INTERIM SUMMARY REPORT

HYDRAULIC INVESTIGATIONS OF THE SALT RIVER FOR THE EAST PAPAGO FREEWAY AND RED MOUNTAIN INTERCHANGE

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HYDRAULIC INVESTIGATIONS OF THE SALT RIVER FOR THE EAST PAPAGO FREEWAY AND RED MOUNTAIN INTERCHANGE

Submitted to:

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I. INTRODUCTION

The purpose of this report is to summarize the hydraulic engineering analyses of the Salt River conducted by SIMONS, LI & ASSOCIATES, INC. (SLA) to support the design of Section 6 of the East Papago Freeway and the Red Mountain Interchange. In order to properly assess and evaluate the potential impacts to the Salt River from the proposed freeway improvements, the hydraulic and sediment transport analyses extended beyond the limits of Section 6. The study area for the analyses includes that portion of the Salt River from just west of the Southern Pacific Railroad bridge to Alma School Road. Figure 1 presents a location map that identifies the limits of the study area.

1.1 Initial Report

The report titled "Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: September, 1989) presents the results of a preliminary hydraulic and scour analysis of the Salt River. The analysis was based on what has been termed the southern alignment of Section 6 of the East Papago Freeway. The southern alignment of Section 6 crossed the north end of McClintock Drive bridge so that the freeway would span the Salt River immediately east of McClintock Drive, and then generally follow the south bank of the river to the Red Mountain Interchange. Figure 2 illustrates the southern alignment for Section 6 of the East Papago Freeway.

The report discusses the existing conditions of the Salt River including changes to the river due to man's activities. The most significant impacts due to man's activities are sand and gravel mining operations and encroachment upon the floodplain of the Salt River.

The focus of the initial investigation was to perform an analysis that would provide hydraulic parameters of the Salt River under a given set of design criteria. The hydraulic parameters derived as a result of the analysis included depths of flow, flow velocities, and elevations of the water surface that a particular flowrate could attain. The most significant design criteria of the

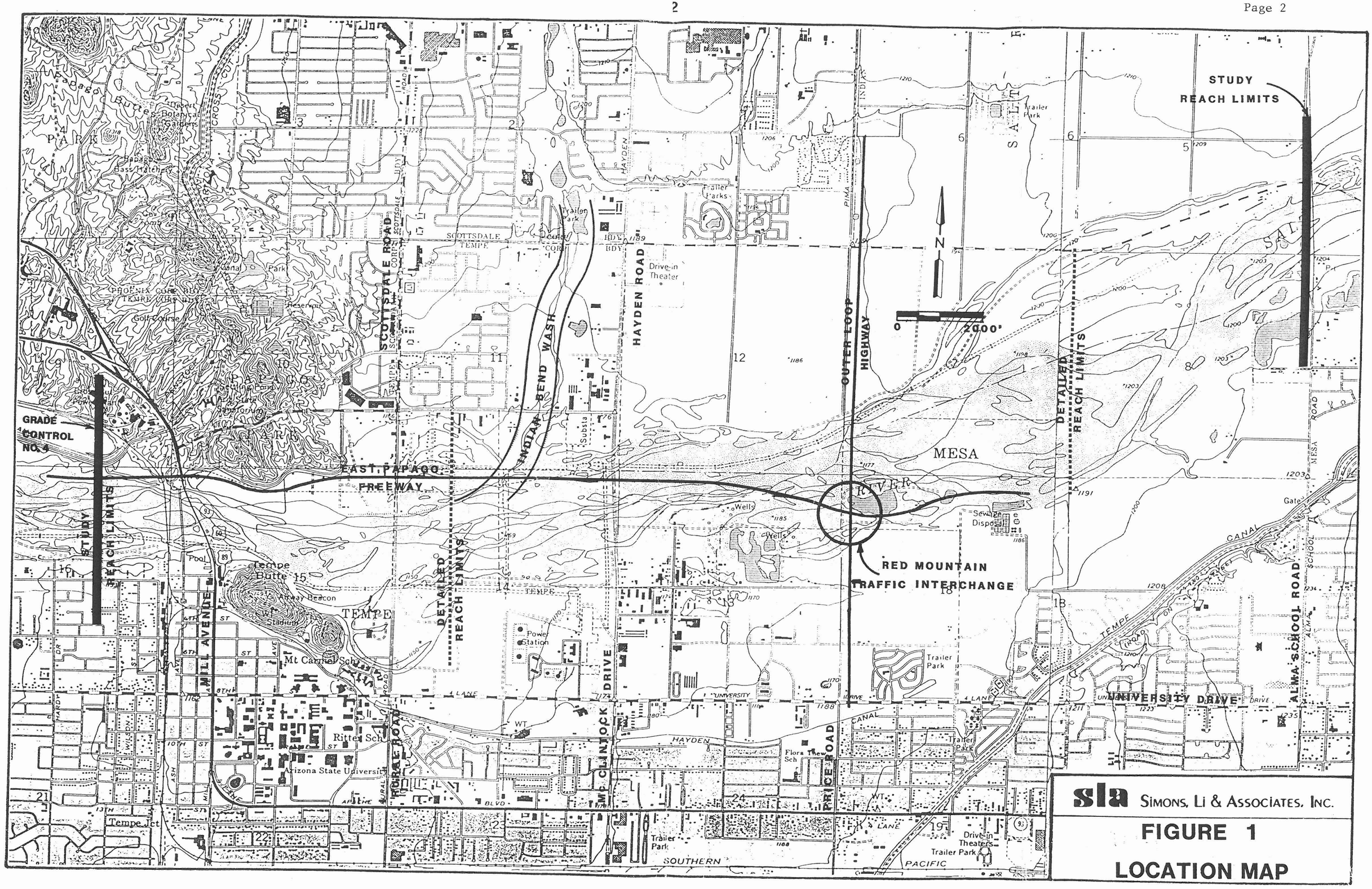

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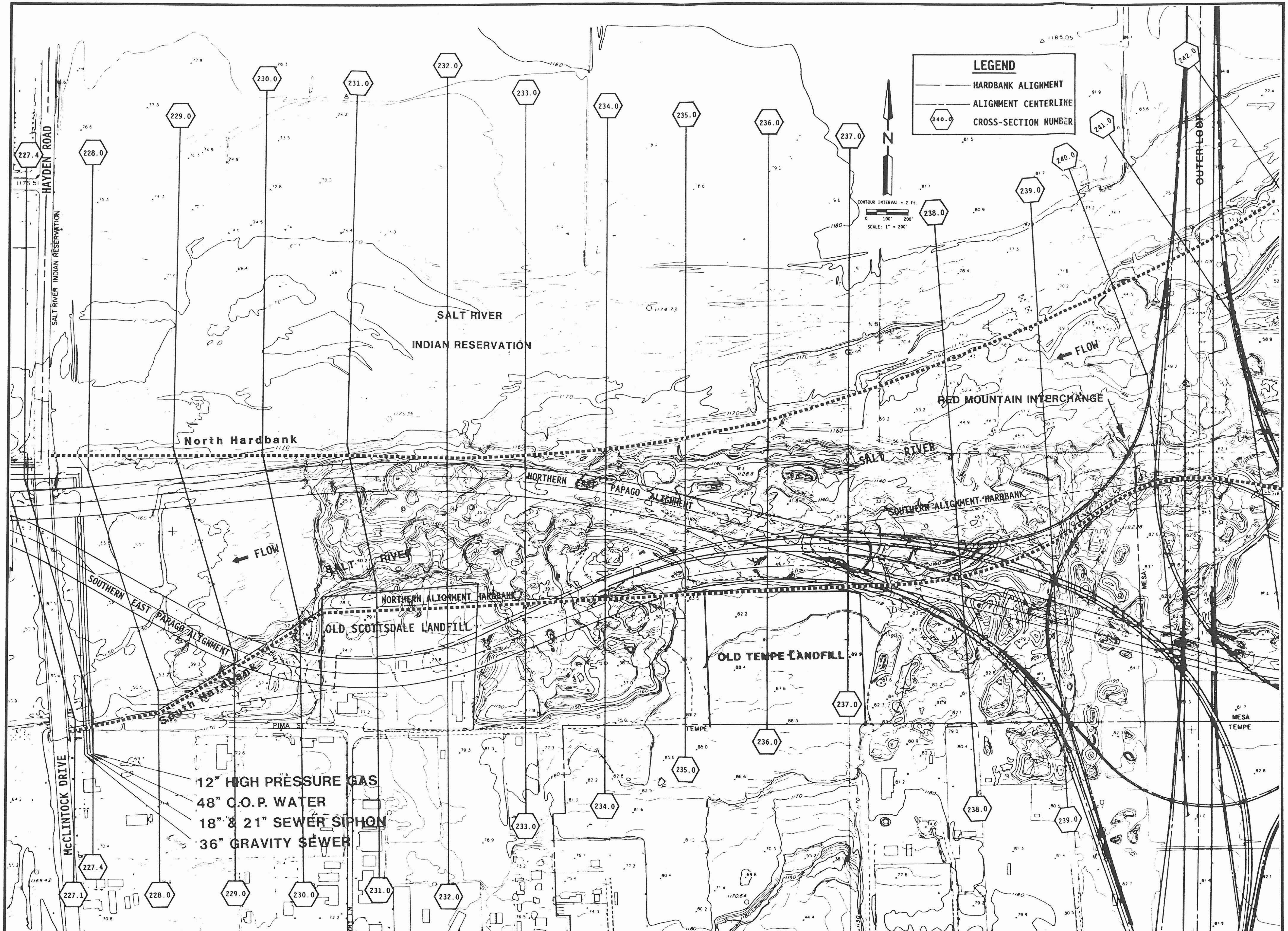
FIGURE 1

LOCATION MAP



SLA Simons, Li & Associates, Inc.
Newport Beach, CA., Fort Collins, Co.,
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East Papago Freeway - Section 6
Alternate Alignments

Project No. AZ-DMJM-03
Date: 11/7/89
Design:
Drawn: JRM
Check:
Revisions:

FIGURE 2

study was to use what is known as the 100-year flood or 100 year peak discharge of 215,000 cubic feet per second (cfs) to determine the river hydraulic parameters. The analysis incorporated the existing bridge crossings over the Salt River and accounted for the sand and gravel mining operations.

The results of the hydraulic analysis were then used to assess the potential for movement or transport of river bed materials (sediment) by the flows in the river. The sediment transport analysis provided estimates of the amount of scour that could occur at bridge piers as well as predictions of how the river will perform (respond) over the long term. The analysis generated information useful in identifying types of stabilization measures required for levee embankments and bridge crossings.

II. ADDENDUMS TO INITIAL REPORT

An alternate alignment for Section 6 of the East Papago Freeway was proposed to improve the freeway alignment through the Red Mountain (Outer Loop) Interchange. The alternate northern alignment required locating the East Papago Freeway to the north and placing the freeway entirely on a bridge structure east of McClintock Drive (see Figure 2). The northern alignment crosses McClintock Drive bridge and proceeds east to a point north of the Old Tempe Landfill where the freeway turns to cross the Salt River and tie into the Red Mountain Interchange.

Four additional hydraulic and scour analyses were performed based on the northern alignment for Section 6 of the East Papago Freeway. The four analyses were conducted to identify Salt River channel configurations which would minimize the proposed project impacts within the study area. A description for each additional analyses is presented below. Table 1 provides a summary of these analyses.

2.1 Addendum No. 1

"Addendum No. 1 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: November 22, 1989) presents the results of the first analysis (Alternative 1) incorporating the northern alignment of Section 6. The hydraulic and scour analyses procedures, and data base used for Addendum No. 1 were the same as those used in the analyses of the proposed southern alignment.

Alternative 1 consists of a proposed levee along the south bank of the Salt River with no bank protection included for the north bank. The proposed south bank levee would be located adjacent to the Old Scottsdale Landfill (Perry Lane Landfill) and the Old Tempe Landfill in order to minimize disturbance to the sites as well as optimizing conditions in the river.

The results of the hydraulic analysis for Alternative 1 indicates a maximum increase in water surface elevation above baseline conditions estimated at 1.0

TABLE 1. Chronological History of Hydraulic Investigations of the Salt River.

REPORT DATE	REPORT TITLE	ALIGNMENT STUDIED	CONCEPTS INVESTIGATED
September, 1989	Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Southern	Hydraulic analysis of Salt River. Sediment transport analysis.
November 22, 1989	Addendum No. 1 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Northern	Hydraulic analysis of Salt River including new south bank levee. Local scour analysis.
November, 1989	Preliminary Erosion Analysis of the North Bank of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Southern and Northern	Stability of the north bank of the Salt River. Effects on Indian gravel mining operations. Flood-plain extent on Indian lands.
December 7, 1989	Addendum No. 2 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Northern	Hydraulic analysis of Salt River including south bank levee and north bank levee. Local scour analysis.
February 28, 1990	Addendum No. 3 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Northern	Hydraulic analysis of Salt River including south bank levee and north bank levee. North bank elevation set at 1170.0 feet. Local scour analysis.
March 12, 1990	Addendum No. 4 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange.	Northern	Hydraulic analysis of Salt River including south bank levee and north bank levee. North bank elevation set at 1170.0 feet. North bank extended and channel bottom elevations modified. Local scour analysis.
April 6, 1990	In-Stream Sand and Gravel Mining Setbacks Recommendations.	Northern	Investigation of setback requirements for sand and gravel mining operations.
May, 1990	Assessment of Alternative Bank Protection Techniques for the Salt River Channel Located Adjacent to Section 6 of the East Papago Freeway, Maricopa County, Phoenix.	Northern	Investigation for alternative bank protection techniques based on economic, social, environmental, and technical issues.

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foot and occurring in the vicinity of the Old Scottsdale Landfill. The section of the Salt River between McClintock Drive and the proposed Outer Loop Highway produced the highest average 100-year flow velocity of 10.8 feet per second near the western edge of the Old Scottsdale Landfill. The maximum increase in average flow velocity above baseline conditions is 1.4 feet per second occurring downstream of the two landfill sites.

2.2 Addendum No. 2

"Addendum No. 2 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: December 7, 1989) presents the results of the second analysis (Alternative 2) incorporating the northern alignment of Section 6. The hydraulic and scour analyses procedures used for Addendum No. 2 were the same as those used in the analyses for the proposed southern alignment.

Alternative 2 consists of a channel having both a south bank and a north bank levee with capacity to convey the design discharge of 215,000 cfs (i.e., the current 100-year event) within the channel banks from the east side of the McClintock Drive bridge through the Outer Loop crossing. The proposed north bank alignment generally follows the southern edge of the Salt River Project's (SRP) power transmission easement.

The results of the hydraulic analysis for Alternative 2 estimates a maximum increase in water surface elevation above baseline conditions of 1.7 feet, occurring within the bank protected section of the Salt River downstream of the Outer Loop. Upstream of the Outer Loop, the water surface elevation increase is 1.0 foot to approximately Dobson Road. The highest average 100-year flow velocity within the study area, 12.8 feet per second, occurred at the western end of the Old Scottsdale Landfill. The maximum increase in average flow velocity over baseline conditions is estimated at 2.7 feet per second upstream of the Old Scottsdale Landfill.

2.3 Addendum No. 3

"Addendum No. 3 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: February 28, 1990) presents the results of the third analysis (Alternative 3) incorporating the northern alignment of Section 6. The hydraulic and scour analyses procedures, and data base used for Addendum No. 3 were the same as those used in the analyses of the proposed southern alignment.

Alternative 3 consists of a leveed south bank identical to that in the first two addendums. However, Alternative 3 provides bank protection along the north bank line to an elevation of 1170.0 feet, the approximate existing top of bank of the main channel for this stretch of the Salt River. This protection of the north bank will extend between McClintock Drive and the Outer Loop crossing and will permit flow in the north overbank for large magnitude flood events. Figure 3 presents a typical section which illustrates the conditions for Alternative 3.

The results of the hydraulic analysis for Alternative 3 estimates a maximum increase in water surface elevation above baseline conditions of 1.2 feet at the upstream end of the Old Scottsdale Landfill. The highest average flow velocity within the study area is estimated to be 10.7 feet per second at the east end of the Old Scottsdale Landfill. The maximum increase in average flow velocity over baseline conditions is estimated at 1.7 feet per second, occurring west of the Old Scottsdale Landfill.

2.4 Addendum No. 4

"Addendum No. 4 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: March 12, 1990) presents the results of the fourth analysis (Alternative 4) incorporating the northern alignment of Section 6. The hydraulic and scour analyses procedures and data base used for Addendum No. 4 were the same as those used in the analyses of the proposed southern alignment.

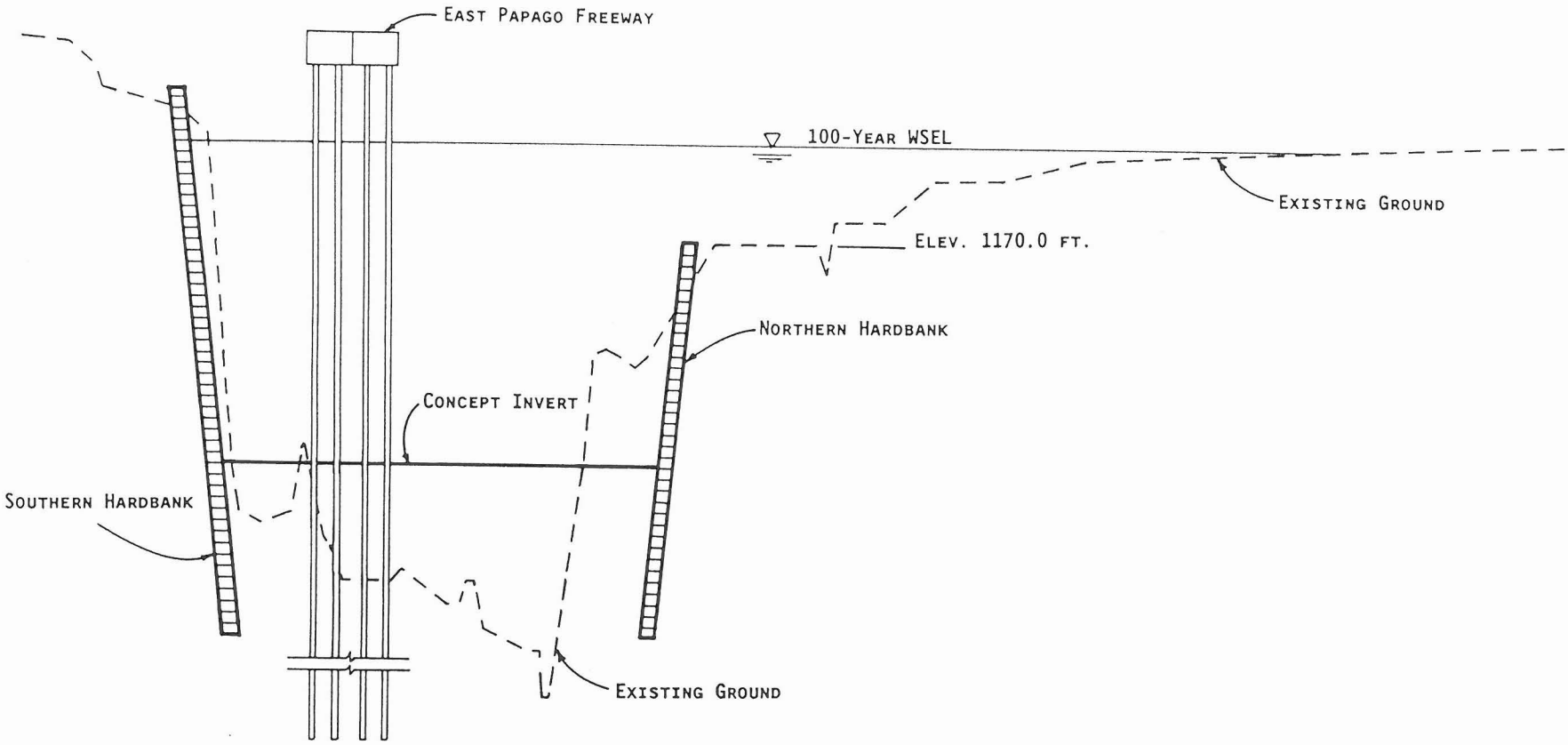

FIGURE 3
TYPICAL SECTION - ALTERNATIVE 3

Alternative 4 consists of the same alignment and configuration for bank protection as Alternative 3. In addition, the north bank protection is extended through the Outer Loop crossing to a termination point at a historical bank of the Salt River. Alternative 4 also incorporates modified channel bed elevations throughout the project, and nine foot diameter piers to reflect the current design for the East Papago Freeway bridge crossing the Salt River.

The results of the hydraulic analysis for Alternative 4 indicates a maximum increase in the 100-year water surface elevation to be 0.2 feet, occurring downstream of the Outer Loop crossing. The highest average flow velocity through the study area is estimated at 12.7 feet per second upstream of the Old Scottsdale Landfill. The estimated maximum average flow velocity is essentially the same as baseline conditions (13.0 feet per second) for this location. Between McClintock Drive and the Outer Loop crossing of the Salt River, the maximum increase in average flow velocity above baseline conditions is 4.0 feet per second.

2.5 Comparison of Alternatives

A comparison of water surface elevations for the four alternatives shows that Alternative 4 will result in lower water surface elevations upstream of McClintock Drive. As a result, average channel velocities between the McClintock Drive bridge and the Outer Loop are generally higher for Alternative 4 than for the other alternatives. Comparison of the four alternative channel configurations indicates that Alternative 4 provides for a stable channel cross section while minimizing the resultant increase in water surface elevations over baseline conditions. Figure 4 shows a plot of the water surface profiles for the four alternatives of the northern alignment for Section 6 of the East Papago Freeway.

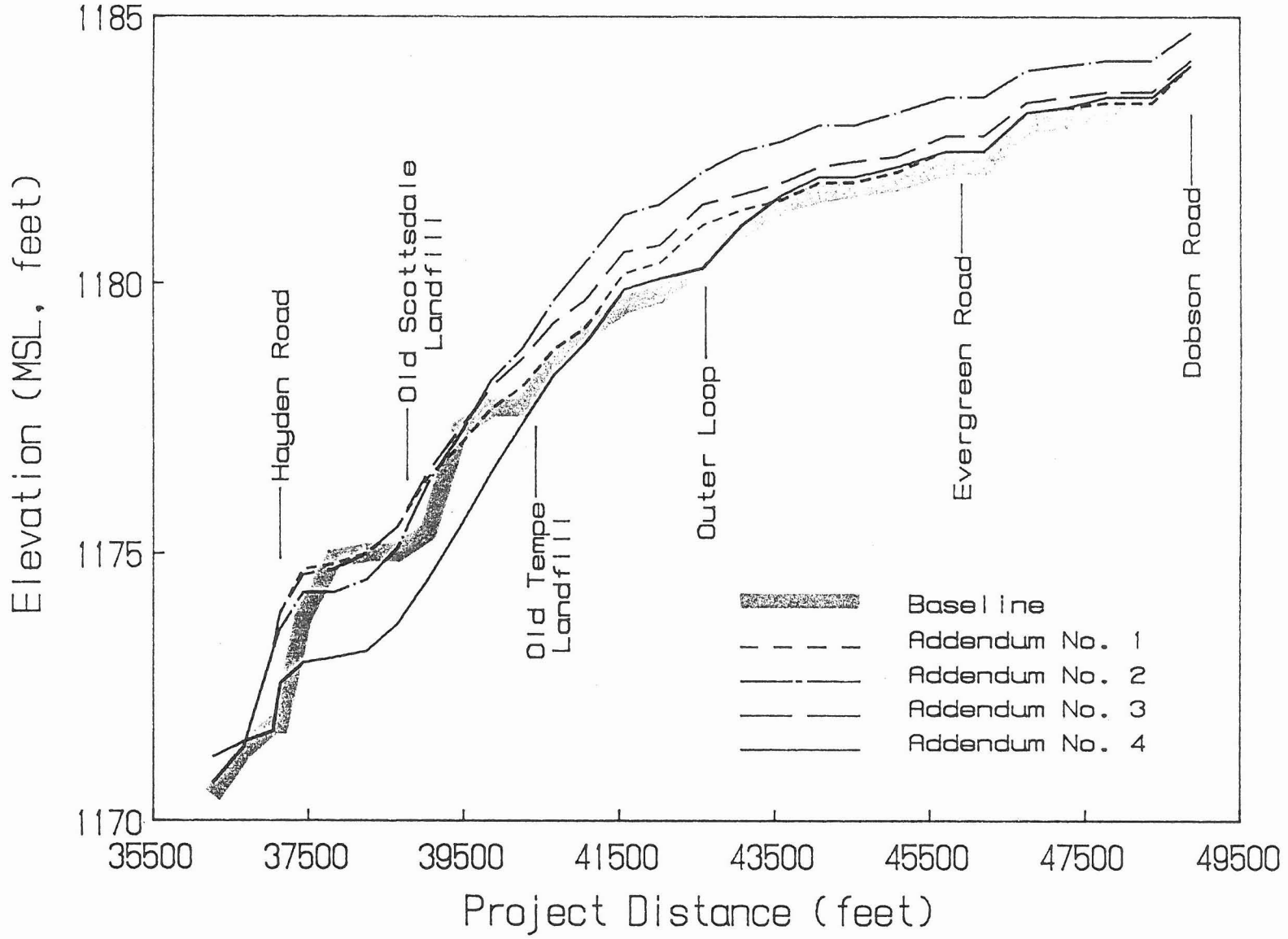

FIGURE 4
WATER-SURFACE PROFILES FOR THE NORTHERN ALIGNMENT
EAST PAPAGO FREEWAY - SECTION 6

III. ADDITIONAL INVESTIGATIONS AND OTHER IMPACTS

In addition to the initial report and four addendums, three other investigations and studies were conducted that addressed concerns within the study area of the Salt River. The three studies focussed upon erosion analysis of the north bank, alternative bank protection techniques, and in-stream sand and gravel mining recommendations. A description of each study is presented below.

3.1 Erosion Analysis of North Bank

The report titled "Preliminary Erosion Analysis of the North Bank of the Salt River for the East Papago Freeway and Red Mountain Interchange" (SLA: November, 1989) addresses questions and issues raised on behalf of the Salt River Pima Maricopa Indian Community (SRPMIC). Items addressed in the report include (1) the stability of the north bank of the Salt River in the vicinity of the Red Mountain Interchange, (2) the effects that the proposed freeway alignments may have on the Indian Communities sand and gravel mining operations, and (3) the effect that the proposed freeway alignments may have on the floodplain extent on Indian lands.

The results of this study included recommendations to provide erosion protection along the north bank and to provide some restrictions for the upstream gravel mining within the area.

3.2 Alternative Bank Protection

The report titled "Assessment of Alternative Bank Protection Techniques for the Salt River Located Adjacent to Section 6 of the East Papago Freeway, Maricopa County, Arizona" (SLA: May, 1990) presents the results of an investigation to assess and evaluate the engineering and environmental consequences of alternative bank protection techniques. A wide range of alternative bank protection techniques were investigated and an acceptable alternative was selected based upon systematic considerations of economic, social, environmental, and technical issues. The selection of the best alternative was made in accordance with Section 404 of the Clean Water Act.

The results of the study concluded that cement stabilized alluvium (CSA) was the least environmentally intrusive and the most practical form of bank protection.

3.3 In-Stream Sand and Gravel Mining

An analysis was conducted for the protection of the proposed structures, ramps, and channel improvements for the East Papago Freeway and Red Mountain Interchange regarding in-stream sand and gravel mining (SLA: April 6, 1990). This analysis was based on a research study for the Arizona Transportation Research Center (SLA: June, 1989) which identified that continual mining, characteristic throughout the design reach of the Salt River, induces long-term detrimental impacts upon channel stability. Therefore, setback distances for mining operations have been proposed to protect the proposed improvements for the East Papago Freeway and Red Mountain Interchange from the long-term effects of in-stream sand and gravel mining.

3.4 Other Impacts

Other items which will likely affect future hydraulic conditions within this reach of the Salt River, (but were not considered during the analyses) include the following:

1) The City of Tempe is planning future channelization of the Salt River in conjunction with the Rio Salado project. When constructed, the Tempe Rio Salado project will likely have the effect of further lowering water-surface elevations upstream of McClintock Drive.

2) Plans exist for the reconstruction of Roosevelt Dam on the Salt River. One result of this planned reconstruction will be to increase the storage capacity of Roosevelt Lake and thereby reduce the estimate of the 100-year flow within the Salt River at the project site. This will also have the effect of further lowering water surface elevations throughout the project reach.

3) During the analyses of the Salt River, the south bank throughout the project reach has always been assumed to be located along the north edge of the Old Tempe and Old Scottsdale landfills. Part of this area has been declared a Superfund Site and is scheduled for clean-up by the Environmental Protection Agency (EPA). After the cleanup, the south bank in the vicinity of the Old Scottsdale Landfill could be constructed further south thereby creating a wider channel and lower water-surface elevations throughout the study reach.

IV. MITIGATION MEASURES

4.1 Channel Hardbank

Channel improvements will be required to maintain a stable channel configuration through the design reach of the Salt River. A hardbank consisting of cement stabilized alluvium will provide the necessary erosion and flood protection for the planned transportation facilities. The proposed channel configuration provides an additional advantage in reducing the erosion and flood hazards that currently exist along the project reach.

Alternative 4 includes channel bottom modifications and bank protection along both the north and south banks through the Outer Loop structures. The south bank is proposed to extend from McClintock Drive to the Tempe Drain and would be leveed to the current 100-year event water-surface elevation (215,000 cfs discharge) with an additional two feet added for freeboard. The north bank, between McClintock Drive and the Outer Loop Highway structures, would be protected to the height of the existing top-of-bank (approximate elevation of 1170 feet) to provide protection against lateral bank erosion, but would allow for overbank flooding during large flow events. Upstream of the Outer Loop structures, the north bank would be leveed to the current 100-year event water-surface elevation with an additional two feet added for freeboard.

The proposed construction sequence for the channel improvements is to be in two phases. The two phased construction sequence results from environmental precautions that are mandated at the Environmental Protection Agency's (EPA) South Indian Bend Wash Superfund Site. Current ongoing studies (Engineering Evaluation/Cost Analysis, etc.) will identify methods to mitigate hazardous wastes which may be encountered during freeway or related bank protection construction.

The first phase of construction includes three major elements. The first element is the construction of the levee along the south bank from the western edge of the Old Tempe Landfill east to the Tempe Drain. The second element is the construction of bank protection along the north bank to the top of the

existing main channel bank between McClintock Drive and the Outer Loop structures. The third element extends the north bank through the Outer Loop structures to the termination point with the same design standards as the south levee.

The second phase of construction consists of two elements which provide flood protection up to the 100-year event for land both north and south of the Salt River between McClintock Drive and the Outer Loop structures. The first element would extend the south bank levee from the Old Tempe Landfill to McClintock Drive, upon resolution of environmental issues. The second element would raise the north hardbank protection to a level which would provide the same flood protection as the south bank levee.

4.2 Gravel-Mining Setback Requirements

Protection of the proposed transportation facilities and associated channel improvements includes consideration for the long-term effects of in-stream mining on channel stability. Results from the ATRC and physical model studies (Chen: December, 1980) were utilized to determine the minimum sand and gravel mining setback requirements. These two studies indicated a minimum setback distance of 1300 feet, or approximately one-quarter mile, is required upstream of the Outer Loop to protect the structures from the effects of the in-stream mining. In addition, data from the physical model study indicates that lateral migration of mining excavations on the order of 300 feet might occur. Therefore, the setback distance recommended to protect the proposed bank protection from the effects of in-stream mining has been set at 300 feet.

V. SUMMARY

5.1 Recommended Alternative

The recommended channel configuration for Section 6 of the East Papago Freeway is Alternative 4. This alternative considers the northern alignment for Section 6 of the East Papago Freeway, which is planned to be entirely on structure from McClintock Drive to the Red Mountain Interchange. The channel configuration for Alternative 4 is proposed to be constructed in two phases. The first phase includes three main elements: 1) leveed south bank from the west end of the Old Tempe Landfill to the Tempe Drain; 2) protection of the north bank to the existing top-of-bank between McClintock Drive and the Outer Loop crossings; and, 3) leveed north bank through the Outer Loop structures to a stable termination point along the Salt River. The second phase includes two main elements: 1) leveed south bank from McClintock Drive to the Old Tempe Landfill; and, 2) raise the elevation of the north bank protection to provide the same protection as the south bank. Upon completion of the second and final construction phase, the proposed channel configuration would provide flood protection up to the 100-year event for land both north and south of the Salt River between McClintock Drive and the Outer Loop Highway.

5.2 Impacts on Sand and Gravel Mining

Independent studies have determined that in-stream sand and gravel mining has the potential to induce long-term impacts upon channel stability. To protect the proposed facilities for the East Papago Freeway and Red Mountain Interchange from long-term mining impacts, setback limits have been developed. It is proposed that in-stream mining operations maintain a one-quarter mile setback upstream of the Outer Loop structures and a 300 foot buffer perpendicular to the proposed bank protection facilities. The proposed mining setbacks would not significantly impact current mining operations due to the fact that a majority of the land within the proposed setback right-of-way has already been mined or is currently part of the main low-flow channel of the Salt River.

5.3 Floodplain Impacts

The hydraulic results show that Alternative 4 will not significantly increase water-surface elevations above baseline conditions. Upstream impacts associated with Alternative 4 are less, in general, than impacts associated with the three other alternatives considered for the northern alignment of Section 6 of the East Papago. Between the McClintock Drive bridge and the Outer Loop Highway crossings, the maximum increase in water-surface elevation is 0.2 feet. Flooding on the north overbank will not be increased, since water-surface elevations for Alternative 4 concept conditions are at or below baseline conditions. Although velocities are slightly higher than for other alternatives investigated, stability of both the north bank and the south bank is provided. Upstream of the Outer Loop Highway crossings, the increase in water-surface elevations remains below 0.2 feet, and gradually diminishes to baseline conditions around Dobson Road.

5.4 Benefits of Selected Alternative

In summary, the recommended alternative, Alternative 4, will provide benefits to adjacent land owners along the study reach of the Salt River. Upon completion of the phased construction of Alternative 4, a substantial quantity of land will be removed from the 100-year floodplain and a stable bank and profile will be established for the design reach of the Salt River.

VI. REFERENCES

1. Simons, Li & Associates, Inc., "Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. September 1989.

2. Simons, Li & Associates, Inc., "Addendum No. 1 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. November 22, 1989.

3. Simons, Li & Associates, Inc., "Addendum No. 2 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. December 7, 1989.

4. Simons, Li & Associates, Inc., "Addendum No. 3 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. February 28, 1990.

5. Simons, Li & Associates, Inc., "Addendum No. 4 to: Preliminary Hydraulic Analysis of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. March 12, 1990.

6. Simons, Li & Associates, Inc., "Preliminary Erosion Analysis of the North Bank of the Salt River for the East Papago Freeway and Red Mountain Interchange." Submitted to Daniel, Mann, Johnson, & Mendenhall. November, 1989.

7. Simons, Li & Associates, Inc., "Effects of In-stream Mining on Channel Stability." Report No. FHWA-AZ88-250. Prepared for Arizona Department of Transportation, Arizona Transportation Research Center. June 1989.

8. Simons, Li & Associates, Inc., "Assessment of Alternative Bank-Protection Techniques for the Salt River Channel Located Adjacent to Section 6 of the East Papago Freeway, Maricopa County, Arizona." Submitted to Daniel, Mann, Johnson, & Mendenhall. Draft, May 1990.

9. Chen, Yung Hai. Civil Engineering Department, Engineering Research Center, Colorado State University, "Investigation of Gravel Mining Effects Salt River Channelization Project at Sky Harbor International Airport." Prepared for Anderson-Nichols. December 1980.

10. Simons, Li & Associates, Letter from Mr. Dennis L. Richards, P.E. (SLA) to Mr. Thomas M. Monchak (DMJM) dated April 6, 1990 RE: In-Stream Sand and Gravel Mining Setbacks Recommendations.