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MULTIPLE PURPOSE PROJECT
HEART RIVER BASIN, NORTH DAKOTA

HEART BUTTE RESERVOIR

RESERVOIR REGULATION PLAN

FOR

STORAGE ALLOCATED TO FLOOD CONTROL
IN RESERVOIR CONSTRUCTED BY
BUREAU OF RECLAMATION

CORPS OF ENGINEERS, U.S. ARMY
GARRISON DISTRICT
BISMARCK, NORTH DAKOTA
NOVEMBER 1950

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CORPS OF ENGINEERS U. S. ARMY
GARRISON DISTRICT
P.O.BOX 300, BISMARCK, NORTH DAKOTA

NOVEMBER 1950

RESERVOIR REGULATION PLANS FOR FLOOD CONTROL STORAGE IN HEART BUTTE RESERVOIR CONSTRUCTED BY THE BUREAU OF RECLAMATION

1. Authority. The following report on Reservoir Regulation Plans for Heart Butte Reservoir is submitted in compliance with instructions contained in a letter from the Division Engineer, Missouri River Division, to the District Engineer, Garrison District, dated 14 December 1948, subject, "Flood Control Provisions, Operating Regulations, and Benefits for Bureau of Reclamation Reservoirs authorized by Flood Control Act of 1944," File 800.5 MRDGU, and in paragraph C 2 of its accompanying inclosure, "General Procedural Outline for Accomplishment of Corps of Engineers' Responsibilities for Flood Control in Bureau of Reclamation Reservoirs in Missouri Basin Plan." The report was also prepared in conformity with paragraph 4220.01, Orders and Regulations and pertinent sections of the Engineering Manual for Civil Works referred to therein.

A. DESCRIPTION OF HEART BUTTE DAM AND RESERVOIR.

2. Purpose. Heart Butte Dam and Reservoir is a multiple-purpose project constructed by the Bureau of Reclamation. The project was included in Senate Document 191, 78th Congress, Second Session, with purposes stated as irrigation, power, flood and silt control, and was

authorized by the Flood Control Act approved 22 December 1944.

3. Location. The Heart Butte dam site is formed by a narrow gorge in the Heart River valley, 103.5 river miles above the mouth. The dam is located in Grant County, 18 miles south of Glen Ullin, North Dakota (plate 1).

4. Description of the basin. The 3,400 square mile drainage area of the Heart River, located in southwestern North Dakota, includes most of Stark and Morton Counties and smaller portions of Grant, Billings, Dunn, Hettinger and Oliver Counties. The basin is approximately 120 miles long and has a maximum width of about 40 miles. The long axis extends almost due west from the mouth of the river, which is at Missouri River mile 1373.3 about seven miles downstream from Mandan, North Dakota. A map of the basin is shown on plate 1. The upland topography is flat and gently rolling, typical of Missouri Plateau prairie land. The valley of the main stem, which averages about $\frac{1}{2}$ mile in width, lies about 100 feet below the general level of the upland plains. The valley walls are precipitous, and in some areas have the appearance of "badlands." Elevations in the basin range from 1630 to about 3300 feet above mean sea level. Stream slopes are adequate except near the mouth, where the stream traverses the broad, flat plain of the Missouri River Valley and the gradient is almost negligible.

5. Climate. Precipitation throughout the basin varies widely from year to year. The average is about 15.5 inches annually. While about 60 percent of the annual precipitation normally occurs during the growing season, agriculture within the basin has suffered severely from extended periods of drought. Summers are short, though sometimes hot,

and winters are long and cold. Recorded temperatures range from a maximum of 119° to a minimum of -50°. The mean annual temperature is 41°. Surface winds are strong and persistent and evaporation rates are high.

6. Economic development. The total population of the basin, by 1940 census, was 33,564 of which 13,684 were urban, living in cities or towns of 500 or over. Two cities, Mandan and Dickinson, have populations of over 5,000. Principal industries are general farming, stock raising, manufacturing, and mining. The Northern Pacific Railway main line traverses the length of the basin, and the area is well served by county, state, and Federal highways.

7. Stream flow. Stream flow is erratic, varying widely from season to season and from year to year. A large portion of the annual stream flow usually occurs during the early spring as a result of melting of the winter's accumulation of snow. This is the usual cause of damaging floods which are often increased in severity by jamming of ice. The most damaging flood of record, that of March 1943, was of the snow-melt type and affected nearly the entire length of the river. This flood had a peak flow of more than twice the previous maximum of record but no ice effect was noted in the lower reaches, apparently because of the very high discharge. Damages resulting from this flood are estimated as $1,257,200 of which $659,000 were direct damages in the city of Mandan. The greatest flood of record, that of April 1950, was also of the snow-melt type. Had not the Heart Butte Dam and the Corps of Engineers' local flood protection project at Mandan been in operation, damages would have exceeded those of 1943 by a wide margin. The 1950 flood damages in Heart River valley are estimated at $1,065,000.

The peak discharge at Mandan, about 31,000 c.f.s., although reduced by Heart Butte Reservoir exceeded that of 1943 by about 50 percent. Ice experience was similar to that of 1943, leading to the tentative conclusion that stage increases due to ice are greatest during floods of moderate discharge.

8. Stream flow usually becomes smaller as the season advances. Such rises as occur during the late spring and summer are the result of rains or heavy local thundershowers. These rises rarely cause flooding, and the minor damage they have caused has been confined to the lower reaches of the stream. During the period when the river is frozen, November through March, stages and discharges are usually low although winter thaws have on occasion caused appreciable stream flow. Prior to the construction of Heart Butte Dam, zero discharges were experienced during dry years.

9. History of the project. Irrigation possibilities along the Heart River were investigated in 1903 and 1904 by the Bureau of Reclamation. It was recommended at that time that no further investigation be made. In 1922 the Missouri Slope Irrigation Association, formed by people of Grant and Morton Counties, North Dakota, first developed interest in a combined irrigation and flood control project at the Heart Butte Reservoir site. In 1926 the Bureau of Reclamation made an investigation and submitted a report which considered such a combined project. In 1932 the Corps of Engineers submitted a report, (the "308 Report") published in House Document No. 238, 73rd Congress, second session, which discussed a multiple-purpose reservoir at the Heart Butte site similar to that considered by the Bureau of Reclamation.

The recommendation of this report was unfavorable because the finding indicated the economic impracticability of development. In 1937 the Corps of Engineers submitted a report which concluded that the flood control and irrigation project was not economically justified because the estimated costs exceeded the benefits. The report was returned for further study, and in June 1941 a review report was submitted which recommended construction of local flood protection works at Mandan, but did not recommend construction of a reservoir at the Heart Butte site because combined estimated benefits did not exceed the costs. Due to the unprecedented discharge and resultant damage caused by the 1943 flood, another review report was prepared with damage and benefit data revised to include information obtained during the 1943 flood. This report recommended construction of both the Mandan local protection project and the Heart Butte Reservoir. Heart Butte Reservoir was also discussed in a Bureau of Reclamation report, submitted in 1944 and published as Senate Document 191, 78th Congress, second session. The Flood Control Act of 1944 authorized construction of the reservoir by the Bureau of Reclamation as part of the comprehensive plan for the Missouri Basin with purposes stated as irrigation, power, flood and silt control. Subsequent studies showed that power production would be impracticable, and power provisions were not incorporated in the construction plans. Construction of the dam was started in March 1948 and completed in December 1949.

10. Description of the project. Heart Butte Dam is an earth-fill structure with a combined spillway and outlet conduit through the dam near the right abutment, and a short earth-fill dike closing a saddle

about 1½ miles southwest of the dam site. The dam rises about 124 feet above the river channel and has a maximum length of approximately 1850 feet. The dam and dike crests are at elevation 2124.0, mean sea level. The spillway consists of a single 14-foot diameter conduit having an uncontrolled, glory-hole intake with crest at elevation 2064.5 and an 11-foot diameter vertical entrance shaft. The irrigation outlet consists of a 63-inch diameter conduit, intake crest elevation 2030.0, with flows controlled by tandem 4-foot by 5-foot hydraulically operated slide gates. Discharges are made at a transition into the 14-foot spillway conduit. General features of the dam, spillway, and irrigation outlet are shown on plates 2, 3, 4, and 5.

11. The reservoir has a gross storage capacity of approximately 426,000 acre-feet at maximum pool elevation 2118.2. At spillway crest elevation 2064.5, the capacity is 75,500 acre-feet of which 68,700 acre-feet is for irrigation use and 6,800 acre-feet (reservoir elevation 2030.0) is for sediment control and dead storage. A map of the reservoir area is shown on plate 6. Of the 350,500 acre-foot capacity above spillway crest, 150,000 (reservoir elevation 2064.5 to 2094.5) is allocated for flood control storage. The remaining 200,500 acre-feet of surcharge capacity is provided for safety of the structure. Spillway capacity with the reservoir at maximum flood control pool elevation is 4,450 c.f.s. The irrigation outlet has a capacity of 690 c.f.s. with reservoir at spillway crest elevation and 710 c.f.s. at elevation 2067.0, the maximum reservoir elevation at which the outlet works can be operated because of design limitation. Reservoir area and capacity curves, and spillway and outlet discharge curves are shown on plate 7.

12. Basin development. Heart Butte is the only reservoir on the Heart River with storage capacity allocated for flood control. Dickinson Reservoir, another Bureau of Reclamation project on which construction was started in 1949 (plate 1), will provide some small flood control benefits incidental to operation for other purposes. The Corps of Engineers has constructed local flood protection works to protect the City of Mandan and has made investigations for protection of lower Heart River areas downstream from Mandan. The Bureau of Reclamation proposes to construct irrigation facilities serving 13,100 acres of the irrigable lands in the Heart River Valley in conjunction with storage capacity of Heart Butte Reservoir. These lands lie in scattered tracts along the Heart River between Heart Butte Dam and the mouth. Present plans call for construction of 37 separate pumping units, together with several additional relift pumps, to carry the water from Heart River to the irrigable tracts. A map showing the location of irrigable lands in the Heart River Valley, and the preliminary proposal for pump and canal locations, is presented on plate 8.

13. Pertinent data. Pertinent data regarding Heart Butte Dam and Reservoir are given in the following table:

TABLE I - Pertinent Data

Drainage Area Controlled		1758 square miles	
Reservoir			
Type of storage	Pool el.	Volume (A.F.)	Pool Area (Acres)
	2118.2		10,950
Surcharge		201,000	
	2094.5		6,625.

Table I - Pertinent Data (Contd)

Flood Control		150,000	
	2064.5		3,375
Irrigation		68,700	
	2030.0		870
Dead and Sediment Storage		6,800	
	2000		0

Dam

Type	Rolled-earth fill embankment
Crest elevation	2124.0 feet, m.s.l.
Base width in river channel	858.5 feet
Top width	40 feet
Length	1850 feet
Height above stream bed	124 feet

Spillway

Type	Ungated glory-hole shaft discharging into a 14-foot diameter conduit
Crest elevation	2064.5 feet, m.s.l.
Diameter at crest	27 feet
Diameter of vertical entrance shaft	11 feet
Capacity at elevation 2094.5 feet (top flood control pool)	4,450 second-feet

Outlet works

Type	Gated 63-inch diameter conduit

Table I - Pertinent Data (Cont'd)

Intake	Bellmouth opening
Discharge	Transition into spillway conduit
Capacity (at reservoir level 2064.5)	690 second-feet
Capacity (at reservoir level 2067.0, maximum pool elevation under which outlet works can be operated)	710 second-feet
Gates, slide, hydraulically Operated	2 - 4.0 ft. by 5.0 ft.
Control house	11.5 ft. by 17.5 ft.
Stilling basin	
Length	216.0 feet
Width (winged section at tunnel portal)	14.0 feet
Width (rectangular section at end sill)	26.5 feet

B. PROPOSED OPERATION OF HEART BUTTE RESERVOIR

14. Reservoir regulation section. Heart Butte Reservoir will at all times be operated under direction of the U. S. Bureau of Reclamation. When flood conditions exist or are imminent, the Corps of Engineers will be responsible for regulations governing such operation. At the present time, no reservoir regulation section exists in Garrison District and the organization of such a section is not contemplated in the near future. The only reservoir completed or nearing completion in the District which has flood control storage is Heart Butte. Its

action is largely automatic when the reservoir is in the flood control zone, and, consequently, there are normally no operating instructions to be issued. Until the time that a reservoir regulation section is needed, the Reports and Hydraulics Branch of the Engineering Division will perform the functions of a reservoir regulation section in addition to its regular duties. Plate 9 shows the present relationship of Heart Butte Reservoir to the District organization.

15. Reservoir regulation orders. It does not appear that reservoir regulation orders will be required. However, if unanticipated conditions should make necessary their issuance, the procedure will be as follows:

a. Normal procedure. Orders will be by memorandum and will conform to the following procedure:

(1) Will be initiated in the Reports and Hydraulics Branch.

(2) Will be numbered serially with the year following the order number, for example, Subject: Heart Butte Flood Control Regulation Order No. 1, 1950. The first order of each calendar year will be number 1.

(3) Will be routed through the following channels:

(a) Chief, Reports and Hydraulics Branch, through

(b) Chief, Engineering Division, to the

(c) District Engineer, to be forwarded simultaneously to the Regional Director and his representative at Bismarck, N. Dak., and to the Water Utilization Section, Missouri River Division.

b. Emergency procedure. During flood emergencies orders will be transmitted directly from the Chief, Engineering Division by radio or telephone to the Regional Director's representative at Bismarck, or in the event of failure of rapid communications with that office, directly to the reservoir operating personnel by whatever means available. Confirmation memoranda will be furnished by normal procedure.

c. Permanent records. Any reservoir regulation orders issued will be transmitted to the Water Utilization Section, Missouri River Division, at the same time they are transmitted to U. S. Bureau of Reclamation, or as soon thereafter as possible, with a brief explanation of the reasons for changing from the previous operation. The orders will also be entered into a permanent record at the District Office.

16. Plan of operation. The Heart Butte Reservoir will be operated primarily for irrigation and in the interest of flood control in accordance with the "Flood Control Regulations, Heart Butte Dam and Reservoir, Heart River, Grant County, North Dakota," appended hereto as exhibit I. Operation of the reservoir through several flood periods is shown graphically on plates 10 to 13, inclusive.

17. Sediment observations. Surveys and office studies for the purpose of preparing estimates of volume and location of sediment deposits in the reservoir will be made by United States Bureau of Reclamation in accordance with paragraph 2 of "Field Working Agreement Between Department of the Interior, Bureau of Reclamation and Department of the Army, Corps of Engineers, Regarding Operation of Heart Butte Dam and Reservoir, Heart River, Grant County, North Dakota," appended hereto as exhibit II.

18. Hydrologic network. The weather stations forming the hydrologic network in and surrounding Heart Basin are shown on plate 1. The stations in this network making regular reports are listed in table 2 below:

Table 2 - Reporting Precipitation Stations

Station	Type of gage (1)	Types of reports made		
		Snow reports (2)	Whenever precipitation of 1" or more occurs in 24 hours	Daily
Almont	N	X	X	
Belfield	N	X		
Bismarck	R	X		X
Carson	N	X		X (3)
Dickinson	R	X		X
Glen Ullin	R	X	X	
Mandan	R	X	X	
New Hradec	N	X		
New Salem	N	X	X	
Richardton	N	X		

(1) R - recording gage and N - nonrecording

(2) Snow reports include depth and moisture content of snow and are made weekly after 1 February and daily during melting period.

(3) April through September.

The reports from the above stations will be collected daily by the U. S. Weather Bureau office at Bismarck, North Dakota and transmitted by telephone to Garrison District office. The other stations shown on plate I will furnish, by telephone, available supporting data as needed.

19. Reporting program of stream-gaging and river-stage stations. Reports of river stages and discharges at the U. S. Geological Survey gaging stations in the Heart River Basin, under the direction of the District Engineer of that agency, with offices at Bismarck, North Dakota, are made available directly to the District Engineer, Garrison District. Reference is made to table 3 for the stage reporting program now in operation in the Heart River Basin. Hydrographs of past discharges at the Glen Ullin gage (near Heart Butte Dam site) are shown on plate 14. Locations of stream gaging stations are shown on plate 1. Rating curves for principal stations are shown on plate 15.

20. Forecasting of river stages and flows. In view of the largely automatic operation of the outlet works available for flood control releases and of the use of a large amount of superstorage in lieu of a spillway the forecasting of reservoir inflows is not as urgent or important as in some other types of project. However, in connection with flood fighting operations at the Mandan Levee project downstream, stage and flow forecasts will be made for the reservoir as well as for the downstream uncontrolled area. To date these forecasts have been made on the basis of routing flow quantities derived from river stage reports (see page 14 and Plate 1). Studies are under way to develop procedures for the quantitative forecasting of runoff from snow melt or from the rainfall from summer storms.

Table 3 - Stream Gaging Stations in Heart River Basin

Miles above mouth of stream	Drainage area (sq.mi.)	Type of gage	Agency	Zero elev. of gage (ft.m.s.l.)	Flood Stage (ft.)	Approx. discharge at flood stage (c.f.s.)	Maximum of record (as of April 1950)			Period of Record	Reporting
							Stage (ft.)	Discharge (c.f.s.)	Date		
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
13.7	5362	R	USGS	1638.70	17	11,000	24.7	30,400 (a)	(b)	1924; 1928-33;1937-	Daily when 3/4 bankfull or higher
62.0	2790	R	USGS		15	9,000	20.70	29,200 (a)	Apr. '50	1946-	Daily when 3/4 bankfull or higher
103.2	1750	R	USGS		(c)		18.77	25,000	(d)	1943-	Daily when 3/4 bankfull or higher
151.5	1310	W	USGS		20	8,000	28.2	22,000 (a)	Apr. '50	1902-22; 1943-	Daily when 3/4 bankfull or higher
190.0	453	W	USGS		14	3,100	17.9	6,000 (a)	Apr. '50	1943-	When requested
210.0	315	R	USGS		18	2,300	21.65	4,000 (a)	Apr. '50	1947-	When requested
63.0	2789										
11.0	454	W	USGS		22	2,400	30.7	20,200 (a)	Apr. '50	Oct. '45-	Daily when 3/4 bankfull or higher
4.0	221	W	USGS		13	1,700	17.95	11,100 (a)	Apr. '50	1948-	When requested
179.5	862										
4.0	370	W	USGS		16	2,500	18.0 (e)	5,500 (a)	Apr. '50	1945-	When requested

Provisional Data, subject to adjustment.
age March 1943, maximum discharge April 1950.
yon with steep walls; not susceptible to overflow.
age March 1943, maximum discharge March 1947.
age known about 20 ft. in March 1943.

Table 5 - Stream Gaging Stations in Heart River Basin

Stream and Station	Miles above mouth of stream	Drainage area (sq.mi.)	Type of gage	Agency	Zero elev. of gage (ft.m.s.l.)	Flood Stage (ft.)	Approx. discharge at flood stage (c.f.s.)	Maximum of record (as of April 1950)			Period of Record	
								Stage (ft.)	Discharge (c.f.s.)	Date		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	
Heart River												
Mandan	13.7	3362	R	USGS	1638.70	17	11,000	24.7	30,400 (a)	(b)	1924; 1928-35;1937-	Dail
Lark	62.0	2790	R	USGS		15	9,000	20.70	29,200 (a)	Apr. '50	1946-	Dail
Glen Ullin	103.2	1750	R	USGS		(c)		18.77	25,000	(d)	1943-	Dail
Richardton	151.5	1310	W	USGS		20	8,000	28.2	22,000 (a)	Apr. '50	1902-22; 1943-	Dail
Lehigh	190.0	453	W	USGS		14	3,100	17.9	6,000 (a)	Apr. '50	1943-	When
South Heart	210.0	315	R	USGS		18	2,300	21.65	4,000 (a)	Apr. '50	1947-	When
Muddy Creek	63.0	2789										
Almont	11.0	454	W	USGS		22	2,400	30.7	20,200 (a)	Apr. '50	Oct. '45-	Dail
Antelope Creek												
Carson	4.0	221	W	USGS		13	1,700	17.95	11,100 (a)	Apr. '50	1948-	When
Green River	179.5	862										
Gladstone	4.0	370	W	USGS		16	2,500	18.0 (e)	5,500 (a)	Apr. '50	1945-	When

(a) Taken from Provisional Data, subject to adjustment.
(b) Maximum stage March 1943, maximum discharge April 1950.
(c) Narrow canyon with steep walls; not susceptible to overflow.
(d) Maximum stage March 1943, maximum discharge March 1947.
(e) Maximum stage known about 20 ft. in March 1943.

21. Forms for reporting data.

a. Monthly reservoir operation chart. It is planned to utilize Form RO-1, "Monthly Reservoir Regulation," to show graphically the complete day to day operation of Heart Butte Reservoir, including the inflow, outflow, reservoir elevation, storage in acre-feet, and precipitation. Completed copies of the Form will be furnished the Chief of Engineers, Washington, D. C., and the Division Engineer, Missouri River Division, Omaha, Nebraska, as set forth in paragraph 4220.01d, Orders and Regulations. Plate 16 is a completed version of the above form showing reservoir operation during the record 1950 flood.

b. Monthly reservoir operation tabulation. A form entitled "Monthly Reservoir Operation" showing the daily reservoir elevation, outflow, storage, evaporation, and inflow in tabular form will also be prepared. A sample of the form is shown on plate 17.

22. Flood control regulations and field working agreement. The "Flood Control Regulations Heart Butte Dam and Reservoir, Heart River, Grant County, North Dakota," and the "Field Working Agreement" regarding operation of Heart Butte Dam and Reservoir reached by representatives of the Corps of Engineers and the Bureau of Reclamation at a conference held in the Office of the Division Engineer, Corps of Engineers, Missouri River Division, Omaha, Nebraska, on 2 March 1950, are included as exhibits I and II of this manual.

23. The flood control storage in Heart Butte Reservoir and the Mandan Levee Project were designed as a team to provide the most effective flood protection to the greatest potential damage center on the Heart River. In addition the operation of this flood control storage has in large part been coordinated with the flood control operation of other reservoirs in the Missouri Basin through the almost fully automatic design of the outlet works available for flood control releases.

24. Estimation of Flood Damages. The Corps of Engineers will make the evaluation of damages presented immediately subsequent to hydrologic events which under natural conditions would have caused overflow of valley lands. The results of such determination will be released to the Bureau of Reclamation and furnished to the public in appropriate news releases as soon as possible.

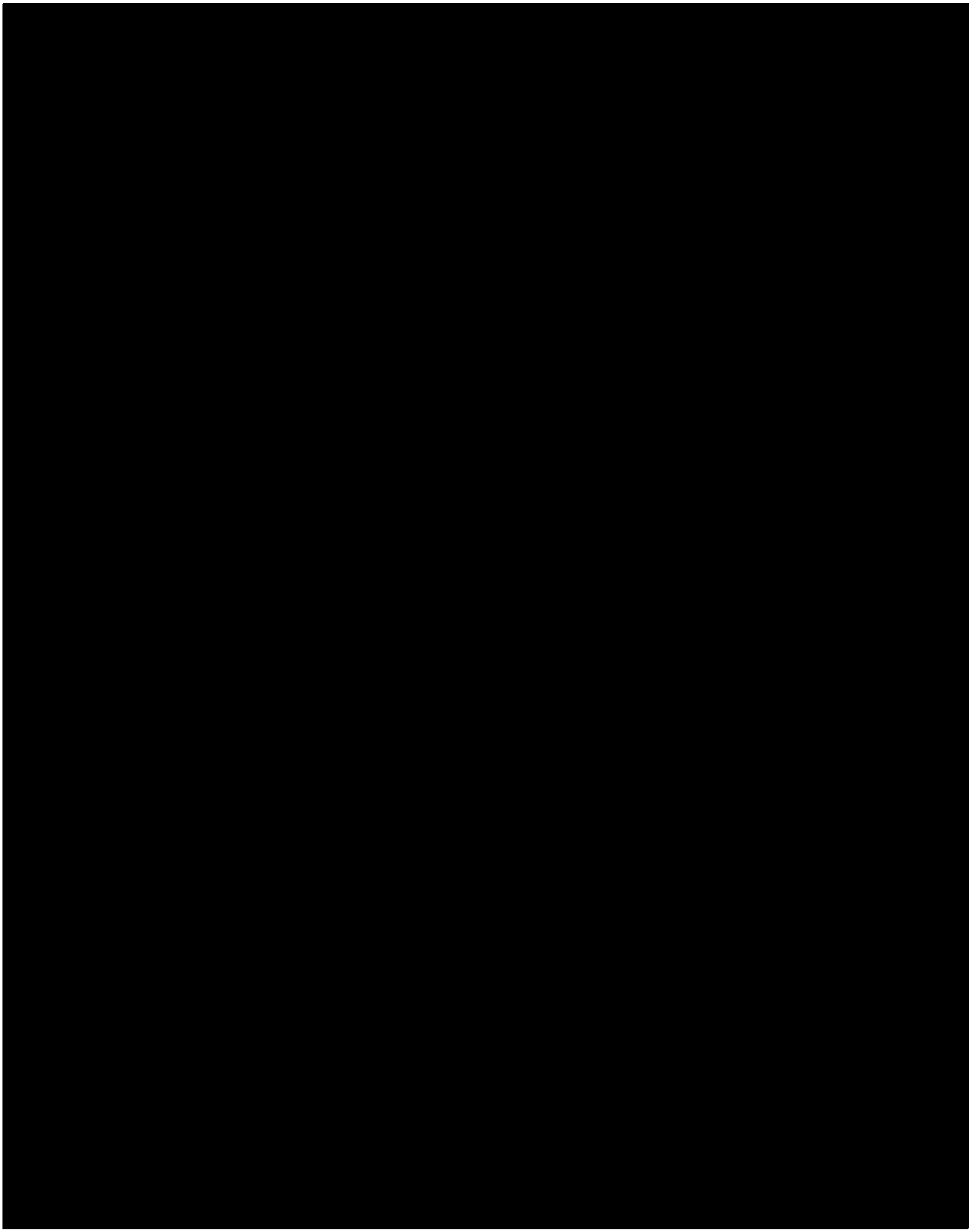


EXHIBIT I

TITLE 33—NAVIGATION AND NAVIGABLE WATERS

Chapter II—Corps of Engineers, Department of the Army

PART 208—FLOOD CONTROL REGULATIONS

HEART BUTTE DAM AND RESERVOIR, HEART RIVER, NORTH DAKOTA

Pursuant to the applicable provisions of sections 7 and 9 of the act of Congress approved December 22, 1944 (58 Stat. 890; 33 U. S. C. 709), the following regulations are hereby prescribed to govern the use of storage capacity for flood control purposes in the Heart Butte Reservoir on Heart River, Grant County, North Dakota, and the operation of Heart Butte Dam for flood control purposes.

§ 208.36 *Heart Butte Dam and Reservoir, Heart River, N. Dak.* The Bureau of Reclamation, Department of the Interior, represented by its appropriate Regional Director, hereinafter referred to as the Regional Director, shall operate the Heart Butte Dam and Reservoir in the interest of flood control as follows:

(a) The flood control storage capacity of the reservoir, which initially amounts to 150,000 acre feet between elevations 2064.5 and 2094.5, will be operated to restrict discharges to the capacity of the ungated glory-hole type shaft spillway except as necessary for irrigation requirements, unless otherwise directed by the District Engineer, Corps of Engineers, Department of the Army, in charge of the locality, hereinafter referred to as the District Engineer. Whenever the reservoir is above elevation 2064.5 and below elevation 2067.0, the Regional Director will at the request of the District Engineer make supplementary releases up to the full capacity of the irrigation outlet for the purpose of expediting evacuation of the flood control storage. Oral instructions of the District Engineer to the Regional Director shall be confirmed in writing under date of the day issued.

(b) The discharge characteristics of the ungated glory-hole type shaft spillway (having an estimated capacity of 4,450 c. f. s. with water surface at maximum flood control pool elevation 2094.5), shall be maintained in accordance with the construction plans (Bureau of Reclamation Specifications No. 1992).

(c) Proposed schedules of irrigation releases and storage changes, if available, and current operating data shall be provided to the District Engineer by the Regional Director. These data shall be tabulated daily and furnished periodically as required, and shall include such items as: reservoir elevation; reservoir storage; inflow; discharge; and pertinent available hydrologic data.

(d) Whenever the reservoir level reaches or exceeds elevation 2064.5 or flood discharges appear imminent, the Regional Director shall report at once to the District Engineer by telephone, telegraph, or radio and as requested thereafter until the reservoir level falls to elevation 2064.5 or below and flood discharges cease.

(e) Nothing in the regulations of this section shall be construed to require that releases shall be made at rates or in a manner that would be inconsistent with requirements for protecting the dam and reservoir from damage.

(f) All elevations stated in this section are at the Heart Butte Dam and are referred to the datum in use at that location.

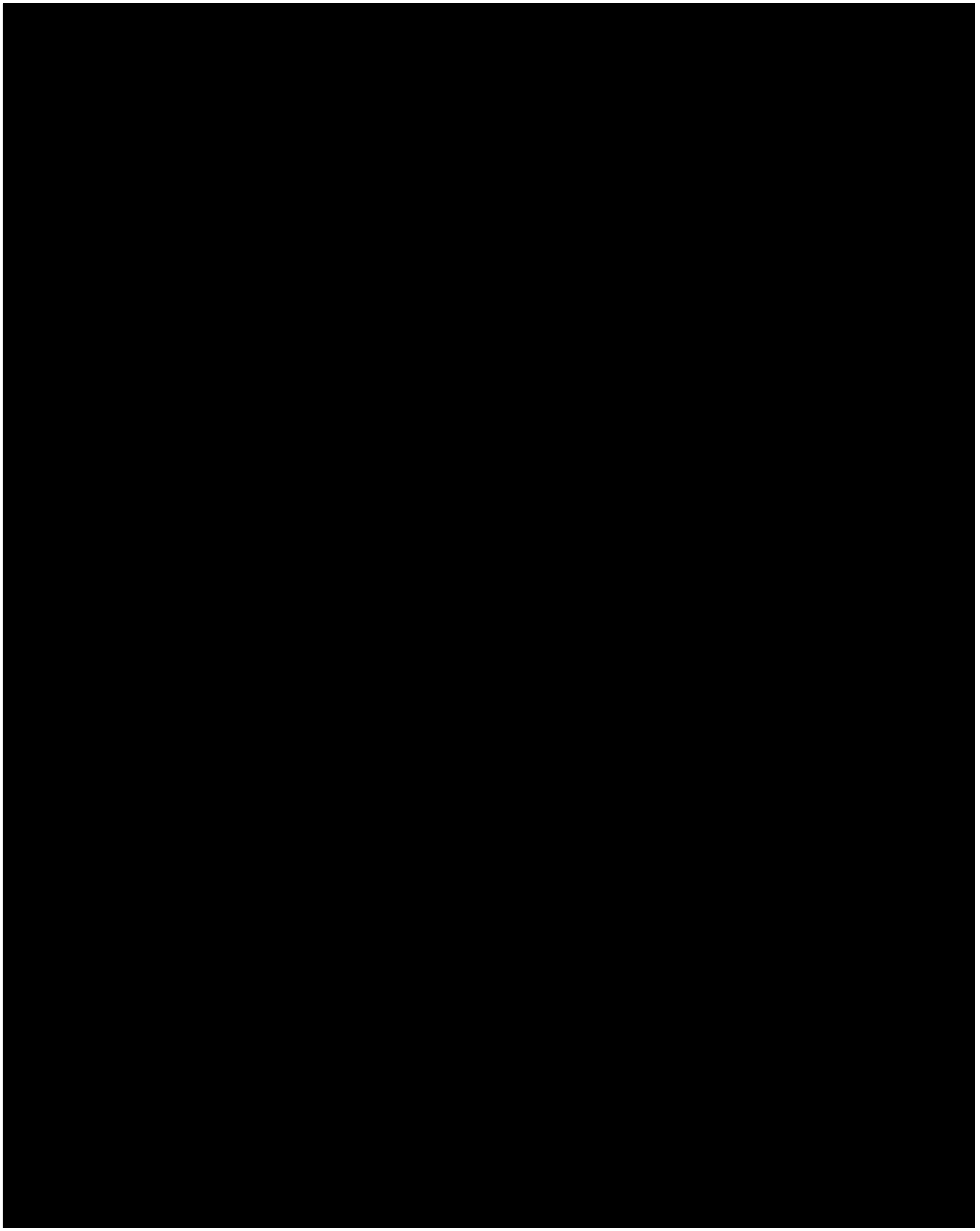
[Regs. Jan. 11, 1951—ENGWE] (Sec. 7, 58 Stat. 890; 33 U. S. C. 709)

[SEAL] EDWARD F. WITSELL,
Major General, U. S. A.
The Adjutant General.

[F. R. Doc. 51-1970; Filed, Feb. 7, 1951; 8:53 a. m.]

*Published in the Federal Register on 8 February 1951.

Incl 1



5/19/53

EXHIBIT II

FIELD WORKING AGREEMENT BETWEEN
DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION AND
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS,
REGARDING OPERATION OF
HEART BUTTE DAM AND RESERVOIR,
HEART RIVER, GRANT COUNTY, NORTH DAKOTA

THIS AGREEMENT, made and entered into this 15th day of March 1951 between the Bureau of Reclamation and the Corps of Engineers.

WITNESSETH, THAT:

WHEREAS, The Department of the Interior, acting through the Bureau of Reclamation, represented by its appropriate Regional Director, hereinafter referred to as the Regional Director, has constructed the Heart Butte Dam and Reservoir on Heart River near Glen Ullin, North Dakota and is responsible for safety of the structure and for irrigation operations of the Heart River Unit of the Missouri River Project, of which said dam and reservoir are a part and

WHEREAS, The Department of the Army, acting through the Corps of Engineers, represented by its appropriate District Engineer, hereinafter referred to as the District Engineer, is responsible for flood-control operations of said dam and reservoir and

WHEREAS, Flood Control Regulations, prepared in accordance with the Flood Control Act of 22 December 1944 and attached hereto as Appendix A and made a part hereof, have been agreed to between the parties hereto and published in the Federal Register and

WHEREAS, there is a need for a working agreement to implement the Flood Control Regulations in order that there will be a clear understanding between the District Engineer and the Regional Director as to reservoir operation for flood control, including details of storage allocations and possible reallocations, hydrologic data collection and reporting arrangements.

Incl 2

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto as follows:

1. Storage capacity allocations.—The storage capacity allocations of Heart Butte Reservoir, exclusive of surcharge storage capacity above elevation 2094.5 m.s.l., which is provided in combination with spillway capacity to insure safety of the structure, are defined in the following subparagraphs:

a. Flood-control storage.—Flood-control storage capacity shall include the storage capacity between elevation 2064.5 m.s.l. and elevation 2094.5 m.s.l. (initially amounting to 150,000 acre-feet) and for which there have been constructed suitable outlet works to provide discharges as expressly indicated herein.

b. Irrigation storage.—Irrigation storage capacity allocations shall include the storage capacity between elevation 2030.0 m.s.l. and 2064.5 m.s.l. (initially amounting to 68,700 acre-feet).

c. Dead storage.—Dead storage capacity includes the storage capacity between streambed elevation and elevation 2030.0 m.s.l. (initially amounting to 6,800 acre-feet). This capacity is established by the elevation of the outlet works.

2. Storage reallocations.—The Regional Director shall at reasonable intervals make necessary field surveys and office studies to prepare estimates of the volume and location of sediment deposits in the reservoir. If the results of these studies show that the storage available for flood control and irrigation, respectively, is reduced by an amount exceeding 10 percent of the allocation for either purpose, the operating plan described herein with respect to the elevation limits of the storage allocations shall be reviewed with the view of equitably distributing the loss of reservoir capacity

between the primary reservoir uses. Any redistribution of storage capacity allocations is to be contingent on paragraph 6.

3. Plan of operation.—The Regional Director shall operate the Heart

[redacted]

control operation. When the reservoir level is above 2094.5 m.s.l. or below 2064.5 m.s.l., the District Engineer may make recommendations to the Regional Director for operation in the interest of flood control, but such recommendations

[redacted]

5. Collection and assembly of hydrologic data and reporting arrangements.—Available reports from precipitation and stream flow stations pertinent to the operation of Heart Butte Reservoir which are collected by the Regional Director will be relayed to the District Engineer by the most expeditious method of communication under detailed arrangements as may be made from time to time.

6. Design limitations.—The irrigation outlet will be closed for reservoir levels above elevation 2067.0 m.s.l. because of limitations in design of the outlets. It is recognized that any changes in the discharge characteristics of the spillway structure resulting from reallocation of storage capacities, or for any other reason, which otherwise are mutually acceptable to the Corps of Engineers and the Bureau of Reclamation must be approved by the Chief Engineer of the Bureau of Reclamation.

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

CORPS OF ENGINEERS

[redacted]

District Engineer
Garrison District

BUREAU OF RECLAMATION

Regional Director
Region 6

5/13/53

EXHIBIT II

FIELD WORKING AGREEMENT BETWEEN
DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION AND
DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS
REGARDING OPERATION OF
HEART BUTTE DAM AND RESERVOIR,
HEART RIVER, GRANT COUNTY, NORTH DAKOTA

[redacted] THIS AGREEMENT, made and entered into this 15 day of March, [redacted] between the Bureau of Reclamation and the Corps of Engineers.

WITNESSETH, THAT:

WHEREAS, the Department of the Interior, acting through the Bureau of Reclamation, represented by its appropriate Regional Director, hereinafter referred to as the Regional Director, has constructed the Heart Butte Dam and Reservoir on Heart River near Glen Ullin, North Dakota and is responsible for safety of the structure and for irrigation operations of the Heart River Unit of the [redacted] which said dam and reservoir are a part and

WHEREAS, the Department of the Army, acting through the Corps of Engineers, represented by its appropriate District Engineer, hereinafter referred to as the District Engineer, is responsible for flood-control operations of said dam and reservoir and

WHEREAS, Flood Control Regulations, prepared in accordance with the Flood Control Act of 22 December 1944, and attached hereto as Appendix A and made a part hereof, have been agreed to between the parties hereto and published in the Federal Register and

WHEREAS, there is a need for a working agreement to implement the Flood Control Regulations in order that there will be a clear understanding between the District Engineer and the Regional Director as to

reservoir operation for flood control, including details of storage allocations and possible reallocations, hydrologic data collection and reporting arrangements.

NOW, THEREFORE, it is mutually understood and agreed by and between the parties hereto as follows:

1. Storage capacity allocations.--The storage capacity allocations of Heart Butte Reservoir, exclusive of surcharge storage capacity above elevation 2094.5 m.s.l., which is provided in combination with spillway capacity to insure safety of the structure, are defined in the following subparagraphs:

a. Flood-control storage.--Flood-control storage capacity shall include the storage capacity between elevation 2064.5 m.s.l. and elevation 2094.5 m.s.l (initially amounting to 150,000 acre-feet) and for which there have been constructed suitable outlet works t[redacted] discharges as expressly indicated herein.

b. Irrigation storage.--Irrigation storage capacit[redacted] allocations shall include the storage capacity between elevation 2030.0 m.s.l. and 2064.5 m.s.l. (initially amounting to 68,700 acre-feet).

c. Dead storage.--Dead storage capacity includes the storage capacity between streambed elevation and elevation 2030.0 m.s.l. (initially amounting to 6,800 acre-feet). This capacity is established by the elevation of the outlet works.

2. Storage reallocations.--The Regional Director shall at reasonable intervals make necessary field surveys and office studies to prepare estimates of the volume and location of sediment deposits in the reservoir. If the results of these studies show that the storage available for flood control and irrigation, respectively, is reduced by an

amount exceeding 10 percent of the allocation for either purpose, the operating plan described herein with respect to the elevation limits of the storage allocations shall be reviewed with the view of equitably distributing the loss of reservoir capacity between the primary reservoir uses. Any redistribution of storage capacity allocations is to be contingent on paragraph 6.

3. Plan of operation.--The Regional Director shall operate the

arrangements.--Available reports from precipitation and stream flow stations pertinent to the operation of Heart Butte Reservoir which are collected by the Regional Director will be relayed to the District Engineer by the most expeditious method of communication under detailed arrangements as may be made from time to time.

6. Design limitations.--The irrigation outlet will be closed for reservoir levels above elevation 2067.0 m.s.l. because of limitations in design of the outlets. It is recognized that any changes in the discharge characteristics of the spillway structure resulting from reallocation of storage capacities, or for any other reason, which otherwise are mutually acceptable to the Corps of Engineers and the Bureau of Reclamation must be approved by the Chief Engineer of the Bureau of Reclamation.

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

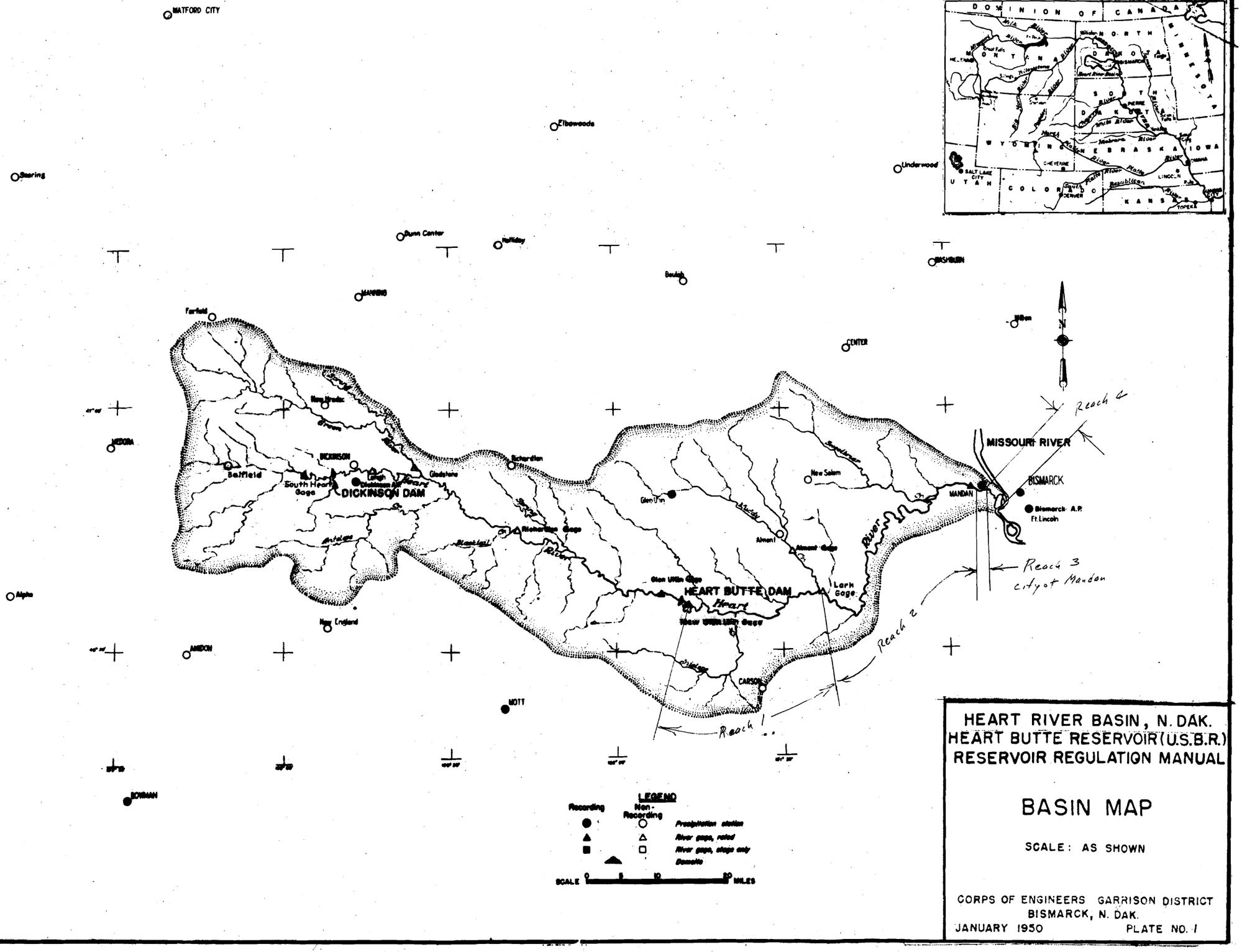
CORPS OF ENGINEERS

BY_____
District Engineer
Garrison District

BUREAU OF RECLAMATION

BY_____
Regional Director
Region VI

U.S. ARMY CORPS OF ENGINEERS



HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)
RESERVOIR REGULATION MANUAL

BASIN MAP

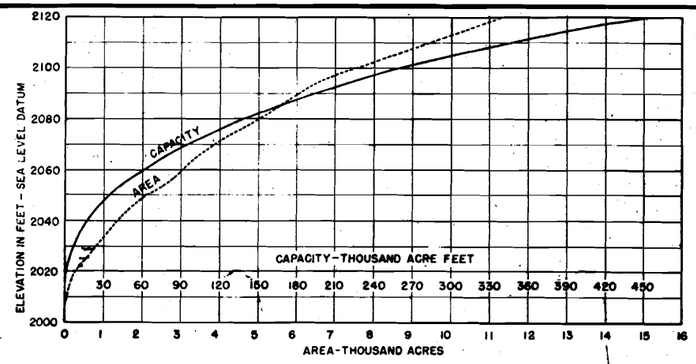
SCALE: AS SHOWN

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.
JANUARY 1950 PLATE NO. 1

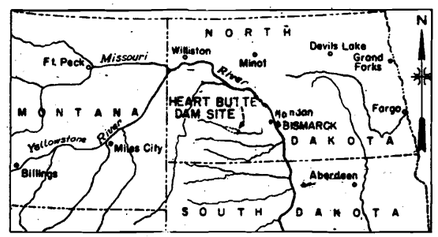
PLATE NO. 3

[redacted]

[redacted]



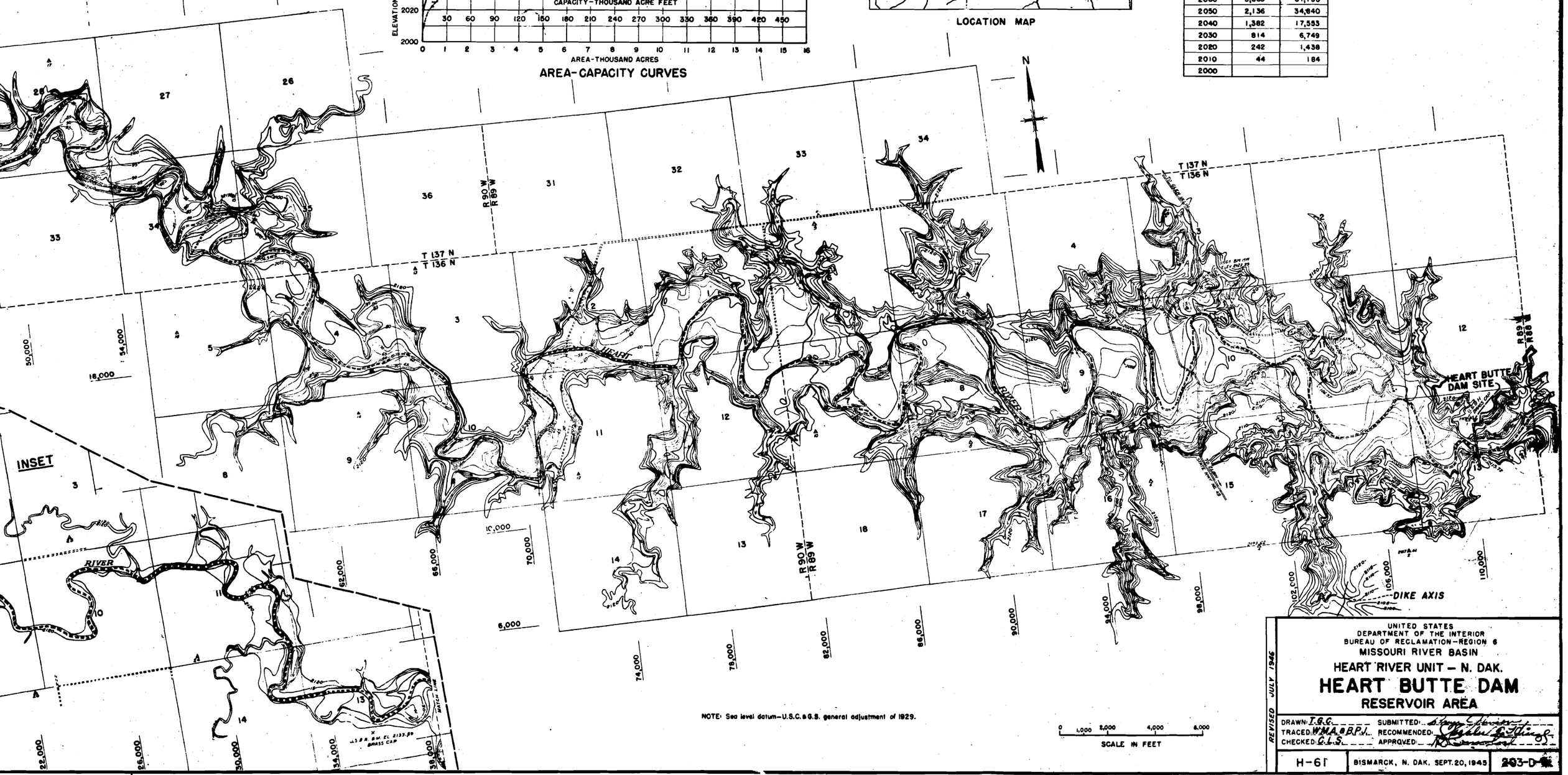
AREA-CAPACITY CURVES



LOCATION MAP

AREA AND CAPACITY

CONTOUR ELEVATION	AREA ACRES	CAPACITY ACRE FEET
2120	11,344	449,243
2100	7,566	262,103
2090	6,059	195,102
2080	5,018	139,840
2070	3,856	95,599
2060	3,069	61,153
2050	2,136	34,840
2040	1,382	17,553
2030	814	6,749
2020	242	1,438
2010	44	184
2000		



NOTE: Sea level datum—U.S.C.&G.S. general adjustment of 1929.

0 1,000 2,000 4,000 6,000
SCALE IN FEET

REVISED JULY 1946

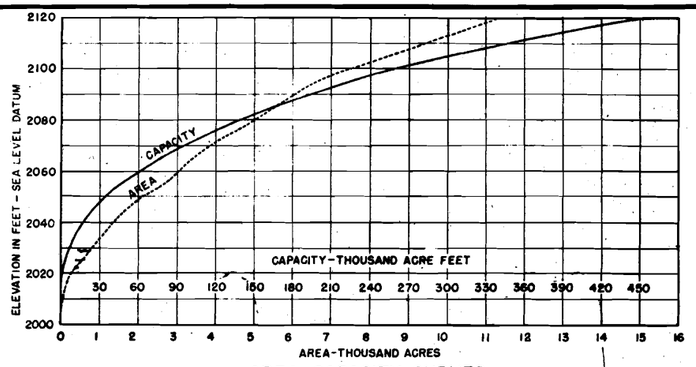
UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION—REGION 6
MISSOURI RIVER BASIN
HEART RIVER UNIT – N. DAK.

HEART BUTTE DAM
RESERVOIR AREA

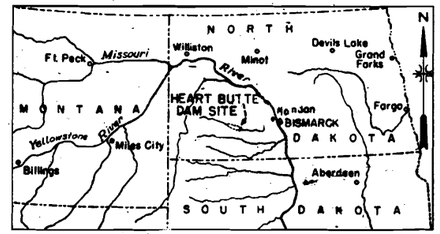
DRAWN: I.G.C. SUBMITTED:
TRACED: W.M.A. & B.P.J. RECOMMENDED:
CHECKED: C.L.S. APPROVED:

H-61 | BISMARCK, N. DAK. SEPT. 20, 1945 | 293-D-61

PLATE NO. 6



AREA-CAPACITY CURVES



LOCATION MAP

STARK COUNTY
GRANT COUNTY

R 91 W
R 90 W

R 90 W
R 89 W

T 137 N
T 136 N

T 138 N
T 137 N

INSET

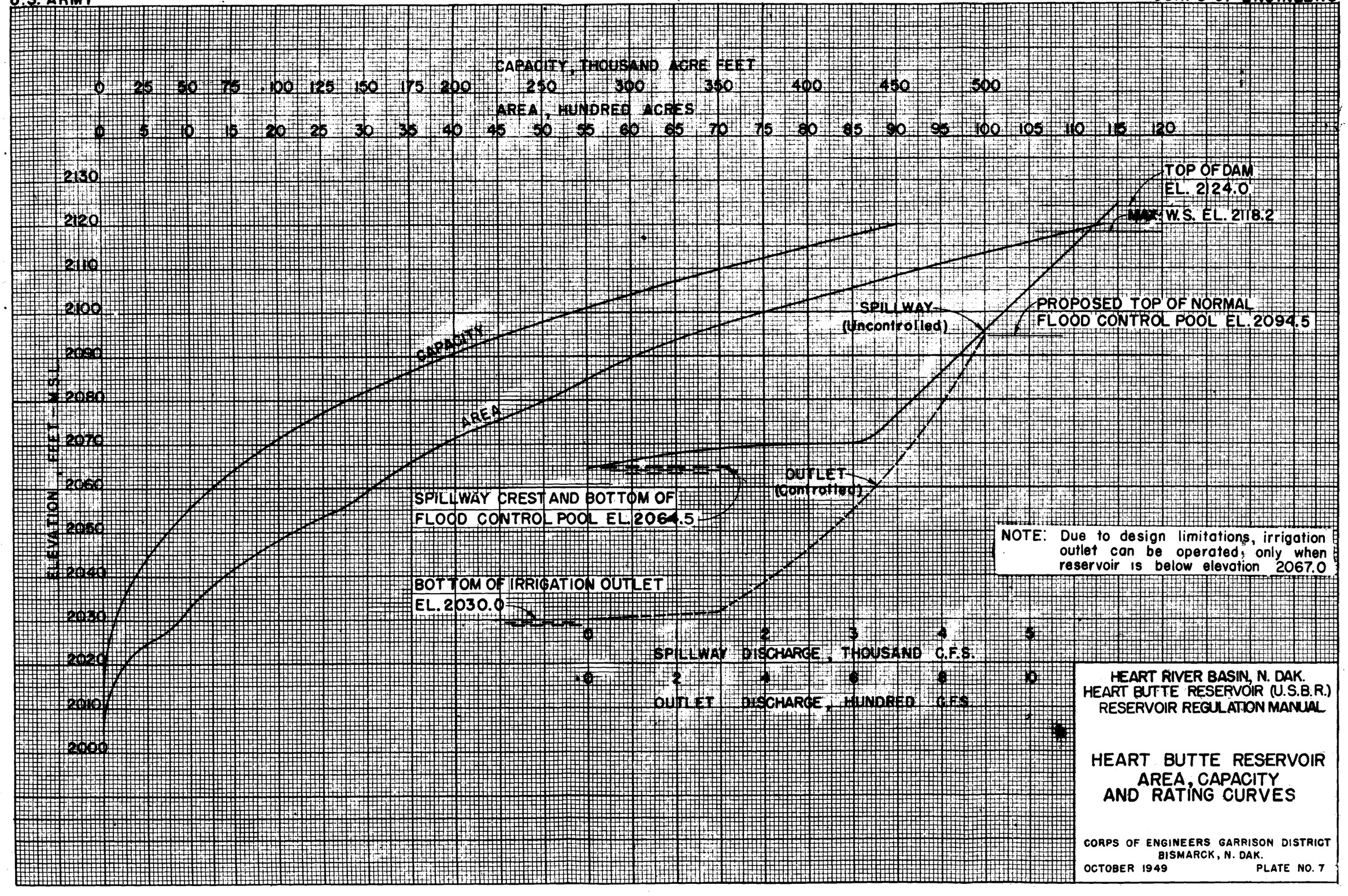
HEART RIVER

NOTE: Sea level datum—U.S.C. & G.S. general adjustment of 1929.

0 1,000 2,000 4,000
SCALE IN FEET

U.S. ARMY

CORPS OF ENGINEERS

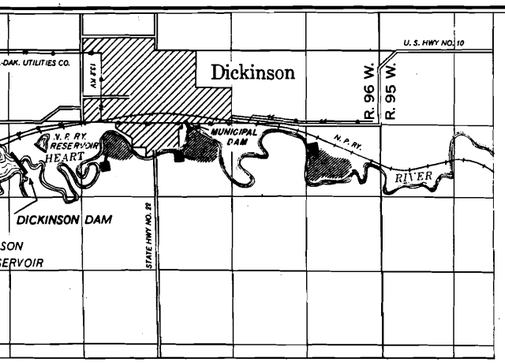


NOTE: Due to design limitations, irrigation outlet can be operated only when reservoir is below elevation 2067.0

HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)
RESERVOIR REGULATION MANUAL

HEART BUTTE RESERVOIR AREA, CAPACITY AND RATING CURVES

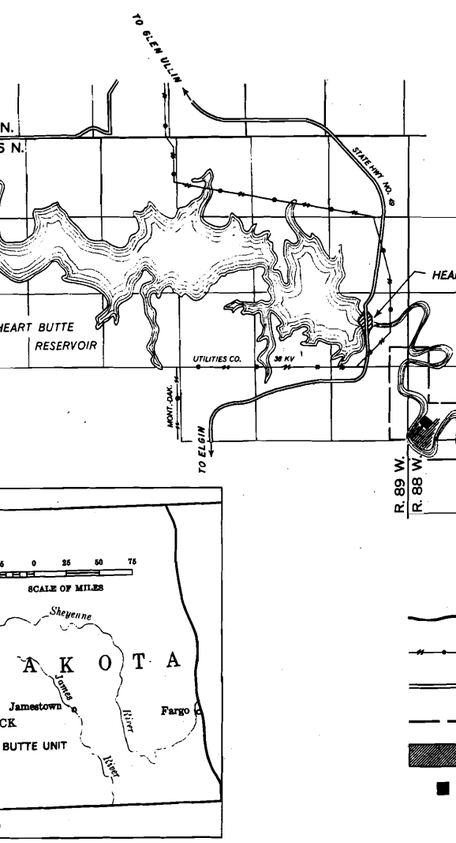
CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.
OCTOBER 1949 PLATE NO. 7



DICKINSON UNIT

INFORMATION OF INTEREST

Location: South Western North Dakota, extending westward along the Heart River from Mandan.
Source of water supply: Heart River and Tributaries.
Climate: Average annual precipitation 15.7 inches with 10.7 inches from April to August; mean annual temperature 40° F; average frost free period is 129 days.
Principal products: Alfalfa, oats, barley, corn, pasture, potatoes and truck crops.
Character of soil of irrigable area: Sandy loams and silt loams.
Irrigable area of Heart Butte Unit is 13,180 acres and of the Dickinson Unit 915 acres.
The irrigation plan of the Heart Butte Unit provides for the storage of water for irrigation in the Heart Butte Reservoir and the installation of a number of pumping units to serve the irrigable areas below the Heart Butte Dam. In the Dickinson Unit the Dickinson Dam and Reservoir will provide municipal and irrigation water and furnish flood protection and other benefits. Separate pumping units will serve the irrigable areas.
The capacities of the pumps vary from 3 sec. ft. to 50 sec. ft.
Status: Construction started.



HEART BUTTE UNIT

EXPLANATION

- CANALS
- POWER TRANSMISSION LINES
- HIGHWAYS
- IRRIGATION DISTRICT BOUNDARY
- IRRIGABLE AREA
- PUMPING PLANT SITE

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. Krug, Secretary

BUREAU OF RECLAMATION—REGION 6
Michael W. Straus, Commissioner

MISSOURI RIVER BASIN PROJECT

HEART DIVISION

DICKINSON AND HEART BUTTE UNITS

NORTH DAKOTA

Prepared in the Regional Office
Billings, Montana
Kenneth F Vernon, Regional Director

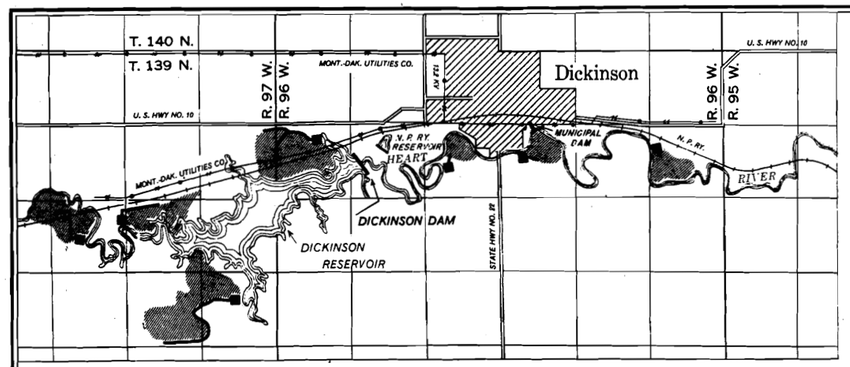
MAP NO. 43-0-124

SCALE OF MILES

1 0 1 2 3

1948

PLATE NO. 8



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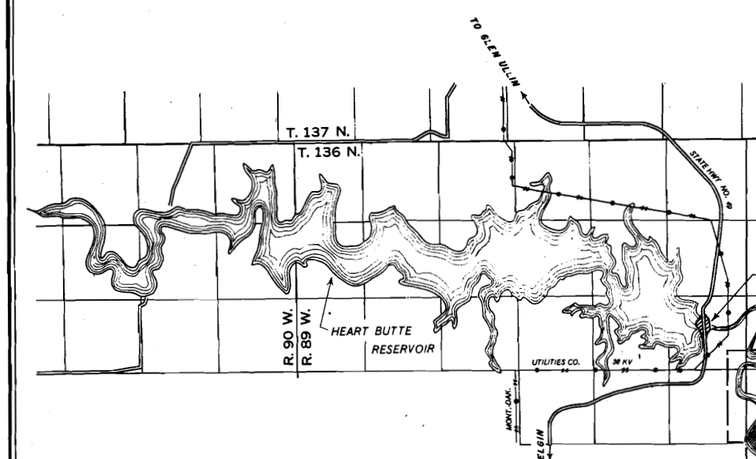
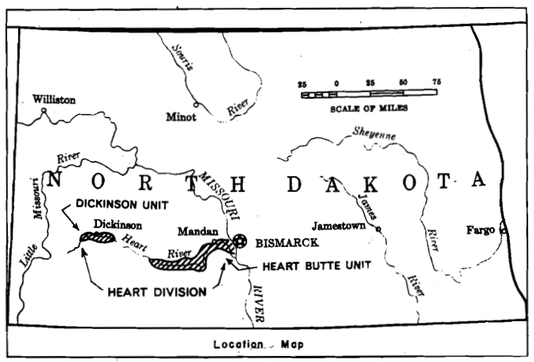


HEART BUTTE UNIT



EXPLANATION

- CANALS
- POWER TRANSMISSION LINES
- HIGHWAYS
- IRRIGATION DISTRICT BOUNDARY
- IRRIGABLE AREA
- PUMPING PLANT SITE

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. Krug, Secretary

BUREAU OF RECLAMATION—REGION 6
Michael W. Straus, Commissioner

MISSOURI RIVER BASIN PROJECT

HEART DIVISION

DICKINSON AND HEART BUTTE UNITS

NORTH DAKOTA

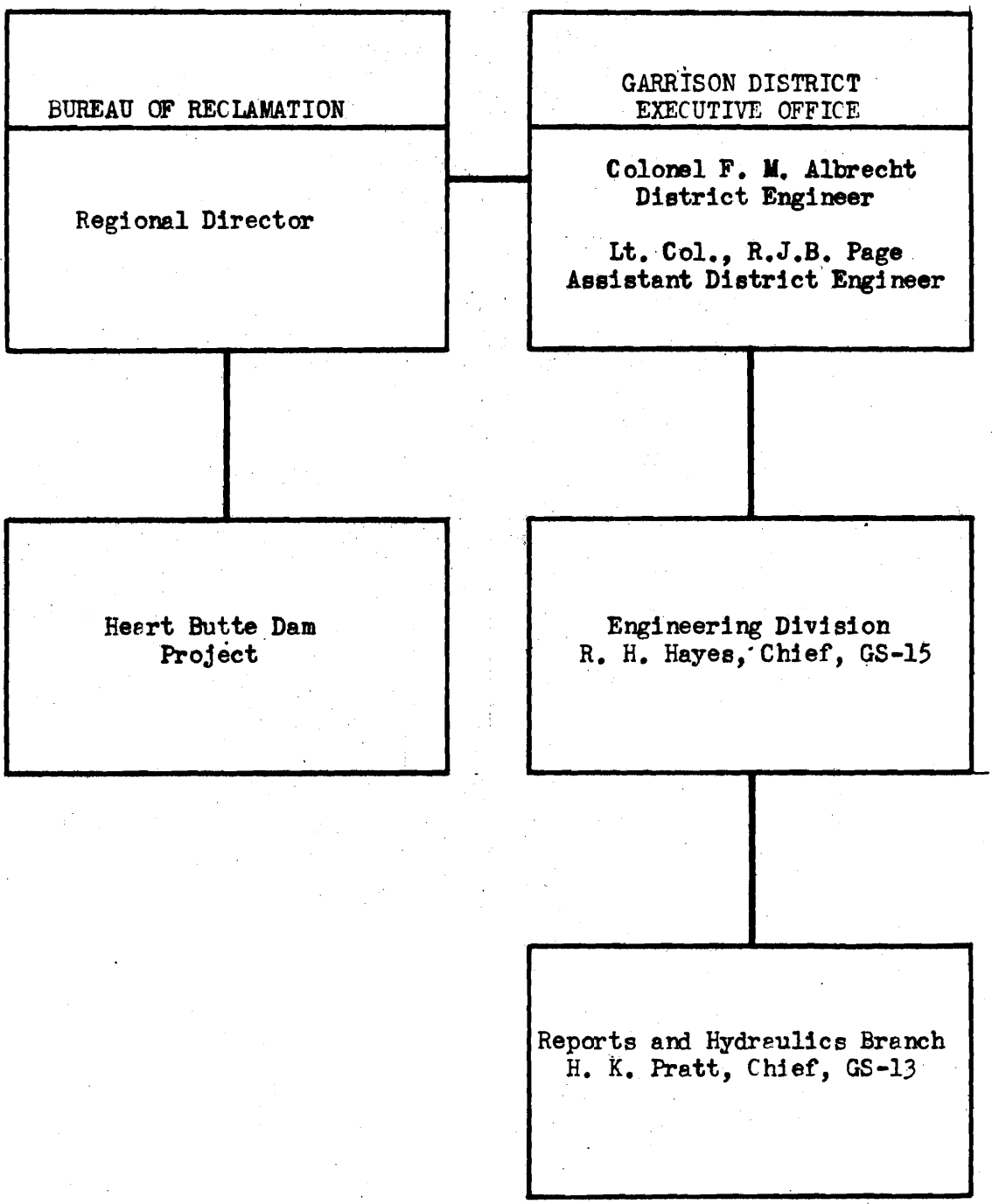
Prepared in the Regional Office
Billings, Montana
Kenneth F Vernon, Regional Director

MAP NO. 43-0-124

SCALE OF MILES

1 0 1 2 3

1948



HEART RIVER BASIN, N. DAK.

HEART BUTTE RESERVOIR (U.S.B.R.)

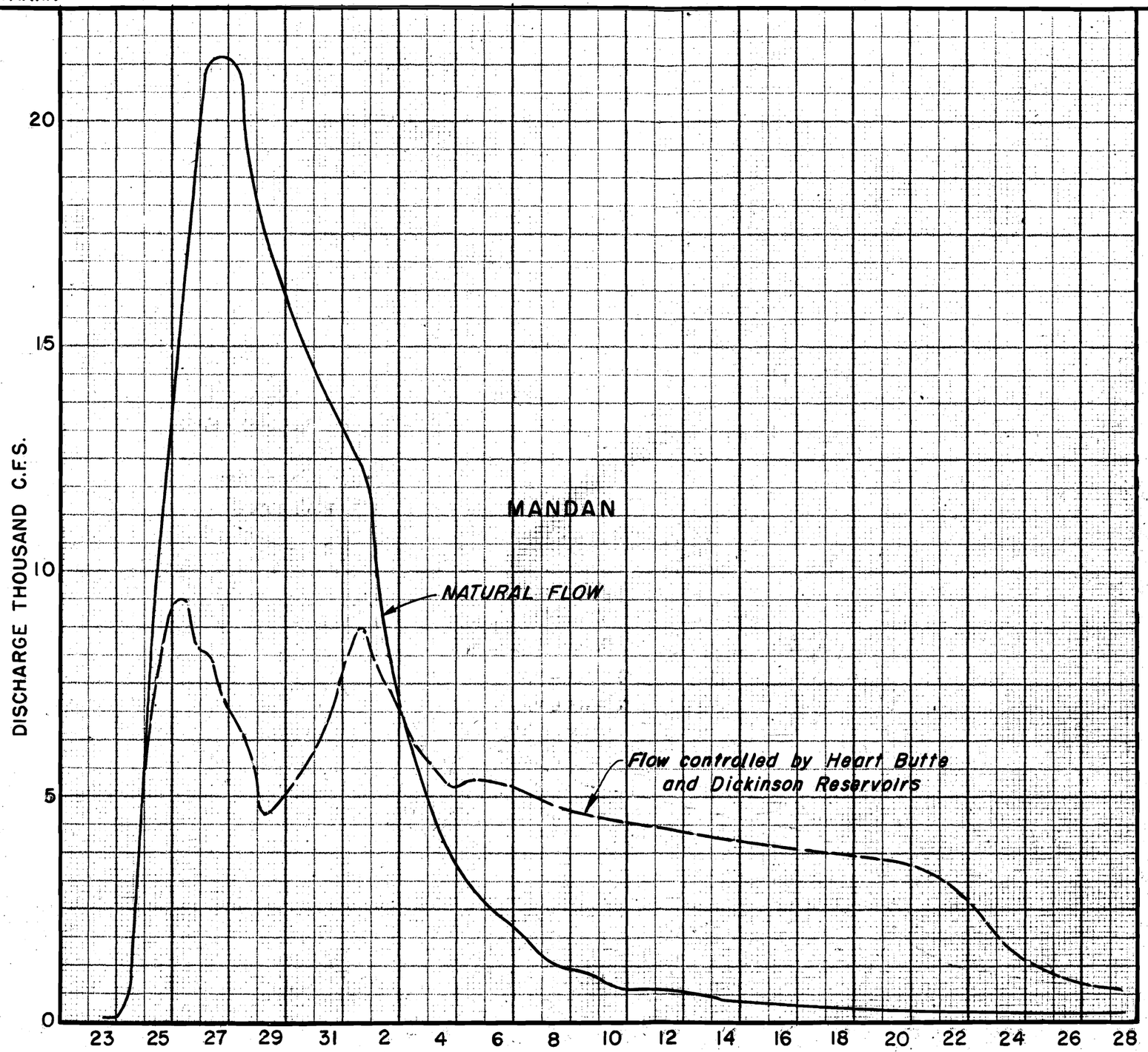
RESERVOIR REGULATION MANUAL

District Office Organization under Normal and Emergency Conditions

Corps of Engineers Garrison District
Bismarck, N. Dak.

U.S. ARMY

CORPS OF ENGINEERS



NOTES:

Releases from reservoir through spillway only (irrigation outlet closed)

Reservoir assumed to be full to spillway lip (el. 2064.5, storage 75,500 acre feet) at start of flood.

HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)

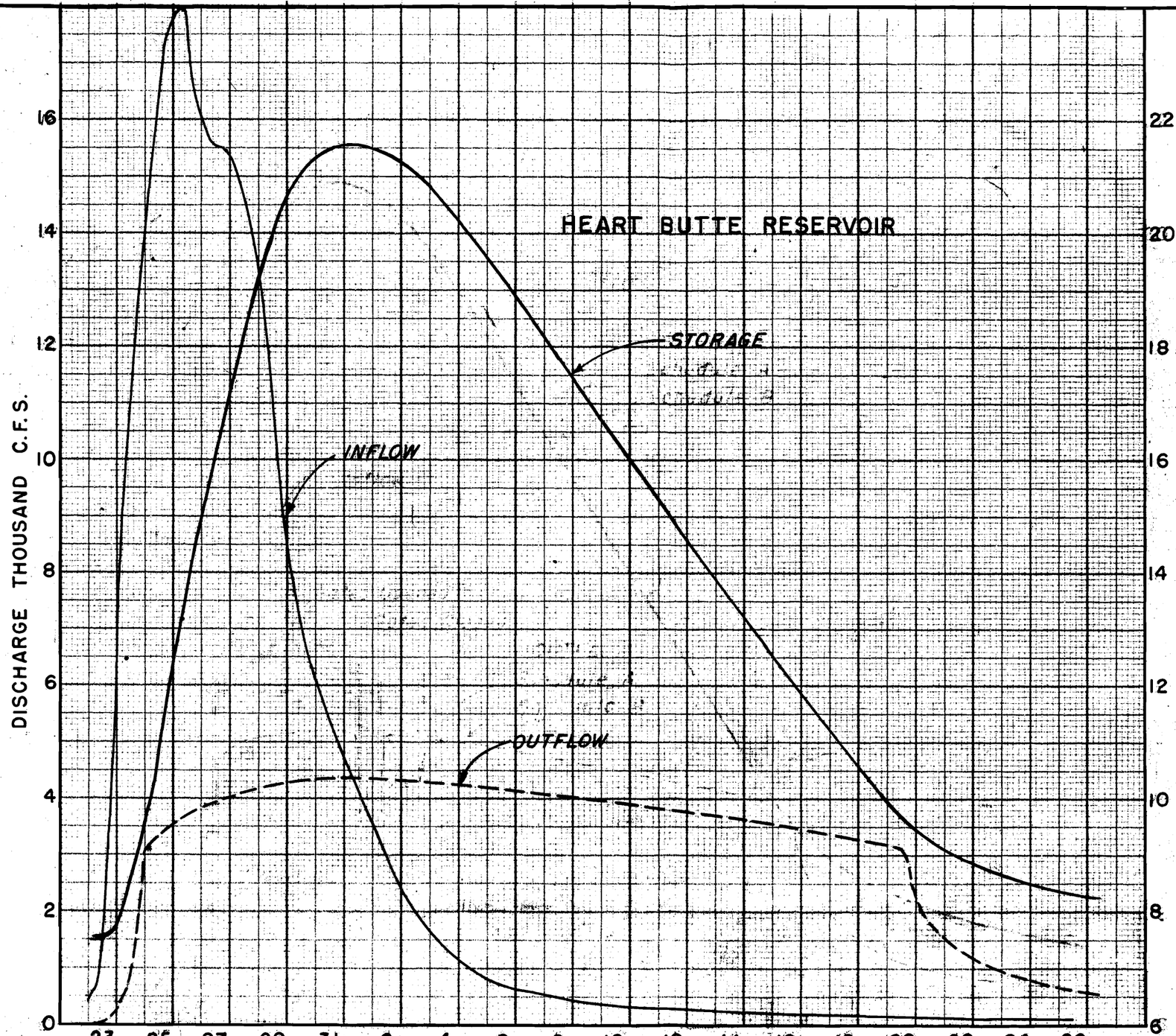
RESERVOIR REGULATION MANUAL

HYDROGRAPHS AT MANDAN, N. DAK. FOR 1943 FLOOD

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.

PLATE NO. 10

U.S. ARMY CORPS OF ENGINEERS



NOTES:

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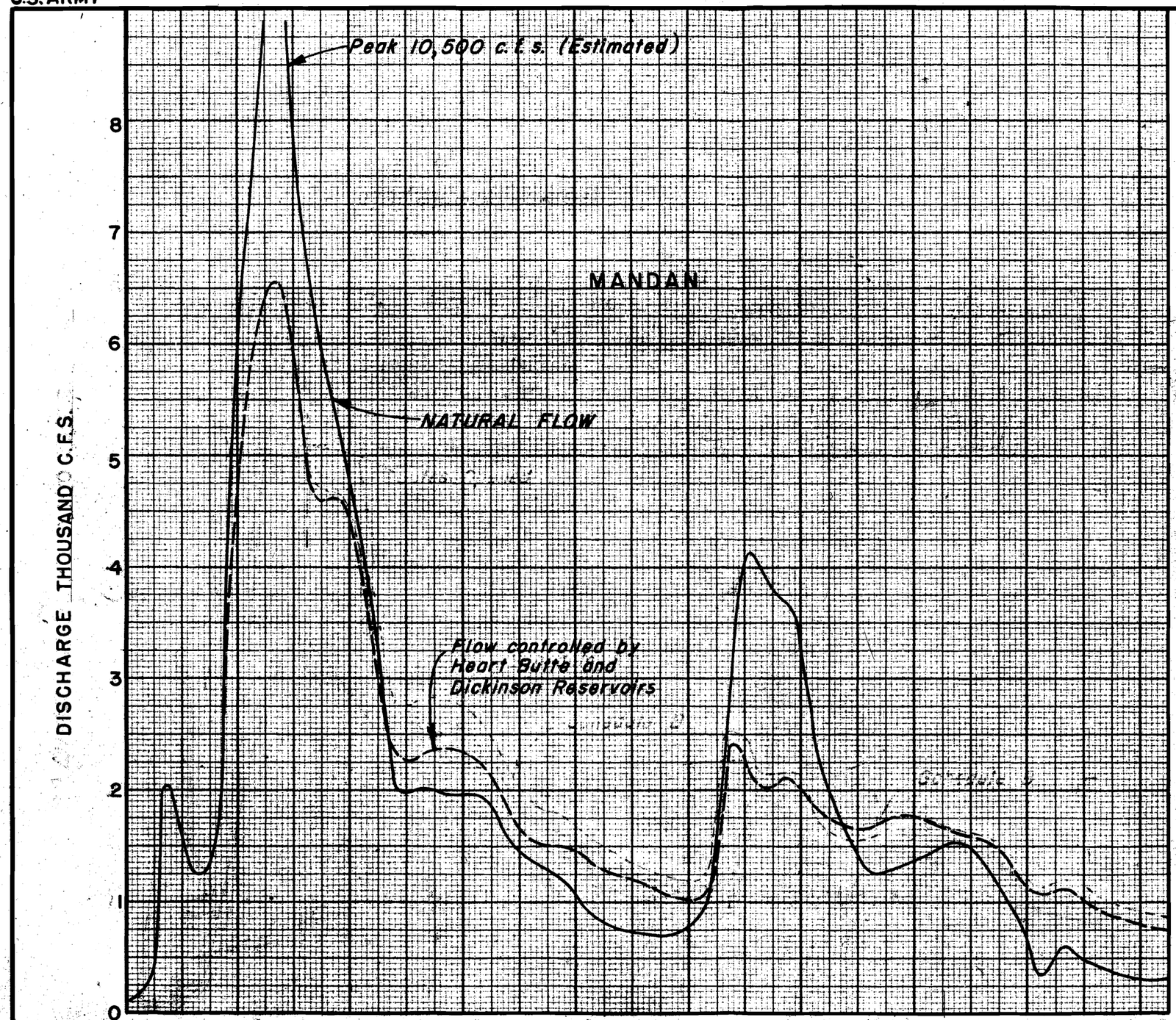
HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)

RESERVOIR REGULATION MANUAL

HYDROGRAPHS & STORAGE CURVES AT HEART BUTTE RESERVOIR FOR 1943 FLOOD

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.
PLATE NO. II

U.S. ARMY CORPS OF ENGINEERS



NOTES:

Releases from reservoir through spillway only (irrigation outlets closed)

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HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)

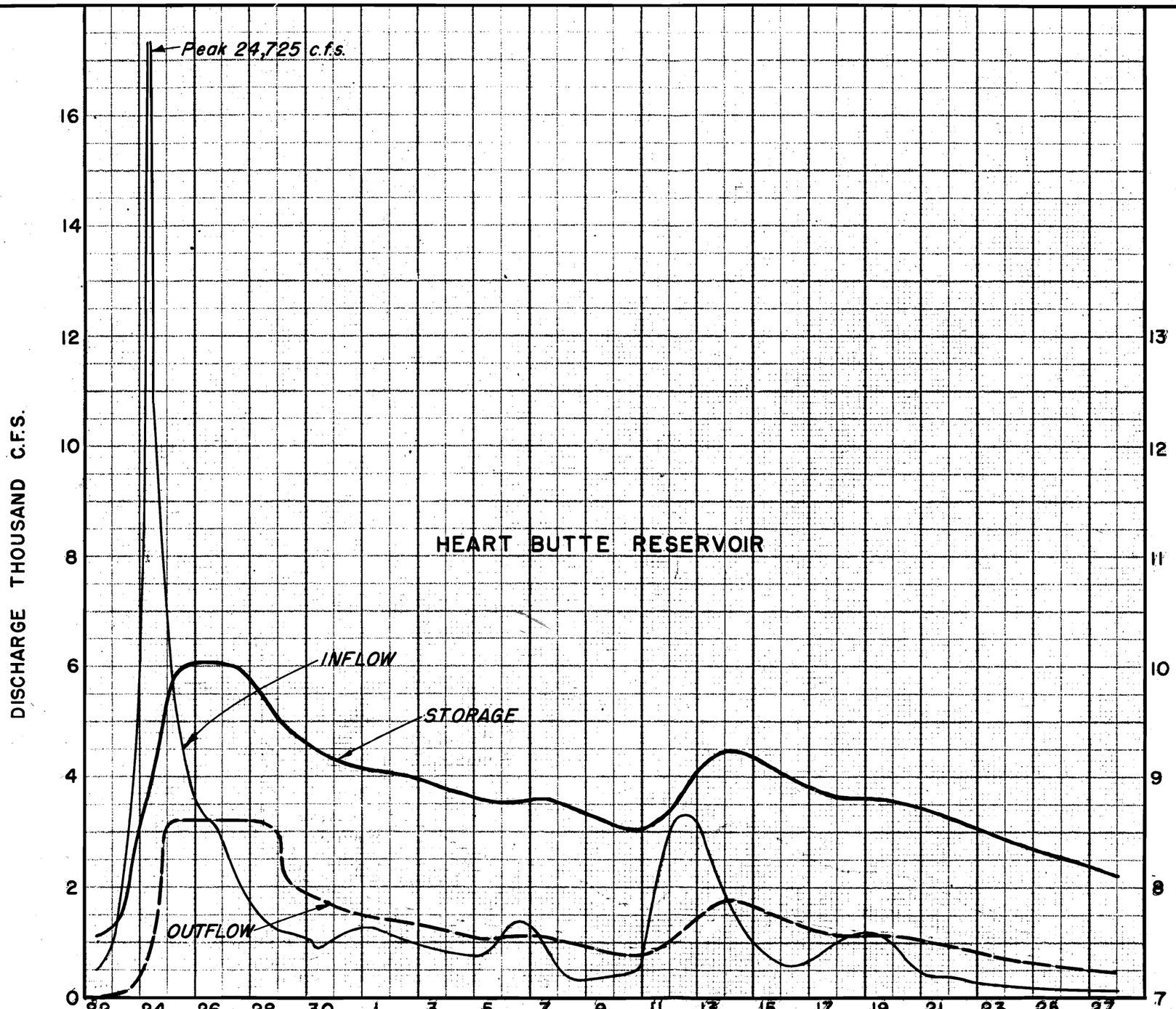
RESERVOIR REGULATION MANUAL

HYDROGRAPHS AT MANDAN FOR 1947 FLOOD

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.
PLATE NO. 12

U.S. ARMY

CORPS OF ENGINEERS



NOTES:

Releases from reservoir through spillway only (irrigation outlets closed).

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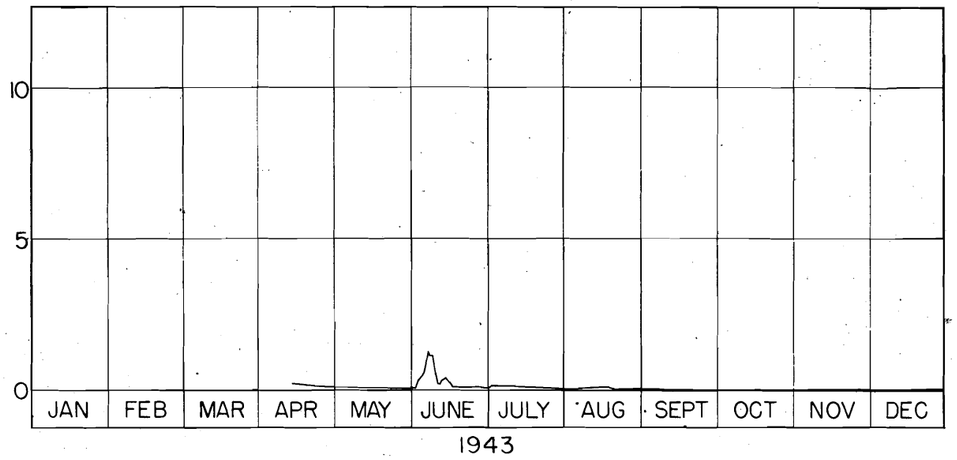
HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)

RESERVOIR REGULATION MANUAL

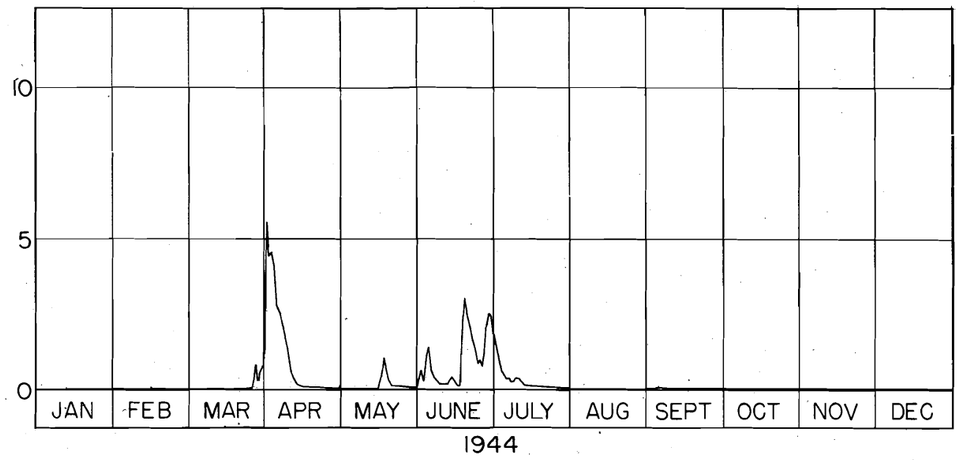
HYDROGRAPHS & STORAGE CURVES AT HEART BUTTE RESERVOIR FOR 1947 FLOOD

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.

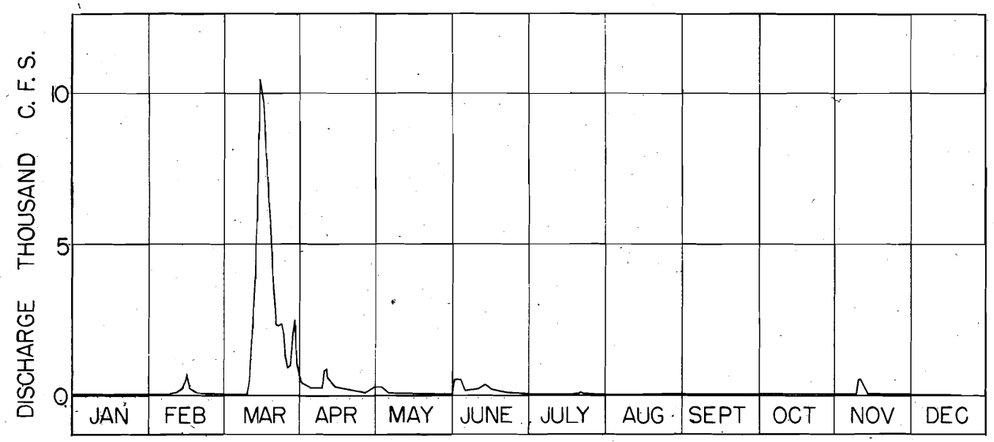
PLATE NO. 13



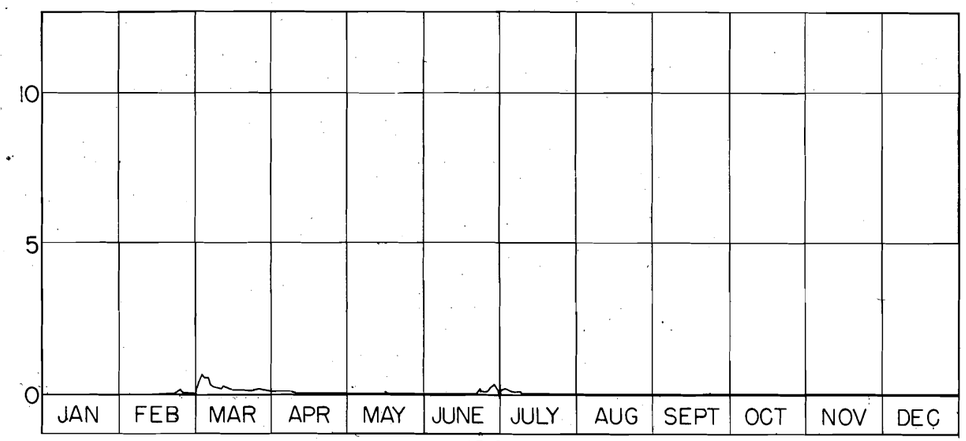
1943



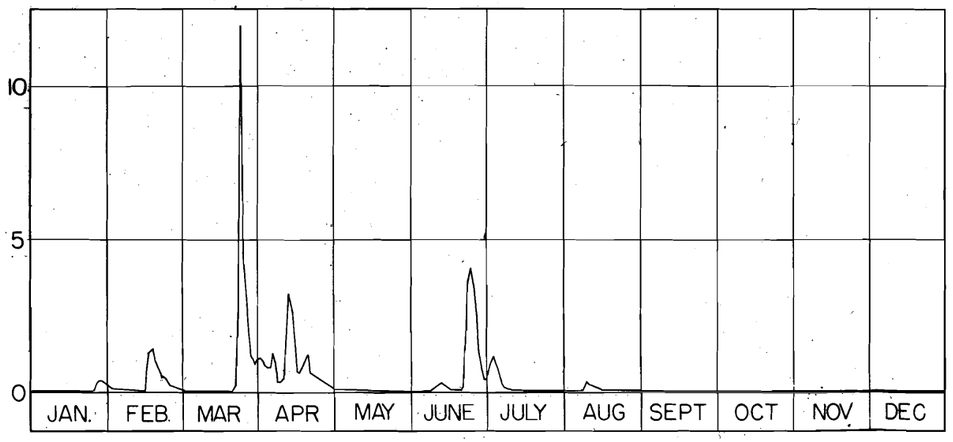
1944



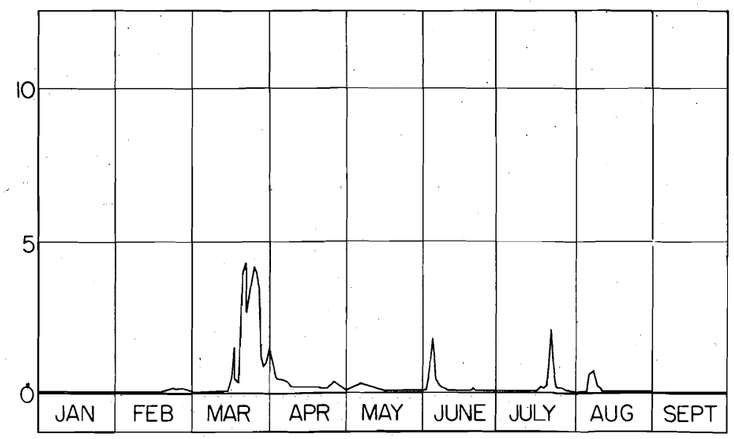
1945



1946



1947



1948

HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)
RESERVOIR REGULATION MANUAL

GLEN ULLIN HYDROGRAPHS

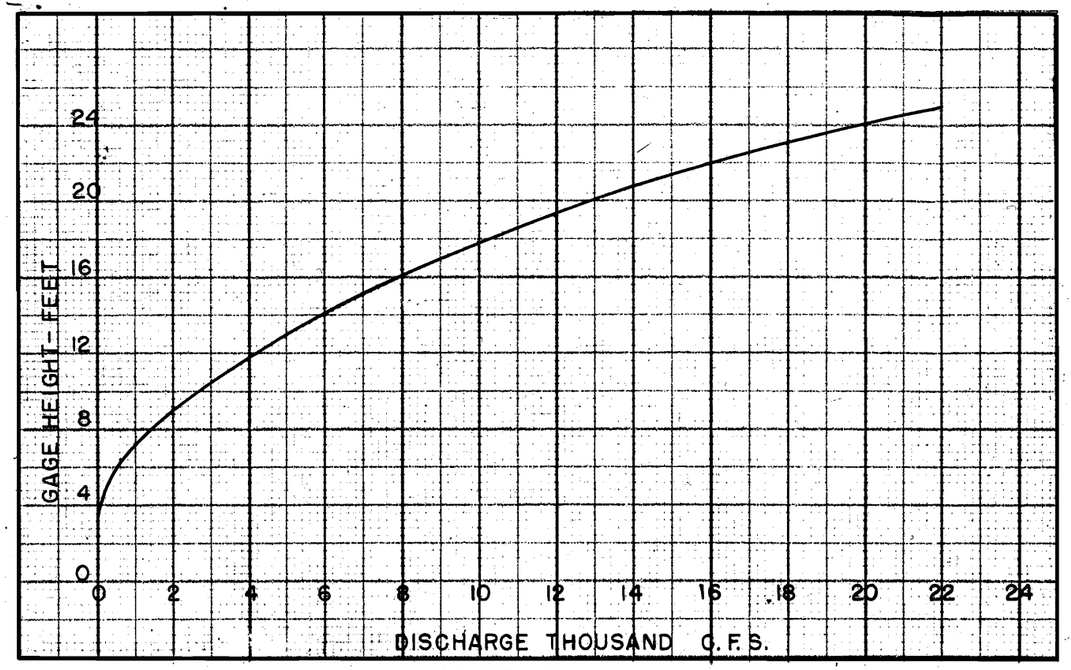
SCALE: AS SHOWN

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK.

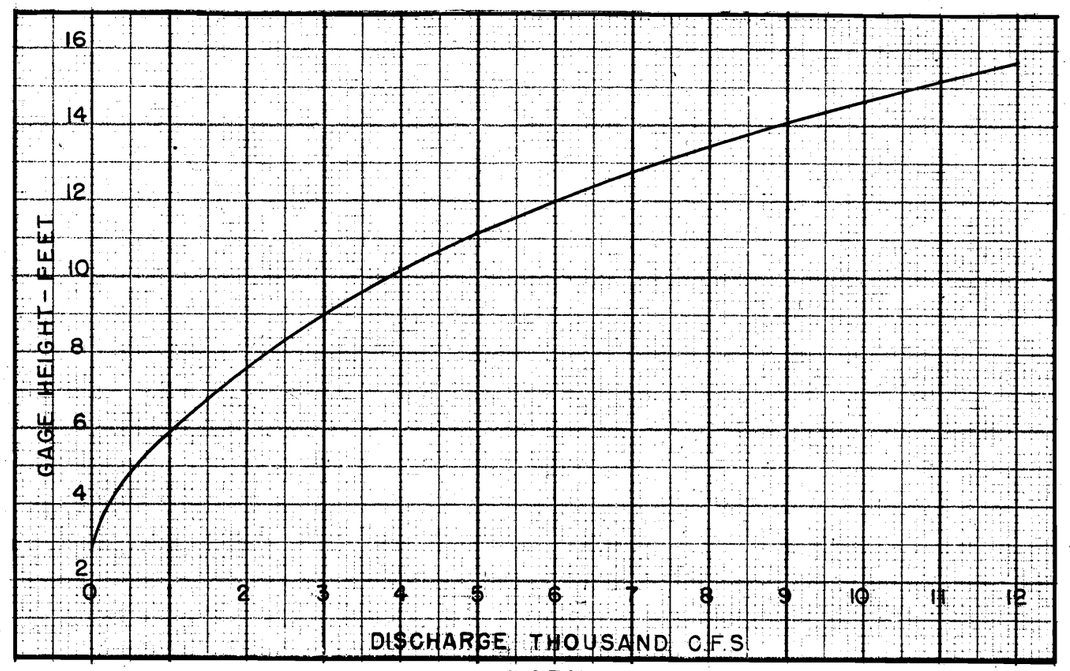
JANUARY 1950 PLATE NO. 14

US. ARMY

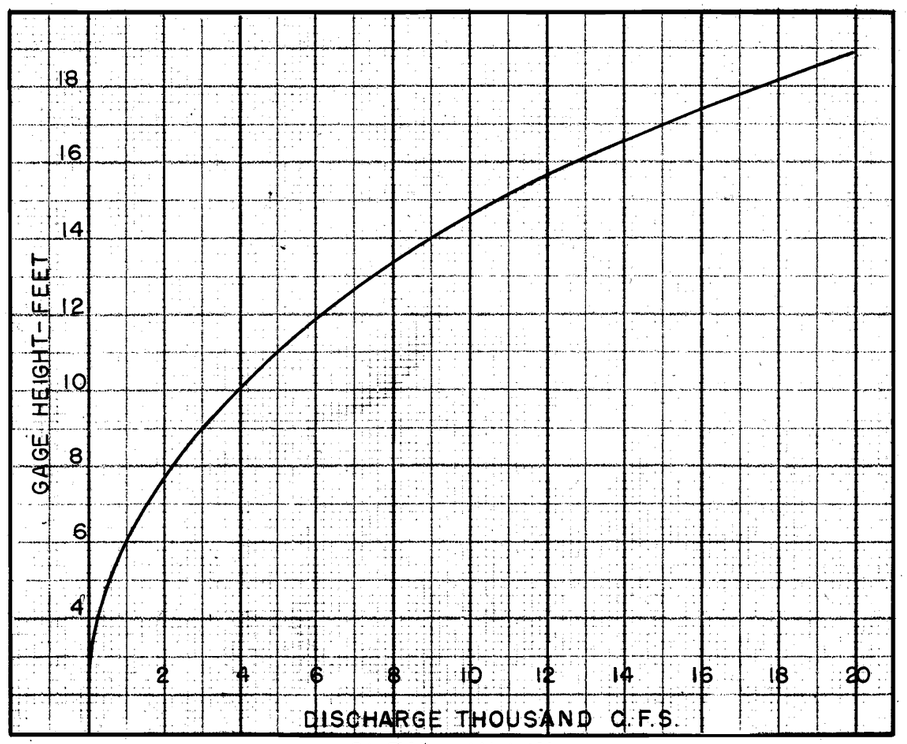
CORPS OF ENGINEERS



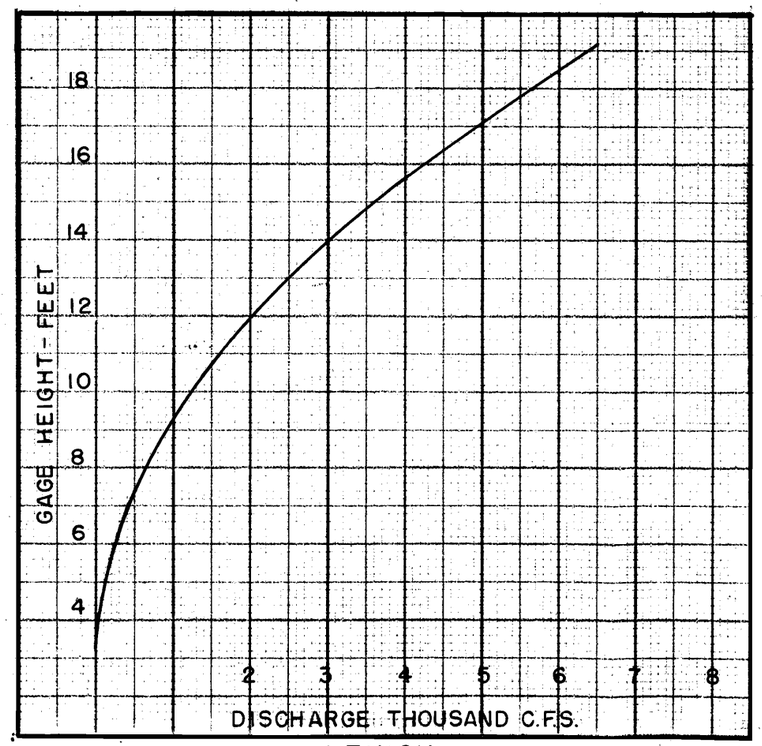
MANDAN



LARK



GLEN ULLIN



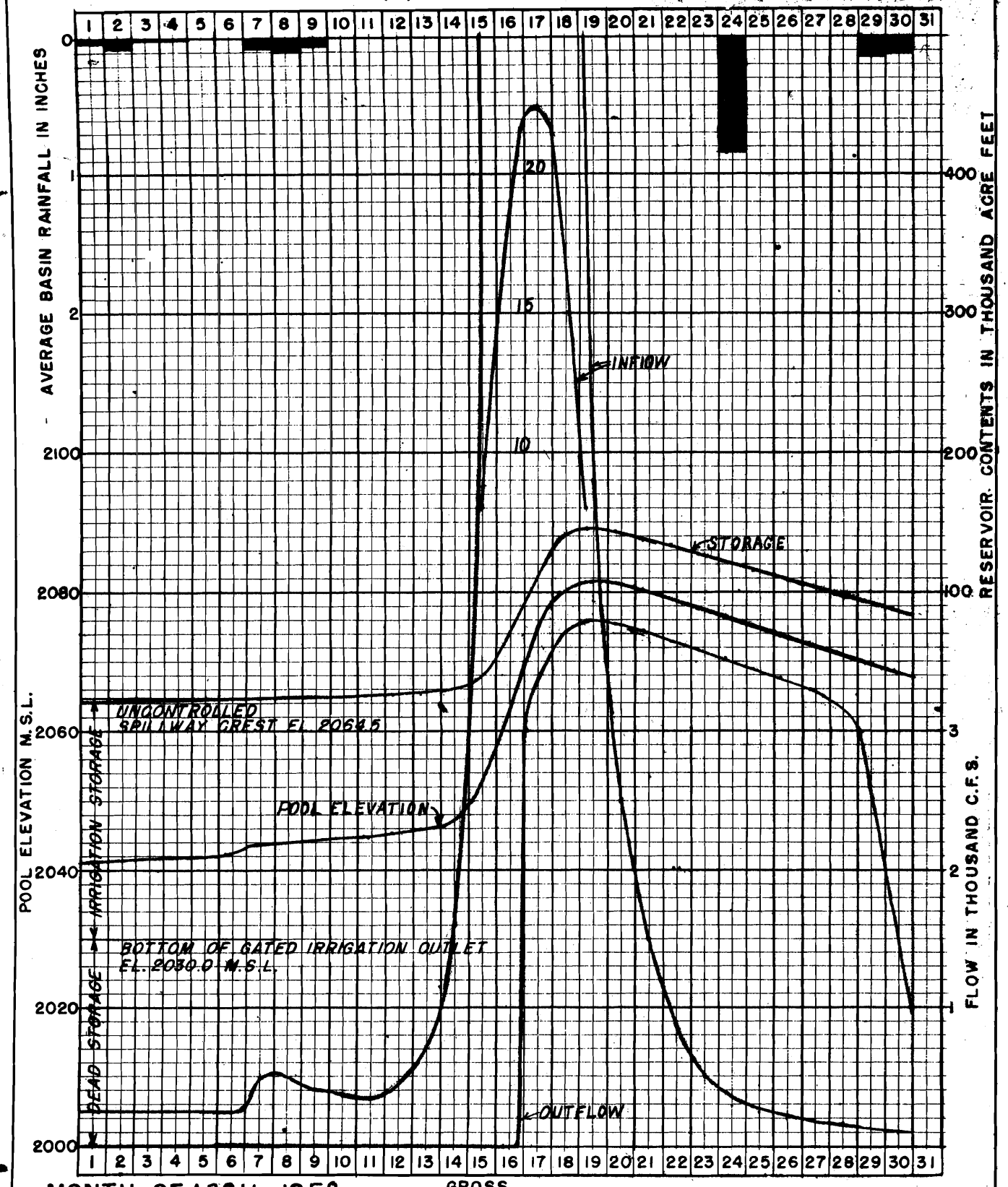
LEHIGH

HEART RIVER BASIN, N. DAK.
HEART BUTTE RESERVOIR (U.S.B.R.)
RESERVOIR REGULATION MANUAL

HEART RIVER RATING CURVES

SCALE: AS SHOWN

CORPS OF ENGINEERS GARRISON DISTRICT
BISMARCK, N. DAK
JANUARY 1950 PLATE NO. 15



MONTH OF APRIL 1950

	ELEVATION	GROSS STORAGE AC. FT.
Top of Dead Storage Pool	2030.0	7000
Top of Irrigation Pool	2064.5	75000
Top of Flood Control Pool	2094.5	225000
Maximum Pool	2118.2	426000
Spillway Capacity at Maximum Pool		5650 c.f.s.

MONTHLY RESERVOIR REGULATION

HEART BUTTE RESERVOIR
HEART RIVER BASIN, N. DAK.
D.A. 1750 SQUARE MILES
MISSOURI RIVER DIVISION
GARRISON DISTRICT

PLATE 16

REPORTS CONTROL SYMBOL ENGKW-51

HEART BUTTE DAM - RESERVOIR REGULATION

CORPS OF ENGINEERS, U.S.ARMY
GARRISON DISTRICT

MONTHLY RESERVOIR OPERATION

PROVISIONAL RECORD OF RESERVOIR DISCHARGES
INFLOWS AND WATER SURFACE ELEVATIONS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Date	E.I. m.s.l.	Disch. c.f.s.	Mean Disch. c.f.s.	Storage A.F.	Change in Storage A.F.	Evap. Inches	Evap. A.F.	Mean Inflow c.f.s. $\frac{(6)+(8)}{2}+(4)$
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
Total								

Plate No. 17