SANTA ROSA WASH, ARIZONA

TAT MOMOLIKOT DAM
AND
LAKE SAINT CLAIR

WATER CONTROL MANUAL

DECEMBER 1990

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
RESERVOIR REGULATION SECTION

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In the event that unusual conditions arise, contact can be made by telephone to the U. S. Army Corps of Engineers, Los Angeles District Office during official business hours (0730-1600, Monday through Friday), plus during non-duty periods of flood operations:

Reservoir Regulation Unit (213) 894-4756

WATER CONTROL MANUAL

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SANTA ROSA WASH, ARIZONA

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ABBREVIATIONS USED

ac-ft	acre-feet or acre-foot
BIA	Bureau of Indian Affairs
cfs	cubic feet per second
COE	United States Army Corps of Engineers
DCP	Data Collection Platform
DRGS	Digital Readout Ground Station
EM	Engineer Manual
ER	Engineer Regulation
ETL	Engineer Technical Letter
ft	feet or foot
GOES	Geostationary Operational Environmental Satellite
LAD	Los Angeles District
MSL	Mean Sea Level
NESDIS	National Environmental Satellite, Data, and Information Service
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
QPF	Quantitative Precipitation Forecast
ROC	Reservoir Operations Center
SEED	Safety Evaluation of Existing Dams
SPF	Standard Project Flood
USGS	United States Geological Survey

I - INTRODUCTION

1-01 Authorization. This Water Control Manual for Tat Momolikot Dam was prepared in compliance with regulations and guidelines set forth in the following directives: Engineer Regulation (ER) 1110-2-240, "Engineering and Design, Water Control Management", dated 8 October 1982; Engineer Technical Letter (ETL) 1110-2-251, "Engineering and Design, Preparation of Water Control Manuals", dated 14 March 1980; and Engineer Manual (EM) 1110-2-3600, "Engineering and Design, Management of Water Control Systems", dated 30 November 1987.

1-02 Purpose and Scope. The main purpose of this manual is to provide water control information for day to day use of Tat Momolikot Dam for essentially all foreseeable conditions. It also provides current information on the dam, the drainage area in which Tat Momolikot Dam is located, and the interagency coordination associated with this dam. Physical characteristics, hydrologic information, and structural details are provided. Because they do not apply to Tat Momolikot Dam, this manual does not address the issues of hydroelectric power generation or navigation. Watershed hydrologic characteristics preclude any application of hydroelectric power generation or navigation.

1-03 Related Manual and Reports. Manuals and reports with data relevant to the regulations in this manual are listed in Table 1-01.

1-04 Project Owner. Tat Momolikot Dam is under the jurisdiction of and is administered by the Bureau of Indian Affairs, as approved by the Secretary of the Interior and the Secretary of the Army.

1-05 Operating Agencies.

a. Bureau of Indian Affairs (BIA). The BIA is responsible for the operation and maintenance of the dam, reservoir, and intake and outake works.

b. Corps of Engineers (COE). The COE has agreed to assist the BIA in the operation of the dam, if asked, and in the collection of hydrologic data.

1-06 Regulating Agencies. A list of agencies together with a brief explanation of their functions related to reservoir operations are given in the following subparagraphs.

a. Bureau of Indian Affairs. This agency is responsible for the operation and maintenance of the project. They have agreed to report local storm and flood conditions to the Corps of Engineers.

b. Tohono O'odham Indian Tribe. The Tohono O'odham (referred to hereafter as O'odham and formerly known as the Papago) Tribal Council furnished to the Federal Government the rights to those lands required for the construction of Tat Momolikot Dam. They also guaranteed public access to the project lands and water areas for recreation and fish and wildlife purposes. All monetary benefits (less operation, maintenance, and replacement costs) from operation of the project for uses other than flood control would accrue to the O'odham Indian Tribe.

c. Department of the Interior. The Department of the Interior is responsible for the adjustment of all claims arising from the construction, operation, repair, maintenance, and periodic inspection of the project for purposes other than flood control. They are also responsible for the establishment and enforcement of floodway limits and regulations and for performing necessary work on the Santa Rosa Wash through the Papago, Maricopa, and Gila River Indian Reservations downstream from the dam to maintain the hydraulic capacity of the existing channel. See the Memorandum of Understanding (Exhibit D) for details.

d. Corps of Engineers. Tat Momolikot Dam was designed and constructed by the COE. The Corps has agreed to assist the BIA in the operation of the dam and in the collection of hydrologic data.

e. U. S. Geological Survey (USGS). This agency measured streamflow below the dam on the Santa Rosa Wash near Cockleburr stream gaging station from 1954 to 1980. The gage has been discontinued.

f. Pinal County. The Pinal County Board of Supervisors is the agency responsible for local cooperation. They adopted Resolution No. 111069 on November 10, 1969, in which they agreed to: (a) hold and save the United States free from damages (downstream from the Papago Indian Reservation) arising from construction, maintenance and operation of the works for flood control and (b) hold and save the United States free from all damages arising from water-rights' claims resulting from construction, maintenance, and operation of the project for flood control.

g. Independent Flood Control Districts. The Maricopa, Midway, and Stanfield Flood Control Districts have been established by the state downstream of Tat Momolikot Dam. The flood control districts are responsible for establishing and enforcing floodway limits and regulations for Santa Rosa Wash from the north boundary of the Papago Indian Reservation to Santa Cruz River (excluding Indian land) and maintaining the existing hydraulic capacity of the existing channel.

h. National Weather Service (NWS). The National Weather Service office at Phoenix, Arizona will provide, upon request, weather forecasts and climatological reports for the region in which the project is located.

Table 1-01. Previously Issued Publications.
(Chronological Listing)

Title	Date
Vaiva Vo Irrigation Project, a feature of the Santa Rosa Wash Multiple Purpose Project, Papago Indian Reservation, Arizona, Bureau of Indian Affairs	March 1963
Interim Report on Survey for Flood Control, Santa Rosa Wash, Arizona, U. S. Army Corps of Engineers	Aug. 1963
Design Memorandum No. 1, Hydrology for Santa Rosa Wash (Tat Momolikot Dam and Lake St. Clair), U. S. Army Corps of Engineers	April 1969
Design Memorandum No. 3, Real Estate for Santa Rosa Wash (Tat Momolikot Dam and Lake St. Clair), U. S. Army Corps of Engineers	Nov. 1970
Design Memorandum No. 2, General Design for Santa Rosa Wash (Tat Momolikot Dam and Lake St. Clair), U. S. Army Corps of Engineers	April 1971
Tat Momolikot Dam, Gila River Basin, Santa Rosa Wash, Arizona, Dam, Outlet Works and Spillway Periodic Inspection Report No. 1, U. S. Army Corps of Engineers	Nov. 1974
Tat Momolikot Dam, Gila River Basin, Santa Rosa Wash, Arizona, Dam, Outlet Works and Spillway Periodic Inspection Report No. 2, U. S. Army Corps of Engineers	Oct. 1975
Tat Momolikot Dam, Gila River Basin, Santa Rosa Wash, Arizona, Dam, Outlet Works and Spillway Periodic Inspection Report No. 3, U. S. Army Corps of Engineers	Dec. 1976
Santa Rosa Wash, Arizona, Tat Momolikot Dam and Lake Saint Clair, Reservoir Regulation Manual, U. S. Army Corps of Engineers	Jan. 1977 Revised Sept. 1984
Safety Evaluation of Existing Dams Report on Tat Momolikot Dam, Bureau of Indian Affairs, Phoenix Area, Papago Agency, Arizona, Bureau of Reclamation, Division of Dam Safety	Dec. 1983
Safety Evaluation of Existing Dams Report on Tat Momolikot Dam, Bureau of Indian Affairs, Phoenix Area, Papago Agency, Arizona, Bureau of Reclamation, Division of Dam Safety	Oct. 1988

II - DESCRIPTION OF PROJECT

2-01 Location. Tat Momolikot Dam is located on the Papago Indian Reservation in Pinal County, Arizona. The dam is about 65 miles south of Phoenix, 60 miles northwest of Tucson, and 20 miles south of Casa Grande. Indian Highway 15 can be taken from Casa Grande to its intersection with the dam's access road. The access road extends about 3-3/4 miles to the dam. The project location is shown on Plate 2-01.

2-02 Purpose. Tat Momolikot Dam was constructed as a multiple-purpose reservoir project. The project was built to provide (a) protection against floods to downstream lands and improvements, (b) water conservation storage, (c) for development of irrigable lands, and (d) recreation and fish and wildlife facilities. The dam provides partial flood protection to development in the overflow area, which for the standard project flood would extend to Santa Cruz Wash, about 33 miles to the north, covering 57,000 acres, as shown on Plate 2-02. The water in the conservation pool was to be used for irrigation and for ground water recharge. Water related recreation was also to be set up. Some of the other recreational activities were to include fishing in the fishponds downstream of the dam, hunting animals attracted to the water in the reservoir, and picnicking. Area redevelopment was to occur because of the increased jobs due to the operation and maintenance of the project.

2-03 Physical Components. The Tat Momolikot Dam project consists of a compacted-earthfill embankment, a reservoir area, flood-control outlet works, water conservation outlet works, several detached dikes, a detached concrete spillway, pits for fish ponds, an overlook area, and two new roads. The components of Tat Momolikot Dam are shown on the site plan on Plate 2-03. They include:

a. Main Dam. The main dam is a compacted-earthfill embankment with a crest length of 12,440 feet (ft) and a crest width of 20 ft. The longitudinal profile of the crest is cambered with a maximum elevation of 1,559.5 ft mean sea level (MSL) near the center and a minimum elevation of 1,557.5 ft MSL at either end. The elevation difference is due to a pipe running over the top of the dam that was used to carry pumped water over the dam from a well within the reservoir to the farm. The road along the dam crest has been raised to go over this pipe. See Photo 2-01. The maximum height above the original streambed is 75.5 ft. The slope of the downstream face is 1 vertical on 2.5 horizontal. The upstream face has a slope of 1 vertical on 3 horizontal above elevation 1,502.4 ft MSL; a slope of 1 vertical on 10 horizontal between elevations 1,492 and 1,502.4 ft MSL; and a slope of 1 vertical on 5 horizontal below elevation 1,492 ft MSL. The upstream slope protection consists of a 1.5 ft layer of facing stone placed on 0.5 ft of bedding material and extends from elevation 1,502.4 ft MSL to the top of the dam. A 1-foot-thick stone facing is provided on the downstream slope for erosion protection. The embankment is composed of random fill with a 12-ft layer of select fill along the upstream slope. A 10-ft wide central vertical sand drain extends from streambed to elevation 1,509 ft MSL. The sand drain would discharge through a downstream, 5-ft-thick horizontal blanket, composed of layers of sand and gravel. The dam's east abutment is a natural hillside. The west end of the dam daylights into the sloping valley floor. The top of the dam is surfaced with a 12-ft-wide asphalt pavement and has 5 equally-spaced turnarounds. A 15-ft-wide asphalt ramp provides access to the conservation outlet tower bridge from the crest road. The main dam is shown on Plate 2-04 and in Photo 2-02.

b. Outlying Dikes. Four dikes are located apart from the main dam. Two are saddle dikes to the east of the main dam. A third dike surrounds the Tat Momoli cemetery and a fourth dike protects the village of Tat Momoli.

(1) Saddle Dikes. Two dikes are located on the eastern edge of the reservoir about five and six miles due east from the dam. The dikes are compacted, homogeneous earthfill structures with crest lengths of 1,440 ft and 1,195 ft, crest widths of 12 ft, crest elevations of 1,552.9 ft MSL and maximum heights of 4.5 ft and 5.5 ft, respectively. Both dikes are completely covered by a 1-foot layer of stone. The upstream and downstream slopes of both dikes are 1 vertical on 2.25 horizontal. The saddle dikes were constructed so that the spillway design flood would travel over the spillway and not flow through the passes into the adjacent valley. For floods larger than the spillway design flood, flows will overtop the saddle dikes before overtopping the main embankment. The saddle dikes were constructed with a crest elevation 4.6 feet lower than that of the main embankment in order to achieve this sequence of overtopping. The saddle dikes are shown on Plate 2-12.

(2) Cemetery Dike. The cemetery dike is a compacted-earthfill embankment with a crest width of 12 ft and side slopes of 1 vertical on 2.25 horizontal. The dike consists of random fill and is entirely surfaced by a 1-ft thick layer of stone. This dike completely surrounds the cemetery, which is located in the reservoir area. The dike has a maximum height of 3 ft and has a crest elevation of 1,539 ft MSL. A ramp with a 6-inch-thick aggregate surface provides access over the dike. A 24-inch diameter corrugated metal pipe with a downstream flap gate provides drainage through the dike. Floods greater than the reservoir design flood would cause the reservoir to inundate the cemetery. The cemetery dike is shown on Plate 2-12 and in Photo 2-03.

(3) Village Dike. A horseshoe shaped dike protects the new Tat Momoli Village from reservoir waters. The village is located about 4 miles southeast of the outlet works on the perimeter of the design reservoir. The old village in the reservoir area has been abandoned. The village dike is identical in structure and elevation to the cemetery dike, however, it reaches a maximum height of six feet. The village dike also has an access ramp and a drainage culvert that are similar to those built at the cemetery dike. Floods greater than the reservoir design flood would cause the reservoir to inundate the new Tat Momoli Village. The village dike is shown on Plate 2-12 and in Photo 2-04.

c. Reservoir Area. Tat Momolikot Dam backs up a reservoir about three miles long and five miles wide. At the spillway crest (elevation 1,539 ft MSL), the reservoir covers an area of 11,790 acres and has a gross capacity of 198,547 acre-feet (ac-ft). At the top of the saddle dikes (elevation

1,552.9 ft MSL), the reservoir has an area of 17,495 acres and a gross capacity of 402,421 ac-ft, which includes a 40,000 ac-ft allowance for sedimentation. The allotted sediment-storage volume of 40,000 ac-ft in the reservoir was determined in a study based on silt-accumulation rates in existing reservoirs in the southwest United States. From this study the average annual silting rate was established at about 0.2 ac-ft per square mile. The distribution of the sediment deposit was assumed to vary in proportion to the reservoir area up to the spillway crest elevation of 1,539 ft MSL. Gross capacity is the total volume in the reservoir below a particular elevation, whereas net capacity or flood control capacity is the gross capacity minus the sediment volume predicted to accumulate below this particular elevation. The reservoir limits are shown on Plate 2-03. Area and capacity curves based on the survey of 1968 and 1975 are shown on Plate 2-05. This information is also tabulated in Table 2-01. A summary of the reservoir's storage allocation is shown on Plate 2-06.

d. Water Conservation Outlet Works. The outlet works for the water conservation pool is located along the east abutment of the main dam. Plate 2-13 illustrates the water conservation outlet works. Discharge rating curves for full and partial gate openings are shown on Plates 2-14 and 2-15. Major components of the water conservation outlet works are described below.

(1) Intake Tower. The intake tower is a reinforced concrete structure of square cross section, about 8 ft by 8 ft and is about 73 ft in height. The tower supports three external 42-inch-square slide gates. The gates, with intake elevations of 1,485 ft MSL and 1,493 ft MSL are on the south wall. The third gate with an intake elevation of 1,501 ft MSL is on the west wall. Trash racks protect the three external gates from debris blockage. The gates are shown on Photo 2-05. An internal 60-inch-wide by 42-inch-high gate regulates flow from inside the tower into the outlet conduit. A 12-inch-diameter air vent is provided immediately below the internal gate. All of the gates are operated by hand cranks located on the operating platform. The operating platform is at elevation 1,539 ft MSL. Access to the operating platform is by a bridge that has two 75-foot spans and a five-foot walkway that leads to the main dam. The instrument house, located atop the outlet tower, has a floor elevation of 1549.5 ft MSL. The instrument house is reached by ladder from the operating platform. The outlet tower is illustrated on Plate 2-16 and in Photo 2-06.

(2) Conduit. The reinforced concrete conduit is 5 ft in diameter and 448 ft long. The first 10 ft of the conduit transitions from a 5-ft-square section to a five-foot-diameter section. Invert elevations in the conduit range from 1,485 ft MSL at the intake to 1,483.85 ft MSL at the exit. The invert slope is 0.0025. The conduit is shown on Plate 2-16.

(3) Outlet Channel. The reinforced concrete outlet channel is a 5-foot-wide rectangular section that extends 78 ft beyond the conduit is at a slope of 0.0025. The outlet channel is shown on Plate 2-16 and on Photo 2-07.

Table 2-01

AREA AND GROSS CAPACITY - TAT MOMOLIKOT DAM

Elevation Feet Above mean sea level	Capacity Acre-feet	Area Acres	Elevation Feet Above mean sea level	Capacity Acre-feet	Area Acres
1,480	0	0	1,519	48,847	3,902
1,481	5	8	1,520	52,850	4,115
1,482	17	14	1,521	57,077	4,348
1,483	34	20	1,522	61,547	4,592
1,484	58	27	1,523	66,262	4,837
1,485	87	37	1,524	71,221	5,081
1,486	133	58	1,525	76,424	5,392
1,487	204	84	1,526	82,006	5,838
1,488	301	110	1,527	88,100	6,351
1,489	424	136	1,528	94,709	6,865
1,490	573	172	1,529	101,830	7,378
1,491	769	229	1,530	109,465	7,877
1,492	1,032	297	1,531	117,584	8,347
1,493	1,363	365	1,532	126,160	8,803
1,494	1,761	432	1,533	135,191	9,260
1,495	2,227	508	1,534	144,678	9,716
1,496	2,778	602	1,535	154,622	10,160
1,497	3,432	705	1,536	164,996	10,575
1,498	4,188	807	1,537	175,775	10,980
1,499	5,046	909	1,538	186,958	11,385
1,500	6,006	1,012	**1,539	198,547	11,790
1,501	7,070	1,117	1,540	210,540	12,195
1,502	8,240	1,223	1,541	222,940	12,605
1,503	9,516	1,328	1,542	235,750	13,015
1,504	10,897	1,433	1,543	248,968	13,420
1,505	12,383	1,544	1,544	262,596	13,830
1,506	13,986	1,667	1,545	276,633	14,245
1,507	15,717	1,795	1,546	291,091	14,675
1,508	17,576	1,922	1,547	305,983	15,110
*1,509	19,562	2,050	1,548	321,308	15,540
1,510	21,676	2,192	1,549	337,068	15,975
1,511	23,946	2,361	1,550	353,261	16,395
1,512	26,399	2,544	1,551	369,857	16,780
1,513	29,034	2,727	1,552	386,828	17,160
1,514	31,853	2,910	1,553	404,172	17,530
1,515	34,855	3,098	1,554	421,890	17,905
1,516	38,050	3,296	1,555	439,982	18,295
1,517	41,447	3,498	1,556	458,483	18,720
1,518	45,046	3,700	1,557	477,427	19,170
			***1,557.5	487,066	19,400

NOTE: Table from computed elevation vs. storage tables based on surveys of July 1968 and October 1975. Table revised in September 1984.
* Conservation Pool, ** Spillway Crest, *** Top of Dam

(4) Stilling Basin. The 77-ft-long stilling basin is located immediately below the outlet channel. The stilling basin dissipates energy from high velocity discharges leaving the outlet channel. Energy is dissipated by the formation of a hydraulic jump. A diversion gate in the west wall of the stilling basin is used to divert water into the Vaiva Vo Irrigation Project. See Photo 2-08. Major components of the stilling basin include a parabolic invert drop, a transition for channel expansion, an 8-ft-high by 10-ft-wide radial gate and a 42-inch-square diversion gate. Both gates can be operated by hand crank. The diversion gate will be used for delivery of water to the Vaiva Vo Irrigation Project. The radial gate is used for creating a head behind the diversion gate and for supplementing flood releases. It can be seen on Photo 2-09. The stilling basin is shown on Plate 2-16.

(5) Auxiliary Outlet Channel. Water not diverted to the Vaiva Vo Irrigation Project can be discharged by opening the radial gate at the downstream end of the stilling basin. A discharge rating curve for this gate is shown on Plate 2-17. This water will flow into the auxiliary outlet channel, which empties into Santa Rosa Wash. The 700-ft-long auxiliary outlet channel has a trapezoidal cross section as shown on Plate 2-16. The invert slope is 0.0025.

e. Flood Control Outlet Works. The flood control outlet works is located in the spillway at the northeast edge of the reservoir. A plan and profile of the outlet works is shown on Plate 2-07, and the discharge rating curve is shown on Plate 2-08. Major components of the outlet works are described below.

(1) Approach Channel. The approach channel directs flow from the flood control pool into the outlet conduit. The approach channel consists of an excavated earth channel leading to a concrete section at the outlet conduit. A 13-ft-wide rectangular concrete channel extends about 60 ft upstream from the outlet conduit. Grooves in the channel walls permit the installation of 12-six-inch-high metal stop logs. Stop logs would function to block outflow and thus raise the conservation pool to a maximum elevation of 1,515 ft MSL. The vertical channel walls project upstream to meet the trapezoidal approach channel. The unlined portion of the trapezoidal channel has a base width of 13 ft, side slopes of 1 vertical on 2 horizontal and a length of about 1,000 ft. The entire approach channel is on an adverse slope of 0.002 and serves to train flow from the reservoir into the outlet conduit. The approach channel is shown on Plate 2-07 and in Photo 2-10.

(2) Conduit. The conduit is an ungated reinforced concrete structure, rectangular in section, 12-ft-high by 13-ft-wide and 79.12 ft long. At the upstream end of the outlet conduit, the roof forms a 20-ft-long, curved transition. The conduit's invert is horizontal at elevation 1,509 ft MSL. This invert elevation permits the formation of a 19,560 ac-ft reservoir that can be evacuated through the water conservation outlet works. The conduit is shown on Plate 2-09 and in Photo 2-11.

(3) Outlet Channel. The walls of the 13-ft-wide rectangular conduit extend about 43 ft downstream from the spillway side slope into the

trapezoidal outlet channel. The trapezoidal channel has a 13-ft base width, 1 vertical on 2 horizontal side slopes, concrete lining, and a length of about 310 ft to station 35+00. In this reach, the channel's bottom has a battery of 9-inch-high dentates that will reduce energy from the high velocity discharges emerging from the conduit, as shown on Plate 2-09. Between station 35+00 and station 41+00, the trapezoidal outlet channel has a base width of 16 ft, side slopes of 1 vertical on 2 horizontal, and has a grouted stone protection on the west bank. Between station 41+00 and station 67+10 a single unlined levee forms the channel's west bank. Rising ground forms the channel's east bank. The outlet channel is shown on Plates 2-07 and 2-09 and in Photos 2-12 through 2-14.

f. Spillway. A detached broadcrested spillway with a crest elevation of 1,539 ft MSL and a crest length of 1,000 ft is located in a saddle about one-half mile east of the right abutment of the dam. The spillway cross section is trapezoidal with side slopes of 2 vertical on 1 horizontal formed by a concrete sill. The spillway crest is atop a concrete lined embankment. The concrete lining is 1-ft thick and is keyed into bedrock on the downstream slope. This embankment has upstream and downstream slopes of 1 vertical on 2.25 horizontal. The crest is 22 ft wide, paved, and serves as an access road to the dam. The upstream toe has an 18-inch layer of stone and the downstream toe has two rows of dentates that will dissipate energy from spillway flow. The dentates are covered with backfill that will quickly be washed away by spillway flows. The ungated flood control outlet works passes directly through the spillway embankment. A sand and gravel drain underlies the concrete surfacing. The spillway plan and profile are shown on Plate 2-10. The spillway can be seen in Photo 2-15. Plate 2-11 shows the spillway discharge rating curve.

g. Fish Ponds. Four borrow pits, 700 ft downstream from the dam, were to be utilized as settling basins to clarify water to be injected into the groundwater by recharge wells. The borrow pits were also designated to be used as fishponds, however, due to lack of surplus water, they have never been filled and maintained. The fishponds were excavated with side slopes of 1 on 1 to a bottom elevation of 1,468 ft MSL. Depths range from 12 ft to 22 ft. The surface area would be about 50 acres. The fishponds were to be supplied with water from the conservation outlet works and from the wells. The U.S. Fish and Wildlife Service was to propagate fish in these ponds. The original plan of the ponds is shown on Plate 2-18.

h. Overlook Area. The overlook area is on the hill just east of the right abutment of the dam. The area includes a 1,200 ft-long road, a parking area for nine cars, rest rooms, an overlook structure, a lookout point, and connecting footpaths. A plan view of the overlook area is shown on Plate 2-19.

i. Access Road. Access to the project is provided by a paved road about 3-3/4 miles in length, which extends from Indian Highway Route 15 to the dam. The road consists of two 11-ft asphalt lanes with 3-ft shoulders and necessary culverts. The access road drainage system was designed for the 50-year-frequency storm. The access road is shown on Plates 2-20 and 2-21.

j. Village Road. Access from Indian Highway Route 15 to Tat Momoli Village and to the cemetery is provided by the village road. The road has a 20-ft-wide driving surface made of aggregate. It includes pertinent drainage structures such as culverts and drainage ditches.

2-04 Related Control Facilities. Downstream of the dam, the Tohono O'odham Farm's irrigation system consists of a main supply canal, a pumping plant, eleven turnout structures, concrete pipe laterals, risers, a concrete-lined ditch lateral, and 13 wells which can supply over 1500 acres with water for agriculture. Presently the irrigation project is farming 800 acres and has an average annual water consumption of 4000 - 4800 ac-ft. When water is released from the dam, the main supply canal receives irrigation water from the gated outlet conduit. The canal length is approximately 7 miles and within this 7 miles, 11 turnout structures supply water to laterals located every 1/2-mile along the east side of the canal. Risers are provided to distribute irrigation water to individual field border strips. During periods of low or no flow from the reservoir, wells located along the main canal and laterals discharge pumped water directly into the canal or laterals. See Photo 2-16. The farm has been relying on well water to irrigate the fields, due to low levels in the conservation pool. The ground water for the well field has been stable with runoff to the reservoir recharging the ground water aquifer.

2-05 Real Estate Acquisition. On 22 July 1975 the Tohono O'odham Council passed a resolution that accepted the sum of $349,215 as full compensation for the 9,000.92 acres of flowage easements associated with the flood control portion of the project. However, since its construction, Tat Momolikot Dam has not provided the recreational benefits that the Tribe envisioned, so they sought compensation for all easements required for the project in addition to those required for flood control. In October 1986, the United States Congress awarded the O'odham Indians a settlement of $6,000,000 as fair and equitable compensation for the rights to the lands required for the construction of the dam and its reservoir. The Tohono O'odham Tat Momolikot Dam Settlement Act is Public Law 99-469 [H.R. 4217]; October 14, 1986.

2-06 Public Facilities. At present, no public facilities have been developed at the project except for the overlook area. The BIA may construct and manage public facilities in the future. Such facilities could include picnic, camping, and fishing areas and associated components such as roads and comfort stations.

III - PROJECT HISTORY

3-01 Authorization. Tat Momolikot Dam was authorized by Flood Control Act of 1965, Public Law 89-298, Eighty-ninth Congress, First Session, approved October 1965. However, the final project plan differs from the Project -Document Plan (House Document 189, 89th Congress, 1st Session), which was the plan for flood control recommended in the Chief of Engineers' report dated 16 September 1964. The departure from the original plan was due primarily to the relocation of the dam about two miles further downstream. In relocating the dam additional changes that were made include: (a) the gross capacity of the reservoir at the spillway crest increased to 198,545 ac-ft from 181,000 ac-ft; (b) the flood control capacity of the reservoir at spillway crest increased to 145,000 ac-ft from 126,000 ac-ft; (c) the height of the dam was increased to 75.5 ft from 66 ft above the streambed; (d) it deferred the proposed initial development of the recreation, and fish and wildlife facilities in the reservoir area; (e) the lengths and heights of 2 compacted earthfill saddle dikes decreased to 1,440 ft and 1,195 ft from 2,800 ft and 3,600 ft, respectively, in length and the height to 4.5 ft and 5.5 ft from about 17 ft.

3-02 Planning and Design. Prior to construction of the dam, the potential standard project flood (SPF) overflow area extended from the dam site to Santa Cruz Wash, about 33 miles to the north. The overflow would cover about 57,000 acres and is shown on Plate 2-02. Populated areas subject to inundation include the communities of Maricopa, Stanfield, and the O'odham Village, Cockleburr. In 1969, 46,000 acres (80 percent of the overflow area) was found to be irrigable land and 31,000 acres were being cultivated. The economy of the Santa Rosa Wash is primarily based on agriculture. Overpumping has depleted the ground water supply and has threatened to cause a reduction in crop acreage. In order to protect the population and agriculture in the overflow area, Tat Momolikot Dam and other flood control projects were proposed in the area. After considering many alternatives, Tat Momolikot Dam was found to be the best alternative to control the design flood, provide storage for sediment carried from the tributary drainage area, and provide water storage for the conservation of storm runoff.

3-03 Construction. Construction of the dam began on 27 September 1972 and was completed on 27 June 1974. The total cost of the project was $7,657,000. Pueblo Construction Company began the work, but the project was finished by Western Construction Company.

3-04 Related Projects. Tat Momolikot Dam is the primary regulating facility on Santa Rosa Wash. No major flood control structures are in the drainage basin above Tat Momolikot Dam. There are many small detention and diversion dikes that have been constructed by the BIA. The detention dikes capture very small runoff volumes but would have little effect on larger floods. There are also excavated stock tanks in the watershed that tend to reduce the peak flows and total runoff to the reservoir. The size of the stock tanks generally varies between about 2 and 500 ac-ft. The average structure capacity is around 10 to 15 ac-ft. Altogether these detention and diversion dikes and stock tanks number 300 to 400 and have a total volume of about 3500 ac-ft. Approximately 9 miles downstream of the dam, the local flood control districts have confined Santa Rosa Wash by constructing levees. The leveed channel of Santa Rosa Wash is 24 miles long to its confluence with Santa Cruz Wash. The design discharge capacity of the channel within these levees is 5000 cfs. The leveed channel is shown on Photos 3-01 through 3-03.

3-05 Modifications to Regulation. The water control plan presented in the 1977 Reservoir Regulation Manual for Tat Momolikot Dam called for the establishment of a water conservation pool. Releases from the pool through the conservation outlet works were to be based upon: (a) the existing needs for water in the Vaiva Vo Irrigation Project; (b) maintenance of the water level in the fish ponds; (c) maintenance of the Lake Saint Clair water level for recreation; and (d) existing hydrologic conditions at the time of operation. The desired water surface elevation for the conservation pool is 1509 ft MSL, however, flashboards can be installed to raise the pool level to 1515 ft MSL. To this date, the maximum elevation of the water in the conservation pool has been approximately 1501.5 ft above sea level and releases have only been made three times since 1980.

3-06 Principal Regulation Problems. No problems have been encountered with regulation since the project was completed. However, the BIA has reported that the stop logs used to provide additional water conservation storage at the flood control outlet works approach channel, have been stolen.

IV - WATERSHED CHARACTERISTICS

4-01 General Characteristics. The Santa Rosa Wash drainage basin upstream of Tat Momolikot Dam (as shown on Plate 4-01 and 4-04) comprises 1,780 square miles and is in parts of Pima, Pinal, and Maricopa Counties. Nearly all of the watershed lies within the Papago Indian Reservation. The drainage area contains three major tributaries that join at the dam. The streams, which are ephemeral, descend the slopes of the mountains to alluvial plains where the watercourses are not well defined and are unstable due to sediment deposition and erosion. The Kohatk Wash to the west drains 301 square miles; the main Santa Rosa Wash drains an area of 683 square miles; and the Tat Momoli Wash to the east drains an area of 793 square miles. The lengths of the three main streams - Kohatk, Santa Rosa, and Tat Momoli Washes - are 38, 51, and 60 miles, respectively. The gradients of the channels range from about 800 feet per mile (0.1515) in the headwaters to 12 feet per mile (0.0023) near the dam site. Streambed profiles are shown on Plate 4-02.

Vegetal cover in the Santa Rosa Wash watershed is sparse to medium density, consisting of various types of cacti, sagebrush, greasewood, and small trees such as mesquite and paloverde. This vegetation tends to be thicker and denser along and adjacent to the stream courses. There are areas with perennial grasses at the higher elevations. Covers of annual grasses occur in much of the basin after the winter rains.

The Santa Rosa Wash drainage basin is part of the Gila River Basin (shown on Plate 4-03), which covers an area of 58,200 square miles, extending from the Continental Divide in New Mexico to where the river drains into the Colorado River. The drainage area comprises 5,600 square miles in New Mexico, 51,450 square miles in Arizona and 1,150 square miles in Sonora, Mexico. The Gila River which is 654 miles long, rises in an area of high mountains and plateaus and flows westward, in a generally central course through the basin, to a point on the Colorado River about 3 miles upstream from Yuma, Arizona. Much of the northern part of the basin is extremely irregular and rugged. The boundary elevations range from about 7,000 ft MSL to more than 12,000 ft MSL. The northern part of the basin is mostly drained by the Salt River, the largest tributary, which joins the Gila River near Phoenix. An extensive system of dams comprise the Salt River Project, which provides power and water to Phoenix. There are also other large dams on the Verde and Agua Fria Rivers. The southeastern part of the basin consists largely of long desert valleys lying between north-south ranges of rugged mountains. In this region, Coolidge Dam forms the large San Carlos Reservoir on the Gila River. The southwest third of the basin consists essentially of broad, flat, low-lying desert valleys and isolated mountains of relatively low relief. Comparatively few localities are more than 4,000 ft NGVD in elevation. The elevation of the Gila River's mouth is about 130 ft NGVD. Painted Rock Dam, constructed and operated by the Corps of Engineers, is a large flood control structure located 126 miles above the Gila River's mouth. About 85 percent of the Gila River basin is tributary to Painted Rock Dam. Tat Momolikot Dam is located 110 stream miles upstream of Painted Rock Dam.

4-02 Topography. The Santa Rosa Wash drainage area is bounded on the east by the Sawtooth, Waterman, and Roskruge Mountains; on the south by the Quinlan and South Comobabi Mountains; on the west by the Sierra Blanca and Sand Tank

Mountains; and on the north by the Vekol and Tat Momoli Mountains. Between the mountain ranges, there are some low divides where the drainage boundary is indistinct. Elevations in the area range from about 1,500 ft at the dam site to about 6,800 ft in the Quinlan Mountains.

4-03 Geology and Soils. The soils in Santa Rosa Wash watershed are extremely varied. The mountains consist of weathered native rock, while the valley floors contain unconsolidated gravels, sands, silts, and the clays derived from these rocks. The rock materials are almost equally divided between schists, granites, and older volcanic rocks such as basalt, with some small amounts of limestone appearing in the northern part of the basin at the dam site. The soils of the mountain area are shallow and stony with occasional rock outcrops. Desert and semi desert soils occur in the hills and valleys. The valley surface soils generally range from fine silty clays to clay and are fairly deep.

4-04 Sediment. Erosion of soil is widespread in the watershed; however, an insignificant amount of sediment has been transported to the reservoir area. The erosion problem is believed to be caused by the loss of ground cover due to livestock overgrazing. Efforts to eliminate the overgrazing problem have had limited success over the past forty or fifty years; however, recent methods of rotating grazing livestock in order to allow the land to rest after the grass has been grazed, have shown excellent results in maintaining a ground cover. Since the dam was completed in 1974, storms have not produced significant sediment deposits in the allocated sediment space.

4-05 Climate. The climate is typically desert in character, with short, mild winters and long, hot summers. Much of the year is dry, but several light general winter storms and a few heavy summer thunderstorms usually occur each year. A summary of climatological data at Casa Grande, Arizona, located about 20 miles north-northeast of Tat Momolikot Dam, is given in Table 4-01.

a. Temperature. Average daily maximum and minimum temperatures (degrees Fahrenheit) over most of the watershed range from about 65 and 35 respectively to about 105 and 75 in summer. In the highest elevations of the watershed the values are about 20 to 25 degrees lower. High diurnal (day-to-night) temperature variations are characteristic of the region. All-time high and low temperature extremes are about 120 and 15 respectively in the lower elevations to about 100 and 0 in the highest mountains of the drainage. Significant periods of freezing are rare in the lower desert areas, but are common during the winter above 6,000 ft. Table 4-01 lists, among other items, the mean daily maximum and minimum temperature and record highest and lowest temperature for each month of the year at Casa Grande.

b. Precipitation. The 30-year (1931-1960) normal annual precipitation (Plate 4-04, the most recent map available) ranges from about 9.0 inches at the dam to about 16.0 inches in the headwater area with an average of 10.8 inches for the drainage area. The heaviest precipitation occurs in the summer, and the driest occurs during late spring (See Table 4-01).

Table 4-01 also lists the mean and maximum monthly and annual precipitation, as well as the maximum daily precipitation for each month of the year, at the Tucson station. Also listed in Table 4-01 are the probabilities (from 5 to 95 percent) for each month of the year that the monthly total precipitation will be equal to or less than the indicated amounts. This table demonstrates that there can be great year-to-year variability in annual, monthly, and daily precipitation.

A description of general winter storms, general summer storms, and local thunderstorms, all of which produce precipitation in the basin, are given in the following subparagraphs:

(1) General Winter Storms. General winter storms usually occur during the period from December through March. They originate over the Pacific Ocean and move slowly eastward across Arizona. These storms last anywhere from a few hours to several days and can result in widespread precipitation over southern Arizona, with snow at the highest elevations.

(2) General Summer Storms. General summer storms usually occur during the period August through early October. They are associated with an influx of tropical maritime air originating over Mexico and the adjacent tropical Pacific Ocean and enter the area from a south or southeast direction. Such storms are often associated with the remnants of a tropical hurricane. General summer storms are often accompanied by relatively heavy precipitation over large areas for periods of from 12 hours to 4 days.

(3) Local Thunderstorms. The local thunderstorms can occur at any time of the year, either during general storms or as isolated phenomena. However, they are most common during the period July through September, when the basin is frequently covered by moist, unstable air originating over Mexico or the Gulf of California. These storms cover comparatively small areas and result in high-intensity precipitation of short duration (up to 3 hours).

c. Snow. Snow falls occasionally at the higher elevations in the basin, but usually melts within a few days. The effect of snowmelt on flood flows in the basin is negligible.

d. Evaporation. There are no evaporation data available for Tat Momolikot Dam or the watershed above, but data for pan evaporation in the desert areas of southwestern Arizona indicate that mean monthly evaporation ranges from 3-4 inches in early winter to 10-20 inches in early summer. Table 4-02 shows this seasonal variation in mean monthly pan evaporation, and also reveals the great variation that occurs from one well-exposed location to another. Raw daily pan evaporation data from Alamo Dam support the range of figures shown in Table 4-02, and show that evaporation can greatly exceed 1 inch per day during very dry, windy conditions. Further support can be obtained for evaporation stations in the Tucson area through the University of Arizona.

e. Wind. The prevailing winds are from the east and are usually light, although severe windstorms occur at rare intervals as the result of local thunderstorms, tropical storms, intense winter storms, or unusually strong Great Basin high pressure cells.

Table 4-01

CLIMATOLOGICAL DATA AT TUCSON, ARIZONA*

Month	Temperatures (Degrees Fahrenheit)			Precipitation (Inches)		
	Mean	Maximum	Minimum	Mean	Maximum	Minimum
Jan	50.1	87	16	.76	4.00	0
Feb	53.2	92	20	.79	4.15	"T"
Mar	57.7	92	20	.71	3.88	0
Apr	64.4	102	27	.34	3.53	0
May	72.6	107	38	.18	1.34	0
Jun	81.9	ill	47	.26	2.07	0
Jul	85.9	ill	63	2.25	6.24	0.25
Aug	83.9	109	61	1.21	7.93	0
Sep	79.8	107	44	1.21	5.11	0
Oct	69.3	101	26	.69	4.51	0
Nov	58.1	90	24	.77	4.61	0
Dec	51.1	84	16	1.02	5.85	0
Period of Record**	67.3	1ll	16	**11.09	7.93	0

* National Weather Service climatological station at Municipal, Airport; 320 07'N Latitude 110 56'W Longitude Elevation (ground), 2,854 feet.

** Mean Annual

Note: 1. Information taken from "Climatological Date, Arizona" by Weather Bureau, National Oceanic and Atmospheric Administration.
2. Period of record is from January 1905 to March 1975.
3. "T" indicates less than 0.01 inch of precipitation.

TABLE 4-02a. EVAPORATION STATIONS IN SOUTHWESTERN ARIZONA

CA DWR NO.	STATION NAME	LATITUDE (Degrees-Minutes-Seconds)	LONGITUDE	ELEVATION (ft)	RECORD from	to
--	Painted Rock Dam	33-04-08	113-01-48	560	8/74	5/88
230202	Davis Dam No. 2	35-12-00	114-34-00	657	3/48	12/73
988502	Yuma Citrus UAEF	32-36-45	114-38-00	191	1/21	12/73
988750	Yuma Field Sta	32-48	114-34	135	5/10	12/46

TABLE 4-02b. MONTHLY EVAPORATION
(inches)

Painted Rock Dam (14-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
8.08	4.61	2.91	3.02	4.41	7.09	10.60	14.35	17.52	16.46	15.04	12.19

Davis Dam No.2 (26-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
10.75	8.03	6.89	6.54	7.05	9.72	12.28	15.90	18.07	18.54	16.81	13.86

Yuma Citrus UAEF (53-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
7.64	4.76	3.50	3.70	4.72	7.60	9.96	12.83	14.13	15.28	13.50	10.63

Yuma Field Station (37-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
5.39	3.46	2.48	2.52	3.35	5.55	7.16	9.37	9.92	10.15	9.02	7.32

Data for Painted Rock Dam are compiled from Corps of Engineers records.

Data for the remaining western Arizona stations (all adjacent to the Colorado River) are published by the California Department of Water Resources, in Evaporation from Water Surfaces in California, Bulletin 73-79, 1979.

Note: Each evaporation station consists of a National Weather Service Class A Pan. Readings are adjusted for observed rainfall to yield net evaporation. Reservoir evaporation may be estimated by multiplying measured pan evaporation by a pan coefficient ranging from 0.6 to 0.8.

4-06 Storms and Floods. Historical accounts indicate that many damaging floods have occurred in the Gila River Basin. Sizable floods occurred in 1884, 1891, 1916, 1926, 1937, 1957, 1962, 1964, 1977, 1980, and 1983. Indications are that these floods were the result either of general storms or, in a few cases, of tropical cyclones centered in or near the Gila River Basin. A summary of peak annual discharges and maximum mean daily discharges as recorded by the USGS stream gage on Santa Rosa Wash near Cockleburr for 1954-1980 are included in Table 4-03. Table 4-04 gives the hourly maximum average inflow to Tat Momolikot Dam for 1974-1988. Brief descriptions of significant past storms and floods are given in the following subparagraphs:

a. Storm and Flood of 3-8 September 1939. The storm apparently had two centers covering large areas, one northeast of the Imperial Valley in California and one east of Needles in Arizona. The unusually heavy precipitation during the storm was associated with three tropical cyclones originating off the west coast of Mexico, one of which traveled northward through the Gulf of California and dissipated over the lower Colorado River Valley. A total of 6 to 7 inches of precipitation fell over an area of more than 2,300 square miles within the center near Imperial Valley and over an area of more than 3,000 square miles within the center of the storm east of Needles, California. Precipitation intensities recorded by the Stations at Yuma and Phoenix were high. At Yuma, 2.17 inches of precipitation fell in 90 minutes; and at Phoenix, 2.41 inches fell in 6 hours. Isohyets of the total storm precipitation are shown on Plate 4-05. No measurements of runoff were made in the Santa Rosa Wash area, but high peak discharges were measured on streams (with well-defined channels) near the centers of the storm. The Big Sandy River (a tributary of the Bill Williams River) below Burro Creek, at Signal, Arizona, had a peak discharge of about 100,000 cfs from an area of 2,670 square miles. Picacho Wash at All-American Canal, near Yuma, Arizona, had a peak discharge of 37,000 cfs from an area of 41.5 square miles.

b. Storm and Flood of 19 August 1954. The storm and flood of 19 August 1954, according to available reports, were the most severe of record in the Queen Creek drainage area (approximately 60 miles northeast of the Santa Rosa Wash area). Very moist, warm, tropical air that originated over the Gulf of California entered Arizona from the south during the storm period, accompanied by widespread thunderstorm activity. Precipitation intensities were very high during small portions of the storm. An estimated 100 square miles of area (near the storm center) had over 5 inches of precipitation. Although the Santa Rosa Wash area was not hard hit by this storm, the peak discharge at the USGS gaging station known as Queen Creek at Whitlow Ranch dam site near Superior, Arizona (area 143 square miles), was estimated at 42,900 cfs.

c. Storm and Flood of 31 October 1957. The storm of 31 October 1957, which was of the general summer type, but with some winter characteristics, is noteworthy because of the hydrologic records available for the Santa Rosa Wash area. The storm was of tropical maritime origin. In and near the area the recorded precipitation varied from about 2 inches in the area around Stanfield to 1.05 inches at Picacho Reservoir, 1.89 inches at Sells, and 0.79 inch at Ajo. Greater depths of precipitation in the headwaters of the streams were likely, but records of amounts are not available. The precipitation continued with moderate to high intensities for a period of 2 to 3 hours at most stations. The isohyets of the total storm precipitation are shown on Plate 4-06. The flooding of fields in the Stanfield-Maricopa area resulted from the failure of dikes along Santa Rosa Wash. A small conservation dam on Anegam Wash, a few miles west of Gu Achi, failed during the flood and caused several breaks in dikes protecting the road from Casa Grande to Quijotoa. The peak discharge of Santa Rosa Wash at Gu Komelik was estimated at 14,000 cfs and near Vaiva Vo at 10,000 cfs.

Table 4-03

RUNOFF DATA SANTA ROSA WASH NEAR COCKLEBURR*

Year**	Maximum Peak discharge	Date	Maximum Mean daily discharge	Date
	Cubic feet per second		Cubic feet per second	
1954-55	1,150	8 Aug	1,040	8 Aug
1955-56	740	24 Jul	434	24 Jul
1956-57	492	12 Aug	212	18 Jul
1957-58	10,000	1 Nov	4,040	1 Nov
1958-59	4,120	13 Jul	1,460	13 Jul
1959-60	805	30 Jul	580	31 Oct
1960-61	892	27 Jul	443	31 Aug
1961-62	53,100	27 Sep	22,000	27 Sep
1962-63	4,180	14 Sep	798	16 Aug
1963-64	6,760	25 Jul	2,370	13 Aug
1964-65	433	4 Sep	176	14 Aug
1965-66	1,820	14 Sep	847	13 Sep
1966-67	302	26 Jun	190	6 Aug
1967-68	840	28 Jul	600	15 Dec
1968-69	514	8 Aug	115	8 Aug
1969-70	865	10 Aug	518	10 Aug
1970-71	6,110	4 Aug	2,230	4 Aug
1971-72	410	14 Aug	195	14 Aug
1972-73	762	21 Oct	568	21 Oct
1973-74	364	2 Aug	24	2 Aug
1974-75	580	17 Jul	45	17 Jul
1975-76	390	25 Sep	18	25 Sep
1976-77	291	17 Jul	19	19 Jul
1977-78	66	13 Feb	5.1	13 Feb
1978-79	51	17 Jan	4.3	17 Jan
1979-80	105	24 Aug	2.5	24 Aug

* Latitude 32° 40'00"N; longitude 11° 55'40"W; in SW1/4, Sec 2, T. 95, R. 4E. Papago Indian Reservation on right bank 3-1/2 miles south of Cockleburr, 1-1/8 miles north of Tat Momolikot Dam. Data from U.S.G.S. Water Records of Arizona. Station was discontinued in September 1980.

** 1 October to 30 September, inclusive.

TABLE 4-04

MAXIMUM AVERAGE INFLOWS AND WATER SURFACE ELEVATIONS

Water Year	1-Hour Maximum Average Inflow (cfs)*	Date	Maximum Elevation (ft)	Date
1974	580	4 Aug	1490.40	4 Aug
1975	550	29 Oct	1490.68	31 Oct
1976	2820	25 Sep	1501.53	27 Sep
1977	1180	18 Jul	1499.84	1 Oct
1978	980	28 Dec	1494.78	13 Mar
1979	246	21 Jul	1489.14	21 Jul
1980	288	31 Jan	1486.55	1 Feb
1981	1250	31 Jul	1493.45	31 Jul
1982	905	12 Aug	1492.57	26 Aug
1983	860	15 Aug	1492.46	30 Sep
1984	2400	3 Oct	1499.63	4 Oct
1985	80	28 Dec	1489.34	4 Oct
1986	1040	26 Aug	1492.01	26 Aug
1987	220	3 Aug	1488.00**	24 Sep
1988	620	30 Jul	1491.59	31 Jul

* Calculated from Reservoir Computation Sheets.

** Estimated value.

d. Storm and Flood of 25-26 September 1962. The unusually heavy precipitation during the storm was associated with Tropical Storm Claudia, which had originated off the west coast of Mexico. The main stream of moist air, which was about 70 miles wide, passed over Sells, the Tucson Mountains-Cortaro area, Oracle, and on into New Mexico. Heaviest rain fell during the night of 25 September and most of 26 September. A total of 4 inches of precipitation occurred at Sells in a 10-hour period on 25-26 September. Estimates of depths of 7 inches were made for two locations, 7 and 12 miles west of the Arizona-Sonora Desert Museum. The peak discharges of Santa Rosa Wash near Vaiva Vo and Santa Rosa Wash at State Highway 84 between Casa Grande and Stanfield were estimated at 53,100 cfs and 12,800 cfs, respectively.

e. Storm and Flood of March 1983. Following a wetter than normal winter, a heavy storm moved into southern Arizona from the southwest, dropping moderate rain throughout the region. Rain began late on 2 March and continued into 4 March, with a few lingering showers into 5 March. The heaviest rain fell late 3 March into early 4 March, with amounts estimated to be as high as 1 inch in 9-12 hours. Total precipitation at nearby stations included 1.65 inches at Casa Grande, 1.15 inches at Eloy, and 1.11 inch at Anvil Ranch. A little farther from the drainage area, .95 inch fell at Ajo, 1.44 inch fell at Organ Pipe Cactus NM, and about 1 inch in the Tucson area. Since the US Geological Survey stream gauges on Santa Rosa Wash had been discontinued in 1980, there were no streamflow measurements on the wash itself in 1983. There was no major inflow to Tat Momolikot Reservoir from this storm.

4-07 Runoff Characteristics. Little streamflow occurs except during and immediately following heavy precipitation. Climatic and drainage-area characteristics are not conducive to continuous runoff. Because of steep gradients, streamflow in the mountains increases rapidly in response to high intensity precipitation and causes debris-laden flash floods to pass out onto the valley plains below. When the floodwaters reach the valley plains, it spreads out as overland flow. The velocities and peaks are reduced, the debris is deposited, and a considerable amount of flow is lost to percolation. Vegetation has negligible effect on flood runoff, except where perennial grasses impede overland flow in the upper areas.

4-08 Channel and Floodway Characteristics. Below Tat Momolikot Dam, the natural watercourse of Santa Rosa Wash extends 9.0 miles. In this reach, braided channels cover the streambed, which varies in width from about 500 ft below the dam to about 2 miles in the downstream end of the reach. Below this natural channel, the flood control districts have confined Santa Rosa Wash by the construction of levees. The leveed channel of Santa Rosa Wash extends 24 miles to its confluence with Santa Cruz Wash. Channel capacities of this reach were evaluated in August 1971. Rating curves based on uniform flow depths and variable roughness coefficients were determined for 23 cross sections. For the leveed sections, the maximum capacity is defined as the discharge 2-1/2 feet (freeboard allowance) below the lower levee's top. The limiting capacity for the reach is about 5,000 cfs. In Exhibit B, plates 1B and 2B show the plan and profile of this reach and the location of cross sections. Plate 3B is a cross section of the Santa Rosa Wash at Sta 1257+00. All 3 of the aforementioned plates were taken from the 1977 Reservoir Regulation Manual for Tat Momolikot Dam. Rating curves for the cross sections are available at the LAD Office. The Santa Cruz Wash extends about 18 miles below its confluence with Santa Rosa Wash to its confluence with the Gila River. In this reach, the Santa Cruz Wash streambed is over 2 miles wide with many braided channels. The Santa Cruz Wash meets the Gila River about 80 miles upstream of Painted Rock Dam and about 10 miles upstream of where the Salt River meets the Gila River. Plate 4-07 exhibits the approximate travel time for outflow from the dam to reach downstream points of interest.

4-09 Structures Affecting Santa Rosa Wash. Upstream of Tat Momolikot Dam there are many small diversion and detention dikes. They have little effect on large floods, but will divert or trap small flows. The few detention dikes upstream will most likely only trap 1 to 2 acre-feet of water each. No operational facilities exist upstream of the dam.

Just downstream of Tat Momolikot Dam, some of the water released through the gated conservation outlet works conduit is diverted from the Santa Rosa Wash into the Vaiva Vo Irrigation Project canal. Approximately 9 miles downstream of the dam, Santa Rosa Wash is confined by levees for about 24 miles.

4-10 Economic Data.

a. Population. The Santa Rosa Wash drainage basin above Tat Momolikot Dam is sparsely populated and no population figures are available specifically for the watersheds above or below the dam. In 1988 the Arizona Department of Economic Security, Population Statistics Section estimated Pinal County to have a population of approximately 110,300. Casa Grande was estimated to have a population of 18,685. The 1980 census counted 825 people in Arizona City and 7,203 people on the Papago Indian Reservation. Only 643 people of the 7,203 on the Reservation were in Pinal County. The College of Business at Arizona State University has projected the population of Pinal County to be approximately 136,000 by July 1, 2000.

b. Agriculture. Agriculture is a major activity in Pinal County. The Arizona Agricultural Statistics Service published a 1988 Arizona Agricultural Statistics report, from which information for this section was taken. Crops and livestock are almost equally important to the revenue of the county. Crops that are planted include cotton, wheat, alfalfa, barley, principal vegetables, grapes, and citrus fruits. Cotton, which is the major crop, was planted on about 159,000 acres. Wheat was planted on 15,400 acres and alfalfa was planted on 11,600 acres.

Livestock in Pinal County includes cattle, sheep, hogs and pigs. At the end of 1988 there were 120,000 head of cattle and calves, 36,000 head of sheep and lambs, and 9,000 head of hogs and pigs. These and other livestock and livestock products accounted for approximately one-half of the agricultural revenue for the county.

c. Industry. Mineral development is a predominant industry throughout Pinal County. In 1987 approximately on quarter of the gross county product was from mining operations. Many mines can be found in the hills south and east of Tat Momolikot Dam. The only working mine in the vicinity of Tat Momolikot is a copper mine that is about 9 miles south-southeast of the dam. Manufacturing operations are predominantly located in central Arizona. They include: chemical processing; manufacturing of stone, clay and glass products; printing and publishing; metal fabrication; primary metals processing; textiles and apparels; leather and leather goods; and especially manufacturing and assembly of electrical and electronic goods.

d. Flood Damages. Since the construction of Tat Momolikot Dam there have been no flood damages downstream of the dam on Santa Rosa Wash. Releases from the dam have only occurred three times. Each time, the release was made through the water conservation outlet works and was only sustained for a short time.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 Hydrometeorological Stations.

a. Facilities.

(1) Reservoir Water Surface Recorder. Reservoir water surface elevations are continuously recorded. The Stevens A-71 graphic water surface recorder is in the instrument house located atop the conservation intake tower. The instrument is mechanically connected to a float and records the reservoir water surface in a 18-inch diameter float well that is located on the east face of the intake tower. The float well is screened such that only water surface levels above elevation 1,485 will be measured.

(2) Reservoir Staff Cages. There are 14 adjustable 5-foot staff sections located on the upstream slope of the dam. These sections are located just east of the conservation outlet tower. The staff gage system indicates reservoir water surface elevations from 1,485 to 1,555 MSL. See Photo 5-01.

(3) Precipitation Gages. Long-term-recording precipitation gages were installed near Kohatk, Santa Rosa School, and Queens Well in January 1972. The Bureau of Indian Affairs services these gages every 4 months. These gages all use catch tank-float systems and are connected to Stevens A35 graphic recorders. In the near future these 3 gages will be replaced with tipping buckets and Stevens digital recorders. A tipping bucket rain gage is installed in the instrument house atop the intake tower. This gage provides current rainfall data. In the near future a Stevens digital recorder will be installed in the instrument house to provide the Corps with a tape copy of the rainfall data. The Corps of Engineers provided assistance for the operation and maintenance of the precipitation gages during the first three years of operation of Tat Momolikot Dam.

(4) Stream Gages. In 1954, the USGS established 3 stream gaging stations on Santa Rosa Wash. The gage on Santa Rosa Wash at Gu Komelik was discontinued in 1959. The gage on Kohatk Wash near Chiapuk was discontinued in 1960. The gage on Santa Rosa Wash near Cockleburr was discontinued in September 1980.

b. Reporting. Hydrologic data from Tat Momolikot Dam and the upstream and downstream watersheds are observed and reported in three different ways. Readings are made manually by BIA personnel, recorded automatically by gages, and reported in real-time by the telemetry system.

(1) Manual. The BIA personnel can observe precipitation, water surface elevation, and gate settings. Reports are only given to the Reservoir Regulation Section when there is rainfall of 1-1/2 inches at Tat Momolikot Dam or at Casa Grande, or when the reservoir water surface elevation reaches 1,505 ft MSL.

(2) Recording Instruments. The recording instruments store data on paper tape, which can be removed at any time and is maintained on file by the BIA. See Photo 5-02.

(3) Telemetry System. LAD's data collection system for Tat Momolikot Dam is the Geostationary Operational Environmental Satellite (GOES) system. Via this system the LAD receives precipitation and water surface elevation information for Tat Momolikot Dam. GOES consists of a Digital Readout Ground Station (DRGS) at the Baseyard facility and hydromet gages connected to Data Collection Platforms (DCP's) located within Arizona, Nevada, and California. These DCP's transmit data to LAD's DRGS through the GOES satellites, operated by the National Oceanic Atmospheric Administration's (NOAA's) National Environmental Satellite, Data, and Information Service (NESDIS). The transmissions are broadcast only at specifically assigned times (every 3 to 4 hours) for each DCP. The system provides near real-time data necessary for flood control operations and monitoring of the dam.

c. Maintenance. Each operating agency is responsible for the maintenance of its own gage.

5-02 Water Quality Stations. No water quality stations exist at Tat Momolikot Dam.

5-03 Sediment Stations. No sediment stations exist for Tat Momolikot Dam. Instead, surveys will be conducted to determine the quantity and distribution of sediment in the reservoir, and to determine aggradation or degradation of the channels below the dam. Range lines, that are topographic cross sections, were established in fiscal year 1977. Resurveys of range lines will indicate the projects affect on sediment transport. Category "A" index ranges will be established in the reservoir area and Category "C" index ranges will be established in the downstream channel. Key range lines will be resurveyed every five years or after a major storm where the reservoir water surface reaches elevation 1,510 ft MSL (which ever comes first). If the range survey indicates a considerable change, the appropriate parts of the reservoir (usually the lower elevations) will be resurveyed to establish a new elevation-capacity relationship.

5-04 Recording Hydrologic Data. Hydrologic data are collected for evaluating past and predicting future effectiveness of Tat Momolikot Dam. The accumulation of such data will be valuable for future hydrologic predictions for both flood control and water conservation.

Each agency maintains records of its own data. The U.S. Army Corps of Engineers maintains a file of data from its recording and telemetry gages at the District's Base Yard Office. The BIA records the data from its manual observations and maintains these records on file.

5-05 Communication Network. There are no permanent attendants, telephones or radios located at the Tat Momolikot Dam. Communications would only be achieved by courier.

5-06 Communication With Project.

a. Regulating Office with Project Office. No routine communication is made between the COE and the BIA. A set of Standing Operating Instructions to the Project Operator for Water Control have been compiled for each dam. A copy of these instructions for Tat Momolikot Dam is included in Exhibit A of this manual.

b. Between Project Office and Others. No routine communication exists between the BIA and other agencies about Tat Momolikot Dam.

5-07 Project Reporting Instructions. The BIA will notify the LAD Reservoir operations Center (ROC) (telephone number (213) 894-4756) when any of the following conditions occur: rainfall of 1-1/2 inches at Tat Momolikot Dam or 1-1/2 inches at Casa Grande, or when reservoir water surface elevation reaches 1,505 ft NGVD.

5-08 Warnings. The responsibility for issuing all weather watches and warnings and all flood and flash flood watches and warnings rests with the NWS. Local emergency officials of the O'odham tribe, cities, and counties are responsible for issuing any public warning regarding unusual overflows, evacuations, unsafe roads or bridges, toxic spills, etc. The BIA is responsible for providing these officials with current information, and when possible, forecasts of water surface elevations within Lake Saint Clair, and flow rates in Santa Rosa Wash downstream of Tat Momolikot Dam. The BIA's Supervisory Civil Engineers of Land Operations for the Papago Agency are authorized to make flood warnings on behalf of the BIA concerning water release from the dam. If an uncontrolled spillway flow or dam break were imminent, the O'odham Tribal Police Department (telephone no. (602) 383-3280) and the Pinal County Sheriff's Office located in Stanfield (telephone no. 1-800-352-3796 or (602) 836-8226) should be notified immediately so they could initiate evacuations.

VI - HYDROLOGIC FORECASTS

6-01 General. There are no official forecasts made by the U. S. Army Corps of Engineers or the National Weather Service for Tat Momolikot Dam. Santa Rosa Wash water quality is not monitored by any agency.

a. Role of Corps. Although no formal hydrologic forecasts are made for Tat Momolikot Dam, the Corps of Engineers does monitor conditions at the dam and can make a general forecast for the area as needed. Any significant change in hydrologic conditions at the dam will prompt the LAD to notify pertinent agencies and coordinate with them when necessary.

The LAD meteorologist-prepares quantitative precipitation forecasts (QPF's), when significant rain is forecast in any region of the district. The QPF assists in estimating the severity of the upcoming event and in scheduling personnel to work in affected areas.

b. Role of Other Agencies. No other agency currently prepares forecasts of inflow to Tat Momolikot Dam. The NWS office at Phoenix, Arizona (phone number (602) 261-4000) will provide, upon request, weather forecasts and climatological reports for the region in which the project is located. Unit hydrographs for drainage subareas are presented in Table 6-01. These unit hydrographs may be applied to predict inflow when rainfall data in these subareas are available.

Historical precipitation and streamflow data are available from the BIA, NWS, USGS, and others. These data, while not of use in real-time, are important to studies of historical storms and floods that aid in the development and refinement of computerized rainfall-runoff models.

6-02 Flood Condition Forecasts. Forecasts of flood hydrographs are not currently made. However, inflow and precipitation conditions are collected and evaluated to provide a general prediction of flood situations. Using such information, an evaluation can be made as to whether an ongoing flood will increase or decrease over the next 24 hours.

6-03 Conservation Purpose Forecasts. The maximum water surface elevation in the conservation pool since the construction of Tat Momolikot Dam has been approximately 1501.5 ft. This is 7.5 ft below the desired water surface elevation. As a result, only three releases have ever been made from the dam and no conservation-purpose forecasts are made.

6-04 Long Range Forecasts. Since water is only rarely and briefly impounded behind Tat Momolikot Dam and since there are no major upstream flood control facilities, there is little if any, direct need for long-range forecasts in the operation of Tat Momolikot Dam. Thus, at this time, no long range forecasts are made for Tat Momolikot Dam.

Only in the event of major impoundment at Lake Saint Clair, would a forecast of more than 1 day be of significance to the operation of Tat Momolikot Dam. In such a case, the forecast of another impending major storm or lack of such storm might influence the release rate of water from the dam in order to prevent or minimize downstream damages.

Table 6-01
UNIT HYDROGRAPHS CORRESPONDING TO SUBAREA
SHOWN ON PLATE 4-04 FOR SANTA ROSA WASH

TIME (hours)	A	B	C	D	E	F	G
	Subarea Unit Hydrographs [(ft3/sec)/(inch/hour)]						
1	390	250	960	370	320	130	680
2	1,550	1,720	8,610	2,560	950	630	3,650
3	3,490	4,410	27,890	6,590	2,050	1,130	10,050
4	6,990	9,440	40,890	14,110	4,270	2,130	21,460
5	13,200	16,050	24,610	24,000	7,110	3,750	37,670
6	19,030	22,790	10,120	34,070	10,750	5,380	44,070
7	27,370	18,510	5,880	27,660	14,850	7,760	31,970
8	27,570	13,240	4,100	19,780	20,540	10,390	20,090
9	20,580	7,600	2,870	11,360	19,750	13,640	11,870
10	15,730	5,020	2,190	7,510	15,330	14,010	8,220
11	10,290	3,800	1,500	5,680	12,330	11,760	6,160
12	7,380	2,820	1,230	4,210	8,220	9,010	4,790
13	5,630	2,450	1,090	3,630	6,000	7,630	4,110
14	4,270	1,840	680	2,750	4,420	5,010	2,970
15	3,490	1,470	680	2,200	3,480	4,000	2,510
16	3,110	1,350	550	2,020	3,160	3,500	2,050
17	2,720	1,100	410	1,650	2,530	2,500	2,050
18	1,940	980	410	1,470	2,210	2,250	1,600
19	1,940	980	410	1,470	1,900	1,750	1,370
20	1,550	610	410	920	1,740	1,750	1,140
21	1,550	610	410	920	1,420	1,380	910
22	1,160	490	410	730	1,260	1,250	910
23	1,160	490	410	730	1,110	1,130	910
24	1,160	490		730	950	1,000	680
25	970	370		550	790	880	680
26	780	370		550	790	880	680
27	780	370		550	790	750	460
28	580	370		550	630	750	460
29	580	250		370	630	630	460
30	580	250		370	630	630	460
31	580	250		370	470	500	460
32	580	250		370	470	380	460
33	580	250		370	470	380	460
34	390	250		370	320	380	460
35	390	250		370	320	380	460
36	390	120		190	320	380	230
37	390	120		180	320	380	230
38	390	120		180	320	380	230
39	200	120		180	320	250	230
40	200	120		180	320	250	
41	200	120		180	320	250	
42	200	120		ISO	160	250	
43	200				160	250	
44	200				160	250	
45	200				160	250	
46	200				160	130	
47	200				160	130	
48	190				160	130	
49	190				160	130	
50	190				160	130	
51	190				160	130	
52	190				160	130	
53	190				160	130	
54					160	130	
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57					160	120	
58					160	120	
59					160	120	
60					160	120	
61					160	120	
62						120	
63						120	
64						120	
65						120	
66						120	
67						120	
68						120	

VII - WATER CONTROL PLAN

7-01 General Objectives. Tat Momolikot Dam and Reservoir was designed as a multiple-purpose project. It was built to provide (a) protection against floods to lands and improvements, (b) conservation storage, (c) for development of irrigable lands, and (d) recreation, and fish and wildlife facilities. It is operated independently of any other flood control facility or system. Floodwaters are stored in the conservation pool, and released as the need for irrigation water arises.

7-02 Major Constraints. Constraints that impact the regulation of Tat Momolikot Dam and Lake Saint Clair are:

a. Channel Capacity. Below Tat Momolikot Dam the natural watercourse of Santa Rosa Wash extends 9.0 miles. In this reach, the streambed is a braided channel and varies in width from about 500 ft below the dam to about 2 miles in the downstream end of the reach. Below this natural channel, local interests have confined Santa Rosa Wash by the construction of levees. The channel is leveed for 24 miles to its confluence with Santa Cruz Wash. Channel capacities of this reach were evaluated in August 1971. Rating curves based on uniform flow depths and variable roughness coefficients were determined for 23 cross-sections. The limiting cross sectional capacity for the 24 mile leveed reach is about 5,000 cfs. If the combination of dam releases and local runoff were greater than 5,000 cfs, it is likely that the levees would be overtopped and would fail. Levee failure could lead to flooding of agricultural fields and towns.

b. Spillway Flow. Spillway flow has great damage potential. Immediately downstream of the Tat Momolikot Dam embankment is the Tohono O'odham farm, which could sustain damage. Four miles downstream of the dam, the O'odham village of Cockleburr would sustain damage from the combined spillway flow and local runoff. In addition, individual farms and dwellings in the vicinity of Santa Rosa Wash would sustain damages.

7-03 Overall Plan for Water Control. Tat Momolikot Dam and Lake Saint Clair is operated as a multiple-purpose facility on Santa Rosa Wash. It was built to provide flood protection, water conservation storage, irrigation water for downstream agriculture, and recreation facilities. The operational emphasis is storing water to maintain a pool for the above purposes. Plate 2-06, which depicts the storage allocations for Lake Saint Clair, shows that the entire space of the reservoir below elevation 1509.0 ft is devoted to conservation operations. Between elevation 1509.0 and 1515.0 ft (the maximum elevation to which the flashboards can be raised), the space can be used for either conservation or flood control or both, depending on whether flashboards are in place. The addition of flashboards to the flood control outlet works approach channel was made so that a minimum of 15,000 acre-ft of conservation storage could be maintained at all times in the future. The flashboards would be added individually as needed to offset the sedimentation in the basin. Assuming no sediment removal from the basin, the flashboards, once inserted, would be left in place. Elevation 1515.0 to 1539.0 ft (the spillway crest) is allocated to flood control. Between elevation 1539.0 and 1551.2 ft (the maximum reservoir water surface elevation for the spillway design flood), the space is used for spillway surcharge. The distance between elevation 1551.2 and 1557.5 ft (the top of the dam) is reserved for freeboard.

7-04 Standing Instructions to Damtender. There are no permanent attendants, telephones or radios at the Tat Momolikot Dam. Communications from the dam site can only be achieved by portable radio. The "Standing Operating Instructions to the Project Operator for Water Control" for Tat Momolikot Dam and reservoir are given in Exhibit A. The project operator should follow the Standing Operating Instructions in Exhibit A.

7-05 Flood Control. Floods of magnitude up to and including the reservoir design flood are controlled by the project such that peak outflows from the reservoir are safely carried in downstream reaches. Floodwaters are released through a 12-ft high by 13-ft wide ungated conduit. The flood control outlet works do not include any mechanical equipment that permits adjustment of reservoir outflows. The flood control conduit capacity when the water surface elevation reaches the spillway crest (elevation 1539.0 ft) is 4,960 cfs. The reservoir design flood discharge of 4,960 cfs would not exceed the downstream channel capacity of 5,000 cfs. The conduit capacity increases to 6,360 cfs when the water reaches the maximum elevation of the spillway design flood (1551.2 ft). At this water surface elevation, 134,240 cfs of water would be flowing over the top of the spillway. If spillway flow does occur, the conservation outlet gates should be closed to minimize the downstream flow as much as possible.

Although the reservoir design flood discharge and limiting cross sectional capacity of the leveed channel are nearly equal, it was concluded that the likelihood of the reservoir design flood discharge and significant local runoff downstream of the dam occurring simultaneously was slim. There is 15,000 ac-ft of water conservation space in the dam to be filled before the water even reaches the elevation of the flood control conduit invert without flashboards in place. With the flashboards in place there is 34,855 ac-ft of storage behind the dam. It is not deemed economically viable to take any structural action when assessing the flood damages resulting from the rare event when the discharge from the dam and local runoff combine to exceed 5,000 cfs causing local downstream flooding.

7-06 Recreation. The Tat Momolikot Dam water control objectives that exist for recreation have to do mainly with fish and wildlife (see paragraph 7-08). Tat Momolikot Dam is not operated to meet recreation objectives such as boating or swimming.

7-07 Water Quality. Tat Momolikot Dam is not operated to meet specific water quality objectives.

7-08 Fish and Wildlife. There are fish and wildlife water control objectives for Tat Momolikot Dam within both the reservoir and fishponds downstream of the dam. If the reservoir were to be stocked with fish, it would be necessary to maintain an adequate water level to support them. It would be necessary to maintain their water level by occasionally releasing water into them from either the conservation pool or some other source (i.e. wells). Water temperature and water quality should be considered when adding water to the fish ponds. Occasional impounding of water behind the dam is expected to intensify wildlife and thus, enhance hunting in the reservoir area. In the event that additional inflows to the reservoir occur while water is impounded behind it, the BIA would decide what releases may be made to keep the wildlife habitat in balance.

Water needed for irrigation and lack of subsequent inflows continues to constrain the fish and wildlife water control objectives.

7-09 Water Supply. The primary water supply objective is irrigation. The Tohono O'odham Farm just downstream of Tat Momolikot Dam is to be supplied with the 4000 - 4800 ac-ft per year of water it needs from the conservation pool whenever available via the Vaiva Vo Irrigation System supply canal. Releases are to be made as water is needed.

This water control objective is the number one priority, so, unless water is left impounded behind the dam for ground water recharge, releases from the dam will reflect irrigation needs.

7-10 Other. In the event of maintenance or construction on the downstream channel of the Santa Rosa Wash, the gated outlet for the conservation pool may be closed in order to reduce releases in support of such downstream activities.

7-11 Deviation from Normal Regulation. There may be instances when it is necessary for the operation of Tat Momolikot Dam to deviate from the established flood control plan. Prior approval of deviations is required from the Reservoir Regulation Section, LAD, except for emergencies and minor deviations as discussed below.

a. Emergencies. Emergencies can take the form of drowning or other accidents, chemical spills, or failure of operation facilities. Necessary action should be taken immediately, so long as this does not create a worsened overall condition. For any action taken, assessment of the situation by those operating the dam should rely on their knowledge of the dangers involved. All concerned agencies should be informed of any deviations due to emergencies as soon as practical.

b. Unplanned Minor Deviations. Unplanned instances arise where there is a need for minor deviations from the normal regulation of the reservoir, although they are not considered emergencies. Construction activities are the primary source of these deviations. Downstream maintenance of culverts, bridges, and channel sections are another reason for minor regulation changes. Each request is analyzed on its own merits. Consideration is given to the potential of flooding and possible alternative measures. Requests will be complied with, providing there are no adverse effects on the overall project regulation. Approval for these minor deviations should be obtained from the BIA when they involve the conservation pool or Reservoir Regulation Section, LAD when they involve flood control. Again, all deviations should be reported to the concerned agencies as soon as practical.

c. Planned Deviations. There are planned instances that require deviations from normal regulation. Each condition will be judged on its own merits. Sufficient data on flood potential, effect on the environment, reservoir and watershed conditions, possible alternative measures, benefits to be expected, probable effects on other projects, and useful purposes will be presented to the BIA and Reservoir Regulation Section, LAD, along with recommendations for review and approval.

d. Drought Contingency Plan. Tat Momolikot Dam and Lake Saint Clair has a storage allocation for water conservation. Santa Rosa Wash downstream of the dam has a natural bed making groundwater recharge possible. In the event of a drought, water would be impounded behind the dam in the conservation space, which can be increased by the insertion of flashboards into the flood control outlet works approach channel. Any such plan would be evaluated to ensure that the flood control purpose of the project would not be compromised.

VIII - EFFECT OF WATER CONTROL PLAN

8-01 General. Tat Momolikot Dam's main benefits come from flood control and water supply. Potentially damaging floods to downstream development are controlled and a percentage of the water can be stored behind the dam to use for water conservation purposes (irrigation and recreation). Section 8-02 discusses the major aspects of flood control at Tat Momolikot Dam for both the reservoir and spillway design floods. Sections 8-03 through 8-06 describe the effects and benefits of the conservation purposes.

8-02 Flood Control.

a. Spillway Design Flood. The spillway design flood represents the discharge and volume that would be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. This flood would result from probable maximum precipitation occurring at a time when ground conditions were conducive to maximum runoff. The Hydrometeorological Section of the U. S. Weather Bureau estimated that the probable maximum precipitation would be 12.1 inches of rain in a 72-hour period. For the determination of flood runoff a constant rainfall loss rate of 0.19 inch per hour was estimated. The loss rate during periods with precipitation-intensity rates less than the 0.19 inch per hour would be 90 percent of the precipitation intensity rate. Base flow was considered to compensate for percolation losses. The resultant peak discharge was 280,000 cfs and the volume of runoff was 455,000 ac-ft at the dam site.

The spillway design flood was routed through the reservoir assuming the reservoir full to spillway crest at the beginning of the flood, the conservation outlet works closed, net capacity available, and the 12-ft by 13-ft flood control outlet discharging at full capacity. A maximum water surface elevation of 1,551.2 ft was calculated and the peak inflow of 280,000 cfs was reduced to a peak outflow of 140,600 cfs (134,240 cfs spillway flow plus 6,360 cfs flood control outlet flow). See Plate 8-01 for the spillway design flooding routing.

b. Standard Project Flood. The standard project flood is the reservoir design flood for Tat Momolikot Dam. The reservoir design flood is expected to occur from the most severe combination of meteorologic and hydrologic conditions that are reasonably characteristic of the geographic area. The reservoir design flood was based on the occurrence of a synthetic storm equal in magnitude to that of 3-8 September 1939. The storm was transposed directly over the drainage area in such a position that the largest possible discharge would result at the dam site. The three-day storm produced an average precipitation depth over the area of 6.40 inches. For the mountain areas a variable rainfall loss rate ranging from 0.35 to 0.15 inch per hour was used. For the valley areas a constant loss rate of 0.20 inch per hour was used. Over the total area loss rates were estimated at 90 percent of the precipitation when precipitation was less than the assigned loss rates, stated above. Effective total runoff resulting from the storm was computed. The average effective total runoff resulting from the storm was computed to be 2.44 inches over the total drainage area. Runoff from snowmelt was considered as not appropriate for this storm. Base flow was considered to be negligible. Percolation losses of 0.20 cubic foot per second per wetted acre were used for flooded parts of the valley floor. The storm produced a reservoir design flood having a peak inflow of 77,000 cfs and a volume of 178,000 acre-feet.

The spillway crest elevation was determined by routing the reservoir design flood through the reservoir assuming the space allocated to sediment storage was full (i.e. net storage) and the water conservation outlet works were assumed closed. A maximum water surface elevation of 1,538.6 ft MSL was reached and the peak inflow of 77,000 cfs was reduced to the peak outflow of 4,960 cfs. The spillway crest was set 0.4 ft higher at elevation 1,539 ft MSL. See Plate 8-02 for the reservoir design flood routing.

c. Other Floods. The water surface elevation behind Tat Momolikot Dam has remained at least 7.5 ft below the flood control conduit invert since construction of the dam. Accordingly, no other floods have been studied for or routed through the dam.

8-03 Recreation. A short-term impoundment behind Tat Momolikot Dam will have no effect on or benefits from recreation.

A long-term impoundment in Lake Saint Clair could affect the area beneficially. Visitors might be drawn to the lake for recreational purposes. This could bring economic benefits to the O'odham tribe.

8-04 Water Quality. No benefits of Tat Momolikot Dam to the water quality of the Santa Rosa Wash have been determined. On the other hand, Tat Momolikot Dam and its operation should not contribute to the degradation of the water quality of the wash.

8-05 Fish and Wildlife. A short-term impoundment behind Tat Momolikot will gain no benefits from and have no effect on fish and wildlife.

A long term impoundment behind the dam could create benefits by enhancing the fish and wildlife situation in the area. If the fish ponds were to be filled, 20,000 person-days of sports fishing could be expected annually as per the 1977 Reservoir Regulation Manual for Tat Momolikot Dam (see Table 101). Hunting wildlife could also be expected to improve.

8-06 Water Supply. Any impoundment behind Tat Momolikot Dam would be beneficial to the water supply of the Tohono O'odham Farm. Releases through the conservation outlet works can be diverted into the Vaiva Vo Irrigation Project canal where they are used for crop irrigation on the farm. The impounded water will also recharge the ground water supply, from which the farm gets its irrigation water when the reservoir is dry. Long term impoundments may result in significant water supply loss due to the high evaporation rates of the region.

8-07 Frequencies.

a. Peak Inflow and Outflow Probability. Plate 8-03 presents the inflow frequency curves for Tat Momolikot Dam as computed for the 1990 Water Control Manual. The 1990 curve was computed from a combination of the instantaneous maximum peak discharges recorded by the USGS stream gage on Santa Rosa Wash near Cockleburr (formerly Vaiva Vo) and the 1-hour maximum average inflows calculated by LAD using reservoir computation sheets. The two were deemed to be similar based on examination of flood hydrographs for the watershed. Statistical analysis of the historic record of annual (water year) inflow peaks to Tat Momolikot Dam for the period 1955 to 1988 was performed using the HEC Flood Flow Frequency Analysis program (FFFA). The annual inflow peak of 1962 is recorded as being the largest peak inflow since water year 1885. Accordingly, an adjustment was made in the FFFA period of record to account for this. FFFA assigns median plotting positions to the data, computes a weighted skew coefficient, and uses log-Pearson Type III distribution to compute a frequency curve. High and low outlier tests revealed one outlier above the test value of 27714 and no outliers below the test value of 33.4. Based on the 34 years of data and the 104-year period of record, skew was computed at 0.6218. See Tables 4-03 and 4-04 for discharge values.

An outflow curve was not drawn due to the incomplete record and high frequency of zero years for Tat Momolikot Dam. After 1980, the USGS stream gage downstream of the dam was discontinued and there are no gages to measure discharge at either the water conservation outlet or the flood control outlet. The BIA maintains that the water conservation outlet has only been opened a few times in attempts to use stored water for irrigation.

b. Pool Elevation Duration and Frequency. Plate 8-04 is the computed filling frequency curves for Tat Momolikot Dam as computed for the 1990 Water Control Manual. Conditions upstream of the dam have not changed significantly since the dam was built. The maximum water surface elevations for water years 1974-1988 are presented in Table 4-04. Statistical analysis of the historic record of the annual (water year) maximum water surface elevation at Tat Momolikot Dam for the period of 1974 to 1988 was performed using the HEC Flood Flow Frequency Analysis program (FFFA). FFFA assigned median plotting positions to the data, which were used in plotting the lower end of the frequency curve. High and low outlier tests revealed no outliers above test values of 1503 or below 1482.8. To create the upper end of the filling frequency curve the HEC-5 computer program was used to route 11 flood hydrographs through the dam. The 11 hydrographs were obtained by 2 methods. The first method included a volume frequency analysis. The six largest storms of record and the SPF were used to create 1-day, 2-day, and 3-day volume frequency curves. The USGS gaging station records were utilized to obtain the volumes needed for the 6 historic events. From the SPF hydrograph, the appropriate SPF volumes were determined. The 50-year, 100-year, 200-year, and 500-year frequency values were selected from the expected probability inflow frequency curve and the 3 volume frequency curves developed. These values were input into a computer program, which develops balanced hydrographs using a pattern hydrograph that is also input. The second method for obtaining hydrographs was to create them from the information in the USGS gaging station records. This was done for the 6 largest recorded events. Hourly discharges from all of the hydrographs, including the SPF hydrograph, were input into the HEC-5 model. The output of the HEC-5 model included the maximum water surface elevation expected behind the dam from each hydrograph input. These elevations have been plotted along with the recorded elevations since the dam was constructed on Plate 8-04. The plotting positions for the elevations from the six largest recorded events were taken to be the same as those for the six largest inflows with a 104 year period of record.

c. Damage-Discharge and Damage-Frequency Relationships. Plate 8-05 is the Damage-Discharge and Damage-Frequency Curves. These curves represent the amount of damage (in dollars) that can be expected from various floods and the frequency with which these floods may occur. The curves are based on 1969 conditions and were computed in 1977 for the Reservoir Regulation Manual. The validity of these curves has not been studied since 1977, so it is possible that they are no longer valid.

8-08 Other Studies. Presently, the COE is conducting a feasibility study for flood control on the Santa Cruz River. Five alternatives are being analyzed in which flows in the Santa Cruz River would be contained and/or diverted. One of the alternatives is the diversion of some of the water from the Santa Cruz River to behind Tat Momolikot Dam. The feasibility portion of the study is scheduled to be completed in 1991. If the alternative involving diversion to Tat Momolikot Dam were to be implemented, a new water control plan would be developed.

IX - WATER CONTROL MANAGEMENT

9-01 Responsibilities and Organization.

a. Corps of Engineers. Tat Momolikot was designed and constructed by the COE. The Corps has agreed to assist the BIA in the operation of the dam and in the collection of hydrologic data. Since the dam has an ungated flood control outlet there is no active regulation of floods through that outlet.

Reservoir regulation criteria that are specified for Tat Momolikot Dam by the Corps are done so by the Reservoir Regulation Section of the LAD. Table 9-01 is an organizational chart depicting the chain of command for Reservoir Regulation decisions.

The flood control regulations are subject to temporary modification by the Los Angeles District Engineer, 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 communications available. The action taken shall be confirmed in writing the same day to the office of the BIA's Area Director and shall include justification for the action.

In the event of a major storm, the Reservoir Regulation Section of the LAD should be notified when 1-1/2 inches of rain falls at either Tat Momolikot Dam or Casa Grande, or when the reservoir water surface elevation reaches 1,505 ft MSL. The COE should also be notified in the event of any drastic changes in the condition of the dam or reservoir storage allocation. Once the floodwaters have subsided, the Corps should be made aware of the condition of the dam and reservoir.

b. Other Federal Agencies. The BIA has responsibility for the operation of Tat Momolikot Dam, although they do receive data and information from the COE and other federal and local agencies and inform these agencies of major decisions affecting Tat Momolikot Dam. As mentioned above in Section 9-01a, the BIA will notify the Corps of conditions at the dam during and after major flood events. The BIA is also responsible for maintenance of the project.

The BIA's Regional Director may temporarily deviate from the flood control regulations in the event an immediate short-term departure is deemed necessary for emergency reasons. Such actions will be immediately reported by the fastest means of communication available. Actions shall be confirmed in writing the same day to the Los Angeles District Engineer, Corps of Engineers, and shall include justification for the action.

The BIA is responsible for performing necessary work on the Santa Rosa Wash through the Papago, Maricopa, and Gila River Indian Reservations downstream of the dam to maintain the hydraulic capacity of the existing channel.

c. State and County Agencies. The Maricopa, Midway, and Stanfield Flood Control Districts include the Santa Rosa Wash within their boundaries and are responsible for maintaining the hydraulic capacity of the Wash in their area.

d. Private Organizations. No private agencies have operation or maintenance responsibilities for the dam or the downstream channel.

Table 9-01.

Chain of Command for Reservoir Operations Decisions

Corps of Engineers
Los Angeles District

Title	Office Phone Number:
District Engineer	(213) 894-5300

Water Control Decisions		Operational and Maintenance	
Title	Phone:	Title	Phone:
Chief, Engineering Division	(213) 894-5470	Chief, Construction-Operations Division	(213) 894-5600
Chief, Hydrology & Hydraulics Branch	(213) 894-5520	Chief, Operations Branch	(213) 894-5620
Chief, Reservoir Regulation Section	(213) 894-6915	Chief, Operations and Maintenance Section	(818) 401-4008
Chief, Reservoir Regulation Unit	(213) 894-6916		

9-02 Interagency Coordination. The BIA coordinates with other Federal, State, County, and local organizations, and informs the press concerning water control of Tat Momolikot Dam and Lake Saint Clair.

a. Local Press and Corps Bulletins. The BIA is responsible for notifying the press regarding operations at Tat Momolikot Dam, but the Public Affairs Office of the Corps of Engineers, LAD, will assist if asked to do so. This notification is accomplished through both interviews and the occasional issuance of press releases. Neither the BIA nor COE publicly issues flood watches or warnings, or other status reports of forecasts to the general public. These notifications are the responsibility of the NWS.

b. National Weather Service. The BIA utilizes NWS data and forecasts to assist in the operation of Tat Momolikot Dam. The BIA and the COE share data with the NWS and other agencies both on a real-time basis and on a post-event basis.

c. U. S. Geological Survey. The USGS will supply historical streamflow data to the BIA or the COE if requested.

d. Other Federal. State, or Local Agencies. The BIA coordinates the flood control operation of Tat Momolikot Dam with the Corps of Engineers, LAD. Coordination with other federal, state, and local agencies generally only occurs in times of emergency.

9-03 Interagency Agreements. The BIA has a maintenance agreement with the Farming Authority of the O'odham Tribe for the main dam, spillway, and outlet channels. The BIA has an agreement with the Bureau of Reclamation to perform 'Safety Evaluation of Existing Dams' (SEED) examinations and analyses and preparation of SEED reports. See Table 1-01 for a list of the above references.

9-04 Commissions, River Authorities, Compacts, and Committees. Tat Momolikot Dam is not involved in any commissions, compacts, or other such formal multi-agency agreements.

9-05 Reports. The BIA does not prepare any formal reports for Tat Momolikot Dam.

As required by ER 1110-2-240 "Water Control Management", the LAD prepares reports for transmittal to the South Pacific Division Office concerning the operation of Tat Momolikot Dam:

a. Annual Division Water Control Management Report. This report covers significant activities of the previous water year and a description of project accomplishments planned for the current year.

b. Summary of Runoff Potentials in Current Season. This report is generally submitted monthly during the storm season (October 15 - April 15), and covers snow accumulation and runoff potential in the District. Supplemental reports are submitted in the event of severe situations.

c. Periodic Inspection. This report gives the condition of the dam and recommendations for any necessary repairs.

Reports prepared by other agencies:

d. Safety Evaluation of Existing Dams (SEED) Reports. This report is prepared by the Bureau of Reclamation approximately once every five years. It is a very extensive report covering all aspects of dam safety after examining the dam and analyzing the data.