```

```
*********************************************
* ******************************************* *
* *                                         * *
* *    ---------------------------------    * *
* *     TSTAB  slope stability analysis     * *
* *        Revision 2.40 - 02/12/85         * *
* *    ---------------------------------    * *
* *                                         * *
* *    TAGA Engineering Software Services   * *
* *           Berkeley, California          * *
* *                                         * *
* *   IBM PC & 8086/8088 MS-DOS Version by  * *
* *                                         * *
* * Design Professionals Management Systems * *
* *           Kirkland, Washington          * *
* *                                         * *
* *      copyright (c) 1983, 1984 TAGA      * *
* *      copyright (c) 1983, 1984 DPMS      * *
* *                                         * *
* ******************************************* *
*********************************************
```

```
*******************************************************************
  92-0933,STA. 2,8,&11 N. Overbank, Base, Try 11
*******************************************************************
```

```
*****************************************
  ANALYSIS BY BISHOP'S SIMPLIFIED METHOD
*****************************************
```

```
**************
  INPUT DATA
**************
```

```
CONTROL DATA,
     AUTOMATIC SEARCH FOR CRITICAL CIRCLE
     NUMBER OF DEPTH LIMITING TANGENTS                  3
     NUMBER OF VERTICAL SECTIONS                        5
     NUMBER OF SOIL LAYER BOUNDARIES                    3
     NUMBER OF POINTS DEFINING COHESION PROFILE         0
     NUMBER OF CURVES DEFINING COHESION ANISOTROPY      0
     NUMBER OF BOUNDARY LINE LOADS                      0
     NUMBER OF BOUNDARY PRESSURE LOADS                  0

     SEISMIC COEFFICIENT                    =        .000
     ATMOSPHERIC PRESSURE                   =        .000
     UNIT WEIGHT OF WATER                   =      62.400
     UNIT WEIGHT OF WATER IN TENSION CRACK  =      62.400

SEARCH STARTS AT CENTER (  90.0,  50.0),WITH FINAL GRID OF  3.0

ALL CIRCLES TANGENT TO DEPTH,  98.0, 103.0, 108.0,
```

GEOMETRY

SECTIONS	.00	40.00	55.00	91.00	200.00
T. CRACKS	80.00	80.00	85.00	97.00	105.00
W IN CRACK	80.00	80.00	85.00	97.00	105.00
BOUNDARY 1	80.00	80.00	85.00	97.00	105.00
BOUNDARY 2	97.00	97.00	97.00	97.00	105.00
BOUNDARY 3	150.00	150.00	150.00	150.00	150.00

SOIL PROPERTIES

LAYER	DENSITY	COHESION	FRICTION ANGLE	DELTA PHI
1	135.00	.00	41.00	.00
2	130.00	.00	35.00	.00

PORE PRESSURE DATA

PHREATIC SURFACE OPTION

SECTIONS	.00	40.00	55.00	91.00	200.00
Y-COORDINATE OF PHREATIC SURFACE	85.00	92.00	95.00	103.00	125.00

1

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RESULTS
****

****
DEPTH LIMITING TANGENT NO. 1 AT Y = 98.00
****

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	98.0	48.0	90.0	50.0	2.690
2	98.0	48.0	84.0	50.0	2.687
3	98.0	54.0	90.0	44.0	2.688
4	98.0	48.0	96.0	50.0	2.890
5	98.0	42.0	90.0	56.0	2.693
6	98.0	48.0	81.0	50.0	2.722
7	98.0	51.0	84.0	47.0	2.686
8	98.0	48.0	87.0	50.0	2.675
9	98.0	45.0	84.0	53.0	2.689
10	98.0	51.0	87.0	47.0	2.675
11	98.0	48.0	90.0	50.0	2.690
12	98.0	45.0	87.0	53.0	2.674
13	98.0	45.0	84.0	53.0	2.689
14	98.0	45.0	90.0	53.0	2.691
15	98.0	42.0	87.0	56.0	2.674
16	98.0	42.0	84.0	56.0	2.692
17	98.0	42.0	90.0	56.0	2.693
18	98.0	39.0	87.0	59.0	2.674

19	98.0	45.0	84.0	53.0	2.689
20	98.0	45.0	90.0	53.0	2.691
21	98.0	39.0	90.0	59.0	2.696
22	98.0	39.0	84.0	59.0	2.695

F.S. MINIMUM= 2.674 FOR THE CIRCLE OF CENTER (87.0, 56.0)

Opened plot file: srslope9.P01
Saved plot file: srslope9.P01

1
****
LOCATION OF CRITICAL CIRCLE
****

```
                                                    2.7

                                          2.7   2.7

                                    2.7   2.7   2.7   2.7

                                          2.7   2.7   2.7

                                          2.7   2*7   2.7

                                          2.7   2.7   2.7
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OOOOO
     OOOOO
          OOOOO
               OOOOOO
                 OOXXOOOOO
                   OOXXXXXOOOOO
                     OOXXXXXXXXOOOOO
                       OOXXXXXXXXXXOOOOO
                         OOXXXXXXXXXXXXXOOOOO
                           OOXXXXXXXXXXXXXXXXOOOOO
                             OOOOOXXXXXXXXXXXXXXXXXOOOOO
                                  OOXXXXXXXXXXXXXXXXXXXXOOOOO
                                    OOOXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                       OOOOXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                           OOOOOXXXXXXXXXXXXXXXXXXXXXXXOOOOO
                                                OOOOOXXXXXXXXXXXXXXXXXXXXXXXXOOOO
                                                     OOOOOOOOOXXXXXXXXXXXXXXXXXXXXO
                                                               OOOOOOOOOOOOOOOOOOOO
1
**************************************************
  DEPTH LIMITING TANGENT NO.  2  AT Y =   103.00
**************************************************
```

NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	103.0	47.0	87.0	56.0	2.912
2	103.0	44.0	78.0	59.0	2.682
3	103.0	50.0	84.0	53.0	2.767
4	103.0	44.0	90.0	59.0	3.128
5	103.0	38.0	84.0	65.0	2.887
6	103.0	44.0	72.0	59.0	2.739
7	103.0	50.0	78.0	53.0	2.663
8	103.0	38.0	78.0	65.0	2.750
9	103.0	50.0	75.0	53.0	2.687
10	103.0	53.0	78.0	50.0	2.668
11	103.0	50.0	81.0	53.0	2.687
12	103.0	47.0	78.0	56.0	2.666
13	103.0	53.0	75.0	50.0	2.699
14	103.0	53.0	81.0	50.0	2.680
15	103.0	47.0	81.0	56.0	2.707
16	103.0	47.0	75.0	56.0	2.681

F.S. MINIMUM= 2.663 FOR THE CIRCLE OF CENTER (78.0, 53.0)

Opened plot file: srslope9.P02
Saved plot file: srslope9.P02

```
1
********************************
  LOCATION OF CRITICAL CIRCLE
********************************
```

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                                  +  +  +

                                  +  *  +   +
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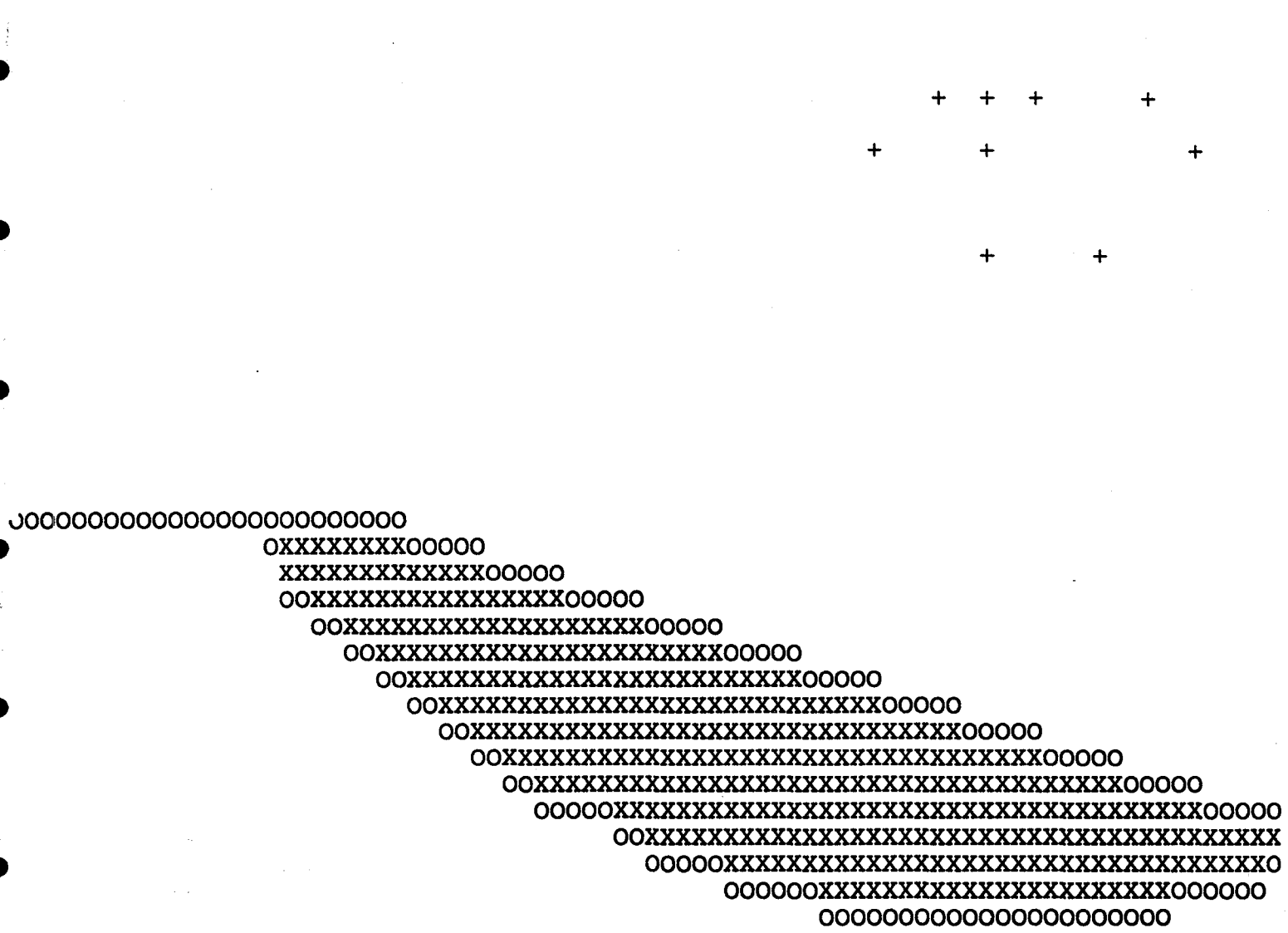


```
1
*************************************************
 DEPTH LIMITING TANGENT NO.  3  AT Y =   108.00
*************************************************
```

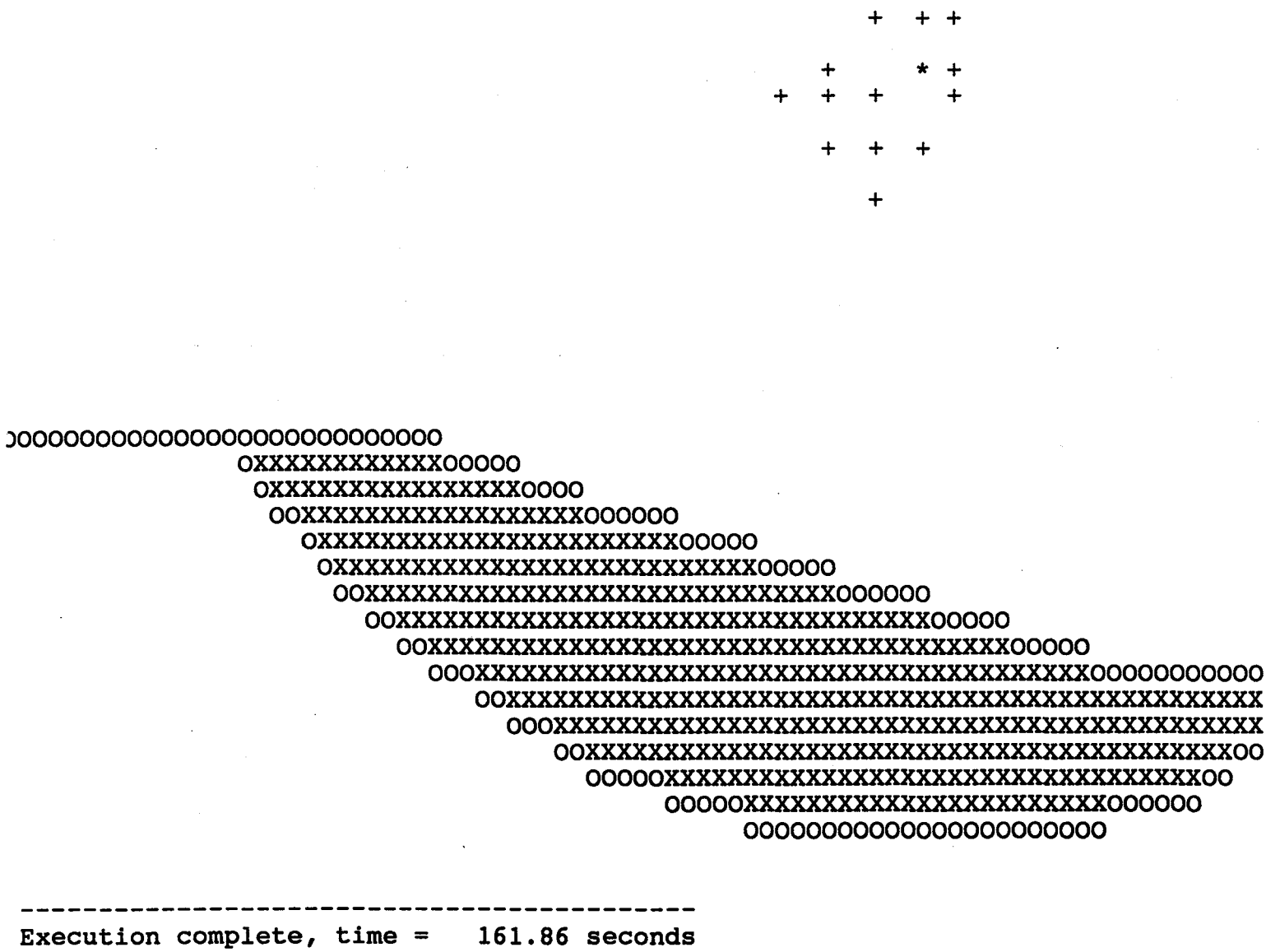
NUMBER	TANGENT	RADIUS	(X) CENTER	(Y) CENTER	F.S.
1	108.0	55.0	78.0	53.0	2.766
2	108.0	52.0	69.0	56.0	2.888
3	108.0	58.0	75.0	50.0	2.793
4	108.0	52.0	81.0	56.0	2.788
5	108.0	46.0	75.0	62.0	2.784
6	108.0	52.0	72.0	56.0	2.817
7	108.0	49.0	75.0	59.0	2.776
8	108.0	55.0	72.0	53.0	2.825
9	108.0	55.0	78.0	53.0	2.766
10	108.0	49.0	78.0	59.0	2.771
11	108.0	49.0	72.0	59.0	2.814
12	108.0	58.0	78.0	50.0	2.773
13	108.0	55.0	81.0	53.0	2.781
14	108.0	58.0	75.0	50.0	2.793
15	108.0	58.0	81.0	50.0	2.781
16	108.0	52.0	81.0	56.0	2.788

```
  17     108.0      52.0         75.0         56.0        2.776

F.S. MINIMUM= 2.766 FOR THE CIRCLE OF CENTER (  78.0,  53.0)

Opened plot file: srslope9.P03
Saved plot file:  srslope9.P03

i
*******************************
 LOCATION OF CRITICAL CIRCLE
*******************************
```



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Execution complete, time =   161.86 seconds
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3. Toedown Scour Analysis

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By GKC 4/18/90
Live Load Per Square Foot _____ Working Stress JFM 4/27/90

Maximum Boundary Shear stress:

Channel Bed:

$$\tau_{max} = K_b K_r K_i \tau_o$$

revised 7/28/90 GKC

Channel Bank:

$$\tau_{max} = K_{ss} K_r K_i \tau_o$$

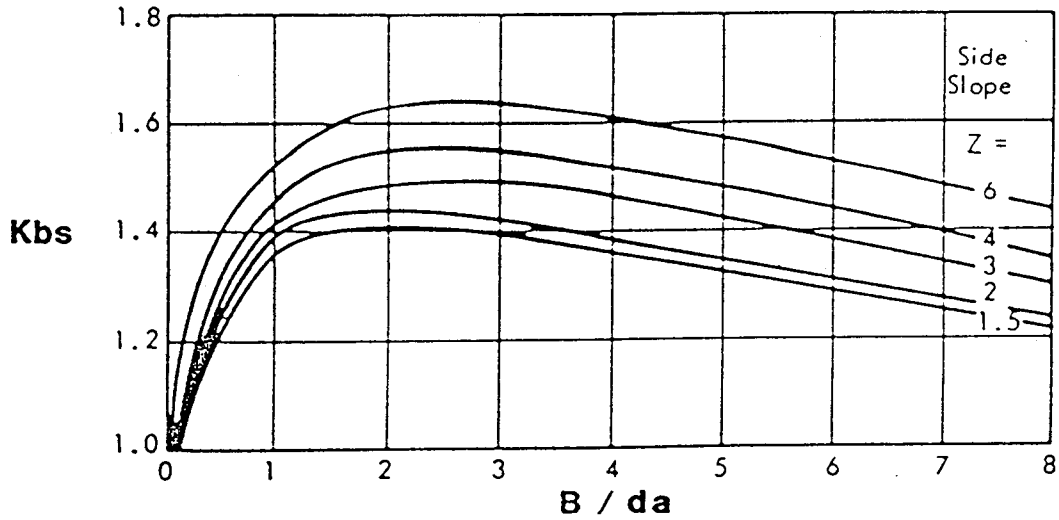
~~Q = 215,000~~

Rch	Bed	Banks North	Banks South
GC3-GC4	2.44	2.56	2.56
GC4-Mill	1.85	1.57	1.57
Mill-Rural	2.26	1.92	1.49
Rural-IBW	2.31	1.34	1.97
IBW-WestBank	—	2.01	—
IBW-McCl.	2.81	2.38	1.66

~~Q = 250,000~~

Rch	Bed	Banks North	Banks South
GC3-GC4	3.24	2.76	2.76
GC4-Mill	2.02	1.72	1.72
Mill-Rural	2.21	1.88	1.44
Rural-IBW	2.38	1.37	2.02
IBW-WestBank	—	2.06	—
IBW-McCl	2.87	2.44	1.69

See Attached worksheets: MESAZ15.WK1
MESAZ50.WK1



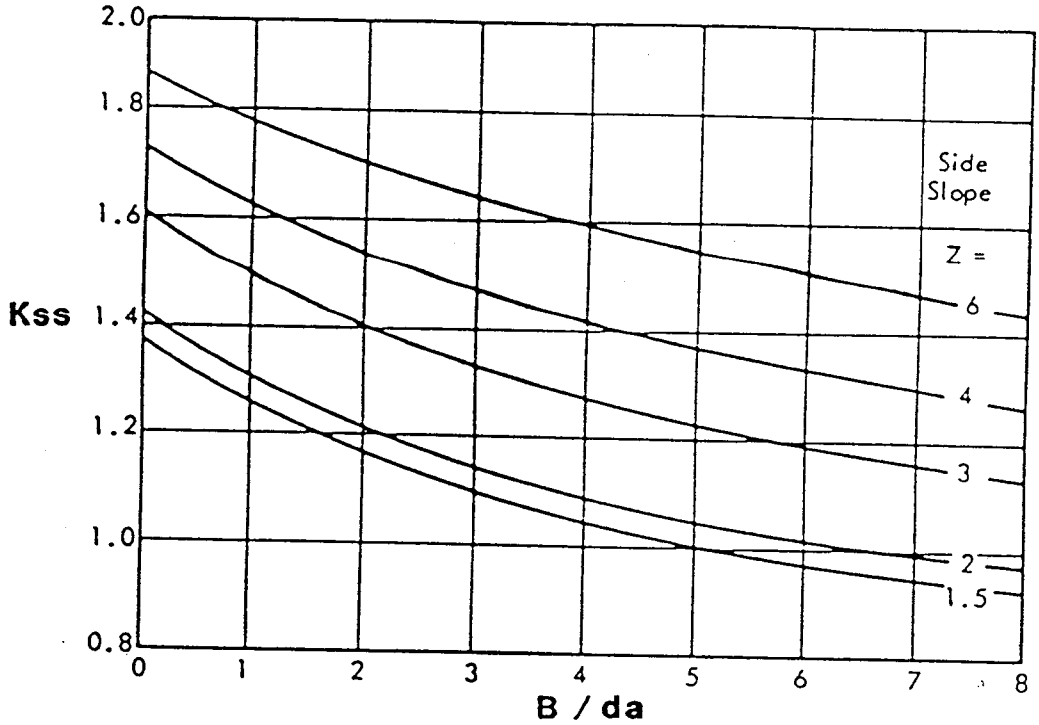
$$K_{bs} = \frac{\frac{B}{da} + 2\sqrt{Z^2 + 1}}{\frac{B}{da} + Z}$$

for $\frac{B}{da} > 8$

Chart 9. Boundary Shear Stress Adjustment Factor for Channel Bottom for a Symmetric Channel (Report 108, Tentative Design Procedure for Riprap Lined Channels)

ADOT Report No: FHWA-AZ89-260 Vol 2.

CHART 12



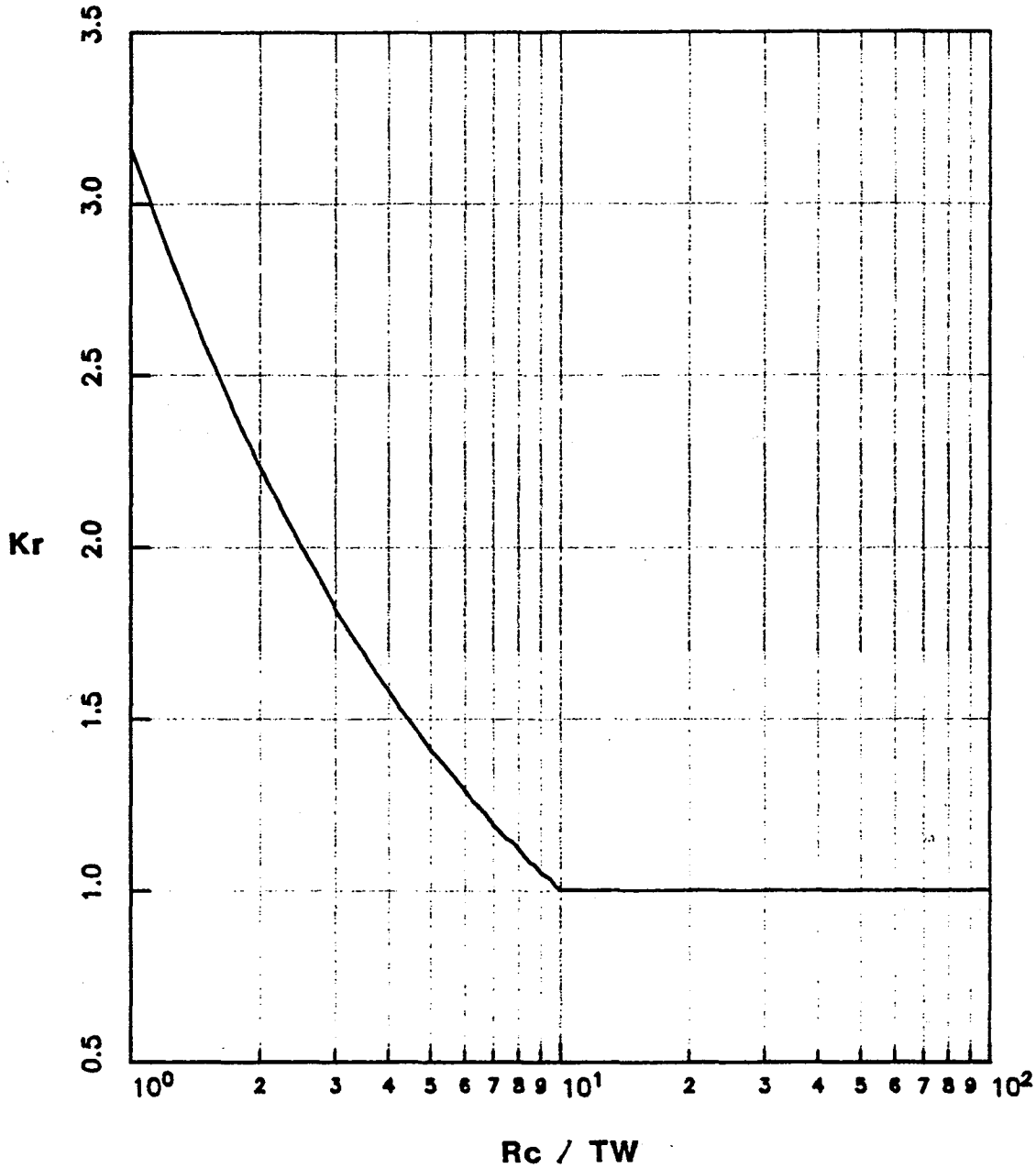
$$K_{ss} = C \left[\frac{\frac{B}{da} + 2\sqrt{Z^2 + 1}}{\frac{B}{da} + Z} \right]$$

for $\frac{B}{da} > 8$

Where

Z	C
1.5	0.76
2	0.785
3	0.85
4	0.935
6	0.97

Chart 12. Boundary Shear Stress Adjustment Factor for a Channel Side-Slope (Report 108, Tentative Design Procedure for Riprap-Lined Channels)



$Kr = 3.16 * (Rc/TW)^{-0.5}$ for $Rc/TW < 10.0$
$Kr = 1.0$ for $Rc/TW \geq 10.0$

Chart 14. Boundary Shear Stress Adjustment Factor, Kr, for a Channel Bend (EM1601 - Hydraulic Design of Flood Control Channels)

CRSS

CRS SIRRINE

DESIGN SHEET

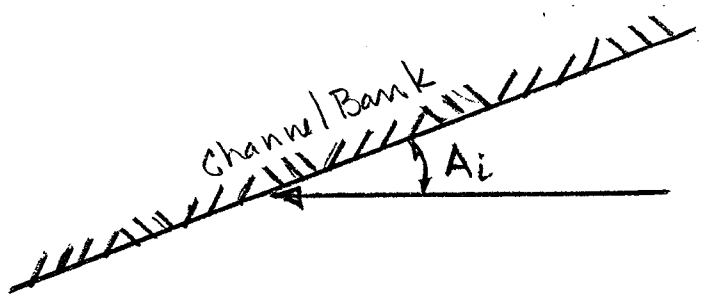
Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

Boundary Shear Stress Adjustment Factor:

Impingment:

$$K_i = 1 + \sin A_i$$

where A_i = ∠ of impingment



Job: R10/N Date
Calc by: GKC 7/28/90
Checked by: JFM 7/30/90
Dwg Chk:

Channel Hydraulic Profiles
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: MESA215.WK1
DATE: 07/28/90

SECND	ELMIN	XLCH	DIST	Q	CWSEL	EGL	AREA	TOPWID	10K*S	HYDDEP	MEAN SHEAR
0.00	129.40	155.00	0.00	215000	150.39	152.75	17607.77	989.45	17.03	17.80	1.89
2.00	129.61	158.00	158.00	215000	150.46	153.13	16700.71	985.15	19.52	16.95	2.06
4.00	129.82	200.00	358.00	215000	151.14	153.52	17796.17	1054.91	16.92	16.87	1.78
6.00	130.03	200.00	558.00	215000	151.47	153.86	17865.85	1091.55	16.94	16.37	1.73
8.00	130.24	200.00	758.00	215000	151.81	154.20	17975.88	1127.24	16.85	15.95	1.68
10.00	130.45	200.00	958.00	215000	152.22	154.54	18370.84	1176.37	16.17	15.62	1.58
12.00	130.65	200.00	1158.00	215000	152.63	154.86	18814.09	1228.75	15.44	15.31	1.48
14.00	130.86	153.00	1311.00	215000	152.93	155.10	19187.39	1287.18	14.93	14.91	1.39
15.40	131.01	105.00	1416.00	215000	153.18	155.26	19646.60	1341.97	14.25	14.64	1.30
15.60	131.03	18.00	1434.00	215000	153.56	155.55	20148.02	1346.58	13.32	14.96	1.24
17.50	131.23	174.00	1608.00	215000	153.79	155.78	20165.63	1347.97	13.26	14.96	1.24
19.00	131.39	164.00	1772.00	215000	153.97	156.02	19387.56	1153.39	13.57	16.81	1.42
19.20	131.41	20.00	1792.00	215000	154.49	156.42	20011.80	1156.34	12.41	17.31	1.34
21.50	131.65	152.00	1944.00	215000	154.64	156.63	19581.52	1110.81	12.79	17.63	1.41
24.00	131.91	145.00	2089.00	215000	154.68	156.89	18643.07	1080.61	14.47	17.25	1.56
24.50	131.96	48.00	2137.00	215000	155.84	157.84	19714.63	1086.32	12.24	18.15	1.39
26.00	132.12	202.00	2339.00	215000	156.10	158.08	19770.34	1093.44	12.18	18.08	1.37
27.00	132.22	202.00	2541.00	215000	156.37	158.33	19881.28	1087.83	11.92	18.28	1.36
28.00	132.33	151.00	2692.00	215000	156.58	158.51	19977.89	1082.34	11.70	18.46	1.35
30.00	132.54	200.00	2892.00	215000	156.79	158.76	19804.66	1061.26	11.82	18.66	1.38
32.00	132.75	200.00	3092.00	215000	157.13	158.99	20329.84	1055.11	11.02	19.27	1.32
34.00	132.96	200.00	3292.00	215000	157.35	159.21	20254.33	1043.73	11.02	19.41	1.33
36.00	133.16	200.00	3492.00	215000	157.85	159.44	21841.84	1071.23	8.93	20.39	1.14
38.00	133.37	219.00	3711.00	215000	157.84	159.75	19912.97	1004.85	11.19	19.82	1.38
40.00	133.58	225.00	3936.00	215000	158.05	160.03	19518.68	976.70	11.57	19.98	1.44
42.00	133.79	235.00	4171.00	215000	158.32	160.30	19516.16	974.78	11.54	20.02	1.44
44.00	134.00	225.00	4396.00	215000	158.53	160.59	19121.28	957.62	12.05	19.97	1.50
46.00	134.21	230.00	4626.00	215000	158.82	160.87	19223.59	961.34	11.87	20.00	1.48
48.00	134.42	234.00	4860.00	215000	159.16	161.15	19509.03	966.47	11.43	20.19	1.44
50.00	134.63	205.00	5065.00	215000	159.47	161.38	19891.16	979.04	10.91	20.32	1.38
52.00	134.84	185.00	5250.00	215000	159.73	161.59	20141.27	988.36	10.60	20.38	1.35
54.00	135.05	185.00	5435.00	215000	159.96	161.78	20342.80	995.62	10.37	20.43	1.32
56.00	135.26	180.00	5615.00	215000	160.19	161.97	20581.93	1004.94	10.10	20.48	1.29
58.00	135.46	183.00	5798.00	215000	160.41	162.16	20770.20	1012.06	9.90	20.52	1.27
60.00	135.67	180.00	5978.00	215000	160.63	162.34	21006.13	1021.25	9.65	20.57	1.24
62.00	135.88	180.00	6158.00	215000	160.88	162.52	21493.42	1033.10	9.16	20.80	1.19
64.00	136.09	176.00	6334.00	215000	161.04	162.68	21404.70	1038.43	9.28	20.61	1.19
66.00	136.30	180.00	6514.00	215000	161.23	162.85	21574.17	1046.48	9.14	20.62	1.18
68.00	136.51	194.00	6708.00	215000	161.44	163.03	21736.62	1053.52	8.99	20.63	1.16
69.50	136.67	95.00	6803.00	215000	161.54	163.12	21839.99	1060.38	8.93	20.60	1.15
70.50	136.77	90.00	6893.00	215000	161.75	163.30	21991.99	1062.11	8.75	20.71	1.13
72.00	136.93	153.00	7046.00	215000	161.88	163.44	21901.76	1044.79	8.71	20.96	1.14
74.00	137.14	179.00	7225.00	215000	162.05	163.59	21846.05	1024.76	8.66	21.32	1.15
76.00	137.35	180.00	7405.00	215000	162.26	163.75	22207.65	1040.46	8.37	21.34	1.11
78.00	137.56	184.00	7589.00	215000	162.49	163.91	22780.09	1064.37	7.93	21.40	1.06
80.00	137.77	174.00	7763.00	215000	162.71	164.05	23413.72	1090.32	7.49	21.47	1.00
82.00	137.97	169.00	7932.00	215000	162.93	164.18	24262.26	1125.36	6.95	21.56	0.93
84.00	138.18	175.00	8107.00	215000	163.14	164.31	25108.05	1161.42	6.47	21.62	0.87
86.00	138.39	180.00	8287.00	215000	163.36	164.43	26222.93	1208.30	5.91	21.70	0.80
88.00	138.60	169.00	8456.00	215000	163.63	164.54	28223.42	1247.67	5.06	22.62	0.71

Channel Hydraulic Profiles
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: MESA215.WK1
DATE: 07/28/90

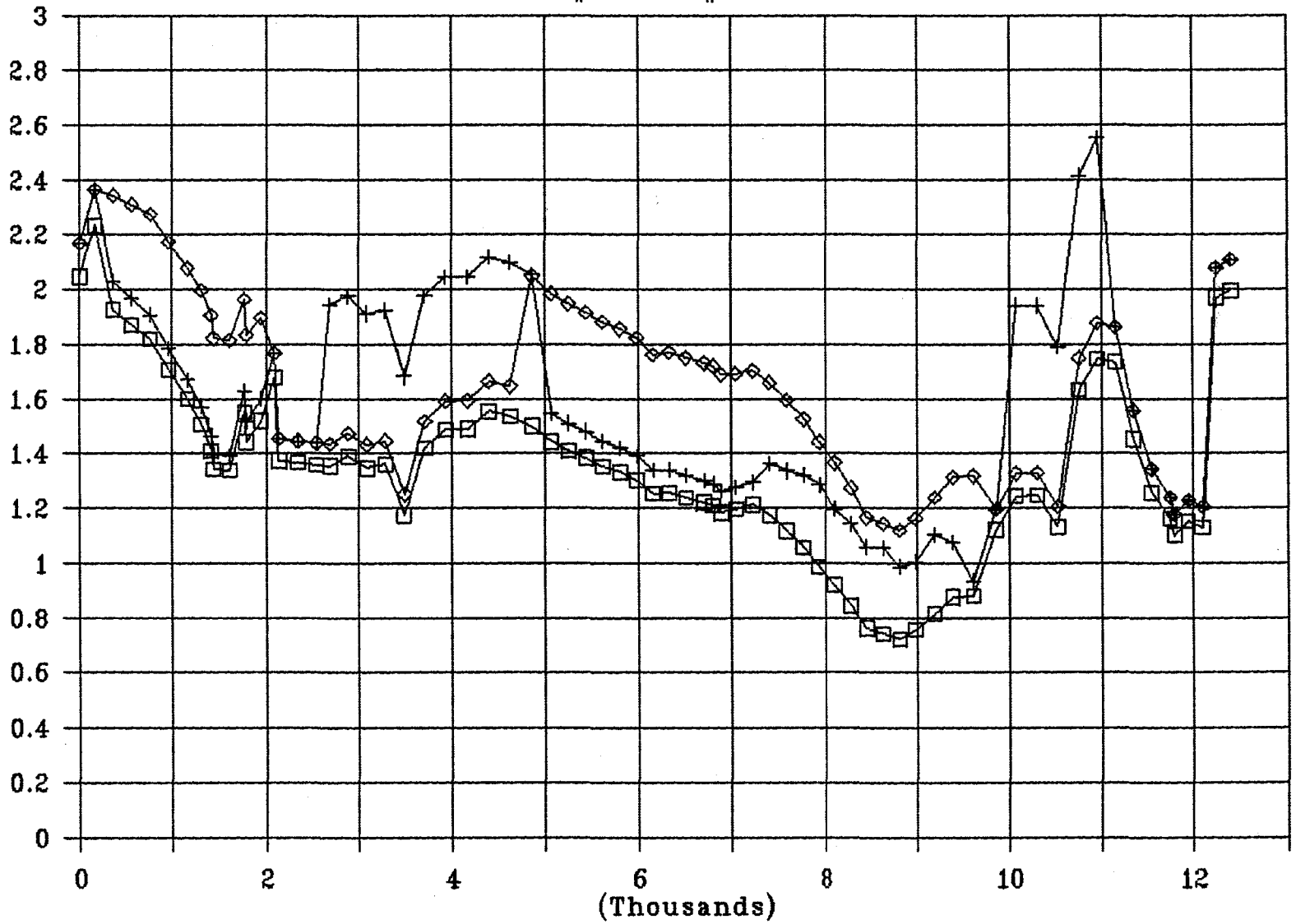
											MEAN
90.00	138.81	180.00	8636.00	215000	163.74	164.63	28569.22	1267.34	4.95	22.54	0.70
92.00	139.02	179.00	8815.00	215000	163.86	164.72	29011.21	1286.79	4.81	22.55	0.68
94.00	139.23	175.00	8990.00	215000	163.92	164.82	28353.70	1266.39	5.08	22.39	0.71
96.00	139.44	200.00	9190.00	215000	163.97	164.95	27308.57	1228.99	5.53	22.22	0.77
98.00	139.65	200.00	9390.00	215000	164.04	165.08	26353.18	1194.60	6.00	22.06	0.83
100.00	139.86	225.00	9615.00	215000	164.17	165.22	26327.22	1197.38	6.03	21.99	0.83
102.00	140.07	238.00	9853.00	215000	164.14	165.47	23377.54	1078.75	7.80	21.67	1.05
104.00	140.27	215.00	10068.00	215000	164.15	165.72	21661.18	1055.81	9.29	20.52	1.19
106.00	140.48	225.00	10293.00	215000	164.37	165.93	21677.09	1050.30	9.23	20.64	1.19
108.00	140.69	225.00	10518.00	215000	164.74	166.14	22778.89	1089.40	8.27	20.91	1.08
110.00	140.90	233.00	10751.00	215000	164.58	166.54	19229.12	939.47	12.12	20.47	1.55
112.00	141.11	200.00	10951.00	215000	164.73	166.83	18600.40	913.08	13.03	20.37	1.66
114.00	141.32	200.00	11151.00	215000	165.01	167.09	18684.87	914.42	12.86	20.43	1.64
116.00	141.53	200.00	11351.00	215000	165.61	167.36	20369.83	975.51	10.53	20.88	1.37
118.00	141.74	200.00	11551.00	215000	166.06	167.58	21882.31	1032.78	8.96	21.19	1.18
120.00	141.95	200.00	11751.00	215000	166.36	167.76	22749.22	1067.24	8.23	21.32	1.09
120.50	142.00	50.00	11801.00	215000	166.48	167.81	23388.98	1077.80	7.63	21.70	1.03
122.00	142.16	150.00	11951.00	215000	166.55	167.95	22851.33	1072.15	8.16	21.31	1.09
122.65	142.22	150.00	12101.00	215000	166.76	168.14	23011.47	1072.94	7.98	21.45	1.07
123.55	147.00	150.00	12251.00	215000	166.25	168.61	17552.96	1056.61	19.30	16.61	2.00
124.00	147.21	150.00	12401.00	215000	166.53	168.90	17491.73	1049.87	19.37	16.66	2.01

MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
TW/da	Kb	Rc	Rc/TW	Kr	Ai	Ki	Tmax	Rc	Rc/TW	Kr	Tmax
55.60	1.06	*********	10.00	1.00	0.00	1.00	2.00	*********	10.00	1.00	2.00
58.11	1.05	*********	10.00	1.00	0.00	1.00	2.18	*********	10.00	1.00	2.18
62.53	1.05	*********	10.00	1.00	0.00	1.00	1.87	8000.00	7.58	1.15	2.15
66.69	1.05	*********	10.00	1.00	0.00	1.00	1.81	8000.00	7.33	1.17	2.12
70.69	1.05	*********	10.00	1.00	0.00	1.00	1.75	8000.00	7.10	1.19	2.08
75.33	1.04	*********	10.00	1.00	0.00	1.00	1.64	8000.00	6.80	1.21	1.99
80.25	1.04	*********	10.00	1.00	0.00	1.00	1.53	8000.00	6.51	1.24	1.90
86.35	1.04	*********	10.00	1.00	0.00	1.00	1.44	8000.00	6.22	1.27	1.83
91.66	1.04	*********	10.00	1.00	0.00	1.00	1.35	8000.00	5.96	1.29	1.74
90.00	1.04	*********	10.00	1.00	0.00	1.00	1.29	8000.00	5.94	1.30	1.67
90.10	1.04	*********	10.00	1.00	0.00	1.00	1.28	8000.00	5.93	1.30	1.66
68.62	1.05	*********	10.00	1.00	0.00	1.00	1.49	8000.00	6.94	1.20	1.79
66.82	1.05	*********	10.00	1.00	0.00	1.00	1.40	8000.00	6.92	1.20	1.69
63.01	1.05	*********	10.00	1.00	0.00	1.00	1.48	8000.00	7.20	1.18	1.74
62.64	1.05	*********	10.00	1.00	0.00	1.00	1.64	*********	10.00	1.00	1.64
59.86	1.05	*********	10.00	1.00	0.00	1.00	1.46	*********	10.00	1.00	1.46
60.47	1.05	*********	10.00	1.00	0.00	1.00	1.45	*********	10.00	1.00	1.45
59.52	1.05	*********	10.00	1.00	0.00	1.00	1.43	*********	10.00	1.00	1.43
58.64	1.05	6000.00	5.54	1.34	0.00	1.00	1.91	*********	10.00	1.00	1.42
56.87	1.06	6000.00	5.65	1.33	0.00	1.00	1.93	*********	10.00	1.00	1.45
54.76	1.06	6000.00	5.69	1.33	0.00	1.00	1.86	*********	10.00	1.00	1.40
53.78	1.06	6000.00	5.75	1.32	0.00	1.00	1.86	*********	10.00	1.00	1.41
52.54	1.06	6000.00	5.60	1.34	0.00	1.00	1.61	*********	10.00	1.00	1.20
50.71	1.06	6000.00	5.97	1.29	0.00	1.00	1.90	*********	10.00	1.00	1.47
48.87	1.06	6000.00	6.14	1.27	0.00	1.00	1.96	*********	10.00	1.00	1.53
48.69	1.06	6000.00	6.16	1.27	0.00	1.00	1.95	*********	10.00	1.00	1.53
47.96	1.07	6000.00	6.27	1.26	0.00	1.00	2.02	*********	10.00	1.00	1.60
48.08	1.07	6000.00	6.24	1.26	0.00	1.00	2.00	*********	10.00	1.00	1.58
47.88	1.07	6000.00	6.21	1.27	0.00	1.00	1.95	6030.00	6.24	1.27	1.94
48.19	1.06	*********	10.00	1.00	0.00	1.00	1.47	6030.00	6.16	1.27	1.88
48.50	1.06	*********	10.00	1.00	0.00	1.00	1.43	6030.00	6.10	1.28	1.84
48.73	1.06	*********	10.00	1.00	0.00	1.00	1.41	6030.00	6.06	1.28	1.81
49.07	1.06	*********	10.00	1.00	0.00	1.00	1.37	6030.00	6.00	1.29	1.77
49.31	1.06	*********	10.00	1.00	0.00	1.00	1.35	6030.00	5.96	1.29	1.75
49.65	1.06	*********	10.00	1.00	0.00	1.00	1.32	6030.00	5.90	1.30	1.71
49.66	1.06	*********	10.00	1.00	0.00	1.00	1.26	6030.00	5.84	1.31	1.65
50.38	1.06	*********	10.00	1.00	0.00	1.00	1.27	6030.00	5.81	1.31	1.66
50.76	1.06	*********	10.00	1.00	0.00	1.00	1.25	6030.00	5.76	1.32	1.64
51.06	1.06	*********	10.00	1.00	0.00	1.00	1.23	6030.00	5.72	1.32	1.62
51.48	1.06	*********	10.00	1.00	0.00	1.00	1.22	6030.00	5.69	1.33	1.61
51.29	1.06	*********	10.00	1.00	0.00	1.00	1.20	6030.00	5.68	1.33	1.59
49.84	1.06	*********	10.00	1.00	0.00	1.00	1.21	6030.00	5.77	1.32	1.59
48.07	1.07	*********	10.00	1.00	0.00	1.00	1.23	6030.00	5.88	1.30	1.60
48.75	1.06	*********	10.00	1.00	5.00	1.09	1.29	6030.00	5.80	1.31	1.56
49.73	1.06	*********	10.00	1.00	7.00	1.12	1.26	6030.00	5.67	1.33	1.49
50.77	1.06	*********	10.00	1.00	10.00	1.17	1.25	6030.00	5.53	1.34	1.43
52.20	1.06	*********	10.00	1.00	13.00	1.22	1.21	6030.00	5.36	1.37	1.35
53.72	1.06	*********	10.00	1.00	13.00	1.22	1.13	6030.00	5.19	1.39	1.28
55.68	1.06	*********	10.00	1.00	16.00	1.28	1.08	6030.00	4.99	1.41	1.20

MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
55.16	1.06	**********	10.00	1.00	18.00	1.31	0.99	6030.00	4.83	1.44	1.09
56.22	1.06	**********	10.00	1.00	20.00	1.34	0.99	6030.00	4.76	1.45	1.07
57.08	1.06	**********	10.00	1.00	17.00	1.29	0.92	6030.00	4.69	1.46	1.04
56.56	1.06	**********	10.00	1.00	15.00	1.26	0.94	6030.00	4.76	1.45	1.09
55.31	1.06	**********	10.00	1.00	16.00	1.28	1.03	6030.00	4.91	1.43	1.16
54.15	1.06	**********	10.00	1.00	9.00	1.16	1.01	6030.00	5.05	1.41	1.23
54.46	1.06	**********	10.00	1.00	0.00	1.00	0.87	6030.00	5.04	1.41	1.23
49.78	1.06	**********	10.00	1.00	0.00	1.00	1.12	**********	10.00	1.00	1.12
51.46	1.06	5000.00	4.74	1.45	0.00	1.00	1.83	**********	10.00	1.00	1.26
50.89	1.06	5000.00	4.76	1.45	0.00	1.00	1.83	**********	10.00	1.00	1.26
52.10	1.06	5000.00	4.59	1.48	0.00	1.00	1.69	**********	10.00	1.00	1.14
45.90	1.07	5000.00	5.32	1.37	0.00	1.00	2.26	**********	10.00	1.00	1.65
44.82	1.07	5000.00	5.48	1.35	0.00	1.00	2.39	**********	10.00	1.00	1.77
44.75	1.07	**********	10.00	1.00	0.00	1.00	1.75	**********	10.00	1.00	1.75
46.72	1.07	**********	10.00	1.00	0.00	1.00	1.46	**********	10.00	1.00	1.46
48.74	1.06	**********	10.00	1.00	0.00	1.00	1.26	**********	10.00	1.00	1.26
50.07	1.06	**********	10.00	1.00	0.00	1.00	1.16	**********	10.00	1.00	1.16
49.67	1.06	**********	10.00	1.00	0.00	1.00	1.10	**********	10.00	1.00	1.10
50.30	1.06	**********	10.00	1.00	0.00	1.00	1.15	**********	10.00	1.00	1.15
50.03	1.06	**********	10.00	1.00	0.00	1.00	1.13	**********	10.00	1.00	1.13
63.60	1.05	**********	10.00	1.00	0.00	1.00	2.10	**********	10.00	1.00	2.10
63.01	1.05	**********	10.00	1.00	0.00	1.00	2.11	**********	10.00	1.00	2.11

Shear Stress Profile

GC#4 to GC#5



Mean Shear + Max North Bank ◇ Max South Bank

Job: 1210 IN	Date
Calc by: SKC	7/28/90
Checked by: JFM	7/30/90
Dwg Chk:	

5/5

Job: R101N
Date
Calc by: GKC 7/28/90
Checked by: JFM 7/30/90
Dwg Chk:

Channel Hydraulic Profiles
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: MESA250.WK1
DATE: 07/28/90

SECND	ELMIN	XLCH	DIST	Q	CWSEL	EGL	AREA	TOPWID	10K*S	HYDDEP	MEAN SHEAR
0.00	129.40	155.00	0.00	250000	152.18	154.82	19391.02	1000.16	16.92	19.39	2.05
2.00	129.61	158.00	158.00	250000	152.24	155.21	18460.61	995.81	19.32	18.54	2.23
4.00	129.82	200.00	358.00	250000	152.97	155.60	19729.64	1065.85	16.68	18.51	1.93
6.00	130.03	200.00	558.00	250000	153.30	155.93	19867.91	1102.50	16.65	18.02	1.87
8.00	130.24	200.00	758.00	250000	153.64	156.26	20037.55	1138.16	16.56	17.61	1.82
10.00	130.45	200.00	958.00	250000	154.07	156.60	20554.92	1187.46	15.80	17.31	1.71
12.00	130.65	200.00	1158.00	250000	154.49	156.92	21109.33	1239.01	15.05	17.04	1.60
14.00	130.86	153.00	1311.00	250000	154.80	157.15	21608.70	1295.02	14.49	16.69	1.51
15.40	131.01	105.00	1416.00	250000	155.07	157.31	22190.40	1352.42	13.79	16.41	1.41
15.60	131.03	18.00	1434.00	250000	155.49	157.63	22755.61	1358.20	12.87	16.75	1.35
17.50	131.23	174.00	1608.00	250000	155.71	157.85	22765.16	1359.60	12.83	16.74	1.34
19.00	131.39	164.00	1772.00	250000	155.84	158.10	21555.25	1163.73	13.42	18.52	1.55
19.20	131.41	20.00	1792.00	250000	156.50	158.61	22348.22	1167.30	12.09	19.15	1.44
21.50	131.65	152.00	1944.00	250000	156.64	158.82	21808.07	1121.54	12.52	19.44	1.52
24.00	131.91	145.00	2089.00	250000	156.66	159.09	20796.02	1093.52	14.13	19.02	1.68
24.50	131.96	48.00	2137.00	250000	158.71	160.74	22856.74	1102.90	10.63	20.72	1.37
26.00	132.12	202.00	2339.00	250000	158.93	160.95	22879.23	1110.18	10.64	20.61	1.37
27.00	132.22	202.00	2541.00	250000	159.16	161.17	22927.96	1105.26	10.51	20.74	1.36
28.00	132.33	151.00	2692.00	250000	159.33	161.33	22973.61	1098.18	10.39	20.92	1.36
30.00	132.54	200.00	2892.00	250000	159.52	161.55	22703.52	1076.91	10.57	21.08	1.39
32.00	132.75	200.00	3092.00	250000	159.81	161.76	23182.36	1069.47	9.97	21.68	1.35
34.00	132.96	200.00	3292.00	250000	160.00	161.97	23051.35	1058.81	10.02	21.77	1.36
36.00	133.16	200.00	3492.00	250000	160.48	162.17	24679.60	1086.13	8.29	22.72	1.18
38.00	133.37	219.00	3711.00	250000	160.45	162.47	22550.81	1019.62	10.30	22.12	1.42
40.00	133.58	225.00	3936.00	250000	160.62	162.74	22043.27	991.25	10.72	22.24	1.49
42.00	133.79	235.00	4171.00	250000	160.87	162.99	22025.10	989.27	10.72	22.26	1.49
44.00	134.00	225.00	4396.00	250000	161.05	163.26	21560.48	971.96	11.23	22.18	1.55
46.00	134.21	230.00	4626.00	250000	161.33	163.52	21650.93	976.37	11.11	22.17	1.54
48.00	134.42	234.00	4860.00	250000	161.65	163.78	21928.06	980.57	10.75	22.36	1.50
50.00	134.63	205.00	5065.00	250000	161.95	164.01	22329.34	993.08	10.30	22.48	1.45
52.00	134.84	185.00	5250.00	250000	162.19	164.20	22592.42	1002.35	10.04	22.54	1.41
54.00	135.05	185.00	5435.00	250000	162.41	164.39	22801.79	1009.56	9.83	22.59	1.39
56.00	135.26	180.00	5615.00	250000	162.64	164.57	23055.68	1018.85	9.59	22.63	1.35
58.00	135.46	183.00	5798.00	250000	162.85	164.74	23252.78	1025.90	9.42	22.67	1.33
60.00	135.67	180.00	5978.00	250000	163.06	164.91	23504.02	1035.06	9.20	22.71	1.30
62.00	135.88	180.00	6158.00	250000	163.31	165.08	24013.25	1045.46	8.75	22.97	1.25
64.00	136.09	176.00	6334.00	250000	163.46	165.24	23931.30	1052.22	8.86	22.74	1.26
66.00	136.30	180.00	6514.00	250000	163.65	165.40	24114.79	1060.21	8.73	22.75	1.24
68.00	136.51	194.00	6708.00	250000	163.84	165.57	24286.96	1067.20	8.60	22.76	1.22
69.50	136.67	95.00	6803.00	250000	163.94	165.66	24403.67	1074.05	8.54	22.72	1.21
70.50	136.77	90.00	6893.00	250000	164.22	165.91	24636.24	1076.18	8.30	22.89	1.19
72.00	136.93	153.00	7046.00	250000	164.35	166.03	24496.97	1059.33	8.29	23.12	1.20
74.00	137.14	179.00	7225.00	250000	164.49	166.18	24378.02	1038.57	8.28	23.47	1.21
76.00	137.35	180.00	7405.00	250000	164.70	166.33	24767.08	1054.42	8.01	23.49	1.17
78.00	137.56	184.00	7589.00	250000	164.93	166.49	25398.32	1078.27	7.60	23.55	1.12
80.00	137.77	174.00	7763.00	250000	165.15	166.62	26096.94	1104.23	7.17	23.63	1.06
82.00	137.97	169.00	7932.00	250000	165.38	166.75	27035.61	1139.30	6.66	23.73	0.99
84.00	138.18	175.00	8107.00	250000	165.59	166.87	27973.87	1175.41	6.20	23.80	0.92
86.00	138.39	180.00	8287.00	250000	165.82	166.99	29209.93	1222.28	5.66	23.90	0.84
88.00	138.60	169.00	8456.00	250000	166.09	167.09	31305.91	1254.30	4.89	24.96	0.76

Channel Hydraulic Profiles
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: MESA250.WK1
DATE: 07/28/90

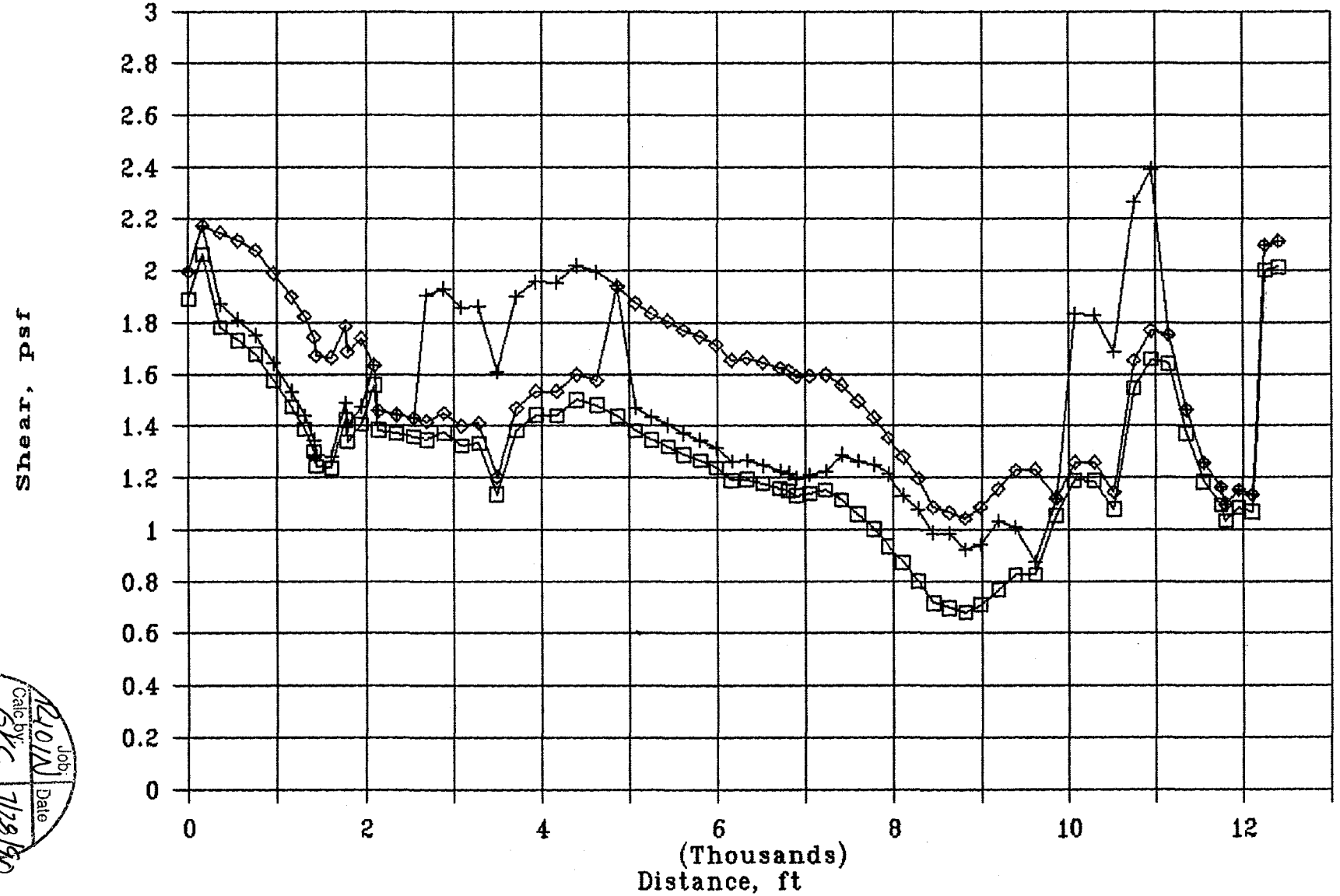
											MEAN
90.00	138.81	180.00	8636.00	250000	166.20	167.18	31698.51	1274.73	4.78	24.87	0.74
92.00	139.02	179.00	8815.00	250000	166.32	167.27	32190.31	1293.43	4.64	24.89	0.72
94.00	139.23	175.00	8990.00	250000	166.38	167.37	31475.84	1273.01	4.89	24.73	0.75
96.00	139.44	200.00	9190.00	250000	166.42	167.49	30328.57	1235.60	5.32	24.55	0.81
98.00	139.65	200.00	9390.00	250000	166.48	167.63	29278.36	1201.18	5.76	24.37	0.88
100.00	139.86	225.00	9615.00	250000	166.61	167.76	29253.28	1203.95	5.80	24.30	0.88
102.00	140.07	238.00	9853.00	250000	166.55	168.01	25987.18	1085.26	7.50	23.95	1.12
104.00	140.27	215.00	10068.00	250000	166.55	168.26	24208.47	1069.46	8.82	22.64	1.25
106.00	140.48	225.00	10293.00	250000	166.75	168.45	24184.93	1063.86	8.80	22.73	1.25
108.00	140.69	225.00	10518.00	250000	167.12	168.66	25395.39	1103.72	7.89	23.01	1.13
110.00	140.90	233.00	10751.00	250000	166.92	169.06	21445.47	952.29	11.61	22.52	1.63
112.00	141.11	200.00	10951.00	250000	167.05	169.35	20736.01	925.80	12.50	22.40	1.75
114.00	141.32	200.00	11151.00	250000	167.32	169.60	20812.03	927.09	12.38	22.45	1.73
116.00	141.53	200.00	11351.00	250000	167.94	169.86	22658.07	988.32	10.16	22.93	1.45
118.00	141.74	200.00	11551.00	250000	168.41	170.07	24320.08	1045.69	8.66	23.26	1.26
120.00	141.95	200.00	11751.00	250000	168.71	170.25	25273.65	1080.20	7.96	23.40	1.16
120.50	142.00	50.00	11801.00	250000	168.83	170.30	25935.84	1087.84	7.41	23.84	1.10
122.00	142.16	150.00	11951.00	250000	168.90	170.43	25383.51	1085.11	7.90	23.39	1.15
122.65	142.22	150.00	12101.00	250000	169.18	170.68	25621.59	1086.28	7.67	23.59	1.13
123.55	147.00	150.00	12251.00	250000	168.70	171.12	20156.65	1071.45	16.79	18.81	1.97
124.00	147.21	150.00	12401.00	250000	168.93	171.39	20030.69	1064.50	17.00	18.82	2.00

MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
TW/da	Kb	Rc	Rc/TW	Kr	Ai	Ki	Tmax	Rc	Rc/TW	Kr	Tmax
51.59	1.06	*********	10.00	1.00	0.00	1.00	2.17	*********	10.00	1.00	2.17
53.72	1.06	*********	10.00	1.00	0.00	1.00	2.36	*********	10.00	1.00	2.36
57.58	1.05	*********	10.00	1.00	0.00	1.00	2.03	8000.00	7.51	1.15	2.34
61.18	1.05	*********	10.00	1.00	0.00	1.00	1.97	8000.00	7.26	1.17	2.31
64.65	1.05	*********	10.00	1.00	0.00	1.00	1.91	8000.00	7.03	1.19	2.27
68.60	1.05	*********	10.00	1.00	0.00	1.00	1.78	8000.00	6.74	1.22	2.17
72.72	1.04	*********	10.00	1.00	0.00	1.00	1.67	8000.00	6.46	1.24	2.08
77.61	1.04	*********	10.00	1.00	0.00	1.00	1.57	8000.00	6.18	1.27	2.00
82.42	1.04	*********	10.00	1.00	0.00	1.00	1.47	8000.00	5.92	1.30	1.91
81.07	1.04	*********	10.00	1.00	0.00	1.00	1.40	8000.00	5.89	1.30	1.82
81.20	1.04	*********	10.00	1.00	0.00	1.00	1.39	8000.00	5.88	1.30	1.82
62.83	1.05	*********	10.00	1.00	0.00	1.00	1.63	8000.00	6.87	1.21	1.96
60.97	1.05	*********	10.00	1.00	0.00	1.00	1.52	8000.00	6.85	1.21	1.83
57.68	1.05	*********	10.00	1.00	0.00	1.00	1.60	8000.00	7.13	1.18	1.90
57.50	1.05	*********	10.00	1.00	0.00	1.00	1.77	*********	10.00	1.00	1.77
53.22	1.06	*********	10.00	1.00	0.00	1.00	1.45	*********	10.00	1.00	1.45
53.87	1.06	*********	10.00	1.00	0.00	1.00	1.45	*********	10.00	1.00	1.45
53.28	1.06	*********	10.00	1.00	0.00	1.00	1.44	*********	10.00	1.00	1.44
52.49	1.06	6000.00	5.46	1.35	0.00	1.00	1.94	*********	10.00	1.00	1.44
51.08	1.06	6000.00	5.57	1.34	0.00	1.00	1.98	*********	10.00	1.00	1.47
49.34	1.06	6000.00	5.61	1.33	0.00	1.00	1.91	*********	10.00	1.00	1.43
48.63	1.06	6000.00	5.67	1.33	0.00	1.00	1.92	*********	10.00	1.00	1.45
47.80	1.07	6000.00	5.52	1.34	0.00	1.00	1.68	*********	10.00	1.00	1.25
46.10	1.07	6000.00	5.88	1.30	0.00	1.00	1.98	*********	10.00	1.00	1.52
44.57	1.07	6000.00	6.05	1.28	0.00	1.00	2.04	*********	10.00	1.00	1.59
44.43	1.07	6000.00	6.07	1.28	0.00	1.00	2.04	*********	10.00	1.00	1.59
43.82	1.07	6000.00	6.17	1.27	0.00	1.00	2.12	*********	10.00	1.00	1.66
44.03	1.07	6000.00	6.15	1.27	0.00	1.00	2.10	*********	10.00	1.00	1.64
43.85	1.07	6000.00	6.12	1.28	0.00	1.00	2.05	6030.00	6.15	1.27	2.05
44.17	1.07	*********	10.00	1.00	0.00	1.00	1.55	6030.00	6.07	1.28	1.98
44.47	1.07	*********	10.00	1.00	0.00	1.00	1.51	6030.00	6.02	1.29	1.95
44.70	1.07	*********	10.00	1.00	0.00	1.00	1.48	6030.00	5.97	1.29	1.92
45.02	1.07	*********	10.00	1.00	0.00	1.00	1.45	6030.00	5.92	1.30	1.88
45.26	1.07	*********	10.00	1.00	0.00	1.00	1.42	6030.00	5.88	1.30	1.86
45.58	1.07	*********	10.00	1.00	0.00	1.00	1.39	6030.00	5.83	1.31	1.82
45.52	1.07	*********	10.00	1.00	0.00	1.00	1.34	6030.00	5.77	1.32	1.76
46.26	1.07	*********	10.00	1.00	0.00	1.00	1.34	6030.00	5.73	1.32	1.77
46.61	1.07	*********	10.00	1.00	0.00	1.00	1.32	6030.00	5.69	1.33	1.75
46.89	1.07	*********	10.00	1.00	0.00	1.00	1.30	6030.00	5.65	1.33	1.73
47.27	1.07	*********	10.00	1.00	0.00	1.00	1.29	6030.00	5.61	1.33	1.72
47.01	1.07	*********	10.00	1.00	0.00	1.00	1.26	6030.00	5.60	1.33	1.69
45.81	1.07	*********	10.00	1.00	0.00	1.00	1.28	6030.00	5.69	1.32	1.69
44.25	1.07	*********	10.00	1.00	0.00	1.00	1.30	6030.00	5.81	1.31	1.70
44.89	1.07	*********	10.00	1.00	5.00	1.09	1.36	6030.00	5.72	1.32	1.66
45.78	1.07	*********	10.00	1.00	7.00	1.12	1.34	6030.00	5.59	1.34	1.59
46.72	1.07	*********	10.00	1.00	10.00	1.17	1.32	6030.00	5.46	1.35	1.53
48.01	1.07	*********	10.00	1.00	13.00	1.22	1.29	6030.00	5.29	1.37	1.44
49.39	1.06	*********	10.00	1.00	13.00	1.22	1.20	6030.00	5.13	1.40	1.37
51.15	1.06	*********	10.00	1.00	16.00	1.28	1.14	6030.00	4.93	1.42	1.27

MAIN CHANNEL:		NORTH BANK:						SOUTH BANK:			
50.25	1.06	*********	10.00	1.00	18.00	1.31	1.06	6030.00	4.81	1.44	1.17
51.26	1.06	*********	10.00	1.00	20.00	1.34	1.06	6030.00	4.73	1.45	1.14
51.97	1.06	*********	10.00	1.00	17.00	1.29	0.99	6030.00	4.66	1.46	1.12
51.49	1.06	*********	10.00	1.00	15.00	1.26	1.01	6030.00	4.74	1.45	1.16
50.34	1.06	*********	10.00	1.00	16.00	1.28	1.10	6030.00	4.88	1.43	1.24
49.28	1.06	*********	10.00	1.00	9.00	1.16	1.08	6030.00	5.02	1.41	1.31
49.55	1.06	*********	10.00	1.00	0.00	1.00	0.93	6030.00	5.01	1.41	1.32
45.32	1.07	*********	10.00	1.00	0.00	1.00	1.20	*********	10.00	1.00	1.20
47.25	1.07	5000.00	4.68	1.46	0.00	1.00	1.94	*********	10.00	1.00	1.33
46.80	1.07	5000.00	4.70	1.46	0.00	1.00	1.94	*********	10.00	1.00	1.33
47.97	1.07	5000.00	4.53	1.48	0.00	1.00	1.79	*********	10.00	1.00	1.21
42.29	1.07	5000.00	5.25	1.38	0.00	1.00	2.42	*********	10.00	1.00	1.75
41.33	1.07	5000.00	5.40	1.36	0.00	1.00	2.55	*********	10.00	1.00	1.88
41.30	1.08	*********	10.00	1.00	0.00	1.00	1.86	*********	10.00	1.00	1.86
43.11	1.07	*********	10.00	1.00	0.00	1.00	1.56	*********	10.00	1.00	1.56
44.96	1.07	*********	10.00	1.00	0.00	1.00	1.34	*********	10.00	1.00	1.34
46.17	1.07	*********	10.00	1.00	0.00	1.00	1.24	*********	10.00	1.00	1.24
45.63	1.07	*********	10.00	1.00	0.00	1.00	1.18	*********	10.00	1.00	1.18
46.39	1.07	*********	10.00	1.00	0.00	1.00	1.23	*********	10.00	1.00	1.23
46.06	1.07	*********	10.00	1.00	0.00	1.00	1.20	*********	10.00	1.00	1.20
56.95	1.06	*********	10.00	1.00	0.00	1.00	2.08	*********	10.00	1.00	2.08
56.57	1.06	*********	10.00	1.00	0.00	1.00	2.11	*********	10.00	1.00	2.11

Mean Shear Stress Profile

GC#4 to GC#5



Mean Shear + Max North Bank ◇ Max South Bank

Job: 12401N	Date 7/28/90
Calc by: GKC	
Checked by: JFM	
Dwg Chk:	7/30/90

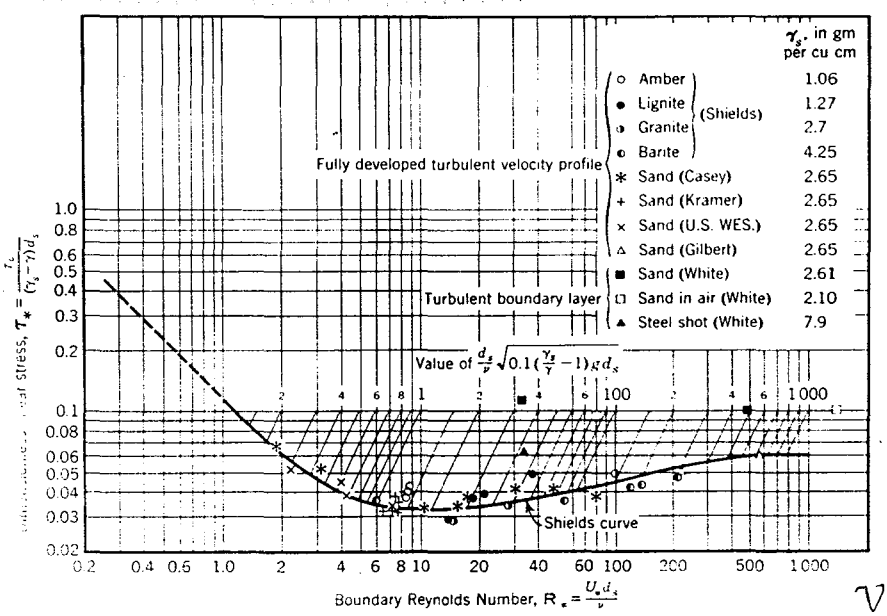
5/5

Maximum Bed Scour

$$y_s = 3 D_a (1/p_c - 1)$$

where $D_a = \tau_p / (\gamma_s - \gamma)\tau_*$

for boundary Reynolds number in excess of ≈ 500, $\tau_* = 0.060$



$\nu = 1 \times 10^{-5}$ ft²/sec

FIG. 2.43.—**Shields Diagram with White Data Added**

ASCE, Manual No. 54 pg. 96

Therefore $D_a = \tau_p / (0.06 \times 103)$

$$= \tau_p / 6.2 \qquad (1)$$

$$\tau_p = \left(\frac{n_p}{n}\right)^2 \cdot \tau_{max} \cdot SF \qquad (2)$$

$$n_p = 0.034\, D_a^{1/6} \qquad (3)$$

where n_p is the roughness due to the partical

τ_p is the shear on the partical

SF = Safety factor : 1.5 for Q = 215,000 cfs
1.3 for Q = 250,000 cfs

Combining equations 1, 2 and 3 gives

$$D_u = \left(\frac{SF \cdot \tau_{max}}{5360\, n^2}\right)^{3/2} \qquad (4)$$

(see derivation pg. 3)

~~Q = 215,000 cfs~~ ~~$D_u = 0.11\, \tau_{max}^{3/2}$~~

Reach	τ_{max} North	τ_{max} South	D_u		P_c		y_s		R_*
GC3-GC4	2.46		0.42		~~17.0~~* 6.3		~~6.2~~ 18.7		67300
GC4-Mill	1.85	1.85	0.28		16.5		4.3		27300
Mill-Rural	2.26	1.75	0.37	0.26	11.7	17.5	8.4	3.7	24700
Rural-IBW	1.57	2.31	0.22	0.39	20.2	10.8	2.6	9.7	19,800
IBW W. Bank	2.36	–	0.40	–	10.4	–	10.3	–	44,100
IBW-McCl	2.02	1.40	0.32	0.18	14.1	23.6	5.8	1.7	15,300

Q = 250,000 cfs $D_u = 0.088\, \tau_{max}^{3/2}$

Reach	τ_{max} North	τ_{max} South	D_u		P_c		y_s		R_*
GC3-GC4	2.70		0.39		~~18.5~~* 7.4		~~5.2~~ 14.6		46,000
GC4-Mill	2.02	2.02	0.25		18.4		3.3		25,500
Mill-Rural	2.32	1.77	0.31	0.21	14.6	21.0	5.4	2.4	20,000
Rural-IBW	1.63	2.43	0.18	0.33	23.6	13.5	1.7	6.3	16500
IBW W. Bank	2.40	–	0.34	–	13.1	–	6.8	–	38,200
IBW-McCl.	2.25	1.54	0.30	0.17	15.1	24.6	5.1	1.6	15,100

~~* SLA Gradation would be 9.9% and 11.1% for CFCS gradation giving a y_s of 1.5 in the Q = 215K~~

See Attached Worksheets
TOED215.WK1
TOED250.WK1

Derivation of Eq. 4

Combining eq 1, 2 and 3 gives

$$D_a = \frac{(n_p/n)^2 \tau_{max} SF}{6.2}$$

$$= \frac{(0.034 D_a^{1/6})^2 \tau_{max} SF}{6.2 n^2}$$

$$D_a^{2/3} = \frac{SF \tau_{max}}{6.2 (n/0.034)^2}$$

$$D_a = \left(\frac{SF \cdot \tau_{max}}{5360 n^2}\right)^{3/2} \qquad (4)$$

for $n = 0.035$ and $SF = 1.5$
equation 4 becomes

$$D_a = 0.11 \tau_{max}^{3/2}$$

for $n = 0.035$ and $SF = 1.3$
equation 4 becomes

$$D_a = 0.088 \tau_{max}^{3/2}$$

Design Gradation

Size (mm)	Percent Finer	ΔP
0.0625	2.0	1.9
0.125	3.9	4.7
0.25	8.6	8.4
0.50	17.0	11.5
1.0	28.5	5.1
2.0	33.6	5.3
4.0	38.9	7.7
8.0	46.6	8.5
16.0	55.1	12.1
32.0	67.2	11.8
64.0	79.0	11.4
128.0	90.4	8.9
256.0	99.3	0.7
512.0	100.0	

$D_{50} = 10.6$ mm

The percent coarser:

$$P_c = 100 - \left[P_L + (P_U - P_L)\left(\frac{\ln d_s - \ln d_L}{\ln d_U - \ln d_L}\right)\right]$$

where P is the cummulative percent finer
L is the index for the lower bound
U is the index for the upper bound
s is the index for a specific size

Job: R101N
Date: 7/28/90
Calc by: GRC
Checked by: JFM 7/30/90
Dwg Chk:

Levee Toedown Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: TOED215.WK1
DATE: 07/28/90

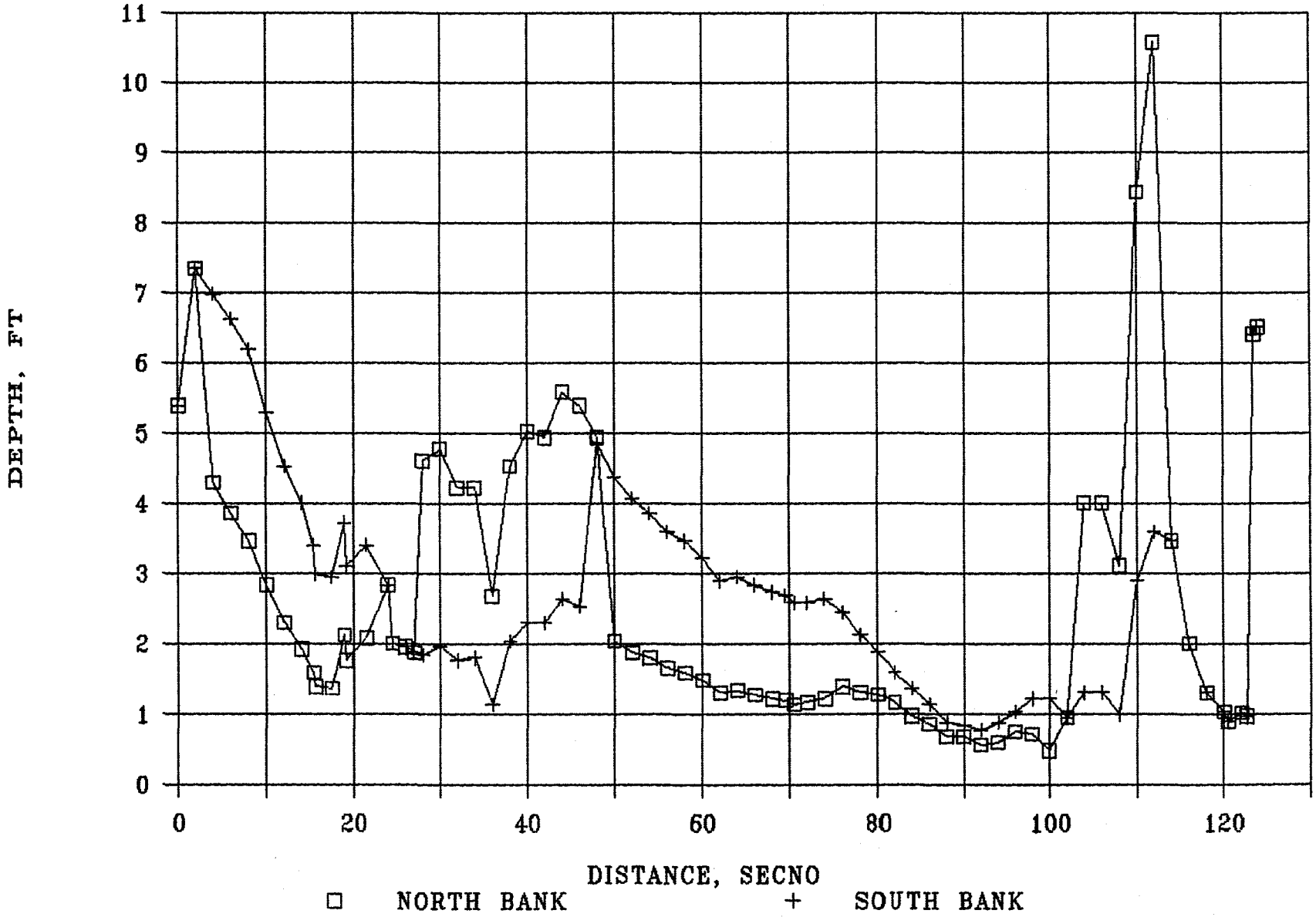
n = 0.035
SF = 1.50

	NORTH BANK:			ARMOR	SOUTH BANK:			ARMOR
SECND	TMAX	DA	%FINER	DEPTH	TMAX	DA	%FINER	DEPTH
0.00	2.00	94.13	85.35	5.40	2.00	94.13	85.35	5.40
2.00	2.18	107.12	87.47	7.36	2.18	107.12	87.47	7.36
4.00	1.87	85.11	83.69	4.30	2.15	104.92	87.13	6.99
6.00	1.81	81.04	82.88	3.86	2.12	102.73	86.78	6.64
8.00	1.75	77.05	82.05	3.47	2.08	99.84	86.31	6.20
10.00	1.64	69.90	80.45	2.83	1.99	93.43	85.22	5.30
12.00	1.53	62.99	78.73	2.29	1.90	87.16	84.08	4.53
14.00	1.44	57.51	77.18	1.91	1.83	82.39	83.15	4.00
15.40	1.35	52.20	75.53	1.59	1.74	76.39	81.91	3.40
15.60	1.29	48.76	74.37	1.39	1.67	71.82	80.90	2.99
17.50	1.28	48.20	74.17	1.36	1.66	71.18	80.75	2.94
19.00	1.49	60.53	78.05	2.12	1.79	79.70	82.61	3.73
19.20	1.40	55.13	76.46	1.76	1.69	73.12	81.19	3.11
21.50	1.48	59.92	77.88	2.08	1.74	76.39	81.91	3.40
24.00	1.64	69.90	80.45	2.83	1.64	69.90	80.45	2.83
24.50	1.46	58.71	77.53	1.99	1.46	58.71	77.53	1.99
26.00	1.45	58.11	77.36	1.95	1.45	58.11	77.36	1.95
27.00	1.43	56.91	77.00	1.88	1.43	56.91	77.00	1.88
28.00	1.91	87.85	84.21	4.61	1.42	56.32	76.82	1.84
30.00	1.93	89.24	84.47	4.78	1.45	58.11	77.36	1.95
32.00	1.86	84.42	83.56	4.22	1.40	55.13	76.46	1.76
34.00	1.86	84.42	83.56	4.22	1.41	55.72	76.64	1.80
36.00	1.61	67.99	79.99	2.68	1.20	43.75	72.52	1.14
38.00	1.90	87.16	84.08	4.53	1.47	59.32	77.71	2.03
40.00	1.96	91.32	84.85	5.03	1.53	62.99	78.73	2.29
42.00	1.95	90.63	84.72	4.95	1.53	62.99	78.73	2.29
44.00	2.02	95.55	85.59	5.59	1.60	67.36	79.84	2.63
46.00	2.00	94.13	85.35	5.40	1.58	66.10	79.53	2.53
48.00	1.95	90.63	84.72	4.95	1.94	89.93	84.59	4.86
50.00	1.47	59.32	77.71	2.03	1.88	85.79	83.82	4.37
52.00	1.43	56.91	77.00	1.88	1.84	83.07	83.29	4.07
54.00	1.41	55.72	76.64	1.80	1.81	81.04	82.88	3.86
56.00	1.37	53.37	75.91	1.65	1.77	78.37	82.33	3.59
58.00	1.35	52.20	75.53	1.59	1.75	77.05	82.05	3.47
60.00	1.32	50.47	74.96	1.49	1.71	74.42	81.48	3.22
62.00	1.26	47.07	73.77	1.30	1.65	70.54	80.60	2.88
64.00	1.27	47.63	73.97	1.33	1.66	71.18	80.75	2.94
66.00	1.25	46.51	73.57	1.27	1.64	69.90	80.45	2.83
68.00	1.23	45.40	73.15	1.22	1.62	68.62	80.15	2.73
69.50	1.22	44.85	72.95	1.19	1.61	67.99	79.99	2.68
70.50	1.20	43.75	72.52	1.14	1.59	66.73	79.69	2.58
72.00	1.21	44.30	72.74	1.16	1.59	66.73	79.69	2.58
74.00	1.23	45.40	73.15	1.22	1.60	67.36	79.84	2.63
76.00	1.29	48.76	74.37	1.39	1.56	64.85	79.22	2.43
78.00	1.26	47.07	73.77	1.30	1.49	60.53	78.05	2.12
80.00	1.25	46.51	73.57	1.27	1.43	56.91	77.00	1.88

82.00	1.21	44.30	72.74	1.16	1.35	52.20	75.53	1.59
84.00	1.13	39.98	70.99	0.96	1.28	48.20	74.17	1.36
86.00	1.08	37.35	69.83	0.85	1.20	43.75	72.52	1.14
88.00	0.99	32.78	67.61	0.67	1.09	37.87	70.07	0.87
90.00	0.99	32.78	67.61	0.67	1.07	36.84	69.60	0.83
92.00	0.92	29.37	65.70	0.55	1.04	35.30	68.87	0.77
94.00	0.94	30.33	66.27	0.59	1.09	37.87	70.07	0.87
96.00	1.03	34.79	68.62	0.75	1.16	41.58	71.66	1.03
98.00	1.01	33.78	68.12	0.71	1.23	45.40	73.15	1.22
100.00	0.87	27.01	64.24	0.48	1.23	45.40	73.15	1.22
102.00	1.12	39.45	70.76	0.94	1.12	39.45	70.76	0.94
104.00	1.83	82.39	83.15	4.00	1.26	47.07	73.77	1.30
106.00	1.83	82.39	83.15	4.00	1.26	47.07	73.77	1.30
108.00	1.69	73.12	81.19	3.11	1.14	40.51	71.21	0.99
110.00	2.26	113.07	88.36	8.45	1.65	70.54	80.60	2.88
112.00	2.39	122.97	89.74	10.59	1.77	78.37	82.33	3.59
114.00	1.75	77.05	82.05	3.47	1.75	77.05	82.05	3.47
116.00	1.46	58.71	77.53	1.99	1.46	58.71	77.53	1.99
118.00	1.26	47.07	73.77	1.30	1.26	47.07	73.77	1.30
120.00	1.16	41.58	71.66	1.03	1.16	41.58	71.66	1.03
120.50	1.10	38.40	70.30	0.89	1.10	38.40	70.30	0.89
122.00	1.15	41.04	71.44	1.01	1.15	41.04	71.44	1.01
122.65	1.13	39.98	70.99	0.96	1.13	39.98	70.99	0.96
123.55	2.10	101.28	86.55	6.41	2.10	101.28	86.55	6.41
124.00	2.11	102.01	86.67	6.53	2.11	102.01	86.67	6.53

ARMOR DEPTH

SALT RIVER CHANNELIZATION



3/3

Job: R101N	Date
Calc by: GLC	7/28/90
Checked by: JFM	7/30/90
Dwg Chk:	

Levee Toedown Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: TOED250.WK1
DATE: 07/28/90

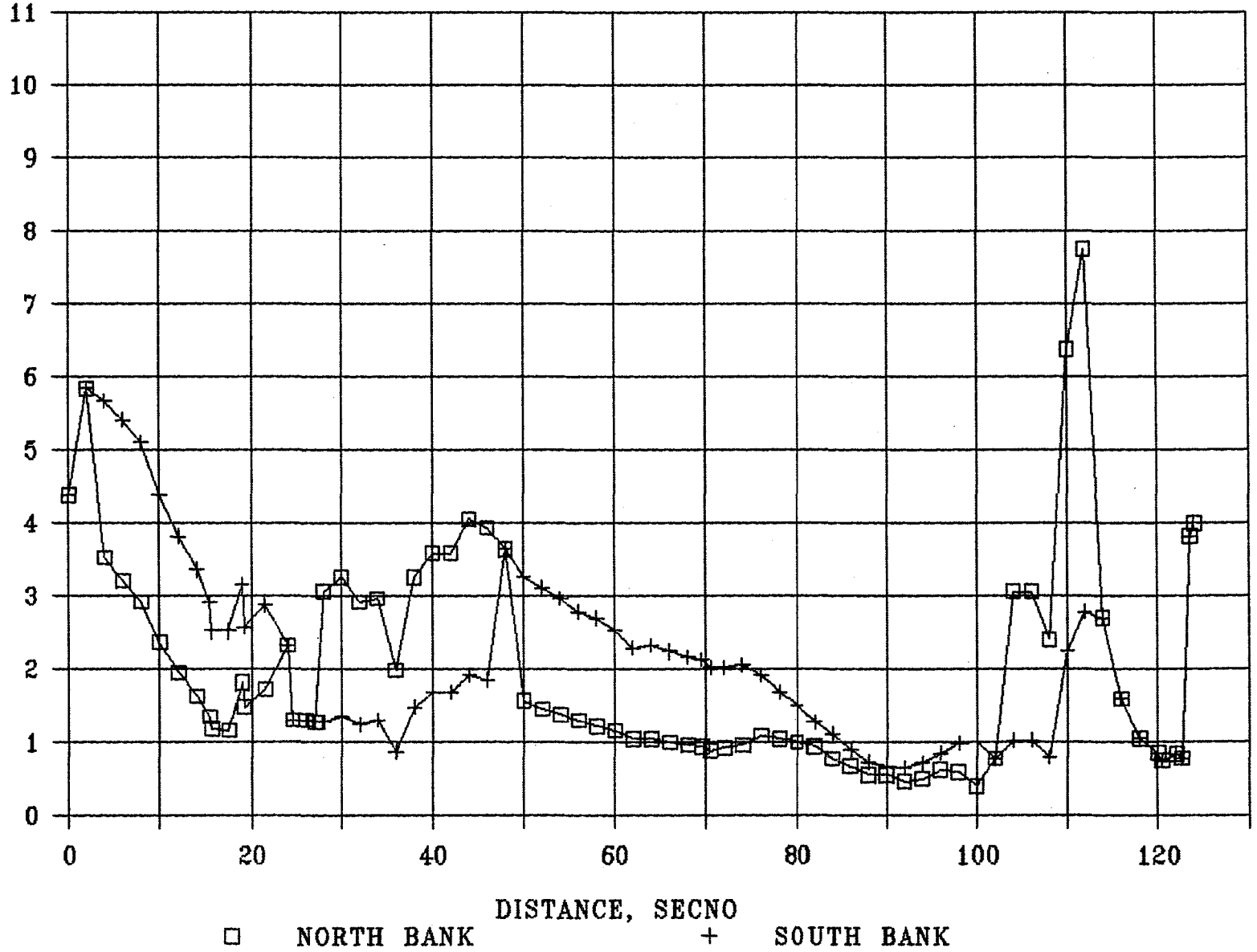
n = 0.035
SF = 1.30

	NORTH BANK:			ARMOR	SOUTH BANK:			ARMOR
SECND	TMAX	DA	%FINER	DEPTH	TMAX	DA	%FINER	DEPTH
0.00	2.17	85.84	83.83	4.38	2.17	85.84	83.83	4.38
2.00	2.36	97.35	85.90	5.84	2.36	97.35	85.90	5.84
4.00	2.03	77.66	82.18	3.53	2.34	96.12	85.69	5.66
6.00	1.97	74.25	81.44	3.21	2.31	94.28	85.37	5.41
8.00	1.91	70.88	80.68	2.91	2.27	91.84	84.94	5.10
10.00	1.78	63.77	78.94	2.35	2.17	85.84	83.83	4.38
12.00	1.67	57.95	77.31	1.94	2.08	80.55	82.78	3.81
14.00	1.57	52.82	75.73	1.62	2.00	75.95	81.82	3.36
15.40	1.47	47.86	74.05	1.34	1.91	70.88	80.68	2.91
15.60	1.40	44.48	72.81	1.17	1.82	65.93	79.49	2.51
17.50	1.39	44.00	72.62	1.15	1.82	65.93	79.49	2.51
19.00	1.63	55.88	76.69	1.81	1.96	73.68	81.32	3.16
19.20	1.52	50.32	74.91	1.48	1.83	66.47	79.62	2.56
21.50	1.60	54.34	76.22	1.71	1.90	70.32	80.55	2.87
24.00	1.77	63.23	78.79	2.31	1.77	63.23	78.79	2.31
24.50	1.45	46.88	73.70	1.29	1.45	46.88	73.70	1.29
26.00	1.45	46.88	73.70	1.29	1.45	46.88	73.70	1.29
27.00	1.44	46.40	73.53	1.27	1.44	46.40	73.53	1.27
28.00	1.94	72.56	81.06	3.06	1.44	46.40	73.53	1.27
30.00	1.98	74.81	81.57	3.26	1.47	47.86	74.05	1.34
32.00	1.91	70.88	80.68	2.91	1.43	45.92	73.35	1.24
34.00	1.92	71.44	80.81	2.96	1.45	46.88	73.70	1.29
36.00	1.68	58.47	77.46	1.98	1.25	37.53	69.91	0.86
38.00	1.98	74.81	81.57	3.26	1.52	50.32	74.91	1.48
40.00	2.04	78.24	82.30	3.58	1.59	53.84	76.06	1.68
42.00	2.04	78.24	82.30	3.58	1.59	53.84	76.06	1.68
44.00	2.12	82.89	83.25	4.06	1.66	57.43	77.16	1.91
46.00	2.10	81.72	83.02	3.93	1.64	56.40	76.85	1.84
48.00	2.05	78.82	82.42	3.64	2.05	78.82	82.42	3.64
50.00	1.55	51.82	75.41	1.56	1.98	74.81	81.57	3.26
52.00	1.51	49.82	74.74	1.45	1.95	73.12	81.19	3.11
54.00	1.48	48.35	74.23	1.37	1.92	71.44	80.81	2.96
56.00	1.45	46.88	73.70	1.29	1.88	69.22	80.29	2.78
58.00	1.42	45.44	73.17	1.22	1.86	68.12	80.03	2.69
60.00	1.39	44.00	72.62	1.15	1.82	65.93	79.49	2.51
62.00	1.34	41.65	71.69	1.04	1.76	62.70	78.65	2.27
64.00	1.34	41.65	71.69	1.04	1.77	63.23	78.79	2.31
66.00	1.32	40.72	71.30	1.00	1.75	62.16	78.50	2.23
68.00	1.30	39.80	70.91	0.96	1.73	61.10	78.21	2.16
69.50	1.29	39.34	70.72	0.94	1.72	60.57	78.06	2.12
70.50	1.26	37.98	70.12	0.88	1.69	58.99	77.61	2.01
72.00	1.28	38.89	70.52	0.92	1.69	58.99	77.61	2.01
74.00	1.30	39.80	70.91	0.96	1.70	59.52	77.76	2.05
76.00	1.36	42.59	72.07	1.08	1.66	57.43	77.16	1.91
78.00	1.34	41.65	71.69	1.04	1.59	53.84	76.06	1.68
80.00	1.32	40.72	71.30	1.00	1.53	50.82	75.07	1.51

82.00	1.29	39.34	70.72	0.94	1.44	46.40	73.53	1.27
84.00	1.20	35.30	68.87	0.77	1.37	43.06	72.25	1.10
86.00	1.14	32.68	67.56	0.67	1.27	38.43	70.32	0.90
88.00	1.06	29.30	65.66	0.55	1.17	33.98	68.22	0.72
90.00	1.06	29.30	65.66	0.55	1.14	32.68	67.56	0.67
92.00	0.99	26.45	63.88	0.46	1.12	31.83	67.11	0.64
94.00	1.01	27.26	64.40	0.49	1.16	33.55	68.00	0.70
96.00	1.10	30.98	66.63	0.61	1.24	37.08	69.71	0.84
98.00	1.08	30.14	66.15	0.58	1.31	40.26	71.11	0.98
100.00	0.93	24.08	62.24	0.39	1.32	40.72	71.30	1.00
102.00	1.20	35.30	68.87	0.77	1.20	35.30	68.87	0.77
104.00	1.94	72.56	81.06	3.06	1.33	41.19	71.50	1.02
106.00	1.94	72.56	81.06	3.06	1.33	41.19	71.50	1.02
108.00	1.79	64.31	79.08	2.39	1.21	35.74	69.08	0.79
110.00	2.42	101.09	86.52	6.38	1.75	62.16	78.50	2.23
112.00	2.55	109.34	87.81	7.75	1.88	69.22	80.29	2.78
114.00	1.86	68.12	80.03	2.69	1.86	68.12	80.03	2.69
116.00	1.56	52.32	75.57	1.59	1.56	52.32	75.57	1.59
118.00	1.34	41.65	71.69	1.04	1.34	41.65	71.69	1.04
120.00	1.24	37.08	69.71	0.84	1.24	37.08	69.71	0.84
120.50	1.18	34.42	68.44	0.73	1.18	34.42	68.44	0.73
122.00	1.23	36.63	69.50	0.82	1.23	36.63	69.50	0.82
122.65	1.20	35.30	68.87	0.77	1.20	35.30	68.87	0.77
123.55	2.08	80.55	82.78	3.81	2.08	80.55	82.78	3.81
124.00	2.11	82.30	83.14	3.99	2.11	82.30	83.14	3.99

ARMOR DEPTH

SALT RIVER CHANNELIZATION



Job:	7/10/N
Calc by:	GKC
Date	7/28/90
Checked by:	JFM
Dwg Chk:	7/30/90

3/3

CRSS

CRS SIRRINE

DESIGN SHEET

Job Rio Salado Channel
Structure
Live Load Per Square Foot

Job No. R101N Date 12/15/89
Computed By GKC
Working Stress FM 12/20/89

Bed Form Analysis

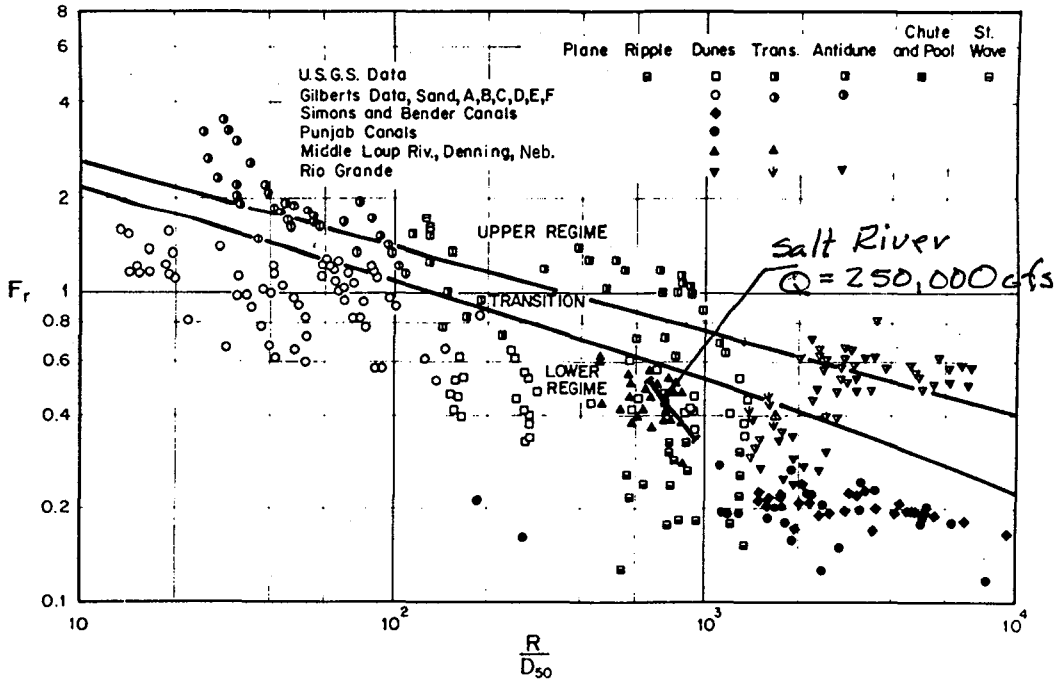


Fig. 5.23 Bed form prediction as a function of F_r and R/D_{50}.

from Simons & Senturk (1977) pg 262

Location	Q = 215,000 F	d_{max}	d/D_{50}	Q = 250,000 F	d_{max}	d/D_{50}
GC3 - GC4	0.62	21.2	646	0.62	23.0	701
GC4 - Mill	0.49	23.0	701	0.49	25.7	783
Mill - Rural	0.47	24.7	753	0.44	27.5	838
Rural - IBW	0.42	24.5	747	0.42	27.0	823
IBW - McClin	0.48	21.5	655	0.48	24.0	732

→ channel is in lower regime
Bed form is dunes

See Attached worksheets: BEDF215.WK1
BEDF250.WK1

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado Channel
Structure:
Live Load Per Square Foot:

Job No.: R101N
Date: 12/15/89
Computed By:
Working Stress: JFM 12/20/89

Dune height - Method #1: Allen (1963)

$$A_D = 0.065 d^{1.21}$$

[from equation 5.13 Simons and Senturk (1977), page 266, converted to feet units]

Reach	Q=215,000 dmax	Q=215,000 A_D	Q=250,000 dmax	Q=250,000 A_D
GC3-GC4	21.2	2.62	23.0	2.89
GC4-Mill	23.0	2.89	25.7	3.30
Mill-Rural	24.7	3.15	27.5	3.59
Rural-IBW	24.5	3.12	27.0	3.51
IBW-McClin	21.5	2.66	24.0	3.04

See Attached worksheets

Method #2: Yalin (1964)

$$A_d = \tfrac{1}{6}((\tau - \tau_c)/\tau)\, d$$

$$\tau_c = 4.83\,(10/304.8) = 0.16 \text{ lb/ft}^2$$

$D_{50} = 10$ mm

Q=215,000

Location	τ	dmax	A_d	τ/τ_c	*
GC3-GC4	2.94	21.2	3.34	18.4	*Dunes
GC4-Mill	1.85	23.0	3.50	11.6	Plane Bed
Mill-Rural	2.26	24.7	3.83	14.1	Plane Bed
Rural-IBW	2.31	24.5	3.80	14.4	Plane Bed
IBW-McClin	2.81	21.5	3.38	17.6	Dunes

See Attached worksheets

* According to Yalin sand waves, i.e. dunes, will disappear when $\tau/\tau_c < 17.63$

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

Method # 2 : continued

Q = 250,000

Reach	τ	dmax	Ad	τ/τ_c	
GC3 - GC4	3.24	23.0	3.64	20.3	Dunes
GC4 - Mill	2.02	25.7	3.94	12.6	Plane
Mill - Rural	2.21	27.5	4.25	13.8	Plane
Rural - IBW	2.38	27.0	4.20	14.9	Plane
IBW - MCI	2.87	24.0	3.78	17.9	Dunes

See Attached Worksheets

4/2

Job: 1210IN	Date
Calc by: GKC	7/28/90
Checked by: JFM	7/30/90
Dwg Chk:	

Bed Form Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: BEDF215.WK1
DATE: 07/19/90

	NORTH BANK:				SOUTH BANK:		
SECND	TMAX	Dmax	YALIN	ALLEN	TMAX	YALIN	ALLEN
0.00	2.00	20.99	3.22	2.59	2.00	3.22	2.59
2.00	2.18	20.85	3.22	2.56	2.18	3.22	2.56
4.00	1.87	21.32	3.25	2.63	2.15	3.29	2.63
6.00	1.81	21.44	3.26	2.65	2.12	3.30	2.65
8.00	1.75	21.57	3.27	2.67	2.08	3.32	2.67
10.00	1.64	21.77	3.27	2.70	1.99	3.34	2.70
12.00	1.53	21.98	3.28	2.73	1.90	3.35	2.73
14.00	1.44	22.07	3.27	2.75	1.83	3.36	2.75
15.40	1.35	22.17	3.26	2.76	1.74	3.36	2.76
15.60	1.29	22.53	3.29	2.82	1.67	3.40	2.82
17.50	1.28	22.56	3.29	2.82	1.66	3.40	2.82
19.00	1.49	22.58	3.36	2.82	1.79	3.43	2.82
19.20	1.40	23.08	3.41	2.90	1.69	3.48	2.90
21.50	1.48	22.99	3.42	2.89	1.74	3.48	2.89
24.00	1.64	22.77	3.42	2.85	1.64	3.42	2.85
24.50	1.46	23.88	3.54	3.02	1.46	3.54	3.02
26.00	1.45	23.98	3.56	3.04	1.45	3.56	3.04
27.00	1.43	24.15	3.57	3.06	1.43	3.57	3.06
28.00	1.91	24.25	3.70	3.08	1.42	3.59	3.08
30.00	1.93	24.25	3.71	3.08	1.45	3.60	3.08
32.00	1.86	24.38	3.71	3.10	1.40	3.60	3.10
34.00	1.86	24.39	3.72	3.10	1.41	3.60	3.10
36.00	1.61	24.69	3.71	3.15	1.20	3.57	3.15
38.00	1.90	24.47	3.73	3.11	1.47	3.63	3.11
40.00	1.96	24.47	3.75	3.11	1.53	3.65	3.11
42.00	1.95	24.53	3.75	3.12	1.53	3.66	3.12
44.00	2.02	24.53	3.76	3.12	1.60	3.68	3.12
46.00	2.00	24.61	3.77	3.13	1.58	3.69	3.13
48.00	1.95	24.74	3.79	3.15	1.94	3.78	3.15
50.00	1.47	24.84	3.69	3.17	1.88	3.79	3.17
52.00	1.43	24.89	3.68	3.18	1.84	3.79	3.18
54.00	1.41	24.91	3.68	3.18	1.81	3.78	3.18
56.00	1.37	24.93	3.67	3.18	1.77	3.78	3.18
58.00	1.35	24.95	3.67	3.19	1.75	3.78	3.19
60.00	1.32	24.96	3.66	3.19	1.71	3.77	3.19
62.00	1.26	25.00	3.64	3.19	1.65	3.76	3.19
64.00	1.27	24.95	3.63	3.19	1.66	3.76	3.19
66.00	1.25	24.93	3.62	3.18	1.64	3.75	3.18
68.00	1.23	24.93	3.61	3.18	1.62	3.74	3.18
69.50	1.22	24.87	3.60	3.17	1.61	3.73	3.17
70.50	1.20	24.98	3.61	3.19	1.59	3.74	3.19
72.00	1.21	24.95	3.61	3.19	1.59	3.74	3.19
74.00	1.23	24.91	3.61	3.18	1.60	3.74	3.18
76.00	1.19	24.91	3.59	3.18	1.56	3.73	3.18
78.00	1.13	24.93	3.57	3.18	1.49	3.71	3.18
80.00	1.06	24.94	3.53	3.19	1.43	3.69	3.19
82.00	0.99	24.96	3.49	3.19	1.35	3.67	3.19
84.00	0.92	24.96	3.44	3.19	1.28	3.64	3.19

Job:
Date
Calc by:
Checked by: JFM 7/30/99
Dwg Chk:

86.00	0.85	24.97	3.38	3.19	1.20	3.61	3.19
88.00	0.75	25.03	3.28	3.20	1.09	3.56	3.20
90.00	0.73	24.93	3.24	3.18	1.07	3.53	3.18
92.00	0.71	24.84	3.21	3.17	1.04	3.50	3.17
94.00	0.75	24.69	3.24	3.15	1.09	3.51	3.15
96.00	0.81	24.53	3.28	3.12	1.16	3.52	3.12
98.00	0.87	24.39	3.32	3.10	1.23	3.54	3.10
100.00	0.87	24.31	3.31	3.09	1.23	3.52	3.09
102.00	1.12	24.07	3.44	3.05	1.12	3.44	3.05
104.00	1.83	23.88	3.63	3.02	1.26	3.47	3.02
106.00	1.83	23.89	3.63	3.02	1.26	3.48	3.02
108.00	1.69	24.05	3.63	3.05	1.14	3.45	3.05
110.00	2.26	23.68	3.67	2.99	1.65	3.56	2.99
112.00	2.39	23.62	3.67	2.98	1.77	3.58	2.98
114.00	1.75	23.69	3.59	2.99	1.75	3.59	2.99
116.00	1.46	24.08	3.57	3.05	1.46	3.57	3.05
118.00	1.26	24.32	3.54	3.09	1.26	3.54	3.09
120.00	1.16	24.41	3.51	3.10	1.16	3.51	3.10
120.50	1.10	24.48	3.49	3.11	1.10	3.49	3.11
122.00	1.15	24.39	3.50	3.10	1.15	3.50	3.10
122.65	1.13	24.54	3.51	3.12	1.13	3.51	3.12
123.55	2.10	19.25	2.96	2.33	2.10	2.96	2.33
124.00	2.11	19.32	2.98	2.34	2.11	2.98	2.34
		MAX Hbf =	3.79	3.20		3.79	3.20
		1/2 Hbf =	1.89	1.60		1.89	1.60

1/2

Job: 12101N	Date
Calc by: GKC	7/28/90
Checked by: JFM	7/30/90
Dwg Chk:	

Bed Form Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: BEDF250.WK1
DATE: 07/19/90

	NORTH BANK:				SOUTH BANK:		
SECND	TMAX	Dmax	YALIN	ALLEN	TMAX	YALIN	ALLEN
0.00	2.17	22.78	3.52	2.85	2.17	3.52	2.85
2.00	2.36	22.63	3.52	2.83	2.36	3.52	2.83
4.00	2.03	23.15	3.55	2.91	2.34	3.59	2.91
6.00	1.97	23.27	3.56	2.93	2.31	3.61	2.93
8.00	1.91	23.40	3.57	2.95	2.27	3.63	2.95
10.00	1.78	23.62	3.58	2.98	2.17	3.65	2.98
12.00	1.67	23.84	3.59	3.02	2.08	3.67	3.02
14.00	1.57	23.94	3.58	3.03	2.00	3.67	3.03
15.40	1.47	24.06	3.57	3.05	1.91	3.67	3.05
15.60	1.40	24.46	3.61	3.11	1.82	3.72	3.11
17.50	1.39	24.48	3.61	3.11	1.82	3.72	3.11
19.00	1.63	24.45	3.68	3.11	1.96	3.74	3.11
19.20	1.52	25.09	3.74	3.21	1.83	3.82	3.21
21.50	1.60	24.99	3.75	3.19	1.90	3.81	3.19
24.00	1.77	24.75	3.75	3.16	1.77	3.75	3.16
24.50	1.45	26.75	3.97	3.47	1.45	3.97	3.47
26.00	1.45	26.81	3.98	3.48	1.45	3.98	3.48
27.00	1.44	26.94	3.99	3.50	1.44	3.99	3.50
28.00	1.94	27.00	4.13	3.51	1.44	4.00	3.51
30.00	1.98	26.98	4.13	3.50	1.47	4.01	3.50
32.00	1.91	27.06	4.13	3.52	1.43	4.01	3.52
34.00	1.92	27.04	4.13	3.51	1.45	4.01	3.51
36.00	1.68	27.32	4.12	3.56	1.25	3.97	3.56
38.00	1.98	27.08	4.15	3.52	1.52	4.04	3.52
40.00	2.04	27.04	4.15	3.51	1.59	4.05	3.51
42.00	2.04	27.08	4.16	3.52	1.59	4.06	3.52
44.00	2.12	27.05	4.17	3.51	1.66	4.07	3.51
46.00	2.10	27.12	4.18	3.53	1.64	4.08	3.53
48.00	2.05	27.23	4.18	3.54	2.05	4.18	3.54
50.00	1.55	27.32	4.08	3.56	1.98	4.19	3.56
52.00	1.51	27.35	4.08	3.56	1.95	4.18	3.56
54.00	1.48	27.36	4.07	3.56	1.92	4.18	3.56
56.00	1.45	27.38	4.06	3.57	1.88	4.17	3.57
58.00	1.42	27.39	4.05	3.57	1.86	4.17	3.57
60.00	1.39	27.39	4.04	3.57	1.82	4.16	3.57
62.00	1.34	27.43	4.03	3.57	1.76	4.16	3.57
64.00	1.34	27.37	4.02	3.56	1.77	4.15	3.56
66.00	1.32	27.35	4.01	3.56	1.75	4.14	3.56
68.00	1.30	27.33	3.99	3.56	1.73	4.13	3.56
69.50	1.29	27.27	3.98	3.55	1.72	4.12	3.55
70.50	1.26	27.45	3.99	3.58	1.69	4.14	3.58
72.00	1.28	27.42	4.00	3.57	1.69	4.14	3.57
74.00	1.30	27.35	4.00	3.56	1.70	4.13	3.56
76.00	1.25	27.35	3.97	3.56	1.66	4.12	3.56
78.00	1.19	27.37	3.95	3.56	1.59	4.10	3.56
80.00	1.13	27.38	3.92	3.57	1.53	4.09	3.57
82.00	1.05	27.41	3.87	3.57	1.44	4.06	3.57
84.00	0.98	27.41	3.82	3.57	1.37	4.03	3.57

2/2

Date
Calc by:
Checked by: JFM 7/30/90
Dwg Chk:

86.00	0.90	27.43	3.76	3.57	1.27	4.00	3.57
88.00	0.81	27.49	3.68	3.58	1.17	3.96	3.58
90.00	0.79	27.39	3.64	3.57	1.14	3.92	3.57
92.00	0.76	27.30	3.59	3.55	1.12	3.90	3.55
94.00	0.80	27.15	3.62	3.53	1.16	3.90	3.53
96.00	0.87	26.98	3.67	3.50	1.24	3.92	3.50
98.00	0.93	26.83	3.70	3.48	1.31	3.93	3.48
100.00	0.93	26.75	3.69	3.47	1.32	3.92	3.47
102.00	1.20	26.48	3.82	3.42	1.20	3.82	3.42
104.00	1.94	26.28	4.02	3.39	1.33	3.85	3.39
106.00	1.94	26.27	4.02	3.39	1.33	3.85	3.39
108.00	1.79	26.43	4.01	3.42	1.21	3.82	3.42
110.00	2.42	26.02	4.05	3.35	1.75	3.94	3.35
112.00	2.55	25.94	4.05	3.34	1.88	3.96	3.34
114.00	1.86	26.00	3.96	3.35	1.86	3.96	3.35
116.00	1.56	26.41	3.95	3.41	1.56	3.95	3.41
118.00	1.34	26.67	3.91	3.45	1.34	3.91	3.45
120.00	1.24	26.76	3.88	3.47	1.24	3.88	3.47
120.50	1.18	26.83	3.87	3.48	1.18	3.87	3.48
122.00	1.23	26.74	3.88	3.47	1.23	3.88	3.47
122.65	1.20	26.96	3.89	3.50	1.20	3.89	3.50
123.55	2.08	21.70	3.34	2.69	2.08	3.34	2.69
124.00	2.11	21.72	3.35	2.69	2.11	3.35	2.69
		MAX Hbf =	4.18	3.58		4.19	3.58
		1/2 Hbf =	2.09	1.79		2.09	1.79

1/3

Job:	Date
1401N	
Calc by: GKC	7/28/90
Checked by: JFM	7/30/90
Dwg Chk:	

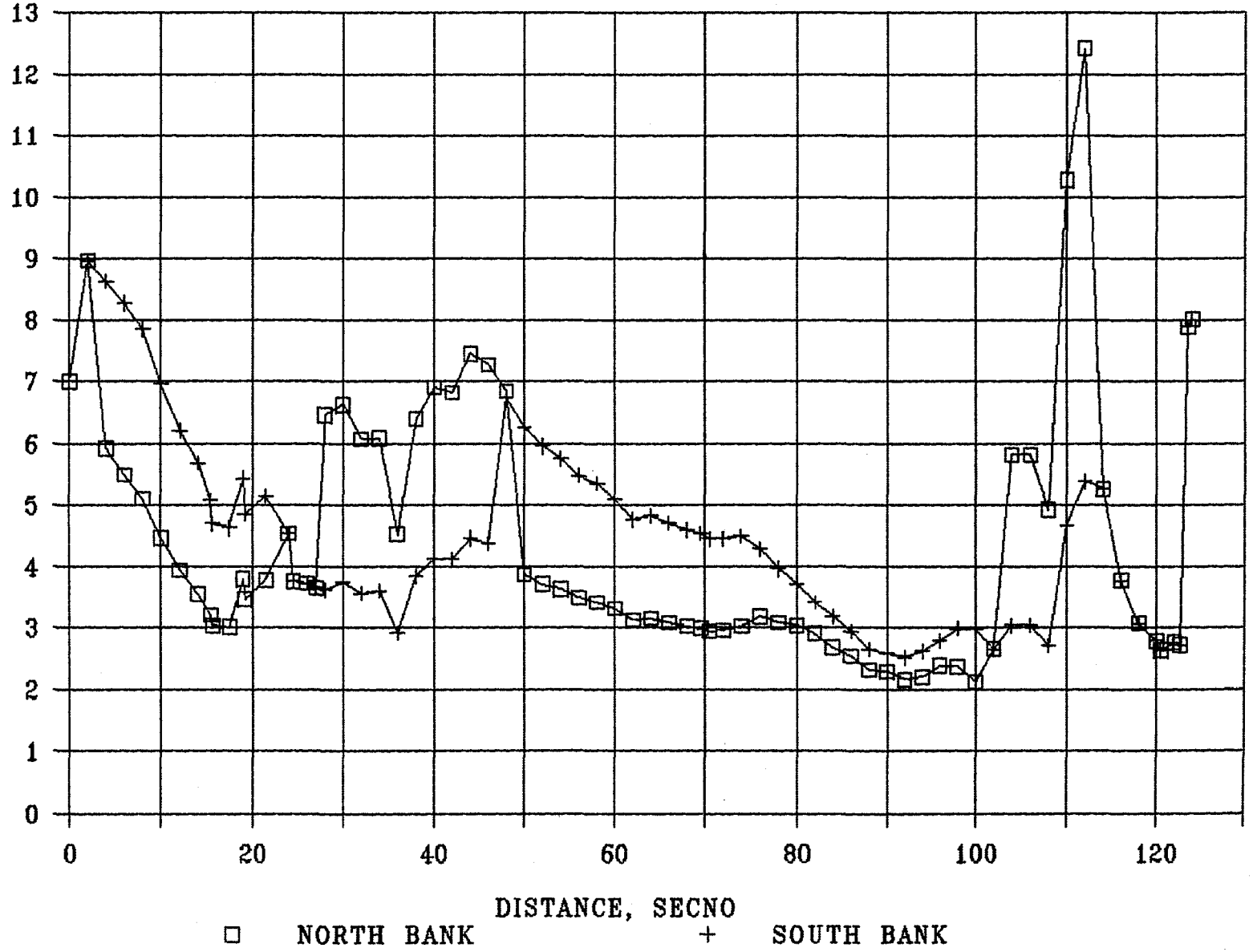
Levee Toedown Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

SECNO	NORTH BANK: BED FORM	TOEDOWN	SOUTH BANK: BED FORM	TOEDOWN
0.00	3.22	7.01	3.22	7.01
2.00	3.22	8.97	3.22	8.97
4.00	3.25	5.92	3.29	8.64
6.00	3.26	5.49	3.30	8.29
8.00	3.27	5.10	3.32	7.86
10.00	3.27	4.47	3.34	6.97
12.00	3.28	3.93	3.35	6.21
14.00	3.27	3.55	3.36	5.68
15.40	3.26	3.22	3.36	5.08
15.60	3.29	3.04	3.40	4.69
17.50	3.29	3.01	3.40	4.64
19.00	3.36	3.80	3.43	5.44
19.20	3.41	3.47	3.48	4.85
21.50	3.42	3.79	3.48	5.14
24.00	3.42	4.54	3.42	4.54
24.50	3.54	3.76	3.54	3.76
26.00	3.56	3.73	3.56	3.73
27.00	3.57	3.66	3.57	3.66
28.00	3.70	6.46	3.59	3.63
30.00	3.71	6.63	3.60	3.75
32.00	3.71	6.08	3.60	3.56
34.00	3.72	6.08	3.60	3.60
36.00	3.71	4.53	3.57	2.92
38.00	3.73	6.40	3.63	3.85
40.00	3.75	6.91	3.65	4.12
42.00	3.75	6.82	3.66	4.12
44.00	3.76	7.47	3.68	4.47
46.00	3.77	7.28	3.69	4.37
48.00	3.79	6.84	3.78	6.75
50.00	3.69	3.88	3.79	6.27
52.00	3.68	3.72	3.79	5.97
54.00	3.68	3.64	3.78	5.75
56.00	3.67	3.49	3.78	5.48
58.00	3.67	3.42	3.78	5.36
60.00	3.66	3.32	3.77	5.11
62.00	3.64	3.12	3.76	4.76
64.00	3.63	3.15	3.76	4.82
66.00	3.62	3.08	3.75	4.71
68.00	3.61	3.02	3.74	4.60
69.50	3.60	2.99	3.73	4.54
70.50	3.61	2.94	3.74	4.45
72.00	3.61	2.97	3.74	4.45
74.00	3.61	3.02	3.74	4.50
76.00	3.59	3.19	3.73	4.30
78.00	3.57	3.09	3.71	3.97
80.00	3.53	3.04	3.69	3.72

82.00	3.49	2.91	¦	3.67	3.42
84.00	3.44	2.68	¦	3.64	3.18
86.00	3.38	2.54	¦	3.61	2.94
88.00	3.28	2.31	¦	3.56	2.65
90.00	3.24	2.29	¦	3.53	2.59
92.00	3.21	2.16	¦	3.50	2.52
94.00	3.24	2.21	¦	3.51	2.63
96.00	3.28	2.39	¦	3.52	2.79
98.00	3.32	2.37	¦	3.54	2.99
100.00	3.31	2.13	¦	3.52	2.98
102.00	3.44	2.66	¦	3.44	2.66
104.00	3.63	5.82	¦	3.47	3.04
106.00	3.63	5.82	¦	3.48	3.04
108.00	3.63	4.92	¦	3.45	2.71
110.00	3.67	10.28	¦	3.56	4.66
112.00	3.67	12.42	¦	3.58	5.38
114.00	3.59	5.26	¦	3.59	5.26
116.00	3.57	3.78	¦	3.57	3.78
118.00	3.54	3.07	¦	3.54	3.07
120.00	3.51	2.79	¦	3.51	2.79
120.50	3.49	2.64	¦	3.49	2.64
122.00	3.50	2.76	¦	3.50	2.76
122.65	3.51	2.72	¦	3.51	2.72
123.55	2.96	7.89	¦	2.96	7.89
124.00	2.98	8.02	¦	2.98	8.02

TOEDOWN DEPTH

SALT RIVER CHANNELIZATION

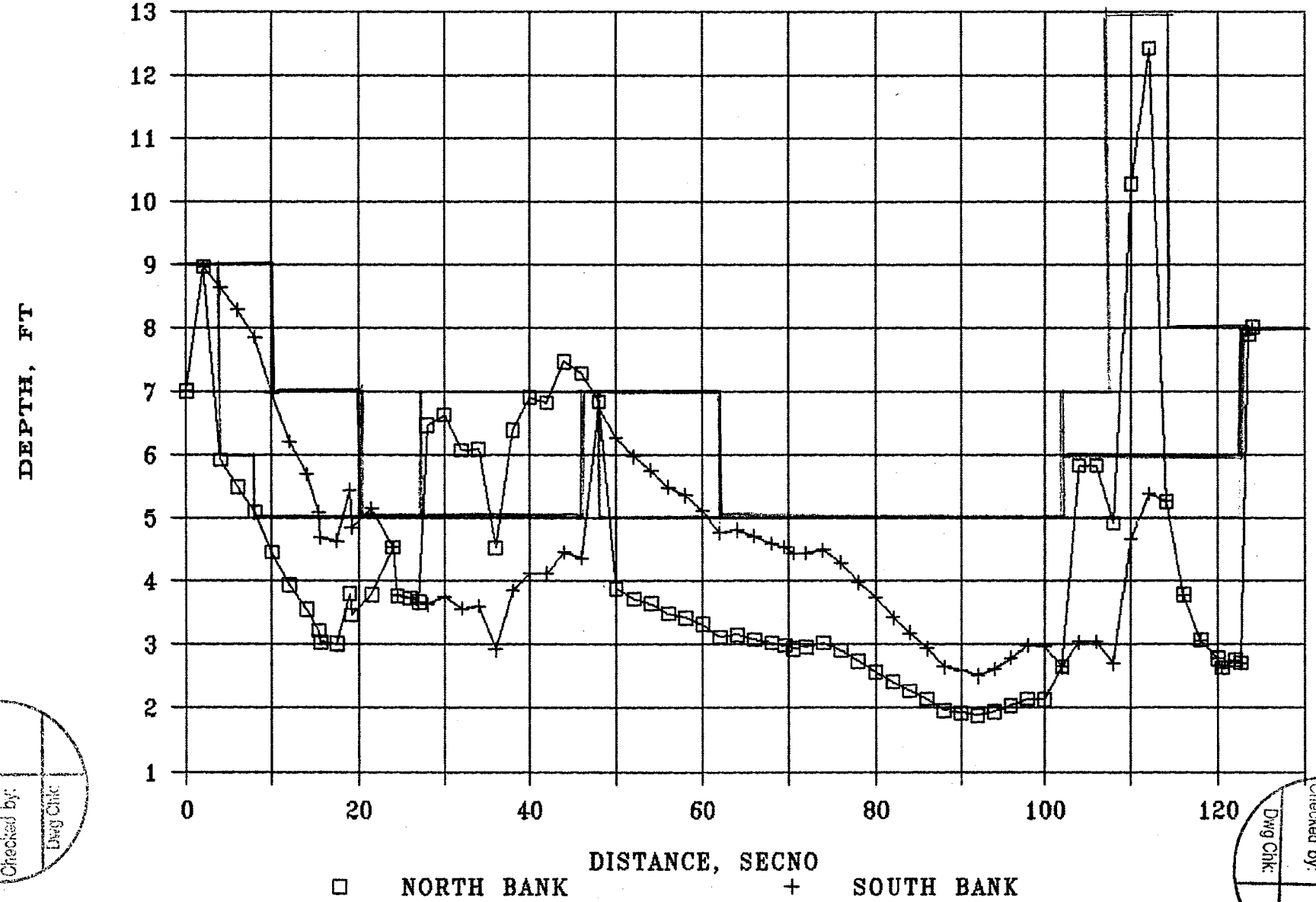


Job: 12101
Calc by: GPC
Date: 7/28/90
Checked by: JFM
Date: 7/30/90
Dwg Chk:

3/3

TOEDOWN DEPTH

SALT RIVER CHANNELIZATION



Job:
Date
Calc by:
Checked by:
Dwg Chk:

Job:
Date
Calc by:
Checked by:
Dwg Chk:

4. General Scour Analysis

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____ JFM 4/27/90

Maximum Boundary Shear Computation
One-dimensional Hydraulics Summary

Q = 215,000 cfs

Rch	Vel Max	Vel Min	Vel Ave	Max Shear	Max Fr	Ave Width
GC3-GC4	14.1	11.6	12.8	2.75	0.62	942
GC4-Mill	11.6	9.4	10.4	1.73	0.49	1192
Mill-Rural	11.7	9.4	10.5	1.62	0.47	1004
Rural-IBW	10.8	8.1	9.2	1.47	0.42	1098
IBW-McCl	11.9	10.4	10.9	1.84	0.48	1037

Q = 250,000 cfs

Rch	Vel Max	Vel Min	Vel Ave	Max Shear	Max Fr	Ave Width
GC3-GC4	14.9	12.3	13.6	3.00	0.62	951
GC4-Mill	12.3	9.6	10.8	1.89	0.49	1216
Mill-Rural	11.7	9.7	10.6	1.56	0.44	1038
Rural-IBW	11.2	8.4	9.6	1.51	0.42	1119
IBW-McCl	12.3	10.8	11.3	1.88	0.48	1063

Reach Description

GC3-GC4: Grade Control No 3 to No 4
Sections 20+82 to 248+00
Length 4018, 22 sections

GC4-Mill: Grade Control No 4 to U/S Mill Ave bridge
Sections 0 to 24; Length 2244; 15 Sections

Mill-Rural: Mill Ave bridge to Rural Rd bridge
Sections 24+58 to 72+00; Length 4957; 26 Secs

Rural-IBW: Rural Rd bridge to Indian Band Wash
Sections 74+00 to 100+00; Length 2569; 14 Secs

IBW-McCl: Sections 100+00 to 124+00; Length 2786; 15 Secs

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress JFM 27 April 90

Continued...

Q = 215,000 cfs

Rch	Bend	Rc	TW	Depth	Rc/TW	TW/d
GC3-GC4	No	-	942	21.2	-	44.4
GC4-Mill	No	-	1192	23.0	-	51.8
Mill-Rural	Yes	6000	1004	24.7	6.0	40.6
Rural-IBW	Yes	5030	1098	24.5	4.6	44.8
IBW-McCl	Yes	5000	1037	21.5	4.8	48.2

Q = 250,000 cfs

Rch	Bend	Rc	TW	Depth	Rc/W	TW/d
GC3-GC4	No	-	951	23.0	-	41.3
GC4-Mill	No	-	1216	25.7	-	47.3
Mill-Rural	Yes	6000	1038	27.5	5.8	37.7
Rural-IBW	Yes	5030	1119	27.0	4.5	41.4
IBW-McCl	Yes	5000	1063	24.0	4.7	44.3

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress JFM 4/27/00

Maximum Boundary Shear Stress Factors

Condition	Factor	Equation/Chart
Max Bed	K_b	Chart 9
Max Bank	K_{ss}	Chart 12
Max Bend	K_r	Chart 14
High Froude	F_{sf}	Chart 13
Impingement	K_i	$K_i = 1 + \sin\theta$; $\theta = \measuredangle$ of impinge

Q = 215,000 cfs

Rch	K_b	K_{ss}	K_r	F_{sf}	K_i	
GC3-GC4	1.07	0.91	1.0	0.87	1.0	
GC4-Mill	1.07	0.91	1.0	0.84	1.0	
Mill-Rural	1.08	0.92	1.29	0.84	1.0	
Rural-IBW	1.07	0.91	1.47	0.83	1.0	
IBW West Bank	1.07	0.91	1.0	0.83	1.50	$\theta = 30°$
IBW-McCl	1.06	0.90	1.44	0.84	1.0	

Q = 250,000 cfs

Rch	K_b	K_{ss}	K_r	F_{sf}	K_i	
GC3-GC4	1.08	0.92	1.0	0.87	1.0	
GC4-Mill	1.07	0.91	1.0	0.84	1.0	
Mill-Rural	1.08	0.92	1.31	0.83	1.0	
Rural-IBW	1.07	0.91	1.49	0.83	1.0	
IBW-West Bank	1.07	0.91	1.0	0.83	1.50	$\theta = 30°$
IBW-McCl	1.07	0.91	1.46	0.84	1.0	

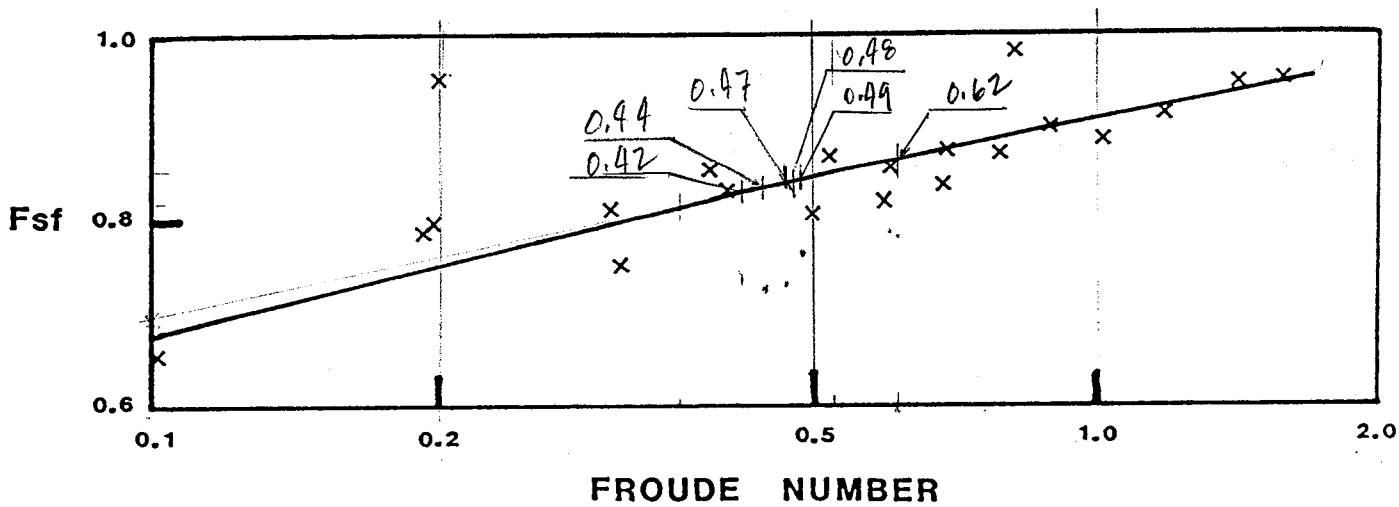


Chart 13. Coefficient for Effect of Froude Number on Boundary Shear Stress Adjustment Factor on Channel Side-Slope (Distribution of Shear in Rectangular Channels, Davidian, Cahal)

CRSS

CRS SIRRINE

DESIGN SHEET

Job Rio Salado Channel
Structure
Live Load Per Square Foot

Job No. R101N Date 12/15/89
Computed By GKC
Working Stress FM 12/20/89

Maximum Bed Scour

$$d_s = y_a \left(1/\Delta p - 1 \right)$$

$$y_a = 2 \cdot D_a$$

$$D_a = \tau_{max} / 4.83$$

where $4.83 = 0.047(\gamma_s - \gamma)$
τ_{max} = max boundary shear, lb/ft²
D_a = armor size, ft
Δp = fraction larger than armor size

Q = 215,000

Reach	τ_{max}	D_a	% Pass	y_a	Δp	d_s
GC3-GC4	2.94	0.61	92.0	1.22	0.080	14.4
GC4-Mill	1.85	0.38	83.0	0.76	0.170	3.7
Mill-Rural	2.26	0.47	87.0	0.94	0.130	6.3 ✓
Rural-IBW	2.31	0.48	87.4	0.96	0.126	6.7 ✓
IBW-McC1	2.81	0.58	91.1	1.16	0.089	11.9 ✓

Q = 250,000

Reach	τ_{max}	D_a	% Pass	y_a	Δp	d_s
GC3-GC4	3.24	0.67	93.8	1.34	0.062	20.3 ✓
GC4-Mill	2.02	0.42	84.9	0.84	0.151	4.7
Mill-Rural	2.21	0.46	86.6	0.92	0.134	6.0
Rural-IBW	2.38	0.49	88.0	0.98	0.120	7.2
IBW-McC1	2.87	0.59	91.5	1.18	0.085	12.7

5. Local Scour Analysis

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

Comparison of Scour and Foundation Elevations at Mill Ave Bridge
Maximum Scour

General:	3.6	
Local:	33.1	Abutment Pier
	26.2	Intermediate Pier

Foundation Elevations:

		Theoretical Scour	Max Scour
South Abut	1114.80	–	–
Pier #2	1117.00	–	–
#3	1119.00	–	–
#4 (Abut)	1120.90	1095.0	1123.9 (R)
#5	1120.75	1101.9	1123.8 (R)
#6	1120.30	1101.9	1123.3 (R)
#7	1119.30	1101.9	1122.3 (R)
#8 (Abut)	1118.60	1095.0	1121.6 (R)
#9	1088.00	1101.9	1101.9
#10	1116.40	–	–
North Abut	1134.04	–	–

* Mill Ave Bridge Plans require piers to extend into solid rock 3 ft as minimum.

* Computed scour depths are greater than foundation depth for all piers except #9.

(R) Bed rock limits scour depth

– Indicates that channelization will place pier out of floodway

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado Channel
Structure:
Live Load Per Square Foot:

Job No. 12101N Date 12/21/89
Computed By GKC
Working Stress JFM 12/20/89

Local Scour Analysis - Q = 215,000

Location	Flow Depth	Vel	Pier Size	Pier Shape	∡ Attack
SPRR	22.2	9.4	8	Circ	0°
Rural	24.7	9.6	6	Circ	0°
McClintock	20.9	10.5	6	Circ	0°
Mill Ave (A)	23.9	9.9	15×62	Wall	15°
Mill Ave (I)	23.9	9.9	9.5×45	Wall	15°

Debris: Scrubs & landfill debris
Characteristic size ~ 10'

Velocity distribution: For channelized conditions the velocity correction factor is ≈ 1.1. 2-D model indicates max vel about 10% higher than average velocity.

Pier Scour equations used:

1. CSU
2. Laursen
3. Froehlich
4. Jain & Fisher

CSU Eq.: $d_s/y = 2.0 K_1 K_2 (b/y)^{0.65} F_r^{0.43}$

Laursen Eq: $b/y = 5.5 (d_s/y)\left[(d_s/11.5/y + 1)^{1.7} - 1\right]$

Froehlich Eq: $d_s/b = 0.32 \phi (b'/b)^{0.62} (y/b)^{0.46} F_r^{0.20} (b/D)^{0.08} + 1$

Jain & Fisher Eq: $d_s/b = 1.86 (y/b)^{0.5} (F_r - F_{rc})^{0.25}$

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado Channel
Structure:
Live Load Per Square Foot:

Job No.: R101N Date: 12/21/89
Computed By: GKC
Working Stress: JFM 12/20/89

CSU Eq.

Location	b	d_h	F_r	K_1	K_2	d_s
SPRR	8.0	16.8	0.40	1.0	1.0	15.4
Rural	6.0	22.3	0.36	1.0	1.0	12.7
McClintock	6.0	18.9	0.43	1.0	1.0	12.9
Mill (A)	15.0	19.8	0.39	1.0	1.5	33.1
Mill (I)	9.5	19.8	0.39	1.0	1.6	26.2

Laursen Eq:

Location	b	y	K_s	K_α	d_s
SPRR	8.0	22.2	~~0.9~~	~~1.0~~	14.7
Rural	6.0	24.7	0.9	1.0	13.4
McClintock	6.0	20.9	~~0.9~~	~~1.0~~	12.3

Froehlich Eq.

Location	b	b'	y	φ	F_r	D	d_s
SPRR	8.0	8.0	22.2	1.0	0.40	0.033	13.3
Rural	6.0	6.0	24.7	1.0	0.36	0.033	10.6
McClintock	6.0	6.0	20.9	1.0	0.43	0.033	10.4

$b' = b\cos\alpha + L\sin\alpha$; L = pier length

$D = 10\text{ mm} = 10/304.8 = 0.033'$

φ : shape factor - 1.3 square
1.0 circular

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado Channel
Structure:
Live Load Per Square Foot:

Job No.: R101N Date: 12/21/89
Computed By: GRC
Working Stress: JFM 12/20/89

Jain & Fisher Eq:

Location	b	y	Fr	Frc	ds
SPRR	8.0	22.2	0.40	0.21	16.4
Rural	6.0	24.7	0.36	0.20	14.3
McClintock	6.0	20.9	0.43	0.22	14.1

$$Fr_c = \frac{V_c}{\sqrt{gy}} \qquad \tau = \gamma y S$$

$$V = \frac{1.49}{n} y^{2/3} S^{1/2} = \frac{1.49}{\sqrt{\gamma n}} y^{1/6} \tau^{1/2}$$

$$n = 0.0395 D^{1/6}$$

$$V_c = \frac{1.49}{0.0395} \left(\frac{y}{D}\right)^{1/6} \left(\frac{\tau_c}{\gamma}\right)^{1/2}$$

$$Fr_c = \frac{1.49}{0.0395} \frac{1}{\sqrt{gy}} \left(\frac{y}{D}\right)^{1/6} \left(\frac{\tau_c}{\gamma}\right)^{1/2} = 1.85 \left(\frac{D}{y}\right)^{1/3}$$

$$\tau_c = 4.83 * D$$

Summary of Pier Scour Equations - No Debris

Location	CSU	Laursen	Froehlich	Jain+Fisher
SPRR	15.4	14.7	13.3	16.4
Rural	12.7	13.4	10.6	14.3
McClintock	12.9	12.3	10.4	14.1

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

JFM 4/27/90

Effect of Debris

Location	b"	d_s''/d_s CSU	Laursen	Froelich	Jain/Fish
SPRR	10	1.16	1.12	1.21	1.12
Rural	10	1.39	1.28	1.53	1.29
McClintock	10	1.39	1.29	1.54	1.29

b" pier width with debris

Dimensionless form:

CSU:

$$\frac{d_s''}{d_s} = \left(\frac{b''}{b}\right)^{0.65}$$

Laursen:

$$\frac{b''}{b} = \frac{d_s''}{d_s}\,\frac{[(d_s''/11.5/y)^{1.7} - 1]}{[(d_s/11.5/y)^{1.7} - 1]}$$

Froelich:

$$\frac{d_s''/b'' - 1}{d_s/b - 1} = \left(\frac{b}{b''}\right)^{0.7}$$

Jain & Fisher:

$$\frac{d_s''}{d_s} = \left(\frac{b''}{b}\right)^{0.5}$$

CRSS

CRS SIRRINE

DESIGN SHEET

Job Rio Salado
Structure
Live Load Per Square Foot

Job No. R101N Date 7/24/90
Computed By
Working Stress
JFM 7/30/90

Comparison of Local Scour Elevations to Foundation Elevations at Bridges:

Foundation Elevations:

Mill Ave:

Location	Found. Elev	Rock (yes/no)	Pier Width
So. Abut	1114.8	yes*	—
Pier #2	1117.0	↓	9.5
#3	1119.0		9.5
#4 (Abut Type)	1120.9		15.0
#5	1120.8		9.5
#6	1120.3		9.5
#7	1119.3		9.5
#8 (Abut Type)	1118.6		15.0
#9	1088.0		9.5
#10	1116.4		9.5
No. Abut	1134.0		—

* 3' excav. into rock typical.

SPRR Salt River Bridge:

Location	Found. Elev.	Pier Diam.	Rock (yes/no)	Depth of Piles below Cyl.
Pier #1	1133.4/25.4*	5.0	no	10 to 16
#2	1133.4/23.4*	7.0	no	10 to 17
#3	1133.4/25.4	8.0	no	8 to 14
#4	1128.2/21.2	8.0	yes **	8 to 13
#5	1128.1/17.1	8.0	yes **	8 to 13
#6	1124.1	8.0	yes	—
#7	1119.6	8.0	yes	—
#8	1115.6	8.0	yes	—
#9	1121.2	7.0	yes	—
#10	1126.9	5.0	yes	—

* end of caison/max pile tip

** pile tips only on rock

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

JFM 7/30/90

Rural Rd:

Location	Bott. of Col.	Pier Diam	Bott of Taper
So Abut	1100.0	—	—
Pier # 1	1085.0	5.0	1140.0
2	1085.0	5.0	1140.0
3	1085.0	5.0	1140.0
4	1085.0	5.0	1140.0
5	1085.0	5.0	1140.0
6	1085.0	5.0	1140.0
7	1085.0	5.0	1140.0
8	1085.0	5.0	1140.0
9	1085.0	5.0	1140.0
10	1085.0	5.0	1140.0
No Abut	1100.0	—	

McClintock Drive:

Location	Bott. of Col.	Pier Diam.
So Abut	1055.0	-
Pier # 2	1042.0	6.0
3	↓	↓
4		
5		
6		
7		
8		
9		
10		
No Abut	1055.0	—

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

JFM 7/30/90

Channel Invert Elevations:

Location	So. Levee Sta.	Invert Elev.	HEC-2 SEC NO
SPRR	415+60	1131.0	15.60
Mill	424+50	1132.0	24.50
Rural	470+30	1136.7	70.50
McClin	522+65	1142.2	122.65

Typical Debris Size:

Use 3* Pier Diam

Local Scour Equation:

CSU Eq: $d_s/y = 2.0\, K_1 K_2 (b/y)^{0.65} F_r^{0.43}$

where b is the pier diameter + debris
y is flow depth at pier
K_1 is pier shape factor
K_2 is a pier skew factor
F_r is the approach flow Froude number, where

$$F_r = \frac{V}{\sqrt{g d_h}}$$

where $d_h = A/T$ $\quad \frac{A}{T}$ = area / topwidth

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

JFM 7/30/90

For Q = 215,000 cfs

Location	b	A	T	d_h	V	F_r
SPRR	24.0	20148	1346	15.0	10.7	0.49
Mill (Abut)	45.0	19715	1086	18.2	10.9	0.45
Mill (Int)	28.5	"	"	"	"	"
Rural	15.0	21992	1062	20.7	9.8	0.38
McClintock	18.0	23011	1073	21.5	9.3	0.35

WSEL	y	b/y	K_1	K_2	d_s/y
1153.6	22.6	1.06	1.0	1.0	1.53
1155.8	23.8	1.89	1.0	1.5	3.22
1155.8	23.8	1.20	1.0	1.6	2.56
1161.8	25.1	0.60	1.0	1.0	0.95
1166.8	24.6	0.73	1.0	1.0	1.04

d_s	Rock Depth	Armor Depth	½ Bed Form Height
34.6	10'-25'	3.0	1.6
76.6	11'to44'	2.0	1.7
60.9	11'to44'	2.0	1.7
23.9	n/a	2.6	1.9
25.6	n/a	1.0	1.8

Total Scour	Scour Elev	Unexposed Found.	
10-25'	varies	0.	(To be secured)
11-44'	"	0.	(Anchored to bedrock)
11-44'	"	0.	
27.8	1108.3	23.3	(Needs protection)
28.4	1113.8	71.8	

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

JFM 7/30/90

Q = 250,000 cfs

Location	b	A	T	d_h	V	F_r
SPRR	24.0	22756	1358	16.8	11.0	0.47
Mill: Abut	45.0	22856	1103	20.7	10.9	0.42
Int	28.5	"	"	"	"	"
Rural:	15.0	24636	1076	22.9	10.2	0.38
McClintock	18.0	25622	1086	23.6	9.8	0.36

WSEl	y	b/y	K_1	K_2	d_s/y
1155.5	24.5	0.98	1.0	1.0	1.43
1158.7	26.7	1.69	1.0	1.5	2.91
"	"	1.07	1.0	1.6	2.30
1164.2	27.5	0.55	1.0	1.0	0.89
1169.2	27.0	0.67	1.0	1.0	0.98

d_s	Rock Depth	Armor Depth	½ Bed Form Height
35.0	10-25'	2.5	1.9
77.7	11-44'	1.3	2.0
61.4	11-44'	1.3	2.0
24.5	n/a	2.0	2.1
26.5	n/a	0.8	1.9

Total Scour	Scour Elev	Unexposed Found.	
10-25'	varies	0.	(To be secured)
11-44'	"	0.	(Anchored to
11-44'	"	0.	bed rock)
28.6	1107.5	22.5	(Needs protect)
29.2	1113.0	71.0	

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

Note on Rural Road Bridge Pier Protection:

1. It is unlikely that the bridge foundation was initially designed to withstand 28 feet of scour.

2. The channelization will lower the channel invert from 1144.0 to 1136.7 or 7.3 feet. This is on the order of the predicted general scour for the reach. Therefore the total scour for existing and new conditions is unchanged.

3. Embedment of 22' to 23' below the maximum scour depth is not adequate.

4. Using the following alternative scour computation $b_{max} = 10$ ft, $V_{max} = 1.3\ V_a$ gives 86% of the local scour depth compared to $b_{max} = 3b$ approach. The difference is minor.

CRSS

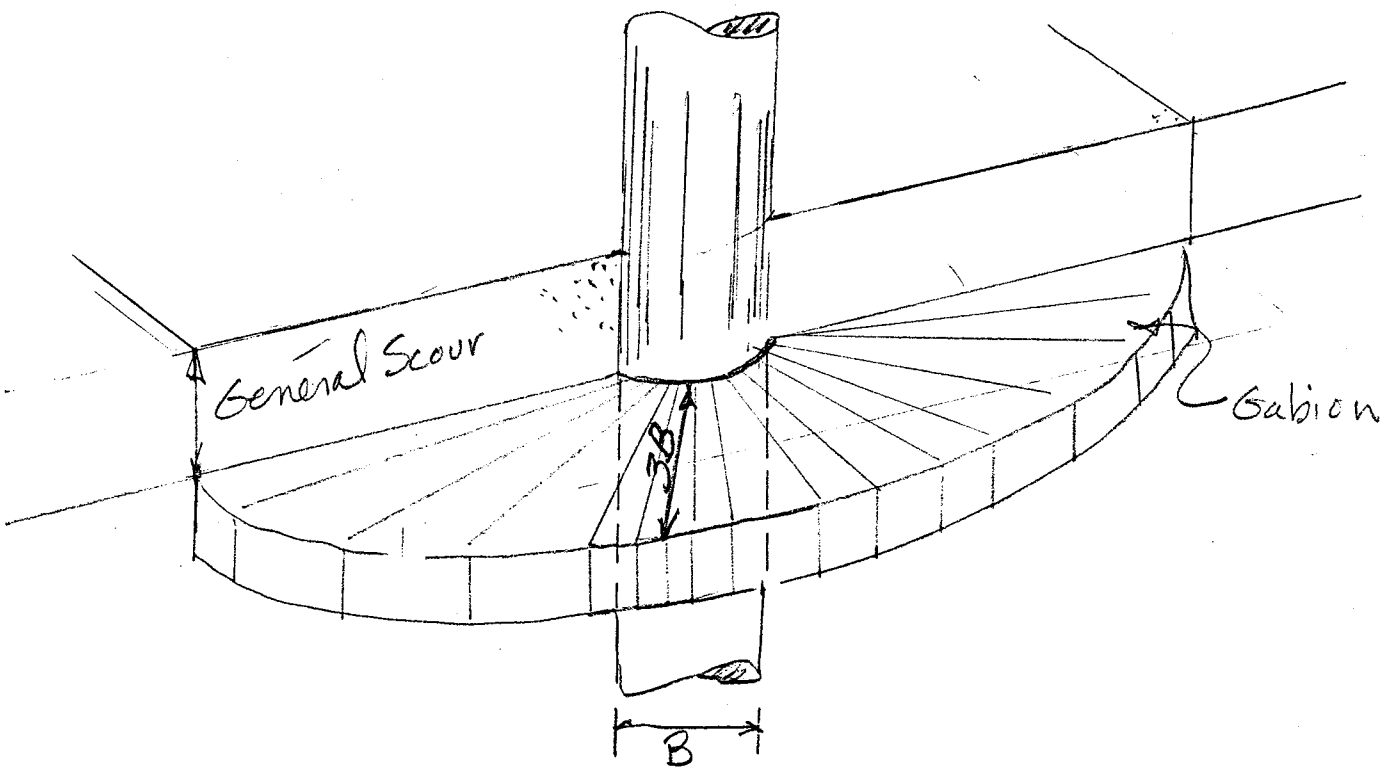
CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____

5. Protection of the piers at the general scour depth would provide 24.5 of additional embedment.

6. Pier protection method:



7. This replaces existing pier protection system at elevation 1140.0. New protection will be at elevation 1132.6, 7.4 feet lower than existing.

8. The commensurate reduction in skin friction on the column is 13%.

6. Bank Protection Design

① The mean bed shear at the Rural Bridge is 1.13 psf. (See MESA215.WK1). Within 1000 ft upstream and downstream of the bridge the mean shear varies from 1.00 to 1.19 psf. To account for an adverse increase in mean shear at the bridge the highest mean shear of 1.19 psf will be used.

② The max bed shear correction factor,

$$K_b = 1.06$$

③ The correction factor for accelerated flow at a bridge pier,

$$K_p = 4.0 \qquad \text{(ADOT, page 22)}$$

④ Max shear acting on bed at pier (So bank)

$$\tau_{max} = K_b K_r K_p \tau_o$$

$$= 1.06 \times 1.35 \times 4.0 \times 1.19$$

$$= 6.8 \text{ psf}$$

⑥ The design shear stress

$$\tau_d = C_a \tau_c$$

for horizontal bed $C_a = 1/SF$

$$\tau_c = 4.83 D_{50}$$

for $SF = 1.5$

$$\tau_d = 3.22 D_{50}$$

(7) Mean Riprap size or Gabion Thickness

$$T_G = \tau_{max}/3.22$$

$$T_G = 6.8/3.22$$

$$T_G = 2.1'$$

(8) Mean stone size for gabion fill

$$D_{50}^{G} = D_{50}^{S}/2.13$$

$$= 1.0'$$

(9) Recommendation 24" Gabion mattress on gravel bedding, for south bank

Fill Gradation: $D_{max} = 24''$

$D_{min} = 3''$

$D_{50} = 1.0$

(10) For north bank $K_r = 1.0$

- Thickness and stone size reduce proportionately

$$T_G = (1/1.35)\,2.1$$

$$= 1.56'$$

$$D_{50G} = (1/1.35)\,1.0$$

$$= 0.74'$$

For northbank use

18" Gabion mattress

$D_{50} = 9''$

Filter Gradation Design Procedure

1. Compare Riprap to bank material
2. If riprap cannot adequately perform as a filter then select a gravel filter or fabric filter.

Step One – Gabions

a. Assume levee embankment material is the same gradation as alluvial material

D85 (levee) = 92 mm
D50 (levee) = 11 mm
D15 (levee) = 0.42 mm

Note: This is based on the envelope gradation for the Salt River.

b. Assume gabion fill is composed of the coarse fraction (3"+) of the alluvial material.

For D50 (riprap) = 134 mm (5.3")
D85 (riprap) = 219 mm
D15 (riprap) = 89 mm

c. The filter gradation criteria are:

i. $\frac{D50\,(riprap)}{D50\,(bank)} < 40 \qquad \frac{134}{11} = 12.2$ OK

ii. $5 < \frac{D15\,(riprap)}{D15\,(bank)} < 40 \qquad \frac{89}{0.42} = 212$ NG

iii. $\frac{D15\,(riprap)}{D85\,(bank)} < 5 \qquad \frac{89}{92} = 1.0$ OK

Step One - Riprap

a. Same as gabions

b. Assume 9" stone is derived from the coarse fraction of the alluvial material.

D50 (riprap) = 230 mm (9" stone)
D85 (riprap) = 430 mm
D15 (riprap) = 115 mm

c. The filter gradation criteria are:

i. $\frac{D50\,(riprap)}{D50\,(bank)} < 40 \quad \frac{230}{11} = 20.9$ OK

ii. $5 < \frac{D15\,(riprap)}{D15\,(bank)} < 40 \quad \frac{115}{0.42} = 274$ NG

iii. $\frac{D15\,(riprap)}{D85\,(bank)} < 5 \quad \frac{115}{92} = 1.3$ OK

Step One - Results

The riprap or gabion stone gradation is not adequate to retain the fine fraction of the bed material. A gravel or fabric filter needs to be provided. The D15 (filter) must be less than 17 mm. and greater than 2 mm. A logical choice for a filter then is a standard subbase material such as an ADOT class 4 or 5 aggregate subbase.

3"	100%
¼"	30-75%
#200	0-10%

Step Two - Filter (Class 4 or 5 ADOT Subbase)

a. Assume levee embankment is the same gradation as alluvial material (see gabion calc)

b. Gradation for filter

D50 (filter) = 6.3 mm
D15 (filter) = 3.2 mm
D85 (filter) = 12.6 mm

c. Comparing to gradation criteria

i. $\frac{D50(\text{filter})}{D50(\text{bank})} < 40$ $\quad \frac{6.3}{11.0} = 0.57$ OK

$\frac{D50(\text{riprap})}{D50(\text{filter})} < 40$ $\quad \frac{230}{6.3} = 36.5$ OK

ii. $5 < \frac{D15(\text{filter})}{D15(\text{bank})} < 40$ $\quad \frac{3.2}{0.42} = 7.6$ OK

$5 < \frac{D15(\text{riprap})}{D15(\text{filter})} < 40$ $\quad \frac{89}{3.2} = 27.8$ OK

iii. $\frac{D15(\text{filter})}{D85(\text{bank})} < 5$ $\quad \frac{3.2}{92} = 0.03$ OK

$\frac{D15(\text{riprap})}{D85(\text{filter})} < 5$ $\quad \frac{115}{12.6} = 9.1$ NG

Step Two - Result

Works in all cases except gradation needs to be coarser than type subbase

Step Two – Filter (Special Gradation)

a. See previous trial

b. Gradation

D50 (filter) = 12.5 mm
D85 (filter) = 25 mm
D15 (filter) = 6.3 mm

c. Compare to gradation criteria:

i. $\frac{D50\,(filter)}{D50\,(bank)} < 40$ $\quad \frac{12.5}{11.0} = 1.1$ OK

$\frac{D50\,(riprap)}{D50\,(filter)} < 40$ $\quad \frac{230}{12.5} = 18.4$ OK

ii. $5 < \frac{D15\,(filter)}{D15\,(bank)} < 40$ $\quad \frac{6.3}{0.42} = 15.0$ OK

$5 < \frac{D15\,(riprap)}{D15\,(filter)} < 40$ $\quad \frac{89}{6.3} = 14.1$ OK

iii. $\frac{D15\,(filter)}{D85\,(bank)} < 5$ $\quad \frac{6.3}{92} = 0.07$ OK

$\frac{D15\,(riprap)}{D85\,(filter)} < 5$ $\quad \frac{115}{25} = 4.6$ OK

Step Two – Result

A course aggregate filter with a D50 of ½" with not more than 15% passing the ¼" sieve size.

CRS SIRRINE	PROJECT: Ri Salado	JOB NO.: R101N	NO. 5
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 7/24/90	OF 5
	SUBJECT: Filter	CHECKED BY: JFM / DATE: 7/30/90	

Alternative Filter Design: Filter Fabric

Task Force No 25 recommends the following criteria for filter fabric design. (see HEC-15, FHWA-IP-87-7, page 20).

1. The fabric must be able to transmit water faster than the soil.
2. The following criteria for the apparent opening size (AOS) must be met:
   a. For soil with less than 50 percent of the particles by weight passing a U.S. No. 200 sieve, AOS < 0.6 mm (0.024 in) (greater than #30 U.S. Std. Sieve).
   b. For soil with more than 50 percent of the particles by weight passing a U.S. No. 200 sieve, AOS < 0.297 mm (0.012 in) (greater that #50 U.S. Std. Sieve).

Criteria 1 and 2a will control
Soil permeability is estimated to be 5.2×10^{-2} cm/s for coarse sand.

Cost Analysis

Cost Comparison
Filter Fabric $3.00 sq yd
Gravel Bedding $14.00 sq. yd.
(Use 1.0 ft bedding thickness for riprap or rock, so 1 cu yd provides 3 sq yds.
Gravel Bedding $12.00 cu. yd.)

Use filter fabric.

CRSS

CRS SIRRINE

DESIGN SHEET

Job: Rio Salado Channel
Structure:
Live Load Per Square Foot:

Job No.: R101N
Computed By: GKC
Working Stress: JFM 12/20/89
Date: 12/18/89

Bank Protection

Riprap Sizing:

Type: Very rounded stone: Angle of repose from Chart 12, HEC-15

Side Slope: 3:1 ($A_z = 18.4°$)

Oblique flow of 30° at west bank of IBW

Design Safety factor = 1.3 (250,000 cfs)
1.5 (215,000 cfs)

$\tau_d = C_a \tau_c$

$\tau_c = 4.83 D_{50}$ (specific gravity = 2.65)

$C_a = (1/SF)\, C_\ell\, C_z\, (1 - C_r C_b SF)$

$C_r = \tan(A_z)/\tan(A_r)$

Stone	A_r	C_r
8"	39°	0.41
12"	39.5°	0.40
18"	39.9°	0.40

$C_z = \cos(A_z) = 0.95$

$C_b = \cos(\tan^{-1}(1/E))$

$E = 2(\tau_c/\tau)\, C_z\, C_r$

for $C_r = 0.41$ then

$E = 3.76\,(D_{50}/\tau)$

$C_\ell = 2/(1 + \sin(\tan^{-1}(1/E)))$

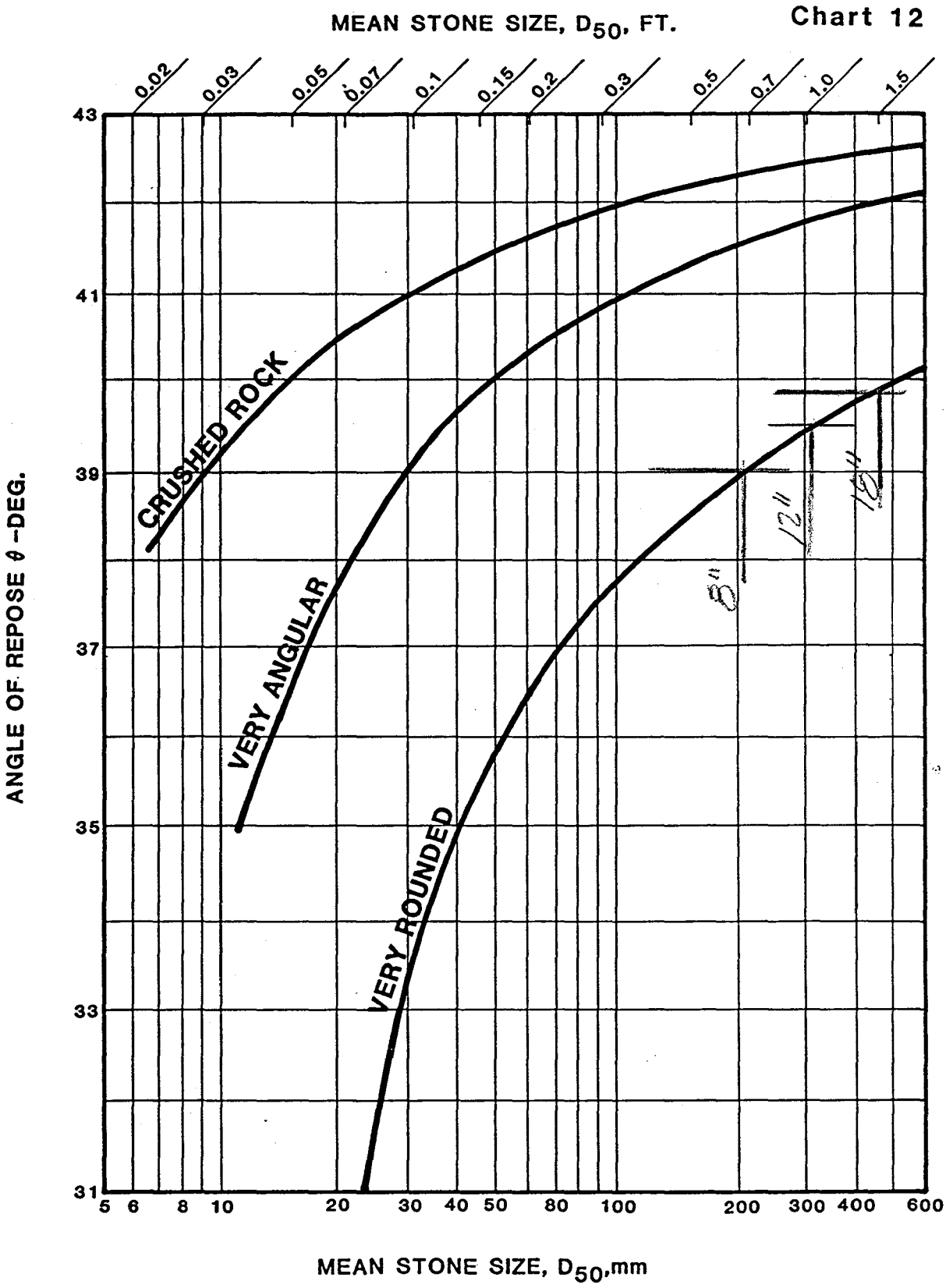


Chart 12. Angle of repose of riprap in terms of mean size and shape of stone.

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress JFM 4/27/90

For $C_r = 0.41$; $C_z = 0.95$ and $SF = 1.5$

$$C_a = 1.27/(1+\sin(\tan^{-1}(1/E))) * (1 - 0.62\cos(\tan^{-1}(1/E)))$$

For $C_r = 0.41$; $C_z = 0.95$ and $SF = 1.3$

$$C_a = 1.46/(1+\sin(\tan^{-1}(1/E))) * (1 - 0.53\cos(\tan^{-1}(1/E)))$$

$Q = 215{,}000$ cfs ; $SF = 1.5$

Location	τ_{max}	D_{50}	E	C_a	τ_c	τ_d
North Bank:						
GC4 - Mill	1.57	9"	1.80	0.46	3.62	1.67
Mill - Rural	1.92	12"	1.96	0.46	4.83	2.22
Rural - IBW	1.34	9"	2.10	0.46	3.62	1.67
IBW W. Bank	2.01	12"	1.87	0.46	4.83	2.22
IBW - MCCI	2.38	12"	1.58	0.46	4.83	2.22
South Bank						
GC4 - Mill	1.57	9"	1.80	0.46	3.62	1.67
Mill - Rural	1.49	9"	1.89	0.46	3.62	1.67
Rural - IBW	1.97	12"	1.91	0.46	4.83	2.22
IBW - MCCI	1.66	9"	1.70	0.46	3.62	1.67

See Attached Worksheets: BANK215.WK1
BANK250.WK1

CRSS

CRS SIRRINE

DESIGN SHEET

Job _____ Job No. _____ Date _____
Structure _____ Computed By _____
Live Load Per Square Foot _____ Working Stress _____ JFM 4/27/90

Q = 250,000

Location	τ_{max}	D_{50}	E	C_a	τ_c	τ_d
North Bank						
GC4-Mill	1.72	12"	2.19	0.45	4.83	2.17
Mill-Rural	1.88	12"	2.00	0.45	4.83	2.17
Rural-IBW	1.37	9"	2.06	0.45	3.62	1.63
IBW W.Bank	2.06	12"	1.83	0.45	4.83	2.17
IBW-MCCI	2.44	12"	1.54	0.45	4.83	2.17
South Bank						
GC4-Mill	1.72	9"	1.64	0.45	3.62	1.63
Mill-Rural	1.44	9"	1.96	0.45	3.62	1.63
Rural-IBW	2.02	12"	1.86	0.45	4.83	2.17
IBW-MCCI	1.69	9"	1.67	0.45	3.62	1.63

Use North Bank	D_{50}	Thickness
GC4-Mill	12"	3.0'
Mill-Rural	12"	3.0'
Rural-IBW	9"	2.25'
IBW W Bank	12"	3.0
IBW-MCCI	Cement Stabilized Alurium	

South Bank		
GC4-Mill	9"	2.25'
Mill-Rural	9"	2.25'
Rural-IBW	12"	3.0'
IBW-MCCI	9"	2.25'

See Attached Figure

Job: R101N
Date
Calc by: GKC 7/25/90
Checked by: JFM 7/30/90
Dwg Chk:

Levee Bank Protection Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: BANK215.WK1
DATE: 07/25/90

SECNO	To	TOPWID	HYDDEP	Kss
0.00	1.89	989.45	17.80	0.90
2.00	2.06	985.15	16.95	0.90
4.00	1.78	1054.91	16.87	0.89
6.00	1.73	1091.55	16.37	0.89
8.00	1.68	1127.24	15.95	0.89
10.00	1.58	1176.37	15.62	0.89
12.00	1.48	1228.75	15.31	0.88
14.00	1.39	1287.18	14.91	0.88
15.40	1.30	1341.97	14.64	0.88
15.60	1.24	1346.58	14.96	0.88
17.50	1.24	1347.97	14.96	0.88
19.00	1.42	1153.39	16.81	0.89
19.20	1.34	1156.34	17.31	0.89
21.50	1.41	1110.81	17.63	0.89
24.00	1.56	1080.61	17.25	0.89
24.50	1.39	1086.32	18.15	0.89
26.00	1.37	1093.44	18.08	0.89
27.00	1.36	1087.83	18.28	0.90
28.00	1.35	1082.34	18.46	0.90
30.00	1.38	1061.26	18.66	0.90
32.00	1.32	1055.11	19.27	0.90
34.00	1.33	1043.73	19.41	0.90
36.00	1.14	1071.23	20.39	0.90
38.00	1.38	1004.85	19.82	0.90
40.00	1.44	976.70	19.98	0.90
42.00	1.44	974.78	20.02	0.90
44.00	1.50	957.62	19.97	0.91
46.00	1.48	961.34	20.00	0.91
48.00	1.44	966.47	20.19	0.91
50.00	1.38	979.04	20.32	0.91
52.00	1.35	988.36	20.38	0.90
54.00	1.32	995.62	20.43	0.90
56.00	1.29	1004.94	20.48	0.90
58.00	1.27	1012.06	20.52	0.90
60.00	1.24	1021.25	20.57	0.90
62.00	1.19	1033.10	20.80	0.90
64.00	1.19	1038.43	20.61	0.90
66.00	1.18	1046.48	20.62	0.90
68.00	1.16	1053.52	20.63	0.90
69.50	1.15	1060.38	20.60	0.90
70.50	1.13	1062.11	20.71	0.90
72.00	1.14	1044.79	20.96	0.90
74.00	1.15	1024.76	21.32	0.91
76.00	1.11	1040.46	21.34	0.90
78.00	1.06	1064.37	21.40	0.90
80.00	1.00	1090.32	21.47	0.90

Job:
Date
Calc by:
Checked by: JFM 7/30/90
Dwg Chk:

2/7

82.00	0.93	1125.36	21.56	0.90
84.00	0.87	1161.42	21.62	0.90
86.00	0.80	1208.30	21.70	0.90
88.00	0.71	1247.67	22.62	0.90
90.00	0.70	1267.34	22.54	0.90
92.00	0.68	1286.79	22.55	0.90
94.00	0.71	1266.39	22.39	0.90
96.00	0.77	1228.99	22.22	0.90
98.00	0.83	1194.60	22.06	0.90
100.00	0.83	1197.38	21.99	0.90
102.00	1.05	1078.75	21.67	0.90
104.00	1.19	1055.81	20.52	0.90
106.00	1.19	1050.30	20.64	0.90
108.00	1.08	1089.40	20.91	0.90
110.00	1.55	939.47	20.47	0.91
112.00	1.66	913.08	20.37	0.91
114.00	1.64	914.42	20.43	0.91
116.00	1.37	975.51	20.88	0.91
118.00	1.18	1032.78	21.19	0.90
120.00	1.09	1067.24	21.32	0.90
120.50	1.03	1077.80	21.70	0.90
122.00	1.09	1072.15	21.31	0.90
122.65	1.07	1072.94	21.45	0.90
123.55	2.00	1056.61	16.61	0.89
124.00	2.01	1049.87	16.66	0.89

Job:
Date 3/7
Calc by:
Checked by: JPM 7/30/90
Dwg Chk:

Levee Ba
Salt Riv
Grade Co

FILE: BANK215.H
DATE: 07/25/90

FILE:
DATE: SF = 1.50

NORTH BANK:

SECND	Kr	Ai	Ki	Td	D50	E	Cb	Cl	Ca	Ta	CHCK
0.00	1.00	0.00	1.00	1.70	1.00	2.21	0.91	1.42	0.39	1.90	1.12
2.00	1.00	0.00	1.00	1.85	1.00	2.04	0.90	1.39	0.39	1.90	1.03
4.00	1.00	0.00	1.00	1.59	1.00	2.37	0.92	1.44	0.40	1.91	1.20
6.00	1.00	0.00	1.00	1.54	1.00	2.44	0.93	1.45	0.40	1.91	1.24
8.00	1.00	0.00	1.00	1.49	1.00	2.52	0.93	1.46	0.40	1.91	1.28
10.00	1.00	0.00	1.00	1.40	1.00	2.69	0.94	1.48	0.40	1.92	1.37
12.00	1.00	0.00	1.00	1.31	0.75	2.16	0.91	1.41	0.39	1.43	1.09
14.00	1.00	0.00	1.00	1.23	0.75	2.30	0.92	1.43	0.39	1.43	1.17
15.40	1.00	0.00	1.00	1.14	0.75	2.47	0.93	1.45	0.40	1.43	1.25
15.60	1.00	0.00	1.00	1.09	0.75	2.58	0.93	1.47	0.40	1.44	1.32
17.50	1.00	0.00	1.00	1.09	0.75	2.58	0.93	1.47	0.40	1.44	1.32
19.00	1.00	0.00	1.00	1.26	0.75	2.23	0.91	1.42	0.39	1.43	1.13
19.20	1.00	0.00	1.00	1.19	0.75	2.36	0.92	1.44	0.40	1.43	1.20
21.50	1.00	0.00	1.00	1.26	0.75	2.24	0.91	1.42	0.39	1.43	1.14
24.00	1.00	0.00	1.00	1.39	0.75	2.02	0.90	1.39	0.39	1.43	1.02
24.50	1.00	0.00	1.00	1.24	0.75	2.27	0.91	1.42	0.39	1.43	1.15
26.00	1.00	0.00	1.00	1.23	0.75	2.30	0.92	1.43	0.39	1.43	1.17
27.00	1.00	0.00	1.00	1.22	0.75	2.32	0.92	1.43	0.39	1.43	1.18
28.00	1.34	0.00	1.00	1.62	1.00	2.32	0.92	1.43	0.39	1.91	1.18
30.00	1.33	0.00	1.00	1.65	1.00	2.28	0.92	1.43	0.39	1.91	1.16
32.00	1.33	0.00	1.00	1.58	1.00	2.38	0.92	1.44	0.40	1.91	1.21
34.00	1.32	0.00	1.00	1.58	1.00	2.38	0.92	1.44	0.40	1.91	1.21
36.00	1.34	0.00	1.00	1.38	1.00	2.73	0.94	1.49	0.40	1.92	1.40
38.00	1.29	0.00	1.00	1.61	1.00	2.34	0.92	1.44	0.40	1.91	1.19
40.00	1.27	0.00	1.00	1.65	1.00	2.27	0.92	1.43	0.39	1.91	1.15
42.00	1.27	0.00	1.00	1.65	1.00	2.27	0.92	1.43	0.39	1.91	1.15
44.00	1.26	0.00	1.00	1.71	1.00	2.20	0.91	1.41	0.39	1.90	1.11
46.00	1.26	0.00	1.00	1.69	1.00	2.23	0.91	1.42	0.39	1.91	1.13
48.00	1.27	0.00	1.00	1.66	1.00	2.27	0.92	1.43	0.39	1.91	1.15
50.00	1.00	0.00	1.00	1.25	0.75	2.26	0.91	1.42	0.39	1.43	1.14
52.00	1.00	0.00	1.00	1.22	0.75	2.31	0.92	1.43	0.39	1.43	1.17
54.00	1.00	0.00	1.00	1.19	0.75	2.36	0.92	1.44	0.40	1.43	1.20
56.00	1.00	0.00	1.00	1.17	0.75	2.42	0.92	1.45	0.40	1.43	1.23
58.00	1.00	0.00	1.00	1.15	0.75	2.46	0.93	1.45	0.40	1.43	1.25
60.00	1.00	0.00	1.00	1.12	0.75	2.52	0.93	1.46	0.40	1.44	1.28
62.00	1.00	0.00	1.00	1.08	0.75	2.62	0.93	1.47	0.40	1.44	1.34
64.00	1.00	0.00	1.00	1.07	0.75	2.62	0.93	1.47	0.40	1.44	1.34
66.00	1.00	0.00	1.00	1.06	0.75	2.65	0.94	1.48	0.40	1.44	1.35
68.00	1.00	0.00	1.00	1.05	0.75	2.69	0.94	1.48	0.40	1.44	1.38
69.50	1.00	0.00	1.00	1.04	0.75	2.72	0.94	1.49	0.40	1.44	1.39
70.50	1.00	0.00	1.00	1.02	0.75	2.77	0.94	1.49	0.40	1.44	1.42
72.00	1.00	0.00	1.00	1.03	0.75	2.74	0.94	1.49	0.40	1.44	1.40
74.00	1.00	0.00	1.00	1.04	0.75	2.71	0.94	1.49	0.40	1.44	1.39
76.00	1.00	5.00	1.09	1.09	0.75	2.58	0.93	1.47	0.40	1.44	1.32
78.00	1.00	7.00	1.12	1.07	0.75	2.62	0.93	1.47	0.40	1.44	1.34
80.00	1.00	10.00	1.17	1.06	0.75	2.66	0.94	1.48	0.40	1.44	1.36

Job: 4/7
Date
Calc by:
Checked by: JPM 7/30/90
Dwg Chk:

82.00	1.00	13.00	1.22	1.03	0.75	2.75	0.94	1.49	0.40	1.44	1.41
84.00	1.00	13.00	1.22	0.96	0.75	2.94	0.95	1.51	0.40	1.45	1.51
86.00	1.00	16.00	1.28	0.92	0.50	2.05	0.90	1.39	0.39	0.95	1.04
88.00	1.00	18.00	1.31	0.84	0.50	2.25	0.91	1.42	0.39	0.95	1.14
90.00	1.00	20.00	1.34	0.84	0.50	2.23	0.91	1.42	0.39	0.95	1.13
92.00	1.00	17.00	1.29	0.79	0.50	2.38	0.92	1.44	0.40	0.95	1.21
94.00	1.00	15.00	1.26	0.80	0.50	2.34	0.92	1.44	0.40	0.95	1.19
96.00	1.00	16.00	1.28	0.88	0.50	2.13	0.91	1.40	0.39	0.95	1.08
98.00	1.00	9.00	1.16	0.86	0.50	2.18	0.91	1.41	0.39	0.95	1.10
100.00	1.00	0.00	1.00	0.75	0.50	2.52	0.93	1.46	0.40	0.96	1.28
102.00	1.00	0.00	1.00	0.95	0.50	1.98	0.89	1.38	0.39	0.95	1.00
104.00	1.45	0.00	1.00	1.56	1.00	2.42	0.92	1.45	0.40	1.91	1.23
106.00	1.45	0.00	1.00	1.56	1.00	2.41	0.92	1.45	0.40	1.91	1.23
108.00	1.48	0.00	1.00	1.44	1.00	2.61	0.93	1.47	0.40	1.92	1.33
110.00	1.37	0.00	1.00	1.93	1.25	2.44	0.93	1.45	0.40	2.39	1.24
112.00	1.35	0.00	1.00	2.04	1.25	2.31	0.92	1.43	0.39	2.38	1.17
114.00	1.00	0.00	1.00	1.49	1.00	2.52	0.93	1.46	0.40	1.91	1.28
116.00	1.00	0.00	1.00	1.24	0.75	2.27	0.92	1.43	0.39	1.43	1.15
118.00	1.00	0.00	1.00	1.07	0.75	2.64	0.94	1.48	0.40	1.44	1.35
120.00	1.00	0.00	1.00	0.98	0.75	2.86	0.94	1.50	0.40	1.45	1.47
120.50	1.00	0.00	1.00	0.93	0.75	3.03	0.95	1.52	0.40	1.45	1.56
122.00	1.00	0.00	1.00	0.98	0.75	2.87	0.94	1.50	0.40	1.45	1.47
122.65	1.00	0.00	1.00	0.97	0.75	2.92	0.95	1.51	0.40	1.45	1.50
123.55	1.00	0.00	1.00	1.78	1.00	2.11	0.90	1.40	0.39	1.90	1.07
124.00	1.00	0.00	1.00	1.79	1.00	2.10	0.90	1.40	0.39	1.90	1.06

Job: 5/7
Calc by: Daiel
Checked by: JPM 7/30/90
Dwg Chk:

Levee BaK1
Salt Riv
Grade Co

FILE: BANK215.W
DATE: 07/25/90

FILE:
DATE:

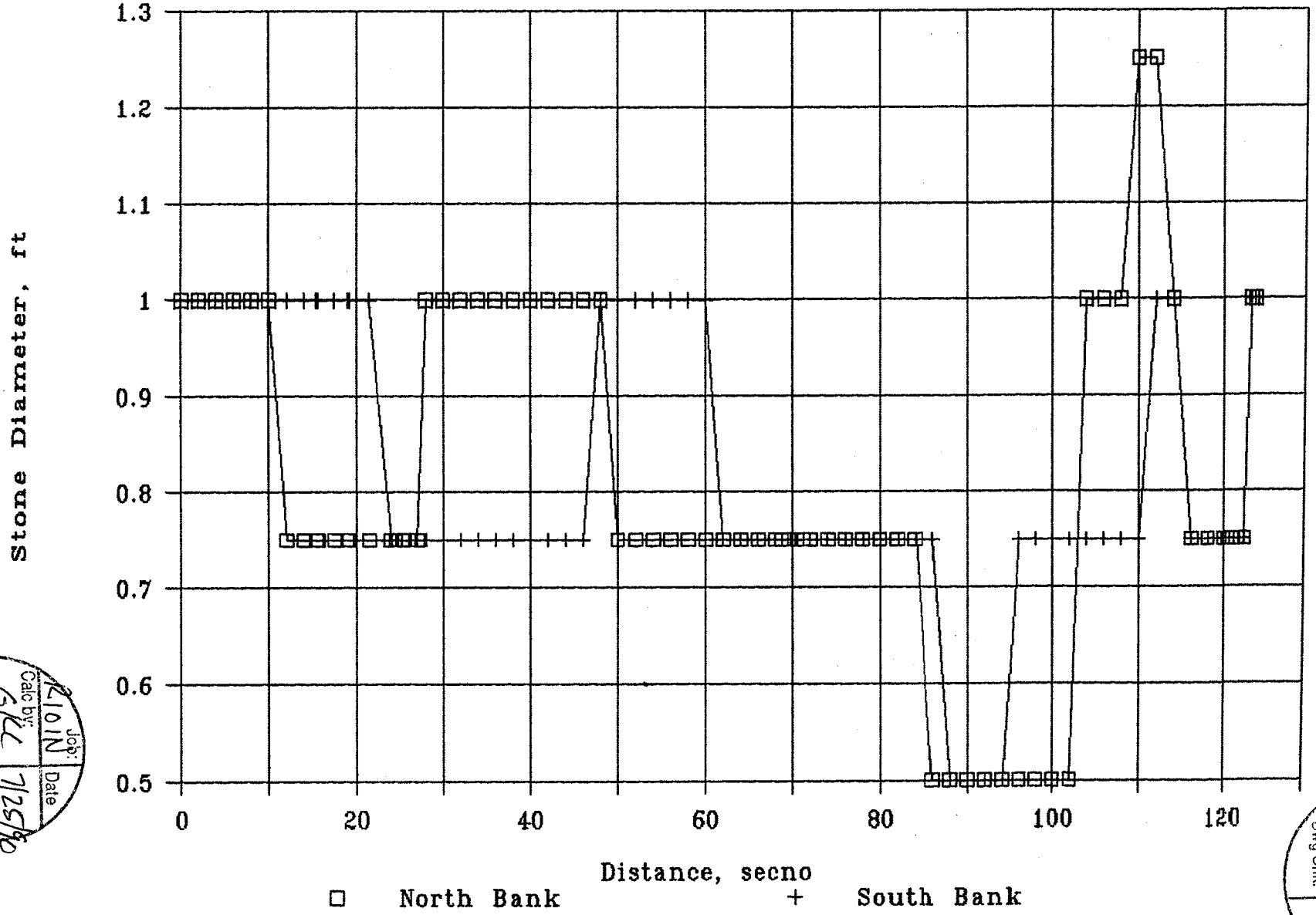
SECND	SOUTH BANK: Kr	Td	D50	E	Cb	Cl	Ca	Ta	CHCK
0.00	1.00	1.70	1.00	2.21	0.91	1.42	0.39	1.90	1.12
2.00	1.00	1.85	1.00	2.04	0.90	1.39	0.39	1.90	1.03
4.00	1.15	1.83	1.00	2.06	0.90	1.39	0.39	1.90	1.04
6.00	1.17	1.80	1.00	2.09	0.90	1.40	0.39	1.90	1.06
8.00	1.19	1.78	1.00	2.12	0.90	1.40	0.39	1.90	1.07
10.00	1.21	1.69	1.00	2.22	0.91	1.42	0.39	1.91	1.12
12.00	1.24	1.62	1.00	2.32	0.92	1.43	0.39	1.91	1.18
14.00	1.27	1.56	1.00	2.42	0.92	1.45	0.40	1.91	1.23
15.40	1.29	1.48	1.00	2.55	0.93	1.46	0.40	1.92	1.30
15.60	1.30	1.42	1.00	2.65	0.94	1.48	0.40	1.92	1.35
17.50	1.30	1.42	1.00	2.65	0.94	1.48	0.40	1.92	1.35
19.00	1.20	1.52	1.00	2.48	0.93	1.46	0.40	1.91	1.26
19.20	1.20	1.43	1.00	2.63	0.93	1.48	0.40	1.92	1.34
21.50	1.18	1.49	1.00	2.53	0.93	1.46	0.40	1.91	1.29
24.00	1.00	1.39	0.75	2.02	0.90	1.39	0.39	1.43	1.02
24.50	1.00	1.24	0.75	2.27	0.91	1.42	0.39	1.43	1.15
26.00	1.00	1.23	0.75	2.30	0.92	1.43	0.39	1.43	1.17
27.00	1.00	1.22	0.75	2.32	0.92	1.43	0.39	1.43	1.18
28.00	1.00	1.21	0.75	2.33	0.92	1.43	0.40	1.43	1.18
30.00	1.00	1.24	0.75	2.28	0.92	1.43	0.39	1.43	1.15
32.00	1.00	1.19	0.75	2.38	0.92	1.44	0.40	1.43	1.21
34.00	1.00	1.20	0.75	2.36	0.92	1.44	0.40	1.43	1.20
36.00	1.00	1.03	0.75	2.75	0.94	1.49	0.40	1.44	1.41
38.00	1.00	1.25	0.75	2.26	0.91	1.42	0.39	1.43	1.15
40.00	1.00	1.30	0.75	2.17	0.91	1.41	0.39	1.43	1.10
42.00	1.00	1.30	0.75	2.16	0.91	1.41	0.39	1.43	1.10
44.00	1.00	1.36	0.75	2.08	0.90	1.39	0.39	1.43	1.05
46.00	1.00	1.34	0.75	2.10	0.90	1.40	0.39	1.43	1.07
48.00	1.27	1.66	1.00	2.27	0.92	1.43	0.39	1.91	1.15
50.00	1.27	1.59	1.00	2.37	0.92	1.44	0.40	1.91	1.20
52.00	1.28	1.56	1.00	2.40	0.92	1.45	0.40	1.91	1.22
54.00	1.28	1.53	1.00	2.46	0.93	1.45	0.40	1.91	1.25
56.00	1.29	1.50	1.00	2.50	0.93	1.46	0.40	1.91	1.27
58.00	1.29	1.48	1.00	2.54	0.93	1.46	0.40	1.92	1.29
60.00	1.30	1.46	1.00	2.58	0.93	1.47	0.40	1.92	1.32
62.00	1.31	1.41	0.75	2.00	0.89	1.38	0.39	1.43	1.01
64.00	1.31	1.41	0.75	2.00	0.89	1.38	0.39	1.43	1.01
66.00	1.32	1.41	0.75	2.01	0.89	1.38	0.39	1.43	1.01
68.00	1.32	1.38	0.75	2.04	0.90	1.39	0.39	1.43	1.03
69.50	1.33	1.38	0.75	2.04	0.90	1.39	0.39	1.43	1.03
70.50	1.33	1.36	0.75	2.08	0.90	1.40	0.39	1.43	1.05
72.00	1.32	1.36	0.75	2.07	0.90	1.39	0.39	1.43	1.05
74.00	1.30	1.35	0.75	2.08	0.90	1.40	0.39	1.43	1.05
76.00	1.31	1.32	0.75	2.14	0.91	1.41	0.39	1.43	1.09
78.00	1.33	1.27	0.75	2.21	0.91	1.42	0.39	1.43	1.12
80.00	1.34	1.21	0.75	2.33	0.92	1.43	0.40	1.43	1.18

Job:
Date 6/7
Calc by:
Checked by: JFM 7/30/90
Dwg Chk:

82.00	1.37	1.15	0.75	2.46	0.93	1.45	0.40	1.43	1.25
84.00	1.39	1.09	0.75	2.59	0.93	1.47	0.40	1.44	1.32
86.00	1.41	1.01	0.75	2.78	0.94	1.49	0.40	1.44	1.43
88.00	1.44	0.92	0.50	2.05	0.90	1.39	0.39	0.95	1.04
90.00	1.45	0.91	0.50	2.06	0.90	1.39	0.39	0.95	1.04
92.00	1.46	0.89	0.50	2.11	0.90	1.40	0.39	0.95	1.07
94.00	1.45	0.92	0.50	2.03	0.90	1.39	0.39	0.95	1.03
96.00	1.43	0.99	0.75	2.85	0.94	1.50	0.40	1.45	1.46
98.00	1.41	1.05	0.75	2.68	0.94	1.48	0.40	1.44	1.37
100.00	1.41	1.05	0.75	2.68	0.94	1.48	0.40	1.44	1.37
102.00	1.00	0.95	0.75	2.97	0.95	1.52	0.40	1.45	1.53
104.00	1.00	1.07	0.75	2.63	0.93	1.48	0.40	1.44	1.34
106.00	1.00	1.07	0.75	2.63	0.93	1.48	0.40	1.44	1.34
108.00	1.00	0.97	0.75	2.90	0.95	1.51	0.40	1.45	1.49
110.00	1.00	1.41	0.75	2.00	0.89	1.38	0.39	1.43	1.01
112.00	1.00	1.51	1.00	2.49	0.93	1.46	0.40	1.91	1.27
114.00	1.00	1.49	1.00	2.52	0.93	1.46	0.40	1.91	1.28
116.00	1.00	1.24	0.75	2.27	0.92	1.43	0.39	1.43	1.15
118.00	1.00	1.07	0.75	2.64	0.94	1.48	0.40	1.44	1.35
120.00	1.00	0.98	0.75	2.86	0.94	1.50	0.40	1.45	1.47
120.50	1.00	0.93	0.75	3.03	0.95	1.52	0.40	1.45	1.56
122.00	1.00	0.98	0.75	2.87	0.94	1.50	0.40	1.45	1.47
122.65	1.00	0.97	0.75	2.92	0.95	1.51	0.40	1.45	1.50
123.55	1.00	1.78	1.00	2.11	0.90	1.40	0.39	1.90	1.07
124.00	1.00	1.79	1.00	2.10	0.90	1.40	0.39	1.90	1.06

Rock Riprap Size Profile

GC#4 to GC#5



Job: 12101N
Calc by: GKC
Date: 7/25/90
Checked by: JPM
Dwg Chk: 7/30/90

Job:
Calc by:
Date
Checked by:
Dwg Chk:

1/5

Job: R101N
Date
Calc by: GKC 7/25/90
Checked by: JFM 7/30/90
Dwg Chk:

Levee Bank Protection Computation
Salt River Channelization
Grade Control #4 to Grade Control #5

FILE: BANK250.WK1
DATE: 07/25/90

SECNO	To	TOPWID	HYDDEP	Kss
0.00	2.05	1000.16	19.39	0.90
2.00	2.23	995.81	18.54	0.90
4.00	1.93	1065.85	18.51	0.90
6.00	1.87	1102.50	18.02	0.89
8.00	1.82	1138.16	17.61	0.89
10.00	1.71	1187.46	17.31	0.89
12.00	1.60	1239.01	17.04	0.89
14.00	1.51	1295.02	16.69	0.89
15.40	1.41	1352.42	16.41	0.88
15.60	1.35	1358.20	16.75	0.88
17.50	1.34	1359.60	16.74	0.88
19.00	1.55	1163.73	18.52	0.89
19.20	1.44	1167.30	19.15	0.89
21.50	1.52	1121.54	19.44	0.90
24.00	1.68	1093.52	19.02	0.90
24.50	1.37	1102.90	20.72	0.90
26.00	1.37	1110.18	20.61	0.90
27.00	1.36	1105.26	20.74	0.90
28.00	1.36	1098.18	20.92	0.90
30.00	1.39	1076.91	21.08	0.90
32.00	1.35	1069.47	21.68	0.90
34.00	1.36	1058.81	21.77	0.90
36.00	1.18	1086.13	22.72	0.91
38.00	1.42	1019.62	22.12	0.91
40.00	1.49	991.25	22.24	0.91
42.00	1.49	989.27	22.26	0.91
44.00	1.55	971.96	22.18	0.91
46.00	1.54	976.37	22.17	0.91
48.00	1.50	980.57	22.36	0.91
50.00	1.45	993.08	22.48	0.91
52.00	1.41	1002.35	22.54	0.91
54.00	1.39	1009.56	22.59	0.91
56.00	1.35	1018.85	22.63	0.91
58.00	1.33	1025.90	22.67	0.91
60.00	1.30	1035.06	22.71	0.91
62.00	1.25	1045.46	22.97	0.91
64.00	1.26	1052.22	22.74	0.91
66.00	1.24	1060.21	22.75	0.91
68.00	1.22	1067.20	22.76	0.91
69.50	1.21	1074.05	22.72	0.91
70.50	1.19	1076.18	22.89	0.91
72.00	1.20	1059.33	23.12	0.91
74.00	1.21	1038.57	23.47	0.91
76.00	1.17	1054.42	23.49	0.91
78.00	1.12	1078.27	23.55	0.91
80.00	1.06	1104.23	23.63	0.91

2/5

Job:
Date
Calc by:
Checked by: JFM 7/30/90
Dwg Chk:

82.00	0.99	1139.30	23.73	0.91
84.00	0.92	1175.41	23.80	0.90
86.00	0.84	1222.28	23.90	0.90
88.00	0.76	1254.30	24.96	0.90
90.00	0.74	1274.73	24.87	0.90
92.00	0.72	1293.43	24.89	0.90
94.00	0.75	1273.01	24.73	0.90
96.00	0.81	1235.60	24.55	0.90
98.00	0.88	1201.18	24.37	0.90
100.00	0.88	1203.95	24.30	0.90
102.00	1.12	1085.26	23.95	0.91
104.00	1.25	1069.46	22.64	0.91
106.00	1.25	1063.86	22.73	0.91
108.00	1.13	1103.72	23.01	0.91
110.00	1.63	952.29	22.52	0.91
112.00	1.75	925.80	22.40	0.91
114.00	1.73	927.09	22.45	0.91
116.00	1.45	988.32	22.93	0.91
118.00	1.26	1045.69	23.26	0.91
120.00	1.16	1080.20	23.40	0.91
120.50	1.10	1087.84	23.84	0.91
122.00	1.15	1085.11	23.39	0.91
122.65	1.13	1086.28	23.59	0.91
123.55	1.97	1071.45	18.81	0.90
124.00	2.00	1064.50	18.82	0.90

Levee Ba
Salt Riv
Grade Co

FILE: BANK250.W
DATE: 07/25/90

FILE:
DATE: SF = 1.30

NORTH BANK:

SECNO	Kr	Ai	Ki	Td	D50	E	Cb	Cl	Ca	Ta	CHCK
0.00	1.00	0.00	1.00	1.85	1.00	2.03	0.90	1.39	0.53	2.56	1.38
2.00	1.00	0.00	1.00	2.01	1.00	1.87	0.88	1.36	0.53	2.54	1.27
4.00	1.00	0.00	1.00	1.73	1.00	2.17	0.91	1.41	0.53	2.57	1.48
6.00	1.00	0.00	1.00	1.67	1.00	2.25	0.91	1.42	0.53	2.58	1.54
8.00	1.00	0.00	1.00	1.62	1.00	2.32	0.92	1.43	0.53	2.58	1.59
10.00	1.00	0.00	1.00	1.52	1.00	2.47	0.93	1.45	0.54	2.60	1.71
12.00	1.00	0.00	1.00	1.42	0.75	1.99	0.89	1.38	0.53	1.91	1.35
14.00	1.00	0.00	1.00	1.34	0.75	2.11	0.90	1.40	0.53	1.92	1.44
15.40	1.00	0.00	1.00	1.25	0.75	2.26	0.91	1.42	0.53	1.93	1.55
15.60	1.00	0.00	1.00	1.19	0.75	2.36	0.92	1.44	0.54	1.94	1.63
17.50	1.00	0.00	1.00	1.18	0.75	2.38	0.92	1.44	0.54	1.94	1.64
19.00	1.00	0.00	1.00	1.38	0.75	2.04	0.90	1.39	0.53	1.92	1.38
19.20	1.00	0.00	1.00	1.29	0.75	2.19	0.91	1.41	0.53	1.93	1.50
21.50	1.00	0.00	1.00	1.36	0.75	2.07	0.90	1.39	0.53	1.92	1.41
24.00	1.00	0.00	1.00	1.51	0.75	1.87	0.88	1.36	0.53	1.91	1.27
24.50	1.00	0.00	1.00	1.23	0.75	2.29	0.92	1.43	0.53	1.93	1.57
26.00	1.00	0.00	1.00	1.23	0.75	2.29	0.92	1.43	0.53	1.93	1.57
27.00	1.00	0.00	1.00	1.22	0.75	2.30	0.92	1.43	0.53	1.94	1.58
28.00	1.34	0.00	1.00	1.64	1.00	2.29	0.92	1.43	0.53	2.58	1.57
30.00	1.33	0.00	1.00	1.67	1.00	2.25	0.91	1.42	0.53	2.58	1.54
32.00	1.33	0.00	1.00	1.62	1.00	2.32	0.92	1.43	0.53	2.58	1.59

34.00	1.32	0.00	1.00	1.62	1.00	2.32	0.92	1.43	0.53	2.58	1.59
36.00	1.34	0.00	1.00	1.43	1.00	2.63	0.93	1.48	0.54	2.61	1.82
38.00	1.29	0.00	1.00	1.66	1.00	2.26	0.91	1.42	0.53	2.58	1.55
40.00	1.27	0.00	1.00	1.72	1.00	2.19	0.91	1.41	0.53	2.57	1.49
42.00	1.27	0.00	1.00	1.72	1.00	2.18	0.91	1.41	0.53	2.57	1.49
44.00	1.26	0.00	1.00	1.78	1.00	2.12	0.90	1.40	0.53	2.56	1.44
46.00	1.26	0.00	1.00	1.77	1.00	2.13	0.91	1.40	0.53	2.56	1.45
48.00	1.27	0.00	1.00	1.73	1.00	2.17	0.91	1.41	0.53	2.57	1.48
50.00	1.00	0.00	1.00	1.32	0.75	2.14	0.91	1.40	0.53	1.92	1.46
52.00	1.00	0.00	1.00	1.28	0.75	2.20	0.91	1.41	0.53	1.93	1.50
54.00	1.00	0.00	1.00	1.26	0.75	2.23	0.91	1.42	0.53	1.93	1.53
56.00	1.00	0.00	1.00	1.23	0.75	2.30	0.92	1.43	0.53	1.93	1.58
58.00	1.00	0.00	1.00	1.21	0.75	2.33	0.92	1.43	0.53	1.94	1.60
60.00	1.00	0.00	1.00	1.18	0.75	2.39	0.92	1.44	0.54	1.94	1.64
62.00	1.00	0.00	1.00	1.14	0.75	2.48	0.93	1.46	0.54	1.95	1.72
64.00	1.00	0.00	1.00	1.14	0.75	2.47	0.93	1.45	0.54	1.95	1.70
66.00	1.00	0.00	1.00	1.12	0.75	2.51	0.93	1.46	0.54	1.95	1.73
68.00	1.00	0.00	1.00	1.11	0.75	2.55	0.93	1.47	0.54	1.95	1.77
69.50	1.00	0.00	1.00	1.10	0.75	2.57	0.93	1.47	0.54	1.96	1.78
70.50	1.00	0.00	1.00	1.08	0.75	2.61	0.93	1.47	0.54	1.96	1.82
72.00	1.00	0.00	1.00	1.09	0.75	2.59	0.93	1.47	0.54	1.96	1.80
74.00	1.00	0.00	1.00	1.10	0.75	2.56	0.93	1.47	0.54	1.95	1.78
76.00	1.00	5.00	1.09	1.16	0.75	2.44	0.93	1.45	0.54	1.95	1.68
78.00	1.00	7.00	1.12	1.14	0.75	2.47	0.93	1.45	0.54	1.95	1.71
80.00	1.00	10.00	1.17	1.13	0.75	2.50	0.93	1.46	0.54	1.95	1.73
82.00	1.00	13.00	1.22	1.10	0.75	2.57	0.93	1.47	0.54	1.96	1.78
84.00	1.00	13.00	1.22	1.02	0.75	2.77	0.94	1.49	0.54	1.97	1.93
86.00	1.00	16.00	1.28	0.97	0.50	1.94	0.89	1.37	0.53	1.27	1.32
88.00	1.00	18.00	1.31	0.90	0.50	2.09	0.90	1.40	0.53	1.28	1.43
90.00	1.00	20.00	1.34	0.90	0.50	2.10	0.90	1.40	0.53	1.28	1.43
92.00	1.00	17.00	1.29	0.84	0.50	2.24	0.91	1.42	0.53	1.29	1.53
94.00	1.00	15.00	1.26	0.85	0.50	2.21	0.91	1.42	0.53	1.29	1.51
96.00	1.00	16.00	1.28	0.93	0.50	2.02	0.90	1.38	0.53	1.28	1.37
98.00	1.00	9.00	1.16	0.92	0.50	2.04	0.90	1.39	0.53	1.28	1.39
100.00	1.00	0.00	1.00	0.80	0.50	2.36	0.92	1.44	0.54	1.29	1.63
102.00	1.00	0.00	1.00	1.02	0.50	1.85	0.88	1.36	0.53	1.27	1.25
104.00	1.45	0.00	1.00	1.64	1.00	2.29	0.92	1.43	0.53	2.58	1.57
106.00	1.45	0.00	1.00	1.64	1.00	2.29	0.92	1.43	0.53	2.58	1.57
108.00	1.48	0.00	1.00	1.51	1.00	2.48	0.93	1.46	0.54	2.60	1.72
110.00	1.37	0.00	1.00	2.04	1.25	2.31	0.92	1.43	0.53	3.23	1.58
112.00	1.35	0.00	1.00	2.16	1.25	2.18	0.91	1.41	0.53	3.21	1.49
114.00	1.00	0.00	1.00	1.58	1.00	2.38	0.92	1.44	0.54	2.59	1.64
116.00	1.00	0.00	1.00	1.32	0.75	2.13	0.91	1.40	0.53	1.92	1.46
118.00	1.00	0.00	1.00	1.15	0.75	2.46	0.93	1.45	0.54	1.95	1.70
120.00	1.00	0.00	1.00	1.05	0.75	2.68	0.94	1.48	0.54	1.96	1.87
120.50	1.00	0.00	1.00	1.00	0.75	2.82	0.94	1.50	0.55	1.98	1.98
122.00	1.00	0.00	1.00	1.04	0.75	2.70	0.94	1.48	0.54	1.97	1.88
122.65	1.00	0.00	1.00	1.03	0.75	2.75	0.94	1.49	0.54	1.97	1.92
123.55	1.00	0.00	1.00	1.77	1.00	2.13	0.91	1.40	0.53	2.56	1.45
124.00	1.00	0.00	1.00	1.79	1.00	2.09	0.90	1.40	0.53	2.56	1.43

Job:	Date
Calc by:	
Checked by: JPM	7/30/90
Dwg Chk:	

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Job:	Date
Calc by:	
Checked by: JFM	7/30/90
Dwg Chk:	

Levee BaK1
Salt Riv
Grade Co

FILE: BANK250.W
DATE: 07/25/90

FILE:
DATE:

SOUTH BANK:

SECNO	Kr	Td	D50	E	Cb	Cl	Ca	Ta	CHCK
0.00	1.00	1.85	1.00	2.03	0.90	1.39	0.53	2.56	1.38
2.00	1.00	2.01	1.00	1.87	0.88	1.36	0.53	2.54	1.27
4.00	1.15	1.99	1.00	1.89	0.88	1.36	0.53	2.54	1.28
6.00	1.17	1.96	1.00	1.92	0.89	1.37	0.53	2.55	1.30
8.00	1.19	1.93	1.00	1.95	0.89	1.37	0.53	2.55	1.32
10.00	1.21	1.84	1.00	2.04	0.90	1.39	0.53	2.56	1.39
12.00	1.24	1.76	1.00	2.14	0.91	1.40	0.53	2.56	1.46
14.00	1.27	1.70	1.00	2.22	0.91	1.42	0.53	2.57	1.52
15.40	1.29	1.61	1.00	2.34	0.92	1.44	0.53	2.58	1.61
15.60	1.30	1.55	1.00	2.42	0.92	1.45	0.54	2.59	1.67
17.50	1.30	1.54	1.00	2.44	0.93	1.45	0.54	2.59	1.69
19.00	1.20	1.66	1.00	2.26	0.91	1.42	0.53	2.58	1.55
19.20	1.20	1.55	1.00	2.43	0.92	1.45	0.54	2.59	1.68
21.50	1.18	1.61	1.00	2.34	0.92	1.44	0.53	2.58	1.61
24.00	1.00	1.51	0.75	1.87	0.88	1.36	0.53	1.91	1.27
24.50	1.00	1.23	0.75	2.29	0.92	1.43	0.53	1.93	1.57
26.00	1.00	1.23	0.75	2.29	0.92	1.43	0.53	1.93	1.57
27.00	1.00	1.22	0.75	2.30	0.92	1.43	0.53	1.94	1.58
28.00	1.00	1.23	0.75	2.30	0.92	1.43	0.53	1.94	1.58
30.00	1.00	1.25	0.75	2.25	0.91	1.42	0.53	1.93	1.54
32.00	1.00	1.22	0.75	2.31	0.92	1.43	0.53	1.94	1.59
34.00	1.00	1.23	0.75	2.29	0.92	1.43	0.53	1.93	1.57
36.00	1.00	1.07	0.75	2.64	0.94	1.48	0.54	1.96	1.84
38.00	1.00	1.29	0.75	2.19	0.91	1.41	0.53	1.93	1.50
40.00	1.00	1.35	0.75	2.08	0.90	1.40	0.53	1.92	1.42
42.00	1.00	1.36	0.75	2.08	0.90	1.40	0.53	1.92	1.42
44.00	1.00	1.41	0.75	2.00	0.89	1.38	0.53	1.91	1.36
46.00	1.00	1.40	0.75	2.01	0.90	1.38	0.53	1.92	1.37
48.00	1.27	1.73	1.00	2.17	0.91	1.41	0.53	2.57	1.48
50.00	1.27	1.68	1.00	2.24	0.91	1.42	0.53	2.57	1.54
52.00	1.28	1.64	1.00	2.29	0.92	1.43	0.53	2.58	1.57
54.00	1.28	1.62	1.00	2.32	0.92	1.43	0.53	2.58	1.60
56.00	1.29	1.58	1.00	2.38	0.92	1.44	0.54	2.59	1.63
58.00	1.29	1.56	1.00	2.41	0.92	1.45	0.54	2.59	1.66
60.00	1.30	1.53	1.00	2.45	0.93	1.45	0.54	2.60	1.69
62.00	1.31	1.49	0.75	1.90	0.88	1.36	0.53	1.91	1.28
64.00	1.31	1.50	0.75	1.88	0.88	1.36	0.53	1.91	1.27
66.00	1.32	1.48	0.75	1.90	0.88	1.36	0.53	1.91	1.29
68.00	1.32	1.46	0.75	1.93	0.89	1.37	0.53	1.91	1.31
69.50	1.33	1.46	0.75	1.93	0.89	1.37	0.53	1.91	1.31
70.50	1.33	1.43	0.75	1.97	0.89	1.38	0.53	1.91	1.33
72.00	1.32	1.44	0.75	1.96	0.89	1.38	0.53	1.91	1.33
74.00	1.30	1.43	0.75	1.97	0.89	1.38	0.53	1.91	1.34
76.00	1.31	1.39	0.75	2.02	0.90	1.39	0.53	1.92	1.38
78.00	1.33	1.35	0.75	2.09	0.90	1.40	0.53	1.92	1.42
80.00	1.34	1.29	0.75	2.19	0.91	1.41	0.53	1.93	1.50

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Job:	Date
Calc by:	
Checked by: JFM	7/30/90
Dwg Chk:	

82.00	1.37	1.23	0.75	2.30	0.92	1.43	0.53	1.93	1.58
84.00	1.39	1.16	0.75	2.44	0.93	1.45	0.54	1.95	1.68
86.00	1.41	1.07	0.75	2.64	0.94	1.48	0.54	1.96	1.84
88.00	1.44	0.99	0.50	1.90	0.89	1.36	0.53	1.27	1.29
90.00	1.45	0.97	0.50	1.94	0.89	1.37	0.53	1.27	1.32
92.00	1.46	0.95	0.50	1.98	0.89	1.38	0.53	1.28	1.35
94.00	1.45	0.98	0.50	1.92	0.89	1.37	0.53	1.27	1.30
96.00	1.43	1.05	0.75	2.70	0.94	1.48	0.54	1.97	1.88
98.00	1.41	1.12	0.75	2.51	0.93	1.46	0.54	1.95	1.74
100.00	1.41	1.12	0.75	2.51	0.93	1.46	0.54	1.95	1.74
102.00	1.00	1.02	0.75	2.77	0.94	1.49	0.54	1.97	1.94
104.00	1.00	1.13	0.75	2.49	0.93	1.46	0.54	1.95	1.72
106.00	1.00	1.13	0.75	2.49	0.93	1.46	0.54	1.95	1.72
108.00	1.00	1.02	0.75	2.76	0.94	1.49	0.54	1.97	1.93
110.00	1.00	1.49	0.75	1.90	0.88	1.36	0.53	1.91	1.28
112.00	1.00	1.60	1.00	2.35	0.92	1.44	0.54	2.59	1.62
114.00	1.00	1.58	1.00	2.38	0.92	1.44	0.54	2.59	1.64
116.00	1.00	1.32	0.75	2.13	0.91	1.40	0.53	1.92	1.46
118.00	1.00	1.15	0.75	2.46	0.93	1.45	0.54	1.95	1.70
120.00	1.00	1.05	0.75	2.68	0.94	1.48	0.54	1.96	1.87
120.50	1.00	1.00	0.75	2.82	0.94	1.50	0.55	1.98	1.98
122.00	1.00	1.04	0.75	2.70	0.94	1.48	0.54	1.97	1.88
122.65	1.00	1.03	0.75	2.75	0.94	1.49	0.54	1.97	1.92
123.55	1.00	1.77	1.00	2.13	0.91	1.40	0.53	2.56	1.45
124.00	1.00	1.79	1.00	2.09	0.90	1.40	0.53	2.56	1.43

This calculation is similar to the calculation for unconfined stone. The only difference is that the Shields parameter is increased from 0.047 to 0.100 to account for the confinement of the stone in the gabion basket.

The equation for stable stone on a slope is $\tau_d \leq C_a \tau_c$ where

$$\tau_c = 10.3\, D_{50} \quad \text{for gabion}$$
$$(\tau_c = 4.83\, D_{50} \text{ for stone})$$

The equivalent stone size for a gabion compared to loose stone is derived as follows

$$10.3\, D_{50}^{G} = 4.83\, D_{50}^{S}$$

$$\frac{D_{50}^{G}}{D_{50}^{S}} = \frac{4.83}{10.3} = 2.13$$

Equivalent sizes are:

Loose Stone	Gabion
6"	2.8"
9"	4.2"
12"	5.6"
15"	7.1"

For the proposed 1' gabion mattress thickness a 6" stone size will provide the equivalent stability as loose stone with $D_{50} = 12"$.

CRS SIRRINE	PROJECT: Rio Salado Channel	JOB NO. R101N		NO. 2
	CLIENT: City of Tempe	DESIGNED BY GRC	DATE 8/14/90	OF 2
	SUBJECT: Gabion Stone Fill	CHECKED BY JFM	DATE 8/15/90	

The gradation of the stone used to fill the mattress must be larger than the wire mesh opening and less than the mattress thickness. Use:

$D_{min} = 3''$

$D_{max} = 12''$

$D_{50} = 6''$

for 1' mattress thickness.

CRS SIRRINE	PROJECT: Ri Salado	JOB NO.: R101N	NO. 5
	CLIENT: Tempe	DESIGNED BY: GKC / DATE: 7/24/90	OF 5
	SUBJECT: Filter	CHECKED BY: JFM / DATE: 7/30/90	

Alternative Filter Design: Filter Fabric

Task Force No 25 recommends the following criteria for filter fabric design. (see HEC-15, FHWA-IP-87-7, page 20).

1. The fabric must be able to transmit water faster than the soil.
2. The following criteria for the apparent opening size (AOS) must be met:
   a. For soil with less than 50 percent of the particles by weight passing a U.S. No. 200 sieve, AOS < 0.6 mm (0.024 in) (greater than #30 U.S. Std. Sieve).
   b. For soil with more than 50 percent of the particles by weight passing a U.S. No. 200 sieve, AOS < 0.297 mm (0.012 in) (greater that #50 U.S. Std. Sieve).

Criteria 1 and 2a will control
Soil permeability is estimated to be 5.2×10^{-2} cm/s for coarse sand.

Cost Analysis

Cost Comparison
Filter Fabric $3.00 sq yd
Gravel Bedding $14.00 sq. yd.

(Use 1.0 ft bedding thickness for riprap or rock, so 1 cu yd provides 3 sq yd.
Gravel Bedding $12.00 cu. yd.)

Use filter fabric.

Appendix D

Key to Cross Section Labeling

Rio Salado HEC-2 Stationing

Station	River Mile	Station	River Mile
0.000	21.399	66.000	22.610
2.000	21.429	68.000	22.644
4.000	21.467	69.300	22.664
6.000	21.505	70.300	22.681
8.000	21.543	72.000	22.710
10.000	21.581	74.000	22.742
12.000	21.619	76.000	22.775
14.000	21.649	78.000	22.808
15.400	21.672	80.000	22.841
15.600	21.675	82.000	22.874
17.300	21.704	84.000	22.907
19.000	21.737	86.000	22.940
21.500	21.771	88.000	22.973
24.000	21.798	90.000	23.005
24.600	21.809	92.000	23.038
26.000	21.843	94.000	23.070
26.450	21.851	96.000	23.109
27.000	21.879	98.000	23.153
28.000	21.908	100.000	23.200
30.000	21.945	102.000	23.252
32.000	21.981	104.000	23.293
34.000	22.018	106.000	23.334
36.000	22.057	108.000	23.375
38.000	22.099	110.000	23.417
40.000	22.140	112.000	23.456
42.000	22.182	114.000	23.492
44.000	22.224	116.000	23.529
46.000	22.266	118.000	23.566
48.000	22.308	119.800	23.601
50.000	22.345	120.420	23.610
52.000	22.380	120.500	23.611
54.000	22.412	122.000	23.639
56.000	22.445	122.650	23.651
58.000	22.478	123.550	23.667
60.000	22.512	124.000	23.676
62.000	22.545	126.000	23.713
64.000	22.578	128.000	23.751