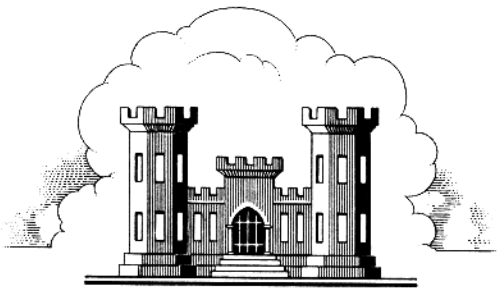
WHITEWATER RIVER BASIN, CALIFORNIA

REPORT ON RESERVOIR REGULATION FOR FLOOD CONTROL

TAHCHEVAH CREEK DETENTION RESERVOIR



U. S. ARMY ENGINEER DISTRICT, LOS ANGELES
CORPS OF ENGINEERS

JANUARY 1967

DEPARTMENT OF THE ARMY
SOUTH PACIFIC DIVISION, CORPS OF ENGINEERS
630 Sansome Street, Room 720
San Francisco, California 94111-2206

REPLY TO
ATTENTION OF:

MAR 2 0 1951

CESPD-ED-W (1110-2-240b)

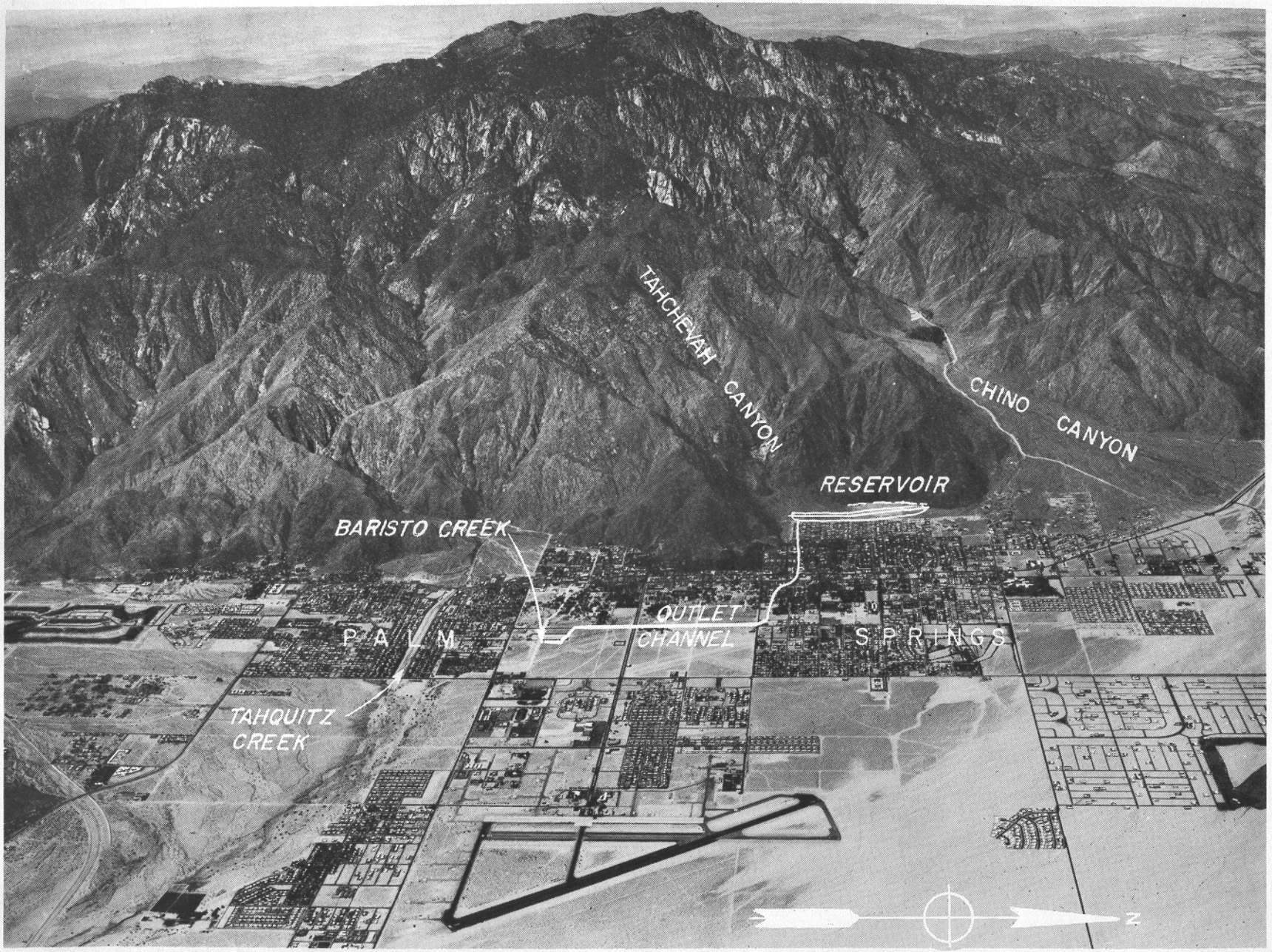
MEMORANDUM FOR Commander, Los Angeles District
Commander, Sacramento District

SUBJECT: Planned Deviations from Approved Water Control Plans

1. All planned deviations from approved water control plans for reservoir projects within the South Pacific Division must be coordinated with the Coastal Engineering and Water Management Division at CESPD. Approval must be given prior to implementation of the deviation.

2. Emergency deviations do not require prior approval but coordination must still be made as soon as is practical.

ROGER F. YANKOPE
Brigadier General, U.S. Army
Commanding



TAHCHEVAH CREEK DETENTION RESERVOIR

R E S E R V O I R R E G U L A T I O N R E P O R T

FOR

TAHCHEVAH CREEK DETENTION
RESERVOIR AND CHANNEL IMPROVEMENTS
WHITEWATER RIVER BASIN, CALIF.

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13.	Spillway design flood routings.

EXHIBITS

A Code of Federal Regulations (Extract)

RESERVOIR REGULATION REPORT

FOR

TAHCHEVAH CREEK DEETENTION
RESERVOIR AND CHANNEL IMPROVEMENTS
WHITEWATER RIVER BASIN, CALIF.

PERTINENT DATA

Drainage area	sq. miles	3.2
Reservoir:		
Elevation –		
Flood-control pool	ft., m.s.l.	565.5
Spillway design surcharge level	ft., m.s.l.	576.8
Area –		
Spillway crest	acres	58.0
Spillway design surcharge level	acres	67.8
Top of dam	acres	73.1
Capacity, gross –		
Allowance for sediment	ac.-ft.	300
Spillway crest	ac.-ft.	945
Spillway design surcharge level	ac.-ft.	1,655
Top of dam	ac.-ft.	2,019
Dam – Type		Earthfill
Top elevation	ft., m.s.l.	582
Height above original streambed	ft.	42
Top length (including spillway)	ft.	3,610
Top width	ft.	20
Freeboard	ft.	5.2
Spillway – type		Broadcrested overflow weir
Crest length	ft.	80
Crest elevation	ft., m.s.l.	565.5
Design surcharge	ft.	11.3
Discharge at design surcharge	c.f.s.	9,500
Outlet Conduit:		
Invert elevation	ft., m.s.l.	543
Diameter	inches	36
Length	ft	150
Maximum capacity at spillway crest	c.f.s.	160
Reservoir design flood:		
Duration	hours	12.5
Total volume	ac.-ft	720
Inflow peak	c.f.s.	4,200
Outflow peak	c.f.s.	160
Reduction in peak	c.f.s.	4,040

PERTINENT DATA—Continued

Spillway design food:		
Duration	hours	12
Total volume	ac.-ft	2,420
Inflow peak	c.f.s.	13,000
Outflow peak	c.f.s.	9,500
Reduction in peak	c.f.s.	3,500
Channel:		
Length	ft.	11,400
Capacity, range	c.f.s.	160 to 300

R E S E R V O I R R E G U L A T I O N R E P O R T

FOR

TAHCHEVAH CREEK DETENTION
RESERVOIR AND CHANNEL IMPROVEMENTS
WHITEWAER RIVER BASIN, CALIF.

AUTHORITY

1. The authority for preparation of this manual is contained in paragraph 5, Engineering Regulation 1110-2-240, titled “Engineering and Design, Reservoir Regulation,” dated 25 March 1963. Detailed instructions pertaining to the contents of the manual are contained in Chanpter 6, Engineering Manual 1110-2-3600, titled “Engineering and Design, Reservoir Regulation,” and dated 25 May 1959.

SCOPE

2. This manual contains (a) descriptive information pertaining to the drainage area and project; (b) a description of the plan of operation; and (c) the basis of design for the project, including the reservoir and spillway design flood routings.

BASIN INFORMATION

3. Description.—-Tahchevah Creek Detention Reservoir is located near the western edge of Palm Springs, California, about 1,200 feet downstream from the mouth of Tahchevah Canyon (see pl.1). The drainage area above the dam is 3.2 square miles. Tahchevah Creek originates on the eastern slope of the San Jacinto Mountains about 3 miles west of the business section of the City of Palm Spirngs. The path of flow is generally east to the dam, thence east and south through the project channel to Baristo Creek channel (see pl. 2). Elevations in the drainage area above the mouth of the canyon vary from about 5,200 feet above mean sea level at the upper end to about 550 feet a the lower end, with the gradient varying from about 3,200 to 300 feet per mile, respectively. The 3.2 square miles of project drainage area is entirely mountainous with the exception of about 0.4 square mile of alluvial cone.

a. The lower slopes of the San Jacinto Maountains below elevation 5,200 feet (which includes all of the project drainage

area) are sparsely covered with scattered creosote bush, ocotillo, paloverde, ironwood, and scattered growths of cactus.

b. Most of the mountainous parts of the drainage area consist of massive bare rock. Soils in the canyon are shallow and low in organic matter and soluble salts. The alluvial cone below the base of the mountains consists of unconsolidated sand, gravel, cobbles, and boulders.

4. Economic development.-—Tahchevah Creek Detention Reservoir and Channel Improvements provide protection against floods and debris for the central part of the City of Palm Springs, California. The protected area is highly developed and includes valuable business property, residential property, and public improvements such as parks, schools, streets, highways, and utilities. The value of property subject to flood damage was estimated to be $57,900,000 in 1963.

5. Existing structures affecting runoff.—-There are no structures in the drainage area above Tahchevah Dam that affect runoff.

6. Climatology.—-The project area lies in a zone characterized by extreme heat and dryness during the summer months, while the climate during the winter months is mild. The monthly mean, maximum, and minimum temperatures at Palm Springs for the period 1922 through 1965 are given in table 1. The extremes of temperature range from 18°F to 122°F. The average annual frostfree period is generally more than 300 days. Prevailing winds are northwest with velocities occasionally exceeding 40 miles per hour.

a. The mean seasonal precipitation, the greater percentage falling during the winter months, varies from about 12 inches at the upper end of the project drainage area to about 6 inches at Palm Springs. Season totals vary widely, and quite frequently precipitation for a single month exceeds the mean seasonal value. At nearby points in the desert, the mean seasonal precipitation has been exceeded by more than 100 percent during a single thunderstorm. Snow falls occasionally in the headwaters of Tahchevah Creek but melts rapidly. The effect of snow on runoff is negligible. Ishoyets of mean seasonal precipitation (July to June, inclusive) for a 77-year period (1878 to 1954, inclusive) are shown on plate 2. The monthly mean, maximum, and minimum precipitation at Palm Springs are give in Table 1.

b. Most precipitation in the drainage area results from general winter storms that are associated with extratropical cyclones of North pacific origin. Major storms, consisting of one or more cyclonic disturbances, occasionally last 4 days or more and result in precipitation over large areas. Tropical hurricanes originating

off the west coast of Mexico occasionally move north of their usual path and pass over southern California, bringing intense precipitation for periods of up to 3 days. Thunderstorms that may result in intense precipitation during short periods over small areas occur occasionally either in association with general storm or independently. Summer thunderstorms in the area are fairly frequent. The duration of critical rainfall intensity is usually not more than 2 hours and rarely more than 3 hours.

7. Runoff.—-Streamflow is negligible except immediately after the heaviest rains, because climate and basin characteristics are not conducive to continuous runoff. During high-intensity storms, the streamflow increases rapidly in response to rainfall. High-intensity rainfall, in combination with the effect of steep gradients, results in intense debris-laden floods. There are no runoff records available for Tahchevah Creek.

8. Floods.—-Historical references indicate that 12 relatively large winter floods occurred in or near the Whitewater River Basin from 1825 through 1891. More authoritative records since 1891 show that moderate to large winter floods occurred in February 1914, January 1916, December 1921, April 1926, February 1927, February 1937, March 1938, December 1940, and January 1943. From the little information available, the floods of 1927 and 1938 appear to have been the largest general floods since 1891. Summer floods, usually caused by local storms of small areal extent but occasionally by storms covering the whole basin, occur infrequently in the area. No reliable records of floods on Tahchevah Creek are available.

9. Flood damages.—-No significant information no monetary damages is available.

10. Downstream channel.—-The outlet channel, from the spillway to its confluence with Baristo Creek, is 11,400 feet long. It consists of 2,270 feet of 54-inch RCP, 4,580 feet of 60-inch RCP, 2,493 feet of 72-inch RCP, 1,802 feet of 8 x 4.5 feet RC Box, and 252 feet of transition sections. The channel is designed for discharges ranging from 160 cubic feet per second at the dam to 300 cubic feet per second at Baristo Creek. See plates 3 and 4 for downstream channel plan and sections.

PROJECT INFORMATION

11. Authorization.—-Tahchevah Creek Detention Reservoir and Channel Improvements was authorized by act of Congress, Flood Control Act of 1960, Public Law 86-645, Eighty-sixth Congress, second session, approved 14 July 1960.

12. Construction history.--Construction of Tahchevah Creek Detention Reservoir and Channel Improvements began on 27 June 1964. Work was completed on 31 March 1965. The cost of the project through 30 June 1965, not including expenditures by local interests, was $1,321,776.

13. Purpose.--The purpose of the project is to provide protection from floods for the highly developed, central part of the City of Palm Springs.

14. Relationship to coordinated plan of development for the basin.—-Tahchevah Creek Detention Reservoir and Channel Improvements is an integral part of the comprehensive plan for the Whitewater River Basin within the Pal Springs area.

15. Description.--The project consists of Tahchevah Creek Flood Control Basin and dam, and the outlet channel to its confluence with Baristo Creek Channel. A general plan of the project is shown on plate 5, and a detailed description is contained in the following paragraphs.

16. Dam.—-The dam is an unzoned, relatively impervious earth-fill embankment with a crest length, including spillway, of 3,610 feet at the top of dam, elevation 582, and a crest width of 20 feet. The maximum height above the original Tahchevah Creek streambed is 42 feet. Both the upstream and downstream slope is 2.25 on 1. The upstream and downstream faces of the dam are protected by a 3-foot layer of stone. Typical embankment sections are shown on plate 6.

17. Deflection dike.—-A deflection dike about 520 feet long with a top width of 20 feet and side slopes of 1 on 2 is located upstream from the outlet works to direct debris and low flow away from the pool drain and spillway (see pl. 5).

18. Outlet works.—-The outlet works are located on the center line of the spillway near the south abutment and consist of an intake tower and an outlet conduit. The plan, profile, and sections of the outlet works are shown on plate 7 and the outlet discharge curve is shown on plate 8. A general description of the outlet works is contained in the following subparagraphs.

a. The intake tower is a rectangular reinforced-concrete structure bout 100 feet upstream from the axis of the embankment. It is 13 feet long, 9 feet wide, and rises 12 feet above invert elevation 543.

b. The outlet conduit extends under the embankment along the centerline of the spillway and discharges into a low-flow channel in the spillway. It consists of a concrete-encased reinforced-concrete

pipe 150 feet long with an inside diameter of 36 inches and a slope of 0.029072. The maximum capacities of the conduit with the water surface at spillway crest (elev. 565.5) and top of dam (elev. 582) are 160 and 210 cubic feet per second, respectively.

19. Spillway.—-The spillway (see pl. 9) is a rectangular reinforced-concrete structure, consisting of a broadcrested overflow weir, 80 feet long, a short approach channel, and an outlet transition channel. The crest of the spillway is at elevation 565.5 feet, the overall length of the spillway channel is 300 feet, including the approach and outlet channel, and the width ranges from 85 feet at the upstream and to 55 feet at the downstream end. The spillway discharge curve is shown on plate 10.

20. Reservoir.—-The reservoir formed by Tahchevah Dam has an area and gross capacity at spillway crest (elev. 565.5) of 58.0 acres ad 945 acre-feet, respectively. At the top of the dam (elev. 582) the area is 73.1 acres and the gross capacity is 2,019 acre-feet. There is a 300 acre-foot allowance for sediment below spillway crest. Area and capacity curves are shown on plate 11 and a tabulation of areas and capacities is given in table 2.

21. Basis for design.—-The hydrologic design of Tahchevah Dam is based upon the assumption that greatest flows from small drainage areas occur during local thunderstorms or tropical hurricanes. The tropical hurricane that centered over Indio, California, on 24 September 1939 was the largest recorded. While it has not been ascertained whether thunderstorm activity attended the 1939 storm, it produced intensities similar to those produced by thunderstorms and its total duration was considerably longer than an average thunderstorm. This storm was assumed to be of sufficient intensity and duration to be used as a basis for the reservoir design flood.

a. The reservoir design flood was computed, using a total precipitation over the drainage area of 6.45 inches and a variable precipitation-loss rate. The loss rate was assumed to average 0.35 inch per hour with a minimum rate of 0.15 inch per hour. The effective rainfall over the drainage area was 4.33 inches. This rainfall resulted in a flood having a peak discharge of 4,200 cubic feet per second and a volume of 720 acre-feet.

b. The spillway crest elevation was determined by routing the reservoir design flood through the reservoir assuming the reservoir empty at the beginning of the routing. Using net storage, a maximum water-surface elevation of 565.5 feet was reached with a peak outflow of 160 cubic feet per second. On this basis, the spillway crest elevation was set at 565.5 feet. See plate 12 for the reservoir design flood routing.

c. The spillway design flood was based on the assumed occurrence of probable maximum precipitation as determined by a method[1] developed by the Los Angeles District. The precipitation-runoff relationships during the spillway design flood were assumed to be, in general, the same as those of the reservoir-design flood, except that a constant precipitation-loss rate of 0.15 inch per hour was used. The total precipitation over the drainage area was 15.05 inches with an effective precipitation of 14.55 inches. The resultant peak discharge was 13,000 cubic feet per second and the volume of runoff 2,420 acre-feet.

d. The spillway design flood was routed through the reservoir assuming the ungated outlet blocked and the reservoir full to spillway crest at the beginning of runoff. A maximum water-surface elevation of 576.8 was reached, and using a free board of 5.2 feet, the top of the dam was set at elevation 582 feet. See plate 13 for the spillway design flood routing.

22. Development of the reservoir area.—-There is no plan of development for the reservoir area at the present time. However, it could be used for recreational facilities. Such facilities could include a golf driving rage, a roving-archery range, day-camping areas, or a community park with picnic tables and equestrian trails.

OPERATION

23. Responsibility for operation.—-The responsibility for operation of Tahchevah Creek Detention Reservoir and Channel Improvements as outlined in the Code of Federal Regulations, paragraph 208.10, lies with the Chief Engineer, Riverside County Flood Control and Water Conservation District. See exhibit A for a reprint of the Code of Federal Regulations (Extract). The project was transferred to the Riverside County Flood Control and Water Conservation District on 2 August 1965 for operation and maintenance.

24. Flood control operation plan.—-There is no plan of operation for flood control because Tahchevah Dam has no gated outlet. However, flood flows are automatically controlled to non-damaging discharges by the ungated outlet in the structure.

[1] Described in paragraphs 26-28 of the District Engineer's report titled "Design Memorandum No. 1, Hydrology for Wilson Canyon and Mansfield Street Channels and Debris Basins," dated May 1959, and approved by the Office of the Chief of Engineers 8 October 1959.

COLLECTION OF HYDROLOGIC DATA

25. Hydrologic facilities.—-Hydrologic facilities include: (a) 10 adjustable staff gages, (b) a waterstage recording system, and (c) a recording rain gage.

a. One 4-foot staff gage is located on the south side of the intake structure, and nine 4-foot staff gages, just south of the spillway, ascend in a row along the upstream face of the dam from elevation 546 to the top of the dam, elevation 582.

b. A water-stage recorder is located in a recording house at the south end of the dam.

c. A long-term recording rain gage is located near the north end of the dam.

26. Sedimentation.—-The sedimentation allowance in Tahchevah Creek reservoir of 300 acre-feet is based on a 100-year design life for the project. There are no sedimentation ranges in the reservoir.

27. Reporting criteria.—-The operating agency is required to report to the Corps of Engineers when any of the following conditions occur:

a. Rainfall of 1 inch in 1 hour at Palm Springs.

b. Rainfall of 2 inches in 3 hours at Palm Springs.

c. Water surface reaches an elevation of 555.0 feet.

The rain gage recorder chart is sent to the Regulation and Meteorology Section, Corps of Engineers, where the data is recorded and the chart returned for permanent filing. The water-surface recorder chart is also sent to the Regulation and Meteorology Section for any record above 555.0 feet. This chart is then returned for permanent filing.

Table 1

Area and gross capacity - Tahchevah Creek Detention Reservoir, Whitewater River basin, Calif.

Elevation	Capacity	Area	Elevation	Capacity	Area
Feet above mean sea level	Acre-feet	Acres	Feet above mean sea level	Acre-feet	Acres
543	0	0	563	800	55.9
544	3.4	11.0	564	857	56.6
545	18	25.8	565	914	57.6
546	44	30.1	566	972	58.4
547	73	32.9	567	1,030	59.4
548	107	35.2	568	1,090	60.4
549	140	37.1	569	1,151	61.4
550	179	38.9	570	1,213	62.3
551	217	40.4	571	1,272	63.1
552	259	41.7	572	1,338	63.9
553	299	43.2	573	1,401	64.6
554	344	44.6	574	1,468	65.4
555	391	46.0	575	1,534	66.2
556	438	47.4	576	1,602	67.1
557	485	48.8	577	1,671	68.0
558	537	50.1	578	1,740	68.8
559	588	51.4	579	1,809	69.8
560	639	52.8	580	1,877	70.8
561	691	53.9	581	1,949	71.9
562	746	54.9	582	2,019	73.1

Table 2

Summary of climatological data at Palm Springs, Whitewater River Basin, Calif.*

Month	Temperature			Precipitation		
	Mean monthly	Record highest	Record lowest	Mean monthly	Maximum monthly	Minimum monthly
	Degrees Fahrenheit	Degrees Fahrenheit	Degrees Fahrenheit	Inches	Inches	Inches
Jan.	54.6	98	18	1.08	8.43	0
Feb.	57.9	105	24	1.16	10.39	0
Mar.	63.2	105	29	.60	3.01	0
Apr.	70.2	110	35	.32	3.70	0
May	76.2	118	36	.03	.60	0
Jun.	84.7	121	48	.02	.37	0
Jul.	91.9	122	54	.23	2.80	0
Aug.	99.9	121	52	.23	2.17	0
Sep.	84.4	121	46	.32	4.88	0
Oct.	74.5	110	30	.35	2.74	0
Nov.	63.1	102	23	.52	6.35	0
Dec.	55.2	93	23	1.28	6.32	0
Period of record	**73.0	122	18	**6.14	10.39	0

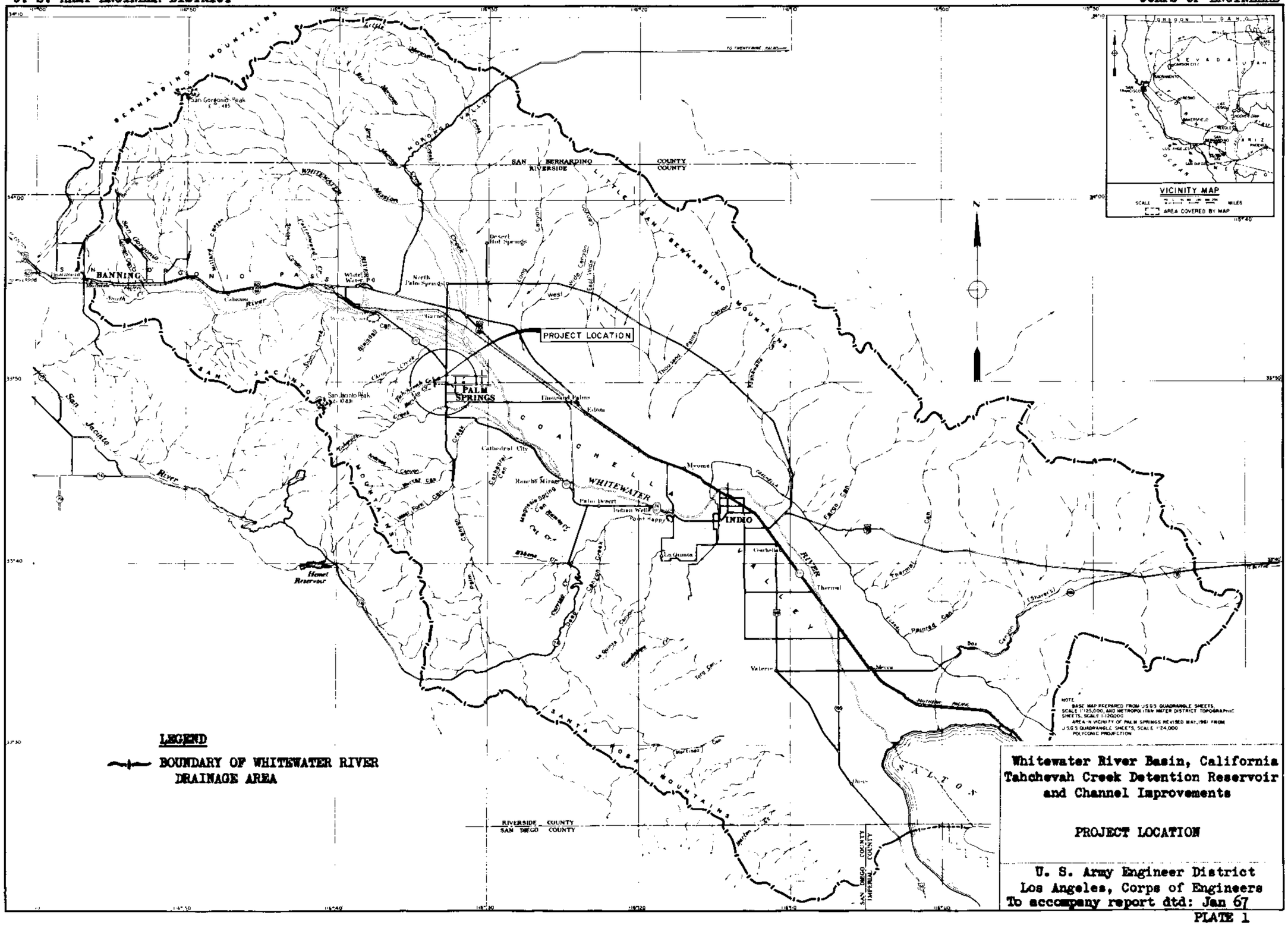
* Latitude 33°49'N; longitude 116°32'W; elevation 411 feet above mean sea level (see plate 2 for location).

** Mean seasonal.

Note.--Rainfall period of record: 44 years (1922 to 1965, inclusive). Gage was at various locations in the City of Palm Springs during the period. Temperature period of record: 68 years (1894 to 1965, inclusive, except for 1939 through 1941, inclusive, and a few scattered months). Temperatures prior to 1915 were at Palm Springs Junction about 6 miles north of Palm Springs, Calif.

U. S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



Whitewater River Basin, California
Tahchevah Creek Detention Reservoir and Channel Improvements

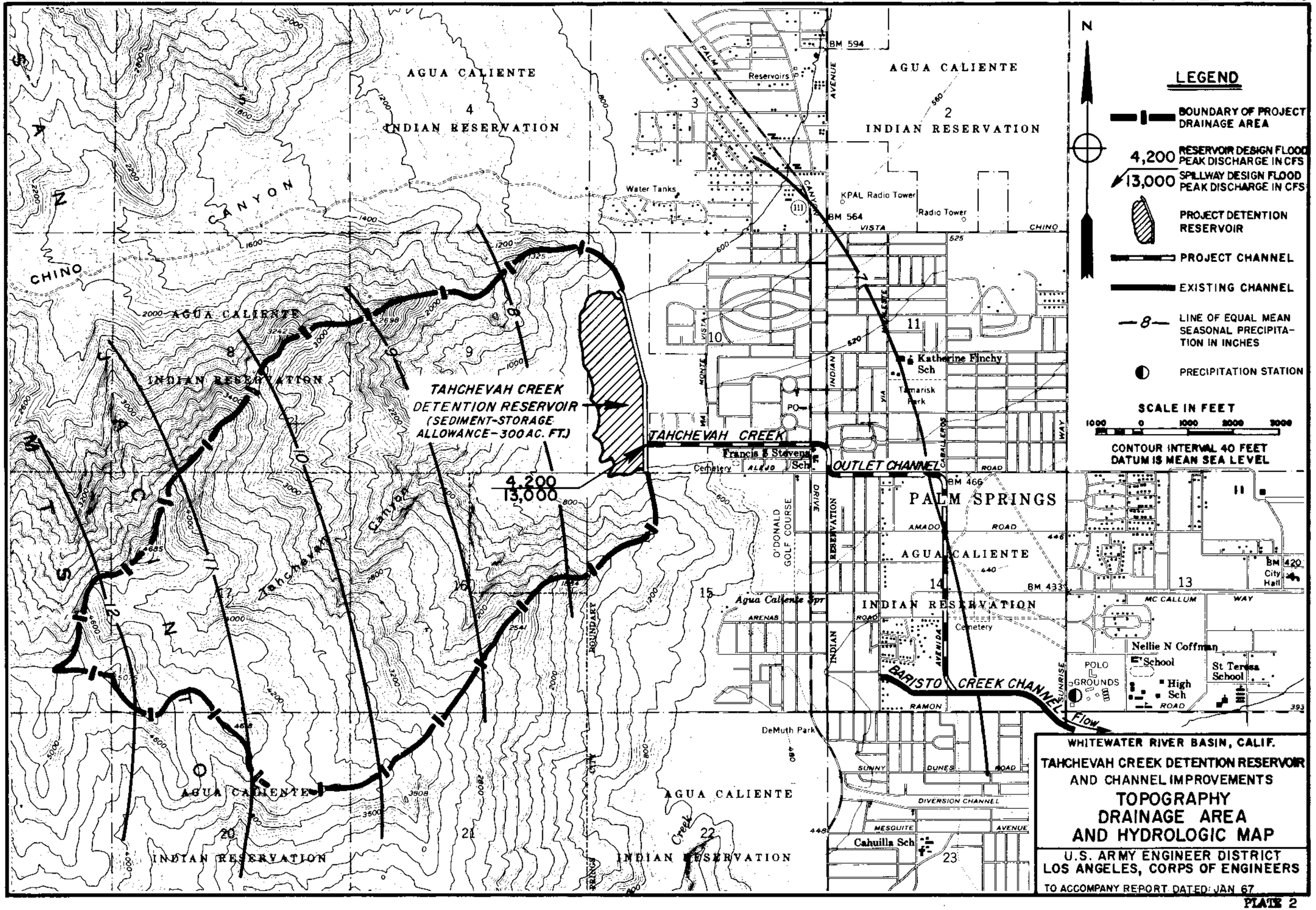
PROJECT LOCATION

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dtd: Jan 67

PLATE 1

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



WHITEWATER RIVER BASIN, CALIF.

TAHCHEVAH CREEK DETENTION RESERVOIR AND CHANNEL IMPROVEMENTS

TOPOGRAPHY DRAINAGE AREA AND HYDROLOGIC MAP

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED: JAN 67

PLATE 2

Whitewater River Basin, California
Tahchevah Creek Detention Reservoir
and Channel Improvements

DOWNSTREAM CHANNEL

U. S. Army Engineer District
Los Angeles, Corps of Engineers
To accompany report dated: Jan 67

PLATE 3

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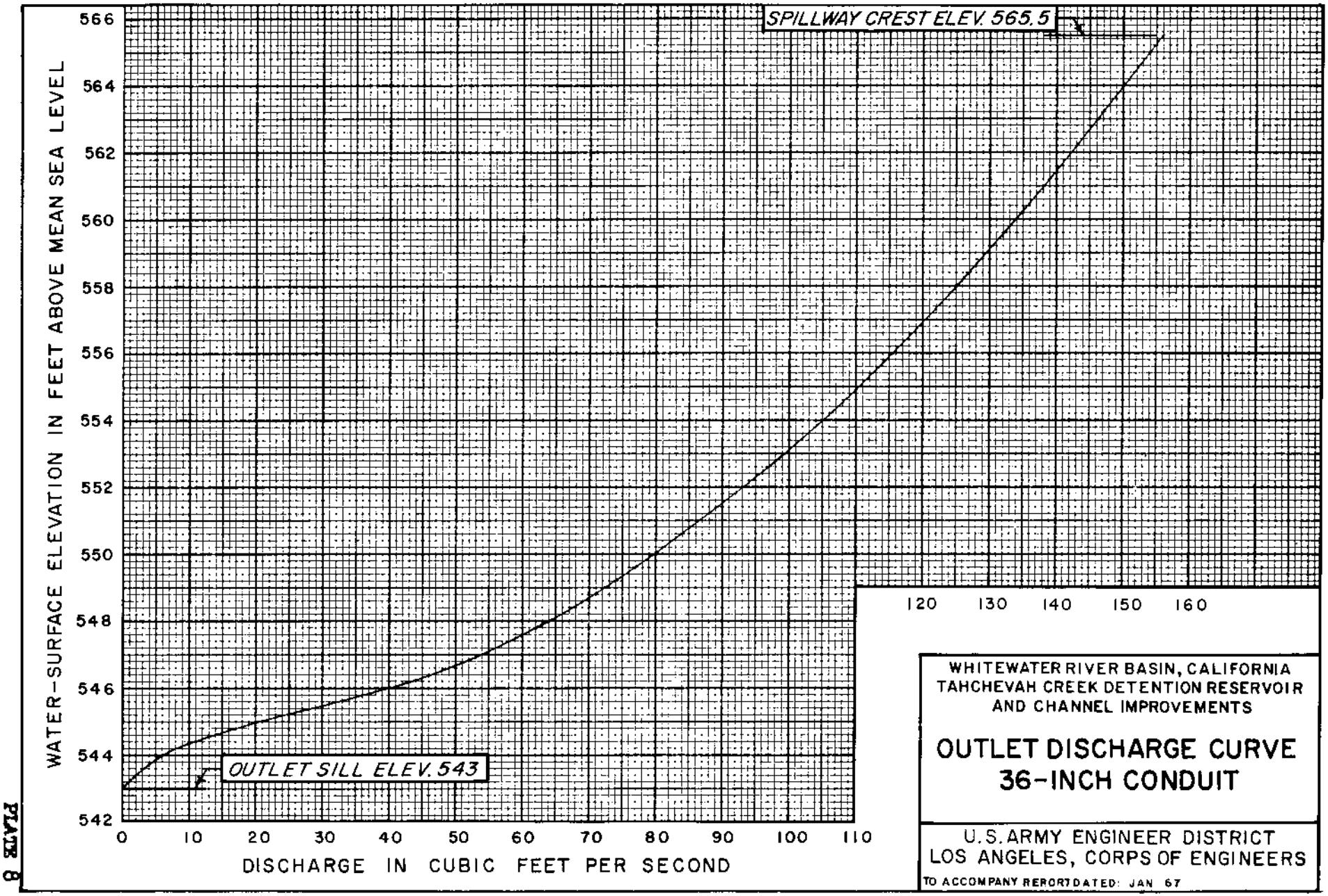
CORPS OF ENGINEERS



WHITEWATER RIVER BASIN, CALIFORNIA
TAHCHEVAH CREEK DETENTION RESERVOIR
AND CHANNEL IMPROVEMENTS

OUTLET DISCHARGE CURVE
36-INCH CONDUIT

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED: JAN 67

PLATE 8

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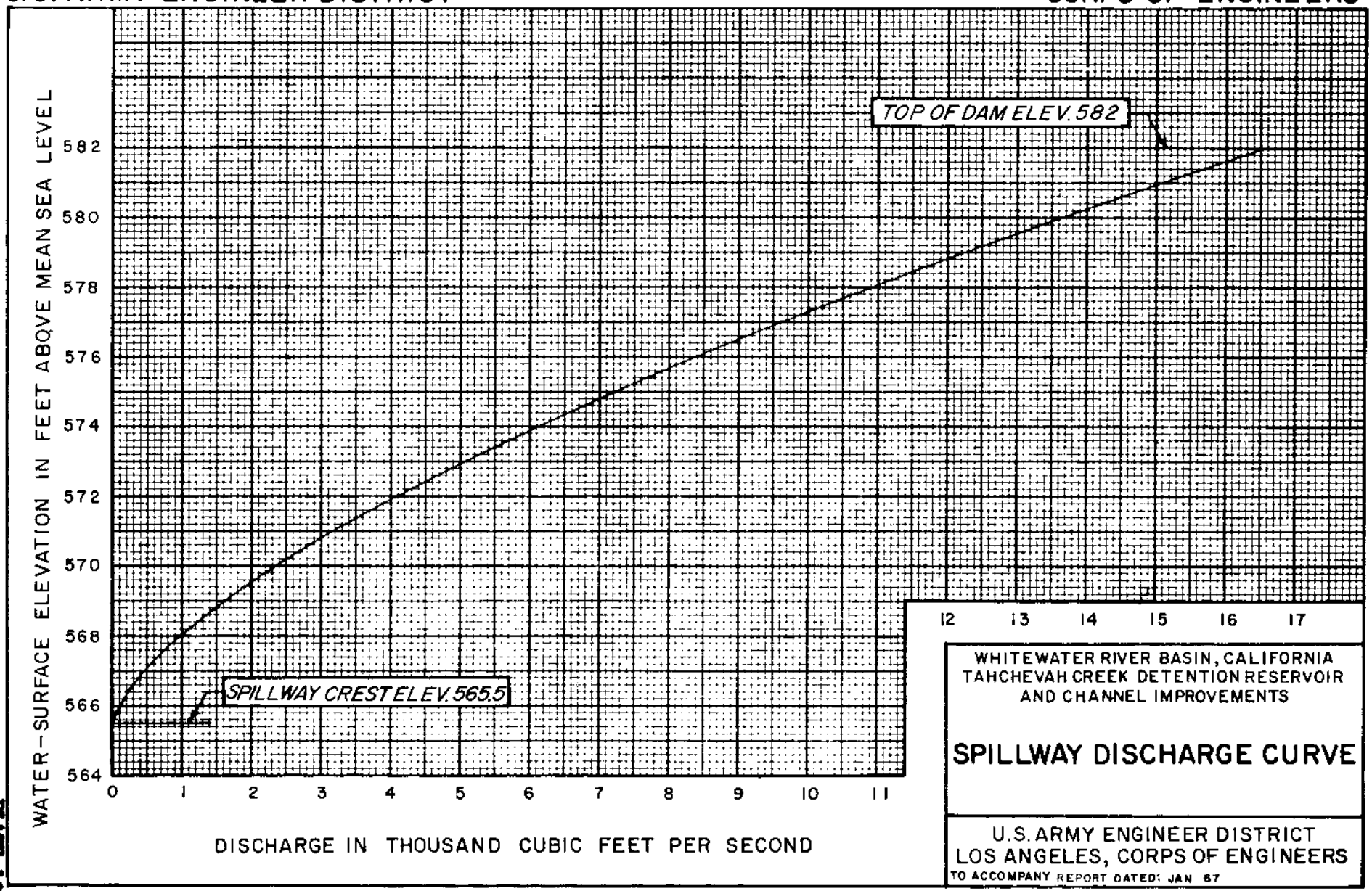
CORPS OF ENGINEERS

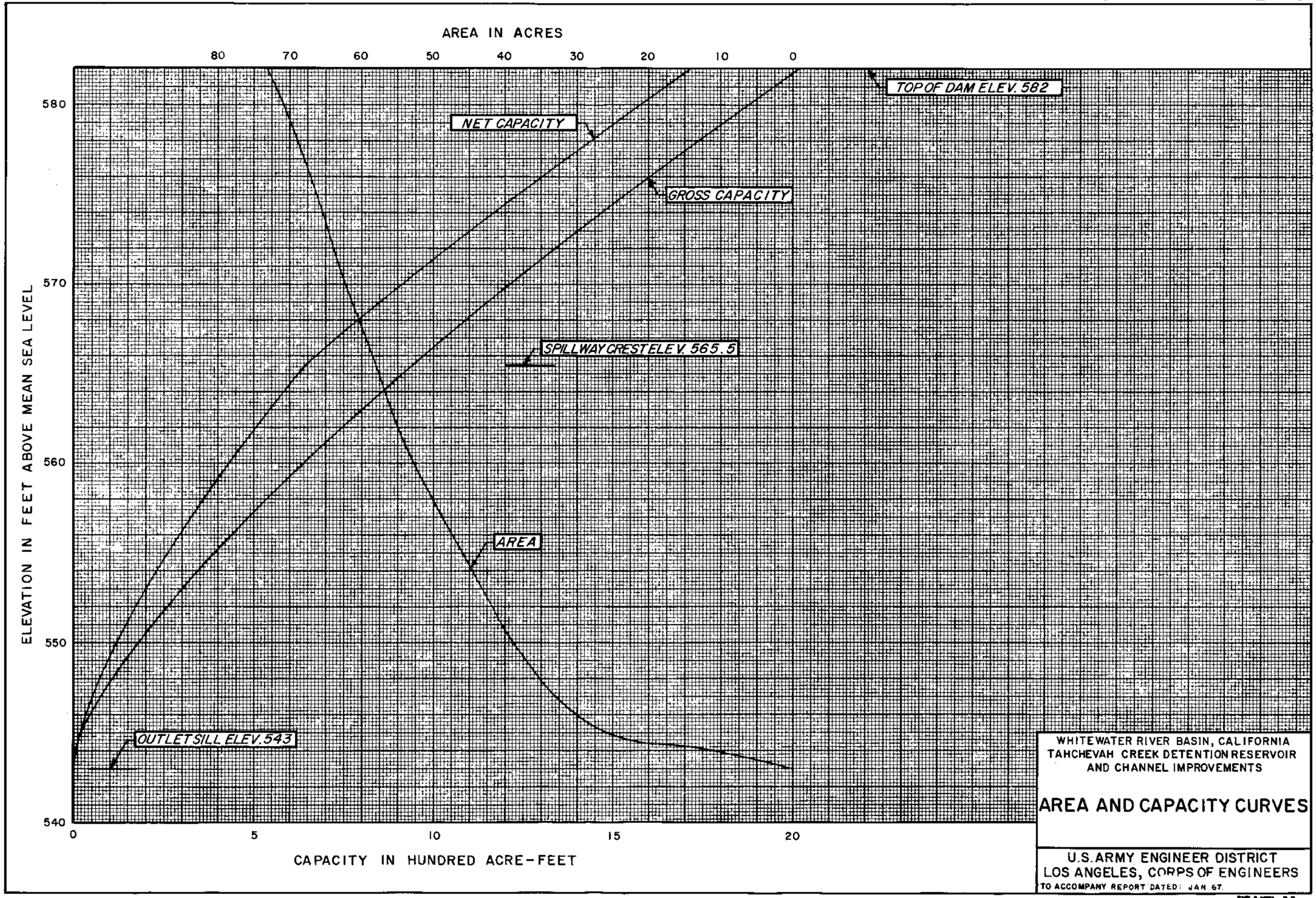


WHITEWATER RIVER BASIN, CALIFORNIA
TAHCHEVAH CREEK DETENTION RESERVOIR
AND CHANNEL IMPROVEMENTS

SPILLWAY DISCHARGE CURVE

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: JAN 67

PLATE 10



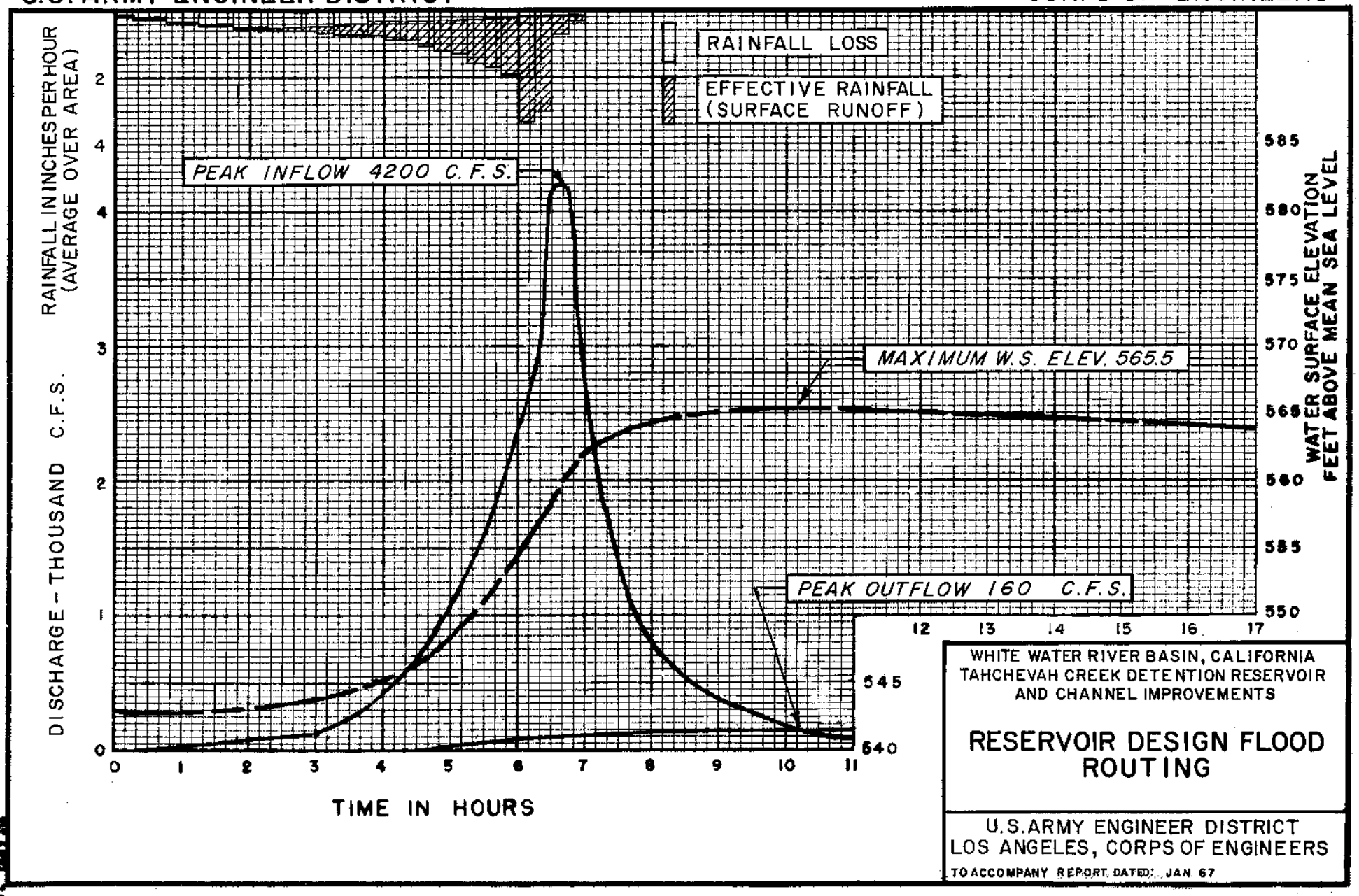
WHITEWATER RIVER BASIN, CALIFORNIA
TAHCHEVAH CREEK DETENTION RESERVOIR
AND CHANNEL IMPROVEMENTS

AREA AND CAPACITY CURVES

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS
TO ACCOMPANY REPORT DATED: JAN 67.

PLATE 11

U.S. ARMY ENGINEER DISTRICT CORPS OF ENGINEERS



WHITE WATER RIVER BASIN, CALIFORNIA
TAHCHEVAH CREEK DETENTION RESERVOIR AND CHANNEL IMPROVEMENTS

RESERVOIR DESIGN FLOOD ROUTING

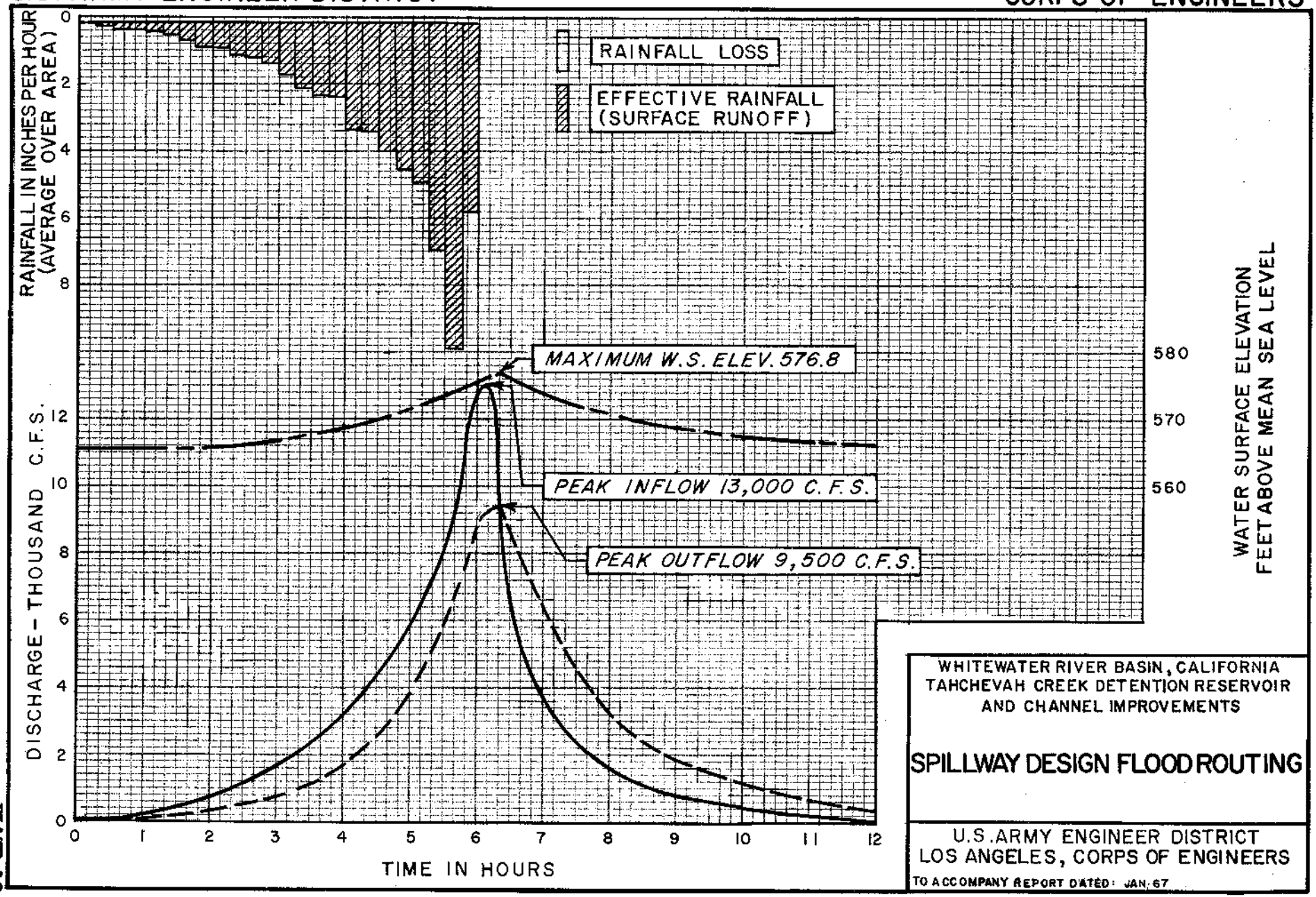
U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED: JAN. 67

PLATE 12

U.S. ARMY ENGINEER DISTRICT

CORPS OF ENGINEERS



WHITEWATER RIVER BASIN, CALIFORNIA
TAHCHEVAH CREEK DETENTION RESERVOIR
AND CHANNEL IMPROVEMENTS

SPILLWAY DESIGN FLOOD ROUTING

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES, CORPS OF ENGINEERS

TO ACCOMPANY REPORT DATED: JAN. 67

PLATE 13

TITLE 33 – NAVIGATION AND NAVIGABLE WATERS

Chapter II – Corps of Engineers, Department of the Army

PART 208 – FLOOD CONTROL REGULATIONS

AUTHORITY: § 208.10 issued under Sec. 7, 58 Stat. 890; 33 U.S.C. 709.

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities* – (a) *General.* (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the Department of the Army or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the Superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The Department of the Army will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under this part.

(b) *Levees* – (1) *Maintenance.* The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation.* During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls.* – (1) *Maintenance.* Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extend which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation.* Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures* – (1) *Maintenance.* Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once

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every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures* – (1) *Maintenance.* Closure structures for traffic openings shall be inspected by the Superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants* – (1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

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

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

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

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

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

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

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

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

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

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

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (Sec. 3, 49 Stat. 1571, as amended; 33 U.S.C. 701C) [9 F.R. 9999, Aug. 17, 1944; 9 F.R. 10203, Aug. 22, 1944]