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Document No. 890014
EH&A Job No. 11345

MEDINA LAKE HYDROLOGY STUDY

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March 1989

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Concluded)

1.0 INTRODUCTION

This report presents the results of hydrologic and hydraulic analyses for the Medina Lake and Medina Diversion Lake reservoir system. This engineering analysis was conducted in order to determine the availability of surface water from these reservoirs under various operating scenarios for the purpose of recharge to the Edwards Aquifer. Also included in the project objective was an engineering analysis of the hydraulic capacity of each of these facilities under a variety of flood conditions.

2.0 FLOOD ROUTING ANALYSES

The revised United States Army Corps of Engineers (USCE) computer model, Flood Hydrograph Package, designated HEC-1 (USCE, 1985), was used to determine the depth and duration of flood flows for the Medina Lake reservoir system. In order to evaluate the spillway structural capabilities and possible modifications of the Medina Lake Dam and Medina Diversion Lake Dam, the design storms considered in these analyses were the historical 1978 flood event, the 100-year flood and the probable maximum flood (PMP). For purposes of these analyses, the reservoir elevation-spillway discharge relationship and tailwater elevation-discharge ratings were also developed for the Medina Lake and Medina Diversion Lake. The following sections describe each of these evaluations.

2.1 TAILWATER

In order to provide input to the EUWD consultant performing the structural stability analyses for the Medina Lake Dam, a tailwater rating curve was first developed using the USCE Water Surface Profiles computer model, HEC-2 (USCE, 1982). Surveyed cross-sections of the Medina Lake Dam and Medina Diversion Dam (provided by W.E. Simpson Company, Inc. through EUWD from Harlan Wolff, R.P.S.) were supplemented with cross-sections and streambed elevations obtained from the USGS 7.5-minute topographic maps, Medina Lake, Texas and Riomedina, Texas. A range of flows from 1,000 cfs to 300,000 cfs were input into the HEC-2

model for the reach between Medina Lake Dam and the Diversion Dam. The resulting water surface elevations (which include backwater effects due to the Diversion Dam) were plotted versus the corresponding discharges in order to determine the tailwater rating curve for the Medina Dam, as shown in Figure 2-1.

A similar process was also completed for the Diversion Dam and the tailwater curve for this structure is included in Figure 2-2. Table 2-1 provides numerical values for the tailwater elevation vs. discharge at both the Medina Dam and the Medina Diversion Dam.

2.2 SPILLWAY DISCHARGE RATING

In performing the spillway discharge ratings for both the Diversion Dam and the Main Dam, all dimensions and elevations relied upon were those provided by W.E. Simpson Company, Inc. through EUWD to EH&A through the work of Mr. Harlan Wolff, R.P.S., of Hondo, Texas.

2.2.1 Diversion Dam

The Diversion Dam cross-section along the majority of the length of the crest provides a nappe-shaped weir. Using techniques described in the Bureau of Reclamation's Design of Small Dams, EH&A determined that the weir cross-section approximates that which would result from a design head of 13 feet on the structure. Using this design head of 13 feet and the weir equation, including corrections for the central pier at the center of the Diversion Dam crest, pier contraction coefficients, abutment contraction coefficients, and actual vs. design heads on the crest, EH&A developed discharges for the approximate 351-foot crest length (resulting from subtracting the 9-foot pier width from the gross length of 360 feet).

Additionally, EH&A computed the rated discharge over the abutment sections of the dam using two techniques. For the horizontal concrete sections immediately adjacent to the nappe-shaped weir crest, EH&A used the sharp-crested weir equation with a coefficient of discharge of 3.09 for the combined abutment lengths of 178.48 feet. For those areas outside of the concreted, horizontal abutment area (i.e., those areas extending up the existing natural ground

slope adjacent to the abutments), EH&A used the triangular weir discharge equation with side slopes of 0.85 to 1 and 1.55 to 1 on the east and west abutments, respectively.

The resulting elevation versus discharge rating data is shown in Figure 2-3 and Table 2-2 and the table of calculations is included in Appendix A.

2.2.2 Main Dam

The Main Dam emergency spillway and top of dam were evaluated with respect to flow capacities. Low flow outlets and/or gated release points at the toe of the main dam structure were ignored for purposes of flood discharges.

2.2.2.1 Emergency Spillway

Using survey data, including cross-sections and profiles of the emergency spillway channel, a control section was selected as shown in Figure 2-4. The control section is that section that would control discharges for various heads through the spillway.

Appendix A gives the discharge rating calculations for the Medina Lake emergency spillway, and the equations and corresponding lengths used therein. The resulting spillway discharge rating curve is shown in Figure 2-5 and Table 2-3.

2.2.2.2 Top of Dam

Discharges which would occur over the top of the Main Lake Dam were computed using the equations and methodologies given in Appendix A, and the results are shown in Table 2-4. This table assumes that handrails do not exist along the crest of the dam.

In addition to this rating, other ratings were performed in which it was assumed that varying lengths of the handrails which do exist on top of the dam would be washed away when the depth of flow over the dam exceeded the height of the handrails. These calculations are

presented in Appendix A. The discharge rating assuming none of the handrail is washed away is shown in Table 2-5. This data is also plotted in Figure 2-6.

The rating of the top of dam was accomplished using the broad-crested weir equation and coefficients of discharge as contained within Brater and King, Handbook of Hydraulics.

The cross section of the dam consists of a vertical upstream face, a 1-foot high by 1-foot wide curb, a concrete roadway of varying width (being 14-feet wide from station 1+68 to station 4+64 and from station 11+73.97 to station 17+12.6, and being 23-feet wide from station 4+64 to station 11+73.97, with the exception of four locations having an approximate total length of 64 feet which are somewhat wider). On the downstream edge of the dam, another 1-foot by 1-foot concrete curb exists, with the dam then dropping away vertically for a short distance before gradually flaring out to the toe of the dam. Atop both the upstream and downstream concrete curbs exist a steel handrail consisting of vertical supports and three horizontal members. The top member is a steel pipe and the middle two members are made up of steel cable. The condition of these rails is somewhat suspect in that corrosion was noted during visits to the dam to some of the support pipes. However, no data exists which would indicate whether or not these railings could withstand the force of the flowing water and debris accumulation which would occur, hence the necessity to assume varying failure modes in the spillway rating analyses and the subsequent flood analyses performed.

2.3 DESIGN FLOOD INFLOWS

2.3.1 Historical 1978 Flood

On July 31, 1978, tropical storm Amelia moved inland on the lower Texas coast. A secondary cell of this storm developed in Bandera County, Texas and was centered near the town of Medina, Texas and the confluence of the North Prong and the West Prong of the Medina River. The flood crest from this storm reached the USGS gaging station near Pipe Creek on August 2, 1978, exceeding the previous maximum stage by more than six feet. The peak discharge at the Pipe Creek station was 281,000 cfs which has been estimated to have a recurrence interval

greater than 100 years (USGS, 1979). During this storm, Medina Lake reached a stage of 1068.9 feet NGVD (1076.67 feet, Medina Dam Datum) with a maximum storage of 281,000 acre-feet (USGS, 1979).

The hourly discharge and gage height records for the Medina River USGS station near Pipe Creek were obtained from the USGS publication Floods in Central Texas, August, 1978 (USGS, 1979). The 1978 flood inflow hydrograph is shown in Figure 2-7 with missing data points filled in to form a smooth curve. Evaluation of USGS records indicate minimal inflows from the intervening drainage area between the Pipe Creek gage and Medina Dam. Therefore, the Pipe Creek gage discharge records were adopted as the 1978 flood inflows for these analyses.

The 1978 flood hydrograph was then routed through Medina Lake and subsequently the Medina Diversion Lake using the USCE HEC-1 computer program and the elevation-area-capacity and spillway discharge data given in sections 3.0 and 2.2, respectively. In order to reconstruct the 1978 flood discharge, computations were started at the historical Medina Lake storage of 198,100 acre-feet which occurred just prior to the flood crest on August 2, 1978 (USGS, 1979). The total runoff volume generated by the 1978 flood was approximately 114,000 acre-feet.

2.3.2 Probable Maximum Flood

The probable maximum precipitation (PMP) and unit hydrograph for the 634-square mile Medina Lake watershed were obtained from the Texas Department of Water Resources (TDWR) Phase I Inspection Report for the Medina Lake Dam (TDWR, 1979). This information was verified using the procedures outlined in the Hydrometeorological Report 51 (HMR-51) published by the National Weather Service (NWS) (Screiner and Riedel, 1978). The 72-hour rainfall of 35.99 inches and runoff volume of 29.45 inches (995,801 acre-feet from a watershed of 634 square miles) from the TDWR report were calculated assuming a uniform loss rate of 0.1 inches per hour (TDWR, 1979). The 2-hour incremental rainfall distribution and rainfall excess, and the TDWR unit hydrograph adopted for the purposes of these analyses are given in Appendix A. Using these inputs, the inflow hydrographs were developed by the HEC-1 computer

program for the Main Dam and the intervening drainage area between the Main Dam and Diversion Dam (see Appendix A) which were then routed through the reservoirs and spillway structures assuming a starting elevation at the spillway crest.

In order to determine the effects of a failure of the Medina Lake Dam handrails which extend across the entire length of the Main Dam, a range of possible handrail failure configurations were routed through the Medina Lake Dam using the PMP design storm. The difference in peak water surface elevations for the PMF in the Main Lake was only 0.44 feet, being 1091.87 feet NGVD for the "no handrail" scenario and 1092.31 feet NGVD for the "100% of handrail remaining" scenario. Therefore, the worst case option with 100 percent of the handrails remaining was carried throughout the remaining flood routing scenarios.

2.3.3 100-Year Flood

Point rainfall values for the 100-year storm were obtained from the National Weather Service (NWS) Rainfall Frequency Atlas of the United States (Hershfield, 1961) for durations from 1 hour to 24 hours. Depths for the 5- and 15-minute durations were obtained from the NWS Technical Memorandum HYDRO-35 (NWS, 1977).

A unit hydrograph was developed for the Medina Lake watershed using the HEC-1 computer model and the Snyder watershed coefficients which were determined by TDWR during the Phase I investigations (TDWR, 1979) for the Medina Lake watershed. The resulting 100-year inflow hydrograph is given in Appendix A. The 100-year, 24-hour design storm with a total runoff volume of 6.31 inches (213,362 acre-feet) was routed through the Medina Lake Dam and Medina Diversion Dam assuming that the handrails on the main dam remained intact as described in Section 2.2.

2.4 FLOOD ROUTING RESULTS

Table 2-6 gives the results of the flood routing scenarios for the Medina Lake and the Medina Diversion Lake. For each scenario, the starting elevation, peak inflow, peak storage,

peak stage, peak outflow and tailwater elevation are listed. The HEC-1 computer outputs and other back-up materials are included in Appendix A, which was also submitted to EUWD in October, 1988 at the conclusion of the flood-routing analyses.

The detailed Medina Lake outflow discharge hydrograph for the 1978 flood event is given in Table 2-7. Also given in this table are the lake storage, stage elevations and tailwater elevations for each 1-hour time interval simulated. The peak outflow from Medina Lake Dam was 14,889 cfs at a stage of 1,068.5 feet NGVD, with 281,377 acre-feet of storage in Medina Lake. The peak outflow from Medina Diversion Dam was 14,878 cfs at elevation 924.15 feet NGVD, and 7,246 acre-feet of storage.

Approximately 56.3 miles downstream from Medina Lake, the USGS station near Somerset, Texas (gage number 08180800) recorded a discharge peak of 12,800 cfs on August 4, 1978 (USGS, 1979). When compared to the 14,878 cfs computed upstream by the model, the model results seem reasonable assuming some attenuation of flows downstream.

Table 2-8 gives the PMP discharge hydrograph which has a peak discharge of 636,688 cfs at reservoir elevation 1,092.31 feet NGVD, overtopping the Medina Lake Dam by over 16 feet. A graph of the reservoir headwater and tailwater elevations as a function of time is shown in Figure 2-8 for the PMP flood event.

The resulting outflow hydrograph, storage and tailwater elevations for the 100-year, 24-hour flood are given in Table 2-9. Under this scenario, a peak inflow of 209,811 cfs resulted in a peak discharge from Medina Lake Dam of 141,088 cfs. The peak inflow of 141,112 cfs from the intervening drainage area plus the Medina Lake outflow was routed through the Medina Diversion Dam and resulted in a peak outflow of 140,815 cfs.

2.5 FLOOD BENEFITS

In order to determine the flood benefits which are dependent on the initial storage level in the lake, the 1978 flood hydrograph was routed through the Medina Lake and Medina

Diversion Lake using a variety of starting lake elevations. The relationship between the beginning lake level and flood discharge peaks is given in Figure 2-9. As shown in Table 2-10, the peak outflow from the Main Lake ranged from 44,241 cfs with a starting elevation at the spillway crest, to 4,823 cfs with the starting elevation 20 feet below the crest. This represents an 89 percent reduction in peak flows due to the lower reservoir level at the beginning of the storm event. The actual reservoir level was approximately 10.8 feet below the crest at the onset of the 1978 flood. Therefore, if the reservoir operations were to result in lower elevations during wet periods than would have occurred historically, benefits could be derived due to a reduction of flood volumes downstream.

3.0 EVALUATION OF ASSUMPTIONS FOR THE RESERVOIR YIELD MODEL

In order to create a computer model to simulate the operation of the Medina Lake and Diversion Lake system, assumptions were required for the recharge and seepage calculations as well as the reservoir inflows. Once these values were established, an evaluation was made concerning their validity by comparing the results of a "historical conditions" scenario to the actual Medina Lake storage records (TDWR, 1980 and US WEST, 1988). Therefore, a scenario was created using the reported Medina Canal diversions obtained from the TWC central files (TWC, 1988) and the USGS gaged data for the Medina Canal (US WEST, 1988). This scenario was designated Scenario 1, Reported Diversions.

The following sections detail the inputs, testing and conclusions derived from the operation of the Reported Diversions scenario.

3.1 HISTORICAL DIVERSIONS

A USGS gaging station for the Medina Canal diversions was in place from April 1922 to April 1934 and was not reestablished until July 1957. Therefore, for the period of record between 1940 and 1957, the diversions reported to the TWC were obtained from the historical

water usage records in the TWC files for Medina Lake (TWC, 1988). According to these records, the historical canal diversions prior to 1957 were reported based on estimations of irrigated acres for each year. In order to derive monthly values, the 1940-1957 annual diversions were then multiplied by the historical distribution ratios for each month which had been determined using the 1957-1986 USGS gaged data (US WEST, 1988). Table 3-1 gives the reported Medina Canal diversions for the full period from 1940 to 1986, representing the combined data from each of the above sources. (As will be discussed later, it is EH&A's belief that the reported canal diversions for the period prior to 1957 were significantly lower than those which actually occurred. This has made it virtually impossible to reconstruct a computer simulation of a pure "historical" context prior to 1957, i.e., a replication of history, and therefore required that care be used to evaluate comparisons between computer runs.)

3.2 RECHARGE AND SEEPAGE

A detailed evaluation of the prior studies and historical data was performed by EH&A to determine the recharge and seepage relationships to be used in the hydrologic analyses of the Medina Lake system. Figures 3-1 and 3-2 give the resulting recharge and seepage curves which were adopted for these purposes, and a detailed discussion concerning their derivation is given in Appendix B.

3.3 MEDINA LAKE INFLOWS

There is no streamflow gaging station on the Medina River above Medina Lake which encompasses the entire 1940 to 1986 period of record used in these analyses. Therefore, inflows for the 636- square mile drainage area for Medina Lake were calculated using the runoff per square mile values obtained from the following USGS streamflow stations:

1) Guadalupe River at Comfort, Texas (1940-52);
2) Medina River near Pipe Creek (1952-56);

3) Medina River near Pipe Creek and Red Bluff Creek near Pipe Creek (1956-82); and

4) Medina River at Bandera (1982-86).

The equations used for the inflow calculations are given in Appendix C along with the resulting inflows for the full period of record.

3.4 RESULTS AND CONCLUSIONS

The Medina Lake inflows, recharge and seepage curves and historical diversions were used in the "reported diversions" Scenario 1 with a starting elevation at 1,064.1 feet NGVD. The resulting end-of-month elevations and contents were then compared to the actual historical values for Medina Lake given in Tables 3-2 and 3-3 (TWC, 1980 and US WEST, 1988). A plot of the end-of-month elevations in Figure 3-3 shows that the actual elevation values for the 1940 to 1957 period were lower than the elevations given by the computer simulation for Scenario 1. This result was investigated further by re-running Scenario 1 with the starting elevation at the historical level in January 1940. The results were similar to those above. However, since the elevations for the historical and simulated cases were very close for the 1957 to 1986 period (when the inflows and canal diversions were based on more reliable, gaged information), it was concluded that the recharge and seepage relationships discussed in Section 3.2 were providing remarkably close results to those observed historically, and could be adopted for use without further evaluation.

The Medina Lake inflows were then verified using a statistical correlation between the Guadalupe River Comfort gage and the Medina River Pipe Creek gage for the 39.5 years of data available at both gages. This analysis predicted a linear relationship between the flows at these gages with an R-squared value of 0.72. Since the average inflows calculated using the statistical equation discussed in this paragraph were larger than the average inflows calculated using the drainage area calculations described above, the original inflows were judged to be the most conservative and appropriate for use in this study. In addition, no justification could be found for lowering the initially computed inflow values.

6-20-4.4

One of the primary differences between the reservoir operations discussed in this report and the actual historical operation was the criteria used for diversions. Historically, the diversions were made for actual year-to-year irrigation requirements and were not directly dependent on the lake elevation for either the diversion rate or amount. When the scenarios evaluated in this report were operated, the diversion rates were based on the beginning of month elevation. In EH&A's opinion, the historical diversions through the Medina Canal during the 1940-1955 time period were much higher than those reported by BMA. Therefore, this discrepancy in the historical diversions was assumed to be the source of the end-of-month elevation discrepancy found using Scenario 1 (vs. actual historical) and Scenario 1 was discarded and not used for further analyses.

Scenarios 2 through 12 were then performed as described in Section 8.0 in order to evaluate the differences and impacts which can be attributed to the various different operating criteria evaluated in Section 8.0 for recharge purposes.

4.0 WATER RIGHTS

The accumulated water rights above Medina Lake Dam total 67,765 acre-feet per year. These rights include the Bexar-Medina-Atascosa Counties Water Control and Improvement District's (BMA's) prior right of 66,000 acre-feet per year from Medina Lake for irrigation, domestic and livestock purposes. The priority date for this water right is 1910, and it is the most senior water right on the Medina River. Therefore, for purposes of this study, the water rights above the Medina Dam were considered to be subordinate to BMA's.

Between the Medina Dam and the confluence of the Medina River and the San Antonio River, there are existing water rights for 78,707 acre-feet per year of usage which includes municipal, irrigation, mining, recreational and recharge uses. The water rights from Medina Lake to the Applewhite Reservoir site were also considered to be subordinate to BMA's for the purposes of the Medina Lake system yield model. However, the water rights below

Medina Lake were taken into account in the development of "available" surface water flows used in the model for areas below the Diversion Lake as described in Section 7.0.

The operation of Applewhite Reservoir was included in these analyses as an existing water right solely for purposes of calculating the changes in inflows to the bays and estuaries. The permitted water rights for the proposed Applewhite Reservoir were also considered to be subordinate to the operations of the Medina Lake system, and the amount of diversions available at the Applewhite location were dependent on the Medina Lake system outflows.

5.0 ELEVATION-AREA-CAPACITY

The elevation-area-capacity data for Medina Lake given in the Preliminary Engineering Report on Applewhite Dam and Reservoir by Freese and Nichols (F&N) and Travis-Braun and Associates, Inc. (F&N, 1974) was adopted for the purposes of this study. Additional data above the crest elevation was developed from the U.S. Geological Survey (USGS) 7.5-minute topographic maps: Medina Lake, Pipe Creek and Timber Creek, Texas. The area contained within each contour was planimetered and this information was then used to calculate the capacity of Medina Lake for levels up to 1,100 feet NGVD using the "average-end-area" methodology. Table 5-1 gives the resulting elevations, areas and capacities used in these analyses.

The elevation-area data for the Medina Diversion Lake were also planimetered from the USGS 7.5-minute topographic map, Medina Lake, Texas, and used to determine the reservoir capacities for elevations of 920 feet NGVD and above. Below the crest elevation of 918.9 feet NGVD the elevation-capacity relationship was assumed to be linear due to discrepancies which were found in the published data. The Medina Diversion Lake elevation-area-capacity data are also given in Table 5-1.

For purposes of including the permitted Applewhite Reservoir in the Medina Lake system yield model described in Section 8.0, the area-capacity data for the Applewhite site was also taken from the F&N report referenced above. In order to include the Leon Creek diversion

point capacity at this location, the Leon Creek Diversion Lake area-capacity curve was obtained from the TWC application files (TWC, 1988) and added to the Applewhite site area-capacity curve. The resulting combined areas and capacities were then used in the system yield model at this location, and are shown in Table 5-2.

6.0 RESERVOIR EVAPORATION

Net lake evaporation data for the four Texas quadrangles surrounding Medina Lake were obtained for the years 1940 through 1986 from the computerized database maintained by the Texas Natural Resources Information System (TNRIS). The following equation was used to develop composite net lake evaporation for the Medina Lake system:

$$E = 0.006(G\text{-}8) + 0.036(G\text{-}9) + 0.421(H\text{-}8) + 0.537(H\text{-}9)$$

The resulting net lake evaporation is given in Table 6-1 for both the Main Lake and the Diversion Lake.

The net lake evaporation data given in Table 6-2 for the Applewhite Reservoir site was obtained using the same methodology and the following equation:

$$E = 0.057(H\text{-}8) + 0.775(H\text{-}9) + 0.168(I\text{-}9)$$

7.0 INFLOWS

The historical streamflow data for the USGS gages in the project area were obtained using the HYDRODATA USGS Daily Values database system (US WEST, 1988). The mean daily streamflow values were accumulated monthly and used in the preparation of the inflows to the Medina Lake, the Medina Diversion Lake, and the other junction locations in the Medina Lake system yield model.

In order to create "available" inflows for the locations downstream from Medina Diversion Lake, the calculated values from the historical gage records were adjusted using the historical diversions, historical return flows and existing water rights for each sub-watershed area. Appendix C gives the formulas which were used to calculate the incremental inflows used in the Medina Lake model and also contains the resulting monthly inflows.

8.0 RESERVOIR OPERATION AND YIELD ANALYSES

8.1 METHODOLOGY

Due to the unique operational characteristics required to accurately model the Medina Lake system including items such as recharge and seepage, an in-house reservoir computer model was modified to operate the Medina Lake and Medina Diversion Lake reservoir system under a variety of scenarios. A schematic diagram of the Medina Lake system configuration is shown in Figure 8-1. The EH&A computer model operates a monthly water balance for each location shown in Figure 8-1, taking into account evaporation, demands, downstream minimum flow releases, recharge losses, seepage losses, as well as releases for artificial recharge. The following paragraphs describe the details and assumptions used in these analyses.

8.2 RESERVOIR OPERATION

Medina Lake was operated assuming a maximum elevation of 1,064.1 feet NGVD, and the Diversion Lake was operated at 913.9 feet NGVD five feet below the normal water level (NWL) of 918.9 feet NGVD unless otherwise stated. Demands from Medina Lake stored water were met by releasing the available water downstream to the Diversion Lake for removal. For scenarios with minimum flow requirements, releases were made based on a given monthly minimum flow requirement up to the amount of available inflows into each reservoir. The minimum flow requirements used for these analyses are described in Section 8.4.

Net evaporation losses were calculated using the average monthly surface area, and spills were made when the resulting end of month storage was greater than the maximum value specified. Except as noted below, recharge and seepage losses for the Main Lake and Diversion Lake were subtracted using the beginning of month reservoir elevation and were calculated according to the relationships given in Section 3.0.

Artificial recharge demands were handled as diversions dependent on the beginning of month lake elevation. The relationships used to determine the amount of diversions for artificial recharge are detailed in the scenario descriptions below.

8.3 SCENARIO DESCRIPTIONS

The twelve scenarios modeled and distinctive features of each were as follows:

1) Reported Diversions Scenario

   Demands = historical diversions from TWC records as given in Table 3-1. This scenario is described in Section 3.0 of this report. (Note: This scenario should not be used for any purpose, other than as discussed in Section 3.0.)

2) No Diversions Scenario

   Demands = none.

3) Safe Yield Scenario

   Demands = amount which could be safely withdrawn throughout the critical drought of record without shortages.

4) Maximum Diversion Scenario

   Demands = 66,000 acre-feet per year distributed monthly.

5) No Diversion at NWL Scenario

Demands = none. Medina Diversion Lake operated at the normal water level of 918.9 feet NGVD.

6) No Diversions with Leakage Correction and Minimum Flows

Leakage from the Medina system was reduced to zero. Minimum flow requirements = monthly values given in Section 8.2.

7) Safe Yield with Leakage Correction and Minimum Flows

Leakage from the Medina system was reduced to zero. Minimum flow requirements = monthly values given in Section 8.2. Demands = amount which could be safely withdrawn throughout the critical drought of record without shortages.

8) Maximum Diversion with Leakage Correction and Minimum Flows

Leakage from the Medina system was reduced to zero. Minimum flow requirements = monthly values given in Section 8.2. Demands = 66,000 acre-feet per year distributed monthly.

9) Artificial Recharge with Historical Leakage

Diversions = artificial recharge, with the recharge rate dependent on the elevation of the reservoir: from a zero to five-foot drawdown (elevation 1,059.1 feet NGVD), the recharge rate was 200 cfs; from elevation 1,059.1 feet NGVD to the low-flow outlet at 957.8 feet NGVD the recharge rate was approximately the historical average diversion rate of 34.8 cfs; below this level, the rate for recharge was zero.

10) Artificial Recharge with Leakage Correction and Minimum Flows

Diversions = artificial recharge, with the recharge rate dependent on the elevation of the reservoir: from a zero to five-foot drawdown (elevation 1,059.1 feet NGVD), the recharge rate was 200 cfs. From elevation 1059.1 feet NGVD

6.20-4.4

to the low-flow outlet at 958.7 feet NGVD the recharge rate was approximately the historical average diversion rate of 34.8 cfs plus the difference between the average leakage rate and the minimum flow required for each month; below this level, the rate for recharge was zero. Minimum flow requirements = monthly values given in Section 8.2.

11) Artificial Recharge with Historical Leakage

Diversions = artificial recharge, with the recharge rate dependent on the elevation of the reservoir: from a zero to ten-foot drawdown (elevation 1,054.1 feet NGVD), the recharge rate was 100 cfs; from elevation 1,054.1 feet NGVD to the low-flow outlet at 958.7 feet NGVD, the recharge rate was approximately the historical average diversion rate of 34.8 cfs; below this level, the rate for recharge was zero.

12) Artificial Recharge with Historical Leakage

Diversions = artificial recharge, with the recharge rate dependent on the elevation of the reservoir: from a zero to five-foot drawdown (elevation 1,059.1 feet NGVD), the recharge rate was 100 cfs; from elevation 1,059.1 feet NGVD to the low-flow outlet at 958.7 feet NGVD, the recharge rate was approximately the historical average diversion rate of 34.8 cfs; below this level, the rate for recharge was zero.

In order to provide information for purposes of determining the impacts of the reservoir operations on the recreational aspects of Medina Lake, another scenario (Scenario 11A) was performed using the starting elevation of Medina Lake at the historical level of 49,440 acre-feet (all other scenarios were performed assuming the reservoir started full) (TDWR, 1980). The resulting elevations from scenario for Medina Lake are plotted along with the historical elevations in Figure 8-2. The median lake levels for this Scenario 11A were 1,045.7 feet NGVD as compared to the median of 1,036.6 feet NGVD for the historical levels.

8.4 MINIMUM FLOW REQUIREMENTS

The monthly minimum flow releases required from the Medina Lake system were provided by the Vickrey Water Resources Group (VWRG, 1988). Depending on the required downstream minimum flow values, inflows were passed through the reservoirs in scenarios which evaluated the option of leakage correction. These minimum flow values are given in Table 8-1 in both cubic feet per second (cfs) and acre-feet per month.

8.5 BAY AND ESTUARY INFLOWS

The effects on the inflows to the San Antonio Bay and Estuary due to operational changes in the Medina Lake system were evaluated using the results of the Medina Lake system computer model combined with the multi-basin, SIMYLD-II computer model for the Guadalupe and San Antonio river basins (EH&A, 1986). The "future baseline" scenario of the SIMYLD-II model which incorporated full recognition of all existing water rights (with the exception of Medina Lake, which was operated using reported historical diversions) was updated for 1983-1986 using historical streamflows obtained from both the HYDRODATA database (US WEST, 1988) and unpublished USGS records (USGS, 1988). Ungaged runoff for 1983-1986 for areas below the confluence of the Guadalupe and San Antonio rivers was estimated based on the gaged data and drainage areas. The contributions of flows from the Medina Lake system were then subtracted from these updated bay inflows given in Table 8-2 to obtain incremental bay inflows (i.e., inflows to the San Antonio Bay generated from the San Antonio and Guadalupe River Basins, excluding those flows originating from above the mouth of the Medina River). The incremental values were then added to the outflows from the various Medina Lake system operations to obtain the resulting bay inflows for each scenario which are included in Appendix D, Preliminary Hydrologic Modeling Results. The inflows to the San Antonio Bay for the artificial recharge Scenario 11 are also presented in Table 8-3.

For purposes of comparison, the historical San Antonio Bay inflows were also calculated using USGS gage data for 1940-1986 (US WEST, 1988 and USGS, 1988), with the

ungaged portion estimated from drainage areas. Table 8-4 gives the resulting historical Bay inflows.

8.6 DURATION ANALYSES

8.6.1 Flow Duration

In order to evaluate the impacts of the reservoir operations on the downstream flows, as well as the inflows to the bays and estuaries, the resulting flows at various points in the basin were tabulated for each scenario, and a flow-duration curve was developed for each location. The locations used for the accumulation of flows were: 1) the Medina Diversion Lake outflows, 2) the Applewhite Reservoir site inflows, and 3) the inflows to the San Antonio Bay. Appendix D contains the flow-duration curves as well as the flow-duration and monthly flow tables for each of these locations for the twelve scenarios modeled.

Tables 8-5 and 8-6 give the resulting flow-duration tables for the San Antonio Bay inflows using the historical data given in Table 8-4 and Scenario 11 flows. The annual flow-duration curves are plotted in Figures 8-3 and 8-4 for these scenarios.

In order to provide information for the instream flow analyses (by others), a flow-duration analysis was also performed for the historical flows at locations 1) and 2), above. These flows were calculated based on the USGS gage data using the formulas and flows given in Appendix E. Tables 8-7 and 8-8 give the resulting flow-duration values for the historical Medina Diversion Lake outflows and Applewhite Reservoir site inflows, respectively.

8.6.2 Elevation and Content Duration

In order to provide a means for comparison of the differences in reservoir elevations under the various scenarios, the computer program used in the flow-duration evaluations described above was modified to calculate elevation and content-duration relationships.

Tables 8-9 and 8-10 give the results of these analyses on a monthly and annual basis for historical records and the artificial recharge Scenario 11 for the San Antonio Bay inflows.

8.7 FLOWS AVAILABLE FOR HYDROPOWER GENERATION

The total volumes of flows available for hydropower generation were calculated on a monthly basis for two reservoir scenarios for purposes of comparison. The types of flows from each scenario which were assumed to contribute to the gross amount of available flows are listed as follows:

1) Scenario 10, Artificial Recharge with leakage correction and minimum flow releases:
   - Diversions for artificial recharge
   - Releases made for minimum flow requirements
   - Releases for maintaining the Diversion Lake elevation at least five feet below normal water level
   - Spills from Main Lake Dam; and

2) Scenario 11, Artificial Recharge with historical leakage:
   - Diversions for artificial recharge
   - Releases for maintaining the Diversion Lake elevation at least five feet below normal water level
   - Spills from Main Lake Dam.

The net amount of flows which could be utilized for hydropower generation were then estimated by "scalping" these available flows using a maximum turbine capacity of 156 cfs (converted to acre-feet per month) and a minimum head of 68 feet at elevation 986.2 feet NGVD in the Main Lake (Prodek, 1986). The resulting tables of monthly net hydropower flows are given in Tables 8-11 and 8-12.

The average annual net flows available for Scenario 10 were 58,838 acre-feet per year, and Scenario 11 had an annual net average of 45,654 acre-feet per year.

Prodek (1986) computed "long term average annual releases at Medina Dam which would be available for generating electricity" to be 58,300 ac-ft/yr. This, at first glance, seems to match well with the results of EH&A's Scenario 10, but is significantly higher than EH&A's Scenario 11. Thus, on the surface, alteration of the system operating criteria could have a significant impact on the proposed hydroelectric power generation scheme.

Caution must be used in making direct comparisons, however, due to significant differences in assumptions and techniques utilized by Prodek in their studies vs. those employed by EH&A in this report. For example, Prodek used a period of record covering 37 years including 1924-33 and 1958-84. This period of record totally excludes the worst drought of record, especially the period 1940-1956 (17 years) wherein the inflows to Medina Lake averaged only 66,000 ac-ft/yr, or only 39.3% of the subsequent 30 years' average of 168,000 ac-ft/yr (1957-1986). EH&A's study used a period of record of 1940-1986 (47 years), which included this significant drought period. Other potentially significant effects could be caused by differences in leakage and recharge used by Prodek vs. EH&A, and by Prodek's possible use of daily flows, rather than monthly. (This last item is unclear, i.e., Prodek may have also used monthly flows even though their report speaks to daily flows.)

Regardless of the methodologies used, Scenario 11, for example, is significantly different in its effect on flows available for hydropower generation than is Scenario 10, as discussed above. The selected operating criteria for the artificial recharge options could therefore have a significant effect on the hydroelectric system generation capability.

8.8 YIELD MODELING RESULTS

Table 8-13 presents the results of each of the scenarios which were used to evaluate various operating strategies for the Medina Lake system. The average annual inflows, diversions, recharge and evaporation given in this table include the amounts for both the Main Lake and

Diversion Lake as a system. The leakage, spills and minimum flows are only given for the Diversion Lake, however. The contents and elevations presented are the median values which were determined from the elevation- and content-duration analyses. For comparison, the historical median content and elevation for Medina Lake are also given in Table 8-13.

8.9 COMPARISON OF SELECTED HISTORICAL PARAMETERS TO SCENARIO 11A

Table 8-14 presents selected parameters for historical conditions, and compares them to Scenario 11A. (Recall that Scenario 11A imposes the Scenario 11 operating criteria on the Medina Lake system assuming that the Main Lake started on January 1, 1940 at its historically recorded content of 49,440 ac-ft.)

The historical median content and median elevation for the Main Lake are 130,500 ac-ft and 1,036.6 ft NGVD, which are substantially lower than would have occurred had the Scenario 11 operating criteria been in place, i.e., 164,887 ac-ft and 1,045.7 ft NGVD, respectively.

The average annual natural recharge under historical conditions was estimated by EH&A using the following assumptions:

(1) Main Lake historical recharge for the period 1940-1986 was estimated monthly by direct computer comparison of the actual historical Main Lake end of month contents to the recharge curve developed by EH&A and presented in Figure 3-1.

(2) Diversion Lake recharge was estimated using two conditions:
   a) for all months in which the Main Lake was historically at or above the historical median elevation of 1,036.6 ft NGVD (130,500 ac-ft capacity) the Diversion Lake recharge was assumed to be at an average level 2.5 ft below the normal operating level of 918.9 ft NGVD, or 1,400 ac-ft per month (reference Figure 3-2);

b) for all months in which the Main Lake was historically below the historical median elevation of 1,036.6 ft NGVD, EH&A assumed the Diversion Lake was operated at an average level of 898.9 ft NGVD (or approximately two-thirds of the difference between zero content and the assumed 5-foot drawdown operating criteria), resulting in an assumed recharge of 933 ac-ft per month.

As shown in Table 8-15, the resulting combined Main Lake and Diversion Lake natural historical recharge of 39,801 ac-ft per year is 2,993 ac-ft per year (7.0%) less than the natural recharge of 42,795 ac-ft per year which was computed to occur if Scenario 11 operating criteria were imposed. Table 8-16 gives the combined natural recharge for the Main Lake and Diversion Lake for Scenario 11A.

Scenario 11 operating criteria would thus result in higher average lake levels and more natural recharge than occurred historically.

9.0 CONCLUSIONS

A summary of the conclusions regarding the results of the Medina Lake flood routing and reservoir yield modeling analyses is given below.

9.1 FLOOD ROUTING ANALYSES

The following conclusions were based on the results of the flood routing analyses:

1) Approximately 23 percent of the PMP flood event will be passed by the Medina Dam without overtopping. However, the PMF overtops the Medina Dam by over 16 feet at the peak flow. The maximum headwater and tailwater differential occurred just at the beginning of overtopping.

2) Flood levels downstream could be reduced if the same or similar artificial recharge criteria used in Scenarios 9, 11, or 12 were adopted. Operating criteria similar to these three scenarios would draw the lake down faster than what occurred historically, especially when the lake levels are high (during wet periods), thus making more storage available for capturing flood flows.

9.2 YIELD MODELING ANALYSES

The conclusions which may be drawn from the results of the yield model are as follows:

1) The optimum reservoir system operation for recharge is to maximize the recharge during wet periods, sustain a constant level of recharge during normal years and to accept no recharge diversions during dry years. This type of operation was illustrated by scenarios 9, 11 and 12 without any correction for leakage.

2) Enhancement of natural recharge by ceasing diversions and maximizing the storage in the reservoir did not, comparatively speaking, prove to be a viable alternative, as demonstrated by Scenario 2. The natural recharge increased by an amount of 8,528 acre-feet per year over the recharge computed by EH&A to have occurred historically.

3) There was no annual demand which could be withdrawn from the reservoir system through the critical drought of record without significant shortages, i.e., there is no firm yield. Even with zero diversions, Medina Lake was drawn down below the outlet levels for 17 consecutive months during the 1949 to 1957 drought, due to evaporation, natural recharge and leakage. This is demonstrated by Scenario 3.

4) Leakage correction at the Diversion Dam will net an additional 4,500 acre-feet per year when the recommended minimum flows are provided downstream.

5) Leakage correction at the Main Dam will not increase the amount of water available for recharge. The Main Dam leakage rate at full level is approximately equal to the Diversion Lake recharge rate, diversions and minimum flows.

6) The flows to the San Antonio Bay were not significantly affected by the different scenarios tested. The maximum difference in bay inflows was observed between Scenario 2, No Diversions, and Scenario 10, Artificial Recharge/Minimum Flows/Leakage Correction. Scenario 2 had a bay inflow of 1,552, 271 ac-ft per year while Scenario 10 had a bay inflow of 1,517,214 ac-ft per year. The difference of 35,057 ac-ft per year represents only 2.26% of the Scenario 2 inflows.

7) The hydroelectric system generation capability as assumed by Prodek in their analyses may be affected by altering the system operating criteria to a recharge operation. specifically, due to significant differences in methodologies employed by Prodek in their studies and those developed in this study, Prodek's analysis may give higher flows being available for hydroelectric power generation than this study would support even with no alteration in the system operating criteria. Also, the impact will vary greatly, depending upon which scenarios of operation are compared.

8) The natural recharge and leakage curves for Medina Lake and Diversion Lake given in Figures 3-1 and 3-2, respectively, should be adopted by the Edwards Underground Water District for future calculations of natural recharge from the lakes. Further studies should be performed including additional stream gaging as described in Appendix B.

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FIGURES

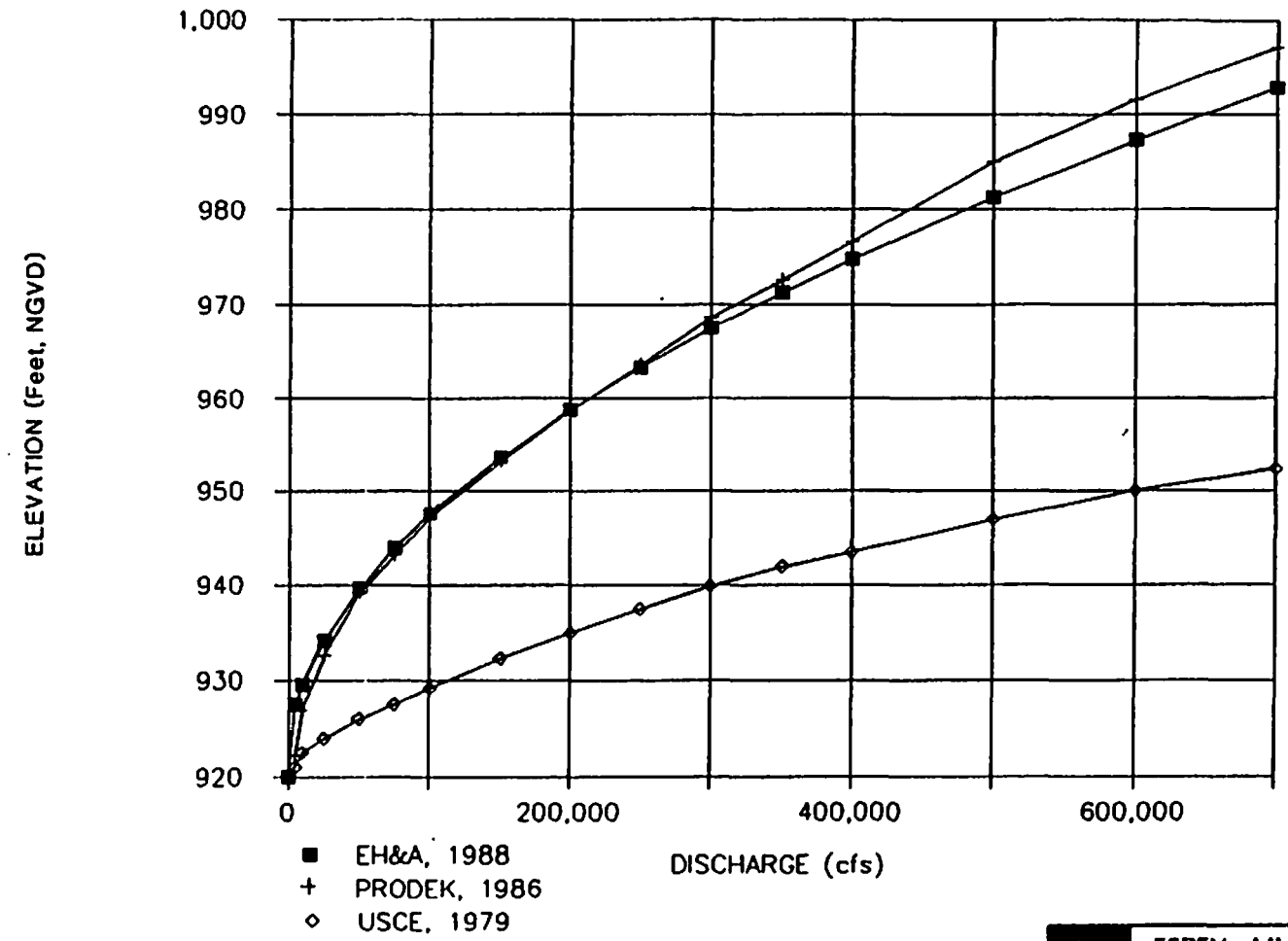

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FIGURE 2-1
TAILWATER RATING CURVES
MEDINA LAKE DAM

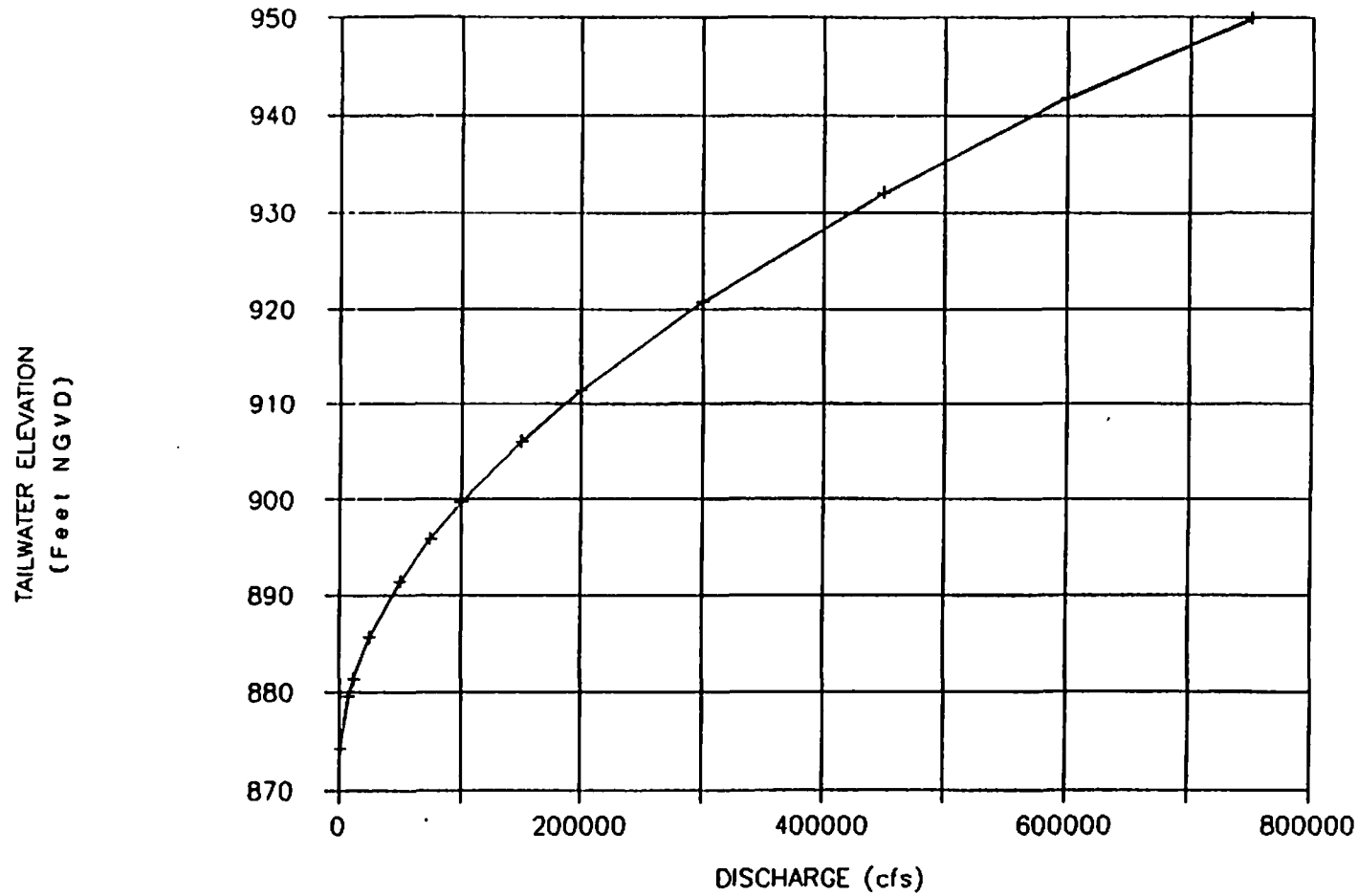

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FIGURE 2-2
TAILWATER RATING CURVE
MEDINA DIVERSION DAM

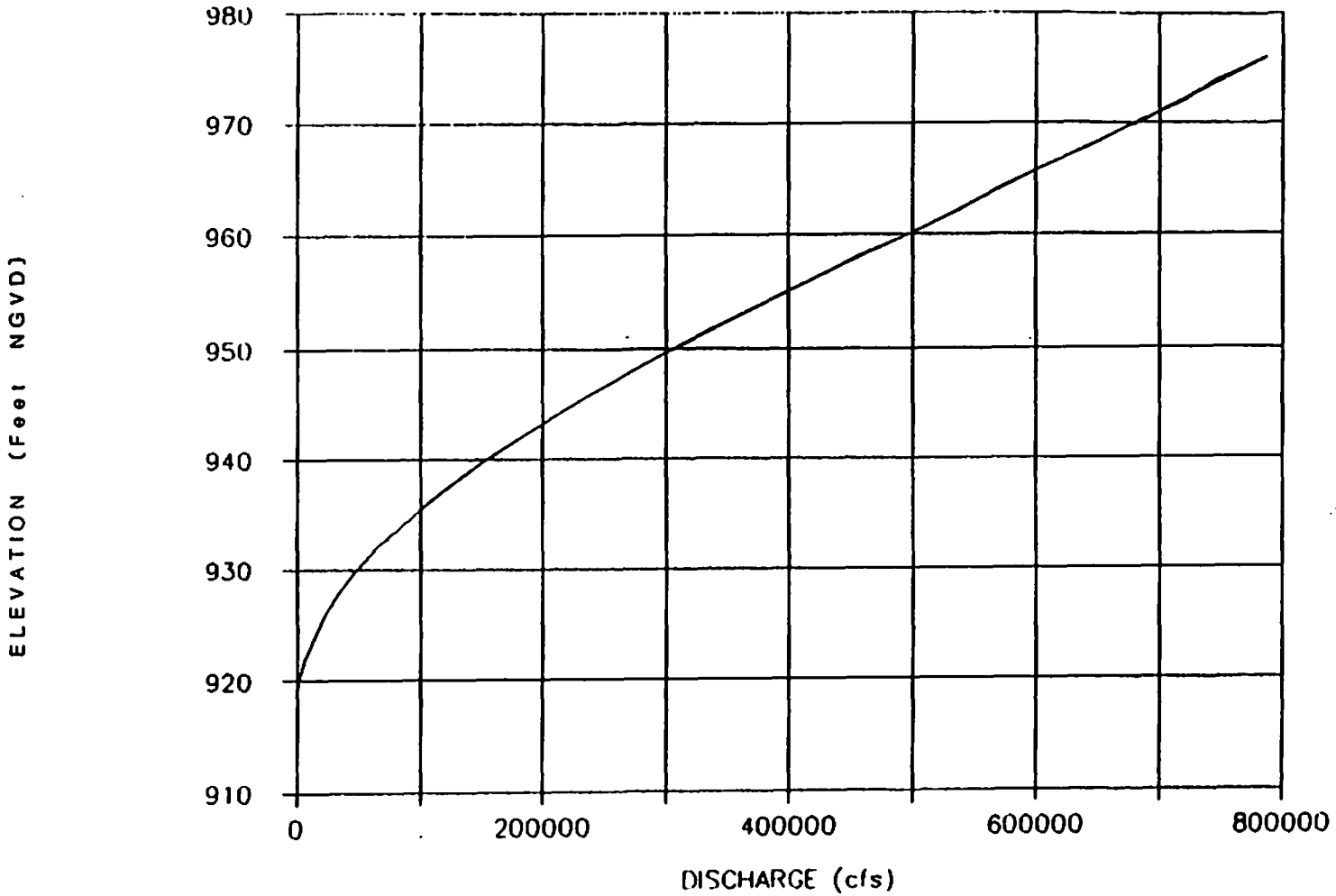

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FIGURE 2-3
SPILLWAY DISCHARGE RATING CURVE
MEDINA DIVERSION LAKE

6.20-2.4

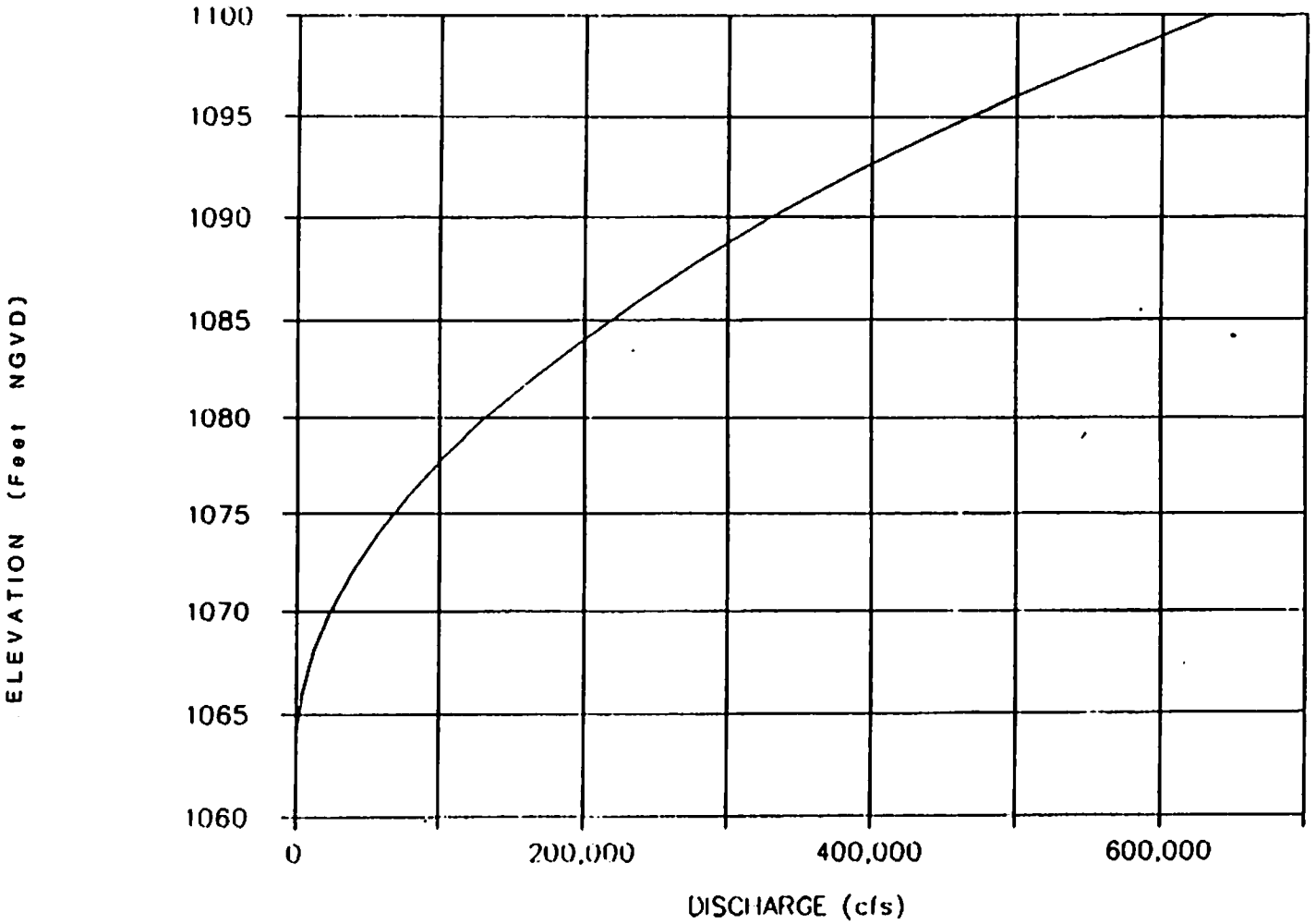

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FIGURE 2-5
SPILLWAY DISCHARGE RATING CURVE
MEDINA LAKE

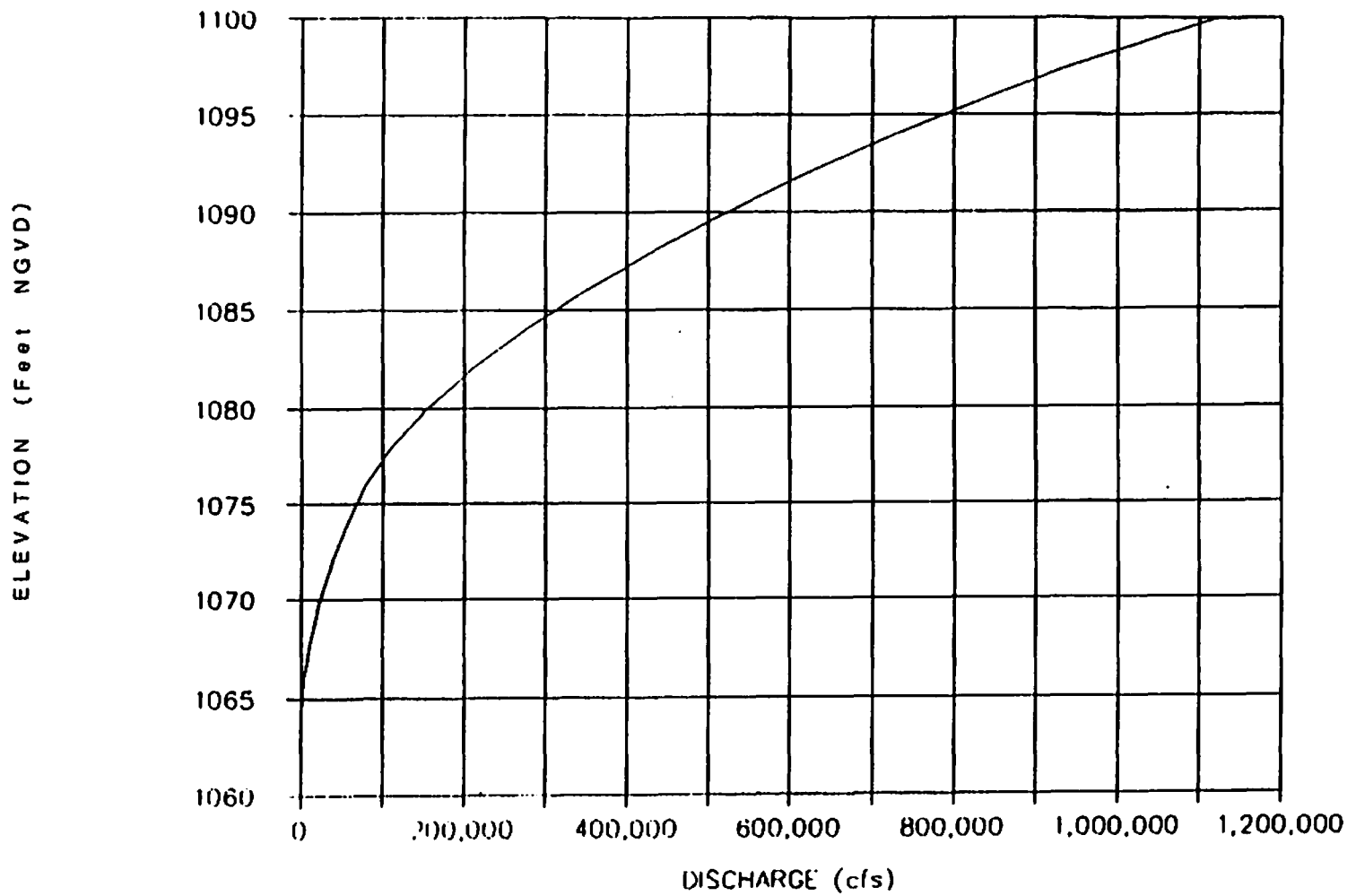

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FIGURE 2-6
TOP OF DAM DISCHARGE
RATING CURVE
MEDINA LAKE

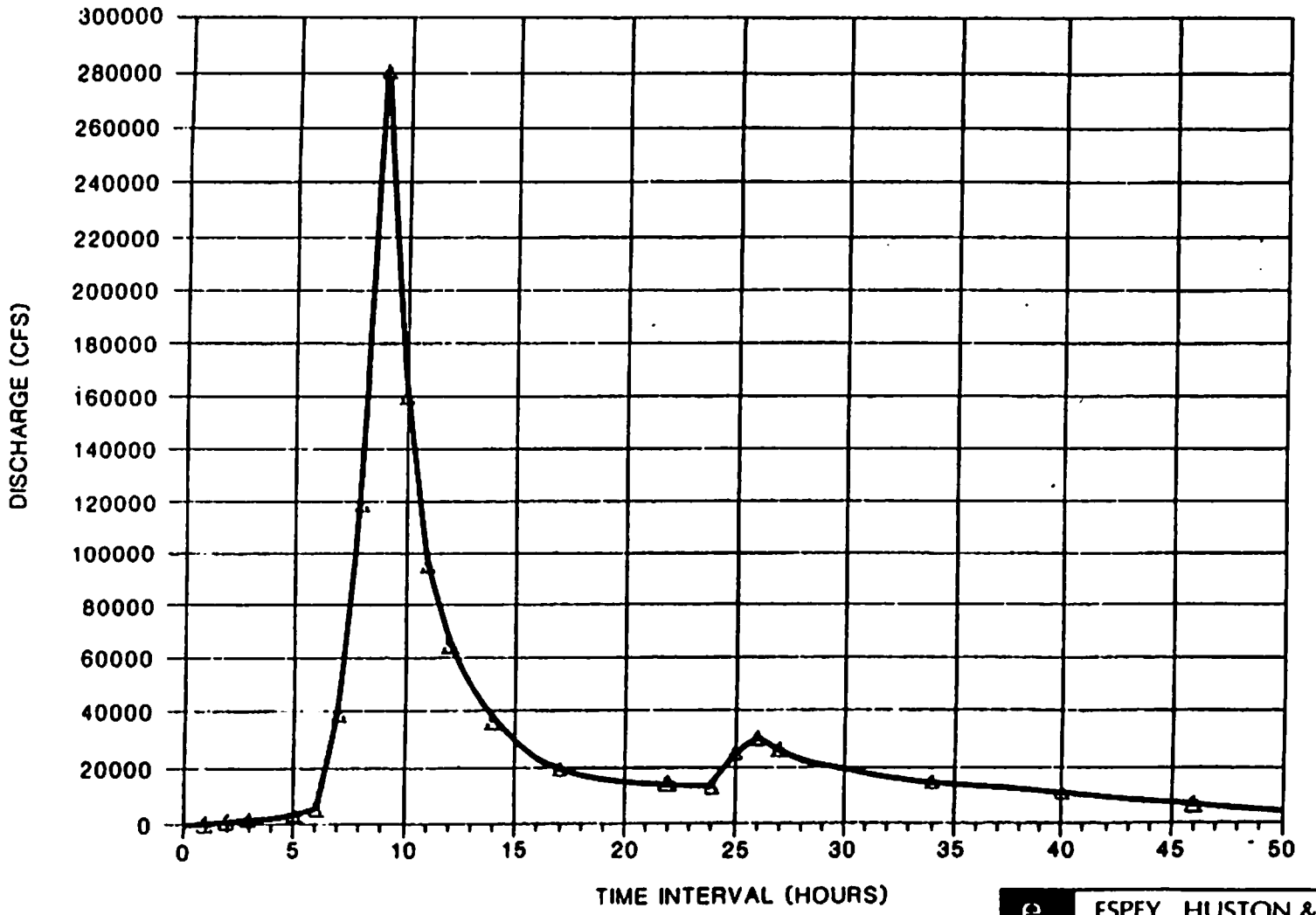

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FIGURE 2-7
AUGUST 1978 FLOOD HYDROGRAPH
MEDINA RIVER NEAR PIPE CREEK

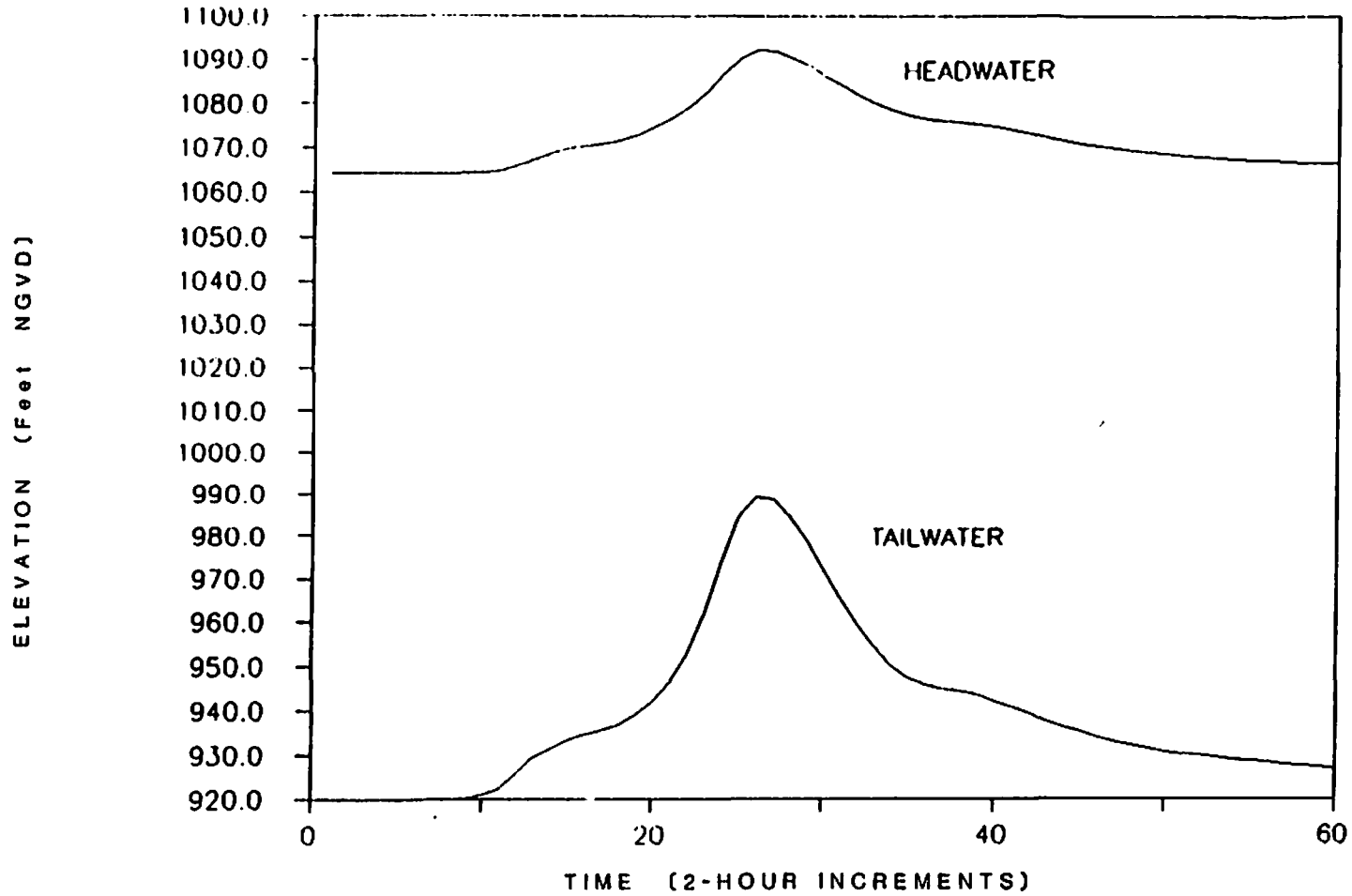

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FIGURE 2-8
HEADWATER VS.
TAILWATER ELEVATIONS
FOR MEDINA LAKE DISCHARGE
PMF FLOOD

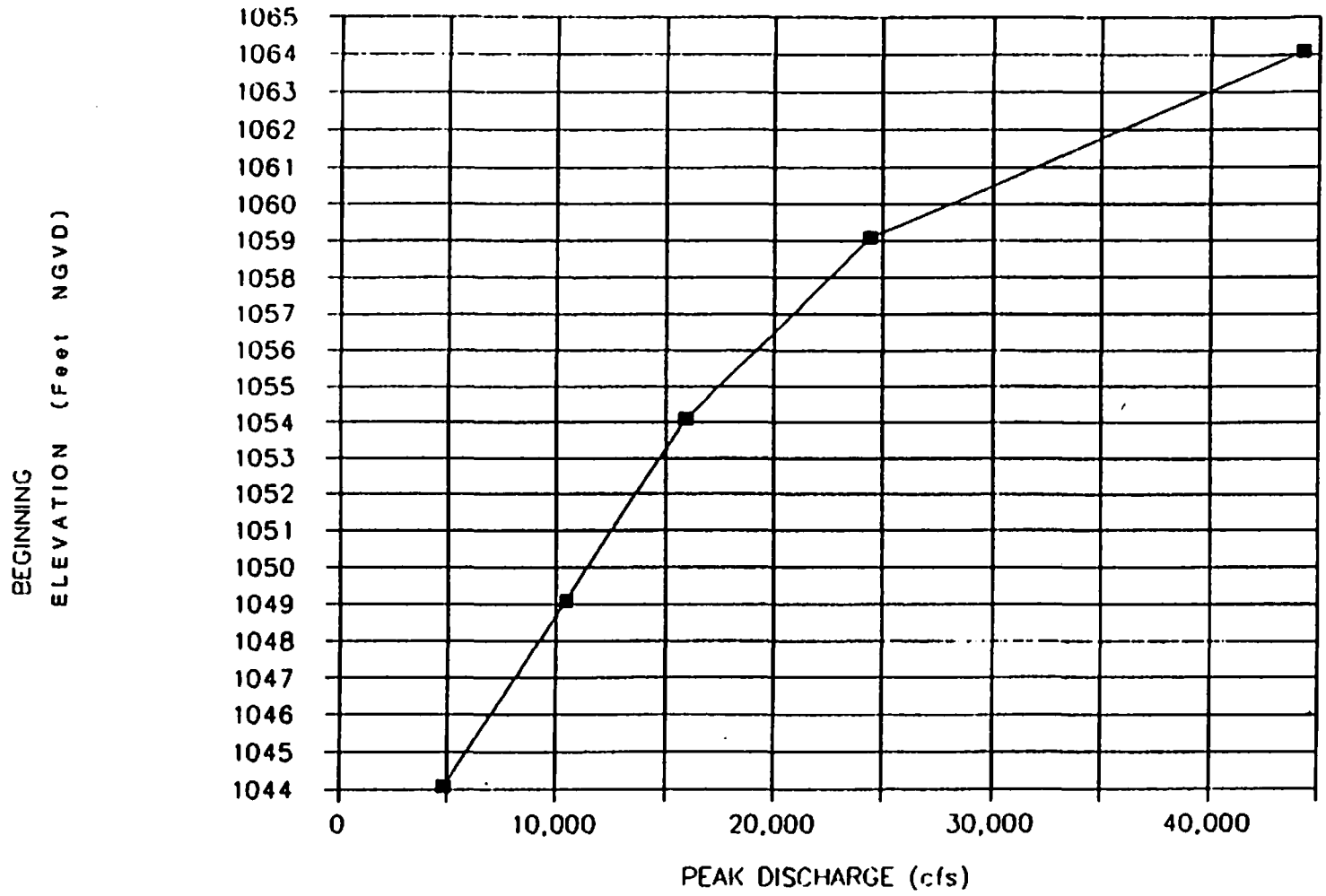

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FIGURE 2-9
BEGINNING ELEVATION VS.
PEAK DISCHARGE FOR
MEDINA LAKE 1978 FLOOD

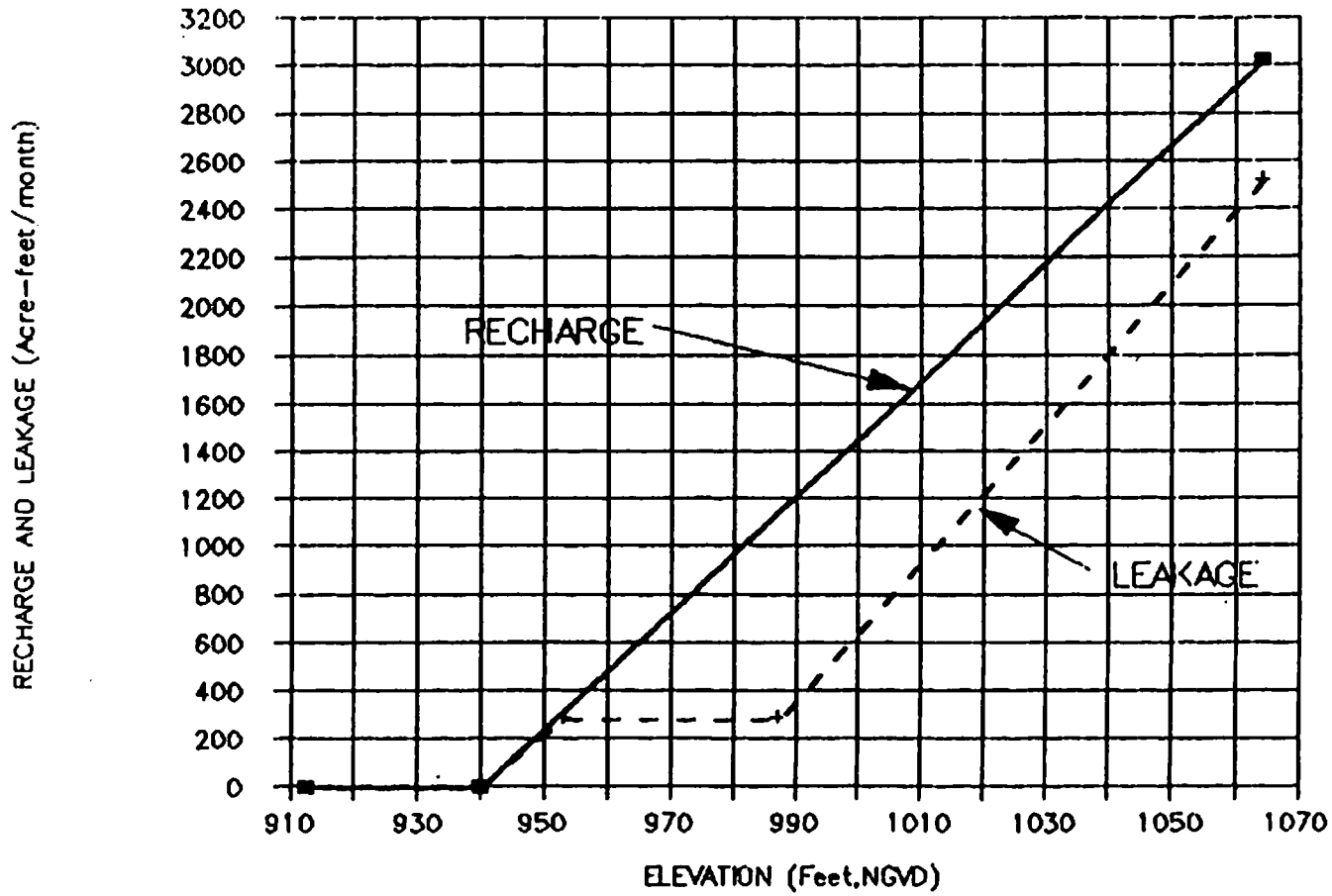

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FIGURE 3-1
RECHARGE AND LEAKAGE CURVES
MEDINA LAKE

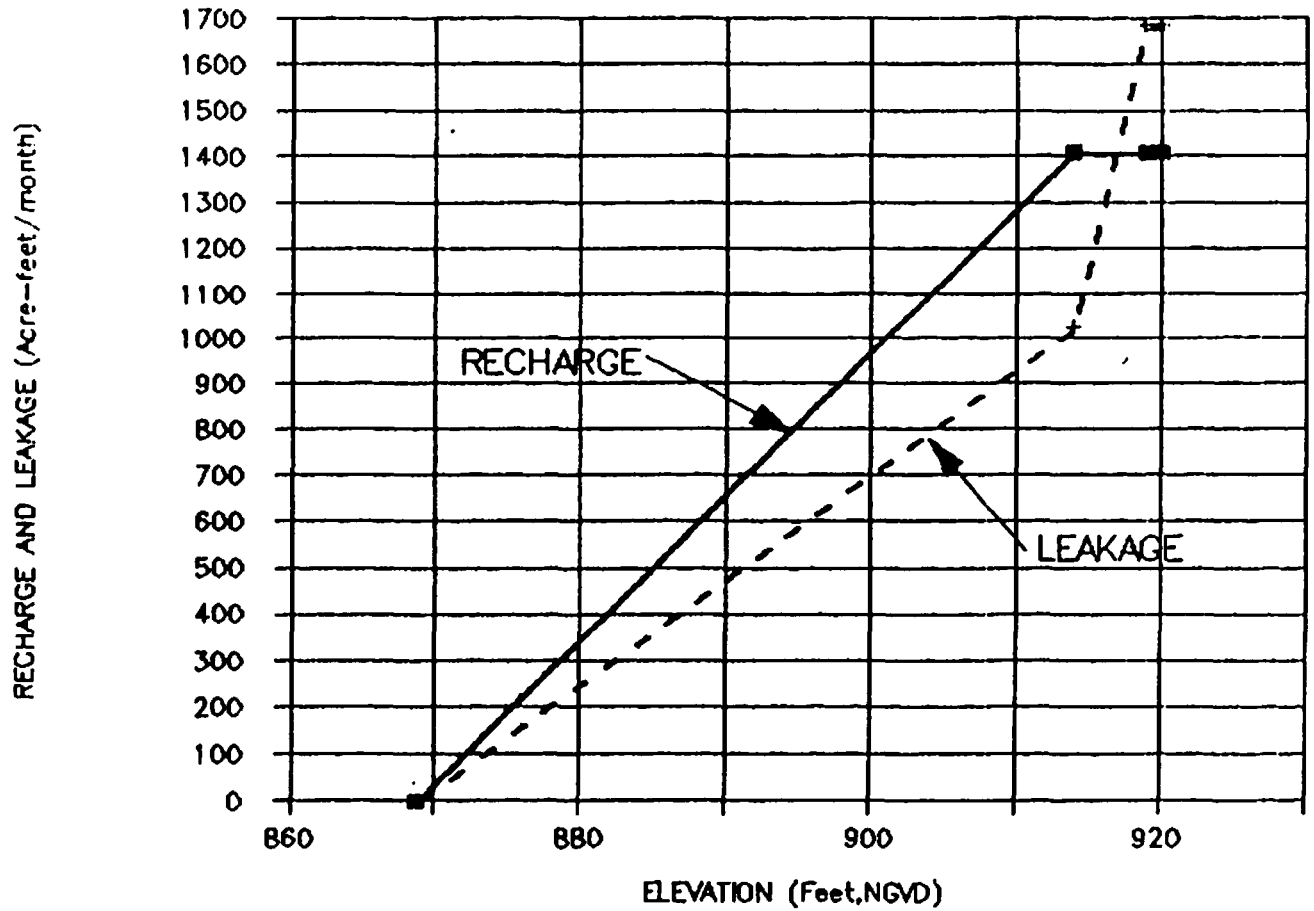

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FIGURE 3-2
RECHARGE AND LEAKAGE CURVES
MEDINA DIVERSION LAKE

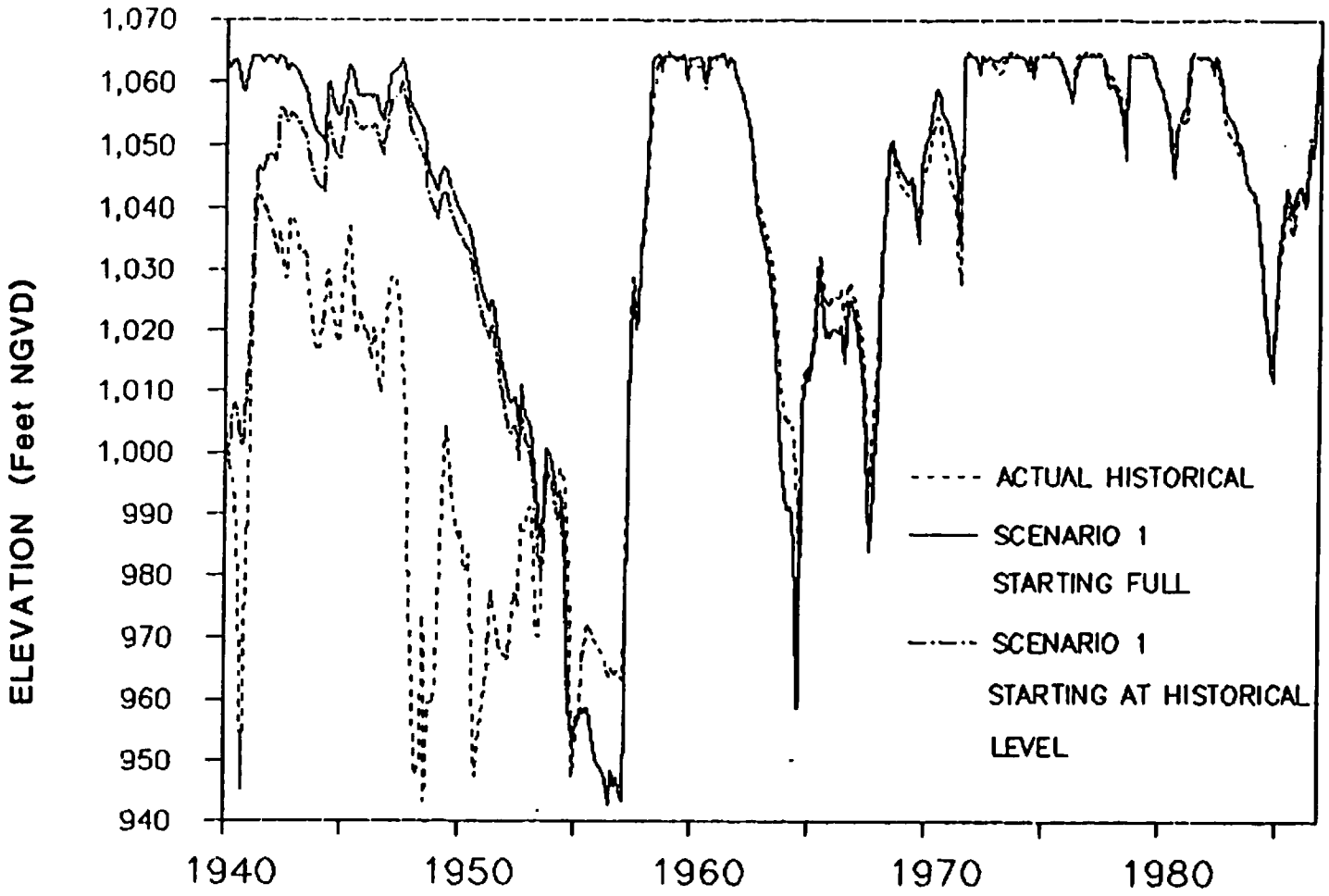

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FIGURE 3-3

COMPARISON OF MEDINA ELEVATIONS

HISTORICAL CONDITIONS

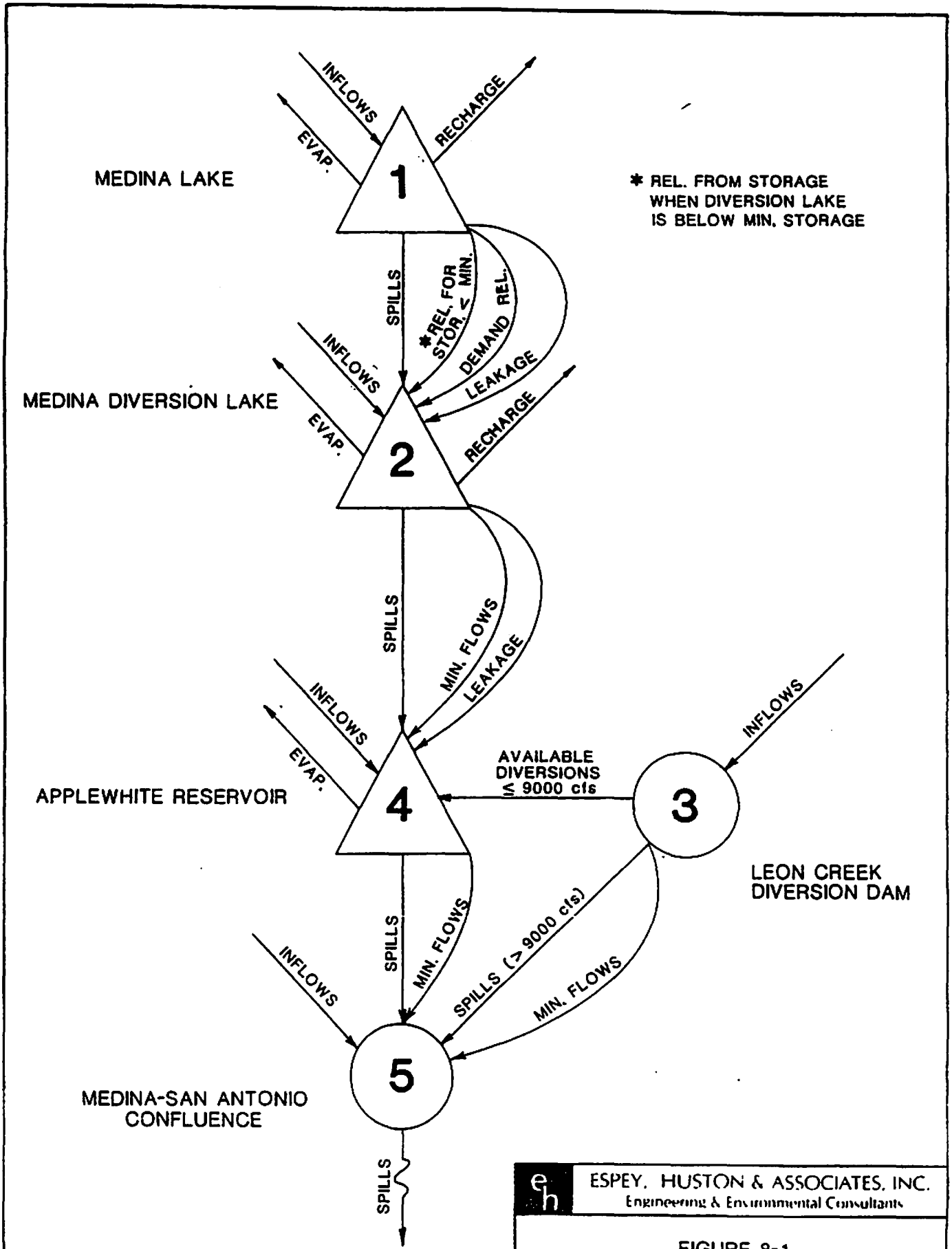

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FIGURE 8-1
MEDINA LAKE SYSTEM
MODEL CONFIGURATION

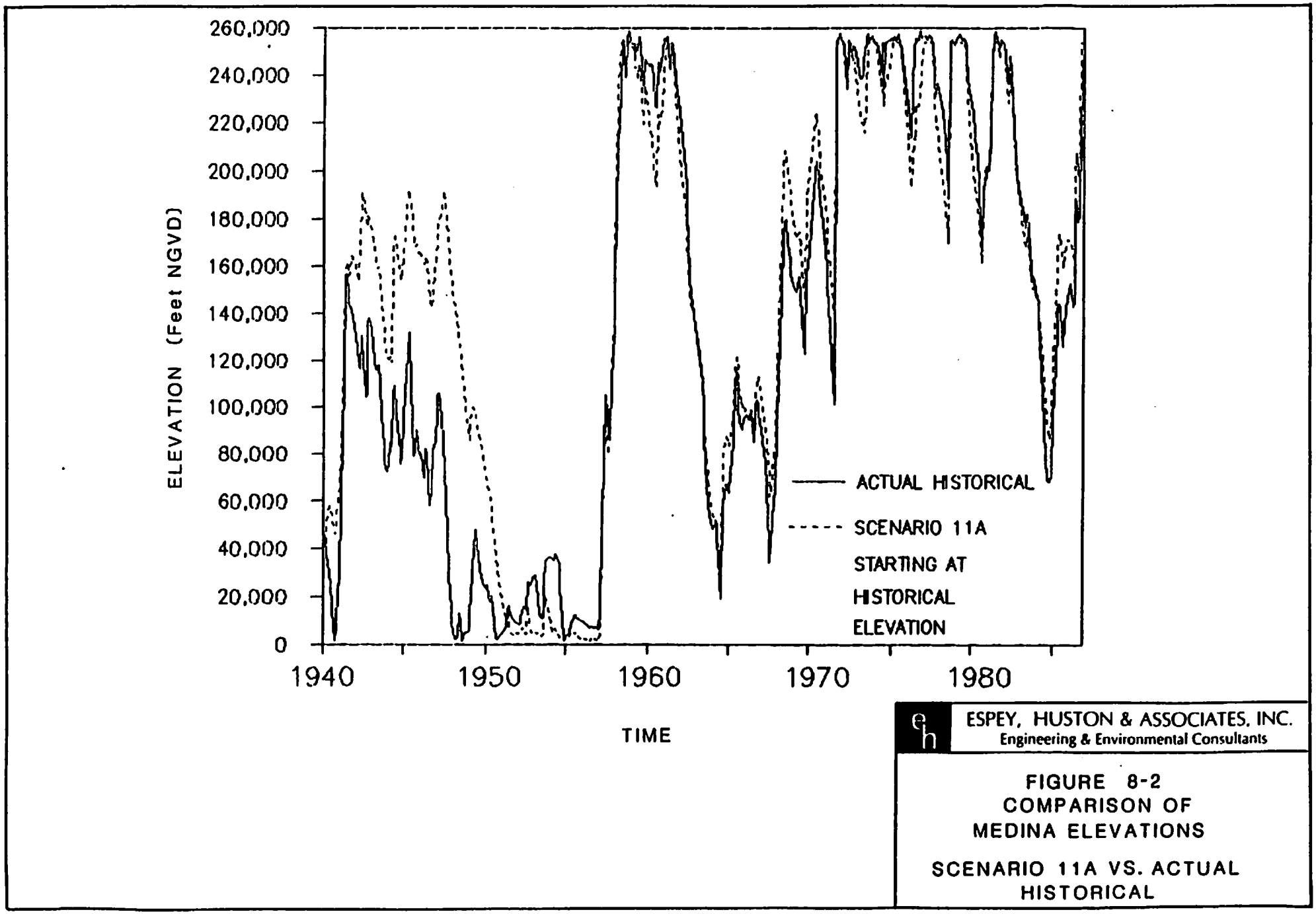

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FIGURE 8-2
COMPARISON OF
MEDINA ELEVATIONS

SCENARIO 11A VS. ACTUAL
HISTORICAL

TABLE 2-8

MEDINA RESERVOIR
PMP HYDROGRAPH

ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV
1	0	254000.0	1064.1	920.0	21	91655	334555.0	1076.8	946.4	41	55850	315725.8	1073.9	940.7
2	0	254000.0	1064.1	920.0	22	140597	352063.7	1079.4	952.5	42	48340	310457.8	1073.1	939.4
3	0	254000.0	1064.1	920.0	23	231089	376772.2	1082.7	961.6	43	40996	305306.3	1072.3	937.8
4	0	254000.0	1064.1	920.0	24	388835	410001.4	1087.0	974.0	44	34927	300488.6	1071.5	936.4
5	0	254000.0	1064.1	920.0	25	556289	439386.3	1090.7	984.7	45	29748	296071.4	1070.8	935.3
6	2	254006.1	1064.1	920.0	26	636688	453342.1	1092.3	989.4	46	25125	292129.0	1070.2	934.2
7	22	254066.0	1064.1	920.0	27	624395	451379.0	1092.1	988.7	47	21638	288648.4	1069.6	933.2
8	94	254282.3	1064.1	920.1	28	556603	439441.9	1090.7	984.7	48	18768	285556.8	1069.1	932.3
9	257	254774.1	1064.2	920.4	29	460849	422939.3	1088.7	978.8	49	16233	282825.0	1068.7	931.5
10	637	255918.7	1064.4	921.0	30	362931	405150.0	1086.4	972.2	50	14011	280430.7	1068.3	930.8
11	1690	259094.8	1064.9	922.5	31	278648	387882.0	1084.1	965.7	51	12117	278341.8	1068.0	930.2
12	3899	265752.3	1066.0	925.8	32	211020	372039.6	1082.0	959.8	52	10897	276486.9	1067.7	929.9
13	9805	274826.2	1067.4	929.5	33	160279	358059.0	1080.2	954.7	53	9794	274808.6	1067.4	929.5
14	16760	283392.7	1068.8	931.7	34	122563	346349.5	1078.6	950.3	54	8797	273293.6	1067.2	929.1
15	22494	289570.6	1069.8	933.4	35	99167	337732.8	1077.3	947.5	55	7899	271928.1	1067.0	928.7
16	26797	293554.4	1070.4	934.6	36	87464	332782.3	1076.6	945.8	56	7090	270697.0	1066.8	928.4
17	30928	297077.9	1071.0	935.5	37	81709	330347.8	1076.2	945.0	57	6360	269587.8	1066.6	928.1
18	36636	301946.2	1071.7	936.8	38	77102	328250.9	1075.9	944.3	58	5704	268590.5	1066.4	927.8
19	46829	309398.3	1072.9	939.0	39	71717	325098.1	1075.4	943.5	59	5116	267696.1	1066.3	927.5
20	63602	320346.0	1074.7	942.1	40	64296	320752.6	1074.7	942.2	60	4589	266893.7	1066.2	926.9

TABLE 2-9

MEDINA RESERVOIR
100-YEAR HYDROGRAPH

ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV
1	0	254000.0	1064.1	920.0	35	66286	321917.8	1074.9	942.5	69	5630	268477.0	1066.4	927.8
2	0	254000.0	1064.1	920.0	36	60003	318238.8	1074.3	941.5	70	5332	268024.4	1066.3	927.6
3	0	254000.0	1064.1	920.0	37	54441	314737.7	1073.8	940.5	71	5050	267595.6	1066.3	927.5
4	0	254000.0	1064.1	920.0	38	49700	311412.1	1073.2	939.7	72	4783	267189.1	1066.2	927.2
5	0	254000.8	1064.1	920.0	39	45215	308266.0	1072.7	938.7	73	4530	266804.0	1066.1	926.8
6	2	254004.6	1064.1	920.0	40	41011	305317.1	1072.3	937.8	74	4290	266439.6	1066.1	926.4
7	7	254022.3	1064.1	920.0	41	37358	302562.3	1071.8	936.9	75	4063	266094.4	1066.0	926.1
8	25	254074.4	1064.1	920.0	42	34325	299975.4	1071.4	936.3	76	3904	265765.3	1066.0	925.9
9	67	254201.0	1064.1	920.1	43	31459	297531.3	1071.0	935.6	77	3798	265446.9	1065.9	925.7
10	152	254459.5	1064.2	920.2	44	28729	295203.0	1070.7	935.0	78	3695	265137.0	1065.9	925.5
11	309	254929.8	1064.2	920.5	45	26162	293013.5	1070.3	934.5	79	3595	264835.5	1065.8	925.4
12	570	255719.2	1064.4	920.9	46	23821	291000.5	1070.0	933.8	80	3498	264542.4	1065.8	925.2
13	1001	257017.3	1064.6	921.5	47	22091	289136.3	1069.7	933.3	81	3403	264257.1	1065.7	925.1
14	1744	259255.1	1064.9	922.6	48	20477	287398.0	1069.4	932.8	82	3311	263979.3	1065.7	925.0
15	3012	263077.9	1065.5	924.5	49	18975	285779.3	1069.2	932.4	83	3222	263709.3	1065.6	924.8
16	5939	268948.0	1066.5	927.9	50	17579	284274.9	1068.9	931.9	84	3134	263446.9	1065.6	924.7
17	11204	276954.1	1067.8	930.0	51	16283	282879.5	1068.7	931.5	85	3050	263191.5	1065.6	924.6
18	20038	286924.7	1069.3	932.7	52	15082	281585.3	1068.5	931.1	86	2967	262942.9	1065.5	924.5
19	32396	298329.9	1071.2	935.8	53	13969	280385.4	1068.3	930.8	87	2887	262701.3	1065.5	924.3
20	48485	310559.8	1073.1	939.4	54	12937	279273.8	1068.1	930.5	88	2809	262465.7	1065.4	924.2
21	67463	322606.6	1075.0	942.7	55	12051	278241.3	1068.0	930.2	89	2733	262236.3	1065.4	924.1
22	88904	333391.4	1076.7	946.0	56	11413	277271.7	1067.8	930.0	90	2659	262013.9	1065.4	924.0
23	109745	342207.7	1078.0	948.8	57	10809	276353.5	1067.7	929.8	91	2587	261796.8	1065.3	923.9
24	128892	348355.0	1078.8	951.1	58	10237	275483.6	1067.5	929.7	92	2517	261585.8	1065.3	923.8
25	139017	351563.1	1079.3	952.3	59	9696	274659.8	1067.4	929.5	93	2449	261380.9	1065.3	923.7
26	141088	352219.5	1079.4	952.6	60	9183	273879.6	1067.3	929.2	94	2383	261181.5	1065.2	923.6
27	137186	350983.0	1079.2	952.1	61	8697	273140.9	1067.1	929.0	95	2318	260987.4	1065.2	923.5
28	129330	348493.9	1078.9	951.2	62	8237	272441.3	1067.0	928.8	96	2256	260798.7	1065.2	923.4
29	119074	345244.3	1078.4	949.9	63	7801	271778.6	1066.9	928.7	97	2195	260614.5	1065.2	923.3
30	108258	341578.5	1077.9	948.6	64	7388	271151.1	1066.8	928.5	98	2135	260435.8	1065.1	923.2
31	98990	337658.2	1077.3	947.5	65	6997	270556.6	1066.7	928.3	99	2078	260261.6	1065.1	923.1
32	89441	333618.8	1076.7	946.1	66	6627	269993.5	1066.6	928.2	100	2021	260092.1	1065.1	923.0
33	80009	329628.8	1076.1	944.7	67	6276	269460.4	1066.6	928.0					
34	72807	325736.3	1075.5	943.6	68	5945	268955.7	1066.5	927.9					

TABLE 2-10

1978 FLOOD BENEFITS COMPARISON

Scenario	Starting Elevation (ft., NGVD)	Peak Outflow (cfs)	Peak Storage (ac-ft)	Peak Stage (ft., NGVD)
At Crest Elevation	1,064.1	44,241	307,582	1,072.63
5 Feet Below Crest	1,059.1	24,421	291,528	1,070.07
10 Feet Below Crest	1,054.1	15,883	282,448	1,068.63
15 Feet Below Crest	1,049.1	10,456	275,816	1,067.57
20 Feet Below Crest	1,044.1	4,823	267,250	1,066.21
Historical Elevation	1,053.3	14,889	281,377	1,068.46

6.0U-4.4

TABLE 3-1

MEDINA RESERVOIR CANAL DIVERSIONS
(Acre-feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	720	819	1728	2024	2214	3171	3468	3021	1771	1339	850	713	21837	1820
1941	279	318	670	785	858	1230	1344	1171	686	519	330	276	8466	706
1942	307	349	737	863	944	1352	1479	1288	755	571	363	304	9311	776
1943	495	563	1187	1390	1521	2179	2382	2075	1216	920	584	490	15000	1250
1944	1116	1269	2677	3136	3430	4914	5373	4680	2743	2074	1318	1104	33834	2820
1945	445	506	1067	1250	1367	1959	2142	1866	1094	827	525	440	13487	1124
1946	387	441	929	1089	1191	1706	1865	1625	952	720	457	383	11747	979
1947	583	662	1398	1637	1791	2565	2805	2443	1432	1083	688	577	17663	1472
1948	272	309	651	763	835	1196	1307	1139	667	505	321	269	8232	686
1949	396	450	949	1112	1217	1743	1906	1660	973	736	467	392	12000	1000
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	2223	2592	1035	0	0	0	0	0	0	0	5850	488
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	0	0	0	1740	5488	3646	252	391	1008	12525	1044
1958	75	250	696	2573	2166	5135	3502	6040	1039	463	740	2805	25484	2124
1959	2225	315	2485	2575	2364	5238	4943	4871	3608	2638	2225	1359	34846	2904
1960	1537	1113	2048	2809	5030	6953	2331	3864	4538	3609	1061	510	35403	2950
1961	853	660	4504	6016	8412	4587	2819	3255	4796	3493	953	1428	41776	3481
1962	3324	2448	4600	2429	5688	5552	7712	7882	4284	5560	3491	3027	55997	4666
1963	114	2849	3249	3610	3861	7083	6411	8817	4461	4161	1871	414	46901	3908
1964	1665	473	1539	1983	4891	3289	8590	5736	2827	2240	253	757	34243	2854
1965	1593	201	569	636	536	3254	6902	4977	4495	611	1277	171	25222	2102
1966	388	401	1528	2474	680	5940	5804	2892	1314	2652	3207	2757	30037	2503
1967	2285	2656	5613	2014	7749	9019	6157	6344	616	1168	400	365	44386	3699
1968	1	117	587	931	980	3818	4026	6684	657	2511	2031	612	22955	1913
1969	994	735	1039	1817	1015	4814	6030	5250	2188	1182	843	550	26457	2205
1970	716	583	337	2146	2289	3614	4286	4348	2983	182	806	250	22540	1878
1971	4040	4610	5860	7390	9660	7990	5400	1030	1040	182	806	250	48258	4022
1972	1133	922	4850	7823	1330	3025	5292	2286	3401	2822	665	895	34444	2870
1973	370	521	955	292	4142	3200	1204	2301	878	109	723	1950	16645	1387
1974	1658	2519	4441	6619	2050	6355	8051	2801	306	1473	281	789	37343	3112
1975	747	610	3239	2158	205	1985	3011	4699	2225	3564	2225	2313	26981	2248
1976	1623	4463	2802	393	220	5227	1514	4145	3059	167	110	2	23725	1977
1977	5	388	2406	1068	1011	5430	4756	6928	2202	2382	1460	2083	30119	2510
1978	1878	1260	4106	3125	4272	7406	10994	3354	385	2729	601	838	40948	3412
1979	137	144	805	758	4653	4198	4021	3154	3388	4758	2729	928	29673	2473
1980	1435	1902	5365	5629	1947	9408	9267	3472	2246	3537	1670	377	46255	3855
1981	878	938	1109	2322	5316	1036	4582	4994	2745	1699	2299	2283	30201	2517
1982	2077	2414	2448	4324	2204	8410	7628	6002	5637	2733	1746	789	46412	3868
1983	716	1156	1081	3695	5514	4301	5070	3804	4302	2845	2955	2228	37667	3139
1984	54	1753	5201	7139	7922	7123	9626	7214	5647	1142	326	0	53147	4429
1985	0	712	1156	1269	3148	4479	5320	2257	1550	1204	902	1164	23161	1930
1986	1250	1290	4174	6293	3524	842	5610	6750	2560	700	826	520	34339	2862
TOT	38770	44088	93008	108950	119182	170725	186669	162606	95313	72060	45776	38370	1175517	
AVG	825	938	1979	2318	2536	3632	3972	3460	2028	1533	974	816	25011	

2/9

e-20-4.4

TABLE 3-2

HISTORICAL MEDINA LAKE END-OF-MONTH ELEVATION
(Feet, NGVD)

YEAR	JAN	FEB	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAGE
1940	1002.2	1002.8	997.5	995.3	991.7	988.0	977.6	964.2	945.2	962.4	987.7	983.1
1941	987.5	1011.7	1031.5	1043.0	1043.7	1041.9	1040.7	1039.9	1039.9	1038.7	1037.9	1032.4
1942	1036.4	1035.4	1032.6	1036.6	1033.1	1031.9	1028.4	1029.0	1038.1	1038.7	1038.2	1034.4
1943	1037.4	1035.6	1032.5	1032.8	1033.1	1030.6	1025.6	1023.6	1020.7	1018.1	1016.8	1027.9
1944	1016.3	1017.6	1020.9	1029.1	1030.1	1026.3	1023.6	1022.5	1019.8	1017.7	1018.9	1022.1
1945	1025.0	1029.1	1034.6	1037.1	1029.7	1025.1	1019.1	1020.0	1023.5	1021.5	1020.7	1025.9
1946	1019.5	1019.7	1015.1	1020.5	1019.6	1014.1	1009.7	1013.1	1020.2	1021.0	1021.7	1017.7
1947	1026.3	1028.6	1027.6	1025.1	1022.2	1016.5	1011.0	1003.5	991.7	984.1	977.0	1010.3
1948	967.5	961.4	947.6	950.7	973.6	967.6	943.1	947.2	959.4	959.8	959.2	957.9
1949	963.0	975.3	993.2	998.9	1004.2	1000.3	997.2	992.7	990.8	988.0	987.1	990.1
1950	985.9	987.1	980.4	981.2	983.3	977.5	965.1	951.9	947.3	952.1	955.5	969.8
1951	956.9	959.9	964.7	975.2	977.4	975.5	973.4	971.1	968.8	968.1	967.4	968.9
1952	967.2	966.1	970.8	973.9	977.4	976.5	975.1	988.4	987.3	987.1	989.6	978.1
1953	990.7	991.1	982.4	972.6	970.5	970.1	975.6	987.9	995.1	996.0	996.3	984.4
1954	996.7	996.5	995.6	997.3	996.7	995.6	994.4	986.6	979.1	971.2	947.3	987.0
1955	950.3	954.8	956.9	967.3	967.3	971.1	972.2	971.3	970.4	969.9	969.2	965.5
1956	968.7	968.1	967.0	966.1	965.0	963.7	965.1	964.3	963.7	964.7	964.1	965.5
1957	963.5	963.1	1005.1	1019.3	1028.7	1026.2	1022.3	1023.3	1030.4	1034.6	1036.6	1013.9
1958	1043.3	1049.1	1057.4	1060.3	1064.3	1063.5	1061.4	1064.4	1064.8	1064.2	1064.1	1059.7
1959	1064.0	1064.0	1063.7	1063.5	1064.5	1063.9	1062.3	1060.7	1062.8	1062.6	1062.5	1063.1
1960	1062.5	1062.3	1062.3	1061.3	1059.1	1058.9	1062.6	1061.9	1062.5	1063.4	1064.4	1061.9
1961	1064.3	1064.5	1063.8	1062.1	1064.1	1063.9	1062.9	1061.4	1060.4	1059.5	1058.7	1062.3
1962	1057.3	1056.5	1054.1	1052.2	1050.1	1047.1	1043.6	1041.3	1040.7	1039.1	1037.6	1047.2
1963	1036.9	1035.7	1032.5	1030.7	1027.1	1022.9	1017.6	1013.9	1010.1	1007.7	1006.0	1021.9
1964	1004.3	1004.8	1004.4	1000.3	997.6	988.4	982.1	1010.3	1011.9	1014.1	1013.7	1002.9
1965	1012.5	1016.5	1022.3	1030.5	1032.2	1029.4	1026.3	1023.9	1024.6	1023.7	1025.3	1024.3
1966	1025.5	1025.8	1025.3	1026.6	1024.4	1021.8	1025.3	1028.0	1027.4	1026.1	1024.7	1025.5
1967	1023.5	1022.1	1018.3	1013.3	1006.8	1000.8	994.7	1000.5	1005.6	1011.2	1012.9	1010.0
1968	1024.5	1030.7	1040.9	1047.6	1049.0	1049.1	1046.7	1046.2	1044.9	1043.7	1043.3	1042.4
1969	1042.5	1042.4	1042.5	1043.5	1041.7	1038.8	1036.1	1034.4	1043.8	1044.3	1046.2	1041.5
1970	1046.7	1047.5	1051.6	1053.8	1054.5	1053.1	1051.2	1049.9	1049.1	1047.4	1046.1	1050.1
1971	1044.4	1042.6	1037.6	1033.8	1030.5	1027.3	1064.3	1064.3	1064.7	1064.3	1064.2	1048.9
1972	1063.9	1063.5	1061.0	1064.3	1064.0	1063.1	1063.9	1063.7	1063.3	1062.7	1061.8	1063.2
1973	1061.3	1061.3	1063.0	1063.1	1064.5	1064.7	1064.2	1064.4	1064.6	1064.2	1064.1	1063.6
1974	1064.1	1063.7	1062.0	1064.1	1062.7	1060.5	1064.1	1064.1	1064.2	1064.2	1064.4	1063.5
1975	1064.3	1064.5	1064.4	1064.7	1064.4	1064.2	1063.6	1062.9	1061.8	1060.9	1060.0	1063.2
1976	1059.1	1057.8	1060.4	1063.8	1064.3	1064.4	1064.3	1064.3	1064.8	1064.4	1064.5	1062.9
1977	1064.5	1064.5	1064.6	1064.5	1064.4	1063.9	1062.2	1061.0	1060.0	1060.9	1060.4	1062.8
1978	1059.7	1059.3	1057.6	1056.0	1054.3	1051.3	1064.1	1064.3	1064.0	1064.1	1063.9	1059.9
1979	1064.3	1064.4	1064.6	1064.3	1064.4	1064.3	1064.0	1063.1	1061.6	1060.3	1059.8	1063.2
1980	1059.2	1058.4	1055.2	1055.2	1052.2	1048.7	1046.7	1052.0	1052.9	1053.1	1053.6	1053.4
1981	1053.8	1053.7	1062.3	1064.5	1064.8	1064.3	1064.1	1063.7	1064.3	1064.1	1064.0	1062.1
1982	1063.3	1062.8	1060.9	1063.1	1062.0	1059.4	1057.4	1055.0	1053.4	1052.4	1051.7	1058.3
1983	1051.0	1050.5	1049.4	1048.3	1049.7	1048.3	1046.4	1044.1	1043.0	1043.2	1042.0	1046.9
1984	1041.3	1040.7	1035.7	1032.0	1029.0	1023.8	1019.2	1014.7	1014.5	1014.4	1015.7	1025.5
1985	1025.5	1028.4	1036.4	1039.7	1040.4	1039.9	1036.9	1035.3	1038.0	1039.5	1041.2	1036.5
1986	1041.8	1042.7	1040.0	1040.8	1050.8	1051.0	1048.9	1049.5	1057.3	1060.5	1064.8	1049.8
AVG	1026.6	1027.8	1029.2	1030.8	1031.2	1028.9	1027.4	1027.3	1027.5	1027.5	1027.5	1028.3

TABLE 3-3

HISTORICAL MEDINA LAKE END-OF-MONTH CONTENTS

(Acre-feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVERAG
1940	44510	45610	36670	37780	34680	29700	25620	16020	7080	1770	5920	25290	2588
1941	25070	61850	84230	112800	153700	156700	148200	145000	142200	142200	137800	135100	12049
1942	129800	126200	118100	116300	130500	118100	113900	103900	105600	135800	137800	136100	12268
1943	133300	126800	120200	115900	117000	118100	110200	95890	90160	82600	76550	73520	10502
1944	72360	75380	84930	83070	105900	108800	97800	90160	87010	80510	75620	78410	8667
1945	94170	105800	113900	123400	132200	107600	94460	78880	80970	89870	84460	82600	9803
1946	78810	80270	75150	69560	82140	80040	67240	58200	64910	81440	83300	84930	7558
1947	97900	104500	105600	101600	94460	86150	72820	60570	46880	29700	21320	15600	6975
1948	8230	5530	2310	2220	2790	13260	9300	1380	2140	5000	5110	4940	526
1949	6280	14430	18910	31700	39820	48160	41780	37380	30990	28710	25620	24630	2903
1950	23310	24630	20220	17950	18500	20440	15950	7670	3010	2160	3050	3960	1340
1951	4330	5130	5850	7410	14360	15880	14570	13120	11570	10080	9620	9180	1009
1952	8020	8320	8780	11380	13460	15880	15260	14260	26060	24890	24680	27380	1661
1953	28600	29040	25320	19450	12580	11180	10890	14630	25510	34400	35740	36100	2362
1954	36640	36360	35820	35110	37450	36670	35110	33400	24080	17050	11640	2160	2845
1955	2720	3770	4250	4330	9100	9100	11570	12280	11700	11120	10780	10340	842
1956	10010	9620	9360	8900	8320	7600	6780	7660	7130	6730	7410	7020	804
1957	6630	6370	13320	49800	79340	104800	97560	86430	89300	109600	123400	130500	7475
1958	155000	179400	212200	218700	233400	255200	250500	238900	255700	258600	254600	254000	23051
1959	253400	253400	249400	251700	250500	256300	252900	243600	235400	246500	245300	244700	24859
1960	244700	243600	244700	243600	238400	227300	226300	245300	241400	244700	250000	255700	24214
1961	255200	256300	255200	252300	242400	254000	252900	247100	238900	233900	228300	225300	24523
1962	218200	214200	205100	202100	192500	183600	171000	156300	147100	145000	139300	134000	17570
1963	131500	127300	121600	115900	110500	100200	88150	75380	66770	58930	54500	51450	9184
1964	48340	49260	50350	48530	41780	37940	26060	19120	59300	62220	67240	66300	4803
1965	63510	72820	77010	86430	109900	114900	106800	97900	91020	93020	90450	95030	9156
1966	95600	96460	95030	95030	98760	92450	85160	95030	102800	101000	97320	93310	9566
1967	89870	85860	80040	77010	65370	52910	42490	33830	42060	50720	60940	64440	6212
1968	92740	110500	130800	145700	173100	179000	179400	169300	167200	161700	156700	155000	1517E
1969	151600	151200	149200	151600	155800	148500	138300	128700	122700	157100	159200	167200	14842
1970	169300	172700	185700	189900	200600	204100	197000	188200	182700	179400	172200	166800	1840:
1971	159600	152100	143200	134000	120500	109900	100800	255200	255200	257500	255200	254600	1831:
1972	252900	250500	245900	236900	255200	253400	248200	252900	251700	249400	245900	240900	2486:
1973	238400	238400	240400	247600	248200	256300	257500	254600	255700	256900	254600	254000	2502:
1974	254000	251700	248800	241900	254000	245900	234400	254000	254000	254600	254600	255700	2503(
1975	255200	256300	254600	255700	257500	255700	254600	251100	247100	240900	236400	231800	24974
1976	227300	220700	213700	233900	252300	255200	255700	255200	255200	258600	255700	256300	2449E
1977	256300	256300	255200	256900	256300	255700	252900	243000	236900	231800	236400	233900	247E:
1978	230300	228300	223300	219700	211700	203100	188600	254000	255200	253400	254000	252900	2312(
1979	255200	255700	257500	256900	255200	255700	255200	253400	248200	239900	233400	230800	2497:
1980	227800	223800	216200	207600	207600	192500	177700	169300	191600	196000	197000	199600	2005:
1981	200600	200100	214200	243600	256300	258100	255200	254000	251700	255200	254000	253400	2413E
1982	249400	246500	243000	236400	248200	241900	228800	218700	206600	198600	193500	190300	2251:
1983	187400	185300	185300	180600	176000	181900	176000	168000	158400	153700	154600	149600	1714(
1984	147100	145000	137900	127300	114200	105600	90730	79110	68600	68170	67930	70960	1018E
1985	95600	103900	121600	129800	141400	143900	142200	131500	125900	135400	140700	146800	1298:
1986	148900	152500	148900	142500	145300	186500	187400	178500	181100	218200	234400	258600	1819:
AVG	125891	127549	128346	130173	134678	134609	128837	128327	127601	129688	129090	129411	1295:

TABLE 5-1

ELEVATION-AREA-CAPACITY

MEDINA LAKE

Elev (ft, NGVD)	Area (ac)	Capacity (ac-ft)
912.4	0	0
932.1	54	500
942.1	125	1200
952.1	226	3050
962.1	459	5720
972.1	670	12220
982.1	896	19120
992.1	1261	30140
1002.1	1622	44330
1012.1	2077	62580
1022.1	2597	85860
1032.1	3205	114500
1042.1	3874	149950
1052.1	4624	192000
1062.1	5417	242430
1064.1	5575	254000
1076.2	6740	330041
1080.0	7136	356405
1090.0	8200	433085
1100.0	9328	520725

MEDINA DIVERSION LAKE

Elev (ft, NGVD)	Area (ac)	Capacity (ac-ft)
868.9	0	0
875.0	27	153
880.0	50	403
885.0	73	765
890.0	95	1248
895.0	120	1848
900.0	145	2573
905.0	170	3423
910.0	195	4448
918.9	240	6423
920.0	249	6705
925.0	273	8078
930.0	300	9573
935.0	325	11215
940.0	357	12988
945.0	384	14918
950.0	415	17068
960.0	476	21843
970.0	540	27228
980.0	601	32933

6.20-4.4

TABLE 5-2

ELEVATION-AREA-CAPACITY

APPLEWHITE RESERVOIR SITE

Elevation (Feet, NGVD)	Area (Acres)	Capacity (Acre-feet)
464	0	0
470	15	28
475	43	170
480	73	460
485	123	940
490	200	1734
495	325	3046
500	450	4984
505	580	7559
510	713	10788
515	858	14706
520	1033	19431
525	1311	25243
530	1772	32882
535	2408	43342
536	2554	45795
540	3237	57274
545	4324	75751

2/1

6·20-4.4

TABLE 6-1

NET LAKE EVAPORATION
MEDINA LAKE AND MEDINA DIVERSION LAKE
(Feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	0.12	0.05	0.25	0.18	0.18	0.03	0.59	0.72	0.67	0.26	-0.02	-0.07	2.96	0.25
1941	0.01	-0.17	-0.14	-0.11	0.09	0.10	0.53	0.68	0.24	0.19	0.26	0.13	1.81	0.15
1942	0.19	0.13	0.32	-0.09	0.15	0.47	0.17	0.50	0.05	0.01	0.27	0.18	2.35	0.20
1943	0.15	0.28	0.27	0.39	0.31	0.38	0.49	0.89	0.14	0.41	0.19	0.05	3.95	0.33
1944	-0.08	-0.02	0.09	0.40	-0.09	0.45	0.84	0.37	0.50	0.43	0.02	-0.05	2.86	0.24
1945	-0.07	-0.03	0.06	0.19	0.51	0.45	0.68	0.76	0.46	0.19	0.30	0.14	3.64	0.30
1946	-0.02	0.09	0.26	0.16	0.08	0.33	0.77	0.49	-0.05	0.15	0.14	0.04	2.44	0.20
1947	-0.09	0.23	0.22	0.29	0.27	0.44	0.82	0.49	0.82	0.60	0.24	0.13	4.46	0.37
1948	0.18	-0.03	0.30	0.33	0.43	0.48	0.61	0.72	0.40	0.28	0.34	0.22	4.26	0.36
1949	-0.04	-0.11	0.14	-0.23	0.36	0.23	0.62	0.53	0.52	0.03	0.36	-0.01	2.40	0.20
1950	0.10	0.08	0.39	0.18	0.24	0.38	0.66	0.70	0.49	0.53	0.41	0.30	4.46	0.37
1951	0.23	0.01	0.13	0.30	-0.08	0.42	0.83	0.91	0.59	0.60	0.31	0.28	4.53	0.38
1952	0.22	0.15	0.15	0.14	0.18	0.50	0.70	1.00	0.13	0.61	0.08	0.07	3.93	0.33
1953	0.28	0.15	0.22	0.36	0.50	0.78	0.93	0.55	0.32	0.09	0.27	0.13	4.58	0.38
1954	0.17	0.38	0.42	0.28	0.41	0.60	0.82	0.91	0.82	0.38	0.33	0.34	5.86	0.49
1955	0.12	0.08	0.30	0.51	0.27	0.59	0.73	0.67	0.58	0.67	0.32	0.23	5.07	0.42
1956	0.15	0.17	0.40	0.41	0.54	0.84	0.91	0.84	0.76	0.51	0.35	0.21	6.09	0.51
1957	0.23	0.08	0.13	-0.39	-0.27	0.33	0.92	0.99	0.16	0.06	-0.08	0.13	2.29	0.19
1958	-0.16	-0.12	0.09	0.18	0.06	0.24	0.66	0.74	-0.11	-0.18	0.18	0.13	1.71	0.14
1959	0.13	-0.04	0.32	0.10	0.19	0.21	0.54	0.52	0.49	-0.09	0.17	0.09	2.63	0.22
1960	0.05	0.11	0.09	0.26	0.36	0.55	0.42	0.32	0.59	-0.14	0.13	-0.15	2.59	0.22
1961	0.03	-0.08	0.24	0.32	0.49	0.01	0.15	0.60	0.50	0.17	0.13	0.09	2.65	0.22
1962	0.14	0.23	0.27	0.04	0.47	0.32	0.84	0.80	0.38	0.41	0.12	0.03	4.05	0.34
1963	0.15	0.01	0.31	0.19	0.26	0.48	0.77	0.80	0.47	0.37	0.14	0.09	4.04	0.34
1964	-0.01	0.07	0.14	0.22	0.26	0.43	0.81	0.66	0.18	0.32	0.16	0.11	3.35	0.28
1965	0.14	-0.24	0.14	0.15	-0.18	0.43	0.79	0.73	0.62	0.16	0.21	-0.16	2.79	0.23
1966	0.02	0.02	0.22	0.16	0.04	0.40	0.69	0.46	0.18	0.29	0.35	0.19	3.02	0.25
1967	0.15	0.12	0.20	0.20	0.27	0.62	0.78	0.52	0.08	0.32	0.08	0.12	3.46	0.29
1968	-0.14	0.01	0.06	0.06	0.01	0.30	0.55	0.58	0.20	0.28	0.24	0.10	2.25	0.19
1969	0.07	-0.04	0.15	0.07	0.04	0.47	0.73	0.43	0.18	0.06	0.20	0.12	2.48	0.21
1970	0.09	0.03	0.09	0.15	0.06	0.47	0.59	0.58	0.03	0.17	0.31	0.23	2.80	0.23
1971	0.27	0.25	0.45	0.32	0.44	0.40	0.69	0.15	0.24	0.09	0.20	0.04	3.54	0.30
1972	0.10	0.22	0.35	0.34	0.11	0.37	0.48	0.37	0.39	0.33	0.16	0.18	3.40	0.28
1973	0.04	-0.03	0.22	0.05	0.37	0.17	0.32	0.56	0.12	0.12	0.28	0.30	2.52	0.21
1974	0.08	0.30	0.23	0.34	0.26	0.58	0.74	0.17	0.26	0.20	0.03	0.06	3.25	0.27
1975	0.16	0.05	0.29	0.16	0.08	0.32	0.46	0.56	0.42	0.33	0.39	0.16	3.38	0.28
1976	0.23	0.30	0.23	0.03	0.16	0.46	0.20	0.56	0.27	0.17	0.09	0.05	2.75	0.23
1977	-0.01	0.17	0.26	0.06	0.17	0.42	0.78	0.78	0.58	0.37	0.14	0.26	3.98	0.33
1978	0.13	0.05	0.31	0.25	0.35	0.41	0.74	0.35	0.17	0.39	0.02	0.11	3.28	0.27
1979	-0.01	0.03	0.08	0.06	0.25	0.24	0.38	0.46	0.61	0.60	0.21	0.05	2.96	0.25
1980	0.10	0.14	0.25	0.37	0.16	0.67	0.85	0.50	0.25	0.34	0.03	0.13	3.79	0.32
1981	0.07	0.08	0.11	0.06	0.20	0.09	0.55	0.55	0.42	0.12	0.26	0.22	2.73	0.23
1982	0.17	0.06	0.20	0.20	0.11	0.40	0.73	0.70	0.56	0.38	0.11	0.12	3.74	0.3
1983	0.06	0.07	0.10	0.44	0.23	0.27	0.44	0.50	0.43	0.27	0.19	0.17	3.17	0.26
1984	0.08	0.25	0.34	0.53	0.47	0.55	0.76	0.73	0.59	0.11	0.20	0.01	4.62	0.39
1985	0.06	0.03	0.09	0.18	0.30	0.33	0.51	0.84	0.43	0.24	0.15	0.13	3.29	0.27
1986	0.16	0.15	0.36	0.29	-0.06	0.02	0.79	0.63	0.23	-0.31	0.08	-0.26	2.08	0.1
TOT	3.92	3.72	10.10	9.08	10.01	18.43	30.36	28.87	17.36	11.89	9.05	5.17	158.24	
AVG	0.08	0.07	0.21	0.19	0.20	0.37	0.60	0.58	0.33	0.24	0.18	0.10	3.15	

2/12

TABLE 6-2

NET LAKE EVAPORATION
APPLEWHITE RESERVOIR SITE
(Feet)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	0.09	0.04	0.24	0.21	0.23	-0.02	0.54	0.71	0.61	0.22	-0.02	-0.07	2.78	0.23
1941	0.01	-0.09	-0.08	-0.13	0.04	0.06	0.50	0.66	0.21	0.19	0.24	0.13	1.74	0.15
1942	0.17	0.12	0.30	-0.04	0.14	0.42	-0.02	0.44	-0.03	-0.01	0.25	0.19	1.93	0.16
1943	0.13	0.26	0.24	0.36	0.26	0.38	0.43	0.81	0.14	0.46	0.15	0.05	3.67	0.31
1944	-0.11	-0.01	0.05	0.37	-0.05	0.47	0.78	0.42	0.48	0.41	-0.03	-0.09	2.69	0.22
1945	-0.03	-0.05	0.09	0.21	0.50	0.42	0.56	0.66	0.49	0.12	0.28	0.13	3.38	0.28
1946	-0.06	0.07	0.21	0.16	0.08	0.26	0.73	0.35	-0.15	0.12	0.10	0.01	1.88	0.16
1947	-0.07	0.20	0.20	0.26	0.15	0.53	0.74	0.45	0.73	0.54	0.24	0.09	4.06	0.34
1948	0.15	-0.05	0.25	0.35	0.42	0.51	0.57	0.61	0.40	0.24	0.28	0.22	3.95	0.33
1949	-0.05	-0.05	0.17	-0.25	0.37	0.18	0.56	0.53	0.56	0.00	0.32	-0.01	2.33	0.19
1950	0.13	0.11	0.35	0.16	0.25	0.37	0.58	0.69	0.48	0.49	0.38	0.28	4.27	0.36
1951	0.26	0.03	0.19	0.36	0.08	0.35	0.78	0.88	0.37	0.41	0.22	0.23	4.16	0.35
1952	0.22	0.14	0.17	0.17	0.26	0.50	0.60	0.94	0.07	0.58	0.05	0.01	3.71	0.31
1953	0.29	0.14	0.24	0.27	0.43	0.70	0.84	0.46	0.31	0.10	0.24	0.12	4.14	0.35
1954	0.15	0.34	0.38	0.24	0.39	0.56	0.78	0.82	0.73	0.37	0.31	0.33	5.40	0.45
1955	0.09	0.04	0.23	0.41	0.25	0.46	0.60	0.54	0.48	0.52	0.24	0.18	4.04	0.34
1956	0.16	0.18	0.38	0.39	0.47	0.74	0.85	0.73	0.68	0.47	0.30	0.18	5.53	0.46
1957	0.25	0.07	0.10	-0.25	-0.16	0.33	0.85	0.88	0.06	0.11	-0.09	0.13	2.28	0.19
1958	-0.15	-0.13	0.11	0.17	-0.01	0.33	0.62	0.73	-0.13	-0.19	0.17	0.13	1.65	0.14
1959	0.15	-0.07	0.31	0.12	0.18	0.21	0.52	0.47	0.47	-0.02	0.17	0.09	2.60	0.22
1960	0.08	0.09	0.10	0.22	0.34	0.42	0.43	0.24	0.56	-0.18	0.12	-0.13	2.29	0.19
1961	0.04	-0.04	0.23	0.28	0.46	-0.02	0.16	0.59	0.45	0.21	0.08	0.09	2.53	0.21
1962	0.12	0.21	0.24	0.02	0.44	0.23	0.78	0.77	0.29	0.38	0.08	0.00	3.56	0.30
1963	0.15	-0.01	0.30	0.17	0.29	0.44	0.71	0.77	0.49	0.36	0.12	0.08	3.87	0.32
1964	-0.01	0.06	0.13	0.24	0.25	0.43	0.80	0.62	0.26	0.35	0.19	0.11	3.43	0.29
1965	0.10	-0.25	0.14	0.14	-0.26	0.41	0.77	0.68	0.59	0.15	0.22	-0.16	2.53	0.21
1966	-0.08	0.02	0.20	0.15	-0.01	0.35	0.66	0.43	0.12	0.42	0.31	0.19	2.76	0.23
1967	0.18	0.11	0.20	0.19	0.26	0.64	0.75	0.56	0.03	0.26	0.09	0.07	3.34	0.28
1968	-0.17	-0.01	0.06	0.07	0.06	0.32	0.49	0.57	0.16	0.32	0.27	0.14	2.28	0.19
1969	0.08	-0.03	0.20	0.08	0.06	0.45	0.72	0.47	0.23	0.12	0.24	0.15	2.77	0.23
1970	0.10	0.05	0.09	0.23	0.12	0.52	0.56	0.59	-0.15	0.22	0.30	0.25	2.88	0.24
1971	0.26	0.24	0.44	0.32	0.41	0.39	0.70	0.16	0.17	0.09	0.18	0.04	3.40	0.28
1972	0.08	0.19	0.33	0.31	0.06	0.32	0.40	0.35	0.38	0.31	0.12	0.17	3.02	0.25
1973	0.03	-0.02	0.20	0.03	0.33	0.12	0.33	0.50	0.06	0.10	0.28	0.29	2.25	0.19
1974	0.07	0.29	0.20	0.30	0.24	0.52	0.67	0.19	0.22	0.17	0.01	0.08	2.96	0.25
1975	0.15	0.06	0.27	0.16	0.09	0.28	0.44	0.49	0.40	0.34	0.36	0.15	3.19	0.27
1976	0.22	0.29	0.22	0.03	0.15	0.47	0.19	0.53	0.30	0.18	0.06	0.03	2.67	0.22
1977	-0.03	0.16	0.25	0.01	0.17	0.39	0.74	0.76	0.55	0.37	0.16	0.26	3.79	0.32
1978	0.12	0.04	0.29	0.21	0.36	0.39	0.67	0.36	0.13	0.38	0.02	0.11	3.08	0.26
1979	-0.03	0.03	0.10	0.04	0.23	0.25	0.31	0.47	0.54	0.55	0.23	0.05	2.77	0.23
1980	0.09	0.13	0.25	0.34	0.13	0.64	0.80	0.46	0.22	0.34	0.03	0.14	3.57	0.30
1981	0.06	0.08	0.13	0.11	0.18	0.09	0.48	0.48	0.44	0.12	0.24	0.21	2.62	0.22
1982	0.17	0.05	0.18	0.17	0.11	0.38	0.73	0.66	0.55	0.28	0.09	0.12	3.49	0.29
1983	0.07	0.06	0.10	0.44	0.23	0.30	0.41	0.50	0.39	0.28	0.22	0.16	3.16	0.26
1984	0.08	0.23	0.32	0.52	0.44	0.55	0.77	0.73	0.59	0.12	0.20	0.04	4.59	0.38
1985	0.06	0.04	0.10	0.16	0.29	0.31	0.51	0.78	0.40	0.25	0.18	0.13	3.21	0.27
1986	0.15	0.13	0.35	0.31	-0.10	-0.05	0.76	0.64	0.19	-0.24	0.09	-0.29	1.94	0.16
TOT	3.92	3.49	9.75	8.79	9.61	17.30	28.15	27.13	15.52	11.38	8.29	4.81	148.14	
AVG	0.08	0.07	0.21	0.19	0.20	0.37	0.60	0.58	0.33	0.24	0.18	0.10	3.15	

TABLE 8-1
RECOMMENDED MINIMUM FLOW REQUIREMENTS

UNITS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
CFS	10.0	10.0	20.0	20.0	20.0	20.0	5.0	5.0	5.0	5.0	5.0	10.0
AC-FT/MO	614.9	560.3	1229.7	1190.0	1229.7	1190.0	307.4	307.4	297.5	307.4	297.5	614.9

6.20-4.4

TABLE 8-2

SAN ANTONIO BAY INFLOWS

HISTORICAL CONDITIONS SCENARIO HONORING EXISTING WATER RIGHTS

(AC-FT/MO)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	AVG
1940	103643	94211	60862	77086	42661	166009	124767	38818	21300	41980	290081	394417	1455835	121320
1941	181564	260476	266130	442592	600999	269169	154996	68412	85630	101608	86505	68701	2586782	215565
1942	67733	116401	87418	122907	100033	41890	504604	114566	464212	259039	116414	100459	2095676	174640
1943	107562	84560	100493	71896	62470	81977	49513	26615	35924	40990	45262	86247	793509	66126
1944	192334	156368	218079	101069	304013	154979	60021	66116	88115	57156	75419	156506	1630175	135848
1945	191872	176755	194947	219895	91656	69370	40385	73514	60834	88745	59599	78198	1345770	112147
1946	135572	154087	201450	116549	191692	131849	46614	116899	363651	401196	260092	177892	2297543	191462
1947	253625	150106	132661	118764	174336	81273	41667	97282	34355	35677	42700	51780	1214226	101185
1948	90225	98477	69776	45434	52222	24542	25182	40095	35958	44202	36117	35480	597710	49809
1949	47911	114354	74312	368610	149408	112873	42841	34191	22049	197262	67276	68667	1299754	108313
1950	52175	55836	41041	54240	39067	98269	14285	10186	11552	20077	22707	23832	443267	36939
1951	27874	25511	27834	20228	55918	123104	9156	3155	139372	64994	46893	37909	581948	48496
1952	31203	39467	31013	42690	89670	38666	7777	2021	361741	39547	105338	124301	913434	76119
1953	98582	72338	55164	118306	91518	8340	454	63287	122092	64017	48182	71748	814028	67836
1954	48994	35849	26331	18186	33950	2449	0	0	0	34078	29523	23168	252528	21044
1955	27590	46892	28544	14567	31803	8238	0	0	6679	8226	13236	18187	203962	16997
1956	20591	19069	11583	6556	9379	0	0	0	3837	7822	10946	29395	119178	9931
1957	13900	20698	137392	526557	380676	283091	38495	12897	206016	246517	269438	150055	2285732	190478
1958	336189	554565	250437	150192	328926	162900	60722	30543	192970	237164	219155	162663	2686426	223869
1959	119777	212188	131202	170130	102984	75173	46293	34843	34979	184393	100166	113890	1326018	110501
1960	123618	148376	120684	175501	80386	165559	64943	117955	57913	609863	371660	380594	2417052	201421
1961	325552	371397	223186	119351	73490	270194	106927	52879	53870	60597	111785	64080	1833308	152776
1962	60936	52385	45604	48482	37352	57972	11571	4653	31670	37650	38576	80777	507628	42302
1963	62084	80688	58373	49735	30250	10445	5652	2422	5718	17696	40191	52376	415630	34636
1964	70478	93117	71006	32886	15112	19700	738	6652	55997	33604	53056	39733	492079	41007
1965	122117	310590	111361	144393	328893	193132	42758	23073	21714	78575	76679	246794	1700079	141673
1966	150076	159564	116046	108049	133795	56878	32279	43922	51037	43236	28937	27902	951721	79310
1967	37350	34084	31399	18864	23635	5860	2067	18630	1238176	305064	223355	107182	2045666	170472
1968	580433	251306	183504	190223	390946	306562	142162	68267	125897	57334	62662	108652	2467948	205662
1969	56982	190870	165862	294991	276366	118124	37631	27633	46472	101987	92633	154057	1563608	130301
1970	161582	147718	246455	122378	314948	186889	51168	30943	50071	93798	60320	50550	1516820	126402
1971	44962	37358	33641	20471	13368	3124	2698	102314	259303	268623	179854	181160	1146876	95573
1972	147968	99105	73644	78716	577779	180070	78574	71142	60177	122553	112805	84853	1687386	140615
1973	138542	184452	166340	256996	114824	637501	438418	180524	316366	810564	288552	150190	3683269	306939
1974	163688	106157	88581	66452	174397	78165	38069	100839	204257	92642	298956	199547	1611750	134312
1975	173339	293461	164477	114686	571005	286391	153348	79824	59494	72215	62185	168965	2199390	183282
1976	110021	75373	63373	406050	435003	198173	188789	90931	109298	397559	398937	451306	2924813	243734
1977	353044	342397	202362	573571	354215	237585	105849	68289	59896	66479	112993	69432	2546112	212176
1978	101859	148669	123354	97635	78268	93062	27104	303923	283624	112744	141225	95321	1606788	133899
1979	381808	297017	331140	394163	393288	301481	124084	88075	133801	80293	62806	61587	2649543	220795
1980	132206	97442	80396	53718	178926	53127	19189	46531	117037	77519	71222	74819	1002132	83511
1981	89546	70519	109281	103290	321998	752929	257536	119409	177454	421657	239518	114265	2777402	231450
1982	84765	200772	112951	71093	258274	63411	25279	19148	21809	45804	140306	87946	1131558	94296
1983	80292	160554	190271	105757	217826	97070	93812	48514	84193	73140	140340	57617	1349386	112449
1984	75928	76207	120385	48912	41344	24169	21814	9867	17868	111810	86906	80928	716138	59678
1985	173301	115490	221859	200507	111519	190967	192678	60122	54492	173577	293998	237751	2026261	168855
1986	159415	134565	136540	114132	126262	337431	120757	47327	95560	222817	217148	520308	2232262	186022
TOTAL	6310808	6767841	5738744	6817456	8606850	6860132	3653666	2667248	6084430	6764090	5952654	5922187	72146106	
AVG	134273	143997	122101	145052	183124	145960	77738	56750	129456	143917	126652	126004	1535024	

TABLE 8-3

SCENARIO 11
SAN ANTONIO BAY INFLOWS
ARTIFICIAL RECHARGE SCENARIO

(AC-FT/MO)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL	AVG
1940	103643	94211	60862	77086	42661	166009	124767	38818	21300	41980	280081	394417	1455835	121320
1941	181564	260476	266130	417305	567777	267900	154996	68412	85630	101608	86505	68701	2527004	210584
1942	67733	116401	87418	122907	99765	41890	504604	114566	450891	245573	116414	100459	2068621	172385
1943	107562	84560	100493	71896	62470	81977	49513	26615	35924	40990	45252	86247	793509	66126
1944	192334	156368	218079	101069	304013	154979	60021	66116	88115	57156	75419	156506	1630175	135848
1945	191872	176755	194947	219895	91656	69370	40385	73514	60834	88745	59599	78198	1345770	112147
1946	135572	154087	201450	116549	191692	131849	46614	116899	363621	401166	259991	177816	2297306	191442
1947	253358	150106	132661	118764	174336	81273	41667	97282	34355	35677	42700	51780	1213959	101163
1948	80225	98477	69776	45434	52222	24542	25182	40095	35958	44202	36117	35480	597710	49809
1949	47911	114354	74312	368610	149408	112873	42841	34191	22049	197262	67276	68667	1299754	108313
1950	52175	55836	41041	54240	39067	98269	14285	10186	11552	20077	22707	23832	443267	36939
1951	27874	25511	27834	20228	55918	123104	9156	3155	139372	64994	46893	37909	581948	48496
1952	31203	39467	31013	42690	89670	38666	7777	2021	361741	39547	105338	124301	913434	76119
1953	98582	72338	55164	118306	81518	8340	387	63287	122092	64017	48182	71748	813961	67830
1954	48994	35849	26331	18186	33950	2449	319	311	302	34045	29369	22861	252986	21080
1955	27590	46892	28544	14416	31803	8238	424	1229	6679	8226	13236	18187	205464	17122
1956	20591	19069	11583	6556	9379	2	146	1229	5937	7822	10946	29395	122655	10221
1957	13900	20698	137392	526557	380676	283089	38495	12897	206016	246517	269438	150055	2285730	190477
1958	336189	554565	250437	150182	312735	161923	60397	30543	185775	231489	213955	159330	2647530	220627
1959	117673	209815	131202	170130	102984	75173	46293	34843	34979	184393	100166	113890	1321541	110128
1960	123618	148376	120684	175501	80386	165559	64843	117955	57913	609863	371660	380594	2417052	201421
1961	325552	352126	211953	119351	73490	270194	106927	52879	53870	60597	111785	64080	1802804	150234
1962	60936	52385	45604	48482	37352	57972	11571	4653	31670	37650	38576	80777	507628	42302
1963	62084	80688	58373	49735	30250	10445	5652	2422	5718	17696	40191	52376	415630	34636
1964	70478	93117	71006	32886	15112	19700	738	6652	55997	33604	53056	39733	492079	41007
1965	122117	310590	111361	144393	328893	193132	42758	23073	21714	78575	76679	246794	1700079	141673
1966	150076	159564	116046	108049	133795	56878	32279	43922	51037	43236	28937	27902	951721	79310
1967	37350	34084	31399	18864	23635	5860	2067	18630	1238176	305064	223355	107182	2045666	170472
1968	580556	251318	183540	190223	391089	306562	142162	68267	125897	57334	62662	108652	2468262	205688
1969	56982	190870	165862	294991	276366	118124	37631	27633	46472	101987	92633	154057	1563608	130301
1970	161582	147718	246455	122378	314948	186889	51168	30943	50071	93798	60320	50550	1516820	126402
1971	44962	37358	33641	20471	13368	3124	2698	111870	259860	263458	174720	175272	1140802	95067
1972	144722	98906	73644	78716	567494	177155	78574	71142	60177	122553	112805	84853	1670741	139228
1973	138542	184452	166340	256994	114824	624225	401150	176687	311304	804535	283335	146612	3609000	300750
1974	161311	105982	88581	66452	174046	78165	38069	100371	202949	90777	286010	189457	1582170	131847
1975	162841	288478	161578	110904	565072	282436	150221	79824	59494	72215	62185	168965	2164213	180351
1976	110021	75373	63373	406050	434672	198173	180712	90931	109298	384758	382829	434206	2870396	239200
1977	344092	337191	198630	568699	348088	237075	105849	68289	59896	66479	112993	69432	2517713	209809
1978	101859	148669	123354	97635	78268	93062	27104	300915	278069	109335	135886	90353	1584509	132042
1979	375475	291567	325807	388981	391803	299739	121967	88075	133801	80293	62806	61587	2621901	218491
1980	132206	97442	80396	53718	178926	53127	19189	46531	117037	77519	71222	74819	1002132	83511
1981	89546	70519	109281	103290	321998	735369	255980	119409	177454	412913	235877	114136	2745772	228814
1982	84765	200772	112951	71093	255551	63411	25279	19148	21809	45804	140306	87946	1128835	94070
1983	80292	160554	190271	105757	217826	97070	93812	48514	84193	73140	140340	57617	1349386	112449
1984	75828	76207	120385	48912	41344	24169	21814	9867	17868	111810	86906	80928	716138	59678
1985	173301	115490	221859	200507	111519	190967	182678	60122	54492	173577	293998	237751	2026261	168855
1986	159415	134565	136540	114132	126262	337466	120757	47327	95560	222817	231356	514690	2240887	186740
TOTAL	6277154	6730196	5715583	6778180	8531077	6817963	3602018	2672260	6054918	6706873	5913022	5871100	71670344	
AVG	133556	143196	121608	144217	181512	145063	76639	56857	128828	142699	125809	124917	1524901	

TABLE B-4

HISTORICAL INFLOWS TO THE SAN ANTONIO BAY
BASED ON USGS GAGES AND CALCULATED UNGAGED RUNOFF

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOT	AVG
1940	107936	111362	73142	99472	67212	173637	526871	70812	41186	65950	610930	594454	2542964	211914
1941	273863	377717	401311	473030	1127843	427824	242840	124319	129467	121155	113697	93317	3906382	325532
1942	85176	150370	107614	210493	136518	77460	820547	162119	595583	323214	155313	126854	2951262	245938
1943	147155	108445	134531	102234	94325	141838	90084	57737	65532	56454	58110	111302	1167748	97312
1944	240867	180406	263677	129445	388642	238584	104117	89268	144333	71326	92342	170527	2113535	176128
1945	249982	233420	205582	420995	124761	113425	74498	110828	76996	118177	69846	88826	1887334	157278
1946	168330	202973	266070	158739	244036	220627	68738	123047	556472	726608	331788	200405	3267834	272319
1947	329583	177209	183018	174773	258328	115656	84523	110831	59995	51632	54708	67827	1668083	139007
1948	111736	136695	101958	66784	118300	46197	72952	81243	55747	56655	37325	38361	923954	76996
1949	51506	114206	137070	499994	279252	158802	119633	66452	50470	311461	102617	120758	2012219	167685
1950	77448	76174	62907	96571	72432	176107	47840	35781	33399	29889	28580	33307	770434	64203
1951	31891	34646	37154	38789	91018	218305	33322	19812	183365	75219	54129	42167	859817	71651
1952	35435	50696	43756	67216	147149	102295	43989	17712	460059	53903	134749	195045	1352003	112667
1953	150229	91131	70555	65025	236421	28496	28731	106450	206277	129971	56062	78319	1247667	103972
1954	55412	40098	34959	39520	61573	22155	14097	9709	10362	41509	33565	27039	389998	32500
1955	29080	99996	43320	27772	72613	58527	17414	24215	24234	10852	10914	18322	437259	36438
1956	18780	20837	14900	14538	26345	5124	6539	6038	15563	35249	16474	58488	238875	19906
1957	16796	39306	239272	607680	732577	521530	78199	41131	363578	576466	420828	190035	3827398	318950
1958	494247	901676	383360	192966	431460	147253	115399	60456	255249	299767	285630	211445	3778908	314909
1959	153998	289431	176708	288552	164987	97566	105603	72719	62782	229896	126195	147714	1916151	159679
1960	147513	180503	153206	125502	180982	215391	202050	161320	86432	976303	716291	460641	3606134	300511
1961	438983	481836	270425	160113	107415	528273	241291	103915	139771	100003	202422	91749	2866196	238850
1962	82898	72519	64404	82306	64159	99765	41995	29422	66772	49657	55133	105067	814097	67841
1963	80586	119021	72735	66599	44925	32142	28248	13542	20893	31255	76353	80218	666517	55543
1964	96938	142400	135498	68559	45408	54503	23235	51996	59998	71870	93892	54038	898335	74861
1965	155459	456056	136211	161746	463879	310239	88340	55608	53011	124743	151629	295181	2452102	204342
1966	186852	208526	165443	180556	247050	110624	81134	60433	78206	68179	51559	48044	1486606	123884
1967	55325	52018	48841	42878	48229	27570	26933	94228	1832388	396398	273142	129968	3027918	252327
1968	799192	274237	203021	237916	543708	582522	203205	100533	186905	80146	85359	168160	3464904	288742
1969	82393	305836	285299	396426	363204	168059	77145	64157	73029	108461	122222	179064	2225295	185441
1970	218235	180987	296162	174339	345585	273795	104122	74469	84968	124729	76927	65982	2020300	168358
1971	61307	49027	49699	36564	31485	41592	29234	177821	438275	304679	200662	222611	1642956	136913
1972	182261	147247	104630	109291	1147360	279904	157678	127557	98118	158593	134756	105750	2753145	229429
1973	173430	219139	236661	496822	202156	896947	616925	286889	308019	1297123	360167	219880	5314158	442847
1974	316318	162225	136781	107304	226138	150902	77781	130376	340719	131867	372681	255094	2408186	200682
1975	204167	384976	201267	183569	711497	521120	265404	159923	119141	99368	83325	213088	3146845	262237
1976	142888	101251	94983	554457	651018	286753	254674	160636	182449	513181	565476	706895	4214661	351222
1977	418821	459446	255167	932408	464672	319862	194557	136545	122371	95694	196103	103756	3699402	308284
1978	131168	166028	127756	118589	85987	149892	53514	337796	434432	167878	192203	112248	2077491	173124
1979	545529	394996	371095	522432	684273	554233	219623	173388	195593	109789	91491	89156	3951598	329300
1980	170376	122711	103680	84621	294751	107311	59539	92210	153519	87037	90920	91813	1458490	121541
1981	116256	97206	115753	135099	435360	1050238	397283	205025	847415	315408	355192	153345	4223580	351965
1982	133183	258944	157107	112063	447056	118807	71643	51680	45812	70455	193943	110089	1770783	147565
1983	93353	174228	205755	123283	238679	121261	119952	71777	104406	86251	150066	67520	1556531	129711
1984	86434	86105	131225	63992	60772	48342	46903	32369	36935	130281	98058	92015	913432	76119
1985	184114	125074	236398	220227	134921	224486	220187	82652	73595	187873	306030	248988	2244545	187045
1986	168701	144823	147823	129498	148832	412513	149245	71153	118741	243626	240215	532772	2507942	208995
TOTAL	8302131	9004160	7487889	9401746	13295294	10778455	6747777	4498100	9692560	9516198	8330018	7617644	104671971	
AVG	176641	191578	159317	200037	282879	229329	143570	95704	206225	202472	177234	162078	2227063	185588

TABLE 8-5

FLOW DURATION AND STATISTICAL ANALYSES

HISTORICAL SAN ANTONIO BAY INFLOWS

(AC-FT/MO)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	799192	901676	401311	932408	1147360	1050238	820547	337796	1832388	1297123	716291	706895	932408
2	545529	481836	383360	607680	1127843	896947	616925	286889	847415	976303	610930	594454	799192
5	494247	459446	371095	554457	732577	582522	526871	205025	595583	726608	565476	532772	554457
10	329583	384976	270425	496822	651018	521530	254674	162119	438275	396398	360167	255094	427824
20	240867	274237	239272	288552	447056	319862	219623	136545	308019	304679	285630	213088	255249
30	182261	202973	203021	183569	345585	238584	149245	110831	183365	167878	196103	179064	193943
40	155459	174228	157107	160113	244036	176107	104122	94228	129467	124743	150066	129968	151629
50	142888	144823	136211	125502	180982	149892	81134	74469	98118	108461	113697	110089	122711
60	111736	122711	127756	109291	136518	118807	74498	70812	76996	87037	92342	93317	100533
70	85176	101251	101958	84621	94325	102295	53514	57737	62782	71326	76927	88826	77781
80	61307	76174	64404	66599	67212	54503	33322	35781	50470	56454	55133	65982	59995
90	35435	49027	43756	39520	48229	32142	26933	19812	33399	41509	37325	42167	37325
92	31891	40098	43320	38789	45408	28496	23235	17712	24234	35249	33565	38361	33322
95	18780	34646	34959	27772	31485	22155	14097	9709	15563	29889	16474	27039	27039
98	16796	20837	14900	14538	26345	5124	6539	6038	10362	10852	10914	18322	14900
99	16796	20837	14900	14538	26345	5124	6539	6038	10362	10852	10914	18322	10852
MEAN, CFS	2878	3456	2596	3368	4609	3861	2339	1559	3472	3299	2984	2641	3079
MINIMUM, AF	16796	20837	14900	14538	26345	5124	6539	6038	10362	10852	10914	18322	5124
MEAN, AF	176641	191578	159317	200037	282879	229329	143570	95704	206225	202472	177234	162078	185589
MAXIMUM, AF	799192	901676	401311	932408	1147360	1050238	820547	337796	1832388	1297123	716291	706895	1832388
MEDIAN, AF	142888	144823	136211	125502	180982	149892	81134	74469	98118	108461	113697	110089	122711

TABLE 8-6

FLOW DURATION AND STATISTICAL ANALYSES

SCENARIO 11
SAN ANTONIO BAY INFLOWS

ARTIFICIAL RECHARGE SCENARIO

(AC-FT/MO)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	580556	554565	325807	568699	567777	735369	504604	300915	1238176	804535	382829	514690	568699
2	375475	352126	266130	526557	567494	624225	401150	176687	450891	609863	371660	434206	526557
5	344092	337191	250437	417305	565072	337466	255980	119408	363621	412913	293998	394417	380676
10	253358	288478	218079	368610	391089	283089	154996	114566	278069	305064	283335	237751	291567
20	173301	200772	194947	200507	321998	237075	121967	90931	185775	231489	231356	168965	190271
30	150076	159564	161578	144393	255551	177155	78574	68412	122092	122553	140306	146612	142162
40	123618	148376	123354	118306	174046	131849	49513	60122	85630	93798	111785	107182	111810
50	103643	114354	111361	105757	111519	97070	41667	43922	59494	77519	86505	84853	88075
60	89546	97442	87418	78716	91518	78165	37631	34191	53870	64994	67276	74819	68412
70	67733	76207	69776	54240	62470	56878	21814	23073	35924	45804	59599	64080	51168
80	48994	52385	45604	45434	39067	24169	7777	9867	21809	39547	42700	50550	36117
90	31203	35849	31013	20228	30250	8238	738	2422	11552	33604	29369	29395	19700
92	27874	34084	28544	18864	23635	5860	424	2021	6879	20077	28937	27902	14416
95	20591	20698	26331	14416	13368	2449	319	1229	5718	8226	13236	22861	8226
98	13900	19069	11583	6556	9379	2	146	311	302	7822	10946	18187	2021
99	13900	19069	11583	6556	9379	2	146	311	302	7822	10946	18187	387
MEAN, CFS	2176	2583	1981	2428	2957	2442	1249	926	2169	2325	2118	2035	2109
MINIMUM, AF	13900	19069	11583	6556	9379	2	146	311	302	7822	10946	18187	2
MEAN, AF	133556	143196	121608	144217	181512	145063	76639	56857	128828	142699	125809	124917	127075
MAXIMUM, AF	580556	554565	325807	568699	567777	735369	504604	300915	1238176	804535	382829	514690	1238176
MEDIAN, AF	103643	114354	111361	105757	111519	97070	41667	43922	59494	77519	86505	84853	88075

TABLE 8-7

HISTORICAL MEDINA DIVERSION LAKE OUTFLOWS a)

FLOW DURATION AND STATISTICAL ANALYSES

(AC-FT/MO)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	17290	53376	27252	12277	33820	80981	188600	26240	33630	64978	34650	19416	33820
2	9897	31470	14836	9362	9492	28099	20725	26178	18693	53940	30441	16004	28099
5	7002	15202	14260	7204	8445	16152	13743	19405	17519	32140	25021	10210	16152
10	4488	4333	3946	3756	4589	11301	6842	5695	11562	17173	6761	6458	7895
20	2550	3590	2507	2340	2918	5620	3650	3701	3096	4704	4690	3683	3499
30	2239	1920	2260	1961	2141	2849	2700	2757	2210	2600	2818	2942	2360
40	2060	1691	2016	1675	1853	2163	2051	2069	1876	1821	1986	2312	1998
50	1640	1480	1750	1522	1763	1847	1750	1820	1650	1595	1630	1792	1730
60	1320	1349	1560	1489	1590	1710	1644	1440	1430	1365	1250	1590	1500
70	1100	1060	1210	1380	1427	1360	1440	1276	1142	1120	1123	1160	1282
80	782	905	762	1040	1330	1237	1152	1130	977	841	920	823	1000
90	320	39	137	487	593	241	235	252	623	144	339	445	368
92	0	0	15	0	173	202	13	0	556	80	153	202	144
95	0	0	0	0	0	0	0	0	0	0	0	0	0
98	0	0	0	0	0	0	0	0	0	0	0	0	0
99	0	0	0	0	0	0	0	0	0	0	0	0	0
MEAN, CFS	39	71	48	37	48	92	114	65	66	101	73	50	67
MINIMUM, AF	0	0	0	0	0	0	0	0	0	0	0	0	0
MEAN, AF	2415	3938	2977	2176	2956	5467	6983	3976	3922	6172	4328	3087	4033
MAXIMUM, AF	17290	53376	27252	12277	33820	80981	188600	26240	33630	64978	34650	19416	188600
MEDIAN, AF	1640	1480	1750	1522	1763	1847	1750	1820	1650	1595	1630	1792	1730

a) Based on USGS gaged data and filled-in flows (1940-53, 1973-82).

TABLE 8-8

HISTORICAL APPLEWHITE RESERVOIR SITE INFLOWS

FLOW DURATION AND STATISTICAL ANALYSES

(AC-FT/MO)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	36899	71342	36277	40205	53792	150681	195287	53511	64358	89841	41122	30768	53792
2	25221	31470	21977	29274	38095	52708	31353	39147	40318	56892	41080	29278	41080
5	17885	24981	18021	21954	33173	51638	21902	34452	37773	40115	35107	17421	30066
10	10926	10551	6671	10575	21069	18660	11383	9255	23944	29499	10503	12202	16890
20	6790	7526	5953	5529	11403	10038	6538	6776	10400	10158	6964	6560	7909
30	5458	4813	4773	4854	8223	6527	4643	4604	5156	6578	5706	5520	5488
40	4739	4565	4516	4119	5462	5007	3854	3363	4139	4569	4347	4662	4559
50	3948	3819	3739	3682	4179	4309	3140	2857	3417	3987	3598	4126	3854
60	3255	3530	3537	3547	3593	3884	2757	2513	2795	3393	3154	3560	3279
70	2442	2802	2646	3091	3096	2816	1922	1849	2428	2885	2684	2732	2689
80	1927	2426	2073	2264	2112	1855	1310	1324	1896	2365	1889	2329	2029
90	791	1870	1434	1306	1330	463	398	1054	1379	1288	722	895	1180
92	767	895	1327	1078	1180	427	267	801	1320	762	587	736	895
95	470	449	499	390	970	287	254	339	644	359	311	648	581
98	210	433	368	242	638	238	231	259	495	287	310	590	310
99	210	433	368	242	638	238	231	259	495	287	310	590	259
MEAN, CFS	96	129	87	104	143	186	148	112	138	163	117	97	126
MINIMUM, AF	210	433	368	242	638	238	231	259	495	287	310	590	210
MEAN, AF	5903	7147	5334	6173	8783	11046	9079	6852	8226	9992	6939	5968	7620
MAXIMUM, AF	36899	71342	36277	40205	53792	150681	195287	53511	64358	89841	41122	30768	195287
MEDIAN, AF	3948	3819	3739	3682	4179	4309	3140	2857	3417	3987	3598	4126	3854

TABLE 8-9

ELEVATION-DURATION AND STATISTICAL ANALYSES

MEDINA HISTORICAL ELEVATIONS a)

(FEET, NGVD)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	1064.5	1064.5	1064.7	1064.6	1064.7	1064.8	1064.7	1064.3	1064.4	1064.8	1064.4	1064.8	1064.7
2	1064.3	1064.5	1064.3	1064.6	1064.5	1064.5	1064.4	1064.3	1064.4	1064.8	1064.3	1064.5	1064.5
5	1064.3	1064.5	1064.3	1064.4	1064.5	1064.5	1064.3	1064.2	1064.3	1064.7	1064.2	1064.4	1064.4
10	1064.0	1063.7	1063.2	1063.0	1064.1	1064.4	1063.9	1064.1	1064.1	1064.2	1064.1	1064.1	1064.2
20	1061.3	1061.3	1061.7	1061.0	1063.1	1064.0	1063.1	1062.9	1062.9	1062.5	1062.6	1062.5	1062.3
30	1053.8	1053.7	1056.1	1055.2	1055.2	1054.3	1051.3	1057.4	1055.0	1057.3	1059.5	1058.7	1056.1
40	1042.5	1042.6	1041.8	1040.9	1043.5	1049.0	1047.1	1046.4	1044.1	1043.8	1043.7	1043.3	1044.3
50	1036.4	1035.4	1034.1	1034.6	1036.6	1033.1	1030.6	1028.4	1029.0	1038.0	1038.7	1037.6	1036.6
60	1025.0	1028.4	1029.0	1031.5	1030.7	1029.7	1026.2	1023.6	1023.3	1023.5	1021.5	1021.7	1026.1
70	1012.5	1016.5	1018.3	1018.3	1020.5	1022.2	1016.5	1011.0	1013.1	1011.9	1014.1	1013.7	1017.5
80	987.5	991.1	987.7	995.6	997.3	996.7	988.4	982.1	988.4	990.8	987.1	987.7	995.3
90	967.2	966.1	967.7	970.8	973.9	977.4	975.5	973.4	971.1	968.8	968.1	967.4	970.5
92	963.5	963.1	966.8	967.0	972.6	973.6	971.1	972.2	964.3	963.7	964.7	964.1	967.5
95	956.9	959.9	956.6	956.9	966.1	967.3	967.6	965.1	951.9	947.3	959.8	955.5	963.7
98	950.3	954.8	948.1	947.6	950.7	965.0	963.7	943.1	947.2	945.2	952.1	947.3	952.1
99	950.3	954.8	948.1	947.6	950.7	965.0	963.7	943.1	947.2	945.2	952.1	947.3	947.6
MINIMUM, FT	950.3	954.8	948.1	947.6	950.7	965.0	963.7	943.1	947.2	945.2	952.1	947.3	943.1
MEAN, FT	1026.6	1027.8	1028.0	1029.2	1030.8	1031.2	1028.9	1027.4	1027.3	1027.5	1027.5	1027.5	1028.3
MAXIMUM, FT	1064.5	1064.5	1064.7	1064.6	1064.7	1064.8	1064.7	1064.3	1064.4	1064.8	1064.4	1064.8	1064.8
MEDIAN, FT	1036.4	1035.4	1034.1	1034.6	1036.6	1033.1	1030.6	1028.4	1029.0	1038.0	1038.7	1037.6	1036.6

a) Based on USGS content records and Medina Lake elevation-capacity data.

TABLE 8-10

ELEVATION DURATION AND STATISTICAL ANALYSES
SCENARIO 11

(FEET, NGVD)

PERCENT OF TIME EQUALED OR EXCEEDED	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1
2	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1
5	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1
10	1063.7	1063.1	1061.9	1063.2	1064.1	1064.1	1063.2	1063.4	1062.4	1064.1	1064.1	1063.7	1064.0
20	1058.3	1057.7	1059.2	1060.3	1061.4	1061.3	1061.8	1061.3	1060.4	1060.7	1059.9	1059.3	1060.7
30	1054.7	1054.2	1056.2	1056.3	1056.8	1058.5	1057.0	1058.4	1057.5	1058.2	1057.3	1056.1	1056.8
40	1052.3	1052.5	1052.3	1051.4	1051.5	1052.6	1052.3	1053.5	1052.8	1052.4	1051.9	1052.8	1052.7
50	1048.8	1048.2	1047.3	1047.3	1048.3	1048.5	1046.7	1045.5	1047.7	1047.1	1046.5	1047.1	1048.5
60	1043.4	1042.7	1043.6	1044.3	1046.4	1046.7	1044.7	1042.8	1042.0	1042.2	1042.4	1041.4	1044.3
70	1031.9	1034.9	1033.2	1031.8	1032.9	1033.5	1030.7	1027.7	1027.9	1029.1	1027.0	1027.0	1031.6
80	1017.3	1016.0	1014.1	1013.0	1016.5	1018.3	1014.8	1011.7	1018.2	1016.2	1020.2	1018.7	1021.1
90	958.6	958.6	958.6	958.6	963.8	963.5	958.6	958.6	968.0	969.0	961.5	958.6	961.5
92	958.6	958.6	958.6	958.6	963.3	958.6	958.6	958.6	958.6	957.5	958.6	958.6	958.6
95	946.5	949.0	953.1	952.9	957.5	954.5	954.0	953.9	951.4	948.8	947.3	945.4	954.5
98	943.9	943.2	948.8	947.4	947.2	944.7	942.6	948.4	947.2	945.6	946.7	945.0	947.2
99	943.9	943.2	948.8	947.4	947.2	944.7	942.6	948.4	947.2	945.6	946.7	945.0	945.4
MINIMUM, FT	943.9	943.2	948.8	947.4	947.2	944.7	942.6	948.4	947.2	945.6	946.7	945.0	942.6
MEAN, FT	1034.7	1034.6	1034.8	1035.8	1037.0	1036.6	1035.2	1034.9	1035.4	1035.7	1035.2	1034.7	1035.4
MAXIMUM, FT	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1	1064.1
MEDIAN, FT	1048.8	1048.2	1047.3	1047.3	1048.3	1048.5	1046.7	1045.5	1047.7	1047.1	1046.5	1047.1	1048.5

6-20-4.4

TABLE 8-11

NET FLOWS AVAILABLE FOR HYDROELECTRIC GENERATION
SCENARIO 10

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	9575	8726	4622	4278	9575	4390	4575	4644	4588	4546	4335	4082	67936	5661
1941	4421	3798	9575	9266	9575	9266	9575	9575	4331	4292	9266	4465	87405	7284
1942	4476	4299	4636	4059	4010	9266	9575	4615	4421	4322	4423	4483	62585	5215
1943	4487	4344	4619	4526	4647	4433	4644	4732	4488	4619	4505	4525	54569	4547
1944	4463	4269	4492	4522	3441	4278	4668	4555	4471	4528	4431	4365	52483	4374
1945	4213	4080	4240	4220	4604	4559	4652	4695	4430	4428	4483	4396	53000	4417
1946	4437	4266	4578	4466	4450	4506	4710	4663	4430	4333	4096	4388	53323	4444
1947	4117	4163	4485	4375	4510	4232	4644	4617	4617	4664	4504	4536	53464	4455
1948	4539	4293	4652	4544	4686	4612	4657	4707	4552	4607	4547	4582	54978	4582
1949	4506	4021	4513	4314	4598	4500	4673	4563	4505	4538	4533	4518	53782	4482
1950	4517	4324	4687	4511	4623	4591	4708	4710	4570	4668	4565	4604	55078	4590
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	3270	3979	4011	4689	4751	4198	3809	3967	4250	36924	3077
1958	3723	3489	3491	9266	9575	9266	9575	9575	9266	9575	9266	9575	95642	7970
1959	9575	8726	9575	9266	4496	4221	9575	4594	4533	3885	9266	4423	82135	6845
1960	4365	4203	4457	4416	4598	4619	4486	3727	9266	9575	9266	9575	72553	6046
1961	9575	8726	9575	9266	9575	9266	9575	9575	4492	4528	4440	4494	93087	7757
1962	4504	4359	4661	4477	4708	4591	4760	4731	4454	4443	4489	4524	54701	4558
1963	4549	4340	4687	4549	4671	4462	4750	4726	4446	4487	4539	4570	54776	4565
1964	4527	4295	4559	4514	4675	4331	4724	0	3312	4344	4349	4471	48101	4008
1965	4494	4064	4484	4365	4154	4378	4659	4692	4569	4437	4477	4384	53157	4430
1966	4438	4269	4596	4433	4487	4536	4654	4148	4099	4439	4454	4515	53068	4422
1967	4514	4339	4651	4546	4630	4005	4589	4682	4371	4274	4155	4398	53154	4430
1968	3690	3740	3996	4106	3809	4244	4383	4574	4428	4550	4474	4496	50490	4208
1969	4500	4294	4606	4374	4494	4589	4724	4659	4507	3328	4268	4284	52627	4386
1970	4361	4172	4205	4280	4209	9266	9575	4635	4424	4501	4493	4545	62666	5222
1971	4551	4372	4706	4579	4714	4565	4723	9575	9266	9575	9266	9575	79467	6622
1972	9575	8726	9575	4508	9575	9266	9575	9575	9266	4431	4368	4465	92905	7742
1973	4429	4172	4421	4319	9575	4022	9575	9575	9266	9575	9266	9575	87770	7314
1974	9575	8726	9575	4480	4160	9266	4638	4169	9266	4382	9266	9575	87078	7257
1975	9575	8726	9575	9266	9575	9266	9575	9575	9266	9575	4468	4495	102937	8578
1976	4511	4358	4645	4203	4214	4359	4010	9575	9266	9575	9266	9575	77557	6463
1977	9575	8726	9575	9266	9575	9266	9575	9575	9266	4565	4269	4474	97707	8142
1978	4468	4268	4618	4527	4685	4558	4729	9575	9266	9575	9266	9575	79110	6593
1979	9575	8726	9575	9266	9575	9266	9575	9575	9266	9575	4459	4487	102920	8577
1980	4483	4325	4630	4546	4577	4645	4738	4652	3678	4144	4255	4300	52973	4414
1981	4349	4231	4020	9266	9575	9266	9575	9575	9266	9575	9266	9575	97539	8128
1982	9575	8726	4557	4473	4150	9266	4615	4616	4521	4600	4468	4520	68087	5674
1983	4504	4315	4573	4556	4621	4348	4576	4635	4546	4563	4361	4529	54127	4511
1984	4441	4320	4650	4604	4727	4651	4745	4726	4607	4565	4494	4197	54727	4561
1985	3824	4059	4147	4243	4218	4343	4533	4680	4500	4334	4289	4374	51544	4295
1986	4430	4242	4620	4525	4408	3698	4299	4598	4036	9575	9266	9575	67272	5606
TOTAL	222006	208617	220104	218836	232703	238469	248855	243396	238316	231904	233884	228314	2765404	
AVERAGE	4724	4439	4683	4656	4951	5074	5295	5179	5071	4934	4976	4858	58838	4903

2/25

TABLE 8-12

NET FLOWS AVAILABLE FOR HYDROELECTRIC GENERATION
SCENARIO 11

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	6138	5594	6138	5940	6138	5940	6138	6239	6212	2322	2131	2136	61066	5089
1941	6138	1947	6138	5940	9575	5940	6138	6138	5940	6138	5940	6138	72110	6009
1942	6138	5594	6241	5940	6138	5940	6138	6179	6034	2136	5987	2248	64713	5393
1943	2277	2154	2348	2320	2424	2257	2512	2666	2487	2635	2567	2626	29273	2439
1944	2602	2425	2547	2617	2136	2067	2250	2411	2370	2427	2350	2297	28499	2375
1945	2136	1951	2136	2067	6138	2256	2419	2524	2316	2299	2367	2298	30907	2576
1946	2347	2184	2401	2340	2285	2363	2629	2649	2472	2362	2087	2330	28449	2371
1947	2136	1976	2230	2147	2231	2067	2315	2405	2470	2549	2436	2503	27465	2289
1948	2546	2325	2602	2566	2702	2697	2819	2934	2853	2943	2942	3031	32860	2747
1949	3011	2518	2850	2672	2901	2845	3081	3029	3014	3061	3102	3140	35224	2935
1950	3189	3030	3325	3231	3330	3364	3582	3688	3654	3828	3824	3957	42002	3500
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1957	0	0	0	1799	2750	2559	3169	3306	2799	2265	2238	2429	23314	1943
1958	2136	1947	2136	5940	6161	9266	6138	6138	9266	9575	9266	9575	77544	6462
1959	6138	5594	6138	5940	6138	5940	6138	6138	5940	6138	5940	6138	72320	6027
1960	6138	5594	6138	5940	6138	6164	2240	2136	5940	6138	5940	6138	64644	5387
1961	6138	8726	9575	5940	6138	5940	6138	6138	5940	6138	5940	6151	78902	6575
1962	6248	2134	2360	2245	2467	2418	2670	2730	2645	2529	2588	2663	33697	2808
1963	2734	2562	2842	2783	2907	2963	3168	3251	3207	3339	3294	3395	36445	3037
1964	3431	3244	3421	3434	3600	3664	3924	3911	2292	2926	2897	3020	39764	3314
1965	3074	2639	2914	2800	2448	2588	2895	2992	2950	2834	2890	2822	33846	2821
1966	2887	2730	2969	2860	2872	2950	3134	2631	2491	2749	2775	2865	33913	2826
1967	2906	2763	3009	2984	3144	3223	3414	3452	3189	3026	2819	2997	36926	3077
1968	2184	2009	2136	2067	2136	2067	6138	6138	2189	2319	2276	2328	33987	2832
1969	2366	2183	2414	2233	2305	2437	2649	2653	2565	2136	2067	2136	28144	2345
1970	2136	1947	6138	5940	6138	5940	6138	6215	6049	2263	2282	2369	53555	4463
1971	2419	2274	2541	2495	2630	2617	2802	9575	9266	9575	9266	9575	65035	5420
1972	6138	5594	6138	5940	9575	7653	6138	6138	5940	6138	5940	6138	77470	6456
1973	6138	5594	6138	5940	6138	5940	9575	9575	9266	9575	9266	6138	89283	7440
1974	6138	5594	6138	5940	6138	5940	6138	6138	5940	6138	5940	6138	72320	6027
1975	8190	8726	9575	8652	9575	9266	9575	6138	5940	6138	5940	6138	93853	7821
1976	6138	5718	6313	2067	6138	5940	6138	6138	5940	6138	5940	6138	68746	5729
1977	9575	8726	9575	9266	9575	9266	6138	6138	5940	6138	5940	6138	92415	7701
1978	6145	5666	2289	2260	2410	2348	2594	9575	9266	6869	7577	6138	63137	5261
1979	9575	8726	9575	9266	9575	9266	9575	6138	5940	6138	5940	6138	95852	7988
1980	6153	5717	2303	2285	2301	2427	2606	2589	2067	2136	2067	6138	38789	3232
1981	6138	1947	2136	5940	9575	9266	9575	6138	5940	9575	8506	6138	80874	6740
1982	6138	5594	6138	5940	6138	5940	6138	6138	6089	6337	2247	2330	65167	5431
1983	2350	2185	2358	2401	2453	2216	2469	2575	2546	2579	2400	2578	29110	2426
1984	2522	2413	2663	2692	2820	2822	3005	3080	3053	3051	3025	2722	33868	2822
1985	2216	2299	2205	2243	2136	2193	2414	2601	2479	2303	2235	2305	27629	2302
1986	2363	2176	2457	2424	2273	2067	2136	6138	2067	9575	9266	9575	52517	4376
TOTAL	175510	154719	169688	166436	190790	181022	184990	193503	184963	185478	180440	178195	2145734	
AVERAGE	3734	3292	3610	3541	4059	3852	3936	4117	3935	3946	3839	3791	45654	3804

6.28-4.4

MEDINA RESERVOIR STUDY
HYDROLOGY MODEL RESULTS a)
Period of Record 1940 to 1986

SCENARIO	(2) NO DIVERSIONS b)	(3) SAFE YIELD	(4) MAXIMUM DIVERSION	(5) NO DIVERSIONS AT NWL c)	(6) NO DIVERSIONS, MIN. FLOWS, LEAK. CORR.	(7) SAFE YIELD MIN. FLOWS, LEAK. CORR.	(8) MAXIMUM DIVERSION MIN. FLOWS, LEAK. CORR.	(9) ARTIFICIAL RECHARGE, HISTORICAL LEAKAGE f)	(10) ARTIFICIAL RECHARGE, MIN. FLOWS, LEAK. CORR.	(11) ARTIFICIAL RECHARGE, HISTORICAL LEAKAGE g)	(12) ARTIFICIAL RECHARGE, HISTORICAL LEAKAGE h)
Avg. Annual Inflows d)	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8	134,595.8
Avg. Annual Diversions for Recharge d)	0.0	0.0	55,703.7	0.0	0.0	0.0	55,484.7	46,039.3	51,543.0	39,764.2	35,896.0
Avg. Annual Natural Recharge d)	48,329.6	48,329.6	37,222.4	47,853.4	48,686.3	48,686.3	37,558.6	43,716.5	42,846.7	43,501.7	44,100.2
TOTAL AVAILABLE FOR RECHARGE d)	48,329.6	48,329.6	92,926.1	47,853.4	48,686.3	48,686.3	93,043.3	89,755.8	94,389.7	83,265.9	79,996.2
Avg. Annual Evap. d)	15,520.4	15,520.4	9,882.3	15,159.2	15,967.8	15,967.8	10,220.6	12,629.1	12,454.8	12,511.6	12,927.2
Avg. Annual Leakage e)	15,071.5	15,071.5	11,585.3	17,674.1	0.0	0.0	0.0	12,875.4	0.0	12,952.4	13,111.4
Avg. Annua Spills e)	55,671.6	55,671.6	21,129.3	53,903.9	62,076.4	62,076.4	24,030.6	19,329.1	19,886.0	25,859.5	28,554.5
Avg. Annual Min. Flows e)	0.0	0.0	0.0	0.0	7,865.3	7,865.3	7,885.6	0.0	7,865.3	0.0	0.0
TOTAL DOWNSTREAM FLOWS e)	70,743.1	70,743.1	32,714.6	71,578.0	69,941.7	69,941.7	31,916.2	32,204.5	27,751.3	38,811.9	41,665.9
Median Content, Ac-Ft	238,471	238,471	104,499	234,789	244,452	244,452	115,804	186,120	183,245	176,920	191,150
Median Elevation, Ft NGVD	1,061.3	1,061.3	1,028.6	1,060.6	1,062.4	1,062.4	1,032.5	1,050.7	1,050.0	1,048.5	1,051.9
Avg. Annual Applewhite Diversions	55,265.3	55,265.3	50,158.3	56,705.1	53,815.0	53,815.0	49,246.6	51,092.2	48,438.2	51,551.9	52,020.5
Avg. Annual Bay Inflows	1,552,271	1,552,271	1,520,206	1,551,554	1,553,045	1,553,045	1,520.524	1,518,687	1,517,214	1,524,901	1,527,200

NOTE: The "Reported Diversions" scenario is not shown on this table.

a) All values in acre-feet/year unless noted.
b) With Medina Diversion Lake at 5 feet below NWL.
c) With Medina Diversion Lake at NWL, 518.9 feet NGVD.
d) Includes Medina Diversion Lake amounts.
e) From Medina Diversion Lake only.
f) Artifical recharge at 200 cfs with a maximum drawdown of 5 feet.
g) Artifical recharge at 100 cfs with a maximum drawdown of 10 feet.
h) Artifical recharge at 100 cfs with a maximum drawdown of 5 feet.

2/2

TABLE 8-14

SELECTED COMPARISONS OF HISTORICAL PARAMETERS VS. SCENARIO 11A

Item	Actual Historical	Scenario 11A
Median Content in Main Lake, ac-ft	130,500	164,887
Median Elevation at Main Lake, ft NGVD	1,036.6	1,045.7
Average Annual Natural Recharge, ac-ft per year[1)]	39,801[2)]	42,794

1) Includes both Main Lake and Diversion Lake.
2) Computed by EH&A using EH&A's recharge curves for the Main Lake and Diversion Lake, and simplifying assumptions regarding Diversion Lake elevations described in the text.

TABLE 8-15

COMBINED MEDINA LAKE AND DIVERSION LAKE RECHARGE
BASED ON HISTORICAL MEDINA LAKE CONTENTS

(AC-FT/MO)

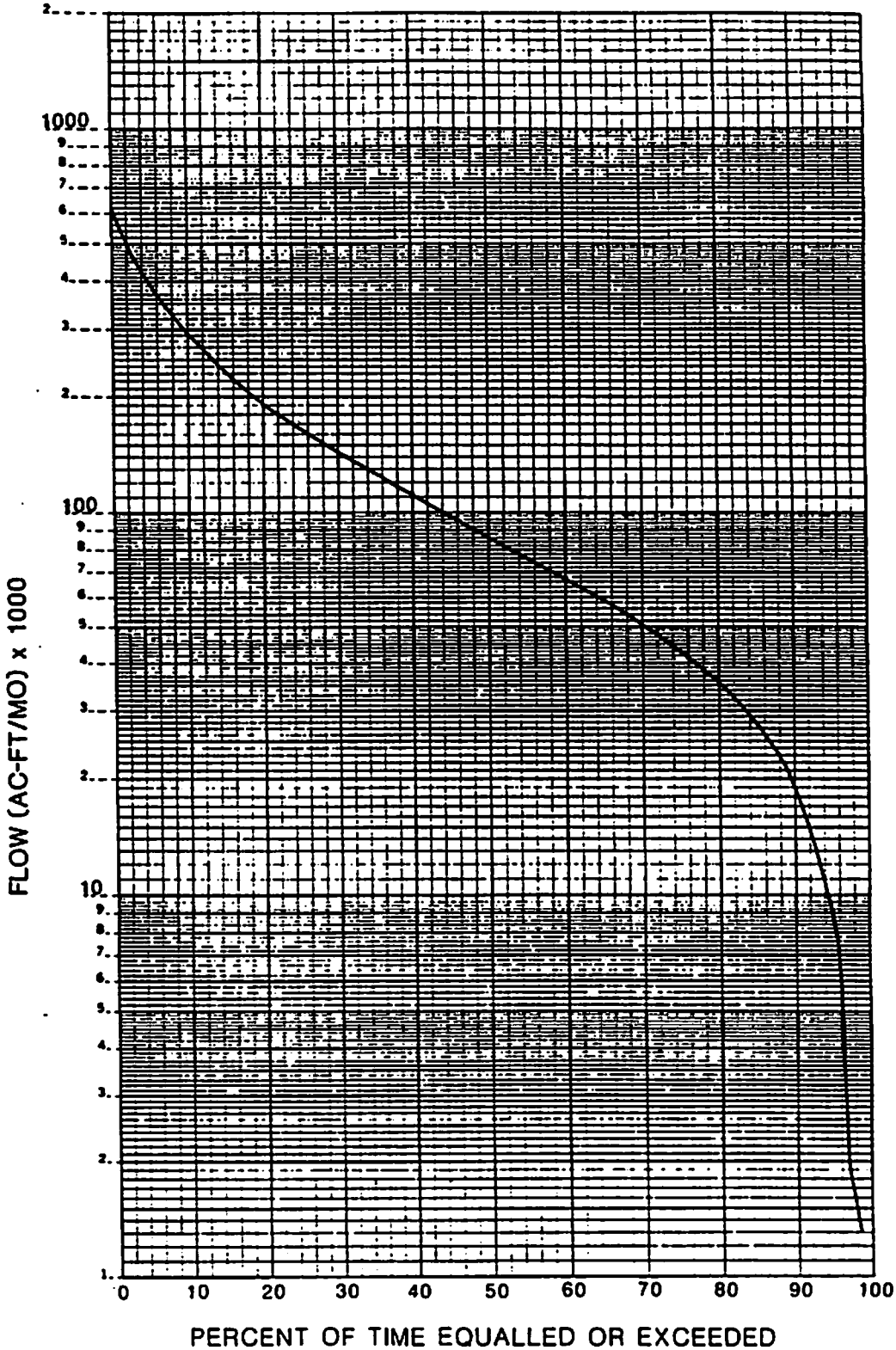
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	2447	2462	2313	2333	2279	2191	2101	1848	1522	1060	1478	2094	24128	2011
1941	2089	2678	2914	3160	3807	3924	3880	3851	3832	3832	3802	3783	41652	3471
1942	3279	3255	3199	3187	3751	3199	3170	3085	3099	3788	3802	3790	40604	3384
1943	3771	3260	3214	3184	3192	3199	3138	3017	2968	2897	2834	2802	37476	3123
1944	2790	2822	2922	2902	3102	3126	3034	2968	2941	2875	2824	2853	35159	2930
1945	3002	3102	3170	3236	3763	3116	3004	2858	2880	2965	2917	2897	36910	3076
1946	2868	2873	2819	2761	2892	2870	2737	2629	2712	2885	2905	2922	33873	2823
1947	3034	3090	3099	3065	3004	2934	2795	2661	2479	2191	2006	1834	32192	2683
1948	1602	1454	1130	1118	1193	1751	1605	1008	1108	1405	1415	1400	16189	1349
1949	1493	1792	1850	2228	2367	2496	2401	2325	2216	2169	2101	2079	25617	2135
1950	2050	2079	1982	1916	1936	1987	1846	1544	1223	1111	1228	1310	20212	1684
1951	1344	1417	1476	1534	1790	1843	1797	1746	1690	1634	1617	1600	19488	1624
1952	1595	1568	1585	1683	1758	1843	1821	1787	2111	2084	2078	2140	22054	1838
1953	2167	2177	2094	1965	1726	1675	1666	1800	2099	2274	2296	2303	24242	2020
1954	2313	2308	2298	2286	2328	2313	2286	2257	2067	1885	1692	1111	25144	2095
1955	1184	1293	1337	1344	1597	1597	1690	1717	1695	1673	1661	1644	18432	1536
1956	1632	1617	1607	1580	1568	1542	1510	1544	1524	1510	1534	1520	18698	1558
1957	1505	1495	1753	2518	2863	3092	3031	2936	2861	3133	3236	3751	32274	2690
1958	3914	4055	4226	4258	4328	4425	4406	4355	4428	4438	4423	4421	51677	4306
1959	4418	4418	4401	4411	4406	4430	4416	4377	4338	4389	4384	4382	52770	4398
1960	4382	4377	4382	4377	4352	4299	4294	4384	4367	4382	4404	4428	52428	4369
1961	4425	4430	4425	4413	4372	4421	4416	4391	4355	4331	4309	4289	52577	4381
1962	4255	4236	4192	4177	4131	4080	4007	3922	3866	3851	3812	3776	48305	4025
1963	3759	3262	3223	3184	3141	3053	2951	2822	2732	2639	2581	2539	35886	2991
1964	2498	2510	2525	2500	2401	2335	2111	1958	2644	2683	2737	2727	29629	2469
1965	2698	2795	2839	2936	3136	3177	3109	3034	2975	2992	2970	3009	35670	2973
1966	3014	3021	3009	3009	3041	2987	2924	3009	3075	3060	3029	2995	36173	3014
1967	2965	2931	2870	2839	2717	2559	2413	2264	2406	2530	2666	2707	31867	2656
1968	2990	3141	3754	3856	4019	4053	4055	3997	3985	3953	3924	3914	45641	3803
1969	3895	3892	3880	3895	3919	3875	3805	3272	3231	3926	3939	3985	45514	3793
1970	3997	4017	4092	4116	4170	4187	4153	4107	4075	4055	4014	3982	48965	4080
1971	3941	3897	3839	3776	3216	3136	3058	4425	4425	4435	4425	4423	46996	3916
1972	4416	4406	4387	4345	4425	4418	4396	4416	4411	4401	4387	4365	52773	4398
1973	4352	4352	4362	4394	4396	4430	4435	4423	4428	4433	4423	4421	52849	4404
1974	4421	4411	4399	4369	4421	4387	4333	4421	4421	4423	4423	4428	52857	4405
1975	4425	4430	4423	4428	4435	4428	4423	4408	4391	4365	4343	4321	52820	4402
1976	4299	4267	4233	4331	4413	4425	4428	4425	4425	4438	4428	4430	52542	4379
1977	4430	4430	4425	4433	4430	4428	4416	4374	4345	4321	4343	4331	52706	4392
1978	4313	4304	4279	4262	4223	4182	4109	4421	4425	4418	4421	4416	51773	4314
1979	4425	4428	4435	4433	4425	4428	4425	4418	4396	4360	4328	4316	52617	4401
1980	4301	4282	4245	4204	4204	4131	4046	3997	4126	4148	4153	4165	50002	4167
1981	4170	4167	4236	4377	4430	4438	4425	4421	4411	4425	4421	4416	52339	4362
1982	4401	4389	4374	4343	4396	4369	4306	4258	4199	4160	4136	4119	51450	4288
1983	4102	4080	4090	4063	4036	4070	4036	3990	3934	3907	3912	3883	48113	4009
1984	3866	3851	3802	3262	3172	3089	2973	2861	2751	2746	2744	2776	37903	3159
1985	3014	3085	3223	3279	3827	3844	3832	3759	3253	3785	3822	3863	42586	3549
1986	3878	3900	3878	3834	3853	4097	4102	4051	4065	4255	4333	4438	48684	4057
TOT	154129	154516	155310	156114	159451	158889	156315	154541	154010	155620	155661	156100	1870656	
AVG	3279	3288	3304	3322	3393	3381	3326	3288	3277	3311	3312	3321	39801	3317

TABLE 8-16

COMBINED MEDINA LAKE AND DIVERSION LAKE RECHARGE
SCENARIO 11A

(AC-FT/MO)

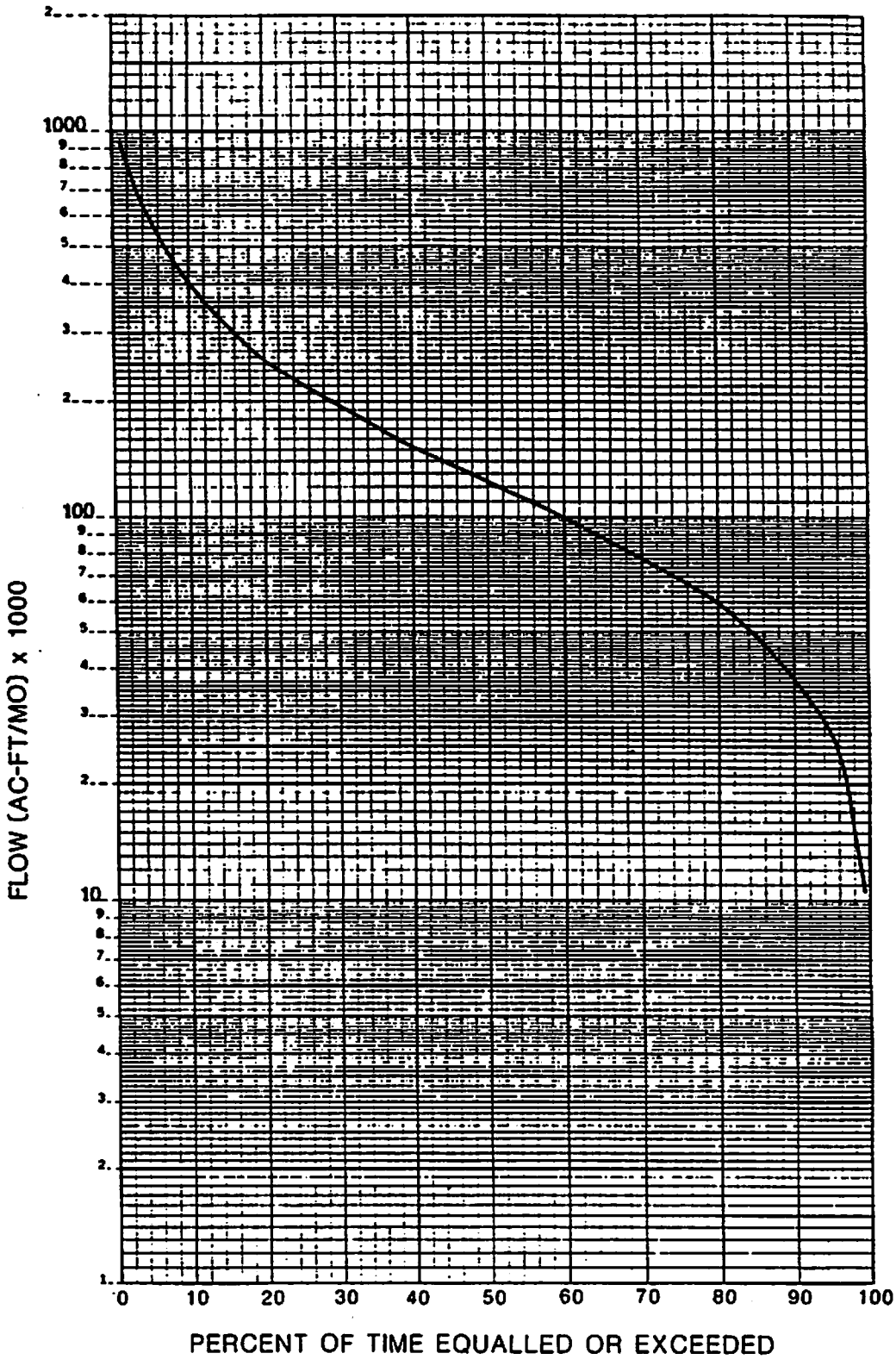
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	AVERAGE
1940	2972	2842	2811	2870	2959	3011	3013	2977	2912	2869	2878	3022	35136	2928
1941	3107	3239	3407	3630	3840	3948	3933	3910	3914	3950	3955	3948	44781	3732
1942	3936	3920	3897	3957	4063	4124	4099	4061	4039	4057	4055	4044	48252	4021
1943	4027	4003	3980	3958	3931	3928	3900	3844	3802	3757	3719	3688	46537	3878
1944	3669	3654	3659	3646	3839	4003	4006	3954	3933	3917	3902	3910	46092	3841
1945	3951	3993	4052	4111	4130	4094	4055	4005	3984	3988	3969	3972	48304	4025
1946	3971	3961	3950	3939	3952	3944	3901	3853	3821	3838	3908	3937	46975	3915
1947	3994	4037	4046	4060	4069	4110	4108	4065	4013	3964	3930	3902	48298	4025
1948	3873	3852	3820	3787	3750	3707	3663	3608	3551	3499	3446	3398	43954	3663
1949	3362	3404	3438	3466	3465	3451	3408	3378	3351	3320	3268	3228	40539	3378
1950	3189	3155	3111	3078	3043	2994	2917	2828	2733	2636	2547	2444	34675	2890
1951	2353	2262	2167	2074	2104	2164	2062	1867	1554	1244	974	839	21664	1805
1952	846	906	955	1146	1628	1885	1753	1373	1499	2111	1927	1794	17823	1485
1953	1658	1708	1609	1478	1218	930	677	681	1316	2197	2320	2254	18047	1504
1954	2147	2021	1885	1695	1595	1797	1385	1060	744	502	385	142	15358	1280
1955	350	424	512	317	794	1389	1264	1591	1338	1024	732	526	10261	855
1956	431	424	216	419	380	145	289	133	413	362	157	371	3740	312
1957	113	287	667	2386	3103	3343	3376	3309	3332	3515	3682	3757	30870	2573
1958	3900	4068	4250	4368	4407	4429	4428	4406	4429	4429	4429	4429	51972	4331
1959	4425	4416	4397	4383	4373	4378	4382	4347	4296	4308	4336	4315	52356	4363
1960	4295	4280	4265	4249	4220	4161	4140	4216	4279	4276	4292	4331	51004	4250
1961	4386	4429	4429	4426	4408	4404	4411	4390	4349	4306	4267	4231	52436	4370
1962	4185	4147	4117	4093	4053	4012	3951	3889	3834	3821	3798	3766	47666	3972
1963	3729	3693	3650	3612	3569	3508	3432	3355	3277	3196	3126	3063	41210	3434
1964	3000	2959	2943	2919	2867	2786	2668	2584	3048	3326	3357	3355	35812	2984
1965	3334	3365	3393	3429	3567	3648	3628	3576	3516	3504	3481	3478	41919	3493
1966	3472	3458	3438	3429	3437	3421	3381	3450	3556	3593	3579	3555	41769	3481
1967	3523	3487	3447	3405	3354	3277	3188	3106	3092	3161	3263	3313	39616	3301
1968	3512	3714	3852	3971	4101	4198	4215	4192	4155	4130	4103	4081	48234	4020
1969	4058	4036	4011	4013	4021	3993	3940	3891	3850	3995	4132	4159	48099	4008
1970	4180	4188	4215	4240	4264	4289	4271	4223	4169	4143	4117	4086	50385	4199
1971	4052	4017	3975	3935	3892	3845	3782	4255	4429	4429	4429	4429	49469	4122
1972	4425	4413	4390	4355	4429	4429	4416	4403	4395	4377	4354	4327	52713	4393
1973	4298	4278	4270	4268	4260	4281	4429	4429	4429	4429	4429	4428	52228	4352
1974	4423	4408	4387	4359	4365	4374	4333	4330	4361	4362	4373	4399	52474	4373
1975	4423	4429	4429	4429	4429	4429	4429	4421	4398	4365	4327	4288	52796	4400
1976	4250	4201	4153	4167	4217	4240	4273	4307	4304	4313	4347	4395	51167	4264
1977	4429	4429	4429	4429	4429	4429	4418	4385	4334	4286	4263	4248	52506	4375
1978	4216	4181	4150	4126	4089	4055	4001	4425	4429	4429	4429	4428	50962	4247
1979	4429	4429	4429	4429	4429	4429	4429	4420	4391	4345	4300	4265	52722	4394
1980	4227	4181	4147	4120	4099	4056	3999	3950	4034	4143	4178	4187	49321	4110
1981	4182	4175	4218	4337	4429	4429	4429	4424	4410	4429	4429	4423	52314	4360
1982	4409	4389	4362	4329	4334	4352	4323	4274	4214	4161	4127	4102	51376	4281
1983	4078	4054	4038	4010	3987	3998	3988	3950	3907	3878	3875	3859	47622	3968
1984	3847	3828	3800	3758	3710	3657	3595	3517	3445	3398	3359	3411	43325	3610
1985	3600	3707	3809	3886	3961	4008	4005	3966	3933	3951	3978	3996	46800	3900
1986	3999	3998	3981	3958	3974	4085	4190	4189	4200	4349	4429	4429	49781	4148
TOT	165235	165449	165566	167450	169537	170567	168883	167771	167712	168582	167660	166950	2011362	
AVG	3516	3520	3523	3563	3607	3629	3593	3570	3568	3587	3567	3552	42795	3566



ESPEY, HUSTON & ASSOCIATES, INC.
Engineering & Environmental Consultants

FIGURE 8-4
FLOW DURATION CURVE
SAN ANTONIO BAY
ANNUAL
ARTIFICIAL RECHARGE
WITH HISTORICAL LEAKAGE SCENARIO

SCENARIO 11



ESPEY, HUSTON & ASSOCIATES, INC.
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FIGURE 8-3
FLOW DURATION CURVE
SAN ANTONIO BAY
ANNUAL
HISTORICAL INFLOWS
BASED ON GAGED DATA

TABLE 2-1

TAILWATER RATING CURVES

MEDINA DAM

DISCHARGE (cfs)	ELEVATION (Feet, NGVD)
0	920.00
5,000	927.50
10,000	929.58
25,000	934.21
50,000	939.75
75,000	944.02
100,000	947.61
150,000	953.67
200,000	958.81
250,000	963.36
300,000	967.48
350,000	971.28
400,000	974.82
500,000	981.33
600,000	987.32
700,000	992.88

MEDINA DIVERSION DAM

DISCHARGE (cfs)	ELEVATION (Feet, NGVD)
0	868.88
1,000	874.33
8,000	879.49
12,000	881.30
25,000	885.59
50,000	891.43
75,000	895.97
100,000	899.74
150,000	906.12
200,000	911.48
300,000	920.71
450,000	932.08
600,000	941.89
750,000	949.97

TABLE 2-2

MEDINA DIVERSION DAM

SPILLWAY DISCHARGE RATING

ELEVATION (FT, NGVD)	TOTAL SPILLWAY DISCHARGE (cfs)
918.9	0
920.0	1,275
922.0	6,431
924.0	14,163
926.0	23,949
928.0	35,535
930.0	48,911
932.0	64,819
934.0	83,850
936.0	105,340
938.0	127,982
940.0	153,704
942.0	179,684
944.0	208,489
946.0	239,076
948.0	271,405
950.0	305,442
952.0	341,157
954.0	378,523
956.0	417,519
958.0	453,541
960.0	495,312
962.0	533,251
964.0	566,250
966.0	605,436
968.0	645,394
970.0	679,099
972.0	720,105
974.0	746,097
976.0	787,593

TABLE 2-3

MEDINA LAKE DAM

SPILLWAY DISCHARGE RATING

ELEVATION (ft, NGVD)	EMERGENCY SPILLWAY DISCHARGE (cfs)
1064.1	0
1066.0	3,962
1068.0	12,227
1070.0	23,893
1072.0	38,630
1074.0	56,549
1076.0	78,012
1078.0	102,899
1080.0	131,261
1082.0	163,197
1084.0	198,761
1086.0	238,059
1088.0	281,361
1090.0	328,859
1092.0	380,718
1094.0	437,088
1096.0	498,108
1098.0	563,915
1100.0	634,635

TABLE 2-4

MEDINA LAKE DAM

TOP OF DAM DISCHARGE RATING

WITHOUT HANDRAILS

ELEVATION (Feet, NGVD)	TOP OF DAM DISCHARGE (CFS)
1064.1	0
1066.0	3,962
1068.0	12,227
1070.0	23,893
1072.0	38,630
1074.0	56,549
1076.0	78,012
1078.0	110,505
1080.0	161,830
1082.0	220,529
1084.0	287,937
1086.0	364,223
1088.0	448,562
1090.0	542,252
1092.0	646,578
1094.0	760,959
1096.0	888,157
1098.0	1,025,822
1100.0	1,173,327

TABLE 2-5

MEDINA LAKE DAM

TOP OF DAM DISCHARGE RATING

WITH 100% HANDRAILS

ELEVATION (Feet, NGVD)	Discharge (cfs)
1064.1	0
1066.0	3,962
1068.0	12,227
1070.0	23,893
1072.0	38,630
1074.0	56,549
1076.0	78,012
1078.0	110,505
1080.0	154,298
1082.0	209,754
1084.0	274,788
1086.0	348,317
1088.0	430,203
1090.0	520,755
1092.0	619,599
1094.0	729,354
1096.0	848,652
1098.0	976,041
1100.0	1,122,971

TABLE 2-6

RESULTS OF FLOOD ROUTING SCENARIOS

Scenario	Medina Reservoir						Medina Diversion Reservoir					
	Start Elev (ft. NGVD)	Peak Inflow (cfs)	Peak Storage (ac-ft)	Peak Stage (ft. NGVD)	Peak Outflow (cfs)	Tailwater Elev (ft. NGVD)	Start Elev (ft. NGVD)	Peak Inflow (cfs)	Peak Storage (ac-ft)	Peak Stage (ft. NGVD)	Peak Outflow (cfs)	Tailwater Elev (ft. NGVD)
Historical 1978 Flood	1053.3	281,000	281,377	1068.46	14,889	931.1	918.9	14,889	7246	924.15	14,878	882.2
100-Year Flood	1064.1	209,811	352,220	1079.4	141,088	952.6	918.9	141,112	11,809	939.0	140,815	904.9
PMP Flood 100% Handrails	1064.1	695,803	453,342	1092.3	636,688	989.4	918.9	641,764	24,547	967.6	635,050	943.8
PMP Flood 50% Handrails	1064.1	695,803	451,143	1092.06	638,282	989.4	918.9	643,357	24,601	967.7	636,872	943.9
PMP Flood 25% Handrails	1064.1	695,803	450,129	1091.94	639,455	989.5	918.9	644,531	24,609	967.7	637,170	943.9
PMP Flood No Handrails	1064.1	695,803	449,472	1091.87	639,784	989.5	918.9	644,859	24,608	967.7	637,170	943.9

TABLE 2-7

MEDINA RESERVOIR
1978 FLOOD HYDROGRAPH

ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV	ORD	OUTFLOW	STORAGE	STAGE	TW ELEV
1	0	198099.9	1053.3	920.0	35	14861	281346.7	1068.5	931.1	69	6472	269758.0	1066.6	928.
2	0	198146.3	1053.3	920.0	36	14794	281274.6	1068.4	931.1	70	6347	269567.0	1066.6	928.
3	0	198264.7	1053.3	920.0	37	14680	281151.8	1068.4	931.0	71	6228	269386.0	1066.5	928.0
4	0	198422.2	1053.4	920.0	38	14519	280978.5	1068.4	931.0	72	6115	269214.9	1066.5	928.0
5	0	198638.3	1053.4	920.0	39	14315	280758.3	1068.4	930.9	73	6009	269053.1	1066.5	927.9
6	0	198993.0	1053.5	920.0	40	14073	280498.2	1068.3	930.8	74	5908	268899.7	1066.5	927.9
7	0	200826.2	1053.8	920.0	41	13793	280196.0	1068.3	930.8	75	5812	268753.9	1066.4	927.8
8	0	207365.6	1055.1	920.0	42	13485	279864.6	1068.2	930.7	76	5721	268615.8	1066.4	927.
9	0	223894.4	1058.4	920.0	43	13154	279507.8	1068.2	930.6	77	5635	268485.4	1066.4	927.7
10	0	242144.3	1062.0	920.0	44	12799	279125.8	1068.1	930.4	78	5554	268361.9	1066.4	927.7
11	0	252685.4	1063.9	920.0	45	12419	278716.1	1068.0	930.3	79	5477	268244.6	1066.4	927.7
12	1724	259196.8	1064.9	922.6	46	12080	278285.0	1068.0	930.2	80	5404	268134.1	1066.3	927.
13	3222	263711.6	1065.6	924.8	47	11777	277824.8	1067.9	930.1	81	5335	268029.0	1066.3	927.6
14	4623	266945.9	1066.2	926.9	48	11456	277336.1	1067.8	930.0	82	5270	267929.3	1066.3	927.6
15	6127	269233.3	1066.5	928.0	49	11118	276822.9	1067.7	929.9	83	5208	267834.9	1066.3	927.5
16	7205	270872.6	1066.8	928.4	50	10764	276284.4	1067.6	929.8	84	5149	267746.0	1066.3	927.5
17	7956	272014.8	1067.0	928.7	51	10412	275749.8	1067.6	929.7	85	5093	267661.6	1066.3	927.5
18	8522	272875.5	1067.1	929.0	52	10079	275242.7	1067.5	929.6	86	5041	267581.8	1066.3	927.5
19	8958	273537.5	1067.2	929.1	53	9763	274761.8	1067.4	929.5	87	4991	267505.9	1066.2	927.5
20	9296	274051.4	1067.3	929.3	54	9463	274306.1	1067.3	929.4	88	4944	267434.5	1066.2	927.4
21	9574	274474.1	1067.4	929.4	55	9179	273874.3	1067.3	929.2	89	4899	267366.3	1066.2	927.3
22	9803	274822.4	1067.4	929.5	56	8910	273465.4	1067.2	929.1	90	4857	267301.8	1066.2	927.3
23	9990	275107.7	1067.5	929.6	57	8655	273078.0	1067.1	929.0	91	4817	267241.2	1066.2	927.3
24	10165	275373.9	1067.5	929.6	58	8414	272711.3	1067.1	928.9	92	4779	267183.7	1066.2	927.2
25	10638	276092.7	1067.6	929.8	59	8186	272363.8	1067.0	928.8	93	4743	267129.2	1066.2	927.1
26	11536	277458.1	1067.8	930.1	60	7969	272034.8	1067.0	928.7	94	4710	267077.8	1066.2	927.
27	12487	278789.0	1068.0	930.3	61	7765	271723.3	1066.9	928.7	95	4677	267028.7	1066.2	927.0
28	13337	279705.0	1068.2	930.6	62	7571	271428.8	1066.9	928.6	96	4647	266981.9	1066.2	927.0
29	13903	280314.9	1068.3	930.8	63	7387	271149.5	1066.8	928.5	97	4618	266938.2	1066.2	926.9
30	14317	280760.6	1068.4	930.9	64	7213	270884.9	1066.8	928.4	98	4591	266896.8	1066.2	926.9
31	14626	281093.5	1068.4	931.0	65	7048	270634.1	1066.7	928.4	99	4565	266857.7	1066.1	926.8
32	14820	281302.2	1068.4	931.1	66	6892	270397.0	1066.7	928.3	100	4540	266820.1	1066.1	926.8
33	14889	281376.6	1068.5	931.1	67	6745	270172.3	1066.7	928.2					
34	14886	281373.5	1068.5	931.1	68	6605	269959.8	1066.6	928.2					