April 2020

US Army Corps
of Engineers®
Omaha District

Water Control Manual

Cherry Creek Dam & Reservoir

South Platte River Basin

REVISED APRIL 2020

WATER CONTROL MANUAL

CHERRY CREEK DAM AND RESERVOIR

South Platte River Basin
Colorado

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

April 2020

THIS PAGE INTENTIONALLY LEFT BLANK

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

CENWD-PDR

7 April 2020

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

SUBJECT: Request for Approval of Cherry Creek, Chatfield, and Bear Creek Water Control Manuals as Changed by the Implementation of the Chatfield Reservoir Joint-Use Flood Control-Conservation Zone

1. Reference memorandum dated 6 April 2020, CENWO-ED-HA, subject as above.

2. The subject water control manuals are approved.

3. As noted in your memo, the update of these manuals incorporates the extensive agency and public involvement in the approval of the Chatfield Reallocation FR/EIS.

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

5. Please provide this office with final hardcopies of the manuals, electronic versions of the manuals to HQUSACE for Continuity of Operations (COOP) purposes, and redacted electronic versions for the national public-facing website.

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

FOR THE COMMANDER:

[redacted]

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

THIS PAGE INTENTIONALLY LEFT BLANK

Cherry Creek Dam and Reservoir

THIS PAGE INTENTIONALLY LEFT BLANK

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this water control manual be published in a hard copy 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.

RECORD OF MANUAL-HOLDERS

U.S. Army Corps of Engineers

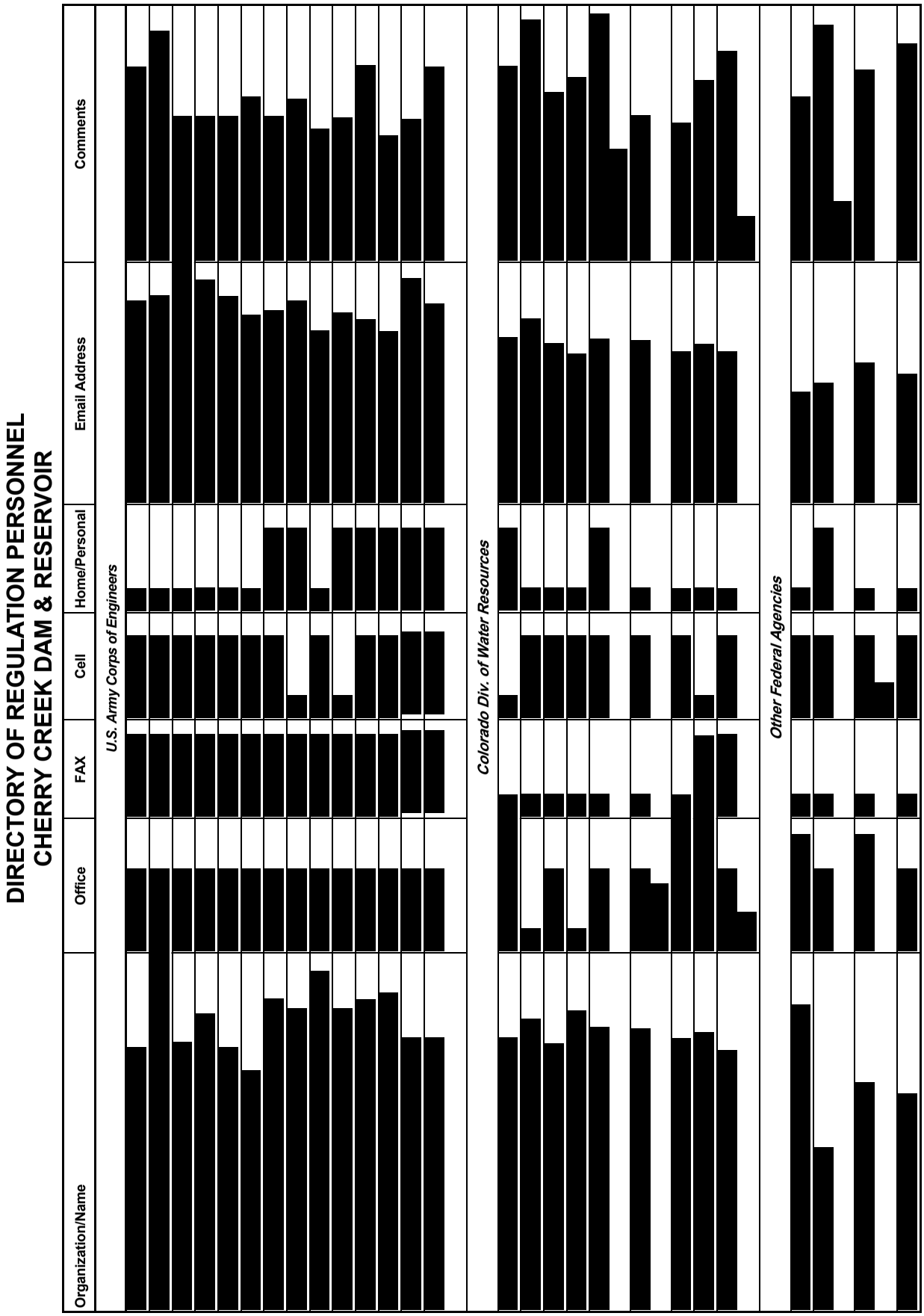
Missouri River Basin Water Management Office	CENWD-PDR	Hard copy
Operations Division, Tri-Lakes Project Office	CENWO-OD-TL	Hard copy
Engineering Division, Dam Safety Section	CENWO-ED-GB	Hard copy
Engineering Division, Water Control Section (chief)	CENWO-ED-HA	Hard copy
Engineering Division, Water Control Section (engineer)	CENWO-ED-HA	Hard copy
Engineering Division, Water Control Section (engineer)	CENWO-ED-HA	Hard copy
Engineering Division, Water Control Section (engineer)	CENWO-ED-HA	Hard copy
Engineering Division, Water Control Section (engineer)	CENWO-ED-HA	Hard copy

External Stakeholder

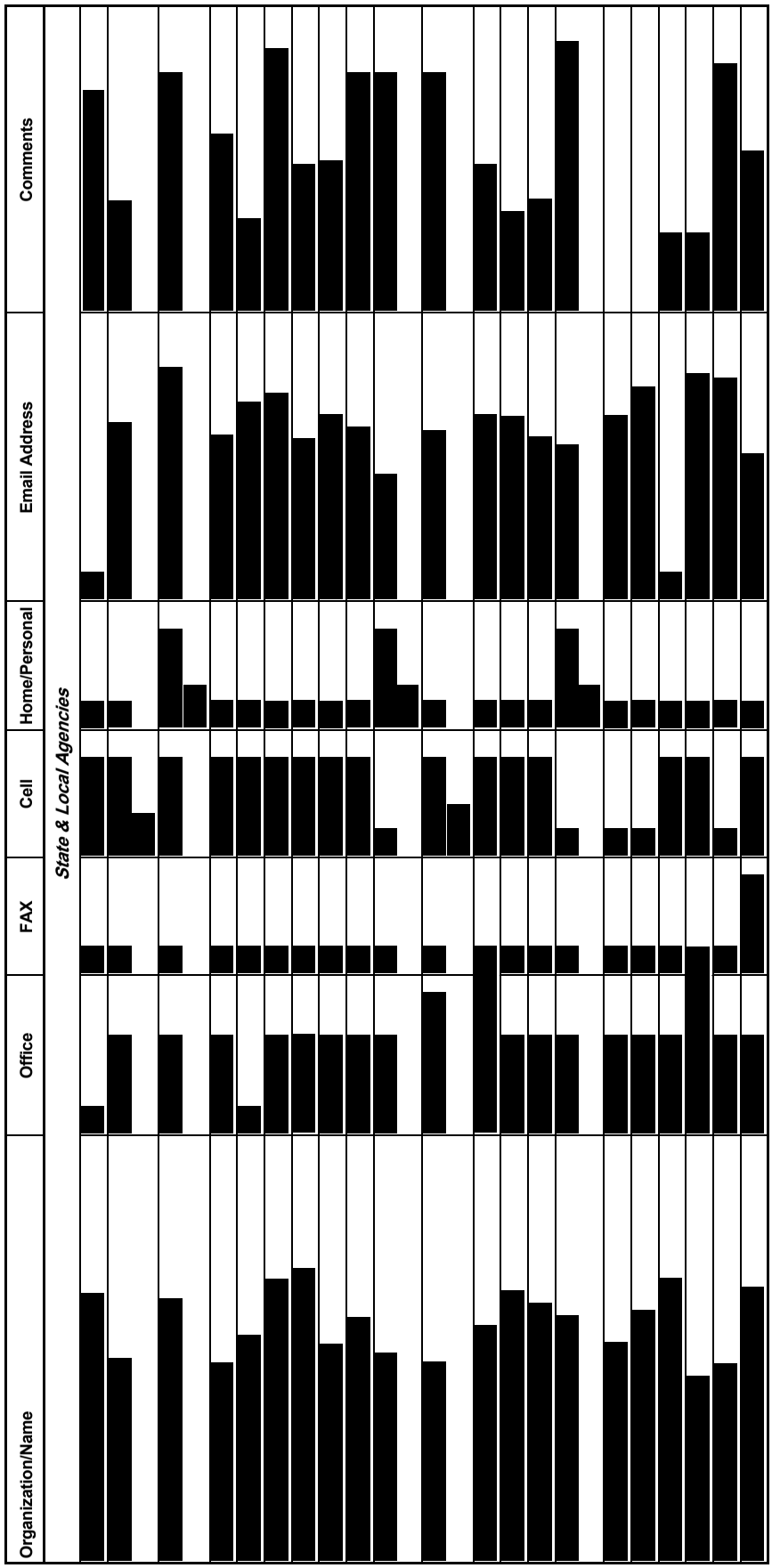
Colorado State Engineer's Office, Division Engineer	[redacted]	Electronic copy

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
CHERRY CREEK DAM & RESERVOIR
Organization/Name
Office
FAX
Cell
Home/Personal
Email Address
Comments
U.S. Army Corps of Engineers
Colorado Div. of Water Resources
Other Federal Agencies

DIRECTORY OF REGULATION PERSONNEL
CHERRY CREEK DAM & RESERVOIR



THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF TABLES PAGE

LIST OF PLATES

LIST OF PLATES (CONTINUED)

LIST OF PLATES (CONTINUED)

LIST OF PLATES (CONTINUED)

LIST OF EXHIBITS

CHERRY CREEK DAM AND RESERVOIR PERTINENT DATA

GENERAL			
Location of Dam	On Cherry Creek 11.4 miles above mouth 6 miles south of Aurora, Colorado		
County	Arapahoe		
River and River Mile	Cherry Creek, river mile 11.4		
Gross drainage area (sq mi)	414 total Cherry Creek and 386 above the dam		
DAM			
Type	Rolled Earthfill		
Crest elevation (ft PD [Project Datum])	5644.4 (low spot due to settlement)		
Height above streambed (ft)	140		
Length (ft)	14,300		
Crest Width (ft)	30		
Date of closure	October 1948		
SPILLWAY			
Type	Ungated side-channel canal through natural ground discharging into adjacent Toll Gate Creek		
Discharge capacity (cfs) at el. 5644.4 ft PD	28,000 (2015 condition)		
Crest elevation (ft PD)	5610.6*		
Crest Length (ft)	12,050		
Crest width design (ft)	67 (approach) 45 (outlet)		
Bottom slope	0.00		
Side slope	1V on 1H (Denver formation) 1V on 2H (overburden)		
OUTLET WORKS			
Gated Outlets	5 - 6x9 ft Hydraulic slide 2 – 18 in dia. bypass gates (knife gate valves)		
Conduit Type	Triple-barrel concrete		
Center conduit	Circular 12 ft diameter		
Outside conduits (2)	Oval shaped		
Width (ft), Height (ft)	8, 12		
Radius, top and invert (ft)	4		
Conduit length (ft)	679.5		
Conduit inverts (ft PD)	5504.0 (2 outside) 5506.5 (center)		
Discharge capacity (cfs) at el. 5644.4 ft PD	9,800 (2 outside) 13,300 (3 tunnels)		
RESERVOIR STORAGE ALLOCATION ZONES	**Elevation Limits (ft PD)**		**Capacity (af) 2006-07 Survey**
Surcharge	5598.0-5545.0		182,149**
Flood Control	5550.0-5598.0		79,294
Multipurpose	5504.0-5550.0		12,558
RESERVOIR STORAGE ALLOCATION ZONES	**Elevation (ft PD)**	**Gross Area (acres) 2010 Survey**	**Gross Storage (af) 2006-07 Survey**
Top of Surcharge (Max Pool)	5645.0	5030	274,001**
Top of Flood Control	5598.0	2638	91,852
Top of Multipurpose	5550.0	840	12,558
Streambed Elevation	5504.0	0	0

* Original design spillway crest is 5598 ft PD. Due to sloughing of steep spillway side slopes the spillway crest is now 5610.6 ft PD. A spillway maintence contract is currently underway to return the crest to the original design.
** The 2006-07 survey did not include the top 5 ft of storage. The curve was extended with LiDAR data to obtain the entire zone's storage capacity.

ACRONYMS AND ABBREVIATIONS

Term	Definition
af	acre-feet
°C	Degrees Celsius
CAVI	Control and Visualization Interface (CWMS)
CC-ATI	Cold Content Antecedent Temperature Index
CCBWQA	Cherry Creek Basin Water Quality Authority
CCP	Corps Computation Processor
CDW	Colorado Division of Wildlife
CDWR	Colorado Division of Water Resources
CFS/cfs	Cubic Feet Per Second
COA	City of Aurora
Corps	Corps of Engineers
CWA	Chatfield Watershed Authority
CWCB	Colorado Water Conservation Board
CWMS	Corps Water Management System
DA	Data Acquisition (CWMS)
DB	Database (CWMS)
DCP	Data Collection Platform
DD	Data Dissemination (CWMS)
DM	Design Memorandum
DRCOG	Denver Regional Council Of Governments
DWB	Denver Water Board
EAP	Emergency Action Plan
EM	Engineer Manual
ENSO	El Niño/Southern Oscillation
EOC	Emergency Operations Center
EPA	Environmental Protection Agency
ER	Engineer Regulation (Corps)
ERDC-CRREL	Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory (Corps)
°F	Degrees Fahrenheit
FIA	Flood Impact Analysis (CWMS)
FR/EIS	Feasibility Report and Environmental Impact Statement
ft	Feet
FWAC	Future Without Action Condition
FY	Fiscal Year
GOES	Geostationary Operational Environmental Satellite
H	Horizontal
HEC	Hydrologic Engineering Center (Corps)
HMS	Hydrologic Modeling System (CWMS)
HMR	Hydro-Meteorological Report
HQUSACE	Headquarters, U.S. Army Corps of Engineers
IDF	Inflow Design Flood
in	inch
LiDAR	Light Detection and Ranging
MAX	Maximum
METAR	METeorological Aerodrome Report
MHFD	Mile High Flood District

Term	Definition
MIN	Minimum
mph	Miles Per Hour
MRBWM	Missouri River Basin Water Management
N/A	Not Applicable
NAVD88	North American Vertical Datum of 1988
NESDIS	National Environmental Satellite, Data, and Information Service
NGVD29	National Geodetic Vertical Datum of 1929
No.	Number
NOAA	National Oceanic and Atmospheric Administration
NOHRSC	National Operational Hydrologic Remote Sensing Center
NRCS	Natural Resources Conservation Service
NWD	Northwestern Division (Corps)
NWDR	Northwestern Division Regulation
NWS	National Weather Service
P&W	Parks and Wildlife
PC	Purchase Contract
PD	Project Datum
pg	Page
PMF	Probable Maximum Flood
PMSA	Primary Metropolitan Statistical Area
RAS	River Analysis System (CWMS)
RDF	Reservoir Design Flood
USBR	U.S. Bureau of Reclamation
ResSim	Reservoir System Simulation (CWMS)
SNOTEL	Snowpack Telemetry
SPF	Standard Project Flood
SPRF	Standard Project Rainfall Flood
sq mi	square mile
SWE	Snow Water Equivalent
UDFCD	Urban Drainage and Flood Control District
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	Vertical
WCP	Water Control Plan
WCWQS	Water Control and Water Quality Section
WFO	Weather Forecast Office
WRDA	Water Resources Development Act

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 1

INTRODUCTION

1-01. Authorization. This manual has been prepared in compliance with instructions contained in Engineer Regulation (ER) 1110-2-240, *Water Control Management*, May 30, 2016.

1-02. Purpose and Scope. The purpose of this manual is to outline the pertinent information and plan of operation for Cherry Creek Dam and Reservoir as set forth in the authorizing legislation. This manual presents detailed information pertinent to the regulation of Cherry Creek Dam and Reservoir, including regulation procedures and schedules. Other publications contain the instructions to reservoir operating personnel for the physical operation and maintenance of Cherry Creek Dam and Reservoir. This report follows the guidance presented in Engineer Manual (EM) 1110-2-3600, *Management of Water Control Systems*, October 10, 2017 and ER 1110-2-8156, *Preparation of Water Control Manuals*, August 31, 1995.

1-03. Elevation Datum. In the original design and construction of Cherry Creek 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. The NAVD88 is more accurate than the NGVD29 datum, 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 Cherry Creek Dam and Reservoir is approximately 1.3 feet (ft) higher than NGVD29 and approximately 1.8 ft lower than NAVD88. The PD has 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.

1-04. Related Manuals and Reports. Table 1-1 lists related manuals and reports for Cherry Creek Dam and Reservoir.

Table 1-1
CORPS OF ENGINEERS REPORTS - CHERRY CREEK DAM AND RESERVOIR

No.	Title	Date Submitted	Date Approved
	Preliminary Definite Project Report	Jan 1944 (Rev May 1944)	Mar 1944 (n/a)
	Historical Report on the Cherry Creek Dam and Reservoir Project	Sep 1950	n/a
CC-1	Reporting Network	Mar 1955 (Rev Sep 1955)	Dec 1955
CC-2	Master Plan / Public Use Plan	Apr 1959	May 1959
CC-2(C1)	On-Project Signs	Dec 1964	Dec 1964
	Reservoir Regulation Manual	May 1967 (Rev Aug 1970)	Feb 1968 (Oct 1971)
CC-2(C2)	Updated Master Plan / Public Use Plan	Sep 1971	Jan 1972
CC-2(C2)	Appendix B, Natural Resources Management Plan	May 1977	Jun 1978
CC-2(C2)	Appendix C, Fire Protection Plan	Sep 1976	Sep 1976
CC-2(C2)	Appendix E, Safety Plan	Aug 1976	Aug 1976
CC-2(C2)	Appendix F, Interpretive Prospectus	Apr 1975	May 1975
CC-3	Public Access Roads	Nov 1959	Jan 1960
CC-4	Spillway Fencing	Feb 1974	Mar 1974
CC-5	Conduit Security Protection	Feb 1975	Sep 1978
CC-6	Fencing Downstream area	Nov 1977	
	Water and Related Land Resources Management Study, Metropolitan Denver and South Platte River and Tributaries, Colorado, Wyoming, and Nebraska	Jan 1980	n/a
	Operation and Maintenance Manual	Nov 1980	n/a
CC-7	Emergency Gate Installation	Apr 1981 (Rev Aug 1982)	Ret Oct 1981 (Dec 1982)
CC-8	Rehabilitation of Spillway Channel	May 1983 (Rev Mar 1984)	Ret Nov 1983 (Mar 1984)
CC-9	Operational Manual Plan	Jul 1983	Dec 1983
CC-10	Sediment Removal	Jan 1985	Mar 1986
CC-11	Spillway Performance Review	Jan 1985	Mar 1985
	Reconnaissance Report-Seismic Evaluation and Analysis	Oct 1985	Apr 1986
CC-12	Low-Flow Outlet Installation	Aug 87	Nov 1987
	Reconnaissance Report: Hydrologic Improvement Assessment	Mar 88 (Rev Sep 88)	Ret Jun 1988 (Apr 1994)
CC-13	Seismic Evaluation	Oct 1988	Ret May 1989
CC-14	Master Plan	Apr 1991	Dec 1992
Recon. Report	Hydrologic Improvement Assessment	Feb 1988 (Rev Sep 1993)	
Non-Corps Report	Cherry Creek Reservoir Watershed Plan 2003, Cherry Creek Basin Water Quality Authority, Greenwood Village, CO	2003	2003
Cherry Creek DSMS	Endorsement of Cherry Creek Dam, Denver Colorado Probable Maximum Precipitation	December 2009	January 2010
Cherry Creek DSMS	Hydrologic Model, Historic Storms, Probable Maximum Flood Simulations & Inflow Design Flood Routings	March 2014	October 2014
Cherry Creek WCPMS	Cherry Creek Water Control Plan Modification Study	March 2017	March 2017

1-05. Project Owner. The project owner is the U.S. Army Corps of Engineers (referred to hereafter as the "Corps"), Omaha District.

1-06. Operating Agency. The operating agency is the Corps, Omaha District, Operations Division, Tri-Lakes Project Office. The gates are operated manually by the Dam Tender. The Dam Tender, who is located at the Chatfield Project full-time, is also responsible for following regulation orders for Chatfield Dam and Bear Creek Dam. It takes the Dam Tender about an hour with heavy traffic to get to Cherry Creek Dam from the Tri-Lakes Project Office. The current personnel assigned to make gate changes at Cherry Creek Dam are listed in the "Notice to Users of this Manual" Section of this manual in the Directory of Regulation Personnel – Tri-Lakes Project Office (pg iv-v).

1-07. Regulating Agencies. The Corps' Omaha District is the regulating agency for the Cherry Creek Project. During periods of flood control operation, Cherry Creek Reservoir will become part of a parallel reservoir system with Bear Creek and Chatfield Reservoirs. During these periods, regulation of the three reservoirs, also known as the Tri-Lakes Projects, will be coordinated as presented in Section 7 of this manual. During non-flood periods, below elevation 5550.0 ft PD, the State of Colorado, represented by the Colorado State Engineer of the Colorado Division of Water Resources (CDWR), tracks water rights on Cherry Creek and the South Platte River and makes requests for gate adjustments to the Omaha District's Water Control and Water Quality Section (WCWQS). These orders are then sent to the Tri-Lakes Project Office as described in Section 7 of this manual.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 2

DESCRIPTION OF PROJECT

2-01. Location. Cherry Creek Dam and Reservoir is located on Cherry Creek in the South Platte River basin, 11.4 miles above the mouth of the South Platte River. The dam is southeast of the City of Denver in Arapahoe County, CO. Plates 2-1 and 2-2 show the general location and features of the basin. Plate 2-3 shows the construction plan for Cherry Creek Dam.

2-02. Purpose. Cherry Creek Dam was constructed by the Corps for the primary purpose of mitigating flood risk to downstream metropolitan Denver from floods originating on Cherry Creek. Secondary purposes include flood protection on the South Platte River and multipurpose uses. Section 3-01 summarizes authorizing legislation.

In April 1958, the Corps granted 10,000 acre-feet (af) of water storage in Cherry Creek for recreation to the Colorado Parks and Wildlife (P&W). In March 1960, an additional 5,000 af of storage (to elevation 5550.0 ft PD) was granted for recreational purposes because the increase had a relatively insignificant effect on flood control benefits and greatly increased the recreation and fish and wildlife benefits.

Fish and wildlife was not included as a project purpose in the original authorization by the Flood Control Act approved August 19, 1941; however, an objective was added to store and release basin flows to facilitate the management of fish and wildlife. Other objectives are to maintain and manage the land and water resources to support a diversity of fish and wildlife and to preserve, protect, and interpret threatened and endangered species and unique and important ecological resources.

2-03. Physical Components.

a. Embankment. The embankment is a rolled zoned earthfill approximately 14,300 ft long with a crest width of 30 ft. The top of the dam was built to elevation 5645.0 ft PD. Since construction, the embankment settled causing a low spot along the crest at elevation 5644.4 ft PD. The maximum height at the embankment is approximately 140 ft. The embankment zoning includes an inclined impervious core with random fill shells. Pervious zones in the upstream rapid drawdown zone and at the base of the downstream shell are for through seepage. The upstream face slope varies from 1 Vertical (V) on 2.46 Horizontal (H) to 1V on 3.5H. Plate 2-4 shows a general plan and sections drawing.

b. Freeboard. The elevation of the top of Cherry Creek Dam (5645.0 ft PD) was established by applying 9 ft of freeboard above the maximum pool elevation (5636.0 ft PD) reached during routing of the original Inflow Design Flood (IDF) through the reservoir with a maximum spillway discharge of 38,440 cubic feet per second (cfs). Computations based on the maximum anticipated wind velocity and on the reservoir fetch indicated that a freeboard of 5 ft was required. However, because of the necessity of limiting spillway discharge into Toll Gate Creek, a freeboard of 9 ft was used to

provide an ample factor of safety against overtopping of the structure. The re-evaluated IDF has increased since the original design and subsequent construction of Cherry Creek Dam resulting in no available freeboard. See Section 8-02.c. for details.

c. Spillway. The spillway is isolated from the main embankment. It is cut through a ridge, which forms the right rim of the reservoir and discharges water into Sand Creek via Toll Gate Creek. The spillway is an unlined cut with constant bottom elevation. The original bottom width was 67 ft at the approach and 45 ft at the outlet. The spillway is cut into the Denver Formation soils. The side slopes are 1V on 1H up to the top of the Denver Formation and 1V on 2H through the overburden.

Since construction, the side slopes have sloughed at numerous locations increasing the spillway crest elevation as much as 13 ft. The spillway crest elevation was surveyed in 2008 at 5610.6 ft PD. The discharge at pool elevation 5644.4 ft PD, which is the top of the dam low spot, is about 31,000 cfs as of 2016. The side slopes now vary widely as does the bottom width and invert elevation; see DM No. CC-11 for more information. Plate 2-5 illustrates the original design spillway plan and sections. See Plates 2-6 through 2-8 for the spillway rating curves and rating tables.

A spillway maintenance contract is underway to return the crest to the original design elevation (5598.0 ft PD) to reduce the potential of overtopping and failure, discussed in Section 8-02.

d. Outlet Works. The outlet works is located near the right abutment. A discharge channel returns the outlet works discharge water back into the Cherry Creek channel. The outlet works structures consist of an approach channel, intake structure, triple barrel concrete conduit, stilling basin, and service bridge. At a pool elevation of 5644.4 ft PD, which is the top of the dam low spot, the capacity is 9,800 cfs for the two outside conduits, and 13,300 cfs for all three conduits. Plate 2-9 shows a detailed drawing of the outlet works. See Plates 2-10a through 2-14b for discharge rating curves and discharge rating tables.

e. Approach Channel. The approach channel to the outlet works intake is 75 ft in length. The first 25 ft of the channel bottom is riprapped and slopes from an elevation of 5503.5 to 5501.0 ft PD. The remaining 50 ft is a 1-ft thick concrete slab. The approach walls, which are identical in design on each side of the intake tower, are cantilever type structures. The approach walls are 75 ft long and vary in height from 3.25 to 24.5 ft at the intake tower.

f. Intake Structure. The intake tower contains five rectangular water passages, each with a 6x9-ft slide gate to control the water flow (see Plate 2-15). The outer two passages on each side converge to form an oblong conduit. The center passage follows a transition to a circular conduit. Trash racks have been installed at the upstream end of the forebay. Operation of the service gates was moved to the operating deck due to the possibility of flooding of the hoist room, which is located just above the water passages. The hoists are hydraulically powered and are controlled from the operating deck. Emergency gates were installed in 1984. The operating deck, which is at the same level

as the embankment crest, is housed in a reinforced concrete superstructure and contains a diesel stand-by generator, an overhead crane, and recording instruments. A steel stairway provides access between the hoist room and the operating deck. A raking deck provides storage for the bulkhead gates and a crane to operate the gates. Plate 2-16 shows a drawing of the service gates.

Low-flow gates were installed in the intake structure in 1989 to release water for downstream water rights (see Plate 2-17). Two bypass pipes were installed. The pipes extend from the existing service manholes just upstream from service gates No. 2 and No. 5 to existing air vent pipes just downstream of the service gates. Knife gate valves with electric operations are used to provide flow control.

g. Conduit Transition. The outer two water passages on each side of the intake structure converge to form an oblong passage in the conduit transition. The circular center passage is 12 ft in diameter and was designed to accommodate a 7-ft steel penstock with control valve. The conduit transition is 61 ft long with a slope of 0.0054 ft/ft and invert elevations of 5504.0 ft PD and 5503.67 ft PD at the upstream and downstream ends, respectively.

h. Conduit. The three cut-and-cover type conduits are encased within one structure. The oblong-shaped conduits are 8 ft wide and 12 ft high. Each opening is formed by a 4-ft radius semi-circular arc on top and bottom connected by 4-ft straight vertical sidewalls. The center conduit has a 7-ft circular steel section that discharges into a 12-ft circular concrete conduit in an abrupt transition. A steel liner was planned for the center conduit but was never installed because the project features were not expanded to include irrigation. The steel liner was placed through the 7-ft transition section only. No water has been released through this conduit under flood control operations. Water has only been released during maintenance activities such as the sedimentation flush. Provisions were made at the downstream end for installation of a regulating gate. The conduit is 603 ft long, with a slope of 0.0054 ft/ft, and invert elevations of 5503.67 ft PD and 5500.42 ft PD at the upstream and downstream ends, respectively.

In 2013, a center conduit study determined that the center conduit should not be used above pool elevation 5590 ft PD. Above this elevation the air demand is exceeded and cavitation is possible. The gate should be used fully opened to avoid problems with vibrations and cavitation.

i. Stilling Basin. The stilling basin contains a stilling pool, which the water enters over a parabolic drop section 75 ft long. The level portion of the stilling basin is 90 ft long and has an elevation of 5480.0 ft PD. Retaining walls, varying in height from 17 to 25 ft through the drop section and 25 ft high throughout the level section, form the outside boundaries. Two training walls, which have a maximum height of 23 ft, keep the water separated from each of the conduits. The slab is 2.5 ft thick through the drop section and 4 ft thick in the level portion. Two rows of baffles 3 ft high extend across the width of the stilling basin. Each flood tunnel has six baffles. Six-inch perforated vitrified

clay pipe was installed beneath the stilling basin for under-slab drainage. Plate 2-18 shows a drawing of the stilling basin.

2-04. Related Control Facilities. Plates 2-19 and 2-20 show a schematic flow diagram of the diversions and storage facilities of the upper South Platte River basin.

2-05. Real Estate Acquisition. The *Definite Project Report, Kenwood Dam, Cherry Creek and Tributaries, Colorado*, dated January 1944, indicated the intent to acquire land in fee to elevation 5623.0 ft PD and to obtain flowage easements on lands between elevations 5623.0 ft PD and 5639.0 ft PD. Easements were eventually acquired up to 5636.0 ft PD, the approximate elevation of the maximum pool as determined in 1944.

The Federal Government currently owns 5,344.65 acres of land in fee simple title and 131.35 acres in flowage easements. The State of Colorado, Parks and Recreation, the City and County of Denver, the City of Aurora, and Greenwood Village all manage lands at this project for park and recreational purposes. The Corps manages the remainder for operational purposes. Plate 2-21 shows the Cherry Creek Project boundary and easements. Additional information pertaining to real estate acquisition for the Cherry Creek Project is located in the Omaha District Real Estate Division files.

2-06. Public Facilities. The development and use of the Cherry Creek Project for recreation and fish and wildlife management has resulted in an outstanding water recreation area within reach of a large population in the Denver area. Since the initial multipurpose storage was established in 1957, there has been an increasing number of users of the Cherry Creek Project facilities. Plate 2-22 shows a map of Cherry Creek State Park.

In 1959, the project area above the dam was originally leased to the Colorado P&W for wildlife management purposes and in 1961, the project area downstream of the dam was originally leased to the City and County of Denver for public park and recreation purposes. The Cherry Creek Lake Master Plan, DM CC-14, approved in December 1992, has been adopted by the State of Colorado and the Corps for recreational and fish and wildlife management purposes. The project lands have been leased to the Colorado P&W by the Corps for management in accordance with terms of the Master Plan.

Upstream from the dam, the Colorado P&W has constructed many facilities, some of which were cost-shared, to develop Cherry Creek State Park on its leased area. These facilities support many recreation activities, including picnicking, swimming, fishing, boating, water skiing, jet skiing, sailboarding, camping, bicycling, jogging, hiking, horseback riding, model aircraft flying, dog training, and wildlife observation. A visitor center was completed in 1996 in the park administration building.

Municipal park facilities for activities such as golf, soccer, baseball, softball, playground use, and bicycling were constructed downstream from the dam by the City of Aurora, the City Denver, and Greenwood Village, lessees of the project lands. The municipal

park facilities that have been built include John F. Kennedy Golf Course, Kennedy Park Soccer Complex, the Village Greens, Olympic Park, and Crestridge Park.

Historically, visitation was computed in days but was changed in 1990 to hours. Beginning in 2014, the method for calculating the visitation hours at the Cherry Creek Project changed, which resulted in non-comparative reduced numbers. Since construction of the Cherry Creek Project, visitation has grown drastically to over 2,700,000 recreation visits in FY16. The Corps has not released the official visitation hours since FY16.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 3

HISTORY OF PROJECT

3-01. Authorization. A survey report on Cherry Creek dated March 1, 1939, prepared by the District Engineer, U.S. Engineer Office, Omaha, NE, was published as House Document No. 426, 76th Congress, 1st Session. The report presented a coordinated plan for the improvement of Cherry Creek. The report recommended the reconstruction of Castlewood Dam for purposes of flood control and irrigation. Castlewood Dam failed during the flood of August 1933. The report also recommended the construction of Cherry Creek Dam for flood control and other purposes. This plan was subsequently authorized by the Flood Control Act (Public Law 228, 77th Congress, 1st Session), which was approved August 18, 1941. The plan included $8,000,000 for initiation and partial accomplishment of the Cherry Creek Project. Section 10 of the 1944 Flood Control Act (Public Law 534, 78th Congress, 2nd Session) approved December 22, 1944, authorized the completion of the Cherry Creek plan approved August 18, 1941. Cherry Creek Dam and Reservoir was also included in a comprehensive plan for the development of the Missouri River basin, which was approved in Section 9 of the 1944 act.

Section 4 of Public Law 534, 78th Congress provided authorization for development of recreation facilities at the Cherry Creek Project. In 1959, the Master Plan was modified to add recreation and fish and wildlife purposes to the project. Storage of water for irrigation was never initiated and in 1968, the U.S. Bureau of Reclamation (USBR) relinquished to flood control 85,000 af of storage which had been reserved for irrigation.

3-02. Planning and Design. Early studies by private interests, the USBR, and the Corps, recognized the need for water storage in the South Platte River basin for hydropower, flood control, and multipurpose purposes. Flood control in the Cherry Creek basin was particularly desired by local interests for the protection of the City of Denver from floods originating on Cherry Creek. Two storage reservoirs had been constructed on Cherry Creek before the construction of the present Cherry Creek Dam. The Castlewood Dam, a masonry irrigation structure that failed during the flood of August 3, 1933, was located on Cherry Creek approximately 40.7 miles above the mouth. It was built in 1890 by the Denver Water Storage Company for the purpose of impounding their water rights of 5257 af. Before its failure, it rendered some incidental benefits in the control of minor floods on Cherry Creek. Kenwood Dam, located immediately downstream of the present Cherry Creek Dam, was built as a Federal Public Works Administration project by the City and County of Denver in 1935-36. The project, constructed after the failure of Castlewood Dam, was designed to protect Denver from floods. The earth embankment and outlet works of Kenwood Dam were removed during the construction of Cherry Creek Dam. The reservoir had a storage capacity of 17,400 af at the top of the parapet wall. The dam was an earthfill structure with a maximum height of 53 ft above the valley floor and included a concrete parapet wall that extended 5 ft above the dam crest. The uncontrolled outlet conduit passed normal flood flows and had a capacity of 7,500 cfs. The spillway had a capacity of 14,500 cfs. Studies by the Corps subsequent to the 1935 storm indicated that Cherry

Creek was vulnerable to extremely high discharges in excess of the capacity of Kenwood Dam.

A review of the Definite Project Report (DPR) hydrologic studies was initiated when new data subsequent to the preparation of the DPR became available. The review indicated that a larger spillway design flood was required than that assumed in the initial preparation of the DPR. Additionally, by letters of February 6, 1943 and March 13, 1943, the USBR advised the Corps that its plans for basin development included storage of 95,000 af (85,000 af irrigation storage and 10,000 af sediment storage) on either Cherry Creek or Toll Gate Creek. The USBR requested the Corps to include this amount of storage for multipurpose uses in their Kenwood Dam site investigations. The USBR's letter of December 11, 1943 expressed its approval of the Corps' plans, which would incorporate its storage needs when the actual need for irrigation storage developed.

The DPR proposed that the primary purpose of the authorized plan of complete flood protection for the City of Denver from floods originating on Cherry Creek would best be provided by a single reservoir project located at the Kenwood Dam site or the present Cherry Creek Dam site. A spillway canal would be constructed to pass extreme inflows into the adjacent Toll Gate Creek, thus bypassing the Cherry Creek channel through Denver. It was also proposed that the project be designed to permit its use as a multipurpose project, thereby incorporating the needs of the USBR for irrigation storage when the need for such capacity became evident. Initially, the dam would be built to multipurpose height, but include only those features of the outlet works and spillway necessary to accomplish flood control regulation.

The water laws of the State of Colorado are based on the principle of priority of application to beneficial use as distinguished from the common law doctrine of riparian ownership. In accordance with the laws, the appropriators may divert waters of the streams only when there is sufficient flow to satisfy all downstream water rights senior to their own. Under such water laws, the most junior appropriators often obtain water only during flood runoff. Included in the reservoir and outlet works design proposed in the DPR were provisions for sediment storage of about 10,000 af, an outlet works intake at the top of the proposed silt storage pool, and an outlet capacity of 1,000 cfs when 20,000 af is stored in the reservoir. These features of the design led to complaints from water users along the South Platte River below Denver that the Cherry Creek Dam outlet works would reduce peak discharges of flash flows on Cherry Creek to less than 5,000 cfs thereby depriving the junior water rights of the benefit of peak flows. On April 22, 1946, representatives of the Corps' Missouri River Division, now the Northwestern Division, the Denver District, and the USBR Region 7 Director met with a special committee of the Colorado Water Conservation Board (CWCB) in Denver, CO to consider the desires of water users relative to the design of the project. As a result of this meeting, the committee transmitted the following recommendations to the Corps by letter dated May 7, 1946:

a. Eliminate all permanent or dead storage as long as the project is used solely for flood control purposes.

b. Modify the inlet so that discharges can begin at the approximate natural bed level.

c. Increase the capacity of the outlet works to approximately 5,000 cfs with 5,000 af of water impounded.

d. Redesign the outlet works to secure the most economy.

e. Operate the Cherry Creek Project, after its construction, in accordance with rules and regulations to be agreed on between the appropriate Federal agencies and the Colorado State Engineer.

Approval of the revised plan for the outlet works in accordance with the above proposals was recommended by the Division Engineer in a letter of May 29, 1946 and approved by the Chief of Engineers by a second endorsement to a letter of July 24, 1946. The project was constructed in accordance with the revised design.

The reservoir site does not have marked topographic advantages. The site determination was dictated by the protection required for the City of Denver and by the suitability of the site for storage of water to be diverted from the Western Slope under a proposed Blue River – South Platte River project of the USBR. The feasibility of the spillway location for diverting flood flows into the adjacent Toll Gate Creek basin through the low eastern ridge, which constitutes the right abutment of the dam, was also a controlling factor. The Cherry Creek valley at the reservoir site is about 1 mile wide and rises gently from the creek channel.

3-03. Construction. Construction of the Cherry Creek Project began with ground-breaking ceremonies on July 16, 1946. Closure of the dam was made in October 1948. The outlet works was completed in 1949 and embankment and spillway construction was completed in January 1950. The dam was considered complete in June 1950. The major contractors on the project were:

a. Gordon, Bressi and Bevanda Construction, Inc.	Cutoff Trench
b. Al Johnson Construction Company	Outlet Works
c. Wunderlich Contracting Company	Embankment and Spillway.

Operation of the project resulted in an initial impoundment of 1500 af of water in the reservoir from the storm of May 13-16, 1957. The multipurpose zone was gradually filled from May 1957 to March 1960.

3-04. Related Projects. Parallel reservoir operation of the three area flood control projects, Bear Creek Dam, Chatfield Dam, and Cherry Creek Dam, is required when two or more of the projects are in flood operation. See Section 7-05 for further explanation of the parallel reservoir operation of these three reservoirs.

No reservoir projects exist that directly impact Cherry Creek Reservoir. Rueter-Hess Reservoir, owned and operated by Parker Water and Sanitation District in Parker, CO, was completed in 2012 for the purpose of water supply storage. The 196 ft high dam

impounds a small tributary to Cherry Creek known as Newlin Gulch about 11 miles south of Cherry Creek Dam. A diversion from Cherry Creek with a current capacity of 78 cfs is used to fill the reservoir when the water rights are in priority. The reservoir has an active storage capacity of 75,686 af at a pool elevation of 6212.0 ft covering 1119 acres. The spillway capacity is 25,227 cfs. Many reservoir projects exist upstream from Chatfield in the South Platte River basin.

A number of reservoirs have been constructed in the South Platte River basin for water supply, irrigation and flood control purposes. Table 3-1 lists the pertinent reservoir information and Plate 3-1 shows a three-dimensional system diagram of the location of these reservoirs in relation to Chatfield Dam, Cherry Creek Dam, and Bear Creek Dam. In addition, a large number of reservoirs and ponds of less capacity have been constructed for irrigation and other conservation purposes.

Table 3-1
PERTINENT EXISTING RESERVOIRS IN SOUTH PLATTE RIVER BASIN

Reservoir	Stream	Storage Capacity (af)	Year Dam Closed	Operating Agency
Antero	South Platte River	19,881	1907	DWB
Spinney Mountain	South Platte River	53,651	1981	COA
Eleven Mile Canyon	South Platte River	97,779	1932	DWB
Tarryall Dam	Tarryall Creek	1,990	1930	CDW
Cheesman Lake	South Platte River	79,064	1902	DWB
Strontia Springs	South Platte River	7,863	1982	DWB & COA
Rueter-Hess	Cherry Creek	75,686	2012	Parker
Chatfield	South Platte River	349,454	1973	Corps
Bear Creek	Bear Creek	46,995 (3)	1977	Corps
Cherry Creek	Cherry Creek	175,460 (3)	1948	Corps
Kelly Road	Westerly Creek	800	1953	COA
Westerly Creek	Westerly Creek	9,300	1990	UDFCD / MHFD
Gross	Boulder Creek	41,811	1954	DWB
Carter Lake	Dry Creek (2)	112,230	1954	USBR
Horsetooth	Charles Hansen Canal (1)	151,750	1951	USBR

(1) Offstream of Cache la Poudre River
(2) Offstream of Big Thompson Creek
(3) Includes Surcharge Zone

DWB (Denver Water Board)
Corps (U.S. Army Corps of Engineers)
USBR (U.S. Bureau of Reclamation)
COA (City of Aurora)
CDW (Colorado Division of Wildlife)
UDFCD (Urban Drainage and Flood Control District)
MHFD (Mile High Flood District)
Parker (Parker Water and Sanitation District)

3-05. <u>Modifications to Regulation</u>. A reservoir regulation plan developed in July 1950, before establishment of the multipurpose zone, was designed to meet the request of

irrigation interests. The project was to be regulated to meet a request that minor flood crests up to 5,000 cfs be permitted to pass through the reservoir with a minimum reduction in crest so as to disturb as little as possible the irrigation diversions and uses of water in downstream irrigation districts. During normal flow periods, Cherry Creek Dam outlet gates were to remain open in such a position that all irrigation demands would be met in the event of a flood. The Colorado State Engineer was to keep the Denver Area Office informed of the current irrigation demand so that the outlet gates could be set in a position, which in the event of a flood, would provide maximum control of floods in the initial stage and yet not interfere with irrigation diversions.

The Colorado State Engineer declared the initial 1500 af of storage in 1957 to be “free water” in excess of the needs of downstream water users and requested authority to retain this and other small quantities of water that may have been available. The Chief of Engineers indicated no objection to retention of up to 10,000 af of multipurpose storage in the reservoir, provided this was desired by the appropriate state officials in compliance with water laws of Colorado. In March 1958, the Governor of Colorado formally requested of the Chief of Engineers that the agreement concerning the method of operating the Cherry Creek Reservoir be changed to allow the Colorado Fish and Game Department to store 10,000 af in the multipurpose zone for the recreational use of the general public in the Denver area. Following approval of this request, the operating plan was changed to accomplish this purpose. By a letter dated February 23, 1960, the Director of the State of Colorado, Department of Natural Resources (DNR), with the support of the Governor, requested authority to increase the multipurpose storage from 10,000 to 15,000 af. The Chief of Engineers gave approval on March 29, 1960, setting an elevation of 5550.0 ft PD as the bottom of the flood control zone. This was based on the storage-elevation relationship from the DPR reservoir capacity table. With this approval, the Chief of Engineers instructed the District Engineer to revise the operating plan for the reservoir to accomplish this purpose.

In 1988, the State of Colorado requested a permanent increase in the top of the multipurpose zone from an elevation of 5550.0 ft PD to 5552.0 ft PD to mitigate evaporation losses at the reservoir. This request was denied due to inadequate storage capacity of the reservoir to contain and safely pass design storms.

In April 1988, the State of Colorado, through the State Engineer, implemented strict administration of water rights within the Cherry Creek basin. Cherry Creek Dam is required to pass inflow through the project when a senior water rights call is in effect. Losses due to evaporation while the water is stored in the reservoir are then made up by the project. The Corps modified two of the outlet gates by adding an 18 in. bypass gate in November 1988 to allow for accurate small releases to be made to satisfy downstream water rights.

In 1992, the State requested permission to temporarily store an extra 0.5 ft of water in Chatfield Reservoir to mitigate evaporation losses at Cherry Creek Reservoir while the state investigated other sources of water that could be used for this purpose. The extra 0.5 ft was allowed for two years when the Cherry Creek State Park showed that they

were able to use some water from several other sources, including Denver Water Board (DWB) and Arapahoe Sanitation and Water Resources.

The cities of Aurora and Colorado Springs have purchased Western Slope waters and are rapidly completing plans for construction of diversion works. Aurora's initial water supply came from wells in the Cherry Creek basin a short distance above the Cherry Creek Project. With the acquisition of rights to South Platte River water, the City of Aurora constructed treatment facilities and pipelines to bring such waters into their system. The City of Aurora has requested authority to drill wells within the Cherry Creek Project limits to supplement their present supply until their Western Slope waters can be delivered to their system. In January 2008, the District Engineer approved the Colorado P&W request to construct up to four non-tributary wells on project lands to make up part of the evaporation losses in the reservoir.

Meetings regarding water supply reallocation at Chatfield Reservoir began in 1994 as a result of the public involvement process initiated during an update to the water control manuals for the Tri-Lakes Projects. A reconnaissance study was initiated in 1996. The Colorado Water Conservation Board (CWCB) signed a Feasibility Cost Share Agreement with the Corps in 1999, and the Feasibility Report and Environmental Impact Statement (FR/EIS) was initiated shortly after. Several challenges related to Federal funding, policy changes, and contract negotiations led to an extended schedule. Following extensive agency and public involvement, the Chatfield Reallocation FR/EIS, was approved in May 2014 and implemented in FY20 following completion of recreation and environmental mitigation projects. The study concluded that transferring 20,600 af of the Chatfield Reservoir exclusive flood control storage to a new Chatfield Reservoir joint-use flood control-conservation zone (5432.0 – 5444.0 ft PD) does not impact the primary flood risk management purpose of Chatfield Reservoir. During Tri-Lakes system flood control storage evacuation for Level I (small flood events), defined in Section 7-05, the reallocation of flood control storage at Chatfield Reservoir slightly increases Cherry Creek Dam and Bear Creek Dam releases, and it affects the timing and duration of these releases, though the primary flood risk management purpose for Cherry Creek and Bear Creek Reservoirs is not affected. Plate 3-2 shows an example of how the release magnitudes are affected. There is no change to system flood control storage evacuation releases during Level II (large flood events), also defined in Section 7-05 The target flow at the South Platte River at Denver streamgage of 5,000 cfs was also unchanged by this study.

The Cherry Creek Dam Water Control Plan Modification Study began in October 2015. The purpose of the study was to establish a timeline and mechanism to allow increased releases from Cherry Creek Dam during an extreme flooding event to reduce the potential for dam overtopping and failure as well as reducing the overall flood extent. The study analyzed theoretical extreme storms, rainfall runoff associated with these storms, current and increased Cherry Creek Dam releases, flood extent boundaries, and economic and environmental impacts as a result of increased releases. The study considered six release alternatives and recommended an alternative that required the release of 7,000 cfs from Cherry Creek Dam if the reservoir reaches elevation 5590.0 ft PD. A modification to the Cherry Creek Dam Water Control Plan (WCP) impacts the

Chatfield Dam WCP and Bear Creek Dam WCP because these projects are operated as a system to mitigate flood risk through Denver, CO. Evacuating flood water from Cherry Creek Reservoir at an accelerated rate reduced the risk of overtopping during an extreme rain event and resulted in minimal incremental damage following single rain events that have limited rainfall downstream of the dam. Some risk of additional damage was determined possible if releasing during subsequent storm events, however, that risk is outweighed by the need to release floodwater and reduce the risk of overtopping and failure because there is uncertainty in forecasting thunderstorm intensity, duration, and location. The environmental analysis resulted in a finding of no significant impact. As a result of the study recommendation, the Cherry Creek Dam, Chatfield Dam, and Bear Creek Dam WCPs were modified and became effective in April 2017.

3-06. Principal Regulation Issues. The control point for Cherry Creek Reservoir regulation is a 5,000-cfs maximum flow target, except during extreme events, at the South Platte River at Denver streamgage. It is important to note that the 5,000-cfs flow target also includes Chatfield and Bear Creek Dam releases as well as incremental runoff downstream of each of the dams. The primary regulation problem with the Tri-Lakes Projects is that the channel capacity downstream of the City of Denver is less than it is within the city itself. The non-damaging channel capacity of Cherry Creek from Cherry Creek Dam to the South Platte River confluence is at least 5,000 cfs and has been verified with recent modeling efforts. The non-damaging channel capacity on the South Platte River through the City of Denver has been improved since the construction of the Tri-Lakes Projects with estimated capacities ranging from 10,000 cfs to 30,000 cfs. Flows in excess of the channel capacity quickly flood the natural flood plain. In the 13-mile reach of the South Platte River from Brighton, CO to the geographic limits of the Denver metropolitan area, the channel capacity ranges from 3,000 cfs to 8,000 cfs. In this reach of the South Platte River, flows in excess of channel capacity spread extensively over the flood plain. Short-duration, high intensity rains in certain downstream reaches can produce regulation problems for the Tri-Lakes Projects. These rains can produce very quick peaking, short-duration basin hydrographs. Therefore, with the 12- to 24-hour travel time between the reservoirs and the downstream target streamgage, and the 4- to 8-hour peaking time on many of the tributaries, it may not be possible for the WCWQS to assess conditions and make gate orders, and the Dam Tender to physically make those gate changes prior to the occurrence of the peak downstream rainfall-runoff.

Other regulation problems that are associated with the operation of the Cherry Creek Project exist and are described in the following paragraphs:

a. Encroachments within the Flood Control Zone. The population and urban development surrounding Cherry Creek Reservoir has escalated significantly since the dam was originally contracted as a dry dam in rural Colorado. The first impoundment of water occurred in 1958 at the request of the State of Colorado. In 1957, additional water was stored to attain the existing pool level. The reservoir has been substantially impacted by the population growth of the surrounding municipalities. Visitation controls and limits have been implemented by the State of Colorado on their lease area.

Developers have attempted to plot and develop some of the land where Federal Government flowage easements exist. Developers continually request easements for water, sewer, and utility lines across project lands.

Developers frequently seek permission to cut and fill on flowage easements or to construct portions of residences on flowage easements. Construction of habitable structures in these easements is prohibited. Cut and fill of soil, which would alter the elevations on the Federal Government easement interest, is also not allowed. It is the policy of the Federal Government to deny requests for road construction on project or flowage easement land if the road is the only access to a proposed residence.

Many areas below the maximum pool level, which the Federal Government did not obtain any interest on, have been developed. This makes it even more important to be alert to rising pool levels and to manage the project to keep flood storage evacuated.

b. Evaporation Losses. State administration of water rights requires a strict accounting of evaporation losses in any reservoir facility. Unless water is stored in priority, pool levels will fall due to evaporation losses. The storage loss could impact recreation uses at the project. The project sponsor, Colorado P&W, has been pursuing several alternate sources of additional water, including water right exchanges, agreements, and non-tributary wells to offset evaporation losses.

c. Intake Structure Sediment Buildup. During the installation of the emergency gates in 1983 and 1984, it was discovered that 10 to 20 ft of hard sediment had been deposited within the intake tunnels of Cherry Creek Dam. In 1983 and 1984, the sediment was removed by dredging at a cost of about $180,000. Design Memorandum No. CC-10 (1985) discusses various methods for preventing a recurrence of the sediment accumulation within the intake structure, which could prevent the emergency gates from being lowered in an emergency. The evaluated alternatives included structural solutions, dredging, and operational strategies. Since the operational strategies were the least costly and disruptive, it was decided to evaluate various methods that could be used on a routine basis to flush sediment through the intake structure. The sediment has been successfully flushed under a regular annual flushing exercise since 1991.

d. Hydrologic/Dam Safety Inadequacy. In 1969, following the newly published Hydro-Meteorological Report (HMR) No. 44, a new, significantly larger IDF for Cherry Creek Dam was developed. The IDF is equivalent to the Probable Maximum Flood (PMF), but did not risk overtopping the dam. In 1988, the PMF was increased. This increase to the PMF, along with an elevated spillway crest, indicated that the dam no longer had adequate freeboard and could overtop. A site-specific Probable Maximum Precipitation (PMP) analysis done in 1995 resulted in a slightly lower PMF, but the dam would still be susceptible to overtopping. The draft Dam Safety Modification Study (DSMS), which will be finalized in 2020, indicated that the dam could contain 75% of the Future Without Action Condition (FWAC) PMF with 5 ft of freeboard, and 87% of the FWAC PMF at the top of the dam low spot, 5644.4 ft PD. Reference Section 8-02 of this manual for additional information.

SECTION 4

WATERSHED CHARACTERISTICS

4-01. General Characteristics. Cherry Creek is a right-bank tributary of the South Platte River, which rises on the northern slope of the Arkansas-South Platte River basin divide in El Paso County, CO, 11 miles south and east of Monument, CO. Cherry Creek flows into the South Platte River in the highly developed business and industrial area of downtown Denver, CO. The basin elevation varies from about 7700 ft at the source of Cherry Creek to about 5170 ft at its confluence with the South Platte River.

The elongated 386-square mile (sq mi) Cherry Creek basin has an average width of about 11 miles and a length of approximately 57 miles above Cherry Creek Dam, with the main channel located approximately through the center of the basin. Cherry Creek Dam, which is located about 11.4 miles upstream from the mouth of Cherry Creek, controls 386 sq mi of the basin's 414-sq mi total drainage area. The lower 5.5 miles of Cherry Creek traverse through Denver residential and industrial districts in a concrete lined channel.

a. Development. The Cherry Creek Project is located in a highly urbanized area that continues to develop. Below its confluence with Cherry Creek, the South Platte River flood plain contains the heaviest concentration of economic development within the Denver area. Cherry Creek and the South Platte River in Denver proper contains railroad facilities, dense concentrations of industrial and commercial properties, and occasional older residential areas. Below Denver proper, the South Platte River flood plain is principally rural; agriculture is the major land use.

b. Topography. The Cherry Creek basin upstream from Franktown, CO has steep to moderately rolling topography. A narrow belt across the central part of the basin, immediately upstream from Franktown, is characterized by sharp topographic relief. Canyon walls and mesa fronts, 200 to 400 ft high, are common in this belt. In the reach from near Franktown to near Parker, CO, Cherry Creek courses through a broad valley bordered by steep to rolling ridges and hills. Downstream from Parker, the upland area consists of rolling hills.

Cherry Creek Dam lies within the Colorado Piedmont section of the Great Plains physiographic province. The general topography of the Cherry Creek basin upstream of the dam consists of flat tablelands separated by flat-bottomed valleys ranging from about 5500 ft to 7500 ft. Cherry Creek is a tributary to the South Platte River, which flows northeastward through this section. Elevations for most of the Denver area are less than 6000 ft, but the Rocky Mountain foothills rise as hogbacks immediately west of Denver. The high peaks of the Rocky Mountains west of the hogbacks exceed 14,000 ft.

The topography immediately adjacent to the reservoir is characterized by a 3,000-ft wide valley, with separating hills that rise 200 ft above the former valley floor. Slopes on the valley walls occasionally exceed 10%, but most slopes do not exceed 3%. Gentler slopes are found on the surrounding tablelands.

c. Geology and Soils. The bedrock below Cherry Creek Dam and the surrounding hills is the Denver Formation of late Cretaceous and early Tertiary age. The Denver Formation overlies a 10,000-ft thick sequence of Cretaceous to Paleozoic sedimentary rocks filling the Denver basin. The Denver Formation is composed of alternating strata of shale, claystone, siltstone, sandstone, and some conglomerate. These units have been described as being thin-bedded, semi-consolidated to consolidated, and friable. The bedrock is encountered from 5 to over 100 ft below the surface.

The Cherry Creek valley is underlain by alluvial sand and gravel and some layers of fat to lean clay. This valley-fill alluvium is generally about 40 ft thick, but exceeds 100 ft in buried ancient channels. Hillslopes are usually covered by weathered Denver Formation deposits, but sometimes by Holocene to Pleistocene windblown sand or loess. These deposits generally range from clayey sandy silt to silty or clean sand.

d. Sediment. The accumulation of sediment within Cherry Creek Reservoir is tracked by the Omaha District's River and Reservoir Engineering Section. Table 4-1 lists the total storage depletion rate between survey years. The average sediment storage depletion rate between survey years 1950 and 2006-07 is 77.3 af/year. The original projected depletion rate was 80 af/year. Most of the sediment load brought into the reservoir is a result of the major flood events within the basin. Plates 4-1 and 4-2 show the 2006-07 reservoir surface area and storage capacity curves, respectively. Exhibit II includes surface area and storage capacity tables. Plate 4-3 shows sediment range locations for Cherry Creek Reservoir. New surface area and volume capacity tables based on a 2016 survey are scheduled to be made effective in 2020.

Table 4-1
CHERRY CREEK RESERVOIR STORAGE DEPLETION

Storage Zone	Elevation (ft PD)	Storage Zone Capacity (af)		Change in Capacity (af)	Capacity Depletion Rate* (af/year)
		1950	2006-07	1950-2006-07	
Multipurpose	5504.0-5550.0	15,155	12,558	-2,597	-44
Flood Control	5550.0-5598.0	80,638	79,294	-1,344	-23
Surcharge	5598.0-5640.0**	152,525	151,905	-620	-11

* Measured storage depletion rates should be used with caution. Actual rates are highly event driven and respond to extreme hydrologic events.
** Top of the surcharge zone is 5645.0 ft. The storage capacity table stops at 5640.0 ft (top 5 ft is not represented).

4-02. Climate. The diverse topography of the Cherry Creek basin above Denver causes a remarkable variety of climates occurring within short distances. The climate of the plains is distinctly continental. Situated a long distance from any moisture source and separated from the Pacific source of moisture by a high mountain barrier, the plains area normally experiences light rainfall, low relative humidity, a large daily range in temperature, a large amount of clear sky sunshine, moderately high wind movement, and few protracted cold spells in the winter. However, invasion of cold air from the north, combined with available

moisture in the air and the high altitude, can result in abrupt and severe weather. In the mountain area, a decrease in temperature and an increase in precipitation and wind movement occur with increasing altitude.

a. Temperature. Temperatures in the Denver area can vary widely from day to day because of the invasion of large air masses from the north or south. Rapid warm-ups during the winter months are common because of the effects of Chinook winds. The diurnal range in temperatures is less on the mountain slopes than in the valleys. The hottest month of the year is July, when daily temperatures average 72 degrees Fahrenheit (°F) at Cherry Creek Dam. The coldest month of the year is January, when daily temperatures average 31 °F at Cherry Creek Dam. Due to the effects of the urban heat island, the length of the frost-free period in Denver is approximately 155 days, several weeks longer than it is outside of the Denver urbanized area. The average date of the latest last freeze of the winter season in Denver is May 5. The average date for the earliest first freeze of the winter season is October 7. The latest last freeze and earliest first freeze dates of record are June 8, 2007 and September 8, 1962, respectively. Table 4-2 lists the minimum and maximum monthly temperature ranges for selected National Weather Service (NWS) weather stations near Cherry Creek Dam.

b. Precipitation. The average annual precipitation at Cherry Creek Dam is about 16 in., most of which occurs as rain during the months of April through August. Thunderstorms, hailstorms, windstorms, and tornadoes are most frequent between May 15 and September 1. Table 4-3 lists the average, minimum and maximum monthly precipitation at Cherry Creek Dam, Castle Rock, CO, and Denver Airport.

c. Snow. The largest amount of snow falls in March in the Cherry Creek basin. On average, there are 41 days with snow cover per year. Table 4-4 lists monthly snowfall averages and maximums for the same gages as listed above.

Table 4-2
CHERRY CREEK RESERVOIR AREA - RECORD OF TEMPERATURES (°F)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
PERIOD OF RECORD – 1951-2003 **CHERRY CREEK DAM (051547) ELEVATION 5650 FT**												
Normals	30.5	33.3	38.6	46.6	56.3	66.2	72.3	70.2	61.8	50.9	38.5	32.4
Max Daily	76	75	83	89	97	105	108	104	100	94	81	73
Min Daily	-32	-24	-14	-7	17	30	41	36	15	-2	-14	-27
PERIOD OF RECORD – 1893-2013 **CASTLE ROCK, COLORADO (051401) ELEVATION 6200 FT**												
Normals	29.2	30.6	37.0	44.7	53.8	63.1	68.9	67.0	59.4	48.5	37.6	29.0
Max Daily	73	75	80	91	94	100	100	99	96	91	80	72
Min Daily	-37	-32	-20	-8	7	25	6	34	13	-17	-18	-29
PERIOD OF RECORD – 1948-2013 **DENVER AIRPORT (052220) ELEVATION 5290 FT**												
Normals	30.5	33.5	39.6	47.9	57.3	67.3	73.7	71.7	62.8	51.5	39.1	31.6
Max Daily	74	76	84	90	96	104	104	102	97	89	81	75
Min Daily	-25	-25	-8	-2	22	30	43	41	17	3	-8	-25
Source: NOAA Climate Summaries – Western Regional Climate Center												

Table 4-3
CHERRY CREEK RESERVOIR AREA – RECORD OF PRECIPITATION (in)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
PERIOD OF RECORD – 1951-2003 CHERRY CREEK DAM (051547) ELEVATION 5650 FT													
Ave	0.47	0.53	1.22	1.81	2.71	2.06	2.36	1.91	1.29	1.07	1.00	0.51	16.51
Min	0.00	0.05	0.17	0.00	0.00	0.00	0.32	0.09	0.00	0.05	0.19	0.00	6.79
Max	1.31	1.35	5.11	7.53	8.74	8.26	6.49	6.96	4.37	5.70	3.25	3.84	30.28
PERIOD OF RECORD – 1893-2013 CASTLE ROCK, COLORADO (051401) ELEVATION 6200 FT													
Ave	0.48	0.61	1.34	1.93	2.29	2.00	2.56	2.21	1.12	1.14	0.74	0.72	17.14
Min	0.00	0.00	0.00	0.01	0.08	0.00	0.14	0.00	0.00	0.00	0.00	0.00	11.40
Max	1.70	1.95	7.08	7.90	7.45	10.07	5.12	8.10	3.17	5.43	2.62	5.35	30.39
PERIOD OF RECORD – 1948-2013 DENVER AIRPORT (052220) ELEVATION 5290 FT													
Ave	0.50	0.57	1.21	1.76	2.40	1.67	2.03	1.70	1.13	1.01	0.80	0.58	15.37
Min	0.00	0.01	0.00	0.03	0.06	0.03	0.15	0.06	0.01	0.05	0.01	0.00	7.51
Max	1.33	1.66	4.81	5.35	7.31	4.69	6.99	5.85	4.67	4.17	2.67	2.84	23.84
Source: NOAA Climate Summaries – Western Regional Climate Center													

Table 4-4
CHERRY CREEK RESERVOIR AREA – RECORD OF SNOWFALL (in)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
PERIOD OF RECORD – 1951-2003 CHERRY CREEK DAM (051547) ELEVATION 5650 FT													
Ave	6.3	7.3	10.4	7.2	1.4	0.0	0.0	0.0	1.4	3.2	7.7	6.6	56.2
Max	18.0	34.9	30.4	27.0	14.0	0.2	0.0	0.0	21.0	44.0	28.5	44.8	103.8
PERIOD OF RECORD – 1893-2013 CASTLE ROCK, COLORADO (051401) ELEVATION 6200 FT													
Ave	5.9	8.2	11.4	10.4	1.4	0.0	0.0	0.0	0.7	5.7	7.5	9.7	60.8
Max	21.1	28.3	50.0	61.0	13.5	0.0	0.0	0.0	11.5	48.5	48.0	43.5	117.3
PERIOD OF RECORD – 1948-2013 DENVER AIRPORT (052220) ELEVATION 5290 FT													
Ave	7.3	7.2	11.9	8.1	1.6	0.0	0.0	0.0	1.4	4.1	8.5	7.8	58.0
Max	24.3	18.3	35.2	25.5	13.7	0.8	0.0	1.3	17.2	31.2	29.6	30.8	112.0
Source: NOAA Climate Summaries – Western Regional Climate Center													

d. Climate Variability. Much research has been conducted over the past several decades concerning the impacts of climate variability on different regions of the planet. One of the more frequently studied phenomena is the El Niño/Southern Oscillation (ENSO) cycle that is observed across the central and east-central equatorial Pacific. The impacts in the continental United States from the different cycles of ENSO (El Niño and La Niña) are typically more pronounced along the Pacific coast and the southern tier states. However, some impacts have been attributed to the subbasins of the Missouri River Basin. It is also important to note that impacts from the ENSO cycle are generally between the months of November and March, or from late fall into early spring.

The precipitation impacts during an El Niño episode are more pronounced within the upper South Platte River basin and would typically result in precipitation amounts that exceeded the climatological averages. This area generally divides the anomalously warmer-than-normal temperatures observed in the northern tier states during an El Niño episode from the typically cooler-than-normal temperatures observed further south, thus no strong correlation for temperatures can be made during an El Niño episode. Therefore, an El Niño episode could be seen as bringing increased chances for above-normal snowfall with snowmelt occurring near the normal time.

As opposed to El Niño, there are no strong correlations between La Niña episodes and climate anomalies across the Colorado Rockies. Warm and dry conditions have been frequently observed across the Southern Rockies during La Niña episodes as a result of the migration northward of the jet stream and primary storm track. The geographic proximity of the upper South Platte River basin would increase the potential for an expansion northward of drought conditions under such a scenario.

e. Wind. Wind speeds are generally low to moderate. Monthly average wind speeds range from 9 to 11 miles per hour (mph), and the yearly average is 10 mph. However, occasional wind gusts exceeding 50 mph do occur. Prevailing winds are generally from the south or south-southwest. During the winter, winds blowing from the north and northwest are generally colder than those blowing from the south. Chinook winds, which blow from the west and are warmed as they descend to the plains east of the Rocky Mountains, are also an important climatic factor. The arrival of a Chinook wind can cause temperatures in the Cherry Creek Reservoir vicinity to suddenly increase by several degrees.

f. Evaporation. Evaporation from Cherry Creek Reservoir is calculated using a physically-based evaporation model implemented in routine calculations in 2012. The model, which was developed by the Corps' Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory (ERDC-CRREL), estimates evaporation from the flood control reservoirs in the Omaha District. The model has two components: the first component calculates the evaporation from the water surface using a Bulk Flux Algorithm, and the second component estimates the vertical temperature profile of the reservoir based on a one-dimensional heat budget of the reservoir. The model requires no new instrumentation to be installed in the field, uses available meteorological observations from the NWS, and is compliant with the Corps Water Management System (CWMS) framework. The model input includes: hourly air temperature, hourly wind speed, hourly relative humidity, hourly barometric pressure, hourly cloud cover extent and elevation, hourly reservoir depth, reservoir location, current 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 using the estimated average pan evaporation found in Table 4-5. 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 4-5 to flow in cfs, the depth is converted to

feet (divided by 12) and then multiplied by a factor of 70% and by the Cherry Creek Reservoir area (in acres) and divided by 1.9835 to convert af to cfs.

Table 4-5
ESTIMATED AVERAGE PAN EVAPORATION

Month	Monthly Loss (in)	Daily Loss (in)
January	1.2	0.04
February	1.1	0.04
March	1.9	0.06
April	3.6	0.12
May	6.2	0.20
June	8.4	0.28
July	9.3	0.30
August	9.3	0.30
September	7.5	0.25
October	4.9	0.16
November	2.4	0.08
December	1.3	0.04
TOTAL	57.1	

4-03. Storms and Floods. The following sections describe some of the floods that have occurred in the Cherry Creek basin for which data are available. These floods were selected for description because of the magnitude of the event or because they represent a runoff characteristic or flood potential that is considered to be applicable to the Cherry Creek Project.

a. Flood of May 1864. This flood was caused by rain and hail falling over the upper portion of the Cherry Creek basin. No data are available as to the intensity, duration and extent of the storm. Cherry Creek floodwaters, coinciding with high water in the South Platte River, inundated the lower sections of Denver to depths of 1 to 5 ft.

b. Flood of July 1875. This flood resulted from a 5-day or 6-day rainstorm. No data are available as to the intensity or extent of this storm. Local newspapers reported that this flood through Denver was one half as high as that of 1864. It was considered a major flood only for the upper part of Cherry Creek basin.

c. Flood of May 1876. This flood resulted from a 24-hour rain and snow storm during which 6.53 in of precipitation, the greatest amount for the period of record (1872 to 1943), was recorded at Denver. No data are available as to the aerial extent of the

storm. The crest of the flood on Cherry Creek was within 2 or 3 ft of the 1864 flood level at Denver. Cold weather and snow materially retarded the runoff.

d. Flood of May 1878. Information is lacking relative to the areal extent, duration and intensity of the storm that led to this flood. According to newspaper accounts, this flood rose nearly as high as the flood of 1864, though the improved channel conditions somewhat reduced the overbank flow.

e. Flood of July 1885. Records are not available as to extent and duration of the storm causing the flood of July 1885. The Colorado State Engineer estimated the peak flood discharge was 20,000 cfs at Denver.

f. Flood of August 1933. A severe storm, covering approximately 130 sq mi, occurred on August 2, 1933 above the former Castlewood Reservoir. The depth of precipitation within the storm area varied from 0 to 8 in Runoff from this storm caused the failure of the Castlewood Dam and resulted in peak discharges of about 34,000 cfs at the Kenwood Dam site and 16,500 cfs at Denver.

g. Flood of August 1945. Heavy rains over a 2-hour period in the Castle Rock area resulted in the heaviest flood in the Cherry Creek basin since the 1933 flood. The rainfall occurred on less than one-sixth of the drainage area. Large areas near Englewood, Castle Rock, Parker, and Franktown were inundated. U.S. Geological Survey (USGS) computations showed peak discharges of 9,170 cfs and 10,700 cfs at the Franktown and Melvin gages, respectively.

h. Flood of June 1965. Torrential rains during the period of June 14-17 resulted in record floods in the South Platte River basin in eastern Colorado. These floods were major hydrologic events that exceeded many previous maxima by several fold. Chatfield and Bear Creek Dams were built as a result of this flood to mitigate flooding impacts in the City of Denver. Six people drowned and two more deaths were later attributed to the flood. The flood was the result of runoff from heavy intense rainfall that started in Greeley and Sterling, CO on June 14-15, continued on the evening of June 16 centered over the high plains of the Plum and Cherry Creek basins and ended on June 17 with rainfall centered over the headwaters of Kiowa and Bijou Creek basins. Near Larkspur, CO, 14 in of rain fell on June 16 and 10 to 12 in were reported at several other locations generally along a line through Monument and Parker, CO in the Plum and Cherry Creek basins. Serious flooding on the South Platte River upstream from Denver began on the afternoon of June 14, when Plum Creek washed out Interstate 25 roadway bridges and flooded portions of the town of Castle Rock. Very little runoff was experienced on the South Platte River above Plum Creek. The peak flow at Waterton, CO of 1,370 cfs was considered coincident with the Plum Creek peak runoff. The runoff from Plum Creek, produced a major disaster not only along the tributary itself, but also through the rural area along the South Platte River. The peak flow on Plum Creek was estimated at 154,000 cfs. Significant attenuation occurred as the flood moved downstream. By the time the flood reached Littleton, CO, the peak flow was reduced to 110,000 cfs, then reduced to 40,300 cfs at the South Platte River at Denver streamgage, nearly two times the previous record of 22,000 cfs. Damage was severe, totaling $500 million in the

South Platte River basin, of which $300 million occurred in the Denver area. Flooding also occurred on all Cherry Creek tributaries below Franktown, CO concurrently with the runoff on Plum Creek. The peak inflow to Cherry Creek Reservoir was estimated to be 58,000 cfs. About 13,780 af of Cherry Creek rainfall runoff was stored in Cherry Creek Reservoir. Without Cherry Creek Dam, it was estimated that Cherry Creek flows would have added directly to the Plum Creek flows through Denver and would have resulted in several times the actual damage experienced. Flooding along Sand Creek caused considerable bridge damage through Denver. A peak flow of 13,400 cfs was estimated below the confluence of Toll Gate and Sand Creeks. A peak flow of 274,000 cfs on East Bijou Creek at Deer Trail, CO was estimated to have occurred on June 17, resulting in a flow on Bijou Creek near Wiggins, CO of 466,000 cfs on June 18. The resulting South Platte River flows attenuated rapidly with travel downstream. Flows at the Nebraska/Colorado state line approximated those of the 1935 flood and were reduced by channel storage to reach only about two-thirds the value of the 1935 flood at North Platte, NE. Table 4-6 summarizes information showing the magnitude of this flood.

Table 4-6
JUNE 1965 FLOOD – SOUTH PLATTE RIVER PEAK FLOWS

Stream	Location	Drainage Area (sq mi)	Peak Flows (cfs)
Plum Creek	Louviers, CO	302	154,000 - Jun 16
South Platte River	Waterton, CO	2,621	1,370 - Jun 18
	Littleton, CO	3,069	110,000 - Jun 16
	Denver, CO	3,804	40,300 - Jun 17
	Kersey, CO	9,598	23,500 - Jun 18
	Weldona, CO	13,245	18,800 - Jun 19
	Balzac, CO	16,852	123,000 - Jun 18
	Julesburg, CO	23,138	37,600 - Jun 20
Cherry Creek	Cherry Creek Res	385	58,000 (est) - Jun 16
Bijou Creek	Wiggins, CO	1,314	466,000 - Jun 18

i. Flood of May-June 1973. On May 6, a peak inflow of 10,100 cfs was experienced at Cherry Creek Reservoir. During this time, there was also major flooding in Denver; a peak flow of 15,000 cfs was experienced. The Cherry Creek Dam releases were shut off to mitigate downstream flooding. As a result of continued rainfall and no evacuation release, the reservoir rose reaching its record maximum pool elevation of 5565.8 ft on June 3, occupying 21% of the flood control zone. Releases were initiated on June 5, gradually reaching a peak release of 375 cfs on June 8. The flood storage was evacuated on July 10. Cherry Creek Dam was credited with preventing flood damages that would have resulted in an estimated $27,000,000 of damage.

Downstream flooding on Cherry Creek was prevented and reduced on the South Platte River.

j. Flood of May-July 1983. For the first time since 1975, flood control releases were initiated from Cherry Creek Dam. Heavy rain brought the reservoir above an elevation of 5555.0 ft three times. On July 24, the reservoir experienced an estimated instantaneous inflow of 10,500 cfs, which produced a maximum daily average pool elevation of 5557.8 ft the following day. Cherry Creek Dam was credited with preventing flood damages that would have resulted in an estimated $6,256,000 of damage.

k. Flood of September 2013. The flood of September 2013 was much more severe downstream of the Tri-Lakes Projects and the relatively small releases from the dams had little to no effect on the downstream flooding. Eight people lost their lives as a direct result of rainfall runoff that occurred in uncontrolled drainage areas located downstream of the Tri-Lakes Projects. Many of the deaths occurred during the height of the flash floods on the evenings of September 11 and 12. Nearly 18,000 people were evacuated by the local emergency management agencies. The flooding damaged approximately 19,000 homes and commercial buildings and about 485 miles of roads including 50 bridges. Monsoonal flow conditions resulted in daily rainfall tracking along the Rocky Mountain Front Range. The topography of the region and the location of a surface front promoted some of the heaviest rainfall in the foothills west and north of Denver, CO and in Aurora, CO, a suburb east of Denver, CO. Radar-estimated rainfall amounts during the entire storm showed the maximum amount in the 15- to 20-in range from Estes Park, CO to Boulder, CO with widespread areas of over 10 in Aurora, CO had radar-estimated rainfall amounts in the 10- to 15-in range during the entire storm. The annual exceedance probabilities for the heavier 48-hour rainfall period exceeded a 500-year event and in some areas even exceeded a 1000-year event. Flooding was widespread and occurred along the main stem South Platte River and tributaries from Denver, CO to Kearney, NE. The South Platte River at Denver, CO streamgage had a peak discharge of only 3,930 cfs while at Henderson, CO it was 11,200 cfs. The South Platte River at Kersey, CO streamgage did not report during the peak flow, no measurement was taken and no estimated flow was calculated. A flow measurement of 24,900 cfs was taken following the peak at the South Platte River at Weldona, CO streamgage on September 17. The peak flow was not estimated, but was likely much higher than the measurement. A flow measurement of 38,900 cfs was taken at the South Platte River at Fort Morgan, CO streamgage on September 15, with a peak flow estimate of 60,000 cfs also on September 15. By the time the flood arrived at the South Platte River at Julesburg, CO streamgage, the peak flow had dropped to 21,820 cfs on September 18 indicating an appreciable attenuation. At the South Platte River at Roscoe, NE streamgage the peak flow estimate was 19,100 cfs on September 21. By the time the flood water arrived at the Platte River at Kearney, NE streamgage the peak flow estimate was 12,500 cfs on September 28. Bear Creek Dam releases were reduced from about 250 cfs to zero (0) cfs from September 13-15 to lessen downstream flooding. The Bear Creek Reservoir peak daily inflow was 1,170 cfs on September 16 and the maximum daily release was 500 cfs on September 27. Bear Creek Reservoir reached its record maximum pool elevation on September 21 of 5607.8 ft PD, which occupied just over 40% of its flood control zone. The Cherry Creek and Chatfield

Reservoir multipurpose zones, which were drawn down due to water rights before the event, were refilled with rainfall runoff. No flood control operations were necessary at Chatfield Dam. Only minor flood control operations were made at Cherry Creek Dam with an evacuation release of 100 cfs following the downstream flooding. In addition, the emergency spillway was operated at Kelly Road Dam, with an estimated peak outflow of 900 cfs.

I. Flood of May-June 2015. Heavy mountain snowfall and cooler-than-average temperatures were experienced in the South Platte River basin from April through June. A near-record snowpack was generated in many of the mountain areas, including those in the drainage basins above Chatfield and Bear Creek Dams, and also downstream along the South Platte River tributaries that enter north (downstream) of Denver. The Chatfield Reservoir record peak daily inflow was 3,896 cfs on June 12, surpassing the record set in 1995. The Chatfield Reservoir record maximum pool elevation was 5448.5 ft PD on June 19, surpassing the previous record set in 1980. During May and June, localized heavy thunderstorms resulted in some flooding along the lower portions of several tributaries and added to the high flows in the South Platte River. Coordinated operations of Chatfield, Bear Creek, and Cherry Creek Dams were challenging due to rapid rises in river flow downstream of the dams along the tributaries and the South Platte River. The releases at Chatfield Dam were decreased several times during the flood event to target 5,000 cfs at the South Platte River at Denver streamgage and to provide relief to the water supply infrastructure downstream from Denver.

4-04. Runoff Characteristics. The mountainous character of the upper half of the Cherry Creek basin and the steep slopes of the main stem and tributary channels, cause rapid runoff from the basin. Plates 4-4 and 4-5 show the stream profiles of several creeks that feed into Cherry Creek Reservoir. Major floods are usually caused by short periods of intense rainfall occurring over a small portion of the basin, or a series of intense storm centers scattered over the basin. The majority of the floods on Cherry Creek have occurred during the season of May to September. The records of the extent, intensities, and durations of the storms causing the past floods are incomplete and flood hydrographs are not available for the major Cherry Creek floods. Plates 4-6 through 4-9 show the historic hydrograph of flows at the Franktown gage. Plate 4-10 shows the historic hydrograph of flows at the Parker gage. Plates 4-11a and 4-11b show the inflow and discharge frequency curves for Cherry Creek Dam, respectively. The curves are derived from the daily annual maximums for the 1958-2016 water years. The inflow frequency curve was best fit with a weighted skew using Bulletin 17C analysis. The discharge frequency curve was best fit with a station skew due to release decision impacts, which made the regional skew less applicable. Unit hydrographs for several key locations in the Cherry Creek Dam vicinity are shown in Section 6-02.b.(2).

About 60% of the annual runoff into Cherry Creek Reservoir occurs during the March through June period. Plate 4-12 shows a graph of historical monthly inflows to Cherry Creek Reservoir and Plate 4-13 presents the data in tabular form. See Plate 4-14 for a graph of the historical annual inflow volume for the period of record.

Table 4-7 lists the results of several runoff studies.

Table 4-7
SOUTH PLATTE RIVER BASIN INFILTRATION STUDIES

Source	Study	Location	Loss Rate (in/hour)
Corps of Engineers	Storm	Cherry Creek	0.8
Corps of Engineers	Storm	S Platte - Right Bank	1.0
Corps of Engineers	Storm	S Platte - Left Bank	1.2
Corps of Engineers	1965 Storm	Cherry Creek	0.86
Exp Station	Infiltrometer	Cherry Creek – Minimum	0.70
Exp Station	Infiltrometer	Cherry Creek – Average	1.07
Forest Service	Infiltrometer	Mountains – Pine Forest	2.37
Forest Service	Infiltrometer	Mountains – Pines – Grass	1.94
Forest Service	Infiltrometer	Mountains – Grass	1.50

4-05. Water Quality. The State of Colorado's water quality standards designate the following beneficial uses to Cherry Creek Reservoir: primary contact recreation (Class E), Class 1 warm-water aquatic life use, domestic water supply, and agriculture. Cherry Creek Reservoir is listed on the 2018 State of Colorado 303(d) list of impaired waters due exceedances of the chlorophyll *a* and dissolved oxygen water quality standards. Due to these exceedances, the State of Colorado has determined the reservoir does not meet its applicable use of supporting warm-water aquatic life. The total maximum daily load development for Cherry Creek Reservoir has been given a high priority by the Colorado Department of Public Health and Environment.

Cherry Creek Reservoir is impacted by point and nonpoint source pollution. Located in the southwest portion of the Denver metropolitan area, the Cherry Creek basin is highly urbanized and located in some of the fastest growing portions of Arapahoe, Douglas, and El Paso counties. The upper basin contains rural and agricultural areas, and about 600 miles of riparian vegetated corridors occur through the basin.

The Cherry Creek Reservoir Watershed Plan established the following reservoir and watershed water quality management goals:

- Understand the watershed and reservoir;
- Preserve beneficial uses;
- Build projects and implement programs;
- Prevent and minimize negative water quality impacts;
- Invest resources wisely; and
- Achieve numeric water quality standards.

Cherry Creek Control Regulation No. 72 sets water quality nutrient standards to meet the beneficial uses of the reservoir. An in-reservoir chlorophyll *a* standard of 18 µg/L (July through September seasonal means) was set with the goal of maintaining an average total phosphorous goal of 35 µg/L.

4-06. Channel and Floodway Characteristics. Plates 4-15 through 4-19 show open water rating curves for selected stations most frequently used in the regulation of Cherry Creek Reservoir. Only the current rating curves are on file with the WCWQS for use in making regulation decisions. The stage-discharge relationships, as defined by these curves, may shift over time and are updated with stage-discharge measurements made by the USGS and CDWR. The relationships illustrated on Plates 4-15 through 4-19, should only be used for approximation. More accurate relationships for current stream conditions are available online through the USGS and CDWR. Larger shifts from these open water relationships will occur when ice forms on the streams, or following heavy rainfall-runoff events. With ice conditions, stages for a particular discharge may be several feet higher than indicated by the open water curves. Following heavy rainfall-runoff events, stages for a particular discharge may be lower than indicated by the open water curves.

a. Cherry Creek. As noted in Section 3-06, the channel capacity of Cherry Creek from Cherry Creek Dam to the South Platte River confluence is at least 5,000 cfs and has been verified with recent modeling efforts.

Table 4-8 and Plate 4-20 list the approximate release travel times below Cherry Creek Dam. Plate 4-21 lists travel times during high flows such as occurred in 1995. As noted in Plate 4-21, travel times for high flows can be 2 to 3 times faster than travel times for normal flow.

Table 4-8
CHERRY CREEK DAM RELEASE TRAVEL TIMES

Location	Travel Time
Cherry Creek Dam to South Platte River at Denver Streamgage	6 hours
Cherry Creek Dam to Henderson, CO	11 hours
Cherry Creek Dam to Kersey, CO	2-3 days
Cherry Creek Dam to Julesburg, CO	4-7 days
Cherry Creek Dam to Mouth of S Platte River at North Platte, NE	6-9 days
Cherry Creek Dam to Mouth of Platte River near Louisville, NE	13-18 days

b. South Platte River. The improved South Platte River channel through Denver has estimated capacities ranging from 10,000 cfs to 30,000 cfs. As in other reaches in the Denver area, much of the flood plain is lower than the channel bank. Flows in excess of channel capacity quickly flood the natural flood plain. A large number of bridges are located in this reach; several have limited capacity. Many of these bridges were lost in the 1965 flood when the flow was obstructed by debris. Backwater flooding in the vicinity of the bridges was also evident as a result of debris accumulation.

c. Toll Gate and Sand Creeks. Emergency spillway releases from Cherry Creek Dam are diverted into Toll Gate Creek through the spillway channel to reduce flood risk to Denver. The spillway directs flow down Toll Gate Creek to Sand Creek, which then

confluences with the South Platte River below Denver. At the time of the planning and construction of Cherry Creek Dam these streams flowed through principally agricultural areas and a small industrial area near the mouth of Sand Creek. After the construction of the dam, a major increase in residential housing occurred along these streams with serious encroachment of the channel in some areas. The channels are also partially obstructed by bridges, culverts, and an irrigation siphon. These two streams have a wide range of capacity. Lowland flooding begins with flows exceeding 1,400 cfs. Significant damage occurs when flows exceed 4,000 cfs.

4-07. Upstream Structures. Before 2012, the only major potential structure upstream of Cherry Creek Reservoir was the Castlewood Dam, located approximately 20 miles upstream of Cherry Creek. It was not rebuilt subsequent to its failure from the flooding in 1933. One alternative discussed in the Hydrologic Improvement Assessment Report for Cherry Creek Dam to permit safe passage of the PMF included rebuilding the dam at the old Castlewood Reservoir site. The Sand Creek study completed in the early 1970s proposed a dam at this location, but considerable opposition from environmental interests has precluded any further studies or proposals.

Rueter-Hess Reservoir, owned and operated by Parker Water and Sanitation District in Parker, CO, was completed is 2012 for the purpose of water supply storage. See Section 3-04 for more information regarding Rueter-Hess Reservoir.

DWB owns and operates Antero, Eleven Mile Canyon, Strontia Springs, and Cheesman Reservoirs on the Upper South Platte River upstream of Chatfield Dam to supply its domestic and industrial water needs. The City of Aurora owns and operates Spinney Mountain Reservoir. With the rapid urban expansion of Denver, Aurora, and other cities in the Denver area has come an increasing demand for additional water for domestic purposes. The City of Denver has obtained rights to waters from the Western Slope and operates trans-mountain diversion facilities to make additional water available for their growing needs.

4-08. Downstream Structures. A large number of pedestrian crossings, road bridges, railway bridges, and other structures have been constructed along Cherry Creek downstream of Cherry Creek Dam. Sixteen pedestrian bridges cross Cherry Creek. Seven of these bridges are limited to Denver Country Club Golf Course patrons; one bridge is used for a school crossing; the remaining eight pedestrian bridges allow people to traverse Cherry Creek and use bicycle/pedestrian paths that are located throughout the Cherry Creek area.

Six railroad bridges cross Cherry Creek within ½ mile of the confluence with the South Platte River. These railways are part of the Colorado & Southern Railroad Shops and Yard system.

Thirty-two road bridges cross Cherry Creek between its confluence with the South Platte River and Cherry Creek Dam. All are within the Denver metro area and support significantly large numbers of daily vehicular traffic. These bridges range in size and magnitude from interstate to predominantly residential roads. The major bridge locations are Interstate 225, Monaco Parkway, University Boulevard, West 6th Avenue, Colfax

Avenue, and Speer Boulevard. Other structures located on Cherry Creek include nine drop structures at various locations and a concrete channel near Downing Street.

Numerous bridges and structures are located on Toll Gate and Sand Creeks downstream of the Cherry Creek Dam Spillway.

4-09. Economic Data.

a. Population Below Cherry Creek Dam, Cherry Creek flows through the cities of Aurora and Denver, CO. Flood damages and flood damage potentials did not reach significant levels until World War II when Denver entered an era of extensive growth. From 1940 to 1950 Denver's metropolitan population increased by 155,000 and new suburban and commercial developments spilled out into the flood plains of the South Platte River and its tributaries. Table 4-9 lists the population changes from 1950-2010 for counties in the Cherry Creek basin as well as the county total, Denver Primary Metropolitan Statistical Area (PMSA), and the State of Colorado for comparison. The Arapahoe County population increased ten-fold from what it was in 1950. The Douglas County population has increased more than 80-fold since 1950.

Table 4-9
POPULATION 1950 THROUGH 2010 CENSUS

Geographical Area	Census 1950	Census 1960	Census 1970	Census 1980	Census 1990	Census 2000	Census 2010
Arapahoe County	52,125	113,426	162,142	293,621	391,511	487,967	572,003
Denver County	415,786	493,887	514,678	490,014	467,610	554,636	600,158
Douglas County	3,507	4,816	8,407	25,153	60,391	175,766	285,465
County Total	571,963	864,262	1,109,548	1,439,852	1,642,622	2,144,360	2,473,328
Denver PMSA*	567,339	859,945	1,106,384	1,428,839	1,622,980	2,179,240	2,543,482
State of Colorado	1,325,089	1,753,947	2,207,259	2,889,964	3,294,394	4,301,261	5,029,196

Notes:
Source of Census Data: U.S. Department of Commerce, Bureau of the Census.
* The current Denver-Aurora-Lakewood Primary Metropolitan Statistical Area (PMSA) includes Adams, Arapahoe, Bloomfield, Clear Creek, Denver, Douglas, Elbert, Gilpin, Park and Jefferson counties. The Denver PMSA has expanded since 1950.

b. Agriculture. According to the Colorado Department of Agriculture, as of 2012 agriculture in the State of Colorado annually contributes $41 billion to the state's economy and employs nearly 173,000 people. Agriculture is very minor in the upper South Platte River basin due to the mountainous and arid nature of the countryside. The primary crops are hay and wheat; cattle are also maintained. Downstream of the City of Denver, there is an extensive irrigation network. Many areas rely on irrigation during the hot and dry summers. A variety of crops are grown including hay, wheat, barley, corn, vegetables, and sugar beets. Cattle, hogs, and sheep are maintained on many of the farms.

c. Industry. Table 4-10 lists 2013 earnings for Colorado workers in major industrial classifications. According to the City and County of Denver, government

website communications, utilities, and transportation are the chief industries. There is also an economic base in skiing, tourism, electronics, computers, and aviation. The Denver Federal Center is the most densely packed Federal area outside of Washington, DC. The center contains 26 Federal agencies.

Table 4-10
2013 EARNINGS BY WORKERS IN MAJOR INDUSTRIAL CLASSIFICATIONS
(IN THOUSANDS OF DOLLARS)

Earning Description	County Description					
	Arapahoe	Denver	Douglas	County Total	State of Colorado	County Total % of State
Accommodation and food services	613,144	1,391,747	252,108	2,256,999	6,445,904	35.0%
Administrative and waste management services	1,451,958	1,625,222	319,495	3,396,675	7,118,706	47.7%
Arts, entertainment, and recreation	379,992	624,511	89,993	1,094,496	2,371,135	46.2%
Construction	1,787,873	1,534,883	479,322	3,802,078	11,428,681	33.3%
Educational services	265,808	811,348	119,942	1,197,098	2,096,854	57.1%
Finance and insurance	3,221,484	4,075,780	775,745	8,073,009	12,115,913	66.6%
Forestry, fishing, and related activities	7,102	2,314	5,585	15,001	327,330	4.6%
Government and government enterprises	2,467,904	5,302,669	692,885	8,463,458	30,258,975	28.0%
Health care and social assistance	2,657,034	2,882,005	633,642	6,172,681	16,161,719	38.2%
Information	3,636,379	2,274,178	729,270	6,639,827	10,136,161	65.5%
Management of companies and enterprises	1,146,404	1,726,718	540,978	3,414,100	4,882,804	69.9%
Manufacturing	636,556	1,493,505	163,422	2,293,483	11,219,126	20.4%
Mining	821,830	4,228,672	147,877	5,198,379	7,939,962	65.5%
Other services, except public administration	950,036	1,247,540	306,958	2,504,534	6,811,006	36.8%
Professional, scientific, and technical services	3,862,891	5,919,239	1,380,279	11,162,409	22,714,903	49.1%
Real estate and rental and leasing	463,425	848,256	98,268	1,409,949	2,932,155	48.1%
Retail trade	1,600,194	1,247,820	576,040	3,424,054	10,207,543	33.5%
Transportation and warehousing	324,205	2,581,334	57,843	2,963,382	5,781,097	51.3%
Utilities	31,409	404,992	22,532	458,933	1,222,647	37.5%
Wholesale trade	1,589,371	2,461,913	463,362	4,514,646	9,241,101	48.9%
Data Source: Bureau of Economic Analysis www.bea.gov						

d. Flood Damages. Plates 4-22 through 4-29e present curves for estimating the approximate magnitude of flood damages by impact area on the South Platte River and major tributaries downstream of Chatfield, Cherry Creek, and Bear Creek Dams; and upstream of Henderson, CO with select flood inundation mapping in the same impact areas. Table 4-11 lists estimated flood damages, in 2014 dollars, for the same impact areas at flow rates of 2,000 cfs up to 20,000 cfs. Table 4-12 lists the flood damages

prevented by each of the Tri-Lakes Projects since 1965. Construction of Cherry Creek was completed in 1951, however no damages prevented were noted until 1965.

Table 4-11
POTENTIAL FLOOD DAMAGES UPPER SOUTH PLATTE RIVER BASIN
Adjusted to 2014 ($1,000)

Impact Area		2,000 cfs	4,000 cfs	6,000 cfs	8,000 cfs	10,000 cfs	15,000 cfs	20,000 cfs
1	Bear Creek	347	974	4750	—	—	—	—
2	S. Platte to Bear Creek conf.	0	0	0	0	59	—	—
3	S. Platte to Cherry Creek conf.	0	0	3272	6810	18,997	68,102	—
4	Cherry Creek	0	1981	64,588	158,826	278,064	693,978	—
5	S. Platte to Sand Creek Conf.	0	4	14	17	19	22	32,705
6	S. Platte from Sand to Clear Creek	No damages estimated up to 30,000 cfs						
7	Clear Creek to Henderson, CO	—	58	102	138	184	371	619
8	Sand Creek	145	231	372	567	762	—	—
Damages represent the total estimated damage for the impact area and are displayed in $1,000s.								

Table 4-12
FLOOD DAMAGES PREVENTED BY TRI-LAKES PROJECTS

Year	Unadjusted ($1,000)				Adjusted to 2014 $ ($1,000)			
	Bear Creek	Chatfield	Cherry Creek	Tri-Lakes Total	Bear Creek	Chatfield	Cherry Creek	Tri-Lakes Total
1965*			130,000	130,000			1,148,872	1,148,872
1966			0	0			0	0
1967			0	0			0	0
1968			0	0			0	0
1969			0	0			0	0
1970			0	0			0	0
1971			0	0			0	0
1972			0	0			0	0
1973			27,000	27,000			131,467	131,467
1974			0	0			0	0
1975			0	0			0	0
1976		0	0	0		0	0	0
1977		0	0	0		0	0	0
1978		0	0	0		0	0	0
1979	0	0	0	0	0	0	0	0
1980	240	800	0	1,040	685	2,284	0	2,969
1981	0	0	0	0	0	0	0	0
1982	0	0	0	0	0	0	0	0
1983	210	1,080	6,256	7,546	488	2,510	14,541	17,539
1984	0	0	0	0	0	0	0	0
1985	0	65	11	76	0	148	25	173
1986	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0
1992	958	2,820	82	3,860	1,858	5,470	160	7,488
1993	0	0	0	0	0	0	0	0
1994	0	0	0	0	0	0	0	0
1995	729	788	93	1,610	1,295	1,398	165	2,858
1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	0	0	0
1998	0	0	0	0	0	0	0	0
1999	0		0	0	0	0	0	0
2000	0	0	0	0	0	0	0	0
2001	0	0	1,342	1,342	0	0	2,063	2,063
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
2004	0	0	0	0	0	0	0	0
2005	0	0	0	0	0	0	0	0
2006	0	0	0	0	0	0	0	0
2007	0	0	0	0	0	0	0	0
2008	0	0	0	0	0	0	0	0
2009	0	0	0	0	0	0	0	0
2010	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0
2013	84	0	5,160	5,244	88	0	5,410	5,498
2014	0	0	0	0	0	0	0	0
2015	1,199	96	2,876	4,171	1,199	96	2,876	4,171
TOTAL	**3,420**	**5,649**	**172,820**	**181,889**	**5,613**	**11,906**	**1,305,579**	**1,323,,098**

* Cherry Creek was completed in 1951. No damages were prevented until the flood of 1965, thus the table begins with year 1965.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 5

DATA COLLECTION AND COMMUNICATION NETWORKS

5-01. Hydro-Meteorological Stations. Multiple agencies maintain an extensive system of reservoir, stream, and precipitation gages within the State of Colorado that are continually being updated and improved. These agencies include the: USGS, NWS, USBR, Natural Resources Conservation Service (NRCS), CDWR, Corps, and Mile High Flood District (MHFD) previously known as Urban Drainage and Flood Control District (UDFCD). Section 4-06 identifies the most relevant streamgage rating curves, which are also shown on Plates 4-15 through 4-19.

a. Facilities.

(1) Streamgages. The USGS, USBR, and CDWR publish discharge records at 313 streamgage locations in the South Platte River basin in Colorado. Some of the streamgage maintenance costs, for which their data is published by the USGS and CDWR, are funded by local agencies such as the DWB, the City of Aurora, and other private interests. Many of these streamgages are not extensively used for the regulation of Cherry Creek Reservoir because they are located outside of the Cherry Creek Reservoir drainage basin and the Denver, CO metropolitan area. About 22 of these streamgages are considered when regulating Cherry Creek Reservoir. Field operations at the sites are primarily performed by the USGS, USBR, and State of Colorado. Other streamgages are operated by various agencies and private interests. The number of streamgages varies from year to year. See Plate 5-1 for a listing and location of the principal streamgages. Table 5-1 lists the streamgaging stations most useful to the regulation of Cherry Creek Reservoir.

(2) Precipitation Gages. The NWS publishes precipitation records for 33 stations in the South Platte River basin. The MHFD publishes precipitation records for 149 stations in the South Platte River basin. Plate 5-2 shows the location of the NWS and MHFD precipitation gages located in the Cherry Creek Reservoir drainage basin that are of specific interest to the regulation of Cherry Creek Reservoir. The primary source of rainfall information is the NWS.

Table 5-1
STREAM AND RESERVOIR GAGING STATIONS
(Useful to Cherry Creek Reservoir Regulation)

Stream	Station	Drainage Area (sq mi)	Operating Agency
South Platte River	South Platte	2,579	State
South Platte River	Waterton	2,621	State
Plum Creek	Louviers	316	USGS
South Platte River	Chatfield Reservoir	3,018	Corps
South Platte River	Below Chatfield Dam	3,018	State
South Platte River	Below Union Ave.	3,098	USGS
Bear Creek	Morrison	164	State

Table 5-1
STREAM AND RESERVOIR GAGING STATIONS
(Useful to Cherry Creek Reservoir Regulation)

Stream	Station	Drainage Area (sq mi)	Operating Agency
Bear Creek	Bear Creek Reservoir	236	Corps
Bear Creek	Below Bear Creek Dam	236	State
Bear Creek	Sheridan	260	State
South Platte River	Englewood	3,391	USGS
Cherry Creek	Franktown	169	USGS
Cherry Creek	Parker	287	USGS
Cherry Creek	Cherry Creek Reservoir	386	Corps
Cherry Creek	Denver	410	USGS
South Platte River	Denver	3,804	State
South Platte River	Commerce	3,895	USGS
Clear Creek	Golden	399	State
Clear Creek	Derby	575	State
South Platte River	Henderson	4,713	State

(3) SNOTEL and Snow Courses. The NRCS and the State of Colorado, in cooperation with other agencies, operate a number of snow survey stations in the mountainous areas of the South Platte River basin. No Snow Telemetry (SNOTEL) stations are in the Cherry Creek basin.

(4) Reservoir Data. There is a stilling well located inside the Cherry Creek Dam intake structure that is used to monitor the reservoir pool elevation. Since the mid-1980s, a Data Collection Platform (DCP) has been used at the dam to automatically collect and transmit the pool elevation and precipitation data via satellite. A staff gage that is attached to the intake structure is used to verify the pool elevation. The current Cherry Creek Reservoir elevation can also be obtained from any telephone location by calling the DCP at (303) 755-4325.

(5) Denver Weather Station. The Cherry Creek Project evaporation model, as described in Section 4-02.f., relies on data from the METeorological Aerodrome Report (METAR) from the Denver Weather Station. The data used by the evaporation model from the weather station are:

- Cloud cover (high, medium and low)
- Cloud elevation (high, medium and low)
- Relative Humidity
- Air Pressure
- Wind Speed
- Air Temperature

(6) Other Basic Hydro-Meteorological Data. River, rain, and snow stations are the principal sources of reservoir regulation hydro-meteorological information. Other items of use are also available from other "value-added" type weather information services. These include radar, satellite, and weather chart information.

(7) Gridded Data. The NWS provides real-time observed and forecast-gridded precipitation, Snow Water Equivalent (SWE), and air temperature for use in real-time modeling. The gridded data is geographically distributed over the South Platte River basin with respect to time and can be used for more accurate model simulations and reservoir forecasting.

b. Reporting. The automated DCPs located throughout the basin transmit river stage, reservoir elevation, and precipitation data via a Geostationary Operational Environmental Satellite (GOES) to the Omaha District's downlink and to the downlink at the NOAA National Environmental Satellite, Data, and Information Service (NESDIS). The WCWQS computer server located in Omaha, NE receives this data via the downlink and stores it in a water control database, which provides accurate up-to-date information as needed during critical periods of regulation. Plate 5-3 illustrates the data system collection. The data system allows for monitoring of the pool elevations at Chatfield, Cherry Creek, and Bear Creek Reservoirs, and the river stage, precipitation, and evaporation parameters such as wind speed and air temperature throughout the basin. The current pool elevations at Chatfield, Cherry Creek, and Bear Creek Reservoirs can also be retrieved via telephone directly connected to the DCPs. The current Cherry Creek Reservoir pool elevation can be retrieved by calling 303-755-4325. If communication between the WCWQS and Tri-Lakes Project Office is lost, the Emergency Operation procedures, as listed in Exhibit I, *Standing Instructions to the Dam Tender*, will be followed. Exhibit I includes a detailed listing of routine and flood observations to be made by the Dam Tender, the frequency of observations, and the manner in which they will be reported.

The automated DCPs are programmed to transmit 15-minute readings once every hour. The 15-minute data is automatically converted to hourly and daily data via the Corps Computation Processor (CCP) within CWMS. This data is used to determine the daily change in storage. Hourly and daily inflows are then automatically computed by CCP on the basis of storage changes and releases. The WCWQS uses this data to prepare a Monthly Reservoir Report for Cherry Creek Reservoir, which contains the official daily elevation, inflow, and outflow; Plate 5-4 provides an example of the report. The daily inflow calculation includes modeled evaporation. See Section 4-02.f for further information on the evaporation model.

When significant precipitation events occur, the data stored in CWMS such as real-time river conditions, pool elevations, estimated rainfall, and snow water equivalent data is used by the WCWQS for water management model simulations and decision making.

c. Maintenance. The USGS, NWS, USBR, NRCS, MHFD, State of Colorado, and Corps contribute personnel, equipment, and/or funds to support the data collection and communications system.

The gaging stations at Chatfield, Cherry Creek, and Bear Creek Reservoirs are maintained by the WCWQS with support from the USGS. A cooperative streamgaging program is maintained by the USGS, the State of Colorado and the Corps. Open water rating curves, which are prepared by the State of Colorado and the USGS and are furnished to the Corps. Plates 4-15 through 4-19 show rating curves of the South Platte River and Cherry Creek. These curves should only be used as an approximation. The stage-discharge relationship, as defined by the rating curves, are shifted as the river channel changes. The ratings are kept current via field measurements by the State of Colorado and the USGS. The current ratings are on file with the WCWQS for use in making regulation decisions.

5-02. Water Quality Stations. The CCBWQA conducts extensive water quality monitoring of Cherry Creek, its tributaries, the alluvium, and the reservoir since 1985. To avoid possible duplication of effort, the Omaha District discontinued water quality monitoring at Cherry Creek Reservoir in 2002. District water quality information requirements are sufficiently met through the monitoring efforts of the CCBWQA. Persons interested in water quality conditions at Cherry Creek Reservoir can visit the website maintained by the CCBWQA at http://www.cherrycreekbasin.org. The CCBWQA is responsible for fully funding the monitoring program and shares data with the Corps as requested.

5-03. Sediment Stations. No sediment sampling is done by the Corps at this project. As shown on Plate 4-5, 10 sediment ranges are located on Cherry Creek Reservoir. The range lines are resurveyed periodically to update the reservoir surface area and volume capacity. The results can be compared to original projections of sediment depletion that determine the remaining life of the project. Surveys for Cherry Creek Reservoir were complete in 1965, 1974, 1988, 1997, and 2007. New surface area and volume capacity tables based on a 2016 survey are scheduled to be made effective in 2020.

5-04. Recording Hydrologic Data. CWMS is the Omaha District's primary data management system. CWMS was developed by the Corps' Hydrologic Engineering Center (HEC) and uses an Oracle database to store river, reservoir, and weather data.

5-05. Communication Network. The Corps maintains contact, anywhere from weekly to daily, with the Colorado State Engineer's Office for water rights releases from Cherry Creek Dam. Periodic contact, mostly during flooding situations, is also maintained with the State of Colorado, NWS, USGS, USBR, and local agencies such as cities, counties, and state parks. The WCWQS has the following communication facilities:

a. Telephone. The primary means of direct contact with personnel at the Tri-Lakes Project Office located at Chatfield Dam is a commercial telephone or cellular phone. A phone list of relevant personnel is presented on page vi of this manual.

b. Email. Routine contact between the Omaha District and Tri-Lakes Project Office is made via email.

c. Hydrologic Data. Telephone and email contact with the Tri-Lakes Project Office and other local agencies can provide on-site information that give a general assessment of the basin and hydrologic conditions. There is no remote gate control operation at Cherry Creek Dam and no emergency warning systems have been installed. However, the Corps and local emergency management officials meet regularly to discuss the Corps' Emergency Action Plan (EAP) and the local emergency management evacuation plans.

5-06. Communication with Project. The Colorado State Engineer's Office maintains a staff of hydraulic engineers to administer the waters of the state. Regulation of Cherry Creek Reservoir requires coordination between the state and the Corps to ensure that, insofar as practical, Cherry Creek Reservoir regulation is compatible with state water administration. Project operating data, streamflow measurements, precipitation, and evaporation information are exchanged and coordinated among all parties.

Attachment 2 of Exhibit I, *Standing Instructions to the Dam Tender*, shows a directory of regulation personnel in the Omaha District, Tri-Lakes Project Office and Colorado State Engineer's Office.

5-07. Regulating Office with Project Office and Others. ER 1110-2-1400, *Reservoir/Water Control Management*, dated May 30, 2016, assigns the Corps' reservoir regulation responsibilities in the Missouri River basin to the Northwestern Division (NWD) Commander. ER 1110-2-1400 also permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area of responsibility the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Cherry Creek Reservoir according to plans agreed to in advance have been delegated to the Omaha District Engineer. The NWD Commander, through the Missouri River Basin Water Management (MRBWM) office, monitors and reviews the regulation activities performed by the Omaha District. The responsibility for the regulation and all associated activities within the District Office is assigned to the WCWQS. Plate 5-5 illustrates the normal coordination for the Omaha District with regard to regulation of the Cherry Creek Project.

All gate changes made at Cherry Creek Dam are recorded by the Tri-Lakes Project Office in a *Dam Tender's Reservoir Regulation Report* (see Plate 5-6). The issuance of regulation orders is the function of the WCWQS; however requests for regulation of project releases may also originate from the Colorado State Engineer's Office as a result of water rights administration primarily in the multipurpose zone. All requests will be referred to the WCWQS for approval and issuance of regulation orders when in the flood control zone. Requests for regulation of releases originating with the State Engineer's Office are made by telephone or email for concurrence and issuance of the formal regulation orders. Verbal or email issued regulation orders will be confirmed via a signed memorandum as soon as possible during the next work day. In the event the State Engineer's Office cannot make contact with the WCWQS, requests can be made directly to the Dam Tender, who will confirm the order with the WCWQS as soon as practical.

It is not anticipated that any emergency regulation other than that provided in Section 7-05 will be required. However, under the provisions of Condition C of Exhibit, *Standing Instructions to the Dam Tender*, communication failure during a flood event may occur and isolate the Dam Tender, thus making that individual the sole project operating organization for the project. The *Standing Instructions to the Dam Tender* provide detailed instructions for regulation of project releases and storage under such emergency conditions.

Daily project operating data and miscellaneous hydrologic information are exchanged between the Colorado State Engineer's Office, the Colorado Division of Wildlife (CDW), and the Corps. The Tri-Lakes Project Office and WCWQS shall be kept apprised by the State Engineer's Office regarding the needs for regulation of releases and water storage in the multipurpose zone.

5-08. Communication Between Project Office and Others. The Colorado State Engineer's Office normally maintains a staff of hydraulic engineers to administer the waters of the state. Regulation of Cherry Creek Reservoir during low flow periods and when the elevation falls below the top of the multipurpose zone (elevation 5550.0 ft PD) requires coordination between the State of Colorado and the Corps to ensure that, as soon as practical, Cherry Creek regulation is compatible with state water administration. Project operating data, streamflow measurements, and precipitation and evaporation information are exchanged and coordinated among all parties. In the event of communication failure, the Dam Tender may communicate via cellular telephone or by vehicular travel between offices.

To provide ample warning to campers in the Cherry Creek Reservoir area of actual or impending rises in water level, the Tri-Lakes Project Office will immediately notify the Colorado P&W representative at the site whenever: (1) the pool level is expected to exceed 5575.0 ft PD, (2) a rapid rise in pool level of 0.5 ft in a 6-hour period is occurring or is expected to occur in the next 6-hour period, (3) the hydrologic network reporting station at Franktown indicates a gage reading of 6.6 ft or more, or (4) rainfall in the hydrologic network of 2 in or more in a 6-hour period is reported. Cherry Creek Dam releases, made under the conditions contained herein, are not likely to endanger any of the inhabitants of the basin; however, the Colorado State Engineer and the City Engineer of Denver will be notified by the Tri-Lakes Project Office of probable prolonged releases that might cause damage to the existing Cherry Creek channel through Denver. The City Engineer and State Engineer are to be notified in advance in all cases when outlet releases in excess of 500 cfs are to be made from Cherry Creek Dam.

5-09. Project Reporting Instructions. The Tri-Lakes Project Office will notify the WCWQS, as soon as practical, regarding confirmation of gate settings, including gate openings, releases, time, and date. Whenever possible, while coordinating gate changes, the Tri-Lakes Project Office will transmit any information they have gathered relative to any concerns, complaints, or any other pertinent information to the WCWQS. During flood regulation, the Project Office and WCWQS coordinate all information related to the regulation decision. All gate changes made at Cherry Creek Dam are logged on the *Dam Tenders Reservoir Regulation Report*. An example report can be

found on Plate 5-6. The form is available to the WCWQS on the Tri-Lakes Project Office shared drive.

5-10. Warnings. Warnings of impending releases will be issued as soon as possible before the release by the Tri-Lakes Project Office from a list of contacts maintained by this office. The Tri-Lakes Project Office will notify the WCWQS of any problems with the impending release. If prolonged or intensive releases are scheduled, the WCWQS may issue a press release if necessary. In addition, the WCWQS provides project release forecasts to the NWS during flood events to be incorporated into downstream river forecasts.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 6

HYDROLOGIC FORECASTS

6-01. General. Regulation of Cherry Creek Reservoir requires the scheduling of releases and storage largely on the basis of observed and anticipated hydrologic events in the Cherry Creek basin, and to a somewhat lesser degree, on the basis of observed and anticipated hydrologic events throughout the South Platte River basin. Flood control releases are predicated on the use of project flood control storage capacity to prevent, insofar as possible, river flows exceeding those that will cause damage at downstream locations. Runoff forecasts will be used largely for the purpose of evacuation of storage from Cherry Creek Reservoir. Forecasts of reservoir inflow from rainfall-only events are extremely challenging due to the very rapid time of concentration and the cloudburst characteristics of storms in the vicinity. While forecast procedures will be used to the maximum extent practical, actual scheduling of releases will generally be based on conditions observed at the time, due to the unpredictability coupled with the very short travel time to major downstream damage centers.

a. Role of the Corps. Using as much of the available hydro-meteorological information as possible, the WCWQS generates an event-driven inflow forecast for Cherry Creek Reservoir. This process includes obtaining and coordinating any pertinent information such as snowpack and runoff forecasts from various agencies for the purpose of making inflow and pool level forecasts. The WCWQS will also prepare an event-driven downstream forecast using information from the NWS, MHFD, DWB, as well as any other information useful for the compilation of streamflow forecasts for Cherry Creek and the South Platte River.

b. Role of Other Agencies. The preparation and distribution of forecasts to the general public relating to precipitation, temperature, river stages, and other meteorological elements are official functions of the NWS. The NWS prepares and transmits numerous forecasts of weather and river conditions throughout each day.

6-02. Flood Condition Forecasts.

a. Requirements Close liaison is maintained between the WCWQS and the NWS. NWS satellite, radar, and forecast data are stored in the WCWQS CWMS database. WCWQS personnel continually monitor NWS forecasts to obtain warnings of impending storms. Past experience has indicated that the South Platte River basin is subject to highly intense localized storms. Historically, the remoteness of the upper Cherry Creek basin and the associated delay in receipt of hydrologic data made it extremely challenging to develop an adequate procedure for real-time forecasting of flood inflows. However, now that spatial radar precipitation estimates are more readily available and a spatial rainfall-runoff model for the upper South Platte River basin exists, the ability to produce skillful inflow forecasts has increased. The upper South Platte River CWMS modeling suite was developed in FY13 and can be used to generate inflow and reservoir operation forecasts. When necessary, downstream inundation mapping can be produced. The WCWQS uses the following meteorological items as short-range and

long-range forecasts of impending flood situations for advance alerting and/or staffing of personnel to operate the project as the severity of forecasts may indicate:

(1) Quantitative Precipitation Estimates and Precipitation Point Values. Each morning the NWS MBRFC generates and disseminates a gridded estimate of Missouri River basin precipitation for the previous day. The gridded precipitation is generated based on precipitation gage-biased radar data. The MBRFC also provides daily precipitation totals for all precipitation gages in the Missouri River basin.

(2) Quantitative Precipitation Forecasts. Each morning the MBRFC generates and disseminates Missouri River basin gridded forecasts of precipitation amounts in 6-hour time steps for the next five days (120 hours).

(3) Temperature Estimate. Each morning the MBRFC generates and disseminates hourly Missouri River basin gridded estimates of temperatures for the previous day. Estimates are generated based on point value data across the basin. The Corps' ERDC-CRREL reformats the grids to make them compatible with HEC-HMS (Hydrologic Modeling System) snowmelt modeling.

(4) Temperature Forecast. Each morning the MBRFC generates and disseminates hourly Missouri River basin gridded forecasts of temperature for the next 15 days (360 hours). Similar to the gridded temperature estimates, the Corps' ERDC-CRREL reformats the grids to make them compatible with HEC-HMS snowmelt modeling.

(5) Snow Water Equivalent (SWE).The NWS National Operational Hydrologic Remote Sensing Center (NOHRSC) generates and disseminates modeled daily SWE grids for the contiguous U.S. The Corps' ERDC–CRREL, in cooperation with HEC, reformats the grids and packages them with the required initial state grids, such as Cold Content Antecedent Temperature Index (CC-ATI) for the Missouri River basin to make them compatible with HEC-HMS snowmelt modeling.

(6) Seven-Day Point Forecast. The NWS generates an extended forecast summary each day for cities across the Missouri River basin.

(7) Regional Weather Summary. The NWS Boulder, CO Weather Forecast Office (WFO) issues an abbreviated language situation report and forecast changes for the next 24 hours on an event-driven basis.

(8) Area Forecast Discussion. The NWS Boulder, CO WFO issues an abbreviated plain language forecast of meteorological features.

(9) Weather Outlooks. The NWS Climate Prediction Center issues 6- to 10-day, 8- to 14-day, 30-day, and seasonal 90-day outlook maps that extend from 1 to 13 months into the future. The maps provide the expected deviation from normal conditions for precipitation and temperature across the United States. The 6- to 10-day and 8- to 14-day outlooks are issued daily while the monthly and seasonal outlooks are issued at the end of each month.

(10) Other Forecast Procedures. A meteorologist and hydraulic engineers with basic meteorological background are employed by the Omaha District, Hydrologic Engineering Branch to further analyze available information and prepare specialized forecasts not available from the NWS. The meteorological staff also interprets the aforementioned official NWS forecasts to alert District personnel of impending flood conditions. During flood events the meteorological staff assist WCWQS personnel by monitoring flood crest movement and hydro-meteorological conditions.

b. Methods. The following paragraphs describe the current methods and procedures to develop real-time hydrologic forecasts.

(1) Computer Applications. Models are used to forecast inflows and facilitate reservoir regulation decision making. There are two HEC-HMS models, and both use the gridded data described in Section 6-02.a. One of the HEC-HMS models is a snowmelt and rainfall model that includes the South Platte River basin above Waterton, CO. The other HEC-HMS model is a rainfall-driven model that includes the South Platte River basin from Waterton, CO downstream to Henderson, CO. This model includes Plum Creek, Cherry Creek, Bear Creek, Sand Creek, Clear Creek, and a portion of the South Platte River through Denver, CO. The HEC-HMS models are linked to the HEC-ResSim (Reservoir System Simulation) model, which is used to determine the Tri-Lakes system evacuation rates. HEC-RAS (River Analysis System) and HEC-FIA (Flood Impact Analysis) models are used to determine inundated areas and consequences, respectively, downstream of the Chatfield, Cherry Creek, and Bear Creek Dams. The HEC-RAS and HEC-FIA models were used to develop stage-damage relationships in 2015 (see Section 4-09.d.).

The CWMS database contains reservoir and river data, such as elevations, inflows, releases, and streamflow. CWMS also has the capability to provide decision support information needed to accomplish the water management mission. CWMS is a client-server system that uses an Oracle Solaris platform on the server side and Microsoft Windows on the client side for the Control and Visualization Interface (CAVI). Hardware and software configuration are customized for each District, but contain the same basic structure of major system components. The major components of CWMS are:

- **Data Acquisition (DA)**, which is the component that receives and processes incoming real-time hydro-meteorological data, transforms and validates data, and prepares data for insertion into the database.
- **Database (DB)**, which consists of the components that provide insertion, storage, and retrieval of CWMS data in the Oracle relational database.
- **Data Dissemination (DD)**, which is the component that retrieves data from the Oracle database, and delivers data, text, and graphic products to other system users, primarily via the internet.
- **Control and Visualization Interface (CAVI)**, which is the component that enables users to perform data validation, data visualization, and modeling analysis.

The HMS, ResSim, RAS, and FIA models are linked together through the CAVI. The CAVI allows the user to simulate a variety of scenarios with different precipitation events, runoff

conditions, and reservoir operations. The HMS model is used to determine runoff upstream and downstream of the dam; ResSim performs the reservoir regulation simulation; RAS determines downstream stage levels and is used to create flood inundation mapping; and FIA performs flood impact analysis and determines consequences.

(2) Unit Hydrographs. Hydrographs of 1 in of uniformly distributed runoff for a rainfall duration of 3 hours were developed for several key locations in the Cherry Creek Dam vicinity. Table 6-1 lists the unit hydrograph ordinates. The unit hydrographs were compared and adjusted to conform to runoff characteristics indicated by actual streamflow records. See the Chatfield Design Memo PC-2 dated August 1966 for a description of the derivation of the graphs. Flood peaks from many existing detailed records are from partial area storms and are of questionable reliability in expanding to unit hydrograph magnitude.

Plate 6-1 shows the unit hydrograph for the Cherry Creek basin at Cherry Creek Dam. Plate 6-2 also shows the Bear Creek tributary unit hydrograph routed to the South Platte River at Denver streamgage near the mouth of Cherry Creek. Plate 6-3 shows the routed Clear Creek unit hydrograph to the South Platte River at Henderson streamgage. Plate 6-5a shows unit hydrographs of the South Platte River basin above the Tri-Lakes Projects; Plate 6-5b shows the subbasin delineation. As the flood progresses and gage heights become available, the hourly discharge values can be translated to the Denver or Henderson streamgage locations by the lag-average procedure summarized in Table 6-2.

Table 6-1
3-HOUR UNIT HYDROGRAPH ORDINATES (cfs)

Hour	Bear Cr at Bear Cr Dam	Bear Cr at Sheridan	Bear Cr Routed to Denver	Cherry Cr at Cherry Cr Dam	Incremental Area above Denver	Clear Cr at Derby	Clear Cr Routed to Henderson
0	0	0	0	0	0	0	0
1	1,400	600	0	1,000	3,300	900	0
2	6,667	3,700	500	5,333	9,700	4,000	400
3	16,433	8,600	2,800	14,167	14,400	10,500	2,900
4	27,700	14,300	6,300	26,500	14,130	20,000	7,600
5	31,633	18,600	10,100	37,933	10,070	29,500	13,200
6	27,867	21,800	12,800	42,633	7,230	34,500	18,000
7	18,467	23,300	14,700	40,633	5,830	34,900	21,600
8	10,900	22,300	16,000	33,933	5,070	32,600	24,400
9	5,567	18,400	16,400	27,267	4,570	30,800	27,300
10	2,300	13,100	15,900	20,533	4,170	29,300	29,000
11	667	7,900	14,500	13,833	3,770	27,800	29,300
12	0	4,100	12,600	7,667	3,430	25,500	28,100
13		1,800	10,200	3,233	3,100	21,900	25,700
14		600	7,500	867	2,770	16,400	22,700
15		100	5,000	167	2,470	11,200	19,600
16		0	3,000	0	2,170	7,100	16,400
17			1,400		1,900	4,100	13,200
18			500		1,630	2,100	10,100
19			0		1,400	800	7,200
20					1,170	200	4,800
21					900	0	3,000
22					600		1,700
23					0		1,000
24							500
25							200
26							0

Table 6-2
SOUTH PLATTE RIVER TRIBUTARY LAG AVERAGES

	No. of hourly discharges averaged	Lag in Hours	
		To Denver	To Henderson
Chatfield Dam releases	3	6	
Bear Creek at Bear Creek Dam	9	5	
Bear Creek at Sheridan	9	3	
Cherry Creek Dam Releases	3	6	
South Platte River at Denver	3		6
Clear Creek at Derby	9		3

(3) Wind/Wave Effects on Pool Readings. The frictional drag of sustained wind over the Cherry Creek Reservoir water surface exerts a horizontal stress on the water, driving it in the direction of the wind. This wind effect results in a piling up of water at the leeward end, and a lowering of water level at the windward end, thus disrupting the nominal flat water surface. The gage reading at any particular site is then depressed or elevated by an amount depending on wind direction, wind speed, and depth of water. The maximum effect on the Cherry Creek Reservoir gage elevation occurs with a northwest wind. The magnitude of this wind tide effect is not great due to the relatively short fetch across the lake. To obtain the elevation of the lake corrected for wind effects, the amounts listed in Table 6-3 should be added to the pool level reading indicated on the pool gage in the intake tower when a north to northwest wind is blowing, and subtracted from the pool level reading when a south to southeast wind is blowing. No correction is necessary for winds from other directions.

Table 6-3
CHERRY CREEK RESERVOIR WIND/WAVE CORRECTION

Average Wind Speed (mph)	Pool Level Correction (ft)
20	0.00
30	0.10
40	0.15
50	0.20
60	0.25
70	0.30

(4) Infiltration. The only available data on infiltration indices in the basin are estimates established in prior studies and field infiltrometer experiments made in the Cherry Creek basin by the NRCS. The results are published in their sub-report titled *Study of the Infiltration Capacities of Some Soil Groups in the Cherry Creek Watershed in Central Colorado*. These data compare favorably with losses computed by District Hydrologic personnel from the streamflow records on gaged streams in the South Platte River basin. Table 6-4 lists average infiltration losses computed for storm durations of 1-hour and greater that resulted in three variations of loss criteria. More detailed subbasin loss rates have been included in the calibration of the real-time HEC-HMS model.

Table 6-4
AVERAGE INFILTRATION LOSSES (in/hour)

Basin	Storm Duration	
	≤ 1 hour	> 1 hour
Cherry Creek Basin above Cherry Creek Dam	0.8	0.7
South Platte River right-bank tributaries, excluding Plum Creek	1.0	0.9
South Platte River left bank tributaries, including Plum Creek	1.2	1.1

6-03. Conservation Purpose Forecasts. No special conservation purpose forecasts are prepared for Cherry Creek Reservoir.

6-04. Long-Range Forecasts. Forecasts of water supply and extended period runoff for the Missouri River basin in Colorado are issued by several agencies on a monthly basis.

a. National Weather Service. Starting in January each year and for the succeeding months through May, the NWS issues a *Water Supply Outlook for the Western United States*. This publication presents runoff forecasts at pertinent points based on an analysis of precipitation, SWE, and runoff. The volume forecasts are issued in three categories: most probable, reasonable maximum, and reasonable minimum. The forecast points pertinent to Cherry Creek Reservoir regulation are South Platte River at South Platte (below Cheesman), Plum Creek near Sedalia, Bear Creek at Morrison, Cherry Creek near Franktown, and Clear Creek at Golden.

b. Natural Resources Conservation Service. The NRCS publishes a report following each of the principal snow survey dates from January 1 through June 1. The report, titled *Colorado Water Supply Outlook Report*, contain snow survey data and select streamflow volume forecasts including the upper South Platte River basin.

c. U.S. Bureau of Reclamation. Water Supply Monthly Operation forecasts for the Colorado and Big Thompson River basins are published by USBR on the first of each month throughout the year. No forecast is created for the upper South Platte River basin by USBR as there are no USBR projects in this area.

d. The Corps. The majority of the annual inflow into Cherry Creek Reservoir results from rainfall-runoff, not mountain snowmelt like Chatfield and Bear Creek Reservoirs.

6-05. Drought Forecasts. No special drought forecasts are prepared for Cherry Creek Reservoir by the Corps.

SECTION 7

WATER CONTROL PLAN

7-01. General Objectives. ER 1110-2-1400 assigns the Corps' reservoir regulation responsibilities in the Missouri River basin to the NWD Commander. ER 1110-2-1400 permits delegation of certain reservoir regulation responsibilities to the District Engineer, in whose area the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Cherry Creek Reservoir, according to plans agreed on in advance, have been delegated to the Omaha District Engineer. The NWD Commander, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District.

Cherry Creek Reservoir is regulated for flood control primarily to mitigate flood risk through the metropolitan area of Denver from floods originating on Cherry Creek upstream of the dam. Secondary purposes include, when feasible, minimizing flood damages along the South Platte River in Denver and in downstream agricultural areas.

Recreation and fish and wildlife were not initially included as project purposes; however, these purposes were later added to provide benefits to the local community. Other objectives are to maintain and manage the land and water resources to support a diversity of fish and wildlife and to preserve, protect, and interpret threatened and endangered species and unique and important ecological resources.

7-02. Constraints. The control point for Cherry Creek Reservoir regulation is a 5,000-cfs maximum flow target at the South Platte River at Denver streamgage when Cherry Creek Reservoir has not reached elevation 5590.0 ft PD. It is important to note that the 5,000-cfs flow target includes Bear Creek Dam and Chatfield Dam releases as well as incremental runoff downstream of each of the dams. Individual design criteria for Chatfield and Cherry Creek Projects were based on releasing 5,000 cfs from each project and not on the control point. Strict adherence to the flood control operation described in detail in Section 7-05 will be followed.

Channel capacity varies widely downstream of the dam. The sustained non-damaging channel capacity of Cherry Creek is approximately 5,000 cfs. The South Platte River through the City of Denver was improved with flood walls to contain incremental runoff. The improvements were not made to increase releases from the Tri-Lakes Projects. The estimated non-damaging capacities range from 10,000 to 30,000 cfs in Denver. In the rural areas downstream from Denver, the natural channel flows wide and shallow and the existing non-damaging channel capacity is less than 5,000 cfs in some high-yield agricultural areas. Protection afforded these areas downstream of the Denver metropolitan area will not be as great as that through Denver. The maximum flow target at the South Platte River at Denver streamgage continues to be 5,000 cfs when Cherry Creek Reservoir has not reached 5590.0 ft PD. To reduce the potential risk of dam failure as a result of an extreme flood, the Cherry Creek Dam release will be increased to 7,000 cfs when the reservoir exceeds elevation 5590.0 ft PD, as described in Section 7-05.

Downstream channel concerns, gate vibration, manpower needed to make gate changes, and required flow travel time to lessen the impact to downstream areas are items that may constrain operations.

Historical releases from the dam have been too low to evaluate the impact to downtown Denver. A steady release of 525 cfs was made for approximately twelve days during mid-August 1965 with no adverse effect. Although modeling efforts indicate a probable channel carrying capacity of at least 5,000 cfs, with a significant increase in structural damages above 7,000 cfs, any releases in excess of 1,000 cfs must be carefully observed in the field. Annual sediment flushing releases of up to 1,300 cfs have been made without problems, although these releases were of only a 15-minute duration. Project releases should be kept as high as practical based on field observations, but not exceeding 5,000 cfs while the reservoir has not reached elevation 5590.0 ft PD.

After completion of the Cherry Creek Project, extensive commercial and residential development has occurred in the Sand Creek and Toll Gate Creek flood plain downstream of the Cherry Creek Dam spillway. Non-damaging channel capacities have been restricted by encroachment and major damage will occur in the event of spillway use. Public safety in these areas could also become a concern, if spillway flow occurs.

Extensive residential development has occurred on the properties adjacent to project boundaries upstream of Cherry Creek Dam, sometimes below the maximum pool elevation. This could cause problems during regulation of the Tri-Lakes system. Public safety could also become a concern, due to the rapid rise of pool levels during storms of the design magnitude.

During high runoff periods debris can accumulate within the reservoir. Releasing water while debris surrounds the tower could result in debris lodging in the gate slots and prevent closure of gates, which would result in a loss of all multipurpose storage. It is conceivable that larger gate openings or higher pool levels would remove the threat of obstruction in the gate passageway. The outlet works are exercised on a routine basis to ensure continued operation during a flood. An annual sediment flush is performed each year to scour the sediment near the upstream side of the gates.

Simultaneous Cherry Creek, Bear Creek, and Chatfield Dams' flood control releases require close coordination. Issues may arise in maintaining appropriate storage balances considering storm recurrence and reservoir and basin conditions within each project.

Revised PMF and design storm routings indicate inadequate flood control storage volume at the project. The ongoing Cherry Creek DSMS addressing this concern was initiated in FY13 and will be finalized in 2020. The study developed and evaluated potential alternatives to reduce risks associated with Cherry Creek Dam. The no action alternative was the final decision; however, this alternative includes spillway maintenance and a modified the water control plan (refer to Section 7-05) to reduce the potential of overtopping and failure. Regulation of the project will require close monitoring of Cherry Creek Reservoir and basin conditions.

7-03. Overall Plan for Water Control.

a. Storage Allocations. Table 7-1 lists the allocation of storage space in Cherry Creek Reservoir. Plate 7-1 schematically shows reservoir storage zones and elevations.

Table 7-1
RESERVOIR STORAGE ALLOCATION ZONES

Reservoir Zone	Elev. Limits (ft PD)	Capacity (af)*
Surcharge Storage	5598.0-5645.0	182,149**
Exclusive Flood Control Storage	5550.0-5598.0	79,294
Multipurpose Storage	5504.0-5550.0	12,558

* 2006-2007 Sediment Survey
**The 2006-07 survey did not include the top 5 ft of storage. The curve was extended with LiDAR data to obtain the entire zone's storage capacity.
PD=Project Datum

The normal regulation of Cherry Creek Reservoir involves responsibilities of the State of Colorado and of the Corps. The State Engineer's Office tracks water rights on Cherry Creek the South Platte River and makes requests for releases to the WCWQS.

The Definite Project Report, dated January 1944, did not present a detailed plan of multipurpose regulation for Cherry Creek Reservoir because no provision had been made for multipurpose storage in the reservoir. Following the retention of surplus runoff during the spring of 1957, the multipurpose zone was established in the reservoir at the request of the State Engineer. With the approval granting the State of Colorado authority to maintain a multipurpose zone in Cherry Creek Reservoir, the operating plan for flood control was revised to include plans for both multipurpose and flood control. The following paragraphs discuss in detail the current plan for regulation of the multipurpose storage. Section 7-05 describes flood control operation in detail.

b. State of Colorado Responsibilities. At the request of the Governor, the Chief of Engineers has permitted the State of Colorado to maintain a multipurpose zone in the Cherry Creek Reservoir. Management of the multipurpose zone for recreational use, administration of water rights, and determination of reservoir evaporation are accomplished by the Colorado P&W in cooperation with the Colorado State Engineer. The regulation plan for the multipurpose zone (5504.0 - 5550.0 ft PD) is to store all inflows in excess of downstream water requirements. Requirements for the retention or release of storage while the reservoir is below elevation 5550.0 ft PD will be determined by the Colorado State Engineer consistent with water laws of Colorado. Normally the State Engineer will make requests for release of water directly to the Omaha District WCWQS. Upon notification and concurrence with such proposed releases, the WCWQS will issue a regulation order to the Tri-Lakes Project Office specifying the amount and duration of releases to be made. If an actual emergency exists involving drowning, present or probable damage to the public works downstream from the dam,

or events of a similar nature, the State Engineer may issue release instructions to the Tri-Lakes Project Office for immediate action. The Tri-Lakes Project Office will confirm such action with the WCWQS as soon as possible.

c. Corps' Responsibilities. The operation of Cherry Creek Reservoir involves two units of the Corps as described in Sections 7-03.c.(1) and 7-03.c.(2) below. Additional responsibilities of the Corps are outlined below.

(1) Water Control and Water Quality Section, Engineering Division. The WCWQS is responsible for matters pertaining to the regulation of Cherry Creek Reservoir. This office prepares the official forecasts for the Corps. Throughout the year, the WCWQS monitors reservoir releases made from the multipurpose zone by the State Engineer's Office. When the pool level is in, or forecasted by the WCWQS to enter the exclusive flood control zone, the WCWQS is responsible for scheduling reservoir releases to attain optimum flood control benefits and control of project storage to ensure regulation in conformance with the authorized functions of the project. The WCWQS is responsible for procurement of necessary snowpack, precipitation, streamflow, and reservoir elevation data, while also making advanced estimates of streamflow from snow cover and/or rainfall reports for regulation purposes and to alert field operating personnel of potential flood occurrences. The WCWQS prepares the official daily elevation, storage, inflow, and release for Cherry Creek Reservoir. Issuance of reservoir regulation orders is also performed by the WCWQS.

(2) Tri-Lakes Project Office, Operations Division. The Operations Division plans and directs the maintenance and physical operation of the project. This Division establishes the standards of maintenance and provides proper staffing of operating personnel at the Tri-Lakes Project Office to accomplish these objectives. The Tri-Lakes Project Office staff performs all gate changes at Cherry Creek Dam. This office organized an informal agreement with the Colorado State Engineer that one gate change per week be made for downstream water rights. This was in response to no longer staffing a full-time Dam Tender on site at Cherry Creek Dam. This office has also agreed to initiate email or telephone correspondence for reservoir releases in excess of 40 cfs with the MHFD, a local agency that coordinates releases with local county emergency managers.

(3) Flood Period Organization. The normal organization of the Omaha District is somewhat modified during a flood period to cover the additional duties made necessary by the flood emergency. These duties are to: 1) regulate the flood control reservoirs for maximum risk mitigation, 2) collect and disseminate flood information, 3) protect the Corps' property and works, 4) obtain engineering data, and 5) in extreme emergency, assist in relief and rescue work. These activities take precedence over normal work and are performed by those employees of the District who have been trained for specific emergency duties. In case of localized flooding in a reservoir-controlled basin, such as Chatfield Reservoir, Bear Creek Reservoir, or Cherry Creek Reservoir, only those units of the Omaha District organization concerned with the normal operation of the reservoir are placed in an emergency status. A directory of regulation personnel is shown in Exhibit I, *Standing Instructions to the Dam Tender.*

(4) Regulation Orders. When it is the responsibility of the State of Colorado as indicated above, the State Engineer's Office will contact the WCWQS for a regulation change due to downstream water rights. The State Engineer's Office determines the necessary release with approval from the WCWQS. The WCWQS then contacts the Tri-Lakes Project Office with the regulation change. In the event the State Engineer's Office cannot make contact with the WCWQS, requests can be made directly to the Dam Tender, who will confirm the order with the WCWQS as soon as practical. The two Corps offices discuss the regulation change, and as long as there are no constraints, the change is performed. All regulation orders will normally be issued verbally and then confirmed in writing, and electronically shared with the Tri-Lakes Project Office by the WCWQS as official signed orders as soon as possible. Tri-Lakes Project Office personnel will record the gate setting for each gate change in the pool report spreadsheet, which can be accessed by the WCWQS to complete the written order. A copy of all orders issued by the WCWQS will be furnished to the State Engineer's Office and the Tri-Lakes Project Office. Under normal circumstances, this copy will contain a brief statement outlining the background and reasons for issuance of the order. In the case of a dam safety issue or major flood control release, the signed reservoir regulation order should contain sufficient details to describe the reasoning of the reservoir regulation decision. In the case of a deviation from the Cherry Creek Dam WCP, the reservoir regulation order should note that a signed deviation approval from the MRBWM office has been acquired.

(5) Coordination with Other Agencies. Daily project operating data and miscellaneous hydrologic information will be exchanged among the Tri-Lakes Project Office, the State Engineer's Office and the WCWQS. Project release forecasts are provided to the NWS during flood events to be incorporated into downstream river forecasts. Cooperation is also maintained with the U.S. Geological Survey and CDWR relative to the collection and reporting of precipitation amounts and stream stages and flows. The NRCS provides snow survey data and select inflow volume forecasts, and the NWS provides precipitation and streamflow forecasts.

(6) Communication. Telephone and email facilities are presently available for communication between the Tri-Lakes Project Office, State Engineer's Office, and WCWQS. In event of communication failure, the Dam Tender may communicate via vehicular travel between the respective offices noted above and/or via cellular phone.

d. Transition Zone. In the interest of regulation of the Cherry Creek Reservoir to serve the functions of (1) maintenance of the multipurpose zone, (2) flood risk mitigation on Cherry Creek, and (3) sediment flushing operations, while at the same time yielding incidental benefits to downstream irrigation interests and providing operational flexibility, it is desirable to maintain a small transition storage zone of approximately one foot between elevations 5550.0 and 5551.0 ft PD. In regulation of the multipurpose zone, the State Engineer will endeavor to keep the reservoir at or above elevation 5550.0 ft PD as inflows will permit. Many occasions arise when small Cherry Creek Reservoir inflows or rainfall on the immediate reservoir area cause small increases in the pool level, many of which will cause the pool to exceed elevation 5550.0 ft PD. The release of these small volumes will cause frequent and difficult gate operation. The quantity of water so

released would also be insufficient in most instances to be practical or beneficial to State water users. If the State Engineer has no call for releases, these small inflows will be accumulated in the reservoir to a maximum elevation of 5551.0 ft PD. Upon reaching elevation 5551.0 ft PD, the WCWQS will issue a regulation order to the Tri-Lakes Project Office to release this accumulated storage at a rate agreed upon between the WCWQS and the State Engineer. The releases will be continued until the pool has receded to elevation 5550.0 ft PD. However, while the reservoir is between elevations 5550.0 and 5551.0 ft PD, the reservoir level may fluctuate as necessary without requiring frequent small reservoir releases. The schedule of releases will be coordinated between the State Engineer's Office and the WCWQS.

7-04. Standing Instructions to Dam Tender. Exhibit I contains detailed instructions for regulation of project releases under emergency conditions. Communication failure may isolate the Dam Tender, thus making them the sole operating organization for the project. Regulation orders issued verbally will be confirmed as soon as possible in writing as official signed orders.

7-05. Flood Control. Cherry Creek Reservoir will be regulated for flood control to mitigate flood risk to the City of Denver from floods originating on Cherry Creek upstream of the project location. Operation of the Cherry Creek Project will require both individual and system reservoir regulation.

a. Operation of Cherry Creek Reservoir as an Individual Project. Before 1985, the developed method of flood control regulation of Cherry Creek Reservoir was Method A, defined in EM 1110-2-3600. Method A is based on the concept of reducing downstream damaging stages as much as possible during each flood using the currently available storage space. After 1985, the method of flood control regulation became Method C, which is a combination of Methods A and B. Method B is regulation based on control of the project design flood. Method C allows some flexibility to store flood water when pool levels are low to reduce downstream damaging stages, allowing releases as the pool reaches certain critical levels. This method was chosen to help improve the safe passage of major flood events. Because of Cherry Creek Dam’s hydrologic deficiency, regulating the dam in accordance with the procedures outlined in the following paragraphs is imperative to reduce the probability of the dam overtopping and failing during extreme storm events. Evacuation of flood control storage from Cherry Creek Reservoir as an individual project will only occur when no flood storage is occupied in Bear Creek or Chatfield Reservoirs.

During flood inflow periods and/or rising pool levels, Chatfield, Cherry Creek, and Bear Creek Reservoirs will be regulated to ensure safe control of each flood event. Releases from the dams will be based on observed inflows and pool levels and downstream flows. During flood inflow periods and/or while the pool level is in the flood control zone, releases will generally be kept as large as possible to meet the 5,000-cfs target at the South Platte River at Denver streamgage. This target includes releases from Chatfield, Cherry Creek, and Bear Creek Dams and incremental runoff below the dams. Releases from the three dams from the forecasted flood onset to the complete evacuation of flood storage will be at the discretion of the WCWQS. However, at the onset of a flood or

during heavy rainfall or knowledge of heavy runoff downstream, consideration will be given to reducing reservoir releases to as low as zero to lessen downstream flooding.

(1) Cherry Creek Reservoir has not reached elevation 5590.0 ft PD. During flood evacuation, when the reservoir inflow has peaked and the reservoir level becomes stationary or begins to fall, releases will be scheduled, consistent with downstream conditions, to evacuate the accumulated flood storage as rapidly as practical. The release rates indicated on Plate 7-2 represent the minimum rate of release required to evacuate the reservoir in a practical period of time. The release rates on Plate 7-2 are based on an evacuation period of 8 days for the April-July period and an evacuation period of 10 days for the September-February period for pool levels above elevation 5572.0 ft PD. The evacuation period was lengthened to a maximum of 15 days for progressively lower pool levels. These evacuation periods were selected to reasonably allow for sufficient storage withdrawal in advance of subsequent high inflow occurrences.

(2) Cherry Creek Reservoir reached elevation 5590.0 ft PD. To reduce the potential risk of dam failure as a result of an extreme flood, the Cherry Creek Dam release will be increased to 7,000 cfs once Cherry Creek Reservoir reaches elevation 5590.0 ft PD to evacuate the flood control storage. Upstream and downstream basin conditions will be monitored and releases may be adjusted to mitigate the overall flood risk.

Under this scenario, the regulation of Cherry Creek Reservoir may require immediate action by the Tri-Lakes Project Office. There may be a combination of events that cause mobilization issues due to bridge closures as a result of extreme flooding and traffic jams.

When the reservoir rises above the spillway crest elevation of 5610.6 ft PD, releases will occur through the ungated spillway channel into West Toll Gate Creek, and then into Toll Gate Creek and Sand Creek. Spillway flow bypasses the Cherry Creek basin and the City of Denver. Since completion of the Cherry Creek Project, considerable residential and commercial development has taken place in the Toll Gate and Sand Creek flood plains. Large spillway releases will result in considerable damage.

b. System Operating Plan for Flood Control Evacuation. The following sections describe the system regulation plan for flood storage evacuation in the Tri-Lakes Projects when more than one project has storage in the flood control zone. This system procedure is also presented in the Water Control Manuals for Chatfield Dam and Reservoir and Bear Creek Dam and Reservoir.

System regulation of Cherry Creek, Chatfield, and Bear Creek Reservoirs will be necessary only after flood flows have entered the reservoirs and during flood storage evacuation. Releases will be made from the projects, to the extent reasonably feasible, when water has accumulated in the flood control storage zones such that an equal protective balance of vacant flood control storage is maintained during flood control storage evacuation. This balance is based on establishing an equal risk in each project of filling the remaining flood control storage space from a similar subsequent flood. The storage remaining should provide equal protection at each project. Flood storage

evacuation will continue at Cherry Creek Reservoir until the pool elevation falls to 5550.0 ft PD, the base of the flood control zone.

Two storage levels in the flood control zone are established in each project. Generally, the upper Level II of storage space approximates the volume of the rainfall Standard Project Flood (SPF), described in Section 8-02.a. of this manual. In Chatfield, Level II volume amounts to 160,000 af, the volume of the rainfall SPF, and Level I is 25,400 af. Since the flood control zones in both Cherry Creek and Bear Creek Reservoirs were designed mainly for protection from the sudden occurrence of a rainfall SPF and not from the longer duration mountain snowmelt flood, 95% of these flood control zones were assigned to Level II. The remaining 5% of flood control storage space in Cherry Creek and Bear Creek Reservoirs is allotted a lower evacuation rate at the downstream control point, the South Platte River at Denver streamgage. This space was assigned to Level I to provide for a transition from flood releases to multipurpose releases and to lessen unnecessary high releases for small encroachments of the flood control zones. The lower evacuation rate of Level I storage will not significantly affect the project flood control function. Table 7-2 presents a tabulation of storage in the three projects assigned to each level. Plate 7-3 shows the parallel reservoir balance for the three projects in percent of storage space filled for the two levels. Table 7-3 states the desired evacuation flow to be targeted at the control point, the South Platte River at Denver streamgage, depending on storage level, percent of storage space filled within the level, and time of year.

Table 7-2
FLOOD REGULATION STORAGE LEVELS

Location	Level I			Level II		
	Elevation (ft PD)	Storage (af)	Incr. Storage (af)	Elevation (ft PD)	Storage (af)	Incr. Storage (af)
Cherry Creek	5550.0	12,600		5554.4	16,500	
	to 5554.4	16,500	3,900*	to 5598.0	91,900	75,400
Chatfield***	5444.0	47,700		5455.3	73,100	
	to 5455.3	73,100	25,400**	to 5500.0	233,100	160,000
Bear Creek	5558.0	1,800		5569.2	3,300	
	to 5569.2	3,300	1,500*	to 5635.5	30,300	27,000

* 5% of total flood control zone
** Total Flood Control Storage (233,100 af) minus 47,700 af = 185,400 af; 185,400 af minus Standard Project Rainfall Flood (160,000 af) = 25,400 af
*** The 1973 Chatfield Preliminary Reservoir Regulation Manual indicates the base of the flood control zone at an elevation 5430.0 ft PD. The base of the flood control zone was changed to 5432.0 ft PD in March 1979. The base of the exclusive flood control zone was changed to 5444.0 ft PD in response to the reallocation of flood control storage to joint-use flood control-conservation.
Note: Based on area/capacity surveys from 2007 for Cherry Creek, 2010 for Chatfield, and 2009 for Bear Creek.

Table 7-3
DESIRED MAXIMUM FLOW TARGET
AT SOUTH PLATTE RIVER AT DENVER STREAMGAGE

April – July: Any Reservoir at Level II – 5,000 cfs All Reservoirs at Level I, with one or more, more than 50% filled – 5,000 cfs All Reservoirs at Level I, and all less than 50% filled – 4,000 cfs August - March: Any Reservoir at Level II – 5,000 cfs All Reservoirs at Level I, with one or more, more than 50% filled – 4,000 cfs All Reservoirs at Level I, and all less than 50% filled – 3,000 cfs
Note: If Cherry Creek Reservoir reaches elevation 5590.0 ft PD or above, the Cherry Creek Dam release is dependent on the criteria in Section 7-05.a.(2). 50% filled refers to 50% of the storage level (e.g., Level I) occupied.

Equal balance must first be achieved by releasing more water from the project with the most occupied flood storage. When two or more of the reservoirs have the same percentage of storage in the same level, equal balance has been achieved.

Four balance combinations were developed dependent upon which reservoirs have occupied flood storage. Table 7-4 displays these combinations and the storage evacuation rates, which are the percentages of the total system release required from each project. Combination B assumes Chatfield and Bear Creek are balanced and Cherry Creek is either storing less water than the other two or no water in its flood control zone. Combination C assumes Chatfield and Cherry Creek are balanced and Bear Creek is either storing less water than the other two or no water in its flood control zone. Combination D assumes Bear Creek and Cherry Creek are balanced and Chatfield is either storing less water than the other two or no water in its flood control zone. The next step after releasing according to combinations B, C, and D may be to release according to combination A. Combination A assumes all three reservoirs have water stored in their flood control zones and the percent of flood storage occupied is balanced.

The following two examples are provided to describe how equal balance may occur:

1. All reservoirs are balanced if each has 50% of their Level II flood control storage occupied at the following total storages: Chatfield 153,000 af, Cherry Creek 54,000 af, and Bear Creek 16,800 af.

2. Chatfield and Cherry Creek are balanced, with Level I - Combination C, if 1,000 af of total flood control storage occupied is split between these projects as follows: Chatfield 870 af (87%) and Cherry Creek 130 af (13%) and if Bear Creek has no water stored in its flood control zone.

When two or more of the reservoirs have the same remaining balance of storage, the storage should be kept in balance or the percent of storage filled should be kept the same until all water is evacuated to the extent reasonably feasible. The percentages in Table 7-4 also indicate the storage evacuation rate required out of each reservoir to enable continued parallel reservoir balance for all combinations of the three projects that may contain storage.

Table 7-4
PERCENTAGE OF STORAGE AND EVACUATION RATE REQUIRED TO CONTINUE A PARALLEL RESERVOIR BALANCE (Values are in percent)

LEVEL II (see Table 7-2 for Elevations)			
Balance Combination	**Chatfield**	**Bear Creek**	**Cherry Creek**
A	61	10	29
B	86	14	0
C	68	0	32
D	0	26	74
LEVEL I (see Table 7-2 for Elevations)			
Balance Combination	**Chatfield**	**Bear Creek**	**Cherry Creek**
A	82	5	13
B	94	6	0
C	87	0	13
D	0	28	72
Based on storage capacity surveys from 2007 for Cherry Creek, 2010 for Chatfield, and 2009 for Bear Creek.			

The system evacuation releases are calculated two ways depending on the Cherry Creek Reservoir elevation.

(1) Cherry Creek Reservoir has not reached elevation 5590.0 ft PD. Releases are calculated based on Table 7-4.

The following example illustrates how to maintain an equal parallel reservoir balance during storage evacuation using Table 7-4. This example assumes that: (1) all three reservoirs are in an equal balanced condition as indicated by balance combination A of Level II of Table 7-4, (2) a maximum flow of 5,000 cfs is targeted at the South Platte River at Denver streamgage, and (3) there are no downstream channel constraints below the three projects. Tabulated flows are average daily flows in cfs.

After the total system release on line 3 is determined, the estimated inflow into the three projects is totaled on line 4. The difference between line 3 (release needed from the three projects) and the total on line 4 (inflow) represents the total storage evacuation from the three projects on line 5. Table 7-4 is used to determine what percent of this storage is required out of each reservoir to enable a continued parallel reservoir balance on line 6. The addition of the estimated inflow and distributed storage evacuation represents the required release for each project on line 7. The total release from the three projects represents the required total release needed to target the desired flow at the South Platte River at Denver streamgage, including an allowance for incremental flow. Note that a release of 1 cfs over a 24-hour period is equivalent to 2 af of storage.

1. Desired flow at South Platte River at Denver streamgage (cfs)				5,000
2. Incremental flow between three projects and the Denver streamgage (cfs)				500
3. Total release needed from three projects (cfs)				**4,500**
	Chatfield	Bear Creek	Cherry Creek	Total
4. Estimated inflow (cfs)	1,100	0	100	1,200
5. Total storage evacuation rate (cfs)*				3,300
6. Distributed storage evacuation rate (cfs)**	3,300*61% = 2,000	3,300*10% = 300	3,300*29% = 1,000	
7. Required release (cfs)	1,100+2,000 = 3,100	0+300 = 300	100+1,000 = 1,100	**4,500**

* The difference between total release and total estimated inflow
** Percentage from Table 7-4

(2) Cherry Creek Reservoir reached elevation 5590.0 ft PD. To reduce the potential risk of dam failure as a result of an extreme flood, the Cherry Creek Dam release will be increased to 7,000 cfs once Cherry Creek Reservoir reaches elevation 5590.0 ft PD until the flood control storage is evacuated. Upstream and downstream basin conditions will be monitored, and releases may be adjusted to mitigate the overall flood risk.

The following example illustrates how to maintain an equal parallel reservoir balance at Chatfield and Bear Creek Reservoirs during storage evacuation using Table 7-4 while increasing releases from Cherry Creek Dam. A Cherry Creek Accounting Reservoir was included to determine releases from Chatfield and Bear Creek Dams, but is **NOT** the actual release made from Cherry Creek Dam. This example assumes (1) the Cherry Creek Accounting, Chatfield and Bear Creek Reservoirs are in an equal balanced condition as indicated by balance combination A of Level II of Table 7-4, (2) a maximum flow of 5,000 cfs is targeted from Cherry Creek Accounting, Chatfield and Bear Creek Reservoirs at the South Platte River at Denver streamgage, and (3) Cherry Creek release is made based on the criteria listed in Section 7-05.a.(2). Values tabulated are average daily flows in cfs.

After the total release on line 3 is determined, the estimated inflow into the three projects is totaled on line 4; this excludes the estimated inflow for the Cherry Creek Accounting Reservoir. The difference between line 3 (release needed from the three projects) and the total on line 4 (inflow) represents the total storage evacuation from the three projects on line 5. Table 7-4 is then utilized to determine what percent of this storage is required out of each reservoir to enable a continued parallel reservoir balance on line 6. The Cherry Creek Accounting Reservoir is used to compute the required release from Chatfield and Bear Creek Dams. The addition of the estimated inflow and distributed storage evacuation represents the calculated release for Chatfield and Bear Creek Dams on line 7. The total release from the Cherry Creek Accounting, Chatfield and Bear Creek Reservoirs represents the required total release needed to target the desired flow at the South Platte River at Denver streamgage, including an allowance for incremental flow. The actual release from Cherry Creek Dam is determined based on the criteria listed in Section 7-05.a.(2). The Cherry Creek Dam release is set to 7,000 cfs because the reservoir rose to elevation 5590.0 ft PD, line 8. In this example, the combined release from the projects plus incremental flow is 10,900 cfs (3,100 + 300 + 7,000 + 500 cfs). Note that a release of 1 cfs over a 24-hour period is equivalent to 2 af of storage.

1. Desired flow at South Platte River at Denver streamgage (cfs)					5,000
2. Incremental flow between three projects and Denver Gage (cfs)					500
3. Total release needed from three projects (cfs)					**4,500**
	Chatfield	Bear Creek	Cherry Creek Accounting	Cherry Creek	Total
4. Estimated inflow (cfs)	1,100	0	100	100	1,200
5. Total storage evacuation rate (cfs) *					3,300
6. Distributed storage evacuation rate (cfs) **	3,300*61% = 2,000	3,300*10% = 300	3,300*29% = 1,000	n/a	
7. Calculated release (cfs)	1,100+2,000 = 3,100	0+300 = 300	100+1,000 = 1,100 #	n/a	**4,500**
8. Required or actual release (cfs)	= 3,100	= 300	n/a	7,000 ł	**10,400**

* The difference between total release and total estimated inflow

** Percentage from Table 7-4

\# Calculated to determine releases from Chatfield and Bear Creek Dams, but is **NOT** the actual release made from Cherry Creek Dam

ł Actual Cherry Creek Dam release made based on the criteria list in Section 7-05.a.(2)

Another example was prepared to demonstrate the time required to evacuate Level II system flood storage as illustrated on Plate 7-4. The example assumed that the flood storage in all three projects, Chatfield, Cherry Creek and Bear Creek, was full. Incremental inflow downstream of the three projects and above the South Platte River at Denver streamgage was estimated to be approximately 500 cfs.

c. <u>Regulation Schedule</u>. When the flood inflow has peaked and the reservoir is rising as a direct result of stream runoff, consideration will be given to utilizing release

rates shown on Plate 7-5a. The emergency flood control regulation curves were developed by methods described in EM 1110-2-3600, primarily for use during large floods or during emergency regulation. The curves will serve as a basis for regulation when other information may not be available. The curves are based on a rainfall-runoff recession assuming the inflow has peaked. The curves display the minimum releases for any combination of pool elevation and recession inflow, to assure effective use of the total flood control storage by 1) filling the remaining flood control storage, 2) reducing the maximum flood release, and 3) reducing the magnitude of changes in release rates. As these release rates are minimum values, actual flood control release rates will be kept as large as possible, to meet the 5,000-cfs target at the South Platte River at Denver streamgage while minimizing flood risk on Cherry Creek and on the South Platte River below Cherry Creek. Plate 7-5b is very similar to Plate 7-5a with the difference being the objective of keeping the pool below the top of dam versus the top of flood control zone. Consideration will be given to utilizing the evacuation rates shown on Plates 7-5a, 7-5b and 7-2 although higher rates will be utilized whenever feasible. While Plates 7-5a, 7-5b and 7-2 list flood control as the primary objective, some incidental multipurpose benefits will also be realized, particularly in evacuation of small- or medium-sized floods.

7-06. Recreation. The demand for water-based recreation near the large metropolitan City of Denver is substantial and the Cherry Creek Project satisfies part of that demand. Recreation is an authorized purpose at the Cherry Creek Project. The lands at the Tri-Lakes Projects are not used for hunting due to the urban character of the area.

The Corps will continue to maintain a closely coordinated planning effort with the State of Colorado, Department of Natural Resources, and Colorado P&W. The Corps constructed recreational areas upstream from the dam that the State of Colorado leases, operates, and maintains for recreation use. Visitation to the Cherry Creek Project has grown dramatically since construction.

According to the Cherry Creek State Park there are known impacts to recreation within the reservoir when water is stored in the flood control zone. Plate 7-6 gives an outline of these conditions or impacts to recreation facilities up to elevation 5558.0 ft PD. The elevations are the levels at which water is on the first floor of the listed building or lowest point of the facility. The numbers were developed from actual elevations measured during previous floods. See Plate 2-27 for a map of Cherry Creek State Park.

7-07. Water Quality. Although the Corps does not have specific responsibilities related to water quality at Cherry Creek Reservoir, all management activities will be executed to protect and enhance the quality of water resources to the extent possible while regulating for other project purposes. Refer to Section 4-05 for a description of water quality characteristics and effects on operation of the lake.

The Cherry Creek Basin Water Quality Authority (CCBWQA) was established by the State of Colorado in 1985 (CRS 25-8.5-111). The mission of the CCBWQA is to “protect the watershed by preserving, enhancing and balancing water quality in Cherry Creek Reservoir and Cherry Creek Watershed.” The CCBWQA consists of the Cherry Creek

Basin Water Quality Board, Cherry Creek Basin Technical Committee, and a Program Manager. The CCBWQA Board consists of 18 Board of Director members and 18 Technical Advisory members, whom can be found on the CCBWQA website. The CCBWQA maintains an ongoing program that involves water quality monitoring. The CCBWQA shares water quality data with the Corps as needed.

Section 8-04 includes a brief overview of how regulation of the reservoir could impact water quality.

7-08. Fish and Wildlife. Fish and wildlife is an authorized project purpose at the Cherry Creek Project. The following describes the fish and wildlife considerations.

a. Constraints. Because Cherry Creek Reservoir a relatively shallow, plains reservoir, it is primarily a warm-water fishery. The outlet works have only a single level for releases. Thus, it is not possible to mix water from multiple levels to manage for a particular species of fish.

Normal operations and normal springtime floodwater inflows would have little effect on the fishery from a water temperature standpoint. Flood inflows could, however, have a very negative impact, at least temporarily, on the lake fishery if the inflows were high in suspended solids by making the water turbid. High turbidity has the effect of reducing light levels in the lower depths of the lake and of interfering with oxygen transfer (breathing) in the aquatic life forms in the lake. As temporary storage increases water residence time, suspended solids will tend to settle out. Settling of particulates may result in the surface waters becoming less turbid, but degradation of organic matter associated with settling particles may deplete oxygen in deeper waters while burial of bottom dwelling organisms may increase sediment oxygen demand.

b. Vegetation. A variety of habitats serve to attract and support wildlife at the project. These habitat types include upland grasslands, riparian woodlands, wetlands, bottomlands, and aquatic areas. The project provides the largest usable area of wildlife cover in the expanding southeastern part of the Denver metropolitan area.

Vegetation in the upland areas consists mainly of grasses in a re-established shortgrass prairie ecosystem. Dominant species include western wheatgrass, blue grama, buffalo grass, and one or more needlegrass species. The grassland ecosystem is being invaded by thistles, partly as a result of overgrazing by the expanding prairie dog populations. While some trees in the upland areas do exist, these are mainly restricted to campground areas and along drainageways. Species include plains cottonwood, elm, hackberry, Russian olive, and willow.

Approximately one-third of project lands lying above the multipurpose zone can be classified as wetlands or wet bottomlands. Typical vegetation consists of such tree species as cottonwoods and willows, wet meadow grasses such as switchgrass, prairie cordgrass and Canada wild rye, and rooted aquatic species such as cattails, bulrushes and arrowhead. Riparian areas along Cherry Creek contain a mosaic of vegetation types. Many grassland areas include common milkweed or Canada milk vetch as the

predominant forb species, with Woods rose often found. The noxious weed species leafy spurge is also present. Extensive stands of cattails and rushes grow at the location where Cherry Creek and Cottonwood Creek flow into Cherry Creek Reservoir.

Certain species of fish, such as the northern pike, require flooded grassy shoreline for successful spawning. This must also occur during a certain period in the early spring and reservoir levels must be slowly rising. For Cherry Creek Reservoir, such a scenario would be unlikely because the typical spring runoff occurs later in the year and would possibly cause a sudden, rather than a gradual, rise.

Cherry Creek Reservoir is eutrophic. Algal blooms reach a high point during the summer months. High turbidity appears to be the primary factor limiting algal growth in Cherry Creek Reservoir. Pondweed and duckweed grow throughout the lake and provide food and habitat for aquatic birds. Submerged trees in the delta area at the upstream end of the lake provide shelter for young fish.

c. Wildlife. Cherry Creek Reservoir is not a primary waterfowl habitat area. It is not on a major migration flyway and it lacks the vegetation and cover necessary for it to be an important stopover point during spring or fall migration. Some local nesting of a few common waterfowl species likely occurs at the project. Larger numbers of Canada Geese use the reservoir as a roosting area in the fall and winter. Normal flood control operations would not be expected to have any significant impacts on such waterfowl nesting.

d. Threatened and Endandered Species. The U.S. Fish and Wildlife Service (USFWS) has responsibility for oversight of the Endangered Species Act and maintains a list of threatened and endangered species of plants and animals. For Douglas County, CO, the bald eagle (*Haliaeetus leucocephalus*) and the American peregrine falcon (*Falco peregrinus anatum*) were delisted due to recovery. The Mexican spotted owl (*Strix occidentalis lucida*), the piping plover (*Charadrius melodus*), the greenback cutthroat trout (*Oncorhynchus clarki stomias*), the Colorado butterfly plant (*Gaura neomexicana var. coloradensis*), the Ute ladies'-tresses (*Spiranthes diluvialis*), the Pawnee montane skipper (*Hesperia leonardus montana*), the Preble's meadow jumping mouse (*Zapus hudsonius preblei*), and the Canada lynx (*Lynx Canadensis*) are listed as threatened. The least tern (*Sterna antillarum*) is listed as endangered.

The USFWS maintains that temporary storage of floodwaters in upstream reservoirs may have impacts on species that depend on the downstream Platte River for part of their life requisites. The Federal agencies that are responsible for manipulations of the Platte River system upstream are said to have some responsibilities for protection of those downstream species. The problem is complex; the two major elements to it are:

(1) Detention of upstream floodwaters in upstream reservoirs reduces the peak and the overall volume of the effects the flood would otherwise have on downstream areas. The Platte River in Nebraska, for instance, is less impacted by heavy and prolonged spring flooding that once periodically scoured the channel and kept trees from gaining a foothold. Where the channel was once wide, shallow, and relatively

treeless, it is now narrower, deeper, and heavily tree-covered in many areas. Each upstream reservoir adds to the situation in a cumulative manner.

(2) The main species of concern on the central Platte River in Nebraska are the whooping crane, least tern, pallid sturgeon, and piping plover. All of these species have been designated as federally threatened or endangered. Upstream impoundments and increased depletions from the Platte River have adversely influenced habitat for these downstream species because they have changed the timing and volume of flows. These adverse impacts have accumulated over the past 40 years or more, and continue to influence the flood plain reservoirs environment.

7-09. Water Supply. There is no water supply storage at the project at the present time.

7-10. Hydroelectric Power. None at this project.

7-11. Navigation. None at this project.

7-12. Drought Contingency Plan. A drought contingency fact sheet was finalized in July 1987 and states that retention or release of storage while the reservoir is below pool elevation 5550.0 ft PD will be determined by the State Engineer's Office. Low flow releases will be made to meet downstream water rights. Refer to Section 7-03.b. for details on responsibilities.

7-13. Flood Emergency Action Plan. Normal flood regulation of Cherry Creek Reservoir is accomplished by specific regulation orders to the Tri-Lakes Project Office from the WCWQS. However, it is conceivable that communication may be disrupted between these offices at times when project events may require changes in existing regulation instructions so that the project may more properly perform its authorized function. A procedure has been developed to determine project operations under emergency conditions so that the Tri-Lakes Project Office staff has appropriate information and instructions for modifying their existing regulation orders. Condition C of Exhibit I, *Standing Instructions to the Dam Tender*, includes this procedure. This procedure is defined to begin with communication failure between the Tri-Lakes Project Office and the WCWQS personnel at a time when the reservoir is rising rapidly, high inflows are indicated, excessive rainfall has occurred, flooding below the dam is occurring or appears imminent, or when a combination of any of these is occurring. During such emergency periods, regulation of project releases will be made by the Tri-Lakes Project Office in accordance with the release schedule given in Exhibit I. Continuous efforts will be made to re-establish communications. The dam will be attended at all times during an emergency.

The Omaha District's Geotechnical Engineering Branch annually updates the EAP for Cherry Creek Dam and Reservoir.

7-14. Deviation from Normal Regulation. Deviations from the release schedule will be made if conditions at the time are such that improved reservoir regulation will result. For example: (1) release more than 7,000 cfs from Cherry Creek Dam when pool

elevation 5590 ft PD has been reached or (2)releases that exceed the 5,000 cfs flow target at the South Platte River at Denver streamgage. Deviations require prior approval from the MRBWM office, except as noted in Section 7-14.a. Written confirmation of the deviation, including a description of the cause of the emergency, will be furnished as soon as practical to the MRBWM office as described in NWDR 1110-2-6, *Deviation Requests for Approved Water Control Manuals*. Requests to deviate from normal regulation of the project fall into one of the categories described below.

a. Emergencies. Deviations from the release schedule will be made if emergency conditions exist upstream or downstream of the dam. Examples of these types of emergencies include dam safety emergencies, downstream chemical spills, drownings, and facility failures. During an emergency activity, the WCWQS will inform the MRBWM office of such activities as soon as possible.

b. Unplanned Minor Deviations. Temporary delays of a few days duration in evacuation of flood storage will be considered to mitigate damages and/or for special circumstances downstream. A typical example of activities that would create the potential for unplanned minor deviations would be modifications of bridge and utility crossings. In evaluating requests for these types of deviations, the WCWQS will consider upstream basin conditions, potential flood threats, the amount of water in storage at Cherry Creek Reservoir, and whether any alternative measures could be taken that would not require a deviation.

c. Planned Deviations. Deviations from the release schedule will be made if determined necessary. All conditions such as data on flood potential, reservoir and basin conditions, possible alternative measures, benefits to be expected, and probable effects on other authorized and useful purposes will be analyzed. Planned deviations will be coordinated with all appropriate entities, including local and state offices.

7-15. Rate of Release Change. Normally, increases in releases should not exceed 500 cfs/day. Releases should preferably be reduced at a similar rate and should consider downstream impacts. However, if a higher rate of change is necessary to accommodate operational circumstances, releases may be increased or reduced at an accelerated rate. The release may even be reduced to zero flow in a single gate change if required. Examples of downstream impacts include environmental, water quality, and bank failure. There should be communication with stakeholders if these rates of change will be exceeded.

Consideration should be given to limit reservoir drawdown to less than 2 ft/day if embankment stability is in question. This drawdown guidance should only be used if practical and reasonable to do so.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 8

EFFECT OF WATER CONTROL PLAN

8-01. General. Floods in the Cherry Creek basin are usually caused by short periods of intense rainfall occurring over a small portion of the basin, or a series of intense storm centers scattered over the basin. The records of the extents, intensities, and durations of the storms causing the floods are incomplete and actual flood hydrographs are not available for reservoir routing examples except for the 1965 flood.

Originally, three design floods were developed for the Cherry Creek Project: the SPF, the Reservoir Design Flood (RDF), and the IDF, which in this case is equivalent to the PMF. The PMF has been updated several times since the original, based on changing design criteria. Additional detail on each flood is described in Section 8-02 of this manual.

8-02. Flood Control.

a. Reservoir Design Flood/Standard Project Flood. The RDF developed for the *Definite Project Report for Cherry Creek Dam and Reservoir*, prepared by the Omaha District and dated January 1944, was based on directly transposing the Bijou and Kiowa centers of the storm of May 30 and 31, 1935 over the Cherry Creek basin. The peak discharge of this flood was 113,000 cfs and the volume was 98,800 af. The design storm had a rainfall average depth of 8.7 in.

The SPF was not determined for the original project design and was not included in the DPR. A SPF of 102,000 af was estimated for Cherry Creek Dam, but since the volume was approximately equal to the RDF, no specific routings were made. Plate 8-1 shows the RDF routing following the implementation of the multipurpose zone resulting in a starting pool of 5550.0 ft PD. A maximum release of 5,000 cfs was assuming from the outlets. The maximum pool elevation attained was 5602.7 ft PD resulting in a maximum discharge of 640 cfs through the spillway.

b. Previous Inflow Design Floods. The original design condition IDF, which for the Cherry Creek Project is also the PMF, developed for the Definite Project Report (DPR) for Cherry Creek Dam and Reservoir for the current project development was derived from the storm of May 30-31, 1935. The depth-area duration curve for this storm was increased by 25%; the resulting runoff was estimated using infiltration rates of 0.6 in/hour for the first 3 hours and 0.3 in/hour for the last 6 hours of the storm. The peak discharge of the computed PMF was 180,700 cfs with a volume of 166,740 af. Plate 8-2 shows the original PMF hydrograph with two routings. The first routing of the PMF started with the pool elevation at the original design spillway crest of 5598.0 ft PD. The second routing of the PMF started with the pool at the top of the multipurpose zone (5550.0 ft PD). This first routing assumed the conduits were inoperative, thus no flood releases were made through the conduits resulting in a maximum pool elevation of 5636.16 ft PD and a maximum spillway discharge of 38,352 cfs. The second routing assumed flood releases from the conduits started at the beginning of the flood and

followed the curve shown on Plate 7-5a, resulting in a maximum pool elevation of 5620.6 ft PD and a maximum combined spillway discharge and conduit release of 17,108 cfs. Table 8-1 is a summary of the flood routings done for the original design of Cherry Creek Dam with plate references for some of the routings.

Table 8-1
SUMMARY OF FLOOD ROUTINGS

		Start of Routing		Conduit		Spillway Maximum Discharge (cfs)	Maximum Pool Elevation (ft PD)	Manual Plate No.
Routing No.	Flood Description	Storage (ac-ft)	Elevation (ft PD)	Operation	Discharge (cfs)			
Current Project Development								
1	1933	13,960	5550	Operative	0	0	5559.46	8-4
2	1965	13,960	5550	Operative	0	0	5563.18	8-6
3	RDF	13,960	5550	Operative	5,000	640	5602.68	8-1
4	RDF	13,960	5550	Operative	5,000	None	5602.76	n/a
5	RDF	93,920	5598	Operative	5,000	14,788	5622.76	
6	RDF	93,920	5598	Inoperative	0	17,220	5624.48	
7	PMF	13,960	5550	Operative	5,000	12,108	5620.59	8-2
8	PMF	13,960	5550	Inoperative	0	13,596	5621.83	n/a
9	PMF	53,940	5580.3	Operative	5,000	23,520	5628.48	
10	PMF	53,940	5580.3	Inoperative	0	25,606	5629.67	
11	PMF	93,920	5598	Operative	5,000	35,438	5634.78	
12	PMF	93,920	5598	Inoperative	0	38,352	5636.16	8-2
Definite Project Development (DPR Routings)								
13	RDF	10,000	5544	Inoperative	0	500	5602.5	n/a
14	PMF	52,500	5578.3	Inoperative	0	24,700	5628.9	
15	PMF	52,500	5578.3	Operative	—	—	5627.2	
Ultimate Project Development (DPR Routings)								
16	RDF	95,960	5598	Inoperative	0	12,300	5624.9	n/a
17	PMF	95,960	5598	Inoperative	0	45,000	5635.8	
18	PMF	95,960	5598	Operative	—	—	5634.6	

In 1969, the NWS completed a site-specific PMP study of the upper South Platte River basin for the design of Chatfield Reservoir and published HMR No. 44. Application of the HMR No. 44 criteria to the Cherry Creek basin resulted in a larger PMF for Cherry Creek Dam than the original PMF. In this derivation of the PMF for Cherry Creek basin, the pattern “A” rainfall values given in the report for the high plains area lying between Chatfield and the Rocky Mountain Front Range were used after applying a small drainage area adjustment. Losses of 0.5 in/hour were applied to the rainfall values to obtain the PMF runoff. This resulted in 9.7 in of runoff from a 96-hour storm with a total of 23.9 in of rainfall. This runoff, when applied to the unit hydrograph for the Cherry Creek basin, produced a hydrograph with a peak discharge of 376,000 cfs and a volume of 207,000 af including a baseflow of 1,000 cfs. The dam still had adequate freeboard based on the original spillway design crest elevation of 5598.0 ft PD and an antecedent pool starting at a half-full flood control zone. However, when the PMF routing was started at elevation 5598.0 ft PD, the spillway crest, the routing resulted in dam overtopping.

In 1975, new surveys of the spillway revealed that sloughing of the steep spillway side slopes had raised the crest to an elevation of 5608.7 ft PD, which further reduced the spillway capacity. In 1988, the NWS published HMR No. 55a, which contained regional PMP criteria for the area between the Continental Divide and the 103rd Meridian. Application of the HMR No. 55a criteria to the Cherry Creek basin indicated that the dam could overtop from a PMF event. This led to the initiation of the Cherry Creek Dam Safety reconnaissance study that was approved in 1993.

After approval of the reconnaissance study, the NWS was requested to conduct a site-specific PMP study for the Cherry Creek basin, which was published in 1995. Although the site-specific PMP criteria resulted in a lower PMF, the dam would still be susceptible to overtopping.

c. Current Inflow Design Flood. The draft DSMS, which will be finalized in 2020, used NWS site-specific techniques and HMR No. 55a. The study established the FWAC PMF and used the previously determined antecedent condition (32% of the PMP). The antecedent condition and the modified water control plan (refer to Section 7-05) produced a starting pool elevation of 5558.7 ft PD. During the period of runoff the average infiltration rate was 0.33 in/hour. Routing of the FWAC PMF to Cherry Creek Dam, results in a runoff volume of 338,800 af and a peak inflow of 551,950 cfs. Assuming a starting pool elevation of 5558.7 ft PD, and a spillway crest of 5598.0 ft PD the FWAC PMF results in the maximum pool elevation of 5646.6 ft PD, a maximum spillway discharge of 45,600 cfs and a maximum dam overtopping discharge of 109,400 cfs. A spillway maintenance contract is currently underway to return the crest to the original design elevation (5598.0 ft PD). The Cherry Creek Project can contain 75% of the FWAC PMF volume with 5 ft of freeboard, and can contain 87% of the FWAC PMF at the top of the dam low spot 5644.4 ft PD. Table 8-2 lists the results of the PMF routings corresponding to each of the PMP studies completed from 1944-2017. Reference Plate 8-3 for the FWAC PMF routing.

Table 8-2
CHERRY CREEK DAM AND RESERVOIR - PMF HISTORY

Study	Year	Runoff (ac-ft)	Peak Inflow (cfs)	Starting Pool Elevation (ft PD)	Max. Pool Elevation (ft PD)	Depth of Overtopping [1] (ft)	Overtopping Flow (cfs)	Max. Spillway Flow (cfs)	Total Peak Outflow (cfs)
DPR (current develop.)	1944	166,740	180,700	5598.0	5636.2	—	—	38,352 [2]	38,352
HMR No. 44	1969	207,000	376,000	5596.0	5639.0	—	—	30,000 [2]	30,000
HMR No. 55a	1988	359,200	662,000	5579.0	5648.7	4.2	354,300	56,300 [3]	410,600
Site Specific (NWS)	1995	256,000	524,500	5576.5	5645.9	1.5	64,000	48,300 [3]	112,300
Site Specific (NWS) (Existing Condition)	2017	324,300	545,400	5576.1	5649.4	3.2	137,800	28,410 [4]	172,280
Site Specific (NWS) (FWAC)	2017	338,800	551,950	5558.7 [5]	5646.6	2.2	63,800	45,600 [2]	109,400

1 Assumes no dam failure and a dam crest elevation of 5644.4 ft PD (top of the dam low spot)
2 Assumes spillway crest of 5598.0 ft PD
3 Assumes spillway crest of 5608.7 ft PD
4 Assumes spillway crest of 5610.6 ft PD
5 Takes into account the modified water control plan

d. Determination of the Existing Threshold Flood. The Office of the Chief of Engineers', *Guidelines for Evaluating Modifications of Existing Dams Related to Hydrologic Deficiencies* (October 1986), describes the existing threshold flood as follows: "Based on the existing dam design, there is an inflow event that will exceed the design criteria of the dam and threatens dam failure. This event, called the existing threshold flood, is determined by routing flood events, expressed as percentages of the PMF, through the reservoir and identifying the event for which the still water level encroaches on the freeboard necessary to accommodate potential wind and wave conditions and threatens the safety of the structure."

The threshold flood for Cherry Creek Dam was determined by routing percentages of the PMF through the reservoir starting at a pool elevation of 5558.7 ft PD. The inflow hydrographs were a percentage of the PMF hydrograph ordinates. The existing threshold flood for Cherry Creek Dam is 75% of the FWAC PMF allowing 5 ft of freeboard.

e. 1933 Flood. Streamflow records of the 1933 flood are incomplete and a hydrograph of the actual flood at Cherry Creek Dam is not available. However, an approximate hydrograph for a flood routing example was developed from the known peak discharge of the flood and unit hydrograph analysis. The synthetic hydrograph developed from the 1933 flood was routed through the reservoir with a starting water surface elevation at the top of the multipurpose zone, elevation 5550.0 ft PD, and no release from the project. A maximum pool level of 5559.5 ft PD resulted from the routing (Plate 8-4). Plate 7-2 indicates a minimum release of about 250 cfs. At this release, it took 20 days to evacuate the accumulated flood storage. Plate 8-5 shows the actual Cherry Creek Dam releases and their effect on the South Platte River flows.

f. 1965 Flood. An inflow hydrograph of the 1965 flood was developed from the observed Cherry Creek Reservoir elevations during the flood. Plate 8-6 shows the actual reservoir operation. During the peak inflow period, the information shown in Plate 7-5a indicated that no releases were required. Also, in view of the excess flow in the South Platte River and local knowledge of dropping stages at Franktown, CO, the outlet gates were left closed and the pool permitted to rise. An actual peak flow on the South Platte River of 40,300 cfs was computed at the South Platte River at Denver streamgage. The peak inflow into Cherry Creek Reservoir was estimated to be 58,000 cfs. From a comparison of travel times, it is estimated that Cherry Creek flows would have added directly to the flow on the South Platte River resulting in an estimated peak flow of over 65,000 cfs at the South Platte River and Cherry Creek confluence. If the uncontrolled flow had occurred on Cherry Creek and in turn contributed to higher flows on the South Platte River, several times the actual damage experienced would have occurred. The information in Plate 7-2 indicated that minimum releases of about 300 cfs were necessary to evacuate the accumulated flood storage. Actual releases of 450 cfs were made in early August after temporary repairs had been made to city water mains, bridges, and irrigation diversion works. Higher evacuation releases would have seriously damaged these facilities and kept them out of service during the remaining critical dry summer period. Plate 8-7 shows the actual Cherry Creek Dam releases and their effect on the South Platte River flows.

8-03. Recreation. Recreation facilities located relatively close to the reservoir were anticipated to be inundated fairly frequently; their designs and materials minimize damage from high pool elevations. The marina's lower level floor, which is located above 5556.0 ft PD, is designed to undergo minimal damage when under water. The main floor, which is at an elevation of 5570.7 ft PD, contains the public use spaces. The third floor of the marina, which is at 5580.7 ft PD, contains the offices.

Inundation of recreation facilities that result from operation of the Cherry Creek Project for downstream flood control would cause a decline in visitation. Based on public safety considerations, low-lying recreation areas or the entire project could be closed to public use. Plate 7-6 lists the impacted recreation facilities.

In general, trails and picnic facilities along the Cherry Creek channel downstream from the area acquired for the Cherry Creek Project are located on the tops of the channel banks so they would be unaffected by all but flood flows. Exceptions to this are where the trails pass beneath major roads. It is at these locations that such trails are at risk from erosion either during a large flood event or as a result of high, sustained releases from Cherry Creek Dam.

8-04. Water Quality. Water quality upstream from Cherry Creek Reservoir can be adversely impacted by nutrients and organic matter that enter Cherry Creek during snowmelt and large rainfall events. Periods with little or no flow may occur, and the creek may dry up entirely under drought conditions.

During snowmelt or large rainfall events, nutrients and organic matter are transported from the basin into the reservoir. The influent concentrations of phosphorus and

nitrogen can lead to nuisance algal growth and subsequent algal decomposition within the reservoir. Algal decomposition, decomposition of influent organic matter, and decomposition processes occurring in the sediment all exert an “in-reservoir” oxygen demand. When this demand surpasses the processes that replenish dissolved oxygen (wind mixing, algal production, influent dissolved oxygen, destratification or aeration systems), it depletes concentrations to hypoxic or even anoxic levels that can lead to fish kill events.

In the winter under snow and ice cover, there is little natural mixing and limited light for photosynthesis. The reservoir may become inversely stratified with the water near the bottom reaching a temperature of near 4 degrees Celsius (°C) and the surface water being slightly colder. Though occurring at a slower rate in cold temperatures, decomposition reactions can still exceed the dissolved oxygen supply. During this time, inflow to the reservoir is minimal; however, it could provide pockets of refugia in the upper reaches of the reservoir with dissolved oxygen conditions suitable for fish. Releases through the low-level gate during the late winter months could potentially send hypoxic, nutrient-laden water downstream while “pulling” some of the oxygenated influent water toward the dam. The hypoxic water would then be quickly oxygenated as it passes over the release structure.

With spring comes substantial mixing and light for photosynthetic oxygen production, but inflow conditions are variable. Thermal stratification of the reservoir occurs in the summer and may be transient depending on weather conditions. While the reservoir is stratified, decomposition occurs in the calm, colder, bottom layer known as the hypolimnion. Decomposition of accumulated organic matter depletes the hypolimnion of dissolved oxygen and creates an expanding hypoxic zone in the reservoir below the mixed, oxygenated upper layer. The actual volume of the hypolimnion will vary with pool elevation and weather conditions. In late summer during thermal stratification, the low-level gate could be opened to send hypoxic nutrient-laden water downstream. However, a dynamic water quality model should first be used to assess how much flow could be passed downstream without disrupting the thermal structure of the reservoir, and to assess the ability of the outlet structure to oxygenate released water at warmer temperatures.

8-05. Fish and Wildlife. Historically, water has been stored in the flood control zone of Cherry Creek Reservoir in relatively small volumes for relatively short periods due mainly to spring runoff. This storage has had little impact to wildlife and wildlife habitat; none of this impact was considered significant. It is anticipated that future temporary storage of such magnitude will continue to have little, if any, significant impact on the fish and wildlife resources of the project. For impacts to be considered significant, the inundation would have to be of sufficient duration to kill the shoreline and upland vegetation. Then, as the floodwaters were released, the remaining barren soil would not be able to provide any nesting, resting, or escape cover for terrestrial wildlife until it became revegetated. The USFWS maintains that temporary storage of floodwaters in upstream reservoirs may have impacts on species that depend on the downstream Platte River for part of their life requisites. See Section 7-08 for more information.

8-06. Water Supply. There is no water supply storage at this project.

8-07. Hydroelectric Power. None at this project.

8-08. Navigation. None at this project.

8-09. Drought Contingency Plan. A drought contingency fact sheet was finalized in July 1987. Reference Section 7-12 for details. A drought contingency plan for Cherry Creek Dam and Reservoir will be coordinated with stakeholders as time allows.

8-10. Flood Emergency Action Plan. See Section 7-13 as well as Exhibit I, *Standing Instructions to the Dam Tender*.

The Omaha District's Geotechnical Engineering Branch annually updates the EAP for Cherry Creek Dam and Reservoir.

8-11. Frequencies.

a. Peak Inflow Frequency. Plates 4-11a and 4-11b show the inflow and discharge frequency curves for Cherry Creek Dam, respectively. The curves are derived from the daily annual maximum values and include the years from 1958-2016.

b. Pool Elevation Duration and Probability. Plates 8-8 and 8-9 show the pool probability curve and volume duration probability, respectively. The curves are derived from the annual maximum values and include the 1961-2011 water years. An update to these curves is expected by the Corps' Risk Management Center in 2018 using the Bulletin 17C analysis, incorporating additional streamflow records, and a paleoflood analysis. The update will be incorporated in this manual at that time

c. Key Control Points. The key control point for the system and individual regulation of Cherry Creek Reservoir is the South Platte River at Denver streamgage. Reference Section 7-05 for further details. Plate 4-18 illustrates the stage-discharge relationship for this location. Plates 8-10 and 8-11 show the flow frequency and flow duration curves, respectively. The data analyzed included 1978-2016 representing the current flood control condition.

8-12. Other Studies.

a. Examples of Emergency Regulation. Examples of system regulation for select years are described in the below paragraphs.

(1) Condition C Emergency. To test the adequacy of the emergency criteria listed in Condition C of Exhibit I, a typical flood of this region of a volume approximately one half of the RDF magnitude was routed through the reservoir (see Plate 8-12). Routing was begun with a pool elevation of 5550.0 ft PD and the outlets closed. Required releases were determined by the emergency release schedule in Paragraph C-6 of Exhibit I. The maximum pool level attained was 5586.3 ft PD and the maximum release was 3,000 cfs.

This assumes that no system operation is necessary; thus there are no releases from Bear Creek or Chatfield Dams.

(2) Flood of 1973. Heavy rainfall experienced in May combined with high flows downstream prevented larger releases from Cherry Creek Dam causing the reservoir to exceed the previous record pool set in 1965. The storage evacuation was not initiated until early June. Bear Creek and Chatfield Dams were not completed before this flood, thus no coordination of releases was required. The Cherry Creek Dam peak daily inflow of 3,195 cfs was observed on May 6. Cherry Creek Reservoir reached its record maximum pool elevation of 5565.8 ft PD on June 3. Plate 8-13 shows more detailed operations and resulting flow on the South Platte River at Denver.

(3) Flood of 1983. Frequent rainfall-runoff in the Cherry Creek basin caused sustained encroachment in the Cherry Creek Reservoir flood control zone from April through August. The storage and release of water from Cherry Creek Dam was coordinated with the storage and release of water from Bear Creek and Chatfield Dams to reduce downstream flooding. The Cherry Creek Reservoir peak daily inflow of 1,440 cfs was observed on July 24. Cherry Creek reached its maximum pool elevation of 5557.8 ft on July 26. The peak release of 330 cfs was made at the end of April and again at the end of May to evacuate flood storage. Plate 8-14 shows more detailed operations.

(4) Flood of 2013. Following a fairly dry year, Cherry Creek Reservoir had been drawn down nearly 4 ft below the top of the multipurpose zone due to evaporation losses. In September 2013, the heaviest area of rainfall-runoff was experienced along the main stem South Platte River and tributaries from Denver, CO to Kearney, NE downstream of Cherry Creek, Chatfield, and Bear Creek Reservoirs. The inflow was stored until the high South Platte River flows began to recede. The Cherry Creek Reservoir peak daily inflow of 797 cfs was observed on September 12. The maximum daily release of 100 cfs was made to evacuate the flood storage. Plate 8-15 shows more detailed operations.

(5) Flood of 2015. Above-average rainfall experienced in May and June caused sustained encroachment in the Cherry Creek Reservoir flood control zone. The May rainfall in the upper South Platte River basin was 3-8 in above normal, which was over 600% of normal in some areas. The worst flooding occurred along the tributaries and main stem South Platte River downstream of Cherry Creek Dam and the City of Denver. As shown on Plate 8-16, the storage and release of water from Cherry Creek Dam was coordinated with the storage and release of water from Bear Creek and Chatfield Dams to reduce downstream flooding. The peak daily inflow of 1,231 cfs was observed on June 12. The peak release of 262 cfs was made mid-May to evacuate the initial flood storage.

b. Improvement of Regulation Techniques. Studies will continue to be produced and updated to improve the regulation techniques.

Following the development of the upper South Platte River CWMS modeling suite in FY13, new curves for estimating the approximate magnitude of flood damages by impact area were developed and finalized in July 2015. Plates 4-23 through 4-30e show the curves and inundation maps. In addition, the modeling suite was used in the FY16

Cherry Creek Dam Water Control Plan Modification Study that resulted in modified Cherry Creek Dam, Chatfield Dam, and Bear Creek Dam WCPs. The ongoing Cherry Creek DSMS, which addresses the overtopping concern related to the PMF routing, was initiated in FY13 and is scheduled to be complete in 2020. The study developed and evaluated potential alternatives to reduce risks associated with Cherry Creek Dam. The no action alternative was the final decision; however, this alternative includes spillway maintenance and a modified water control plan (refer to Section 7-05) to reduce the potential of overtopping and failure.

c. Channel and Floodway Improvement. Between the Corps, MHFD, and the various other local entities, many studies have been done concerning flood plain improvements and channel capacity through the Denver metropolitan area. Recently the City and County of Denver (along with the MHFD, CWCB, and others) partnered with USACE to conduct an FR/EIS to investigate opportunities to restore degraded habitats and reduce flood risks along the South Platte River and several tributaries within City and County of Denver. The Final Chief's Report was approved in July 2019 and the record of decision was signed in October 2019 recommending a plan that will restore about 450 acres of habitat and increase channel capacity along the South Platte River, as well as reducing flood threats on Weir Gulch and Harvard Gulch tributaries through channel improvements and nonstructural means. The approved plan is expected to be implemented over the next 10-15 years.

Maintenance of downstream channel conveyance has been a challenge. The open conveyance areas downstream of reservoirs are often seen as locations for development and/or vegetated open space. These activities are at risk of inundation and may be impacted by large reservoir releases and local runoff.

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 9

WATER CONTROL MANAGEMENT

9-01. Responsibilities and Organization.

a. Corps of Engineers. ER 1110-2-1400 assigns the Corps' reservoir regulation responsibilities in the Missouri River basin to the NWD Commander. ER 1110-2-1400 also permits delegation of certain reservoir regulation responsibilities to the District Engineer in whose area the project is located. The responsibilities for assembly and interpretation of data affecting current reservoir regulation and for carrying out routine regulation of Cherry Creek Reservoir, according to plans agreed on in advance, have been delegated to the Omaha District Engineer. The NWD Commander, through the MRBWM office, monitors and reviews the regulation activities performed by the Omaha District. Plate 9-1 shows an organization chart for the Omaha District.

Plate 5-5 illustrates the normal coordination of the Omaha District with regards to Cherry Creek Reservoir regulation. The operation of Cherry Creek Dam and Reservoir normally involves two units of the Omaha District organization:

(1) Water Control and Water Quality Section, Engineering Division. The WCWQS acting for the District Engineer, is responsible for matters pertaining to the regulation of the reservoir. Throughout the year, the WCWQS maintains control of reservoir releases to attain optimum flood control benefits and control of project storage to ensure regulation in conformance with the authorized functions of the project. The WCWQS is responsible for procurement of necessary precipitation, streamflow, and reservoir elevation data. The WCWQS also makes advance estimates of streamflows from snow cover and/or rainfall reports for forecasting and regulation purposes and to alert field operating personnel of potential flood threats.

(2) Tri-Lakes Project Office, Operations Division. The Operations Division plans and directs the maintenance and physical operation of the project. It establishes the standards of maintenance and provides proper staffing of operating personnel at the Tri-Lakes Project Office to accomplish these objectives. The Tri-Lakes Project Office's staff performs in the field those functions of operation, maintenance, and regulation requested by the Operations Division and the WCWQS. Exhibit I, *Standing Instructions to the Dam Tender*, details the Dam Tender's duties for regulation, which generally are to:

(i) collect and report project hydrologic data;

(ii) receive and report streamflow and precipitation data;

(iii) alert WCWQS personnel of actual or impending flood conditions affecting the project;

(iv) maintain liaison with State Water Engineers;

(v) determine releases to be made from the project in the event of communication failure during a flood emergency;

(vi) prepare records and reports of regulation activities; and

(vii) operate outlet gates as required by regulation orders.

(3) Flood Period Organization. The normal organization of the Omaha District is somewhat modified during a flood period to take care of the additional duties made necessary by a flood emergency. Refer to Section 7-03.c.(3) for additional information.

b. Other Federal Agencies. None at this project.

c. State of Colorado. The State of Colorado will be represented by the Colorado State Engineer's Office of the CDWR. The State Engineer's Office is responsible for administration of all state water laws and accounting for ownership of all water stored in the multipurpose zone (5504 to 5550 ft PD) of the reservoir. The State Engineer's Office is also responsible for satisfying all downstream water requirements below the Cherry Creek Project. Under normal circumstances, the State Engineer's Office tracks water rights on Cherry Creek and the South Platte River and makes requests for releases to the WCWQS. However, as determined by the Corps' Omaha District dam safety officer, should any dam safety issues arise, the Corps will assume all regulation decisions.

The Colorado P&W, as the project sponsor, is responsible for acquiring the water for multipurpose uses including fish and wildlife. The project sponsor is also responsible for developing the recreation facilities at the project in accordance with the Cherry Creek Project Master Plan, which is developed by the Corps.

d. Private Organizations. None at this project.

9-02. Interagency Coordination.

a. Local Press and Corps Bulletins. Press releases are made on an "as-needed" basis. Corps reservoir bulletins or reports are prepared daily and are available via the MRBWM website.

b. National Weather Service. Local weather forecasting information is provided by the Boulder, CO NWS WFO.

c. U.S. Geological Survey. An existing cooperative streamgaging program between the Corps and the USGS is used to maintain DCPs and streamflow measurements.

d. Colorado Division of Water Resources. An existing cooperative streamgaging agreement between the Corps and the State of Colorado is used to maintain DCPs and streamflow measurements.

e. Natural Resources Conservation Service. The NRCS is the agency responsible for compiling all snow course and SNOTEL information for the basin although none exist in the Cherry Creek basin. No snowmelt runoff forecast is computed for the Cherry Creek basin since very little of the annual runoff comes from snowmelt.

f. Other Federal, State, or Local Agencies. The MHFD, CWCB, and Denver Regional Council of Governments (DRCOG) are agencies with great interest in the Cherry Creek Project operations.

9-03. Interagency Agreements. None at this project.

9-04. Commissions, River and Authorities, Compacts, and Committees. All water rights activities are administered by the State of Colorado.

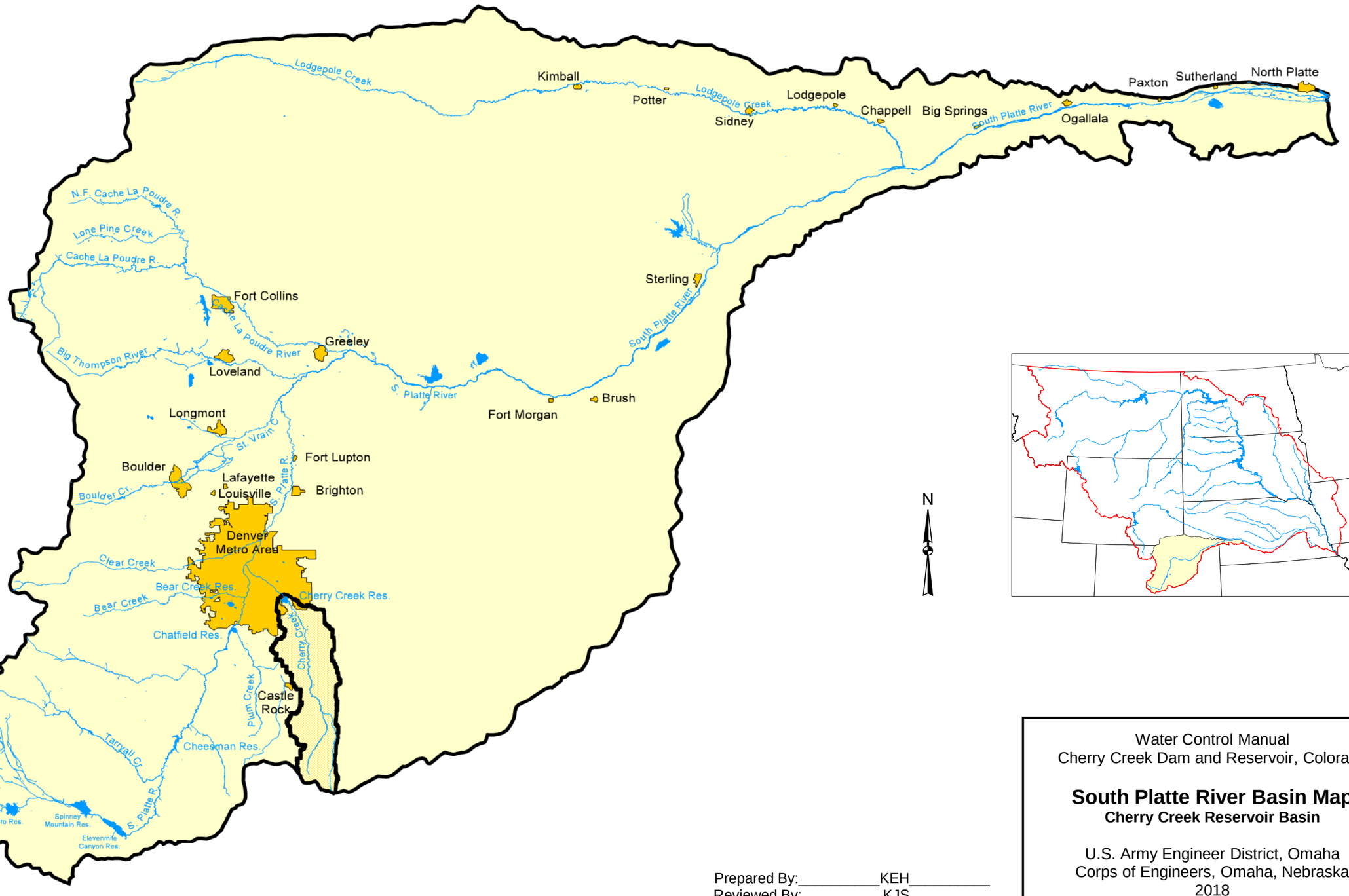
9-05. Non-Federal Hydropower. None at this project.

9-06. Reports. Required reports are shown in Table 9-1, along with the report's governing regulation and required schedule.

Table 9-1
CHERRY CREEK PROJECT REPORT REQUIREMENTS

Report Title	Regulation or Guidance	Schedule
Reservoir Regulation Orders	EM 1110-2-3600	Every release change
Reservoir Bulletin Omaha District WCWQS	EM 1110-2-3600	Daily
Monthly Reservoir Operation Reports	EM 1110-2-3600 ER 1110-2-240	Monthly
Annual Report Omaha District WCWQS	EM 1110-2-3600	Annual
Flood Damages Prevented Omaha District WCWQS	EM 1110-2-3600	Annual
Flood Emergency Reporting	EM 500-1-1	Per flood requirements

THIS PAGE INTENTIONALLY LEFT BLANK

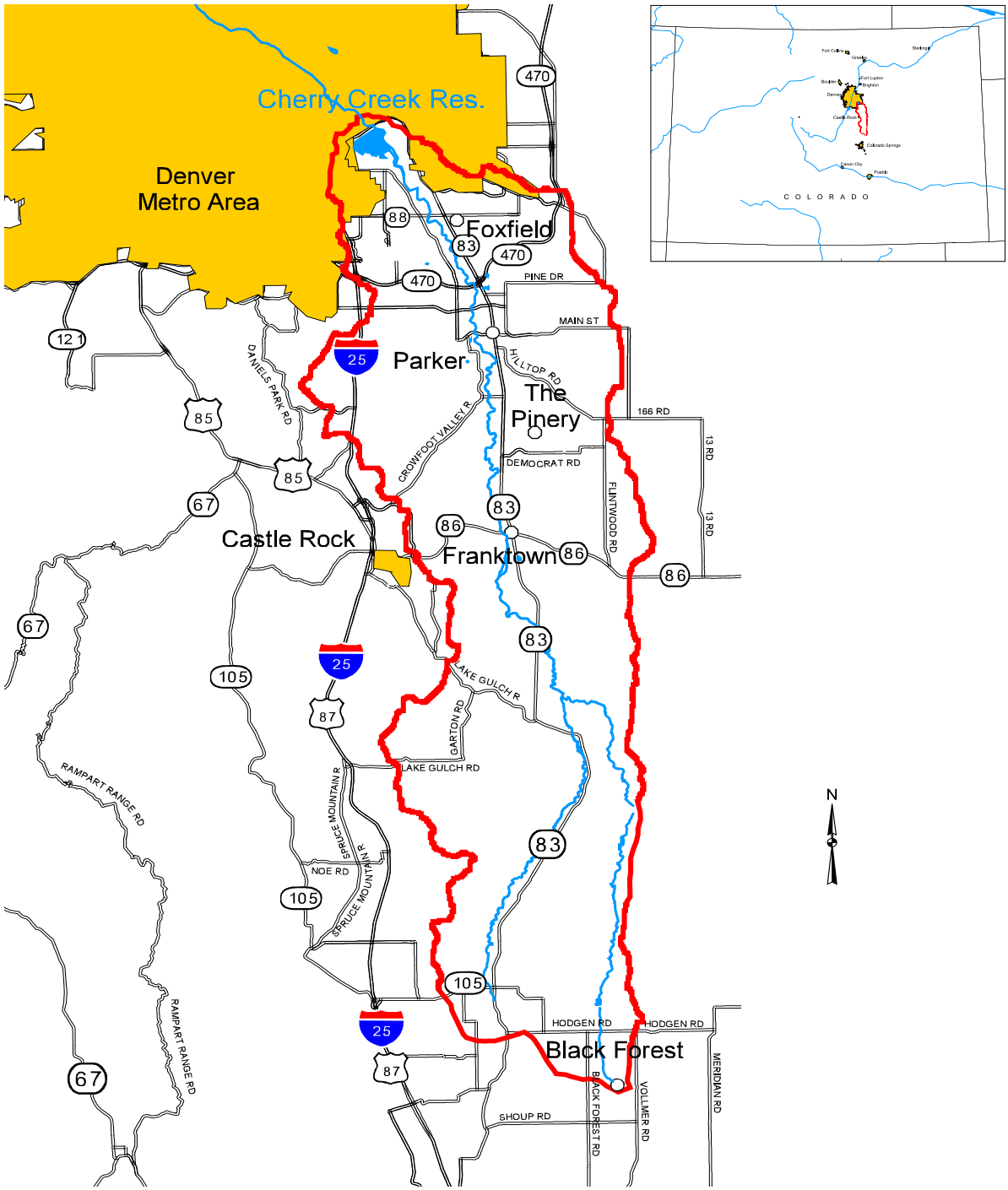


Prepared By:_____KEH_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

South Platte River Basin Map
Cherry Creek Reservoir Basin

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Cherry Creek Basin Map

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

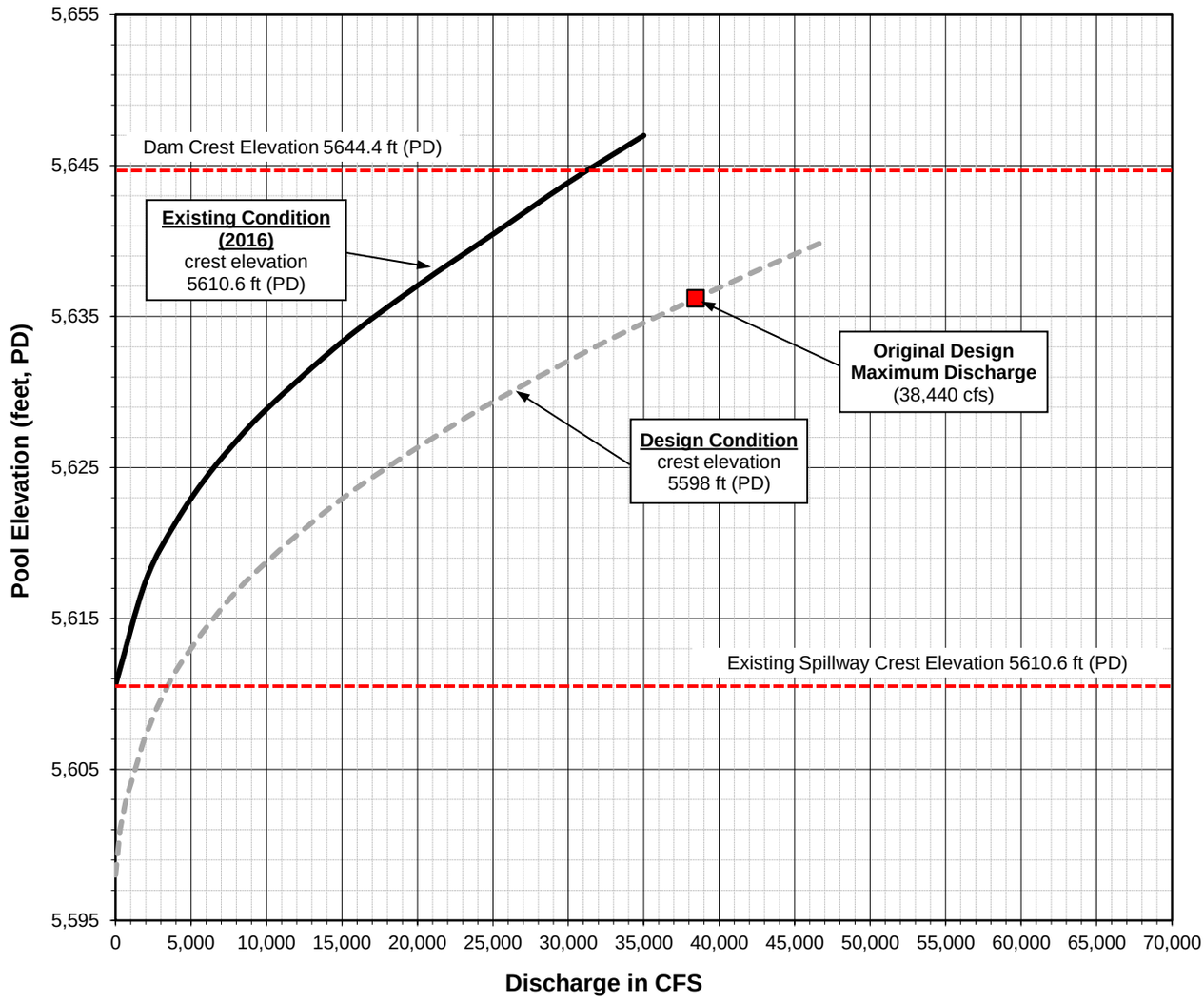
Prepared By:_____KEH_____
Reviewed By:_____KJS_____

Plate 2-3

Plate 2-4

Plate 2-5

Spillway Discharge Rating Curves Comparison



Design Condition (NOT FOR CURRENT USE)

The spillway was originally excavated to elevation 5598.0 feet Project Datum (PD) with a 67-foot bottom width for the first 8,500 feet and a 1,000-foot transition to a 45-foot bottom width for the remaining 2,600 feet of the excavation. The spillway channel was excavated into overburden with 1V on 2H side slopes and into the Denver Formation with 1V on 1H side slopes. All of the excavated material was placed in spoil banks adjacent to both sides of the spillway. These spoil banks had 50-foot top widths and side slopes of 1V on 3H.

Existing Condition (2016)

In 2008 a spillway survey was conducted that determined the spillway side slopes had continued to slough into the spillway bottom increasing the spillway crest and lowering the capacity. The new crest was measured at 5610.6 feet PD. As part of the dam safety modification study, it was determined that the low steel on the bike trail bridge and Parker Road bridge located at the spillway entrance interferes with spillway flow. Also, manning's n was adjusted along the entire length to 0.05. The spillway curve was re-calculated in 2016 assuming a spillway crest of 5610.6 feet PD from the 2008 spillway survey.

Note: the reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Spillway Discharge Rating Curves

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM
SPILLWAY RATING TABLE -- DESIGN CONDITIONS

DISCHARGE IN CFS

POOL ELEV. (feet, PD)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5598	0	10	20	30	40	50	60	70	80	90
5599	100	110	120	130	140	150	160	170	180	190
5600	200	210	220	230	240	250	260	270	280	290
5601	300	320	340	360	380	400	420	440	460	480
5602	500	520	540	560	580	600	620	640	660	680
5603	700	730	760	790	820	850	880	910	940	970
5604	1000	1030	1060	1090	1120	1150	1180	1210	1240	1270
5605	1300	1330	1360	1390	1420	1450	1480	1510	1540	1570
5606	1600	1630	1660	1690	1720	1750	1780	1810	1840	1870
5607	1900	1940	1980	2020	2060	2100	2140	2180	2220	2260
5608	2300	2340	2380	2420	2460	2500	2540	2580	2620	2660
5609	2700	2750	2800	2850	2900	2950	3000	3050	3100	3150
5610	3200	3250	3300	3350	3400	3450	3500	3550	3600	3650
5611	3700	3760	3820	3880	3940	4000	4060	4120	4180	4240
5612	4300	4370	4440	4510	4580	4650	4720	4790	4860	4930
5613	5000	5070	5140	5210	5280	5350	5420	5490	5560	5630
5614	5700	5070	5140	5210	5280	5350	5420	5490	5560	5630
5615	6500	6580	6660	6740	6820	6900	6980	7060	7140	7220
5616	7300	7390	7480	7570	7660	7750	7840	7930	8020	8110
5617	8200	8300	8400	8500	8600	8700	8800	8900	9000	9100
5618	9200	9310	9420	9530	9640	9750	9860	9970	10080	10190
5619	10300	10410	10520	10630	10740	10850	10960	11070	11180	11290
5620	11400	11520	11640	11760	11880	12000	12120	12240	12360	12480
5621	12600	12720	12840	12960	13080	13200	13320	13440	13560	13680
5622	13800	13930	14060	14190	14320	14450	14580	14710	14840	14970
5623	15100	15240	15380	15520	15660	15800	15940	16080	16220	16360
5624	16500	16650	16800	16950	17100	17250	17400	17550	17700	17850
5625	18000	18150	18300	18450	18600	18750	18900	19050	19200	19350
5626	19500	19660	19820	19980	20140	20300	20460	20620	20780	20940
5627	21100	21260	21420	21580	21740	21900	22060	22220	22380	22540
5628	22700	22870	23040	23210	23380	23550	23720	23890	24060	24230
5629	24400	24580	24760	24940	25120	25300	25480	25660	25840	26020
5630	26200	26380	26560	26740	26920	27100	27280	27460	27640	27820
5631	28000	28190	28380	28570	28760	28950	29140	29330	29520	29710
5632	29900	30090	30280	30470	30660	30850	31040	31230	31420	31610
5633	31800	32000	32200	32400	32600	32800	33000	33200	33400	33600
5634	33800	34010	34220	34430	34640	34850	35060	35270	35480	35690
5635	35900	36110	36320	36530	36740	36950	37160	37370	37580	37790
5636	38000	38220	38440	38660	38880	39100	39320	39540	39760	39980
5637	40200	40420	40640	40860	41080	41300	41520	41740	41960	42180
5638	42400	42630	42860	43090	43320	43550	43780	44010	44240	44470
5639	44700	44930	45160	45390	45620	45850	46080	46310	46540	46770
5640	47000									

Note: the reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Spillway Rating Table
Design Conditions

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM

SPILLWAY RATING TABLE -- EXISTING CONDITIONS (2016)

DISCHARGE IN CFS

(feet, PD)	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
5610							0	29	58	87
5611	116	145	174	203	232	261	290	319	348	377
5612	406	435	464	493	522	552	581	610	639	668
5613	697	726	755	784	813	842	871	900	929	958
5614	987	1,016	1,045	1,074	1,103	1,132	1,161	1,190	1,219	1,248
5615	1,277	1,306	1,335	1,364	1,393	1,422	1,451	1,480	1,509	1,538
5616	1,567	1,597	1,626	1,655	1,684	1,713	1,742	1,771	1,800	1,829
5617	1,858	1,887	1,916	1,945	1,974	**2,000**	2,057	2,108	2,159	2,211
5618	2,262	2,314	2,365	2,416	2,468	2,519	2,571	2,622	2,674	2,725
5619	2,776	2,828	2,879	2,931	2,982	3,033	3,085	3,136	3,188	3,239
5620	3,290	3,342	3,393	3,445	3,496	3,548	3,599	3,650	3,702	3,753
5621	3,805	3,856	3,907	3,959	**4,000**	4,081	4,149	4,217	4,285	4,353
5622	4,420	4,488	4,556	4,624	4,692	4,759	4,827	4,895	4,963	5,031
5623	5,098	5,166	5,234	5,302	5,369	5,437	5,505	5,573	5,641	5,708
5624	5,776	5,844	5,912	5,980	**6,000**	6,140	6,223	6,306	6,388	6,471
5625	6,554	6,636	6,719	6,802	6,884	6,967	7,050	7,132	7,215	7,298
5626	7,380	7,463	7,545	7,628	7,711	7,793	7,876	7,959	**8,000**	8,142
5627	8,237	8,332	8,427	8,521	8,616	8,711	8,806	8,900	8,995	9,090
5628	9,185	9,280	9,374	9,469	9,564	9,659	9,754	9,848	9,943	**10,000**
5629	10,157	10,269	10,381	10,493	10,605	10,717	10,830	10,942	11,054	11,166
5630	11,278	11,390	11,502	11,614	11,726	11,839	11,951	12,063	12,175	12,287
5631	12,399	12,511	12,623	12,735	12,848	12,960	13,072	13,184	13,296	13,408
5632	13,520	13,632	13,744	13,857	13,969	14,081	14,193	14,305	14,417	14,529
5633	14,641	14,753	14,865	**15,000**	15,108	15,242	15,376	15,511	15,645	15,780
5634	15,914	16,048	16,183	16,317	16,452	16,586	16,720	16,855	16,989	17,124
5635	17,258	17,392	17,527	17,661	17,796	17,930	18,065	18,199	18,333	18,468
5636	18,602	18,737	18,871	19,005	19,140	19,274	19,409	19,543	19,677	19,812
5637	**20,000**	20,088	20,235	20,381	20,528	20,674	20,821	20,968	21,114	21,261
5638	21,408	21,554	21,701	21,848	21,994	22,141	22,287	22,434	22,581	22,727
5639	22,874	23,021	23,167	23,314	23,460	23,607	23,754	23,900	24,047	24,194
5640	24,340	24,487	24,633	24,780	24,927	**25,000**	25,219	25,364	25,510	25,656
5641	25,802	25,948	26,093	26,239	26,385	26,531	26,676	26,822	26,968	27,114
5642	27,259	27,405	27,551	27,697	27,843	27,988	28,134	28,280	28,426	28,571
5643	28,717	28,863	29,009	29,155	29,300	29,446	29,592	29,738	29,883	**30,000**
5644	30,193	30,354	30,514	30,675	30,836	30,997	31,158	31,318	31,479	31,640
5645	31,801									

Notes:
1) Survey data from April 2008.
2) Values that are not bolded were linearly interpolated. This table should be used as an estimate of spillway discharge.
3) The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

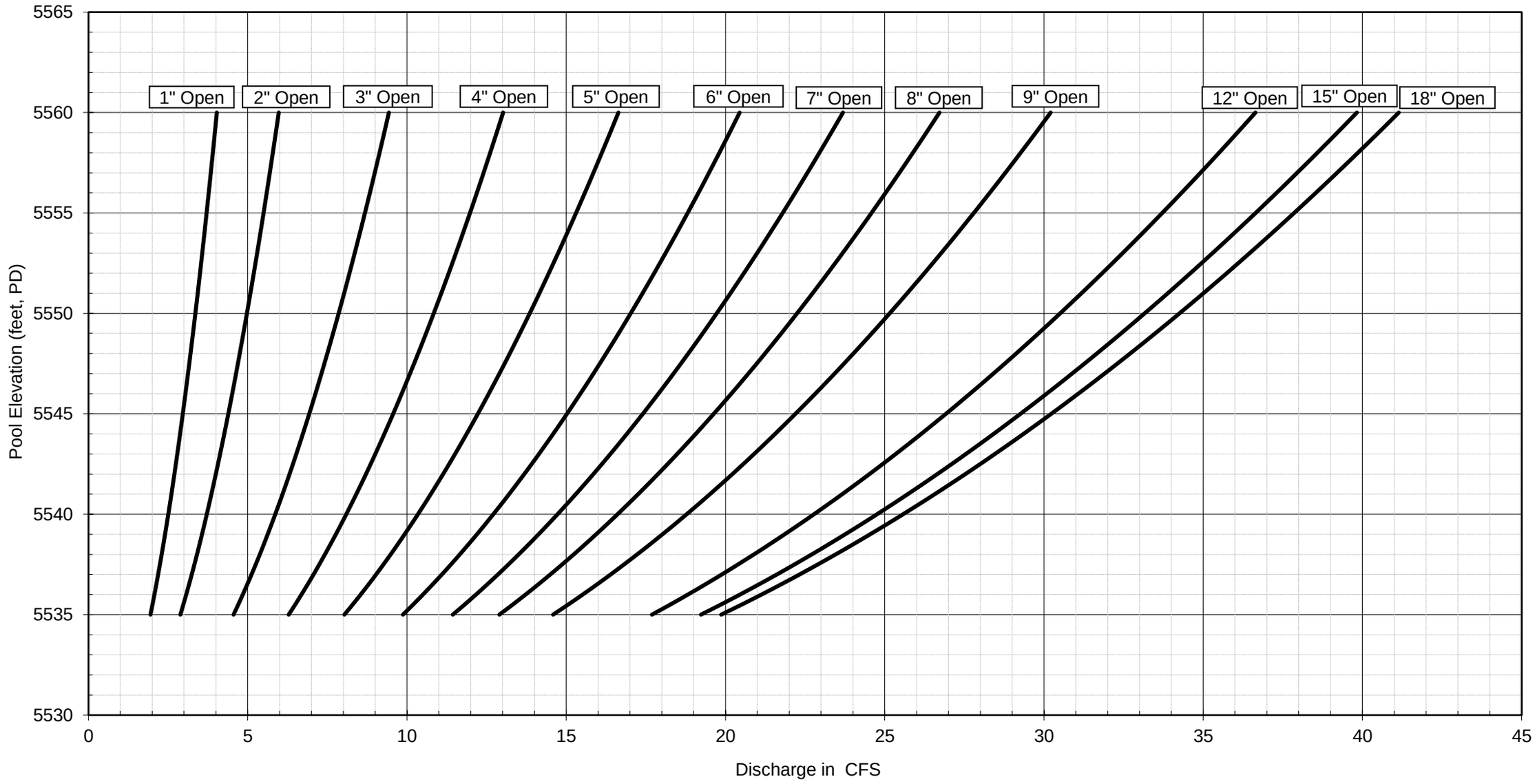
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Spillway Rating Table
Existing Conditions

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 2-9

Cherry Creek Dam Low Flow Bypass Regulation
Rating Curves for One Pipe with Gate Openings as Shown



Notes:
1. Rating based on one low flow gate in one conduit opened.
2. Double the discharge to determine discharge for two gates open.
3. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Discharge Rating Curves
18" Low Flow Bypass Valve Regulation

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 2-10a

CHERRY CREEK DAM

OUTLET WORKS DISCHARGE RATING TABLE -- LOW-FLOW CONDITIONS

DISCHARGE IN CFS

Pool Elev. (feet, PD)	GATE OPENING IN INCHES											
	18"	15"	12"	9"	8"	7"	6"	5"	4"	3"	2"	1"
5535.0	19.9	19.2	17.7	14.6	12.9	11.4	9.9	8.0	6.3	4.6	2.9	1.9
5535.5	20.5	19.9	18.3	15.1	13.3	11.8	10.2	8.3	6.5	4.7	3.0	2.0
5536.0	21.1	20.5	18.8	15.5	13.7	12.2	10.5	8.5	6.7	4.8	3.1	2.1
5536.5	21.7	21.0	19.4	16.0	14.1	12.5	10.8	8.8	6.9	5.0	3.2	2.1
5537.0	22.3	21.6	19.9	16.4	14.5	12.9	11.1	9.0	7.1	5.1	3.2	2.2
5537.5	22.9	22.2	20.4	16.8	14.9	13.2	11.4	9.3	7.2	5.3	3.3	2.2
5538.0	23.5	22.7	20.9	17.2	15.2	13.5	11.7	9.5	7.4	5.4	3.4	2.3
5538.5	24.0	23.2	21.4	17.6	15.6	13.8	11.9	9.7	7.6	5.5	3.5	2.4
5539.0	24.5	23.8	21.9	18.0	15.9	14.1	12.2	9.9	7.8	5.6	3.6	2.4
5539.5	25.1	24.3	22.3	18.4	16.3	14.4	12.5	10.1	7.9	5.7	3.6	2.5
5540.0	25.6	24.8	22.8	18.8	16.6	14.7	12.7	10.3	8.1	5.9	3.7	2.5
5540.5	26.1	25.2	23.2	19.2	16.9	15.0	13.0	10.5	8.3	6.0	3.8	2.6
5541.0	26.6	25.7	23.7	19.5	17.3	15.3	13.2	10.7	8.4	6.1	3.9	2.6
5541.5	27.1	26.2	24.1	19.9	17.6	15.6	13.4	10.9	8.6	6.2	3.9	2.7
5542.0	27.5	26.7	24.5	20.2	17.9	15.9	13.7	11.1	8.7	6.3	4.0	2.7
5542.5	28.0	27.1	24.9	20.6	18.2	16.1	13.9	11.3	8.9	6.4	4.1	2.7
5543.0	28.5	27.5	25.3	20.9	18.5	16.4	14.1	11.5	9.0	6.5	4.1	2.8
5543.5	28.9	28.0	25.7	21.2	18.8	16.6	14.4	11.7	9.1	6.6	4.2	2.8
5544.0	29.4	28.4	26.1	21.6	19.1	16.9	14.6	11.9	9.3	6.7	4.3	2.9
5544.5	29.8	28.8	26.5	21.9	19.4	17.2	14.8	12.1	9.4	6.8	4.3	2.9
5545.0	30.2	29.3	26.9	22.2	19.6	17.4	15.0	12.2	9.6	6.9	4.4	3.0
5545.5	30.7	29.7	27.3	22.5	19.9	17.7	15.2	12.4	9.7	7.0	4.5	3.0
5546.0	31.1	30.1	27.7	22.8	20.2	17.9	15.4	12.6	9.8	7.1	4.5	3.0
5546.5	31.5	30.5	28.0	23.1	20.5	18.1	15.6	12.7	10.0	7.2	4.6	3.1
5547.0	31.9	30.9	28.4	23.4	20.7	18.4	15.9	12.9	10.1	7.3	4.6	3.1
5547.5	32.3	31.3	28.8	23.7	21.0	18.6	16.1	13.1	10.2	7.4	4.7	3.2
5548.0	32.7	31.7	29.1	24.0	21.2	18.8	16.3	13.2	10.3	7.5	4.7	3.2
5548.5	33.1	32.0	29.5	24.3	21.5	19.1	16.4	13.4	10.5	7.6	4.8	3.2
5549.0	33.5	32.4	29.8	24.6	21.7	19.3	16.6	13.5	10.6	7.7	4.9	3.3
5549.5	33.9	32.8	30.2	24.9	22.0	19.5	16.8	13.7	10.7	7.8	4.9	3.3
5550.0	34.3	33.2	30.5	25.2	22.2	19.7	17.0	13.9	10.8	7.9	5.0	3.4
5550.5	34.6	33.5	30.8	25.4	22.5	19.9	17.2	14.0	11.0	7.9	5.0	3.4
5551.0	35.0	33.9	31.2	25.7	22.7	20.2	17.4	14.2	11.1	8.0	5.1	3.4
5551.5	35.4	34.2	31.5	26.0	23.0	20.4	17.6	14.3	11.2	8.1	5.1	3.5
5552.0	35.7	34.6	31.8	26.2	23.2	20.6	17.8	14.5	11.3	8.2	5.2	3.5
5552.5	36.1	34.9	32.2	26.5	23.4	20.8	17.9	14.6	11.4	8.3	5.2	3.5
5553.0	36.5	35.3	32.5	26.8	23.7	21.0	18.1	14.7	11.5	8.4	5.3	3.6
5553.5	36.8	35.6	32.8	27.0	23.9	21.2	18.3	14.9	11.6	8.4	5.3	3.6
5554.0	37.2	36.0	33.1	27.3	24.1	21.4	18.5	15.0	11.8	8.5	5.4	3.6
5554.5	37.5	36.3	33.4	27.5	24.4	21.6	18.6	15.2	11.9	8.6	5.4	3.7
5555.0	37.9	36.6	33.7	27.8	24.6	21.8	18.8	15.3	12.0	8.7	5.5	3.7
5555.5	38.2	37.0	34.0	28.0	24.8	22.0	19.0	15.4	12.1	8.8	5.5	3.7
5556.0	38.5	37.3	34.3	28.3	25.0	22.2	19.2	15.6	12.2	8.8	5.6	3.8
5556.5	38.9	37.6	34.6	28.5	25.2	22.4	19.3	15.7	12.3	8.9	5.6	3.8
5557.0	39.2	37.9	34.9	28.8	25.5	22.6	19.5	15.9	12.1	9.0	5.7	3.8
5557.5	39.5	38.3	35.2	29.0	25.7	22.8	19.6	16.0	12.5	9.1	5.7	3.9
5558.0	39.9	38.6	35.5	29.3	25.9	23.0	19.8	16.1	12.6	9.1	5.8	3.9
5558.5	40.2	38.9	35.8	29.5	26.1	23.1	20.0	16.3	12.7	9.2	5.8	3.9
5559.0	40.5	39.2	36.1	29.7	26.3	23.3	20.1	16.4	12.8	9.3	5.9	4.0
5559.5	40.8	39.5	36.4	30.0	26.5	23.5	20.3	16.5	12.9	9.4	5.9	4.0
5560.0	41.1	39.8	36.6	30.2	26.7	23.7	20.4	16.6	13.0	9.4	6.0	4.0

Notes:
1. Rating based on one low flow gate in one conduit opened.
2. Double the discharge to determine discharge for two gates open.
3. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

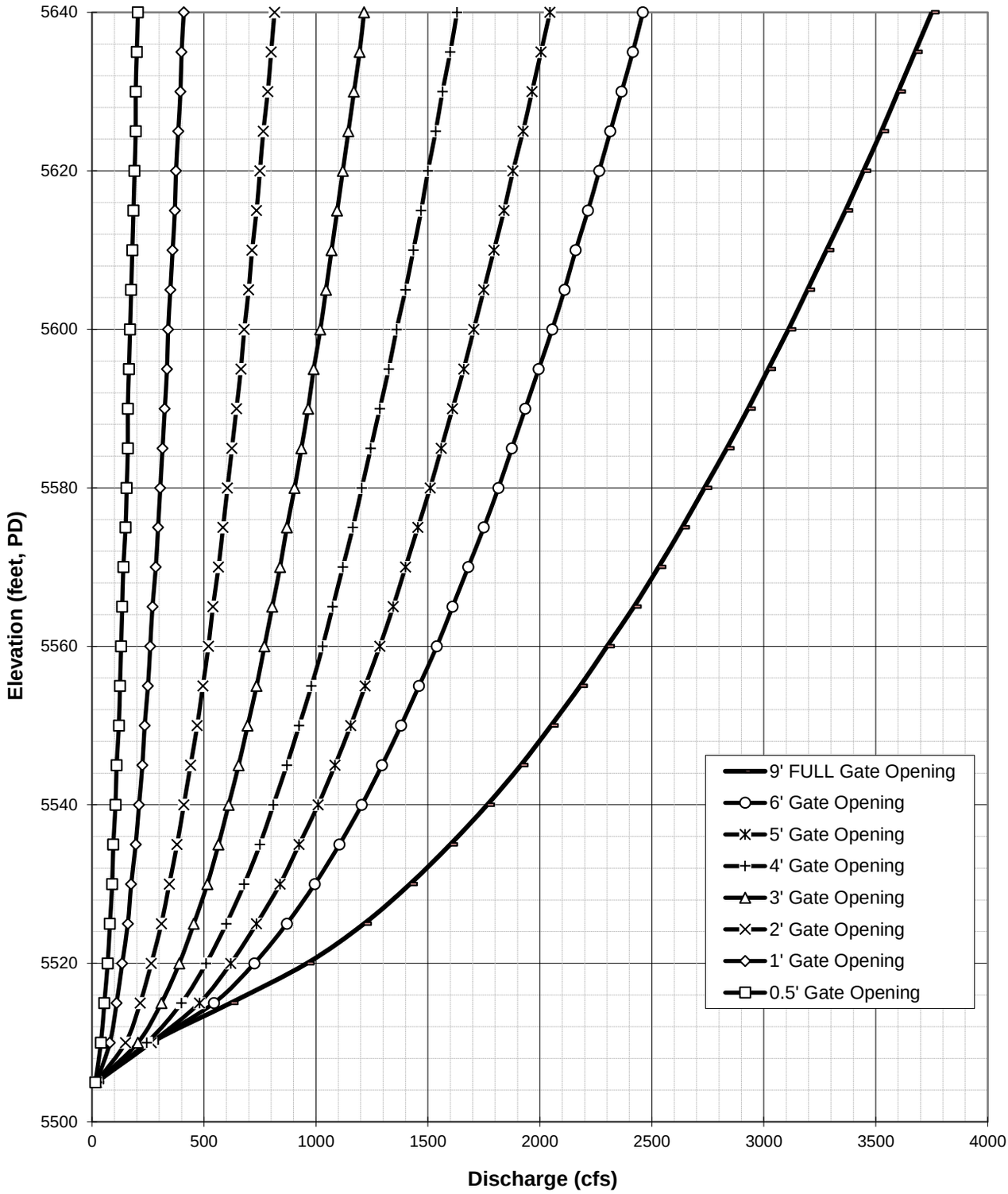
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works Discharge Rating Table
Low Flow Conditions

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Outlet Works
Discharge Rating Curves, 1 Main Service Gate Open



Notes:
1. Rating based on <u>one</u> gate in <u>one</u> conduit opened.
2. Center conduit should not be used above elevation 5590 feet, PD, due potential cavitation.
3. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
One Main Service Gate Open

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM
OUTLET WORKS DISCHARGE RATING TABLE -- 1 MAIN SERVICE GATE OPEN
Effective 2005

DISCHARGE IN CFS

Pool Elev. (feet, PD)	Gate Opening in Feet							
	0.5'	1'	2'	3'	4'	5'	6'	9' FULL
5505	15	20	20	20	20	20	20	20
5510	40	80	150	205	245	265	265	265
5515	55	110	215	310	400	480	545	620
5520	70	135	265	390	510	620	725	960
5525	80	160	310	455	600	735	870	1215
5530	90	175	345	515	680	840	995	1420
5535	95	195	380	565	750	925	1105	1600
5540	105	210	410	610	810	1010	1205	1765
5545	110	225	440	655	870	1085	1295	1915
5546	115	225	445	665	880	1100	1315	1940
5547	115	230	450	670	895	1115	1330	1970
5548	115	230	455	680	905	1125	1345	1995
5549	115	235	465	690	915	1140	1365	2025
5550	120	235	470	695	925	1155	1380	2050
5551	120	240	475	705	935	1170	1400	2075
5552	120	240	480	710	945	1180	1415	2105
5553	120	245	485	720	960	1195	1430	2130
5554	125	245	490	725	970	1210	1445	2155
5555	125	250	495	735	980	1220	1460	2180
5560	130	260	520	770	1030	1285	1540	2300
5565	135	270	540	805	1075	1345	1610	2420
5570	140	285	565	840	1120	1400	1680	2530
5575	150	295	585	870	1165	1455	1750	2635
5580	155	305	605	905	1205	1510	1815	2735
5585	160	315	625	935	1245	1560	1875	2835
5590	160	325	645	965	1285	1610	1935	2930
5595	165	335	665	990	1325	1660	1995	3020
5600	170	340	680	1020	1360	1705	2055	3110
5605	175	350	700	1045	1400	1750	2110	3195
5610	180	360	715	1070	1435	1795	2160	3280
5615	185	370	735	1095	1470	1840	2215	3365
5620	190	375	750	1120	1500	1880	2265	3445
5625	195	385	765	1145	1535	1925	2315	3525
5630	195	395	785	1170	1565	1965	2365	3600
5635	200	400	800	1195	1600	2005	2415	3675
5640	205	410	815	1215	1630	2045	2460	3750

Notes:
1. Rating based on one gate in one conduit opened.
2. Center conduit should not be used above elevation 5590 feet, PD.
3. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

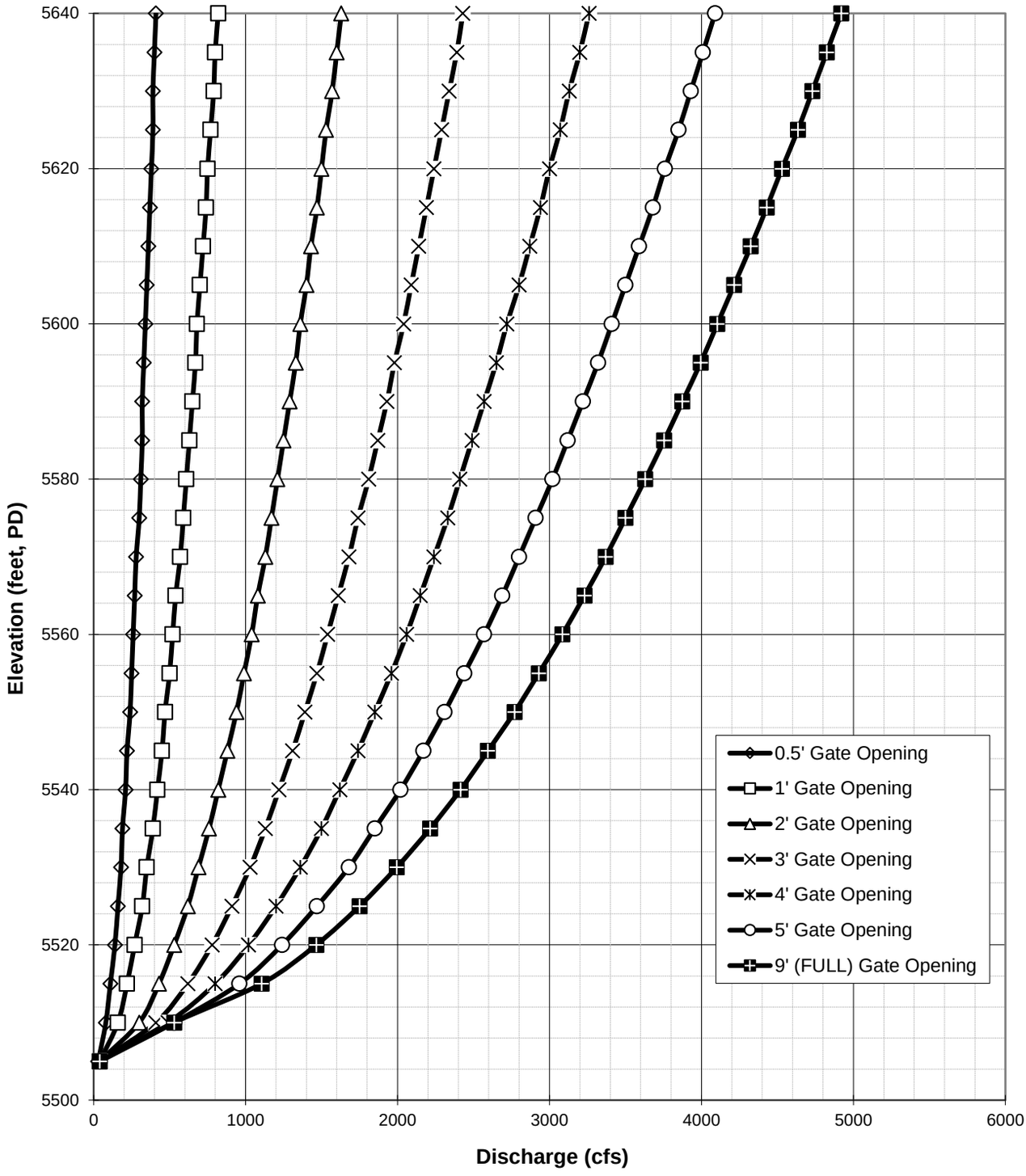
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
One Main Service Gate Open

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 2-11b

Outlet Works
Discharge Rating Curves, 2 Main Service Gates Open Uniformly



Notes:

1. Rating based on both gates in a conduit opened uniformly.
2. For two main gates the ratings for a 6 and 9 foot opening are nearly the same because the tunnel is controlling.
3. Center conduit should not be used above elevation 5590 feet, PD.
4. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
Two Main Service Gates Open Uniformly
One Conduit

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM
OUTLET WORKS DISCHARGE RATING TABLE -- 2 MAIN SERVICE GATES OPEN UNIFORMLY
Effective 2005

DISCHARGE IN CFS

Pool Elev. (feet, PD)	Gate Opening in Feet							
	0.5'	1'	2'	3'	4'	5'	6'	9' FULL
5505	30	40	40	40	40	40	40	40
5510	80	160	300	410	490	530	530	530
5515	110	220	430	620	800	960	1090	1105
5520	140	270	530	780	1020	1240	1450	1465
5525	160	320	620	910	1200	1470	1740	1750
5530	180	350	690	1030	1360	1680	1990	1995
5535	190	390	760	1130	1500	1850	2210	2215
5540	210	420	820	1220	1620	2020	2410	2415
5545	220	450	880	1310	1740	2170	2590	2595
5546	230	450	890	1330	1760	2200	2630	2630
5547	230	460	900	1340	1790	2230	2660	2665
5548	230	460	910	1360	1810	2250	2690	2700
5549	230	470	930	1380	1830	2280	2730	2735
5550	240	470	940	1390	1850	2310	2760	2770
5551	240	480	950	1410	1870	2340	2800	2800
5552	240	480	960	1420	1890	2360	2830	2835
5553	240	490	970	1440	1920	2390	2860	2865
5554	250	490	980	1450	1940	2420	2890	2900
5555	250	500	990	1470	1960	2440	2920	2930
5560	260	520	1040	1540	2060	2570	3080	3085
5565	270	540	1080	1610	2150	2690	3220	3230
5570	280	570	1130	1680	2240	2800	3360	3370
5575	300	590	1170	1740	2330	2910	3500	3500
5580	310	610	1210	1810	2410	3020	3630	3630
5585	320	630	1250	1870	2490	3120	3750	3755
5590	320	650	1290	1930	2570	3220	3870	3875
5595	330	670	1330	1980	2650	3320	3990	3995
5600	340	680	1360	2040	2720	3410	4105	4105
5605	350	700	1400	2090	2800	3500	4215	4215
5610	360	720	1430	2140	2870	3590	4320	4325
5615	370	740	1470	2190	2940	3680	4430	4430
5620	380	750	1500	2240	3000	3760	4530	4530
5625	390	770	1530	2290	3070	3850	4630	4635
5630	390	790	1570	2340	3130	3930	4730	4730
5635	400	800	1600	2390	3200	4010	4825	4825
5640	410	820	1630	2430	3260	4090	4920	4920

Notes:
1. Rating based on both gates in a conduit opened uniformly.
2. For two main gates the ratings for a 6 and 9 foot opening are nearly the same because the tunnel is controlling.
3. Center conduit should not be used above elevation 5590 feet, PD.
4. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

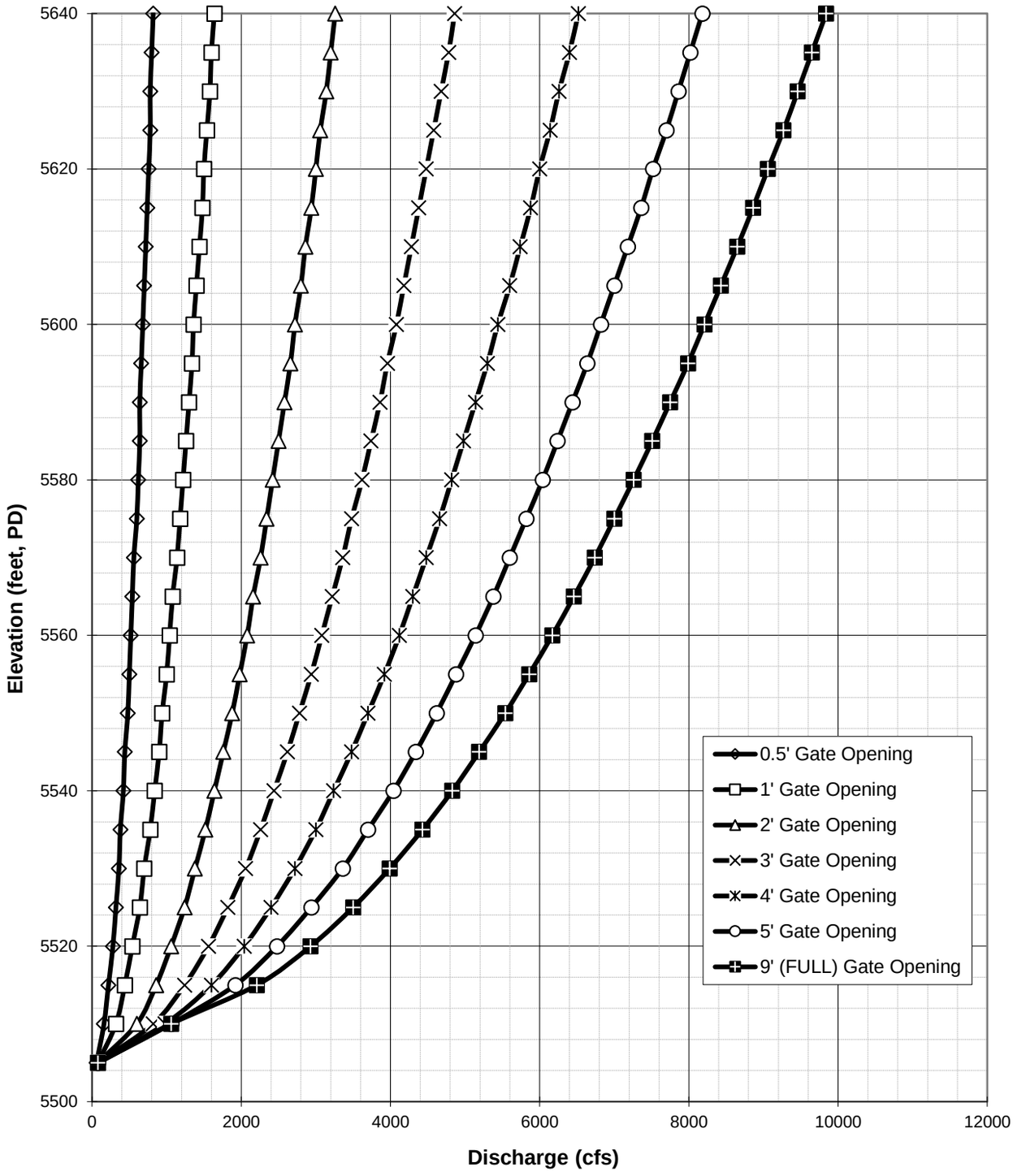
Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
Two Main Service Gates Open Uniformly
One Conduit

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Outlet Works
Discharge Rating Curves, 4 Main Service Gates Open Uniformly



Notes:

1. Rating based on both gates in both conduit opened uniformly.
2. For two main gates the ratings for a 6 and 9 foot opening are nearly the same because the tunnel is controlling.
3. Center conduit should not be used above elevation 5590 feet, PD.
4. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
Four Main Service Gates Open Uniformly
Two Conduits

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM

OUTLET WORKS DISCHARGE RATING TABLE -- 4 MAIN SERVICE GATES OPEN UNIFORMLY

Effective 2005

DISCHARGE IN CFS

Pool Elev. (feet, PD)	Gate Opening in Feet							
	0.5'	1'	2'	3'	4'	5'	6'	9' FULL
5505	60	80	80	80	80	80	80	80
5510	160	320	600	820	980	1060	1060	1060
5515	220	440	860	1240	1600	1920	2180	2210
5520	280	540	1060	1560	2040	2480	2900	2930
5525	320	640	1240	1820	2400	2940	3480	3500
5530	360	700	1380	2060	2720	3360	3980	3990
5535	380	780	1520	2260	3000	3700	4420	4430
5540	420	840	1640	2440	3240	4040	4820	4830
5545	440	900	1760	2620	3480	4340	5180	5190
5546	460	900	1780	2660	3520	4400	5260	5260
5547	460	920	1800	2680	3580	4460	5320	5330
5548	460	920	1820	2720	3620	4500	5380	5400
5549	460	940	1860	2760	3660	4560	5460	5470
5550	480	940	1880	2780	3700	4620	5520	5540
5551	480	960	1900	2820	3740	4680	5600	5600
5552	480	960	1920	2840	3780	4720	5660	5670
5553	480	980	1940	2880	3840	4780	5720	5730
5554	500	980	1960	2900	3880	4840	5780	5800
5555	500	1000	1980	2940	3920	4880	5840	5860
5560	520	1040	2080	3080	4120	5140	6160	6170
5565	540	1080	2160	3220	4300	5380	6440	6460
5570	560	1140	2260	3360	4480	5600	6720	6740
5575	600	1180	2340	3480	4660	5820	7000	7000
5580	620	1220	2420	3620	4820	6040	7260	7260
5585	640	1260	2500	3740	4980	6240	7500	7510
5590	640	1300	2580	3860	5140	6440	7740	7750
5595	660	1340	2660	3960	5300	6640	7980	7990
5600	680	1360	2720	4080	5440	6820	8210	8210
5605	700	1400	2800	4180	5600	7000	8430	8430
5610	720	1440	2860	4280	5740	7180	8640	8650
5615	740	1480	2940	4380	5880	7360	8860	8860
5620	760	1500	3000	4480	6000	7520	9060	9060
5625	780	1540	3060	4580	6140	7700	9260	9270
5630	780	1580	3140	4680	6260	7860	9460	9460
5635	800	1600	3200	4780	6400	8020	9650	9650
5640	820	1640	3260	4860	6520	8180	9840	9840

Notes:

1. Rating based on both gates in both conduit opened uniformly.
2. For two main gates the ratings for a 6 and 9 foot opening are nearly the same because the tunnel is controlling.
3. Center conduit should not be used above elevation 5590 feet, PD.
4. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____

Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

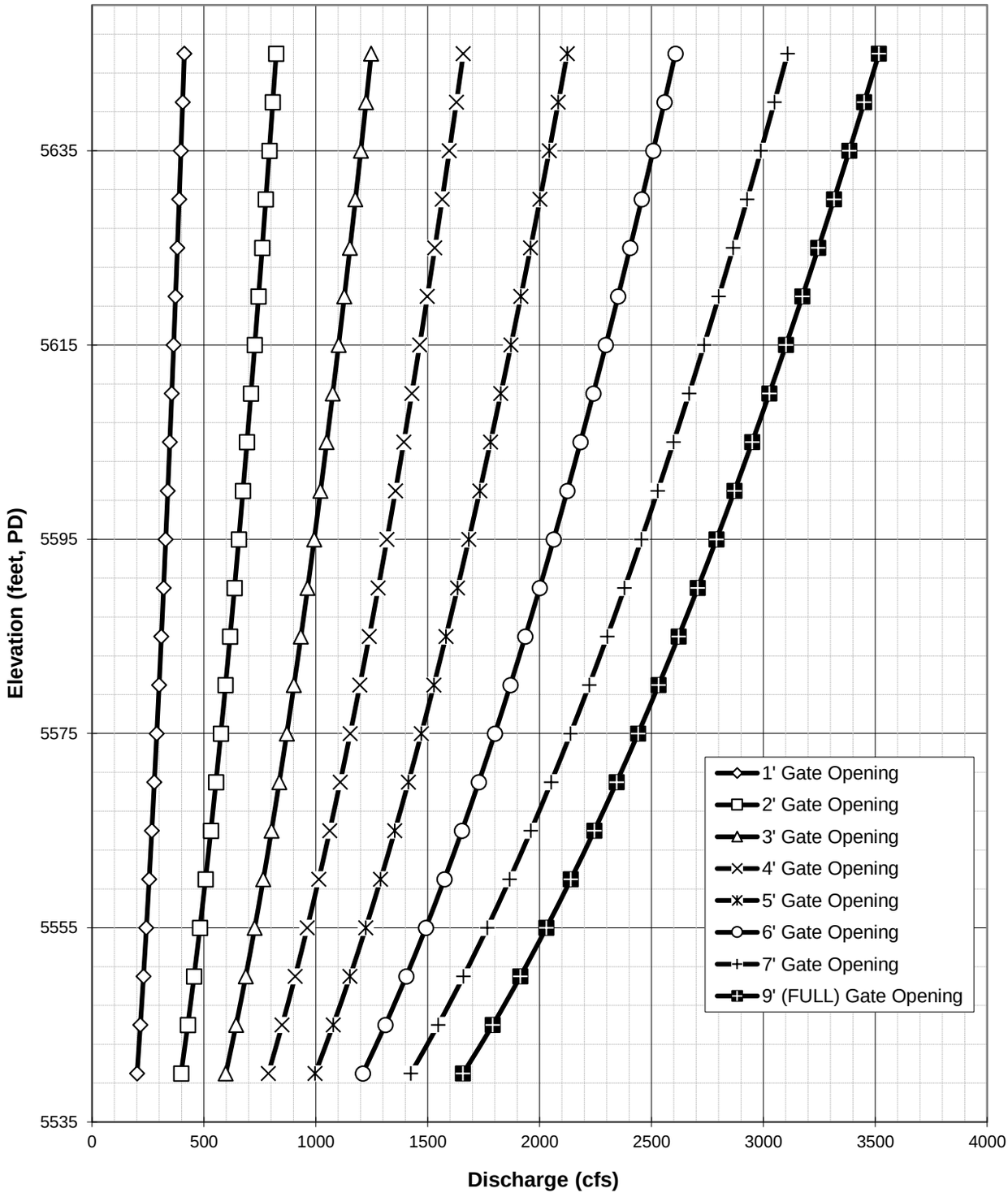
Outlet Works

Four Main Service Gates Open Uniformly
Two Conduits

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 2-13b

Outlet Works
Discharge Rating Curves, Center Conduit



Notes:
1. Center conduit should not be used above elevation 5590 feet, PD.
2. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
Center Conduit

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

CHERRY CREEK DAM
OUTLET WORKS DISCHARGE RATING TABLE -- CENTER CONDUIT

DISCHARGE IN CFS

Pool Elev. (feet, PD)	Gate Opening in Feet 1'	2'	3'	4'	5'	6'	7'	8'	9' FULL
5540	201	398	598	788	997	1210	1424	1622	1658
5545	216	428	644	850	1078	1310	1547	1766	1791
5550	230	456	687	907	1153	1404	1660	1898	1914
5555	243	482	727	962	1223	1492	1766	2023	2030
5560	255	507	765	1013	1290	1574	1866	2139	2140
5565	267	531	802	1062	1353	1653	1961	2245	2245
5570	278	554	837	1109	1414	1728	2052	2344	2344
5575	289	576	870	1154	1472	1800	2138	2440	2440
5580	300	597	902	1197	1528	1869	2222	2532	2532
5585	310	617	934	1239	1581	1936	2302	2621	2621
5590	320	637	964	1279	1633	2001	2380	2707	2707
5595	329	656	993	1318	1684	2063	2455	2790	2790
5600	339	674	1021	1356	1733	2124	2528	2871	2871
5605	348	693	1049	1393	1781	2183	2599	2950	2950
5610	356	710	1076	1429	1827	2240	2668	3027	3027
5615	365	727	1102	1464	1872	2296	2735	3101	3101
5620	373	744	1128	1498	1916	2351	2801	3174	3174
5625	381	761	1153	1532	1960	2404	2865	3246	3246
5630	389	777	1177	1565	2002	2456	2928	3315	3315
5635	397	792	1201	1597	2043	2507	2989	3384	3384
5640	405	808	1225	1628	2084	2558	3049	3451	3451
5645	413	823	1248	1659	2124	2607	3108	3517	3517

Notes:
1. Center conduit should not be used above elevation 5590 feet, PD.
2. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KKA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Outlet Works
Center Conduit

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 2-15

Plate 2-16

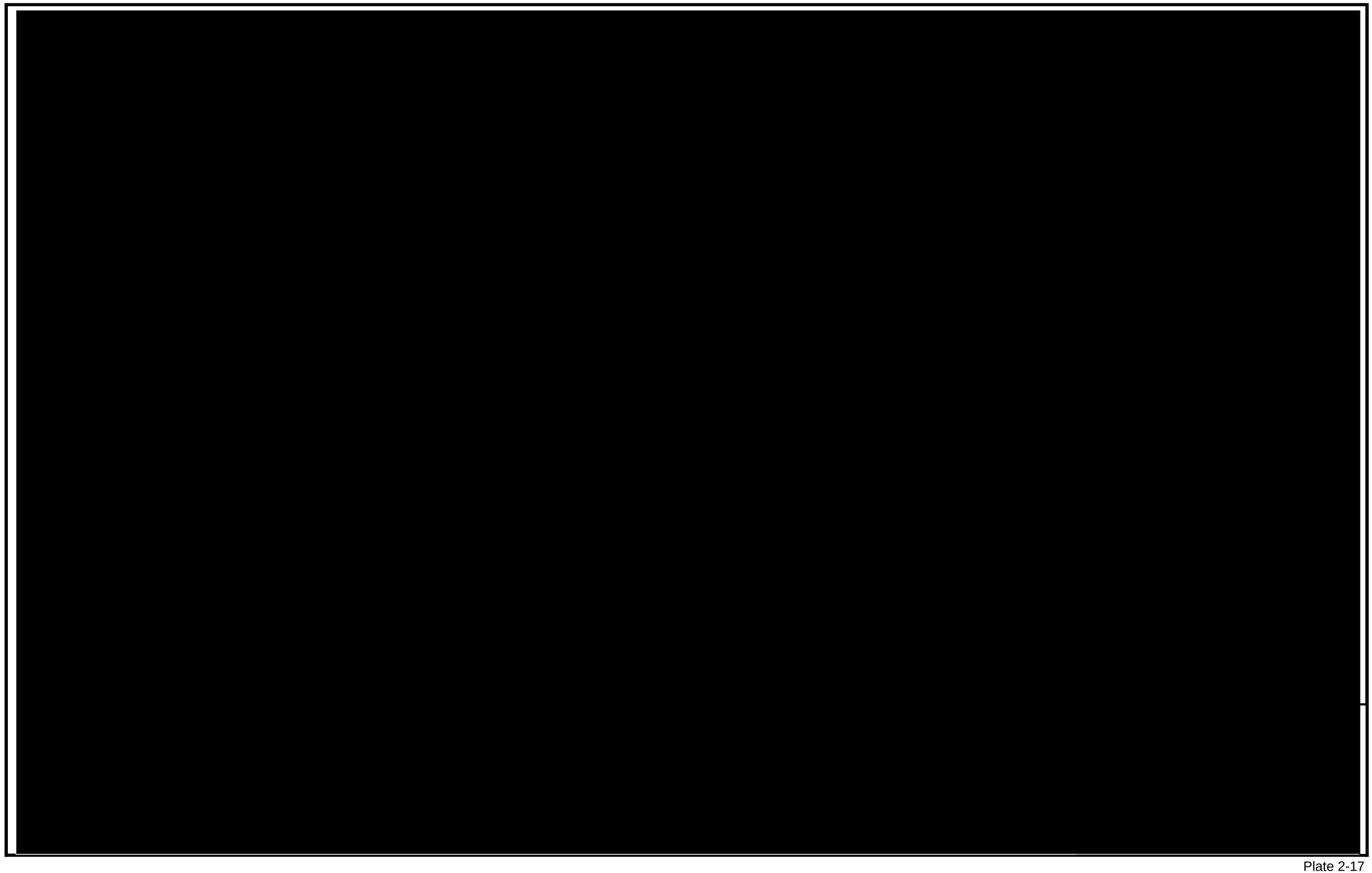
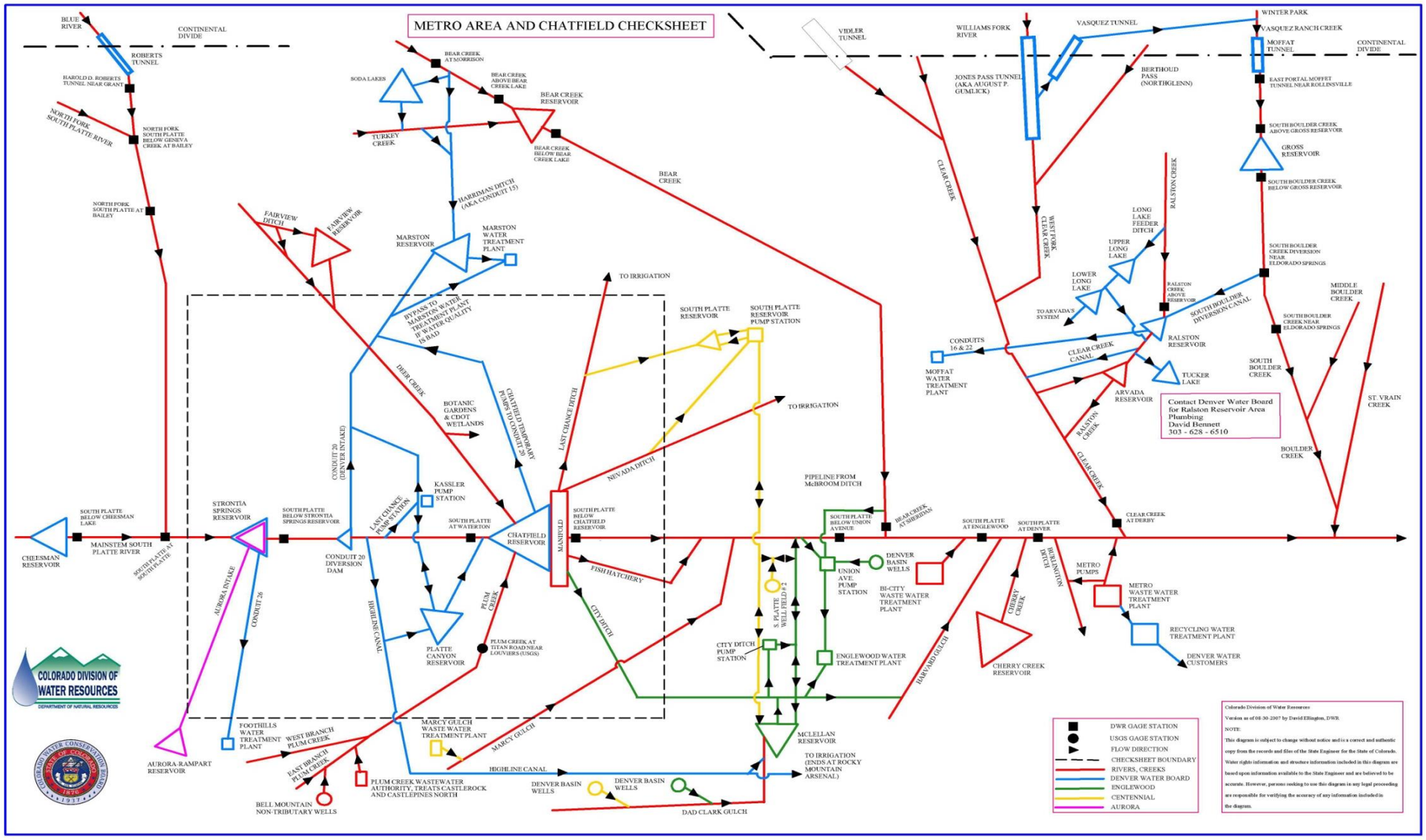


Plate 2-17

Plate 2-18



Visit the following website for a file with better resolution:
http://water.state.co.us/DivisionsOffices/Div1SPlatteRiverBasin/Pages/Div1SPlatteRB.aspx

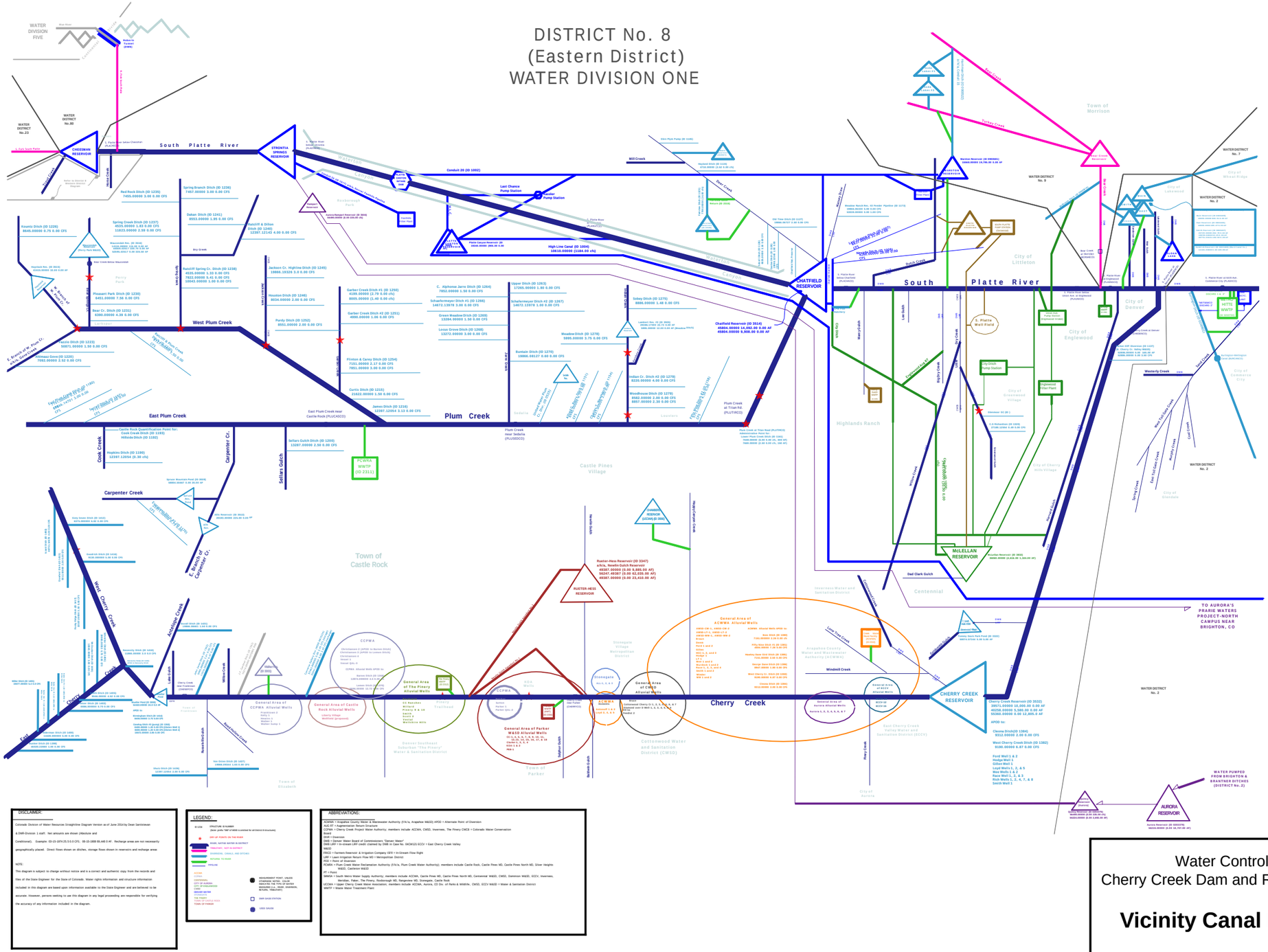
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Schematic Flow Diagram
Denver Water Department
Raw Water System

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

DISTRICT No. 8
(Eastern District)
WATER DIVISION ONE



Visit the following website for a file with better resolution:
http://water.state.co.us/DivisionsOffices/Div1SPlatteRiverBasin/Pages/Div1SPlatteRB.aspx

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Vicinity Canal Diversions

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Cherry Creek Project Boundary Map

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Prepared By:_____SDS_____
Reviewed By:_____KJS_____

Plate 2-21

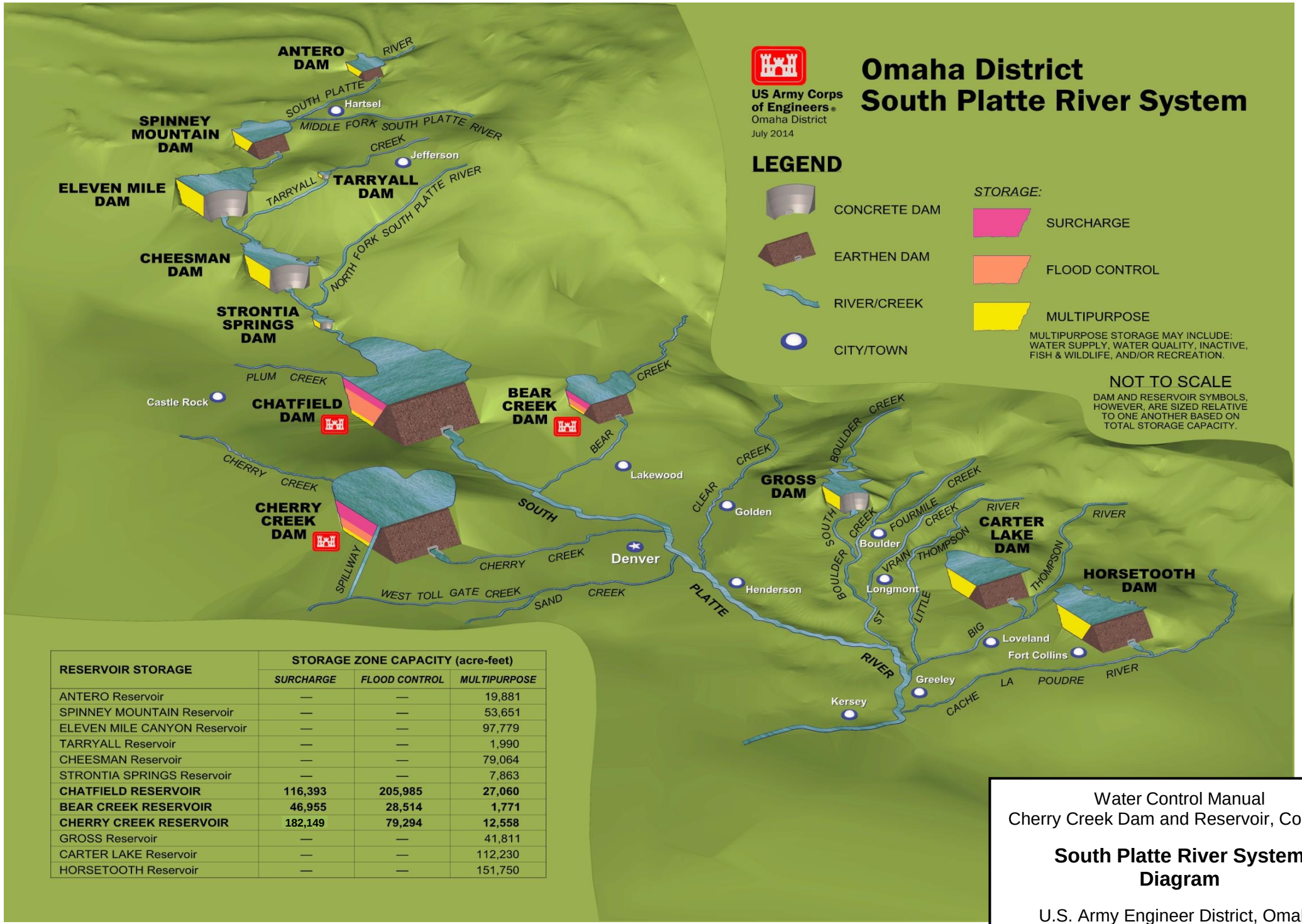
Source: http://www.parks.state.co.us

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Cherry Creek State Park Map

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



RESERVOIR STORAGE	STORAGE ZONE CAPACITY (acre-feet)		
	SURCHARGE	*FLOOD CONTROL*	*MULTIPURPOSE*
ANTERO Reservoir	—	—	19,881
SPINNEY MOUNTAIN Reservoir	—	—	53,651
ELEVEN MILE CANYON Reservoir	—	—	97,779
TARRYALL Reservoir	—	—	1,990
CHEESMAN Reservoir	—	—	79,064
STRONTIA SPRINGS Reservoir	—	—	7,863
CHATFIELD RESERVOIR	**116,393**	**205,985**	**27,060**
BEAR CREEK RESERVOIR	**46,955**	**28,514**	**1,771**
CHERRY CREEK RESERVOIR	**182,149**	**79,294**	**12,558**
GROSS Reservoir	—	—	41,811
CARTER LAKE Reservoir	—	—	112,230
HORSETOOTH Reservoir	—	—	151,750

Prepared By:_____BCA_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

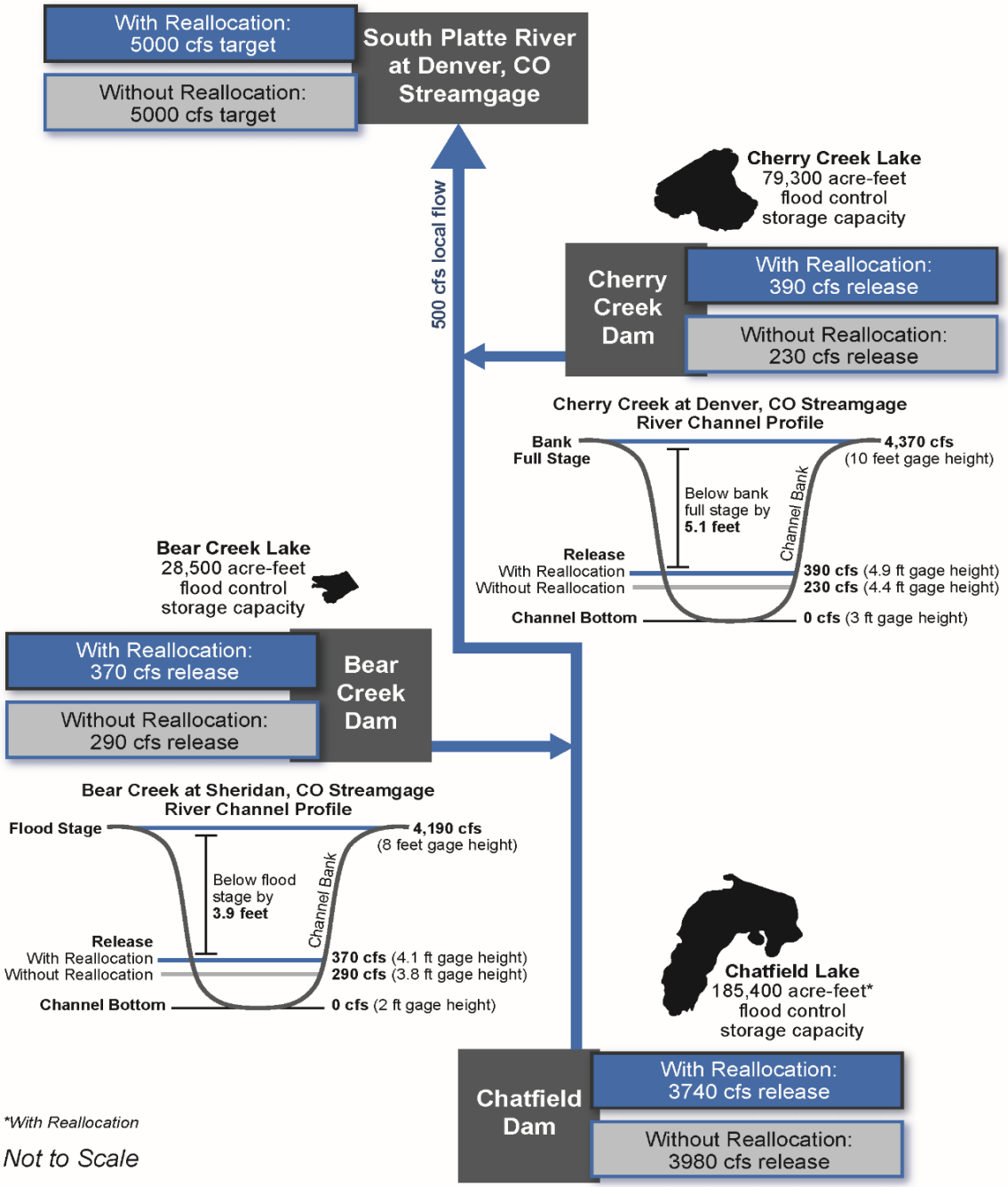
South Platte River System Diagram

U.S. Army Engineer District, Omaha
Corps of Engineers
2018

Plate 3-1

Chatfield Reservoir Flood Control Storage Reallocation

Example of Tri-Lakes system flood control storage evacuation for Level I (small flood events)



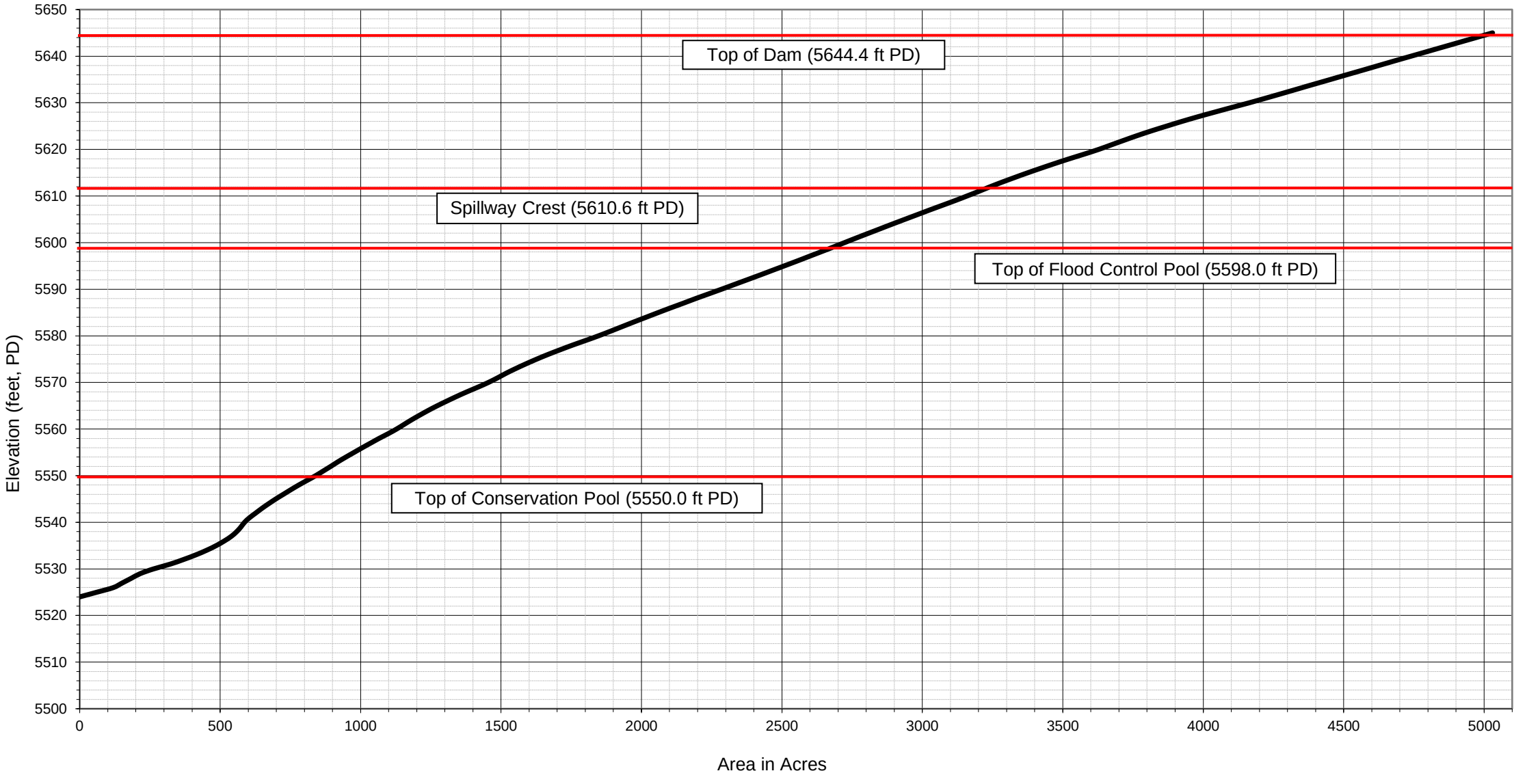
Prepared By:_____KJS_____
Reviewed By:_____MJN_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Example System Flood Control Storage Evacuation

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek Reservoir Surface Area



Effective 09 December 2010

Notes:
1. The 2006-07 survey did not include the capacity from elevation range 5641-5649 feet. The curve was extended with LiDAR data to obtain the entire zone's surface area.
2. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

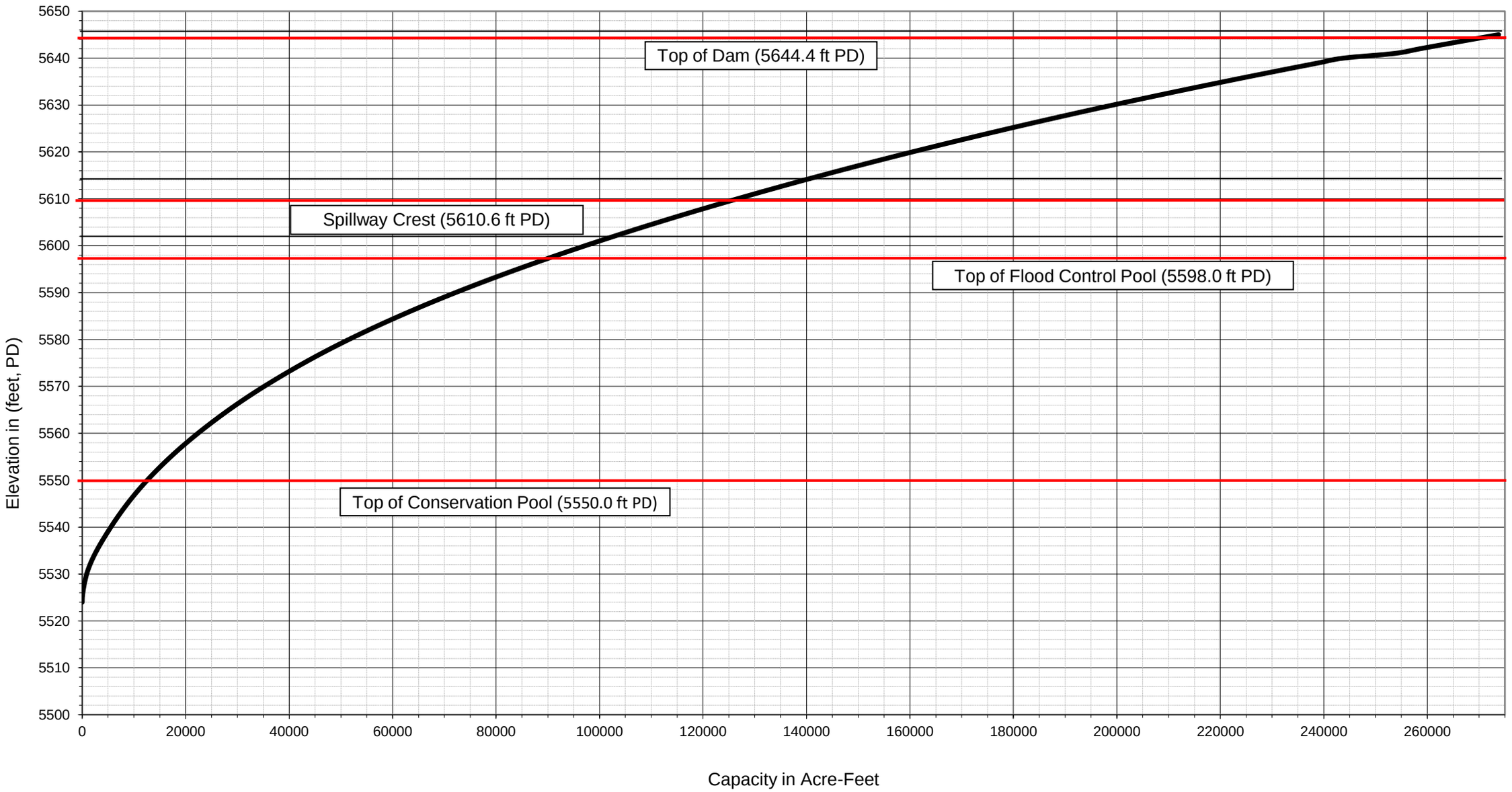
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Reservoir Surface Area Curve
2006-07 Survey

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek Reservoir Storage Capacity



Effective 09 December 2010

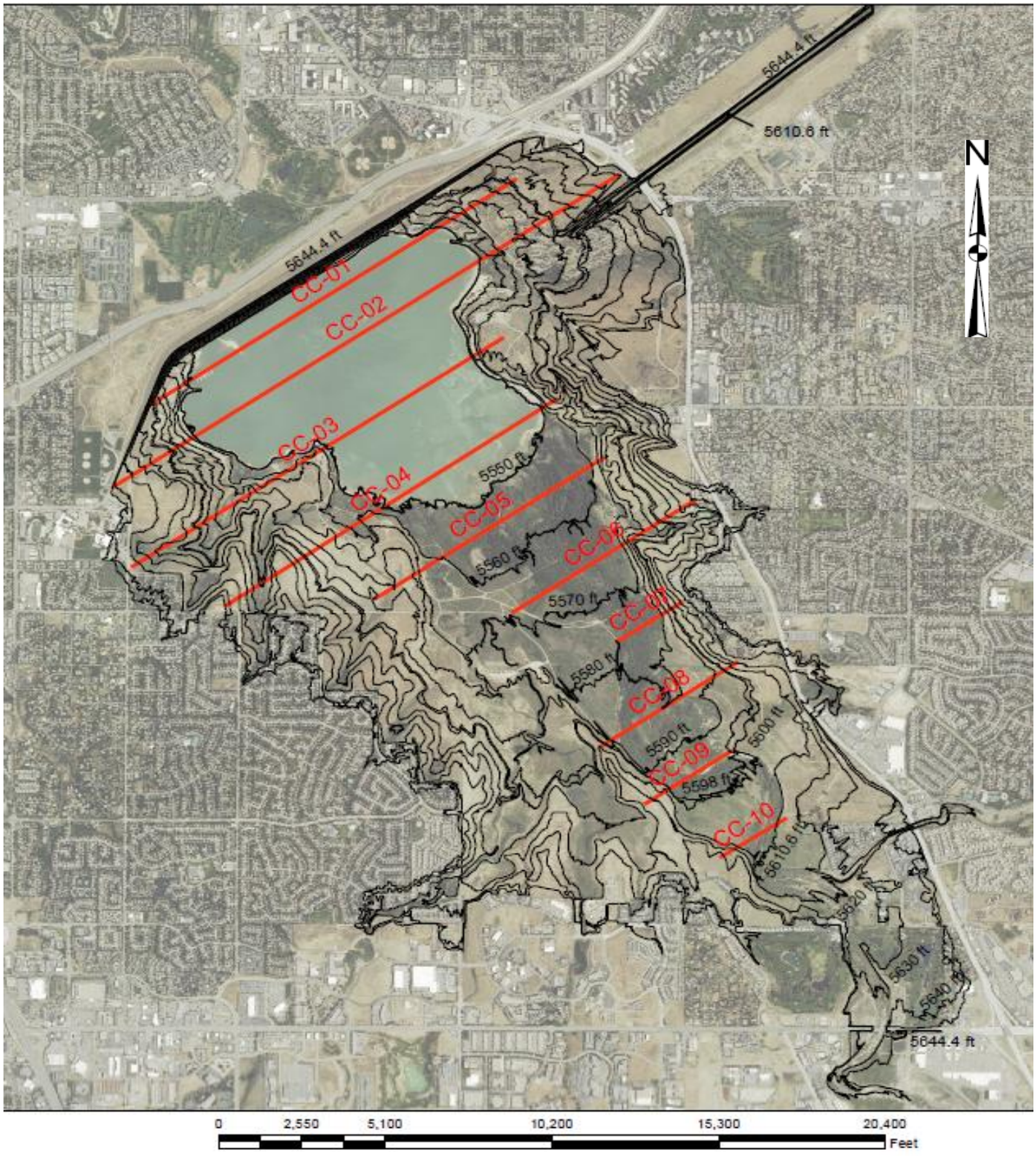
Notes:
1. The 2006-07 survey did not include the capacity from elevation range 5641-5649 feet. The curve was extended with LiDAR data to obtain the entire zone's surface area.
2. The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Reservoir Storage Capacity Curve
2006-07 Survey

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



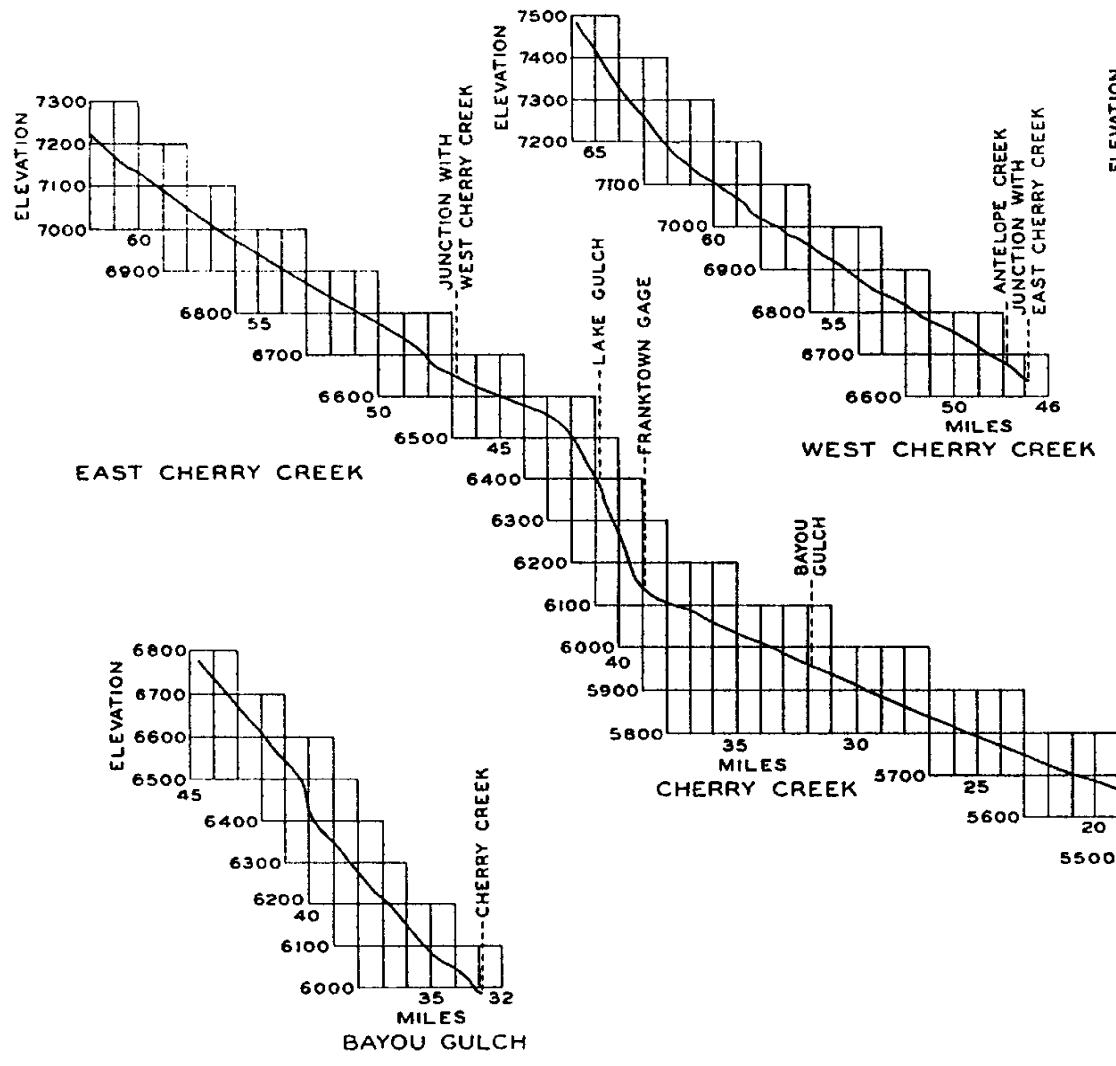
Note:
The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Sediment Range Locations

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



NOTE:

CHERRY CREEK AND TRIBUTARIES
MILES ABOVE MOUTH OF CHERRY CREEK.
SAND CREEK AND TOLL GATE CREEK
MILES ABOVE MOUTH OF SAND CREEK

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

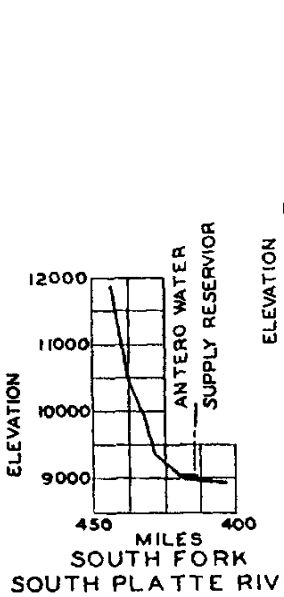
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

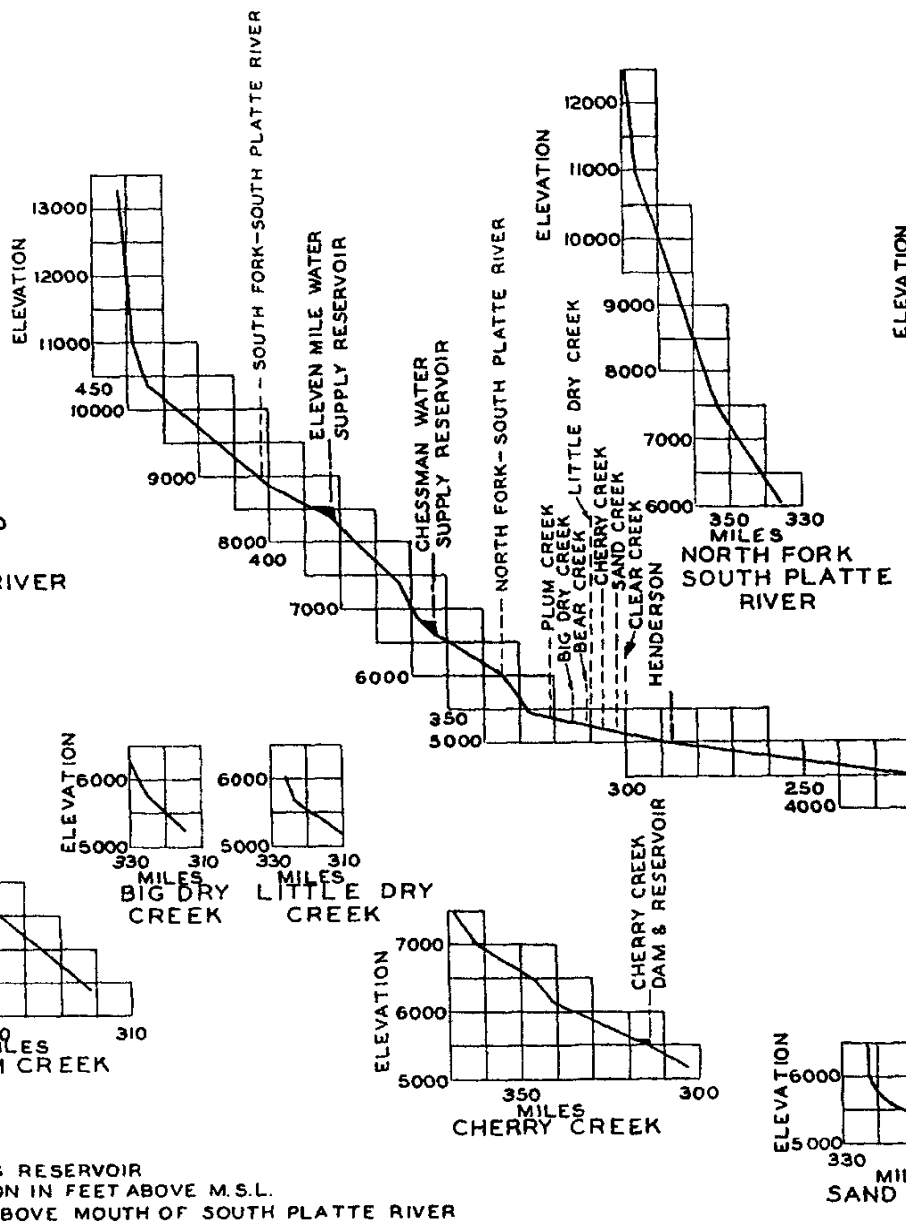
Stream Profiles

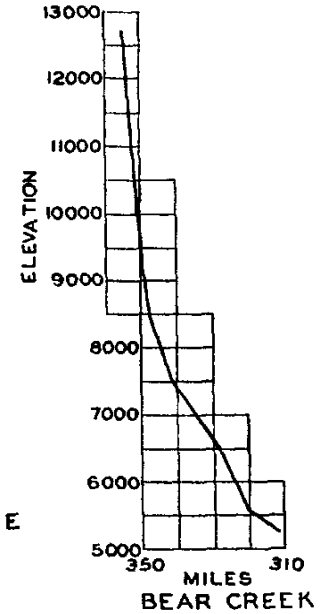
Cherry Creek and Tributaries

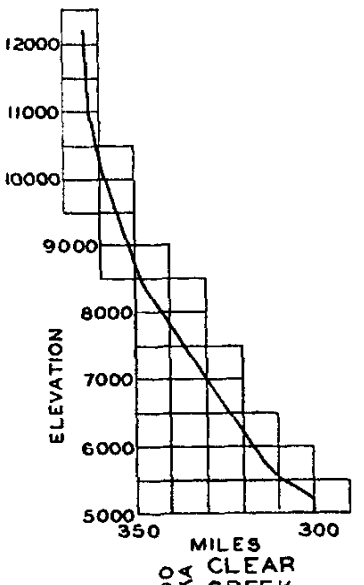
U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

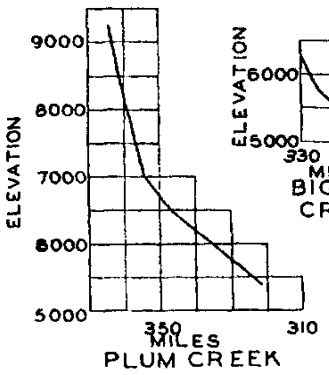
Plate 4-4

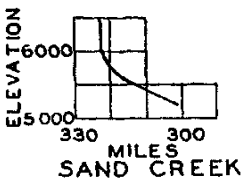












NOTE:
EXISTING RESERVOIR
ELEVATION IN FEET ABOVE M.S.L.
MILES ABOVE MOUTH OF SOUTH PLATTE RIVER

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

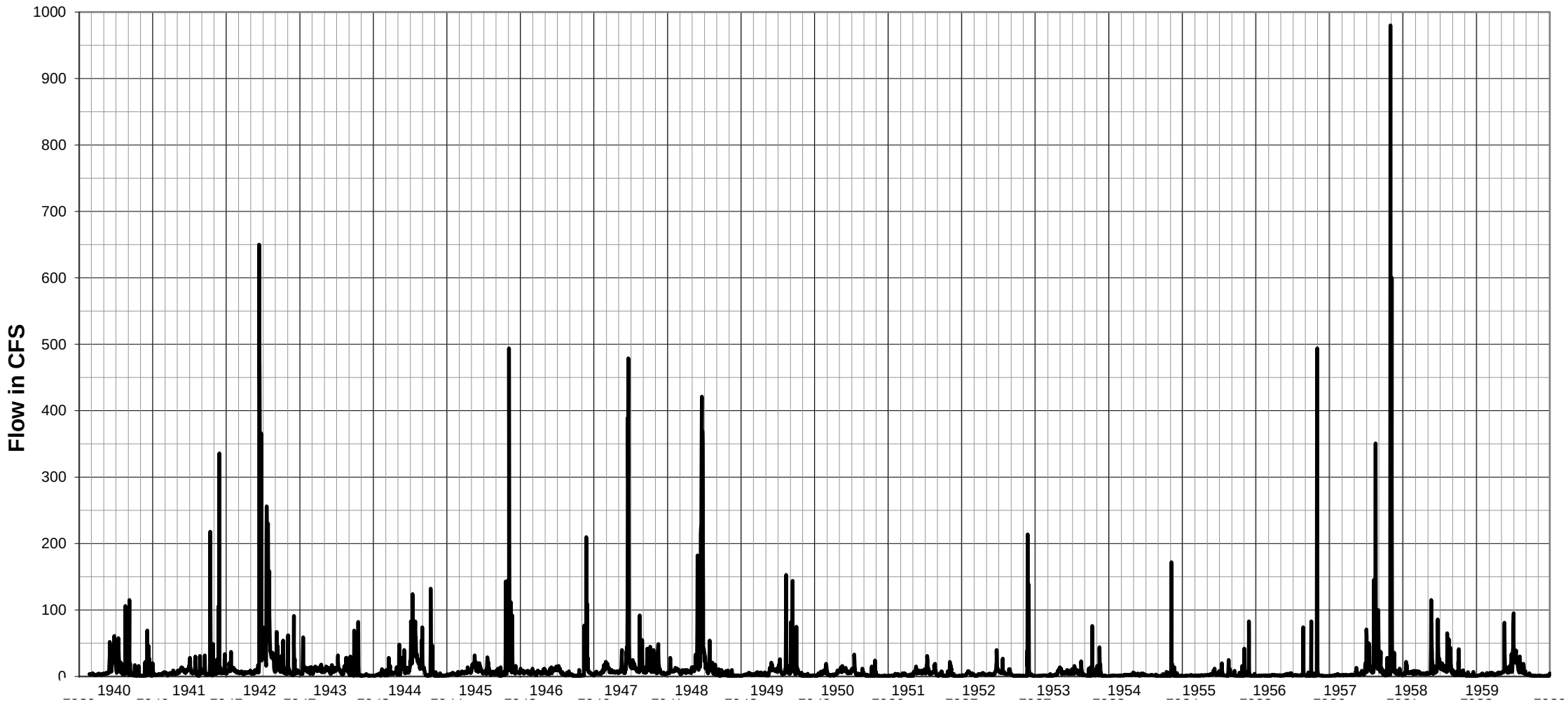
Stream Profiles

South Platte River and Principal Tributaries above Henderson, CO

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-5

Cherry Creek at Franktown, CO (1940-1959)



Note: Average Daily Flows - Obtained from USGS website.
https://waterdata.usgs.gov/co/nwis/uv/?site_no=06712000&PARAmeter_cd=00065,00060

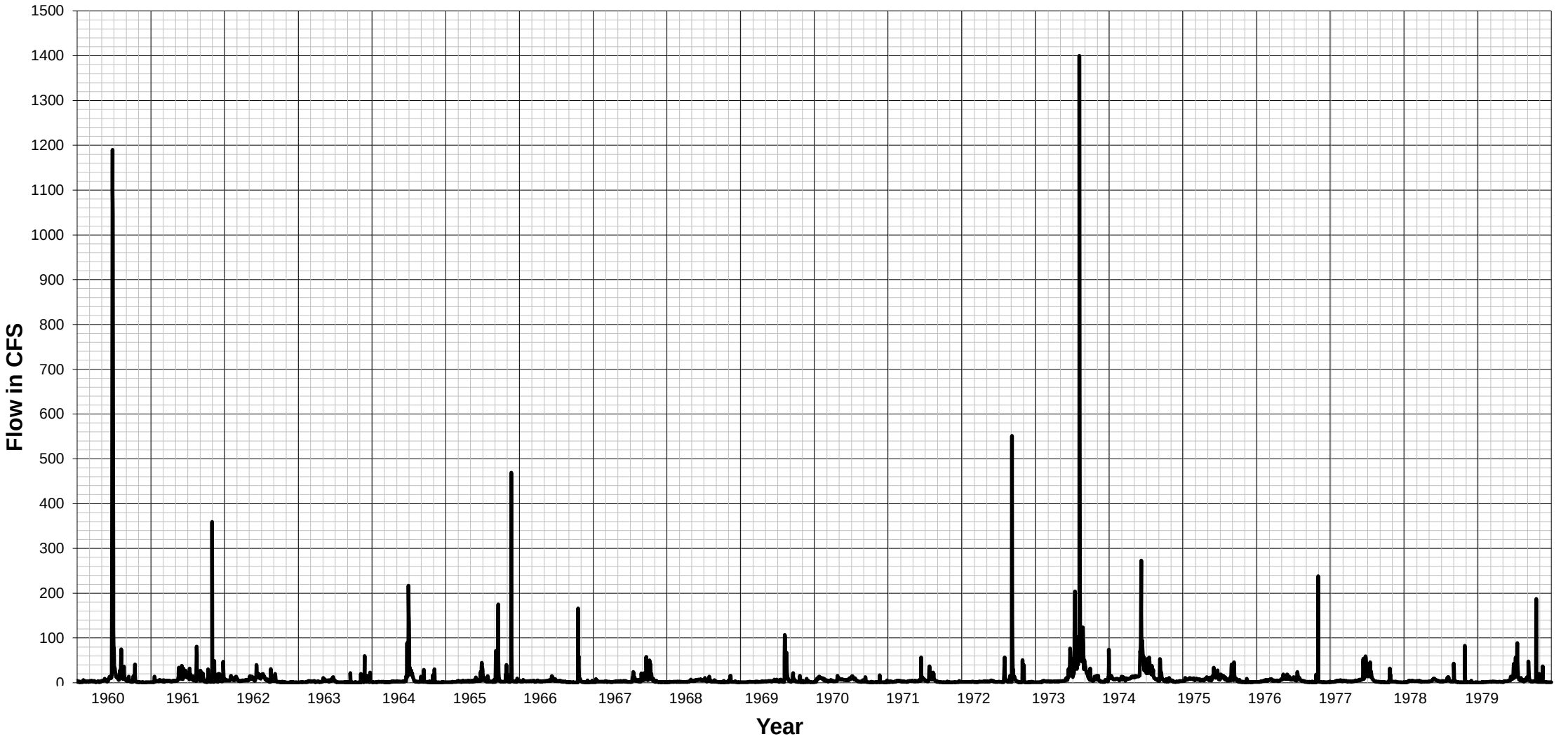
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Hydrograph (1940-1959)
Cherry Creek at Franktown, CO

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek at Franktown, CO (1960-1979)



Note: Average Daily Flows - Obtained from USGS website.
https://waterdata.usgs.gov/co/nwis/uv/?site_no=06712000&PARAmeter_cd=00065,00060

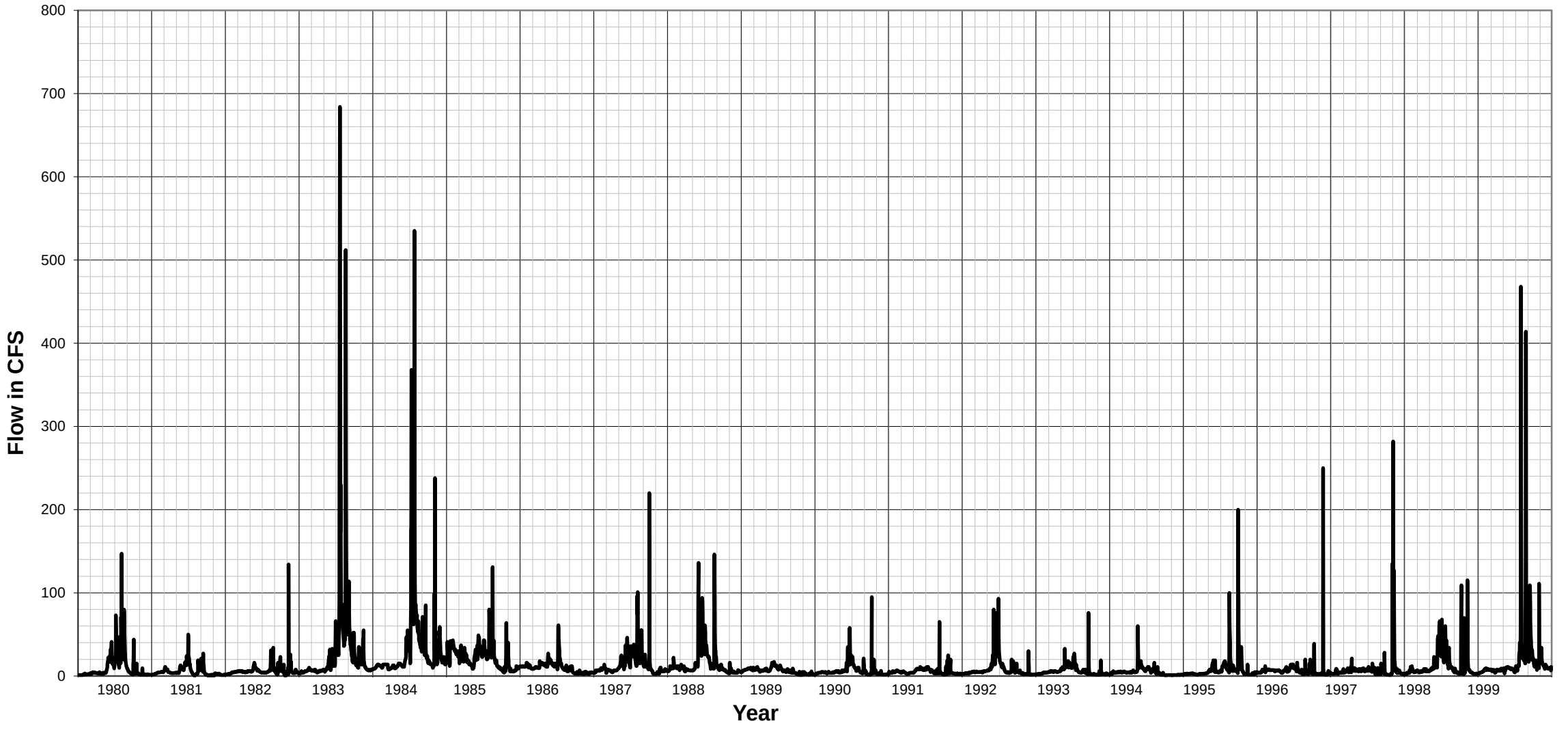
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Hydrograph (1960-1979)
Cherry Creek at Franktown, CO

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek at Franktown, CO (1980-1999)



Note: Average Daily Flows - Obtained from USGS website.
https://waterdata.usgs.gov/co/nwis/uv/?site_no=06712000&PARAmeter_cd=00065,00060

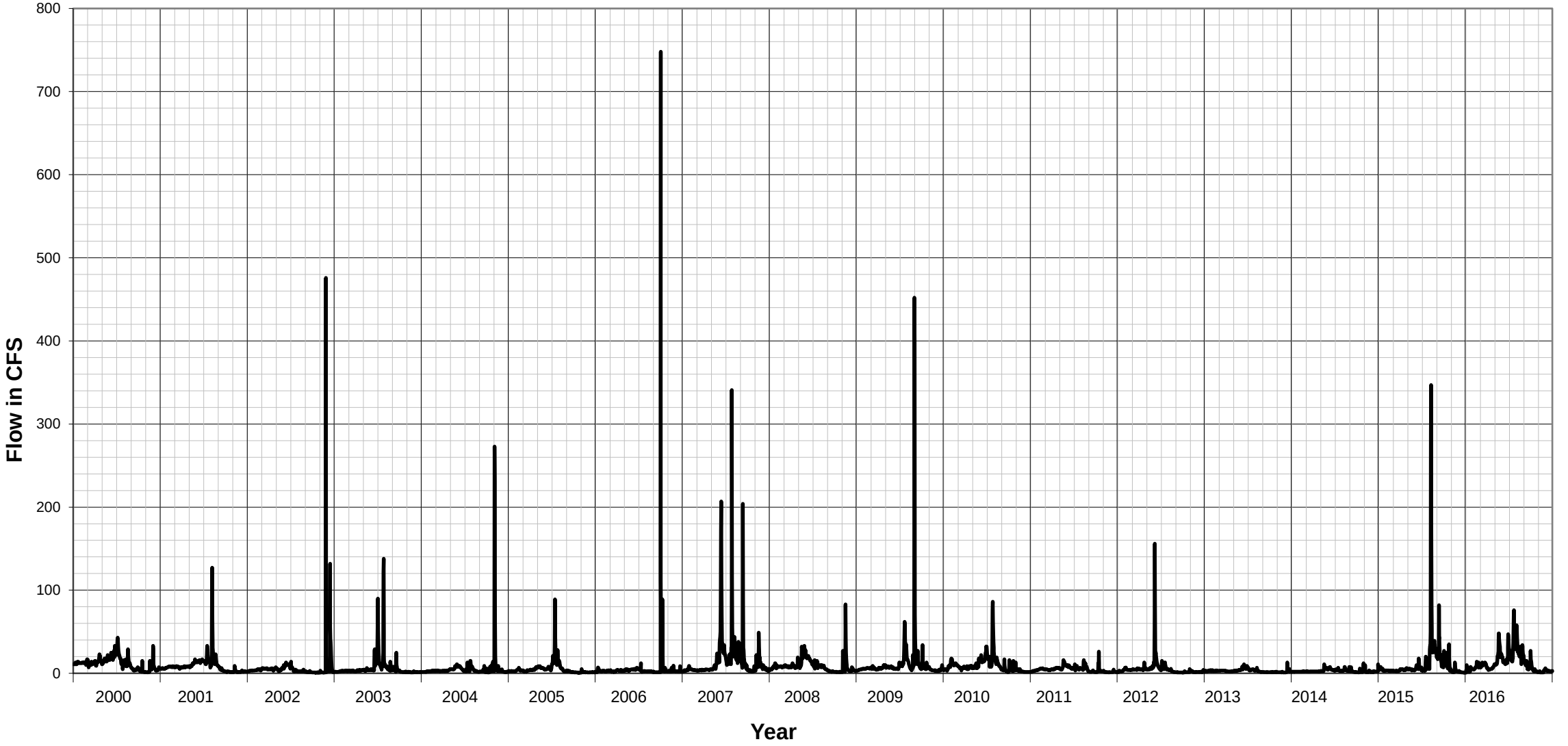
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Hydrograph (1980-1999)
Cherry Creek at Franktown, CO

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek at Franktown, CO (2000-2016)



Note: Average Daily Flows - Obtained from USGS website.
https://waterdata.usgs.gov/co/nwis/uv/?site_no=06712000&PARAmeter_cd=00065,00060

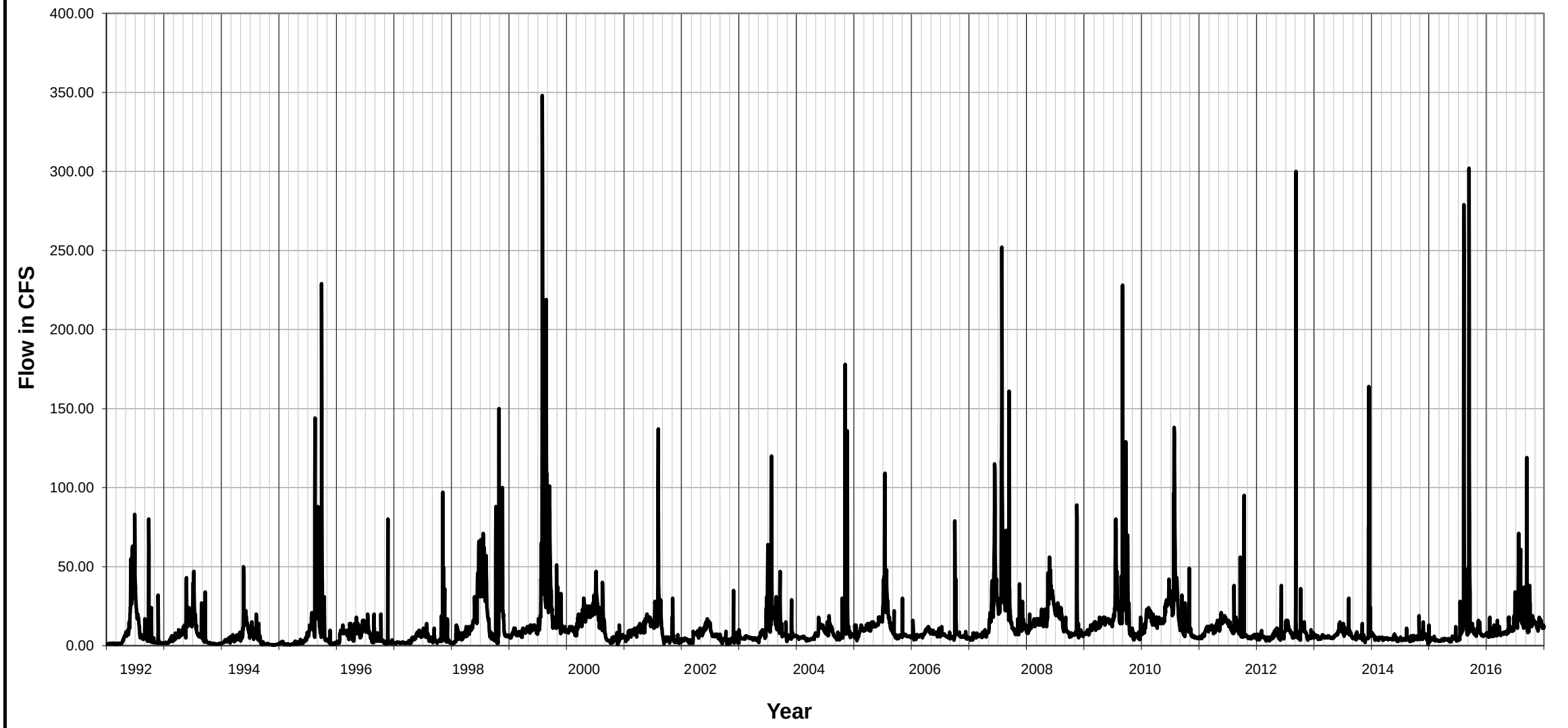
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Hydrograph (2000-2016)
Cherry Creek at Franktown, CO

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek at Parker, CO (1992-2016)



Note: Average Daily Flows - Obtained from USGS website.
https://waterdata.usgs.gov/co/nwis/uv/?site_no=393109104464500&PARAmeter_cd=00065,00060

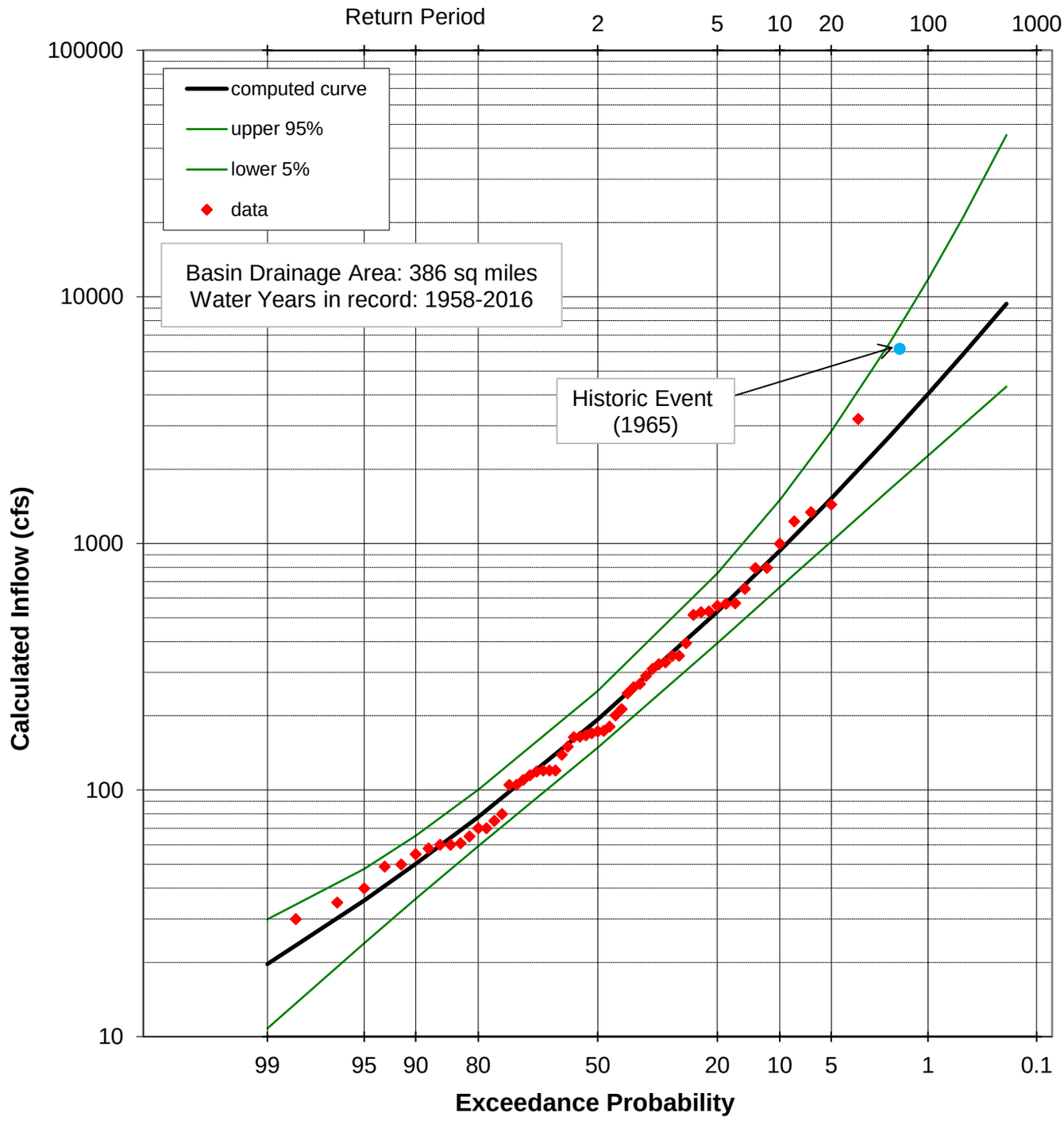
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Hydrograph (1992-2016)
Cherry Creek at Parker, CO

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek Inflow Frequency Curve



Log Transform: Flow (cfs)		Number of Events	
Mean	2.316	Historic Events	1
Standard Dev	0.497	High Outliers	0
Station Skew	0.618	Low Outliers & Zero Flows	0
Regional Skew	-0.2	Missing Events	0
Weighted Skew	0.37	Systematic Events	58
Adopted Skew	0.37	Historic Period	59

NOTE: Derived from the daily annual maximum and is calculated based on the daily change in storage, reservoir release, and evaporation loss. Used Bulletin 17C analysis. The weighted skew fit the dataset the best and therefore was applied.

Prepared By:_____KJS_____
Reviewed By:_____JPD_____

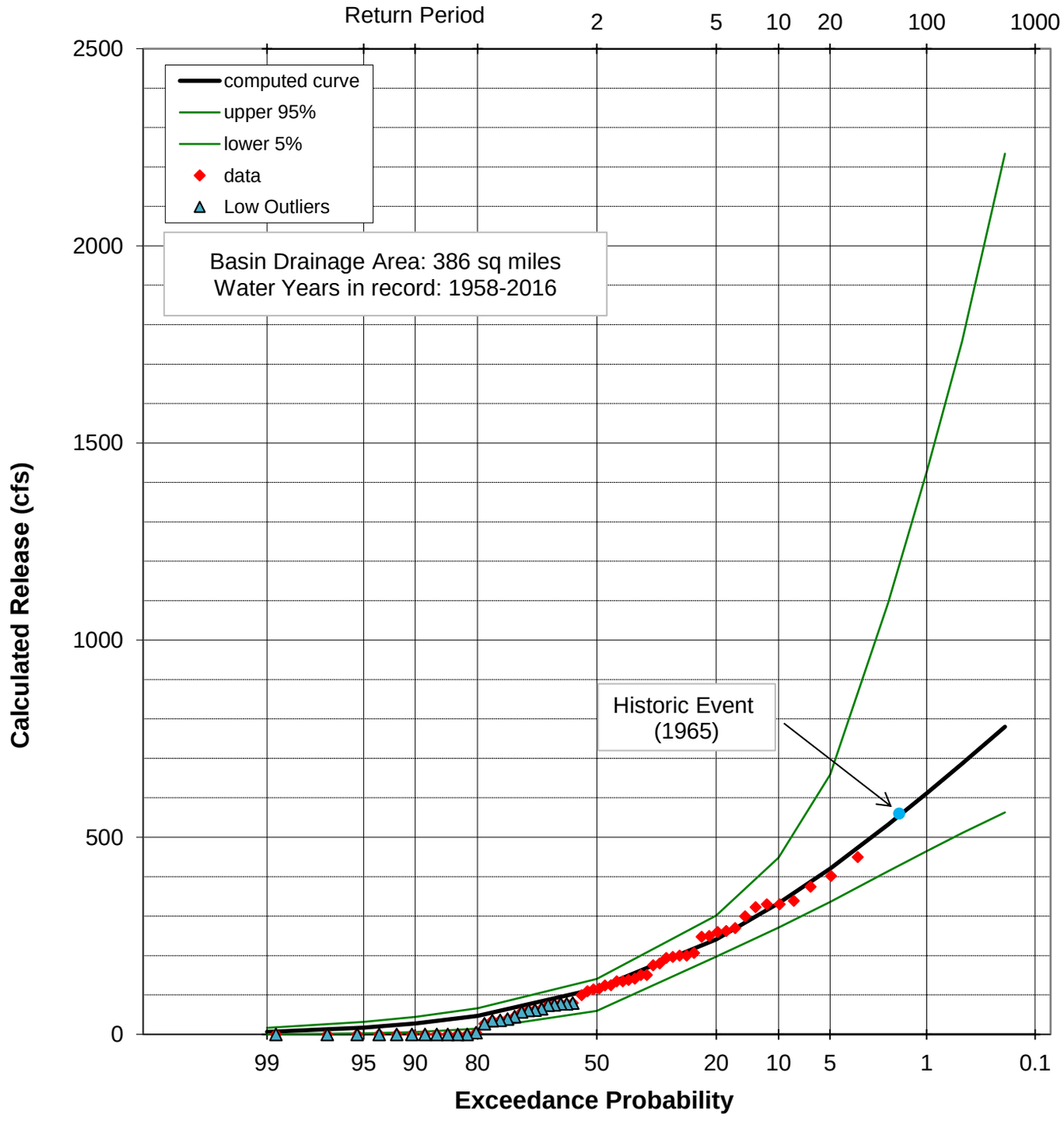
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Inflow Frequency Curve
Cherry Creek Dam

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-11a

Cherry Creek Discharge Frequency Curve



Log Transform: Flow (cfs)		Number of Events	
Mean	2.013	Historic Events	1
Standard Dev	0.43	High Outliers	0
Station Skew	-0.713	Low Outliers & Zero Flows	26
Regional Skew		Missing Events	0
Weighted Skew		Systematic Events	58
Adopted Skew	-0.713	Historic Period	59

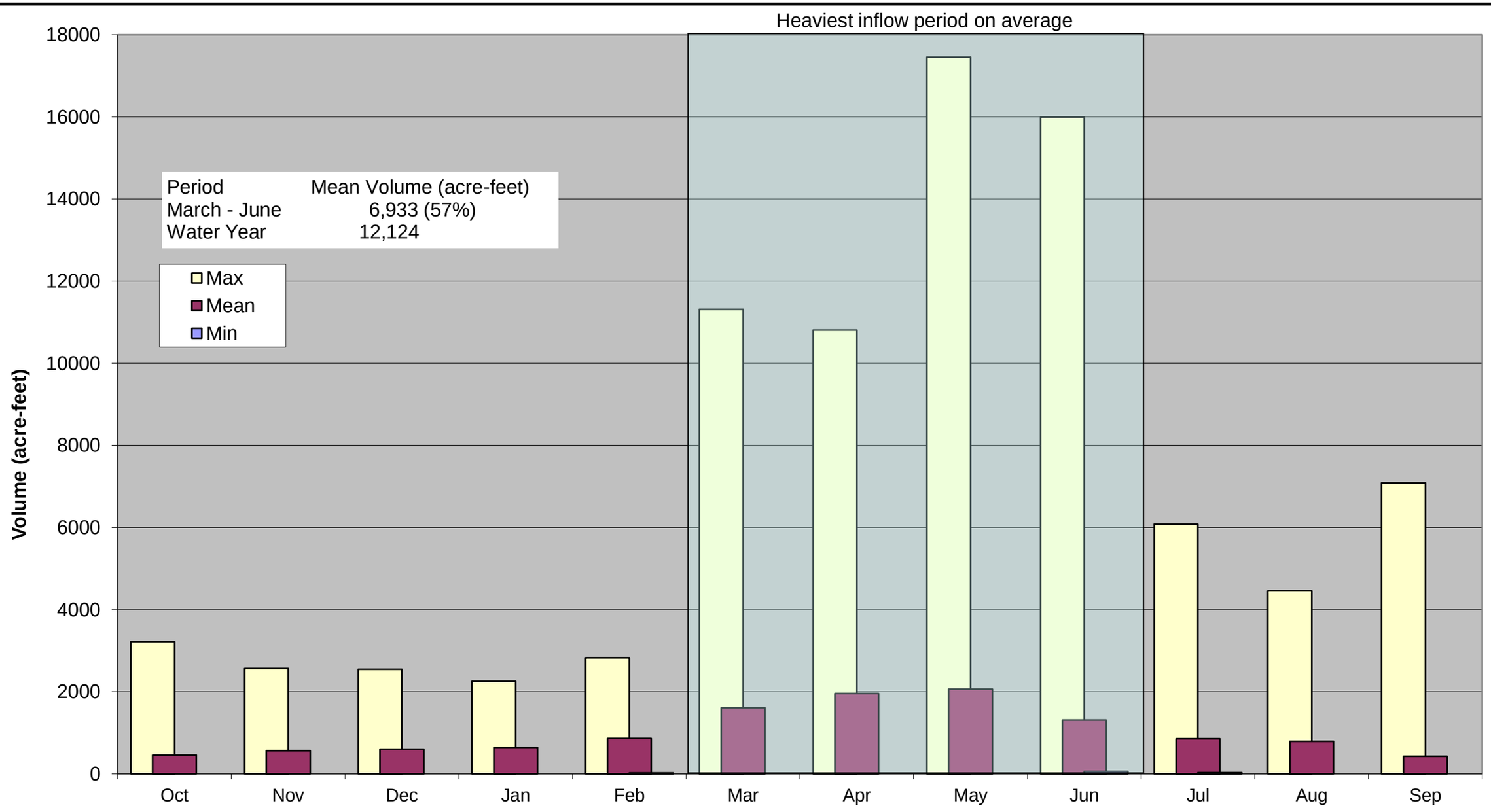
NOTE: Derived from the daily annual maximum and is calculated based on the daily change in storage, reservoir release, and evaporation loss. Used Bulletin 17C analysis. Station skew was applied because the discharge is impacted by release decisions making the regional skew less applicable.

Prepared By:_____KJS_____
Reviewed By:_____JPD_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Discharge Frequency Curve
Cherry Creek Dam

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Source of data: Corps Cherry Creek Inflow Calculation (1957-2016).
Calculated based on the daily change in storage, reservoir release, and evaporation loss.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Monthly Inflow Volume

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-12

Water Year	Flow per Month (Acre-Feet)												WY Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
1957									437	2164	1599	0	4,200
1958	9	10	4	30	910	1328	737	2127	203	313	218	0	5,891
1959	0	0	0	0	455	619	1701	734	160	179	99	118	4,064
1960	120	21	60	92	208	11312	953	1339	141	278	0	0	14,523
1961	139	0	162	41	176	830	638	1338	319	368	1164	393	5,568
1962	57	392	117	208	1493	1102	738	197	307	111	43	50	4,816
1963	0	20	18	133	131	79	0	0	218	30	2494	154	3,277
1964	0	0	20	50	99	1101	674	117	240	89	50	0	2,440
1965	0	20	20	27	139	280	121	79	15997	3422	3838	630	24,573
1966	94	40	79	79	333	587	250	79	60	317	0	0	1,919
1967	0	0	0	50	20	40	337	337	723	1903	22	0	3,431
1968	0	60	69	178	187	217	473	201	78	95	161	0	1,720
1969	50	79	30	89	40	60	159	2063	714	179	325	2	3,788
1970	461	183	158	219	79	447	791	141	407	40	0	50	2,975
1971	20	139	59	69	109	188	405	300	110	134	40	110	1,682
1972	16	40	69	40	60	0	236	171	625	30	298	0	1,583
1973	9	218	134	173	119	769	2955	17457	1877	345	131	196	24,385
1974	120	88	583	960	1232	6689	3407	500	333	304	0	29	14,245
1975	30	0	59	138	854	1448	1029	526	716	179	119	0	5,098
1976	79	139	99	129	109	198	334	251	109	308	140	267	2,162
1977	70	59	69	69	50	257	496	127	200	337	169	0	1,905
1978	79	89	0	91	99	99	172	379	222	118	2	0	1,351
1979	149	30	89	136	145	300	458	583	399	80	376	0	2,745
1980	49	139	159	148	159	328	893	2705	111	139	30	0	4,860
1981	0	98	50	107	121	305	151	394	241	228	60	30	1,785
1982	0	69	89	89	109	1	0	465	342	218	348	120	1,849
1983	168	128	258	98	195	2126	7632	7294	3164	6078	1992	276	29,409
1984	339	757	798	578	1597	3298	10810	4946	2234	1215	3516	831	30,918
1985	3221	2274	2549	2140	2098	2762	2249	3550	1081	1515	506	925	24,868
1986	652	1168	1083	1322	1160	1126	3283	838	912	280	69	89	11,982
1987	328	345	367	741	1914	2321	2921	4753	1408	1056	478	375	17,007
1988	518	1302	1649	1227	2358	4287	2360	3236	895	259	783	268	19,142
1989	246	288	783	1093	1334	1441	805	737	532	229	198	248	7,935
1990	89	198	336	278	249	1670	955	518	210	333	471	228	5,533
1991	238	288	277	316	200	311	389	630	652	497	714	87	4,599
1992	190	661	302	377	375	3233	1703	358	538	694	634	120	9,185
1993	258	589	332	358	601	670	1227	607	452	267	259	276	5,898
1994	404	405	322	454	1179	1352	1463	968	456	105	138	107	7,352
1995	210	243	322	363	376	374	1254	3932	2392	1390	320	295	11,473
1996	277	322	491	770	791	1372	1018	1108	842	411	182	402	7,986
1997	147	279	336	353	545	760	1380	497	516	947	1697	465	7,920
1998	659	1271	1294	1454	1623	2931	3982	2804	694	2058	2019	328	21,117
1999	462	1363	1185	1607	1515	1474	4061	7385	3568	1011	1708	484	25,821
2000	1290	1793	1837	2253	2230	3069	2524	2307	528	1033	970	565	20,399
2001	694	1250	1200	1372	1645	2017	2737	4679	635	1720	510	273	18,732
2002	200	669	796	1063	1101	1699	801	513	639	157	133	275	8,047
2003	506	327	301	340	335	2156	4696	2235	1914	1031	763	655	15,259
2004	298	370	409	488	734	993	1985	1341	648	922	4455	862	13,507
2005	1551	1627	1589	1559	1751	1828	4912	1671	2115	234	1328	250	20,415
2006	922	850	1115	1266	1003	1353	1112	678	336	1875	1184	497	12,191
2007	1191	1015	1291	1417	2827	4588	6372	5174	1998	442	1480	646	28,441
2008	1357	1525	1754	1799	2271	2634	2242	2257	765	191	1941	786	19,522
2009	1122	1171	1662	949	1492	1682	4777	2741	5248	3490	1227	1570	27,131
2010	2336	2563	1779	1789	1954	3414	5343	2999	1742	1849	910	108	26,786
2011	450	1122	1400	1403	1738	1649	1458	3043	1120	2180	178	383	16,124
2012	759	1148	1139	1322	1607	1160	1450	903	2301	1050	148	747	13,734
2013	557	625	772	803	865	1444	1276	1721	392	338	708	7089	16,590
2014	1415	774	748	940	869	1208	1370	1824	1282	1589	1122	1106	14,247
2015	1305	988	919	1043	1173	1521	2023	6842	7930	1396	1992	457	27,589
2016	1048	1733	1642	1365	1554	2518	4734	3867	2951	1434	1013	1147	25,006

	Flow per Month (Acre-Feet)												WY Total
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
MEAN	**457**	**565**	**597**	**645**	**859**	**1611**	**1956**	**2060**	**1306**	**853**	**791**	**423**	**12,124**
MAX	**3221**	**2563**	**2549**	**2253**	**2827**	**11312**	**10810**	**17457**	**15997**	**6078**	**4455**	**7089**	**86,611**
MIN	**0**	**0**	**0**	**0**	**20**	**0**	**0**	**0**	**60**	**30**	**0**	**0**	**110**

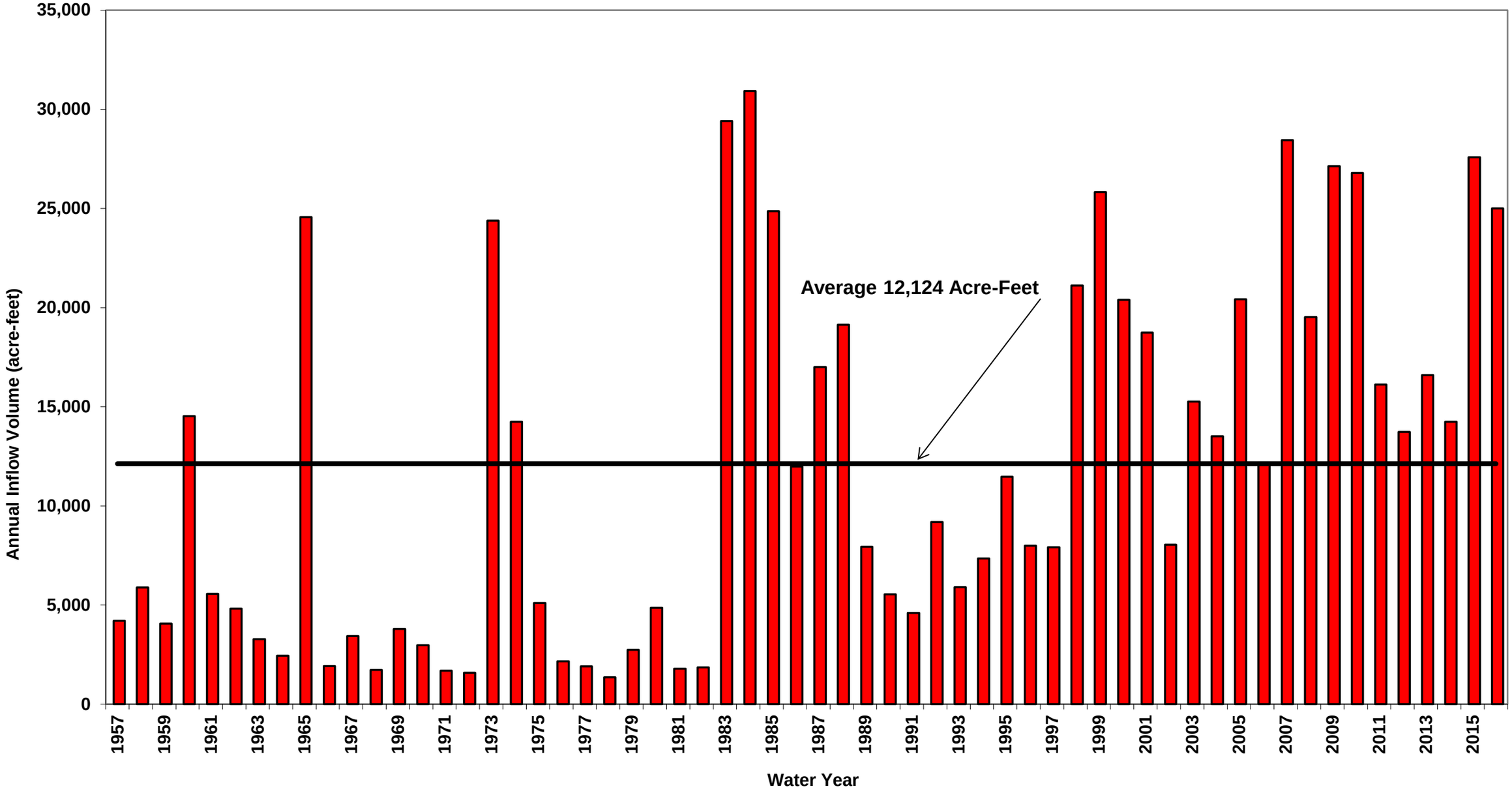
Source of data: Corps Cherry Creek Inflow Calculation (1957-2016).
Calculated based on the daily change in storage, reservoir release, and evaporation loss.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Reservoir and Dam, Colorado

Historic Monthly Inflow Volume

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Source of data: Corps Cherry Creek Inflow Calculation (1957-2016).
Calculated based on the daily change in storage, reservoir release, and evaporation loss.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

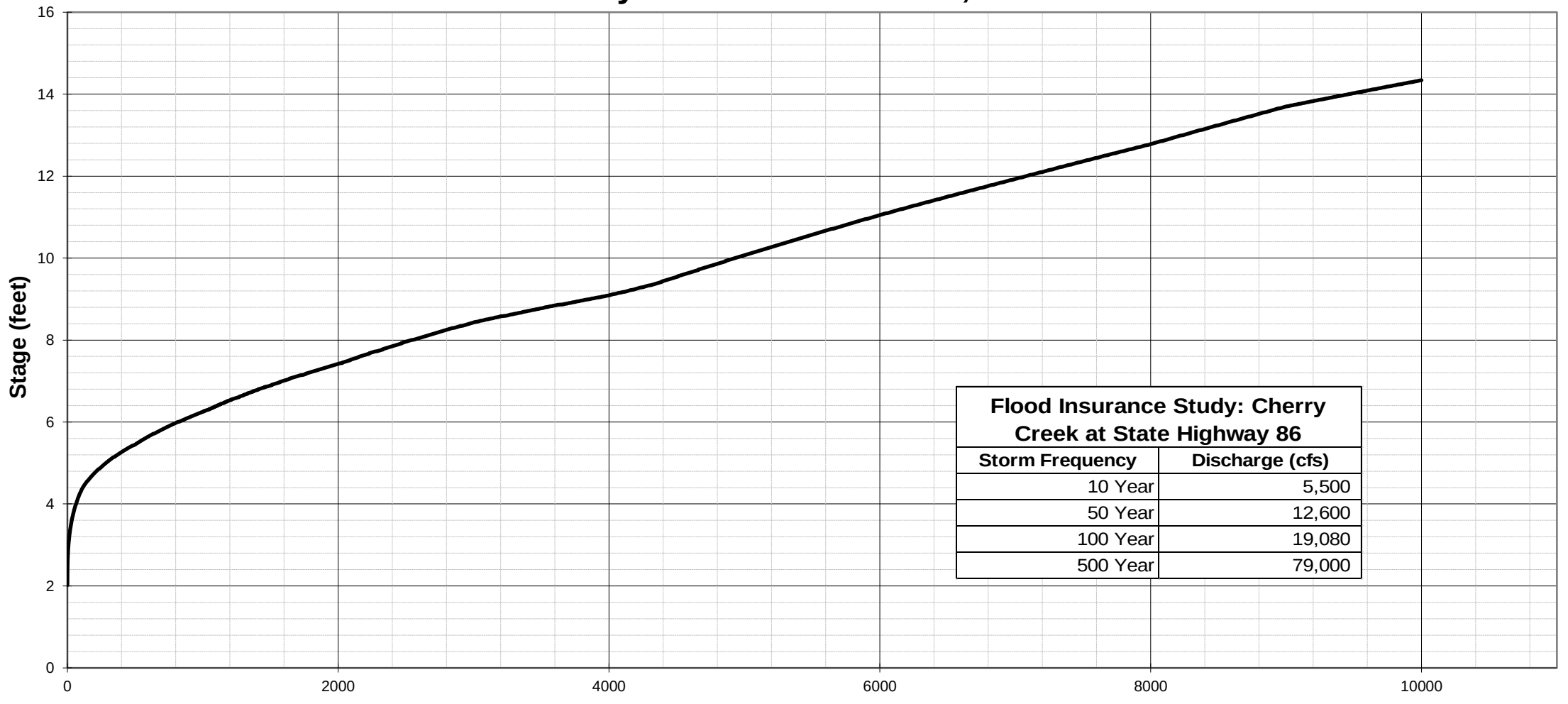
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Historic Annual Inflow Volume

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-14

Discharge Rating Curve
Cherry Creek at Franktown, CO



Flood Insurance Study: Cherry Creek at State Highway 86	
Storm Frequency	**Discharge (cfs)**
10 Year	5,500
50 Year	12,600
100 Year	19,080
500 Year	79,000

Note:
1. Rating table #17 from United States Geological Survey.
2. Rating curves change on a frequent basis due to regular field measurements. Therefore, these values should only be used as an approximation. Please check the USGS website for the most up-to-date rating for this station.
3. Datum of gage is 6,150 feet (NGVD29).
4. Flood Insurance Study, Douglas County, Colorado September 30, 2005. Cherry Creek at State Highway 86 is the nearest FIS site, and is therefore used to be representative of the gage at Cherry Creek at Franktown, Colorado.

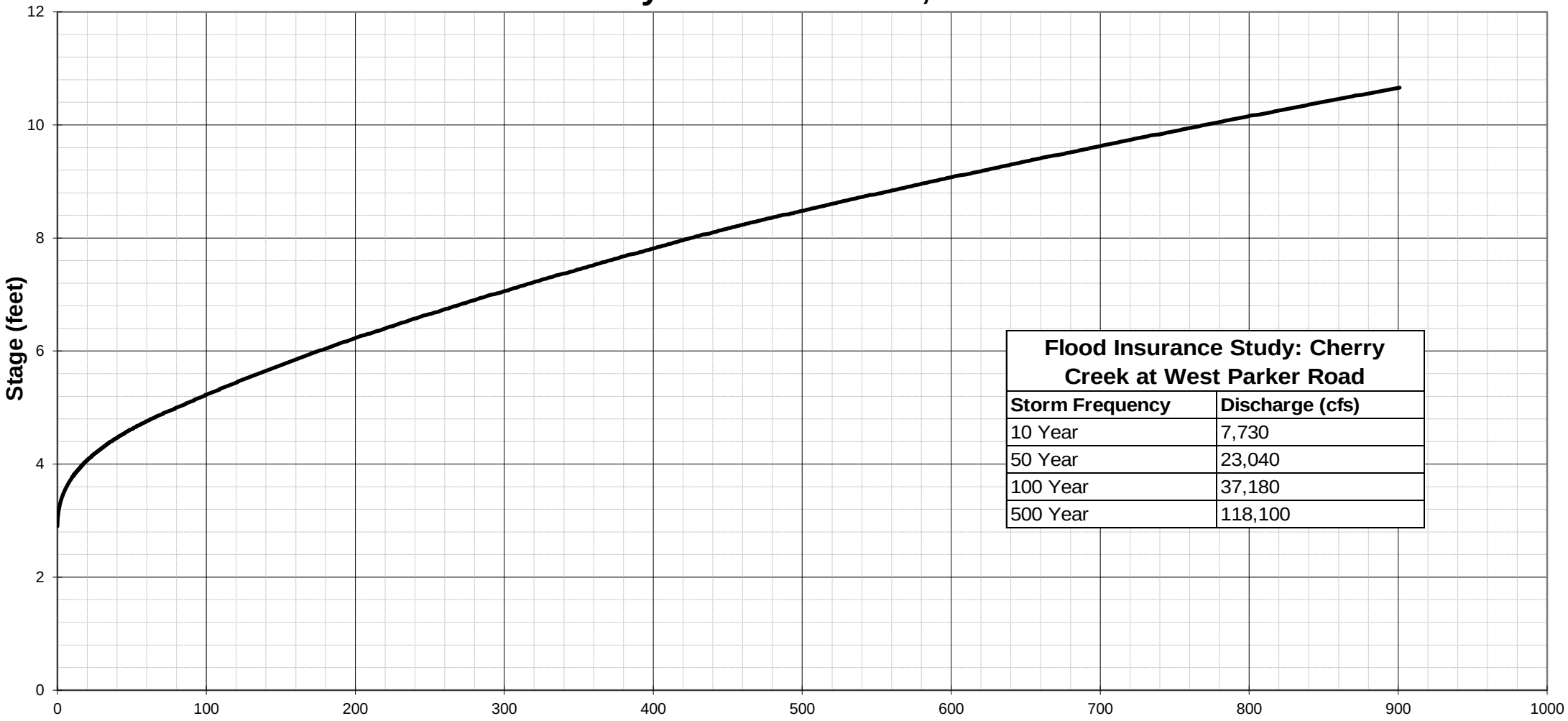
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Low Flow Discharge Rating Curve
Cherry Creek at Franktown, CO
Rating #17

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Discharge Rating Curve
Cherry Creek at Parker, CO



Flood Insurance Study: Cherry Creek at West Parker Road	
Storm Frequency	**Discharge (cfs)**
10 Year	7,730
50 Year	23,040
100 Year	37,180
500 Year	118,100

Note:
1. Rating table #4.2 from United States Geological Survey.
2. Rating curves change on a frequent basis due to regular field measurements. Therefore, these values should only be used as an approximation. Please check the USGS website for the most up-to-date rating for this station.
3. Datum of gage is 5,805 feet (NGVD29).
4. Flood Insurance Study, Douglas County, Colorado September 30, 2005. Cherry Creek at West Parker Road (West Main Street) is the nearest FIS site, and is therefore used to be representative of gage at Cherry Creek at Parker, Colorado.

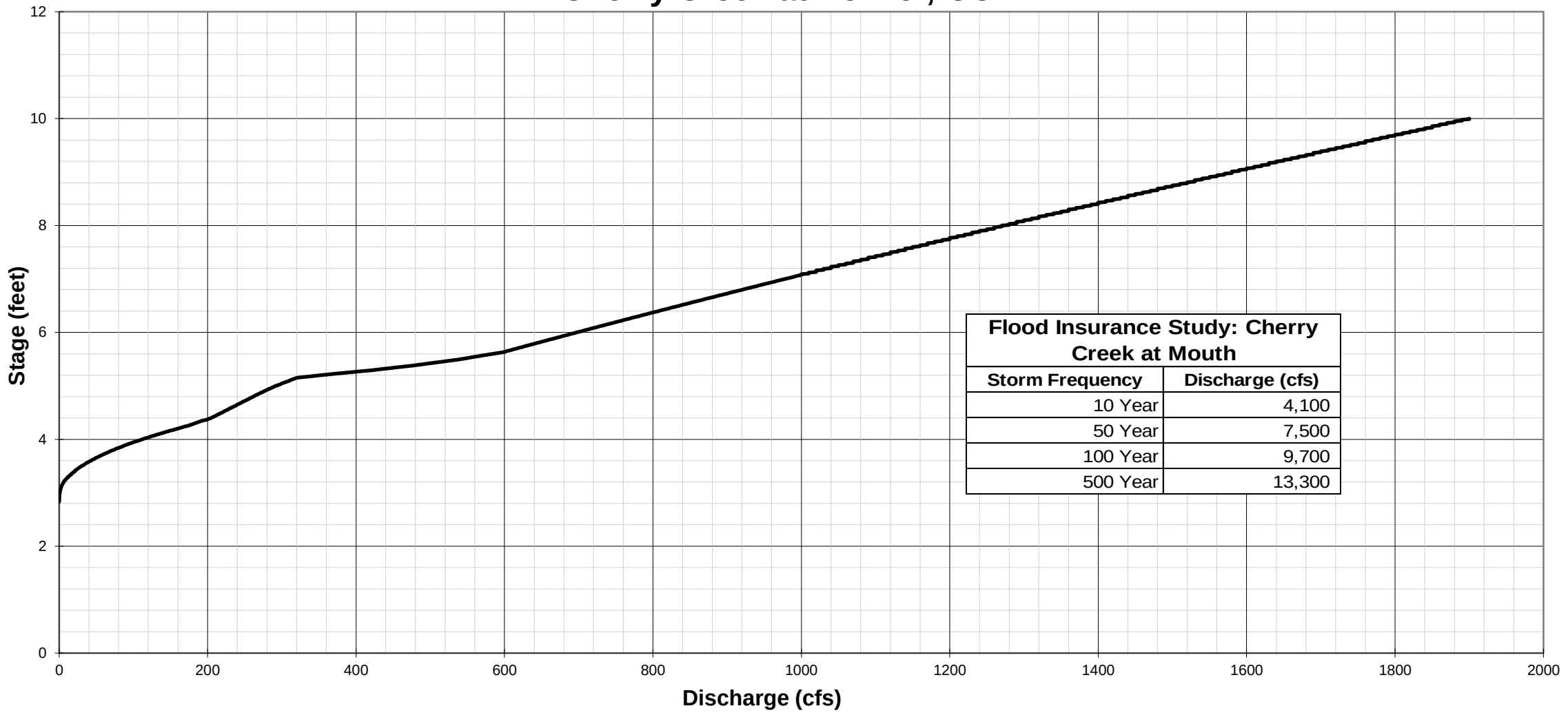
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Low Flow Discharge Rating Curve
Cherry Creek at Parker, CO
Rating #4.2

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Discharge Rating Curve
Cherry Creek at Denver, CO



Flood Insurance Study: Cherry Creek at Mouth	
Storm Frequency	**Discharge (cfs)**
10 Year	4,100
50 Year	7,500
100 Year	9,700
500 Year	13,300

Note:
1. Rating table #21 from Colorado Division of Water Resources (CO-CWR).
2. Rating curves change on a frequent basis due to regular field measurements. Therefore, these values should only be used as an approximation. Please check the CO-DWR website for the most up-to-date rating for this station.
3. Datum of gage is 5,180.48 feet (NGVD29).
4. Flood Insurance Study, Denver County, Colorado November 20, 2013. Cherry Creek at Mouth is the nearest FIS site, and is therefore used to be representative of the gage at Cherry Creek at Denver, Colorado.

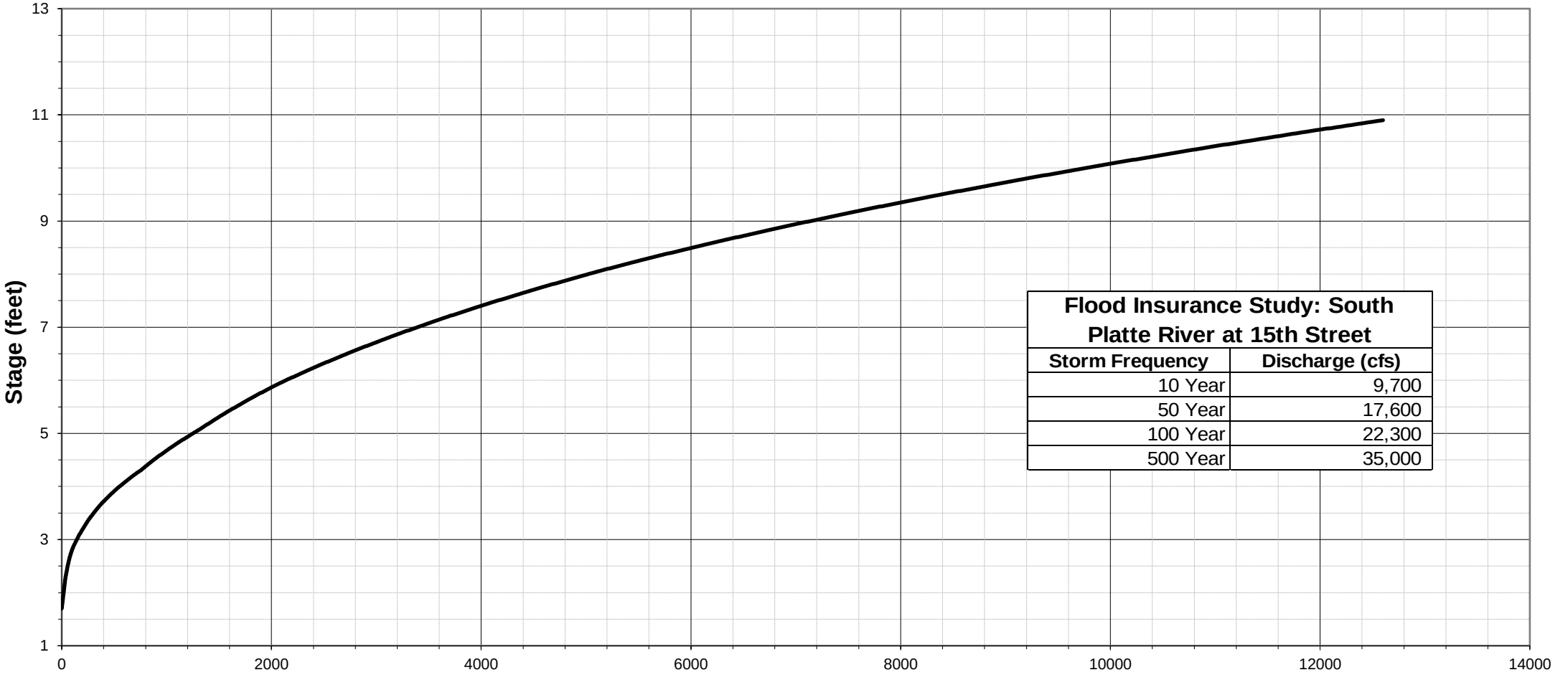
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Low Flow Discharge Rating Curve
Cherry Creek at Denver
Rating #21

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Low Flow Discharge Rating Curve
South Platte River at Denver, CO



Flood Insurance Study: South Platte River at 15th Street	
Storm Frequency	**Discharge (cfs)**
10 Year	9,700
50 Year	17,600
100 Year	22,300
500 Year	35,000

Note:
1. Rating table #34 from Colorado Division of Water Resources (CO-DWR).
2. Rating curves change on a frequent basis due to regular field measurements. Therefore, these values should only be used as an approximation. Please check the CO-DWR website for the most up-to-date rating for this station.
3. Datum of gage is 5,157.64 feet (NGVD29).
4. Flood Insurance Study, Denver County, Colorado November 20, 2013. South Platte River (Main Channel Only) at 15th Street is the nearest FIS site, and is therefore used to be representative of the gage at South Platte River at Denver, CO.

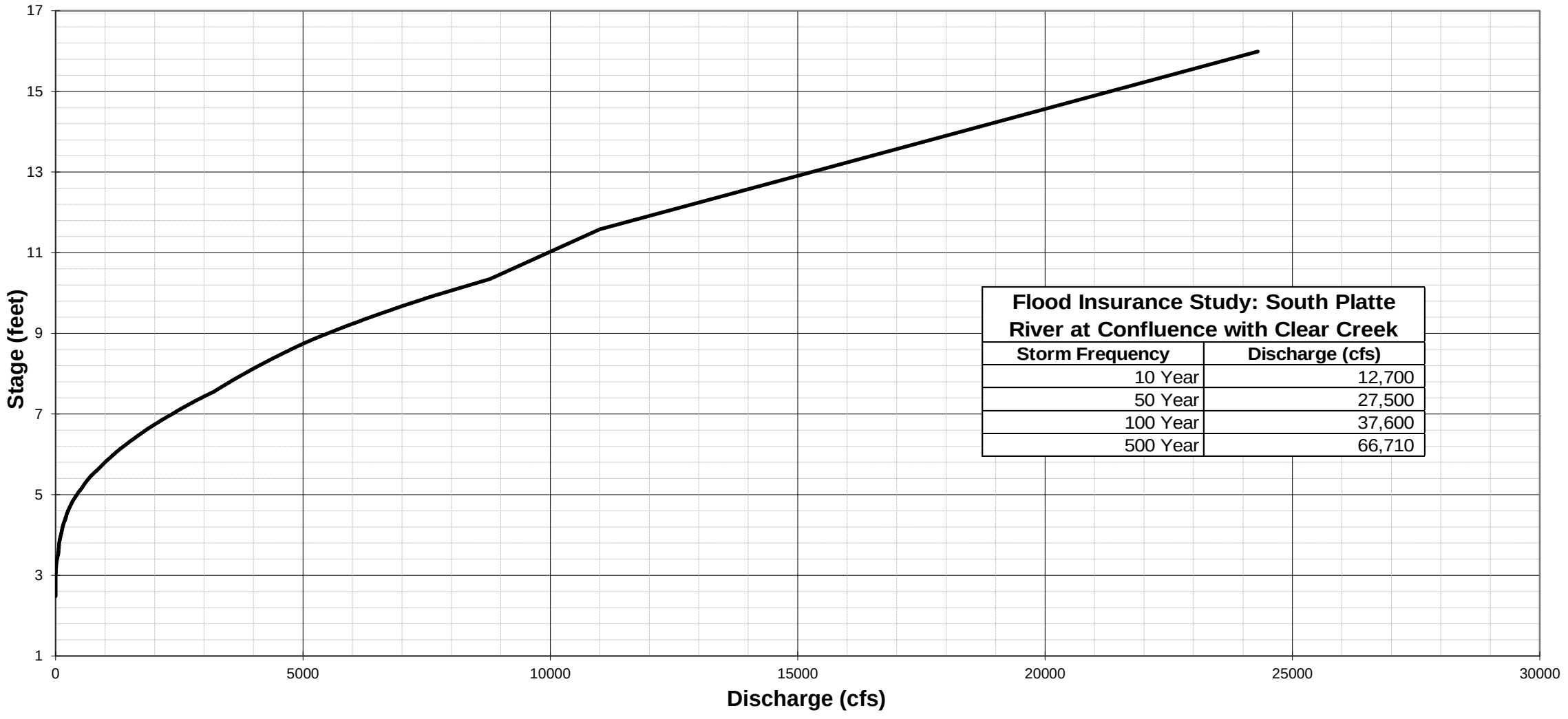
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Low Flow Discharge Rating Curve
South Platte River at Denver, CO
Rating #34

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Low Flow Discharge Rating Curve
South Platte River at Henderson, CO



Flood Insurance Study: South Platte River at Confluence with Clear Creek	
Storm Frequency	**Discharge (cfs)**
10 Year	12,700
50 Year	27,500
100 Year	37,600
500 Year	66,710

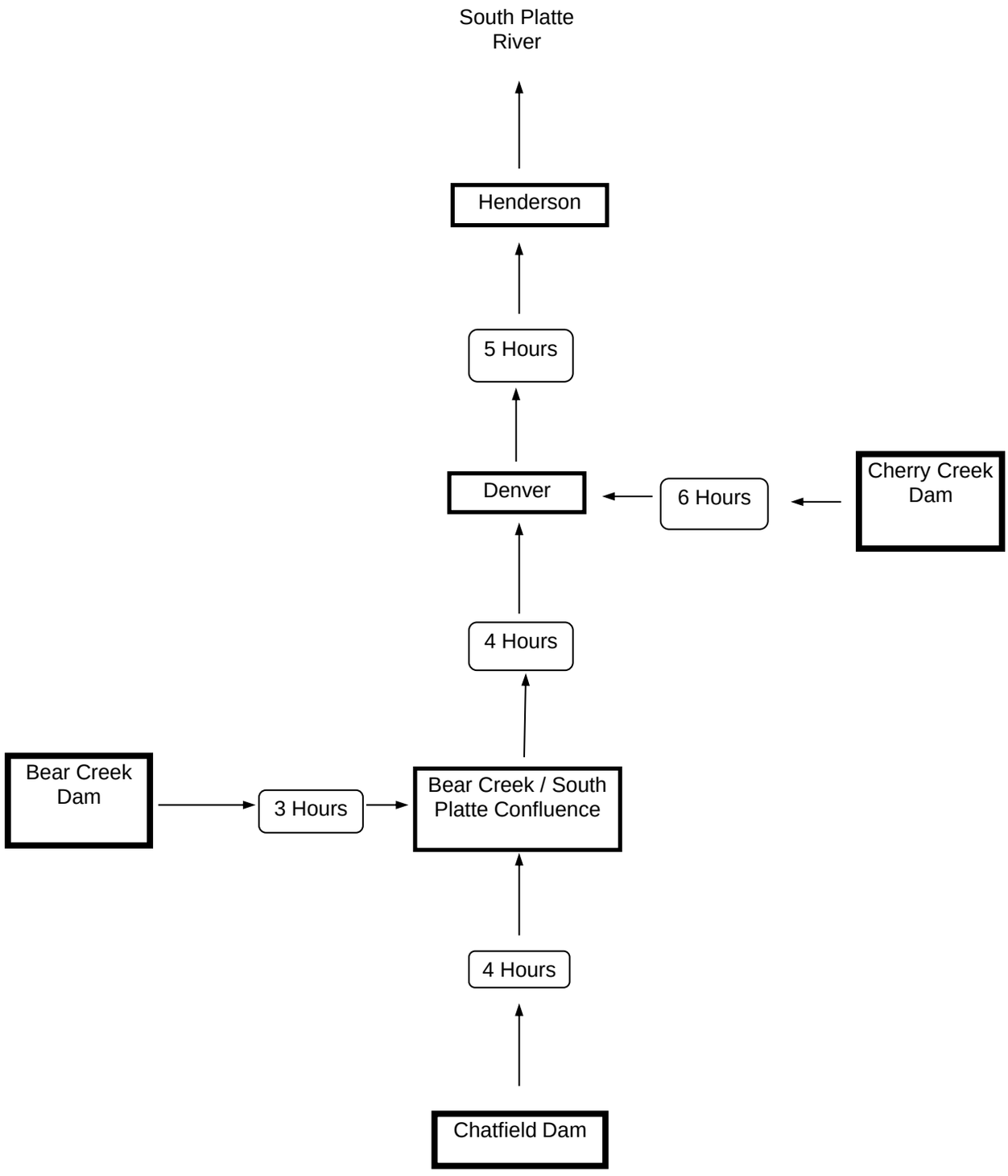
Note:
1. Rating table #34 from Colorado Division of Water Resources (CO-DWR).
2. Rating curves change on a frequent basis due to regular field measurements. Therefore, these values should only be used as an approximation. Please check the CO-DWR website for the most up-to-date rating for this station.
3. Datum of gage is 5,001.25 feet (NGVD29).
4. Flood Insurance Study, Denver County, Colorado November 20, 2013. South Platte River at Confluence with Clear Creek is the nearest FIS site, and is therefore used to be representative of the gage at South Platte River at Henderson, CO

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Low Flow Discharge Rating Curve
South Platte River at Henderson, CO
Rating #34

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Comparative Travel Times (hrs)
Normal Flow

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

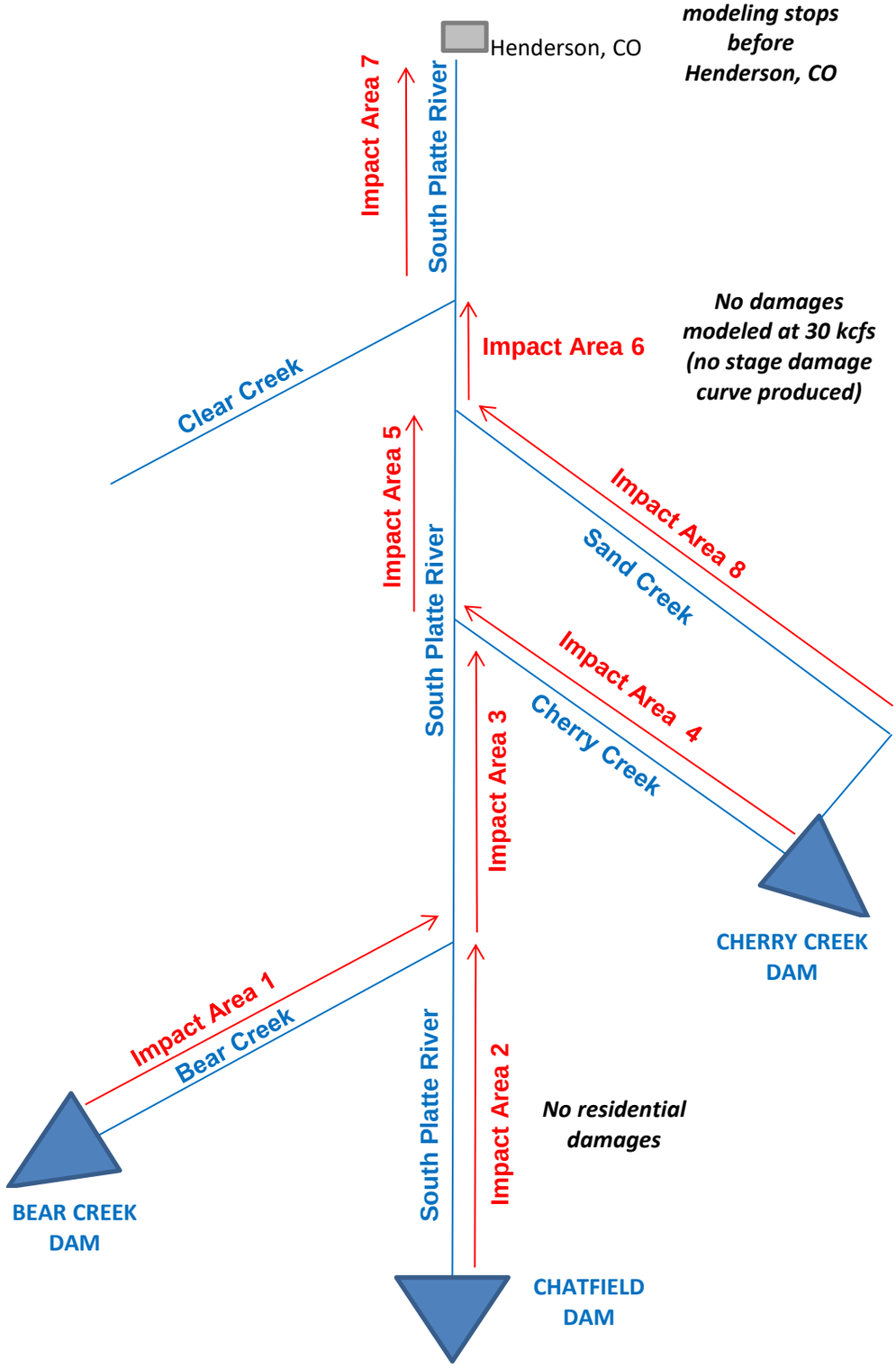
Note: *Travel times in hours between locations for high flows (June 1995). For normal flows, times will be 2 to 3 times faster.*	South Platte River											Cherry Creek Reservoir	Bear Creek			Clear Creek	
	Antero	Spinney	Eleven Mile	Cheesman (Deckers)	South Platte	Strontia	Chatfield Reservoir	Denver	Henderson	Ft. Lupton	Kersey		Morrison	Bear Creek Reservoir	Sheridan	Golden	Derby
Antero		4	6	30	38	39	40	44	47	50	76						
Spinney			2	26	34	35	36	40	43	46	72						
Eleven Mile				24	32	33	34	38	41	44	70						
Cheesman (Deckers)					8	9	10	14	17	20	54						
South Platte						1	2	6	9	12	38						
Strontia							1	5	8	11	37						
Chatfield Reservoir								4	8	10	36						
Denver									4	6	29						
Henderson										3	34						
Ft. Lupton											26						
Kersey																	
Cherry Creek Reservoir								6	9	12	38						
Morrison								7	10	13	39			2	5		
Bear Creek Reservoir								5	8	11	37				3		
Sheridan								2	5	8	34						
Golden									4	7	33						2
Derby									2	5	31						

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Comparative Travel Times (hrs)
High Flow

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



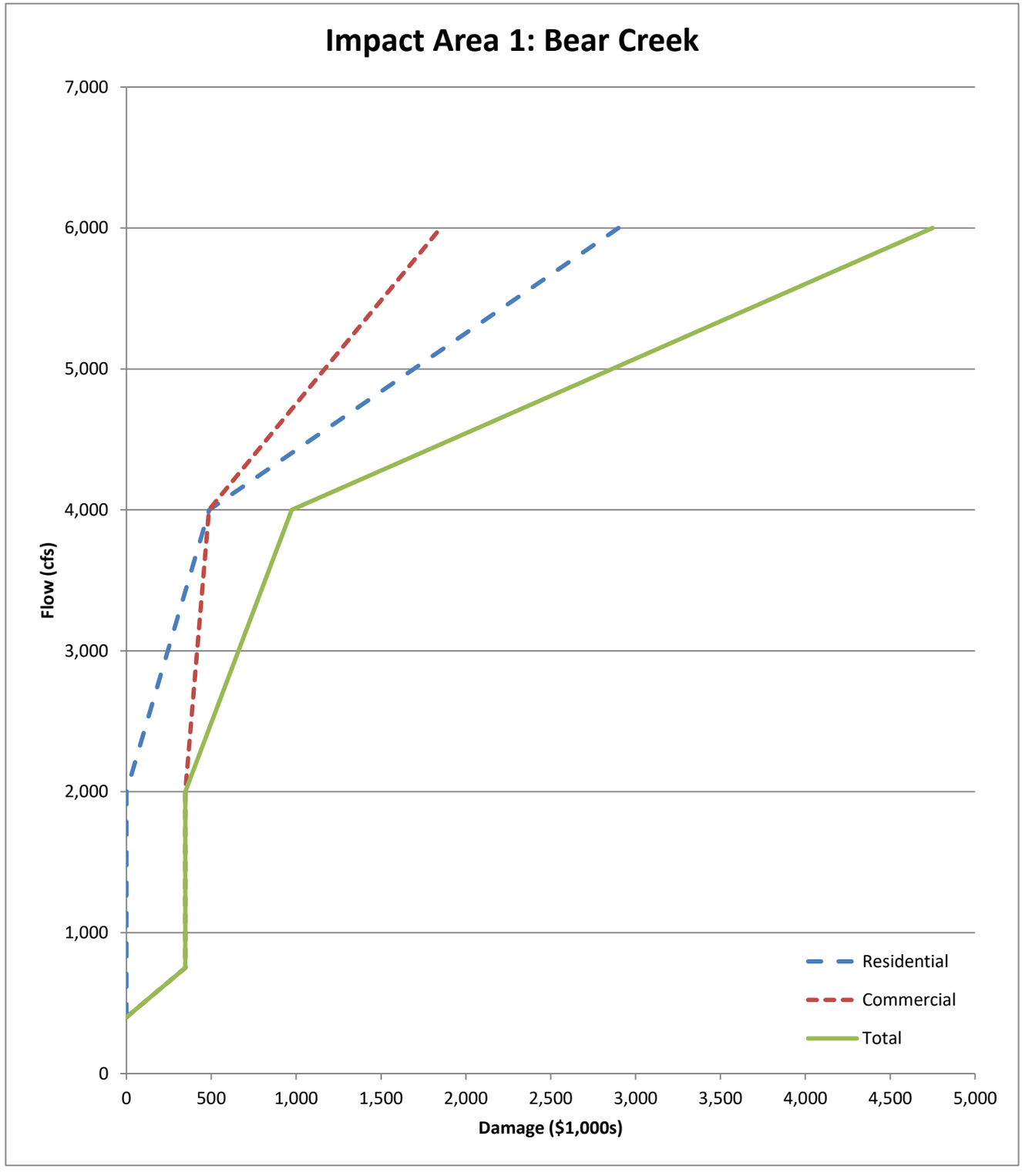
Note: Eight impact areas were analyzed as defined in the graphic. Seven of them showed damages with the selected modeled depth grids. Thus, seven stage damage curves were developed downstream of the Tri-Lakes Dams.

Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damage Impact Areas

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



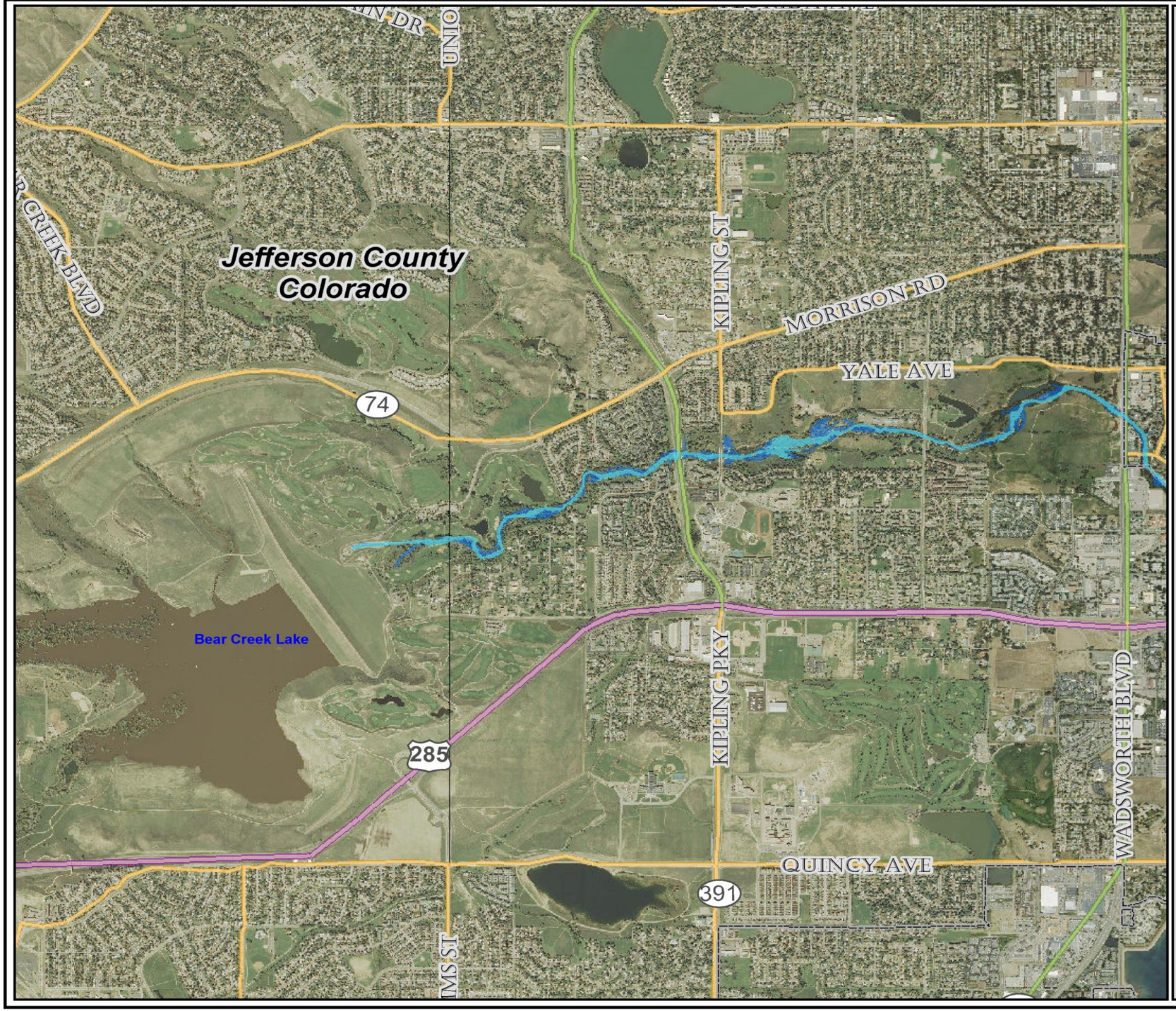
Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves
Impact Area 1 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



MAP REACH: **IMPACT AREA 1**

BEAR CREEK - BEAR CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

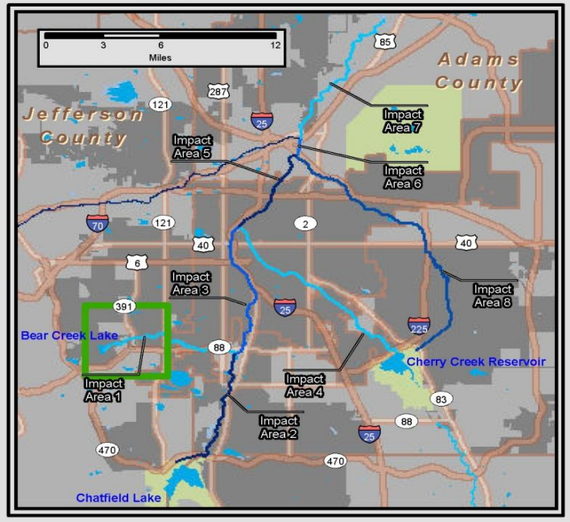
400 cfs

2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Wednesday, September 23, 2015

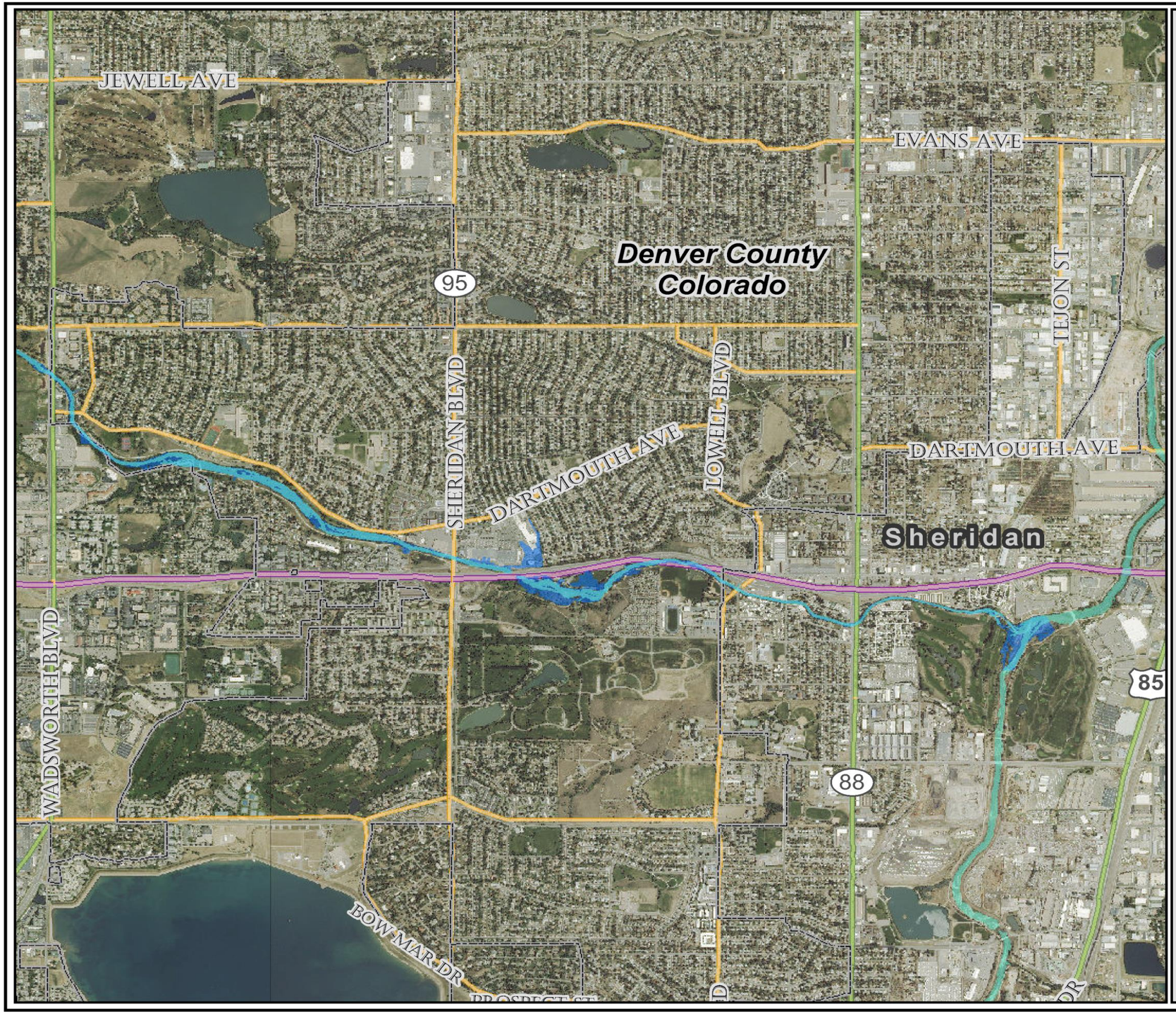
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 1 - Bear Creek
upstream of Wadsworth Blvd.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-23b



MAP REACH: **IMPACT AREA 1**

BEAR CREEK - BEAR CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

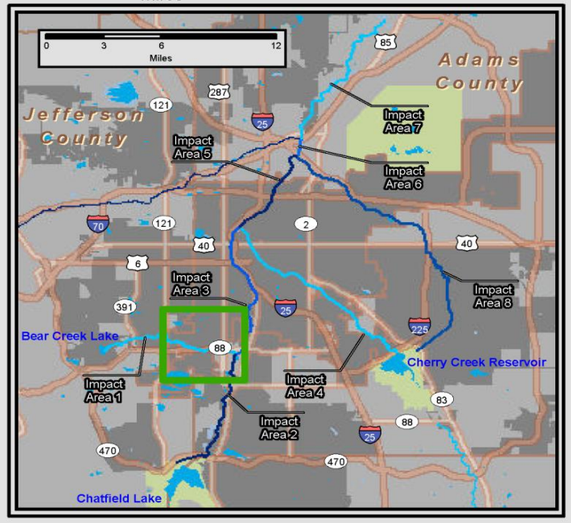
400 cfs

2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Thursday, September 24, 2015

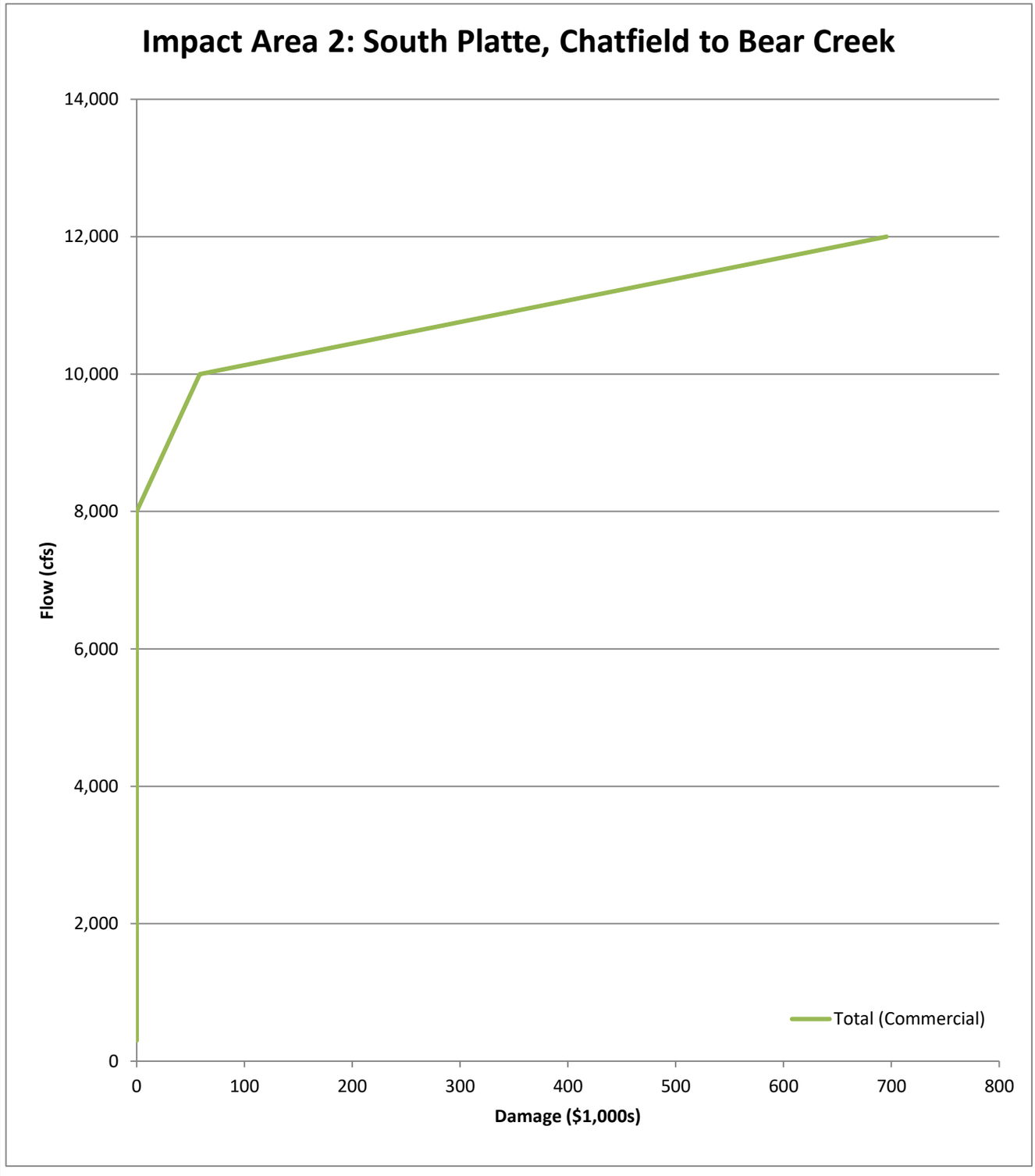
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 1 - Bear Creek
downstream of Wadsworth Blvd.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-23c



Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

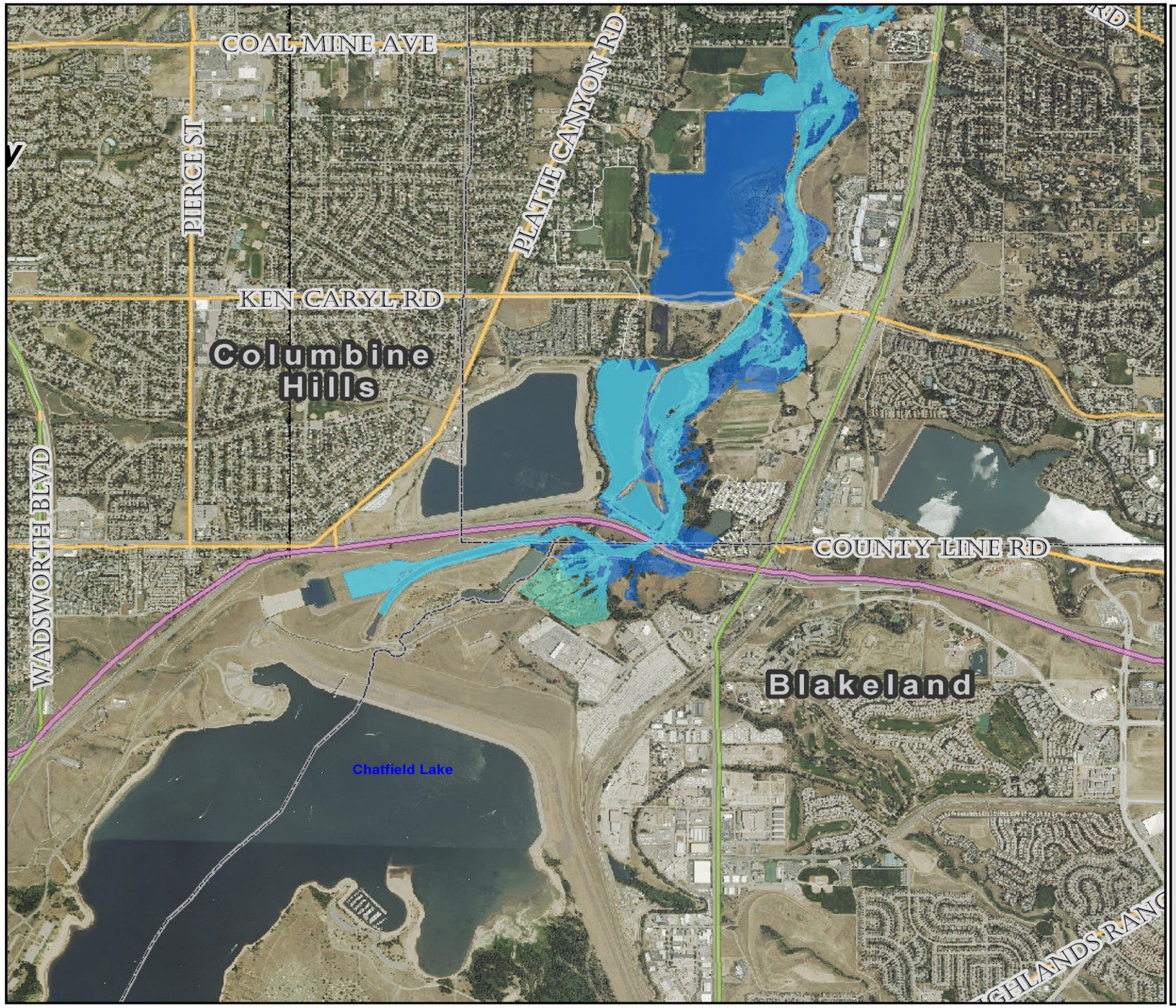
Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves
Impact Area 2 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-24a



MAP REACH: **IMPACT AREA 2**

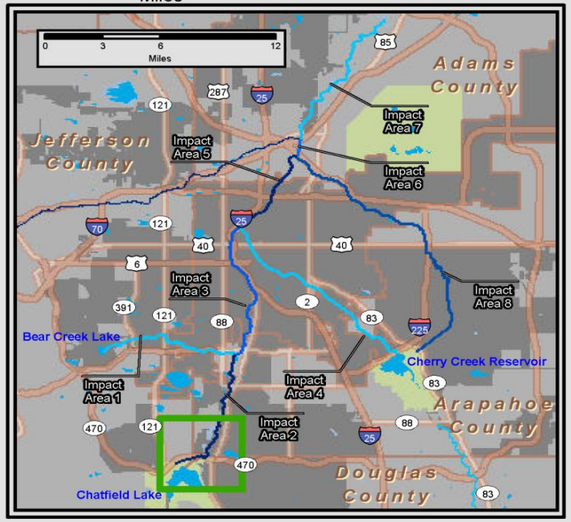
S. PLATTE RIVER - CHATFIELD DAM TO BEAR CREEK CONFLUENCE

Inundation at:

- 5,000 cfs
- 10,000 cfs

0 0.125 0.25 0.5 0.75 Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Wednesday, September 23, 2015

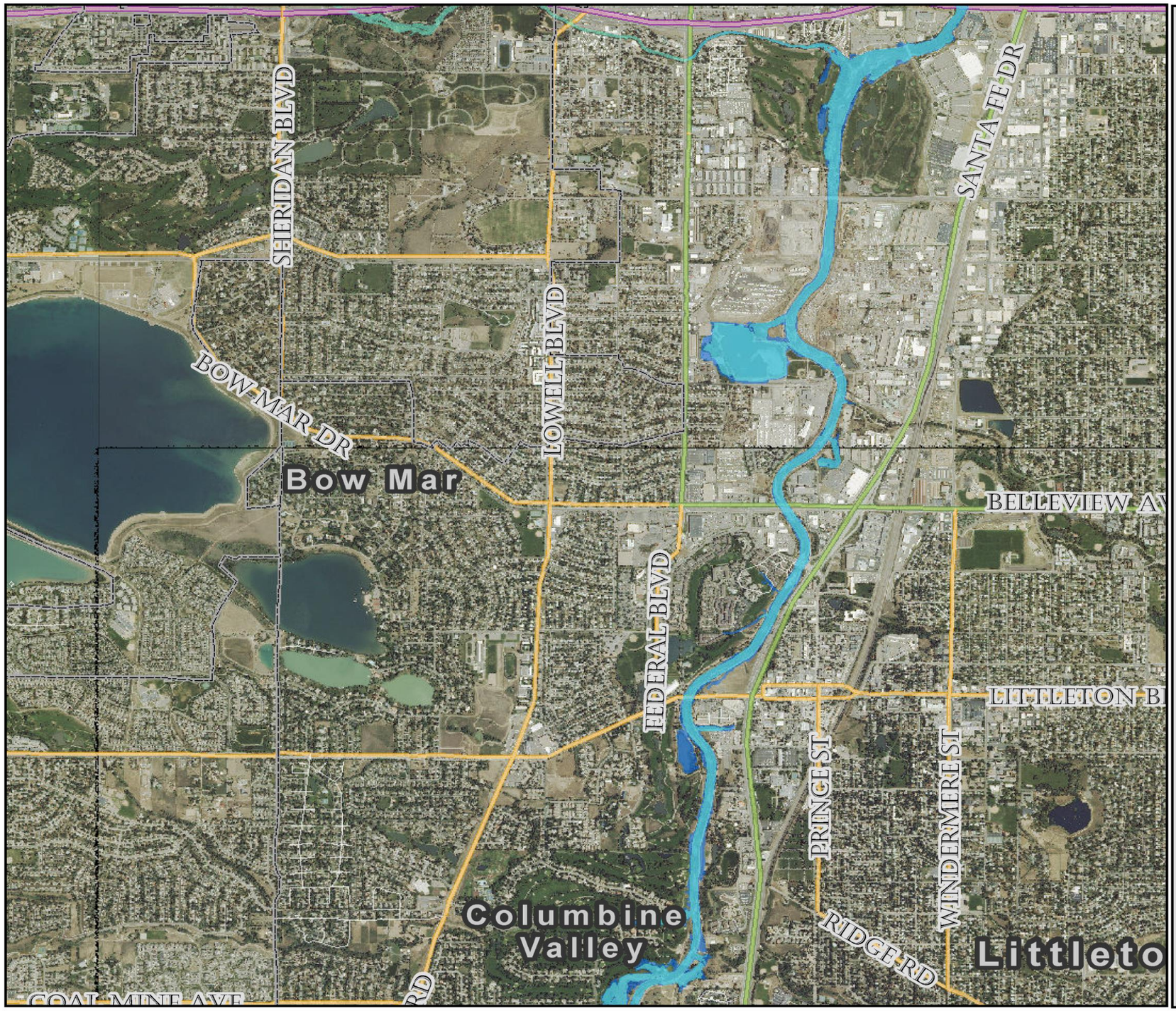
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 2 - South Platte
upstream of Coal Mine Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-24b



MAP REACH: **IMPACT AREA 2**

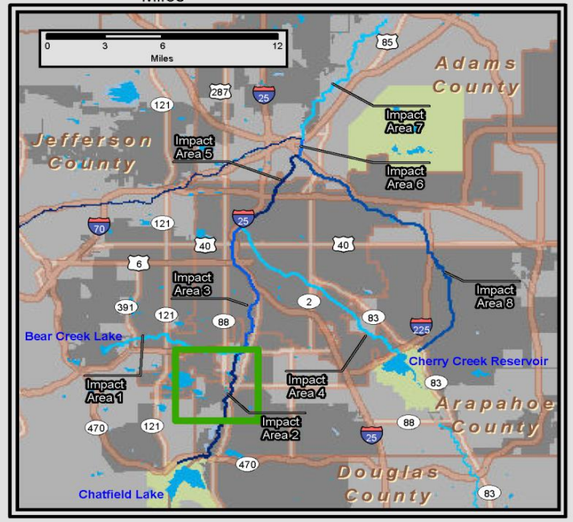
S. PLATTE RIVER - CHATFIELD DAM TO BEAR CREEK CONFLUENCE

Inundation at:

- 5,000 cfs
- 10,000 cfs

0 0.125 0.25 0.5 0.75
Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Thursday, September 24, 2015

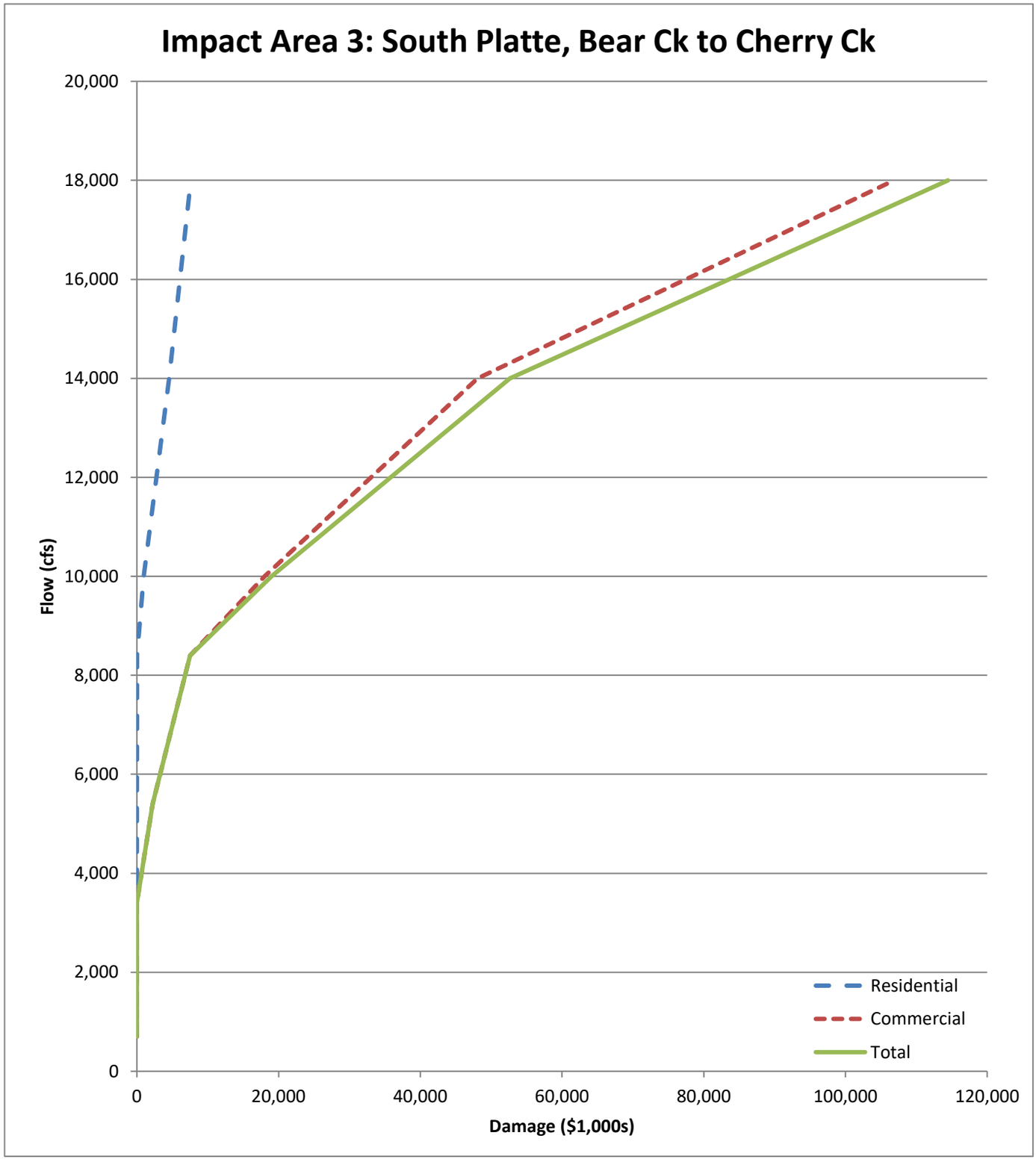
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 2 - South Platte
downstream of Coal Mine Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-24c



Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

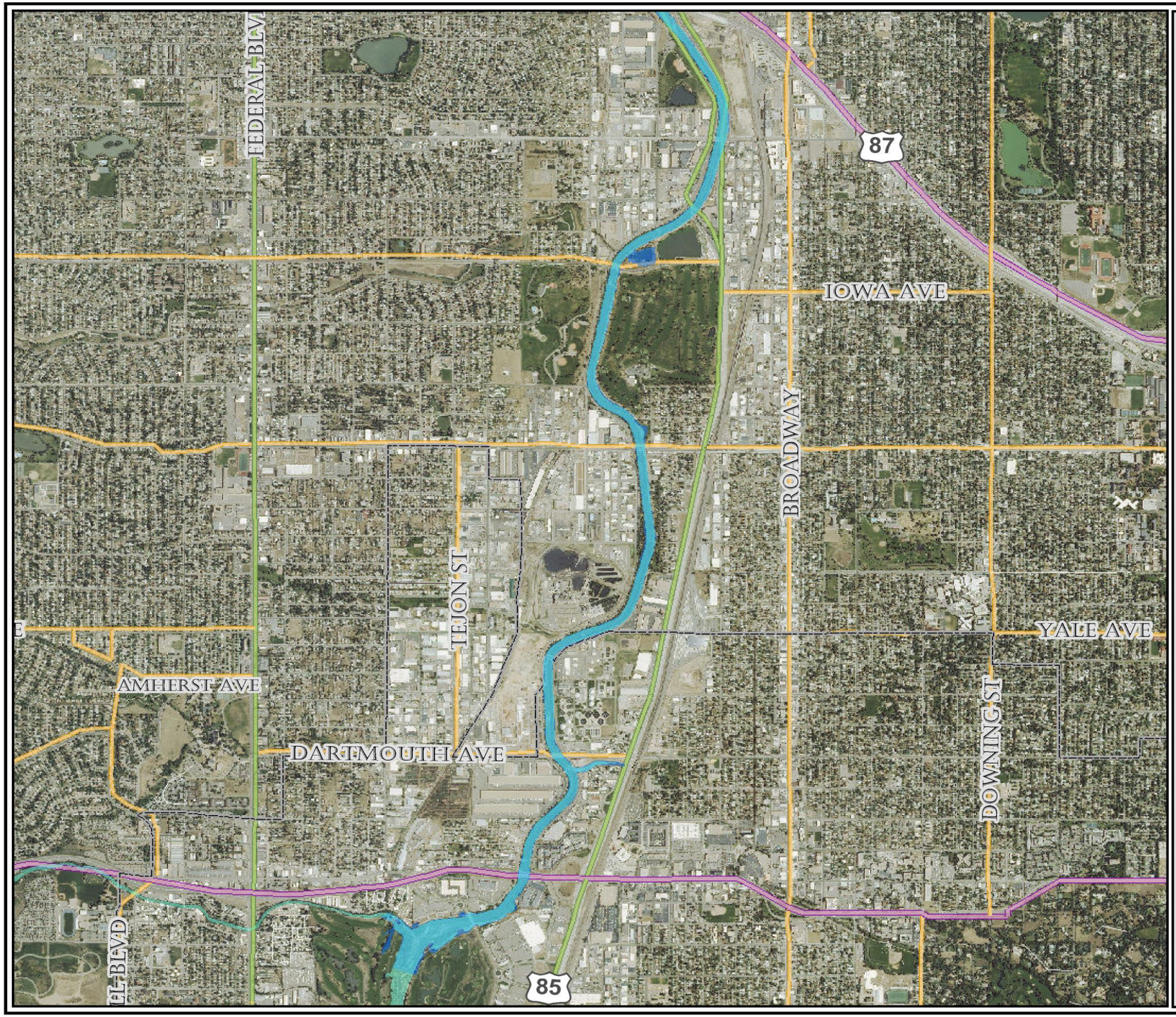
Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves

Impact Area 3 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



MAP REACH: **IMPACT AREA 3**

SOUTH PLATTE RIVER - BEAR CREEK TO CHERRY CREEK CONFLUENCE

Inundation at:

5,400 cfs

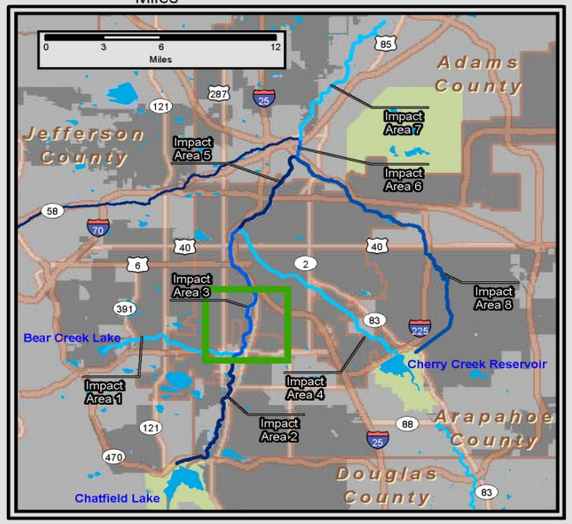
10,000 cfs

0 0.125 0.25 0.5 0.75

Miles

N

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture,
Farm Service Agency

Compiled On: Thursday, September 24, 2015

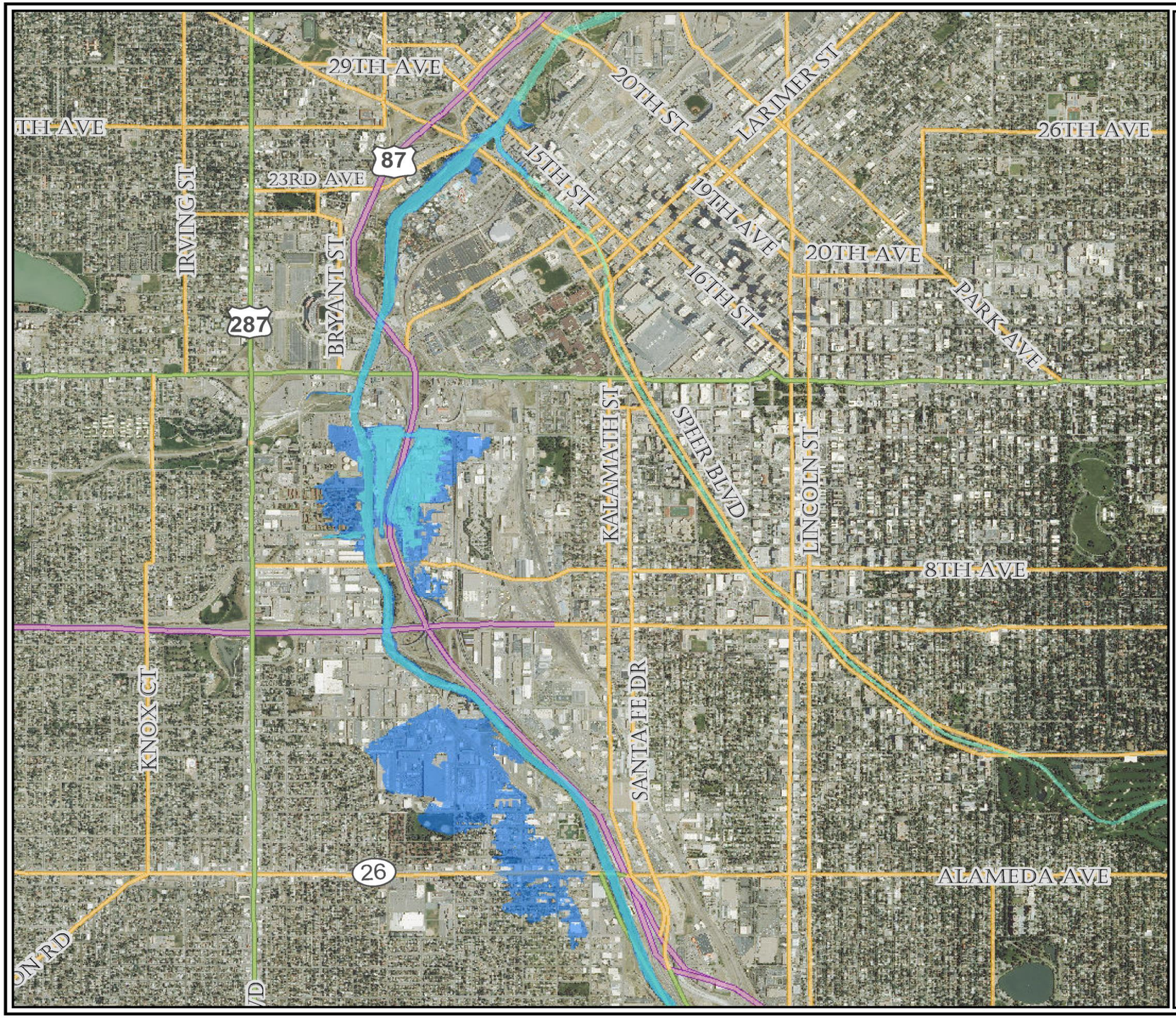
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 3 - South Platte
upstream of Almeda Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-25b



MAP REACH: **IMPACT AREA 3**

SOUTH PLATTE RIVER - BEAR CREEK TO CHERRY CREEK CONFLUENCE

Inundation at:

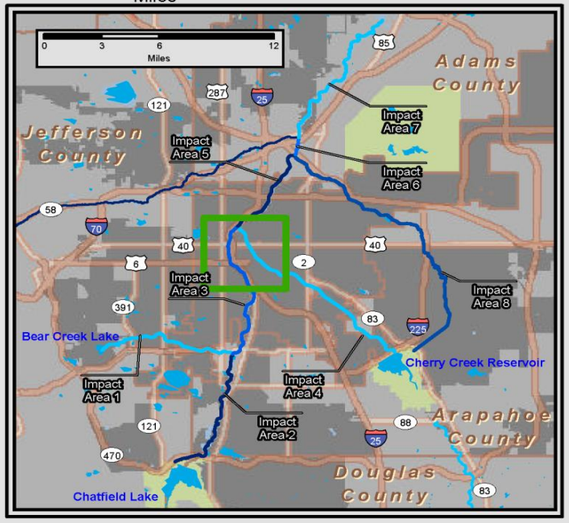
5,400 cfs

10,000 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture,
Farm Service Agency

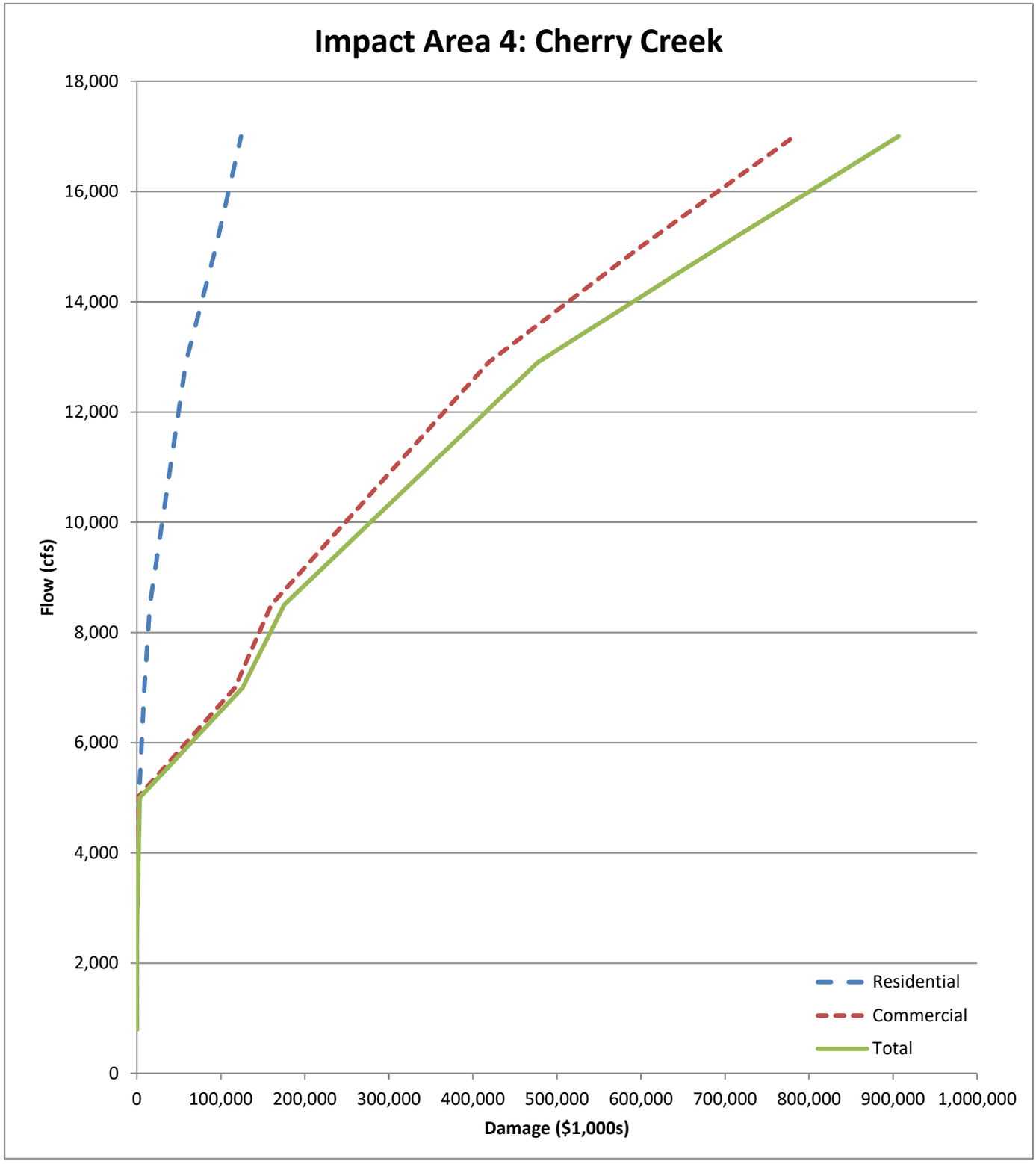
Compiled On: Thursday, September 24, 2015

Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 3 - South Platte
downstream of Almeda Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



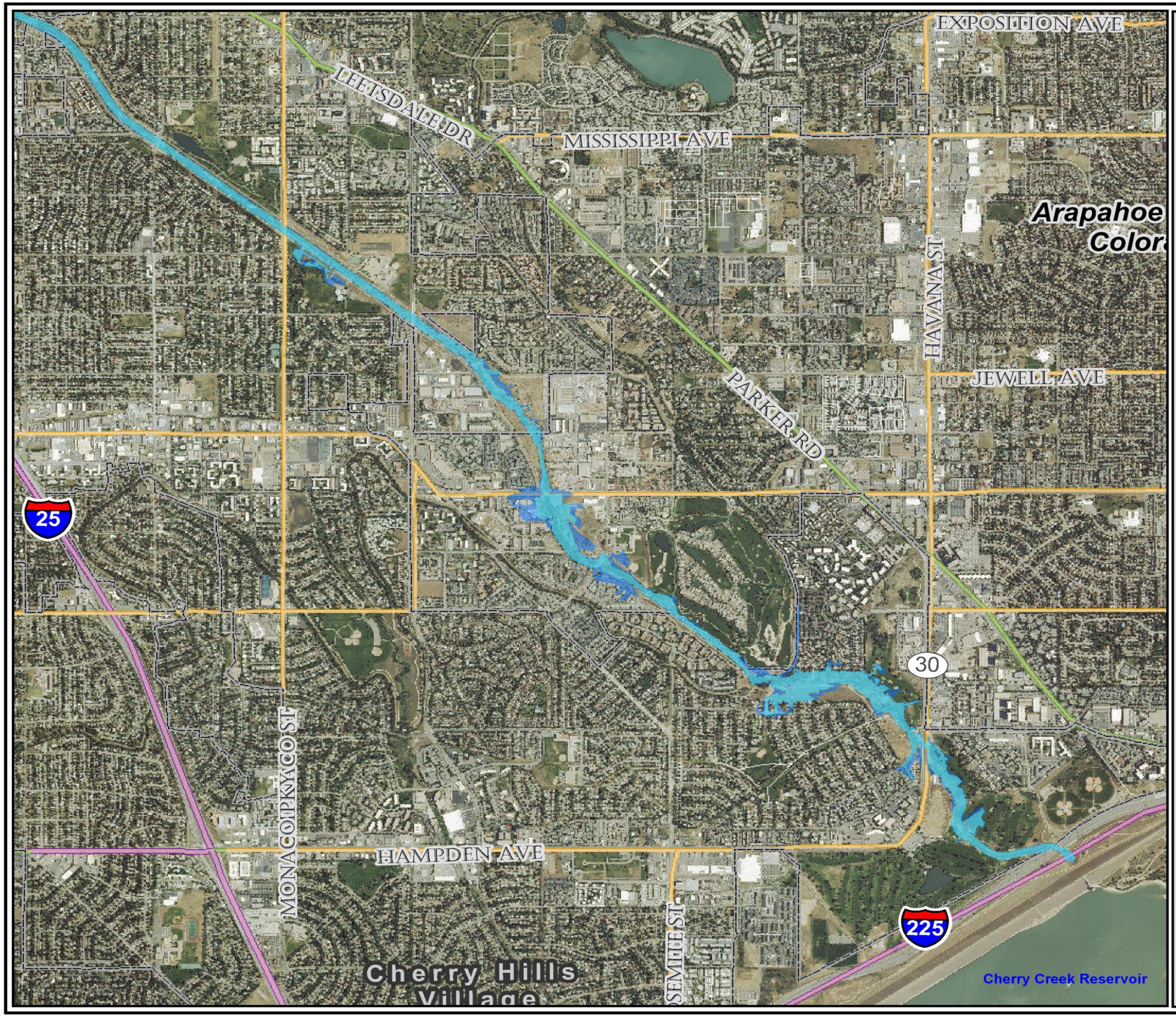
Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves
Impact Area 4 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



MAP REACH: **IMPACT AREA 4**

CHERRY CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

5,000 cfs

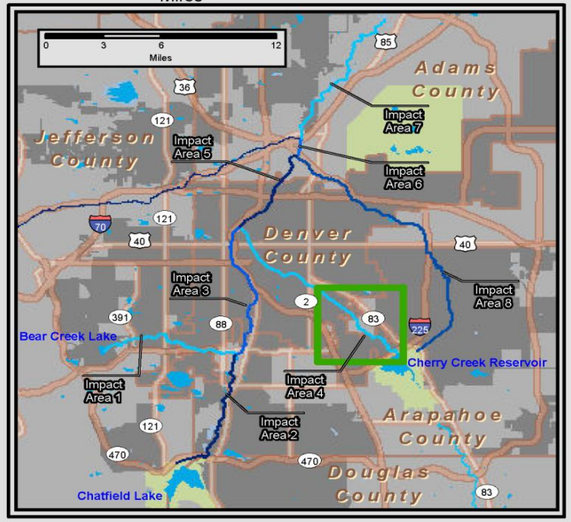
7,000 CFS

0 0.125 0.25 0.5 0.75

Miles

N

US Army Corps of Engineers
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Thursday, September 24, 2015

Disclaimer: The United States Government and USACE furnishes this data and the recipient accepts and uses it with the express understanding that the Government makes no warranties, expressed, or implied, concerning the accuracy, completeness, reliability, usability, or suitability for any particular purpose of the information and data furnished. The United States shall be under no liability whatsoever to any person by reason of any use made thereof. Data displayed on this map are approximations derived from GIS layers and should not be used in place of survey data or legal land descriptions.

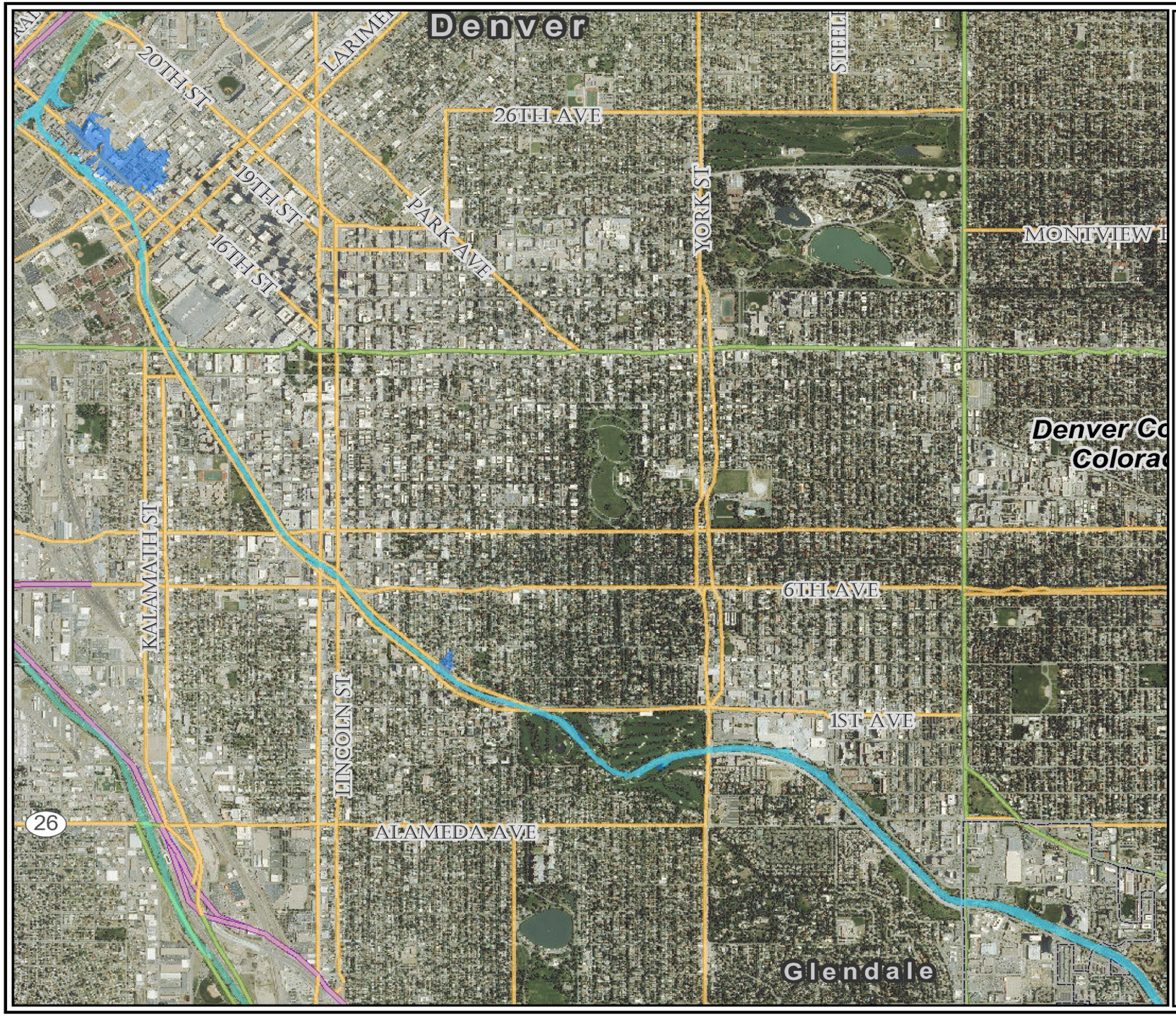
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 4 - Cherry Creek
upstream of Cherry Street

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-26b



MAP REACH: **IMPACT AREA 4**

CHERRY CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

5,000 cfs

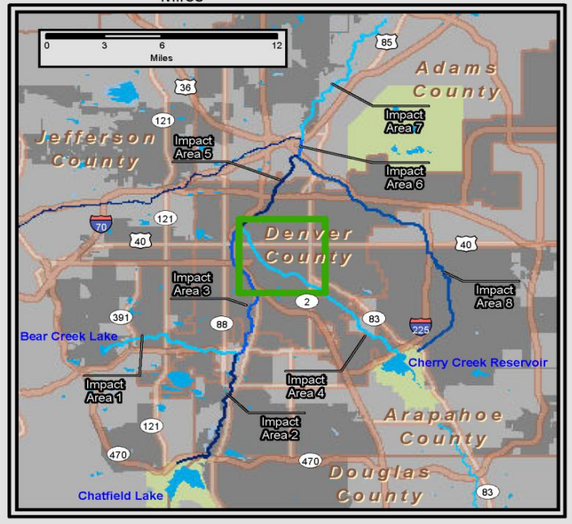
7,000 CFS

0 0.125 0.25 0.5 0.75

Miles

N

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

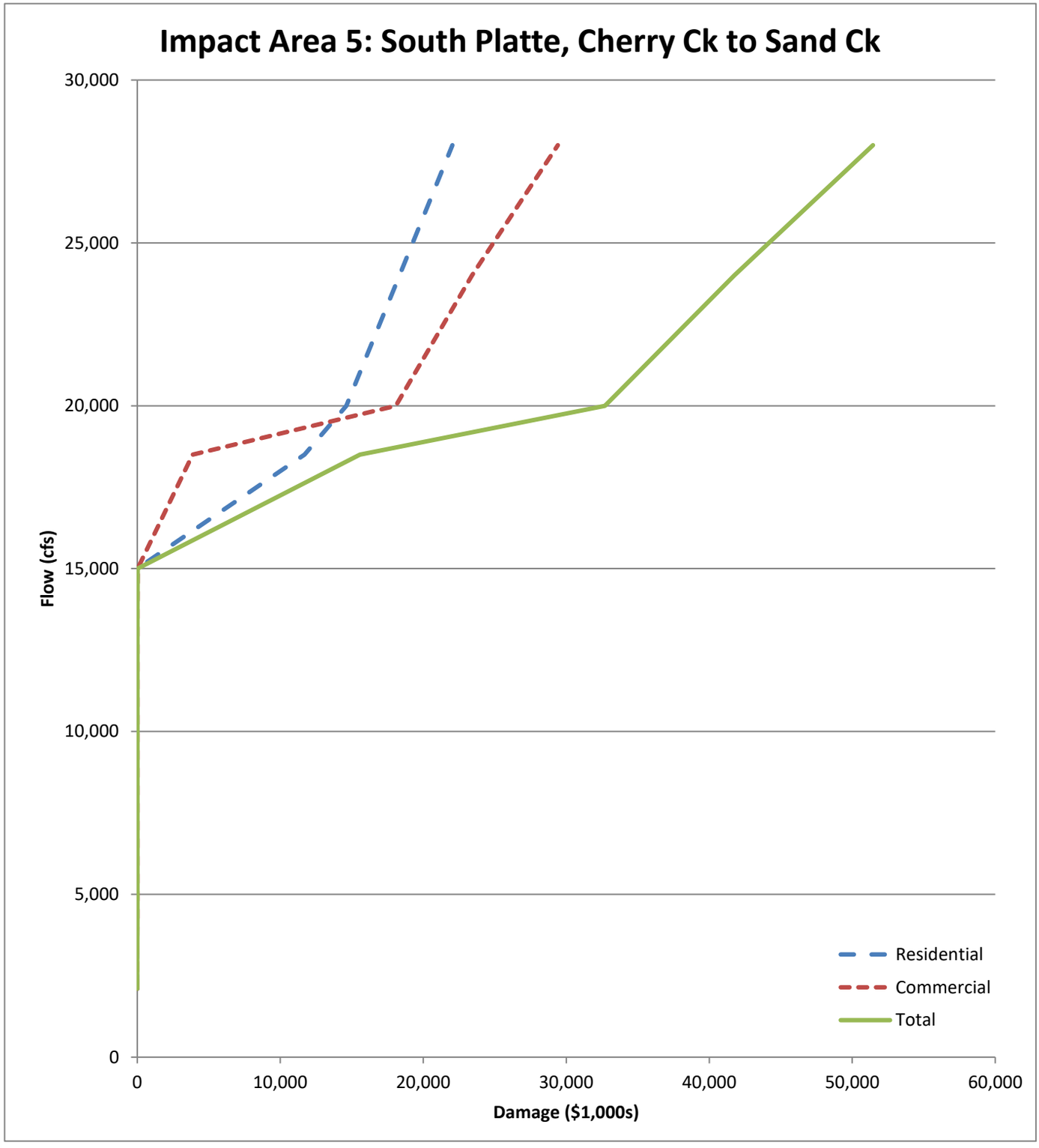
Compiled On: Thursday, September 24, 2015

Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 4 - Cherry Creek
downstream of Cherry Street

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



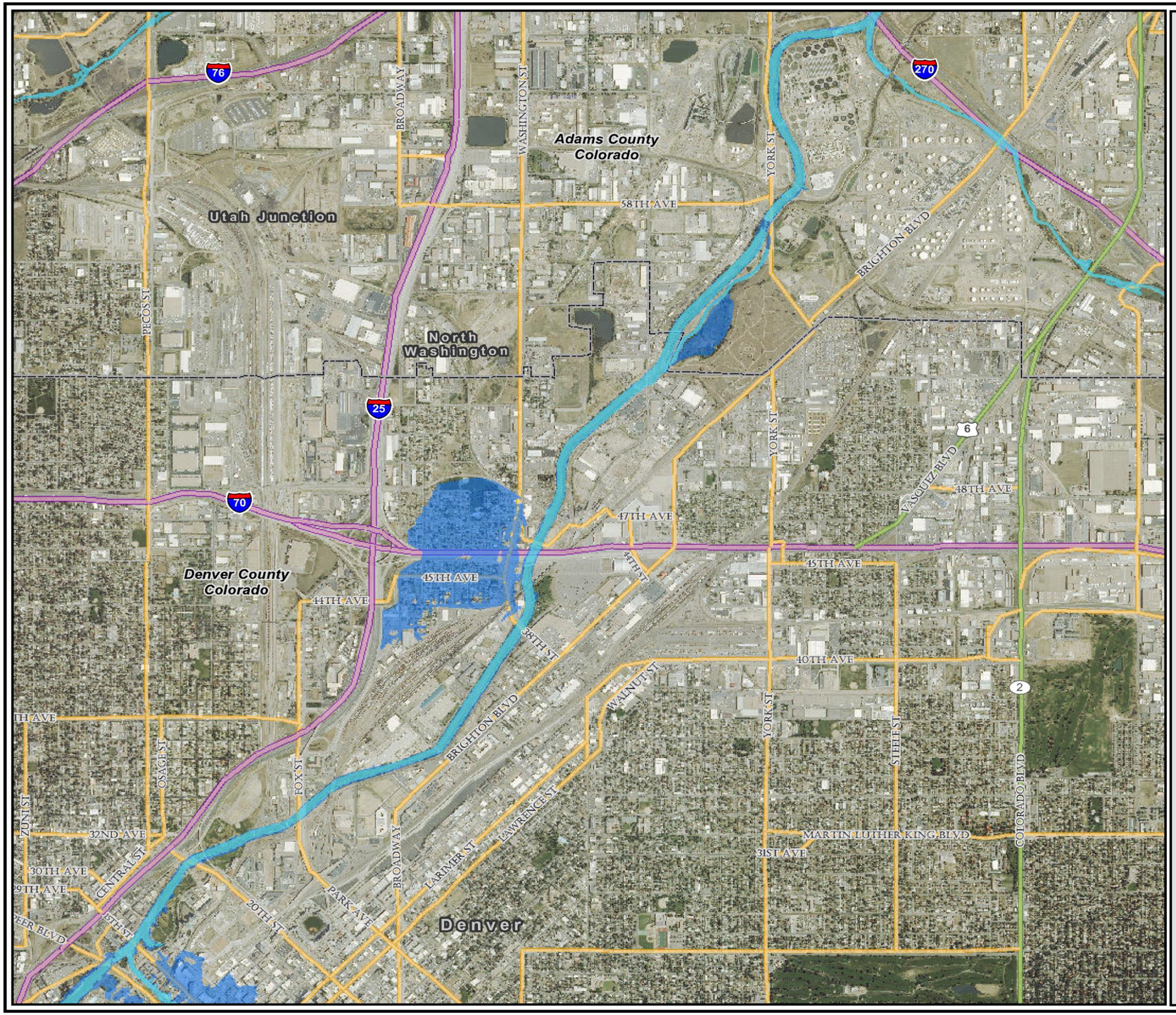
Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves
Impact Area 5 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



MAP REACH: **IMPACT AREA 5**

SOUTH PLATTE RIVER - CHEERY CREEK TO SAND CREEK

Inundation at:

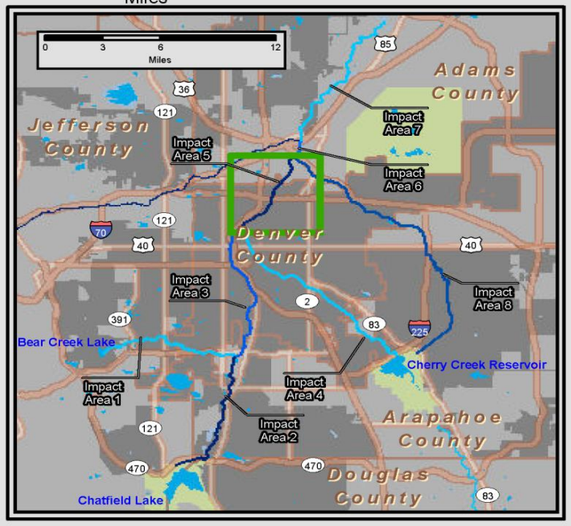
5,700 cfs

18,500 cfs

0 0.25 0.5

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Thursday, September 24, 2015

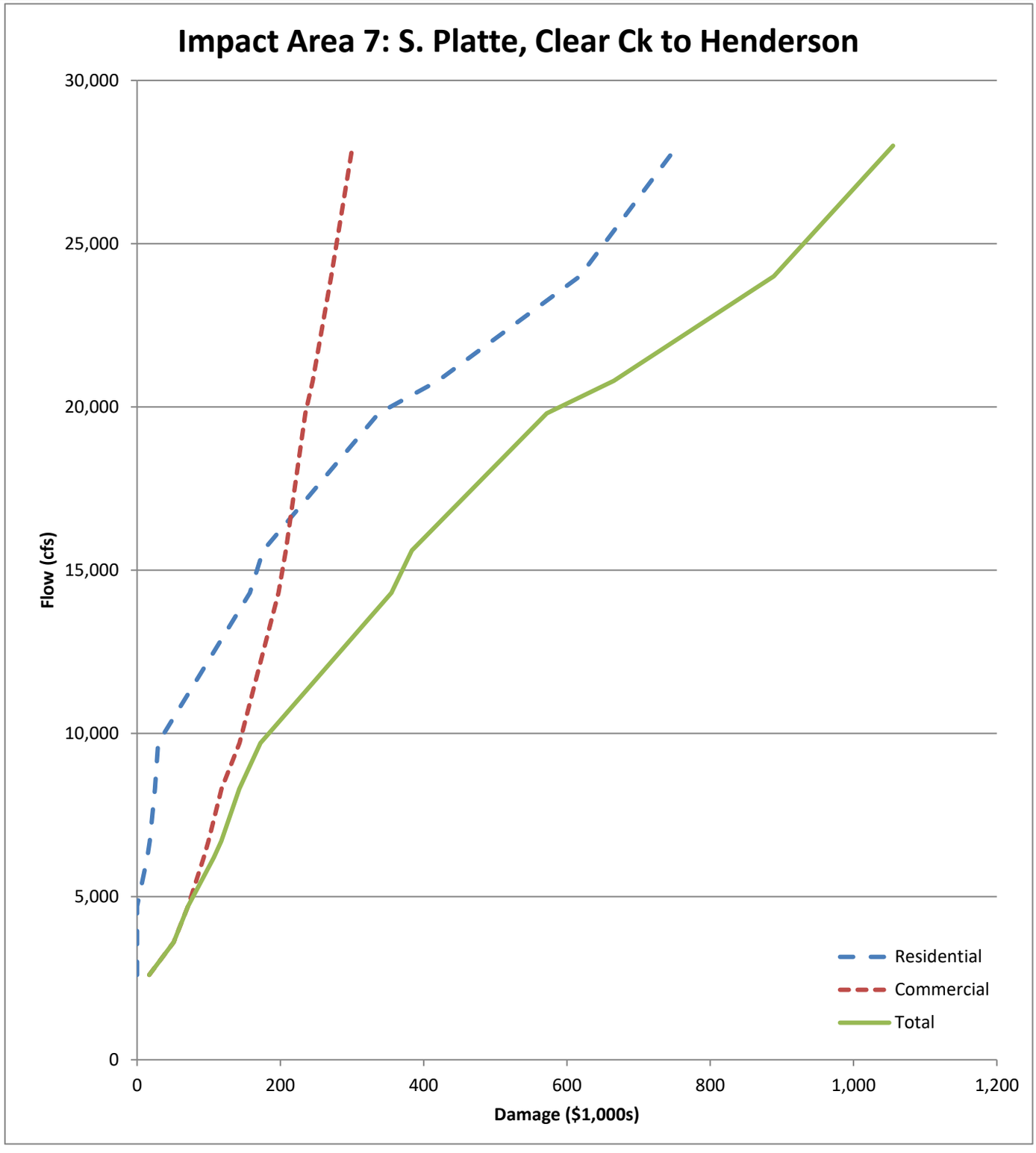
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 5 - South Platte
Cherry Creek to Sand Creek

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-27b



Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves
Impact Area 7 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

MAP REACH: **IMPACT AREA 7**

SOUTH PLATTE RIVER - DOWNSTREAM FROM CLEAR CREEK

Inundation at:

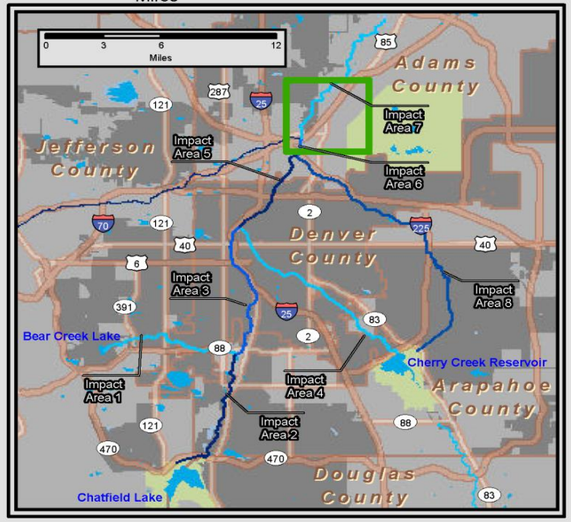
6,700 cfs

19,800 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Friday, September 25, 2015

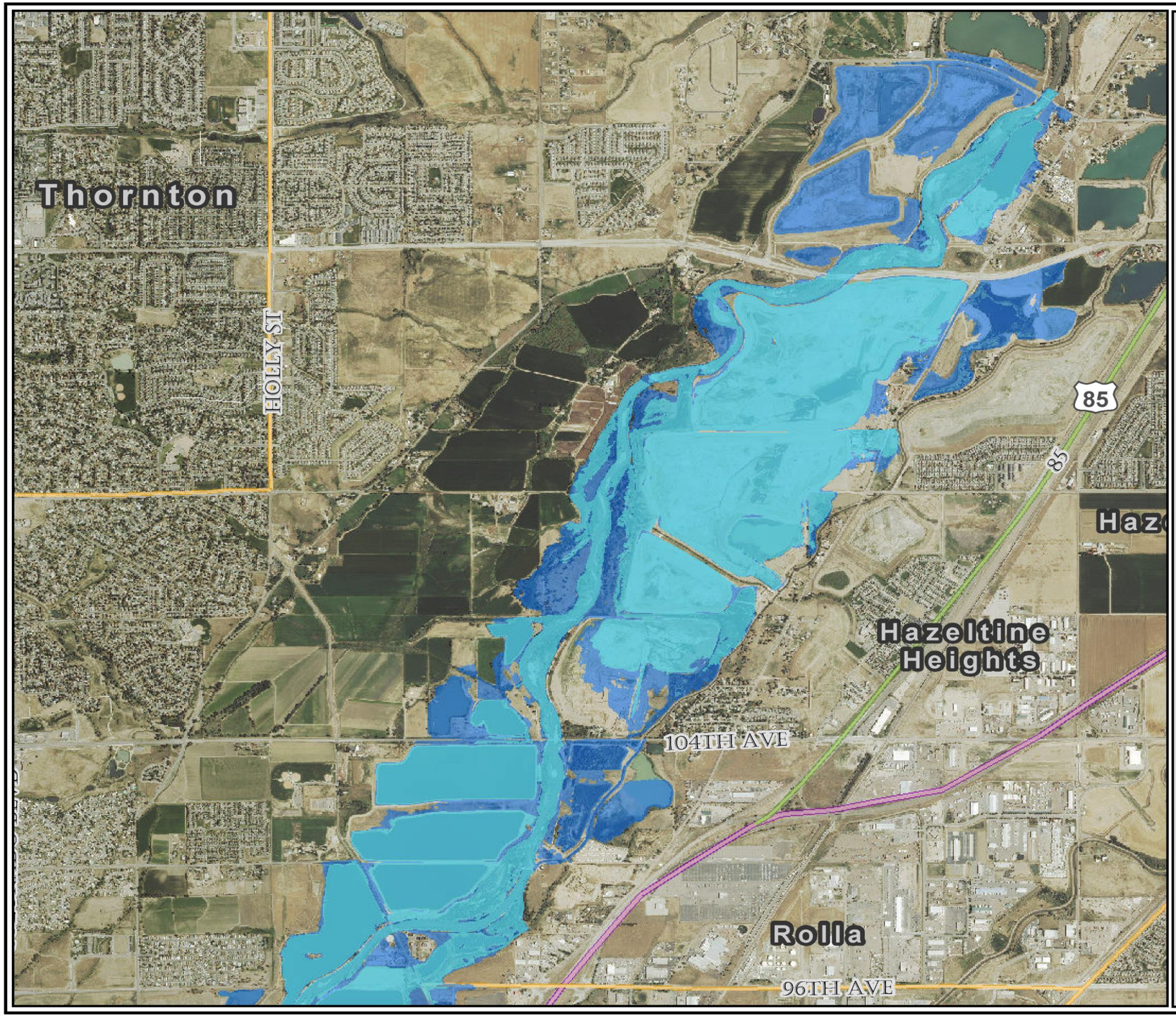
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 7 - South Platte
upstream of 96th Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-28b



MAP REACH: **IMPACT AREA 7**

SOUTH PLATTE RIVER - DOWNSTREAM FROM CLEAR CREEK

Inundation at:

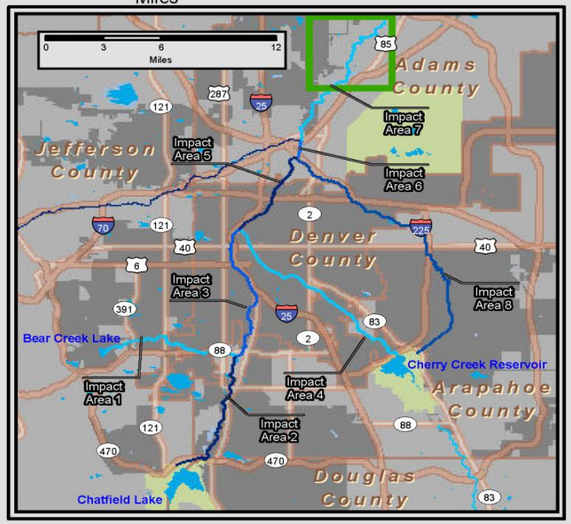
6,700 cfs

19,800 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

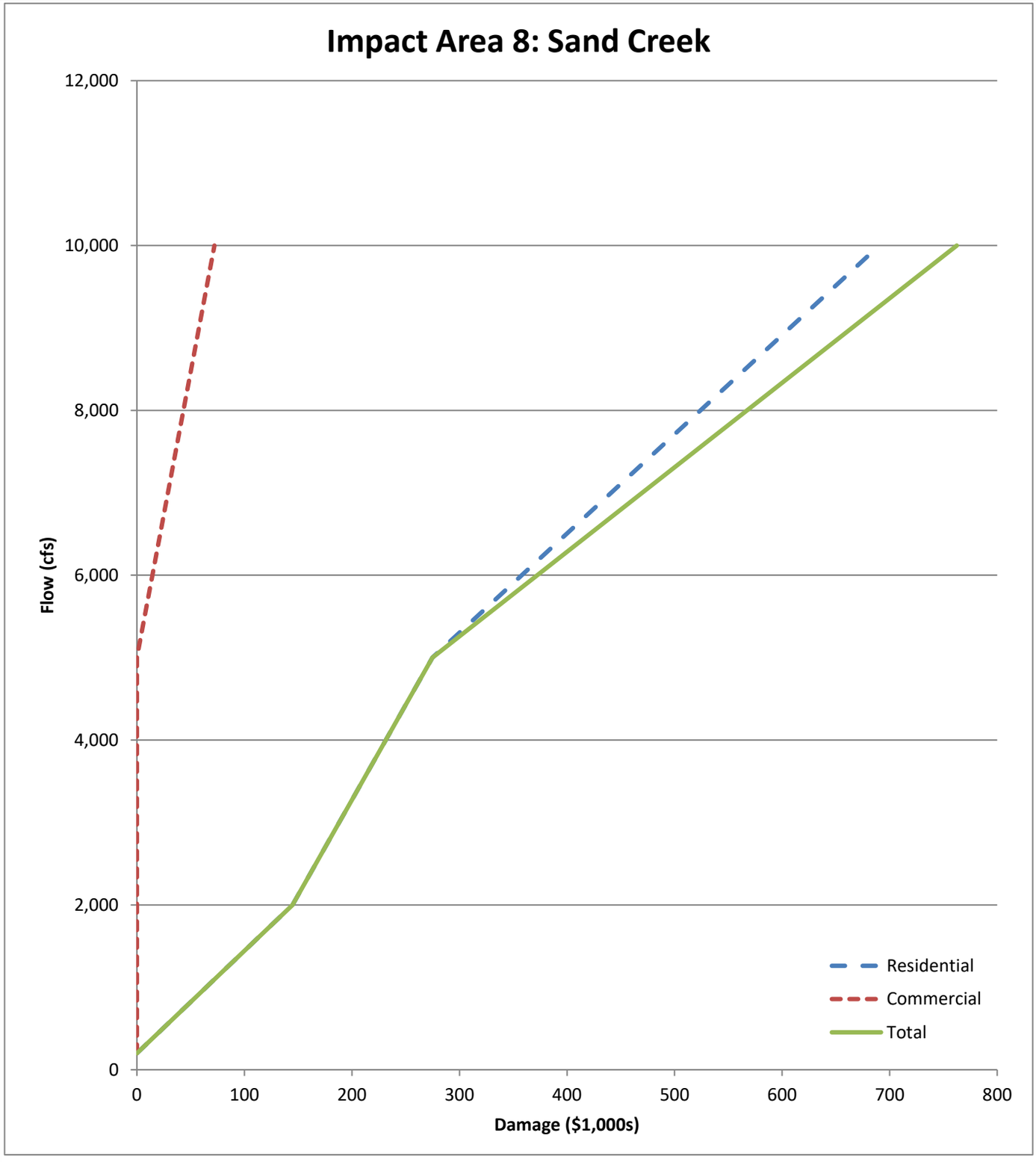
Compiled On: Friday, September 25, 2015

Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 7 - South Platte
downstream of 96th Ave.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Prepared By:_____LJH_&_JB_____
Reviewed By:_____KJS_____

Notes:
1) The curves were finalized in August 2015 using HEC-FIA version 3.0 beta.
2) Curves focus solely on damages to structures and contents; agriculture and life loss estimates were not a primary motivator for these curves.
3) Input data sources: HEC-RAS modeled stream alignments, depth grids, and terrain grids as well as structure data obtained from assessors data in Denver, Arapahoe, Jefferson and Adams Counties.

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Stage Damages Curves

Impact Area 8 - Adjusted to 2014 $

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

MAP REACH: **IMPACT AREA 8**

SAND CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

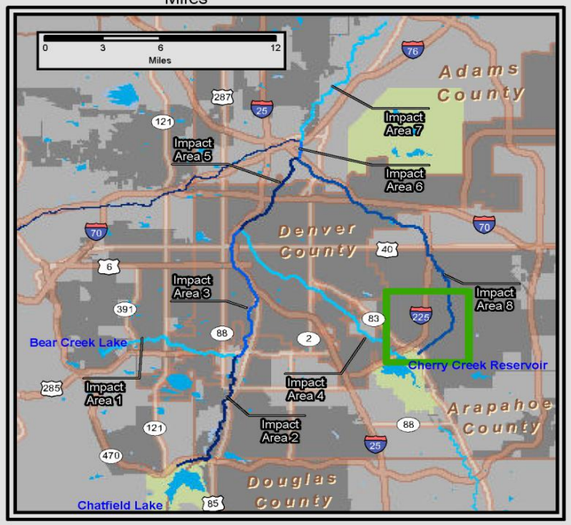
200 cfs

2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture,
Farm Service Agency

Compiled On: Thursday, September 24, 2015

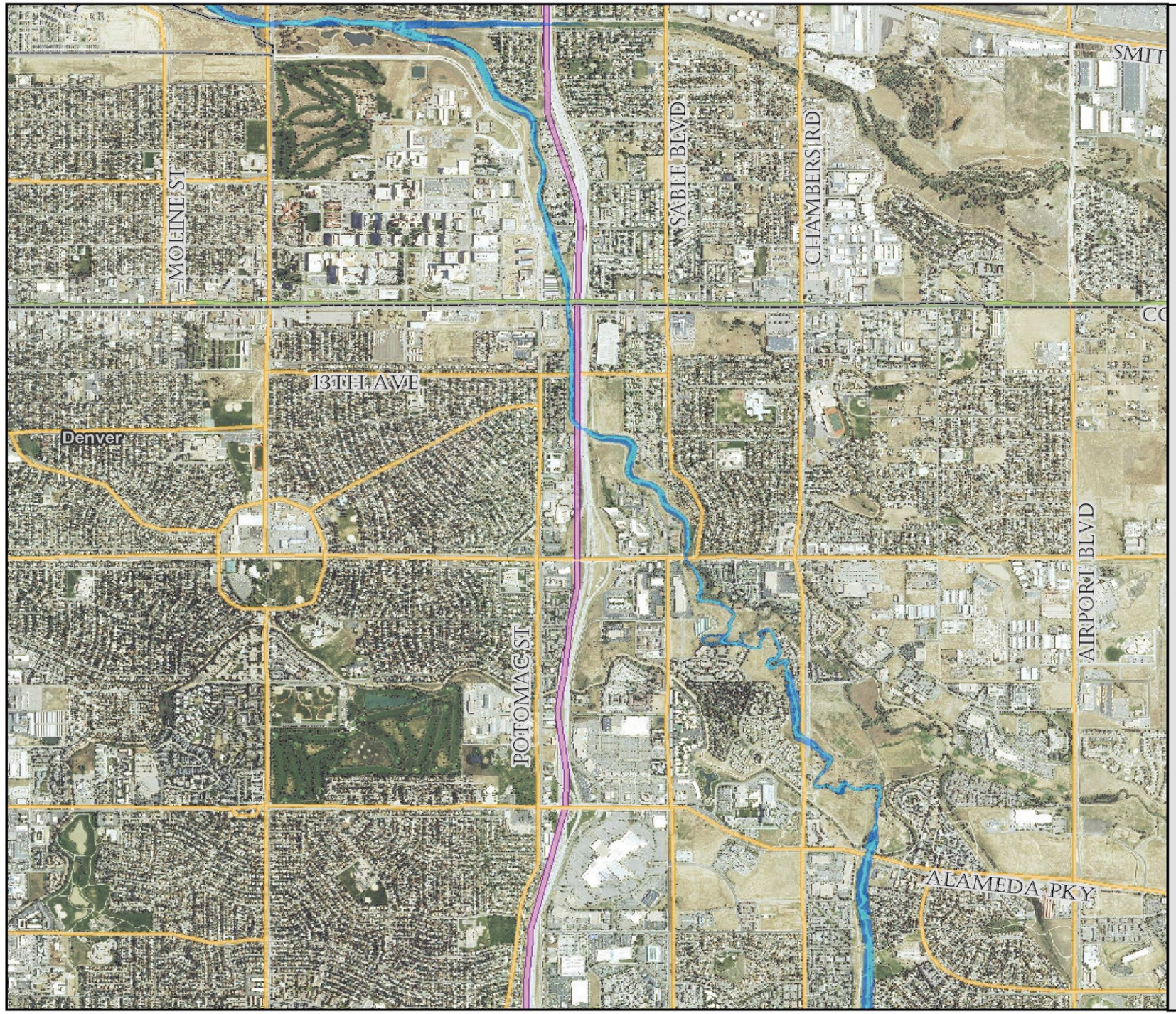
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 8 - Sand Creek
upstream of Almeda Pkwy.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-29b



MAP REACH: **IMPACT AREA 8**

SAND CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

200 cfs

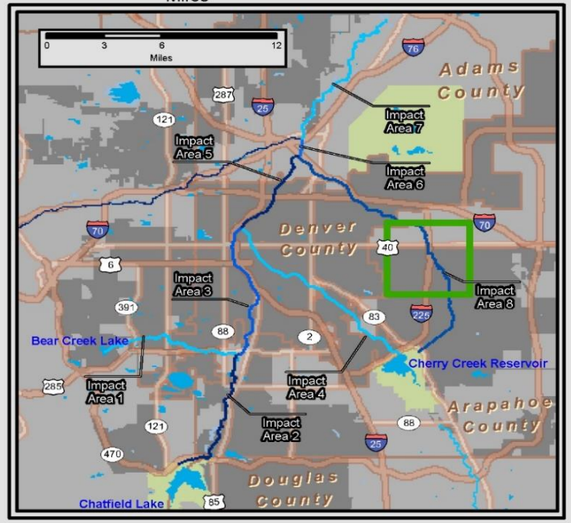
2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

N

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Tuesday, November 28, 2017

Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 8 - Sand Creek
downstream of Almeda Pkwy.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-29c

MAP REACH: **IMPACT AREA 8**

SAND CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

200 cfs

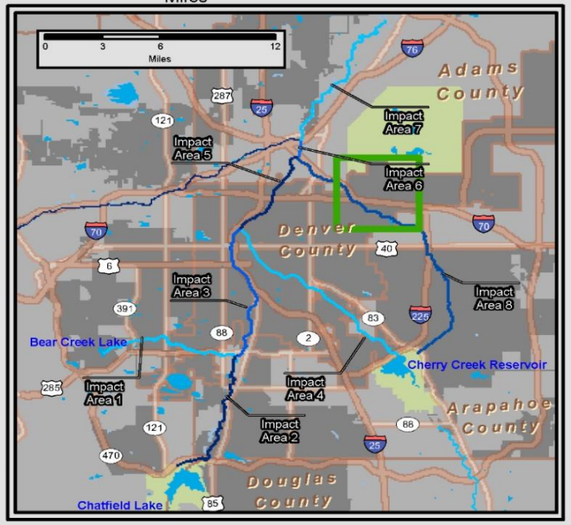
2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

N

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture,
Farm Service Agency

Compiled On: Tuesday, November 28, 2017

Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 8 - Sand Creek
Peoria St. to Quebec St.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-29d

MAP REACH: **IMPACT AREA 8**

SAND CREEK - CHERRY CREEK DAM TO SOUTH PLATTE RIVER

Inundation at:

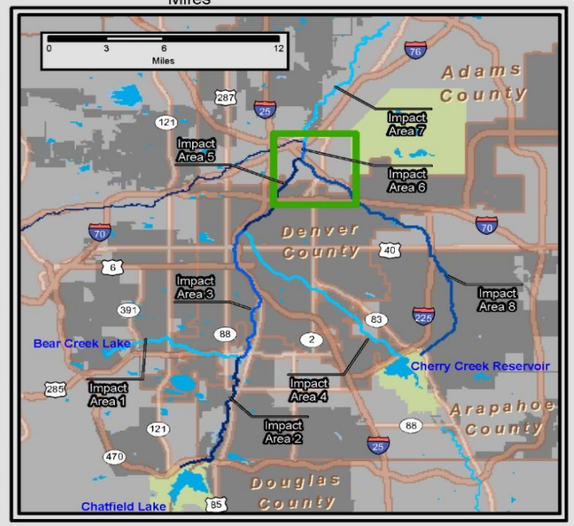
200 cfs

2,000 cfs

0 0.125 0.25 0.5 0.75

Miles

US Army Corps of Engineers ®
Omaha District



Imagery Source:
U. S. Department of Agriculture, Farm Service Agency

Compiled On: Tuesday, November 28, 2017

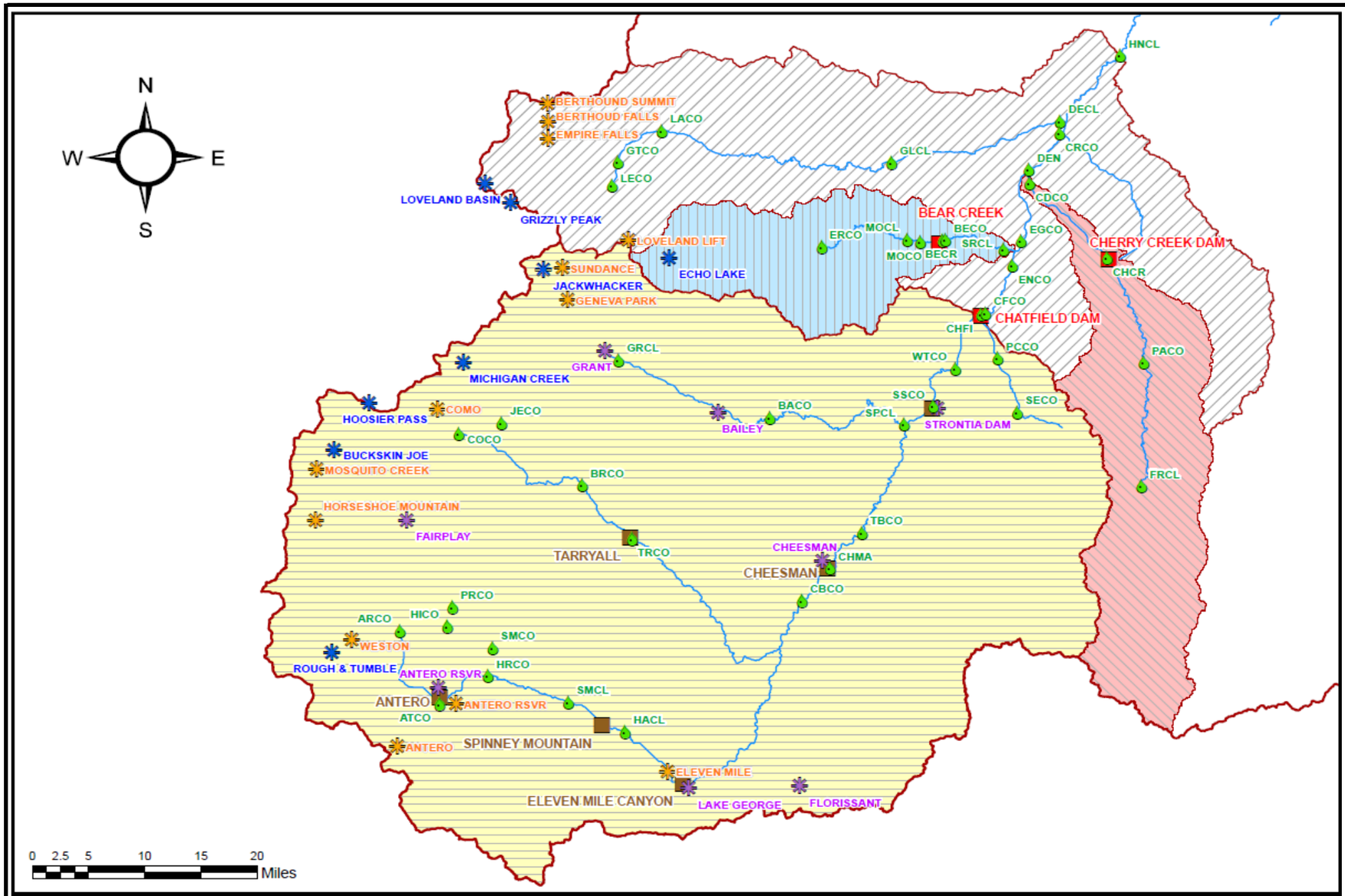
Prepared By:_____LJH__MAS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Impact Area 8 - Sand Creek
Quebec St. to South Platte R.

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 4-29e



Label	Gage Name	Owner*
ARCO	South Fork South Platte above Antero Reservoir	COA
ATCO	South Fork South Platte below Antero Reservoir	CDWR
BACO	North Fork South Platte at Bailey, CO	CDWR
BECO	Bear Creek Dam Outflow	CDWR
BECR	Bear Creek Reservoir	COE
BRCO	Tarryall Creek at Borden Ditch	COA
CBCO	South Platte River above Cheesman Lake	USGS
CDCO	Cherry Creek at Denver	USGS
CFCO	South Platte River below Chatfield Reservoir	CDWR
CHCR	Cherry Creek Reservoir	COE
CHFI	Chatfield Reservoir	COE
CHMA	Cheesman Reservoir	CDWR
COCO	Tarryall Creek at Como, CO	USGS
CRCO	South Platte River at Commerce, CO	USGS
DECL	Clear Creek at Derby, CO	CDWR
DEN	South Platte River at Denver, CO	CDWR
EGCO	South Platte River at Englewood, CO	USGS
ENCO	South Platte River below Union Ave., CO	USGS
ERCO	Bear Creek above Evergreen, CO	USGS
FRCL	Cherry Creek near Franktown, CO	USGS
GLCL	Clear Creek at Golden, CO	USGS
GRCL	North Fork South Platte at Grant, CO	CDWR
GTCO	Clear Creek near Georgetown, CO	USGS
HACL	South Platte River above Elevenmile Reservoir	CDWR
HICO	Four Mile Creek at High Creek	COA
HNCL	South Platte River at Henderson, CO	CDWR
HRCO	Four Mile Creek at Hartsel, CO	COA
JECO	Michigan Creek at Jefferson, CO	COA
LACO	Clear Creek near Lawson, CO	USGS
LECO	Leavenworth Creek at Georgetown, CO	USGS
MOCL	Bear Creek at Morrison, CO	CDWR
MOCO	Bear Creek above Bear Creek Reservoir	USGS
PACO	Cherry Creek near Parker, CO	USGS
PCCO	Plum Creek at Louviers, CO	USGS
PRCO	Middle Fork South Platte at Prince, CO	COA
SECO	Plum Creek at Sedalia, CO	USGS
SMCL	South Platte River above Spinney Reservoir	COA
SMCO	Middle Fork South Platte at Santa Maria, CO	COA
SPCL	South Platte River at South Platte, CO	CDWR
SRCL	Bear Creek at Sheridan, CO	CDWR
SSCO	South Platte River below Strontia Springs Reservoir	CDWR
TBCO	South Platte at Trumbull, CO	USGS
TRCO	Tarryall Creek below Tarryall Reservoir	CDWR
WTCO	South Platte River at Waterton, CO	CDWR

*CDWR = Colorado Department of Water Resources
*COA = City of Aurora (Station Cooperator)
*COE = Corps of Engineers
*USGS = U.S. Geological Survey

Upper South Platte Watershed and River Gages

Flow and Reservoir Gages
Stream Centerline
NCDC
NRCS Snow Course
NRCS SNOTEL
USACE Dams
Local Water Supply Reservoirs
Chatfield Watershed
Bear Creek Watershed
Cherry Creek Watershed
Upper South Platte Watershed

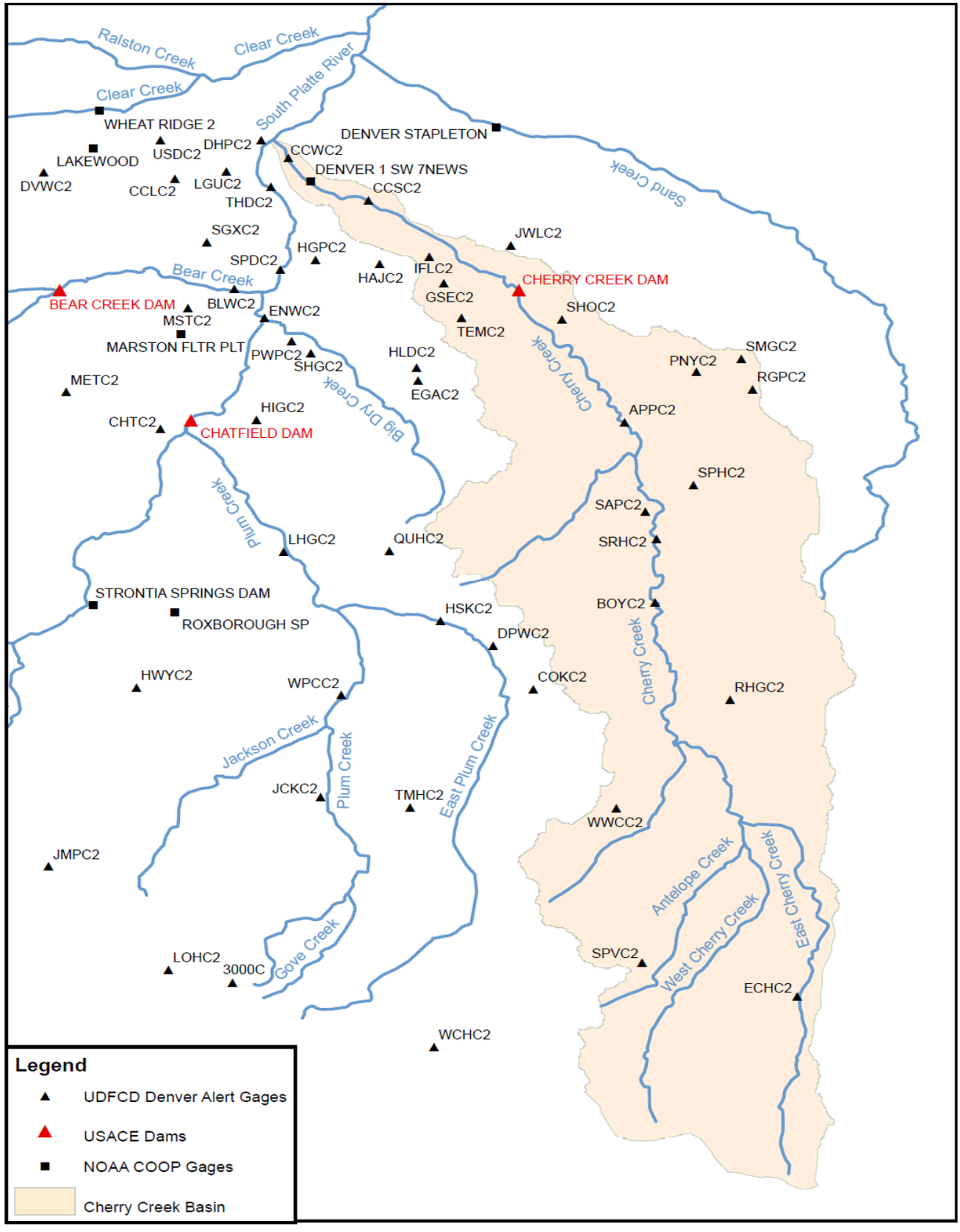
Prepared By:_____KEH_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Tri-Lakes Snotel, River and Precipitation Stations

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 5-1



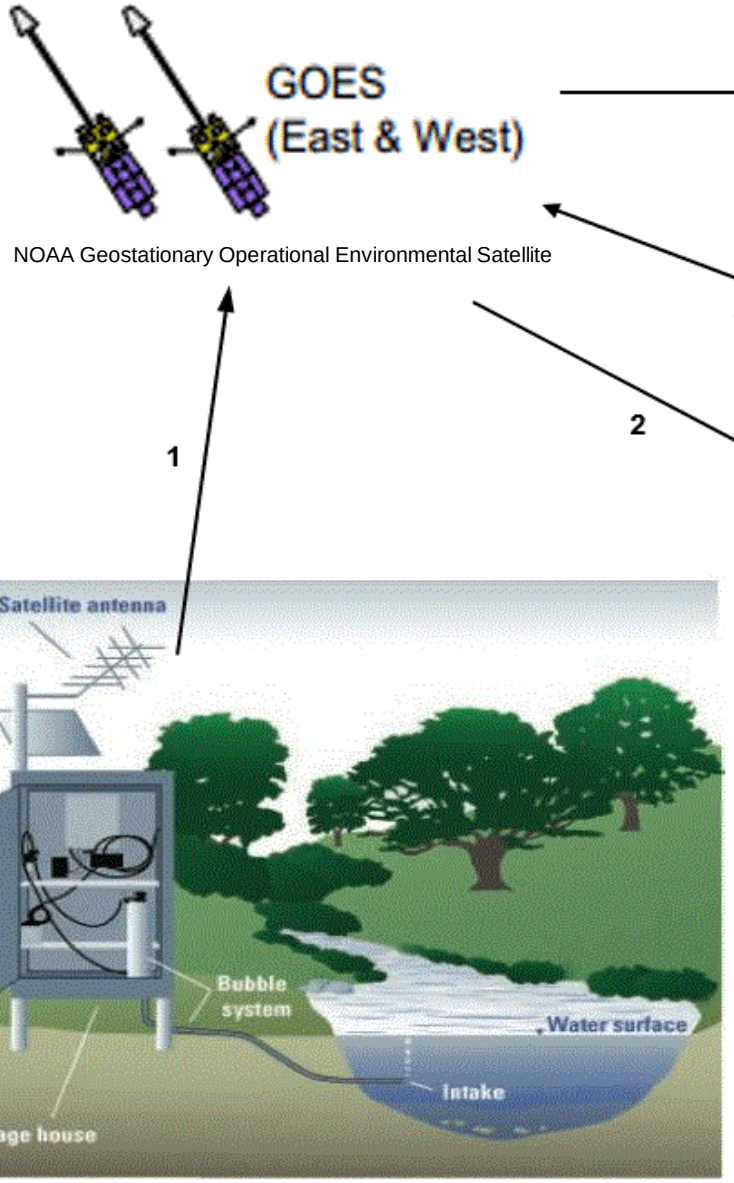
Sources:
http://alert5.udfcd.org/LDAD/gmapV3.html
http://scacis.rcc-acis.org/

Prepared By:_____KEH_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Cherry Creek Denver Alert & NOAA Precipitation Stations

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Data Collection Platform (DCP)
hundreds located across Omaha District

GOES
(East & West)

NOAA Geostationary Operational Environmental Satellite

1

2

3

4

NOAA

Wallops Command and Data Acquisition Station
Wallops Island, VA

LRIT Receiver

Low-Rate Information Transmission
Omaha District Roof Satellite

5

LRGS

Local Readout Ground Station
Omaha District Computer Room

6

Omaha District Server

Data Collection System (DCS)
DECODES and Corps Computational Processor (CCP)
Oracle Database – Corps Water Management System (CWMS)
Omaha District Computer Room

Prepared By:_____KJS_____
Reviewed By:_____JAB_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Data System Collection Diagram

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Monthly Reservoir Operation
Provisional Record

Cherry Creek Reservoir

Northwestern Division | U.S. Army Corps of Engineers | Omaha District

Date	Midnight Elevation (ft msl)	Estimated Evaporation (cfs)	Mean Daily Outflow (cfs)	Est. Mean Daily Inflow (cfs)
1-May-14	5550.56	5.3	10	9 -
2-May-14	5550.59	3.3	0 -	15
3-May-14	5550.61	3.5	0 -	14
4-May-14	5550.63	4.7	0 -	14
5-May-14	5550.65	4.9	0 -	12
6-May-14	5550.67	3.9	0 -	12
7-May-14	5550.71	3.3	0 -	21
8-May-14	5550.81	4.8	13	64
9-May-14	5550.81	5.0	29	33
10-May-14	5550.77	3.9	29	13
11-May-14	5550.82	7.7 +	29	57
12-May-14	5550.98	7.4	29	110 +
13-May-14	5551.07 +	4.4	39	80
14-May-14	5551.06	4.4	54	56
15-May-14	5551.02	3.8	54	38
16-May-14	5550.95	2.5	54	28
17-May-14	5550.89	2.2	54	26
18-May-14	5550.81	3.0	54	23
19-May-14	5550.73	4.0	54	22
20-May-14	5550.66	2.0	54	26
21-May-14	5550.65	1.7 -	28	22
22-May-14	5550.67	2.6	9	22
23-May-14	5550.71	3.0	9	27
24-May-14	5550.76	3.4	9	34
25-May-14	5550.79	4.4	9	31
26-May-14	5550.82	4.1	9	24
27-May-14	5550.83	4.5	9	20
28-May-14	5550.81	6.2	22	17
29-May-14	5550.57	5.8	110 +	18
30-May-14	5550.49	3.7	51	17
31-May-14	5550.40 -	5.2	51	17
Total (dsf)		128	868	922
Total (ac-ft)		211	1721	1829
Mean	5550.75	3	28	30

End of Month Storage (ac-ft) 12896 Max Storage (ac-ft) 13471
Change in Storage (ac-ft) -147 Min Storage (ac-ft) 12896

Remarks:
1. Total Reported Monthly Precip (inches) 1.76
2. Estimated Dam Seepage (cfs/day): 0.0

+ Maximum; - Minimum

Pool Elevations are affected by wind

MRD 0168

Prepared by _____ Date _____

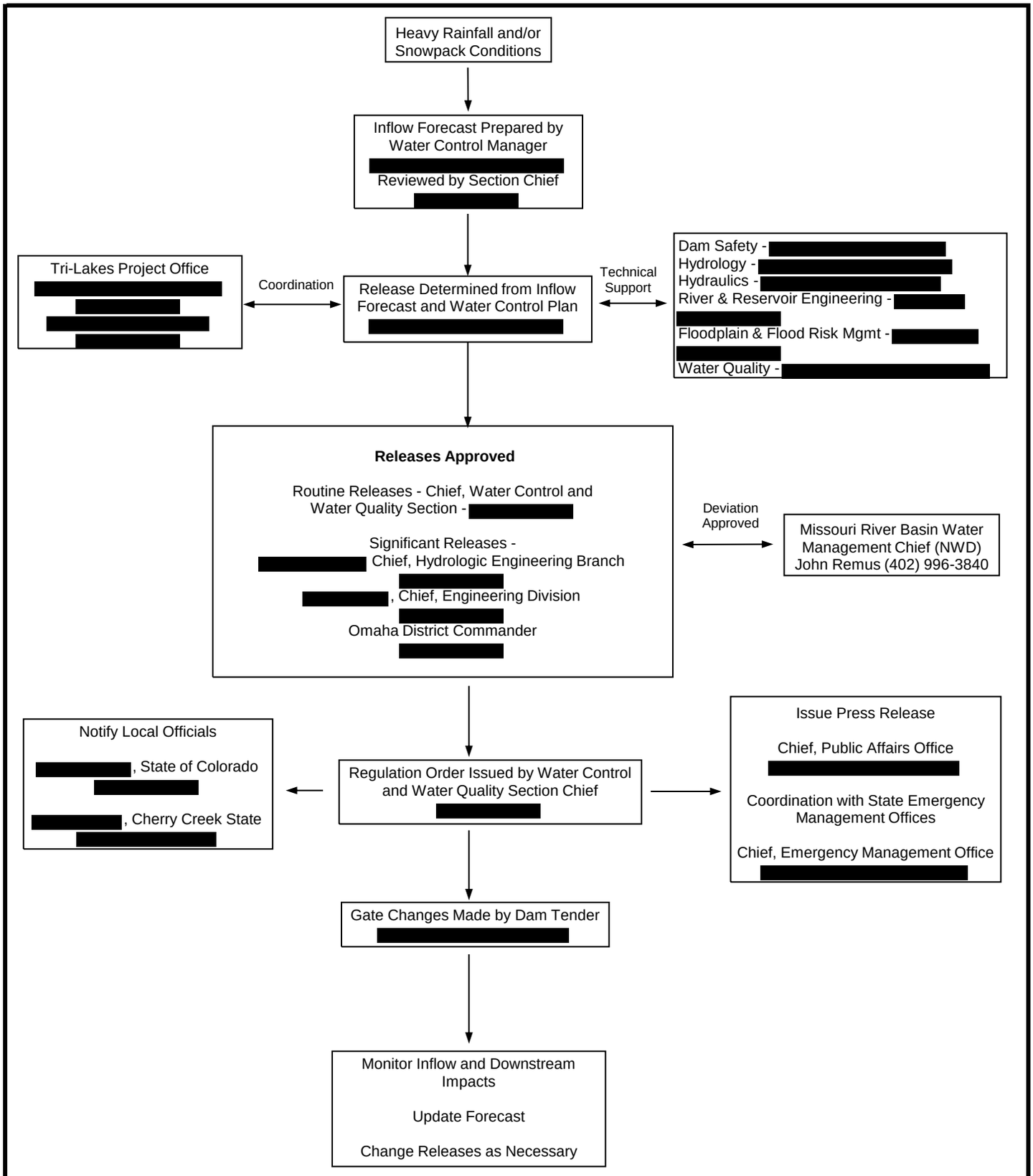
Reviewed by _____ Date _____

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Monthly Summary Report

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Reservoir Regulation
Coordination Chart

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Corps of Engineers – Omaha District
Cherry Creek Dam and Lake
Dam Tender's Reservoir Regulation Report
Authorized Pool Elevatio: 5550
Authorized Storage 27046
Format Revised April 2007

Week Ending Day/Month/Year
SOURCE - (1) Colorado State Engineer (2) Corps District Engineer
MEANS - (1) Telephone (2) Person to Person
PERSONNEL - Note Issuant and Person
VERIFICATION OF VERBAL ORDERS ISSUED AND REGULATION BY COLORADO STATE ENGINEER
My Signature formally confirms the below logged verbal orders for this weekly period.

DATE												
Determined By - Flow Rate		0		0		0		0		0		0
Time of Flow	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00
Hours/24 x Flow Rate	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0
Time of Flow	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0
Time of Flow	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0
Time of Flow	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	24:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	24 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0	
24 Hour Release Volume	0		0		0		0		0		0	

DATE	TIME	SOURCE	MEANS	PERSONNEL	ORDER - INCLUDE GATE SETTING

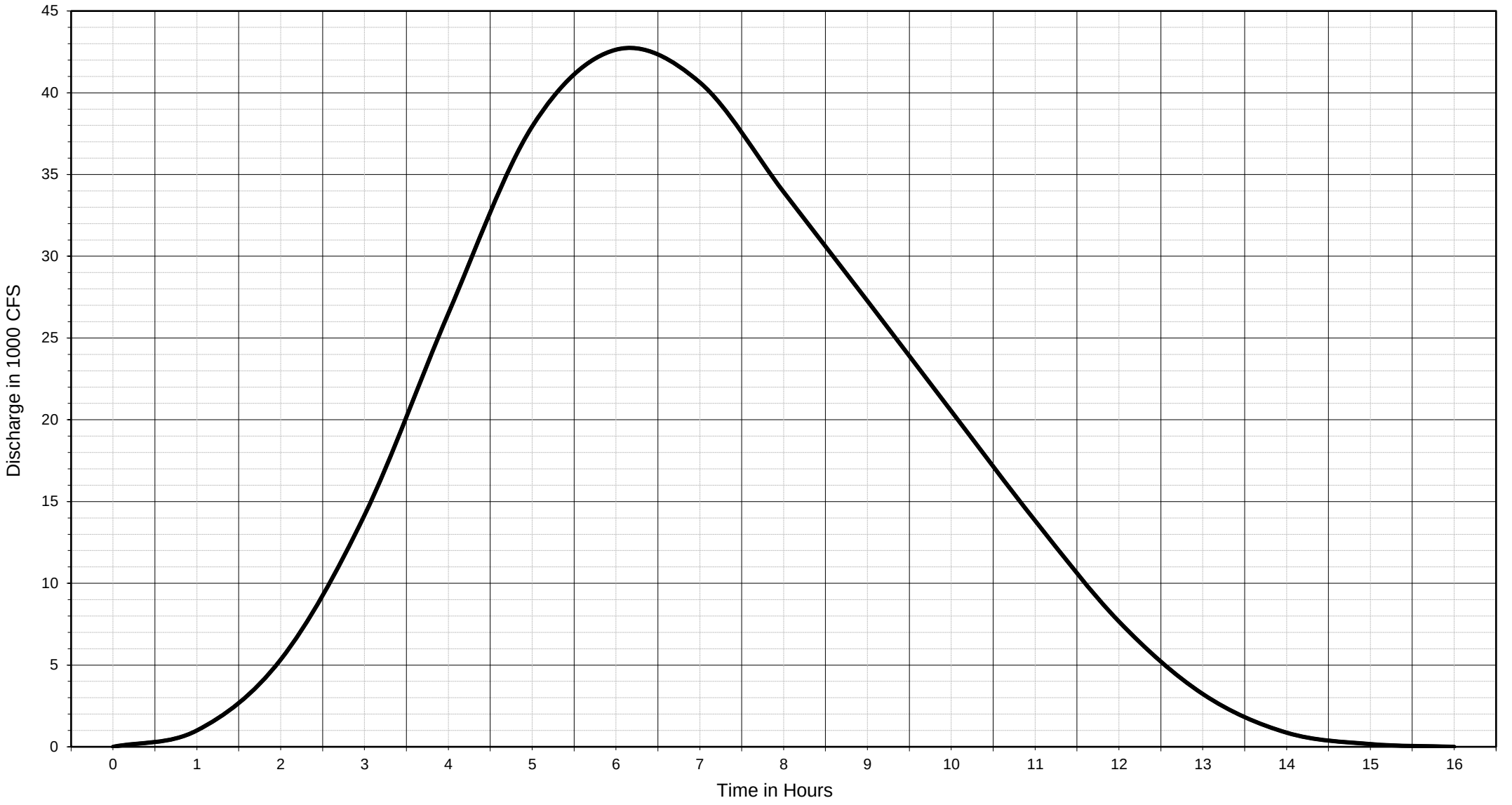
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Dam Tender's Reservoir Regulation Report

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

3 - Hour Unit Hydrograph
Cherry Creek below Cherry Creek Dam



Drainage Area = 386 Sq. Mi.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

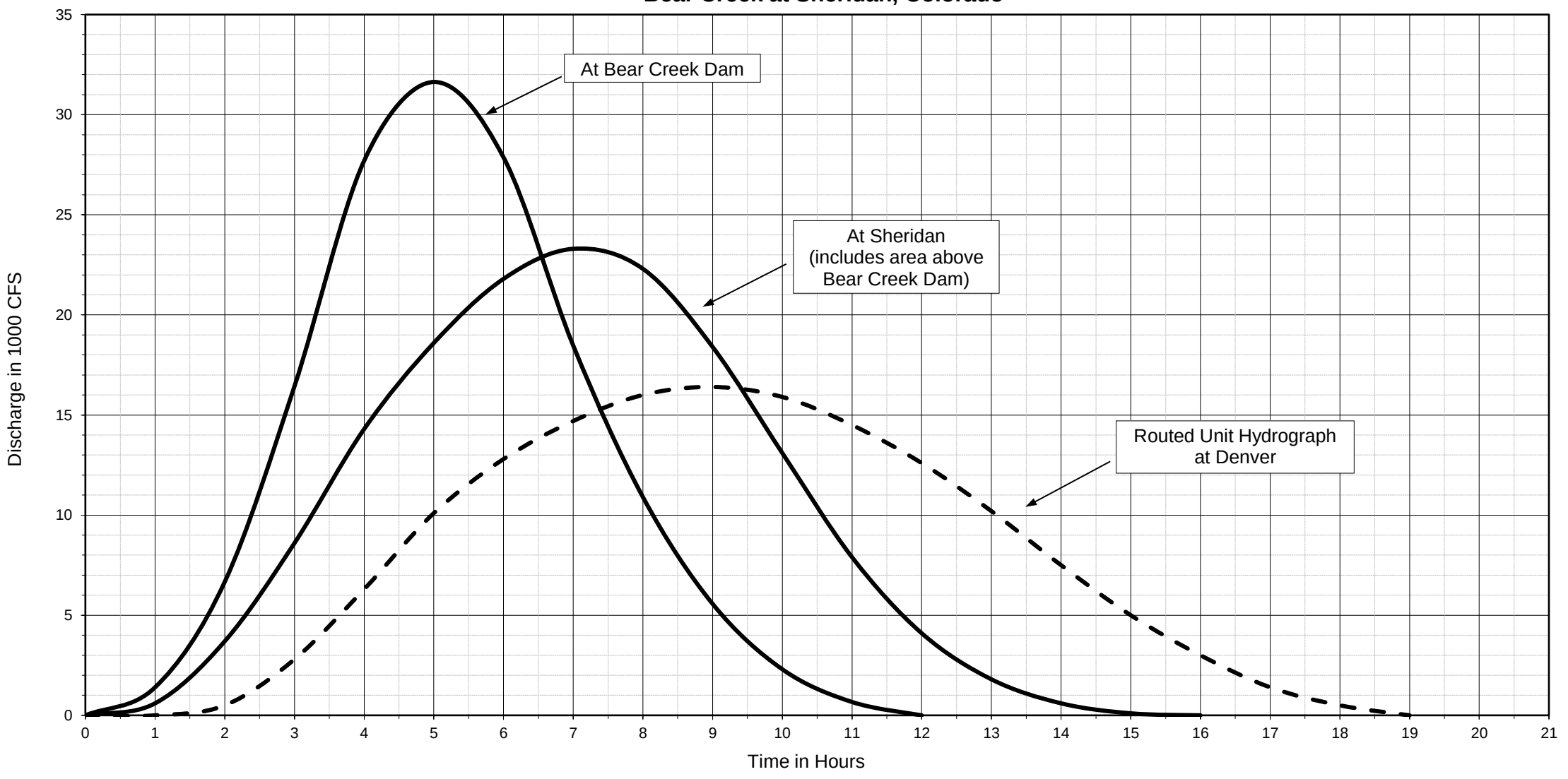
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
Cherry Creek below Cherry Creek Dam

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 6-1

3 - Hour Unit Hydrograph
Bear Creek at Sheridan, Colorado



Drainage Area = 260 Sq. Mi.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

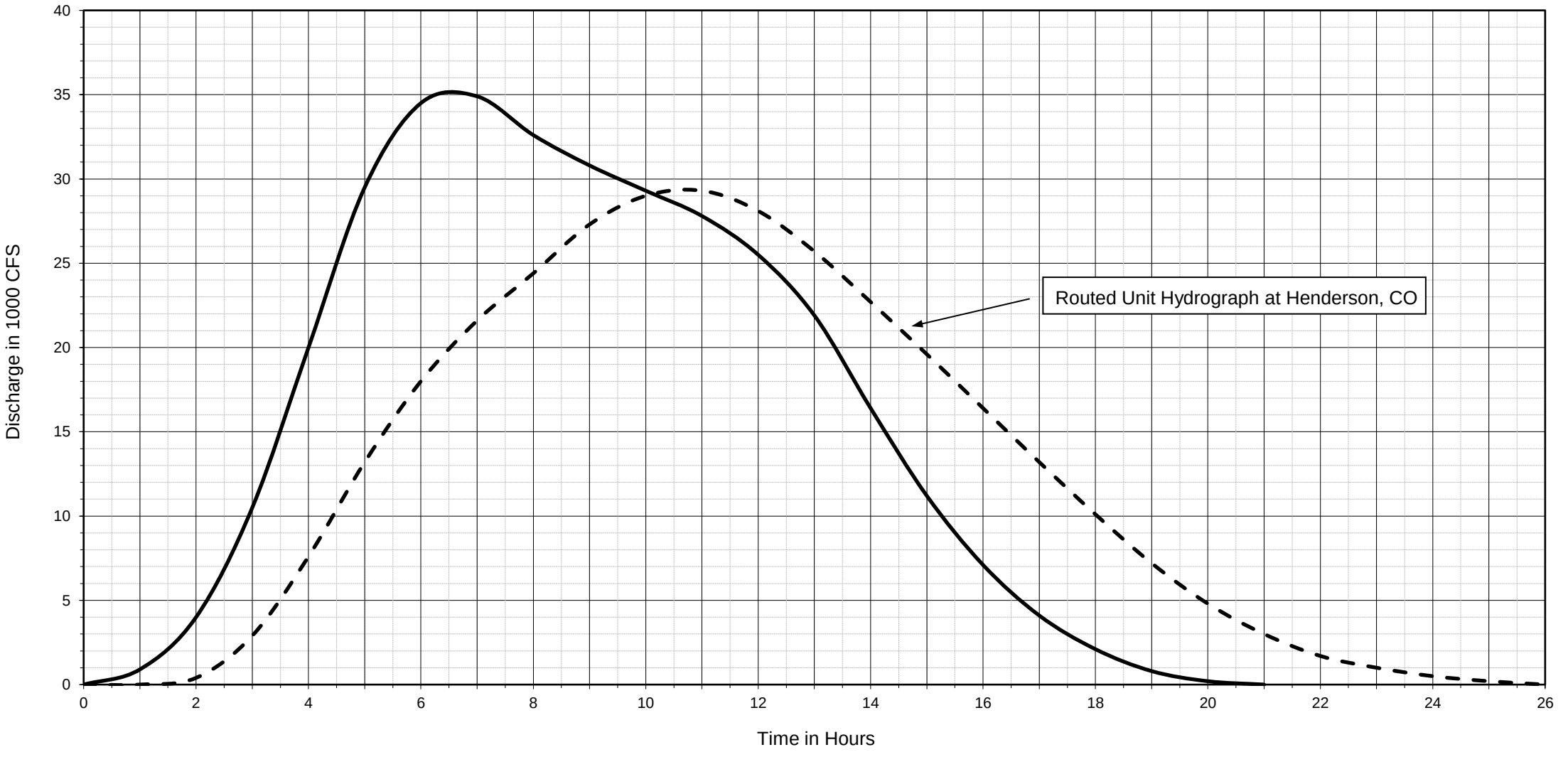
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
Bear Creek at Sheridan, Colorado

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 6-2

3 - Hour Unit Hydrograph
Clear Creek at Derby, Colorado



Drainage Area = 575 Sq. Mi.

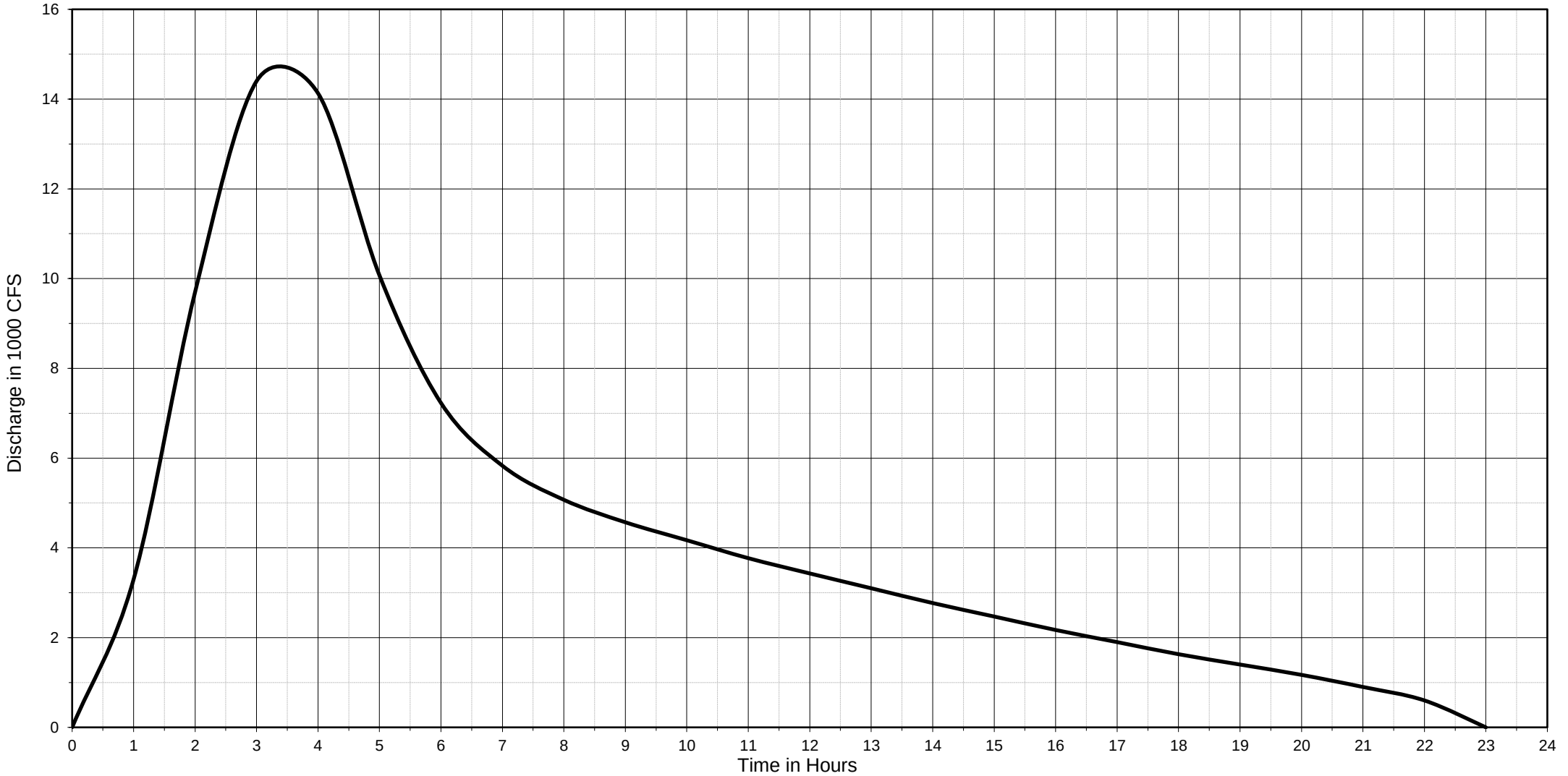
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
Clear Creek at Derby

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

3 - Hour Unit Hydrograph
South Platte River Incremental Area above Denver, Colorado



Drainage Area = 165 Sq. Mi.

Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
South Platte River, Incremental above Denver

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

3-Hour Unit Graphs (CFS)
South Platte Basin

Hrs.	1	2	3A	3B	4	5	6	7A	7B	8	9	10	11	12	13	14	15	16	17
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	1330	1000	833	500	333	1167	633	1100	1333	4083	1133	500	267	433	300	633	1400	3300	1000
2	9667	5833	6667	3933	2967	6333	4633	6767	7633	12250	5233	1633	833	1300	900	1867	6667	9700	5333
3	20833	14500	13433	7333	5400	15500	10333	16966	1876	19183	14166	6733	1667	4267	3400	7467	16433	14400	14167
4	25833	21000	16566	8833	6467	25566	12966	25400	2926	18200	26766	16833	4800	10700	8000	18000	27700	14130	26500
5	21166	20433	12933	6450	4600	27566	10800	27133	3046	11200	34833	28800	10233	20633	12900	29000	31633	10070	37933
6	11916	14100	7166	3450	2400	23200	6000	22500	2390	4533	34333	33700	17900	26666	14800	32400	27867	7230	42633
7	6350	7833	3500	1516	1000	15133	3100	16966	1473	1433	26366	30933	21866	27133	13200	27766	18467	5830	40633
8	2800	4217	1300	467	233	10083	1366	12333	8900	267	18333	23933	22133	22166	10100	20166	10900	5070	33933
9	883	2117	300	67	0	6583	467	8600	5567	0	13066	18533	18860	17666	7366	14433	5567	4570	27267
10	117	883	0	0		4250	100	5667	3733		9800	14200	15766	13733	5300	10166	2300	4170	20533
11	0	233				2600	0	3500	2600		7533	10800	12900	10333	3800	7100	667	3770	13833
12		0				1517		2000	1667		5666	8200	10300	7500	2733	5000	0	3430	7667
13						750		1100	933		4000	6166	8067	5233	1866	3633		3100	3233
14						283		500	400		2700	4466	6167	4300	1100	2766		2770	867
15						67		167	100		1733	3100	4667	2933	500	2033		2470	167
16						0		0	0		1067	1933	3500	1967	133	1333		2170	0
17											567	1000	2633	1200	0	700		1900	
18											233	367	1900	616		267		1630	
19											67	67	1300	217		67		1400	
20											0	0	800	50		0		1170	
21													433	0				900	
22													167					600	
23													33					0	
													0						
Total acre-ft	8530	7790	5390	2880	2080	11840	4370	12800	12750	6130	17280	17760	13970	14670	7250	15470	12590	8800	20530

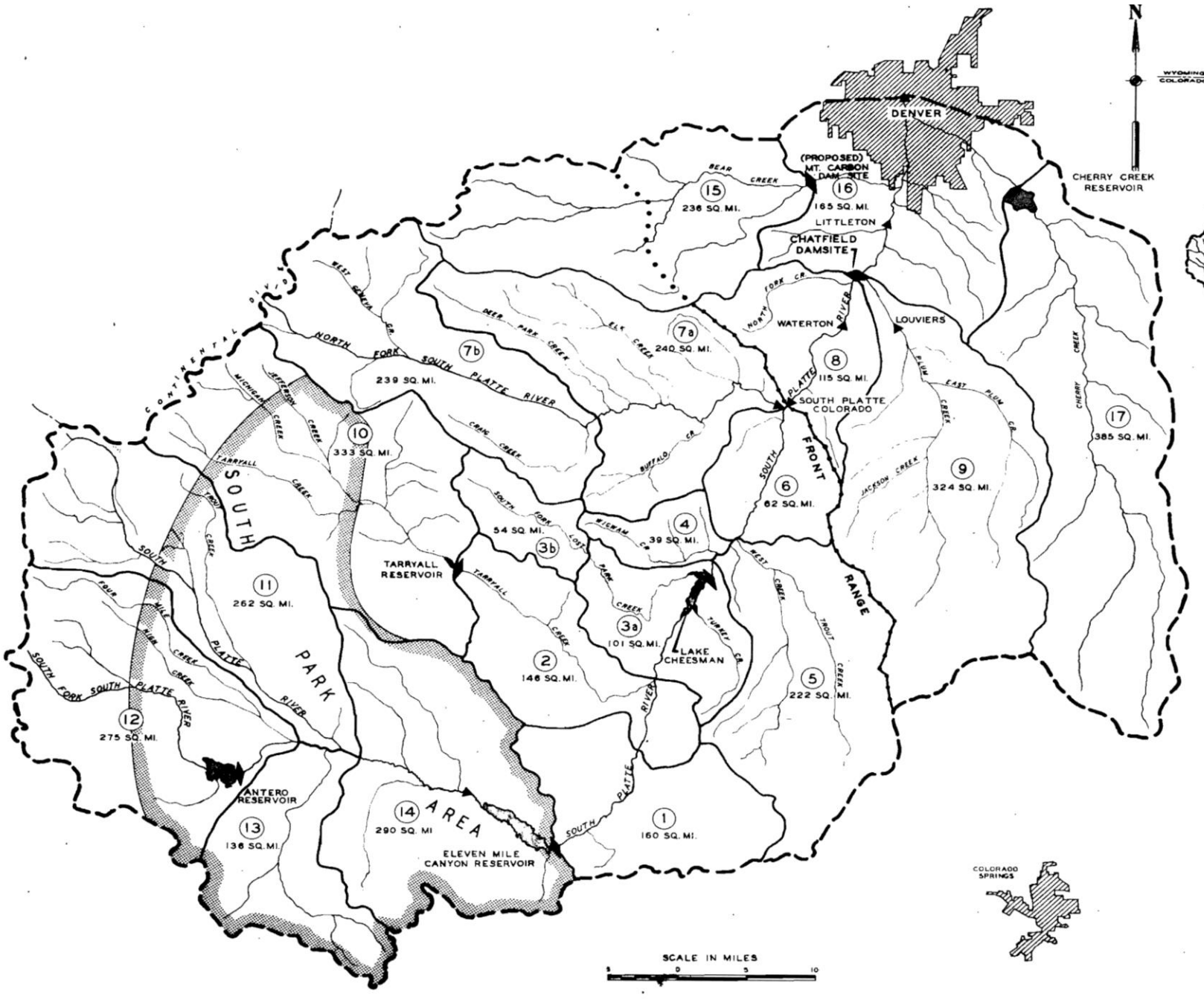
NOTE: Sub-basin delineations and drainage area by unit graph number are available on Plate 6-7b.
Source: Chatfield Dam Design Memorandum PC-2

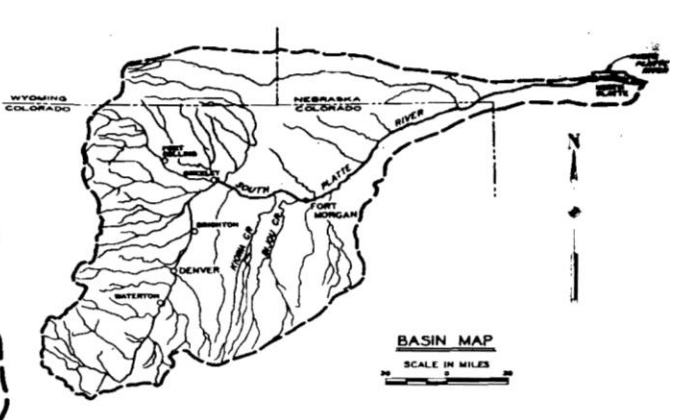
Prepared By:_____JWS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
Upstream of Tri-Lake Dams

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018





Unit Graph	Area (sq. mile)
1	160
2	146
3A	101
3B	54
4	39
5	222
6	82
7A	240
7B	239
8	115
9	324
10	333
11	262
12	275
13	136
14	290
15	236
16	165
17	385

LEGEND:
▲ STREAM GAGING STATIONS

Source: Chatfield Dam Design Memorandum PC-2

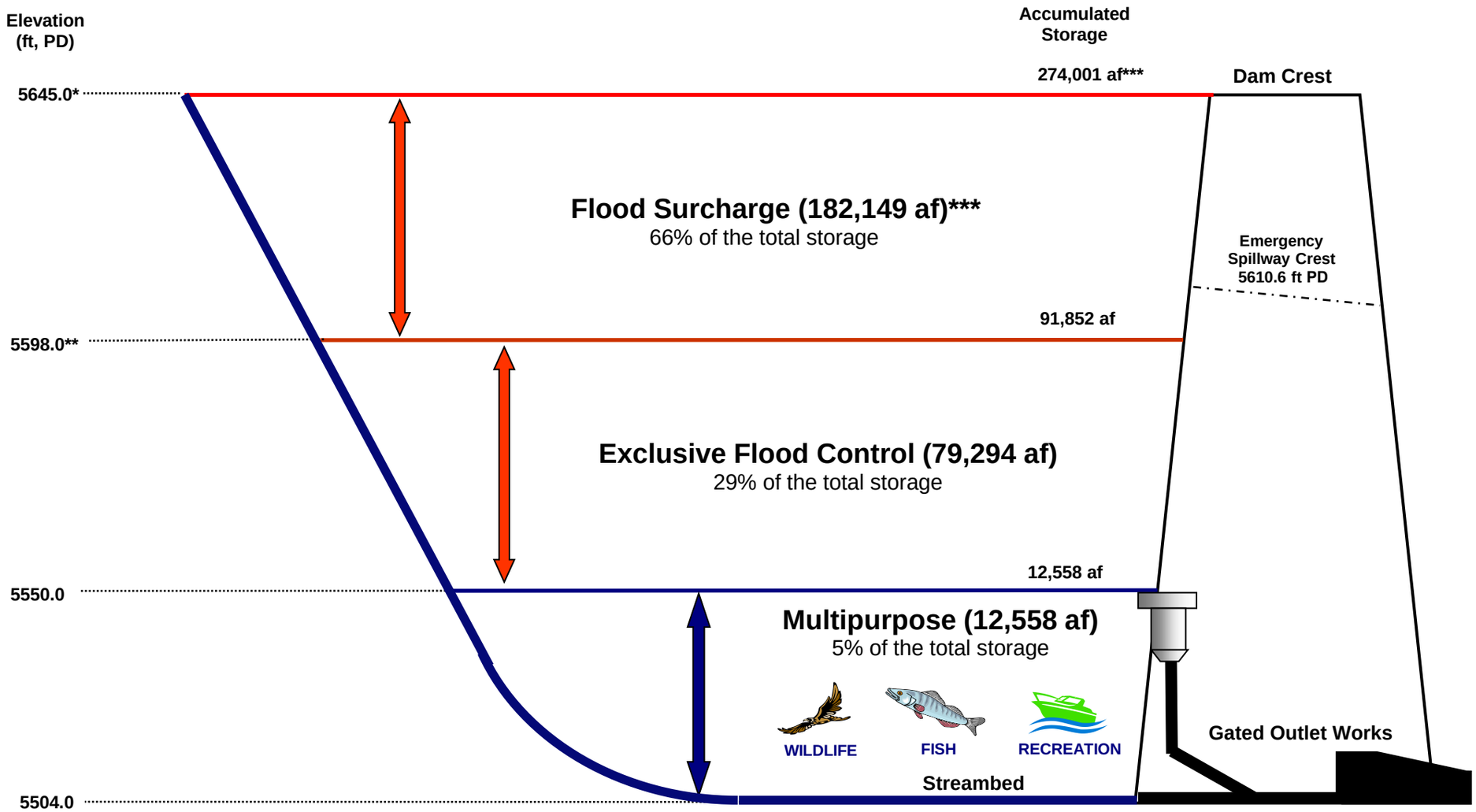
Prepared By:_____JWS_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

3-Hour Unit Hydrograph
Subbasin Delineation

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 6-5b



* Surveys indicate a low spot in the dam crest. The dam crest elevation is 5644.4 feet Project Datum (PD).

** Top of Original Design Flood Control Pool is 5598.0 feet PD, which was the original spillway crest elevation. Due to sloughing of spillway side slopes, the spillway crest elevation is 5610.6 feet PD.

*** The 2006-07 survey did not include the top 5 feet of the surcharge zone. The curve was extended with LiDAR data to obtain the entire zone's storage capacity.

2006-07 Survey. Effective 09 December 2010.

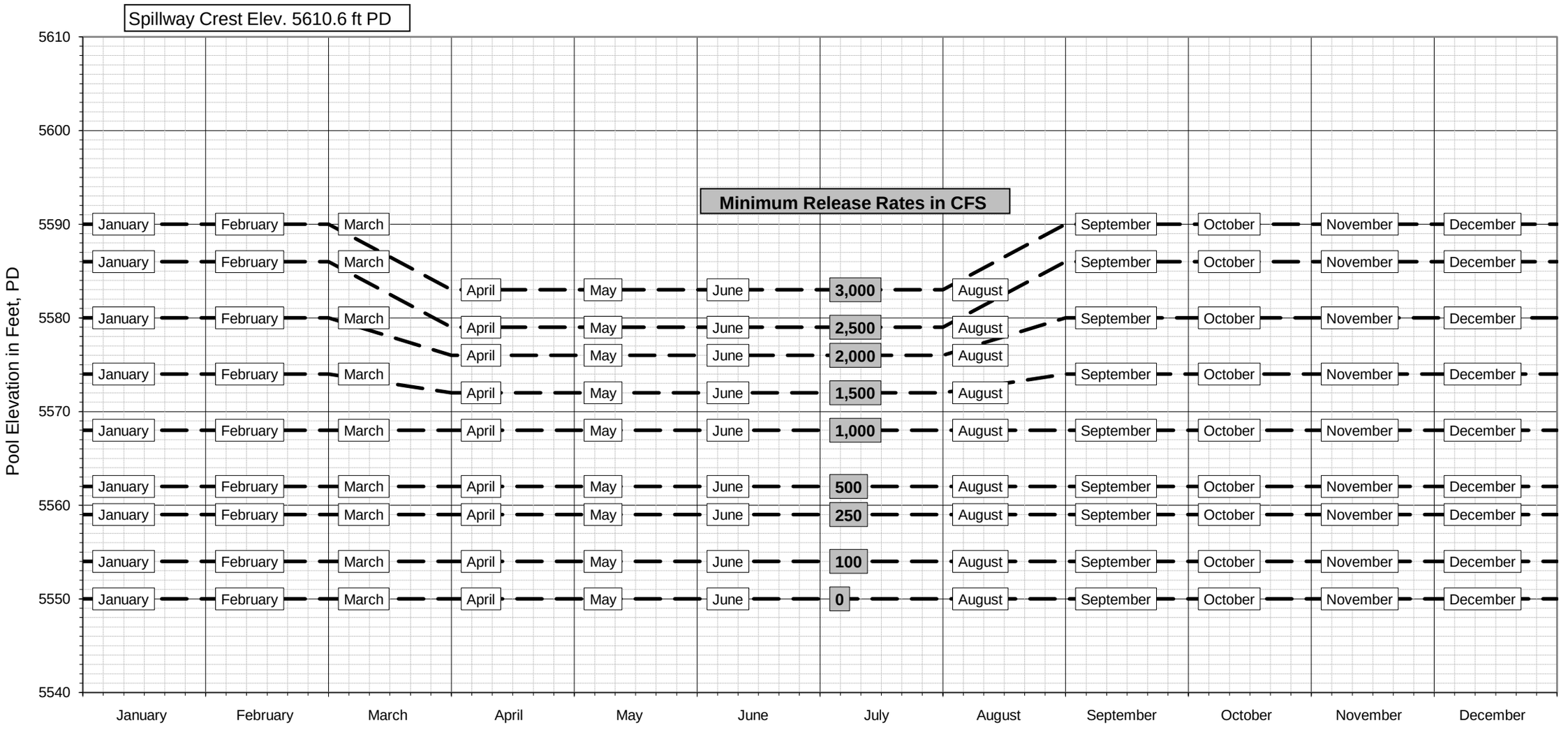
Prepared By:_____KJS_____
Reviewed By:_____MJN_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Reservoir Storage Allocations

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Rule Curve for Cherry Creek Reservoir Flood Storage Evacuation



Notes:

1. These are minimum release rates. Higher rates will be utilized whenever feasible.
2. If Cherry Creek Reservoir reaches elevation 5590 feet PD refer to Section 7-05.a(2) of the Water Control Manual.

Prepared By:_____KJS_____
Reviewed By:_____KKB_____

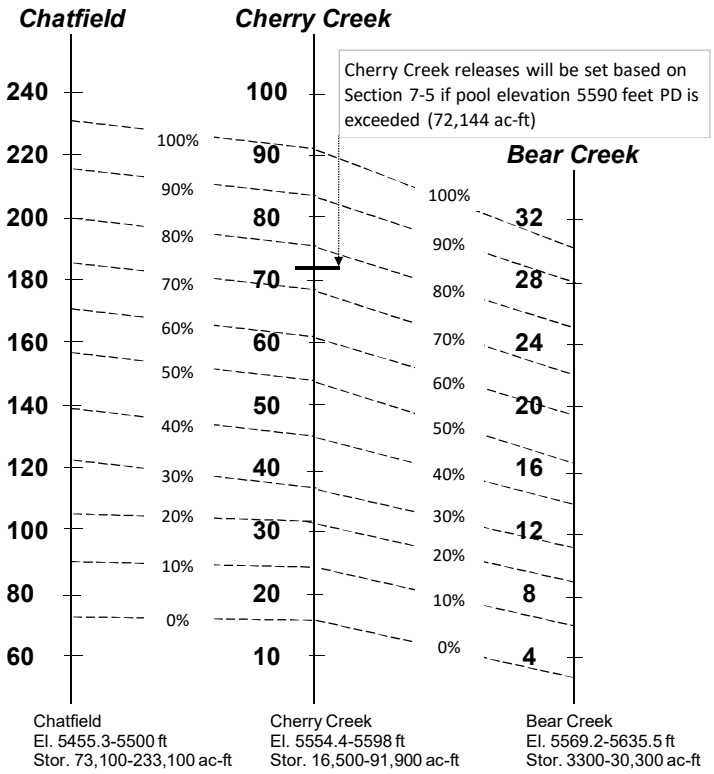
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Rule Curve for Flood Storage Evacuation

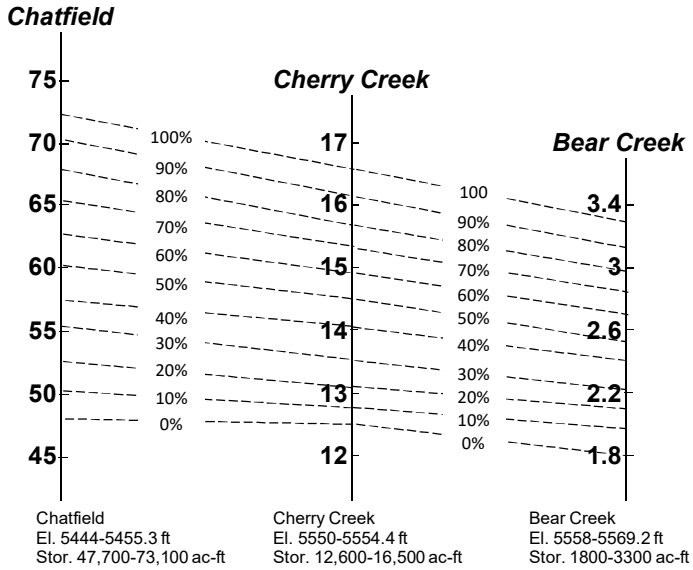
U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 7-2

LEVEL II



LEVEL I



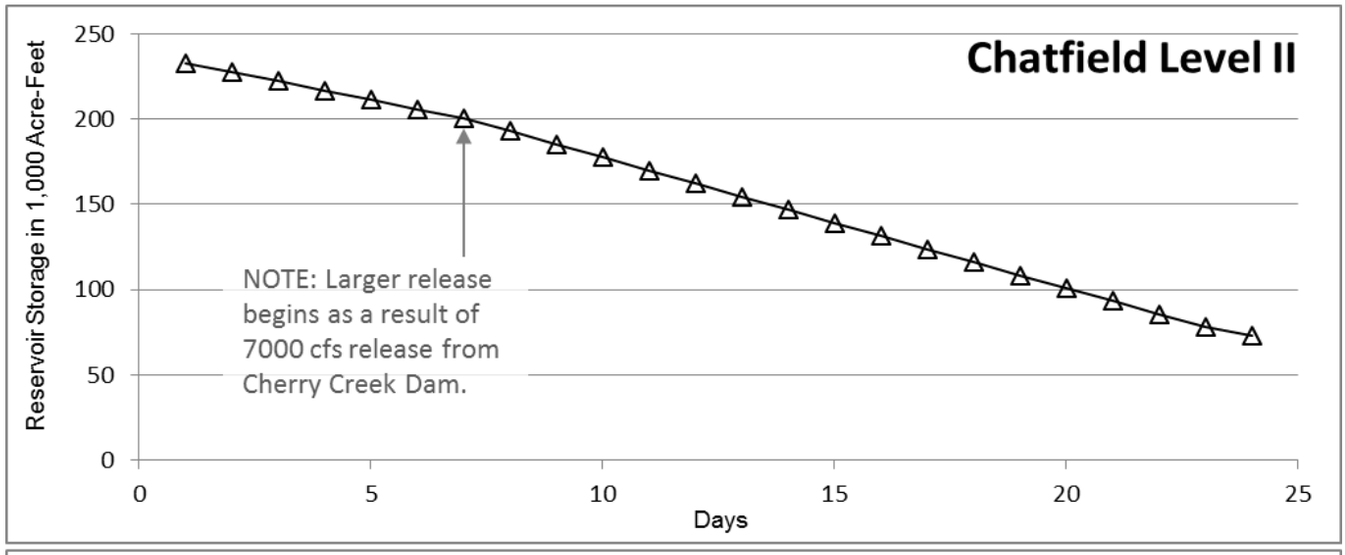
NOTES:
1) For Chatfield Level II storage approximates the volume of the rainfall Standard Project Flood (160,000 ac-ft). The remaining flood control storage space is assigned to Level I.
2) For Cherry Creek and Bear Creek Level I is 5 percent of the total flood storage with the remainging flood control storage

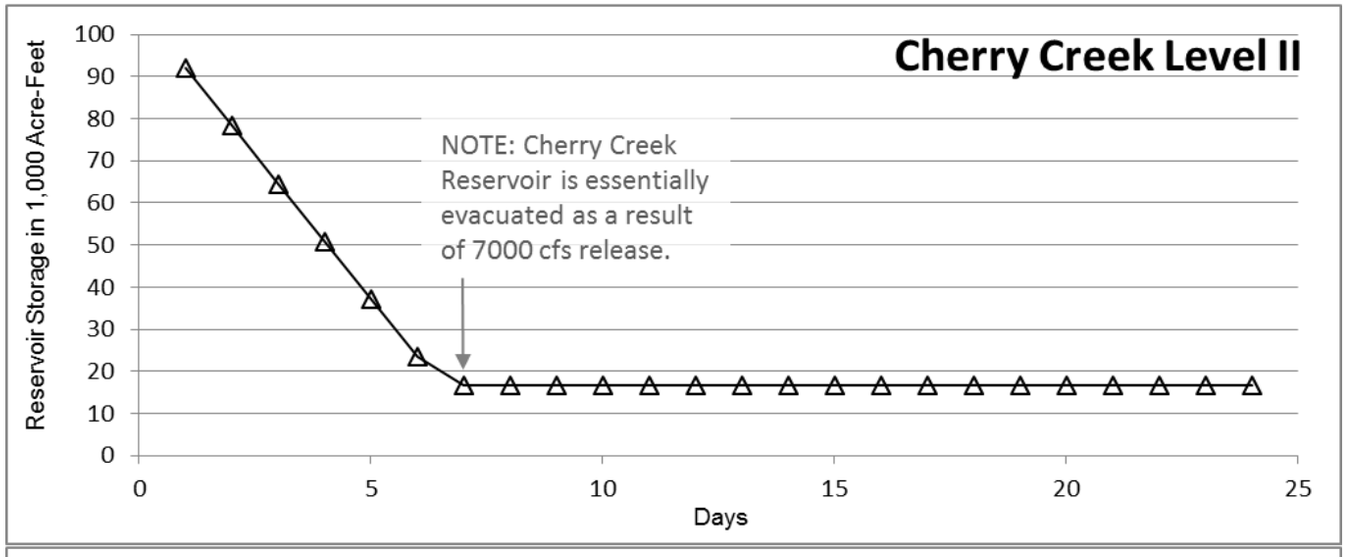
Prepared By:_____KJS_____
Reviewed By:_____MJN_____

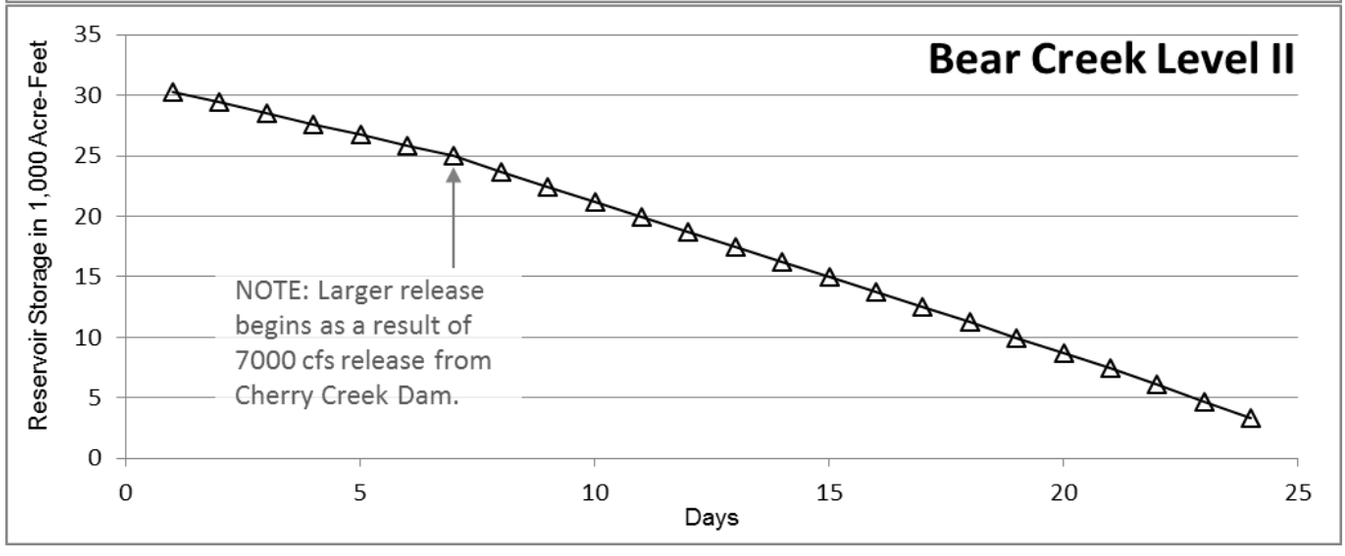
Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Parallel Reservoir Balance

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







Notes:
1. System reservoir inflow assumed to be 400 cfs.
2. Uncontrolled drainage assumed to be 100 cfs.
3. Chatfield, Bear Creek and Cherry Creek Accounting are regulated for 5,000 cfs at the South Platte River at Denver streamgage.
4. Actual Cherry Creek release is 7000 cfs when the reservoir reaches elevation 5590 ft.

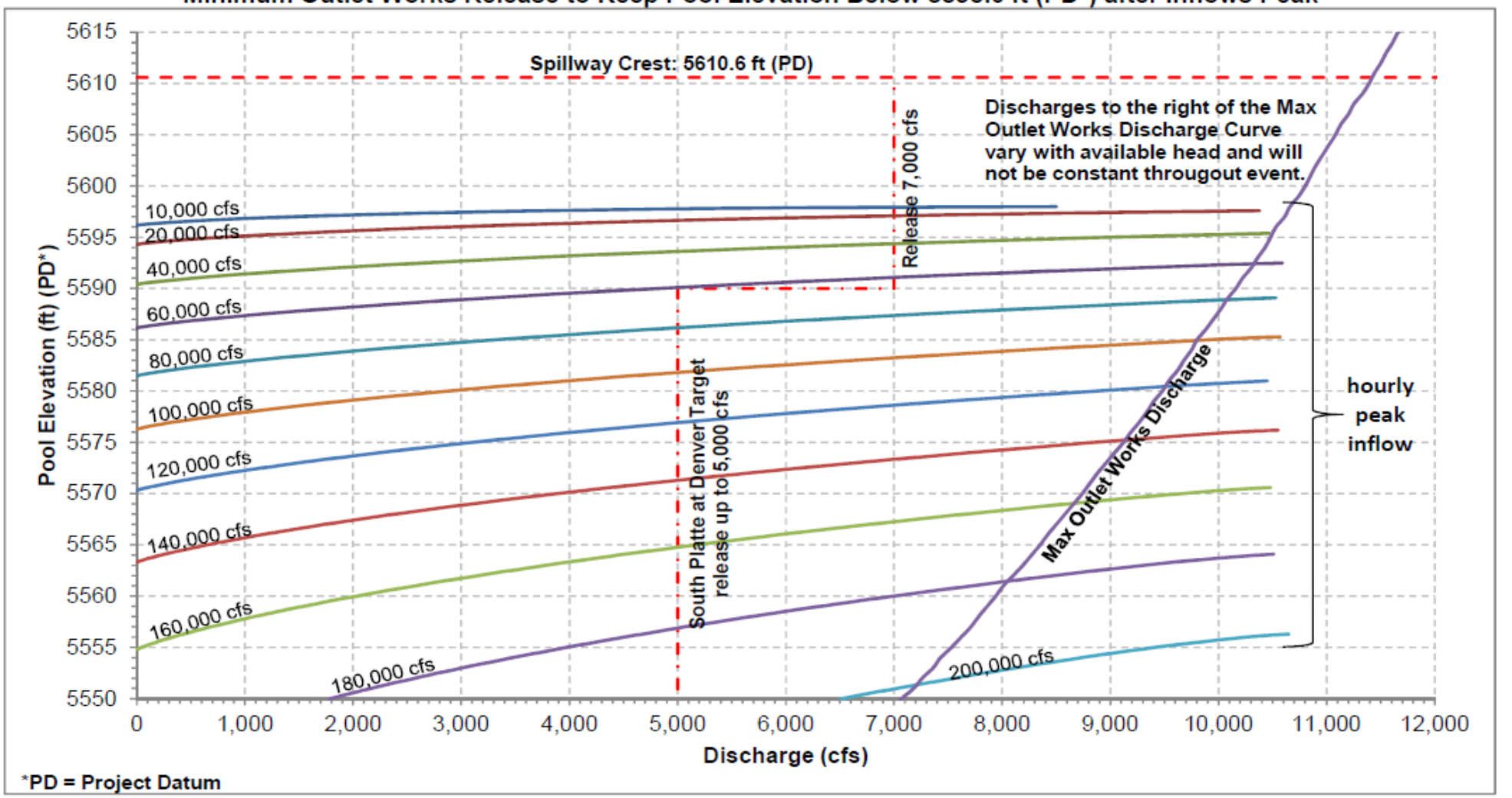
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

System Flood Control Storage
Evacuation Example (Level II)

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Minimum Outlet Works Release to Keep Pool Elevation Below 5598.0 ft (PD*) after Inflows Peak



*PD = Project Datum

Example:

Pool Elevation = 5575.0 ft (PD*)
Peak Inflow = 120,000 cfs

Procedure:

Enter left hand edge of chart with pool elevation 5575.0. Continue horizontally to the right on the line representing elevation 5575.0 until intersecting with the line representing a peak inflow of 120,000 cfs. Drop vertically down to the dishcarge scale at the bottom of the chart. Maximum release required to keep the pool elevation below 5598.0 ft is 3,100 cfs. If the starting pool elevation is above the peak inflow curve and does not intersect it, the pool elevation will exceed 5598.0. If the starting pool elevation is below the peak inflow curve, no release is required to keep the pool elevation below 5598.0.

Notes:

1- Releases start when inflow from rainfall reaches the reservoir
2- Inflow hydrographs produced using a 0.85 recession coefficient
3- Max outlet works discharge based on gates 1, 2, 3, 4, & 5 fully open
4- The PMF peak inflow is 545,440 cfs
5- This chart is used to quickly determine the minimum release from Cherry Creek Dam to keep the reservoir below elevation 5598.0 ft PD. If elevation 5590.0 ft PD is reached, the Cherry Creek Dam release will be increased to 7,000 cfs.

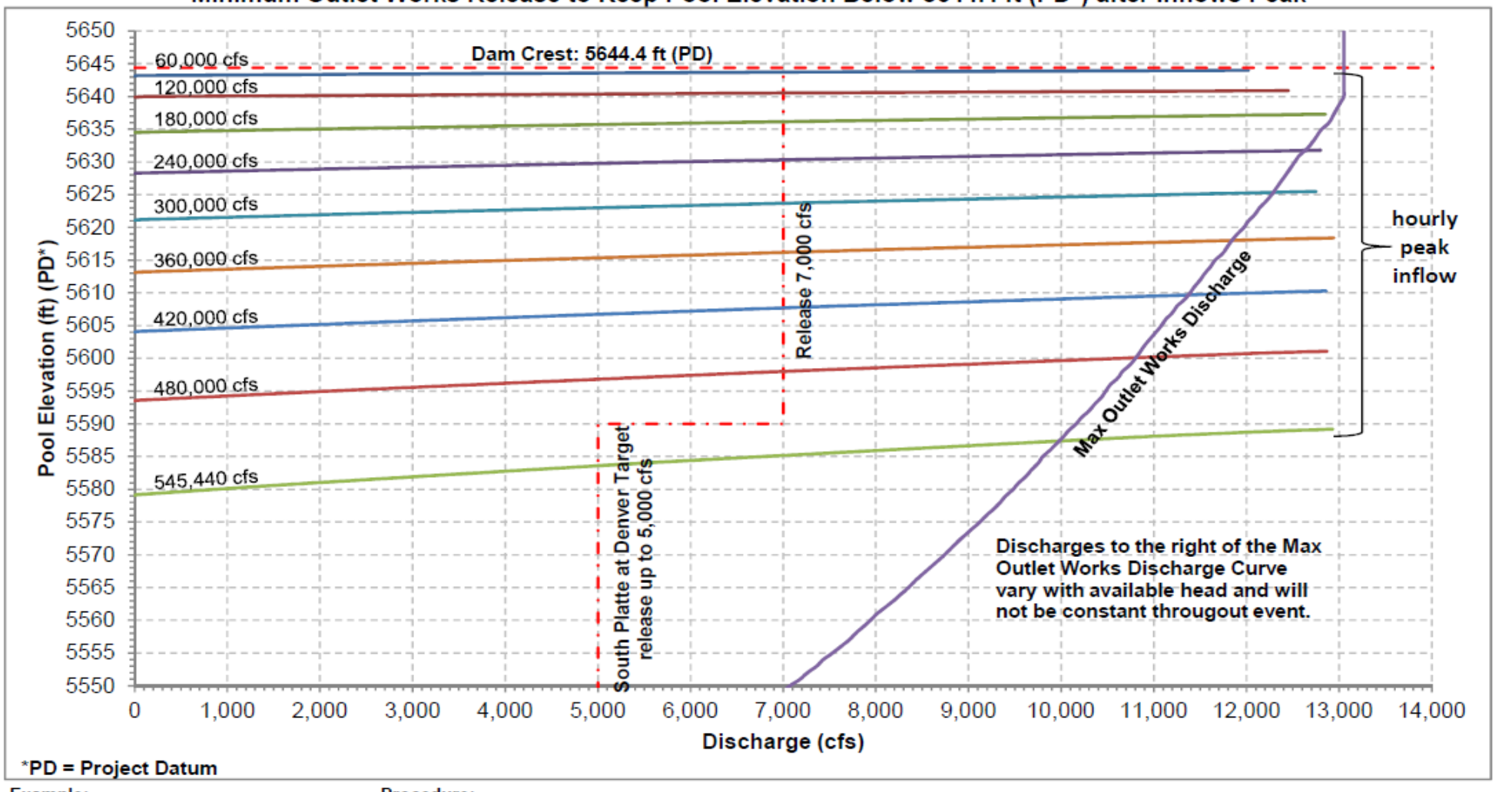
Prepared By:_____RJL_____
Reviewed By:_____DJC_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Emergency Flood Control Regulation
releases needed to keep below 5598.0 ft PD

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Minimum Outlet Works Release to Keep Pool Elevation Below 5644.4 ft (PD*) after Inflows Peak



*PD = Project Datum

Example:
Pool Elevation = 5605.0 ft (PD*)
Peak Inflow = 420,000 cfs

Procedure:
Enter left hand edge of chart with pool elevation 5605.0. Continue horizontally to the right on the line representing elevation 5605.0 until intersecting with the line representing a peak inflow of 420,000 cfs. Drop vertically down to the dishcarge scale at the bottom of the chart. Maximum release required to keep the pool elevation below 5644.4 ft is 1,640 cfs. If the starting pool elevation is above the peak inflow curve and does not intersect it, the pool elevation will exceed 5644.4. If the starting pool elevation is below the peak inflow curve, no release is required to keep the pool elevation below 5644.4.

Notes:
1- Releases start when inflow from rainfall reaches the reservoir
2- Inflow hydrographs produced using a 0.85 recession coefficient
3- Max outlet works discharge based on gates 1, 2, 3, 4, & 5 fully open
4- The PMF peak inflow is 545,440 cfs
5- This chart is used to quickly determine the minimum release from Cherry Creek Dam to keep the reservoir below elevation 5644.4 ft PD. If elevation 5590.0 ft PD is reached, the Cherry Creek Dam release will be increased to 7,000 cfs.

Prepared By:_____RJL_____
Reviewed By:_____DJC_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Emergency Flood Control Regulation
releases needed to keep below 5644.4 ft PD

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Water Level Influence Report

September 1983 (Modified)

Feet above Multipurpose Zone (5550 ft PD)	Location	Influence Report
+1.5	*ISLAND*	completely submerged, only shrubbery above water
+3	*SWIM BEACH*	water reaches lower picnic seawalls; beach signs, lifeguard towers, and trash cans may need to be moved depending on their locations
	MOUNTAIN LOOP	water begins to touch outer edge of parking area
	DIXON GROVE	water covers bike trail on western edge
+4	*EAST BOAT RAMP*	water up to edge of parking lot, but not in lot yet
	MARINA	public docks must be removed from bulkhead posts to prevent damage to docks
	LAKE VIEW ROAD	water approaches road shoulder at Cherry Creek and Cottonwood Creek
+5	*EAST BOAT RAMP*	water begins to encroach onto parking lot; ramps can be left open if marked with buoys and cables to outline ramps
	SWIM BEACH	signs, trash cans, and lifeguard towers will need to be moved to higher ground
	MOUNTAIN LOOP	water partially covering parking area
+6	*EAST BOAT RAMP*	water covers most of the parking area
	MARINA	jetty becomes totally submerged, should be marked with hazard markers; water begins to come over bulkhead
+7	*EAST BOAT RAMP*	parking lot totatally submerged
	MARINA	bulkhead submerged
+8	***7.92***	**highest water level reached in 1983**
	SWIM BEACH	water submerges approx. 2/3 of the beach area, water is within 100 feet of office/first aid station
	DIXON GROVE	approx. 1/3 to 1/2 of area is under water, toilets may be partially submerged
	LAKE VIEW ROAD	submerged at or near Cherry Creek and Cottonwood Creek
	PRAIRIE LOOP	water approaches bird observatory, iron bridge may be submerged
	MARINA	access road is completely submerged, water reaches upper level of Sailside buildings, gas tanks fully submerged
	WEST SHELTERS	all beaches submerged, rip-rap bank nearly submerged, shade shelters still on dry land, water approaching restroom building
	WEST BOAT RAMP	boat ramp and parking lot unaffected by high water
	MOUNTAIN LOOP	water totally covers parking area, pit toilet may be partially submerged

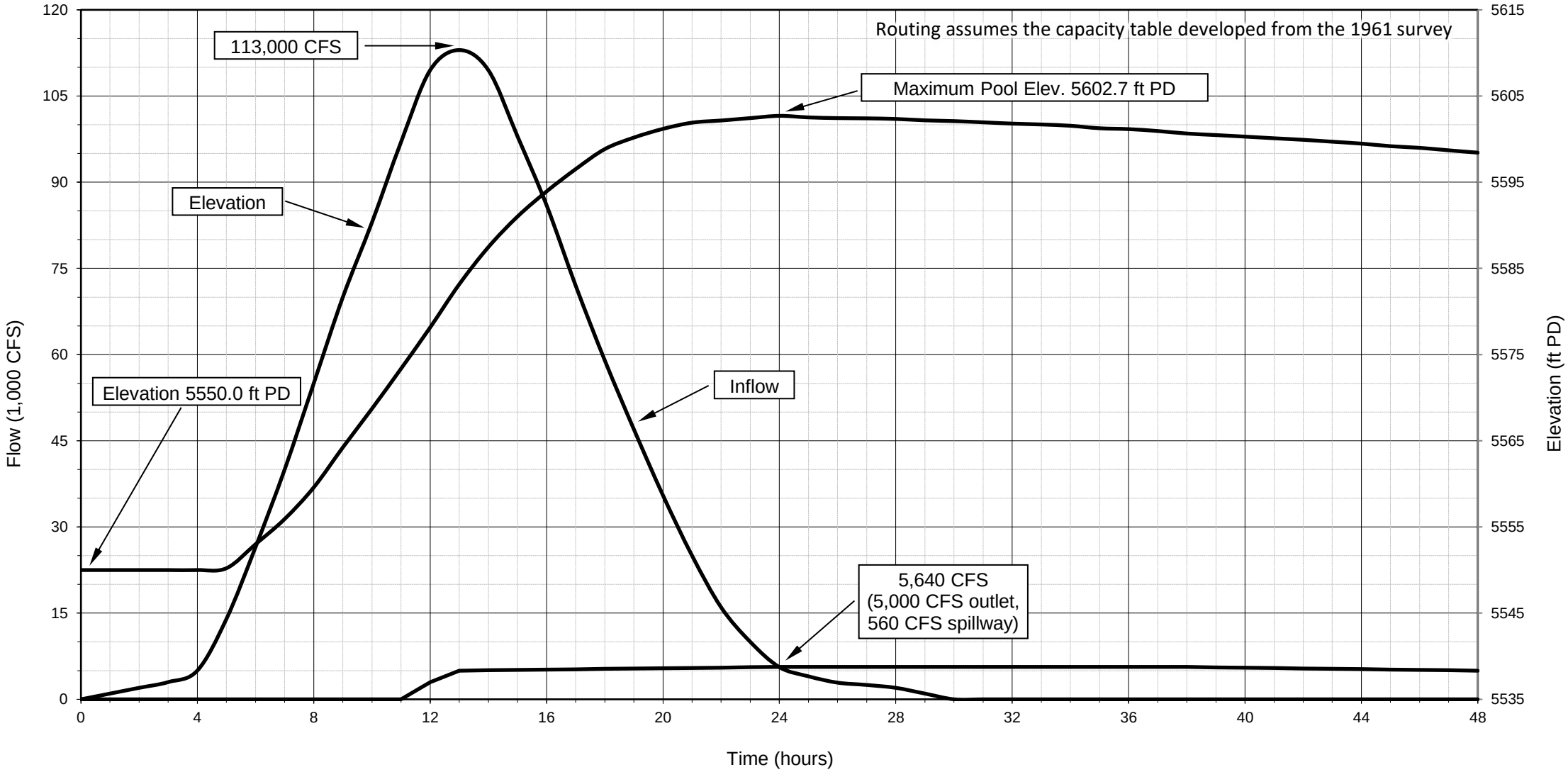
Source: Cherry Creek State Park Procedures Manual. Sept 1983 modified.

Prepared By:_____KEH_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Cherry Creek State Park
Recreation Impacts

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Notes:

1. Reservoir design storm over drainage area above Cherry Creek Dam.
2. Drainage area 386 sq. miles.
3. Total flood volume 98,800 Acre-Feet.
4. Storage at beginning of inflow 13,960 Acre-Feet (elev. 5550.0 ft PD).
5. Minimum rate of release according to regulation curves shown on plate 7-2a.

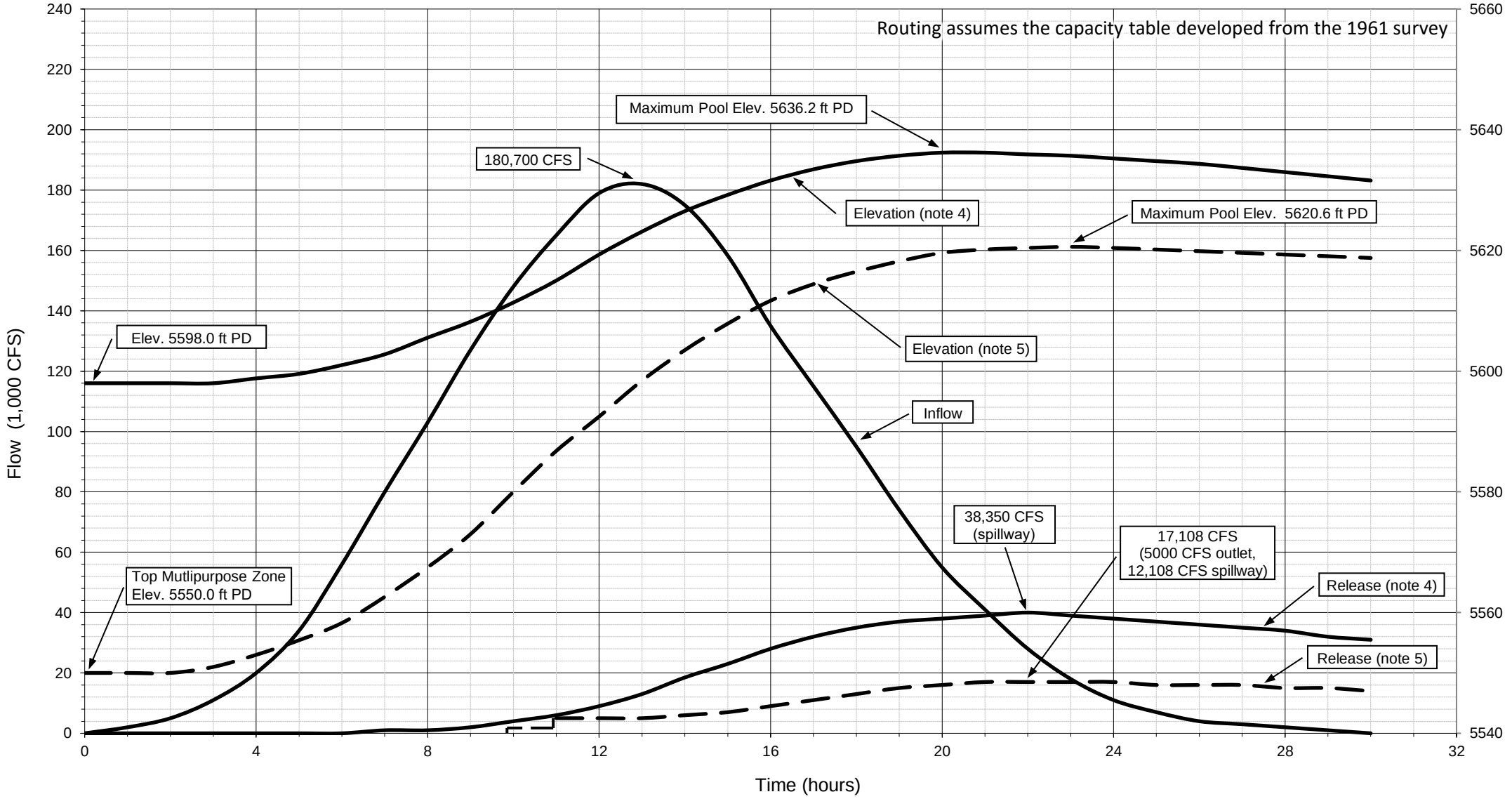
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Reservoir Design Flood Routing

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 8-1



Notes:
1. Developed for Cherry Creek design preliminary report.
2. Total volume 166,740 Acre-Feet.
3. Earth channel spillway with crest at elevation 5598.0 ft PD.
4. Reservoir at elevation 5598.0 (spillway crest) at beginning of flood; conduits inoperative.
5. Reservoir at elevation (top conservation pool) at beginning of flood; conduits operating. Releases determined by rule curve plate 7-2a (maximum conduit release is 5,000 cfs).

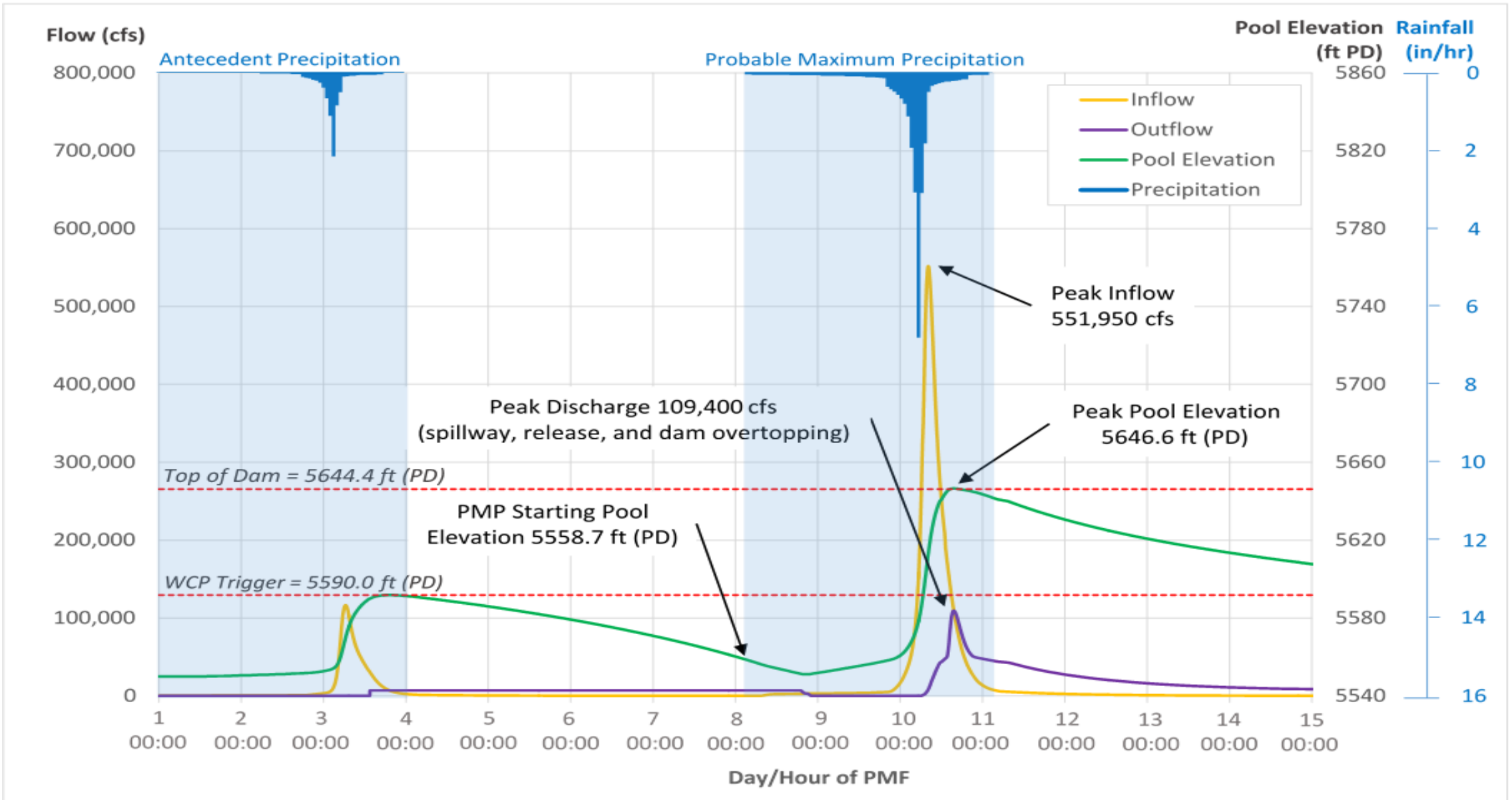
Prepared By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Probable Maximum Flood Routing
Original Design Condition

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 8-2



NOTES:
1. Based on the previous antecedent flood studies and the results of the antecedent simulations, 32% of the PMP was recommended as the antecedent rainfall for the PMF event at Cherry Creek. This is less than the 50% ratio required by ER 1110-8-2(FR), but it is more representative of the antecedent precipitation for the Cherry Creek basin and it also incorporates some conservatism, based on previous antecedent studies.
2. Assumptions: spillway crest of 5558.0 ft PD, top of dam 5644.4 ft PD, and modified water control plan.

Source: Draft Cherry Creek DSMS 2017

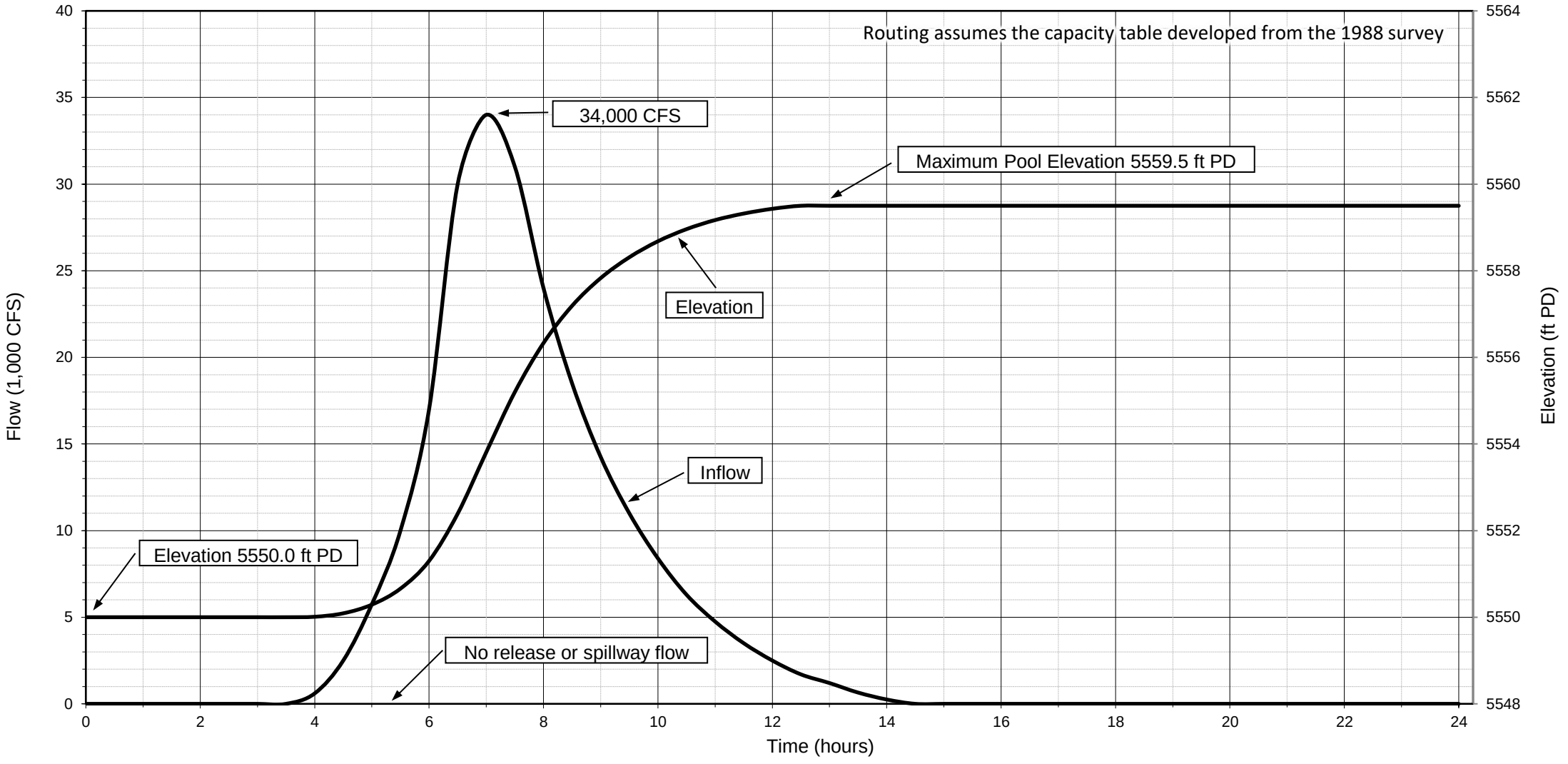
Prepared By:_____KMW_____
Reviewed By:_____JJM_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Probable Maximum Flood Routing
NWS Site-Specific PMP and FWAC PMF Routing

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

1933 Cherry Creek Reservoir Flood Routing (Inflow)



Notes:

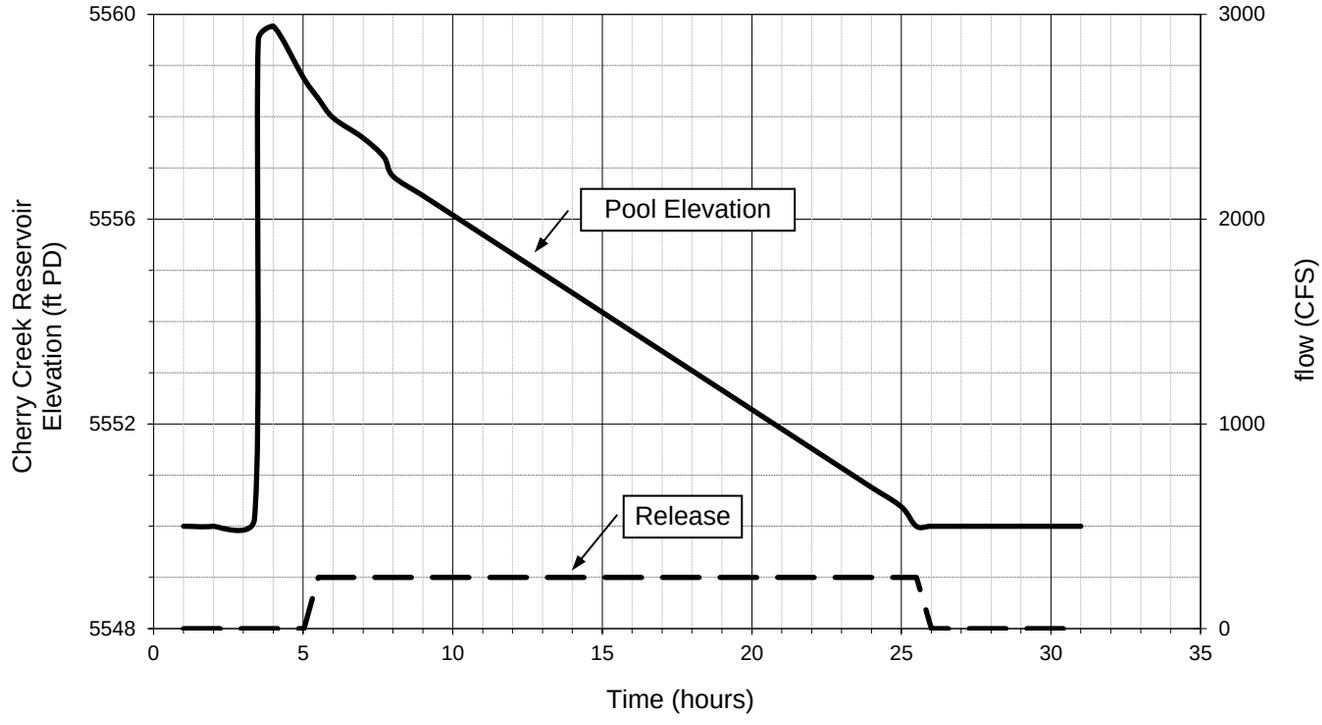
1. Hydrograph 1933 storm over drainage area above Cherry Creek Dam.
2. Total flood volume 23,330 Acre-Feet.
3. Storage at beginning of inflow 13,960 Acre-Feet (elev. 5550).
4. Minimum rate of release according to rule curve for flood control regulation.

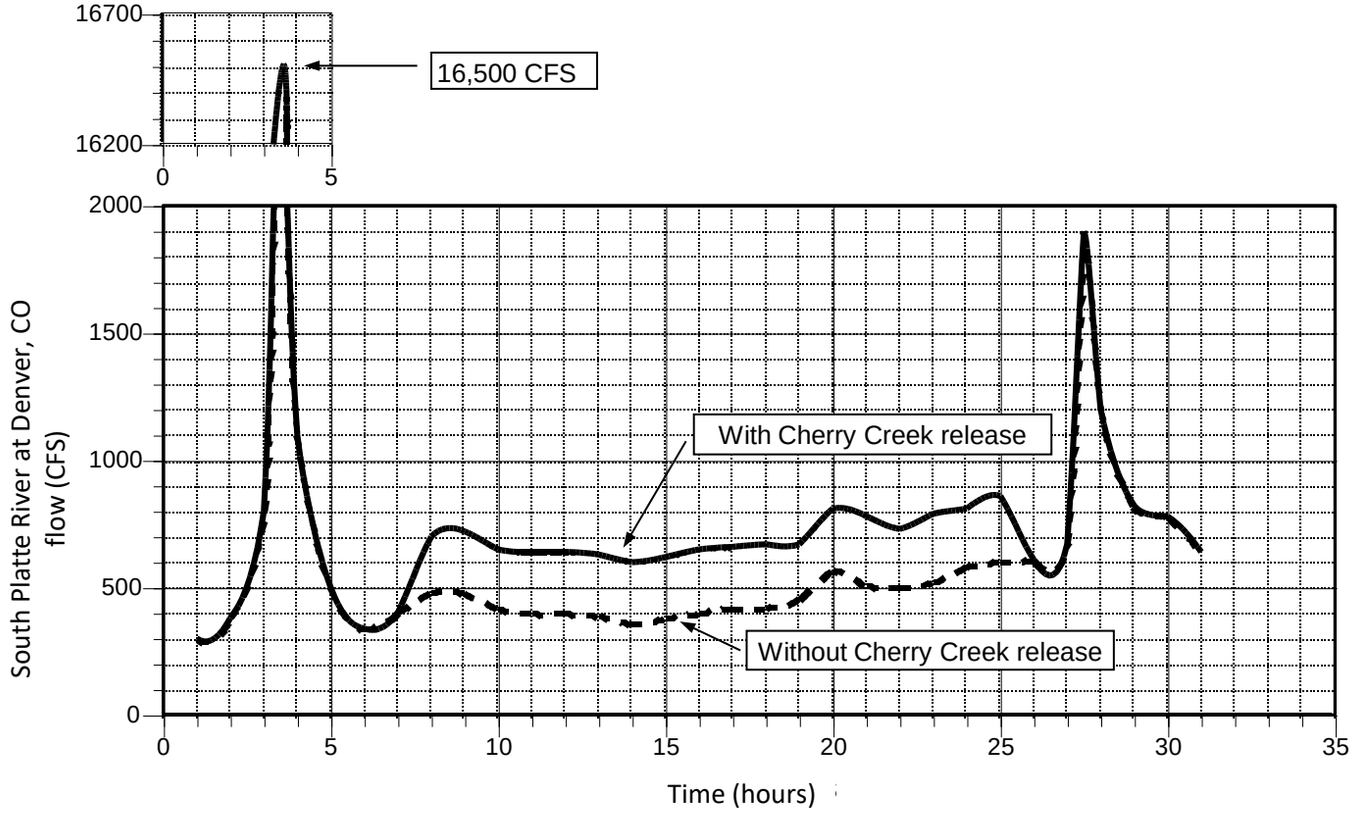
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

1933 Flood Routing (Inflow)

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



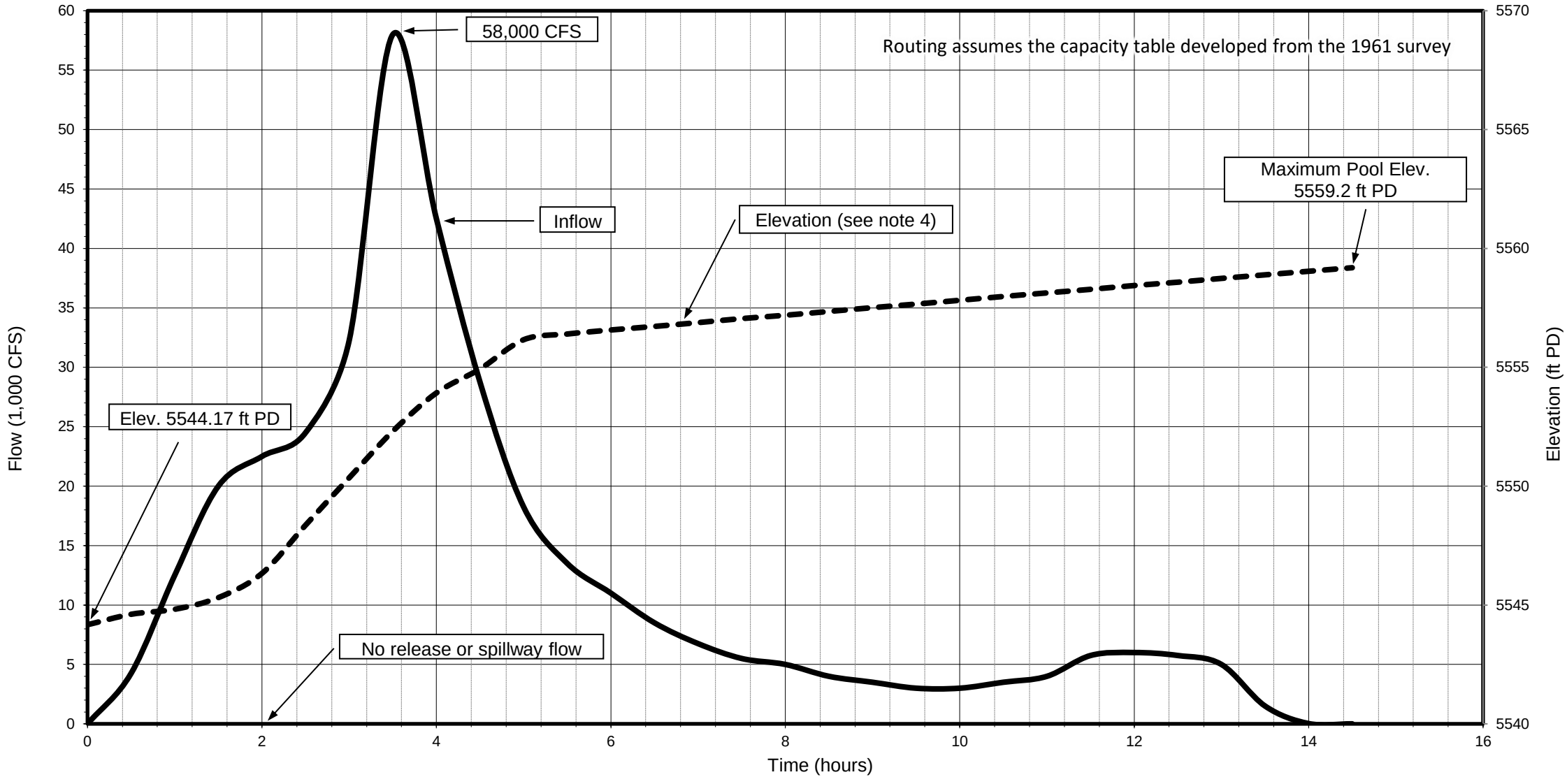


Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

1933 Flood Evacuation Routing

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



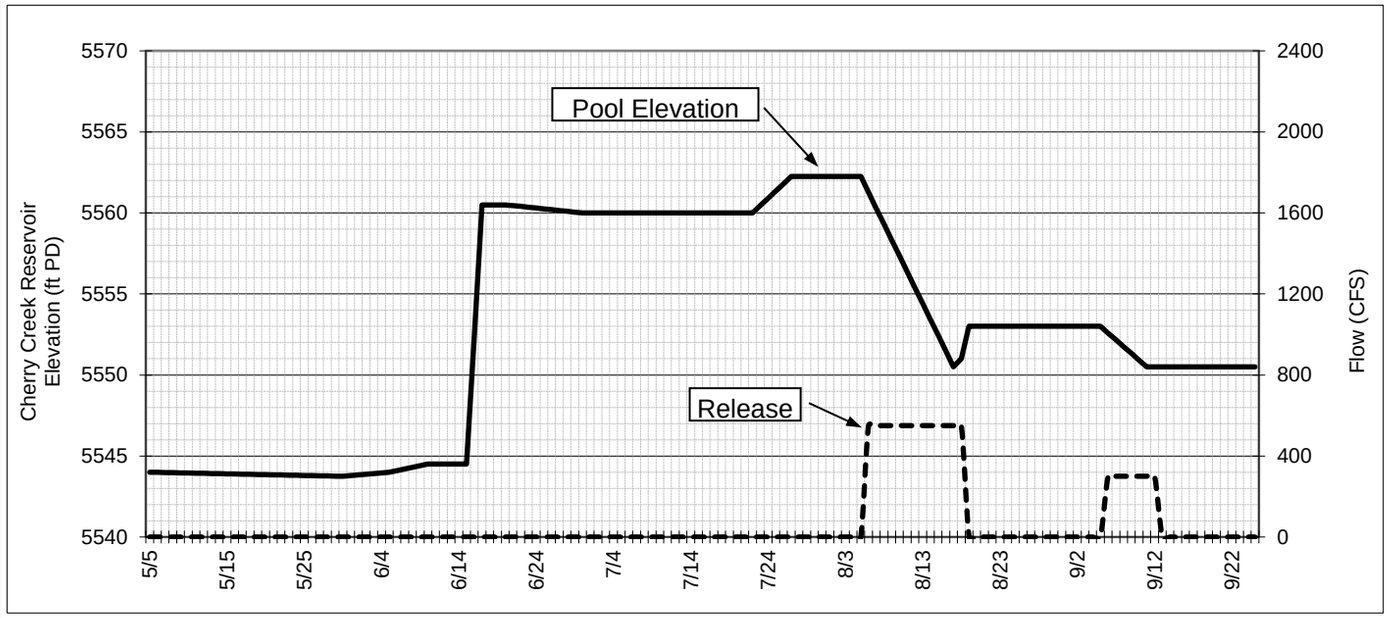
Notes:
1. Hydrograph of June 16-17, 1965 Storm.
2. Total flood volume=13,780 Acre-Feet.
3. Storage at beginning of inflow 9,471 Acre-Feet (actual pool elev. 5544.17).
4. Observed reservoir storage and reservoir regulation according to rule curve for flood control regulation.

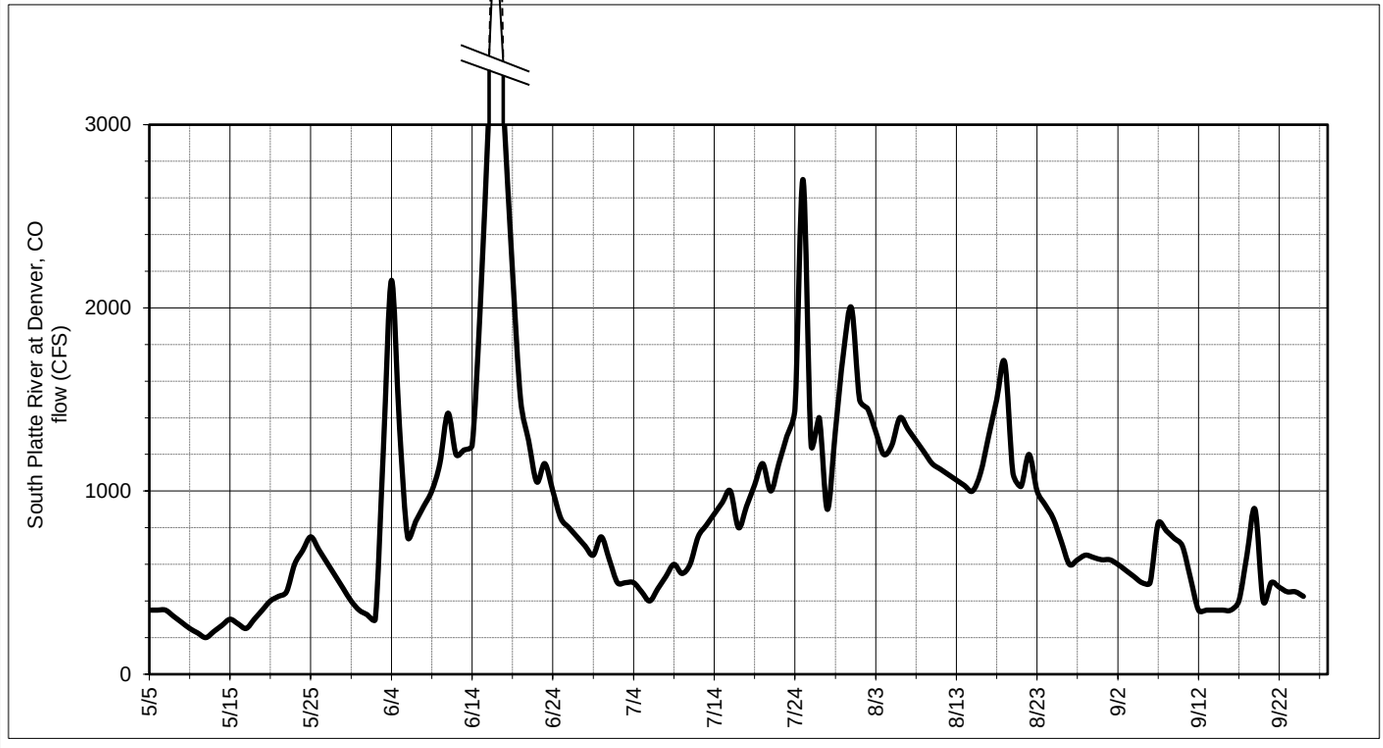
Prepared By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

1965 Flood Routing (Inflow)
Actual Operation

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



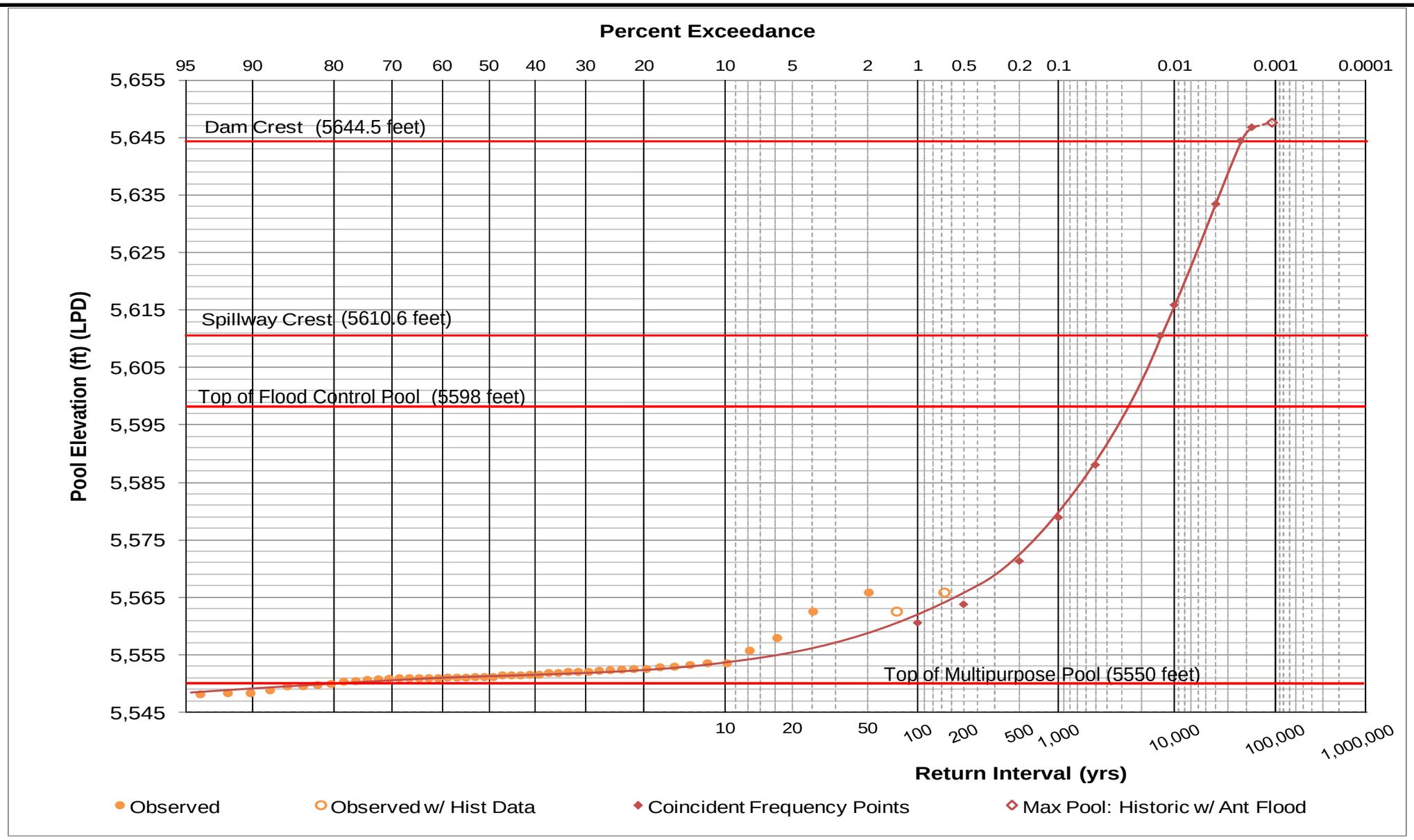


Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

1965 Flood Evacuation Routing

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Prepared By:_____KJS_____
Reviewed By:_____AJF_____



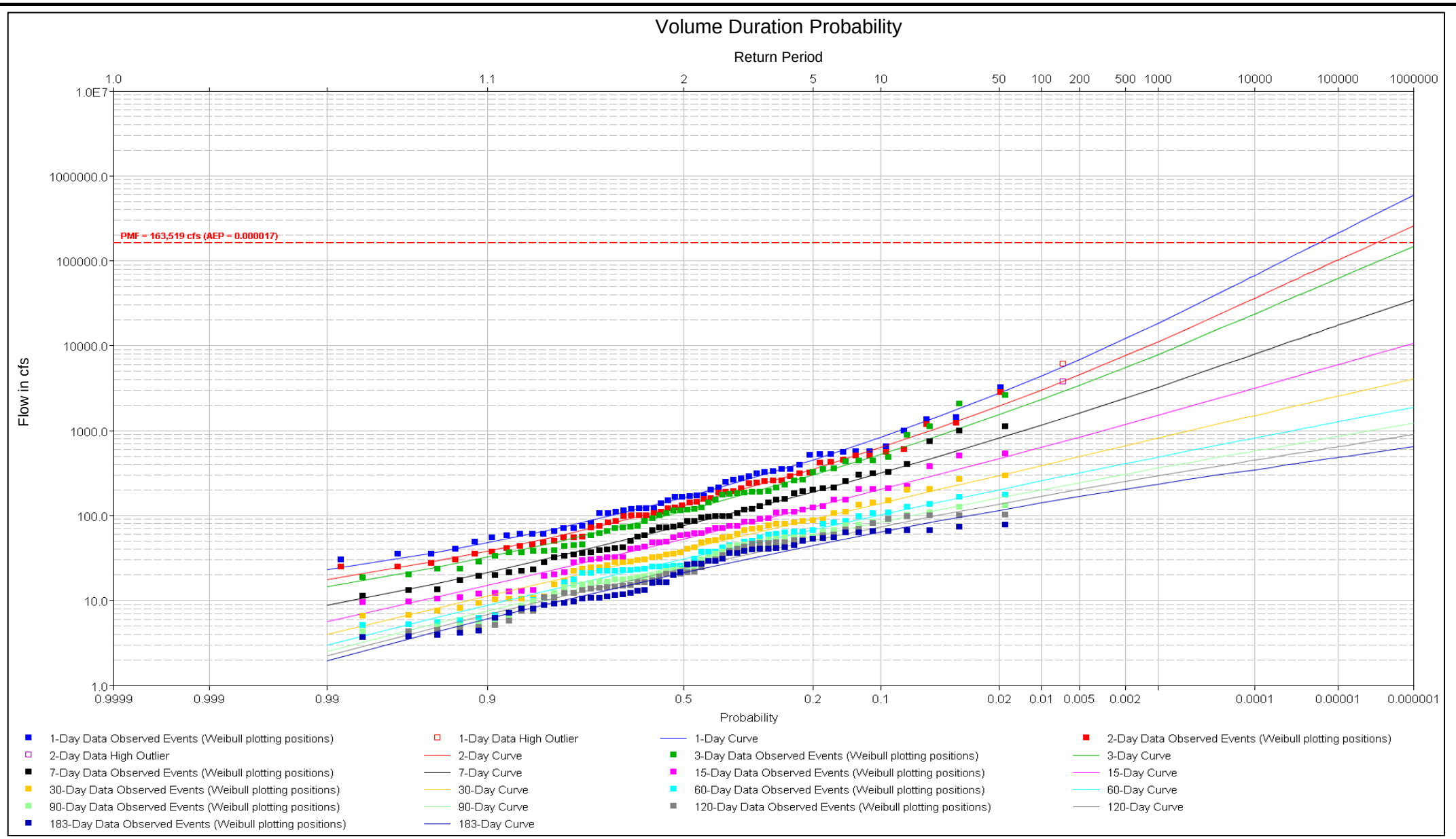
Notes:
1) 1961 was the date of initial fill of the reservoir.
2) The coincident frequency points were modeled assuming zero releases.
3) Source: Cherry Creek DSMS - Hydrologic Risk Assessment and PMP Coincident Flows, February 2013.
4) An update to the curve is expected by the Corps of Engineer's Risk Management Center early 2018.

Prepared By:_____RJL_____
Reviewed By:_____DJC_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Pool Probability Curve (1961-2011)

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Note:
1) Annual maximum values for the durations of 1 through 183 days are shown. Assumes zero reservoir release.
2) Computed using the Cherry Creek daily calculated inflow (1961-2011), which is calculated based on the daily change in storage, reservoir release, and evaporation loss.
3) Final flow frequency relationships were computed from the smoothing statistics in accordance with EM 1110-2-1415.
4) Source: Cherry Creek DSMS - Hydrologic Risk Assessment and PMP Coincident Flows, February 2013
5) An update to the curves is expected by the Corps of Engineer's Risk Management Center early 2018.

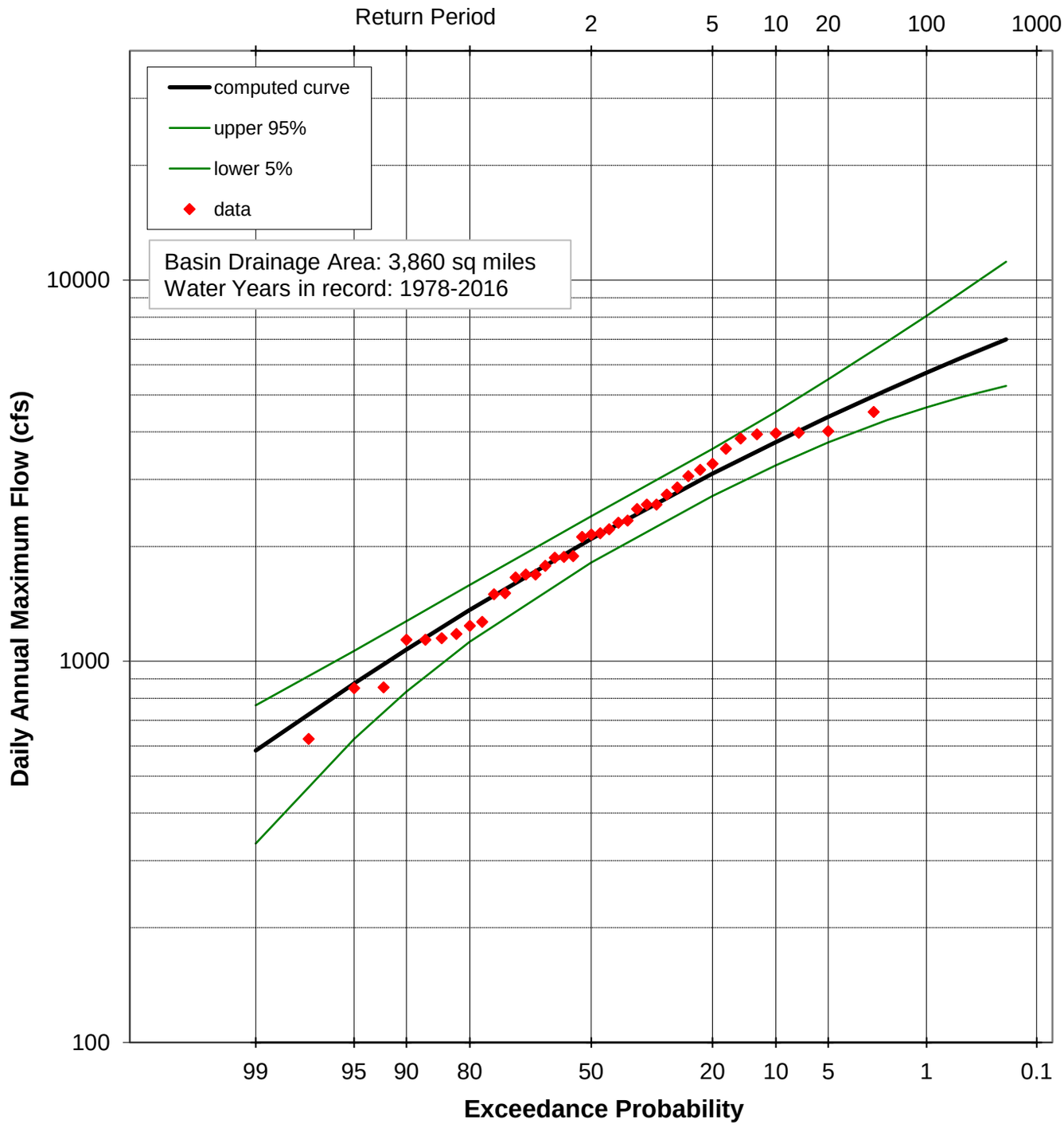
Prepared By:_____RJL_____
Reviewed By:_____DJC_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Volume Duration Probability (1961-2011)

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

South Platte River at Denver Flow Frequency Curve



Log Transform: Flow (cfs)		Number of Events	
Mean	3.31	Historic Events	0
Standard Dev	0.213	High Outliers	0
Station Skew	-0.368	Low Outliers & Zero Flows	0
Regional Skew	-0.2	Zero Events	0
Weighted Skew	-0.31	Systematic Events	39
Adopted Skew	-0.31	Historic Period	39

NOTE: Derived from the daily annual maximum flow data at the South Platte River at Denver, CO streamgage after Cherry Creek, Chatfield and Bear Creek Dams where built in 1978 to represent the current flood control condition. Used Bulletin 17C analysis. The weighted skew fit the dataset the best and therefore was applied.

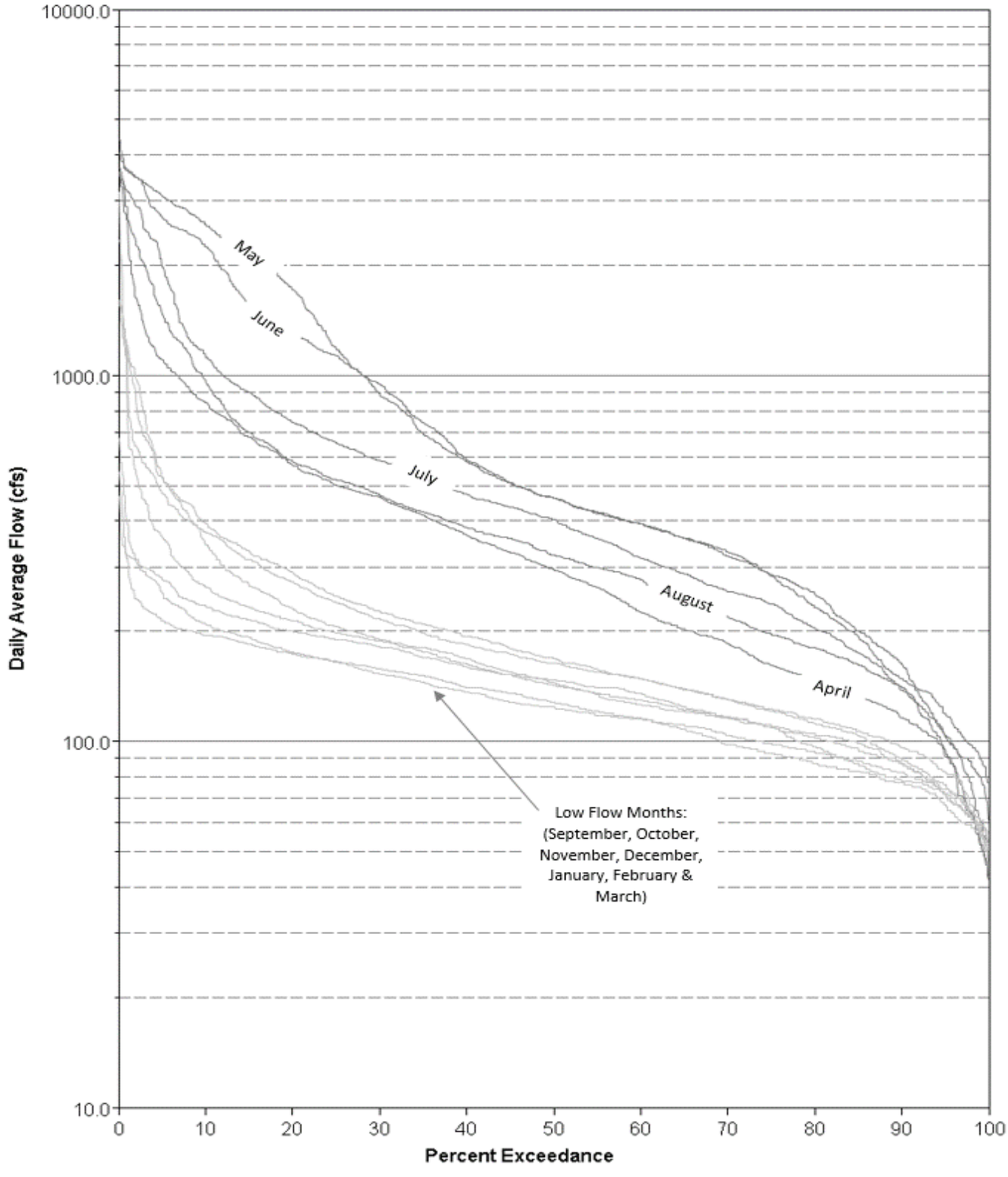
Prepared By:_____KJS_____
Reviewed By:_____JPD_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Flow Frequency Curve
South Platte River at Denver, CO

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

South Platte River at Denver - Flow Duration Curve



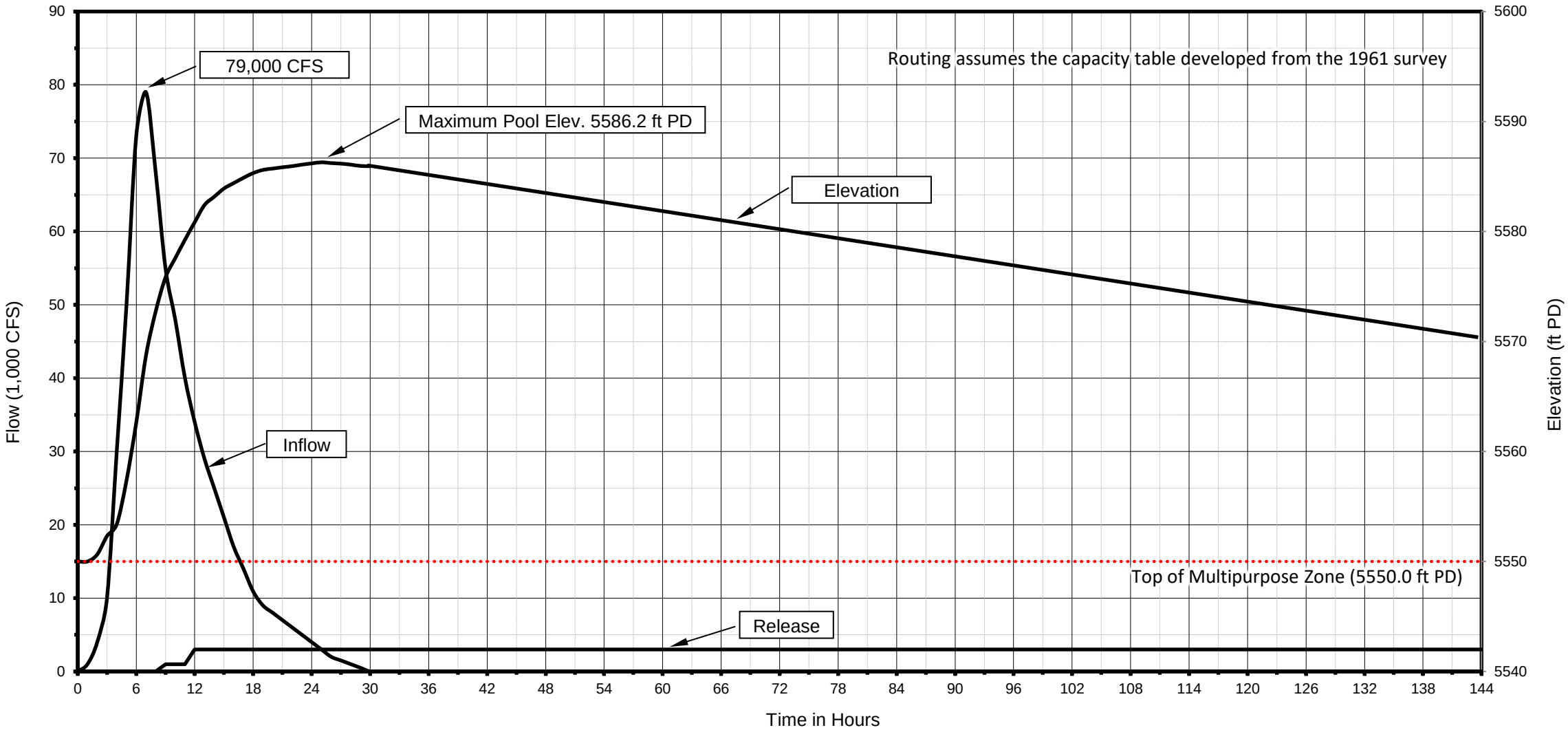
NOTE: Derived from the daily flow data at the South Platte River at Denver, CO streamgage after Cherry Creek, Chatfield and Bear Creek Dams were built (1978-2016). Cherry Creek, Chatfield, and Bear Creek Dams were completed in 1950, 1975, and 1977, respectively. The data record represents the current flood control condition.

Prepared By:_____KJS_____
Reviewed By:_____JPD_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Flow Duration Curve
South Platte River at Denver, CO

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Steps taken when following Condition C (Standing Instructions to the Dam Tender):

The inflow shown is an assumed flood, approximately one-half of the design flood values. Pool elevation at the beginning of the flood is assumed to be 5550.0 feet PD, top of the multipurpose zone. Releases are those required by the Standing Instructions to the Dam Tender for emergency action according to Condition C in the event of a flood:

1. No release required until the 8th hour.
2. At the start of the 8th hour, the reservoir elevation is rising and exceeds 5570.0 ft PD. A release of 1,000 CFS is indicated by the Standing Instructions because the pool level is in the range of 5570.0-5590.0 ft PD.
3. At the end of the 12th hour, the reservoir elevation is rising and exceeds 5580.0 ft PD. A release of 3,000 CFS is indicated by the Standing Instructions because the pool level is in the range of 5580.0-5590.0 ft PD.
4. At the end of the 75th hour, the reservoir fell below 5580.0 ft PD, the current gate opening is maintained and the release gradually drops as the pool level falls. These gate openings will remain constant until the pool has fallen to elevation 5570.0 ft PD.
5. When the pool level falls below 5570.0 ft PD, the release is made in accordance with latest regulation order.

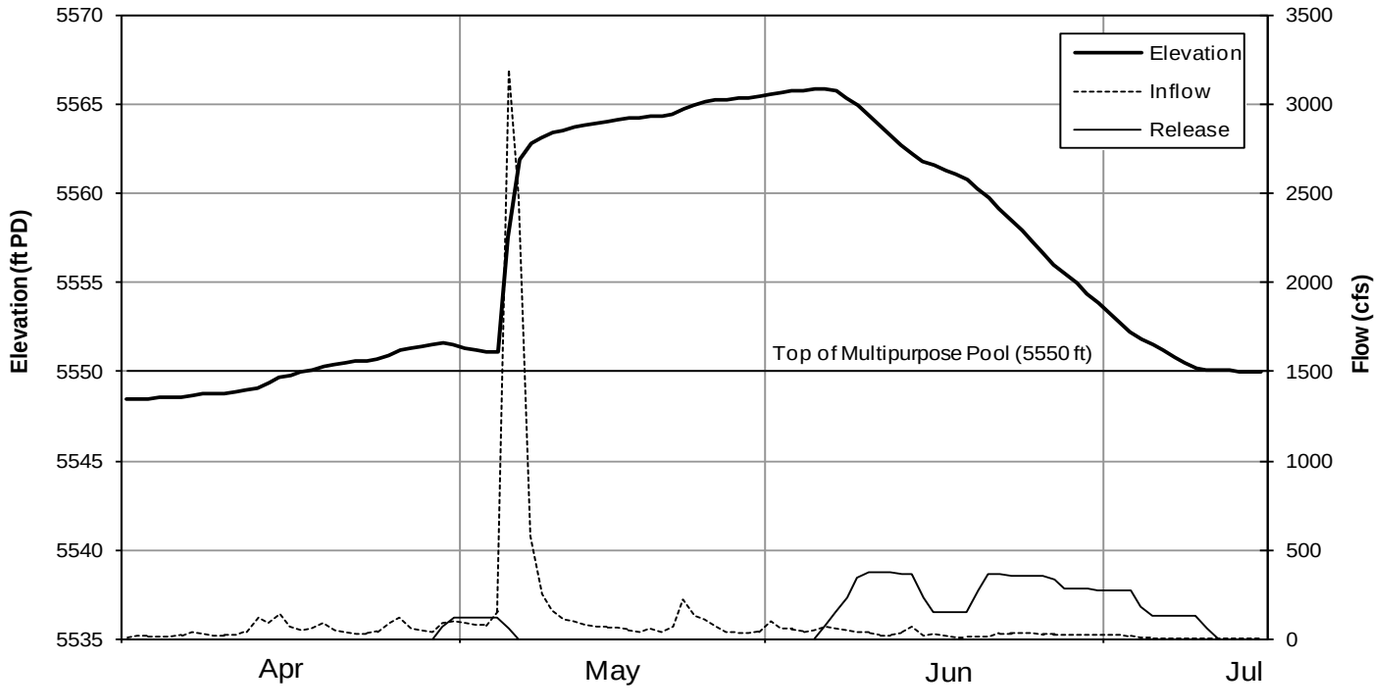
Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

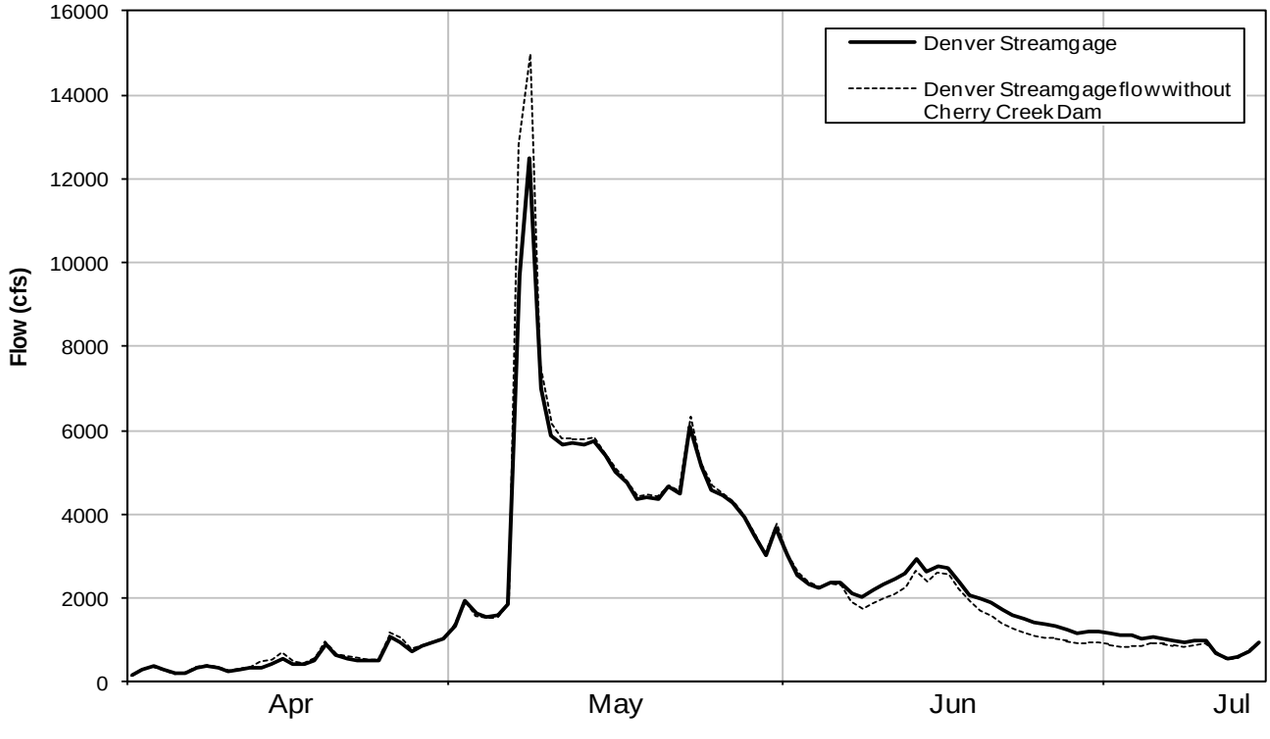
Emergency Regulation
Flood Routing - Condition C

U. S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Cherry Creek Reservoir



South Platte River at Denver Streamgage



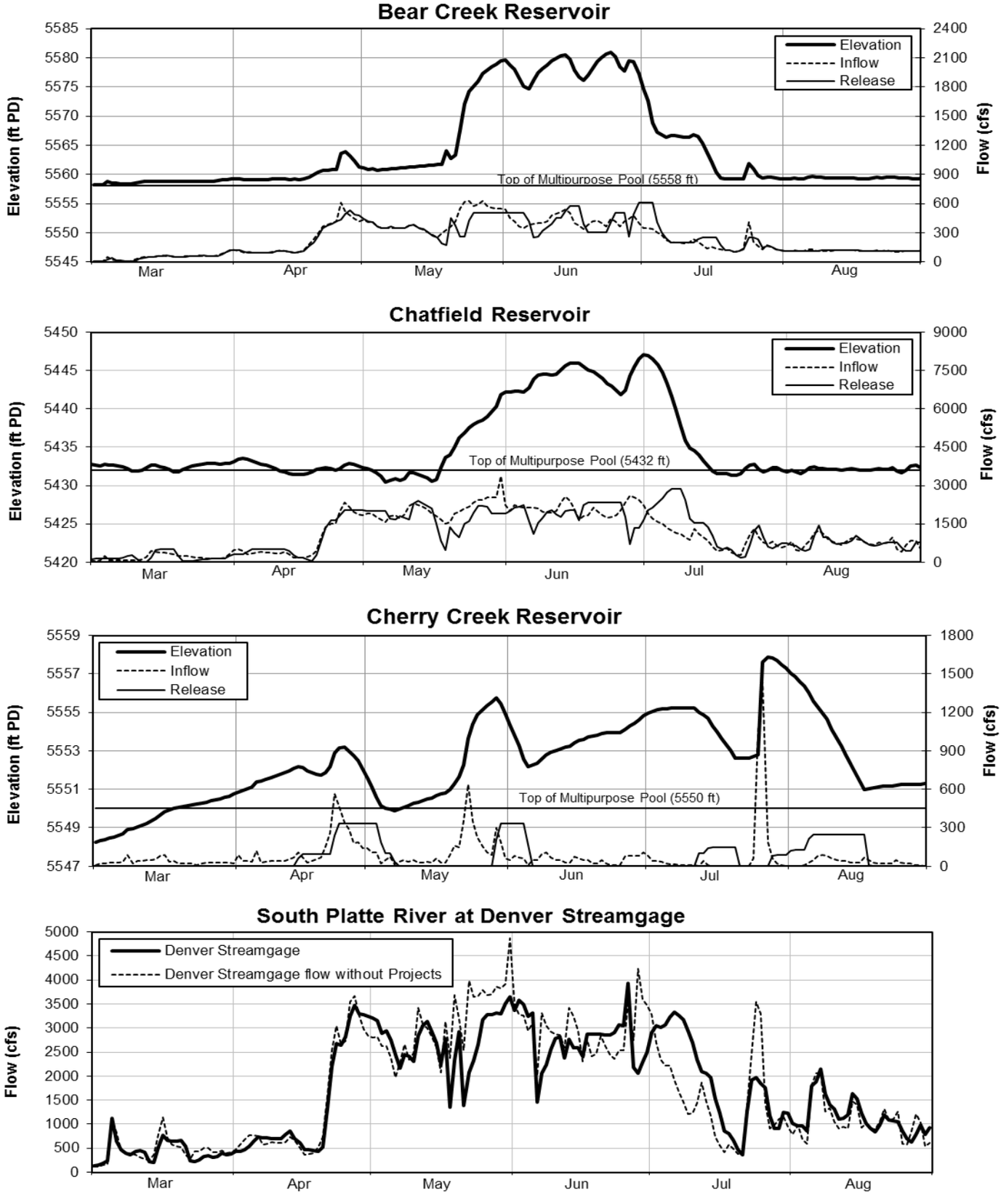
Note:
1) The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Actual Individual Regulation
1973 Flood Flows

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Note:
1) The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

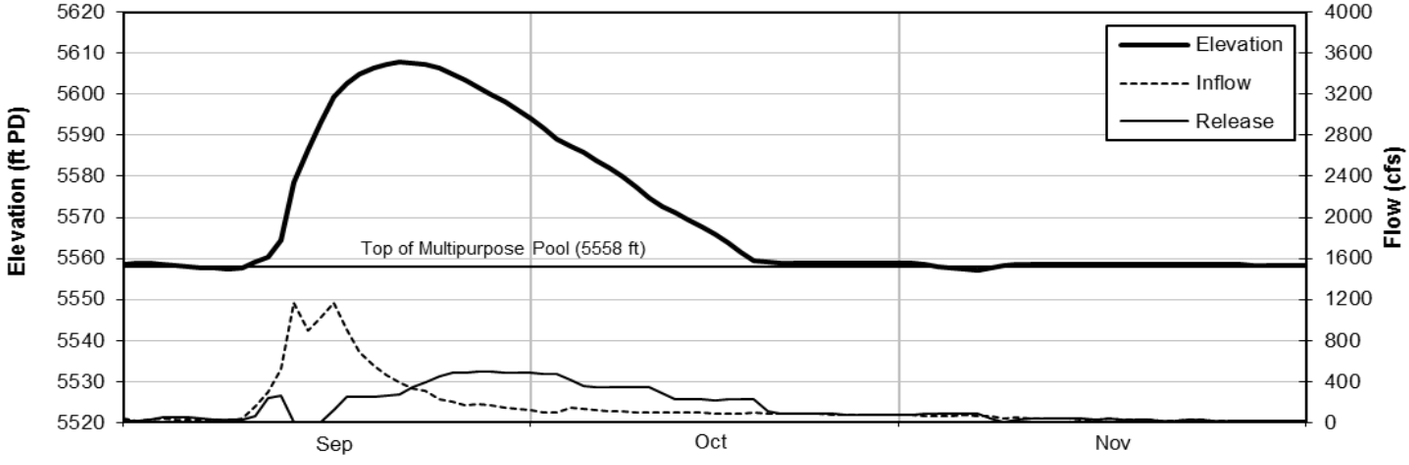
Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

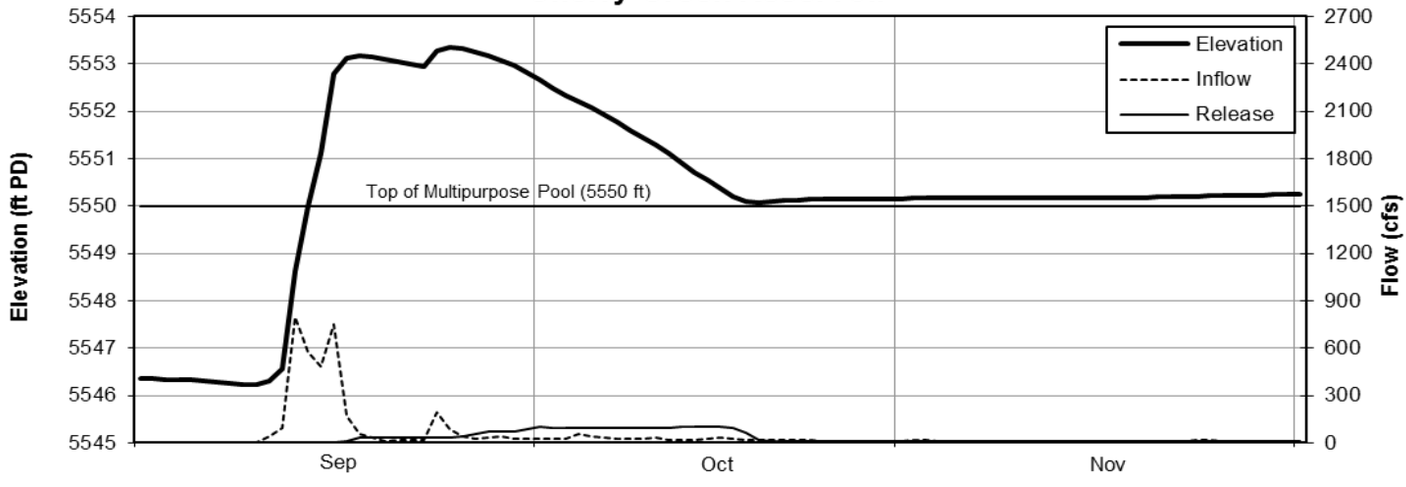
Actual System Regulation
1983 Flood Flows

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

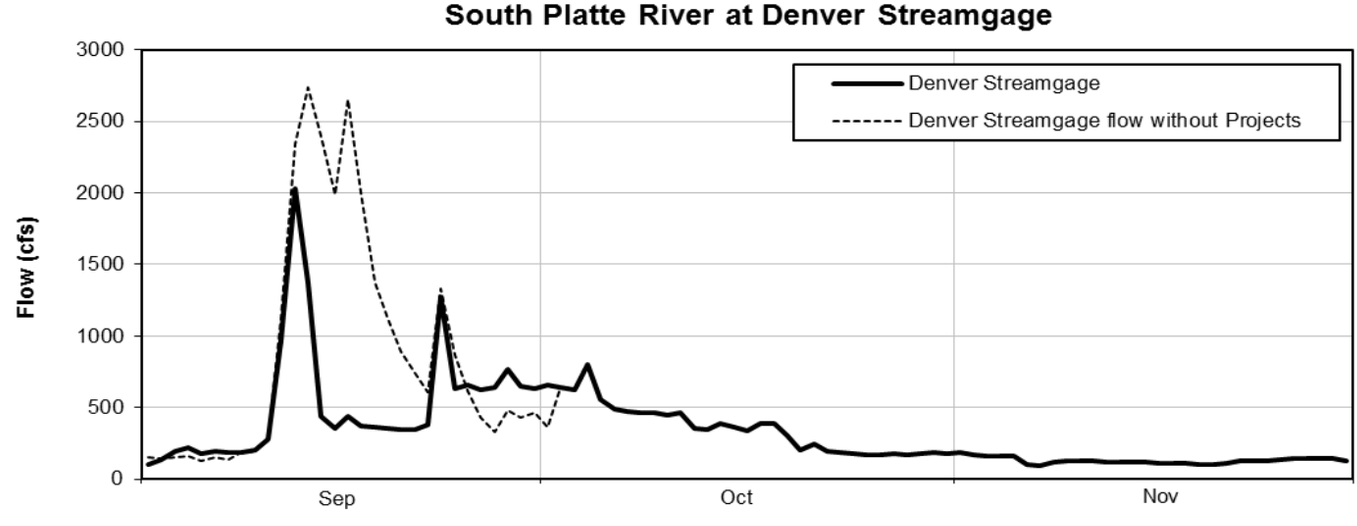
Bear Creek Reservoir



Cherry Creek Reservoir



South Platte River at Denver Streamgage



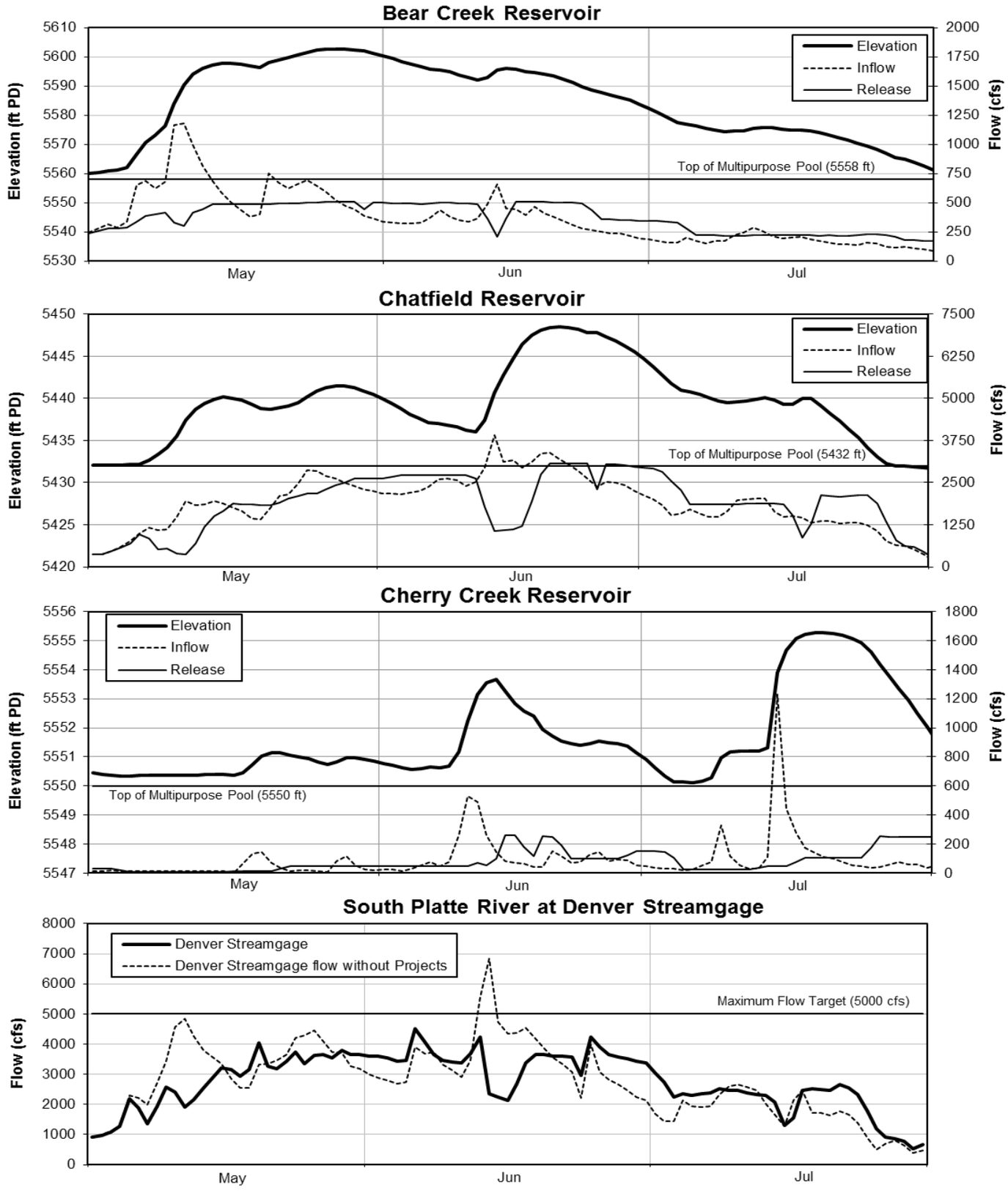
Notes:
1) The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.
2) Chatfield Reservoir inflow during 2013 was minor compared to Bear Creek and Cherry Creek Reservoirs, thus is not shown.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Actual System Regulation
2013 Flood Flows

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



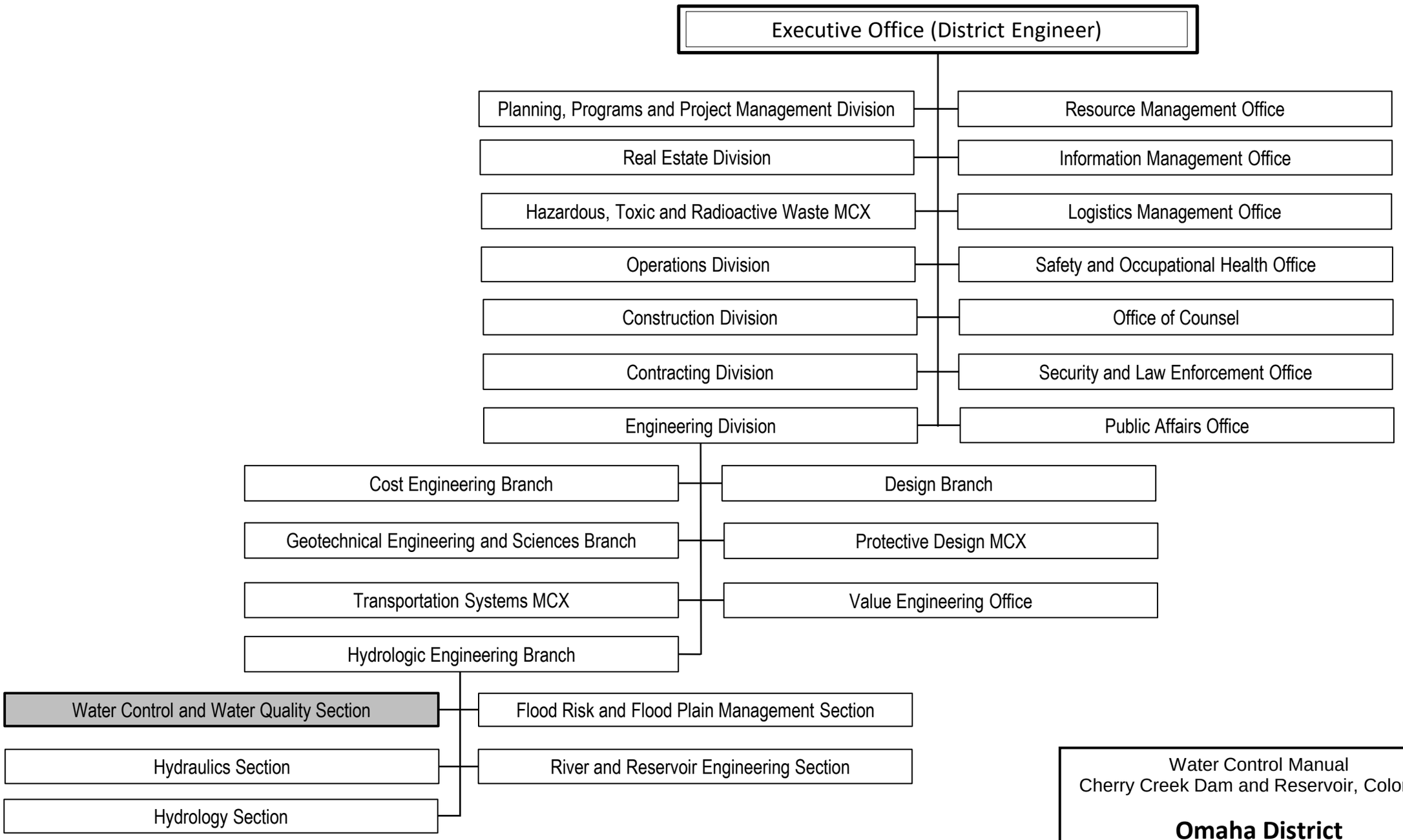
Note:
1) The reservoir elevation is based on the Project Datum (PD), which for Cherry Creek Reservoir is 1.3 feet higher than NGVD29 and 1.8 feet lower than NAVD88.

Prepared By:_____JDM_____
Reviewed By:_____KJS_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Actual System Regulation
2015 Flood Flows

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018



Prepared By:_____KJS_____
Reviewed By:_____AJF_____

Water Control Manual
Cherry Creek Dam and Reservoir, Colorado

Omaha District
Organization Chart

U.S. Army Engineer District, Omaha
Corps of Engineers, Omaha, Nebraska
2018

Plate 9-1

EXHIBIT I

STANDING INSTRUCTIONS TO DAM TENDER

FOR

RESERVOIR REGULATION

CHERRY CREEK DAM AND RESERVOIR

THIS PAGE INTENTIONALLY LEFT BLANK

Condition A - General

A-1. Purpose of Instructions. It is the purpose of these instructions to set forth the responsibilities of the Dam Tender and procedures to be followed for regulation of Cherry Creek Reservoir. 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 regulation.

A-2. Purpose of Project. The project's primary purpose is to protect the City of Denver from floods originating on Cherry Creek. Development and use of the sediment or multipurpose pool will provide incidental benefits for all forms of water related recreation activity. Storage allocations are listed in Table 1.

Table 1
Cherry Creek Reservoir Storage Allocations

Zone	Pool Elevations (feet PD*)	Storage Allocations (Acre-Feet)**
Surcharge	5598 to 5645	181,942***
Exclusive Flood Control	5550 to 5598	79,294
Multipurpose	5504 to 5550	12,558

* PD = Project Datum
** 2006-07 Sediment Survey
*** The 2006-07 survey did not include the top 5 feet of storage. The curve was extended with LiDAR data to obtain the entire zone's storage capacity.

A-3. Types of Regulation and Responsibilities. The present status of the project entails both multipurpose and flood control regulation. The State of Colorado through its State Engineer, or designated representative, is responsible for multipurpose regulation and accordingly will specify releases from and the storage of inflows when the pool is in the multipurpose zone. However, as determined by the Corps' Omaha District dam safety officer, should any dam safety issues arise, the Corps will assume all regulation decisions.

A-4. Flood Control Responsibilities. The Corps of Engineers has prime responsibility for determining releases from the exclusive flood control zone and is solely responsible for specifying releases from the surcharge zone. Such regulation will be construed as flood control regulation. In order to satisfy the water rights of irrigators taking water from the South Platte River, the State Engineer of Colorado may request the release of inflows to Cherry Creek Reservoir while the pool is in the exclusive flood control zone. If such releases will not contribute to damages at or below Cherry Creek Dam, the Corps of Engineers, upon receiving such requests, will order releases of inflow up to a maximum of 5,000 cfs unless Cherry Creek Reservoir is above elevation 5590 ft PD.

A-5. Hydrologic Reporting Network. To facilitate the rapid collection and receipt of hydrologic data pertinent to regulation of the Chatfield, Cherry Creek and Bear Creek Dams and Reservoirs, a Hydrologic Reporting Network has been established and expanded by several local, state and federal agencies. The network includes an extensive system of reservoir, stream and precipitation gages within the State of Colorado. Table 2 provides a list of pertinent stream and reservoir gages useful during the regulation of Chatfield, Cherry Creek, and Bear Creek Reservoirs. Real-time stage and flow data for these streamgages can be found on the CDWR website.

Table 2
Stream and Reservoir Gaging Stations

Stream	Station
South Platte River	South Platte
South Platte River	Waterton
Plum Creek	Louviers
South Platte River	Chatfield Lake
South Platte River	Below Chatfield Dam
South Platte River	Below Union Ave.
Bear Creek	Morrison
Bear Creek	Bear Creek Lake
Bear Creek	Below Bear Creek Dam
Bear Creek	Sheridan
South Platte River	Englewood
Cherry Creek	Franktown
Cherry Creek	Parker
Cherry Creek	Cherry Creek Lake
Cherry Creek	Denver
South Platte River	Denver
South Platte River	Commerce
Clear Creek	Golden
Clear Creek	Derby
South Platte River	Henderson

https://www.dwr.state.co.us/SurfaceWater/default.aspx

A-6. Routine Observations and Reports. Attachment 1 shows an example routine regulation report required of the Dam Tender.

A-7. Special Reports. The following observations of conditions will be relayed immediately by the Dam Tender to one of the Omaha District Water Control and Water Quality Section (WCWQS) personnel listed on Attachment 2. Phone calls will be made in the order listed to the office phone numbers and cell phone numbers until notification is made.

(1) Knowledge exists of any flooding, flood damages, requests for regulation of releases, or heavy runoff occurring or appearing to be imminent upstream or downstream from the dam.

(2) Rainfall at any point in the South Platte River basin above Henderson, Colorado exceeds two inches in a 6-hour period.

(3) Pool level rises 0.5 foot or more in a 6-hour period. (A rise in pool, which in the opinion of the Dam Tender, reaches this limit only as a result of wind effects, need not be reported).

A-8. Notification Schedule. If the pool rises above elevation 5550.0 feet PD and is expected to continue to rise in the exclusive flood control zone above 5551.0 feet PD, the Dam Tender will notify the WCWQS personnel listed in Attachment 2. If the rise in pool occurs between 7:00 am and 3:30 pm notification will be the same day. If the rise in pool occurs between 3:30 pm and 7:00 am, weekends and holidays included, notification will be made by 9:00 am the following day. All times assumed to be mountain time.

Condition B - Normal Regulation

B-1. Regulation Objectives. Regulation of the Cherry Creek Dam and Reservoir will be based on observed and anticipated hydrologic and meteorologic conditions with the objective of providing as high a degree of flood protection as practicable to downstream areas. In addition, regulation of the reservoir will be based on providing the maximum service to the other purposes for which the project was intended insofar as this regulation is consistent with the primary flood control function.

B-2. Definition of Normal Regulation. For the purpose of these instructions, normal regulation is defined to occur at all times when:

(1) Rapid communication (telephone) between the Dam Tender and the WCWQS is possible.

(2) Rapid communication between the Dam Tender and regulatory offices referenced above is impaired; however, hydrologic and meteorologic conditions are such that flooding, flood damages or rapid increase in the Cherry Creek pool elevation (defined in Condition C "Emergency Regulation") is not occurring or is not anticipated in the near future.

B-3. Regulation Instructions. Regulation orders will normally be issued to the Dam Tender by the WCWQS. However, when the pool level is below elevation 5550.0 ft PD the State Engineer's Office will determine the necessary release due to water rights and will contact the WCWQS for approval and regulation order issuance. The State Engineer's Office may issue instructions on releases for water rights directly to the Dam Tender if contact cannot be made with the WCWQS. All verbal orders will be confirmed in writing by the WCWQS as soon as practical. The orders will specify total reservoir release and time of release change. All regulation orders will be filed in a convenient, accessible place in the Dam Tender's office. The Dam Tender will inform the substitutes as to the location of the regulation orders and their content.

During non-working hours when the Project Office or District Offices are not normally staffed, verbal instructions may be issued to the Dam Tender by the WCWQS personnel and will be confirmed in writing at the next regulation work period. Regulation requests received by the Dam Tender directly from the State Engineer of Colorado or designated representative will not be carried out until confirmed by the WCWQS unless a bona fide emergency exists, such as drowning, present or probable damage to public works downstream from the dam, or events of a similar nature.

B-4. Regulation Order Execution. The Dam Tender will carry out the required operations in each regulation order upon receipt thereof in the manner specified and in accordance with the time schedule given in the order. In the event conditions prevent the compliance with an order, the Dam Tender will immediately notify the Tri-Lakes Project Office personnel of the corrective measures required before execution of the order is possible. If the regulation order requires reservoir releases in cubic feet per

second (cfs), the Dam Tender will determine the required gate settings (see Cherry Creek Water Control Manual Plates 2-10a through 2-14b). Releases will be made to the maximum extent with equal openings of gates 1, 2, 4 and 5. If only one tunnel is required, both gates in the tunnel will be opened the same amount.

B-5. Regulation Records. The Dam Tender shall keep a routine report of reservoir regulation (see Attachment 1 for a report example). The Dam Tender shall make the reports available to the WCWQS for use in development of the reservoir regulation orders. In the routine reservoir regulation report, the Dam Tender shall note all reservoir regulation orders received from the WCWQS. The notes shall include whom the reservoir regulation order was given by, the time and the discharge. The Dam Tender shall keep, as part of the permanent files, copies of all reservoir regulation orders received. The Dam Tender shall keep records complete enough to reconstruct the events and activities at the project during flood periods.

The Dam Tender shall also keep a flood report during normal regulation. All conversations, especially with personnel outside the Corps, relative to flooding, flood damages, requests for regulation of releases, etc., should be documented. All observations of flooding and flood damages should also be documented. An example flood report under this condition can be found in Attachment 1 of this document.

B-6. Safety - Public Information. In order to provide ample warning to campers in the Cherry Creek Project area of actual or impending rises in water level, the Dam Tender will immediately notify the Colorado State Parks and/or Fish and Wildlife representative at the site, as listed in Attachment 2, whenever the pool level is expected to exceed 5575.0 feet PD or when a rapid rise in pool level of 0.5 foot in a 6-hour period is occurring or is expected to occur in the next 6 hours. Cherry Creek Project releases, made under the conditions contained herein, are not likely to endanger any of the inhabitants of the basin; however, the Colorado State Engineer and the Colorado Division Engineer, as listed in Attachment 2, will be notified by the Dam Tender of probable prolonged releases which might cause damage to the existing Cherry Creek channel through the City of Denver. The Division 1 Engineer and State Engineer should be notified in all cases when outlet releases in excess of 500 cfs are to be made from Cherry Creek Dam.

B-7. Dam Tender Email Notification – Routine and Flood Regulation. In order to keep stakeholders, local agencies, local emergency management officials, and downstream contractors aware of changing downstream conditions due to reservoir operations, reservoir release change email notification lists are used and maintained by the Dam Tender. The email notification identifies the date, time, and release. For the Cherry Creek Reservoir Project there are two email lists.

(1) For all reservoir release changes, an email will be sent by the Dam Tender to the WCWQS, the State of Colorado, local agencies, contractors located within Cherry Creek and the South Platte River below Cherry Creek Dam, and designated stakeholders.

(2) For a 40 cfs or greater reservoir release change, an email will be sent by the Dam Tender to the group noted in B-7.(1) as well as the US Geological Survey, the National Weather Service, Urban Drainage and Flood Control District (UDFCD), and local emergency management officials.

Condition C - Emergency Regulation

C-1. Purpose of Emergency Instructions. Regulation of Cherry Creek Reservoir will be normally accomplished by specific reservoir regulation orders to the Dam Tender from the WCWQS. However, it is conceivable that interruptions in communication may occur at times when regulation action, other than required in the latest available regulation order, may be necessary particularly in order for the project to fulfill its primary objective of flood control.

C-2. Reason for Emergency Instructions. Emergency instructions have been developed to provide the Dam Tender with instructions for the regulation of releases from the project during periods of communication failure. These instructions have been formulated to provide as high a degree of flood protection as practical for the City of Denver, within the safe capability of the project, and involve action by the Dam Tender based on meteorologic and hydrologic conditions of which the Dam Tender has knowledge.

C-3. Definition of Emergency. For the purpose of these instructions, an emergency is defined to begin with a failure in communications between the Dam Tender and the WCWQS personnel at a time when a report from the Dam Tender is required by Paragraph A-7.

C-4. Emergency Conditions. Emergency conditions will continue until such time personnel in the WCWQS have been contacted and the appropriate instructions are received by the Dam Tender. During the progress of the emergency as defined above, the Cherry Creek Dam Tender shall proceed and regulate the Cherry Creek Reservoir in accordance with the conditions and instructions which follow. The Dam Tender shall continue to record data and provide for safety and public information insofar as possible as directed in Condition B of these instructions.

C-5. Re-establishment of Communications. Telephone and email are presently available for communication between the Dam Tender and the WCWQS personnel. During an emergency every effort should be made to re-establish communications between the Tri-Lakes Project Office and the WCWQS by any means available. If Tri-Lakes Project Office personnel are available, a vehicle should be dispatched to convey messages to contact the WCWQS personnel shown on Attachment 2 from a point where communications are not impaired. However, the Dam Tender shall ensure that the dam is attended at all times during the emergency.

C-6. <u>Emergency Regulation</u>. In the event of an emergency as defined in Paragraph C-3, the Dam Tender shall regulate releases as indicated by the following schedule. The Cherry Creek Reservoir inflow may be estimated by determining the flow at the Cherry Creek at Parker streamgage. The goal is to store rainfall or snowmelt runoff to mitigate the downstream flood risk. Once downstream flooding has subsided, the stored flood water is evacuated as quickly as practical to return the reservoir to the base of the flood control pool. This prepares the reservoir to store the next runoff event. **Once the reservoir level is stationary or begins to fall, the Dam Tender shall maintain the maximum gate opening attained while above elevation 5550.0 feet PD unless conditions change. At no time should water be released at a rate greater than the peak inflow experienced during the flood event.**

Pool Elevation (feet PD)	Release Schedule
Above El. 5590.0, rising pool	Release the greater of:
	1. That specified in the latest regulation order.
	2. 7,000 cfs.
Above El. 5590.0, falling or stationary pool	Release as necessary to maintain a stationary pool subject to a maximum release of 7,000 cfs.
El. 5580.0 to 5590.0	Release the greater of:
	1. That specified in the latest regulation order.
	2. The discharge of current gate openings
	3. 3,000 cfs.
El. 5570.0 to 5580.0	Release the greater of:
	1. That specified in the latest regulation order.
	2. The discharge of current gate openings.
	3. 1,000 cfs.
El. 5550.0 to 5570.0	Release in accordance with the latest regulation order. (Do not adjust gates to higher discharge if pool should show slight rise when this step is begun)

The hourly increase in gate openings shall not exceed one foot per gate. No limit on the rate of decreasing releases. If practical releases will be made through equal openings of gates 1, 2, 4 and 5.

C-7. <u>Special Reports of Emergency Operations</u>. It is essential that the Dam Tender keep a flood report under emergency regulation. The flood report shall be complete enough to reconstruct the events and regulation activities at the project during the flood period. An explanation of the attempts to re-establish communications with the WCWQS personnel should be documented. All conversations, especially with personnel outside the Corps, relative to flooding, flood damages, requests for regulation or releases, etc., should be documented. All observations of flooding and flood damages should also be documented. For all reservoir release changes made without the guidance of the WCWQS personnel, the release schedule outlined in Condition C-6 shall be followed. Also, the current flood event peak inflow and reason for the reservoir

release change shall be determined and listed in the report prior to the physical reservoir release change. An example emergency report under this condition can be found in Attachment 1 of this document.

C-8. <u>Dam Tender Email Notification – Routine and Flood Regulation</u>. Reference Condition B-7 for details on email notification during routine and flood regulation. No change to the email notification is required during a communication interruption with the WCWQS personnel.

THIS PAGE INTENTIONALLY LEFT BLANK

ATTACHMENT 1

Routine Dam Tender's Reservoir Regulation Report Example - Condition A

Corps of Engineers – Omaha District
Cherry Creek Dam and Lake
Dam Tender's Reservoir Regulation Report
Authorized Pool Elevatio: 5550
Authorized Storage 27046
Format Revised April 2007

Week Ending Day/Month/Year
SOURCE - (1) Colorado State Engineer (2) Corps District Engineer
MEANS - (1) Telephone (2) Person to Person
PERSONNEL - Note Issuant and Person
VERIFICATION OF VERBAL ORDERS ISSUED AND REGULATION BY COLORADO STATE ENGINEER
My Signature formally confirms the below logged verbal orders for this weekly period.

DATE														
Determined By - Flow Rate		0		0		0		0		0		0		0
Time of Flow	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00	00:00 -	24:00
Hours/24 x Flow Rate	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0	24 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0		0
Time of Flow	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00	0:00 -	00:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0		0
Time of Flow	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0		0	
Determined By - Flow Rate		0		0		0		0		0		0		0
Time of Flow	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	00:00	00:00 -	24:00
Hours/24 x Flow Rate	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	0 / 24 x	0	24 / 24 x	0
Flow Volume DSF	0		0		0		0		0		0		0	
24 Hour Release Volume	0		0		0		0		0		0		0	

DATE	TIME	SOURCE	MEANS	PERSONNEL	ORDER - INCLUDE GATE SETTING

Flood Report - Condition B

Normal Regulation - NO Communication Interruption

Date	Time	Observations AND/OR Conversations with Local Agencies or Public		
		Flooding Location	Flooding Damage	Other Comments

Flood Report - Condition C

Emergency Regulation - Communication Interruption

Date	Time	Explain Attempts to Re-Establish Communication

Date	Time	Observations AND/OR Conversations with Local Agencies or Public	
		Flooding Location	Flooding Damage

(Continued on next page)

Flood Report - Condition C

Emergency Regulation - Communication Interruption

Date	Time	Current Pool Elevation	Is the flood above or below the dam? Explain in some detail	Release Schedule to be Followed (C-6)

Date	Time	Current Flood Event Peak Inflow*	Reason for Release Change	Reservoir Release Change

* Release shall not exceed current flood event peak inflow. The Cherry Creek Reservoir inflow may be estimated by determining the flow at the Cherry Creek at Parker streamgage.

ATTACHMENT 2

Regulation Assistance Procedures

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

DIRECTORY OF REGULATION PERSONNEL
CHATFIELD, CHERRY CREEK, AND BEAR CREEK RESERVOIRS

Personnel (Call in order listed)	Office Phone	Cell Phone
CORPS OF ENGINEERS - OMAHA DISTRICT		
Water Control and Water Quality Section (WCWQS)		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
Tri-Lakes Project Office		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
STATE OF COLORADO		
Division of Water Resources		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]

DIRECTORY OF PERSONNEL
DENVER METROPOLITAN - STATE AND LOCAL AGENCIES

Personnel	Office Phone	Cell Phone
U.S. Geological Survey – Denver		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
National Weather Service		
[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]
State of Colorado – Division of Homeland Security		
[redacted]	[redacted]	[redacted]
Colorado State Patrol		
[redacted]	[redacted]	[redacted]
Colorado Division of Wildlife		
[redacted]	[redacted]	[redacted]
City and County of Denver – Emergency Management		
[redacted]	[redacted]	[redacted]
City of Littleton – Emergency Management		
[redacted]	[redacted]	[redacted]
City of Sheridan – Public Works		
[redacted]	[redacted]	[redacted]
Commerce City Police Department – Emergency Management		
[redacted]	[redacted]	[redacted]
City of Aurora – Emergency Management		
[redacted]	[redacted]	[redacted]
City of Glendale – Public Works		
[redacted]	[redacted]	[redacted]

DIRECTORY OF PERSONNEL
DENVER METROPOLITAN - STATE AND LOCAL AGENCIES

Personnel	Office Phone	Cell Phone
Arapahoe County – Emergency Management		
[redacted]	[redacted]	[redacted]
Jefferson County – Emergency Management		
[redacted]	[redacted]	[redacted]
Adams County – Emergency Management		
[redacted]	[redacted]	[redacted]
Urban Drainage and Flood Control District		
[redacted]	[redacted]	[redacted]
Chatfield State Park		
[redacted]	[redacted]	[redacted]
Cherry Creek State Park		
[redacted]	[redacted]	[redacted]
Bear Creek Lake Park		
[redacted]	[redacted]	[redacted]
Last Chance and Nevada Ditch		
[redacted]	[redacted]	[redacted]
City Ditch		
[redacted]	[redacted]	[redacted]
Denver Water		
[redacted]	[redacted]	[redacted]

For Colorado EM updates: https://www.colorado.gov/pacific/dhsem/local-emergency-managers

THIS PAGE INTENTIONALLY LEFT BLANK

EXHIBIT II

CHERRY CREEK DAM AND RESERVOIR

AREA AND STORAGE CAPACITY TABLES

THIS PAGE INTENTIONALLY LEFT BLANK

CHERRY CREEK RESERVOIR EFFECTIVE 09-DEC-2010

AREA IN ACRES
(2006-07 SURVEY)

ELEV	0	1	2	3	4	5	6	7	8	9
5520	0	0	0	0	0	61	120	152	184	216
5530	263	321	369	413	452	486	515	540	559	574
5540	587	605	627	649	673	698	725	752	780	810
5550	840	867	894	920	948	977	1006	1036	1066	1098
5560	1128	1155	1182	1211	1241	1273	1307	1342	1379	1418
5570	1455	1488	1519	1553	1589	1627	1667	1710	1754	1801
5580	1847	1890	1932	1974	2017	2060	2104	2149	2193	2239
5590	2285	2330	2375	2420	2464	2508	2552	2595	2638	2681
5600	2723	2765	2808	2851	2894	2938	2982	3026	3071	3116
5610	3159	3201	3242	3285	3330	3376	3424	3473	3524	3577
5620	3628	3674	3720	3767	3817	3870	3924	3981	4041	4102
5630	4164	4223	4281	4338	4395	4453	4510	4568	4625	4682
5640	4740	*4910*	*4978*	*5046*	*5112*	*5181*				

Note: The 2006-07 survey did not include the top 5 feet of the surcharge zone. To obtain the entire zone's surface area it was extended with LiDAR data.

CHERRY CREEK RESERVOIR EFFECTIVE 09-DEC-2010

CAPACITY IN ACRE-FEET
(2006-07 SURVEY)

ELEV	0	1	2	3	4	5	6	7	8	9
5520	0	0	0	0	0	17	122	258	426	626
5530	858	1153	1500	1892	2326	2796	3298	3827	4378	4946
5540	5526	6121	6737	7375	8036	8721	9433	10171	10937	11732
5550	12558	13412	14293	15200	16134	17097	18089	19110	20161	21243
5560	22357	23499	24668	25864	27090	28347	29637	30961	32321	33719
5570	35157	36630	38133	39669	41240	42848	44495	46183	47915	49692
5580	51517	53387	55298	57252	59247	61286	63368	65495	67666	69882
5590	72144	74452	76804	79202	81645	84131	86661	89235	91852	94512
5600	97214	99958	102745	105575	108447	111364	114324	117328	120376	123470
5610	126608	129789	133010	136274	139581	142934	146334	149782	153281	156831
5620	160435	164087	167784	171527	175319	179162	183059	187011	191022	195093
5630	199227	203422	207674	211984	216350	220775	225256	229796	234392	239046
5640	243757	*253837*	*258760*	*263788*	*268842*	*274001*				

Note: The 2006-07 survey did not include the top 5 feet of the surcharge zone. To obtain the entire zone's capacity it was extended with LiDAR data.

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006-07 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5525.0	17	18	19	20	21	22	23	24	25	26
.1	27	29	30	31	32	33	34	35	36	37
.2	38	39	40	41	42	43	44	45	46	47
.3	48	50	51	52	53	54	55	56	57	58
.4	59	60	61	62	63	64	65	66	67	68
.5	69	71	72	73	74	75	76	77	78	79
.6	80	81	82	83	84	85	86	87	88	89
.7	90	92	93	94	95	96	97	98	99	100
.8	101	102	103	104	105	106	107	108	109	110
.9	111	113	114	115	116	117	118	119	120	121
5526.0	122	123	125	126	127	129	130	132	133	134
.1	136	137	138	140	141	142	144	145	146	148
.2	149	151	152	153	155	156	157	159	160	161
.3	163	164	166	167	168	170	171	172	174	175
.4	176	178	179	180	182	183	185	186	187	189
.5	190	191	193	194	195	197	198	200	201	202
.6	204	205	206	208	209	210	212	213	214	216
.7	217	219	220	221	223	224	225	227	228	229
.8	231	232	234	235	236	238	239	240	242	243
.9	244	246	247	248	250	251	253	254	255	257
5527.0	258	260	261	263	265	266	268	270	271	273
.1	275	276	278	280	282	283	285	287	288	290
.2	292	293	295	297	298	300	302	303	305	307
.3	308	310	312	313	315	317	318	320	322	324
.4	325	327	329	330	332	334	335	337	339	340
.5	342	344	345	347	349	350	352	354	355	357
.6	359	360	362	364	366	367	369	371	372	374
.7	376	377	379	381	382	384	386	387	389	391
.8	392	394	396	397	399	401	402	404	406	408
.9	409	411	413	414	416	418	419	421	423	424
5528.0	426	428	430	432	434	436	438	440	442	444
.1	446	448	450	452	454	456	458	460	462	464
.2	466	468	470	472	474	476	478	480	482	484
.3	486	488	490	492	494	496	498	500	502	504
.4	506	508	510	512	514	516	518	520	522	524
.5	526	528	530	532	534	536	538	540	542	544
.6	546	548	550	552	554	556	558	560	562	564
.7	566	568	570	572	574	576	578	580	582	584
.8	586	588	590	592	594	596	598	600	602	604
.9	606	608	610	612	614	616	618	620	622	624
5529.0	626	628	631	633	635	638	640	642	645	647
.1	649	652	654	656	658	661	663	665	668	670
.2	672	675	677	679	682	684	686	689	691	693
.3	696	698	700	703	705	707	710	712	714	716
.4	719	721	723	726	728	730	733	735	737	740
.5	742	744	747	749	751	754	756	758	761	763
.6	765	768	770	772	774	777	779	781	784	786
.7	788	791	793	795	798	800	802	805	807	809
.8	812	814	816	819	821	823	826	828	830	832
.9	835	837	839	842	844	846	849	851	853	856

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5530.0	858	861	864	867	870	873	876	879	882	885
.1	887	890	893	896	899	902	905	908	911	914
.2	917	920	923	926	929	932	935	938	941	944
.3	946	949	952	955	958	961	964	967	970	973
.4	976	979	982	985	988	991	994	997	1000	1003
.5	1005	1008	1011	1014	1017	1020	1023	1026	1029	1032
.6	1035	1038	1041	1044	1047	1050	1053	1056	1059	1062
.7	1064	1067	1070	1073	1076	1079	1082	1085	1088	1091
.8	1094	1097	1100	1103	1106	1109	1112	1115	1118	1121
.9	1123	1126	1129	1132	1135	1138	1141	1144	1147	1150
5531.0	1153	1156	1160	1163	1167	1170	1174	1177	1181	1184
.1	1188	1191	1195	1198	1202	1205	1209	1212	1215	1219
.2	1222	1226	1229	1233	1236	1240	1243	1247	1250	1254
.3	1257	1261	1264	1268	1271	1274	1278	1281	1285	1288
.4	1292	1295	1299	1302	1306	1309	1313	1316	1320	1323
.5	1326	1330	1333	1337	1340	1344	1347	1351	1354	1358
.6	1361	1365	1368	1372	1375	1379	1382	1385	1389	1392
.7	1396	1399	1403	1406	1410	1413	1417	1420	1424	1427
.8	1431	1434	1438	1441	1444	1448	1451	1455	1458	1462
.9	1465	1469	1472	1476	1479	1483	1486	1490	1493	1497
5532.0	1500	1504	1508	1512	1516	1520	1524	1527	1531	1535
.1	1539	1543	1547	1551	1555	1559	1563	1567	1571	1574
.2	1578	1582	1586	1590	1594	1598	1602	1606	1610	1614
.3	1618	1622	1625	1629	1633	1637	1641	1645	1649	1653
.4	1657	1661	1665	1669	1672	1676	1680	1684	1688	1692
.5	1696	1700	1704	1708	1712	1716	1720	1723	1727	1731
.6	1735	1739	1743	1747	1751	1755	1759	1763	1767	1770
.7	1774	1778	1782	1786	1790	1794	1798	1802	1806	1810
.8	1814	1818	1821	1825	1829	1833	1837	1841	1845	1849
.9	1853	1857	1861	1865	1868	1872	1876	1880	1884	1888
5533.0	1892	1896	1901	1905	1909	1914	1918	1922	1927	1931
.1	1935	1940	1944	1948	1953	1957	1961	1966	1970	1974
.2	1979	1983	1987	1992	1996	2001	2005	2009	2014	2018
.3	2022	2027	2031	2035	2040	2044	2048	2053	2057	2061
.4	2066	2070	2074	2079	2083	2087	2092	2096	2100	2105
.5	2109	2113	2118	2122	2126	2131	2135	2139	2144	2148
.6	2152	2157	2161	2165	2170	2174	2178	2183	2187	2191
.7	2196	2200	2204	2209	2213	2217	2222	2226	2231	2235
.8	2239	2244	2248	2252	2257	2261	2265	2270	2274	2278
.9	2283	2287	2291	2296	2300	2304	2309	2313	2317	2322
5534.0	2326	2331	2335	2340	2345	2349	2354	2359	2364	2368
.1	2373	2378	2382	2387	2392	2396	2401	2406	2411	2415
.2	2420	2425	2429	2434	2439	2444	2448	2453	2458	2462
.3	2467	2472	2476	2481	2486	2490	2495	2500	2505	2509
.4	2514	2519	2523	2528	2533	2537	2542	2547	2552	2556
.5	2561	2566	2570	2575	2580	2584	2589	2594	2599	2603
.6	2608	2613	2617	2622	2627	2631	2636	2641	2646	2650
.7	2655	2660	2664	2669	2674	2678	2683	2688	2693	2697
.8	2702	2707	2711	2716	2721	2725	2730	2735	2740	2744
.9	2749	2754	2758	2763	2768	2772	2777	2782	2787	2791

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5535.0	2796	2801	2806	2811	2816	2821	2826	2831	2836	2841
.1	2846	2851	2856	2861	2866	2871	2876	2881	2886	2891
.2	2896	2901	2906	2911	2916	2922	2927	2932	2937	2942
.3	2947	2952	2957	2962	2967	2972	2977	2982	2987	2992
.4	2997	3002	3007	3012	3017	3022	3027	3032	3037	3042
.5	3047	3052	3057	3062	3067	3072	3077	3082	3087	3092
.6	3097	3102	3107	3112	3117	3122	3127	3132	3137	3142
.7	3147	3152	3157	3162	3167	3172	3178	3183	3188	3193
.8	3198	3203	3208	3213	3218	3223	3228	3233	3238	3243
.9	3248	3253	3258	3263	3268	3273	3278	3283	3288	3293
5536.0	3298	3303	3309	3314	3319	3324	3330	3335	3340	3346
.1	3351	3356	3361	3367	3372	3377	3383	3388	3393	3399
.2	3404	3409	3414	3420	3425	3430	3436	3441	3446	3451
.3	3457	3462	3467	3473	3478	3483	3488	3494	3499	3504
.4	3510	3515	3520	3525	3531	3536	3541	3547	3552	3557
.5	3562	3568	3573	3578	3584	3589	3594	3600	3605	3610
.6	3615	3621	3626	3631	3637	3642	3647	3652	3658	3663
.7	3668	3674	3679	3684	3689	3695	3700	3705	3711	3716
.8	3721	3726	3732	3737	3742	3748	3753	3758	3764	3769
.9	3774	3779	3785	3790	3795	3801	3806	3811	3816	3822
5537.0	3827	3833	3838	3844	3849	3855	3860	3866	3871	3877
.1	3882	3888	3893	3899	3904	3910	3915	3921	3926	3932
.2	3937	3943	3948	3954	3959	3965	3970	3976	3981	3987
.3	3992	3998	4003	4009	4014	4020	4025	4031	4036	4042
.4	4047	4053	4058	4064	4069	4075	4080	4086	4091	4097
.5	4102	4108	4114	4119	4125	4130	4136	4141	4147	4152
.6	4158	4163	4169	4174	4180	4185	4191	4196	4202	4207
.7	4213	4218	4224	4229	4235	4240	4246	4251	4257	4262
.8	4268	4273	4279	4284	4290	4295	4301	4306	4312	4317
.9	4323	4328	4334	4339	4345	4350	4356	4361	4367	4372
5538.0	4378	4384	4389	4395	4401	4406	4412	4418	4423	4429
.1	4435	4440	4446	4452	4458	4463	4469	4475	4480	4486
.2	4492	4497	4503	4509	4514	4520	4526	4531	4537	4543
.3	4548	4554	4560	4565	4571	4577	4582	4588	4594	4600
.4	4605	4611	4617	4622	4628	4634	4639	4645	4651	4656
.5	4662	4668	4673	4679	4685	4690	4696	4702	4707	4713
.6	4719	4724	4730	4736	4742	4747	4753	4759	4764	4770
.7	4776	4781	4787	4793	4798	4804	4810	4815	4821	4827
.8	4832	4838	4844	4849	4855	4861	4866	4872	4878	4884
.9	4889	4895	4901	4906	4912	4918	4923	4929	4935	4940
5539.0	4946	4952	4958	4963	4969	4975	4981	4987	4992	4998
.1	5004	5010	5016	5021	5027	5033	5039	5045	5050	5056
.2	5062	5068	5074	5079	5085	5091	5097	5103	5108	5114
.3	5120	5126	5132	5137	5143	5149	5155	5161	5166	5172
.4	5178	5184	5190	5195	5201	5207	5213	5219	5224	5230
.5	5236	5242	5248	5253	5259	5265	5271	5277	5282	5288
.6	5294	5300	5306	5311	5317	5323	5329	5335	5340	5346
.7	5352	5358	5364	5369	5375	5381	5387	5393	5398	5404
.8	5410	5416	5422	5427	5433	5439	5445	5451	5456	5462
.9	5468	5474	5480	5485	5491	5497	5503	5509	5514	5520

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5540.0	5526	5532	5538	5544	5550	5556	5562	5568	5574	5580
.1	5585	5591	5597	5603	5609	5615	5621	5627	5633	5639
.2	5645	5651	5657	5663	5669	5675	5681	5687	5693	5699
.3	5704	5710	5716	5722	5728	5734	5740	5746	5752	5758
.4	5764	5770	5776	5782	5788	5794	5800	5806	5812	5818
.5	5823	5829	5835	5841	5847	5853	5859	5865	5871	5877
.6	5883	5889	5895	5901	5907	5913	5919	5925	5931	5937
.7	5942	5948	5954	5960	5966	5972	5978	5984	5990	5996
.8	6002	6008	6014	6020	6026	6032	6038	6044	6050	6056
.9	6061	6067	6073	6079	6085	6091	6097	6103	6109	6115
5541.0	6121	6127	6133	6139	6146	6152	6158	6164	6170	6176
.1	6183	6189	6195	6201	6207	6213	6220	6226	6232	6238
.2	6244	6250	6257	6263	6269	6275	6281	6287	6293	6300
.3	6306	6312	6318	6324	6330	6337	6343	6349	6355	6361
.4	6367	6374	6380	6386	6392	6398	6404	6411	6417	6423
.5	6429	6435	6441	6447	6454	6460	6466	6472	6478	6484
.6	6491	6497	6503	6509	6515	6521	6528	6534	6540	6546
.7	6552	6558	6565	6571	6577	6583	6589	6595	6601	6608
.8	6614	6620	6626	6632	6638	6645	6651	6657	6663	6669
.9	6675	6682	6688	6694	6700	6706	6712	6719	6725	6731
5542.0	6737	6743	6750	6756	6763	6769	6775	6782	6788	6794
.1	6801	6807	6814	6820	6826	6833	6839	6845	6852	6858
.2	6865	6871	6877	6884	6890	6897	6903	6909	6916	6922
.3	6928	6935	6941	6948	6954	6960	6967	6973	6979	6986
.4	6992	6999	7005	7011	7018	7024	7030	7037	7043	7050
.5	7056	7062	7069	7075	7082	7088	7094	7101	7107	7113
.6	7120	7126	7133	7139	7145	7152	7158	7164	7171	7177
.7	7184	7190	7196	7203	7209	7215	7222	7228	7235	7241
.8	7247	7254	7260	7267	7273	7279	7286	7292	7298	7305
.9	7311	7318	7324	7330	7337	7343	7349	7356	7362	7369
5543.0	7375	7382	7388	7395	7401	7408	7415	7421	7428	7434
.1	7441	7448	7454	7461	7468	7474	7481	7487	7494	7501
.2	7507	7514	7520	7527	7534	7540	7547	7553	7560	7567
.3	7573	7580	7587	7593	7600	7606	7613	7620	7626	7633
.4	7639	7646	7653	7659	7666	7672	7679	7686	7692	7699
.5	7705	7712	7719	7725	7732	7739	7745	7752	7758	7765
.6	7772	7778	7785	7791	7798	7805	7811	7818	7824	7831
.7	7838	7844	7851	7858	7864	7871	7877	7884	7891	7897
.8	7904	7910	7917	7924	7930	7937	7943	7950	7957	7963
.9	7970	7977	7983	7990	7996	8003	8010	8016	8023	8029
5544.0	8036	8043	8050	8057	8063	8070	8077	8084	8091	8098
.1	8104	8111	8118	8125	8132	8139	8146	8152	8159	8166
.2	8173	8180	8187	8194	8200	8207	8214	8221	8228	8235
.3	8241	8248	8255	8262	8269	8276	8283	8289	8296	8303
.4	8310	8317	8324	8331	8337	8344	8351	8358	8365	8372
.5	8378	8385	8392	8399	8406	8413	8420	8426	8433	8440
.6	8447	8454	8461	8468	8474	8481	8488	8495	8502	8509
.7	8515	8522	8529	8536	8543	8550	8557	8563	8570	8577
.8	8584	8591	8598	8605	8611	8618	8625	8632	8639	8646
.9	8652	8659	8666	8673	8680	8687	8694	8700	8707	8714

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5545.0	8721	8728	8735	8742	8749	8757	8764	8771	8778	8785
.1	8792	8799	8806	8814	8821	8828	8835	8842	8849	8856
.2	8863	8871	8878	8885	8892	8899	8906	8913	8920	8927
.3	8935	8942	8949	8956	8963	8970	8977	8984	8992	8999
.4	9006	9013	9020	9027	9034	9041	9049	9056	9063	9070
.5	9077	9084	9091	9098	9105	9113	9120	9127	9134	9141
.6	9148	9155	9162	9170	9177	9184	9191	9198	9205	9212
.7	9219	9227	9234	9241	9248	9255	9262	9269	9276	9283
.8	9291	9298	9305	9312	9319	9326	9333	9340	9348	9355
.9	9362	9369	9376	9383	9390	9397	9405	9412	9419	9426
5546.0	9433	9440	9448	9455	9463	9470	9477	9485	9492	9499
.1	9507	9514	9522	9529	9536	9544	9551	9558	9566	9573
.2	9581	9588	9595	9603	9610	9618	9625	9632	9640	9647
.3	9654	9662	9669	9677	9684	9691	9699	9706	9713	9721
.4	9728	9736	9743	9750	9758	9765	9772	9780	9787	9795
.5	9802	9809	9817	9824	9832	9839	9846	9854	9861	9868
.6	9876	9883	9891	9898	9905	9913	9920	9927	9935	9942
.7	9950	9957	9964	9972	9979	9986	9994	10001	10009	10016
.8	10023	10031	10038	10046	10053	10060	10068	10075	10082	10090
.9	10097	10105	10112	10119	10127	10134	10141	10149	10156	10164
5547.0	10171	10179	10186	10194	10202	10209	10217	10225	10232	10240
.1	10248	10255	10263	10271	10278	10286	10294	10301	10309	10317
.2	10324	10332	10340	10347	10355	10363	10370	10378	10385	10393
.3	10401	10408	10416	10424	10431	10439	10447	10454	10462	10470
.4	10477	10485	10493	10500	10508	10516	10523	10531	10539	10546
.5	10554	10562	10569	10577	10585	10592	10600	10608	10615	10623
.6	10631	10638	10646	10654	10661	10669	10677	10684	10692	10700
.7	10707	10715	10723	10730	10738	10745	10753	10761	10768	10776
.8	10784	10791	10799	10807	10814	10822	10830	10837	10845	10853
.9	10860	10868	10876	10883	10891	10899	10906	10914	10922	10929
5548.0	10937	10945	10953	10961	10969	10977	10985	10993	11001	11009
.1	11016	11024	11032	11040	11048	11056	11064	11072	11080	11088
.2	11096	11104	11112	11120	11128	11136	11144	11152	11160	11168
.3	11175	11183	11191	11199	11207	11215	11223	11231	11239	11247
.4	11255	11263	11271	11279	11287	11295	11303	11311	11319	11327
.5	11334	11342	11350	11358	11366	11374	11382	11390	11398	11406
.6	11414	11422	11430	11438	11446	11454	11462	11470	11478	11486
.7	11493	11501	11509	11517	11525	11533	11541	11549	11557	11565
.8	11573	11581	11589	11597	11605	11613	11621	11629	11637	11645
.9	11652	11660	11668	11676	11684	11692	11700	11708	11716	11724
5549.0	11732	11740	11749	11757	11765	11773	11782	11790	11798	11806
.1	11815	11823	11831	11839	11848	11856	11864	11872	11881	11889
.2	11897	11905	11914	11922	11930	11939	11947	11955	11963	11972
.3	11980	11988	11996	12005	12013	12021	12029	12038	12046	12054
.4	12062	12071	12079	12087	12095	12104	12112	12120	12128	12137
.5	12145	12153	12162	12170	12178	12186	12195	12203	12211	12219
.6	12228	12236	12244	12252	12261	12269	12277	12285	12294	12302
.7	12310	12318	12327	12335	12343	12351	12360	12368	12376	12385
.8	12393	12401	12409	12418	12426	12434	12442	12451	12459	12467
.9	12475	12484	12492	12500	12508	12517	12525	12533	12541	12550

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5550.0	12558	12567	12575	12584	12592	12601	12609	12618	12626	12635
.1	12643	12652	12660	12669	12678	12686	12695	12703	12712	12720
.2	12729	12737	12746	12754	12763	12772	12780	12789	12797	12806
.3	12814	12823	12831	12840	12848	12857	12865	12874	12883	12891
.4	12900	12908	12917	12925	12934	12942	12951	12959	12968	12976
.5	12985	12994	13002	13011	13019	13028	13036	13045	13053	13062
.6	13070	13079	13087	13096	13105	13113	13122	13130	13139	13147
.7	13156	13164	13173	13181	13190	13198	13207	13216	13224	13233
.8	13241	13250	13258	13267	13275	13284	13292	13301	13310	13318
.9	13327	13335	13344	13352	13361	13369	13378	13386	13395	13403
5551.0	13412	13421	13430	13438	13447	13456	13465	13474	13482	13491
.1	13500	13509	13518	13527	13535	13544	13553	13562	13571	13579
.2	13588	13597	13606	13615	13623	13632	13641	13650	13659	13667
.3	13676	13685	13694	13703	13712	13720	13729	13738	13747	13756
.4	13764	13773	13782	13791	13800	13808	13817	13826	13835	13844
.5	13852	13861	13870	13879	13888	13897	13905	13914	13923	13932
.6	13941	13949	13958	13967	13976	13985	13993	14002	14011	14020
.7	14029	14038	14046	14055	14064	14073	14082	14090	14099	14108
.8	14117	14126	14134	14143	14152	14161	14170	14178	14187	14196
.9	14205	14214	14223	14231	14240	14249	14258	14267	14275	14284
5552.0	14293	14302	14311	14320	14329	14338	14347	14356	14366	14375
.1	14384	14393	14402	14411	14420	14429	14438	14447	14456	14465
.2	14474	14483	14493	14502	14511	14520	14529	14538	14547	14556
.3	14565	14574	14583	14592	14601	14610	14620	14629	14638	14647
.4	14656	14665	14674	14683	14692	14701	14710	14719	14728	14737
.5	14746	14756	14765	14774	14783	14792	14801	14810	14819	14828
.6	14837	14846	14855	14864	14873	14883	14892	14901	14910	14919
.7	14928	14937	14946	14955	14964	14973	14982	14991	15000	15010
.8	15019	15028	15037	15046	15055	15064	15073	15082	15091	15100
.9	15109	15118	15127	15137	15146	15155	15164	15173	15182	15191
5553.0	15200	15209	15219	15228	15237	15247	15256	15265	15275	15284
.1	15293	15303	15312	15321	15331	15340	15349	15359	15368	15377
.2	15387	15396	15405	15415	15424	15434	15443	15452	15462	15471
.3	15480	15490	15499	15508	15518	15527	15536	15546	15555	15564
.4	15574	15583	15592	15602	15611	15620	15630	15639	15648	15658
.5	15667	15676	15686	15695	15704	15714	15723	15732	15742	15751
.6	15760	15770	15779	15788	15798	15807	15816	15826	15835	15844
.7	15854	15863	15872	15882	15891	15900	15910	15919	15929	15938
.8	15947	15957	15966	15975	15985	15994	16003	16013	16022	16031
.9	16041	16050	16059	16069	16078	16087	16097	16106	16115	16125
5554.0	16134	16144	16153	16163	16173	16182	16192	16201	16211	16221
.1	16230	16240	16250	16259	16269	16278	16288	16298	16307	16317
.2	16327	16336	16346	16355	16365	16375	16384	16394	16404	16413
.3	16423	16433	16442	16452	16461	16471	16481	16490	16500	16510
.4	16519	16529	16538	16548	16558	16567	16577	16587	16596	16606
.5	16615	16625	16635	16644	16654	16664	16673	16683	16693	16702
.6	16712	16721	16731	16741	16750	16760	16770	16779	16789	16798
.7	16808	16818	16827	16837	16847	16856	16866	16876	16885	16895
.8	16904	16914	16924	16933	16943	16953	16962	16972	16981	16991
.9	17001	17010	17020	17030	17039	17049	17058	17068	17078	17087

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5555.0	17097	17107	17117	17127	17137	17147	17157	17166	17176	17186
.1	17196	17206	17216	17226	17236	17246	17256	17266	17276	17285
.2	17295	17305	17315	17325	17335	17345	17355	17365	17375	17385
.3	17395	17405	17414	17424	17434	17444	17454	17464	17474	17484
.4	17494	17504	17514	17524	17533	17543	17553	17563	17573	17583
.5	17593	17603	17613	17623	17633	17643	17653	17662	17672	17682
.6	17692	17702	17712	17722	17732	17742	17752	17762	17772	17781
.7	17791	17801	17811	17821	17831	17841	17851	17861	17871	17881
.8	17891	17901	17910	17920	17930	17940	17950	17960	17970	17980
.9	17990	18000	18010	18020	18029	18039	18049	18059	18069	18079
5556.0	18089	18099	18109	18120	18130	18140	18150	18160	18171	18181
.1	18191	18201	18212	18222	18232	18242	18252	18263	18273	18283
.2	18293	18303	18314	18324	18334	18344	18354	18365	18375	18385
.3	18395	18406	18416	18426	18436	18446	18457	18467	18477	18487
.4	18497	18508	18518	18528	18538	18548	18559	18569	18579	18589
.5	18599	18610	18620	18630	18640	18651	18661	18671	18681	18691
.6	18702	18712	18722	18732	18742	18753	18763	18773	18783	18793
.7	18804	18814	18824	18834	18845	18855	18865	18875	18885	18896
.8	18906	18916	18926	18936	18947	18957	18967	18977	18987	18998
.9	19008	19018	19028	19039	19049	19059	19069	19079	19090	19100
5557.0	19110	19121	19131	19142	19152	19163	19173	19184	19194	19205
.1	19215	19226	19236	19247	19257	19268	19278	19289	19299	19310
.2	19320	19331	19341	19352	19362	19373	19383	19394	19404	19415
.3	19425	19436	19446	19457	19467	19478	19488	19499	19509	19520
.4	19530	19541	19551	19562	19572	19583	19593	19604	19614	19625
.5	19635	19646	19657	19667	19678	19688	19699	19709	19720	19730
.6	19741	19751	19762	19772	19783	19793	19804	19814	19825	19835
.7	19846	19856	19867	19877	19888	19898	19909	19919	19930	19940
.8	19951	19961	19972	19982	19993	20003	20014	20024	20035	20045
.9	20056	20066	20077	20087	20098	20108	20119	20129	20140	20150
5558.0	20161	20172	20183	20193	20204	20215	20226	20237	20248	20258
.1	20269	20280	20291	20302	20312	20323	20334	20345	20356	20367
.2	20377	20388	20399	20410	20421	20432	20442	20453	20464	20475
.3	20486	20496	20507	20518	20529	20540	20551	20561	20572	20583
.4	20594	20605	20615	20626	20637	20648	20659	20670	20680	20691
.5	20702	20713	20724	20734	20745	20756	20767	20778	20789	20799
.6	20810	20821	20832	20843	20853	20864	20875	20886	20897	20908
.7	20918	20929	20940	20951	20962	20972	20983	20994	21005	21016
.8	21027	21037	21048	21059	21070	21081	21092	21102	21113	21124
.9	21135	21146	21156	21167	21178	21189	21200	21211	21221	21232
5559.0	21243	21254	21265	21276	21288	21299	21310	21321	21332	21343
.1	21354	21366	21377	21388	21399	21410	21421	21432	21444	21455
.2	21466	21477	21488	21499	21510	21522	21533	21544	21555	21566
.3	21577	21588	21599	21611	21622	21633	21644	21655	21666	21677
.4	21689	21700	21711	21722	21733	21744	21755	21767	21778	21789
.5	21800	21811	21822	21833	21845	21856	21867	21878	21889	21900
.6	21911	21923	21934	21945	21956	21967	21978	21989	22001	22012
.7	22023	22034	22045	22056	22067	22078	22090	22101	22112	22123
.8	22134	22145	22156	22168	22179	22190	22201	22212	22223	22234
.9	22246	22257	22268	22279	22290	22301	22312	22324	22335	22346

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5560.0	22357	22368	22380	22391	22403	22414	22426	22437	22448	22460
.1	22471	22483	22494	22505	22517	22528	22540	22551	22563	22574
.2	22585	22597	22608	22620	22631	22643	22654	22665	22677	22688
.3	22700	22711	22722	22734	22745	22757	22768	22780	22791	22802
.4	22814	22825	22837	22848	22859	22871	22882	22894	22905	22917
.5	22928	22939	22951	22962	22974	22985	22997	23008	23019	23031
.6	23042	23054	23065	23076	23088	23099	23111	23122	23134	23145
.7	23156	23168	23179	23191	23202	23213	23225	23236	23248	23259
.8	23271	23282	23293	23305	23316	23328	23339	23351	23362	23373
.9	23385	23396	23408	23419	23430	23442	23453	23465	23476	23488
5561.0	23499	23511	23522	23534	23546	23557	23569	23581	23593	23604
.1	23616	23628	23639	23651	23663	23674	23686	23698	23709	23721
.2	23733	23744	23756	23768	23780	23791	23803	23815	23826	23838
.3	23850	23861	23873	23885	23896	23908	23920	23932	23943	23955
.4	23967	23978	23990	24002	24013	24025	24037	24048	24060	24072
.5	24083	24095	24107	24119	24130	24142	24154	24165	24177	24189
.6	24200	24212	24224	24235	24247	24259	24271	24282	24294	24306
.7	24317	24329	24341	24352	24364	24376	24387	24399	24411	24423
.8	24434	24446	24458	24469	24481	24493	24504	24516	24528	24539
.9	24551	24563	24574	24586	24598	24610	24621	24633	24645	24656
5562.0	24668	24680	24692	24704	24716	24728	24740	24752	24764	24776
.1	24788	24800	24812	24823	24835	24847	24859	24871	24883	24895
.2	24907	24919	24931	24943	24955	24967	24979	24991	25003	25015
.3	25027	25039	25051	25063	25075	25087	25099	25111	25122	25134
.4	25146	25158	25170	25182	25194	25206	25218	25230	25242	25254
.5	25266	25278	25290	25302	25314	25326	25338	25350	25362	25374
.6	25386	25398	25410	25421	25433	25445	25457	25469	25481	25493
.7	25505	25517	25529	25541	25553	25565	25577	25589	25601	25613
.8	25625	25637	25649	25661	25673	25685	25697	25709	25720	25732
.9	25744	25756	25768	25780	25792	25804	25816	25828	25840	25852
5563.0	25864	25876	25889	25901	25913	25925	25938	25950	25962	25974
.1	25987	25999	26011	26023	26036	26048	26060	26072	26085	26097
.2	26109	26121	26134	26146	26158	26171	26183	26195	26207	26220
.3	26232	26244	26256	26269	26281	26293	26305	26318	26330	26342
.4	26354	26367	26379	26391	26403	26416	26428	26440	26452	26465
.5	26477	26489	26502	26514	26526	26538	26551	26563	26575	26587
.6	26600	26612	26624	26636	26649	26661	26673	26685	26698	26710
.7	26722	26734	26747	26759	26771	26783	26796	26808	26820	26833
.8	26845	26857	26869	26882	26894	26906	26918	26931	26943	26955
.9	26967	26980	26992	27004	27016	27029	27041	27053	27065	27078
5564.0	27090	27103	27115	27128	27140	27153	27165	27178	27191	27203
.1	27216	27228	27241	27253	27266	27279	27291	27304	27316	27329
.2	27341	27354	27367	27379	27392	27404	27417	27429	27442	27455
.3	27467	27480	27492	27505	27517	27530	27543	27555	27568	27580
.4	27593	27605	27618	27631	27643	27656	27668	27681	27693	27706
.5	27718	27731	27744	27756	27769	27781	27794	27806	27819	27832
.6	27844	27857	27869	27882	27894	27907	27920	27932	27945	27957
.7	27970	27982	27995	28008	28020	28033	28045	28058	28070	28083
.8	28096	28108	28121	28133	28146	28158	28171	28184	28196	28209
.9	28221	28234	28246	28259	28272	28284	28297	28309	28322	28334

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5565.0	28347	28360	28373	28386	28399	28411	28424	28437	28450	28463
.1	28476	28489	28502	28515	28528	28540	28553	28566	28579	28592
.2	28605	28618	28631	28644	28657	28670	28682	28695	28708	28721
.3	28734	28747	28760	28773	28786	28798	28811	28824	28837	28850
.4	28863	28876	28889	28902	28915	28927	28940	28953	28966	28979
.5	28992	29005	29018	29031	29044	29056	29069	29082	29095	29108
.6	29121	29134	29147	29160	29173	29185	29198	29211	29224	29237
.7	29250	29263	29276	29289	29302	29314	29327	29340	29353	29366
.8	29379	29392	29405	29418	29431	29443	29456	29469	29482	29495
.9	29508	29521	29534	29547	29560	29572	29585	29598	29611	29624
5566.0	29637	29650	29663	29677	29690	29703	29716	29730	29743	29756
.1	29769	29783	29796	29809	29822	29836	29849	29862	29875	29889
.2	29902	29915	29928	29942	29955	29968	29981	29994	30008	30021
.3	30034	30047	30061	30074	30087	30100	30114	30127	30140	30153
.4	30167	30180	30193	30206	30220	30233	30246	30259	30273	30286
.5	30299	30312	30325	30339	30352	30365	30378	30392	30405	30418
.6	30431	30445	30458	30471	30484	30498	30511	30524	30537	30551
.7	30564	30577	30590	30604	30617	30630	30643	30656	30670	30683
.8	30696	30709	30723	30736	30749	30762	30776	30789	30802	30815
.9	30829	30842	30855	30868	30882	30895	30908	30921	30935	30948
5567.0	30961	30975	30988	31002	31015	31029	31043	31056	31070	31083
.1	31097	31111	31124	31138	31151	31165	31179	31192	31206	31219
.2	31233	31247	31260	31274	31287	31301	31315	31328	31342	31355
.3	31369	31383	31396	31410	31423	31437	31451	31464	31478	31491
.4	31505	31519	31532	31546	31559	31573	31587	31600	31614	31627
.5	31641	31655	31668	31682	31695	31709	31723	31736	31750	31763
.6	31777	31791	31804	31818	31831	31845	31859	31872	31886	31899
.7	31913	31927	31940	31954	31967	31981	31995	32008	32022	32035
.8	32049	32063	32076	32090	32103	32117	32131	32144	32158	32171
.9	32185	32199	32212	32226	32239	32253	32267	32280	32294	32307
5568.0	32321	32335	32349	32363	32377	32391	32405	32419	32433	32447
.1	32461	32475	32489	32503	32517	32531	32545	32559	32573	32587
.2	32601	32615	32629	32643	32657	32671	32684	32698	32712	32726
.3	32740	32754	32768	32782	32796	32810	32824	32838	32852	32866
.4	32880	32894	32908	32922	32936	32950	32964	32978	32992	33006
.5	33020	33034	33048	33062	33076	33090	33104	33118	33132	33146
.6	33160	33174	33188	33202	33216	33230	33244	33258	33272	33286
.7	33300	33314	33328	33342	33356	33369	33383	33397	33411	33425
.8	33439	33453	33467	33481	33495	33509	33523	33537	33551	33565
.9	33579	33593	33607	33621	33635	33649	33663	33677	33691	33705
5569.0	33719	33733	33748	33762	33777	33791	33805	33820	33834	33848
.1	33863	33877	33892	33906	33920	33935	33949	33963	33978	33992
.2	34007	34021	34035	34050	34064	34079	34093	34107	34122	34136
.3	34150	34165	34179	34194	34208	34222	34237	34251	34265	34280
.4	34294	34309	34323	34337	34352	34366	34380	34395	34409	34424
.5	34438	34452	34467	34481	34496	34510	34524	34539	34553	34567
.6	34582	34596	34611	34625	34639	34654	34668	34682	34697	34711
.7	34726	34740	34754	34769	34783	34797	34812	34826	34841	34855
.8	34869	34884	34898	34913	34927	34941	34956	34970	34984	34999
.9	35013	35028	35042	35056	35071	35085	35099	35114	35128	35143

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5570.0	35157	35172	35186	35201	35216	35231	35245	35260	35275	35290
.1	35304	35319	35334	35348	35363	35378	35393	35407	35422	35437
.2	35452	35466	35481	35496	35511	35525	35540	35555	35569	35584
.3	35599	35614	35628	35643	35658	35673	35687	35702	35717	35731
.4	35746	35761	35776	35790	35805	35820	35835	35849	35864	35879
.5	35893	35908	35923	35938	35952	35967	35982	35997	36011	36026
.6	36041	36056	36070	36085	36100	36114	36129	36144	36159	36173
.7	36188	36203	36218	36232	36247	36262	36276	36291	36306	36321
.8	36335	36350	36365	36380	36394	36409	36424	36439	36453	36468
.9	36483	36497	36512	36527	36542	36556	36571	36586	36601	36615
5571.0	36630	36645	36660	36675	36690	36705	36720	36735	36750	36765
.1	36780	36795	36810	36825	36840	36855	36870	36886	36901	36916
.2	36931	36946	36961	36976	36991	37006	37021	37036	37051	37066
.3	37081	37096	37111	37126	37141	37156	37171	37186	37201	37216
.4	37231	37246	37261	37276	37291	37306	37321	37336	37351	37366
.5	37381	37397	37412	37427	37442	37457	37472	37487	37502	37517
.6	37532	37547	37562	37577	37592	37607	37622	37637	37652	37667
.7	37682	37697	37712	37727	37742	37757	37772	37787	37802	37817
.8	37832	37847	37862	37877	37893	37908	37923	37938	37953	37968
.9	37983	37998	38013	38028	38043	38058	38073	38088	38103	38118
5572.0	38133	38148	38164	38179	38194	38210	38225	38241	38256	38271
.1	38287	38302	38317	38333	38348	38363	38379	38394	38409	38425
.2	38440	38456	38471	38486	38502	38517	38532	38548	38563	38578
.3	38594	38609	38625	38640	38655	38671	38686	38701	38717	38732
.4	38747	38763	38778	38793	38809	38824	38840	38855	38870	38886
.5	38901	38916	38932	38947	38962	38978	38993	39009	39024	39039
.6	39055	39070	39085	39101	39116	39131	39147	39162	39177	39193
.7	39208	39224	39239	39254	39270	39285	39300	39316	39331	39346
.8	39362	39377	39393	39408	39423	39439	39454	39469	39485	39500
.9	39515	39531	39546	39561	39577	39592	39608	39623	39638	39654
5573.0	39669	39685	39700	39716	39732	39748	39763	39779	39795	39810
.1	39826	39842	39858	39873	39889	39905	39920	39936	39952	39967
.2	39983	39999	40015	40030	40046	40062	40077	40093	40109	40125
.3	40140	40156	40172	40187	40203	40219	40235	40250	40266	40282
.4	40297	40313	40329	40345	40360	40376	40392	40407	40423	40439
.5	40454	40470	40486	40502	40517	40533	40549	40564	40580	40596
.6	40612	40627	40643	40659	40674	40690	40706	40722	40737	40753
.7	40769	40784	40800	40816	40832	40847	40863	40879	40894	40910
.8	40926	40942	40957	40973	40989	41004	41020	41036	41051	41067
.9	41083	41099	41114	41130	41146	41161	41177	41193	41209	41224
5574.0	41240	41256	41272	41288	41304	41320	41336	41353	41369	41385
.1	41401	41417	41433	41449	41465	41481	41497	41513	41529	41546
.2	41562	41578	41594	41610	41626	41642	41658	41674	41690	41706
.3	41722	41738	41755	41771	41787	41803	41819	41835	41851	41867
.4	41883	41899	41915	41931	41948	41964	41980	41996	42012	42028
.5	42044	42060	42076	42092	42108	42124	42140	42157	42173	42189
.6	42205	42221	42237	42253	42269	42285	42301	42317	42333	42350
.7	42366	42382	42398	42414	42430	42446	42462	42478	42494	42510
.8	42526	42542	42559	42575	42591	42607	42623	42639	42655	42671
.9	42687	42703	42719	42735	42752	42768	42784	42800	42816	42832

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5575.0	42848	42864	42881	42897	42914	42930	42947	42963	42980	42996
.1	43013	43029	43046	43062	43079	43095	43112	43128	43144	43161
.2	43177	43194	43210	43227	43243	43260	43276	43293	43309	43326
.3	43342	43359	43375	43392	43408	43424	43441	43457	43474	43490
.4	43507	43523	43540	43556	43573	43589	43606	43622	43639	43655
.5	43671	43688	43704	43721	43737	43754	43770	43787	43803	43820
.6	43836	43853	43869	43886	43902	43919	43935	43951	43968	43984
.7	44001	44017	44034	44050	44067	44083	44100	44116	44133	44149
.8	44166	44182	44199	44215	44231	44248	44264	44281	44297	44314
.9	44330	44347	44363	44380	44396	44413	44429	44446	44462	44479
5576.0	44495	44512	44529	44546	44563	44579	44596	44613	44630	44647
.1	44664	44681	44698	44714	44731	44748	44765	44782	44799	44816
.2	44833	44849	44866	44883	44900	44917	44934	44951	44968	44985
.3	45001	45018	45035	45052	45069	45086	45103	45120	45136	45153
.4	45170	45187	45204	45221	45238	45255	45271	45288	45305	45322
.5	45339	45356	45373	45390	45407	45423	45440	45457	45474	45491
.6	45508	45525	45542	45558	45575	45592	45609	45626	45643	45660
.7	45677	45693	45710	45727	45744	45761	45778	45795	45812	45829
.8	45845	45862	45879	45896	45913	45930	45947	45964	45980	45997
.9	46014	46031	46048	46065	46082	46099	46115	46132	46149	46166
5577.0	46183	46200	46218	46235	46252	46270	46287	46304	46322	46339
.1	46356	46374	46391	46408	46425	46443	46460	46477	46495	46512
.2	46529	46547	46564	46581	46599	46616	46633	46651	46668	46685
.3	46703	46720	46737	46755	46772	46789	46807	46824	46841	46858
.4	46876	46893	46910	46928	46945	46962	46980	46997	47014	47032
.5	47049	47066	47084	47101	47118	47136	47153	47170	47188	47205
.6	47222	47240	47257	47274	47291	47309	47326	47343	47361	47378
.7	47395	47413	47430	47447	47465	47482	47499	47517	47534	47551
.8	47569	47586	47603	47621	47638	47655	47673	47690	47707	47724
.9	47742	47759	47776	47794	47811	47828	47846	47863	47880	47898
5578.0	47915	47933	47951	47968	47986	48004	48022	48039	48057	48075
.1	48093	48110	48128	48146	48164	48182	48199	48217	48235	48253
.2	48270	48288	48306	48324	48341	48359	48377	48395	48413	48430
.3	48448	48466	48484	48501	48519	48537	48555	48572	48590	48608
.4	48626	48644	48661	48679	48697	48715	48732	48750	48768	48786
.5	48803	48821	48839	48857	48875	48892	48910	48928	48946	48963
.6	48981	48999	49017	49035	49052	49070	49088	49106	49123	49141
.7	49159	49177	49194	49212	49230	49248	49266	49283	49301	49319
.8	49337	49354	49372	49390	49408	49425	49443	49461	49479	49497
.9	49514	49532	49550	49568	49585	49603	49621	49639	49656	49674
5579.0	49692	49710	49728	49747	49765	49783	49801	49820	49838	49856
.1	49874	49893	49911	49929	49947	49966	49984	50002	50021	50039
.2	50057	50075	50094	50112	50130	50148	50167	50185	50203	50221
.3	50239	50258	50276	50294	50312	50331	50349	50367	50385	50404
.4	50422	50440	50458	50477	50495	50513	50531	50550	50568	50586
.5	50604	50623	50641	50659	50677	50696	50714	50732	50750	50769
.6	50787	50805	50823	50842	50860	50878	50896	50915	50933	50951
.7	50969	50988	51006	51024	51042	51061	51079	51097	51115	51134
.8	51152	51170	51188	51207	51225	51243	51261	51280	51298	51316
.9	51334	51353	51371	51389	51407	51426	51444	51462	51480	51499

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5580.0	51517	51536	51554	51573	51592	51610	51629	51648	51667	51685
.1	51704	51723	51741	51760	51779	51797	51816	51835	51854	51872
.2	51891	51910	51928	51947	51966	51985	52003	52022	52041	52059
.3	52078	52097	52115	52134	52153	52171	52190	52209	52228	52246
.4	52265	52284	52302	52321	52340	52358	52377	52396	52415	52433
.5	52452	52471	52489	52508	52527	52545	52564	52583	52602	52620
.6	52639	52658	52676	52695	52714	52732	52751	52770	52789	52807
.7	52826	52845	52863	52882	52901	52919	52938	52957	52976	52994
.8	53013	53032	53050	53069	53088	53106	53125	53144	53163	53181
.9	53200	53219	53237	53256	53275	53293	53312	53331	53350	53368
5581.0	53387	53406	53425	53444	53463	53483	53502	53521	53540	53559
.1	53578	53597	53616	53635	53655	53674	53693	53712	53731	53750
.2	53769	53788	53807	53827	53846	53865	53884	53903	53922	53941
.3	53960	53979	53999	54018	54037	54056	54075	54094	54113	54132
.4	54151	54171	54190	54209	54228	54247	54266	54285	54304	54323
.5	54342	54362	54381	54400	54419	54438	54457	54476	54495	54514
.6	54534	54553	54572	54591	54610	54629	54648	54667	54686	54706
.7	54725	54744	54763	54782	54801	54820	54839	54858	54878	54897
.8	54916	54935	54954	54973	54992	55011	55030	55050	55069	55088
.9	55107	55126	55145	55164	55183	55202	55222	55241	55260	55279
5582.0	55298	55318	55337	55357	55376	55396	55415	55435	55454	55474
.1	55493	55513	55532	55552	55572	55591	55611	55630	55650	55669
.2	55689	55708	55728	55747	55767	55787	55806	55826	55845	55865
.3	55884	55904	55923	55943	55962	55982	56001	56021	56041	56060
.4	56080	56099	56119	56138	56158	56177	56197	56216	56236	56255
.5	56275	56295	56314	56334	56353	56373	56392	56412	56431	56451
.6	56470	56490	56509	56529	56549	56568	56588	56607	56627	56646
.7	56666	56685	56705	56724	56744	56763	56783	56803	56822	56842
.8	56861	56881	56900	56920	56939	56959	56978	56998	57018	57037
.9	57057	57076	57096	57115	57135	57154	57174	57193	57213	57232
5583.0	57252	57272	57292	57312	57332	57352	57372	57392	57412	57432
.1	57451	57471	57491	57511	57531	57551	57571	57591	57611	57631
.2	57651	57671	57691	57711	57731	57751	57771	57791	57811	57831
.3	57850	57870	57890	57910	57930	57950	57970	57990	58010	58030
.4	58050	58070	58090	58110	58130	58150	58170	58190	58210	58230
.5	58249	58269	58289	58309	58329	58349	58369	58389	58409	58429
.6	58449	58469	58489	58509	58529	58549	58569	58589	58609	58629
.7	58648	58668	58688	58708	58728	58748	58768	58788	58808	58828
.8	58848	58868	58888	58908	58928	58948	58968	58988	59008	59028
.9	59047	59067	59087	59107	59127	59147	59167	59187	59207	59227
5584.0	59247	59267	59288	59308	59329	59349	59369	59390	59410	59431
.1	59451	59471	59492	59512	59532	59553	59573	59594	59614	59634
.2	59655	59675	59696	59716	59736	59757	59777	59798	59818	59838
.3	59859	59879	59899	59920	59940	59961	59981	60001	60022	60042
.4	60063	60083	60103	60124	60144	60165	60185	60205	60226	60246
.5	60266	60287	60307	60328	60348	60368	60389	60409	60430	60450
.6	60470	60491	60511	60532	60552	60572	60593	60613	60634	60654
.7	60674	60695	60715	60735	60756	60776	60797	60817	60837	60858
.8	60878	60899	60919	60939	60960	60980	61001	61021	61041	61062
.9	61082	61102	61123	61143	61164	61184	61204	61225	61245	61266

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5585.0	61286	61307	61328	61348	61369	61390	61411	61432	61453	61473
.1	61494	61515	61536	61557	61577	61598	61619	61640	61661	61682
.2	61702	61723	61744	61765	61786	61807	61827	61848	61869	61890
.3	61911	61931	61952	61973	61994	62015	62036	62056	62077	62098
.4	62119	62140	62160	62181	62202	62223	62244	62265	62285	62306
.5	62327	62348	62369	62389	62410	62431	62452	62473	62494	62514
.6	62535	62556	62577	62598	62618	62639	62660	62681	62702	62723
.7	62743	62764	62785	62806	62827	62847	62868	62889	62910	62931
.8	62952	62972	62993	63014	63035	63056	63077	63097	63118	63139
.9	63160	63181	63201	63222	63243	63264	63285	63306	63326	63347
5586.0	63368	63389	63411	63432	63453	63474	63496	63517	63538	63559
.1	63581	63602	63623	63645	63666	63687	63708	63730	63751	63772
.2	63793	63815	63836	63857	63878	63900	63921	63942	63964	63985
.3	64006	64027	64049	64070	64091	64112	64134	64155	64176	64198
.4	64219	64240	64261	64283	64304	64325	64346	64368	64389	64410
.5	64431	64453	64474	64495	64517	64538	64559	64580	64602	64623
.6	64644	64665	64687	64708	64729	64751	64772	64793	64814	64836
.7	64857	64878	64899	64921	64942	64963	64985	65006	65027	65048
.8	65070	65091	65112	65133	65155	65176	65197	65218	65240	65261
.9	65282	65304	65325	65346	65367	65389	65410	65431	65452	65474
5587.0	65495	65517	65538	65560	65582	65604	65625	65647	65669	65690
.1	65712	65734	65756	65777	65799	65821	65842	65864	65886	65907
.2	65929	65951	65973	65994	66016	66038	66059	66081	66103	66125
.3	66146	66168	66190	66211	66233	66255	66277	66298	66320	66342
.4	66363	66385	66407	66429	66450	66472	66494	66515	66537	66559
.5	66580	66602	66624	66646	66667	66689	66711	66732	66754	66776
.6	66798	66819	66841	66863	66884	66906	66928	66950	66971	66993
.7	67015	67036	67058	67080	67102	67123	67145	67167	67188	67210
.8	67232	67254	67275	67297	67319	67340	67362	67384	67405	67427
.9	67449	67471	67492	67514	67536	67557	67579	67601	67623	67644
5588.0	67666	67688	67710	67732	67755	67777	67799	67821	67843	67865
.1	67888	67910	67932	67954	67976	67998	68021	68043	68065	68087
.2	68109	68131	68154	68176	68198	68220	68242	68264	68286	68309
.3	68331	68353	68375	68397	68419	68442	68464	68486	68508	68530
.4	68552	68575	68597	68619	68641	68663	68685	68708	68730	68752
.5	68774	68796	68818	68840	68863	68885	68907	68929	68951	68973
.6	68996	69018	69040	69062	69084	69106	69129	69151	69173	69195
.7	69217	69239	69262	69284	69306	69328	69350	69372	69394	69417
.8	69439	69461	69483	69505	69527	69550	69572	69594	69616	69638
.9	69660	69683	69705	69727	69749	69771	69793	69816	69838	69860
5589.0	69882	69905	69927	69950	69972	69995	70018	70040	70063	70086
.1	70108	70131	70153	70176	70199	70221	70244	70267	70289	70312
.2	70334	70357	70380	70402	70425	70448	70470	70493	70515	70538
.3	70561	70583	70606	70628	70651	70674	70696	70719	70742	70764
.4	70787	70809	70832	70855	70877	70900	70923	70945	70968	70990
.5	71013	71036	71058	71081	71103	71126	71149	71171	71194	71217
.6	71239	71262	71284	71307	71330	71352	71375	71398	71420	71443
.7	71465	71488	71511	71533	71556	71578	71601	71624	71646	71669
.8	71692	71714	71737	71759	71782	71805	71827	71850	71873	71895
.9	71918	71940	71963	71986	72008	72031	72054	72076	72099	72121

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5590.0	72144	72167	72190	72213	72236	72259	72282	72306	72329	72352
.1	72375	72398	72421	72444	72467	72490	72513	72536	72559	72583
.2	72606	72629	72652	72675	72698	72721	72744	72767	72790	72813
.3	72836	72859	72883	72906	72929	72952	72975	72998	73021	73044
.4	73067	73090	73113	73136	73160	73183	73206	73229	73252	73275
.5	73298	73321	73344	73367	73390	73413	73436	73460	73483	73506
.6	73529	73552	73575	73598	73621	73644	73667	73690	73713	73737
.7	73760	73783	73806	73829	73852	73875	73898	73921	73944	73967
.8	73990	74013	74037	74060	74083	74106	74129	74152	74175	74198
.9	74221	74244	74267	74290	74314	74337	74360	74383	74406	74429
5591.0	74452	74476	74499	74523	74546	74570	74593	74617	74640	74664
.1	74687	74711	74734	74758	74781	74805	74828	74852	74875	74899
.2	74922	74946	74969	74993	75016	75040	75064	75087	75111	75134
.3	75158	75181	75205	75228	75252	75275	75299	75322	75346	75369
.4	75393	75416	75440	75463	75487	75510	75534	75557	75581	75604
.5	75628	75652	75675	75699	75722	75746	75769	75793	75816	75840
.6	75863	75887	75910	75934	75957	75981	76004	76028	76051	76075
.7	76098	76122	76145	76169	76192	76216	76240	76263	76287	76310
.8	76334	76357	76381	76404	76428	76451	76475	76498	76522	76545
.9	76569	76592	76616	76639	76663	76686	76710	76733	76757	76780
5592.0	76804	76828	76852	76876	76900	76924	76948	76972	76996	77020
.1	77044	77068	77092	77116	77140	77164	77188	77212	77236	77260
.2	77284	77308	77332	77356	77380	77404	77427	77451	77475	77499
.3	77523	77547	77571	77595	77619	77643	77667	77691	77715	77739
.4	77763	77787	77811	77835	77859	77883	77907	77931	77955	77979
.5	78003	78027	78051	78075	78099	78123	78147	78171	78195	78219
.6	78243	78267	78291	78315	78339	78363	78387	78411	78435	78459
.7	78483	78507	78531	78555	78579	78602	78626	78650	78674	78698
.8	78722	78746	78770	78794	78818	78842	78866	78890	78914	78938
.9	78962	78986	79010	79034	79058	79082	79106	79130	79154	79178
5593.0	79202	79226	79251	79275	79300	79324	79349	79373	79397	79422
.1	79446	79471	79495	79520	79544	79568	79593	79617	79642	79666
.2	79691	79715	79739	79764	79788	79813	79837	79862	79886	79910
.3	79935	79959	79984	80008	80033	80057	80081	80106	80130	80155
.4	80179	80204	80228	80252	80277	80301	80326	80350	80375	80399
.5	80423	80448	80472	80497	80521	80546	80570	80595	80619	80643
.6	80668	80692	80717	80741	80766	80790	80814	80839	80863	80888
.7	80912	80937	80961	80985	81010	81034	81059	81083	81108	81132
.8	81156	81181	81205	81230	81254	81279	81303	81327	81352	81376
.9	81401	81425	81450	81474	81498	81523	81547	81572	81596	81621
5594.0	81645	81670	81695	81720	81744	81769	81794	81819	81844	81869
.1	81894	81918	81943	81968	81993	82018	82043	82068	82092	82117
.2	82142	82167	82192	82217	82242	82267	82291	82316	82341	82366
.3	82391	82416	82441	82465	82490	82515	82540	82565	82590	82615
.4	82639	82664	82689	82714	82739	82764	82789	82813	82838	82863
.5	82888	82913	82938	82963	82987	83012	83037	83062	83087	83112
.6	83137	83161	83186	83211	83236	83261	83286	83311	83335	83360
.7	83385	83410	83435	83460	83485	83509	83534	83559	83584	83609
.8	83634	83659	83684	83708	83733	83758	83783	83808	83833	83858
.9	83882	83907	83932	83957	83982	84007	84032	84056	84081	84106

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5595.0	84131	84156	84182	84207	84232	84257	84283	84308	84333	84359
.1	84384	84409	84435	84460	84485	84510	84536	84561	84586	84612
.2	84637	84662	84688	84713	84738	84764	84789	84814	84839	84865
.3	84890	84915	84941	84966	84991	85016	85042	85067	85092	85118
.4	85143	85168	85194	85219	85244	85269	85295	85320	85345	85371
.5	85396	85421	85447	85472	85497	85522	85548	85573	85598	85624
.6	85649	85674	85700	85725	85750	85775	85801	85826	85851	85877
.7	85902	85927	85953	85978	86003	86028	86054	86079	86104	86130
.8	86155	86180	86206	86231	86256	86281	86307	86332	86357	86383
.9	86408	86433	86459	86484	86509	86534	86560	86585	86610	86636
5596.0	86661	86687	86712	86738	86764	86790	86815	86841	86867	86893
.1	86918	86944	86970	86996	87021	87047	87073	87099	87124	87150
.2	87176	87202	87227	87253	87279	87305	87330	87356	87382	87407
.3	87433	87459	87485	87510	87536	87562	87588	87613	87639	87665
.4	87691	87716	87742	87768	87794	87819	87845	87871	87897	87922
.5	87948	87974	87999	88025	88051	88077	88102	88128	88154	88180
.6	88205	88231	88257	88283	88308	88334	88360	88386	88411	88437
.7	88463	88489	88514	88540	88566	88591	88617	88643	88669	88694
.8	88720	88746	88772	88797	88823	88849	88875	88900	88926	88952
.9	88978	89003	89029	89055	89081	89106	89132	89158	89184	89209
5597.0	89235	89261	89287	89314	89340	89366	89392	89418	89444	89471
.1	89497	89523	89549	89575	89601	89628	89654	89680	89706	89732
.2	89758	89785	89811	89837	89863	89889	89915	89942	89968	89994
.3	90020	90046	90072	90099	90125	90151	90177	90203	90229	90256
.4	90282	90308	90334	90360	90386	90413	90439	90465	90491	90517
.5	90543	90570	90596	90622	90648	90674	90701	90727	90753	90779
.6	90805	90831	90858	90884	90910	90936	90962	90988	91015	91041
.7	91067	91093	91119	91145	91172	91198	91224	91250	91276	91302
.8	91329	91355	91381	91407	91433	91459	91486	91512	91538	91564
.9	91590	91616	91643	91669	91695	91721	91747	91773	91800	91826
5598.0	91852	91879	91905	91932	91958	91985	92012	92038	92065	92091
.1	92118	92145	92171	92198	92224	92251	92278	92304	92331	92357
.2	92384	92411	92437	92464	92490	92517	92544	92570	92597	92623
.3	92650	92677	92703	92730	92756	92783	92810	92836	92863	92889
.4	92916	92943	92969	92996	93022	93049	93076	93102	93129	93155
.5	93182	93209	93235	93262	93288	93315	93342	93368	93395	93421
.6	93448	93475	93501	93528	93554	93581	93608	93634	93661	93687
.7	93714	93741	93767	93794	93820	93847	93874	93900	93927	93953
.8	93980	94007	94033	94060	94086	94113	94140	94166	94193	94219
.9	94246	94273	94299	94326	94352	94379	94406	94432	94459	94485
5599.0	94512	94539	94566	94593	94620	94647	94674	94701	94728	94755
.1	94782	94809	94836	94863	94890	94917	94944	94971	94998	95025
.2	95052	95079	95106	95133	95160	95188	95215	95242	95269	95296
.3	95323	95350	95377	95404	95431	95458	95485	95512	95539	95566
.4	95593	95620	95647	95674	95701	95728	95755	95782	95809	95836
.5	95863	95890	95917	95944	95971	95998	96025	96052	96079	96106
.6	96133	96160	96187	96214	96241	96268	96295	96322	96349	96376
.7	96403	96430	96457	96484	96511	96538	96566	96593	96620	96647
.8	96674	96701	96728	96755	96782	96809	96836	96863	96890	96917
.9	96944	96971	96998	97025	97052	97079	97106	97133	97160	97187

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5600.0	97214	97241	97269	97296	97324	97351	97379	97406	97434	97461
.1	97488	97516	97543	97571	97598	97626	97653	97680	97708	97735
.2	97763	97790	97818	97845	97873	97900	97927	97955	97982	98010
.3	98037	98065	98092	98120	98147	98174	98202	98229	98257	98284
.4	98312	98339	98366	98394	98421	98449	98476	98504	98531	98559
.5	98586	98613	98641	98668	98696	98723	98751	98778	98806	98833
.6	98860	98888	98915	98943	98970	98998	99025	99052	99080	99107
.7	99135	99162	99190	99217	99245	99272	99299	99327	99354	99382
.8	99409	99437	99464	99492	99519	99546	99574	99601	99629	99656
.9	99684	99711	99738	99766	99793	99821	99848	99876	99903	99931
5601.0	99958	99986	100014	100042	100069	100097	100125	100153	100181	100209
.1	100237	100265	100292	100320	100348	100376	100404	100432	100460	100488
.2	100515	100543	100571	100599	100627	100655	100683	100710	100738	100766
.3	100794	100822	100850	100878	100906	100933	100961	100989	101017	101045
.4	101073	101101	101129	101156	101184	101212	101240	101268	101296	101324
.5	101351	101379	101407	101435	101463	101491	101519	101547	101574	101602
.6	101630	101658	101686	101714	101742	101770	101797	101825	101853	101881
.7	101909	101937	101965	101993	102020	102048	102076	102104	102132	102160
.8	102188	102215	102243	102271	102299	102327	102355	102383	102411	102438
.9	102466	102494	102522	102550	102578	102606	102634	102661	102689	102717
5602.0	102745	102773	102802	102830	102858	102886	102915	102943	102971	103000
.1	103028	103056	103085	103113	103141	103169	103198	103226	103254	103283
.2	103311	103339	103368	103396	103424	103453	103481	103509	103537	103566
.3	103594	103622	103651	103679	103707	103735	103764	103792	103820	103849
.4	103877	103905	103934	103962	103990	104018	104047	104075	104103	104132
.5	104160	104188	104217	104245	104273	104301	104330	104358	104386	104415
.6	104443	104471	104500	104528	104556	104584	104613	104641	104669	104698
.7	104726	104754	104783	104811	104839	104867	104896	104924	104952	104981
.8	105009	105037	105066	105094	105122	105150	105179	105207	105235	105264
.9	105292	105320	105349	105377	105405	105433	105462	105490	105518	105547
5603.0	105575	105604	105632	105661	105690	105719	105747	105776	105805	105833
.1	105862	105891	105920	105948	105977	106006	106035	106063	106092	106121
.2	106149	106178	106207	106236	106264	106293	106322	106350	106379	106408
.3	106437	106465	106494	106523	106551	106580	106609	106638	106666	106695
.4	106724	106753	106781	106810	106839	106867	106896	106925	106954	106982
.5	107011	107040	107068	107097	107126	107155	107183	107212	107241	107269
.6	107298	107327	107356	107384	107413	107442	107471	107499	107528	107557
.7	107585	107614	107643	107672	107700	107729	107758	107786	107815	107844
.8	107873	107901	107930	107959	107987	108016	108045	108074	108102	108131
.9	108160	108189	108217	108246	108275	108303	108332	108361	108390	108418
5604.0	108447	108476	108505	108535	108564	108593	108622	108651	108680	108710
.1	108739	108768	108797	108826	108855	108885	108914	108943	108972	109001
.2	109030	109060	109089	109118	109147	109176	109205	109235	109264	109293
.3	109322	109351	109380	109410	109439	109468	109497	109526	109555	109585
.4	109614	109643	109672	109701	109730	109760	109789	109818	109847	109876
.5	109905	109935	109964	109993	110022	110051	110081	110110	110139	110168
.6	110197	110226	110256	110285	110314	110343	110372	110401	110431	110460
.7	110489	110518	110547	110576	110606	110635	110664	110693	110722	110751
.8	110781	110810	110839	110868	110897	110926	110956	110985	111014	111043
.9	111072	111101	111131	111160	111189	111218	111247	111276	111306	111335

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5605.0	111364	111394	111423	111453	111482	111512	111542	111571	111601	111630
.1	111660	111690	111719	111749	111778	111808	111838	111867	111897	111926
.2	111956	111986	112015	112045	112074	112104	112134	112163	112193	112222
.3	112252	112282	112311	112341	112370	112400	112430	112459	112489	112518
.4	112548	112578	112607	112637	112666	112696	112726	112755	112785	112814
.5	112844	112874	112903	112933	112962	112992	113022	113051	113081	113110
.6	113140	113170	113199	113229	113258	113288	113318	113347	113377	113406
.7	113436	113466	113495	113525	113554	113584	113614	113643	113673	113702
.8	113732	113762	113791	113821	113850	113880	113910	113939	113969	113998
.9	114028	114058	114087	114117	114146	114176	114206	114235	114265	114294
5606.0	114324	114354	114384	114414	114444	114474	114504	114534	114564	114594
.1	114624	114654	114684	114715	114745	114775	114805	114835	114865	114895
.2	114925	114955	114985	115015	115045	115075	115105	115135	115165	115195
.3	115225	115255	115285	115315	115345	115375	115405	115435	115466	115496
.4	115526	115556	115586	115616	115646	115676	115706	115736	115766	115796
.5	115826	115856	115886	115916	115946	115976	116006	116036	116066	116096
.6	116126	116156	116186	116217	116247	116277	116307	116337	116367	116397
.7	116427	116457	116487	116517	116547	116577	116607	116637	116667	116697
.8	116727	116757	116787	116817	116847	116877	116907	116937	116968	116998
.9	117028	117058	117088	117118	117148	117178	117208	117238	117268	117298
5607.0	117328	117358	117389	117419	117450	117480	117511	117541	117572	117602
.1	117633	117663	117694	117724	117755	117785	117816	117846	117877	117907
.2	117938	117968	117999	118029	118060	118090	118120	118151	118181	118212
.3	118242	118273	118303	118334	118364	118395	118425	118456	118486	118517
.4	118547	118578	118608	118639	118669	118700	118730	118761	118791	118822
.5	118852	118882	118913	118943	118974	119004	119035	119065	119096	119126
.6	119157	119187	119218	119248	119279	119309	119340	119370	119401	119431
.7	119462	119492	119523	119553	119584	119614	119644	119675	119705	119736
.8	119766	119797	119827	119858	119888	119919	119949	119980	120010	120041
.9	120071	120102	120132	120163	120193	120224	120254	120285	120315	120346
5608.0	120376	120407	120438	120469	120500	120531	120562	120593	120624	120654
.1	120685	120716	120747	120778	120809	120840	120871	120902	120933	120964
.2	120995	121026	121057	121088	121119	121150	121180	121211	121242	121273
.3	121304	121335	121366	121397	121428	121459	121490	121521	121552	121583
.4	121614	121645	121675	121706	121737	121768	121799	121830	121861	121892
.5	121923	121954	121985	122016	122047	122078	122109	122140	122171	122201
.6	122232	122263	122294	122325	122356	122387	122418	122449	122480	122511
.7	122542	122573	122604	122635	122666	122696	122727	122758	122789	122820
.8	122851	122882	122913	122944	122975	123006	123037	123068	123099	123130
.9	123161	123192	123222	123253	123284	123315	123346	123377	123408	123439
5609.0	123470	123501	123533	123564	123596	123627	123658	123690	123721	123752
.1	123784	123815	123847	123878	123909	123941	123972	124003	124035	124066
.2	124098	124129	124160	124192	124223	124255	124286	124317	124349	124380
.3	124411	124443	124474	124506	124537	124568	124600	124631	124662	124694
.4	124725	124757	124788	124819	124851	124882	124913	124945	124976	125008
.5	125039	125070	125102	125133	125165	125196	125227	125259	125290	125321
.6	125353	125384	125416	125447	125478	125510	125541	125572	125604	125635
.7	125667	125698	125729	125761	125792	125823	125855	125886	125918	125949
.8	125980	126012	126043	126075	126106	126137	126169	126200	126231	126263
.9	126294	126326	126357	126388	126420	126451	126482	126514	126545	126577

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5610.0	126608	126640	126672	126703	126735	126767	126799	126831	126862	126894
.1	126926	126958	126990	127022	127053	127085	127117	127149	127181	127212
.2	127244	127276	127308	127340	127371	127403	127435	127467	127499	127530
.3	127562	127594	127626	127658	127690	127721	127753	127785	127817	127849
.4	127880	127912	127944	127976	128008	128039	128071	128103	128135	128167
.5	128198	128230	128262	128294	128326	128358	128389	128421	128453	128485
.6	128517	128548	128580	128612	128644	128676	128707	128739	128771	128803
.7	128835	128867	128898	128930	128962	128994	129026	129057	129089	129121
.8	129153	129185	129216	129248	129280	129312	129344	129375	129407	129439
.9	129471	129503	129535	129566	129598	129630	129662	129694	129725	129757
5611.0	129789	129821	129853	129886	129918	129950	129982	130014	130047	130079
.1	130111	130143	130176	130208	130240	130272	130304	130337	130369	130401
.2	130433	130465	130498	130530	130562	130594	130626	130659	130691	130723
.3	130755	130788	130820	130852	130884	130916	130949	130981	131013	131045
.4	131077	131110	131142	131174	131206	131238	131271	131303	131335	131367
.5	131399	131432	131464	131496	131528	131561	131593	131625	131657	131689
.6	131722	131754	131786	131818	131850	131883	131915	131947	131979	132011
.7	132044	132076	132108	132140	132173	132205	132237	132269	132301	132334
.8	132366	132398	132430	132462	132495	132527	132559	132591	132623	132656
.9	132688	132720	132752	132785	132817	132849	132881	132913	132946	132978
5612.0	133010	133043	133075	133108	133141	133173	133206	133238	133271	133304
.1	133336	133369	133402	133434	133467	133500	133532	133565	133598	133630
.2	133663	133695	133728	133761	133793	133826	133859	133891	133924	133957
.3	133989	134022	134054	134087	134120	134152	134185	134218	134250	134283
.4	134316	134348	134381	134414	134446	134479	134511	134544	134577	134609
.5	134642	134675	134707	134740	134773	134805	134838	134870	134903	134936
.6	134968	135001	135034	135066	135099	135132	135164	135197	135230	135262
.7	135295	135327	135360	135393	135425	135458	135491	135523	135556	135589
.8	135621	135654	135686	135719	135752	135784	135817	135850	135882	135915
.9	135948	135980	136013	136046	136078	136111	136143	136176	136209	136241
5613.0	136274	136307	136340	136373	136406	136439	136472	136505	136539	136572
.1	136605	136638	136671	136704	136737	136770	136803	136836	136869	136902
.2	136935	136968	137002	137035	137068	137101	137134	137167	137200	137233
.3	137266	137299	137332	137365	137398	137431	137465	137498	137531	137564
.4	137597	137630	137663	137696	137729	137762	137795	137828	137861	137894
.5	137927	137961	137994	138027	138060	138093	138126	138159	138192	138225
.6	138258	138291	138324	138357	138390	138424	138457	138490	138523	138556
.7	138589	138622	138655	138688	138721	138754	138787	138820	138853	138887
.8	138920	138953	138986	139019	139052	139085	139118	139151	139184	139217
.9	139250	139283	139316	139350	139383	139416	139449	139482	139515	139548
5614.0	139581	139615	139648	139682	139715	139749	139782	139816	139849	139883
.1	139916	139950	139983	140017	140050	140084	140117	140151	140185	140218
.2	140252	140285	140319	140352	140386	140419	140453	140486	140520	140553
.3	140587	140620	140654	140687	140721	140755	140788	140822	140855	140889
.4	140922	140956	140989	141023	141056	141090	141123	141157	141190	141224
.5	141257	141291	141325	141358	141392	141425	141459	141492	141526	141559
.6	141593	141626	141660	141693	141727	141760	141794	141828	141861	141895
.7	141928	141962	141995	142029	142062	142096	142129	142163	142196	142230
.8	142263	142297	142330	142364	142398	142431	142465	142498	142532	142565
.9	142599	142632	142666	142699	142733	142766	142800	142833	142867	142900

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5615.0	142934	142968	143002	143036	143070	143104	143138	143172	143206	143240
.1	143274	143308	143342	143376	143410	143444	143478	143512	143546	143580
.2	143614	143648	143682	143716	143750	143784	143818	143852	143886	143920
.3	143954	143988	144022	144056	144090	144124	144158	144192	144226	144260
.4	144294	144328	144362	144396	144430	144464	144498	144532	144566	144600
.5	144634	144668	144702	144736	144770	144804	144838	144872	144906	144940
.6	144974	145008	145042	145076	145110	145144	145178	145212	145246	145280
.7	145314	145348	145382	145416	145450	145484	145518	145552	145586	145620
.8	145654	145688	145722	145756	145790	145824	145858	145892	145926	145960
.9	145994	146028	146062	146096	146130	146164	146198	146232	146266	146300
5616.0	146334	146368	146403	146437	146472	146506	146541	146575	146610	146644
.1	146679	146713	146748	146782	146817	146851	146886	146920	146955	146989
.2	147024	147058	147093	147127	147162	147196	147230	147265	147299	147334
.3	147368	147403	147437	147472	147506	147541	147575	147610	147644	147679
.4	147713	147748	147782	147817	147851	147886	147920	147955	147989	148024
.5	148058	148092	148127	148161	148196	148230	148265	148299	148334	148368
.6	148403	148437	148472	148506	148541	148575	148610	148644	148679	148713
.7	148748	148782	148817	148851	148886	148920	148954	148989	149023	149058
.8	149092	149127	149161	149196	149230	149265	149299	149334	149368	149403
.9	149437	149472	149506	149541	149575	149610	149644	149679	149713	149748
5617.0	149782	149817	149852	149887	149922	149957	149992	150027	150062	150097
.1	150132	150167	150202	150237	150272	150307	150342	150377	150412	150447
.2	150482	150517	150552	150587	150622	150657	150692	150727	150762	150797
.3	150832	150867	150902	150937	150972	151007	151042	151077	151112	151147
.4	151182	151217	151252	151287	151322	151357	151392	151427	151462	151497
.5	151531	151566	151601	151636	151671	151706	151741	151776	151811	151846
.6	151881	151916	151951	151986	152021	152056	152091	152126	152161	152196
.7	152231	152266	152301	152336	152371	152406	152441	152476	152511	152546
.8	152581	152616	152651	152686	152721	152756	152791	152826	152861	152896
.9	152931	152966	153001	153036	153071	153106	153141	153176	153211	153246
5618.0	153281	153316	153352	153387	153423	153458	153494	153529	153565	153600
.1	153636	153671	153707	153742	153778	153813	153849	153885	153920	153956
.2	153991	154027	154062	154098	154133	154169	154204	154240	154275	154310
.3	154346	154381	154417	154452	154488	154523	154559	154594	154630	154665
.4	154701	154736	154772	154807	154843	154878	154914	154949	154985	155020
.5	155056	155091	155127	155162	155198	155233	155269	155304	155340	155375
.6	155411	155446	155482	155517	155553	155588	155624	155659	155695	155730
.7	155766	155801	155837	155872	155908	155943	155979	156014	156050	156085
.8	156121	156156	156192	156227	156263	156298	156334	156369	156405	156440
.9	156476	156511	156547	156582	156618	156653	156689	156724	156760	156795
5619.0	156831	156867	156903	156939	156975	157011	157047	157083	157119	157155
.1	157191	157227	157263	157300	157336	157372	157408	157444	157480	157516
.2	157552	157588	157624	157660	157696	157732	157768	157804	157840	157876
.3	157912	157948	157984	158020	158056	158092	158128	158164	158201	158237
.4	158273	158309	158345	158381	158417	158453	158489	158525	158561	158597
.5	158633	158669	158705	158741	158777	158813	158849	158885	158921	158957
.6	158993	159029	159065	159102	159138	159174	159210	159246	159282	159318
.7	159354	159390	159426	159462	159498	159534	159570	159606	159642	159678
.8	159714	159750	159786	159822	159858	159894	159930	159966	160003	160039
.9	160075	160111	160147	160183	160219	160255	160291	160327	160363	160399

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5620.0	160435	160472	160508	160545	160581	160618	160654	160691	160727	160764
.1	160800	160837	160873	160910	160946	160983	161019	161056	161092	161129
.2	161165	161202	161238	161275	161311	161348	161385	161421	161458	161494
.3	161531	161567	161604	161640	161677	161713	161750	161786	161823	161859
.4	161896	161932	161969	162005	162042	162078	162115	162151	162188	162224
.5	162261	162298	162334	162371	162407	162444	162480	162517	162553	162590
.6	162626	162663	162699	162736	162772	162809	162845	162882	162918	162955
.7	162991	163028	163064	163101	163137	163174	163211	163247	163284	163320
.8	163357	163393	163430	163466	163503	163539	163576	163612	163649	163685
.9	163722	163758	163795	163831	163868	163904	163941	163977	164014	164050
5621.0	164087	164124	164161	164198	164235	164272	164309	164346	164383	164420
.1	164457	164494	164531	164568	164605	164642	164679	164715	164752	164789
.2	164826	164863	164900	164937	164974	165011	165048	165085	165122	165159
.3	165196	165233	165270	165307	165344	165381	165418	165455	165492	165529
.4	165566	165603	165640	165677	165714	165751	165788	165825	165862	165899
.5	165935	165972	166009	166046	166083	166120	166157	166194	166231	166268
.6	166305	166342	166379	166416	166453	166490	166527	166564	166601	166638
.7	166675	166712	166749	166786	166823	166860	166897	166934	166971	167008
.8	167045	167082	167119	167156	167192	167229	167266	167303	167340	167377
.9	167414	167451	167488	167525	167562	167599	167636	167673	167710	167747
5622.0	167784	167821	167859	167896	167934	167971	168009	168046	168083	168121
.1	168158	168196	168233	168271	168308	168345	168383	168420	168458	168495
.2	168533	168570	168607	168645	168682	168720	168757	168795	168832	168869
.3	168907	168944	168982	169019	169057	169094	169131	169169	169206	169244
.4	169281	169319	169356	169393	169431	169468	169506	169543	169581	169618
.5	169655	169693	169730	169768	169805	169843	169880	169918	169955	169992
.6	170030	170067	170105	170142	170180	170217	170254	170292	170329	170367
.7	170404	170442	170479	170516	170554	170591	170629	170666	170704	170741
.8	170778	170816	170853	170891	170928	170966	171003	171040	171078	171115
.9	171153	171190	171228	171265	171302	171340	171377	171415	171452	171490
5623.0	171527	171565	171603	171641	171679	171717	171755	171792	171830	171868
.1	171906	171944	171982	172020	172058	172096	172134	172172	172210	172247
.2	172285	172323	172361	172399	172437	172475	172513	172551	172589	172627
.3	172665	172703	172740	172778	172816	172854	172892	172930	172968	173006
.4	173044	173082	173120	173158	173195	173233	173271	173309	173347	173385
.5	173423	173461	173499	173537	173575	173613	173651	173688	173726	173764
.6	173802	173840	173878	173916	173954	173992	174030	174068	174106	174143
.7	174181	174219	174257	174295	174333	174371	174409	174447	174485	174523
.8	174561	174599	174636	174674	174712	174750	174788	174826	174864	174902
.9	174940	174978	175016	175054	175091	175129	175167	175205	175243	175281
5624.0	175319	175357	175396	175434	175473	175511	175550	175588	175626	175665
.1	175703	175742	175780	175819	175857	175895	175934	175972	176011	176049
.2	176088	176126	176164	176203	176241	176280	176318	176357	176395	176433
.3	176472	176510	176549	176587	176626	176664	176702	176741	176779	176818
.4	176856	176895	176933	176971	177010	177048	177087	177125	177164	177202
.5	177240	177279	177317	177356	177394	177433	177471	177510	177548	177586
.6	177625	177663	177702	177740	177779	177817	177855	177894	177932	177971
.7	178009	178048	178086	178124	178163	178201	178240	178278	178317	178355
.8	178393	178432	178470	178509	178547	178586	178624	178662	178701	178739
.9	178778	178816	178855	178893	178931	178970	179008	179047	179085	179124

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5625.0	179162	179201	179240	179279	179318	179357	179396	179435	179474	179513
.1	179552	179591	179630	179669	179708	179747	179786	179824	179863	179902
.2	179941	179980	180019	180058	180097	180136	180175	180214	180253	180292
.3	180331	180370	180409	180448	180487	180526	180565	180604	180643	180682
.4	180721	180760	180799	180838	180877	180916	180955	180994	181033	181072
.5	181110	181149	181188	181227	181266	181305	181344	181383	181422	181461
.6	181500	181539	181578	181617	181656	181695	181734	181773	181812	181851
.7	181890	181929	181968	182007	182046	182085	182124	182163	182202	182241
.8	182280	182319	182358	182397	182435	182474	182513	182552	182591	182630
.9	182669	182708	182747	182786	182825	182864	182903	182942	182981	183020
5626.0	183059	183099	183138	183178	183217	183257	183296	183336	183375	183415
.1	183454	183494	183533	183573	183612	183652	183691	183731	183770	183810
.2	183849	183889	183928	183968	184007	184047	184087	184126	184166	184205
.3	184245	184284	184324	184363	184403	184442	184482	184521	184561	184600
.4	184640	184679	184719	184758	184798	184837	184877	184916	184956	184995
.5	185035	185075	185114	185154	185193	185233	185272	185312	185351	185391
.6	185430	185470	185509	185549	185588	185628	185667	185707	185746	185786
.7	185825	185865	185904	185944	185983	186023	186063	186102	186142	186181
.8	186221	186260	186300	186339	186379	186418	186458	186497	186537	186576
.9	186616	186655	186695	186734	186774	186813	186853	186892	186932	186971
5627.0	187011	187051	187091	187131	187171	187212	187252	187292	187332	187372
.1	187412	187452	187492	187532	187573	187613	187653	187693	187733	187773
.2	187813	187853	187893	187934	187974	188014	188054	188094	188134	188174
.3	188214	188254	188295	188335	188375	188415	188455	188495	188535	188575
.4	188615	188656	188696	188736	188776	188816	188856	188896	188936	188976
.5	189016	189057	189097	189137	189177	189217	189257	189297	189337	189377
.6	189418	189458	189498	189538	189578	189618	189658	189698	189738	189779
.7	189819	189859	189899	189939	189979	190019	190059	190099	190140	190180
.8	190220	190260	190300	190340	190380	190420	190460	190501	190541	190581
.9	190621	190661	190701	190741	190781	190821	190862	190902	190942	190982
5628.0	191022	191063	191103	191144	191185	191226	191266	191307	191348	191388
.1	191429	191470	191511	191551	191592	191633	191673	191714	191755	191795
.2	191836	191877	191918	191958	191999	192040	192080	192121	192162	192203
.3	192243	192284	192325	192365	192406	192447	192488	192528	192569	192610
.4	192650	192691	192732	192773	192813	192854	192895	192935	192976	193017
.5	193057	193098	193139	193180	193220	193261	193302	193342	193383	193424
.6	193465	193505	193546	193587	193627	193668	193709	193750	193790	193831
.7	193872	193912	193953	193994	194035	194075	194116	194157	194197	194238
.8	194279	194320	194360	194401	194442	194482	194523	194564	194604	194645
.9	194686	194727	194767	194808	194849	194889	194930	194971	195012	195052
5629.0	195093	195134	195176	195217	195258	195300	195341	195382	195424	195465
.1	195506	195548	195589	195630	195672	195713	195754	195796	195837	195878
.2	195920	195961	196002	196044	196085	196127	196168	196209	196251	196292
.3	196333	196375	196416	196457	196499	196540	196581	196623	196664	196705
.4	196747	196788	196829	196871	196912	196953	196995	197036	197077	197119
.5	197160	197201	197243	197284	197325	197367	197408	197449	197491	197532
.6	197573	197615	197656	197697	197739	197780	197821	197863	197904	197945
.7	197987	198028	198069	198111	198152	198193	198235	198276	198318	198359
.8	198400	198442	198483	198524	198566	198607	198648	198690	198731	198772
.9	198814	198855	198896	198938	198979	199020	199062	199103	199144	199186

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010
(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5630.0	199227	199269	199311	199353	199395	199437	199479	199521	199563	199605
.1	199646	199688	199730	199772	199814	199856	199898	199940	199982	200024
.2	200066	200108	200150	200192	200234	200276	200318	200360	200402	200444
.3	200485	200527	200569	200611	200653	200695	200737	200779	200821	200863
.4	200905	200947	200989	201031	201073	201115	201157	201199	201241	201283
.5	201324	201366	201408	201450	201492	201534	201576	201618	201660	201702
.6	201744	201786	201828	201870	201912	201954	201996	202038	202080	202122
.7	202163	202205	202247	202289	202331	202373	202415	202457	202499	202541
.8	202583	202625	202667	202709	202751	202793	202835	202877	202919	202961
.9	203002	203044	203086	203128	203170	203212	203254	203296	203338	203380
5631.0	203422	203465	203507	203550	203592	203635	203677	203720	203762	203805
.1	203847	203890	203932	203975	204017	204060	204102	204145	204187	204230
.2	204272	204315	204357	204400	204442	204485	204528	204570	204613	204655
.3	204698	204740	204783	204825	204868	204910	204953	204995	205038	205080
.4	205123	205165	205208	205250	205293	205335	205378	205420	205463	205505
.5	205548	205591	205633	205676	205718	205761	205803	205846	205888	205931
.6	205973	206016	206058	206101	206143	206186	206228	206271	206313	206356
.7	206398	206441	206483	206526	206568	206611	206654	206696	206739	206781
.8	206824	206866	206909	206951	206994	207036	207079	207121	207164	207206
.9	207249	207291	207334	207376	207419	207461	207504	207546	207589	207631
5632.0	207674	207717	207760	207803	207846	207889	207933	207976	208019	208062
.1	208105	208148	208191	208234	208277	208320	208364	208407	208450	208493
.2	208536	208579	208622	208665	208708	208752	208795	208838	208881	208924
.3	208967	209010	209053	209096	209139	209182	209226	209269	209312	209355
.4	209398	209441	209484	209527	209570	209613	209657	209700	209743	209786
.5	209829	209872	209915	209958	210001	210044	210088	210131	210174	210217
.6	210260	210303	210346	210389	210432	210475	210519	210562	210605	210648
.7	210691	210734	210777	210820	210863	210906	210950	210993	211036	211079
.8	211122	211165	211208	211251	211294	211337	211381	211424	211467	211510
.9	211553	211596	211639	211682	211725	211768	211812	211855	211898	211941
5633.0	211984	212028	212071	212115	212159	212202	212246	212290	212333	212377
.1	212421	212464	212508	212552	212595	212639	212683	212726	212770	212814
.2	212857	212901	212945	212988	213032	213076	213119	213163	213206	213250
.3	213294	213337	213381	213425	213468	213512	213556	213599	213643	213687
.4	213730	213774	213818	213861	213905	213949	213992	214036	214080	214123
.5	214167	214211	214254	214298	214342	214385	214429	214473	214516	214560
.6	214604	214647	214691	214735	214778	214822	214866	214909	214953	214997
.7	215040	215084	215128	215171	215215	215258	215302	215346	215389	215433
.8	215477	215520	215564	215608	215651	215695	215739	215782	215826	215870
.9	215913	215957	216001	216044	216088	216132	216175	216219	216263	216306
5634.0	216350	216394	216438	216483	216527	216571	216615	216660	216704	216748
.1	216792	216837	216881	216925	216969	217014	217058	217102	217147	217191
.2	217235	217279	217324	217368	217412	217456	217501	217545	217589	217633
.3	217677	217722	217766	217810	217854	217899	217943	217987	218031	218076
.4	218120	218164	218208	218253	218297	218341	218385	218430	218474	218518
.5	218562	218607	218651	218695	218739	218784	218828	218872	218916	218961
.6	219005	219049	219093	219138	219182	219226	219270	219315	219359	219403
.7	219447	219492	219536	219580	219624	219669	219713	219757	219801	219846
.8	219890	219934	219978	220023	220067	220111	220155	220200	220244	220288
.9	220332	220377	220421	220465	220509	220554	220598	220642	220686	220731

CHERRY CREEK RESERVOIR CAPACITY IN ACRE-FEET EFFECTIVE 09-DEC-2010

(2006 SURVEY)

ELEV	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
5635.0	220775	220820	220865	220909	220954	220999	221044	221089	221133	221178
.1	221223	221268	221313	221358	221402	221447	221492	221537	221582	221626
.2	221671	221716	221761	221806	221850	221895	221940	221985	222030	222074
.3	222119	222164	222209	222254	222299	222343	222388	222433	222478	222523
.4	222567	222612	222657	222702	222747	222791	222836	222881	222926	222971
.5	223015	223060	223105	223150	223195	223240	223284	223329	223374	223419
.6	223464	223508	223553	223598	223643	223688	223732	223777	223822	223867
.7	223912	223957	224001	224046	224091	224136	224181	224225	224270	224315
.8	224360	224405	224449	224494	224539	224584	224629	224673	224718	224763
.9	224808	224853	224898	224942	224987	225032	225077	225122	225166	225211
5636.0	225256	225301	225347	225392	225438	225483	225528	225574	225619	225665
.1	225710	225755	225801	225846	225892	225937	225982	226028	226073	226119
.2	226164	226209	226255	226300	226346	226391	226436	226482	226527	226573
.3	226618	226663	226709	226754	226800	226845	226890	226936	226981	227027
.4	227072	227117	227163	227208	227254	227299	227344	227390	227435	227481
.5	227526	227571	227617	227662	227708	227753	227798	227844	227889	227935
.6	227980	228025	228071	228116	228162	228207	228252	228298	228343	228389
.7	228434	228479	228525	228570	228616	228661	228706	228752	228797	228843
.8	228888	228933	228979	229024	229070	229115	229160	229206	229251	229297
.9	229342	229387	229433	229478	229524	229569	229614	229660	229705	229751
5637.0	229796	229842	229888	229934	229980	230026	230072	230118	230164	230210
.1	230256	230302	230348	230393	230439	230485	230531	230577	230623	230669
.2	230715	230761	230807	230853	230899	230945	230991	231037	231083	231129
.3	231175	231221	231267	231313	231359	231405	231451	231497	231542	231588
.4	231634	231680	231726	231772	231818	231864	231910	231956	232002	232048
.5	232094	232140	232186	232232	232278	232324	232370	232416	232462	232508
.6	232554	232600	232646	232691	232737	232783	232829	232875	232921	232967
.7	233013	233059	233105	233151	233197	233243	233289	233335	233381	233427
.8	233473	233519	233565	233611	233657	233703	233749	233795	233840	233886
.9	233932	233978	234024	234070	234116	234162	234208	234254	234300	234346
5638.0	234392	234439	234485	234532	234578	234625	234671	234718	234764	234811
.1	234857	234904	234950	234997	235044	235090	235137	235183	235230	235276
.2	235323	235369	235416	235462	235509	235556	235602	235649	235695	235742
.3	235788	235835	235881	235928	235974	236021	236067	236114	236161	236207
.4	236254	236300	236347	236393	236440	236486	236533	236579	236626	236672
.5	236719	236766	236812	236859	236905	236952	236998	237045	237091	237138
.6	237184	237231	237277	237324	237371	237417	237464	237510	237557	237603
.7	237650	237696	237743	237789	237836	237882	237929	237976	238022	238069
.8	238115	238162	238208	238255	238301	238348	238394	238441	238488	238534
.9	238581	238627	238674	238720	238767	238813	238860	238906	238953	238999
5639.0	239046	239093	239140	239187	239234	239282	239329	239376	239423	239470
.1	239517	239564	239611	239658	239706	239753	239800	239847	239894	239941
.2	239988	240035	240082	240130	240177	240224	240271	240318	240365	240412
.3	240459	240506	240554	240601	240648	240695	240742	240789	240836	240883
.4	240930	240978	241025	241072	241119	241166	241213	241260	241307	241354
.5	241401	241449	241496	241543	241590	241637	241684	241731	241778	241825
.6	241873	241920	241967	242014	242061	242108	242155	242202	242249	242297
.7	242344	242391	242438	242485	242532	242579	242626	242673	242721	242768
.8	242815	242862	242909	242956	243003	243050	243097	243145	243192	243239
.9	243286	243333	243380	243427	243474	243521	243569	243616	243663	243710