NOT APPROVED IN REVIEW DRAFT

NAVAJO DAM AND RESERVOIR
SAN JUAN RIVER, COLORADO

WATER CONTROL MANUAL

UPPER COLORADO RIVER BASIN

US ARMY CORPS
OF ENGINEERS
Albuquerque District

JUNE 1970
REVISED April 2011

DRAFT - Tech Reviewed by Joe Evelyn, August 1, 2010

WATER CONTROL MANUAL

NAVAJO DAM AND RESERVOIR

San Juan River
Colorado and New Mexico

NOT APPROVED IN REVIEW

Upper Colorado River Basin,
Colorado and New Mexico

U.S. ARMY CORPS OF ENGINEERS
ALBUQUERQUE DISTRICT
ALBUQUERQUE, NEW MEXICO

June 1970
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NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in loose-leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current. Changes to individual pages must indicate the date of revision, which is also the division's approval date. Pages or sections that are changed after the revision is approved and distributed will indicate the new change month/year.

All elevations referred to in this manual are in feet, National Geodetic Vertical Datum of 1929 (NGVD29).

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EMERGENCY REGULATION ASSISTANCE PROCEDURES

During duty hours, contact U.S. Army Corps of Engineers (Corps) personnel in the Reservoir Control Branch (RCB) of the Albuquerque District Office by telephone 505-342-3351, x3385, or x3381. Assistance during non-duty hours can be obtained by contacting one of the following Corps personnel at home, in the order listed (see below). Refer to Table 5-1 (page 5-5) for a more complete list of personnel who can provide assistance.

NAME	RESIDENCE TELEPHONE
[redacted]	[redacted]
[redacted]	[redacted]
[redacted]	[redacted]

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NAVAJO DAM AND RESERVOIR
SAN JUAN RIVER
COLORADO AND NEW MEXICO

U.S. Army Corps of Engineers
Albuquerque District

TABLE OF CONTENTS

Table No | Title | Page

LIST OF TABLES

Plate No | Title | Page

LIST OF PLATES

LIST OF EXHIBITS

Abbreviations and Acronyms

ac	acre
ac-ft	acre-feet (the volume of an acre one foot deep)
AFOS	Automation of Field Operations and Services
API	Antecedent Precipitation Index
ASOS	Automated Surface Observation Site
CESPD	U.S. Army Corps of Engineers, South Pacific Division
CESPK	U.S. Army Corps of Engineers, South Pacific Division, Sacramento District
CESPA	U.S. Army Corps of Engineers, South Pacific Division, Albuquerque
CFR	Code of Federal Regulations
cfs	cubic feet per second
CO	Colorado
Corps	Corps of Engineers
cu-yd	cubic yard
DCP	Data Collection Platforms
DETS	Directorate of Engineering and Technical Services
EA	Environmental Assessment
EIP	Environmental Inventory Paper
EIS	Environmental Impact Statement
elev	elevation
EM	Engineering Manual, U.S. Army Corps of Engineers
EOC	Emergency Operations Center
ERB	Environmental Review Board
ESA	Endangered Species Act
ESRD	Emergency Spillway Release Diagram
ER	Engineering Regulation, U.S. Army Corps of Engineers
ETL	Engineering Technical Letter, U.S. Army Corps of Engineers
F	Fahrenheit
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulation Commission
ft	**f**eet
GOES	Geostationary Operational Environmental Satellite
H.J.	Hollow jet valve
in	inch
mi	mile
mi2	square mile
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MW	Megawatt
NAP	Normal Annual Precipitation
NAVD	North American Vertical Datum
NEPA	National Environmental Policy Act
NEXRAD	Next Generation Weather Radar System
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanographic Atmospheric Administration
NRCS	Natural Resources Conservation Service
NM	New Mexico
NWS	National Weather Service (an organization of NOAA)
PAO	Public Affairs Officer
PC	Personal Computer
pf	power factor
PL	Public Law

PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
PMS	Probable Maximum Storm
PO	Project Office
PPM	parts per million
PRV	Pressure Regulator Valve
QPF	Quantitative Precipitation Forecast
RAWS	Remote Automated Weather Station
RCB	Reservoir Control Branch, Corps' Albuquerque District
RDF	Reservoir Design Flood
RFC	River Forecast Center
RM	River Mile
RPM	Revolutions Per Minute
SD	Standard deviation
SDF	Spillway Design Flood
SNOTEL	Snow Telemetry
SOP	Standard Operation Procedure
SPA	Albuquerque District of the Corps of Engineers
SPF	Standard Project Flood
TDS	Total Dissolved Solids
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WCD	Water Control Diagram
WCM	Water Control Manual
WCDS	Water Control Data System
WCP	Water Control Plan
yr	year

Abbreviations Special to this Manual

CBRFC	Colorado Basin River Forecast Center
CDWR	Colorado Division of Water Resources
CRFS	Colorado River Forecast Service
PDI	Palmer Drought Index
USDA	United States Department of Agriculture
USFS	United States Forest Service
WCAO-SD	Western Colorado Area Office - Southern Division

PERTINENT DATA

LOCATION

Navajo Dam and Reservoir is on the San Juan River in San Juan and Rio Arriba Counties, New Mexico, approximately 300 miles above its confluence with the Colorado River at Lake Powell, Utah, and 33 miles east of the city of Farmington, New Mexico. Latitude 36° 48' 28" N Longitude 107° 36' 31" W

DRAINAGE AREA

Total area of the San Juan Basin is approximately 27,000 square miles. The San Juan Basin above Navajo is 3,230 square miles. One inch of runoff over the basin above Navajo Dam equals 172,265 acre-feet.

EMBANKMENT

The embankment is earth and rock-fill with three zones: an impervious central zone, a pervious zone both upstream and downstream of the central zone, and a miscellaneous zone in the upstream and downstream slopes. Height above streambed is 388 feet. Length of the dam is 3,648 feet and the crest width is 30 feet.

MAIN OUTLET WORKS

AUXILIARY OUTLET WORKS

EMERGENCY SPILLWAY

HYDROELCTRIC POWER FACILITY

Reservoir Data

Feature	Elevation (feet) NGVD	Area[1] (acres)	Storage[1] (acre-feet)		Release Capacity (cfs)			
			Total	Increment	Outlets			Spillway
					Main	Aux.	Hydro.	
Top of Dam	6108.0	18,491	2,096,500	117,900	4,100	1,800	1,400	58,000
Max Pool	6101.6	17,691	1,978,600	277,300	4,075	1,775	1,380	34,000
Top of Joint Use	6085.0	15,624	1,701,300	1,039,500	3,980	1,740	1,325	0
Top of Inactive	5990.0	7,395	661,800	499,120	3,440	1,410	0	0
Main Outlet Invert	5882.5	2,661	162,680	162,680	0	1,025	0	0
Aux. Outlet Invert	5775.0	0	0	0	0	0	0	0

Authorized Space (acre-feet): Flood Control = 1,036,100 Minimum Pool = 672,500 Sediment = 276,000

[1] Area-Capacity-Elevation Data taken from February 2002 revised USBR table

San Juan River Flow Data

USGS Gaging Station	Drainage Area (mi^2)	Year Began	Average Annual Volume (ac-ft)	Max		Min	
				Flow (cfs)	Date	Flow (cfs)	Date
at Pagosa Springs, CO	298	1935	266,700	25,000	5-Oct-1911	8.3	28-Aug-02
near Carracas, CO	1,230	1962	445,732	9,730	6-Sep-70	1	1-Sep-02
near Archuleta, NM	3,260	1956	815,841	18,900	27-Jul-57	8	28-Feb-63
near Archuleta since completion of Navajo Dam	3,260	1963	803,900	6,500	20-Jun-65	8	28-Feb-63
at Farmington, NM	7,240	1924	1,473,000	68,000	29-Jun-27	14	22-Aug-39
				*150,000	6-Oct-1911		
at Shiprock, NM	12,900	1928	1,483,00	80,000	11-Aug-29	8	27-Aug-39
at Four Corners, CO	14,600	1977	1,562,00	16,900	29-May-79	110	18-Aug-78
near Bluff, UT	23,000	1914	1,619,00	70,000	10-Sep-27	0	Several

* Estimated from high water marks

Record Storages

Navajo Dam Began Operation June 1962

Date	Elevation (feet)	Storage (acre-feet)
3-Jul-73	6087.25	1,732,000
9-Aug-83	6084.00	1,679,000
5-Jul-84	6083.45	1,672,000
30-Jun-86	6084.04	1,681,000

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I – INTRODUCTION

1-01. Authorization. This Water Control Manual (WCM) is for Navajo Dam and Reservoir, located on the San Juan River in northwestern New Mexico and southwestern Colorado. It is prepared in accordance with instructions contained in the Code of Federal Regulations 33, Part 222.5 and Part 208.11, as well as in Corps of Engineers guidance:

ER 1110-2-240	Water Control Management	8 October 1982
EM 1110-2-3600	Management of Water Control Systems	30 November 1987
ER 1110-2-241	Use of Storage Allocated for Flood Control and Navigation at Non-Corps Projects	24 May 1990
ER 1110-2-8156	Preparation of Water Control Manuals	31 August 1995
EM 1110-1-1004	Geodetic and Control Surveying	01 June 2002

All instructions pertain to requirements for reports on reservoir regulation for projects subject to the provisions of Section 7 of the 22 December 1944 Flood Control Act (58 Stat 890). The pertinent portion of that act reads as follows:

> "Hereafter it shall be the duty of the Secretary of War to prescribe regulations for use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with . . ."

1-02. Purpose and Scope. The purpose of this WCM is to document the plan of water control at Navajo Dam and Reservoir and to provide a reference source for those who are concerned with control of lake levels throughout the life of the project. Additional information within this WCM that supports the Navajo Dam water control plan consists of a detailed description of the project, including its history since authorization for construction, and a description of the watershed covering such features as: topography, climate, floods, economic data, and flood forecasting procedures employed for the project (including storm and run-off data collection). The effects of project control on stream flows are presented and the interests of local agencies and organizations are discussed. This WCM also defines responsibilities of the water control operation of the project.

1-03. Related Manuals and Reports. WCMs published by the U.S. Army Corps of Engineers (Corps) and reports published by both the U.S. Bureau of Reclamation (USBR) and the Corps that are pertinent to the San Juan River Basin are:

"Vallecito Dam and Reservoir Water Control Manual," dated December 1973, Revised June 2002. (Corps)

"Lemon Dam and Reservoir Water Control Manual," dated July 1974, Revised June 2002. (Corps)

"Standing Operating Procedures for Navajo Dam," draft dated 1993. (USBR)

"Benefits from Flood Control, Navajo Dam and Reservoir, San Juan River, New Mexico," dated December 1954, October 1958, and December 1966. (Corps)

“San Juan River and Tributaries Reconnaissance Report,” dated December 1994. (Corps)

“Channel Capacity Below Navajo Dam and the Potential for Increasing it to 6,000 Cubic Foot Per Second,” dated August 1998. (Corps, USBR)

Final Environmental Impact Statement, Navajo Reservoir Operations,” dated April 2006. (USBR)

(Some materials in this WCM, including some plates, were furnished by USBR.)

1-04. Project Owner. Navajo Dam and Reservoir is owned by the U.S. Government and represented by the USBR. The city of Farmington is the owner of the hydroelectric power facility.

1-05. Operating Agency. The USBR’s Facilities Resource Group, Western Colorado Area Office, in Durango, Colorado, is responsible for flood control operations and oversees the safe and proper operation and maintenance of Navajo Dam and Reservoir. Mr. Michael Velasquez is the Navajo Dam superintendent and he resides in Ignacio, CO. The office telephone number is (505) 632-3115 and his cellular telephone number is (970) 946-4167. A dam operator is at the project during normal working hours and other times as needed. The city of Farmington operates the hydroelectric power plant.

1-06. Regulating Agencies. The USBR is responsible for the regulation of conservation water (irrigation, municipal and industrial water supply, and recreation). The USBR’s Western Colorado Area Office, in Grand Junction, Colorado is responsible for the regulation of the project. The office telephone number is 970-248-0690. The Corps is responsible for prescribing the flood control plan and for monitoring flood control regulations in accordance with Section 7 of the 1944 Flood Control Act.

II - DESCRIPTION OF PROJECT

2-01. Location. Navajo Dam is located on the San Juan River in San Juan and Rio Arriba Counties, New Mexico, about 300 miles above its confluence with the Colorado River at Lake Powell, Utah, and 33 miles east of the city of Farmington, New Mexico. The San Juan River Basin and reservoir location is shown on Plate 2-1. A more detailed map of the San Juan River Basin above Navajo Dam is shown on Plate 2-2. The Navajo Reservoir Area Map is shown on Plate 2-3. The geographic coordinates of the project are:

Latitude: 36º 48' 28" N
Longitude: 107º 36' 31" W

2-02. Purpose. Navajo Dam and Reservoir is a Colorado River Storage Project (CRSP). It was designed as a multiple use project providing irrigation and municipal water supplies, and flood control. In addition to regulating flows on the San Juan River, it provides reservoir storage for upstream irrigation withdrawals for approximately 100,000 acres of land on the Navajo Indian Irrigation Project. Navajo Reservoir provides boating and fishery opportunities above the dam and increases the recreational use on the adjacent Carson National Forest. Below the dam, the river supports a world-class trout fishery. Hydroelectric power is also generated from Navajo Dam releases.

2-03. Physical Components. Navajo Dam is an earth fill structure with a gated outlet works, a gated auxiliary outlet works, an emergency spillway, and a hydroelectric power facility.

a. Embankment. The dam embankment is a zoned earth and rock fill dam with a maximum height of 388 feet above the San Juan River streambed. The crest of the dam, at elevation 6,108 feet, is 3,648 feet long and 30 feet wide. The embankment is constructed in three zones: an impervious central zone, a pervious zone both upstream and downstream of the impervious central zone, and a miscellaneous zone in the upstream and downstream toes. A cutoff trench is provided under the impervious zone. In 1988, modifications to Navajo Dam were constructed to control abutment seepage. The modifications were the construction of a drainage tunnel system in the right abutment and the placement of a diaphragm wall inside the left abutment. Plate 2-4 shows Navajo Dam plans and sections. Plate 2-5 shows the drainage tunnel system and diaphragm wall modifications.

b. Main Outlet Works. [redacted]

c. Auxiliary Outlet Works. [redacted]

d. Emergency Spillway. The emergency spillway is near the right abutment of the dam. It has an approach apron, a level crest overflow section of ogee profile, and a rectangular concrete chute terminating in a stilling basin. The approach apron is 118 feet long and converges in width from 162 feet at the entrance to 138 feet at the spillway crest, with a net crest length of 132 feet. The spillway crest is at elevation 6,085 feet. The rectangular chute is 1,094.5 feet long and varies in width from 138 feet to 195 feet. The stilling basin is 163 feet long by 195 feet wide. A bridge with a 26-foot roadway width carries a service road across the spillway. An agreement was executed in 1964 providing for the New Mexico Highway Commission to convert the service road to state highway status (New Mexico State Highway 511). The plan, profile, and sections of the spillway are shown on Plate 2-8.

e. Hydroelectric Power Facilities. The hydroelectric power plant is a run-of-river facility with a 30 MW capacity. The powerhouse is immediately adjacent to and south of the outlet works stilling basin. [redacted]

2-04. Related Control Facilities.

a. Navajo Indian Irrigation Project (NIIP). The Navajo Indian Irrigation Project (NIIP) diverts water directly from Navajo Reservoir for the purpose of irrigating 110,630 acres of Navajo Indian land. NIIP is a participating project of the Colorado River Storage Project (CRSP). It was authorized by the 87th Congress on June 13, 1962 (Public Law 87-483, 76 Stat. 96) and amended September 25, 1970 (public Law 91-406, 84 Stat. 867). Current diversions (2010) are approximately 210,000 acre-feet per year. The NIIP main headworks (shown on Plate 2-11) is located within the reservoir area approximately 400

feet east of where the dam crest meets the left abutment.

2-05. Real Estate Acquisitions. The USBR acquired 14,765.62 acres in fee and 23,315.7 acres were withdrawn from other federal agencies for Navajo Reservoir. An additional 3.8 acres were acquired in an easement. Navajo Reservoir project lands are shown on Plate 2-3. The USBR has agreements with the New Mexico State Parks and the Colorado Division of Parks and Outdoor Recreation on the operation of recreational facilities.

2-06. Public Facilities. Facilities at Navajo Reservoir include: marinas, boat launching ramps, visitors' centers, camping and picnic sites, recreation areas, sanitary facilities, concession facilities, and utilities. Navajo Reservoir has two major arms, the Pine and the San Juan, which provide ample opportunities for boating, water skiing, fishing, and other recreational activities. There are three marinas on the reservoir; two in New Mexico and one in Colorado. Navajo Dam Marina is the largest marina on the lake and is located at the Pine Recreation Area on the south end of Navajo State Park on N.M. State Road 511. It has a 6 lane concrete boat ramp that extends from elevation 5,997 to 6,101 feet. Sims Lake Marina is located at the Sims Mesa Recreation Area about 5 miles off of U.S. Highway 64 on N.M. State Road 527. It has a 3 lane concrete boat ramp that extends from elevation 6,000 to 6,199 feet. The Two Rivers Marina, located at the Arboles Recreation Area in Colorado, is accessed from Ignacio, Colorado. Navajo Reservoir has an average of 475,000 visitors per year. Facilities are operated by the New Mexico State Parks and Recreation Division, New Mexico Department of Game and Fish, Colorado Division of Parks and Outdoor Recreation, and Colorado Division of Wildlife. See Plate 2-3 for more information regarding the names and locations of these recreation facilities.

III - HISTORY OF PROJECT

3-01. Authorization. Navajo Dam and Reservoir was authorized as part of the Colorado River Storage Project (CRSP) by act of the 84th Congress dated 11 April 1956 (Public Law 485, 70 Stat. 105). The plan of development for the Navajo Unit was included in House Document No. 364, 83rd Congress, 2nd Session. The authorized purposes of Navajo Dam per the CRSP legislation are water supply, irrigation, flood control, and hydropower.

a. The following Congressional acts also apply to Navajo Dam and Reservoir:

(1) PL 78-534 Flood Control Act of 1944 (recreation, surplus water)

(2) PL 85-624 Fish and Wildlife Coordination Act of 1958

(3) PL 85-500 Water Supply Act of 1958

(4) PL 88-29 (77 Stat. 49) Coordination of Recreation Programs Act of 1963

(5) PL 89-72 (79 Stat. 213) Federal Recreation Programs Act of 1965

(6) PL 89-665 National Historic Preservation Act of 1966 (historic and archaeological data preservation)

(7) PL 91-190 National Environmental Policy Act of 1969 (environmental protection)

(8) PL 92-500 Federal Water Pollution Control Act Amendments of 1972 (water quality)

(9) PL 93-205 Endangered Species Act of 1973 (endangered or threatened fish/wildlife)

(10) PL 102-240 Clean Air Act of 1990

(11) Title 28 of PL 102-575 Reclamation Recreation Management Act of 1992

3-02. Planning and Design. The USBR first obtained funds for the planning and design of Navajo Dam in 1953. The design was completed and construction started in 1958. Navajo Dam was completed in 1963, as described in section 3-03. Plans for modifications on the dam were made in 1988 to control seepage. The city of Farmington prepared plans for the construction of the hydroelectric power facility in 1986, based on the original concept of the USBR.

3-03. Construction. [redacted]

3-04. Related Projects. The following is a brief description of each individual project.

a. Vallecito Dam and Reservoir. Vallecito Dam and Reservoir, a USBR project, is located on the upper Los Pinos River, a tributary of the San Juan River. The dam is located in La Plata County, Colorado, about 45 miles upstream from Navajo Dam, and controls a drainage area of 240 square miles. Vallecito Reservoir has an active storage capacity of 125,400 acre-feet, and is used for irrigation storage under the Pine River Project. Vallecito Dam is operated for flood control by the Corps' Sacramento District to limit the flows in the Los Pinos River to 2,000 cfs.

b. Lemon Dam and Reservoir. Lemon Dam and Reservoir, a USBR project, is located on the Florida River, a tributary of the Animas River. The dam is located in La Plata County, Colorado, approximately 14 miles northeast of Durango, Colorado. It controls a drainage area of 67.6 square miles. Lemon Reservoir has a joint pool capacity of 40,100 acre-feet, and is used for irrigation storage under the CRSP. Lemon Dam is operated for flood control by the Corps' Sacramento District to limit flows in the Florida River to 1,000 cfs.

c. San Juan-Chama Project. The San Juan-Chama Project (SJC) straddles the CO/NM state line in the headwaters of the San Juan Basin. The SJC, authorized in the same legislation as NIIP, is a trans-mountain diversion project owned and operated by the USBR. It diverts water from the San Juan, Rio Blanco and Navajo Rivers in the San Juan River Basin to the Rio Chama in the Rio Grande Basin. Annual diversion averages 110,000 acre-feet, although up to 270,000 acre-feet can be taken during high water years as long as the 10-year average is not greater than 135,000 acre-feet per year.

3-05. Modification to Regulations. In 1958, the safe channel capacities at Blanco, Farmington, and Shiprock were estimated to be 20,000, 21,000, and 22,000 cfs, respectively. Later studies showed that these channel capacities had been reduced, so the releases from Navajo Reservoir are scheduled to avoid exceeding, insofar as possible, the current safe channel capacities in the San Juan River of 5,000 cfs from below Navajo dam to Farmington, 12,000 cfs below the Animas River confluence, and 12,000 cfs through Shiprock, NM.

3-06. Principal Regulation Problems.

IV - WATERSHED CHARACTERISTICS

4-01. General Characteristics. The San Juan River watershed is located in the states of Colorado, New Mexico, Arizona, and Utah, in the Rocky Mountains and mesa lands of southwestern United States, between latitudes 36° 40'N and 37° 30'N and longitudes 106° 30'W and 110° 45'W. The basin is one of extreme contrast in both topography and climate. The San Juan River, the second largest tributary of the Colorado River, has its source on the western slope of the Continental Divide in Rio Grande and Mineral Counties, Colorado It flows in a general southwestward direction into New Mexico, where it is regulated by Navajo Dam. Below the dam the river continues its course across New Mexico and portions of Colorado and Utah before arriving at its confluence with the Colorado River at Lake Powell, Utah. Plate 2-1 shows the San Juan River Basin. The total area of the San Juan River is approximately 27,000 square miles. The watershed, which extends approximately 300 miles northeast from the confluence of the San Juan River and the Colorado River (at Lake Powell), has a maximum width of about 160 miles running north to south through Durango, Colorado and Bloomfield, New Mexico. Major tributaries above Navajo dam are the Navajo, Piedra, and Los Pinos Rivers. Downstream from the Dam, the major tributaries in downstream order are Largo Canyon, Animas River, La Plata River, Chaco River, Mancos River, McElmo Creek, Montezuma Creek, and Chinle Creek.

4-02. Topography. The upstream part of the basin originates in the San Juan Mountains and is extremely rugged and mountainous. The downstream part consists essentially of a broad mesa desert landscape, ringed by the rugged Chuska and Carrizo Mountains to the south and Abajo Mountains to the north. Elevations range from over 14,000 feet at the mountain peaks on the northeast rim of the basin to about 3,650 feet at the mouth of Lake Powell. High tree-clad mountain areas with numerous streams and small lakes rapidly give way to fertile foothill valleys and mesas, merging into a vast, broken and barren but picturesque and brightly colored plateau area at the lower end of the basin. The relatively flat relief of the mesa lands is marked by shallow arroyos and sand dunes formed by wind action.

The topography of the San Juan River above Navajo Dam is typical of a mountain stream, particularly in the upper reaches. Elevations range from 14,084 feet at Windom Peak in the northwest corner of the watershed to 5,720 feet at the streambed elevation at Navajo Dam. Between the mouth of the West Fork and Pagosa Springs its fall decreases from 188 to 48 feet per mile, and between Pagosa Springs and Navajo Dam the average fall is about 19 feet per mile. The Navajo watershed is shown on Plate 2-2.

4-03. Geology and Soils. The San Juan Basin is a structural depression containing deep Tertiary fill resting on rocks of Late Cretaceous age. The San Juan Mountains, in the northern part of the Navajo drainage area, are made up of nearly horizontal sheets of lava and tuff. Glaciation has sculptured the mountains. Troughs, cirques, horns, cols and serrate ridges are common. Rocks ranging in age from Precambrian to Quaternary are exposed. They consist of crystalline igneous and metamorphic rock of Precambrian Age; a thick sequence of sedimentary rock of Paleozoic, Mesozoic, and Cenozoic Age; and a variety of unconsolidated alluvial, glacial, and Eolian deposits of Quaternary Age. The older rocks generally are exposed in the mountainous areas and the younger rocks occur mainly in the

central part of the San Juan Basin. The oldest rocks include Twilight Gneiss; the Irving formation, consisting of amphibolite, gneiss, quartzite and schist; the Electra Lake Gabbro; and the Bakers Bridge Granite. The younger rocks include quartzite, limestone, and shale overlain by red arkosic sandstone and conglomerate with beds of red mudstone and siltstone.

The southern portion of the San Juan drainage basin is underlain by shale, limestone, and resistant sandstone beds of the early Tertiary San Jose Formation and form prominent structural benches, rock terraces, retreating escarpments, canyons, buttes and mesas bounded by cliffs. The beds vary from neatly level to steeply dipped and folded. Except for local areas underlain by cliff forming Ojo Alamo and Pictured Cliff Sandstone of Late Cretaceous Age, the relatively smooth and gently sloping topography of the plateaus reflects the erodibility of generally shaly bedrock such as that of the Kirtland and Nacimiento Formations of Cretaceous to early Tertiary Age.

The rock formations which are exposed in the reservoir basin belong to the Wasatch formation of the Eocene Age. This formation is a massive sandstone layer that is interbedded with some thin layers of shale. The sandstone in the formation is slightly to moderately well-cemented and is weathered to form fairly high vertical cliffs.

The San Juan River watershed above Navajo Dam is divided into mountainous areas, and areas of valleys and mesas that encompass three main soil groups. The mountainous areas contain numerous igneous rock outcrops and deep well-drained soils formed in material weathered from quartz, latite, andesite and other volcanic rock, and are mainly Hydrologic Soil groups B and C. The mesas and canyons consist of moderately deep to deep well drained soils formed in residuum and alluviums derived from interbedded shale and sandstone, and are mainly Hydrologic Soil groups C and D. The lower valleys consist of deep well-drained soils formed in material derived from shale and sandstone, and along rivers and streams there is deep somewhat poorly drained soils formed in fine textured alluvium and colluvium derived from mixed rock sources. The Hydrologic Soil groups in these areas are mainly B and C, with some D.

Elevation and precipitation are the governing factors controlling native vegetation in the San Juan River Basin. In general, annual precipitation in the drainage area increases with elevation. The water requirements of the major vegetative types are indicators of the average amounts of precipitation. Vegetative cover in the San Juan River Basin consists of: (1) the alpine plant community located above the timberline (elevations above 11,500 feet) where vegetation is delicate and meager and barren areas of shale, rock slides, and snow fields; (2) the forest areas, situated between elevations 7,000 - 11,500 feet, which are composed of huge stands of spruce, fir, and aspen at the upper elevations, ponderosa pine mixed with aspen and Douglas fir at the intermediate elevations, and mountain brush and rangelands (shrub types) at the lower elevations; (3) pinon-juniper woodland and rangelands occurring in foothill and low mountain areas between elevations 4,000-7,000 feet; (4) scattered communities of grasslands, desert shrub, and sagebrush in the rangelands of (2) and (3) above; and (5) irrigated crop lands located adjacent to waterways at various elevations.

4-04. Sediment. The runoff from the densely vegetated mountain areas above Navajo Dam is perennial and of significant volume originating mainly from snowmelt; consequently, the streamflow is relatively free of sediment. The runoff from the sparsely vegetated desert area below Navajo Dam is erratic, usually of low-volume and has a high sediment concentration. The San Juan Basin has long been recognized as a major sediment contributor to the Colorado River, particularly due to the lower portion of the basin. From planning studies for Navajo Dam, an annual sediment yield of 2,760 acre-feet per year was determined for the area above the dam and 276,000 acre-feet of sediment space is allocated at Navajo Dam. A sediment survey was conducted during 2001-2002 to determine an average sediment yield and to develop new elevation-area-volume table (see paragraph 7-15). A complete sediment station on the Animas River at Farmington (1,360 square miles) passes an average of 520 acre-feet per year. Most of the sediment producing areas in the San Juan River Basin are the sparsely vegetated desert areas below Navajo Dam.

4-05. Climate. Climate conditions vary considerably within the San Juan River Basin. These variations are due principally to the geographical location and topography of the drainage area. Generally, the mountainous portion of the basin is characterized by short warm summers and long snowy winters; the lower portion has hot dry summers and moderate winters with occasional cold waves of short duration. Within the watershed, maximum and minimum observed temperatures of 104 degrees Fahrenheit (°F) and -20° F have been recorded at Bloomfield, New Mexico, elevation 5,794 feet. The prevailing winds are from the west. The maximum recorded wind velocity near the watershed was 67 miles per hour (mph) at Alamosa, Colorado. Relative humidity is low and reflects the diurnal and nocturnal temperatures.

a. Temperature. A wide range of temperature is experienced in the watershed as evidenced by the difference between mean, maximum and minimum monthly temperatures. In the mountains, much colder daily temperatures are experienced as shown below. The monthly and annual mean, average maximum, and average minimum temperatures for three stations in the local area, including data from Navajo Dam, are presented in Table 4-1.

TABLE 4-1 TEMPERATURE DATA
MONTHLY AND ANNUAL MEAN,
AVERAGE MAXIMUM, AND AVERAGE MINIMUM (°F)

Month	Navajo Dam, NM (5,775 ft)			Wolf Creek Pass, CO (10,640 ft)			Shiprock, NM (4,970 ft)		
	Monthly Averages			Monthly Averages			Monthly Averages		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
January	29.3	39.9	18.7	17.4	31.1	3.6	30.7	44.4	17.0
February	34.5	46.2	22.8	18.7	31.8	5.6	37.1	52.3	21.9
March	42.1	55.4	29.1	22.7	34.9	10.5	45.4	62.5	28.2
April	49.7	64.2	35.1	29.0	40.9	17.0	52.3	70.6	33.9
May	59.2	74.4	44.0	38.5	49.9	27.1	61.7	80.5	42.9
June	68.7	84.7	52.8	47.9	60.9	34.8	71.0	90.9	51.1
July	75.4	90.5	60.2	53.0	65.8	40.2	76.5	95.0	58.0
August	73.2	87.6	58.8	51.6	64.1	39.0	74.7	82.2	57.7
September	64.9	79.2	50.7	45.3	57.3	33.2	66.6	85.3	47.9
October	53.6	67.5	39.7	35.6	47.4	23.7	54.2	72.7	35.7
November	40.0	51.6	28.6	24.2	36.8	11.6	41.0	56.4	25.5
December	30.4	40.4	20.5	18.2	31.2	5.2	31.5	45.4	17.6
Average-Annual	51.8	65.1	38.4	33.5	46.0	21.0	53.6	70.7	36.4
Record	1971-2005			1971-2000			1971-2000		

Source: National Oceanic and Atmospheric Administration
National Climatic Data Center (www.ncdc.noaa.gov)
Western Regional Climate Center (www.wrcc.dri.edu)

b. Precipitation. The average annual precipitation over the San Juan Basin above Navajo Dam is about 20 inches. Precipitation over the upper basin commonly falls as snow during late autumn, winter and early spring, constituting a considerable percentage of the annual precipitation over the watershed. Average annual precipitation varies from seven inches at Shiprock, New Mexico to over 45 inches at Wolf Creek Pass, Colorado. Isohyets of mean annual precipitation for the San Juan watershed above Navajo Dam are shown in Plate 4-1. Mean monthly precipitation is shown on Table 4-2a. Annual and extreme precipitation data for representative stations are listed in Table 4-2b.

TABLE 4-2a PRECIPITATION DATA
MEAN MONTHLY

Month	Navajo Dam, NM (5,775 ft)		Wolf Creek Pass, CO (10,640 ft)		Shiprock, NM (4,970 ft)	
	inches	%	inches	%	inches	%
January	0.95	7.32	3.92	8.44	0.64	8.40
February	0.94	7.25	4.25	9.15	0.51	6.69
March	1.20	9.25	5.29	11.38	0.54	7.09
April	0.98	7.56	3.31	7.12	0.42	5.51
May	0.80	6.17	2.47	5.32	0.60	7.87
June	0.53	4.09	1.71	3.68	0.22	2.89
July	1.19	9.18	3.70	7.96	0.75	9.84
August	1.74	13.42	4.71	10.14	1.13	14.83
September	1.21	9.33	4.31	9.27	0.74	9.71
October	1.25	9.64	4.96	10.67	0.77	10.10
November	1.12	8.64	4.30	9.25	0.69	9.06
December	1.06	8.17	3.54	7.62	0.61	8.01
Average Annual	12.97	100.00	46.47	100.00	7.62	100.00
Maximum Annual	22.81	(1983)	58.30	(1993)	12.86	(1986)
Minimum Annual	5.85	(1989)	29.62	(1969)	1.49	(1976)
Record	1971-2000		1971-2000		1971-2000	

Source: National Oceanic and Atmospheric Administration
National Climatic Data Center (www.ncdc.noaa.gov)
Western Regional Climate Center (www.wrcc.dri.edu)

TABLE 4-2b PRECITATION DATA
TOTAL MONTHLY AND ANNUAL AVERAGE,
MAXIMUM, AND MINIMUM PRECIPITATION (in)

Month	Navajo Dam, NM (5,775 ft)			Wolf Creek Pass, CO (10,640 ft)			Shiprock, NM (4,970 ft)		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
January	0.95	3.92	0.00	3.82	15.66	0.00	0.51	2.34	0.00
February	0.94	3.45	0.00	4.30	19.08	0.02	0.46	1.36	0.00
March	1.20	4.40	0.00	5.14	14.38	0.00	0.53	1.88	0.00
April	0.98	3.57	0.00	3.31	8.35	0.00	0.40	1.96	0.00
May	0.80	2.78	0.00	2.19	7.21	0.00	0.48	3.10	0.00
June	0.53	2.30	0.00	1.63	6.25	0.00	0.22	1.01	0.00
July	1.19	3.54	0.01	3.57	7.84	0.00	0.64	2.22	0.00
August	1.74	4.21	0.19	4.55	10.89	0.00	1.11	3.34	0.00
September	1.21	3.25	0.01	4.08	9.85	0.00	0.72	1.66	0.00
October	1.25	5.15	0.00	4.75	14.45	0.00	0.70	2.12	0.00
November	1.12	2.96	0.00	4.10	11.00	0.00	0.63	3.16	0.00
December	1.06	3.35	0.00	3.20	14.82	0.00	0.55	2.12	0.00
Annual	12.97			44.64			6.95		
Record	1971-2000			1971-2000			1971-2000		

Source: Western Regional Climate Center

c. Snow. Average annual recorded snowfall in the Basin's mountainous area varies from 12 inches at Bloomfield, New Mexico to 400 inches at Wolf Creek Pass, Colorado. The snowfall on the upper portion of the watershed remains on the ground for several months. In the lower elevations, snow seldom remains on the ground for more than a few days. Snowfall data for three stations are shown in Table 4-3a. Average and maximum snow water equivalent (SWE) for several mountain locations are shown in Table 4-3b.

TABLE 4-3a SNOWFALL DATA
MONTHLY AND ANNUAL AVERAGES (in)

Month	Navajo Dam, NM (5,775 ft)		Wolf Creek Pass, CO (10,640 ft)		Shiprock, NM (4,970 ft)	
	Avg	Max	Avg	Max	Avg	Max
January	4.6	23.0	63.5	171.0	1.7	9.8
February	2.6	32.3	53.1	209.0	0.5	4.2
March	0.8	14.5	61.8	165.5	0.4	4.5
April	0.1	2.0	34.8	118.1	0.0	0.0
May	0.0	0.0	12.2	40.0	0.0	0.0
June	0.0	0.0	1.3	15.0	0.0	0.0
July	0.0	0.0	0.0	0.0	0.0	0.0
August	0.0	0.0	0.0	0.0	0.0	0.0
September	0.0	0.0	2.1	34.0	0.0	0.0
October	0.2	6.6	23.0	69.1	0.1	1.0
November	0.7	8.0	45.4	117.0	0.2	3.2
December	2.8	13.0	52.2	201.0	0.8	7.4
Average Annual	11.6		341.7		3.3	
Record	1971-2000		1971-2000		1971-2000	

Source: Western Regional Climate Center (www.wrcc.dri.edu)

TABLE 4-3b SNOWFALL DATA
MONTHLY AVERAGE AND MAXIMUM
(Snow Water Equivalent - Inches)

SNOTEL STATION	AVERAGE 1971-2000					MAX. (Date)	MIN. (Date)
	1-Jan	1-Feb	1-Mar	1-Apr	1-May		
Wolf Creek Summit (10,880 feet)	14.3	20.1	26.0	33.3	36.8	47.9 (Apr 95)	0.0 (Many)
Red Mountain Pass (11,200 feet)	10.1	14.6	19.2	25.5	27.1	44.9 (May 84)	0.0 (Many)
Vallecito (10,880 feet)	9.0	11.3	16.4	19.3	16.2	34.4 (Apr 93)	0.0 (Many)
Upper San Juan (10,130 feet)	12.9	19.0	25.6	31.7	29.8	64.7 (APR 79)	0.0 (Many)

Source: Natural Resources Conservation Service
(http://www.wcc.nrcs.usda.gov/factpub/ads/ads_co.html)

d. Evaporation. A class "A" land pan is used for evaporation measurement at the dam. Evaporation measurements are made for the period April through October. The April through October record was extended to annual by data comparison from a Rio Grande Basin study of evaporation. April through October average pan evaporation is 48.54 inches. The other five months had no data available. The highest monthly evaporation occurs in July and is about 13 percent of the annual. The lowest rates occur in October, which is about 9 percent of the annual. Monthly evaporation data for Navajo Reservoir are shown in Table 4-4.

TABLE 4-4 EVAPORATION DATA
AVERAGE MONTHLY PAN
AT NAVAJO DAM, NEW MEXICO

Evaporation (inches)							
YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
1991	7.49	8.18	9.53	11.15	9.01	7.64	5.80
1992	7.00	7.92	10.37	9.98	9.30	7.42	5.12
1993	6.89	7.78	9.96	11.63	8.99	7.33	-
1994	4.17	-	11.02	11.55	10.31	6.84	4.05
1995	5.99	5.75	8.66	9.74	8.96	7.64	5.78
1996	-	-	11.01	13.14	9.86	6.58	-
1997	-	9.27	9.33	11.72	7.41	7.28	-
1998	-	10.08	12.00	10.23	8.24	6.96	-
1999	-	-	8.06	9.28	7.50	6.60	-
2000	-	11.30	12.22	12.65	-	6.31	-
2001	-	10.14	10.42	9.87	9.38	9.51	-
2002	7.69	9.71	10.77	10.20	10.04	6.76	-
2003	-	-	12.69	12.93	9.95	7.45	4.90
2004	-	11.30	12.57	10.84	9.45	6.48	3.24
2005	-	9.91	11.04	10.87	9.57	8.13	3.73
2006	-	11.43	-	9.61	8.37	6.17	3.50
2007	6.68	9.13	12.23	10.23	9.57	7.50	-
2008	-	8.17	10.28	10.33	9.68	7.33	-
2009	-	10.16	8.44	9.83	10.71	7.34	-

e. Wind. Wind data at Alamosa, Colorado are considered representative of occurrences at Navajo Reservoir, since there are no significant wind gust records nearer the project. According to observations made during 1974, the greatest wind activity is in the spring with the maximum monthly average of 12.1 miles per hour (mph) occurring in May. A maximum velocity of 67 mph was recorded during April 1986. All months of the year have, at some time, experienced velocities greater than 45 mph. Wind data are shown in Table 4-5.

TABLE 4-5 WIND DATA
MEAN AND PEAK MONTHLY VELOCITIES

MONTH	MEAN (mph)		PEAK GUST (mph)	
	Farmington, NM	Durango, CO	Alamosa, Co	Grand Junction, CO
January	7.3	4.6	49	41
February	8.3	5.5	46	59
March	9.0	6.6	52	53
April	9.8	7.9	61	78
May	9.4	7.6	57	62
June	9.4	7.3	49	74
July	8.7	6.3	57	64
August	8.2	5.8	44	74
September	8.0	5.6	43	64
October	7.8	5.7	48	57
November	7.6	4.9	55	49
December	7.3	4.6	45	45
Annual	8.4	6.0	61	78

Source: Western Regional Climate Center (www.wrcc.dri.edu)

4-06. Storms and Floods. Snowmelt runoff accounts for approximately 70% of the annual runoff and generally begins in April at low elevations in the watershed. It increases in May, as considerable melting occurs in the higher mountains and normally reaches a peak in late May or early June. Although snowmelt produces the greatest volume of runoff, the largest flows have occurred during general precipitation events, which typically occur in the late summer and fall. Thunderstorm precipitation in the summer months may cause local floods with high peak discharges, but comparatively small flood volume. Monthly and annual flows at Navajo Dam are listed on Table 4-6.

TABLE 4-6
AVERAGE MONTHLY FLOWS (acre-feet)
NAVAJO DAM AND RESERVOIR, NEW MEXICO

MONTH	INFLOW (ac-ft)	PERCENT OF ANNUAL	OUTFLOW at ARCHULETA GAGE (ac-ft)	PERCENT OF ANNUAL
January	20,909	2.17	57,129	7.11
February	28,367	2.94	53,972	6.71
March	79,623	8.25	65,544	8.15
April	137,988	14.29	74,767	9.30
May	217,314	22.51	108,210	13.46
June	190,487	19.73	111,913	13.92
July	80,483	8.34	69,104	8.60
August	58,121	6.02	58,176	7.24
September	51,697	5.35	53,711	6.68
October	46,962	4.86	49,349	6.14
November	30,120	3.12	47,563	5.92
December	23,493	2.43	54,464	6.77
Annual	965,565	100	803,900	100

Source: USGS Website for Navajo Reservoir Daily Inflow Values (WY: 1963-2009)

a. Historical Floods. Historical evidence, prior the establishment of stream gaging stations, includes reference to three major floods in the San Juan River Basin prior to 1904.

Accounts beginning in 1859 indicate that major floods occurred in 1859, 1882, and 1884.

b. Major Floods of Record. Recorded data of major floods cover the period from 1909 to date. The largest flood of record in the basin occurred in October 1911 when a peak discharge of 150,000 cfs occurred at Shiprock, New Mexico. The largest tributary discharge in the Navajo Dam area had a peak of 14,000 cfs and occurred on the Piedra River above Navajo Dam on 26 June 1927. Maximum peak discharges on the San Juan River are listed in Table 4-7.

TABLE 4-7
RECORDED MAXIMUM PEAK FLOWS

Station	Drainage Area (mi^2)	Period of Record	Maximum Flood of Record (date)	Peak Flow (cfs)
San Juan River at Pagosa Springs, CO	298	1935 to Present	6 Sep 1970	6,580
San Juan River near Carracas, CO	1,230	1961 to Present	6 Sep 1970	9,730
San Juan River near Archuleta, NM	3,260	1954 to Present	27 Jul 1957	18,900
San Juan River at Farmington, NM	7,240	1930 to Present	28 Sep 1935	32,800
San Juan River at Shiprock, NM	12,900	1934 to Present	28 Sep 1935	44,200

Source: USGS (http://waterdata.usgs.gov)

The following paragraphs discuss major storms in the basin of which substantial information is available.

(1) October 1911. In early October 1911, a severe rainstorm occurred over the southwestern corner of Colorado and the northwestern corner of New Mexico. The rain flood of October 2-6, 1911 was the largest known to have occurred in the valley of the San Juan River and in many of its tributaries. The flood followed a summer during which precipitation was above normal. Most gaging stations were washed out by this flood, so peak discharges are generally estimated. The estimated flow at the Navajo dam site was 67,000 cfs on 5 October 1911, and 150,000 cfs was estimated at Shiprock, New Mexico on 6 October 1911.

(2) June 1927. During June 26-30, 1927, rapid snow melting caused by a warm general rain created the highest flows and most widespread flooding on the San Juan and Animas Rivers since the flood of October 1911. The peak discharge recorded at San Juan River at Farmington, New Mexico was 68,000 cfs. A flow of 14,000 cfs was estimated at Piedra River near Piedra.

(3) August 1929. The largest rain flood during which most gages operated, occurred in August 1929, resulting in a peak flow of 25,000 cfs on August 11 at the gaging station near Blanco (now near Archuleta).

(4) May 1941. In early May 1941, a general rainstorm occurred over northern New Mexico inundating much of the drainage basins of the San Juan, Animas, and La Plata Rivers. About two weeks of hot weather followed the storm, causing snowmelt flooding on the San Juan River and Tributaries. A peak discharge of 23,300 cfs was recorded at San Juan River near Blanco on May 14, 1941.

(5) September 1970. A rare combination of meteorological events in early September 1970 resulted in flood-producing rains over the upper Colorado region of Colorado, New Mexico, Utah, and Arizona. Large amounts of rainfall occurred over a 12 to 18 hour period beginning before noon on September 5, 1970. The San Juan River gage near Carracas, Colorado, recorded a peak discharge of 9,730 cfs, the peak discharge of record at that station. The Piedra River near Piedra recorded a peak flow of 8,370 cfs.

4-07. Runoff Characteristics. Streamflow in the San Juan River is normally perennial, except in the lower desert reaches in Utah. Snowmelt floods are the major threat along the San Juan River and generally occur during the period from May through July. Snowmelt floods are characterized by large volume, long duration, moderate peaks, and marked diurnal fluctuation and may be augmented by rain. General rain floods have caused the most severe damages along the San Juan River and its tributaries, and have usually occurred during September and October. This type of flood results from prolonged heavy rainfall over the tributary areas and is characterized by high peak flows of moderate duration.

Thunderstorms lasting from several minutes to a few hours often occur during the summer months and create the most severe flooding along the tributaries. Flooding from thunderstorms is characterized by high peak flows, short duration, and small volume of runoff.

Streamflow records are available for eight stream gaging stations on the San Juan River and for 27 stations on tributary streams. Records were first obtained at Animas River at Durango, Colorado, in 1895, but records for the mainstem of the San Juan River are continuous at only six stations from 1927 to date. Plate 2-1 shows stream gaging stations in the San Juan River Basin. Thalweg profiles from the mouth to the San Juan headwaters are shown on Plate 4-2.

Consumptive use in the drainage basin has varied with irrigation developments and changed vegetative cover; these depletions are reflected in the records. The records show the general surface runoff contributions for different portions of the watershed. The maximum, minimum, mean, average annual runoff, period of record, and drainage area for selected stations are shown in Table 4-8. Monthly and annual flow records for the San Juan River at Carracas, CO and San Jaun River near Archuleta, NM are given in Tables 4-9 and 4-10, respectively.

TABLE 4-8
SAN JUAN RIVER GAGING STATIONS

Gage/Station Name Contributing Drainage Name	Area (square miles)	Complete Water Years of Record	Annual Runoff (acre-feet)			Average Annual Runoff (Inches)
			Maximum	Minimum	Mean	
San Juan River at Pagosa Springs, CO	298	74	528,400	42,700	269,800	16.98
San Juan River near Carracas, CO	1,230	48	869,300	81,100	445,700	6.79
San Juan River near Archuleta, NM	3,260	54	1,944,800	202,800	815,800	4.69
Los Piños at La Boca, CO	520	58	421,600	32,300	172,300	6.21
Piedra River near Arboles, CO	629	47	595,200	38,800	289,400	8.63
Animas River at Farmington, NM	1,360	86	1,258,400	128,300	630,200	8.69
San Juan River at Shiprock, NM	12,900	74	3,854,400	475,400	1,476,200	2.15

4-08. Water Quality. The quality of water in the river above and just below Navajo Reservoir is very good. The area below Navajo dam is an excellent trout fishery, one of the best in the western United States. The river generally gets warmer, more sediment laden, and decreases in quality as you move downstream from Navajo Dam. The outlet inverts in Navajo Dam are towards the bottom of the reservoir, so the river just below Navajo is at a more or less constant temperature (within 10°C), even through summer. The dissolved oxygen content just below Navajo Dam is typically above 10 mg/l and other water quality parameters are within State and Federal Standards. Downstream reduction in quality is caused by natural conditions, oil and gas production, and communities along the river, such as Farmington and Shiprock. Reductions in quality caused by communities are due to sewage treatment discharge and irrigation return flows.

4-09. Channel and Floodway Characteristics. Downstream from its source to Pagosa Springs, about 11 miles, the San Juan River channel is shallow and broad. The gradient in this reach is about 48 feet per mile. Downstream from Pagosa Springs, the river meanders in a narrow irrigated valley hemmed in by steep slopes. The river is shallow in this reach and the gradient is about 38 feet per mile. From the Navajo River confluence to its confluence with the Piedra River, just upstream of the head of Navajo Reservoir, the stream channel and valley are fairly narrow. Downstream from Navajo Dam to Farmington, the river flows through a narrow valley with numerous small communities at the river's edge, and the gradient drops to about 10 feet per mile. The channel capacity to Farmington has been reduced to about 5,000 cfs due to encroachment on the river. The capacity below the confluence with the Animas River is 12,000 cfs. Below Shiprock, the river meanders in a wide, shallow, sandy river bottom, through desert area until it flows through a steep sided, narrow canyon below Bluff, Utah, on into Lake Powell.

4-10. Upstream Structures.

a. Vallecito Dam and Reservoir. Vallecito Dam and Reservoir, a USBR project completed in 1941, is on the Los Pinos River, a tributary of the San Juan River. The dam is located in La Plata County, Colorado, about 45 miles upstream from Navajo Dam, and controls a drainage area of 240 square miles. Vallecito Reservoir is used for irrigation storage under the Pine River Project.

The dam consists of a zoned, earth and rockfill structure rising 126 feet above the streambed. Total dam length is about 0.75 miles and has a crest width of 35 feet. The outlet works consist of a twin-section concrete conduit through the right abutment, controlled by two 5X5 foot slide gates, with a maximum discharge of 3,100 cfs. The spillway structure has three gated bays totaling 111 feet in length, with the discharge (design capacity - 30,000 cfs) controlled by three radial arm gates (tainter gates) which are 37 feet wide by 19 feet high. Vallecito Reservoir has a capacity of 129,000 acre-feet, of which 125,400 acre-feet is active capacity for joint irrigation and flood control purposes. Vallecito Dam is operated for flood control (by the Corps Sacramento District) to limit the flows in Los Pinos River to 2,000 cfs. The Water Control Manual for Vallecito Reservoir (prepared by the Sacramento District) has further information on this project.

b. San Juan-Chama Project. The San Juan-Chama Project, authorized in the same legislation with NIIP, is an inter-basin diversion project owned and operated by the USBR. It diverts water from the San Juan, Rio Blanco and Navajo Rivers in the upper San Juan River Basin to the Rio Chama in the Rio Grande Basin. Annual diversions average 135,000 acre-feet, although up to 270,000 acre-feet can be taken during high water years, as long as the 10-year average is not greater than 135,000 acre-feet per year.

4-11. Downstream Structures.

a. Lemon Dam and Reservoir. Lemon Dam and Reservoir, a USBR project completed in 1963, is on the Florida River, a tributary of the Animas River. The dam is located in La Plata County, Colorado, approximately 14 miles northeast of Durango,

Colorado. It controls a drainage area of 67.6 square miles. Lemon Reservoir is used for irrigation storage under the CRSP.

The dam consists of zoned earth and rockfill with a height of 215 feet above the streambed, a crest length of 1,360 feet, and a crest width of 30 feet. The outlet works, located in the right abutment of the dam, consist of an approach channel and a concrete intake structure. The concrete tower directs flow into an 8.5 foot diameter pressure tunnel upstream from two 2.25 X 2.25 foot high pressure tandem slide gates. An ungated spillway is on the right abutment of the dam and consists of an approach channel, concrete inlet structure, concrete ogee crest section, open concrete chute, concrete stilling basin, and a concrete outlet channel. Lemon Reservoir has a capacity of 40,146 acre-feet, of which 354 acre-feet is dead storage, 762 acre-feet is inactive, and 39,030 acre-feet is joint use storage for conservation and flood control. Lemon Dam is operated for flood control (by the Corps Sacramento District) to limit flows in Florida River to 1,000 cfs. The Water Control Manual for Lemon Reservoir (prepared by the Sacramento District) has further information on this project.

b. Animas-La Plata. The Animas La Plata is a USBR project. It consists of an off-stream reservoir at Ridges Basin (Lake Nighthorse), southwest of Durango, Colorado, that can store 120,000 acre-feet (total capacity) of water pumped from the Animas River through a buried pipeline from the pumping plant (located south of Durango) at a capacity of 280 cfs. Water stored in Lake Nighthorse is released, as necessary, back to the Animas River for municipal and industrial users within Colorado and New Mexico. Lake Nighthorse, which is in the initial phase of filling, will include an inactive pool of approximately 30,000 acre-feet for recreational, fishery, and water quality purposes. Recreation facilities will be provided by other entities.

4-12. Economic Data. The population and labor pool in San Juan County, New Mexico has been steadily growing for the past few decades (New Mexico Department of Labor, 2004; Census, 2000). This growth is expected to continue based primarily on the petro-chemical industry, agriculture, and tourism (refer to Table 4-11 for population growth projections). The following paragraphs and their tables demonstrate various aspects of the basin and flood damage potential in San Juan County, New Mexico.

TABLE 4-11
POPULATION GROWTH PROJECTIONS

POPULATION BY YEAR	LOCALITY			
	United States	New Mexico	San Juan County, NM	Farmington
2000*	281,421,906	1,819,046	114,237	37,844
2005*	295,507,134	1,925,985	125,820	43,161
2010**	308,936,000	2,112,986	128,592	***
2020**	335,805,000	2,383,116	142,074	***
2030**	363,484,435	2,626,553	154,403	***

*US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)

**BBER-UNM (http://www.unm.edu/~bber/demo/table1.htm), National data from Bureau of the Census (http://www.census.gov/ipc/www/usinterimproj/natprojtab01a.xls)
***Data not available

a. Population. Population in the San Juan River Basin is primarily based in the county of San Juan, New Mexico. The majority of the population is dispersed throughout the county with approximately 47% living within the cities of Aztec, Farmington & Shiprock. Of these three, Farmington is the only metropolitan area in the floodplain below Navajo Dam & Reservoir. Farmington and its immediate surroundings contain approximately 33.25% of San Juan County's population (refer to Table 4-12 for demographic characteristics).

TABLE 4-12
PROFILE OF DEMOGRAPHIC CHARACTERISTICS, 2000

Geographic Area	Total Population	% Race (Percent of Total Population)*						
		White	Black or African Amer.	Amer. Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some Other Race	Hispan. or Latino (of Any Race)
U.S.*	281,421,906	74.7	12.1	0.8	4.3	0.1	6.0	14.5
New Mexico*	1,819,046	69.5	1.9	9.6	1.2	0.1	14.5	43.6
San Juan (County)**	114,237	50.6	0.4	39.5	0.8	0.2	5.5	16.2
Farmington (City)***	37,844	70.7	0.8	17.0	0.5	0.1	7.8	17.7

Percentages may add to more than 100% because individuals may report more than one race.
*US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/=)
** US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/=)
***Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/).

b. Income. The 2000 per capita income was $18,167 for Farmington, $14,282 for San Juan County, $17,261 for New Mexico, and $21,587 for the United States (refer to Table 4-13 for income statistics).

TABLE 4-13
INCOME, 2000

Geographic Area	Median Household Income (Dollars)	Per Capita Income (Dollars)	% Individuals Below Poverty Level
United States*	$41,994	$21,587	12.4
New Mexico**	$34,133	$17,261	18.4
San Juan County**	$33,762	$14,282	21.5
Farmington (City)*	$37,663	$18,167	16.0

*US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/=)
**Ibid (http://factfinder.census.gov/=) and
(http://factfinder.census.gov/=)

c. Employment. San Juan County industry was once primarily based on agriculture and the oil and natural gas industries. Retail trade is now the leading industry in the county, followed by health care and social assistance (refer to Tables 4-14 and 4-15 for employment statistics and to Table 4-16 for housing information).

With over 20,000 wells in the San Juan County now, and over 10,000 more planned for the near future, oil and gas production in the Four Corners (CO, NM, UT, AZ) area is a major source of income and employment and drives the local economy. In 2004, the oil and gas industry generated about $226 million in taxable gross receipts for San Juan County, or about 7.5% of the $3 billion in total oil and gas revenues. The oil and gas industry has provided employment for over 59 years in the San Juan Basin. Employment in the oil and gas industry in San Juan County in 2003 was 4,353. The oil and gas industry continues to grow as the price for these commodities continues to rise.

The irrigated lands that receive water from Navajo Reservoir include lands along the San Juan River and land that is included within the Navajo Indian Irrigation Project (NIIP). Thirty-seven operational ditch companies serve farmers that irrigate approximately 26,000 acres of the privately owned portion of the county below Navajo Dam. The NIIP project is a water delivery system from Navajo Reservoir to 110,630 acres of irrigable land control by the Navajo Nation. This project is managed by the Navajo Agricultural Products Industry (NAPI), and is one of the largest employers of Navajo people on the Navajo Nation.

TABLE 4-14
SAN JUAN COUNTY EMPLOYMENT, 2002, by
North American Industry Classification Code (NAICS)

NAICS Code	Industry Description	Number of Establishments	Sales, Shipments, Receipts, or Revenue ($1,000)	Annual Payroll ($1,000)	Number of Employees
31-33	Manufacturing	76	241,039	35,550	1,153
42	Wholesale trade	157	686,934	52,800	1,380
44-45	Retail trade	470	1,238,836	118,330	6,157
51	Information	39	N	10,064	466
53	Real estate & rental & leasing	106	81,938	17,047	577
54	Professional, scientific, & technical services	184	D	D	g
56	Administrative & support & waste management & remediation service	89	59,586	24,106	1,292
61	Educational services	15	6,967	2,203	103
62	Health care & social assistance	210	447,598	158,284	4,973
71	Arts, entertainment, & recreation	24	32,611	6,234	311
72	Accommodation & food services	177	137,499	36,196	3,832
81	Other services (except public administration)	229	147,433	35,805	1,695

D: Withheld to avoid disclosing data for individual companies; data are included in higher level totals.
N: Not available or not comparable
g. 1,000 to 2,499 employees

Source : U.S. Bureau of the Census, 2002 Economic Census
(http://factfinder.census.gov/)

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TABLE 4-15
UNEMPLOYMENT STATISTICS, 2000

Geographic Area	Percent Unemployed (Percent of Civilian Labor Force)	Percent Not in Labor Force
United States*	5.8	36.1
New Mexico**	7.3	39.0
San Juan County***	9.1	39.7
Farmington (City)****	7.0	35.0

* US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/servlet/QTTable?_bm=y&-geo_id=01000US&-qr_name=DEC_2000_SF3_U_DP3&-ds_name=DEC_2000_SF3_U&-_lang=en&-redoLog=false&-_sse=on)
** US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)
***US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)
****US Dept. of Commerce, Bureau of the Census (*http //factfinder.census.gov/*

TABLE 4-16
HOUSING INFORMATION, 2000

	New Mexico*	San Juan County**	Farmington (City)***
Total Housing Units	780,579	43,221	15,077
% of Occupied	86.9	87.3	92.7
Median Value ($)	108,100	91,300	100,600

*US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)
** US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)
*** US Dept. of Commerce, Bureau of the Census (http://factfinder.census.gov/)

d. Flood Damages. Floods have occurred in Farmington, NM as a result of high flows from the Animas and San Juan Rivers in 1911, 1927, 1941, and 1952. Damage figures were not developed for these events. Because of high snowmelt predictions by the National Weather Service in 1979, the Albuquerque District undertook advanced protection measures under PL 84-99 on the Animas River through Farmington, NM. These measures prevented damages estimated as $2.5 million. The Animas River flows which occurred during the period were approximately 8,000 cfs. The channel capacity of the San Juan River below the confluence of the Animas River is 12,000 cfs. The 2004 estimate of the value of damageable property within the 100-year floodplain is $54.7 million. The estimated damages to land and improvement within the San Juan River floodplain are detailed below as a function of flood magnitude (refer to Table 4-17).

Table 4-17
SINGLE OCCURRENCE FLOOD DAMAGES

SAN JUAN RIVER FLOODPLAIN
August, 2004 price level (x $1,000)

Land Use Type	FLOW (cfs)									
	5500 cfs		10,000 cfs		20,000 cfs		40,000 cfs		70,000 cfs	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Residential	339	29	557	38	1,096	66	2,020	102	3,493	119
Res. Content	176	26	271	35	496	49	907	70	1,463	81
Commercial	15	6	30	9	88	22	357	90	6,259	1,093
Comm. Content	10	5	31	14	395	106	863	193	21,016	5,825
Public	1	0	67	20	191	46	321	76	1,870	484
Pub. Content	0	0	49	20	340	129	380	135	3,638	914
Subtotal - Structures	355	30	654	44	1,374	86	2,698	159	11,622	1,161
Subtotal - Contents	186	27	351	44	1,231	173	2,150	243	26,117	5,881
Subtotal – Structures and Contents	541	42	1,005	64	2,605	193	4,848	291	37,739	6,005
Vehicles	80	12	108	14	178	20	428	32	649	36
Streets	0	0	239		2,150		10,402		29,848	
Utilities	6		64		338		379		1,102	
Agriculture	0		47		173		11,027		15,919	
Emergency costs	8		15		39		73		566	
Total	627		1,416		5,271		16,058		69,337	

Note: SD is standard deviation.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydrometeorological Stations

a. Facilities. The location of precipitation and stream gages within the San Juan Basin, from its headwaters to the Four Corners area, are shown on Plate 2-1.

(1) Precipitation Gages. There are a number of automated precipitation gages in or near the San Juan Basin that are a part of 2 observation networks. The Automated Surface Observation Site (ASOS) network has 4 stations and is maintained by the National Weather Service (NWS). The Remote Automated Weather Station (RAWS) network has 8 stations and are maintained by the Bureau of Land Management.. Rainfall gages are located at Vallecito, Lemon, and Navajo Dams. The NWS also utilizes a network of manual observers. Paragraph 5-01b describes reporting methods of these hydrometeorological stations, while Paragraph 5-04 gives information on retrieval of this data from the appropriate agency.

(2) Stream Gages. There are 34 automated stream gaging stations in the San Juan Basin with 8 of these stations maintained by the Colorado Division of Water Resources, and 26 maintained by the US Geological Survey (USGS). All of these gages are equipped with Data Collection Platforms (DCP) that collect and periodically transmit data from remote sites using telemetry.

(3) Snowpack Data. The Natural Resource Conservation Service (NRCS) operates and maintains 9 automated SNOTEL sites in or near the San Juan Basin. The primary purpose of these gages is to monitor snowpack, but they also collect temperature and rainfall data. These SNOTEL locations are shown on Plate 2-1. SNOTEL readings of snowpack, water content, and temperature are available from the NRCS web page on a daily basis. Field measurements of snow depth and water content are made twice each the winter.

(4) Navajo Dam. DCP automated stage gages at Navajo Reservoir include an outflow gage on the San Juan River (near Archuleta) and a gage for the reservoir level. Flow data from the Navajo Indian Irrigation Project canal is obtain through USBR maintained telemetry equipment. In addition, the weather station at Navajo Dam measures temperature, precipitation, evaporation, humidity, wind speed and direction, barometric pressure, dew point, and solar radiation.

b. Reporting. The Corps' Albuquerque District (SPA) has established a Water Control Data System (WCDS) for receiving, decoding, evaluating, and storing real-time meteorologic and hydrologic data for its water management activities and responsibilities. All Data Collection Platforms (DCPs) in the San Juan Basin on the WCDS are equipped with Geostationary Operational Environmental Satellite (GOES) radios for transmitting via satellite to the DOMSAT Receive Only Terminal (DROT) at the District Office and other Districts (as backups). Most of these stations are reservoir elevation and streamflow gages.

In addition, hydrometeorological information at Navajo Reservoir and elsewhere in the San Juan River Basin is monitored through the automated data collection system HYDROMET. HYDROMET software was developed by the Sutron Corporation to facilitate the collection of data from the DCPs, and is processed into a database management system. This data is transmitted from the DCPs and relayed via the GOES to the USBR downlink. This raw data is transmitted every half-hour from the downlink to the Salt Lake City H2O VAX computer. These raw messages are processed by the Sutron software, while data for the SNOTEL sites are transmitted via meteor burst radio.

The NWS receives rainfall data from automated and manual observer stations. The NWS disseminates this information along with weather forecasts over the Automation of Field Operations and Services (AFOS) system to its various offices. Selected AFOS information is accessible via the web.

(1) Normal Conditions. The hydrometeorological data required for reservoir regulation, under normal conditions, consists of daily reports on stage, storage, outflow, inflow, evaporation, and precipitation. The USBR's Durango Projects Office (PO) in Durango, Colorado, will be able to obtain some of the above information through a real-time data base stored on the SPA WCDS via GOES DCPs. Information that is not available through automated reporting methods will be obtained by the damtender in the field and transmitted to the Durango PO by telephone or computer. Reporting criteria and methods are described in Standing Instructions to Damtender, Exhibit F.

(2) Flood periods. During flood periods, information on downstream conditions, current inflow forecasts, and anticipated release changes at Navajo Dam is required in addition to the data required under normal conditions, described in paragraph 5-01-b-(1). The Reservoir Control Branch (RCB), Albuquerque District, will monitor reservoir and weather data via the web. Supplemental information on conditions at Navajo Reservoir shall be transmitted from the Durango PO to the RCB as necessary on a daily basis.

c. Maintenance. The lake level monitoring devices at Navajo Reservoir will be maintained by the reservoir damtender. In addition, the reservoir damtender is responsible for operation and maintenance of the weather station at Navajo Dam in accordance with instructions furnished by the NWS. NWS personnel visit all stations periodically to inspect and repair instruments, and are also informed when major repairs are needed. Stream gages, including reservoir inflow and outflow gages, are operated and maintained by the U.S. Geological Survey (USGS). Personnel from the USGS conduct scheduled visits to each gage to insure proper operations.

5-02. Water Quality Stations. The USGS no longer collects water quality data applicable to Navajo Reservoir. However, retired stations include: (1) San Juan River at Pagosa Springs, and (2) San Juan River near Archuleta. The USGS publishes this data on their web site.

5-03. Sediment Stations. Suspended sediment samples have been taken on the San Juan River and tributaries at a number of stations since 1930. No current suspended sediment

stations exist. However, historical records are available for: Animas River at Farmington (1951-2005); at Rosa (1949-1950); near Blanco (1949-1955); near Archuleta (1959-1965); near Bloomfield (1956-1964); at Shiprock (1968-1986); and at Bluff (1930-1980). The USGS collected most of these samples, and the sediment loads are published in USGS publications as well as their web site (http://waterdata.usgs.gov/nwis).

5-04. Recording Hydrologic Data. Daily summaries of Navajo Reservoir data, including stage, storage, outflow, inflow, precipitation, and evaporation are available at the Durango PO. Monthly tabulations of this information are forwarded to the RCB and retained indefinitely as the official record of operation. Preliminary data collected by automated methods is generally stored on the various computers of the owner agencies, and current information is available through these agencies. Summary data, monthly, and annual data is available from the various agencies and their publications. In general, this is historical data which may not be available in final form for some time after it is collected.

5-05. Communication Network. Communication between the Corps and the USBR's Durango PO is through the telephone, facsimile, and by e-mail. Communication between the Durango PO and the damtender is normally by telephone. In the event of communication disruption, satellite phones are available. Refer to the front of this manual (under EMERGENCY REGULATION ASSISTANCE PROCEDURES) for a list of personnel involved with the operation of Navajo Dam. Table 5-1 lists telephone numbers of pertinent individuals and organizations.

5-06. Communication with Navajo Dam

a. Navajo Dam Supervisor and Durango PO. Under normal conditions, the Navajo Dam supervisor will be in contact with the Durango PO each work day to transmit required hydrologic data. During flood periods, communications between Navajo and Durango PO will be extended as necessary. Contact between Navajo Dam and Durango PO will be by commercial telephone or radio.

b. Reservoir Control Branch and Durango PO. The RCB is responsible for collecting and recording hydrologic data, approving or disapproving emergency changes in operation recommended by the USBR, and issuing instructions for such changes of the Corps' own initiative as necessary. During flood periods, the RCB and Durango PO personnel will be in contact with each other every workday by commercial telephone in order to transmit data and instructions. The Durango PO will act as the relay between RCB personnel and Navajo personnel. Communications between RCB, Durango PO, and Navajo personnel will be extended up to a 24-hour, 7 day-a-week basis as necessary.

c. Between Durango PO and Others. When high rates of unscheduled releases (see paragraph 7-14) are made, the organizations and individuals listed in the Bureau's manual "Standing Operating Procedures for Navajo Dam and Navajo Reservoir" will be notified via telephone. Information on release rates can be obtained by calling the Navajo Dam project office at 505-632-3115.

5-07. Reporting Instructions. The damtender normally reports pertinent data each workday morning to the Durango PO in Durango, Colorado, while weekend and holiday reports are transmitted the next workday. Weekend and holiday daily reports are made daily during flood periods or when the reservoir elevation is above 6,085. However, situations may dictate communication directly with the RCB. These daily reports will consist of lake elevation, storage, inflow and release rates, and weather data as required to supplement automated data collection. A monthly summary of daily regulation is mailed to the RCB by the 10th of each month for the preceding month. Unusual weather conditions or inflow will be reported immediately to the Durango PO via telephone.

When changes in reservoir release have been made in compliance with RCB instructions, Durango PO personnel are required to confirm the release change, and give the downstream river gage reading to RCB after the flow has stabilized. Unanticipated conditions will be reported immediately to the RCB, and the RCB will issue new instructions. Details of reporting instructions are contained in Exhibit F, Standing Instructions to the Project Operators.

5-08. Warnings. The USBR issues warnings on flood control operations for Navajo Reservoir that notify the public of reservoir release rates and reservoir conditions. The RCB will issue the necessary instructions for flood warnings to the Durango PO. Organizations and agencies that will be notified by the damtender or Durango PO prior to any flood control release are listed in the Bureau manual "Standing Operating Procedures for Navajo Dam and Navajo Reservoir". The Corps and the USBR also work closely with the NWS who issue flood warnings to the public as the San Juan River approaches flood stage
.

TABLE 5-1

NAVAJO RESERVOIR

TELEPHONE DIRECTORY FOR RESERVOIR REGULATIONS

NAME	TITLE	OFFICE NUMBER	CELL NUMBER
CORPS OF ENGINEERS			
OFFICE, CHIEF OF ENGINEERS, WASHINGTON DC			
[redacted]	Special Assistant, Dam Safety	[redacted]	[redacted]
[redacted]	Chief, Civil Branch	[redacted]	[redacted]
SOUTH PACIFIC DIVISION, SAN FRANCISCO, CA			
[redacted]	Chief, Reservoir Control Ctr	[redacted]	[redacted]
ALBUQUERQUE DISTRICT, ALBUQUERQUE, NEW MEXICO			
[redacted]	District Engineer	[redacted]	[redacted]
[redacted]	Dist Flood Emerg Cood		
[redacted]	Emergency Ops Manager		
[redacted]	Ch, Engineering Div		
[redacted]	Chief, Operations Div		
[redacted]	Chief, Operations Br		
[redacted]	Chief, Planning Br		
[redacted]	Chief, Reservoir Cntl		
[redacted]	Reservoir Cntl	[redacted]	[redacted]
U.S. BUREAU OF RECLAMATION			
REGIONAL OFFICE, SALT LAKE, UTAH			
[redacted]	Regional Director	(801) 524-3600	[redacted]
[redacted]	Resource Management Div	[redacted]	
[redacted]	Regional Public Affairs		
WESTERN COLORADO AREA OFFICE, DURANGO, COLORADO			
[redacted]	Area Manager	[redacted]	[redacted]
[redacted]	Chief Resources Mgt. Div		
[redacted]	Chief, Water Mgt. Group		
[redacted]	Chief, Facility Mgt. Group		
[redacted]	Chief, Facility Maintenance Group		
NAVAJO DAM			
[redacted]	Dam Tender	[redacted]	[redacted]
[redacted]	Maintenance Worker	[redacted]	
CITY OF FARMINGTION (HYDROPOWER OPERATIONS)			
[redacted]	Generation Specialist	[redacted]	[redacted]
[redacted]	Power Plant Engineer		
STATE ENGINEER'S OFFICE, NEW MEXICO			
[redacted]	State Engineer	[redacted]	n/a
[redacted]	Interstate Stream Engineer	[redacted]	n/a

VI - HYDROLOGIC FORECASTS

6-01. General. Hydrologic forecasts are made in conjunction with the operation of Navajo Dam for essentially two purposes: management of water during the snowmelt season and for water supply operations planning. NWS/NRCS coordinated forecasts for spring snowmelt volume runoff are made on the first of the month for January through July. Mid-month forecasts are provided by the NWS-RFC in Salt Lake City for operational adjustments. Rain-flood forecasts are infrequent since general area storms of large magnitude are rare, but they are available from the National Weather Service (NWS).

a. Role of the Corps. The Corps' Albuquerque District is responsible for monitoring the operation of Navajo Dam and Reservoir to ensure it complies with the approved Water Control Plan. The reservoir is drawn down, if needed, to accommodate the forecasted snowmelt runoff inflow and then allowed to refill. The Corps monitors the reservoir storage, outflow, calculated inflow, precipitation, and forecasted hydrometeorological conditions. Snowmelt volume forecasts are provided by the NWS and the Natural Resource Conservation Service (NRCS). Quantitative forecasts from precipitation and runoff data are provided by the NWS.

b. Role of Other Agencies. Forecasts are prepared by the NWS Colorado Basin River Forecast Center (CBRFC) in Salt Lake City, Utah. The NWS is the lead agency for the forecasting service. Forecasts represent a coordinated effort between the NWS, NRCS, USBR, USGS, and local water district managers. The USGS and USBR provide flow and storage data, which are incorporated into the forecasts. The USBR develops water supply drawdown estimates for each year. The NRCS provides snow depth, extent of areal coverage, and snow-water content data from its extensive snow measurement network. Hydrologists in the NRCS and the NWS coordinate preparation of the forecasts.

6-02. Flood Condition Forecasts. The forecasts are developed by the CBRFC for both long-term, snowmelt-based floods, and short-term runoff from rainfall.

a. Requirements

(1) Snowmelt Floods. Snowmelt floods are characterized by large flow volumes, several months in duration, and low to moderate peak inflows. The magnitude of snowmelt floods may be forecast well in advance of the actual events due to the relatively long time required for the snow to melt and produce runoff, the relative ease and reliability in measuring basic data, and the reliability of the methodology used. The time required for the USBR to compute an inflow hydrograph is approximately 1 to 2 hours. The inflow is a monthly time increment based on forecasted snowmelt. The inflow volume can be redistributed into smaller time increments using historical runoff patterns.

Snowmelt forecasts are estimates of the total runoff volume from the date of the forecast through the end of July. Forecasted inflows by the CBRFC are issued regularly (at least once a month between January and May) for Navajo Reservoir. Preliminary forecasts are

available to the USBR and the USACE by telephone the first of each month. The official forecast is not distributed until approximately the 7th of the month because of the time required to check the forecast. The current official forecast of snowmelt runoff for inflow to Navajo Reservoir is made available on the NWS' DATACOL computer system and through the Internet. Supplementary forecasts are available by telephone request whenever conditions change significantly due to the passage of large storms.

(2) Rain Floods. Rain floods arise from rainstorms and thunderstorms, which are two distinct types of events. General rainstorms produce widespread flooding of one to several days duration. These volumes are relatively low when compared with snowmelt flood volumes, but peak flows are often much higher. Local floods from thunderstorms are characterized by extremely high peaks, short durations, and small volumes, and generally dissipate within a relatively short distance from their origin. Of the two main rain flood events, general rain floods are both more predictable and more likely to cause widespread damage. Thunderstorms, on the other hand, occur erratically whenever atmospheric conditions are "ripe." This makes local thunderstorm floods very difficult to predict.

The limited capacity of the downstream channel makes the pre-release of forecasted inflow from rain floods occurring above the dam impractical. The rapid response of the downstream tributaries and the relatively long travel time of releases from Navajo Dam cause the reduction of outflow due to observed or forecasted rain floods below the dam to be problematic. Consequently, most flood control benefits for rain floods result from storage in the reservoir.

b. Methods

(1) Snowmelt Flood. Snowmelt flood forecasts utilizing regression equations are based on a statistical correlation of historical runoff volumes to related hydrologic variables. The forecasted runoff is the natural inflow for the forecast period (usually April thru July). It is based on the 30-year average of observed inflow to Navajo Dam. Adjustments of natural inflow are made to Navajo Reservoir to account for upstream depletions including the San Juan-Chama diversions and Vallecito Reservoir change in storage.

The hydrologic variables include the current snow depth in water equivalent and antecedent precipitation from October to the forecast date. Snow depth is obtained from SNOTEL sites and antecedent precipitation is obtained from gages as shown on Plate 2-1.

One key assumption of the forecast is that weather during the forecast period will be the same as the 30-year average of historical weather, as described in paragraph 6-02.

(2) General Rain Floods. The Corps at this time does not have the capability to forecast rainfall events in the San Juan River Basin. General rain flood forecasts are provided by the NWS. Forecasts are issued by telephone and are also made available on the DATACOL computer networks of the NWS and the Internet.

c. Uncertainty. Forecasts of any kind are not perfect. Streamflow forecast uncertainty arises from three primary sources: (1) uncertain knowledge of future weather conditions, (2) uncertainty in the forecasting procedure, and (3) errors in the data. The CBRFC snowmelt forecast, therefore, must be interpreted not as a single value, but as a range of values with specific probabilities of occurrence. The middle range is expressed by the 50 percent exceedence probability forecast, for which there is a 50 percent chance that the actual flow will be above this value and a 50 percent chance that the actual flow will be below this value. To describe the expected range around this 50 percent value, four other forecasts are provided, two smaller values (90 percent and 70 percent exceedence probability) and two larger values (30 percent, and 10 percent exceedence probability). For example, there is a 90 percent chance that the actual flow will be more than the 90 percent exceedence probability forecast. The others can be interpreted similarly. The wider the spread between these values the more uncertain the forecast. As the season progresses forecasts become more accurate, primarily because a greater portion of future weather conditions becomes known; this is reflected by a narrowing of the range around the 50 percent exceedence probability forecast. The Water Control Diagram for Navajo Reservoir is based upon the 50 percent exceedence probability forecast.

6-03. Conservation Purpose Forecasts.

a. Requirements. The CBRFC in Salt Lake City makes snowmelt runoff forecasts for Navajo Reservoir, as described in paragraph 6-02. The USBR utilizes these snowmelt runoff forecasts to project water operations for the entire year to meet downstream requirements for irrigation and the goals of the San Juan Recovery Implementation Program.

b. Methods. The methods used by the CBRFC to determine snowmelt runoff f forecasts are described in paragraph 6-02. User demands are developed by the USBR based on downstream demands.

6-04. Long-Range Forecasts

a. Requirements. During the snowmelt season, the release schedule for Navajo Reservoir is based on snowmelt runoff forecasts, as described in paragraph 6-02.

b. Methods. The methods used by the CBRFC to determine snowmelt runoff forecasts are described in paragraph 6-02b.

6-05. Drought Forecast

a. Requirements. . The CBRFC in Salt Lake City makes snowmelt runoff forecasts for Navajo Reservoir, as described in paragraph 6-02. The USBR utilizes these snowmelt runoff forecasts to project water operations for the entire year to meet downstream requirements for irrigation, municipal, and the goals of the San Juan Recovery

Implementation Program for the endangered Colorado pikeminnow and the razorback sucker (see Exhibit G). There are no specific drought forecasts for Navajo Reservoir. However, as a result of the snowmelt runoff forecasts, shortages to meet normal project deliveries will be indicated well in advance of drought conditions developing.

b. Methods. The U.S. Department of Agriculture determines the moisture of the soil based using a testing method called the Palmer Drought Index (PDI). This test is done in conjunction with the NRCS and their projected runoff forecast, and the NWS and their long- range forecasts.

c. Reference Documents. No reference documents have been produced on drought forecasts.

VII - WATER CONTROL PLAN

7-01. General Objectives. Navajo Dam and Reservoir is regulated for irrigation, municipal and industrial water supply, flood control, hydroelectric power, recreation, and fish and wildlife purposes.

7-02. Constraints. [redacted]

7-03. Overall Plan for Water Control. The USBR will operate Navajo Dam and Reservoir as a storage unit of the CRSP in accordance with the terms of the Upper Colorado River Basin Compact, The Colorado River Compact, the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 105), the act of June 13, 1962 (76 Stat. 96) authorizing the San Juan-Chama and Navajo Indian Irrigation Projects (NIIP), and such other laws as are applicable.

Each year an attempt will be made to fill Navajo Reservoir by the end of the snowmelt season, usually mid-July. Water supply forecasts are provided by the NWS CBRFC. By use of the bimonthly forecasts, a release schedule is developed which fills the reservoir, meets downstream demands, and leaves the surcharge pool above the spillway crest available for handling unpredictable rain floods. The bimonthly forecasts can be updated more frequently as required and the release schedule will be modified accordingly.

Flood control operation of Navajo Dam is independent of any other flood control project, and flood control benefits are achieved by evacuating water on a forecast basis prior to snowmelt-runoff. The operating diagram has the prime objective of ending the snowmelt season with the reservoir full to spillway crest on the 15th of July. A maximum of 1,039,500 acre-feet of space is used for flood control, and whenever any part of this space is not required for flood control it may be used temporarily for other purposes. Whenever the reservoir content in Navajo Reservoir is greater than that allowed by the operating diagram (1 January through 15 July), it will be released as rapidly as can be safely

accomplished without causing flows in San Juan River below Navajo Dam to exceed the controlling flow rates given on the Flood Control Diagram, Exhibit E. There is no exclusive flood control space in Navajo Reservoir during the period 16 July through 31 December.

The USBR operates Navajo Reservoir to meet the flow requirements of the San Juan Recovery Implementation Program (see Exhibit G) for the endangered Colorado pikeminnow and the razorback sucker.

7-04. Standing Instructions to Damtender. Procedures used in regulation of flow at Navajo Dam during normal flow conditions will be in accordance with USBR's "Standing Operating Procedures for Navajo Dam and Reservoir". Flood control operations will be in accordance with paragraph 7-05 and Exhibits E and F of this manual.

7-05. Flood Control. The Corps and USBR roles in flood control operations are stated in paragraphs 9-01-a and 9-01-b, respectively. Navajo Dam will be operated for downstream flood control on the San Juan River. Navajo Dam will be operated to control the flow of the San Juan River to a maximum of 5,000 cfs at Archuleta, 12,000 cfs at Farmington, and 12,000 cfs at Shiprock, New Mexico to the extent possible. The Archuleta gage is immediately downstream of the dam and is above Blanco, New Mexico. Travel time to the Archuleta gage is about 6 hours, to the Farmington gage about 12 hours, and to Shiprock about 24 hours.

a. Derivation of Flood Control Diagram. For the five years of maximum snowmelt runoff of record at Navajo Dam, it was assumed that the coordinated forecasted snowmelt inflow (50% probability) would have been the same as the actual inflow, i.e., a perfect forecast. The inflow forecast used in the Reservoir Control Diagram (Exhibit E) was adjusted for upstream depletions, including the estimated San Juan-Chama diversion and the Vallecito Reservoir change in storage through the end of the snowmelt runoff season (until July 31st). Successive routings were made at about 10-day intervals during the period of January 1st through July 31st, to determine the minimum space required to control the runoff for each flood event to elevation 6,085 feet (spillway elevation), and to the safe downstream channel capacities along the San Juan River (5,000 cfs from below Navajo Dam to Farmington, 12,000 cfs below the Animas River confluence, and 12,000 cfs through Shiprock), giving due consideration to intervening flow which varied depending on the event being routed. In each of these computations, the runoff remaining between the date in question and July 31st, and the total available space were considered. A separate graph was prepared from the routing studies for each date, using the remaining inflow volume through the 31st of July as the abscissa and the reservoir content as the ordinate. Each flood event provided one point per graph. After all points were plotted, an enveloping curve was drawn on each graph. This curve was drawn on the side most advantageous to flood control, that is, the points were enveloped on the lower side of allowable reservoir content. Data from the enveloping curves were then adjusted and used to complete the family of curves shown on the Flood Control Diagram, Exhibit E.

b. Normal Flood Control Regulations. Flood control benefits are achieved by using

reservoir storage space in combination with controlled releases to reduce the magnitude of reservoir peak inflows. The required reservoir storage space is generated by evacuating water on a forecast basis prior to and during snowmelt-runoff. Snowmelt flood control operations at Navajo Dam are prescribed by the Flood Control Diagram, Exhibit E. The diagram was derived with the objective of drawing the reservoir down, if needed, to capture the forecasted snowmelt runoff and end the snowmelt season with the reservoir full on the 15th of July, without exceeding downstream non-damaging discharge targets. Reservoir operations shall be planned so that the available reservoir storage space is equal to or greater than the space required in the Flood Control Diagram.

(1) January 1st to July 15th Releases. For the period of January 1st to July 15th, releases from Navajo Reservoir are determined from the Flood Control Diagram (Exhibit E) for various conditions of reservoir content and adjusted forecast inflow from the forecast date through July 30th. If, on any given date, the reservoir content exceeds the allowable content, water is released as rapidly as can be safely accomplished without exceeding downstream non-damaging discharge targets. Releases are scheduled to avoid exceeding the channel capacities of 5,000 cfs from below Navajo Dam to Farmington, 12,000 cfs below the Animas River confluence, and 12,000 cfs through Shiprock. Recompilation of the required average outflow is made daily to account for the runoff of the previous day until a new forecast is made on the first day of the next month, at mid-month, or more frequently.

(2) July 16th to December 31st Releases. There is no exclusive flood control space requirement for Navajo Reservoir during the period of July 16th through December 31st. However, to the extent feasible, available reservoir storage space including surcharge storage will be used to control flood inflow so that reservoir outflow can be limited to downstream non-damaging discharge targets.

c. Emergency Flood Regulations. In the event communications are disrupted during a flood and information concerning stream-flow conditions is not available, the operator shall continue to operate in accordance with the latest instructions until communications are restored unless an emergency condition occurs which requires immediate action to protect the safety of the dam or to avoid other serious hazards such as those listed in Paragraph 7-14a. Navajo Dam personnel will make every effort to reestablish communications. This effort will continue through the period of disrupted communications.

d. Rating Tables and Curves. Elevation versus area and capacity values for one-foot increments are shown in Table 7-1. Elevation versus area and capacity to one-hundredths of a foot is published under separate cover and maintained at Navajo Dam, and the USBR Durango Projects and Corps Albuquerque District offices. Outlet works rating curves are shown on Plates 7-2 through 7-2b. The spillway rating curve is shown on Plate 7-3. The tailwater curve is shown on Plate 7-4. Flood peak travel times are shown on Plate 7-5. Gage rating curves for the San Juan River near Archuleta, at Farmington, and at Shiprock are shown on Plates 7-6 through 7-8, respectively.

7-06. Recreation. A fishery flow of 250 cfs is maintained below the dam for recreational

purposes. There are no specific recreational requirements for storage levels in the reservoir.

7-07. Water Quality. Although water quality control is not an authorized project purpose, compliance with Public Law 92-500 requires that all federal facilities be managed, operated, and maintained to protect and enhance the quality of water and land resources through conformance with applicable federal, state, interstate, and local substantive standards.

7-08. Fish and Wildlife. In 2006 the USBR completed the Navajo Reservoir Operations FEIS. This document adopted water operations for the recovery of the Colorado pike minnow and the razorback sucker in the San Juan River below its confluence with the Animas River at Farmington, NM. A target base flow minimum of 500 cfs, measured on a 7-day moving mean, is maintained for endangered fish habitat in the San Juan River below Farmington. The USBR cooperates with the New Mexico Department of Game and Fish (NMDGF) and the Bureau of Land Management (BLM) to implement measures to the extent possible to reduce adverse impacts to the trout fishery and support wildlife within limits imposed by the availability of water for downstream release after the effects of upstream diversions. The USBR shall also try to implement the "Flow Recommendations for the San Juan River," as described in the May 1999 report by The San Juan River Basin Recovery Implementation Program (SJBRIP), insofar as possible. These flow recommendations are provided in Exhibit G and lay out objectives for high flow duration and reoccurrence intervals.

7-09. Water Supply. The USBR schedules releases from Navajo Reservoir to ensure that they meet the downstream water right entitlements, as determined by the NM State Engineer. The NIIP is the major consumptive user of irrigation water from the reservoir. Releases are in accordance with the terms of the Upper Colorado River Basin Compact, The Colorado River Compact, the Colorado River Storage Project Act of April 11, 1956 (70 Stat. 105), the act of June 13, 1962 (76 Stat. 96) authorizing the San Juan-Chama and Navajo Indian Irrigation Projects (NIIP), and such other laws as are applicable.

7-10. Hydroelectric Power. Reservoir release determinations are not made to achieve any specific operational objectives for hydroelectric power. The hydroelectric power plant, which is owned and operated by the city of Farmington, utilizes the releases determined by the USBR, to generate base load energy. There are no widely varying hourly fluctuations of flow over the course of a day or week solely for hydropower purposes. The power plant is operated as a run-of-river facility. The power plant is operated to maximize energy production with the available releases, and not with the intent of producing dependable peaking capacity. Plate 7-9 shows the Turbine Performance Curves for the hydropower plant.

7-11. Navigation. Flow in the San Juan River is insufficient to support navigation, except for recreational purposes. There are no reservoir releases made for the purpose of supporting navigation or recreation.

7-12. Drought Contingency Plans. The USBR does not have a specific drought plan for Navajo Reservoir. However, in 2009, federal, state, and local interests executed a shortage sharing agreement to address developing drought conditions. This agreement is Exhibit H, and is for the 2009 to 2012 time period. In essence, this is a short-term drought contingency plan.

7-13. Flood Emergency Action Plans. The USBR has developed a set of Standing Operating Procedures for Navajo Dam. Contained in this information is the Emergency Preparedness Brief with downstream inundation maps depicting flood inundation for a dam failure scenario. The USBR also has an Emergency Preparedness Plan outlining steps to be taken by those responsible for dam safety.

7-14. Deviation from Normal Regulations. Deviations from approved Water Control Plans occur because every possible circumstance cannot be accounted for in a Water Control Plan. Because of the often competing goals and complex interactions of interested groups/agencies, even seemingly inconsequential deviations from an approved plan can lead to unforeseen environmental and legal complications. Deviations from approved Water Control Plans are intended, therefore, to address unforeseen and unique circumstances. They are not intended as a means for identifying or initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs. Exhibit I of this manual is a guide for the preparation of deviation, and provides general information for preparing all deviations. Requests for operational deviations from the water control plan may be made to the District Engineer. Authority to approve deviation requests resides with the Corps' South Pacific Division (SPD) office.

a. Emergencies. The supervisor at Navajo Dam has the authority to make emergency deviations in matters of life and death. Some emergencies that can be expected are drownings, other accidents, and failure of operation facilities. Necessary action under emergency conditions is taken immediately unless such action would create equal or worse conditions. SPA is to be informed as soon as practicable. A written confirmation describing the deviation and conditions will be furnished to SPA who will then coordinate with SPD.

b. Unplanned Minor Deviations. There are unplanned instances that create a temporary need for minor deviations from the normal regulation of Navajo Dam and Reservoir, although they are not considered emergencies. Construction accounts for the major portion of these incidents and includes utility, stream crossing, bridge work, and major construction contracts. Changes in release rates are sometimes necessary for maintenance and inspection. Request for changes of release rates are generally for a few hours to a few days. Each request is analyzed on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions on the reservoir, and possible alternative measures. In the interest of maintaining good public relations, the requests are complied with providing there are no adverse effects on the overall operation of Navajo Dam and Reservoir. Approval for these minor deviations will normally be obtained from SPD by telephone or email.

c. Planned Deviations. Planned deviations provide the mechanism to modify the water control plan to obtain greater flood control benefits. Each situation should be analyzed on its merits. Sufficient data on flood potential, reservoir and watershed conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be presented by letter or email, to SPD along with recommendations for review and approval.

7-15. Rate of Release Change. Change in release rates during flood operations will normally be limited to the greater of 200 cfs or 10 percent of the flow in any 2-hour period. Unusual conditions that can occur may require the limiting flow rate change to be exceeded.

VIII - EFFECTS OF WATER CONTROL PLAN

8-01. General. The effect of Navajo Dam on the San Juan River downstream is to reduce flow magnitude. Normal low flows and most flood flows are stored and utilized for irrigation and water supply. Low flow quality is improved and the amount of suspended solids reduced. Both recreation and fish and wildlife are enhanced due to the minimum and joint-use pools. Water quality, hydroelectric power, and sediment control benefits are incidental to project operation.

8-02. Flood Control.

a. Spillway Design Flood. The design flood used for the spillway sizing was based on a 1956 USBR study. It is a composite snowmelt-rain flood, consisting of the largest 30-day snowmelt of record (778,400 acre-feet) and the Spring Probable Maximum Flood (PMF) (259,300 acre-feet), with a peak inflow of 107,000 cfs. The flood was routed through Navajo Reservoir with a starting elevation of 6,085 feet (spillway crest), resulting in a maximum water surface elevation of 6,106.6 feet and a maximum outflow of 37,400 cfs (33,875 over the spillway and 3,525 cfs through the outlets). The routing is shown on Plate 8-1.

b. Probable Maximum Flood (PMF). The PMF was revised in 1984 by the USBR, based on the NWS's Hydrometeorological Report No. 49 (HMR 49) criteria. Two floods were developed, a spring rain on 100-year snowmelt (15-day, June event) with a 72-hour average rainfall depth of 8.41 inches, and a summer general storm (96-hour, August event) with a 72-hour average rainfall depth of 9.46 inches. The spring rain on snowmelt produced the highest reservoir elevation (6,103.70 feet) and the most severe downstream flooding. The selected PMF has a 15-day volume of 922,000 acre-feet, a peak inflow of 195,000 cfs, and a maximum release of 47,600 cfs. The reservoir elevation at the beginning of the PMF would be 6,072.0 feet (on May 25th), which represents a drawdown of 13-feet below the spillway crest and complies with the Flood Control Diagram, Exhibit E. The PMF routing is shown on Plate 8-2.

c.. October 1911 Flood. The highest peak flood of record occurred in October 1911. This flood was routed through Navajo Reservoir at a starting elevation of 6,085 feet (spillway crest); the peak inflow of 67,000 cfs was controlled to an outflow of 16,000 cfs and maximum water surface elevation of 6093.7 feet. The 1911 flood routing is shown on Plate 8-3.

8-03. Recreation. Navajo Dam and Reservoir provides a huge recreational opportunity for the four corners (UT, NM, CO, and AZ) area. The minimum and joint-use pools provide fishing, boating, and water sports recreation upstream. The river downstream provides a world-class trout fishery. There are 3 recreation areas on the reservoir and 1 below the dam. Visitor days at the project average about 475,000 per annum.

8-04. Water Quality. The quality of water into and released from Navajo Reservoir is very good and is improved immediately downstream because of reduction of suspended

sediment. The stored water in the reservoir is of good quality and acceptable for municipal and industrial use. Paragraph 4-08, herein, gives additional information on water quality.

8-05. Fish and Wildlife. Fish and wildlife in the Reservoir are dependent on the minimum and joint-use pools. The downstream habitat is dependent on irrigation and water supply releases. The USBR cooperates with the New Mexico Department of Game and Fish to maintain adequate flows to support fish and wildlife within limits imposed by the availability of water for downstream release after the effects of upstream diversions.

8-06. Water Supply. A portion of the joint-use pool is for irrigation, municipal and industrial water supply for downstream users. Downstream releases are scheduled to ensure that they are meeting downstream water rights as determined by the NM State Engineer and to meet demands for contract water, including demands for the Hammond Project. Reservoir diversions to the NIIP provide a dependable water supply to the Navajo Nation.

8-07. Hydroelectric Power. The hydroelectric plant has no effect on the normal operation of Navajo Dam and Reservoir, and will not interfere with the obligation that New Mexico has under the Upper Colorado River Basin Compact. In emergency conditions, the power plant may be needed as a capacity reserve, and the USBR would be requested by the city of Farmington to provide flows at a ramping rate to allow reaching the maximum hydraulic capacity in no more than 12 hours, depending on the discharge at the start of the emergency. Flows would be constant at this level for the duration of the emergency (one week or less) and then gradually reduced to the prior flow level. A typical flow range for this type of operation would be an increase from 500 cfs to 1,200 cfs.

8-08. Navigation. There are no navigation features associated with Navajo Dam, and there are no reservoir releases for the purpose of supporting downstream navigation.

8-09 Drought Contingency Plans. The USBR utilizes the snowmelt runoff forecasts to project water supply availability for the year. Although there are no specific drought contingency plans for the operation of Navajo Reservoir, these projections are used to identify and plan for shortages. As described in paragraph 7-12, a shortage sharing agreement has been used to facilitate the ability of junior water right users to obtain dependable water supplies in drought situations.

8-10 Flood Emergency Action Plans. The USBR has prepared the Standard Operating Procedures for Navajo Dam which covers actions to be taken in various emergency situations. This plan was prepared to minimize adverse impacts during flood emergencies.

8-11. Frequencies.

a. Peak Flow Probability. Peak frequency curves for four upstream gages, (1) San Juan River at Carracas, (2) Piedra River near Arboles, (3) Los Pinos River at La Boca, and (4) Spring Creek at La Boca, are shown on Plates 8-4 through 8-7, respectively. The peak frequency curve for the San Juan River near Archuleta for the period since the construction

of Navajo Dam is shown on Plate 8-8. See Table 4-8 (page 4-14) for drainage area sizes and periods of record.

b. Pool Elevation Duration and Frequency. The Navajo Reservoir peak and daily inflow-frequency curves are shown on Plate 8-9. Annual and seasonal volume-frequency curves are shown on Plate 8-10. The pool-elevation frequency curve is shown on Plate 8-11. Historic pool elevations are shown on Plate 8-12.

c. Key Control Points. The key control points for the flood control operation of Navajo Dam are San Juan River near Archuleta (limit flow to 5,000 cfs), at Farmington (limit flow to 12,000 cfs), and at Shiprock (limit flow to 12,000 cfs). Stage – Discharge ratings curves for these locations are shown on Plates 7-6, 7-7, and 7-8 respectively.

8-12. Other Studies. A seven-year study by the U.S. Fish and Wildlife Service and USBR was initiated in 1991 to determine the habitat needs of the endangered Colorado pike minnow and the razorback sucker in the San Juan River Basin. The study was completed and results were published in the "Flow Recommendations for the San Juan River," dated May 1999, prepared by The San Juan River Basin Recovery Implementation Program (SJBRIP). Highlights of this report maintain that releases from the reservoir will target a minimum base flow of 500 cfs in the San Juan River below Farmington. Large releases will be made in May and June of each year to mimic a natural snowmelt-runoff hydrograph in order to provide better spawning conditions for endangered fish.

IX - WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization.

a. Corps. The Corps under Section 7 of the 1944 Flood Control Act has the responsibility of prescribing regulations for storage allocated for flood control at all reservoirs constructed wholly or in part with Federal funds. Procedures for developing regulation plans are contained in the Code of Federal Regulations, Title 33, Part 208.11. The 208.11 regulations are shown in Exhibit D.

The Corps is responsible for the following, which applies to both normal and emergency conditions:

(1) Monitoring storage, inflow, and outflow for Navajo Reservoir on a day-to-day basis to ensure that the operation is in accordance to the Water Control Plan. The Corps also coordinates with the USBR and the NWS so that agreement on the forecasted inflow volumes is reached. The 50 percent frequency forecast is the basis used in the Water Control Diagram. For further information, refer to Exhibit E.

(2) Advising operating agencies and the Corps' Division Engineer of any departure from the Water Control Plan.

(3) Reviewing and reporting to the Corps' Division Engineer any emergency or planned deviations from the prescribed Water Control Plan. Refer to Exhibit I for more detailed information on deviations.

(4) Preparing short period, daily, and monthly operation and other special reports relative to the operation of the project required by the Office, Chief of Engineers.

(5) Preparing revisions to the Water Control Manual and the Water Control Plan found herein.

The organization chart for the Corps and USBR in relation to Navajo Dam is shown on Plate 9-1. The telephone directory of officials is shown in Table 5-1. Instructions to the damtender are contained in Exhibit F.

b. USBR. Navajo Dam is owned by the USBR. The Durango Projects Office of the Upper Colorado Area has direct regulatory control and responsibility for Navajo Dam operations and is responsible for:

(1) Accomplishing the physical operation of the reservoir and associated facilities in accordance with the official regulations.

(2) Coordinating with the Corps: if available storage space becomes less than the required flood control space on the Flood Control Diagram; when it is apparent that the

reservoir elevation will exceed the spillway crest elevation of 6,085 feet; or if the flow in the San Juan River below Navajo Dam will exceed the channel capacities of 5,000 cfs from below Navajo Dam to Farmington, 12,000 cfs below the Animas River confluence, and 12,000 cfs through Shiprock.

(3) Advising the Corps of any need for emergency change in operation.

(4) Annually inspecting channel conditions to determine if any deterioration in flow capacity has occurred that could inhibit release of water corresponding to flows of 5,000 cfs from below Navajo Dam to Farmington, 12,000 cfs below the Animas River confluence, and 12,000 cfs at Shiprock, New Mexico.

(5) Reporting to the Corps any unusual condition in the reservoir or along downstream channels that might temporarily interfere with the planned flood control operation of the reservoir.

(6) Keeping downstream interests advised of impending changes in flood control releases which may affect them.

(7) Reporting to the Corps' Reservoir Control Branch, Albuquerque District, the hydrologic and meteorologic data outlined in paragraph 5-01 and other pertinent data relative to flood control operations that may be requested from time to time.

(8) Keeping informed of the rules and regulations contained in these instructions and bringing to the attention of the Corps any feature contained herein that may require clarification or revision.

(9) By the tenth of each month, transmitting to the Corps, the monthly reservoir operation data specified in paragraph 5-04.

c. State of New Mexico. The State Engineer's Office is responsible for the administration of water rights in the San Juan River Basin.

9-02. Interagency Coordination

a. Local Press and Corps Bulletins. The Albuquerque District Public Affairs Office coordinates with the USBR and local press for release of information of public interest.

b. National Weather Service.

(1) The Albuquerque NWS provides forecasts on weather, precipitation, and stream flows to the public. The NWS also issues flood watch and flood warning notifications. The Corps receives forecasts of weather, precipitation and stream flows through the NWS Automation of Field Operations and Services (AFOS) system by computer. If additional information is required, the Albuquerque NWS office will be contacted by telephone.

(2) The NWS CBRFC in Salt Lake City, Utah, has the responsibility for forecasting inflow to Navajo Reservoir under an interagency agreement between the USBR, the Natural Resource Conservation Service (NRCS), the Corps, and NWS. Forecasts are made the first of each month and mid-month updates are furnished. These forecasts predict monthly and seasonal inflow volumes. Daily and weekly flow rates are also provided during the peak snowmelt runoff season.

c. U.S. Geological Survey (USGS). The USGS operates stream and precipitation gages on a cooperative basis with State and Federal agencies. They make measurements, provide maintenance service, and publish records from stream gage stations regularly. They also provide preliminary flow data upon request. The Durango Projects Office supplies the USGS with lake stages and reservoir contents for publication.

d. Natural Resource Conservation Service (NRCS). The NRCS, U.S. Department of Agriculture, operates snow courses in cooperation with State and Federal agencies. Snow courses are normally sampled twice during the winter. Supplemental measurements are made on 15 May and 15 June when warranted by the snowpack.

9-03. Interagency Agreements. The Letter of Understanding between the Corps and USBR, detailing the duties and responsibilities of all parties during a flood control operation, is shown in Exhibit B.

9-04. Upper Colorado River Basin Compact Commission. The Upper Colorado River Basin River Compact was finalized in 1948 by Commissioners for the States of Colorado, New Mexico, Arizona and Utah and approved by the Congress of the United States of America shortly thereafter. Article III of the Compact provides for the division of waters among the four states. A copy of the Compact is contained in Exhibit C. The USBR has the primary role of coordinating with Compact officials on Navajo Reservoir water operations.

9-05. Non-Federal Hydropower. The city of Farmington, NM owns and operates the hydro-power plant at Navajo Dam. This 30 megawatt capacity plant is a run-of-river facility. The Corps' water management decisions for flood control operations are independent of whether or not the plant is generating power. USBR personnel coordinate continuously with hydropower staff to facilitate generation of power.

9-06. Reports. Four recurring reports are prepared by the RCB. These reports are as follows:

a. A daily report of reservoir operations is transmitted to SPD by 1000 hours each working day.

b. A monthly regulation report is prepared for submission to the SPD by the tenth of each month. This report summarizes the monthly regulation of the reservoir.

c. An Annual Report of Reservoir Regulation Activities is prepared for the Division Annual Report.

d. A summary of Project Operations is prepared as part of the Annual Report of Chief of Engineers.

Additional reporting is required during a flood event. Refer to EM 500-1-1 for details. Flood reports normally will be made initially by telephone to assure that information on flood situations is provided as rapidly as possible.

Table 4-9
San Juan River near Carracas, Colorado; USGS Gage No. 09346400;
Drainage Area = 1,230 mi^2; (all volumes in acre-feet)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Annual
1962	-	14,260	7,310	6,880	16,220	123,170	123,120	131,150	108,870	29,210	8,040	7,380	575,610
1963	14,270	10,740	8,030	6,310	16,060	33,870	54,270	94,160	29,320	8,950	10,040	11,920	297,940
1964	7,680	6,690	4,660	4,560	3,860	10,720	31,560	104,000	50,500	15,860	37,870	11,760	289,720
1965	8,400	6,450	8,600	11,880	8,460	19,700	114,520	178,410	214,670	120,420	33,100	32,810	757,420
1966	26,670	17,160	14,600	10,690	8,240	70,680	90,050	147,790	78,820	20,960	12,620	5,730	504,010
1967	5,620	6,310	15,100	6,410	12,250	22,830	28,410	80,230	83,820	39,360	43,910	24,270	368,520
1968	9,130	6,230	5,190	5,460	6,170	14,630	32,360	106,260	144,830	39,780	63,700	10,110	443,850
1969	8,590	7,430	6,140	6,040	6,570	18,420	98,560	146,480	115,540	61,660	28,810	25,660	529,900
1970	27,070	15,760	11,350	7,930	8,030	10,020	25,090	114,800	84,420	29,890	17,560	81,910	433,830
1971	18,530	13,240	8,980	8,070	8,150	22,390	38,600	50,080	52,550	14,760	12,330	10,510	258,190
1972	20,240	13,430	10,350	6,920	13,260	24,590	29,940	53,690	35,180	8,120	4,240	6,630	226,590
1973	51,400	21,890	9,390	11,290	10,360	42,330	99,070	196,440	207,590	79,280	17,980	13,640	760,660
1974	9,320	7,030	6,330	5,570	5,270	27,930	27,300	67,230	30,740	13,870	11,250	4,440	216,280
1975	10,300	10,430	5,820	5,310	5,750	30,210	83,810	145,110	179,580	87,110	19,150	12,890	595,470
1976	7,660	7,230	6,340	6,880	8,760	24,120	38,570	99,960	85,660	21,310	12,650	14,770	333,910
1977	12,280	6,970	4,970	4,860	5,240	8,230	13,850	24,260	14,920	12,890	22,580	14,010	145,060
1978	11,810	7,630	5,980	5,750	6,460	27,770	47,110	89,060	105,880	24,190	6,150	3,640	341,430
1979	6,490	9,820	7,130	8,480	8,200	47,180	150,170	182,560	207,010	103,110	24,800	7,720	762,670
1980	7,050	6,820	7,580	7,440	11,130	21,820	98,950	123,630	170,500	47,930	14,360	15,370	532,580
1981	9,730	9,960	8,950	7,060	6,630	8,830	23,280	51,410	48,240	20,830	13,590	13,870	222,380
1982	32,340	13,340	8,530	8,630	8,510	38,970	68,240	104,000	10,180	49,070	43,520	52,360	437,690
1983	27,840	19,050	15,340	12,000	12,870	38,720	60,940	108,060	158,180	57,280	28,850	12,060	551,190
1984	26,810	11,110	10,730	11,700	11,900	41,990	54,830	173,440	93,960	28,940	22,970	17,660	506,040
1985	34,340	22,530	17,830	13,550	11,480	81,100	141,480	174,680	242,810	70,370	27,830	31,310	869,310
1986	36,370	21,360	18,600	17,870	26,730	61,270	101,850	157,980	183,050	81,480	21,700	33,020	761,280
1987	57,310	58,490	24,970	18,190	18,310	41,940	99,870	126,720	127,400	37,200	18,920	10,890	640,210
1988	9,290	15,620	9,860	8,870	10,450	28,800	52,080	68,270	61,510	18,950	19,730	15,420	318,850
1989	9,980	9,260	11,710	10,810	12,480	62,630	79,330	77,870	47,910	14,130	13,960	8,170	358,240

Table 4-9 (cont.)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Annual
1990	11,740	6,170	4,480	4,590	4,720	12,210	32,910	74,360	73,800	23,760	15,950	18,220	282,910
1991	24,260	19,420	11,350	12,040	13,350	29,230	81,590	109,190	83,720	26,680	25,360	27,940	464,130
1992	9,710	15,070	15,870	12,500	13,050	38,420	72,110	117,100	93,700	32,490	33,720	19,340	473,080
1993	9,930	10,570	8,950	11,390	13,800	71,340	93,780	159,490	148,480	52,650	45,070	32,480	657,930
1994	9,930	10,570	8,950	11,390	13,800	71,340	93,780	159,490	148,480	52,650	45,070	32,480	657,930
1995	17,750	25,190	15,910	13,030	23,520	84,160	57,900	97,900	196,660	149,240	32,940	18,420	732,620
1996	11,980	8,770	7,990	7,880	11,140	12,210	25,050	71,570	19,580	11,570	7,400	10,060	205,200
1997	11,090	10,480	9,220	9,980	10,740	55,240	45,880	117,500	131,720	32,580	26,060	34,800	495,290
1998	32,410	19,750	15,450	12,600	10,110	38,430	49,320	108,790	66,530	27,290	17,500	8,700	406,880
1999	20,300	25,280	15,000	10,710	10,130	20,960	48,490	93,060	103,790	40,160	61,740	38,490	488,110
2000	12,660	7,520	7,850	8,270	8,460	13,310	40,410	56,820	17,090	5,960	5,490	4,590	188,430
2001	11,750	10,060	8,670	7,870	7,860	28,570	66,730	141,900	78,560	18,920	24750	7,620	413,260
2002	6,630	6,400	6,540	6,190	5,520	7,970	14,470	16,540	4,290	1,390	1,150	4,010	81,100
2003	8,410	6,830	5,110	4,410	4,810	16,330	23,680	65,440	39,210	5,510	5,680	15,160	200,580
2004	6,730	10,690	7,880	8,710	8,620	47,010	47,430	86,110	57,910	14,900	7,000	26,590	329,580
2005	19,730	15,790	11,910	18,440	27,240	35,170	98,810	184,820	144,520	38,900	15,390	14,070	624,790
2006	33,550	12,400	8,790	7,960	6,640	11,290	40,280	70,330	25,110	15,240	25,140	20,450	277,180
2007	54,120	20,160	17,850	17,150	16,250	56,340	43,780	97,730	74,360	18,600	23,250	14,960	454,550
2008	18,770	7,840	31,290	19,370	18,180	56,130	86,350	127,950	127,220	32,800	16,830	19,020	561,750
2009	14,990	9,500	8,180	7,400	10,770	36,590	48,070	137,300	56,560	17,830	5,750	8,060	361,000

Maximum Annual = 869,310
Minimum Annual = 81,100
Average Annual = 445,732

Table 4-10
San Juan River near Archuleta, New Mexico; USGS Gage No. 09355500;
Drainage Area = 3,260 mi^2; (all volumes in acre-feet)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Annual
1956	19,480	16,530	15,180	16,070	14,750	47,810	78,730	173,550	116,880	24,790	22,980	11,180	557,930
1957	11,980	11,350	8,790	13,290	30,160	45,620	120,100	222 ,110	479,840	326,560	164,130	66,910	1,278,730
1958	67,330	67,530	43,780	21,860	51,320	76,670	278,970	459,660	270,210	42,380	35,000	40,080	1,454,790
1959	25,370	16,910	13,540	10,970	14,500	17,990	36,960	87,050	83,780	17,510	34,420	15,490	374,490
1960	59,570	38,550	19,500	14,380	15,650	175,220	240,040	193,090	231,790	55,010	24,860	22,540	1,090,200
1961	25,840	16,180	14,290	11,690	15,660	43,160	113,060	192,450	121,610	37,640	52,180	58,470	702,230
1962	51,790	34,020	18,120	15,410	41,550	51,370	241,620	227,980	164,690	38,530	29,460	18,830	933,370
1963	18,330	14,260	9,950	7,050	8,260	14,660	30,750	18,730	18,820	20,200	21,680	20,080	202,770
1964	23,910	23,770	23,960	17,380	13,190	12,750	14,530	33,860	81,900	107,880	47,990	26,150	427,270
1965	28,280	20,590	32,200	90,220	92,230	51,860	85,110	138,280	215,070	101,900	136,180	112,170	1,104,090
1966	131,040	179,580	177,420	168,020	93,520	114,110	180,870	129,300	27,280	28,060	29,040	27,000	1,285,240
1967	91,090	47,210	25,150	25,160	44,670	69,530	23,130	17,130	17,860	19,660	62,100	58,640	501,330
1968	21,500	21,120	21,170	18,600	20,130	17,930	60,370	48,710	28,200	30,270	38,480	47,020	373,500
1969	35,050	22,800	24,420	39,670	110,240	93,770	110,190	116,910	117,800	98,640	71,770	76,420	917,680
1970	95,980	81,330	89,710	50,650	110,440	90,810	26,220	28,860	29,620	31,050	39,000	78,550	752,220
1971	111,070	102,960	117,280	140,820	120,170	67,700	29,860	30,670	29,250	30,780	30,610	29,870	841,040
1972	24,700	18,180	65,600	92,590	84,460	92,630	48,700	30,850	30,220	30,640	38,570	37,160	594,300
1973	31,840	29,680	62,450	70,670	96,810	29,260	29,780	133,440	182,430	265,660	215,700	159,090	1,306,810
1974	119,920	117,320	119,700	103,340	65,370	62,800	58,700	57,030	38,170	36,040	43,040	41,760	863,190
1975	31,860	28,020	30,260	32,260	26,820	31,240	82,100	147,850	144,180	150,560	112,730	92,290	910,170
1976	89,680	84,950	96,320	76,920	53,680	56,260	41,740	87,810	82,060	33,470	37,410	39,630	779,930
1977	29,420	27,480	72,840	74,880	36,800	31,720	30,550	34,160	35,910	34,450	35,140	31,230	474,580
1978	32,760	30,450	28,960	30,510	28,970	31,200	31,170	32,350	28,310	30,020	34,070	37,700	376,470
1979	30,160	30,140	31,160	30,690	32,170	98,660	283,710	304,990	307,570	315,210	114,240	45,160	1,623,860
1980	46,720	32,690	103,690	100,760	98,890	145,010	91,150	120,400	71,290	60,940	78,820	71,900	1,022,260
1981	72,070	84,240	84,210	101,020	62,650	39,830	26,460	30,520	33,960	49,170	53,330	53,290	690,750
1982	54,390	35,050	36,790	41,180	27,260	44,850	84,750	115,890	101,240	73,840	63,090	65,710	744,040
1983	63,820	53,620	90,920	112,500	96,570	127,460	158,680	105,910	76,950	97,870	64,070	65,590	1,113,960

Table 4-10 (cont.)

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Annual
1984	68,670	58,920	66,490	114,580	135,870	115,670	91,020	117,020	52,770	53,450	52,620	62,050	989,130
1985	83,310	96,490	111,830	111,270	119, 420	160,960	218,420	305,110	279,370	112,860	72,900	87,810	1,640,330
1986	69,080	144,830	161,410	170,220	96,060	86,780	81,920	75,450	133,820	191,050	148520	120,340	1,479,480
1987	99,590	146,830	168,750	168,510	132,270	178,870	235,440	211,630	288,530	218,810	48,170	47,430	1,944,830
1988	40,040	36,390	37,730	36,390	35,090	38,850	37,000	38,350	38,690	42,380	36,700	33,180	450,790
1989	36,320	38,470	39,930	40,000	36,540	39,350	38,060	40,940	40,040	38,110	38,640	36,970	463,370
1990	37,980	36,990	34,330	31,270	28,630	32,060	31,350	33,020	31,370	31,290	30,660	32,750	391,700
1991	34,900	32,330	31,850	32,780	30,080	34,060	56,030	118,200	38,170	37,490	37120	35,920	518,930
1992	38,460	37,760	35,450	32,590	33,420	36,580	126,560	219,810	165,680	42,680	38,260	37,740	844,990
1993	36,890	31,370	34,910	35,440	46,690	259,220	264,500	176,530	196,300	44,980	38,980	37,180	1,202,990
1994	37,610	43,660	47,040	45,380	30,270	32,070	37,300	214,540	255,890	119,690	38,790	36,380	938,620
1995	37,220	33,200	32,740	33,440	28,630	99,360	163,500	265,110	261,660	75,630	49,940	47,180	1,127,610
1996	48,470	46,190	45,100	23,300	28,390	30,620	29,090	38,150	129,320	37,660	38,390	37,000	531,680
1997	39,240	19,400	16,280	16,210	14,340	64,600	57,790	181,700	240,180	67,640	37,470	36,420	791,270
1998	38,140	36,810	46,530	52,600	47,250	39,630	55,490	244,660	150,980	36,640	36,150	33,330	818,210
1999	34,030	34,020	33,650	35,180	33,400	35,040	32,350	82,020	152,500	32,860	187,660	192,830	885,540
2000	45,520	29,940	30,200	30,630	28,760	31,160	28,970	33,780	90,240	36,650	52,270	42,310	480,430
2001	40,060	31,090	32,110	31,450	28,290	29,840	31,070	136,160	199,520	33,490	40,980	48,740	682,800
2002	47800	30,300	30,420	30,380	27,480	31,330	43,850	50,170	46,460	51,780	49,450	36,110	475,530
2003	30,400	21,090	22,070	21,210	18,750	21,670	20,310	24,240	28,100	58,200	43,140	23,410	332,590
2004	27,330	16,030	15,450	16,710	14,960	14,570	20,130	21,690	21,310	33,360	44,290	36,520	282,350
2005	21,590	15,140	14,940	15,560	15,000	24,230	32,460	215,600	180,530	32,990	32,450	38,290	638,780
2006	39,360	36,060	27,290	25,740	19,980	22,490	21,570	45,820	128,870	45,970	36,420	31,640	481,210
2007	28,450	26,440	25,290	28,480	28,690	40,750	42,090	214,290	72,330	45,320	48,190	54,890	655,210
2008	43,220	40,160	42,350	48,790	126,880	225,860	158,840	158,780	223,770	31,730	39,870	44,830	1,185,080
2009	32,130	30,050	31,490	32,010	28,220	30,890	30,420	59,400	115,390	48,860	49,140	36,760	524,760

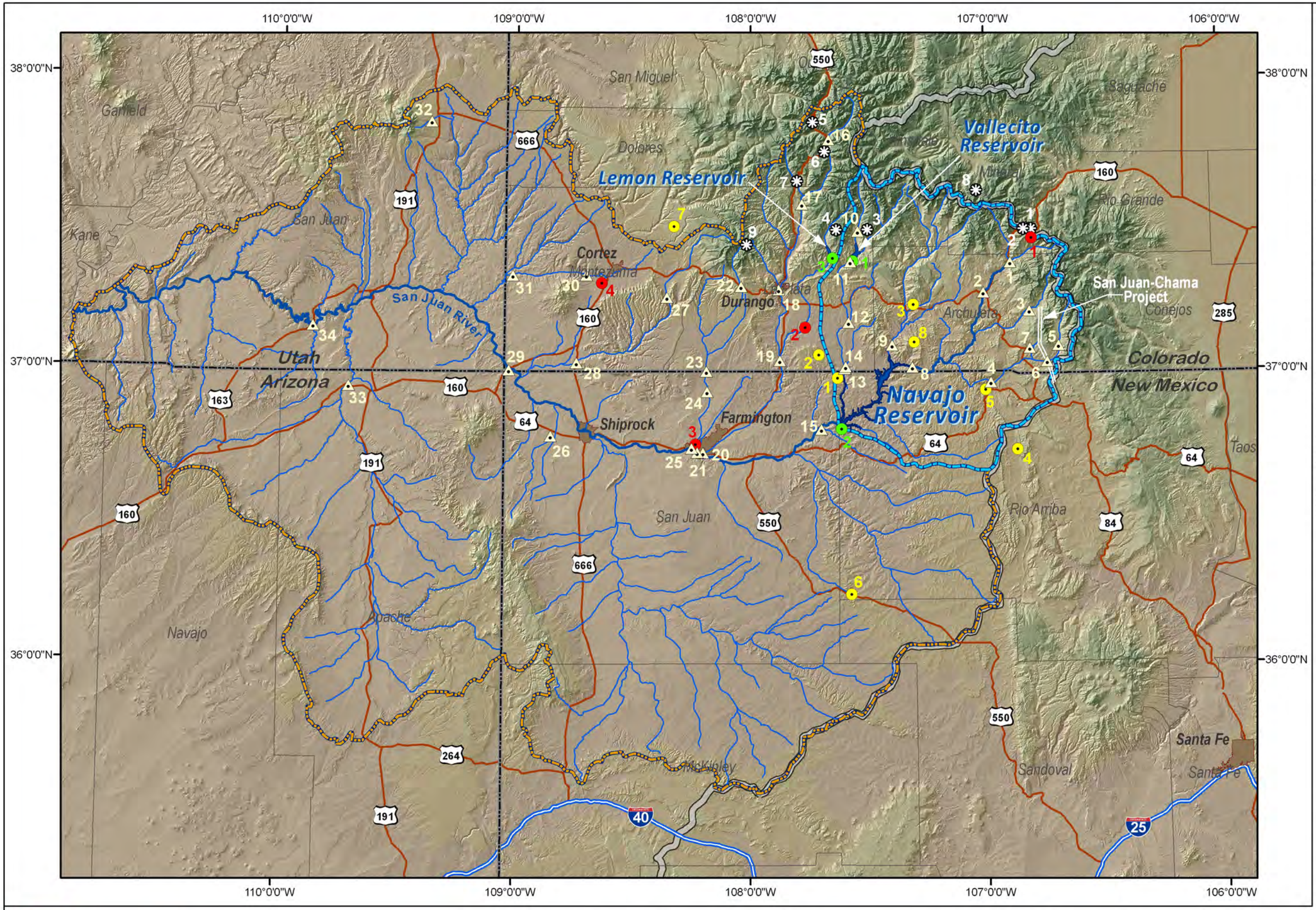
Maximum Annual = 1,944,830
Minimum Annual = 202,770
Average Annual = 815,841

Table 7-1
Navajo Reservoir
Elevation-Area-Capacity

Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)
5775.0	0	0	5817.0	38299	1253	5859.0	106960	2085	5901.0	217520	3207
5776.0	598	609	5818.0	39565	1270	5860.0	109050	2109	5902.0	220760	3237
5777.0	1212	624	5819.0	40849	1286	5861.0	111160	2133	5903.0	224040	3266
5778.0	1842	640	5820.0	42150	1303	5862.0	113300	2157	5904.0	227340	3296
5779.0	2488	655	5821.0	43468	1319	5863.0	115460	2181	5905.0	230680	3325
5780.0	3150	671	5822.0	44803	1335	5864.0	117650	2205	5906.0	234040	3355
5781.0	3827	686	5823.0	46154	1352	5865.0	119860	2229	5907.0	237440	3384
5782.0	4519	702	5824.0	47522	1368	5866.0	122100	2253	5908.0	240860	3414
5783.0	5225	718	5825.0	48906	1385	5867.0	124360	2277	5909.0	244320	3443
5784.0	5946	733	5826.0	50307	1401	5868.0	126650	2301	5910.0	247800	3473
5785.0	6681	749	5827.0	51724	1418	5869.0	128960	2324	5911.0	251320	3502
5786.0	7431	764	5828.0	53158	1434	5870.0	131300	2348	5912.0	254860	3532
5787.0	8195	780	5829.0	54608	1451	5871.0	133660	2372	5913.0	258440	3561
5788.0	8974	795	5830.0	56075	1467	5872.0	136050	2396	5914.0	262040	3591
5789.0	9767	811	5831.0	57558	1483	5873.0	138460	2420	5915.0	265680	3620
5790.0	10575	827	5832.0	59058	1500	5874.0	140900	2444	5916.0	269340	3650
5791.0	11397	842	5833.0	60574	1516	5875.0	143360	2468	5917.0	273040	3679
5792.0	12234	858	5834.0	62107	1533	5876.0	145850	2492	5918.0	276760	3709
5793.0	13085	873	5835.0	63656	1549	5877.0	148360	2516	5919.0	280520	3738
5794.0	13951	889	5836.0	65222	1566	5878.0	150900	2540	5920.0	284300	3768
5795.0	14831	904	5837.0	66804	1582	5879.0	153460	2563	5921.0	288120	3804
5796.0	15726	920	5838.0	68403	1599	5880.0	156050	2587	5922.0	291970	3840
5797.0	16635	936	5839.0	70018	1615	5881.0	158670	2617	5923.0	295860	3877
5798.0	17559	951	5840.0	71650	1631	5882.0	161330	2646	5924.0	299780	3913
5799.0	18497	967	5841.0	73302	1655	5883.0	164030	2676	5925.0	303740	3949
5800.0	19450	982	5842.0	74976	1679	5884.0	166760	2705	5926.0	307730	3985
5801.0	20419	998	5843.0	76674	1703	5885.0	169510	2735	5927.0	311760	4022
5802.0	21405	1013	5844.0	78394	1727	5886.0	172300	2764	5928.0	315820	4058
5803.0	22409	1029	5845.0	80138	1751	5887.0	175110	2794	5929.0	319920	4094
5804.0	23430	1045	5846.0	81904	1775	5888.0	177960	2823	5930.0	324050	4130
5805.0	24469	1060	5847.0	83694	1799	5889.0	180830	2853	5931.0	328220	4167
5806.0	25525	1076	5848.0	85506	1823	5890.0	183730	2882	5932.0	332420	4203
5807.0	26599	1091	5849.0	87342	1846	5891.0	186660	2912	5933.0	336660	4239
5808.0	27690	1107	5850.0	89200	1870	5892.0	189610	2942	5934.0	340930	4275
5809.0	28799	1122	5851.0	91082	1894	5893.0	192600	2971	5935.0	345240	4312
5810.0	29925	1138	5852.0	92986	1918	5894.0	195610	3001	5936.0	349580	4348
5811.0	31069	1154	5853.0	94913	1942	5895.0	198660	3030	5937.0	353960	4384
5812.0	32230	1171	5854.0	96864	1966	5896.0	201730	3060	5938.0	358370	4420
5813.0	33409	1187	5855.0	98837	1990	5897.0	204830	3089	5939.0	362820	4456
5814.0	34605	1204	5856.0	100830	2014	5898.0	207960	3119	5940.0	367300	4493
5815.0	35819	1220	5857.0	102850	2038	5899.0	211110	3148	5941.0	371830	4545
5816.0	37050	1237	5858.0	104900	2062	5900.0	214300	3178	5942.0	376410	4597

Table 7-1
Navajo Reservoir
Elevation-Area-Capacity

Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)	Elevation NGVD (feet)	Capacity (acre-feet)	Area (acres)
5943.0	381050	4649	5985.0	625680	7085	6027.0	978740	9713	6069.0	1466800	13652
5944.0	385740	4701	5986.0	632760	7147	6028.0	988600	9777	6070.0	1480600	13757
5945.0	390490	4753	5987.0	639920	7209	6029.0	998540	9840	6071.0	1494500	13881
5946.0	395290	4805	5988.0	647140	7271	6030.0	1008600	9904	6072.0	1508500	14006
5947.0	400150	4858	5989.0	654440	7333	6031.0	1018600	9992	6073.0	1522600	14130
5948.0	405060	4910	5990.0	661800	7395	6032.0	1028800	10080	6074.0	1536900	14255
5949.0	410030	4962	5991.0	669230	7457	6033.0	1039000	10168	6075.0	1551200	14379
5950.0	415050	5014	5992.0	676720	7519	6034.0	1049400	10256	6076.0	1565700	14504
5951.0	420130	5066	5993.0	684270	7581	6035.0	1059700	10344	6077.0	1580300	14628
5952.0	425260	5118	5994.0	691880	7643	6036.0	1070200	10433	6078.0	1595000	14753
5953.0	430450	5170	5995.0	699550	7705	6037.0	1080700	10521	6079.0	1609900	14877
5954.0	435690	5222	5996.0	707280	7767	6038.0	1091400	10609	6080.0	1624800	15002
5955.0	440990	5274	5997.0	715070	7829	6039.0	1102000	10697	6081.0	1639900	15126
5956.0	446340	5327	5998.0	722920	7891	6040.0	1112800	10785	6082.0	1655000	15251
5957.0	451750	5379	5999.0	730830	7953	6041.0	1123600	10873	6083.0	1670300	15375
5958.0	457210	5431	6000.0	738800	8015	6042.0	1134600	10961	6084.0	1685800	15500
5959.0	462730	5483	6001.0	746830	8077	6043.0	1145600	11050	6085.0	1701300	15624
5960.0	468300	5535	6002.0	754930	8139	6044.0	1156800	11138	6086.0	1717000	15749
5961.0	473930	5597	6003.0	763090	8201	6045.0	1168000	11226	6087.0	1732800	15873
5962.0	479610	5659	6004.0	771320	8263	6046.0	1179300	11314	6088.0	1748700	15998
5963.0	485350	5721	6005.0	779610	8325	6047.0	1190700	11402	6089.0	1764800	16122
5964.0	491140	5783	6006.0	787970	8387	6048.0	1202200	11490	6090.0	1781000	16247
5965.0	496990	5845	6007.0	796390	8449	6049.0	1213800	11579	6091.0	1797300	16371
5966.0	502890	5907	6008.0	804880	8511	6050.0	1225600	11667	6092.0	1813800	16496
5967.0	508850	5969	6009.0	813430	8573	6051.0	1237300	11771	6093.0	1830400	16620
5968.0	514860	6031	6010.0	822050	8635	6052.0	1249200	11876	6094.0	1847100	16745
5969.0	520930	6093	6011.0	830730	8698	6053.0	1261200	11980	6095.0	1864000	16869
5970.0	527050	6155	6012.0	839480	8762	6054.0	1273300	12085	6096.0	1881000	16994
5971.0	533230	6217	6013.0	848290	8825	6055.0	1285500	12189	6097.0	1898100	17118
5972.0	539460	6279	6014.0	857170	8889	6056.0	1297800	12294	6098.0	1915400	17243
5973.0	545750	6341	6015.0	866110	8952	6057.0	1310100	12398	6099.0	1932800	17367
5974.0	552090	6403	6016.0	875120	9015	6058.0	1322600	12503	6100.0	1950300	17492
5975.0	558490	6465	6017.0	884190	9079	6059.0	1335100	12607	6101.0	1968000	17616
5976.0	564940	6527	6018.0	893330	9142	6060.0	1347800	12712	6102.0	1985800	17741
5977.0	571450	6589	6019.0	902530	9206	6061.0	1360600	12816	6103.0	2003800	
5978.0	578010	6651	6020.0	911800	9269	6062.0	1373400	12921	6104.0	2021900	
5979.0	584630	6713	6021.0	921140	9333	6063.0	1386400	13025	6105.0	2040300	
5980.0	591300	6775	6022.0	930550	9396	6064.0	1399500	13130	6106.0	2058800	
5981.0	598040	6837	6023.0	940040	9460	6065.0	1412700	13234	6107.0	2077500	
5982.0	604840	6899	6024.0	949600	9523	6066.0	1426100	13339	6108.0	2096500	
5983.0	611720	6961	6025.0	959240	9586	6067.0	1439500	13443			
5984.0	618660	7023	6026.0	968950	9650	6068.0	1453100	13548			



Legend

- Subdrainage Boundary
- Drainage Boundary
- States
- Counties
- Continental Divide

Stream Gages

1 - East Fork San Juan Rvr, CO*
2 - San Juan Rvr at Pagosa Springs, CO**
3 - Rio Blanco blw Blanco Div Dam near Pagosa, CO*
4 - Navajo Rvr near Dulce, NM**
5 - Navajo Rvr at Banded Peak Ranch near Chromo, CO*
6 - Navajo Rvr blw Oso Div Dam near Chromo, CO*
7 - Little Navajo Rvr blw Little Oso Div Ditch, CO*
8 - San Juan Rvr near Carracas, CO**
9 - Piedra Rvr near Arboles, CO**
10 - Vallecito Creek near Bayfield, CO**
11 - Pine River Blw Vallecito Reservoir near Bayfield, CO*
12 - Los Pinos Rvr near Ignacio, CO**
13 - Los Pinos Rvr at La Boca, CO**
14 - Spring Creek at La Boca, CO**
15 - San Juan Rvr near Archuleta, NM**
16 - Animas Rvr blw Silverton, CO**
17 - Animas Rvr at Tall Timber Resort abv Tacoma, CO**
18 - Animas Rvr at Durango, CO**
19 - Animas Rvr near Cedar Hill, NM**
20 - Animas Rvr at Farmington, NM**
21 - San Juan Rvr at Farmington, NM**
22 - La Plata Rvr at Hesperus, CO*
23 - La Plata Rvr at CO-NM State Line*
24 - La Plata Rvr at La Plata, NM**
25 - La Plata Rvr near Farmington, NM**
26 - San Juan Rvr at Shiprock, NM**
27 - Mancos Rvr at Anitas Flat blw Mancos, CO**
28 - Mancos Rvr near Towaoc, CO**
29 - San Juan Rvr at Four Corners, NM**
30 - McElmo Creek abv Trail Canyon near Cortez, CO**
31 - McElmo Creek near CO-UT State Line**
32 - South Creek abv Reservoir near Monticello, UT**
33 - Chinle Creek near Mexican Water, AZ**
34 - San Juan Rvr near Bluff, UT**

** Colorado Division of Water Resources*
*** United States Geological Survey*

Precipitation Gages

RAWS
1 - Albino Canyon
2 - Mesa Mountain
3 - Devil Mountain
4 - Stone Lake
5 - Dulce #2
6 - Farmington QD1
7 - SJF1 Durango 555
8 - Sandoval Mesa

ASOS
1 - Wolf Creek Pass
2 - Durango
3 - Farmington
4 - Cortez

Other
1 - Vallecito Dam
2 - Navajo Dam
3 - Lemon Dam

SNOTEL Sites

1 - Wolf Creek Summit
2 - Upper San Juan
3 - Vallecito
4 - Stump Lakes
5 - Mineral Creek
6 - Molas Lake
7 - Cascade
8 - Middle Creek
9 - Columbus Basin

US Army Corps of Engineers
Albuquerque District

TETRA TECH

25 12.5 0 25 50 75 100 Kilometers

25 12.5 0 25 50 75 100 Miles

1:1,421,472

N

Map projection:
Albers Equal Area Conic NAD83;
Central Meridian = -108.300000
Standard Parallel 1 = 35.178000
Standard Parallel 2 = 37.708000
Latitude of Origin = 35.300000
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLRADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

SAN JUAN RIVER BASIN

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE 2-1

108°0'0"W

107°0'0"W

37°0'0"N

Lemon Reservoir

Vallecito Reservoir

Navajo Reservoir

Durango

Bayfield

Ignacio

Pagosa Springs

Archuleta

San Juan

Aztec

Bloomfield

La Plata

Dolores

San Juan

Hinsdale

Mineral

Rio Grande

Conejos

Rio Arriba

Colorado

New Mexico

San Juan-Chama Project

Florida River

Los Pinos River

Beaver Creek

Piedra River

San Juan River

Navajo River

Animas River

San Juan RIV ec

160

550

64

84

Legend

- Subdrainage Boundary
- Drainage Boundary
- Contour Interval = 1,500 ft.
- States
- Counties
- Continental Divide

Navajo Reservoir elevation approximately 6,086 ft.

Stream Gages

1 - East Fork San Juan Rvr, CO*
2 - San Juan Rvr at Pagosa Springs, CO**
3 - Rio Blanco blw Blanco Div Dam near Pagosa, CO*
4 - Navajo Rvr near Dulce, NM**
5 - Navajo Rvr at Banded Peak Ranch near Chromo, CO*
6 - Navajo Rvr blw Oso Div Dam near Chromo, CO*
7 - Little Navajo Rvr blw Little Oso Div Ditch, CO*
8 - San Juan Rvr near Carracas, CO**
9 - Piedra Rvr near Arboles, CO**
10 - Vallecito Creek near Bayfield, CO**
11 - Pine River Blw Vallecito Reservoir near Bayfield, CO*
12 - Los Pinos Rvr near Ignacio, CO**
13 - Los Pinos Rvr at La Boca, CO**
14 - Spring Creek at La Boca, CO**
15 - San Juan Rvr near Archuleta, NM**
16 - Animas Rvr at Tall Timber Resort abv Tacoma, CO**
17 - Animas Rvr at Durango, CO**
18 - Animas Rvr near Cedar Hill, NM**
19 - La Plata Rvr at Hesperus, CO*

* *Colorado Division of Water Resources*
** *United States Geological Survey*

Precipitation Gages

RAWS

1 - Albino Canyon
2 - Mesa Mountain
3 - Devil Mountain
4 - Stone Lake
5 - Dulce #2
6 - Sandoval Mesa

ASOS

1 - Wolf Creek Pass
2 - Durango

Other

1 - Vallecito Dam
2 - Navajo Dam
3 - Lemon Dam

SNOTEL Sites

1 - Wolf Creek Summit
2 - Upper San Juan
3 - Vallecito
4 - Stump Lakes
5 - Cascade
6 - Middle Creek
7 - Columbus Basin

US Army Corps of Engineers
Albuquerque District

TETRA TECH

8 4 0 8 16 24 32 Kilometers

8 4 0 8 16 24 32 Miles

1:540,000

N

Map projection:
Albers Equal Area Conic NAD83;
Central Meridian = -107.100000
Standard Parallel 1 = 37.300000
Standard Parallel 2 = 36.500000
Latitude of Origin = 36.000000
Units = meters

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

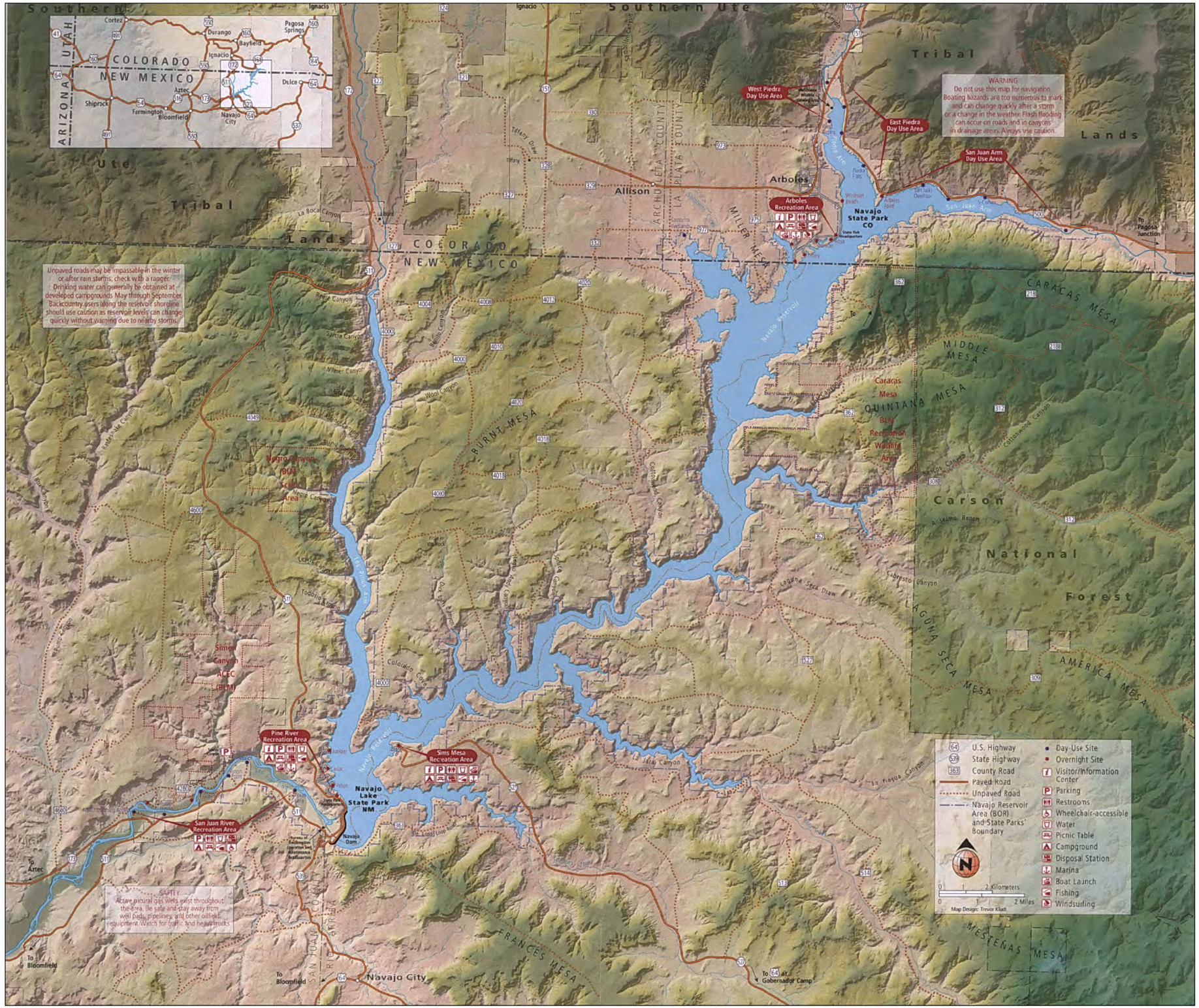
SAN JUAN RIVER BASIN — COLRADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

Navajo Area Map and Contours

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE 2-2



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

AREA LAND USE

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
2 - 3

SCALE OF FEET

PROFILE ON CENTERLINE OF CREST OF DAM

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

NAVAJO DAM
EMBANKMENT, PLAN, PROFILE, AND SECTIONS

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
2 - 4

[redacted]

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

DRAINAGE TUNNEL SYSTEM AND DIAPHRAGM WALL MODIFICATION

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 2-5

[redacted]

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

OUTLET WORKS, PLAN, PROFILE, AND SECTIONS

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **2 -6**

[redacted]

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

OUTLET WORKS, INTAKE STRUCTURE
PLAN AND SECTIONS

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **2 - 7**

[redacted]

U.S. ARMY ENGINEER [redacted], ALB[redacted]UE
CORPS [redacted]S
ALBUQUERQ[redacted]MEXI[redacted]

SAN JUAN RIVER BASIN [redacted]OLORA[redacted]EXICO

NAVAJO DAM [redacted]ERVO[redacted]

SPILLWAY, PLAN, P[redacted]AND S[redacted]

TO ACCOMPANY WAT[redacted]
CONTROL MANUAL
DATED 2010

U.S. ARMY E... DIST... ...UE
OF ENG...
AL... ...UE, N...

SAN JUAN RIVER B... ...EXICO

NAV... ...AND...

NAVAJO... ...ROE...
...TE MA...

TO ACCOMP... ...ER
CONTROL MANUAL
DATED 2010

2 -9

[redacted]

U.S. ARMY ENGINE
CO
ALBUQU

SAN JUAN RIVER BASIN

NAVAJO D

NAVAJO DAM H
GENERAL

TO ACCOMPANY WATER
CONTROL MANUAL
DATED 2010

2 - 10

[redacted]

U.S. ARMY ENGINEER D[redacted]ICT, A[redacted]E
CORPS OF [redacted]NEERS
ALBUQUERQU[redacted]EW M[redacted]

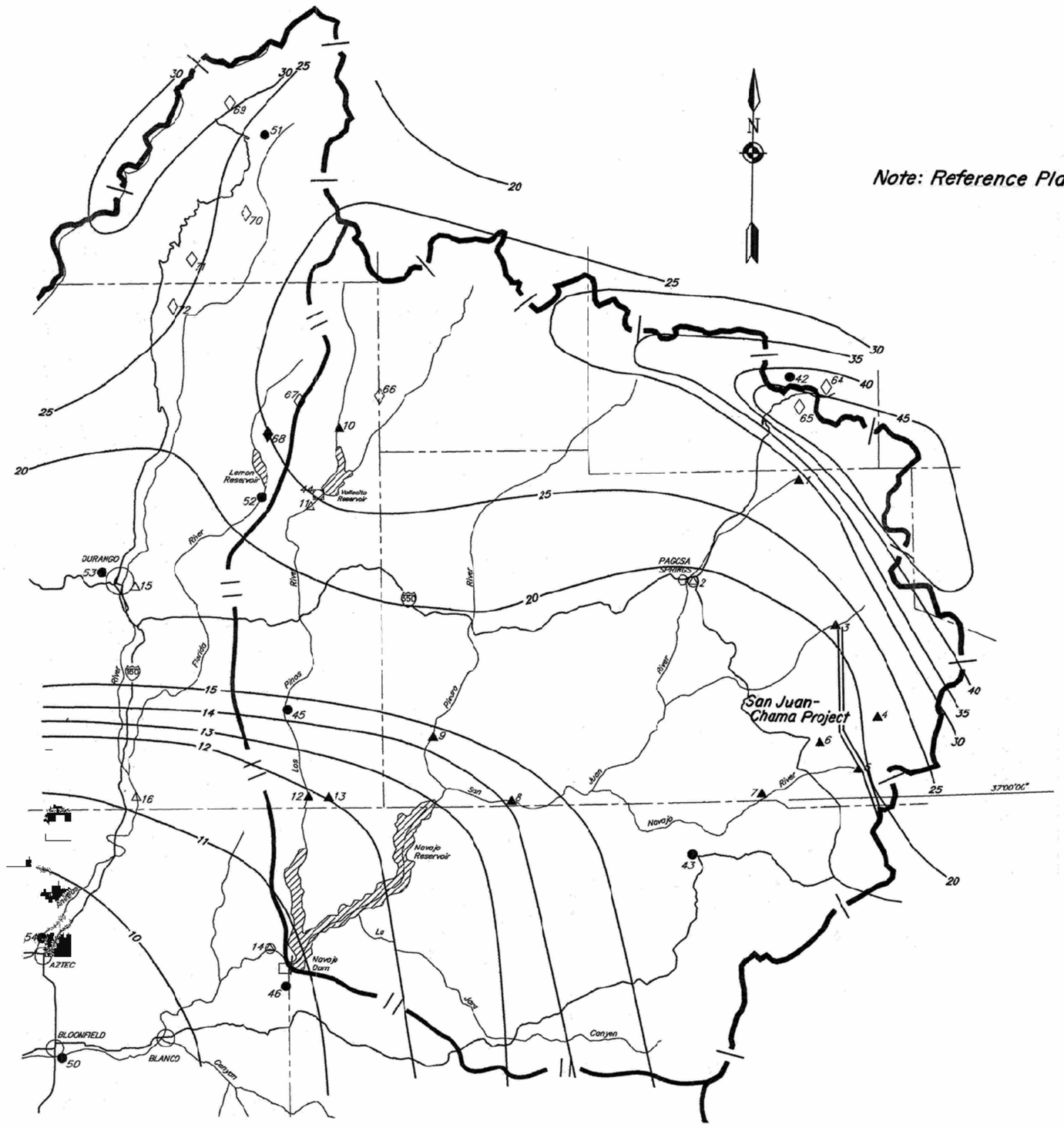
SAN JUAN RIVER BASIN [redacted]XICO

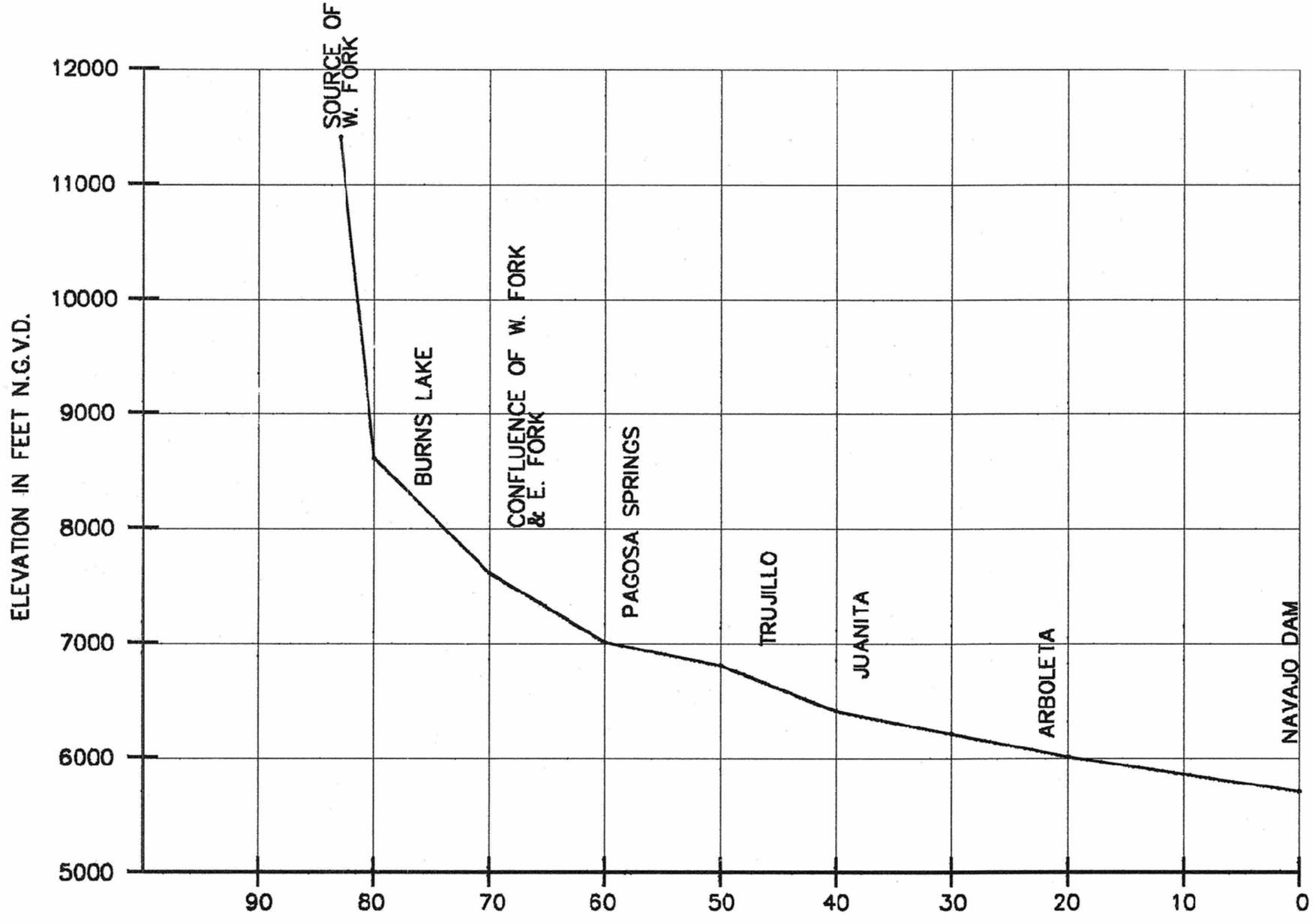
NAVAJO DAM A[redacted]RESE[redacted]

NAVAJO INDIAN IR[redacted]ATION[redacted]
MAIN CANAL [redacted]ADWO[redacted]

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

[redacted]


N
Note: Reference Plate 2-1 For Station Name.
LEGEND
Drainage Boundary
Subdrainage Boundary
10 Precipitation In Inches
State
County
14 Highway
River, Creek
City
Reservoir
Precipitation Gage
Stream Gage
Stream Gage – DCP Equipped
Stream And Precipitation Gage – DCP Equipped
Reservoir Gage – DCP Equipped
Reservoir And Precipitation Gage – DCP Equipped
Snow Data Site
Snow Data Site – Snotel Equipped
GRAPHIC SCALES
0 50,000 100,000 150,000
DURANGO
AZTEC
BLOOMFIELD
BLANCO
PAGOSA SPRINGS
Lemon Reservoir
Vallecito Reservoir
Navajo Reservoir
Navajo Dam
San Juan-Chama Project
37°00'00"
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO
SAN JUAN RIVER BASIN
COLORADO & NEW MEXICO
NAVAJO DAM AND RESERVOIR
MEAN ANNUAL PRECIPITATION
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010
PLATE
4-1



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

THALWEG PROFILES, UPPER REACH OF SAN JUAN RIVER TO NAVAJO DAM

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 4-2

AREA IN THOUSAND ACRES

20 18 16 14 12 10 8 6 4 2 0

WATER SURFACE ELEVATION IN FEET N.G.V.D

6150
6100
6050
6000
5950
5900
5850
5800
5750

TOP OF DAM ELEVATION 6108.0'

SPILLWAY CREST ELEVATION 6085.0'

CAPACITY

AREA

MINIMUM OPERATING ELEVATION 5990.0'

INTAKE STRUCTURE SILL ELEVATION 5882.5'

500 1000 1500 2000 2500

CAPACITY IN THOUSAND ACRE-FEET

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

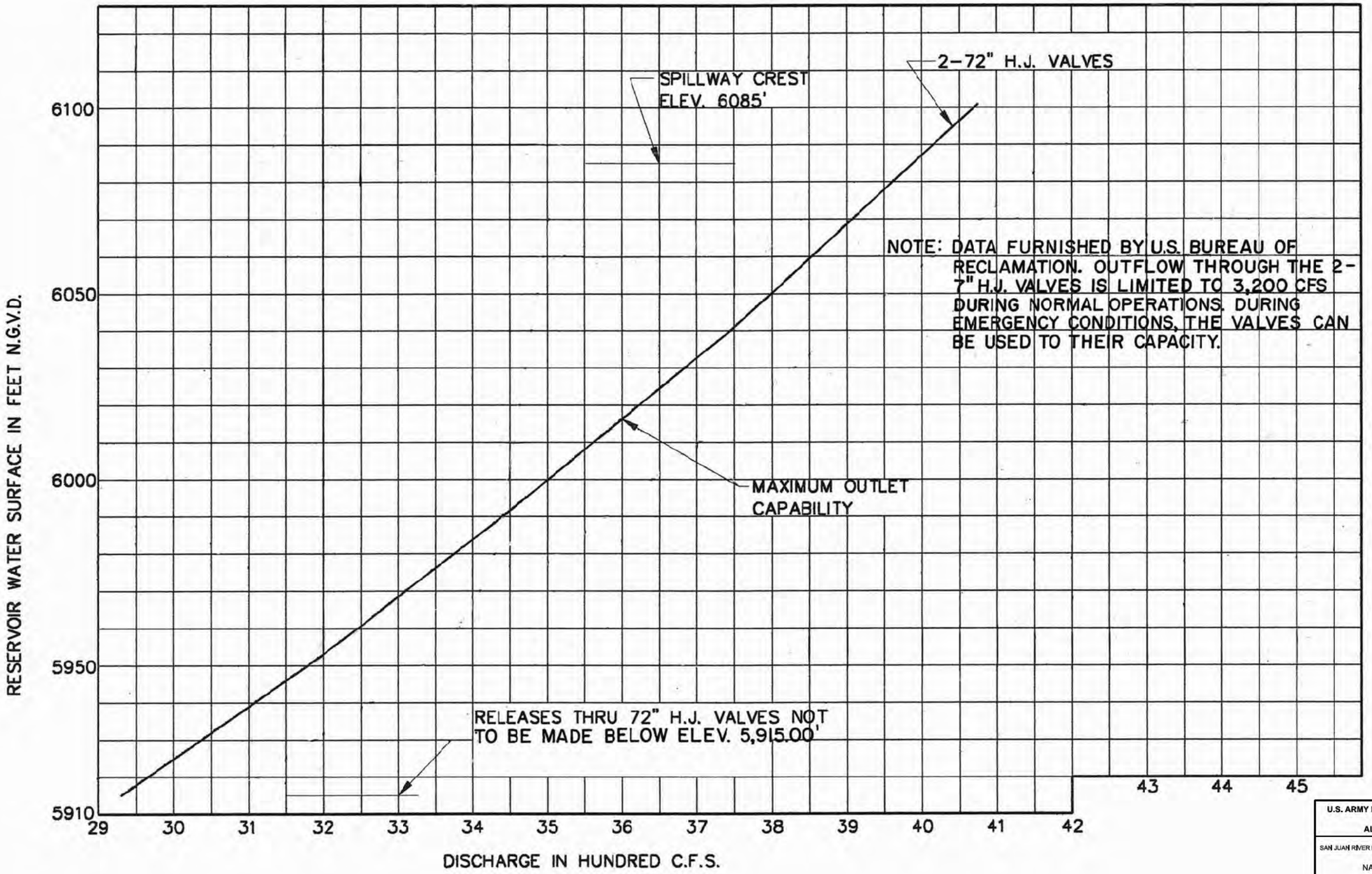
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

AREA AND CAPACITY CURVES

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
7-1



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

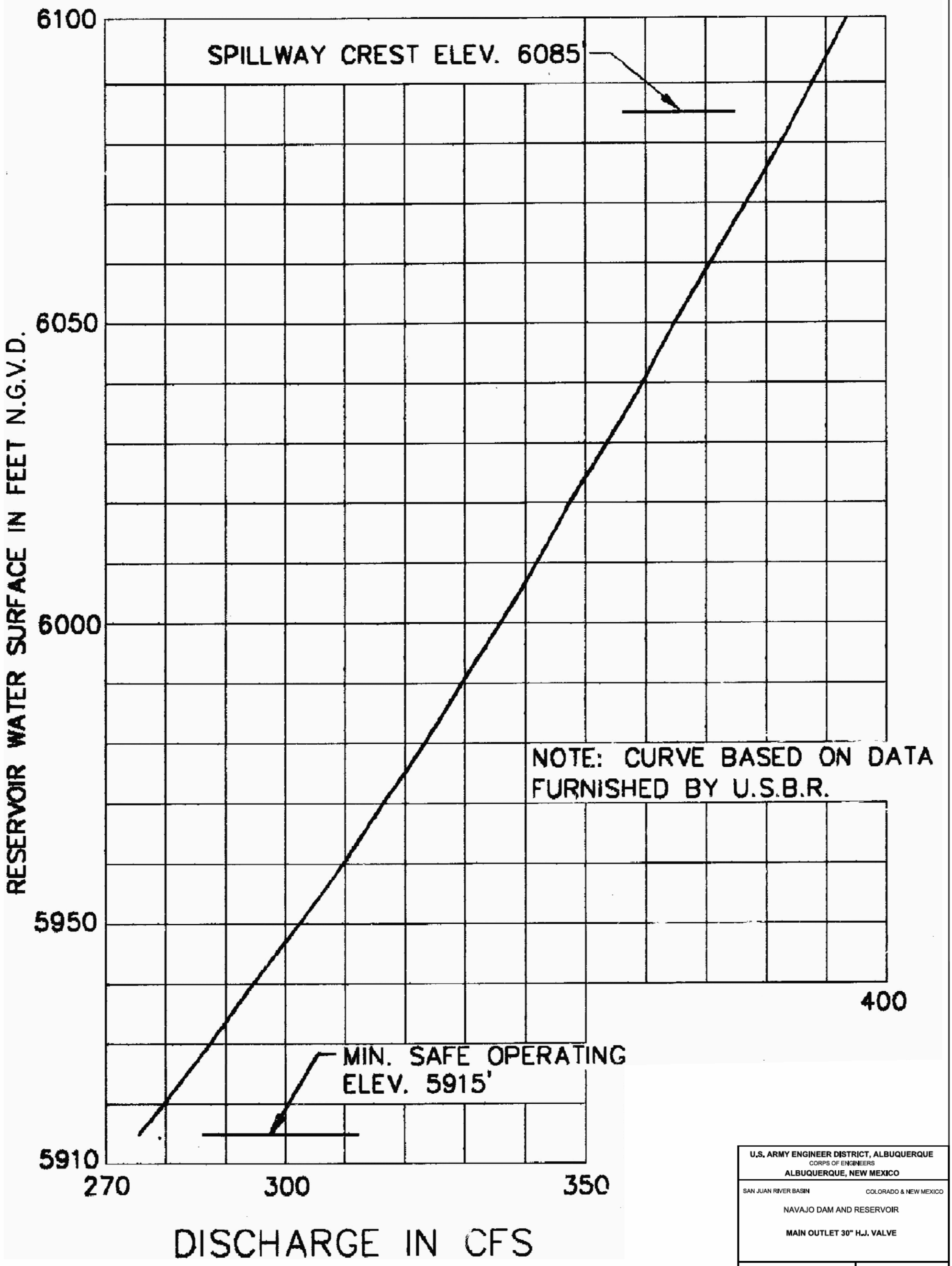
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

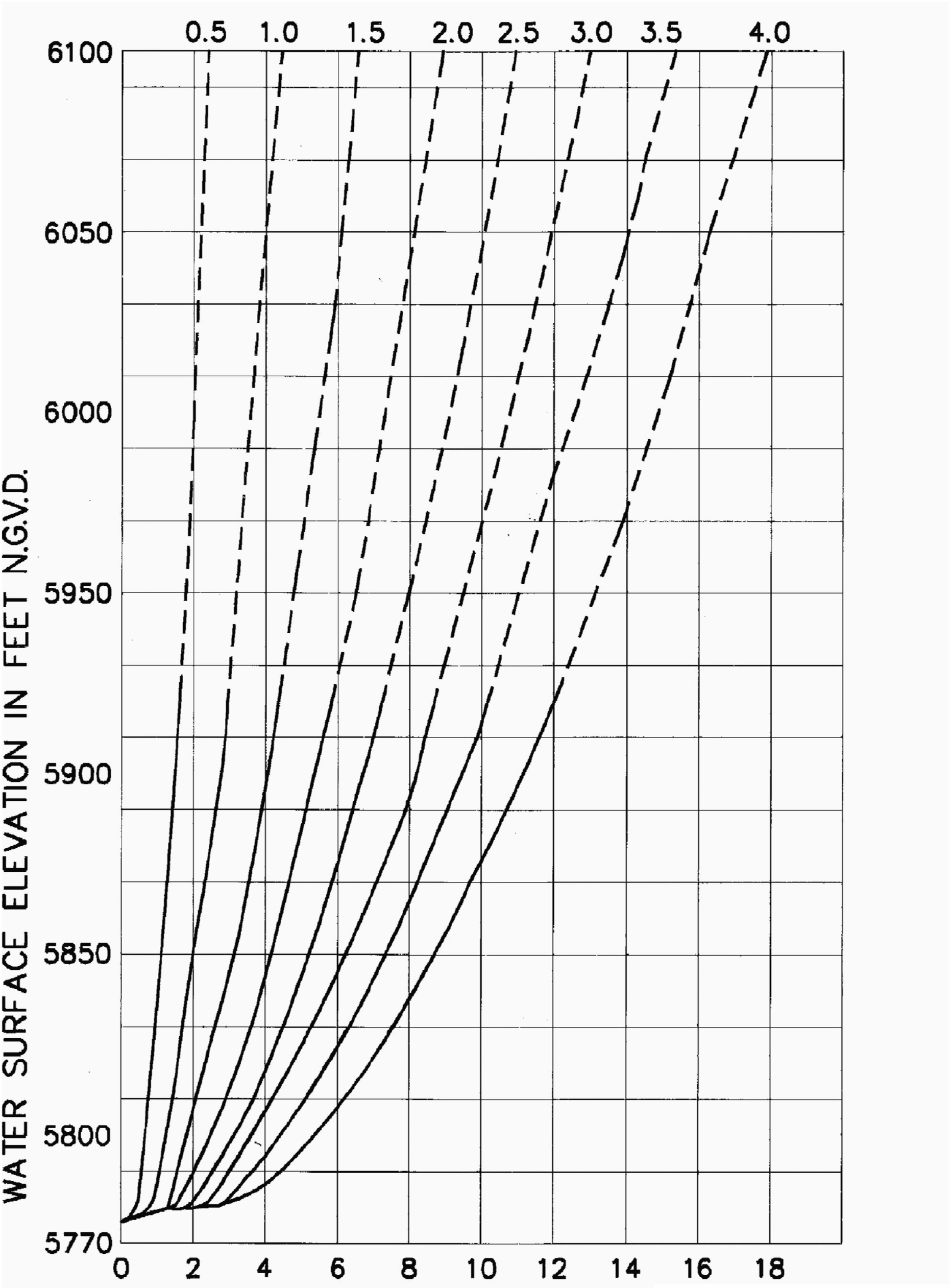
MAIN OUTLET
2-72" H.J. VALVES

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
7-2



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
SAN JUAN RIVER BASIN	COLORADO & NEW MEXICO
NAVAJO DAM AND RESERVOIR **MAIN OUTLET 30" H.J. VALVE**	
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **7-2A**



NOTE: DATA FURNISHED BY U.S. BUREAU OF RECLAMATION

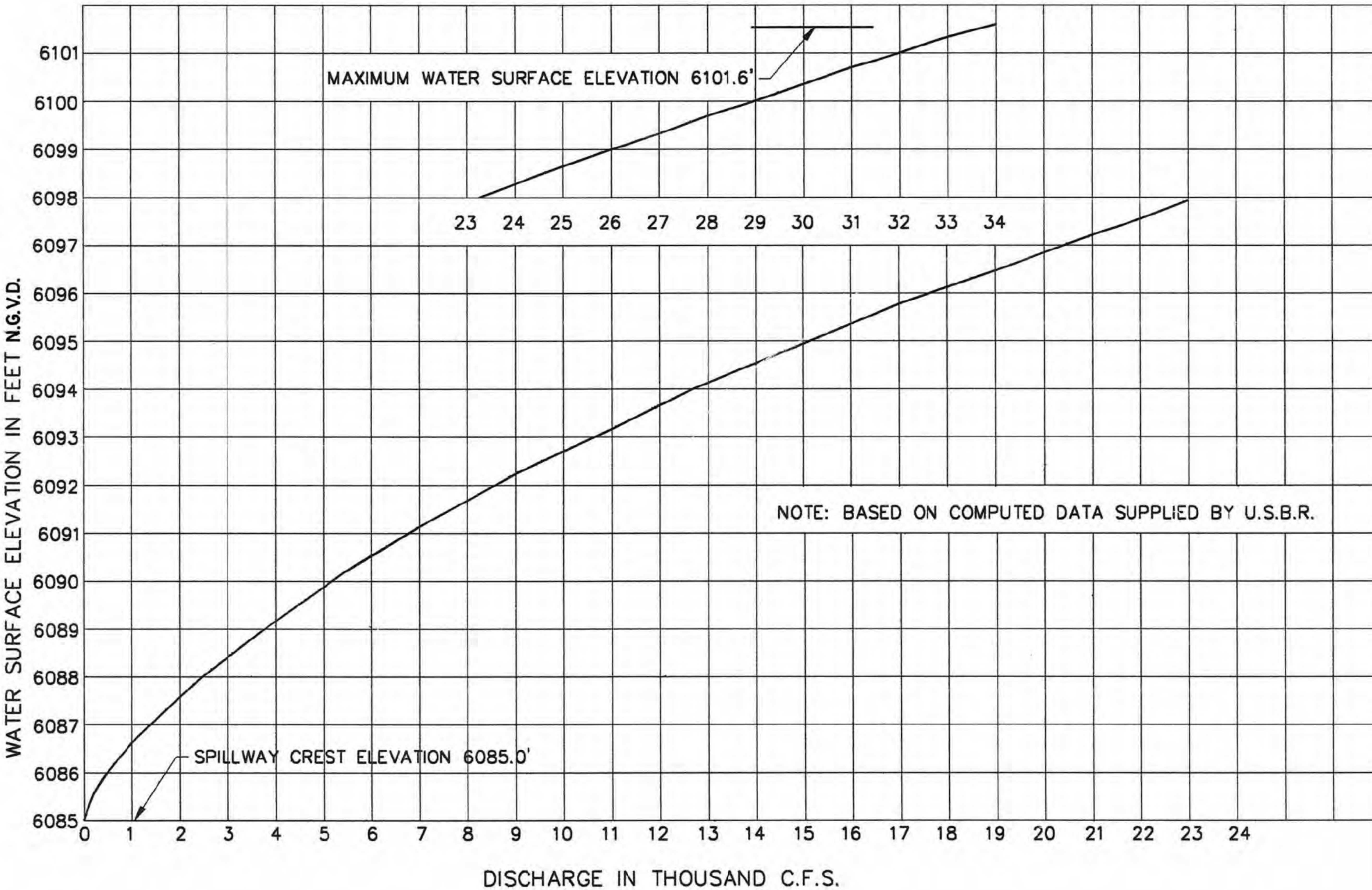
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

AUXILIARY OUTLET WORKS

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **7-2B**



[redacted] DISTRICT, [redacted]UQUE[redacted]E
[redacted]F ENGINEERS
[redacted]UE, NEW M[redacted]O

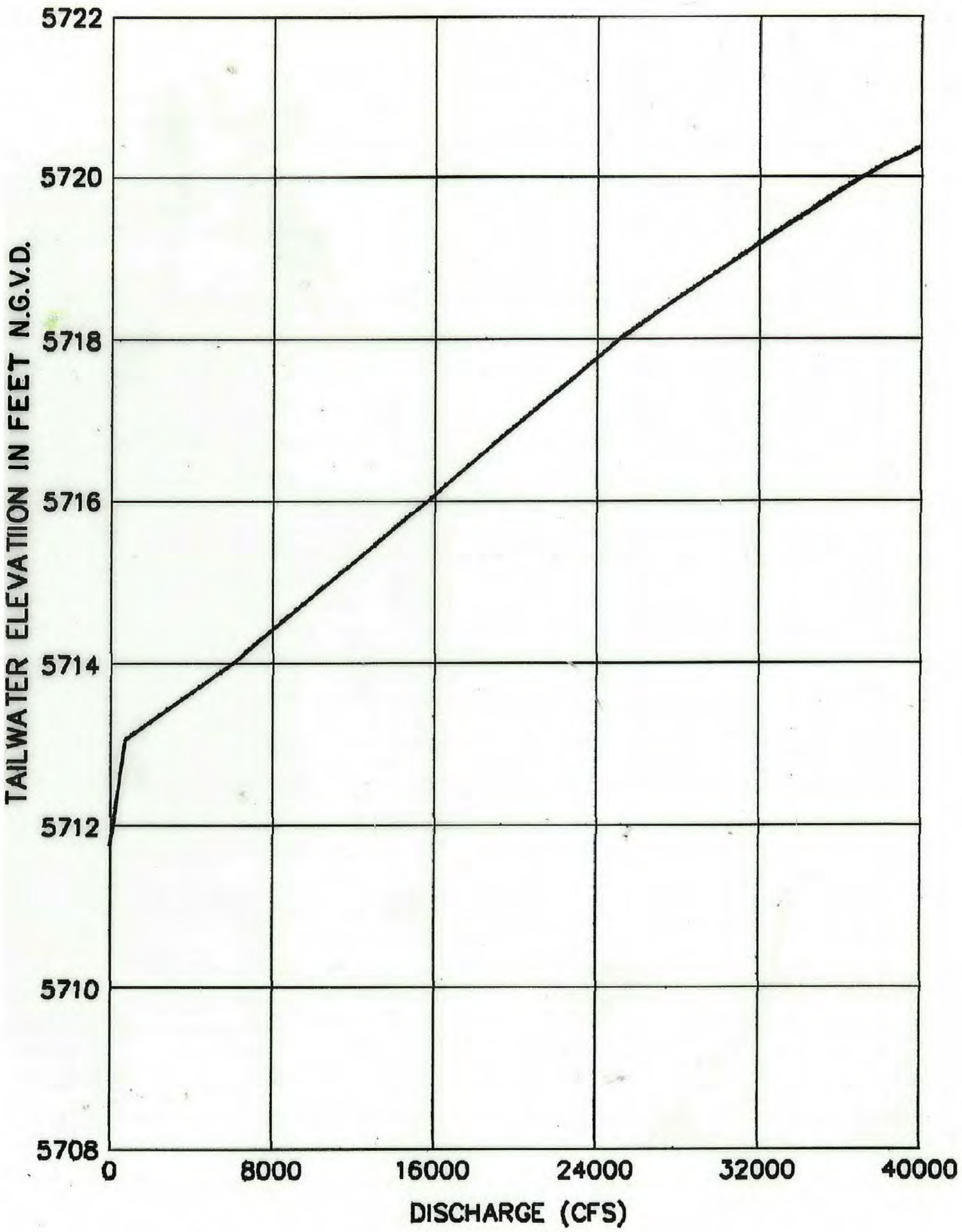
S[redacted] CO[redacted]DO & N[redacted]XICO

[redacted]AND RESE[redacted]R

[redacted] DISCHAR[redacted]

[redacted]
CONTROL MANUAL
DATED 2010

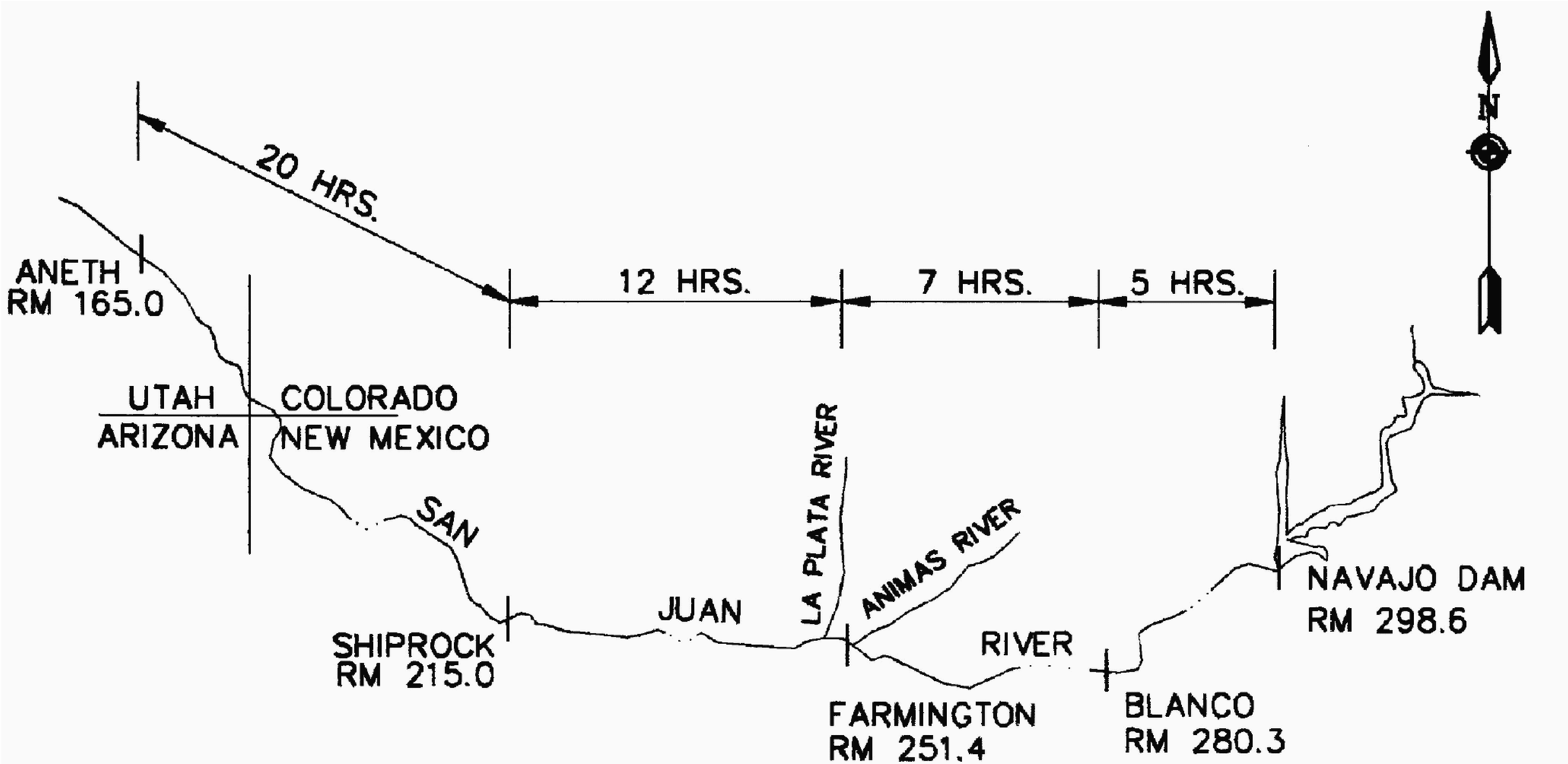
PLAT[redacted]
7-3



NOTE:

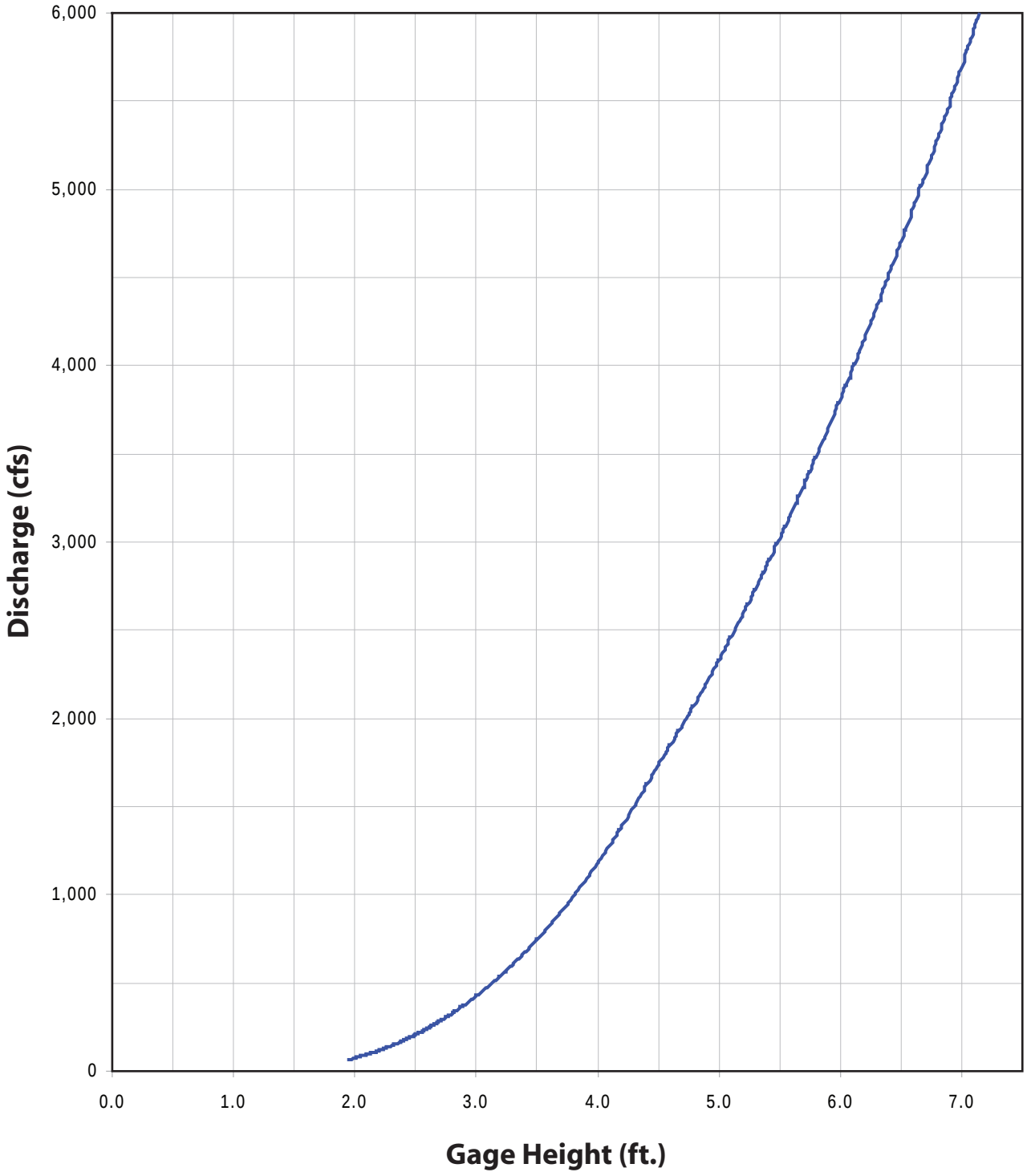
Curve From USBR Dwg. 711-D-38.

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO NAVAJO DAM AND RESERVOIR **TAILWATER**	
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 7-4



NOTES: 1. TRAVEL TIMES APPROXIMATE
2. REFER TO ADR 500-1-3

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
SAN JUAN RIVER BASIN	COLORADO & NEW MEXICO
NAVAJO DAM AND RESERVOIR **FLOOD PEAK TRAVEL TIMES**	
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 7-5



Brief Table of Values

Gage height (ft.)	Discharge (cfs)
2.0	74.4
2.5	206
3.0	426
3.5	746
4.0	1,180
4.5	1,740
5.0	2,330
5.5	3,020
6.0	3,810
6.5	4,700
7.0	5,690
7.1	5,900

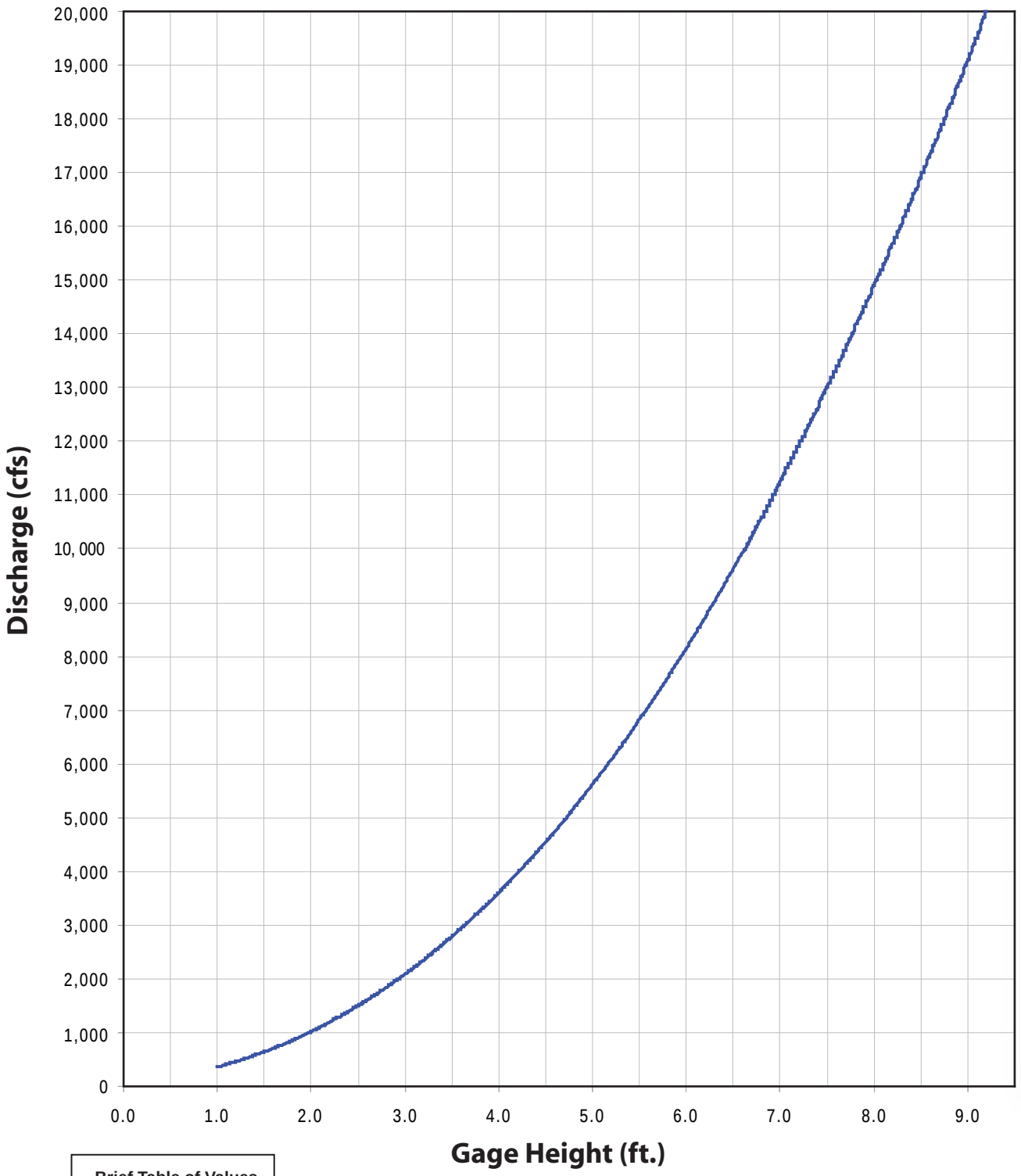
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

DISCHARGE RATING CURVE
SAN JUAN RIVER NEAR ARCHULETA, NM

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 7-6



Brief Table of Values

Gage height (ft.)	Discharge (cfs)
1.0	362
1.5	644
2.0	1,020
2.5	1,500
3.0	2,090
3.5	2,790
4.0	3,610
4.5	4,550
5.0	5,620
5.5	6,820
6.0	8,160
6.5	9,630
7.0	11,200
7.5	13,000
8.0	14,900
8.5	16,900
9.0	19,100
9.2	20,000

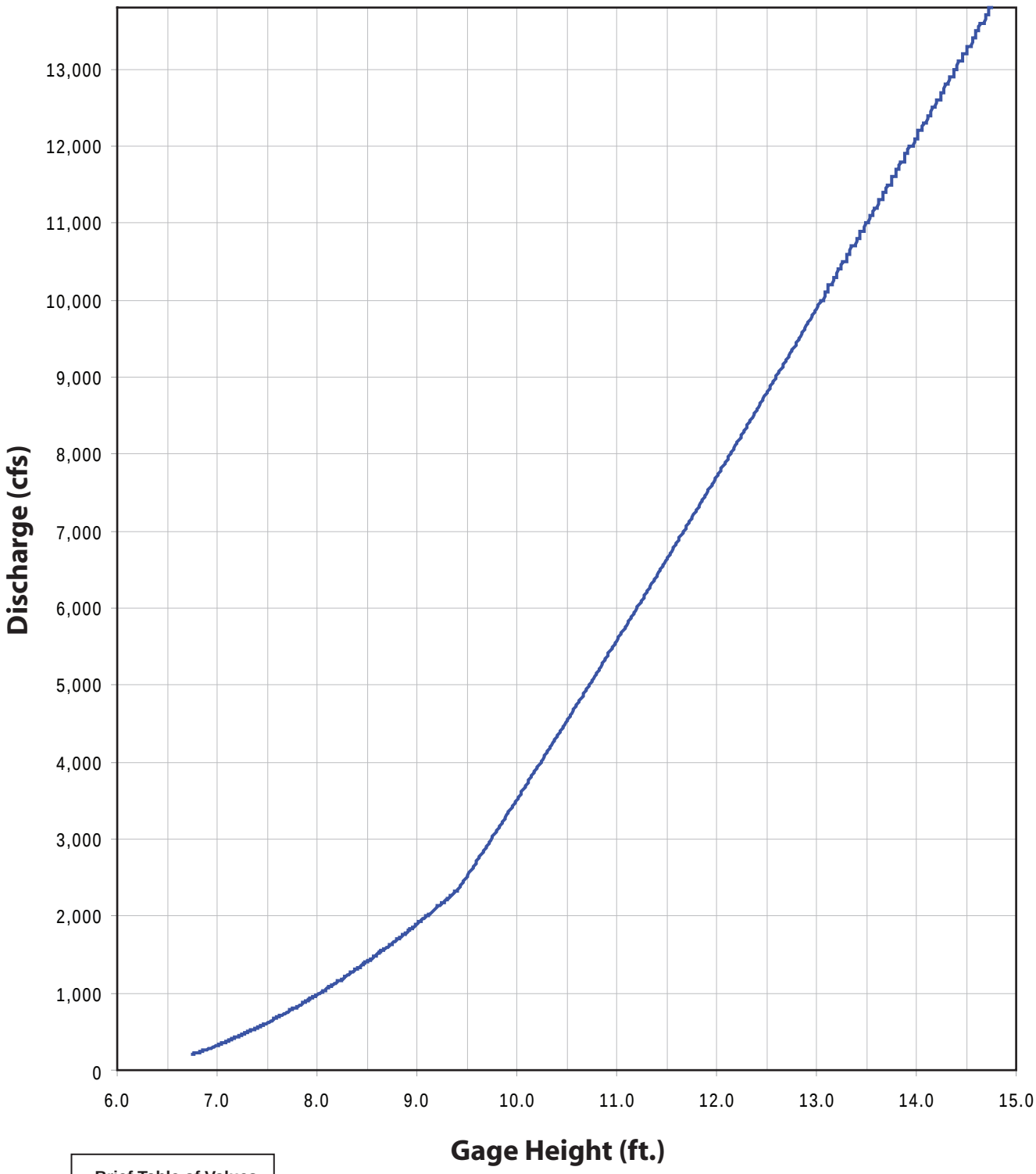
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

DISCHARGE RATING CURVE
SAN JUAN RIVER AT FARMINGTON, NM

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 7-7



Brief Table of Values

Gage height (ft.)	Discharge (cfs)
6.8	225
7.0	320
7.5	612
8.0	977
8.5	1,410
9.0	1,900
9.5	2,520
10.0	3,510
10.5	4,530
11.0	5,570
11.5	6,630
12.0	7,700
12.5	8,790
13.0	9,890
13.5	11,000
14.0	12,100
14.5	13,200
14.7	13,700

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
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ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

DISCHARGE RATING CURVE
SAN JUAN RIVER AT SHIPROCK, NM

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 7-8

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

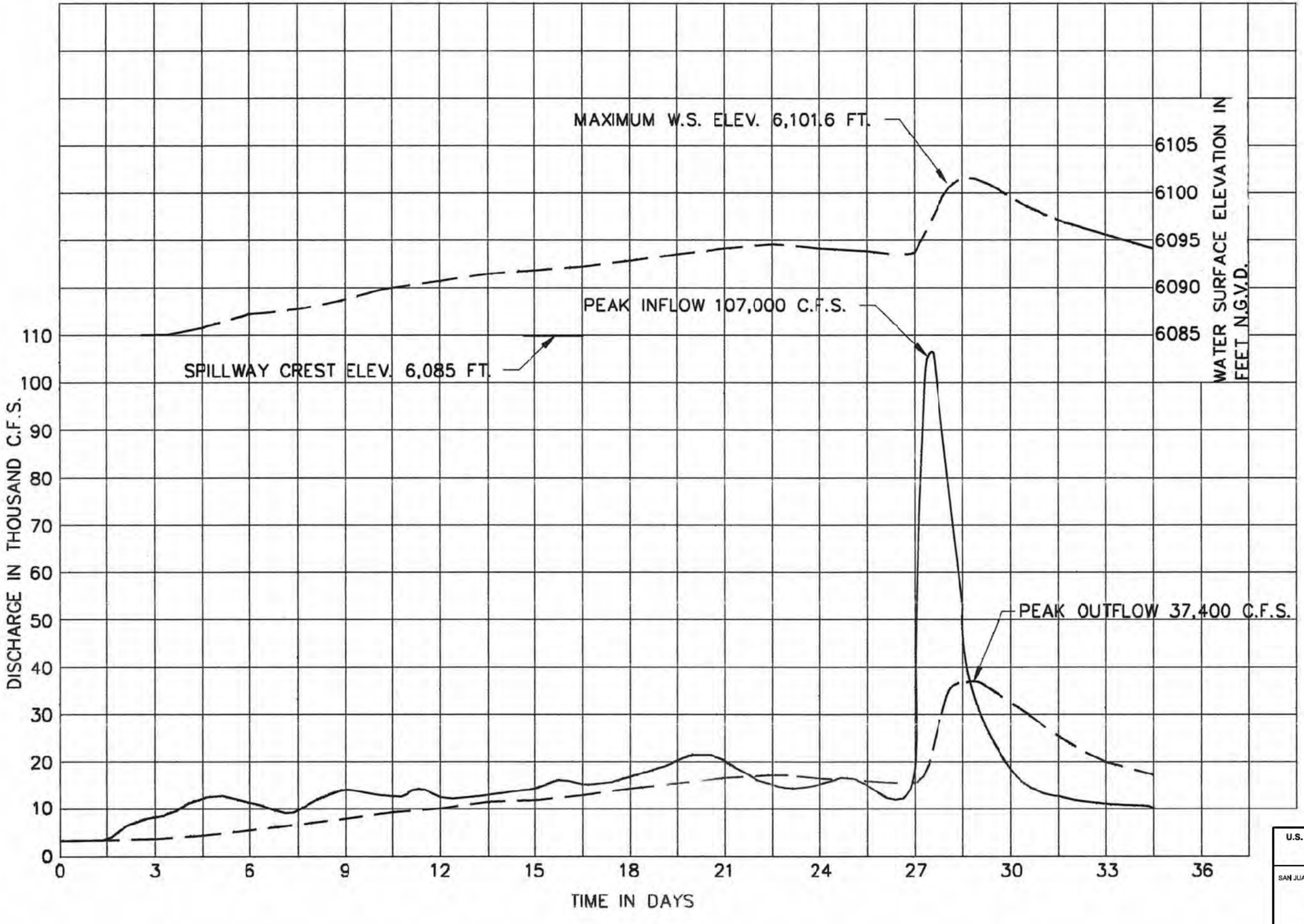
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

TURBINE PERFORMANCE CURVES

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
7-9



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

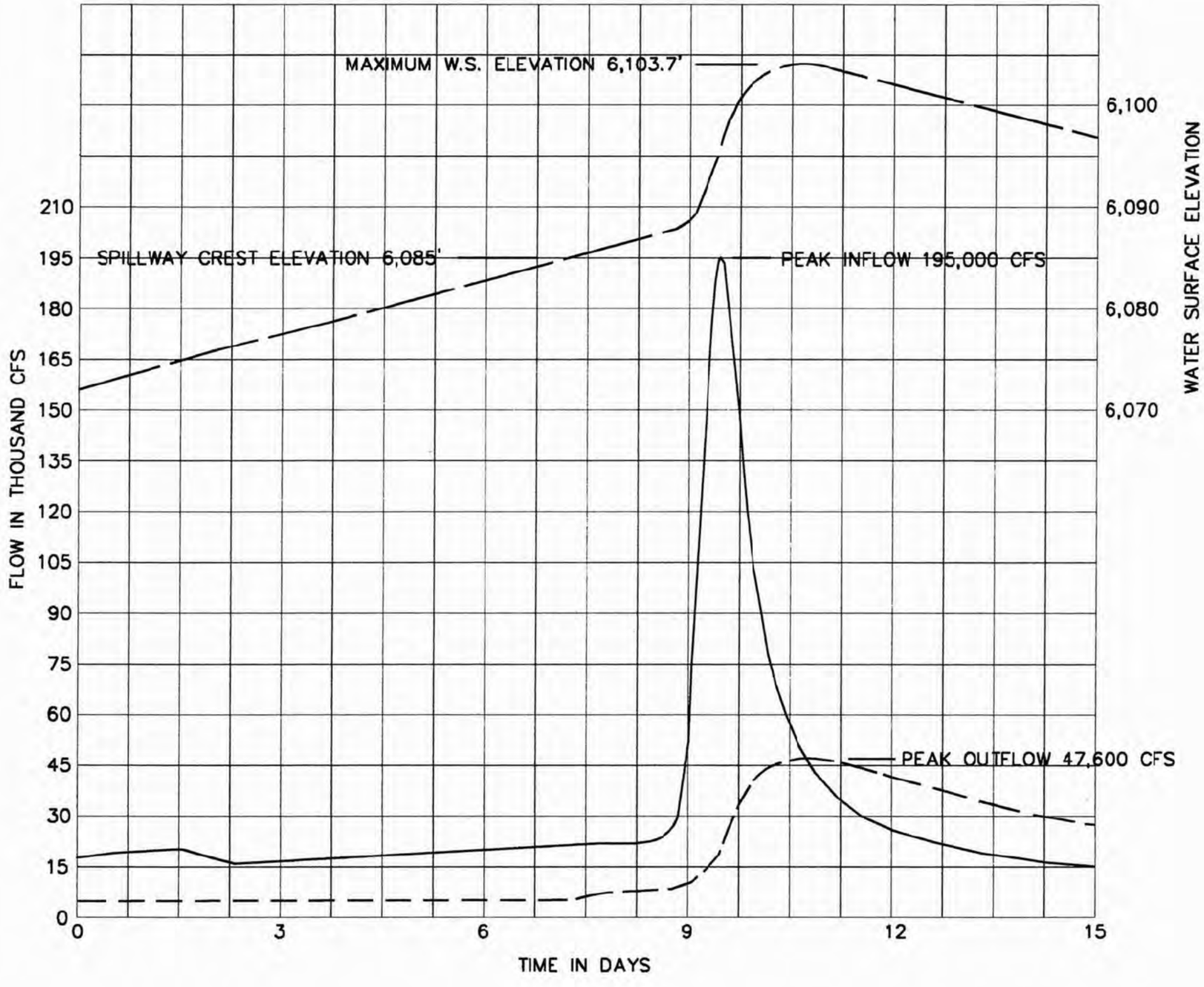
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

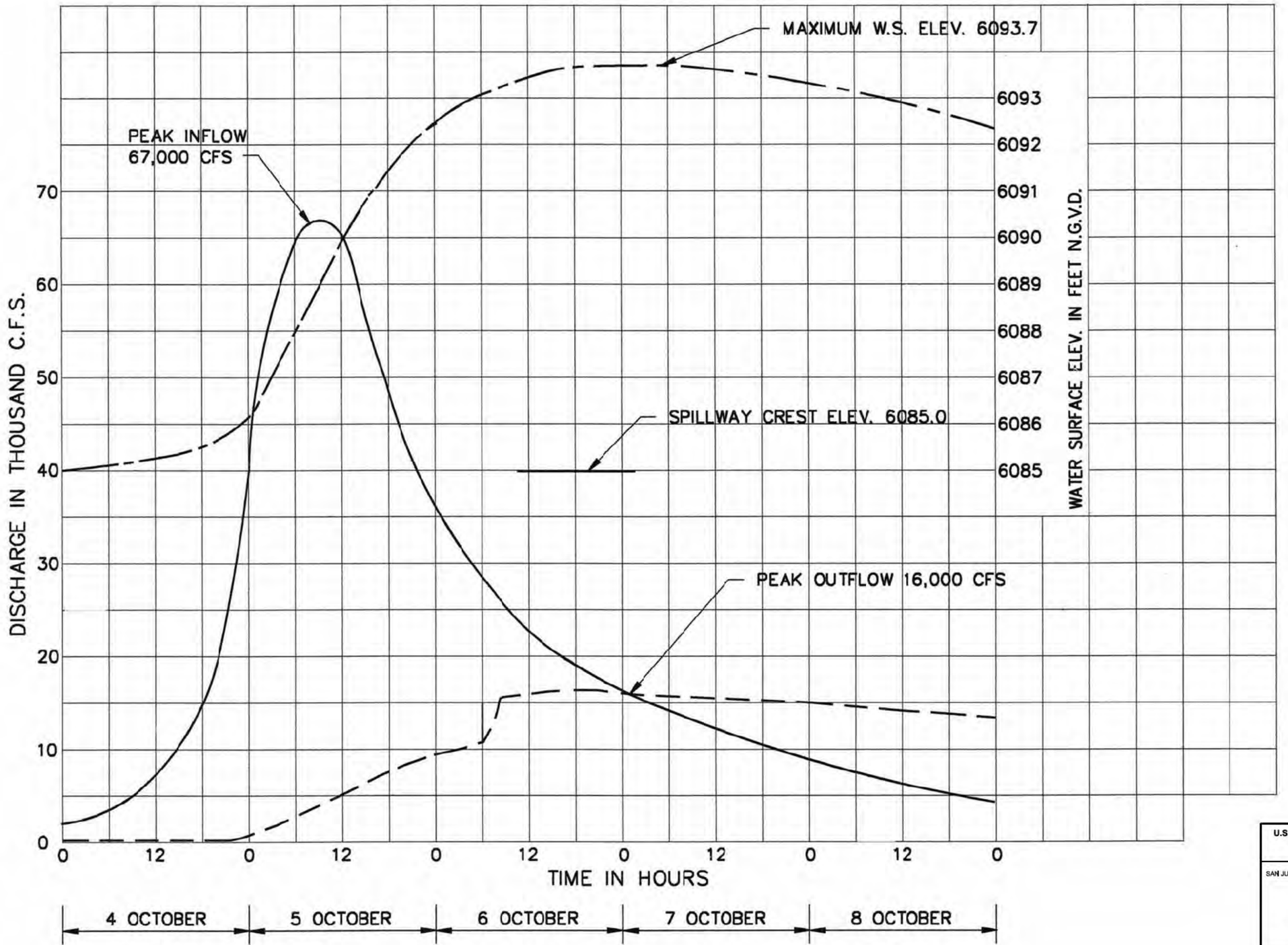
RESERVOIR DESIGN FLOOD ROUTING

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE 8-1



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO	
NAVAJO DAM AND RESERVOIR **PROBABLE MAXIMUM FLOOD**	
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **8-2**



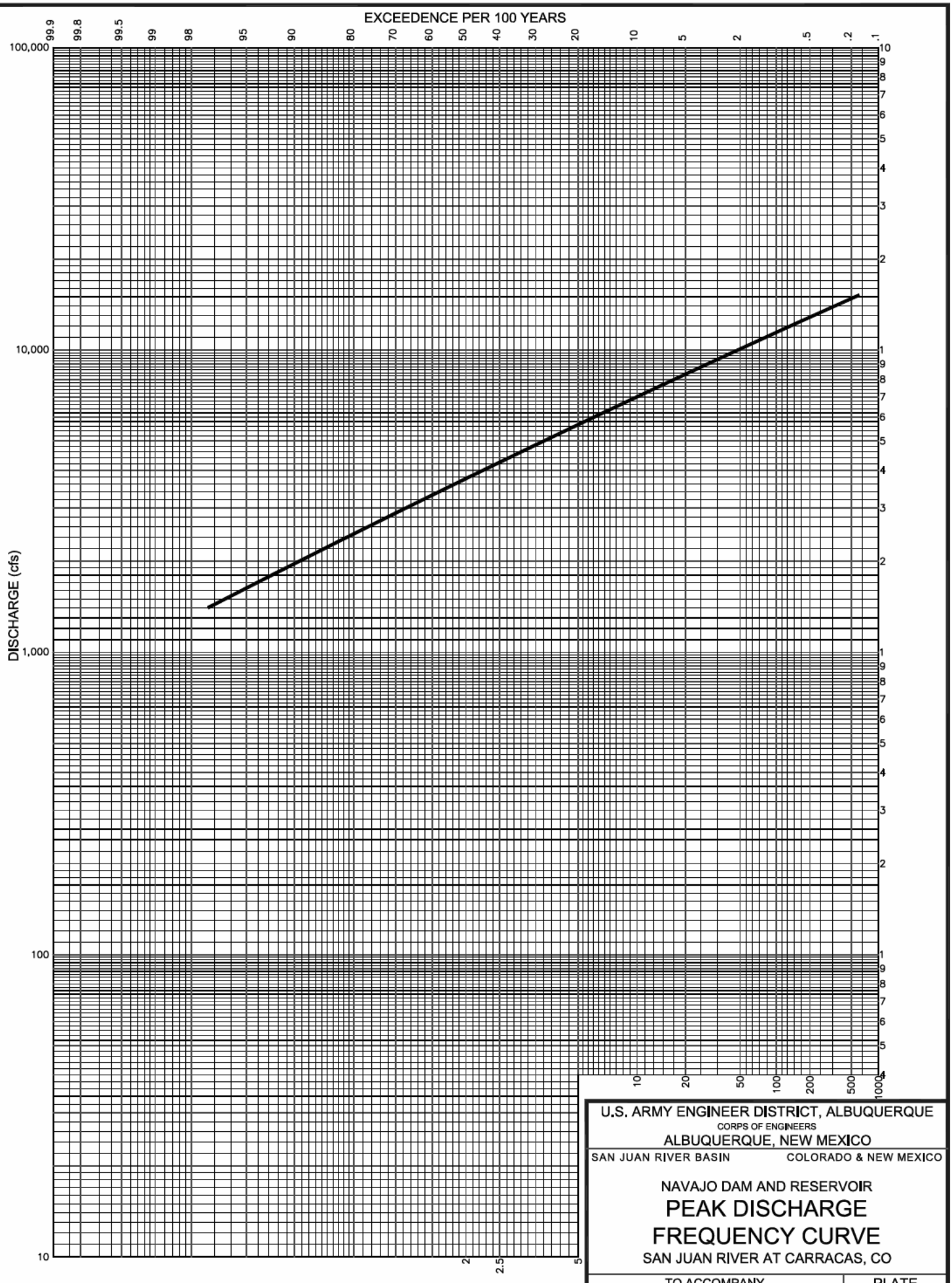
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

OCTOBER 1911 RAIN FLOOD ROUTING

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 8-3



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

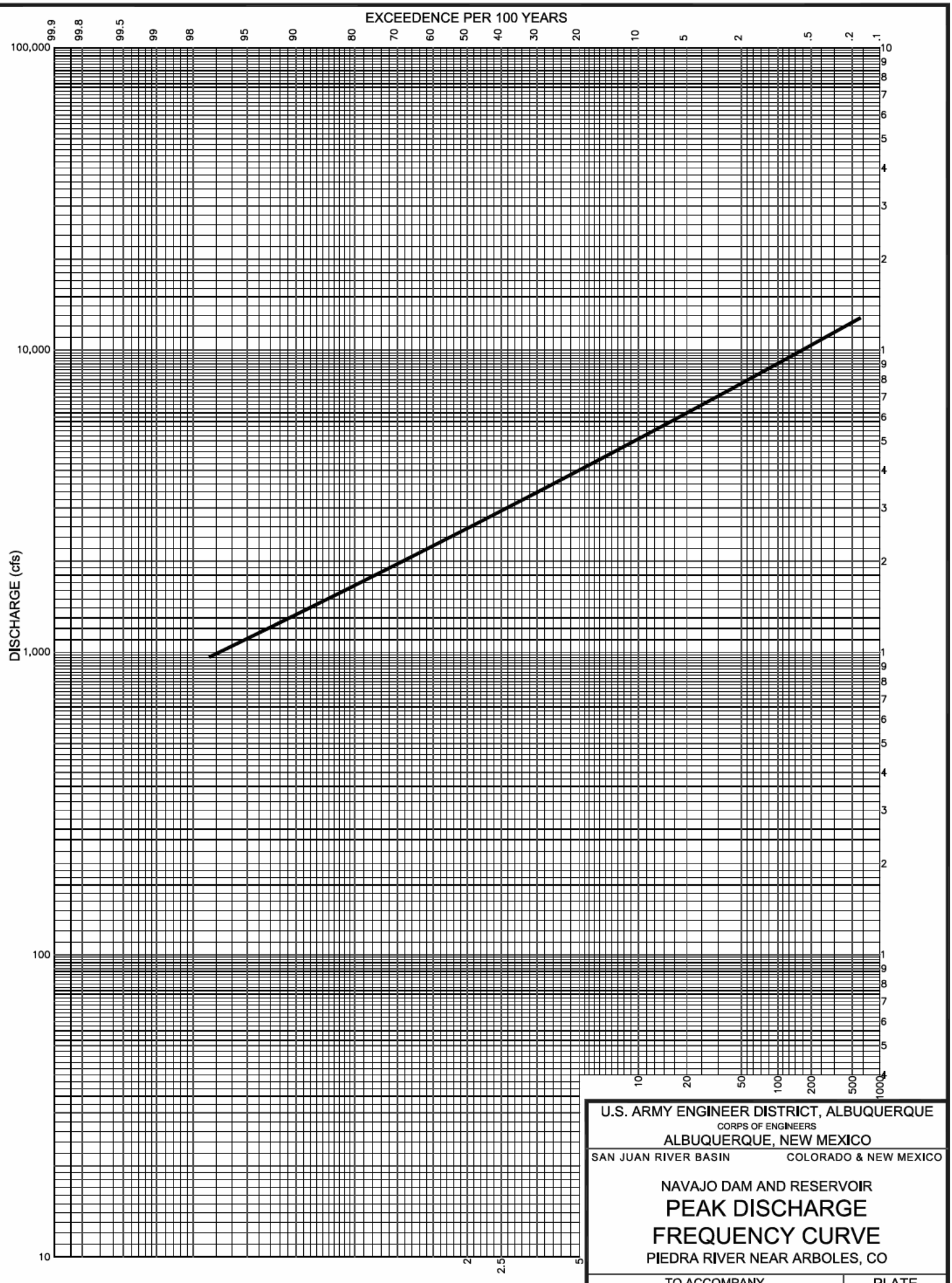
NAVAJO DAM AND RESERVOIR

PEAK DISCHARGE FREQUENCY CURVE

SAN JUAN RIVER AT CARRACAS, CO

TO ACCOMPANY
WATER CONTROL MANUAL
DATED 2010

PLATE
8-4



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CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

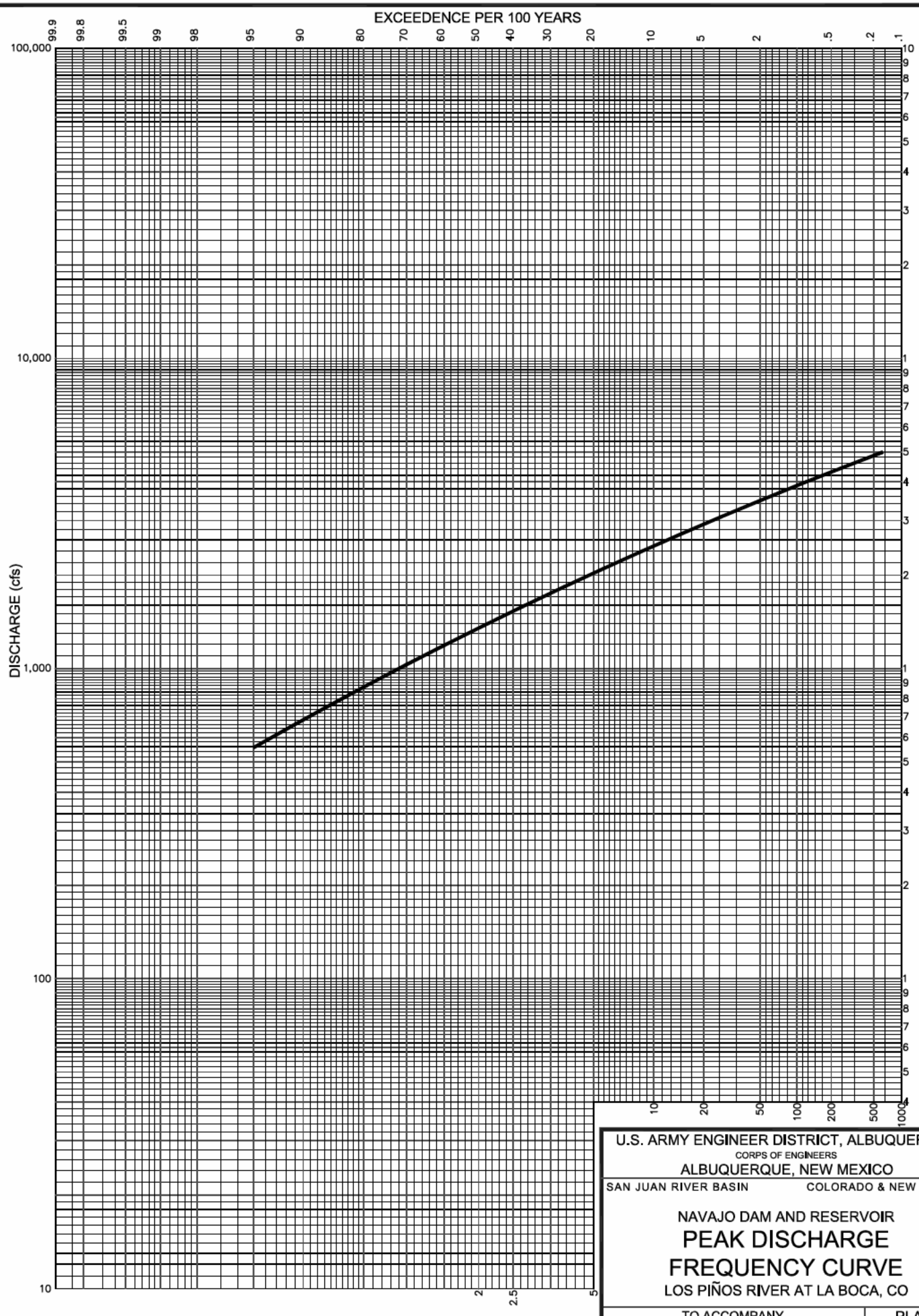
NAVAJO DAM AND RESERVOIR

PEAK DISCHARGE FREQUENCY CURVE

PIEDRA RIVER NEAR ARBOLES, CO

TO ACCOMPANY
WATER CONTROL MANUAL
DATED 2010

PLATE
8-5



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

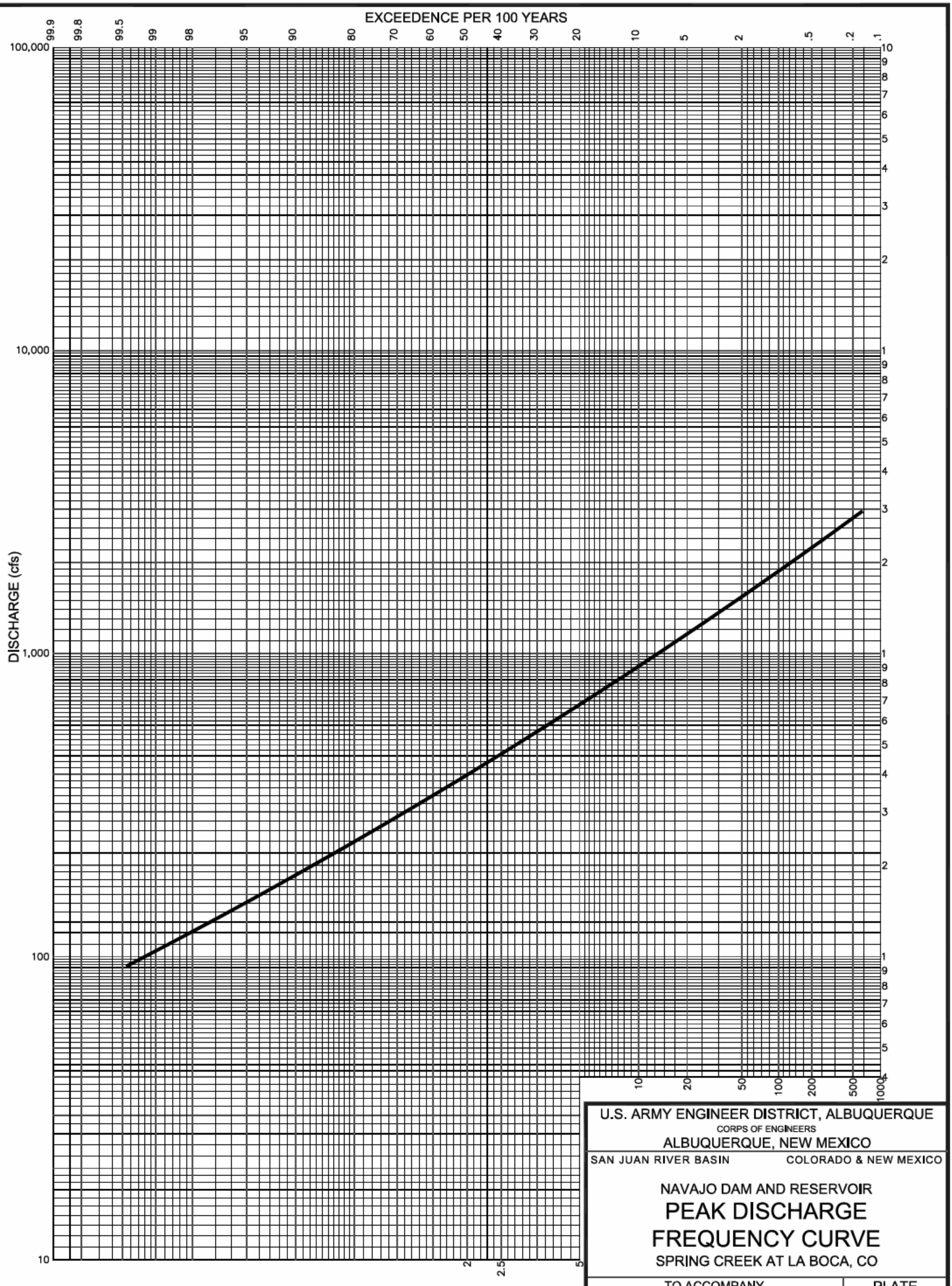
NAVAJO DAM AND RESERVOIR

PEAK DISCHARGE FREQUENCY CURVE

LOS PIÑOS RIVER AT LA BOCA, CO

TO ACCOMPANY
WATER CONTROL MANUAL
DATED 2010

PLATE
8-6



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

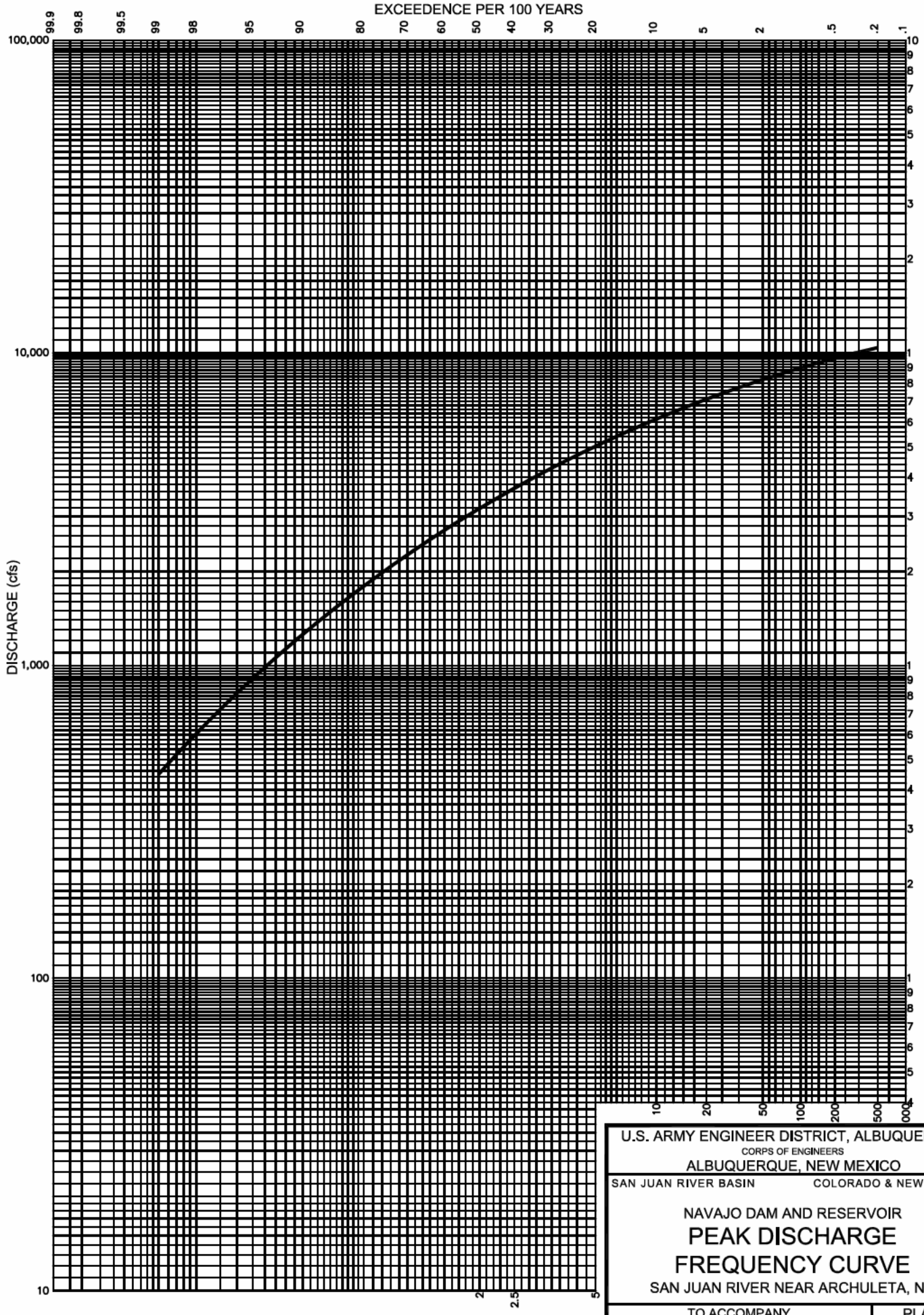
NAVAJO DAM AND RESERVOIR

PEAK DISCHARGE FREQUENCY CURVE

SPRING CREEK AT LA BOCA, CO

TO ACCOMPANY
WATER CONTROL MANUAL
DATED 2010

PLATE
8-7



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

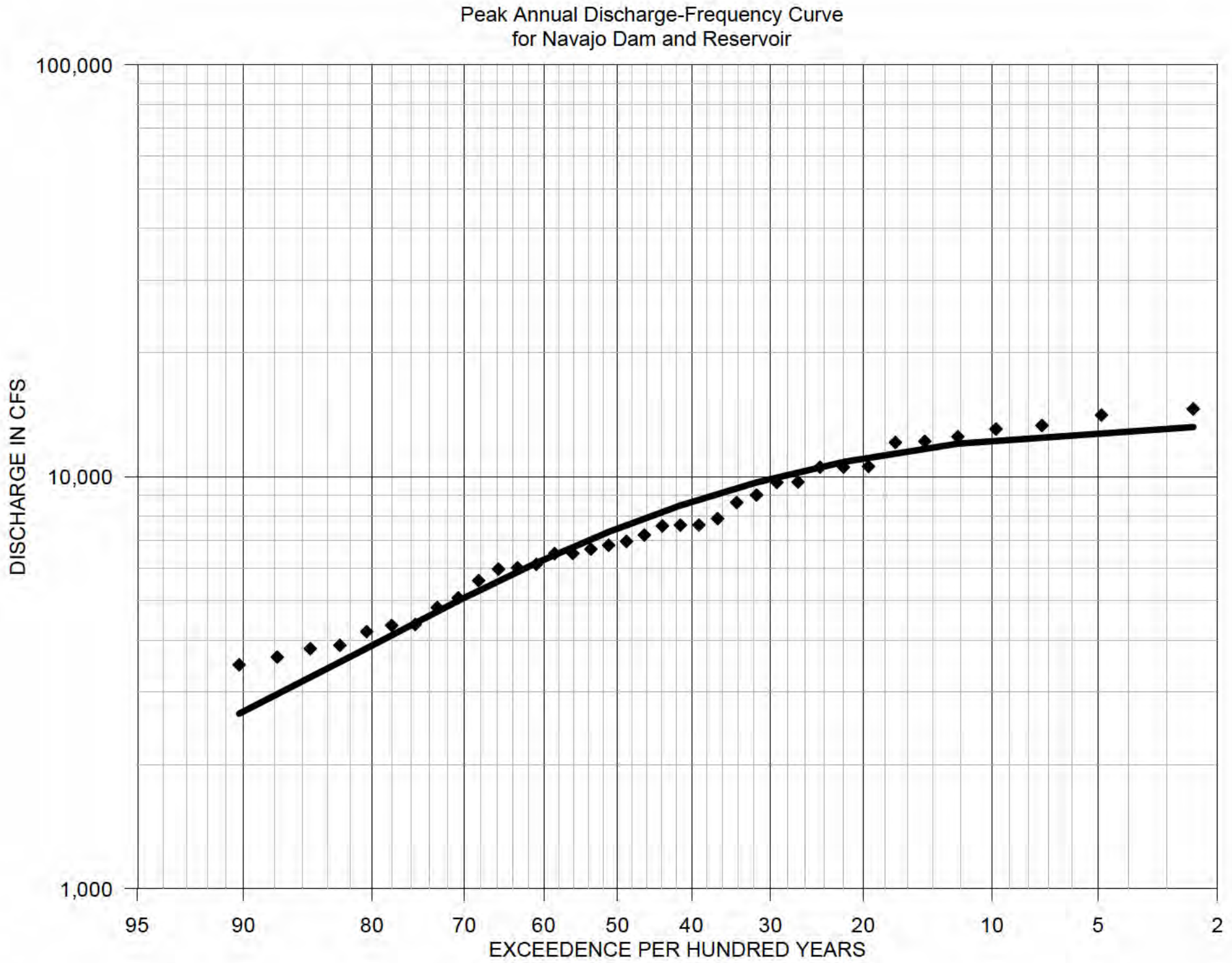
NAVAJO DAM AND RESERVOIR

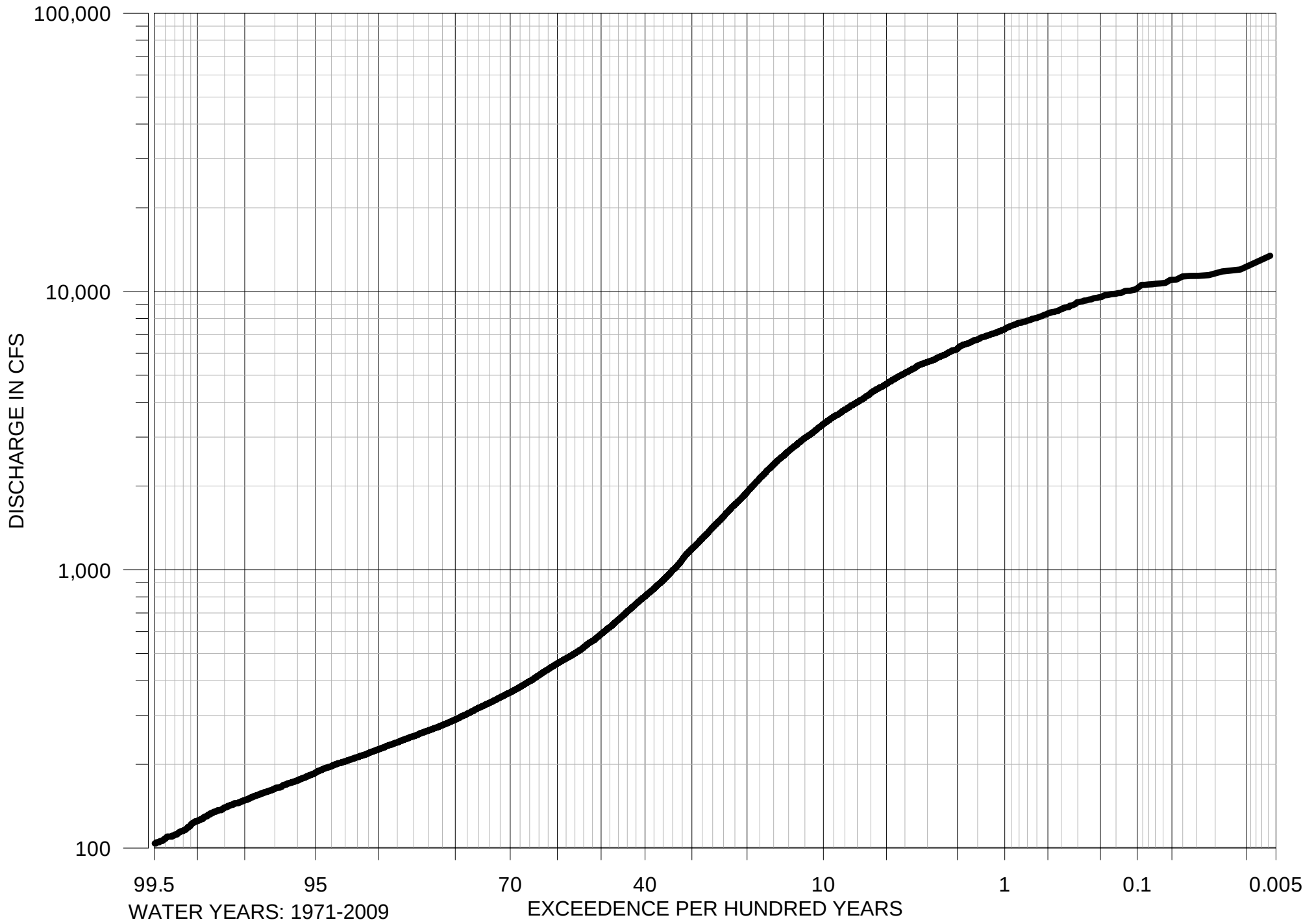
PEAK DISCHARGE FREQUENCY CURVE

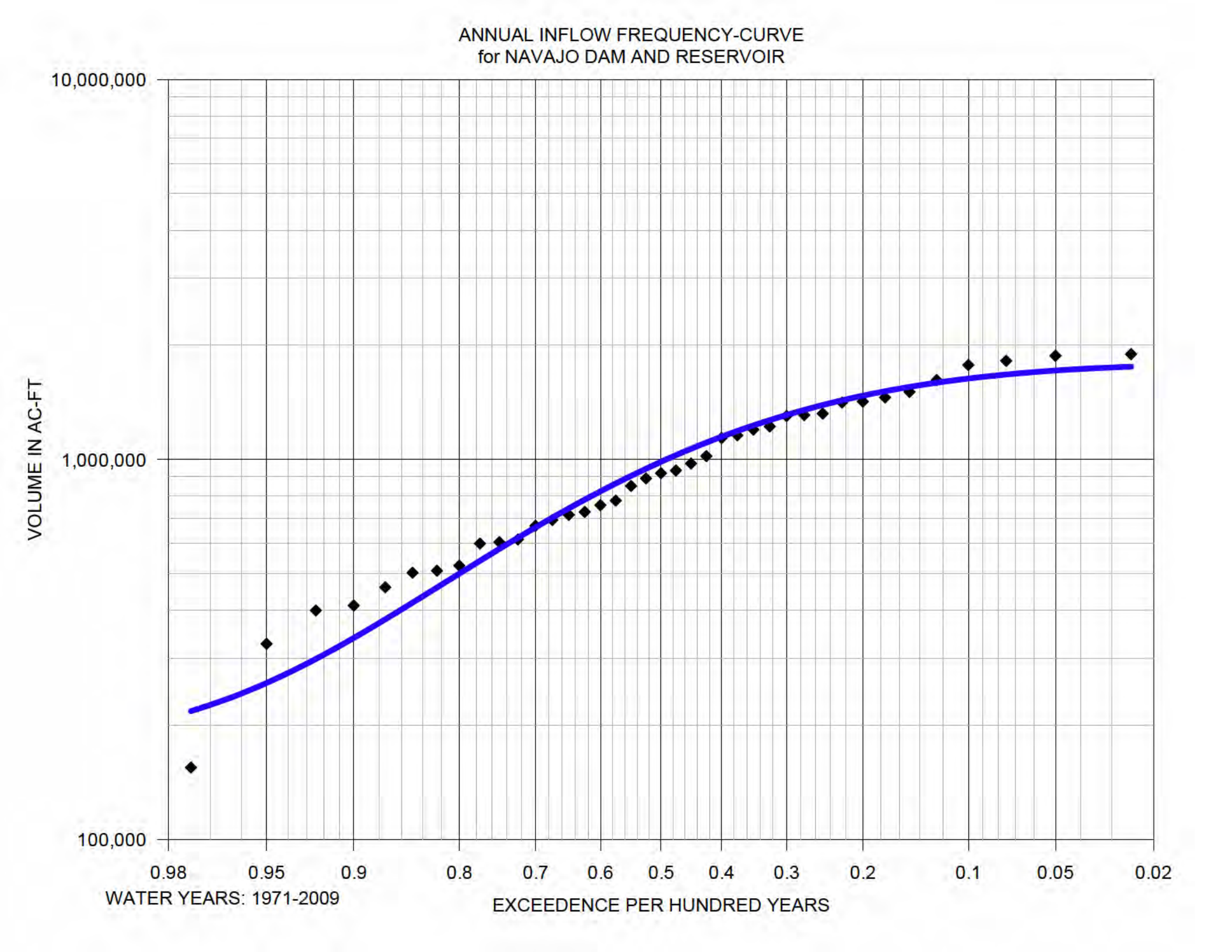
SAN JUAN RIVER NEAR ARCHULETA, NM

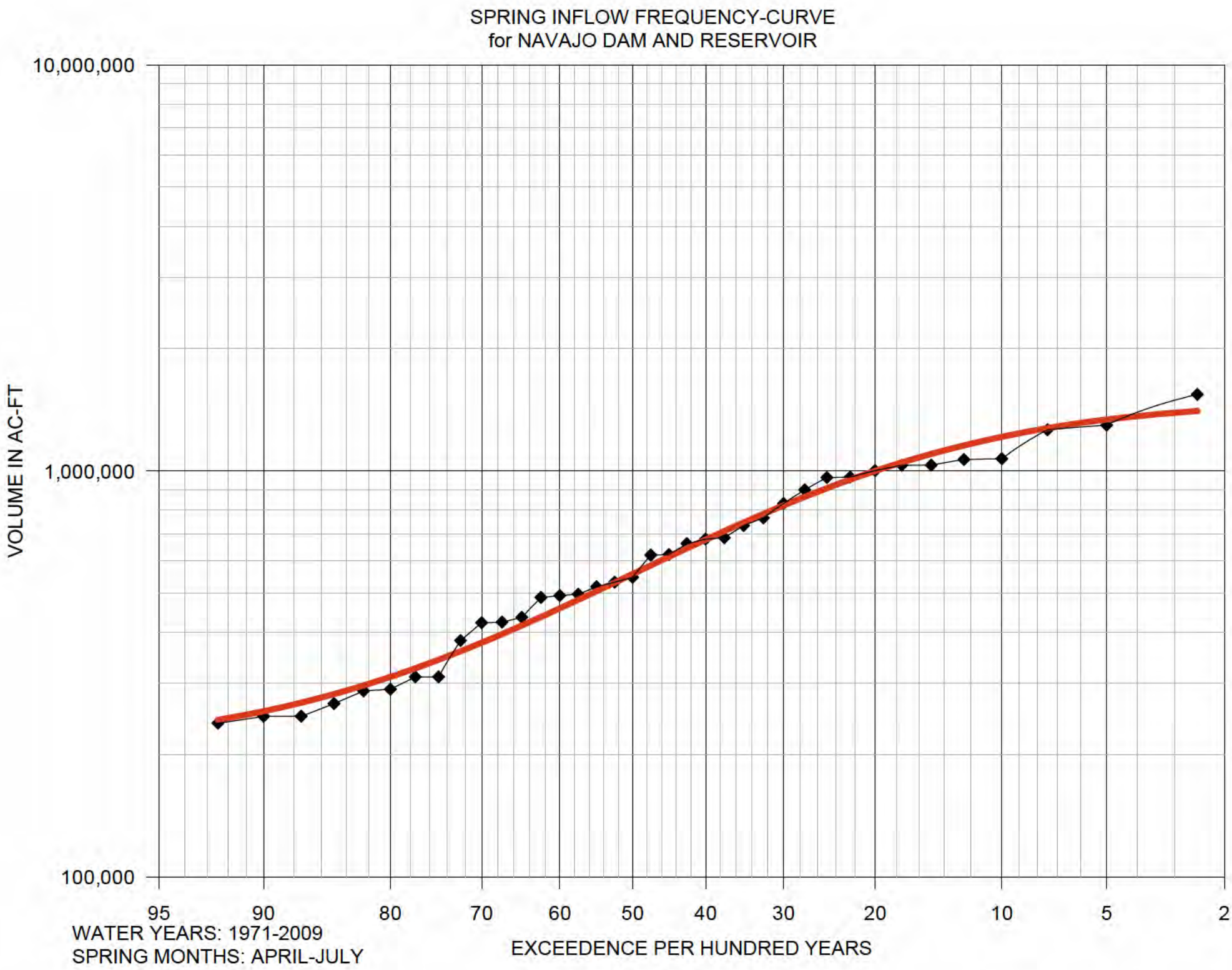
TO ACCOMPANY
WATER CONTROL MANUAL
DATED 2010

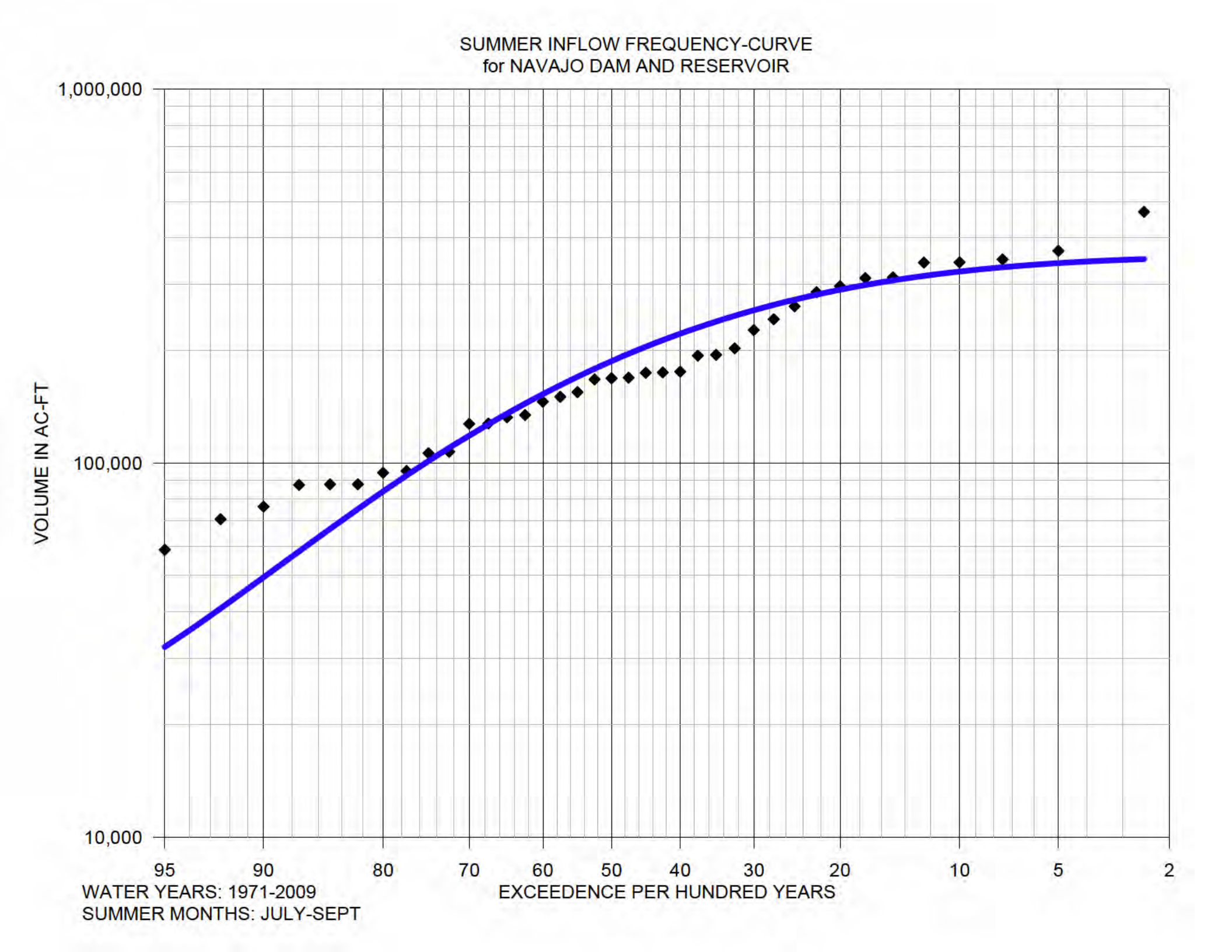
PLATE
8-8

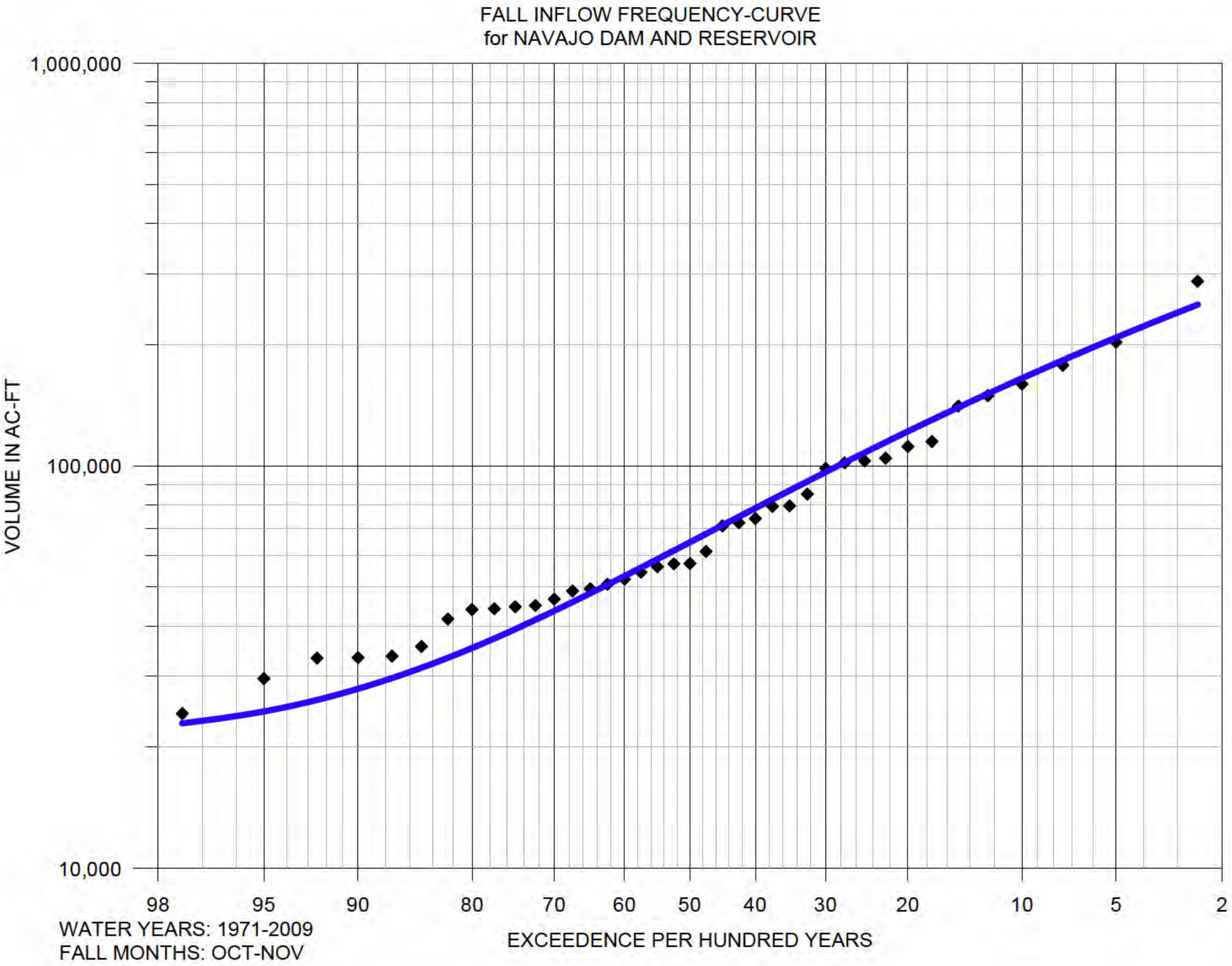

Peak Annual Discharge-Frequency Curve
for Navajo Dam and Reservoir
100,000
10,000
1,000
DISCHARGE IN CFS
95
90
80
70
60
50
40
30
20
10
5
2
EXCEEDENCE PER HUNDRED YEARS

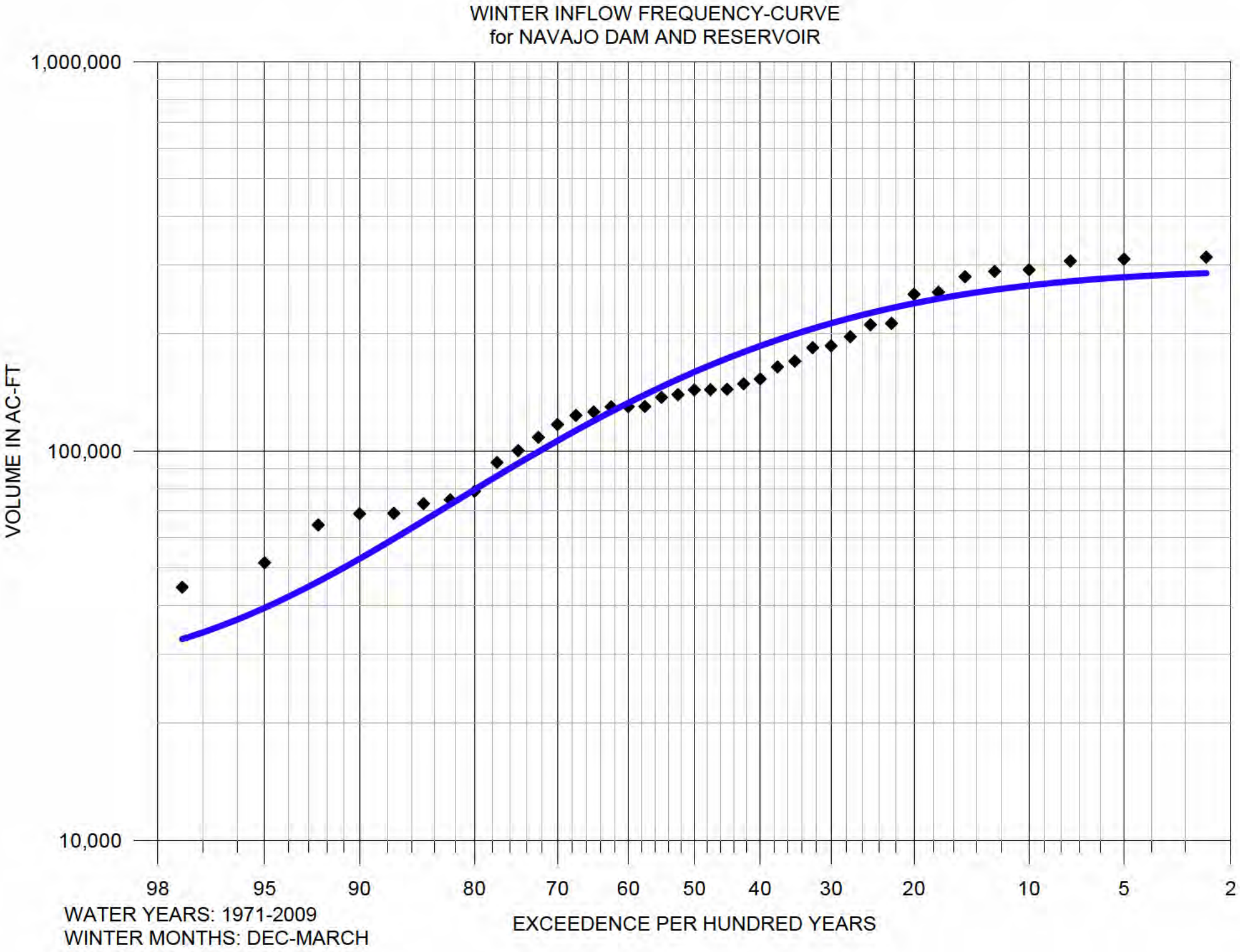

1-DAY DISCHARGE-FREQUENCY CURVE
for NAVAJO DAM AND RESERVOIR
100,000
10,000
1,000
100
DISCHARGE IN CFS
99.5
95
70
40
10
1
0.1
0.005
WATER YEARS: 1971-2009
EXCEEDENCE PER HUNDRED YEARS

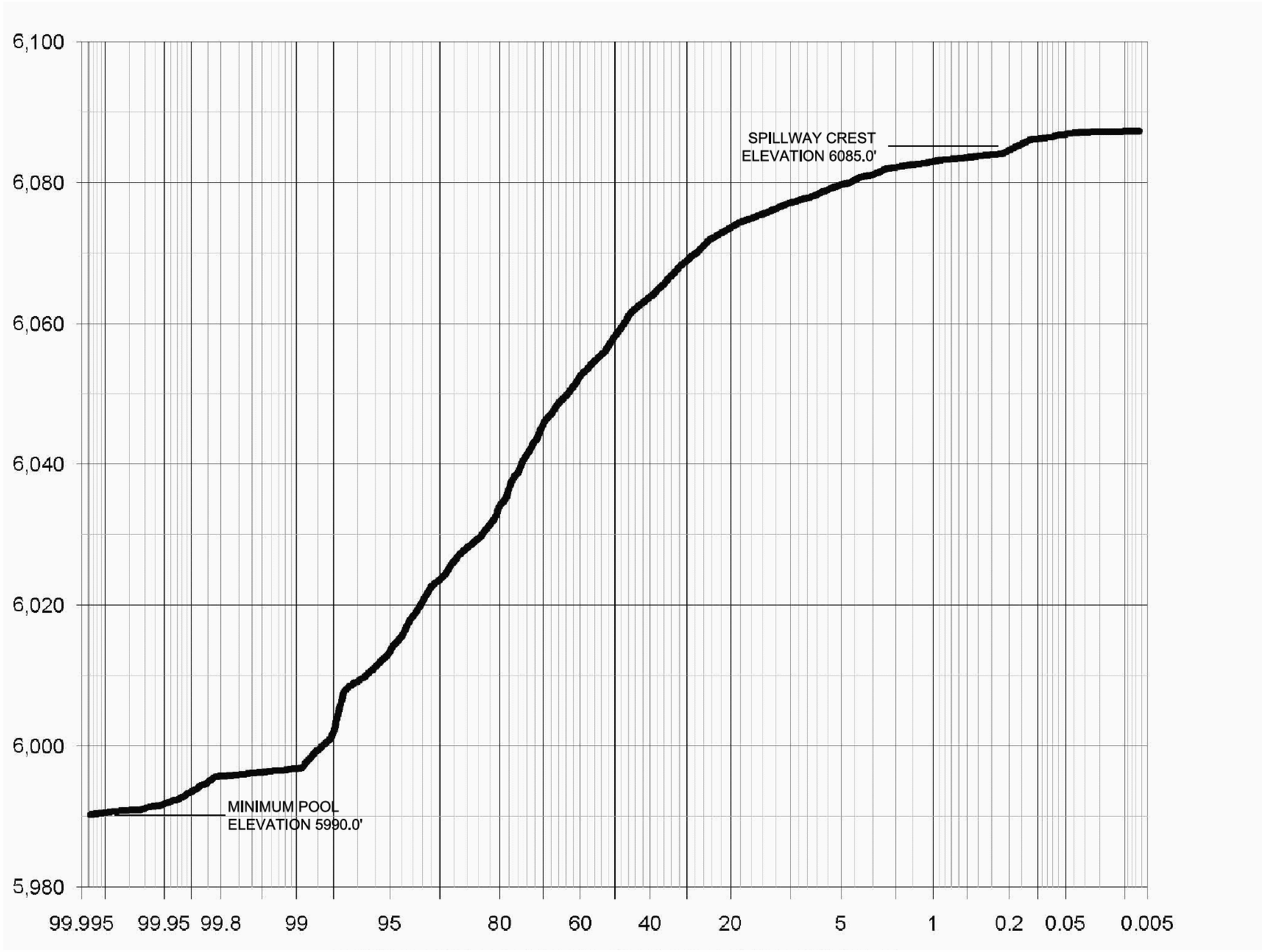

ANNUAL INFLOW FREQUENCY-CURVE
for NAVAJO DAM AND RESERVOIR
10,000,000
1,000,000
100,000
VOLUME IN AC-FT
0.98
0.95
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.05
0.02
WATER YEARS: 1971-2009
EXCEEDENCE PER HUNDRED YEARS


SPRING INFLOW FREQUENCY-CURVE
for NAVAJO DAM AND RESERVOIR
10,000,000
1,000,000
100,000
VOLUME IN AC-FT
95
90
80
70
60
50
40
30
20
10
5
2
EXCEEDENCE PER HUNDRED YEARS
WATER YEARS: 1971-2009
SPRING MONTHS: APRIL-JULY


SUMMER INFLOW FREQUENCY-CURVE
for NAVAJO DAM AND RESERVOIR
1,000,000
100,000
10,000
VOLUME IN AC-FT
95
90
80
70
60
50
40
30
20
10
5
2
EXCEEDENCE PER HUNDRED YEARS
WATER YEARS: 1971-2009
SUMMER MONTHS: JULY-SEPT


FALL INFLOW FREQUENCY-CURVE
for NAVAJO DAM AND RESERVOIR
1,000,000
100,000
10,000
VOLUME IN AC-FT
98
95
90
80
70
60
50
40
30
20
10
5
2
EXCEEDENCE PER HUNDRED YEARS
WATER YEARS: 1971-2009
FALL MONTHS: OCT-NOV


WINTER INFLOW FREQUENCY-CURVE
for NAVAJO DAM AND RESERVOIR
1,000,000
100,000
10,000
VOLUME IN AC-FT
98
95
90
80
70
60
50
40
30
20
10
5
2
EXCEEDENCE PER HUNDRED YEARS
WATER YEARS: 1971-2009
WINTER MONTHS: DEC-MARCH



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

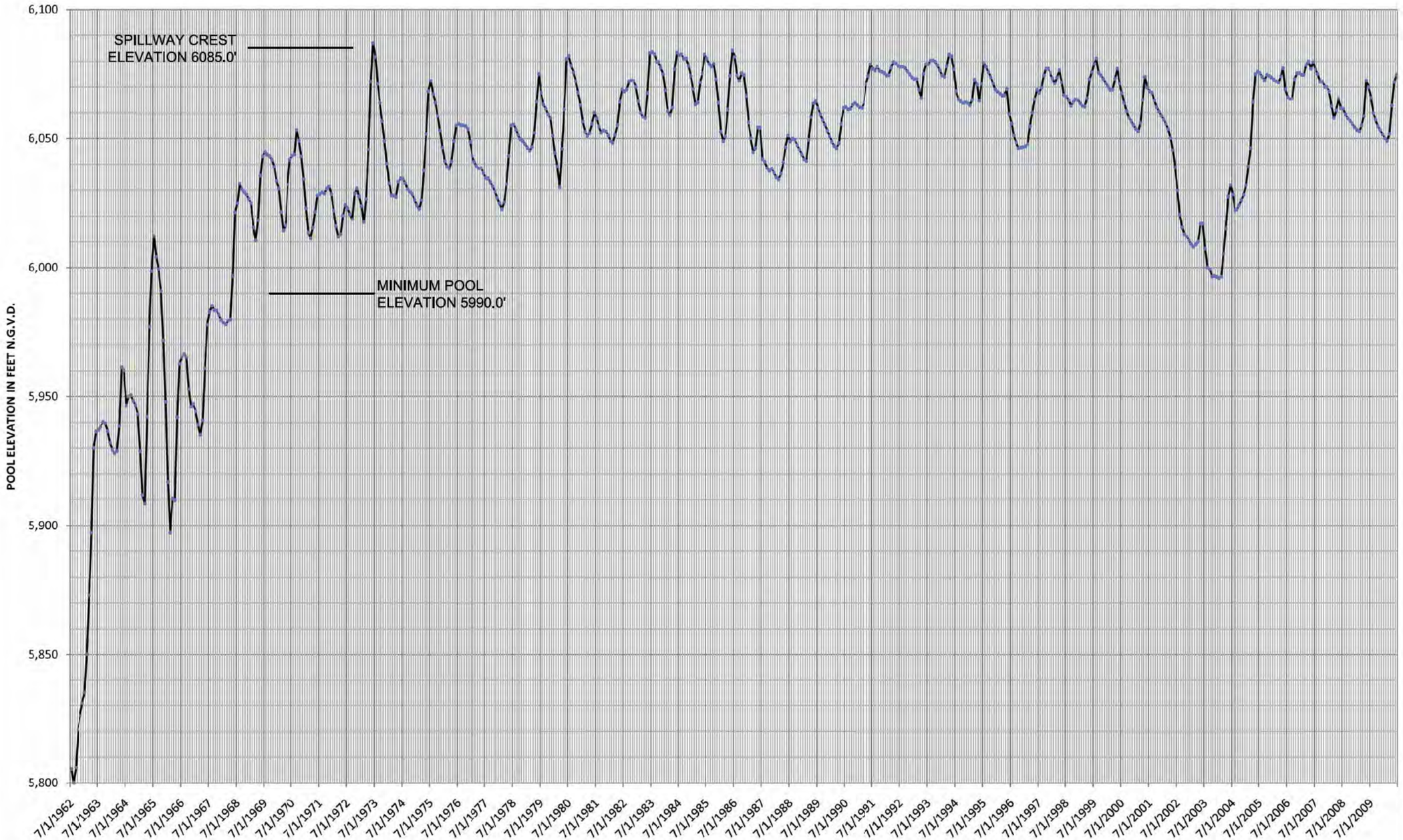
SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

POOL ELEVATION FREQUENCY CURVE

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010

PLATE
8-11



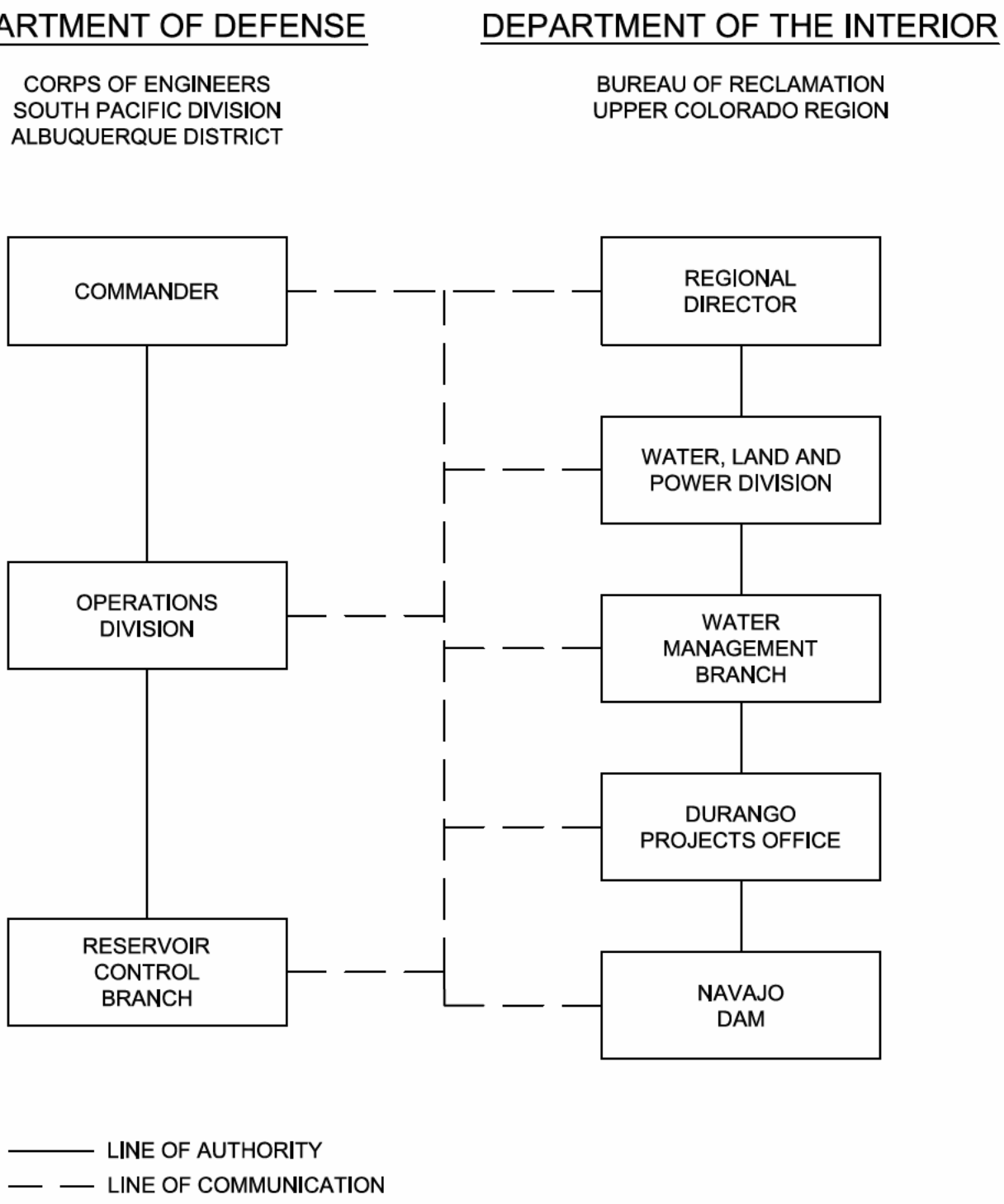
U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

NAVAJO RESERVOIR HISTORIC POOL ELEVATIONS

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE **8-12**



U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE
CORPS OF ENGINEERS
ALBUQUERQUE, NEW MEXICO

SAN JUAN RIVER BASIN — COLORADO & NEW MEXICO

NAVAJO DAM AND RESERVOIR

ORGANIZATION

TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE 9-1

EXHIBIT A – (under development)

Supplementary Pertinent Data

EXHIBIT B

Field Working Agreement

FIELD WORKING AGREEMENT
BETWEEN
DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION
AND
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS
FOR
FLOOD CONTROL OPERATION
OF
UPPER COLORADO BASIN DAMS AND RESERVOIRS
IN
COLORADO, NEW MEXICO, UTAH AND WYOMING

THIS agreement, made and entered into this 23 RD day of March 1978, between the Bureau of Reclamation and the Corps of Engineers,

WITNESSETH THAT:

WHEREAS, the Department of the Interior, acting through the Bureau of Reclamation, represented by its appropriate Regional Director, has constructed dams and reservoirs on the Upper Colorado Basin Rivers and their tributaries, and is responsible for normal operation and structural safety of the projects, and

WHEREAS, the Department of the Army, acting through the Corps of Engineers, represented by its appropriate District and Division Engineers, is responsible for the flood control operation plans of said dams and reservoirs in accordance with Section 7 of the 1944 Flood Control Act (33 U.S.C. 709) and as promulgated in Code of Federal Regulations, Title 33, Part 208.11, 15 May 1976, and

WHEREAS, there is a need for a working agreement to insure a clear understanding of the flood control regulations and information exchange required for the projects operation.

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto that the Upper Colorado Basin Projects will be operated in accordance with the following criteria:

(a) Conservation operations shall be in accordance with Bureau of Reclamation criteria as determined by the Regional Director or his designated representative.

(b) Storage space in the Upper Colorado Basin Projects shall be made available on a seasonal basis and operated for flood control in accordance with the Flood Control Diagrams currently in force.

(c) Emergency operation shall be in accordance with the procedure set forth on the Spillway Gate Operation Curves or procedures currently in force.

(d) The Regional Director is responsible for the safety of the dam and appurtenant facilities and for regulation of the Upper Colorado Basin Projects during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the Regional Director, and does not relieve the Regional Director of the responsibility for safety of the Upper Colorado Basin Projects.

(e) Revisions of the Flood Control or Spillway Gate Operation Curves and procedures may be developed as necessary by parties of this agreement. Each such revision shall be effective on the date specified.

(f) Except as necessary in order to comply with Emergency Operation procedures, the flood control regulations shall not be construed to require dangerously rapid changes in magnitude of releases. Releases will be made in a manner consistent with requirements for protecting the dam, reservoir and appurtenances from major damages.

(g) Any water impounded in the flood control space defined by the Flood Control Diagrams shall be evacuated as rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from the reservoir shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dams, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan or regulation may require releases to be completely curtailed in the interest of flood control or safety of the projects.

(h) The Regional Director shall procure such current basic hydrologic data and make such current determinations of required flood control space and releases at the reservoir as are required to accomplish the flood control objectives.

(i) The Regional Director shall keep the District Engineer advised of such reservoir operating data as the District Engineer may request. The minimum data required is reservoir storage, inflow, releases and streamflow at control points designated by the Flood Control Diagrams on a daily basis.

(j) The flood control regulations are subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the office of the Regional Director and shall include justification for the action.

(k) The Regional Director may temporarily deviate from the flood control regulations in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Division Engineer.

IN WITNESS WHEREOF, the parties hereto have caused this memorandum of agreement to be executed as the day and date first above written.

CORPS OF ENGINEERS

By: William E. Vandenberg
Division Engineer
South Pacific Division

BUREAU OF RECLAMATION

By: D. Crandall
Regional Director
Upper Colorado Region

EXHIBIT C

Upper Colorado River Basin Compact

Colorado River Compact, 1922

The States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming, having resolved to enter into a compact under the Act of the Congress of the United States of America approved August 19, 1921 (42 Statutes at Large, page 171), and the Acts of the Legislatures of the said States, have through their Governors appointed as their Commissioners:

W.S. Norviel for the State of Arizona,
W.F. McClure for the State of California,
Delph E. Carpenter for the State of Colorado,
J.G. Scrugham for the State of Nevada,
Stephen B. Davis, Jr., for the State of New Mexico,
R.E. Caldwell for the State of Utah,
Frank C. Emerson for the State of Wyoming,
who, after negotiations participated in by Herbert Hoover appointed by The President as the representative of the United States of America, have agreed upon the following articles:

ARTICLE I

The major purposes of this compact are to provide for the equitable division and apportionment of the use of the waters of the Colorado River System; to establish the relative importance of different beneficial uses of water, to promote interstate comity; to remove causes of present and future controversies; and to secure the expeditious agricultural and industrial development of the Colorado River Basin, the storage of its waters, and the protection of life and property from floods. To these ends the Colorado River Basin is divided into two Basins, and an apportionment of the use of part of the water of the Colorado River System is made to each of them with the provision that further equitable apportionments may be made.

ARTICLE II

As used in this compact

(a) The term “Colorado River System” means that portion of the Colorado River and its tributaries within the United States of America.
(b) the term “Colorado River Basin” means all of the drainage area of the Colorado River System and all other territory within the United States of America to which the waters of the Colorado River System shall be beneficially applied.
(c) The term “States of the Upper Division” means the States of Colorado, New Mexico, Utah, and Wyoming.
(d) The term “States of the Lower Division” means the States of Arizona, California, and Nevada.
(e) The term “Lee Ferry” means a point in the main stream of the Colorado River one mile below the mouth of the Paria River.

(f) The term “Upper Basin” means those parts of the States of Arizona, Colorado, New Mexico, Utah, and Wyoming within and from which waters naturally drain into the Colorado River System above Lee Ferry, and also all parts of said States located without the drainage area of the Colorado River System which are now or shall hereafter be beneficially served by waters diverted from the System above Lee Ferry.

(g) The term “Lower Basin” means those parts of the States of Arizona, California, Nevada, New Mexico, and Utah within and from which waters naturally drain into the Colorado River System below Lee Ferry, and also all parts of said States located without the drainage area of the Colorado River System which are now or shall hereafter be beneficially served by waters diverted from the System below Lee Ferry.

(h) The term “domestic use” shall include the use of water for household, stock, municipal, mining, milling, industrial, and other like purposes, but shall exclude the generation of electrical power.

ARTICLE III

(a) There is hereby apportioned from the Colorado River System in perpetuity to the Upper Basin and to the Lower Basin, respectively, the exclusive beneficial consumptive use of 7,500,000 acre-feet of water per annum, which shall include all water necessary for the supply of any rights which may now exist.

(b) In addition to the apportionment in paragraph (a), the Lower Basin is hereby given the right to increase its beneficial consumptive use of such waters by one million acre-feet per annum.

(c) If, as a matter of international comity, the United States of America shall hereafter recognize in the United States of Mexico any right to the use of any waters of the Colorado River System, such waters shall be supplied first from the waters which are surplus over and above the aggregate of the quantities specified in paragraphs (a) and (b); and if such surplus shall prove insufficient for this purpose, then, the burden of such deficiency shall be equally borne by the Upper Basin and the Lower Basin, and whenever necessary the States of the Upper Division shall deliver at Lee Ferry water to supply one-half of the deficiency so recognized in addition to that provided in paragraph (d).

(d) The States of the Upper Division will not cause the flow of the river at Lee Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years reckoned in continuing progressive series beginning with the first day of October next succeeding the ratification of this compact.

(e) The States of the Upper Division shall not withhold water, and the States of the Lower Division shall not require the delivery of water, which cannot reasonably be applied to domestic and agricultural uses.

(f) Further equitable apportionment of the beneficial uses of the waters of the Colorado River System unapportioned by paragraphs (a), (b), and (c) may be made in the manner provided in paragraph (g) at any time after October first, 1963,

if and when either Basin shall have reached its total beneficial consumptive use as set out in paragraphs (a) and (b).
(g) In the event of a desire for a further apportionment as provided in paragraph (f) any two signatory States, acting through their Governors, may give joint notice of such desire to the Governors of the other signatory States and to The President of the United States of America, and it shall be the duty of the Governors of the signatory States and of The President of the United States of America forthwith to appoint representatives, whose duty it shall be to divide and apportion equitably between the Upper Basin and Lower Basin the beneficial use of the unapportioned water of the Colorado River System as mentioned in paragraph (f), subject to the legislative ratification of the signatory States and the Congress of the United States of America.

ARTICLE IV

(a) Inasmuch as the Colorado River has ceased to be navigable for commerce and the reservation of its waters for navigation would seriously limit the development of its Basin, the use of its waters for purposes of navigation shall be subservient to the uses of such waters for domestic, agricultural, and power purposes. If the Congress shall not consent to this paragraph, the other provisions of this compact shall nevertheless remain binding.
(b) Subject to the provisions of this compact, water of the Colorado River System may be impounded and used for the generation of electrical power, but such impounding and use shall be subservient to the use and consumption of such water for agricultural and domestic purposes and shall not interfere with or prevent use for such dominant purposes.
(c) The provisions of this article shall not apply to or interfere with the regulation and control by any State within its boundaries of the appropriation, use, and distribution of water.

ARTICLE V

The chief official of each signatory State charged with the administration of water rights, together with the Director of the United States Reclamation Service and the Director of the United States Geological Survey shall cooperate, ex-officio:

(a) To promote the systematic determination and coordination of the facts as to flow, appropriation, consumption, and use of water in the Colorado River Basin, and the interchange of available information in such matters.
(b) To secure the ascertainment and publication of the annual flow of the Colorado River at Lee Ferry.
(c) To perform such other duties as may be assigned by mutual consent of the signatories from time to time.

ARTICLE VI

Should any claim or controversy arise between any two or more of the signatory States: (a) with respect to the

waters of the Colorado River System not covered by the terms of this compact; (b) over the meaning or performance of any of the terms of this compact; (c) as to the allocation of the burdens incident to the performance of any article of this compact or the delivery of waters as herein provided; (d) as to the construction or operation of works within the Colorado River Basin to be situated in two or more States, or to be constructed in one State for the benefit of another State; or (e) as to the diversion of water in one State for the benefit of another State; the Governors of the States affected, upon the request of one of them, shall forthwith appoint Commissioners with power to consider and adjust such claim or controversy, subject to ratification by the Legislatures of the States so affected.

Nothing herein contained shall prevent the adjustment of any such claim or controversy by any present method or by direct future legislative action of the interested States.

ARTICLE VII

Nothing in this compact shall be construed as affecting the obligations of the United States of America to Indian tribes.

ARTICLE VIII

Present perfected rights to the beneficial use of waters of the Colorado River System are unimpaired by this compact. Whenever storage capacity of 5,000,000 acre-feet shall have been provided on the main Colorado River within or for the benefit of the Lower Basin, then claims of such rights, if any, by appropriators or users of water in the Lower Basin against appropriators or users of water in the Upper Basin shall attach to and be satisfied from water that may be stored not in conflict with Article III.

All other rights to beneficial use of waters of the Colorado River System shall be satisfied solely from the water apportioned to that Basin in which they are situate.

ARTICLE IX

Nothing in this compact shall be construed to limit or prevent any State from instituting or maintaining any action or proceeding, legal or equitable, for the protection of any right under this compact or the enforcement of any of its provisions.

ARTICLE X

This compact may be terminated at any time by the unanimous agreement of the signatory States. In the event of

such termination all rights established under it shall continue unimpaired.

ARTICLE XI

This compact shall become binding and obligatory when it shall have been approved by the Legislatures of each of the signatory States and by the Congress of the United States. Notice of approval by the Legislatures shall be given by the Governor of each signatory State to the Governors of the other signatory States and to the President of the United States, and the President of the United States is requested to give notice to the Governors of the signatory States of approval by the Congress of the United States.

IN WITNESS WHEREOF, the Commissioners have signed this compact in a single original, which shall be deposited in the archives of the Department of State of the United States of America and of which a duly certified copy shall be forwarded to the Governor of each of the signatory States.
DONE at the City of Santa Fe, New Mexico, this twenty-fourth day of November, A.D. One Thousand Nine Hundred and Twenty-two.

W. S. NORVIEL
W. F. McCLURE
DELPH E. CARPENTER
J. G. SCRUGHAM
STEPHEN G. DAVIS, JR.
R. E. CALDWELL
FRANK C. EMERSON
Approved:
HERBERT HOOVER

EXHIBIT D

Section 7 Flood Control Regulations

(g) *Channels and floodways*—(1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities*—(1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor.

(Sec. 3, 49 Stat. 1571, as amended; 33 U.S.C. 701c)

[9 FR 9999, Aug. 17, 1944; 9 FR 10203, Aug. 22, 1944]

§ 208.11 Regulations for use of storage allocated for flood control or navigation and/or project operation at reservoirs subject to prescription of rules and regulations by the Secretary of the Army in the interest of flood control and navigation.

(a) *Purpose.* This regulation prescribes the responsibilities and general procedures for regulating reservoir projects capable of regulation for flood control or navigation and the use of storage allocated for such purposes and provided on the basis of flood control and navigation, except projects owned and operated by the Corps of Engineers; the International Boundary and Water Commission, United States and Mexico; and those under the jurisdiction of the International Joint Commission, United States, and Canada, and the Columbia River Treaty. The intent of this regulation is to establish an understanding between project owners, operating agencies, and the Corps of Engineers.

(b) *Responsibilities.* The basic responsibilities of the Corps of Engineers regarding project operation are set out in the cited authority and described in the following paragraphs:

(1) Section 7 of the Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) directs the Secretary of the Army to prescribe regulations for flood control and navigation in the following manner:

> Hereafter, it shall be the duty of the Secretary of War to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds provided on the basis of such purposes, and the operation of any such project shall be in accordance with such regulations: *Provided*, That this section shall not apply to the Tennessee Valley Authority, except that in case of danger from floods on the lower Ohio and Mississippi Rivers the Tennessee Valley Authority is directed to regulate the release of water from the Tennessee River into the Ohio River in accordance with such instructions as may be issued by the War Department.

(2) Section 9 of Public Law 436–83d Congress (68 Stat. 303) provides for the development of the Coosa River, Alabama and Georgia, and directs the Secretary of the Army to prescribe rules and regulations for project operation in the interest of flood control and navigation as follows:

> The operation and maintenance of the dams shall be subject to reasonable rules and regulations of the Secretary of the Army in the interest of flood control and navigation.

NOTE: This Regulation will also be applicable to dam and reservoir projects operated under provisions of future legislative acts wherein the Secretary of the Army is directed to prescribe rules and regulations in the interest of flood control and navigation. The Chief of Engineers, U.S. Army Corps of Engineers, is designated the duly authorized representative of the Secretary of the Army to exercise the authority set out in the Congressional Acts. This Regulation will normally be implemented by letters of understanding between the Corps of Engineers and project owner and will incorporate the provisions of such letters of understanding prior to the time construction renders the project capable of significant impoundment of water. A water control agreement signed by both parties will follow when deliberate impoundment first begins or at such time as the responsibilities of any Corps-owned projects may be transferred to another entity. Promulgation of this Regulation for a given project will occur at such time as the name of the project appears in the FEDERAL REGISTER in accordance with the requirements of paragraph 6k. When agreement on a water control plan cannot be reached between the Corps and the project owner after coordination with all interested parties, the project name will be entered in the FEDERAL REGISTER and the Corps of Engineers plan will be the official water control plan until such time as differences can be resolved.

(3) Federal Energy Regulatory Commission (FERC), formerly Federal Power Commission (FPC), Licenses.

(i) Responsibilities of the Secretary of the Army and/or the Chief of Engineers in FERC licensing actions are set forth in reference 3c above and pertinent sections are cited herein. The Commission may further stipulate as a licensing condition, that a licensee enter into an agreement with the Department of the Army providing for operation of the project during flood times, in accordance with rules and regulations prescribed by the Secretary of the Army.

(A) Section 4(e) of the Federal Power Act requires approval by the Chief of Engineers and the Secretary of the Army of plans of dams or other structures affecting the navigable capacity of any navigable waters of the United States, prior to issuance of a license by the Commission as follows:

> The Commission is hereby authorized and empowered to issue licenses to citizens * * * for the purpose of constructing, operating and maintaining dams, water conduits, reservoirs, powerhouses, transmission lines, or other project works necessary or convenient for the development and improvement of navigation and for the development, transmission, and utilization of power across, along, from or in any of the streams or other bodies of water over which Congress has jurisdiction * * * *Provided further,* That no license affecting the navigable capacity of any navigable waters of the United States shall be issued until the plans of the dam or other structures affecting navigation have been approved by the Chief of Engineers and the Secretary of the Army.

(B) Sections 10(a) and 10(c) of the Federal Power Act specify conditions of project licenses including the following:

(1) *Section 10(a).* ''That the project adopted * * * shall be such as in the judgment of the Commission will be best adapted to a comprehensive plan

for improving or developing a waterway or waterways for the use or benefit of interstate or foreign commerce, for the improvement and utilization of waterpower development, and for other beneficial public uses * * *.''

(2) *Section 10(c).* ''That the licensee shall * * * so maintain and operate said works as not to impair navigation, and shall conform to such rules and regulations as the Commission may from time to time prescribe for the protection of life, health, and property * * *.''

(C) Section 18 of the Federal Power Act directs the operation of any navigation facilities built under the provision of that Act, be controlled by rules and regulations prescribed by the Secretary of the Army as follows:

> The operation of any navigation facilities which may be constructed as part of or in connection with any dam or diversion structure built under the provisions of this Act, whether at the expense of a licensee hereunder or of the United States, shall at all times be controlled by such reasonable rules and regulations in the interest of navigation; including the control of the pool caused by such dam or diversion structure as may be made from time to time by the Secretary of the Army, * * *.

(ii) Federal Power Commission Order No. 540 issued October 31, 1975, and published November 7, 1975 (40 FR 51998), amending §2.9 of the Commission's General Policy and Interpretations prescribed Standardized Conditions (Forms) for Inclusion in Preliminary Permits and Licenses Issued Under part I of the Federal Power Act. As an example, Article 12 of Standard Form L–3, titled: ''Terms and Conditions of License for Constructed Major Projects Affecting Navigable Waters of the United States,'' sets forth the Commission's interpretation of appropriate sections of the Act, which deal with navigation aspects, and attendant responsibilities of the Secretary of the Army in licensing actions as follows:

> The United States specifically retains and safeguards the right to use water in such amount, to be determined by the Secretary of the Army, as may be necessary for the purposes of navigation on the navigable waterway affected; and the operations of the Licensee, so far as they affect the use, storage and discharge from storage of waters affected by the license, shall at all times be controlled by such reasonable rules and regulations as the Secretary of the Army may prescribe in the interest of navigation, and as the Commission may prescribe for the protection of life, health, and property, * * * and the Licensee shall release water from the project reservoir at such rate * * * as the Secretary of the Army may prescribe in the interest of navigation, or as the Commission may prescribe for the other purposes hereinbefore mentioned.

(c) *Scope and terminology.* This regulation applies to Federal authorized flood control and/or navigation storage projects, and to non-Federal projects which require the Secretary of the Army to prescribe regulations as a condition of the license, permit or legislation, during the planning, design and construction phases, and throughout the life of the project. In compliance with the authority cited above, this regulation defines certain activities and responsibilities concerning water control management throughout the Nation in the interest of flood control and navigation. In carrying out the conditions of this regulation, the owner and/or operating agency will comply with applicable provisions of Pub. L. 85–624, the Fish and Wildlife Coordination Act of 1958, and Pub. L. 92–500, the Federal Water Pollution Control Act Amendments of 1972. This regulation does not apply to local flood protection works governed by §208.10, or to navigation facilities and associated structures which are otherwise covered by part 207 (Navigation Regulations) of title 33 of the code. Small reservoirs, containing less than 12,500 acre-feet of flood control or navigation storage, may be excluded from this regulation and covered under §208.10, unless specifically required by law or conditions of the license or permit.

(1) The terms *reservoir* and *project* as used herein include all water resource impoundment projects constructed or modified, including natural lakes, that are subject to this regulation.

(2) The term *project owner* refers to the entity responsible for maintenance, physical operation, and safety of the project, and for carrying out the water control plan in the interest of flood control and/or navigation as prescribed by the Corps of Engineers. Special arrangements may be made by the

project owner for ''operating agencies'' to perform these tasks.

(3) The term *letter of understanding* as used herein includes statements which consummate this regulation for any given project and define the general provisions or conditions of the local sponsor, or owner, cooperation agreed to in the authorizing legislative document, and the requirements for compliance with section 7 of the 1944 Flood Control Act, the Federal Power Act or other special congressional act. This information will be specified in the water control plan and manual. The letter of understanding will be signed by a duly authorized representative of the Chief of Engineers and the project owner. A ''field working agreement'' may be substituted for a letter of understanding, provided that the specified minimum requirements of the latter, as stated above, are met.

(4) The term *water control agreement* refers to a compliation of water control criteria, guidelines, diagrams, release schedules, rule curves and specifications that basically govern the use of reservoir storage space allocated for flood control or navigation and/or release functions of a water control project for these purposes. In general, they indicate controlling or limiting rates of discharge and storage space required for flood control and/or navigation, based on the runoff potential during various seasons of the year.

(5) For the purpose of this regulation, the term *water control plan* is limited to the plan of regulation for a water resources project in the interest of flood control and/or navigation. The water control plan must conform with proposed allocations of storage capacity and downstream conditions or other requirements to meet all functional objectives of the particular project, acting separately or in combination with other projects in a system.

(6) The term *real-time* denotes the processing of current information or data in a sufficiently timely manner to influence a physicial response in the system being monitored and controlled. As used herein the term connotes * * * the analyses for and execution of water control decisions for both minor and major flood events and for navigation, based on prevailing hydrometeorological and other conditions and constraints, to achieve efficient management of water resource systems.

(d) *Procedures*—(1) *Conditions during project formulation.* During the planning and design phases, the project owner should consult with the Corps of Engineers regarding the quantity and value of space to reserve in the reservoir for flood control and/or navigation purposes, and for utilization of the space, and other requirements of the license, permit or conditions of the law. Relevant matters that bear upon flood control and navigation accomplishment include: Runoff potential, reservoir discharge capability, downstream channel characteristics, hydrometeorological data collection, flood hazard, flood damage characteristics, real estate acquisition for flowage requirements (fee and easement), and resources required to carry out the water control plan. Advice may also be sought on determination of and regulation for the probable maximum or other design flood under consideration by the project owner to establish the quantity of surcharge storage space, and freeboard elevation of top of dam or embankment for safety of the project.

(2) *Corps of Engineers involvement.* If the project owner is responsible for real-time implemenetation of the water control plan, consultation and assistance will be provided by the Corps of Engineers when appropriate and to the extent possible. During any emergency that affects flood control and/or navigation, the Corps of Engineers may temporarily prescribe regulation of flood control or navigation storage space on a day-to-day (real-time) basis without request of the project owner. Appropriate consideration will be given for other authorized project functions. Upon refusal of the project owner to comply with regulations prescribed by the Corps of Engineers, a letter will be sent to the project owner by the Chief of Engineers or his duly authorized representative describing the reason for the regulations prescribed, events that have transpired, and notification that the project owner is in violation of the Code of Federal Regulations. Should an

impasse arise, in that the project owner or the designated operating entity persists in noncompliance with regulations prescribed by the Corps of Engineers, measures may be taken to assure compliance.

(3) *Corps of Engineers implementation of real-time water control decisions.* The Corps of Engineers may prescribe the continuing regulation of flood control storage space for any project subject to this regulation on a day-to-day (real-time) basis. When this is the case, consultation and assistance from the project owner to the extent possible will be expected. Special requests by the project owner, or appropriate operating entity, are preferred before the Corps of Engineers offers advice on real-time regulation during surcharge storage utilization.

(4) *Water control plan and manual.* Prior to project completion, water control managers from the Corps of Engineers will visit the project and the area served by the project to become familiar with the water control facilities, and to insure sound formulation of the water control plan. The formal plan of regulation for flood control and/or navigation, referred to herein as the water control plan, will be developed and documented in a water control manual prepared by the Corps of Engineers. Development of the manual will be coordinated with the project owner to obtain the necessary pertinent information, and to insure compatibility with other project purposes and with surcharge regulation. Major topics in the manual will include: Authorization and description of the project, hydrometeorology, data collection and communication networks, hydrologic forecasting, the water control plan, and water resource management functions, including responsibilities and coordination for water control decisionmaking. Special instructions to the dam tender or reservoir manager on data collection, reporting to higher Federal authority, and on procedures to be followed in the event of a communication outage under emergency conditions, will be prepared as an exhibit in the manual. Other exhibits will include copies of this regulation, letters of understanding consummating this regulation, and the water control agreements. After approval by the Chief of Engineers or his duly authorized representative, the manual will be furnished the project owner.

(5) *Water control agreement.* (i) A water control diagram (graphical) will be prepared by the Corps of Engineers for each project having variable space reservation for flood control and/or navigation during the year; e.g., variable seasonal storage, joint-use space, or other rule curve designation. Reservoir inflow parameters will be included on the diagrams when appropriate. Concise notes will be included on the diagrams prescribing the use of storage space in terms of release schedules, runoff, nondamaging or other controlling flow rates downstream of the damsite, and other major factors as appropriate. A water control release schedule will be prepared in tabular form for projects that do not have variable space reservation for flood control and/or navigation. The water control diagram or release schedule will be signed by a duly authorized representative of the Chief of Engineers, the project owner, and the designated operating agency, and will be used as the basis for carrying out this regulation. Each diagram or schedule will contain a reference to this regulation.

(ii) When deemed necessary by the Corps of Engineers, information given on the water control diagram or release schedule will be supplemented by appropriate text to assure mutual understanding on certain details or other important aspects of the water control plan not covered in this regulation, on the water control diagram or in the release schedule. This material will include clarification of any aspects that might otherwise result in unsatisfactory project performance in the interest of flood contol and/or navigation. Supplementation of the agreement will be necessary for each project where the Corps of Engineers exercises the discretionary authority to prescribe the flood control regulation on a day-to-day (real-time) basis. The agreement will include delegation of the responsibility. The document should also cite, as appropriate, section 7 of the 1944 Flood Control Act, the Federal Power

Act and/or other congressional legislation authorizing construction an/or directing operation of the project.

(iii) All flood control regulations published in the FEDERAL REGISTER under this section (part 208) of the code prior to the date of this publication which are listed in § 208.11(e) are hereby superseded.

(iv) Nothing in this regulation prohibits the promulgation of specific regulations for a project in compliance with the authorizing acts, when agreement on acceptable regulations cannot be reached between the Corps of Engineers and the owner.

(6) *Hydrometeorological instrumentation.* The project owner will provide instrumentation in the vicinity of the damsite and will provide communication equipment necessary to record and transmit hydrometeorological and reservoir data to all appropriate Federal authorities on a real-time basis unless there are extenuating circumstances or are otherwise provided for as a condition of the license or permit. For those projects where the owner retains responsibility for real-time implementation of the water control plan, the owner will also provide or arrange for the measurement and reporting of hydrometeorological parameters required within and adjacent to the watershed and downstream of the damsite, sufficient to regulate the project for flood control and/or navigation in an efficient manner. When data collection stations outside the immediate vicinity of the damsite are required, and funds for installation, observation, and maintenance are not available from other sources, the Corps of Engineers may agree to share the costs for such stations with the project owner. Availability of funds and urgency of data needs are factors which will be considered in reaching decisions on cost sharing.

(7) *Project safety.* The project owner is responsible for the safety of the dam and appurtenant facilities and for regulation of the project during surcharge storage utilization. Emphasis upon the safety of the dam is especially important in the event surcharge storage is utilized, which results when the total storage space reserved for flood control is exceeded. Any assistance provided by the Corps of Engineers concerning surcharge regulation is to be utilized at the discretion of the project owner, and does not relieve the owner of the responsibility for safety of the project.

(8) *Notification of the general public.* The Corps of Engineers and other interested Federal and State agencies, and the project owner will jointly sponsor public involvement activities, as appropriate, to fully apprise the general public of the water control plan. Public meetings or other effective means of notification and involvement will be held, with the initial meeting being conducted as early as practicable but not later than the time the project first becomes operational. Notice of the initial public meeting shall be published once a week for 3 consecutive weeks in one or more newspapers of general circulation published in each county covered by the water control plan. Such notice shall also be used when appropriate to inform the public of modifications in the water control plan. If no newspaper is published in a county, the notice shall be published in one or more newspapers of general circulation within that county. For the purposes of this section a newspaper is one qualified to publish public notices under applicable State law. Notice shall be given in the event significant problems are anticipated or experienced that will prevent carrying out the approved water control plan or in the event that an extreme water condition is expected that could produce severe damage to property or loss of life. The means for conveying this information shall be commensurate with the urgency of the situation. The water control manual will be made available for examination by the general public upon request at the appropriate office of the Corps of Engineers, project owner or designated operating agency.

(9) *Other generalized requirements for flood control and navigation.* (i) Storage space in the reservoirs allocated for flood control and navigation purposes shall be kept available for those purposes in accordance with the water control agreement, and the plan of regulation in the water control manual.

(ii) Any water impounded in the flood control space defined by the water control agreement shall be evacuated as

rapidly as can be safely accomplished without causing downstream flows to exceed the controlling rates; i.e., releases from reservoirs shall be restricted insofar as practicable to quantities which, in conjunction with uncontrolled runoff downstream of the dam, will not cause water levels to exceed the controlling stages currently in force. Although conflicts may arise with other purposes, such as hydropower, the plan or regulation may require releases to be completely curtailed in the interest of flood control or safety of the project.

(iii) Nothing in the plan of regulation for flood control shall be construed to require or allow dangerously rapid changes in magnitudes of releases. Releases will be made in a manner consistent with requirements for protecting the dam and reservoir from major damage during passage of the maximum design flood for the project.

(iv) The project owner shall monitor current reservoir and hydro- meteorological conditions in and adjacent to the watershed and downstream of the damsite, as necessary. This and any other pertinent information shall be reported to the Corps of Engineers on a timely basis, in accordance with standing instructions to the damtender or other means requested by the Corps of Engineers.

(v) In all cases where the project owner retains responsibility for real-time implementation of the water control plan, he shall make current determinations of: Reservoir inflow, flood control storage utilized, and scheduled releases. He shall also determine storage space and releases required to comply with the water control plan prescribed by the Corps of Engineers. The owner shall report this information on a timely basis as requested by the Corps of Engineers.

(vi) The water control plan is subject to temporary modification by the Corps of Engineers if found necessary in time of emergency. Requests for and action on such modifications may be made by the fastest means of communication available. The action taken shall be confirmed in writing the same day to the project owner and shall include justification for the action.

(vii) The project owner may temporarily deviate from the water control plan in the event an immediate short-term departure is deemed necessary for emergency reasons to protect the safety of the dam, or to avoid other serious hazards. Such actions shall be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Corps of Engineers and shall include justification for the action. Continuation of the deviation will require the express approval of the Chief of Engineers, or his duly authorized representative.

(viii) Advance approval of the Chief of Engineers, or his duly authorized representative, is required prior to any deviation from the plan of regulation prescribed or approved by the Corps of Engineers in the interest of flood control and/or navigation, except in emergency situations provided for in paragraph (d)(9)(vii) of this section. When conditions appear to warrant a prolonged deviation from the approved plan, the project owner and the Corps of Engineers will jointly investigate and evaluate the proposed deviation to insure that the overall integrity of the plan would not be unduly compromised. Approval of prolonged deviations will not be granted unless such investigations and evaluations have been conducted to the extent deemed necessary by the Chief of Engineers, or his designated representatives, to fully substantiate the deviation.

(10) *Revisions.* The water control plan and all associated documents will be revised by the Corps of Engineers as necessary, to reflect changed conditions that come to bear upon flood control and navigation, e.g., reallocation of reservoir storage space due to sedimentation or transfer of storage space to a neighboring project. Revision of the water control plan, water control agreement, water control diagram, or release schedule requires approval of the Chief of Engineers or his duly authorized representative. Each such revision shall be effective upon the date specified in the approval. The original (signed document) water control agreement shall be kept on file in the respective Office the Division Engineer, Corps of Engineers, Department of the

Army, located at division offices throughout the continental USA. Copies of these agreements may be obtained from the office of the project owner, or from the office of the appropriate Division Engineer, Corps of Engineers.

(11) *Federal Register.* The following information for each project subject to section 7 of the 1944 Flood Control Act and other applicable congressional acts shall be published in the FEDERAL REGISTER prior to the time the projects becomes operational and prior to any significant impoundment before project completion or * * * at such time as the responsibility for physical operation and maintenance of the Corps of Engineers owned projects is transferred to another entity:

(i) Reservoir, dam, and lake names,

(ii) Stream, county, and State corresponding to the damsite location,

(iii) The maximum current storage space in acre-feet to be reserved exclusively for flood control and/or navigation purposes, or any multiple-use space (intermingled) when flood control or navigation is one of the purposes, with corresponding elevations in feet above mean sea level, and area in acres, at the upper and lower limits of said space,

(iv) The name of the project owner, and

(v) Congressional legislation authorizing the project for Federal participation.

(e) *List of projects.* The following tables, ''Pertinent Project Data—Section 208.11 Regulation,'' show the pertinent data for projects which are subject to this regulation.

LIST OF PROJECTS

[Non-Corps projects with Corps Regulation Requirements]

Project name [1]	State	County	Stream [1]	Project purpose [2]	Storage 1000 AF	Elev limits feet M.S.L.		Area in acres		Authorizing legis. [3]	Proj. owner [4]
						Upper	Lower	Upper	Lower		
Col. No. 1	2	3	4	5	6	7	8	9	10	11	12
Agency Valley Dam & Res	OR	Malheur	N Fork Malheur R	FICR	60 0	3340.0	3263.0	1900	0	PL 68–292	USBR.
Alpine Dam	IL	Winnebago	Keith Cr	F	0 6	796.0	760.0	52	0	PWA Proj	Rkfd, L.
Altus Dam & Res	OK	Jackson	N Fork Red R	F	19.6	1562.0	1559.0	6800	6260	PL 761	USBR.
				IMR	132 6	1559.0	1517.5P	6260	735		
Anderson Ranch Dam & Res	ID	Elmore	S Fk Boise R	FEI	423 2	4196.0	4039.6	4740	1150	Act of 1939 53 Stat 1187.	USBR.
Arbuckle Dam & Res	OK	Murray	Rock Cr	F	36.4	885.3	872.0	3130	2350	PL 594	USBR.
				MRC	62.5	872.0	827.0	2350	606		
Arrowrock Dam & Res	ID	Elmore	Boise R	FI	286.6	3216.0	2974.0	3100	200	Act of 1902 32 Stat 388.	USBR.
Bear Cr Dam	MO	Marion Ralls	Bear Cr	F	8.7	546.5	520.0	540	0	PL 83–780	Hnbl, MO.
Bear Swamp Fife Brook (Lo)	MA	Franklin	Deerfield R	E	6 9	870.0	830.0	152	115	FERC 2669	NEPC.
Bear Swamp PS (Upper)	MA	Franklin	Deerfield R Trib	E	8 9	1600.0	1550.0	118	102	Fed Pwr Act	NEPC.
Bellows Falls Dam & Lk	VT	Cheshire	Connecticut R	E	7 5	291.6	273.6	2804	836	FERC 1885	NEPC.
Big Dry Creek and Div	CA	Fresno	Big Dry Cr & Dog Cr.	F	16 2	425.0	393.0	1530	0	PL 77–228	Rclm, B CA.
Blue Mesa Dam & Res	CO	Gunnison	Gunnison R	FER	748.5	7519.4	7393.0	9180	2790	PL 84–485	USBR
Boca Dam & Res	CA	Nevada	Little Truckee R	I	32.8	5596.5	5521.0	873	52	PL 61–289	USBR.
				FI	8.0	5605.0	5596.0	980	873	PL 68–292	
Bonny Dam & Res	CO	Yuma	S Fork Republic R	F	128 2	3710.0	3672.0	5036	2042	PL 78–534	USBR.
				ICR	39.2	3672.0	3638.0	2042	331	PL 79–732	
Boysen Dam & Res	WY	Fremont	Wild R	F	150.4	4732.2	4725.0	22170	19560	PL 78–534	USBR.
				FEIQ	146.1	4725.0	4717.0	19560	16960		
				EIQ	403 8	4717.0	4685.0	16960	9280		
Brantley Dam & Res	NM	Eddy	Pecos R	FIRQ	348.5	3283.0	3210.7	21294	38	PL 92–515	USBR.
Brownlee Dam & Res	OR ID	Baker Washington	Snake R	FE	975 3	2077.0	1976.0	13840	6650	FERC No 1971–C	ID Pwr.
Bully Cr Dam & Res	OR	Malheur	Bully Cr	FI	31 6	2516.0	2456.8	1082	140	PL 86–248	USBR.
Camanche Dam & Res	CA	San Joaquin	Mokelumne R	FRIE	200 0	235.5	205.1	7600	5507	PL 86–645	EB-MUD.
				R E	230 9	205.1	92.0	5507	0		
Canyon Ferry Dam & Lk	MT	Lewis Clark	Missouri R	F	99.5	3800.0	3797.0	33535	32800	PL 78–534	USBR.
				FEI	795.1	3797.0	3770.0	32800	24125		
				EI	711 5	3770.0	3728.0	24125	11480		
Cedar Bluff Dam & Res	KS	Trego	Smoky Hill R	F	191 9	2166.0	2144.0	10790	6869	PL 78–534	USBR.
				IMCR	149 8	2144.0	2107.8	6869	2086		
Cheney Dam & Res	KS	Sedgwick	N Fork Ninnescah R.	F	80.9	1429.9	1421.6	12420	9540	PL 86–787	USBR.
				MC	151 8	1421.6	1392.9	9540	1970		
					0.0	0.0	0.0	0	0		

LIST OF PROJECTS—Continued

[Non-Corps projects with Corps Regulation Requirements]

Project name [1]	State	County	Stream [1]	Project purpose [2]	Storage 1000 AF	Elev limits feet M.S.L.		Area in acres		Authorizing legis. [3]	Proj. owner [4]
						Upper	Lower	Upper	Lower		
Col. No. 1	2	3	4	5	6	7	8	9	10	11	12
Clark Canyon Dam & Res	MT	Beaverhead	Beaverhead R	F	79.1	5560.4	5546.1	5900	5160	PL 78–534	USBR.
				FI	50.4	5546.1	5535.7	5160	4495		
				I	126.1	5535.7	5470.6	4495	220		
Del Valle Dam & Res	CA	Alameda	Alameda Cr	F	37.0	745.0	703.1	1060	710	PL 87–874	DWR.
				FIM	1.0	703.1	702.2	710	700		CA.
				IMR	29.0	702.2	635.0	700	275		
Don Pedro Dam & Lk	CA	Tuolumne	Tuolumne R	FIER	340.0	830.0	802.0	12900	11260	PL 78–534	M&T.
				EIR	1381 0	802.0	600.0	11260	3520		Irr.
					308.0	600.0	342.0	3520	29		
East Canyon Dam & Res	UT	Morgan	East Canyon Cr	FEIM	48 0	5705.5	5578.0	684	130	PL 81–273	USBR.
Echo Dam & Res	UT	Summit	Weber R	FEIM	74 0	5560.0	5450.0	1455	0	PL 81–83	USBR.
Emigrant Dam & Res	OR	Jackson	Emigrant Cr	FIR	39 0	2241.0	2131.5	801	80	PL 83–606	USBR.
Enders Dam & Res	NE	Chase	Frenchman Cr	F	30.0	3127.0	3112.3	2405	1707	PL 78–534	USBR.
				ICR	34.5	3112.3	3082.4	1707	658	PL 84–505	
Folsom Dam & Lk	CA	Sacramento	American R	FEIM	400 0	466.0	427.0	11450	9040		USBR.
				EIM	610 0	427.0	210.0	9040	0		
Fort Cobb Dam & Res	OK	Caddo	Pond (Cobb) Cr	F	63.7	1354.8	1342.0	5980	4100	PL 419	USBR.
				IMCR	78.3	1342.0	1300.0	4100	337		
Foss Dam & Res	OK	Custer	Washita R	F	180 6	1668.6	1652.0	13140	8800	PL 419	USBR.
				IMRC	243.8	1652.0	1597.2	8800	1360		
Friant Dam & Millerton Lk	CA	Fresno	San Joaquin R	FEIM	390 5	578.0	466.3	4850	2101	PL 75–392	USBR.
										PL 76–868	
Galesville Dam	OR	Douglas	Cow Cr	FEMCR	42 2	1881.5	1780.0	760	150	FERC No. 71	Dgls, CO.
										61001	
Gaston Dam & Res	NC	Halifax	Roanoke R	FE	63 0	203.0	200.0	22500	20300	Fed Pwr Act	VA Pwr.
		Northampton									
Glen Elder Dam & Waconda Lk	KS	Mitchel	Solomon R	F	722 3	1488.3	1455.6	33682	12602	PL 78–534	USBR.
				IM	204 8	1455.6	1428.0	12602	3341	PL 79–526	
Glendo Dam & Res	WY	Platte	N Platte R	F	271 9	4653.0	4635.0	17990	12370	PL 78–534	USBR.
				EIM	454.3	4635.0	4570.0	12370	3130		
Grand Coulee Dam & FDR Lk	WA	Okanogan Grant	Columbia R	FEI	5185 5	1290.0	1208.0	82280	45592	PL 89–561	USBR.
H Neely Henry Dam & Res	AL	Calhoun St. Clair	Coosa R	FE	49.7	508.0	502.5	11235	7632	PL 83–436	AL Pwr.
Harris Dam & Res	AL	Randolph	Tallapoosa R	FE	215 0	793.0	785.0	10661	9012	PL 89–789	AL Pwr.
Heart Butte Dm & Lk Tschida	ND	Grant	Heart R	F	147 9	2094.5	2064.5	6580	3400	PL 78–534	USBR.
				IQ	69.0	2064.5	2030.0	3400	810		
Hells Canyon Dam & Res	OR	Wallowa	Snake R	EN	11.7	1688.0	1683.0	2380	2280	FERC No 1971–A	ID Pwr.
	ID	Adams									
Hoover Dam & Lk Mead	NV	Clark Mohave	Colorado R	F	1500 0	1229.0	1219.6	162700	156500	PL 70–642	USBR.
	AZ			FEIMCAR	15 8	1219.6	1083.0	156500	83500		
Hungry Horse Dam & Res	MT	Flathead	S Fork Flathead R	FEI	2982 0	3560.0	3336.0	23800	5400	PL 78–329	USBR.

Indian Valley Dam & Res	CA	Lake	N Fork Cache Cr	FIMR	40.0	1485.0	1474.0	3975	3734	PL 84–984	Yolo FC&W.
				IMR	260 0	1474.0	1334.0	3734	308		
Jamestown Dam & Res	ND	Stutsman	James R	F	185.4	1454.0	1429.8	13210	2090	PL 78–534	USBR.
				IQ	28.1	1429.8	1400.0	2090	160		
Jocassee Dam & Res	SC	Pickens	Keowee R	PRFC	1160 0	1110.0	1080.0	7565	6815	FERC 2503	USBR Pwr.
Keowee Dam & Lk	SC	Pickens	Keowee R	FPMCAR	392 0	800.0	775.0	18372	13072	FERC 2503	Duke Pwr.
Kerr Dam Flathead Lk	MT	Lake	Flathead R	FER	1219.0	2893.0	2883.0	125560	120000	FERC No 5	MT Pwr.
Kerr Dam & Lk Hudson (Markham Ferry Project).	OK	Mayes	Grand Neosho R	F	244 2	636.0	619.0	18800	10900	PL 76–476	GRD Auth.
				E	48.6	619.0	599.0	10900	4500		
Keyhole Dam & Res	WY	Crook	Belle Fourche R	F	140.5	4111.5	4099.3	13730	9410	PL 78–534	USBR.
				IQ	185 8	4099.3	4051.0	9410	820		
Kirwin Dam & Res	KS	Phillips	N Fork Solomon R	F	215.1	1757.3	1729.3	10640	5080	PL 78–534	USBR.
				ICR	89 6	1729.2	1697.0	5080	1010	PL 79–732; PL 79–526.	
Lake Kemp Dam & Res	TX	Wichita	Wichita R	F	234.9	1156.0	1144.0	23830	15590	SD 144	WF&C.
				MI	268 0	1144.0	1114.0	15590	3350		WID2.
Leesville Dam & Res	VA	Campbell Pttsylvnia.	Roanoke R	EQ	37 8	613.0	600.0	3235	2400	Fed Pwr Act	Appl Pwr.
Lemon Dam & Res	CO	La Plata	Florida R	FIM	39 0	8148.0	8023.0	622	62	PL 84–485	USBR.
Lewis M Smith Dam & Res	AL	Walker Culman	Sipsey Fork; Black Warrior R.	F	280.6	522.0	510.0	25700	21200	Fed Pwr Act	AL Pwr.
				E	394 3	510.0	488.0	21200	15097		
Little Wood	ID	Blain	Little Wood R	FI	30 0	5237.3	5127.4	572	0	PL 84–993	USBR.
Logan Martin Dam & Res	AL	Talladega	Cossa R	F	245 3	477.0	465.0	26310	15260	PL 83–436	AL Pwr.
				E	67.0	465.0	460.0	15263	11887		
Los Banos Dam & Detention	CA	Merced	Los Banos Cr	R	20.6	327.8	231.2	467	0		USBR.
Los Banos Dam & Detention Res.	CA	Merced	Los Banos Cr	F	14.0	353.5	327.8	619	467	PL 86–488	USBR.
Lost Creek Dam & Res	UT	Morgan	Lost Cr	FEIM	20.0	6005.0	5912.0	365	93	PL 81–273	USBR.
Lovewell Dam & Res	KS	Jewell	White Rock Cr	F	50.5	1595.3	1582.6	5025	2986	PL 78–534	USBR.
				ICR	24.9	1582.6	1571.7	2986	1704	PL 79–732	
Marshall Ford Dam & Res	TX	Travis	Colorado R	F	779.8	714.0	681.0	29060	18955	PL 73–392	USBR.
				NE M	810 5	681.0	618.0	18955	8050	PL 78–534	
Mayfield Dam & Res	WA	Lewis	Cowlitz R	FER	21.4	425.0	415.0	2250	2030	FPC No 2016–A	Tac WN.
McGee Creek Dam & Res	OK	Atoka	McGee Cr	F	85.3	595.5	577.1	5540	3810	PL 94–423	USBR.
				MCR	108.0	577.7	515.1	3810	370		
Medicine Cr Dam Harry Strunk Lk.	NE	Frontier	Medicine Cr	F	52.7	2386.2	2366.1	3483	1840	PL 78–534	USBR.
				ICR	26.8	2366.1	2343.0	1840	701	PL 84–505	
Mossyrock Dam Davisson Lk	WA	Lewis	Cowlitz R	FER	1397 0	778.5	600.0	11830	4250	FERC No 2016–B	Tac, WN
Mt Park Dam Tom Steed Res	OK	Kiowa	W Otter Cr	F	20.3	1414.0	1411.0	7130	6400	PL 90–503	USBR.
				MRC	89.0	1411.0	1386.3	6400	1270		
Navajo Dam & Res	NM	San Juan Rio Arriba	San Juan R	FEIRQ	1036.1	6085.0	5990.0	15610	7400	PL 84–485	USBR.
New Bullards Bar Dam & Res	CA	Yuba	Yuba R	FEIMR	170.0	1956.0	1918.3	4809	4225	PL 89–298	YCWA.
				EIMR	790 9	1918.3	1447.5	4225	129		
New Exchequer Dam & Lk	CA	Tuolumne	Merced R	FEIR	400.0	867.0	799.7	7110	4849	PL 86–645	Mrcd, Irr.
				EIR	451 6	799.7	660.0	4849	1900		
				IR	171.0	660.0	467.0	1900	150		
New Melones Dam & Lk	CA	Tuolumne Calaveras	Stanislaus R	FEIMR	450 0	1088.0	1049.5	12500	10900	PL 87–874	USBR.
				EIMR	1670.0	1049.5	808.0	10900	3500		
				IMR	300 0	808.0	540.0	3500	0		

LIST OF PROJECTS—Continued

[Non-Corps projects with Corps Regulation Requirements]

Project name [1]	State	County	Stream [1]	Project purpose [2]	Storage 1000 AF	Elev limits feet M.S.L.		Area in acres		Authorizing legis. [3]	Proj. owner [4]
						Upper	Lower	Upper	Lower		
Col. No. 1	2	3	4	5	6	7	8	9	10	11	12
Northfield Mt (Up) PS	MA	Franklin	Connecticut	E	14 0	965.0	938.0	196	134	FERC 1889	WMEC.
Norton Dam & Kieth Sebelius Lk.	KS	Norton	Prairie Dog Cr	F	98.8	2331.4	2304.3	5316	2181	PL 78–534	USBR.
				IMRC	30.7	2304.3	2280.4	2181	587	PL 79–526	
										PL 79–732	
Ochoco Dam & Res	OR	Crook	Ochoco Cr	FICR	52 5	3136.2	0.0	1130	130	PL 84–992	USBR.
Oroville Dam & Lk	CA	Butte	Feather R	FEIMAR	750 0	900.0	848.5	15800	13346	PL 85–500	CA.
				EIMAR	2788.0	848.5	210.0	13346	0		
Pactola Dam & Res	SD	Pennington	Rapid Cr	F	43.1	4621.5	4580.2	1230	860	PL 78–534	USBR.
				IM	55.0	4580.2	4456.1	860	100		
Palisades Dam & Res	ID	Bonneville	Snake R	FIE	1202 0	5620.0	5452.0	16100	2170	PL 81–864	USBR.
Paonia Dam & Res	CO	Gunnision	Muddy Cr	FIR	17.0	6447.5	6373.0	334	120	PL 80–177	USBR.
										PL 84–485	
Pensacola Dam Grand Lake O' the Cherokees.	OK	Mayes	Grand (Neosho) R	F	525 0	755.0	745.0	59200	46500	PL 77–228	Grd, Auth.
				E	1192.0	745.0	705.0	46500	17000		
Pineview Dam & Res	UT	Weber	Odgen R	FEIM	110.0	4900.0	4818.0	2874	0	PL 81–273	USBR.
Platoro Dam & Res	CO	Conejos	Conejos R	F	6.0	10034.0	10027.5	947	920	PL 76–640	USBR.
				IR	54 0	10027.5	9911.0	920	0		
Priest Rapids Dam & Res	WA	Grant	Columbia R	FER	44 0	488.0	481.5	7600	6500	FERC No 2114–A	Grnt, PUD.
Prineville Dam & Res	OR	Crook	Crooked R	FIRC	233 0	3257.9	3114.0	3997	140	PL–84–992	USBR.
Prosser Cr Dam & Res	CA	Nevada	Prosser Cr	C	8.6	5703.7	5661.0	334	86	PL 84–858	USBR.
				FC	20 0	5761.0	5703.7	745	334	PL 85–706	
Pueblo Dam & Res	CO	Pueblo	Arkansas R	F	93.0	4898.7	4880.5	5671	4640	PL 87–590	USBR.
				IR	261.4	4880.5	4764.0	4640	421		
Red Willow Dam Hugh Butler Lk.	NE	Frontier	Red Willow Cr	F	48.9	2604.9	2581.8	2682	1629	PL 78–534	USBR.
				IRC	27.3	2581.8	2558.0	1629	787	PL 85–783	
										PL 84–505	
Ririe Dam & Res	ID	Bonneville	Willow Cr	FIRC	99 0	5119.0	5023.0	150	360	PL 87–874	USBR.
Roanoke Rapids Dam & Res	NC	Halifax	Roanoke R	EC	16 8	132.0	128.0	4600	4100	FPC 2009	VA, Pwr.
Rocky Reach Dam Lk Entiat	WA	Chelan	Columbia R	FER	36 0	707.0	703.0	9920	9490	FERC No 2145	Chln PUD.
Rocky River PS Lk Candlewood	CT	Litchfield	Housatonic R	E	142 5	430.0	418.0	5608	4692	FERC 2576	CLPC.
Ross Dam & Res	WA	Whatcom	Skagit R	E	1052 0	1602.5	1475.0	11700	4450	FERC 553	Sttl.
Sanford Dam & Lk Meredith	TX	Hutchison	Canadian R	F	462.1	2965.0	2941.3	21640	17320	PL 81–898	USBR.
				IMCRQ	761 3	2941.3	2860.0	17320	4500		
Savage River Dam & Res	MD	Garrett	Savage R	FMA	20 0	1468.5	1317.0	366	0	PL 78–534	Ptmc Comm.
Scoggins Dam Henry Hagg Lk			Scoggins Cr	FIR	56 3	305.8	235.3	116	4	PL 89–596	USBR.
Shadehill Dam & Res	SD	Perkins	Grand R	F	218 3	2302.0	2271.9	9900	4800	PL 78–534	USBR.
				IQ	80.9	2271.9	2250.8	4800	2800		
Shasta Dam Lk	CA	Shasta	Sacramento R	FEIA	1300.0	1067.0	1018.6	29570	23894	PL 75–392	USBR.
				EIA	3241 0	1018.6	735.8	23894	2200		
Shepaug Dam & Lk	CT	Litchfield	Housatonic R	E	5 0	200.0	172.0	1882	1125	FERC 2576	CLPC.

Smith Mtn Dam & Res	VA	Bedford Franklin Roanoke Pttsylvnia	Roanoke R	E	40 8	795.0	793.0	20600	20200	Fed Pwr Act	Appl Pwr.
Stampede Dam & Res	CA	Sierra	Little Truckee R	FEM	22.0	5949.0	5942.1	3430	3230	PL 84–858	USBR.
				EM	199.4	5942.0	5798.0	3230	210		
Starvation Dam and Res	UT	Duchesne	Strawberry R	FIM	165.3	5712.0	5595.0	3310	689	PL 84–485	USBR.
Stevens Creek Dam & Res	GA	Columbia	Savannah River	P	10.5	187.5	183.0	4300	0	FERC 2535	SC E&G.
Stevenson Dam Lk Zoar	CT	Litchfield	Housatonic R	E	5 0	108.0	80.0	1148	516	FERC 2576	CLPC.
Summer Dam & Lk	NM	De Baca	Pecos R	FI	51.4	4261.0	4200.0	2835	0	PL 83–780	USBR.
Tat Momolikot Dam & Lake	AZ	Pinal	Santa Rosa Wash	FIC	198.5	1539.0	1480.0	11790	0	PL 89–298	BIA.
Tiber Dam & Res	MT	Libert Toole	Marias R	F	400 9	3012.5	2993.0	23150	17890	PL 78–534	USBR.
				FIQ	268 0	2993.0	2976.0	17890	13790		
				IQ	121.7	2976.0	2966.4	13790	11710		
Trenton Dam & Res	NB	Hitchcock	Republican R	F	134.1	2773.0	2752.0	7940	4922	PL 78–534	USBR.
				IRC	99 8	2752.0	2720.0	4922	1572	PL 84–505	
Turners Falls (Low) Dam & Lk	MA	Franklin	Connecticut R	E	8.7	185.0	176.0	2110	1880	FERC 1889	WMEC
Twin Buttes Dam & Lake	TX	Tom Green	Concho R	F	454.4	1969.1	1940.2	23510	23510	PL 85–152	USBR
				IM	150 0	1940.2	1885.0	9080	670	PL 78–534	
Twitchell Dam & Res	CA	Santa Barbara	Cuyama R	F	89.8	651.5	623.0	3671	2556	PL 83–774	USBR
				IM	135.6	623.0	504.0	2556	0		
Upper Baker Dam Baker Lk	WA	Whatcom	Baker R	FE	184.6	724.0	674.0	4985	2375	PL 89–298	Pgt
										FERC 2150B	P&L
Vallecito Dam & Res	CO	La Plata	Los Pinos R	FEI	125.4	7665.0	7582.5	2720	350	PL 61–288	USBR
										PL 68–292	
Vernon Dam & Lk	VT	Windham	Connecticut R	E	18.3	220.1	212.1	2550	1980	FERC 1904	NEPC
Wanapum Dam & Res	WA	Grant	Columbia R	FER	151 6	571.5	560.0	14300	13350	FERC No 2114–B	Grnt PUD
Wanship Dam & Rockport	UT	Summit	Weber R	FEIM	61 0	6037.0	5930.0	1077	121	PL 81–273	USBR
Warm Springs Dam & Res	OR	Malheur	Middle Fork Malheur R.	FICR	191.0	3406.0	3327.0	460	90	PL 78–534	Vale USBR
Waterbury Dam & Res	VT	Washington	Little R	FP	27.7	617.5	592.0	1330	890	PL 78–534	VT
Webster Dam & Res	KS	Rocks	S Fork Solomon R	F	183.4	1923.7	1892.5	8480	3772	PL 78–534	USBR
				IRC	72.1	1892.5	1860.0	3772	906	PL 79–526	
										PL 79–732	
Weiss Dam & Res	AL	Cherokee	Coosa R	F	397 0	574.0	564.0	50000	30200	PL 83–436	AL Pwr
				E	148.4	564.0	558.0	30200	19545		
Wells Dam L Pateros	WA	Douglas	Columbia R	FER	74 0	781.0	771.0	10000	8000	FERC No 2149	Dgls PUD
Wilder Dam & Lk	VT	Windsor	Connecticut R	E	13 3	385.0	380.0	3100	2240	FERC 1893	NEPC
Yellowtail Dam & Bighorn Lk	MT	Big Horn	Bighorn R	F	258 3	3657.0	3640.0	17280	12600	PL 78–534	USBR
				FEIQ	240 3	3640.0	3614.0	12600	6915		PUD
				EIQ	336.1	3614.0	3547.0	6915	4150		

[1] Cr—Creek; CS—Control Structure; Div—Diversion; DS—Drainage Structure; FG—Floodgate; Fk—Fork; GIWW—Gulf Intercoastal Waterway; Lk—Lake; L&D—Lock & Dam; PS—Pump Station; R—River; Res—Reservoir

[2] F—Flood Control; N—Navigation; P—Corps Hydropower; E—Non Corps Hydropower; I—Irrigation; M—Municipal and/or Industrial Water Supply; C—Fish and Wildlife Conservation; A—Low Flow Augmentation or Pollution Abatement; R—Recreation; Q—Water Quality or Silt Control

[3] FCA—Flood Control Act; FERC—Federal Energy Regulatory Comm; HD—House Document; PL—Public Law; PW—Public Works; RHA—River & Harbor Act; SD—Senate Document; WSA—Water Supply Act

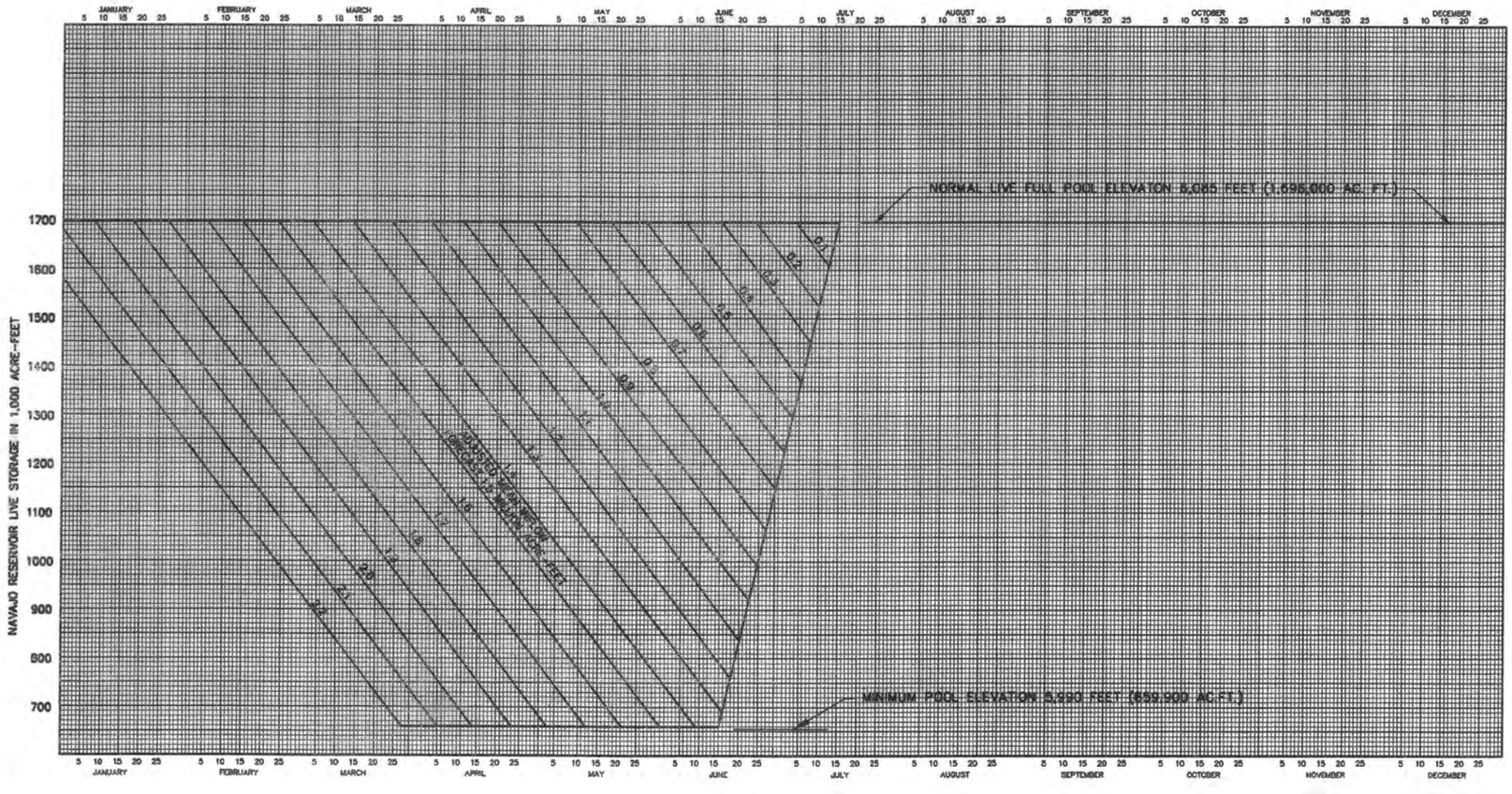
[4] Appl Pwr—Appalachian Power; Chln PUD—Chelan Cnty PUD 1; CLPC—CT Light & Power Co; Dgls PUD—Douglas Cnty PUD 1; DWR—Department of Water Resources; EB–MUD—East Bay Municipal Utility Dist; GRD—Grand River Dam Auth; Grnt PUD—Grant Cnty PUD 2; Hnbl—city of Hannibal; M&T Irr—Modesto & Turlock Irr; Mrcd Irr—Merced Irr; NEPC—New England Power Co; Pgnt P&L—Pugent Sound Power & Light; Ptmc Comm—Upper Potomac R Comm; Rclm B—Reclamation Board; Rkfd—city of Rockford; Sttl—city of Seattle; Tac—City of Tacoma; Vale USBR—50% Vale Irr 50% USBR; WF&CW D—City of Wichita Falls and Wichita Cnty Water Improvement District No. 2; WMEC—Western MA Electric Co; YCWA—Yuba City Water Auth; Yolo FC&W—Yolo Flood Control & Water Conserv Dist

(Sec. 7, Pub. L. 78–534, 58 Stat. 890 (33 U.S.C. 709); the Federal Power Act, 41 Stat. 1063 (16 U.S.C. 791(A)); and sec. 9, Pub. L. 83–436, 68 Stat. 303)

[43 FR 47184, Oct. 13, 1978, as amended at 46 FR 58075, Nov. 30, 1981; 55 FR 21508, May 24, 1990]

EXHIBIT E

Flood Control Diagram



USE OF DIAGRAM

1. THE COORDINATED FEDERAL AGENCY (NWS AND SCS) FORECASTED MEAN INFLOWS (50% PROBABILITY) ARE ADJUSTED FOR UPSTREAM DEPLETIONS INCLUDING ESTIMATED SAN JUAN–CHAMA DIVERSIONS AND VALLECITO RESERVOIR CHANGE IN STORAGE.

2. PARAMETER VALUES FOR THE OPERATING DIAGRAM ARE ADJUSTED FORECASTED MEAN INFLOWS IN MILLIONS OF ACRE–FEET BETWEEN THE GIVEN DATE AND 1 AUGUST.

3. WHENEVER THE RESERVOIR CONTENT IN NAVAJO RESERVOIR IS GREATER THAN THAT ALLOWED BY THE OPERATING DIAGRAM, WATER SHALL BE RELEASED AS RAPIDLY AS CAN BE SAFELY ACCOMPLISHED WITHOUT CAUSING FLOWS IN THE SAN JUAN RIVER BELOW NAVAJO DAM TO EXCEED 5,000 CUBIC FEET PER SECOND (CFS) FROM THE DAM TO FARMINGTON, AND 12,000 CFS FROM FARMINGTON (BELOW ANIMAS RIVER CONFLUENCE) THROUGH SHIPROCK, NEW MEXICO.

4. WHEN WATER IS STORED ABOVE NORMAL FULL POOL (ELEV. 6,085) THE OUTLETS MAY BE REGULATED SUCH THAT THE COMBINED SPILLWAY AND CONTROLLED RELEASE DO NOT CAUSE FLOWS IN THE SAN JUAN RIVER BELOW NAVAJO DAM TO EXCEED 5,000 CFS FROM THE DAM TO FARMINGTON, AND 12,000 CFS FROM FARMINGTON (BELOW ANIMAS RIVER CONFLUENCE) THROUGH SHIPROCK, NEW MEXICO, INSOFAR AS POSSIBLE.

5. THIS DIAGRAM IS IN ACCORDANCE WITH SECTION 7 OF THE FLOOD CONTROL ACT OF 1944 AND PARAGRAPH 208.11, TITLE 33, OF THE CODE OF FEDERAL REGULATIONS.

6. THERE IS NO EXCLUSIVE FLOOD CONTROL SPACE IN NAVAJO RESERVOIR DURING THE PERIOD 15 JULY THROUGH 31 DECEMBER.

APPROVED: _____
ROLAND ROBISON
REGIONAL DIRECTOR
U.S. BUREAU OF RECLAMATION
UPPER COLORADO REGIONAL OFFICE
AUTHORIZED REPRESENTATIVE
OF THE COMMISSIONER

APPROVED: _____
M.G. ERNEST J. HARRELL
COMMANDER
WESTERN DIVISION
CORPS OF ENGINEERS
AUTHORIZED REPRESENTATIVE
OF THE CHIEF OF ENGINEERS

U.S. ARMY ENGINEER DISTRICT, ALBUQUERQUE CORPS OF ENGINEERS ALBUQUERQUE, NEW MEXICO	
SAN JUAN RIVER BASIN	COLORADO & NEW MEXICO
NAVAJO DAM AND RESERVOIR EXHIBIT E RESERVOIR CONTROL DIAGRAM	
TO ACCOMPANY WATER CONTROL MANUAL DATED 2010	PLATE EXHIBIT E

EXHIBIT F

Standing Instructions to the Project Operator

WATER CONTROL MANUAL

NAVAJO DAM AND RESERVOIR

San Juan River, New Mexico

EXHIBIT F

STANDING INSTRUCTIONS TO THE PROJECT OPERATORS

FOR

NAVAJO DAM AND RESERVOIR

U.S. Army Corps of Engineers
Albuquerque District
Albuquerque, New Mexico

STANDING INSTRUCTIONS TO THE PROJECT OPERATORS
FOR
NAVAJO DAM AND RESERVOIR
SAN JUAN RIVER, NEW MEXICO

Paragraph | Table of Contents | Page

F-01. Background and Responsibilities

a. General Information

(1). Standing Instructions to the project operators is essential to ensure efficient and safe operation of the project at all times. The instructions apply to project operators, power plant superintendents, resource managers and other operators in a similar position. Any physical operating constraints should be within design limitations and clearly outlined to ensure that water control features are operated in a safe manner during all phases of the project's life.

This exhibit is prepared in accordance with instructions contained in EM 1110-2-3600 and ER 1110-2-241. All elevations in this manual are based on the National Geodetic Vertical Datum of 1929 (NGVD29).

This exhibit pertains to duties and responsibilities of the project operator, in connection with the flood control operation of Navajo Dam, and the reporting of required hydrologic/meteorologic data. A copy of these Standing Instructions must be kept on hand at all times. Any deviation from the Standing Instructions will require approval of the District Engineer or designee. For information on personnel telephone numbers refer to Table 5-1 in Chapter 5 of this Water Control Manual (WCM). Operational instructions to the project operator are briefly outlined with specific emphasis on the project operator’s duties and responsibilities during extreme flood emergencies when communication facilities between the operator and the USBR’s Facilities Resource Group, Southern Division, Western Colorado Area Office (WCAO-SD), located in Durango, Colorado, may be disrupted. It is designed to be used with the WCM

(2) Navajo Dam and Reservoir will be operated for flood control in accordance with rules and regulations prescribed by the Code of Federal Regulations Title 33, Part 222.5 and Part 208.11, and the Field Working Agreement for Navajo Dam and Reservoir. Chapter 7 of the WCM and the Flood Control Diagram, Exhibit E, define the requirements for the flood control regulation of Navajo Reservoir. The flood control objectives are:

(a) To control flows into the San Juan River below Navajo Dam to the confluence of the Animas River, insofar as possible, to not exceed the current estimated non-damaging safe channel capacity of 5,000 cfs; thus not endangering life and property in the flood plain. The dam will also control flows in the San Juan River to 12,000 cfs at Farmington and at Shiprock.

(b) Change in release rates will normally be limited to the greater of 200 cfs or 10 % of flow in any two-hour period.

(c) To permit use of the maximum practical amount of storage reservation for conservation without impairing the flood control functions.

(3) The operation of Navajo Dam and Reservoir is performed by USBR personnel under the direction of the USBR, Durango, Colorado. Therefore, the communication chain in this project is as follows:

(a) Western Colorado Area Office - Southern Division (WCAO-SD), Durango, Colorado

(b) Upper Colorado Regional Office, Salt Lake City, Utah

(c) Denver Office, Denver, Colorado

d) Commissioner's Office, Washington, D.C.

(4) The Navajo Dam is located in San Juan County, New Mexico on the San Juan River, about 300 miles upstream from its confluence with the Colorado River. It is about 33 miles east of Farmington, NM.

(5) The required flood control reservation varies up to a maximum of 1,036,100 acre-feet from 1 January to 15 July. This reservation varies, according to snowmelt parameters, based on the remaining forecasted snowmelt runoff issued by the CBRFC through 1 July. A 50 percent exceedence forecast is used for computing the top of conservation storage for the Water Control Diagram. Consultation with the CBRFC on forecasts is also done. The parameter is computed daily by subtracting the previous day's runoff from the remaining forecasted runoff through 31 July. The variable storage provides for the required flood control reservation, while allowing the space below the flood control pool to be filled for conservation purposes. Year round minimum releases are made to satisfy the direct flow rights of downstream irrigators and also fishery requirements. Minimum fishery flows are 250 cfs below the dam and 500 cfs below Farmington.

(6) The physical operation and maintenance of Navajo Dam is performed by USBR personnel. All operational reports are provided to the USBR's WCAO-SD, in Durango,

b. Role of U.S. Bureau of Reclamation. The USBR's WCAO-SD is responsible for the following, which apply to both normal conditions (not dependent on day-to-day instruction) and all emergency conditions (flood or drought):

(1) Overseeing and directing project personnel in the operation of Navajo Dam and Reservoir in accordance with the official regulations.

(2) Following deviation procedure process explicitly for any proposed or emergency deviations from the Water Control Plan. See Exhibit I for types of deviations and process.

(3) Reporting to the District Engineer, or designee, Albuquerque District, U.S. Army Corps of Engineers, any unusual condition in the reservoir or along downstream channels that might interfere with the approved flood control operation of the reservoir.

(4) Taking reasonable steps to inform the public of significant changes in flood control releases.

(5) Providing to the Reservoir Control Branch, U.S. Army Corps of Engineers, Albuquerque District, data as outlined in Section A-02, below, and other data and at other times that may be required.

(6) Keeping informed of the rules and regulations contained in this Water Control Manual and bringing to the attention of the District Engineer or designee, Albuquerque District, U.S. Army Corps of Engineers, any feature of the manual that may require clarification or revision.

c. Role of U.S. Army Corps of Engineers. The Albuquerque District, U.S. Army Corps of Engineers is responsible for the following, which apply to both normal and emergency conditions:

(1) Monitoring storage, inflow, and outflow for Navajo Reservoir on a day-to-day basis to ensure that the operation is in accordance to the Water Control Plan. The Corps also coordinates with the USBR and the NWS, so that agreement on the forecasted inflow volumes is reached. The 50 percent frequency forecast is the basis used in the Water Control Diagram.

(2) Advising operating agencies and the Division Engineer of any departure from this Water Control Plan.

(3) Reviewing and reporting to the Division Engineer any emergency or planned deviations from the prescribed Water Control Plan.

(4) Preparing short period, daily, and monthly operation, and other special reports relative to operation of the project required by the Office, Chief of Engineers.

(5) Preparing revisions to the Water Control Manual and the Water Control Plan.

F-02. Data Collection and Reporting

a. Normal Conditions. The USBR will provide to the Reservoir Control Branch, Albuquerque District, U.S. Army Corps of Engineers, by phone or "electronic media," as early as possible each and every day, and at other times as requested, the following data:

(1) The amount of flood control reservation required in Navajo Reservoir based on the current forecasted inflow.

(2) Midnight elevation and storage, calculated mean daily inflow and outflow, and anticipated outflow changes for the next 72 hours at the project.

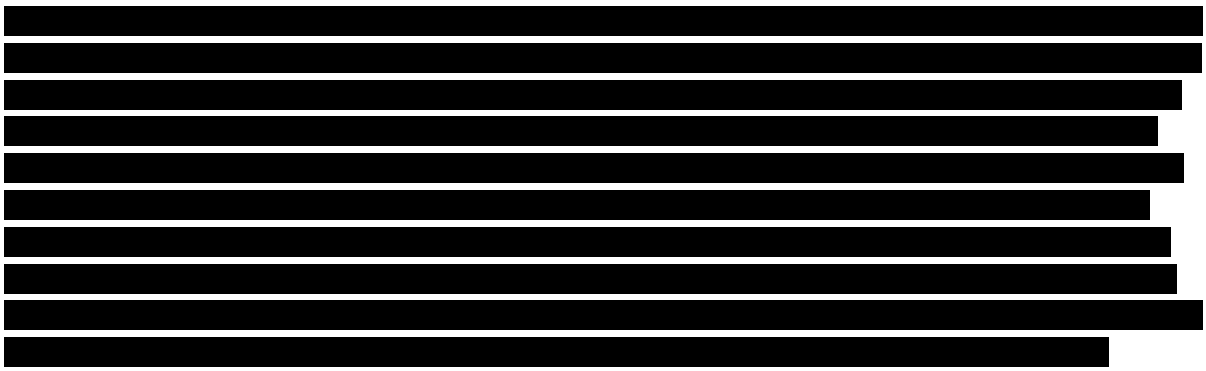
(3) Daily precipitation, and daily maximum and minimum temperatures at the dam. Immediately after the end of each month, the Project Operator will provide, by mail or "electronic media," to the Reservoir Control Branch (RCB), Albuquerque District, U.S. Army Corps of Engineers, a monthly summary of the data outlined in this section in its final archival quality. The RCB shall prepare monthly operation reports and other special reports relative to the operation, as required by the Chief of Engineers.

b. Emergency Conditions. The USBR will immediately notify the appropriate agencies, as well as the Corps, of flooding or emergency conditions. For flood events and other emergency conditions, the information required in paragraph A-02a above will be provided by the USBR at a frequency required by the Corps.

c. Regional Hydrometeorological Conditions. The Project Operator will be informed by WCAO-SD of the USBR of regional hydrometeorological conditions that could impact the structure.

F-03. Water Control Action and Reporting

a. Normal Conditions. The water control operation each day consists of determining the required flood control reservation, and scheduling releases in order to provide the required reservation by the end of day. This procedure requires a forecast of reservoir inflow for the next 24 hours. Storage reservation in Navajo Reservoir shall be on the basis of the Water Control Diagram, Exhibit E, which indicates required storage reservation according to the current flood hazard, as measured by the remaining snowmelt runoff over the basin. Whenever encroachment into the currently required flood control reservation occurs, this water should be released as rapidly as possible, in accordance with criteria contained on the Water Control Diagram. Releases from Navajo Dam, insofar as possible, will be restricted so that the flows into the San Juan River below the dam to the confluence of the Animas River do not exceed the current estimated non-damaging safe channel capacity of 5,000 cfs. Releases from the dam will also be regulated to not exceed 12,000 cfs on the San Juan River at Farmington and at Shiprock. The rate of change of release is restricted to the maximum of 200 cfs or 10 % of the flow in any 2-hour period. There is no restriction on the rate of rise in the reservoir. The rate of drawdown shall not exceed 2 feet per day, when the reservoir is above 5990 feet and 1 foot per day when the reservoir is below 5990 feet.



[redacted]

b. Emergency Conditions. Instructions are the same as above during flood events and other emergency conditions. However, the official regulations are subject to temporary modifications during flood emergencies by the District Engineer or his designee. The Water Control Plan will be revised by the Corps of Engineers as necessary, to reflect changed conditions that come to bear upon flood control operation of the reservoir. Permanent revisions of the Water Control Plan are subject to prior approval of the Chief of Engineers.

c. Inquiries. All significant inquiries received by the project operator, from citizens, constituents, or interest groups regarding water control procedures or actions, must be referred directly to the WCAO-SD. The WCAO-SD will provide a courtesy copy of their response and the inquiries to the Chief, Reservoir Control Branch.

d. Water Control Problems. When water control problems occur, such as in the event of an operational malfunction, erosion, or an incident occurs, WCAO-SD must be contacted immediately, by the most rapid means available. The USBR will then forward a description of the problem with the executed or recommended resolution to the District Engineer or designee, Chief, Reservoir Control Branch.

e. Communication Outage. During emergencies, if communication between the project operator and the WCAO-SD of the USBR in Durango is lost, then the project operator should continue flood control releases in accordance with the last instructions received and try to re-establish communications. However, if communication between the project operator and the WCAO-SD is lost and cannot be re-established, then releases should be made in accordance with the Water Control Diagram.

F-04. Deviation from Normal Regulation. Deviations from approved Water Control Plans occur because every possible circumstance cannot be accounted for in a Water Control Plan. Because of the often competing goals and complex interactions of interested groups/agencies, even seemingly inconsequential deviations from an approved plan can lead to unforeseen environmental and legal complications. The CESPD regulation, CESPD R 1110-2-8 dated 12 September 2002, serves to assist in preparing deviation requests. It outlines a minimum set of considerations that need to be addressed when making a recommendation to deviate from an approved Water Control Plan. Deviations from approved Water Control Plans are intended, therefore, to address unforeseen and unique circumstances. They are not intended as a means for identifying or initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs. Deviations are discussed in Chapter 7, paragraph 7-13.

EXHIBIT G

Record of Decision for the Navajo Reservoir Operations

RECLAMATION

Managing Water in the West

Record of Decision for the Navajo Reservoir Operations, Navajo Unit - San Juan River New Mexico, Colorado, Utah Final Environmental Impact Statement

U.S. Department of the Interior
Bureau of Reclamation

July 2006

Summary of Action

The Bureau of Reclamation (Reclamation) has completed a final environmental impact statement (EIS) on the operation of Navajo Reservoir, Colorado River Storage Project, San Juan River, New Mexico, Colorado, and Utah. The proposed action is to operate Navajo Dam and Reservoir to meet Endangered Species Act (ESA) related Flow Recommendations for the San Juan River[1] or a reasonable alternative to those recommendations, in a manner which enables both current and future water depletions to proceed in compliance with the ESA. The EIS was prepared by Reclamation to provide sufficient releases of water at times, quantities, and durations believed to be necessary to conserve two endangered fish species, the Colorado pikeminnow (*Ptychocheilus lucius)* and the razorback sucker (*Xyrauchen texanus)* and their critical habitat, as recommended by the San Juan River Basin Recovery Implementation Program's (SJRBRIP)[2] Flow Recommendations, while protecting authorized purposes of the Navajo Unit. Reclamation's goal is to implement the proposed action and, at the same time, continue to protect all authorized purposes of the Colorado River Storage Project, including the Navajo Unit, and to protect Indian trust assets.

The Notice of Intent to prepare the EIS was published in the *Federal Register* on October 1, 1999, and described the purpose of the proposed action as ". . . to mimic the natural hydrograph of the [San Juan] river to create and maintain habitat and to maintain a healthy biological community in order to conserve populations of two endangered fishes, while maintaining the other authorized purposes of the Unit." The EIS on Navajo Reservoir Operations was filed with the Environmental Protection Agency on April 20, 2006 (FES 06-06).

The EIS and this Record of Decision were prepared pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended; the Council on Environmental Quality's regulations for implementing NEPA (40 CFR 1500-1508); the Department of the Interior's NEPA Implementing Procedures (516 DM 1-15); and Reclamation's NEPA Handbook. As the primary Federal agency responsible for the operation of Navajo Reservoir, Reclamation was the lead agency in preparing the EIS. Nineteen cooperating agencies, including Indian Tribes, Federal and state agencies, and water user organizations, participated in preparing the EIS.

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[1] Holden, Paul B., comp., *Flow Recommendations for the San Juan River.* San Juan River Basin Recovery Implementation Program, Biology Committee. Albuquerque, NM: U.S. Fish and Wildlife Service, 1999.

[2] The SJRBRIP is a major cooperative effort among entities interested in the goals of recovery of endangered fish and provision for water use and development in the San Juan River Basin. In addition to Reclamation, participants include the U.S. Fish and Wildlife Service, Bureau of Indian Affairs, Bureau of Land Management, Southern Ute Indian Tribe, Ute Mountain Ute Tribe, Navajo Nation, Jicarilla Apache Nation, water development interests, and the states of Colorado and New Mexico.

Reclamation's Decision

Reclamation's decision is to implement the Preferred Alternative, the 250/5000 Alternative, as described in the EIS. The preferred alternative, to the extent possible,[3] implements criteria needed to assist in meeting the Flow Recommendations for the San Juan River and to assist both current and future water development in the San Juan River Basin to proceed in compliance with Federal and state laws, interstate compacts, and the ESA. The preferred alternative best protects Indian trust assets by facilitating present and future tribal water development. Navajo Reservoir will be operated so that releases range from 250 cubic feet per second (cfs) to 5,000 cfs. Flexibility will be retained to adjust release rates within this range to respond to new information, including any revision to the Flow Recommendations, as it becomes available. In making this decision, Reclamation has carefully reviewed the alternatives and their predicted environmental, economic, technical, and social impacts, and has considered the comments and concerns of agencies, tribes, organizations, and the public. This decision includes the potential for refinement of the Flow Recommendations based on relevant new information as may be gained through adaptive management.

Operating major water resources projects, like the Navajo Unit, is contingent on a number of factors, in addition to regulatory and statutory constraints, that are outside the control of Reclamation. Factors including hydrologic conditions, reservoir storage, runoff timing, forecasting inaccuracies, and gage errors all affect Reclamation's ability to meet the Flow Recommendations. Thus, built into this decision is the acknowledgement that Reclamation may not be able to precisely meet the Flow Recommendations 100 percent of the time, but the intent will be to operate in a manner that is consistent with the goals of the SJRBRIP.

Background and Associated Issues

Navajo Unit

Navajo Dam was completed in 1963 under the authority of the Colorado River Storage Project Act (CRSPA) to meet multiple water resource purposes. The dam is located on the San Juan River approximately 38 miles upstream from Farmington, New Mexico, and about 55 miles southeast of Durango, Colorado. The reservoir extends into both Colorado and New Mexico and has a maximum content of 1,701,300 acre feet (af), including an inactive pool of 625,675 af. During the irrigation season, the minimum operating level for the Navajo Indian Irrigation Project (NIIP) diversion intake is at elevation 5,990 feet, or about 662,000 af of storage; but the reservoir can be drawn down during the winter to elevation 5,985 feet, or about 626,000 af of storage, so long as storage recovers sufficiently prior to the NIIP irrigation season. Through a Federal Energy Regulatory Commission issued license and an agreement with Reclamation, the City of Farmington owns and operates a hydroelectric plant at Navajo Dam.

[3] As described in the Biological Opinion and EIS.

Water development in New Mexico and Colorado supported by the Navajo Unit includes, but is not limited to, the San Juan-Chama Project; the NIIP; the Jicarilla Apache Nation Water Rights Settlement Act; and, as part of the Southern Ute and Ute Mountain Ute Indian Water Rights Settlement, development of the Animas-La Plata Project (ALP). Also included are numerous smaller water uses and the proposed Navajo-Gallup Water Supply Project. Navajo Reservoir also provides benefits of river regulation, water supply, flood control, recreation, fish and wildlife uses, and generation of hydroelectric power.

The United States has a trust responsibility to protect and maintain rights reserved by or granted to Indian Tribes by treaties, statutes, and executive orders. This trust responsibility requires that Federal agencies take actions reasonably necessary to protect Indian trust assets. The operation of Navajo Reservoir has the potential to affect Indian trust assets in the form of water rights. Indian trust assets exist for four federally recognized tribes within the San Juan River Basin: the Navajo Nation, the Jicarilla Apache Nation, the Southern Ute Indian Tribe, and the Ute Mountain Ute Tribe. Several existing and proposed Indian water projects, including ALP and NIIP, depend on reoperation of Navajo Reservoir for ESA compliance; and if reoperation is not implemented, future Indian water development in the Basin might not proceed as planned and several existing projects could be affected as well. In addition to the NIIP, the proposed Navajo-Gallup Water Supply Project is a component of a water rights settlement proposed by the State of New Mexico and the Navajo Nation.

After initial filling of Navajo Reservoir, water management focused primarily on meeting NIIP irrigation needs, providing flood control, and maintaining relatively stable river flows. Spring peak flows in the San Juan River were substantially decreased (post-reservoir peaks averaged 54 percent of pre-reservoir peaks) and flows for the remainder of the year increased (August-February flows averaged 18 percent higher).

Endangered Species Issues

The catalyst for changing Navajo Reservoir operations was consultation with the U.S. Fish and Wildlife Service (Service) on the proposed construction of ALP, located in Colorado within the San Juan River Basin. The Service issued a draft Biological Opinion in 1990 concluding ALP would jeopardize the continued existence of the Colorado pikeminnow in the San Juan River and no reasonable and prudent alternative to avoid jeopardy was identified at that time. Subsequent hydrologic investigations suggested that flexibility in the operation of Navajo Dam could help offset the negative impacts of operating ALP.

Reclamation requested initiation of ESA consultation on the operation of Navajo Reservoir in 1991, and the Service concurred with a later request from Reclamation that consultation be extended while research was conducted on flow needs of the endangered fish. During the 1991-1998 research period, Reclamation operated Navajo Reservoir to provide test flows to mimic a natural hydrograph. The SJRBRIP directed research efforts. The SJRBRIP was established in 1992 to conserve San Juan River populations of Colorado pikeminnow and razorback sucker consistent with recovery goals for the species established by the Service, while providing measures for compliance with the ESA for water development and management activities in the San Juan River Basin conducted consistent with Federal and

state laws, including interstate compacts. The SJRBRIP includes elements to protect the genetic integrity of the endangered fish, to augment populations by stocking, to protect and restore habitat, to protect water quality, to address non-native fish competition, and to monitor endangered fish status and trends.

Following the research period, the SJRBRIP published the Flow Recommendations which generally call for a spring peak flow and certain base flows the remainder of the year. The recommendations suggest hydrology-based Navajo Reservoir operating criteria that provide for the flow variability to create and maintain habitat for the endangered fish. The recommendations integrate hydrology, geomorphology, habitat, and biology to define flow magnitude, duration, and frequency for the spring runoff and target base flows for the remainder of the year.

In 1994, critical habitat was designated for the Colorado pikeminnow on the San Juan River from Farmington to Lake Powell and for the razorback sucker from the Hogback Diversion, near Shiprock, to Lake Powell.

In June 2000, the Service prepared a new Biological Opinion that allowed the ALP Project to proceed, dependent on the following conservation measure: the operation of Navajo Reservoir to mimic the natural hydrograph of the San Juan River to benefit endangered fish species and their critical habitat. Mimicry of the natural hydrograph would be achieved by operating Navajo to follow the Flow Recommendations. Such reoperations would be subject to completion of the Navajo Reservoir Operations EIS and Record of Decision.

A Biological Assessment for Navajo operations was prepared by Reclamation under Section 7(c)(1) of the ESA and was provided to the Service in July 2003. The Service submitted their final Biological Opinion on the project to Reclamation on January 5, 2006.

Biological Opinions for other water projects in the San Juan Basin depend on the SJRBRIP, including the ability to operate Navajo Reservoir in a manner that helps to meet the Flow Recommendations. For example, completion of NIIP, the Public Service Company of New Mexico water contract with the Jicarilla Apache Nation, the Jicarilla Navajo River Project, Florida and Mancos Project water contracts, and unspecified minor depletions all depend on the SJRBRIP.

Flow Recommendations

The recommendations are for river flows downstream from the confluence of the Animas-San Juan Rivers at Farmington. A summary of flow recommendation criteria follows. The duration and frequency statistics for categories A-D are determined by modeling of projected basin depletions for the 1929-1993 period of hydrology.

A.	Category:	Flows greater than 10,000 cfs during spring runoff
	Duration:	A minimum of 5 days between March 1 and July 31
	Frequency:	20% of years, with maximum interval of 11 years

B.	Category:	Flows greater than 8,000 cfs during runoff
	Duration:	A minimum of 10 days between March 1 and July 31
	Frequency:	33% of years, with maximum interval of 7 years
C.	Category:	Flows greater than 5,000 cfs during spring runoff
	Duration:	A minimum of 21 days between March 1 and July 31
	Frequency:	50% of years, with maximum interval of 5 years
D.	Category:	Flows greater than 2,500 cfs during spring runoff
	Duration:	A minimum of 10 days between March 1 and July 31
	Frequency:	80% of years, with maximum interval of 3 years
E.	Category:	Timing of peak flows
	Timing:	Within 5 days of historical mean peak date of May 31 (on average, based on modeling for the period 1929-1993).
F.	Category:	Target base flows (mean weekly)
	Level:	500 cfs target; range 500-1,000 cfs (actual target base flows measured as the average of the weekly base flows at three of four streamflow gaging stations on the San Juan River in accordance with the Biological Opinion.
G.	Category:	Flood control releases
	Control:	Handle as a high magnitude, short duration spike and release when flood control rules require, except that the release shall not occur earlier than September 1 unless necessary for protection of life and property.

The SJRBRIP is in the process of reevaluating the Flow Recommendations based on extension of the hydrologic record through at least 2000 and on new habitat and biological response data collected and analyzed after 1998. Any revisions to the Flow Recommendations, in combination with anticipated development of interstate compact allocations, will likely require the flexibility to adjust Navajo Dam releases between a minimum of 250 cfs and a maximum of 5,000 cfs consistent with the preferred alternative of the EIS. If revisions to the Flow Recommendations were outside the scope of the EIS, further evaluation under NEPA would be necessary.

Alternatives Considered in the EIS

The purpose of modifying the operations of Navajo Reservoir is to provide sufficient releases of water at times, quantities, and durations believed to be needed to conserve the two endangered fish species and their designated critical habitat, in concert with other recovery actions. The need for a plan to modify operations has resulted from previous ESA consultations on San Juan River Basin projects and the requirement for Reclamation to comply with the ESA for and through discretionary actions that affect endangered species.

Three alternatives were fully considered in the EIS: no action, 250/5000 alternative, and the 500/5000 alternative.

No Action Alternative

Under this alternative, Navajo Reservoir would be operated as it was prior to the 1990's research flows. Operations to mimic a natural hydrograph or to provide spring peaks would not be implemented. Minimum releases would be 500 cfs and planned spring releases of 5,000 cfs would not occur. This alternative would not meet the Flow Recommendations. It would continue to benefit the tailwater trout fishery, operation of irrigation diversions, recreation, and hydropower.

The No Action Alternative would adversely affect Indian trust assets. It would likely jeopardize the continued existence of endangered fish and could also require reconsultation with the Service for the ALP and other projects. Consequently, that portion of the Ute Mountain Ute and Southern Ute Indian Tribes' water right settlement provided under ALP might not be met as planned and the settlement might be compromised. This could adversely affect non-Indian water users as well. The No Action Alternative would put the operation and completion of NIIP at risk and could require reconsultation under the ESA. Future Navajo Nation water development could also be adversely affected. Similarly, the Jicarilla Apache Nation's Navajo River Project and their third-party contract with New Mexico Public Service for the San Juan Generating Station and other Navajo Reservoir supply contracts serviced by the Jicarilla Nation could also be compromised. Further, the proposed Navajo-Gallup Water Supply Project might not be able to proceed as planned, thus compromising the proposed Navajo Nation Water Rights Settlement with the State of New Mexico in the San Juan River Basin. Other projects that rely on Navajo Reservoir operations for ESA compliance might also require reconsultation.

250/5000 Alternative (Preferred)

This alternative would have a range of releases between 250 and 5,000 cfs and would meet the Flow Recommendations within the constraints of CRSPA purposes and hydrologic conditions. This alternative also provides operational flexibility to reduce environmental impacts as well as to address extreme hydrologic conditions. The Flow Recommendations would be followed to provide recommended spring peak frequencies, quantities, and durations, and also target base flows. CRSPA authorized purposes would also be maintained and Indian trust assets protected. The alternative would support water projects with ESA consultation dependent on Navajo Reservoir operations. The 250/5000 Alternative would have significant impacts on certain resources such as the downstream trout fishery, recreation, and hydropower. This alternative was designated the preferred alternative in the EIS.

500/5000 Alternative

This alternative would have a range of releases between 500 and 5,000 cfs. It was developed because of the strong public interest in maintaining a minimum release of 500 cfs to continue

to benefit resources such as recreation, the downstream trout fishery, hydropower, and water quality. This alternative would not fully meet the Flow Recommendations because sufficient water supplies would not be stored to provide recommended spring peaks. In addition, less of the states' interstate compact allocations might be considered to be available for development. The 500/5000 Alternative would likely jeopardize the continued existence of the endangered fish and thus could also require reconsultation with the Service for the ALP Project and other projects that rely on the SJRBRIP and the associated Navajo Reservoir operations for ESA compliance.

Environmentally Preferred Alternative

Based on the analysis in the EIS, the 250/5000 Alternative is the Environmentally Preferred Alternative. The decision is to implement the 250/5000 Alternative. The 250/5000 Alternative helps mimic a natural hydrograph for the San Juan River and because of this is considered the Environmentally Preferred Alternative. The natural hydrograph is projected to benefit river habitat, native riparian areas and associated vegetation and wildlife, and native fish.

Basis of Decision and Issues Evaluated

Key elements in evaluating alternatives were the degree to which alternatives met Flow Recommendations, maintained CRSPA purposes, and protected Indian trust assets. The 250/5000 Alternative has been selected as the Preferred Alternative and the Environmentally Preferred Alternative because it is the only alternative that meets Flow Recommendations while maintaining an adequate water supply to continue providing CRSPA authorized purposes. This alternative best meets the purpose and need and best protects Indian trust assets. Positive impacts would occur for Indian water projects and settlements because the 250/5000 Alternative supports ESA compliance for existing and future water uses and the SJRBRIP. The 250/5000 Alternative provides the best potential for future water development and maintains ESA compliance for water projects in the San Juan River Basin such as NIIP, ALP, and existing and future Navajo Nation and Jicarilla Apache Nation water uses.

It is recognized in the EIS that the 250/5000 Alternative has significant adverse effects on the trout fishery downstream from Navajo Dam and also adversely affects river recreation (trout fishing and rafting), hydropower production, irrigators' ability to divert water, and water quality. While there are negative economic effects associated with adverse effects on these resources, the 250/5000 Alternative protects existing and planned water uses in the San Juan River Basin which have significant economic benefits.

As discussed in the EIS and Biological Opinion, the 250/5000 Alternative would provide flexibility at certain times for limited durations to increase minimum releases during the irrigation season to reduce impacts to downstream resources and water uses. This flexibility derives from water committed for future development but not currently used and from other operational and/or hydrological factors and will be available in many, but not all years. When possible, the release of this water will be incorporated into operations to augment the

250 cfs minimum release during the irrigation season. The availability and use of flexibility will be addressed at the Navajo Reservoir operation meetings and reviewed throughout the year using modeling and forecasting tools. Using this approach, and notwithstanding factors that are beyond Reclamation's control, Reclamation would operate the reservoir consistent with the goals of the SJRBRIP and would exercise flexibility in such a way as to avoid impacts to the magnitude and duration of spring peak releases planned for in the Flow Recommendations. This flexibility will be reduced as the use of approved but not fully developed projects increases. Flexibility will not create a risk of shortages of Navajo Reservoir supplies and will not be considered a release of storage water to downstream senior water rights.

The Service's final Biological Opinion on the preferred alternative concluded this action would not jeopardize the continued existence of threatened and endangered species nor adversely modify critical habitat. The bald eagle and southwestern willow flycatcher may be affected, but not likely adversely affected. Concerning the Colorado pikeminnow and razorback sucker, the Service concluded that these fish may be affected and are likely to be adversely affected. These determinations were based on the adverse effects of reservoir operations continued into the future and not on the implementation of the Flow Recommendations. The Service concluded that meeting the Flow Recommendations should prove beneficial for the endangered fish.

In its opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the razorback sucker and Colorado pikeminnow nor would the Preferred Alternative cause destruction or adverse modification of their critical habitat. Two Reasonable and Prudent Measures and two Terms and Conditions were included in the opinion and are adopted as environmental commitments.

The following paragraphs describe the Department of the Interior's basis and authority for this decision. The authority to implement the preferred alternative is found in Section 1 of CRSPA. This section states:

> In order to initiate the comprehensive development of the water resources of the Upper Colorado River Basin, for the purposes, among others, of regulating the flow of the Colorado River, storing water for beneficial consumptive use, making it possible for the States of the Upper Basin to utilize, consistently with the provisions of the Colorado River Compact, the apportionments made to and among them in the Colorado River Compact and the Upper Colorado River Basin Compact, respectively, providing for the reclamation of arid and semi-arid land, for the control of floods, and for the generation of hydroelectric power, as an incident of the foregoing purposes, the Secretary of the Interior is authorized (1) to construct, operate, and maintain the following initial units of the Colorado River storage project, consisting of dams, reservoirs, powerplants, transmission facilities and appurtenant works: Wayne N. Aspinall, Flaming Gorge, Navajo (dam and reservoir only), and Glen Canyon . . . [43 U.S.C. § 620].

The Colorado River Compact of 1922 established an Upper Basin and a Lower Basin within the Colorado River system and apportioned the exclusive beneficial consumptive use of Colorado River water in perpetuity to the Upper and Lower Basins. The Upper Colorado River Basin Compact of 1948 apportioned the Upper Basin's share of the Colorado River system among the states of Colorado, Utah, Arizona, Wyoming, and New Mexico. The CRSPA was enacted in 1956 to facilitate the development of the water and power resources of the Upper Basin consistent with the Compacts.

The SJRBRIP was developed to facilitate the continued development of states' Compact apportionments in light of ESA concerns. The goal of the SJRBRIP, therefore, is to conserve the San Juan River populations of endangered fish species consistent with the recovery goals of the species published by the Service, while proceeding with the continued operation and development of both Indian and non-Indian water resources of the San Juan River Basin. All SJRBRIP participants, agreeing that recovery to the point of de-listing will both facilitate and ensure the continued development of water resources, have agreed with the principles and goals of the SJRBRIP through their participation in and support of program activities. In addition to its recovery objectives, the SJRBRIP includes an agreement on principles for conducting ESA Section 7 consultations, wherein program actions and sufficient progress toward recovery constitute a Reasonable and Prudent Alternative for existing and future water resource management and development activities that are likely to jeopardize the continued existence of endangered fish species or cause the destruction of or adverse modification of critical habitat of those species.

The SJRBRIP's Flow Recommendations, in concert with other program actions, are intended to avoid jeopardy and assist in recovery. By implementing actions that assist in meeting the Flow Recommendations, Reclamation is taking the steps necessary to avoid jeopardizing the continued existence of the endangered fish from the operation of Navajo Dam and to voluntarily and cooperatively take steps to facilitate recovery of the fish, which, in turn, will support the continued and further utilization of the Federal facilities to aid in the development of the states' Compact apportionments. Thus, consistent with the authorized purposes of CRSPA, implementation of the Flow Recommendations supports the states in the utilization of their Compact apportionment while assisting in the recovery of endangered species. Moreover, that specific authorized purposes of the Navajo Unit may not be fully maximized for limited durations in certain year types does not invalidate the actions of the Secretary of the Interior, as long as the overall purposes of CRSPA are met. And we expect in this instance, these purposes will be met.

This action is limited to the proposition that both avoiding jeopardy and making progress toward recovery of listed fish facilitate the ability of the San Juan Basin states to continue utilizing and further developing their Colorado River apportionments. It is not a decision that reads CRSPA as generally authorizing the release of water for fish and wildlife purposes. In these particular and unique circumstances, therefore, we conclude the implementation of an operations regime that is consistent with the Preferred Alternative is deemed to be within the authorization contained in Section 1 of CRSPA.

Environmental Commitments

All practicable means to avoid or minimize environmental harm have been included in the Preferred Alternative and are summarized below:

1. Reclamation will follow the Reasonable and Prudent Measures as well as the Terms and Conditions in the Biological Opinion on the project.

2. Navajo Reservoir will be operated to assist in meeting spring peak and annual base flows as described in the Biological Opinion which may be amended from time to time through the SJRBRIP adaptive management process. Release changes will be limited to increments of 200 cfs or 10 percent of flow, whichever is higher, every 2 hours. Base flows and spring peaks will be monitored with U.S. Geological Service gages as described in the EIS and Biological Opinion.

3. Public operation meetings for Navajo Reservoir will continue to be held 3 times per year to provide information to and receive input from stakeholders and the public on operations and other water-related activities.

4. Currently, some flexibility in reservoir releases exists because water committed under present water rights and/or future development is not fully used. This may be a significant amount of water in some, but not all, years. The release of this water will be incorporated into operations to augment the minimum 250 cfs release during the irrigation season with a goal of minimum releases of 350 cfs. The release of this additional water will help alleviate adverse effects on the trout fishery, river recreation, hydropower, irrigators' ability to divert, and water quality. The use of this additional water will be discussed at Navajo Reservoir operation meetings. As noted previously, the flexibility to augment minimum releases will diminish as committed water that is unused becomes developed. The impacts of the release of this additional water will be carefully monitored, particularly as depletions increase in the future.

5. Severe droughts, with anticipated shortages to Navajo Reservoir water users, will be addressed according to the shortage sharing provisions of Section 11 of Public Law 87-483, or through cooperative water sharing agreements, provided such agreements do not violate Section 11. Operational changes in severe droughts could include temporary modifications to normal operations of the reservoir and potential short-term modifications in spring peak release criteria or the target base flows in the Flow Recommendations. In periods of extreme, multi-year droughts, releases from Navajo Reservoir may have to be reduced below 250 cfs to match the inflow to the reservoir. This would not occur until after Reclamation has completed additional environmental review and coordination with the Indian Tribes and Nations, the Service, the State of New Mexico, and the public.

6. Reclamation will retain the ability to modify planned releases in order to complete extraordinary maintenance, address emergency situations, and complete safety of dam activities that may be required in the future.

7. Reclamation will coordinate with the Corps of Engineers and the National Weather Service as well as with local agencies to assist in reducing potential flooding problems that could result from combinations of spring peak releases and downstream flash floods.

8. Reclamation will carry on its activities in a manner which protects Indian trust assets and avoids adverse impacts to Indian trust assets when possible. Positive effects to Indian trust assets are anticipated from the Preferred Alternative which supports water projects that have received environmental clearance and potentially for others currently undergoing environmental review.

9. Reclamation will continue to participate in and support the SJRBRIP. Monitoring endangered fish populations and habitat responses to the new operations will be conducted by the SJRBRIP. Recovery goals for the two endangered fish species and criteria for measuring positive population responses of the species are addressed in the Navajo Operations Biological Opinion. If, based on SJRBRIP monitoring results, there are not positive population responses in the time frames outlined in the recovery goals and in the positive population response criteria, reinitiation of ESA consultation may be required by the Service.

10. Reclamation will participate with the New Mexico Game and Fish Department and other agencies in planning and implementing instream measures to reduce adverse impacts to the trout fishery resulting from lower minimum flows. Specifically, Reclamation can provide technical assistance and use of Reclamation lands for habitat improvement projects.

11. Lands associated with the Navajo Unit have potential for long-term habitat for the southwestern willow flycatcher. The lands downstream from Navajo Dam are of particular interest because the habitat has strong potential for long-term stability and management. Potential habitat in inflow areas is subject to seasonal reservoir level fluctuations. Reclamation will develop and implement a flycatcher management plan on Unit lands to protect and improve flycatcher habitat.

12. While the Preferred Alternative results in slightly lower impacts (in comparison to other alternatives) to cultural resources on the reservoir shoreline, fluctuations of Navajo Reservoir continue to result in adverse impacts. Reclamation is committed to implementing a cultural resources program to address the impacts of reservoir fluctuation. An initial goal will be to prepare and implement a Cultural Resource Management Plan in consultation with the State Historic Preservation Officers of Colorado and New Mexico and other consulting parties such as Indian Tribes.

Implementation

Reclamation will implement the operating criteria contained in the Preferred Alternative beginning 30 days after issuance of this Record of Decision.

Approved:

Rick L. Gold

Regional Director
Bureau of Reclamation, Upper Colorado Region
Salt Lake City, Utah

7-31-06

Date

EXHIBIT H

Recommendations for San Juan River Operations and Admin: 2009-2012

Recommendations for San Juan River Operations and Administration for 2009 through 2012
January 29, 2009

The endorsing parties make the following Recommendations for Navajo Dam operations and San Juan River administration from 2009 through 2012 with certain limitations on the time period as described herein to the US Bureau of Reclamation and the New Mexico State Engineer for the purpose of establishing a cooperative distribution of water supplies during the time these Recommendations are in effect among users of water from the San Juan River in New Mexico. The agreement of the endorsing parties to make the Recommendations, their commitment to abide by the Recommendations if accepted and implemented by Reclamation and the State Engineer, and any results from the implementation of the Recommendations shall not be construed to: (1) be a determination or evidence of, or to establish, any party's water rights or consumptive use of water; (2) be a precedent for Navajo Dam operations or water administration in the San Juan River Basin in New Mexico in succeeding years; (3) be an agreement as to the validity or applicability of, or to imply an accepted modification to, the San Juan River Basin Recovery Implementation Program's flow Recommendations for endangered fish habitat in the San Juan River or any interpretation thereof; (4) establish any cause and effect relationships between any water uses, including water uses described in section 1 of the Recommendations below and water uses not included in section 1, and streamflow impacts, water supplies or shortages; (5) establish any priorities between a given use of water from the San Juan River and other uses of water from either the San Juan River or its tributaries; (6) establish any entitlements to water, including any entitlements of fish to specific instream flows; or (7) alter or amend any pre-existing agreements between parties unless otherwise expressly agreed to by parties to said agreements. The endorsing parties further understand that Reclamation's acceptance of the Recommendations is contingent upon Reclamation's opinion that the operating criteria presented herein are not inconsistent with Section 11 of Public Law 87-483 and the Navajo Reservoir Operations Environmental Impact Statement Record of Decision, dated July 31, 2006, and that the New Mexico State Engineer's acceptance of the Recommendations is subject to the Upper Colorado River Commission making no determination, pursuant to Article IV of the Upper Colorado River Basin Compact, that uses in the Upper Basin need to be curtailed during the time these Recommendations are in effect in order that the flow at Lee Ferry shall not be depleted below that required by Article III of the Colorado River Compact. In the event there is a determination under Article IV, the parties to these Recommendations agree to meet to within thirty days of the determination to make any necessary adjustments to the Recommendations.

1. Water Use Demands

The water diversion demands for specified projects or uses shown in Table 1 shall be recognized for 2009 through 2012, subject to certain limitations on the time period. The diversion demand amounts listed for the Hammond Irrigation Project, the San Juan Generating Station, the Four Corners Power Plant and the City of Farmington may

include amounts to be diverted under contract with the Secretary of the Interior, direct flow rights, and/or subcontracts or agreements with other parties. Also, the diversion amounts listed for the San Juan Generating Station and the Four Corners Power Plant include diversions by BHP Billiton made at the power plants' diversion works for uses at the San Juan/La Plata Mines and Navajo Mines, respectively. The diversion amount for minor Jicarilla Apache Nation subcontracts does not include the 8,500 acre-feet to be provided annually through subcontract with the Nation for supplemental water to mitigate any shortages in supply to the San Juan Generating Station, the Four Corners Power Plant and the mines.

Table 1. Negotiated limits on diversion demand by project or use for purposes of implementation of this agreement.

Project	**Diversion Amount (acre-feet)**				**Rate (cfs)**	**Period**
	2009	**2010**	**2011**	**2012**		
Navajo Indian Irrigation Project	198,660	205,239	209,546	214,730	--	3/15 – 11/15
Hammond Irrigation Project	26,700	26,700	26,700	26,700	90	4/01 – 10/31
San Juan Generating Station	32,985	32,985	32,985	32,985	--	1/01 – 12/31
Four Corners Power Plant	31,000	31,000	31,000	31,000	--	1/01 – 12/31
Minor Jicarilla subcontracts	1,055	1,055	1,055	1,055	--	1/01-12/31
City of Farmington	16,500	17,000	17,500	18,000	--	1/01 – 12/31
Citizens Ditch	--	--	--	--	160	4/01 – 10/31
Farmers Mutual Ditch	--	--	--	--	110	4/01 – 10/31
Fruitland Irrigation Project	--	--	--	--	100	4/01 – 10/31
Jewett Valley Ditch	--	--	--	--	32	4/01 – 10/31
Hogback Irrigation Project	--	--	--	--	170	4/01 – 10/31

The diversion demand amounts and rates in Table 1 are negotiated values that take into consideration differing opinions of the parties as to the demands and rights to divert water under existing conditions, facilities, rights, permits, contracts and applicable law; however, the diversion demand amounts and rates shown in Table 1 and recognized for implementation only during 2009 through 2012, subject to certain limitations on the time period, shall not be construed to be an agreement by the endorsing parties on, a determination of, or evidence of, or to establish, the specific and definitive rights of the parties to divert water for any purpose or project during any particular year or at any particular time. Nevertheless, to put aside differences and cooperate in the administration of the San Juan River during 2009 through 2012 for the overall benefit of the San Juan River Basin in New Mexico, the endorsing parties agree to limit their diversion of water during 2009 and 2012, subject to certain time limitations, from the San Juan River and/or its tributaries for the specified projects or uses to the quantities or the rates, and to the time periods, specified in Table 1. In the event that a water supply shortage is determined to exist on the San Juan River in 2009 through 2012 using the shortage determination procedure set forth in section 3 below, the endorsing parties agree to further limitations on their diversion of water for the specified projects or uses in accordance with the provisions of sections 3 and 4. If a shortage is deemed to exist when applying these

provisions, the San Juan Generating Station and Four Corners Power Plant diversions will be voluntarily reduced by 5% from the amounts shown in Table 1 prior to computing the shortage amount.

The Navajo Nation agrees for the purposes of this recommendation to limit the NIIP diversion in any year in which a shortage is declared pursuant to the provisions of Section 3 to the level shown in Table 1 for the respective year of shortage, less any computed amount of shortage allocated to the NIIP under this recommendation. In the event that there is no shortage in a given year, either forecasted or actual for any particular forecast period, the Navajo Nation agrees to limit the NIIP diversion to the level shown in Table 1 for the respective year; except, that the Navajo Nation, at its discretion, may increase the NIIP diversion during the given year by up to an additional 5,000 acre-feet as long as such increase does not induce a shortage. This allowed increase is in recognition of the continuing development of NIIP whereby acreage is increased each year as construction progresses.

In recognition of the difficulties some irrigation ditches have had in providing water to all users within their respective ditch systems, the endorsing parties agree to allow those ditches to increase their diversion rates from those shown in Table 1 by up to12.5% for the months of July and August only. It is understood that this provision to increase diversions is further subject to the following conditions: 1) The entity has implemented reasonable good faith efforts to enhance the efficiency of their system and improve the overall water management of their system, and difficulties in getting water down the entire reach of the ditch still exist during July and August; and 2) When applying the provisions of Section 3, no shortage is determined to exist. If a shortage is determined to exist, the ditch shall adhere to the diversion rates in Table 1 and shortages shall be applied as described in Section 3.

The endorsing parties agree during 2009 through 2012 only to exempt from any use reduction requirement projects or uses in the San Juan River Basin that are not included in the tabulation above and that are not otherwise contrary to adjudicated, permitted or licensed diversion rights; except, that the parties recommend that the Bureau of Reclamation's San Juan-Chama Project diversions be limited in accordance with the provisions of section 3 below.

Amounts diverted by Farmington that shall not be charged against the diversion demand amount listed for the City of Farmington include amounts: (1) diverted for delivery to local water users associations or to the Navajo Tribal Utility Authority-Shiprock or (2) diverted for non-consumptive use at the Farmington hydro-electric power plant. Also, the amount of diversion by the Hammond Irrigation Project that is chargeable or accountable against its diversion demand amount shall be computed for 2009 through 2012 as the measured diversion amount by the project less the measured returns to the San Juan River on the Armenta wasteway. Diversions by ditches for delivery to municipalities, industrial users, domestic water user associations and stock uses may continue outside the specified irrigation season.

The endorsing parties agree that during November and December of 2009 through 2012, the San Juan Generating Station, the Four Corners Power Plant, the City of Farmington and the minor Jicarilla Apache Nation subcontractors may divert water under existing permits or licenses from the direct flow of the San Juan River system in excess of their respective annual diversion amount limitations described in this section if the target base flow in the San Juan River from its confluence with the Animas River downstream to Lake Powell is being met and will continue to be met without increasing Navajo Dam releases if the additional diversions are made.

2. Navajo Dam Release Demands

The Bureau of Reclamation shall determine the quantity of water anticipated to be needed to be released from Navajo Dam during each month of 2009 through 2012 in consideration of: (1) the water diversion demands specified in section 1 above and the diversion demands for water uses not included in the demands tabulated in section 1 that are to be met from diversions from Navajo Reservoir or the San Juan River below Navajo Dam; and (2) a target minimum base flow of 500 cfs in the San Juan River below its confluence with the Animas River downstream to Lake Powell[1]. In making said determination, Reclamation shall: (1) distribute the annual diversion demand amounts for the Hammond Irrigation Project, the San Juan Generating Station, the Four Corners Power Plant and the minor Jicarilla Apache Nation subcontracts on a monthly basis using monthly distributions specified by the contractors; and (2) assume that tributary inflow to the San Juan River below Navajo Dam and river losses occur in such amounts daily as reflected by the streamflows that occurred in the San Juan River during 2002. Reclamation shall utilize the following computational procedure in making said determination:

(a) Compute the daily flows in the San Juan River below its confluence with the Animas River downstream to Lake Powell that occurred during 2002 as the minimum of: (1) the average of the flows in the San Juan River measured at the Shiprock, Four Corners and Bluff gages; and (2) the average of the flows in the river measured at the Farmington, Shiprock and Four Corners gages. If a daily gage record is missing, use the remaining gages in the set. Also, add 20 cfs to the Shiprock gage flows for the period April 1 through October 31 to account for anticipated changes in 2009 through 2012, as compared to 2002, in the return flows from the Hogback Irrigation Project that reenter the river below the gage. The resultant daily flows shall be assumed to approximate the flow through the reach of endangered fish critical habitat under the combination of minimum probable flow conditions on the Animas River and other tributaries and 2002 San Juan River operations.

[1] If the Minimum Probable Inflow Forecast projected or actual Navajo Reservoir content falls below 1,000,000 acre-feet on July 31 in 2009 through 2012, then: (1) the summer (April 1 through October 31) target flow for the corresponding year shall be 400 cfs; and (2) the winter (November 1 through March 31) target flow following the corresponding year may be reduced below 500 cfs, but not lower than 400 cfs, for a total of 8 weeks.

(b) Calculate the daily differences between the approximated daily flows through the reach of critical habitat and the target minimum base flow for the San Juan River below its confluence with the Animas River downstream to Lake Powell. Adjust the daily Navajo Dam release rates made in 2002 for the calculated differences to indicate the daily releases that might be made in 2009 through 2012 under minimum probable runoff conditions, based on a seven-day running average. Also, adjust the daily dam release rates for any significant differences in the monthly diversion demand amounts for the Hammond Irrigation Project, the San Juan Generating Station, the Four Corners Power Plant and the minor Jicarilla Apache Nation subcontracts in 2009 through 2012 as compared to 2002.

(c) Adjust the computed daily Navajo Dam release rates for maximum dam releases during seven-day periods in consideration of real-time dam operation practices. Also, adjust dam release rates as necessary or possible to maintain a minimum release of 250 cfs during 2009 through 2012.

The determination of Navajo Dam release demands shall be updated if a change in the forecasted runoff or actual runoff for the Animas River suggests that tributary inflow to the San Juan River will be significantly different than the tributary inflow that occurred during 2002.

3. Shortage Determination and Sharing

The Bureau of Reclamation shall make calculations of any water supply shortage on the San Juan River for 2009 through 2012 using operations studies for Navajo Reservoir that evaluate monthly dam and reservoir operations for calendar years 2009 through 2012. The operations studies shall consider: (1) the amount of water physically stored in Navajo Reservoir above elevation 5990 feet; (2) monthly evaporation from Navajo Reservoir to be estimated based on actual and projected storage levels and Navajo Dam evaporation rates; (3) anticipated monthly reservoir inflows estimated by Reclamation; (4) anticipated monthly Navajo Dam releases to meet all demands on the San Juan River below the dam as determined pursuant to section 2 above; and (5) anticipated monthly diversions to the Navajo Indian Irrigation Project. The anticipated monthly reservoir inflows shall be estimated using the National Weather Service's forecasts for minimum probable unregulated inflows to Navajo Reservoir, then adjusted by Reclamation for anticipated operations of Vallecito Dam and the San Juan-Chama Project under minimum probable runoff conditions. For periods for which reservoir inflow forecasts are not available, the anticipated monthly inflows shall be estimated as the 90-percent exceedence inflow to the reservoir as determined from the hydrologic record.

If the operational studies indicate that the reservoir water surface level would fall below elevation 5990 feet at any time during 2009 through 2012 should the diversion demands at and below Navajo Dam and Reservoir be fully satisfied, then Reclamation shall calculate the amount of shortage to the diversion demands that must occur to prevent the projected water surface level in the reservoir from falling below elevation 5990 feet.

Reclamation shall use iterative procedures to determine the percentage shortage that if applied uniformly to the following demands on an annual basis would result in reductions in water uses on the San Juan River in a total amount equal to that of the calculated amount of shortage: (1) the annual diversion demand amounts for the Navajo Indian Irrigation Project, the San Juan Generating Station, the Four Corners Power Plant and the minor Jicarilla Apache Nation subcontracts as listed in section 1 above for the year of the shortage; (2) an annual irrigation depletion demand of 37,000 acre-feet in the aggregate for the Citizens Ditch, the Hammond Irrigation Project, the Farmers Mutual Ditch, the Fruitland Irrigation Project, the Jewett Valley Ditch and the Hogback Irrigation Project; and (3) the target minimum base flow in the San Juan River below its confluence with the Animas River for the period March 1 through October 31, in the subject year. Reclamation shall provide the results of its reservoir operations studies and calculations of any shortage to the State Engineer and the parties for their review.

The endorsing parties agree that the annual diversion amount limitations for 2009 through 2012 for the Navajo Indian Irrigation Project, the San Juan Generating Station, the Four Corners Power Plant, the minor Jicarilla Apache Nation subcontracts and the City of Farmington shall be reduced from the diversion amounts identified in section 1 above by the same percentage shortage, if any, as calculated by the Bureau of Reclamation; except, that the annual diversion amount limitation for the City of Farmington shall not be reduced below 14,000 acre-feet in 2009, 14,500 acre-feet in 2010, 15,000 acre-feet in 2011, 15,500 acre-feet in 2012.. The water users will determine the time schedules for bearing their share of any shortage during 2009 through 2012. In the event of shortage, the parties also request that Reclamation limit its annual San Juan-Chama Project diversions for 2009 through 2012 to an annual amount equal to 107,500 acre-feet less the percentage shortage calculated by Reclamation. If the amount of water already diverted by any user during 2009 through 2012 exceeds its resultant diversion limitation, then the user shall cease diverting water for the remainder of 2009 through 2012; alternatively, the user may continue diverting water if it transfers water that may become available within other users' diversion amount limitations or if it acquires and transfers water under valid water rights that currently are in use.

The endorsing parties further agree that the diversions for the Citizens Ditch, the Hammond Irrigation Project, the Farmers Mutual Ditch, the Fruitland Irrigation Project, the Jewett Valley Ditch and the Hogback Irrigation Project shall be reduced to effectively short the annual irrigation depletion demand under each ditch or project by the same percentage shortage, if any, as calculated by the Bureau of Reclamation. In the event of shortage, each ditch or project shall shorten its irrigation season in order to meet its commitment to reduce irrigation depletions during 2009 through 2012. The end date for the period during which the ditch or project may divert water for irrigation uses during 2009 through 2012 shall be moved forward in time from October 31 until the percentage reduction in irrigation depletion matches the same percentage shortage as calculated by Reclamation. To determine a revised end date to the irrigation season, the following percentages indicating the distribution of the annual irrigation depletion by month shall be used: 5 percent for October; 12 percent for September; 19 percent for August; 22 percent for July; 19 percent for June; 13 percent for May; and 10 percent for April. The

revised end date shall be adjusted further to provide credit for any irrigation depletion demand forgone as a result of delaying the start date of the irrigation season past April 1 or as a result of ceasing diversions during the irrigation season. In order for a ditch to receive credit for irrigation depletion demand foregone as a result of ceasing diversions for a period of time after starting irrigation deliveries but prior to ending irrigation deliveries, the ditch must: (1) provide Reclamation and the State Engineer with one-week advance notice of the number of days and the dates during which diversions will cease; and (2) cease all diversions for agricultural purposes during the dates specified, for a period of not less than seven consecutive days. Irrigation depletion reductions for partial months shall be estimated assuming a constant daily irrigation depletion rate within each month. Diversions by ditches for delivery to municipalities, industrial users, domestic water user associations and stock uses may continue whether the irrigation season is shorted or not.

The endorsing parties recommend that the Bureau of Reclamation not make any spring peak flow release from Navajo Dam for endangered fish habitat purposes during 2009 through 2012 unless the SJRIP's San Juan Model Operating Rule Decision Tree indicates that such a release could be made without causing a shortage to water users.[2] Reclamation, in consultation with the U.S. Fish & Wildlife Service, shall operate the dam during 2009 through 2012 to maintain a target minimum base flow rate of 500 cfs in the San Juan River from its confluence with the Animas River downstream to Lake Powell unless in 2009 through 2012 the Minimum Probable Inflow Forecast projects the July 31, Navajo Reservoir content to be below 1,000,000 acre-feet. In that event, the target base flow rate through October of that year shall be 400 cfs; provided that Reclamation's operations studies for Navajo Reservoir do not result in the calculation of a water supply shortage. If Reclamation calculates a shortage in 2009 through 2012 in accordance with the preceding provisions, then the target minimum base flow demand amount for the period April 1 through October 31, shall be reduced by the same percentage as the percentage shortage calculated by Reclamation; provided, that the target minimum base flow rate shall not be less than 350 cfs for more than 50 days of which no more than 40 days may be below 300 cfs, with a minimum flow of 250 cfs. The base flow in the San Juan River during 2009 through 2012 shall be measured as the minimum of: (1) the average of the flows in the river at the Shiprock, Four Corners and Bluff gages; and (2) the average of the flows in the river at the Farmington, Shiprock and Four Corners gages. It is recognized that the actual base flow at times may not meet the target minimum base flow for short periods of time (for example, one or more days) due to hydrologic uncertainty and operational limitations; but, Reclamation shall operate Navajo Dam to maintain the target minimum base flow on a weekly-average basis.

The endorsing parties also agree that during November and December in 2009 through 2012, the San Juan Generating Station, the Four Corners Power Plant, the City of Farmington and the minor Jicarilla Apache Nation subcontractors may divert water from the direct flow of the San Juan River system in excess of any shorted diversion amount

[2] The Decision Tree utilizes the Most Probable Inflow Forecast, the available water in storage, and the anticipated demands to determine if sufficient water will be available to allow for a spring peak release while not creating a shortage to users.

limitation if: (1) the current release from Navajo Dam is being maintained at the minimum release rate consistent with the then-current Navajo Dam operating criteria; and (2) the target minimum base flow in the San Juan River from its confluence with the Animas River downstream to Lake Powell is being met and will continue to be met without increasing Navajo Dam releases if the additional diversions are made.

The occurrence and amount of any shortage shall be determined or revised twice a month as runoff forecasts become available from the Colorado Basin River Forecast Center and in consideration also of actual runoff and water supply conditions. The computational procedure set forth above may be adjusted for changed water supply conditions upon agreement of the signatory parties. Reclamation's initial calculation of any shortage shall be made on or prior to March 15 and after the March 1 snowmelt runoff forecasts for the San Juan River Basin become available; and a percentage shortage will be applied if the State Engineer concurs in Reclamation's calculations of any shortage. The last determination of any shortage shall be made on or before October 15 based on the October 1 reservoir content and streamflow forecast for the remainder of the year.

4. Agreements to Transfer or Broker Water between Parties

The Bureau of Reclamation has approved a subcontract for delivery of water from the Navajo Reservoir supply entered between the Jicarilla Apache Nation and the Public Service Company of New Mexico, the Arizona Public Service Company and BHP Billiton limited to the delivery in the aggregate of 8,500 acre-feet of water annually during 2009 through 2012 to the San Juan Generating Station, the Four Corners Power Plant and the related mines (collectively, the power plants), the actual delivery of which water under the subcontract is made only to supplement existing water supplies pursuant to New Mexico State Engineer permit Nos. 2838 and 3258 when it is needed to replace water normally available pursuant to those permits, and which water supply is available to the Companies pursuant to those permits absent a shortage occasioned by State administration or a shortage to the Navajo Reservoir Supply as determined by the Secretary of the Interior or imposed pursuant to the Secretary's implementation of Recommendations in agreements among water users in the San Juan River Basin. In the event of shortage, the power plants under their subcontract may divert water in excess of their resultant diversion limitations computed pursuant to section 3 and up to the diversion demand amounts for the power plants recognized in section 1; provided that the delivery of supplemental water under the subcontract does not exceed an annual aggregate of 8,500 acre-feet. The signatory parties support the approval of any necessary permits from the Office of the New Mexico State Engineer regarding the diversion and use of water under the subcontract. The reduction in water supply caused by delivery of supplemental water to the power plants under the subcontract shall be offset by applying an additional increment of percentage shortage to the shorted water diversion demands for the irrigation uses specified in section 1, to wit: the diversion amount limitation for the Navajo Indian Irrigation Project will be further reduced by the added increment of shortage, and the irrigation seasons for the Hammond Irrigation Project, the Citizens Ditch, the Farmers Mutual Ditch, the Fruitland Irrigation Project, the Jewett Valley Ditch

and the Hogback Irrigation Project will be further reduced by the added increment of shortage.

The Public Service Company of New Mexico, the Arizona Public Service Company and BHP Billiton agree to provide funds to mitigate the effects to the water supply of any added increment of shortage that is caused by actual diversion of water under the subcontracts, with the proviso that actual shortages and deliveries of water may vary from projected shortages and deliveries. To this end, the Public Service Company of New Mexico, the Arizona Public Service Company and BHP Billiton shall provide mitigation funds of $147,800 in 2009, 2010, 2011, and 2012 plus up to an additional $541,400 in 2009, 2010, 2011, and 2012 based on the proportionate amounts of the supplemental water over an initial ten percent (10%) actually used by the power plants under the subcontracts, and will distribute said funds directly to representative bodies for the specified irrigation uses or projects in the following percentages: 4.4 percent to the Hammond Conservancy District, 3.6 percent to the Bloomfield Irrigation District, 3.5 percent to the Farmers Mutual Ditch, 1.3 percent to the Jewett Valley Ditch, and 87.2 percent to the Navajo Nation[3]. The Navajo Nation may distribute its share of mitigation funds to the Navajo Agricultural Products Industry and the San Juan River Dineh Water Users, Inc. as it deems appropriate. Any required mitigation funds shall be provided to the representative bodies no later than January 30th of the following year for any year in which these Recommendations are in effect and the representative bodies for the specified irrigation uses or projects may utilize or dispose of said funds in a manner or manners of their choosing to the benefit of the water users under the projects. In no event shall the provisions of this section be construed to establish any requirement on behalf of the Public Service Company of New Mexico, the Arizona Public Service Company, BHP Billiton, the Jicarilla Apache Nation, the Bureau of Reclamation or any other party to mitigate any impacts to water supply on the San Juan River caused by the power plants taking delivery of water under the subcontracts, or to establish any precedent for water use arrangements between them or San Juan River operations and administration in 2013 or succeeding years.

Additional agreements to transfer or broker water between endorsing parties within the water allocations made pursuant to the Recommendations provided herein may be negotiated.

5. Dispute Resolution

The endorsing parties agree to cooperate fully in the implementation of the above Recommendations and to abide by the diversion limitations for 2009 through 2012 provided herein to the extent of their authority and ability. In the event that a dispute should arise regarding the implementation of the Recommendations or the performance of an endorsing party under the Recommendations, the endorsing parties commit to resolve such dispute in a cooperative, timely and effective manner. If a dispute involves only endorsing parties and cannot be resolved among themselves, the Bureau of Reclamation and the New Mexico State Engineer may be requested to hear and facilitate

resolution of the dispute. The endorsing parties further request that, in order to result in an orderly distribution of water supplies on the San Juan River during 2009 through 2012 in accordance with the Recommendations contained herein, Reclamation and the State Engineer commit to: (1) assist in the measurement, monitoring and administration of streamflows and diversions on the San Juan River and its tributaries, in cooperation also with the Bureau of Indian Affairs; (2) work with the endorsing parties in a coordinated manner on water management and administration issues that may arise during 2009 through 2012 as a result of implementing the Recommendations; (3) assist as may be requested, and to the extent of their authority and ability, in the implementation of any feasible water transfer agreements that may be negotiated between the endorsing parties for 2009 through 2012; and (4) resolve any disputes in a timely and effective manner, including any disputes between endorsing parties and Reclamation or the State Engineer. The endorsement of the Recommendations provided herein by any and all parties shall not be construed to: (1) waive the sovereign immunity of any Indian tribe; or (2) constitute a consent to tribal jurisdiction by any party.

6. Cooperative Activities

The parties request the assistance and cooperation of the Bureau of Reclamation to improve their ability to manage diversions as flow conditions change in the San Juan River. Specifically, the Bureau of Reclamation should: (1) establish and maintain a direct contact list for operations representatives for each water use or project listed in section 1; and (2) notify in a timely manner each contact representative directly as to planned or actual changes to the release rate from Navajo Dam and other information that may be pertinent to improving coordination between Bureau of Reclamation operations and water user operations. Similarly, the endorsing parties shall provide the Bureau of Reclamation with any information on their planned or actual water operations that might create opportunities for reducing Navajo Dam releases or otherwise improving water operations to help conserve water.

Further, the parties agree to provide to the Bureau of Reclamation and the State Engineer measurements of actual diversions bi-weekly, unless such information is available through an alternate source. Reclamation is requested to submit a report of all water diversions subject to this agreement to all signatories monthly unless such information is available through publicly accessible means.

7. Endorsement and Term

The endorsing parties agree to present the Recommendations provided herein to the Bureau of Reclamation and the New Mexico State Engineer as their Recommendations, collectively and individually, regarding procedures for operating Navajo Dam and administering diversions in the San Juan River Basin in New Mexico during calendar years 2009 through 2012. Any of the parties listed in section 9 as endorsing parties may choose not to endorse these Recommendations. In the event one or more parties choose not to endorse the Recommendations, the parties endorsing the Recommendations retain

the right to submit the Recommendations to the Bureau of Reclamation and the State Engineer for acceptance and adoption pursuant to this section with less endorsing parties than listed in paragraph 9. The Recommendations shall be effective upon written notice to the endorsing parties that the Bureau of Reclamation and the State Engineer accept and adopt the Recommendations for implementation; provided that all parties choosing to endorse the Recommendations have provided original signed copies of such endorsement to Reclamation and the State Engineer. The Recommendations are valid for calendar years 2009 through 2012, unless a shortage is declared in any of those years, in which case, the term of these Recommendations shall end on January 1st of the year following the shortage year. If no shortage is declared during the term, these Recommendations shall terminate on January 1, 2013, unless terminated earlier or extended by agreement of the endorsing parties.

8. Waiver of Liability

No party endorsing the Recommendations shall hold another endorsing party responsible or liable for any damages or claims that may occur or arise as a result of implementing the Recommendations presented herein, including as a result of analyses, decisions or operations made under the Recommendations; provided that the other endorsing party fulfills its commitments and obligations as expressed herein. In the event that an endorsing party does not fulfill its commitments and obligations as expressed herein to the detriment of other endorsing parties and the matter cannot be resolved through dispute resolution as provided in section 5 above, the endorsing parties reserve the right to seek appropriate remedies, if any, under applicable law in state or federal court. An endorsing party's remedies shall not be limited to the enforcement of any commitment or obligation as expressed in the Recommendations provided herein and may include remedies that would be available to any party that has not endorsed the Recommendations. This provision shall not be construed to: (1) waive the sovereign immunity of any Indian tribe; or (2) constitute a consent to tribal jurisdiction by any party. The endorsing parties waive no rights with regard to non-endorsing water users in 2009 or thereafter.

9. Endorsing Parties

The following entities are endorsing parties to the Recommendations herein:

The Navajo Nation
The Jicarilla Apache Nation
The City of Farmington
Public Service Company of New Mexico
Arizona Public Service Company
BHP Billiton
Hammond Conservancy District
Bloomfield Irrigation District
Farmers Mutual Ditch
Jewett Valley Ditch

EXHIBIT I

Guidance on the Preparation of Deviations

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION CORPS OF ENGINEERS
333 Market Street
CESPD-MT-E San Francisco, California 94105-2195

REGULATION
No. 1110-2-8

12 September 2002

Engineering and Design
GUIDANCE ON THE PREPARATION OF DEVIATIONS
FROM APPROVED WATER CONTROL PLANS

1. PURPOSE. This document establishes the protocol for reporting deviations from approved Water Control Plans for water control projects within the South Pacific Division. It defines coordination, review, and approval procedures between the Division and District offices. Approval from Division must be obtained from all deviations (reference e., paragraph 6.b.) [1]

2. APPLICABILITY. The following is applicable to all South Pacific Division Districts and field-operating activities having civil works responsibilities.

3. REFERENCES. Authority and guidance can be found in:

a. ER 200-2-2 (33 CFR 230), 4 March 1988, subject: Procedures for Implementing NEPA.

b. ER 1105-2-100, 22 April 2000, subject: Guidance for Conducting Civil Works Planning Studies.

c. ER 1110-2-240 (33 CFR 222.5), 8 October 1982, subject: Water Control Management.

d. ER 1110-2-241 (33 CFR 208.1), 24 May 1990, subject: Use of Storage Allocated for Flood Control and Navigation at Non-Corps Projects.

e. ER 1110-2-1400, 30 September 1993, subject: Reservoir Water Control Centers.

f. ER 1110-2-8156, 31 August 1995, subject: Preparation of Water Control Manuals.

g. ER 1165-2-501, 30 September 1999, subject: Civil Works Ecosystem Restoration Policy.

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[1] This regulation supercedes CESPD-ET-EW Regulation, Subject: Guidance On The Preparation Of Deviations From Approved Water Control Plans dated 1 August 1999.

h. EP 1165-2-502, 30 September 1999, subject: Ecosystem Restoration – Supporting Policy Information.

i. EM 1110-2-3600, 30 November 1987, subject: Management of Water Control Systems.

j. CESPD R 1110-2-8, August 1999, subject: Guidance on the Preparation of Deviations From Approved Water Control Plans.

4. OVERVIEW.

a. Water Control Plans are prepared for all Corps projects and non-Corps projects within Federal flood control space. For Corps projects, the Water Control Plan is all encompassing in that it covers regulation of the project over the entire regime of pool elevations and conditions. The Corps' responsibility regarding non-Corps reservoirs is defined by Section 7 of the Flood Control Act of 1944 (58 Stat 890), which directs the Secretary of the Army to prescribe regulations for the use of storage allocated for flood control or navigation at all reservoirs constructed wholly or in part with Federal funds.

b. Water Control Plans define the regulation criteria and guidelines that govern how and when water will be stored and released from a project. The process of formulation and eventual approval of the Water Control Plan is a complex and time-consuming process because the plan must account for diverse goals (flood control, the environment, water quality, recreation, water supply, hydropower, etc.) and situations (e.g. normal, flood, drought, and emergency operations). Formulation of these plans requires a comprehensive knowledge of such diverse items as: project goals, project history, authorizing legislation, Corps policies and regulations, how a project interacts with other reservoirs within a basin, the role of other water interests/agencies, the effects to the general public in relation to environmental and aesthetic considerations, basin meteorology and hydrology, changing conditions (e.g. sedimentation, channel capacity, scour, etc.), and the physical capabilities of project features, such as outlet works, spillways, flood routing characteristics, etc.). Prior to approval and implementation, the proposed Water Control Plan is released for public review and comment. The public review process normally occurs concurrently with the NEPA public review process.

c. Deviations from approved Water Control Plans occur because every possible circumstance cannot be accounted for in a Water Control Plan. The competing goals and complex interactions of interested groups/agencies can cause even seemingly inconsequential deviations from an approved plan to lead to unforeseen environmental and legal complications. This regulation serves to assist a District in preparing their deviation requests. It outlines a minimum set of considerations that need to be addressed when making a recommendation to deviate from an approved Water Control Plan.

d. Deviations from approved Water Control Plans are intended, therefore, to address unforeseen and unique circumstances. They are not intended as a means for identifying or

initiating new opportunities to re-operate or reallocate storage in response to new and changing public needs.

5. DEFINITIONS.

a. Emergency Deviations. An emergency deviation from an approved Water Control Plan is one that is required due to an emergency situation. An emergency situation is defined herein as a situation in which there is a potential for injury, loss of life, threat to the project, or other serious hazards; but furthermore, also demanding immediate action, such that time constraints render impractical notification to the division. Depending upon the need for immediate action, an emergency situation could include: drowning and other accidents, assistance to local authorities responding to an emergency (e.g. police and fire departments), failure of operations facilities, chemical spills, treatment plant failures, and other temporary pollution or water quality problems. Water control actions necessary to abate the problem are taken immediately unless such action would create equal or worse conditions.

b. Planned Deviations. Planned deviations cover all other deviations not addresses by an emergency deviation.

6. OFFICE OF RECORD. The originating District's water control management office will be responsible for maintaining all relevant records documenting the deviation.

7. GENERAL INFORMATION FOR PREPARING ALL DEVIATIONS.

a. Approval of Deviations. Approval for all deviations must be obtained from the Division Commander or delegated representative prior to their implementation. As noted in paragraph 5.a, an emergency deviation situation may warrant an immediate action, delegated to the Leader, Water Management Team or his designated representative. The Leader of the Water Management Team shall consult with the Chief of Engineering and Construction and appropriate SPD staff and subsequently advise the Director, Military and Technical Services Directorate of the temporary change. Approval may be made by telephone, E-mail, or FAX.

b. Preparation of Deviations. Processing of a deviation request originates at the District water control management office. The District Commander may delegate signature authority for requesting deviations from approved water control plans to the appropriate functional division head or designated representative. Consultation with the District staffs, including engineering, planning, environmental, economics, operations, construction and legal must take place.

c. Costs and Charges for Preparing Deviations. Deviations from approved Water Control Plans require a similar level of scrutiny as applied to permanent changes to a water control plan. Any District charges incurred for processing a deviation are to be assessed and collected from the agency/entity requesting the deviation. The District should estimate the cost to process the deviation and provide that estimate to the requesting agency/entity. The District must collect the funds (in a revolving fund advance account under Support for Others) prior to processing the deviation request. Examples of costs for which the requesting entity would be responsible include costs for any required reviews or studies concerning associated hydrologic, water

control, legal, real estate, and environmental maters. After the deviation work is completed, any amount of funds left over in the account would be paid back to the requesting entity.

d. Fees for Water Supply Deviations. Deviations that result in Corps project flood control space being used for water supply purposes must address reimbursement by the sponsor to the Federal government for use of the flood control space. The district's deviation request package must include an economic analysis that determines a value for the reallocated flood control space. Section 7 projects will not require the economic analysis, as water supply charges are under the authority of the project owner.

e. Time to Prepare Deviations. District offices should also inform potential agencies/entities that the lead time required to assemble the necessary information required to evaluate a deviation request may be on the order of months (normally due to the required environmental analysis and the public review process). Thus, the request to the District should be made well in advance of the proposed initiation date fro the deviation. The requesting agency/entity should also be made aware that approval of the deviation request would depend upon such things as a review of the impacts (e.g., environmental, hydrologic, legal, etc.).

f. Coordinating with Division Staff. Preparation of a deviation package is a time consuming and costly undertaking, and incomplete or inadequate package can delay approval, District personnel are encouraged to coordinate any questions or concerns about potential deviations and to discuss any atypical situations with their Division counterparts early in the process and before the package submittal. All technical review will be conducted at the District level and will provide a review certification. In an emergency situation, a formal quality certification will most likely not be required. Appendix D lists the Division staff with which deviation-related issues are to be coordinated Division will provide updates to Appendix A as needed.

g. Non-Corps Projects. Deviation requests fro non-Corps (Section 7) projects must be prepared with the approval of the project owner. This is required because project owners are responsible for assuring that the project is operated as prescribed in the Water Control Plan developed in concert with the Corps' flood control interest. The owner is also ultimately responsible for dam safety at the project and for funding the project.

h. Environmental Requirements. Each deviation request shall include a summary of the environmental effects of the proposed deviation and a statement of how the proposal is in compliance with pertinent environmental requirements, including but not limited to the National Environmental Policy Act (NEPA), Endangered Species Act, the Clean Water Act, and the Clean Air Act and Section 176 Conformity Determination. NEPA documentation requirements ordinarily are met by an Environmental Assessment (EA) of the proposed action with a Finding of No Significant Impact (FONSI) signed by the District Commander. If an existing Environmental Impact Statement/Record of Decision or EA/FONSI accurately covers the action, and if there have been no environmental changes since that documentation, this can be cited. Supporting environmental documents shall be included in the deviation request package when it is submitted. Typically these will include an EA, a signed FONSI, a Biological Assessment, and a final Biological Opinion or a letter from Fish & Wildlife or National Marine and Fishery

Service concurring that there is not likely to be adverse effect on listed species. Sometimes other documents, such as 404(b)(1) evaluation are required. In the case of emergency deviation, the emergency provisions and requirements of he various environmental laws should be followed.

i. Required Information/Analysis. Table 1 outlines the information and analysis that are required in a deviation request package that is submitted to Division.

TABLE 1
Information and Analysis Required in a Deviation Request Package

a. Copy of sponsor's/project owner's letter requesting a deviation.
b. A description of the deviation.
c. Its effects on the operational objectives or project purposes.
d. A description of the potential flood threat over the period of the deviation.
e. The current and predicted maximum reservoir storage and elevation.
f. Documentation that the proposed deviation is in compliance with all pertinent environmental laws.
g. The effect on other agencies and individual interest.
h. The coordination that has taken place with other agencies.
i. Alternative measures that could be taken.
j. Recommendation/rationale on whether a permanent change to the Water Control Plan for this situation is warranted.
k. A District legal opinion.
l. Any recommended fees or reimbursements to the Federal Government.
m. Any other information that may be pertinent to the deviation request.
n. The District Commander's recommendation.
o. Quality Control Certification

8. PREPARING EMERGENCY DEVIATIONS

a. Emergency deviations are the only type of deviation that do not require prior approval from Division, and must only be used if events warrant an immediate emergency action, such that time constraints render impractical notification to the Division. However, even in an emergency situation, the District shall notify the Division of the action as soon as possible, and shall comply with all applicable requirements.

b. A record of the emergency deviation shall be developed at the district office and transmitted to the Division office within a day of the action taken.

c. Procedures for emergency deviations:

(1) Take the necessary action.

(2) Contact Division as soon as possible (See Appendix A for telephone numbers) to describe the action taken and the cause (NOTE: The order of (1) and (2) may be reversed depending on the nature of the emergency). Continuation of the deviation will require Division approval.

(3) The District shall provide written conformation to the Division office within 7 days of the deviation. The correspondence shall include the items outlined in Table 1 (as applicable).

(4) The Division shall respond within 3 days of the district's notification of the emergency deviation.

9. PREPARING PLANNED DEVIATIONS.

a. The District shall inform Division within 2 days of receiving a request for a proposed deviation.

b. At least 7 days prior to the proposed action, the District shall transmit a deviation request package to the Division office. The deviation request package shall include the items in Table 1. This package may be initially transmitted electronically.

c. The Division shall review the proposal and approve or disapprove the District's deviation request within 5 days, assuming a complete package with all required documentation has been received. Early, detailed, coordination and transmittal of documents to Division may reduce the processing time.

d. The District and Division shall follow-up with formal correspondence within 3 days of their electronically transmitted request (District) and approval/disapproval (Division).

10. SPECIAL CIRCUMSTANCES.

Per reference 3.c, Water Control Plans are subject to continuing and progressive study in order to keep them current. Should a new re-operation or reallocation opportunity be identified for a Corps project, then it should be addressed under authority of Section 216 of Public Law 911-611, an Initial Appraisal Report can be conducted with O&M funding to determine whether or not a study, if deemed appropriate, among other things, could initiate the process to incorporate the new opportunity in the project's Water Control Plan. Re-operation or reallocation studies for non-Corps projects would need to be initiated by the project owner.

FOR ROBERT L. DAVIS
BG, USA
Commanding

COL, EN
DEPCDR

1 Appendix
APP A – CESPD Phone list for Coordination of Water Control Plan Deviations
APP B - Quality Control Certification

DISTRIBUTION:
Electronic Copy Available

APPENDIX A

CESPD Phone List for Coordination of Water Control Plan Deviations

Note: Initial District notification to the Division shall be made to Water Management.

Water Management

[redacted] [redacted]

Internal SPD Coordination with Respective District Support Team Members

Legal

[redacted] [redacted]

Planning & Environmental

[redacted] [redacted]

Real Estate

[redacted] [redacted]

Program Management

[redacted] [redacted]

APPENDIX B

DISTRICT ENGINEER'S QUALITY CERTIFICATION

COMPLETION OF QUALITY CONTROL ACTIVITIES

The District has completed the review/analysis of the water control deviation from the Approved Water Control Plan for *(Project Name and Location).* Certification is hereby given that all quality control activities appropriate to the level of risk and complexity inherent in this analysis have been completed.

GENERAL FINDINGS

Compliance with clearly established policy principles and procedures, utilizing clearly justified and valid assumptions, data and the reasonableness of the results. The undersigned recommends certification of the quality control certification for this deviation request.

(Signature) *(Date)*
Chief, Responsible Functional Element

CERTIFICATION OF LEGAL REVIEW*

The request f or a water control deviation from the approved Water Control Plan report for *indicate name of project*, has been fully reviewed by the Office of Counsel, and is approved as legally sufficient.

(Signature) *(Date)*
District Counsel

QUALITY CERTIFICATION

All issues and concerns resulting from technical review of the water control deviation have been resolved. This deviation is recommended for approval.

(Signature) *(Date)*
District Commander