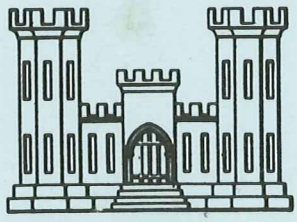
FLOOD CONTROL AND WATER CONSERVATION

RED LAKE RIVER, MINNESOTA

RED RIVER OF THE NORTH WATERSHED

RED LAKE DAM AND RED LAKES RESERVOIR

RESERVOIR REGULATION MANUAL



U. S. ARMY ENGINEER DISTRICT, ST. PAUL
CORPS OF ENGINEERS
ST. PAUL, MINNESOTA

APRIL 1964

FLOOD CONTROL AND WATER CONSERVATION
RED LAKE RIVER, MINNESOTA
RED RIVER OF THE NORTH WATERSHED
RED LAKE DAM AND RED LAKES RESERVOIR
AND
RED LAKE RIVER AND CLEARWATER RIVER - CHANNEL IMPROVEMENT

RESERVOIR REGULATION MANUAL

CORPS OF ENGINEERS, U. S. ARMY
Office of the District Engineer, St. Paul, Minnesota
April 1964

RESERVOIR REGULATION MANUAL
FOR
RED LAKE DAM AND RED LAKES RESERVOIR

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
ST. PAUL DISTRICT
ST. PAUL 1, MINNESOTA

APRIL 1964

RESERVOIR REGULATION MANUAL FOR RED LAKE DAM AND RED LAKES

A. GENERAL

1. Authority. - The Reservoir Regulation Manual for Red Lake Dam and Red Lakes is authorized by letter, 800.2 (Reservoirs) UMVCW, Upper Mississippi Valley Division, 30 August 1948, subject, "Manual of Regulation for Flood Control and Multiple Purpose Reservoirs." The interim Reservoir Regulation Manual was submitted as requested by first indorsement, UMVCS, Upper Mississippi Valley Division, 8 October 1952, to letter, 800.2 (Reservoirs) UMPRH, St. Paul District, 30 September 1952, subject, "Operation of Flood Control Reservoirs". This manual contains information as required by Engineering Manual 1110-2-3600, chapter 6, dated 25 May 1959 and is in final form incorporating the comments in accordance with letter of 25 August 1955 from the Office of the Chief of Engineers to the Division Engineer, North Central Division, subject, "Interim Reservoir Regulation Manual, Red Lake Dam and Lakes".

B. HISTORY AND DESCRIPTION OF RED LAKE DAM AND RED LAKES

2. History of project. - Residents of the Red Lake River Basin have been harassed by floods of varying frequency and intensity since the agricultural development of the region began. In accordance with an Act of Congress, 21 June 1906, which authorized a "drainage survey of certain wet, overflowed or marshy lands, ceded by the Chippewa Indians to the State of Minnesota, with a view of determining the possibilities of their reclamation by drainage", the U. S. Geological Survey executed a survey in 1907-1908. A comprehensive drainage program for the basin was submitted in 1909. Based on the plans submitted by the U. S. Geological Survey, the construction of drainage ditches was carried out on a large scale by judicial drainage districts and other local interests during the period 1910-1916. In 1931, the United States Department of the Interior, Office of Indian Affairs, constructed a control structure at the outlet of Lower Red Lake to regulate the level of both Lower and Upper Red Lakes. Since the establishment of the Red Lake control structure,

certain areas along the Red Lake and Clearwater Rivers were still subject to annual flooding, except during the drouth years of 1934, 1935 and 1936. The problem of providing an adequate flow of water for the municipalities along the Red Lake River is also important. At various times in the 1930's, the flow in the river has been inadequate for drinking, sanitary and fire protection purposes. An opportunity to study this problem was provided by the Flood Control Act of 28 June 1938, which authorized the Corps of Engineers to make a preliminary examination and survey report of the Red Lake River and its tributaries and the Clearwater River. The report proposed a plan of improvement which included channel enlargment and straightening on both the Red Lake and Clearwater Rivers, modification of the existing control structure at the outlet of Lower Red Lake, and regulation of lake stages with normal pool elevation at 1174.0*. The project was authorized by the Flood Control Act approved 22 December 1944. Construction was initiated in February of 1948 and the project was essentially completed in 1951.

3. Purpose. - Red Lake Dam serves a dual-purpose designed to impound water in the natural reservoir formed by Upper and Lower Red Lakes during flood periods and to release stored water for water supply and pollution abatement during the low-flow periods. For flood control purposes, storage is available above elevation 1174.0. During low-water periods, minimum releases from the lakes will be made to meet downstream water requirements. Regulation of low flows will be coordinated with releases from Lake Ashtabula on the Sheyenne River, North Dakota and with Orwell Reservoir on the Otter Tail River, Minnesota.

4. Location. - Red Lake Dam is located at the outlet of Lower Red Lake in the northeastern part of Clearwater County, Minnesota, approximately 18 miles northwest of the village of Red Lake, Minnesota and 196.0 river miles above the mouth of Red Lake River. Upper and Lower Red Lakes have an area of about 451 square miles at elevation 1174.0, normal lake elevation. The location of the projects on the Red Lake and Clearwater Rivers is shown on Plate 1.

5. Mapping. - Topographic maps are available for the lower or western part of the watershed. These quadrangles are the Grand Forks, Crookston, and Red Lake Falls, drawn to a scale of 1:62,500. These maps are available from the U. S. Geological Survey. Also, published by the U. S. Geological Survey are a series of topographic maps covering the entire watershed which were compiled by the Army Map Service and drawn to a scale of 1:250,000.

6. Climate. - The climate in the region is variable. The area is subject to cold winters and warm summers, typical of continental conditions in the temperate zone. The mean annual precipitation over the basin is

* All elevations in this manual are referred to mean sea level datum (1912 Adjustment)

about 21.0 inches of which about 58% occurs during May, June and July and about 77% occurs during the months of April through September. During the period November to March the precipitation accumulates in the form of snow which normally begins to melt and runoff during the latter part of March or early April. During the period May through September, the precipitation is usually the heaviest. About 80% of the excessive storms occur during June, July and August and the remaining 20% occur in May and September. However, precipitation after 1 July appears to cause little runoff unless it occurs at excessive rates. During this period evaporation and transpiration normally are heavy and tend to offset the effect of the rainfall. The result is a material reduction in runoff after June. The mean annual temperature is about 39°F with extremes ranging from -51°F to +110°F. The growing season averages about 120 days. However, killing frosts have been recorded in June and August under exceptional conditions. The climate is generally favorable for the agricultural activity carried on in the area. Table 1 shows temperature and precipitation at typical U. S. Weather Bureau stations in and adjacent to the Red Lake River basin.

7. Watershed. - The Red Lake River Basin lies entirely within northwestern Minnesota with the north edge of the basin being 40 to 60 miles south of the International Boundary. The basin covers all of Red Lake County and parts of Koochiching, Beltrami, Clearwater, Marshall, Pennington, Polk, Mahnomen and Itasca Counties. Total area of the basin is about 5,988 square miles with the area above the project dam draining 1,951 square miles. About 80% of the entire Red Lake River Basin is a relatively smooth plain once occupied by the ancient glacial Lake Agassiz. The eastern or headwaters area is a series of moraines and drift areas and is referred to as the Upland area. Elevations in the basin range from about 830 feet above sea level at the junction of the Red Lake River and the Red River of the North to about 1,450 feet above sea level in the extreme eastern portion. The elevation of the Uplands at the highest shoreline of Lake Agassiz is about 1,100 feet above sea level. The Red Lake River has two principal tributaries, Thief River which joins it from the north about 70 miles west from its source in Lower Red Lake, and the Clearwater River which roughly parallels the Red Lake River to the south until it joins at Red Lake Falls. In the total distance of 196 miles from Red Lake Dam to the mouth, the Red Lake River has a total fall of about 345 feet. The greatest fall in the entire reach occurs between Red Lake Falls and Crookston where the river is entrenched to a depth of 50 to 80 feet and the fall is about 5.0 feet per mile for a stretch of about 18 miles. There are three principal flood damage reaches in the basin, two on the Red Lake River and one on the Clearwater River. The damage reach on the Red Lake River from HighLanding to the western boundary of the Red Lake Indian Reservation is mostly agricultural while the principal urban damage occurs in the reach through the City of Crookston. Damage curves and areas flooded in the HighLanding reach are shown on Plate 2, while Table 2 indicates average annual damages in the Crookston reach based on January 1962 prices. Plate 2A shows areas subject to flooding in the City of Crookston. The HighLanding reach has been improved by channel dredging and

TABLE 1 - TEMPERATURE AND PRECIPITATION AT TYPICAL U. S. WEATHER BUREAU STATIONS IN AND ADJACENT TO THE RESERVOIR BASIN

Station		Red Lake Agency	Fosston Power Plant	Red Lake Falls	Crookston	Bemidji	Angus
Years of record		56	52	46	72	58	59
Mean temperature °F	Jan.	4.7	5.6	4.6	5.2	4.9	3.8
	Feb.	8.0	9.4	8.6	9.2	8.6	6.7
	Mar.	20.3	22.3	21.7	23.1	20.7	22.0
	Apr.	38.5	41.0	41.0	41.1	38.6	40.2
	May	52.7	54.4	54.7	54.9	52.5	53.8
	June	62.7	63.6	63.7	63.8	62.2	62.8
	July	68.8	69.5	69.7	70.2	68.5	69.0
	Aug.	66.1	67.3	67.6	68.2	65.7	66.7
	Sept.	56.5	57.5	57.4	57.3	55.5	56.8
	Oct.	45.3	45.6	45.4	45.9	44.0	44.6
	Nov.	26.4	26.7	26.3	26.8	25.5	25.8
	Dec.	11.6	12.1	11.6	12.5	10.9	11.2
Mean Annual		38.5	39.6	39.4	39.8	38.1	38.6
Maximum		109	110	110	106	107	108
Minimum		-50	-48	-50	-51	-50	-49
Mean Precip-itation Inches	Jan.	.72	.82	.62	.59	.69	.43
	Feb.	.64	.66	.65	.59	.58	.45
	Mar.	.80	1.10	.82	1.00	1.06	.72
	Apr.	1.43	1.83	1.61	1.49	1.85	1.28
	May	2.40	2.64	2.45	2.60	2.60	1.95
	June	4.03	3.95	3.40	3.43	3.49	3.32
	July	3.36	3.15	3.17	2.80	3.31	3.23
	Aug.	3.29	3.42	3.07	3.13	3.29	3.06
	Sept.	2.54	1.88	2.13	1.93	2.01	1.90
	Oct.	1.59	1.20	1.49	1.16	1.34	1.23
	Nov.	.97	.99	.93	.92	1.02	.80
	Dec.	.66	.69	.73	.62	.71	.42

TABLE 1 - continued

Station	Red Lake Agency	Fosston Power Plant	Red Lake Falls	Crookston	Bemidji	Angus
Years of record	56	52	46	72	58	59
Mean Annual	22.43	22.33	21.07	20.26	21.95	18.79
Max. & Year	36.83-1937	32.81-1941	32.03-1947	32.87-1941	39.76-1901	27.01-1941
Min. & Year	10.41-1917	11.40-1910	11.03-1936	9.99-1936	12.47-1917	7.81-1936
Mean Apr.-Sept.	17.05	16.87	15.83	15.38	16.55	14.74
Mean Oct.-Mar.	5.38	5.46	5.24	4.88	5.40	4.05
Max. in 24 hours & date	4.35 5-29-49	8.97 5-19-09	-	5.85 8-31-08	4.15 7-22-14	3.76 6-26-15
Mean Annual Snowfall (inches)	42.7	31.7	44.1	39.8	45.7	25.2

Crookston is protected by levees and dikes constructed by local interests. The damage reach on the Clearwater River is from Plummer upstream and the flood damage is mostly agricultural (see Plate 2). This latter reach also has been improved by channel dredging. Floods and flood damage has been covered under paragraph 30, while economic development of the basin is covered under paragraph 29. Other damage areas throughout the basin are mostly agricultural and minor in comparison to the above noted areas.

TABLE 2 - AVERAGE ANNUAL FLOOD DAMAGE - CROOKSTON

Reach or Area	Damage*
Sampson Addition (Residential)	$40,600
Chase Addition (Residential)	14,600
South Crookston (Residential)	22,400
Woods Addition (Residential)	72,000
Jerome's Addition (Residential)	20,100
Business District	7,600
Total	$177,300

* Based on January 1962 prices.

8. Topography and Geology. - The Red Lake River Basin contains two types of topography as a result of the last continental ice sheet to invade this area. The invasion of this last ice sheet caused a marked effect on the topography and the formation of the soils of the area. Prior to the glacial period the surface was rough and the drainage clearly defined, but as the glacier moved southward over the region, it wore down the divides and ridges and filled the valleys; thus, producing the rolling surface of a portion of the basin. As the glacier retreated northward a heterogeneous mass of clay, sand, gravel, and boulders was deposited as "drift" over the area to depths up to 400 feet. With each halt in the general recession of the ice sheet, debris accumulated at the edge of the ice sheet, forming recessional moraines which gave greater relief to the area than that characteristic of the drift plain in general. After the ice front had retreated within the Red River of the North drainage basin, water from the melting glacier was ponded between the surrounding highlands while the ice front blocked the northern outlet thus forming the glacial Lake Agassiz. This lake supplied the mechanics for a nearly level lacustrine deposit over the bottom of the lake bed covering the drift up to depths of 100 feet. As the lake drained, it left a more or less featureless plain interrupted by parallel north-south ridges which represent the ancient recessional beaches of Lake Agassiz and a few independent lakes as remnants of the original lake. These lakes are the Red Lakes, Thief Lake and Mud Lake. It has been such a short time geologically, since the last glacier withdrew from the basin that erosion has affected the area only slightly and the streams have had little opportunity to develop typical valleys. The level terrain which was

originally occupied by the glacial lake is referred to as the lake plain and the rolling country comprising glacial moraine and drift areas as the uplands. The lake plain occupies about 80% of the entire basin and is almost devoid of relief with elevations ranging from about 830 feet at the mouth of the Red Lake River to about 1100 feet at the eastern limits where it merges with the uplands. Considerable tracts of land in the lake plain remain perpetually swampy and boggy. Large tracts of such land are sub-marginal and are mostly uninhabited. The elevation of the uplands at the highest shoreline of the extinct Lake Agassiz is about 1100 feet above mean sea level and this section rises to about elevation 1450 feet at the rim of the Continental Divide which separates the drainage areas of the Red River of the North and the Mississippi River. This area is gently rolling to undulating and contains many depressions or ponds with no outlets. The bedrock underlying the drift consists of pre-cambrian crystalline rock such as granite, greenstone, and slate in the eastern two thirds of the area and cretaceous shale and sand in the western one third. The cretaceous sediments consist chiefly of soft clayey bluish-gray shale with thin beds of lignite and sand.

9. Dam. - Red Lake Dam consists of an earth dike road along the western edge of Lower Red Lake with top at elevation 1181.5. The maximum height is 15.5 feet and the length 36,500 feet. The general plan of the earth dike road is shown on Plate 3.

10. Outlet structure. - The control structure is located in the natural outlet of Lower Red Lake. It consists of a concrete broad crested weir at elevation 1169.6 surmounted by four 16-foot bays. The discharge through three bays is regulated by lift gates and through the fourth bay by two 8-foot stop log sections. The abutments and intermediate piers of the outlet structure support the bridge which carries Minnesota State Trunk Highway Nos. 1 and 89 over the structure. Beginning at the downstream end of the abutments and extending through the stilling basin, vertical walls form the sides of the outlet structure. A curved drop section is located 39 feet downstream from the gates. The stilling basin at the downstream end of the curved section is designed to produce a hydraulic jump for the dissipation of energy. The stilling basin is 12.0 feet long, 71.5 feet wide, and the floor is at elevation 1165.0. An end sill with top elevation at 1166.0 is provided at the downstream end of the stilling basin. Flared wing walls at the end of the stilling basin tie into the 113-foot channel which carries the flow downstream. Plate 4 shows the outlet structure plan and sections.

11. Reservoir - Upper and Lower Red Lakes. - Upper and Lower Red Lakes are located in the eastern portion of the Red Lake River basin. The lakes are connected by a small strait about 1 mile wide, known as the "Narrows", and are elliptical in shape with major axes of about 21 and 23 miles and minor axes of about 10 and 12 miles respectively. Most of the inflow into Red Lakes comes from the Tamarac and Battle Rivers which enter Upper Red Lake from the east and the Cormorant River which empties

into Lower Red Lake from the east. The lakes are shallow and the shores are very flat. Upper and Lower Red Lakes have a capacity of 2,680,000 acre-feet between the base elevation of 1167.5 and elevation 1177.0 which corresponds to an estimated frequency of once in 70 years. At elevation 1177.0, the water surface area is 295,200 acres. At normal lake elevation, 1174.0, the capacity is 1,810,000 acre-feet and the area is 288,800 acres. Area-capacity curves are shown on Plate 5. It is estimated that a maximum probable storm would cause a 2.6-foot rise in the level of Red Lakes. If it were assumed that this rise might occur with the lakes at the computed maximum regulated lake level, elevation 1176.43, the maximum elevation would be 1179.03. All of Lower Red Lake and about one-half of Upper Red Lake lie within the Red Lake Indian Reservation. Lumbering and fishing are the principal industries of the Red Lake Indians. Principal settlements and villages on the lakes are Red Lake where the agency headquarters are located; Redby, the center of the lumber and fishing industries; and Waskish on Upper Red Lake, the latter being located outside of the reservation.

12. General Dam and Reservoir Data. - Pertinent data for Red Lake Dam and Red Lakes are given in Table 3

TABLE 3 - PERTINENT DATA, RED LAKE DAM AND RED LAKES

General	
Total drainage area	1,951 square miles
Red Lakes	
Maximum probable lake elevation	1179.03 ft. m.s.l.
Capacity at maximum probable lake elevation (est.)	3,270,000 acre-feet
Normal lake elevation	1174.0 ft. m.s.l.
Capacity at normal lake elevation	1,810,000 acre-feet
Area at normal lake elevation	288,800 acres
Maximum length of Upper Red Lake	21 miles
Maximum width of Upper Red Lake	10 miles
Maximum length of Lower Red Lake	23 miles
Maximum width of Lower Red Lake	12 miles
Red Lake Dam	
Type	Earth dike road
Crest elevation	1181.5 ft. m.s.l.
Total length of earth embankment	36,500 feet
Maximum height	15.5 feet
Freeboard above maximum probable lake elevation	2.5 feet
Total volume of earth dam	140,285 cubic yards

TABLE 3 - continued

Outlet structure	
Type	Gated broad crested weir
Crest elevation	1169.6 ft. m.s.l.
Length of crest	64.0 feet
Gates	3 - 16x5 lift gates 2 - 8x5 stop log sections
Design discharge	3700 cfs
Stilling basin	Rectangular
Length of stilling basin	12.0 feet
Width of stilling basin	71.5 feet
Elevation of stilling basin floor	1165.0 ft. m.s.l.
Channel improvement	
Red Lake River	27.5 miles, Mi. 154.3 to 178.5 and for 3.3 miles below outlet structure
Clearwater River	38.0 miles, Mi. 41.6 to 79.6

13. Channel improvement. - The Red Lake River project includes rectification and enlargement of 27.5 miles of the Red Lake River channel between miles 154.3 and 178.5 and also a 3.3-mile reach below the outlet structure, a submerged channel wier and low water bypass shown on Plate 4 at mile 178.8, and rectification, clearing, and enlargement of 38.0 miles of channel on the Clearwater River between miles 41.6 and 79.6. Plans, sections, and profiles of the channel improvements are shown on Plates 3, 6, 7, and 8.

14. Status of project. - The project is complete. Reservoir operation was initiated in April 1951. Completion of the project as a whole was accomplished in 1956.

C. OPERATION OF THE RED LAKES RESERVOIR PROJECT

15. Organization of the Reservoir Regulating Section. - The over-all hydraulic operation of the Red Lakes project is under the technical direction of the Reservoir Regulating Section, Hydraulics Branch, Engineering Division. This section consists of three engineers and one engineering aide. Two engineering aides are also on continuous field duty checking gages etc., for the section. A chart showing the position of the Reservoir Regulating Section in the St. Paul District office organization is shown on Plate 9. The duties and responsibilities of the three engineers are outlined as follows:

a. Responsible for the planning and directing of the operation of 11 navigation dams, 6 multiple-purpose dams, and 6 Mississippi River headwaters reservoirs.

(1) Receive discharge, stage, snowfall, and rainfall data by telephone, radio, telegraph, and mail from climatological stations, dams, U. S. Weather Bureau offices, U. S. Geological Survey, public utilities, and private firms.

(2) Analyze data and route discharges.

(3) Issue operating instructions to dam tenders and lockmasters.

(4) Make forecast of stages and conditions for official use only.

(5) Maintain all Corps of Engineers gages and records.

b. Plan snow surveys and analyze data therefrom.

c. During flood emergencies act as flood intelligence branch.

(1) Collect all pertinent data during floods or other emergencies.

(2) Keep higher authority informed in compliance with paragraph 4223.05, Orders and Regulations.

(3) Maintain liaison with U. S. Weather Bureau and U. S. Geological Survey.

d. During open-water season, the section is on duty from 8 a.m. to 4:45 p.m. daily, Monday through Friday; 8 a.m. to 12 noon on Saturdays, Sundays, and holidays, when and as necessary. Personnel are on call 24 hours daily as noted in letter, NCSED-H, subject, "Pool Operation", dated 6 March 1964, included as Exhibit 1 to this manual. During flood emergencies, if conditions warrant, the section is on a 24-hour duty basis with trained personnel in charge of each 8-hour shift. The engineering aide assists in the collection of flood data, plotting hydrographs, computing discharges, and compiling data, etc. The dam tender for Red Lake Dam is appointed by the Superintendent of the Red Lake Indian Agency. Operating instructions are transmitted directly by mail or telephone from the Reservoir Regulating Section to the dam tender. For other than the hydraulic operation of the dam, the dam tender at Leech Lake Dam, Mississippi River Headwater Reservoir will perform other necessary operation and maintenance functions at Red Lake Dam under the direction of the Operations Division of the District office.

16. Reservoir regulation instructions. - In order to effect an orderly and efficient operation of the Red Lakes Reservoir both during low-water periods and flood emergencies, it is necessary to issue operating instructions to the dam tender. The procedure that is followed in issuing instructions is as follows:

a. Normal procedure. - During normal periods of operation, instructions are issued to the dam tender by mail or by occasional telephone calls. A record of all such instructions is maintained in a log book in the Reservoir Regulating Section and at the dam.

b. Flood emergencies. - During flood periods, daily contact by telephone or telegraph is made with the dam tender in order to issue frequent operating instructions and also to keep the District office currently advised of conditions.

17. Purpose of operation. - Red Lake Dam is operated to effect a reduction of flood flows along the Red Lake River and to augment the low water flows in the Red River of the North and lower reaches of the Red Lake River. The plan utilizes the tremendous storage capacity of Red Lakes over 450 square miles at normal lake level for flood control. In addition to these primary objectives, the reservoir is operated with proper regard to incidental functions including land use, and fish and wildlife conservation.

18. Reservoir operation. - The operation of Red Lakes has a dual purpose, flood control and the improvement of low-water flows. Duplicate use of the reservoir storage is possible due to the large capacity of the lakes. Normal pool is at elevation 1174.0. However, the pool is lowered to elevation 1173.5 annually to provide storage capacity for the spring runoff. Since the normal recharge is about 1.0 foot, the crest level of about elevation 1174.5 is expected annually. However, should abnormally heavy rains occur, the lake could rise to elevation 1176.43, the maximum regulated elevation. Should the maximum probable storm occur, a further rise of 2.6 feet to elevation 1179.03 would result. In lieu of flowage easements above elevation 1177.0, the Red Lake Drainage and Conservancy District have agreed to hold and save the U. S. Government free of all damage claims as the result of operation of the Red Lakes project. See Appendix B of this manual. Excess runoff will be stored during flood periods and released immediately thereafter as soon as downstream conditions permit or during low flow periods to meet downstream requirements for water supply and pollution abatement. Detailed instructions for the operation of the reservoir are contained in Appendix A, "Standing Instructions to the Dam Tender - Red Lake Dam". Operation orders will be issued to the dam tender by the Reservoir Regulating Section based on the best available information from all sources and on specific data furnished by the dam tender.

a. Flood flows. - Conservation or normal reservoir level has been established at 1174.0. Winter drawdown to elevation 1173.5 is based on analysis of past records. Available storage for flood runoff between elevations 1173.5 and 1177.0 is about 1,010,000 acre-feet. The channel downstream from Red Lake Dam has been improved for a distance of about 27.5 miles. This improvement will protect about 36,000 acres of agricultural land against flooding for all periods up to the 10-year frequency flood. Since the normal annual recharge of the Red Lakes is one foot to elevation 1174.5, the following is the method of operation of the project. Just prior to the spring breakup, the discharge from Red Lakes Dam is cut to a token flow necessary to sustain fish and wildlife and for other downstream needs. The dam is kept at this low discharge until high water downstream has abated. When the lake is above elevation 1174.5, releases are made to lower the pool as soon as practicable. These releases are limited to amounts which will maintain 8.75 feet or less on the gage at High Landing, Minnesota. At this stage, no flooding occurs at High Landing, but near bankful stages occur at Kratka, several miles downstream. Flooding at this stage was ascertained during the 1962 flood when farmers in the Kratka area invited representatives from the St. Paul District office to view their flooding. These farmers have been keeping unofficial rainfall records and at their request a river gage was set near Kratka. One of these farmers now keeps this office advised regarding both stage and precipitation during critical periods. If after a rain it appears the stage at the control at Kratka will rise to 8.75 feet or above, the Red Lake Dam is sealed until recession below this stage has occurred. This method is used in place of operating on forecasts based on the unit hydrograph for computing the local inflow between Red Lake Dam and Kratka, since infiltration rates vary widely and are hard to estimate. Also, since the time of travel between Red Lake Dam and Kratka is about 1.5 days or about one-half the cresting time of the local inflow, operation of the gates must take place immediately after flood producing rains. The gates at the dam ordinarily will be sealed less than a two week period and since the area of the Red Lakes is abnormally large, the difference in stage in the lakes caused by even the maximum reduction in outflow would be less than 0.1 foot during a two week period. If the river does not rise to 8.75 feet at High Landing or recedes below this elevation, the dam is opened again in a shorter period of time and only a slight rise occurs in the lakes. In the event of a summer flood or a potential flood threat from a prolonged wet spell, the discharge from the Red Lake Dam will be regulated so as not to add to any flooding or flood threat at downstream points including the River Valley, High Landing, Kratka, Crookston, and Grand Forks areas. All inflow into the reservoir will be stored if necessary. Plate 10 shows the profile through the downstream urban damage area of Crookston, Minnesota. Table 2 shows annual damages to the urban areas.

b. Low flows. - With the winter drawdown of the reservoir to elevation 1173.5, there is little likelihood of being unable to fill the reservoir from the spring runoff to the conservation level of 1174.0.

The normal regain during the spring breakup period is normally about 1.0 foot, resulting in a reservoir level of 1174.5, six inches above normal and 2.5 feet below design elevation of 1177.0. Caution will be exercised however with regard to the drawdown during drought periods. During periods of low flows, the releases from the Red Lakes will be made to supplement the natural flows at critical points downstream to meet the water supply and pollution abatement requirements. During periods of extreme drought when the reservoir level is between 1174.0 and 1172.0, the discharge from Red Lake Dam will be limited to the requirements for water supply and pollution abatement. When the level is between 1172.0 and 1171.0, the total annual release will not exceed 50,000 acre-feet during a calendar year or a proportionate share thereof for the part of the year that the lakes are between these elevations. Whenever the reservoir level is below 1171.0, the maximum discharge will be limited to about 15 cfs. Minimum discharge will not be less than 5 cfs. The requirements at downstream points for water supply and pollution abatement are shown in Table 4. Theoretical operation of Red Lakes during the period 1930-1942 is shown on Plate 11.

19. Sedimentation observations. - Inasmuch as the Red Lakes Reservoir consists of two large natural lakes, operation of these lakes for flood control and low-flow improvement is not expected to change sedimentation rates which existed under natural conditions; therefore, no plans for sedimentation observations have been made for Red Lakes.

20. Malaria control.- Climatic conditions in the Red Lake Reservoir area are such that the possibility of malaria infection is considered extremely remote. If a malaria problem ever should develop, the operation of the reservoir would have little, if any, effect on the mosquito incidence. Operation of the reservoir will follow recommendations of the U. S. Public Health Service. Flotage, drift and obnoxious vegetation are removed when necessary.

21. Stations of the hydrologic network. - The existing hydrologic network in and adjacent to the Red Lake River and Clearwater River basins consist of 15 climatological stations, 7 river discharge stations, and 23 snow survey stations in and adjacent to the basin. Plate 1 shows the type and location of the various stations.

22. Precipitation reports from key stations. - Key precipitation stations in and adjacent to the Red Lake River Basin report directly to the U. S. Weather Bureau office in Fargo, North Dakota. These reports are then sent out on a special teletype circuit "RAWARC" of the Weather Bureau. This information is then picked up by the Weather Bureau office in Minneapolis, Minnesota and relayed to the Reservoir Regulating Section in the District office. Table 5 shows the network stations and the conditions under which they report precipitation. In the event that the reporting stations indicate excessive precipitation, the Weather Bureau will contact additional stations by telephone to determine the extent of the storm area. These stations are shown on Plate 1.

TABLE 4 - STREAM-FLOW REQUIREMENTS (CFS)

Month	For Water Supply			For Pollution Abatement	
	Red Lake River at Thief River Falls	Red Lake River at Crookston	Red Lake River at East Grand Forks	Red Lake River below Crookston	Red River below Grand Forks
January	1	9	10	5	115
February	1	2	2	5	106
March	1	2	2	5	85
April	1	2	2	3	11
May	1	2	2	3	18
June	1	2	2	3	23
July	1	2	2	3	23
August	1	2	2	3	23
September	1	2	2	3	22
October	1	9	10	3	13
November 1-15	1	9	10	3	8
November 16-30	1	9	10	5	144
December	1	9	10	5	124

Requirements shown are for critical points along the stream. When a requirement is not critical during some months, it has been omitted. The requirements as shown in the above tabulation have been used in the coordinated water plan studies for Red River of the North.

TABLE 5 - HYDROLOGIC STATIONS IN AND ADJACENT TO THE RED LAKE RIVER BASIN

North Dakota

Grand Forks A.P. (Recorder)**

Minnesota

Crookston*
Red Lake Falls
Thief River Falls*
Agassiz Refuge
Thief Lake Wildlife Area (Recorder)
High Landing*

Minnesota - continued

Oklee
Fosston Power Plant (Recorder)*
Thorhult 3E
Gonvick
Wayland 9NW
Red Lake Indian Agency (Recorder)
Bemidji A.P.**
Angus 4NNE

* Report 0.50 inch of precipitation in 24 hours
** Report precipitation every 6 hours

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23. Reporting stream-flow stations in the hydrologic network. - The stream gaging stations report through regular U. S. Geological Survey facilities during normal flow periods with copies of measurements mailed to the Reservoir Regulating Section. During flood periods, measurements are usually telephoned to the Geological Surveys District Office in St. Paul and results are relayed to the Reservoir Regulating Section by telephone. The stations are shown on Plate 1.

24. Forecasting flows into Red Lakes Reservoir. - Red Lake and its drainage area lies in the basin of glacial Lake Agassiz. The 1,951 square miles comprising the drainage area are either low swampy areas or open waters. Red Lake itself comprises about 450 square miles or nearly 25% of the total area. The longest tributaries average less than 25 miles in length. Therefore, total runoff from rainfall occurs in a relatively short period averaging about 10 days. However, snowmelt usually takes approximately 15 to 20 days. Runoff from snowmelt ordinarily occurs in April, but occasionally is delayed until May and is generally sustained by rainfall. Each rain of any consequence contributes to and prolongs the runoff. However, after mid-May, evaporation becomes a factor in the runoff and the control of the lake. The normal evaporation from the lake surface of 4 to 5 inches per month during June, July, August and September results in a loss of nearly 2,000 cfs daily during this period. This is equivalent to approximately twice the capacity of the channel downstream from the Red Lake Dam. Unless sustained by normal or greater than normal rainfall, evaporation causes the lakes to drop during these months. Studies indicate that the total volume of runoff from accumulated snow on the ground during the winter is almost identical to the total volume of runoff from an equal amount of rainfall. However, the runoff pattern is different. Runoff from rainfall consists of an initial runoff equivalent to the amount of rain falling directly on the lake plus an additional amount of runoff from the land area. The total volume of runoff is tempered by evaporation,

which sometimes causes negative net inflows especially for smaller rains occurring during June thru October inclusive. Snowmelt runoff from snows accumulating during the winter differs from rain runoff in that the weight of the snow on Red Lakes proper increases the stages of the lakes immediately at the time of the snowfall and reflects an increase in runoff before snowmelt actually occurs. Therefore, snowmelt runoff results from the drainage area excluding the Red Lakes proper, unless snowfall occurs simultaneously with the melt. The total volume of runoff from equal amounts of snowmelt or precipitation are practically identical. This indicates that infiltration and evaporation are relatively small during the snowmelt period and results in comparatively heavy runoff from the land area; thus, compensating for that portion of runoff as the result of rainfall on the lake proper. Plate 12 shows total precipitation versus total inflow curve which was developed from past records. For determining volume of snowmelt runoff, the precipitation to be used is the amount accumulated from freezeup through snowmelt. For determining rainfall runoff, the total precipitation is the amount occurring during an isolated storm. The total inflow is determined by adding the amount of evaporation to the net inflow. Evaporation is determined from curves by Adolph Meyer, Plate 13. Basic data on a monthly basis is plotted in the form of mass precipitation and mass net inflow curves as shown on Plate 14. These curves are used for forecast purposes. For computing snowmelt runoff, precipitation is accumulated from freezeup through breakup. Any precipitation during the snowmelt period is included in the total. Enter the former curve with the total precipitation and read the total inflow. From the evaporation curve, Plate No. 13, compute the amount of evaporation during the snowmelt. This value is then subtracted from the total inflow to arrive at a net inflow. This net inflow is then superimposed on the current net inflow-mass curve, similar to those on Plate 14, from which stages in Red Lakes are forecast. Runoff from rainfall is computed in a similar manner. However, as the summer progresses, the evaporation becomes more pronounced. To compute runoff from rainfall, enter the curve with rain from any storm and compute inflow. If no intense rainfalls occur, runoff is computed for 10-day intervals.

25. Forms for reporting operating data. - Records of reservoir operation are reported on the forms described below. These records may be supplemented by additional reports on special subjects as required.

a. Weekly log sheet. - Operating data are recorded on NCP Form 420, "Weekly Log Sheet", which is included as Exhibit 2. The dam tender records readings of the pool and tailwater gages, the lift gates and stop log openings, as well as temperature and precipitation data. Space is also provided on this form to record other miscellaneous information when necessary. The log sheet is prepared in duplicate by the dam tender so that both the dam tender and the Reservoir Regulating Section have complete records of the reservoir operation.

b. Monthly report of reservoir operation. - Form NCP 418, Reports Control Symbol ENGKW-51 "Monthly Reservoir Operation", included as Exhibit 3 is used to show graphically the complete monthly operation of the Red Lakes Reservoir and the average precipitation in the watershed above the dam. The two key stations used in determining the average precipitation and the percentage of the drainage area covered by each (From Thiessen polygons) are as follows:

Station	Percentage of area
Red Lake	78
Wayland	22

26. Correlation of operations. - At the present time, there are no other major reservoirs on either the Red Lake River or its tributaries with which the operation of Red Lakes must be correlated. During low flow in the Red River of the North, the operation of Red Lakes will be coordinated with that of the other reservoirs and local power dams in the basin to satisfy requirements for water supply and pollution abatement.

27. Cooperation with other agencies. - The St. Paul District is cooperating financially with the U. S. Weather Bureau on precipitation stations and with the U. S. Geological Survey on stream gaging stations in the hydrologic network of reporting stations. The District is also cooperating with the U. S. Fish and Wildlife Service and the Minnesota Department of Conservation in the best interests of all concerned. In turn these agencies cooperate in furnishing data during flood emergencies.

28. Examples of regulation. - There is shown graphically on Plate 11, the theoretical operation of Red Lakes as a part of the Red River of the North coordinated water plan during an assumed recurrence of the dry period, 1930-1942. On Plate 15, the regulation of Red Lakes is shown for the calendar year 1962. This was a year where precipitation during the winter months of January through March was normal or slightly below. Breakup began about the first week of April producing only minor rises in the Red Lake River at High Landing, Minnesota, then dropping off rather sharply after the ice went out of the channel. Precipitation beginning about the first week of April became heavy and general over the basin for the next 4½ months. Through operation of the Red Lake Dam, the flows throughout this period were confined to within bank capacities at High Landing except for about 2 days in June. Rating curves for Red Lake Dam are shown on Plates 16-20 inclusive. Additional rainfall stations were established in the reach between High Landing and Kratka which indicated some very heavy local precipitation in this area. Inflow and storage in Red Lakes are based on the records at Red Lake Dam only.

29. Economic development of the watershed area. - The economic development of the basin can be traced back to 1863. Prior to 1863 the settlement of whites over most of the basin was prohibited by the Chippewa Indians who controlled a large portion of the land area. However, in 1863, 1867, 1889 and 1904, successive portions of the Indian lands were ceded for settlement and the most productive lands were occupied. Since then, the economy of the area has been predominantly agricultural. About 80% of the basin is in the relatively smooth lake plain and it was here that the first principal crop, wheat was raised while in the eastern or upland area, forests of pine provided forest products. The trend towards diversification has resulted in crops such as potatoes, sugar beets, small grains, such as corn, barley, oats, flax and soybeans. Dairying and the production of dairy products and the raising of poultry are also on the increase, while the development of processing plants in the urban areas to process these and other products is also increasing. In the upland areas the state is managing forest areas for continuous yields of commercial timber. The total population within the watershed area of 5,988 square miles based on 1950 figures was 67,904 of which 19,327 was classed as urban, 9,490 as rural non-farm and 39,087 as rural farm. However, 1960 population figures indicate an average total loss of 5.8% while the average rural loss is about 9.4% indicating a trend away from agriculture, the main occupation of the area.

D. FLOODS AND FLOOD DAMAGE

30. History and description of maximum floods. - Floods in the Red Lake River Basin are divided into 2 categories, Spring floods and Summer floods. Spring floods are the result of snowmelt and early Spring rains and usually occur most frequently in March, April and May, while summer floods result from excessive storms, 80% of which usually occur during the months of June, July and August and 20% occur in May and September. From the western edge of the basin, the land rises gently toward the east or northeast on a gradient so slight as to make the land appear flat. This results in a very slow movement of excess water from large areas that may be flooded by excessive precipitation falling directly upon the land. A considerable portion of the floodwaters are ponded in swamps, bogs, and shallow depressions and as a consequence, a large portion of the potential runoff does not reach the main streams but seeps into the porus ground or is lost through evaporation or transpiration. This type of flooding resulting from the overland movement of water toward the main channels is referred to as local flooding and is responsible for 75% of flooding. Overbank flooding from the main channels is called direct flooding. Nearly one-half million acres of farm lands are subject to flooding in the basin of which only about 25% will be from direct flooding. Flood conditions are further aggravated in reaches of the Red Lake River and Clearwater River by weed growth which usually reaches its peak about mid-August, decreasing the efficiency of the channel and creating a backwater effect of as much as $2\frac{1}{2}$ feet. This condition was particularly bad above High Landing on the Red Lake River and Plummer on the Clearwater River prior

to the channel improvement in these reaches. Weed growth was eliminated or kept to a minimum growth for a few years, but, it now appears that as much as 2 feet of backwater from weed growth is occurring annually. In order to facilitate the operation of Red Lake Dam when indications of local or direct flooding are about to occur in the reach downstream to High Landing, a standard operating procedure for reporting high water conditions in that area is in effect. These procedures are as follows:

a. The gage observer at High Landing will contact the Reservoir Regulating Section by telephone whenever any of the following conditions exist:

(1) Whenever rainfall in excess of 2-inches falls within a 24-hour period regardless of the river stage.

(2) Whenever the river stage at High Landing is rising and reaches a stage of 4.5 feet.

(3) Whenever the river stage is between 4.5 and 7.0 feet and a rise in river stage of 0.5 foot occurs in 24 hours, or if 1-inch or more of rainfall occurs in a 24-hour period, telephone daily.

(4) Whenever the river stage is above 7.0 feet, telephone daily.

(5) Whenever a prolonged period of high water occurs, the observer will be instructed verbally as to the frequency of telephone calls.

b. Recently it was discovered that 12 farmers below High Landing were keeping rainfall records on their farms on an unofficial basis. The cooperation of these farmers was obtained to furnish these data to the Reservoir Regulating Section. One farmer in this group will notify this office by telephone whenever heavy rainfall occurs in their area. Also, this office provided this farmer with a river gage tied into the High Landing gage to provide a warning of conditions in the unimproved area below. Agricultural damage curves and areas flooded are shown on Plate 2. In the Thief River Basin direct flooding is not a major problem since the channel is comparatively adequate for most flood flows. However, extensive local flooding occurs in the headwaters of the Thief River due mainly to inadequate drainage. Spring floods occur almost annually in the Red Lake River Basin with breakup ordinarily in late March or early April. Flood water from snowmelt spreads out over still frozen ground and in general recedes quite rapidly causing only minor property damage and highway inconvenience. Flooding during this period does not interfere with the planting of crops or cause any appreciable crop loss. However, a summer flood resulting from excessive rainfall can cause extensive crop damage and constitutes the major flood problem in the basin. The settlers and residents of

the Red Lake River Basin have been harassed by floods of varying frequency and intensity ever since the agricultural development of this region began over seventy years ago. Major flooding has occurred in the following years, 1887, 1896, 1897, 1901, 1902, 1904, 1905, 1908, 1915, 1916, 1919, 1922, 1925, 1927, 1937, 1938, 1941, 1950, 1951, 1952, 1957 and 1962. Minor flooding has occurred during most of the remaining years since 1896 except during the drought years of 1934-1936. Up until 1950, the most devastating flood of record occurred in July of 1919, but it now appears that the floods of April and May 1950 are the floods of record for the basin. Only fragmentary information is available on most of the floods that have occurred in the basin. A brief description of a few of these floods for which some information is available follows:

a. July 1919 Flood. - The flood was caused by precipitation averaging 5.9 inches which fell on the basin on 1, 2, and 3 July 1919 with the heaviest occurring over the north central part of the basin with about 9 inches reported in the vicinity of Thief Lake where the entire country was inundated to depths varying from 4 to 8 feet and the water was reported, "at a higher level than at any time since the flood of 1887." Over 500 families were evacuated in the flooded portions of Marshall, Pennington, Beltrami, Red Lake, and Roseau Counties. The lower portion of the city of Crookston was flooded, and many families were forced to leave their homes. Appeals were made to the Red Cross for assistance. According to local estimates more than $50,000 was required to provide for the immediate relief of the flood victims. The gaging station at Crookston had been maintained since May of 1901; and while the maximum stage of 21.1 feet on 5 July 1919 was exceeded during April 1916 with a stage of 21.8 feet and in March 1920 with a stage of 23.3 feet, these higher stages occurred at the time of the breakup when the flow was retarded by floating ice and ice jams. Before gage heights were kept regularly, a stage of 25.2 feet was authenticated for 11 April of either 1896 or 1897, the exact year not being known. The maximum discharge for the 1919 flood at Crookston was 14,700 cfs. The frequency of this flood has been estimated at 70 years. Flood stage has been established by the U. S. Weather Bureau for the U. S. Geological Survey gage at 18.0 feet.

b. May 1938 flood. - This flood resulted from heavy precipitation which prolonged the normal spring runoff. As a result seeding operations were delayed and portions of agricultural land remained soggy during the entire month of May. Flood damages were confined mostly to the areas in the vicinity of High Landing on the Red Lake River and Plummer on the Clearwater River, but considerable damage was also sustained in the Thief River basin. Flooding and damage caused by direct overflow of the Thief River was primarily caused by the destruction of a dike in the Mud Lake refuge. The water released by the break in the dike overtopped the channel immediately downstream and a considerable area was inundated from the direct overflow.

c. June 1941 flood. - This flood was also caused by excessive precipitation which fell during the period 5-14 June 1941 and caused considerable damage throughout the basin. This storm followed above normal precipitation during the latter part of May, which had left the basin in a comparatively wet condition. On 5, 6, and 7 June an average of about 4 inches of rain fell over the basin. The storm apparently centered on the headwaters of the Clearwater and Red Lake River, where large areas were subject to local flooding. The channels of both the Clearwater and Red Lake Rivers in the critical reaches above Plummer and High Landing respectively were quickly filled, resulting in direct overflow. The flood condition was further aggravated by about 1 inch of rain during the period 10-13 June inclusive. The Clearwater and Red Lake Rivers were above bankfull stage for about 35 days and crops on approximately 21,000 acres of farmland out of a total of 28,600 acres flooded were destroyed or damaged by direct overflow.

d. April-May 1950 floods. - The following information was taken from the U. S. Geological Survey Water Supply Paper No. 1137-B "Floods of 1950 in the Red River of the North and Winnipeg River Basins". The spring floods of 1950 in the Red Lake River basin and throughout the Red River of the North drainage resulted from a combination of causes. These causes were: above normal antecedent soil moisture; unusually heavy snowfall during a colder than normal winter; delayed melting of the snow cover until mid-April; and above normal precipitation during the breakup. Over much of the drainage area of the Red River of the North, these floods were the largest that have occurred since 1897. An unusual feature on many tributaries including the Red Lake and Clearwater Rivers and on much of the main stem of the Red River of the North was the occurrence of two separate flood peaks of nearly the same size; one in April, the other in May. The first flood started at Crookston on 20 April when snowmelt waters originating in the Clearwater drainage area reached the city. The rise was gradual until the crest, 6.2 feet above flood stage on 23 April. This flood caused severe damage but receded almost as fast as it had risen. Many homes in Crookston had water up to the first floor ceilings for 3 days. Outside the city, there was little damage. A timber crib dam at Red Lake Falls was partially destroyed by ice floes. The Red Lake River from Red Lake Falls to Thief River Falls overflowed its banks and caused water logging of fields for several weeks as this reach of the river remained at a nearly constant discharge for almost a month. Colder weather after 25 April delayed further snowmelt until warmer weather early in May. Rain and wet snow brought the Clearwater River up to a second crest. When this crest reached Crookston, it exceeded the April rise. The second rise crested at 7.7 feet over flood stage on 7 May, and the river remained above flood stage for over a week. All areas flooded the first time were again flooded. Attempts to dike the flooded areas were unsuccessful. A temporary dike around one section in the city failed near flood stage (18.0 feet) and added to the general distress of the flood victims. Much trouble was experienced by water backing into homes

through the sewer system. Direct flood damage to farm lands by erosion was extensive throughout the Red River Basin and almost as serious were the effects of saturated lands which delayed planting. High ground water levels interfered with normal drainage of many fields for several weeks after the recession of the flood waters. Some fields adjacent to the Red River proper could not be planted during the 1950 growing season. Flood damage throughout the entire Red River Basin in the United States amounted to almost $31,000,000 with almost $2,500,000 in the Red Lake River Basin.

e. May-June 1962 floods. - During the spring of 1962, runoff in the Red Lake River Basin started early with conditions near normal, However, cold weather set in and curtailed the runoff until about 13 April, when warmer weather again started the final runoff of the snowmelt. The Red Lake River at Crookston crested on 20 April at a stage of 12.2, or 5.8 feet below flood stage. Beginning about 15 May, numerous storms with excessive rainfall began to plague the entire Red River of the North watershed. These storms and heavy rainfall extended into July. Between 12 May and 12 June, there were areas that reported as much as 17 inches of rainfall. Two flood crests resulted from this period of excessive rainfall. The first crest reached Crookston on 26 May, resulting in a stage of 20.18 feet, 2.2 feet above flood stage. Damage was minor as it was confined to basement flooding and low lying park areas. The dikes were sandbagged in the event that a further rise would overtop the dikes. On 27 May, the Red Lake River started dropping rapidly at Crookston and continued until 31 May. During the entire month of May, the outflow from Red Lake Dam was controlled to 40 cfs. Only during the period 23-25 May, following a particularly heavy rainfall, was the critical stage of 8.75 feet exceeded at High Landing. Thus, the reservoir reduced the crest stage at High Landing by about 3.3 feet, Kratka by about 2.3 feet, and Crookston by approximately 0.8 foot. On 4 June when the stage at High Landing had dropped to 5.0 feet and it appeared that flooding at Crookston was over, Red Lake Dam was opened gradually to 1,000 cfs by 6 June. On 8 June exceedingly heavy rains occurred in the Red Lake River Basin. Flooding was now general from High Landing to Crookston. The level of Red Lakes was the highest since 1957. Crest stages of 12.1 feet and 21.9 feet were recorded at High Landing and Crookston on 11 June, both locations at least 3.0 feet over flood stage. Local and overbank flooding was general between Red Lake Dam and Thief River Falls. At Crookston, some seepage was reported through the dikes; basements were flooded a second time. However, the chief concern was for 2 large residential areas that would be flooded out if the dike failed. The discharge from Red Lake Dam was 1,000 cfs with a peak inflow rate of 4,600 cfs for about one week. Due to the local and overbank flooding between Red Lake Dam and Thief River Falls, farmers in this reach requested that Red Lake Dam be closed. A total of 10 inches of rain in May plus an additional 7.5 inches during the first part of June had raised the level of Red Lake to within 0.5 foot of the upper flowage limit as established for the project. It also was 0.74 feet higher than the stage reached in 1957 which had resulted

in damage claims from property owners on Upper Red Lake. These differences are based on instantaneous readings. Lake levels are subject to fluctuation caused by change in direction and velocity of wind and seiches. The discharge of 1,000 cfs was only about 20% of the peak inflow into the reservoir which was continuing to rise. The District Engineer regretted that it was inadvisable to reduce the discharge at that time under the existing conditions. By 13 June, there was considerable improvement in the weather conditions with a sharp decrease in the inflow rate into Red Lakes, so it was decided to cut the outflow at Red Lake Dam from 1,000 cfs to 60 cfs to allow the farm land between the dam and Thief River Falls to drain off. In the future it is anticipated that under similar conditions, the gates at the dam will be sealed immediately upon report of heavy rains. By 14 June, the Red Lake River was dropping from the dam to the mouth. Stages continued to drop and the discharge from Red Lake Dam was slowly increased to lower the reservoir level. Bankfull stage was not exceeded during the remainder of the year. Stages continued to drop until about 7 July when another period of excessive rainfall occurred during the first 10 days of July. Control of the outflow at Red Lake Dam kept this excess runoff within the banks at High Landing and a crest stage at Crookston on 12 July about 4.0 feet under flood stage. Rating curves for High Landing and Crookston are shown on Plates 21 and 22. Red Lakes continued a slow increase in stage until about 20 August. A drawdown of 1.0 foot in reservoir stage was accomplished by the end of November. The discharge from Red Lake Dam was in excess of 1,000 cfs from the middle of July through the end of November without causing any overbank flooding. Tentative figures indicate that during the overbank flooding in June that 5,800 acres of cropland were flooded with direct and indirect losses totaling about $26,300. Operation of the Red Lake Project was responsible for preventing additional flooding and losses which would have occurred over a much longer period of time if the tremendous amount of flood storage had not been held in the reservoir. Complete figures on all damages from this flood are not available.

31. Flood damage. - Flood damage in the Red Lake River Basin is mostly agricultural and crop damage comes from the local flooding caused by heavy storms that occur during the period May through September. Of the excessive storms that occur during this period, 80% occur during June, July and August. The other 20% occur in May and September. Other damages include bridges, culverts and roadways. Flooding during the breakup period in March and April have caused the least damage except in 1950. The only urban damage center is located in Crookston where damage is usually confined to basement flooding in a low area protected by dikes. Discharge rating curves for the Clearwater River at Plummer and Red Lake Falls are shown on Plates 23 and 24 and on the Thief River at Thief River Falls and the Red River of the North at Grand Forks on Plates 25 and 26. Discharge hydrographs for Red Lake River below Red Lake Dam are shown on Plates 27 thru 40.

32. Damage due to low water. - Low flows in the Red Lake River Basin do not ordinarily cause any damage except where swampy or bog areas are dried up during drought periods. This results in considerable wildlife loss. Low flows also effect the water supply of various communities in the basin where most sources of water from deepwells is moderately to heavily mineralized, chiefly with bicarbonates of calcium and magnesium. No real flow deficiency has occurred since the drought period of 1934, 1935 and 1936. However, with the present plan of operation of the Red Lake Project, water requirements could be met except for an extended period of drought.

NCSED-H

6 March 1964

SUBJECT: Pool Operation

TO: All Lockmasters, Lockmen, and Dam Tenders, U. S. Army Engineer District, St. Paul

1. The following schedule for the Reservoir Regulating Section of the Hydraulics Branch will become effective 7 March 1964 and will continue to about 5 December 1964.

2. Personnel of the Reservoir Regulating Section will be on duty at the St. Paul office during the following hours:

Monday through Fridays	7:55 a.m. to 4:40 p.m.
Saturdays	8 a.m. to 12 noon
Sundays and holidays	When and as necessary

3. The engineer on duty will contact the locks and dams daily by radio, Monday through Friday, beginning at 8 a.m. On Saturdays, when no radio operator is available and at times when reception is poor, he will call by telephone. He will call the dam tenders at the Mississippi River headwaters reservoirs and the flood control reservoirs by telephone when conditions warrant. Additional contact with any radio-equipped installation will be made at 2 p.m. by radio when conditions indicate that a change in orders may be necessary. During flood emergencies special arrangements will be made regarding communications. It is requested that dam tenders or lockmen on duty contact the St. Paul office during hours noted above when conditions occur which would indicate that changes in operation might be necessary. Should such conditions occur after hours, the engineer who placed the last calls should be called at his home.

4. During the above-mentioned hours that personnel are on duty at the District office, calls from the dams should be made to CApital 2-8011, extensions 589, 680 or 664. On weekends, holidays and after hours, two direct telephone lines (CApital 2-0610 and CApital 2-5770) are connected to the Reservoir Regulating Section. Should emergencies arise requiring personnel on duty in the Reservoir Regulating Section other than regular hours, you will be informed. Calls should then be made to the latter numbers.

5. Telephone calls initiated by any dam or lock and dam should be charged to that site.

6. It is believed that the above schedule for the Reservoir Regulating Section will prove sufficient for practically all operation. However, in case of emergency, when an engineer is not on duty at the St. Paul office (or cannot be contacted as indicated above), the following, in order of preference, may be called at their homes:

H. W. Harich	Phone 699-6790 (St. Paul)
R. C. Greene	Phone JUniper 8-7698 (Robbinsdale)
L. M. Katz	Phone 929-6879 (St. Louis Park)
R. M. Cowan	Phone 451-3418 (South St. Paul)

DISTRIBUTION
Lockmasters (to be posted)
Dam tenders

R. M. COWAN
Chief, Hydraulics Branch
Engineering Division

EXHIBIT 1

U. S. ARMY
ENGINEER DIST.
ST. PAUL, MINN.

FLOOD CONTROL - WEEKLY LOG SHEET

RED LAKES DAM, MINN.

RED LAKE RIVER

Date _____ 19__

LOCATION	Day:						
RED LAKES DAM							
POOL	Outside Staff						
	Inside "						
	Tape						
(U.S.G.S.)	Recorder						
(U.S.C.E.)	Recorder						
T.W.	Outside Staff						
	Inside Staff						
	Tape						
(U.S.G.S.)	Recorder						
Head (Use Tare pages)							
SLIDE GATE - OPENING IN FT.							
	Gate No. 1						
	Gate No. 2						
	Gate No. 3						
Total Drech thru gates (c.f.)							
STOP LOGS (Top elev.)							
	Gate No. 1						
	Gate No. 2						
	Gate No. 3						
	Bay No. 4						
Discharge over stop logs (c.f.)							
Total Discharge through Dam							
GAGE READINGS							
CHANNEL DAM	Pool						
	T.W.						
River Valley							
Highlanding							
Waskish							
TEMP DEG F.	Max.						
	Min.						
	7 A.M.						
PRECIPITATION	24 hrs to 7 A.M.						
Snow on ground in inches							
WIND DIRECTION							
VELOCITY							

Remarks:

KCP Form 460
DEC. 1952

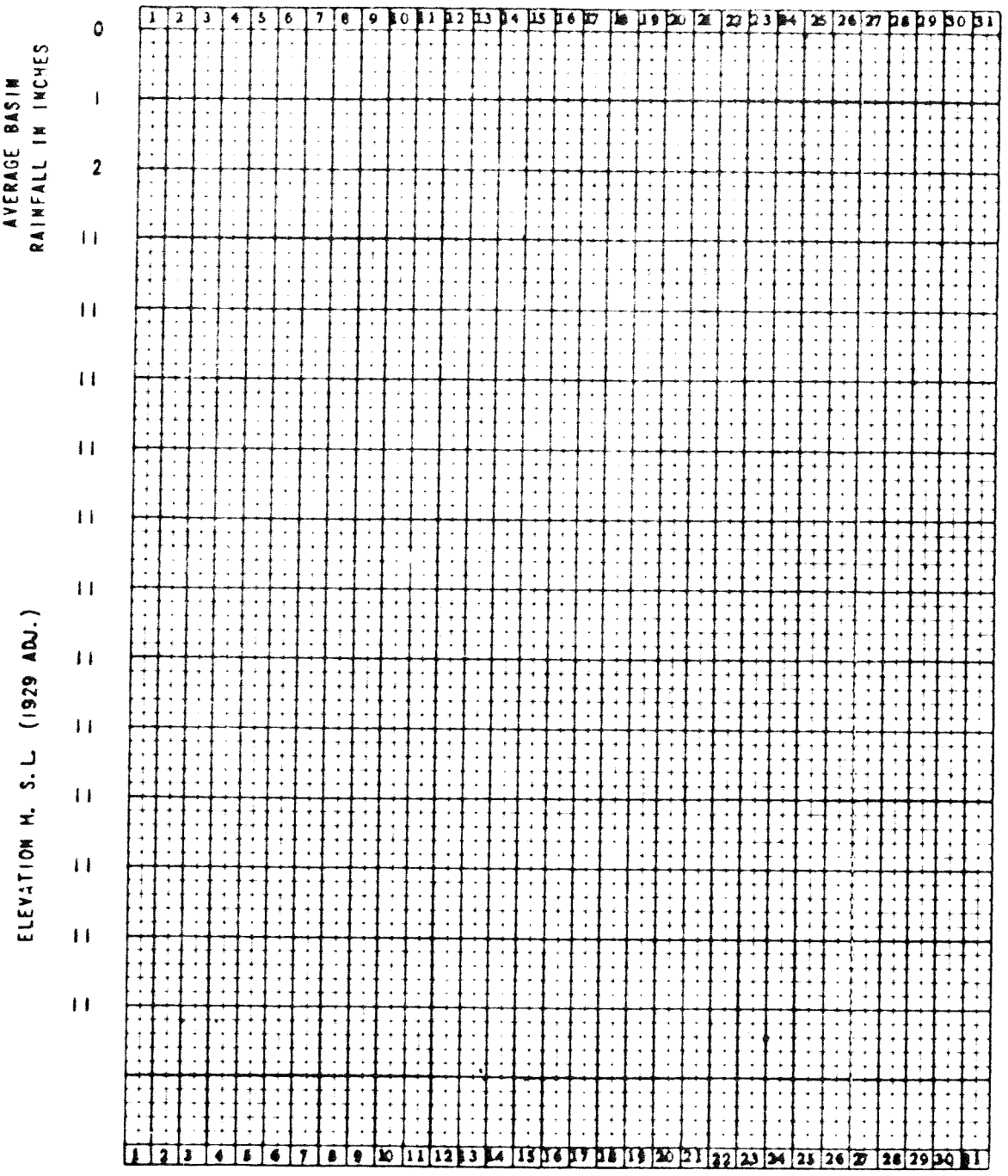
Dam Tender

EXHIBIT 2

Reports Control Symbol ENGEW-51

CORPS OF ENGINEERS

U.S. ARMY



MONTH OF

MONTHLY RESERVOIR OPERATION

	ELEV. M.S.L.	STORAGE ACRE FT.	FLOOD STORAGE ACRE FEET
MAX. POOL	1177.0	2,680,000	
NOR. POOL	1174.0	1,810,000	
			870,000

RED LAKE RESERVOIR
RED LAKE RIVER BASIN
D.A. 1950 SQ. MILES
NORTH CENTRAL DIVISION
ST. PAUL DISTRICT

OUTLET CAPACITY AT FULL POOL 1100 c.f.s.

EXHIBIT 3

CORPS OF ENGINEERS, U.S ARMY

SNOW SURVEY DATA SHEET

ST. PAUL DISTRICT

STATION No._____

LOCATION OF SNOW SAMPLING STATION

NO SCALE

DATE _____ TIME _____ A.M. _____ P.M.

LOCATION: _____ BASIN _____ RIVER

LAND USE _____

PERCENTAGE OF SNOW COVER: AT STATION _____ %

BETWEEN STATIONS _____ AND _____ IS ___ %

SAMPLE No.	SNOW DEPTH	GROSS WEIGHT	TARE WEIGHT	NET WEIGHT	WATER CONT.
1					
2					
3					
4					
TOTAL					
AVERAGE					

AVERAGE DEPTH OF SNOW AND ICE _____ INCHES

AVERAGE WATER CONTENT OF SNOW AND ICE _____ TO HUNDRETHS

CONDITION OF SNOW _____

SEVERITY OF DRIFTING _____

THICKNESS OF ICE LAYER ON GROUND _____ INCHES

FROST CONDITIONS _____

WEATHER CONDITIONS _____

REMARKS: _____

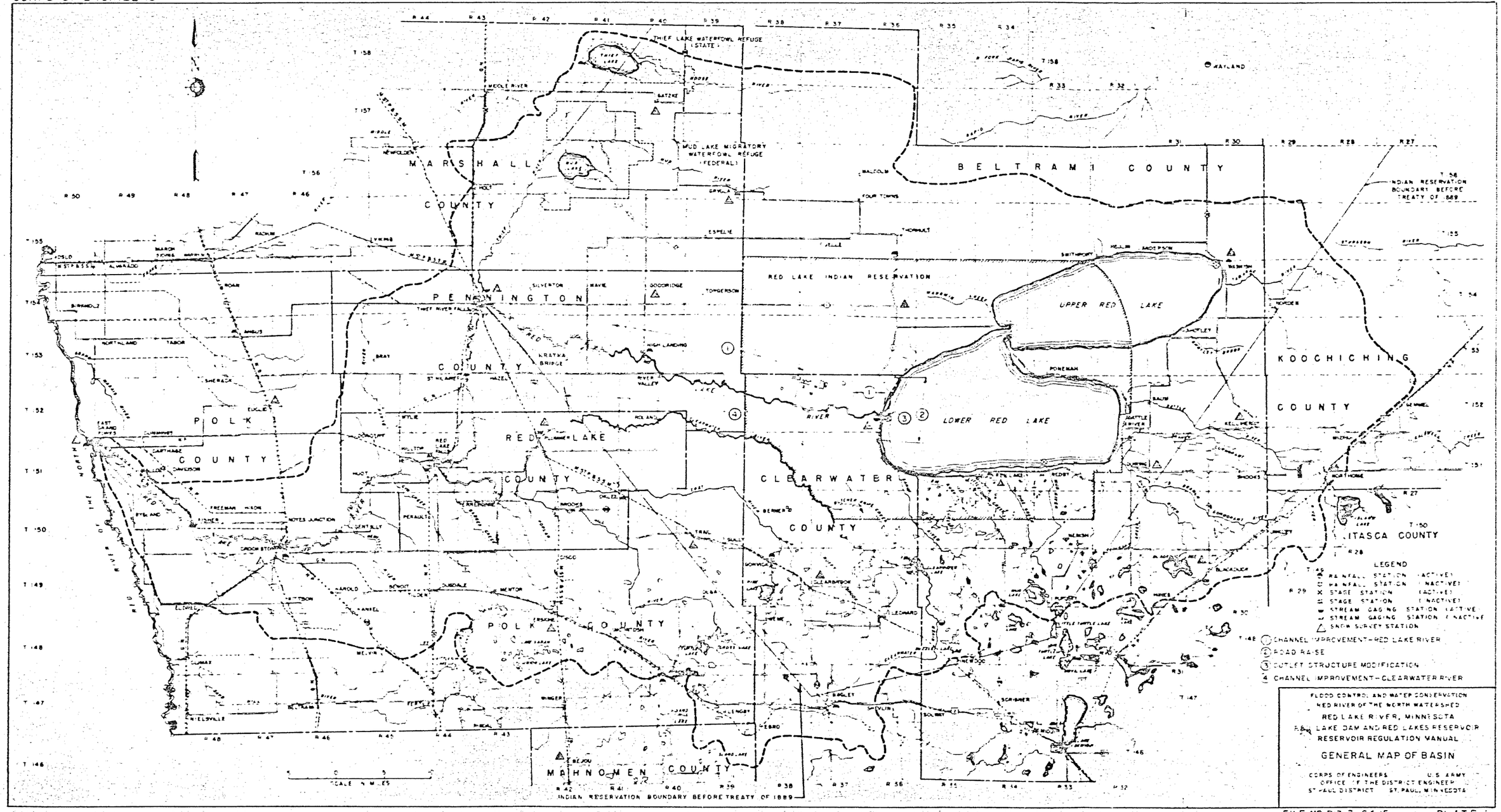
SURVEY PARTY _____

UMP FORM 430
18 June 52

EXHIBIT 4

APS STL 10715

CORPS OF ENGINEERS U. S. ARMY



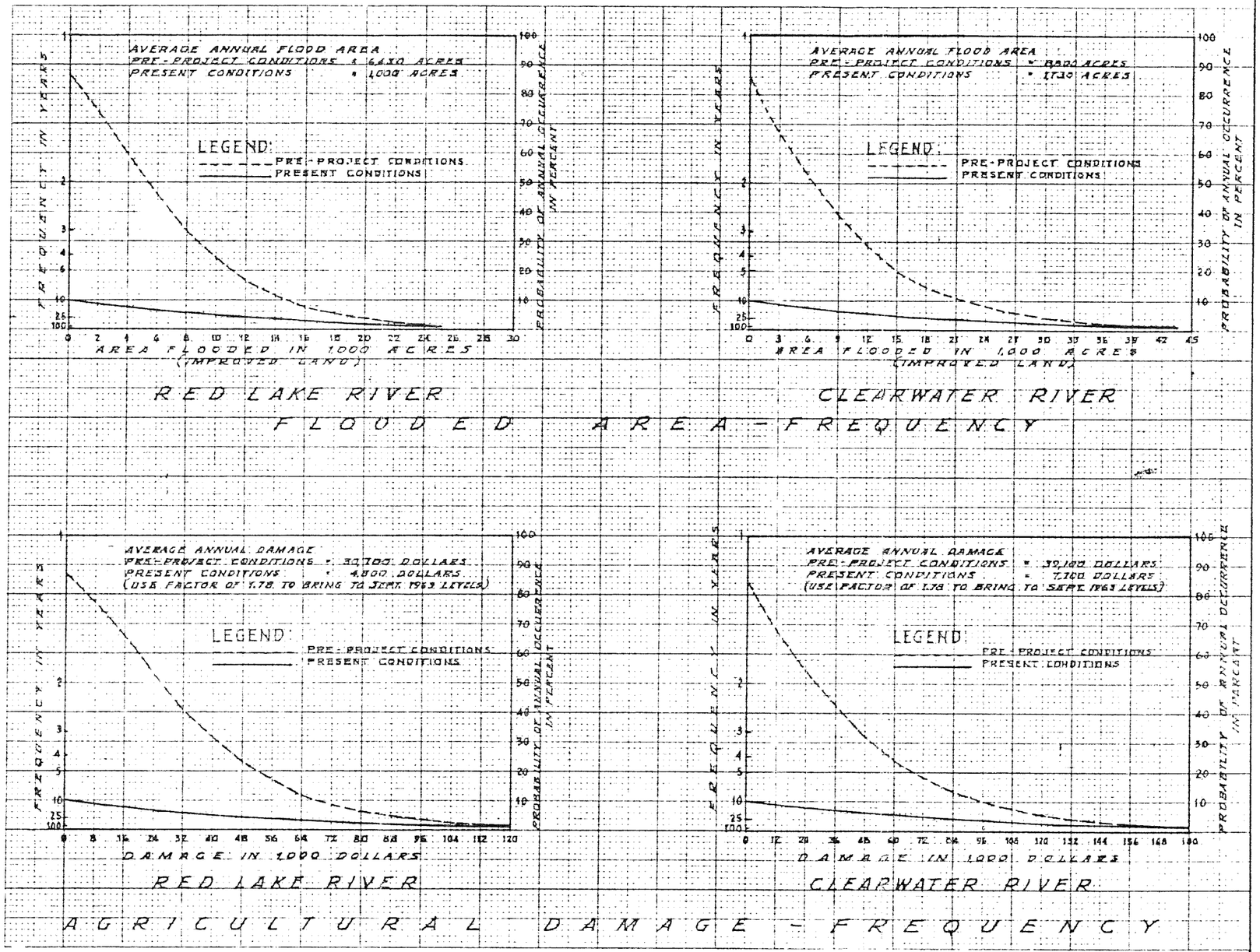
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

GENERAL MAP OF BASIN

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R:3-Z-64/5 PLATE 1

CORPS OF ENGINEERS U. S. ARMY



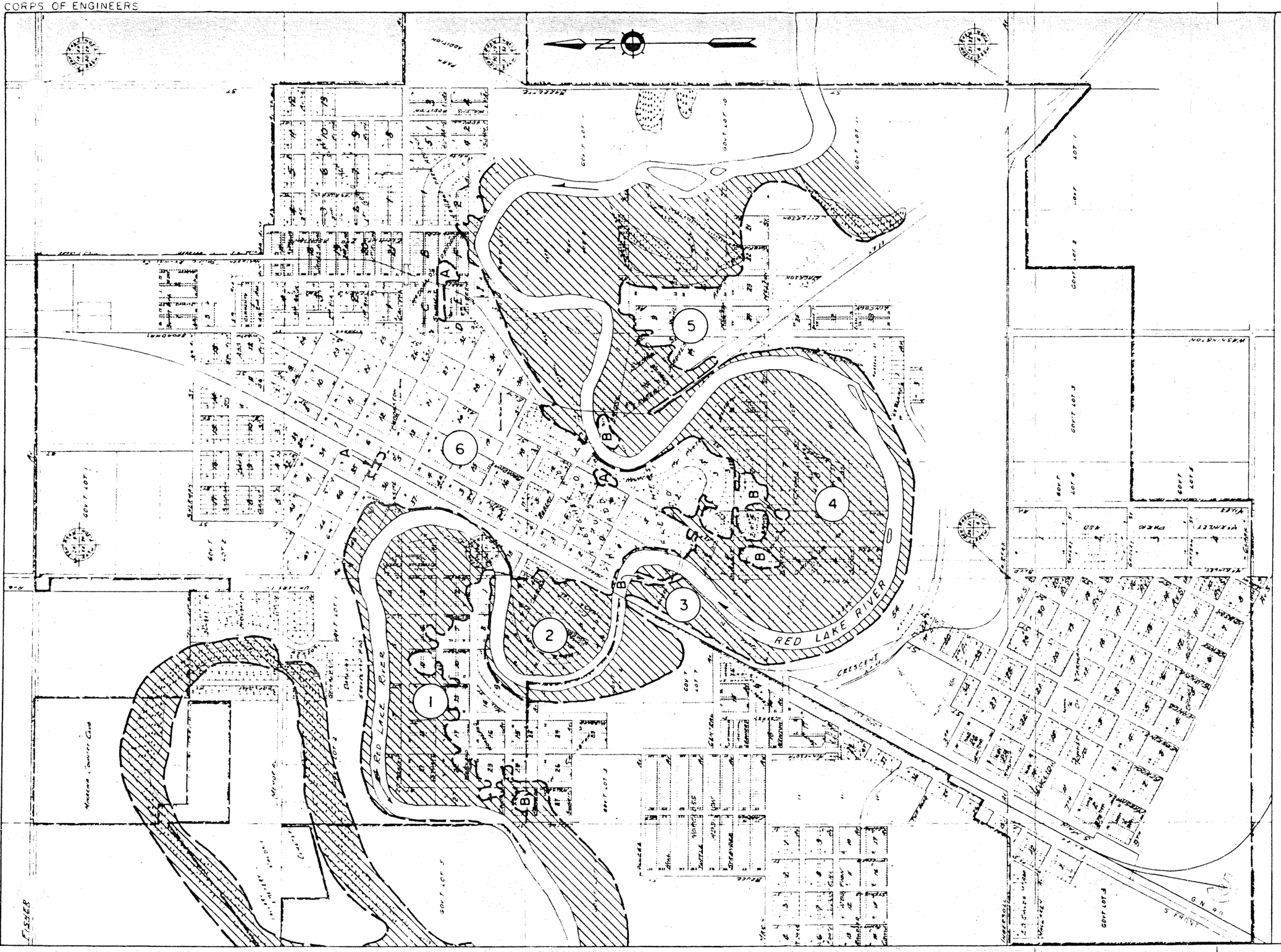
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

ECONOMIC ANALYSIS

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/6 PLATE 2

CORPS OF ENGINEERS U. S ARMY



LEGEND

- AREAS INUNDATED BY 1950 HIGH WATER
- (B) AREAS ABOVE 1950 HIGH WATER
- (A) AREAS FLOODED DUE TO FLOOD WATER BACKING UP IN SEWER
- (1) SAMPSON ADDITION
- (2) CHASE ADDITION
- (3) SOUTH CROOKSTON
- (4) WOODS ADDITION
- (5) JEROMES ADDITION
- (6) BUSINESS ADDITION

NOTE:

REPRODUCED FROM ORIGINAL MAP BY OFFICE OF THE DISTRICT ENGINEER, ST PAUL DISTRICT, C OF E , U. S. ARMY.

1000' 500' 0 1000'

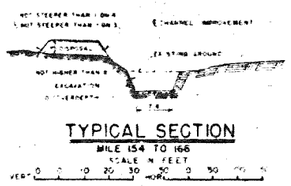
SCALE IN FEET

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
CITY OF CROOKSTON
MINNESOTA

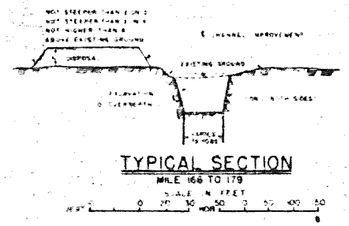
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/6A PLATE 2

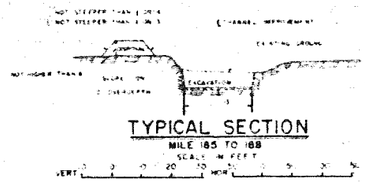
CORPS OF ENGINEERS U. S. ARMY



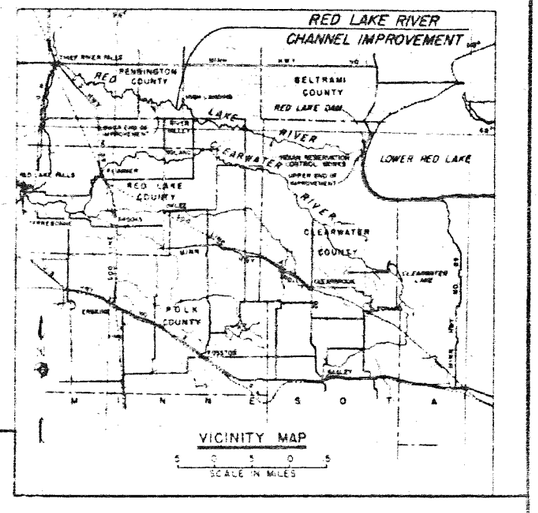
TYPICAL SECTION
MILE 154 TO 166
SCALE IN FEET



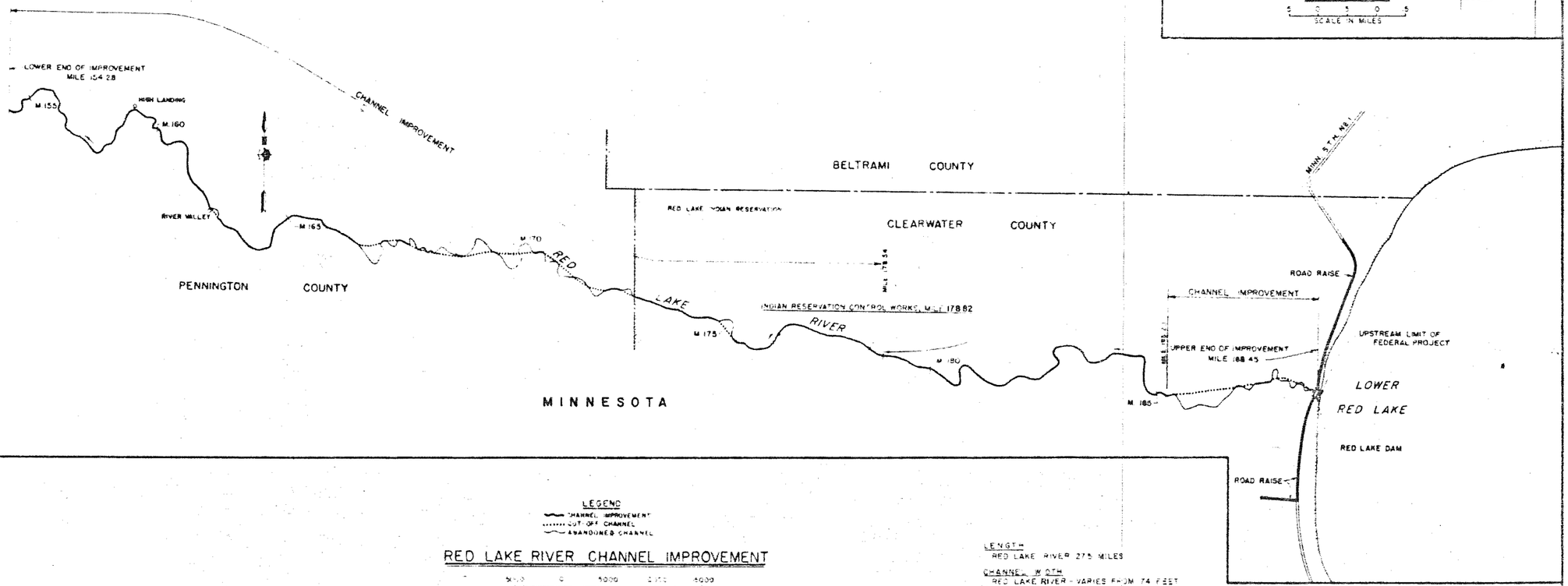
TYPICAL SECTION
MILE 166 TO 179
SCALE IN FEET



TYPICAL SECTION
MILE 185 TO 188
SCALE IN FEET



VICINITY MAP
SCALE IN MILES



LEGEND
CHANNEL IMPROVEMENT
OUT-OFF CHANNEL
ABANDONED CHANNEL

RED LAKE RIVER CHANNEL IMPROVEMENT
SCALE IN FEET

LENGTH
RED LAKE RIVER 27.5 MILES

CHANNEL WIDTH
RED LAKE RIVER - VARIES FROM 74 FEET TO 113 FEET

DESIGN CAPACITY, RED LAKE RIVER 1,000 SEC-FT AT UPPER END TO 1,520 SEC-FT AT LOWER END. THIS WILL PROVIDE FOR FLOODS WITH 10 YEAR FREQUENCY WITH APPROXIMATELY 1 FT. FREEBOARD

M 150 - MILES ABOVE MOUTH

SEE PLATE 6 FOR PROFILE

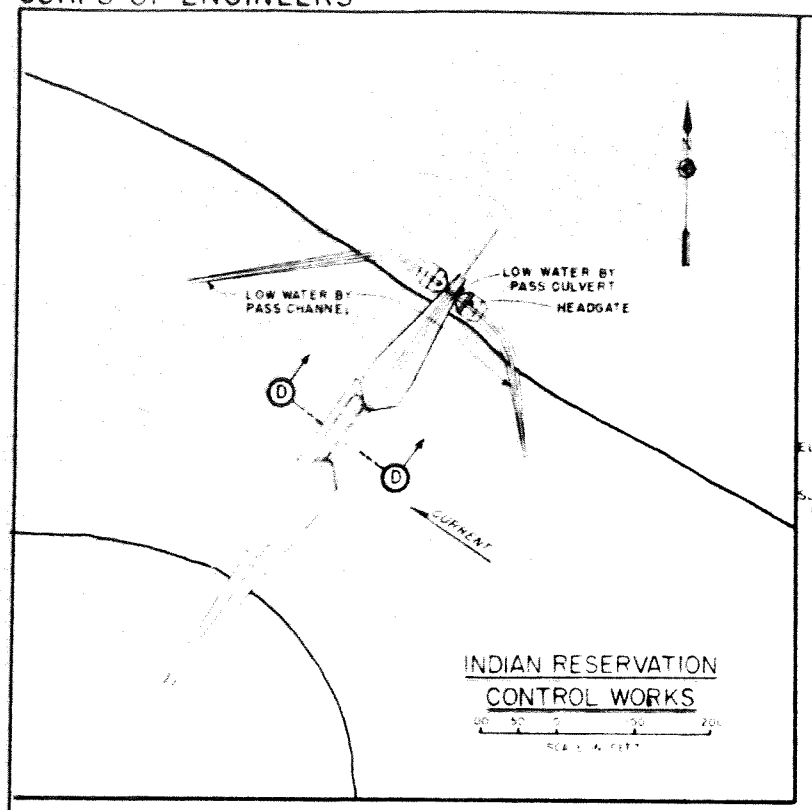
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

PROJECT MAP
RED LAKE RIVER

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

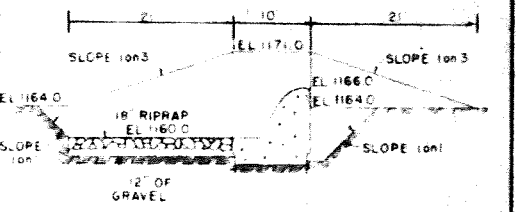
FILE NO. RI3-Z-64/7 PLATE 3

CORPS OF ENGINEERS U. S. ARMY



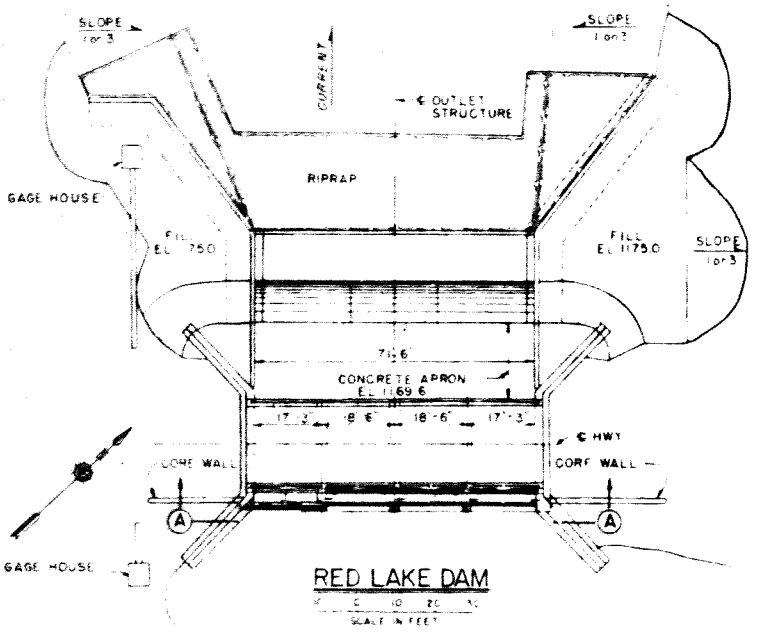
INDIAN RESERVATION CONTROL WORKS

SCALE IN FEET



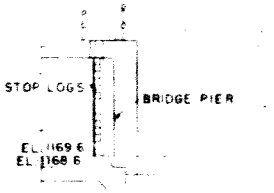
SECTION D-D

SCALE IN FEET



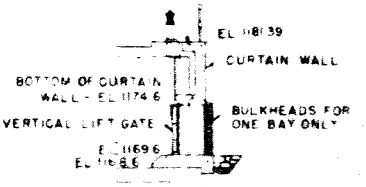
RED LAKE DAM

SCALE IN FEET



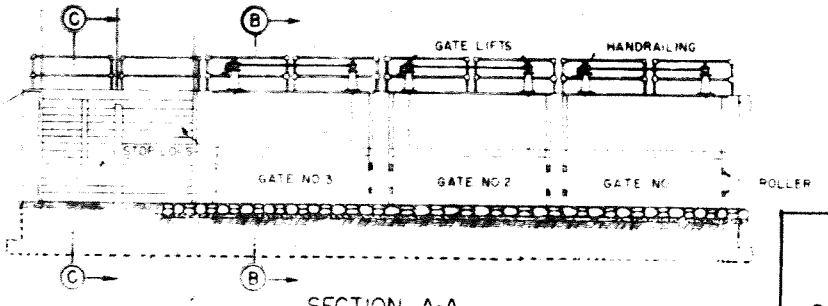
SECTION C-C

SCALE IN FEET



SECTION B-B

SCALE IN FEET



SECTION A-A

5 0 5 10 15

ELEVATIONS IN FEET ABOVE M.S.L. (1912 ADJ.)

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

CONTROL STRUCTURES

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/8 PLATE 4

CORPS OF ENGINEERS

U.S. ARMY

AREA IN THOUSANDS OF ACRES

296 294 292 290 288 286 284 282 280 278 276 274 272

ELEVATION IN FEET ABOVE M.S.L. (1912 ADJ.)

1179 1178 1177 1176 1175 1174 1173 1172 1171 1170

AREA

CAPACITY ABOVE ELEV. 1167.5

Estimated

Normal Lake Level 1174.0

CAPACITY IN THOUSANDS OF ACRE-FEET

600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 3000 3200

ELEV.	AREA (ACRES)	CAPACITY (ACRE-FT.)
1170.0	245,400	690,000
1171.0	272,000	963,000
1172.0	282,450	1225,000
1173.0	285,700	1525,000
1174.0	288,800	1810,000
1175.0	291,500	2,100,000
1176.0	293,640	2,390,000
1177.0	295,200	2,680,000
1178.0		2,970,000
1179.0		3,260,000

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

AREA AND CAPACITY CURVES

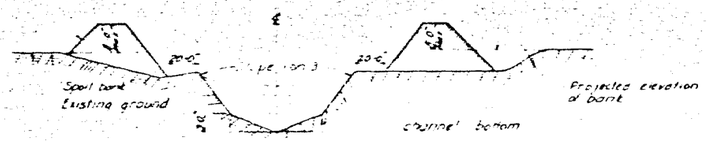
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/9

PLATE 5

CORPS OF ENGINEERS

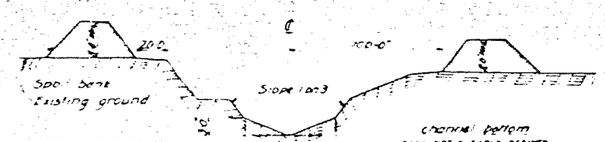
U. S. ARMY



TYPICAL SECTION

FROM RIVER VALLEY UPSTREAM

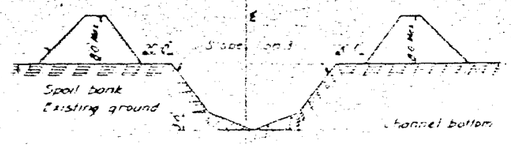
SCALE IN FEET



TYPICAL SECTION

FROM RIVER VALLEY DOWNSTREAM

SCALE IN FEET



TYPICAL SECTION

AT CUT-OFFS

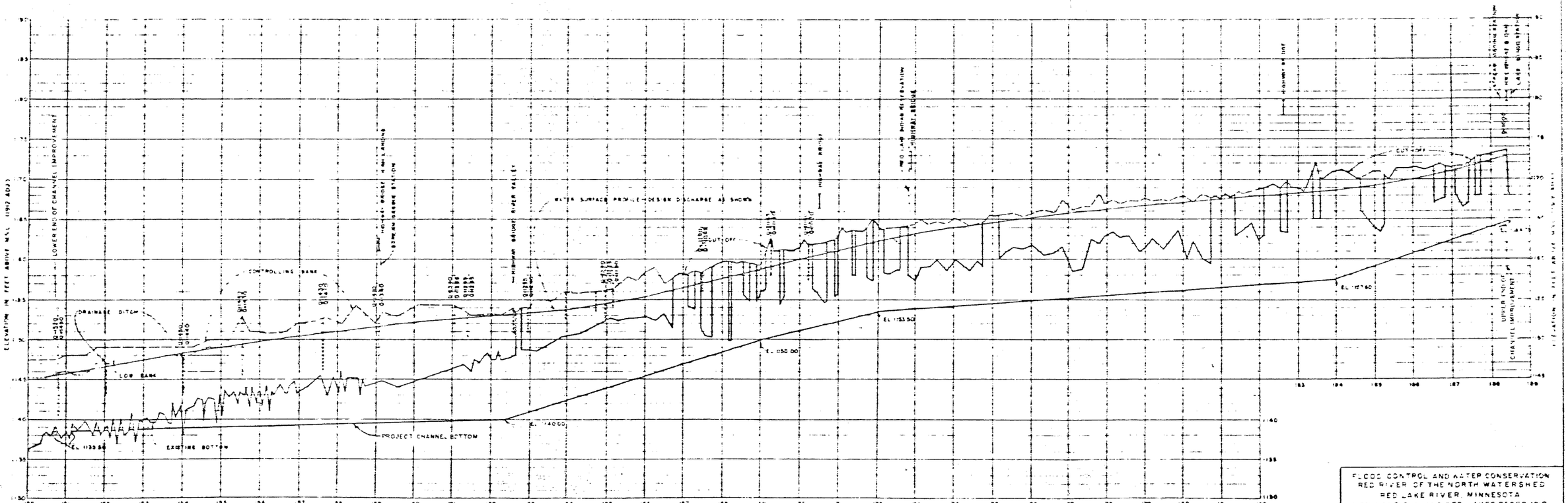
SCALE IN FEET

Notes

Mileage marks refer along improved channel.

Spoil banks to be left down to provide for natural drainage.

Spoil bank slopes not steeper than on 3 on channel side and 1on4 on landward side.



PROFILE ALONG ℄ OF CHANNEL

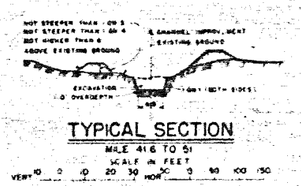
(SEE PLATE 3 FOR PLAN)

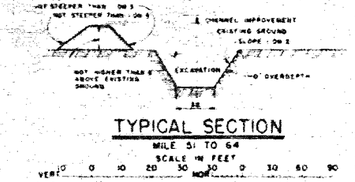
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

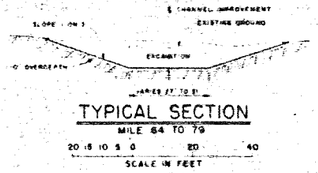
CHANNEL IMPROVEMENT
RED LAKE RIVER

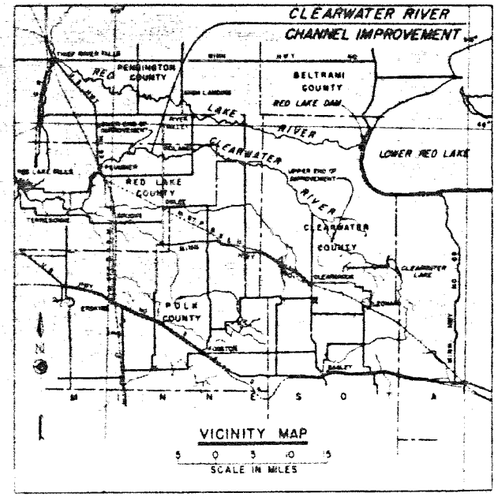
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

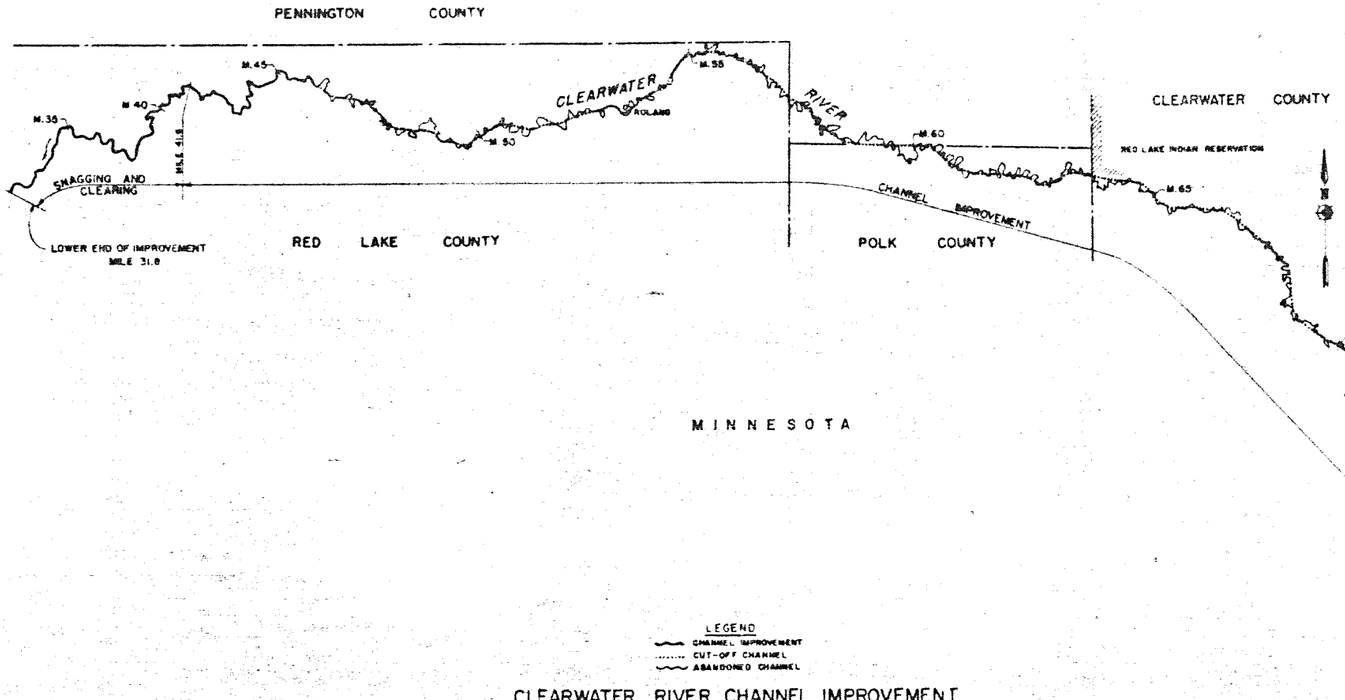
FILE NO. RB-Z-64/10 PLATE 5











LEGEND
- CHANNEL IMPROVEMENT
- CUT-OFF CHANNEL
- ABANDONED CHANNEL

CLEARWATER RIVER CHANNEL IMPROVEMENT

SCALE IN FEET

(SEE PLATE 8 FOR PROFILE)

LENGTH
CLEARWATER RIVER 47.3 MILES

CHANNEL WIDTH
CLEARWATER RIVER VARIES FROM 38 FEET TO 49 FEET.

DESIGN CAPACITY, CLEARWATER RIVER, 850 SEC-FT. AT UPPER END TO 1,510 SEC-FT AT LOWER END. THIS WILL PROVIDE FOR FLOODS WITH 10 YEAR FREQUENCY WITH APPROXIMATELY 1 FT. FREEBOARD

M.50-MILES ABOVE MOUTH

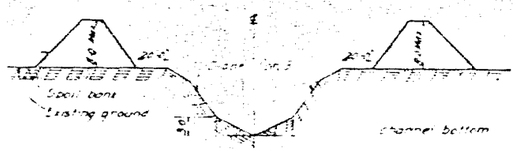
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

PROJECT MAP CLEARWATER RIVER

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

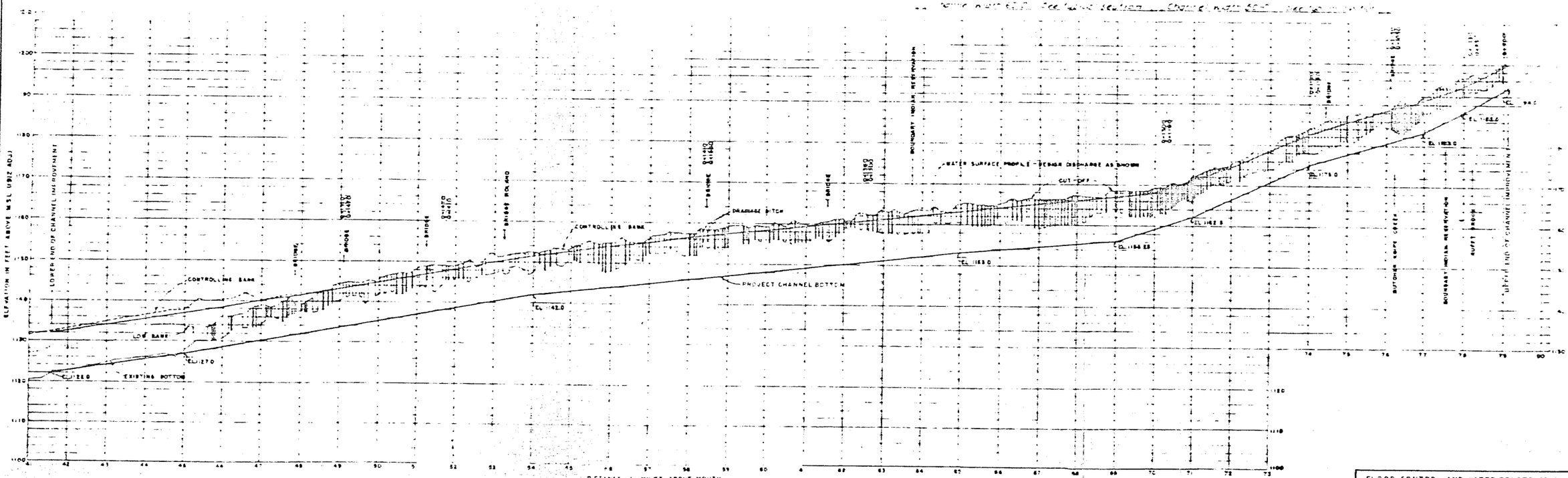
CORPS OF ENGINEERS

U. S. ARMY



TYPICAL SECTION

TYPICAL SECTION



PROFILE ALONG ℄ OF CHANNEL

(SEE PLATE 7 FOR PLAN)

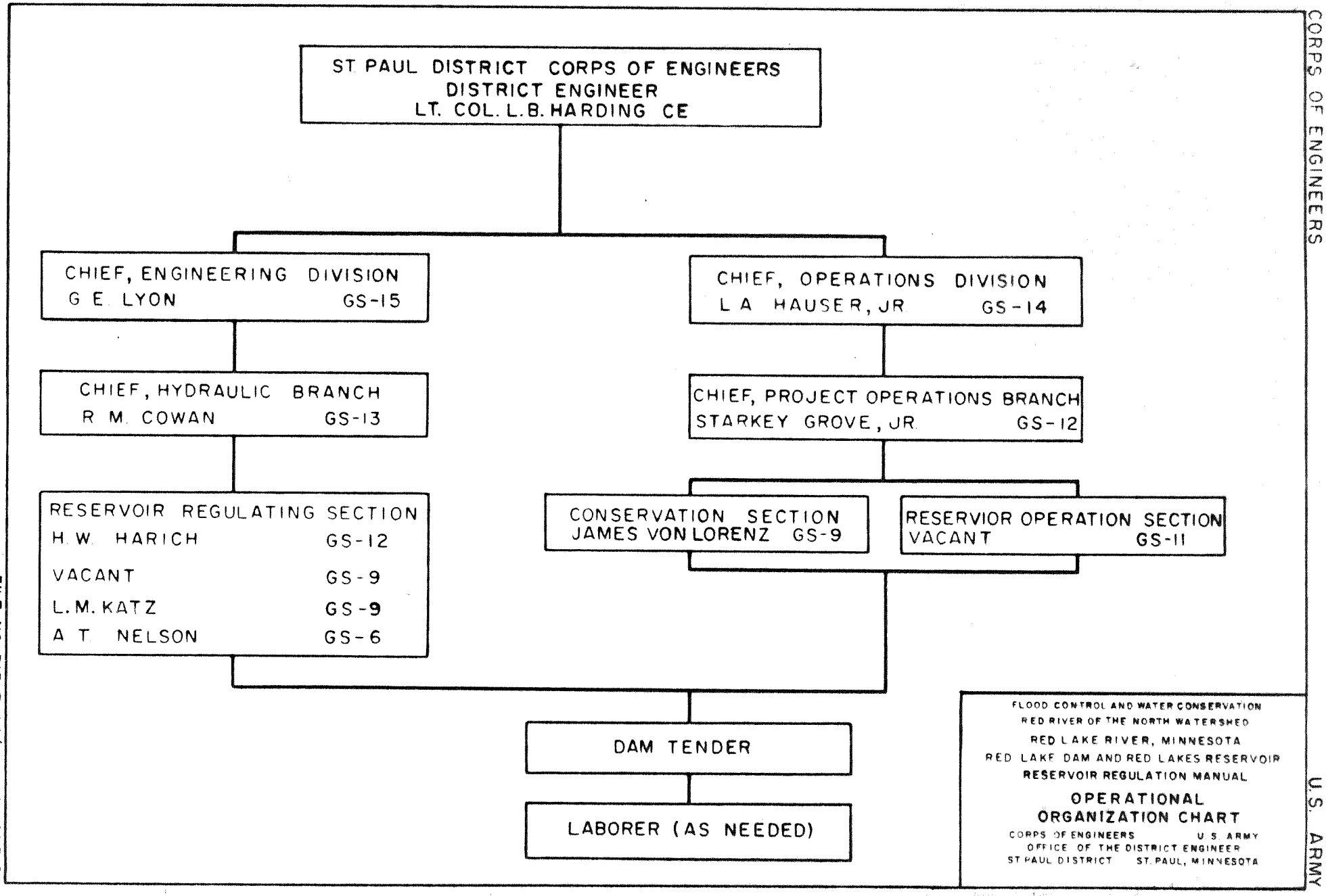
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

CHANNEL IMPROVEMENT

CLEARWATER RIVER

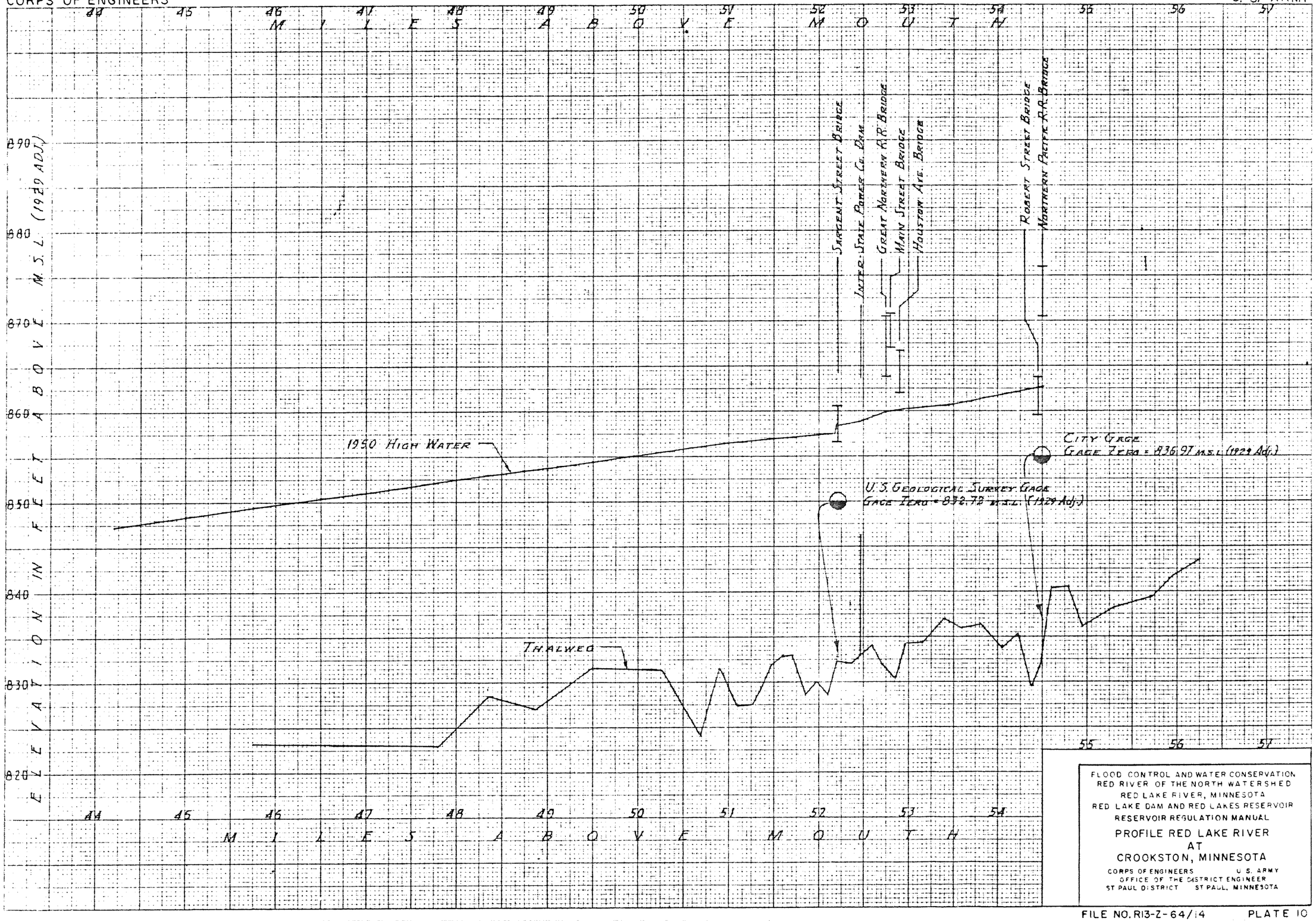
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. RB-Z-64/12 PLATE 8


ST PAUL DISTRICT CORPS OF ENGINEERS
DISTRICT ENGINEER
LT. COL. L.B. HARDING CE
CHIEF, ENGINEERING DIVISION
G E LYON GS-15
CHIEF, OPERATIONS DIVISION
L A HAUSER, JR GS-14
CHIEF, HYDRAULIC BRANCH
R M. COWAN GS-13
CHIEF, PROJECT OPERATIONS BRANCH
STARKEY GROVE, JR. GS-12
RESERVOIR REGULATING SECTION
H W. HARICH GS-12
VACANT GS-9
L.M. KATZ GS-9
A T NELSON GS-6
CONSERVATION SECTION
JAMES VON LORENZ GS-9
RESERVIOR OPERATION SECTION
VACANT GS-11
DAM TENDER
LABORER (AS NEEDED)
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
OPERATIONAL
ORGANIZATION CHART
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA
CORPS OF ENGINEERS
U.S. ARMY
FILE NO. R13-Z-64/13 PLATE 9

CORPS OF ENGINEERS

U. S. ARMY

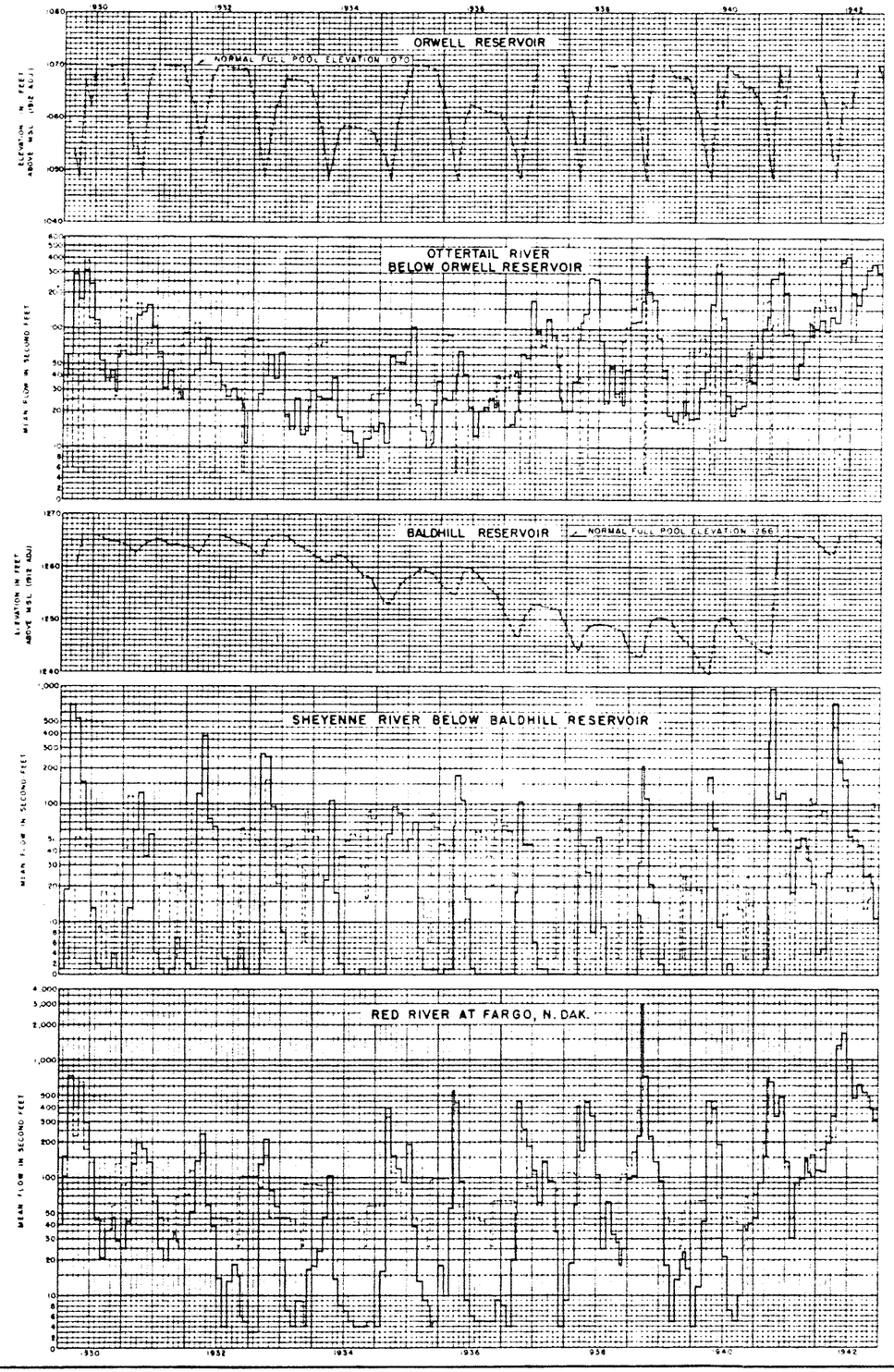


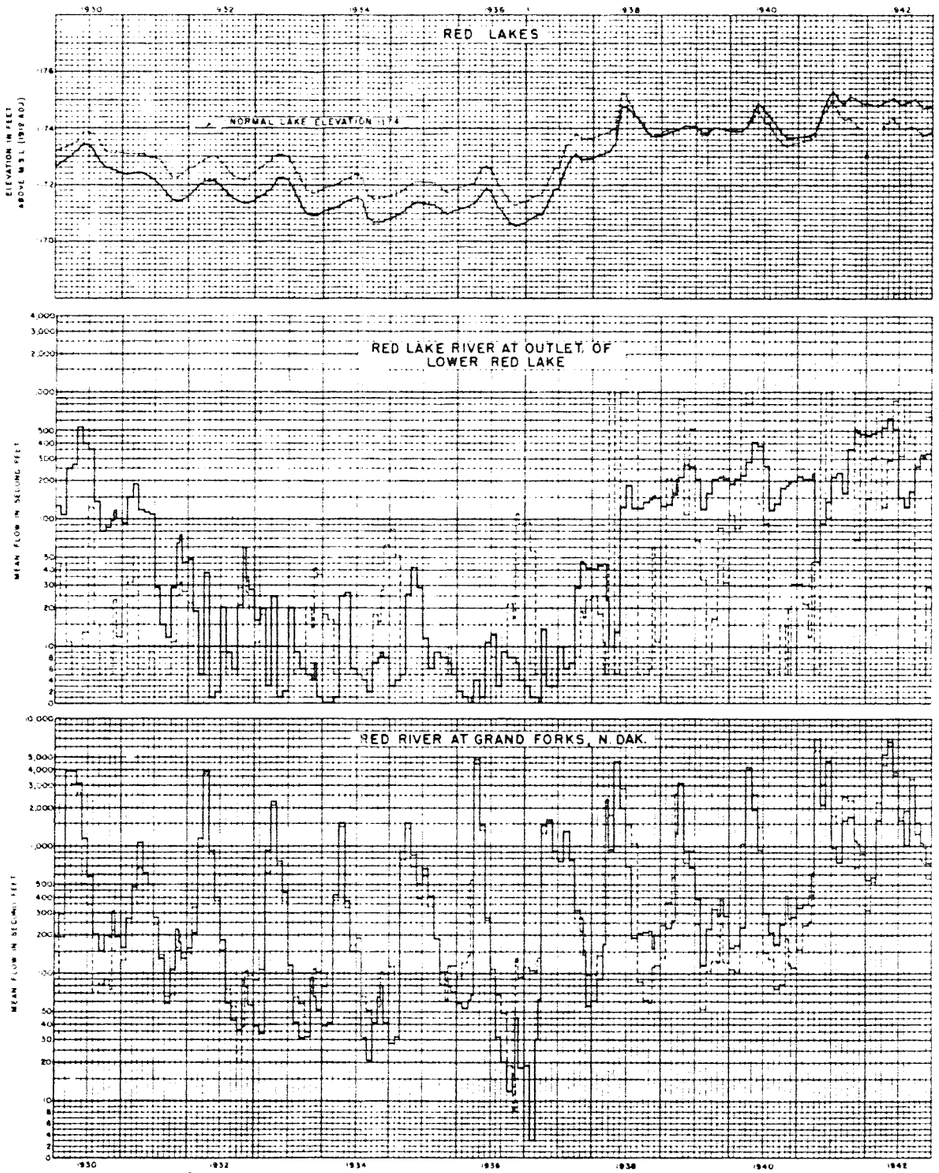
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

PROFILE RED LAKE RIVER AT CROOKSTON, MINNESOTA

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. R13-Z-64/14 PLATE 10





LEGEND

——— NATURAL ELEVATION OR FLOW

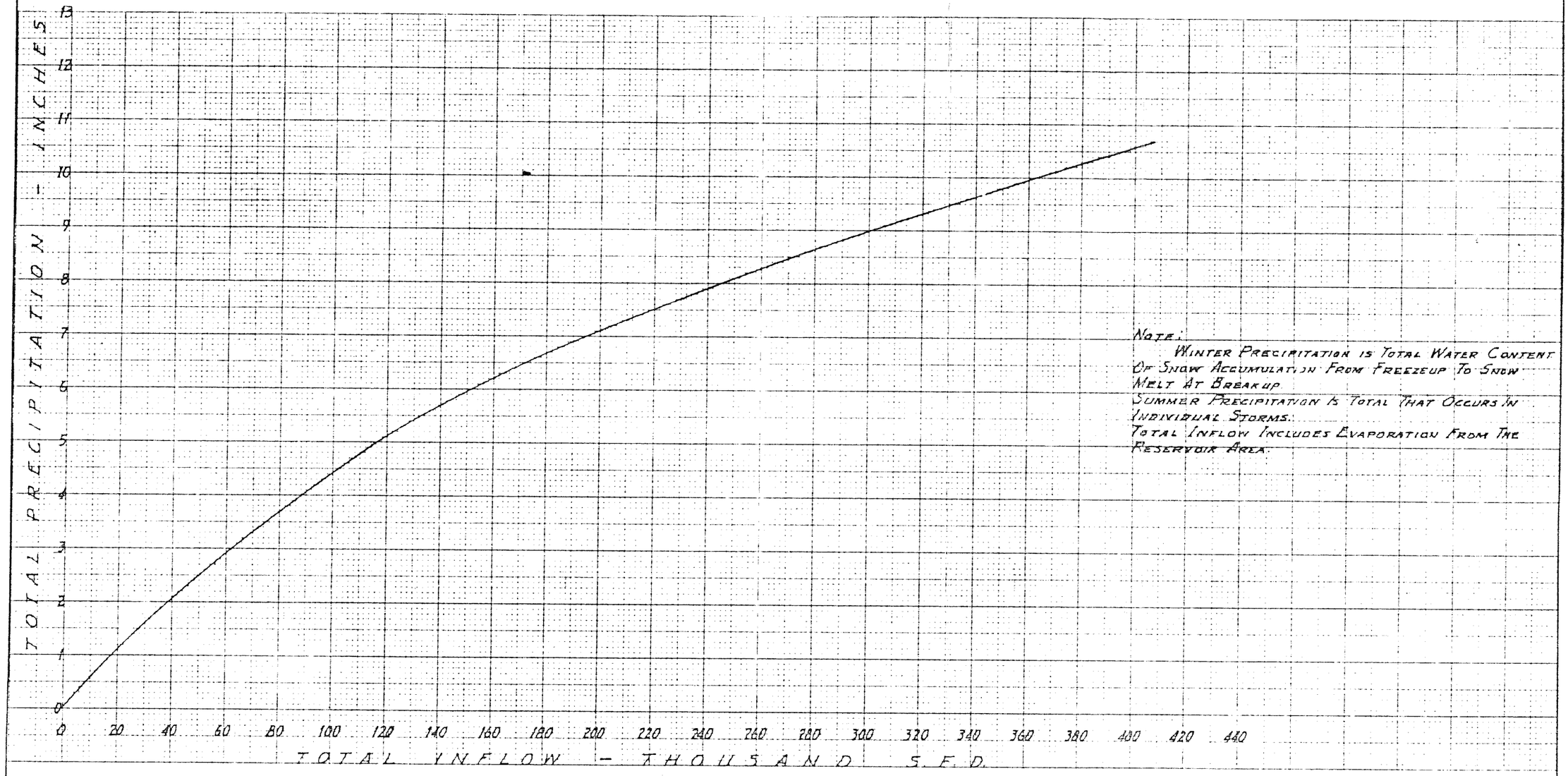
- - - - - REGULATED ELEVATION OR FLOW

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

COORDINATED STREAM FLOW REGULATION

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

U. S. ARMY



Note:
Winter Precipitation is Total Water Content Of Snow Accumulation From Freezeup To Snow Melt At Breakup
Summer Precipitation Is Total That Occurs In Individual Storms.
Total Inflow Includes Evaporation From The Reservoir Area.

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

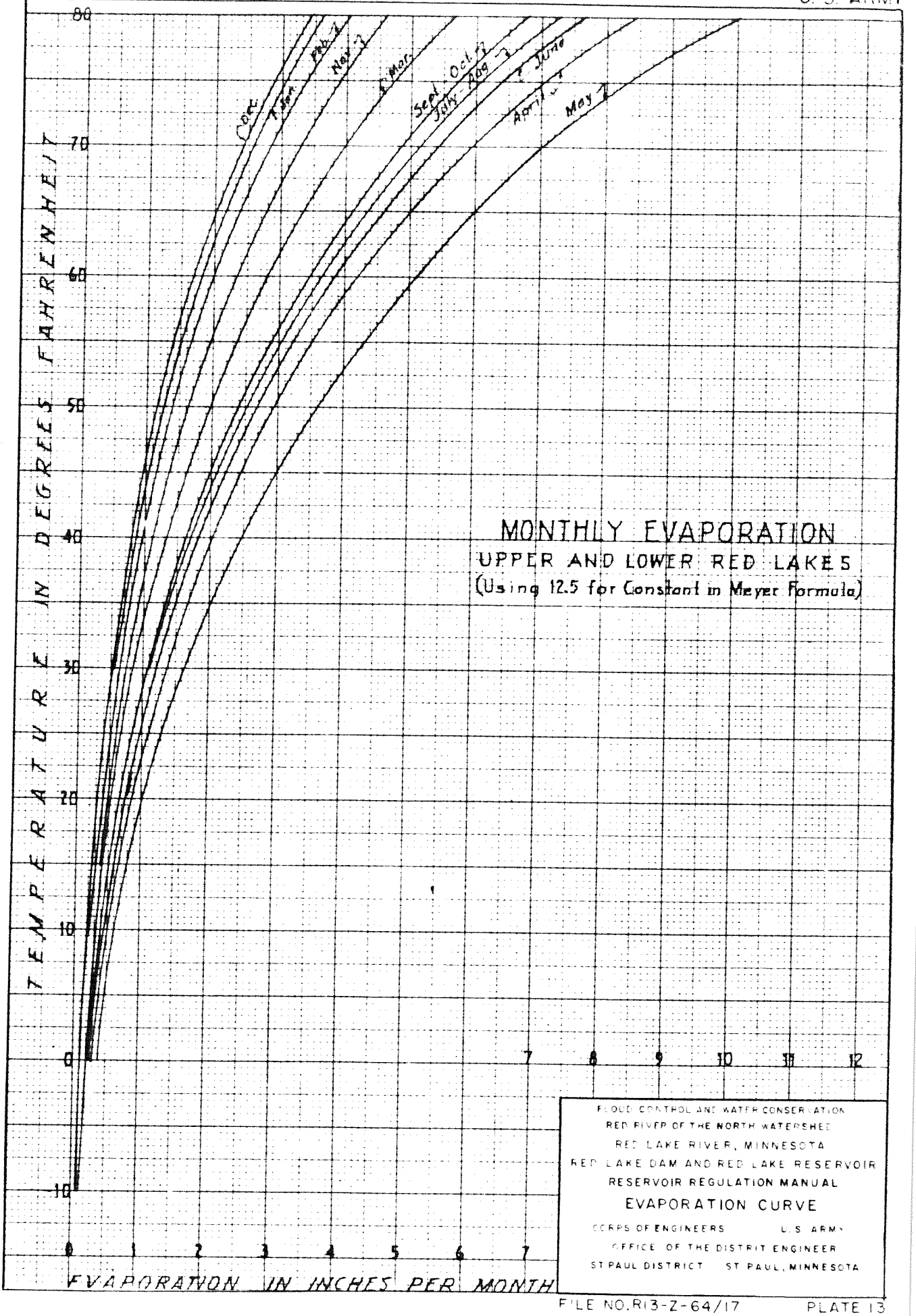
PRECIPITATION-INFLOW CURVE

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/16 PLATE 12

CORPS OF ENGINEERS

U. S. ARMY



MONTHLY EVAPORATION

UPPER AND LOWER RED LAKES

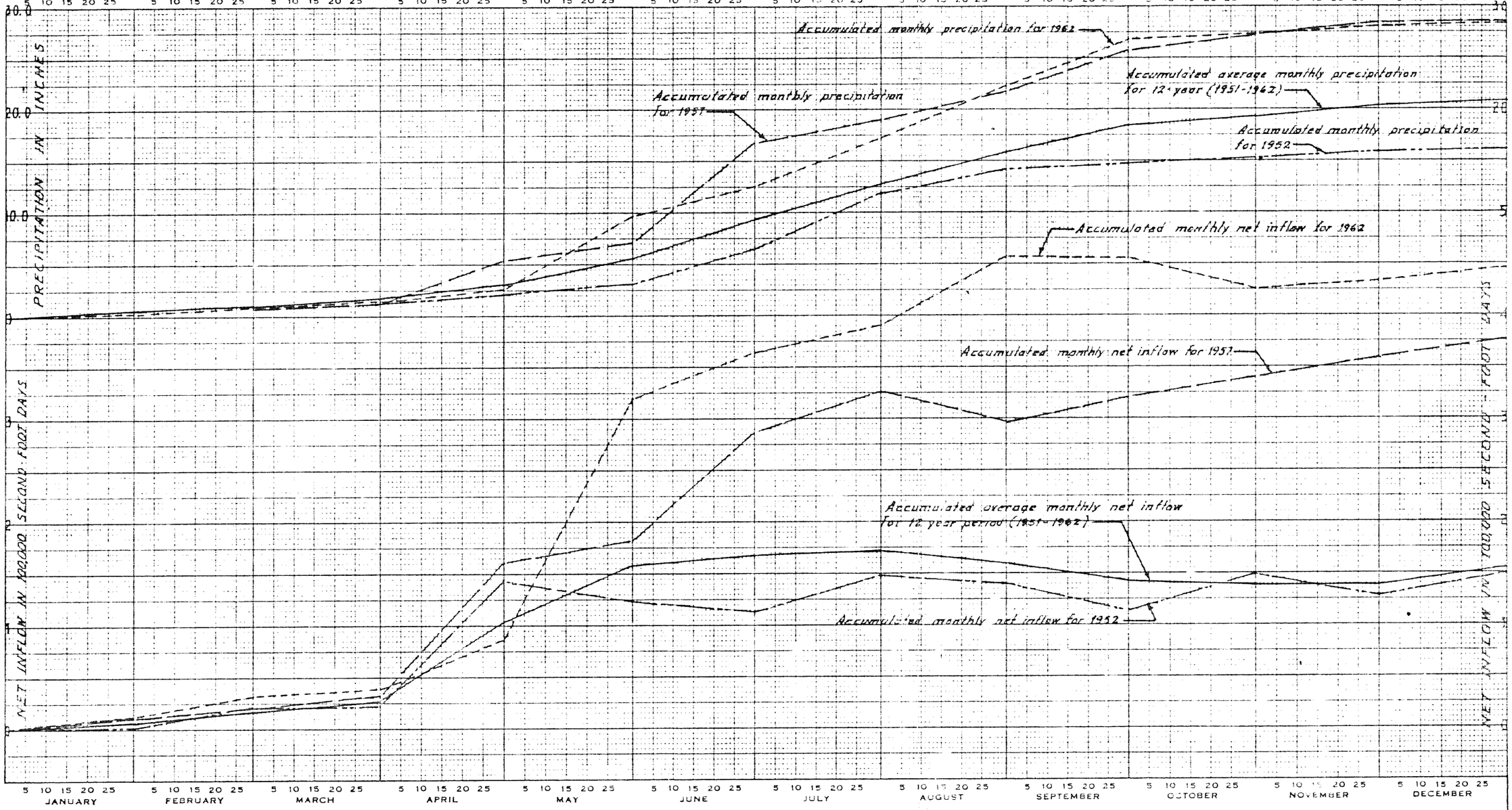
(Using 12.5 for Constant in Meyer Formula)

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKE RESERVOIR
RESERVOIR REGULATION MANUAL
EVAPORATION CURVE
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. RI3-Z-64/17 PLATE 13

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

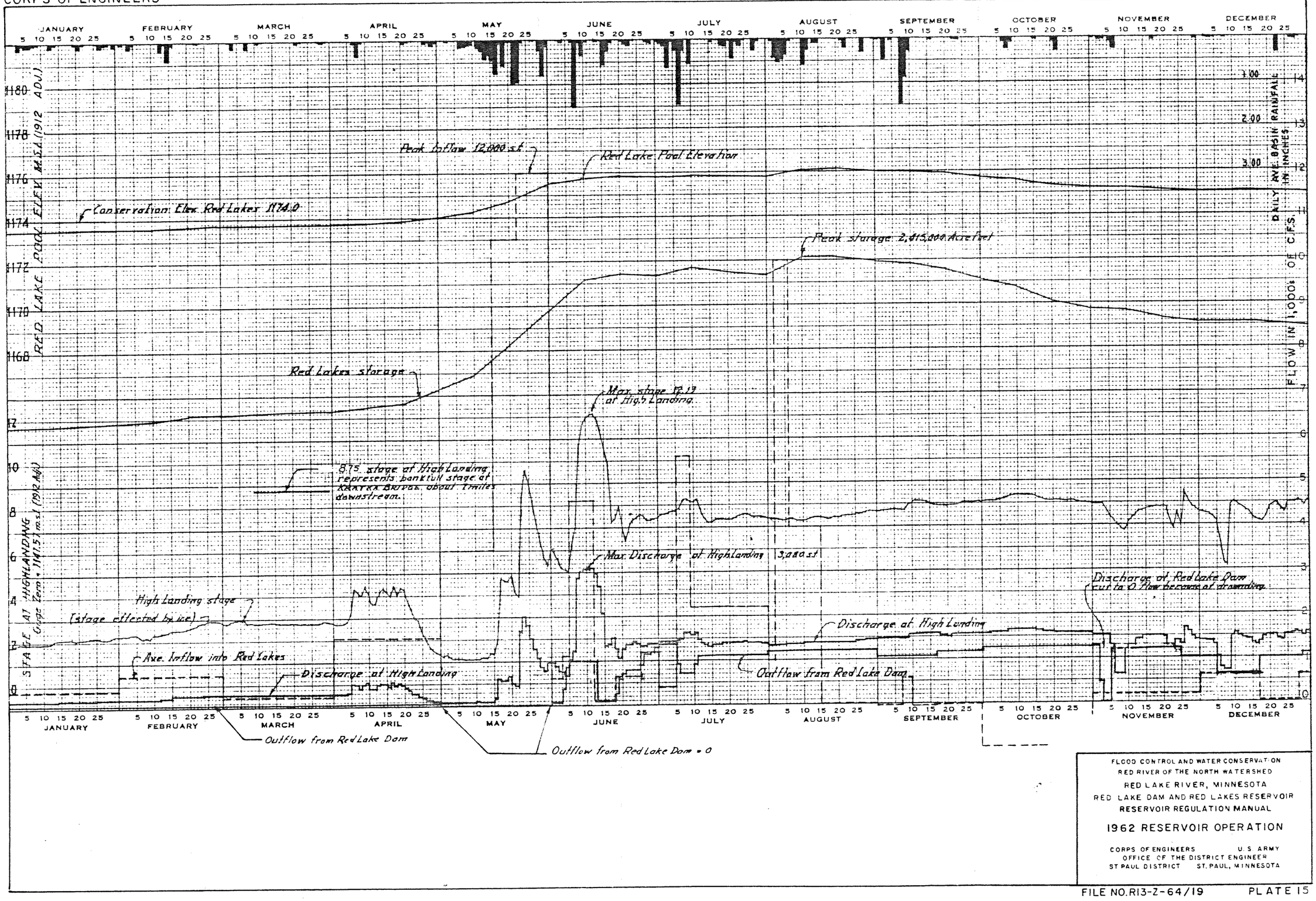
PRECIPITATION & NET INFLOW MASS CURVE

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/18 PLATE 14

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

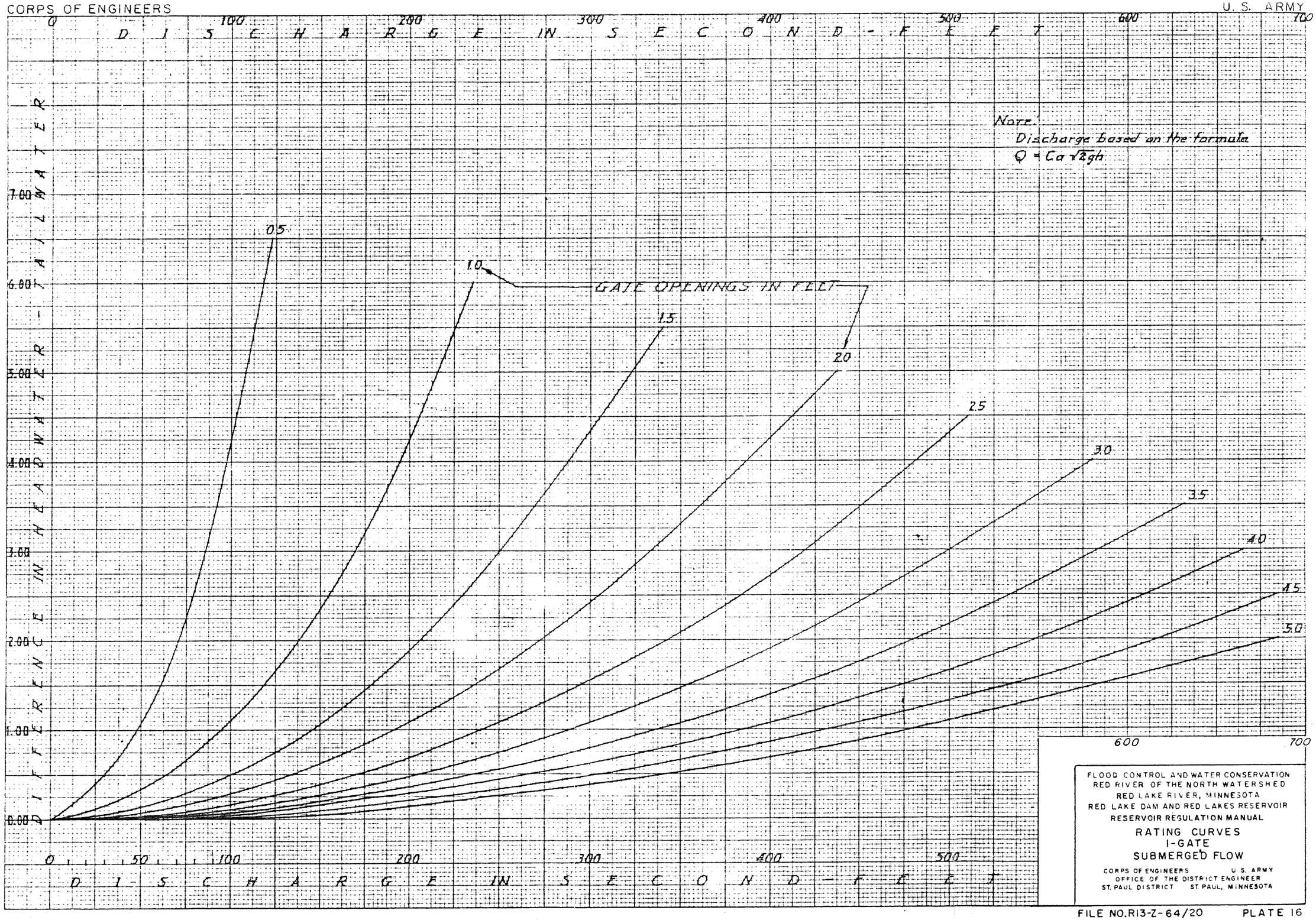
1962 RESERVOIR OPERATION

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/19

PLATE 15

CORPS OF ENGINEERS U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

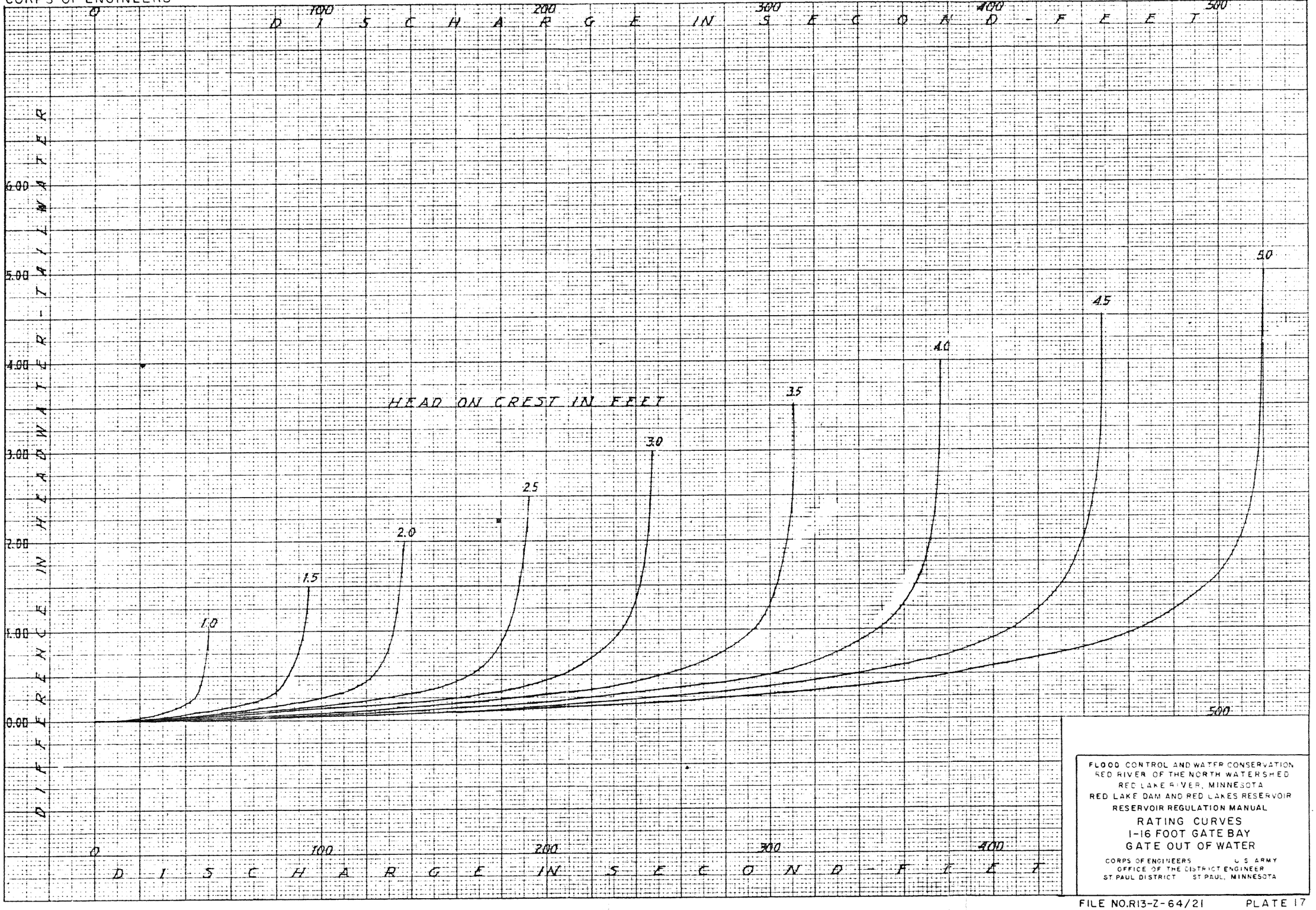
RATING CURVES
I-GATE
SUBMERGED FLOW

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/20 PLATE 16

CORPS OF ENGINEERS

U. S. ARMY



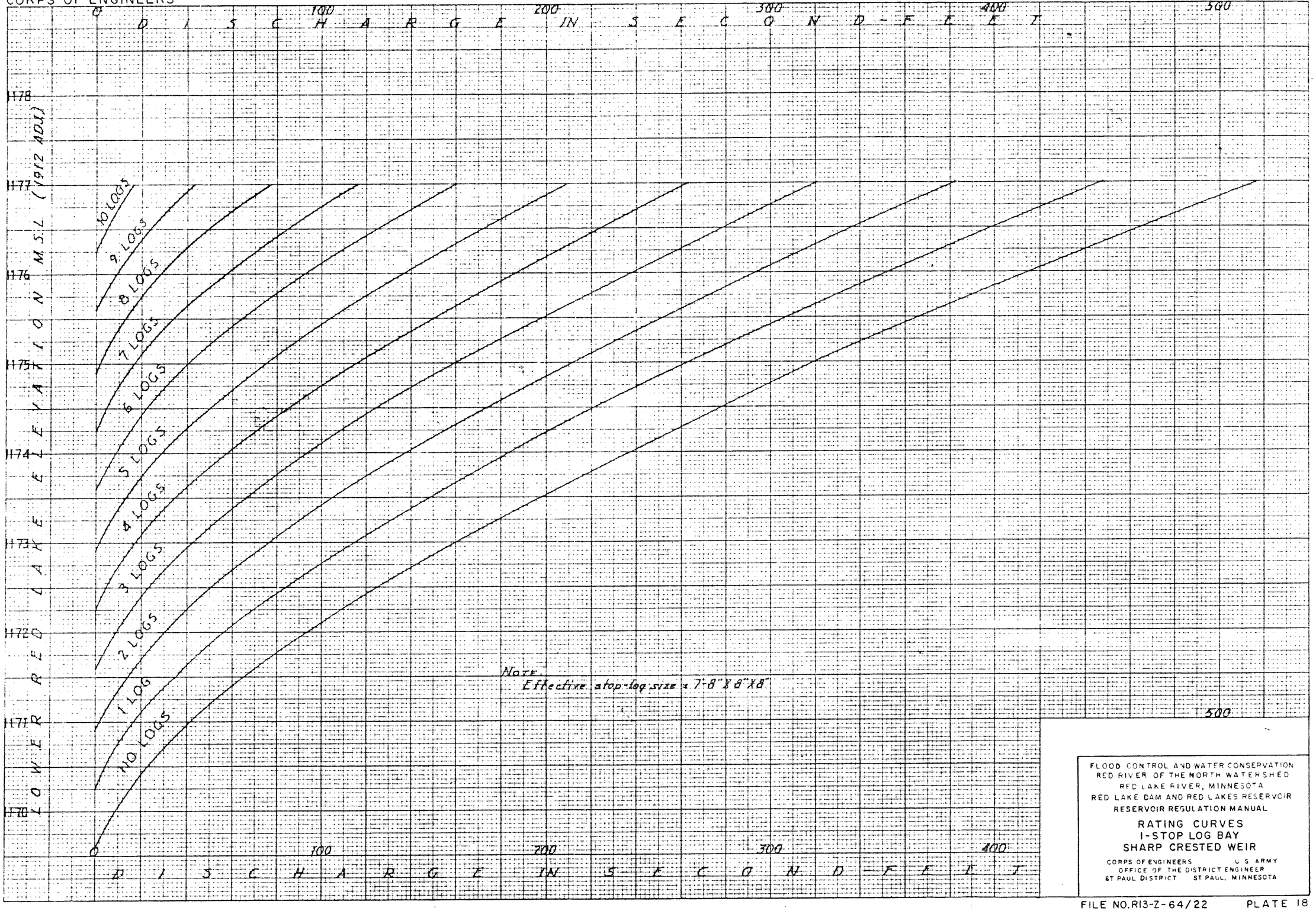
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

RATING CURVES
1-16 FOOT GATE BAY
GATE OUT OF WATER

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/21 PLATE 17

CORPS OF ENGINEERS U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

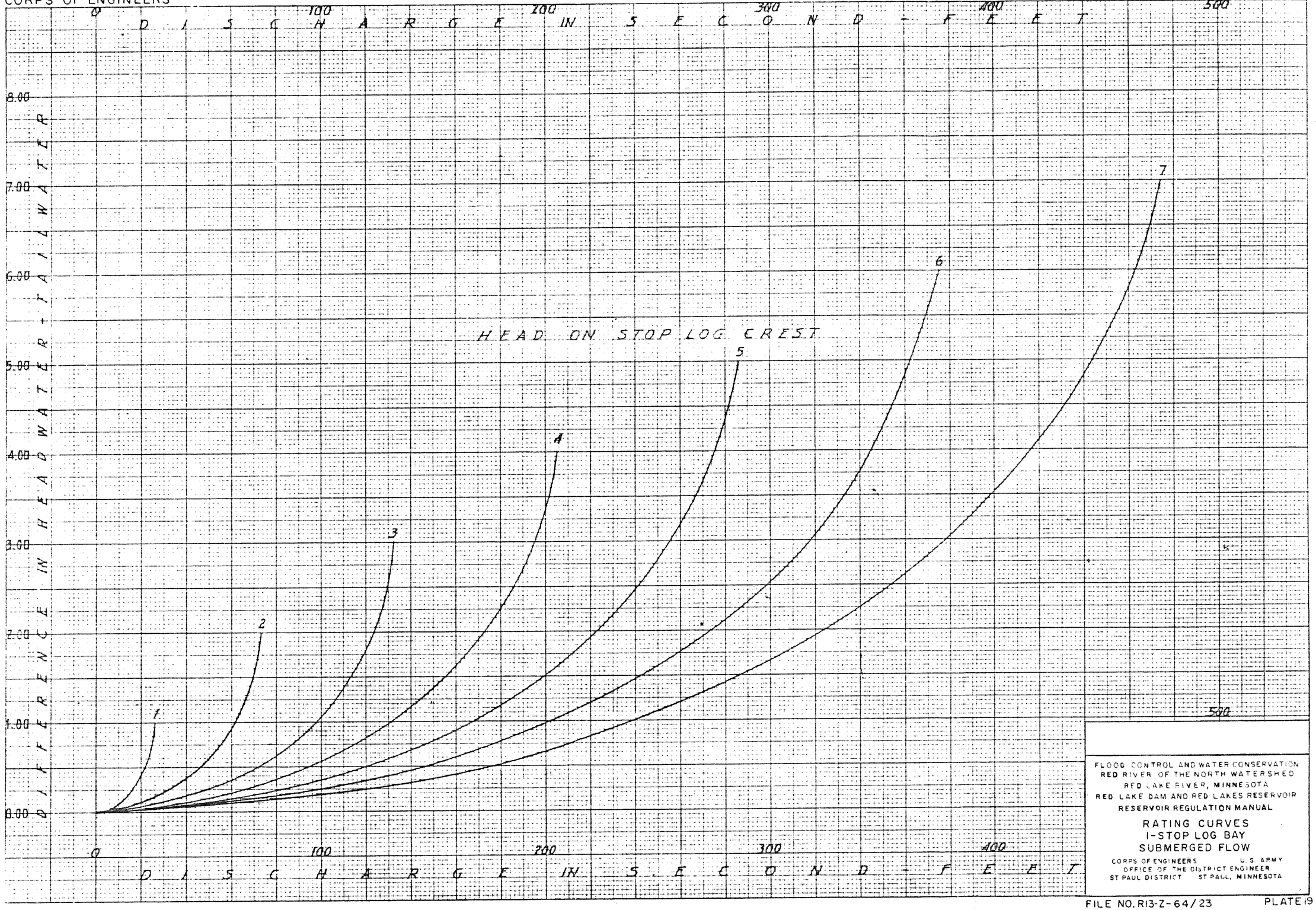
RATING CURVES
1-STOP LOG BAY
SHARP CRESTED WEIR

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/22 PLATE 18

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

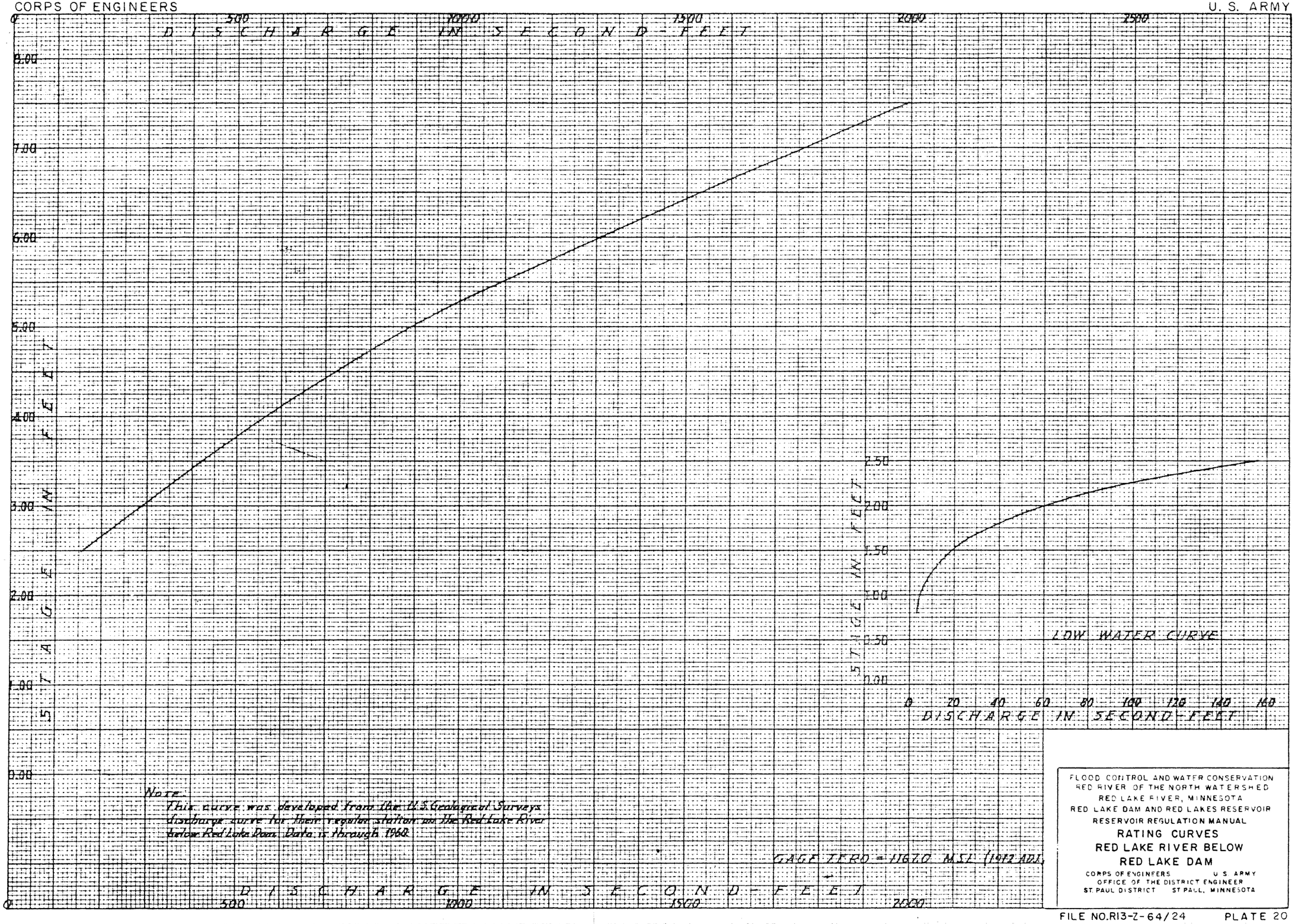
RATING CURVES
1-STOP LOG BAY
SUBMERGED FLOW

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. R13-Z-64/23

PLATE 19

CORPS OF ENGINEERS U. S. ARMY



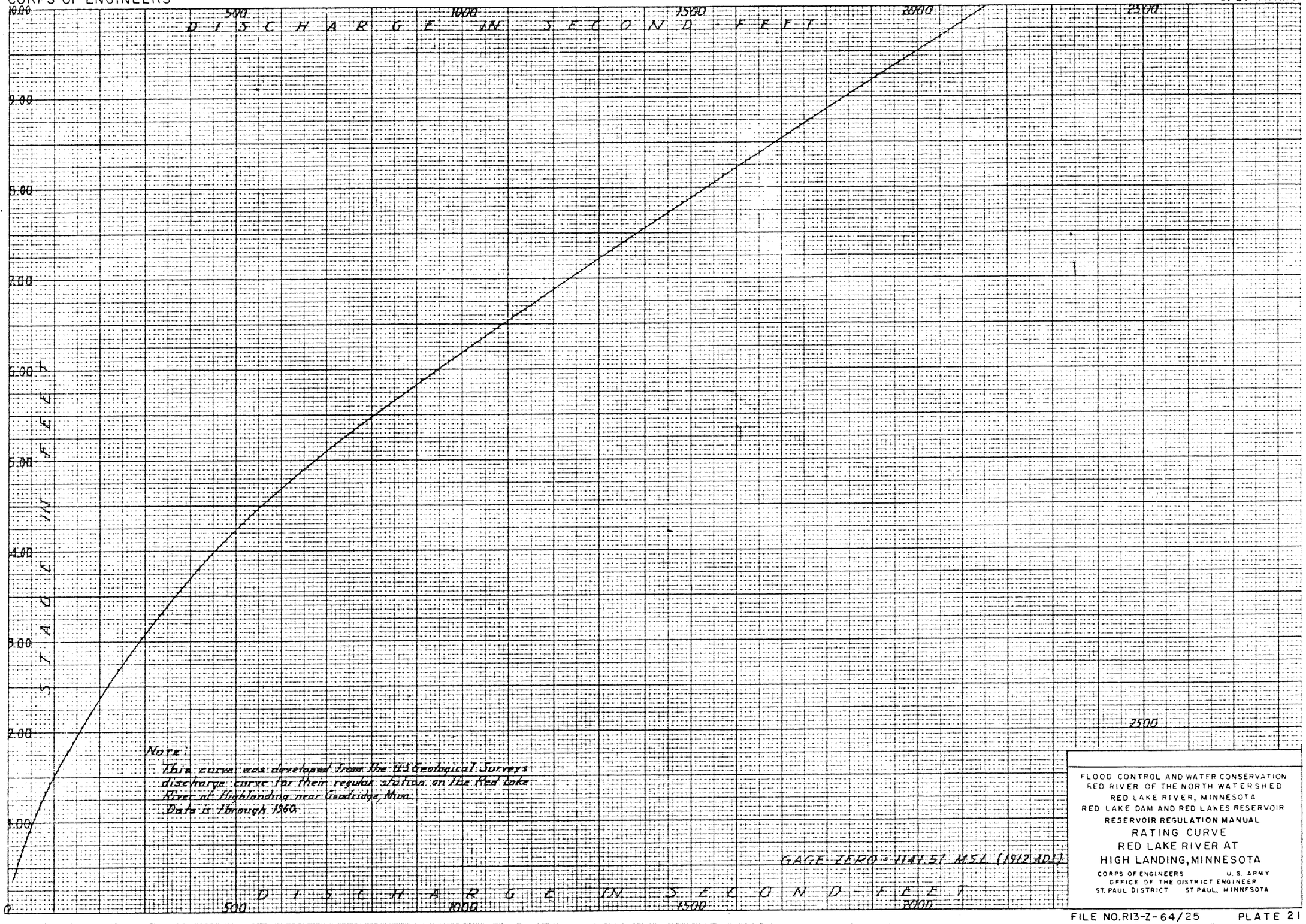
Note.
This curve was developed from the U.S. Geological Survey's discharge curve for their regulation station on the Red Lake River below Red Lake Dam. Data is through 1962.

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
RATING CURVES
RED LAKE RIVER BELOW
RED LAKE DAM
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/24 PLATE 20

CORPS OF ENGINEERS

U.S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

RATING CURVE
RED LAKE RIVER AT HIGH LANDING, MINNESOTA

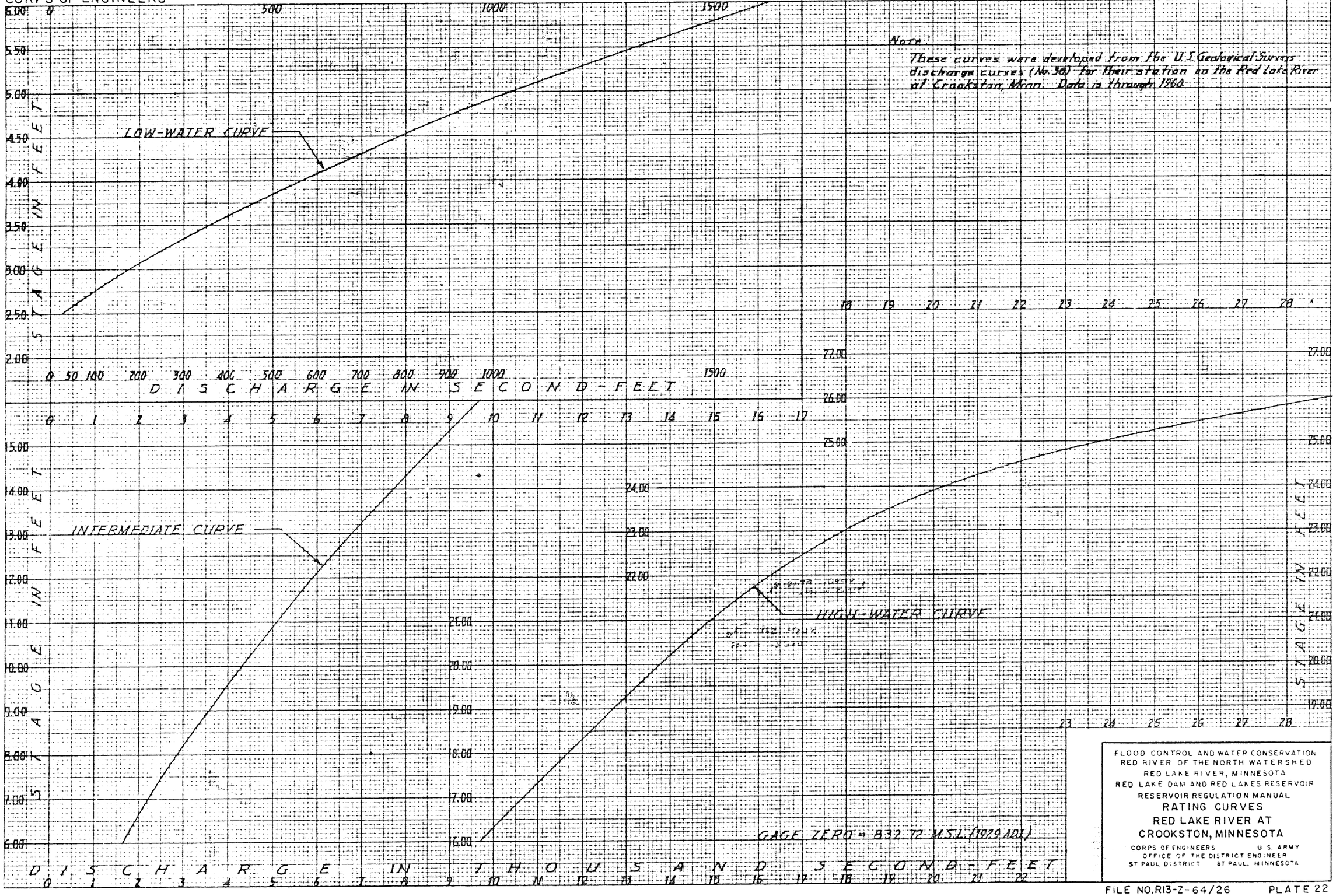
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/25 PLATE 21

CORPS OF ENGINEERS

U. S. ARMY

Note:
These curves were developed from the U.S. Geological Survey's discharge curves (No. 38) for their station on the Red Lake River at Crookston, Minn. Data is through 1960.



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

RATING CURVES
RED LAKE RIVER AT CROOKSTON, MINNESOTA

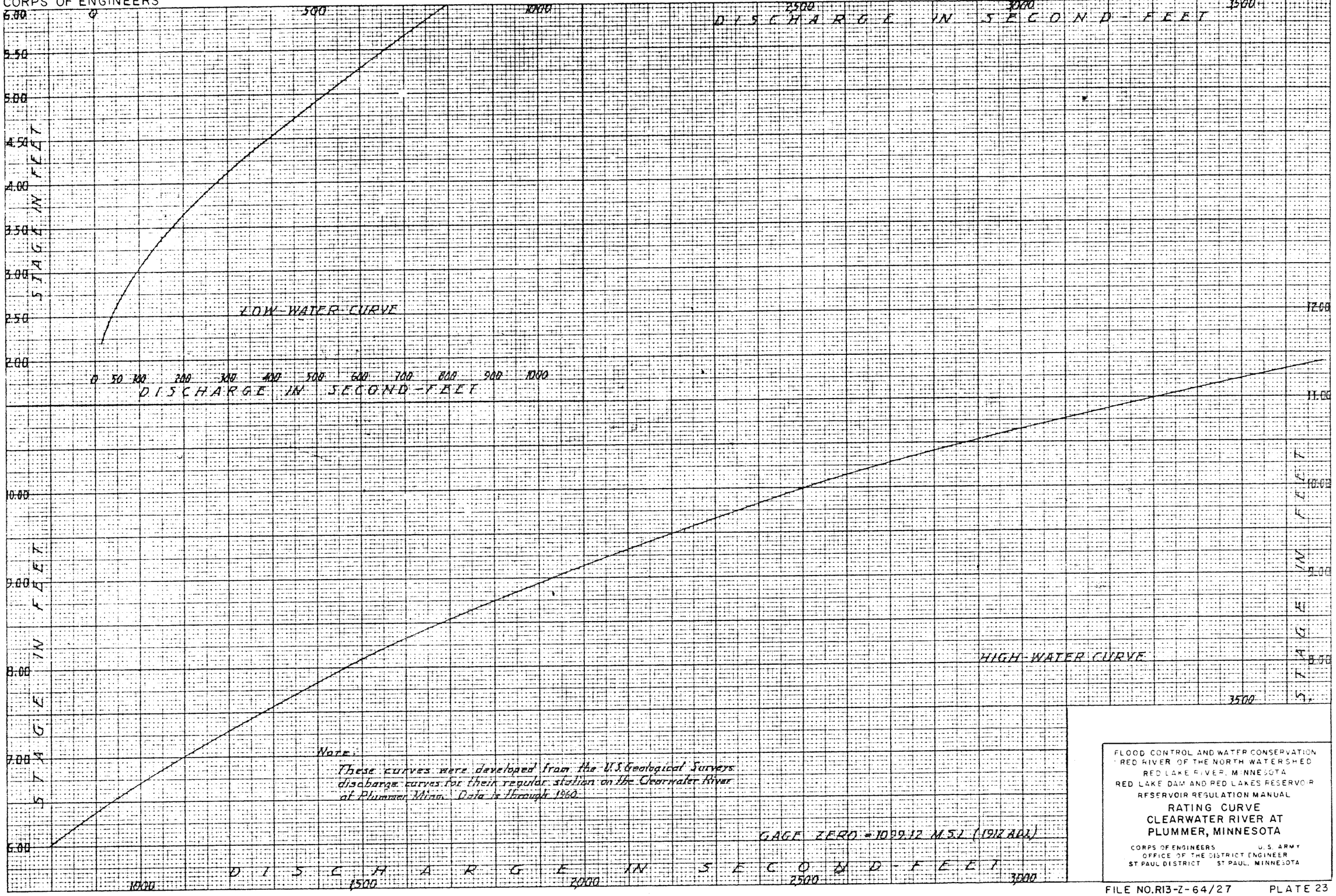
CORPS OF ENGINEERS — U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT — ST PAUL, MINNESOTA

FILE NO. R13-Z-64/26

PLATE 22

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

RATING CURVE CLEARWATER RIVER AT PLUMMER, MINNESOTA

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. R13-Z-64/27 PLATE 23

CORPS OF ENGINEERS U. S. ARMY

LOW-WATER CURVE

HIGH-WATER CURVE

STAGE IN FEET

DISCHARGE IN SECOND-FEET

DISCHARGE IN THOUSAND SECOND-FEET

Note

These curves were developed from the U.S. Geological Survey discharge curves (No. 24 - low-water, No. 23-24 for medium-water and No. 22 for high-water) for their station on the Clearwater River at Red Lake Falls, Minn. The medium and low-water curves were combined. Data is through 1960.

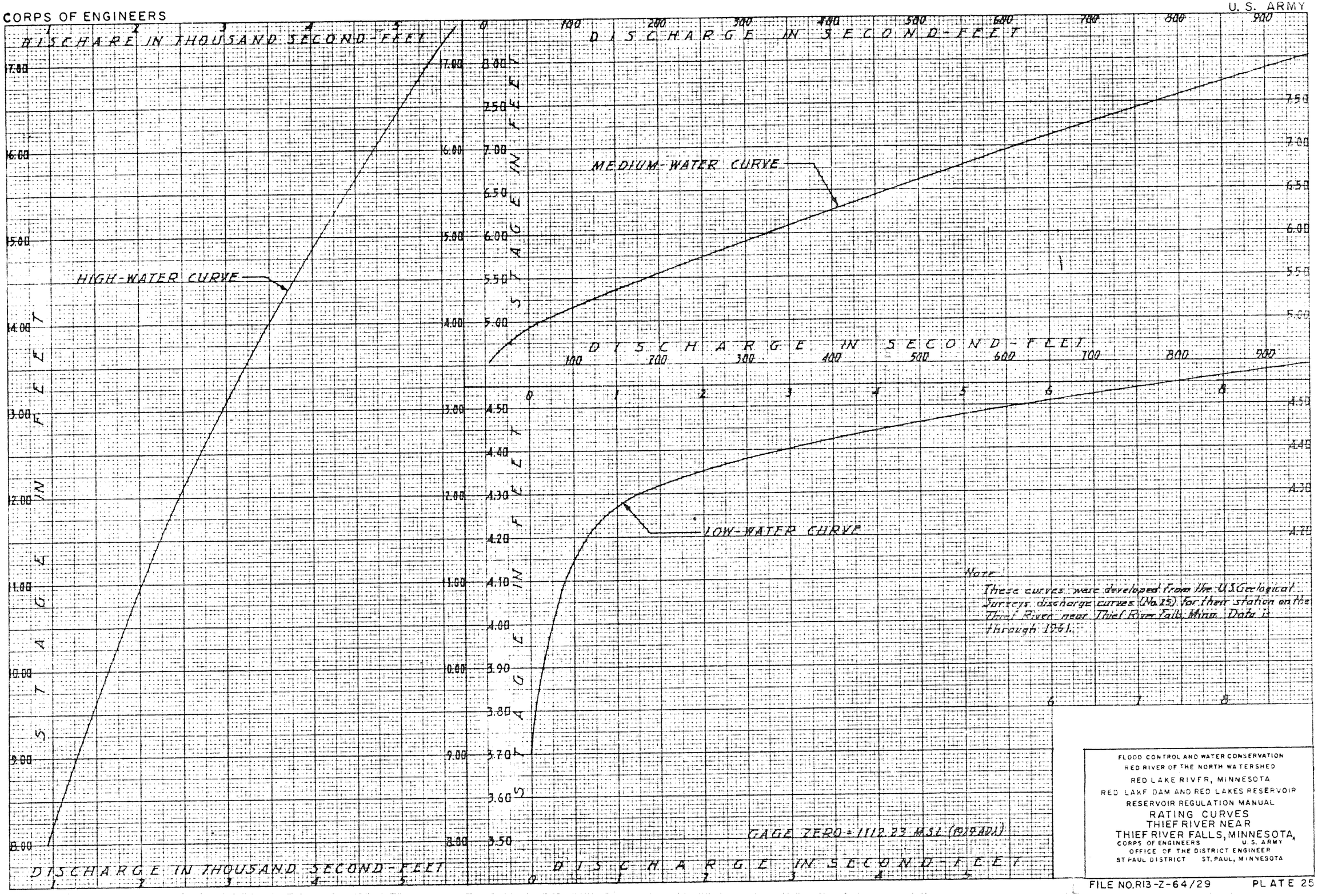
GAGE ZERO - 949.19 MSL (1912 ADJ.)

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
RATING CURVES
CLEARWATER RIVER AT
RED LAKE FALLS, MINNESOTA
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/28 PLATE 24

CORPS OF ENGINEERS

U. S. ARMY



Note

These curves were developed from the U.S. Geological Surveys discharge curves (No. 25) for their station on the Thief River near Thief River Falls, Minn. Data is through 1961.

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
RATING CURVES
THIEF RIVER NEAR
THIEF RIVER FALLS, MINNESOTA,
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/29 PLATE 25

CORPS OF ENGINEERS

U. S. ARMY

Note:
This curve was developed from U.S. Geological Survey measurements.
No. 1-18 incl. were made during the period of 10 April 1950 to 2 June 1950.
The solid line represents the approximate mean. Loops are indicated between 23 feet and 25 feet and between 43 feet and 46 feet. Measurements No. 1-9 incl. were made between 10 April 1950 and 29 April 1950 and were probably affected by B.W. from ice or debris.

DISCHARGE IN THOUSAND SECOND-FEET

STAGE IN FEET

INTERMEDIATE CURVE

LOW-WATER CURVE

HIGH-WATER CURVE
(See note above.)

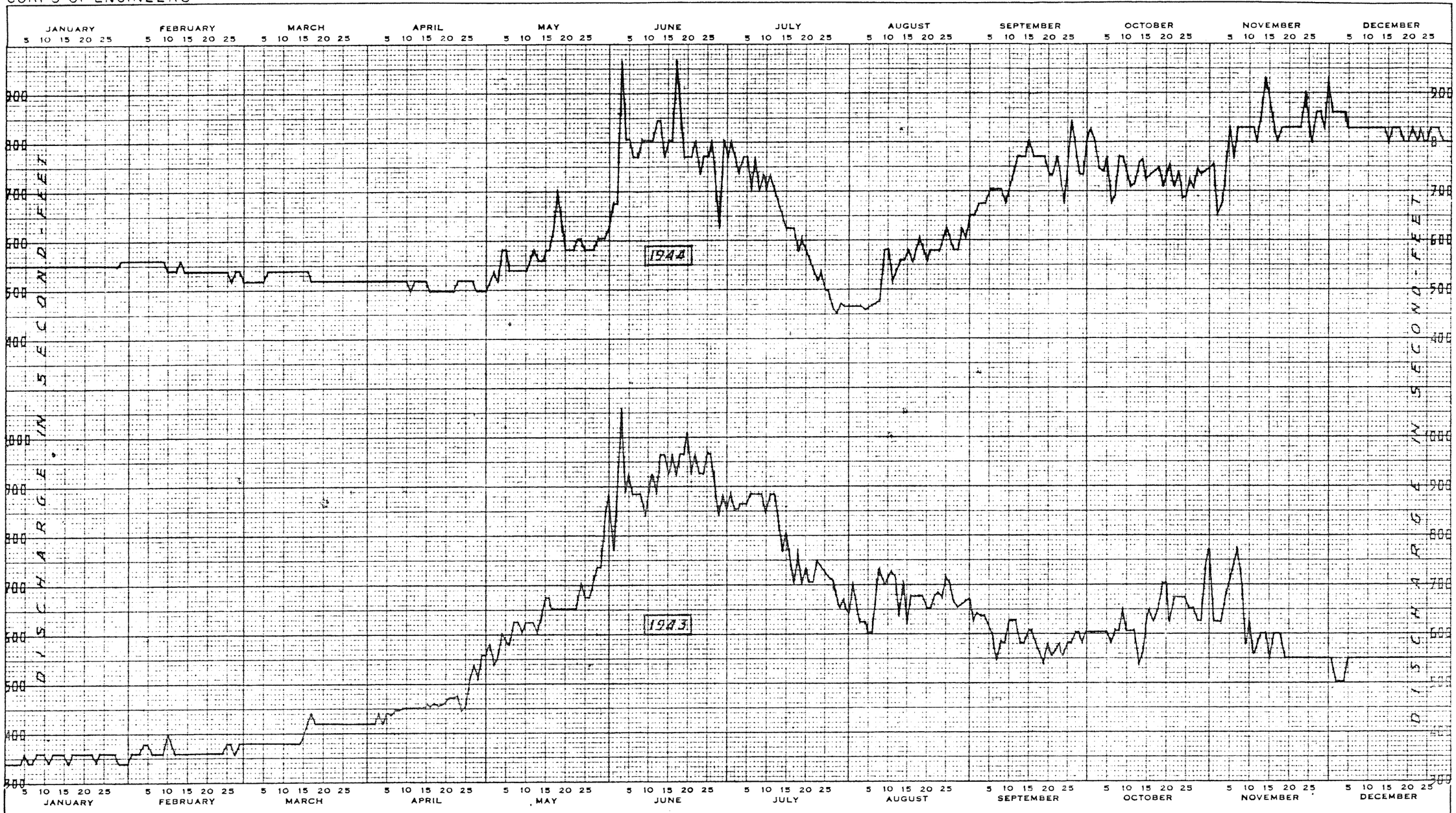
GAGE ZERO = 718.35 M.S.L. (1929 ADJ.)

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
RATING CURVES
RED RIVER OF THE NORTH AT
GRAND FORKS, NORTH DAKOTA

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/30 PLATE 26

CORPS OF ENGINEERS U. S. ARMY



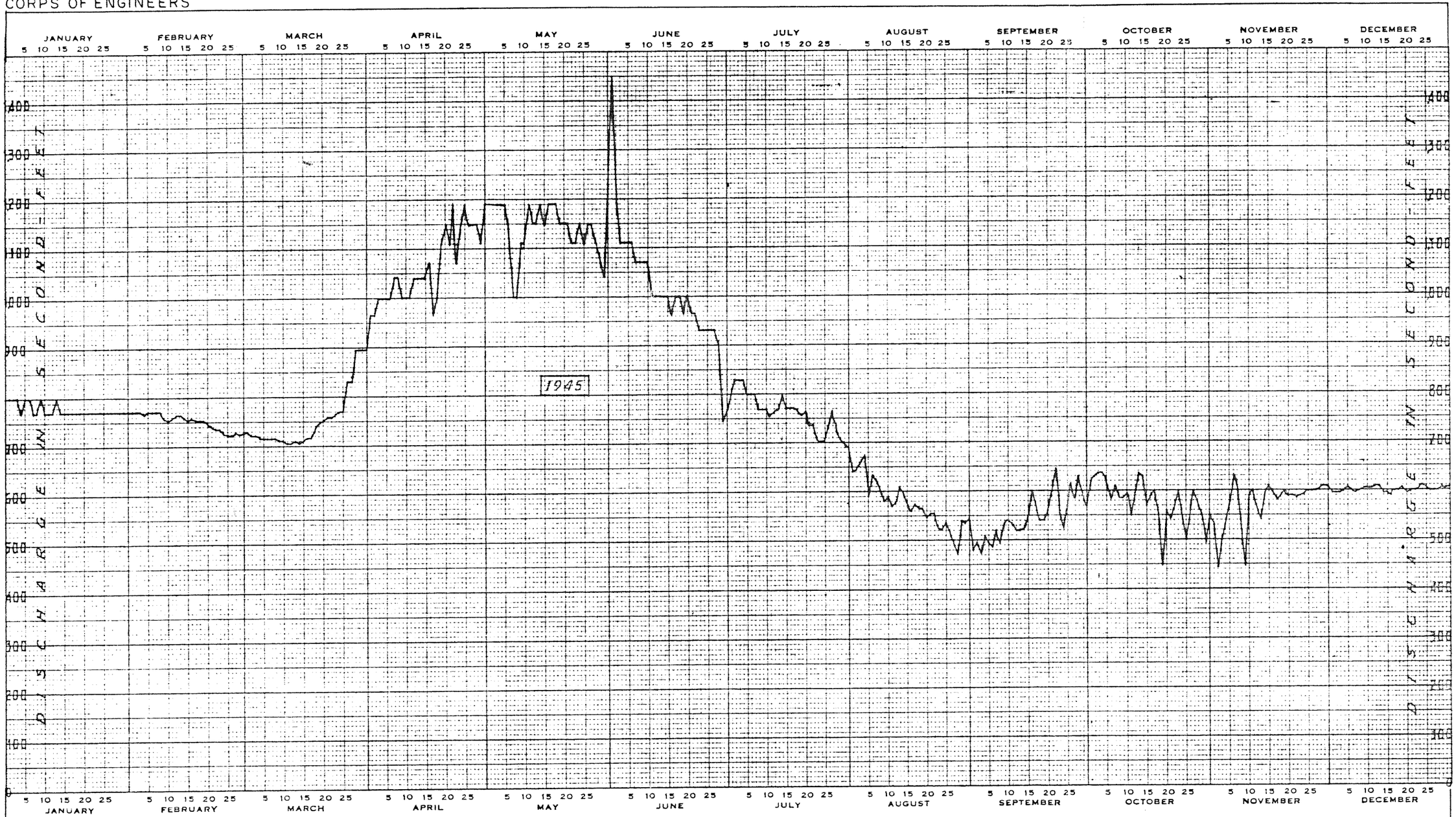
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/31 PLATE 27

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. R13-Z-64/32 PLATE 28

CORPS OF ENGINEERS U. S. ARMY

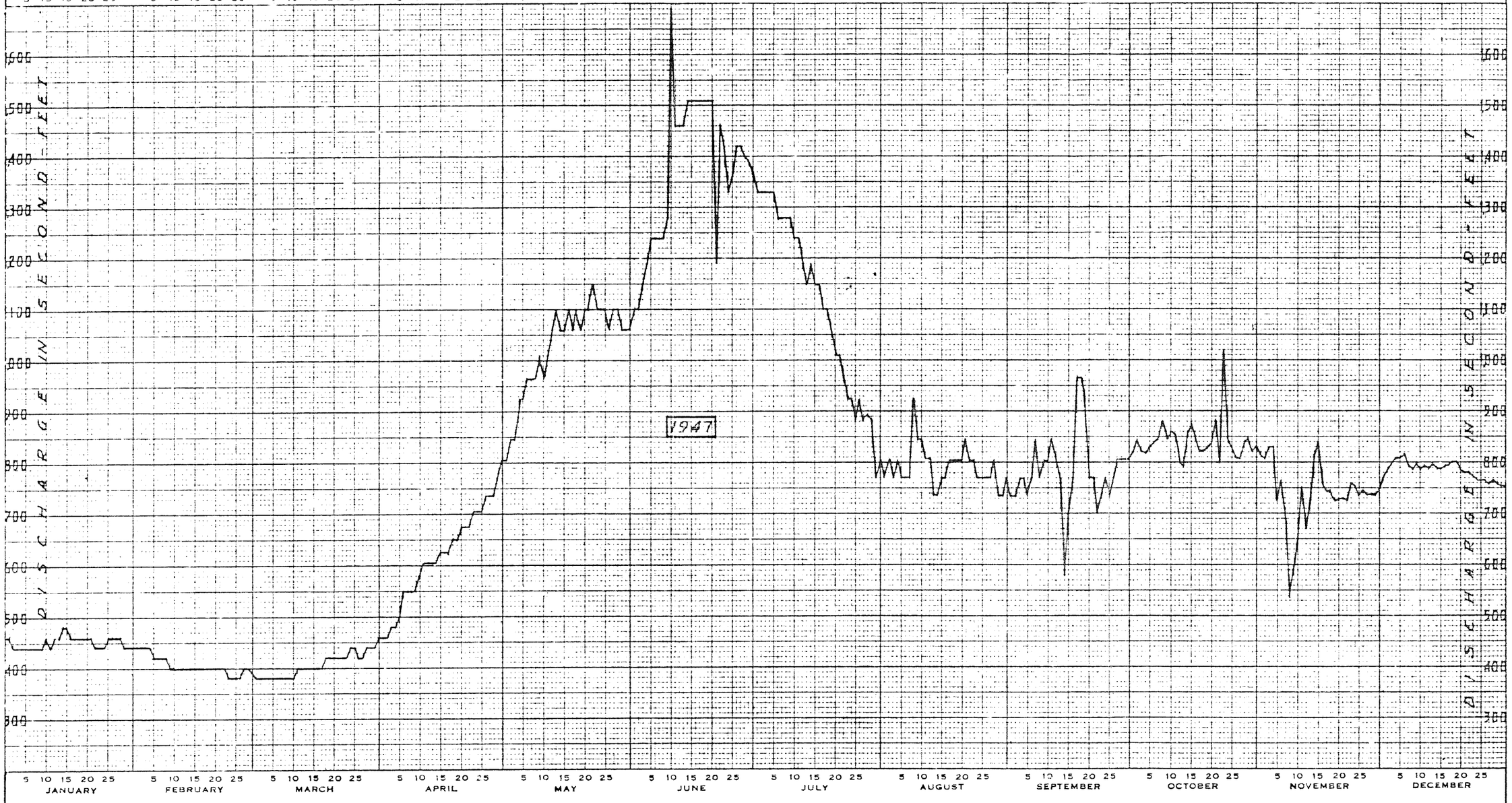
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

5 10 15 20 25

1947

HARGE IN SECOND-FEET

1600 1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300

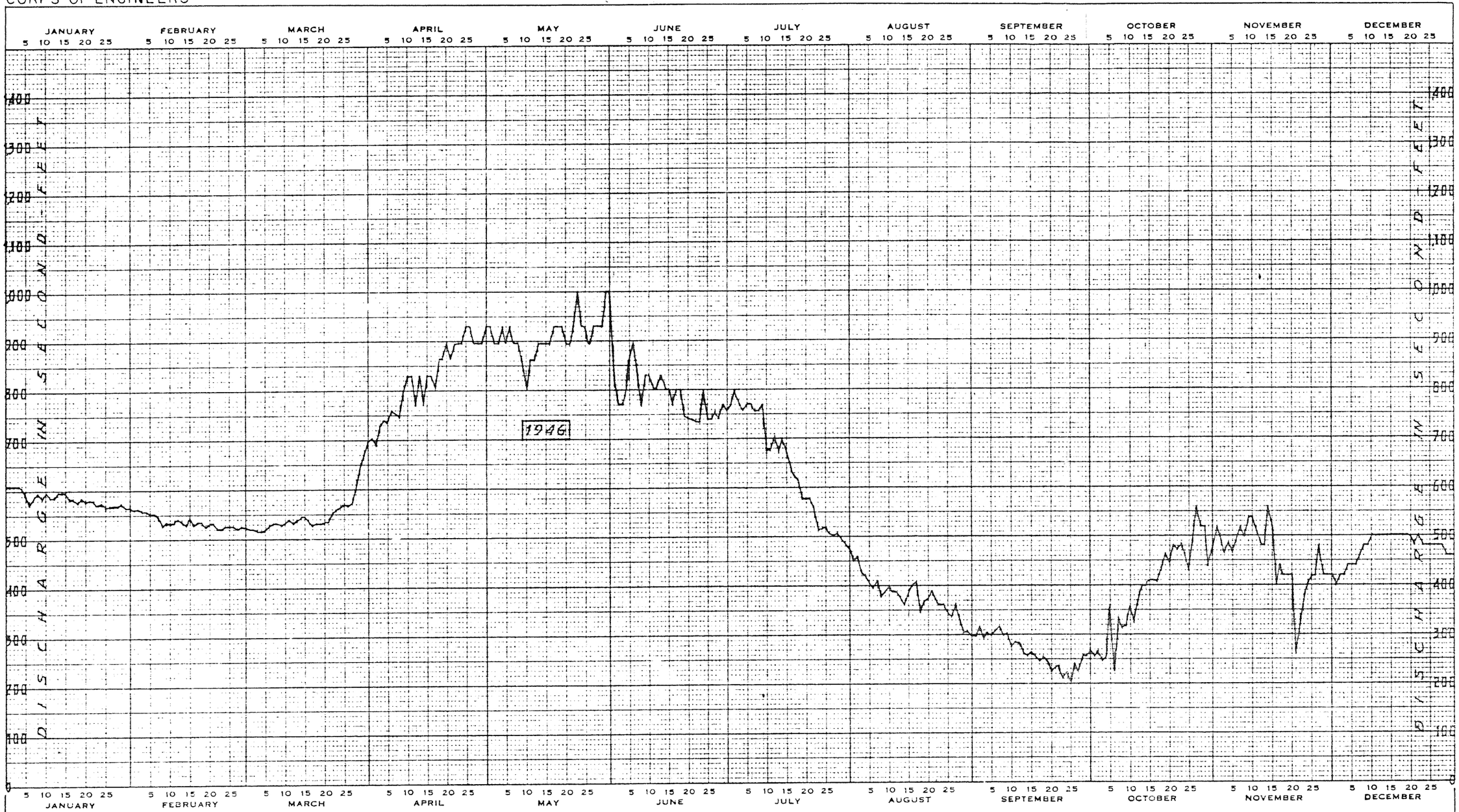


FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/34 PLATE 30

CORPS OF ENGINEERS U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/33 PLATE 29

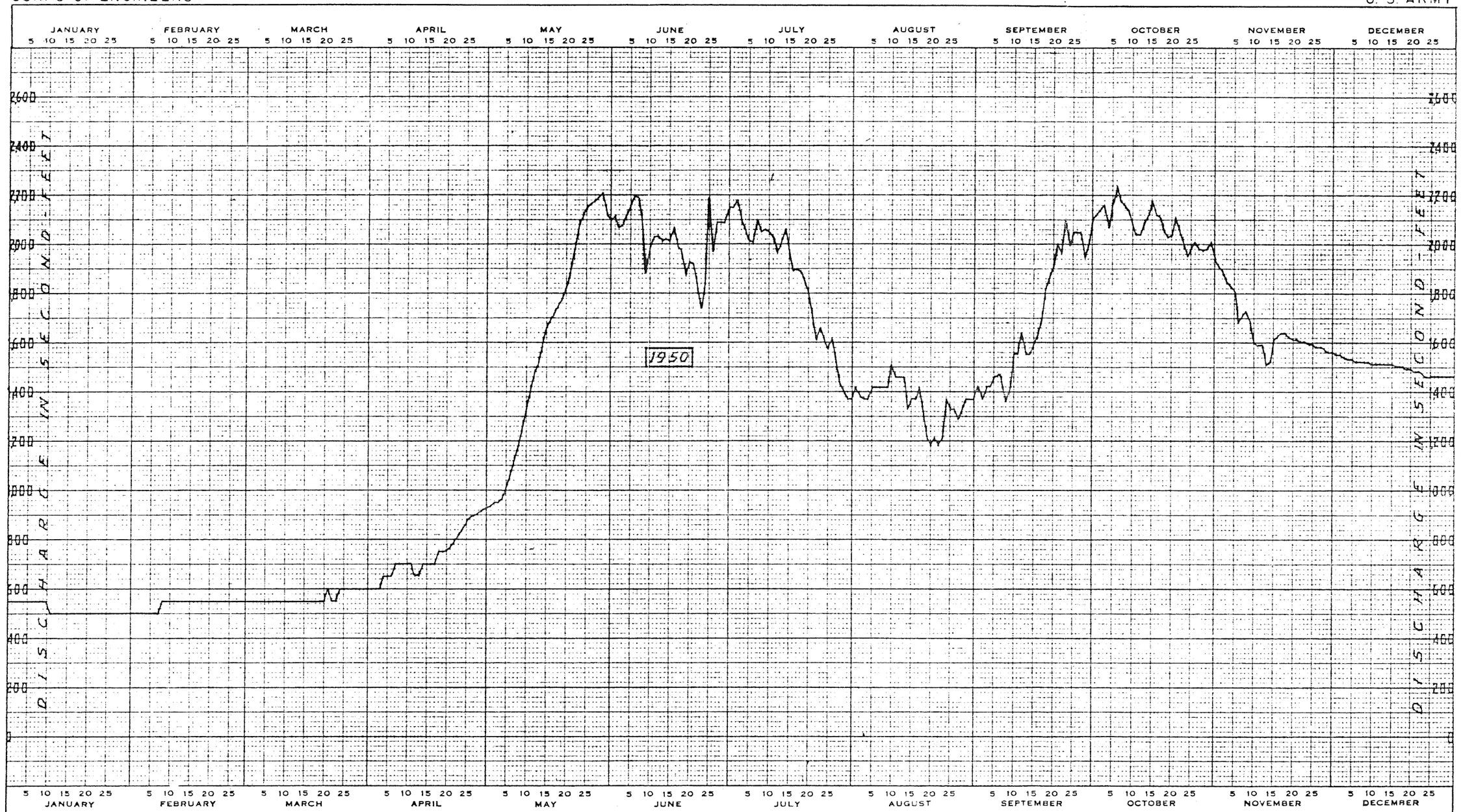
CORPS OF ENGINEERS U. S. ARMY

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/35 PLATE 31

CORPS OF ENGINEERS U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/36 PLATE 32

CORPS OF ENGINEERS U. S. ARMY

JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

5 10 15 20 25

2600 2400 2200 2000 1800 1600 1400 1200 1000 800 600 400 200 0

DISCHARGE IN SECOND FEET

1951

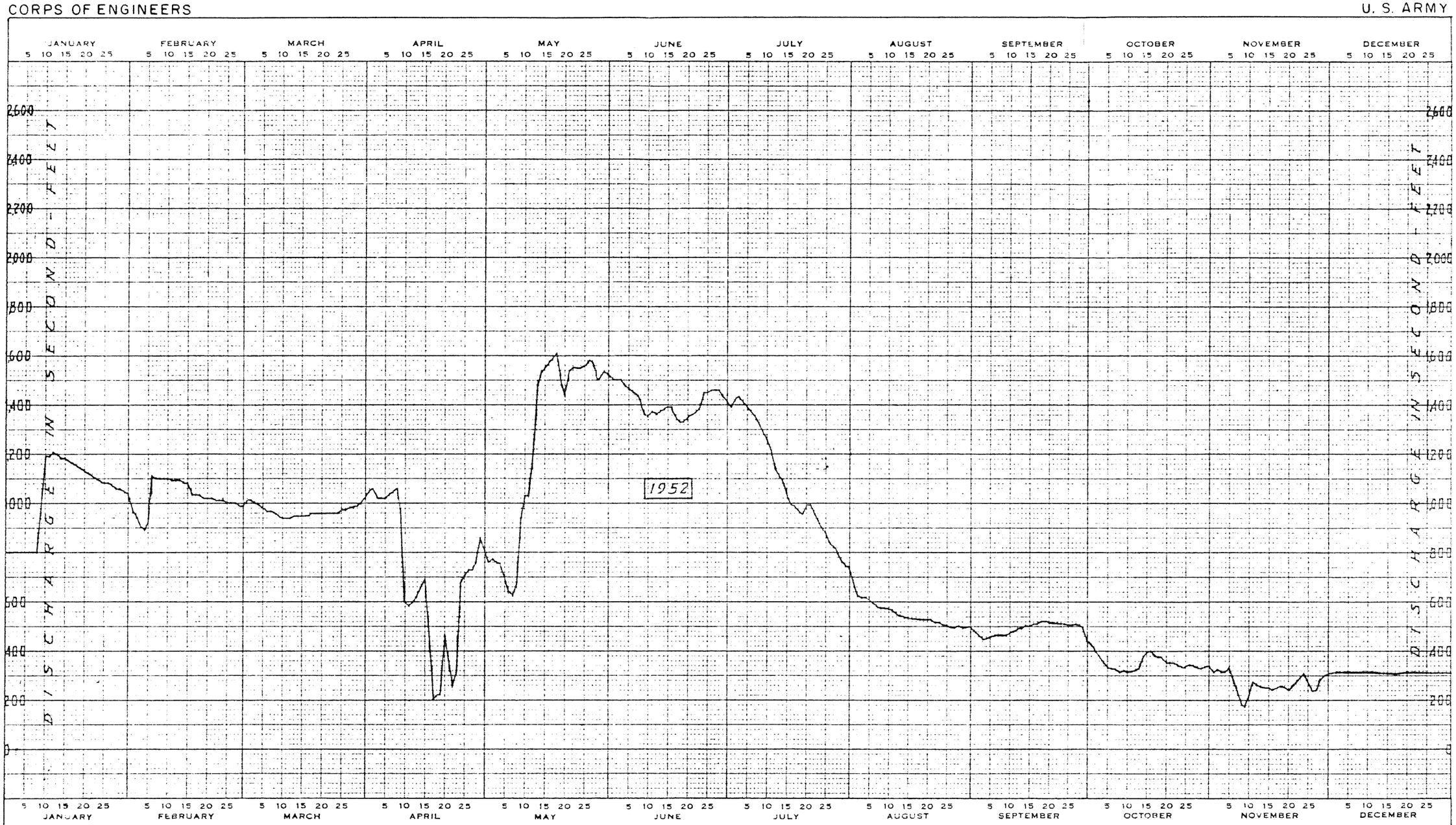
JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. RI3-Z-64/37 PLATE 33

CORPS OF ENGINEERS U. S. ARMY

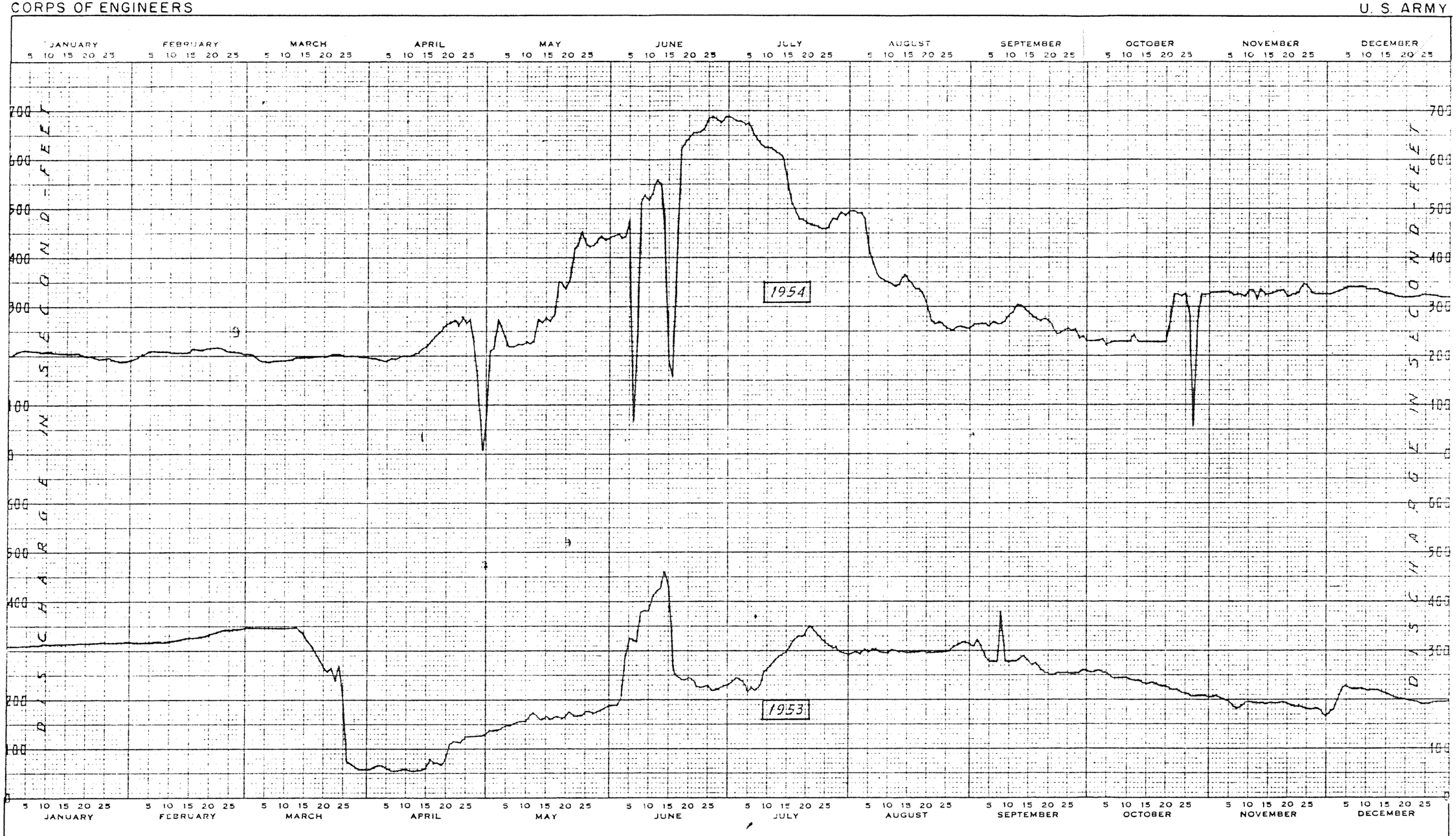


FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/38 PLATE 34

CORPS OF ENGINEERS U. S. ARMY



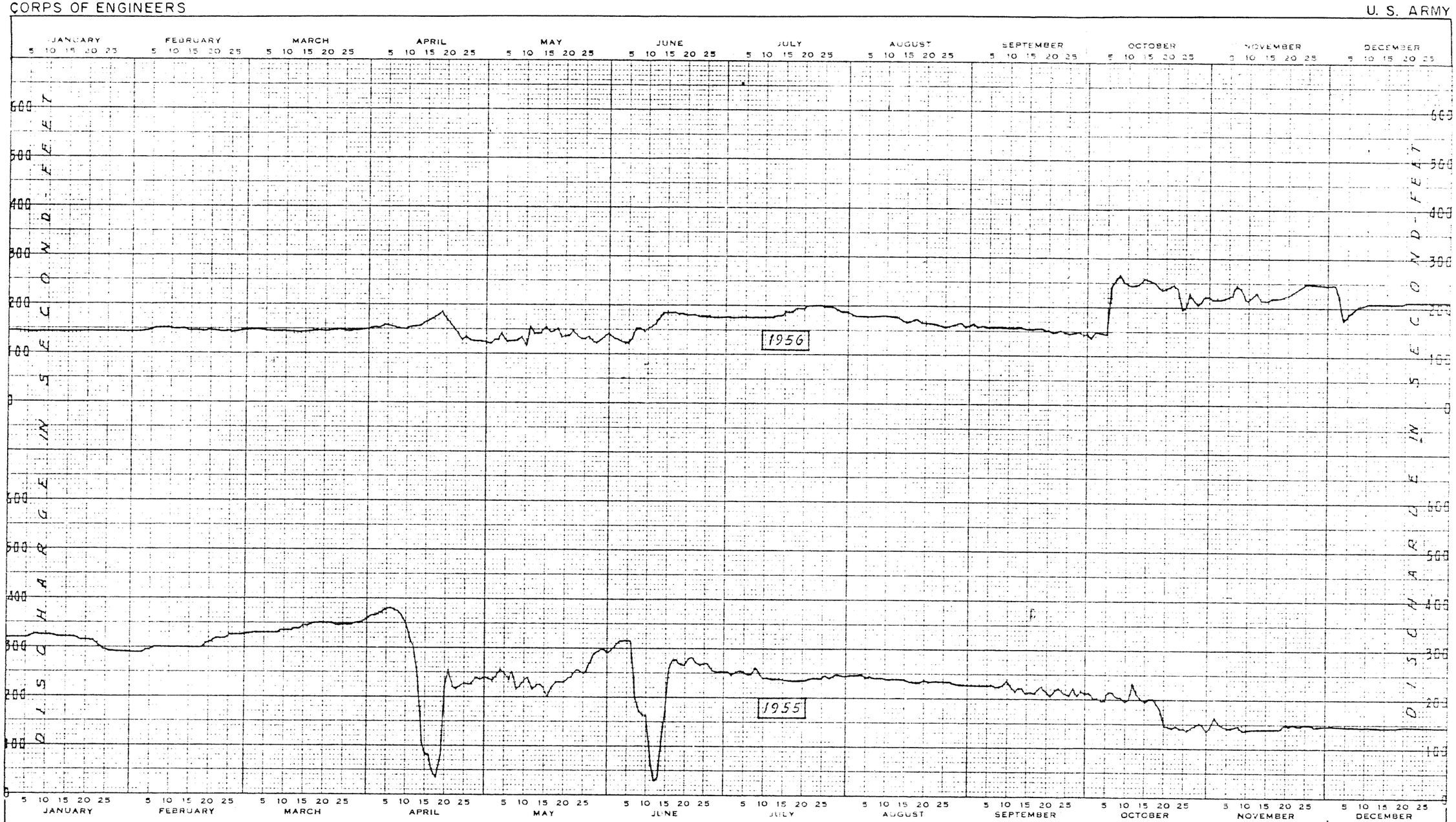
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/39 PLATE 35

CORPS OF ENGINEERS

U. S. ARMY



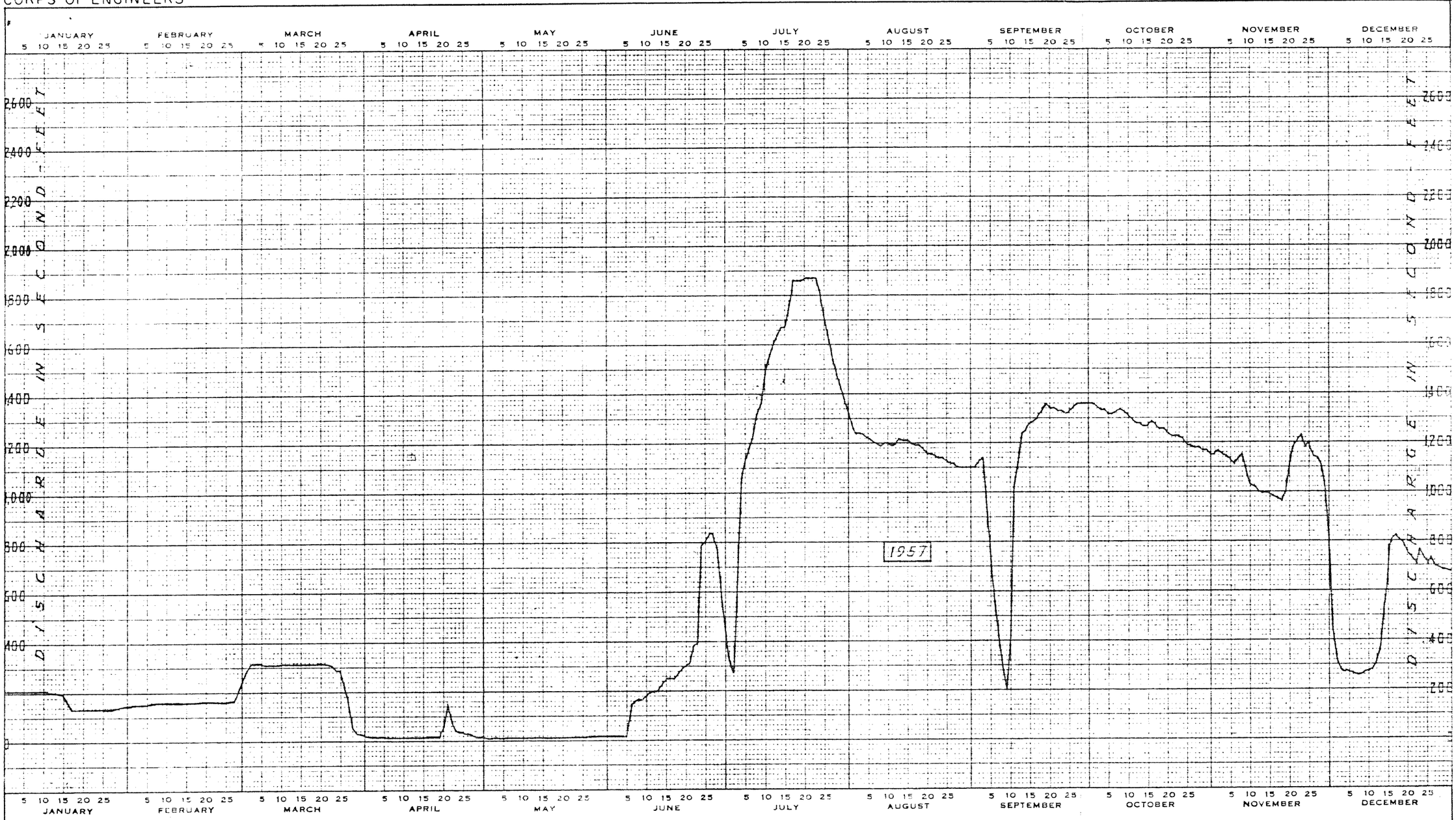
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U. S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/40 PLATE 36

CORPS OF ENGINEERS U. S. ARMY



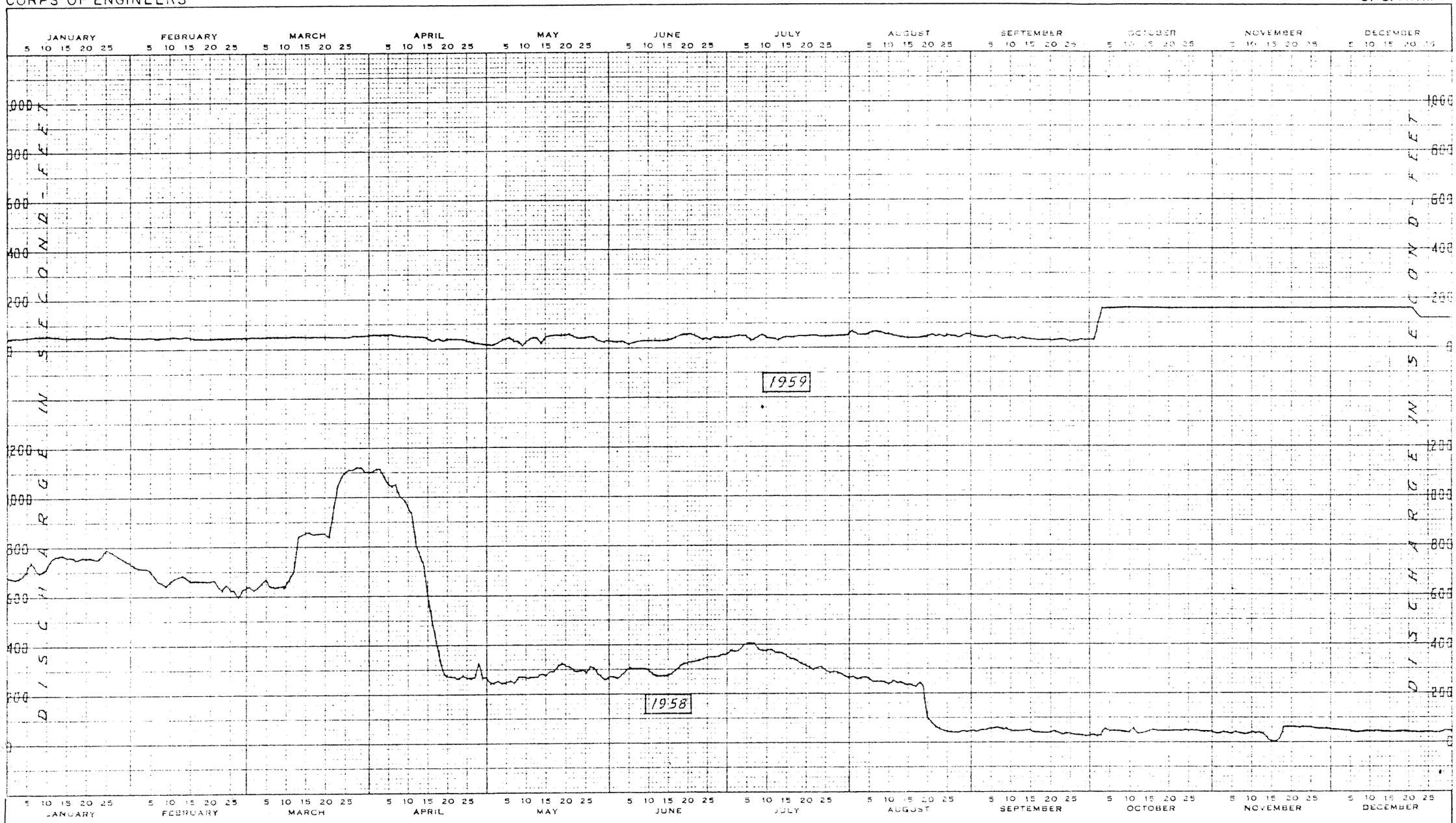
FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U S ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST PAUL, MINNESOTA

FILE NO. RI3-Z-64/41 PLATE 37

CORPS OF ENGINEERS

U. S. ARMY



FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL
DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/42 PLATE 38

CORPS OF ENGINEERS U. S. ARMY

JANUARY 5 10 15 20 25 | FEBRUARY 5 10 15 20 25 | MARCH 5 10 15 20 25 | APRIL 5 10 15 20 25 | MAY 5 10 15 20 25 | JUNE 5 10 15 20 25 | JULY 5 10 15 20 25 | AUGUST 5 10 15 20 25 | SEPTEMBER 5 10 15 20 25 | OCTOBER 5 10 15 20 25 | NOVEMBER 5 10 15 20 25 | DECEMBER 5 10 15 20 25

DISCHARGE IN THOUSANDS OF CUBIC FEET PER SECOND

600
500
400
300
200
100
0

1961

1960

5 10 15 20 25 JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

DISCHARGE HYDROGRAPHS
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/43 PLATE 39

CORPS OF ENGINEERS U.S. ARMY

FLOOD CONTROL AND WATER CONSERVATION
RED RIVER OF THE NORTH WATERSHED
RED LAKE RIVER, MINNESOTA
RED LAKE DAM AND RED LAKES RESERVOIR
RESERVOIR REGULATION MANUAL

DISCHARGE HYDROGRAPH
RED LAKE RIVER BELOW RED LAKE DAM

CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT ST. PAUL, MINNESOTA

FILE NO. R13-Z-64/44 PLATE 40

APPENDIX A

STANDING INSTRUCTIONS TO THE DAM TENDER

RED LAKE DAM AND RESERVOIR

APPENDIX A

STANDING INSTRUCTIONS TO THE DAM TENDER

RED LAKE DAM AND RESERVOIR

Section A. - General Operation Directives

A-1. General. - These instructions will be followed at all times except when the operation is based on a special directive issued by the Reservoir Regulating Section of the District office. Instructions contained in a special directive will be applicable for the period specified. The dam tender will maintain a log book of all such instructions received from the Reservoir Regulating Section. The date and time of call, the information, and the name of the operator issuing the instructions will be recorded.

A-2. Gate operation. - At Red Lake Dam, the discharge is regulated by three 16x5-foot lift gates and two 8x5-foot stop log sections. Discharge rating curves for the dam are shown on Plates 16-19 inclusive. A tailwater discharge rating curve for the downstream recording gage is shown on Plate 20.

A-3. Routine operation. - Following the spring breakup, any accumulation of storage above conservation level will be held until danger of downstream flooding has passed. Releases not to exceed channel capacity will depend on downstream conditions. Reservoir levels will be maintained as near to conservation level (1174.0) as possible.

A-4. Operation for floods. -

a. Spring floods. - Red Lake reservoir will store as much flood runoff as necessary depending on downstream conditions. Inflow will be stored and held up to reservoir elevation 1177.0. The discharge from Red Lake Dam may range from zero flow to a maximum of 1,000 cfs depending on downstream conditions. Drawdown to conservation elevation 1174.0 will start as soon as downstream conditions permit.

b. Summer floods. - Should floods occur in the Red Lake River Basin because of excessive rainfall, the reservoir will be operated to minimize damage at downstream points. Operation will be the same as noted under spring floods.

A-5. Operation for low-water control. - During normal periods of operation, instructions will be issued from the Reservoir Regulating Section to the dam tender by mail, telephone or radio. The reservoir will be operated during low-water periods so as to provide required flows downstream from the dam. Releases will be made as required to

supplement natural flows at critical points downstream. All requests for increase or decrease of flow from the reservoir from interested parties shall be transmitted to the District office for approval.

A-6. Emergency operation procedures. - In the event of failure of normal communication facilities, every effort will be made by the dam tender to maintain contact with the District office by any means available, including radio, telegraph, or sending a messenger to the nearest point where communications are available. In such circumstances, the primary objective will be to insure the safety of the structure and to provide the most effective operation of the project by following the reservoir regulation schedule as shown on Table A-1. During such emergency operation, the schedule will be followed until contact with the District office is re-established. It will also be necessary for the dam tender to keep himself informed concerning effects of any reservoir releases on downstream damage centers.

SECTION B. - COLLECTION OF HYDROLOGIC DATA

A-7. Precipitation at Red Lake Reservoir. -

a. Official precipitation gage. - A Friez, 24-hour dual traverse rain and snow gage, 12-inch recording capacity, is the official gage (property of the U. S. Weather Bureau) for the Red Lake Reservoir. The gage is located at the Red Lake Indian Agency, Red Lake, Minnesota, about 19 miles by road from Red Lake Dam. The records are published by the Weather Bureau.

b. Regular readings. - The 24-hour precipitation will be recorded at 8 a.m. daily. The time of beginning and ending of the precipitation will also be recorded. Instructions for the preparation and transmission of precipitation reports are contained in Section C of this appendix.

c. Extra and special readings. - Extra readings of the precipitation or other gages shall be made whenever requested by the District office. When extra readings of the rain gage are made, the total which has fallen since the last regular time of observation is to be reported even though a portion of it may already have been reported as an extra reading. The regular reading in the morning following any extra readings should always include the amounts reported in any extra readings. Instructions pertaining to the transmission of special readings are contained in Section C of this appendix.

d. Snow depth and moisture content. - During the winter regular measurements of snowfall shall be made. In addition, measurements of the water content of the snow on the ground shall be made at least as often as indicated below:

(1) Each day when any new snowfall occurs.

TABLE A-1 - RESERVOIR REGULATION SCHEDULE - RED LAKES

Regulation Schedule	Reservoir Elevation	Condition	Operation
Routine Operation			
	1174.5-1173.5	Normal	Regulate outflow according to instructions from the Reservoir Regulating Section to drawdown the reservoir level to 1173.5 just prior to spring breakup. Annual normal recharge 1.0 will raise level to 1174.5. Normal evaporation will cause drawdown to 1174. Otherwise regulate outflow to maintain 1174.0.
Flood Control			
	1173.5-1176.4	Above normal runoff predicted	Have lake drawdown to elevation 1173.5 prior to spring breakup otherwise lower to 1174.0, if possible. Store runoff as necessary to a maximum operating level, elevation 1176.4, if necessary. Thereafter, lower reservoir to elevation 1174.0 as soon as possible. Maximum discharge dependent upon downstream conditions. Must not aggravate flooding downstream. Maximum regulated stage of 8.75 at High Landing, Minnesota and 18.0 feet at Crookston. Capacity of the channel immediately downstream from Red Lake Dam was designed for 1,000 cfs. However, presently at times when the channel is not affected by weed growth, discharges in excess of 1,600 cfs can be discharged. The time lag to High Landing is 1.5 days, to Crookston $5\frac{1}{2}$ days, and to Grand Forks 7 days.

TABLE A-1 - Reservoir Regulation Schedule - Red Lakes - continued

Regulation Schedule	Reservoir Elevation	Condition	Operation
Flood Control - cont.			
	1176.4	Design storm predicted	Should the lake level be at elevation 1176.4 and the flood of record occur, the lake will rise to elevation 1179.03. As soon as flooding is past downstream, the dam must be opened to maximum allowable as noted above.
Water Supply			
	1173.5-1174.0	Runoff not sufficient to raise reservoir elevation to 1174.0	Releases from the reservoir shall be limited to the requirements downstream for water supply and pollution abatement. (See Table 4)
	1171.0-1172.0	Drought conditions	Releases shall not exceed 50,000 acre-feet during a calendar year or a proportionate share thereof for the part of the year that the reservoir is between these elevations. Releases shall not exceed the requirements for downstream water supply and pollution abatement.
	Below elev. 1171.0	Drought conditions	Maximum releases from the reservoir shall not exceed 15 cfs. Minimum releases shall not be less than 5 cfs during extreme drought conditions.

(2) At 2-week intervals whether or not any new snow has fallen during the previous period. To determine the water content of the snow, follow the instructions contained in Circular B, "Instructions for Climatological Observers".

e. Snow survey in the Red Lake River Basin. - Prior to the spring breakup, a regular survey crew will, if conditions warrant, conduct a snow survey in and adjacent to the Red Lake River Basin. The survey will start about the first or second week of March each year. Instructions as to the exact date to start the survey will be issued by the Reservoir Regulating Section of the District office. If an appreciable amount of snow should fall after the survey has been completed, another survey may be required. Prior to making the actual snow survey, the dam tender may be requested to make a reconnaissance of a portion of the basin to determine if a detailed snow survey is necessary. The reconnaissance will cover a general area laid out by the Reservoir Regulating Section and the dam tender will drive the area making a visual inspection and making an occasional snow depth measurement. A report of this reconnaisance will be forwarded to the Reservoir Regulating Section as soon after completion as possible. Snow survey stations in and adjacent to the Red Lake River Basin are shown on Plate 1 of this manual. Standing instructions for personnel making a snow survey are listed below:

a. Standing instructions for making a snow survey. -

(1) The 23 stations listed in Table A-2 are permanent and will be used each time a snow survey is required.

(2) If a listed station is inaccessible, a temporary station may be selected as near to the listed station as possible, but must be noted as an alternate station.

(3) Notes on general conditions shall be made at all stations and points between stations, such as; crusted snow, loose snow, drifted snow, conditions of snow in ditches and river channels, in open fields, timbered and brushy areas.

(4) Note frost conditions wherever obtainable from construction, telephone or power line crews, etc.

(5) Submit information during the progress of the survey by telephone, as instructed by the Reservoir Regulating Section in the District office, giving station number, average depth of snow, and average water content for each station completed so that the information can be plotted and worked up as rapidly as possible.

(6) It is estimated that to properly cover all of the 23 stations in and adjacent to the Red Lake River Basin, a total of about 570 miles will be covered, involving about 4 or 5 days of time. The stations in the basin are numbered consecutively; however, this

does not mean that the stations must necessarily be taken in that order. By locating the stations on a state map, the most practical route can be determined that will require a minimum of driving. If weather and/or road conditions do not permit entry to an area where a station is located, this information should be noted on the data sheet, Form 430 shown as Exhibit 4, and arrangements should be made to follow the instructions in sub-paragraph (2) above. If the inaccessible area can be outlined, it will give a fair indication of conditions therein.

(7) Upon completion of the snow survey, a general report of the survey together with the data sheets shall be submitted to the District office as soon as possible.

TABLE A-2 - SNOW SURVEY STATIONS
IN AND ADJACENT TO THE RED LAKE RIVER BASIN

Station No.	Location	Highway No.
RL-1	Crookston, Minn.	U.S. 2
RL-2	Euclid, Minn.	U.S. 75
RL-3	Erskine, Minn.	U.S. 2
RL-4	Plummer, Minn.	U.S. 59
RL-5	Thief River Falls, Minn.	U.S. 59
RL-6	Goodridge, Minn.	S.T.H. 1
RL-7	Gatzke, Minn.	S.T.H. 89
RL-8	Grygla, Minn.	S.T.H. 89
RL-9	12 miles N of Red Lake Dam	Jct. S.T.H. 1-89
RL-10	Red Lake Dam	S.T.H. 1-89
RL-11	Red Lake Agency, Minn.	S.T.H. 1
RL-12	Quiring, Minn.	S.T.H. 1
RL-13	Kelliher, Minn.	S.T.H. 72
RL-14	Washkish, Minn.	S.T.H. 72
RL-15	Blackduck, Minn.	U.S. 71
RL-16	Clearbrook, Minn.	S.T.H. 92
RL-17	Trail, Minn.	S.T.H. 92
RD-10	Grand Forks, North Dakota	U.S. 81
RM-8	Bejou, Minn.	U.S. 59

Section C. - Instructions For Transmission Of Reports

A-8. Regular reports. -

a. Weekly log sheets. - NCP Form 420, "Weekly Log Sheet", included as Exhibit 2 shall be used to record all gate openings, stop log elevations, gage readings, other gage readings, which may be required, and local weather conditions. This record is prepared in duplicate and the original shall be mailed directly to the Reservoir Regulating Section in the District office after the last entry has been made at the end of the week.

b. Recording gage chart. - The District office gage is a weekly recorder located in the U. S. Geological Surveys pool gage house. The U. S. Geological Surveys gage is a continuous recorder which will be serviced by that agency whenever necessary. The chart from the District recorder is removed and mailed each Friday. Whenever, the charts are removed or the new chart started, the date, correct time, and the gage height from either the inside staff or tape gage together with the initials of the observer is to be noted on the chart at the beginning and end of the chart record. These notations will enable the Reservoir Regulating Section to make whatever corrections are necessary to the record.

c. Emergency reports. - During flood or other emergencies, the dam tender will report by telephone daily to the Reservoir Regulating Section as soon after 8 a.m. as possible. Requests for additional reports at specific times on the same day, if necessary, will be made by the District office at the time of the morning call.

d. Radio report. - Plans for providing radio equipment at all reservoir sites has been rescinded by higher authority. The Agency at Red Lake now has radio communication for their own use and future plans may be developed to set up a direct tie to the present District network for emergency use only.

e. Supplementary data. - Additional data covering gate operation, precipitation, snow cover and moisture content may be sent in message form by mail whenever necessary.

f. Recording rain gage charts. - Instructions for the operation, care, and transmission of the rain gage charts will be the responsibility of the U. S. Weather Bureau.

A-9. Special Reports. -

a. Reporting criteria. - Special reports shall be made whenever requested by the District office.

b. Special report data. - The following data shall be collected for inclusion in the special reports.

(1) Stage and precipitation readings made in accordance with the requests from the District Engineer.

(2) Precipitation reports from stations anywhere in or adjacent to the basin as selected by the Reservoir Regulating Section.

(3) Snow depth and moisture content.

(4) Damage due to flooding, low-water, wave action, detrimental conditions for fish and wildlife, etc.

c. Transmission of special reports. - Special reports shall be transmitted by telephone or as written reports as directed by the District office. If the report is to be made by telephone, call CApital 2-8011 after 8 a.m. each weekday, asking for extensions 589, 680 or 664 in the Reservoir Regulating Section. If a call should be placed after the regular office hours or regular workdays and/or Saturdays, Sundays and Holidays, first try the Reservoir Regulating Section telephones, CApital 4-0610 or CApital 2-5770. If the District office cannot be contacted, place a person to person call to one of the following, in the order of preference as shown.

Henry W. Harich	699-6790, St. Paul, Minn.
L. M. Katz	929-6879, Minneapolis, Minn.
R. C. Greene	588-7698, Minneapolis, Minn.
R. M. Cowan	451-3418, So. St. Paul, Minn.
G. E. Lyon	699-1938, St. Paul, Minn.

Section D. - Collection of Stream-Flow Data

A-10. General. - River and reservoir stage data will be obtained from gages in the vicinity of the dam site and other pertinent locations either in or adjacent to the reservoir. The data will be collected by recording gages and by observing the gages directly at frequencies varying with the conditions. Stream-flow measurements will be made by the U. S. Geological Survey as requested by the District office.

A-11. Method of collection. - During flood conditions the dam tender will collect stage data at Red Lake Dam as often as requested by the District office. Stage and discharge data from other stations will be collected by the Reservoir Regulating Section from regular observers and the U. S. Geological Survey. Reports from the dam tender will be transmitted according to the instructions contained in Section C.

APPENDIX B

RED LAKE DRAINAGE AND CONSERVANCY DISTRICT

APPENDIX B

RED LAKE DRAINAGE AND CONSERVANCY DISTRICT

After the disasterous flood of 1919 the Red Lake Drainage and Conservancy District was organized for the express purpose of improving the channels of the Red Lake and Clearwater Rivers so as to decrease the direct overflow and provide adequate outlets for drainage ditches.

"The following are excerpts from a letter dated 30 September 1946 from Mr. Paul A. Lundgren, County Attorney, Pennington County, Minnesota with regards to the Red Lake Drainage and Conservancy District:

The Red Lake Drainage and Conservancy District came into being by an order of the District Court dated 13 February 1920 pursuant to Chapter 13 of the Laws of 1919. This law is now codified in Minnesota Statutes for 1945, Volume 1, Chapter III.

The present directors of the Red Lake Drainage and Conservancy District hold their position by reason of the order of the District Court of Pennington County, Minnesota dated 10 January 1946.

From my examination of Chapter III of the Minnesota Statutes for 1945 and the files and records in the matter of the Red Lake Drainage and Conservancy District, it is my opinion that:

1. The Red Lake Drainage and Conservancy District is a legal entity authorized by law.

2. That the Board of Directors of the Red Lake Drainage and Conservancy District have been duly appointed according to law and have duly qualified for their respective positions.

3. That the attached resolution has been duly and legally adopted by the Board of Directors of the Red Lake Drainage and Conservancy District.

4. That the Red Lake Drainage and Conservancy District is empowered by Chapter III of Minnesota Statutes for 1945 to enter into, contract and to raise the required funds for the fulfillment of such contracts through the power of taxation.

5. That the Board of Directors is specifically authorized by Chapter 111.21--"to enter into contracts or other arrangements with The United States Government, or any department thereof, with persons, railroads, or other corporations, with public corporations, and the State Government of this state or other states with drainage, conservancy or other improvement districts, in this state or other states for cooperation

or assistance in constructing, maintaining and operating the works of the district or for the control of the waters thereof, or for making surveys and investigation or reports thereon."

Signed Paul A. Lundgren

The resolution as noted under Mr. Lundgren's third opinion and as adopted by the Board of Directors of the Red Lake Drainage and Conservancy District on 30 March 1946 in the City of Thief River Falls, Minnesota is as follows:

RED LAKE DRAINAGE AND CONSERVANCY DISTRICT

THIEF RIVER FALLS, MINNESOTA

RESOLUTION

At a regular meeting of the Board of Directors of the Red Lake Drainage and Conservancy District held at its office in the City of Thief River Falls, Minnesota, on Saturday, March 30, 1946, J. L. Radniecki offered the following Resolution and moved its adoption:

"WHEREAS, the first session of the 78th Congress of the United States of America in House Document Number 345 approved the letter and report from the Secretary of War for the improvement, rectification and enlargement of the Red Lake and Clearwater Rivers in Minnesota as an authorized project as more particularly set forth in the report of the United States Army Engineers contained in said House Document Number 345, and,

WHEREAS, said project as approved by House Document Number 345 is subject to assurances being furnished, satisfactory to the Secretary of War, that responsible local interests will:

1. Provide all necessary flowage easements and rights-of-way;

2. Make a cash contribution of $33,220 in lieu of altering bridges;

3. Hold and save the United States free from damages due to construction works and operation;

4. Take over the maintenance and subsequent replacement of all bridges improved by the United States;

5. Maintain the improved river channels;

6. Treat to the satisfaction of the War Department all sewage wastes discharged into the Red Lake, Clearwater, and Thief Rivers, prior to their release;

7. Take practicable preventive measures to control contamination of the streams by rural areas and villages without sewer systems; and

8. Construct no new dams nor raise any existing dams on these streams downstream from Red Lake, Clearwater Lake, and Mud Lake unless authorized by the War Department, and,

WHEREAS, the Red Lake Drainage and Conservancy District was duly formed as a body corporate by order of the District Courts of the Fourteenth and Fifteenth Judicial Districts of Minnesota dated February 13, 1920, and,

WHEREAS, the Red Lake Drainage and Conservancy District comprises the entire watershed of the Red Lake River in Minnesota, including its tributaries of the Clearwater and Thief Rivers, and,

WHEREAS, the Board of Directors of the Red Lake Drainage and Conservancy District is empowered by law to contract with the United States Government or any agency thereof for cooperation or assistance in constructing, maintaining and operating the works of the District or for the control of the waters thereof, and,

WHEREAS, the County of Pennington, State of Minnesota, a municipal subdivision lying within the Red Lake Drainage and Conservancy District has, pursuant to the provisions of Chapter 111, Minnesota Laws of 1941, and acts amendatory thereof, the laws governing the operation of the Red Lake Drainage and Conservancy District, petitioned said District to undertake, in cooperation with the United States of America, the improvement, rectification and enlargement of the Red Lake and Clearwater River channels in accordance with the survey and report made thereon by the United States Army Engineers pursuant to House Document Number 345, and,

WHEREAS, the Board of Directors of the Red Lake Drainage and Conservancy District, after due consideration of the aforesaid petition and the report of the United States Army Engineers, has determined that said project if constructed will benefit public health and the general welfare of the inhabitants of said Drainage District,

NOW, THEREFORE, be it resolved that the Red Lake Drainage and Conservancy District undertake:

1. To provide all necessary flowage easements and rights-of-way as shall be determined by the detailed surveys of the United States Army Engineers and to that end the President and Secretary of said District are hereby authorized and empowered to institute the necessary proceedings for the acquisition of said easements and rights-of way;

2. To assume the cost and responsibility of the alteration and repair of all bridges as shall become necessary by reason of said project or in lieu thereof, make a cash contribution to the United States of America in the sum of $33,220.00;

3. To hold and save the United states free from damages due to construction works and operation;

4. To take over the maintenance and subsequent replacement of all bridges improved by the United States;

5. To maintain the improved river channels;

6. In cooperation with the Department of Health of the State of Minnesota and so far as law permits to treat to the satisfaction of the War Department all sewage wastes discharged into the Red Lake, Clearwater, and Thief Rivers, prior to their release;

7. Take practicable preventive measures to control contamination of the streams by rural areas and villages without sewer systems; and

8. To construct no new dams nor raise any existing dams on these streams downstream from Red Lake, Clearwater Lake and Mud Lake unless authorized by the War Department; and

BE IT FURTHER RESOLVED, that the President and Secretary be authorized and empowered to enter into all necessary contracts and aggreements with the United States of America or its agency, the United States Army Engineers as shall be required for the further compliance by the District with the conditions as set forth in said House Document 345, and,

BE IT FURTHER RESOLVED, that the Secretary be instructed to transmit certified copies of this resolution to the St. Paul Office of the United States Army Engineers, Congressman Harold C. Hagen, Senators Joseph H. Ball and Henrick Shipstead, Governor Ed Thye and the Department of Conservation of the State of Minnesota."

The foregoing Resolution was seconded by W. J. Kirkwood and on roll call declared unanimously carried.

I hereby certify that the foregoing is a true, correct and exact copy of the Resolution passed by the Board of Directors of the Red Lake Drainage and Conservancy District at a regular meeting thereof held at Thief River Falls, Minnesota, on the 30th day of March 1946.

L. W. RULIEN
Secretary

RED LAKE INDIAN RESERVATION

RED LAKE BAND OF CHIPPEWA INDIANS

The Red Lake Band of Chippewa Indians by resolution adopted 17 April 1949 have consented to the use of their lands concerning flowage rights for the Red Lake Flood Control Project, Minnesota. The resolution authorized the Department of the Army through the Department of the Interior to make the necessary improvements subject to the following conditions:

1. No cost of the construction shall be charged to the Red Lake Band of Chippewa Indians.

2. No cost of repair or maintenance shall be charged to the Red Lake Band of Chippewa Indians.

3. Control of the lake levels to be vested in the Department of the Army.

4. The tribe shall not be liable for any damages that may be caused by such improvements.

5. The tribe reserves the right to present a claim against the Government for any damages caused by construction, operation and maintenance of the project.

6. Members of the Red Lake Band of Chippewa Indians shall be employed on any work within the Red Lake Reservation whenever possible.

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS
OFFICE OF THE DISTRICT ENGINEER
ST. PAUL DISTRICT
1217 U. S. Post Office and Custom House
St. Paul 1, Minnesota

UMPRE

15 September 1949

Mr. Stanley N. Mortenson, Secretary
Red Lake Drainage and Conservancy District
Thief River Falls, Minnesota

Dear Sir:

Attention is invited to previous correspondence and conferences between representatives of the Red Lake Drainage and Conservancy District and of this office in regard to the need for securing flowage easements on land adjacent to Upper Red Lake outside of the Indian Reservation.

It is the understanding of this office that, in lieu of acquiring flowage easements on subject lands, the Conservancy District is willing to agree to assume all liability with respect to any possible future claims for damages to these lands, arising as a result of variations in water levels in the Red Lakes.

If the officers of your District desire to enter into an agreement of this nature rather than to acquire flowage easements on the private land outside the Indian Reservation on Upper Red Lake, it will be necessary to have a formal agreement executed by the officers of the Conservancy District after approval by the District Court.

Accordingly, a draft of a resolution by the Conservancy District providing for the assumption of liability with respect to any future claims has been prepared and is submitted herewith for your consideration.

If the form of resolution is satisfactory, it will be appreciated if you will have it executed and returned, together with copies of the order of approval by the District Court. After execution, three of the four copies inclosed should be returned for the files of this Department.

Very truly yours,

JOHN D. KEEFE
Major, Corps of Engineers
Acting District Engineer

1 Incl
Resolution (in quad.)

RED LAKE DRAINAGE AND CONSERVANCY DISTRICT

THIEF RIVER FALLS, MINNESOTA

RESOLUTION

At a regular meeting of the Board of Directors of the Red Lake Drainage and Conservancy District held at its office in the City of Thief River Falls, Minnesota on Wednesday, October 19, 1949, Olaf E. Olstad offered the following Resolution and moved its adoption:

"WHEREAS, the Congress of the United States, by the Flood Control Act approved 22 December 1944, authorized the Red Lake-Clearwater River Flood Control Project providing for the regulation of Red Lakes and channel rectification of portions of the Red Lake and Clearwater Rivers in the State of Minnesota, substantially in accordance with the recommendations of the Chief of Engineers set forth in House Document No. 345, 78th Congress, 1st Session; and

"WHEREAS, said project was authorized subject to certain specific items of local cooperation set forth in said House Document being furnished by local interests, which, among other things, required that local interests should furnish and provide without cost to the United States all flowage easements and necessary rights-of-way; and

"WHEREAS, the Red Lake Drainage and Conservancy District was duly formed, created and organized as a body corporate under and pursuant to the laws of the State of Minnesota, the said Drainage District, comprising the entire watershed of the Red Lake River including its tributaries, the Clearwater and Thief Rivers, in Minnesota, and is specifically authorized by law to enter into contracts or other arrangements with the United States Government for assistance in constructing, maintaining and operating the works of the District for the control of the waters thereof; and

"WHEREAS, said Red Lake Drainage and Conservancy District, acting as the local agency in connection with the aforementioned public improvement, has furnished to the Government an assurance agreement wherein and whereby said Conservancy District undertook and agreed, among other things, to furnish without cost to the United States all flowage easements and rights-of-way required, and to hold and save the United States free from damages due to the construction works and operation of the project; and

"WHEREAS, at the time said assurances were given by said Conservancy District to the Government it was understood and agreed that the Conservancy District would furnish required flowage easements along the lake shore of that part of Upper Red Lake lying outside of the Red Lake Indian Reservation; and

"WHEREAS, the said Red Lake Drainage and Conservancy District is of the opinion that as a result of the aforesaid work of improvement there will be very little likelihood, if any, of the land along the Upper Red Lake being adversely affected by water in that said work of improvement will permit a more flexible control of the water level of said lakes. The said Red Lake Drainage and Conservancy District has, therefore, requested of the Government that in lieu of furnishing flowage easements over the land along the shoreline of Upper Red Lake, the District be permitted to enter into an agreement with the Government wherein and whereby the said Conservancy District would assume all liability with respect to any claims which may at any time arise resulting from the flooding or overflowing of the lands along the shore line of Upper Red Lake outside of the Red Lake Indian Reservation; and

"WHEREAS, the Government is willing to accept such agreement from the Red Lake Drainage and Conservancy District,

"NOW, THEREFORE, in consideration of the waiver by the Government of its requirement that the Red Lake Drainage and Conservancy District furnish to the Government flowage easements over the lands lying along the shore of Upper Red Lake, outside the Indian Reservation, BE IT HEREBY RESOLVED that the Red Lake Drainage and Conservancy District does hereby accept, assume, and obligate itself for any claim which may at any time hereafter be made for damages to all or any portion of the lands lying along the shore line of Upper Red Lake, caused by or resulting from the overflowing of said lands by reason of the construction, operation, and maintenance of the aforesaid Red Lake-Clearwater River Flood Control Project, and

"The said Red Lake Drainage and Conservancy District does hereby release and forever discharge and quitclaim the United States of America, its officers, agents, contractors, and employees from any and all liability, causes of action, suits at law or equity, claims and demands of any nature whatsoever which may in any manner arise out of or by reason of the flooding of any lands, along the shore line of Upper Red Lake, lying outside of the Red Lake Indian Reservation, by reason of the construction, operation and maintenance of said project.

"BE IT FURTHER RESOLVED, that the President and Secretary be and they are hereby authorized, empowered and directed to furnish certified copies of this Resolution, after the same has been approved by the District Court, to the Secretary of the Army through the District Engineer of the St. Paul District, Corps of Engineers, U. S. Army, as and for the binding obligation and agreement of the Red Lake Drainage

and Conservancy District with the Government to assume all liability in connection with said Red Lake-Clearwater River Flood Control Project, to the extent herein set forth."

The foregoing Resolution was seconded by John L. Radniecki and on rollcall was unanimously carried and adopted.

Stanley N. Mortenson
Secretary

APPROVED:

Ole O. Melby
President

I hereby certify that the foregoing is a true, correct and exact copy of the Resolution passed and adopted by the Board of Directors of the Red Lake Drainage and Conservancy District at a regular meeting of said Board held at Thief River Falls, Minnesota, on the 19th day of October, 1949.

Secretary

REGISTERED MAIL - R. R. R.

UMPVK

12 November 1953

Mr. Ole O. Melby
President, Red Lake Drainage
and Conservancy District
Oklee, Minnesota

Dear Mr. Melby:

Re: Formal Transfer of the Red Lake and Clearwater Rivers, Minnesota, Flood Control Project to the Red Lake Drainage and Conservancy District

The channel improvement of the Red Lake and Clearwater Rivers, Minnesota for flood control and other work incidental thereto has now, with the exception of the clearing and snagging to be performed on the Clearwater River downstream from the present limits of channel excavation, been completed under the direction of the Corps of Engineers in accordance with the congressional authorization therefor. A joint inspection of the completed work was made on 5 November 1953 by the District Engineer and representatives of the Engineering, Construction and Operations Divisions, Corps of Engineers, St. Paul District, in company with representatives of the Red Lake Drainage and Conservancy District, which drainage and conservancy district will be responsible for the maintenance and operation of those portions of the project as outlined below in accordance with the regulations prescribed by the Secretary of the Army.

a. Channel deepening and straightening of the Red Lake River, Minnesota, from station 205+00 (mile 154.3) (about 320 feet west of the half section line in section 25, township 153 North, range 41 West, Pennington County) to station 1485+00 (mile 178.5) (about 2,000 feet upstream of the forest ranger station and tower within the Indian Reservation) and from station 1860+00 (mile 185.6) (about 3.3 miles west of the outlet structure at Lower Red Lake) to station 2032+00 (mile 188.9) (at the outlet structure).

b. Channel deepening and straightening of the Clearwater River from station 0+00 (mile 41.6) (at the west line of section 30, township 152 North, range 41 West, Red Lake County) to station 2004+00 (mile 79.6) (about 700 feet west of the half section line in section 27, township 150 North, range 37 West, Clearwater County).

c. Stone protection at three bridges over the Clearwater River located as follows:

1. Section 34, township 152 North, range 41 West, Red Lake County.

2. Between sections 35 and 36, township 152 North, range 41 West, Red Lake County.

3. Section 33, township 152 North, range 40 West, Red Lake County (at Roland).

d. Protection to footing of center pier of bridge over the Clearwater River between sections 5 and 8, township 150 North, range 37 West, Clearwater County.

As you will recall, formal transfer of the two new bridges over the Clearwater River and the work of encasing the piers on two other bridges over the Clearwater River was effected 15 April 1952. As indicated in conversation during the joint inspection, this formal transfer does not include the maintenance and operation of the outlet structure at Lower Red Lake and adjacent dike; the rock and brush weir on the Red Lake River within the Indian Reservation, nor the bridge and control structure at the mouth of Butcher Knife Creek. The clearing and snagging which is scheduled to be accomplished next year downstream of the present limits of the channel improvement now on the Clearwater River will be formally transferred to the drainage and conservancy district following completion of the work.

Pursuant to existing regulations the Red Lake Drainage and Conservancy District, the duly qualified acting board of directors of said district, and the superintendent to be appointed by the board of directors of said drainage and conservancy district to be responsible for the maintenance and operation of the completed work outlined above, are hereby formally notified that the completed work as outlined above is hereby transferred and turned over to the Red Lake Drainage and Conservancy District of Thief River Falls, Minnesota, as of the 15th day of November 1953 for maintenance and operation in accordance with the requirements of the authorizing legislation and the assurance of said drainage district that it would maintain and operate the project in accordance with regulations prescribed therefor by the Secretary of the Army.

Control regulations governing the maintenance and operation of flood control works such as the Red Lake and Clearwater Rivers flood control project are contained in part 208, chapter 2, title 33, Navigation and Navigable Waters Flood Control Regulations, a copy of which is attached to the interim instructions for maintenance and operation of the Red Lake and Clearwater Rivers flood control project, Minnesota. Three copies of said interim instructions with the above-mentioned general regulations are inclosed herewith. Supplementary instructions pertaining to this project will be furnished at a later date in the form of an operation and maintenance manual which will supersede the inclosed interim instructions which are being furnished as a guide to the maintenance and operation of said project until the manual is completed.

UMPVK
Mr. Ole O. Melby

12 November 1953

This office greatly appreciates the cooperation the board of directors and the Secretary of the Red Lake Drainage and Conservancy District have given to representatives of this office in connection with the construction of this project. It is requested that this office be advised by letter as soon as possible the name and address of the superintendent appointed by the drainage district whom this office can contact relative to matters of maintenance and operation. The date of his appointment should also be indicated.

It will be appreciated if you as president of the board of directors of the Red Lake Drainage and Conservancy District will sign and return to this office two copies of the inclosed letter which acknowledges receipt of this letter, accepts the completed work as of the effective date, and acknowledges the responsibility for maintaining and operating the project as prescribed by the flood control regulations and other instructions.

Sincerely yours,

2 Incl (in trip
1. Letter
2. Interim Instructions

L. W. VOGEL
Lt. Col., Corps of Engineers
Acting District Engineer

Copy furnished:
Mr. Stanley N. Mortenson
Thief River Falls, Minn.

INTERIM INSTRUCTIONS FOR MAINTENANCE AND OPERATION OF THE RED LAKE AND CLEARWATER RIVERS FLOOD CONTROL PROJECT, MINNESOTA

1. The authorized flood control project on Red Lake and Clearwater Rivers, which is completed except for clearing and snagging of 9.7 miles of the Clearwater River from the lower end of the channel improvement project to the vicinity of Plummer, Minnesota, will be turned over to the Red Lake Drainage and Conservancy District for maintenance and operation in accordance with assurances of local cooperation furnished to the Secretary of the Army by the Conservancy District.

2. Briefly, the project to be turned over to the Red Lake Drainage and Conservancy District consists of 27.5 miles of channel enlargement and rectification on Red Lake River and 38.0 miles on Clearwater River. The improvement on Red Lake River extends from mile 154.3 to mile 178.5 and for 3.3 miles immediately below the outlet dam at Lower Red Lake; the portion above mile 173.2 being located within the Red Lake Indian Reservation. The rock and brush dam at mile 178.8 (within the Indian Reservation) will be maintained by the Federal Government. The channel enlargement and rectification on Clearwater River extends from mile 41.6 to mile 79.6. The general location of the channel improvements and typical cross sections are shown on inclosure 1.

3. In addition to retaining the maintenance and operation of the rock and brush dam at mile 178.8, the Federal Government will maintain and operate the remodeled control dam at the outlet of Lower Red Lake (inclosure 2).

4. General regulations covering the maintenance and operation of flood control works are contained in the inclosed instructions (title 33 - Navigation and Navigable Waters, chapter II, part 208 - Flood Control Regulations). The terms "Secretary of War" and "War Department" contained therein now refer to the Secretary of the Army and Department of the Army, respectively. Please note that only certain portions of section "(a) General" and most of section "(g) Channels and Floodways" are applicable to this project. The general regulations state that Operation and Maintenance Manual, which will cover requirements for the project in specific detail, will also be furnished. These interim instructions for the project are being furnished for guidance until such an Operation and Maintenance Manual is completed. In the absence of any features of this project which require operation by the Red Lake Drainage and Conservancy District, the only specific requirements at this time are as follows:

a. Inspections at least twice a year, preferably in April and July, and immediately after the recession of major floods to determine conditions along the improved channels.

b. The removal of any silt deposits, debris, grass or woody growths which may cause scour or channel changes, or decrease channel-carrying capacity.

c. Prevention of encroachment or trespassing and construction of any structures, inlet channels, etc. not previously approved by the District Engineer or his authorized agent.

d. Submission of semiannual reports covering inspections, maintenance and operation of the protective works to the District Engineer, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota, ATTENTION: Chief, Structures Branch.

3 Incl
1. Project map
2. Red Lake Dam Alterations
3. Flood control regulations

A. H. BAGNULO
Colonel, Corps of Engineers
District Engineer