SALT RIVER CHANNELIZATION DRAFT DESIGN CONCEPT REPORT

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

CMT. NO.	SUBJECT: SALT RIVER CHANNEL PLANS	☐ FILE ☐ DESTROY

TO: Dick Perreault FROM: L.C. Huang Via: Nick Karan NPK DATE: 1-23-89

WE HAVE REVIEWED THE 90% PLANS FOR THE SALT RIVER CHANNELIZATION DESIGN; AND HAVE THE FOLLOWING COMMENTS:

CHANNEL PLANS

CH-1.4 to 1.6 HOW ARE GABIONS TO BE ANCHORED?

CH-1.5 SHOULD THE DRAIN PIPE DETAIL BE ON DWG NO. CH-10.2

CH-2.6. STATION FOR THE 8'x4' BOX READ AS 149+42.11, HOWEVER IT WAS SHOWN AS 149+42.16 IN DWG. NO. CH-9.2.

CH-2.8 SOUTH LEVEE TOE ELEVATION AT STA. 195+00 READ AS 1106.8, BUT IT WAS SHOWN AS 1106.9 IN DWG. NO. CH-2.10

CH-2.13 STATIONS OF THE SOUTH GUIDE BANK OPENINGS SHOULD BE GIVEN. WHAT IS THE FLOW DISCHARGE FLOW THROUGH THE OPENINGS, THE SOIL-CEMENT SHOULD WRAP AROUND THE BACKSIDE (SOUTH) OF

6900-003
11/78

FLOOD CONTROL DISTRICT of Maricopa County

Interoffice Memorandum

PG 4/4

CMT. NO.	SUBJECT:	☐ FILE ______ ☐ DESTROY
	TO: FROM: DATE:	

5. REMOVAL OF ALL UNACCEPTABLE MATERIALS WAS NOT INCLUDED IN THE SPECIAL PROVISIONS

6. OUR REVIEWS ARE GIVEN TO THE CHANNEL PLANS ONLY.

Rec'd 5/19/88

Memorandum

Re: Hydraulic/River Mechanics Analysis
From: Simons, Li & Associates, Inc.
Date: April 14, 1988

A preliminary backwater analysis was run for a channelized section from Mill Avenue to Hayden Road. This analysis revealed that due to the restrictive open area under the Scottsdale Road Bridge that the Scottsdale Bridge becomes a control for the reach. In order to maintain free flow the slope was flattened throughout the reach as shown in figure 1. [DIDN'T RECEIVE] The elevation at the grade control structure approximately 2100 feet below Mill Avenue was maintained at 1132 feet, and a constant slope (S = 0.0009) up to Hayden Road was used. This slope pivoted at the grade control structure and intersected elevation 1138.22 at Scottsdale Road (4 feet below the original slope conditions at Scottsdale Road).

The lowering of the channel invert has three advantages, it allows the 100 year discharge to free flow at the Scottsdale Road Bridge, it lowers the elevation of the top of the levees needed to contain the flows, and it also provides fill used for the levees which maintain a freeboard of 3 feet above the 100 year water surface elevation.

To further improve water surface elevations through the reach, the gradient was lowered for the reach from the grade-control structure to Scottsdale Road as shown in figure 2. The slope for this section is 0.0002. Pivoting at the grade-control structure it intersects elevation 1133.21 at Scottsdale Road and jumps up an additional 5 feet where it resumes the same slope as the previous condition.

This alternative has the same advantages as the previous situation but in addition has a milder slope.

The channel alignment was shifted slightly in the area of Scottsdale Road. The channel was moved about 300 feet south so that it ties in with the south abutment rather than the north abutment. This was done for two reasons. First, it frees up more usable land on the north side of the channel. This gives approximately 24 fewer acres on the south and an additional 24 acres on the north side. Second, the increased curvature in the channel tends to conform better to the bed forms and channel conditions for the confluence which exists directly above the Scottsdale Road Bridge. With flows coming into the channel from Indian Bend Wash the tendency for natural conditions is to erode the channel downstream and opposite the inflow location and deposit downstream on the same side as the inflow. Figure 3 (Mosley, 1976) helps to explain the situation occurring. For low flow situations the flow would more than likely tend to hug the south abutment at Scottsdale Road.

For low flow situations, meandering could occur within the main channel. The geometry of meandering rivers is quantitatively measured in terms of: (1) meander wavelength λ ; (2) meander width Wm, approximately equal to the main channel width of 1,000 feet; and (3) meander amplitude A. These are all related to the low flow channel width. For conditions existing in this reach the meander wavelength should be approximately

2,100 feet and the meander amplitude less than 820 feet as shown in figure 4 (FHA, 1987). This has a sinuosity of about 1.34.

References

Mosley, M. P., 1976, An Experimental Study of Channel Confluences: J. Geol., V. 84. Cited from; Schumm, Stanley A., 1977, The Fluvial System; John Wiley & Sons, New York, Pg. 184.

U.S. Department of Transportation, Federal Highway Administration, Highways in the River Environment, Jan., 1987, pp. IV-11-16.

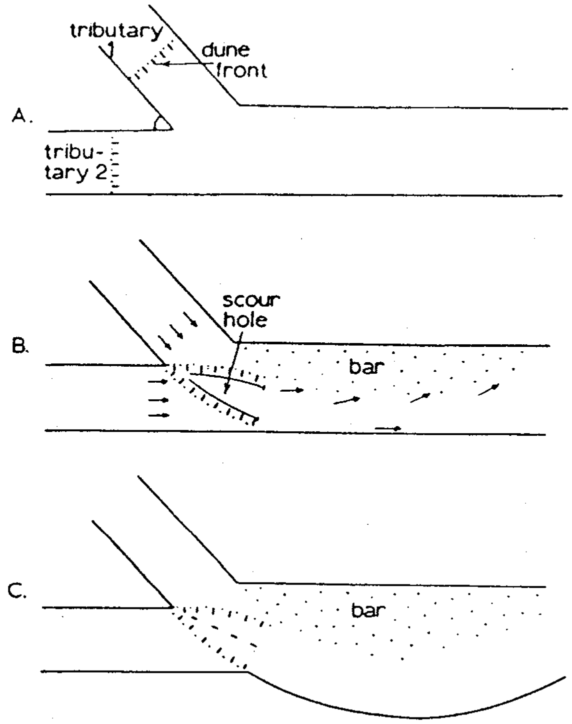


Figure 3 Effect of large tributary on position of main channel and channel scour during experimental study. (From Mosley, 1976.)

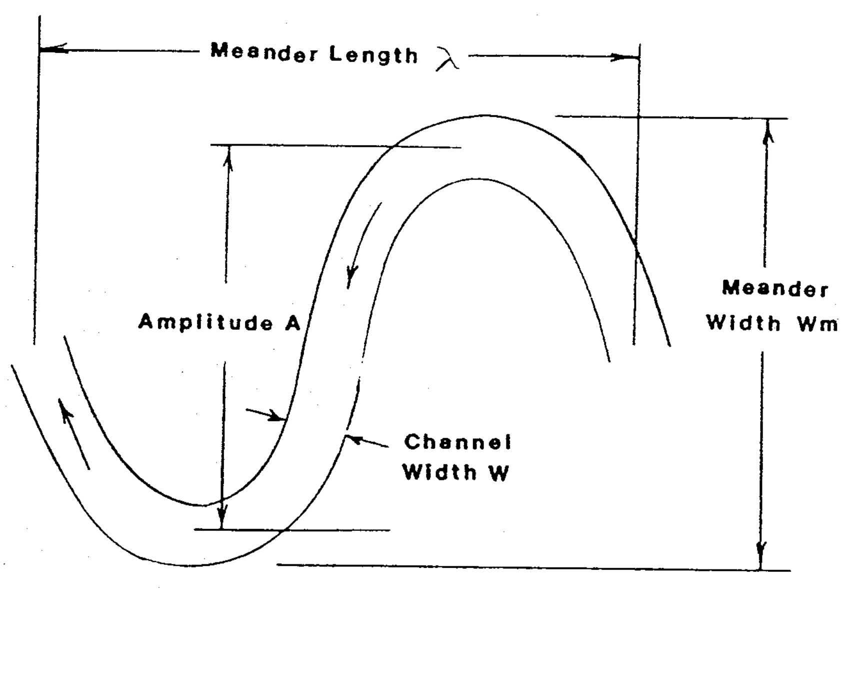
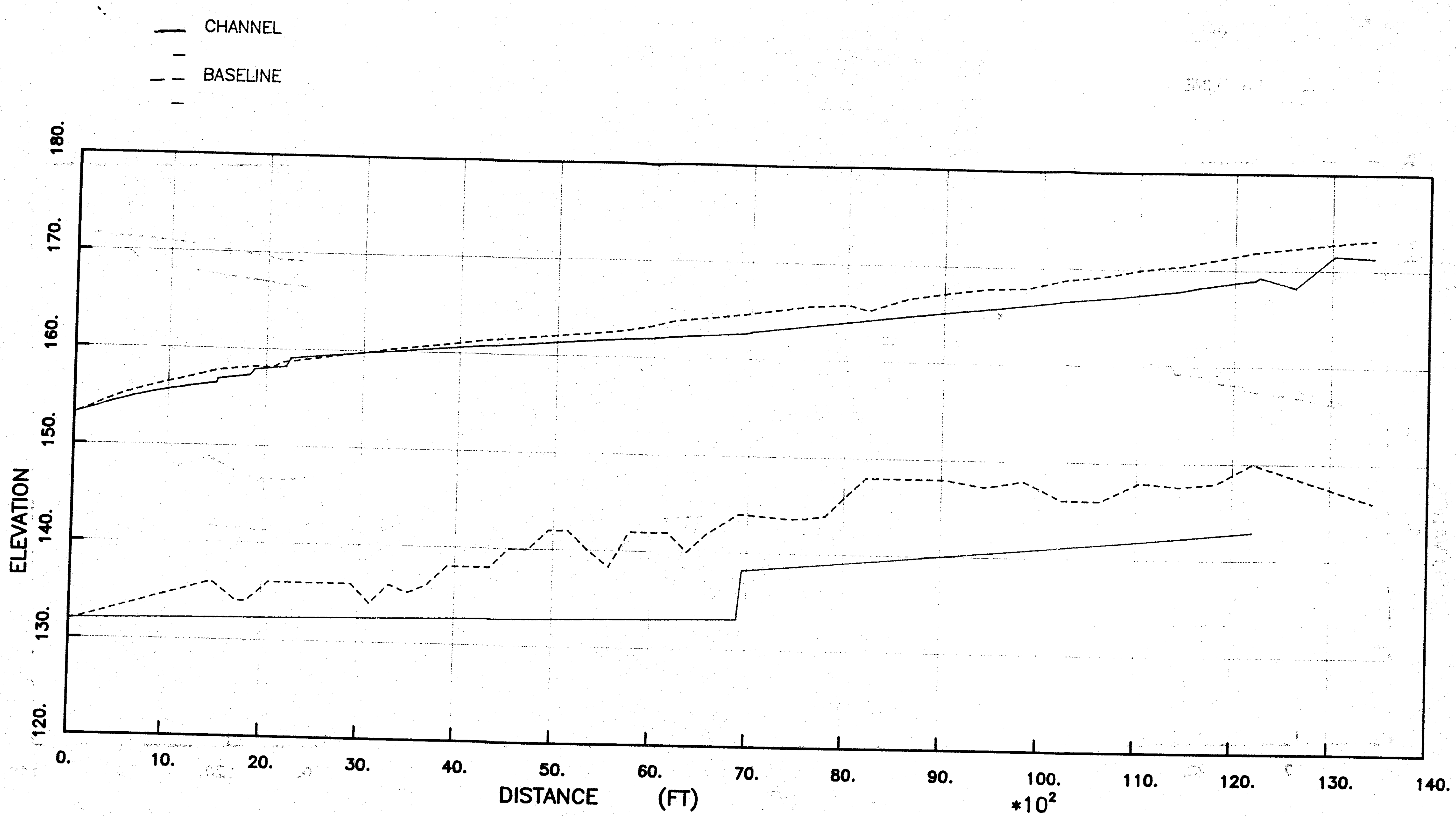
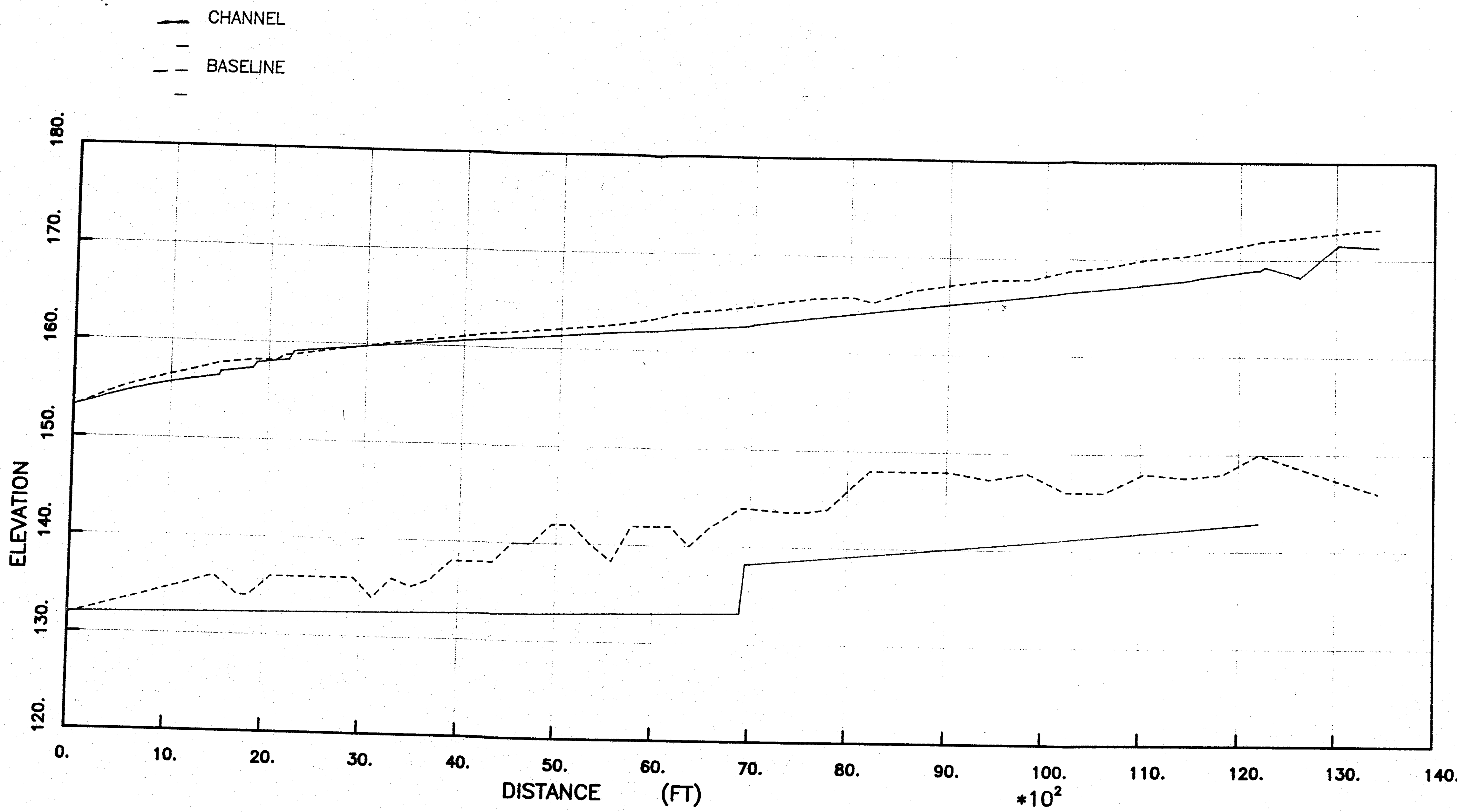


Figure 4. Definition Sketch For Meanders



CHANNEL
BASELINE
ELEVATION
180.
170.
160.
150.
140.
130.
120.
0.
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
110.
120.
130.
140.
DISTANCE (FT)
*10²

FIGURE 2


CHANNEL
BASELINE
ELEVATION
180.
170.
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120.
0.
10.
20.
30.
40.
50.
60.
70.
80.
90.
100.
110.
120.
130.
140.
DISTANCE (FT)
*10²

FIGURE 2

DMJM

Daniel, Mann, Johnson, & Mendenhall
300 West Clarendon Avenue
Suite 400
Phoenix, Arizona 85013-3499
Telephone: 602/264-1397, 602/264-0217

Planning
Architecture
Engineering
Landscape
Architecture

letter of transmittal

To: Maricopa Co. Flood Control District
3335 West Durango
Phoenix, Arizona 85007

Attn. Richard Perreault 1/6/88

DOCUMENT NO.

Date: 5/27/88	Project No.
Project: East Papago/Hohokam/Sky Harbor Access	

FILE NO. 500.15, 300.11, 800

We transmit:
(X) herewith ( ) under separate cover via
( ) in accordance with your request

For your:
( ) approval ( ) distribution to parties ( ) information
( ) review & comment ( ) record
(X) use ( )

The following:
( ) prints ( ) copy of letter ( ) change order
( ) originals ( ) specifications ( ) calculations
( ) shop drawings (X) Copy

Copies	Dwg. No.	Description	Action Code
1	11"x17"	Landscape Concepts Papago Channelization	
		8 Concepts.	

Action Code
A. Reviewed
B. Reviewed as noted
C. Revise & resubmit
D. See remarks below

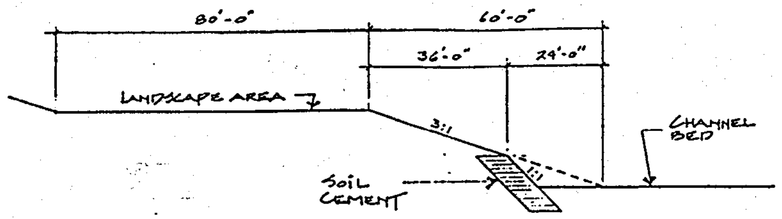
Remarks:

If enclosures are not as noted, please inform us immediately.

Copies to: PDB

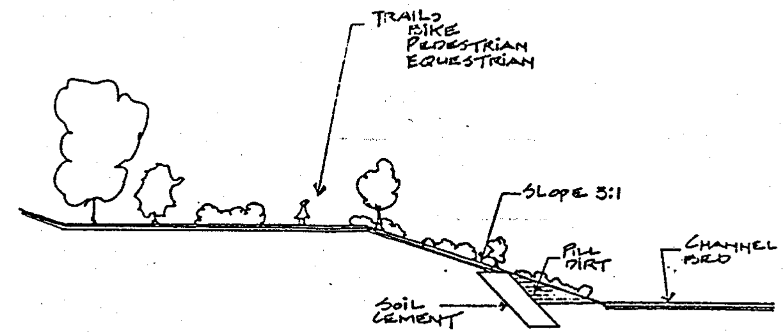
Signed: [signature]
Turan Ceran
Project Manager

85-04 (9/86)



BANK STABILIZATION "A"

DMJM | 0' 10' 20' 40' 60' | LANDSCAPE CONCEPTS PAPAGO CHANNELIZATION



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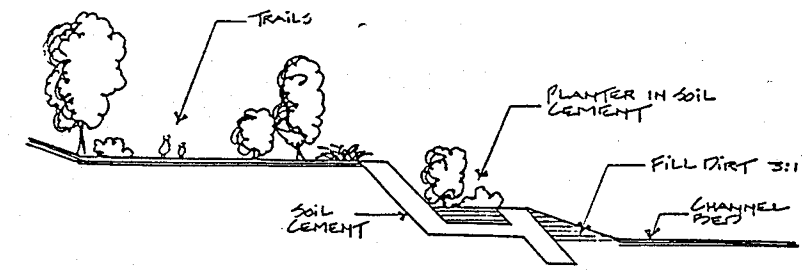

BANK STABILIZATION "B2"

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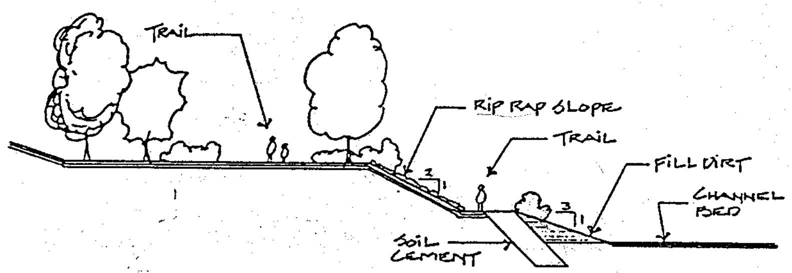

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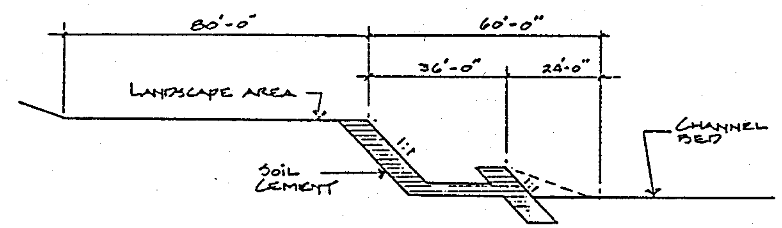

BANK STABILIZATION "B"

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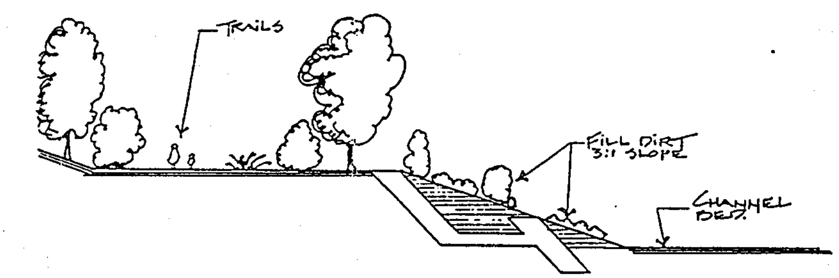

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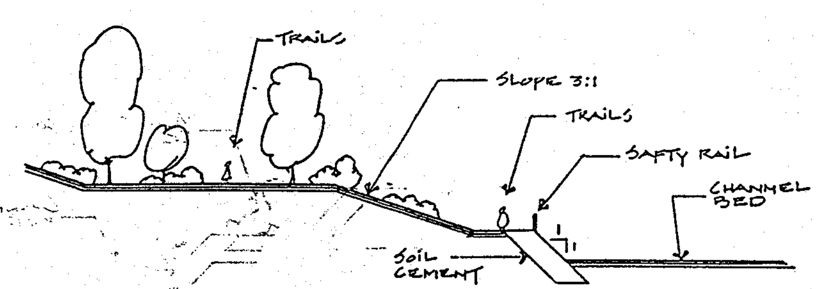

BANK STABILIZATION "A2"

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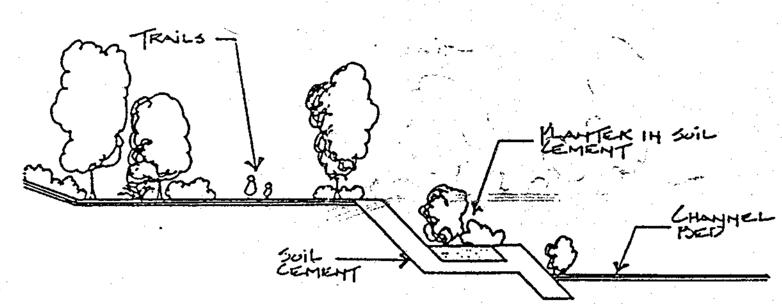

BANK STABILIZATION "B1"

DMJM | 0' 10' 20' 40' 60' | LANDSCAPE CONCEPTS PAPAGO CHANNELIZATION

LANDSCAPE CONCEPTS

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300 West Clarendon Avenue
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Phoenix, Arizona 85013-3499
Telephone: 602/264-1397, 602/264-0217

SHEET: 1 of 1

DRAFT
CONCEPT DESIGN REPORT

SALT RIVER CHANNELIZATION

May 1988

Prepared by:
Daniel, Mann, Johnson, & Mendenhall
300 West Clarendon Avenue, Suite 400
Phoenix, Arizona 85013

In Association with:
Simons, Li & Associates, Inc.
1225 East Broadway Road, Suite 200
Tempe, Arizona 85282

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Registered Professional Engineer (Civil) CERTIFICATE 2020 GEORGE K. COTTON Signed 5/5/88 ARIZONA, U.S.A.

PAZ-DMJM-01/PH/R01

DRAFT

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Registered Professional Engineer (Civil) CERTIFICATE No. 20307 GEORGE K. COTTON ARIZONA, U.S.A. 5/5/88

I. INTRODUCTION AND BACKGROUND

1.1 Introduction

This report presents the hydraulic concept design for the Salt River channelization that will be constructed in conjunction with the East Papago and Hohokam Freeways. The report presents the major elements of the design, and discusses the analyses conducted for the overall channelization and specific design elements. This report provides technical documentation for the permit application package that was submitted to the U.S. Army Corps of Engineers for compliance with Section 404 of the Clean Water Act. This report also provides supporting technical documentation for a request for a revision of flood-hazard boundary maps from the Federal Emergency Management Agency.

This concept design was developed following an extensive review of possible freeway corridors in this area of metropolitan Phoenix. The location study phase of the project resulted in the development and analysis of several freeway alignments for the Hohokam and East Papago Freeways. At this time, several freeway alignments were proposed that encroached, or proposed to modify the Salt River floodway in the reach from 40th Street to Mill Avenue. Studies evaluating the impact of these various alternatives were prepared (SLA, 1987; ADOT, 1987a; ADOT, 1987b), including an analysis of river mechanics and floodplain impacts, and environmental assessments for both freeways. Public hearings were conducted to solicit public comment on the freeway alternatives, and numerous coordination meetings were conducted throughout the study to inform affected municipalities and agencies. The selected alternative (ADOT, 1987c) included an alignment for the East Papago Freeway that required channelization of the Salt River. The channelization was found to significantly reduce the length of bridges for the associated transportation facilities of State Route 153, Hohokam Freeway, and Priest Drive. This lowered the cost of the overall system and more than offset the estimated cost of channel construction.

The channelized reach (see Figure 1) is located in the existing Salt River channel, and extends from the upstream terminus of the Sky Harbor channel to the Southern Pacific Railroad bridge. The primary purpose of the channel is to reclaim land from the river floodplain and floodway for

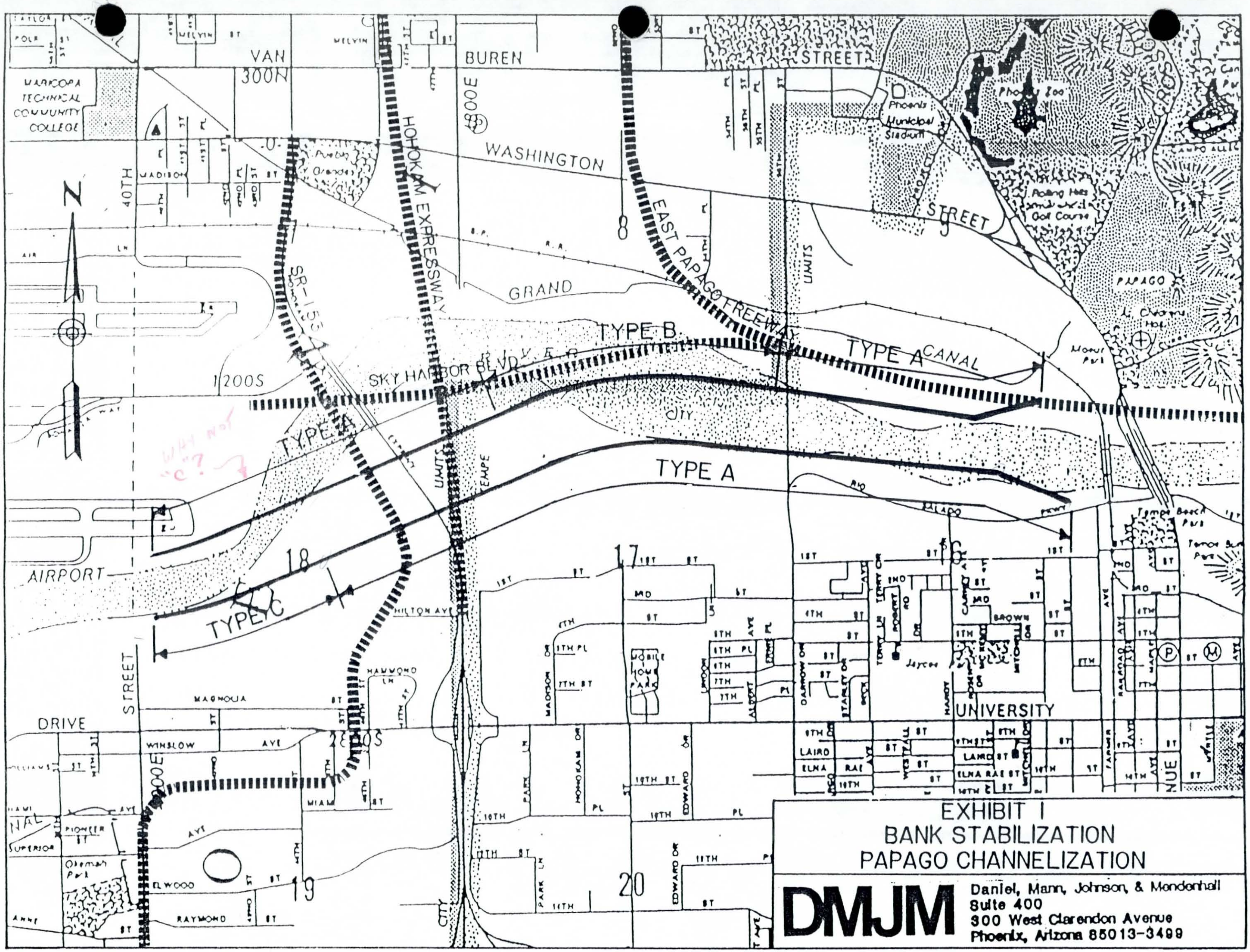
EXHIBIT I
BANK STABILIZATION
PAPAGO CHANNELIZATION
DMJM
Daniel, Mann, Johnson, & Mendenhall
Suite 400
300 West Clarendon Avenue
Phoenix, Arizona 85013-3499
TYPE A
TYPE A
TYPE A
TYPE B
TYPE C
VAN BUREN STREET
WASHINGTON STREET
GRAND
CANAL
SKY HARBOR BLVD
HOHOKAM EXPRESSWAY
EAST PAPAGO FREEWAY
SR-153
AIRPORT DRIVE
40TH STREET
UNIVERSITY
MAGNOLIA
WINSLOW AVE
HILTON AVE
HAMMOND LN
ELWOOD
RAYMOND
PAPAGO
Phoenix Municipal Stadium
Phoenix Zoo
Rolling Hills Golf Course
Maricopa Technical Community College
RIO SALADO PKWY
CITY LIMITS
TEMPE
300N
1200S
2400S
800E
17
18
19
20

Figure 1

location of the freeway alignment. The associated purpose of the channel is, therefore, flood protection including stabilization of the river boundary to prevent erosion damage to freeway embankments and other adjacent property. Several secondary uses of the channel area were identified, which included recreational use and improved aesthetic quality. Issues related to wildlife habitat were considered with the replacement of displaced native habitat to an area adjacent to the freeway corridor. The channelized reach of the Salt River will include several structural elements in order to meet the project purpose. Stabilized banks, grade-control structures, and bridge crossings are the primary structural elements. In addition, access roads and landscape features will be constructed.

Rigid-boundary backwater analysis was conducted for the concept design for the 10-year, 100-year, and Standard Project Floods on the entire study reach of the Salt River from I-10 to Hayden Road. Existing conditions were assessed; and a baseline condition established, to which results of an analysis of the river including proposed channelization between 40th Street and the Southern Pacific Railroad, were compared. The Corps of Engineers 1983-1984 Salt River Flood Insurance Study was used as an initial reference for the analysis of existing hydraulic conditions.

A moveable-bed analysis was also conducted to determine potential changes in the channel profile, and to evaluate the effectiveness of four proposed grade-control structures for controlling the degradation process in the newly channelized portion of the river. An analysis of local scour phenomenon at various locations in the reach was conducted, and added to the general scour estimates to provide an estimate of the total scour depths.

1.2 Geomorphic Background

An analysis of the geomorphic characteristics of the Salt River in the reach from 40th Street to Hayden Road was conducted during the location phase of the East Papago project. Aerial photographic and topographic data were gathered. The aerial photos were used to qualitatively assess changes that had taken place in channel plan form during the period from 1953 to 1983. The topographic data was used to provide a quantitative assessment of changes in channel section and profile. The findings of this analysis are briefly summarized here, copies of the aerial photos are reproduced in the location report (SLA, 1987).

The river reach of the Salt River in the vicinity of Tempe Buttes is hydraulically and geomorphically unique. Historically, the Salt River responded to the constriction created by the Buttes by forming several large meander bends upstream of the Buttes to Hayden Road. Below the Buttes, the channel straightened, indicating a reach of flow acceleration. In the reach of particular interest to this study, Priest Drive to 40th Street, the river widened forming a depositional area. The channel formed one large meander bend in this reach with smaller channels located across the channel bar.

Development of the river channel since 1953 included construction of a number of structures within the channel floodplain, and also extensive development of aggregate resources. Structures include the southern runway for Sky Harbor Airport, landfills (predominantly on the south bank), and numerous small diversion structures. The development east of Tempe Buttes gradually obliterated the meander form of the channel in this reach. In 1975, the river was channelized from Mill Avenue to Scottsdale Road.

Sand and gravel mining is evident throughout the study reach. Also, most of the embankment used to construct airport runways, came from the Salt River channel. Comparison of the bed profile measured in 1962 to the current profile (1986) indicates an average bed lowering of eleven feet (see Figure 2). Measurements of changes in cross-sectional area at locations along the channel indicates that approximately 17.7 million cubic yards (23.9 million tons) of material was removed from the channel bed. The average increase in cross-sectional area is 16,300 square feet (see Figure 3).

The reversal of the basic depositional nature of the river channel created a number of noticeable instabilities in the river channel during the large magnitude floods of the late 1970s. The instabilities are particularly evident in the reach below Priest Drive to 40th Street. The general trend has been for further downcutting, and a general straightening of the river form. The Joint Head dam measurement weir was outflanked in 1965. The 48th Street at-grade crossing was made unuseable by severe downcutting at several locations during 1977, 1978, 1979, and 1980 floods. The 1980 flood threatened a large diameter waterline which supplies the City of Phoenix. A

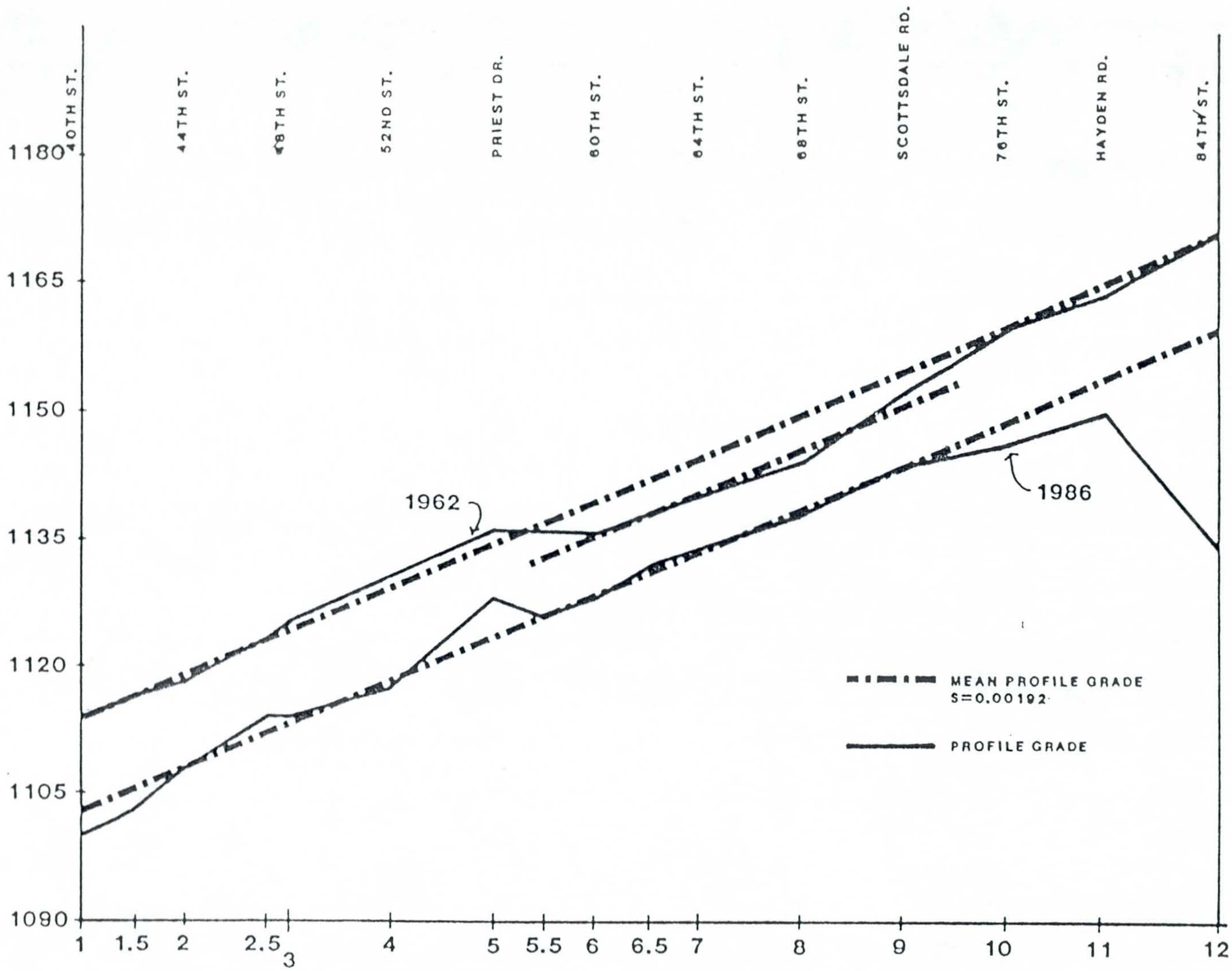

Figure 2. Bed Profile Change 1962 to 1986.

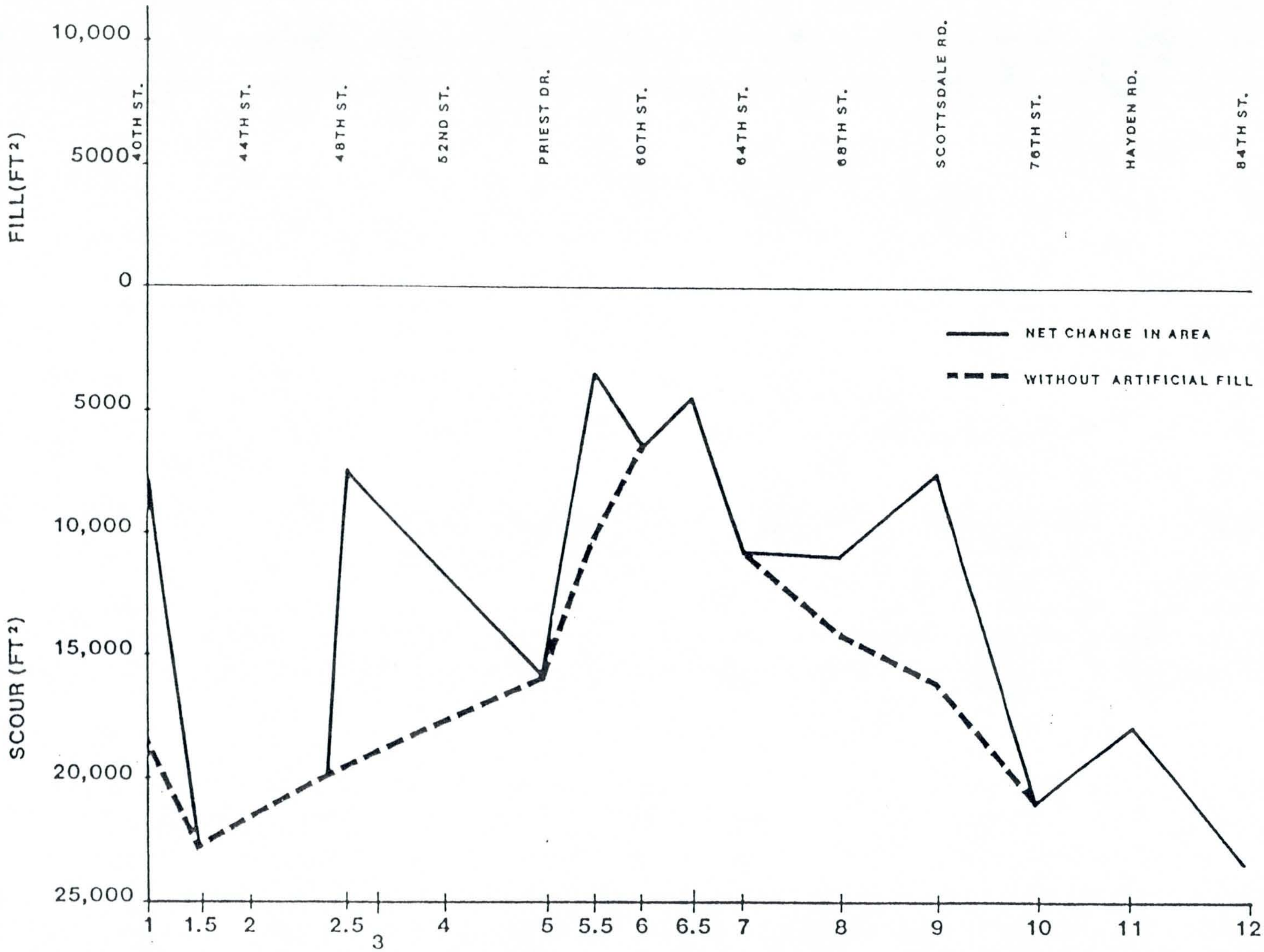

Figure 3. Change In Channel Cross-Sectional Area 1962 to 1986.

protective levee was completed in 1986 to restrain the lateral movement of the channel.

Since several channels have commenced downcutting in the Priest Drive to 40th Street reach, the future location of the river channel is uncertain. Locations of the highway alignment on the north bank of the river could potentially affect the stability of the river channel near the south bank. Because of this inherent instability, it was found that channelization provided the best means of controlling river behavior. Additional benefits were shorter bridge lengths, and an availability of borrow material from the new channel alignment.

II. DESIGN CRITERIA AND METHODOLOGIES

2.1 Introduction

The channel concept, that was prepared during the location study, flagged a number of issues for the design phase of the project. Issues identified included: the proximity of existing landfills to the proposed channel banklines; channel capacity/levee heights; scour profile between grade-control structures; toedown requirements for channel bank protection; upstream and downstream impacts resulting from channelization; and, use of channel banks and bed for landscape features. Early on in the design concept phase of the project, the Flood Control District of Maricopa County was consulted regarding these issues. The engineering staff of the FCD responded by informing the design team of their criteria. However, several aspects of this project presented new problems that had not been previously encountered by FCD. To maintain close communication on all issues regarding the channel, the planning division of the FCD assigned one of their staff as a liaison to the project.

Other municipalities and affected parties were also involved in the concept design via their liaison staff, which were established during the location phase of the project. The cities of Tempe and Phoenix were actively involved, and representatives of the Salt River Project. The U.S. Fish & Wildlife Service and the Arizona Game and Fish Department were involved in the issue of replacement of natural riparian habitat due to freeway and channel construction.

The design criteria which emerged from this coordination are presented in the following section. The criteria are broken down into three areas: 1) hydraulic design; 2) landscaping and aesthetic considerations; and, 3) habitat loss mitigation. The hydraulic design criteria address the primary issue of flood protection and channel stability. The landscaping and aesthetic considerations address many of the planned secondary uses of the channel for recreation. The habitat mitigation criteria address replacement of natural riparian habitat lost due to alteration of the Salt River floodplain.

2.2 Design Criteria

2.2.1 Hydraulic Design Criteria

The hydraulic design criteria cover requirements for channel capacity, scour protection, and analysis of changes in river regime upstream and downstream of the project.

1. The channel alignment will be set to avoid including existing landfill areas within the channel section.
2. Backwater analysis will be conducted for 10-, 50-, 100-, and Standard Project (SPF) floods for existing and channelized conditions.
3. General scour analysis will be conducted for the SPF event for the channelized condition showing impacts upstream and downstream of the channelized reach.
4. Channel capacity/levee height will be designed to convey the SPF event.
5. Protection for channel banks, grade-control structures, and levees will be designed for the SPF, using a factor of safety = 1.10.
6. Standards for rock quality for bank protection must meet the following specifications: Specific Gravity, ASTM C127 - 2.5 min.; Absorption, ASTM C127 - 2.0% max.; Wetting & Drying, 15 cycles - no fracturing; Magnesium Sulfate, ASTM C88 - 10% max.; Abrasion, ASTM C535 - 50% max.

2.2.2 Landscaping and Aesthetic Design Criteria

The landscaping and aesthetic design criteria evolved primarily in consultation with the City of Tempe. The concepts were reviewed in consultation with the Flood Control District, related to issues of channel debris and flow retardance. For the reach of the channel from 48th Street to the eastern limit of the project, the river channel is largely within the city limits of Tempe. That portion of the City of Tempe has been designated as a special overlay district by the City of Tempe known as the Tempe Rio Salado District. Planned development in the district calls for upgrading of the river environment and development of the floodplain fringe. To conform to the City's plans, criteria were adopted for the hydraulic features that would permit additional landscape features.

1. Access to the channel bed and banks for cycling and jogging trails. Access roads to the channel bed would be provided at approximately half-

mile intervals from both channel banks.

2. Development of a composite bank stabilization design that will permit approximately half of the bank slope to be landscaped with appropriate vegetation or other materials.
3. Development of a bank stabilization design that permits variation in the channel bank slope and the alignment of the bank line.

2.2.3 Habitat Mitigation

The location of the East Papago Freeway and the relocated Salt River channel will remove existing riparian habitat resources from both banks of the Salt River. As part of the Environmental Assessment prepared for the East Papago Freeway, ADOT committed to replace the lost habitat in-kind. The U.S. Fish and Wildlife Service and the Arizona Fish and Gam stated their requirements for riparian revegetation. The amoun habitat was quantified as follows:

147 acres - Desert scrub habitat

37 acres - Cottonwood/mesquite/salt cedar habitat

in a 3 mile reach the attenuation is minimal especially that there are no overbank storage.

To mitigate this loss, a commitment was made in the Secti application to develop 50 contiguous acres (or the equivalent) of mesquite/ salt cedar habitat as part of the freeway construction. Preparation of a habitat mitigation plan using the "Riparian Revegetation Considerations and Requirements" outline prepared by the U.S. Fish and Wildlife Service is planned once a site is selected.

NOT DESIRABLE

2.3 Hydrologic Criteria and Methodologies

Discharges used in the hydraulic analyses were based on values presented in the May 1982 Central Arizona Water Control Study (CAWCS) and the 1983-1984 Salt River Flood Insurance Study conducted by the Corps of Engineers. For the channelized conditions, only one discharge was used throughout the entire reach under the assumption that there would be little attenuation of the flood wave. This assumption represents the worse case conditions for flood-wave propagation in the channel. Since the dynamics of the flood-wave propagation were not analyzed in this study, this approach provides a conservative assessment of downstream impacts. It is assumed that if changes mile intervals from both channel banks.

2. Development of a composite bank stabilization design that will permit approximately half of the bank slope to be landscaped with appropriate vegetation or other materials.
3. Development of a bank stabilization design that permits variation in the channel bank slope and the alignment of the bank line.

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147 acres - Desert scrub habitat

37 acres - Cottonwood/mesquite/salt cedar habitat

To mitigate this loss, a commitment was made in the Section 404 permit application to develop 50 contiguous acres (or the equivalent) of mesquite/ salt cedar habitat as part of the freeway construction. Preparation of a habitat mitigation plan using the "Riparian Revegetation Considerations and Requirements" outline prepared by the U.S. Fish and Wildlife Service is planned once a site is selected.

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For baseline conditions, the following discharges were used:

Discharge, cfs				
10-year	50-year	100-year	SPF	Location
91,000	155,000	205,000	285,000	I-10 Bridge
92,360	158,400	210,200	287,720	Hohokam Bridge
93,000	160,000	215,000	289,000	Mill Ave. Bridge

You mean "averaging"?

The following discharges were used for the channelized conditions:

10-year: 93,000 cfs
50-year: 160,000 cfs
100-year: 215,000 cfs
SPF: 289,000 cfs

Hydrographs for sediment transport analysis were developed based on recorded hydrographs at Granite Reef Dam and flood volume estimates from the CAWCS report. The flood hydrograph shape was determined by normalizing two recorded flood events that occured on 3/1/78 and 12/15/78 (see Figure 4). These two normalized hydrographs are sufficiently similar, that the resulting average normalized hydrograph is selected as the typical hydrograph for this analysis. The duration of the normalized hydrograph is 10 days. The 10-day flood volume and the peak discharge for each flood event were obtained from the CAWCS report for the 100-year and Standard Project Flood events. It was found that the volume of the normalized flood hydrograph was slightly greater than the CAWCS volumes and that is was necessary to adjust the ordinates of the recession limb in order to match the CAWCS volume (see Figure 5).

2.4 Hydraulic Criteria and Methodologies

2.4.1 Water-Surface Profile Calculation Procedure

Two water-surface profile programs were used in combination for the rigid boundary analysis of the Salt River. The Bridge Waterways Analysis Model (WSPRO) was used at each bridge location, and Corp of Engineers

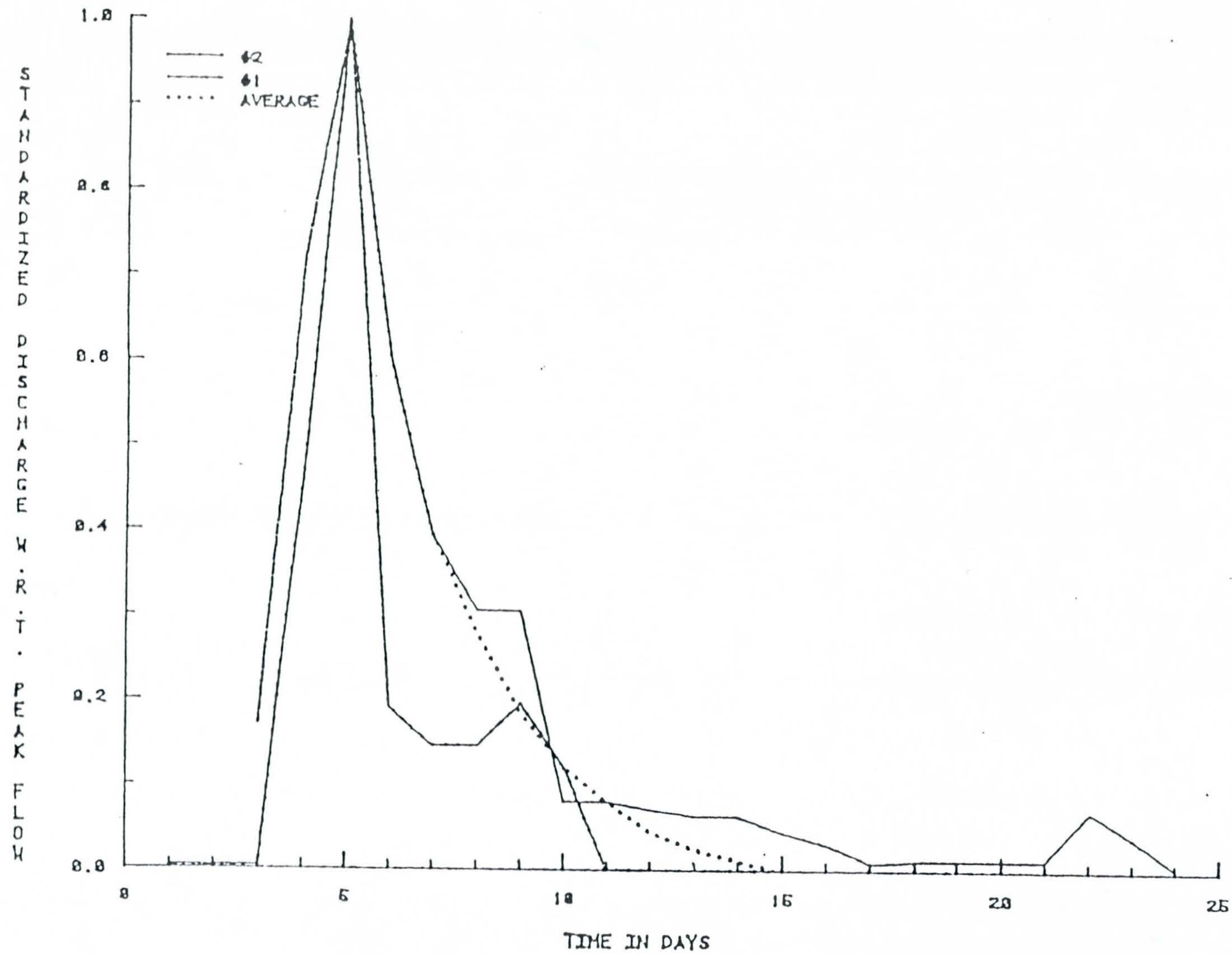


Figure 4. Hydrographs for Salt River.

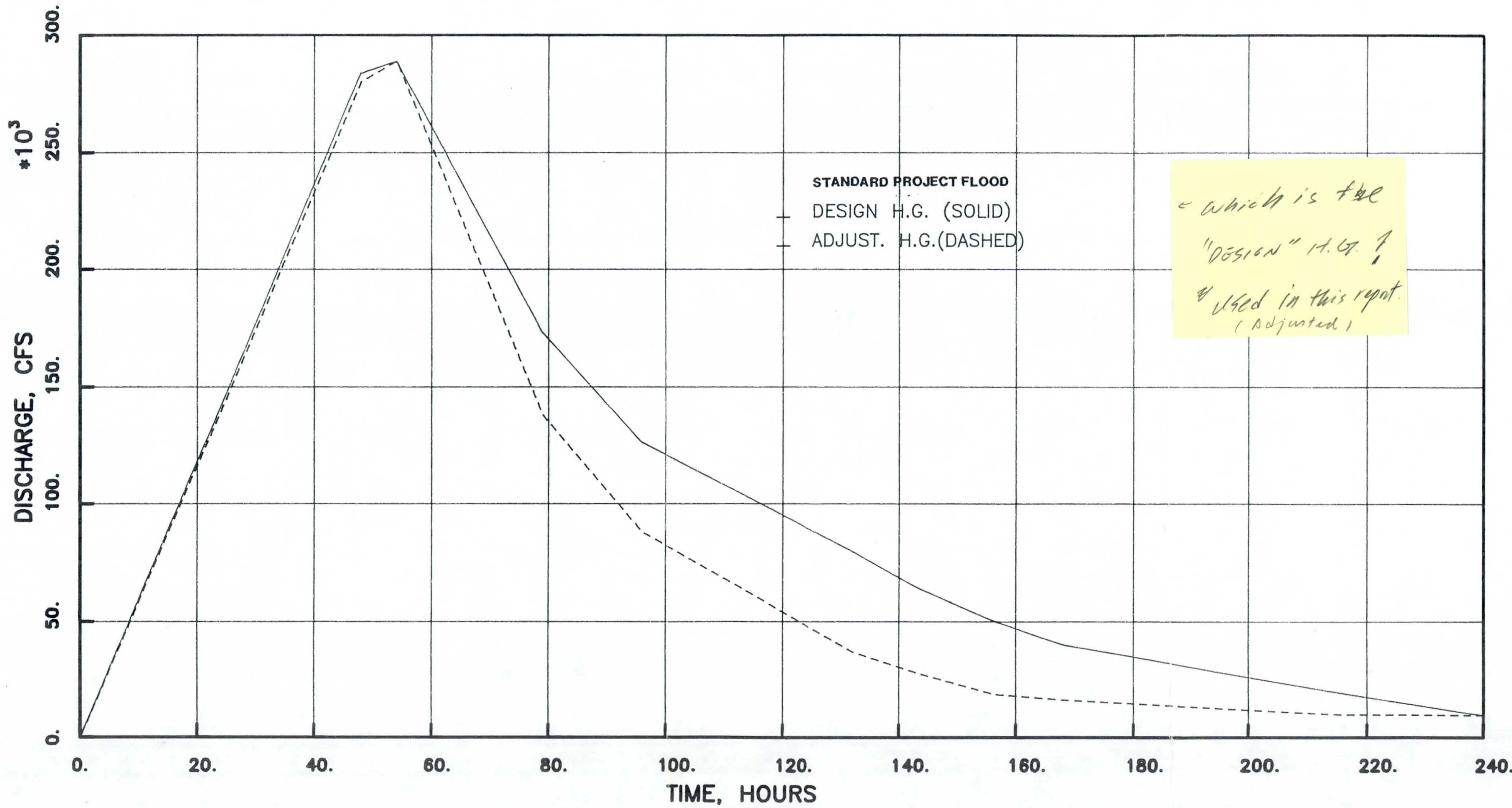


Figure 5. Design Hydrographs for the Salt River

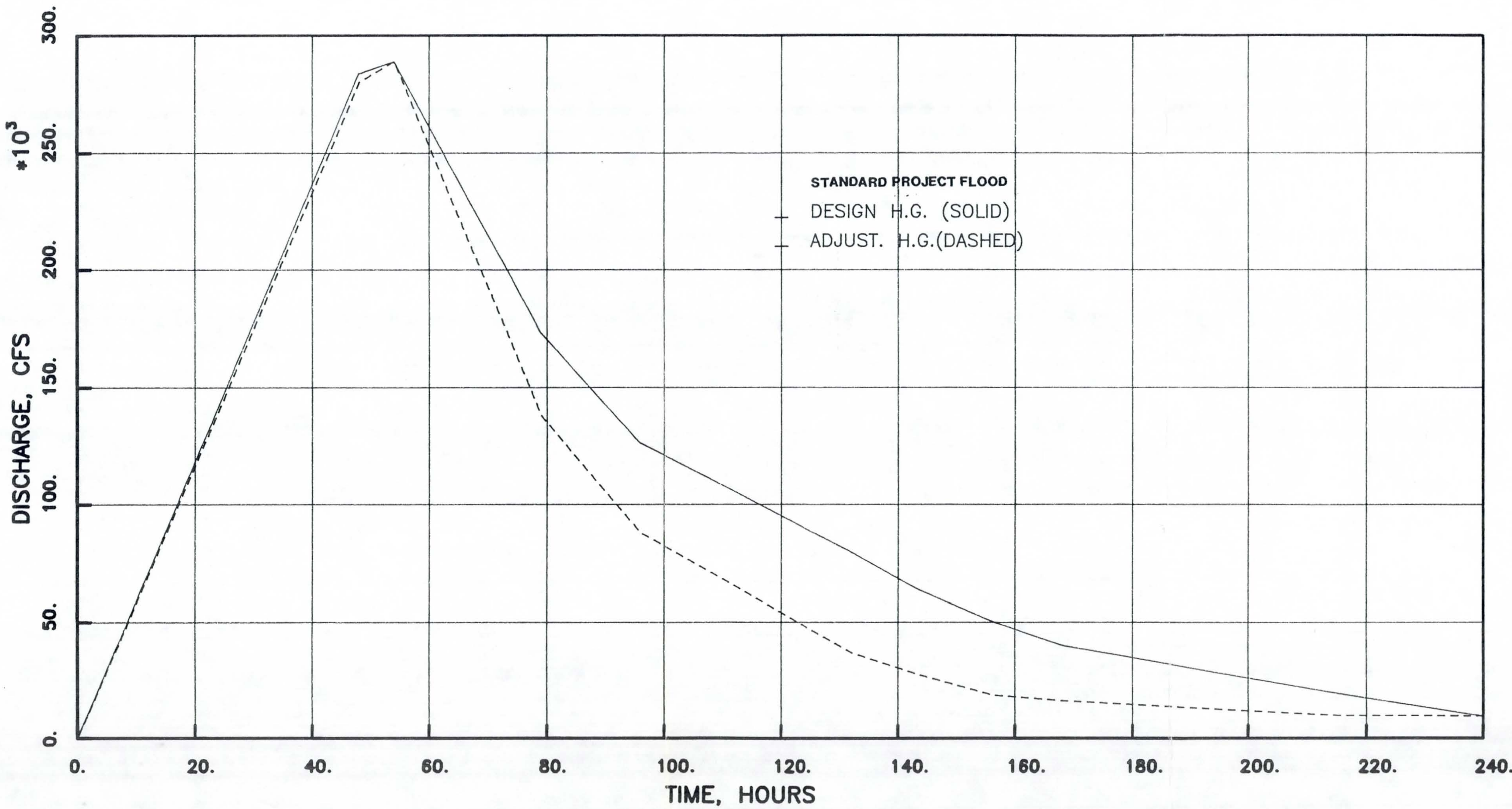


Figure 5. Design Hydrographs for the Salt River

backwater program, HEC-2, was used for the intervening reaches of river. The WSPRO program is specifically oriented toward the hydraulic design of bridges. A number of features of this program facilitate the analysis of complex bridge sites, which was necessary in evaluating the upstream impact of channelization for the group of bridges near Mill Avenue. Baseline conditions included the existing Hohokam Expressway bridge and existing bridges above the upstream limit of channelization: Southern Pacific Railroad, Ash Avenue, Mill Avenue, Scottsdale Road, and Hayden Road. The proposed condition removes the Hohokam Expressway bridge and includes new bridges at State Route 153, the Hohokam Freeway, and Priest Drive, that cross the channelized reach. All existing bridges above the channelized reach were included in the proposed condition.

The procedure that was followed, for the combined use of both models, involved running HEC-2 up to the exit reach downstream of each bridge, and then running WSPRO, using the upstream calculated water-surface elevation from the most upstream HEC-2 reach. Upstream of the bridge, the procedure was reversed with the HEC-2 run continuing using a starting water surface elevation calculated by WSPRO.

2.4.2 Downstream Boundary Conditions

Starting water surface elevations for the rigid boundary analysis are based on the 1983-84 Salt River Flood Insurance Study. The rigid boundary analysis begins 120 feet upstream of the Interstate 10 bridge across the Salt River at cross-section 16.927, of the Flood Insurance Study. The water surface elevation for the 100-year flood (205,000 cfs) at section 16.927 is 1106.99 feet. This water-surface elevation accounts for the hydraulic effect of the downstream grade-control structure and the bridge waterway at this location.

2.4.3 Topograph Datasets

The topographic information for the hydraulic modeling was provided by Kenney Aerial Mapping. From upstream of the I-10 bridge to 40th Street, the cross sections were digitally encoded by Kenney Aerial. SLA encoded the cross-section data for the reach from 40th Street to Hayden Road from contour maps. Cross-sections for the channelized reach of the preferred alternative are hypothetical.

A control line was established along the dominant streamline for the 100-year flow condition (see Exhibit A). From the initial downstream cross section up through the proposed channelization, this control line follows the channel centerline. The point where a cross section intersects the control line is set at the horizontal distance of 10,000 feet.

The cumulative flow distance is measured along the control line beginning at the downstream cross section and continuing up to Mill Avenue. The first cross section corresponds to station 24+12 on the control line, and station 100+00 corresponds to the beginning of the proposed channelization alignment near 40th Street.

2.4.4 Energy-Loss Coefficients

Near I-10, the roughness coefficients used coincide with the 1983-84 Flood Insurance Study values of 0.03 and 0.04 for the main channel and overbanks, respectively. In the Sky Harbor reach which ends at 40th Street, the roughness coefficient is set at 0.035. The proposed channel from 40th Street to Mill Avenue also uses a roughness coefficient of 0.035. For the baseline condition above 40th Street, the roughness coefficient is set to 0.04 for the channel and overbanks. Supporting documentation for channel roughness characteristics in the Salt River is provided in the location study based on flow measurements taken by the U.S. Geological Survey. This analysis indicated n-values in the range of 0.035 to 0.045 for large magnitude flood events with most values falling near 0.040.

Expansion and contraction coefficients are set at 0.3 and 0.1, respectively, for the HEC-2 model. The WSPRO fixed geometry routine was used for each of the existing bridges. The expansion and contraction coefficients for bridge waterways are set as values of 0.5 and 0.1, respectively, for the WSPRO model. The larger expansion coefficient for bridge waterways indicates the more severe nature of the expansion for this case compared to a natural river section. The coefficient of discharge is calculated by the program based on one of four possible bridge opening types as specified by the user.

SPF = 289,000 cfs
Q_{100} = 215,000 cfs
Table 3

2.4.5 <u>Bridge Information</u>

The bridge crossings are major elements of the channel design. The bridge hydraulic design criteria are set to provide a stable bridge site sufficient to convey the channel capacity, and with foundation depths below anticipated scour depths. Since the channel capacity is designed to convey the SPF, the recommended low chord for the bridges is one foot above that flood level. This will provide a minimum of four feet of freeboard above the elevation of the 100-year flood. This freeboard is sufficient to permit the passage of large debris, and to accommodate surface waves. Scour depths at the bridges were based on local and general scour conditions for the SPF, which conforms with the channel design criteria.

Nine bridge sites were evaluated during the study, six existing bridges and three proposed bridges. A total of eight bridges will cross the Salt River upon completion of the project. Table 1 summarizes the bridge waterway characteristics for each of the sites.

2.4.6 <u>Ineffective Flow Locations</u>

Upstream of the channelization, encroachment stations were located along the toe of the proposed East Papago freeway embankment to simulate encroachment of the freeway on the river floodplain. The baseline run does not contain these highway encroachments, while channelized analysis does.

Encroachments were also included for ineffective flow areas on the south bank near the Southern Pacific Railroad, Ash Avenue, Mill Avenue, and Hayden Road bridges. Since WSPRO does not have this option available, a vertical wall was encoded in the cross-section data to represent the encroachment.

2.5 <u>Stability and River Mechanics</u>

A river mechanics analysis was conducted to identify the size and type of stabilization measures required for the proposed channelized reach of the Salt River. The river mechanics analysis was also conducted to quantify the upstream and downsteam impacts of the project and the need for mitigation measures in these reaches. The channel design criteria are set to provide freeboard adequate to contain the SPF, and toedown for bank stabilization and

TABLE 1

BRIDGE WATERWAYS CHARACTERISTICS

Location	Status	WSPRO Type	Skew	Low Chord Elevation	Bridge Width, ft	Channel Width, ft	No. of Bents	Pier Shape
SR 153*	planned	3	0	1140.0	80	1046	7	cylindrical
Hohokam Expressway	existing	3	15	1125.3	46	457	6	cylindrical
Hohokam Frwy*	planned	3	21.6[1]	1140.0	111[1]	1046	8[2]	cylindrical
Priest Drive*	planned	3	0	1155.0	81	946	7[2]	cylindrical
SPRR	existing	3	9	1160.9	25	1706.3	38[3]	round
Ash Avenue	existing	2	10	1169.0	20	1418.3	10	round
Mill Avenue	existing	2	29	1170.0	55	1452	9	square nose and tail
Scottsdale Road	existing	3	0	1170.9	85	1329	10	cylindrical
Hayden Road	existing	3	15	1172.5	86	1157	10	cylindrical

* Estimated dimensions

[1] Average
[2] Aligned to flow
[3] Includes 28 trestles

grade-control structures below the scour depth associated with the SPF.

The river mechanics analysis consisted of a multi-level approach, which evaluated the river in both qualitative geomorphic terms and using a variety of engineering models. The qualitative geomorphic analysis was conducted during the location phase of the study and is reported in Technical Memoradum No. 4 of the Location and Design Report (ADOT, 1987). Computational models were used to assess the magnitude of local scour and general scour. Mathematical models were used for the analysis of bend scour, pier scour, and bedform movement. A computer model of river response was used to estimate the general aggradation and degradation along the channel reach.

QUASED-WSPR, a quasi-dynamic sediment routing program developed by SLA, which uses the backwater profile program WSPR, was used to determine the amount of material either transported or deposited in the river reach by the 100-year and SPF flood events. The backwater component of the model was initially compared to the results of HEC-2 and WSPRO analysis. Procedures for estimating local effects in the river channel are conducted separately using methods from Design Manual for Engineering Analysis of Fluvial Systems (SLA, 1985), which was prepared for the Arizona Department of Water Resources.

The bed-material gradation data was gathered as a part of the preliminary geotechnical investigation (SHB, 1988). Thirty bed-material samples were collected, classified, and the grain-size distributions determined. The sample population was separated into two groups: the first group indicates the gradation of the surface layer as shown in Figure 6; and the second group indicates the more variable gradation of the sand bars and dunes as shown in Figure 7. The model gradations include an estimate of the surface and subsurface layers in the channel. The surface layer was characterized as the mean of the sampled population of the surface layer. The subsurface layer was characterized as the lower envelope of the dune and bar sample population. Both model gradations were skewed slightly to include the largest sizes present in the Salt River (approximately 450 mm). The amount of this unmeasured largest size was estimated by plotting both gradation on log-normal probability paper.

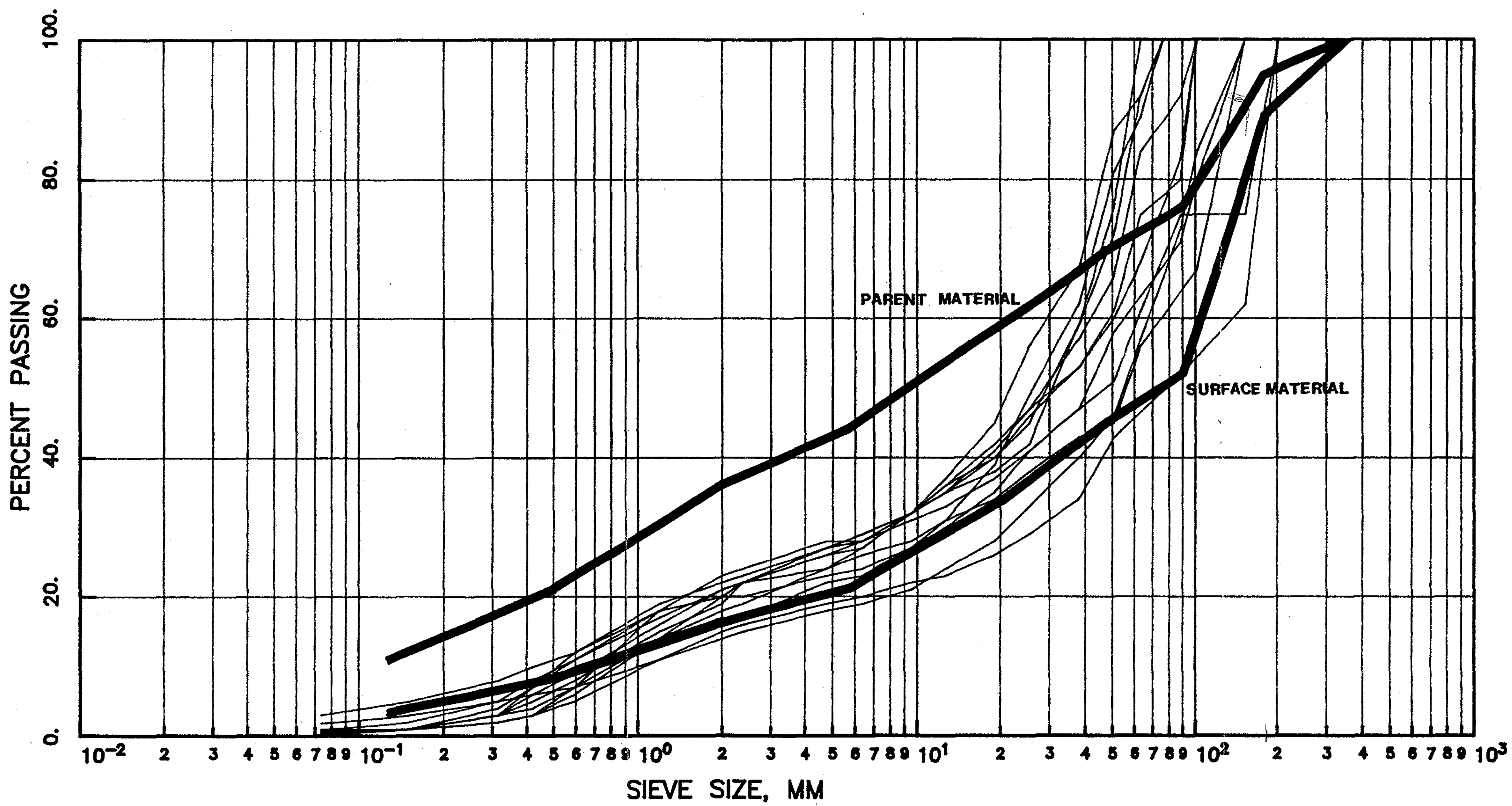


Figure 6. Surface-Layer Gradation Samples

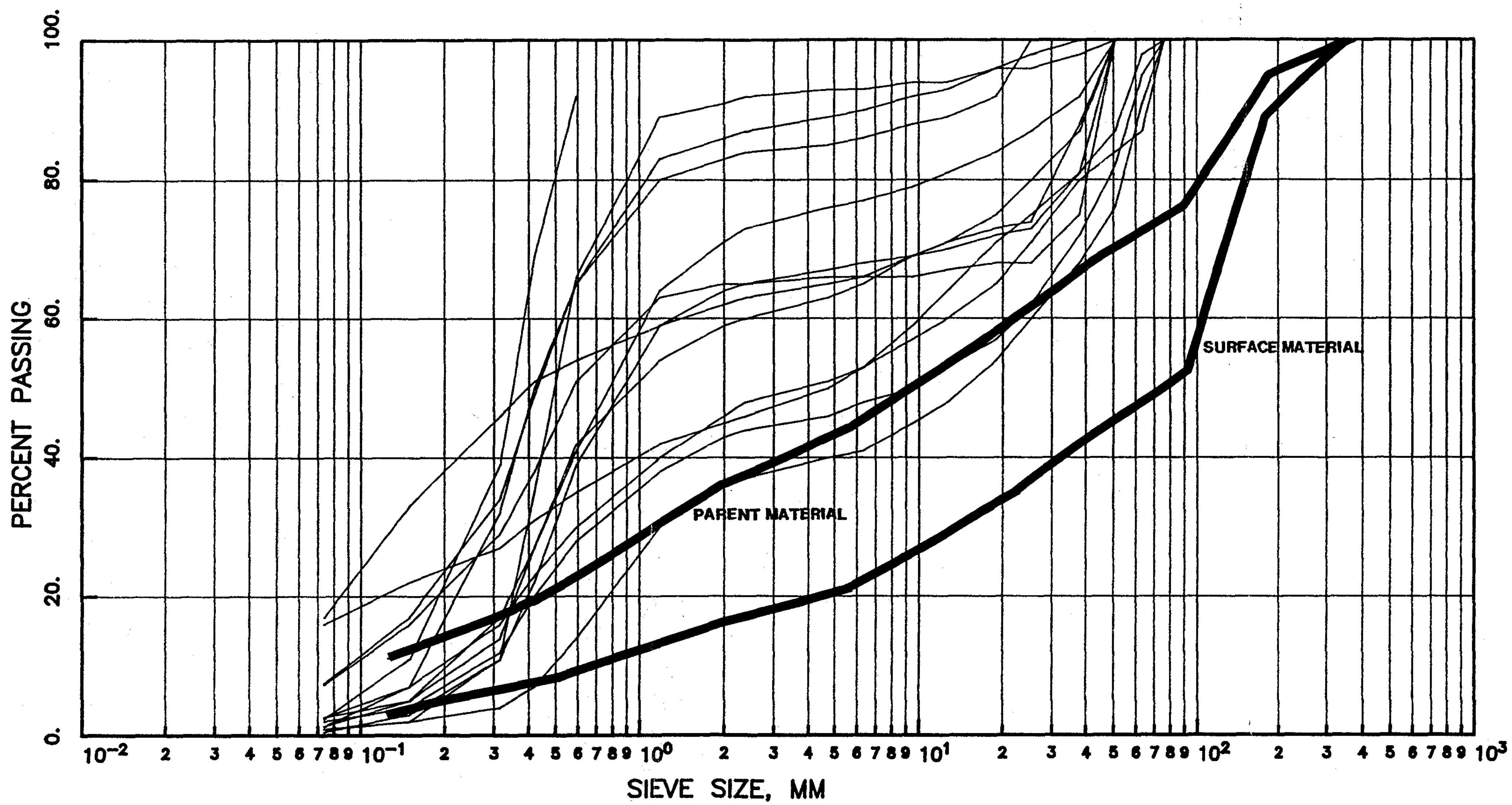


Figure 7. Bar and Dune Gradation Samples

III. MAJOR DESIGN ELEMENTS

3.1 Channel Alignment, Section and Profile

3.1.1 Channel Alignment

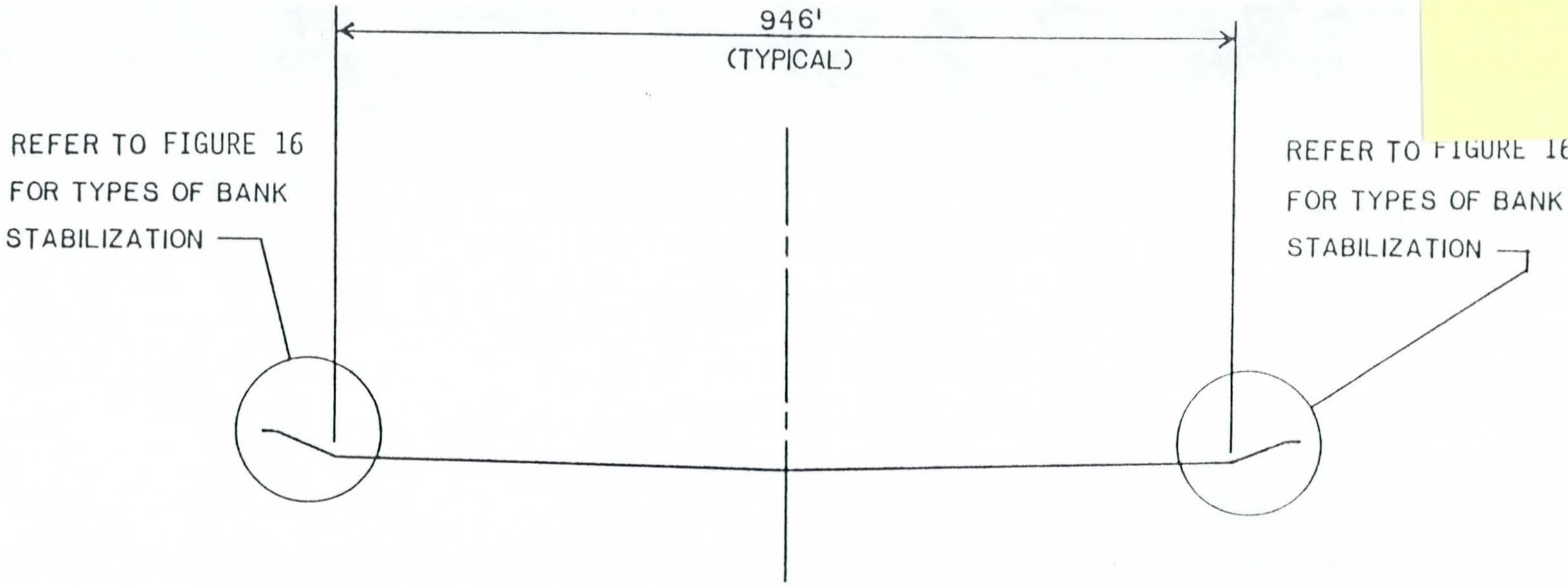
The channel alignment, as shown in Exhibit A, is set to gradually redirect the flow of the river from its location at Mill Avenue to the Sky Harbor channel entrance. The location of the north bank of the channel is constrained by the proposed alignment of the Papago Freeway that was set during the location study. This encroachment consists primarily of the ramps for the Hardy interchange that parallel the channel section for about 3000 feet, and extend laterally into the channel for a maximum distance of 150 feet. The landfills on the south bank of the river from College Drive to the Southern Pacific Railroad constrain the alignment of the channel on the south bank. The approximate location of the landfills is shown in Figure 13. This results in a channel alignment that bears slightly north, until it curves south downstream of Priest Drive to align with the Sky Harbor Channel. The resulting channel alignment creates a slight skew at the proposed bridges for State Route 153, the Hohokam Freeway, and Priest Drive.

The new channel will require two bends in the Salt River alignment: one bend between the Hohokam Freeway to Priest Drive, and the second bend as the channel meets the existing Sky Harbor channel. Both bends have a radius of curvature to channel width ratio of approximately 5:1, which is a relatively mild channel bend. There will be a change in the sinuosity of the low flow braid of the Salt River in this reach as a result of channelization. The sinuosity is reduced from 1.13 for the existing condition to 1.03 for the channelized condition. The sinuosity of the channel during high flows remains the same at 1.03. Basically the Salt River is quite straight in this reach, for either the existing or channelized conditions and the change in low-flow sinuosity is not expected to adversely effect the long-term stability of the river.

3.1.2 Channel Cross-Section

A five-point channel cross-section is proposed for the channelized reach. A typical channel section is shown in Figure 8. Banks for the channel are set at an average slope of 3:1 (horizontal to vertical), which provides for adequate room for bank stabilization measures and landscaping

Figure 19?



NOTE: REFER TO FIGURE 1
FOR PLACEMENT OF
BANK STABILIZATION.

FIGURE 8
TYPICAL CROSS SECTION
PAPAGO CHANNELIZATION

DMJM

Daniel, Mann, Johnson, & Mendenhall
Suite 400
300 West Clarendon Avenue
Phoenix, Arizona 85013-3499

features. The channel depth is approximately 25 feet from top-of-bank to channel invert. Toe-of-bank elevations are six feet higher than the channel invert. This results in a v-shaped channel invert with a lateral gradient of 1.3 percent.

The bottom width of the channel varies from 946 feet to 846 feet (with a corresponding top-width variation of 1060 feet to 960 feet). The narrowest reach is from the channel entrance near the Southern Pacific Railroad (station 270+00) to downstream of Priest Drive (station 200+25). The channel transitions to its full width through the bend upstream of the Hohokam Freeway bridge (station 200+25 to 170+58). Downstream of this bend, the channel is at its full bottom width of 946 feet.

The section transitions to the existing 8-point channel section that is used in the Sky Harbor channel just upstream of 40th Street at station 106+40. The north and south banks tie into the existing channel banks of the Sky Harbor channel at stations 116+00 and 128+00, respectively.

The channel bottom width provides adequate room for a low-flow channel to develop. No specific provisions are made for a low-flow channel, although such a feature could be developed in conjunction with specific landscape plans for the channel. Since the sinuosity of the low flow channel has been reduced, it is expected that a low flow channel will form within the main channel boundary with a slightly higher sinuosity compared to the main channel. It is expected that the area between the channel banks will be subject to frequent flooding and shifts in low-flow channel alignment. Because of the inherent problems of providing a predictable low flow alignment, the channel section does not include a specific low-flow channel section.

3.1.3 Channel Profile

The existing channel profile for the Salt River falls at a gradient of 0.002 ft/ft or approximately 10 feet per mile. This is a relatively steep gradient for a river of this size, and results in high-flow velocities and boundary shear stresses during major floods. As shown in Exhibit B, the initial gradient of the channelization is set at a uniform slope that is approximately equal to the existing channel gradient. Because the channelized reach concentrates flood flows and provides stabilized banks, vertical adjustment of the river profile will occur. Grade-control structures are, therefore, necessary to stabilize the river profile.

3.1.4 Water-Surface Profiles

The results of the water-surface profile computations are summarized in Table 2 for the baseline condition and in Table 3 for the channelized condition. Water-surface profiles for the 10-, 50-, 100-, and SPF floods are tabulated for both conditions. Hydraulic variables are tabulated in Tables 4 and 5 for the 100-year baseline and channelized conditions, respectively. Tables 6 and 7 present the same set of hydraulic variables for the SPF flood for both conditions.

Plots of the 100-year and SPF flood elevations for the baseline condition are given in Figure 9. Figure 9a shows the water-surface profiles for the reach downstream from the project, which extends from I-10 to 40th Street. Note in this profile that at station 90+, a constriction in the cross-sectional area occurs for an airport facility, which results in locally increased water-surface elevations. Figure 9b shows the water-surface profiles in the project reach, and Figure 9c shows the profile upstream of the project in the reach from the Southern Pacific Railroad bridge to Hayden Road. The water-surface profiles for the channelized condition are given in Figure 10. The reach from I-10 to 40th Street is given in Figure 10a; the project reach is shown in Figure 10b; and the upstream reach from the Southern Pacific Railroad bridge to Hayden Road is shown in Figure 10c.

Comparative plots of the changes in water-surface elevation and average velocity are given in Figures 11 and 12, respectively. Figure 11a shows an increase in water-surface elevations in the reach downstream of the project of 0.4 to 0.5 feet. This increase is the result of an increased river discharge due to channelization from 205,000 cfs to 215,000 cfs. There is a small corresponding increase in channel velocity as shown in Figure 12a. Thru the project reach, there is a general lowering of the 100-year flood elevation and a corresponding increase in channel flow velocities, as shown by Figures 11b and 12b. There is a local increase in the water-surface elevation that exceeds 1.0 feet from station 260+ to 285+, which is caused by the contraction of the river flow from the natural section to the channelized section and the bridges below Mill Avenue. This large increase in backwater

Carried downstream to Painted Rock Dam?

Continued on p. 61

TABLE 2

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Baseline Water-Surface Elevations

SALT RIVER
BASELINE CONDITIONS

Station Number	Water Surface Elevation 10 Year	50 Year	100 Year	SPF
24+12	1098.79	1104.46	1107.00	1110.45
27+35	1099.14	1104.62	1107.09	1110.44
28+35	1099.19	1104.65	1107.11	1110.46
29+35	1099.22	1104.67	1107.14	1110.48
30+35	1099.34	1104.81	1107.30	1110.67
31+35	1099.47	1104.98	1107.53	1110.98
32+35	1099.67	1105.30	1107.96	1111.56
33+35	1099.77	1105.43	1108.13	1111.77
34+35	1099.81	1105.49	1108.20	1111.88
35+35	1099.83	1105.53	1108.26	1111.98
36+35	1099.86	1105.56	1108.30	1112.04
37+35	1099.90	1105.61	1108.37	1112.12
39+35	1099.97	1105.71	1108.48	1112.26
40+35	1099.99	1105.72	1108.49	1112.27
41+35	1100.02	1105.75	1108.52	1112.30
42+35	1100.02	1105.75	1108.52	1112.30
43+35	1099.98	1105.68	1108.44	1112.18
44+35	1099.91	1105.58	1108.30	1111.99
45+35	1099.94	1105.61	1108.33	1112.01
46+35	1100.04	1105.72	1108.47	1112.19
47+35	1099.88	1105.45	1108.07	1111.59
48+35	1099.94	1105.51	1108.15	1111.68
49+35	1100.01	1105.57	1108.22	1111.77
50+35	1100.07	1105.63	1108.29	1111.85
51+35	1100.14	1105.70	1108.37	1111.95
52+35	1100.21	1105.77	1108.45	1112.05
53+35	1100.29	1105.84	1108.54	1112.15
54+35	1100.37	1105.92	1108.63	1112.27
55+35	1100.46	1106.01	1108.73	1112.39
56+35	1100.53	1106.07	1108.81	1112.48
57+35	1100.60	1106.13	1108.88	1112.56
58+35	1100.69	1106.22	1108.97	1112.68
59+35	1100.80	1106.32	1109.08	1112.81
60+35	1100.93	1106.43	1109.22	1112.98
61+35	1101.06	1106.54	1109.34	1113.13
62+35	1101.22	1106.68	1109.49	1113.31
63+35	1101.35	1106.79	1109.62	1113.46
64+35	1101.48	1106.90	1109.74	1113.59
65+35	1101.63	1107.02	1109.87	1113.75
66+35	1101.86	1107.22	1110.08	1113.99
67+35	1102.02	1107.36	1110.24	1114.17
68+35	1102.13	1107.45	1110.34	1114.27
69+35	1102.24	1107.53	1110.42	1114.37
70+35	1102.26	1107.54	1110.42	1114.36
71+35	1102.29	1107.54	1110.41	1114.34
72+35	1102.36	1107.55	1110.42	1114.34
73+35	1102.77	1107.73	1110.58	1114.48
74+35	1103.35	1107.98	1110.80	1114.68

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Table 2 (continued)

75+35	1103.78	1108.22	1111.00	1114.86
76+35	1104.15	1108.43	1111.18	1115.00
77+35	1104.64	1108.73	1111.43	1115.23
78+35	1104.92	1108.89	1111.56	1115.32
79+35	1105.32	1109.14	1111.76	1115.48
80+35	1106.07	1109.67	1112.21	1115.85
81+35	1106.61	1110.14	1112.63	1116.24
82+35	1107.01	1110.50	1112.95	1116.52
83+35	1107.32	1110.79	1113.22	1116.76
84+35	1107.77	1111.28	1113.71	1117.24
85+35	1108.11	1111.63	1114.05	1117.57
86+35	1108.38	1111.90	1114.33	1117.83
87+35	1108.59	1112.09	1114.49	1117.96
88+35	1108.64	1111.96	1114.22	1117.49
89+35	1108.75	1111.87	1113.97	1116.96
90+35	1109.05	1112.15	1114.20	1117.13
91+35	1110.06	1113.69	1116.19	1119.80
92+35	1110.86	1114.72	1117.35	1121.15
93+35	1111.48	1115.49	1118.22	1122.16
94+35	1111.86	1115.95	1118.74	1122.75
95+35	1112.05	1116.15	1118.94	1122.96
96+35	1112.24	1116.34	1119.13	1123.14
97+35	1112.24	1116.56	1119.36	1123.37
98+35	1112.59	1116.72	1119.51	1123.52
99+35	1112.70	1116.83	1119.62	1123.62
100+35	1113.01	1117.18	1119.99	1124.02
102+37	1113.09	1117.25	1120.06	1124.08
104+35	1113.49	1117.65	1120.44	1124.46
106+40	1113.83	1117.97	1120.75	1124.73
108+12	1114.31	1118.41	1121.17	1125.13
109+99	1114.98	1119.07	1121.83	1125.82
112+02	1115.56	1119.66	1122.42	1126.41
114+02	1115.82	1119.93	1122.70	1126.68
115+87	1116.34	1120.46	1123.22	1127.18
117+73	1116.73	1120.86	1123.62	1127.55
119+67	1117.03	1121.17	1123.93	1127.86
121+49	1117.71	1121.90	1124.70	1128.69
123+29	1118.03	1122.28	1125.17	1129.28
125+16	1118.47	1122.78	1125.71	1129.88
127+26	1118.90	1123.03	1125.91	1130.05
129+24	1119.40	1123.55	1126.46	1130.64
131+26	1120.75	1124.62	1127.43	1131.51
133+37	1121.09	1124.92	1127.71	1131.78
135+44	1121.31	1125.12	1127.89	1131.95
137+59	1121.64	1125.35	1128.08	1132.12
139+68	1121.94	1125.57	1128.26	1132.26
142+03	1122.37	1125.85	1128.48	1132.43
144+13	1123.11	1126.21	1128.73	1132.61
146+44	1124.15	1126.54	1128.97	1132.79
149+44	1126.23	1128.66	1130.08	1132.10
157+63	1128.35	1130.94	1132.48	1134.64
159+81	1129.81	1132.29	1133.80	1135.79
162+63	1130.18	1132.76	1134.35	1136.41
169+78	1130.86	1133.29	1134.81	1136.80

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Table 2 (continued)

174+58	1131.57	1133.94	1135.41	1137.36
178+38	1131.94	1134.28	1135.75	1137.68
181+53	1133.05	1135.29	1136.71	1138.57
183+53	1133.23	1135.50	1136.93	1138.80
185+48	1133.57	1135.89	1137.35	1139.23
188+03	1133.80	1136.17	1137.64	1139.55
190+75	1134.13	1136.50	1137.98	1139.89
193+60	1134.73	1136.99	1138.44	1140.33
196+40	1135.43	1137.59	1139.01	1140.88
199+20	1136.03	1138.13	1139.53	1141.38
201+50	1136.52	1138.62	1140.02	1141.87
203+40	1136.86	1138.99	1140.39	1142.25
205+32	1137.20	1139.35	1140.77	1142.63
207+32	1137.61	1139.79	1141.23	1143.11
209+37	1138.02	1140.26	1141.73	1143.65
211+09	1138.13	1140.37	1141.83	1143.74
212+79	1138.51	1140.75	1142.22	1144.13
214+64	1138.83	1141.09	1142.56	1144.49
216+42	1139.02	1141.28	1142.76	1144.68
217+97	1139.26	1141.58	1143.05	1144.97
219+77	1139.51	1141.83	1143.31	1145.21
221+82	1139.83	1142.18	1143.67	1145.60
223+77	1140.13	1142.51	1144.01	1145.96
225+72	1140.47	1142.88	1144.42	1146.39
227+70	1140.86	1143.34	1144.91	1146.93
229+72	1141.06	1143.56	1145.15	1147.18
231+80	1141.21	1143.67	1145.24	1147.26
233+75	1141.51	1144.00	1145.59	1147.63
235+75	1142.03	1144.79	1146.48	1148.68
237+74	1142.29	1144.90	1146.55	1148.76
239+70	1142.68	1145.53	1147.35	1149.84
241+70	1143.00	1145.99	1147.85	1150.39
243+70	1143.50	1146.93	1148.93	1151.34
244+70	1143.82	1147.22	1149.22	1151.62
246+70	1144.17	1147.53	1149.51	1151.87
248+80	1144.84	1148.41	1150.40	1152.73
250+85	1145.14	1148.78	1150.77	1153.10
252+87	1145.61	1149.46	1151.61	1154.11
254+87	1146.07	1150.21	1152.52	1155.14
256+87	1146.22	1150.26	1152.53	1155.09
258+88	1146.55	1150.57	1152.83	1155.41
260+90	1146.83	1150.92	1153.22	1155.83
262+90	1147.21	1151.40	1153.75	1156.44
264+90	1147.37	1151.50	1153.81	1156.46
266+91	1147.57	1151.78	1154.19	1156.93
268+91	1147.73	1151.95	1154.37	1157.09
270+90	1148.21	1152.48	1154.95	1157.81
272+94	1148.39	1152.66	1155.10	1157.94
274+94	1148.59	1152.84	1155.27	1158.09
276+94	1148.69	1152.93	1155.35	1158.13
278+96	1148.88	1153.07	1155.46	1158.30
282+76	1149.28	1153.41	1155.83	1158.60
284+58	1149.65	1153.67	1156.03	1158.61
286+32	1149.95	1153.94	1156.29	1158.86

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Table 2 (continued)

288+24	1150.17	1153.99	1156.37	1158.79
289+94	1150.74	1154.65	1157.09	1159.64
297+02	1151.71	1155.81	1158.55	1161.61
299+02	1151.95	1156.16	1158.94	1162.02
301+02	1152.29	1156.50	1159.26	1162.32
303+02	1152.50	1156.74	1159.51	1162.58
305+02	1152.79	1157.00	1159.73	1162.78
307+02	1153.04	1157.27	1160.02	1163.11
308+93	1153.31	1157.58	1160.36	1163.52
311+05	1153.55	1157.88	1160.73	1163.95
313+05	1153.75	1158.04	1160.88	1164.09
315+05	1154.02	1158.27	1161.07	1164.26
317+05	1154.29	1158.48	1161.25	1164.42
319+05	1154.59	1158.70	1161.45	1164.63
321+05	1154.88	1158.91	1161.64	1164.81
323+05	1155.25	1159.26	1161.90	1165.01
325+05	1155.57	1159.60	1162.32	1165.51
327+05	1155.87	1159.99	1162.90	1166.05
329+05	1156.26	1160.48	1163.28	1166.36
331+05	1156.69	1160.82	1163.51	1166.52
333+05	1157.04	1161.09	1163.77	1166.74
336+26	1157.69	1162.51	1164.57	1167.70
341+07	1158.39	1162.70	1164.72	1167.48
343+07	1158.79	1163.05	1165.04	1167.70
345+07	1158.98	1163.20	1165.22	1167.91
347+07	1159.12	1163.27	1165.30	1167.96
349+07	1159.54	1163.86	1165.82	1168.31
353+07	1160.46	1164.41	1166.20	1168.51
357+07	1161.18	1164.99	1166.79	1169.01
361+07	1161.80	1165.56	1167.42	1169.62
365+07	1162.18	1165.76	1167.54	1169.74
369+07	1162.81	1166.50	1168.45	1170.83
373+07	1163.33	1167.03	1168.99	1171.51
377+07	1163.94	1167.78	1169.97	1172.16
381+07	1164.40	1168.19	1170.38	1172.84
385+07	1164.99	1168.73	1170.95	1173.03
388+79	1165.71	1170.55	1172.72	1175.65
401+04	1166.49	1170.62	1173.07	1176.45

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TABLE 3

Channelized Water-Surface Elevations

SALT RIVER

PREFERRED CONDITIONS

Station Number	—— Water Surface Elevation —— 10 Year	50 Year	100 Year	SPF
24+12	1098.98	1104.75	1107.43	1110.61
27+35	1099.32	1104.90	1107.51	1110.59
28+35	1099.37	1104.92	1107.53	1110.61
29+35	1099.41	1104.95	1107.56	1110.64
30+35	1099.53	1105.09	1107.73	1110.82
31+35	1099.66	1105.27	1107.97	1111.14
32+35	1099.86	1105.60	1108.42	1111.73
33+35	1099.97	1105.74	1108.59	1111.94
34+35	1100.01	1105.80	1108.67	1112.05
35+35	1100.03	1105.84	1108.74	1112.15
36+35	1100.05	1105.87	1108.78	1112.21
37+35	1100.09	1105.92	1108.85	1112.30
39+35	1100.17	1106.02	1108.97	1112.44
40+35	1100.18	1106.03	1108.97	1112.45
41+35	1100.21	1106.05	1109.00	1112.48
42+35	1100.22	1106.06	1109.01	1112.48
43+35	1100.17	1105.99	1108.91	1112.36
44+35	1100.11	1105.88	1108.77	1112.16
45+35	1100.14	1105.91	1108.80	1112.19
46+35	1100.23	1106.03	1108.94	1112.36
47+35	1100.08	1105.74	1108.52	1111.75
48+35	1100.14	1105.80	1108.60	1111.85
49+35	1100.20	1105.87	1108.68	1111.94
50+35	1100.26	1105.93	1108.74	1112.02
51+35	1100.33	1106.00	1108.83	1112.11
52+35	1100.40	1106.07	1108.91	1112.21
53+35	1100.48	1106.14	1109.00	1112.32
54+35	1100.56	1106.23	1109.10	1112.43
55+35	1100.65	1106.31	1109.20	1112.56
56+35	1100.72	1106.38	1109.28	1112.65
57+35	1100.79	1106.44	1109.35	1112.74
58+35	1100.88	1106.53	1109.45	1112.85
59+35	1100.99	1106.62	1109.56	1112.98
60+35	1101.12	1106.74	1109.70	1113.15
61+35	1101.25	1106.85	1109.83	1113.30
62+35	1101.41	1106.99	1109.99	1113.49
63+35	1101.54	1107.11	1110.12	1113.64
64+35	1101.67	1107.21	1110.24	1113.76
65+35	1101.81	1107.34	1110.37	1113.92
66+35	1102.04	1107.53	1110.59	1114.17
67+35	1102.20	1107.67	1110.75	1114.35
68+35	1102.31	1107.77	1110.85	1114.45
69+35	1102.41	1107.85	1110.94	1114.55
70+35	1102.44	1107.85	1110.94	1114.54
71+35	1102.46	1107.85	1110.93	1114.52
72+35	1102.53	1107.86	1110.93	1114.52
73+35	1102.93	1108.04	1111.09	1114.66
74+35	1103.49	1108.29	1111.30	1114.86

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Table 3 (continued)

75+35	1103.91	1108.52	1111.50	1115.04
76+35	1104.27	1108.73	1111.67	1115.18
77+35	1104.76	1109.02	1111.93	1115.41
78+35	1105.04	1109.18	1112.05	1115.50
79+35	1105.43	1109.42	1112.24	1115.65
80+35	1106.18	1109.94	1112.68	1116.03
81+35	1106.72	1110.40	1113.10	1116.41
82+35	1107.12	1110.76	1113.41	1116.69
83+35	1107.44	1111.05	1113.68	1116.93
84+35	1107.89	1111.53	1114.17	1117.41
85+35	1108.23	1111.88	1114.51	1117.73
86+35	1108.50	1112.16	1114.78	1118.00
87+35	1108.71	1112.34	1114.94	1118.12
88+35	1108.75	1112.19	1114.65	1117.65
89+35	1108.86	1112.10	1114.36	1117.10
90+35	1109.16	1112.36	1114.59	1117.27
91+35	1110.18	1113.95	1116.66	1119.97
92+35	1111.00	1114.99	1117.85	1121.33
93+35	1111.62	1115.78	1118.74	1122.34
94+35	1112.00	1116.25	1119.27	1122.94
95+35	1112.19	1116.44	1119.47	1123.14
96+35	1112.38	1116.63	1119.66	1123.32
97+35	1112.58	1116.86	1119.89	1123.56
98+35	1112.73	1117.01	1120.04	1123.71
99+35	1112.85	1117.12	1120.15	1123.81
100+35	1113.15	1117.48	1120.52	1124.21
102+37	1113.24	1117.55	1120.58	1124.25
104+35	1113.57	1117.86	1120.89	1124.54
106+40	1113.85	1118.11	1121.12	1124.76
108+00	1114.28	1118.48	1121.45	1125.04
110+00	1114.65	1118.84	1121.81	1125.39
112+00	1115.02	1119.21	1122.17	1125.73
114+00	1115.41	1119.58	1122.53	1126.09
116+00	1115.80	1119.96	1122.91	1126.45
118+00	1116.20	1120.35	1123.29	1126.82
120+00	1116.61	1120.75	1123.67	1127.19
122+00	1117.02	1121.15	1124.06	1127.57
124+00	1117.43	1121.55	1124.46	1127.96
126+00	1117.86	1121.96	1124.86	1128.34
128+00	1118.28	1122.38	1125.26	1128.74
130+00	1118.71	1122.79	1125.67	1129.13
132+00	1119.14	1123.21	1126.08	1129.53
134+00	1119.57	1123.63	1126.50	1129.94
136+00	1120.00	1124.06	1126.91	1130.35
138+00	1120.44	1124.49	1127.33	1130.76
140+00	1120.88	1124.92	1127.76	1131.17
142+00	1121.31	1125.35	1128.18	1131.59
144+00	1121.75	1125.78	1128.61	1132.00
146+50	1122.30	1126.33	1129.15	1132.53
150+00	1123.25	1127.24	1130.03	1133.36
151+00	1123.46	1127.45	1130.24	1133.58
152+00	1123.66	1127.66	1130.45	1133.79
156+00	1124.50	1128.50	1131.30	1134.63
160+00	1125.50	1129.50	1132.25	1135.55

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Table 3 (continued)

162+00	1125.91	1129.90	1132.67	1135.97
164+00	1126.32	1130.32	1133.09	1136.40
166+00	1126.74	1130.74	1133.52	1136.82
168+00	1127.16	1131.16	1133.94	1137.25
170+00	1127.59	1131.59	1134.36	1137.67
172+00	1128.01	1132.01	1134.79	1138.09
174+00	1128.44	1132.42	1135.19	1138.49
176+00	1128.87	1132.85	1135.61	1138.90
178+00	1129.31	1133.28	1136.04	1139.32
180+00	1129.75	1133.72	1136.47	1139.74
182+00	1130.21	1134.17	1136.92	1140.19
184+00	1130.68	1134.63	1137.38	1140.64
186+00	1131.15	1135.10	1137.84	1141.10
188+00	1131.62	1135.57	1138.30	1141.56
190+00	1132.10	1136.05	1138.78	1142.03
192+00	1132.58	1136.53	1139.27	1142.52
194+00	1133.06	1137.01	1139.75	1142.99
196+00	1133.54	1137.50	1140.24	1143.48
198+00	1134.02	1137.99	1140.73	1143.97
200+00	1134.51	1138.49	1141.23	1144.48
202+00	1135.00	1138.99	1141.75	1145.00
204+00	1135.51	1139.53	1142.30	1145.57
206+00	1136.01	1140.04	1142.83	1146.12
208+00	1136.49	1140.55	1143.35	1146.66
210+00	1136.97	1141.04	1143.85	1147.17
211+65	1137.37	1141.45	1144.27	1147.60
214+00	1138.28	1142.44	1145.26	1148.61
216+00	1138.69	1142.86	1145.70	1149.06
218+00	1139.09	1143.29	1146.14	1149.52
220+00	1139.51	1143.71	1146.57	1149.97
222+00	1139.93	1144.14	1147.01	1150.42
224+00	1140.35	1144.57	1147.45	1150.87
226+00	1140.77	1145.00	1147.89	1151.32
228+00	1141.20	1145.43	1148.33	1151.76
230+00	1141.62	1145.86	1148.77	1152.21
232+00	1142.05	1146.30	1149.21	1152.66
234+00	1142.49	1146.73	1149.64	1153.10
236+00	1142.92	1147.17	1150.08	1153.55
238+00	1143.35	1147.60	1150.52	1153.99
240+00	1143.79	1148.04	1150.96	1154.43
242+00	1144.22	1148.47	1151.40	1154.88
244+00	1144.66	1148.91	1151.84	1155.32
246+00	1145.10	1149.35	1152.28	1155.76
248+00	1145.53	1149.79	1152.72	1156.21
250+00	1145.96	1150.22	1153.15	1156.64
251+40	1146.39	1150.69	1153.66	1157.19
253+38	1147.07	1151.45	1154.49	1158.10
255+42	1147.66	1152.12	1155.21	1158.91
257+42	1148.15	1152.65	1155.77	1159.50
259+44	1148.61	1153.13	1156.28	1160.04
261+49	1149.04	1153.59	1156.77	1160.56
264+91	1149.76	1154.53	1157.90	1161.70
266+73	1150.11	1154.71	1158.00	1163.21
268+47	1150.40	1154.92	1158.17	1163.32

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Table 3 (continued)

270+39	1150.56	1155.01	1158.13	1163.20
272+09	1151.08	1155.52	1158.63	1163.56
279+17	1151.97	1156.51	1159.70	1164.56
281+17	1152.19	1156.78	1159.99	1164.82
283+17	1152.51	1157.09	1160.27	1165.04
285+17	1152.71	1157.29	1160.47	1165.21
287+17	1152.98	1157.52	1160.67	1165.35
289+17	1153.22	1157.77	1160.93	1165.59
291+08	1153.47	1158.04	1161.19	1165.82
293+20	1153.70	1158.32	1161.50	1166.14
295+20	1153.89	1158.47	1161.65	1166.28
297+20	1154.15	1158.68	1161.84	1166.43
299+20	1154.41	1158.87	1162.00	1166.55
301+20	1154.69	1159.07	1162.18	1166.71
303+20	1154.97	1159.25	1162.35	1166.84
305+20	1155.32	1159.56	1162.56	1166.99
307+20	1155.64	1159.88	1162.89	1167.26
309+20	1155.93	1160.21	1163.30	1167.61
311+20	1156.32	1160.71	1163.76	1167.97
313+20	1156.74	1161.04	1164.00	1168.13
315+20	1157.08	1161.28	1164.20	1168.26
318+41	1157.73	1162.73	1164.69	1168.54
323+22	1158.42	1162.96	1165.32	1168.84
325+22	1158.82	1163.29	1165.60	1169.00
327+22	1159.00	1163.42	1165.72	1169.10
329+22	1159.14	1163.50	1165.86	1169.20
331+22	1159.55	1164.07	1166.30	1169.49
335+22	1160.48	1164.56	1166.59	1169.60
339+22	1161.19	1165.15	1167.21	1170.07
342+22	1161.80	1165.68	1167.77	1170.51
347+22	1162.18	1165.88	1167.91	1170.63
351+22	1162.80	1166.60	1168.73	1171.50
355+22	1163.33	1167.11	1169.23	1171.96
359+22	1163.93	1167.77	1169.99	1172.82
363+22	1164.38	1168.17	1170.37	1173.49
367+22	1165.01	1168.82	1171.13	1173.69
370+94	1165.74	1170.55	1172.82	1173.76
383+19	1166.51	1170.64	1173.19	1176.83

TABLE 4

Baseline Hydraulic Information,
100-Year Flood

SALT RIVER
BASELINE CONDITIONS
HYDRAULIC INFORMATION
100-YEAR FLOOD

STATION	WSEL	DEPTH	VELOCITY	INVERT
24+12	1107.00	15.69	8.07	1081.00
27+35	1107.09	18.98	8.91	1078.70
28+35	1107.11	18.93	9.07	1078.30
29+35	1107.14	18.62	9.27	1080.50
30+35	1107.30	20.01	8.95	1079.20
31+35	1107.53	20.04	8.32	1079.50
32+35	1107.96	22.94	6.81	1078.70
33+35	1108.13	24.77	6.22	1078.50
34+35	1108.20	24.80	5.99	1077.20
35+35	1108.26	23.15	5.83	1078.00
36+35	1108.30	22.81	5.77	1076.70
37+35	1108.37	22.64	5.59	1077.40
39+35	1108.48	24.27	5.23	1076.50
40+35	1108.49	24.34	5.34	1077.90
41+35	1108.52	25.35	5.30	1075.50
42+35	1108.52	25.07	5.48	1075.50
43+35	1108.44	22.64	6.38	1079.00
44+35	1108.30	21.34	7.57	1081.00
45+35	1108.33	21.78	7.72	1081.20
46+35	1108.47	22.43	7.38	1081.10
47+35	1108.07	22.41	9.83	1081.90
48+35	1108.15	22.17	9.89	1082.60
49+35	1108.22	22.03	9.97	1082.80
50+35	1108.29	21.82	10.08	1083.00
51+35	1108.37	21.72	10.14	1083.10
52+35	1108.45	21.60	10.20	1081.90
53+35	1108.54	21.45	10.25	1081.30
54+35	1108.63	21.31	10.28	1080.60
55+35	1108.73	21.12	10.29	1080.50
56+35	1108.81	20.81	10.41	1083.20
57+35	1108.88	20.32	10.59	1083.70
58+35	1108.97	20.00	10.68	1084.90
59+35	1109.08	19.74	10.71	1085.20
60+35	1109.22	19.57	10.68	1085.00
61+35	1109.34	19.34	10.68	1085.20
62+35	1109.49	19.37	10.59	1085.90
63+35	1109.62	19.21	10.57	1086.10
64+35	1109.74	19.07	10.60	1087.40
65+35	1109.87	18.94	10.57	1087.30
66+35	1110.08	19.28	10.31	1087.20
67+35	1110.24	19.37	10.18	1086.40
68+35	1110.34	19.10	10.27	1087.40
69+35	1110.42	18.75	10.40	1088.80
70+35	1110.42	17.78	10.98	1089.10
71+35	1110.41	16.71	11.66	1089.70
72+35	1110.42	15.66	12.40	1089.10

Table 4 (continued)

73+35	1110.58	15.27	12.66	1089.20
74+35	1110.80	15.22	12.72	1089.40
75+35	1111.00	15.06	12.87	1090.60
76+35	1111.18	14.81	13.16	1090.60
77+35	1111.43	14.77	13.20	1090.70
78+35	1111.56	14.23	13.75	1091.00
79+35	1111.76	13.82	14.16	1091.30
80+35	1112.21	14.07	13.91	1091.80
81+35	1112.63	14.29	13.66	1091.90
82+35	1112.95	14.40	13.62	1092.30
83+35	1113.22	14.35	13.71	1092.30
84+35	1113.71	14.71	13.27	1092.50
85+35	1114.05	14.92	13.11	1093.00
86+35	1114.33	14.89	13.09	1093.80
87+35	1114.49	14.76	13.46	1094.40
88+35	1114.22	14.36	15.35	1094.80
89+35	1113.97	13.94	17.27	1095.40
90+35	1114.20	13.56	18.05	1096.10
91+35	1116.19	14.90	15.35	1096.10
92+35	1117.35	15.79	13.63	1096.50
93+35	1118.22	16.65	12.15	1095.80
94+35	1118.74	17.08	11.30	1095.30
95+35	1118.94	17.20	11.19	1094.80
96+35	1119.13	17.35	11.11	1095.50
97+35	1119.36	17.63	10.90	1095.20
98+35	1119.51	17.74	10.87	1095.40
99+35	1119.62	17.52	11.03	1096.80
100+35	1119.99	18.56	10.39	1097.20
102+37	1120.06	17.14	12.33	1100.00
104+35	1120.44	17.08	12.47	1100.00
106+40	1120.75	16.42	13.20	1100.00
108+12	1121.17	16.25	12.98	1102.00
109+99	1121.83	16.80	12.29	1102.00
112+02	1122.42	17.13	11.22	1102.00
114+02	1122.70	16.11	11.99	1104.00
115+87	1123.22	16.97	11.62	1104.00
117+73	1123.62	17.03	11.62	1104.00
119+67	1123.93	16.22	12.53	1104.00
121+49	1124.70	16.67	11.39	1104.00
123+29	1125.17	15.47	11.45	1104.00
125+16	1125.71	14.64	10.91	1104.00
127+26	1125.91	13.79	11.82	1104.00
129+24	1126.46	12.79	11.42	1104.00
131+26	1127.43	14.19	8.53	1106.00
133+37	1127.71	13.84	7.99	1108.00
135+44	1127.89	12.94	8.27	1108.00
137+59	1128.08	12.43	8.40	1108.00
139+68	1128.26	11.46	8.80	1110.00
142+03	1128.48	10.41	9.64	1110.00
144+13	1128.73	9.68	9.93	1110.00
146+44	1128.97	8.60	11.50	1108.00
149+44	1130.08	6.01	10.84	1112.00
157+63	1132.48	7.23	12.70	1114.00
159+81	1133.80	8.86	9.32	1114.00

Table 4 (conintued)

162+63	1134.35	8.27	8.43	1118.00
169+78	1134.81	8.04	9.33	1114.00
174+58	1135.41	8.25	8.64	1112.00
178+38	1135.75	7.19	10.18	1116.00
181+53	1136.71	8.86	7.90	1113.10
183+53	1136.93	8.57	8.39	1116.00
185+48	1137.35	9.13	7.57	1118.00
188+03	1137.64	9.54	7.78	1118.00
190+75	1137.98	8.73	7.45	1124.00
193+60	1138.44	8.51	7.96	1124.00
196+40	1139.01	8.56	7.70	1124.00
199+20	1139.53	8.66	7.87	1124.00
201+50	1140.02	9.04	7.74	1124.00
203+40	1140.39	9.18	7.71	1126.00
205+32	1140.77	9.01	7.77	1124.00
207+32	1141.23	9.08	7.36	1122.00
209+37	1141.73	10.38	6.59	1126.00
211+09	1141.83	8.89	7.59	1116.00
212+79	1142.22	9.26	7.06	1124.00
214+64	1142.56	10.04	6.50	1126.00
216+42	1142.76	9.62	7.09	1126.00
217+97	1143.05	10.09	7.01	1126.00
219+77	1143.31	10.44	7.61	1126.00
221+82	1143.67	10.53	7.92	1129.00
223+77	1144.01	10.45	8.44	1130.00
225+72	1144.42	10.50	8.83	1130.00
227+70	1144.91	11.40	8.47	1128.00
229+72	1145.15	11.03	9.19	1128.00
231+80	1145.24	9.66	11.05	1128.00
233+75	1145.59	9.17	12.27	1128.00
235+75	1146.48	9.94	11.68	1128.00
237+74	1146.55	8.53	13.72	1126.00
239+70	1147.35	8.88	13.42	1126.00
241+70	1147.85	7.45	13.68	1126.00
243+70	1148.93	7.91	12.49	1126.00
244+70	1149.22	8.36	12.56	1126.00
246+70	1149.51	8.37	13.41	1128.00
248+80	1150.40	8.40	12.28	1128.00
250+85	1150.77	9.28	12.42	1128.00
252+87	1151.61	9.49	11.19	1126.00
254+87	1152.52	9.93	9.16	1128.00
256+87	1152.53	9.69	10.09	1128.00
258+88	1152.83	10.14	10.06	1128.00
260+90	1153.22	10.65	9.57	1128.00
262+90	1153.75	10.86	8.62	1130.00
264+90	1153.81	13.58	9.31	1129.40
266+91	1154.19	10.66	8.92	1130.00
268+91	1154.37	11.75	9.26	1132.00
270+90	1154.95	10.64	7.50	1130.00
272+94	1155.10	11.23	7.31	1130.00
274+94	1155.27	12.65	7.11	1130.00
276+94	1155.35	14.05	7.70	1132.00
278+96	1155.46	12.15	8.25	1134.00
282+76	1155.83	14.25	9.14	1136.00

Table 4 (continued)

284+58	1156.03	14.93	9.37	1134.00
286+32	1156.29	15.97	9.53	1134.00
288+24	1156.37	14.49	11.15	1136.00
289+94	1157.09	16.38	10.10	1136.00
297+02	1158.55	12.59	10.30	1136.00
299+02	1158.94	13.18	9.89	1134.00
301+02	1159.26	13.65	9.48	1136.00
303+02	1159.51	13.72	9.49	1135.20
305+02	1159.73	14.45	9.46	1136.00
307+02	1160.02	13.04	9.31	1138.00
308+93	1160.36	13.28	8.82	1138.00
311+05	1160.73	12.37	8.33	1138.00
313+05	1160.88	11.79	8.59	1140.00
315+05	1161.07	11.54	8.68	1140.00
317+05	1161.25	10.92	9.06	1142.00
319+05	1161.45	9.98	9.42	1142.00
321+05	1161.64	8.85	10.18	1140.00
323+05	1161.90	8.66	10.51	1138.30
325+05	1162.32	7.47	10.23	1142.00
327+05	1162.90	7.27	9.45	1142.00
329+05	1163.28	7.09	9.01	1142.00
331+05	1163.51	7.02	8.89	1140.00
333+05	1163.77	6.73	8.67	1142.00
336+26	1164.57	6.68	6.07	1144.00
341+07	1164.72	6.54	7.81	1143.60
343+07	1165.04	7.19	7.34	1143.70
345+07	1165.22	6.11	7.59	1144.00
347+07	1165.30	5.88	8.51	1146.00
349+07	1165.82	6.74	7.58	1148.00
353+07	1166.20	8.39	8.22	1148.00
357+07	1166.79	9.93	7.97	1148.00
361+07	1167.42	9.90	7.41	1147.30
365+07	1167.54	11.66	9.79	1148.00
369+07	1168.45	7.22	8.98	1146.00
373+07	1168.99	13.14	9.58	1146.00
377+07	1169.97	11.50	8.69	1148.00
381+07	1170.38	10.83	9.59	1147.60
385+07	1170.95	10.45	10.34	1148.00
388+79	1172.72	14.68	9.33	1150.00
401+04	1173.07	12.40	8.00	1146.00

TABLE 5

Channelized Hydraulic Information, 100-Year Flood

SALT RIVER
PREFERRED CONDITIONS
HYDRAULIC INFORMATION
100-YEAR FLOOD

STATION	WSEL	DEPTH	VELOCITY	INVERT
24+12	1107.43	16.11	8.23	1081.00
27+35	1107.51	19.40	9.15	1078.70
28+35	1107.53	19.33	9.32	1078.30
29+35	1107.56	19.02	9.53	1080.50
30+35	1107.73	20.38	9.20	1079.20
31+35	1107.97	20.45	8.56	1079.50
32+35	1108.42	23.37	7.00	1078.70
33+35	1108.59	25.21	6.40	1078.50
34+35	1108.67	25.25	6.16	1077.20
35+35	1108.74	23.61	6.00	1078.00
36+35	1108.78	23.27	5.92	1076.70
37+35	1108.85	23.05	5.74	1077.40
39+35	1108.97	24.72	5.38	1076.50
40+35	1108.97	24.79	5.49	1077.90
41+35	1109.00	25.80	5.45	1075.50
42+35	1109.01	25.52	5.63	1075.50
43+35	1108.91	23.08	6.55	1079.00
44+35	1108.77	21.68	7.77	1081.00
45+35	1108.80	21.99	7.93	1081.20
46+35	1108.94	22.86	7.57	1081.10
47+35	1108.52	22.82	10.10	1081.90
48+35	1108.60	22.57	10.16	1082.60
49+35	1108.68	22.44	10.24	1082.80
50+35	1108.74	22.23	10.36	1083.00
51+35	1108.83	22.13	10.42	1083.10
52+35	1108.91	22.02	10.48	1081.90
53+35	1109.00	21.87	10.53	1081.30
54+35	1109.10	21.74	10.55	1080.60
55+35	1109.20	21.54	10.56	1080.50
56+35	1109.28	21.24	10.68	1083.20
57+35	1109.35	20.75	10.85	1083.70
58+35	1109.45	20.43	10.94	1084.90
59+35	1109.56	20.17	10.97	1085.20
60+35	1109.70	20.01	10.93	1085.00
61+35	1109.83	19.79	10.92	1085.20
62+35	1109.99	19.82	10.82	1085.90
63+35	1110.12	19.66	10.80	1086.10
64+35	1110.24	19.53	10.83	1087.40
65+35	1110.37	19.40	10.80	1087.30
66+35	1110.59	19.75	10.53	1087.20
67+35	1110.75	19.84	10.41	1086.40
68+35	1110.85	19.56	10.49	1087.40
69+35	1110.94	19.22	10.62	1088.80
70+35	1110.94	18.26	11.19	1089.10
71+35	1110.93	17.18	11.87	1089.70
72+35	1110.93	16.14	12.59	1089.10

Table 5 (continued)

73+35	1111.09	15.75	12.85	1089.20
74+35	1111.30	15.70	12.91	1089.40
75+35	1111.50	15.53	13.06	1090.60
76+35	1111.67	15.27	13.35	1090.60
77+35	1111.93	15.23	13.39	1090.70
78+35	1112.05	14.69	13.94	1091.00
79+35	1112.24	14.28	14.35	1091.30
80+35	1112.68	14.73	14.12	1091.80
81+35	1113.10	14.73	13.88	1091.90
82+35	1113.41	14.84	13.84	1092.30
83+35	1113.68	14.77	13.93	1092.30
84+35	1114.17	15.14	13.50	1092.50
85+35	1114.51	15.35	13.34	1093.00
86+35	1114.78	15.31	13.32	1093.80
87+35	1114.94	15.18	13.69	1094.40
88+35	1114.65	14.74	15.64	1094.80
89+35	1114.36	14.28	17.64	1095.40
90+35	1114.59	13.92	18.40	1096.10
91+35	1116.66	15.33	15.60	1096.10
92+35	1117.85	16.25	13.85	1096.50
93+35	1118.74	17.12	12.36	1095.80
94+35	1119.27	17.57	11.49	1095.30
95+35	1119.47	17.69	11.38	1094.80
96+35	1119.66	17.84	11.31	1095.50
97+35	1119.89	18.11	11.10	1095.20
98+35	1120.04	18.22	11.07	1095.40
99+35	1120.15	18.01	11.23	1096.80
100+35	1120.52	19.05	10.59	1097.20
102+37	1120.58	17.57	11.54	1100.00
104+35	1120.89	17.50	11.63	1100.00
106+40	1121.12	16.75	12.16	1100.00
108+00	1121.45	17.17	12.08	1100.36
110+00	1121.81	17.09	12.14	1100.80
112+00	1122.17	17.03	12.19	1101.24
114+00	1122.53	16.95	12.25	1101.69
116+00	1122.91	16.89	12.31	1102.14
118+00	1123.29	16.83	12.35	1102.58
120+00	1123.67	16.78	12.39	1103.02
122+00	1124.06	16.72	12.43	1103.47
124+00	1124.46	16.68	12.47	1103.91
126+00	1124.86	16.64	12.51	1104.36
128+00	1125.26	16.61	12.53	1104.80
130+00	1125.67	16.58	12.56	1105.24
132+00	1126.08	16.54	12.59	1105.69
134+00	1126.50	16.52	12.61	1106.13
136+00	1126.91	16.50	12.63	1106.57
138+00	1127.33	16.47	12.65	1107.02
140+00	1127.76	16.45	12.66	1107.46
142+00	1128.18	16.44	12.68	1107.90
144+00	1128.61	16.42	12.69	1108.35
146+50	1129.15	16.41	12.70	1108.90
150+00	1130.03	16.48	12.63	1109.68
151+00	1130.24	16.47	12.63	1109.90
152+00	1130.45	16.45	12.65	1110.13

Table 5 (continued)

156+00	1131.30	16.42	12.67	1111.01
160+00	1132.25	16.52	12.62	1111.90
162+00	1132.67	16.50	12.64	1112.34
164+00	1133.09	16.48	12.65	1112.78
166+00	1133.52	16.47	12.66	1113.22
168+00	1133.94	16.45	12.68	1113.66
170+00	1134.36	16.42	12.70	1114.12
172+00	1134.79	16.40	12.74	1114.56
174+00	1135.19	16.36	12.86	1115.00
176+00	1135.61	16.34	12.96	1115.45
178+00	1136.04	16.31	13.07	1115.89
180+00	1136.47	16.26	13.20	1116.36
182+00	1136.92	16.28	13.28	1116.80
184+00	1137.38	16.28	13.36	1117.25
186+00	1137.84	16.29	13.44	1117.69
188+00	1138.30	16.29	13.54	1118.14
190+00	1138.78	16.32	13.61	1118.58
192+00	1139.27	16.36	13.66	1119.02
194+00	1139.75	16.37	13.75	1119.47
196+00	1140.24	16.41	13.80	1119.91
198+00	1140.73	16.44	13.89	1120.36
200+00	1141.23	16.49	13.92	1120.80
202+00	1141.74	16.55	13.92	1121.24
204+00	1142.29	16.65	13.83	1121.68
206+00	1142.83	16.73	13.75	1122.12
208+00	1143.35	16.80	13.69	1122.56
210+00	1143.85	16.83	13.66	1123.02
211+65	1144.27	16.88	13.61	1123.39
214+00	1145.26	17.28	13.25	1123.91
216+00	1145.70	17.28	13.25	1124.35
218+00	1146.14	17.28	13.25	1124.79
220+00	1146.57	17.28	13.25	1125.23
222+00	1147.01	17.28	13.25	1125.67
224+00	1147.45	17.28	13.25	1126.11
226+00	1147.89	17.28	13.25	1126.55
228+00	1148.33	17.28	13.26	1126.99
230+00	1148.77	17.28	13.26	1127.43
232+00	1149.21	17.28	13.26	1127.87
234+00	1149.64	17.29	13.26	1128.31
236+00	1150.08	17.29	13.26	1128.75
238+00	1150.52	17.29	13.26	1129.19
240+00	1150.96	17.29	13.26	1129.63
242+00	1151.40	17.29	13.26	1130.07
244+00	1151.84	17.29	13.26	1130.51
246+00	1152.28	17.29	13.26	1130.95
248+00	1152.72	17.29	13.26	1131.39
250+00	1153.15	17.25	13.29	1131.87
251+40	1153.66	17.43	12.92	1132.22
253+38	1154.49	17.80	12.14	1132.76
255+42	1155.22	17.95	11.43	1133.31
257+42	1155.77	18.15	10.99	1133.84
259+44	1156.28	18.23	10.58	1134.39
261+49	1156.77	18.16	10.16	1134.94
264+91	1157.90	16.03	8.07	1136.00

Table 5 (continued)

266+73	1158.00	16.82	8.30	1134.00
268+47	1158.17	17.79	8.49	1134.00
270+39	1158.13	15.98	9.93	1136.00
272+09	1158.63	17.70	9.22	1136.00
279+17	1159.70	15.83	9.68	1136.00
281+17	1159.99	15.59	9.44	1134.00
283+17	1160.27	15.91	9.06	1136.00
285+17	1160.47	15.60	9.09	1135.20
287+17	1160.67	15.89	9.08	1136.00
289+17	1160.93	15.34	8.91	1138.00
291+08	1161.19	16.01	8.58	1138.00
293+20	1161.50	15.30	8.20	1138.00
295+20	1161.65	14.26	8.34	1140.00
297+20	1161.84	13.84	8.34	1140.00
299+20	1162.00	12.87	8.67	1142.00
301+20	1162.18	11.46	9.00	1142.00
303+20	1162.35	10.65	9.66	1140.00
305+20	1162.56	10.29	10.02	1138.30
307+20	1162.89	9.66	9.87	1142.00
309+20	1163.30	8.73	9.58	1142.00
311+20	1163.76	8.69	8.84	1142.00
313+20	1164.00	8.75	8.61	1140.00
315+20	1164.20	7.99	8.64	1142.00
318+41	1164.74	7.92	7.06	1144.00
323+22	1165.32	7.58	7.50	1143.60
325+22	1165.60	8.31	7.08	1143.70
327+22	1165.72	7.65	7.59	1144.00
329+22	1165.86	7.56	8.10	1146.00
331+22	1166.30	8.13	7.33	1148.00
335+22	1166.59	9.85	8.21	1148.00
339+22	1167.21	11.87	7.81	1148.00
342+22	1167.77	12.21	7.38	1147.30
347+22	1167.91	10.03	9.52	1148.00
351+22	1168.73	11.83	8.82	1146.00
355+22	1169.23	13.37	9.42	1146.00
359+22	1169.99	15.05	9.13	1148.00
363+22	1170.37	15.75	10.42	1147.60
367+22	1171.13	15.08	10.64	1148.00
370+94	1172.82	14.54	9.23	1150.00
383+19	1173.19	12.19	7.92	1146.00

TABLE 6

Baseline Hydraulic Information, SPF Event

SALT RIVER
BASELINE CONDITIONS
HYDRAULIC INFORMATION
STANDARD PROJECT FLOOD

STATION	WSEL	DEPTH	VELOCITY	INVERT
24+12	1110.45	19.07	9.19	1081.00
27+35	1110.44	22.32	10.61	1078.70
28+35	1110.46	21.60	10.81	1078.30
29+35	1110.48	21.30	11.04	1080.50
30+35	1110.67	22.52	10.73	1079.20
31+35	1110.98	22.88	9.96	1079.50
32+35	1111.56	25.93	8.18	1078.70
33+35	1111.77	27.81	7.53	1078.50
34+35	1111.88	27.79	7.25	1077.20
35+35	1111.98	26.26	6.99	1078.00
36+35	1112.04	25.96	6.88	1076.70
37+35	1112.12	26.13	6.66	1077.40
39+35	1112.26	27.78	6.29	1076.50
40+35	1112.27	27.82	6.42	1077.90
41+35	1112.30	28.84	6.41	1075.50
42+35	1112.30	28.61	6.61	1075.50
43+35	1112.18	26.06	7.60	1079.00
44+35	1111.99	23.07	8.94	1081.00
45+35	1112.01	24.10	9.15	1081.20
46+35	1112.19	25.22	8.79	1081.10
47+35	1111.59	25.49	11.80	1081.90
48+35	1111.68	25.32	11.84	1082.60
49+35	1111.77	25.21	11.92	1082.80
50+35	1111.85	25.00	12.04	1083.00
51+35	1111.95	24.91	12.09	1083.10
52+35	1112.05	24.82	12.15	1081.90
53+35	1112.15	24.68	12.19	1081.30
54+35	1112.27	24.58	12.20	1080.60
55+35	1112.39	24.38	12.18	1080.50
56+35	1112.48	24.12	12.29	1083.20
57+35	1112.56	23.59	12.45	1083.70
58+35	1112.68	23.33	12.51	1084.90
59+35	1112.81	23.11	12.51	1085.20
60+35	1112.98	22.99	12.43	1085.00
61+35	1113.13	22.74	12.40	1085.20
62+35	1113.31	22.81	12.28	1085.90
63+35	1113.46	22.67	12.23	1086.10
64+35	1113.59	22.59	12.25	1087.40
65+35	1113.75	22.50	12.18	1087.30
66+35	1113.99	22.87	11.90	1087.20
67+35	1114.17	22.97	11.76	1086.40
68+35	1114.27	22.67	11.82	1087.40
69+35	1114.37	22.35	11.93	1088.80
70+35	1114.36	21.40	12.48	1089.10
71+35	1114.34	20.33	13.11	1089.70
72+35	1114.34	19.29	13.77	1089.10

Table 6 (continued)

73+35	1114.48	18.90	13.99	1089.20
74+35	1114.68	18.82	14.06	1089.40
75+35	1114.86	18.64	14.22	1090.60
76+35	1115.00	18.33	14.51	1090.60
77+35	1115.23	18.32	14.57	1090.70
78+35	1115.32	17.75	15.10	1091.00
79+35	1115.48	17.32	15.49	1091.30
80+35	1115.85	17.50	15.34	1091.80
81+35	1116.24	17.66	15.15	1091.90
82+35	1116.52	17.72	15.15	1092.30
83+35	1116.76	17.62	15.26	1092.30
84+35	1117.24	17.99	14.86	1092.50
85+35	1117.57	18.19	14.73	1093.00
86+35	1117.83	18.14	14.71	1093.80
87+35	1117.96	17.98	15.13	1094.40
88+35	1117.49	17.33	17.35	1094.80
89+35	1116.96	16.66	19.75	1095.40
90+35	1117.13	16.27	20.61	1096.10
91+35	1119.80	18.21	17.15	1096.10
92+35	1121.15	19.14	15.24	1096.50
93+35	1122.16	20.04	13.64	1095.80
94+35	1122.75	20.30	12.70	1095.30
95+35	1122.96	20.58	12.59	1094.80
96+35	1123.14	20.32	12.53	1095.50
97+35	1123.37	20.64	12.32	1095.20
98+35	1123.52	21.07	12.30	1095.40
99+35	1123.62	20.82	12.47	1096.80
100+35	1124.02	21.84	11.84	1097.20
102+37	1124.08	19.91	13.70	1100.00
104+35	1124.46	19.77	13.84	1100.00
106+40	1124.73	19.81	14.55	1100.00
108+12	1125.13	19.60	14.32	1102.00
109+99	1125.82	18.67	13.65	1102.00
112+02	1126.41	19.67	12.66	1102.00
114+02	1126.68	19.43	13.31	1104.00
115+87	1127.18	19.89	13.00	1104.00
117+73	1127.55	19.79	13.04	1104.00
119+67	1127.86	19.21	13.82	1104.00
121+49	1128.69	19.81	12.60	1104.00
123+29	1129.28	19.07	12.29	1104.00
125+16	1129.88	18.45	11.48	1104.00
127+26	1130.05	15.68	12.30	1104.00
129+24	1130.64	15.58	11.60	1104.00
131+26	1131.51	17.45	8.90	1106.00
133+37	1131.78	17.62	8.30	1108.00
135+44	1131.95	16.89	8.42	1108.00
137+59	1132.12	16.35	8.44	1108.00
139+68	1132.26	15.31	8.64	1110.00
142+03	1132.43	14.25	9.19	1110.00
144+13	1132.61	13.48	9.35	1110.00
146+44	1132.79	12.35	10.22	1108.00
149+44	1132.10	11.53	7.99	1112.00
157+63	1134.64	8.26	13.11	1114.00
159+81	1135.79	10.24	10.21	1114.00

Table 6 (continued)

162+63	1136.41	10.28	9.00	1118.00
169+78	1136.80	10.02	10.04	1114.00
174+58	1137.36	10.02	9.42	1112.00
178+38	1137.68	9.07	10.80	1116.00
181+53	1138.57	10.68	8.87	1113.10
183+53	1138.80	10.39	9.34	1116.00
185+48	1139.23	10.91	8.55	1118.00
188+03	1139.55	11.34	8.77	1118.00
190+75	1139.89	10.62	8.32	1124.00
193+60	1140.33	10.34	8.81	1124.00
196+40	1140.88	10.35	8.59	1124.00
199+20	1141.38	10.40	8.83	1124.00
201+50	1141.87	10.83	8.75	1124.00
203+40	1142.25	10.95	8.74	1126.00
205+32	1142.63	10.86	8.77	1124.00
207+32	1143.11	10.92	8.34	1122.00
209+37	1143.65	12.25	7.59	1126.00
211+09	1143.74	10.75	8.55	1116.00
212+79	1144.13	11.14	8.05	1124.00
214+64	1144.49	11.93	7.56	1126.00
216+42	1144.68	11.50	8.21	1126.00
217+97	1144.97	11.96	8.18	1126.00
219+77	1145.21	12.01	8.88	1126.00
221+82	1145.60	12.35	9.24	1129.00
223+77	1145.96	12.33	9.79	1130.00
225+72	1146.39	12.42	10.19	1130.00
227+70	1146.93	13.36	9.86	1128.00
229+72	1147.18	12.98	10.66	1128.00
231+80	1147.26	11.52	12.61	1128.00
233+75	1147.63	11.15	13.86	1128.00
235+75	1148.68	10.20	13.09	1128.00
237+74	1148.76	8.53	15.24	1126.00
239+70	1149.84	9.05	14.48	1126.00
241+70	1150.39	8.84	14.51	1126.00
243+70	1151.34	9.24	13.46	1126.00
244+70	1151.62	9.25	13.65	1126.00
246+70	1151.87	9.27	14.71	1128.00
248+80	1152.73	9.36	13.72	1128.00
250+85	1153.10	9.33	13.97	1128.00
252+87	1154.11	10.03	12.45	1126.00
254+87	1155.14	12.21	10.10	1128.00
256+87	1155.09	11.16	11.27	1128.00
258+88	1155.41	10.46	11.25	1128.00
260+90	1155.83	11.16	10.74	1128.00
262+90	1156.44	12.22	9.63	1130.00
264+90	1156.46	11.10	10.58	1129.40
266+91	1156.93	12.71	9.98	1130.00
268+91	1157.09	14.15	10.35	1132.00
270+90	1157.81	13.15	8.26	1130.00
272+94	1157.94	13.83	8.17	1130.00
274+94	1158.09	13.94	8.07	1130.00
276+94	1158.13	16.75	8.82	1132.00
278+96	1158.30	13.59	9.12	1134.00
282+76	1158.60	16.77	10.28	1136.00

Table 6 (continued)

284+58	1158.61	17.23	10.73	1134.00
286+32	1158.86	18.00	11.03	1134.00
288+24	1158.79	16.55	12.81	1136.00
289+94	1159.64	18.23	11.73	1136.00
297+02	1161.61	15.47	11.25	1136.00
299+02	1162.02	15.87	10.78	1134.00
301+02	1162.32	16.04	10.43	1136.00
303+02	1162.58	16.15	10.41	1135.20
305+02	1162.78	16.71	10.49	1136.00
307+02	1163.11	16.08	10.22	1138.00
308+93	1163.52	14.28	9.59	1138.00
311+05	1163.95	14.49	8.87	1138.00
313+05	1164.09	13.80	9.07	1140.00
315+05	1164.26	13.60	9.16	1140.00
317+05	1164.42	12.94	9.50	1142.00
319+05	1164.63	12.33	9.74	1142.00
321+05	1164.81	11.60	10.33	1140.00
323+05	1165.01	10.69	10.75	1138.30
325+05	1165.51	9.80	10.05	1142.00
327+05	1166.05	9.75	9.00	1142.00
329+05	1166.36	8.87	8.54	1142.00
331+05	1166.52	8.54	8.50	1140.00
333+05	1166.74	8.55	8.26	1142.00
336+26	1167.70	8.48	5.65	1144.00
341+07	1167.48	8.23	7.64	1143.60
343+07	1167.70	8.19	7.37	1143.70
345+07	1167.91	8.32	7.36	1144.00
347+07	1167.96	8.35	8.23	1146.00
349+07	1168.31	9.12	7.52	1148.00
353+07	1168.51	7.03	8.79	1148.00
357+07	1169.01	7.00	8.81	1148.00
361+07	1169.62	9.96	8.29	1147.30
365+07	1169.74	7.41	10.78	1148.00
369+07	1170.83	8.15	9.45	1146.00
373+07	1171.51	7.71	9.13	1146.00
377+07	1172.16	8.65	8.71	1148.00
381+07	1172.84	10.37	7.63	1147.60
385+07	1173.03	9.86	9.03	1148.00
388+79	1175.65	8.62	10.88	1150.00
401+04	1176.45	13.24	8.12	1146.00

TABLE 7

Channelized Hydraulic Information, SPF Event

SALT RIVER
PREFERRED CONDITIONS
HYDRAULIC INFORMATION
STANDARD PROJECT FLOOD

STATION	WSEL	DEPTH	VELOCITY	INVERT
24+12	1110.61	19.23	9.24	1081.00
27+35	1110.59	22.48	10.68	1078.70
28+35	1110.61	21.76	10.89	1078.30
29+35	1110.64	21.45	11.12	1080.50
30+35	1110.82	22.66	10.81	1079.20
31+35	1111.14	23.04	10.04	1079.50
32+35	1111.73	26.10	8.24	1078.70
33+35	1111.94	27.98	7.59	1078.50
34+35	1112.05	27.96	7.30	1077.20
35+35	1112.15	26.44	7.04	1078.00
36+35	1112.21	26.13	6.94	1076.70
37+35	1112.30	26.12	6.71	1077.40
39+35	1112.44	27.94	6.33	1076.50
40+35	1112.45	27.98	6.47	1077.90
41+35	1112.48	29.00	6.46	1075.50
42+35	1112.48	28.77	6.66	1075.50
43+35	1112.36	26.22	7.65	1079.00
44+35	1112.16	23.23	9.00	1081.00
45+35	1112.19	24.21	9.22	1081.20
46+35	1112.36	25.32	8.85	1081.10
47+35	1111.75	25.58	11.89	1081.90
48+35	1111.85	25.46	11.93	1082.60
49+35	1111.94	25.36	12.01	1082.80
50+35	1112.02	25.15	12.12	1083.00
51+35	1112.11	25.06	12.18	1083.10
52+35	1112.21	24.96	12.23	1081.90
53+35	1112.32	24.82	12.27	1081.30
54+35	1112.43	24.73	12.28	1080.60
55+35	1112.56	24.53	12.27	1080.50
56+35	1112.65	24.27	12.37	1083.20
57+35	1112.74	23.74	12.53	1083.70
58+35	1112.85	23.48	12.59	1084.90
59+35	1112.98	23.26	12.60	1085.20
60+35	1113.15	23.14	12.51	1085.00
61+35	1113.30	22.89	12.48	1085.20
62+35	1113.49	22.96	12.35	1085.90
63+35	1113.64	22.83	12.31	1086.10
64+35	1113.76	22.75	12.32	1087.40
65+35	1113.92	22.66	12.25	1087.30
66+35	1114.17	23.03	11.97	1087.20
67+35	1114.35	23.13	11.83	1086.40
68+35	1114.45	22.83	11.89	1087.40
69+35	1114.55	22.51	12.00	1088.80
70+35	1114.54	21.57	12.55	1089.10
71+35	1114.52	20.50	13.17	1089.70
72+35	1114.52	19.46	13.83	1089.10

Table 7 (continued)

73+35	1114.66	19.07	14.05	1089.20
74+35	1114.86	18.99	14.12	1089.40
75+35	1115.04	18.80	14.29	1090.60
76+35	1115.18	18.49	14.57	1090.60
77+35	1115.41	18.49	14.63	1090.70
78+35	1115.50	17.91	15.16	1091.00
79+35	1115.65	17.49	15.55	1091.30
80+35	1116.03	17.66	15.40	1091.80
81+35	1116.41	17.81	15.21	1091.90
82+35	1116.69	17.88	15.21	1092.30
83+35	1116.93	17.77	15.33	1092.30
84+35	1117.41	18.15	14.93	1092.50
85+35	1117.73	18.34	14.80	1093.00
86+35	1118.00	18.29	14.78	1093.80
87+35	1118.12	18.13	15.20	1094.40
88+35	1117.65	17.47	17.43	1094.80
89+35	1117.10	16.79	19.86	1095.40
90+35	1117.27	16.39	20.72	1096.10
91+35	1119.97	18.36	17.22	1096.10
92+35	1121.33	19.20	15.31	1096.50
93+35	1122.34	20.14	13.71	1095.80
94+35	1122.94	20.32	12.76	1095.30
95+35	1123.14	20.77	12.65	1094.80
96+35	1123.32	20.50	12.59	1095.50
97+35	1123.56	20.83	12.39	1095.20
98+35	1123.71	21.26	12.37	1095.40
99+35	1123.81	21.00	12.53	1096.80
100+35	1124.21	22.02	11.91	1097.20
102+37	1124.25	20.09	12.79	1100.00
104+35	1124.54	19.84	12.90	1100.00
106+40	1124.76	19.84	13.38	1100.00
108+00	1125.04	20.50	13.41	1100.36
110+00	1125.39	20.41	13.47	1100.80
112+00	1125.73	20.40	13.53	1101.24
114+00	1126.09	20.30	13.60	1101.69
116+00	1126.45	20.22	13.66	1102.14
118+00	1126.82	20.04	13.70	1102.58
120+00	1127.19	19.94	13.74	1103.02
122+00	1127.57	19.86	13.79	1103.47
124+00	1127.96	19.82	13.83	1103.91
126+00	1128.34	19.76	13.87	1104.36
128+00	1128.74	19.72	13.91	1104.80
130+00	1129.13	19.68	13.94	1105.24
132+00	1129.53	19.64	13.97	1105.69
134+00	1129.94	19.60	14.00	1106.13
136+00	1130.35	19.58	14.02	1106.57
138+00	1130.76	19.54	14.05	1107.02
140+00	1131.17	19.52	14.07	1107.46
142+00	1131.59	19.51	14.09	1107.90
144+00	1132.00	19.47	14.11	1108.35
146+50	1132.53	19.43	14.13	1108.90
150+00	1133.36	19.48	14.09	1109.68
151+00	1133.58	19.47	14.10	1109.90
152+00	1133.79	19.45	14.11	1110.13

Table 7 (continued)

156+00	1134.63	19.41	14.14	1111.01
160+00	1135.55	19.48	14.12	1111.90
162+00	1135.97	19.46	14.13	1112.34
164+00	1136.40	19.45	14.14	1112.78
166+00	1136.82	19.43	14.15	1113.22
168+00	1137.25	19.42	14.16	1113.66
170+00	1137.67	19.39	14.19	1114.12
172+00	1138.09	19.37	14.23	1114.56
174+00	1138.49	19.32	14.37	1115.00
176+00	1138.90	19.27	14.48	1115.45
178+00	1139.32	19.25	14.60	1115.89
180+00	1139.74	19.20	14.75	1116.36
182+00	1140.19	19.19	14.85	1116.80
184+00	1140.64	19.19	14.94	1117.25
186+00	1141.10	19.19	15.04	1117.69
188+00	1141.56	19.19	15.14	1118.14
190+00	1142.03	19.21	15.23	1118.58
192+00	1142.52	19.25	15.29	1119.02
194+00	1142.99	19.26	15.39	1119.47
196+00	1143.48	19.29	15.47	1119.91
198+00	1143.97	19.32	15.56	1120.36
200+00	1144.48	19.37	15.60	1120.80
202+00	1145.00	19.44	15.61	1121.24
204+00	1145.57	19.55	15.51	1121.68
206+00	1146.12	19.65	15.42	1122.12
208+00	1146.66	19.73	15.34	1122.56
210+00	1147.17	19.77	15.31	1123.02
211+65	1147.60	19.82	15.26	1123.39
214+00	1148.61	20.87	14.89	1123.91
216+00	1149.06	20.25	14.88	1124.35
218+00	1149.52	20.26	14.88	1124.79
220+00	1149.97	20.27	14.87	1125.23
222+00	1150.42	20.28	14.86	1125.67
224+00	1150.87	20.29	14.85	1126.11
226+00	1151.32	20.30	14.84	1126.55
228+00	1151.76	20.31	14.84	1126.99
230+00	1152.21	20.32	14.83	1127.43
232+00	1152.66	20.32	14.83	1127.87
234+00	1153.10	20.33	14.83	1128.31
236+00	1153.55	20.33	14.82	1128.75
238+00	1153.99	20.34	14.82	1129.19
240+00	1154.43	20.34	14.82	1129.63
242+00	1154.88	20.34	14.81	1130.07
244+00	1155.32	20.35	14.81	1130.51
246+00	1155.76	20.35	14.81	1130.95
248+00	1156.21	20.35	14.81	1131.39
250+00	1156.64	20.32	14.83	1131.87
251+40	1157.19	20.56	14.42	1132.22
253+38	1158.10	21.08	13.55	1132.76
255+42	1158.91	21.32	12.73	1133.31
257+42	1159.50	21.60	12.24	1133.84
259+44	1160.04	21.75	11.78	1134.39
261+49	1160.56	21.71	11.28	1134.94
264+91	1161.70	19.84	8.68	1136.00

Table 7 (continued)

266+73	1163.21	21.55	8.47	1134.00
268+47	1163.32	21.56	8.82	1134.00
270+39	1163.20	20.58	10.09	1136.00
272+09	1163.56	22.06	9.66	1136.00
279+17	1164.56	20.68	9.93	1136.00
281+17	1164.82	20.42	9.63	1134.00
283+17	1165.04	20.07	9.34	1136.00
285+17	1165.21	20.07	9.34	1135.20
287+17	1165.35	20.54	9.44	1136.00
289+17	1165.59	19.97	9.20	1138.00
291+08	1165.82	19.69	8.89	1138.00
293+20	1166.14	18.50	8.34	1138.00
295+20	1166.28	17.91	8.36	1140.00
297+20	1166.43	16.56	8.31	1140.00
299+20	1166.55	16.18	8.57	1142.00
301+20	1166.71	15.21	8.71	1142.00
303+20	1166.84	14.64	9.20	1140.00
305+20	1166.99	13.87	9.55	1138.30
307+20	1167.26	12.64	9.29	1142.00
309+20	1167.61	12.91	8.74	1142.00
311+20	1167.97	11.19	7.94	1142.00
313+20	1168.13	11.31	7.77	1140.00
315+20	1168.26	10.83	7.77	1142.00
318+41	1168.54	10.32	6.17	1144.00
323+22	1168.84	10.49	7.05	1143.60
325+22	1169.00	11.09	6.89	1143.70
327+22	1169.10	10.40	7.27	1144.00
329+22	1169.20	10.34	7.68	1146.00
331+22	1169.49	11.20	7.07	1148.00
335+22	1169.60	9.14	8.46	1148.00
339+22	1170.07	8.89	8.30	1148.00
342+22	1170.51	12.84	8.12	1147.30
347+22	1170.63	10.76	10.29	1148.00
351+22	1171.50	11.10	9.32	1146.00
355+22	1171.96	10.16	9.79	1146.00
359+22	1172.82	11.13	8.87	1148.00
363+22	1173.49	13.01	7.95	1147.60
367+22	1173.69	13.69	9.13	1148.00
370+94	1175.96	8.88	10.07	1150.00
383+19	1176.83	13.54	7.89	1146.00

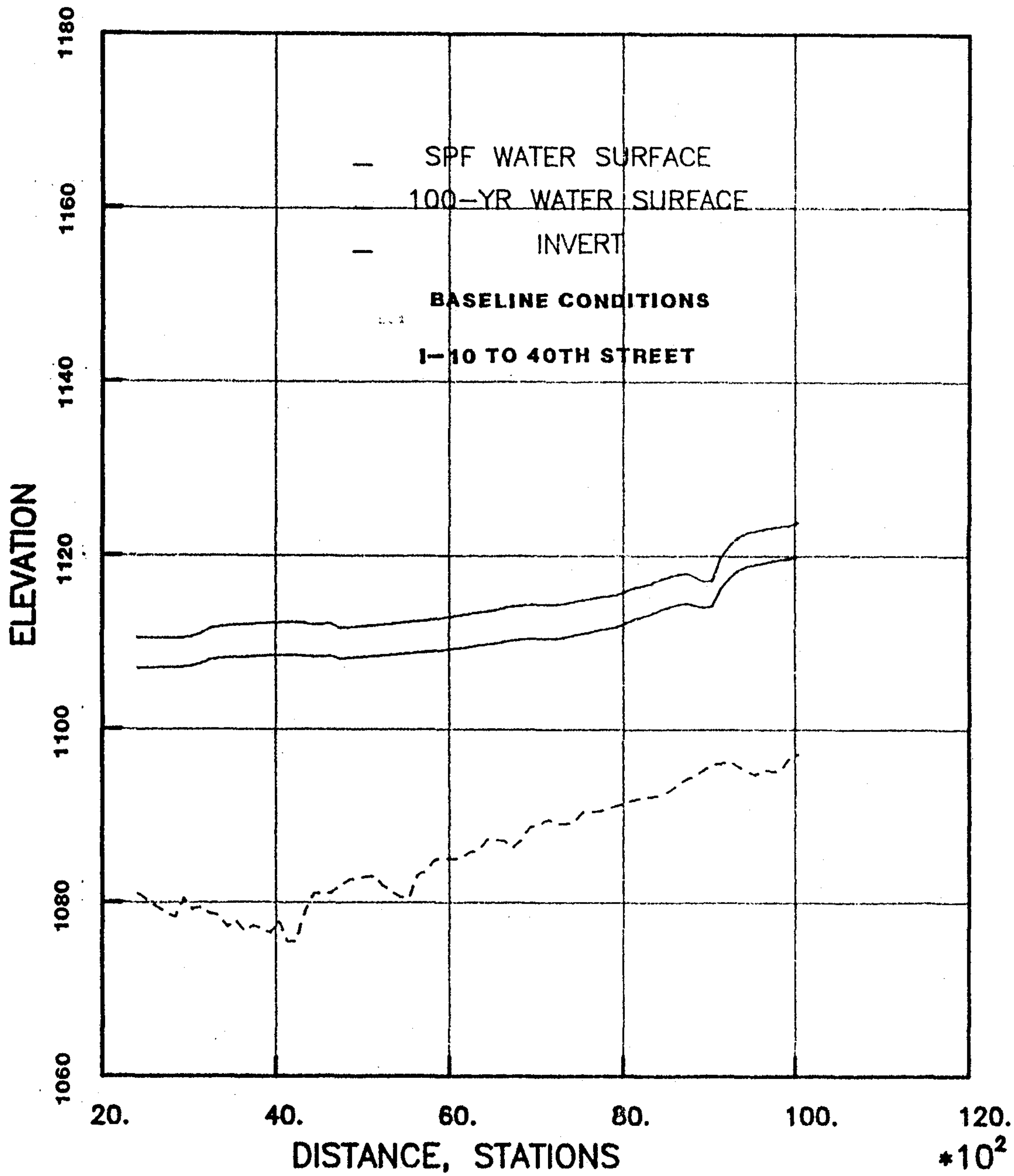


Figure 9a. Baseline Water-Surface Profile Conditions

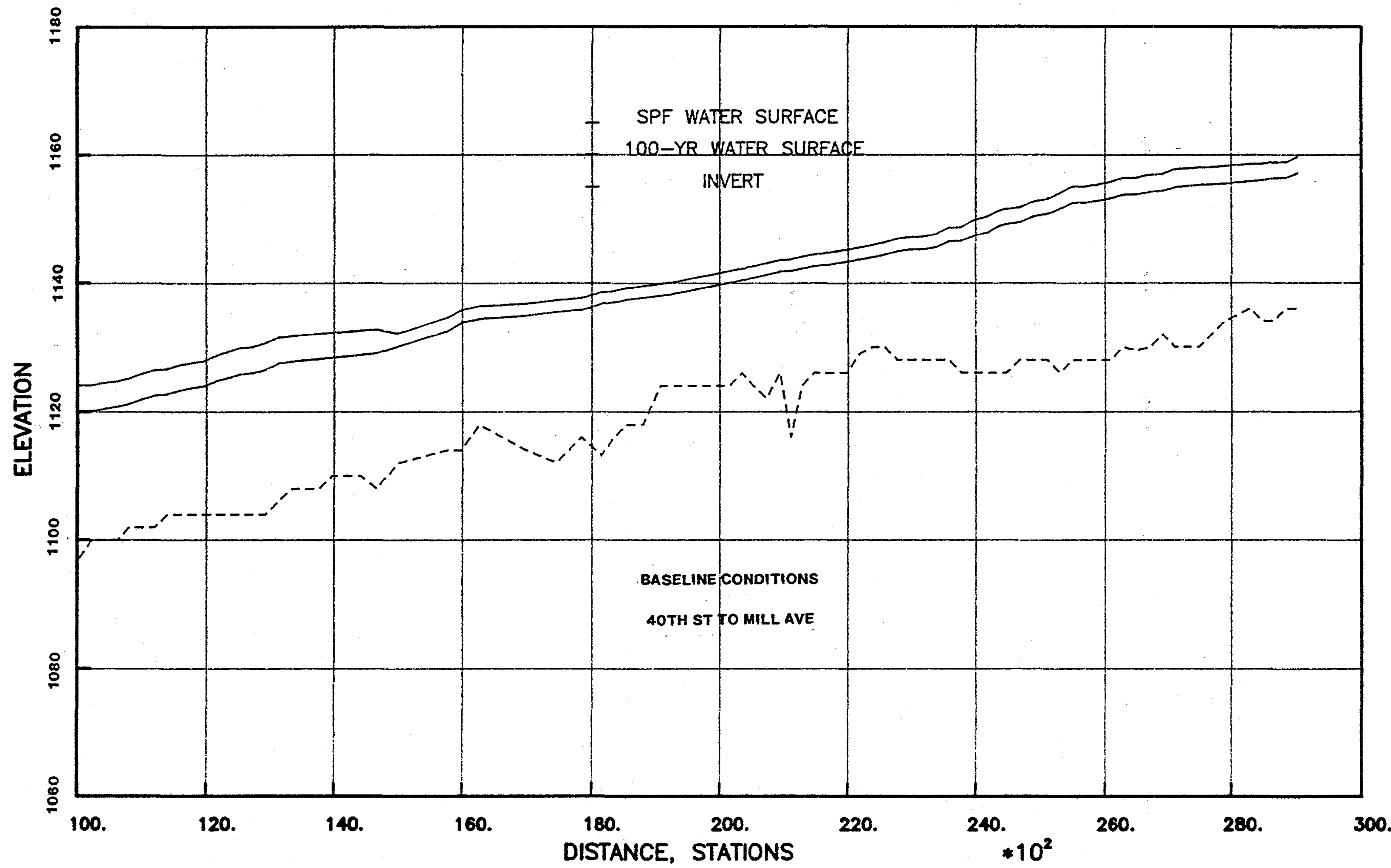


Figure 9b. Baseline Water-Surface Profile Conditions

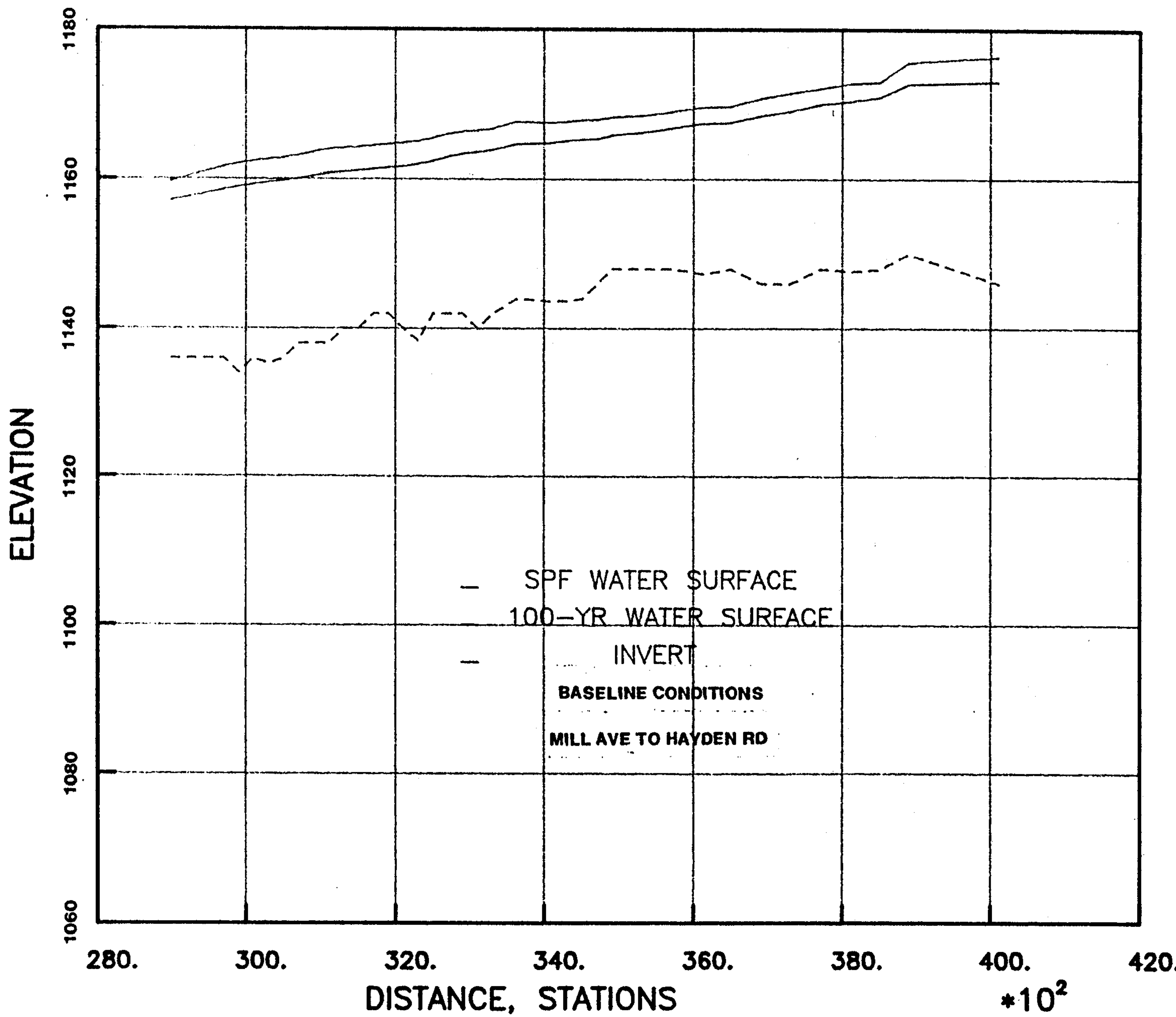


Figure 9c. Baseline Water-Surface Profile Conditions

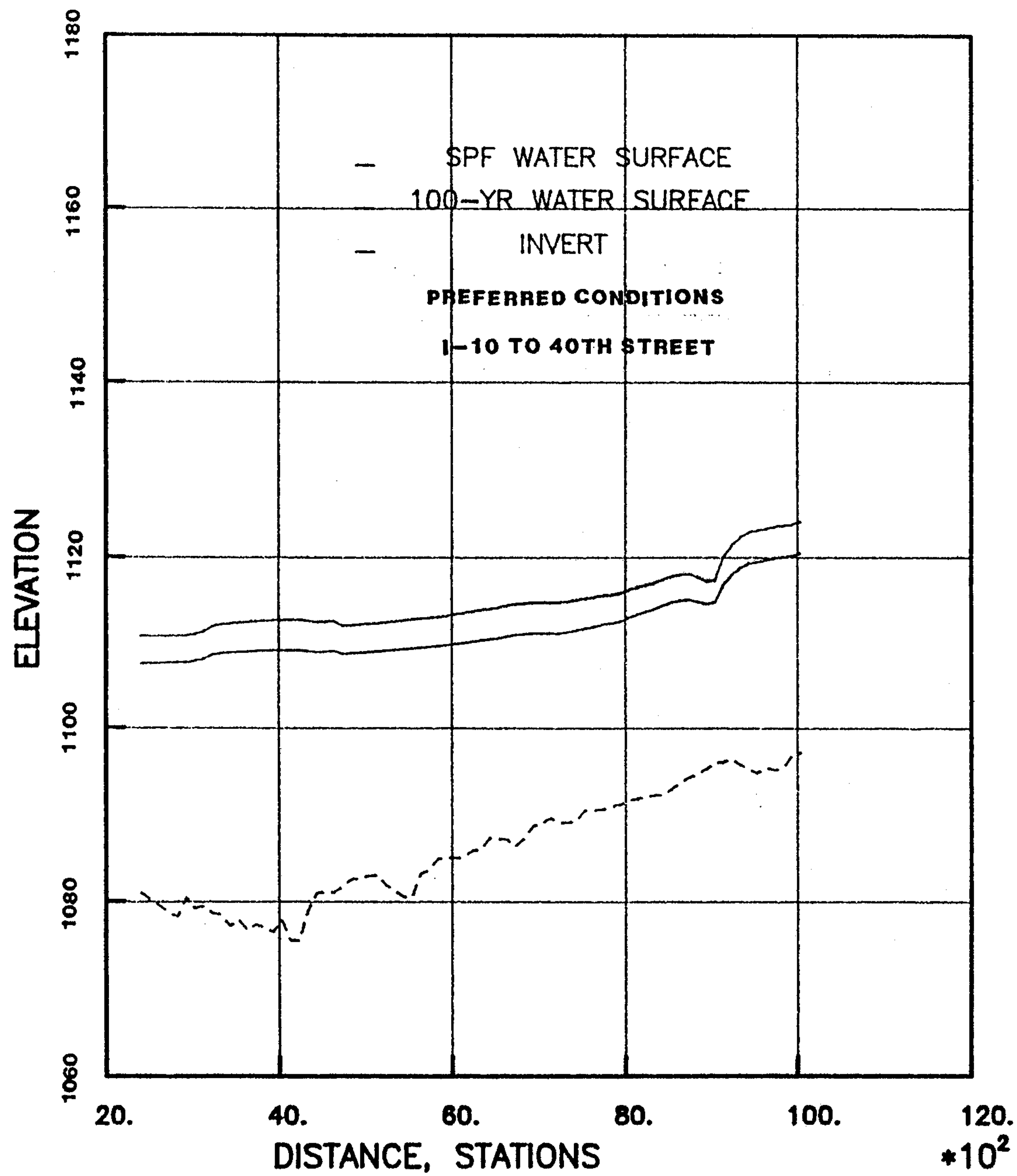


Figure 10a. Channelized Water-Surface Profile Conditions

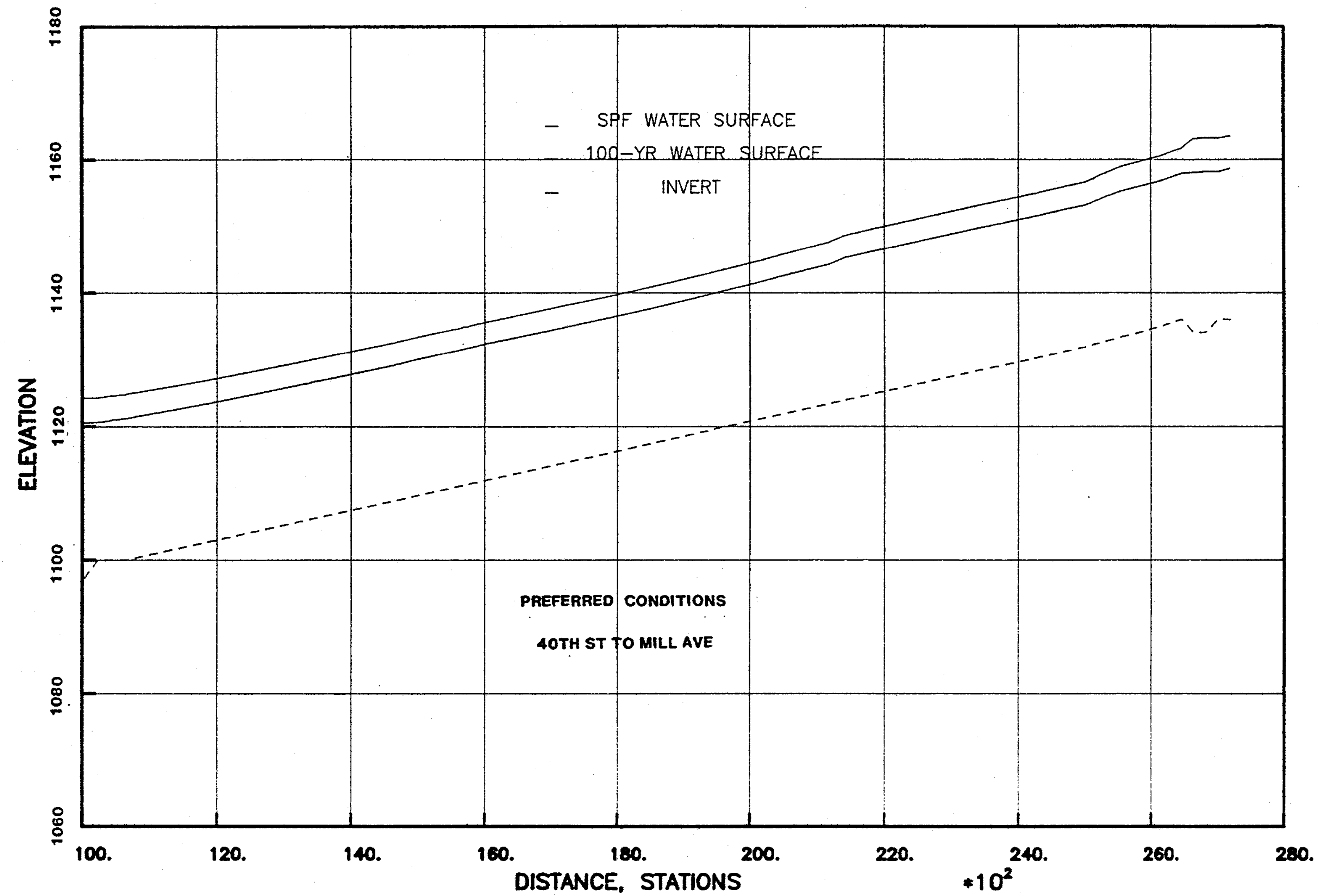


Figure 10b. Channelized Water-Surface Profile Conditions

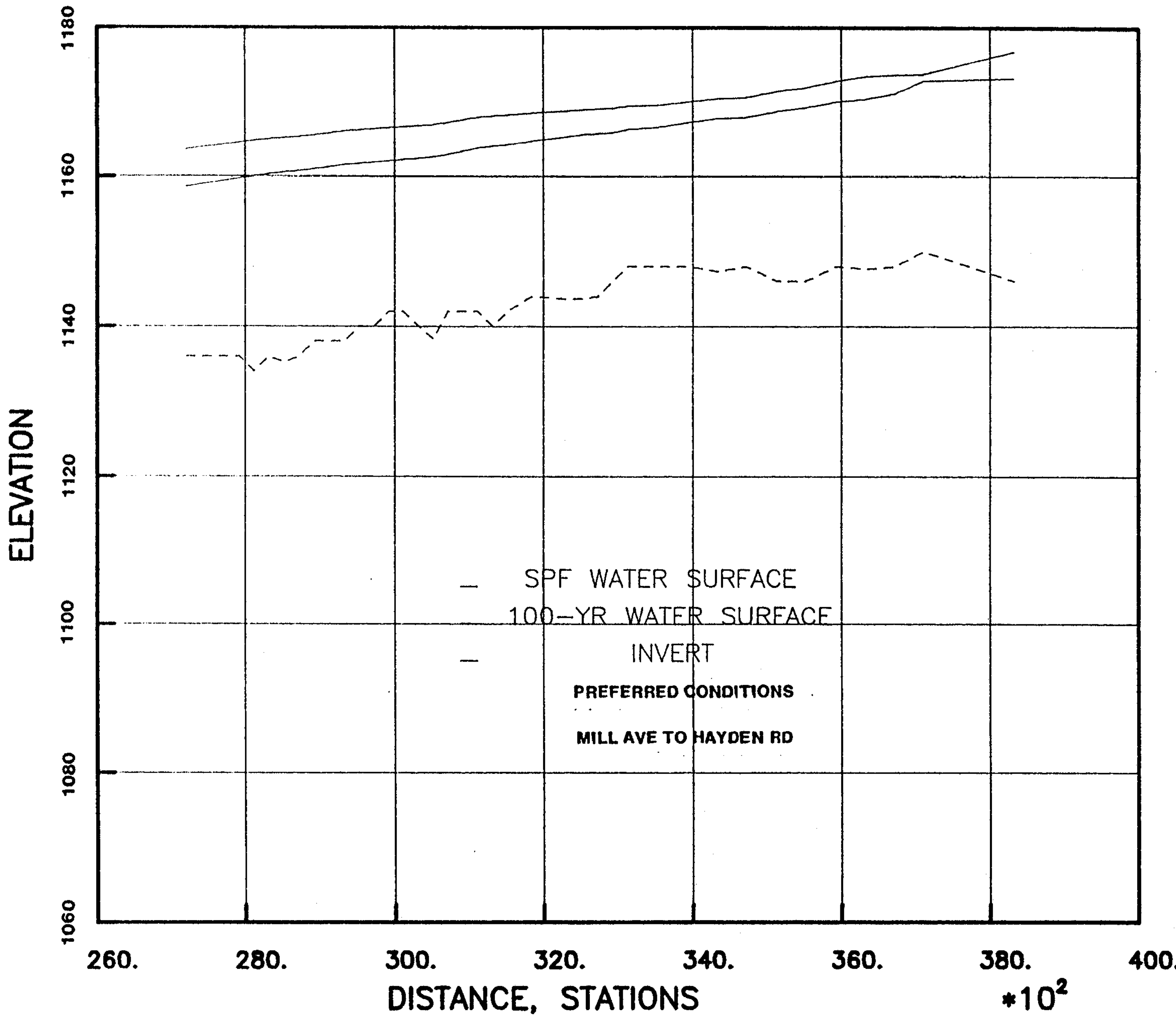


Figure 10c. Channelized Water-Surface Profile Conditions

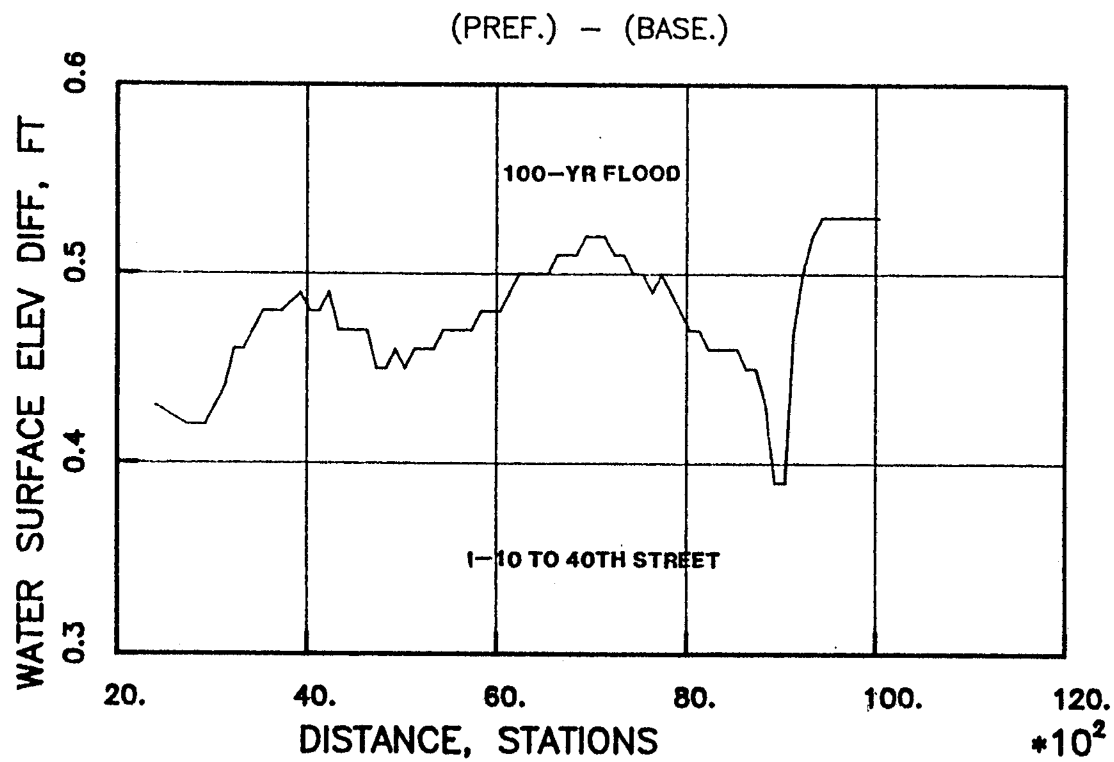


Figure 11a. Comparison of Change in Water-Surface Elevation

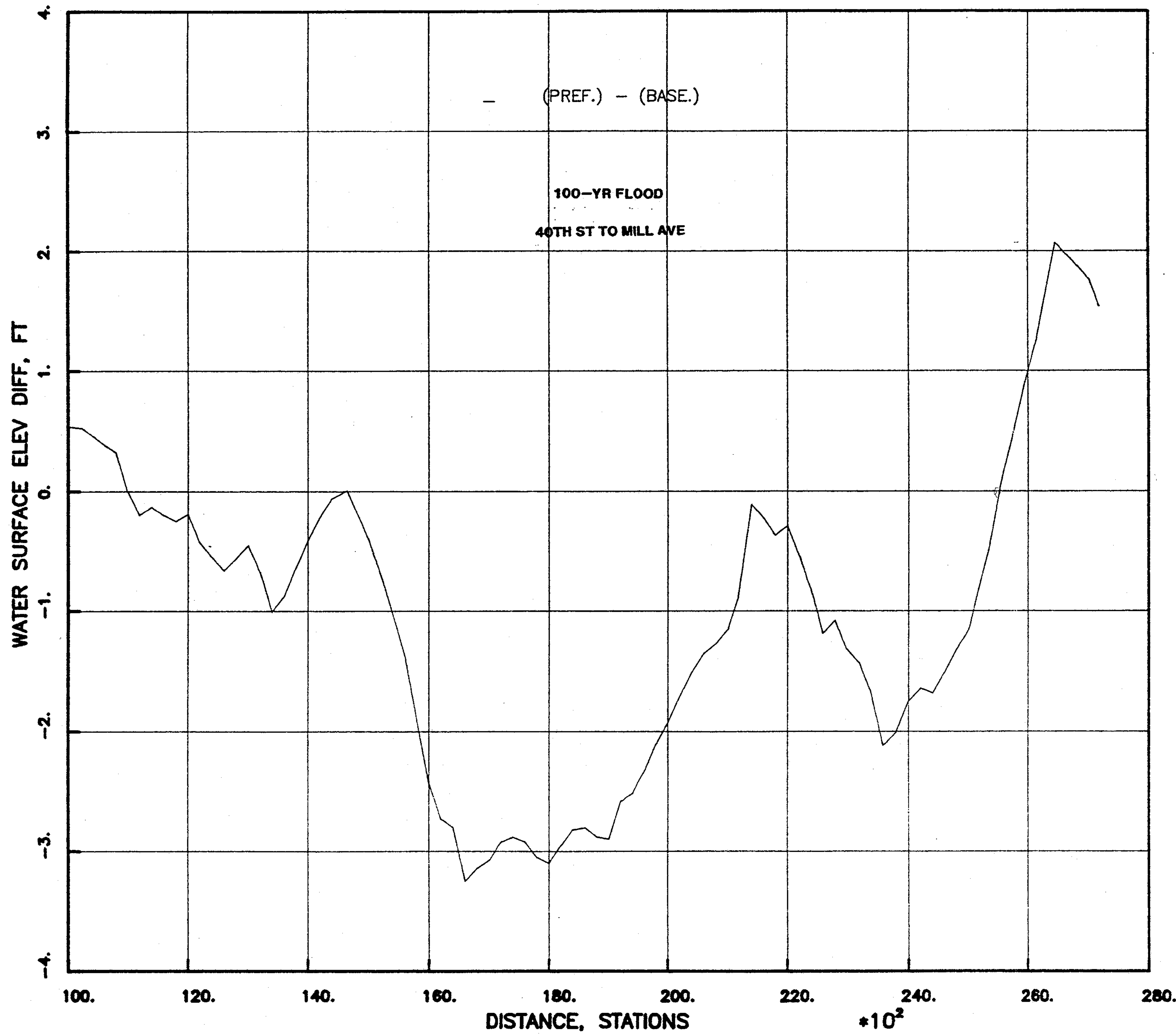


Figure 11b. Comparison of Change in Water-Surface Elevation

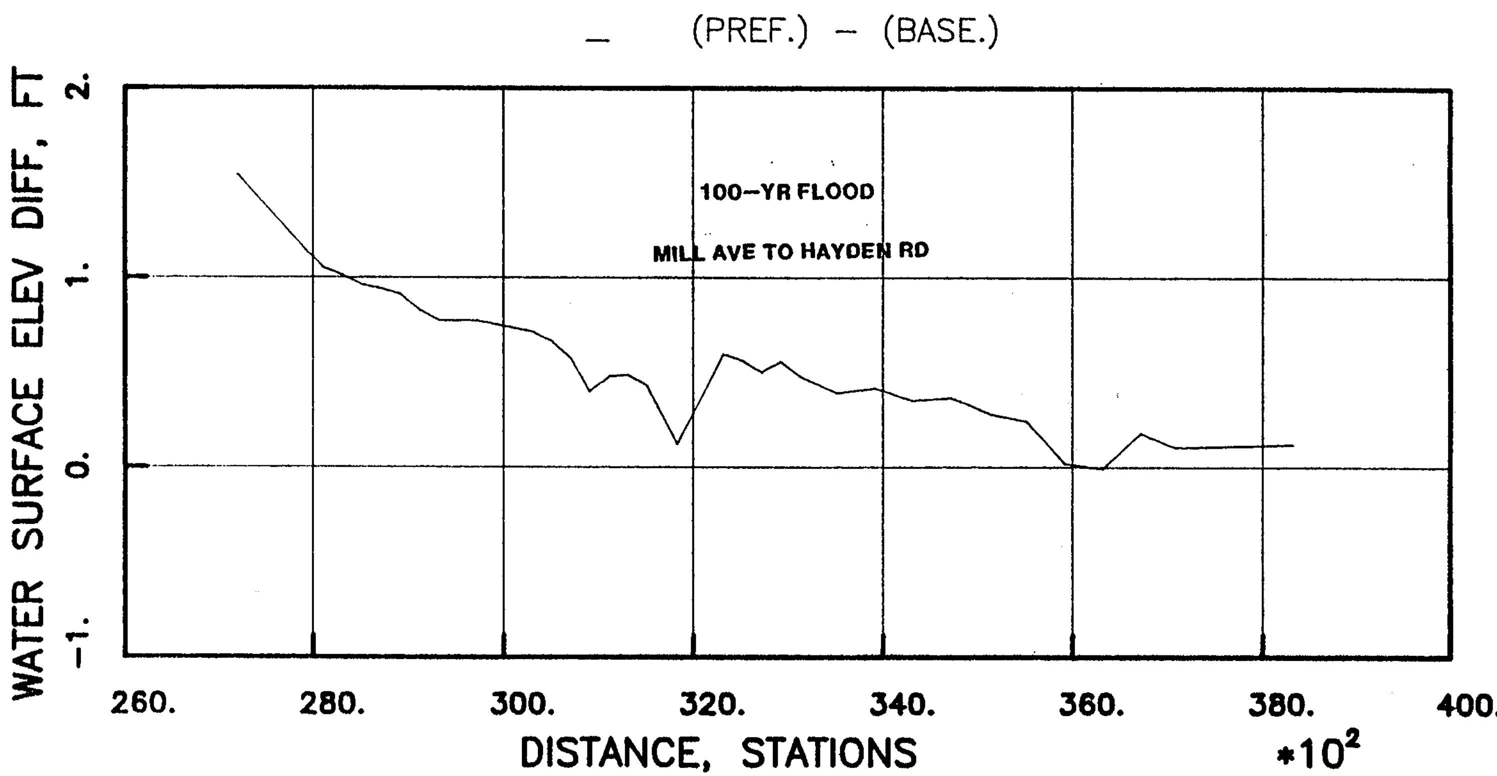


Figure 11c. Comparison of Change in Water-Surface Elevation

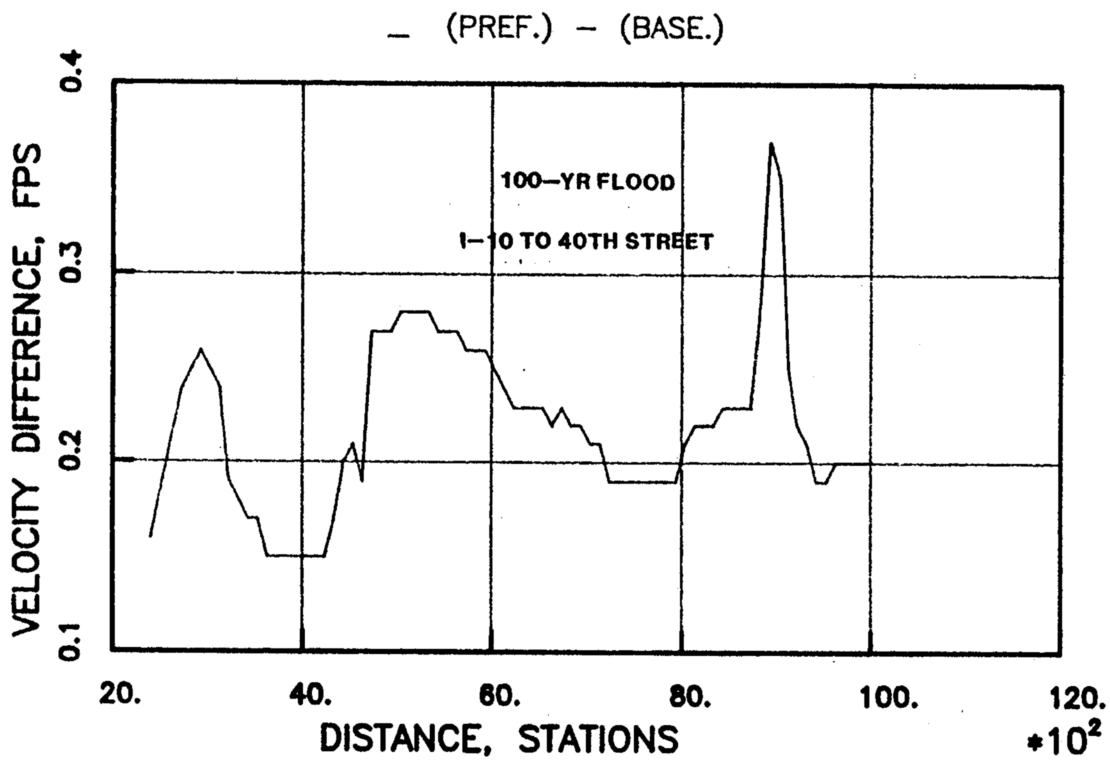


Figure 12a. Comparison of Change in Average Velocity

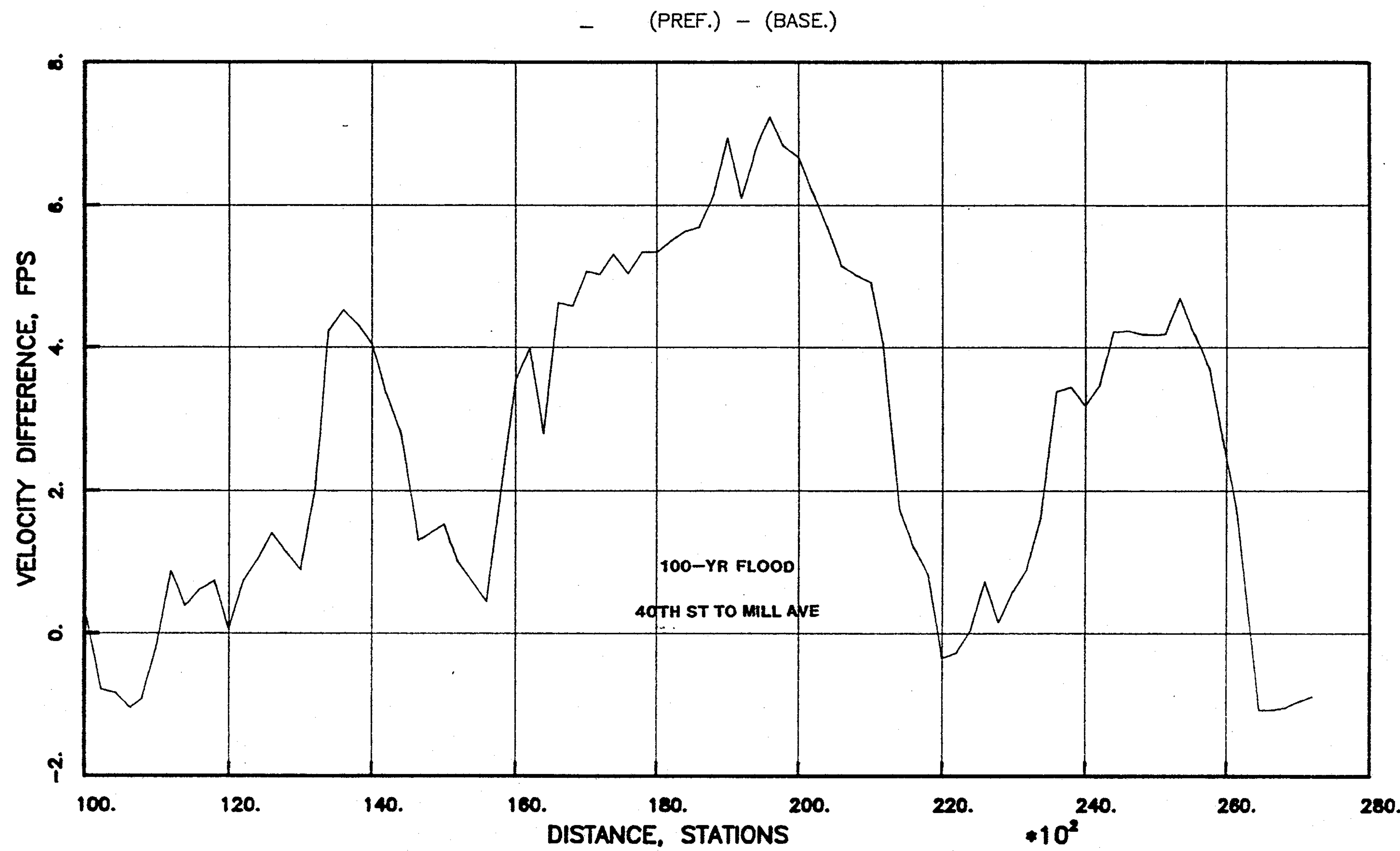


Figure 12b. Comparison of Change in Average Velocity

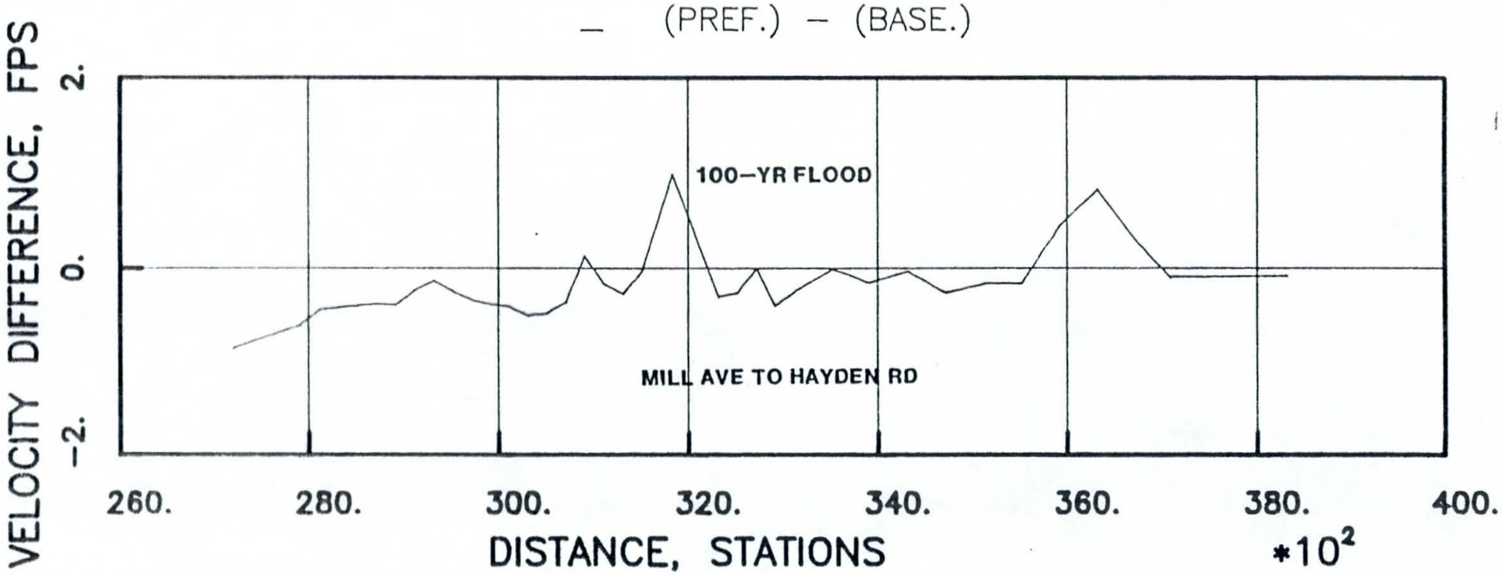


Figure 12c. Comparison of Change in Average Velocity

extends 1200 feet upstream of the Mill Avenue bridge. Flow velocities are little changed in the reach upstream of the project, as is shown by Figure 12c.

3.1.5 Channel-Bed Profiles

The results of the moveable-bed simulations for the SPF event for the baseline and channelized conditions are summarized in Tables 8 and 9, respectively. The initial, maximum, minimum, and final bed elevations are given for both conditions.

Plots of the maximum and minimum range of bed profile changes for the SPF event are given in Figure 13 for the baseline condition, and in Figure 14 for the channelized condition. As these plots show, the overall study reach is degradational. The reach above the project is eroding primarily from the deficit in sediment supply created by extensive sand and gravel mining in the Salt River above Hayden Road. Both simulations start with an upstream sediment inflow equal to zero. For the channelized condition, scouring is limited by the presence of grade-control structures in the project reach. General scour depths are locally greater below each grade control due to the higher sediment transport rates immediately downstream of each grade control. ? A large amount of scour occurs in the vicinity of one of Sky Harbor Ariport's Instrument Landing System (I.L.S.) sites, which protrudes into the north portion of the channel, narrowing the available flow area and causing a sharp increase in the flow velocity. In the reach downstream of the I.L.S., deposition occurs, which results in an aggrading channel profile for approximately 4500 feet upstream of the I-10 bridge. Figure 15 shows the change in bed profile conditions for the channelized condition relative to the baseline.

The aggradation in the reach upstream of the I-10 bridge occurs during the peak flow period in each flood hydrograph. The result is a corresponding increase in the maximum water-surface elevations. Such an increase in flood elevation would be a major impact to the existing river reach and to the I-10 bridge. The existing levee heights in this reach are inadequate to contain an increase in flood elevations caused by aggradation. Problems would also result at the I-10 bridge waterway.

Continued on p. 75

TABLE 8

Baseline Bed-Profile Adjustment,
SPF Event

QUASED-WSPR
SPF BASELINE CONDITION

	BED ELEVATION			
STATION	INITIAL	MAX.	MIN.	FINAL
24+12	1081.00	1081.00	1081.00	1081.00
24+62	1081.00	1082.52	1080.68	1082.52
28+35	1078.30	1080.05	1077.62	1080.05
29+35	1080.50	1082.25	1079.81	1082.25
32+35	1080.50	1082.24	1079.81	1082.24
34+35	1081.00	1082.73	1080.32	1082.73
35+35	1080.40	1084.20	1080.40	1084.20
37+35	1080.90	1084.71	1080.90	1084.71
39+35	1081.80	1085.58	1081.80	1085.58
41+35	1081.10	1084.80	1081.10	1084.80
43+35	1081.80	1085.44	1081.80	1085.44
45+35	1081.20	1084.83	1081.20	1084.83
47+35	1081.90	1085.03	1081.81	1085.03
49+35	1082.80	1085.94	1082.71	1085.94
51+35	1083.10	1086.28	1083.00	1086.28
53+35	1081.30	1084.47	1081.20	1084.47
55+35	1080.50	1083.63	1080.41	1083.63
57+35	1083.70	1086.82	1083.61	1086.82
59+35	1085.20	1088.15	1085.10	1088.15
61+35	1085.20	1088.06	1085.11	1088.06
63+35	1086.10	1088.92	1086.01	1088.92
65+35	1087.30	1090.03	1087.21	1090.03
67+35	1086.40	1089.10	1086.31	1089.10
69+35	1088.80	1091.48	1088.71	1091.48
71+35	1089.70	1091.12	1089.37	1090.35
73+35	1089.20	1090.32	1088.76	1089.50
75+35	1090.60	1091.99	1090.16	1091.35
77+35	1090.70	1092.10	1090.25	1091.41
79+35	1091.30	1092.63	1090.85	1091.87
81+35	1091.90	1091.90	1080.68	1081.05
83+35	1092.30	1092.30	1080.92	1081.31
85+35	1093.00	1093.00	1081.70	1082.09
87+35	1094.40	1094.40	1082.88	1083.27
89+35	1095.40	1095.40	1081.52	1081.99
91+35	1096.10	1096.23	1094.42	1094.72
93+35	1095.80	1095.90	1094.29	1094.63
95+35	1094.80	1094.88	1093.34	1093.67
97+35	1095.20	1095.28	1093.76	1094.12
99+35	1096.80	1096.88	1095.33	1095.73
100+35	1097.20	1097.31	1095.77	1096.14
102+37	1100.00	1100.00	1096.90	1097.76
104+35	1100.00	1100.00	1097.16	1098.03
106+40	1100.00	1100.00	1096.94	1097.81
108+12	1102.00	1102.00	1098.93	1099.79
109+99	1102.00	1102.00	1099.27	1100.13
112+02	1102.00	1102.00	1099.13	1100.53
114+02	1104.00	1104.00	1101.16	1102.51
115+87	1104.00	1104.00	1101.17	1102.51

Table 8 (continued)

117+73	1104.00	1104.00	1101.17	1102.51
119+67	1104.00	1104.00	1101.19	1102.46
121+49	1104.00	1104.00	1100.46	1100.46
123+29	1104.00	1104.00	1100.87	1100.87
125+16	1104.00	1104.00	1101.21	1101.21
127+26	1104.00	1104.00	1101.09	1101.09
129+24	1104.00	1104.00	1101.41	1101.41
131+26	1106.00	1106.26	1103.66	1103.66
133+37	1108.00	1108.19	1105.77	1105.77
135+44	1108.00	1108.19	1105.81	1105.81
137+59	1108.00	1108.16	1105.84	1105.84
139+68	1110.00	1110.11	1107.87	1107.87
142+03	1110.00	1110.00	1107.91	1107.96
144+13	1110.00	1110.00	1108.05	1108.05
146+44	1108.00	1108.00	1105.95	1106.04
148+04	1110.00	1110.00	1107.89	1107.97
149+41	1112.00	1112.00	1109.92	1109.94
150+30	1112.00	1112.00	1109.02	1109.06
152+52	1110.00	1110.00	1105.68	1105.94
155+22	1110.00	1110.00	1106.54	1106.83
157+62	1114.00	1114.00	1110.96	1111.21
159+80	1114.00	1114.00	1112.06	1112.06
162+62	1118.00	1118.00	1116.35	1116.35
169+77	1114.00	1114.00	1112.51	1112.51
174+57	1112.00	1112.00	1111.23	1111.23
178+37	1116.00	1116.00	1115.08	1115.08
181+52	1113.10	1113.10	1112.34	1112.34
183+52	1116.00	1116.00	1115.13	1115.13
185+47	1118.00	1118.08	1117.31	1117.31
188+02	1118.00	1118.06	1117.26	1117.26
190+74	1124.00	1124.00	1123.18	1123.18
193+59	1124.00	1124.00	1123.01	1123.01
196+39	1124.00	1124.00	1123.09	1123.09
199+19	1124.00	1124.00	1123.05	1123.05
201+49	1124.00	1124.00	1123.10	1123.10
203+39	1126.00	1126.09	1125.31	1125.31
205+31	1124.00	1124.06	1123.28	1123.28
207+31	1122.00	1122.06	1121.30	1121.30
209+36	1126.00	1126.10	1125.34	1125.34
211+08	1116.00	1116.03	1115.25	1115.25
212+78	1124.00	1124.03	1123.50	1123.50
214+63	1126.00	1126.08	1125.51	1125.51
216+41	1126.00	1126.09	1125.47	1125.47
217+96	1126.00	1126.10	1125.46	1125.46
219+76	1126.00	1126.12	1125.40	1125.40
221+81	1129.00	1129.10	1128.34	1128.34
223+76	1130.00	1130.00	1128.83	1128.83
225+71	1130.00	1130.00	1128.84	1128.84
227+69	1128.00	1128.00	1126.84	1126.84
229+24	1128.00	1128.00	1126.80	1126.80
231+69	1128.00	1128.00	1126.64	1126.64
233+64	1128.00	1128.02	1124.78	1125.06
235+64	1128.00	1128.02	1124.82	1125.12
237+63	1126.00	1126.03	1122.70	1123.09

Table 8 (continued)

239+59	1126.00	1126.03	1122.76	1123.18
241+59	1126.00	1126.03	1122.81	1123.23
243+59	1126.00	1126.25	1123.00	1123.96
244+59	1126.00	1126.24	1122.92	1123.88
246+59	1128.00	1128.22	1124.69	1125.74
248+69	1128.00	1128.19	1124.71	1125.75
250+74	1128.00	1128.19	1124.59	1125.61
252+76	1126.00	1126.00	1123.90	1124.33
254+76	1128.00	1128.00	1126.20	1126.55
256+76	1128.00	1128.00	1125.92	1126.31
258+77	1128.00	1128.00	1125.96	1126.34
260+79	1128.00	1128.00	1125.96	1126.29
262+79	1130.00	1130.00	1128.76	1128.80
264+79	1129.40	1129.40	1127.99	1128.04
266+80	1130.00	1130.00	1128.74	1128.79
268+80	1132.00	1132.00	1130.61	1130.65
270+79	1130.00	1130.00	1128.98	1129.04
272+83	1130.00	1130.04	1129.02	1129.02
274+83	1130.00	1130.02	1129.04	1129.04
276+83	1132.00	1132.00	1130.84	1130.84
278+85	1134.00	1134.00	1132.95	1132.95
280+85	1134.00	1134.00	1132.30	1132.30
282+89	1134.00	1134.00	1132.31	1132.31
284+81	1134.00	1134.00	1132.18	1132.18
286+81	1136.00	1136.00	1133.99	1133.99
288+82	1136.00	1136.00	1134.38	1134.51
290+82	1136.00	1136.00	1134.25	1134.41
292+82	1138.00	1138.00	1136.19	1136.36
294+82	1136.00	1136.00	1134.25	1134.41
296+82	1136.00	1136.00	1134.38	1134.53
298+82	1134.00	1134.02	1133.13	1133.13
300+82	1136.00	1136.03	1135.15	1135.15
302+82	1135.20	1135.22	1134.34	1134.34
304+82	1136.00	1136.01	1135.14	1135.14
306+82	1138.00	1138.01	1137.15	1137.15
308+73	1138.00	1138.09	1136.50	1136.50
310+85	1138.00	1138.06	1136.67	1136.67
312+85	1140.00	1140.04	1138.67	1138.67
314+85	1140.00	1140.03	1138.70	1138.70
316+85	1142.00	1142.06	1140.71	1140.71
318+85	1142.00	1142.00	1140.29	1140.29
320+85	1140.00	1140.00	1138.31	1138.31
322+85	1138.30	1138.30	1136.62	1136.62
324+85	1142.00	1142.00	1140.42	1140.42
326+85	1142.00	1142.00	1140.61	1140.61
328+85	1142.00	1142.00	1141.48	1141.48
330+85	1140.00	1140.00	1139.49	1139.49
332+85	1142.00	1142.00	1141.48	1141.48
334+85	1142.00	1142.00	1141.51	1141.51
335+90	1144.00	1144.00	1143.25	1143.25
336+90	1144.00	1144.00	1143.26	1143.26
338+82	1144.00	1144.00	1142.77	1142.77
340+82	1143.60	1143.60	1142.30	1142.30
342+82	1143.70	1143.70	1142.47	1142.47

Table 8 (continued)

344+82	1144.00	1144.00	1142.75	1142.75
346+82	1146.00	1146.00	1144.72	1144.72
348+82	1148.00	1148.00	1146.57	1146.57
352+82	1148.00	1148.00	1146.71	1146.71
356+82	1148.00	1148.00	1146.76	1146.76
360+82	1147.30	1147.30	1146.09	1146.09
364+82	1148.00	1148.00	1146.53	1146.53
368+82	1146.00	1146.00	1144.46	1144.46
372+82	1146.00	1146.00	1144.07	1144.07
376+82	1148.00	1148.00	1145.83	1145.83
380+82	1147.60	1147.60	1145.06	1145.06
384+82	1148.00	1148.00	1145.05	1145.05
388+57	1150.00	1150.00	1148.03	1148.03
389+47	1150.00	1150.00	1148.03	1148.03
392+77	1150.00	1150.00	1147.95	1147.95
396+77	1138.10	1138.10	1136.23	1136.23
400+77	1146.00	1146.00	1146.00	1146.00

TABLE 9

Channelized Bed-Profile Adjustment, SPF Event

QUASED-WSPR
SPF CHANNELIZED CONDITION

STATION	BED ELEVATION INITIAL	MAX.	MIN.	FINAL
24+12	1081.00	1081.00	1081.00	1081.00
24+62	1081.00	1082.34	1080.81	1082.18
28+35	1078.30	1080.13	1077.89	1079.98
29+35	1080.50	1082.33	1080.07	1082.18
32+35	1080.50	1082.31	1080.08	1082.16
34+35	1081.00	1082.80	1080.57	1082.65
35+35	1080.40	1084.32	1080.40	1084.09
37+35	1080.90	1084.82	1080.90	1084.59
39+35	1081.80	1085.72	1081.80	1085.49
41+35	1081.10	1084.96	1081.10	1084.74
43+35	1081.80	1085.61	1081.80	1085.39
45+35	1081.20	1085.00	1081.20	1084.78
47+35	1081.90	1085.22	1081.80	1084.76
49+35	1082.80	1086.13	1082.70	1085.67
51+35	1083.10	1086.45	1083.00	1085.98
53+35	1081.30	1084.67	1081.20	1084.21
55+35	1080.50	1083.82	1080.40	1083.36
57+35	1083.70	1086.94	1083.60	1086.49
59+35	1085.20	1088.82	1085.12	1088.24
61+35	1085.20	1088.77	1085.12	1088.23
63+35	1086.10	1089.63	1086.02	1089.09
65+35	1087.30	1090.76	1087.22	1090.25
67+35	1086.40	1089.78	1086.32	1089.28
69+35	1088.80	1092.14	1088.72	1091.64
71+35	1089.70	1092.85	1089.41	1090.62
73+35	1089.20	1092.13	1088.81	1089.83
75+35	1090.60	1093.76	1090.23	1091.53
77+35	1090.70	1093.87	1090.32	1091.66
79+35	1091.30	1094.40	1090.93	1092.11
81+35	1091.90	1091.90	1073.71	1074.46
83+35	1092.30	1092.30	1074.04	1074.79
85+35	1093.00	1093.00	1074.75	1075.50
87+35	1094.40	1094.40	1075.66	1076.44
89+35	1095.40	1095.40	1072.83	1073.75
91+35	1096.10	1096.60	1093.89	1093.89
93+35	1095.80	1096.24	1093.98	1093.98
95+35	1094.80	1095.20	1093.09	1093.09
97+35	1095.20	1095.60	1093.61	1093.61
99+35	1096.80	1097.21	1095.27	1095.27
100+35	1097.20	1097.66	1095.73	1095.73
102+37	1100.00	1100.00	1100.00	1100.00
104+35	1100.08	1100.08	1100.08	1100.08
106+40	1100.17	1100.17	1100.17	1100.17
108+00	1100.36	1100.36	1100.23	1100.23
110+00	1100.80	1100.80	1100.31	1100.31
112+00	1101.24	1101.24	1100.39	1100.39
114+00	1101.69	1101.69	1100.48	1100.48
116+00	1102.14	1102.14	1100.56	1100.56

Table 9 (continued)

118+00	1102.58	1102.58	1100.95	1100.98
120+00	1103.02	1103.02	1101.39	1101.42
122+00	1103.47	1103.47	1101.84	1101.87
124+00	1103.91	1103.91	1102.34	1102.44
126+00	1104.36	1104.36	1102.79	1102.89
128+00	1104.80	1104.80	1103.23	1103.33
130+00	1105.24	1105.24	1103.67	1103.77
132+00	1105.69	1105.69	1104.12	1104.22
134+00	1106.13	1106.13	1104.56	1104.66
136+00	1106.57	1106.57	1103.22	1103.22
138+00	1107.02	1107.02	1103.66	1103.66
140+00	1107.46	1107.46	1104.10	1104.10
142+00	1107.90	1107.90	1104.53	1104.53
144+00	1108.35	1108.35	1104.98	1104.98
146+00	1108.79	1108.79	1108.79	1108.79
148+00	1109.24	1109.24	1108.87	1108.87
150+00	1109.68	1109.68	1108.95	1108.95
152+00	1110.13	1110.13	1109.04	1109.04
154+00	1110.57	1110.57	1109.12	1109.12
156+00	1111.01	1111.01	1109.20	1109.20
158+00	1111.46	1111.46	1109.34	1109.36
160+00	1111.90	1111.90	1109.78	1109.80
162+00	1112.35	1112.35	1110.23	1110.25
164+00	1112.79	1112.79	1110.67	1110.69
166+00	1113.23	1113.23	1111.11	1111.13
168+00	1113.68	1113.68	1111.65	1111.65
170+00	1114.12	1114.12	1112.09	1112.09
172+00	1114.56	1114.56	1112.53	1112.53
174+00	1115.00	1115.00	1112.95	1112.95
176+00	1115.45	1115.45	1113.39	1113.39
178+00	1115.89	1115.89	1113.12	1113.13
180+00	1116.36	1116.36	1113.57	1113.58
182+00	1116.80	1116.80	1113.97	1113.98
184+00	1117.25	1117.25	1114.41	1114.43
186+00	1117.69	1117.69	1114.84	1114.86
188+00	1118.14	1118.14	1116.51	1116.61
190+00	1118.58	1118.58	1116.95	1117.05
192+00	1119.02	1119.02	1117.38	1117.48
194+00	1119.47	1119.47	1117.82	1117.90
196+00	1119.91	1119.91	1118.25	1118.33
198+00	1120.36	1120.36	1111.11	1111.11
200+00	1120.80	1120.80	1111.51	1111.51
202+00	1121.24	1121.24	1111.93	1111.93
204+00	1121.68	1121.68	1112.37	1112.37
206+00	1122.13	1122.13	1112.82	1112.82
208+00	1122.57	1122.57	1122.57	1112.57
210+00	1123.02	1123.02	1122.65	1122.65
212+00	1123.46	1123.46	1122.73	1122.73
214+00	1123.90	1123.90	1122.82	1122.82
216+00	1124.35	1124.35	1122.90	1122.90
218+00	1124.79	1124.79	1122.98	1122.98
220+00	1125.24	1125.24	1123.06	1123.06
222+00	1125.68	1125.68	1123.14	1123.14
224+00	1126.12	1126.12	1123.23	1123.23

Table 9 (continued)

226+00	1126.57	1126.57	1123.31	1123.31
228+00	1127.01	1127.01	1123.39	1123.39
230+00	1127.45	1127.45	1124.96	1125.27
232+00	1127.90	1127.90	1125.41	1125.72
234+00	1128.34	1128.34	1125.85	1126.16
236+00	1128.79	1128.79	1126.30	1126.61
238+00	1129.23	1129.23	1126.74	1127.04
240+00	1129.67	1129.67	1119.81	1119.81
242+00	1130.12	1130.12	1120.27	1120.27
244+00	1130.56	1130.56	1120.68	1120.68
246+00	1131.01	1131.01	1121.11	1121.11
248+00	1131.45	1131.45	1121.55	1121.55
250+00	1131.87	1131.87	1131.87	1131.87
251+40	1132.22	1132.22	1131.93	1131.93
253+38	1132.76	1132.76	1132.01	1132.01
255+42	1133.31	1133.31	1132.09	1132.09
257+42	1133.84	1133.84	1132.17	1132.17
259+44	1134.39	1134.39	1132.26	1132.26
261+49	1134.94	1134.94	1132.34	1132.34
263+44	1135.46	1135.46	1132.89	1132.89
265+44	1136.00	1136.00	1133.66	1133.66
267+36	1134.00	1134.00	1131.87	1131.87
269+36	1136.00	1136.00	1133.70	1133.70
271+37	1136.00	1136.05	1134.41	1134.47
273+37	1136.00	1136.04	1134.32	1134.39
275+37	1138.00	1138.05	1136.25	1136.33
277+37	1136.00	1136.05	1134.31	1134.39
279+37	1136.00	1136.05	1134.44	1134.52
281+37	1134.00	1134.01	1133.06	1133.06
283+37	1136.00	1136.00	1135.06	1135.06
285+37	1135.20	1135.20	1134.27	1134.27
287+37	1136.00	1136.00	1135.06	1135.06
289+37	1138.00	1138.00	1137.09	1137.09
291+28	1138.00	1138.09	1136.50	1136.50
293+40	1138.00	1138.05	1136.59	1136.59
295+40	1140.00	1140.04	1138.61	1138.61
297+40	1140.00	1140.05	1138.68	1138.68
299+40	1142.00	1142.06	1140.66	1140.66
301+40	1142.00	1142.00	1140.29	1140.29
303+40	1140.00	1140.00	1138.31	1138.31
305+40	1138.30	1138.30	1136.64	1136.64
307+40	1142.00	1142.00	1140.43	1140.43
309+40	1142.00	1142.00	1140.58	1140.58
311+40	1142.00	1142.01	1141.48	1141.48
313+40	1140.00	1140.01	1139.51	1139.51
315+40	1142.00	1142.01	1141.48	1141.48
317+40	1142.00	1142.01	1141.57	1141.57
318+45	1144.00	1144.00	1143.29	1143.29
319+45	1144.00	1144.00	1143.29	1143.29
321+37	1144.00	1144.01	1142.72	1142.72
323+37	1143.60	1143.60	1142.30	1142.30
325+37	1143.70	1143.70	1142.47	1142.47
327+37	1144.00	1144.00	1142.76	1142.76
329+37	1146.00	1146.00	1144.69	1144.69

Table 9 (continued)

331+37	1148.00	1148.00	1146.60	1146.60
335+37	1148.00	1148.00	1146.67	1146.67
339+37	1148.00	1148.00	1146.77	1146.77
343+37	1147.30	1147.30	1146.05	1146.05
347+37	1148.00	1148.00	1146.55	1146.55
351+37	1146.00	1146.00	1144.48	1144.48
355+37	1146.00	1146.00	1144.01	1144.01
359+37	1148.00	1148.00	1145.87	1145.87
363+37	1147.60	1147.60	1145.04	1145.04
367+37	1148.00	1148.00	1145.07	1145.07
371+12	1150.00	1150.00	1148.04	1148.04
372+02	1150.00	1150.00	1148.05	1148.05
375+32	1150.00	1150.00	1147.96	1147.96
379+32	1138.10	1138.10	1136.20	1136.20
383+32	1146.00	1146.00	1146.00	1146.00

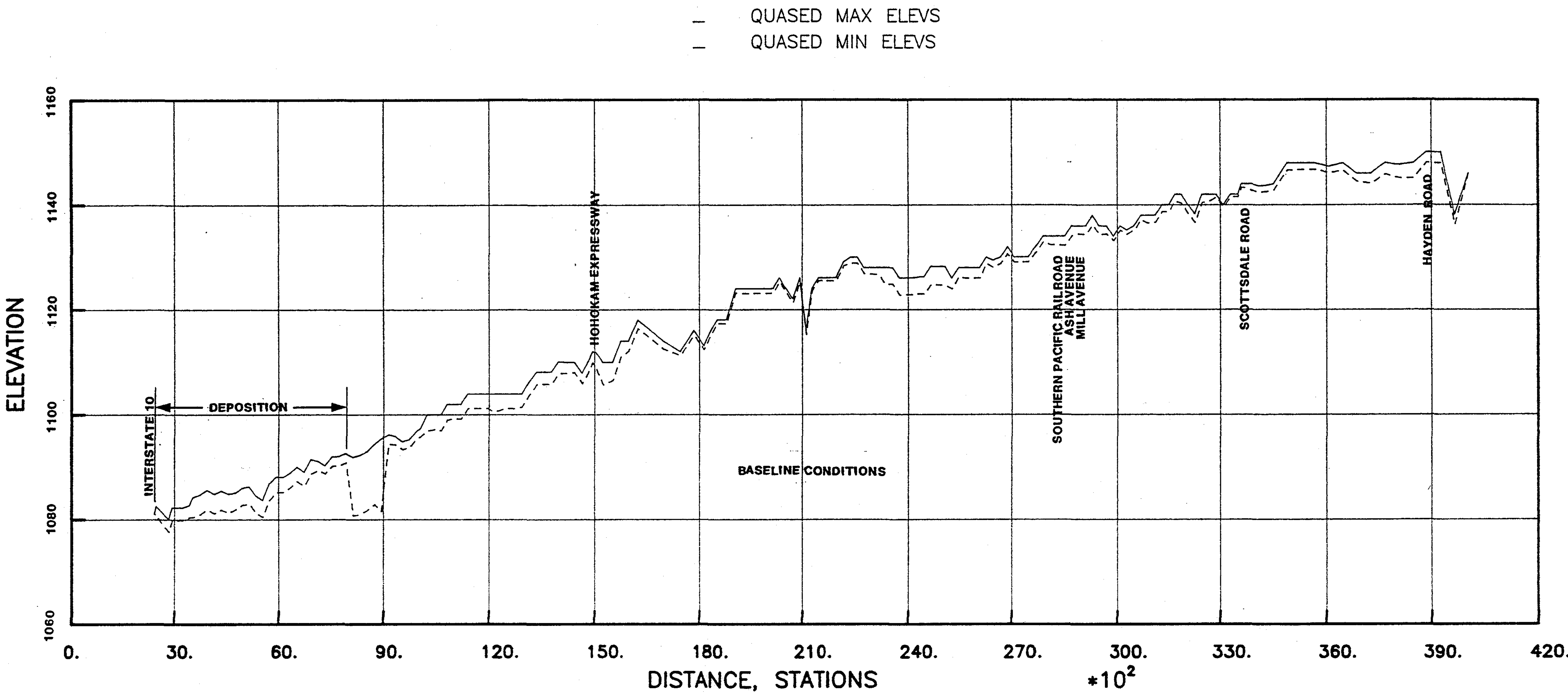


Figure 13. Baseline Bed Profile for SPF Event

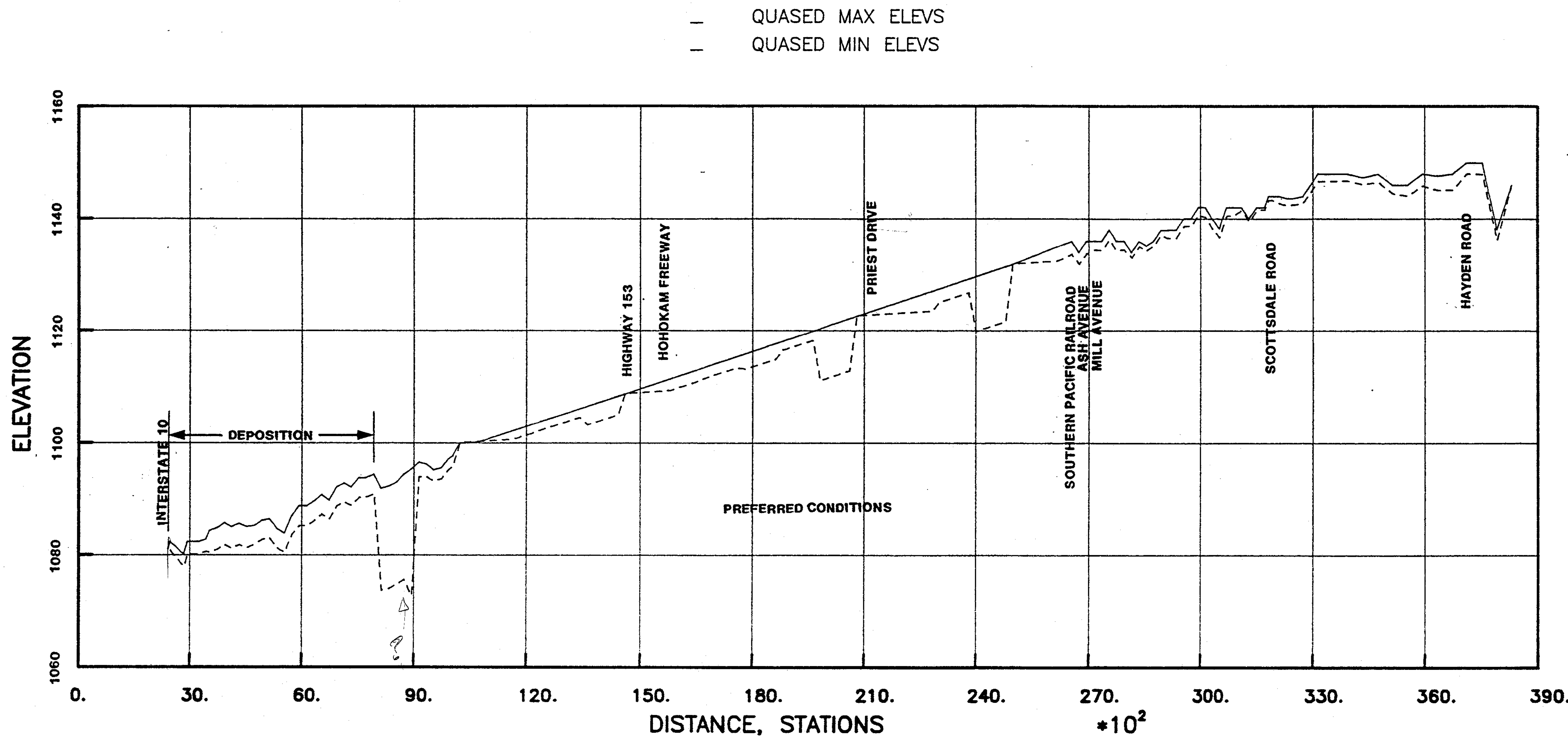


Figure 14. Channelized Bed Profile for SPF Event

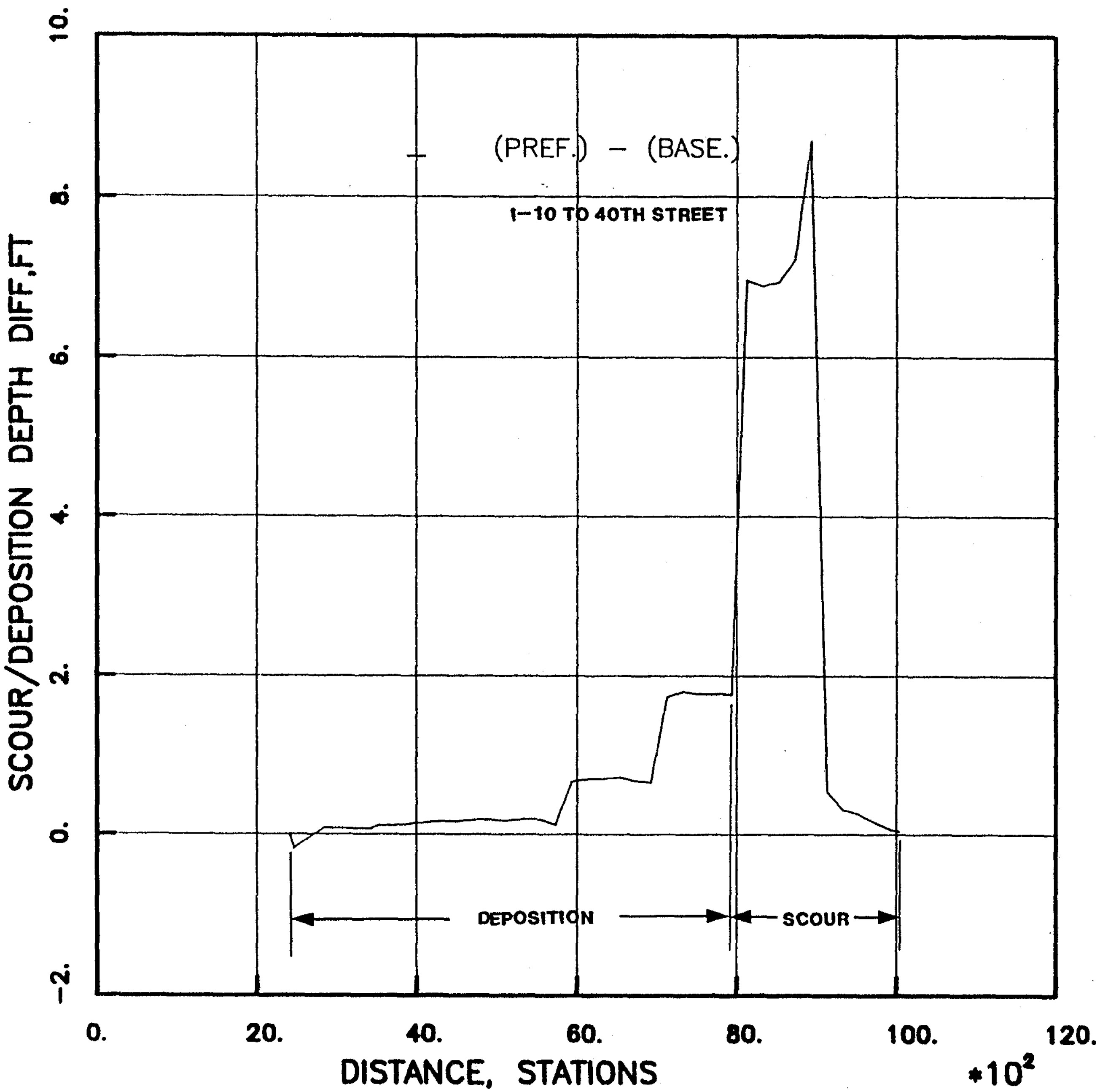


Figure 15a. Comparison of Change in Bed Profile

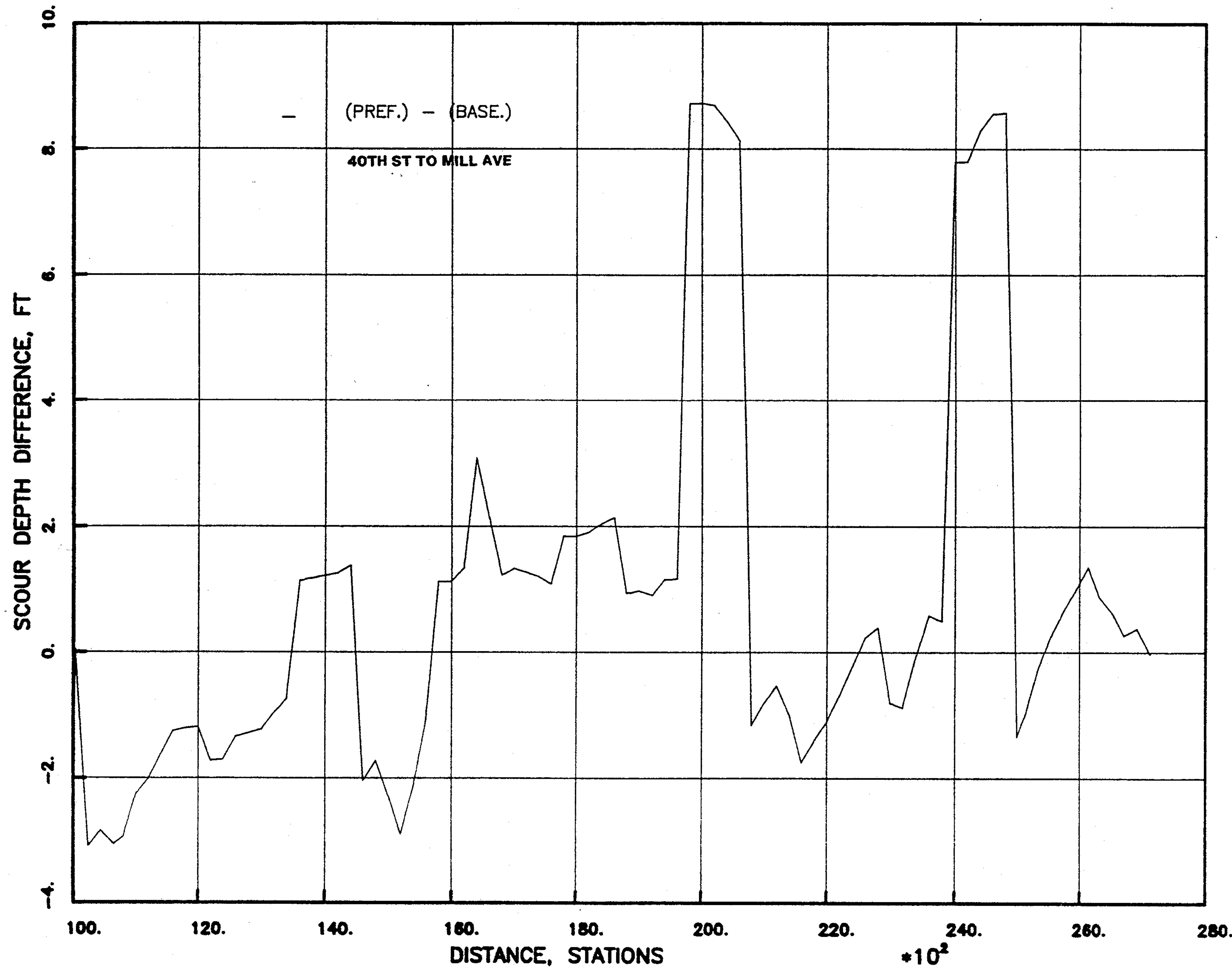


Figure 15b. Comparison of Change in Bed Profile

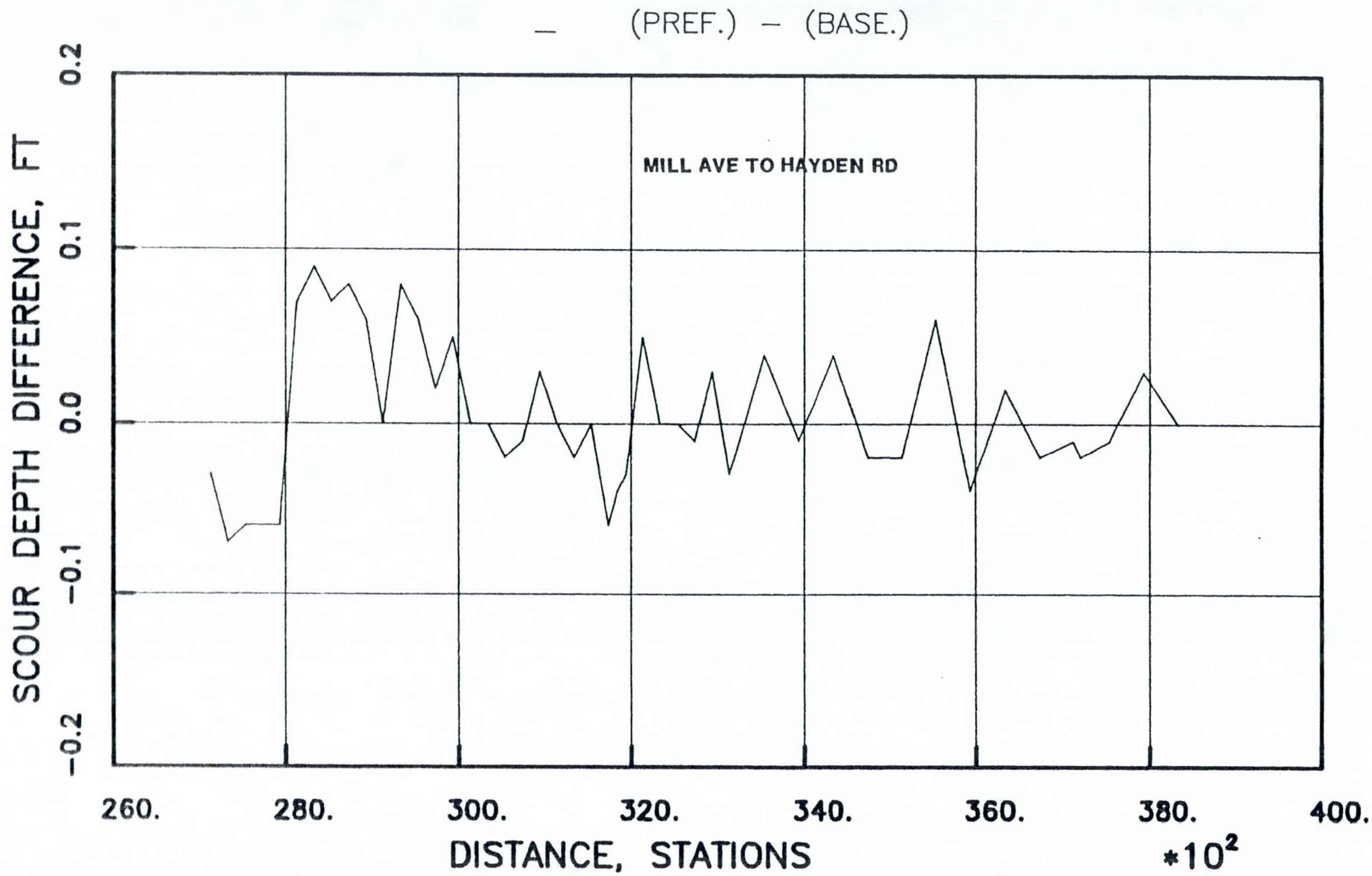
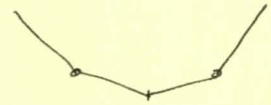


Figure 15c. Comparison of Change in Bed Profile

normal depth for x-sub-



with Q_{10} = 93,000 cfs

y = 14.04'

14 - 6 = 8'

3.2 Grade-Control Structures

Four grade-control structures are pla
A). They were originally located at the
the project and below the bridges for SR 1
the channel bed profile indicates that a
feet downstream of a bridge will significar
at the bridge. For this reason, the
downstream of SR 153 will protect that bridge as well as the bridge for the Hohokam Freeway.

However, due to the large scour depths calculated near the I.L.S., a second channelized moveable-bed simulation was conducted, which included moving the grade control at the downstream limit of the project to the I.L.S. location. This will limit the scour near the I.L.S. site as well as reduce the amount of deposition downstream, and is, therefore, the recommended alternative. The initial maximum, minimum, and final bed elevations for this alternative are summarized in Table 10. Figure 16 is a plot of the maximum and minimum range of bed profile changes. The change in bed profile conditions for this alternative, relative to the baseline condition, is shown in Figure 17.

The general concept for a grade-control is simply to provide a substantial mass of concrete that extends below the local scour depths, and can resist overturning forces. A typical cross-section of the grade-control structure is shown in Figure 18. Upstream of the grade-control structure, the bank protection extends to the depth below bed form displacement and other general scour. Below the grade control the bank protection extends to the depth of general scour plus the local scour caused by the drop over the grade control. The grade-control structure is, therefore, an integral feature with the bank protection.

3.3 Bank Protection Measures

Bank protection will consist of a composite system of cement stabilized alluvium (CSA) and a second bank protection material, as shown in Figure 19. For most sections of the river, the CSA protection will extend up to the 10-year water surface elevation, approximately eight feet above the toe-of-bank

how was this established?

Cont. on p. 86

3.2 Grade-Control Structures

Four grade-control structures are planned in the project (see Exhibit A). They were originally located at the upstream and downstream limits in the project and below the bridges for SR 153 and Priest Drive. Analysis of the channel bed profile indicates that a single grade control located 1000 feet downstream of a bridge will significantly limit the general degradation at the bridge. For this reason, the grade-control structure located downstream of SR 153 will protect that bridge as well as the bridge for the Hohokam Freeway.

However, due to the large scour depths calculated near the I.L.S., a second channelized moveable-bed simulation was conducted, which included moving the grade control at the downstream limit of the project to the I.L.S. location. This will limit the scour near the I.L.S. site as well as reduce the amount of deposition downstream, and is, therefore, the recommended alternative. The initial maximum, minimum, and final bed elevations for this alternative are summarized in Table 10. Figure 16 is a plot of the maximum and minimum range of bed profile changes. The change in bed profile conditions for this alternative, relative to the baseline condition, is shown in Figure 17.

The general concept for a grade-control is simply to provide a substantial mass of concrete that extends below the local scour depths, and can resist overturning forces. A typical cross-section of the grade-control structure is shown in Figure 18. Upstream of the grade-control structure, the bank protection extends to the depth below bed form displacement and other general scour. Below the grade control the bank protection extends to the depth of general scour plus the local scour caused by the drop over the grade control. The grade-control structure is, therefore, an integral feature with the bank protection.

3.3 Bank Protection Measures

Bank protection will consist of a composite system of cement stabilized alluvium (CSA) and a second bank protection material, as shown in Figure 19. For most sections of the river, the CSA protection will extend up to the 10-year water surface elevation, approximately eight feet above the toe-of-bank

how was this established?

Cont. on p. 86

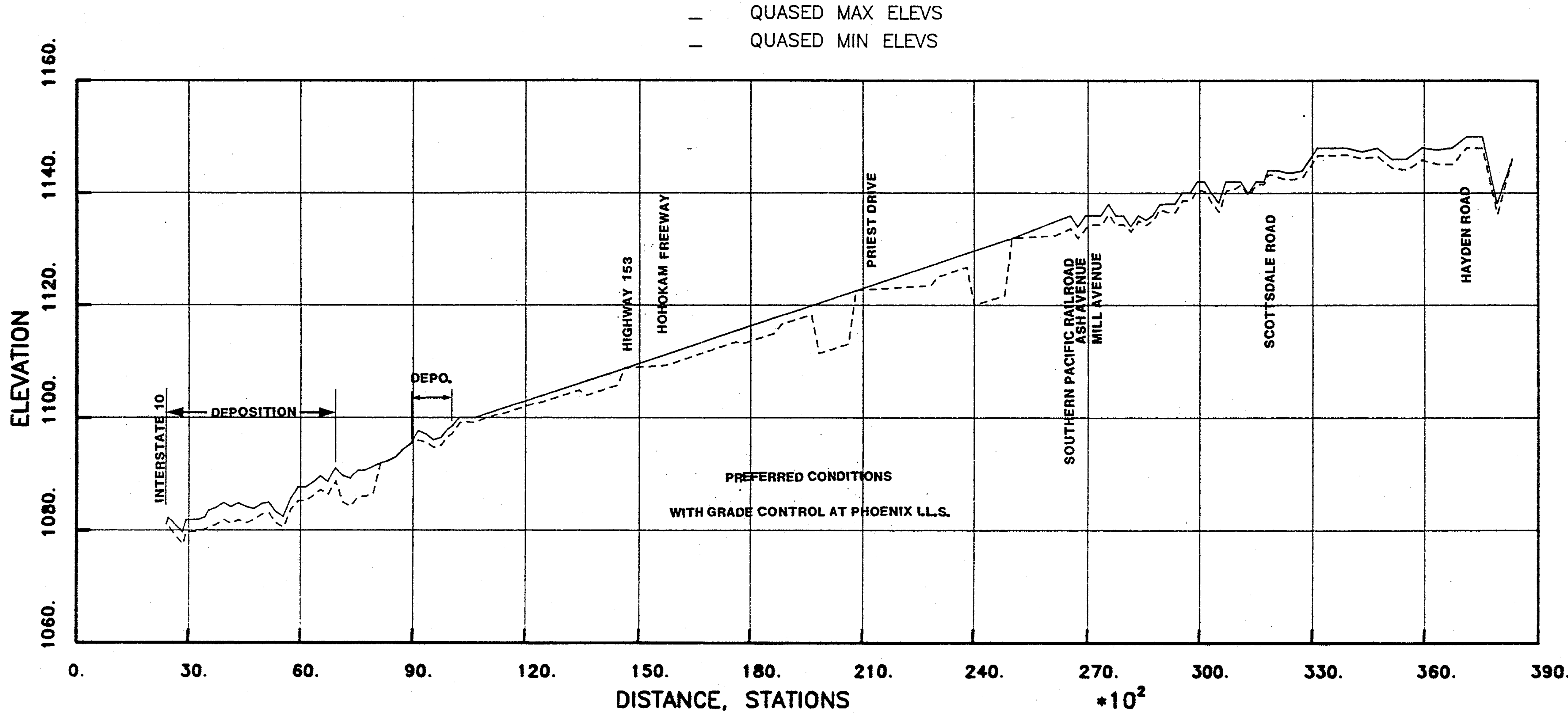


Figure 16. Channelized Bed Profile for SPF Event with Grade Control at Phoenix I.L.S. Included.

TABLE 10

Channelized Bed-Profile Adjustment with Grade Control at Phoenix I.L.S. Included, SPF Event

QUASED-WSPR
SPF CHANNELIZED CONDITION
WITH GRADE CONTROL AT PHOENIX I.L.S.

STATION	BED ELEVATION			
	INITIAL	MAX.	MIN.	FINAL
24+12	1081.00	1081.00	1081.00	1081.00
24+62	1081.00	1082.20	1080.58	1082.20
28+35	1078.30	1079.60	1077.42	1079.60
29+35	1080.50	1081.78	1079.60	1081.78
32+35	1080.50	1081.80	1079.62	1081.80
34+35	1081.00	1082.29	1080.11	1082.29
35+35	1080.40	1083.45	1080.40	1083.45
37+35	1080.90	1083.96	1080.90	1083.96
39+35	1081.80	1084.85	1081.80	1084.85
41+35	1081.10	1084.10	1081.10	1084.10
43+35	1081.80	1084.78	1081.80	1084.78
45+35	1081.20	1084.12	1081.20	1084.12
47+35	1081.90	1083.73	1081.81	1083.73
49+35	1082.80	1084.63	1082.71	1084.63
51+35	1083.10	1084.94	1083.01	1084.94
53+35	1081.30	1083.16	1081.21	1083.16
55+35	1080.50	1082.35	1080.41	1082.35
57+35	1083.70	1085.53	1083.61	1085.35
59+35	1085.20	1087.66	1085.10	1087.30
61+35	1085.20	1087.62	1085.11	1087.28
63+35	1086.10	1088.48	1086.01	1088.15
65+35	1087.30	1089.60	1087.21	1089.27
67+35	1086.40	1088.67	1086.31	1088.34
69+35	1088.80	1091.05	1088.71	1090.74
71+35	1089.70	1089.70	1084.88	1084.88
73+35	1089.20	1089.20	1084.13	1084.13
75+35	1090.60	1090.60	1085.81	1085.81
77+35	1090.70	1090.70	1085.91	1085.91
79+35	1091.30	1091.30	1086.38	1086.38
81+35	1091.90	1091.90	1091.90	1091.90
83+35	1092.30	1092.30	1092.30	1092.30
85+35	1093.00	1093.00	1093.00	1093.00
87+35	1094.40	1094.40	1094.40	1094.40
89+35	1095.40	1095.40	1095.40	1095.40
91+35	1096.10	1097.65	1095.97	1096.70
93+35	1095.80	1097.11	1095.67	1096.27
95+35	1094.80	1096.03	1094.67	1095.25
97+35	1095.20	1096.43	1095.07	1095.67
99+35	1096.80	1098.04	1096.67	1097.28
100+35	1097.20	1098.48	1097.12	1097.72
102+37	1100.00	1100.00	1099.03	1099.08
104+35	1100.00	1100.00	1099.26	1099.31
106+40	1100.00	1100.00	1099.06	1099.11
108+00	1100.36	1100.36	1099.56	1099.61
110+00	1100.80	1100.80	1100.01	1100.06
112+00	1101.24	1101.24	1100.45	1100.50
114+00	1101.69	1101.69	1100.68	1100.71

Table 10 (continued)

116+00	1102.14	1102.14	1101.13	1101.16
118+00	1102.58	1102.58	1101.57	1101.60
120+00	1103.02	1103.02	1102.01	1102.04
122+00	1103.47	1103.47	1102.46	1102.49
124+00	1103.91	1103.91	1102.70	1102.76
126+00	1104.36	1104.36	1103.15	1103.21
128+00	1104.80	1104.80	1103.59	1103.65
130+00	1105.24	1105.24	1104.03	1104.09
132+00	1105.69	1105.69	1104.48	1104.55
134+00	1106.13	1106.13	1104.92	1104.98
136+00	1106.57	1106.57	1104.00	1104.00
138+00	1107.02	1107.02	1104.45	1104.45
140+00	1107.46	1107.46	1104.88	1104.88
142+00	1107.90	1107.90	1105.32	1105.32
144+00	1108.35	1108.35	1105.77	1105.77
146+00	1108.79	1108.79	1108.79	1108.79
148+00	1109.24	1109.24	1108.87	1108.87
150+00	1109.68	1109.68	1108.95	1108.95
152+00	1110.13	1110.13	1109.04	1109.04
154+00	1110.57	1110.57	1109.12	1109.12
156+00	1111.01	1111.01	1109.20	1109.32
158+00	1111.46	1111.46	1109.49	1109.50
160+00	1111.90	1111.90	1109.93	1109.94
162+00	1112.35	1112.35	1110.38	1110.39
164+00	1112.79	1112.79	1110.82	1110.83
166+00	1113.23	1113.23	1111.26	1111.27
168+00	1113.68	1113.68	1111.66	1111.66
170+00	1114.12	1114.12	1112.10	1112.10
172+00	1114.56	1114.56	1112.54	1112.54
174+00	1115.00	1115.00	1112.97	1112.97
176+00	1115.45	1115.45	1113.42	1113.42
178+00	1115.89	1115.89	1113.17	1113.18
180+00	1116.36	1116.36	1113.59	1113.60
182+00	1116.80	1116.80	1114.02	1114.04
184+00	1117.25	1117.25	1114.46	1114.48
186+00	1117.69	1117.69	1114.89	1114.91
188+00	1118.14	1118.14	1116.56	1116.63
190+00	1118.58	1118.58	1116.99	1117.06
192+00	1119.02	1119.02	1117.40	1117.47
194+00	1119.47	1119.47	1117.84	1117.91
196+00	1119.91	1119.91	1118.26	1118.34
198+00	1120.36	1120.36	1111.44	1111.44
200+00	1120.80	1120.80	1111.80	1111.80
202+00	1121.24	1121.24	1112.21	1112.21
204+00	1121.68	1121.68	1112.64	1112.64
206+00	1122.13	1122.13	1113.07	1113.07
208+00	1122.57	1122.57	1122.57	1122.57
210+00	1123.02	1123.02	1122.65	1122.65
212+00	1123.46	1123.46	1122.73	1122.73
214+00	1123.90	1123.90	1122.82	1122.82
216+00	1124.35	1124.35	1122.90	1122.90
218+00	1124.79	1124.79	1122.98	1122.98
220+00	1125.24	1125.24	1123.06	1123.06
222+00	1125.68	1125.68	1123.14	1123.14

Table 10 (continued)

224+00	1126.12	1126.12	1123.23	1123.23
226+00	1126.57	1126.57	1123.31	1123.31
228+00	1127.01	1127.01	1123.39	1123.39
230+00	1127.45	1127.45	1124.97	1125.29
232+00	1127.90	1127.90	1125.42	1125.74
234+00	1128.34	1128.34	1125.86	1126.18
236+00	1128.79	1128.79	1126.31	1126.63
238+00	1129.23	1129.23	1126.75	1127.07
240+00	1129.67	1129.67	1119.90	1119.90
242+00	1130.12	1130.12	1120.37	1120.37
244+00	1130.56	1130.56	1120.78	1120.78
246+00	1131.01	1131.01	1121.23	1121.23
248+00	1131.45	1131.45	1121.67	1121.67
250+00	1131.87	1131.87	1131.87	1131.87
251+40	1132.22	1132.22	1131.93	1131.93
253+38	1132.76	1132.76	1132.01	1132.01
255+42	1133.31	1133.31	1132.09	1132.09
257+42	1133.84	1133.84	1132.17	1132.17
259+44	1134.39	1134.39	1132.26	1132.26
261+49	1134.94	1134.94	1132.34	1132.34
263+44	1135.46	1135.46	1132.92	1132.92
265+44	1136.00	1136.00	1133.63	1133.63
267+36	1134.00	1134.00	1131.88	1131.88
269+36	1136.00	1136.00	1133.69	1133.69
271+37	1136.00	1136.01	1134.38	1134.44
273+37	1136.00	1136.01	1134.29	1134.35
275+37	1138.00	1138.01	1136.25	1136.31
277+37	1136.00	1136.01	1134.31	1134.37
279+37	1136.00	1136.01	1134.41	1134.47
281+37	1134.00	1134.01	1133.04	1133.04
283+37	1136.00	1136.01	1135.05	1135.05
285+37	1135.20	1135.20	1134.26	1134.26
287+37	1136.00	1136.00	1135.07	1135.07
289+37	1138.00	1138.00	1137.07	1137.07
291+28	1138.00	1138.12	1136.53	1136.53
293+40	1138.00	1138.05	1136.57	1136.57
295+40	1140.00	1140.03	1138.58	1138.58
297+40	1140.00	1140.04	1138.62	1138.62
299+40	1142.00	1142.06	1140.62	1140.62
301+40	1142.00	1142.00	1140.31	1140.31
303+40	1140.00	1140.00	1138.29	1138.29
305+40	1138.30	1138.30	1136.63	1136.63
307+40	1142.00	1142.00	1140.38	1140.38
309+40	1142.00	1142.00	1140.57	1140.57
311+40	1142.00	1142.00	1141.48	1141.48
313+40	1140.00	1140.00	1139.50	1139.50
315+40	1142.00	1142.00	1141.46	1141.46
317+40	1142.00	1142.00	1141.55	1141.55
318+45	1144.00	1144.00	1143.27	1143.27
319+45	1144.00	1144.00	1143.27	1143.27
321+37	1144.00	1144.00	1142.74	1142.74
323+37	1143.60	1143.60	1142.30	1142.30
325+37	1143.70	1143.70	1142.43	1142.43
327+37	1144.00	1144.00	1142.75	1142.75

Table 10 (continued)

329+37	1146.00	1146.00	1144.69	1144.69
331+37	1148.00	1148.00	1146.61	1146.61
335+37	1148.00	1148.00	1146.71	1146.71
339+37	1148.00	1148.00	1146.77	1146.77
343+37	1147.30	1147.30	1146.07	1146.07
347+37	1148.00	1148.00	1146.52	1146.52
351+37	1146.00	1146.00	1144.44	1144.44
355+37	1146.00	1146.00	1144.06	1144.06
359+37	1148.00	1148.00	1145.82	1145.82
363+37	1147.60	1147.60	1145.05	1145.05
367+37	1148.00	1148.00	1145.01	1145.01
371+12	1150.00	1150.00	1148.05	1148.05
372+02	1150.00	1150.00	1148.05	1148.05
375+32	1150.00	1150.00	1147.94	1147.94
379+32	1138.10	1138.10	1136.23	1136.23
383+32	1146.00	1146.00	1146.00	1146.00

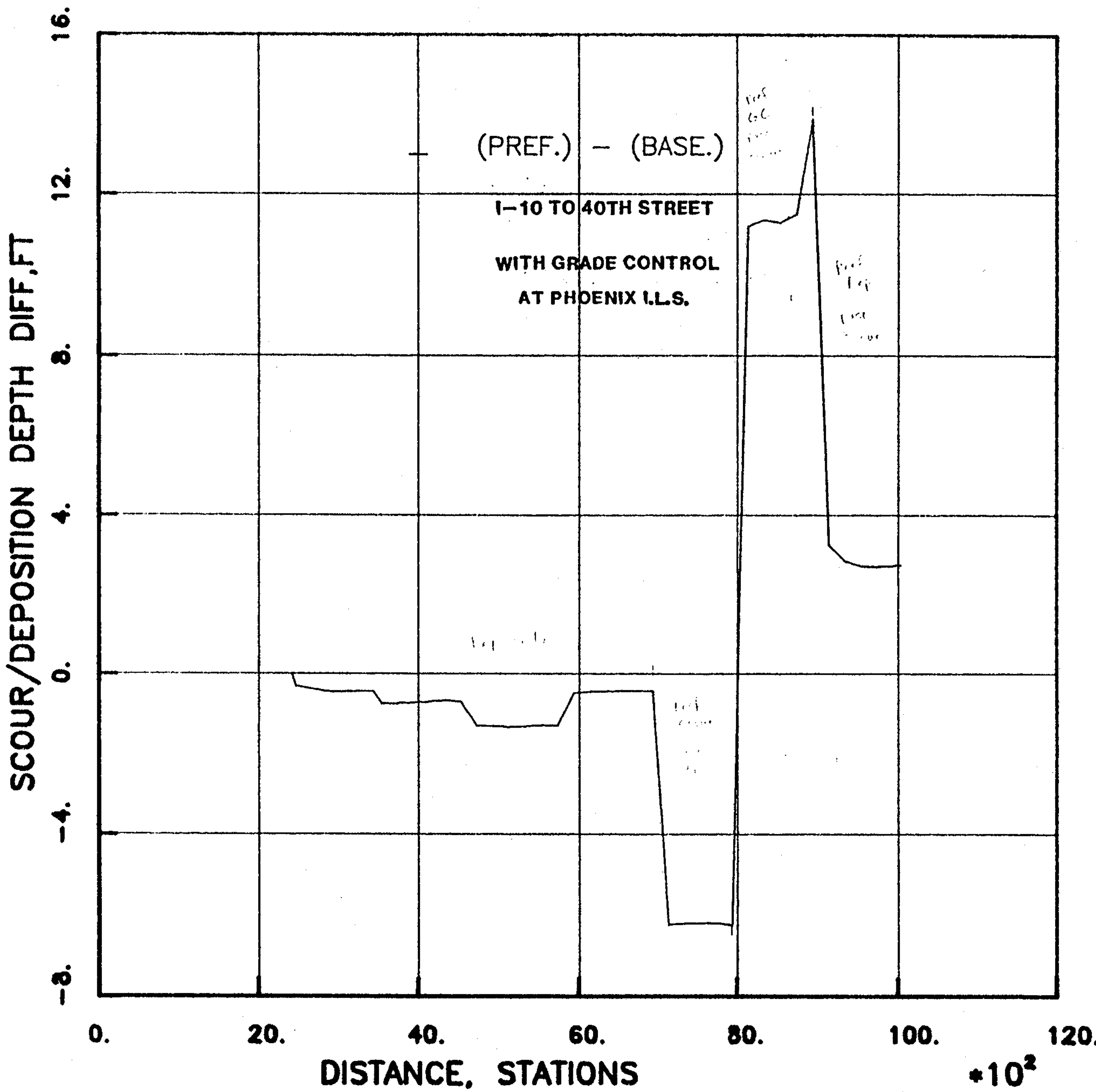


Figure 17a. Comparison of Change in Bed Profile with Grade Control at Phoenix I.L.S. Included.

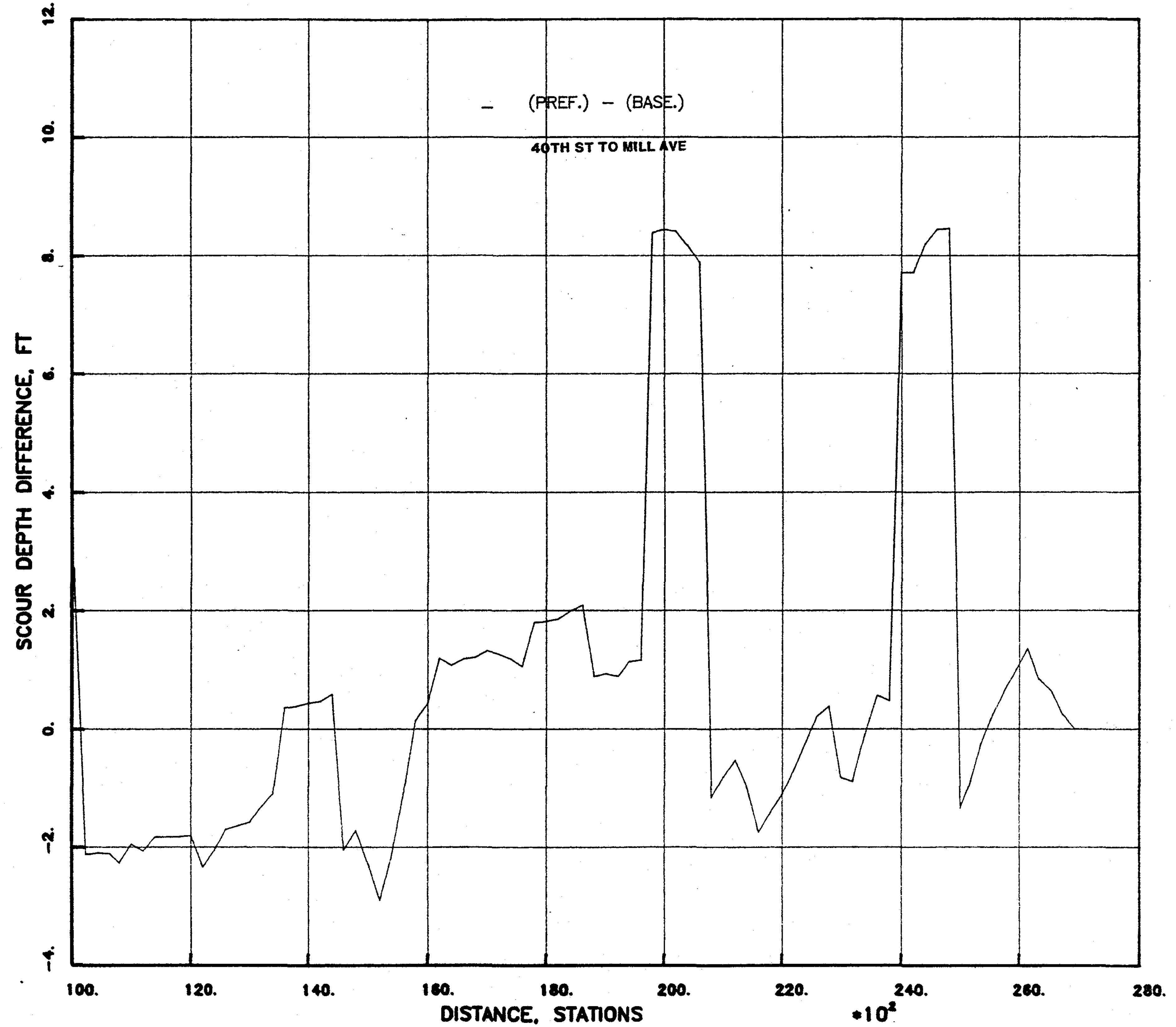


Figure 17b. Comparison of Change in Bed Profile with Grade Control at Phoenix I.L.S. Included.

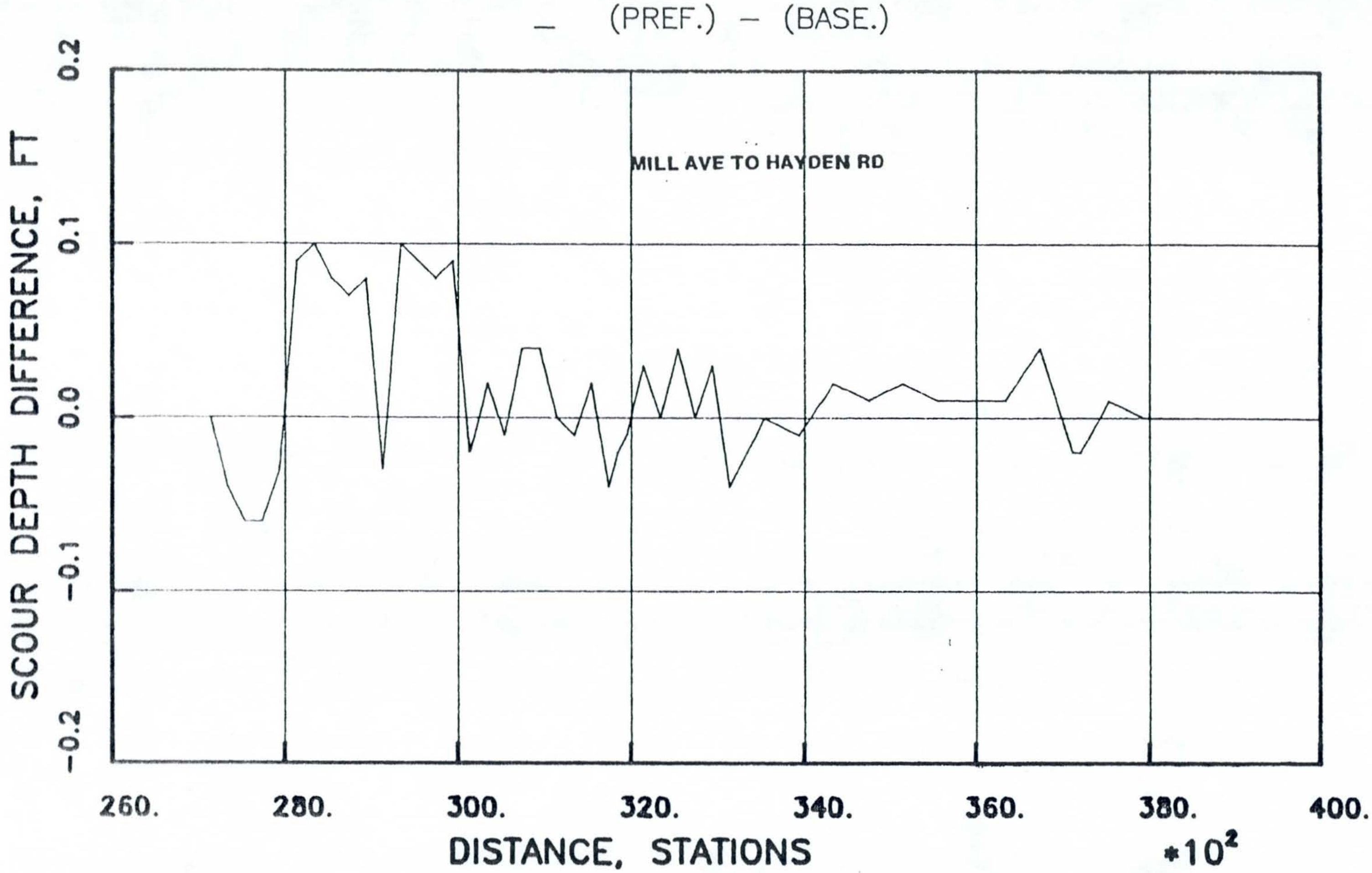


Figure 17c. Comparison of Change in Bed Profile with Grade Control at Phoenix I.L.S. Included.

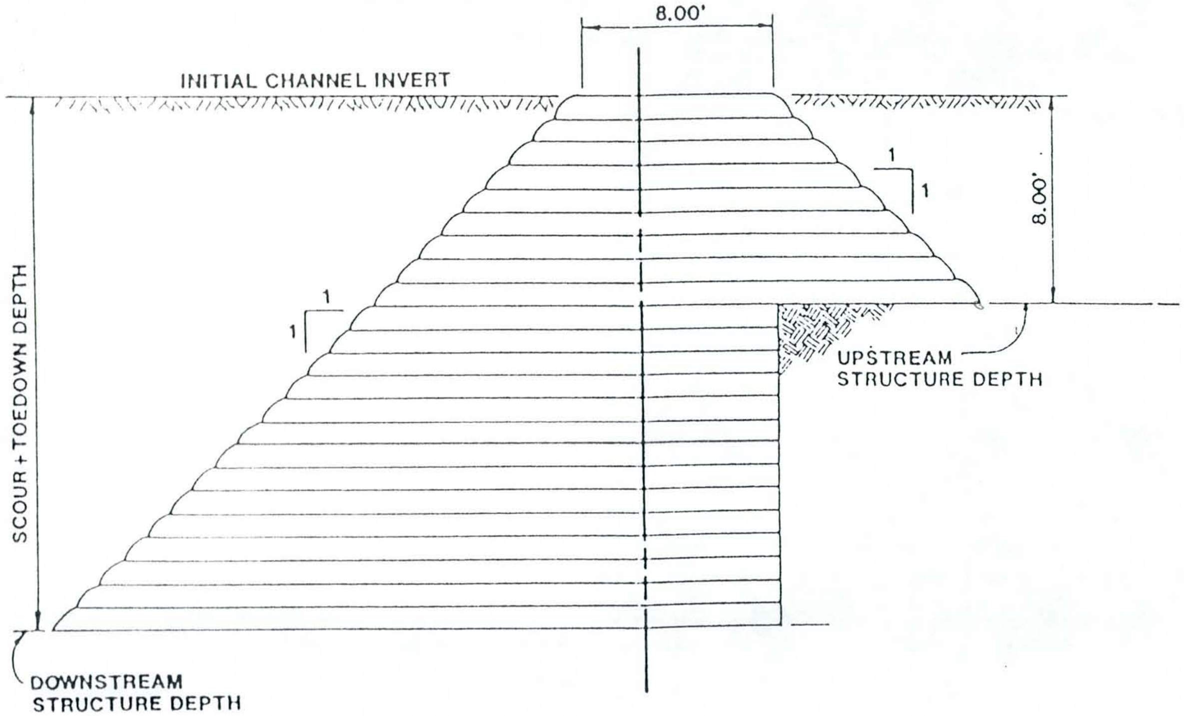
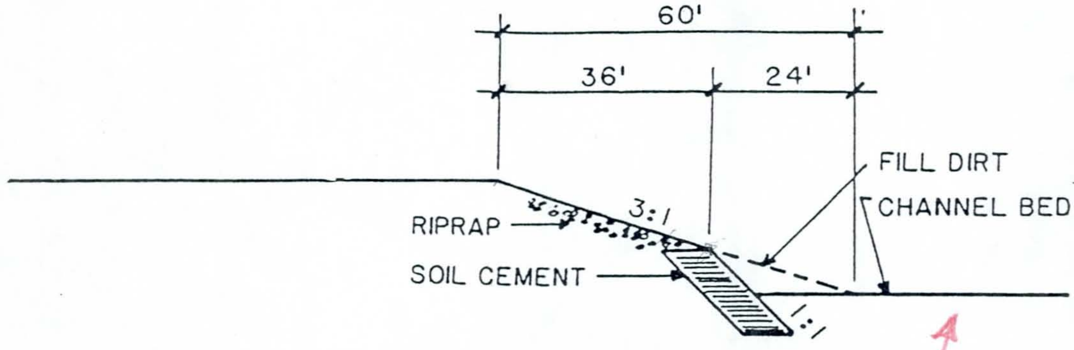
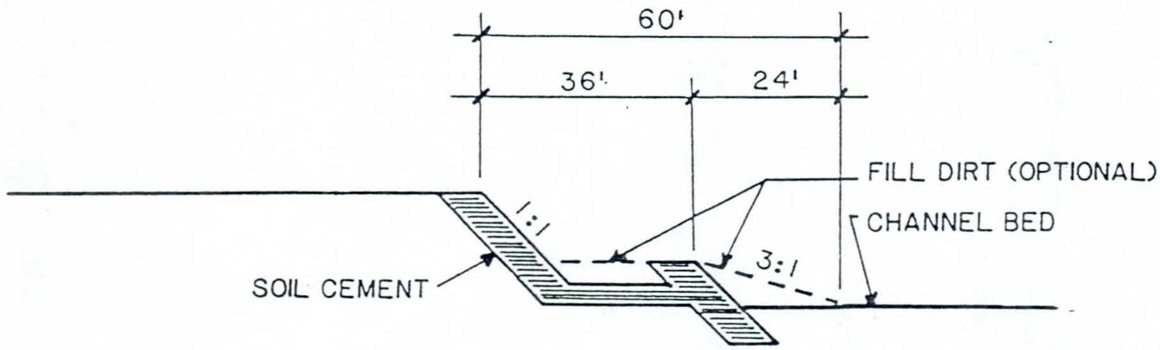


Figure 18. Section Through Grade-Contol Structure



BANK STABILIZATION TYPE 'A'

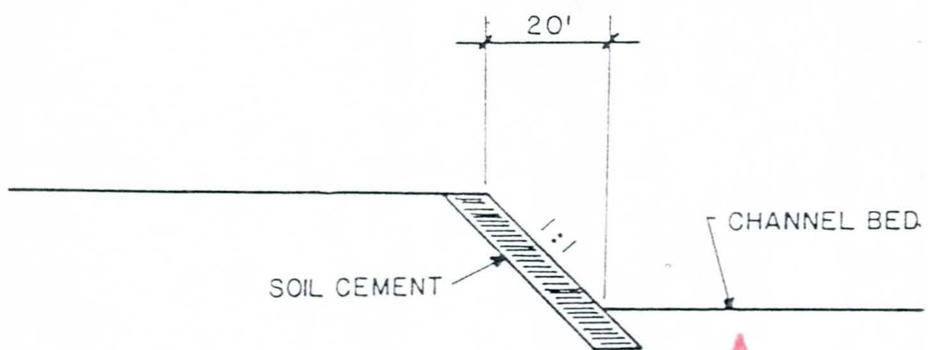
(TYPICAL)



BANK STABILIZATION TYPE 'B'

(TYPICAL)

See Page 2



BANK STABILIZATION TYPE 'C'

(TYPICAL)

DMJM
Daniel, Mann, Johnson, & Mendenhall
Suite 400
300 West Clarendon Avenue
Phoenix, Arizona 85013-3499

FIGURE 19
BANK STABILIZATION
PAPAGO CHANNELIZATION

elevation, shown as Type "A" protection. The CSA will be constructed at a 1:1 side-slope, and have a toedown that extends to the depth of total scour below the channel invert. The width of the CSA bank protection is eight feet (measured horizontal). Above the CSA will be a three foot thick (measured perpendicular to the bank) secondary bank protection material extending to the top of the bank. Along the outside bank of channel bends, the CSA will extend from the toe to the top of the bank, using either a Type-B or Type-C protection.

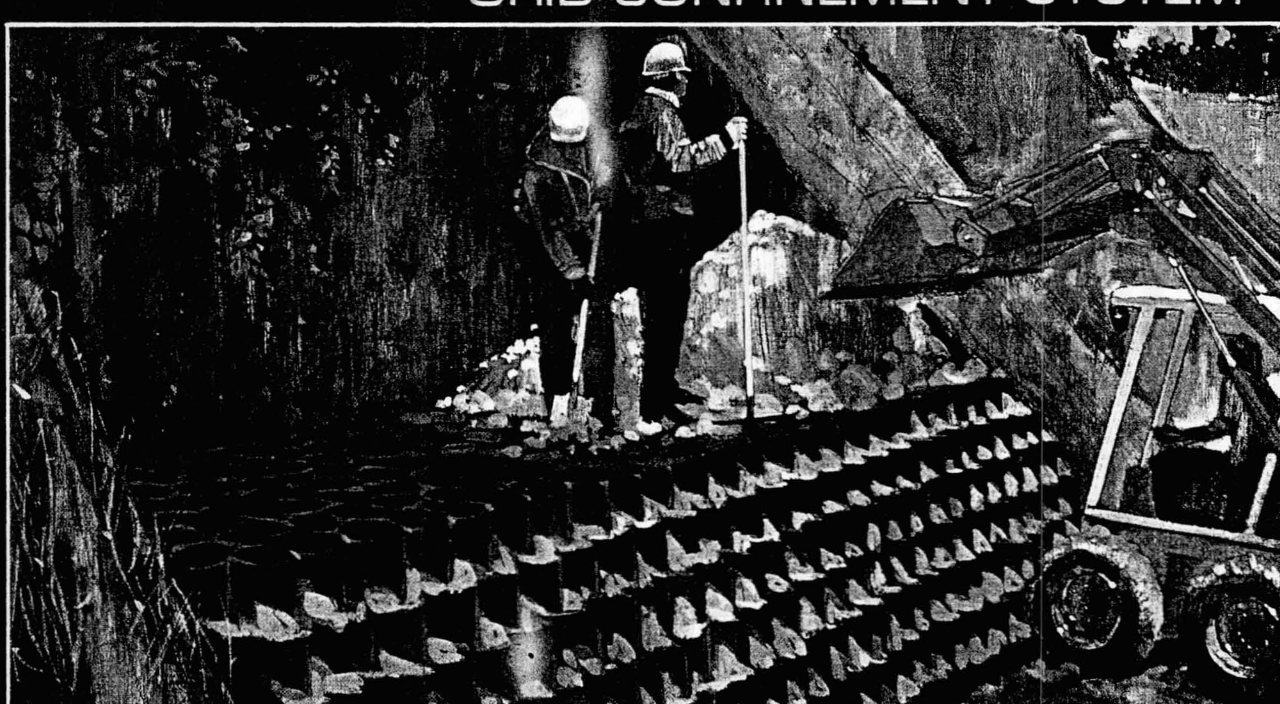
Three types of secondary bank protection materials were analyzed which included: rock riprap, wire-tied stone, and expandable plastic matrix stabilization. The secondary bank protection was sized based on estimates of the maximum boundary shear stress on the channel bank, and the allowable shear stress for each material. The boundary shear stress varies with location in the channelized reach, and is assumed to be the same for all bank-protection measures. The allowable shear stress for riprap varies depending on stone size, shape, density, bank slope, and factor of safety. The stone used for riprap is specified to be angular in shape, with a density of 2.65. The bank slope will be no greater than three units horizontal to one vertical. The stone size was varied to provide an allowable shear stress in excess of the maximum boundary shear stress with a factor of safety to 1.6.

The allowable shear stress of wire-ties stone (i.e., gabion mattress) is a function of the size of stone held by the wire basket, and the thickness of the mattress. The design is controlled by one of these characteristics, usually the thickness of the mattress. The mattress thickness is designed to provide a factor of safety of 1.6. HEC-15

The allowable shear stress for expandable nylon matrix stabilization (commercial product names include: GeoWeb by Presto Products; and GeoMatric by BASF) is approximately constant at 5.0 lb/sf. In the proposed application, this is sufficient to provide a factor-of-safety in excess of 1.6. Expandable plastic matrix stabilization is a three-dimensional, semi-rigid cellular matrix made of lightweight, rotproof plastic panels. As shown in Figure 20, the product expands into a cellular matrix, which is then filled with aggregate and secured to the underlying slope with stakes.

STRENGTH BY CONFINEMENT with GEOWEB®

GRID CONFINEMENT SYSTEM



A Presto T.M. GEOSYSTEMS T.M. PRODUCT

Why 5.4'
not "factor"

Testing of this product has been conducted by
for the U.S. Bureau of Reclamation, who are
product for stabilization of earthen spillways.

Table 11 summarizes bank protection measu
both banks. Riprap stone sizes are quite l
from sources near the project (see Geote
sources). The stone sizes necessary for wire-enclosed
the bed material gradation.

3.4 Bridge Crossings

The hydraulics of the bridge waterways in the study reach are summarized in Table 12. The cross-sections for each of the bridge openings are shown in Figures 21-29.

3.5 Summary of Scour Conditions

At each cross section in the channelized portion of the river, a total scour depth has been calculated, which is the cumulative result of the general scour depth determined by the sediment transport analysis, the bend scour depth and one-half of the dune height. A factor of safety equal to 30 percent of this cumulative result is also included in the total depth. An additional scour depth calculation below each grade control structure has also been made. It was assumed that there would be a 1:1 slope from the downstream face of each grade control to the bottom of each scour hole. A factor of safety of 5.4 feet was included.

The scour calculations are summarized in Table 13. Dune height, bend scour, pier scour, and grade control scour calculations can be found in Appendix A.

A summary of elevations pertaining to the design of each of the proposed bridges in the channelized section of the river is given. The low chord elevation is one foot above the SPF water surface elevation at that site.

BRIDGE	LOW CHORD ELEVATION	INVERT ELEVATION	SCOUR ELEVATION
Highway 153	1133.52	1108.90	1092.46
Hohokam Fwy	1135.62	1111.01	1092.31
Priest Drive	1148.59	1123.39	1105.41

Testing of this product has been conducted by Simons, Li & Associates, Inc. for the U.S. Bureau of Reclamation, who are investigating the use of this product for stabilization of earthen spillways.

Table 11 summarizes bank protection measures for channelized reaches on both banks. Riprap stone sizes are quite large and could not be produced from sources near the project (see Geotechnical Report, SH&B on rock sources). The stone sizes necessary for wire-enclosed stone are available in the bed material gradation.

3.4 Bridge Crossings

The hydraulics of the bridge waterways in the study reach are summarized in Table 12. The cross-sections for each of the bridge openings are shown in Figures 21-29.

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At each cross section in the channelized portion of the river, a total scour depth has been calculated, which is the cumulative result of the general scour depth determined by the sediment transport analysis, the bend scour depth and one-half of the dune height. A factor of safety equal to 30 percent of this cumulative result is also included in the total depth. An additional scour depth calculation below each grade control structure has also been made. It was assumed that there would be a 1:1 slope from the downstream face of each grade control to the bottom of each scour hole. A factor of safety of 5.4 feet was included.

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A summary of elevations pertaining to the design of each of the proposed bridges in the channelized section of the river is given. The low chord elevation is one foot above the SPF water surface elevation at that site.

BRIDGE	LOW CHORD ELEVATION	INVERT ELEVATION	SCOUR ELEVATION
Highway 153	1133.52	1108.90	1092.46
Hohokam Fwy	1135.62	1111.01	1092.31
Priest Drive	1148.59	1123.39	1105.41

TABLE 11

Bank Protection Alternatives

BANK PROTECTION
NORTH BANK

REACH	ROCK RIPRAP D50(FT)	GABIONS D50(FT)	GABIONS T(FT)	GEOWEB
STA. 116+00 TO 166+00	2.00	.33	.75	OK
166+00 TO 200+00	FULL HEIGHT CA PROTECTION			
200+00 TO 250+00	2.40	.40	.75	OK
250+00 TO 263+44	2.30	.38	.75	OK

SOUTH BANK

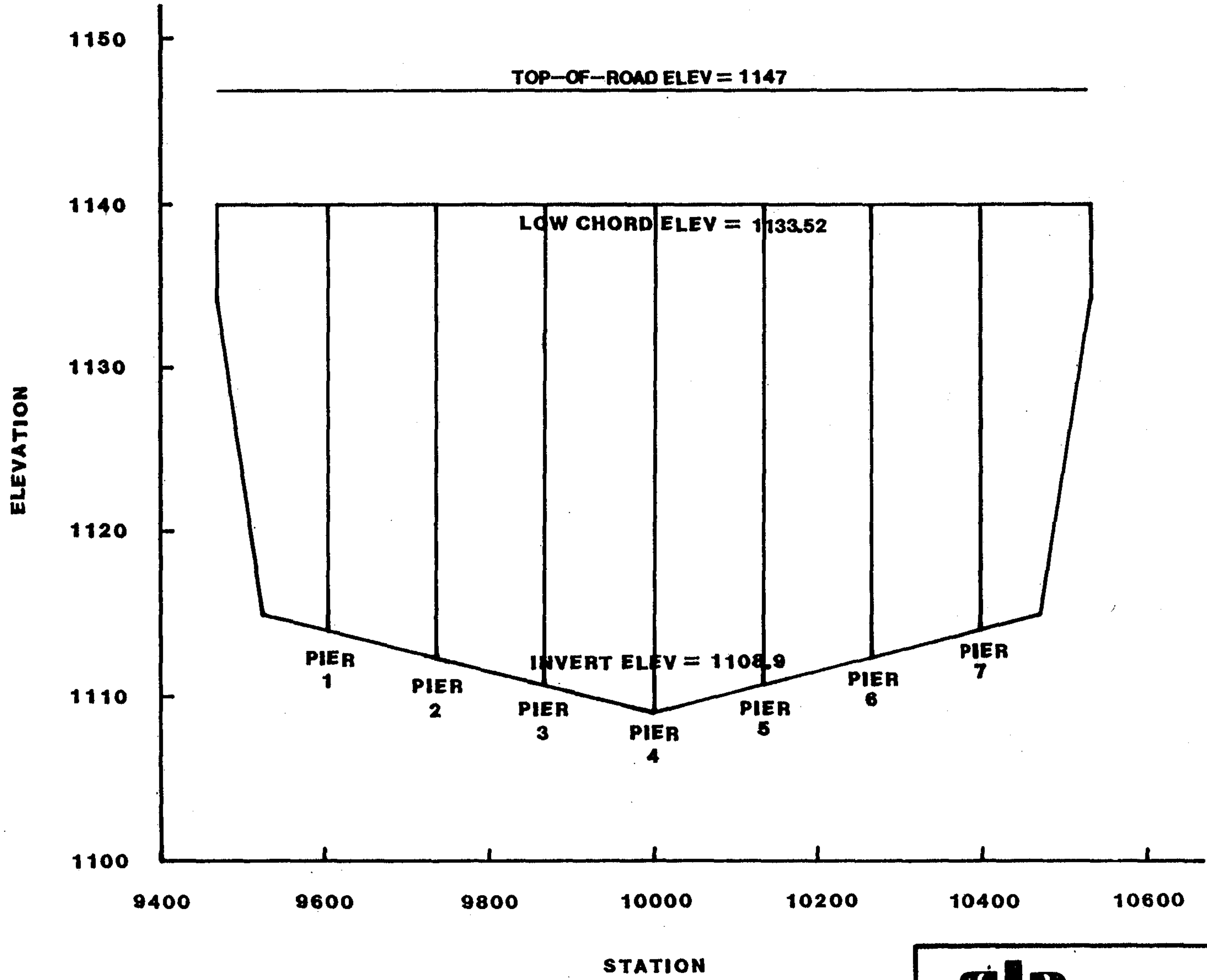
REACH	ROCK RIPRAP D50(FT)	GABIONS D50(FT)	GABIONS T(FT)	GEOWEB
STA. 116+00 TO 166+00	2.00	.33	.75	OK
166+00 TO 200+00	2.10	.35	.75	OK
200+00 TO 250+00	2.40	.40	.75	OK
250+00 TO 263+44	2.30	.38	.75	OK

TABLE 12

HYDARULIC CONDITIONS AT BRIDGE WATERWAYS - SPF

Location	Pier Shape	Number of Pins	Pier Width	Velocity	Waterway Area	Topwidth	Froude Number	% Contraction	WSEL
SR 153	Round	7	5	14.14	20441	1052	0.57	0.32	1132.52
Hohokam Freeway	Round	8	5	14.15	20430	1052	0.57	0.21	1134.62
Priest Drive	Round	7	5	15.27	18928	955	0.60	5.53	1147.59
SPRR	Round	38	7	10.05	28188	1592	0.44	17.31	1161.70
Ash Avenue	Round	10	6	8.90	32473	1466	0.37	-	1163.08
Mill Avenue	Square	9	8.5	9.88	29253	1326	0.41	-	1163.22
Scottsdale Road	Round	10	6	4.91	29806	1072	0.21	42.15*	1168.54
Hayden Road	Round	10	6	10.65	19823	1157	0.46	45.89*	1172.50[1]

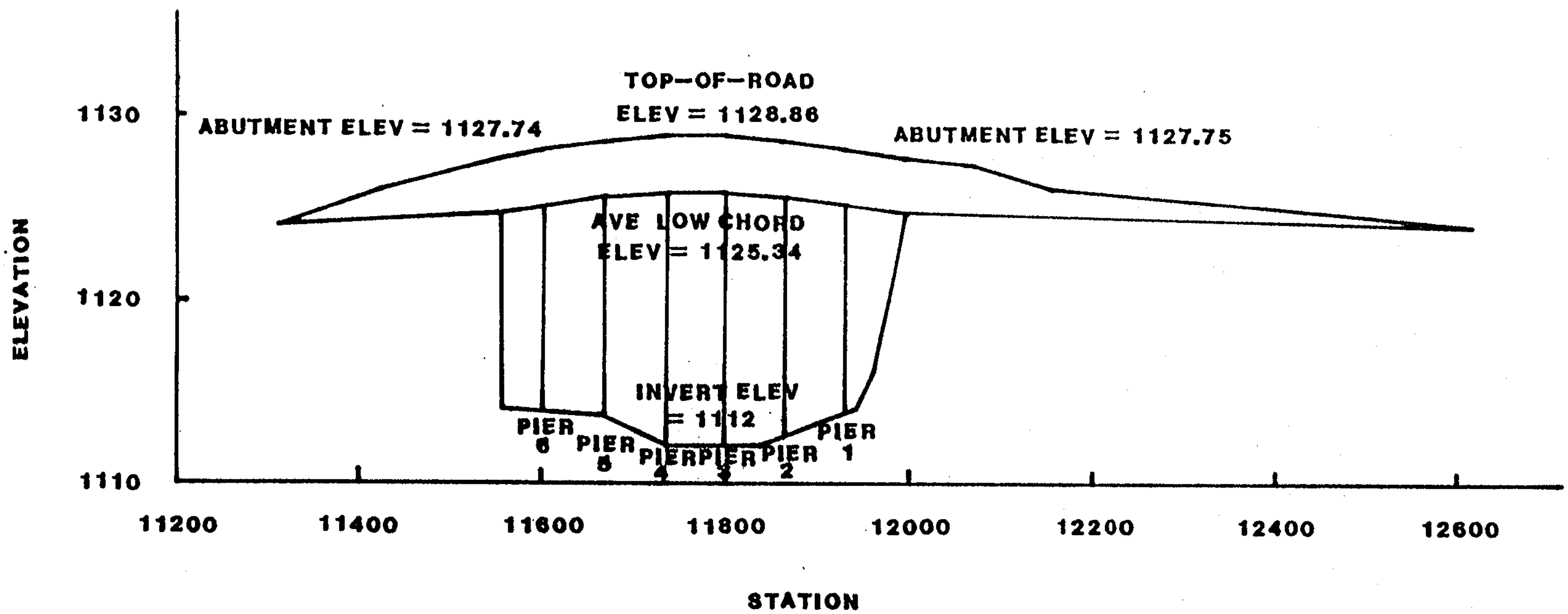
* Approach roadway overtopping occurs.
[1] Pressure flow.



SIMONS, LI & ASSOCIATES, INC.

HIGHWAY 153

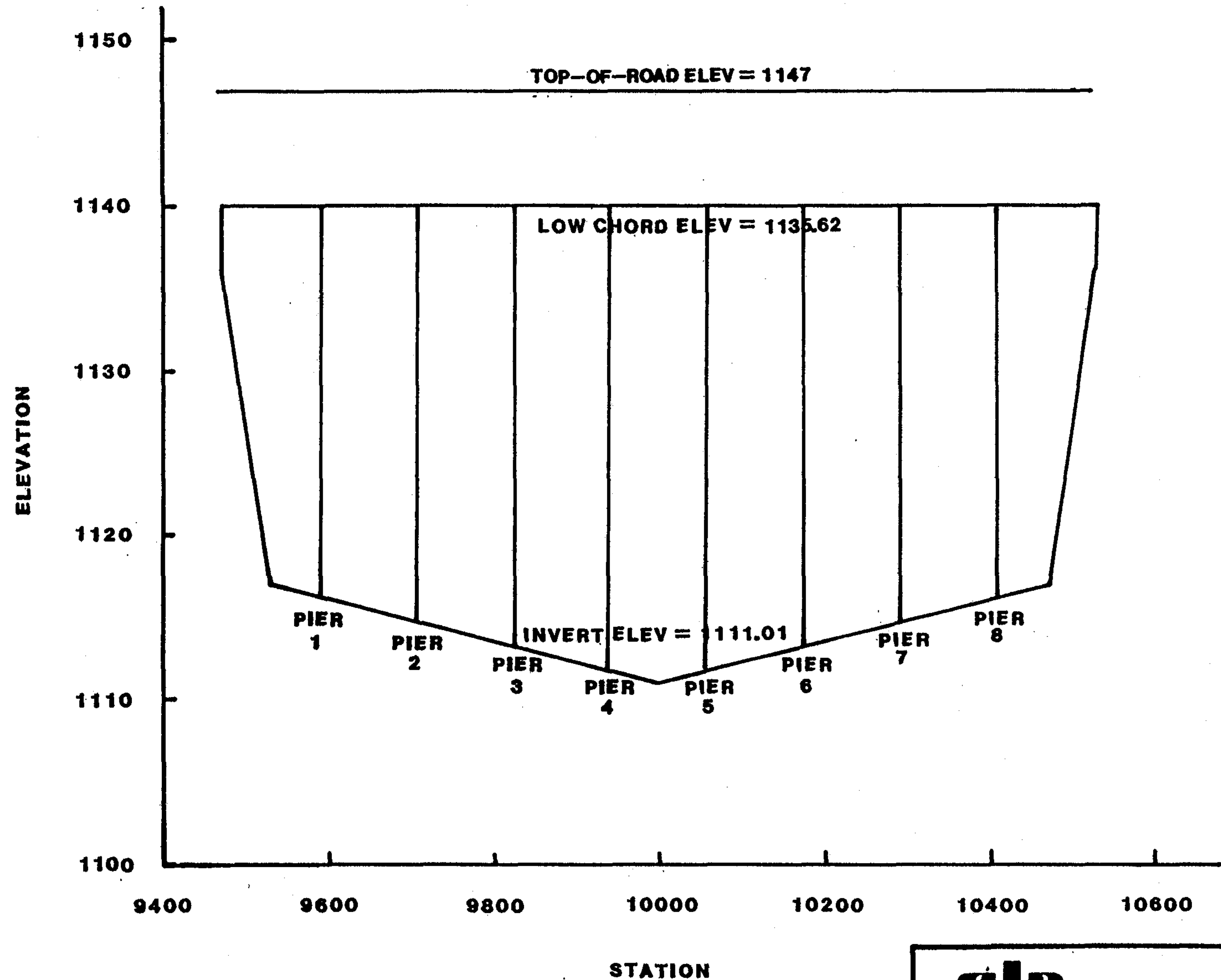
Figure 21



Simons, Li & Associates, Inc.

EXISTING HOHOKAM EXPY.

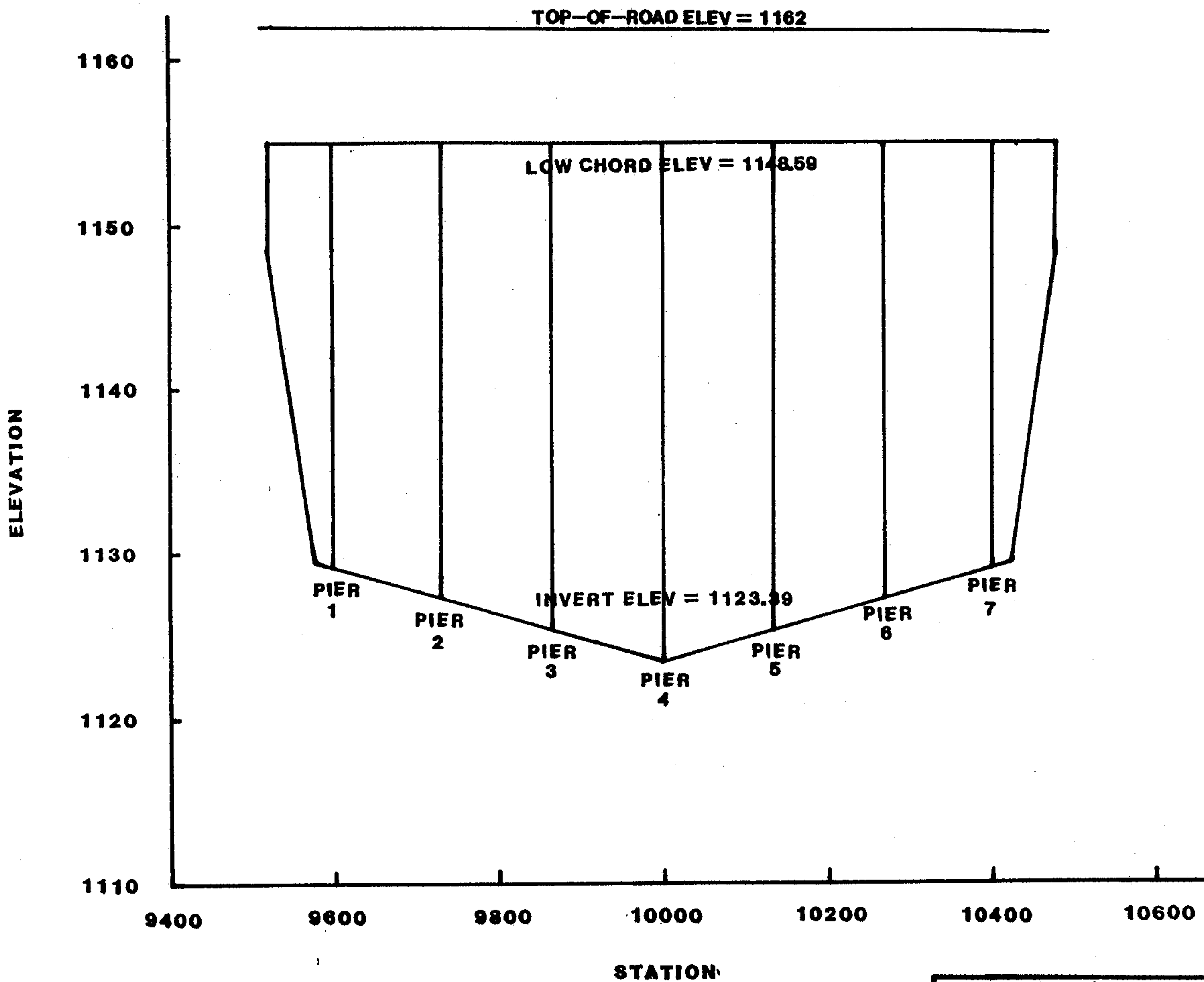
Figure 22



SIMONS, LI & ASSOCIATES, INC.

PROPOSED HOHOKAM FWY

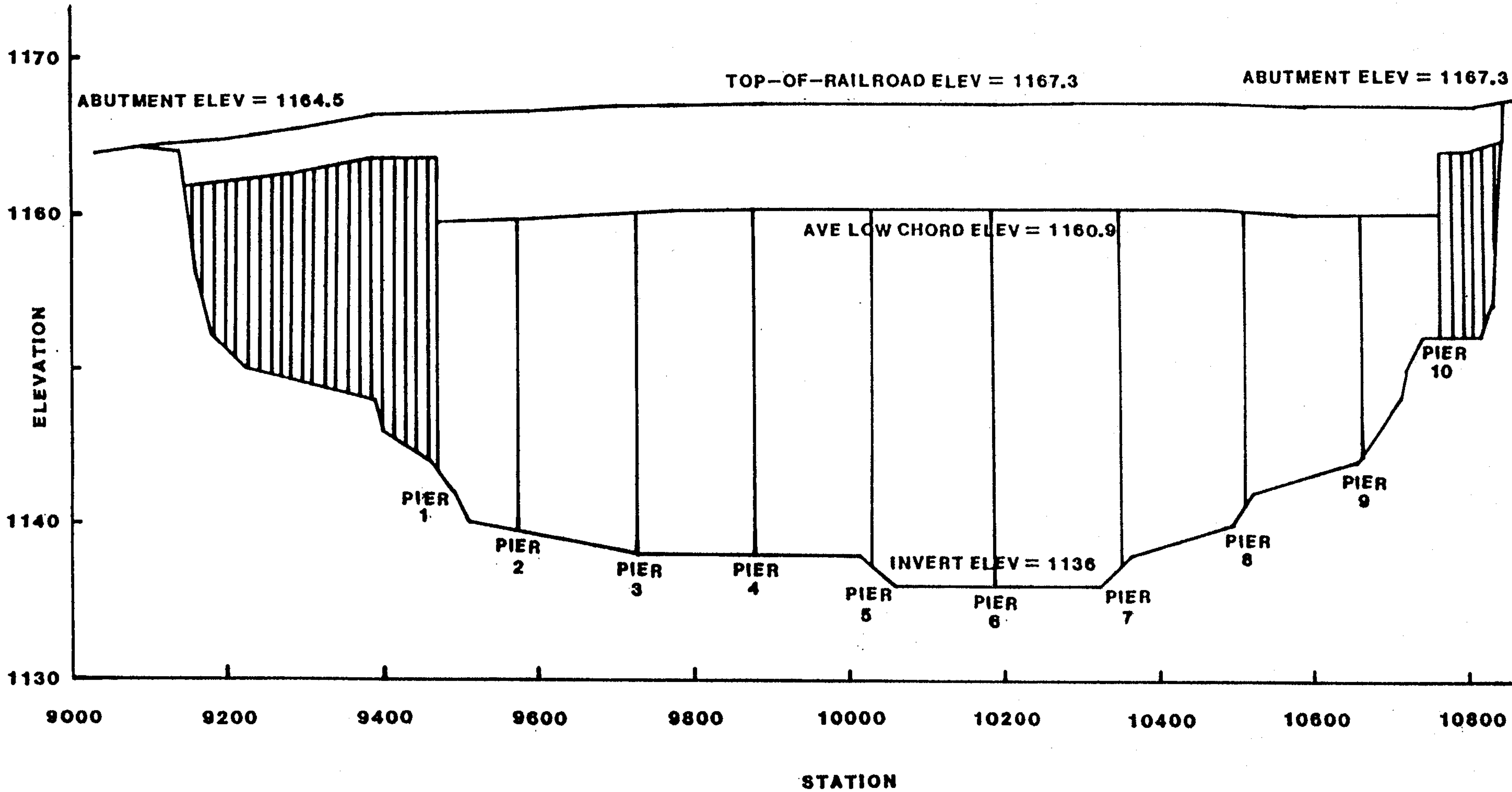
Figure 23



Simons, Li & Associates, Inc.

PRIEST DRIVE

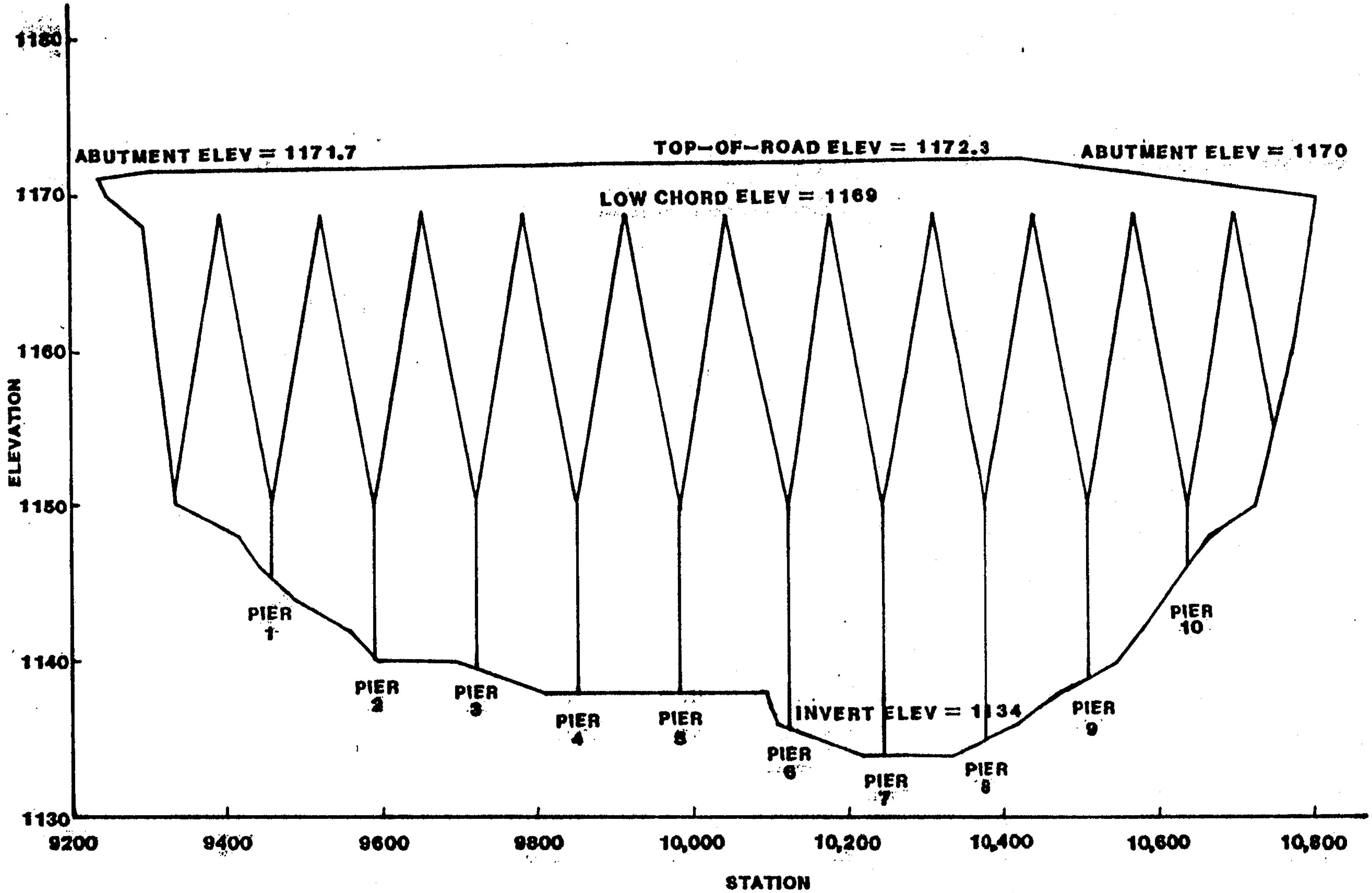
Figure 24



Simons, Li & Associates, Inc.

SOUTHERN PACIFIC RR

Figure 25



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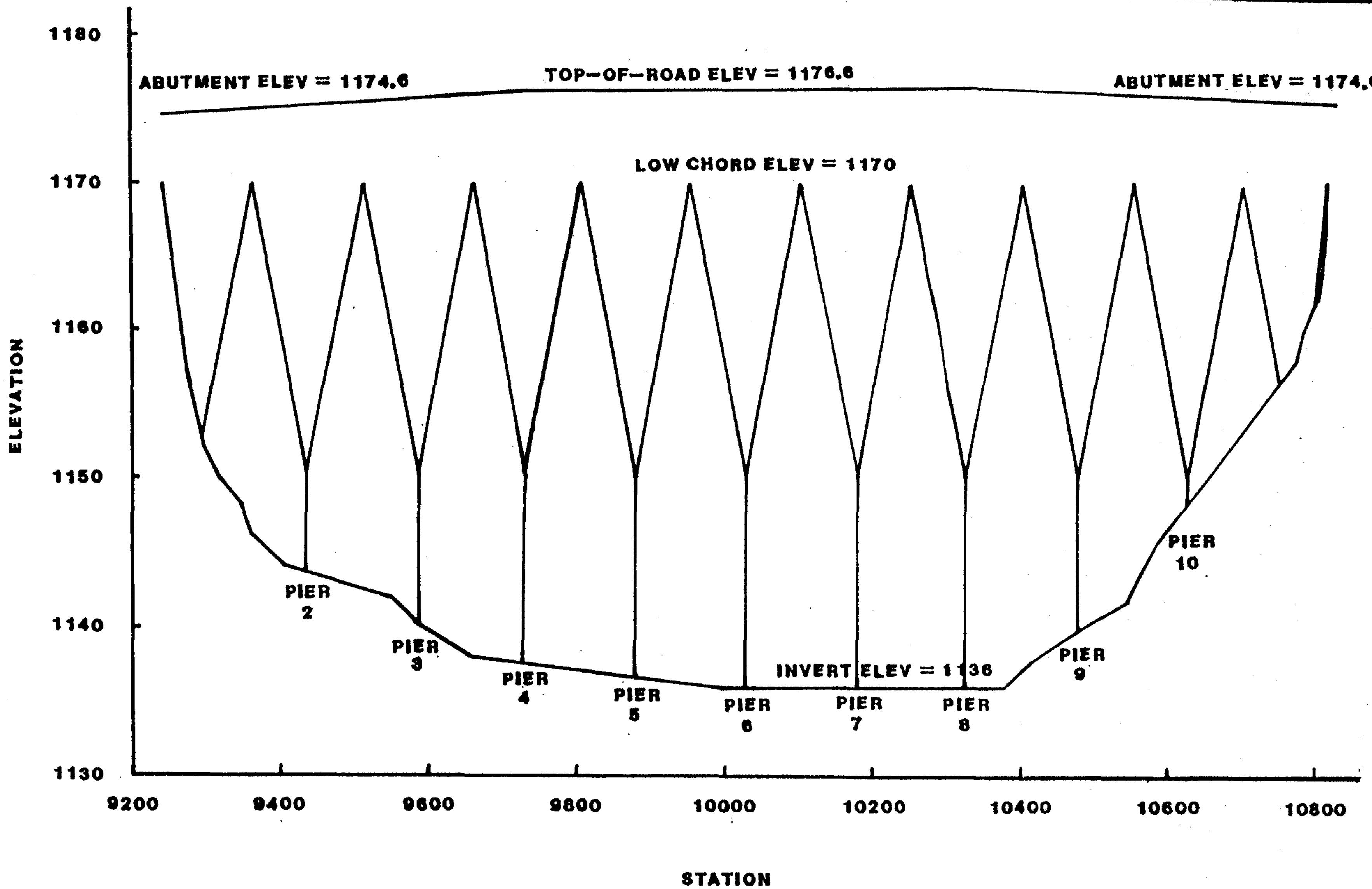
ASH AVENUE

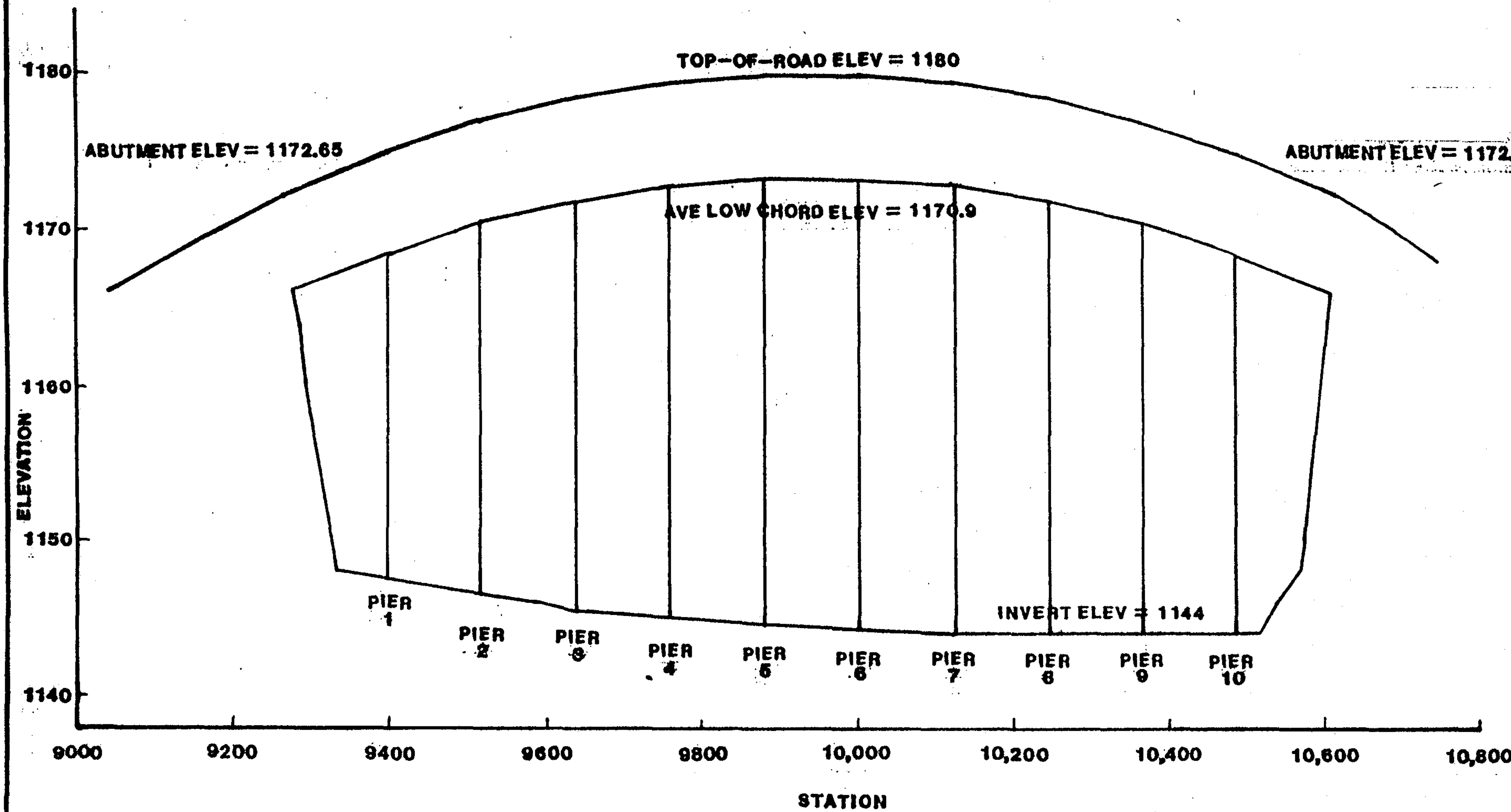
Figure 26



Simons, Li & Associates, Inc.

MILL AVENUE

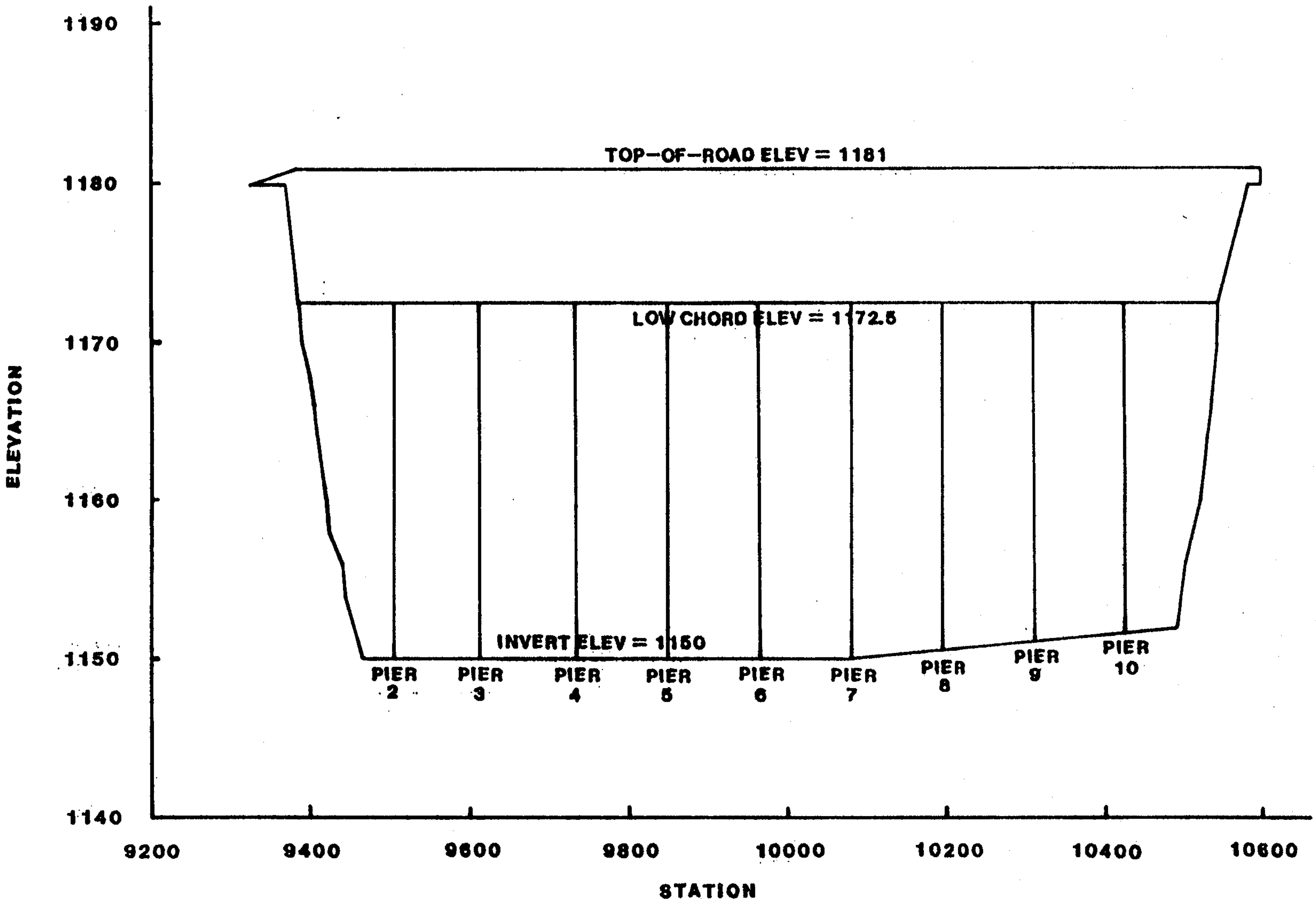
Figure 27



Simons, Li & Associates, Inc.

SCOTTSDALE ROAD

Figure 28



sla Simons, Li & Associates, Inc.

HAYDEN ROAD

Figure 29

TABLE 13

Scour Depth Summary

Long-term

LOCAL SCOUR SUMMARY
SALT RIVER CHANNELIZATION
STANDARD PROJECT FLOOD

STATION	GENERAL SCOUR (FT)	BEND SCOUR (FT)	DUNE HEIGHT (FT)	GRADE CONTROL	PIER SCOUR (FT)	FACTOR OF SAFETY (FT)	TOTAL SCOUR (FT)	COMMENT
100+35	1.47	2.60	2.10			1.85	8.02	BEND SCOUR AT S. BANK / 40TH ST ALIGN.
102+22				14.90		5.40	20.30	
102+37	.00	2.60	2.10			1.41	6.11	BEND SCOUR AT S. BANK / GRADE CONTROL #1
104+35	.00	2.60	2.10			1.41	6.11	BEND SCOUR AT S. BANK
106+40	.00	2.60	2.10			1.41	6.11	BEND SCOUR AT S. BANK
108+00	.13	2.60	2.10			1.45	6.28	BEND SCOUR AT S. BANK
110+00	.49	2.60	2.10			1.56	6.75	BEND SCOUR AT S. BANK
112+00	.85	2.60	2.10			1.67	7.22	BEND SCOUR AT S. BANK
114+00	1.21	2.60	2.10			1.77	7.68	BEND SCOUR AT S. BANK
116+00	1.58	2.60	2.10			1.88	8.16	BEND SCOUR AT S. BANK
118+00	1.60	2.60	2.10			1.89	8.19	BEND SCOUR AT S. BANK
120+00	1.60	2.60	2.10			1.89	8.19	BEND SCOUR AT S. BANK
122+00	1.60	.00	2.10			1.11	4.81	
124+00	1.47	.00	2.10			1.07	4.64	
126+00	1.47	.00	2.10			1.07	4.64	
128+00	1.47	.00	2.10			1.07	4.64	
130+00	1.47	.00	2.10			1.07	4.64	
132+00	1.47	.00	2.10			1.07	4.64	
134+00	1.47	.00	2.10			1.07	4.64	
136+00	3.35	.00	2.10			1.64	7.09	
138+00	3.36	.00	2.10			1.64	7.10	
140+00	3.36	.00	2.10			1.64	7.10	
142+00	3.37	.00	2.10			1.64	7.11	
144+00	3.37	.00	2.10			1.64	7.11	
145+83				16.90		5.40	22.30	
146+00	.00	.00	2.10			.63	2.73	GRADE CONTROL #2
147+30	.24	.00	2.10		13.40	.70	16.44	HWY 153
148+00	.37	.00	2.10			.74	3.21	
150+00	.73	.00	2.10			.85	3.68	
152+00	1.09	.00	2.10			.96	4.15	
154+00	1.45	.00	2.10			1.07	4.62	
156+00	1.81	.00	2.10			1.17	5.08	
157+19	1.98	.00	2.10		13.40	1.22	18.70	HOHOKAM EXPY
158+00	2.10	.00	2.10			1.26	5.46	
160+00	2.10	.00	2.10			1.26	5.46	
162+00	2.10	.00	2.10			1.26	5.46	
164+00	2.10	4.60	2.10			2.64	11.44	BEND SCOUR AT N. BANK
166+00	2.10	4.60	2.10			2.64	11.44	BEND SCOUR AT N. BANK
168+00	2.03	4.60	2.10			2.62	11.35	BEND SCOUR AT N. BANK
170+00	2.03	4.60	2.10			2.62	11.35	BEND SCOUR AT N. BANK
172+00	2.03	4.60	2.10			2.62	11.35	BEND SCOUR AT N. BANK
174+00	2.05	4.60	2.10			2.63	11.38	BEND SCOUR AT N. BANK
176+00	2.06	4.60	2.10			2.63	11.39	BEND SCOUR AT N. BANK
178+00	2.76	4.60	2.10			2.84	12.30	BEND SCOUR AT N. BANK

Table 13 (continued)

180+00	2.78	4.60	2.10			2.84	12.32	BEND SCOUR AT N. BANK
182+00	2.82	4.60	2.10			2.86	12.38	BEND SCOUR AT N. BANK
184+00	2.82	4.60	2.10			2.86	12.38	BEND SCOUR AT N. BANK
186+00	2.83	4.60	2.10			2.86	12.39	BEND SCOUR AT N. BANK
188+00	1.53	4.60	2.10			2.47	10.70	BEND SCOUR AT N. BANK
190+00	1.53	4.60	2.10			2.47	10.70	BEND SCOUR AT N. BANK
192+00	1.54	4.60	2.10			2.47	10.71	BEND SCOUR AT N. BANK
194+00	1.57	4.60	2.10			2.48	10.75	BEND SCOUR AT N. BANK
196+00	1.58	4.60	2.10			2.48	10.76	BEND SCOUR AT N. BANK
198+00	9.25	4.60	2.10			4.79	20.74	BEND SCOUR AT N. BANK
200+00	9.29	4.60	2.10			4.80	20.79	BEND SCOUR AT N. BANK
202+00	9.31	.00	2.10			3.42	14.83	
204+00	9.31	.00	2.10			3.42	14.83	
206+00	9.31	.00	2.10			3.42	14.83	
207+82				18.30		5.40	23.70	
208+00	.00	.00	2.10			.63	2.73	GRADE CONTROL #3
210+00	.37	.00	2.10			.74	3.21	
212+00	.73	.00	2.10			.85	3.68	
212+46	.81	.00	2.10		14.20	.87	17.98	PRIEST DR
214+00	1.08	.00	2.10			.95	4.13	
216+00	1.45	.00	2.10			1.07	4.62	
218+00	1.81	.00	2.10			1.17	5.08	
220+00	2.18	.00	2.10			1.28	5.56	
222+00	2.54	.00	2.10			1.39	6.03	
224+00	2.89	.00	2.10			1.50	6.49	
226+00	3.26	.00	2.10			1.61	6.97	
228+00	3.62	.00	2.10			1.72	7.44	
230+00	2.18	.00	2.10			1.28	5.56	
232+00	2.18	.00	2.10			1.28	5.56	
234+00	2.18	.00	2.10			1.28	5.56	
236+00	2.18	.00	2.10			1.28	5.56	
238+00	2.19	.00	2.10			1.29	5.58	
240+00	9.86	.00	2.10			3.59	15.55	
242+00	9.85	.00	2.10			3.59	15.54	
244+00	9.88	.00	2.10			3.59	15.57	
246+00	9.90	.00	2.10			3.60	15.60	
248+00	9.90	.00	2.10			3.60	15.60	
249+82				18.20		5.40	23.60	
250+00	.00	.00	2.10			.63	2.73	END CHANNEL / GRADE CONTROL #4
251+40	.29	.00	2.20			.75	3.24	
253+38	.75	.00	2.20			.89	3.84	
255+42	1.22	.00	2.20			1.03	4.45	
257+42	1.67	.00	2.20			1.16	5.03	
259+44	2.13	.00	2.20			1.30	5.63	
261+49	2.60	.00	2.20			1.44	6.24	
263+44	2.57	.00	2.20			1.43	6.20	END TRANSITION

IV. COST ESTIMATES

Construction costs for the Salt River channelization have been determined taking into account not only the costs related to the bank protection, excavation, fill, and grade control structures, but also those pertaining to landscaping and replacement of habitat. These costs have been summarized in Table 14. The construction cost calculations can be found in Appendix B.

TABLE 14

Channelization Construction Costs Summary

	Quantity	Units	Unit Cost	Cost
Primary Bank Protection	231,016	C.Y.	$28	$6,468,448
Secondary Bank Protection	104,758	C.Y.	$24	$2,514,192
Grade Control Structures	70,354	C.Y.	$28	$1,969,912
Grade Control Excavation	214,958	C.Y.	$ 3	$ 644,874
Channel Excavation	3,309,260	C.Y.	$ 2	$6,618,520
Toedown Excavation	423,875	C.Y.	$ 3	$1,271,625
Levee Embankment	1,036,703	C.Y.	$ 0	$0
Replacement of Habitat	50	Acres	$2000	$ 100,000
Landscaping	75	Acres	$2000	$ 150,000
			Subtotal	$19,737,571
			15% Contingency	$ 2,960,636
			TOTAL	$22,698,207

Toedown = 10 feet, except for 100 feet downstream of grade control structures, use 25 feet.

Why 10' toe?
- Is this below channel invert? (99)

Toe excavation cost should be included in the S.C. cost

APPENDIX A

APPENDIX A

Scour Equation

Reference A:
Simons & Sentürk p. 266 Dune

Dune height:

$$A = 0.38y^{0.74}$$

or $A = 1/6y$, whichever is greater

where A is the dune height, ft

y is the maximum flow depth, ft.

Bend scour:

$$\Delta Z_{bs} = 0.0685y\ V^{0.8}\ Yh^{-0.4}\ Se^{-0.3}\ [2.1\ (\frac{\sin^2(\alpha/2)}{\cos^{0.2}})^{0.2} - 1]$$

where ΔZ_{bs} = bend scour, ft;
V = mean velocity, fps;
y = maximum flow depth, ft;
Yh = hydraulic depth, ft;
Se = slope of the energy grade line; and,
α = bend angle, degrees.

Pier Scour:

Modified Laursen-Toch

$$\Delta Zp = 1.84\ (\frac{Yh}{b})^{0.3}\ (F-Fc)^{0.25}b$$

Shen's equation

$$\Delta Zp = 3.4\ (\frac{Yh}{b})^{1/3}\ (F-Fc)^{2/3}b$$

Neill's equation

$$\Delta Zp = 1.5\ (\frac{Yh}{b})^{0.3}b$$

Laursen's equation

$$\Delta Zp = 1.34\ (\frac{Yh}{b})^{1/2}b$$

Jain's equation

$$\Delta Zp = 2.0 \left(\frac{Yh}{b}\right)^{1/2} (F-Fc)^{1/4} b$$

where ΔZp = pier scour, ft;
Yh = hydraulic depth, ft;
b = pier width, ft;
F = approach Froude number;
Fc = critical Froude number;

where $Fc = 8.52 \sqrt{Cs}\, (D_{50}/Yh)^{1/3}$;
Cs = Shield's parameter; and,
D_{50} = mean sediment size, ft.

Grade Control Structures:

$$D_{sc} = (C)\ (q)^{0.667}\ (HdT)^{P1}\ (Sub)^{P2}$$

For a grade-control structure with a 1:1 embankment slope

$C = 0.483$
$P_1 = -0.158$
$P_2 = -0.134$

D_{sc} = maximum depth of scour measured from the original downstream bed surface, feet

q = unit discharge of the stream, cfs/ft.

HdT = vertical distance from the upstream energy grade line of the flow to the downstream water surface, in feet, divided by the downstream tailwater depth above the original bed surface, in feet, multiplied by 100 to express the ratio in percent.

Sub = the submergence of the flow given as the depth of the downstream water above the grade-control structure crest divided by the water depth of the flow upstream of the crest, multiplied by 100 to express the ratio in percent.

TABLE A.1

Calculated Pier Scour

Alignment: Preferred

Bridge Name	Dia	Vel	Dep	Fr	Cr Fr	ML-T	Shen	Neill	Laur	Jain
Highway 153	5.0	14.1	19.4	0.6	0.4	9.4	9.6	11.3	13.2	13.4
Hohokam Freeway	5.0	14.2	19.4	0.6	0.4	9.4	9.6	11.3	13.2	13.4
Priest Drive	5.0	15.3	19.8	0.7	0.4	9.9	11.0	11.3	13.3	14.2

APPENDIX B

B.1

CHANNEL EXCAVATION

STATION	CROSS SECTION	LENGTH	NATURAL GROUND ELEV.	CHANNEL INVERT ELEV.	BOTTOM WIDTH	CHANNEL EXCAVATION AREA (S.F.)	AVE.CHANNEL EXCAVATION VOLUME (C.Y.)
106+00	103		--	--	946	0	
		400					6,950
110+00	105		104.25	100.80	946	938	
		1000					43,621
120+00	110		107.26	103.02	946	1,417	
		1000					136,680
130+00	115		114.51	105.24	946	5,963	
		1000					248,901
140+00	120		118.29	107.46	946	7,477	
		1000					297,224
150+00	125		121.63	109.68	946	8,573	
		1000					343,626
160+00	130		125.28	111.90	946	9,983	
		1000					412,209
170+00	135		129.80	114.12	946	12,276	
		1000					405,210
180+00	140		129.66	116.36	917	9,605	
		1000					340,687
190+00	145		131.38	118.58	883	8,792	
		1000					319,150
200+00	150		133.57	120.80	850	8,442	
		1000					239,183
210+00	155		131.29	123.02	846	4,474	
		1000					147,940
220+00	160		132.36	125.21	846	3,515	
		1000					145,712
230+00	165		135.56	127.43	846	4,354	
		1000					122,720
240+00	170		135.02	129.65	846	2,273	
		1000					65,926
250+00	175		135.91	131.87	846	1,287	
		684					19,743
256+84	179		135.63	133.84	--	272	
		604					11,107
262+88	182		138.13	135.46	--	721	
		200					2,670
264+88	183		136.00	136.00	--	0	
						TOTAL	3,309,260

LEVEE EMBANKMENT CALCULATIONS

NORTH BANK

STATION	CROSS SECTION	DISTANCE	EXISTING GROUND ELEV AT TOP-OF-BANK	INVERT ELEV	SPF WSEL	AVE. EXISTING GROUND ELEV AT TOP-OF-BANK	AVE. INVERT ELEV	AVE. SPF WSEL	LEVEE HEIGHT	BOTTOM WIDTH	VOLUME (C.Y.)
116+00	108		126.00	102.13	126.64					946.00	
		353				115.00	102.58	127.00	13.00		8328
120+00	110		104.00	103.02	127.36					946.00	
		998				111.00	104.13	128.25	18.25		43679
130+00	115		118.00	105.24	129.14					946.00	
		1000				118.00	106.35	130.16	13.16		24100
140+00	120		118.00	107.46	131.17					946.00	
		1000				120.50	108.57	132.27	12.77		22833
150+00	125		123.00	109.68	133.36					946.00	
		1000				124.50	110.79	134.47	10.97		17420
160+00	130		126.00	111.90	135.57					946.00	
		1000				129.00	113.01	136.63	8.63		11460
170+00	135		132.00	114.12	137.68					946.00	
		1000				131.00	115.24	138.72	8.72		11667
180+00	140		130.00	116.36	139.75					917.00	
		1000				130.50	117.47	140.90	11.40		18648
190+00	145		131.00	118.58	142.04					883.00	
		1000				134.50	119.69	143.26	9.76		14199
200+00	150		138.00	120.80	144.48					850.00	
		1000				136.00	121.91	145.83	10.83		17029
210+00	155		134.00	123.02	147.17					846.00	
		1000				138.00	124.12	148.56	11.56		19130
220+00	160		142.00	125.21	149.95					846.00	
		1000				143.00	126.32	151.08	9.08		12512
230+00	165		144.00	127.43	152.20					846.00	
		1000				144.00	128.54	153.32	10.32		15643
240+00	170		144.00	129.65	154.43					846.00	
		1000				142.00	130.76	155.54	14.54		28857
250+00	175		140.00	131.87	156.64					846.00	
		946				146.50	132.86	158.34	12.84		21828
259+44	180		153.00	133.84	160.04					--	
		602				153.50	134.92	161.62	9.12		7597
265+43	183		154.00	136.00	163.20					--	

NORTH BANK TOTAL 294,929

LEVEE EMBANKMENT CALCULATIONS

SOUTH BANK

STATION	CROSS SECTION	DISTANCE	EXISTING GROUND ELEV AT TOP-OF-BANK	INVERT ELEV	SPF WSEL	AVE. EXISTING GROUND ELEV AT TOP-OF-BANK	AVE. INVERT ELEV.	AVE. SPF WSEL	LEVEE HEIGHT	BOTTOM WIDTH	VOLUME (C.Y.)
130+00	115		130.00	105.24	129.14					946.00	
		1000				126.00	106.35	130.16	5.16		4862
140+00	120		122.00	107.46	131.17					946.00	
		1000				121.00	108.57	132.27	12.27		21257
150+00	125		120.00	109.68	133.36					946.00	
		1000				118.00	110.79	134.47	17.47		40360
160+00	130		116.00	111.90	135.57					946.00	
		1000				122.50	113.01	136.63	15.13		31020
170+00	135		129.00	114.12	137.68					946.00	
		1000				131.00	115.24	138.72	8.72		11667
180+00	140		133.00	116.36	139.75					917.00	
		1000				134.00	117.47	140.90	7.90		9850
190+00	145		135.00	118.58	142.04					883.00	
		1000				132.50	119.69	143.26	11.76		19722
200+00	150		130.00	120.80	144.48					850.00	
		1000				129.50	121.91	145.83	17.33		39767
210+00	155		129.00	123.02	147.17					846.00	
		1000				127.50	124.12	148.56	22.06		71170
220+00	160		126.00	125.21	149.95					846.00	
		1000				127.00	126.32	151.08	25.08		116099
230+00	165		128.00	127.43	152.20					846.00	
		1000				128.00	128.54	153.32	26.32		142529
240+00	170		128.00	129.65	154.43					846.00	
		1000				131.00	130.76	155.54	25.54		125221
250+00	175		134.00	131.87	156.64					846.00	
		945				136.50	133.13	158.34	22.84		72227
259+44	180		139.00	134.39	160.04					1029.20	
		834				144.50	135.20	161.62	18.12		36023
265+43	183		150.00	136.00	163.20					--	

SOUTH BANK TOTAL 741,774

RCC BANK PROTECTION

NORTH BANK

STATION	XSEC	TOTAL DIST	SPF W.S. ELEV.	AVE. SPF W.S. ELEV.	INV. ELEV.	AVE. INV. ELEV.	TOEDOWN ELEV.	10-YR BANK PROT HGT	10-YR BANK PROT DIST	10-YR BANK PROT VOL. (C.Y.)	SPF BANK PROT HGT	SPF BANK PROT DIST	SPF BANK PROT VOL. (C.Y.)	VOLUME OF BANK PROT. (C.Y.)	TOEDOWN EXC. (C.Y.)	COMMENT
116+00	108		126.64		102.13											
		553		127.00		102.58	92.58	24.00	553	3932	35.43	0	0	3,932	7,648	CHANNEL INCL 200' D/S
120+00	110		127.36		103.02											OF TIE-IN W/ EXISTING
		998		128.25		104.13	94.13	24.00	998	7097	35.12	0	0	7,097	13,802	CHANNEL.
130+00	115		129.14		105.24											
		1000		130.16		106.35	96.35	24.00	1000	7111	34.81	0	0	7,111	13,830	CHANNEL.
140+00	120		131.17		107.46											
		1000		132.27		108.57	97.07	25.50	1000	7556	36.20	0	0	7,556	16,096	CHANNEL. INCL. G.C.
150+00	125		133.36		109.68											
		1000		134.47		110.79	100.79	24.00	1000	7111	34.68	0	0	7,111	13,830	CHANNEL.
160+00	130		135.57		111.90											
		1000		136.63		113.01	103.01	24.00	995	7076	34.62	5	63	7,139	13,830	CHANNEL.
170+00	135		137.68		114.12											
		1090		138.72		115.24	105.24	24.00	0	0	34.48	1090	13718	13,718	15,074	CHANNEL.
180+00	140		139.75		116.36											
		1100		140.90		117.47	107.47	24.00	0	0	34.43	1100	13827	13,827	15,213	CHANNEL.
190+00	145		142.04		118.58											
		1098		143.26		119.69	109.69	24.00	160	1138	34.57	938	11831	12,969	15,185	CHANNEL.
200+00	150		144.48		120.80											
		1000		145.83		121.91	110.41	25.50	1000	7556	36.42	0	0	7,556	16,096	CHANNEL. INCL. G.C.
210+00	155		147.17		123.02											
		1000		148.56		124.12	114.12	24.00	1000	7111	35.45	0	0	7,111	13,830	CHANNEL.
220+00	160		149.95		125.21											
		1000		151.08		126.32	116.32	24.00	1000	7111	35.76	0	0	7,111	13,830	CHANNEL.
230+00	165		152.20		127.43											
		1000		153.32		128.54	118.54	24.00	1000	7111	35.78	0	0	7,111	13,830	CHANNEL.
240+00	170		154.43		129.65											
		1000		155.54		130.76	119.26	25.50	1000	7556	37.28	0	0	7,556	16,096	CHANNEL. INCL. G.C.
250+00	175		156.64		131.87											

		142		156.92		132.05	122.05	24.00	142	1010	35.87	0	0	1,010	1,964	TRANSITION
251+40	176		157.19		132.22											
		198		157.65		132.49	122.49	24.00	202	1436	36.16	0	0	1,436	2,738	TRANSITION
253+38	177		158.10		132.76											
		204		158.50		133.04	123.04	24.00	209	1486	36.47	0	0	1,486	2,821	TRANSITION
255+42	178		158.90		133.31											
		200		159.20		133.58	123.58	24.00	204	1451	36.62	0	0	1,451	2,766	TRANSITION
257+42	179		159.49		133.84											
		202		159.77		134.12	124.12	24.00	207	1472	36.65	0	0	1,472	2,794	TRANSITION
259+44	180		160.04		134.39											
		205		160.30		134.67	124.67	24.00	210	1493	36.64	0	0	1,493	2,835	TRANSITION
261+49	181		160.56		134.94											
		197		160.85		135.20	125.20	24.00	201	1429	36.65	0	0	1,429	2,724	TRANSITION
263+44	182		161.13		135.46											
		200		162.17		135.73	125.73	24.00	204	1451	37.44	0	0	1,451	2,766	TRANSITION
265+44	183		163.20		136.00											
											NORTH BANK TOTALS			128,133	219,597	

RCC BANK PROTECTION

SOUTH BANK

STATION	XSEC	TOTAL DIST	SPF W.S. ELEV.	AVE. SPF W.S. ELEV.	INV. ELEV.	AVE. INV. ELEV.	TOEDOWN ELEV.	10-YR BANK PROT HGT	10-YR BANK PROT DIST	10-YR BANK PROT VOL. (C.Y.)	SPF BANK PROT HGT	SPF BANK PROT DIST	SPF BANK PROT VOL. (C.Y.)	VOLUME OF BANK PROT. (C.Y.)	TOEDOWN EXC. (C.Y.)	COMMENT
122+00	111		127.71		103.46											
		800		128.43		104.35	94.35	24.00	800	5689	35.08	0	0	5,689	11,064	CHANNEL.
130+00	115		129.14		105.24											
		1000		130.16		106.35	96.35	24.00	1000	7111	34.81	0	0	7,111	13,830	CHANNEL.
140+00	120		131.17		107.46											
		1000		132.27		108.57	97.07	25.50	1000	7556	36.20	0	0	7,556	16,096	CHANNEL. INCL. G.C.
150+00	125		133.36		109.68											
		1000		134.47		110.79	100.79	24.00	1000	7111	34.68	0	0	7,111	13,830	CHANNEL.
160+00	130		135.57		111.90											
		1000		136.63		113.01	103.01	24.00	1000	7111	34.62	0	0	7,111	13,830	CHANNEL.
170+00	135		137.68		114.12											
		910		138.72		115.24	105.24	24.00	910	6471	34.48	0	0	6,471	12,585	CHANNEL.
180+00	140		139.75		116.36											
		900		140.90		117.47	107.47	24.00	900	6400	34.43	0	0	6,400	12,447	CHANNEL.
190+00	145		142.04		118.58											
		902		143.26		119.69	109.69	24.00	902	6414	34.57	0	0	6,414	12,474	CHANNEL.
200+00	150		144.48		120.80											
		990		145.83		121.91	110.41	25.50	990	7480	36.42	0	0	7,480	15,935	CHANNEL. INCL. G.C.
210+00	155		147.17		123.02											
		1000		148.56		124.12	114.12	24.00	1000	7111	35.45	0	0	7,111	13,830	CHANNEL.
220+00	160		149.95		125.21											
		1000		151.08		126.32	116.32	24.00	1000	7111	35.76	0	0	7,111	13,830	CHANNEL.
230+00	165		152.20		127.43											
		1000		153.32		128.54	118.54	24.00	1000	7111	35.78	0	0	7,111	13,830	CHANNEL.
240+00	170		154.43		129.65											
		1000		155.54		130.76	119.26	25.50	1000	7556	37.28	0	0	7,556	16,096	CHANNEL. INCL. G.C.
250+00	175		156.64		131.87											
		140		156.92		132.05	122.05	24.00	140	996	35.87	0	0	996	1,936	TRANSITION
251+40	176		157.19		132.22											

		198		157.65		132.49	122.49	24.00	198	1408	36.16	0	0	1,408	2,738	TRANSITION
253+38	177		158.10		132.76											
		204		158.50		133.04	123.04	24.00	204	1451	36.47	0	0	1,451	2,821	TRANSITION
255+42	178		158.90		133.31											
		200		159.20		133.58	123.58	24.00	200	1422	36.62	0	0	1,422	2,766	TRANSITION
257+42	179		159.49		133.84											
		203		159.77		134.12	124.12	24.00	203	1444	36.65	0	0	1,444	2,807	TRANSITION
259+44	180		160.04		134.39											
		205		160.30		134.67	124.67	24.00	205	1458	36.64	0	0	1,458	2,835	TRANSITION
261+49	181		160.56		134.94											
		199		160.85		135.20	125.20	24.00	199	1415	36.65	0	0	1,415	2,752	TRANSITION
263+44	182		161.13		135.46											
		430		162.17		135.73	125.73	24.00	430	3058	37.44	0	0	3,058	5,947	TRANSITION
265+44	183		163.20		136.00											
											SOUTH BANK TOTALS			102,883	204,278	

APPENDIX C

QUASED-WSPR
Quasi-dynamic Sediment Routing w/WSPR Backwater Profile

This version of QUASED is identical to QUASED-PC (as developed within the Tucson SLA Office) except that WSPR is used to compute backwater profiles rather than the HEC-2 Model.

Input Data :

WASRIVB.DAT - Watershed & river data file. This is the same data that has been used in previous versions of QUASED.

WSPR.IN - Hydraulic model input file. This is the same data file used in the current version of WSPR (ie. Ver 2.1).

To Run :

- Make sure the following files are on the default directory:

RQ-WSPR.BAT
INITW.COM
TITLEW.COM
FORMFD.COM
WSPR-Q.COM
LOOPW.COM
FLM.EXE
RCH.EXE
SED.EXE
CHD-WSPR.EXE
OUT.EXE
QSUM.EXE

Also: OUTPUTW.COM
SEDHYD (if necessary)

- Copy the input files to the default directory.

- Run the model by executing the RQ-WSPR.BAT batch file.

- All output will be copied to the QSOUT.DAT file.

RJS
11/5/1987

Water Surface Profile Program
WSPR Ver 2.1

Data File Configuration

Data File Structure:

Card	Note
T	- Title card, 2 required
T	
B	- one card required
C	- one card required, additional C-cards may be used to change parameters
Q	- optional card to change discharge value
D	- one card required for each cross-section
E	- one card required for each cross-section

Variable List:

Card	Variables
T	- CD, NAM
B	- CD, S, NXSEC, QT, OPT, STWSEL or ESDF, GSF or CRDEST
C	- CD, FSOPT, COFE, COFC, NL, NC, NR
Q	- CD, QT
D	- CD, SECN, LLOB, LCH, LROB, NPL, NPC, NPR
E	- CD, ELV[1], STA[1], ELV[2], STA[2], . . .

All values can be separated by one or more spaces, tabs or carriage returns/line feeds (no commas).

T - CARD   2 required for each job

CD NAM

Variable	Value	Description
CD NAM	"T" str	- card identifer - job title

B - CARD   1 card required for each job

CD	S	NXSEC	QT	OPT	STWSEL ESTDF CRDEST	GSF

Variable	Value	Description
CD	"B"	- card identifer
S	"0" "1"	- indicates subcritical profile - indicates supercritical profile
NXSEC	integer	- total number of cross-sections for job
QT	real	- initial discharge value - will be used for all cross-sections unless changed by a Q-card
OPT	"1"	- use known WSEL to start profile, enter known WSEL (STWSEL) in following field
	"2"	- use slope-area method to start profile, enter estimated flow depth (ESTDF) and friction slope (SF) in following fields
	"3"	- use critical depth to start profile, enter critical depth estimate (CRDEST) in following field
STWSEL or ESTDF or CRDEST	real real real	- known WSEL (msl) if OPT = 1 - est. flow depth (ft) if OPT = 2 - est. crit. depth (ft) if OPT = 3
GSF	real	- known friction slope - use only if OPT = 2. DO NOT enter a value in this field if OPT = 1 or 3

C - CARD   1 required for each job
subsequent C-cards may be used to change previously specified values of Manning's "n" , shock losses and friction slope options. All values on the C-card must be specified each time a C-card is used.

CD, FSOPT, COFE, COFC, NL, NC, NR

Variable	Value	Description
CD	"C"	- Card identifer
FSOPT	integer "0" "1" "2" "3" "4"	FRICTION EQN. OPTION - program selects most appropriate equation based on profile type - average conveyance equation - average friction slope equation - geometric mean equation - harmonic mean equation
COFE	real	- expansion coefficient
COFC	real	- contraction coefficient
NL	real	- Mannings "n" for left overbank
NC	real	- Mannings "n" for main channel
NR	real	- Mannings "n" for right overbank

Q - CARD   Optional card to change discharge value

```
CD,   QT
```

Variable	Value	Description
CD	"Q"	- card identifer
QT	real	- new value for discharge (cfs)

D - CARD 1 required for each cross-section

CD, SECN, LLOB, LCH, LROB, NPL, NPC, NPR

Variable	Value	Description
CD	"D"	- card identifer
SECN	real	- cross-section number (range 0.01 to 9999.99)
LLOB	real	- *reach length along left overbank
LCH	real	- *reach length along main channel
LROB	real	- *reach length along right overbank
NPL	integer	- **number of ground points used to describe left overbank on E-card
NPC	integer	- **number of ground points used to describe main channel on E-card
NPR	integer	- **number of ground points used to describe right overbank on E-card

* - Reach lengths must be measured to the next downstream section for subcritical runs (S = 0) and to the next upstream section for supercritical runs (S = 1). Therefor, the first cross-section of a run will always have a reach length = 0.

** - The last ground point for the left overbank must be counted again as the first point of the main channel in determining values for NPL & NPC. Similarly the last point of the main channel must be counted again as the first point of the right overbank in determining the values of NPC & NPR. If the cross-section does not have a left or right overbank enter a 0 for NPL and/or NPR.

E - CARD - 1 required for each cross-section

```
CD,  ELV[1],  Sta[1],   ELV[2],  STA[2], . . .
```

Variable	Value	Description
CD	"E"	- card identifer
ELV[i]	real	- elevation of the i'th ground point
STA[i]	real	- distance from left to right of the i'th ground point

- Distance along the cross-section must increase from left to right as the section is viewed looking downstream.

- Any number of ground point pairs (ELV[i], STA[i]) may be entered on the initial E-card provided they fit within the 80-column field width. Any number of continuation E-cards may be used until the total number of ground points are entered. However, only the first E-card of a cross-section may have the "E" identifer. Continuation E-cards must not have an "E" in the first field.

- A maximum of 50 ground points can be used for any cross-section. However this is an artificial limitation which can be extended by changing the value of "MaxNumPts" in the constant declaration segment of the source code.

I. INTRODUCTION

QUASED is a quasi-dynamic sediment routing procedure developed by Simons, Li & Associates, Inc. (SLA) for the purposes of determining watershed sediment yield and the subsequent degradation and aggradation in a river system. Conceptually, the fluvial system is decomposed into two parts, referred to as the watersheds and main river. The watershed areas are the source of sediment and water discharge to the main river. The main river is the transporting portion of the system, channel aggradation and degradation are calculated within this part of the system.

The main river is subdivided into a series of computational reaches. Each of these subreaches is selected as a portion of the main river where hdyraulic and geomorphic characteristics are similar. A subreach has sediment discharge input from the upstream portion of the main river and can have sediment and water discharges from tributary watersheds. Hydraulic conditions for each subreach are calculated using Simons, Li & Associates, Inc. WSPR watersurface profile program. See the WSPR data file structure found at the end of this manual.

The model was developed for a Control Data Corporation mainframe utilizing the Network Operating System (NOS). Familiarity with NOS is assumed throughout this manual.

II. SEDIMENT TRANSPORT THEORY

2.1 General

The amount of material transported or deposited in a channel reach is the result of the interaction of two processes. The first is the transport capacity of the reach. This is determined in part by the hydraulic conditions which are a direct result of the water discharge, channel configuration, and channel resistance and the sediment sizes present. Smaller particles can be transported at larger rates than larger particles under the same flow conditions. The second process is the supply of sediment entering the reach. This is determined by the nature of the channel and watershed above the study reach and development that it may be subjected to.

When sediment supply is less than sediment transport, the flow will remove additional sediment from the channel bed and banks to reduce the difference. This results in degradation of the channel and possible failure of the banks. If the supply entering the reach is greater than the capacity, the excess supply will be deposited, causing aggradation.

2.2 Sediment Transport Capacity

Transport of the bed material load of a channel is divided into two zones. The sediment moving in a layer close to the bed is referred to as the bed load. The sediment which is carried in the remaining upper region of the flow is referred to as suspended load. The total bed material load is the sum of the two quantities. The turbulent mixing process and the action of gravity on the sediment particles cause a continual transfer between the two zones. Although there is no distinct line between the zones, the definitions are made in order to aid in the mathematical description of the process. A third type of load, the wash load, is also defined. It consists of fine particles that are not present in the bed in appreciable quantities, and will not easily settle out. Wash load concentration is used to correct for the discharge of sand-sized sediments by applying a correction factor developed by Colby.

Sediments of different sizes will experience different rates of transport. Therefore, the transport capacities for a range of sediment sizes are determined and totaled to produce an acceptable determination of total transport capacity. The total transport capacity for a channel section is

$$Q_s = T \Sigma C_f P_i (q_{bi} + q_{si}) \qquad (1)$$

In Equation (1), T is the top width of the channel, C_f is a calibration factor, P_i is the fraction of one sediment size, q_{bi} is the bed load transport rate per unit width for the ith size, and q_{si} is the suspended load transport rate for the ith size.

2.2.1 Bed Load Transport Capacity

The Meyer-Peter, Muller formula gives good results for bed load transport over a wide range of sediment sizes. It was adopted for this study because of the wide range of sediment sizes present in the study system. The Meyer-Peter, Muller formula is well suited to model the dynamics of channel armoring processes as well as transport of sand sizes with little armoring potential. The formula is

$$q_b = \frac{12.85}{\sqrt{\rho}\,\gamma_s} (\tau_o - \tau_c)^{1.5} \tag{2}$$

in which

$$\tau_c = 0.047\,(\gamma_s - \gamma) d_s \tag{3}$$

In Equations (2) and (3), q_b is the bed load transport rate in volume per unit width for a specific size of sediment, τ_c is the critical tractive force necessary to initiate particle motion, ρ is the density of water, γ_s is the specific weight of sediment, γ is the specific weight of water, and d_s is the size of sediment.

The boundary shear stress acting on the grain is

$$\tau_o = \frac{f_o}{8} \rho V^2 \tag{4}$$

where ρ is the density of flowing water and f_o is the Darcy-Weisbach friction factor, and V is the mean velocity of the flow. The friction factor was derived from Sticklers' equation

$$n' = \frac{D_{90}^{1/6}}{31.7} \tag{5}$$

where D_{90} is the sediment size (in feet) for which 90 percent of the sediment is finer and n' is Manning's coefficient representing the skin roughness. For loose boundary channels the resistance due to form drag must be added to the resistance due to skin friction. Combining Sticklers' equation with the Manning formula and equivalencing the tractive force on the bed of the channel to Equation (5) gives the friction factor in the following form

$$f_o = 0.116 \, (D_{90}/R)^{1/3} \qquad (6)$$

where R is the hydraulic radius in feet. A typical D_{90} value of 20 mm was used for the Rillito River. This gives an n'-value of 0.020 from Equation (5) and Equation (6) becomes

Salt River ?

$$f_o = 0.0467 \, R^{-1/3} \qquad (7)$$

The total Manning's resistance coefficient for the Rillito River system is 0.[illegible] 0.020 representing as the n'-value for skin resistance and an n"-va[illegible]

Is refence to Rillito River a mistake ?

Is D_{90} = 20 mm reasonable ?

[illegible] apacity is determined by using a solution [illegible] relies upon an integration of the sed[illegible]ction of depth. The nature of the profil[illegible]sport theory. The sediment profile is ass[illegible]fore the rate at which sediment is tr[illegible]nd the concentration gradient is exactly eq[illegible] transporting sediment downward. If the se[illegible] point, then the entire concentration is determined. The [illegible]entration is assumed to be the upper limit of the bed load layer. The resulting equation is

$$q_s = \frac{q_b}{11.6} \frac{G^{w-1}}{(1-G)^w} \left[\left(\frac{V}{U_*} + 2.5\right) I_1 + 2.5 \, I_2\right] \qquad (8)$$

in which q_s is the suspended load, q_b is the bed load, G is the relative depth of the bed layer, U_* is the shear velocity, V is the mean velocity of flow, I_1 and I_2 are the Einstein integrals and w is a dimensionless parameter given by roughness. For loose boundary channels the resistance due to form drag must be added to the resistance due to skin friction. Combining Sticklers' equation with the Manning formula and equivalencing the tractive force on the bed of the channel to Equation (5) gives the friction factor in the following form

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$$f_o = 0.0467 \ R^{-1/3} \quad (7)$$

The total Manning's resistance coefficient for the Rillito River system is 0.025 with 0.020 representing as the n'-value for skin resistance and an n"-value for 0.005 due to form drag.

2.2.2 Suspended Transport Capacity

The suspended sediment transport capacity is determined by using a solution developed by Einstein. This method relies upon an integration of the sediment concentration profile as a function of depth. The nature of the profile is determined using turbulent transport theory. The sediment profile is assumed to be in equilibrium, and therefore the rate at which sediment is transported upward due to turbulence and the concentration gradient is exactly equal to the rate at which gravity is transporting sediment downward. If the sediment concentration is known at one point, then the entire concentration is determined. The point of known concentration is assumed to be the upper limit of the bed load layer. The resulting equation is

$$q_s = \frac{q_b}{11.6} \frac{G^{w-1}}{(1-G)^w} \left[\left(\frac{V}{U_*} + 2.5\right) I_1 + 2.5 \ I_2\right] \quad (8)$$

in which q_s is the suspended load, q_b is the bed load, G is the relative depth of the bed layer, U_* is the shear velocity, V is the mean velocity of flow, I_1 and I_2 are the Einstein integrals and w is a dimensionless parameter given by

QUASED sediment routing model was tested during the sediment analysis for Tucson Urban Study; and was calibrated using the Rillito River sediment measurement data. A calibration factor of 2 was obtained. This number is based on the sediment data in Rillito River, and should not be used universally.

Sediment capacity estimators in the model are M-P-M for bed load and Einstein for suspended load.

M-P-M eq. was derived based on the experiment data with (mean size) d_m ranging 0.4 mm – 30 mm, it is used as a whole without subdividing into size fraction.

Einstein suspended load equation was developed with bed load ~~equa~~ function for individual size fractions.

Combination of two different method is somewhat questionable; especially M-P-M was developed for 1 size only while Einstein's is based on individual size fractions.

Without any calibration or measurement data, no equation can be claimed is correct.

$$w = \frac{V_s}{KU_*} \qquad (9)$$

In Equation (9), V_s is the fall velocity of the sediment particles and K is the Karman constant (assumed 0.4).

I_1 and I_2 are integrals which cannot be evaluated directly. One must either use tables or numerical techniques. In the computer routine used to determine transport capacity, these integrals are evaluated using a numerical technique developed by Simons, Li & Associates, Inc.

The bed layer is assumed equal to twice the D_{65} sediment size. The average D_{65} size is 7 mm which gives a bed layer thickness of 0.05 feet.

2.2.3 Sediment Transport Calibration

Water and suspended-sediment discharge measurement are available at three locations on the Rillito River. These thirteen measurements by the U.S. Geological Survey cover a range of water discharges from 8 to 10,200 cfs. Figure 1 shows these data points and an eye fit of the trend for this data. For a discharge of 10,000 cfs, the fitted relationship gives a suspended sediment concentration of 35,000 parts per million. Using a channel cross section at the present gage site at First Avenue and assuming normal depth with an n-value of 0.025 gives a velocity of 7.9 feet per second, a depth of 4.4 feet, and a topwidth of 285 feet for 10,000 cfs. A sediment size distribution is not reported for the samples taken on the Rillito so a wash load concentration of 15,000 ppm was assumed based on information derived for the Rillito River Basin. This gives a bed material concentration of 20,000 ppm for the measured zone. Measurements of total bed material concentration by the USGS on sand bed channels, indicate that the total bed material concentration is ten percent greater that of the measured zone. This gives a total bed load concentration of 22,000 ppm.

Based on hydraulic conditions estal[...] is, a bed material concentration was calcula[...] Einstein methods. A calibration factor [...] s of the theoretical transport rate to matc[...]. The theoretical equations were then teste[...] 5,000 to 16,400 cfs (bankfull discharge) [...] fitted relationship in Figure 1.1.

Is D_{65} = 7 mm reasonable ?

?

$$w = \frac{V_s}{KU_*} \qquad (9)$$

In Equation (9), V_s is the fall velocity of the sediment particles and K is the Karman constant (assumed 0.4).

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Based on hydraulic conditions established from the normal depth analysis, a bed material concentration was calculatd from the Meyer-Peter, Muller and Einstein methods. A calibration factor of 2.0 was used to adjust the results of the theoretical transport rate to match the measured results at 10,000 cfs. The theoretical equations were then tested over a range of discharges from 5,000 to 16,400 cfs (bankfull discharge) and was found to closely match the fitted relationship in Figure 1.1.

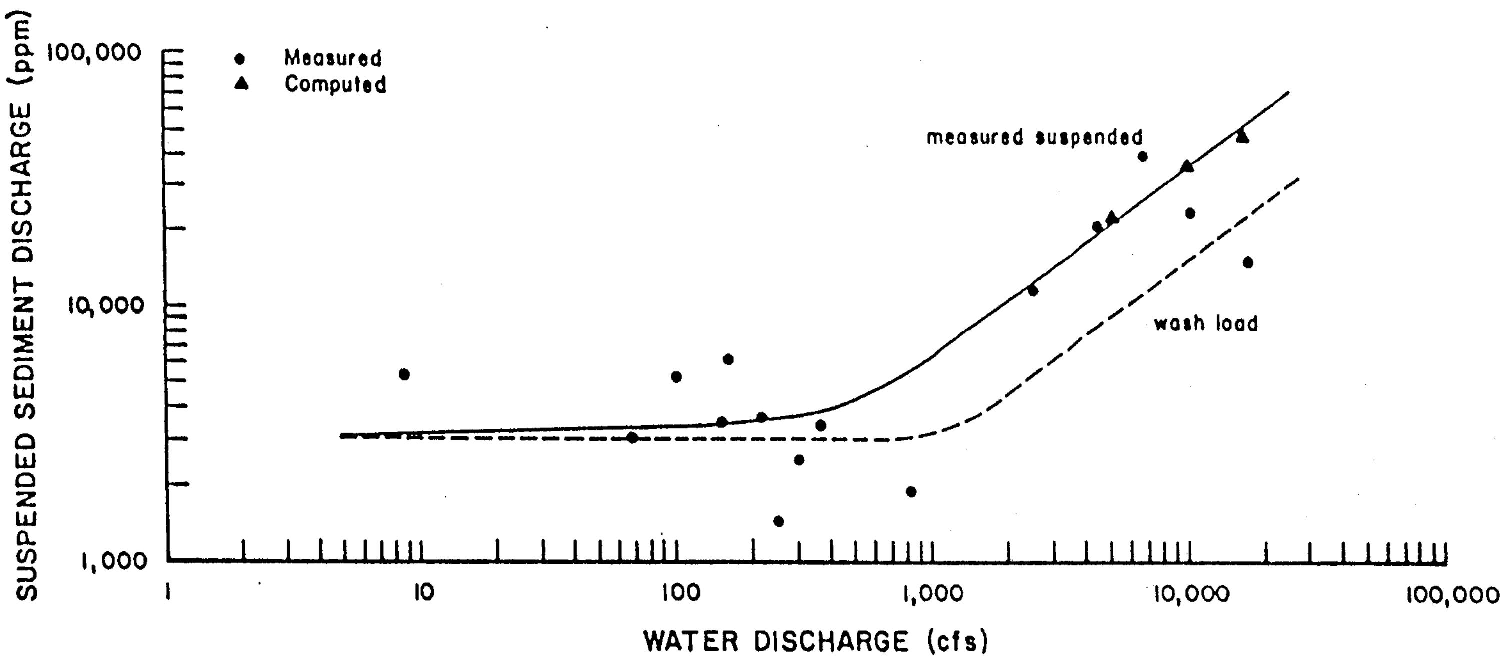

Figure 1.1. Sediment

C.14

3. HYDRAULIC COMPUTATION

Hydraulic conditions are assumed to be predominantly subcritical for this version of QUASED. The sediment routing procedure uses Simons, Li and Associates, Inc. WSPR water surface program to determine hydraulic conditions in the subreaches.

The sediment routing procedure is quasi-dynamic where the flow is assumed constant for a given time increment but varies from subreach to subreach. The flood event is broken into a number of time increments, each with a different flow, but during each increment the flow is considered steady. To account for the moveable nature of the alluvial boundary, the cross sections are recomputed at the end of each time interval. Sediment transport by size fraction is determined for the overbanks and main channel portions of the cross section then summed to give the total transport capacity within a subreach.

IV. AGGRADATION AND DEGRADATION

Sediment aggradation or degradation within a subreach for a given time interval is ΔV_s = (sediment supply - sediment transport). $C_s \cdot BF$, where ΔV_s is the change in sediment volume in the reach, C_s is a conversion factor, and BF is a bulking factor given as $BF = 1/(1-\lambda)$, where λ is the porosity of the bed material. The change in cross-sectional area is assumed to be uniform for the subreach. Changes in the elevation of points within the cross section and below the water surface are determined by conveyance weighting of the flow in the overbanks and the main channel. Since HEC-2 assumes that the slope of the energy grade line is uniform across the section, the sediment distribution weighting factors are

$$W_L = \frac{Q_L}{Q_T} \; ; \; W_R = \frac{Q_R}{Q_T} \; ; \; W_M = \frac{Q_M}{Q_T}$$

where W_L, W_R, and W_M are the weighting factors, and Q_L, Q_R, and Q_M are the discharges for the left overbank, right overbank, and main channel, respectively. Q_T is the total discharge in the cross section. The change in elevation for a point within the main channel is

$$\Delta Z_M = \frac{A_S}{T_M} \cdot W_M$$

where A_S is the change in cross-sectional area and T_M is the width of the main channel. The change in elevation for the left and right overbank points is

$$\Delta Z_L = \frac{A_S}{T_L} \quad W_L \; ; \; \Delta Z_R = \frac{A_S}{T_R} \cdot W_R$$

where T_L and T_R are the topwidths of the left and right overbanks, respectively. The changes in elevation are used to generate new data for the next time interval.

V. INPUT REQUIREMENTS

Input data for the sediment routing procedure consists of river and watershed information, WSPR data, and sediment loading from the tributaries. River and watershed information consists of the subreach definitions in the main river, the surface and subsurface bed material size distributions for each subreach, and the discretized watershed hydrographs.

The changes in discharge along the channel due to flood attenuation or tributary inflows are accounted for within the procedure by change of discharge cards (card Q) inserted at the appropriate location in the WSPR input file. The tributary and upstream watershed sediment inputs can be made via a separate input file which consists of the sediment transport rates for each particle size for each time step. Sediment loading from the tributaries can also be calculated based on normal depth hydraulic conditions for the tributary channels. The routing procedure contains an option which allows the upstream watershed sediment loading to be determined based on the transport capacity of the first upstream subreach.

5.2 River and Watershed Data Input File Structure

In performing the sediment routing analysis, a group of cross sections is considered together as a single reach. The aggradation/degradation process is then considered using the average properties for a reach. The reason for this grouping is that the analysis method is designed for determining general scour. Thus, by grouping a number of cross sections together and considering their properties as a single unit, local effects confined to a single cross section are reduced. Reaches may contain as few as 1 cross section with no upper limit on the number of cross sections per reach. This allows a more reasonable application of present state-of-the-art sediment transport theory. The regions of large local effects are isolated and their additional response determined separately.

The groupings of cross sections into reaches must be performed so that,

1. All cross sections in a reach have similar hydraulic and sediment transport characteristics,

2. Areas of special concern, such as proposed bridge sites, are represented by a reach,

3. Sections of the channel which are expected to have different responses are separated.

4. Sediment size distributions should be similar within a reach.

The segmentation of the study area into reaches was carried out following these principles. Additionally the computational method determines transport rates for given sediment size intervals. The determination of the limits of these intervals should be performed so that

1. The total range of sizes should encompass all sizes of sediment that may be transported.

2. Each interval should represent approximately the same percentage of the sediment distribution, and

3. It is recommended that the sediment size distribution be discretized from a log-normal plot of the distribution. If approximately the same percentage of the distribution is included within each interval, the size ranges will approximate a geometric progression.

4. The total number of sediment size intervals is limited to ten.

The River and Watershed Data input file contains reach definition data, geometric mean diameter of each sediment size interval, surface and subsurface percentages of sediment in each size interval, and information of tributary water and sediment yield. Each record or line of the file (hereafter referred to as a "card") on the file contains ten fields with eight characters per field. Figure 5.1 is an example of a relatively simple case of a river divided into eight reaches with no tributaries in any reach. Cards A, B, H, I and J are used to define the river system and hydrographs, while cards C, D, E, F, G and K contain sediment size distribution data and card J has tributary or upstream supply reach data. Details concerning each card are given in this section, a general discussion of each card follows (see Appendix B for the detailed discussion of variables on each card).

Card A contains the number of time steps within the discretized flood hydrograph, the number of reaches, the type of sediment (sand or gravel) and the porosity of the sediment. Cards B are the reach definitions and contain the number of tributaries per reach, the number of cross sections per reach, the upstream limit and downstream limit of the reach given as river distance in feet, and a grade control indicator. If this indicator is set equal to one then no aggradation or degradation is allowed to occur within the reach. If the indicator is zero, aggradation/degradation is computed for the reach. Cards B are ordered from the most upstream reach to the most downstream reach. Card C is the number of sediment sizes. Card D contains the geometric mean of each sediment size interval. Card E contains the surface layer thickness for

Card(s)

Card										
A	12	8	0	0.4						
	0	3	23806.	22016.	0					
	0	4	22016.	19516.	0					
	0	4	19516.	17516.	0					
	0	4	17516.	14506.	0					
B	0	3	14506.	12316.	0					
	0	4	12316.	9055.	0					
	0	7	9055.	2410.	0					
	0	9	2410.	0.	0					
C	10									
D	.173	.424	.775	1.41	2.83	6.32	20.0	50.0	100.0	200.0
E	500	500	500	500	500	500	500	500		
	.09	.20	.20	.20	.15	.11	.05	0.0	0.0	0.0
	.09	.20	.20	.20	.15	.11	.05	0.0	0.0	0.0
	.09	.20	.20	.20	.15	.11	.05	0.0	0.0	0.0
F	.09	.20	.20	.20	.15	.11	.05	0.0	0.0	0.0
	.09	.20	.20	.20	.15	.11	.05	0.0	0.0	0.0
	.14	.205	.185	.15	.19	.06	.07	0.0	0.0	0.0
	.14	.205	.185	.15	.19	.06	.07	0.0	0.0	0.0
	.14	.205	.185	.15	.19	.06	.07	0.0	0.0	0.0
	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
G	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
	.1	.14	.12	.155	.165	.13	.14	.05		
H	4	1	1	1	1	1	1	2	2	3
	3	3								
I	2510	5175	6760	10780	17050	20490	19460	14770	8745	4750
	2600	1725								
J	.006	.025	26.3	.31	26.3	.31	26.3	.31	1	0
L	22000.									

Figure 5.1. Example river and watershed data input file.

each reach. Cards F contain the percentage of sediment within each size interval for the surface layer for each reach, ordered from upstream to downstream. Cards G contain the same information as cards F except in the subsurface layer. Card H contains the time intervals for the discretized hydrographs. The same time steps are used for all tributaries (see the section 5.2.1 on tributaries). Card I contains the discharges corresponding to the time steps in card H. For the example given in Figure 5.1, cards H and I are the discretized flood hydrograph for the supply reach described by card J. Card K (not shown in the example) gives the sediment size distribution for the supply reach and for tributaries. Card L gives the washload concentration for the supply reach and tributaries. Further I, J and K cards can be added to describe tributaries and/or reduction in discharges due to attenuation of the peak, infiltration, and other losses. This is discussed in more detail in the tributary section.

Upstream Supply

The first I and J cards represent the upstream sediment supply reach. Several options are available for modeling the supply reach. For the example being considered, the J card represents a supply reach immediately upstream of the furthermost upstream reach as defined by the B cards. Geometric characteristics of the supply reach are modeled by the following relationships:

$$\text{Cross-Sectional Area} = a_1 \text{ Depth}^{b_1}$$
$$\text{Wetted Perimeter} = a_2 \text{ Depth}^{b_2}$$
$$\text{Topwidth} = a_3 \text{ Depth}^{b_3}$$

where a_1, b_1, a_2, b_2, a_3, b_3 are empirically determined coefficients. Variables on card J are average slope of the supply reach, Manning's n, a_1, b_1, a_2, b_2, a_3, b_3, a sediment hydrograph indicator, and an upstream reach supply indicator. If the sediment hydrograph indicator is zero then the model uses the geometric relations as given above to determine the sediment transport from the supply reach. If the indicator is one as in the example, the model ignores the geometric relationships and looks for a sediment inflow hydrograph on file SEDHYD. The structure of this file is discussed in section 5.4. The sediment hydrograph must be based on the same time steps as used in card H.

The upstream reach supply indicator is used for two different situations. If it is set equal to one on the first J card, then the most upstream reach as defined by the B cards is used as the supply reach and any other information on card J is ignored. This indicator can also be used on later J cards to indicate points where water discharge changes but sediment is not contributed. This application will be discussed later. The upstream supply indicator takes precedence over the sediment hydrograph indicator however to avoid confusion, one should always be zero when the other is equal to one.

In summary, three supply reach options are available:

1. Geometric modeling of a supply reach,
2. Inputting a known sediment hydrograph for the supply, and
3. Using the upstream reach as the supply reach.

Figure 5.1 gives an example of case two. Here the first eight fields of card J could be zero to avoid confusion. If field 9 was zero instead of one then this would be an example of Case 1. Figure 5.2 gives an example of using the upstream reach as the supply reach. In addition, it has two tributaries, which will be discussed in the next section.

5.2.1 Tributary and Discharge Changes

Two options exist for modeling tributaries:

1. A known inflow sediment hydrograph may be used, and
2. The geometry of the tributary may be modeled in exactly the same manner as the supply reach, already discussed.

Figure 5.2 gives an example of geometric modeling of tributaries. Here a wide rectangular channel was assumed for the tributaries, hence the relatively simple area-depth, perimeter-depth, and topwidth-depth factors. Each tributary J card is preceded by an I card. This I card contains the discharges for the tributary hydrograph. The tributary hydrographs must be discretized for the same time intervals as the supply reach hydrograph since all tributaries and the supply reach use the same H card values as time increments. If the tributary is being modeled geometrically then the J card must be followed by a K card as illustrated in Figure 5.2. This K card contains the percentage of sediment in each size interval (whose geometric mean is given on card D) for the tributary. Following the K card is an L card which gives the washload concentration for the tributary. If the input sediment hydrograph option is selected then the K card is omitted.

Due to attenuation of the peak, infiltration or other losses, and

Card(s)											
	A	12	9	0	0.4						
	B	0	5	21505	16030	0					
	B	1	2	16030	14137	0					
	B	0	4	14137	9845	0					
	B	1	3	9845	8473	1					
	B	0	4	8473	6520	0					
	B	0	2	6520	5195	0					
	B	0	2	5195	4005	0					
	B	0	3	4005	2245	0					
	B	0	3	2245	0	0					
	C	10									
	D	0.173	0.424	0.775	1.41	2.83	6.32	20.0	50.0	100.0	200.0
	E	300	300	300	300	300	300	300	300	300	300
	F	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	F	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	F	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	F	.04	.14	.19	.23	.26	.10	.04	.00	.00	.00
	F	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	F	.04	.14	.19	.23	.26	.10	.04	.00	.00	.00
	F	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	F	.02	.08	.12	.20	.20	.16	.11	.06	.04	.01
	F	.02	.08	.12	.20	.20	.16	.11	.06	.04	.01
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.03	.10	.15	.20	.20	.01	.04	.04	.06	.15
	G	.02	.08	.12	.20	.20	.16	.11	.06	.04	.01
	G	.02	.08	.12	.20	.20	.16	.11	.06	.04	.01
	H	4.	1.	1.	1.	1.	1.	1.	2.	2.	3.
	H	3.	3.								
Supply Reach	I	259.59	1004.91	1651.95	2218.31	2145.23	1430.77	793.62	431.63	272.98	198.89
	I	139.80	84.02								
	J	0	0	0	0	0	0	0	0	0	1
	L	10000									
1st Tributary	I	119.77	469.02	782.44	1063.43	1044.75	711.11	400.44	213.02	131.38	93.83
	I	66.24	39.64								
	I	0.016	0.035	160.	1.	160.	0.0	160.	0.0	0	
	K	.01	.01	.01	.01	.01	.04	.12	.13	.19	.49
	L	10000									
2nd Tributary	I	300.34	1151.67	1339.77	693.21	0.00	0.00	0.00	0.00	0.00	0.00
	I	0.00	0.00								
	J	0.016	0.035	80.	1.	80.	0.0	80.	0.0	0	
	K	.01	.01	.01	.01	.01	.04	.12	.13	.19	.49
	L	10000									

Figure 5.2. River and watershed input data file with tributaries.

overland flow directly into the main stem of a river, the discharge may increase or decrease along the river. To account for this change in discharge "artificial" tributaries are available. These have no sediment inflow or outflow, but may have positive, negative, or a combination of postive and negative discharges in their hydrographs. Again these hydrographs must be discretized in the same fashion as the supply reach and the regular tributaries since only one H card is used throughout. Figure 5.3 is the last part of an extensive River and Watershed data file and illustrates the use of tributaries where an input sediment hydrograph was used as well as "artificial" tributaries which represent attenuation, losses, and/or overland gains. Negative discharges should never be used on a regular tributary as the program will try to calculate negative transport rates and most likely terminate execution with an error condition.

Tributary location is specified by the B cards. The first field of each B card gives the number of tributaries in the reach. While the model can handle multiple tributaries per reach, it is recommended that the reaches be divided so that only one major tributary enters at the upstream end of the reach. This is because the model distributes sediment uniformly throughout a reach, so that if aggradation occurs as a result of sediment loading from a tributary and that tributary enters at a downstream section of the reach, sediment will be distributed upstream of where the tributary enters, which is clearly a physical impossibility. Referring back to Figure 5.2, we see that the two tributaries enter at reaches two and four, respectively. The I, J, K and L cards for each tributary should be ordered from the most upstream tributary to the most downstream one.

5.3 WSPR Considerations for Tributaries

Hydraulic parameters for the model are determined by Simons, Li and Associates, WSPR backwater program. After each time step the input file for is updated to reflect aggradation/degradation within the reach, and Q card within the file are updated to reflect the new discharges. Care should be taken when setting up the initial Q cards in the WSPR input data file. The sediment routing calculations are performed from upstream to downstream, while subcritical WSPR calculations are performed from downstream to upstream. Therefore the discharge on the first Q card in the WSPR input file should equal the sum of the upstream supply reach discharge plus all

Card(s)											
	G	.06	.16	.18	.20	.23	.10	.07	.00	.00	.00
		.06	.16	.18	.20	.23	.10	.07	.00	.00	.00
		.06	.16	.18	.20	.23	.10	.07	.00	.00	.00
	H	4.	1.	1.	1.	1.	1.	1.	2.	2.	3.
		3.	3.								
Supply Reach	I	400	1380	2320	3185	3175	2185	1225	655	400	285
		200	120								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
Discharge Change	I	0	1110	1545	1140	140	-235	-120	-65	-70	-80
		-95	-95								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
Discharge Change	I	0	-780	-585	110	825	890	560	215	40	-5
		-5	0								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
1st Tributary	I	0	80	740	1700	2310	2070	1400	670	255	110
		55	25								
	J	0	0	0	0	0	0	0	0	1	0
	L	23400									
2nd Tributary	I	0	2615	3885	4260	3290	2060	1300	755	455	310
		195	110								
	J	0	0	0	0	0	0	0	0	1	0
	L	23400									
Discharge Change	I	235	895	1255	1305	1040	755	540	325	180	115
		65	45								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
3rd Tributary	I	1030	3665	4925	8930	15770	20300	19940	15390	9150	4860
		2540	1580								
	J	0	0	0	0	0	0	0	0	1	0
	L	23400									
Discharge Change	I	-500	-2960	-3675	-3915	-3120	-1060	580	1125	850	235
		-150	-350								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
Discharge Change	I	15	-1180	-1325	-1300	-690	470	1435	1605	1180	615
		270	115								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									
Discharge Change	I	85	-760	-775	-840	-540	220	930	1115	810	415
		185	90								
	J	0	0	0	0	0	0	0	0	0	1
	L	23400									

Figure 5.3. Last part of a river and watershed data file with sediment inflow hydrograph tributaries and discharge changes, i.e., "Artificial" Tributaries.

tributary and "artificial" tributary discharges for the first time step of the hydrographs. Likewise, the second Q card in a subcritical WSPR deck is equal to the value of the first Q card minus the first time step discharge of the farthest downstream tributary on flow charge. Continuing, the third Q discharge is equal to the first Q discharge minus the first time step discharges of the two farthest downstream tributaries and/or "artificial" tributaries. This process is continued until the last Q card in the WSPR input data file should equal the first time step discharge of the upstream supply reach.

5.4 Sediment Inflow Hydrograph File (SEDHYD) Structure

If the input sediment hydrograph option is selected for the upstream supply reach, then the sediment routing program searches file SEDHYD for the input hydrograph. Figure 5.4 is the SEDHYD file corresponding to the River and Watershed data file of which part is shown in Figure 5.3. In this example, the most upstream reach as defined by the B cards is used as the supply reach and hence there is no sediment hydrograph for the supply reach in Figure 5.4. If a sediment hydrograph was available for the supply reach it would precede the data describing the first tributary in Figure 5.4.

Format of the file is relatively simple. Each field has a format of 12E.5 and there are as many fields per line as there are sediment size intervals. Units are cfs of sediment. Tributaries should be arranged upstream to downstream with the supply reach (if used) before all tributaries. Each line represents the sediment flow by sizes for each time step. In Figure 5.4 there are twelve lines of ten numbers for each tributary representing twelve time steps and ten sediment size intervals. Lines are arranged in increasing temporal order for the supply reach and each tributary. That is, the first line represents the first time step, the second line represents the second time step, etc.

1st Tributary	.31400E-01	.24900E-01	.49000E-01	.38200E-01	.26700E-01	.50000E-02	0.	0.	0.	0.
	.57810E+00	.28720E+00	.44870E+00	.31970E+00	.24740E+00	.11640E+00	.70000E-03	0.	0.	0.
	.12887E+01	.68670E+00	.95870E+00	.63270E+00	.46540E+00	.21670E+00	.30000E-02	0.	0.	0.
	.18458E+01	.96450E+00	.13063E+01	.83080E+00	.60060E+00	.28630E+00	.13000E-01	0.	0.	0.
	.14283E+01	.70490E+00	.96850E+00	.62640E+00	.45330E+00	.21470E+00	.69000E-02	0.	0.	0.
	.87620E+00	.46180E+00	.67810E+00	.46400E+00	.34220E+00	.15440E+00	0.	0.	0.	0.
	.34570E+00	.18050E+00	.29830E+00	.22230E+00	.16970E+00	.75500E-01	0.	0.	0.	0.
	.10560E+00	.66900E-01	.12240E+00	.95500E-01	.72700E-01	.26500E-01	0.	0.	0.	0.
	.42000E-01	.32100E-01	.62300E-01	.49000E-01	.35800E-01	.87000E-02	0.	0.	0.	0.
	.22200E-01	.19400E-01	.39100E-01	.30700E-01	.20700E-01	.27000E-02	0.	0.	0.	0.
	.12100E-01	.12000E-01	.24500E-01	.18900E-01	.11400E-01	.10000E-03	0.	0.	0.	0.
	.49000E-02	.57000E-02	.11800E-01	.84000E-02	.33000E-02	0.	0.	0.	0.	0.
2nd Tributary	.16100E+00	.20700E+00	.21600E+00	.27700E+00	.19000E+00	.48100E-01	0.	0.	0.	0.
	.14500E+01	.12600E+01	.10500E+01	.12300E+01	.91500E+00	.45600E+00	0.	0.	0.	0.
	.26900E+01	.22000E+01	.16200E+01	.17800E+01	.13000E+01	.68200E+00	.13100E-01	0.	0.	0.
	.28000E+01	.24900E+01	.17500E+01	.18600E+01	.13500E+01	.70700E+00	.20400E-01	0.	0.	0.
	.19300E+01	.19000E+01	.13700E+01	.14700E+01	.10800E+01	.54500E+00	0.	0.	0.	0.
	.10300E+01	.11300E+01	.87900E+00	.97500E+00	.71700E+00	.33600E+00	0.	0.	0.	0.
	.42600E+00	.53900E+00	.46300E+00	.53300E+00	.38500E+00	.14800E+00	0.	0.	0.	0.
	.16000E+00	.24000E+00	.22300E+00	.26000E+00	.17600E+00	.42100E-01	0.	0.	0.	0.
	.77400E-01	.13100E+00	.12700E+00	.14700E+00	.91400E-01	.86700E-02	0.	0.	0.	0.
	.47100E-01	.87600E-01	.86500E-01	.98900E-01	.56100E-01	.20500E-03	0.	0.	0.	0.
	.35000E-01	.67400E-01	.67100E-01	.74600E-01	.42900E-01	0.	0.	0.	0.	0.
	.18200E-01	.38800E-01	.39300E-01	.43400E-01	.20600E-01	0.	0.	0.	0.	0.
[illegible] Tributary	.14000E+02	.73800E+01	.37900E+01	.20700E+01	.18900E+01	.40700E+00	.80700E-01	0.	0.	0.
	.39300E+02	.21300E+02	.10400E+02	.51300E+01	.43200E+01	.94700E+00	.39600E+00	0.	0.	0.
	.61600E+02	.31700E+02	.15200E+02	.73800E+01	.60000E+01	.13100E+01	.62600E+00	0.	0.	0.
	.14000E+03	.68600E+02	.30700E+02	.13800E+02	.10300E+02	.21700E+01	.12000E+01	0.	0.	0.
	.25900E+03	.14500E+03	.61500E+02	.25400E+02	.16900E+02	.33500E+01	.19900E+01	0.	0.	0.
	.27800E+03	.18600E+03	.81200E+02	.32700E+02	.20500E+02	.40300E+01	.24200E+01	0.	0.	0.
	.22500E+03	.17000E+03	.80100E+02	.32600E+02	.20000E+02	.40200E+01	.23800E+01	0.	0.	0.
	.12700E+03	.10100E+03	.54400E+02	.24300E+02	.15200E+02	.32800E+01	.18200E+01	0.	0.	0.
	.52800E+02	.41500E+02	.25100E+02	.12700E+02	.87700E+01	.20700E+01	.97600E+00	0.	0.	0.
	.18300E+02	.14100E+02	.97000E+01	.57700E+01	.44200E+01	.11000E+01	.37800E+00	0.	0.	0.
	.83500E+01	.62900E+01	.47500E+01	.31500E+01	.25500E+01	.62800E+00	.11600E+00	0.	0.	0.
	.44600E+01	.34300E+01	.27900E+01	.19600E+01	.16100E+01	.38300E+00	.21400E-01	0.	0.	0.

Figure 5.4. Input sediment hydrograph file (file SEDHYD)