SEDIMENT TRANSPORT AND MINE PLAN STUDY FOR ALLIED CONCRETE COMPANY CENTER STREET PROPERTY

CMG DRAINAGE ENGINEERING, INC.

SEDIMENT TRANSPORT AND MINE PLAN STUDY FOR ALLIED CONCRETE COMPANY CENTER STREET PROPERTY

Prepared For:

CALMAT COMPANY OF ARIZONA
P.O. BOX 52012
PHOENIX, AZ 85072

Submitted by:

CMG DRAINAGE ENGINEERING, INC.
201 N. STONE AVENUE, STE. 200
TUCSON, AZ 85701
882-4244

NOVEMBER 29, 1988

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

I. INTRODUCTION

This report presents results of engineering analyses conducted to develop a mine plan for the Allied Concrete Center Street Plant property within the Salt River in the southeast $\frac{1}{4}$ of the southeast $\frac{1}{4}$ of Section 34, Township 2 North, Range 5 East, G & S, R B & M, Maricopa County, Arizona. A location map for the subject property is provided on Figure 1 of this report. The principle elements of the engineering analyses included: 1) a sediment transport model to evaluate riverbed response due to flow across the pit boundaries (ie., headcutting); 2) identification of physical constraints on mining which included adjacent, above and below ground utilities and 3) to provide recommendations for channel bank stabilization which would prevent an increase in the bank erosion rate due to channel excavation.

The subject property is a 40-acre parcel being square in shape and having a width and length of about 1320 feet. Roughly 30 acres of the site exist within the channel and floodway of the Salt River. The remainder of the property which is on the south overbank of the channel is at an elevation about 30 feet above channel flowline. The site is bounded on the north, east and west by the Salt River Pima-Maricopa Indian Community (SRPMIC) and on the south by an adjoining private property.

Allied Concrete Company was granted a floodplain use permit (FA87-06) by the floodplain administrator on July 18th, 1988, to conduct limited excavation on the property and to construct bank protection along the south bank.

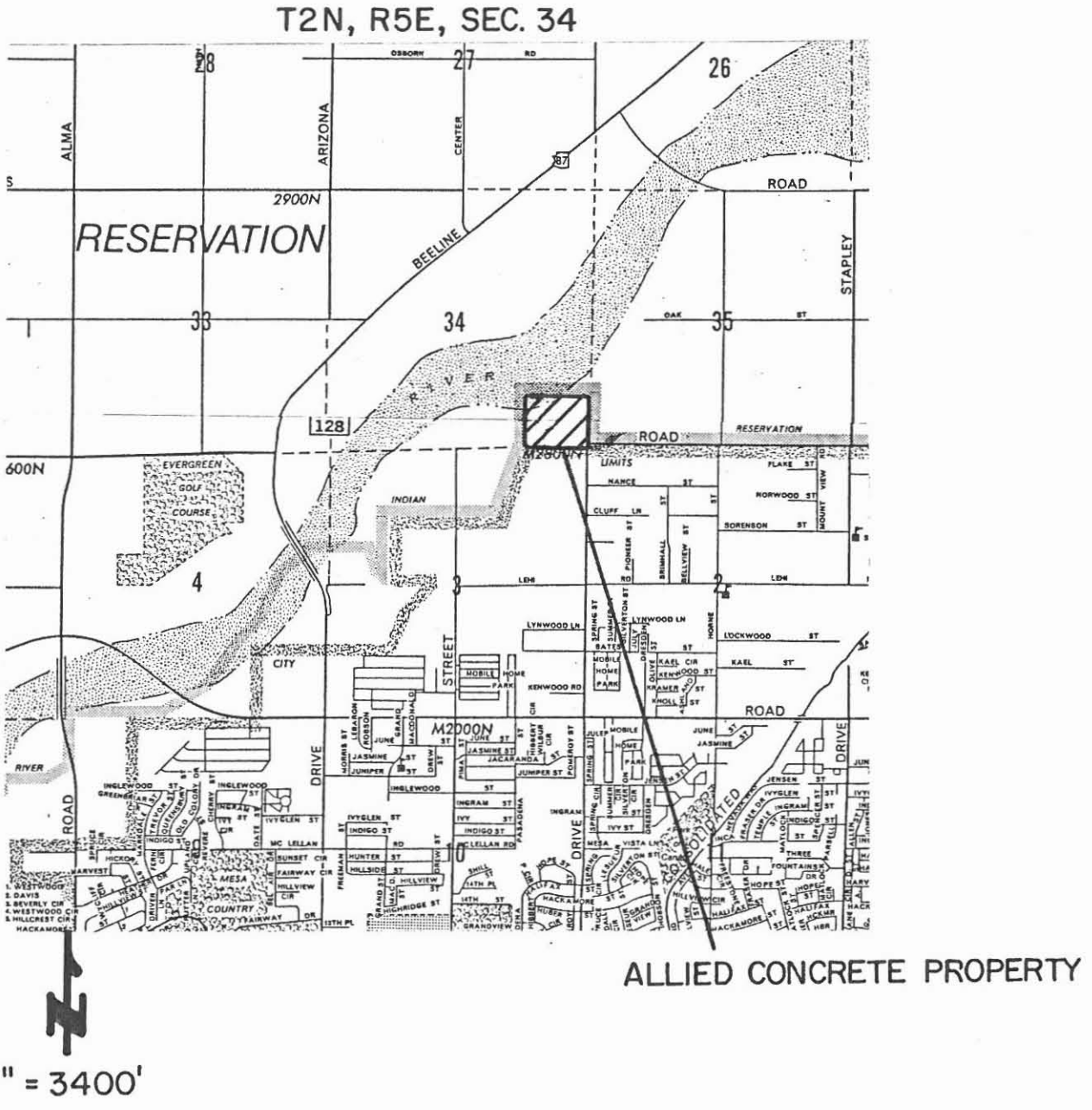


FIGURE I

LOCATION MAP

On November 23rd, 1988, Mr. Lee Edmonson of CalMat Company of Arizona and Clinton Glass of CMG Drainage Engineering met with the MCFCD design department to discuss a proposed modification to the bank protection cross section. Conceptual approval from the MCFCD staff was given for the modification to the bank protection design arrived at during that meeting. The computations for the bank protection design are included within this report and have been provided as a separate item in an effort to receive approval of the bank protection plan even prior to resolution of the overall mine plan design parameters. Approval of the bank protection design cross section was being requested so that construction of the bank protection may begin immediately, allowing significant completion prior to the beginning of in-channel excavation.

II. ANALYSIS OF HISTORICAL CHANGES IN THE SALT RIVER CHANNEL GEOMETRY ALONG PROJECT REACH

Aerial photographs from 1979 and 1980 were reviewed to examine historical changes in the river channel geometry through the reach adjacent to and upstream and downstream of the subject property. Examination comparison of these photographs found that the south bank of the channel migrated about 100-200 feet during the major floods. In addition, the banks along the reaches of the channel upstream and downstream of the site have been re-aligned and contoured by the SRPMIC as a part of landfill operation. The south bank of the channel through the Allied Concrete Company of Arizona property has a small radius meander bend which has developed during historical flows. The lowflow channel of the Salt River follows the meander bend adjacent to the south bank. The development of the lowflow path along this sinuous alignment has caused some minor erosion of the south bank through the property during historical flows.

Figures 2 and 3 are copies of the 1978 and 1980 flood photos through the project reach.

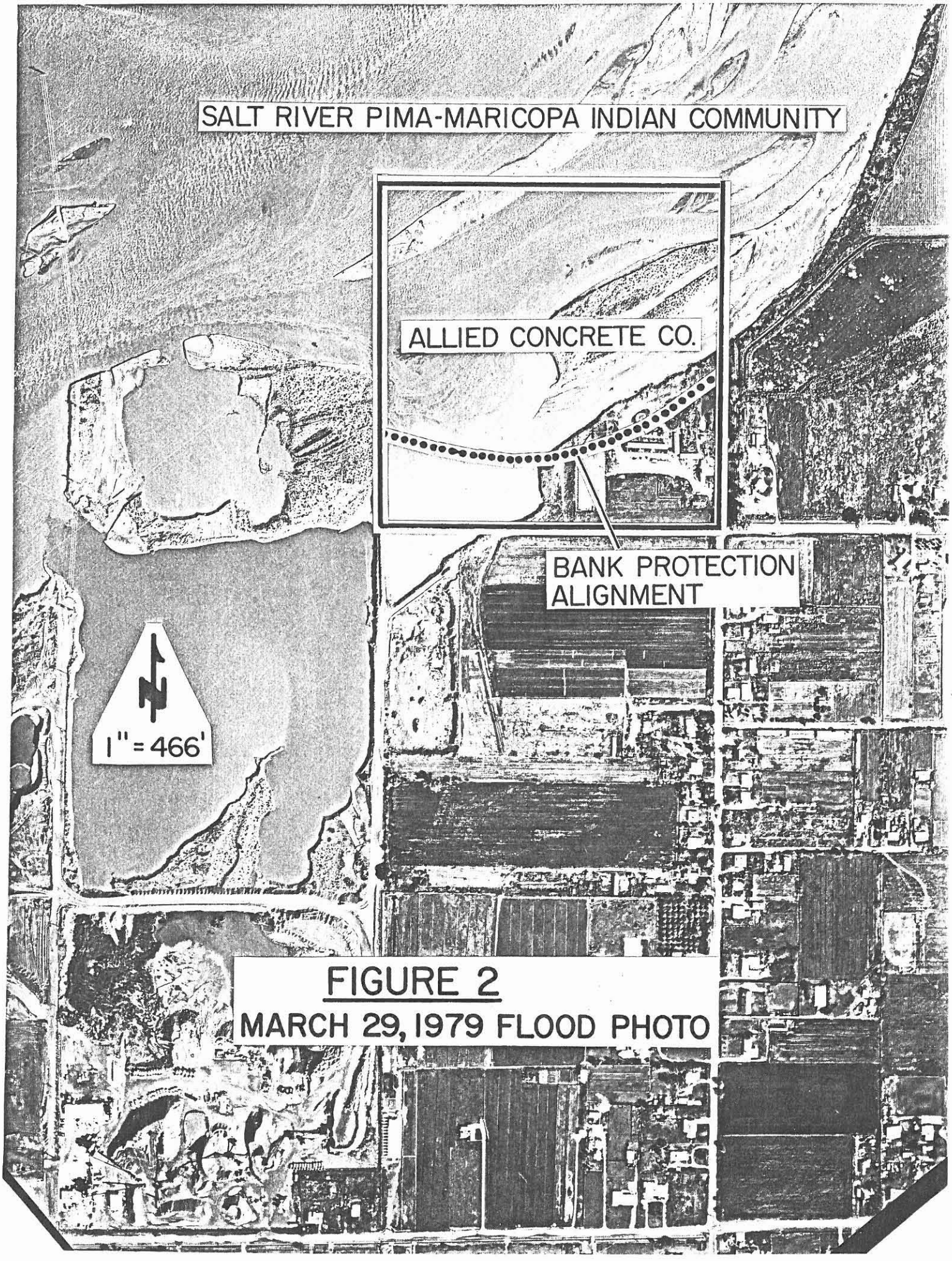


FIGURE 2
MARCH 29, 1979 FLOOD PHOTO

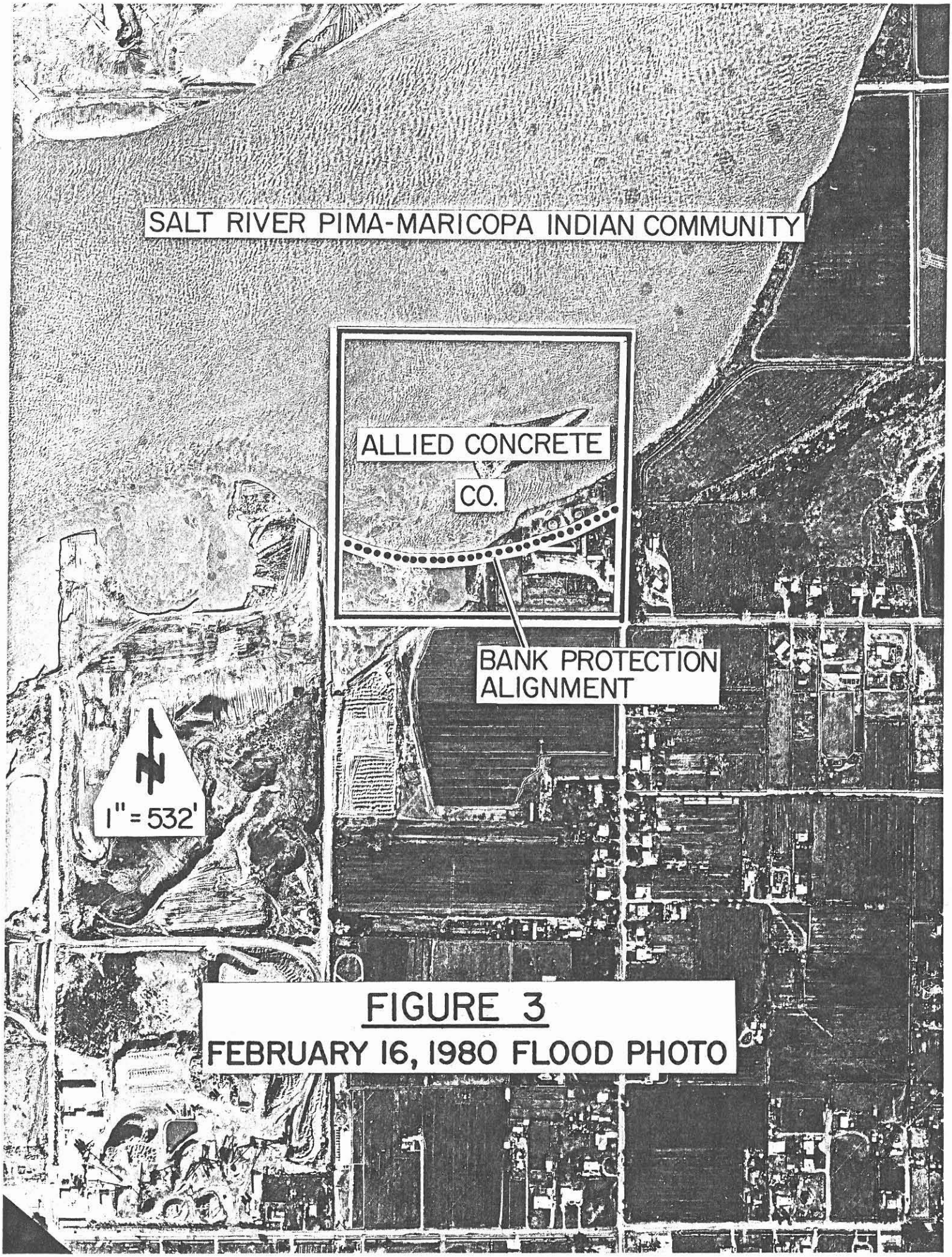


FIGURE 3

FEBRUARY 16, 1980 FLOOD PHOTO

III. HYDRAULIC ANALYSES

A HEC-II backwater model was prepared in order to evaluate the 100-year floodplain limits and hydraulic conditions for the Salt River between a point extending about ½ mile downstream and 1½ miles upstream of the subject property. The river cross section data used in the HEC-II model was based upon the FEMA baseline run prepared by Burgess & Niple, Inc. The topographic elevations derived from this source are on National Geodetic Vertical Datum (NGVD). The hydraulic analysis was conducted for the 100-year discharge of 225,000 cfs and for discharges of 20,000 cfs to 200,000 cfs increments. Figure 4 shows the limits of the 100-year floodplain as determined by this analysis. Appendix A contains the FEMA HEC-II baseline model input output, including flow distribution printout.

LEGEND

- 100-Year Flood Limits
- Floodway Limits
- 34.5 — Distance In Miles Upstream From Confluence With Gila River
- (E) — Cross Section
- XXX N — Natural Elev.
- XXX F — Floodway Elev.

Elevations Based On National Geodetic Vertical Datum Of 1929

ADDITIONAL CROSS-SECTIONS ADDED FOR SEDIMENT TRANSPORT MODELING

ERODABLE FILL

SEDIMENT SAMPLE #2

SEDIMENT SAMPLE #1

SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY

ALLIED CONCRETE PROPERTY PIT AREA

FLOODWAY

100-YR. FLOODPLAIN LIMIT

HAUL ROAD

MATERIALS PLANT & STOCKPILING AREA

Zone X

Zone AE

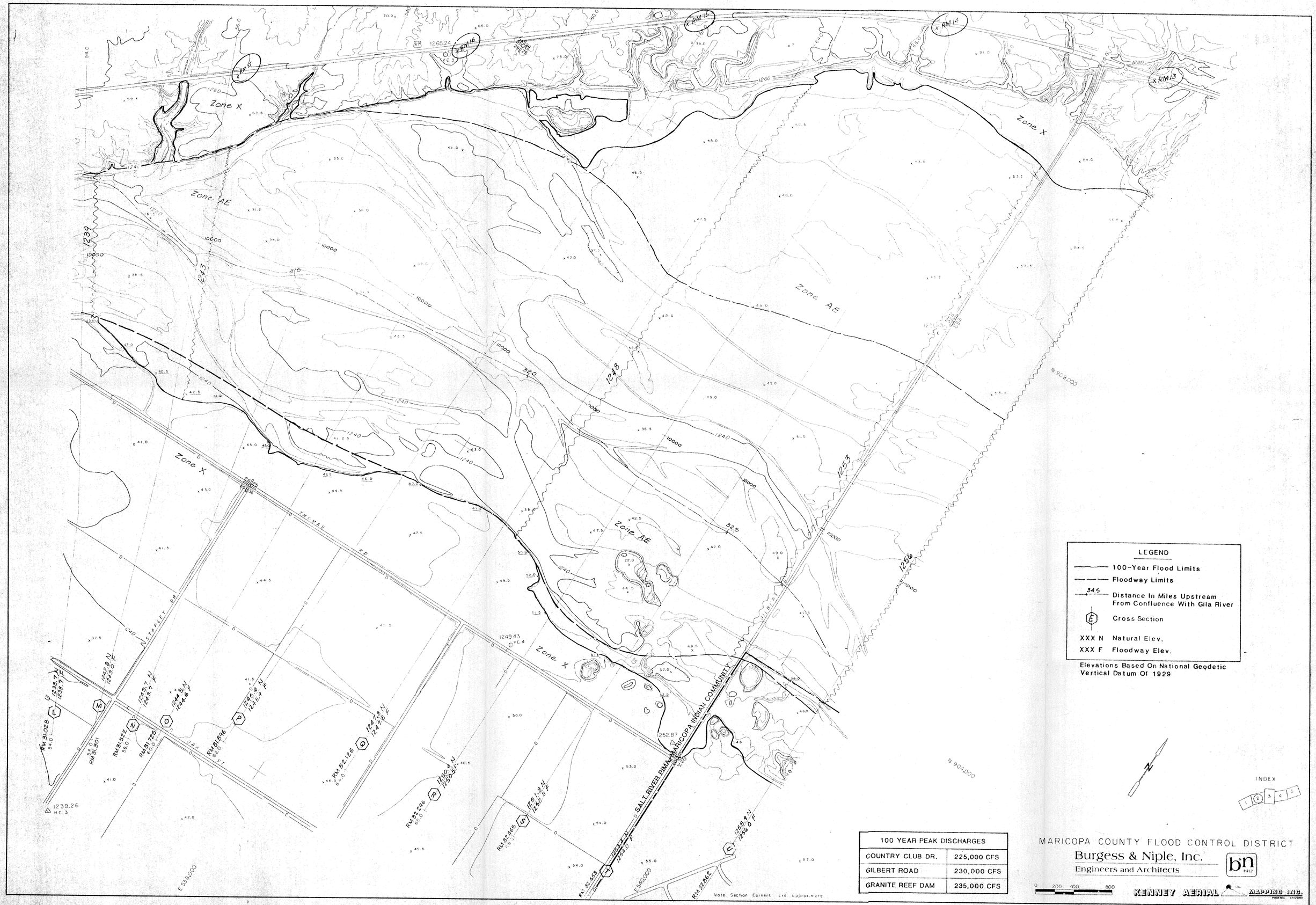
100 YEAR PEAK DISCHARGES	
COUNTRY CLUB DR.	225,000 CFS
GILBERT ROAD	230,000 CFS
GRANITE REEF DAM	235,000 CFS

Note: Section Corners are approximate

MARICOPA COUNTY FLOOD CONTROL DISTRICT

Burgess & Niple, Inc.
Engineers and Architects

KENNEY AERIAL MAPPING INC.
PHOENIX ARIZONA



LEGEND

- 100-Year Flood Limits
- Floodway Limits
- 34.5 Distance In Miles Upstream From Confluence With Gila River
- (E) Cross Section
- XXX N Natural Elev.
- XXX F Floodway Elev.

Elevations Based On National Geodetic Vertical Datum Of 1929

100 YEAR PEAK DISCHARGES	
COUNTRY CLUB DR.	225,000 CFS
GILBERT ROAD	230,000 CFS
GRANITE REEF DAM	235,000 CFS

INDEX

1 2 3 4 5

MARICOPA COUNTY FLOOD CONTROL DISTRICT

Burgess & Niple, Inc.
Engineers and Architects

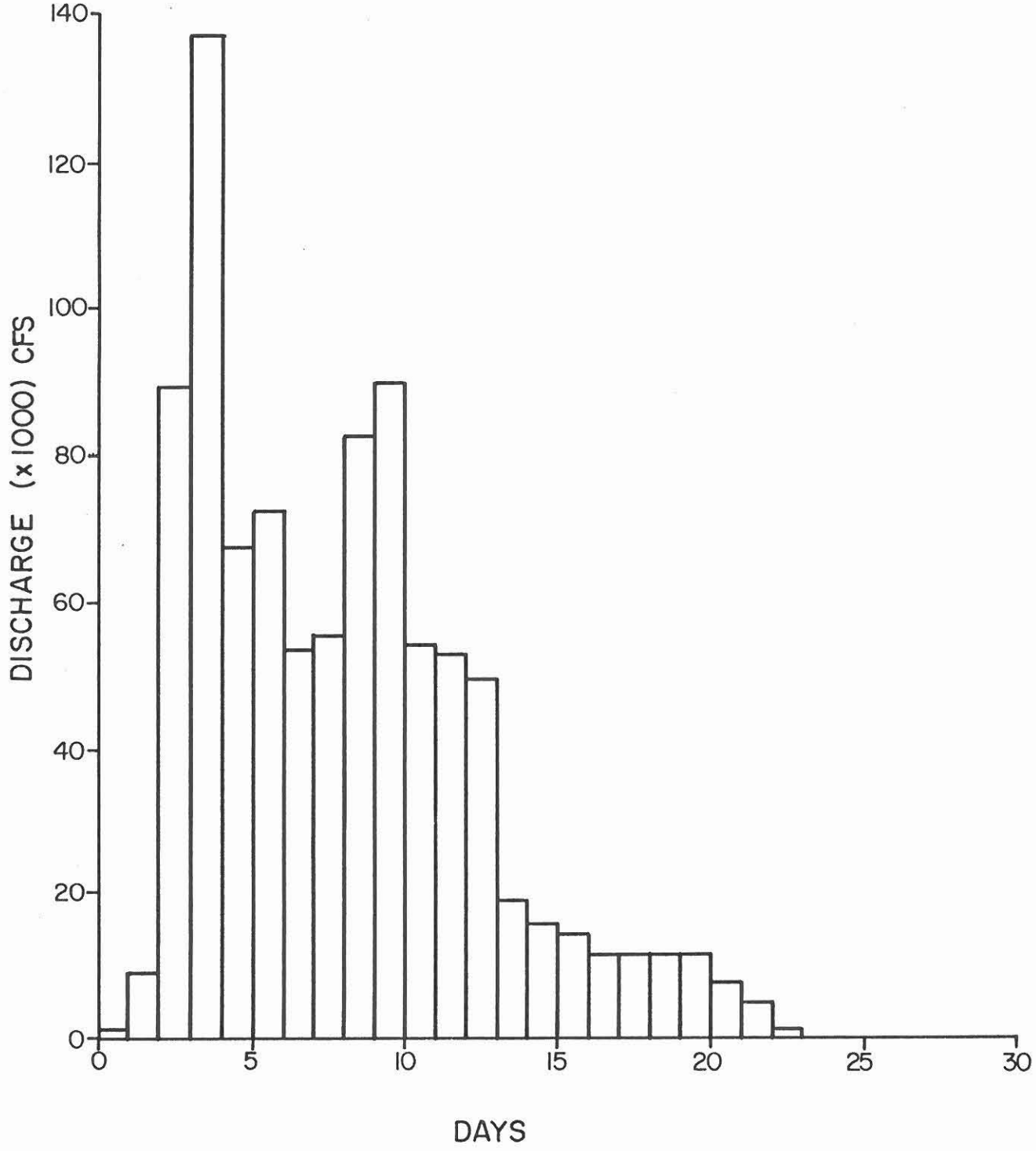
0 200 400 800

KENNEY AERIAL MAPPING INC. PHOENIX, ARIZONA

IV. DEVELOPMENT OF 100-YEAR HYDROGRAPH

A 100-year flood hydrograph was developed for use in the sediment transport analyses. Development of the 100-year hydrograph was based upon the daily peak flow pattern exhibited during the flow event which occurred on the Salt River between February 13th and March 6th, 1980. The highest daily peak which occurred during the above event was approximately 138,000 cfs. The 100-year hydrograph was developed by multiplying the discretized hydrograph by the ratio of 225,000 to 138,000. Figure 5 shows the February 13th to March 6, 1980 hydrograph. The discharge data for the flood hydrograph development was obtained from the Salt River Project (SRP).

FIGURE 5 - FEBRUARY 13, 1980 - MARCH 6, 1980
HYDROGRAPH



V. UTILITIES AND PUBLIC IMPROVEMENTS

Preliminary field investigations in review of available survey information found no public utilities or improvements within the immediate area of the project site. The only known public facility in the area is the Country Club Road bridge which is one mile downstream of the subject property. Coordination with the utility companies and public agencies is presently being conducted and copies of correspondence will be provided to the MCFCD upon receipt.

VI. DEVELOPMENT AND EVALUATION OF MINE PLAN

6.1 Problem Identification and Method of Analysis

The purpose of developing a mine plan is to establish the allowable horizontal limits, depth, and sideslopes of excavation to allow economic use of the property while preventing adverse impacts to adjacent properties and utilities. The principal area of concern is the occurrence of channel bed headcutting and downstream degradation which occurs due to the flow of water over the pit embankment on its upstream edge and due to the entrapment of sediments within the pit which then creates a clear water release at the downstream edge of the pit. The evaluation of potential headcutting and downstream erosion is conducted by sediment transport modeling.

6.2 Description of Erosion and Sedimentation Processes Along the Pit Boundary

A description of the physical processes governing sediment transport and channel bed aggradation/degradation is described within an article entitled "Modeling Fluvial Processes in Streams with Gravel Mining" by Howard H. Chang, Department of Civil Engineering, San Diego State University, San Diego, California. A copy of this reference is provided in Appendix B of this report.

6.3 Description of Sediment Transport Modeling Procedures

The sediment transport analyses was conducted using the computer program Fluvial 12 as written and developed by Dr. Howard H. Chang, Sand Diego State University. River channel changes which are simulated by the model include channel bed scour and fill (or aggradation and degradation),

width variation, and changes in bed topography induced by curvature effects. Applications of this model include evaluations of general scour at bridge crossings, sediment delivery, channel response to sand and gravel mining, and channelization. The model has been tested and calibrated with field data from several rivers. Technical publications written to describe the analytical background of the model are provided in Appendix C of this report. Appendix C also contains a user's manual that describes the model input/output data. Cross-section locations used in the sediment transport models are shown on Figure 4 of this report. Note that several additional cross-sections were added to the FEMA baseline HEC-II model to evaluate erosion and sedimentation processes on the pit boundaries.

6.4 Description of Channel Bed Sediments

The sediments which comprise the bed material of the Salt River consist of a sand/gravel aggregate. The materials which have accumulated on the near-surface of the bed consist mostly of large diameter gravels and cobbles having a size range between 0.25 and 1.0 feet. These materials have accumulated on the surface as a result of the armoring process whereby large diameter cobbles settle out while smaller diameter sand and gravels are washed away. The accumulation of these large diameter materials on the bed surface creates an erosion-resistant bed surface that is immobile except during large flood flows. The sub-surface bed materials consist of a mix of sand, gravels, and cobbles.

Two near-surface (Depth 0-3 ft.) sediment samples were taken from the bed of the Salt River adjacent to the Allied Concrete Company property. Sieve analyses were prepared for the purpose of developing size

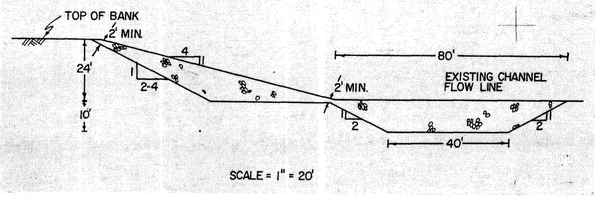
distribution gradation curves and size fractioning for the sediment transport models. Copies of the gradation curves are provided in Appendix D of this report.

6.5 Description of Mine Plan and Mitigation Measures

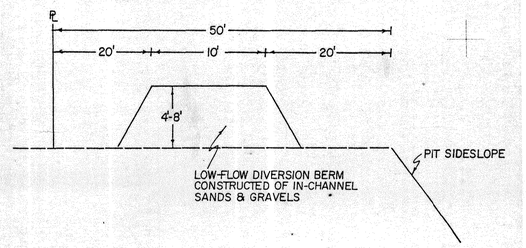
The mine plan which is being proposed for the Allied Concrete Company property is shown on Figure 6 of this report. The key features in the mine plan include:

1. Setback distances
    a. 50-foot setback from the east, west and north property lines.
    b. 50-foot setback from the toe of the proposed bank protection to be placed on the south bank adjacent to the area of mining. The south edge of pit is located a minimum of 200 feet north of the south property line and is outside of the regulatory floodway.
2. Sideslopes
    a. All pit sideslopes will be 2 horizonal to 1 vertical in excavation and contoured to 3 horizontal to 1 vertical in reclamation.
3. Depth of mining
    a. The depth of mining for the pit will be 40 feet below channel flowline. The bottom of pit elevation for this depth at excavation will be 1164.0.
4. Bank protection
    a. Rock riprap bank protection will be placed along the south bank of the Salt River channel adjacent to the area of

CROSS-SECTION A-A' - ROCK RIP-RAP BANK PROTECTION



CROSS-SECTION B-B' LOW DIVERSION BERM



SHEET INDEX

		24	19	20
		26	25	30	29
		34	35	36	31	32
	5	4	3	2	1
7	8	9	10	11	
18	17				

FIGURE 6

CONCEPTUAL MINE PLAN FOR ALLIED CONCRETE COMPANY CENTER ST. PROPERTY

0 100 200 400

JOB NO. 860315-1

KENNEY AERIAL MAPPING INC. PHOENIX ARIZONA

mining. This rock riprap will consist of rounded stones with a median diameter of 1.0 feet. The riprap blanket will be placed on the embankment at a minimum thickness of 2.0 feet. The bank protection will have a toe depth of 10 feet. The toe down will be placed in a trapezoidal cross section with a topwidth of 80 feet, bottomwidth of 40 feet, and 2:1 sideslopes. The front slope of the riprap above channel flowline will be 4 horizontal to 1 vertical and the backslope adjacent to the natural channel bank will be contoured to a maximum slope of 2 horizontal to 1 vertical. The height of the riprap above channel flowline will be approximately 23 feet, which will enable it to contain the 100-year flood discharge of 225,000 cfs plus 3 feet of freeboard.

5. Low flow diversion berm.

   a. An unstabilized berm consisting of in-channel sands and gravels will be placed along the north property line to divert low flows away from the pit to reduce the frequency of inundation. This berm will have a top width of 10 feet, 1½:1 sideslopes and height of 4 to 8 feet above channel flowline. This height will enable it to divert discharges approximately equal and less than 20,000 cfs. A typical cross section of the lowflow diversion berm is shown on Figure 7 of this report and the top of low flow berm elevations are indicated on Figure 6.

6. Material processing and stockpiling.

   a. All material processing and stockpiling will take place at the existing Allied Concrete Company plant site located at the

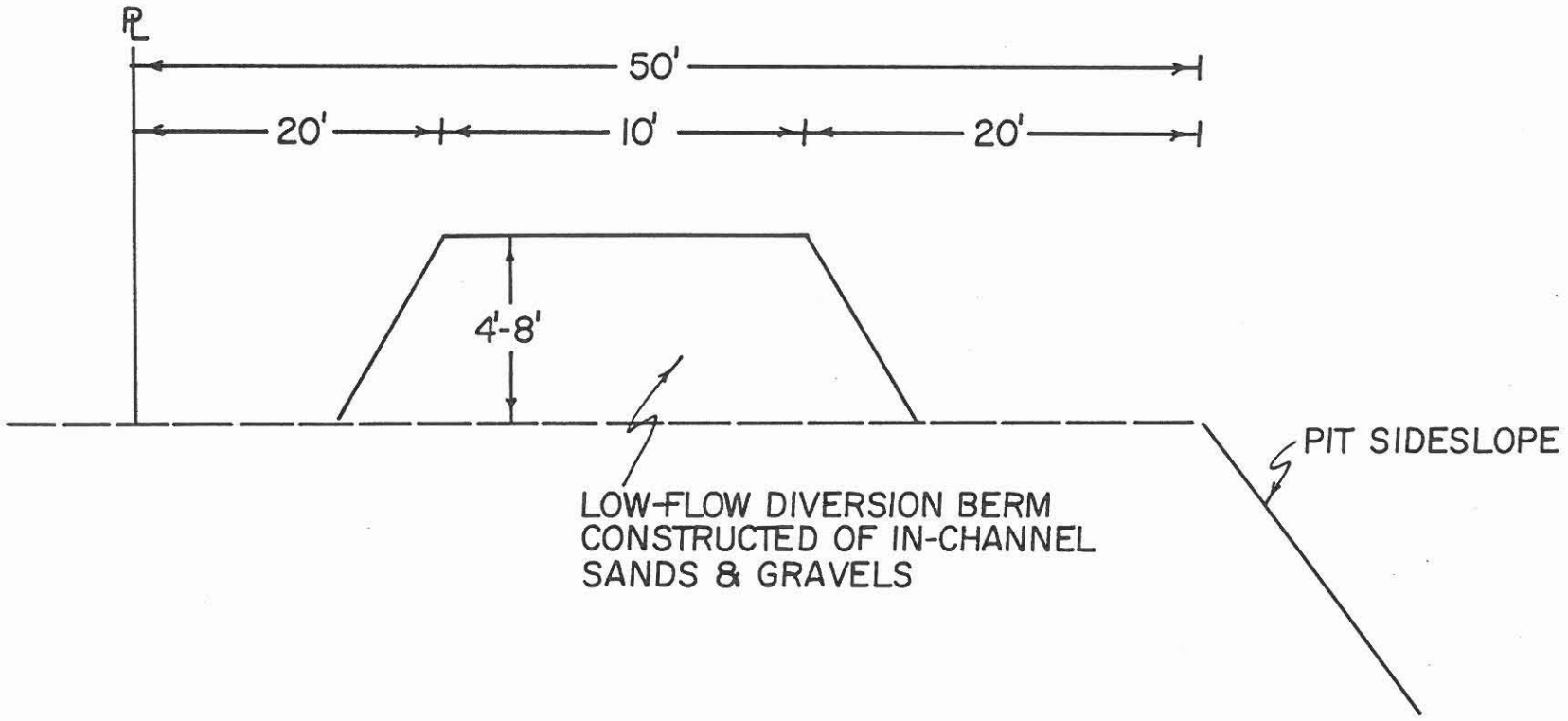
northeast corner of the intersection of Center St. and Lehi Rd. This plant and stockpiling area is not within the 100-year floodplain of the Salt River. The location of the pit, plant site, stockpiling area, and haul road are shown on Figure 4 of this report.

7. Excavation Phasing

   a. Excavation will begin on the downstream edge of the mining area along the west property line, then proceed easterly. This approach provides a buffer between the upstream edge of the pit and the east property line during the period of excavation and allows containment of the headcutting within property boundaries.

FIGURE 7

CROSS-SECTION B-B′ LOW DIVERSION BERM



VII. RESULTS OF SEDIMENT TRANSPORT MODELING

Figure 8 shows the existing conditions channel flowline and the worst case and post-flood headcutting profiles through the proposed instream mining area. The depth of headcutting on the upstream boundary of the pit is about 14 feet below channel flowline. At a distance of 600 feet upstream of the pit, the depth headcutting is 4 feet and the total length of the headcutting profile from pit to boundary is about 1,200 feet. The slope of the headcutting profile is about 1.3 percent. The length and depth of the headcutting profile are believed to be a function of the pit drown out time and reduction in the rate of headcut migration due to the accumulation of large cobbles on the stream bed surface. The pit volume is approximately 1.1 million cubic yards (or about 680 ac/ft.). The duration of time needed to drown out the pit at a flow discharge of 10,000 cfs is about 0.8 hours. The relatively short duration of fill time reduces the headcutting depth and length. The accumulation of cobbles on the channel bed does not armor the surface, but does act to retard the rate of degradation and headcutting. The sediment transport model input/output for the headcutting analysis is provided in Appendix E of this report.

At the downstream edge of pit, the change in channel bed elevation is 0.5 feet lower than that which would occur under existing conditions. The scour depth at the downstream edge of pit is 3.5 feet for with-pit conditions and is 3.0 feet for existing conditions.

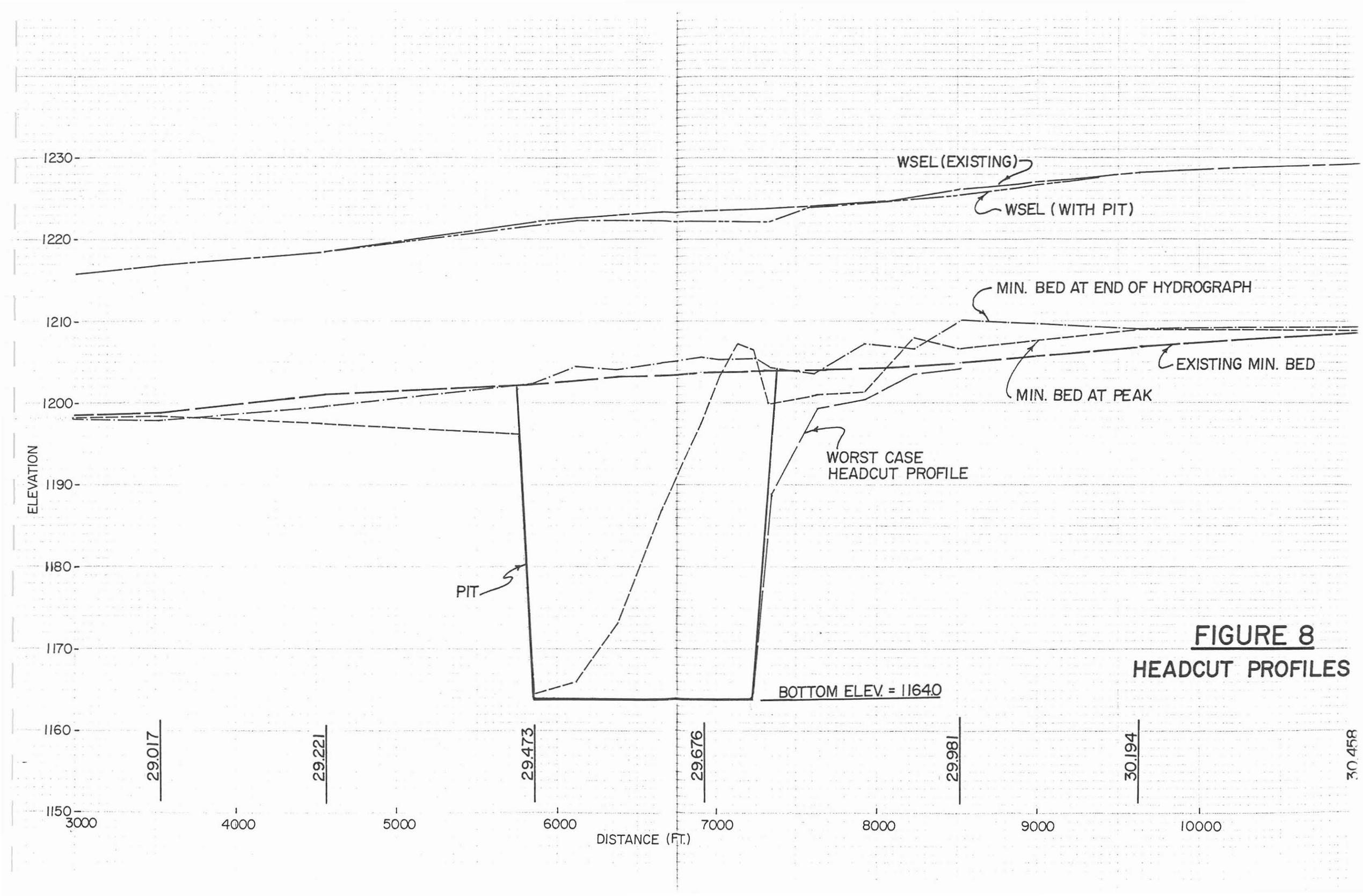


FIGURE 8

HEADCUT PROFILES

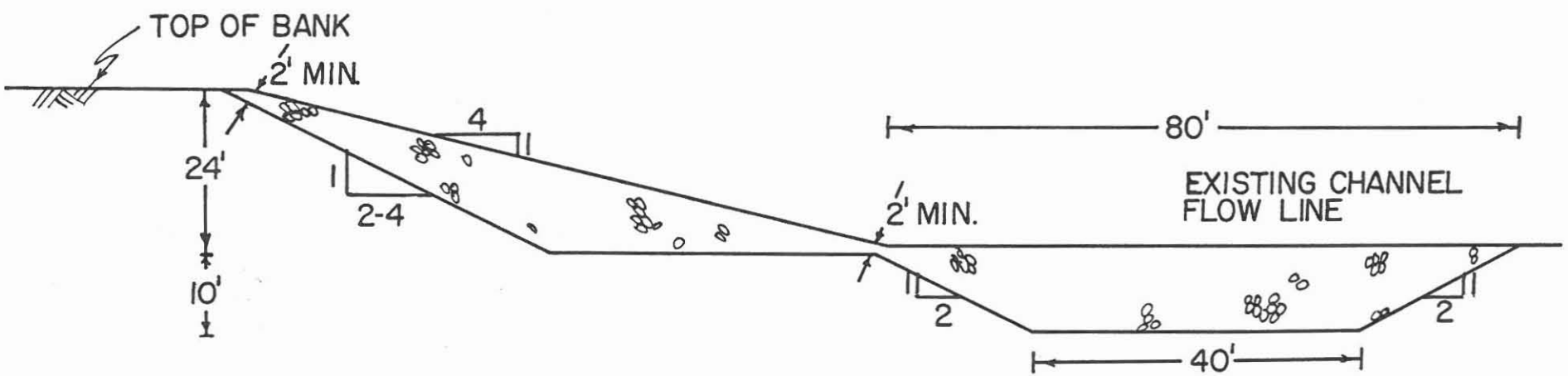
VIII. BANK PROTECTION DESIGN

The portion of the south bank of the Salt River which runs through the property will be stabilized to prevent an increase in the rate of bank erosion due to the mining activity. The bank protection will consist of rounded stone rock riprap placed on a 4 horizontal to 1 vertical sideslope. The median diameter of the riprap will be 1.0 feet. A typical cross section of the proposed bank protection is shown on Figure 9 of this report. Riprap safety factor computations for the determination of median diameter are provided in Appendix F of this report. These computations assume a 48° angle of impingement upon the bank protection sideslope and is based upon the thalweg velocity (point velocity). The proposed bank protection cross section was arrived at during a meeting with the MCFCD on November 23, 1988. The concept utilized the riprap safety factor approach to develop the median diameter and blanket thickness. The toe depth of the riprap blanket was determined based upon an assumed long-term degradation depth of 29 feet as determined by Simons, Li & Associates in their study for ADOT and a toe depth of 10 feet. The volume of material needed to construct the design cross section was then doubled and retrofitted to the cross section shown on Figure 9. Computations for determination of the riprap gradation and stone sizes are provided in Appendix F of this report.

Total scour depth was computed as the sum of short-term general scour (sediment transport model) and anti-dune scour, multiplied by a safety factor of 1.3. Short-term general scour was determined to be 4.22 feet from sediment transport modeling and anti-dune scour was computed to be 1.8 feet. The sum of these components multiplied by 1.3 safety factor is

FIGURE 9

CROSS-SECTION A-A' - ROCK RIP-RAP BANK PROTECTION



SCALE = 1" = 20'

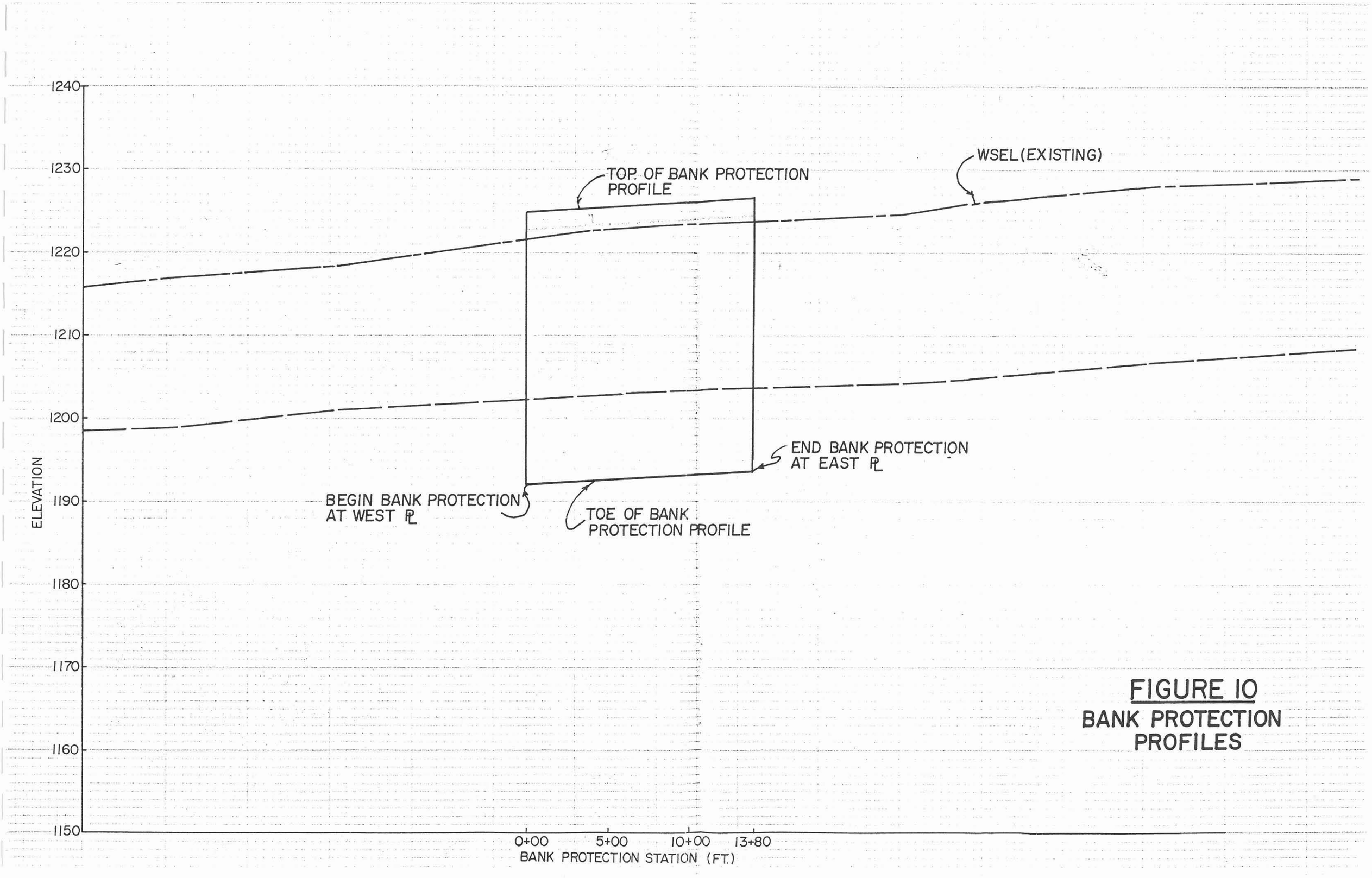
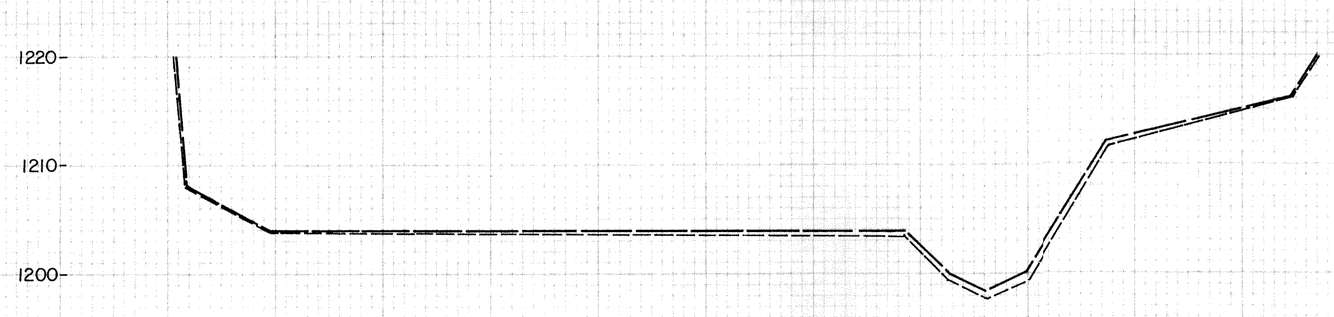


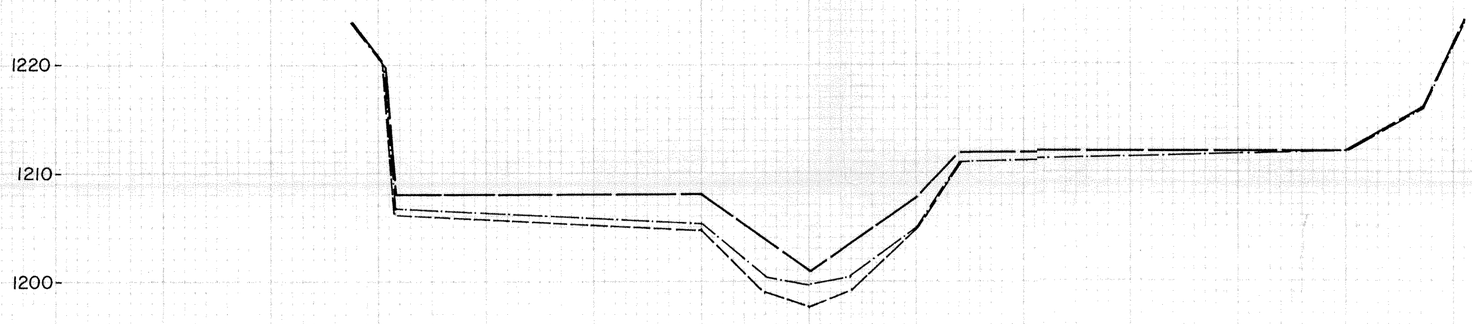
FIGURE 10
BANK PROTECTION PROFILES

SECTION 28.831

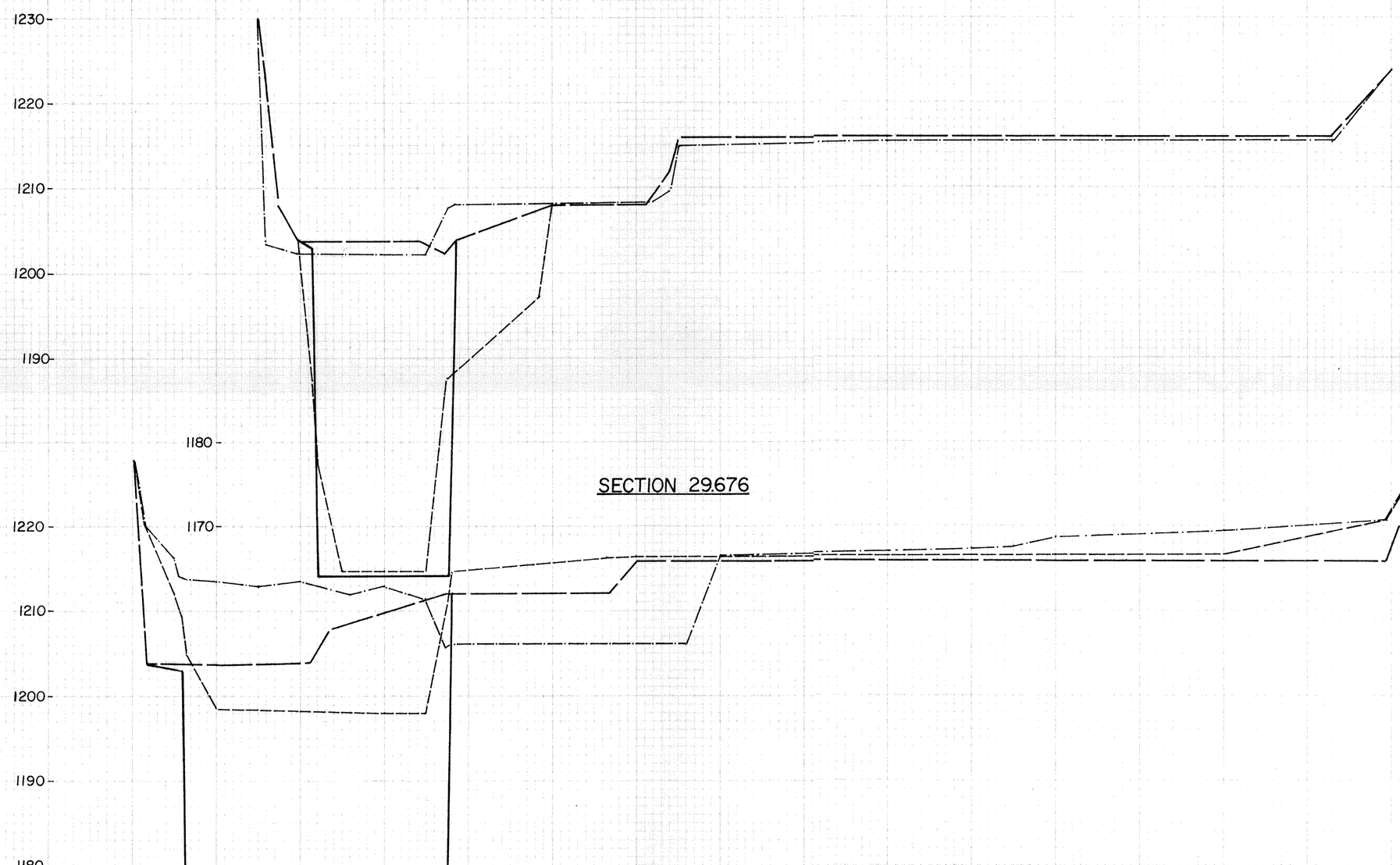


SECTION 29.017

SECTION 29.221

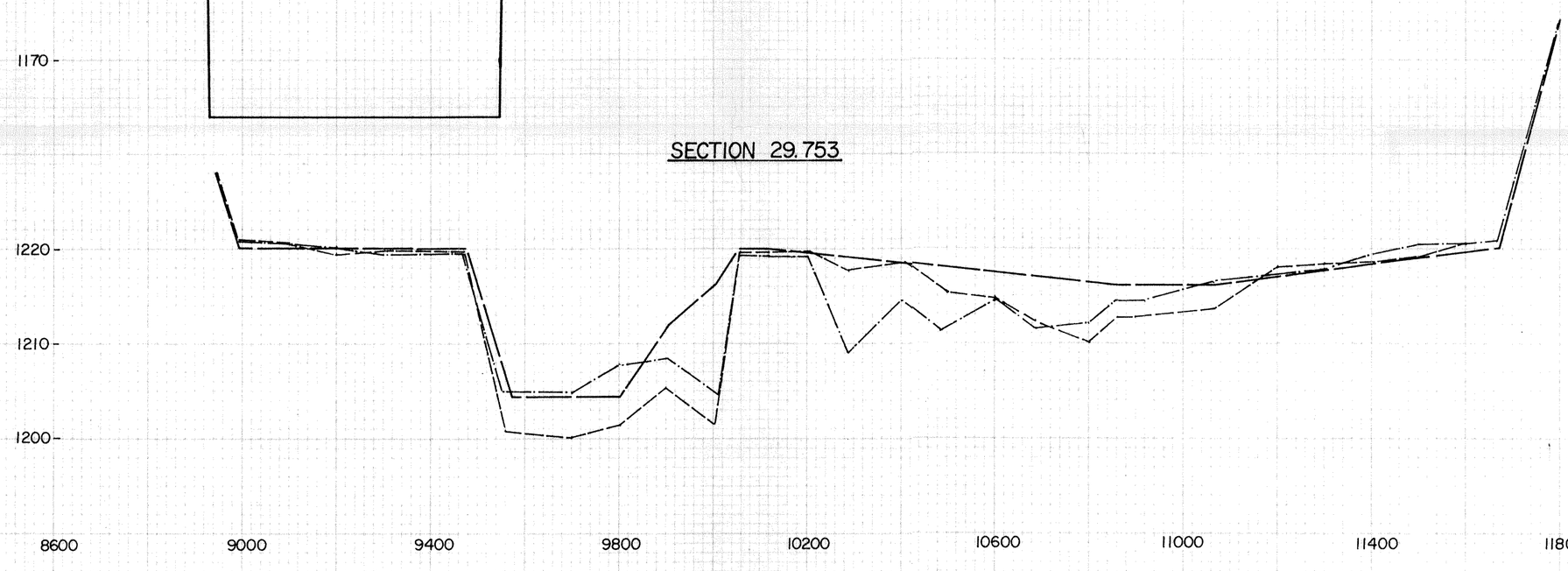


SECTION 29.473



SECTION 29.676

SECTION 29.753

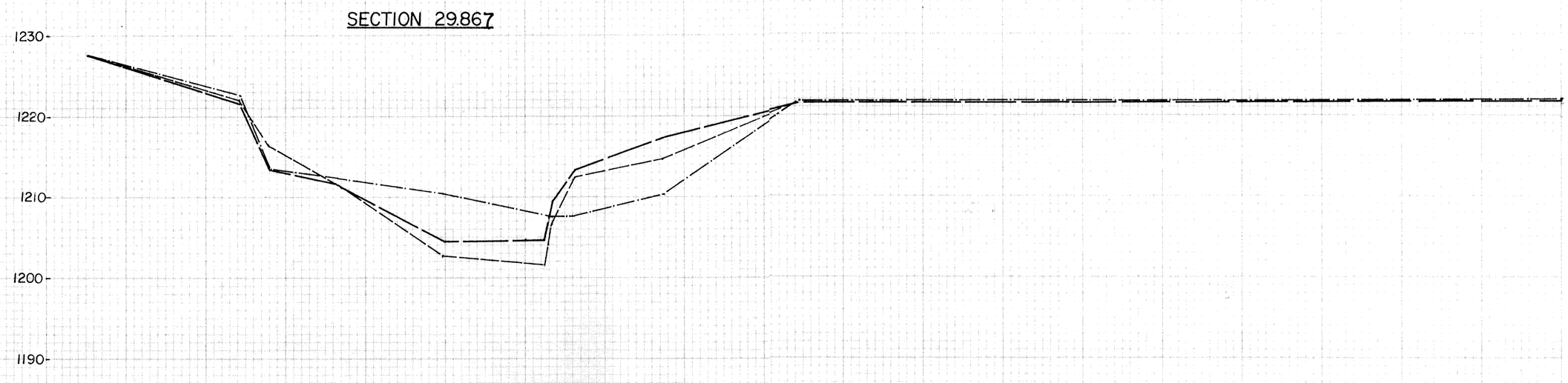


LEGEND

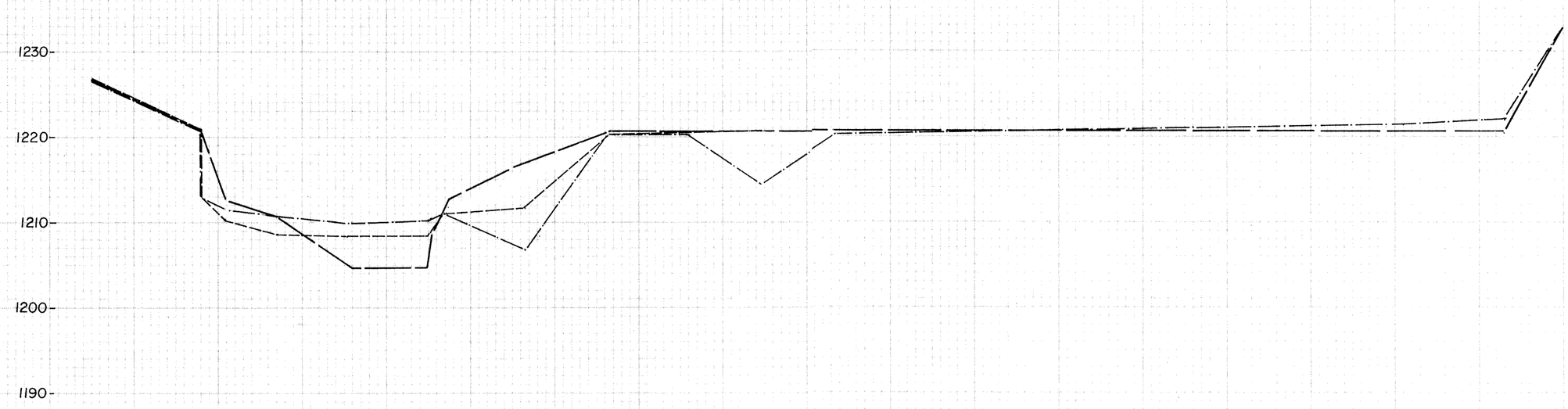
- EXISTING CONDITIONS CHANNEL CROSS-SECTION
- CROSS-SECTION AT HYDROGRAPH PEAK
- CROSS-SECTION AT END OF HYDROGRAPH
- INITIAL PIT GEOMETRY

FIGURE 11
RIVER CROSS SECTION PLOTS
SHEET 1 OF 2

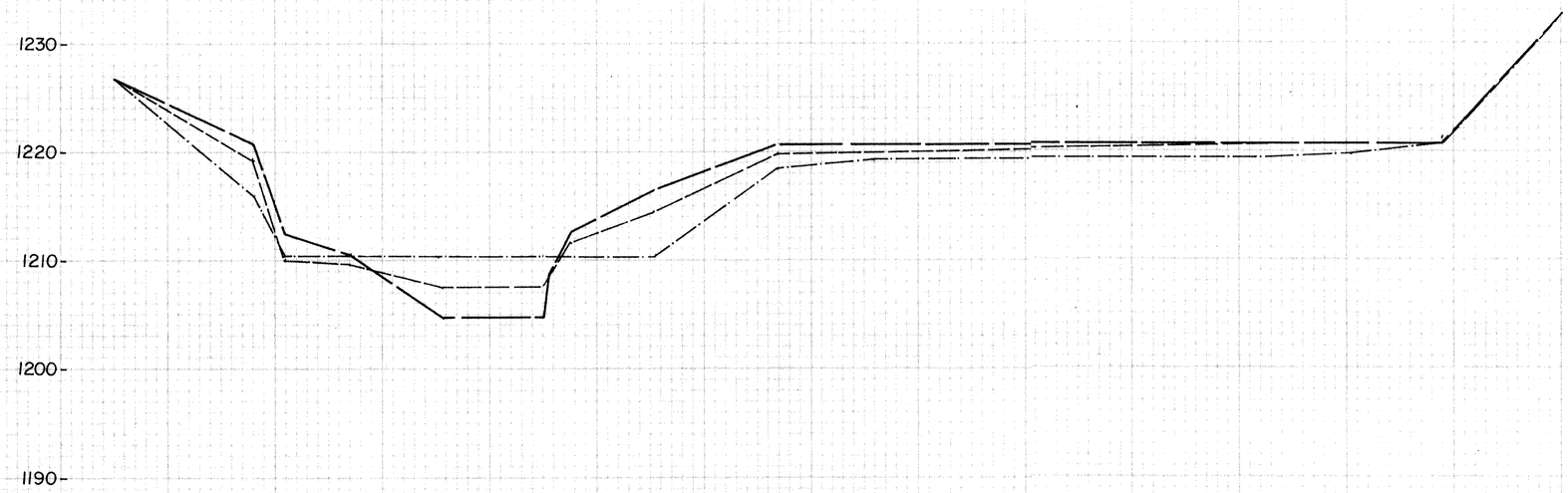
SECTION 29.867



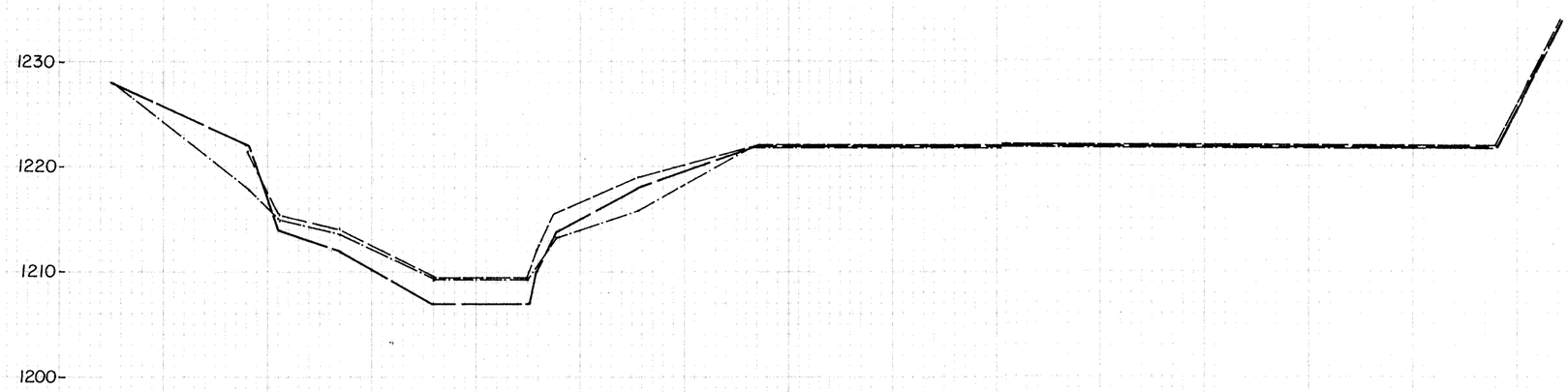
SECTION 29.923



SECTION 29.981



SECTION 30.194



SECTION 30.458

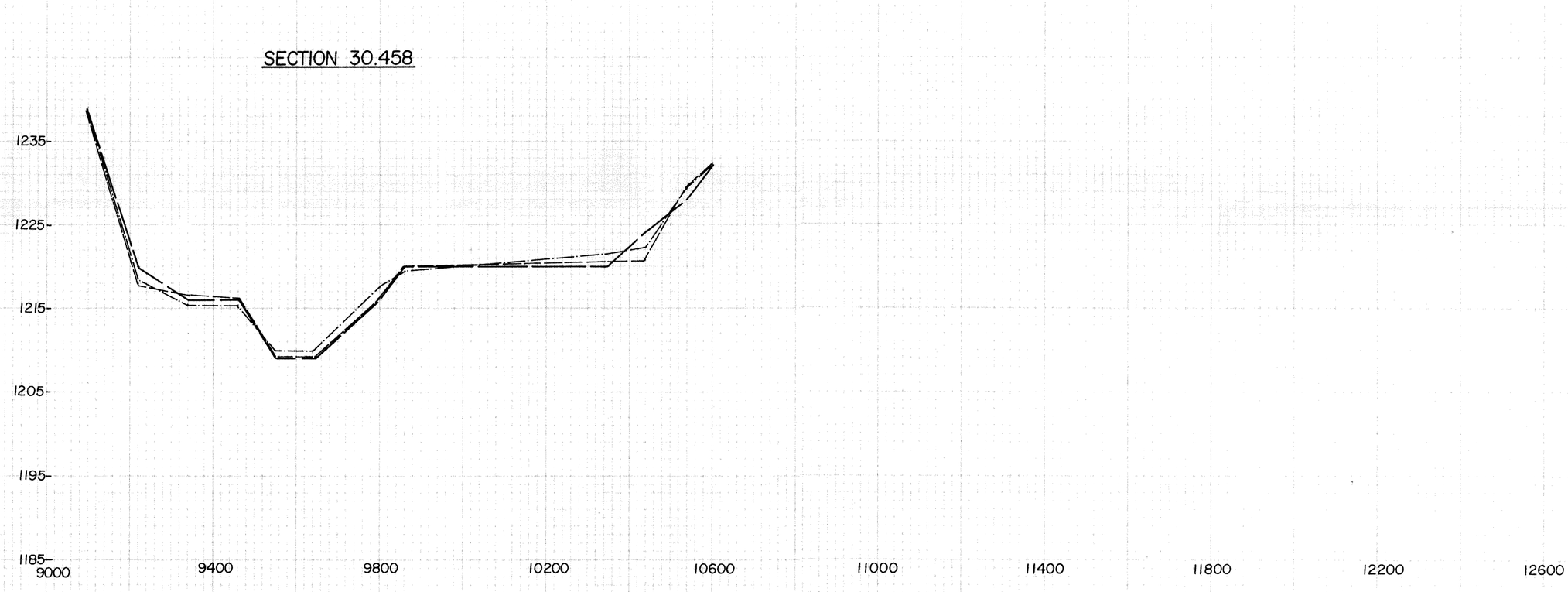


FIGURE 11

RIVER CROSS-SECTION PLOTS
SHEET 2 OF 2

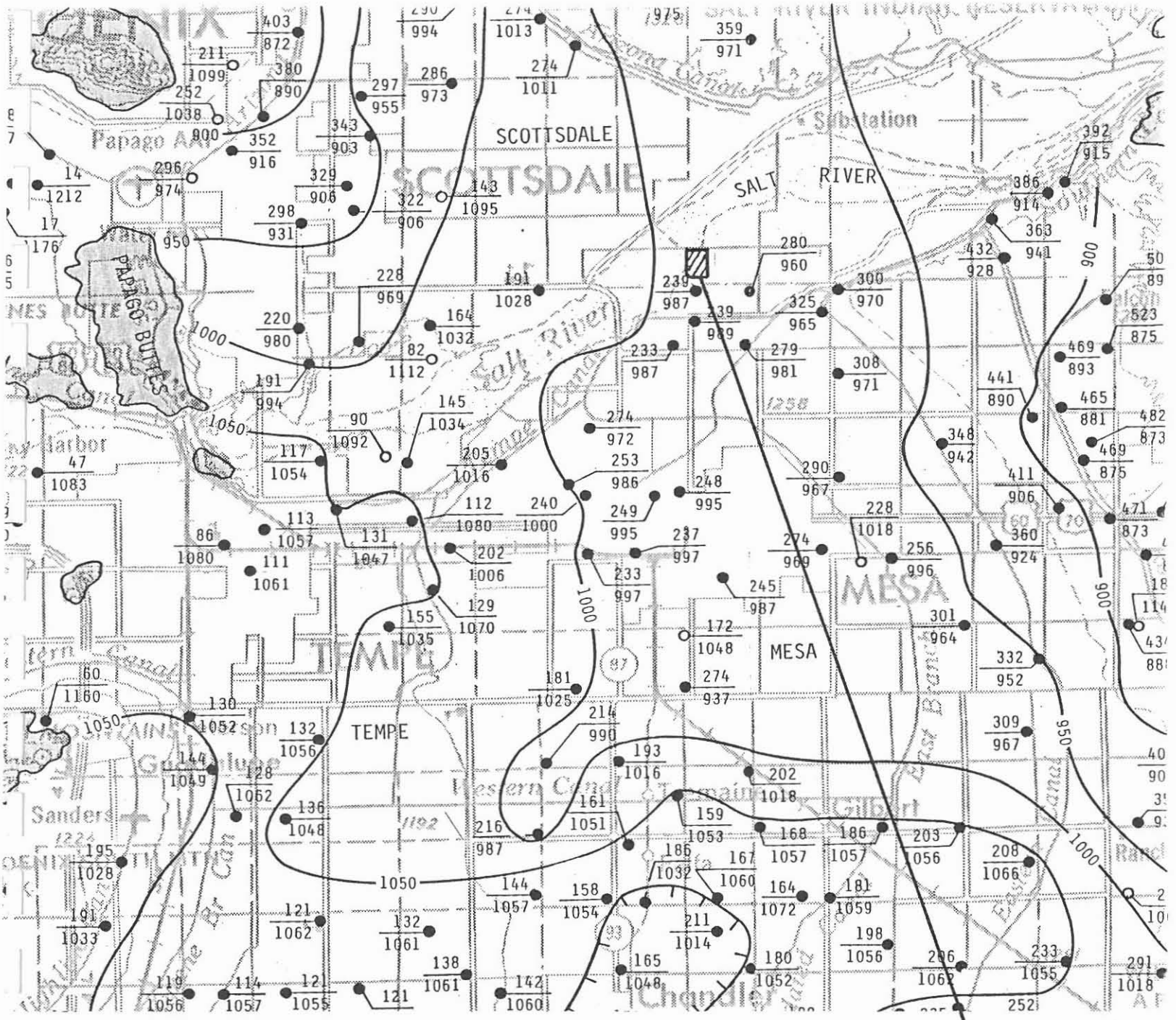
7.8 feet. The bank protection toe depth is proposed to be 10.0 feet. A summary sheet for the total scour computations is provided in Appendix F.

Figure 10 shows the proposed profiles for top and toe of bank protection. The stationing shown on Figure 10 uses the west property line as station 0 + 00. The top of bank protection profile is based upon the 100-year water surface profile for existing conditions. The bank protection will not be constructed as a levee cross section at any location and therefore is not subject to FEMA levee policy. Figure 11 shows cross-section plots for existing conditions, during the flood peak, and at the end of flood as determined by the Fluvial 12 sediment transport model.

The placement of the bank protection will begin prior to in-channel excavation. Allied Concrete Company has available a large volume of oversize stone to be begin placement of the bank protection immediately. This material will be used to construct as much of the bank protection as possible prior to the commencement of any in-channel excavation.

IX. LOCAL GROUNDWATER TABLE CONDITIONS

The local groundwater table beneath the Allied Concrete Company mining site was derived from a report entitled, "Maps Showing Groundwater Conditions in the West Salt River, East Salt River, Lake Pleasant, Carefree and Fountain Hills Sub-basins of the Phoenix Active Management Area, Maricopa, Pinal and Yavapi Counties, Arizona, 1983" by R. W. Reeder and W. H. Remmick, Department of Water Resources Hydrologic Map Series Report Number 12. A copy of a portion of these maps for the area in the vicinity of the Allied Concrete Company pit is shown on Figure 12 of this report. Examination of Figure 12 indicates the depth to groundwater table at the pit site is about 210 feet below channel flowline and the water table elevation is 987.00. Existing channel flow line elevation at the pit site is 1204.00



– UPPER NUMBER IS GROUNDWATER TABLE DEPTH
– LOWER NUMBER IS GROUNDWATER TABLE ELEVATION

FIGURE 12

GROUNDWATER TABLE MAP