I - Alamo Dam

1-1. Project Background.

Alamo Dam was built by the Corps of Engineers to provide flood protection for the valley of the lower Colorado River. Alamo Dam is located on the Bill Williams River, approximately 39 miles from its confluence with the Colorado River in Lake Havasu. The generally mountainous drainage area above Alamo Dam is approximately 4,770 sq. mi. and is shown on Fig 1-1. The reservoir behind the dam has a total storage of 995,300 ac-ft (1985 survey, and 1993 reservoir capacity calculation.). Completed in January 1968, Alamo Dam also provides storage for water conservation and recreation. Figure 1-2 shows the project's pertinent data[1], and Figure 1-3 shows the reservoir's storage allocation diagram[2] .

The maximum scheduled flood control release from Alamo Dam is 7,000 cfs, as specified in the Alamo Dam General Design Memorandum, dated April 1964; however, operation schedules (original version taken from Alamo Dam water control manual dated 1973, and the July 1982 revised version shown on Fig. 1-4[3]) show that up to a maximum release of 7,600 cfs can be made from Alamo Dam. The downstream channel is adequate to handle such flows without significant damage. There are no major structures on the Bill Williams River that have a regulatory effect on the flood flows at Alamo Dam.

Subsequent to initial authorization, Alamo Dam became subject to the stipulations of the Fish and Wildlife Coordination Act of 1958 (P.L. 85-624), Federal Water Project Recreation Act - Uniform Policies (P.L. 89-72), the National Environmental Policy Act of 1969 (P.L. 91-190), the Clean Water Act of 1977 (P.L. 95-217), and the Endangered Species Act of 1973 (P.L. 93-205). Alamo Dam is therefore operated to conform with objectives and specific provisions of the authorizing legislation, as well as in a manner consistent with these subsequent applicable Congressional acts.

1-2. Downstream Development.

Below Alamo Dam, the Bill Williams River flows approximately 39 miles west into the Colorado River. Economic developments protected by Alamo Dam are along the lower Colorado River with a very few improvements on the Bill Williams River. Properties of significant values are situated in the lowlands of the Colorado River between Parker Dam and the Mexican border, a distance of about 200 miles. Areas susceptible to damage contain

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[1]Pertinent data sheet shown on Figure 1-2 is from the Alamo Dam water control manual dated 1973, revised in 1983, and does not reflect the latest information about the project in all categories.

[2] Storage allocation diagram shown on Fig 1-3 was updated in 1993 and is based on 1985 bathymetric survey plus interpolation of historic data. Elevations shown are based on the 1993 storage-elevation information.

[3]The operation schedule shown on Fig 1-4 was last revised in July 1982, and does not agree with the elevations shown on Fig 1-3 for reasons stated in footnote 2 above.

residential, business, and industrial properties, and various facilities such as irrigation, and flood control works, highways and public utilities. Alamo Dam also provides flood protection to the communities and agricultural areas of Sonora and Mexicali Valleys in Mexico.

1-3. Agencies Involved in the Operation of the Dam.

1-3.a. The Corps of Engineers (COE). The COE is responsible for the operation and maintenance of Alamo Dam.

1-3.b. US Bureau of Reclamation (USBR). The USBR operates Parker Dam and controls the elevation of Lake Havasu located at the confluence of the Bill Williams and Colorado Rivers. The USBR is also responsible for the operation of the lower Colorado River system and for flood protective works on the lower Colorado River.

1-3.c. US International Boundary and Water Commission (IBWC). The IBWC is interested in the operation of Painted Rock Dam because of the Commission's responsibilities relating to the United States' 1944 Water Treaty with Mexico.

1-3.d. Arizona State Parks. The Arizona State Parks is recreational licensee for Alamo Reservoir.

1-3.e. Arizona Department of Game and Fish. The Arizona Department of Game and Fish is a licensee for all fish and wildlife areas at Alamo Dam.

1-3.f. Bill Williams River Corridor Technical Committee (BWRTC). The BWRTC's membership includes the Corps of Engineers, U.S. Fish and Wildlife Service, Arizona Bureau of Land Management, Arizona State Parks, and Arizona Fish and Game. The committee was formed to develop a coordinated approach for managing the Bill Williams River including Alamo Dam and Reservoir. It serves as a means of obtaining valuable input from agencies interested in the operation of Alamo Dam and the Bill Williams River.

1-4. Constraints at Alamo Dam.

Several constraints associated with the operation of Alamo Dam exists, they include the following:

1-4.a. Operational Constraints. There are 2 identical sets of gates placed in tandem at Alamo Dam. Each set, called the emergency gates and service gates, consists of three 5.5 ft-wide by 8.5 ft-high slide gates . The service gates are used for discharge regulation. The emergency gates are open most of the time except when the service gates malfunction or require maintenance. There is also a butterfly valve for discharging low flows of 25 cfs or less. Constraints associated with the operation of the gates include the following:

1-4.a.1. Maximum Gate Setting. Operational constraints for the outlet gates restrict the maximum gate setting to 80 percent of the 8.5-ft vertical dimension of the

gates, which is 6.8 ft. Because of this restriction, the minimum elevation within the pool at which the maximum release of 7,000 cfs can be made is 1148.4 ft.

1-4.a.2. Minimum Gate Setting. Pursuant to an inspection and subsequent rehabilitation of the outlet gates in 1990, criteria have been established which prohibit the gates from being set at less than 0.5 ft of opening. Therefore, discharges less than approximately 150 cfs cannot be made from the service gates. The bypass gate, however, can be used to low discharges of up to 25 cfs. This leaves a range of flows, from about 25 cfs to 150 cfs, where releases cannot be met by gate operations.

1-4.b. Environmental Constraints.

1-4.b.1. Bald Eagles. Pairs of Southern Bald Eagles, an endangered species, have been observed nesting within the Alamo Lake area since the early 1980's. As a result of informal consultation with the USFWS and AG&FD, from December to April of each year Alamo lake has to be maintained 1) at a minimum elevation of 1100 ft in order to provide sufficient lake surface foraging area for the nesting eagles, and 2) below 1124 ft which is the approximate elevation of one of the eagle nest.

1-4.b.2. Cottonwood Trees within Lake Havasu National Wildlife Refuge. Approximately 200 species of birds have been observed nesting within the stands of cottonwood trees located within the Lake Havasu National Wildlife Refuge at the mouth of the Bill Williams River. In the past, many trees have died due to high ground water inundating their root zones. To prevent this, the USFWS asked the COE to make larger releases for shorter durations, instead of lesser flows for longer durations, as a means of drawing down Alamo Reservoir. The critical period of preventing inundation is during the budding season from April through June.

1-4.b.3. Bass Spawning and Growing. The Arizona Game and Fish Department (AG&FD) maintains a bass fishery in Alamo Lake. The AG&FD criteria for sustaining the fishery are: 1) a maximum lake level fluctuations of 2 in. per day during 15 Mar - 31 May, and 2) a maximum weekly fluctuation of 9.5 in. during 16 May - 30 Sep of each year.

1-4.c. Water Supply. Water supply releases within the water supply pool are coordinated with the operations of the USBR's Hoover, Davis, and Parker Dams on the lower Colorado River. Releases within the water supply pool is limited to 2,000 cfs.

1-5. Alamo Dam Operation During the Floods of 1993.

During the last months of 1992, the lake level at Alamo Reservoir was maintained steadily within the water conservation pool (just below WSE 1100 ft) with releases limited to about 10 cfs. The dam was being operated in this manner to be in compliance with Section 7 of the Endangered Species Act, and to satisfy downstream water rights. During the 2nd week of January, a series of storm events caused high inflows that raised the reservoir water level significantly, up to elevations above 1143 ft beginning on 12 January 1993. On the same day,

high water conservation discharges were initiated by gradually increasing the releases to 1,500 cfs, and then to 2,000 cfs on the following day. These release rates were maintained for about a month. In the second week of February, another storm event in the basin brought more inflows into the reservoir causing the water surface elevation to go even higher. On 12 February, with the water surface elevation at approximately 1175 ft., discharges were increased up to 5,000 cfs.

During the last week of February, Painted Rock Dam, another COE dam located on the Gila River Basin, started spilling with flows in excess of 20,000 cfs (see Section II of this report). Painted Rock Dam discharges into the Gila River approximately 126 miles upstream of its confluence with the Colorado River. A flow in the magnitude of about 23,000 cfs at the Southerly International Boundary of the Colorado River (SIB) causes serious flooding in Mexico. The Mexican officials understood that high flows would be reaching Mexico as a result of uncontrolled discharges from Painted Rock Dam; however, they were not willing to accept additional flows resulting from releases at other Colorado River dams. In order to prevent further damages, the Mexican Government through the International Boundary and Water Commission (IBWC), requested a reduction of flows from Alamo Dam. The COE concurred with the request and lower releases from Alamo Dam (ranging from 1,200 to 1,500 cfs) were started on 26 February.

As Painted Rock spill reached its peak and begun to recede, higher Alamo releases were possible without causing additional flooding in Mexico. Higher releases were initiated from Alamo Dam starting on 9 March , reaching 5,000 cfs by 11 March. During this time period, Parker Dam, located downstream of Alamo Dam was releasing at a rate equal to the consumptive use rate downstream from Parker Dam; therefore, Alamo releases did not cause an increase in the deliveries of water to Mexico. On 11 March, the USBR informed the COE that with warmer weather, consumptive use was high enough to allow the COE to go as high as the maximum scheduled release of 7,000 cfs from Alamo Dam. On 15 March, with a water surface elevation of 1173.22, releases from Alamo Dam were increased to 7,000 cfs. The Alamo gate regulation schedule calls for a reduction in releases once water surface elevation reaches 1160 ft., which occurred on 21 March. However, the COE kept releasing 7,000 cfs in order to better meet the project purposes of the dam, namely flood control, recreation and water supply. In addition, such an increase in releases minimized the duration of inundation of riparian habitation (Cottonwood stands) in the Havasu Wildlife Refuge located downstream of the dam (see Section 1-4.b.3).

On 29 March, the water surface elevation dropped below 1140 ft, and discharges were gradually reduced. April through July releases of 200 to 300 cfs were made for the primary purpose of enhancing the cottonwood trees located in the Lake Havasu Refuge area; at the same time, during the middle of March to the end of May, the dam was also operated to insure that the water level behind Alamo Dam would not change by more than 2 inches per day in order to enhance bass spawning in the lake area (Section 1-4.b.4).

The 1993 flood season resulted in a record historic maximum release of 7,000 cfs. The previous maximum release was 4,730 cfs in February 1969. A peak water surface elevation of 1182.40 ft and peak storage of approximately 499,500 ac-ft (a little less than 50 percent of capacity) were recorded on 21 February. The peak inflow of 122,800 cfs occurred on 8 January

(see Table 1-1). Fig. 1-5 shows inflow and outflow hydrograph from 1 January to 15 April, while Fig 1-6 shows the water surface elevation and the corresponding storage for the same time period. Table 2-2 summarizes the COE's operation of Alamo Dam.

Table 1-1 Maximum Inflow, Outflow, Water Surface Elevation and Storage at Alamo Dam During Jan - Feb 1993 Floods

	Maximum Value	Date
Inflow (cfs)	122,800	8 January
Outflow (cfs)	7,000	17 -29 March
WSE (ft)	1182.40	21 February
Storage (ac-ft)	499,500	21 February

Table 1-2 Summary of COE's Alamo Dam Operation During Jan - Feb 1993 Floods

Date	Discharge	Remarks
12 Jan - 11 Feb	1,500 - 2,000	High water conservation releases.
12 Feb - 25 Feb	5,000	Flood control releases.
26 Feb - 10 Mar	1,200 - 1,500	Releases coordinated with Colorado River system in order to prevent additional flow to Mexico.
11 Mar - 14 Mar	5,000	Flood control releases.
15 Mar - 28 Mar	7,000	Higher flood control releases. Lasted until 29 March.
29 March -	200 - 300	To enhance cottonwood trees downstream. Drop in lake level was limited to 2 in per day during the middle of March through May to enhance bass spawning in the reservoir.