BRIDGE SCOUR EVALUATIONS

Work Order No. 80407
Contract No. CY 1995-11

Tuthill Road Bridge over the Gila River

(SN8584)

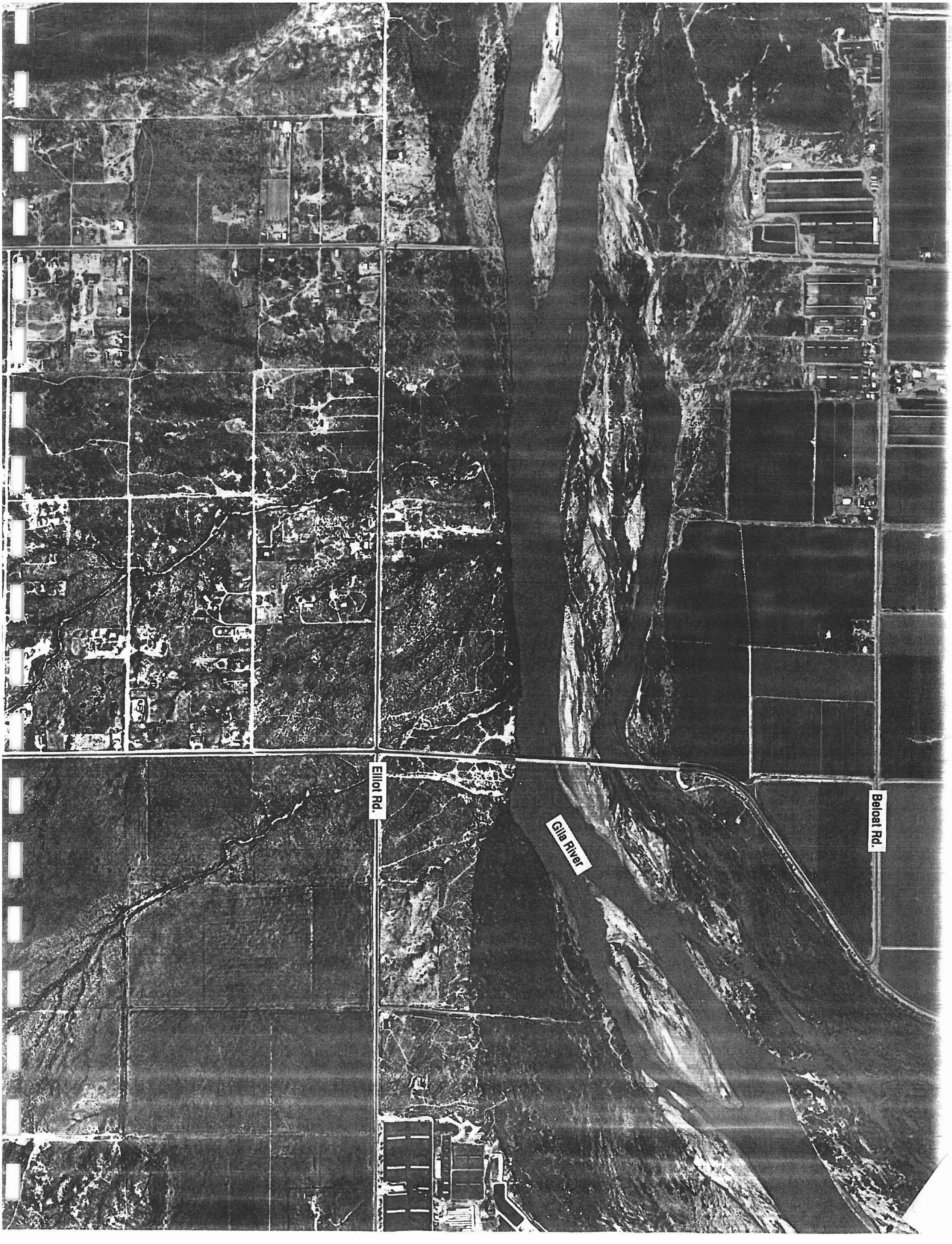
Preliminary Report

Submitted to:

Maricopa County
Department of Transportation

Submitted by:

PARSONS BRINCKERHOFF



Elliot Rd.
Gila River
Beloat Rd.

HYDRAULIC ANALYSIS FOR THE TUTHILL ROAD BRIDGE OVER THE GILA RIVER

MARICOPA COUNTY, ARIZONA

April 1, 1996

Submitted by:

Parsons Brinckerhoff Quade & Douglas

Tempe, Arizona

PB 100 YEARS

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1.0 INTRODUCTION

The existing Tuthill Road Bridge carries vehicular traffic over the Gila River in Maricopa County, Arizona. Construction plans for the Tuthill Road Bridge over the Gila River were prepared by Sverdrup & Parcel and Associates, Inc. and are dated June, 1980. The plans show the as-built date as July, 1981. The total length of the bridge is 1,770 feet. The plans are for a 15-span bridge with span lengths of 118 feet. The abutments and piers are supported on driven H-piles with a pile cap. Bank protection consists of a grouted riprap spur dike that extends upstream and downstream for 200 feet. The south abutment also has dumped riprap along the bottom of the abutment. The bridge carries two lanes of traffic and is approximately 39'-2" wide. The roadway is oriented in a north-south direction and the profile is a vertical curve, except for the bridge approaches. The north and south approach roadways have a 1.0 percent grade.

Evaluating scour potential of the existing bridge is the primary goal of the project. This report provides data on Gila River hydrology and hydraulics in the bridge vicinity. Using the hydraulic data, a complete scour analysis is performed for the Tuthill Road Bridge.

Total scour depths for the 100-year flood are estimated to be 25.6 feet at the north abutment, 48.6 feet at the south abutment, and 40.3 feet for all piers. Total scour for the 500-year flood is estimated to be 40.2 feet at the north abutment, 64.3 feet at the south abutment, and 53.5 feet for all piers. Scour countermeasures are currently underway at the south abutment due to scour at pier no. 2. The reason for scour at this location is that the South end of the bridge lies on the outside of a bend in the river. This does not mean that future lateral migration may someday extend to the North causing similar problems to other piles. However, the as-built plans were not completed at the time of this report. These scour calculations were performed for conditions observed during the field visit, which did not include any scour countermeasures.

Section 2.0 describes data collection followed by the site description in section 3.0. Section 4.0 summarizes the results of the hydraulic HEC-2 modeling. Section 5.0 explains scour processes and procedures for calculating bridge scour. Section 6.0 provides the results of the scour calculations. Section 7.0 provides an initial evaluation of the bridge and lists any deficiencies. No recommendations are provided in this report, they will be deferred to the final report.

2.0 DATA COLLECTION

Data was supplied by the Maricopa County Department of Transportation in the form final plans for the Tuthill Road Bridge over the Gila River, project number 68019 dated 1980. US Army Corps of Engineers HEC-2 output data files for the 100-year flood were supplied by the Maricopa County Flood Control District. Floodplain maps prepared by the Corps of Engineers for the Flood Control District were obtained along with USGS topographic maps for the bridge site.

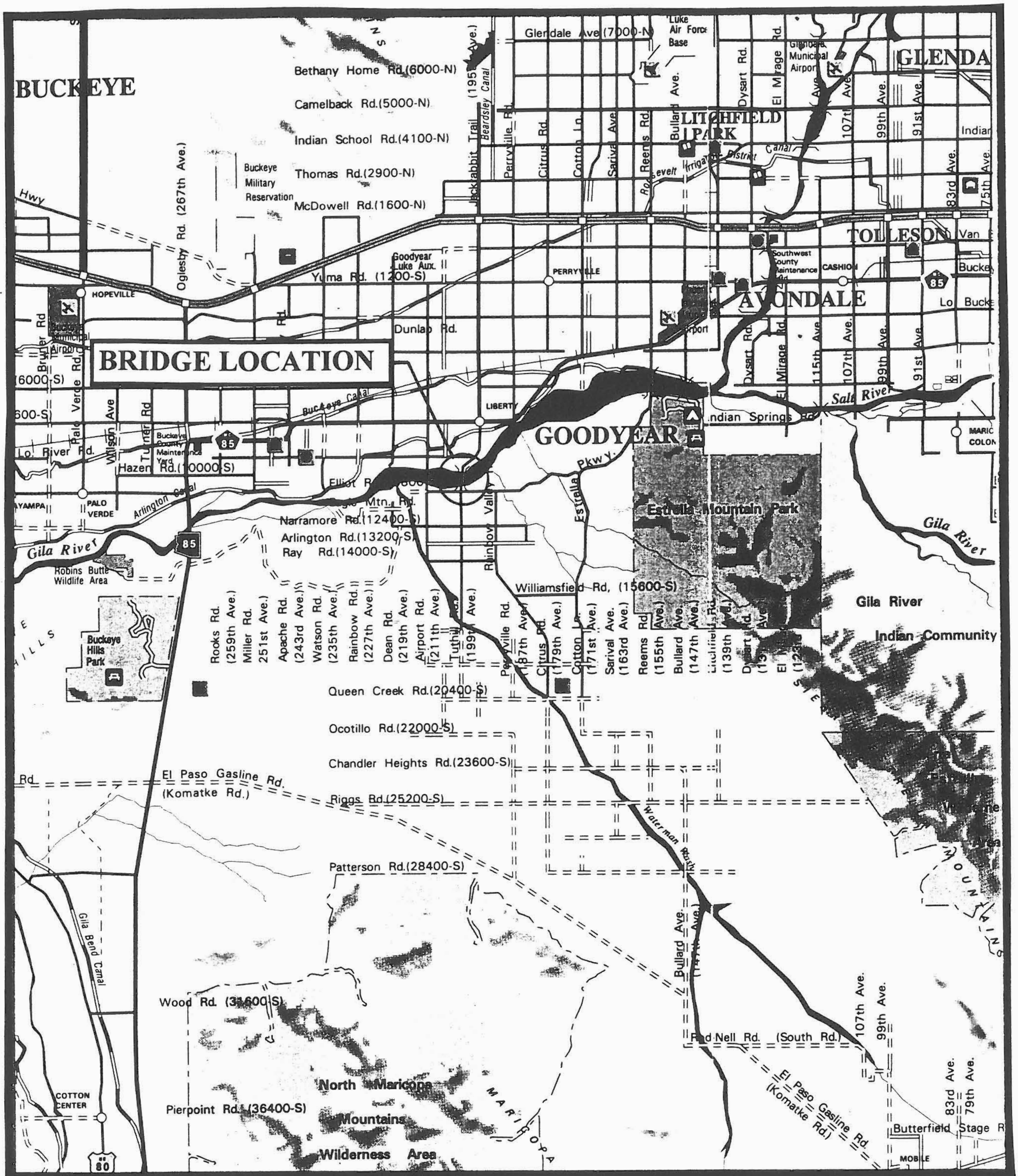
Parsons Brinckerhoff conducted a site visit on April 19, 1995. Extensive photographs of the site were taken and a visual survey of the bridge and surrounding area was made. A simple survey of the channel cross section was performed on May 31, 1995.

The scour screening procedure for the National Bridge Inventory System is completed for the Tuthill Road Bridge. The screening forms are included in the Appendix. The Tuthill Road Bridge is rated as a scour-critical bridge with a recommended Item 113 rating of 3C. Scour countermeasures are recommended as a result of the screening. Monitoring is to be utilized until scour countermeasures are in place. In order to verify the screening results and demonstrate the validity of the screening procedures a scour analysis was performed for the Tuthill Road Bridge. This information may be used in a structural stability analysis to verify if the bridge has an adequate foundation.

3.0 SITE DESCRIPTION

As shown in Figure 1, the site lies southwest of Phoenix in Maricopa County. The bridge lies west of Goodyear approximately eight miles downstream of the convergence of the New River with the Gila River. The terrain in the immediate area is rough with moderate vegetation. The south side of the floodplain is well-defined by the erosion of the river into the south overbank. Spur dikes are present at the bridge. As seen in the pictures, the south abutment has been exposed to significant erosion because of the river thalweg continually migrating south, cutting into the south abutment and south overbank. There is significant debris accumulation present on several piers near both the north and south abutments. The grouted riprap protection on the south abutment has been undermined and appears to be ineffective on the lower part of the abutment.

Figure 1


BUCKEYE
BRIDGE LOCATION
GOODYEAR
AVONDALE
TOLLESON
LITCHFIELD PARK
GLENDA
Glendale Ave.(7000-N)
Luke Air Force Base
Bethany Home Rd.(6000-N)
Camelback Rd.(5000-N)
Indian School Rd.(4100-N)
Thomas Rd.(2900-N)
McDowell Rd.(1600-N)
Buckeye Military Reservation
Oglesby Rd. (267th Ave.)
Yuma Rd. (1200-S)
Goodyear Luke Aux.
Dunlap Rd.
HOPEVILLE
PERRYVILLE
LIBERTY
CASHION
Southwest County Maintenance Yard
Buckeye Canal
Hazen Rd.(10000-S)
Lo River Rd.
Palo Verde Rd.
Wilson Ave.
Turner Rd.
PALO VERDE
Arlington Canal
Narramore Rd.(12400-S)
Arlington Rd.(13200-S)
Ray Rd.(14000-S)
Gila River
Robins Butte Wildlife Area
Buckeye Hills Park
Estrella Mountain Park
Estrella Pkwy.
Indian Springs Rd.
Salt River
Williamsfield Rd, (15600-S)
Gila River Indian Community
Rocks Rd. (259th Ave.)
Miller Rd. 251st Ave.)
Apache Rd. (243rd Ave.)
Watson Rd. (235th Ave.)
Rainbow Rd. (227th Ave.)
Dean Rd. (219th Ave.)
Airport Rd. (211th Ave.)
Perryville Rd.
Citrus Rd.
Cotton Ln.
Sarival Ave.
Reems Rd.
Bullard Ave.
Dysart Rd.
El Mirage Rd.
115th Ave.
107th Ave.
99th Ave.
91st Ave.
83rd Ave.
75th Ave.
Queen Creek Rd.(20400-S)
Ocotillo Rd.(22000-S)
Chandler Heights Rd.(23600-S)
El Paso Gasline Rd. (Komatke Rd.)
Riggs Rd.(25200-S)
Patterson Rd.(28400-S)
Waterman Wash
Gila Bend Canal
Wood Rd. (31600-S)
Pierpoint Rd. (36400-S)
North Maricopa Mountains Wilderness Area
Riggs Nell Rd. (South Rd.)
Butterfield Stage Rd.
COTTON CENTER
MOBILE
85
80

3.1 Geotechnical Evaluation

The geotechnical investigation was performed by Thomas-Hartig & Associates, Inc. in 1979. The soils underlying the site consist of sand and gravel deposits that extend from the surface to elevations of about 830 to 845 feet. Clayey sands underlain the surface stratum and extended to the full depths of the borings. These soils are very firm to hard. The estimated D_{50} particle size, based on plan review and field reconnaissance, is 5mm for the bed materials and 0.1mm for the bank and overbank materials.

Due to bank erosion, the approach waterway is wide in the vicinity of the bridge. There is dense vegetation growth at the banks and some parts of the river channel. In general, the river bottom is even, except close to the south abutment. At this location the river has channeled itself to a width of about 200 feet. The river load consist of silty sand and gravel with some large cobbles. The river banks are generally high and show extensive signs of erosion. During the field reconnaissance on April 19, 1995, it appeared that a considerable amount of scour has occurred at the base of Abutment Number 1 bank protection and Pier Number 2. The dumped riprap at the south end of the bridge had been extended and the base of the grouted riprap was exposed. Water was standing around Pier Number 2; however, it is estimated that the pier cap was near exposure. The bed elevation has been lowered about 7 to 14 feet between Pier Numbers 3 and 13. The river is migrating to the south due to a bend in the river upstream from the bridge. Some brush has accumulated on the upstream side of some of the piers. Vegetation in the river channel is limited to a sparse growth of trees. The overbank vegetation consists of a light growth of grass and brush. Local erosion of abutment fills and overbank soils was noted near Abutment Number 1. These soils consist of silty sands that are highly erodible. Erosion in this area was caused by runoff from the roadway.

3.2 Structural Evaluation

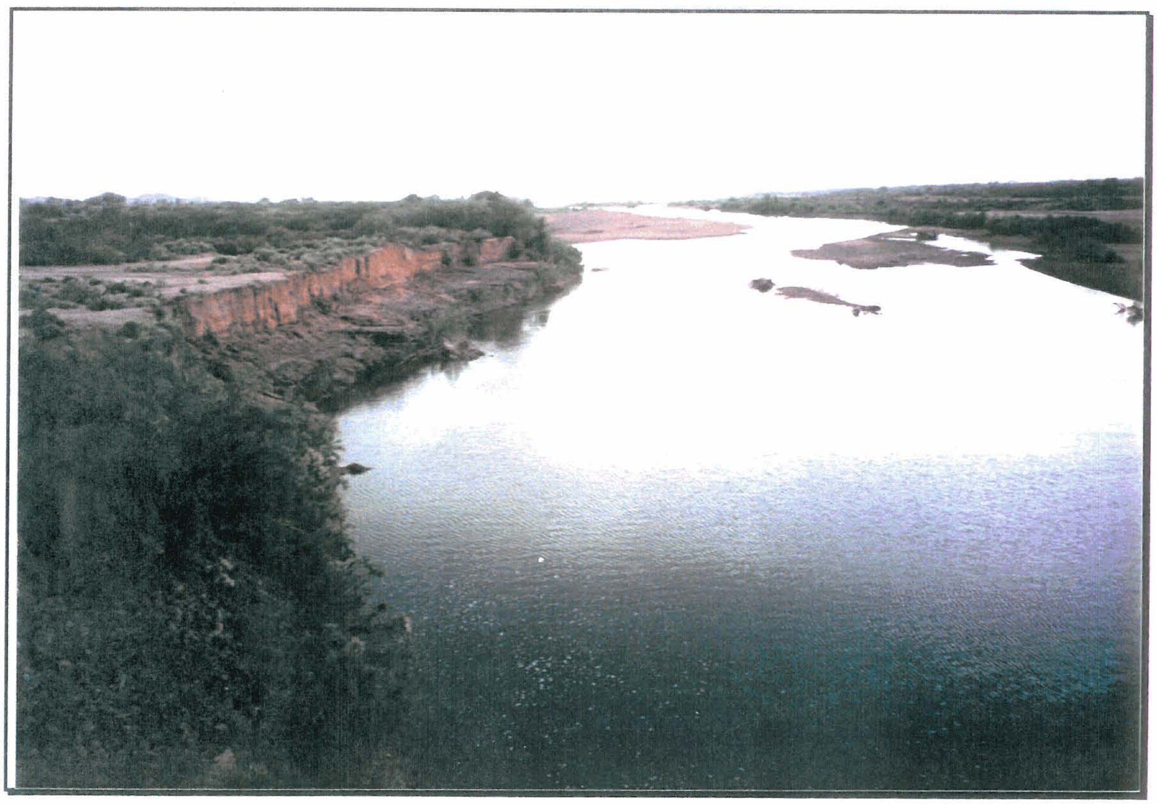
The Tuthill Road Bridge over the Gila River is located on Tuthill Road between stations 14+54 to 32+24. This structure is a 15-span precast, prestressed AASHTO girder bridge. The total length of the bridge is 1,770 feet and the width is 39'-2". The piers and abutments are supported on steel H-piles. The abutments are protected by spur dikes and grouted riprap. The slope of the riprap protection is 2:1 and there is a toe down pit of riprap at the base of the slope for a depth of about 10 feet. The length of the spur dikes are 200 feet and 250 feet at the south abutment and north abutment, respectively.

The steel H-piles (HP 12x53) at the abutments were driven to a minimum tip elevation of 788 feet or until a capacity of 90 tons was achieved. Six vertical piles and 14 battered piles were driven at the abutments and 16 vertical piles and 12 battered piles were driven at the pier locations. The top of the pile or bottom of the pile cap elevation for the abutments is 844.5 feet and varied from 840.13 to 843.38 feet at the pier locations. Based on the plans, the proposed bed elevation is approximately 860 feet. At the time of the survey the channel bed elevation was approximately 850' at the south abutment and 860' to 865' elsewhere. Bank protection is present at the abutments and consists of grouted riprap with dumped riprap at the base of the grouted riprap. The grouted riprap extends to about elevation 860 feet.

There are indications of erosion and undermining of the south abutment riprap protection. There is soil erosion and evidence of scouring of the south bank upstream of the bridge. There is indication of erosion at the toe down pit at the south abutment. Due to local drainage there is soil erosion behind the south abutment downstream of the bridge.

On the upstream side of the piers, organic debris have collected to a width of about 12 feet. There is an indication of minor local scour around the piers. There is some vegetation growth such as bushes and trees at the north abutment and adjacent piers in the river bed. There is no indication of exposed pilecap at this structure. The piers seem to be in good condition.

Looking upstream; South end of bridge.



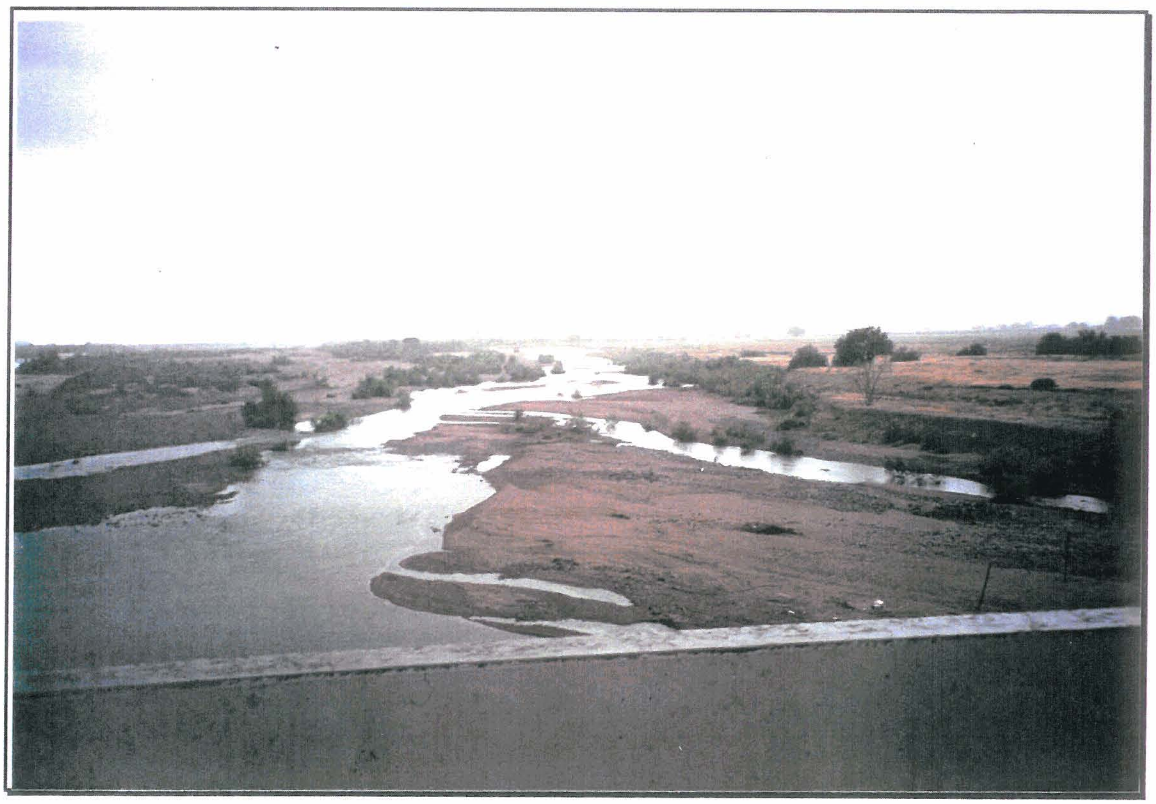
Looking downstream; South end of bridge.

Looking upstream; towards middle from South end of bridge.

Looking downstream near middle of bridge.

TUTHILL ROAD

Looking upstream; North end of bridge.



Looking downstream; North end of bridge.

TUTHILL ROAD

Grouted riprap on South abutment.

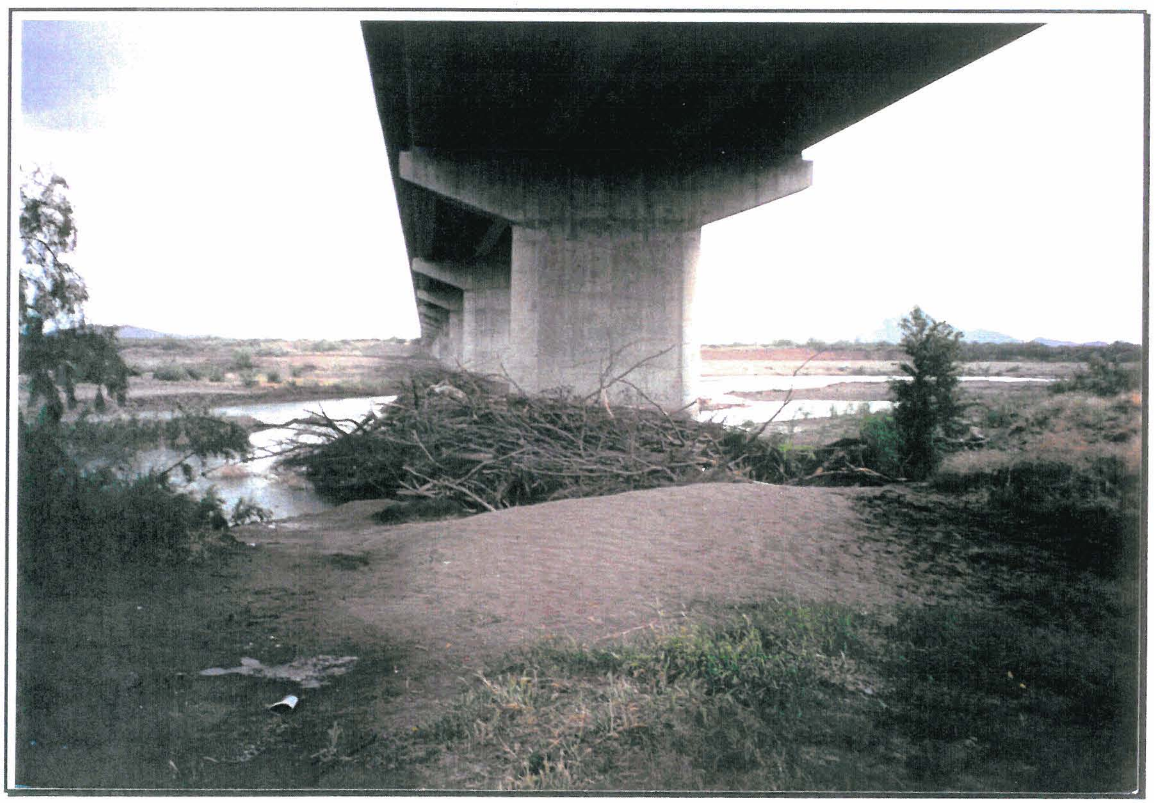
Top edge of grouted riprap on South abutment.

Erosion behind South abutment; upstream side.

Pier on South end of bridge; notice elevations and water marks.

TUTHILL ROAD

Debris on South end of bridge; looking North.



Debris on piers; North end of bridge.

4.0 HYDRAULIC ANALYSIS

The Gila River is subject to heavy flood flows during the spring, fall, and winter seasons. As shown in Table 1, the 100-year design flood flow for the existing conditions is 245,000 cfs and the 500-year flood flow is 350,000 cfs. These discharges were obtained from the FEMA Flood Insurance Study for Maricopa County dated September 1991, and supplied to PB through the Flood Control District of Maricopa County. Design flows for post Roosevelt Dam modifications and operations were not supplied at this time.

As displayed in Table 1, the HEC-2 output for the existing conditions calculates the maximum velocity at the bridge to be 17.9 fps for the 100-year flood event. Water surface elevation at the bridge is 873.6 feet for the 100-year flood conditions. The maximum velocity at the bridge is calculated as 20.5 fps for the 500-year flood. The corresponding depth of flows are 22 feet and 24.3 feet respectively. The computed water surface elevation at the bridge is 875.9 feet for the 500-year flood. The minimum freeboard requirement of 3 feet for the 100-year flood event is met at the Tuthill Road Bridge.

Table 1

	100-Year Flood Existing Conditions	500-year Flood Existing Conditions
Discharge (cfs)	**245,000**	**350,000**
Velocity (fps)*	**17.9**	**20.5**
WSEL (feet)	**873.6**	**875.9**

*Maximum velocity at South Abutment.

5.0 SCOUR ANALYSIS

A scour analysis is performed for the proposed conditions for both the 100-year flood and 500-year flood scenarios. The potential for scour damage to the bridge piers and abutments is evaluated using the guidelines and procedures presented in Hydraulic Engineering Circular Number 18 (HEC-18). Total scour is comprised of four components: long-term trends, contraction scour, bend scour, and local abutment and pier scour.

5.1 Long-Term Trends

Long-term trends in channel aggradation, degradation, and lateral migration are predicted qualitatively based on available sources of information including mapping, field observations, history of flooding and erosion, previous inspection reports, geomorphology, soil characteristics, land uses, flow patterns, control works, and any other factors which may have an influence on the river. The observations for long-term degradation and aggradation for this bridge can be found in section 6.1.

5.2 Contraction Scour

Contraction scour is caused by the channel width decreasing at the bridge crossing. Contraction scour occurs when the area of flow is decreased, resulting in increases in both velocity and bed shear stress in the contracted area. There are two basic forms of contraction scour, live-bed and clear-water, both of which are based on the principle of conservation of sediment transport. Live-bed is the condition where bed material upstream of the crossing is being transported. For live-bed scour, material is removed until equilibrium is reached between sediment transported into and out of the contracted section. Clear-water is the condition where there is no transportation of upstream bed material.

Live bed conditions exist at the site because the critical velocity for beginning sediment motion is less than the average channel velocity. For this bridge critical velocities for the flood conditions are well below the average flow velocities calculated in the hydraulic analysis.

FHWA recommends the modified version of Laursen's 1960 equation for estimating live-bed contraction scour. Input parameters for the equation include average depth, discharge, bottom width, and D_{50} of the bed material. It should be noted that Laursen's equation will overestimate scour if the contraction is the result of bridge piers and abutments. Using the median grain size, k_1 conservatively assumes transported sediment is mostly suspended bed material discharge. The equation is

$$\frac{Y_2}{Y_1} = \left(\frac{Q_2}{Q_1}\right)^{\frac{6}{7}} \left(\frac{W_1}{W_2}\right)^{k_1}$$

where:

Y_1 = average depth in the upstream main channel
Y_2 = average depth in the contracted section
W_1 = bottom width of the upstream main channel
W_2 = bottom width of the contracted section
Q_1 = flow in the upstream channel transporting sediment
Q_2 = flow in the contracted channel
k_1 = relates to the mode of bed material transport (contact bed material vs. suspended bed load.
$Y_S = Y_2 - Y_1$ = average scour depth.

5.3 Local Scour

Local scour is the result of water flowing around a pier, abutment, or other obstruction. These obstructions induce the formation of vortex systems caused by the acceleration of the flow around the obstruction. A horseshoe vortex is formed by water hitting the upstream surface of the obstruction and then traveling down the pier. In addition, piers have horizontal vortices, referred to as wake vortices, acting transverse to the pier downstream of the obstruction. Both vortices remove material from the base of the obstruction. However, the intensity of the vortices diminishes downstream from the obstruction.

The Colorado State University (CSU) equation is recommended for both live-bed and clear water pier scour. The basic input parameters are flow depth, pier shape, Froude number, pier width, and angle of attack. The bridge is skewed to the channel, however, the angle of attack of the water on the piers at the Tuthill Road Bridge over the Gila River is 0 degrees, i.e. the flow is normal to the bridge. Maps of the area show the Gila River meandering significantly both upstream and downstream of the bridge; however, at the piers the flow is normal to the bridge. Since the angle of attack is 0 degrees and a single column is used, the pier width is the width of a single column plus any debris accumulation. The pier width used for scour calculations is 8.0 feet (actual pier width = 4 ft.). Debris accumulation was estimated at twice the pier width for all piers.

The CSU equation estimates equilibrium scour depths. Depending on the bed configuration, adding a recommended correction factor to the equilibrium scour yields the estimated maximum scour. The CSU equation is

$$\frac{Y_s}{Y_1} = 2.0 K_1 K_2 K_3 \left(\frac{a}{Y_1}\right)^{0.65} Fr_1^{0.43}$$

where:

Y_s = scour depth
Y_1 = flow depth just upstream of the pier
K_1 = correction for pier nose shape
K_2 = correction for angle of attack
K_3 = correction for bed configuration
a = pier width
Fr_1 = Froude number; $Fr_1 = V_1/(gY_1)^{1/2}$
V_1 = Maximum Ave. Velocity of flow directly upstream of the pier (worst case).

Froehlich's live-bed equation, shown below, is used for estimating live-bed and clear-water scour at abutments. The equation is based entirely on laboratory data and provides very conservative estimates of scour. The basic input parameters are Froude number, shape, and projection of abutment, skew, and depth of flow. The use of engineering judgment is recommended in using these estimates of abutment scour depth, because cost will be the deciding factor between greater foundation depth or protection of the abutment area.

$$\frac{Y_s}{Y_a} = 2.27 K_1 K_2 \left(\frac{a'}{Y_a}\right)^{0.43} Fr^{0.61} + 1$$

Where:

K_1 = coefficient for abutment shape

K_2 = coefficient for angle of embankment to flow

$a' = A_e/Y_a$ = length of abutment projected normal to flow

A_e = flow area of the approach cross section obstructed by the embankment

$Fr_e = V_e/(gY_a)$ = Froude number of approach flow upstream of the abutment

$V_e = Q_e/A_e$ = local velocity at abutment

Q_e = flow obstructed by the abutment and approach embankment

Y_a = average depth of flow on the floodplain

Y_s = scour depth.

The Gila River turns significantly at the Tuthill Road Bridge. This bend in the channel allows for the possibility of bend scour to occur at and downstream of the bridge (or outside edge of the bend). The bend will induce secondary currents which will scour from the outside of a bend and cause material to be deposited along the inside of the bend. Based on the assumption of constant stream power through the channel bend, Zeller developed the following relationship for estimating the maximum scour component resulting from channel curvature in sand bed channels:

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

Where:

ΔZ_{bs} = bend scour component of total scour depth (feet)

V = mean velocity of upstream flow (fps)

Y = Maximum depth of upstream flow (feet)

Y_h = hydraulic depth of upstream flow (feet)

S_e = upstream energy slope (bed slope for uniform conditions, feet/feet)

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

5.4 Total Scour

Total scour at any location is estimated as the sum of any long term trends, contraction scour, bend scour, and local scour. The total scour is then plotted on a cross section view of the bridge. For this bridge the degradation of the channel was taken into account when the existing ground line was plotted. The estimated scour depth due to contraction scour and bend scour is then plotted a computed distance below the revised channel bottom. Local scour is finally plotted for each pier and abutment in the shape of a scour hole. The top width of a scour hole is estimated to be 2.8 times the predicted scour depth. Debris blockage will add to the effective width of the piers and thus increase the scour depth. This increase in the scour depth has a direct result on the width of the scour hole as noted above. If the estimated limits of scour holes overlap, the resulting scour may be deeper than originally estimated.

6.0 RESULTS

The scour calculations were performed based on conditions present at the time of the field inspection and the survey. The scour countermeasures scheduled for the Tuthill Road Bridge were not incorporated. These countermeasures will be taken into account for the final report.

6.1 Long-Term Trends

Based on survey data taken during the site visit on May 31, 1995 it appears degradation of approximately 3 feet has occurred at the south abutment and 1 foot elsewhere. There are two scour depths shown in figure 2 for total scour. The black lines show the scour depths applied to the channel at the time of the field survey and the gray lines show maximum scour depths across the whole channel because the thalweg may migrate to the north. Because lateral migration may occur across the floodplain, the maximum degradation, as shown at the south abutment, will be applied to all piers and abutments.

Lateral migration of the thalweg may occur, although the river tends to flow in a relatively straight line in the bridge vicinity. The wide, flat floodplain, combine with the silty-sandy soil to create a condition where extensive lateral migration may occur with each flood event. Because the thalweg could shift to different points in the floodway, a constant invert elevation of 848' is used at the south abutment and for scour calculations for the entire cross section.

6.2 Contraction Scour

Significant contraction scour occurs at the bridge site. As shown in Table 2, contraction scour is estimated at approximately 15 feet for the 100-year flood event and 24 feet for the 500-year flood event. This is due to the large amount of flow being contracted into the bridge section. Significant scour will occur at the upstream spur dikes and at the bridge. The upstream width is approximately 3,500 feet, which represents the distance across the floodplain upstream of the bridge, whereas the width at the bridge is approximately 1,660 feet. Flow through the bridge section is significantly higher than flow in the approach channel.

6.3 Local Scour

Bend scour was estimated at the Tuthill Road Bridge because the Gila River cuts across the floodplain from north to south and then turns west to go through the bridge opening. This turn in the river creates additional scour that can be calculated with the bend scour equations. As shown in table 2, bend scour was estimated at approximately 3.3 feet for the 100-year flood and 3.52 feet for the 500-year flood. The north abutment should not be susceptible to bend scour. From existing conditions the angle used in bend scour calculations is 30°

Local pier scour is predicted to occur at the bridge site for each of the flood events. The effective width used in the scour calculations was equal to twice the pier width to account for debris accumulation. The maximum pier scour is estimated to be approximately 21 feet for the 100-year flood and 23 feet for the 500-year flood scenario. The maximum estimated pier scour may occur at any of the piers. Calculations for pier scour are included in the Appendix.

The north and south abutment scour estimates for each of the floods are shown in Table 2. Please note that the abutment scour equation recommended by HEC-18 is inherently conservative and includes a large factor of safety. The grouted riprap should help protect the abutments and should reduce the predicted maximum scour depth. However, the grouted riprap on the south abutment has been undermined and its effectiveness has been greatly reduced. This condition should be corrected quickly before significant scour occurs.

HEC-18 recommends placing abutment footings at least 6 feet below the depth reached by long-term degradation and contraction scour. The abutment piles are well below the recommended depth. Abutment scour is not expected to be problematic at the Tuthill Road Bridge.

Table 2

100-Year Flood Existing Conditions	South Abutment	Pier	North Abutment
Degradation	3 feet*	1 feet*	1 feet*
Bend Scour	3.3 feet	3.3 feet	0 feet
Local Scour	27.3 feet	21 feet	9.6 feet
Contraction	15 feet	15 feet	15 feet
Total Scour	**48.6 feet**	**40.3 feet**	**25.6 feet**
Remaining Pile Depth	11.4 feet**	19.7 feet**	34.4 feet**
500-year Flood Existing Conditions	**South Abutment**	**Pier**	**North Abutment**
Degradation	4 feet*	1 feet*	1 feet*
Bend Scour	3.52 feet	3.52 feet	0 feet
Local Scour	30.8 feet	23 feet	13.2 feet
Contraction	26 feet	26 feet	26 feet
Total Scour	**64.3 feet**	**53.5 feet**	**40.2 feet**
Remaining Pile Depth	-4.32 feet**	6.5 feet**	19.8 feet**

*The natural ground elevation shown on the scour plot is the ground line surveyed from the field inspection which already takes the degradation into account.
**This depth assumes a minimum pile tip elevation of 788' as shown in the bridge plans and a plan bed elevation of 848'.

6.4 Total Scour

Table 2 summarizes the total scour predicted at each pier and abutment for the 100-year and 500-year flood event, this includes an amount for degradation of the channel. It is possible for the maximum pier scour depth to occur at each pier, therefore only one representative pier is displayed in the table. Figure 2 shows the plotted scour holes associated with the 100-year flood. Degradation is not shown specifically on the scour plot because the ground line is plotted to the elevation of the degradation, therefore no addition depth was subtracted. Degradation is shown in table 2 because the channel elevation from the bridge plans was used to calculate remaining pile depths. Debris accumulation is not shown in the scour plot, however, accumulation of twice the pier width was used to calculate the scour depths. Scour computations are included in the appendix.

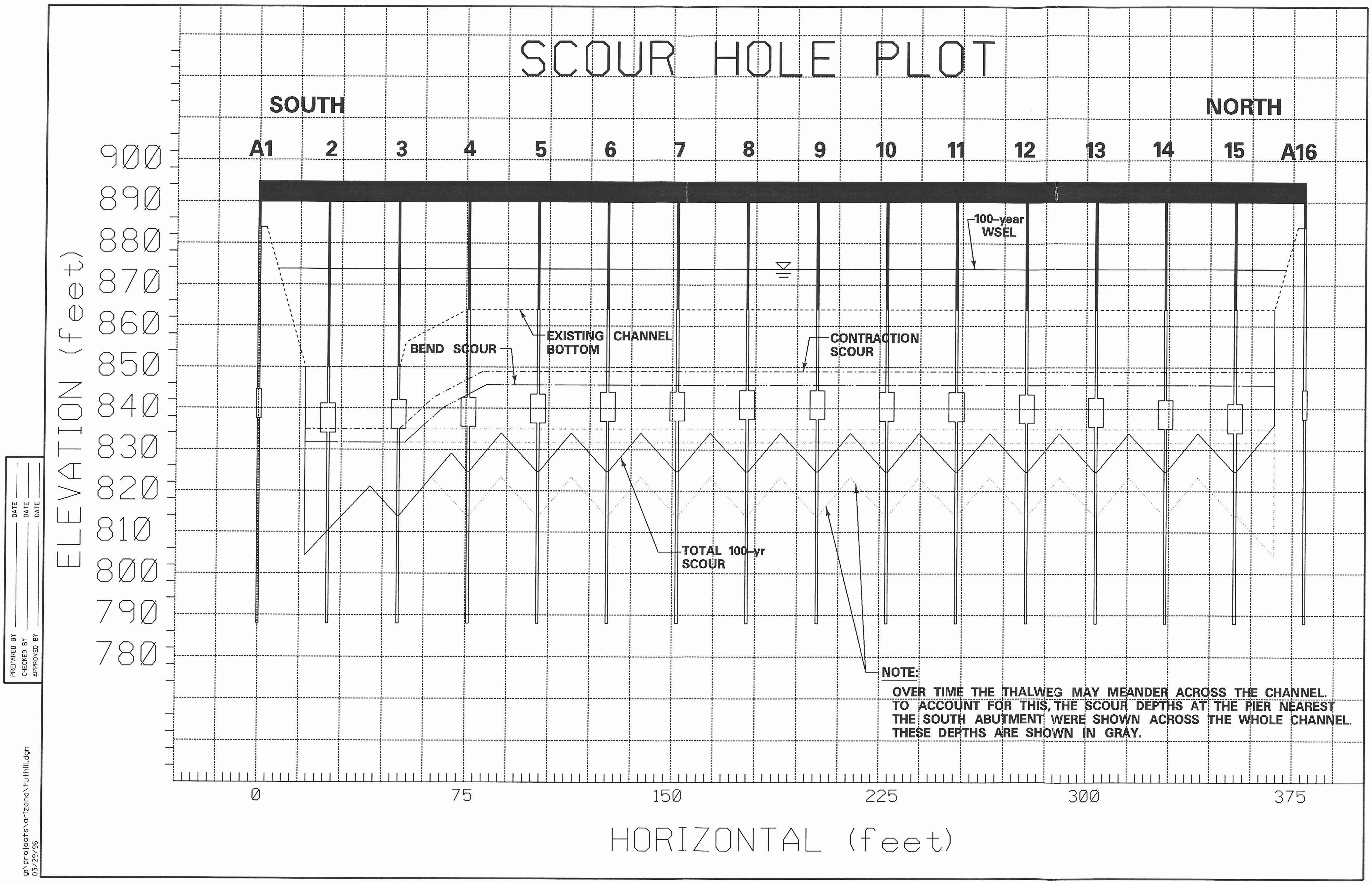
7.0 INITIAL EVALUATION

The Tuthill Road Bridge is scour critical. The calculated scour depths extend below the pile caps; however, there is still some remaining embedded pile depth. The riprap protection should prevent scour of the magnitude calculated even though significant scour depths are calculated at both abutments. Table 2 shows remaining pile depth for both the 100-year and 500-year floods. Even though the pile tips are not exposed, the shallow embedded pile depth may lead to settling of the bridge because of low friction on the piles. The scour calculations did not consider the scour countermeasures currently being installed because as-built plans were not available. For the final report the countermeasures will be considered and the scour calculations refined to estimated the impact of the improvements.

Significant debris accumulation was observed on the piers. This debris blockage should be removed from around the piers because it creates a larger obstruction to the flow and may cause deeper scour depths. There is damage to the grouted riprap on the south abutment. This damage should be corrected to protect the abutment from further scour damage. Riprap at the abutments should be inspected after each major flood event and replaced or repaired if necessary.

The south bank is cut vertically both upstream and downstream of the bridge. The north and south approaches run the risk of being washed out if long spur dikes are not installed to protect them.

The Tuthill Road Bridge is rated as a scour critical bridge with a recommended Item 113 rating of 3C. Scour countermeasures are recommended as a result of the screening. Monitoring is to be utilized until scour countermeasures are in place.


SCOUR HOLE PLOT
SOUTH
NORTH
A1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
A16
100-year WSEL
EXISTING CHANNEL BOTTOM
BEND SCOUR
CONTRACTION SCOUR
TOTAL 100-yr SCOUR
ELEVATION (feet)
900
890
880
870
860
850
840
830
820
810
800
790
780
HORIZONTAL (feet)
0
75
150
225
300
375
NOTE:
OVER TIME THE THALWEG MAY MEANDER ACROSS THE CHANNEL. TO ACCOUNT FOR THIS, THE SCOUR DEPTHS AT THE PIER NEAREST THE SOUTH ABUTMENT WERE SHOWN ACROSS THE WHOLE CHANNEL. THESE DEPTHS ARE SHOWN IN GRAY.
PREPARED BY DATE
CHECKED BY DATE
APPROVED BY DATE
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03/29/96

REFERENCES

1. *Design Manual for Engineering Analysis of Fluvial Systems*, Arizona Department of Water Resources, 1985.

2. *Hydrology and Floodplain Analysis.* Bedient, Philip B., and Wayne C. Huber. New York: Addison-Wesley Publishing Company, 1988.

3. *Drainage Design Manual*, Volumes I, II, III., Flood Control District

4. *HEC-2 Water Surface Profiles.* Davis, California: United States Army Corps of Engineers, September 1982.

5. *Stream Stability at Highway Structures*, Lagasse, P.F., D.F. Schall, F. Johnson, E.V. Richardson, J.R. Richardson, and F. Chang, U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 20, Publication No. FHWA-IP-90-014, February 1991.

6. *Stream Stability and Scour at Highway Bridges: Participant Workbook*, National Highway Institute, Federal Highway Administration, April 1993.

7. *Evaluating Scour at Bridges: Second Edition*, Richardson, E.V., L.J. Harrison, J.R. Richardson, and S.R. Davis, U.S. Department of Transportation, Federal Highway Administration, Hydraulic Engineering Circular No. 18, Publication No. FHWA-IP-90-017, Revised April 1993.

8. *Highways in the River Environment: Participant Notebook*, Richardson, E.V., D.B. Simons, and P.Y. Julien, NHI Course No. 13010, National Highway Institute, Federal Highway Administration, McLean, Virginia 1990.

TUTHILL ROAD BRIDGE OVER THE GILA RIVER

CONTRACTION SCOUR

CASE 1 - LIVE BED	SEE NOTE	100-YEAR	500-YEAR
Y1 - AVE. DEPTH IN UPSTREAM MAIN CHANNEL(FT)	1	17.3	21.47
W1 - WIDTH OF UPSTREAM MAIN CHANNEL(FT)		3200	3200
W2 - WIDTH OF CONTRACTED SECTION(FT)	2	1770	1770
N1 - AT MAIN CHANNEL		0.065	0.065
N2 - AT CONTRACTED SECTION		0.032	0.032
Q_1 - FLOW IN UPSTREAM MAIN CHANNEL (CFS)		179,539	207,900
Q_2 - FLOW IN CONTRACTED SECTION (CFS)		245,000	350,000
(Q_2/Q_1)^6/7		1.31	1.56
S1 - SLOPE OF ENERGY GRADE LINE IN US CHANNEL (FT/FT)	3	0.00049	0.00031
V*c - SHEAR VELOCITY(FPS) = [32.2(Y1)(S1)]^0.5		0.52	0.46
K1	4	0.59	0.59
(W1/W2)^K1		1.42	1.42
Y2/Y1 = Q_2/Q_1^(6/7)(W1/W2)^K1		1.85	2.22
Ys = Y2-Y1 = SCOUR (FT)	5,6	15	26

NOTES:

1. Y1 IS AVE. DEPTH IN MAIN CHANNEL.

2. W2 = (BOTTOM WIDTH)-(SUM OF EFFECTIVE PIER WIDTHS). 1767'-(14x8') = 1655'

3. ENERGY GRADE LINE (USED TO OBTAIN K1).TAKEN FROM HEC-2.

4. K1 VALUE ASSUMES MOSTLY SUSPENDED BED MATERIAL DISCHARGE.

5. EQ. ASSUMES SEDIMENT TRANSPORT IN CHANNEL UPSTRM = SEDIM. TRANSP. AT CONTRACTED SECTION.

6. ASSUMES LIVE BED CONTRACTION SCOUR BECAUSE Vc<Vmean. Vc=10.95Y1^(1/6)(D50)^(1/3)

TUTHILL ROAD BRIDGE OVER THE GILA RIVER

BEND SCOUR

BEND SCOUR	SEE NOTE	100-YEAR	500-YEAR
Y - MAX DEPTH OF UPSTREAM FLOW (FT)		17.82 (22.0)	21.47
Yh - HYDRAULIC DEPTH OF UPSTREAM FLOW (FT)		17.1	26.7
V - MEAN VELOCITY OF UPSTREAM FLOW (FPS)		4.47 (17.9)	4.0
Se - UPSTREAM ENERGY SLOPE (FT/FT)		0.000492	0.000311
[(0.0685)(Y)(V)^0.8] / [(Yh^0.4)(Se^0.3)]		13	14
ALPHA (a) - ANGLE FORMED BY CHANNEL CENTERLINE AND A TANGENT POINT ON OUTER BANK	1	30	30
SIN^2(a/2)		0.066987	0.066987
COS a		0.866025	0.866025
2.1{[(sin^2)(a/2)/cosa)]^0.2}-1		0.258669	0.258669
Zbs = [(0.0685)(Y)(V)^0.8] / [(Yh^0.4)(Se^0.3)] x 2.1{[(sin^2)(a/2)/cosa)]^0.2}-1		3.30	3.52
Zbs = BEND SCOUR (FT)		3.30	3.52

Where these #'s come from?

NOTES:

1. ALPHA (a) IS THE ANGLE FORMED BY THE PROJECTION OF THE CHANNEL CENTERLINE FROM THE POINT OF CURVATURE TO A POINT WHICH MEETS A LINE TANGENT TO THE OUTER BANK OF THE CHANNEL (DEGREES).

$$\frac{(.0685)(22)(17.9)^{0.8}}{(17.1)^{0.4}(.00049)^{0.3}} \times 0.26 = 39.388$$

TUTHILL ROAD BRIDGE OVER THE GILA RIVER

PIER SCOUR - EXISTING CONDITIONS

		100-YEAR			500-YEAR		
CONTINUOUS PIER	SEE NOTE	LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK	LEFT OVERBANK	MAIN CHANNEL	RIGHT OVERBANK
PIER NUMBER(S)			1-14			1-14	
SKEW ANGLE (DEGREES)			0			0	
a - PIER WIDTH (FT)	1		8			8	
K1	2		1.0			1.0	
K2	2		1.0			1.0	
K3	2		1.1			1.1	
V1 - VELOCITY, UPSTREAM FACE OF PIER (FT)	3		17.9			20.5	
Y1 - DEPTH OF FLOW UPSTRM. FACE OF PIER (FT)	4		22.0			24.3	
Fr1 - FROUDE NUMBER = V1/(32.2*Y1)^1/2			0.67			0.73	
[a/Y1]^0.65			0.52			0.49	
Ys/Y1 = 2K1K2K3(a/Y1)^.65(Fr1)^.43	5		0.96			0.93	
Ys SCOUR DEPTH (FT)			21			23	

NOTES:

1. TWICE THE PIER WIDTH IS USED FOR THE EFFECTIVE PIER WIDTH TO ACCOUNT FOR DEBRIS ACCUMULATION.

$$\frac{Y_s}{Y_1} = 2.0 * 1.1 * \left(\frac{8}{22}\right)^{.65} (.67)^{.43}$$

$$= (2.2 * 0.52 * 0.8) * 22' = 21.2'$$

2. K1=1.0 SINCE PIERS HAVE A ROUNDED NOSE.
   K2=1.0 SINCE ANGLE OF ATTACK IS 0.
   K3=1.1 FOR PLANE BED

3. THE MAXIMUM VELOCITY IS USED BECAUSE THE THALWEG MAY MOVE TO ANY PIER IN THE CHANNEL. VELOCITY OBTAINED FROM HEC-2 OUTPUT.

w/ SAFETY FACTOR

4. DEPTH VARIES AT DIFF. PIERS. MAX VALUE IS OBTAINED FROM HEC-2 OUTPUT TO. ACCOUNT FOR POSSIBLE THALWEG MOVEMENT.

5. THE C.S.U. EQ. ESTIMATES EQUILIBRIUM SCOUR.

why this info for Bend scour diff. from this?

TUTHILL ROAD BRIDGE OVER THE GILA RIVER

ABUTMENT SCOUR

SPILLTHROUGH	SEE NOTE	100-YEAR NORTH ABUTMENT	100-YEAR SOUTH ABUTMENT	500-YEAR NORTH ABUTMENT	500-YEAR SOUTH ABUTMENT
Ya - DEPTH AT ABUT. (FT)		3.05	8.50	4.00	9.20
a'- ABUT. LENGTH NORMAL TO FLOW (FT)		12.2	34	16	36.6
(a'/Ya)^0.43		1.82	1.82	1.82	1.81
Ve = Qe/Ae	1	9.00	15.90	11.70	18.30
Fre = Ve/(32.2*Ya)^(1/2) = FROUDE NO.		0.91	0.96	1.03	1.06
Fre^0.61		0.94	0.98	1.02	1.04
(THETA) = ANGLE BTWN. ABUT. AND FLOW	2	90	90	90	90
K2 = ((THETA)/90)^0.13		1	1	1	1
K1	3	0.55	0.55	0.55	0.55
Ys/Ya = 2.27K1K2* (a'/Ya)^0.43(Fre^0.61) + 1		3.1	3.2	3.3	3.3
Ys SCOUR (FT)		9.6	27.3	13.2	30.8

* This info. shall be used for bend scour!!!

NOTES:

1. Ve TAKEN FROM HEC-2 VELOCITY IN MAIN CHANNEL.

2. THETA < 90 IF POINTED DOWNSTREAM, > 90 IF POINTED UPSTREAM.
   THETA = 90 FOR NORTH ABUTMENT, 90 FOR SOUTH ABUTMENT.

3. K1 = 0.55 FOR SPILLTHROUGH ABUTMENT.

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*******************************************                    **************************************
* HEC-2 WATER SURFACE PROFILES            *                    * U.S. ARMY CORPS OF ENGINEERS       *
*                                         *                    * HYDROLOGIC ENGINEERING CENTER      *
* Version   4.6.2;  May 1991              *                    * 609 SECOND STREET, SUITE D         *
*                                         *                    * DAVIS, CALIFORNIA 95616-4687       *
* RUN DATE    28MAR96    TIME   18:15:56  *                    *         (916) 756-1104             *
*******************************************                    **************************************


                         X     X  XXXXXXX  XXXXX           XXXXX
                         X     X  X       X     X         X     X
                         X     X  X       X                     X
                         XXXXXXX  XXXX    X         XXXXX   XXXXX
                         X     X  X       X                X
                         X     X  X       X     X          X
                         X     X  XXXXXXX  XXXXX           XXXXXXX
1
   28MAR96      18:15:56                                                               PAGE    1



                                                        THIS RUN EXECUTED 28MAR96    18:15:56
************************************
HEC-2 WATER SURFACE PROFILES

Version   4.6.2;  May 1991
************************************


            TUTHILL ROAD BRIDGE OVER THE GILA RIVER
            FILE NAME TUTHILL
            PARSONS BRINCKERHOFF - TEMPE, ARIZONA
            AN EXISTING HEC-2 RUN (12/20/94) PROVIDED BY THE MARICOPA
            COUNTY FLOOD CONTROL DISTRICT WAS EDITED TO REFLECT RECENT
            SURVEY DATA AT THE BRIDGE.
            THE 100-YEAR DISCHARGE OF 245,000 CFS WAS OBTAINED FROM THE
            FEMA FLOOD INSURANCE STUDY.
            DEBRIS BLOCKAGE WAS ESTIMATED USING TWICE THE PIER WIDTH FOR
            ALL PIERS.
T1          MCDOT HYDRAULIC ANALYSIS
T2          100-yr SUB-CRITICAL RUN FOR TUTHILL ROAD BRIDGE
T3          GILA RIVER

J1  ICHECK    INQ      NINV     IDIR     STRT     METRIC    HVINS    Q       WSEL      FQ

                2                                                        873.47

J2  NPROF     IPLOT    PRFVS    XSECV    XSECH    FN       ALLDC    IBW     CHNIM     ITRACE

     1                  -1                                  -6


NC                                     0.3        0.5
QT       2     245000     350000
```

NH	4	0.065	19105.1	0.03	20615.2	0.032	21671.2	0.025	32822.9	
	EXIT SECTION - 780' FROM DOWNSTREAM FACE OF BRIDGE									
X1	187.91	96	19105.1	21671.2	0	0	0			
X3				19105.1		25000				
GR	880.8	18003.2	877.8	18217.8	878.6	18433.4	876.2	18691.1	875.2	18803.4
GR	870.3	18947.3	868.7	19049.7	869.8	19105.1	863.3	19184.5	858.4	19212.2
GR	858.5	19285	859.2	19608	860.6	19815.6	858.2	19824.7	856.5	19913.6
GR	864.1	20023.9	865.6	20081.6	861.6	20095.6	859.6	20145.5	857.4	20158.6
GR	861.1	20452.6	866.6	20492.7	868.4	20615.2	867.1	20861.3	868.7	21099.5
GR	868.7	21319.3	869.2	21608.1	868.2	21635.5	873.1	21671.2	870.8	21690.3
GR	870.2	21772.7	870	22007.1	870	22113.4	869.6	22353.1	869.4	22602.5
GR	868.8	22851.6	870.7	23024.5	867.5	23040.3	868.3	23057.7	870.4	23061.7
GR	869.2	23279.5	869.3	23505.4	869.3	23813.2	868.7	24023.9	869	24242.8
GR	868.9	24448.9	870.9	24457.2	871.6	24605.1	877.8	24644.2	870.5	24660
GR	871.1	24676.7	878.4	24696.7	874.1	24770.5	874.9	25041.4	874.9	25398.2
GR	874.8	25628	873.6	25855.6	873.2	25946.5	877.2	26134.7	876.9	26290.9
GR	876.8	26509.7	876.7	26695.5	876.6	26935.7	876.4	27193.9	877.6	27489.9
GR	877.8	27760.5	877.5	28014.6	878	28227.1	877.8	28397.1	875.2	28412
GR	877	28462.3	878.5	28463.1	874.1	28497.2	877.9	28548.8	876.3	28817.1
GR	877	29100.5	877.3	29394.7	876.8	29675.7	877.3	29699.8	876.2	29714.9
GR	878	29719.9	877.2	29740	870.8	29751.4	877	29766	877.7	30036.6
GR	877.7	30409.7	877.7	30488.1	878.1	30717.4	878.5	30951.8	878.9	31075.8

GR	877.4	31384	878.3	31731.1	879.7	32092.9	880	32309.3	880.4	32596
GR	881.5	32822.9								
NH	4	0.065	19009.2	0.03	20360.5	0.032	21647.5	0.025	32782.3	
X1	188.00	96	19009.2	21647.5	505	545	526.41			
X3				19009.2		26200				
GR	882.7	17809.5	871.3	18032.2	870.2	18276.6	868.3	18423.8	871.2	18503
GR	867.4	18526.5	871.2	18545	873.5	18580.9	877.1	18792	876.1	19009.2
GR	873.5	19095.9	871	19119.6	866.6	19135.5	858.5	19146.6	863.6	19191.6
GR	863.4	19215.5	858.8	19613.8	860.8	19662.5	858.6	19687.5	864.2	19855.8
GR	858.3	19952.9	859.2	20053.8	860.5	20309.5	866.1	20360.5	863.3	20417.8
GR	864.6	20632.7	868.3	20848.7	868.5	21143.7	868.6	21354.6	869	21579.2
GR	867.8	21617.4	872.3	21647.5	872.3	21867.1	871.9	22088	871.9	22301.1
GR	873.3	22378.5	870.1	22407.2	869.9	22631.3	869.8	22874.1	869.1	22916.6
GR	869.7	23000.5	869.1	23239.4	869.4	23543.4	869.4	23676.7	868.7	23898.3
GR	868.8	24195.4	868.8	24409.2	871.4	24443	869.3	24470.7	870.5	24810.4
GR	871.2	25085.2	872.1	25305.8	872.3	25559.6	874.4	25738.2	878.9	25745.9
GR	878.1	25763.1	872	25772.8	872.2	25787.1	879.8	25796.4	875.5	25832.3
GR	875.3	26004.6	878.7	26202.5	878	26529.2	878	26570.7	878	26857.9
GR	877.7	27071.1	874.8	27120.8	877.1	27140.6	877.5	27366	878.2	27646.8
GR	878.3	27689.4	878.6	28007.8	879	28238.9	879.7	28350.4	877.1	28686.3
GR	877.4	28911.9	877.3	28974.7	878.1	29188.7	878.8	29434.6	878.9	29673.3
GR	876.3	29685.9	879.6	29706.7	872.7	29717	878	29732.6	876.6	29953.2
GR	877.6	30214.9	878.5	30455.5	879.1	30815.7	879.8	31029.5	877.7	31098.8
GR	878.8	31381.4	878.6	31701.5	879	31992	879.2	32205.1	880.8	32566.2
GR	881.9	32782.3								
NH	4	0.065	19086.5	0.032	20458.5	0.032	20893.4	0.025	32737.4	
X1	188.04	96	19086.5	20893.4	250	265	250.89			
X3						25851				
GR	885.8	17507.4	885.8	17726.3	883.2	17933.3	882.3	18232	882.2	18481.8
GR	883.9	18716	886	18831.9	886.5	19086.5	878.8	19104.6	861.4	19156.7
GR	850	19220	860.6	19385.1	855.8	19652.7	858.5	19683.6	859.4	19784.1
GR	862	19826.9	862.5	19902.2	857.8	19999.7	860.6	20255.8	859.8	20458.5

GR	860	20564.4	866.1	20631.8	867.1	20836.6	885.4	20880.1	888.1	20893.4
GR	886.5	21105.9	882.8	21215.7	867.1	21349	868.7	21391.9	867.8	21604.1
GR	872.3	21639.6	872.6	21858	872.7	22095.6	874.2	22385.2	871.9	22632.4
GR	872.3	22835.7	873.1	22983.9	870	23006.6	869.3	23227.4	869.7	23596.2
GR	869.1	23986.7	868.7	24233.4	870.8	24410.3	868.9	24443.1	870.3	24672.7
GR	870.5	24716.9	871.2	24963.3	871.9	25188.3	871.9	25395.5	873.1	25667.1
GR	873.1	25840.4	879.3	25851.7	878.3	25864.4	873	25873.5	872.5	25890.4
GR	879.7	25904.4	876.6	25957.9	879.4	25986	879	26242.4	878.9	26279.4
GR	878.7	26550.6	878.7	26586	878.7	26850.5	878.6	27026.3	876.4	27052.7
GR	877.6	27283.8	878.3	27532.5	878.5	27739	878.5	27840.1	878.5	28068
GR	879	28268.6	878.8	28411.3	877.4	28645.6	878.2	28854.3	877.5	29086.2
GR	878.6	29325.3	879.3	29578	879.1	29636.6	876.6	29645.3	879.6	29654.2
GR	878.6	29666.8	873	29674.6	878.6	29690.1	877.5	30007.3	878.2	30258
GR	878.8	30532.5	879.3	30782.9	879.9	30987.7	879.2	31310.6	879.4	31575.1
GR	879.6	31657.6	879.2	31871	879.6	32109.3	880	32340.8	880.7	32546.3
GR	881.6	32737.4								

Downstream face of Tuthill bridge section

Code out vertical ineffective flow area below elevation 855

under the bridge

Ground profile at Tuthill Road bridge was modified according to field survey data from May 1995 by PEC. Pier widths were doubled to allow for debris.

NH	4	0.065	19098	0.032	20472.7	0.032	20865.3	0.025	25851.7

DOWNSTREAM FACE OF BRIDGE

X1	188.05	96	19098	20865.3	6.03	6.03	6.03			
X2										15
X3						21833.8				
BT	-14	19088.5	887.43	887.43	19098	887.43	881.18	19216.5	888.73	882.48
BT		19334.2	889.38	883.01	19451.6	890.03	883.78	19687.0	891.43	885.12
BT		19923.3	891.93	885.69	20159.2	891.93	885.71	20395.5	890.93	884.68
BT		20513.5	889.98	883.73	20631.4	889.03	882.78	20749.1	888.33	882.12
BT		20869	886.15	879.9	20881.8	886.15	886.15			
GR	884	17738.5	887.43	19088.5	881.18	19098	876.53	19104.8	864.01	19134.7
GR	850	19178.0	848	19216.5	882.48	19216.5	882.52	19224.5	848	19224.5
GR	850	19264.3	856.2	19334.2	883.01	19334.2	883.05	19342.2	856.2	19342.2
GR	857.5	19387.3	859	19451.6	883.78	19451.6	883.82	19459.6	859	19459.6
GR	861	19545.9	862	19569.5	884.48	19569.5	884.52	19577.5	862	19577.5
GR	863	19633.0	864	19687.0	885.18	19687.0	885.22	19695.0	864	19695.0
GR	865	19749.5	866.7	19805.5	885.43	19805.5	885.47	19813.5	866.7	19813.5
GR	867	19867.6	867.4	19923.3	885.69	19923.3	885.71	19931.3	867.4	19931.3
GR	863	19980.7	862.1	20041.4	885.7	20041.4	885.7	20049.4	862.1	20049.5
GR	862	20070.5	862	20159.2	885.71	20159.2	885.69	20167.2	862	20167.2
GR	863	20224.3	863.9	20278.0	885.22	20278.0	885.18	20286.0	863.9	20286.0
GR	863.5	20335.5	863.5	20395.5	884.68	20395.5	884.72	20403.5	863.5	20403.5
GR	862.0	20472.7	862.0	20485.6	863.5	20513.5	883.77	20513.5	883.73	20521.5
GR	863.5	20521.5	863.5	20527.6	864	20562.1	871.6	20631.4	882.82	20631.4
GR	882.78	20639.4	862.4	20639.4	865.43	20686.6	866.47	20749.1	882.12	20749.1
GR	882.08	20753.1	866.47	20753.1	867.7	20842.4	878.48	20865.3	879.9	20869
GR	886.15	20881.8	885.6	21833.8	872.6	21858	872.7	22095.6	874.2	22385.2
GR	871.9	22632.4	873.1	22983.9	870	23006.6	868.7	24233.4	870.8	24410.3
GR	868.9	24443.1	871.9	25188.3	871.9	25395.5	873.1	25667.1	873.1	25840.4
GR	879.3	25851.7								

Upstream face of bridge Tuthill Bridge section

NH	4	0.065	19098	0.032	20472.7	0.032	20865.3	0.025	25851.7	

UPSTREAM FACE OF BRIDGE - NORMAL BRIDGE METHOD

X1	188.06				33	33	33			
X2							1			15
X3						21833.8				
NH	5	0.065	19007.7	0.065	19439.4	0.03	20236.5	0.043	20890.7	0.025
NH	32651									
X1	188.07	96	19007.7	20890.7	6.03	6.03	6.03			
X3						25993.2				
GR	887.7	17503.1	884.6	17760	882.5	18001	882.6	18257.2	883	18547.3
GR	884.5	18776.9	885.9	19007.7	883.2	19086.6	877.5	19098.7	850	19220
GR	860.1	19439.4	856.1	19619.1	860.2	19652.1	861.4	19798.4	864.9	19909.6

GR	860.5	19949.1	863.6	20000.5	858.3	20014	860.8	20236.5	859.8	20466.9
GR	861.1	20581.3	869.1	20667.8	866.2	20833.3	886.3	20890.7	884.1	21139.3
GR	884.2	21338.8	867.6	21445.9	868.6	21609.2	871.7	21625.4	871.6	21645.3
GR	869.9	21668.6	872.2	21938.3	873.9	22258.8	873.3	22568.6	873.9	22908.4
GR	871.7	23196.3	871.7	23221.4	870.9	23539.6	872.1	23659.4	874.8	23759.9
GR	870.2	23828.7	869.4	24065.4	868.8	24304.7	871.6	24360	869.1	24400.8
GR	869.2	24684.8	869.2	24697.6	870.3	24947.1	871.6	25169.2	871.6	25185.6
GR	871.8	25432.6	872.6	25658.5	872.8	25789.2	877.2	25869.7	875.2	25963.9
GR	881.1	25983.9	880.8	25993.2	874.2	25997.9	874.3	26010.5	880.3	26026.2
GR	877.5	26067.2	880.4	26100.8	879.2	26403.1	877.9	26718.4	878.4	26942.7
GR	876	26968.7	878.1	27197.3	877.9	27258.7	878.8	27552.6	879.5	27642.9
GR	880.1	27957.4	881	28212.3	878.5	28267.4	878.1	28518.1	878.6	28886.7
GR	879.1	29194.8	879.5	29541.3	879.6	29555.7	878.2	29565.2	880.3	29570.7
GR	879.3	29584.8	873.6	29593.1	878.1	29611.2	877.5	29806.9	879	30088.7
GR	879.6	30338.5	879.6	30635.7	879.7	30884.2	878	31053.3	879.7	31283.7
GR	879.6	31556.3	879.9	31655.3	880.6	31939.8	880.7	32202.3	882.1	32435.5
GR	882.3	32651								
NH	5	0.065	18941.3	0.065	19118.1	0.03	20340	0.043	21504.3	0.025
NH	32616									
X1	188.10	96	18941.3	21504.3	190	240	187.78			
X3						26000				
GR	882.4	18347.4	878.8	18572.7	878.7	18758.4	876.6	18775.8	878	18941.3
GR	864.6	19094.2	860.9	19118.1	861	19192.9	861.5	19412.6	860.9	19528.9
GR	855.8	19600.5	861.4	19728.6	856.4	19774.5	862.5	19832	862.7	19890.5
GR	866.3	19949.7	860	19988.2	864.2	20045.1	857	20057.9	859.8	20120.8
GR	858.4	20135	858.6	20312.5	862.6	20340	860.2	20360.2	861.4	20434.8
GR	860.3	20503.2	861.2	20731.2	860.6	20768.8	867.3	20853.2	865	20859.8
GR	866.7	20890.9	868.4	21120	869.2	21317.1	867.2	21327.3	872.2	21462.4
GR	879.5	21504.3	880.9	21594.5	871.9	21619.2	872.4	21838.1	872.5	22088.8
GR	873.3	22346.6	871.8	22618.3	872.1	22871.4	870.9	23110.7	870.5	23328.5
GR	870.7	23654	870.9	23910.7	870.9	24128.5	871.9	24346.8	872.8	24634.3
GR	875.3	24851.6	871.3	24992.5	871.8	25315.1	872.1	25537.8	873.2	25759.5
GR	877.1	25996.2	876.8	26048.2	880.9	26058.8	880.8	26068.9	874.4	26074.6
GR	874.9	26085.1	881.1	26105.2	877.4	26162	877.8	26406	877	26697.1
GR	877.5	26922.7	876.8	27143.8	877.8	27491.2	879.2	27752.4	879.7	28017.5
GR	879	28234.9	879.6	28483	879.3	28715.8	879.3	28936	877.4	29185.5
GR	877	29421.8	878.6	29550.5	874.3	29564.2	879.2	29579.5	879.9	29599.5

GR	878.2	29632.4	878.4	29794.7	878.4	30073.8	878.5	30120	879.2	30375.2
GR	880.4	30599.9	879.1	30849.7	881.5	30888.1	879.1	30961.6	879.4	31200.2
GR	879.4	31417.6	879.5	31470.1	879.2	31848.8	880.6	32174	881.4	32428.3
GR	881.2	32616								
NH	5	0.043	18481.2	0.15	19103.9	0.03	20352	0.065	21652.9	0.025
NH	32447									
X1	188.20	96	18481.2	21652.9	620	340	525.06			
X3						25950				
GR	884.1	18202.1	882.8	18292.2	884.9	18364.8	880.3	18481.2	870.1	18517.5
GR	865.2	18656.4	869.4	18668.5	864.7	18959.8	867.3	19103.9	861	19127.9
GR	859.3	19303.3	861.6	19579.2	861.2	19818.3	861.3	19932	859.4	19971.9
GR	862.3	20039	859.6	20082.8	864.3	20097	860	20135.8	865.7	20352
GR	859.3	20387.9	862.1	20412.2	859.7	20465.3	864.1	20706.5	861.2	20891.9
GR	862.5	21134.1	874.7	21232.4	872	21481	872.7	21602	880.4	21652.9
GR	878.8	21696.5	872.7	21718.1	873.5	22013.9	871.8	22319.8	872.5	22552.9

GR	873.9	22791.9	871.8	22854.8	873.2	22934	873.1	23168	873.1	23187.6
GR	872.6	23502.4	872.6	23512.1	872.2	23892.5	871.3	24135.9	872	24219.2
GR	872.1	24453.8	872.5	24691.3	871.8	24794.9	874.3	24812.5	872.1	25118.6
GR	872.2	25362.1	873.6	25635.8	877	25892.1	876.3	26124.2	881.2	26142.4
GR	881	26155.8	876.2	26160.3	875.7	26172.1	882.2	26190.2	879.9	26255.1
GR	881.6	26277.8	881.6	26559.1	880.9	26906.3	880.3	27019.2	879.4	27325.4
GR	879	27457.7	879	27731	879.7	27979.4	880.5	28323.1	879.4	28566.5
GR	880.1	28798.1	878.2	28887.2	878.6	29119.4	880.3	29138.4	877.7	29373.1
GR	879.6	29429.2	875.6	29438	880.6	29451.9	877.7	29469	878.6	29678.4
GR	879.2	29955.6	879.1	30014.2	878.6	30389.6	879.1	30704.5	880.7	30750.7
GR	878.8	30757.7	880.2	31041	880.2	31048.4	880.9	31312.4	880.9	31321
GR	880.6	31577.2	880.6	31611.9	881.8	31883.3	879.8	32123.6	882.1	32423.1
GR	882.4	32447								
NH	5	0.15	18355.9	0.15	19223.3	0.026	21587.3	0.065	21871.2	0.025
NH	32101									

APPROACH SECTION - 1211' FROM UPSTREAM FACE OF BRIDGE

X1	188.29	96	18355.9	21871.2	505	310	492.53			
X2										15
X3						26200				
GR	885.4	18244	881.5	18266.4	880.3	18355.9	875.2	18379.2	868.2	18392.2
GR	870.2	18404.3	866.2	18528.5	866.6	18634.8	863.9	18804.2	867.9	19004.2
GR	864.7	19223.3	860.7	19241	860.8	19602.1	861.2	19893.5	862.5	20119.1
GR	868.3	20155	864.6	20242.1	864.4	20313.2	862.6	20418.4	859.6	20456.6
GR	861	20473.6	860.1	20520.1	865	20540.3	859.9	20577.8	869.4	20605.8
GR	864.9	20647.8	862.5	20774.5	866.1	20982.3	862.1	21068.6	864.6	21139.6
GR	864.7	21491.6	864.4	21506.8	874.8	21587.3	873.5	21797.3	880.2	21871.2
GR	879.5	21886.5	872.9	21905.2	872.4	22321.3	872.6	22601.4	872.8	22962.3
GR	872.6	23435	872.5	23731.4	870.8	23999.3	872.4	24276.9	872.3	24557.8
GR	872.2	24661.2	874.4	24686	872.8	24953.8	872.2	25217.3	872.2	25419.5
GR	875.7	25497.3	872.1	25597.5	875.8	25817.6	876.7	26152.9	876.6	26275.3
GR	882.5	26285.7	883	26299	876.2	26304.3	876.1	26319	881.5	26330.3
GR	877.9	26367.6	880	26411.8	880.5	26713.5	879.4	27091	879.9	27521.9
GR	879.5	27830.4	880.6	27985	879.1	27986.7	879.4	28026	880.8	28044.1
GR	880	28489.9	879.4	28771.7	877.5	28996.7	881.1	29002.5	876.6	29241.2
GR	879.9	29301.1	875.7	29307.9	879.5	29323	877.3	29339.7	878.2	29613.4
GR	877.8	29894.1	878	30242.1	877.8	30503.1	879	30590.3	882.1	30602.2
GR	879.2	30611.5	881.3	30619.3	878.1	30632	880.7	30666.8	880	30984
GR	880.2	31294	880.6	31756.8	878.9	32026.5	878.7	32055.1	881.7	32070.6
GR	882.8	32101								

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SECNO      DEPTH      CWSEL      CRIWS      WSELK      EG         HV         HL         OLOSS      L-BANK ELEV
Q          QLOB       QCH        QROB       ALOB       ACH        AROB       VOL        TWA        R-BANK ELEV
TIME       VLOB       VCH        VROB       XNL        XNCH       XNR        WTN        ELMIN      SSTA
SLOPE      XLOBL      XLCH       XLOBR      ITRIAL     IDC        ICONT      CORAR      TOPWID     ENDST


*PROF 1

CRITICAL DEPTH TO BE CALCULATED AT ALL CROSS SECTIONS
ALLOWABLE ERROR FOR CRITICAL DEPTH DETERMINATION (ALLDC) =  6.000 PERCENT OF THE DEPTH
0

CCHV=      .300 CEHV=      .500
1490 NH CARD USED
*SECNO 187.910

3265 DIVIDED FLOW


3470 ENCROACHMENT STATIONS=     19105.1   25000.0  TYPE=      1  TARGET=      5894.900
            EXIT SECTION - 780' FROM DOWNSTREAM FACE OF BRIDGE
   187.910      16.97     873.47     870.96     873.47     874.26        .79        .00        .00     869.80
  245000.0         .0   189805.4    55194.6         .0    24636.9    11568.2         .0         .0     873.10
       .00        .00       7.70       4.77       .000       .028       .025       .000     856.50   19105.10
   .001019         0.         0.         0.          0          8          0        .00    5541.41   24683.19


1490 NH CARD USED
*SECNO 188.000

3265 DIVIDED FLOW


3470 ENCROACHMENT STATIONS=     19009.2   26200.0  TYPE=      1  TARGET=      7190.801
   188.000      15.89     874.19     871.45        .00     874.81        .62        .50        .05     876.10
  245000.0         .0   176180.8    68819.2         .0    25448.6    15216.0      470.2       75.3     872.30
       .02        .00       6.92       4.52       .000       .029       .025       .000     858.30   19072.93
   .000864       505.       526.       545.          2         14          0        .00    6667.52   25789.53


1490 NH CARD USED
*SECNO 188.040

3265 DIVIDED FLOW


3470 ENCROACHMENT STATIONS=          .0   25851.0  TYPE=      1  TARGET=     25851.000
   188.040      24.35     874.35     868.65        .00     875.06        .71        .20        .04     886.50
  245000.0         .0   183066.5    61933.6         .0    24542.2    15151.1      706.5      114.0     888.10
       .03        .00       7.46       4.09       .000       .032       .025       .000     850.00   19117.93
   .000736       250.       251.       265.          2         11          0        .00    6291.10   25842.67
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SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

1490 NH CARD USED

*SECNO 188.050

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

3302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = .42

3370 NORMAL BRIDGE, NRD= 14 MIN ELTRD= 886.15 MAX ELLC= 885.71

3470 ENCROACHMENT STATIONS= .0 21833.8 TYPE= 1 TARGET= 21833.800

DOWNSTREAM FACE OF BRIDGE

188.050	25.24	873.24	871.35	.00	876.18	2.94	.01	1.11	881.18
245000.0	.0	245000.0	.0	.0	17811.7	.0	710.5	114.5	878.48
.03	.00	13.75	.00	.000	.030	.000	.000	848.00	19112.65
.004151	6.	6.	6.	3	19	0	.00	1633.47	20854.18

FLOW DISTRIBUTION FOR SECNO= 188.05 CWSEL= 873.24

STA=	19113.	19225.	19342.	19460.	19578.	19695.	19814.	19931.	20167.	20286.	20404.	20473.	20522.
PER Q=	11.8	18.1	11.0	8.3	5.8	4.0	2.6	11.9	5.9	5.3	3.9	2.3	
AREA=	1738.3	2372.9	1703.4	1420.0	1122.4	890.5	682.5	2278.9	1139.3	1057.0	726.1	437.8	
VEL=	16.6	18.7	15.8	14.3	12.6	11.0	9.4	12.7	12.6	12.2	13.1	12.6	
DEPTH=	16.7	21.6	15.6	12.9	10.2	8.1	6.2	10.4	10.3	9.7	10.5	10.7	

STA=	20522.	20639.	20753.	20865.
PER Q=	3.2	4.0	2.2	
AREA=	764.1	896.1	582.5	
VEL=	10.2	11.0	9.1	
DEPTH=	7.0	8.2	5.8	

1490 NH CARD USED

*SECNO 188.060

3265 DIVIDED FLOW

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

3370 NORMAL BRIDGE, NRD= 14 MIN ELTRD= 886.15 MAX ELLC= 885.71

3470 ENCROACHMENT STATIONS= .0 21833.8 TYPE= 1 TARGET= 21833.800

UPSTREAM FACE OF BRIDGE - NORMAL BRIDGE METHOD

188.060	25.64	873.64	871.35	.00	876.37	2.73	.13	.06	881.18
245000.0	.0	245000.0	.0	.0	18478.5	.0	724.2	115.8	878.48
.04	.00	13.26	.00	.000	.031	.000	.000	848.00	19111.68
.003736	33.	33.	33.	2	19	0	.00	1635.32	20855.04

FLOW DISTRIBUTION FOR SECNO= 188.06 CWSEL= 873.64

STA=	19112.	19225.	19342.	19460.	19578.	19695.	19814.	19931.	20167.	20286.	20404.	20473.	20522.
PER Q=	11.5	17.6	10.8	8.3	5.8	4.1	2.8	11.9	5.9	5.3	3.9	2.3	
AREA=	1780.8	2417.6	1748.0	1464.8	1167.0	935.6	727.3	2368.6	1184.5	1101.6	754.3	454.4	
VEL=	15.9	17.9	15.2	13.8	12.2	10.7	9.3	12.4	12.2	11.8	12.7	12.2	
DEPTH=	17.0	22.0	16.0	13.3	10.7	8.5	6.6	10.8	10.7	10.1	10.9	11.1	

STA=	20522.	20639.	20753.	20865.
PER Q=	3.3	4.1	2.3	
AREA=	809.0	940.8	624.0	
VEL=	10.0	10.7	9.0	
DEPTH=	7.4	8.6	6.1	

1490 NH CARD USED

SECNO 188.070

3265 DIVIDED FLOW

3301 HV CHANGED MORE THAN HVINS

302 WARNING: CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE, KRATIO = 2.80

470 ENCROACHMENT STATIONS= .0 25993.2 TYPE= 1 TARGET= 25993.200

188.070	26.71	876.71	869.96	.00	877.09	.37	.01	.71	885.90
245000.0	.0	148991.6	96008.4	.0	27757.7	23349.4	729.1	116.3	886.30
.04	.00	5.37	4.11	.000	.038	.025	.000	850.00	19102.19
.000477	6.	6.	6.	4	12	0	.00	6310.96	25969.02

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

490 NH CARD USED

*SECNO 188.100

265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= .0 26000.0 TYPE= 1 TARGET= 26000.000

188.100	21.05	876.85	869.45	.00	877.19	.33	.09	.01	878.00
245000.0	.5	174150.9	70848.6	4.1	34595.0	20846.3	985.2	150.3	879.50
.05	.11	5.03	3.40	.065	.033	.025	.000	855.80	18773.69
.000383	190.	188.	240.	2	8	0	.00	6942.76	25981.34

490 NH CARD USED

*SECNO 188.200

265 DIVIDED FLOW

470 ENCROACHMENT STATIONS= .0 25950.0 TYPE= 1 TARGET= 25950.000

188.200	17.82	877.12	869.18	.00	877.41	.28	.20	.02	880.30
245000.0	.0	179538.9	65461.1	.0	40126.9	18259.2	1588.2	218.3	880.40
.08	.00	4.47	3.59	.000	.040	.025	.000	859.30	18492.50
.000492	620.	525.	340.	2	11	0	.00	7386.32	25950.00

490 NH CARD USED

*SECNO 188.290

265 DIVIDED FLOW

470 ENCROACHMENT STATIONS= .0 26200.0 TYPE= 1 TARGET= 26200.000

APPROACH SECTION - 1211' FROM UPSTREAM FACE OF BRIDGE

188.290	17.70	877.30	869.59	.00	877.57	.27	.16	.00	880.30
245000.0	.0	193381.5	51618.5	.0	43321.3	18703.9	2191.5	286.1	880.20
.11	.00	4.46	2.76	.000	.030	.025	.000	859.60	18369.56
.000278	505.	493.	310.	1	11	0	.00	7777.04	26200.00

LOW DISTRIBUTION FOR SECNO= 188.29 CWSEL= 877.30

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

STA=	18370.	19223.	21587.	21871.	22601.	23435.	23999.	24558.	25217.	26200.
PER Q=	3.0	75.7	.2	3.8	4.3	3.6	3.7	3.1	2.6	
AREA=	9209.1	33368.7	743.5	3313.4	3842.3	2926.8	2978.0	2883.2	2760.3	
VEL=	.8	5.6	.8	2.8	2.7	3.0	3.0	2.7	2.3	
DEPTH=	10.8	14.1	3.0	4.5	4.6	5.2	5.3	4.4	2.8	

1

T1 MCDOT HYDRAULIC ANALYSIS

500-yr SUB-CRITICAL RUN FOR TUTHILL ROAD BRIDGE

T3 GILA RIVER

J1	ICHECK	INQ	NINV	IDIR	STRT	METRIC	HVINS	Q	WSEL	FQ
		3			.0008				875	

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

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

*PROF 2

CCHV= .300 CEHV= .500
1490 NH CARD USED
*SECNO 187.910

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= 19105.1 25000.0 TYPE= 1 TARGET= 5894.900
EXIT SECTION - 780' FROM DOWNSTREAM FACE OF BRIDGE

187.910	19.42	875.92	.00	875.00	876.72	.80	.00	.00	869.80
350000.0	.0	239077.8	110922.2	.0	30929.8	19267.3	.0	.0	873.10
.00	.00	7.73	5.76	.000	.029	.025	.000	856.50	19105.10
.000812	0.	0.	0.	0	0	3	.00	5829.68	25000.00

1490 NH CARD USED
*SECNO 188.000

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= 19009.2 26200.0 TYPE= 1 TARGET= 7190.801

188.000	18.25	876.55	.00	.00	877.17	.62	.40	.05	876.10
350000.0	.0	216447.3	133552.7	.0	31631.8	25204.8	656.2	79.2	872.30
.02	.00	6.84	5.30	.000	.030	.025	.000	858.30	19009.20
.000687	505.	526.	545.	2	0	0	.00	7013.75	26077.68

1490 NH CARD USED
*SECNO 188.040

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= .0 25851.0 TYPE= 1 TARGET= 25851.000

188.040	26.67	876.67	.00	.00	877.40	.73	.17	.06	886.50
350000.0	.0	220376.3	129623.7	.0	28590.8	25764.9	984.7	119.1	888.10
.03	.00	7.71	5.03	.000	.032	.025	.000	850.00	19110.97
.000652	250.	251.	265.	2	0	0	.00	6327.54	25846.91

```
SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


1490 NH CARD USED
SECNO 188.050

3265 DIVIDED FLOW


301 HV CHANGED MORE THAN HVINS


302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .33


370 NORMAL BRIDGE, NRD=  14 MIN ELTRD=   886.15 MAX ELLC=   885.71


470 ENCROACHMENT STATIONS=          .0   21833.8  TYPE=       1  TARGET=    21833.800
           DOWNSTREAM FACE OF BRIDGE
  188.050     26.72    874.72       .00       .00    879.36      4.64       .01      1.96    881.18
 350000.0        .0  350000.0        .0        .0   20239.9        .0     989.9     119.7    878.48
      .03       .00     17.29       .00      .000      .031      .000      .000    848.00  19109.11
  .005865        6.        6.        6.         3         0         0       .00   1640.17  20857.33


LOW DISTRIBUTION FOR SECNO=    188.05          CWSEL=    874.72

TA=    19109.   19225.   19342.   19460.   19578.   19695.   19814.   19931.   20167.   20286.   20404.   20473.   20522.
 PER Q=      11.0      16.6      10.5       8.2       5.9       4.3       3.1      12.1       6.0       5.5       4.0       2.3
  AREA=    1894.9    2535.6    1865.7    1583.0    1284.8    1054.4     845.3    2605.1    1303.7    1219.4     828.8     498.3
   VEL=      20.3      22.9      19.6      18.1      16.1      14.4      12.7      16.3      16.2      15.7      16.8      16.0
 DEPTH=      17.6      23.1      17.1      14.4      11.7       9.5       7.7      11.8      11.8      11.1      12.0      12.2

STA=   20522.   20639.   20753.   20865.
 PER Q=       3.6       4.3       2.6
  AREA=     927.2    1058.8     734.8
   VEL=      13.6      14.4      12.3
 DEPTH=       8.4       9.7       7.1

1490 NH CARD USED
*SECNO 188.060

265 DIVIDED FLOW
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SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
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SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


3301 HV CHANGED MORE THAN HVINS


3370 NORMAL BRIDGE, NRD=  14 MIN ELTRD=   886.15 MAX ELLC=   885.71


3470 ENCROACHMENT STATIONS=         .0   21833.8  TYPE=      1  TARGET=    21833.800
           UPSTREAM FACE OF BRIDGE - NORMAL BRIDGE METHOD
   188.060     27.89    875.89       .00       .00    879.76      3.88       .17       .23    881.18
  350000.0        .0  350000.0        .0        .0   22155.2        .0    1005.9     120.9    878.48
       .03       .00     15.80       .00      .000      .031      .000      .000    848.00  19106.32
   .004514       33.       33.       33.         5         0         0       .00   1645.44  20859.80


FLOW DISTRIBUTION FOR SECNO=    188.06          CWSEL=    875.89

TA=    19106.   19225.   19342.   19460.   19578.   19695.   19814.   19931.   20167.   20286.   20404.   20473.   20522.
  PER Q=      10.6      15.6      10.1       8.1       6.0       4.6       3.4      12.3       6.1       5.6       4.0       2.3
   AREA=    2021.8    2663.5    1993.2    1711.2    1412.5    1183.3     973.4    2861.4    1432.9    1347.1     909.4     545.9
    VEL=      18.3      20.5      17.8      16.5      14.9      13.5      12.1      15.1      14.9      14.5      15.6      14.7
  DEPTH=      18.4      24.3      18.2      15.6      12.9      10.7       8.9      13.0      12.9      12.3      13.1      13.4

TA=    20522.   20639.   20753.   20865.
  PER Q=       3.9       4.6       2.9
   AREA=    1055.3    1186.7     857.8
    VEL=      12.8      13.4      11.7
  DEPTH=       9.6      10.8       8.0

1490 NH CARD USED
 SECNO 188.070

3265 DIVIDED FLOW


3301 HV CHANGED MORE THAN HVINS


3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  3.90


470 ENCROACHMENT STATIONS=         .0   25993.2  TYPE=      1  TARGET=    25993.200
1
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  SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS     L-BANK ELEV
  Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA       R-BANK ELEV
  TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN     SSTA
  SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID    ENDST


   188.070     30.49    880.49       .00       .00    880.83       .34       .00      1.06    885.90
  350000.0        .0  167366.7  182633.4        .0   34460.3   40741.4    1012.7     121.5    886.30
       .04       .00      4.86      4.48      .000      .038      .025      .000    850.00  19092.35
   .000297        6.        6.        6.         4         0         0       .00   6400.88  25981.84
```

1490 NH CARD USED

*SECNO 188.100

3265 DIVIDED FLOW

3470 ENCROACHMENT STATIONS= .0 26000.0 TYPE= 1 TARGET= 26000.000

188.100	24.81	880.61	.00	.00	880.90	.29	.06	.01	878.00
350000.0	694.3	203295.7	146010.0	1048.5	44198.1	37415.1	1399.8	156.9	879.50
.05	.66	4.60	3.90	.065	.034	.025	.000	855.80	18459.26
.000244	190.	188.	240.	2	0	0	.00	7521.44	26000.00

1490 NH CARD USED

*SECNO 188.200

3470 ENCROACHMENT STATIONS= .0 25950.0 TYPE= 1 TARGET= 25950.000

188.200	21.47	880.77	.00	.00	881.03	.26	.12	.01	880.30
350000.0	.7	207899.9	142099.5	2.8	51644.5	33823.0	2262.9	229.2	880.40
.08	.23	4.03	4.20	.043	.042	.025	.000	859.30	18469.23
.000311	620.	525.	340.	2	0	0	.00	7480.77	25950.00

1490 NH CARD USED

*SECNO 188.290

3470 ENCROACHMENT STATIONS= .0 26200.0 TYPE= 1 TARGET= 26200.000

APPROACH SECTION - 1211' FROM UPSTREAM FACE OF BRIDGE

188.290	21.30	880.90	.00	.00	881.14	.24	.10	.01	880.30
350000.0	.8	236617.1	113382.1	13.1	55855.1	34174.5	3112.7	298.1	880.20
.11	.06	4.24	3.32	.150	.031	.025	.000	859.60	18311.62
.000192	505.	493.	310.	0	0	0	.00	7888.38	26200.00

FLOW DISTRIBUTION FOR SECNO= 188.29 CWSEL= 880.90

SECNO	DEPTH	CWSEL	CRIWS	WSELK	EG	HV	HL	OLOSS	L-BANK ELEV
Q	QLOB	QCH	QROB	ALOB	ACH	AROB	VOL	TWA	R-BANK ELEV
TIME	VLOB	VCH	VROB	XNL	XNCH	XNR	WTN	ELMIN	SSTA
SLOPE	XLOBL	XLCH	XLOBR	ITRIAL	IDC	ICONT	CORAR	TOPWID	ENDST

TA=	18312.	18356.	19223.	21587.	21871.	22321.	22962.	23435.	23999.	24558.	25217.	25818.	26200.
PER Q=		.0	2.8	64.3	.5	3.4	5.1	3.7	5.0	5.0	4.9	4.1	1.1
AREA=		13.1	12297.8	41842.3	1715.0	3534.0	5308.2	3873.2	4949.5	4979.9	5247.1	4527.2	1755.5
VEL=		.1	.8	5.4	1.1	3.3	3.4	3.4	3.5	3.5	3.3	3.2	2.3
DEPTH=		.3	14.2	17.7	6.0	7.9	8.3	8.2	8.8	8.9	8.0	7.5	4.6

THIS RUN EXECUTED 28MAR96 18:15:59

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*************************************
 HEC-2 WATER SURFACE PROFILES

 Version   4.6.2;  May 1991
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

GILA RIVER

SUMMARY PRINTOUT TABLE 150

	SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
	187.910	.00	.00	.00	856.50	245000.00	873.47	870.96	874.26	10.19	7.70	36205.02	76746.09
	187.910	.00	.00	.00	856.50	350000.00	875.92	.00	876.72	8.12	7.73	50197.05	122831.70
	188.000	526.41	.00	.00	858.30	245000.00	874.19	871.45	874.81	8.64	6.92	40664.56	83340.20
	188.000	526.41	.00	.00	858.30	350000.00	876.55	.00	877.17	6.87	6.84	56836.61	133521.80
	188.040	250.89	.00	.00	850.00	245000.00	874.35	868.65	875.06	7.36	7.46	39693.37	90308.65
	188.040	250.89	.00	.00	850.00	350000.00	876.67	.00	877.40	6.52	7.71	54355.68	137071.60
*	188.050	6.03	886.15	885.71	848.00	245000.00	873.24	871.35	876.18	41.51	13.75	17811.71	38027.50
	188.050	6.03	886.15	885.71	848.00	350000.00	874.72	.00	879.36	58.65	17.29	20239.86	45699.93
	188.060	33.00	886.15	885.71	848.00	245000.00	873.64	871.35	876.37	37.36	13.26	18478.48	40083.46
	188.060	33.00	886.15	885.71	848.00	350000.00	875.89	.00	879.76	45.14	15.80	22155.21	52092.64
*	188.070	6.03	.00	.00	850.00	245000.00	876.71	869.96	877.09	4.77	5.37	51107.08	112178.30
	188.070	6.03	.00	.00	850.00	350000.00	880.49	.00	880.83	2.97	4.86	75201.71	202949.60
	188.100	187.78	.00	.00	855.80	245000.00	876.85	869.45	877.19	3.83	5.03	55445.38	125198.70
	188.100	187.78	.00	.00	855.80	350000.00	880.61	.00	880.90	2.44	4.60	82661.67	224047.80
	188.200	525.06	.00	.00	859.30	245000.00	877.12	869.18	877.41	4.92	4.47	58386.10	110409.70
	188.200	525.06	.00	.00	859.30	350000.00	880.77	.00	881.03	3.11	4.03	85470.27	198425.10
	188.290	492.53	.00	.00	859.60	245000.00	877.30	869.59	877.57	2.78	4.46	62025.27	147020.60
	188.290	492.53	.00	.00	859.60	350000.00	880.90	.00	881.14	1.92	4.24	90042.69	252405.80

GILA RIVER

SUMMARY PRINTOUT TABLE 150

SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
187.910	245000.00	873.47	.00	.00	.00	5541.41	.00
187.910	350000.00	875.92	2.45	.00	.92	5829.68	.00
188.000	245000.00	874.19	.00	.72	.00	6667.52	526.41
188.000	350000.00	876.55	2.37	.63	.00	7013.75	526.41

	188.040	245000.00	874.35	.00	.16	.00	6291.10	250.89
	188.040	350000.00	876.67	2.32	.12	.00	6327.54	250.89
*	188.050	245000.00	873.24	.00	-1.10	.00	1633.47	6.03
*	188.050	350000.00	874.72	1.48	-1.95	.00	1640.17	6.03
	188.060	245000.00	873.64	.00	.40	.00	1635.32	33.00
	188.060	350000.00	875.89	2.25	1.17	.00	1645.44	33.00
*	188.070	245000.00	876.71	.00	3.07	.00	6310.96	6.03
*	188.070	350000.00	880.49	3.78	4.60	.00	6400.88	6.03
	188.100	245000.00	876.85	.00	.14	.00	6942.76	187.78
	188.100	350000.00	880.61	3.76	.12	.00	7521.44	187.78
	188.200	245000.00	877.12	.00	.27	.00	7386.32	525.06
	188.200	350000.00	880.77	3.65	.16	.00	7480.77	525.06
	188.290	245000.00	877.30	.00	.18	.00	7777.04	492.53
	188.290	350000.00	880.90	3.59	.12	.00	7888.38	492.53

SUMMARY OF ERRORS AND SPECIAL NOTES

WARNING SECNO= 188.050 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO= 188.050 PROFILE= 2 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO= 188.070 PROFILE= 1 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
WARNING SECNO= 188.070 PROFILE= 2 CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

MARYLAND SHA CODING GUIDE FOR ITEM 113
SCOUR CRITICAL BRIDGES

CODE		DESCRIPTION
1ST DIGIT	2ND DIGIT	
N	-	BRIDGE NOT OVER WATERWAY
9	-	BRIDGE FOUNDATIONS (INCLUDING PILES) WELL ABOVE FLOOD WATER ELEVATIONS (SEE NOTE 1)
8	P	BRIDGE IS A STRUCTURE WITH A FULL LENGTH PAVED BOTTOM
8	L	BRIDGE HAS BEEN EVALUATED/ASSESSED IN THE FIELD AND OFFICE AS A LOW RISK STRUCTURE; NO FURTHER STUDY IS PLANNED
7	-	COUNTERMEASURES HAVE BEEN INSTALLED SINCE THE ORIGINAL CONSTRUCTION TO CORRECT A PROBLEM WITH SCOUR; BRIDGE IS NO LONGER SCOUR CRITICAL
6	-	BRIDGE HAS NOT BEEN EVALUATED FOR SCOUR
6	R	BRIDGE IS SCHEDULED FOR MAJOR REHABILITATION OR REPLACEMENT WITHIN THE NEXT 5 YEARS; THE SCOUR STUDY IS DEFERRED TO THE LOCATION/DESIGN PHASE OF THE BRIDGE PROJECT
6	T	TIDAL FLOW PREDOMINATES FOR WORST SCOUR CONDITIONS; THE ITEM 113 RATING IS DEFERRED WHERE THERE IS NO INDICATION OF SEVERE SCOUR CONDITIONS
5	U	THE BRIDGE FOUNDATIONS ARE UNKNOWN. THE BRIDGE SITE CONDITIONS HAVE BEEN EVALUATED/ASSESSED WITH CURSORY STUDY IN THE FIELD AND OFFICE AND THE RISK OF POTENTIAL DAMAGE FROM SCOUR IS JUDGED TO BE MODERATE OR MILD. STRUCTURE HAS NO HISTORY OF SCOUR PROBLEMS. FURTHER EVALUATION IS DEFERRED. (SEE NOTE 1)
5	-	A DETAILED SCOUR STUDY (ANALYSIS) HAS BEEN MADE AND THE STRUCTURE IS RATED AS STABLE.
4	-	BRIDGE FOUNDATIONS DETERMINED TO BE STABLE ON THE BASIS OF A FIELD AND OFFICE SCOUR EVALUATION OR ANALYSIS; BRIDGE INSPECTION REVEALS THAT ACTION IS REQUIRED TO PROTECT EXPOSED PILES FROM EFFECTS OF ADDITIONAL EROSION AND CORROSION

3	A	BRIDGE IS RATED AS SCOUR CRITICAL ON THE BASIS OF A FIELD AND OFFICE EVALUATION OR AN ANALYSIS; THE POTENTIAL RISK IS JUDGED TO BE MILD, AND NO ACTIONS ARE PLANNED OTHER THAN MONITORING.
3	B	BRIDGE IS RATED AS SCOUR CRITICAL ON THE BASIS OF A FIELD AND OFFICE EVALUATION OR AN ANALYSIS; THE POTENTIAL RISK IS JUDGED TO BE MODERATE AND NO ACTIONS ARE PLANNED OTHER THAN MONITORING.
3	C	BRIDGE IS RATED AS SCOUR CRITICAL ON THE BASIS OF A FIELD AND OFFICE EVALUATION OR AN ANALYSIS; THE POTENTIAL RISK IS JUDGED TO BE SEVERE AND SCOUR COUNTERMEASURES ARE PLANNED. MONITORING IS TO BE UTILIZED UNTIL SCOUR COUNTERMEASURES ARE IN PLACE.
2	-	BRIDGE IS SCOUR CRITICAL; FIELD REVIEW INDICATES THAT EXTENSIVE SCOUR HAS OCCURRED AT A BRIDGE FOUNDATION. IMMEDIATE ACTION IS REQUIRED TO PROVIDE SCOUR COUNTERMEASURES.
1	-	BRIDGE IS SCOUR CRITICAL; FIELD REVIEW INDICATES THAT FAILURE OF PIERS/ABUTMENTS IS IMMINENT. BRIDGE IS CLOSED TO TRAFFIC.
0	-	BRIDGE IS SCOUR CRITICAL; BRIDGE HAS FAILED AND IS CLOSED TO TRAFFIC.

NOTE 1: IF THE RISK OF DAMAGE FROM POTENTIAL OR ACTUAL SCOUR DAMAGE IS JUDGED TO BE SEVERE, ADDITIONAL SCOUR STUDIES WILL BE UNDERTAKEN INCLUDING BORINGS OR OTHER MEANS OF SUBSURFACE EXPLORATION TO ASCERTAIN FOUNDATION AND SUPPORTING SOIL CONDITIONS.

STRUCTURES INVENTORY AND APPRAISAL
(NATIONAL BRIDGE INVENTORY SYSTEM)

SCREENING PROCEDURE FOR
RATING BRIDGES FOR ITEM 113, SCOUR CRITICAL BRIDGE

AGENCY: *PARSONS BRINCKERHOFF* BRIDGE NO.: *8584*
ROUTE: *TUTHILL ROAD* STREAM: *GILA RIVER*

SCREEN 1 - BRIDGE INSPECTOR'S SCREEN

EVALUATOR'S NAME: _____ DATE: *4/19/95*
RECOMMENDATION: ☐ RATE BRIDGE: 3C ☒ GO TO SCREEN 2

CRITERIA	RESPONSE		ITEM 113 RATING
	YES	NO	
1-1. BRIDGE OVER WATERWAY?	CONTINUE	RATE BRIDGE	N
1-2. BRIDGE INSPECTION REPORTS INDICATE:			
• BRIDGE FAILED/CLOSED DUE TO SCOUR	RATE BRIDGE	CONTINUE	0
• BRIDGE CLOSED; FAILURE IMMINENT DUE TO SCOUR	RATE BRIDGE	CONTINUE	1
• FOOTING EXPOSED; PROMPT ACTION REQUIRED TO PROTECT BRIDGE FROM SCOUR	NOTIFY OWNER; RATE BR.	CONTINUE	2
• SCOUR HOLES HAVE FORMED TO DEPTHS NEAR BOTTOM OF SPREAD FOOTINGS	NOTIFY OWNER; RATE BR.	CONTINUE	2
• EXPOSED PILES REQUIRE PROTECTION	NOTIFY OWNER; RATE BR.	CONTINUE	4
1-3. BRIDGE IS A CULVERT WITH A PAVED INVERT	RATE BRIDGE	CONTINUE	8C
1-4. TIDAL FLOWS GOVERN BRIDGE HYDRAULICS FOR WORST SCOUR CONDITIONS	RATE BRIDGE (INTERIM RATING)	CONTINUE	6T

1-5. BRIDGE IS ON THE 5 YEAR CAPITAL REPLACE. PROGRAM	RATE BRIDGE	CONTINUE	6R
1-6 BRIDGE IS ON THE 2 YEAR PROGRAM FOR REMEDIAL WORK	RATE BRIDGE	CONTINUE SCREEN 2	6R

SCOUR EVALUATION FORM FOR RATING BRIDGES FOR ITEM 113

SCREEN 2 - BRIDGE ENGINEER'S SCREEN

Agency: *PARSONS BRINCKERHOFF*

Date/Placeof Meeting: *APRIL 19, 1995;TUTHILL ROAD BRIDGE*

Attendees:

Bridge No.: *8584* Date Built on Bridge Plans: *7/81*

Description of Bridge/Bridge Type: *15 SPAN BRIDGE ON DRIVEN H-PILES WITH A PILE CAP. SUPERSTRUCTURE: AASHTO TYPE IV GIRDER*

Route: *TUTHILL ROAD* Water Course: *GILA RIVER*

Underclearance at thalweg (ft): *+-40*

Elevation of stream thalweg (ft): *+-848*

Normal water elevation (ft): *N/A*

Reported high water elevation: *883*

Description of flood: *200000 cfs*

Description of approach and "getaway" conditions: *WIDE APPROACH, HIGH BANKS ON LEFT UPSTREAM, RIVER CUTS INTO LEFT OVERBANK AREA BOTH UPSTREAM AND DOWNSTREAM OF THE BRIDGE.*

Description of bed load: *SAND AND GRAVEL.*

Condition of banks; evidence of lateral movement, degradation or aggradation: *LEFT OVERBANK SHOWS SIGNIFICANT EROSION, LATERAL MOVEMENT VERY VISIBLE AS RIVER CUTS FROM NORTH TO SOUTH JUST UPSTREAM OF BRIDGE. DEGRADATION APPARENT ON SOUTH END OF BRIDGE.*

Overtopping Q (cfs)/Recurrence interval: *> Q500 cfs/*

Stage rise to overtopping: ____

Depth/velocity through bridge at overtopping: *≥ Q500*

Confluences: *N/A*

BRIDGE NUMBER 8584

Description of flood plain: *WIDE FLAT FLOODPLAIN WITH SPARSE VEGETATION*

Item 321 rating: *3*
Item 71 rating: *8*
Item 61 rating: *3*

ABUTMENTS		
	LEFT	RIGHT
TYPE	*SPILL THROUGH*	*SPILL THROUGH*
SPREAD/PILES	*H-PILES*	*H-PILES*
EXPOSED FOOTINGS	*NO*	*NO*
FOOTING ELEVATION	*843.5*	*843.5*
ROCK ELEVATION AND DESCRIPTION	*N/A*	*N/A*
SOIL ELEVATION AND DESCRIPTION	*848'* *SAND-GRAVEL*	*848'* *SAND-GRAVEL*
ANGLE OF ATTACK OF FLOOD FLOWS ON ABUTMENT	*0*	*0*
DESCRIPTION OF RIPRAP OR OTHER SCOUR PROTECTION	*GROUTED RIPRAP OVERLAYED W/LARGE COBBLES*	*GROUTED RIPRAP OVERLAYED W/LARGE COBBLES*
ITEM 113 RATING	*9*	*9*

GENERAL COMMENTS:

1.) LEFT OVERBANK: UNDERMINING OF GROUTED RIPRAP HAS OCCURED.

2.) RIGHT ABUTMENT: GOOD CONDITION.

BRIDGE NUMBER 8584

PIERS						
	1	2	3	4	5	6
CHANNEL/FLOODPLAIN	*CH.*					
PIER WIDTH	*48"*					
SPREAD/PILES	*H-PILES*					
EXPOSED FOOTINGS	*NO*					
FOOTING HEIGHT	*6'-9"*					
FOOTING ELEVATION AND WIDTH	*+-840'* *25'X25'*					
ROCK ELEVATION/TYPE	*N/A*					
ELEVATION OF TOP OF GROUND OR CHANNEL; SOIL TYPE	*848' TO 860'* *SAND-GRAVEL*					
ANGLE OF ATTACK (DEG)	*0*					
RIPRAP OR OTHER PROTECTION	*NONE*					
ITEM 113 RATING	*8**					

General Comments/Assessment:

1.) *PIER 1 IS TYPICAL FOR ALL PIERS.*

2.) *SOME VISIBLE DEGRADATION IN CHANNEL AROUND PIERS.*

3.) *LOCAL SCOUR HOLES VISIBLE*

4.) *EXTENSIVE DEBRIS BUILDUP ON PIERS (UP TO 20' ON N. END, 10' ON S. END.*

Recommended Item 113 and Risk Ratings:

* FROM FIELD VISIT A RATING OF 8 WAS GIVEN, HOWEVER, USING THE SCOUR CALCULATIONS THE RATING BELOW IS GIVEN.

3C

BRIDGE NUMBER 8584

SCREEN 3 - HYDRAULIC ENGINEER'S SCREEN

NAME: *TUTHILL ROAD* DATE: *4/19/95*

AGENCY: *PARSONS BRINCKERHOFF*

THE RECOMMENDED ITEM 113 RATING FOR THIS STRUCTURE IS: *3C*

THIS RECOMMENDATION IS BASED ON:

X A SCOUR EVALUATION

X A FULL OR DETAILED SCOUR ANALYSIS

THE RECOMMENDATION HAS BEEN APPROPRIATELY COORDINATED WITH THE BRIDGE/FOUNDATION/GEOTECHNICAL ENGINEERS WHO HAVE PREPARED SCREENS 1, 2 AND 4.

COMMENTS ON SCREEN 3:

- USE OF SCREEN 3 IS RECOMMENDED WHEN THERE ARE QUESTIONS OR ISSUES WHICH HAVE NOT BEEN FULLY ADDRESSED DURING THE ITEM 113 BRIDGE SCOUR EVALUATION UTILIZING SCREEN 2.

- **AS A FIRST STEP, THE HYDRAULIC ENGINEER IS ENCOURAGED TO REVIEW APPROPRIATE AVAILABLE INFORMATION AND TO INSPECT THE BRIDGE SITE TO DETERMINE IF ADEQUATE INFORMATION CAN BE DEVELOPED TO RESPOND TO THE ISSUES ON SCOUR RAISED IN THE SCREEN 2 REVIEW WITHOUT CONDUCTING A FULL OR DETAILED SCOUR ANALYSIS.**

- SINCE THE ITEM 113 RATING REQUIRES THE EVALUATION OF THE STABILITY OF THE STRUCTURE UNDER WORST CASE SCOUR CONDITIONS, THE HYDRAULIC ENGINEER WILL GENERALLY NEED TO CONDUCT THE EVALUATION/ANALYSIS IN COOPERATION WITH A FOUNDATION/GEOTECHNICAL ENGINEER, AND SCREEN 4 SHOULD BE PREPARED AS APPROPRIATE.

- THE HYDRAULIC ENGINEER SHOULD DOCUMENT THE BASIS FOR HIS OR HER RECOMMENDATION OF THE ANTICIPATED EXTENT OF SCOUR TO BE EXPECTED AT THE BRIDGE. SCOUR ANALYSES SHOULD BE BASED ON THE PROCEDURES SET FORTH IN THE MARYLAND SHA PPM ON SCOUR EVALUATION OF BRIDGES DATED 6/17/91 AND IN THE FHWA HYDRAULIC ENGINEERING CIRCULARS 18 AND 20.

BRIDGE NUMBER 8584

SCREEN 4 - FOUNDATION/GEOTECHNICAL ENGINEER'S SCREEN

NAME: *TUTHILL ROAD* Date: *4/19/95*

AGENCY: *AGRA - EARTH AND ENVIRONMENTAL INC.*

THE RECOMMENDED ITEM 113 RATING FOR THIS STRUCTURE IS: *3B/C*

THIS RECOMMENDATION IS BASED ON:

X A SCOUR EVALUATION

☐ A FULL OR DETAILED SCOUR AND STRUCTURAL STABILITY ANALYSIS

THE RECOMMENDATION HAS BEEN APPROPRIATELY COORDINATED WITH THE BRIDGE AND HYDRAULIC ENGINEERS WHO HAVE PREPARED SCREENS 1, 2 AND 3.

COMMENTS ON SCREEN 4:

- USE OF SCREEN 4 IS RECOMMENDED WHEN THERE ARE QUESTIONS OR ISSUES WHICH HAVE NOT BEEN FULLY ADDRESSED DURING THE ITEM 113 BRIDGE SCOUR EVALUATION UTILIZING SCREEN 2.
- **AS A FIRST STEP, THE FOUNDATION/GEOTECHNICAL ENGINEER IS ENCOURAGED TO REVIEW APPROPRIATE AVAILABLE INFORMATION AND TO INSPECT THE BRIDGE SITE TO DETERMINE IF ADEQUATE INFORMATION CAN BE DEVELOPED TO RESPOND TO THE ISSUES ON SCOUR RAISED IN THE SCREEN 2 REVIEW WITHOUT CONDUCTING A FULL OR DETAILED SCOUR ANALYSIS.**
- SINCE THE ITEM 113 RATING REQUIRES THE EVALUATION OF THE STABILITY OF THE STRUCTURE IN ACCORDANCE WITH AASHTO STABILITY CRITERIA UNDER WORST CASE SCOUR CONDITIONS, THE FOUNDATION/GEOTECHNICAL ENGINEER WILL GENERALLY NEED TO CONDUCT THE EVALUATION/ANALYSIS IN COOPERATION WITH A HYDRAULICS ENGINEER TO ADDRESS PERTINENT SCREEN ISSUES.
- THE FOUNDATION/GEOTECHNICAL ENGINEER SHOULD DOCUMENT THE BASIS FOR HIS OR HER RECOMMENDATION REGARDING THE STABILITY OF THE BRIDGE FOR THE ANTICIPATED WORST CASE SCOUR CONDITIONS AND THE EXTENT OF SCOUR TO BE EXPECTED AT THE BRIDGE. PARTICULAR ATTENTION SHOULD BE GIVEN TO:
  - FOUNDATIONS ON ROCK AND THE DEGREE TO WHICH THE ROCK IS SCOUR- RESISTANT.
  - THE STABILITY OF FOUNDATIONS ON PILES, IF THE PILING CAN BE EXPECTED TO BE EXPOSED BY SCOUR.
  - EVALUATION OF EXISTING INFORMATION TO DETERMINE OR ESTIMATE FOUNDATION CONDITIONS WHEN THE BRIDGE PLAN DETAILS ARE INCOMPLETE.

BRIDGE NUMBER 8584

REVIEW BY INTERDISCIPLINARY SCOUR EVALUATION TEAM

DATE: ____________________ ITEM 113 RATING: ____________________

RISK RATING: ____

PROPOSED ACTIONS:

1.) _____

_____

_____

Notes:

BRIDGE NUMBER 8584

SCREEN 5 - BRIDGE MANAGER'S SCREEN

NAME/SIGNATURE : *PARSONS BRINCKERHOFF* DATE: 4/19/95

I HAVE REVIEWED SCREENS 1-4 AND CONCUR WITH THE FOLLOWING RATINGS:

- ITEM 113 RATING: *3C* DESCRIPTION:DEGRADATION AND SCOUR HOLES CAN BE SEEN AT THE BRIDGE, ESPECIALLY AT THE SOUTH ABUTMENT. LATERAL MOVEMENT MAY EVENTUALLY MOVE AROUND ABUTMENT. APPEARS LONG SPUR DIKES ARE NEEDED AT BOTH ABUTMENTS FOR THE APPROACHES AND DOWNSTREAM FOR THE SOUTH ABUTMENT. A STABILITY ANALYSIS SHOULD BE DONE USING REMAINING PILE DEPTHS.

- RISK RATING (FOR ITEM 113 RATING CODES 3 AND 6): *HIGH*

COMMENTS ON SCREEN 5:

1. THE CODES SET FORTH IN TABLE 1, ARE TO BE USED IN RATING BRIDGES FOR ITEM 113.

2. EACH BRIDGE MANAGER/OWNER NEEDS TO DEVELOP AN ACTION PLAN FOR SCOUR CRITICAL BRIDGES (SEE FHWA HEC- 18, CHAPTER 7) THIS PLAN SHOULD ADDRESS MONITORING OF SCOUR CRITICAL BRIDGES DURING HIGH WATER AND SCHEDULING AND INSTALLATION OF SCOUR COUNTERMEASURES WHERE DETERMINED TO BE NECESSARY. IT IS RECOMMENDED THAT SCOUR CRITICAL BRIDGES BE PRIORITIZED (ACCORDING TO THE ENGINEER'S JUDGMENT AS TO THE RELATIVE RISK OF SUSTAINING DAMAGE DUE TO SCOUR IN A FUTURE FLOOD) AS SEVERE (3), MODERATE (2) OR MILD (1). BRIDGES CODED AS 6 U SHOULD ALSO BE GIVEN A RISK RATING AS DESCRIBED IN TABLE 1.

BM1 = BRASS CAP ON TOP OF BARRIER WALL
SW CORNER OF BRIDGE, ELEV = 997.38

BM2 = BRASS CAP ON TOP OF BARRIER WALL
NE CORNER OF BRIDGE, ELEV = 997.43

BENCH MARK ELEVATIONS ARE ACCORDING TO MARICOPA COUNTY DEPARTMENT OF TRANSPORTATION DATUM. THE CORRESPONDING BRIDGE PLAN ELEV IS LISTED BELOW THE FLAGGING LINE.

A/B
A = MCDOT ELEVATION
B = CORRESPONDING BRIDGE PLAN ELEV.

SCHEMATIC
NOT FOR CONSTRUCTION

TUTHILL ROAD BRIDGE

SURVEYED BY: JVB KJS 5-30-95
DRAWN BY: KJS 5-31-95