US Army Corps of Engineers ®
Omaha District

WATER CONTROL MANUAL

COLD BROOK DAM AND RESERVOIR

Fall River Basin
South Dakota

U.S. ARMY CORPS OF ENGINEERS
OMAHA DISTRICT
NORTHWESTERN DIVISION
OMAHA, NEBRASKA

July 2020

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DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, NORTHWESTERN DIVISION
1616 CAPITOL AVENUE, STE 365
OMAHA NE 68102

CENWD-PDR 17 July 2020

MEMORANDUM FOR Commander, Omaha District (CENWO-ED-HA, Attn: Nelson)

SUBJECT: Request for Review and Approval Water Control Manual, Cold Brook Dam and Reservoir, Missouri River Basin

1. Reference memorandum dated 6 July 2020, CENWO-EDH-A, subject as above.

2. The subject water control manual is approved.

3. We commend your staff for their professional and dedicated effort in updating this manual. We realize that updating any water control manual is a considerable undertaking.

4. Thank you for providing a hardcopy to this office. Please provide an electronic version of the manual to HQUSACE for Continuity of Operations (COOP) purposes, and a redacted electronic version for the national public-facing website.

5. If you have any questions concerning this reply, please contact me at [redacted]

FOR THE COMMANDER:

[redacted]

JOHN I. REMUS II, P.E.
Chief, Missouri River Basin Water
Management Division

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
1616 CAPITOL AVENUE
OMAHA NE 68102-4901

CENWO-EDH-A 6 July 2020

MEMORANDUM FOR CENWD-PDR/Remus, Suite 3300, 1616 Capitol Avenue, Omaha, NE 68102

SUBJECT: Request for Review and Approval of Water Control Manual, Cold Brook Dam and Reservoir, Missouri River Basin

1. Enclosed for your review and approval is a copy of the Water Control Manual, Cold Brook Dam and Reservoir, Missouri River Basin, including recommended edits. An electronic version of this document can be accessed in the following directory: V:\Public\NWO WCMs - Mar2013\ColdBrook WCM_Jun2020\WCM_Cold Brook_Jul2020.pdf.

2. This update did not contain any major changes to the water control plan.

3. Please contact me at [redacted] if you have any questions.

[redacted]

Encl

MATTHEW NELSON, P.E.
Chief, Water Control and
Water Quality Section
Hydrologic Engineering Branch
Engineering Division

Figure 1-1 Cold Brook Dam and Reservoir (looking northwest)

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in a hardcopy binder with loose leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current. Changes to individual pages must carry the date of revision, which is the Division's approval date.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, communication can be achieved by contacting, in the order listed, one of the following personnel:

Directory of Regulation Personnel

Organization/Name	Office	Fax	Cell	Email Address
US Army Corps of Engineers				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]		[redacted]	[redacted]

Organization/Name	Office	Fax	Cell	Email Address
City of Hot Springs/Fall River County				
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]		[redacted]
State and Local Agencies				
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[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		
Other Federal Agencies				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

*Hidden Lake is formerly known as Larive Lake. In 2018 it changed ownership and name.

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Cold Brook Dam and Reservoir Pertinent Data

GENERAL				
Dam Operator: U.S. Army Corps of Engineers				
Location of Dam	1 mile N of Hot Springs, SD (43° 27' 13"N 103° 29' 21"W)			
County	Fall River County, SD			
River and River Mile	Cold Brook at River Mile 1			
Contributing Drainage Areas (square miles)				
Fall River at mouth	164			
Fall River at Hot Springs, SD	136			
Cold Brook at Cold Brook Dam (One inch runoff 3,760 af)	70.5			
RESERVOIR				
Item	**Elevation (feet)**	**Area (acres)**	**Storage (af)**	**Cumulative Storage (af)**
Top of Dam	3675.0			
Top of Surcharge Storage Zone	3667.2	279	3,831	11,323
Top of Flood Control Zone	3651.4	206	6,801	7,492
Top of Conservation Zone (crest of overflow weir*)	3585.0	37	691	691
Streambed	3536.0			
DAM				
Type	Rolled earthfill with protective riprapping on the slopes			
Top of Dam Elevation	3675.0 feet			
Crest Width	20 feet			
Height above Streambed	130 feet			
Length	925 feet			
Date of Closure	September, 1952			
SPILLWAY				
Location	Left – remote			
Type	Ungated sharp crested weir with a triangular cross section			
Crest Elevation	3646.5 feet			
Crest Length	200 feet			
Number of Gates	None			
Spillway Capacity at Maximum Pool Elevation 3667.2 feet	80,600 cfs			
OUTLET WORKS				
Location	In pool			
Type	Uncontrolled circular concrete intake structure with small gated outlets for draining the conservation zone; a concrete conduit structure that passes beneath the dam; a concrete stilling basin with baffle blocks and an end sill followed by a rock and gravel-lined section of channel			
Discharge Capacity				
Of ports with water surface at El. 3600.0 feet	250 cfs			
Of Conduit with water surface at El. 3610.0 feet	1,230 cfs			
Of Conduit with water surface at El. 3646.5 feet	1,540 cfs			

Cold Brook Dam and Reservoir Pertinent Data (Cont'd)

INLET STRUCTURE	
Type	Circular free-standing reinforced concrete tower with inlets at two elevations
Crest Elevation of Four Ports*	3585.3 feet*
Crest Elevation of Bell-mouthed Inlet	3600.0 feet
Top of Tower Elevation	3618.75 feet
Outside Diameter of Bell-mouthed Inlet	18 feet
Total Area of Opening of the Four Ports	14.4 square feet
CONDUIT	
Type	Circular reinforced concrete
Inside Diameter	6.67 feet
Length	907 feet
STILLING BASIN	
Type	Reinforced concrete basin with baffle blocks and sill
Width	
At end of first 65 feet	43.6 feet
At end of stilling basin	50.0 feet
Length	105 feet
Number of Baffle Blocks	13
ROCK & GRAVEL LINED CHANNEL SECTION	
Length	55 feet
Bottom Width	50 feet
EARTH OUTLET CHANNEL	
Length (approx.)	675 feet
Bottom Width	50 feet

* The crest elevation of the ports (3585.0 feet) was increased to elevation 3585.3 feet following concrete repairs to the intake tower.

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ACRONYMS AND ABBREVIATIONS

af	acre-feet
BLM	Bureau of Land Management
cfs	cubic feet per second
Co-op	Cooperative Stream Gaging Program
Corps	U.S. Army Corps of Engineers
CWMS	Corps Water Management System
DSAC	Dam Safety Action Classification
EAP	Emergency Action Plan
EM	Engineering Manual
ER	Engineering Regulation
°F	degrees Fahrenheit
FY	Fiscal Year
HEC	Hydrologic Engineering Center
MBRFC	Missouri Basin River Forecast Center
MRBWM	Missouri River Basin Water Management
NAVD88	North American Vertical Datum of 1988
NESDIS	National Environmental Satellite, Data, and Information Service
NGVD29	National Geodetic Vertical Datum of 1929, feet above mean sea level
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWD	Northwestern Division
NWS	National Weather Service
PD	Project Datum
PMF	Probable Maximum Flood
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
WCWQS	Water Control and Water Quality Section
WFO	Weather Forecast Office

I. INTRODUCTION

1-01 AUTHORIZATION

This manual was prepared as directed in Engineering Regulation (ER) 1110-2-240 and covers the pertinent topics of information specified in Chapter 9 of Engineering Manual (EM) 1110-2-3600. The format follows ER 1110-2-8156.

1-02 PURPOSE AND SCOPE

The purpose of this manual is to outline the pertinent information and plan of regulation for Cold Brook Dam and Reservoir as set forth in the authorizing legislation. Detailed information on project authorized purposes, project description, project history, watershed characteristics, data collection and communications networks, forecast methodology, water control plan, effect of the water control plan, and water control management are presented herein. This manual follows the guidance presented in EM 1110-2-3600 "Management of Water Control Systems", October 23, 2017 and ER 1110-2-8156 "Preparation of Water Control Manuals", September 30, 2018. This report is subject to future revision and updating as circumstances warrant.

1-03 RELATED MANUALS AND REPORTS

The most relevant reports and manuals on Cold Brook Dam reservoir regulations are:

Cold Brook and Cottonwood Springs Dam and Lake Projects Master Plan, July 2016.

U.S. Army Corps of Engineers Reconnaissance Report, Hydrologic Improvement Assessment, May 1993.

U.S. Army Corps of Engineers Operations and Maintenance Manual, 1980.

Definite Project Report, Cold Brook Dam and Reservoir, Fall River and Tributaries, Hot Springs, South Dakota, April 1945.

Department of the Army License for Public Park, Recreational, and Fish and Wildlife Management Purposes, Cold Brook Reservoir Area, South Dakota, May 17, 1955.

U.S. Army Corps of Engineers Cold Brook Reservoir Regulation Manual, March 1954.

The 1954 reservoir regulation manual is superseded by this updated water control manual, which is subject to future revision and updating as circumstances warrant.

1-04 PROJECT OWNER

The project owner is the U.S. Army Corps of Engineers (Corps), Omaha District.

1-05 OPERATING AGENCY

The operating agency is the Corps' Omaha District, Operations Division, Big Bend Project Office and Cold Brook Project Office. Gates are operated manually from the project by the Dam Tender, who is located at the Cold Brook Project during the recreation season and otherwise at the Big Bend Project. The Corps' Dam Tender address and phone number is listed below. In the event of unusual conditions during nonduty hours please consult the directory of regulation personnel on page v, Regulation Assistance Procedures, at the beginning of this document.

Dam Tender
Corps of Engineers
Omaha District
Cold Brook Project Office
P.O. Box 664
Hot Springs, SD 57747
(605) 745-5476

Dam Tender
Corps of Engineers
Omaha District
Big Bend Project Office
33573 N Shore Rd
Chamberlain, SD 57325
(605) 245-1801

1-06 REGULATING AGENCY

The Corps' Omaha District, is the regulating agency for Cold Brook Dam. The Corps' Omaha District Water Control and Water Quality Section (WCWQS) is responsible for determining the releases from Cold Brook. The Corps' Operations Division is responsible for changing the gate settings to achieve the required release.

1-07 ELEVATION DATUM

In the original design and construction of Cold Brook Dam, elevations on design drawings and reservoir levels referenced the Sea Level Datum of 1929. This was based on measured water levels at 26 tide stations in the United States and Canada, commonly referred to as "feet above mean sea level". In 1973, the Sea Level Datum of 1929 was renamed the "National Geodetic Vertical Datum of 1929" (NGVD29). The NGVD29 was subsequently replaced by the North American Vertical Datum of 1988 (NAVD88) as the current vertical reference datum used by the National Oceanic and Atmospheric Administration (NOAA). NAVD88 is based on a single point as the reference point from which all other elevations are measured. NAVD88 is more accurate than NGVD29, and takes into account variations in the earth's surface due to subsidence and rebounding, and distortions caused by gravity. As such, the conversion from NGVD29 to NAVD88 varies depending on location. As specified in ER 1110-2-8160, long-term efforts shall be programmed to transition from older datums to NAVD88.

In this water control manual, elevations for reservoir levels and project drawings are based on the Project Datum (PD), which for Cold Brook Dam and Reservoir is close to NGVD29. NGVD29 elevations have not been converted to NAVD88 in an effort to provide elevation data that is consistent with historical events and the original design drawings for the project. If elevations referenced to NAVD88 are needed for Cold Brook Dam and Reservoir, use the following conversion: PD + 1.65 feet = NAVD88.

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II. DESCRIPTION OF PROJECT

2-01 LOCATION

Cold Brook Dam is located on river mile one of Cold Brook in the Fall River basin about one mile north of Hot Springs, SD. The dam lies in Fall River County about one mile north of the confluence of Cold Brook and Hot Brook. The location and general configuration of the Fall River basin is shown in Plate 2-1.

2-02 PURPOSE

Cold Brook Dam was constructed to reduce flooding at the City of Hot Springs, SD and to provide water conservation for recreation and fish and wildlife. Public Law 228, 77th Congress, 1st Session, approved on August 18, 1941, authorized the project for improvement of the Fall River and its tributaries in South Dakota.

2-03 PHYSICAL COMPONENTS

The physical components of Cold Brook Dam are shown on Plates 2-2 to 2-9 and are described below. The project works consists of an earthen dam, an ungated sharp crested weir spillway, and an ungated circular concrete outlet structure. Three 12-inch gates and pipes are provided in the outlet structure to permit draining of the conservation zone.

a. Embankment

The dam is a rolled fill earth embankment having an impervious core, a pervious upstream zone, and a random downstream zone. The dam crest elevation is 3675.0 feet, and the crest width is 20 feet. The crest length is approximately 925 feet with symmetrical side slopes, a maximum height of 130 feet, and an average base width of 765 feet. The upstream face of the dam is covered with a layer of stone two feet thick placed on a layer of spalls one foot thick while the crest and the downstream face of the dam are covered with a layer of spalls six inches thick. The limestone formation in the bottom of a seepage cutoff trench placed upstream of the axis was grouted with concrete as an additional precaution against reservoir leakage. Embankment drawings are shown on Plate 2-2.

b. Outlet Works

The outlet works consists of an intake structure, conduit, stilling basin, and downstream channel. A vertical uncontrolled circular concrete intake tower with controlled small pipes for draining the conservation zone is connected to a horizontal conduit structure that passes beneath the dam. The conduit discharges into a concrete stilling basin having baffle blocks and an end sill, followed by a rock and gravel-lined section of open channel. The hydraulic capacity of the outlet works at the spillway crest (3646.5 feet) is 1,540 cubic feet per second (cfs). Outlet works discharge rating curves are shown on Plate 2-3.

(1) Intake Structure

The intake structure is a circular free-standing tower of reinforced concrete having an ungated bell-mouthed entrance. The entrances are protected by two tiers of circular trash racks, each 6.75 feet high and 1.6 feet in diameter. Supported on four buttress-type spread footings, the tower stands in the deepest part of the reservoir about 70 feet upstream of the toe of the dam. The crest of the bell-mouthed entrance is at elevation 3600.0 feet and the top of the concrete tower is at elevation 3618.75 feet where the roof slab supports the hoisting mechanism for trash removal operations, floor gratings, hand rails, cranks attached to valves to open gates, and a radar gage.

Lowering of the water surface to the bottom of the conservation zone is accomplished by manual control of three 12-inch gate valves located in the footings of the tower which discharge through openings into the conduit. In 1998 butterfly valves were installed were installed on the low level gates, but issues with sealing occurred. In 2012, the gates were modified again. The pipes were overdrilled to 15 inches, and then a 12 inch pipe was grouted in with a gate valve. A new assembly was installed on the intake structure to manage the new slide gates.

Four port openings, each 1.2 feet high by 3 feet wide, are spaced uniformly around the periphery of the vertical tower at a design elevation of 3585.0 feet, which is the upper limit of the conservation zone. Following concrete repairs to the tower, the invert elevation is now 3585.3 feet. The inside diameter of the intake structure is 6.67 feet. Intake structure drawings are shown on Plate 2-4. The Hidden Lake water supply line has intakes in the wall of the intake tower. For more information on the Hidden Lake water supply line see Section 3-04.c and drawings shown in Plates 3-3 through 3-5.

(2) Conduit

The inside diameter of the circular horizontal conduit is the same as the intake structure, 6.67 feet. The conduit is made of reinforced concrete embedded in bedrock to a minimum depth of two feet throughout its total length of 907 feet. Seepage cutoff collars are spaced 20 feet apart along the full length of the conduit. The Hidden Lake supply line consisting of an 8-inch cast-iron pipe is embedded in the floor of the conduit throughout its length. The 8-inch supply line exits the conduit underground and continues easterly to a concrete stilling box where it discharges through a manually controlled valve into a buried pipe leading to Hidden Lake. Conduit drawings are shown on Plate 2-5.

(3) Stilling Basin

The stilling basin is a reinforced concrete structure having a floor that widens from 6.67 feet at the upstream end to 50 feet at the downstream end. The floor slab is bedded on the natural rock, is anchored thereto by means of steel bars grouted in the rock, and is drained by means of 2-inch diameter weep holes drilled to depths of six feet below the bottom of the slab. The sidewalls of the basin are gravity sections backfilled with pervious materials underlain by a positive drainage system. For the purpose of dissipating stream velocities, the basin is equipped with two rows of baffle blocks extending 2.75 feet above the floor and an end sill extending 4 feet above the floor of the basin and 1.25 feet above the floor of the outlet channel on the downstream side of the sill. Stilling basin drawings are shown on Plate 2-6.

(4) Outlet Channel

The outlet channel extending downstream from the stilling basin has a bottom width of 50 feet and consists of a riprapped reach 55 feet in length, followed by 675 feet of channel excavated in the natural materials of the valley. The riprap on the channel floor, side slopes, and berms consists of two feet of rock placed on one foot of gravel.

c. Spillway

The spillway is located to the east of the reservoir, on a natural divide between a short, steep valley entering Cold Brook above the dam site and a long, gently sloping valley entering Cold Brook below the dam site and is capable of discharging 80,600 cfs at elevation 3667.2 feet. The spillway structure with a crest elevation of 3646.5 feet consists of an ungated sharp crested concrete weir 200 feet long, 4.5 feet high, and is triangular in cross section. The weir structure is flanked by concrete wing walls extending into the Spearfish shale on the west and into the Minnekahta limestone on the east. A concrete apron 50 feet long is provided below the weir. The channel downstream from the apron is excavated on a 2% grade for a distance of about 335 feet. At low discharges the spillway structure will function as a sharp-crested weir, whereas during peak flood overflows the structure will be submerged and the spillway will act as a channel lined with the natural materials of the Spearfish and Minnekahta formations. Spillway drawings are shown on Plate 2-7. Spillway discharge rating curves are shown on Plate 2-8.

d. Water Supply Facilities

Releases are made from the reservoir outlet works to satisfy downstream water rights requirements at Hidden Lake and a private residence.

e. Reservoir

The Cold Brook Dam drainage area is 70.5 square miles. The maximum depth of the reservoir is about 40 feet near the intake tower location, although most of the reservoir is shallower. Plate 2-9 shows the sediment range locations as well as the reservoir flooded areas for the pool elevations at the top of each storage zone. The storage allocations for the reservoir are shown in Table 2-1. Area and capacity curves are shown on Plate 2-10, and similar information is shown in the Pertinent

Data on page xiii. Exhibits A and B show the area and capacity tables at one foot increments while the capacity is shown in more detail to tenth-foot increments in Exhibit C. Additional information concerning sediment accumulation in the reservoir is contained in Section 4-04.

Table 2-1. Cold Brook Reservoir Storage Allocations

Storage Zone	Pool Elevation (feet)	Zone Capacity (af)	Cumulative Capacity (af)
Inactive	(none)	-	-
Conservation	3548.0 – 3585.0	691	691
Flood Control	3585.0 – 3651.4	6,801	7,492
Surcharge	3651.4 – 3667.2	3,831	11,323

2-04 RELATED CONTROL FACILITIES

Hidden Lake is supplied by Cold Brook Reservoir. See more on Hidden Lake in Section 3-04.c.

2-05 REAL ESTATE ACQUISITION

Real estate acquisition authority was granted in 1950 based on a real estate planning effort for the Cold Brook Reservoir Project which established a real estate property line at 3657.0 feet. Later that year, fee title to 10 tracts, comprising of 483.83 acres, was acquired.

In 1990, after completing a dam safety exercise, action was initiated to acquire five easements (approximately 4.72 acres) for emergency equipment access to the right dam abutment and the left side of the spillway. However, the action was placed on hold in 1995 pending further determination of the limits and means by which an access route would be needed. This action has not been revisited.

Downstream and outside the project boundary, a single channel improvement easement consisting of 0.32 acres was acquired in 2010 to restore the channel capacity and install larger culverts where the channel crossed Evans Avenue, which is the only public access road to the project. Section 4-09 includes details on the culvert construction.

2-06 PUBLIC FACILITIES

Cold Brook Reservoir offers an excellent variety of recreational activities. Found in the Southern Black Hills of South Dakota, Cold Brook Reservoir supplies numerous views and activities. Fishing and sightseeing are the most common recreational activities at Cold Brook Reservoir. The project also has a campground north of the reservoir. A beach area at the west end of the reservoir has picnic tables and a playground. Also available are trails for hiking, wildlife viewing, archery, canoeing, fishing, and swimming. Winter activities include ice fishing, skating, and cross-country skiing.

III. HISTORY OF PROJECT

3-01 AUTHORIZATION

Public Law 228, 77th Congress, 1st Session, approved on August 18, 1941, authorized the project for improvement of the Fall River and its tributaries in South Dakota for flood control to be constructed substantially in accordance with the recommendations of the Chief of Engineers as given in House Document Number 655, 76th Congress, 3rd Session. The Chief of Engineers recommended that Cottonwood Springs Reservoir, Cold Brook Reservoir, and Hot Springs Channel Improvement be constructed at an estimated first cost of $1,050,000 with $1,000 annually for maintenance of the reservoirs. The recommended construction was subject to the provisions that, with respect to the Hot Springs Channel Improvement, local interests provide all lands, easements, and rights-of-way necessary for the construction; prevent public encroachment on the flood channel; bear the expense of bridge alterations; and maintain all the works in accordance with regulations prescribed by the Secretary of War.

The Definite Project Report for Cold Brook Dam was approved by the Chief of Engineers on January 22, 1945 subject to revisions which were completed April 5, 1945. This revised report contained an estimated cost for Cold Brook Dam and Reservoir of $829,000.

3-02 PLANNING AND DESIGN

A tentative plan of regulation was suggested in the Definite Project Report and expanded in the "Analysis of Design", dated May 1950. The proposed plan of regulation was summarized as follows: the dam and reservoir will operate automatically by an uncontrolled outlet works and spillway. The reservoir is designed to retard peak flood discharges and provide temporary floodwater storage with the outlet works and spillway designed to limit discharges from the reservoir to those which, in combination with the flows from the Cottonwood Springs Creek Reservoir and the uncontrolled area, will minimize peak flow at Hot Springs. Floods of the magnitude of the flood of June 1947 will be controlled by the reservoir to a maximum release of approximately 250 cfs. The primary consideration governing the selection of the dam site was the necessity for controlling the runoff from the largest possible portion of the Cold Brook watershed.

The following was taken from the *Cold Brook Reservoir Regulation Manual*, March 1954 and discusses in more detail the planning phases. This italicized section below provides valuable history into Cold Brook Dam.

The following considerations were included in the Chief's recommendation: The Cold Brook Project would be automatic in operation and very durable in construction, thus requiring very few charges for operation and maintenance. The project will control floods of the magnitude of those of past record at Hot Springs, SD, and will materially reduce major floods that are to be anticipated. The degree of flood control that the Project provides for the watershed will result in enhancement of real estate values in the *areas affected by floods, continued economic welfare and development of the area and reduction of the hazard to human life. The only property in the watershed that is important from a flood control point of view is the City of Hot Springs, SD, whose importance is due chiefly to its use as a health and tourist resort.*

<u>Proposals by Local Interests</u>. At public hearings conducted in Hot Springs, local interests proposed such projects as the erection of flood-detention and storage reservoirs; improvement of the main channel through the City of Hot Springs, SD; the diversion of floods to other watersheds for the combined purposes of flood control and irrigation; and the development of water conservation projects for the purpose of maintaining fish life in the watershed.

Several of the proposals would have involved the utilization of the waters of Fall River for irrigation purposes. One plan proposed to erect a diversion dam below the City of Hot Springs and thence to convey the water by means of a flume 6-1/4 miles long to the proposed Horse Camp Reservoir on the Cheyenne River for irrigation purposes. A second plan called for the diversion of floodwaters from Cold Brook to Beaver Creek where they could be used for irrigation. A third proposal would have required the diversion of floodwaters from Cottonwood Springs Creek and upper Hot Brook to the Horse Camp Reservoir by means of a tunnel through the mountains to discharge into Alabaugh Canyon. All plans which proposed to combine irrigation with flood control were found infeasible from engineering and economic standpoints.

Other proposals advocated the construction of dams of various types and sizes on the mainstem of Cold Brook, on the headwaters of Hot Brook, on Cottonwood Springs Creek, on Bruce Creek, and on other tributaries of Fall River. Reconnaissance and preliminary surveys and studies indicated that some of the proposed projects would be infeasible and that the others possessed various degrees of feasibility. Subsequent comprehensive surveys and studies led to the development of the most feasible plan of flood control.

At a public meeting on April 12, 1949, representatives of the South Dakota State Game and Parks Department, State Board of Health, City of Hot Springs, Fall River County, the Hot Springs Recreation Council, the Hot Springs Chamber of Commerce, and local sportsmen's clubs requested the development in the Cold Book Reservoir area of public use facilities that would provide for water supply and sanitation, picnicking, fishing, boating, swimming, sightseeing, tent and trailer camping, renting of cabins, and organized group camps. The local interests indicated their willingness to cooperate in providing the recreational facilities and to enter into an operation and maintenance agreement.

<u>Events Following Authorization of the Project</u>. The act of August 18, 1941 gave specific authority for the construction of only those features named therein; the Cold Brook Reservoir, the Cottonwood Springs Reservoir, and the Hot Springs Channel Improvement, Subsequent acts passed by Congress authorized the development of recreational features and directed the conservation of the nation's fish and wildlife resources in connection with the three basic features. Pursuant to the act of August 18,

1941, funds were allotted on June 1943 for preparation of definite project reports for the three units of the Fall River Basin Project. Field investigations and engineering studies were initiated in Fiscal Year 1944 and, during the calendar year 1945; the Chief of Engineers approved the definite project reports for the three units, subject to minor revisions.

In 1946, Congress appropriated funds for the construction of Cottonwood Springs Creek Dam and for the Hot Springs Channel Improvement. The low bid for the Cottonwood Springs Creek Dam was rejected as being excessive and its funds were reallotted to the Hot Springs Channel Improvement Unit. A contract was awarded for the construction of the Hot Springs Channel Improvement unit on June 9, 1947, at an estimated cost of $771,418.64. A contract was awarded to the Northwestern Engineering Company of Rapid City, SD, for the construction of the major features of the Cold Brook Dam on June 6, 1950 at an estimated cost of $1,092,509.

Several departures from the Definite Project Plans became necessary during the course of the construction activity. On July 14, 1950, the contractor was directed to eliminate the water level recorder well and piping and, on November 6, 1950, he was directed to install a water level recorder according to drawings that were furnished him at the time by the Corps of Engineers. Wing excavation for the downstream concrete monolith of the conduit, it was found necessary to excavate below the planned grade in order to obtain a satisfactory foundation and, on December 28, 1950, the contractor was directed to dig test pits for exploration of foundation conditions in the area of the stilling basin. As a result of the foundation exploration, the Definite Project Design of the stilling basin was modified, in April of 1951, to allow the basin floor slabs to rest on firm shale with a minimum of fill concrete. On May 2, 1951, the inlet for the Larive Lake supply line was lowered from the Project Design Elevation of 3575 feet to Elevation 3548 feet for the sake of assurance of flow during periods of low pool levels. As an additional precaution against reservoir leakage, on May 9, 1951, the Government furnished fly ash and intrusion aid for grouting in areas upstream of the cutoff trench. By a change order of March 31, 1953, the contractor was directed to install a compacted earth levee with rock riprap protection between the end of the left wing wall of the concrete spillway structure and the natural ground contour at elevation 3655.5 feet for the purpose of preventing the possibility of the wing wall being flanked by a flood of "reservoir design" magnitude.

For several months after the start of construction in 1950, the work progressed satisfactorily and by October 24, 1950 relocation of the County Road was completed. Thereafter, difficulties arose, and by November 29, 1950 construction progress was behind schedule by about 9 percent of the scheduled amount and during the calendar year 1951, progress was further hampered by shortages of materials and rising prices. Foundation drilling and pressure grouting was completed on May 2, 1951. On April 23, 1953, the contractor notified the District Engineer at Fort Peck, Montana, that the project was ready for final inspection and on May 8, 1953 all of the work required under Contract No. DA-24-016-eng-64 was accepted as satisfactorily completed at a cost of about $1,202,000 for the contracted construction, including all change orders.

Being almost entirely automatic in its operation, the reservoir has been accumulating a conservation pool since completion of the embankment. A new road was constructed by Fall River County, providing access to the reservoir area from U.S. Highway 85A about one-half mile east of the reservoir. The Master Plan for the reservoir area is complete. A license has been granted to the State of South Dakota (Department of Game, Fish and Parks) for the use of certain areas within the Cold Brook Reservoir area for public park, recreational, and fish and wildlife management purposes.

The Federal Power Commission made studies and concluded by letter to the Secretary of the Army dated March 2, 1948 that penstocks or other facilities for future development of power at Cold Brook Dam are not warranted and, therefore, did not recommend the installation of such facilities. In accordance with that recommendation, no hydroelectric facilities were incorporated in the works of the project.

3-03 CONSTRUCTION

The design and construction of Cold Brook Dam was coordinated under the former Fort Peck District. The primary contractor for this project was Northwestern Engineering Company of Rapid City, SD. They employed two subcontractors: Boyles Brothers Drilling Company, responsible for the foundation grouting, and Emme Construction Company, who did the foundation excavation. Construction began in 1950, and closure of the dam was made in September 1952. The project completion date was May 8, 1953. The approximate total cost of the project was $1,633,700, according to the "Operation and Maintenance Manual for Cold Brook Dam", 1980. See Section 3-02 for more construction detail.

3-04 RELATED PROJECTS

Early investigations for the "308" reports recognized that flooding was one of the major problems in the Fall River basin with the damages largely centered at Hot Springs, SD. At public hearings several plans were proposed by local residents for combined flood control and irrigation development but additional study proved them uneconomical. Other proposals were found feasible and led to the passage of Public Law 228, 77th Congress, 1st Session, dated August 18, 1941 authorizing a project for improvement of the Fall River through Hot Springs and the construction of Cottonwood Springs Creek Reservoir and Cold Brook Reservoir.

a. Cottonwood Springs Creek Dam

The Cottonwood Springs Creek Dam and Reservoir is located on Cottonwood Springs Creek approximately 0.5 mile above its confluence with Hot Brook and controls a drainage area of 26 square miles. It was closed in May 1969 and the authorized purposes include flood control, recreation, and protection of fish and wildlife. The combined Cold Brook and Cottonwood Springs Creek projects reduce the design flood estimated peak at Hot Springs of 63,000 cfs to 25,000 cfs. Automatic operation of the Cottonwood Springs Creek project provides a maximum reservoir release of 500 cfs in the event of the reservoir design storm. Details of the Cottonwood Springs Creek project are in the "Cottonwood Springs Creek Dam and Lake, Reservoir Regulation Manual", 1973. Plate 3-1 illustrates this project.

b. Hot Springs Channel Improvement

In 1950, the Corps completed construction of approximately 1.2 miles of channel improvement on the Fall River through the business district of Hot Springs. The channel improvement, which is designed to carry 16,000 cfs with approximately 2 feet of freeboard, will nearly carry 25,000 cfs without overtopping. Since construction of the Fall River channel, some vegetation growth has occurred in the channel bottom. The vegetation is not significant enough to cause great concern. The City of Hot Springs is actively pursuing potential solutions. See Section 4-09.b for more information on other channel restoration activities. Plate 3-2 illustrates this project.

c. Hidden Lake, formerly known as Larive Lake

What is formerly known as Larive Lake changed ownership in 2018. The new property owners changed the name of the lake to Hidden Lake at the time of purchase. Hidden Lake is a privately-owned lake downstream of Cold Brook Dam currently being used for recreation. An 8-inch-diameter cast iron pipe was installed during the Cold Brook Project construction through the Cold Brook Outlet Works to supply Hidden Lake with water. See Plate 3-3 for the plan and sections of the water supply line.

The owners of Hidden Lake hold a valid water right on streamflows (reservoir releases) of a continuous flow of up to 1.1 cfs. The use of the water is a continuance-of-use established under a February 12, 1894 water right filed by the Hermosa Ice Company (File No. 0619-2). Another water right exists for diverting 0.03 cfs for irrigational and domestic purposes to Gregory and Mildred Frohman (File No. 0618–2B). This water right is used from April through September for irrigation of two acres, and January through December domestically. This water right does not allow appropriation to exceed 3 acre-feet per irrigated acre per year. Both water rights can be found in Exhibit E.

Several modifications were made to the Cold Brook Dam inlet openings in 1978 as a portion of the "Miscellaneous Rehab" contract. The lowest inlet, at elevation 3548.0 feet, was abandoned by placing 0.5-inch thick, 27-inch-by-27-inch steel cover plates on the inlet openings on each face of the leg. This lower inlet was abandoned due to its proximity to the bottom of the reservoir as unwanted amounts of sediment were being diverted to Hidden Lake. Cover plates were also placed on one of the faces of the inlet openings at elevations 3560.0 feet and 3580.0 feet. Slide gates were constructed on the opposite face of these inlet openings. This work was done so that the water supply could be shut off at the source. The two slide gates operate simultaneously and are controlled by a hand-crank gate lift mounted to the intake structure at elevation 3590.0 feet. See Plate 3-4 for construction details of the rehabilitation work.

An 8-inch butterfly valve was installed in 1978 on the water supply line to allow for the water to be shut off so maintenance of the flush line and the water supply line downstream of the valve pit could be performed without shutting the two sluice gates on the intake structure or the shut off in the conduit. See Plate 3-5 for construction details of the butterfly valve.

Also in 1978, as part of the “Miscellaneous Rehab” contract, an orifice was installed on-line in a manhole located 20 to 30 feet upstream of the outlet stilling box. This orifice was installed so that no more than 1.1 cfs could be diverted from Cold Brook Reservoir to Hidden Lake. See Plate 3-5 for construction details of the orifice and manhole. An open ditch and Parshall Flume originally provided water to Hidden Lake past the orifice and manhole, but buried pipe has since replaced these structures.

3-05 MODIFICATION TO REGULATIONS

Increased Cold Brook groundwater inflows through the 1990s highlighted the Cold Book channel constriction between Cold Brook Dam and the Fall River. As a result, an effort was made to improve channel capacity downstream of the dam. Between 1999 and 2012 deviations to the Cold Brook Water Control Plan were made each year. During this period the reservoir was lowered 3 to 5 feet to reduce flood risk while channel improvements were completed. By 2012, all channel improvements were complete and normal operations were reinstated.

3-06 PRINCIPAL REGULATION PROBLEMS

On August 11, 1993, the revised draft reconnaissance report for the Cold Brook Dam hydrologic improvement assessment was completed. The report concluded that the Cold Brook Project was hydrologically deficient as it could not safely pass the Probable Maximum Flood (PMF). A periodic assessment was completed in 2015 to determine the incremental risks associated with Cold Brook Dam. Cold Brook Dam received a Dam Safety Action Classification (DSAC) [redacted] rating. The incremental risks are primarily driven by [redacted]. The DSAC system classifies dams into five classes, with DSAC 1 having the highest urgency in taking safety related actions and DSAC 5 the lowest urgency based on incremental risk. Cold Brook is considered hydrologically deficient as the PMF is expected to overtop the dam. Due to the DSAC rating, an Interim Risk Reduction Measures Plan is required until long term solutions are studied and/or implemented. Interim measures include increasing risk communication, updating inundation mapping for areas downstream of the dam, and stockpiling filter material for use during an emergency.

The campground at Cold Brook Reservoir starts to become inundated if the pool elevation rises 1.5 feet into the flood control zone or if backwater is observed above the culvert under the road to the beach. Replacement of the culvert is planned for 2020, which should eliminate backwater impacts once completed. The campground may be completely inundated if the water rises 13 feet into the flood control zone. A flood warning system has been installed to provide advance warning time in the event of a flood. A float gage on Cold Brook at Argyle Road is intended to sound an alarm in the campground should floodwaters rise at Argyle Road. Campers in this area are expected to stay apprised to current weather conditions and move uphill should the reservoir reach their campsites with or without warning from the system.

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IV. WATERSHED CHARACTERISTICS

4-01 GENERAL CHARACTERISTICS

The Fall River drainage basin has an area of 164 square miles, all of which is rough and partially timbered. The Cold Brook Dam drainage area is 70.5 square miles. The Fall River basin lies on the southern edge of the Black Hills uplift in Custer and Fall River Counties of South Dakota. The basin is bounded by the watersheds of the Cheyenne River on the south, Pleasant Valley Creek on the west, and Beaver Creek on the northeast. Fall River is formed by the junction of Cold Brook and Hot Brook at the northern limits of Hot Springs, SD, and flows southeasterly through a narrow canyon a distance of about seven miles to its confluence with the Cheyenne River. Cold Brook rises northwest of Pringle, SD, and flows southeasterly and south to its confluence with Hot Brook. Hot Brook rises near Minnekahta, SD, and flows in an easterly direction to its junction with Cold Brook. The principal tributary of Hot Brook is Cottonwood Springs Creek, which enters Hot Brook from the northwest about 5 miles above the mouth. The Cottonwood Springs Creek Dam drainage area is 26 square miles. Approximately 68 square miles of the Fall River basin is uncontrolled, with approximately 40.5 square miles of this area located above Hot Springs, SD. A general view of the Fall River, Cold Brook, and Cottonwood Springs Creek basins is shown in Plate 2-1.

4-02 TOPOGRAPHY

The drainage area above Cold Brook Dam makes up the head of the Fall River basin and lies at an elevation of 5800 feet on a limestone plateau between Custer and Pringle, SD. The streamflows through narrow valleys and canyons to meet the Cheyenne River at an elevation of 3030 feet. The average Cold Brook River basin elevation is about 4700 feet and the average basin slope is 18 percent. The Fall River basin is flanked by similar watersheds. Beaver Creek lies to the northeast and Red Canyon Creek lies to the west.

4-03 GEOLOGY AND SOILS

a. Geology

Cold Brook is situated on the southeastern slope of the mountainous uplift known as the Black Hills. The core of the uplift is comprised of a mass of granite. The core is surrounded by a series of pre-Cambrian crystalline rocks and a nearly complete sequence of sedimentary formations ranging in age from late Cambrian to late Cretaceous. Because of extensive erosion of the uplifted area, roughly concentric outcrops of the various formations are encountered, with the oldest formation cropping out near the center. Beds of unequal hardness have eroded at different rates so that the present topography consists of a series of concentric hogbacks of hard rocks separated by valleys carved in the softer formations.

The geologic formations encountered at the dam site are of sedimentary origin and are of upper Paleozoic and lower Mesozoic age. They include in ascending order, the Minnelusa formation (Pennsylvanian); Opeche formation (Permian); Minnekahta formation (Permian); and Spearfish formation (Permo-Triassic). Pleistocene and recent stream gravels are also present above the older formations.

b. Soils

There are two major soil associations within the Cold Brook Reservoir: Rockerville-Sawdust-Rock and Rapidcreek loam. The Rockerville series consists of shallow, well-drained soils that formed in residuum derived from sedimentary rocks such as limestone or, less commonly, calcareous sandstone. Rapidcreek series consist of well-drained soils derived from loamy alluvium characteristic of floodplains.

4-04 SEDIMENT

Sediment accumulation into Cold Brook has not been a problem at Cold Brook Reservoir. A lack of large runoff events since the dam was closed has limited large sediment events. Plate 2-10 shows the 2020 reservoir capacity and surface area data. Table 4-1 shows the storage changes between historical surveys.

Table 4-1. Historical Cold Brook Reservoir Storage Capacity Survey Results

Storage Zone with Pool Elevation Range (ft)	Original (1954)	1972			2018		
	Capacity (af)	Capacity (af)	Rate of Change (af/yr)	Percent of Original	Capacity (af)	Rate of Change (af/yr)	Percent of Original
Surcharge 3651.4 – 3667.2	3,600	3,723	6.83	103.4	3,831	2.35	106.4
Flood Control 3585.0 – 3651.4	6,700	6,711	0.61	100.2	6,801	1.96	101.5
Conservation 3543.4 – 3585.0	500	520	1.11	104.0	691	3.72	138.2

*As a result of changing methodologies between 1954 and 2018, no depletion trend analysis should be completed on this reservoir

4-05 CLIMATE

The climate in the Fall River and adjacent Cheyenne River basins is classified as semi-arid. Summer temperatures above 100 degrees Fahrenheit (°F) are not uncommon and during the winter months temperatures well below zero are observed on occasion. However, the proximity of this area to the Rocky Mountains, leeward of the prevailing westerly winds, often results in downslope winds with associated rapid warming trends. As a consequence, significant amounts of snowfall do not normally accumulate during the winter months. Thunderstorms deliver most of the precipitation during the summer months and can create flash floods. In the winter, the bulk of the precipitation falls as snow. The nearest available climate data station to Cold Brook Dam is in Hot Springs, SD, approximately 1.5 miles southeast of the dam. Table 4-2 summarizes the period of record climate values at Hot Springs, SD. This is the most updated table available for this site.

Table 4-2. Climate Summary for Hot Springs, SD (NOAA COOP* Station #394007)

Month	Average Max Temperature (°F)	Average Min Temperature (°F)	Average Total Precipitation (inches)	Average Total Snowfall (inches)
January	37.2	9.9	0.45	6.1
February	41.2	6.8	0.48	5.9
March	48.9	21.9	0.95	7.4
April	54.1	37.1	1.85	4.0
May	69.0	48.8	3.03	0.4
June	75.6	56.8	2.96	0.0
July	84.0	63.7	2.40	0.0
August	79.6	65.2	1.71	0.0
September	68.5	51.2	1.36	0.2
October	57.2	37.2	1.14	1.6
November	44.3	21.4	0.49	3.8
December	36.5	9.2	0.44	5.7
Annual	**53.1**	**43.3**	**17.40**	**35.4**

*Cooperative Observer Network
Source: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?sd4007, 1894-2019

a. Temperature

Daily temperature extremes can vary significantly in the area. Historical daily temperatures range from a maximum of 112°F to a minimum of -41°F. Average monthly temperatures vary from a maximum of 84°F to a minimum of 6.8°F.

b. Precipitation

Spring and summer rainfall in the area falls as heavy showers of short duration. The average annual snowfall is about 35 inches, occurring normally during the months of October through April. The largest amount of snow generally falls in March. Of the 17.40 inches of average annual precipitation at Hot Springs, 13.31 inches fall during the months of April through September. The maximum monthly precipitation usually occurs in May and June. Temperature and precipitation records for Hot Springs are summarized in Table 4-1. Precipitation gages in the vicinity are shown on Plate 4-1.

c. Evaporation

According to Technical Report No. 33 published by the National Weather Service

(NWS), lake evaporation in the Fall River basin averages from 44 to 46 inches per year. Evaporation is now calculated using a bulk flux evaporation estimate developed by the Corps' Cold Regions Research and Environmental Lab. This estimate uses real-time hydrometeorological data along with Cold Book's physical properties to calculate an evaporated volume and is stored into the WCWQS Corps' Water Management System (CWMS) database for use in water management decisions and historical recording. The model inputs include air temperature, wind speed, relative humidity, barometric pressure, cloud cover extent and elevation, reservoir depth, reservoir location, water surface elevation, and the elevation-area relationship. The model has some limitations, which include the inability to accurately calculate evaporation when the reservoir is ice covered. When the reservoir is ice covered, the WCWQS personnel estimate the evaporation utilizing the estimated average pan evaporation found in Table 4-2. This data is determined from an analysis of past computed evaporation including an analysis of empirical means for estimating evaporation for this area. To convert the pan evaporation depth in Table 4-3 to flow in cfs, the depth is converted to feet (divided by 12), multiplied by a factor of 0.70 and by the Cold Brook Reservoir area (in acres), and divided by 1.9835 (to convert from af to cfs).

Table 4-3. Estimated Average Pan Evaporation

Month	**Monthly Loss (in)**
January	0.49
February	0.63
March	1.12
April	2.17
May	2.94
June	3.99
July	5.53
August	5.11
September	3.99
October	2.73
November	1.47
December	0.63
Total	**30.80**

4-06 STORMS AND FLOODS

Flood information prior to 1939 is limited to high water marks and historical records. Information regarding the total amount of rainfall during flood-producing storms is available only for the more recent floods. Floods in the Hot Springs area are described in the following sections. Figure 4-1 below shows a summary of all peak stages at the Fall River at Hot Springs streamgaging site for reference. Peaks occurring before 1952 are completely unregulated.

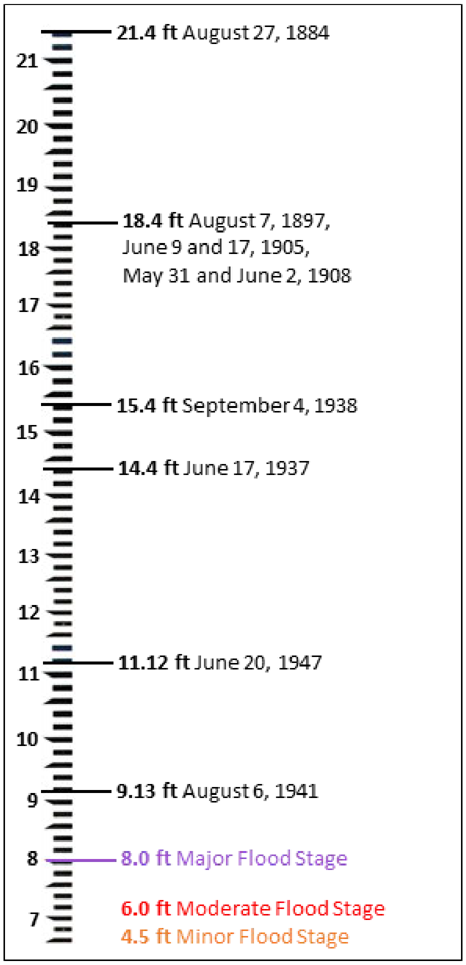

Figure 4-1. Historical Peak Stages on the Fall River at Hot Springs, SD

a. Flood of August 27, 1884

High water marks indicate that a flood that occurred on August 27, 1884 was the greatest flood of record to date, but there is no information concerning the duration of the storm or the amount of rainfall. It was estimated that this flood had a peak stage seven feet higher than the June 1937 flood, which would be 21.4 feet.

b. Floods of 1897, 1905, and 1908

Historical data and high water marks indicate that floods that occurred on August 7, 1897, June 9 and 17, 1905, May 31, 1908, and June 2, 1908 reached peak stages approximately four feet higher than the flood of June 1937, which would be 18.4 feet. A 12-foot rise in 25 minutes occurred during the August 1897 flood.

c. Flood of June 17, 1937

The Hot Springs Weekly Star and the Rapid City Journal describe a heavy rain and hail storm hitting the Hot Springs area the night of June 17, 1937 before 7:00 p.m. The utility office at Battle Mountain reported 2.70 inches of rainfall. Hail stones were seen ranging in size from marbles to small eggs covering the ground before sheets of rain filled the streets and alleys and draws with water. The Fall River rose quickly, tearing away sections of retaining wall downstream. City damages were estimated at $100,000, not including 13 railroad bridges washed away and other railroad property damages, which were also estimated at $100,000. The peak stage of the 1937 flood of 14.4 feet was about one foot lower than the peak stage recorded during the 1938 flood.

d. Flood of September 4-5, 1938

The largest recorded flow on record on the Fall River was caused by a heavy rainstorm during the evening of September 4, 1938. At Hot Springs, 2.10 inches of rain fell between 7:00 p.m. and 11:00 p.m. Estimates of rainfall amounts at other points in the basin varied from 0.50 inches to 5.00 inches. The US Geological Survey (USGS) determined a peak discharge of 13,100 cfs at the Hot Springs gage. The peak stage was 18.4 feet with the gage datum then in use. The current gage would indicate a stage of 15.4 feet for this discharge. The Central Electric Company suffered severe flood damage to its hydroelectric installations, basements and business establishments were flooded, and highway and railroad facilities suffered damages from erosion and debris.

e. Flood of August 6, 1941

Little is known about the flood of 1941, other than that 2.70 inches of rainfall fell in the Hot Springs area. The Hot Springs gage reported a peak flow of 4,700 cfs with a peak stage of 9.13 feet.

f. Flood of June 20, 1947

After 3.5 to 4 inches of rain fell in the basin, the Fall River began rising rapidly through the City of Hot Springs. The river rose over the banks and flooded business streets and basements, ripped out bridges, and caused some residents in the lower elevation areas to abandon their homes. The river began its rise at 5:00 p.m. and peaked and began receding by 7:00 p.m. The peak was the highest stage since the 1938 flood. Major damages were sustained by business and residential property, utilities, roads and streets, and rural flood plain areas. The estimated damages to urban and rural areas were estimated at $221,776 and $24,595, respectively. The USGS reported a peak discharge of 8,300 cfs and peak stage of 11.1 feet. This was the last large peak flow prior to the construction of Cold Brook and Cottonwood Springs Creek Dams. As of 2020, flooding to this magnitude has not occurred since

1947. Cold Brook Dam was closed in 1952 and Cottonwood Springs Dam was closed in 1969.

4-07 RUNOFF CHARACTERISTICS

Runoff in the Fall River basin generally occurs as a result of high intensity short duration rainstorms that occur during the spring and summer months. On rare occasions early spring snowmelt causes a rise in stage, but it has not produced a serious flood threat. Table 4-4 shows average monthly streamflow at the Fall River at Hot Springs streamgage location for the period of record, both prior to storage effects at Cold Brook and Cottonwood Springs Dams and after the initial fill of Cold Brook Dam.

Table 4-4. Average Monthly Streamflow at Hot Springs, SD*

Month	1937 to 1950 Streamflow (cfs)	1953 to 2018 Streamflow (cfs)
January	29	25
February	29	25
March	30	25
April	28	25
May	29	25
June	31	25
July	30	24
August	30	24
September	31	24
October	29	24
November	29	25
December	28	25

*Data is derived from the USGS daily average discharge data for the Fall River at Hot Springs, SD streamgage.

4-08 WATER QUALITY

The water quality of Cold Brook Reservoir is suitable for primary contact and recreation, and the growth and propagation of fish and associated aquatic life, waterfowl, and furbearers. Special regulation of Cold Brook Reservoir may be required occasionally to enhance the water quality conditions for authorized project purposes. The need for any regulation to enhance water quality will first be evaluated by water quality personnel in the WCWQS. Water control personnel will issue the necessary reservoir regulation orders.

4-09 CHANNEL AND FLOODWAY CHARACTERISTICS

a. Stage-Discharge Relationship

The open water rating curve for the Fall River at Hot Springs, SD is shown on Plate 4-2. Similar curves or tables are on file in the WCWQS CWMS database for this station and other stations in the Cheyenne River basin. The stage-discharge relationships, as defined by these curves, may shift from time to time and are kept current with measurements made by the USGS. The largest shifts on these open water relationships will occur when ice forms on the streams. With ice conditions, stages for a particular discharge may be several feet higher than indicated by the open water curves.

b. Channel Capacities

From the initial construction of Cold Brook Dam until 1994, the reservoir rarely filled to the top of the conservation zone, and outflows were at or near zero. Since 1994, groundwater conditions in the Black Hills area have changed and there has been an increase in flow from natural springs, causing higher reservoir elevations and minor discharges. Traditionally, releases from the dam had been absorbed into the bed of the outflow channel; however, beginning in December 1998, the outflow began to extend farther downstream within the channel. In a one-quarter mile reach of private property below Cold Brook Dam, the historic channel and floodplain of Cold Brook had been completely filled in with homes, trailers, and outbuildings. Due to the lack of a channel to convey the flows, a significant area was flooded with only a small release from the reservoir. In addition to the potential for property damage, the warning time for high releases is very small, which could result in potential loss of life in the residential area. From 1999 through 2012, a summertime drawdown of the reservoir was initiated to increase warning time and to minimize project discharges while channel restoration construction was completed. Deviations from the water control plan were requested each spring for this drawdown. The channel restoration on Corps land was completed in 2008. The City of Hot Springs completed the channel through town in 2009 with capacity for a 100-year flow event (510 cfs). Fall River County will complete channel work once funding becomes available. There are no structures in the county portion of the channel, but some driveways could be inundated with releases from Cold Brook Dam. The Corps funded the construction of a culvert on the county portion of the channel in 2012, which provides access to the reservoir during large Cold Brook Dam releases. This increased channel capacity to about 1,500 cfs in the affected area. An overview of channel restoration activities on Cold Brook is shown in Plate 4-3.

The Fall River channel through Hot Springs, SD was improved as part of the three-part Fall River Project including the Cold Brook Reservoir Project, Cottonwood Springs Creek Reservoir Project, and the Hot Springs Channel Improvement Project. The channel improvement, which was designed to carry 16,000 cfs with about 2 feet of freeboard, will carry a flood flow slightly under 25,000 cfs without overtopping. The Hot Springs Channel Improvement Project is shown on Plate 3-2.

The Fall River channel below the City of Hot Springs traverses a sparsely-settled area due to the rugged nature of the basin and no channel capacities have been determined for this reach.

c. Travel Times

The travel time from Cold Brook to the confluence with the Fall River is less than one hour.

4-10 UPSTREAM STRUCTURES

There are no major flow regulation structures upstream of Cold Brook Reservoir.

4-11 DOWNSTREAM STRUCTURES

There are no major flow regulation structures downstream of Cold Brook Dam.

4-12 ECONOMIC DATA

a. Population

The population concentration in the basin is sparse and is shown in Table 4-5. The total population of the two contributing counties (Custer and Fall River) was 15,310, per the 2010 census report. The largest city in the vicinity is Hot Springs, SD, with a 2010 census population of 3,711.

Table 4-5. Populations near Cold Brook Dam

Town	1960	1970	1980	1990	2000	2010
Buffalo Gap, SD	194	155	- - -	173	164	126
Custer, SD	2,105	1,597	- - -	1,741	1,860	1,987
Edgemont, SD	1,772	1,174	- - -	906	867	774
Hot Springs, SD	4,943	4,434	- - -	4,325	4,129	3,711
Oelrichs, SD	132	94	- - -	138	145	126
Pringle, SD	145	86	- - -	96	125	112
County	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**
Custer, SD	4,906	4,698	6,000	6,179	7,275	8,216
Fall River, SD	10,688	7,505	8,439	7,353	7,453	7,094
State	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**
South Dakota	680,514	665,507	690,768	696,004	754,844	814,180

Data Source: U.S. Department of Commerce, Bureau of the Census

b. Agriculture and Industry

Table 4-6 highlights the role of agriculture in the area around Cold Brook Dam. Irrigation plays a minor role in the basin. The majority of crop and pasture land in the watershed is non-irrigated. Livestock represents the majority of agricultural revenues in the basin. Cattle and calves are the prominent form of livestock; sheep, lambs, bison, horses, layers and goats add to the livestock and poultry inventory. Major crops in the basin include forage, wheat, corn, sorghum, and sunflower seed.

Table 4-6. Agricultural Data near Cold Brook Dam and Reservoir

	Custer County	Fall River County
Land in Farms (acres)	623,206	1,088,818
Average Size of Farm (acres)	1,397	3,330
Market Value of Agriculture Products Sold	$ 26,013,000	$ 116,858,000
% Crops	11%	6%
% Livestock, Poultry, and their products	89%	94%
Total Cropland (acres)	46,911	63,815
Irrigated Land (acres)	3,140	7,480

Data from 2012 Census of Agriculture, USDA, National Agriculture Statistics Service

The City of Hot Springs grew up around the thermal springs located in an attractive terrain below the confluence of Hot Brook and Cold Brook. Its business and industrial areas, hotels, and thermal springs are situated on the floodplain near the head of Fall River Canyon. All of these improvements plus railroads and bridges in the vicinity were subjected to severe flood damages before the construction of Cold Brook Dam. Employments by industry in the Cold Brook Dam basin are found in Table 4-7.

Table 4-7. Employment by Industry near Cold Brook Dam

	Custer County	Fall River County
Service-Providing	88%	87%
Trade, Transportation, & Utilities	18.6%	21.4%
Information	1.8%	2.5%
Financial Activities	6.2%	4.8%
Professional and Business Services	11.8%	8.0%
Education & Health Services	21.5%	34.4%
Leisure & Hospitality	25.8%	13.8%
Other Services	2.3%	2.5%
Goods-Producing	12%	13%
Natural Resources & Mining	2.9%	5.5%
Construction	8.5%	6.7%
Manufacturing	0.7%	0.5%

Data from 2017 2nd Quarter, Quarterly Census of Employment and Wages, U.S. Department of Labor, Bureau of Labor Statistics

c. Flood Damages

Cold Brook Dam and Cottonwood Spring Creek Dam are both designed to reduce the risk of flooding in the City of Hot Springs, SD. Flood damages prevented beginning in 1953 are shown in Table 4-8.

Table 4-8. Flood Damages Prevented by Cold Brook Dam (in $1,000s)

Year	Unadjusted	Adjusted to 2019	Year	Unadjusted	Adjusted to 2019
1953	0.0	0.0	1989	0.0	0.0
1954	0.0	0.0	1990	0.0	0.0
1955	0.0	0.0	1991	0.0	0.0
1956	0.0	0.0	1992	0.0	0.0
1957	0.0	0.0	1993	50.1	102.3
1958	8.6	100.7	1994	0.0	0.0
1959	0.0	0.0	1995	0.0	0.0
1960	0.0	0.0	1996	0.0	0.0
1961	41.7	451.3	1997	6.3	11.4
1962	34.0	360.3	1998	25.5	46.2
1963	27.1	280.4	1999	97.8	171.6
1964	0.0	0.0	2000	0.0	0.0
1965	0.0	0.0	2001	0.0	0.0
1966	20.6	194.8	2002	0.0	0.0
1967	21.7	197.3	2003	0.0	0.0
1968	0.0	0.0	2004	0.0	0.0
1969	0.0	0.0	2005	136.0	197.1
1970	0.0	0.0	2006	0.0	0.0
1971	0.0	0.0	2007	0.0	0.0
1972	0.0	0.0	2008	0.0	0.0
1973	0.0	0.0	2009	0.0	0.0
1974	0.0	0.0	2010	142.3	178.1
1975	0.0	0.0	2011	0.0	0.0
1976	0.0	0.0	2012	0.0	0.0
1977	0.0	0.0	2013	153.2	178.2
1978	0.0	0.0	2014	0.0	0.0
1979	0.0	0.0	2015	0.0	0.0
1980	0.0	0.0	2016	0.0	0.0
1981	0.0	0.0	2017	0.0	0.0
1982	78.0	214.6	2018	0	0.0
1983	0.0	0.0	2019	0	0.0
1984	0.0	0.0	**TOTAL**	**916.5**	**2,858.6**
1985	0.0	0.0			
1986	0.0	0.0			
1987	0.0	0.0			
1988	73.6	174.1			

Source: USACE Omaha District, Environmental, Economic and Cultural Resources Section. Data is presented in Fiscal Year (October 1 – September 30).

V. DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 HYDROMETEOROLOGICAL STATIONS

Various agencies and the State of South Dakota have streamgages, precipitation gages and radar rainfall sensing in the Fall River basin. The USGS, NWS and the State contribute personnel and/or funds to the support of pertinent data collection. Meteorological and hydrological data from this system are received via satellite and electronically by the WCWQS.

a. Facilities

The Cooperative Stream Gaging (Co-op) program is a joint effort between the Corps and the USGS providing remote site, satellite data transmissions utilized for water management. Streamgage and precipitation stations in the vicinity of Cold Brook Dam are listed in Table 5-1 and are shown on Plate 4-1. Not all stations listed are part of the Co-op program.

CWMS is the Omaha District's primary water management data system. CWMS was developed by the Corps' Hydrologic Engineering Center (HEC) and utilizes an Oracle database to store river, reservoir, and weather data. CWMS collects and presents water management data in a clear, concise, and comprehensive manner. It also provides access to both real-time observed data and results from forecast scenarios. Observed and forecasted information are displayed in two dimensional plots and in special graphics using a schematic, map, or image backgrounds.

Table 5-1. Cold Brook Gaging Stations

Station Name	Agency	Stream Gage	Precipitation Gage	USGS ID	*NESDIS ID	NWS ID
Cold Brook on Argyle Rd nr Cold Brook Reservoir nr Hot Springs	USACE	✓		---	CE8295FC	ARGS2
Cold Brook Reservoir at Hot Springs, SD	USACE		✓	06401950	CE42C1E4	CBKS2
Cottonwood Reservoir	USACE		✓	---	CE23C12C	CDHS2
Custer 2SW RAWS**	USFS		✓	---	326760FA	CRRS2
Custer State Park RAWS near Custer 12ESE	BLM		✓	---	32D35192	CSPS2
Fall River at Hot Springs	USGS	✓	✓	06402000	CE332540	HOTS2
Red Canyon RAWS near Edgemont 7NE	USFS		✓	---	323075FA	RDCS2
WICA Elk Mountain RAWS near Pringle 5SE	NPS		✓	---	FA6600F8	WCAS2
Pringle, SD	USACE		✓	---	CE5149B2	---

*National Environmental Satellite, Data, and Information Service
**Remote Automated Weather Station
Source: https://hads.ncep.noaa.gov/

b. Reporting

Data from hydrologic gages are obtained from various sources including contract observers, project offices, NWS, USGS, and state offices. The NWS provides current weather conditions, precipitation, temperature and river stage and flow forecasts, observed precipitation reports, river level data, and special hydrologic forecasts including flood warnings.

There are many websites that provide a variety of weather products including universities, NWS, and commercial vendors of weather products. Products range from raw data (i.e., precipitation, temperature) to upper air maps and forecast products.

Periodic discharge measurements made by the USGS are normally furnished to the WCWQS through automated computer exchange but can also be obtained by mail, email, fax, or telephone for various stations. These are used to maintain current stage-discharge relationships.

The automated data collection platforms, located throughout the basin, transmit real-time information such as river and reservoir levels, precipitation, wind, water temperature and air temperature data via a Geostationary Operational Environmental Satellite to the Omaha District office building and to the NOAA National Environmental Satellite, Data, and Information Service. The WCWQS receives and stores this data (see Section 5-01.a). Computer software allows the WCWQS to retrieve and view the data in real-time and make reservoir regulation decisions while simultaneously archiving data for future use.

c. Maintenance

The Corps supports the collection of data by contributing personnel, funds and equipment. Streamgage sites are installed and maintained by the Corps and USGS.

The WCWQS personnel coordinate the Omaha District's Co-op program with assistance from the USGS. USGS activities are funded through the Co-op program executed by the WCWQS. The Co-op program provides financial support for operation and maintenance of multiple streamgaging stations.

5-02 WATER QUALITY STATIONS

The WCWQS collects monthly samples (May, June, July, August, and September) once every three years. Depth discrete samples are collected near the surface and bottom of the water column at the near-dam station. Water quality depth profiles are taken at 0.5-meter intervals at all stations. Typical analytical parameters are nutrients, metals, pesticides, and general field parameters (e.g., oxygen, temperature, and pH). All data sets are stored in the WCWQS water quality database until they can be transferred to the Environmental Protection Agency's Water Quality Exchange database. Data is analyzed by the WCWQS personnel.

5-03 SEDIMENT STATIONS

a. Facilities

No sediment sampling is done by the Corps at this project. Seventeen sediment ranges are located on Cold Brook Reservoir (see Plate 2-9). The sediment ranges are resurveyed periodically to assess surface area and capacity changes. The results can be compared to original projections of sediment depletion which determine the remaining life of the project.

The original 1954 surveys were surveyed by Omaha District personnel. Additional surveys were completed in 1966, 1974, 1983, 1988, 1994, and 2015. The 1974, 1988 and 1994 surveys were a reconnaissance level survey of sediment ranges CB-01 through CB-05 and CB-31 only. Most survey control points were ¾-inch diameter by 4-foot long iron pipe and marked with a 6-foot long, steel T-type fence post and witness plate combination as seen in Figure 5-1.

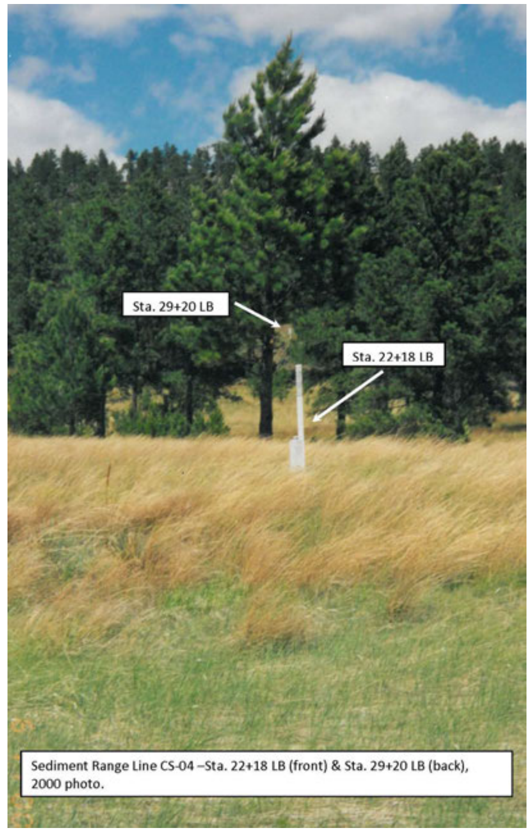

Figure 5-1 Typical Survey Control Point

b. Reporting

Data is analyzed and used to produce updated area and capacity tables. Plate 2-10 shows the current area and capacity relationships used in Cold Brook regulation.

c. Maintenance

The permanent survey monuments are maintained periodically, usually in conjunction with a planned survey.

5-04 RECORDING HYDROLOGIC DATA

The Omaha District's primary data management system is CWMS. CWMS was developed by the HEC and utilizes an Oracle database to store river, reservoir and weather data.

CWMS collects and presents the Omaha District's data in a clear and comprehensive manner. It provides access to both the current observed data and the results from forecast scenarios. Observed and forecasted information are displayed in two-dimensional plots and in special graphics using schematic, map or image backgrounds.

5-05 COMMUNICATION NETWORK

A functioning communication network between Corps offices, other Federal partners, state/local government and law enforcement is vital to safe operations at Cold Brook Dam. The WCWQS will maintain liason and cooperate with Federal, State, and County agencies and officials and with local public and private interests relative to the regulation of the reservoir. Along with telephone, email and text communications between WCWQS employees and the Dam Tender, a robust satellite and server network is available to transmit real-time data used to inform current and future project conditions. See Section 5-01 for more information.

5-06 COMMUNICATION WITH PROJECT

a. Regulating Office with Project Office

The WCWQS should maintain telephone, email and text communications with the Cold Brook Dam Tender. This two-way communication channel should transmit real-time weather conditions, observations from the Dam Tender and locals, forecasts received locally or from WCWQS, and any other information pertinent to the operation of Cold Brook Dam. Telephone or email should be used to convey reservoir regulation orders from the WCWQS to the Dam Tender. Email confirmation should be sent following any reservoir regulation orders made over the phone. In the event the Dam Tender cannot be reached by the WCWQS, the WCWQS should contact the Big Bend Project Office. See Exhibit C, Standing Instructions to Dam Tender for more detailed information and responsibilities.

b. Between Project Office and Others

During times of heavy precipitation or when flood storage is being evacuated from Cold Brook, the Dam Tender should assist the WCWQS in collection of data pertinent to operations. The Dam Tender should also assist in facilitating communications between local government, law enforcement and other entities involved in state and local emergency management.

5-07 PROJECT REPORTING INSTRUCTIONS

In the event automated collection of pool elevation or precipitation data is interrupted, the Dam Tender and the WCWQS will communicate by the most direct means available. The Dam Tender will report pool elevation and observed precipitation data to the WCWQS at an interval determined by the WCWQS. See Exhibit C, Standing Instructions to Dam Tender for more detailed information and responsibilities.

5-08 WARNINGS

The campground at Cold Brook Reservoir is susceptible to flash flooding during heavy rain events upstream. An auto dialer and alarm system are connected to a monitoring station upstream of Argyle Road to provide early flood warning. In the event the monitoring station is triggered, the auto dialer calls Fall River dispatch, the Cold Brook

Dam Tender, the Big Bend Power Plant, and the NWS in Rapid City. Once contacted, the aforemented should take appropriate efforts to notify those at the campground as quickly as possible. A siren is also triggered at the campground notifying visitors they need to evacuate.

The Corps' Missouri River Basin Water Management (MRBWM) office will be kept informed by telephone and email of hydrologic conditions in the basin during flood periods and will be furnished, by email, a copy of special directives to the Dam Tender. The procedure for the dissemination of Emergency Public Information is detailed in the Cold Brook Dam and Reservoir Emergency Action Plan (EAP).

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VI. HYDROLOGIC FORECASTS

6-01 GENERAL

No inflow forecasting has historically been done using snowpack data because there is not a consistent snowpack. However, there are websites that can be used to give a general idea of what to expect in terms of the spring runoff. The NWS National Operational Hydrologic Remote Sensing Center has a website that contains information on the current snow water equivalent for the area upstream of Cold Brook Reservoir.

The website for the NWS Rapid City Weather Forecast Office (WFO), which has the weather forecast responsibility for the area around Cold Brook Reservoir, may also have useful information on snow conditions. During flood conditions, the NWS Rapid City WFO will issue flood warnings and watches, as well as river forecasts for the Fall River. The NWS may also provide short-term forecasts on expected precipitation in the area. Current streamflow information for streamgaging sites in the Fall River basin are available via the internet from the USGS in South Dakota. All of these sources can be utilized to provide the most up-to-date basin conditions.

The CWMS software integrates with HEC models to provide real-time forecasting capability. CWMS models have been developed to assist in regulation. The Hydrologic Modeling System (HMS) simulates the precipitation-runoff processes, the River Analysis System (RAS) calculates water surface profiles for river reaches downstream of the reservoirs, and the Flood Impact Analysis (FIA) model computes flood damages for regulated flow. It is expected that modeling cabilities will improve with continued use.

6-02 FLOOD CONDITION FORECASTS

a. Weather and River Forecasts

The WCWQS receives meteorological data from several sources. General weather conditions and forecasts are accessed from the NWS National Centers for Environmental Prediction, NWS Missouri Basin River Forecast Center (MBRFC), and NOAA or NWS websites. NWS products include upper air charts, surface synoptic maps, national and local radar summaries and depictions of daily temperature and precipitation for the United States and southern Canada. The MBRFC also provides river stage and flow forecasts.

b. Unit Hydrographs

The storm of August 6, 1941 with a peak discharge of 3,450 cfs, the largest runoff from any of the storms that have occurred since the establishment of the recorder gage at Hot Springs, and with best established areal distribution, was used as a basis for the unit hydrograph determinations for the total Fall River basin and sub-areas. A 45-minute unit hydrograph was constructed for the Hot Springs zone and then from this hydrograph, synthetic 15-minute unit hydrographs were developed for the subareas and the basin. These 15-minute unit hydrographs were used for all flood routing studies. The unit hydrograph is shown on Plate 6-1.

6-03 CONSERVATION PURPOSE FORECASTS

In the history of the project there has existed enough water to meet downstream consumptive uses and maintain Cold Brook Reservoir's conservation zone. Conservation forecasts have not been necessary to this point at Cold Brook Reservoir.

6-04 LONG RANGE FORECASTS

Given the flashy hydrograph shapes seen at Cold Brook, long-range forecasts are not prepared for Cold Brook Reservoir.

6-05 DROUGHT FORECAST

Currently, the WCWQS does not prepare drought forecasts for Cold Brook Reservoir.

VII. WATER CONTROL PLAN

7-01 GENERAL OBJECTIVES

It is essential that automatic operation of the ungated spillway and the uncontrolled portion of the outlet works at Cold Brook Dam be assured and unhindered in order to accomplish its authorized purposes. This operation will provide the maximum possible benefits consistent with its physical characteristics. This plan of regulation is drawn up for the purpose of ensuring the project shall at all times be maintained in optimum operating conditions and result in the dependable functioning capacity for which it was designed.

7-02 CONSTRAINTS

The major constraints for Cold Brook Dam are that it is unable to pass the PMF and there is limited channel capacity downstream of the dam, particularly in the portion of the channel between Cold Brook Dam and the City of Hot Springs in Fall River County.

7-03 OVERALL PLAN FOR WATER CONTROL

Generally the regulation of Cold Brook Reservoir above elevation 3585.0 feet is automatic, being dependent on the uncontrolled operation of the outlet works and spillway. The reservoir, spillway, and outlet works were designed along with Cottonwood Creek Reservoir to minimize discharges at Hot Springs.

7-04 STANDING INSTRUCTIONS TO DAM TENDER

The WCWQS will normally issue the regulation directly to the Dam Tender at Cold Brook Reservoir. Should a break in normal communications occur, the Dam Tender must make a continuing effort to re-establish communications by use of local or State emergency systems, or by driving to a location where normal communications are available. Exhibit D contains the detailed Standing Instructions to the Dam Tender.

7-05 FLOOD CONTROL

The objective of reservoir regulation for flood control storage is to mitigate downstream flood risk to the greatest extent possible with available facilities. The regulation of Cold Brook Reservoir above elevation 3585.0 feet is automatic, being dependent on the uncontrolled operation of the outlet works and spillway. When normal communications are disrupted, the Dam Tender will operate the reservoir according to the Standing Instructions to the Dam Tender as described in Section 7-04 and Exhibit D.

7-06 RECREATION

Recreational opportunities at Cold Brook Reservoir include picnicking, canoeing, fishing, swimming, archery, hiking, wildlife viewing, and camping. Winter activities include ice fishing, skating, and cross-country skiing. For additional information on recreational facilities and impacts to these facilities refer to Section 2-06 and Section 8-03.

fishing, skating, and cross-country skiing. For additional information on recreational facilities and impacts to these facilities refer to Section 2-06 and Section 8-03.

7-07 WATER QUALITY

Water Quality is not an authorized purpose at Cold Brook Dam, but is monitored by the WCWQS. See Section 4-08 of this manual for additional information regarding water quality.

7-08 FISH AND WILDLIFE

Fish and wildlife is one of the authorized purposes of the reservoir. See Section 8-05 for more information on Fish and Wildlife at Cold Brook Reservoir.

7-09 WATER SUPPLY

Water Supply is not an authorized purpose at Cold Brook Dam. Releases are made from the reservoir outlet works to satisfy senior downstream water rights requirements at Hidden Lake and a private residence. See Section 3-04 for more information.

7-10 HYDROELECTRIC POWER

Hydropower is not an authorized purpose of Cold Brook Dam, and no hydroelectric power facilities exist at the site.

7-11 NAVIGATION

Navigation is not an authorized purpose for Cold Brook Dam.

7-12 DROUGHT CONTINGENCY PLANS

The "Drought Contingency Fact Sheet for Cold Brook Reservoir, South Dakota", July 1987 (Exhibit F) states:

The small volume in storage in the multipurpose pool could provide a very limited amount of water to meet drought needs.

7-13 FLOOD EMERGENCY ACTION PLANS

The Corps' Omaha District Geotechnical Engineering Branch maintains an EAP that is distributed among state, county, and local emergency officials. The EAP is designed to provide early detection of potential dam safety concerns, procedures to evaluate concerns, and notification procedures with the ultimate goal of protection of life and property.

7-14 DEVIATION FROM NORMAL REGULATION

a. Emergencies

An emergency situation is defined as a circumstance where failure to act immediately could result in loss of life or significant property damage. Occasional non-flood emergencies can occur where a deviation from the normal operating procedures would assist other interests in managing the emergency. Examples of these types of emergencies include dam safety emergencies, downstream chemical spills, drowning, and facility failures. The EAP describes identification of impending and existing emergencies, emergency operations and repairs, and a response level determination matrix. Copies of the EAP are maintained in the Omaha District Geotechnical Engineering Branch. If the flood control reservoir regulation activities taken during an emergency are not covered in the water control plan of this manual, and a deviation is deemed necessary, the WCWQS must inform the MRBWM office by telephone or email as soon as possible. Written confirmation of the deviation request per NWDR 1110-2-6 must be furnished to the MRBWM office for their official approval.

b. Unplanned Minor Deviations

Activities of other interests can create the potential need for unplanned minor deviations from normal operations. These activities usually require temporary deviations, lasting from a few hours to a few days. Examples of unplanned minor deviation would be a gate malfunction or emergency conduit inspection. Each request should be analyzed on its own merits to determine if it is covered by the water control manual. If the proposed action is not covered by the water control manual, a deviation will be required. An evaluation of the proposed action should be included in the deviation request, including consideration of upstream watershed conditions, potential flood threats, the amount of water in storage in the reservoir, and whether any alternative measures could be taken that would not require a deviation. Each deviation request will be evaluated to ensure any potential adverse impacts to authorized project purposes are identified and considered prior to implementation. Initial approval for these minor deviations will usually be obtained from the MRBWM office via email or telephone. The formal written deviation request for approval from the MRBWM office should contain an explanation of the deviation and its cause per NWDR 1110-2-6.

c. Planned Deviations

In accordance with NWDR 1110-2-6, the Chief of MRBWM is the responsible approving official for all deviation requests for Cold Brook Dam and Reservoir. All deviation requests involving controversial regional or nationally significant actions shall be coordinated with the Chief of MRBWM prior to approval. The Chief of MRBWM retains authority to approve or disapprove all deviation requests. Prior approval is required for deviations from this water control manual that do not meet the requirements of Sections 7-14.a and 7-14.b. Pre-coordination of a potential deviation request should occur between the requesting office and the approving authority to ensure a deviation is necessary. Deviation requests should be submitted to the Chief of MRBWM. The MRBWM office will coordinate with the appropriate district or districts for all division-originated deviation requests. All deviations shall be documented in order to respond to any public concerns raised by those deviations. Coordination with federal, state, tribal, local, and private interests should be undertaken as appropriate. At a minimum, deviation requests should discuss the need for coordination and present a coordination plan. Informal coordination between WCWQS and the MRBWM office prior to WCWQS submitting the formal deviation request should be considered.

7-15 RATE OF RELEASE CHANGE

Since the regulation of Cold Brook Reservoir is generally achieved by the use of an uncontrolled spillway and ungated outlet works above an elevation of 3858.0 feet, there is limited control over the rate of release change at these pool levels. Total releases can be increased by use of the three slide gates on the outlet works.

VIII. EFFECT OF WATER CONTROL PLAN

8-01 GENERAL

Cold Brook Dam and Reservoir is regulated for flood control to reduce the risk of flooding for the City of Hot Springs. Plate 8-1 through Plate 8-7 show plots of pool elevation, inflow and releases for the period of record.

8-02 FLOOD CONTROL

a. Reservoir Design Flood

The regulation criteria developed for Cold Brook Reservoir in the 1945 Definite Project Report limited the maximum outflow during the Reservoir Design Flood to not exceed 8,000 cfs. The storm of June 12-13, 1907 at Fort Meade, SD is considered representative of the severe thunderstorm type cloudburst that may occur in the Black Hills region. The reservoir design storm is 85 percent of the Fort Meade storm centered over the contributing drainage area. The total rainfall was 5.23 inches. The loss rate was 0.28 inches per 15-minute period and the total runoff was 2.22 inches. When applied to the unit hydrograph, the reservoir design flood had a peak inflow of 32,900 cfs and a total volume of 8,350 af. The routing for this flood started at the top of the conservation zone. Routing through the reservoir resulted in a maximum pool elevation of 3651.4 feet. The maximum outlet works discharge was 1,540 cfs and the maximum spillway discharge was 6,460 cfs for a total maximum outflow of 8,000 cfs. A plot of the Reservoir Design Flood is shown in Plate 8-8.

b. Spillway Design Flood

The original Spillway Design Flood, from the 1945 Definite Project Report, was based on 150 percent of the 1907 Fort Meade storm. A loss rate of 0.20 inches per 15-minute period was used. The resulting 6.45 inches of runoff, when applied to the unit hydrograph, produced a hydrograph with a peak inflow of 95,700 cfs and a volume of 24,250 af. The routing for this flood started at elevation 3620.0 feet, the half-full flood control zone. When routed through the reservoir, the maximum pool elevation was 3667.2 feet and the peak outflow was 80,600 cfs. A plot of the Spillway Design Flood is shown in Plate 8-9.

c. Probable Maximum Flood

A 1993 Reconnaissance Study used Hydrometeorological Report 55a to derive the probable maximum precipitation (PMP) event for use in developing the PMF. The PMP event had a basin wide average rainfall total of 31.5 inches, a peak inflow of 201,900 cfs, and total runoff volume of 57,500 af. In 1996, the Corps requested the NWS to conduct a site specific PMP analysis for the Cold Brook basin. The site specific analysis resulted in a basin wide average rainfall of 27.6 inches. This produces a PMF peak inflow of 212,400 cfs and a runoff volume of 44,000 af. A plot of the PMF hydrograph is shown in Plate 8-10.

8-03 RECREATION

The beach area may see more use due to larger sand areas when the reservoir is drawn down below the top of the conservation pool. Fishing may also see increased uses due to the concentration of fish in a smaller pool. A drawdown greater than five feet may cause the reservoir to recede beneath the sand beach. See Section 2-06 for more information about public facilities around the Cold Brook Reservoir and Section 7-06 regarding recreation.

8-04 WATER QUALITY

Reservoir drawdowns and winter weather conditions may adversely affect water quality conditions in the reservoir. During periods of extended low water surface elevations, there may be concerns regarding low dissolved oxygen concentrations. Extended periods of snow and ice cover may also result in low dissolved oxygen concentrations due to the decomposition of organic matter and the lack of wind mixing and algal dissolved oxygen production. Cold Brook Reservoir is classified by South Dakota as a Category 5 water, meaning it is impaired by a pollutant and in need of a Total Maximum Daily Load (TMDL). Water temperature has been identified as a stressor on cold-water permanent fish life propagation. South Dakota has placed a low priority on establishing a TMDL at Cold Brook Reservoir. See Section 4-08 for more information on water quality.

The temperature criterion of 18.3 ºC for the protection of coldwater permanent fish life propagation was exceeded in 64 percent of all measurements taken throughout the reservoir during water quality monitoring in 2012, 2015, and 2018 (n=653). It is noted that if the reservoir were classified for the protection of warm-water permanent fish life propagation the criterion of 26.6 ºC would have only been exceeded in a total of three measurements. Ambient water temperatures in Cold Brook Reservoir do not appear to be cold enough to fully support coldwater permanent fish life propagation as defined by South Dakota water quality standards criteria. Consideration should be given to reclassify Cold Brook Reservoir for warmwater permanent fish life propagation use based on a use attainability assessment of “natural conditions” regarding ambient water temperatures.

8-05 FISH AND WILDLIFE

Cold Brook Reservoir is home to an abundance of fish and wildlife. The reservoir is stocked annually with rainbow trout, which occupy the majority of the fish population. Other fish include black crappie, channel catfish, largemouth bass, and green sunfish. Cold Brook Reservoir does not improve fishing at Cold Brook Creek, but Fall River is benefitted due to the reduction in intensity from major floods. Cold Brook Reservoir has a high value for fishing based on its proximity to Hot Springs and the abundance of fish.

Wildlife in the area includes black-tailed prairie dog, swift fox, deer, turkey, and a variety of mice. The more heavily wooded areas surrounding the reservoir are home to eastern red bats as well as northern flying squirrel. Predatory animals, including lynx, gray wolf, red fox, and long-tailed weasel, can be found in the area. Despite a relatively small area, waterfowl such as blue-winged teal, mallard, widgeon, scaup and Canadian geese may be found at this project.

Reservoir drawdowns of 1 to 5 feet will not impact fish and wildlife.

8-06 WATER SUPPLY

Water Supply is not an authorized purpose at Cold Brook Dam. Releases are made from the reservoir outlet works to satisfy senior downstream water rights requirements at Hidden Lake and a private residence. See Section 3-04 for more information.

8-07 HYDROELECTRIC POWER

Hydropower is not an authorized purpose of Cold Brook Dam, and no hydroelectric power facilities exist at the site.

8-08 NAVIGATION

Navigation is not an authorized purpose for Cold Brook.

8-09 DROUGHT CONTINGENCY PLAN

See Section 7-12 for details regarding drought contingency plans.

8-10 FLOOD EMERGENCY ACTION PLAN

See Section 7-13 for details on Cold Brook Dam’s EAP.

8-11 FREQUENCIES

Historical pool elevations at Cold Brook Dam are shown in Plate 8-1 through 8-7. Historic frequency and duration estimates can be inferred from this information.

8-12 OTHER STUDIES

As part of ongoing operations, the Corps will make note of possible improvements to the reservoir regulation procedures outlined in this manual. Data collection and conducting studies are included in normal reservoir regulation activities. The need and method of reporting precipitation and river stages will be evaluated on a continuing basis and changes made to improve the system as needs become apparent. As forecast methods and capabilities are improved, forecast methods should be modified accordingly and reviewed, and if deemed appropriate, integrated into the normal reservoir regulation activities.

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IX. WATER CONTROL MANAGEMENT

9-01 RESPONSIBILITIES AND ORGANIZATION

ER 1110-2-1400, dated May 30, 2016, assigns the Corps' reservoir regulation responsibilities in the Missouri River basin to the Northwestern Division (NWD) Commander. This ER also permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area the project is located. The Omaha District Engineer has the responsibility for assembly and interpretation of data affecting reservoir regulation and for carrying out routine regulation of Cold Brook Reservoir according to plans agreed to in advance. The NWD Commander, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District. The responsibility for the regulation of Cold Brook Reservoir and all associated activities is assigned to the WCWQS. An organization chart of the Omaha District is shown on Plate 9-1.

9-02 INTERAGENCY COORDINATION

a. Local Press and Corps Bulletins

When necessary, the Corps' Omaha District Public Affairs Office will issue new releases to inform the public of its activities. The WCWQS daily bulletin provides daily and real-time reservoir information on a public website.

b. National Weather Service

The Corps maintains a working relationship with the NWS and these existing lines of communication will be used during a flood event.

c. U.S. Geological Survey

The Corps maintains a working relationship with the USGS and these existing lines of communication will be used during a flood event.

d. Other Federal State, or Local Agencies

The Corps maintains a working relationship with other federal, state, and local agencies and these existing lines of communication will be used during a flood event.

9-03 INTERAGENCY AGREEMENTS

There are no interagency agreements for Cold Brook Reservoir.

9-04 COMMISIONS, RIVER AUTHORITIES, COMPACTS AND COMMITTEES

There are no commissions, river authorities, compacts, or committees for the Cold Brook project.

9-05 NON-FEDERAL HYDROPOWER

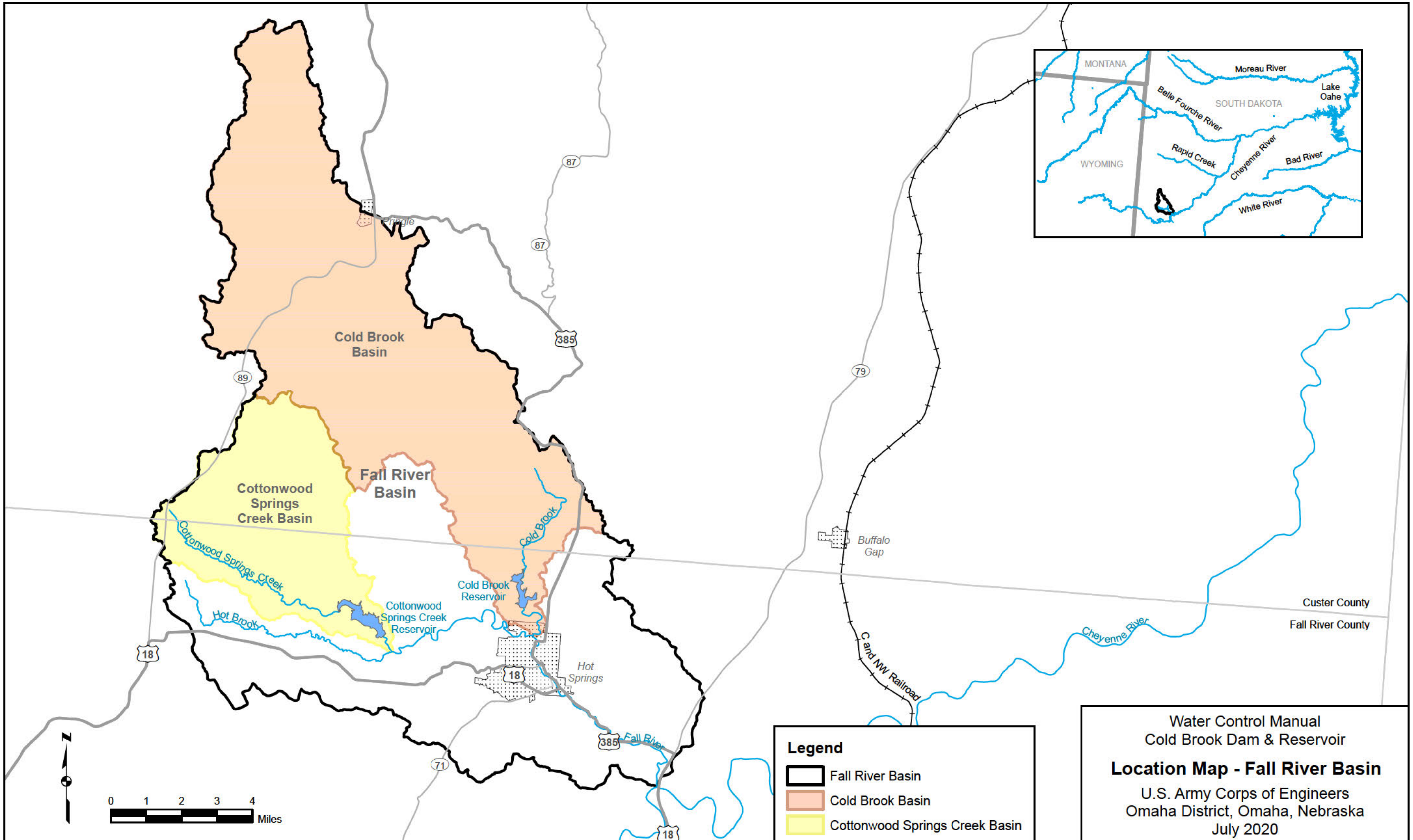
Hydropower is not an authorized purpose for Cold Brook. Thus, there is no non-federal hydropower coordination for Cold Brook Dam.

9-06 REPORTS

Reports required when Cold Brook Reservoir is in the flood control zone are shown in Table 9-1, along with the reports governing regulation and the required schedule.

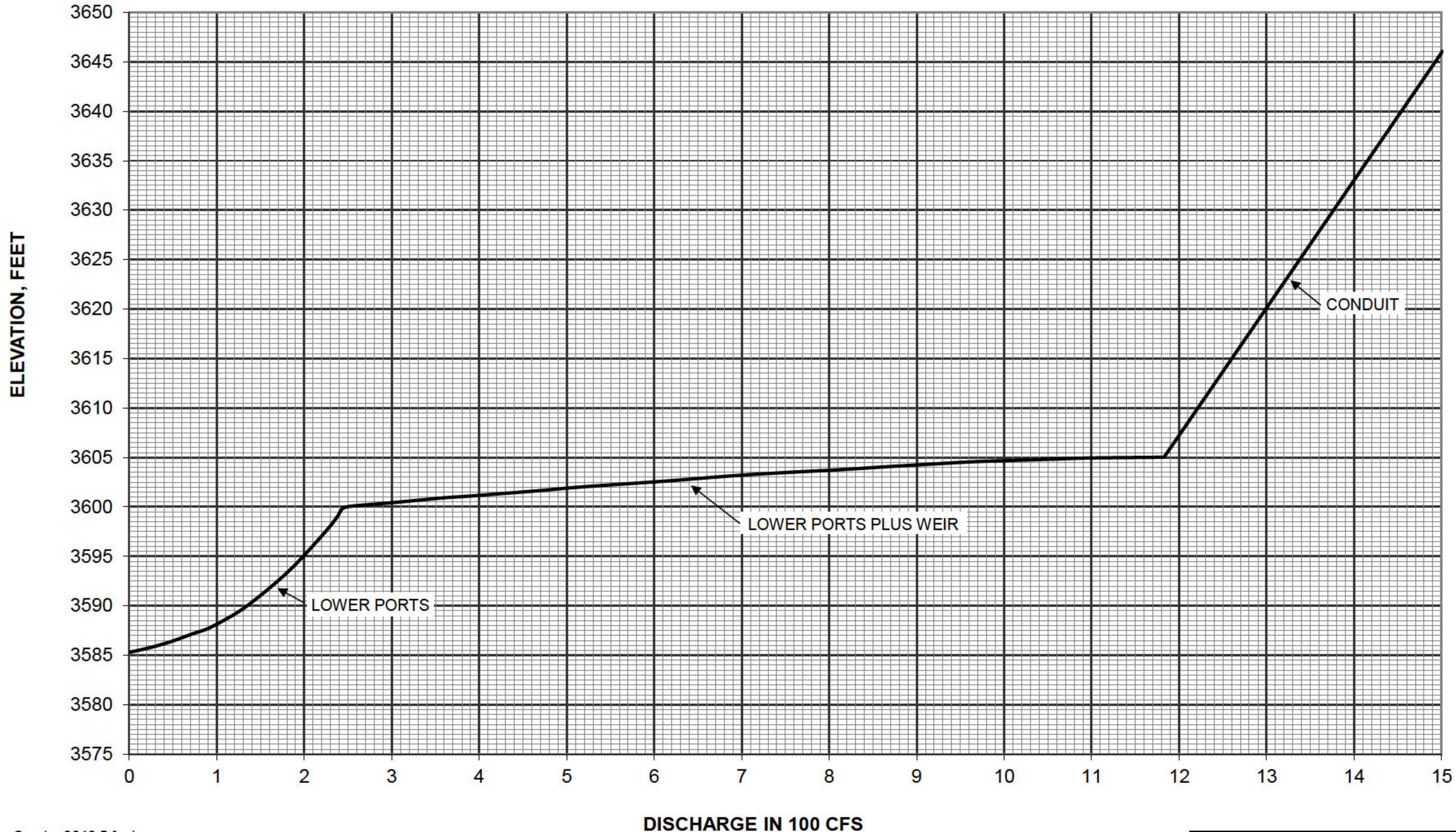
Table 9-1. Report Requirements

Report Title	Regulation or Guidance	Schedule
Reservoir Regulation Orders, WCWQS	EM 1110-2-3600	Every release change
Monthly Reservoir Operations, WCWQS	EM 1110-2-3600 ER 1110-2-240	Monthly
Annual Report, WCWQS	ER 1110-2-1400 ER 1110-2-240	Annual
Flood Emergency Reporting	EM 500-1-1	Per flood requirement
Daily Reservoir Bulletin, WCWQS	EM 1110-2-3600	Daily
Annual Report of Flood Damages Prevented	EM 1110-2-3600	Annual


MONTANA
Moreau River
Lake Oahe
Belle Fourche River
SOUTH DAKOTA
WYOMING
Rapid Creek
Cheyenne River
Bad River
White River
Pringle
87
87
385
89
79
Cold Brook Basin
Fall River Basin
Cottonwood Springs Creek Basin
Cottonwood Springs Creek
Cold Brook
Cold Brook Reservoir
Cottonwood Springs Creek Reservoir
Hot Brook
Buffalo Gap
Custer County
Fall River County
Cheyenne River
C and NW Railroad
Hot Springs
18
18
385
71
18
Fall River
0 1 2 3 4 Miles
Legend
Fall River Basin
Cold Brook Basin
Cottonwood Springs Creek Basin
Water Control Manual
Cold Brook Dam & Reservoir
Location Map - Fall River Basin
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020

[redacted]

Plate 2-2



Spillway Crest	3646.5 feet
Maximum Pool	3667.2 feet
Top of Dam	3675.0 feet

Water Control Manual
Cold Brook Dam & Reservoir
Conduit Rating Curve
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020

[redacted]

Plate 2-4

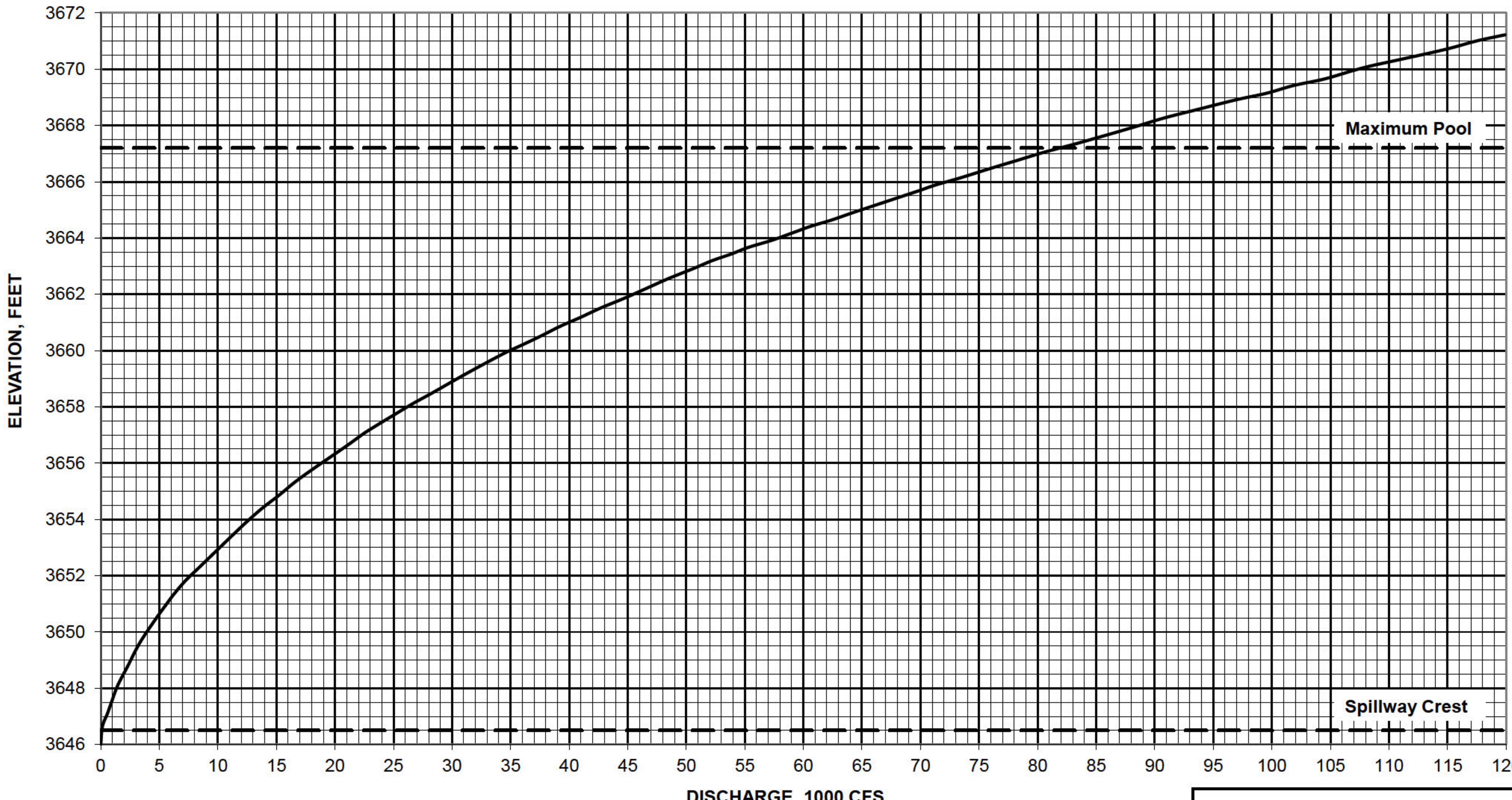
[redacted]

[redacted]

Plate 2-6

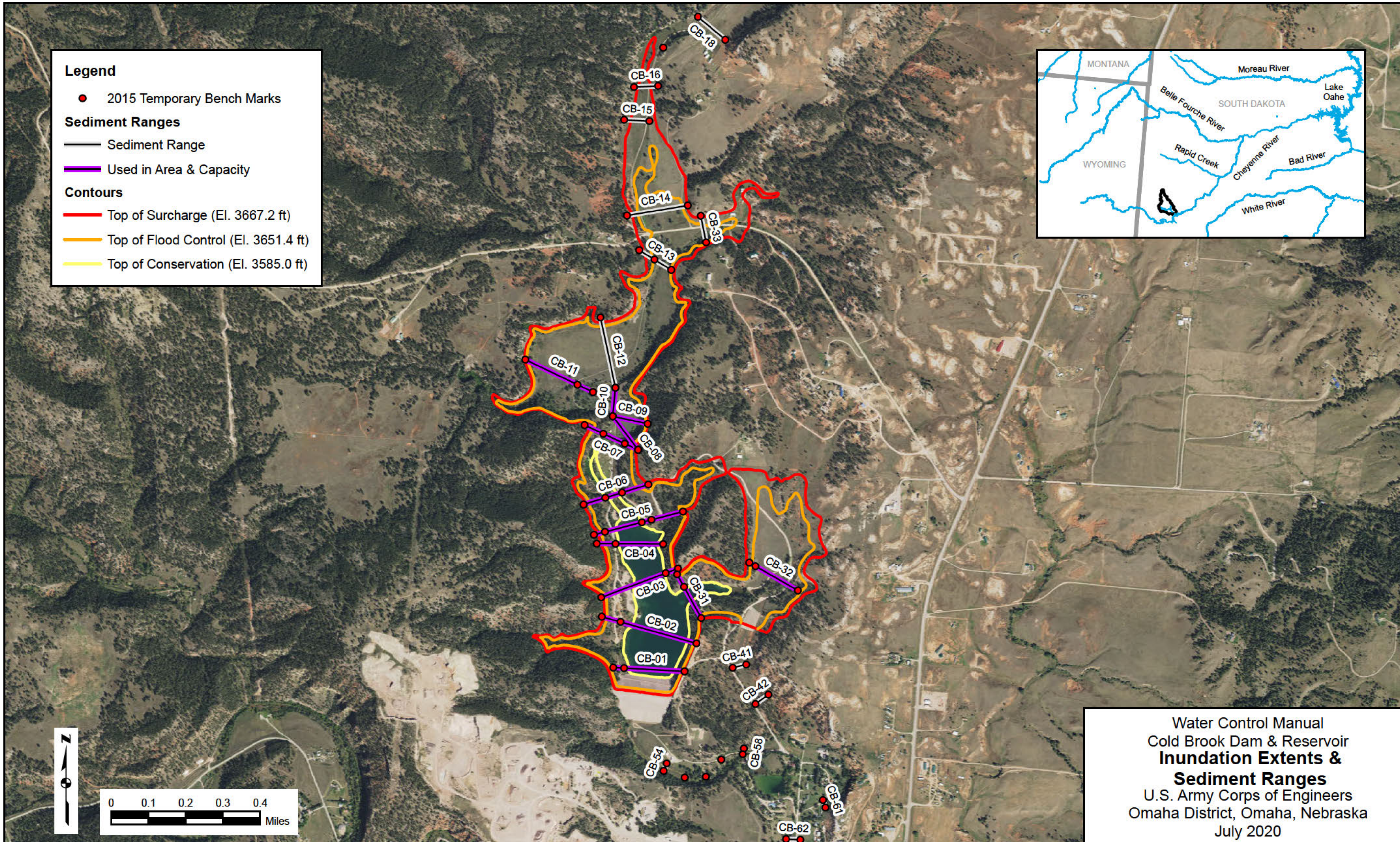
[redacted]

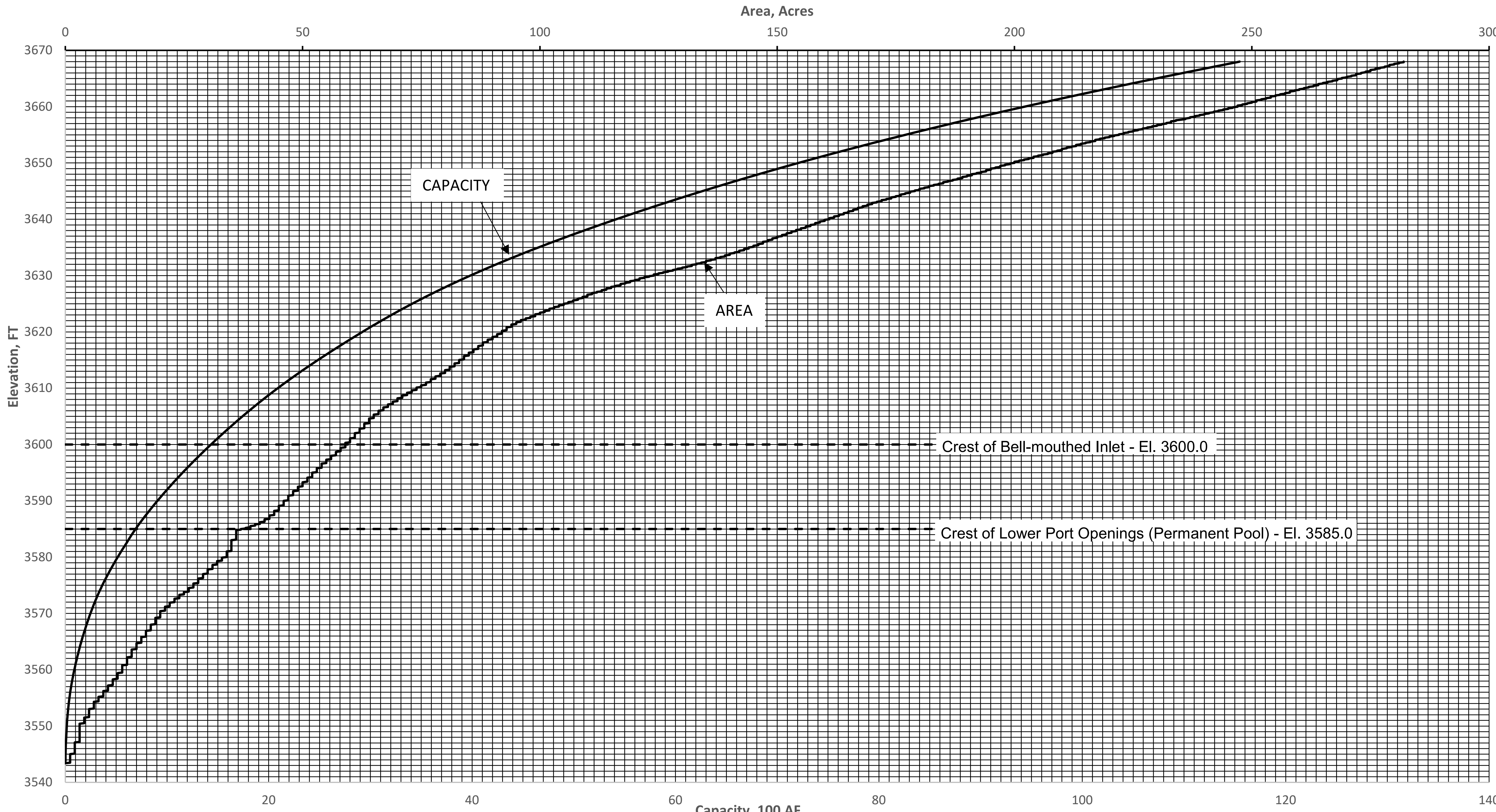
Plate 2-7



Spillway Crest	3646.5 feet
Maximum Pool	3667.2 feet
Top of Dam	3675.0 feet

Water Control Manual
Cold Brook Dam & Reservoir
Spillway Rating Curve
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020


Legend
2015 Temporary Bench Marks
Sediment Ranges
Sediment Range
Used in Area & Capacity
Contours
Top of Surcharge (El. 3667.2 ft)
Top of Flood Control (El. 3651.4 ft)
Top of Conservation (El. 3585.0 ft)
MONTANA
Moreau River
Lake Oahe
Belle Fourche River
SOUTH DAKOTA
WYOMING
Rapid Creek
Cheyenne River
Bad River
White River
CB-18
CB-16
CB-15
CB-14
CB-33
CB-13
CB-12
CB-11
CB-10
CB-09
CB-08
CB-07
CB-06
CB-05
CB-04
CB-32
CB-03
CB-31
CB-02
CB-01
CB-41
CB-42
CB-54
CB-58
CB-61
CB-62
N
0
0.1
0.2
0.3
0.4
Miles
Water Control Manual
Cold Brook Dam & Reservoir
Inundation Extents & Sediment Ranges
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



Spillway Crest	3646.5 feet
Maximum Pool	3667.2 feet
Top of Dam	3675.0 feet

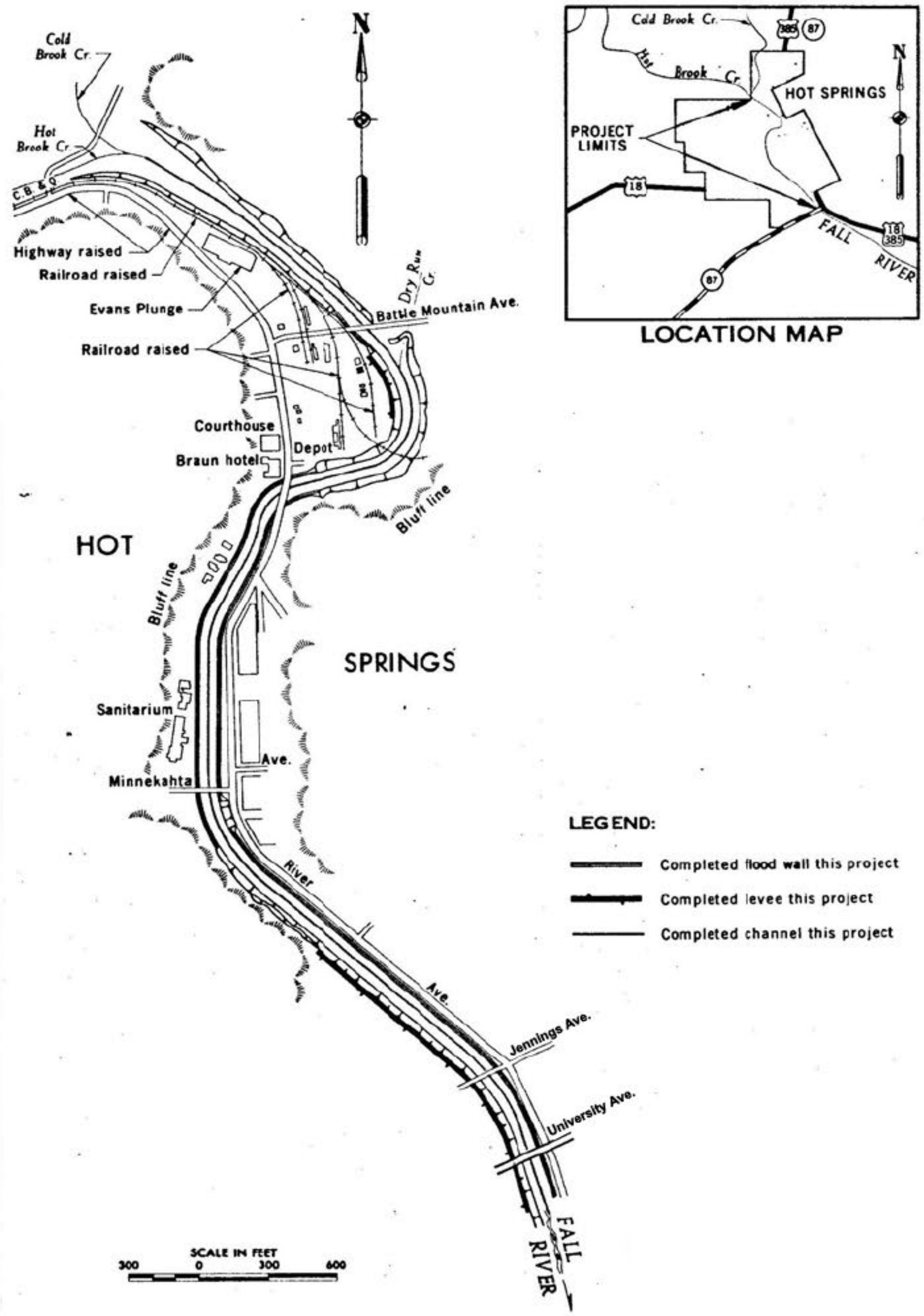
Water Control Manual
Cold Brook Dam & Reservoir

Area and Capacity Curves

U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020

[redacted]

Plate 3-1



Water Control Manual

Cold Brook Dam & Reservoir

Hot Springs Channel Improvement

U.S. Army Corps of Engineers

Omaha District, Omaha, Nebraska

July 2020

[redacted]

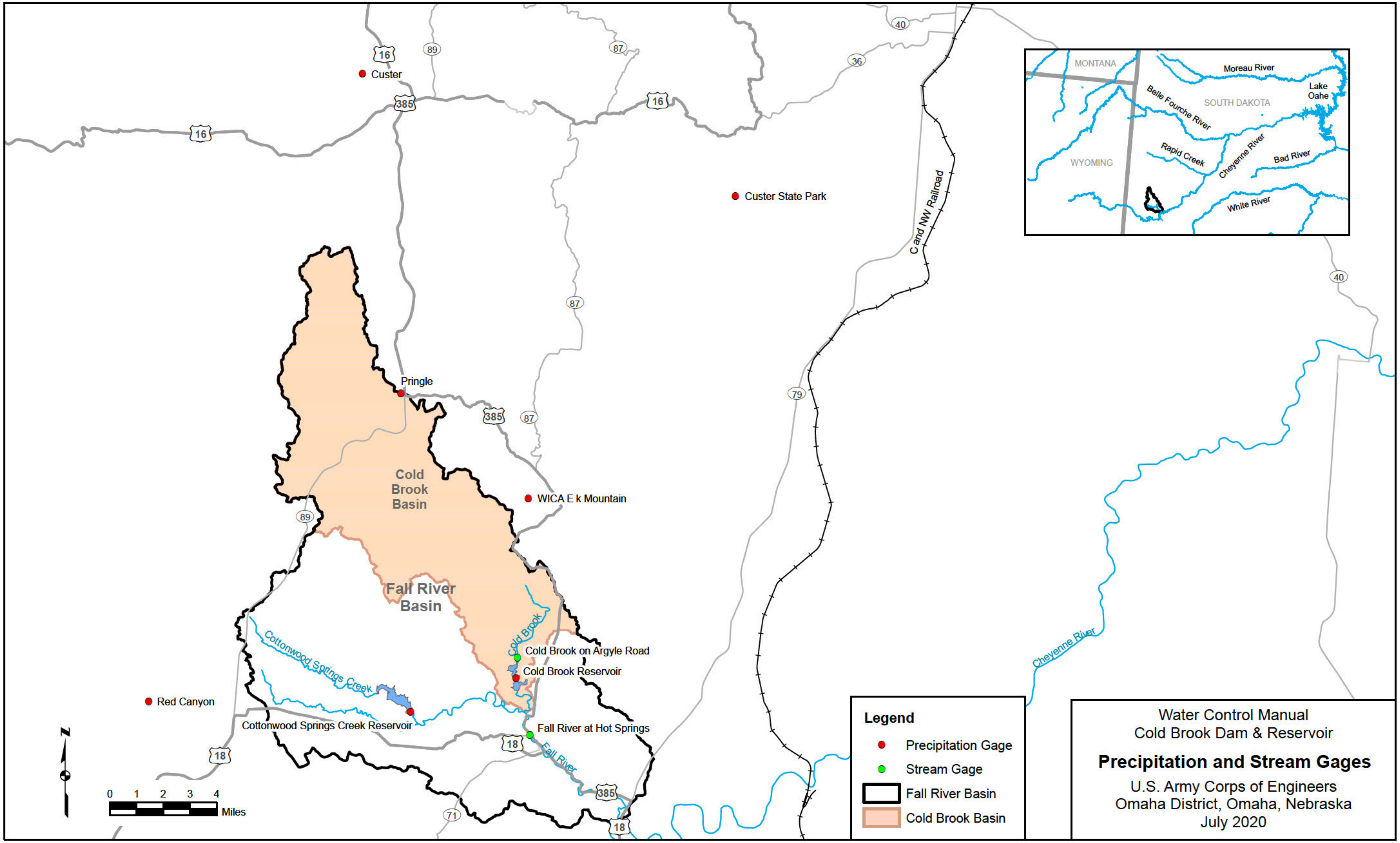
Plate 3-3

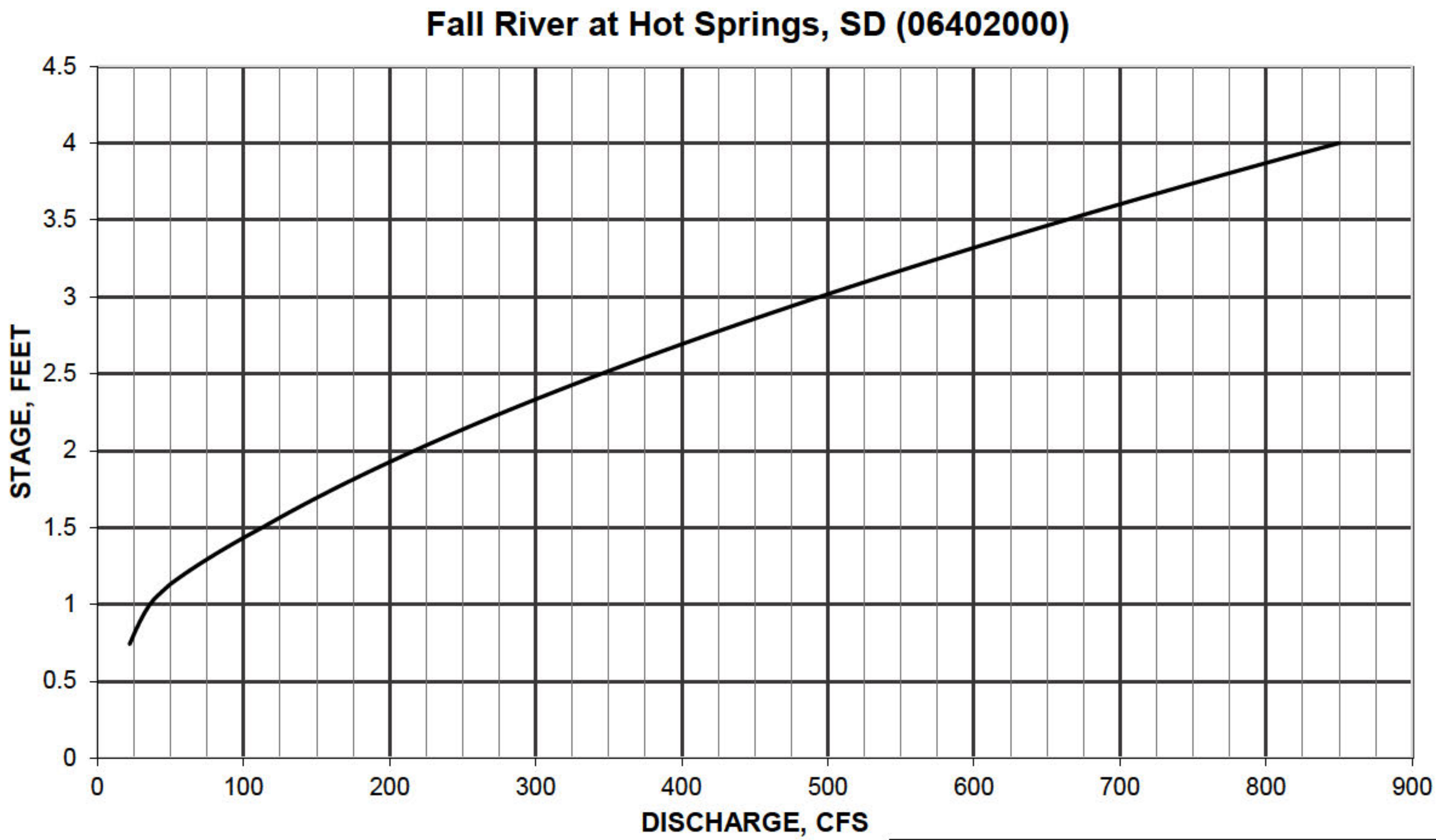
[redacted]

Plate 3-4

[redacted]

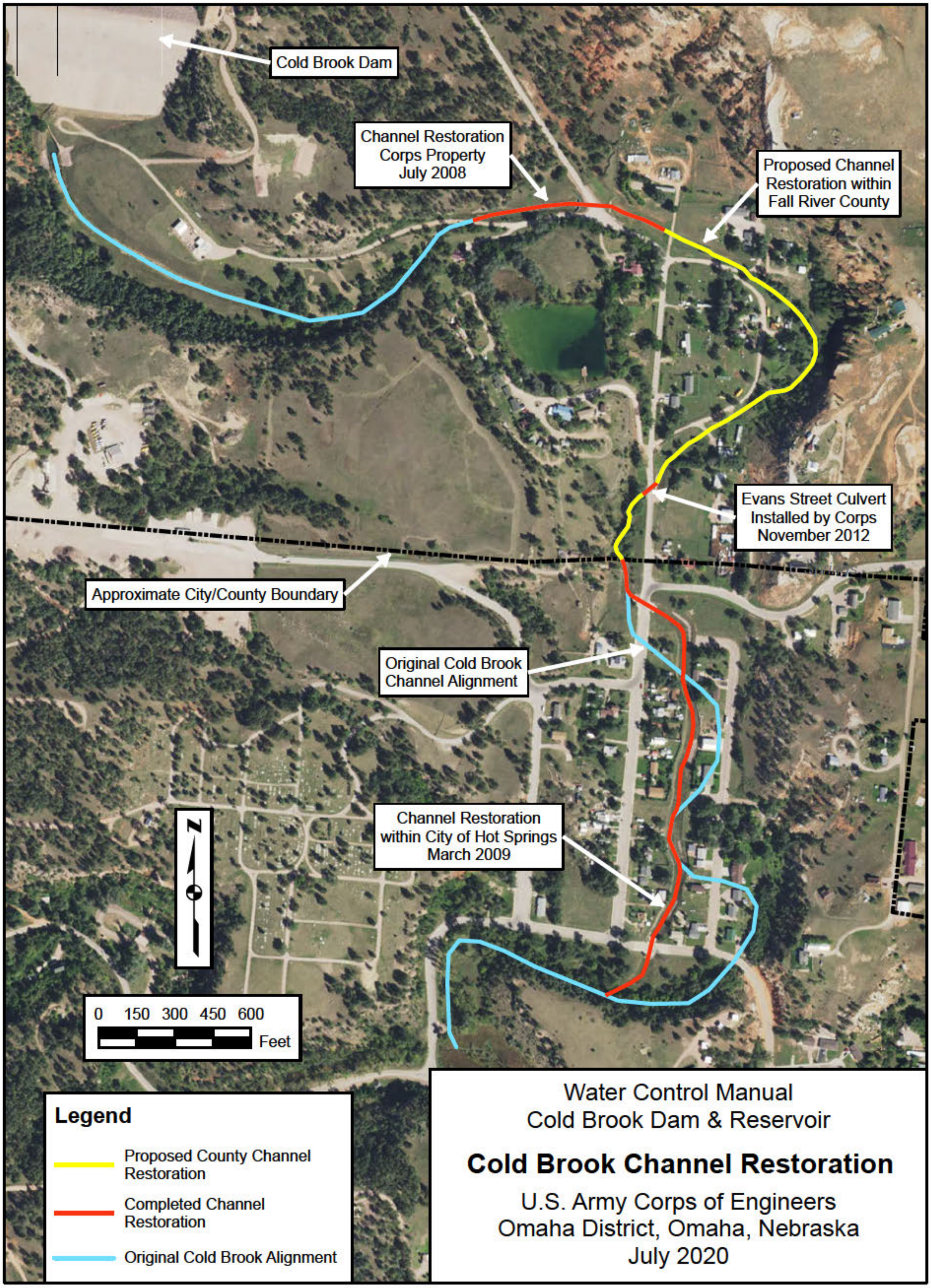
Plate 3-5


Custer
Custer State Park
Pringle
WICA E k Mountain
Red Canyon
Cold Brook Basin
Fall River Basin
Cottonwood Springs Creek
Cold Brook
Cold Brook on Argyle Road
Cold Brook Reservoir
Cottonwood Springs Creek Reservoir
Fall River at Hot Springs
Fall River
Cheyenne River
C and NW Railroad
16
385
89
87
40
36
79
18
71
0 1 2 3 4
Miles
MONTANA
WYOMING
SOUTH DAKOTA
Moreau River
Lake Oahe
Belle Fourche River
Rapid Creek
Cheyenne River
Bad River
White River
Legend
Precipitation Gage
Stream Gage
Fall River Basin
Cold Brook Basin
Water Control Manual
Cold Brook Dam & Reservoir
Precipitation and Stream Gages
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020

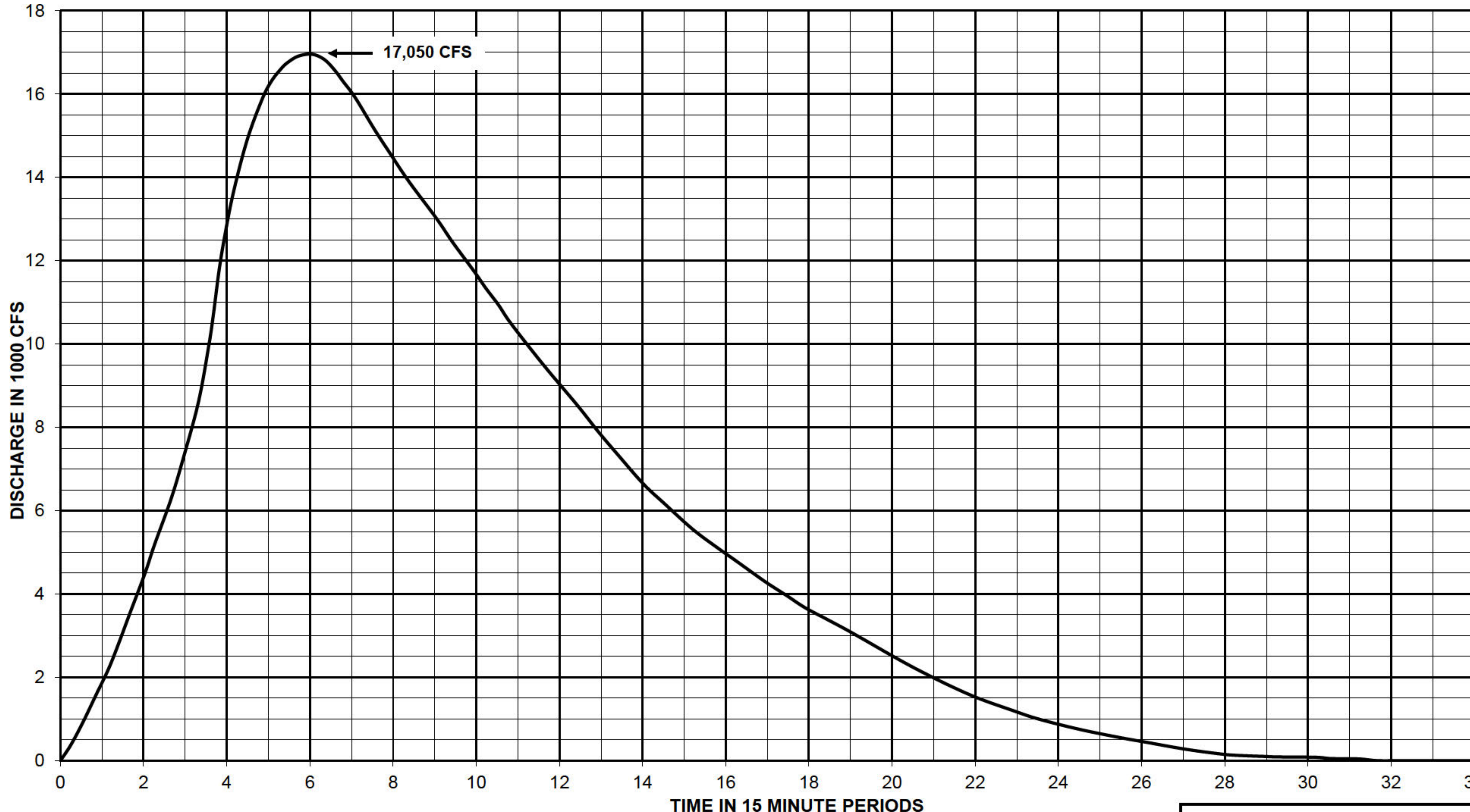


USGS Curve Number (Rating ID): 13

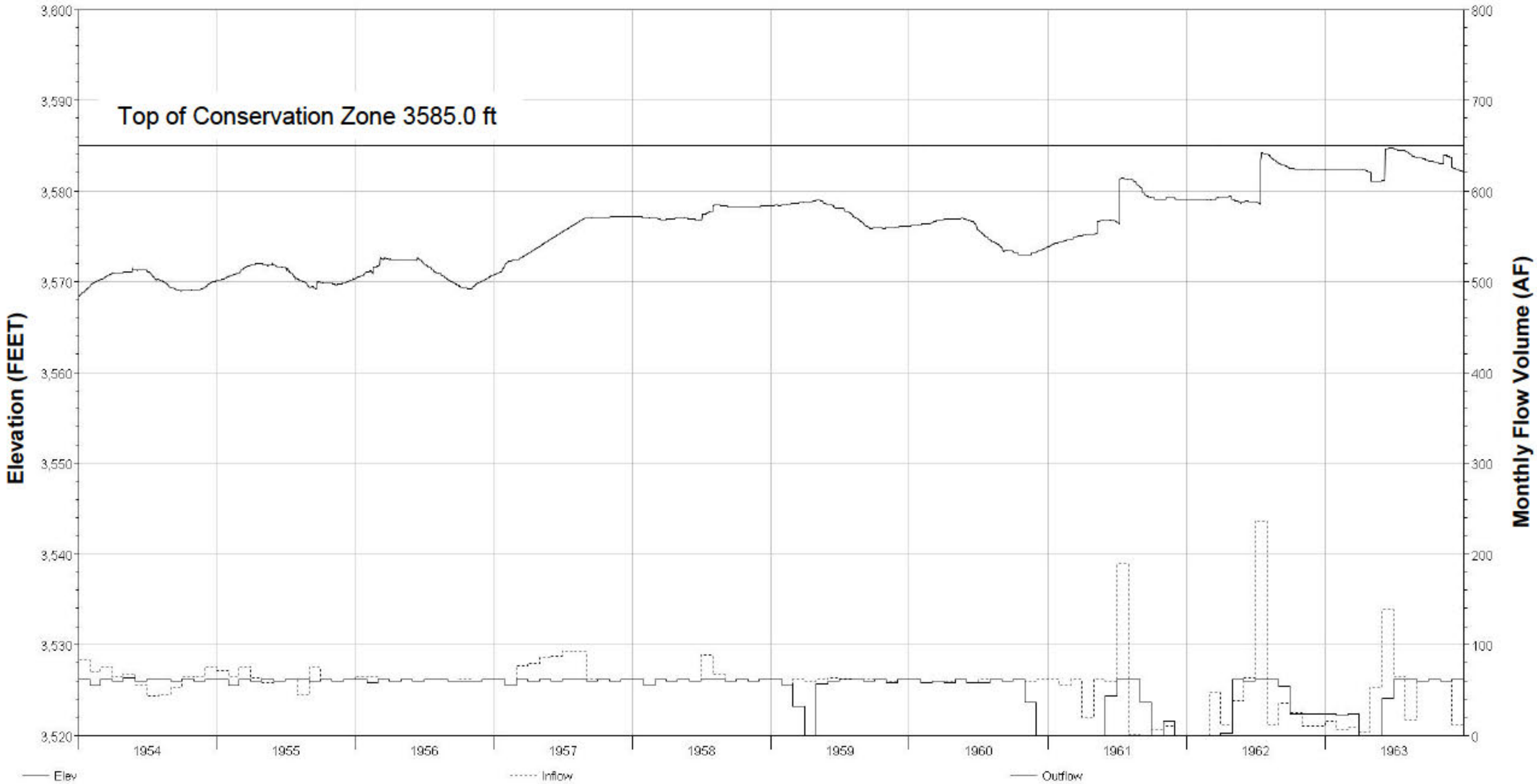
Water Control Manual
Cold Brook Dam & Reservoir
Rating Curve
For Fall River at Hot Springs, SD
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



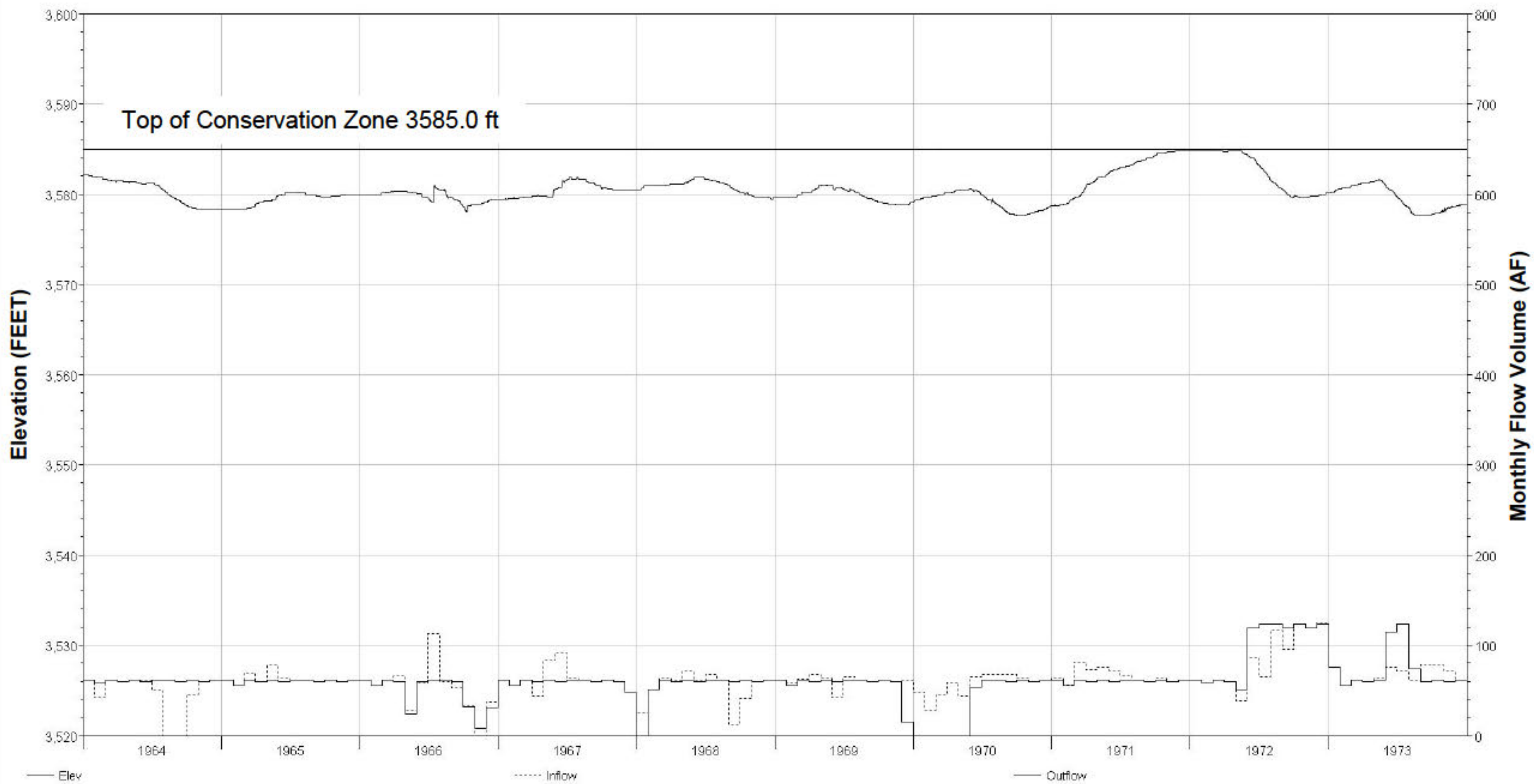
Cold Brook Dam
Channel Restoration Corps Property July 2008
Proposed Channel Restoration within Fall River County
Evans Street Culvert Installed by Corps November 2012
Approximate City/County Boundary
Original Cold Brook Channel Alignment
Channel Restoration within City of Hot Springs March 2009
N
0 150 300 450 600
Feet
Legend
Proposed County Channel Restoration
Completed Channel Restoration
Original Cold Brook Alignment
Water Control Manual
Cold Brook Dam & Reservoir
Cold Brook Channel Restoration
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



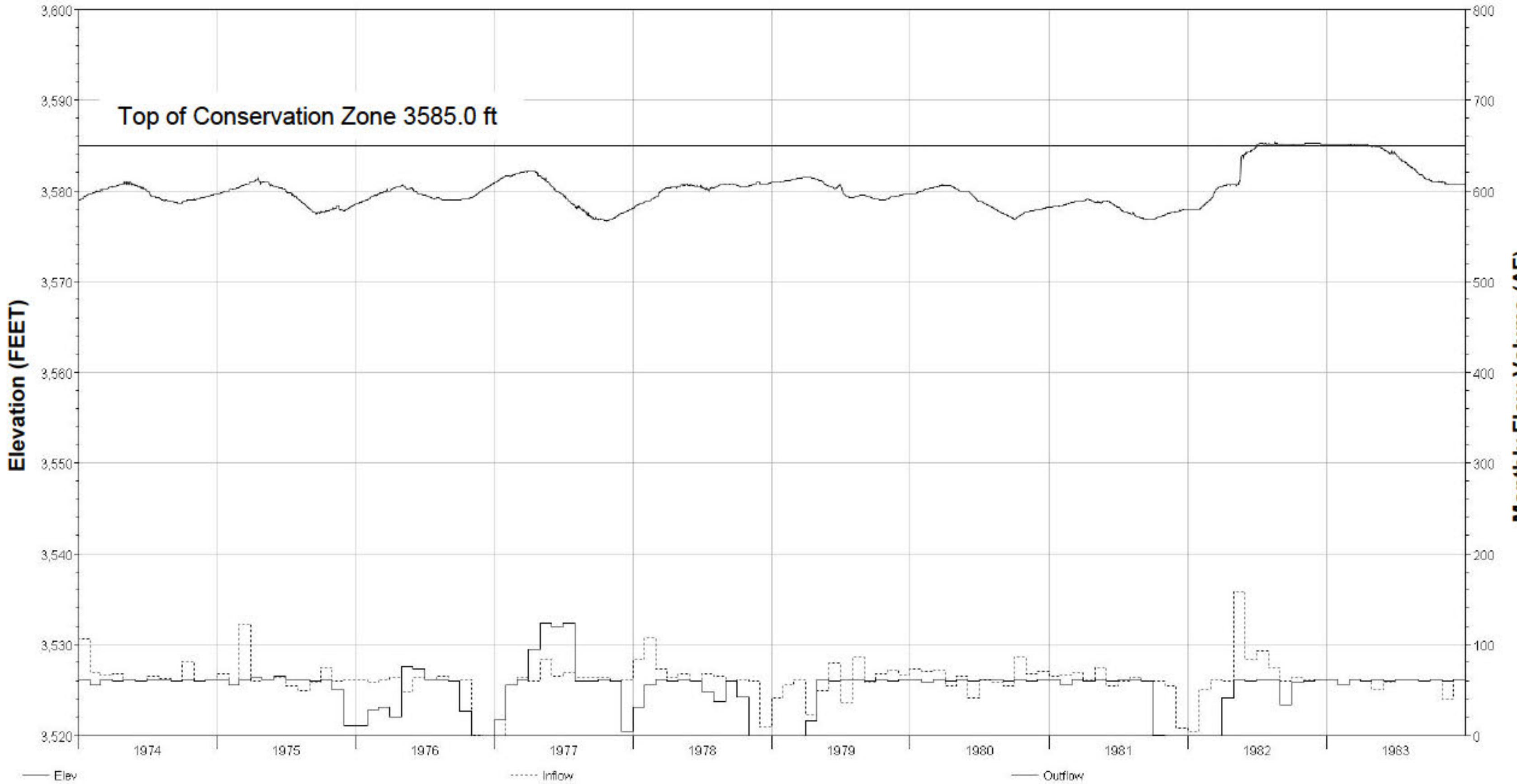
Water Control Manual
Cold Brook Dam & Reservoir
Unit Hydrograph
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



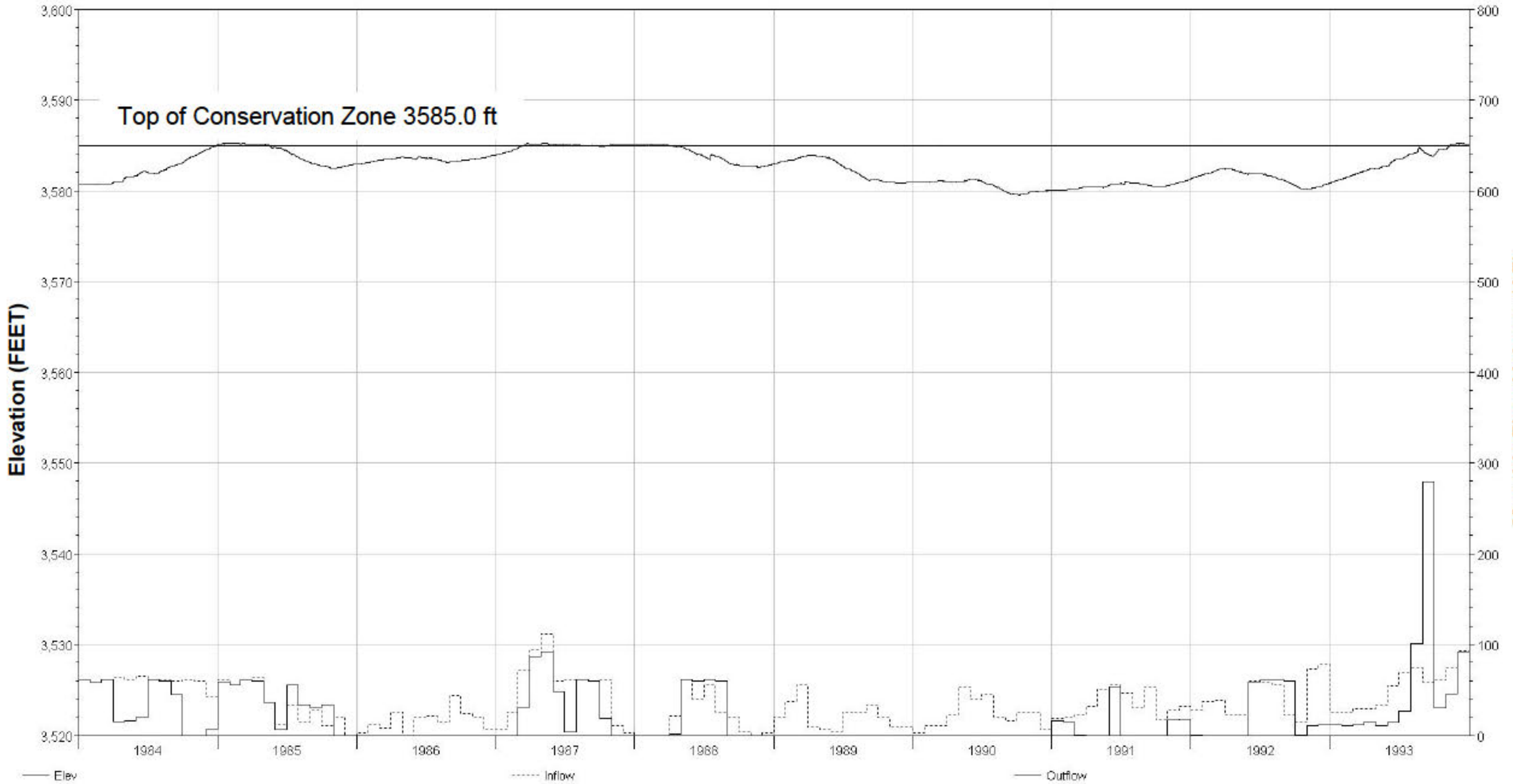
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 1954-1963
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



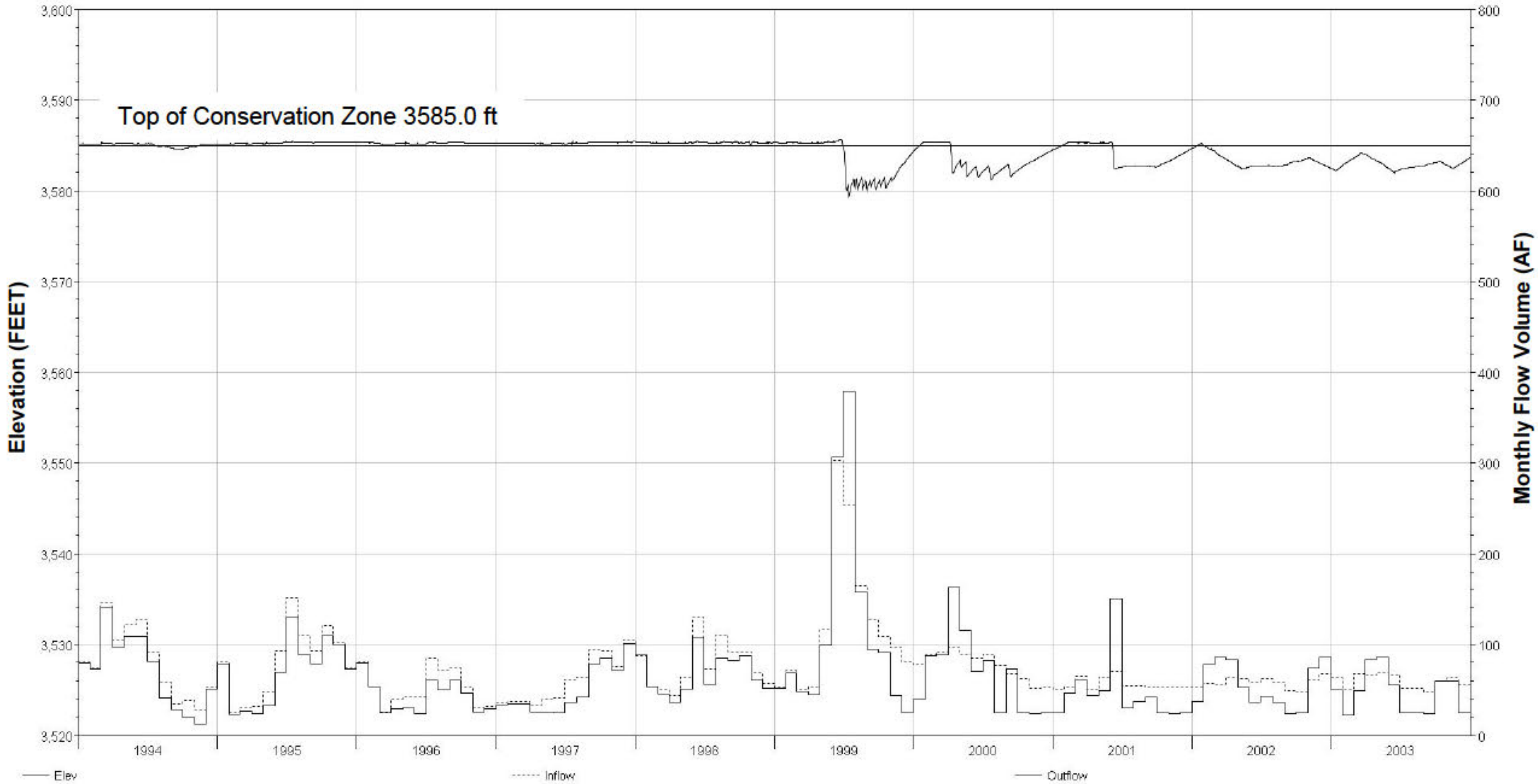
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 1964-1973
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



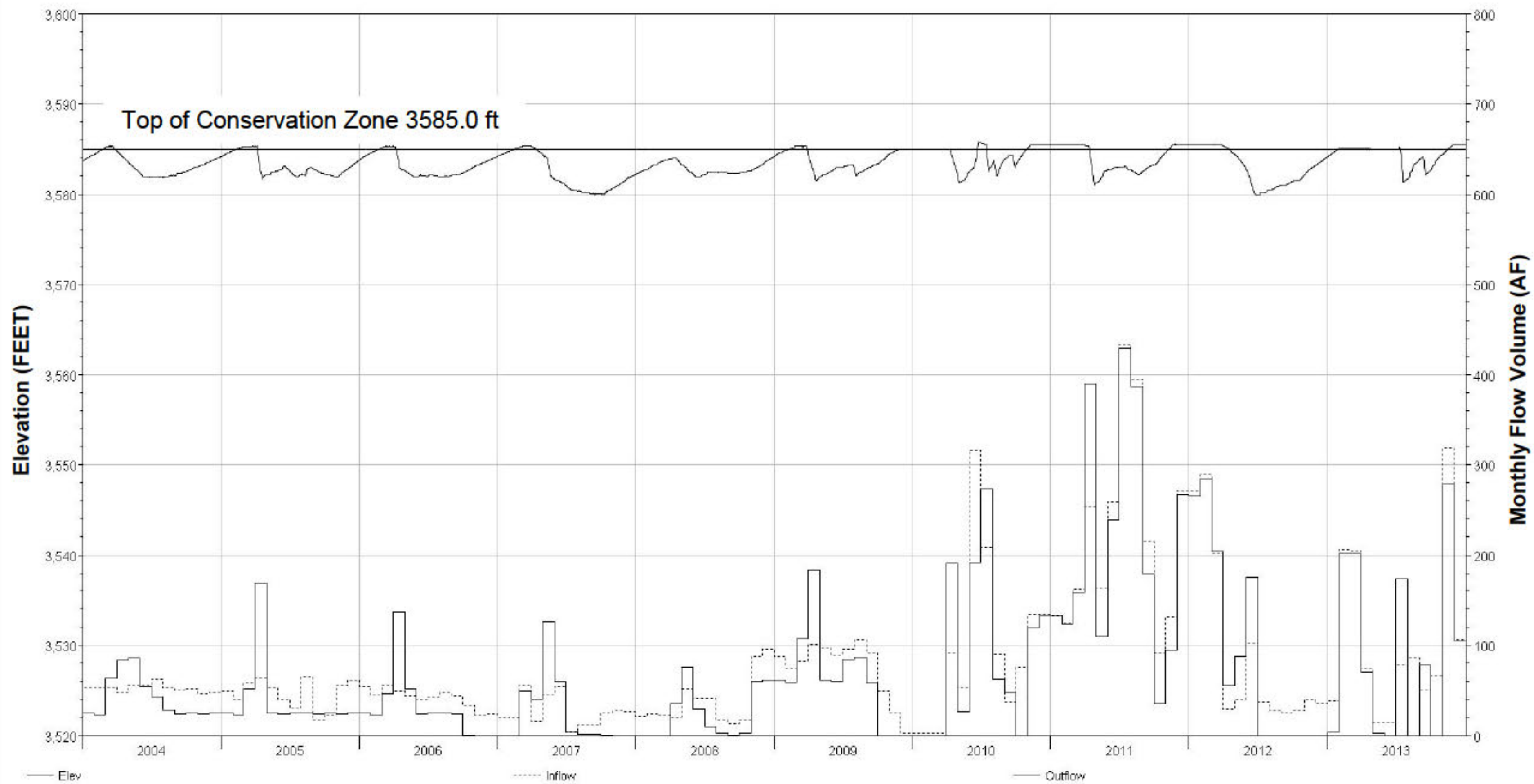
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 1974-1983
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



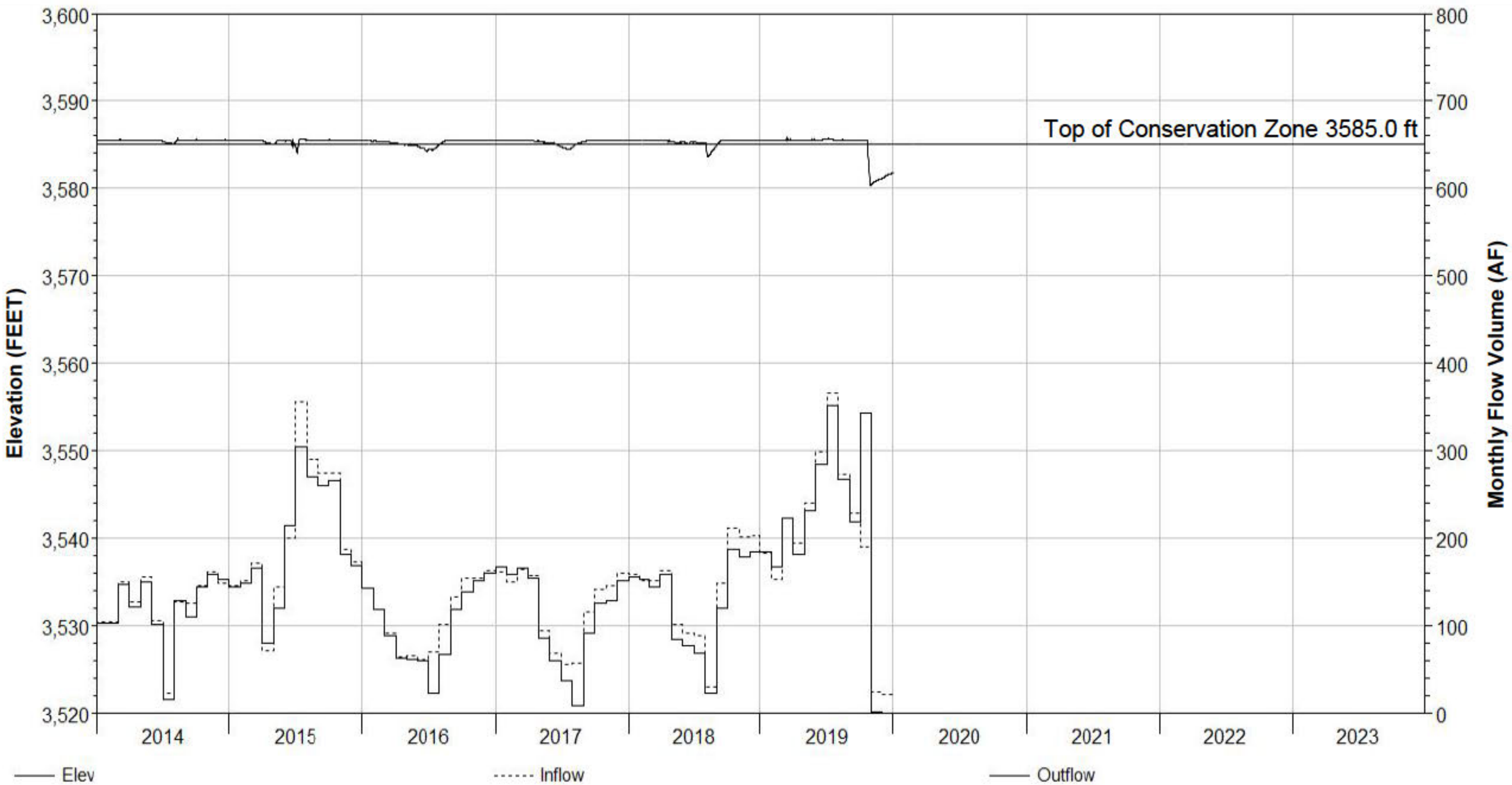
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 1984-1993
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



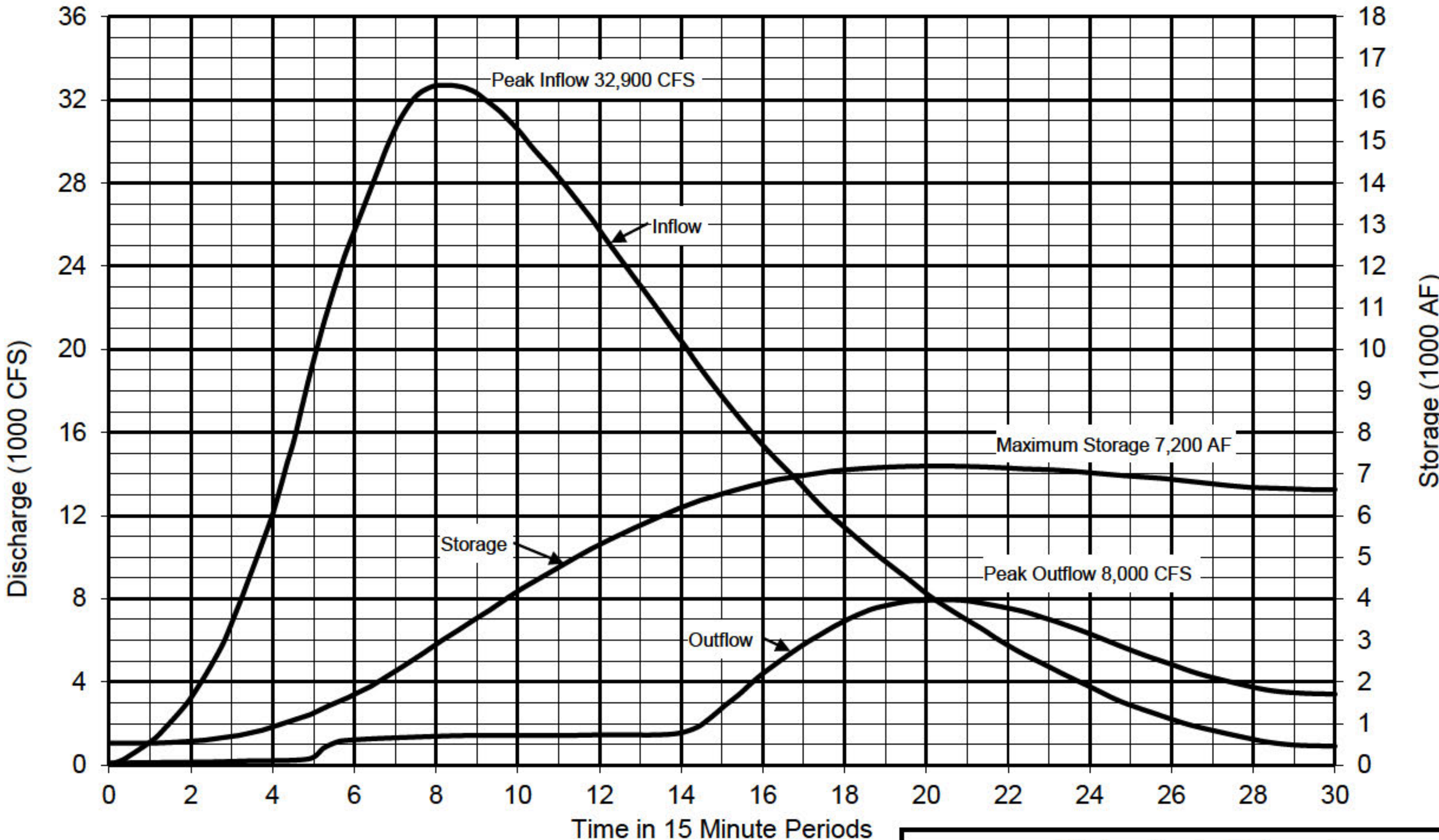
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 1994-2003
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



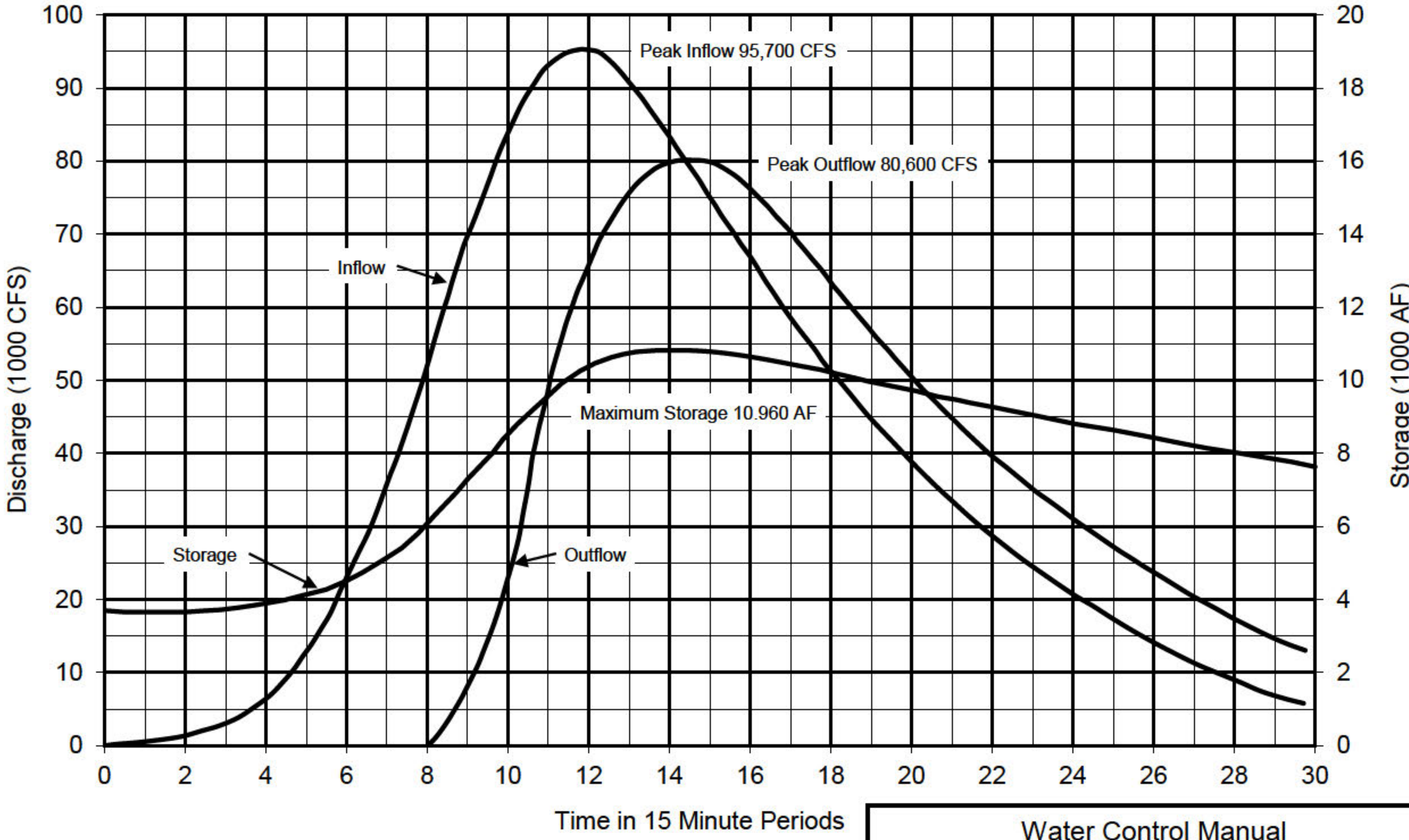
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 2004-2013
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



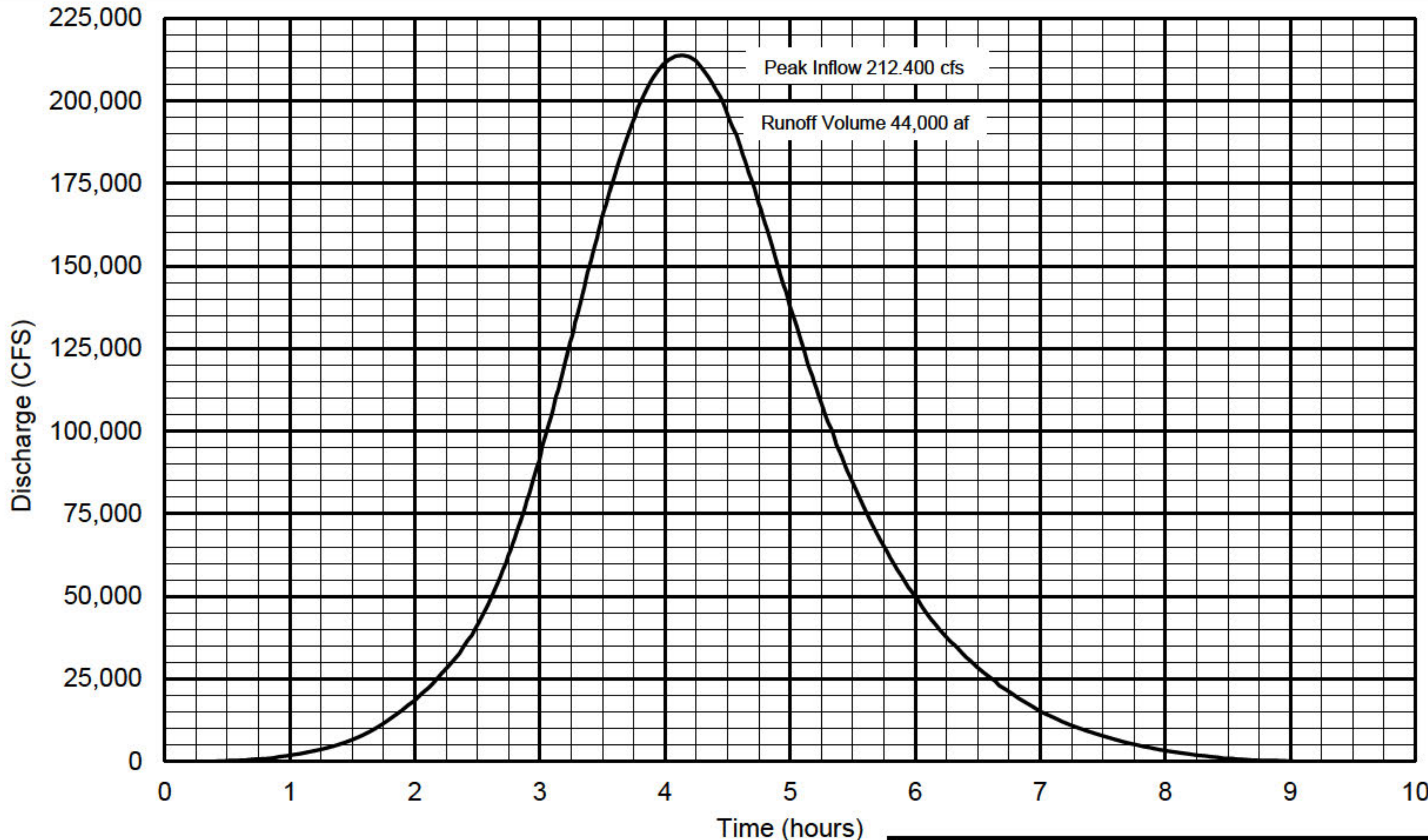
Water Control Manual
Cold Brook Dam & Reservoir
Operating Hydrographs 2014-2023
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



Water Control Manual
Cold Brook Dam & Reservoir
Reservoir Design Flood
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



Water Control Manual
Cold Brook Dam & Reservoir
Spillway Design Flood
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020



Water Control Manual
Cold Brook Dam & Reservoir
PMF Hydrograph
U.S. Army Corps of Engineers
Omaha District, Omaha, Nebraska
July 2020

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Plate 9-1

Exhibit A

COLD BROOK RESERVOIR – AREA AT 1-FOOT INCREMENTS

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Cold Brook Reservoir – Area in Acres

Elevation (feet)	Elevation Increment (in feet)									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
3540			0	0	1	1	2	2	3	3
3550	3	4	5	5	6	7	8	9	10	11
3560	12	13	13	14	15	16	17	18	18	19
3570	20	21	23	24	26	27	28	29	31	32
3580	34	34	35	35	36	37	41	43	44	45
3590	46	48	49	50	51	52	54	55	56	58
3600	59	60	61	63	64	65	66	68	70	72
3610	74	76	78	80	82	83	85	87	88	90
3620	92	94	96	99	102	105	109	112	115	119
3630	124	128	133	137	141	144	147	151	154	157
3640	161	164	167	171	175	179	183	187	191	195
3650	200	204	208	213	217	222	227	232	237	242
3660	247	251	255	260	264	269	273	278	282	

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Exhibit B

COLD BROOK RESERVOIR – CAPACITY AT 1-FOOT INCREMENTS

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Cold Brook Reservoir - Capacity in Acre-Feet

Elevation (feet)	Elevation Increment (in feet)									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
3540			0	0	1	2	4	6	8	11
3550	14	18	23	28	34	40	48	57	66	77
3560	89	101	114	128	142	157	173	191	208	227
3570	247	268	289	313	338	364	392	421	451	482
3580	515	549	584	619	654	691	730	772	815	860
3590	906	953	1001	1051	1101	1153	1206	1261	1316	1373
3600	1432	1492	1552	1614	1678	1742	1808	1875	1944	2015
3610	2088	2164	2241	2320	2401	2484	2568	2654	2741	2830
3620	2922	3015	3109	3207	3308	3411	3518	3628	3742	3859
3630	3981	4107	4237	4372	4511	4654	4800	4949	5101	5257
3640	5416	5578	5744	5913	6086	6262	6443	6628	6818	7011
3650	7209	7410	7617	7827	8042	8261	8486	8715	8949	9188
3660	9433	9681	9934	10192	10454	10721	10992	11267	11547	

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Exhibit C

COLD BROOK RESERVOIR - CAPACITY AT 0.1-FOOT INCREMENTS

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Cold Brook Reservoir - Capacity in Acre-Feet

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
3543	0	0	0	0	0	0	0	0	1	1
3544	1	1	1	1	1	1	1	1	2	2
3545	2	2	2	2	2	3	3	3	3	3
3546	4	4	4	4	4	5	5	5	5	6
3547	6	6	6	7	7	7	7	8	8	8
3548	8	9	9	9	10	10	10	10	11	11
3549	11	12	12	12	13	13	13	13	14	14
3550	14	15	15	15	16	16	16	17	17	18
3551	18	18	19	19	20	20	21	21	22	22
3552	23	23	24	24	25	25	26	26	27	27
3553	28	28	29	29	30	31	31	32	32	33
3554	34	34	35	35	36	37	37	38	39	40
3555	40	41	42	42	43	44	45	46	46	47
3556	48	49	50	51	51	52	53	54	55	56
3557	57	58	59	60	61	62	62	63	64	65
3558	66	68	69	70	71	72	73	74	75	76
3559	77	78	79	81	82	83	84	85	86	88
3560	89	90	91	92	94	95	96	97	98	100
3561	101	102	103	105	106	107	109	110	111	113
3562	114	115	117	118	119	121	122	123	125	126
3563	128	129	130	132	133	135	136	138	139	141

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
3564	142	143	145	146	148	150	151	153	154	156
3565	157	159	160	162	164	165	167	168	170	172
3566	173	175	177	178	180	182	184	185	187	189
3567	191	192	194	196	198	199	201	203	205	207
3568	208	210	212	214	216	218	220	222	224	225
3569	227	229	231	233	235	237	239	241	243	245
3570	247	249	251	253	255	257	259	261	263	266
3571	268	270	272	274	276	278	281	283	285	287
3572	289	292	294	296	299	301	303	306	308	310
3573	313	315	318	320	323	325	328	330	333	335
3574	338	340	343	345	348	351	353	356	359	361
3575	364	367	369	372	375	378	380	383	386	389
3576	392	395	397	400	403	406	409	412	415	418
3577	421	423	426	429	432	435	438	441	444	447
3578	451	454	457	460	463	466	469	472	475	479
3579	482	485	488	492	495	498	501	505	508	511
3580	515	518	521	525	528	532	535	538	542	545
3581	549	552	556	559	563	566	570	573	577	580
3582	584	587	591	594	598	601	605	608	612	615
3583	619	622	626	629	633	637	640	644	647	651
3584	654	658	662	665	669	672	676	680	683	687
3585	691	694	698	702	706	710	714	718	722	726
3586	730	734	738	742	746	751	755	759	763	768

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3587	772	776	781	785	789	794	798	802	807	811
3588	815	820	824	829	833	838	842	847	851	856
3589	860	865	869	874	878	883	888	892	897	901
3590	906	911	915	920	925	929	934	939	944	948
3591	953	958	963	967	972	977	982	987	992	996
3592	1001	1006	1011	1016	1021	1026	1031	1036	1041	1046
3593	1051	1056	1061	1066	1071	1076	1081	1086	1091	1096
3594	1101	1106	1112	1117	1122	1127	1132	1138	1143	1148
3595	1153	1158	1164	1169	1174	1180	1185	1190	1196	1201
3596	1206	1212	1217	1222	1228	1233	1239	1244	1250	1255
3597	1261	1266	1272	1277	1283	1288	1294	1299	1305	1311
3598	1316	1322	1327	1333	1339	1345	1350	1356	1362	1368
3599	1373	1379	1385	1391	1397	1402	1408	1414	1420	1426
3600	1432	1438	1444	1450	1456	1462	1467	1473	1479	1485
3601	1492	1498	1504	1510	1516	1522	1528	1534	1540	1546
3602	1552	1559	1565	1571	1577	1583	1589	1596	1602	1608
3603	1614	1621	1627	1633	1640	1646	1652	1659	1665	1671
3604	1678	1684	1690	1697	1703	1710	1716	1723	1729	1736
3605	1742	1749	1755	1762	1768	1775	1781	1788	1795	1801
3606	1808	1814	1821	1828	1834	1841	1848	1855	1861	1868
3607	1875	1882	1889	1896	1903	1909	1916	1923	1930	1937
3608	1944	1951	1958	1965	1972	1980	1987	1994	2001	2008
3609	2015	2023	2030	2037	2044	2052	2059	2066	2074	2081

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
3610	2088	2096	2103	2111	2118	2126	2133	2141	2149	2156
3611	2164	2171	2179	2187	2194	2202	2210	2218	2225	2233
3612	2241	2249	2257	2265	2273	2280	2288	2296	2304	2312
3613	2320	2328	2336	2344	2352	2361	2369	2377	2385	2393
3614	2401	2409	2418	2426	2434	2442	2451	2459	2467	2475
3615	2484	2492	2500	2509	2517	2526	2534	2543	2551	2559
3616	2568	2576	2585	2594	2602	2611	2619	2628	2636	2645
3617	2654	2662	2671	2680	2689	2697	2706	2715	2724	2732
3618	2741	2750	2759	2768	2777	2786	2794	2803	2812	2821
3619	2830	2839	2848	2858	2867	2876	2885	2894	2903	2912
3620	2922	2931	2940	2949	2959	2968	2977	2986	2996	3005
3621	3015	3024	3033	3043	3052	3062	3071	3081	3090	3100
3622	3109	3119	3129	3138	3148	3158	3168	3177	3187	3197
3623	3207	3217	3227	3237	3247	3257	3267	3277	3287	3297
3624	3308	3318	3328	3338	3349	3359	3369	3380	3390	3401
3625	3411	3422	3432	3443	3454	3464	3475	3486	3497	3507
3626	3518	3529	3540	3551	3562	3573	3584	3595	3606	3617
3627	3628	3640	3651	3662	3673	3685	3696	3708	3719	3731
3628	3742	3754	3765	3777	3789	3800	3812	3824	3836	3848
3629	3859	3871	3883	3895	3907	3920	3932	3944	3956	3968
3630	3981	3993	4006	4018	4031	4043	4056	4068	4081	4094
3631	4107	4120	4132	4145	4158	4171	4185	4198	4211	4224
3632	4237	4251	4264	4277	4291	4304	4318	4331	4345	4359

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
3633	4372	4386	4400	4414	4427	4441	4455	4469	4483	4497
3634	4511	4525	4539	4554	4568	4582	4596	4611	4625	4639
3635	4654	4668	4683	4697	4712	4726	4741	4756	4770	4785
3636	4800	4814	4829	4844	4859	4874	4889	4904	4919	4934
3637	4949	4964	4979	4994	5009	5025	5040	5055	5070	5086
3638	5101	5117	5132	5147	5163	5179	5194	5210	5225	5241
3639	5257	5273	5288	5304	5320	5336	5352	5368	5384	5400
3640	5416	5432	5448	5464	5480	5497	5513	5529	5546	5562
3641	5578	5595	5611	5628	5644	5661	5677	5694	5710	5727
3642	5744	5761	5777	5794	5811	5828	5845	5862	5879	5896
3643	5913	5930	5947	5964	5982	5999	6016	6033	6051	6068
3644	6086	6103	6121	6138	6156	6174	6191	6209	6227	6245
3645	6262	6280	6298	6316	6334	6352	6370	6389	6407	6425
3646	6443	6462	6480	6498	6517	6535	6554	6572	6591	6610
3647	6628	6647	6666	6685	6704	6722	6741	6760	6779	6799
3648	6818	6837	6856	6875	6895	6914	6933	6953	6972	6992
3649	7011	7031	7050	7070	7090	7109	7129	7149	7169	7189
3650	7209	7229	7249	7269	7289	7309	7329	7349	7370	7390
3651	7410	7431	7451	7472	7492	7513	7534	7554	7575	7596
3652	7617	7637	7658	7679	7700	7721	7742	7763	7785	7806
3653	7827	7848	7870	7891	7912	7934	7955	7977	7999	8020
3654	8042	8064	8085	8107	8129	8151	8173	8195	8217	8239
3655	8261	8283	8306	8328	8350	8373	8395	8418	8440	8463

Elevation (feet)	Elevation Increment (in 0.1 feet)									
	0	**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**
3656	8486	8508	8531	8554	8577	8600	8623	8646	8669	8692
3657	8715	8738	8761	8785	8808	8831	8855	8878	8902	8925
3658	8949	8973	8996	9020	9044	9068	9092	9116	9140	9164
3659	9188	9212	9237	9261	9285	9310	9334	9359	9383	9408
3660	9433	9457	9482	9507	9531	9556	9581	9606	9631	9656
3661	9681	9706	9732	9757	9782	9807	9833	9858	9883	9909
3662	9934	9960	9986	10011	10037	10063	10088	10114	10140	10166
3663	10192	10218	10244	10270	10296	10323	10349	10375	10401	10428
3664	10454	10481	10507	10534	10560	10587	10614	10640	10667	10694
3665	10721	10748	10775	10802	10829	10856	10883	10910	10937	10965
3666	10992	11019	11047	11074	11102	11129	11157	11184	11212	11240
3667	11267	11295	11323	11351	11379	11407	11435	11463	11491	11519
3668	11547	0	0	0	0	0	0	0	0	0

Exhibit D

STANDING INSTRUCTIONS TO THE DAM TENDER

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Standing Instructions to Dam Tender for Water Control Regulation of Cold Brook and Cottonwood Springs Creek Dams and Reservoirs

General

1. Purpose of Instructions. The purpose of these instructions is to set forth the responsibilities of the Dam Tender and procedures to be followed for regulation of Cold Brook and Cottonwood Springs Creek Reservoirs. The Dam Tender will be familiar with these instructions and post them in a readily accessible place for reference and emergency use. The Dam Tender is responsible for notifying substitutes of the provisions and use of these instructions for reservoir regulations.

2. Elevation Datum. In the original design and construction of the projects, elevations on design drawings and reservoir levels are based on the National Geodetic Vertical Datum of 1929 (NGVD29). If elevations referenced to the North American Vertical Datum of 1988 (NAVD88) are needed for Cold Brook Dam and Reservoir, use the following conversion: NGVD29 + 1.65 feet = NAVD88. For Cottonwood Springs Creek Dam and Reservoir, use the following conversion: NGVD29 + 1.76 feet = NAVD88.

3. Purpose of Project. The projects' primary purpose is to provide flood control along the Fall River and its tributaries (Cold Brook and Hot Brook). Pool zones and storage allocations are shown in Table 1.

Table 1. Cold Brook & Cottonwood Springs Creek Pool Elevations and Storage Allocations

Zone	Pool Elevations (feet)	Storage Allocations
	Cold Brook	
Surcharge	3651.4 to 3667.2	3,831
Flood Control	3585.0 to 3651.4	6,801
Multipurpose	3548.0 to 3585.0	691
	Cottonwood Springs Creek	
Surcharge	3936.0 to 3950.0	3,221
Flood Control	3875.0 to 3936.0	7,752
Multipurpose	3868.0 to 3875.0	257

4. Responsibilities.

a. The Omaha District's Water Control and Water Quality Section (WCWQS), Hydrologic Engineering Branch, Engineering Division, is responsible for all matters pertaining to the regulation of the reservoirs and prepares reports of reservoir elevations, inflow, and outflow. It is their responsibility to optimize reservoir operations while fulfilling project purposes. Inquiries relating to reservoir releases or regulation are to be referred to the WCWQS for response.

b. The Big Bend Project Manager is responsible for routine operation, inspection, and maintenance of Cold Brook and Cottonwood Springs Creek Dams. The Big Bend Operations Project Manager's assigned Dam Tender will adjust the reservoir outlet gates on orders from the WCWQS and perform other duties as specified in this document. The Dam Tender may also be referred to as the Park Manager or Park Ranger.

5. Routine Duties, Observations, and Reports. The Dam Tender shall regulate the gates of the dam outlet works as the WCWQS directs. The Dam Tender will periodically check the data collection platform to verify the accuracy of pool elevation measurements. All readings and observations requested by the WCWQS shall be the responsibility of the Dam Tender. The Dam Tender will be accessible and available to receive orders from the WCWQS personnel and/or Big Bend Project Office personnel. The Dam Tender will maintain and forward all applicable records to the appropriate personnel.

6. Special Reports. The Dam Tender will maintain surveillance of all hydrologic conditions and should any of the following conditions occur, relay the information immediately to the WCWQS. The Dam Tender will make repeated calls to WCWQS personnel's office and cell phone until notification is made when:

(1) Any reports of rainfall in the Hot Springs area over 3.0 inches.

(2) If a pool level at either project rises so that there is a high possibility of significant release from the outlet works or emergency spillway.

7. Telephone Directory. Table 2 is a telephone directory of pertinent offices including reservoir regulation personnel. A copy of the telephone directory should be in the gate house at the dam site.

Regulation

1. Below Ungated Outlets.

a. Cold Brook. Below elevation 3585.0 feet, the pool will be regulated according to the following precepts:

(1) The three gate valves at the base of the tower will be opened only for drawdown operations.

(2) The degree of opening of the valve in the 8-inch supply line to Hidden Lake will be set by the regular demands of the lake.

(3) The natural and uncontrollable forces, such as evaporation and percolation, to which the pool is exposed.

b. Cottonwood Springs Creek. Below elevation 3875.0 feet, the pool will be regulated according to the following precepts:

(1) The low-gated outlet will be opened only for drawdown operations.

(2) The natural and uncontrollable forces, such as evaporation and percolation, to which the pool is exposed.

2. Above Ungated Outlets. Reservoir regulation during flood periods is automatic via the outlet works and spillway. Regulation of low flow outlet gates are not required during flood periods as the limited capacity would have little effect on the project flood control operation.

3. Communication during Ungated Releases. The Dam Tender shall report ungated releases to the Omaha District WQWCS as promptly as communication facilities permit.

4. Public Flood Warning System. The campground at Cold Brook Reservoir is susceptible to flash flooding during heavy rain events upstream. An auto dialer and alarm system are connected to a monitoring station upstream of Argyle Road to provide early flood warning. In the event the monitoring station is triggered, the auto dialer calls Fall River dispatch, the Cold Brook Dam Tender, the Big Bend Power Plant, and the NWS in Rapid City. Once contacted, those listed above will make all available efforts to notify those at the campground as quickly as possible. A siren is also triggered at the campground notifying visitors they need to evacuate.

Table 2. Cold Brook and Cottonwood Springs Creek Dams and Reservoirs Flood Control Regulation Personnel

Directory of Regulation Personnel

Organization/Name	Office	Fax	Cell	Email Address
US Army Corps of Engineers				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		[redacted]
[redacted]	[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	[redacted]
City of Hot Springs/Fall River County				
[redacted]	[redacted]		[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]		[redacted]	
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]		[redacted]

Organization/Name	Office	Fax	Cell	Email Address
State and Local Agencies				
[redacted]	[redacted]			[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]		
Other Federal Agencies				
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]			
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

*Hidden Lake is formerly known as Larive Lake. In 2018 it changed ownership and name.

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Exhibit E

COLD BROOK RESERVOIR – EXISTING WATER RIGHTS

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HIDDEN LAKE WATER RIGHT

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

FROHMAN WATER RIGHT

[redacted]

[redacted]

[redacted]

Exhibit F

COLD BROOK RESERVOIR – DROUGHT CONTINGENCY PLAN

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CEMRO-ED-HC 31 July 1987

DROUGHT CONTINGENCY FACT SHEET
PROJECT: COLD BROOK RESERVOIR, SOUTH DAKOTA

PURPOSES: Flood control, recreation and fish and wildlife.

STATUS: Completed.

MULTIPURPOSE POOL: 3585.0 ft., msl, 520 AF. (Includes sediment pool).

SEDIMENT STORAGE: 3585.0 ft., msl, 520 AF.

LOW FLOW RELEASES: Inflow up to 1.1 cfs.

WATER SUPPLY CONTRACTS: None.

OPPORTUNITY TO MEET DROUGHT NEEDS: The small volume in storage in the multipurpose pool could provide a very limited amount of water to meet drought needs.

COORDINATION: South Dakota Department of Water Resources, South Dakota Department of Game, Fish and Parks, South Dakota Emergency Disaster Service, City of Hot Springs, South Dakota and the Omaha District Reservoir Regulation Section.