DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, NORTHWESTERN DIVISION
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CENWD-PDW (1110-2-240b) 19 August 2026

MEMORANDUM FOR: David Doll, Chief, CENWS-ENH-WM

SUBJECT: Approval of the Water Control Manual Update for Libby Dam

1. Reference: USACE, ER-1110-2-8156, Preparation of Water Control Manuals

2. Recommendation: Thank you for your efforts in the updating of the water control manual for the Libby Dam Project. These updates were administrative and the manual now includes the previously approved 2024 Water Control Plan. The updated manual is approved.

3. Point of Contact: If you have any additional questions regarding this matter, please contact [redacted], CENWD-PDW Hydrologic Engineering Team Lead, at [redacted]

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WATER CONTROL MANUAL

LIBBY DAM AND LAKE KOOCANUSA

Kootenai River, Montana

U.S. Army Corps of Engineers
Northwestern Division
Seattle District
Seattle, Washington

June 2026



Libby Dam – Looking Upstream from Left Bank



Libby Dam – Looking Upstream from Right Bank



Libby Dam – Downstream Face of Dam from Right Bank



Libby Dam – Visitor's Center and Downstream Face of Dam

RECORD OF CHANGES

Date of Change	Section Number of Change/ Complete Update	Summary of Change
29 MARCH 2024	CHAPTER 7	APPROVAL OF WATER CONTROL PLAN UPDATE
01 June 2026	ALL	MANUAL UPDATE

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this water control manual be published in digital form in the central repository located at the following link:

https://cwbi-int.sec.usace.army.mil/dcp

The water control manual at the central repository will be considered the official manual and will be kept current at all times. Instructions and information to upload or document the review status of the water control manual, as per ER 1110-2-240, in the central repository portal can be found under the help tab in the portal.

It is not unexpected that U.S. Army Corps of Engineers (USACE) Corporate Information may move the central repository link to a new location. This information will be shared with all offices if a situation occurs by the HQUSACE.

REGULATION ASSISTANCE PROCEDURES

In the event that unusual conditions arise during non-duty hours, communication can be achieved by contacting appropriate water management personnel.

Directory of Regulation Personnel

Organization/Name	Office Phone	Mobile Phone	Email Address
Reservoir Control Center	(206) 764-3584		
[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]	[redacted]	[redacted]
[redacted]	[redacted]	[redacted]	[redacted]
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[redacted]	[redacted]		[redacted]
[redacted]	[redacted]		[redacted]
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[redacted]	[redacted]		[redacted]

U.S. ARMY CORPS OF ENGINEERS (SEATTLE DISTRICT/NORTHWESTERN DIVISION)

JUNE 2026

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LIST OF ACRONYMS AND ABBREVIATIONS

ACHP	Advisory Council on Historic Preservation
ADJDUR	Adjusted Duration
ADJPLAN	Planned Release Adjustment
ADJSTO	Adjusted Storage
APE	Area of Potential Effect
ARPA	Archaeological Resources Protection Act
BA	Biological Assessment
BFFLS	Bonners Ferry Flood Level Study
BiOp	Biological Opinion
BNRR	Burlington Northern Railroad
BPA	Bonneville Power Administration
CAD	Canadian Dollar
CAFE	CROHMS Automated Front End
CBT	Columbia Basin Teletype
CENWD	U.S. Army Corps of Engineers, Northwestern Division
CENWS	U.S. Army Corps of Engineers, Seattle District
CF	Control Flow
CHPS	Community Hydrologic Prediction Systems
CIC	Columbia Interagency Committee
CML	CROHMS Master List
CROHMS	Columbia River Operational Hydromet Management System
CRS	Columbia River system
CSKT	Confederated Salish and Kootenai Tribes
DCP	Data Collection Platforms
DOMSAT	Domestic Satellite
DSAC	Dam Safety Action Classification
DSS	Data Storage System

EAD	Expected Annual Damages
EIS	Environmental Impact Statement
EM	Engineering Manual
EP	Engineering Pamphlet
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
ESP	Ensemble Streamflow Prediction
FC	Flood Control
FCRC	Flood Control Refill Curve
FCRPS	Federal Columbia River Power System
FPIP	Flow Plan Implementation Protocol
FRM	Flood Risk Management
FTP	File Transfer Protocol
GDACS	Generic Data Acquisition and Control System
GOES	Geo-Stationary Operational Environmental Satellite
HDS	Hydromet Data System
HPMP	Historic Properties Management Plan
ICF	Initial Control Flood
IDFG	Idaho Department of Fish and Game
IES	Issue Evaluation Study
IFS	Interactive Forecast System
IJC	International Joint Commission
IRRMP	Interim Risk Reduction Measure Plan
LAURD	Libby Additional Units and Reregulating Dam
LIBTMC	Libby Dam Near Ten Mile Creek
LJAD	Libby-Jennings Archaeological District
LRDPU	Libby Reregulating Dam Power Units

MDEQ	Montana Department of Environmental Quality
MFWP	Montana Department of Fish, Wildlife and Parks
MKRAD	Middle Kootenai River Archaeological District
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Metro Optical Ethernet
MOU	Memorandum of Understanding
NAGPRA	Native American Graves Protection and Repatriation Act
NASA	National Aeronautics and Space Administration
NAVD	North American Vertical Datum
NCAT	NGS Coordinate Conversion and Transformation Tool
NEPA	National Environmental Policy Act
NFP	Normal Full Pool
NGS	National Geodetic Survey
NGVD	National Geodetic Vertical Datum
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPCC	Northwest Power and Conservation Council
NPD	North Pacific Division (obsolete abbreviation)
NPS	Seattle District (obsolete abbreviation)
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWPP	Northwest Power Pool
NWRFC	Northwest River Forecast Center
NWS	National Weather Service
NWSRFS	National Weather Service River Forecasting System
OMP	Operational Management Plan
PA	Programmatic Agreement

PMF	Probable Maximum Flood
RCC	Reservoir Control Center
RD	Regional District
RFC	River Forecast Center
RIOG	Regional Implementation Oversight Group
RM	River Mile
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RWCDS	Regional Water Control Data System
SCT	System Configuration Team
SDF	Spillway Design Flood
SETEC	Society of Environmental Toxicology and Chemistry
SFTP	Secure File Transfer Protocol
SNOTEL	Snow Telemetry
SOR	System Operational Requests
SPF	Standard Project Flood
SRD	Storage Reservation Diagram
SSARR	Streamflow Synthesis & Reservoir Routing
SWE	Snow Water Equivalent
SWS	Selective Withdrawal System
TDG	Total Dissolved Gas
TMDL	Total Maximum Daily Load
TMT	Technical Management Team
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

VARQ	Variable Project Discharge (Q)
WCDS	Water Control Data System
WCM	Water Control Manual
WRC	Water Resources Council
WSF	Water Supply Forecasts

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LIBBY DAM AND LAKE KOOCANUSA PERTINENT DATA (SHEET 1 OF 3)

GENERAL		
	Location of Dam	17 miles (27.4 km) east of Libby, Montana
	County	Lincoln County
	River and River Mile	Kootenai River, 221.9 miles (357 km) above mouth
	Drainage Area at Libby Dam and Lake Koocanusa	8,985 sq. mi (23,271 sq. km)
	Dam Coordinates	SW1-4NW1/4NE1/4sec.33,T.31 N., R29 W. Latitude 48.410555 Longitude -115.313055
PROJECT AUTHORIZATION		
	Public Law 516, Flood Control Act of 17 May 1950, 81st Congress, Second Session	
HYDROLOGIC DATA		
	Drainage Area at Dam	8,985 mi^2 (23,271 km^2)
	Minimum Instantaneous Regulated Discharge	0 cfs (0 m^3/s) on 1&2 October 1974 *Stilling basin inspection* 0 cfs (0 m^3/s) on 28 March 1975 *Powerhouse construction*
	Minimum Historical Discharge *(Unregulated)*	895 cfs (25.3 m3/s) – USGS Gage 12303000 *January 1930*
	Maximum Regulated Discharge	53,100 cfs (1,503.4 m3/s) – USGS Gage 12301933 *June 18, 2006*
	Maximum Historical Discharge *(Estimated)*	130,000 cfs (3,681 m3/s) at Libby Montana *1894 Flood of Record*
	Maximum Recorded Discharge	121,000 cfs (3,426.3 m3/s) – USGS Gage 1303000 *1916 Flood of Record*
DAM		
	Type	Concrete Gravity
	Crest Elevation (feet)	El 2,472 ft (753.47 m)
	Maximum Base Width (feet)	310
	Crest width (feet)	Non-Overflow Monoliths 32.1 ft (9.8 m) Powerhouse and Spillway Monoliths 44.6 ft (13.6 m)
	Height above Streambed (feet)	432 ft (131.7 m)
	Length (feet)	2,887 ft (880 m)
SPILLWAY		
	Location	Center of Dam
	Type	Ogee Crest
	Crest Elevation (feet)	El 2,405 ft (733.04 m)
	Length (feet)	400 ft
	Number of Gates	2
	Type of Gates	Radial
	Width of Gates (feet)	48 ft (14.6 m)
	Height of Gates (feet)	59 ft (18.0 m)
	Type of Gate Operating Machinery Hoist	Hydraulically Operated Tainter Gate
	Discharge Capacity at Maximum Water Surface Elevation	150,000 cfs (4,247 m^3/s) at elevation 2,459 feet (749.5 m)
	Spillway Design Flood Inflow Peak *(Probable Maximum Flood)*	282,000 cfs (7,985.4 m^3/s)
	Spillway Design Flood Outflow Peak	206,000 cfs (5,833.3 m^3/s)

LIBBY DAM AND LAKE KOOCANUSA PERTINENT DATA (SHEET 2 OF 3)

OUTLET WORKS		
Power Penstocks		20-foot (6.1 m) inside diameter
	Location	Right bank abutment at base of dam
	Rated Capacity (300-foot (91.4 m) head) (cfs)	27,000 cfs (764.6 cms) (total)
	Intake elevation CL	El 2,222.0 ft (El 677.27 m) NGVD 29
POWERPLANT		
Powerhouse		
	Overall Length	576.5 ft (175.7 m)
	Overall Width Including Transformer Deck	145 ft (44.2 m)
	Number of Units	5
	Number of Units in Ultimate Installation	8
	Penstock Intake Invert Elevation	2,222.0 ft (677.27 m) NGVD29
Turbines		
	Manufacturer	Allis Chalmers
	Type	Francis – Vertical Shaft
	Units	5
	Rated Net Head	300 ft (91.4 m)
	Rated Output	165,000 hp
	Maximum Discharge, *1 Unit*	5,400 cfs (152.9 m3/s)
	Maximum Discharge, *5 Units*	27,000 cfs (764.6 m3/s)
	Maximum Discharge Within Cavitation Limits *1 Unit*	5,300 cfs (150.1 m3/s)
	Maximum Discharge Within Cavitation Limits *5 Units*	26,500 cfs (750.4 m3/s)
	Maximum Hydraulic Head *El 2,459 ft (749.50 m) - 4,000 cfs (113.3 m3/s)*	341 ft (104 m)
	Minimum Hydraulic Head *El 2,287 ft (697.08 m) – 14,000 cfs (396.4 m3/s)*	165 ft (50.3 m)
Generators		
	Manufacturer	Westinghouse
	Type	Vertical Shaft
	Units	8
	Rated Output	110,526 kVA
	Rated Power Factor	0.95
	Nameplate Rating:	105,000 kW
	Maximum Continuous Output (115% Nameplate, 0.95 pf)	120,750 kW
	Plant Capacity, *5 Units*	525,000 kW
	Plant Capacity, *8 Units*	840,000 kW

LIBBY DAM AND LAKE KOOCANUSA PERTINENT DATA (SHEET 3 OF 3)

RESERVOIR – LAKE KOOCANUSA

Storage Capacity	Gross Storage *2,459 ft (749.50 m) NGVD29*	Usable Storage *2,287-2,459 ft (697.08 – 749.50 m) NGVD29*
United States	4,877,175 ac-ft (601,594.2 ha-m)	3,987,251 ac-ft (491,823.0 ha-m)
Canada	992,217 ac-ft (122,388.9 ha-m)	992,217 ac-ft (122,388.9 ha-m)
Total	**5,869,392 ac-ft (723,983.1 ha-m)**	**4,979,468 ac-ft (614,211.9 ha-m)**

Surface Area	Normal Full Pool *2,459 ft (749.50 m) NGVD29*	Minimum Pool *2,287-2,459 ft (697.08 – 749.50 m) NGVD29*
United States	28,994 ac (11,733.5 ha)	14,487 ac (5,862.7 ha)
Canada	17,462 ac (7,066.7 ha)	0 ac (0 ha)
Total	**46,456 ac (18,800.2 ha)**	**14,487 ac (5,862.7 ha)**

Length	
United States	48 mi (77 km)
Canada	42 mi (68 km)
Total	**90 mi (145 km)**

RESERVOIR OPERATING RANGE

Normal Full Pool Elevation	2,459 ft (749.50 m) NGVD29
Minimum Regulated Pool Elevation *(Power and Flood Control)*	2,287 ft (697.08 m) NGVD29
Drawdown	172 ft (52.43 m)
Flood Stage Elevation	1,764 ft (537.7 m) NGVD29
Lake Koocanusa Storage	5,869,392 ac-ft (723,981.1 ha-m) (total)

TAILWATER ELEVATION	FLOW	ELEVATION (NGVD29)
Mean Flow	11,360 cfs (321.7 m^3/s)	2,120.5 ft (646.33 m)
Normal Minimum Flow	4,000 cfs (113.3 m^3/s)	2,117.8 ft (645.51 m)
Powerhouse Hydraulic Capacity	27,000 cfs (764.6 m3/s)	2,124.1 ft (647.43 m)
Still Basin Design Flood	60,000 cfs (1,699 m3/s)	2,130.3 ft (649.32 m)
Spillway Design Flood	206,000 cfs (5,833.27 m^3/s)	2,144.0 ft (653.49 m)

SLUICES

Sluice Crest Elevation	2,201.5 ft (671.02 m) NGVD29
Number of Sluices	3
Sluice Width	10 ft (3.05 m)
Sluice Height	17 ft (5.2 m)
Capacity of 3 Sluices	60,000 cfs (1,699 m3/s) at Elevation 2,459 ft (749.5 m)

RESERVOIR POOLS	Elevation (NGVD 29)	Gross Area	Gross Storage
Lake Koocanusa Normal Full Pool Elevation	2,459 ft (749.5 m)	46,456 ac (18,800.2 ha)	4,980,000 acre-ft (610,000 hectare-m)
Lake Koocanusa Minimum Pool Elevation	2,287 ft (697.1 m)		

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VERTICAL DATUM CONVERSION

Unless otherwise stated, all elevations in this manual are provided in the North American Vertical Datum of 1988 (NAVD 88). Vertical datum conversions were conducted using the National Geodetic Survey (NGS) Coordinate Conversion and Transformation Tool (NCAT): https://www.ngs.noaa.gov/NCAT/.

NGVD 29+/-#.##=NAVD 88

Point Name	Latitude	Longitude	NGVD 29 Elevation (feet)	NAVD 88 Elevation (feet)	Delta Elevation (feet)
Libby Dam	48.410810	-115.31537	2,472.00	2,475.85	3.845
USGS Gage 12301933 Below Libby Dam	48.400664	-115.31872	2,100.00	2,103.84	3.842
USGS Gage 12303000 at Libby, ID	48.400219	-115.55364	2,041.54	2,045.40	3.862
USGS Gage 12305000 at Leonia, ID	48.616883	-116.04919	1,790.92	1,794.75	3.848
USGS Gage 12309500 Bonners Ferry, ID	48.698056	-116.31250	1,700.00	1,703.86	3.861

UNIT CONVERSIONS AND UNITS OF MEASURE

Length
1 in. = 25.4 mm
1 ft = 0.3048 m
1 mi = 1.60934 km

Area
1 sq. mi = 2.59 sq. km
1 sq. mi = 259 hectares

Volume
1 ac-ft = 1,233.48 m^3
1 ac-ft = 0.123348 hectare-m

Flow
1 cfs = 0.02832 cms

Power
1 hp = 0.7457 kW

Temperature
°F = 9/5 * °C + 32

af	acre-feet
cfs	cubic feet per second
cms	cubic meters per second
hp	horsepower
kW	kilo Watt
sq. km	square kilometer
sq. mi	square mile

CHAPTER 1—INTRODUCTION

1-1 AUTHORIZATION

This water control manual (WCM) was prepared in compliance with the following authorities and directives:

- Engineering Regulation (ER) 1110-2-240, Water Control Management, 30 May 2016.
- Engineering Manual (EM) 1110-2-3600, Management of Water Control Systems, dated 10 October 2017.
- SD-10, Guide for Identification and Development of Metric Standards, Department of Defense, December 2003.
- ER 1110-2-8156, Preparation of Water Control Manuals, 30 September 2018.
- ER 1110-2-8160, Policies for Referencing Project Elevation Grades to Nationwide Vertical Datums, 1 March 2009.
- NWDR 1110-2-6, Deviation Requests for Approved Water Control Manuals, 20 June 2023.
- Seattle District (CENWS) is delegated primary responsibility for regulation of Libby Dam Project by NPDR 1165-2-2, “Water Resources Policies and Authorities, WATER MANAGEMENT RESPONSIBILITIES,” dated 23 January 2014, Exhibit 1-1.
- Section 5 of the Flood Control Act, 22 June 1936.

Construction of Libby Dam and Lake Koocanusa was authorized by Public Law 81-516, Flood Control Act of 17 May 1950, 81st Congress, Second Session.

1-2 PURPOSE AND SCOPE

This manual is applicable to the Libby Dam and Lake Koocanusa. Water management activities prescribed comply with all applicable Federal laws and regulations, including the Flood Control Act of 1944 and the Water Resource Development Acts of various years and those laws listed in Appendices A and B of ER 1110-2-240, Water Control Management.

This manual presents the reservoir regulation plan for Libby Dam (Libby) for use as a reference document for higher authority and as a guidance manual for U.S. Army Corps of Engineers (USACE) staff involved in project activities. Detailed information describing local sub-basins, project features, data collection facilities, forecasting procedures, reservoir regulation plans, and the effects of regulation are provided in this manual.

Development of this plan and implementation of regulatory strategies uses a systems approach considering hydrologic and ecological relationships within and among systems,

comprehensive scope, multiple users, project purposes, and economic impacts throughout the system.

Risk and uncertainty analysis and the need to effectively communicate the concept of risk to the public were considered in the preparation of this manual

This manual addresses USACE's role as an environmental steward and activities prescribed are guided by the USACE Environmental Principles in accordance with authorized or approved purposes and comply with the National Environmental Policy Act (NEPA) as provided in ER 200-2-2 and other applicable environmental laws, executive orders, and regulations. Policies for project operations support enhanced ecosystem sustainability whenever compatible with other project purposes.

1-3 RELATED MANUALS AND REPORTS

This WCM supersedes Libby Dam and Lake Koocanusa Water Control Manual (2012). Manuals and reports pertinent to Libby Dam and Lake Koocanusa are listed below:

- "Columbia River Basin Water Management Plan," Bonneville Power Administration, U.S. Bureau of Reclamation, and USACE, developed annually.
- "Columbia River Treaty Assured Operating Plan and Determination of Downstream Power Benefits," Columbia River Treaty Operating Committee, developed annually for sixth succeeding water year.
- "Columbia River Treaty Entity Agreement on the Detailed Operating Plan for Canadian Storage," Columbia River Treaty Entities, developed annually.
- "Columbia River Treaty Hydrometeorological Committee Report," Columbia River Treaty Hydrometeorological Committee, developed annually.
- "Biological Opinion for Operation and Maintenance of the Fourteen Multiple-Use Dam and Reservoir Projects in the Columbia River System," National Marine Fisheries Service, 4 July 2020.
- "Hydraulic Model of the Kootenai River from Libby Dam to Bonners Ferry," Columbia River Treaty Review Studies, CENWS, February 2011.
- "Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System, 11 Bureau of Reclamation Projects in the Columbia Basin and ESA Section 10(a)(I)(A) Permit for Juvenile Fish Transportation Program," National Marine Fisheries Service, 20 May 2010. (2010 Supplemental BiOp).
- "Libby Dam Selective Withdrawal Reconnaissance Study," CENWS, July 2010.
- "Kootenay Lake Flood Damage Assessment," BC Hydro, 1 May 2009.
- "Upper Columbia Alternative Flood Control and Fish Operations: Record of Decision for Libby Dam Flood Control and Fish Operations," USACE Northwestern Division (CENWD), 6 June 2008.

- “Biological Opinion (BiOp) on Operation and Configuration of Major Projects in the Federal Columbia River Power System (FCRPS),” National Marine Fisheries Service, 5 May 2008.

- “Fish and Wildlife Service Biological Opinion Regarding the Effects of Libby Dam Operations on the Kootenai White Sturgeon, Bull Trout and Kootenai Sturgeon Critical Habitat,” dated 18 February 2006 and the “Clarification” dated 29 December 2008. These are the principal documents that guide the changes in Libby project operation adopted for protection of threatened and endangered species.

- “Emergency Action and Notification Subplan for Libby Dam,” CENWS, July 2006. This plan is located at the project and in the CENWD and CENWS Reservoir Control Centers.

- “Kootenai River Levee Inspection Report,” CENWS, April 2007.

- “Upper Columbia Alternative Flood Control and Fish Operations: Final Environmental Impact Statement,” CENWS, April 2006.

- “Simulation of Hydraulic Characteristics in the White Sturgeon Spawning Habitat of the Kootenai River near Bonners Ferry, Idaho,” U.S. Geological Survey, August 2005.

- “Bonners Ferry Flood Level Study Report, Includes Kootenai River Channel Capacity Study Report,” CENWS, 30 September 2005.

- “Economic Flood Depth-Damage Analysis for the Kootenai River, Bonners Ferry Idaho to U.S./Canada Border,” CENWS, May 2005.

- “Columbia River Treaty Flood Control Operating Plan, CENWD, North Pacific Region, For the United States Entity,” May 2003.

- “Columbia River Treaty Entity Agreement Coordinating the Operation of the Libby Project with the Operation of Hydroelectric Plants on the Kootenay River and Elsewhere in Canada,” Columbia River Treaty Entities, 16 February 2000.

- “The Project Master Plan, Design Memorandum 52,” USACE, dated September 1997, also describes the project’s facilities and resources.

- “The Columbia River Basin Master Water Control Manual,” prepared by the North Pacific Division (NPD), now CENWD, dated December 1984.

- “Lake Koocanusa near Libby, Montana, Area-Capacity Table,” dated June 1980.

- “Libby Dam Project, Montana, Supplement 1 to Design Memo No. 2, Derivation of Spillway Design Flood Inflow,” CENWS, 26 October 1962.

- “1938 Kootenay Lake Order,” International Joint Commission, 11 November 1938.

Design Memoranda and supplements describing the development and construction of primary project features are listed in Exhibit 1-2.

Other operating reports and bulletins of interest concerning the project are available in the Seattle District office in the Engineering Records and Information Section. Some reports and data are also available in the Technical Section at Libby at 406-293-7751 x212.

1-4 PROJECT OWNER

The United States Government has full title, ownership, and fee control of all USACE reservoir and lake lands including Libby Dam and Lake Koocanusa and operating structures.

1-5 OPERATING AGENCY

USACE, Seattle District (CENWS) operates the Libby Project under the general supervision of the USACE Northwestern Division (CENWD) office. Prior to 1997, CENWD and CENWS were known as NPD and Seattle District (NPS). The project office is staffed 24 hours a day.

Libby Dam and Lake Koocanusa Project Office
17877 Highway 73
Libby, MT 59923
Office Phone: [redacted]

1-6 REGULATING AGENCIES

Primary responsibility for regulation of Libby Project is assigned to the District Engineer, CENWS, who directs day-to-day operations through the District Hydrology and Hydraulics Branch (CENWS-ENH). CENWS also conducts engineering investigations and coordinates with the public on matters concerning the project operation, regulation, and public affairs. The Division Engineer, CENWD assumes operational control of Libby Project in certain regional flood emergencies and specifies operation through Columbia Basin Water Management Division (CENWD-PDW). CENWD-PDW also has responsibility for the planning, oversight, and implementation of the current Columbia River Treaty and Pacific Northwest Coordination Agreement, both of which involve the Libby Project. Each office has personnel who help accomplish Libby's water resource regulation mission. The CENWD and CENWS reservoir control centers are referred to in this document as the CENWD-PDW-R and CENWS-RCC, respectively. The details of delegation of authority pertinent to Libby Project are provided in the Regulation NWDR 1165-2-2, "Water Resource Policies and Authorities, Water Management Responsibilities," CENWD-PDW, dated January 2014 (See Exhibit 1-1).

1-7 VERTICAL DATUM

Per the U.S. Army Corps of Engineers Engineering Regulations listed above, structures for inland flood risk management, navigation, and water control systems (to include levees, floodwalls, multipurpose hydropower projects, locks and dams, and non-tidal inland navigation systems) designed or constructed for flood protection or navigation clearance grades, hydraulic or hydrodynamic water surface profiles, river or pool stages, and stream gages in inland flood risk and water control systems shall be accurately referenced to the NSRS (e.g., NAVD88).

For clarity in this document, vertical elevations listed in this manual are referenced to the original project vertical datum of NGVD 1929 and the datum conversion factors to the NAVD88 vertical datum at multiple locations within the project area are included in Table 1-2. Vertical datum conversions were conducted using the National Geodetic Survey (NGS) Coordinate Conversion and Transformation Tool (NCAT): https://www.ngs.noaa.gov/NCAT/.

Table 1-1: Vertical Datum Conversion Points

Location	Latitude	Longitude	NGVD29 (feet)	NAVD88 (feet)	Conversion
Libby Dam	48.410810	-115.31537	2,472.00	2,475.85	3.845
U.S. Geological Survey (USGS) Gage 12301933 Below Libby Dam	48.400664	-115.31872	2,100.00	2,103.84	3.842
USGS Gage 12303000 at Libby, ID	48.400219	-115.55364	2,041.54	2,045.40	3.862
USGS Gage 12305000 at Leonia, ID	48.616883	-116.04919	1,790.92	1,794.75	3.848
USGS Gage 12309500 Bonners Ferry, ID	48.698056	-116.31250	1,700.00	1,703.86	3.861

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CHAPTER 2—DESCRIPTION OF PROJECT

2-1 LOCATION

Libby Dam Project is located in northwestern Montana in Lincoln County. The dam site is situated in the northern half of section 33, township 31 North, range 29 West, Montana principal meridian, on the Kootenai River at river mile (RM) 221.9 (river kilometer (RK) 357.1). The dam is about 40 miles (64.4 km) south of Roosville, Montana, at the United States/Canadian international boundary; 48 miles (77.2 km) west-northwest of Kalispell, Montana; and 17 miles (27.4 km) east of Libby, Montana. Montana State Highway 37 and Montana/British Columbia Highway 93 parallel the east side of the reservoir to the reservoir northern terminus near Wardner, BC. Forest Development Road 228 parallels the west side of the reservoir to within about 2 miles (3.2 km) of the U.S./Canada border. The RM location of the dam is based on the River Mile Index published by the Columbia Interagency Committee (CIC), dated November 1965, and calculations by the CENWS, to precisely adjust for the present dam location. An alternate dam site is used in the CIC index. The Pacific Northwest Reservoir System is shown on Plate 2-1 and Plate 2-2, while a location and vicinity map are shown on Plate 2-3.

2-2 PURPOSE

Libby Dam Project is a major unit of the comprehensive water resource development plan of the Columbia River Basin in the United States and Canada. The project was authorized by Public Law No. 81-516, Flood Control Act of 17 May 1950, 81st Congress, Second Session, substantially in accordance with a plan set forth in House Document 531, 81st Congress, Second Session. Libby Dam is also one of four Columbia River Treaty projects and is a key project in terms of overall Columbia River system (CRS) water management. Article XII of the Columbia River Treaty, signed in 1964, specified the extent to which water can be impounded in Canada and established that Libby Dam operations are to be coordinated with Canada. The project is authorized for multiple uses including flood control, power generation, recreation, navigation, and fish and wildlife conservation.

The project provides up to 4.98 million acre-feet (MAF) (0.61 million ha-meters (ha-m)) of reservoir space for flood risk management, which is designed to reduce risk for floods in the CRS as well as the Kootenai Basin. For the CRS, it helps achieve the objective of reducing flows to non-damaging levels at all potential flood damages areas in Canada and the United States insofar as possible and to regulate larger floods that cannot be controlled to non-damaging levels to the lowest possible level with the available storage space. For the Kootenai River Basin, it is designed to reduce the risk of floods as great as the largest known flood on the Kootenai River—the flood of 1894—which was approximately a standard project flood. Protection of the local area in Montana and Idaho from loss of life and catastrophic damage during the spring/summer freshet is a flood risk management priority and operations at Libby Dam also are obligated for overall system flood risk management in the lower Columbia River.

Generally, the gradual release of water stored during the spring/summer freshet provides hydropower benefits at Libby and at 17 projects downstream on the Kootenay/CRS. It should be noted that “Kootenay” and “Kootenai” refer to the same river. The former is the Canadian spelling, and the latter is the United States spelling. The reservoir is gradually

drawn down during the fall and winter months with a goal of providing necessary storage evacuation by 31 March. Storage, however, may be adjusted based on runoff volume forecasts until operation for flood risk management begins. Maximum project discharge during the freshet is selected to manage flood risk. However, within that constraint, project discharge is variable to meet multiple project objectives. A more detailed explanation of project operations is provided in Chapter 7, the Water Control Plan, and other following sections.

2-3 PHYSICAL COMPONENTS

The following are the major components of the Libby Dam Project:

- Reservoir
- Concrete gravity dam
- Hydraulic outlet facilities (spillway, sluices, stilling basin, and selective withdrawal system)
- Powerhouse

Plate 2-4 shows the Libby Dam Project layout as described in this section and Plate 2-5 presents a general plan and sections.

a. Reservoir

The Libby forebay reservoir, Lake Koocanusa, is approximately 90 miles (144.8 km) long (48 miles (77.2 km) of which are in the United States and 42 miles (67.6 km) in Canada) and extends about 5 miles (8 km) north of Wardner, British Columbia. Normal full pool (NFP) and minimum regulated reservoir elevations are 2,459 feet (749.5 m) and 2,287 feet (697.1 m), respectively. The maximum elevation of 2,459 feet (749.5 m) is the maximum water surface elevation permitted by Article XII (1) of the Columbia River Treaty. The minimum elevation of 2,287 feet (697.1 m) is the elevation to which the reservoir is drawn down in the years with the largest water supply forecasts and is considered the lowest elevation the sluice capacity is sufficient to maintain before the initiation of refill. Lake Koocanusa has gross storage and usable storage of 5,869,392 acre-feet (0.72 million ha-m) and 4,979,468 acre-feet (0.61 million ha-m), respectively. Reservoir area at NFP is 46,456 acres (18,800 hectares (ha)) including 28,994 acres (11,733 ha) in the United States and 17,462 acres (7,067 ha) in Canada. The reservoir area-capacity curves are shown on Plate 2-12. An abbreviated storage-elevation table from the Seattle District report “Lake Koocanusa near Libby, Montana, Area-Capacity Table,” dated June 1980, is presented in Table 2-1 located in the Supplemental Tables Section. Table 2-1 lists capacity at 0.1-foot intervals, whereas the referenced report lists capacity at 0.01-foot intervals

b. Dam

The dam is a concrete gravity structure with 47 monoliths, a total length of 2,887 feet (880 m) (total length of concrete monoliths), and a maximum height of 432 feet (131.7 m) from bedrock to the roadway deck on the top of the dam. The top width of the dam is 32.1 feet (9.8 m) at the non-overflow monoliths and 44.6 feet (13.6 m) at the powerhouse

monoliths. The roadway deck atop the dam at elevation 2,472 feet (753.5 m) is 39.9 feet (12.2 m) wide at the non-overflow monoliths and 52.3 feet (15.9 m) wide at the powerhouse and spillway monoliths and accommodates walkways, the vehicular roadway, and tracks for a 75 ton (68,039 kg) gantry crane. Project layout and elevation details of the dam are shown on Plate 2-4 and Plate 2-5.

c. Hydraulic Outlet Facilities

(1) Spillway

The spillway is a concrete gravity, gated ogee section with the crest at elevation 2,405 feet (733 m). Two spillway tainter gates, 48 feet (14.6 m) wide and 59 feet (18.0 m) high, can be used in reservoir regulation between the spillway crest and NFP of 2,459 feet (749.5 m). Maximum spillway capacity at NFP is 150,000 cubic feet per second (cfs) (4,248 cubic meters per second (m^3/s)). Whenever the forebay water surface is above the spillway crest, the spillway will be used for reservoir regulation before using the sluices. The total spillway discharge will be equally divided between the two spillway bays. Spillway details and the spillway rating curve are shown on Plate 2-6 and Plate 2-13, respectively.

(2) Sluices

The sluice outlet system includes three sluices individually regulated by a 10-foot-wide by 17-foot-high (3.0-m-wide by 5.2-m-high) hydraulically operated tainter gate. The sluices have an intake invert at elevation 2,201.5 feet (671 m) and empty into the spillway stilling basin. One roller gate designed to close under maximum discharge at full head is provided for emergency closure and is transferable for use in any sluice as required. The three radial sluice gate outlets at Libby Dam are designed for a total discharge of about 60,000 cfs (1,699 m^3/s) at a pool elevation of 2,459 feet (749.5 m). Cavitation and air supply to the sluices was recognized as a problem soon after the project became operational in 1972, and several modifications have been made to the sluiceways and associated air vent facilities since 1974 in an attempt to improve airflow characteristics and allow full use of the gates. The most recent modification, addition of air vent divider panels in 1981, has proven to be vulnerable to structural and performance issues. The Air vent dividers have been removed, and bulkhead doors have been put in place at the access areas. The Bulkhead doors stabilize the air flow in the dam and help direct the air flow from the air vents to the Sluices.

(3) Stilling Basin

The stilling basin is a conventional hydraulic jump type which provides energy dissipation for both sluice and spillway flow. The basin is designed for a discharge of 50,000 cfs (1,416 m^3/s) with a tailwater elevation corresponding to a discharge of 60,000 cfs (1,699 m^3/s), which includes a 10,000 cfs (283 m^3/s) powerhouse discharge. A release of 60,000 cfs (1,699 m^3/s) is approximately the 200-year outflow. Discharges greater than the basin design capacity will move the toe of the hydraulic jump farther and farther downstream as the discharge increases. At approximately 90,000 cfs (2,549 m^3/s), the flow will sweep out of the basin with a resulting flow trajectory rising over 100 feet (30.5 m) into the air and then fall to impact in the exit channel in the vicinity of the Thompson Bridge. The impact of this trajectory will result in considerable damage to the channel, the bridge, and the powerline transmission tower located on the right bank just upstream from the bridge. These flow

conditions will not compromise the integrity of the dam. The basin has a width of 116 feet (35.4 m), a length of 275 feet (83.8 m), and a floor elevation of 2,073 feet (632.2 m). The basin design was verified by hydraulic model tests at the NPD Hydraulic Laboratory. The stilling basin is shown on Plate 2-4, which also shows the complete project layout.

(4) Selective Withdrawal System (SWS)

A multiple-bulkhead intake system permits selective withdrawal of water from a water column of selected depth above elevation 2,222 feet (677.3 m) for discharge through the powerhouse. The SWS helps to regulate water quality constituents--primarily temperature--in waters released from the project through the powerhouse. The system consists of a concrete housing for bulkheads and guides attached to the upstream side of the dam over the penstock intakes. Each guide accommodates up to 22 10-foot-high (3.0-m-high) steel bulkheads. The bulkheads are stacked by gantry crane in the guide slots until the desired water is diverted over the top of the stacked bulkheads into the penstock intakes. As a safety measure, 69 of the gates are equipped with pressure-relief panels to ensure the turbines are never starved for water. The framework extends approximately 240 feet (73.2 m) below the full pool surface and is equipped with guides to allow for the stacking of gates. The SWS framework is partitioned into two “wet-wells,” one common to units 1-4 and the other common to Unit 5 and the unused units 6-8. SWS operation protocol calls for maintaining at least 30 feet (9.1 m) of submergence on the top row of gates stacked in the framework to prevent the formation of vortices and allow for stable and damage-free operation of the turbines.

The SWS works by taking advantage, when possible, of temperature stratification that occurs in the reservoir. Such temperature stratification typically occurs due to differences in water density, where colder water is found lower in the reservoir behind the dam, and warmer water is found closer to the surface. When warmer discharge water is desired through the powerhouse, and temperature stratification is present, gates are stacked in the SWS framework, forcing the warmer water from higher in the water column to be drawn through the powerhouse. Conversely, when colder water is desired, the bulkheads are removed, and colder water is drawn through the powerhouse. Powerhouse discharge temperatures cannot be managed to be either warmer or colder than the warmest or coldest temperatures present in the reservoir water column. Practically speaking, it is impossible to manipulate the SWS to provide powerhouse discharges that are the temperature of either the warmest or coldest temperatures in the water column due to mixing of the layers. Temperature stratification, key to the using the SWS to manipulate powerhouse release temperatures, has proven to be unstable, particularly in May and early June when it starts to form. Changes in meteorological conditions, reservoir inflow volume and reservoir inflow temperature can alter or eliminate temperature stratification in a short amount of time. The SWS is shown on Plate 2-4 and Plate 2-5.

d. Powerhouse

An indoor powerhouse, architecturally treated to smoothly connect with the face of the dam, is located at the base of the dam as shown on Plate 2-4. A longitudinal section with bays 1 through 8 and the transverse sections of the erection bay and generator bays are shown on Plate 2-8 and Plate 2-9, respectively. Penstock details are shown on Plate 2-10. The powerhouse contains eight generator bays, five units in operation (units 1 through 5),

three partially completed units (units 6 through 8), auxiliary mechanical and electrical control equipment, an erection bay, a powerhouse control room located in the generator bay section, and maintenance areas and equipment. Units 6 through 8 are partially complete (turbines are installed; generators and electrical control equipment have been manufactured and are stored in the powerhouse). The eight hydroelectric units are nearly identical in design. The turbines are Allis Chalmers Francis-type vertical shaft and are rated 165,000 hp at a rated net head of 300 feet (91.4 m). The generators are Westinghouse vertical shaft, 128.6 revolutions per minute synchronous speed, and rated 110,526 kilovolt amperes at a rated power factor of 0.95. The nameplate rating is 105,000 kW, and maximum continuous output is 120,750 kW (115% nameplate rating at 0.95 power factor). The penstocks are 20 feet (6.1 m) in diameter.

The individual turbine hydraulic capacity at rated output is 5,400 cfs (152.9 m^3/s) and the powerhouse hydraulic capacity of the five-unit installation is 27,000 cfs (764.6 m^3/s). Turbine cavitation limits applied during normal operation slightly reduce the hydraulic capacity of each unit to about 5,300 cfs (150.1 m^3/s) and the five-unit powerplant to that of 26,500 cfs (750.4 m^3/s). Full gate operation of the five-unit powerplant at rated net head and a power factor of 1.00 increases the hydraulic discharge to about 28,750 cfs (814.1 m^3/s); however, the system power factor is rarely at unity. Unit 2 was calibrated in 1976 by the Gibson method and found to compare favorably with performance characteristics based on initial turbine model tests. Unit performance curves are shown on Plate 2-15 and Plate 2-16. Maximum unit output during normal operation is scheduled in accordance with Table 2-2.

The generator floor elevation is 2,148 feet (654.7 m), 4 feet (1.2 m) above the tailwater elevation (elevation 2,144 feet (653.5 m)) corresponding to the spillway design flood.

e. Transformers

Libby's main transformers are three-winding, three-phase transformers rated 256 MVA, 230 kV to 13.2 kV. Transformer T1 connects Unit 1 and Unit 2 to Transmission Line 1, Transformer T2 connects Unit 3 and Unit 4 to Transmission Line 2, and Transformer T3 connects Unit 5 to Transmission Line 2. The transformers are located adjacent to the upstream side of the Powerhouse.

f. Switching Equipment

Bonneville Power Administration (BPA) owns and operates the high voltage breakers in the 230/115 kV BPA switchyard which connects the project to BPA's three transmission lines. Two of the transmission lines are 230 kV and the third is 115 kV. The switchyard is located on the left bank of the river approximately 1 mile (1.6 km) downstream. The project maintains motor operated disconnects and the transformers onsite.

Table 2-2. Maximum Generation to Comply With Cavitation Guarantee[1/]

Gross Head	Maximum Load	Gross Head	Maximum Load	Gross Head	Maximum Load	Gross Head	Maximum Load
340	120	272	102	241	82	210	63
320	120	271	101	240	82	209	62
310	120	270	100	239	81	208	62
300	119	269	100	238	80	207	61
299	113	268	99	237	80	206	60
298	118	267	98	236	79	205	60
297	117	266	98	235	78	204	59
296	117	265	97	234	78	203	58
295	116	264	97	233	77	202	58
294	115	263	96	232	77	201	57
293	115	262	95	231	76	200	57
292	114	261	95	230	75	199	56
291	113	260	94	229	75	198	55
290	112	259	93	228	74	197	55
289	111	258	93	227	73	196	54
288	110	257	92	226	73	195	53
287	110	256	92	225	72	194	53
286	109	255	91	224	72	193	52
285	109	254	90	223	71	192	52
284	109	253	90	222	70	191	51
283	108	252	89	221	70	190	50
282	108	251	88	220	69	189	50
281	107	250	88	219	68	188	49
280	107	249	87	218	68	187	48
279	106	248	87	217	67	186	48
278	105	247	86	216	67	185	47
277	105	246	85	215	66	184	47
276	104	245	85	214	65	183	46
275	103	244	84	213	65	182	45
274	103	243	83	212	64	181	45
273	102	242	83	211	63	180	44

[1/]Gross head and maximum load units are shown in feet and megawatts, respectively, for a single unit. Data are based on the requirements contained in the turbine contract specifications.

g. Gages

Lake Koocanusa (forebay) elevation is recorded at a stilling well in the dam. Project discharge and water quality is measured at USGS gage Kootenai River below Libby Dam, located 0.7 mi (1.1 km) downstream of the dam. The Kootenai River stage (not discharge) is recorded at the principal flood damage reduction control point; USGS gage Kootenai River

at Bonners Ferry, Idaho. Another principal downstream gage is Kootenay Lake Elevation at Queens Bay, British Columbia.

2-4 RELATED CONTROL FACILITIES

There are no related control facilities at Libby Dam.

2-5 INCIDENTAL FACILITIES

a. Fish Hatchery

Libby Dam Project includes the Murray Springs Fish Hatchery which was developed to mitigate project-related fishery losses caused by the construction and operation of Libby Dam. The hatchery is located 38 miles (61.2 km) north of Libby Dam and 3 miles (4.8 km) west of Eureka, Montana. The Montana Department of Fish, Wildlife and Parks (MFWP) operates and maintains the hatchery under a contract with the Federal Government. Montana hatches and rears westslope cutthroat trout to be placed in the waters of northwest Montana. Additionally, as practical and cost effective, they maintain inland rainbow trout for management of the Lake Koocanusa resource.

b. Drift Control

The Lake Koocanusa drawdown ranges from about 32 feet (9.8 m) to 172 feet (52.4 m), with median annual drawdown of 61 feet (18.6 m). This reservoir fluctuation together with the relatively high spring runoff into the reservoir causes some debris to collect along the shoreline. Due to the prevailing southerly wind direction, most of the debris is blown toward the north end of the reservoir. In the U.S. portion of the reservoir, the U.S. Forest Service has the responsibility for overall drift control with the USACE being responsible for a small portion of the reservoir between Libby Dam and the Souse Gulch 2,000 feet (609.6 m) upstream of the dam. Until 1983, a log boom was placed across the reservoir at Souse Gulch to protect the southern part of the reservoir from river borne debris. Safety booms now located at the dam to protect boaters from the spillway and penstock intakes provide some debris protection although they are not specifically intended for this purpose. Drift control in the Canadian portion of the reservoir is managed by the British Columbia Department of Lands, Forests, and Water Resources.

2-6 REAL ESTATE ACQUISITION

Real estate for the Libby Dam Project includes lands in the immediate vicinity of the dam, lands within and bordering the reservoir, and land for the Murray Springs Fish Hatchery complex located 3 mi (4.8 km) northwest of Eureka, Montana. Reservoir lands in the Canadian portion of Lake Koocanusa were provided and prepared by Canada in accordance with Article XII (4) of the Columbia River Treaty and are entirely under Canadian administration. Reservoir lands in the United States extend to the project boundary located landward of NFP elevation 2,459 ft (749.5 m) according to a 300 ft (91.4 m) horizontal and 300 ft (91.4 m) vertical setback distance.

All reservoir lands in the United States are federally owned and administered by the U.S. Forest Service. Lands administered by the USACE total 1,922.90 acres (778.17 hectares), with 1,194.8 acres (483.52 hectares) of the total acreage being within the vicinity of the

project (Plate 2-11). The 78.21 acres (31.65 hectares) Murray Springs Fish Hatchery complex includes lands for the hatchery, a buffer zone, and improved access to Murray Springs Creek and Lake Koocanusa. The remaining acreage includes a 62.76 acres (25.40 hectares) Fisher River quarry, the 6.68 acres (2.70 hectares) Brimstone-Sunday Creek Road, the 0.23 acres (0.09 hectares) Town of Rexford Well Site, the 48.22 acres (19.51 hectares) Pacific Northwest Trail, the 149.96 acres (60.69 hectares) Highway 37 Right-of-Way and the Cattle Drive Trail, and the remaining 381.86 acres (154.53 hectares) acquired in fee for construction of the Reregulating Dam Project.

The following three wildlife areas were acquired by the USACE for the mitigation of lost, critical winter habitat for big game--including deer, elk, moose, and bighorn sheep--caused by construction of the project.

- DeRozier Creek Unit (4 miles (6.4 km) north of Eureka, Montana)—1,417.0 acres (573.44 hectares)
- West Kootenai Unit (5 miles (8.0 km) north of Rexford, Montana)—920.12 acres (372.35 hectares)
- Kootenai Falls Unit (6 miles (9.7 km) northwest of Libby, Montana)—106.69 acres (43.17 hectares)

The three mitigation units were transferred under Public Law 93-251 to the MFWP for development, operation, and maintenance in accordance with the 10 February 1976 Memorandum of Understanding executed among the USACE, the MFWP, and the U.S. Fish and Wildlife Service (USFWS).

2-7 PUBLIC FACILITIES

Lake Koocanusa boating facilities in the United States are given in Table 2-3. The following public recreation facilities are associated with Libby Dam Project (Plate 2-17).

a. USACE

(1) Souse Gulch Day-Use Area

Day-use facilities in this management unit complement the visitor accommodations available at the Visitor Center and dam. Major facilities include a boat ramp, three picnic shelters with two barbecue stoves, one sink, four concrete picnic tables each, one volleyball court serving shelters two and three, two horseshoe pits, two modern restrooms, a vault toilet, one concrete floating dock with ramp (with an optimum operating range between elevations 2,308 feet (703.5 m) and 2,459 feet (749.5 m)), associated parking, and two plastic adjustable floating platforms to accommodate various lake levels. The general area has 28 additional picnic tables, 11 water fountains, 11 trash receptacles, and 13 fireplace units. Two playground areas are part of the unit. A network of nature and hiking trails extends along the shoreline and through the wooded areas of the site and provides a link to the Visitor Center area. An 18-hole disc golf course covers the unit as well.

(2) Libby Dam Visitor Center

Libby Dam has a Class B Visitor Center with interactive exhibits for all ages. One of the main draws in recreation to Libby Dam is the guided tours provided by the staff and the operation of Libby Dam Visitor Center. Tours are available at 10 AM and 4 PM daily from Memorial Day weekend through Labor Day weekend.

(3) Downstream Day-Use Area

Three primitive overnight camping sites and boat access provide visitor accommodations close to the dam and fishing access to the Kootenai River. Campsite facilities include picnic table, fire ring, pull in parking and tent site, two vault toilets, and primitive boat access. A trail runs between the downstream area and Dunn Creek campground.

(4) Alexander Creek Campground

Two primitive overnight camping sites and boat access provide visitor accommodations close to the dam and fishing access to the Kootenai River. Campsite facilities include picnic table, fire ring, pull in parking and tent site, two vault toilets, and primitive boat access.

(5) Blackwell Flats Campground

The area is frequented by fishermen who either fish from the banks or launch small boats from a gently sloping primitive boat ramp. In the summer, the area receives overnight and limited day use. Seven semi-developed campsites within close proximity to the Kootenai River provide overnight camping. One vault toilet centrally located in the campground provides visitor accommodations along with picnic tables, fire rings, and campsites. Additional public uses include picnicking and bird watching.

(6) Dunn Creek Campground

Currently the area provides day-use and overnight camping as well as river access and wildlife viewing opportunities. Thirteen semi-developed picnic/campsites have been added to accommodate visitors. The campsites are enhanced by their close proximity to the Kootenai River. One site meets accessibility requirements, there are two accessible vault toilets, and potable water is available. The area has one developed boat launch facility for launching small to medium craft and emergency vessels, with a seven-car/trailer parking lot. The area is frequented by anglers who either fish from the banks or launch their boats. Anglers are provided parking and fishing access trails to the river at various points. Additional public use includes picnicking, bird watching, and nature study. A trail extends along the former Burlington Northern Santa Fe Railroad grade from this area, through the Dunn Creek Environmentally Sensitive Area, to the parking lot at the left bank visitor area near the dam. A small amphitheater where campfire programs are given during the summer months is also located in the management unit.

(7) Left Abutment Visitor Area

Visitor accommodations include an 18 car and three car-trailer parking lot on the upstream side of the dam. A sidewalk parallels the reservoir providing a view of the

upstream face of the dam, the reservoir, and Souse Gulch day-use area on the right bank. Two picnic tables are provided for day-use picnicking. A pedestrian ramp leads visitors under the dam roadway to a viewpoint on the downstream side of the dam. This point provides an excellent view of the downstream face of the dam, the powerhouse, and the downstream area. Comfort station facilities are built into a partially buried structure against the MSH 37 roadbed. A visitor orientation kiosk was built through a partnership with Flathead Valley Community College in 2005.

b. U.S. Forest Service

(1) During the construction of Libby Dam, the USACE built recreational facilities on Lake Koocanusa and turned them over to the U.S. Forest Service (USFS) for ownership and management.

(2) Camping and recreation facilities on Lake Koocanusa include: McGillivray, Barron Creek Boat Ramp, Yarnell Island, Rocky Gorge, Peck Gulch, Rexford Bench Complex, Tobacco Plains, and Gateway Boat Camp.

c. Commercial – Privately Operated

(1) Koocanusa Resort and Marina is a private lease of the USFS. The facility contains campgrounds, day use, boat ramp, dock facilities, camp store, and restaurant.

(2) Abayance Bay is a private facility near Rexford, Montana. This facility has camping, day use, boat ramps, dock facilities, and a camp store.

Table 2-3. Lake Koocanusa Boating Facilities in the U.S.

Name of Ramp	Minimal Usable Boat Ramp Elevations (feet)
Barron Creek	2,440
Tobacco Plains	2,433
Abayance Bay	2,420
McGillivray	2,385
Rocky Gorge	2,370
Rexford Bench	2,341
Peck Gulch	2,340
Koocanusa Resort and Marina	2,334
Souse Gulch	2,310

CHAPTER 3—HISTORY OF PROJECT

3-1 AUTHORIZATION FOR PROJECT

Libby Dam Project was authorized by Public Law 81-516, Flood Control Act of 17 May 1950, 81st Congress, Second Session, substantially in accordance with a plan set forth in House Document 531, 81st Congress, Second Session. House Document 531 indicated that the project would provide benefits of flood control, power generation, navigation, fish and wildlife conservation, and recreation. The reservoir created by Libby Dam was officially designated Lake Koocanusa by Public Law 91-625, dated 31 December 1970. Since the mid-1970s, the official project name has been Libby Dam and Lake Koocanusa project.

3-2 PLANNING AND DESIGN

a. Planning

A plan for multiple-purpose storage development on the Kootenai River was initially reported in House Document 531 as part of the comprehensive plan for water resource development of the Columbia River and tributaries for flood risk management, navigation, hydroelectric power, irrigation, recreation, and other purposes. Development on the Kootenai River was intended to provide flood control and hydroelectric power as well as to benefit navigation and recreation. Libby Dam Project as proposed in House Document 531 included a dam at Kootenai RM 212.8 (RK 342.5), a powerplant with a six-unit initial installation and 10-unit ultimate installation (all units rated 135,000 horsepower (hp) and 98,000 kilowatts (kW)), and a reservoir which would extend northward into Canada. Because the reservoir would require land in Canada, Canadian approval of the project was necessary. Accordingly, the project plan was presented to the International Joint Commission (IJC), the permanent governing commission authorized by the Boundary Waters Treaty of 1909 to administer Canadian-American boundary water issues.

On 01 November 1950, the Columbia River Engineering Board presented the “Interim Report on Kootenay River” to the IJC which recommended project development. On 12 January 1950, the United States applied to the IJC for approval to construct Libby Dam, but the application was subsequently withdrawn. Public hearings on the Libby Project held in several locations in Canada and the United States during March 1951 revealed widespread project support. In 1954, an amended construction application submitted by the United States to the IJC stalled over the problem of compensation for project impacts. Progress on Libby Project was not revived until 1961 when Congress endorsed the “Treaty between Canada and the United States of America Relating to Cooperative Development of the Water Resources of the Columbia River Basin” (The Columbia River Treaty). The Columbia River Treaty was signed by President Eisenhower and Prime Minister Diefenbaker on 17 January 1961 and consummated by both governments on 16 September 1964.

b. Design

Design of Libby Dam, the powerhouse, and extensive highway and railroad relocations were accomplished during the 1960s. The damsite at RM 221.9 (RK 357.1) was selected over several alternative locations after comprehensive investigations of the foundation and materials, evaluation of economic costs, and consideration of public preference. The

powerhouse was designed for two-phase development—the first phase to include four units to be completed about 1975, and the final phase to include four additional units (eight-unit ultimate development) to be completed about 1985 depending on Pacific Northwest electric power needs. All units were rated 165,000 hp and 120,750 kW. Planning and design of units 5 through 8 were completed during the mid-1970s, including investigation of a reregulating project (reregulator) to smooth river fluctuations caused by daily peaking operation of units 5 through 8. The final phase of the powerplant development, consisting of units 5 through 8 and the reregulator is officially known as the Libby Additional Units and Reregulating Dam (LAURD) project. Public objection to the LAURD project developed during the mid-1970s because of concerns over the loss of free-flowing river within the reregulator reservoir reach and the use of the reregulator to smooth only the river fluctuations resulting from units 5 through 8. Under the LAURD plan, approved tailwater criteria established for use at Libby Dam would have applied at the reregulator upon development of the eight-unit Libby Dam powerplant. Tailwater criteria were:

- Normal minimum discharge 4,000 cfs (113.3 m^3/s)

Development of a powerplant at the reregulator was included in the comprehensive plan. A hydropower plant planned for the reregulator is identified as the Libby Reregulating Dam Power Units (LRDPU) project. River regulation is the primary objective of the reregulator, and hydropower is a secondary purpose.

c. Litigation

In June 1978, three organizations - Libby Rod and Gun Club, Montana Wildlife Federation, and Montana Wilderness Association filed a complaint in United States District Court, Missoula, Montana Division, against the District Engineer, CENWS, to halt construction of the LAURD project. Complaints centered on the following four issues:

- Congress had not specifically authorized the LAURD project.
- The LAURD project was in violation of the Endangered Species Act as related to the bald eagle.
- The environmental impact statement (EIS) was not sufficient.
- The project economic analysis did not comply with Water Resources Council (WRC) Principles and Standards.

Following several appeals and related court decisions concerning the first issue, a three-judge panel of the 9th Circuit Court issued a split decision on 15 March 1979 that units 5 through 8 were authorized but the reregulator was not. Accordingly, construction of units 5 through 8 continued, but construction of the reregulator was halted. Manufacturing of the turbines and generators for units 5 through 8 was nearly complete at the time of the court decision. Because hydroelectric operation at Libby Dam must comply with the approved tailwater criteria, an eight-unit powerplant could not operate efficiently without a reregulator. Accordingly, in appropriating funds for FY 1982 and remaining years, Congress limited installation to only Unit 5. Unit 5 generates most of the remaining undeveloped potential

energy from spilled water during flood risk management drawdown and freshet runoff and serves as a backup unit in case of mechanical breakdown of any of units 1 through 4.

The last three issues listed were never resolved by the courts; however, they were subsequently investigated and resolved to the satisfaction of the USACE as follows: A consultant's investigation of the endangered species issue resulted in a beneficial finding for the LAURD project; an EIS supplement was prepared in response to comments relating to the sufficiency of the original EIS; and the economic feasibility of the LAURD project has been verified based on the latest WRC Principles and Guidelines (08 July 1983).

3-3 CONSTRUCTION

A summary of Libby Dam construction activities is presented in Table 3-1.

Table 3-1. Resumé of Construction Activities

Activity	Date
Construction begins	30 June 1966
Excavation begins	April 1967
First mass concrete pour	01 June 1968
Commencement of first pool raise	21 March 1972
Last concrete poured on dam structure	Spring 1973
Dam construction complete	09 July 1973
Full pool achieved	29 July 1974
Unit 1 in service	August 1975
Project dedication	24 August 1975
Unit 2 in service	October 1975
Unit 3 in service	January 1976
Unit 4 in service	March 1976
Sluice gate concrete cavitation and repair	1976
Aeration slots added to sluiceways	1982
Unit 5 in service	December 1984
Unit 3 stator failure and rewind	1995
Unit 1 Stator rewind	1996
Visitor Center office space expansion	September 1996
Building 2 storage building construction	1998
Intake crane rehabilitation	1998
Administration building construction	1998
Powerhouse crane rehabilitation	2001
Technical Section office construction	2010
Electrical distribution upgrade	2014
Digital Gov upgrade	2016
Recreation volunteer campground addition	2016
Hydro Critical Spare Storage Facility	2017
Powerhouse crane rehab	2018
Control room upgrade	2024
Intake crane replacement	2025 (estimated completion)
Unit 6	2027 (estimated completion)

Libby Dam Project required relocation of 60 miles (96.6 km) of Great Northern Railroad main line, a 7 miles (11.3 km) railroad tunnel (the second longest in North America), relocation and construction of 135 miles (217.3 km) of roads and highways, placement of 3,800,000 cubic yards (yd^3) (2,905,308 m^3) of concrete in Libby Dam and clearing of 50,000 acres (20,234 ha) of land in Lake Koocanusa. Actual cost of the project was approximately $486 million (October 1981 prices). The estimated cost of the Libby additional units (units 5 through 8) is estimated to be $52.8 million (October 1983 prices)

3-4 RELATED PROJECTS

a. Kootenai Flats Levees and Pumping Facilities

Kootenai Flats is an area downstream of Bonners Ferry, Idaho occupying the Kootenai Valley from Bonners Ferry north about 43 mi (69.2 km) to the main body of Kootenay Lake. The valley is generally 2 to 3 mi (3.2 to 4.8 km) wide and flat and includes approximately 72,000 acres (29,137 hectares) of rich farmland. The river is confined by non-Federal levees virtually all the way from Bonners Ferry to Kootenay Lake. The valley is subdivided into 18 levee districts in the U.S. portion and similarly subdivided on the Canadian side. Most of the levee districts operate facilities to pump interior runoff and ground water to facilitate agricultural activities in the Flats area.

b. Corra Linn Dam and Kootenay Lake

Kootenay Lake is approximately 70 mi (112.7 km) long in the north-south direction and drains through the West Arm. The lake elevation is controlled by Corra Linn Dam except during the peak of the spring/summer freshet when the lake is put on freeflow where the discharge control shifts from Corra Linn Dam about 8 mi (12.9 km) upstream to the natural lake outlet at Grohman Narrows. The lake typically reaches elevation 1,748 ft (532.8 m) during the freshet in an average runoff year but may reach elevation 1,752 ft (534.0 m) or higher in a very high runoff year. The maximum lake elevation is restricted by the “1938 Kootenay Lake Order” from the International Joint Commission, dated 11 November 1938, and aside from the freshet, the lake is operated to be in the 1,739.32 ft (530.14 m) to 1,745.32 ft (531.97 m) elevation range. Backwater effects from Kootenay Lake extend upstream to Bonners Ferry, Idaho.

c. Columbia River System

The Libby Project is an integral member of the CRS. Operation is coordinated with other system members. See references listed in Section 1-03 for more detailed information on Libby Project’s relationship to Columbia System operation.

3-5 DAM SAFETY HISTORY/ISSUES

Libby Dam has a Dam Safety Action Classification (DSAC) rating of 3, reflecting the moderate incremental risk associated with the project. Based on the outcome of the quantitative risk assessment from the 2024 Issue Evaluation Study (IES), the incremental risks are primarily driven by the following three concerns: 1) Overtopping of the right abutment during an extreme flood event leads to erosion of material downstream of the dam eventually causing monolith instability and a larger breach and uncontrolled release of water; 2) Deep-seated movement of the left abutment rock wedge causes monolith displacement

and an associated uncontrolled release of water; and, 3) An upstream rock slide-induced wave overtops the dam, leading to an uncontrolled release of water.

The largest contributor to risk at Libby Dam is associated with the deep-seated movement detailed in concern number 2 above, resulting in adversely oriented intersecting shear zones and bedding planes within the left abutment foundation triggered by seismic loading during normal pool conditions. No significant seismic events have been recorded at Libby Dam since the construction of the project. Both historic and pre-historic rockslides have occurred along the eastern (left) side of the reservoir and at the dam during construction. The two pre-historic rockslides were known to be very large slide events, both occurring along the rock geometry in the left abutment repeating features referred to as rock ribs. These slides occurred within 3,000 feet of the dam location. A smaller slide located near the dam axis during construction happened in 1971 and is likely related to the removal of the passive resistance at the toe of a rock wedge when the State highway along the left abutment was constructed. After the construction-related slide was cleared away, instrumentation and rock anchors were installed in the remaining hanging wedge. Subsequent analysis indicated the hanging wedge is slowly moving downslope and likely to fail onto the highway. A real-time radar instrument was later installed and monitored by dam safety instrumentation staff to reduce risk to travelers on the road by potentially providing advance notice of an impending rockslide. A slide of the hanging wedge is not expected to impact dam safety risk. Incremental project risk at the dam is related to movement of a deep-seated wedge of rock that underlies multiple monoliths on the left abutment.

Per guidance from ER 1110-2-1156, Safety of Dams – Policy and Procedures, all USACE dams with a DSAC rating of 1, 2, or 3 require an Interim Risk Reduction Measure Plan (IRRMP). The purpose of an IRRMP is to recommend short-term actions to reduce dam safety risk while long-term solutions are sought. As of 2024, the Seattle District has proposed to implement the following four Interim Risk Reduction Measures: 1) Update the IRRMP; 2) Update the Emergency Action Plan; 3) Update the Risk Communication Plan based on the findings of the IES; and 4) Review and improve the Surveillance and Monitoring Plan based on the findings of the IES.

3-6 PRINCIPAL REGULATION ISSUES

The following problems involving levees and channels downstream of Libby Dam have developed since completion of Libby Dam Project. Reservoir regulation procedures are coordinated to prevent or reduce these problems whenever possible.

a. Sluice Operation

Operation of the sluices has been problematic since the project became operational in 1972. Total dissolved gas is very high and injurious or fatal to fish with sluice operation relative to powerhouse or spillway discharge. Similarly, air supply and cavitation have been ongoing problems and various measures have been attempted to alleviate the issues with limited success. General guidance is that sluices will only be used as a discharge conduit if regulation objectives cannot be met with discharge through the powerhouse and spillway. See Chapter 2 for more descriptive information and Chapter 7 and Exhibit 2-1 for operational constraints.

b. Kootenai Flats Drainage and Erosion

Seasonal storage regulation at Libby Dam Project has eliminated much of the flood potential on the Kootenai River while increasing average wintertime streamflows required for hydropower and flood risk management storage drawdown. In the vicinity of Bonners Ferry/Kootenai Flats, Idaho, increased river depths during the winter due to higher streamflows have restricted gravity outflow from some leveed areas and have increased river seepage through some levees into protected lands. In 1974, Congress passed Public Law 93-251 which provided $1.5 million to help defray additional costs for pumping, pumphouse improvements, and drainage and erosion damages to Kootenai Flats farmlands as a result of Libby reservoir drawdown. Landowners filed damage claims which were evaluated and approved claims were paid until the entire $1.5 million was expended. No additional claims will be paid as PL 93-251 is the only existing authority for these claims.

Non-Federal levees in the Kootenai Flats area were built prior to construction of Libby Dam and all those levees that are intact have top elevations significantly greater than that required to provide 0.5% exceedance (200 year) flood protection. However, with rare exceptions, levee maintenance of these non-Federal levees has been grossly inadequate, and levees are badly eroded at many locations. To date, no levee failure has resulted in flooding of unleveed land. For additional information, reference the April 2007 Levee Inspection report.

Sections of levee have been removed at some locations. The most obvious example is at Bonners Ferry on the left bank in the vicinity of the Kootenai River Inn, where approximately 12 feet (3.7 m) has been removed from the top of the levee leaving a levee with top elevation near 1,768 feet (538.9 m). With the decreased levee height, the inn now experiences first-floor flooding at a water surface elevation of approximately 1,769 feet (539.2 m).

Since Libby Dam became operational, Kootenai River flooding in the Kootenai Flats area has been limited to areas where levees have been lowered or otherwise compromised, where development has occurred in flood prone areas, and where minor damage has occurred on unleveed land.

c. Downstream Effects

Although Libby Dam Project has reduced floods on the Kootenai River mainstem, tributary streams continue to flood periodically and carry bedload material and debris into the Kootenai River. Prior to Libby Dam, flooding of the river and its tributaries usually occurred coincidentally causing tributary bedload materials to be flushed and widely dispersed. Now, reduced river flow during flood regulation and operation at Libby Dam Project allows tributary bedload materials to settle and form deltas at the creek mouths when slower moving river water is encountered. The deltas may then cause the Kootenai River to realign causing localized channel bank erosion and damage—Libby Creek at Libby, Montana, is a prime example of this problem. Although the USACE has no authority for direct support in this particular instance, reservoir regulation support is provided whenever possible to assist debris disposal operations.

3-7 MODIFICATION TO REGULATIONS

a. Variable Project Discharge (Q) (VARQ FC)

VARQ FC stands for variable project discharge (Q) flood control (FC).

(1) Original Plan for Flood Operation (Standard Flood Control)

The original plan for flood operation for Libby Project was developed as part of the design of the project. This plan is referred to as “standard flood control.” Spring reservoir drawdown was variable as specified by a Flood Control Storage Reservation Diagram (SRD) based on forecasts of April through August runoff volume. Flood risk reduction operation was initiated 15 days prior to the “initial control flow” date for the Columbia River at The Dalles (since changed to 10 days in the updated Columbia River Treaty Flood Control Operating Plan, 2003). Typically, project discharge would be reduced to 4,000 cfs (113.3 cms), and that discharge would be held throughout the freshet period until the project refilled. This operation provided flood risk reduction both locally on the Kootenai River and on the lower Columbia River. The operation had two principal disadvantages: associated SRDs required large reservoir drawdown that resulted in relatively frequent refill failure; 4,000 cfs (113.3 cms) control flow was much lower than unregulated (natural) discharge which was disadvantageous to the fishery.

(2) Development of VARQ FC

The State of Montana began a modeling effort in the mid-1980s in an attempt to find an operation that offset the disadvantages of standard flood control. Generally, the concept was to develop new SRDs that required less winter/spring reservoir drawdown and to provide higher in-stream flows in the spring for fish and wildlife protection while not compromising the ability to protect for downstream flooding. CENWS and CENWD became actively involved in investigating the possibility of adopting a VARQ FC type operation for Libby in the early 1990s. The 6 September 1994 listing of Kootenai white sturgeon under the Endangered Species Act provided a strong incentive to seriously consider a revision to the Water Control Plan, in place since the project became operational in 1972. The 2000 FCRPS BiOps from USFWS and National Oceanic and Atmospheric Administration (NOAA) Fisheries included implementation of VARQ FC procedures for Libby Dam, pending NEPA compliance and coordination with Canada. VARQ FC was integrated into the plan of operation for Libby Project on an interim basis in 2003 pending completion of the EIS in April 2006 and VARQ FC was formally incorporated into the Libby Water Control Plan upon signing of the Record of Decision on 06 June 2008. See the Water Control Plan, Section 7, for details of VARQ FC operation.

b. Revised Bonners Ferry Flood Stage

The original Water Control Plan for Libby Project adopted elevation 1,770 feet (539.5 m) (27 feet stage (8.2 m stage)) on the Kootenai River at Bonners Ferry gage as the principal limit for local flood risk reduction. That control objective was based on previous flood fight experience and the condition of levees in the Kootenai Flats area at the time Libby Project became operational. Levee deterioration and encroachment have caused damage to be encountered at lower elevations. Local interests, especially in the Bonners Ferry area,

have urged the National Weather Service, the official U.S. Government agency responsible for designating flood stage, to designate flood stage at a lower elevation. By letter dated 25 September 1996, the National Weather Service specified elevation 1,764 feet (537.7 m) as flood stage at the Bonners Ferry gage. Libby Project is presently operated to the extent feasible to not exceed elevation 1,764 feet (537.7 m) at Bonners Ferry recognizing that in some situations over filling of the reservoir or excessive local inflow in the reach between the dam and Bonners Ferry will cause elevation 1,764 feet (537.7 m) to be exceeded.

c. Operations for Fisheries as Required by the Biological Opinions (BiOps)

Environmental legislation including NEPA and Endangered Species Act (ESA) have been enacted subsequent to the original plan for operation of Libby Project and have resulted in new constraints of project operation. Libby operation is required to be in accord with the most current U.S. Fish and Wildlife Service and National Marine Fisheries Service BiOps. Each year, CENWS Water Management Section (CENWS-ENH-W) takes the lead in developing an annual Water Management Plan. Typically, representatives of the Federal Action Agencies—USACE, the Bureau of Reclamation (Reclamation), and BPA—meet periodically with representatives of the U.S. Fish and Wildlife, National Marine Fisheries, and State and Tribal fishery agencies and reach consensus on a detailed plan of operation for projects that have BiOp requirements. This group is called the Technical Management Team (TMT). Requests to deviate from or refine planned, existing, or BiOp recommended operations using adaptive management may be brought to the team for consideration. These requests are called System Operational Requests (SOR). Details of the processes followed by the TMT are described in Exhibit 3-1, Guidelines for Technical Management Team.

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CHAPTER 4—WATERSHED CHARACTERISTICS

4-1 GENERAL CHARACTERISTICS

The Kootenai River drains an area of 19,300 sq. mi (49,987 sq. km), including 8,985 sq. mi (23,271 sq. km) above Libby Dam. Three-fourths of the total drainage lies within British Columbia. The Kootenay River (Canadian spelling) has its source high in the Canadian Rockies near the easterly border of British Columbia. The river flows southward until it enters Lake Koocanusa, about 42 RM (68 RK) north of the international boundary. The reservoir lies generally in a north-south direction with 42 miles (68 km) in Canada and 48 miles (77 km) in Montana. The drainage basin above Libby Dam is roughly diamond-shaped with a 200 miles (322 km) length and 90 miles (145 km) maximum width. Major tributaries in the basin (Plate 2-3) include the Tobacco River in Montana and the Elk, Bull, White, and St. Mary Rivers in British Columbia. Downstream from Libby Dam, the Kootenai River begins a 116-mile (187-km) northwesterly course that flows 50 miles (80 km) through Montana and 66 miles (106 km) through the Idaho panhandle. The river flows back into Canada at RM 105.6 (RK 170.0), enters Kootenay Lake at Kootenay Landing (29 miles (46.7 km) north of the international boundary) and leaves the lake at RM 23.6 (RK 38.0) near Nelson, British Columbia, and makes a swift descent to its confluence with the Columbia River at Castlegar. Profiles of the upper Columbia and the Kootenay and Kootenai Rivers are shown on Plate 4-1. Most of the headwater streams flow in deep canyons and have steep gradients. The Kootenay River above Canal Flats has a gradient of about 20 feet per mile (3.8 meters per kilometer) changing to 4 feet per mile (0.8 meters per kilometer) through the project reach and down to Bonners Ferry, Idaho. These gradients contribute to a mildly swift-flowing stream that swells greatly during the spring snowmelt season.

4-2 TOPOGRAPHY

The Kootenai River drainage basin is along the western slopes of the Continental Divide in rugged and mountainous country. The basin is bordered by the Rocky and Flathead Mountain ranges on the east and the Purcell Mountains on the west. Elevations range from about 1,500 feet (457 m) at the confluence of the Kootenay and Columbia Rivers to 11,870 feet (3,618 m) at the summit of Mount Assiniboine in British Columbia. With six mountain peaks exceeding 10,000 feet (3,048 m) and numerous peaks above 8,000 feet (2,438 m), permanent snowfields and glaciers are common to the basin. Broad, flat valleys are located adjacent to the mainstem Kootenai River in the reach between Canal Flats, British Columbia, and Eureka, Montana, and in the reach between Bonners Ferry, Idaho, and Kootenay Lake.

4-3 GEOLOGY AND SOILS

The Kootenai River lies in a geologically mature valley within the northern Rocky Mountains in the folded and faulted metasediments of the Precambrian Belt Series. The river valley may be divided into two distinct segments: an upper valley segment upstream of Pinkham Creek marked by extensive glacial lake deposits and a lower valley segment from Pinkham Creek downstream to the dam characterized by steep-rock valley walls composed of cliff and bench topography with a thin mantle of rubbly overburden. Extensive glacial terrace deposits are generally associated with major re-entrants in the lower valley segment. These terrace deposits, as well as the glacial lake deposits of the upper valley segment, are highly

susceptible to erosion. There are numerous areas within the lower valley segments that are currently undergoing erosion. Most of the area in the upper valley segment exhibit continuing extensive erosion in glacial lake deposits due principally to wave action, sliding, and sloughing. The metasedimentary rocks which comprise the foundation and abutments of the dam are siliceous argillites with varying facies of sandy and limy argillites. The bedrock contains prominent sets of bedding and regional joints. On the left abutment near the dam, the bedding and joint sets intersect to form discrete blocks of rock that become unstable when support is removed at the toe either by excavation or erosion. A rockslide occurred at the left abutment of the dam on 31 January 1971 in the partially constructed Montana State highway relocation excavation causing extensive damage to the dam contractor's concrete-cooling facilities. As a safeguard against additional slides in this area, potential slide material located uphill from the slide was removed and the rock below the slide plane was strengthened with prestressed rock anchors and further instrumented to detect possible future rock movements. For stability, two buttress fills were also built upstream from the dam along the left bank at the toe of other potential slide areas. Instrumentation was installed to monitor these areas.

4-4 SEDIMENT

Sediment sources for the Kootenai River include the Purcell Mountains in the west and erosion of glacial drift and remnant terraces in the river valley in the eastern watershed. For a more complete description of erosion potential, see Section 4-03 above. The suspended sediment transported by the river varies seasonally and with flow. Spring runoff carries a large suspended sediment load, which drops during the fall due to a decreased sediment supply. Data collected at the Kootenai River below Libby Dam Highway 37 Bridge Station prior to the construction of Libby Dam (water years 1968–1970) had an average annual suspended sediment load of 1,572,000 tons (1.426×10^9 kg) (range from 473,000 to 2,676,000 tons per year (4.291×10^8 to 2.428×10^9 kg per year)), with the greatest sediment concentrations occurring during spring runoff (Libby Design Memorandum 25, Sediment Observation Plan). At the Kootenai River below Libby Dam sediment station, the mean daily suspended sediment concentration for water years 1968–1970 ranged from 1 mg/L to 1,200 mg/L with an annual mean range of 56 mg/L to 195 mg/L (LAURD Phase I Design Memorandum, Environmental Appendix).

4-5 CLIMATE

The Kootenai River Basin is influenced by a modified west coast marine and continental climate. The climate varies with elevation and proximity to mountain ranges. Marine influences are strongest during the winter and cause most of the winter snowfall when warm, moist air from the Pacific Ocean is cooled by orographic lifting over mountains in the basin or by frontal contact with Arctic air masses. Continental influences are strongest in early summer when the northward extension of low-pressure areas from the southerly interior cause heavy convective-type showers with occasional cloudbursts over the eastern portion of the basin. Summaries of climatological data for Libby Dam are given in English and metric units in Table 4-1 and Table 4-2, respectively. Locations of climatological stations in and near the basin are shown on Plate 4-2.

Table 4-1. 30-Year Normal Climate Values Libby Dam and Lake Koocanusa (1991–2020, °F, inches)

Month	Average Temperature (°F)	Average Precipitation (inches)	Average Snowfall Depth (inches)
January	28.1	1.5	9.4
February	30.6	1.1	5.0
March	37.4	1.1	2.0
April	44.7	1.2	0.2
May	53.9	1.8	0.0
June	60.4	2.4	0.0
July	67.8	0.9	0.0
August	67.3	0.7	0.0
September	58.0	1.1	0.0
October	45.4	1.7	0.1
November	34.9	1.8	2.6
December	28.4	1.7	7.0
Annual	**46.4**	**17.1**	**24.0**

Source: National Climatic Data Center, U.S. Department of Commerce
Data are at LIBBY DAM (BASE), MT station

Table 4-2. 30-Year Normal Climate Values for Libby Dam and Lake Koocanusa (1991–2020, °C, millimeters)

Month	Average Temperature (°C)	Average Precipitation (mm)	Average Snowfall Depth (mm)
January	-2.2	38.1	238.8
February	-0.8	29.0	127.0
March	3.0	27.7	50.8
April	7.1	31.2	5.1
May	12.2	44.5	0.0
June	15.8	60.7	0.0
July	19.9	21.6	0.0
August	19.6	17.8	0.0
September	14.4	28.4	0.0
October	7.4	43.7	2.5
November	1.6	46.7	66.0
December	-2.0	43.4	177.8
Annual	**8.0**	**433.1**	**609.6**

Source: National Climatic Data Center, U.S. Department of Commerce
Data are at LIBBY DAM (BASE), MT station

a. Temperature

Seasonal variations of temperature are substantial. Average monthly temperatures at Libby Dam (Base), Montana, range from 28.1 °F (-2.2 °C) in January to 67.8 °F (19.9 °C) in July. The maximum recorded temperature at the nearby Libby 1 NE RS was 110 °F (43.3 °C) while the minimum recorded temperature was -46 °F (-43.3 °C). Normal monthly temperature values for 15 representative stations in the basin are given in English and metric units in Tables 4-3 and 4-4, respectively. Normal monthly temperatures near the Kootenay River headwaters at Banff, Alberta, ranged from 16.7 °F (-8.5 °C) in January to 58.5°F (14.7 °C) in July. The maximum recorded temperature at this location was 93.9 °F (34.4 °C) while the minimum recorded temperature was -60.2 °F (-51.2 °C). The mean annual temperature for the drainage basin is about 41 °F (5 °C). The duration of winter cold spells is usually 1 to 2 weeks with periods of mild temperatures often occurring between cold waves. Hot summer days are typically followed by relatively cool nighttime temperatures in the 50 °F (10 °C) to 60 °F (15.6 °C) range.

Table 4-3. Normal Monthly Temperature (1991–2020, °F)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LIBBY 1 NE RS, MT	27.9	31.5	39.3	46.6	55.6	62.5	69.2	68.5	59.2	46.2	34.7	27.3	47.4
LIBBY DAM (BASE), MT	28.1	30.6	37.4	44.7	53.9	60.4	67.8	67.3	58.0	45.4	34.9	28.4	46.4
LIBBY 32 SSE, MT	22.7	24.9	32.5	40.1	48.4	54.0	59.8	58.7	50.6	39.5	29.4	22.1	40.2
BONNERS FERRY, ID	28.7	31.6	39.0	47.3	56.3	61.9	69.0	68.3	58.9	45.9	35.6	28.5	47.6
EUREKA RANGER STATION, MT	25.8	29.8	38.3	46.8	55.9	62.5	69.6	68.6	59.4	46.3	34.4	26.1	47.0
HERON 2 NW, MT	28.0	30.5	36.7	44.0	52.9	58.6	64.5	63.8	55.5	44.1	34.7	27.7	45.1
KALISPELL GLACIER AIRPORT, MT	23.7	26.8	34.5	42.7	51.6	57.6	64.9	63.7	54.3	41.6	31.4	24.1	43.1
PORTHILL, ID	28.2	31.1	38.8	47.1	56.4	61.9	68.8	67.6	58.1	45.7	35.7	28.4	47.3
TROUT CREEK RS, MT	28.0	30.8	38.0	45.0	53.6	59.5	66.8	65.7	57.6	46.1	34.7	27.6	46.1
TROY, MT	27.8	31.3	38.9	46.0	54.9	61.0	68.1	66.8	58.3	45.6	34.9	27.9	46.8
YAAK 9NNE, MT	21.7	25.0	33.2	40.7	50.0	56.0	62.1	61.6	52.6	40.2	28.6	20.7	41.0
CRANBROOK, BC	21.0	25.7	35.2	43.5	52.7	58.8	66.6	65.5	55.6	42.1	29.7	20.3	43.0
CRESTON, BC	29.5	32.2	39.4	47.5	56.5	62.1	70.3	69.6	59.7	46.6	36.0	28.8	48.2
BANFF, ALBERTA	16.7	20.1	28.0	37.0	45.3	52.2	58.5	57.2	48.9	38.1	25.2	15.8	36.9
FERNIE, BC[1/]	22.6	25.2	33.4	41.7	49.8	56.5	62.2	61.3	52.3	41.9	30.0	21.0	41.5

[1/]1981–2010 Normals Used

Table 4-4. Normal Monthly Temperature (1991–2020, °C)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LIBBY 1 NE RS, MT	-2.3	-0.3	4.1	8.1	13.1	16.9	20.7	20.3	15.1	7.9	1.5	-2.6	8.6
LIBBY DAM (BASE), MT	-2.2	-0.8	3.0	7.1	12.2	15.8	19.9	19.6	14.4	7.4	1.6	-2.0	8.0
LIBBY 32 SSE, MT	-5.2	-3.9	0.3	4.5	9.1	12.2	15.4	14.8	10.3	4.2	-1.4	-5.5	4.6
BONNERS FERRY, ID	-1.8	-0.2	3.9	8.5	13.5	16.6	20.6	20.2	14.9	7.7	2.0	-1.9	8.7
EUREKA RANGER STATION, MT	-3.4	-1.2	3.5	8.2	13.3	16.9	20.9	20.3	15.2	7.9	1.3	-3.3	8.3
HERON 2 NW, MT	-2.2	-0.8	2.6	6.7	11.6	14.8	18.1	17.7	13.1	6.7	1.5	-2.4	7.3
KALISPELL GLACIER AIRPORT, MT	-4.6	-2.9	1.4	5.9	10.9	14.2	18.3	17.6	12.4	5.3	-0.3	-4.4	6.2
PORTHILL, ID	-2.1	-0.5	3.8	8.4	13.6	16.6	20.4	19.8	14.5	7.6	2.1	-2.0	8.5
TROUT CREEK RS, MT	-2.2	-0.7	3.3	7.2	12.0	15.3	19.3	18.7	14.2	7.8	1.5	-2.4	7.8
TROY, MT	-2.3	-0.4	3.8	7.8	12.7	16.1	20.1	19.3	14.6	7.6	1.6	-2.3	8.2
YAAK 9NNE, MT	-5.7	-3.9	0.7	4.8	10.0	13.3	16.7	16.4	11.4	4.6	-1.9	-6.3	5.0
CRANBROOK, BC	-6.1	-3.5	1.8	6.4	11.5	14.9	19.2	18.6	13.1	5.6	-1.3	-6.5	6.1
CRESTON, BC	-1.4	0.1	4.1	8.6	13.6	16.7	21.3	20.9	15.4	8.1	2.2	-1.8	9.0
BANFF, ALBERTA	-8.5	-6.6	-2.2	2.8	7.4	11.2	14.7	14.0	9.4	3.4	-3.8	-9.0	2.7
FERNIE, BC[1/]	-5.2	-3.8	0.8	5.4	9.9	13.6	16.8	16.3	11.3	5.5	-1.1	-6.1	5.3

[1/]1981–2010 Normals Used

b. Precipitation

Rain-producing or snow-producing storms occur chiefly during the November–March period, but heavy snowstorms can occur as early as mid-September or as late as June. The increased pressure gradient from the Pacific Ocean produces westerly to southwesterly flow of moist marine air over the area. Distribution of precipitation depends largely upon elevation and topographic influences on the air masses. Precipitation tends to increase at higher elevations; hence, mountains and adjacent foothills experience the greatest precipitation with a few “rain shadow” exceptions. The recorded mean annual precipitation varies from about 15.2 inches (38.6 cm) at Cranbrook, BC to nearly 48.3 inches (122.7 cm) at Fernie, BC. The mean annual precipitation for the Kootenai Basin above Libby Dam is 33.07 inches (84.0 cm). The maximum recorded 24-hour rainfall in the vicinity of the dam is 3.11 inches (7.9 cm) at the Libby Ranger Station. Plate 4-3 is an isohyetal map of the Kootenai Basin. Normal monthly and normal annual precipitation values for 15 representative stations in the basin are presented in English and metric in Tables 4-5 and 4-6, respectively.

Table 4-5. Normal Monthly Precipitation (1991–2020, inches)

STATION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LIBBY 1 NE RS, MT	1.92	1.29	1.73	1.13	1.66	2.04	0.91	0.74	1.09	1.82	2.29	2.52	19.14
LIBBY DAM (BASE), MT	1.50	1.14	1.09	1.23	1.75	2.39	0.85	0.70	1.12	1.72	1.84	1.71	17.05
LIBBY 32 SSE, MT	2.12	1.84	2.17	1.62	2.09	1.98	0.78	0.84	1.19	2.15	2.94	2.59	22.31
BONNERS FERRY, ID	2.63	1.83	2.00	1.26	1.78	1.92	0.64	0.53	1.02	1.73	2.54	3.17	21.07
EUREKA RANGER STATION, MT	0.92	0.72	0.90	1.00	1.78	2.52	1.12	1.05	1.27	1.24	1.24	1.22	15.00
HERON 2 NW, MT	4.51	2.92	3.26	2.72	2.76	2.99	1.12	0.89	1.62	3.11	4.13	4.19	34.22
KALISPELL GLACIER AIRPORT, MT	1.40	0.96	1.11	1.34	1.84	2.84	1.13	0.76	1.17	1.35	1.35	1.50	16.76
PORTHILL, ID	2.16	1.70	1.91	1.65	2.19	2.10	1.24	0.82	1.06	1.80	2.41	2.45	21.49
TROUT CREEK RS, MT	3.20	2.34	1.93	1.75	2.06	2.42	0.90	0.86	1.32	2.86	3.46	3.72	26.82
TROY, MT	2.63	1.85	2.44	1.65	1.79	2.52	0.88	0.71	1.21	2.42	3.50	2.79	24.39
YAAK 9NNE, MT	2.27	1.73	2.27	1.23	2.18	2.54	1.17	0.93	1.31	1.70	2.75	2.69	22.77
CRANBROOK, BC	1.05	0.78	1.04	0.91	1.65	2.45	1.39	0.94	1.19	1.03	1.37	1.37	15.18
CRESTON, BC	2.98	1.88	2.55	1.83	2.48	2.90	1.37	0.95	1.57	2.12	3.30	3.19	27.13
BANFF, ALBERTA	0.74	0.73	1.15	1.54	1.97	2.89	1.85	1.85	1.77	1.41	1.09	0.89	17.87
FERNIE, BC[1/]	5.48	3.46	3.85	3.65	3.61	4.33	2.64	2.04	2.98	4.56	7.05	4.63	48.31

[1/]1981–2010 Normals Used

Table 4-6. Normal Monthly Precipitation (1991–2020, millimeters)

Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
LIBBY 1 NE RS, MT	48.8	32.8	43.9	28.7	42.2	51.8	23.1	18.8	27.7	46.2	58.2	64.0	486.2
LIBBY DAM (BASE), MT	38.1	29.0	27.7	31.2	44.5	60.7	21.6	17.8	28.4	43.7	46.7	43.4	433.1
LIBBY 32 SSE, MT	53.8	46.7	55.1	41.1	53.1	50.3	19.8	21.3	30.2	54.6	74.7	65.8	566.7
BONNERS FERRY, ID	66.8	46.5	50.8	32.0	45.2	48.8	16.3	13.5	25.9	43.9	64.5	80.5	535.2
EUREKA RANGER STATION, MT	23.4	18.3	22.9	25.4	45.2	64.0	28.4	26.7	32.3	31.5	31.5	31.0	381.0
HERON 2 NW, MT	114.6	74.2	82.8	69.1	70.1	75.9	28.4	22.6	41.1	79.0	104.9	106.4	869.2
KALISPELL GLACIER AIRPORT, MT	35.6	24.4	28.2	34.0	46.7	72.1	28.7	19.3	29.7	34.3	34.3	38.1	425.7
PORTHILL, ID	54.9	43.2	48.5	41.9	55.6	53.3	31.5	20.8	26.9	45.7	61.2	62.2	545.8
TROUT CREEK RS, MT	81.3	59.4	49.0	44.5	52.3	61.5	22.9	21.8	33.5	72.6	87.9	94.5	681.2
TROY, MT	66.8	47.0	62.0	41.9	45.5	64.0	22.4	18.0	30.7	61.5	88.9	70.9	619.5
YAAK 9NNE, MT	57.7	43.9	57.7	31.2	55.4	64.5	29.7	23.6	33.3	43.2	69.9	68.3	578.4
CRANBROOK, BC	26.7	19.9	26.5	23.2	42.0	62.2	35.4	24.0	30.1	26.1	34.8	34.8	385.5
CRESTON, BC	75.8	47.8	64.7	46.5	62.9	73.7	34.7	24.2	40.0	53.9	83.9	80.9	689.0
BANFF, ALBERTA	18.8	18.6	29.3	39.2	50.0	73.3	46.9	46.9	44.9	35.8	27.8	22.5	454.0
FERNIE, BC[1/]	139.3	88.0	97.8	92.8	91.8	110.0	67.0	51.9	75.8	115.7	179.1	117.7	1,227.1

[1/]1981–2010 Normals Used

c. Snow

Libby 1 NE RS, Montana, and Fernie, British Columbia, have mean annual measured snowfall of 50.4 inches (128.0 cm) and 127.9 inches (324.9 cm), respectively. Mean annual measured snowfall varies from about 40 inches (101.6 cm) in some of the low valleys to an estimated 300 inches (7.6 m) in some mountain areas. Based on period of record computations at snow survey courses both inside and outside of the Libby Basin, it was found that the average 01 April water content of the snowpack varied from 3.39 inches (8.60 cm) at Duncan Lake No. 2 to 52.45 inches (133.22 cm) at Redfish Creek. Sites on the lower end and higher end of the snowpack water content values are shown in Table 4-7. Snow survey course and snow pillow locations are shown on Plate 4-4. Additional information regarding these snow course and snow pillow sites is given in Table 4-8 in the Supplemental Tables Section.

Table 4-7. Average 01 April Snowpack Water Content Values

	Snow Survey Course	Average Water Content, in (cm)
Sites with lowest average SWC	Duncan Lake No. 2	3.39 (8.60)
	Upper Elk River	4.80 (12.20)
	Sinclair Pass	4.98 (12.66)
Sites with highest average SWC	St. Leon Creek	51.09 (129.78)
	Downie Slide (Upper)	51.61 (131.08)
	Redfish Creek - Pillow	52.45 (133.22)

d. Evaporation

There is no information about evaporation at Libby Dam and Lake Koocanusa.

e. Wind

Wind data has been recorded since March 2007 at weather station LBWM located on the west bank about a quarter of a mile upstream from Libby Dam. Wind primarily blows from the north or from the southwest with a median wind speed of 2.7 mph. A majority of the time (90%), wind speeds were 6.9 mph or slower with max speeds reaching 27.1 mph.

f. Infrastructure Resilience

USACE has a statutory responsibility (e.g., WRDA 2014, §3022) to the communities it serves and the American taxpayer to ensure it manages projects effectively throughout their project service life. Effective management includes consideration of resilient practices in the face of uncertainty about future hydrometeorological conditions (EP 1100-1-5 USACE Guide to Resilience Practices, 2020).

NOAA has released a set of State Climate Summaries 2022 containing information on historical climate variations and trends, future climate model projections of climate conditions, and past and future conditions of sea level and coastal flooding: (https://statesummaries.ncics.org/). Per the State Climate Summaries, Montana and Idaho have already experienced the effects of a warming climate, fewer very cold days, a decrease in the April 1 SWE, and more frequent droughts and extreme events, according to the NOAA State Climate Summaries. There is moderate consensus in the literature that annual average air temperatures will increase in the region, and throughout the country, over the next century. Projected rising temperatures will raise the snow line in Montana and Idaho. A strong consensus is also seen in the literature with respect to projected increases in extreme temperature events, including more frequent, longer, and more intense summer heat waves in the long-term future compared to the recent past.

Projections of precipitation and streamflow in the study basin are less certain than those associated with air temperature. In Montana and Idaho, the projections of overall annual precipitation are uncertain; however, the winter and spring precipitation is projected to increase. The increased winter and spring precipitation and the projected changes in snow melt patterns may increase the potential for flooding and reduce the availability of water during the summer months. There is, however, a strong consensus that future storm events in the region will be more intense and more frequent compared to the recent past.

Based on the above observations and projections, the region has potential for historically unprecedented warming to continue through the end of the 21st century. Wildfires during the dry summer months are a particular concern for Montana, and the frequency and severity of wildfires are projected to increase.

The Water Management Plan for Libby Dam has considered these observations and projections to the extent practicable. The water management plans will be reviewed periodically and updated as needed to manage climate change and variability impacts. Data and models that support water management decisions must also be periodically reviewed and updated to provide reliable and current information to decision-makers. Statistical analyses that relate hydrologic variables such as volumetric runoff or streamflow to meteorological or current system states such as snowfall and snowpack will be influenced if those relationships are changing. Physical or numerical models that have been calibrated to historic conditions may need to be re-evaluated within the context of climate change and calibrated to current conditions as changes are observed.

4-6 STORMS AND FLOODS

The spring snowmelt in the Kootenai River has produced floods characterized by high flows that last for several weeks accentuated by sharp peaks of short duration. The highest and most frequent floods occur in May and June. Prior to regulation by Libby Dam Project, damaging floods on the Kootenai River occurred on the average of once every 2 years. The areas principally affected were the towns of Troy, Montana; Bonners Ferry, Idaho; and 34,000 acres (13,759 ha) of leveed agricultural land north of Bonners Ferry commonly known as Kootenai Flats. The largest known flood on the Kootenai River occurred in June 1894. On the basis of very limited information, the crest-stage elevation for Bonners Ferry was estimated to be about 1,777 feet (541.6 m). The highest stage recorded by the U.S. Geological Survey (USGS) at Bonners Ferry occurred in 1961 with a peak of 1,780.13 feet

(542.6 m); however, the floods of 1894, 1916, and 1948 would have had higher stages under current channel conditions. Historical flood stages at Bonners Ferry are not directly comparable throughout the entire past century because of changed hydraulic conditions in the Kootenai River. For example, levee developments in the Kootenai Flats vicinity have modified the river channels and flood plains. Also, construction and operation of Corra Linn Dam at the outlet of Kootenay Lake and the Kootenay Lake outlet enlargement have changed the seasonal regulation and levels of Kootenay Lake which affect river stages at Bonners Ferry.

a. Frequency Analysis – Inflow to Libby Dam and Libby Dam Release

The frequency analysis for the inflow to Libby Dam was performed using the 2020-Level modified flows dataset from 1928 to 2018. The expected probability flow for the 1% chance exceedance event is 107,136 cfs (3,034 cms). The expected and computed probability values for the inflow to Libby Dam in addition to the system statistics are given in Table 4-9. A graphical representation of the frequency results is given in Plate 4-5. The relationship between inflow volume and peak release at Libby Dam is given in Plate 4-6. The modeled, regulated Libby Dam release frequency analysis is given in Plate 4-7. The modeled regulated release values were derived by simulating the 2020-Level modified flows dataset.

Table 4-9. Summary of Results for Inflow to Libby Frequency Analysis

Percent Chance Exceedance	Computed Curve Flow, cfs (cms)	Expected Probability Flow, cfs (cms)	Confidence Limits Flow, cfs (cms)	
			0.05	0.95
0.2	121,775 (3,448)	129,515 (3,668)	152,465 (4,317)	107,508 (3,044)
0.5	113,552 (3,216)	117,696 (3,333)	136,558 (3,867)	102,373 (2,899)
1	107,075 (3,032)	109,561 (3,103)	125,029 (3,541)	97,968 (2,774)
2	100,310 (2,841)	101,732 (2,881)	113,839 (3,224)	92,992 (2,633)
5	90,761 (2,570)	91,374 (2,588)	99,433 (2,816)	85,284 (2,415)
10	82,862 (2,346)	83,153 (2,355)	88,817 (2,515)	78,363 (2,219)
20	74,007 (2,096)	74,103 (2,098)	78,291 (2,217)	70,237 (1,989)
50	59,109 (1,674)	59,072 (1,673)	62,251 (1,763)	56,110 (1,589)
80	46,675 (1,322)	46,506 (1,317)	49,342 (1,397)	43,679 (1,237)
90	41,064 (1,163)	40,792 (1,155)	43,763 (1,239)	37,359 (1,058)
95	36,854 (1,044)	36,403 (1,031)	39,760 (1,126)	32,278 (914)
99	29,907 (847)	28,617 (810)	33,551 (950)	23,702 (671)

Log Transform		**Number of Events**	
Flow, cfs (cms)			
Mean	4.77 (0.135)	Historic Events	0
Standard Dev	0.12 (0.003)	High Outliers	
Station Skew	-0.176	Low Outliers	2
Regional Skew		Missing Flows	0
Weighted Skew		Systematic Events	90
Adopted Skew	-0.176	Historic Period	90
EMA Estimate of MSE (G at-site)	0.068	Equivalent Record Length (years)	88.629
Grubbs-Beck Critical Value	35,540		

b. Frequency Analysis – Intervening Flow between Libby Dam and Bonners Ferry

The frequency analysis for the intervening flow between Libby Dam and Bonners Ferry, ID was performed using the 2020-Level modified flows dataset from 1928–2018. The expected probability flow for the 1% chance exceedance event is 48,342 cfs (1,369 cms). The expected and computed probability values for the intervening flows between Libby Dam and Bonners Ferry, ID in addition to the system statistics are given in Table 4-10. A graphical representation of the frequency results is given in Plate 4-8.

Table 4-10. Summary of Results for Intervening from Libby Dam to Bonners Ferry Frequency Analysis

Percent Chance Exceedance	Computed Curve Flow, cfs (cms)	Expected Probability Flow, cfs (cms)	Confidence Limits Flow, cfs (cms)	
			0.05	0.95
0.2	53,723 (1,521)	56,869 (1,610)	66,389 (1,880)	44,476 (1,259)
0.5	50,280 (1,424)	51,942 (1,471)	59,938 (1,697)	43,093 (1,220)
1	47,439 (1,343)	48,342 (1,369)	55,131 (1,561)	41,747 (1,182)
2	44,353 (1,256)	44,785 (1,268)	50,342 (1,426)	40,027 (1,133)
5	39,796 (1,127)	39,953 (1,131)	43,918 (1,244)	36,874 (1,044)
10	35,860 (1,015)	35,950 (1,018)	38,829 (1,100)	33,527 (949)
20	31,292 (886)	31,308 (887)	33,483 (948)	29,258 (829)
50	23,342 (661)	23,291 (660)	25,118 (711)	21,701 (615)
80	16,650 (471)	16,547 (469)	18,071 (512)	15,114 (428)
90	13,699 (388)	13,573 (384)	15,092 (427)	11,985 (339)
95	11,545 (327)	11,343 (321)	12,986 (368)	9,563 (271)
99	8,173 (231)	7,678 (217)	9,759 (276)	5,701 (161)

Log Transform		Number of Events	
Flow, CFS			
Mean	4.354 (0.123)	**Historic Events**	0
Standard Dev	0.165 (0.005)	**High Outliers**	0
Station Skew	-0.5	**Low Outliers**	0
Regional Skew		**Zero Events**	0
Weighted Skew		**Missing Events**	0
Adopted Skew	-0.5	**Systematic Events**	90

c. Frequency Analysis – Stage for Kootenai River at Bonners Ferry, ID

The frequency analysis for the stage at Bonners Ferry was performed using the 2020-Level modified flows dataset. The flows derived from this analysis were converted to stage using the multi-parameter rating at Bonners Ferry shown in Plate 4-9. Graphical representations of the frequency results showing the observed regulated and the modeled regulated flow are given in Plate 4-10 and Plate 4-11, respectively. The unregulated frequency curve is shown with the modeled regulated frequency curve. The observed regulated data consists of stage data at Bonners Ferry after Libby Dam was completed. The expected and computed probability values for the stage at Bonners Ferry, ID, in addition to the system statistics, are given in Table 4-11.

Table 4-11. Summary of Results for Bonners Ferry Stage Frequency Analysis (1929–2018 for Modeled Data, 1973–2018 for Observed Regulated Data)

Percent Chance Exceedance	Computed Curve from Modeled Unregulated	Expected Probability from Modeled Unregulated	Confidence Limits for Modeled Unregulated		Estimated Observed Regulated Curve	Estimated Modeled Regulated Curve
	Stage, ft (m)		Stage, ft (m)		Stage, ft (m)	
			0.05	0.95		
0.2	89.32 (27.23)	90.01 (27.44)	92.72 (28.26)	86.69 (26.42)	71.66 (21.84)	72.34 (22.05)
0.5	87.14 (26.56)	87.64 (26.71)	90.17 (27.48)	84.77 (25.84)	69.68 (21.24)	70.14 (21.38)
1.0	85.36 (26.02)	85.76 (26.14)	88.11 (26.86)	83.2 (25.36)	68.23 (20.8)	68.55 (20.89)
2.0	83.46 (25.44)	83.75 (25.53)	85.92 (26.19)	81.52 (24.85)	66.83 (20.37)	67.05 (20.44)
5.0	80.68 (24.59)	80.86 (24.65)	82.73 (25.22)	79.02 (24.09)	65.06 (19.83)	65.17 (19.86)
10.0	78.27 (23.86)	78.38 (23.89)	80 (24.38)	76.83 (23.42)	63.8 (19.45)	63.85 (19.46)
20.0	75.43 (22.99)	75.49 (23.01)	76.84 (23.42)	74.21 (22.62)	62.61 (19.08)	62.63 (19.09)
50.0	70.24 (21.41)	70.24 (21.41)	71.29 (21.73)	69.2 (21.09)	61.23 (18.66)	61.23 (18.66)
80.0	65.35 (19.92)	65.3 (19.9)	66.42 (20.25)	64.15 (19.55)	60.7 (18.5)	60.7 (18.5)
90.0	62.91 (19.18)	62.82 (19.15)	64.09 (19.53)	61.55 (18.76)	60.61 (18.47)	60.61 (18.47)
95.0	60.96 (18.58)	60.81 (18.54)	62.24 (18.97)	59.43 (18.11)	60.59 (18.47)	60.59 (18.47)
99.0	57.42 (17.5)	57.14 (17.42)	58.94 (17.97)	55.6 (16.95)	60.58 (18.47)	60.58 (18.47)

Log Transform		Number of Events	
Stage (feet)			
Mean	1.846	**Historic Events**	0
Standard Dev	0.037	**High Outliers**	0
Station Skew	-0.042	**Low Outliers**	0
Regional Skew	---	**Zero Events**	0
Weighted Skew	---	**Missing Events**	0
Adopted Skew	-0.00	**Systematic Events**	90

d. Streamflow Statistics

The greatest known April–August runoff volume at Libby, Montana (USGS gage 12303000; period of record 1910–1991) occurred in 1974 in the amount of 9.96 million acre-feet (1,229,041 ha-m); regulation by Libby Dam Project safely controlled this flood. The second greatest known April–August runoff volume at Libby, Montana, 9.79 million acre-feet (1,208,072 ha-m), occurred in 1954 prior to regulation by Libby Dam. The 1954 flood was above the zero-damage stage for 44 days, and the 1961 flood was above the zero-damage stage for 31 days. The 10 highest floods of record in terms of peak stages for the Kootenai River at Libby, Montana, the Kootenai River below Libby Dam, and Bonners Ferry, Idaho, are listed in Table 4-12 through Table 4-14. The floods with the largest runoff volumes (April–August) at Libby, Montana, and below Libby Dam are listed in Table 4-15 and Table 4-16. The 10 largest April to August inflow volumes to Libby Dam are shown in Table 4-17.

Table 4-12. Largest 10 Known Floods Kootenai River at Libby, Montana[1/]

Rank	Date of Flow	Flow, cfs (cms)	Gage Height, ft (m)
1	Jun 1894	130,000 (3,681)	Not available
2	21 Jun 1916	121,000 (3,426)	20.70 (6.31)
3	28 May 1948	109,000 (3,087)	19.93 (6.07)
4	23 May 1956	96,600 (2,735)	18.63 (5.68)
5	29 May 1961	96,000 (2,718)	18.23 (5.56)
6	21 May 1954	86,600 (2,452)	17.33 (5.28)
7	18 Jun 1933	85,600 (2,424)	16.90 (5.15)
8	12 Jun 1927	83,100 (2,353)	14.90 (4.54)
9	29 May 1919	80,200 (2,271)	Not available
10	23 Jun 1950	79,100 (2,240)	16.23 (4.95)

[1/]The USGS streamgage (12303000) was located on the Kootenai River at Libby, Montana, at RM 204.3 (RK 328.8). Period of record is October 1910 to September 1991. Datum of gage was elevation 2,041.54 ft (622.26 m) NGVD. The 1894 flood height is based on historical reports. Major flood damage in the vicinity of Libby and Troy, Montana, was generally associated with a gage height of about 20.0 ft (6.1 m).

Table 4-13. Largest 10 Known Floods Kootenai River below Libby Dam, Montana[1/]

Rank	Date of Flow	Flow, cfs (cms)	Gage Height, ft (m)
1	18 June 2006	54,000 (1,529)	28.3 (8.6)
2	04 July 2012	48,900 (1,385)	27.6 (8.4)
3	05 August 1974	47,200 (1,337)	27.5 (8.4)
4	06 June 1981	41,500 (1,175)	26.49 (8.1)
5	01 July 2002	40,400 (1,144)	26.28 (8.0)
6	29 November 1976	40,100 (1,136)	26.46 (8.1)
7	10 September 1975	39,700 (1,124)	26.4 (8.0)
8	22 September 1982	37,700 (1,068)	25.92 (7.9)
9	13 October 1972	37,400 (1,059)	Not available
10	28 July 1972	37,200 (1,053)	26.74 (8.2)

[1/]The USGS streamgage (12301933) has a peak streamflow period of record from WY1972 through present/WY2023. The datum of the gage is elevation 2,100 ft (640.1 m) NGVD.

Table 4-14. Largest 10 Known Floods Kootenai River at Bonners Ferry, Idaho[1/]

Rank	Date of Crest	Elevation, ft (m) NGVD	Elevation Based on 1982 Conditions, ft (m)[2/]	Regulated Elevation, ft (m)[3/]
1	June 1894	1,777.2 (541.7)	1,781.6 (543.0)	1,770.0 (539.5)
2	22 June 1916	1,775.8 (541.3)	1,780.8 (542.8)	[4/]
3	28 May 1948	1,778.2 (542.0)	1,780.6 (542.7)	1,761.9 (537.0)
4	29 May 1961	1,780.1 (542.6)	Not available	[4/]
5	22 May 1956	1,780.1 (542.6)	Not available	1,764.3 (537.8)
6	21 May 1954	1,778.6 (542.1)	Not available	1,767.3 (538.7)
7	18 June 1933	1,775.0 (541.0)	1,777.7 (541.8)	[4/]
8	22 June 1950	1,777.0 (541.6)	1,777.2 (541.7)	1,764.0 (537.7)
9	30 May 1919	1,771.6 (540.0)	1,776.4 (541.4)	[4/]
10	11 June 1967	1,776.0 (541.3)	Not available	[4/]

[1/]The USGS streamgage (12309500) is located on the Kootenai River at Bonners Ferry, Idaho, at RM 152.8 (RK 245.9. Period of record is 1904 to present for stage only; 1928 to 1960 discharge available from near Bonners Ferry gage. The 1894 historical data are included for comparison purposes. Reference elevations for major and minor floods are 1,774 ft (540.7 m) and 1,770 ft (539.5 m), respectively.

[2/]Streamgage elevation-discharge relationships have changed substantially in the past due to the Kootenay Lake outlet enlargement and levee developments in the Bonners Ferry vicinity.

[3/]Hypothetical – based on regulation by Libby Project

[4/]Elevation not available but would be less than 1,770 ft (539.5 m).

Table 4-15. Largest 10 Known Volumes (April–August) Kootenai River at Libby, MT

Rank	Year	Volume 1,000 acre-ft (hectare-m)
1	1974	9,964 (1,229,041)[1/]
2	1954	9,794 (1,208,072)[2/]
3	1916	9,500 (1,171,808)[2/]
4	1972	9,423 (1,162,310)[1/]
5	1956	9,293 (1,146,275)[2/]
6	1948	9,216 (1,136,777)[2/]
7	1951	9,051 (1,116,424)[2/]
8	1969	8,803 (1,085,834)[2/]
9	1959	8,731 (1,076,953)[2/]
10	1967	8,682 (1,070,909)[2/]

[1/]Adjusted for storage change in Lake Koocanusa

[2/]Prior to the construction of Libby Dam

Source: USACE Dataquery and USGS database

Table 4-16. Largest 10 Known Volumes (April–August) Kootenai River below Libby Dam

Rank	Year	Volume 1,000 acre-ft (hectare-m)[1/]
1	2012	7,195 (887,525)
2	1972	5,399 (665,909)
3	2014	5,300 (653,688)
4	1996	5,295 (653,135)
5	2007	5,206 (642,092)
6	2006	5,082 (626,869)
7	2013	5,039 (621,570)
8	2011	4,842 (597,256)
9	2017	4,816 (594,080)
10	2002	4,616 (569,325)

[1/]Volumes are regulated values.

Source: USGS database

Table 4-17. Largest 10 Known Inflow Volumes (April–August) to Lake Koocanusa

Rank	Year	Inflow[1/] Volume 1,000 acre-ft (hectare-m)
1	1974	9,274 (1,143,967)
2	2012	9,181 (1,132,428)
3	1954	9,147 (1,128,317)
4	1972	8,895 (1,097,184)
5	1956	8,742 (1,078,263)
6	1951	8,541 (1,053,475)
7	1991	8,486 (1,046,702)
8	1948	8,479 (1,045,864)
9	1996	8,371 (1,032,509)
10	1969	8,262 (1,019,079)

[1/]For years prior to Libby Dam construction, listed values are the inflow volumes if the dam existed.

Source: USACE Dataquery

4-7 RUNOFF CHARACTERISTICS

Kootenai River natural streamflows are typically low during the winter (snowpack accumulation period) and high during the spring snowmelt runoff. Spring runoff usually begins in April or early May with melting of the low-elevation snowpack and peaks by late May or early June as warmer temperatures cause basin-wide melting. A slow recession normally occurs during the late summer and fall as the high-elevation snowpack is slowly depleted. The summary hydrograph shown on Plate 4-12 illustrates the natural streamflow characteristics of the Kootenai River at Libby, Montana. Seasonal modification of these characteristics caused by water regulation at the Libby Dam Project is reflected on the summary hydrograph on Plate 4-13 for the 1972–2024 period of record at the upstream gage, Kootenai River below Libby Dam. The character of spring or summer runoff varies with climatic conditions. A single major crest may occur as in 1948, 1956, and 1961, or a series of crests may occur at varying intervals and magnitudes as occurred in 1951 and 1954. The rate of rise or fall varies from slow to rapid, and high flows may exist for a few days or for extended periods. These characteristics are shown on the daily discharge hydrographs for Libby, Montana (Plate 4-14). Daily discharge hydrographs for the Kootenai River below Libby Dam (Plate 4-15) show the effects of reservoir regulation at the Libby Dam Project. Plate 4-16 shows the daily values for inflow, release, and pool elevation for Lake Koocanusa. Plate 4-17 shows the daily stage values for the Kootenai River at Bonners Ferry while Plate 4-18 shows the daily elevations for Kootenay Lake at the Queens Bay gage. Table 4-18 contains the streamflow statistics of important gaging locations in the Kootenai Basin. The average annual regulated flow at Libby, Montana, (from years 1974–1991) was 11,876 cfs (336.3 cms), which represents a basin runoff of 18.0 inches (45.7 cm).

Streamgaging stations in the Kootenai River Basin are shown on Plate 4-19. Additional information on these stations is provided in Table 4-19.

Table 4-18. Kootenai River Basin Streamflow Statistics

Stream Name	Kootenai River							
Station Location	**Wardner, BC**	**Fort Steele, BC**	**Libby, MT**	**Libby, MT**	**below Libby Dam**	**Wardner, BC**	**Phillips Bridge, BC**	**near Libby, MT**
Station Number	08NG005	08NG065	12303000	12303000	12301933	08NG002	08NK005	12302055
Drainage Area in sq. mi (sq. km)	5,251 (13,600)	4,440 (11,500)	10,179 (26,363)	10,179 (26,363)	8,999 (23,307)	587 (1,520)	1,718 (4,450)	842 (2,181)
Period of Record	1914–1972	1963–2023	1910–1972[1/]	1974–1991[2/]	1974–2023[3/]	1914–2022	1924–1996	1967–2023
	Mean Monthly Flow in cfs (cms)							
January	1,740 (49.2)	1,420 (40.2)	3,330 (94.3)	16,800 (475.7)	11,400 (322.8)	270 (7.6)	750 (21.1)	236 (6.7)
February	1,620 (46.0)	1,290 (36.6)	3,420 (96.8)	12,900 (365.3)	9,240 (261.6)	260 (7.3)	720 (20.4)	313 (8.9)
March	1,650 (46.8)	1,420 (40.3)	3,850 (109.0)	7,740 (219.2)	6,280 (177.8)	330 (9.3)	850 (24.1)	563 (15.9)
April	4,030 (114)	2,990 (84.6)	10,400 (294.5)	6,720 (190.3)	6,560 (185.8)	1,080 (30.5)	2,460 (69.6)	1,130 (32.0)
May	16,460 (466)	13,350 (378)	30,200 (855.2)	7,100 (201.0)	9,850 (278.9)	3,430 (97.1)	7,950 (225.0)	1,330 (37.7)
June	26,100 (739)	22,460 (636)	40,200 (1,138.3)	8,700 (246.4)	14,100 (399.3)	3,850 (109)	9,110 (258.0)	773 (21.9)
July	15,400 (436)	13,210 (374)	21,800 (617.3)	11,500 (325.6)	12,000 (339.8)	1,820 (51.6)	3,960 (112.0)	267 (7.6)
August	6,890 (195)	5,900 (167)	9,730 (275.5)	10,100 (286.0)	10,600 (300.2)	750 (21.3)	1,760 (49.9)	127 (3.6)
September	4,630 (131)	3,810 (108)	6,950 (196.8)	10,200 (288.8)	8,820 (249.8)	540 (15.3)	1,340 (38.0)	110 (3.1)
October	3,780 (107)	2,990 (84.7)	6,140 (173.9)	15,400 (436.1)	9,720 (275.2)	500 (14.2)	1,250 (35.4)	129 (3.7)
November	2,740 (77.6)	2,350 (66.6)	5,050 (143.0)	16,600 (470.1)	13,600 (385.1)	450 (12.8)	1,120 (31.7)	217 (6.1)
December	2,000 (56.6)	1,660 (47.0)	3,930 (111.3)	17,200 (487.0)	16,800 (475.7)	330 (9.4)	890 (25.3)	225 (6.4)
Mean Annual in cfs (cms)	7,240 (205)	6,070 (172)	12,113 (343.0)	11,876 (336.3)	10,809 (306.1)	1,130 (32.1)	2,680 (75.9)	455 (12.9)
Max Mean Annual in cfs (cms)	9,890 (280)	8,300 (235)	16,590 (469.8)	16,390 (464.1)	15,720 (445.1)	1,760 (49.7)	3,960 (112)	938 (26.5)
Min Mean Annual in cfs (cms)	4,450 (126)	3,600 (102)	6,509 (184.3)	9,510 (269.3)	6,212 (175.9)	540 (15.2)	1,400 (39.6)	169 (4.8)
Daily Maximum in cfs (cms)	67,450 (1,910)	64,270 (1,820)	120,000 (3,398)	42,000 (1,189)	53,100 (1,503.6)	13,700 (388)	36,020 (1,020)	7,790 (220.6)
Daily Minimum in cfs (cms)	840 (23.8)	565 (16.0)	1,000 (28.3)	2,430 (68.8)	2,100 (59.5)	29 (0.8)	200 (5.7)	35 (1.0)

[1/]Unregulated flow through February 1972

[2/]Regulated flows from March 1972 through September 1974 were not used because project was not fully operational; gage in operation until September 1991

[3/]Regulated flows from March 1972 through September 1974 were not used because project was not fully operational

Table 4-19. Streamgaging Stations

Stream	Location	State/Province	Data Source	ID#	Available Data[1/]	Real-Time Available?	Above Libby Dam?
Arrow Creek	near Erickson	British Columbia	Environment Canada	08NH084	F,S	Yes	No
Boundary Creek	near Porthill	Idaho	USGS	12321500	F	Yes	No
Bull River	near Wardner	British Columbia	Environment Canada	08NG002	F	Yes	Yes
Duncan Reservoir	at Duncan Dam	British Columbia	Environment Canada	08NH127	R	Yes	No
Duncan River	below B.B. Creek	British Columbia	Environment Canada	08NH119	F	Yes	No
Duncan River	below Duncan Dam	British Columbia	Environment Canada	08NH126	F	No	No
Duncan River	below Lardeau River	British Columbia	Environment Canada	08NH118	F	Yes	No
Elk River	at Fernie	British Columbia	Environment Canada	08NK002	F,S	Yes	Yes
Elk River	below Elko Dam Diversion	British Columbia	Environment Canada	08NK030	F	Yes	Yes
Elk River	near Natal	British Columbia	Environment Canada	08NK016	F,S	Yes	Yes
Fisher River	near Libby, MT	Montana	USGS	12302055	F,S,ST	Yes	No
Fording River	at the mouth	British Columbia	Environment Canada	08NK018	F,S	Yes	Yes
Kaslo River	below Kemp Creek	British Columbia	Environment Canada	08NH005	F	No	No
Kootenai River	Klockmann Ranch near Bonners Ferry	Idaho	USGS	12314000	ST	No	No
Kootenai River	at Tribal Hatchery near Bonners Ferry	Idaho	USGS	12310100	F,S,ST	No	No
Kootenai River	at Bonners Ferry	Idaho	USGS	12309500	S,ST	Yes	No
Kootenai River	at Leonia	Idaho	USGS	12305000	F,ST	Yes	No
Kootenai River	at Porthill	Idaho	USGS	12322000	F,S,ST	Yes	No
Kootenai River	below Moyie River near Bonners Ferry	Idaho	USGS	12308000	S,ST	Yes	No
Kootenai River	below Libby Dam near Libby, MT	Montana	USGS	12301933	F,S,ST	Yes	No
Kootenay Lake	at Kuskonook	British Columbia	Environment Canada	08NH067	R	Yes	No
Kootenay Lake	at Queens Bay	British Columbia	Environment Canada	08NH064	R	Yes	No
Kootenay Lake	Outflow near Corra Linn	British Columbia	Environment Canada	08NJ158	F	No	No
Kootenay River	at Fort Steele	British Columbia	Environment Canada	08NG065	F,S	Yes	Yes
Kootenay River	at Kootenay Crossing	British Columbia	Environment Canada	08NF001	F	Yes	Yes
Lake Koocanusa	near Libby, MT	Montana	Dataquery	12301920	F,R	Yes	Yes
Lardeau River	at Marblehead	British Columbia	Environment Canada	08NH007	F	Yes	No
Mather Creek	below Houle Creek	British Columbia	Environment Canada	08NG076	F	Yes	Yes
Moyie River	above Negro Creek	British Columbia	Environment Canada	08NH120	F	No	No
Moyie River	at Eastport	Idaho	USGS	12306500	F,ST	Yes	No
Slocan River	near Crescent Valley	British Columbia	Environment Canada	08NJ013	F	Yes	No
Tobacco River	near Eureka	Montana	USGS	12301300	F,ST	No	Yes
Yaak River	near Troy	Montana	USGS	12304500	F,S,ST	Yes	No

[1/]F = flow, S = sediment, R = reservoir elevation, ST = river stage

a. Travel Time Analysis

The travel time from Libby Dam to Leonia, ID was developed using observed release hydrographs from Libby Dam along with observed flow data at Leonia, ID. The travel time varies with the magnitude of flow with shorter travel times for higher flow values. Travel times from Libby Dam to Leonia, ID range from about 10 hours for 10,000 cfs (283 cms) to about 7 hours for 25,000 cfs (708 cms). It should be noted that these values represent the best fit for the observed travel times. The travel times from Libby Dam to Leonia, ID are shown in Table 4-20 and Plate 4-20. The travel times from Libby Dam to Bonners Ferry, ID are shown in Table 4-21 as well as Plate 4-21. Travel times from Libby Dam to Bonners Ferry, ID range from about 13.5 hours for 10,000 cfs (283 cms) to about 11 hours for 25,000 cfs (708 cms). The travel time to both sites was computed as the difference in time from the beginning of change of discharge at the Kootenai River below Libby Dam gage to the beginning of discharge change at the Kootenai River at Leonia gage and Bonners Ferry gage attributable to the discharge change at Libby Dam.

Table 4-20. Travel Time from Libby Dam to Leonia, ID

Flow Value in cfs (cms)	Travel Time (hrs)
10,000 (283.2)	10
15,000 (424.8)	9
20,000 (566.3)	7.5
25,000 (707.9)	7

Table 4-21. Travel Time from Libby Dam to Bonners Ferry, ID

Flow Value in cfs (cms)	Travel Time (hrs)
10,000 (283.2)	13.5
15,000 (424.8)	12.5
20,000 (566.3)	11.5
25,000 (707.9)	11

4-8 WATER QUALITY MONITORING PROGRAM

Water quality parameters of concern, analytical methods, detection limits, and sampling details are presented in greater detail in Sections 5-2 and 8-4.

a. USGS Monitoring Program 1967–2004

Water quality sampling of Lake Koocanusa and the Kootenai River was conducted by the USGS for the Seattle District from 1972 through 2004 and 1967 through 2004, respectively. The water quality program consisted of collecting monthly samples at three in-reservoir stations from May to October and at one downstream station from February to December. In-reservoir stations were located about 77 kilometers upstream of Libby Dam near the U.S.-Canada border (station USGS No. 12300110), 16 kilometers upstream of the dam near Ten Mile Creek (station USGS No. 12302830), and at the forebay (station USGS No. 12301919), while the downstream Kootenai River station was located in the tailwater of Libby Dam about 1 kilometer downstream of the dam at the site of the USGS gaging station (station USGS No. 12301933). Additional sampling stations were added and removed over time for special studies; however, the four core stations noted above remained the same during this time period.

The in-reservoir water quality program conducted by the USGS consisted of conducting vertical profiles of water quality at each station (temperature, conductivity, dissolved oxygen, and pH) and collecting monthly grab samples in the reservoir from May to October from about 3 meters above the reservoir bottom and 3 meters below the reservoir surface. These grab samples were analyzed for nutrients (monthly), major ions (twice per year), and trace metals (twice per year). Additionally, a photic zone composite sample was collected and analyzed for chlorophyll a (monthly). The river water quality program consisted of collecting monthly depth-integrated samples from February to December at the USGS tailwater gaging station. These depth-integrated samples were analyzed for nutrients (monthly), major ions (twice per year), and trace metals (twice per year).

b. Seattle District Monitoring Program 2006–Current

The Seattle District implemented a water quality monitoring study in 2006 to continue the long-term monitoring program on Lake Koocanusa and the Kootenai River that was started by the USGS in 1967. The current Seattle District program consists of three permanent in-reservoir stations and one permanent downstream river station (located at the tailwater of Libby Dam) distributed throughout the Lake Koocanusa/Kootenai River system at the same locations sampled by the USGS between 1967 to 2004 (Figure 2-2).

The three in-reservoir stations consisted of one up-reservoir station located about 77 kilometers upstream of Libby Dam near the U.S.-Canada border (station LIBBOR [USGS No. 12300110]), one mid-reservoir station located about 16 kilometers upstream of Libby Dam near Ten Mile Creek (station LIBTMC [USGS No. 12302830]), and one forebay station located immediately upstream of the dam (station LIBFB [USGS No. 12301919]). The in-reservoir stations were collected from the reservoir thalweg, which represents the deepest point at each sampling location. The Kootenai River station (station LIBTW) is located on the Kootenai River in the tailwater of Libby Dam about 0.5 kilometer downstream of the dam at the David Thompson Bridge (about 0.5 km upstream of the long-term USGS station No.

12301933) and collected at mid-channel from the bridge. Additional sampling stations have been added and removed over time for special studies; however, the four core stations noted above remained the same.

The Seattle District's in-reservoir water quality program consisted of conducting vertical profiles of water quality at each station (temperature, conductivity, dissolved oxygen, and pH) and collecting monthly grab samples in the reservoir from April through October. All water quality sampling was performed by two field technicians wearing new powder-free vinyl gloves. In-reservoir (LIBBOR, LIBTMC, and LIBFB) samples were collected by submerging a cleaned and decontaminated 3.0 liter (L) polycarbonate (Lexan) van-dorn style sampler with ultra-clean seals to depth and filling. From 2006 through 2013, samples were collected from up to four depths in the epilimnion and hypolimnion (as determined from vertical profiling) and equally composited in laboratory-cleaned, prelabled sample containers at the surface. From 2014 through 2024 samples were collected from a depth of 3 meters below the surface (representative of the epilimnion) and 3 meters above the bottom (representative of the hypolimnion). The downstream Kootenai River station (LIBTW) was collected from the David Thompson Bridge about 0.5 km downstream of the dam in the tailwater of Libby Dam by submerging a cleaned and decontaminated van-dorn style sampler to depth and filling. At all stations, sample containers were rinsed three times prior to filling, capped with headspace for mixing or the addition of preservative, and immediately placed on ice in a cooler. Samples for chlorophyll a analysis were collected from up to five depths in the photic zone and composited into a clean 22 L bucket at the surface. Measurements of field parameters were performed in situ using a Hydrolab MiniSonde 5 multiprobe coupled with a Surveyor 4 surface display and recording unit. Equipment used for field measurements was calibrated prior to each sampling event.

Phytoplankton samples were collected from the photic zone following the procedures used for chlorophyll a sample collection. Zooplankton samples were collected by vertical tow from a depth of 10 meters to the surface using a 64 µm mesh net. Phytoplankton and zooplankton samples were immediately placed on ice in a cooler and preserved with either a 1-percent Lugols solution (phytoplankton) or 25-percent Isopropyl Alcohol solution (zooplankton) within 12 hours of sample collection.

4-9 CHANNEL AND FLOODWAY CHARACTERISTICS

Major flood damage has occurred to lands in the floodplain of the Kootenai River—especially in the reach that extends from about 7 miles (11.3 km) upstream of the town of Bonners Ferry, Idaho, downstream to Kootenay Lake—due to both failure and overtopping of levees. In the United States portion of this floodplain, non-Federal levee systems protect 34,437 acres (13,936 ha) of land including 190 acres (76.9 ha) in the urban community of Bonners Ferry. In the Canadian portion of the floodplain above Kootenay Lake, levee systems protect about 17,500 acres (7,082 ha). Floods have also caused limited damage to low-lying commercial and residential areas in Troy and Libby, Montana. Flood damages have occurred in Canada due to high water on Kootenay Lake. Lands in the United States portion inundated by major floods as a result of levee failures are listed in Table 4-22.

Table 4-22. Leveed Lands Inundated by Major Floods in the Vicinity of Bonners Ferry, ID

Year	Acres Flooded (Hectares)
1948	32,000 (12,950)
1950	4,800 (1,942)
1954	6,600 (2,671)
1956	17,000 (6,880)
1961	7,021 (2,841)

a. Flood Stage

Prior to construction of Libby Dam, relative to the Kootenai River at Bonners Ferry gage, zero-damage elevation was 1,770 feet (539.5 m) (~70,000 cfs (1,981.9 cms)) and major damage stage was 1,774 feet (540.7 m) (~85,000 cfs (2,406.6 cms)). The discharges are approximate because Bonners Ferry stage is also affected by backwater from Kootenay Lake. At or slightly below the zero-damage elevation, over bank flooding of unleveed areas began in the Kootenai Flats area, and at elevation 1,774 feet (540.7 m) levee seepage became a major problem. Threat of levee overtopping began at about elevation 1,778 feet (541.9 m). The original flood operation plan for Libby Project was designed to use the capability of the project to limit stage at Bonners Ferry to elevation 1,770 feet (539.5 m).

In the intervening period since Libby Project began operation in March 1972, development and encroachment have occurred along the river downstream of the dam. In some cases, portions of the levees have been removed to facilitate building construction and river access. Consequently, some residences in the vicinity of the towns of Libby and Troy, Montana, require sandbag protection when discharge at the Leonia gage exceeds 40,000 cfs (1,132.5 cms). The Kootenay River Inn in Bonners Ferry is subject to flooding at approximately elevation 1,769 feet (539.2 m). Although most levees only become subject to overtopping when Bonners Ferry is at elevation 1,778 feet (541.9 m) or higher, the locally owned levees have experienced major, unrepaired erosion in many areas and are threatened by breach in many locations. In September 1996, the National Weather Service, in response to existing conditions, lowered flood stage at the Bonners Ferry gage to elevation 1,764 feet (537.7 m).

Table 4-23 tabulates the degree of flooding associated with river stage at the Kootenai River at Bonners Ferry gage. The National Weather Service identifies the flood stage at the Kootenai River below Libby Dam gage at a stage of 27.5 feet (8.4 m), corresponding to a discharge of 48,100 cfs (1,326 cms).

Stage-discharge rating curves for the stations Kootenai River below Libby Dam, Montana, and Kootenai River at Leonia, Idaho are shown on Plate 4-22 and Plate 4-23. River stages at Bonners Ferry, Idaho, are affected by river flows and backwater from Kootenay Lake. Plate 4-9 provides the values of the multi-parameter rating at Bonners Ferry, Idaho. The Bonners Ferry rating table was developed from an unsteady flow model that extends from Libby Dam to Kootenay Lake. Variability is expected at most gage sites due to size and shape of the hydrograph and the differences in stage seen for the same flow on the

rising and falling limb of hydrographs. An example of these differences is shown in Plate 4-24.

The 2003 Flood Control Operating Plan noted that damages commence at Nelson when Kootenay Lake reaches elevation 1,755 feet. Memoranda written by BC Hydro in November 2005 and May 2009 included estimations of damages on Kootenay Lake for a lake elevation at Queen's Bay of 1,752 feet.

Table 4-23. Flood Conditions Related to River Gage on Kootenai River at Bonners Ferry, ID

Elevation		Character of Flooding
ft	m	
1,780	542.54	Peak elevation 22 May 1956 & 29 May 1961. Top elevation of levees in City of Bonners Ferry, including levee protecting sewage treatment ponds.
1,779	542.23	
1,778	541.93	Weather Svc "Major Flood Stage;" some Kootenai Flats levees overtop.
1,777	541.63	
1,776	541.32	Peak elevation, 11 June 1967. Extensive seepage and boil threat in Kootenai Flats area.
1,775	541.02	
1,774	540.71	Seepage through levees becomes a major problem.
1,773	540.41	Bonners Ferry Main Street elevation.
1,772	540.1	Approximately 500 acres (202 hectares) of unleveed area in Kootenai Flats area flooded.
1,771	539.8	
1,770	539.49	Weather Svc "Moderate Flood Stage" level.
1,769	539.19	1. Kootenai River Inn first-floor elevation.
		2. Elevation of sewage treatment chlorine control chamber.
1,768	538.89	Kootenai River Inn storm sewer invert; drainage impeded by Kootenai R. backwater.
1,767	538.58	Sewage treatment lagoons weir invert elevation; drainage impeded by Kootenai R. backwater.
1,766	538.28	Kootenai River Inn lawn 1,766.22 ft (538.34 m).
1,765	537.97	Storm sewer on Bonners Ferry 3rd Street subject of backwater overflow.
1,764	537.66	Weather Svc. "Flood Stage."
1,763	537.36	
1,762	537.05	1. Subsurface Seepage north side of river in City of Bonners Ferry.
		2. Residences at low elevations, especially riverward of levees, may require sandbagging to prevent damage. Applies to residents between Libby, MT, and Bonners Ferry and Pearson residence on west bank, north of Bonners Ferry.
		3. Access flooding to Fodge Sawmill on Lt. bank just upstream of Bonners Ferry and upstream residences.
1,761	537.75	
1,760	536.45	
1,759	536.14	
1,758	535.84	Pumping required at some Kootenai Flats locations to prevent subsurface seepage damage to farm ground.
1,757	535.53	Weather Svc. "Action Stage."
1,756	535.23	
1,755	534.92	
1,754	534.62	Lowest known storm drain invert, Bonners Ferry 4th Street (Invert = the bottom of the discharge pipe). Drainage impeded by Kootenai R. backwater.

4-10 UPSTREAM STRUCTURES

There are no major regulating structures upstream of Libby Dam.

4-11 DOWNSTREAM STRUCTURES

Libby Dam is the furthest upstream major structure on the Kootenai River and the only major structure on the Kootenai River in the United States. Corra Linn Dam is located at RM 16.1 (RK 25.9), about 206 miles (331 km) downstream of Libby Dam. Corra Linn Dam is the first of five dams located on the lower portion of the Kootenai River. The other four dams are Upper Bonnington, Lower Bonnington, South Slocan, and Brilliant. Water can be released from Kootenay Lake either through Corra Linn Dam or by utilizing the Kootenay Canal. Water that is sent through the Kootenay Canal returns to the Kootenai River between South Slocan and Brilliant. There is one significant project located on a tributary to the Kootenai River, Duncan Dam, on the Duncan River. Plate 4-25 shows the locations of these projects. The backwater effect from Kootenay Lake impacts the stage at Bonners Ferry in Idaho.

4-12 ECONOMIC DATA

a. Population

The population in the Libby Dam Project area is concentrated near the St. Mary River in Canada and along the Kootenai River downstream from Libby Dam. The principal population centers are Cranbrook, Kimberley, and Fernie in Canada and Libby and Bonners Ferry in the United States. Tables 4-24 and 4-25 contain population data for the Kootenai Basin.

Table 4-24. Watershed Current Population Data

Location	Population
Cranbrook, BC	20,499
Kimberley, BC	8,115
Fernie, BC	5,519
Libby, MT	2,775
Bonners Ferry, ID	2,520
Eureka, MT	1,380
Troy, MT	797

United States Census Bureau, 2020 Census Statistics
Statistics Canada, 2021 Census of Population

Table 4-25. Watershed Population Details

U.S.	Population in Year							Percent Increase						
Location	**1960**	**1970**	**1980**	**1990**	**2000**	**2010**	**2020**	**1960-1970**	**1970-1980**	**1980-1990**	**1990-2000**	**2000-2010**	**2010-2020**	**1960-2020**
Lincoln County, MT	12,537	18,063	17,752	17,481	18,837	18,717	19,672	44%	-1.7%	-1.5%	7.8%	-0.6%	5.1%	57%
Libby, MT	2,828	3,286	2,748	2,532	2,626	2,880	2,775	16%	-16%	-7.9%	3.7%	10%	-3.6%	-1.9%
Troy, MT	855	1,046	1,088	963	957	953	797	22%	4.0%	-11%	-0.6%	-0.4%	-16%	-6.8%
Eureka, MT	1,229	1,195	1,119	1,043	1,017	998	1,380	-2.8%	-6.4%	-6.8%	-2.5%	-1.9%	38%	12%
Boundary County, ID	5,809	6,371	7,289	8,332	9,871	10,951	12,056	10%	14%	14%	18%	11%	10%	108%
Bonners Ferry, ID	1,921	1,909	1,906	2,193	2,515	2,567	2,520	-0.6%	-0.2%	15%	15%	2.1%	-1.8%	31%
Canada	**Population in Year**							**Percent Increase**						
Location	**1966**	**1971**	**1976**	**2006**	**2011**	**2016**	**2021**	**1966-1971**	**1971-1976**	**1976-2006**	**2006-2011**	**2011-2016**	**2016-2021**	**1966-2021**
Cranbrook	7,849	12,000	13,510	18,267	18,761	20,047	20,499	53%	13%	35%	2.7%	6.9%	2.3%	161%
Fernie	2,715	4,422	4,608	4,217	4,448	4,860	5,519	63%	4.2%	-8.5%	5.5%	9.3%	14%	103%
Kimberley	5,901	7,641	7,111	6,139	6,652	7,425	8,115	29%	-6.9%	-14%	8.4%	12%	9.3%	38%

United States Census Bureau, Census Statistics
Statistics Canada, Census of Population

b. Agriculture

(1) East and Central Kootenay Regional Districts (RDs), Canada

The East Kootenay RD is primarily a ranching area, although farming is also carried out. There are 307 farms, with 28.7% cattle ranching, 28.0% other crop farming, and 24.4% hay farming. Total operating revenues, excluding forest products from the East Kootenay RD in 2021 were approximately $14.92 million in Canadian dollars (CAD). Hay, much of which is irrigated, is the largest crop and is produced for cattle use. Alfalfa, oats, and barley are other crops produced in the area. The Central Kootenay RD has a large area of prime farmland around Creston. There are 461 farms, with 22.1% other crop farming, 18.7% hay farming, 16.5% fruit and tree nut farming, and 14.8% cattle ranching and farming. Field vegetables and tree fruits grown here on irrigated fields include potatoes, peas, beans, apples, and berries. The dairy industry is important in this area. Total operating revenues, excluding forest products from the Central Kootenay RD were approximately $62.90 million CAD, Statistics Canada, Census of Agriculture, 2021.

(2) Lincoln County, Montana

Approximately 50,005 acres (20,236 ha) are farmed in Lincoln County, with about 5,890 acres (2,384 ha) irrigated (~12%). Major agricultural products include livestock and poultry such as beef cows, milk cows, hogs and pigs, sheep and lambs, and chickens. Hay and pastureland is the other dominant crop, with small amounts of oats and barley grown for grain. A total of 16 acres (6.5 ha) is in vegetable or fruit production in the county. The market value of the county's agricultural products sold in 2022 was $5,373,000. Net cash income is the cash earnings realized within a calendar year from the sales of farm production and the conversion of assets, both inventories (in years in which reduced and capital consumption), into cash. Net cash farm income is a solvency measure representing the funds that are available to farm operators to meet family living expenses and make debt payments. The county's 2022 net cash farm income totaled -$567,000, an average of -$2,261 per farm (compared to -$1,953,000 and -$5,660, respectively per the 2017 Census of Agriculture).

(3) Boundary County, Idaho

Approximately 73,364 acres (29,689 ha) are farmed in Boundary County with about 2,500 acres (1,012 ha) irrigated (< 4%). Major agricultural products primarily include wheat and both beef and milk cows. Hay and alfalfa are also dominant crops with oats and barley for both grain and forage. Specialty crops include hops and tree fruits (apples). The market value of the county's agricultural products sold in 2022 was $48,912,000. The net cash farm income totalled was $7,880,000 in 2022, an average of $24,701 per farm (compared to $3,293,000 and $9,462, respectively per the 2017 Census of Agriculture).

c. Industry

Kootenai River Basin is a forested mountainous region with a historically strong natural resources industry including timber and mining. Tourism and recreation have become important components of the regional economy and government employment is also important. Agriculture is less important in this area relative to per capita employment. The

population base is small and does not support a large number of manufacturing industries, but a few are important and are described below.

(1) British Columbia

The major industries in the Central and East Kootenay RDs, BC, include health care and social assistance, retail trade, construction, manufacturing, forestry, agriculture, mining, tourism, technology and electronics, and retail and commercial businesses. Federal, provincial, and local governments (including school districts) are the dominant employers. Forestry is an important employer in the Castlegar region, as well as Selkirk College and other educational facilities. Other major employers in the Central and East Kootenay RDs include the Interior Health Authority, FortisBC (utility company), and Cominco, later merged with Tech Resources and renamed Teck (mining, fertilizer). Nelson is the provincial administrative center for the Central Kootenay Regional District. Lake Koocanusa and Kootenay Lake in British Columbia are tourist attractions for fishing, hunting, camping, and boating. Small towns and resorts are located along Lake Koocanusa catering to fishers and campers. The agriculture, hydropower, and tourism industries are most closely related to the river and reservoir system.

(2) Montana

The Federal Government owns approximately 72% of the area of Lincoln County, Montana. Lake Koocanusa, Kootenai National Forest, and wilderness areas within Lincoln County are tourist destinations for fishing, boating, camping, hiking, and hunting. The major industries in the county include government (Federal, State, and local) and health and social services; arts, entertainment, recreation, and accommodation and food services; retail trade; construction; and agriculture, forestry, fishing and hunting, and mining. Major employers in Libby, Montana, include school districts, hospitals and healthcare facilities, and city, county, and Federal government. The household median money income in Lincoln County was reported as $47,018 in the 2022 Census and the 2023 American Community Survey 5-Year Estimates; for comparison, this was approximately 67% of the Montana median. Approximately 16.2% of the population of the county lived below poverty level per the 2023 American Community Survey 5-Year Estimates; for comparison, this was higher than the State average of 11.7% in that year. Historically, forestry and mining were major employers in the area, but they have declined over many years and now provide a relatively smaller number of jobs (~9% of county employment)—U.S. Census Bureau 2022 Census and the 2023 American Community Survey 5-Year Estimates.

(3) Idaho

Boundary County, Idaho is dominated by 61% federally owned lands, including the Panhandle National Forest. The Kootenai River and Panhandle National Forest are tourist destinations for fishing, camping, hiking, and hunting. The major industries in the county include government (Federal, State, and local) and health and social services; retail trade; construction; manufacturing; arts, entertainment, recreation, and accommodation and food services; and agriculture, forestry, fishing and hunting, and mining. The household median money income in Boundary County was reported as $62,438 in the 2022 Census and the 2023 American Community Survey 5-Year Estimates; for comparison, this was approximately 84% of the Idaho median. Approximately 17.2% of the population lived below

poverty level per the 2023 American Community Survey 5-Year Estimates; for comparison, this was higher than the State average of 10.1% in that year.

Historically, transportation and supply to the mining and timber industries were large employers. Mining and timber were also major employers. The Kootenai Tribe operates the Kootenai River Inn and Casino, which is also a relatively large employer. The Boundary Community Hospital, school district, and local and Federal government are also major employers (Boundary County Labor Force and Economic Profile, January 2023).

d. Flood Damages

(1) Bonners Ferry

Table 4-26 provides a table of expected damages based on elevations at the Bonners Ferry gage, and exceedance frequencies under regulated conditions described in Chapter 7, Water Control Plan. The damages at each elevation analyzed are from the Bonners Ferry Flood Level Study (BFFLS). Damages are probability weighted or expected values that take the probabilities of the Canadian Reservoir levels and levee fragility (probability of failure curves) under consideration. The BFFLS was completed in 2005 and in 2005 prices that have been updated to 2024 prices using a simple CPI inflation calculator available at the Bureau of Labor Statistics (website: http://www.bls.gov/data/inflation_calculator.htm).

Table 4-26. Expected Annual Damages (EAD) Based on Bonners Ferry Gage

Elevation at Bonners Ferry Gage (ft (m) NGVD29)	Exceedance Frequency	EAD in $1,000s (2005 prices, 2004 conditions)	EAD in $1,000s (2024 prices, 2004 conditions)
1,764.00 (537.67)	.05	0	0
1,764.06 (537.69)	.049	131	212
1,764.13 (537.71)	.048	174	281
1,764.20 (537.73)	.047	189	306
1,764.32 (537.76)	.045	203	328
1,764.50 (537.82)	.043	216	349
1,764.68 (537.87)	.040	231	374
1,764.76 (537.90)	.039	239	387
1,765.14 (538.01)	.033	255	412
1,765.46 (538.11)	.028	262	424
1,765.90 (538.25)	.022	272	440
1,766.98 (538.58)	.016	5,098	8,245
1,768.16 (538.94)	.011	5,440	8,798
1,770.18 (539.55)	< .01	8,874	14,352
1,771.00 (539.80)	< .01	26,644	43,091
1,771.36 (539.91)	< .01	28,087	45,425

(2) Kootenay Lake

Canada’s evaluation estimate damage levels on Kootenay Lake to begin at 1,752 feet at Queen’s Bay. BC Hydro will communicate through the Columbia River Treaty Operating Committee (CRTOC) when there is a chance of exceeding 1,752 feet at Kootenay Lake to coordinate operations and communications within the basin for the duration of the flooding risk on the lake. The 2003 Flood Control Operating Plan noted that damages commence at Nelson when Kootenay Lake reaches elevation 1,755 feet. However, memoranda written by BC Hydro in November 2005 and May 2009 estimated damages on Kootenay Lake for a lake elevation at Queen’s Bay of 1,752 feet. The elevation at Queen’s Bay reached elevation 1,753.8 feet in July 2012, the highest level since Libby Dam became operational. The damage commencement elevation of 1,755 feet in the 2003 Flood Control Operating Plan may be revised in the future based on the Canadian engineering memoranda and information collected during the 2012 flood event.

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CHAPTER 5—DATA COLLECTION AND COMMUNICATION NETWORKS

5-1 HYDROMETEOROLOGICAL STATIONS

This section describes the weather stations, snow pillows, and streamgaging stations in the Kootenai River Basin and the facilities for collection, transmission, and processing of hydrometeorological data for planning and operation of Libby Dam. For purposes of this manual, all first order weather stations (stations staffed full-time by the National Weather Service (NWS)), cooperative climatological stations, and snow pillow stations are considered meteorological stations.

a. Facilities

(1) Meteorological Stations

The meteorological stations for the Kootenai River Basin are found in both Canada and the United States. Stations located both inside and outside of the basin are located on Plate 4-2. These stations include both historical and current locations and are grouped by elevation in 1,000 feet (304.8 m) increments from an elevation of 0 feet (0 m) up to 8,000 feet (2,438.4 m). There are 11 active stations located above Libby Dam. These stations are found in British Columbia as well as Montana. Summary data from selected historical and current sites can be found in Table 4-3.

(2) Snow Survey Courses and Snow Pillow Sites

The snow survey courses and snow pillow sites can be found on Plate 4-4. These sites include both current and historic locations and are grouped by elevation in 1,000 feet (304.8 m) increments. There are 16 snow survey courses above Libby Dam that have real-time data available. These sites are located in Alberta, British Columbia, and Montana. The Ministry of Environment is responsible for the sites in Alberta and British Columbia while the Natural Resources Conservation Service (NRCS) is responsible for the locations in the United States. Of these 16 sites, seven of them are used in the current Libby Dam water supply forecast. The snow pillow sites are given in Table 5-1. Below Libby Dam, there are six sites with real-time snow data available. These sites are located in Montana and Idaho. In addition to the real-time sites, the Ministry of Environment and the NRCS maintain sites where historical data are made available. In British Columbia, there are 18 of these sites. The NRCS maintains 15 of these sites in Montana and Idaho. Additional information on the snow survey courses and snow pillows is provided in Table 4-8.

Table 5-1. Snow Pillow Sites Used in Libby Dam Water Supply Forecast

Snow Pillow Site	State / Province
East Creek	British Columbia
Moyie Mountain	British Columbia
Akamina Pass[1/]	Alberta
Hawkins Lake	Montana
Stahl Peak	Montana
Sunshine Village	Alberta
South Racehorse Creek	Alberta

[1/]Akamina Pass data consists of analyzing data from four different sites: Grave Creek (Montana), Poorman Creek (Montana), Morrissey Ridge (British Columbia), and Mount Odlum (Alberta).

(3) Streamgaging Stations

Plate 4-19 shows the location of both current and historical streamgaging stations along the Kootenai River and its tributaries. There are 33 active sites in Canada and the United States. Gages in Canada are maintained by Environment Canada while the gages in the United States are maintained by the U.S. Geological Survey (USGS). Of these 33 sites, 10 are located above Libby Dam while 23 are located below. All of the sites maintained by the USGS have real-time data available; however, only 8 of the 20 Environment Canada sites have real-time data available. Additional information on the streamgaging sites can be found in Table 4-18.

b. Reporting

The CENWS portion of the hydromet data collection system at Libby Dam consists of several data collection platforms (DCPs) in the vicinity of the dam. Weather parameters, forebay water temperature, and Total dissolved gas (TDG) water quality data (April through September only) are measured hourly. Forebay and tailwater elevations are measured every 15 minutes. A computer set up specifically to poll the pool elevation and tailwater stage receives data via USACE network and line of site radio. All data are transmitted hourly via GOES satellite, Iridium satellite, and radio system to the RCC in Seattle. These stations are polled automatically by a designated computer to collect the hourly data. Additionally, all stations can be polled manually at any time from the RCC.

With the exception of the DCP that collects hourly forebay water temperatures, each data collection site is also equipped with a Geo-Stationary Operational Environmental Satellite System Data Collection Platform (GOES DCP). These GOES units are set to transmit data on an hourly interval at a specific transmission time within each hour. The GOES units serve as a secondary method of collecting the hydromet data in case there is an issue with the radio or microwave system.

Both forebay and tailwater temperature measurements are made every hour, and the data are transmitted via radio directly to the Seattle District Data Storage System (HEC-DSS) water quality database. Data are then sent out from Seattle each hour via Secure File Transfer Protocol (SFTP) to the Columbia River Operational Hydromet Management System (CROHMS) in Portland, Oregon.

The DCP in the microwave tower at Libby Dam has a dedicated modem that is connected to a backup tie line system. This secondary phone system is used when the microwave modems and radios cannot send data. A computer in the Seattle RCC can dial into the Libby Dam microwave tower DCP (gateway) to collect data from that platform and use the radio system to collect data from the other CENWS sites. The Libby Project hydromet system is shown on Plate 5-1.

c. Maintenance

Routine and emergency maintenance arrangements for the hydrometeorological facilities in the Libby Basin are as follows.

(1) Meteorological Stations and Pillow Stations

Weather stations are operated and maintained by the United States Weather Service and the Canadian Ministry of the Environment. The U.S. NRCS operates and maintains snow survey stations in the Libby Basin and vicinity. CENWS-ENH-W maintains the weather station at Libby Dam, LBWM. In case of emergency or problem at any other station, notify the NWS, River Forecast Center (RFC) in Portland, Oregon, at telephone [redacted] and they will alert the appropriate agency.

(2) Streamgaging Stations

The U.S. Geological Survey (USGS) operates and maintains streamgaging and surface water stations in the United States portion of the Kootenai Basin. CENWS-ENH-W operates and maintains a redundant streamgage at the Libby tailwater gage (LIBM; Kootenai River below Libby Dam near Libby, Montana USGS gage No. 12301933), as well as a stage gage in the Libby forebay (LIB). With the exception of these two USACE gages, the USGS office in Helena, Montana, telephone [redacted], should be notified concerning any streamgage operation or maintenance problems in Montana. The USGS office in Post Spokane Valley, Washington, telephone [redacted] should be notified concerning any streamgage operation or maintenance problems in Idaho. Additionally, the RFC should be notified about any streamgage problem in the United States. BC Hydro should be notified of any streamgage problem in Canada.

5-2 WATER QUALITY STATIONS

CENWS-ENH-W is the lead agency for the Libby Dam water quality monitoring program and is responsible for conducting all water quality monitoring and gage maintenance. Libby Dam personnel assist the CENWS-ENH-W with collecting water samples in the Kootenai River and Lake Koocanusa. Water quality is monitored at Libby Dam for temperature, TDG, and general constituents. A brief description of the water quality station locations and parameters monitored is provided below. The locations of these stations are shown in Plate 5-2 and

Plate 5-3. Table 5-2 provides details, including location and parameters measured at each sampling station.

Table 5-2. List of Water Quality Parameters Measured at Libby Dam

Field Parameters	Water Quality Stations Key
Temperature	A,D,E
pH	A
Conductivity	A
Dissolved Oxygen	A
Total Dissolved Gas	E
Laboratory Chemical Parameters	
Total Phosphorus	A
Soluble Phosphorus	A
Total Nitrogen	A
Nitrate + Nitrite	A, F
Ammonia	A
Alkalinity	A
Hardness	A
Calcium	A
Magnesium	A
Potassium	A
Sodium	A
Sulfate	A
Chloride	A
Total Aluminum	B
Total Arsenic	B
Total Cadmium	A
Total Chromium	B
Total Copper	B
Total Lead	A
Total and Dissolved Selenium	A
Total Zinc	B
Laboratory Biological Parameters	
Phytoplankton	C
Zooplankton	C
Chlorophyll a	C

A Stations LIBTW, LIBBOR, LIBTMC, LIBFB: Monthly April–October

B Stations LIBTW, LIBBOR, LIBTMC, LIBFB: May, July, and October

C Stations LIBBOR, LIBTMC, LIBFB: Monthly April–October

D Stations LBTM and LIBM: Hourly all year

E Stations LBQM: Hourly April–September

F Stations LBOM and LIBM: Hourly March-November

a. Temperature

Real-time temperature is monitored in the forebay at stations LBTM and in the tailwater at station LIBM. The existing forebay real-time water temperature sensors are anchored to the face of Libby Dam near the right bank (station LBTM). A total of 19 sensors are placed at fixed elevations on the dam in a vertical profile ranging from 2,170–2,450 feet (661.4–746.8 m), with sensors placed every 10 feet (3.0 m) in the region of more significant temperature gradients between 2,300–2,450 feet (701.0–746.8 m). Because these sensors are fixed to

the face of the dam, the depths of the sensors below the water surface varies with the reservoir elevation. Instrumentation at the real-time stations consists of Geokon Model 4700 thermal sensors, a Sutron 9210 XLite DCP, a radio transmitter, and a power source. The sensors and DCP are powered by a 12-volt battery that is charged by a 120-volt AC line.

The existing tailwater real-time water temperature station (LIBM) is located along the right bank of the river, 0.6 miles (1.0 km) downstream from the dam at the USGS gaging station (No. 12301933) located below Libby Dam. The temperature probe is housed inside an anchored perforated PVC pipe that extends into the Kootenai River to a depth of at least 6 feet (1.8 m) during low flow conditions. Instrumentation consists of a Met One temperature probe, a Sutron 9210 XLite DCP, a radio transmitter, and a power source.

For special temperature studies, automated thermal loggers are deployed in the middle of the forebay about 200 feet (61.0 m) upstream of the dam (station LIBFB). These loggers are deployed as a string attached to a buoy in a vertical profile, with loggers concentrated in the region of more significant temperature gradients down to a depth of about 250 feet (76.2 m). Because these loggers are hanging from a buoy, they represent a fixed depth below the surface regardless of reservoir elevation. A study conducted by the CENWS Water Quality team from 2002 to 2004 measured little difference in water temperatures between LIBFB and LBTM, suggesting that the existing real-time monitoring station at LBTM is representative of forebay conditions.

b. Total Dissolved Gas (TDG)

Real-time TDG is monitored at Libby Dam tailwater station LBQM from 01 April to 30 September. The tailwater TDG station is located on the left bank (spillway side) of the river and represents gas saturations in spillway flow undiluted with powerhouse flows. Station LBQM is located 0.6 miles (1.0 km) downstream from the dam at the USGS gaging station (No. 12301933) located below Libby Dam. The TDG probe is housed inside an anchored perforated PVC pipe that extends into the Kootenai River to a depth of at least 6 feet (1.8 m) during low flow conditions. Instrumentation consists of a Hydrolab MiniSonde water quality probe, a Sutron electronic barometer, a Sutron 9210 XLite DCP, a radio transmitter, and a power source. Measurements are made every hour, and the data are transmitted via radio directly to the Seattle District's HEC-DSS water quality database. Data are then sent out from Seattle every hour via File Transfer Protocol (FTP) to the CROHMS database in Portland, Oregon.

c. Nitrate-Nitrogen

Real-time nitrate concentrations are monitored in Lake Koocanusa near the U.S.-Canadian border at station LBOM, and in the Kootenai River downstream of Libby Dam at the existing tailwater station LIBM. A Satlantic Submersible Ultraviolet Nitrate Analyzer (SUNA) is deployed at both the border station and tailwater station from about mid-April to November. Hourly data are collected at both stations.

The existing Lake Koocanusa real time nitrate station (LBOM) is located about 48 miles (77.2 km) upstream of Libby Dam near the U.S.-Canadian border station LIBBOR. The nitrate sensor is deployed from a floating platform located in the reservoir thalweg and maintained at a depth of about 3 to 5 meters off of the bottom. Instrumentation consists of a

Satlantic Submersible Ultraviolet Nitrate Analyzer, a Sutron 9210 XLite DCP equipped with a Geo-Stationary Operational Environmental Satellite System Data Collection Platform (GOES DCP), and a power source.

The existing tailwater real-time nitrate station (LIBM) is located along the right bank of the river, 0.6 miles (1.0 km) downstream from the dam at the USGS gaging station (No. 12301933) located below Libby Dam. The nitrate sensor is housed inside an anchored perforated PVC pipe that extends into the Kootenai River to a depth of at least 6 feet (1.8 m) during low flow conditions. Instrumentation consists of a Satlantic Submersible Ultraviolet Nitrate Analyzer, a Sutron 9210 XLite DCP, a radio transmitter, and a power source. Table 5-3 shows the current real-time nitrate sampling program at Libby Dam.

Table 5-3. Current Real-Time Nitrate Sampling Program at Libby Dam

Station Name	Station Location	Water Body	Years Sampled	Historical USGS Station	Latitude (NAD 83)	Longitude (NAD 83)
LIBBOR	Lake Koocanusa at International Border	Lake Koocanusa	1974–2025	YES (#12300110)	48.995982	-115.182805
LIBTMC	Lake Koocanusa at Ten Mile Creek	Lake Koocanusa	1974–2025	YES (#12302830)	48.587128	-115.232889
LIBFB	Lake Koocanusa at Forebay	Lake Koocanusa	1974–2025	YES (#12301919)	48.411106	-115.312348
LIBTW	Kootenai River at Tailwater	Kootenai River	2006–2025	NO	48.406555	-115.317283
LIBM	Kootenai River at Tailwater	Kootenai River	1974–2025	YES (#12301933)	48.400642	-115.320200
LBQM	Kootenai River at Tailwater	Kootenai River	2002–2025	NO	48.400595	-115.318626
LBTM	Lake Koocanusa at Forebay	Lake Koocanusa	1999–2025	NO	48.411208	-115.316055
LBOM	Lake Koocanusa at International Border	Lake Koocanusa	2016–2025	NO	48.995982	-115.182805

d. General Water Quality Parameters

Water Quality is monitored at Libby Dam monthly between April and October of each year at three (3) stations in Lake Koocanusa and one (1) station located downstream of the dam. The downstream station (LIBTW) is located on the Kootenai River about 0.3 miles (0.5 km) downstream of Libby Dam at the Thompson Bridge and collected at mid-channel. The in-reservoir stations consist of one (1) up-reservoir station located about 48 miles (77.2 km) upstream of Libby Dam near the U.S.-Canadian border (LIBBOR), one (1) mid-reservoir station located about 10 miles (16.1 km) upstream of Libby Dam near Ten Mile Creek (LIBTMC), and one (1) forebay station located immediately upstream of the dam (LIBFB). Water quality parameters of concern include temperature, pH, dissolved oxygen, alkalinity, nutrients (i.e., phosphorus and nitrogen), major anions and cations, dissolved metals, chlorophyll A, and plankton. Collection methods and reporting of results are outlined in the annual sampling plan for Libby Dam. A Washington State Department of Ecology or U.S. EPA approved water quality laboratory is responsible for analysis of the water samples.

5-3 SEDIMENT STATIONS

Sediment data were previously provided from 12 of the streamgaging stations. Of these 12, 5 are in British Columbia, 3 are in Montana, and the remaining 4 are in Idaho. The sites located in British Columbia were maintained by Environment Canada, while the sites in Montana and Idaho were maintained by the USGS. The sediment stations along with their period of record are given in Table 5-4. All sediment stations are currently inactive.

Table 5-4. Sediment Monitoring Stations along the Kootenai River and Tributaries

Stream	Location	State / Province	Period of Record
Arrow Creek	near Erickson	British Columbia	1979–1985
Elk River	at Fernie	British Columbia	1970–1977
Elk River	near Natal	British Columbia	1970–1977
Fisher River	near Libby, MT	Montana	1969–
Fording River	at the mouth	British Columbia	1970–1977
Kootenai River	at Tribal Hatchery near Bonners Ferry	Idaho	2005
Kootenai River	at Bonners Ferry	Idaho	2002
Kootenai River	at Porthill	Idaho	1983–2008
Kootenai River	below Moyie River near Bonners Ferry	Idaho	2010
Kootenai River	below Libby Dam near Libby, MT	Montana	1968
Kootenai River	at Fort Steele	British Columbia	1988
Yaak River	near Troy	Montana	1999

5-4 RECORDING HYDROLOGIC DATA

The USACE Hydrologic Engineering Center report, Water Control Data System (WCDS), Past, Present, and Future; RD#39, dated September 1995, describes the WCDS as follows "The WCDS is an automated information system that supports the Corps of Engineers' water control mission including the hardware, software, manpower, and other resources required to acquire, develop, maintain, and operate the system. The WCDS includes the collection, acquisition, retrieval, verification, storage, display, transmission, interpretation, and archival of information needed to carry out the Corps' water control mission. The WCDS is a nationwide integrated system of hardware and software that allows users access to virtually any data and information in the system. A suite of software gives users the ability to display, manipulate, disseminate, interpret, and transmit information throughout the Corps and to any other interested user." Real-time data are published daily on the CENWD Water Management website at: https://www.nwd-

wc.usace.army.mil/dd/common/projects/www/lib.html. Data are reviewed for omissions and errors, and a corrected record is filed each month. Historic data may be obtained using the CENWD dataquery website at: https://www.nwd-wc.usace.army.mil/dd/common/dataquery. A diagram detailing the NWS water management data system is provided in Plate 5-4.

a. CENWD-PDW-H (RWCDS)

The Regional Water Control Data System (RWCDS) is a system that collects, acquires, stores, and computes data for real-time modeling and decision support for water control in the Northwestern Division. It consists of 3 geographic nodes, and is operated regionally by the following 4 water management offices: Northwestern Division (NWD), Portland District (NWP), Seattle District (NWS), and Walla Walla District (NWW).

USACE utilizes the Corps Water Management System (CWMS) as its automated information system for water management operations. The CWMS database is a central component of this system, designed to store time series and relational data crucial for modeling and managing CWMS watersheds. It serves as a repository for various types of data, including observed and forecasted hydrometeorological data (e.g., precipitation, temperature, streamflow), as well as computation results from internal CWMS modules (like HEC-HMS, HEC-ResSim, HEC-RAS, HEC-FIA) and external sources.

The Corps Water Management System (CWMS) is a comprehensive, integrated software system developed by USACE to support real-time water resources management. It enables the collection, processing, visualization, and analysis of hydrologic data to assist in managing reservoirs, rivers, and other water infrastructure. CWMS is used for flood risk management, water supply, navigation, environmental stewardship, and emergency response by enabling data-driven decisions across USACE's districts.

b. Seattle District WCDS

The WCDS in CENWS-ENH-W is primarily used to process project operation and hydromet data for the USACE projects in Western Washington (Howard Hanson Dam, Mud Mountain Dam, and Lake Washington Ship Canals) and three private hydropower projects (Upper Baker, Ross, and Wynoochee Dams) with Federal flood risk management components, and to monitor the operation of the three USACE hydropower projects (Libby Dam, Albeni Falls Dam, and Chief Joseph Dam) located in CENWS.

In Seattle District, we collect data from a number of sources to complete the regional WCDS database. The primary sources are USACE owned and maintained Data Collection Platforms (DCPs), which are located at the project and various associated field instrumentation sites. All of these sources are combined into one or more databases after going through various quality checks, computations, and conversions.

5-5 COMMUNICATION NETWORK

The CENWS office and Libby Dam Project use communications through land lines, as well as the data network between Seattle and Portland. The project operator can be reached on the public line at [redacted] In the event that telephone service to the project is lost, the project operator will be able to be reached at [redacted] The BPA DATS line and the CBT are also used for the normal day-to-day communications with the project.

5-6 COMMUNICATION WITH PROJECT

Communications between CENWS-ENH-W and Libby Dam is accomplished primarily via telephone. Flow schedules are pre-coordinated with the operator and then submitted via the CBT. In the event that the communication network is down (listed in Section 5-05), the satellite phone communication system can be used as an alternate means of communications.

5-7 PROJECT REPORTING INSTRUCTIONS

Powerhouse operators send hourly and daily powerhouse data through the CBT network. Hourly powerhouse data include total generation, station service usage, mean total discharge, mean power discharge, mean spillway discharge, powerhouse forebay elevation at the beginning of the hour, powerhouse tailwater elevation at the beginning of the hour, total powerhouse head at the beginning of the hour, surplus generation capability at the end of the hour from on-line units, number of on-line units, and number of available units. Daily powerhouse data include total generation, total station service usage, daily mean inflow, daily mean total discharge, daily mean power discharge, daily mean spillway discharge, reservoir elevation at the end of the day, daily mean forebay elevation, and daily mean tailwater elevation. Generation, powerhouse flow, forebay elevation, and tailwater elevations are all reported to the operators via the Generic Data Acquisition and Control System (GDACS) output in the dam control room. Flows are calculated manually or automatically using lookup tables. All data are stored in the CROHMS database.

5-8 WARNINGS

The NWS is responsible for issuing flood watches, warnings, and advisories for the Kootenai River and its tributaries in the United States. CENWS-ENH-W is responsible for disseminating information on flow changes from Libby Dam via email to regional stakeholders.

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CHAPTER 6—HYDROLOGIC FORECASTS

6-1 GENERAL

Three agencies prepare water supply forecasts (WSFs) for Libby Dam: CENWS-ENH-W, NWRFC, and NRCS. The official period used for reservoir operations is April–August. Only the NWRFC does a short-term forecast of 10 days.

a. Role of USACE

CENWS-ENH-W produces the official April–August WSF used for USACE reservoir planning. CENWS-ENH-W is responsible for all regulation of Libby Dam and coordinates their operations through CENWD-PDW-R during Columbia System flood operations. At times when special streamflow regulation is required to meet at-site and downstream discharge requirements, regulation assistance is available from CENWD-PDW-R and the NWRFC to determine the level of flood potential at Bonners Ferry. CENWS-ENH-W coordinates with State and local agencies and the public to address water resource concerns and conflicts relating to flood risk management and provides support to CENWD-PDW-R in case of special requests or problems.

b. Role of Other Agencies

NWRFC produces the only short-term forecast, which is updated at least daily. Additionally, NWRFC and NRCS each produce a seasonal forecast. The NWRFC located in Portland, Oregon (telephone [redacted]) is the agency primarily responsible for weather and streamflow forecasting in the Pacific Northwest. The NWRFC Portland office is staffed 6 a.m. to 6 p.m. throughout the year except during flood risk management and other special events when full-time operations may be required.

6-2 FLOOD CONDITION FORECASTS

Floods on the Kootenai River generally occur during peak snowmelt periods and may or may not be in conjunction with additional runoff from rainfall. The following are descriptions of the various Libby Dam forecasts used to prepare for and predict flood conditions.

a. USACE Snowmelt Runoff Forecast

USACE revised their seasonal forecasting procedure in 2010 and updated it in 2011 and again in 2014, with a minor update in 2017. The monthly forecast of the cumulative April through August inflow volume to Libby Dam is produced starting in November, with the final forecast issued in June

(1) Requirements

The forecasts are issued by CENWS-ENH-W by the third business day of the month, after review and approval by CENWD-PDW-H. The forecasting procedure was created to take advantage of snow pillow stations located along the Continental Divide in Alberta and update existing meteorological stations with additional years of record. The update was adjusted in December 2021 to incorporate updated thirty-year averages for climate

variables. The new procedure utilizes a period of record corresponding to the time period since Libby Dam was constructed.

(2) Methods

The forecasted inflow calculation uses only snow pillow sites, replacing snow course sites from previous forecast methods. The forecast calculation uses one climate index (Southern Oscillation Index [SOI]), four precipitation stations (Eureka Ranger Station and West Glacier in Montana and Fernie and Cranbrook in British Columbia) and seven snow pillow sites (Stahl Peak and Hawkins Lake in Montana; East Creek and Moyie Mountain in British Columbia; and Sunshine Village, Akamina Pass, and South Racehorse Creek in Alberta). June and July precipitation is variable and can be significant in terms of flooding potential but is not directly predicted in this forecast. The statistical forecast equations were developed based on principal components regression models. The regression models were developed for each of the eight forecast issue dates of 01 November to 01 June, inclusively. The regression variables, coefficients, statistics, and recommended data sources for the 2014 updated forecast method are included in Exhibit 6-1.

b. NWRFC Daily and Long-Range Forecasts

NWRFC uses the Community Hydrologic Prediction Systems (CHPS), which runs the National Weather Service River Forecasting System (NWSRFS) computer programs to forecast streamflow and runoff for the Columbia and Kootenai River Basins. These programs are used to forecast short and long-range streamflow at specified control points in the basin for a selected number of days into the future. Short and long-term forecasts are available for several locations in the Kootenai Basin including Kootenai River at Libby, Montana, Kootenai River at Leonia, and Kootenai River at Bonner’s Ferry. Short and long-term forecasts are also available for the tributaries of the Fisher River near Libby, Montana, Yaak River near Troy, and Moyie River at Eastport.

(1) Requirements

Short-range forecasts of streamflow, up to 10 days in advance, are based upon current observed data, forecasts of meteorological conditions that affect snowmelt and/or precipitation rates, and routing through natural storage or controlled reservoirs. Short-range forecasts of daily streamflow are especially significant during the spring runoff in the Columbia and Kootenai Basins to inform reservoir regulation and to identify potential flood conditions. The day-to-day regulation of individual projects in the CRS as a whole is based on short-to-medium-range forecasts of streamflow rates and reservoir conditions.

The long-range forecasts, up to 120 days in advance, involve extending the short-range forecasts by adding additional daily forecasts using basin means of climatological data to define future weather conditions. The primary purpose of the long-range forecasts is to define runoff under certain specified conditions to determine the effect on reservoir filling schedules and on the potential for downstream flooding to see if the current regulation plans should be revised.

During normal operations, CENWD-PDW-R reviews the short- and long-range forecasts for the Columbia Basin and inputs projected reservoir operations via the CHPS

model each Monday. At least weekly, and routinely on Mondays and Thursdays between fall and mid-summer, CENWD-PDW-R reviews and revises the projected reservoir operations for the updated short-term forecasts. In both cases, CENWD-PDW-R coordinates with CENWS-ENH-W on projected operations at Libby Dam. In the case of more rapidly changing reservoir operations, such as during flood events or special operations, NWRFC, CENWS-ENH-W, or CENWD-PDW-R may request more frequent updates to the projected Libby Dam operations in the CHPS model.

NWRFC also provides long-range forecasts in Ensemble Streamflow Prediction (ESP) form. The ESP forecasts are a simulation of forecast traces based on historic rainfall and temperature patterns from 1981 – 2024 recent years, with the initial conditions set using current basin conditions. The ESP forecasts do not encompass all possible outcomes, including possible flood conditions which may occur within the forecast period, but are used to build a set of plausible streamflow forecast traces. The ESP forecast is updated multiple times per week and is one of the tools used both by CENWS-ENH-W and CENWD-PDW-R to analyze local and system water supply scenarios.

(2) Methods

The NWRFC used the Streamflow Synthesis & Reservoir Routing (SSARR) computer program for forecasting beginning in the late 1950s. This procedure was discontinued in favor of a nationally standardized National Weather Service program called the NWSRFS. In August of 2010, the NWRFC then switched to CHPS, which uses the same internal models as NWSRFS, but allows newer models to be incorporated into the product, the procedure to test different alternatives, and allows better interaction with the model from outside users such as CENWD and CENWS-ENH-W.

CHPS is a modular forecast system that allows modelers to choose from various operations or models to simulate hydrologic conditions for a particular river basin. CHPS is composed of multiple hydrologic models, including the Sacramento Soil Moisture model, the Snow-17 Accumulation and Ablation model, API models, routing algorithms, and reservoir regulation schemes. Several algorithms in the SSARR program have been adapted to operate within CHPS including the reservoir regulation and river reach routing components. This collection of interrelated pieces of software comprises three basic components: Calibration, Interactive Forecast System (IFS), and ESP System.

c. Other Forecast Tools

The NRCS produces seasonal forecast volumes for the Kootenai Basin based on climate, precipitation, and snowpack data. BC Hydro produces a volume forecast for Duncan Dam and local inflow into Kootenay Lake.

During the snowmelt period, monitoring indexes of the snowpack water volume and the aerial extent of the snowpack via National Aeronautics and Space Administration’s (NASA’s) Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data may provide additional information on the basin snowmelt potential.

6-3 CONSERVATION PURPOSE FORECASTS

While there are no forecasts for Libby Dam designed specifically for conservation purpose, the USACE April–August inflow forecast and the long-range forecasts from NWRFC and NRCS are tools used to help predict seasonal water supply, including water that is used for conservation purposes. As described in Chapter 7, the USACE WSF is used to set seasonal minimum flows for bull trout and to determine the volume of water to be released for sturgeon augmentation.

6-4 LONG-RANGE FORECASTS

Long-range forecasts for Libby Dam are described in Section 6-02, Flood Condition Forecasts. Flooding and reservoir operations on the Kootenai River is commonly snowmelt-driven and is largely dependent on basin snowpack.

6-5 DROUGHT FORECAST

There are no forecasts for Libby Dam designed specifically for prediction of drought conditions.

6-6 WATER QUALITY FORECASTING

Water quality forecasting is not applicable to the operational purpose of Libby Dam.

CHAPTER 7—WATER CONTROL PLAN

7-1 GENERAL OBJECTIVES

The primary objective of the Water Control Plan for Libby Dam is to efficiently regulate waters of the Kootenai River for the authorized purposes of flood risk management and hydroelectric power production. Other uses such as recreation; fish and wildlife; navigation; and water quality concerns in the Kootenai River, and the Columbia River; are also all taken into consideration when scheduling Libby Dam regulation.

Beginning in the 1990s, multiple species of fish have been listed under the ESA as either "threatened" or "endangered" and identified as being affected by the ongoing operation of the CRS. Current Biological Opinions under the ESA include the 2020 National Marine Fisheries Service (NMFS) CRS BiOp (2020 NMFS BiOp) and 2020 USFWS BiOp, collectively referred to as the 2020 BiOps.

Due in part to ESA consultations, USACE developed and implemented the "Variable Discharge Flood Control (VARQ FC)" flood risk management procedure at Libby Dam. The original VARQ FC procedure was implemented at Libby Dam in 2003, and a Record of Decision (ROD) was signed on 06 June 2008. Revisions to the VARQ FC procedure were indicated in the 2020 Columbia River System Operations (CRSO) EIS (2020 CRSO EIS). The VARQ FC procedure described in this chapter represents the 2020 CRSO EIS operation initially implemented in WY2021.

7-2 CONSTRAINTS

The following operating limits for Libby Dam are provided to guide operations for flood risk management in addition to operations for hydropower, fish and wildlife conservation, and other secondary purposes. Additional requirements from the 2020 BiOps are detailed in Section 7-08. All elevations are in NGVD29, for a conversion to NAVD88 see Section 1-07.

a. Libby Dam Normal Maximum and Minimum Reservoir Elevations

- Normal Full Pool ..... El 2,459 ft (749.50 m)
- Surcharge Flood Control Pool[1] ..... El 2,461 ft (750.11 m)
- Target refill elevation ..... El 2,454 ft (747.98 m)
- Minimum Pool ..... El 2,287 ft (697.07 m)

[1] In 2012, under close coordination with Canada, a deviation was approved such that the reservoir was operated assuming a maximum allowable elevation of 2,461 feet to allow for increased flood risk reduction downstream of Libby Dam. The reservoir reached a maximum level of 2,459.97 feet on 16 July 2012. During the 2012 event, sandbags were required inside the dam at the sluice gate access slots to keep water from entering inside the dam. The area is open to a lower section of the gallery where electrical controls are located. Internal flooding could result in loss of all electrical control at Libby Dam, therefore close coordination with Libby Project staff is required. The coordination process to surcharge Libby Dam is documented in Exhibit 7-5.

b. Reservoir Filling and Drafting Limits

There are no known structural, geological, or other conditions that limit the rate of reservoir filling or drafting.

c. Minimum Normal Discharge at Libby Dam

- Normal Minimum Flow .....4,000 cfs (113 cms)
- Minimum Instantaneous (Emergency Only) .....2,000 cfs (56 cms)
- Bull Trout Minimum 15 May to 30 September .....6,000 cfs (170 cms)
- Rate of change of releases, see Section 7.16

Note: The 2,000 cfs (56 cms) minimum is to be used only in emergency conditions such as a forced plant outage and assumes that four units are run at speed no load. As soon as possible, outflows should be returned to 4,000 cfs (113 cms). The standing orders to the damtenders (Exhibit 7-1) contain detailed operating instructions to accomplish minimum discharge regulation during emergency situations. For Apr-Aug forecast runoff volumes greater than or equal to 4.80 MAF, Bull Trout minimum flows greater than 6,000 cfs (170 cms) are shown in Table 7-4.

d. Local Flood Risk Management Requirements (Kootenai River at Bonners Ferry – Flood Stage)

- Flood Stage……1,764 feet (537.7 m)

Note: Libby Dam will be regulated to not exceed a stage of 1,764 feet (537.7 m) at the USGS Kootenai River gage at Bonners Ferry insofar as possible. Elevations at Bonners Ferry are affected by backwater from Kootenay Lake, shown on Plate 4-5. There may be extreme cases where Libby Dam is regulated to keep the Bonners Ferry stage at 1,770 feet (540 m) or another target chosen using professional judgment.

e. System Flood Risk Management Requirements (System Flood Risk Management at The Dalles)

- Control Flow at The Dalles.....450,000 cfs (12,742.20 cms)
- Libby Dam Outflow requirements for Flood Risk Management at The Dalles are explained in Section 7.05 and follow the VARQ FC procedure.

f. Sluice Gates

- Normal Maximum Opening .....16 feet (4.9 m)

Note: Maximum sluice gate opening is 17 feet (5.2 m). Above 16 feet (4.9 m), severe cavitation may occur; thus, sluice gate openings are restricted to 16 feet (4.9 m) unless a greater opening is required to pass the last increment of a flood that threatens to exceed reservoir

elevation 2,459 feet (749.5 m).

g. Powerhouse

- Number of Units…….. 5
- Nameplate capacity (5 @ 105 MW)…… ...525 MW
- Overload Capacity (5 @ 120 MW) …… ....600 MW
- Hydraulic capacity (within cavitation limits)…….. ...27,000 cfs (750.4 cms)

Note: Additional units 6 through 8 are partially complete; unit 6 is currently in design. However, the completion of units 7 and 8 remains uncertain. Even after unit 6 becomes available, maximum powerhouse capacity is the hydraulic capacity of five units.

7-3 OVERALL PLAN FOR WATER CONTROL MANAGEMENT

The storage regulation of Libby Dam can be generally categorized into four periods: the fall period (October–November), a storage evacuation period (December–March), a refill period (April–June), and the summer period (July–September). These four periods serve as a general guide for annual operations and reflect the current operating regime at the time the WCM was written. The following subsections provide more detail on the operations in each period.

a. Fall Period (October–November)

Libby Dam is drafted in this period to prepare for the storage evacuation period and to provide hydropower production. The October and November elevation targets should be set to reach the end of December flood risk management elevation by using the powerhouse capacity at Libby Dam. In general, releases in October are set to the normal minimum flow to conserve water for the November draft. The pool elevation at the end of November must be below 2,448 ft. Typically, the end of November draft target elevation is approximately 2,435 ft (742 m), which gives Libby Dam flexibility to meet the 31 December target and stay within powerhouse capacity.

b. Storage Evacuation Period (December–March)

Libby Dam is operated to meet end-of-month elevation targets during the December–March period, continuing into April if the start of refill has not been declared. The elevation targets are meant to create storage space for the upcoming spring which also provides the mainstem of the Columbia River with additional water for power generation. The end-of-month targets are set by the VARQ FC SRD and the official April–August Libby Dam water supply inflow forecast (Libby Dam WSF), issued by the Seattle District Water Management Section (CENWS-ENH-W) by the third business day of the month after review and approval by CENWD-PDW-H. The VARQ FC SRD (Plate 7-1) is used to calculate the space requirement that is translated into an end-of-month elevation target. VARQ FC SRD guidance targets a full draft prior to the expected start of refill. Refer to Section 7-05.b.2 for a

more detailed discussion of the initiation of refill. Flood risk management releases during the drawdown period, December–April, should stay within the powerhouse capacity.

c. Refill Period (April–June)

During the month of April prior to the initiation of refill, Libby Dam continues to operate to meet the required flood risk management space and elevation target determined by the VARQ FC SRD and the Libby Dam WSF. Under some conditions, including an increasing WSF, continued drafting may be required during April to meet the elevation target prior to refill. If the observed reservoir elevation is below the required flood risk management elevation target, the reservoir elevation may be permitted to increase toward the target elevation prior to the initiation of refill.

Refill is typically initiated based on system flood risk management requirements and occurs no later than May 1st (refer to Section 7-05.b.2 for a discussion of the initiation of refill). However, during April there is the option to initiate earlier refill. Refill at Libby Dam may be initiated when the forebay elevation at Libby Dam is anticipated to fall below the Flood Control Refill Curve (FCRC)[2] described in Section 7-05.b.2 and Section 7-05.d. The FCRC should only be used as a guide for regulation; regulators should use forecasts and current hydrological conditions to determine appropriate operations.

After the initiation of refill has been declared, Libby Dam will be regulated to the VARQ FC Operating procedure described in Section 7-05.b, as well as the sturgeon flow augmentation and bull trout minimum flow requirements described in Section 7-08. Releases set by VARQ FC should be viewed as minimums unless the inflow is below the VARQ FC flow or the stage at Bonners Ferry is expected to go above elevation 1,764 ft. Finally, Libby Dam should be regulated to an elevation to keep enough space in the reservoir for summer precipitation events and to allow for the capability to complete refill during the summer.

d. Summer Operations (July–September)

After the refill period, releases are set to allow Libby Dam to reach its seasonal maximum elevation in late July or early August and then meet the 30 September target elevation. Releases will be informed by the 2020 BiOps, including bull trout minimum flows (see Section 7-08b) and operations to avoid double peaking. After the sturgeon pulse, a double peak operation at Libby Dam is defined as any increase in discharge while discharges are below 9,000 cfs, an increase in discharge of greater than 2,000 cfs while discharges are between 9,000 and 16,000 cfs, and an increase in discharge of greater than 5,000 cfs, or one unit, while discharge is 16,000 cfs or greater (CRSO EIS Appendix V part 1, or see 2020 CRS Biological Assessment (BA) for detail). The end-of-September target elevation will be determined through the use of a sliding scale based on the May Libby Dam WSF, with the target ranging from 2,439 ft to 2,454 ft (Section 7-08d).

[2] Flood Control Refill Curves are curves to help guide the refill of reservoirs and as much as possible ensure that flood control regulation does not adversely affect refill. The FCRC defines the lower limit of reservoir drawdown that assures refill with a 95 percent assurance.

7-4 STANDING INSTRUCTIONS TO DAMTENDER

Operations of the physical facilities to accomplish water management objectives are the responsibility of the Libby Project personnel. Such operation will be in accordance with the Libby Dam operations and maintenance manuals. Orders pertinent to reservoir regulation activities are included in Exhibit 7-1.

7-5 FLOOD RISK MANAGEMENT

Libby Dam provides flood risk reduction for spring floods in the Kootenai Valley below Libby, Montana, and on the lower Columbia River. Seasonal storage operations at Libby Dam are conducted for flood risk management and fish habitat and flow considerations, and there are hydropower benefits from additional winter water supply. Seattle District flood risk management coordination includes:

- Seattle District calculates the monthly WSF and determines the end-of-month pool target elevation. The Division Hydrologic Engineering and Power Branch (CENWD-PDW-H) reviews and approves the Libby Dam WSF and works with NWS to establish elevation targets as part of setting flood risk management requirements.

- The USACE CENWS-ENH-W will coordinate flood risk management for Bonners Ferry, ID and the downstream Kootenay Flats area while jointly coordinating with the CENWD-PDW-H and Reservoir Control Center (CENWD-PDW-R) to assist in meeting requirements for the lower Columbia River using the variable discharge Flood Control (VARQ FC) procedure.

- Coordination with Technical Management Team (TMT), described in Section 7-08, to assure that Libby Dam complies with the NMFS BiOp and U.S. Fish and Wildlife Service (USFWS) BiOp requirements.

- CENWD-PDW-H and CENWD-PDW-R provide updates and exchange information regarding Libby Dam operations to Canada via the Columbia River Treaty Operating Committee forum and coordinate with CENWS-ENH-W regarding any concerns or special operation requests by Canadian parties.

- During a major system flood event, Libby Dam will be operated in accordance with the CENWD System Flood Protocol. Under this protocol, during a major system flood event CENWD-PDW, in coordination with CENWS-ENH-W, has the lead role for coordinating system flood risk management operations.

a. Flood Risk Management Regulation

Flood risk management at Libby Dam follows the VARQ FC procedure (see Section 7-05.b) to meet system and local flood risk management objectives. This generally provides adequate flood reduction in both the lower Kootenai River and the Columbia River. In some circumstances, project flood risk operations needed for local and system flood risk management may conflict; in this case, the District and Division will work together to balance operations and risk. This will be informed by available data and based on professional

engineering judgment of CENWS-ENH-W, CENWD-PDW-H, CENWD-PDW-R and in consultation with CENWS-ODLI fishery biologist insofar as possible. Operating Libby Dam releases to control flood risk for both local and system flood risk management. This risk assessment will be coordinated between CENWS-ENH-W and CENWD-PDW. If control for the lower Kootenai River is the primary operation, Libby Project releases will be regulated to limit the stage at the Bonners Ferry gage to 1,764 ft (538 m), insofar as possible. The ability to regulate to a 1,764 ft (538 m) stage is dependent upon tributary streamflows between Libby, Montana, and Bonners Ferry, available storage capacity at Libby Dam Project, backwater effects at Bonners Ferry due to Kootenay Lake, and the Libby Dam minimum-discharge constraint. Various combinations of Kootenai River streamflow and Kootenay Lake stage can cause a 1,764 ft (538 m) stage at Bonners Ferry as indicated by Plate 4-9. Thus, releases at Libby Project must consider Kootenay Lake stage to limit stages at Bonners Ferry to 1,764 ft (538 m) or below, insofar as possible. There may be extreme cases where Libby Dam is regulated to keep the Bonners Ferry stage at 1,770 ft (540 m) or at another target, chosen by using professional judgment. Libby Dam regulation can be modified specifically to respond to flooding issues in Canada, insofar as the operations fit within water management constraints and obligations.

b. Flood Risk Management Operating Procedures

The Variable Discharge Flood Control (VARQ FC) Operating Procedures determine operations during an evacuation period in the winter (approximately December to March) and a refill period (approximately April to July). The evacuation and refill operations are based on the Libby WSF for the expected inflow volume to Libby Dam, which USACE currently prepares once a month during the months of December through June. During evacuation, VARQ FC sets flood risk management storage space requirements. During refill, VARQ FC sets minimum flow requirements. It is possible during the refill period that Libby Dam could still draft if deemed necessary by professional judgement and supported modeling. The VARQ FC Operating Procedures for Libby Dam are as follows:

(1) Rule 1. Flood Risk Management during the Evacuation Period

The VARQ FC Storage Reservoir Diagram (VARQ FC SRD) for Libby Dam (Plate 7-1) is used to guide the evacuation of water in the reservoir for flood risk management purposes. The required storage space for flood risk management is a function of the time of year (month) and the most recent Libby Dam WSF. During evacuation and until the initiation of refill, outflows are to be limited to hydraulic capacity of the powerhouse to the best extent possible to avoid using the sluice gates. This may result in some years where it is not possible to draft down to the required storage space. In most cases, Rule 5 will adjust VARQ FC flows to adequately compensate for this reduced storage space. However, in rare situations, such as the loss of hydraulic capacity or significantly changing forecasts, a risk analysis may show that spill is warranted. There may also be some years where observed elevation at the end of the evacuation period is significantly below the target elevation, and more than the required storage space is provided. In these years, Rule 5 will adjust VARQ FC flows to attempt to compensate for this additional storage space. Libby Dam will be operated to provide the required storage space indicated by monthly Libby Dam WSFs until the initiation of refill, which is defined by Rule 2.

(2) Rule 2. Initiation of Refill

Initiation of refill is typically determined by the operating procedures for system flood risk management on the lower Columbia River or local flood risk management in the Kootenai Valley. The system refill procedures initiate the FRM fill period when natural inflows exceed desired flow thresholds and managed fill is needed to reduce flood flows in the lower Columbia River, as determined by CENWD. When the Libby Dam WSF released at the start of April is less than 6.9 MAF, refill is initiated based on local flood risk management requirements, which sets the start of refill on May 1. If the Libby Dam WSF is greater than or equal to 6.9 MAF, refill is initiated with the earlier of either the local or system flood risk management requirements: either May 1 or 3 days prior to when streamflow forecasts of unregulated flow are projected to exceed the ICF at The Dalles, Oregon. Under certain conditions, the FCRC procedure may be used in April to determine when refill is to begin. A detailed discussion of conditions that trigger application of the FCRC procedures is provided in Section 7-04.d. The FCRC is a curve to estimate the required pool elevation to fill the reservoir with 95 percent confidence.

(3) Rule 3. Initial VARQ FC[3] Outflow During Refill

Use Table 7-1 to determine an initial VARQ FC outflow for Libby Dam with the most recent April–August WSF (Libby Dam WSF or “early-bird”).

Given that initiation of refill will occur prior to the issuance of the May Libby Dam WSF and in some years will be in April, the following guidance may be used to help reduce or avoid spring flow double peaking below Libby Dam. Double peaking could materialize when the April Libby Dam WSF is greater than the May Libby Dam WSF. Current weather and hydrologic conditions such as runoff timing will also impact if and when a double peak occurs. Prior to setting the VARQ flow, develop an “early-bird” May WSF. If the “early-bird” forecast suggests that the May Libby Dam WSF is expected to be less than the April Water Supply Forecast, then professional judgement and supported modeling may be used to set the initial VARQ flow based on the “early-bird” May Water Supply Forecast to avoid a double peak.

During refill, the initial VARQ flow will need to be recalculated each time a new Libby Dam WSF is developed.

[3] Initial VARQ refers to the first step of determining the VARQ flow and should not be confused with Initiation of refill.

Table 7-1. Initial VARQ Flow

April through August Inflow Volume Forecast (MAF)	Initial VARQ Flow (kcfs)
≤ 4	12
7	16
8	16
≥ 9	18

Note: Linear interpolate between table values 4–7 MAF and 8–9 MAF.

(4) Rule 4: Determining VARQ Flood Control Duration

The flood control duration for Libby Dam is determined by the most recent WSF (same as used in Rule 3) and either the local or system flood control duration. The flood control duration is updated each time the initial VARQ is updated.

If the WSF is less than 6.9 MAF then flood control duration is the local flood control duration, where:

Local flood control duration is determined using interpolation of Table 7-2.

Table 7-2. Libby Dam Water Supply and Local Flood Duration

April through August Inflow Volume Forecast (MAF)	Local Flood Duration (days)
< 4	46
> 7.5	76

If the most recent WSF is greater or equal to 6.9 MAF, then the flood control duration is the greater of either the system flood control duration or the local flood control duration, where:

System flood control duration is determined using Plate 7-3[4]. Select the appropriate curve based on the level of the most recent projected control flow at The

[4] While Plate 7-3 was developed for ICF, it is also used for determining subsequent CF values.

Dalles (CF). If the CF is less than 350 kcfs, for purposes of this computation, the system duration is assumed to be zero.

Local flood control duration is determined using interpolation of Table 7-2.

(5) Rule 5. Adjusting VARQ FC Outflows for Delta Storage During Refill

As soon as the most recent Libby Dam WSF becomes available, adjust the initial VARQ FC outflow, if necessary, to compensate for any storage difference between the actual reservoir storage space on the refill start date and the recalculated required storage space at the start of refill using the most recent Libby Dam WSF. This difference may reflect under or over-drafted conditions (Delta).

The adjusted storage (ADJSTO) is given by:

$$\text{ADJSTO} = \frac{\text{Delta (kaf)} * 0.504 \text{ (ksfd/kaf)}}{\text{Duration (days)}}$$

Where:

Delta = Required storage space on refill start date (using the most recent Libby Dam WSF) minus the actual space (on refill start date)

Flood Control Duration = developed in Rule 4

The storage VARQ FC flow is then given by:

VARQ (storage) = VARQ (initial) + ADJSTO

(6) Rule 6. Adjusting VARQ FC Outflows for Planned Releases During Refill

Adjust the VARQ FC releases to incorporate planned releases during refill. The most common example of planned releases is the sturgeon flow augmentation. To account for the uncertainty in the planned releases, the adjustment is conservatively applied to the entire flood control duration, including the period during which the planned flow is to be released. Additionally, for this calculation assume the entire sturgeon pulse volume is released during the flood control duration. The planned release adjustment is only updated if there is a change in the planned release volume. The planned release adjustment (ADJPLAN) is given by:

$$\text{ADJPLAN} = \frac{[\text{VARQ(storage)} - \text{Qout(planned)}] * [\text{Planned Release Duration (days)}]}{\text{Flood Control Duration (days)}}$$

Where:

Qout(planned) = the average planned outflow, Planned outflow for the sturgeon pulse may be calculated as follows:

$$\left(\frac{\text{Sturgeon Pulse Volume (KAF)}}{\text{Planned Release Duration (days)}} * 0.504\right) + 4\ kcfs\ (minimum\ flow)$$

Planned Release Duration = the number of days, within the flood duration, over which the planned outflow will be released.

Flood Control Duration = determined in Rule 4

The new VARQ FC flow is then given by:

VARQ (planned) = VARQ (storage) +ADJPLAN

(7) Rule 7. Adjusting VARQ FC Outflows for Prior Releases During Refill

VARQ FC are minimum releases. Actual outflows can vary due to real-time regulation decisions. This rule accounts for the difference in actual averaged outflows released beginning on the refill start date and the new VARQ FC outflows developed using the most recent April–August WSF (Libby Dam WSF or "early-bird"). This adjustment may be recalculated daily although given real-time regulation limitations, a weekly recalculation of this step is expected.

$$\text{ADJDUR} = \frac{\text{[VARQ(planned) – Qout(prior)] * [Prior Release (days)]}}{\text{[Flood Control Duration (days) – Prior Release (days)]}}$$

Where:

Qout(prior) = average outflow since start of refill

Prior Release (days) = number of days since start of refill

Flood Control Duration = determined in Rule 4

Compute final VARQ FC outflow:

VARQ (final) = VARQ (planned) + ADJDUR

(8) Rule 8. Inflows Less than VARQ FC Outflows

At the initiation of refill, if inflows are less than the VARQ FC outflow, pass inflow until inflows rise to the VARQ FC level. Thereafter, if inflows drop below the VARQ FC outflow, pass inflow only until they rise again to the VARQ FC level.

(9) Rule 9. Adjusting VARQ FC Outflows for Flood Damage Reduction

Use available forecasts to evaluate the performance of the VARQ FC outflows in meeting system and local flood risk management objectives. VARQ FC outflows may be adjusted (increased or decreased) if necessary to provide protection for human life, health, and safety, insofar as possible.

(10) Rule 10. Adjusting VARQ FC Outflows to Achieve Refill Objective

Increase outflows during the final stages of refill to avoid overfilling and unwanted spill. Likewise, decrease outflows during the final stages of refill if the present outflow would otherwise not fill the reservoir. Use available information and engineering judgment to select the appropriate outflows.

c. Discharge Regulation Schedule

During very large floods, continued regulation according to the normal flood risk management procedures could result in a premature filling of the reservoir, potentially requiring Libby Dam to pass high inflows. The discharge regulation schedule, shown on Plate 7-1, is used to determine discharge requirements to best use the remaining storage below the maximum full pool level of 2,459 feet (750 m). The discharge regulation schedule is entered with the current reservoir elevation and estimated inflow to determine the discharge to be scheduled for the upcoming hour. Adjusting the outflow hourly will adequately maximize the benefit of remaining storage while minimizing adverse effects due to changes in the rate of discharge downstream. An example of the use of the discharge regulation schedule is shown in Exhibit 7-2.

d. Flood Control Refill Curve (FCRC)

The FCRC for Libby Dam is used to help guide refill from 01 April through 31 July. The curve defines the lower limit of reservoir drawdown that can be filled with a 95 percent assurance. It is computed daily based on the latest available estimate of residual inflow volume expected during the refill period and using the best estimate of minimum flows as described in Sections 7-02 and 7-08. If the elevation of Libby Dam is below the computed FCRC, the regulator may initiate refill which will begin VARQ operations. This operation depends heavily on regulator discretion and is not a requirement. Exhibit 7-3 shows how to calculate the FCRC for Libby Dam.

Assumed outflows for Libby Dam to be used in the FCRC calculation should be highly predictable. The VARQ flow should not be used because 1) the duration for VARQ is highly variable, 2) the start date is, generally, between 1-Apr and 1-May, and 3) the flow can be anywhere from 4,000 cfs to powerhouse capacity. The recommended outflows to use in the FCRC calculation are 4,000 cfs through May 14th, the bull trout minimums (see Section 7-08.a), and the releases associated with the sturgeon flow augmentation (see Section 7-08.b). Bull trout minimums are highly predictable: 6,000 cfs 15-May to 30-Sep and use the tiered bull trout minimums after the sturgeon operation through 31-Aug. The sturgeon operation can vary by shape and timing, but coordination between CENWS-ENH-W and the Flow Plan Implementation Protocol (FPIP) Technical Team prior to May provides an idea of the timing and shape that is going to be requested for the sturgeon operation given the current forecast. If there is too much uncertainty regarding the sturgeon operation for a given year, it should not be used in calculating the FCRC. If FCRC is used to initiate refill, Seattle District will submit the appropriate outflows to be used in the FCRC calculation to CENWD-PDW-H.

7-6 RECREATION

While Libby Dam is authorized for recreation, there is no specific reservoir regulation associated with the purpose.

7-7 WATER QUALITY

a. Water Quality Criteria and Total Maximum Daily Loads.

The Montana Department of Environmental Quality (MDEQ) determines water quality criteria for Lake Koocanusa and the Kootenai River downstream of Libby Dam in Montana. The MDEQ has classified Lake Koocanusa and the Kootenai River below Libby Dam as a Class B-1 water body. Waters classified as B-1 shall be suitable for drinking, culinary and food processing after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply. Water quality standards for Lake Koocanusa and the Kootenai River below Libby Dam are presented in Table 7-3.

The Libby Dam downstream water quality compliance locations are station LBQM for TDG, station LIBM for temperature, and station LIBTW for all other water quality parameters. In-reservoir compliance locations are stations LIBBOR, LIBTMC, and LIBFB. The location of these stations was described in Section 5-02 and shown in Plates 5-2 and 5-3.

The MDEQ, in Appendix A of its 2020 Water Quality Integrated Report (MDEQ 2021), identified Lake Koocanusa as Category 5 water quality impaired and not fully supporting aquatic life for flow regime modifications and selenium. Consequently, Lake Koocanusa was included in the 2020 MDEQ Clean Water Act 303(d) list which is defined by the U.S. Environmental Protection Agency (EPA) as waters impaired or threatened by pollutant(s) for one or more designated uses. A total maximum daily load (TMDL) is required to address the impairment or threat from pollutants but not from all forms of pollution. For Lake Koocanusa, a TMDL is needed for selenium but not for flow regime modifications because flow modifications are classified as a form of pollution and not as a pollutant.

The Kootenai River was identified by MDEQ as Category 5 water quality impaired and not fully supporting aquatic life for flow regime modifications and water temperature in Appendix A of its 2020 Water Quality Integrated Report. The river was included in the 303(d) Category 5 list requiring a TMDL for water temperature but not flow regime modifications since flow modification is a form of pollution and is not a pollutant. A TMDL is being developed for water temperature.

b. Total Dissolved Gas (TDG)

TDG supersaturation is generated by spilling water at Libby as a result of air entrainment and transfer of atmospheric nitrogen into solution at depth in the stilling basin. Spilling water at dams can result in increased TDG saturations in downstream waters by plunging the aerated spill water to depth where hydrostatic pressure increases the solubility of atmospheric gases. Elevated TDG levels generated by spillway releases from dams can promote the potential for gas bubble trauma in downstream aquatic biota. Libby is a headwater project with no upstream sources of TDG supersaturation. Libby can increase TDG saturations in the Kootenai River downstream via spillway discharges and sluiceway

discharges. Libby is not equipped with any TDG reduction system, such as spillway flow deflectors.

c. Water Temperature

The species composition and activity of aquatic organisms in the Kootenai River is regulated by temperature. Water temperature and associated water quality processes are known to impact anadromous and resident fishes in the CRS. Dams may alter a river's water quality characteristics by altering temperature gradients due to the creation of reservoirs. Water temperature has a significant impact on fish survival and growth, TDG saturations, biotic community composition, chemical and biological reaction rates, and other aquatic processes.

A SWS was designed and installed at Libby Dam to manage release water temperatures during periods of thermal stratification in the forebay. Beginning in 1977, Libby Dam began to operate the SWS to supply water to the penstocks from different thermal layers in the forebay. By utilizing a system of bulkheads to remove water from different depths in the forebay, operation of the SWS attempts to provide as close to a normative thermograph as possible throughout the year.

Downstream temperatures are regulated using the SWS for three primary purposes. First, temperatures have generally been managed according to a temperature rule curve established by USACE in cooperation with Montana Fish, Wildlife & Parks; discharge temperature targets are now managed, to the extent possible, to mimic pre-dam mean river temperatures. The temperature rule curve is shown in Plate 7-4. Second, temperatures are managed to provide the most reliable and best available temperatures for endangered Kootenai River white sturgeon. Current operation of the system strives to provide steadily increasing release temperatures during the receding limb of the sturgeon operation hydrograph while avoiding a sudden drop of more than 3.6°F (2°C) from Libby Dam during sturgeon incubation, hatching, and larval development phases; targets at Bonners Ferry are 50°F (10°C) minimum for sturgeon spawning. Third, the SWS is operated to provide the coldest water temperature available in the forebay during late fall through early spring, for burbot migration and spawning during this period, as well as to provide a thermally normative discharge temperature for other aquatic riverine organisms.

The SWS only provides temperature management for powerhouse discharges. The other two discharge mechanisms, the spillway and the sluiceway, are not equipped with temperature management systems.

d. Dissolved Oxygen

Dissolved oxygen is considered to be significant in the protection of fish and other aquatic life. Dissolved oxygen standards are generally based on the concentration that will support aquatic life. Low dissolved oxygen concentrations are typically not an issue for Libby Dam releases. In general, dissolved oxygen concentrations measured near the surface in the epilimnion of all stations were similar and ranged from about 8 to 11 mg/L. Dissolved oxygen concentrations measured near the bottom in the hypolimnion were lower at the LIBBOR station when compared to the LIBTMC and LIBFB stations. Hypolimnetic oxygen at LIBBOR ranged from about 9 to 11 mg/L in April and May to about 4 to 6 mg/L in August

through October. Hypolimnetic oxygen at LIBTMC and LIBFB were similar and ranged from about 9 to 11 mg/L in April and May to about 7 to 9 mg/L in August through October. The lower dissolved oxygen near the bottom at the shallower LIBBOR station is likely due to both warmer hypolimnetic waters at LIBBOR compared to LIBTMC and LIBFB, as well as greater biological productivity near the border resulting in oxygen consumption from decomposition and respiration.

e. pH

pH is a measure of the hydrogen ion concentration in water and can have either a direct effect on aquatic organisms or an indirect effect because the toxicity of metals and ammonia are affected by changes in pH. Waters that exhibit a pH in the range of 0.0 to 7.0 are acidic, while waters in the pH range of 7.0 to 14.0 are alkaline. Typically, pH in the range of 6.5 to 8.5 is considered acceptable for most aquatic species. Monthly vertical pH profiles collected in the reservoir were generally similar between stations and years with a majority of pH readings ranging from about 8.6 near the surface to 7.4 near the bottom. In addition, pH values tended to be lowest during April and May with the greatest pH values measured in July, August, and September. Except for a few outliers, the higher pH values were largely associated with near surface waters in the summer and are likely due to photosynthetic activity of phytoplankton removing carbon dioxide from the water, thereby increasing pH. Conversely, the pH decrease in the hypolimnion may be partly because carbon dioxide and organic acids are released to the deeper waters by the respiration of bacteria and decomposition of organic matter. Periodically, near surface pH values were between 8.5 and 9.0. These high pH readings corresponded to phytoplankton blooms in Lake Koocanusa. Kootenai River pH values were slightly lower than Lake Koocanusa and ranged from about 7.0 to 8.5.

f. Metals

Trace metals occur naturally in rivers and lakes from the weathering of rocks and mineral soils in the watershed. However, metals can also be introduced by a variety of other sources such as mining activities, industrial wastewater discharges, and urban runoff. The most toxic form of metals to aquatic biota is the dissolved state. Water hardness directly influences the toxic effect of metals such as cadmium, chromium, copper, lead, nickel, and zinc on aquatic biota. The toxicity of these metals is reduced as water hardness increases. The toxic effect of metals such as aluminum, arsenic and selenium on aquatic biota are not influenced by water hardness.

Selenium concentrations in the Elk River, a major tributary to Lake Koocanusa located in southeastern British Columbia, have increased from about 1 µg/L in 1984 to greater than 8 µg/L in 2020 (USGS 2022). Sources of selenium to the watershed include increased coal mining operations, and the corresponding waste rock spoils it generates, in southeastern British Columbia in the watersheds of the Elk and Fording Rivers (USGS 2022). Jenni et al, (2017) noted that selenium loading to Lake Koocanusa from the Elk River increased fivefold between 1992 and 2012. Selenium can bioaccumulate in the food web and is toxic to fish and aquatic birds (Skorupa 1998; Chapman et al. 2010).

g. Turbidity/Total Suspended Sediments

No plan is currently in place to measure turbidity and total suspended sediments in the Kootenai River downstream of Libby Dam. These are not typically an issue from Libby Dam releases.

Table 7-3. Montana Department of Environmental Quality (MDEQ) Class B-1 Water Quality Standards.

Parameter	Standard
Total Dissolved Gas	Shall not exceed 110% of saturation at any point of sample collection.
Dissolved Oxygen	Shall exceed a 7-day mean concentration of 9.5 mg/L, with a 1 day minimum concentration of 8.0 mg/L and a 7 day mean minimum concentration of 5.0 mg/L.
pH	Shall be within the range of 6.5 to 8.5 with no induced variation of pH greater than 0.5 pH units. Natural pH outside this range must be maintained without change.
Turbidity	The maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units.
Temperature	A 1°F maximum increase above naturally occurring water temperature is allowed within the range 32°F to 66°F; within the naturally occurring range 66°F to 66.5°F, no discharge is allowed which causes the water temperature to exceed 67°F; and where the naturally occurring water temperature is 66.5°F or greater, the maximum allowable increase in water temperature is 0.5°F.
Dissolved Metals	Shall not exceed an acute criterion for a 1-hour average or a chronic criterion for a 96-hour average for the following dissolved metals:
Aluminum	Acute criterion of 750 µg/L and chronic criterion of 87 µg/L.
Arsenic	Acute criterion of 340 µg/L and chronic criterion of 150 µg/L.
Cadmium	Acute criterion of 3.7[1/] µg/L and chronic criterion of 1.0[1/] µg/L.
Chromium	Acute criterion of 549[1/] µg/L and chronic criterion of 178[1/] µg/L.
Copper	Acute criterion of 17.0[1/] µg/L and chronic criterion of 11.4[1/] µg/L.
Lead	Acute criterion of 64.6[1/] µg/L and chronic criterion of 2.5[1/] µg/L.
Selenium	Acute criterion of 20 µg/L and chronic criterion of 5 µg/L (0.8 µg/L for Lake Koocanusa and 3.1 µg/L for the Kootenai River downstream of Libby Dam).
Zinc	Acute criterion of 114.4[1/] µg/L and chronic criterion of 104.5[1/] µg/L.

[1/]Toxicity criterion is hardness dependent. Value based on an average hardness in the Kootenai River of 100 mg/L as $CaCO_3$.

7-8 FISH AND WILDLIFE

The 2020 BiOps require Libby Dam to meet certain objectives for fish species. The 2020 BiOps modified the end-of-September targets designed to provide water for Columbia River salmon recovery to better fit local water availability. Please refer to current BiOps for detailed information on ESA operations. These operations are subject to in-season modification through adaptive management when coordinated through the TMT[5] process. The TMT mission is to develop recommendations from sovereign representatives to the Action Agencies on a variety of in-season operations to benefit fish, including spill, temperature, and flows as outlined in the current BiOps for ESA-listed salmon, steelhead, sturgeon, and bull trout species within the Columbia River Basin, while taking into account the needs of (and effects on) other listed and non-listed species (such as lamprey).

This section describes how to implement BiOp discharge requirements that are in the current 2020 BiOps. See Section 7-16 for the associated ramping rate information. The BiOp requirements described in this section serve as a guide on how to regulate Libby Dam in accordance with them. Always consult the most current BiOps or review the Water Management Plan that is produced by TMT for the latest information on how to regulate Libby Dam to the BiOps.

a. Tiered Bull Trout Minimum Discharge at Libby Dam

From May 15 to May 31 and during the month of September, a bull trout minimum flow of 6,000 cfs (170 cms) will be discharged. The additional 2,000 cfs flow and volume to sustain the basal bull trout minimum flow of 6,000 cfs (170 cms) from May 15 through May 31 will be accounted for with sturgeon volumes, if necessary, and in the fall will be concurrent with the autumn FRM draft. Minimum bull trout flows of 6,000 cfs (170 cms) May 15 through September, and up to 9,000 cfs after the sturgeon pulse through August 31, as determined in Table 7-4. Minimum flows of 4,000 cfs (113 cms) will be provided for the rest of the year.

[5] The TMT was part of the proposed Reasonable and Prudent Alternative (RPA) in the FCRPS BA Appendix B at B.2.1-13, and included in the NMFS 2008 FCRPS BiOp RPA No. 6 “In-Season Water Management.”

Table 7-4. Minimum Bull Trout Releases from Libby Dam After Sturgeon Flow Augmentation Volume is Exhausted Through August 31, Based on May Final Libby Dam Water Supply Forecast for April–August

Apr–Aug Forecast Runoff Volume at Libby Dam	**Min Bull Trout Flows (after Sturgeon Pulse and Through August 31) (cfs)**
forecast <4.80 MAF	6,000
4.80 MAF≤ forecast < 6.00 MAF	7,000
6.00 MAF≤ forecast < 6.70 MAF	8,000
6.70 MAF≤ forecast	9,000

Notes:

Minimum bull trout flows from May 15–May 31 and all of September is 6,000 cfs

MAF = million acre-feet

(Table modified from BA Table 2.3 to clarify implementation details, but there are no modifications to the operation that was consulted on with the Services)

b. Sturgeon Flow Augmentation

Sturgeon flow augmentation volume (Table 7-5) is measured above the 4,000 cfs (113 cms) minimum releases from Libby Dam. Accounting for these total tiered volumes will begin when the FPIP Technical Team determines benefits to conservation of sturgeon are most likely to occur. Sturgeon flows will generally be initiated between early May and mid-June to augment lower basin runoff, consistent with the FPIP and the 2020 USFWS BiOp. The sturgeon flow augmentation volume is calculated by interpolating the May WSF for Libby Dam using the table below. The actual shape and flows used to expend the volume will be coordinated with the FPIP Technical Team. Generally, the shape of the receding limb of the hydrograph is constructed to expend the sturgeon volume as discharge is ramped toward bull trout minimums or the summertime flat flow rate.

Table 7-5 shows “Tiered” volumes of water for sturgeon flow enhancement to be released from Libby Dam according to the May Libby Dam WSF. Actual flow releases would be shaped according to seasonal requests from the FPIP Technical Team to TMT and in-season management of water available.

Table 7-5. Sturgeon Flow Volumes Released from Libby Dam

Apr-Aug Forecast (MAF)	Sturgeon Volume (MAF)
Less than 4.80	0.0
4.8 to 5.40	0.8
5.40 to 6.35	0.80 to 1.12
6.35 to 7.40	1.12 to 1.20
7.40 to 8.50	1.20
8.5 to 8.90	1.20 to 1.60
Greater than 8.90	1.60

Notes:

Measured as flow volume from Libby Dam in excess of 4 kcfs minimum flow.

Linear interpolate between values as needed.

c. Maximum Regulated Discharge at Libby Dam (May–September)

Maximum discharge target to meet BiOps schedules is powerhouse capacity between 19,000–27,200 cfs, depending on head at Libby Dam. Bonners Ferry stage during this period should be regulated at or below 1,764 feet for the BiOps schedules, if possible.

Note: In rare situations, such as the loss of hydraulic capacity or significantly changing forecasts, engineering judgment may determine that spill is warranted. The spill amount should adhere to the Montana State water quality standard of 110% TDG if possible. The spill tests of 2010–2012 showed that spill above approximately 1,500 cfs will likely result in TDG above 110 percent. Any spill operations should be communicated to regional stakeholders and with TMT.

d. Post Sturgeon Operation

After the sturgeon operation, flows will be planned to be stable or slowly declining over the summer while targeting reservoir refill, if possible, in late July or early August; double peaks in discharge will be avoided to the extent possible. Double peaking is described in Section 7-05.b.3. Bull trout minimums will be maintained as described earlier in Section 7-08.a. Summer operations will be coordinated through TMT in-season management. Libby Dam releases will follow ramp rates listed in the 2020 CRS BA and as shown in Exhibit 7-4.

e. Summer Storage Evacuation

During the summer (July through September), insofar as possible, USACE will operate Libby Dam to help meet the flow objectives for juvenile salmon out-migration in the Columbia River in accordance with the updated 2020 NMFS BiOp. Based on the 2020 USFWS BiOp, summer operations will avoid double peaking (as previously defined in Section 7-05.b.3), meet the bull trout minimum flow (Section 7-08.a), reach the seasonal maximum lake

elevation in late July or early August, and draft to the end-of-September pool target. The USACE will draft Lake Koocanusa 5 to 20 feet from full by the end of September, using the May Libby Dam WSF and Table 7-6 to determine the target elevation. If Libby Dam fails to refill, then Libby Dam will release inflows or operate to meet minimum bull trout flows through the summer months.

Table 7-6. End-of-September Target for Libby Dam using May Libby Dam WSF

Libby Dam Water Supply Forecast for April–August Inflow (percentile)	**Libby Dam Water Supply Forecast for April–August Inflow (MAF[1/])**	**End-of-September Target Pool Elevation (ft-NGVD29)[2/]**
≤15th	4.48	2,439
25th	5.08	2,449
75th	7.06	2,449
≥85th	7.53	2,454

[1/]MAF = million acre-feet, value based on the current 1991 to 2020 30-year period

[2/]Targets are interpolated between 15th and 25th percentile and between 75th and 85th percentile

7-9 WATER CONSERVATION/WATER SUPPLY

Water supply is not an authorized purpose of the project for municipal, industrial, or irrigation usage.

7-10 HYDROELECTRIC POWER

Libby Dam is a major project in the Pacific Northwest coordinated electric power system. Libby Dam is operated primarily as a base-load plant with peaking events occurring during the winter period during storage evacuation (November and continuing through March or April). However, per the 2020 USFWS BiOp, peaking or daily load shaping is only allowed from October through March. Powerhouse releases can vary from 4,000 cfs up to powerhouse capacity of 19,000–27,200 cfs depending on head at Libby Dam. Power generation schedules are based on day-to-day conditions and are requested by BPA, then reviewed, revised if necessary, approved, and then issued by CENWS-ENH-W. The operators at Libby Dam are responsible for implementing the schedules and reporting the powerhouse status to BPA hourly. See Exhibit 7-4 for additional guidance on ramping rates.

7-11 NAVIGATION

While Libby Dam is authorized for navigation, there is no specific reservoir regulation associated with the purpose.

7-12 DROUGHT CONTINGENCY PLANS

Libby Dam is operated as part of the Columbia River reservoir system under all conditions, including droughts. A detailed Drought Contingency Plan for the entire CRS is presented in Section XII of the *Columbia River Basin, Master Water Control Manual*, dated December 1984, and is applicable to Libby Dam. The Drought Contingency Plan is a detailed guideline for operation of the Columbia River reservoir system under adverse streamflow conditions. The plan addresses historical droughts, drought forecasting techniques, drought impacts and operational requirements for the system and individual drought management stations.

7-13 FLOOD EMERGENCY ACTION PLANS

Please refer to the most recent Emergency Action Plan from CENWS Dam Safety.

7-14 OTHER

Article XII, Paragraph (6) of the Columbia River Treaty states: “The operation of the storage by the United States of America shall be consistent with any order of approval which may be in force from time to time relating to the levels of Kootenay Lake made by the International Joint Commission under the Boundary Waters Treaty, 1909.”

7-15 DEVIATION FROM NORMAL REGULATION

CENWS-ENH-W is occasionally requested to authorize, coordinate, and conduct special regulations for Lake Koocanusa and/or the Kootenai River below Libby Dam. Although they are not considered emergencies, situations occasionally occur which require temporary deviations from the normal regulation of Libby Dam. Construction accounts for the majority of deviations and can include utility stream crossings, bridge work, major construction contracts, and in-stream fish habitat projects. Changes in releases are sometimes necessary during maintenance for periods from a few hours to a few days, and each request is evaluated based on its own merits. Consideration is given to upstream watershed conditions, potential flood threat, conditions of the reservoir and the river below Libby Dam, and possible alternative measures. In the interest of maintaining good public relations, these requests are satisfied provided there are no adverse effects in overall operation for Libby Dam's authorized purposes. Except as noted below, prior approval by Seattle District RCC, and approval from CENWD-PDW-H is required if the operation constitutes a deviation from this WCM, per NWDR 1110-2-6:

a. Emergencies

In the event Libby Dam's structural integrity is or could be threatened, or if outflows will or could endanger downstream human life, health, or property, then the procedures outlined in the “Flood Emergency Plan, Emergency Action and Notification Subplan” (Subplan) are to be followed. Specifically, the Subplan is to be implemented in the following situations:

(1) Uncontrollable Emergency

Defined as a condition in which the occurrence of a significant hazard to life and property is certain to occur, and no time is available to repair or modify operational procedures to prevent dam failure.

(2) Controllable Emergency

Defined as a condition, not normally encountered in the routine operation of the dam, in which the occurrence of a significant hazard to life and property is possible unless timely repairs and/or modification to operational procedures are conducted. Time must be made available to conduct corrective actions.

(3) Earthquake

Condition immediately following a felt earthquake at the dam.

(4) Security Alert

Condition at Libby Dam caused by a security incident which could threaten the safety of the structure.

(5) Excessive Releases

Releases that exceed routine operational criteria and/or are in excess of 60,000 cfs (1,700 cms). The Subplan describes procedures and means of initiating operation, repairs, and notifying pertinent parties of the hazard. The procedures have been coordinated with USACE elements and relevant non-USACE authorities and are updated periodically. Their prompt use is essential for minimizing hazards to affected life and property.

The “Physical Security Plan for Libby Dam” contains additional procedures to be followed in the event of a security alert. The “Manual of Procedures for National Emergency Situations, Libby Dam Project (July 1981)” addresses operational procedures during times of national emergency.

b. Abnormal Conditions

Should a condition(s) occur or appear to be developing, other than those described in paragraph above, which requires operational modification, the Project Engineer or dam-tending representative will promptly contact the Seattle District RCC to report the field conditions and receive instructions. BPA and other parties upstream and downstream of Libby Dam that may be affected by the condition will also be informed as soon as possible. When immediate action is required to protect life and valuable property, the Project Engineer will not wait for instruction. In these special situations, a written confirmation showing the deviation and conditions will be furnished to Seattle District RCC by the Project Engineer as soon as possible. Instructions for the proper response to conditions such as failure of operating facilities, drowning and other accidents, and power failures are included in the Station Standing Orders (Exhibit 7-1).

c. Libby Dam Operations for Body Recovery

In the event of non-emergency request for body recovery, Libby Dam staff should coordinate with CENWS-ENH-W to determine preferred timing and any other related operational considerations.

7-16 RATE OF RELEASE CHANGE

Exhibit 7-4 shows the maximum hourly and daily ramping rates consistent with the 2020 USFWS BiOp. Daily and hourly ramping rates may be exceeded during flood emergencies to protect health and public safety, and in association with power or transmission emergencies. (Note: Ramping rates will be followed except when they would cause a unit(s) to operate in the rough zone. In this case, Libby Dam will use a ramping rate which allows all units to operate outside the rough zone). See Exhibit 7-4 for more details on ramping rates. See Section 7-08.a for related biological requirements.

7-17 SPECIAL COLD WEATHER OPERATIONS

The Kootenai Tribe of Idaho (KTOI) Twin Rivers hatchery is located approximately 60 miles downstream of Libby Dam. The hatchery raises ESA listed Kootenai River White Sturgeon and Burbot (an unlisted freshwater cod) year-round. Water for the hatchery is drawn from the Kootenai River during the winter. In the winter, both when discharge from Libby Dam is at 4 kcfs (the minimum flow for bull trout) and during periods of very cold conditions, the tributaries can freeze and drop water levels in the river. These conditions expose the intake making it susceptible to ice formation and flow constriction which can block water from entering the hatchery. When these conditions occur, KTOI may request increased discharge from Libby Dam up to 6 kcfs to prevent ice formation on the hatchery intake. Libby discharge will return to the minimum flow (4 kcfs) as soon as the weather and the instream conditions change. Typically, these conditions may occur between mid-January and mid-March and can last a week.

7-18 SUPPLEMENTAL RELATED REPORTS

- Columbia River System Operations Final Environmental Impact Statement, U.S. Army Corps of Engineers Northwestern Division, Bureau of Reclamation Columbia-Pacific Northwest Region, Bonneville Power Administration, July 2020. (CRSO EIS 2020).

- National Marine Fisheries Service Endangered Species Act Section 7(a)(2) Biological Opinion for the Continued Operation and Maintenance of the Federal Columbia River Power System, July 2020. (NMFS BiOp 2020).

- U.S. Fish and Wildlife Service Endangered Species Act Section 7(a)(2) Biological Opinion for the Columbia River System Operations and Maintenance of 14 Federal Dams and Reservoirs, July 2020. (USFWS BiOp 2020).

- Biological Assessment of Effects of the Operations and Maintenance of the Federal Columbia River System on ESA-Listed Species, Bonneville Power Administration, Bureau of Reclamation, U.S. Army Corps of Engineers, January 2020. (CRS BA 2020).

- Montana 2020 Final Water Quality Integrated Report, Montana Department of Environmental Quality, April 2021. (MDEQ 2021).

- Jenni, K. E., D. L. Naftz, and T. S. Presser. 2017. “Conceptual Modeling Framework to Support Development of Site-Specific Selenium Criteria for Lake Koocanusa, Montana, U.S.A., and British Columbia, Canada.” (Jenni et al., (2017)).

- Skorupa J. P. 1998. “Selenium Poisoning of Fish and Wildlife in Nature: Lessons from Twelve Real-World Examples.” In Environmental Chemistry of Selenium. W. T. Frankenberger and R. A. Engberg, Jr., eds, pp. 315–354. Marcel Dekker. (Skorupa 1998).

- Chapman P. M., W. J. Adams, M. L. Brooks, C. G. Delos, S. N. Luoma, W. A. Maher, H. M. Ohlendorf, T. S. Presser, and D. P. Shaw. 2010. “Ecological Assessment of Selenium in the Aquatic Environment: A SETAC Pellston Workshop.” Pensacola, FL: Society of Environmental Toxicology and Chemistry (SETEC). (Chapman et al. 2010).

- “Manual of Procedures for National Emergency Situations, Libby Dam Project (July 1981)”

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CHAPTER 8—EFFECT OF WATER CONTROL PLAN

8-1 GENERAL

Libby Dam provides local flood risk management on the Kootenai River and also plays a key role in system flood risk management on the Columbia River in the U.S. and Canada. Regulation of storage in Lake Koocanusa provides the potential for additional hydroelectric power generation at downstream projects, in addition to the power generated at Libby Dam. The impoundment of Lake Koocanusa resulted in new recreational opportunities in the form of boating, fishing, swimming, and camping. Additionally, regulated releases of water from the Libby Project augment flows in the Columbia River which, in turn, benefit navigation, irrigation, fish migration, and water quality.

8-2 FLOOD RISK MANAGEMENT

a. Spillway Design Flood (SDF)

The SDF inflow recommended in Supplement No. 1 to Design Memorandum No. 2, approved by the Office of the Chief of Engineers by letter dated 28 November 1962, has been routed through the reservoir and the resultant hydrograph is shown on Plate 8-1. The reservoir is assumed to be drawn down to minimum elevation prior to the flood in accordance with the flood storage allocation parameters. Flood risk management releases are maintained from the project until higher releases are required by the discharge regulation schedule shown on Plate 7-1. The stage at Bonners Ferry is maintained at or below elevation 1,770 feet (539.5 m) (the elevation corresponding to the original zero-damage flood stage) until Libby Dam discharge is increased in response to the discharge regulation schedule. The SDF inflow increases so rapidly that most of the time the discharge regulation schedule requires free spillway discharges until inflow and outflow are equal on the recession side of the hydrograph. Peak inflow is 282,000 cfs (7,985 cms). The maximum regulated pool elevation is 2,459 feet (749.5 m), and the maximum discharge is 206,000 cfs (5,833 cms), with 63,000 cfs (1,784 cms) released through the sluices and 143,000 cfs (4,049 cms) released over the spillway. No powerhouse discharge is used in the SDF routing. The SDF was based on the Probable Maximum Flood (PMF).

b. Standard Project Flood (SPF)

A detailed SPF investigation for the Libby Project is not available at this time; however, a preliminary estimate of the SPF peak outflow from Libby Dam is 65,000 cfs (1,841 cms). During extreme floods such as an SPF or SDF, the discharge regulation schedule shown on Plate 7-1 is used to determine project releases}

c. Other Floods

(1) High Runoff Year

Based on the 2018-level modified flow dataset of the 90 years from 1929 through 2018, the 90th percentile unregulated peak flow was 82,840 cfs (2,346 cms), and the 90th percentile April–August inflow volume was 8,273,000 acre-feet (1,020,420 hectare-m). The flood of 1954 represents the 13th highest flood of record in terms of the unregulated peak

flow (80,300 cfs (2,274 cms)) and the 3rd highest in terms of April–August inflow volume (9,147,000 acre-feet (1,128,308 ha-m)) to Libby Dam. Plate 8-2 shows both the natural and the modeled regulated flood hydrographs, under current reservoir operations, at Lake Koocanusa, Kootenai River below Libby Dam, Kootenai River at Bonners Ferry, and Kootenay Lake.

(2) Average Runoff Year

Based on the 2018-level modified flow dataset of the 90 years from 1929 through 2018, the average unregulated peak flow was 60,700 cfs (1,720 cms), and the average April–August inflow volume was 6,279,000 acre-feet (774,551 hectare-m). The flood of 1978 represents the 45th highest flood of record in terms of the unregulated peak flow (61,000 cfs (1,727 cms)) and the 46th highest in terms of April–August inflow volume (6,321,000 acre-feet (779,773 ha-m)) to Libby Dam. Plate 8-3 shows both the natural and the modeled regulated flood hydrographs, under current reservoir operations, at Lake Koocanusa, Kootenai River below Libby Dam, Kootenai River at Bonners Ferry, and Kootenay Lake.

(3) Low Runoff Year

Based on the 2018-level modified flow dataset of the 90 years from 1929 through 2018, the 10th percentile unregulated peak flow was 39,700 cfs (1,124 cms), and the 10th percentile April–August inflow volume was 4,490,000 acre-feet (553,838 hectare-m). The flood of 1937 represents the 83rd highest flood of record in terms of the unregulated peak flow (38,500 cfs (1,090 cms)) and the 81st highest in terms of April–August inflow volume (4,491,000 acre-feet (553,925 ha-m)) to Libby Dam. Plate 8-4 shows both the natural and the modeled regulated flood hydrographs, under current reservoir operations, at Lake Koocanusa, Kootenai River below Libby Dam, Kootenai River at Bonners Ferry, and Kootenay Lake.

8-3 RECREATION

Libby Dam expanded recreational opportunities and usage in the vicinity of Libby, Montana. Recreational activities include boating, fishing, water sports, day use, camping, hiking, disc golf, and sightseeing. Lake Koocanusa is one of the largest bodies of water in the area which provides the opportunity for boating recreation. Public boat launches and a private marina on Lake Koocanusa provide boater access to the water and the miles of scenic shoreline. Murray Springs Fish Hatchery plants fish in Lake Koocanusa and surrounding waters annually as mitigation for losses of fisheries that occurred due to the construction of Libby Dam. These efforts help to produce a sport fishery in Lake Koocanusa. The release of water at Libby Dam using a SWS greatly enhanced the trout fishery in the Kootenai River below the project. The USACE-constructed campgrounds, day-use areas, and hiking trails adjacent to the lake. A visitor center with hands-on interpretive exhibits, campgrounds, day-use areas, and observation points have been constructed at the dam. Additionally, dam tours are offered daily during the summer and by appointment year-round. With the exception of the Souse Gulch day-use area, all recreation facilities on Lake Koocanusa in the United States are administered by the U.S. Forest Service (USFS). USACE administers the lands for camping and day use on properties downstream of the dam. For additional information, consult the Libby Dam Project Master Plan (Design Memorandum No. 52) and the Forest Service Libby Dam Public Use Development Plan.

8-4 WATER QUALITY

The following is a discussion of the effects of Libby Dam on water quality. Please see Section 5-2 for details on water quality station locations and parameters.

a. Temperature

The operation of Libby Dam and the existence of Lake Koocanusa have altered the natural thermal regime in the Kootenai River. Downstream water temperatures during the fall and winter are several degrees warmer than pre-dam river conditions, and water temperatures are typically several degrees cooler than pre-dam temperatures during the spring release. Release water temperatures are managed using the SWS to supply water to the penstocks from different thermal layers in the reservoir. Operation of the SWS attempts to provide downstream water temperatures that more closely resemble pre-impoundment conditions by utilizing a system of bulkheads to remove water from different depths in the forebay. This system provides some control over release water temperatures but is dependent on the thermal stratification in Lake Koocanusa.

Water temperatures in Lake Koocanusa typically lag seasonal weather conditions by several months due to the large volume of water, long residence time, and latent heat in the water body. The heat contained in the reservoir during the summer is stored through the fall and early winter, while the cooling experienced during the late winter is stored through the spring and early summer. Water temperatures at the forebay of Libby Dam typically reach isotherm during mid-December and reach minimum temperatures during January. A uniform temperature of less than 39 °F (3.9 °C) persists through late March or early April. Solar heating is sufficient to develop thermal stratification and a thermocline in Lake Koocanusa during the spring and summer months. With the onset of thermal stratification during late April into May, the SWS can begin to be used to manage release temperatures. However, the temperature stratification in late April and May is typically weak and can be easily disrupted by meteorological events that mix the vertical temperature structure in the forebay of Libby Dam.

Operation of the SWS to manage downstream water temperatures relies on the forebay real-time temperature station LBTM to provide accurate temperatures. A forebay temperature study conducted from 2002 through 2004 concluded that temperatures collected on a vertical profile at station LBTM along the face of the dam were similar to profile temperatures collected in the middle of the forebay at station LIBFB (see Plate 5-3 for station locations). The study concluded that station LBTM was representative of temperatures at the forebay of Libby Dam.

In general, Kootenai River water temperatures range from about 37 °F (2.8 °C) in April to about 61 °F (16.1 °C) in August. Current selective withdrawal operations manage downstream temperatures to meet (1) the temperature rule curve and (2) the best available and most reliable temperature for sturgeon (early summer) and burbot (mid-winter) spawning. Temperature management for sturgeon is directed by USFWS Biological Opinion RPAs. Temperature management for burbot is informed by the 2005 Kootenai Tribe of Idaho Burbot Conservation Strategy and Memorandum of Understanding (Exhibit 8-1).

b. Total Dissolved Gas—Spillway Operations

Detailed investigations of TDG exchange from spillway operations at Libby Dam were conducted in 2002 by USACE Engineer Research and Development Center Coastal and Hydraulics Laboratory, and in 2006 and 2010 by USACE Seattle District. These investigations determined that the TDG exchange in spillway flows, as measured immediately below the stilling basin, ranged from 105 to 134 percent saturation and are a direct function of the specific spillway discharge. For the 2006 spill, the TDG saturation in spillway releases, as measured 0.6 miles below Libby Dam at Station LBQM, increased abruptly from 105 to 123 percent saturation as spill discharge increased from 1.5 to 6.0 kcfs. A mild increase in TDG saturations from 123 to 126 percent was observed as spillway discharges increased from about 6 to 15 kcfs, and a moderate increase from 126 to 133 percent as spill discharges increased from about 15 to 31 kcfs. The passage of water through the powerhouse does not change the TDG saturations in the Kootenai River.

The TDG characteristics in the Kootenai River below Libby Dam are dominated by the development of a mixing zone between spillway and powerhouse releases, and in-river processes such as degassing at the air-water interface, lateral mixing, tributary dilution, biological productivity, and thermal heat exchange. The development of a mixing zone and in-river processes result in decreasing TDG saturations in the Kootenai River downstream of the dam. Strong lateral gradients in TDG saturation developed in the Kootenai River 1.0 km (0.6 miles) below Libby Dam at Station LBQM during spillway releases in 2002 and 2010 (Plate 8-5 and Plate 8-6, respectively). The maximum TDG saturations were consistently observed along the left channel bank with decreasing TDG saturations along a transect moving from left bank to right bank. TDG saturations measured along the right bank were similar to powerhouse releases. Strong lateral TDG gradients still exist in the Kootenai River about 3.5 miles (5.6 km) downstream at the Highway 37 Bridge immediately upstream of the Fisher River. However, TDG saturations in the Kootenai River are generally well mixed by about 8.6 miles (13.8 km) downstream of the dam at the constriction of the river at an old haul bridge site.

c. Total Dissolved Gas—Sluiceway Operations

Detailed investigations of TDG exchange from sluiceway operations at Libby Dam were conducted in 2011 by USACE Seattle District. This investigation determined that the TDG exchange in sluiceway flows, as measured 0.6 miles (1.0 km) below Libby Dam at Station LBQM, increased abruptly from 105 to 136 percent saturation as sluice discharge increased from 0 to 5.0 kcfs. Strong lateral gradients in TDG saturation developed in the Kootenai River, as measured 0.3 miles (0.5 km) below Libby Dam at the Thompson Bridge. The maximum TDG saturations were consistently observed along the left channel bank with decreasing TDG saturations along a transect moving from left bank to right bank. Sluiceway TDG production was a factor of discharge per outlet and powerhouse flows. Increased powerhouse flows diluted TDG saturations with maximum sluiceway TDG saturations measured during lowest powerhouse output. For a discharge of 5 kcfs, the use of 3 outlets with 1.65 kcfs per outlet produced about 1 to 2 percent less TDG than 2 outlets with 2.5 kcfs per outlet.

d. Dissolved Oxygen

Dissolved oxygen profiles collected in Lake Koocanusa at the forebay show a well oxygenated system with little difference in oxygen concentrations between the surface and bottom of the lake during the spring and early summer, but more pronounced differences are measured during the late summer and fall. In general, dissolved oxygen concentrations measured near the surface at all stations were similar and ranged from about 8 to 11 mg/L. However, during the late summer and early fall, dissolved oxygen concentrations measured near the bottom were lower at the border (range of 4 to 6 mg/L) when compared to the forebay (range of 7 to 9 mg/L). Profile data show that the lake does not become anoxic near the bottom in the summer or fall. Moreover, although there are year-to-year variations in dissolved oxygen these differences are small.

e. pH

Lake Koocanusa and the Kootenai River pH levels are relatively stable and generally range from 7.5 to 8.5. However, near surface pH levels in Lake Koocanusa can periodically exceed 8.5 in the late summer largely due to algae growth resulting in a corresponding increase in pH. Typically, pH levels in the Kootenai River typically do not exceed Montana's water quality criteria.

f. Metals

Water quality samples collected from the epilimnion (3 meters below the surface) and hypolimnion (3 meters above the bottom) at all stations in Lake Koocanusa and from the tailwater station in the Kootenai River have been analyzed for major trace metals including aluminum (Al), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn) since 2006 and for selenium (Se) since 2012. For all metals except Se, the dissolved form was measured from 2006 through 2011, while the total recoverable form has been measured since 2012. For Se, the total recoverable form has been measured since 2012 and the dissolved form of Se since 2019. Trace metals, except for Se, were measured quarterly in May, July, and October from 2006–2018 and monthly since 2019. Selenium has been measured monthly since 2012.

From 2006 through 2024, concentrations of dissolved and total metals were near or below the laboratory detection limits except for aluminum and selenium, with periodic detections of copper, lead, and zinc. Dissolved and total aluminum concentrations were highest at the border station LIBBOR, with the greatest concentrations measured near the bottom in May, June, and July. The increased aluminum concentrations measured during the spring runoff period suggests that the major source of aluminum is likely suspended sediments from the watershed. Dissolved aluminum concentrations measured at all stations did not exceed MDEQ acute or chronic standards.

Dissolved and total arsenic, cadmium, chromium, and nickel were consistently below the reported lab detection limits and did not exceed MDEQ acute or chronic standards. Copper, lead, and zinc concentrations also tended to be below the laboratory detection limits except for an occasional sample. These periodic detections of copper, lead, and zinc were below the MDEQ acute and chronic standards.

Total and dissolved selenium concentrations measured in Lake Koocanusa ranged from about 0.5 µg/L to 2.5 µg/L. The concentrations of both the dissolved and total forms were similar, indicating the majority of selenium in the reservoir exists in the dissolved form. In general, selenium concentrations were greatest during the spring and fall and lower in the summer. Little to no variation in selenium concentrations were noted between the surface and bottom samples at any station in Lake Koocanusa suggesting that selenium is evenly distributed in the reservoir with no change in form or concentration between the border and forebay stations.

g. Nutrients

Phosphorus and nitrogen are the major nutrients required for the growth and productivity of phytoplankton and aquatic plants. The vast majority of lake water quality problems are associated with an overabundance of these nutrients resulting in excessive phytoplankton growth, causing nuisance blooms, and resulting decay. The decay of large amounts of phytoplankton can reduce oxygen concentrations to levels that are harmful to many organisms. In freshwater ecosystems, phosphorus is generally the nutrient with the smallest supply to demand ratio for phytoplankton growth. Consequently, phosphorus is often the nutrient limiting productivity in freshwater ecosystems and has relatively limited sources, so it is frequently the nutrient focused on for control of eutrophication. However, in some circumstances, nitrogen can be limiting instead of phosphorus, although nitrogen cycling and control of nitrogen sources is more complex. Increased phosphorus and nitrogen inputs to freshwater ecosystems from human activities can be attributed to numerous sources including: the discharge of detergents, runoff containing fertilizers or manure, seepage from failing septic systems, urban runoff and sewage discharges, as well as from nitrogen-based explosives used in mining operations.

Total phosphorus concentrations measured from 2006 through 2024 ranged from less than the detection limit of 2 µg/L measured periodically at all stations to greater than 100 µg/L at LIBBOR. Total phosphorus followed similar seasonal pattern at all stations with low concentrations in April, increasing concentrations during high runoff spring conditions in May and June, and decreasing concentrations during the summer and fall. Total phosphorus concentrations were substantially greater at the international border (station LIBBOR) when compared to all other stations in Lake Koocanusa and the Kootenai River. In addition, phosphorus concentrations were greater near the bottom of the reservoir compared to near the surface. As the loading of phosphorus in the inflow waters moves down-reservoir largely as underflow, phosphorus continues to be settled out of the system with little phosphorus reaching the forebay of Libby Dam. As such, it is likely that little of the inflow loading of phosphorus is available for phytoplankton and zooplankton beyond the border area. It is likely that winter drawdown elevation and the corresponding reservoir volume as well as spring runoff volume and the corresponding phosphorus concentrations are all factors in determining how far down-reservoir total phosphorus reaches.

Soluble reactive phosphorus concentrations were low in Lake Koocanusa, ranging from less than the detection limit of 1 µg/L to a maximum concentration of about 6 µg/L with several years having no detectable soluble phosphorus. In general, soluble phosphorus concentrations were greatest at the border (LIBBOR) and decreased down-reservoir at the forebay (LIBFB). Similar to total phosphorus, soluble concentrations were greatest during the spring runoff May and June time period at all stations. The lack of soluble phosphorus

moving downstream in the Kootenai River is clearly shown in the nearly consistent non-detected soluble phosphorus at the downstream station (LIBTW).

Nitrate-nitrogen concentrations measured in Lake Koocanusa were similar to or slightly less than total nitrogen concentrations indicating that nitrate is the dominant form of nitrogen in Lake Koocanusa. Nitrate concentrations at all stations followed similar seasonal patterns with the highest concentrations during the April to June spring runoff, sharply lower concentrations during the July and August, and slightly increased concentrations in September and October. The nitrate concentrations were greater in the hypolimnion suggesting that nitrate in the epilimnion is being utilized by summer phytoplankton growth. Additionally, the greater hypolimnetic concentrations indicates that considerable loadings of nitrate from the inflow may be associated with underflow conditions. Nitrate concentrations measured down-reservoir at the forebay as well as in the Kootenai River were only slightly less than at the border suggesting that the majority of the nitrate entering Lake Koocanusa from the inflow is passing down-reservoir.

Long-term nutrient trend analysis was conducted on total phosphorus and nitrate-nitrogen. Data from 1999–2020 show a significant increasing trend for nitrate at all stations and all depths with little to no trend for phosphorus. The major change in the Lake Koocanusa watershed over the past 20 years that could account for the increase in nitrate loadings to the reservoir is an increase in coal mining operations in the Elk and Fording rivers watershed located upstream in British Columbia.

h. Nutrient Limitation

Phosphorus and nitrogen are the two major essential nutrients that limit phytoplankton growth in freshwater ecosystems. The limiting nutrient concept maintains that the growth of a plant crop will be limited by the essential nutrient in shortest supply (Ryding and Rast 1989). Total nitrogen to total phosphorus ratios (TN:TP) are often used to determine whether nitrogen or phosphorus is most likely to limit phytoplankton growth. Typically, TN:TP ratios, by weight, greater than 17:1 suggest phosphorus limitation while ratios less than 10:1 suggest nitrogen limitation (Forsberg and Ryding 1980). The yearly progression of TN:TP suggests that phosphorus concentrations limited phytoplankton growth in Lake Koocanusa during the entire 2006 to 2024 study period. Furthermore, there has been an increase in the TN:TP ratio at all stations since about 2006, with the most pronounced increase seen down-reservoir at the forebay. Median annual ratios at the border have increased from about 20 in 2006 to more than 60 by 2022, while at the forebay the rations have increased from about 30 in 2006 to more than 100 by 2022. The TN:TP ratios at all stations clearly suggest that phosphorus is the limiting nutrient.

The lower nutrient ratios measured at the border are indicative of the greater loadings of phosphorus from the inflow resulting in ratios that are considerably lower than at the forebay, where little phosphorus is measured. Because nitrogen moves through the reservoir while phosphorus is lost to the reservoir, the ratio of nitrogen to phosphorus becomes substantially greater toward the forebay. An increasing trend in the ratio has occurred since about 2012, likely due to increasing loadings of nitrogen to Lake Koocanusa from coal mining operations in British Columbia, while phosphorus loadings have remained somewhat stable.

i. Transparency

Water clarity is an important parameter when determining the trophic status of a lake because the amount of algae suspended in the water column (phytoplankton) directly impacts transparency. Other factors that can affect transparency include suspended matter, soil particles, and natural water color. Water transparency has been measured in Lake Koocanusa at all water quality stations from the Canadian Border down reservoir to the forebay.

Seasonal and annual variations in transparency in Lake Koocanusa were noted at all water quality stations from 2006 to 2024. Transparancies in Lake Koocanusa were lowest near the border at station LIBBOR and increased downreservoir towards the forebay at station LIBFB. Transparencies at the border station were lowest from April through June (0.5 to 1.5 meters) showing the effect of high spring Kootenai River flows that generally reduce water clarity in the upper reservoir. The Kootenai River's watershed is heavily glaciated, resulting in highly turbid inflows to Lake Koocanusa. In particular, the transport of fine-grained glacial flour to Lake Koocanusa during the spring runoff results in highly turbid conditions and low water transparencies in the upper reservoir as measured at LIBBOR. Water transparencies increase during the summer months at LIBBOR with maximum water clarity (5 to 7 meters) generally in August or September.

The seasonal variation of water transparency near the dam at station LIBFB show a slightly different pattern than at the border. At the forebay, transparencies are moderately high in April (4 to 5 meters), greatly reduced in May and June (1.5 to 2.5 meters), and then increasing during the summer to a maximum water clarity (7 to 9 meters) in August or September. The moderately high April transparencies near the dam indicate that any influence on water clarity from turbid spring inflows seen near the border at LIBBOR have not reached the dam due to the relatively long residence time of the reservoir. However, typically by the end of May, a reduction in water transparency can be measured near the forebay of the dam. The other main factor affecting the transparency of Lake Koocanusa is phytoplankton growth. A moderately strong negative relationship between transparency and chlorophyll a has been seen at all stations, suggesting that in addition to inflow, the reduced water clarity measured at all stations for all years is also likely due in part to the amount of algae suspended in the water column.

j. Chlorophyll a

Chlorophyll a is the primary photosynthetic pigment in all photosynthetic organisms requiring oxygen and is found in all freshwater phytoplankton species. Consequently, measurements of chlorophyll a in the water column are an indirect estimate of the amount of phytoplankton present. Although there are several different forms of chlorophyll present in plants, chlorophyll a is the dominant form and is generally considered an indicator of phytoplankton biomass in freshwater ecosystems (Wetzel 1975).

Temporal variations in chlorophyll a occur at all stations. Concentrations did not vary much between stations with only small differences chlorophyll a concentrations measured at the border station LIBBOR (range from less than 1 µg/L to about 7 µg/L) and at the forebay station LIBFB (range from less than 1 µg/L to about 9 µg/L). In general, chlorophyll a concentrations varied seasonally, with peak concentrations in May and June and an

occasional peak concentration in August and September. The negative relationship between transparency and chlorophyll a apparent at all stations suggests that the reduced water clarity measured at all stations for all years is partly due to the amount of algae suspended in the water column.

k. Trophic State

The biological productivity, or trophic state, can be classified into three general categories: oligotrophic (low productivity), mesotrophic (moderate productivity), and eutrophic (high productivity). Lakes with low nutrient concentrations and low rates of phytoplankton productivity are classified as oligotrophic. Lakes with high nutrient concentrations and high rates of phytoplankton productivity are classified as eutrophic. Mesotrophic lakes have nutrient concentrations and phytoplankton productivity between eutrophic and oligotrophic lakes.

Carlson (1977) and the Organization for Economic Co-Operation and Development (OECD 1982) have developed a trophic state classification system based on total phosphorus, chlorophyll a, and transparency values. Carlson (1977) recommends using summer values to classify lakes while the OCED (1982) recommends annual values for trophic classification. Based on Carlson (1977), Lake Koocanusa would be classified as oligotrophic/mesotrophic at the border station LIBBOR, and oligotrophic at the forebay station LIBFB. Using the OECD (1982) methodology, Lake Koocanusa would be classified as mesotrophic at the border and oligotrophic/mesotrophic at the forebay.

8-5 FISH AND WILDLIFE

The Libby Dam Project has replaced a free-flowing section of the Kootenai River with two different ecological environments: a regulated river downstream and a fluctuating reservoir upstream.

a. Fish

Lake Koocanusa has a history similar to all reservoir systems. That is, after initial inundation the reservoir becomes very productive due to nutrients released from the surrounding landscapes. Over time, declines in nutrient production force changes in species composition, often times to ones that are less desirable.

The tributaries and mainstem of the pre-dam Kootenai River harbored substantial westslope cutthroat trout populations. When Lake Koocanusa was filled, hundreds of miles of low-gradient tributaries were inundated, which eliminated spawning habitat for cutthroat. Over time these populations dwindled and now are remnant fisheries.

Kokanee were accidentally introduced into the lake via a Canadian fish hatchery in the late 1970s and have been tremendously successful in establishing and maintaining a strong, though variable, population. They have provided a fishery in the absence of westslope cutthroat trout and have also provided a forage base for the bull trout population in the reservoir.

The trout fishery below Libby Dam is biologically unique in that it supports a number of very large fish, both bull trout and rainbow trout. The size of these fish is due to the fact that

Libby Dam entrains kokanee salmon on a year-around basis, and fish below the dam use the nutrients, in the form of dead and dying kokanee, to attain tremendous size. Bald eagles, ospreys, gulls, ducks, and various mammals also use entrained kokanee as a food source.

Libby Dam flow regulation affects ESA endangered Kootenai River white sturgeon and threatened bull trout, and operation of the dam is subject to the USFWS Biological Opinion regarding operation for the species. The dam is also subject to the NOAA Biological Opinion for Columbia River anadromous fish, providing volume for salmon emigration during summer months.

b. Wildlife

USACE acquired scattered parcels of land near Lake Koocanusa to replace wildlife habitat inundated by the reservoir. Management of the wildlife replacement lands was licensed to the MFWP. Any enquiries regarding the status or management of these lands should be directed to MFWP.

8-6 WATER CONSERVATION/WATER SUPPLY

Libby Dam is not operated for water supply. In general, streamflow in the Kootenai River below Libby Dam is higher in the winter and lower in the spring and summer, as compared to without-project conditions.

8-7 HYDROELECTRIC POWER

Hydroelectric power generation at the Libby Dam powerplant is listed in Table 8-1.

Table 8-1. Hydroelectric Power Generation at Libby Dam Powerplant

Year	Energy (MWh)[1]	Year	Energy (MWh)[1]
1975 (partial year)	521,000	2000	1,772,000
1976	2,154,000	2001	1,128,000
1977	1,595,000	2002	2,262,000
1978	1,948,000	2003	1,917,000
1979	1,566,000	2004	2,014,000
1980	1,873,000	2005	2,362,000
1981	2,441,000	2006	2,296,000
1982	2,210,000	2007	2,352,000
1983	2,073,000	2008	1,959,000
1984	1,980,000	2009	1,582,000
1985	1,750,000	2010	1,709,000
1986	2,215,000	2011	2,379,000
1987	1,706,000	2012	2,829,000
1988	1,752,000	2013	2,320,000
1989	1,733,000	2014	2,524,000
1990	2,434,000	2015	1,769,000
1991	2,768,000	2016	2,270,000
1992	1,623,000	2017	2,283,000
1993	1,668,000	2018	1,998,000
1994	1,511,000	2019	1,519,000
1995	2,315,000	2020	2,326,000
1996	2,958,000	2021	1,862,000
1997	2,517,000	2022	2,143,000
1998	2,135,000	2023	1,580,000
1999	2,477,000	2024	1,901,000

Total Energy (MWh)	100,979,000
Total Energy (MWh) w/o Year 1975	100,458,000
Average Energy (MWh) w/o Year 1975	2,050,163
Average (megawatts)	231

[1] 1 megawatt-hour (MWh) = 1,000 kilowatt hours (kWh). In addition to at-site hydroelectric generation, seasonal storage regulation at Libby Dam Project is estimated to provide 385,000 MWh of average annual power and 575,000 kW of dependable capacity at downstream powerplants.

Data are for the calendar year.

8-8 NAVIGATION

Libby Dam is not operated specifically for navigation. However, Lake Koocanusa is one of the largest bodies of water in the area that provides the opportunity for boating recreation.

8-9 DROUGHT CONTINGENCY PLAN

Libby Dam is operated as part of the Columbia River reservoir system under all conditions, including droughts. Refer to the CRS Drought Contingency Plan presented in Section XII of the Columbia River Basin, Master Water Control Manual, dated December 1984. The plan addresses historical droughts, drought forecasting techniques, drought impacts, and operational requirements for the system and individual drought management stations.

8-10 FLOOD EMERGENCY ACTION PLAN

Refer to the most recent Libby Dam Emergency Action Plan. The plan details the responses and notifications required under various states of emergency at Libby Dam. The Emergency Action Plan does not, in and of itself, direct operations at Libby Dam. However, emergencies accounted for in the plan, such as equipment malfunctions or dam failure, could correspond with extremely low or high flows downstream of the dam that would not have been present in the without-project conditions.

8-11 FREQUENCIES

Operation of the Libby Dam Project as specified in this manual has changed the streamflow characteristics of the Kootenai River as follows:

a. Peak Inflow Probability

The frequency of downstream flooding has been reduced. Annual peak discharge-frequency curves for both natural and regulated conditions for the Kootenai River at Libby Dam are shown on Plate 4-7. Plate 4-11 shows the maximum annual peak-stage frequency for both natural and regulated conditions for the Kootenai River at Bonners Ferry.

b. Seasonal Flow Pattern

The seasonal flow pattern of the Kootenai River downstream of Libby Dam has been altered. Regulated flows generally exceed natural flows from August through March, while the opposite is generally true during the runoff period from April through July. The average monthly flows for natural and regulated conditions at Libby, Montana, are given in Table 8-2. Higher than natural releases during winter months have maintained an elevated water table in the Kootenai Flats area which is detrimental to drainage necessary for agricultural usage. Pumping to lower the water table and provide agricultural drainage has required increased power consumption and expenses.

Table 8-2. Average Monthly Flows Kootenai River Below Libby Dam, Regulated and Unregulated Conditions

Month	Average Discharge (cfs)	
	Regulated[1/] (m^3/s)	Unregulated[2/] (m^3/s)
October	4,200 (119)	5,500 (156)
November	14,400 (408)	4,900 (139)
December	17,100 (484)	3,800 (108)
January	11,500 (326)	3,200 (91)
February	10,000 (283)	3,200 (91)
March	7,100 (201)	3,700 (105)
April	8,200 (232)	8,800 (249)
May	16,400 (464)	28,000 (793)
June	16,500 (467)	37,700 (1,068)
July	10,700 (303)	20,200 (572)
August	10,200 (289)	9,000 (255)
September	8,200 (232)	6,300 (178)
Average	11,200 (317)	11,200 (317)

[1/] Regulated flows are current reservoir operations applied to 2020 Modified Flows Dataset.

[2/] Unregulated flows are the 2020 Modified Flows Dataset (LIB6M, Inflow to Libby Dam).

c. Minimum Flows

The minimum flows have been increased. Natural minimum flows during October to March were about 1,600 cfs (45.3 cms), while regulated minimum releases are 4,000 cfs (113.3 cms).

d. Lake Koocanusa Elevations

Plate 8-7 shows the minimum, maximum, and average elevations based on modeled reservoir regulation. The simulation uses the 2020-Level Modified Flows dataset and assumes current Libby Dam operations. Recorded elevations of Lake Koocanusa for the period 1975–2024 are shown on Plate 4-16.

8-12 OTHER STUDIES

The following is a discussion of other effects of reservoir regulation at Libby Dam.

a. Sedimentation

The following is a discussion of the effects of Libby Dam on sediment.

(1) Sediment Transport

Lake Koocanusa has an estimated trap efficiency greater than 90%. The larger size sediment in the bedload will deposit on the channel bed closer to the reservoir with the finer bedload deposited on top, creating a vertical profile defined by upward fining of sediment sizes. Over time, the location where the larger sediments deposit would shift upstream in the reservoir. Currently, most of the bedload trapped by the reservoir is expected to deposit in the Canadian portion of Lake Koocanusa (Libby Design Memorandum 25, Sedimentation Observation Plan, 1971). The reduction in upstream sediment supply has markedly reduced the sediment concentrations currently transported by suspension in the Kootenai River. Prior to dam construction, the mean annual suspended sediment concentration in the Kootenai River was 132 mg/L, with a range of up to 1,200 mg/L. Two years post dam construction, the mean annual suspended sediment concentration downstream of the dam was reduced to 3 mg/L, with a maximum of 60 mg/L (LAURD, General Design Memorandum Phase I, Environmental Appendix, 1977). The combination of a lack of sediment supply and reduction in downstream flows capable of eroding the channel bed or banks contributed to this significant reduction.

(2) Upstream Deposition

In 1998, USACE produced a report comparing sediment deposits in Lake Koocanusa and the Kootenai River downstream of Libby Dam in 1997 with sediment surveys done in 1972 (Libby Dam Sedimentation Survey Report, 1998). The 1998 report compares sediment ranges within the 48-mile stretch of the reservoir in the United States only. During this 25-year period, the U.S. portion of the reservoir capacity decreased by 11,925 acre-feet (1,471 ha-m) or approximately 0.3% (Libby Dam Sedimentation Survey Report, 1998). The deposition of sediment in the U.S. portion of the reservoir was not uniform throughout Lake Koocanusa. All calculated deposition occurred within the upper 60% of the U.S. portion of the reservoir, within the elevation range of 2,240 ft (682.8 m) to 2,450 ft (746.8 m), with the largest amount of sediment found between 2,300 ft (701.0 m) and 2,315 ft (705.6 m). The comparison from the lower 40% of the reservoir indicated an increase in reservoir capacity (Libby Dam Sedimentation Survey Report, 1998).

(3) Downstream Effects

During the period from 1972 to 1997, the portion of the Kootenai River downstream of Libby Dam experienced minimal changes in cross-sectional morphology (Libby Dam Sedimentation Survey Report, 1998). The average downstream slope in the Kootenai River between Libby Dam (RM 221.9) and the town of Libby, Montana (RM 204.7), increased slightly from 0.078 to 0.082% (WEST, 1998). There were specific locations of significant changes. The thalweg elevation decreased 2.0 feet at the Highway 37 Bridge in Libby, Montana (RM 204.7), due to localized bridge scour. At the confluence with the Fisher River, deposition from the tributary caused a 2.7foot increase in the thalweg elevation (Libby Dam Sedimentation Survey Report, 1998). Significant cross-section area change occurred only at those cross sections closest to the dam, between RM 221 and 221.9. A significant increase in cross-sectional area was attributed to these locations being used as borrow sites for a construction project (Libby Dam Sedimentation Survey Report, 1998).

b. Cultural Resources[6]

Cultural resource management is integral to USACE operations and maintenance projects. Cultural resources encompass archaeological sites, historic districts, cultural landscapes, buildings, objects, and Traditional Cultural Properties (TCPs) that reflect community heritage and identity. These resources may qualify for the National Register of Historic Places (NRHP) based on architecture, history, archaeology, or cultural significance (36 CFR 60.4). Protecting these resources ensures that the stories, values, and traditions they represent are preserved for future generations. Each cultural resource reflects an important chapter in the nation's history, highlighting diverse contributions to its development.

Stewardship of cultural resources on USACE Civil Works water resources projects is a key aspect of the Federal government's responsibility. Several laws emphasize the identification, evaluation, and protection of cultural resources, Native American rights, and the prevention of looting and vandalism. These laws reflect Congress's intent to ensure the Federal government preserves cultural heritage. Key regulations include Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966 (as amended), the Archaeological Resources Protection Act (ARPA) of 1979, the Native American Graves Protection and Repatriation Act (NAGPRA), and 36 CFR Part 79, which covers the curation of federally owned archaeological collections. Implementing regulations for Section 106 and NAGPRA are found in 36 CFR Part 800 and 43 CFR Part 10, respectively. These cultural resource laws are integrated with the requirements of the National Environmental Policy Act

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[6] ACHP (Advisory Council on Historic Preservation). 1999. Recommended Approach for Consultation on Recovery of Significant Information from Archeological Sites. Section 106 Guidance Materials, updated April 26, 2002, Washington, D.C.

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(NEPA) of 1969, and USACE provides a summary of the guidance in ER and Engineering Pamphlet (EP) 1130-2-540.

(1) Prehistory, Ethnohistory, and Historic

Post-glacial landscapes supported early human settlement more than 10,000 years ago, as evidenced by tools and artifacts (Pevney, 2006). These artifacts, including large lanceolate-shaped projectile points, reveal the ingenuity and adaptability of early inhabitants. A warmer climate between 7,500 and 4,500 years ago expanded forests and grasslands, supporting hunter-gatherer societies that thrived on abundant natural resources. Approximately 1,250 years ago, cooler climates and denser forests fostered more settled populations reliant on hunting, fishing, and gathering. Archaeological records indicate the development of complex social structures and technological innovations during this period. The introduction of the horse 300 years ago revolutionized mobility, expanded trade networks, and enabled new forms of cultural exchange, while European diseases reshaped populations and disrupted traditional lifeways (Pevney, 2006).

The Kootenai people's traditional territory spanned parts of modern Montana and British Columbia. Upper Kootenai bands, including those in the Libby region, engaged in hunting, fishing, and gathering. Historical accounts detail their reliance on the region's natural resources and their sophisticated understanding of the environment. European contact in the 18th century introduced trade, horses, and diseases, significantly altering traditional lifeways (Smith, 1984; Manning, 1983). Despite these changes, the Kootenai people continue to maintain a strong connection to their heritage, language, and cultural practices.

(2) Cultural Resources at the Libby Dam

The Libby Dam Project Area spans 29,626 acres across 90 miles, extending to the U.S.-Canada border. It is divided into two archaeological districts: the Middle Kootenai River Archaeological District (MKRAD) and the Libby-Jennings Archaeological District (LJAD). The MKRAD, the larger district, is located on Kootenai National Forest land, while the smaller LJAD is on Core land. The project area contains over 480 recorded archaeological sites, grouped into two NRHP-eligible districts: more than 420 sites in MKRAD and over 60 sites in LJAD. While many sites in MKRAD were determined eligible under NHPA criterion D in 2003, 125 properties remain unresolved, and no sites in either district have been evaluated under Criteria A, B, or C.

Archaeological surveys within the Libby Dam Project area began in the 1950s, with the primary goal of identifying sites before reservoir inundation and assessing the potential impacts of flooding. Surveys continued after the reservoir was filled to catalog sites in the drawdown zone, and additional surveys on adjacent uplands were conducted to assess the effects of proposed federal actions. Since the 1980s, site monitoring has been ongoing, with goals including the nomination of sites for NRHP listing, data recovery, and compliance with Antiquities laws. Although the hydroelectric facility and its components possess significant architectural value, their eligibility under Criteria A, B, and C has not yet been formally assessed, and no archaeological sites are currently listed on the NRHP.

(a) Middle Kootenai River Archaeological District

The MKRAD spans from Montana State Highway 37 to Forest Service Road 228 and contains 485 known archaeological sites, 421 of which are part of MKRAD: 255 prehistoric, 66 historic, and 100 multi-component. An inventory in 1984 recorded 249 properties, and subsequent USFS monitoring between 1985 and 2003 identified an additional 169. The USFS, using 20 years of data, formally determined in 2003 that 162 sites were contributing and 136 were non-contributing, with eligibility primarily assessed under Criterion D. Some sites eligibility remains unresolved, including 93 buried sites and others that need further evaluation, with some potentially never being resolved due to deep sediment cover.

(b) Libby-Jennings Archaeological District

LJAD cultural resources are located below Libby Dam. USACE proposed the LJAD based on inventories conducted through 1977 by various organizations, including the Smithsonian River Basin Surveys, the University of Montana, Montana State University, the University of Idaho, and USACE. In 1978, USACE requested a determination of eligibility from the Keeper of the NRHP (the Keeper) for the district as an archaeological district under Criterion D. The Keeper determined the district was eligible for listing in the National Register, though it was never formally nominated. The district consists of over 60 sites, including both prehistoric and historic sites. An ongoing assessment of the archaeological sites within the LJAD is currently underway.

(c) Built Environment

Designed by modernist architect Paul Thiry, Libby Dam represents a striking balance between human-made structures and the natural environment. Thiry’s vision emphasized simplicity, functionality, and harmony, which is evident in the dam’s angular concrete form, clean lines, and integration with its surroundings. The dam’s design features horizontal and vertical elements that create a sense of stability and strength, while the angular downstream face mirrors the natural slopes of the riverbanks. These architectural choices reflect Thiry’s commitment to creating structures that are not only functional but also aesthetically pleasing.

The David Thompson Bridge, rebuilt in 1978, is another notable feature of the built environment. Originally constructed to facilitate access for workers during the dam’s construction, the bridge was later reconstructed with durable steel diaphragms, a reinforced concrete deck, and asphalt paving. Retaining elements of its original design, the bridge now serves as a vital connection across the Kootenai River, blending functional infrastructure with historical preservation.

The setting of Libby Dam and its associated features constitute a landscape that is a composite of the natural and the man-made. Imposed upon the natural landscape of a rugged and forested river canyon are the mostly concrete structural elements of the dam, connected to each other by a system of roads and embellished by ornamental, groomed grounds. The dam's impact goes far beyond the structure itself, affecting flood control, recreation, fish and wildlife management, transportation, and tourism in large areas of both the United States and Canada. The agreement between these two nations, which ensured future management of the Columbia River basin and made construction of Libby Dam possible, was a milestone in international cooperation.

In 2003, Libby Dam and its associated structures were determined eligible for inclusion in the NRHP under Criteria A, B, and C. The designation recognizes the dam as the last major hydroelectric project constructed in the Pacific Northwest and its role as a significant source of power in Montana. It also acknowledges the contributions of Paul Thiry, whose modernist architectural principles and innovative designs left a lasting legacy in the region. This recognition underscores the importance of preserving the dam's historic and cultural integrity.

(3) Lake Koocanusa

USACE and USFS jointly manage cultural resources in the Lake Koocanusa area under a 1966 Memorandum of Understanding (MOU). Action Plan "O," initiated in 1988, set responsibilities for addressing adverse effects on cultural sites. USACE and Bonneville Power Administration (BPA) collaborate under a Programmatic Agreement to ensure NHPA compliance. Their objectives include long-term site monitoring, annual activity prioritization, and systematic identification of tribal heritage sites.

(4) Federal Columbia River Power System

Libby Dam is part of the Federal Columbia River Power System (FCRPS) Cultural Resource Program, which oversees the effects of operating and maintaining 14 federally owned dams and reservoirs on historic properties within the Columbia River Basin. The program is a collaborative effort involving three Lead Federal Agencies: the U.S. Bureau of Reclamation (Reclamation), USACE, and the Bonneville Power Administration (BPA). It also includes ten federally recognized tribes, four State Historic Preservation officers, the Advisory Council on Historic Preservation (ACHP), and other federal agencies. The program emphasizes regular communication through meetings, field visits, and other forms of coordination. It represents the combined efforts of federal, tribal, and state employees, cooperating groups, tribal elders, private contractors, and other stakeholders working together to preserve cultural resources.

(a) Systemwide Programmatic Agreement

USACE, Reclamation, and BPA (Lead Federal Agencies) have released a FCRPS Systemwide Programmatic Agreement (PA). The PA covers the management of historic properties affected by the multi-purpose operations of the 14 dam/reservoir Projects comprising the FCRPS. It provides the system wide principles and commitments for the Lead Federal Agencies' compliance with Section 106 of the NHPA. The PA allows for the Lead Federal Agencies to meet their Section 106 responsibilities through the development and implementation of a Project-specific PA or a signed Project Historic Properties Management Plan (HPMP).

(b) Historic Properties Management Plan

USACE and the Bonneville Power Administration (BPA) are responsible for managing historic properties within the Area of Potential Effect (APE) at Libby Dam. Their management program includes routine activities and one-time tasks related to NHPA compliance, including inventory, evaluation, treatment, and curation. The program also includes administrative functions, such as coordination with stakeholders and the

development of emergency response plans. Activities are prioritized over a ten-year period, with annual updates to schedules and budgets. Any incomplete tasks are carried forward for review and prioritization in the following year.

Libby Dam's HPMP provides the framework for complying with NHPA and other applicable laws. It serves as a tool for achieving historic preservation goals and ensuring consistency with national stewardship policies. The plan covers all project-related activities, such as hydroelectric power generation, flood control, and recreation, and outlines their potential effects on historic properties. The HPMP also reflects the values of the Confederated Salish and Kootenai Tribes (CSKT) and other associated tribes, with a focus on protecting tribal heritage and identifying significant cultural properties, an effort that will continue in future studies.

The HPMP defines the APE, lists inventoried historic properties, and provides recommendations for future preservation efforts. It also includes processes for Section 106 consultation and is considered a living document to guide the project's compliance activities over the next decade. The HPMP ensures that the agencies involved, including USACE, BPA, and other stakeholders, adhere to the guidelines for preserving historic properties while balancing the project's multiple purposes, such as power generation and flood control.

(c) Libby Dam Co-op Group

The Co-op Group, formed in 1984 and formalized in 1997, is an intergovernmental technical work group that provides an informal structure for streamlining coordination among the involved parties. The group makes technical recommendations to management to aid in decision-making. Participants in the Co-op Group include USACE, BPA, KNF, Confederated Salish and Kootenai Tribes of the Flathead Reservation, the Montana State Historic Preservation Officer, and the ACHP. The Co-op group is primarily responsible for recommending annual and five-year prioritized work plans for managing historic properties within the Libby area.

The Co-op Group is a technical work group that provides an informal structure for streamlining coordination among the involved parties and makes technical recommendations to management to aid in decision-making. It strives to ensure that tUSACE, BPA, and USFS manage, protect, and mitigate losses to historic properties affected by the operation of Libby Dam so they may be appreciated by future generations.

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CHAPTER 9—WATER CONTROL MANAGEMENT

9-1 RESPONSIBILITIES AND ORGANIZATION

Libby Dam Project is one of four Columbia River Treaty projects and is a major element in the system of reservoirs in the Columbia River Basin. Comprehensive cooperation and coordination in the operation of this complex system of reservoirs is required due to the diverse ownership and the many water resource functions involved. A number of agencies and regional organizations are involved in data collection and in planning and scheduling the operation of system and project water resource developments for efficient and effective regulation of the Columbia River.

Congressional authorizations include responsibility for USACE to operate projects under its jurisdiction for all authorized purposes. USACE is responsible for ensuring the maximum sustained public benefits from Libby Dam Project for all desirable purposes as an integral part of the comprehensive plan for the regulation, control, conservation, and utilization of the water resource. Responsibility for reservoir regulation activities falls to the CENWS District Engineer. Planning seasonal regulation and directing day-to-day regulation of Libby Dam Project are the responsibility of CENWS-ENH-W (telephone [redacted] in consultation with Northwestern Division Water Management. CENWD-PDW assumes responsibility for regulation of Libby Project in certain regional flood emergencies and has responsibility for the planning, oversight, and implementation of the Columbia River Treaty as they relate to Libby Dam. A detailed description of District and Division water management responsibilities is included in Exhibit 1-1. The CENWS District Engineer also has direct responsibility for project operation and maintenance activities which are assigned to the Operations Division. The physical operation of project facilities to affect the regulation directed by CENWS-ENH-W and the performance of maintenance is the responsibility of the Project Engineer. Communications between CENWS-RCC and the Libby Dam Project are discussed in Chapter 5 of this manual and standing orders to the damtender are included as Exhibit 7-1. The Seattle District organization chart is shown as Exhibit 9-1.

9-2 INTERAGENCY COORDINATION

a. Local Press and USACE Bulletins

Occasional press releases for Libby Dam operations are coordinated by CENWS-ENH-W and released by the CENWS Public Affairs Office.

b. National Weather Service (NWS)

The NWS has 13 regional RFCs that prepare river and flood forecasts, warnings, and water resource information. Forecast information is distributed to the public through the Service Hydrology Program of the Weather Forecast Offices. The NWRFC in Portland, Oregon (telephone [redacted]) works closely with the CENWS and CENWD offices to provide up-to-date river information for the Kootenai Basin. During periods of flooding, the RFC issues forecasts for the time and stage or discharge of the flood crest. The RFC coordinates directly with water management agencies to optimize reservoir flood risk management space during major flood events. During non-flood periods, the RFC makes

daily streamflow forecasts for routine water management applications and prepares seasonal WSFs.

c. U.S. Geological Survey

The USGS Water Resources Division collects and processes water quality and quantity records for stations in the Kootenai Basin. There are 12 USGS streamgaging stations in the Kootenai Basin in the United States (Table 4-18), 10 of which are funded by USACE through the Cooperative Streamgaging Program.

Streamflow, storage, and water quality data obtained from the USGS data collection system are assembled and published by each USGS district office. Administrative services for USGS facilities in the Kootenai Basin in Montana are provided by the Montana Water Science Center in Helena, Montana (telephone [redacted]); maintenance service is performed by the field office in Kalispell, Montana (telephone [redacted]. In Idaho, these services are provided by the Idaho Water Science Center in Boise (telephone [redacted] and the field office in Post Falls, Idaho (telephone [redacted], respectively.

d. Bonneville Power Administration (BPA)

BPA is the marketing and transmission agency for power generated at Federal projects in the Pacific Northwest. The transmission facilities and the Federal electric generating projects they interconnect are known as the FCRPS. A Memorandum of Understanding (entered into on 8 October 1956 and revised on 16 November 1970) between NPD (now CENWD) and BPA documents the policies and procedures to be followed in the operation of USACE projects, including Libby Dam. This memorandum provided for BPA to schedule the operation of Libby Dam Project within the normal and special project limitations established by the USACE and to generate the maximum amount of electric energy consistent with the requirements of other authorized purposes. CENWS-ENH-W coordinates with the BPA Branch of Power Operations and Planning on regulation decisions that affect power generation. Power is scheduled and dispatched by BPA from the Dittmer Control Center, Vancouver, Washington, telephone [redacted].

e. Other Federal State, or Local Agencies

(1) Natural Resources Conservation Service (NRCS)

The NRCS operates, maintains, and publishes records for Snow Telemetry (SNOTEL) sites in or near the Kootenai Basin which provide data used in water resource management.

(2) U.S. Fish and Wildlife Service (USFWS)

At the Federal level, the USFWS is the agency primarily responsible for ensuring the conservation and management of the nation's wild birds, mammals, and sport fishes for their recreational and economic values. The following are included in the USFWS major program areas: technical assistance to Federal, State, and private organizations in the development and administration of sport fish and wildlife management programs; administration and operation of a national system of fish hatcheries engaged in the propagation and distribution of sport fish; and cooperation with other Federal and non-Federal agencies engaged in water resource development projects to determine the effects of such projects on fish and

wildlife resources and recommend measures for the protection and improvement of these resources. Regional USFWS offices are located in Portland and Spokane.

(3) National Oceanic and Atmospheric Administration (NOAA) Fisheries

The NMFS is the Federal agency responsible for the stewardship of living marine resources and their habitat. The NMFS is responsible for the management, conservation, and protection of living marine resources within the U.S. Exclusive Economic Zone (water 3 to 200 miles offshore). NOAA Fisheries provides technical assistance to Federal, State, and private organizations in the development and administration of marine and anadromous species management programs; implementation of the ESA for marine and anadromous species; and cooperation with other Federal and non-Federal agencies engaged in water resource development projects to determine the effects of such projects on marine and anadromous species and recommend measures for their protection and management.

(4) Canadian Agencies

(a) Federal

Canadian meteorological data are collected and published by Environment Canada. Twenty stations in and near the Kootenay Basin provide data used in Libby Dam Project management.

(b) Provincial

- British Columbia Hydro and Power Authority (BC Hydro) is a regulated provincial Crown Corporation reporting to the Minister of Energy and Mines. It is the third largest electric utility in Canada, serving 95% of the population of the Province of British Columbia (the province), which represents approximately 1.8 million residential customers. In addition, BC Hydro supplies electricity to the province’s commercial and industrial sector. BC Hydro is responsible for the regulation of Duncan Dam that feeds the north arm of Kootenay Lake and the Kootenay Canal in coordination with FortisBC’s Corra Linn Dam.

- The British Columbia Ministry of Forests, Lands and Natural Resource Operations provides support to the Libby Dam Project through the RFC. The RFC collects and interprets snow, meteorological, and streamflow data. USACE uses the snow data collected and published by the RFC to track and forecast the snowpack in the Kootenai Basin above Libby Dam.

(5) State Agencies

The MFWP and the Idaho Department of Fish and Game (IDFG) have the primary authority for regulation and management of fish and wildlife resources within their State boundaries. These agencies collect data and conduct studies to evaluate the effect of the Libby Dam Project in their respective areas, to exchange information with USACE and provincial agencies, and to make recommendations as to potentially beneficial changes in project regulation.

(6) Tribal

The Kootenai Tribe of Idaho works to restore fish population and habitats through their BPA-funded Fish and Wildlife mitigation programs. The programs include an ongoing habitat restoration project on the 55-mile reach of the Kootenai River in Idaho to be completed over 7–15 years beginning in 2011. The Kootenai Tribe also operates two conservation aquaculture hatcheries for sturgeon and burbot and co-manages a nutrient restoration program at the Montana/Idaho State line on the Kootenai River downstream of Libby Dam with the IDFG. In addition to coordination with the Kootenai Tribe, Libby Dam operations are coordinated through the TMT (described in Section 9-04) with the Colville, Umatilla, Spokane, and Nez Perce tribes.

9-3 INTERAGENCY AGREEMENTS

a. Columbia River Treaty

In 1964 a treaty was ratified by the governments of Canada and the United States which provided for the development of storage reservoirs in Canada, and cooperative measures for hydroelectric power generation and flood risk management which make possible other benefits as well. As part of the Treaty, Canada was required to build three large storage dams (Duncan, Keenleyside, and Mica) on the upper reaches of the Columbia River in British Columbia. The Treaty also granted the United States permission to build Libby Dam on the Kootenai River in Montana (called Kootenay River in Canada). The three Canadian reservoirs provide improved streamflow in both countries, and the Treaty requires Canada to operate these reservoirs on a coordinated basis with the United States for flood control and hydropower, and for the United States to compensate Canada for a portion of those benefits, or certain other costs depending on the operation.

The coordinated operations and most other duties of the Treaty are implemented by entities from each country. The United States Entity is comprised of the administrator of BPA and the CENWD Commander. The Canadian entity includes British Columbia Hydro, the provincial power-utility.

9-4 COMMISSIONS, RIVER AUTHORITIES, COMPACTS AND COMMITTEES

a. Treaty Hydrometeorological Committee

The Canadian and United States Entities of the Columbia River Treaty established the Hydrometeorological Committee (CRTHC) in 1968. The mandate of the CRTHC is primarily to be responsible for ensuring that hydrometeorological data required for the planning and operation of Treaty project facilities are collected and communicated to the Entities. This responsibility includes ensuring sufficient data are available for performing all required forecasts. The CRTHC makes recommendations concerning the development and operation of the hydrometeorological system established in accordance with paragraph 2 of Annex A to the CRT.

b. Treaty Operating Committee

Paragraph 5 of Annex A of the treaty requires that for the flood control operation of the treaty reservoirs the “…United States entity will submit flood control operating plans which

may consist of or include flood control storage reservation diagrams and associated criteria for each dam." The Operating Committee is the organizational body primarily responsible for implementation of the flood control operating plan. The Operating Committee prepared the publication "Columbia River Treaty Principles and Procedures for Preparation and Use of Hydroelectric Operating Plans." The committee is responsible for making the system regulation studies, preparing the operating plans, ensuring the plans are accomplished, and performing other duties as required by the entities. The United States Section of the committee is composed of the Chief of the CENWD Water Management Branch, (co-chairman) and the BPA Chief of the Branch of Power Resources (member).

c. International Joint Commission (IJC)

The IJC is a permanent body established under the provisions of the Boundary Waters Treaty of 1909 and consists of six commissioners: three Canadians and three Americans. The commissioners act as a unitary body, not as separate national delegations or representatives of their respective governments, striving to deal impartially with problems of mutual concern along the frontier to arrive at common, impartial solutions which will best serve both countries. One of the major responsibilities of the commission involves the exercise of quasi-judicial powers in approving applications for the use, obstruction, or diversion of water on either side of the border that would affect the natural level or flow on the other side. The West Kootenay Power and Light Company, Limited, made application to the IJC in 1929 for permission to construct and operate certain works in and adjacent to the channel of the Kootenay River in British Columbia and for the right to store water in Kootenay Lake. After amended applications were received and hearings held, the IJC issued an Order (Exhibit 9-2), dated 11 November 1938, approving raising the level of the waters of Kootenay Lake for storage purposes subject to certain construction requirements and operational restrictions. The Order specifies that "…after August 31st the level of Kootenay Lake may be raised to elevation 1,745.32 which shall be the maximum storage level until January 7, and thereafter it shall be lowered so that it shall not exceed elevation 1,744 on February 1, elevation 1,742.4 on March 1 and elevation 1,739.32 (i.e., zero on the Nelson gage) on or about April 1, except under extraordinary natural high inflow conditions, when sufficient gates shall be opened and remain open throughout such period of excess so as to lower the level of the main body of Kootenay Lake to the storage level at that time obtaining as above defined." The Kootenay Lake IJC rule curve is shown on Plate 9-1. To ensure accomplishment of the provisions of the Order, the IJC established the International Kootenay Lake Board of Control (Board). The Board is composed of four representatives and one secretary from Canada and four representatives and one secretary from the United States. The United States Section consists of four people including the CENWS District Engineer (chair); the Director of the Idaho Water Science Center, USGS, Boise, Idaho; a member of the public; and an individual with Indigenous knowledge and experience (typically a Tribal member or staff person). The CENWS also provides the U.S. secretary. These representatives serve on the Board in a personal professional capacity, and not as representatives of their country or employing organization.

d. Western Power Pool (WPP)

The WPP is a voluntary organization comprised of major generating utilities serving the Pacific Northwest, British Columbia, and Alberta. Smaller, principally non-generating utilities in the region participate indirectly through the member system with which they are

interconnected. The Pool, formerly known as the Northwest Power Pool, was originally formed in 1942, when the federal government directed utilities to coordinate operations in support of wartime production.

e. Technical Management Team for the Federal Columbia River Power System (FCRPS)

For FCRPS BiOp implementation issues, the Regional Implementation Oversight Group (RIOG) Senior Policy Group is supported by a Senior Hydro Technical Team (Senior Hydro Team), which in turn is supported by the TMT, the System Configuration Team (SCT), and other technical teams. The TMT operates under the RIOG Guidelines and Procedures approved October 31, 2008.

The TMT mission is specifically to ensure broad technical participation and use of the best available technical information, and to encourage regional consensus on technical recommendations regarding operations of the CRS. The focus of the TMT is to make in-season recommendations for the implementation of the NMFS and USFWS on operation of the CRS while considering the provisions of (and effects on) the Northwest Power and Conservation Council's (NPCC) Fish and Wildlife Program, other BiOps, State and Tribal plans and programs, and other relevant operational requirements. Specifically, the TMT explores operational scenarios under the BiOps that would serve to protect other fish and wildlife in the Columbia River Basin and promote coordination and consistency with these other objectives to the extent possible.

USACE, Reclamation, and BPA, collectively referred to as the Action Agencies (AAs), consult with the NMFS, the USFWS, four states (Idaho, Montana, Oregon, and Washington), and five tribes (Colville, Kootenai, Nez Perce, Spokane, and Umatilla) on the effects of the operation of 14 Federal multi-purpose hydropower projects in the CRS on species listed under the Endangered Species Act.

The TMT is responsible for discussion and recommendations to the AAs on hydro system flows at designated control points and expected project operations to implement the BiOps for listed salmon, steelhead, sturgeon, and bull trout species within the Columbia River Basin while considering the needs of (and effects on) other listed and non-listed species (such as lamprey).

The fisheries managers are responsible for the management of anadromous fish and resident fish in the basin. USACE and Reclamation are responsible for decisions on operation of the CRS projects; and USACE and the BPA are responsible for Treaty agreements with Canada regarding storage in Canada and other Treaty-related matters. The participation of other affected sovereign and non-sovereign entities is intended to ensure that decision-makers have the broadest possible source of information upon which to base their in-season management decisions. All parties are encouraged to succinctly present their views regarding biological or operational recommendations. Input can provide alternative options for the appropriate authority to consider when making their decisions, but authority for implementing the request remains with the appropriate agencies.

Planning includes development of a Water Management Plan. In-season management focuses on implementation of BiOps and the Water Management Plan. Post-season review

consists of a review of the previous year's activities and performances, and updating operating procedures as needed.

f. Northwest Power and Conservation Council(NWPCC)

The Pacific Northwest Electric Power Planning and Conservation Act of 5 December 1980 established an eight-member Pacific Northwest Electric Power Planning Council (now known as the Pacific Northwest Power and Conservation Council) comprised of two voting members representing each state--Washington, Oregon, Idaho, and Montana. Although initially governors designated one of their two representatives to serve only 2 years, each member currently serves a term of 3 years. Convinced that regional electric energy planning should be placed firmly in the hands of the people of the Pacific Northwest, Congress made each council member an officer of his respective State. The Council was initially formed in April 1981. The initial tasks of the Council were to (l) adopt a fish and wildlife program by 15 November 1982 and (2) prepare a regional electric power and conservation plan by April 1983. The adopted fish and wildlife program was developed to protect, mitigate, and enhance fish and wildlife--including related spawning grounds--on the Columbia River and its tributaries. Under the program, flows of sufficient quality and quantity must be provided between hydroelectric facilities to improve production, migration, and fish habitat as required to meet sound biological objectives. Libby Dam operations are guided by Biological Opinions (described in Section 2), which incorporate the Council’s programmatic guidance for integrated flood risk, hydropower, and species conservation.

9-5 NON-FEDERAL HYDROPOWER

There are no non-Federal hydropower facilities at Libby Dam.

9-6 REPORTS

a. Seattle District Water Management

CENWS-ENH-W publishes Libby Dam WSFs monthly between December and June. Additionally, the office is responsible for distributing regular email reports to stakeholders notifying stakeholders of flow changes and water management operations at Libby Dam.

b. Columbia Basin Water Management Division

CENWD-PDW-R publishes quarterly and annual reports summarizing Libby Dam operations for the Columbia River Treaty Operating Committee.

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SUPPLEMENTAL TABLES

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (Seattle District 1980)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,200	114,669	115,097	115,526	115,956	116,387	116,819	117,251	117,685	118,120	118,555	4,275
2,201	118,992	119,430	119,868	120,308	120,748	121,189	121,632	122,075	122,519	122,965	4,371
2,202	123,411	123,858	124,306	124,755	125,206	125,657	126,109	126,562	127,016	127,471	4,467
2,203	127,927	128,384	128,842	129,301	129,761	130,222	130,684	131,147	131,611	132,076	4,565
2,204	132,541	133,008	133,476	133,945	134,415	134,886	135,358	135,831	136,304	136,779	4,664
2,205	137,255	137,732	138,210	138,689	139,169	139,650	140,132	140,615	141,098	141,583	4,764
2,206	142,069	142,556	143,044	143,533	144,023	144,514	145,007	145,500	145,994	146,489	4,865
2,207	146,985	147,482	147,980	148,480	148,980	149,481	149,984	150,487	150,991	151,497	4,967
2,208	152,003	152,511	153,019	153,529	154,039	154,551	155,064	155,577	156,092	156,608	5,070
2,209	157,125	157,643	158,162	158,682	159,203	159,725	160,248	160,772	161,298	161,824	5,174
2,210	162,351	162,879	163,409	163,938	164,469	165,001	165,533	166,066	166,601	167,135	5,279
2,211	167,671	168,208	168,745	169,283	169,822	170,362	170,903	171,444	171,986	172,529	5,361
2,212	173,073	173,618	174,164	174,710	175,258	175,806	176,355	176,904	177,455	178,006	5,444
2,213	178,559	179,112	179,666	180,221	180,776	181,333	181,890	182,448	183,007	183,567	5,527
2,214	184,128	184,689	185,252	185,815	186,379	186,944	187,510	188,076	188,644	189,212	5,611
2,215	189,781	190,351	190,922	191,494	192,066	192,639	193,214	193,789	194,365	194,942	5,696
2,216	195,519	196,098	196,677	197,257	197,838	198,420	199,003	199,587	200,171	200,757	5,781
2,217	201,343	201,930	202,518	203,107	203,696	204,287	204,878	205,471	206,064	206,658	5,867
2,218	207,253	207,848	208,445	209,043	209,641	210,240	210,840	211,441	212,043	212,646	5,953
2,219	213,249	213,854	214,459	215,065	215,672	216,280	216,889	217,499	218,110	218,721	6,040
2,220	219,333	219,945	220,559	221,174	221,790	222,406	223,023	223,641	224,259	224,879	6,128
2,221	225,499	226,120	226,742	227,364	227,988	228,612	229,237	229,863	230,489	231,116	6,206
2,222	231,744	232,373	233,003	233,633	234,265	234,897	235,529	236,163	236,797	237,433	6,285
2,223	238,069	238,705	239,343	239,981	240,620	241,260	241,901	242,543	243,185	243,828	6,364
2,224	244,472	245,117	245,762	246,409	247,056	247,704	248,352	249,002	249,652	250,303	6,443
2,225	250,955	251,608	252,261	252,916	253,571	254,227	254,884	255,541	256,200	256,859	6,523
2,226	257,519	258,179	258,841	259,503	260,167	260,831	261,496	262,161	262,828	263,495	6,604
2,227	264,163	264,832	265,502	266,172	266,843	267,516	268,189	268,862	269,537	270,212	6,685
2,228	270,889	271,566	272,244	272,922	273,602	274,282	274,963	275,645	276,328	277,012	6,766
2,229	277,696	278,381	279,067	279,754	280,442	281,131	281,820	282,510	283,201	283,893	6,848

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,230	284,586	285,281	285,976	286,672	287,369	288,067	288,767	289,467	290,169	290,872	6,931
2,231	291,576	292,281	292,988	293,695	294,404	295,114	295,825	296,537	297,250	297,965	7,046
2,232	298,680	299,397	300,115	300,834	301,554	302,276	302,999	303,722	304,447	305,174	7,162
2,233	305,901	306,629	307,359	308,090	308,822	309,555	310,290	311,025	311,762	312,500	7,279
2,234	313,239	313,979	314,721	315,464	316,207	316,952	317,699	318,446	319,195	319,945	7,397
2,235	320,696	321,448	322,201	322,956	323,712	324,469	325,227	325,986	326,747	327,509	7,516
2,236	328,272	329,036	329,801	330,568	331,336	332,105	332,875	333,646	334,419	335,193	7,636
2,237	335,968	336,744	337,522	338,301	339,081	339,862	340,644	341,428	342,212	342,998	7,757
2,238	343,786	344,574	345,364	346,155	346,947	347,740	348,535	349,331	350,128	350,926	7,879
2,239	351,726	352,526	353,328	354,132	354,936	355,742	356,549	357,357	358,166	358,977	8,001
2,240	359,789	360,601	361,416	362,232	363,049	363,869	364,689	365,511	366,335	367,160	8,125
2,241	367,986	368,814	369,643	370,474	371,306	372,140	372,976	373,812	374,651	375,490	8,272
2,242	376,331	377,174	378,018	378,864	379,711	380,560	381,410	382,262	383,115	383,969	8,420
2,243	384,825	385,683	386,542	387,403	388,265	389,129	389,994	390,860	391,729	392,598	8,569
2,244	393,469	394,342	395,216	396,092	396,969	397,848	398,728	399,610	400,493	401,378	8,719
2,245	402,264	403,152	404,042	404,933	405,825	406,719	407,615	408,512	409,410	410,310	8,871
2,246	411,212	412,115	413,020	413,926	414,834	415,743	416,654	417,567	418,481	419,396	9,024
2,247	420,313	421,232	422,152	423,074	423,997	424,922	425,849	426,777	427,706	428,637	9,179
2,248	429,570	430,504	431,440	432,377	433,316	434,257	435,199	436,142	437,088	438,034	9,335
2,249	438,983	439,933	440,884	441,837	442,792	443,748	444,706	445,666	446,627	447,589	9,492
2,250	448,554	449,519	450,486	451,454	452,424	453,394	454,366	455,339	456,313	457,288	9,650
2,251	458,264	459,242	460,221	461,201	462,183	463,165	464,149	465,134	466,120	467,108	9,771
2,252	468,096	469,096	470,077	471,070	472,063	473,058	474,054	475,051	476,050	477,050	9,893
2,253	478,051	479,053	480,056	481,061	482,067	483,074	484,082	485,092	486,102	487,114	10,016
2,254	488,128	489,142	490,158	491,175	492,193	493,213	494,233	495,255	496,279	497,303	10,139
2,255	498,329	499,356	500,384	501,413	502,444	503,476	504,509	505,543	506,579	507,616	10,263
2,256	508,654	509,694	510,734	511,776	512,819	513,864	514,909	515,956	517,005	518,054	10,388
2,257	519,105	520,157	521,210	522,265	523,320	524,377	525,436	526,495	527,556	528,618	10,514
2,258	529,682	530,746	531,812	532,879	533,948	535,017	536,088	537,161	538,234	539,309	10,640
2,259	540,385	541,462	542,541	543,621	544,702	545,784	546,868	547,953	549,040	550,127	10,767

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,260	551,216	552,306	553,397	554,490	555,584	556,679	557,775	558,873	559,971	561,071	10,895
2,261	562,173	563,275	564,379	565,484	566,590	567,697	568,806	569,916	571,027	572,140	11,019
2,262	573,253	574,368	575,484	576,602	577,720	578,840	579,961	581,084	582,208	583,332	11,143
2,263	584,459	585,586	586,715	587,845	588,976	590,108	591,242	592,377	593,513	594,650	11,268
2,264	595,789	596,929	598,070	599,213	600,357	601,502	602,648	603,795	604,944	606,094	11,393
2,265	607,246	608,398	609,552	610,707	611,864	613,021	614,180	615,341	616,502	617,665	11,520
2,266	618,829	619,994	621,161	622,329	623,498	624,668	625,840	627,013	628,187	629,363	11,647
2,267	630,540	631,718	632,897	634,078	635,260	636,443	637,627	638,813	640,000	641,189	11,775
2,268	642,378	643,569	644,762	645,955	647,150	648,346	649,543	650,742	651,942	653,143	11,903
2,269	654,346	655,550	656,755	657,961	659,169	660,378	661,589	662,800	664,013	665,227	12,032
2,270	666,443	667,661	668,879	670,098	671,318	672,538	673,760	674,983	676,206	677,431	12,162
2,271	678,657	679,883	681,111	682,340	683,570	684,800	686,032	687,265	688,499	689,733	12,262
2,272	690,969	692,206	693,444	694,682	695,922	697,163	698,405	699,647	700,891	702,136	12,363
2,273	703,382	704,629	705,877	707,126	708,375	709,626	710,878	712,131	713,385	714,640	12,463
2,274	715,896	717,153	718,411	719,670	720,930	722,191	723,453	724,716	725,980	727,245	12,565
2,275	728,511	729,779	731,047	732,316	733,586	734,857	736,130	737,403	738,677	739,953	12,666
2,276	741,229	742,506	743,785	745,064	746,344	747,626	748,908	750,192	751,476	752,762	12,768
2,277	754,049	755,336	756,625	757,914	759,205	760,497	761,790	763,083	764,378	765,674	12,871
2,278	766,971	768,269	769,568	770,868	772,169	773,471	774,774	776,078	777,383	778,689	12,974
2,279	779,997	791,305	782,614	783,924	785,236	786,548	787,862	789,176	790,492	791,808	13,077
2,280	793,126	794,443	795,764	797,087	798,411	799,738	801,066	802,396	803,728	805,061	13,181
2,281	806,397	807,734	809,073	810,414	811,757	813,102	814,448	815,796	817,147	818,499	13,364
2,282	819,852	821,208	822,566	823,925	825,286	826,649	828,014	829,381	830,750	832,120	13,548
2,283	833,493	834,867	836,243	837,621	839,001	840,382	841,766	843,151	844,539	845,928	13,733
2,284	847,319	848,712	850,106	851,503	852,902	854,302	855,704	857,108	858,514	859,922	13,920
2,285	861,332	862,744	864,157	865,573	866,990	868,409	869,830	871,253	872,678	874,105	14,107
2,286	875,534	876,964	878,397	879,831	881,267	882,706	884,146	885,588	887,032	888,477	14,296
2,287	889,925	891,375	892,826	894,280	895,735	897,192	898,651	900,113	901,576	903,041	14,487
2,288	904,507	905,976	907,447	908,919	910,394	911,870	913,349	914,829	916,311	917,796	14,678
2,289	919,282	920,770	922,260	923,752	925,246	926,741	928,239	929,739	931,241	932,744	14,871

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,290	934,250	935,757	937,266	938,778	940,291	941,806	943,323	944,842	946,363	947,885	15,065
2,291	949,410	950,937	952,465	953,996	955,528	957,062	958,598	960,136	961,676	963,218	15,256
2,292	964,762	966,308	967,856	969,406	970,957	972,511	974,066	975,624	977,183	978,744	15,449
2,293	980,308	981,873	983,440	985,009	986,580	998,153	989,728	991,305	992,884	994,464	15,642
2,294	996,047	997,632	999,218	1,000,807	1,002,397	1,003,990	1,005,584	1,007,181	1,008,779	1,010,380	15,937
2,295	1,011,982	1,013,586	1,015,192	1,016,801	1,018,411	1,020,023	1,021,637	1,023,253	1,024,871	1,026,491	16,033
2,296	1,028,113	1,029,737	1,031,363	1,032,991	1,034,621	1,036,253	1,037,887	1,039,523	1,041,161	1,042,801	16,230
2,297	1,044,443	1,046,086	1,047,732	1,049,380	1,051,030	1,052,682	1,054,336	1,055,991	1,057,649	1,059,309	16,429
2,298	1,060,971	1,062,635	1,064,300	1,065,968	1,067,638	1,069,310	1,070,984	1,072,660	1,074,338	1,076,017	16,628
2,299	1,077,699	1,079,383	1,081,069	1,082,757	1,084,447	1,086,139	1,087,833	1,089,529	1,091,227	1,092,927	16,829
2,300	1,094,629	1,096,332	1,098,037	1,099,744	1,101,451	1,103,160	1,104,870	1,106,581	1,108,294	1,110,008	17,031
2,301	1,111,723	1,113,439	1,115,157	1,116,876	1,118,596	1,120,318	1,122,041	1,123,765	1,125,490	1,127,217	17,158
2,302	1,128,945	1,130,674	1,132,404	1,134,136	1,135,869	1,137,603	1,139,339	1,141,076	1,142,814	1,144,553	17,285
2,303	1,146,294	1,148,036	1,149,779	1,151,524	1,153,270	1,155,017	1,156,765	1,158,515	1,160,266	1,162,018	17,413
2,304	1,163,772	1,165,526	1,167,282	1,169,040	1,170,799	1,172,559	1,174,320	1,176,082	1,177,846	1,179,611	17,542
2,305	1,181,378	1,183,145	1,184,914	1,186,685	1,188,456	1,190,229	1,192,003	1,193,779	1,195,556	1,197,334	17,671
2,306	1,199,113	1,200,894	1,202,676	1,204,459	1,206,243	1,208,029	1,209,816	1,211,605	1,213,394	1,215,185	17,800
2,307	1,216,978	1,218,771	1,220,566	1,222,363	1,224,160	1,225,959	1,227,759	1,229,560	1,231,363	1,233,167	17,930
2,308	1,234,973	1,236,779	1,238,587	1,240,396	1,242,207	1,244,019	1,245,832	1,247,647	1,249,462	1,251,280	18,060
2,309	1,253,098	1,254,918	1,256,739	1,258,561	1,260,385	1,262,210	1,264,036	1,265,864	1,267,693	1,269,523	18,191
2,310	1,271,354	1,273,186	1,275,020	1,276,855	1,278,690	1,280,527	1,282,365	1,284,204	1,286,043	1,287,884	18,322
2,311	1,289,726	1,291,569	1,293,413	1,295,257	1,297,103	1,298,950	1,300,798	1,302,647	1,304,497	1,306,348	18,423
2,312	1,308,200	1,310,052	1,311,906	1,313,761	1,315,617	1,317,474	1,319,332	1,321,191	1,323,051	1,324,912	18,524
2,313	1,326,774	1,328,638	1,330,502	1,332,367	1,334,233	1,336,100	1,337,968	1,339,837	1,341,708	1,343,579	18,626
2,314	1,345,451	1,347,324	1,349,199	1,351,074	1,352,950	1,354,828	1,356,706	1,358,585	1,360,466	1,362,347	18,727
2,315	1,364,230	1,366,113	1,367,997	1,369,883	1,371,769	1,373,657	1,375,546	1,377,435	1,379,326	1,381,218	18,830
2,316	1,383,110	1,385,004	1,386,899	1,388,794	1,390,691	1,392,589	1,394,488	1,396,388	1,398,288	1,400,190	18,932
2,317	1,402,093	1,403,997	1,405,902	1,407,808	1,409,715	1,411,623	1,413,533	1,415,443	1,417,354	1,419,266	19,034
2,318	1,421,179	1,423,093	1,425,009	1,426,925	1,428,842	1,430,761	1,432,680	1,434,601	1,436,522	1,438,445	19,137
2,319	1,440,368	1,442,293	1,444,218	1,446,145	1,448,073	1,450,001	1,451,931	1,453,862	1,455,794	1,457,727	19,241

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,320	1,459,660	1,461,595	1,463,533	1,465,471	1,467,412	1,469,355	1,471,299	1,473,245	1,475,193	1,477,142	19,344
2,321	1,479,094	1,481,047	1,483,002	1,484,959	1,486,917	1,488,878	1,490,840	1,492,804	1,494,770	1,496,738	19,523
2,322	1,498,707	1,500,678	1,502,651	1,504,626	1,506,603	1,508,582	1,510,562	1,512,544	1,514,528	1,516,514	19,704
2,323	1,518,501	1,520,491	1,522,482	1,524,475	1,526,470	1,528,466	1,530,465	1,532,465	1,534,467	1,536,471	19,885
2,324	1,538,477	1,540,484	1,542,494	1,544,505	1,546,518	1,548,533	1,550,549	1,552,568	1,554,588	1,556,610	20,066
2,325	1,558,634	1,560,660	1,562,688	1,564,717	1,566,749	1,568,782	1,570,817	1,572,854	1,574,892	1,576,933	20,249
2,326	1,578,975	1,581,019	1,583,065	1,585,113	1,587,163	1,589,215	1,591,268	1,593,323	1,595,380	1,597,439	20,433
2,327	1,599,500	1,601,563	1,603,627	1,605,693	1,607,762	1,609,832	1,611,903	1,613,977	1,616,053	1,618,130	20,617
2,328	1,620,209	1,622,291	1,624,374	1,626,458	1,628,545	1,630,634	1,632,724	1,634,816	1,636,911	1,639,007	20,802
2,329	1,641,105	1,643,204	1,645,306	1,647,409	1,649,515	1,651,622	1,653,731	1,655,842	1,657,955	1,660,069	20,988
2,330	1,662,186	1,664,305	1,666,425	1,668,545	1,670,667	1,672,790	1,674,914	1,677,040	1,679,166	1,681,294	21,175
2,331	1,683,423	1,685,554	1,687,685	1,689,818	1,691,952	1,694,087	1,696,224	1,698,361	1,700,500	1,702,640	21,297
2,332	1,704,782	1,706,924	1,709,068	1,711,213	1,713,360	1,715,507	1,717,656	1,719,806	1,721,957	1,724,109	21,420
2,333	1,726,263	1,728,418	1,730,574	1,732,731	1,734,890	1,737,050	1,739,211	1,741,373	1,743,537	1,745,701	21,543
2,334	1,747,867	1,750,035	1,752,203	1,754,373	1,756,544	1,758,716	1,760,889	1,763,064	1,765,240	1,767,417	21,666
2,335	1,769,595	1,771,775	1,773,955	1,776,138	1,778,321	1,780,505	1,782,691	1,784,878	1,787,066	1,789,256	21,790
2,336	1,791,447	1,793,639	1,795,832	1,798,026	1,800,222	1,802,419	1,804,617	1,806,817	1,809,017	1,811,219	21,914
2,337	1,813,422	1,815,627	1,817,832	1,820,039	1,822,247	1,824,457	1,826,668	1,828,879	1,831,093	1,833,307	22,038
2,338	1,835,523	1,837,739	1,839,958	1,842,177	1,844,398	1,846,619	1,848,843	1,851,067	1,853,293	1,855,520	22,163
2,339	1,857,748	1,859,977	1,862,208	1,861,440	1,866,673	1,868,907	1,871,143	1,873,380	1,875,618	1,877,857	22,288
2,341	1,902,571	1,904,826	1,907,081	1,909,337	1,911,595	1,913,854	1,916,114	1,918,376	1,920,638	1,922,902	22,535
2,342	1,925,167	1,927,433	1,929,701	1,931,970	1,934,240	1,936,511	1,938,783	1,941,057	1,943,332	1,945,608	22,657
2,343	1,947,885	1,950,164	1,952,443	1,954,724	1,957,007	1,959,290	1,961,575	1,963,861	1,966,148	1,968,436	22,779
2,344	1,970,726	1,973,016	1,975,308	1,977,602	1,979,896	1,982,192	1,984,489	1,986,787	1,989,086	1,991,387	22,902
2,345	1,993,689	1,995,992	1,998,296	2,000,602	2,002,909	2,005,217	2,007,526	2,009,837	2,012,148	2,014,461	23,025
2,346	2,016,775	2,019,091	2,021,408	2,023,725	2,026,045	2,028,365	2,030,687	2,033,009	2,035,334	2,037,659	23,148
2,347	2,039,985	2,042,313	2,044,642	2,046,973	2,049,304	2,051,637	2,053,971	2,056,306	2,058,643	2,060,980	23,272
2,348	2,063,319	2,065,660	2,068,001	2,070,344	2,072,688	2,075,033	2,077,379	2,079,727	2,082,076	2,084,426	23,396
2,349	2,086,778	2,089,130	2,091,484	2,093,839	2,096,196	2,098,553	2,100,912	2,103,272	2,105,634	2,107,996	23,520

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,350	2,110,360	2,112,725	2,115,091	2,117,459	2,119,828	2,122,199	2,124,570	2,126,943	2,129,318	2,131,693	23,645
2,352	2,157,913	2,160,304	2,162,697	2,165,091	2,167,486	2,169,883	2,172,281	2,174,681	2,177,081	2,179,483	23,908
2,353	2,181,887	2,184,291	2,186,697	2,189,105	2,191,513	2,193,923	2,196,335	2,198,747	2,201,161	2,203,576	24,040
2,354	2,205,993	2,208,411	2,210,830	2,213,251	2,215,673	2,218,096	2,220,521	2,222,946	2,225,374	2,227,802	24,173
2,355	2,230,232	2,232,663	2,235,096	2,237,530	2,239,965	2,242,401	2,244,839	2,247,279	2,249,719	2,252,161	24,305
2,356	2,254,604	2,257,049	2,259,495	2,261,942	2,264,390	2,266,840	2,269,291	2,271,744	2,274,198	2,276,653	24,439
2,357	2,279,109	2,281,567	2,284,027	2,286,487	2,288,949	2,291,412	2,293,877	2,296,343	2,299,810	2,301,279	24,572
2,358	2,303,749	2,306,220	2,308,692	2,311,166	2,313,642	2,316,118	2,318,596	2,321,076	2,323,556	2,326,038	24,706
2,359	2,328,522	2,331,007	2,333,493	2,335,980	2,338,469	2,340,959	2,343,450	2,345,943	2,348,437	2,350,933	24,840
2,360	2,353,429	2,355,927	2,358,427	2,360,929	2,363,433	2,365,938	2,368,445	2,370,953	2,373,463	2,375,975	24,975
2,361	2,378,489	2,381,004	2,383,521	2,386,040	2,388,560	2,391,082	2,393,606	2,396,132	2,398,659	2,401,188	25,145
2,362	2,403,718	2,406,251	2,408,785	2,411,320	2,413,858	2,416,397	2,418,938	2,421,480	2,424,025	2,426,570	25,315
2,363	2,429,118	2,431,668	2,434,219	2,436,771	2,439,326	2,441,882	2,444,440	2,447,000	2,449,561	2,452,124	25,485
2,364	2,454,689	2,457,255	2,459,824	2,462,394	2,464,965	2,467,539	2,470,114	2,472,691	2,475,269	2,477,849	25,657
2,365	2,480,431	2,483,015	2,485,600	2,488,188	2,490,776	2,493,367	2,495,959	2,498,553	2,501,149	2,503,747	25,828
2,366	2,506,346	2,508,947	2,511,549	2,514,154	2,516,760	2,519,368	2,521,977	2,524,589	2,527,202	2,529,816	26,001
2,367	2,532,433	2,535,051	2,537,671	2,540,293	2,542,916	2,545,541	2,548,168	2,550,797	2,553,427	2,556,060	26,174
2,368	2,558,693	2,561,329	2,563,966	2,566,605	2,569,246	2,571,889	2,574,533	2,577,179	2,579,827	2,582,476	26,347
2,369	2,585,128	2,587,781	2,590,435	2,593,092	2,595,750	2,598,410	2,601,072	2,603,735	2,606,400	2,609,067	26,521
2,370	2,611,736	2,614,407	2,617,079	2,619,752	2,622,426	2,625,102	2,627,780	2,630,459	2,633,139	2,635,821	26,696
2,371	2,638,505	2,641,189	2,643,876	2,646,563	2,649,252	2,651,943	2,654,635	2,657,328	2,660,023	2,662,720	26,840
2,372	2,665,417	2,668,117	2,670,817	2,673,520	2,676,223	2,678,928	2,681,635	2,684,343	2,687,052	2,689,763	26,985
2,373	2,692,475	2,695,189	2,697,904	2,700,621	2,703,339	2,706,059	2,708,780	2,711,502	2,714,226	2,716,952	27,131
2,374	2,719,679	2,722,407	2,725,137	2,727,868	2,730,601	2,733,335	2,736,071	2,738,808	2,741,546	2,744,286	27,276
2,375	2,747,028	2,749,771	2,752,515	2,755,261	2,758,008	2,760,757	2,763,507	2,766,259	2,769,012	2,771,767	27,422
2,376	2,774,523	2,777,281	2,780,040	2,782,800	2,785,562	2,788,326	2,791,090	2,793,857	2,796,625	2,799,394	27,569
2,377	2,802,165	2,804,937	2,807,711	2,810,486	2,813,263	2,816,041	2,818,821	2,821,602	2,824,384	2,827,168	27,715
2,378	2,829,954	2,832,741	2,835,529	2,838,319	2,841,111	2,843,903	2,846,698	2,849,494	2,852,291	2,855,090	27,862
2,379	2,857,890	2,860,692	2,863,495	2,866,300	2,869,106	2,871,913	2,874,723	2,877,533	2,880,345	2,883,159	28,010

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,380	2,885,974	2,888,792	2,891,610	2,894,430	2,897,251	2,900,075	2,902,899	2,905,726	2,908,553	2,911,383	28,158
2,381	2,914,214	2,917,047	2,919,881	2,922,717	2,925,555	2,928,394	2,931,235	2,934,078	2,936,922	2,939,768	28,320
2,384	2,999,906	3,002,787	3,005,671	3,008,556	3,011,442	3,014,330	3,017,220	3,020,112	3,023,005	3,025,900	28,808
2,385	3,028,796	3,031,694	3,034,594	3,037,495	3,040,398	3,043,303	3,046,209	3,049,117	3,052,026	3,054,937	28,972
2,386	3,057,850	3,060,765	3,063,681	3,066,599	3,069,518	3,072,439	3,075,362	3,078,286	3,081,212	3,084,140	29,136
2,387	3,087,069	3,090,000	3,092,932	3,095,867	3,098,803	3,101,740	3,104,679	3,107,620	3,110,563	3,113,507	29,301
2,388	3,116,453	3,119,400	3,122,394	3,125,300	3,128,252	3,131,206	3,134,162	3,137,120	3,140,079	3,143,039	29,466
2,389	3,146,002	3,148,966	3,151,931	3,154,899	3,157,868	3,160,838	3,163,811	3,166,785	3,169,760	3,172,738	29,632
2,390	3,175,717	3,178,699	3,181,683	3,184,670	3,187,659	3,190,652	3,193,648	3,196,646	3,199,648	3,202,652	29,798
2,391	3,205,659	3,208,669	3,211,682	3,214,698	3,217,716	3,220,738	3,223,762	3,226,790	3,229,820	3,232,853	30,086
2,392	3,235,889	3,238,928	3,241,969	3,245,014	3,248,062	3,251,112	3,254,166	3,257,222	3,260,281	3,263,343	30,374
2,393	3,266,408	3,269,476	3,272,547	3,275,621	3,278,697	3,281,777	3,284,859	3,287,945	3,291,033	3,294,124	30,665
2,394	3,297,219	3,300,316	3,303,416	3,306,519	3,309,624	3,312,733	3,315,845	3,318,960	3,322,077	3,325,198	30,956
2,395	3,328,321	3,331,448	3,334,577	3,337,709	3,340,844	3,343,983	3,347,124	3,350,268	3,353,415	3,356,565	31,249
2,396	3,359,717	3,362,873	3,366,032	3,369,194	3,372,359	3,375,526	3,378,697	3,381,870	3,385,047	3,388,226	31,544
2,397	3,391,409	3,394,594	3,397,783	3,400,974	3,404,168	3,407,366	3,410,566	3,413,769	3,416,975	3,420,185	31,839
2,398	3,423,397	3,426,612	3,429,830	3,433,051	3,436,275	3,439,502	3,442,732	3,445,965	3,449,201	3,452,440	32,137
2,399	3,455,683	3,458,928	3,462,176	3,465,427	3,468,681	3,471,937	3,475,197	3,478,440	3,481,726	3,484,995	32,435
2,400	3,488,267	3,491,542	3,494,821	3,498,102	3,501,388	3,504,676	3,507,968	3,511,264	3,514,562	3,517,864	32,735
2,401	3,521,170	3,524,479	3,527,791	3,531,106	3,534,425	3,537,747	3,541,073	3,544,402	3,547,735	3,551,070	33,071
2,402	3,554,410	3,557,752	3,561,098	3,564,448	3,567,800	3,571,156	3,574,516	3,577,879	3,581,245	3,584,615	33,409
2,403	3,587,988	3,591,365	3,594,745	3,598,128	3,601,515	3,604,905	3,608,298	3,611,695	3,615,096	3,618,500	33,748
2,404	3,621,907	3,625,318	3,628,732	3,632,149	3,635,570	3,638,995	3,642,422	3,645,854	3,649,288	3,652,726	34,090
2,405	3,656,168	3,659,613	3,663,061	3,666,513	3,669,968	3,673,427	3,676,889	3,680,355	3,683,824	3,687,297	34,433
2,406	3,690,773	3,694,252	3,697,735	3,701,221	3,704,711	3,708,204	3,711,701	3,715,201	3,718,705	3,722,212	34,777
2,407	3,725,723	3,729,237	3,732,755	3,736,276	3,739,800	3,743,328	3,746,860	3,750,395	3,753,933	3,757,475	35,124
2,408	3,761,020	3,764,569	3,768,122	3,771,678	3,775,237	3,778,800	3,782,366	3,785,936	3,789,510	3,793,086	35,472
2,409	3,796,667	3,800,251	3,803,838	3,807,429	3,811,023	3,814,621	3,818,223	3,821,828	3,825,436	3,829,048	35,821

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,410	3,832,664	3,836,282	3,839,903	3,843,526	3,847,151	3,850,779	3,854,409	3,858,042	3,861,677	3,865,314	36,173
2,411	3,868,954	3,872,596	3,876,240	3,879,887	3,883,536	3,887,187	3,890,841	3,894,497	3,898,156	3,901,816	36,408
2,412	3,905,480	3,909,145	3,912,813	3,916,483	3,920,156	3,923,831	3,927,508	3,931,188	3,934,870	3,938,555	36,644
2,413	3,942,242	3,945,931	3,949,622	3,953,316	3,957,013	3,960,711	3,964,412	3,968,116	3,971,822	3,975,530	36,880
2,414	3,979,240	3,982,953	3,986,669	3,990,386	3,994,106	3,997,829	4,001,554	4,005,281	4,009,010	4,012,742	37,117
2,415	4,016,477	4,020,213	4,023,953	4,027,694	4,031,438	4,035,184	4,038,933	4,042,684	4,046,437	4,050,193	37,355
2,416	4,053,952	4,057,712	4,061,475	4,065,241	4,069,008	4,072,779	4,076,551	4,080,326	4,084,104	4,087,883	37,594
2,417	4,091,666	4,095,450	4,099,237	4,103,026	4,106,818	4,110,612	4,114,409	4,118,208	4,122,009	4,125,813	37,834
2,418	4,129,619	4,133,428	4,137,239	4,141,052	4,144,868	4,148,687	4,152,507	4,156,330	4,160,156	4,163,984	38,074
2,419	4,167,814	4,171,647	4,175,482	4,179,319	4,183,159	4,187,002	4,190,847	4,194,694	4,198,543	4,202,396	38,315
2,420	4,206,250	4,210,107	4,213,966	4,217,828	4,221,691	4,225,556	4,229,424	4,233,294	4,237,166	4,241,040	38,557
2,421	4,244,916	4,248,794	4,252,675	4,256,558	4,260,443	4,264,330	4,268,219	4,272,111	4,276,004	4,279,900	38,774
2,422	4,283,798	4,287,698	4,291,601	4,295,505	4,299,412	4,303,321	4,307,232	4,311,145	4,315,060	4,318,978	38,991
2,423	4,322,898	4,326,820	4,330,744	4,334,670	4,338,599	4,342,529	4,346,462	4,350,397	4,354,334	4,358,274	39,209
2,424	4,362,215	4,366,159	4,370,105	4,374,053	4,378,004	4,381,956	4,385,911	4,389,868	4,393,827	4,397,788	39,421
2,425	4,401,752	4,405,717	4,409,685	4,413,655	4,417,628	4,421,602	4,425,579	4,429,558	4,433,539	4,437,522	39,646
2,426	4,441,507	4,445,495	4,449,485	4,453,477	4,457,471	4,461,468	4,465,466	4,469,467	4,473,470	4,477,475	39,866
2,427	4,481,483	4,485,493	4,489,505	4,493,519	4,497,535	4,501,553	4,505,574	4,509,597	4,513,622	4,517,650	40,086
2,428	4,521,679	4,525,711	4,529,745	4,533,781	4,537,819	4,541,860	4,545,903	4,549,948	4,553,995	4,558,045	40,307
2,429	4,562,096	4,566,150	4,570,206	4,574,265	4,578,325	4,582,388	4,586,453	4,590,520	4,594,590	4,598,661	40,528
2,430	4,602,735	4,606,808	4,610,886	4,614,966	4,619,048	4,623,133	4,627,219	4,631,307	4,635,397	4,639,490	40,750
2,431	4,643,584	4,647,681	4,651,779	4,655,879	4,659,982	4,664,087	4,668,193	4,672,307	4,676,413	4,680,525	40,954
2,432	4,684,640	4,688,757	4,692,876	4,696,997	4,701,120	4,705,245	4,709,372	4,713,501	4,717,633	4,721,766	41,159
2,433	4,725,901	4,730,039	4,734,178	4,738,320	4,742,463	4,746,609	4,750,756	4,754,906	4,759,058	4,763,212	41,364
2,434	4,767,368	4,771,526	4,775,686	4,779,848	4,784,012	4,788,178	4,792,346	4,796,516	4,800,689	4,804,863	41,569
2,435	4,809,040	4,813,218	4,817,399	4,821,581	4,825,766	4,829,953	4,834,142	4,838,333	4,842,526	4,846,721	41,775
2,436	4,850,918	4,855,117	4,859,318	4,863,522	4,867,727	4,871,935	4,876,144	4,880,356	4,884,570	4,888,785	41,982
2,437	4,893,003	4,897,223	4,901,445	4,905,669	4,909,895	4,914,123	4,918,354	4,922,586	4,926,821	4,931,057	42,189
2,438	4,935,296	4,939,536	4,943,779	4,948,024	4,952,271	4,956,520	4,960,771	4,965,024	4,969,279	4,973,537	42,396
2,439	4,977,796	4,982,057	4,986,321	4,990,587	4,994,854	4,999,124	5,003,396	5,007,670	5,011,194	5,016,224	42,604

Table 2-1. Lake Koocanusa at Libby Dam, MT Storage-Elevation Table in acre-ft (continued)

Elev. (ft)	0.00	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	Area (acres)
2,440	5,020,505	5,024,789	5,029,074	5,033,360	5,037,648	5,041,938	5,046,231	5,050,525	5,054,821	5,059,119	42,813
2,441	5,063,420	5,067,722	5,072,026	5,076,332	5,080,640	5,084,951	5,089,263	5,093,577	5,097,893	5,102,211	43,012
2,442	5,106,531	5,110,853	5,115,178	5,119,504	5,123,832	5,128,162	5,132,494	5,136,828	5,141,164	5,145,503	43,212
2,443	5,149,843	5,154,185	5,158,529	5,162,875	5,167,223	5,171,574	5,175,926	5,180,280	5,184,636	5,188,994	43,411
2,444	5,193,354	5,197,717	5,202,081	5,206,447	5,210,815	5,215,185	5,219,558	5,223,932	5,228,308	5,232,686	43,612
2,445	5,237,067	5,241,449	5,245,833	5,250,220	5,254,608	5,258,998	5,263,391	5,267,785	5,272,181	5,276,580	43,813
2,446	5,280,980	5,285,382	5,289,787	5,294,193	5,298,602	5,303,012	5,307,425	5,311,839	5,316,256	5,320,674	44,014
2,447	5,325,095	5,329,518	5,333,942	5,338,369	5,342,797	5,347,228	5,351,661	5,356,096	5,360,532	5,364,971	44,216
2,448	5,369,412	5,373,855	5,378,300	5,382,746	5,387,195	5,391,646	5,396,099	5,400,554	5,405,011	5,409,470	44,418
2,449	5,413,931	5,418,394	5,422,860	5,427,327	5,431,796	5,436,267	5,440,740	5,445,216	5,449,693	5,454,172	44,621
2,450	5,458,654	5,463,139	5,467,624	5,472,111	5,476,599	5,481,090	5,485,582	5,490,076	5,494,572	5,499,070	44,824
2,451	5,503,569	5,508,071	5,512,574	5,517,079	5,521,585	5,526,094	5,530,604	5,535,116	5,539,630	5,544,146	45,004
2,452	5,548,663	5,553,183	5,557,704	5,562,227	5,566,751	5,571,278	5,575,806	5,580,336	5,584,868	5,589,402	45,184
2,453	5,593,938	5,598,475	5,603,014	5,607,555	5,612,098	5,616,643	5,621,189	5,625,737	5,630,287	5,634,839	45,365
2,454	5,639,393	5,643,948	5,648,506	5,653,065	5,657,626	5,662,188	5,666,753	5,671,319	5,675,887	5,680,457	45,546
2,455	5,685,029	5,689,603	5,694,178	5,698,756	5,703,335	5,707,915	5,712,498	5,717,083	5,721,669	5,726,257	45,727
2,456	5,730,847	5,735,439	5,740,032	5,744,628	5,749,225	5,753,824	5,758,425	5,763,028	5,767,632	5,772,239	45,909
2,457	5,776,847	5,781,457	5,786,069	5,790,682	5,795,298	5,799,915	5,804,534	5,809,155	5,813,778	5,818,402	46,091
2,458	5,823,029	5,827,657	5,832,287	5,836,919	5,841,552	5,846,188	5,850,825	5,855,465	5,860,106	5,864,748	46,273
2,459	5,869,393	5,874,040	5,878,688	5,883,338	5,887,990	5,892,644	5,897,300	5,901,957	5,906,616	5,911,278	46,456
2,460	5,915,941										46,639

Table 4-8. Snow Survey Courses and Snow Pillow Sites

Station	State / Province	Data Source	Station ID	Elev. (ft (m))	Lat.	Long.	Available Data[1]	Period of Record	URL
Real Time Data Above Libby Dam									
East Creek[2]	BC	Ministry of Environment	2D08P	6,660 (2,030)	50º 38'	116º 56'	AT,P,SWC	1980-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D08P/Interval/Latest
Floe Lake[2]	BC	Ministry of Environment	2C14P	6,857 (2,090)	51º 03'	116º 08'	AT,P,SWC	1992-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C14P/Interval/Latest
Gardiner Creek[2]	AB	Ministry of Environment	GCKQ1	6,463 (1,970)	49º 22'	114º 31'	AT,P,SD,SWC	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?GCKQ1
Grave Creek	MT	NRCS	14A11S	4,350 (1,326)	48º 55'	114º 46'	AT,P,SD,SWC	1976-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Hand Creek	MT	NRCS	14A14S	5,040 (1,536)	48º 18'	114º 50'	AT,P,SD,SWC	1977-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Hawkins Lake[2]	MT	NRCS	15A03S	6,460 (1,969)	48º 58'	115º 57'	AT,P,SD,SWC	1969-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Little Elbow Summit	AB	Ministry of Environment	LESQ1	6,955 (2,120)	50º 42'	114º 59'	AT,P,SWC,WS	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?LESQ1
Lost Creek South[2]	AB	Ministry of Environment	LCKQ1	7,084 (2,159)	50º 10'	114º 42'	AT,P,SWC	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?LCKQ1
Morrissey Ridge[2]	BC	Ministry of Environment	2C09Q	6,102 (1,860)	49º 27'	114º 58'	AT,P,SWC	1983-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C09Q/Interval/Latest
Mount Odlum	AB	Ministry of Environment	MTOQ1	6,988 (2,130)	50º 29'	114º 54'	AT,P,SWC	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?MTOQ1
Moyie Mountain	BC	Ministry of Environment	2C10P	6,020 (1,835)	49º 15'	115º 46'	AT,P,SWC,SD	1971-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C10P/Interval/Latest
Skoki Lodge	AB	Ministry of Environment	SKOQ1	6,759 (2,060)	51º 32'	116º 03'	AT,P,SWC	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?SKOQ1
South Racehorse Creek	AB	Ministry of Environment	SRCQ1	6,299 (1,920)	49º 49'	114º 38'	AT,P,SWC,SD,WS	1999-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?SRCQ1
Stahl Peak[2]	MT	NRCS	14A12S	6,040 (1,841)	48º 55'	114º 52'	AT,P,SD,SWC	1976-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Sunshine Village[2]	AB	Ministry of Environment	SUNQ1	7,316 (2,230)	51º 04'	115º 47'	AT,P,SWC	1997-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?SUNQ1
Three Isle Lake[2]	AB	Ministry of Environment	TILQ1	7,110 (2,167)	50º 38'	115º 17'	AT,P,SWC,WS	1998-current	https://rivers.alberta.ca/; https://www.nwrfc.noaa.gov/snow/snowplot.cgi?TILQ1
Real Time Data Below Libby Dam									
Banfield Mountain	MT	NRCS	15A08S	5,580 (1,701)	48º 34'	115º 27'	AT,P,SD,SWC	1969-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Bearountain	ID	NRCS	16A08S	5,460 (1,664)	48º 18'	116º 04'	AT,P,SD,SWC	1981-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=ID
Garver Creek	MT	NRCS	15A05S	4,250 (1,295)	48º 59'	115º 49'	AT,P,SD,SWC,WS	1969-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Hidden Lake	ID	NRCS	16A12S	5,000 (1,524)	48º 54'	116º 45'	AT,P,SD,SWC	2001-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=ID
Myrtle Creek	ID	NRCS	16A14S	3,540 (1,079)	48º 43'	116º 28'	AT,P,SD,SWC,WS	2004-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=ID
Poorman Creek	MT	NRCS	15A12S	5,050 (1,539)	48º 08'	115º 37'	AT,P,SD,SWC,WS	1969-87; 1999-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT

Table 4-8. Snow Survey Courses and Snow Pillow Sites (continued)

Station	State / Province	Data Source	Station ID	Elev. (ft (m))	Lat.	Long.	Available Data[1]	Period of Record	URL
British Columbia Historical Data									
Char Creek	BC	Ministry of Environment	2D06	4,298 (1,310)	49º 05'	116º 57'	SD,SWC	1965-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D06/Interval/Latest
Duncan Lake No. 2	BC	Ministry of Environment	2D07A	2067 (630)	50º 15'	116º 57'	SD,SWC	1991-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D07A/Interval/Latest
Ferguson	BC	Ministry of Environment	2D02	2887 (880)	50º 40'	117º 28'	SD,SWC	1938-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D02/Interval/Latest
Fernie East	BC	Ministry of Environment	2C07	4,101 (1,250)	49º 30'	115º 02'	SD,SWC	1951-2019	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C07/Interval/Latest
Gray Creek (Lower)	BC	Ministry of Environment	2D05	5,413 (1,650)	49º 36'	116º 41'	SD,SWC	1948-2023	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D05/Interval/Latest
Gray Creek (Upper)	BC	Ministry of Environment	2D10	6,332 (1,930)	49º 36'	116º 39'	SD,SWC	1969-2023	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D10/Interval/Latest
Kimberley (Middle) Vor	BC	Ministry of Environment	2C12	5,512 (1,680)	49º 33'	116º 03'	SD,SWC	1969-2023	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C12/Interval/Latest
Kimberley (Upper) Vor	BC	Ministry of Environment	2C11	7,021 (2,140)	49º 33'	116º 05'	SD,SWC	1969-2023	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C11/Interval/Latest
Koch Creek	BC	Ministry of Environment	2B07	6,102 (1,860)	49º 43'	117º 58'	SD,SWC	1959-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2B07/Interval/Latest
Mount Assiniboine	BC	Ministry of Environment	2C15	7,316 (2,230)	50º 54'	115º 36'	SD,SWC	1969-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C15/Interval/Latest
Mount Joffre	BC	Ministry of Environment	2C16	5,741 (1,750)	50º 32'	115º 07'	SD,SWC	1969-2020	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C16/Interval/Latest
Mount Templeman	BC	Ministry of Environment	2D09	6,102 (1,860)	50º 42'	117º 12'	SD,SWC	1967-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D09/Interval/Latest
Nelson	BC	Ministry of Environment	2D04	3051 (930)	49º 24'	117º 13'	SD,SWC	1938-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D04/Interval/Latest
Sandon	BC	Ministry of Environment	2D03	3,510 (1,070)	49º 58'	117º 13'	SD,SWC	1938-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2D03/Interval/Latest
Sinclair Pass	BC	Ministry of Environment	2C01	4,495 (1,370)	50º 39'	115º 57'	SD,SWC	1936-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C01/Interval/Latest
Thunder Creek	BC	Ministry of Environment	2C17	6,594 (2,010)	50º 02'	115º 14'	SD,SWC	1969-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C17/Interval/Latest
Vermilion River No. 3	BC	Ministry of Environment	2C20	5,151 (1,570)	51º 12'	116º 04'	SD,SWC	1970-80; 2005-2011	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C20/Interval/Latest
Sullivanine	BC	Ministry of Environment	2C04	5,085 (1,550)	49º 43'	116º 00'	SD,SWC	1946-current	https://bcmoe-prod.aquaticinformatics.net/Data/Location/Summary/Location/2C04/Interval/Latest

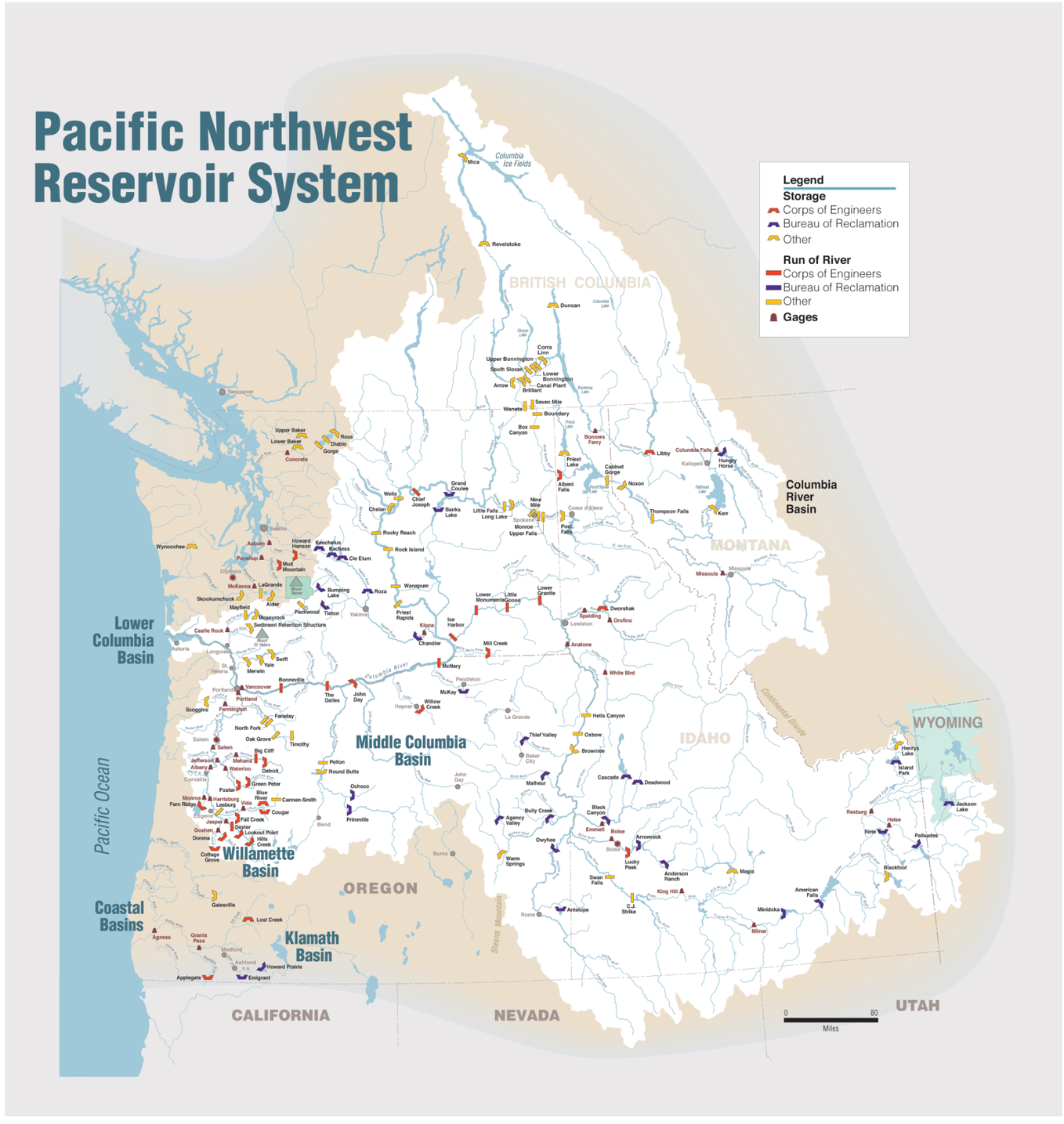
Table 4-8. Snow Survey Courses and Snow Pillow Sites (continued)

Station	State / Province	Data Source	Station ID	Elev. (ft (m))	Lat.	Long.	Available Data[1]	Period of Record	URL
NRCS Historical Data									
Davis Creek	MT	NRCS	15A04	5,400 (1,646)	48º 57'	115º 56'	SWC	1969-2012	https://wcc.sc.egov.usda.gov/reportGenerator/view_csv/customGroupByMonthReport/monthly/15a04:MT:SNOW%7Cid=%22%22%7Cname/POR_BEGIN,POR_END:1,2,3,4,5,6/WTEQ::collectionDate,SNWD::value,WTEQ::value
Weasel Divide	MT	NRCS	14A07	5,350 (1,631)	48º 57'	114º 44'	SWC	1937-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Chicago Ridge	MT	NRCS	15B22	5,680 (1,731)	48º 03'	115º 41'	SWC	2003-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Redountain	MT	NRCS	15A01	5,980 (1,823)	48º 55'	115º 21'	SWC	1937-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Rock Creekdws	MT	NRCS	15B24	3,490 (1,064)	48º 02'	115º 40'	SWC	2003-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Baree Trail	MT	NRCS	15B15	3,780 (1,152)	47º 57'	115º 30'	SWC	1965-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Bristow Creek	MT	NRCS	15A10	3,900 (1,189)	48º 34'	115º 24'	SWC	1969-2024	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Bareeidway	MT	NRCS	15B16	4,820 (1,469)	47º 58'	115º 31'	SWC	1966-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Lost Soul	MT	NRCS	15A09	4,800 (1,463)	48º 34'	115º 24'	SWC	1961-2012	https://wcc.sc.egov.usda.gov/reportGenerator/view_csv/customGroupByMonthReport/monthly/15a09:MT:SNOW%7Cid=%22%22%7Cname/POR_BEGIN,POR_END:1,2,3,4,5,6/WTEQ::collectionDate,SNWD::value,WTEQ::value
Brush Creek Timber	MT	NRCS	14A13	4,950 (1,509)	48º 22'	114º 52'	SWC	1949-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Griffin Creek Divide	MT	NRCS	14A09	5,150 (1,570)	48º 12'	114º 43'	SWC	1960-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Government Saddle	MT	NRCS	15B23	5,240 (1,597)	48º 33'	115º 44'	SWC	2003-current	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Baree Creek	MT	NRCS	15B11	5,510 (1,679)	47º 58'	115º 32'	SWC	1937-2024	https://wcc.sc.egov.usda.gov/nwcc/snow-course-sites.jsp?state=MT
Cedar Grove	MT	NRCS	15A13	3,780 (1,152)	48º 09'	115º 33'	SWC	1961-2012	https://wcc.sc.egov.usda.gov/reportGenerator/view_csv/customGroupByMonthReport/monthly/15a13:MT:SNOW%7Cid=%22%22%7Cname/POR_BEGIN,POR_END:1,2,3,4,5,6/WTEQ::collectionDate,SNWD::value,WTEQ::value
Smith Creek	ID	NRCS	16A01	4,830 (1,472)	48º 52'	116º 45'	SWC	1937-2010	https://wcc.sc.egov.usda.gov/reportGenerator/view_csv/customGroupByMonthReport/monthly/16A01:ID:SNOW%7Cid=%22%22%7Cname/POR_BEGIN,POR_END:1,2,3,4,5,6/WTEQ::collectionDate,SNWD::value,WTEQ::value

[1/] AT = air temperature, P = precipitation, SD = snow depth, SWC = snow water content
[2/] site used in the current Libby Dam water supply forecast

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Pacific Northwest Reservoir System



NOTE: THIS PLATE WAS CREATED USING A REVISED IMAGE OF THE IMAGE SHOWN IN PLATE 2-1 OF THE PREVIOUS WCM DATED 2012.

NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

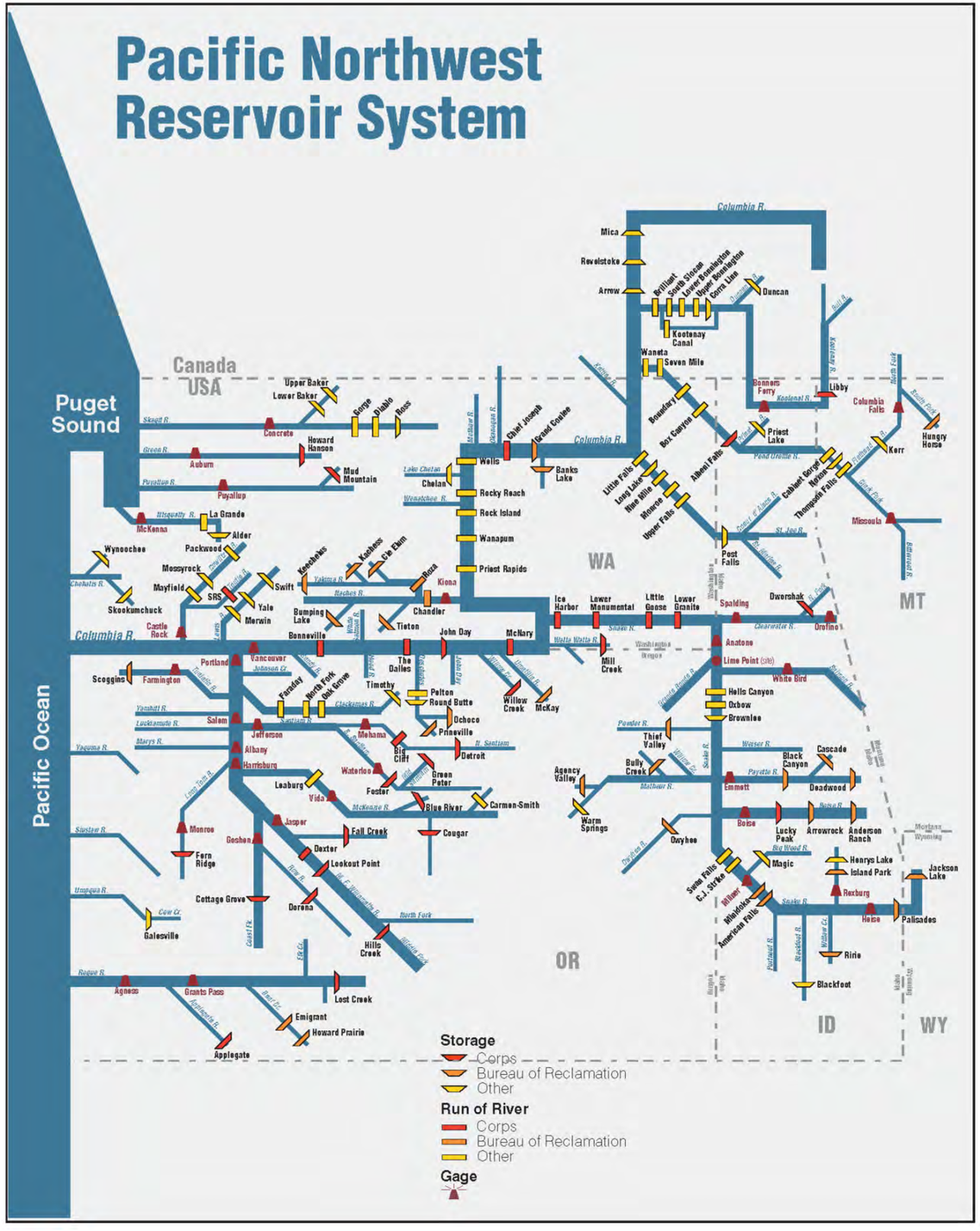
Libby Dam
Pacific Northwest Reservoir System

Source: See Left Note

April 2025

PLATE 2-1

Pacific Northwest Reservoir System



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 2-2 IN THE PREVIOUS WCM DATED 2012.

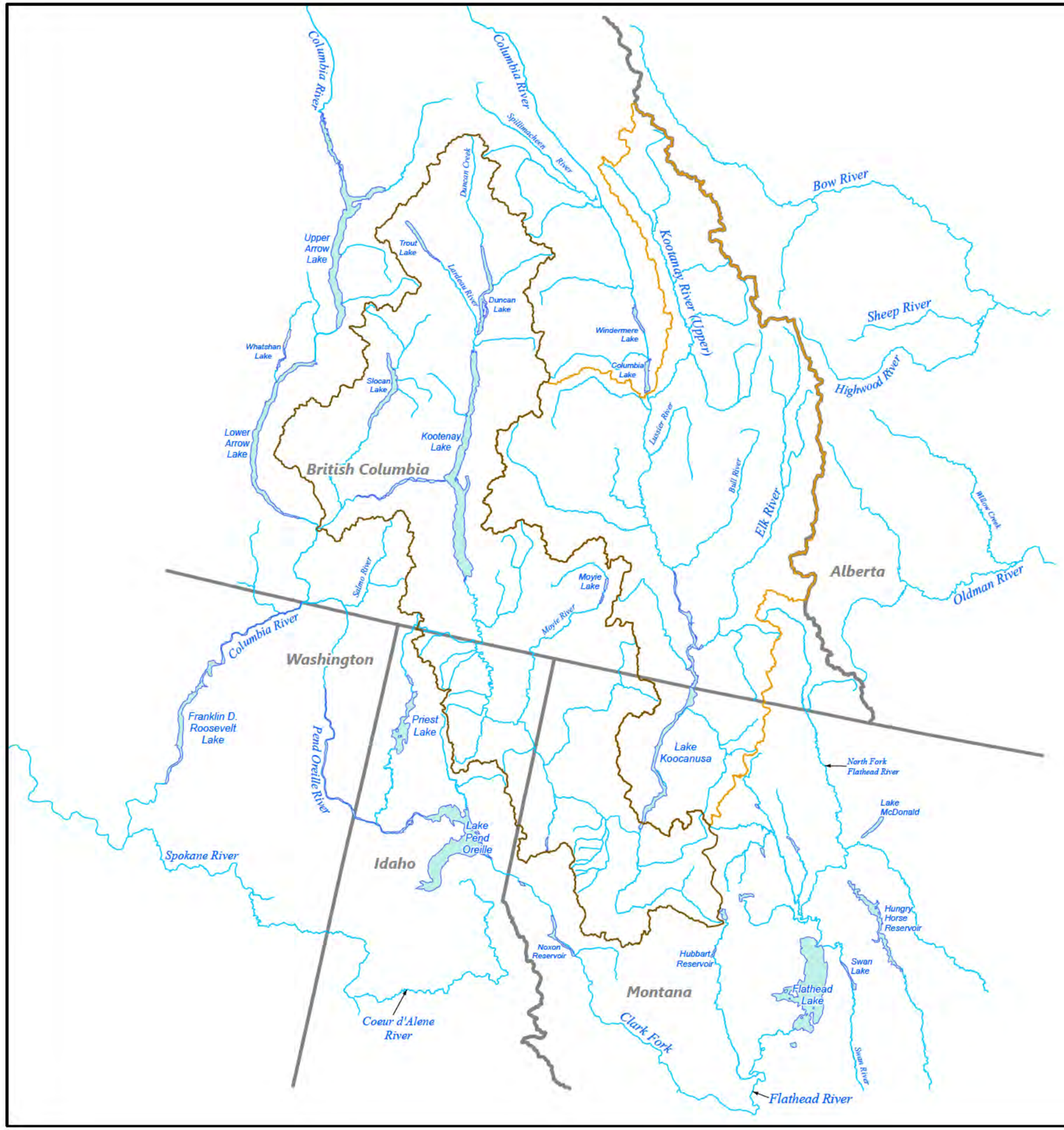
NOTE: PLATE SIZE IS 11” x 17”

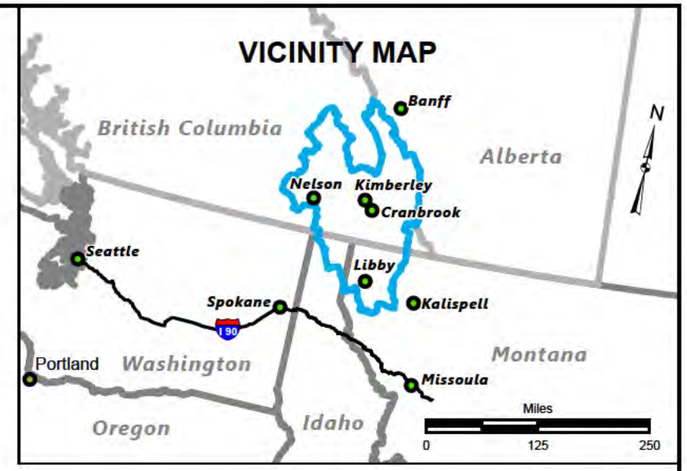
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Pacific Northwest Reservoir System
Stick Diagram

Source: See Left Note | April 2025

PLATE 2-2





Legend

- Kootenai River Basin above Libby Dam Project
- Kootenai River Basin below Libby Dam Project

0 20 40 60 80 100 Miles

N

NOTE: PLATE SIZE IS 11" X 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Location and Vicinity

Completed by: WEST	April 2025

PLATE 2-3



PLATE 2-4



PLATE 2-5



PLATE 2-6



PLATE 2-7



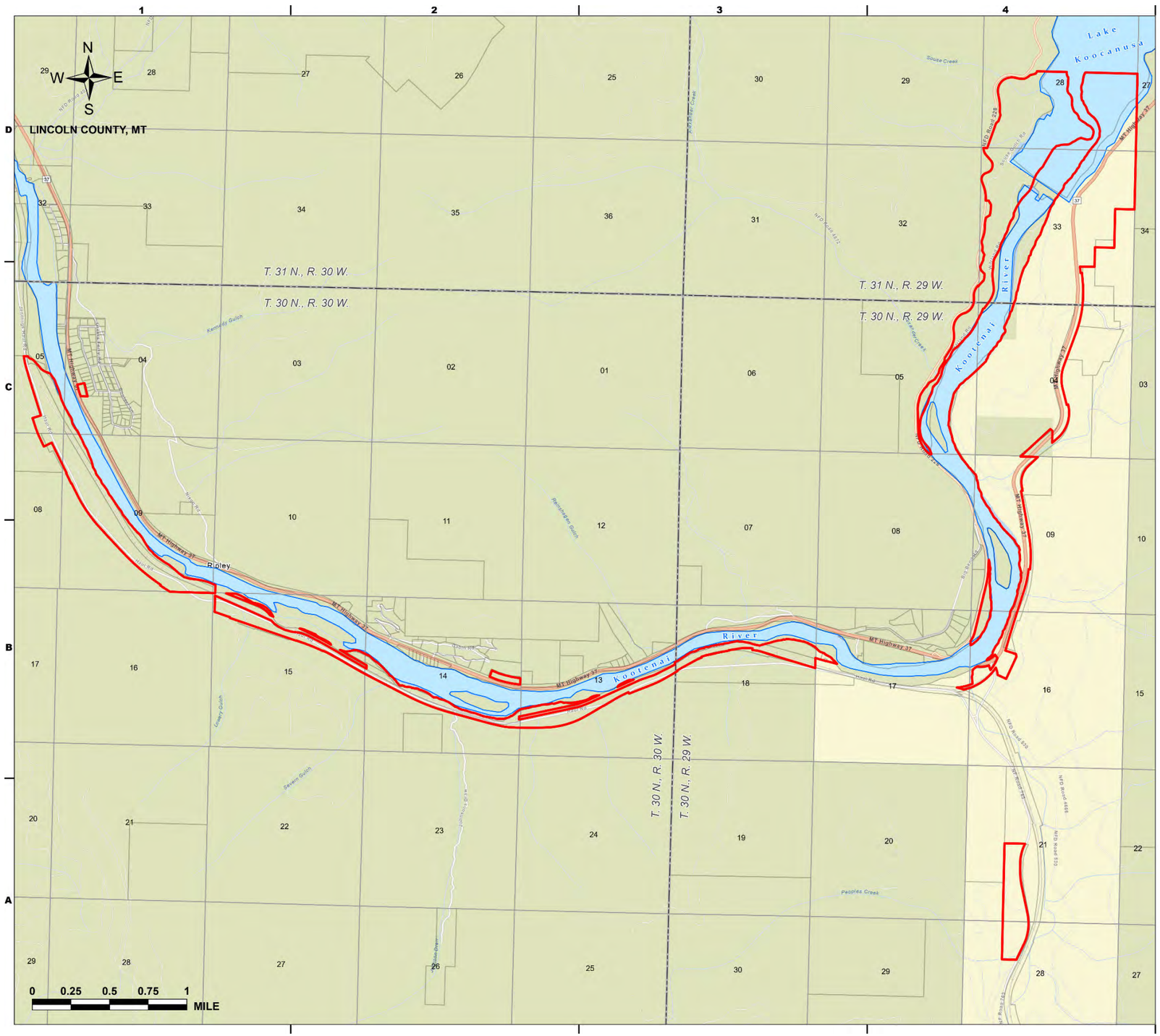
PLATE 2-8



PLATE 2-9



PLATE 2-10



LIBBY DAM & LAKE KOOCANUSA PROJECT

REAL ESTATE (Fee Owned Lands)

LEGEND

- USACE FEE OWNERSHIP BOUNDARY**
- LINCOLN COUNTY PARCELS
- BLM PLSS - Townships
- BLM PLSS - Sections

NOTES

MRM - MULTIPLE RESOURCE MANAGEMENT
ESA - ENVIRONMENTAL SENSITIVE AREA

** USACE REAL ESTATE INTERESTS "LESS THAN FEE OWNERSHIP" SUCH AS EASEMENTS AND USE PERMITS ARE NOT SHOWN IN THIS MAP.

VICINITY MAP



DISCLAIMER

THE CONTENT OF THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. LOCATION AND EXTENT OF SHOWN FEATURES ARE APPROXIMATE.

NOTE: PLATE SIZE IS 11" x 17"

NOTE: PLATE DEVELOPED AND PROVIDED BY USACE SEATTLE DISTRICT, DATED AUGUST 8, 2024.

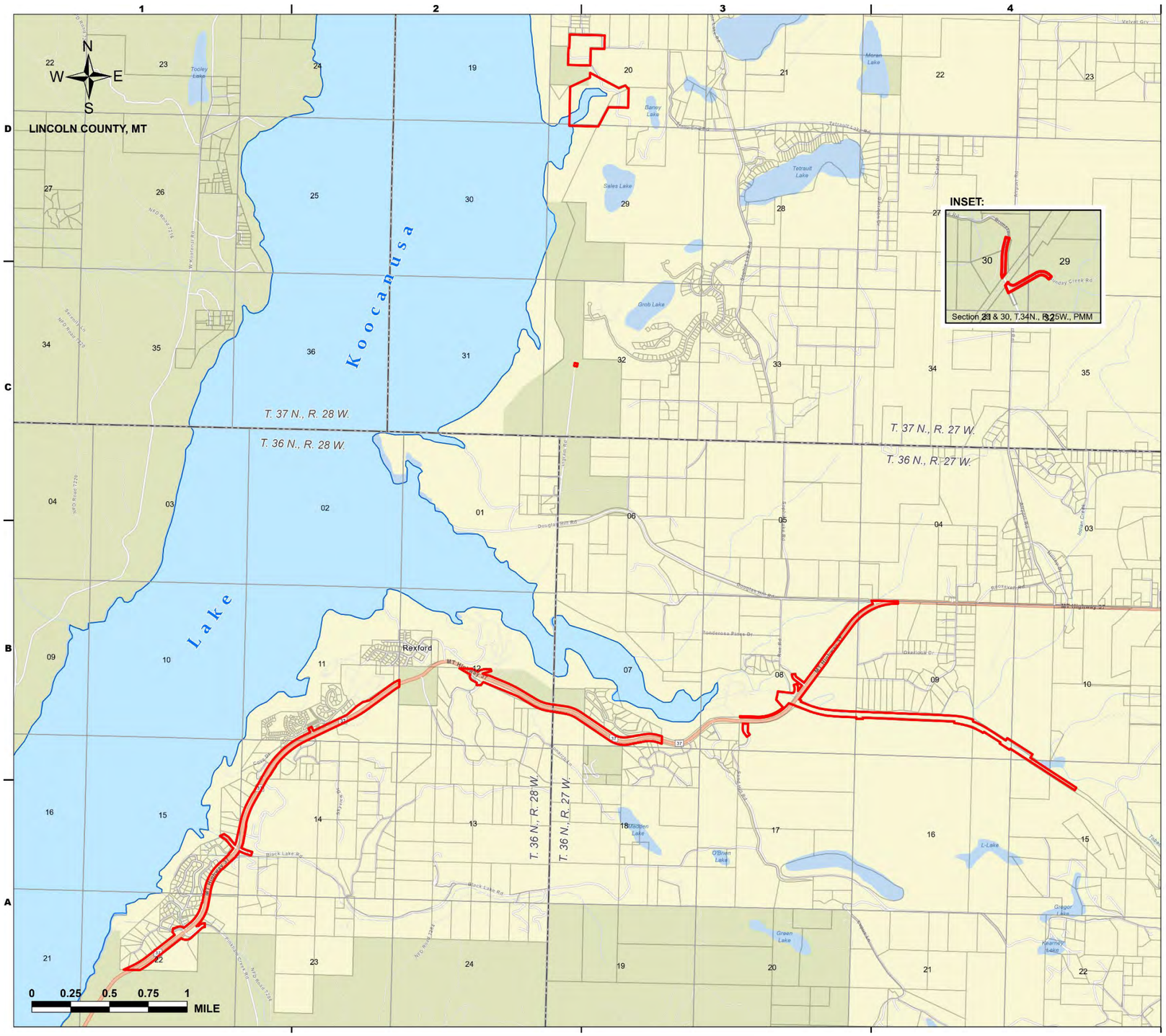
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Real Estate Ownership

Source: See Left Note | April 2025

PLATE 2-11 SHEET 1/2

REAL ESTATE (Fee Owned Lands)



NOTE: PLATE DEVELOPED AND PROVIDED BY USACE SEATTLE DISTRICT, DATED AUGUST 8, 2024.

LEGEND

- USACE FEE OWNERSHIP BOUNDARY**
- LINCOLN COUNTY PARCELS
- BLM PLSS - Townships
- BLM PLSS - Sections

NOTES

MRM - MULTIPLE RESOURCE MANAGEMENT
ESA - ENVIRONMENTAL SENSITIVE AREA

USACE REAL ESTATE INTERESTS "LESS THAN FEE OWNERSHIP" SUCH AS EASEMENTS AND USE PERMITS ARE NOT SHOWN IN THIS MAP.

VICINITY MAP



DISCLAIMER

THE CONTENT OF THIS MAP IS FOR INFORMATIONAL PURPOSES ONLY. LOCATION AND EXTENT OF SHOWN FEATURES ARE APPROXIMATE.

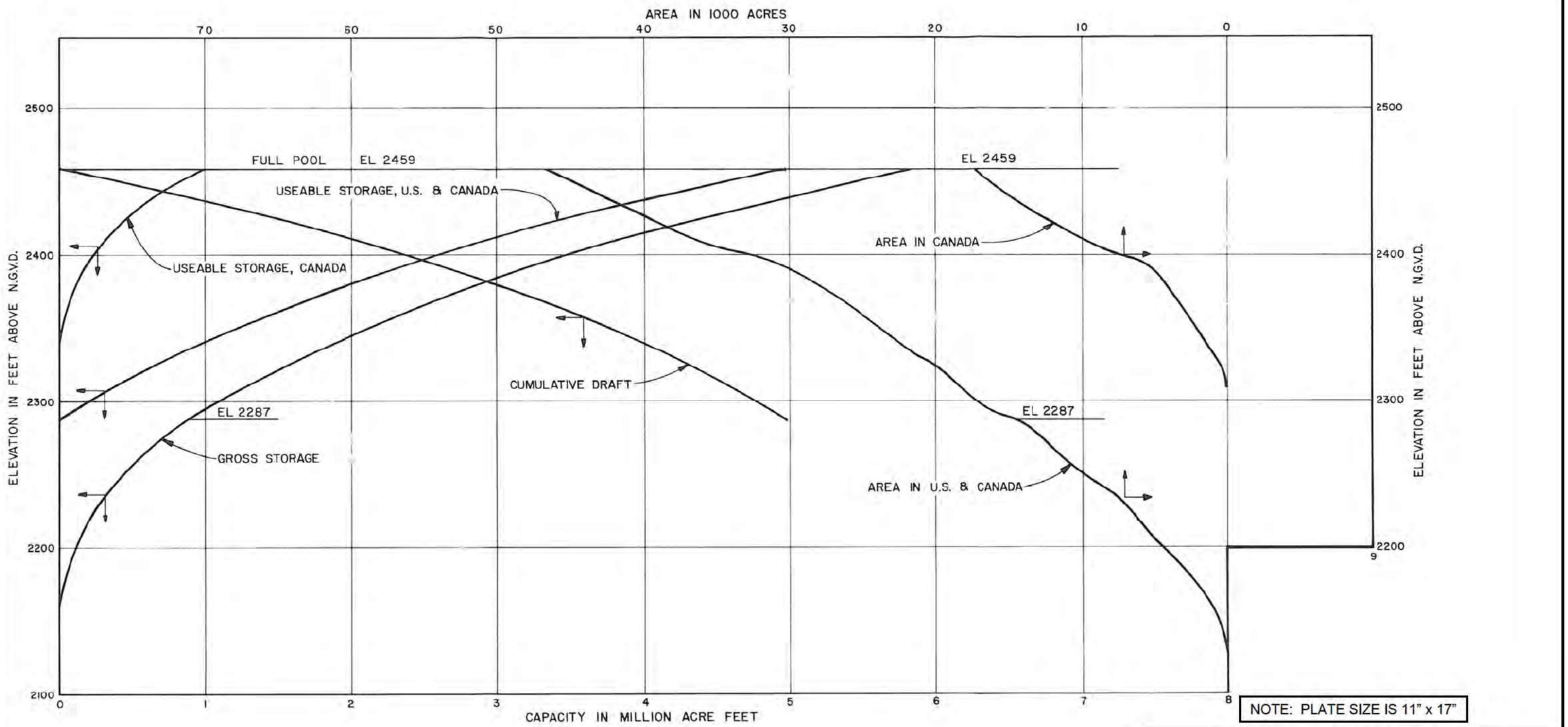
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Real Estate Ownership

Source: See Left Note | April 2025

PLATE 2-11 SHEET 2/2



NOTE: PLATE SIZE IS 11" x 17"

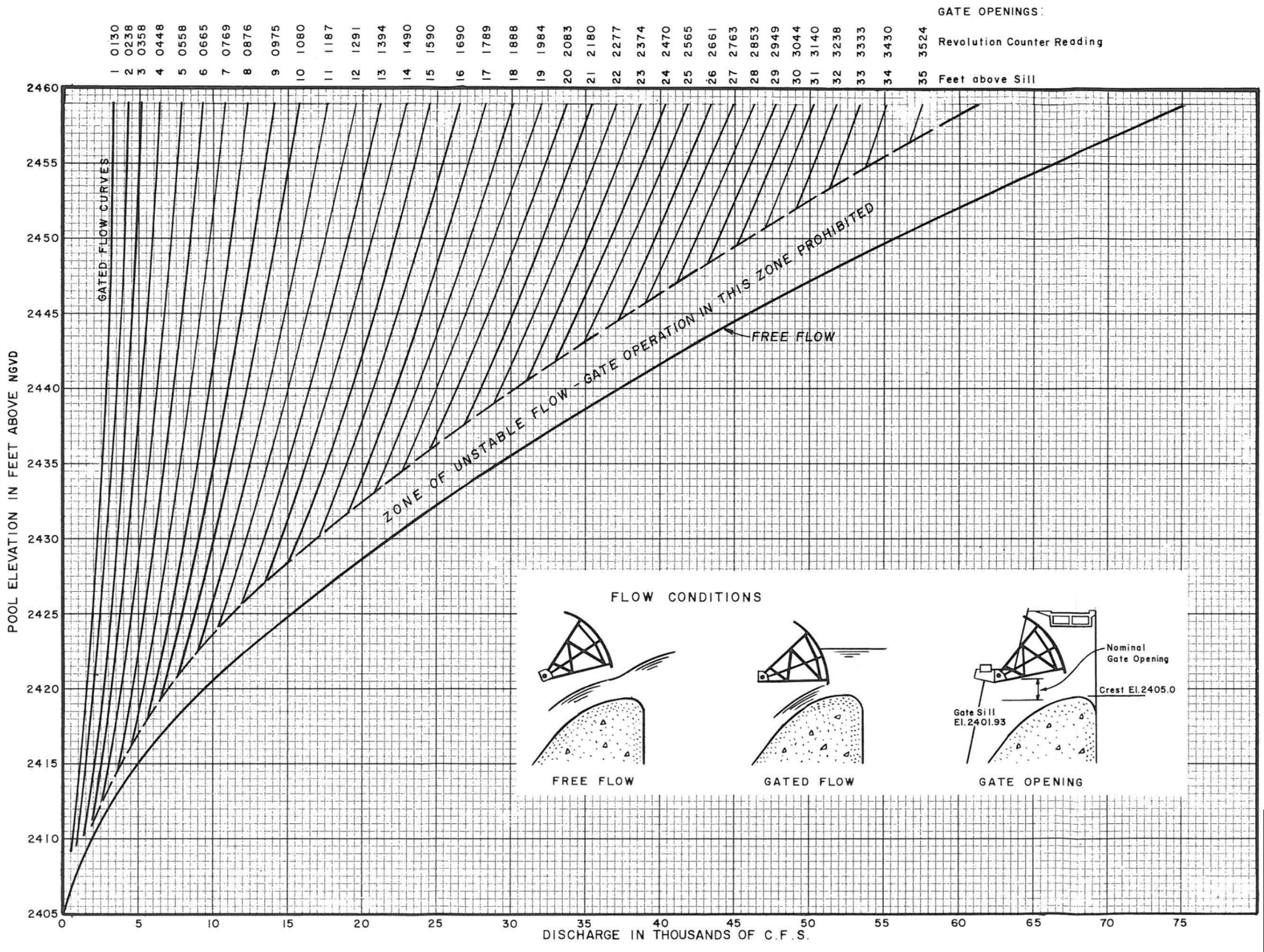
NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 2-1 IN THE PREVIOUS WCM DATED 2012.

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Area-Capacity Curves

Source: See Left Note | April 2025

PLATE 2-12



NOTES:

1. Rating is based on Scheme "B" of spillway model data, as drawn 14 July 1974, for gate openings greater than 20 feet. Rating for gate openings less than 10 feet are based on observed prototype data. Gate openings between 10 and 20 feet are adjusted for a transition between model and prototype data.
2. Spillway discharge is measured at the U.S.G.S. gage 0.7 Mile downstream from Libby Dam, "Kootenai River below Libby Dam, near Libby, Montana".
3. Revolution counter reading is indicated on the gate machinery on the spillway gate hoist machinery bridge. The readings are from the June 1973 calibration and are averaged for the two spillway gates.
4. Spillway gates are 48 feet wide by 59 feet high and shall be operated so gate lip elevations do not differ by more than one foot.

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 2-2 IN THE PREVIOUS WCM DATED 2012.

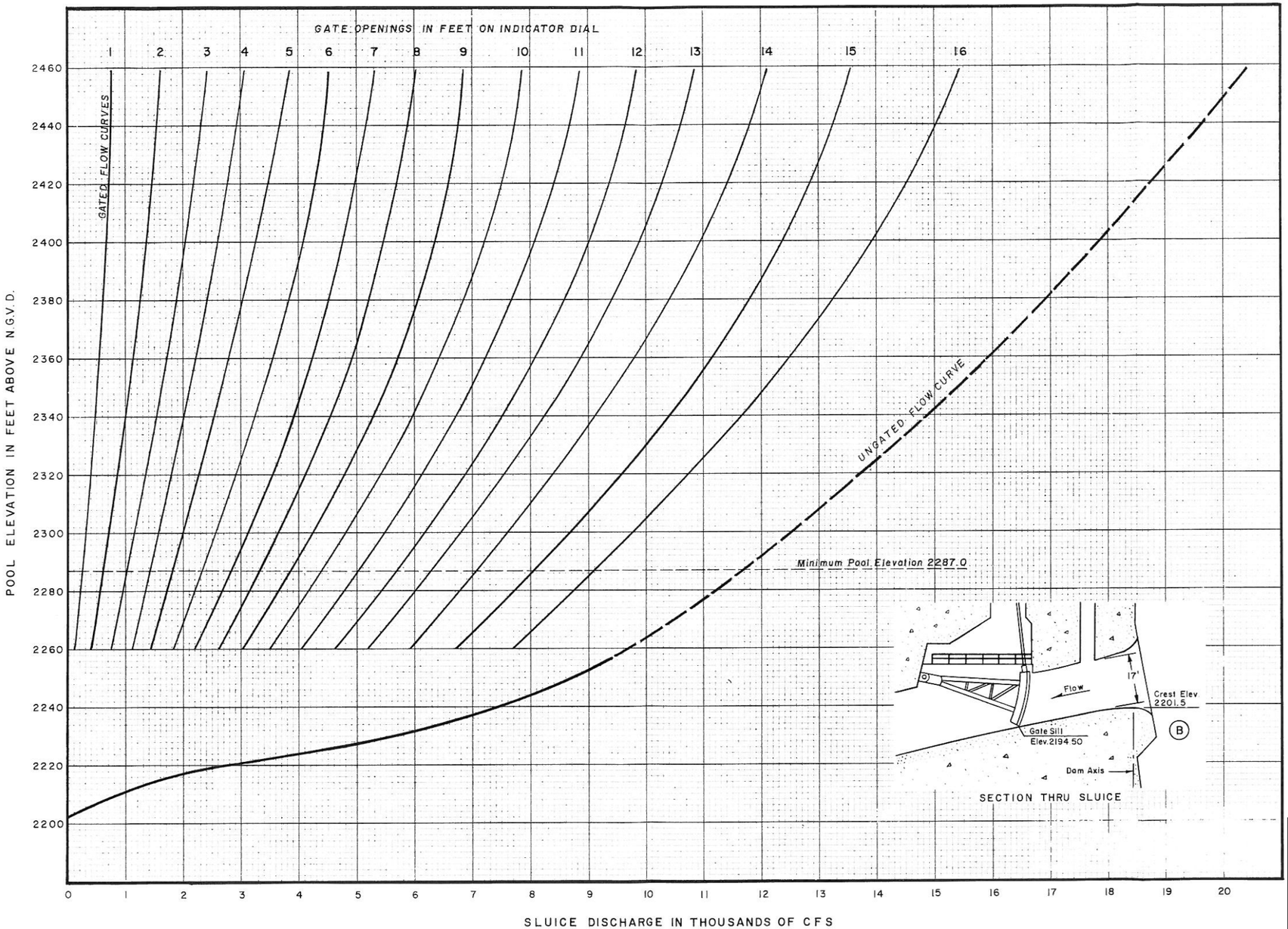
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Spillway Rating Curve
Single Bay

Source: See Left Note | April 2025

PLATE 2-13



NOTES:

1. Rating is for one sluice only and applies directly to any of three sluices. Sluices are 10 feet wide by 17 feet high.
2. Rating curves are based on prototype obsevations made during the period March 1972 through July 1974. The ungated flow curve was computed from sluice geometry above elevation 2257 as no observervations were available.
3. Gate openings are from the indicator dial on the sluice gate control console in the lower service gallery.
4. Sluice discharge is measured at the U.S.G.S. gage 3700 feet downstream from Libby Dam, "Kootenai River below Libby Dam near Libby Montana".
5. Operation of the sluices above an opening of 16 feet is expected to create a high cavitation potential. Gate openings are to be restricted to 16 feet, except as required during large floods to limit the maximum reservoir level to elevation 2459 feet, N.G.V.D.
6. Refer to Exhibit 2-1 for information regarding the operation of Libby Dam sluice gates.

NOTE: PLATE SIZE IS 11" x 17"

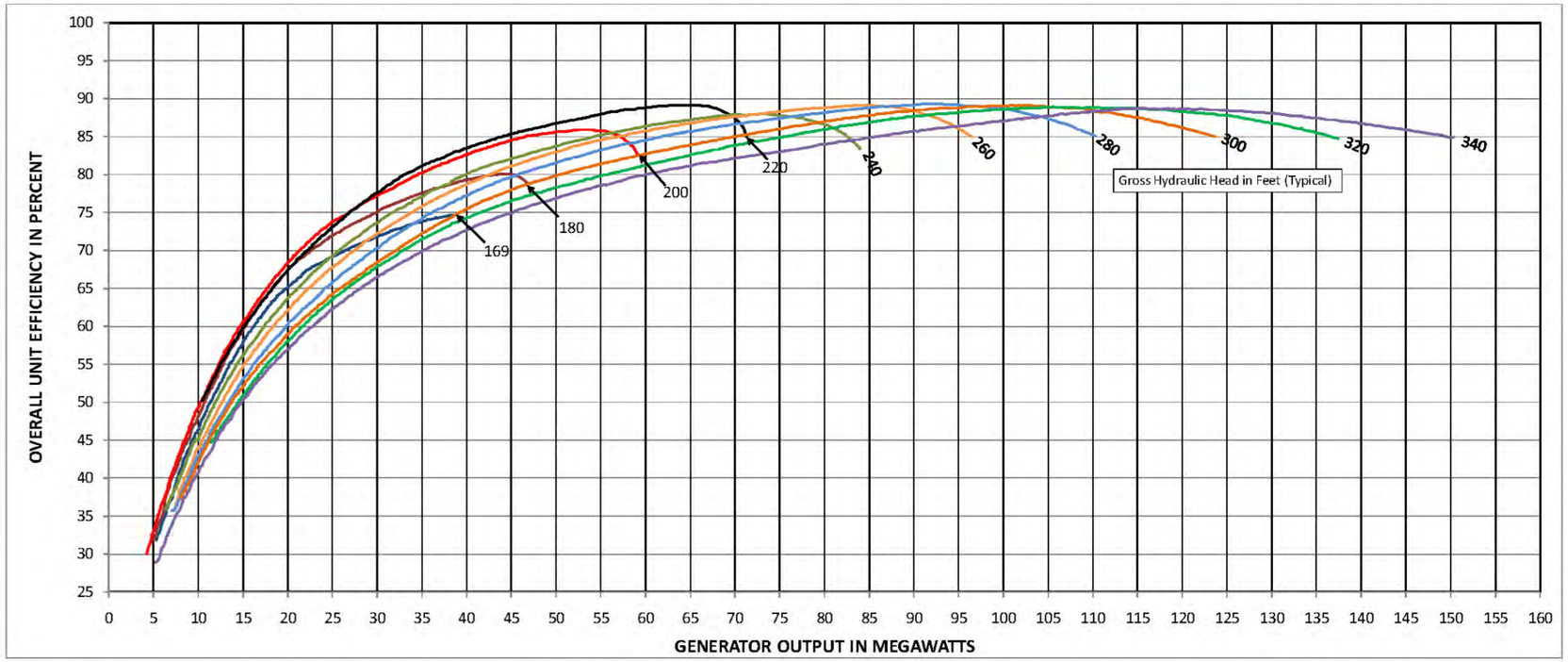
NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 2-3 IN THE PREVIOUS WCM DATED 2012.

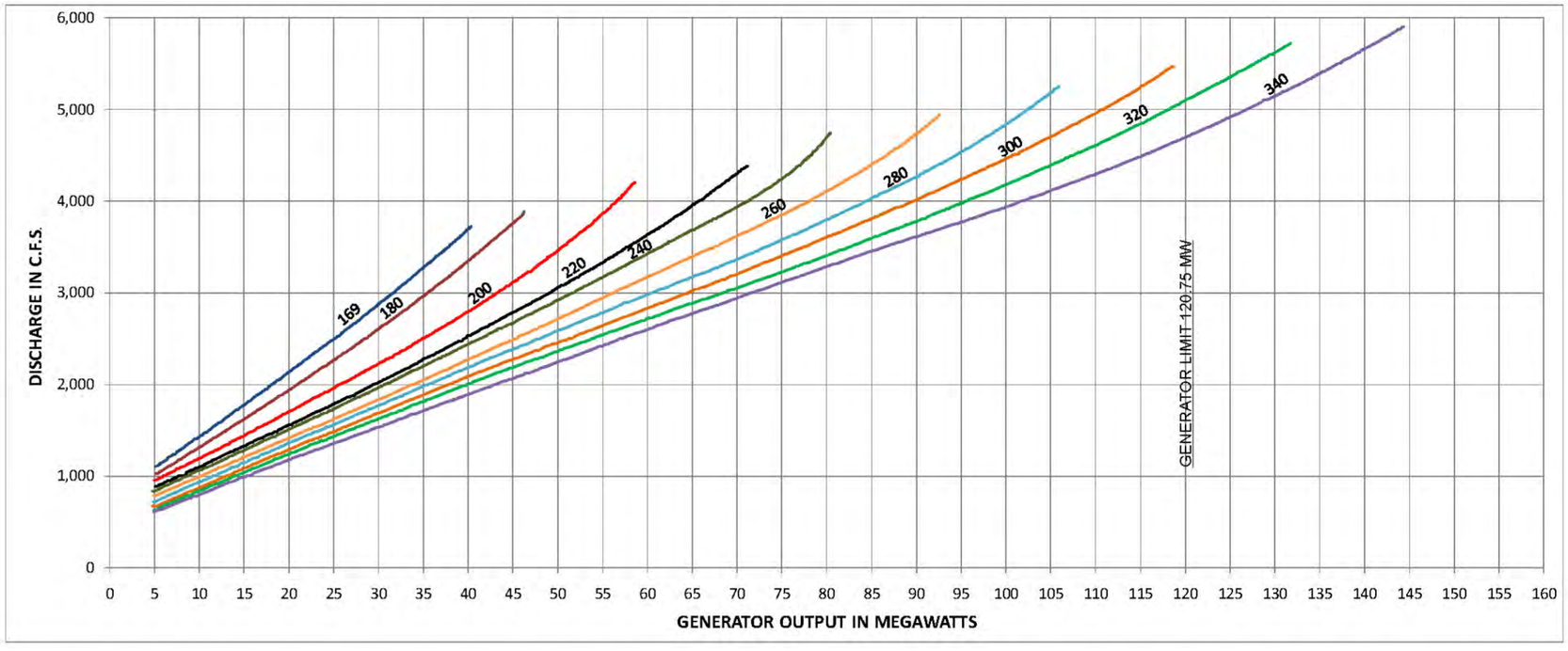
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Sluice Rating Curve

Source: See Left Note | April 2025

PLATE 2-14





NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 2-4 IN THE PREVIOUS WCM DATED 2012.

DATA BASED ON JULY 1984 WATER CONTROL MANUAL. VALUES FOR HYDRAULIC HEAD 240 AND GREATER WERE ADJUSTED BASED ON MORE RECENT EFFICIENCY TESTS. TESTS SHOWED EFFICIENCY AT 4% LESS THAN SHOWN ON THE PREVIOUS PLOTS FOR HYDRAULIC HEADS 240 AND GREATER. EFFICIENCY AT 220 WAS SIMILAR TO THE PREVIOUS PLOTS. NO NEW EFFICIENCY DATA WAS AVAILABLE FOR HYDRAULIC HEADS LESS THAN 220 AND NO ADJUSTMENTS WERE MADE FOR HYDRAULIC HEAD 220 OR LESS.

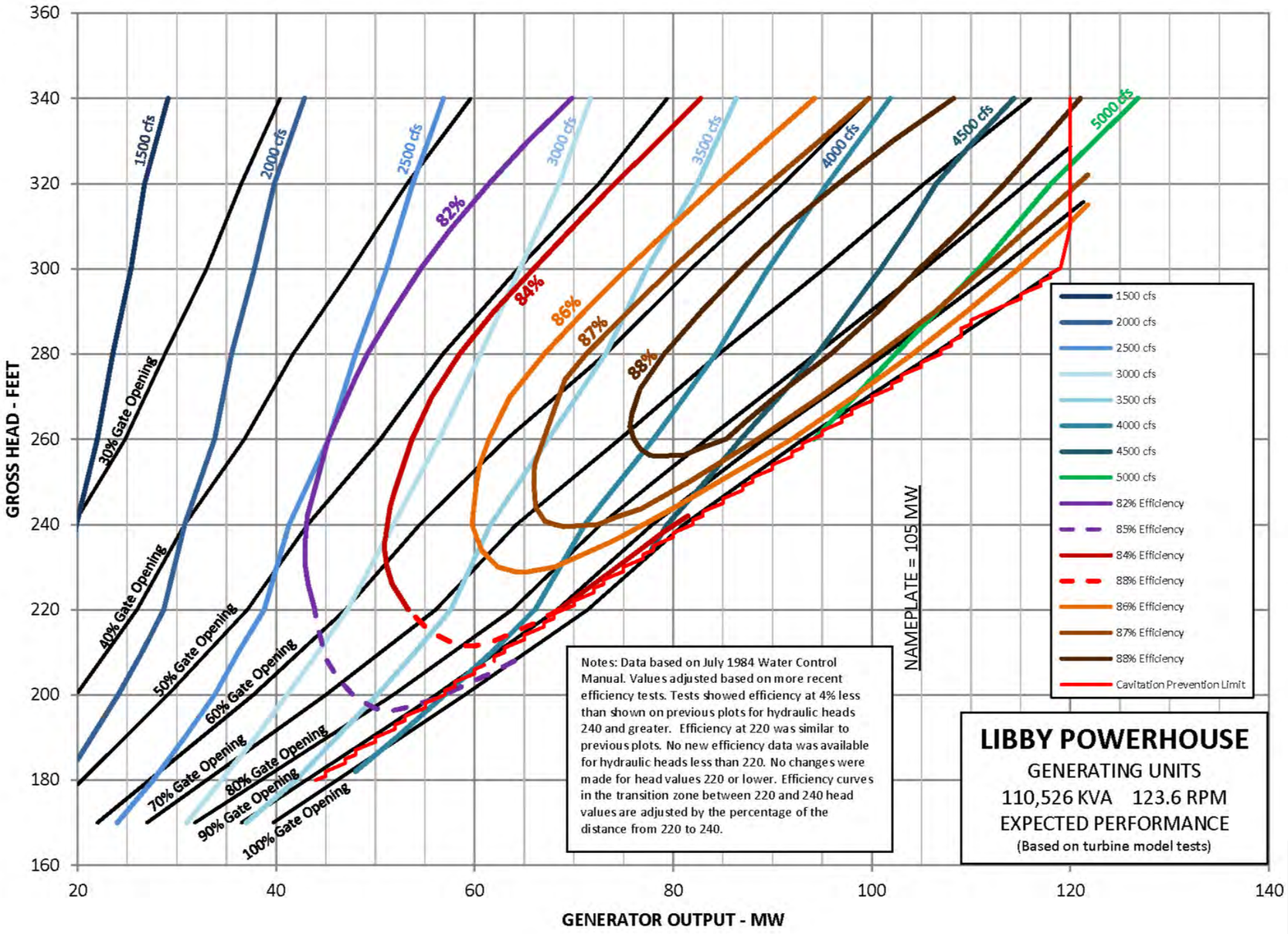
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Power Unit Discharge Rating
105.00 Megawatt Unit

Source: See Left Note | April 2025

PLATE 2-15



Notes: Data based on July 1984 Water Control Manual. Values adjusted based on more recent efficiency tests. Tests showed efficiency at 4% less than shown on previous plots for hydraulic heads 240 and greater. Efficiency at 220 was similar to previous plots. No new efficiency data was available for hydraulic heads less than 220. No changes were made for head values 220 or lower. Efficiency curves in the transition zone between 220 and 240 head values are adjusted by the percentage of the distance from 220 to 240.

LIBBY POWERHOUSE
GENERATING UNITS
110,526 KVA 123.6 RPM
EXPECTED PERFORMANCE
(Based on turbine model tests)

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 2-5 IN THE PREVIOUS WCM DATED 2012.

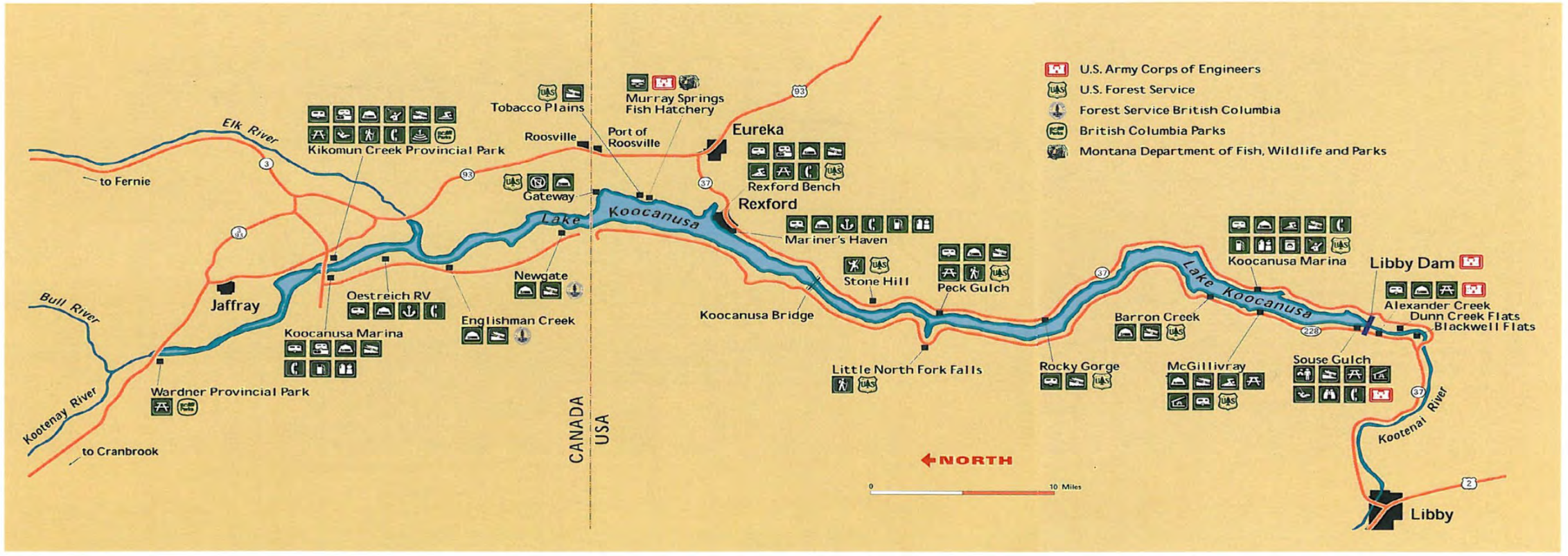
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Powerhouse
Generating Units
Expected Performance

Source: See Left Note | April 2025

PLATE 2-16



NOTE: PLATE SIZE IS 11” x 17”

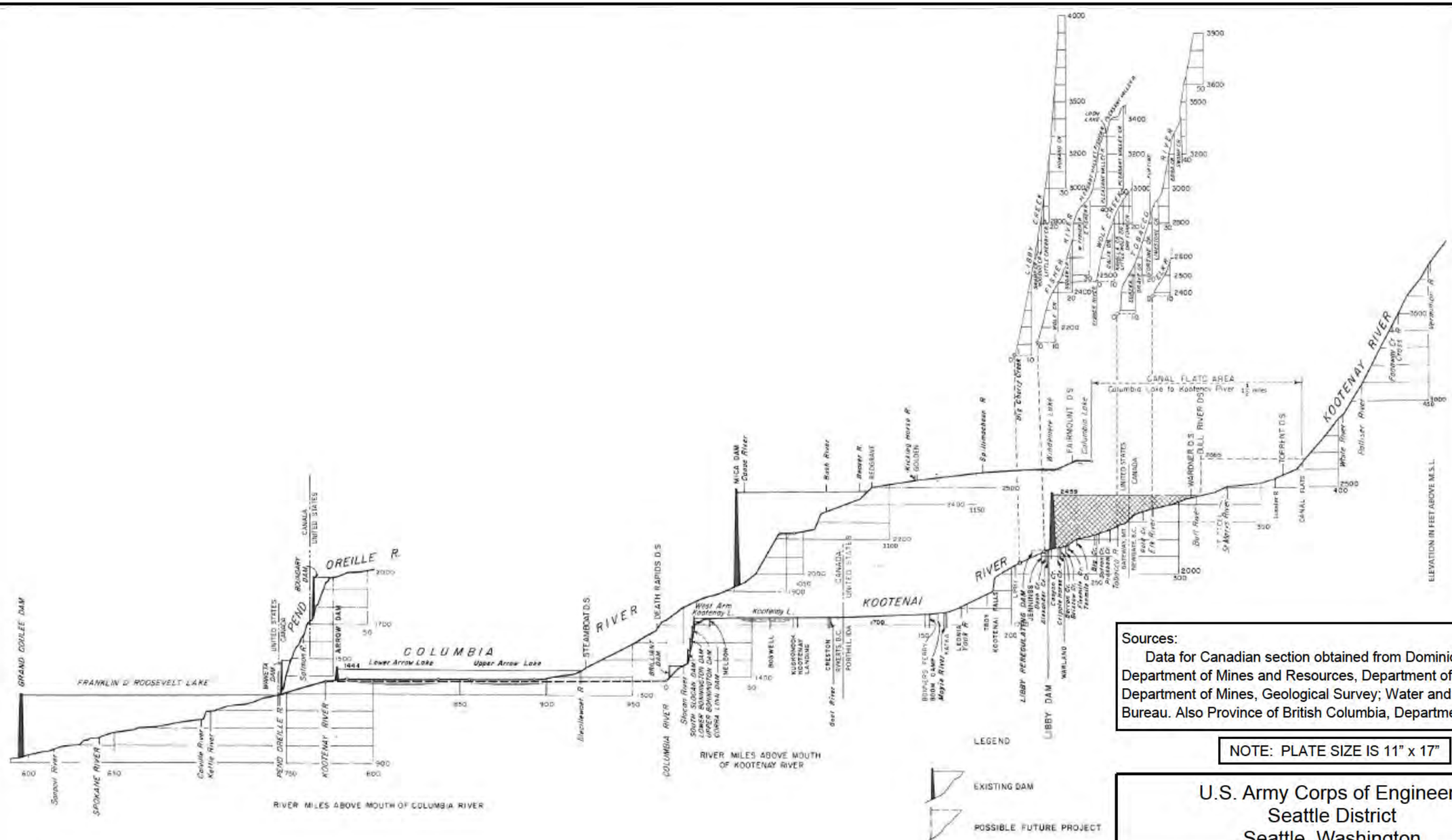
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Public Use Sites

Source: See Left Note | April 2025

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 2-12 IN THE PREVIOUS WCM DATED 2012.

PLATE 2-17



This chart taken directly from July 1984 manual. Some text was retraced to make it more readable. No content was changed.

Sources:
Data for Canadian section obtained from Dominion of Canada Department of Mines and Resources, Department of Interior; Department of Mines, Geological Survey; Water and Power Bureau. Also Province of British Columbia, Department of Land.

NOTE: PLATE SIZE IS 11" x 17"

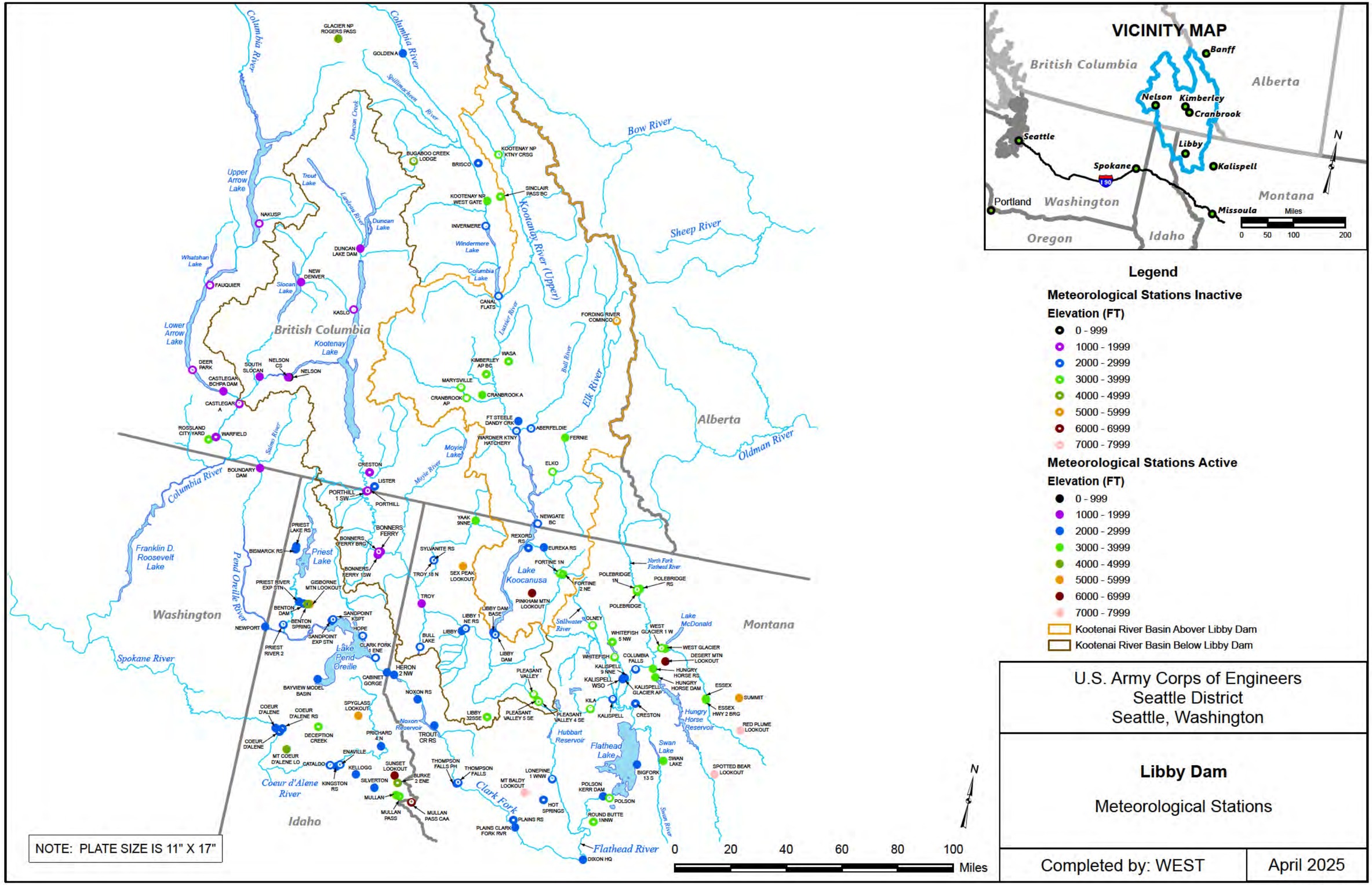
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Upper Columbia and
Kootenai River Profile

Source: See Left Note | April 2025

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 4-5 IN THE PREVIOUS WCM DATED 2012. THIS CHART WAS TAKEN DIRECTLY FROM JULY 1984 MANUAL.

PLATE 4-1



NOTE: PLATE SIZE IS 11" X 17"

Legend

Meteorological Stations Inactive

Elevation (FT)

- 0 - 999
- 1000 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 4999
- 5000 - 5999
- 6000 - 6999
- 7000 - 7999

Meteorological Stations Active

Elevation (FT)

- 0 - 999
- 1000 - 1999
- 2000 - 2999
- 3000 - 3999
- 4000 - 4999
- 5000 - 5999
- 6000 - 6999
- 7000 - 7999

Kootenai River Basin Above Libby Dam

Kootenai River Basin Below Libby Dam

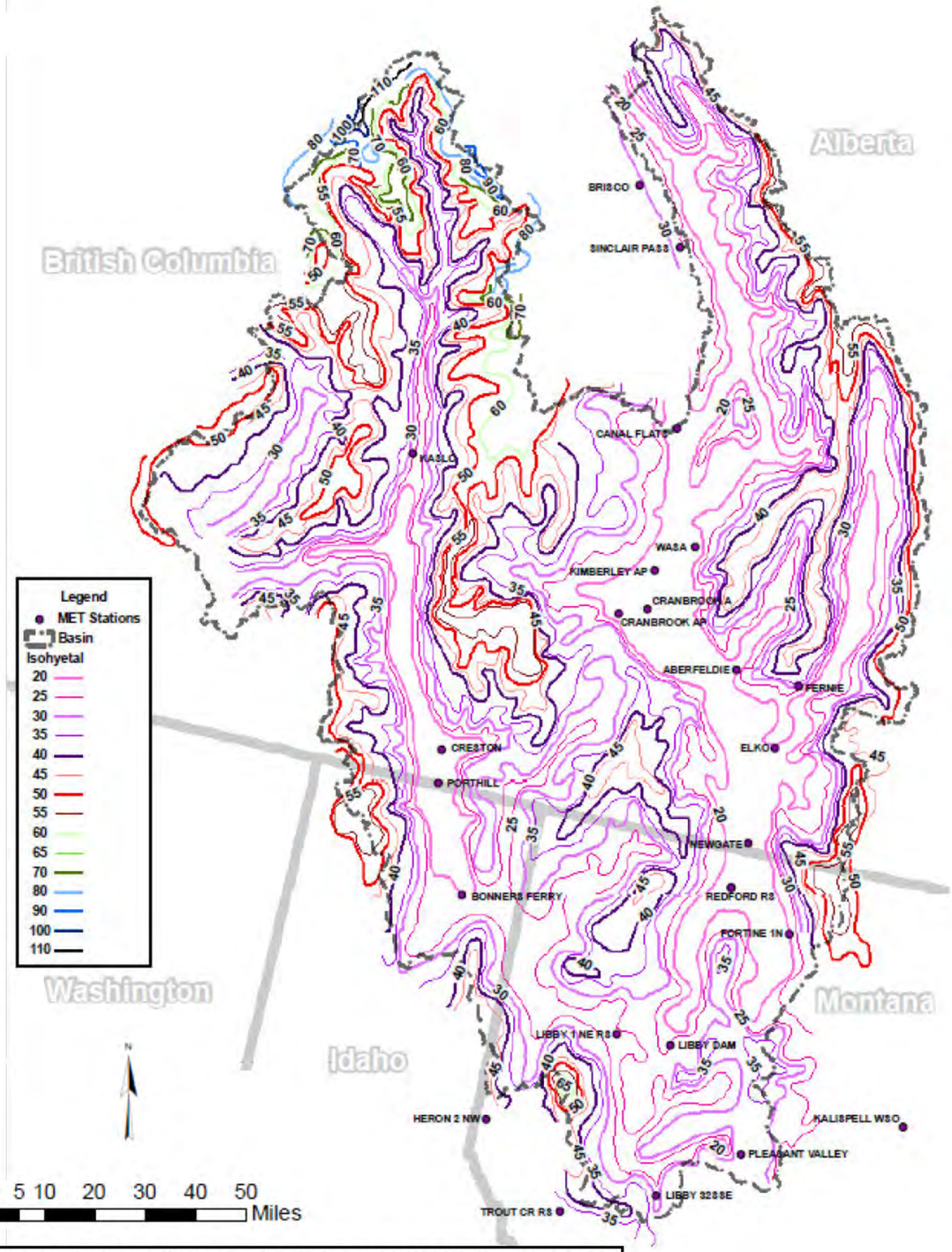
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Meteorological Stations

Completed by: WEST | April 2025

PLATE 4-2



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 4-3 IN THE PREVIOUS WCM DATED 2012.

NOTE: PLATE SIZE IS 11" x 17"

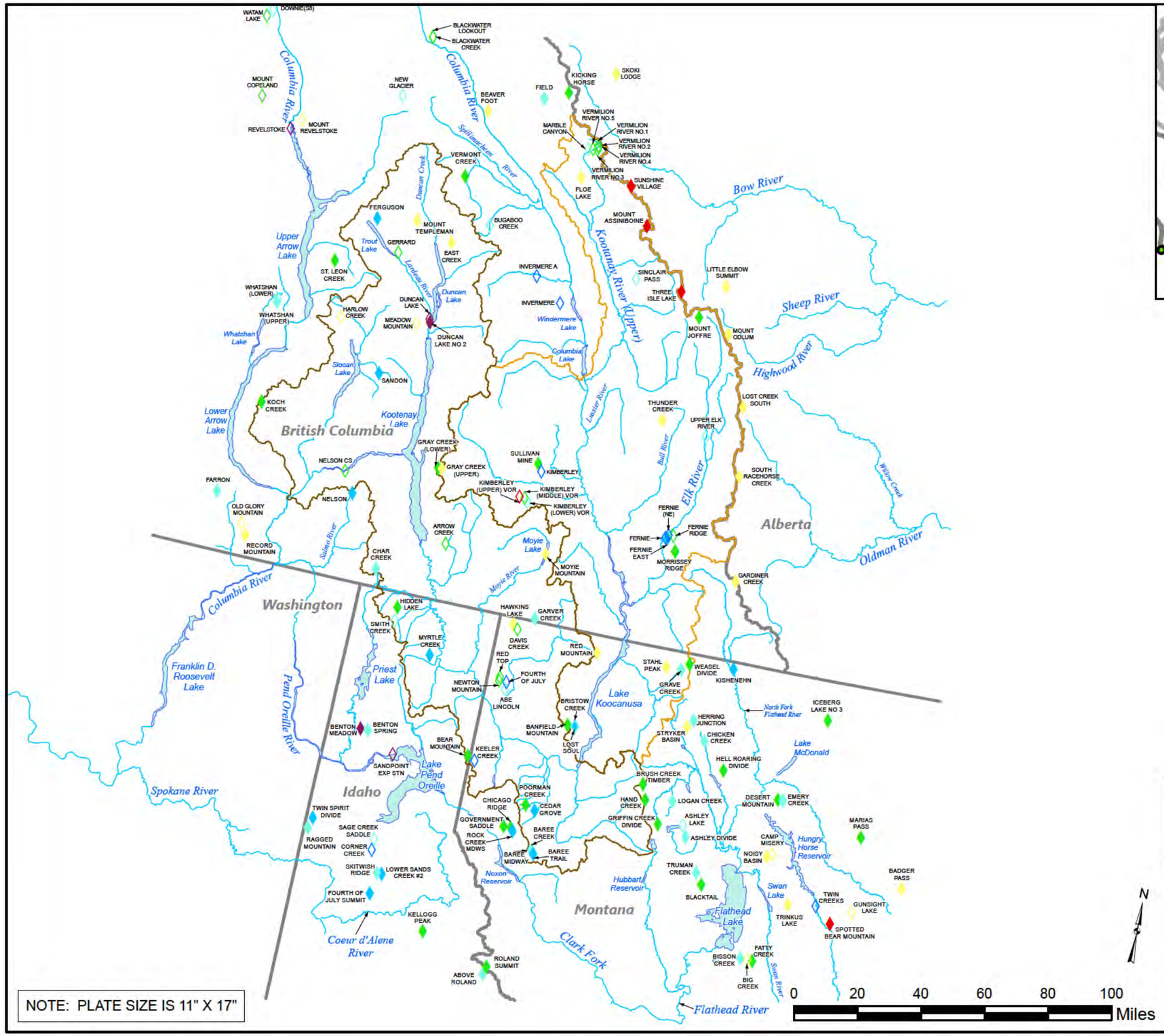
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

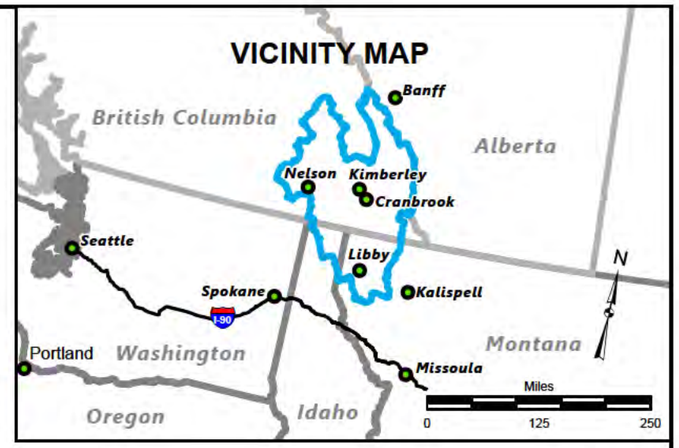
Libby Dam

Isohyetal Map

Source: See Left Note | April 2025

PLATE 4-3





Legend

Inactive Snow Stations

Elevation

- 0 - 2999
- 3000 - 3999
- 4000 - 4999
- 5000 - 5999
- 6000 - 6999
- 7000 - 7999

Active Snow Stations

Elevation

- 0 - 2999
- 3000 - 3999
- 4000 - 4999
- 5000 - 5999
- 6000 - 6999
- 7000 - 7999
- Kootenai River Basin below Libby Dam Project
- Kootenai River Basin above Libby Dam Project

NOTE: PLATE SIZE IS 11" X 17"

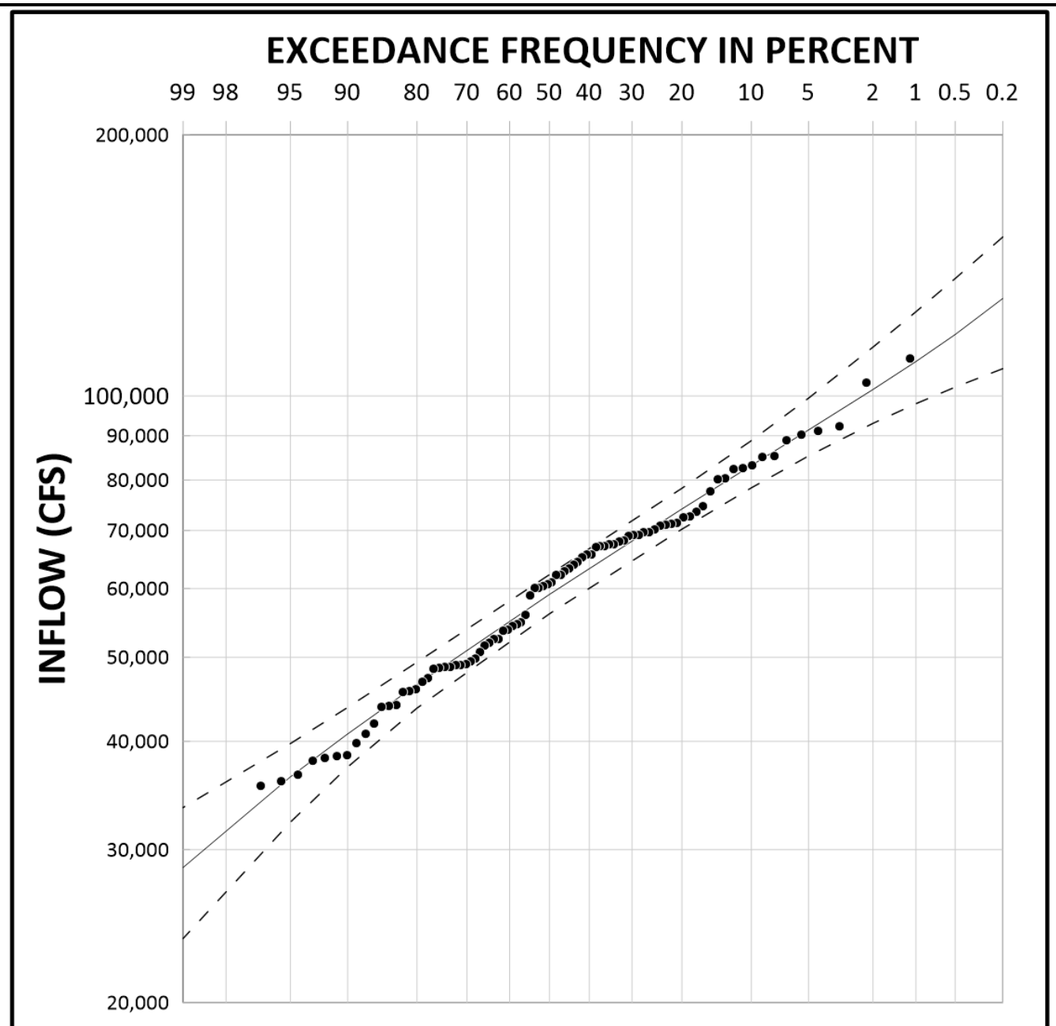
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Snow Courses and
Snow Pillow Sites

Completed by: WEST | April 2025

PLATE 4-4



FLOW FREQUENCY WITH EXPECTED PROBABILITY

5% AND 95% CONFIDENCE LIMITS

MEDIAN PLOTTING POSITION

SYSTEMATIC STATISTICS LOG TRANSFORM OF FLOW	NUMBER OF EVENTS
MEAN = 4.768 **ST DEV.** = 0.119 **STATION SKEW** = -0.176 **ADOPTED SKEW** = -0.176	**HISTORIC EVENTS** = 0 **HIGH OUTLIERS** = 0 **LOW OUTLIERS** = 2 **ZERO OR MISSING** = 0 **SYSTEMATIC EVENTS** = 90

Maximum Annual Peak Frequency Curve
Daily Inflow to Libby Reservoir
Based on 2020-Level Modified Flow Dataset
R.M. 221.9
Lat. 48.42 Long. 115.32
CORPS OF ENGINEERS, SEATTLE DISTRICT
03 MARCH 2025
BASIN AREA = 8,985 SQ. MI.
WATER YEARS OF RECORD
1929 - 2018
Bulletin 17C Analysis
Performed using HEC-SSP v 2.3

CONSTRUCTED BY:	APPROVED BY:
TETRA TECH	

NOTE: THIS PLATE WAS DEVELOPED USING THE 2020-LEVEL MODIFIED FLOW DATASET.

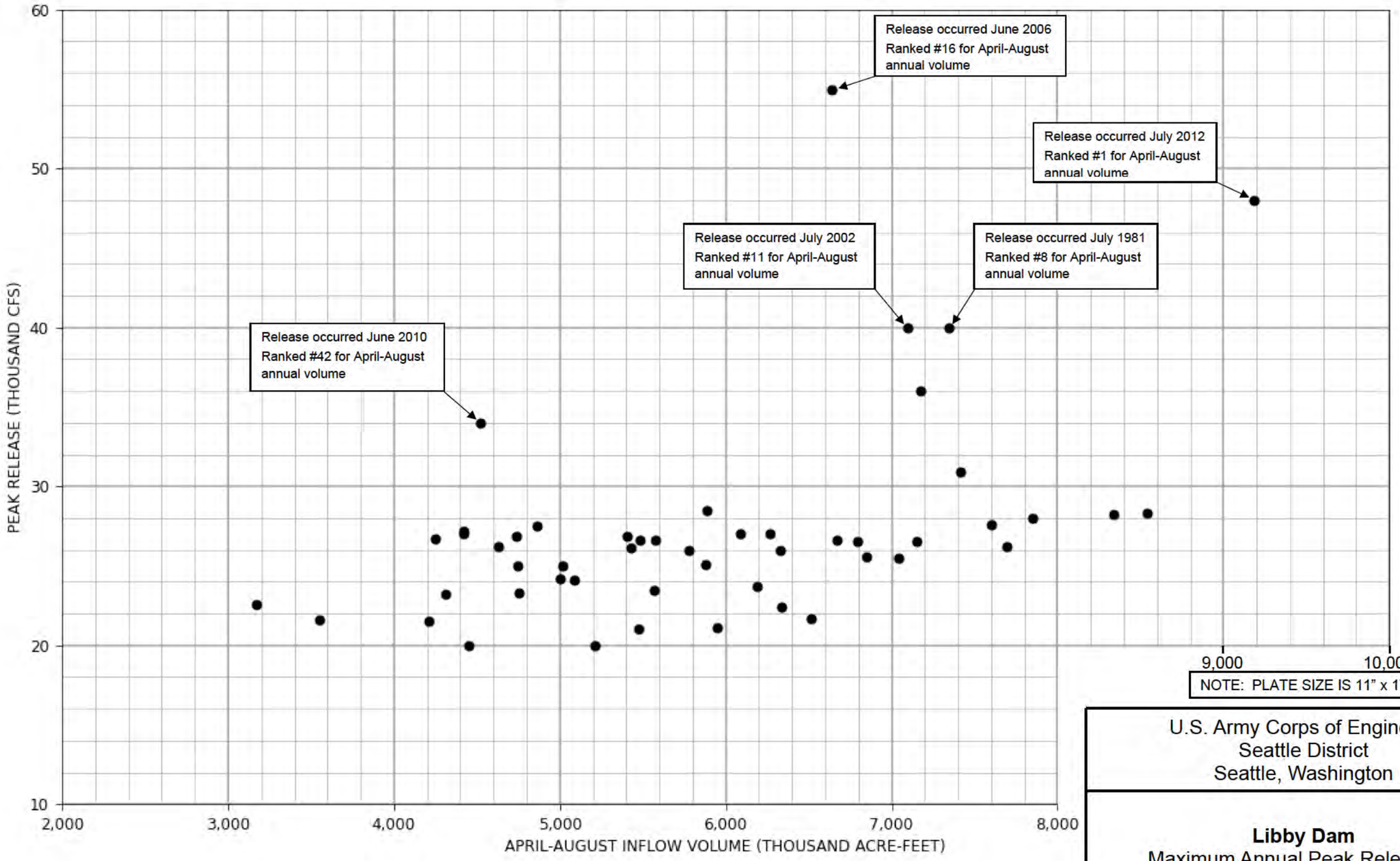
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Peak Frequency Curve
Daily Inflow into Libby Reservoir

Source: See Left Note	April 2025

PLATE 4-5



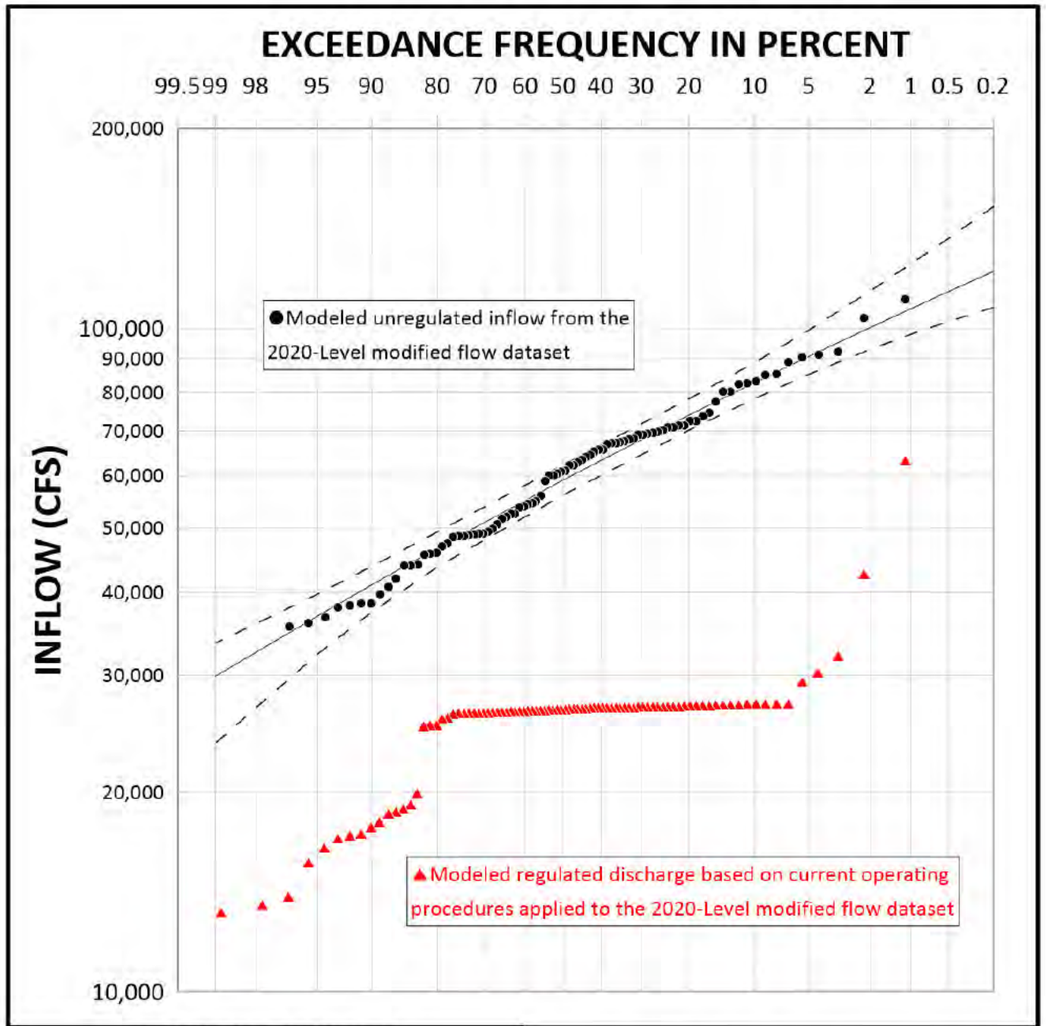
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Peak Release vs
April-August Inflow Volume for Libby Reservoir

Completed by: WEST	April 2025

PLATE 4-6



FLOW FREQUENCY WITH EXPECTED PROBABILITY

5% AND 95% CONFIDENCE LIMITS

REGULATED-MODELED MEDIAN PLOTTING POSITION

UNREGULATED-MODELED MEDIAN PLOTTING POSITION

SYSTEMATIC STATISTICS LOG TRANSFORM OF FLOW	NUMBER OF EVENTS
MEAN = 4.768 ST DEV. = 0.119 STATION SKEW = -0.176 ADOPTED SKEW = -0.176	HISTORIC EVENTS = 0 HIGH OUTLIERS = 0 LOW OUTLIERS = 2 ZERO OR MISSING = 0 SYSTEMATIC EVENTS = 90

Maximum Annual Peak Frequency Curve
Daily Inflow and Discharge From Libby Reservoir
Based on 2020-Level Modified Flow Dataset
R.M. 221.9
Lat. 48.42 Long. 115.32
CORPS OF ENGINEERS, SEATTLE DISTRICT
03 MARCH 2025
BASIN AREA = 8,985 SQ. MI.
WATER YEARS OF RECORD
1929 - 2018
Bulletin 17C Analysis
Performed using HEC-SSP v 2.3

CONSTRUCTED BY:	APPROVED BY:
TETRA TECH	

NOTE: THIS PLATE WAS DEVELOPED USING THE 2020-LEVEL MODIFIED FLOW DATASET.

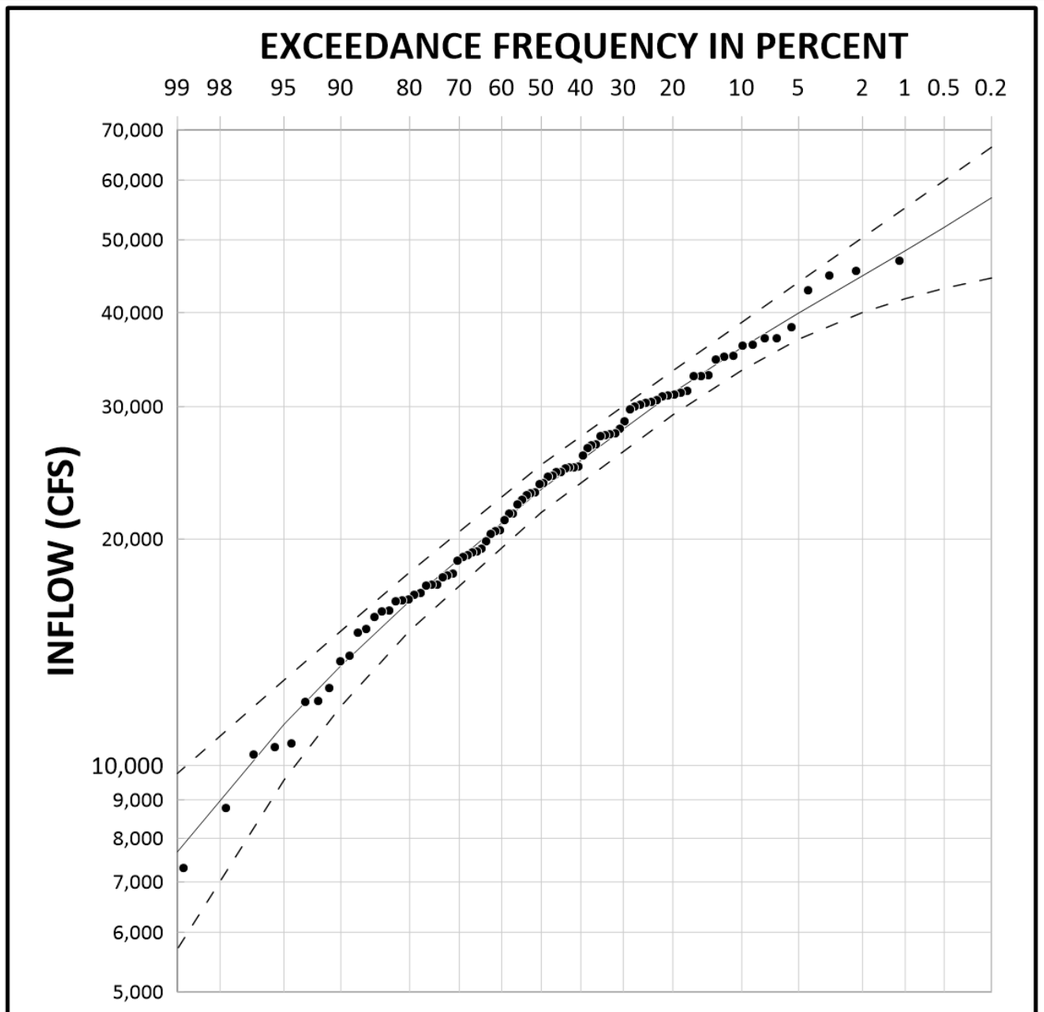
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Peak Frequency Curve
Daily Inflow and Discharge
from Libby Reservoir

Source: See Left Note	April 2025

PLATE 4-7



FLOW FREQUENCY WITH EXPECTED PROBABILITY

5% AND 95% CONFIDENCE LIMITS

MEDIAN PLOTTING POSITION

SYSTEMATIC STATISTICS LOG TRANSFORM OF FLOW	NUMBER OF EVENTS
MEAN = 4.354 **ST DEV.** = 0.165 **STATION SKEW** = -0.5 **ADOPTED SKEW** = -0.5	**HISTORIC EVENTS** = 0 **HIGH OUTLIERS** = 0 **LOW OUTLIERS** = 0 **ZERO OR MISSING** = 0 **SYSTEMATIC EVENTS** = 90

Maximum Annual Peak Frequency Curve
Daily Intervening Libby Dam to Bonners Ferry
Based on 2020-Level Modified Flow Dataset
Bonners Ferry R.M. 152.8
Lat. 48.70 Long. 116.31
CORPS OF ENGINEERS, SEATTLE DISTRICT
03 MARCH 2025
BASIN AREA = 12,690 SQ. MI.
WATER YEARS OF RECORD
1929 - 2018
Bulletin 17C Analysis
Performed using HEC-SSP v 2.3

CONSTRUCTED BY:	APPROVED BY:
TETRA TECH	

NOTE: THIS PLATE WAS DEVELOPED USING THE 2020-LEVEL MODIFIED FLOW DATASET.

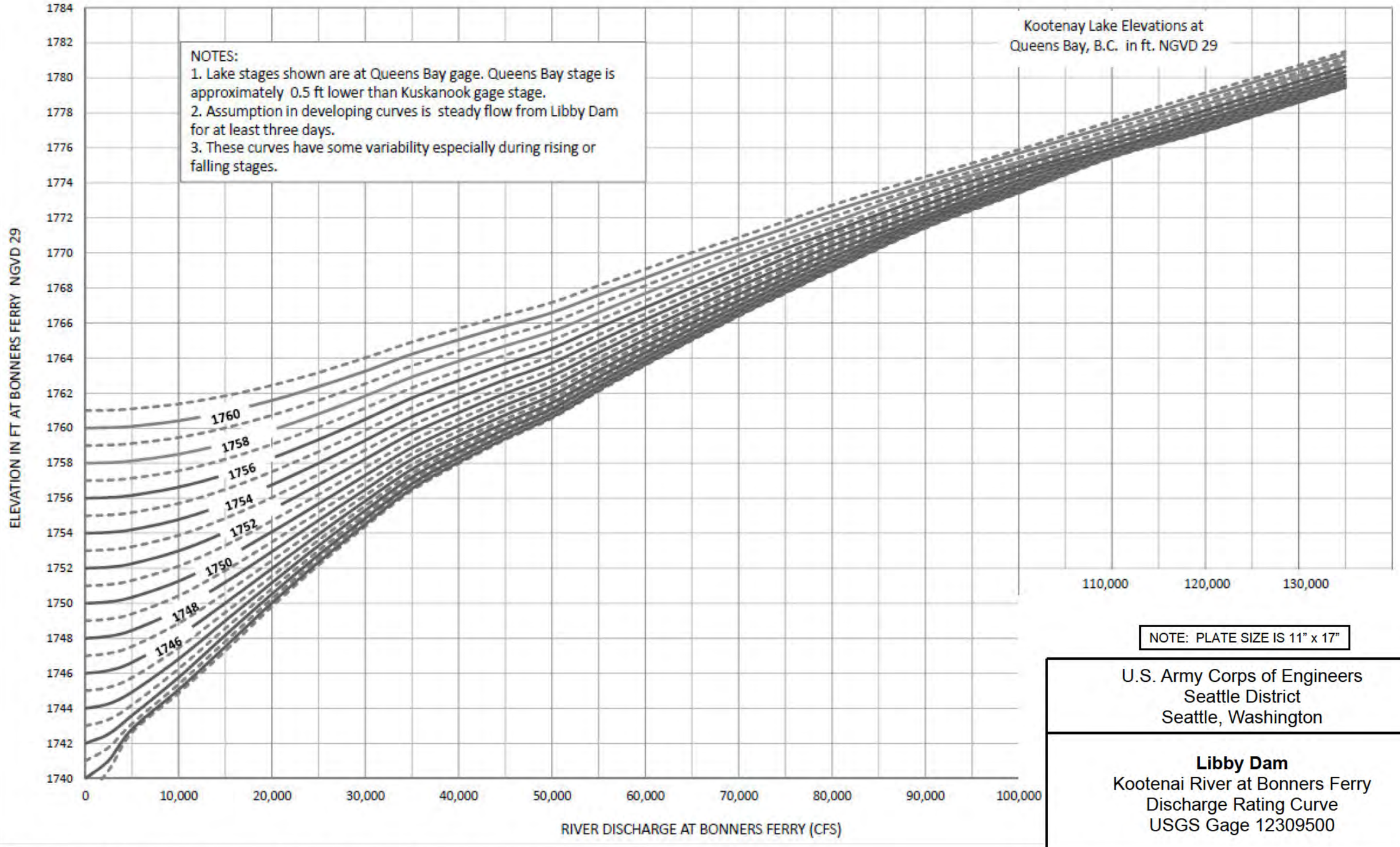
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Peak Frequency Curve
Daily Intervening Flow
between Libby Dam and Bonners Ferry

Source: See Left Note	April 2025

PLATE 4-8



NOTE: PLATE SIZE IS 11" x 17"

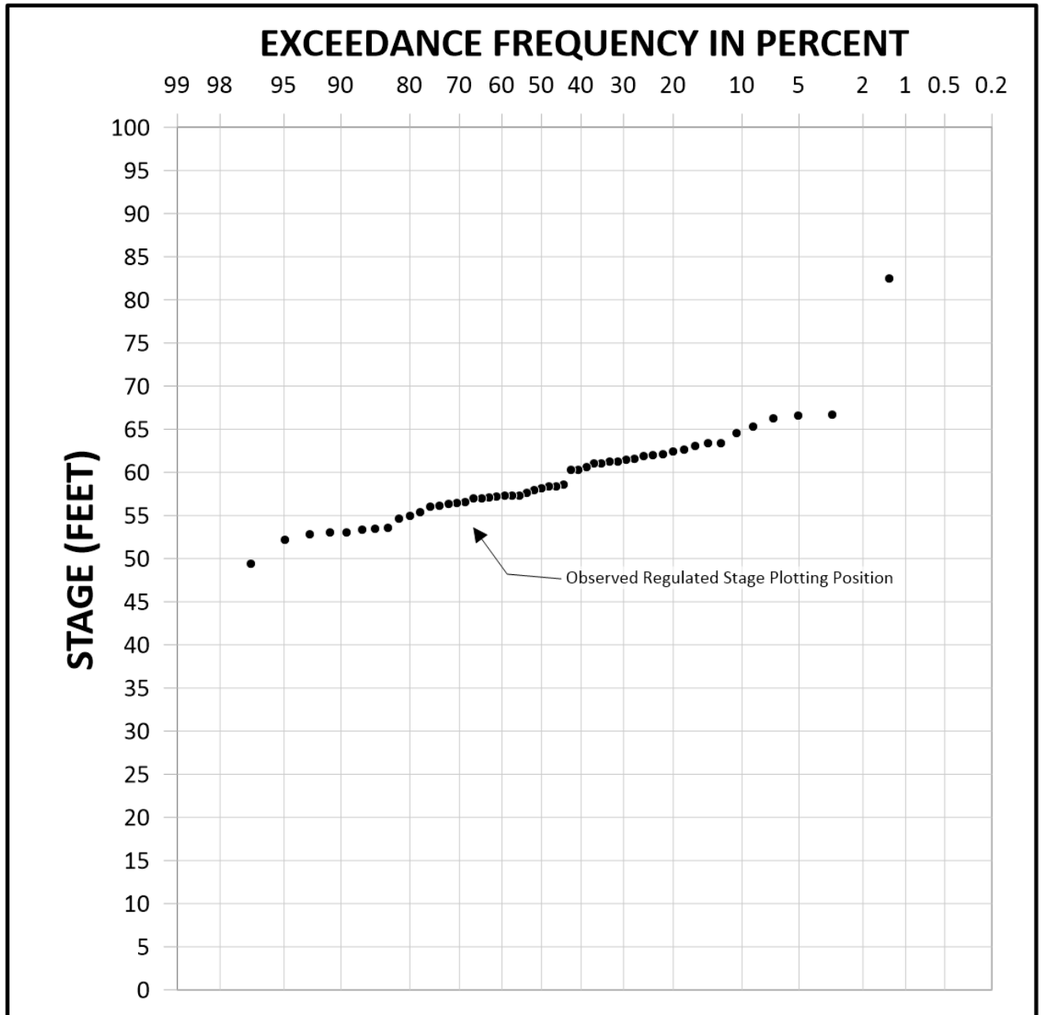
NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 4-5 IN THE PREVIOUS WCM DATED 2012.

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Kootenai River at Bonners Ferry
Discharge Rating Curve
USGS Gage 12309500

Source: See Left Note | April 2025

PLATE 4-9



• • • **WEIBULL PLOTTING POSITION**

SYSTEMATIC STATISTICS LOG TRANSFORM OF FLOW	NUMBER OF EVENTS
MEAN = 1.77 **ST DEV.** = 0.037 **STATION SKEW** = 1.036 **ADOPTED SKEW** = --	**HISTORIC EVENTS** = 0 **HIGH OUTLIERS** = 0 **LOW OUTLIERS** = 1 **ZERO OR MISSING** = 0 **SYSTEMATIC EVENTS** = 52

Maximum Annual Stage Frequency Curve
USGS Gage 12309500
Kootenai River at Bonners Ferry, ID
Based on Observed Regulated Data
Lat. 48.70, Long. 116.31
CORPS OF ENGINEERS, SEATTLE DISTRICT
03 MARCH 2025
BASIN AREA = 12,690 SQ. MI.
WATER YEARS OF RECORD
1973 - 2024
General Frequency Analysis
Performed using HEC-SSP v 2.3

CONSTRUCTED BY:	APPROVED BY:
TETRA TECH	

NOTE: THIS PLATE WAS DEVELOPED USING DATA FROM USGS GAGE 12309500.

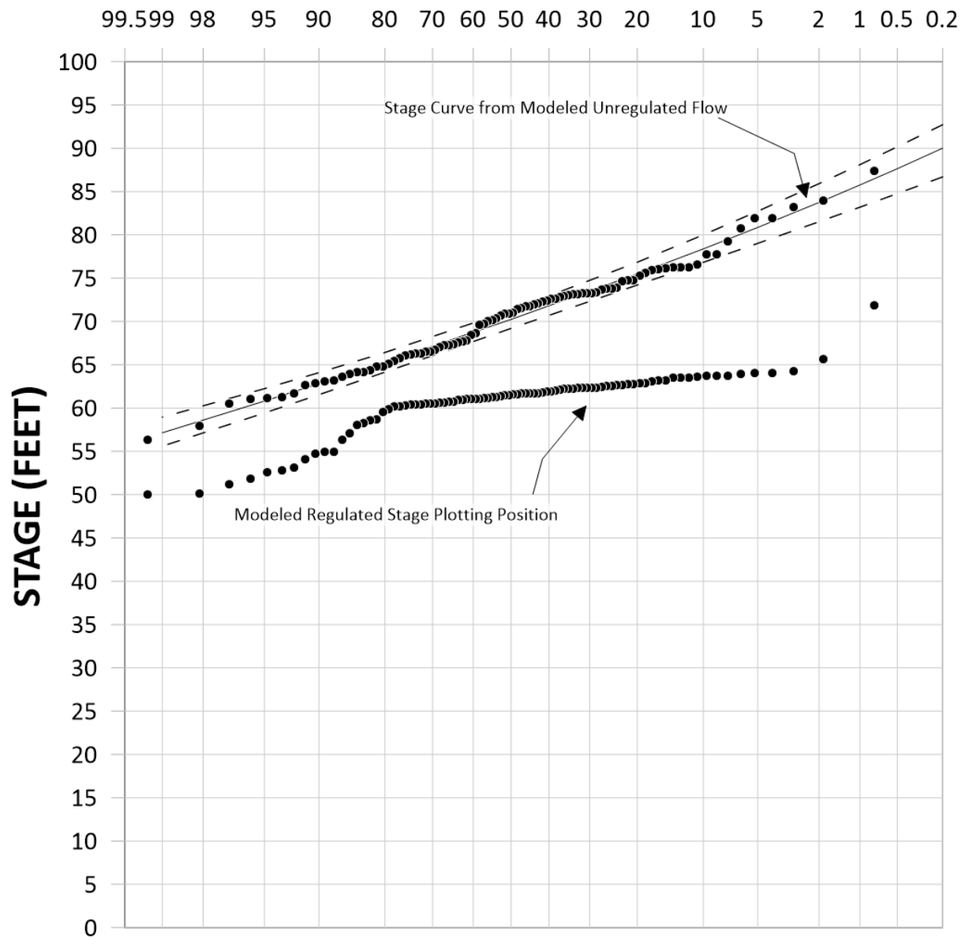
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Stage Frequency Curve
Kootenai River at Bonners Ferry, ID

Source: See Left Note	April 2025

PLATE 4-10



STAGE FREQUENCY WITH EXPECTED PROBABILITY	Maximum Annual Stage Frequency Curve USGS Gage 12309500 Kootenai River at Bonners Ferry, ID Based on Modeled Unregulated Daily Flows and Modeled Regulated Data Lat. 48.70, Long. 116.31 03 MARCH 2025 CORPS OF ENGINEERS, SEATTLE DISTRICT BASIN AREA = 12,690 SQ. MI. WATER YEARS OF RECORD 1929 - 2018 General Frequency Analysis Performed using HEC-SSP v 2.3
5% AND 95% CONFIDENCE LIMITS	
WEIBULL PLOTTING POSITION	

SYSTEMATIC STATISTICS LOG TRANSFORM OF FLOW	NUMBER OF EVENTS
MEAN = 1.846 **ST DEV.** = 0.037 **STATION SKEW** = -0.042 **ADOPTED SKEW** =	**HISTORIC EVENTS** = 0 **HIGH OUTLIERS** = 0 **LOW OUTLIERS** = 0 **ZERO OR MISSING** = 0 **SYSTEMATIC EVENTS** = 90

CONSTRUCTED BY:	APPROVED BY:
TETRA TECH	

NOTE: THIS PLATE WAS DEVELOPED USING DATA FROM USGS GAGE 12309500 AND THE 2020-LEVEL MODIFIED FLOW DATASET.

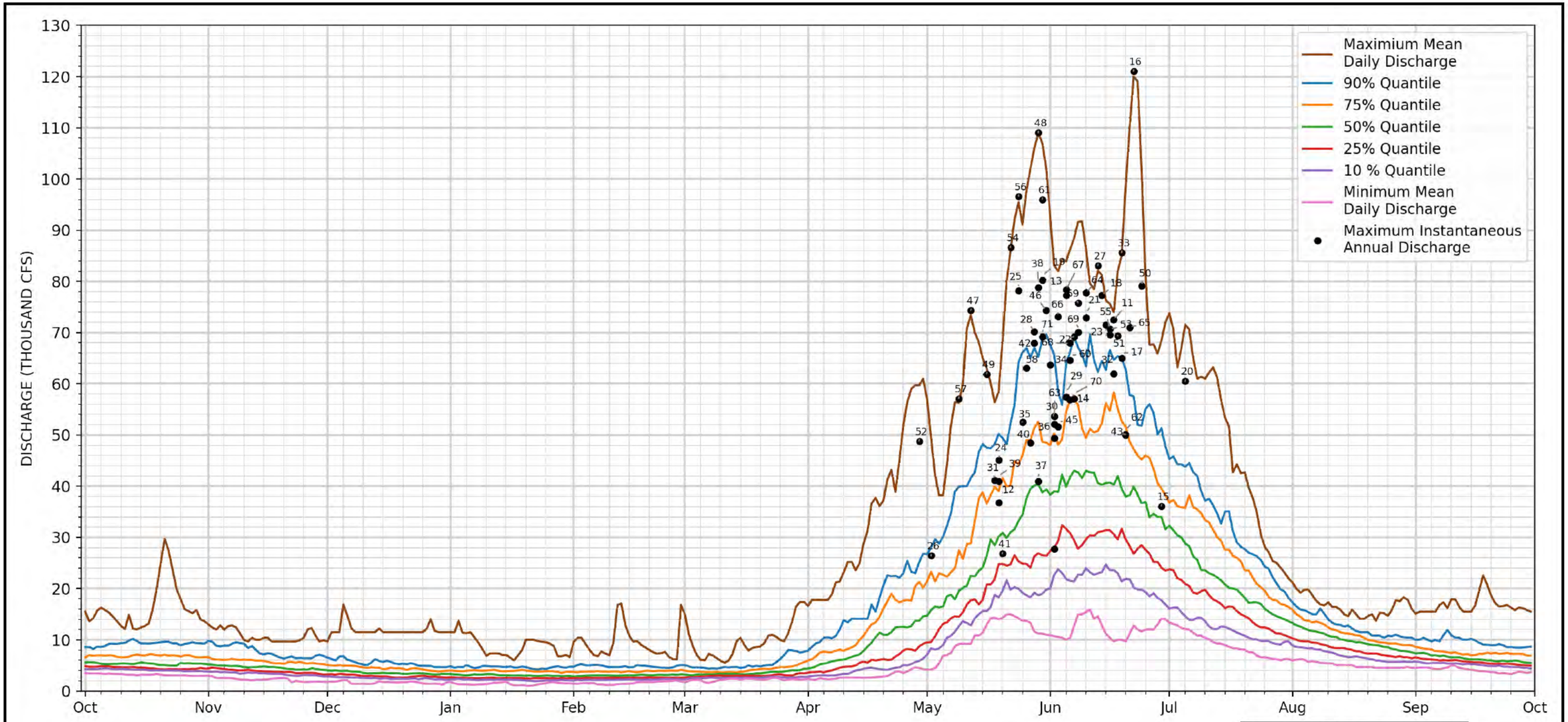
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Maximum Annual Stage Frequency Curve
Kootenai River at Bonners Ferry, ID
Modeled Unregulated Daily Flows and
Modeled Regulated Data

Source: See Left Note	April 2025

PLATE 4-11



NOTE: PLATE SIZE IS 11" x 17"

NOTES: Example: the 10th percentile line indicates that 10% of the historic discharge values fall below the line, while 90% are above.

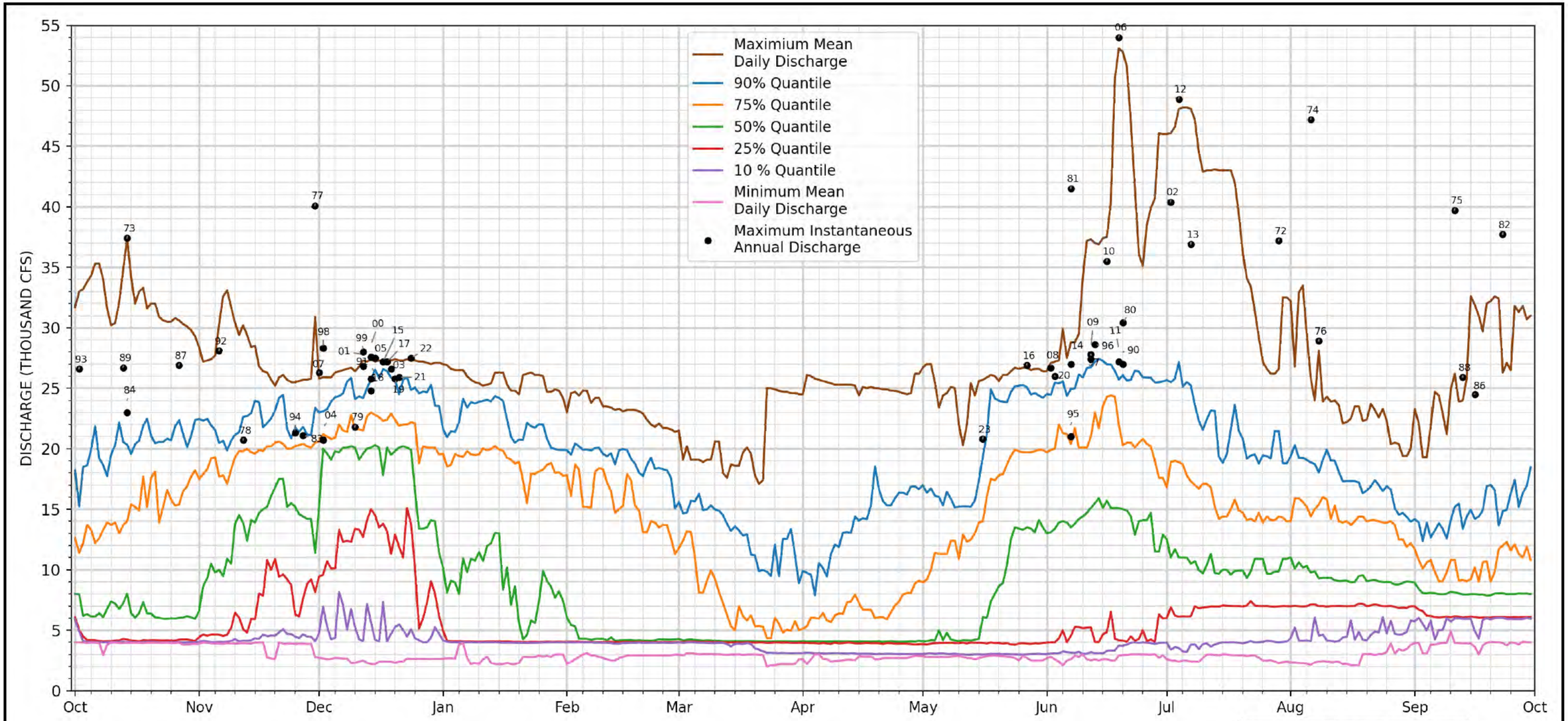
Data Obtained from USGS (Oct 01, 1910 – February 29, 1972)
USGS Gage: 12303000

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Summary Hydrograph, Natural Conditions
Kootenai River at Libby, MT

Completed by: WEST	April 2025

PLATE 4-12



NOTE: PLATE SIZE IS 11" x 17"

NOTES: Example: the 10th percentile line indicates that 10% of the historic discharge values fall below the line, while 90% are above.

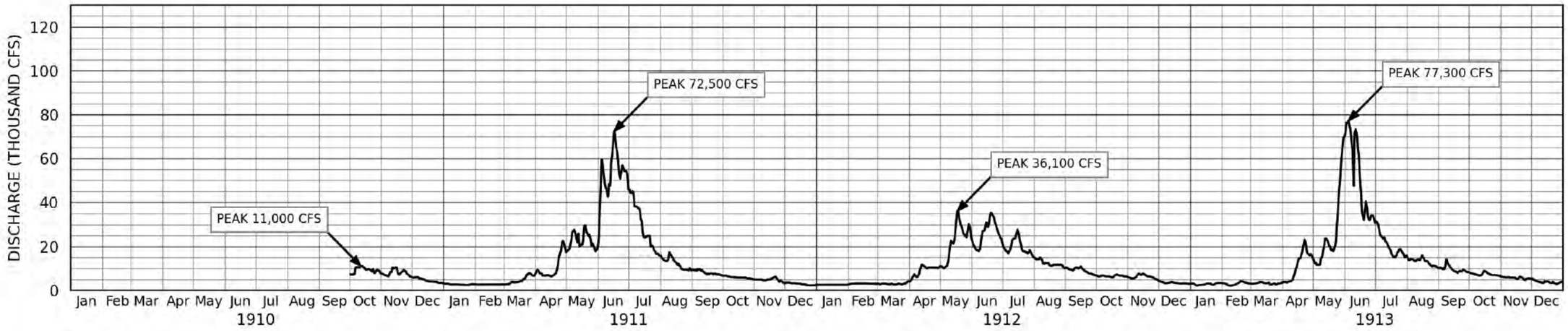
Data Obtained from USGS (Feb 01, 1972 – Dec 31, 2024)
USGS Gage: 12301933

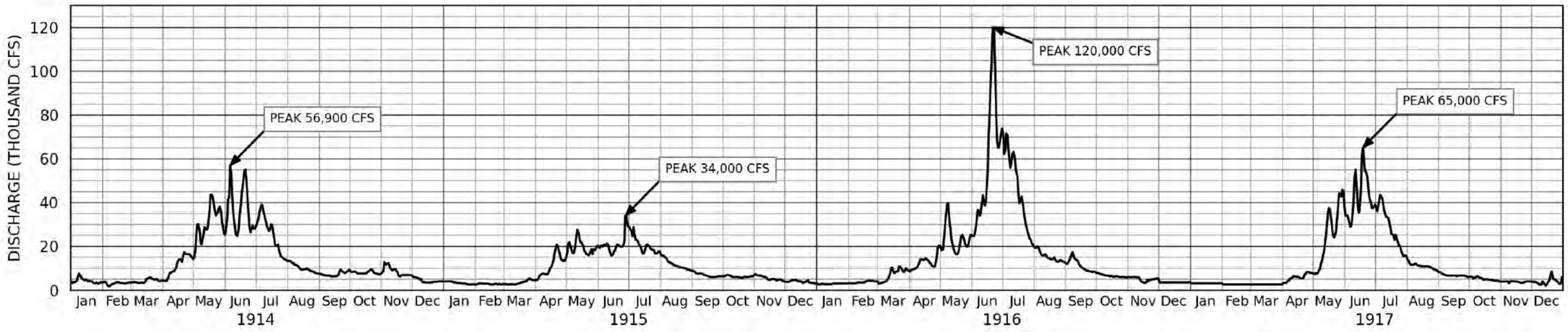
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

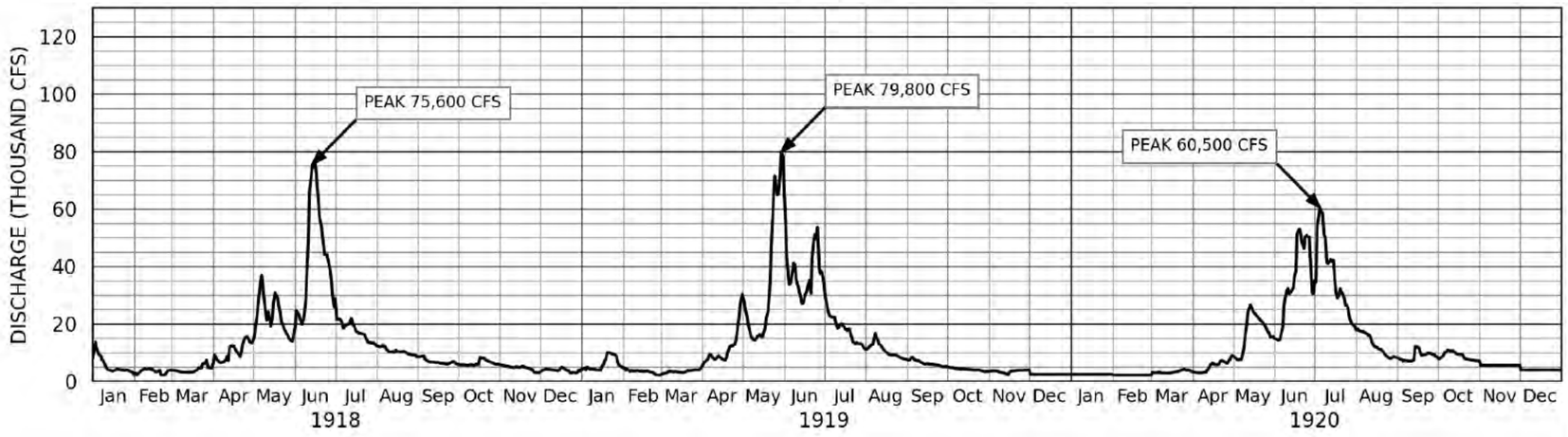
Libby Dam
Summary Hydrograph, Regulated Conditions
Kootenai River bl Libby Dam nr Libby, MT

Completed by: WEST	April 2025

PLATE 4-13







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

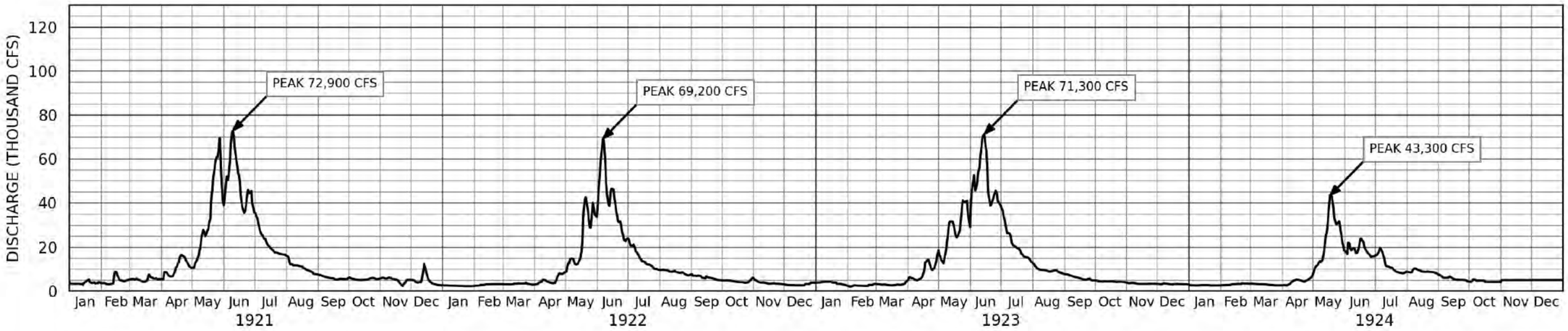
NOTE: PLATE SIZE IS 11" x 17"

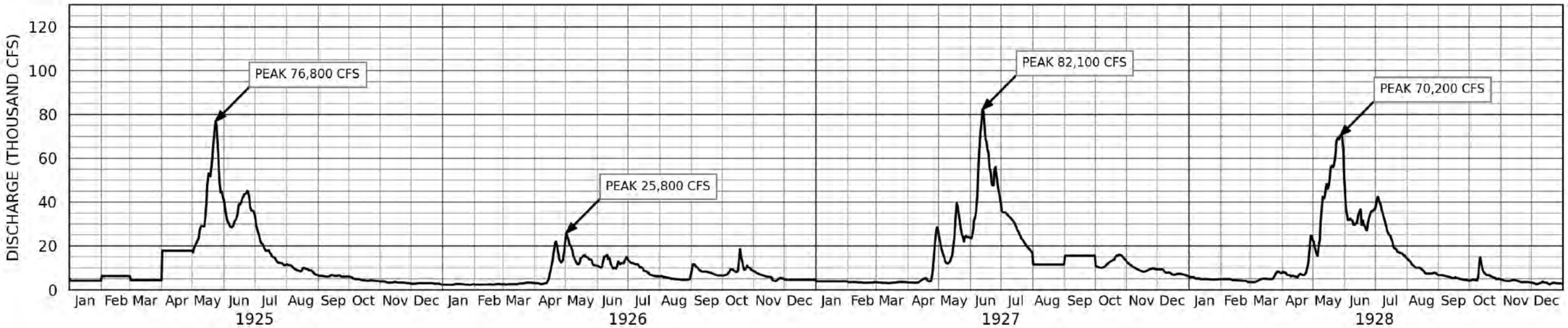
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

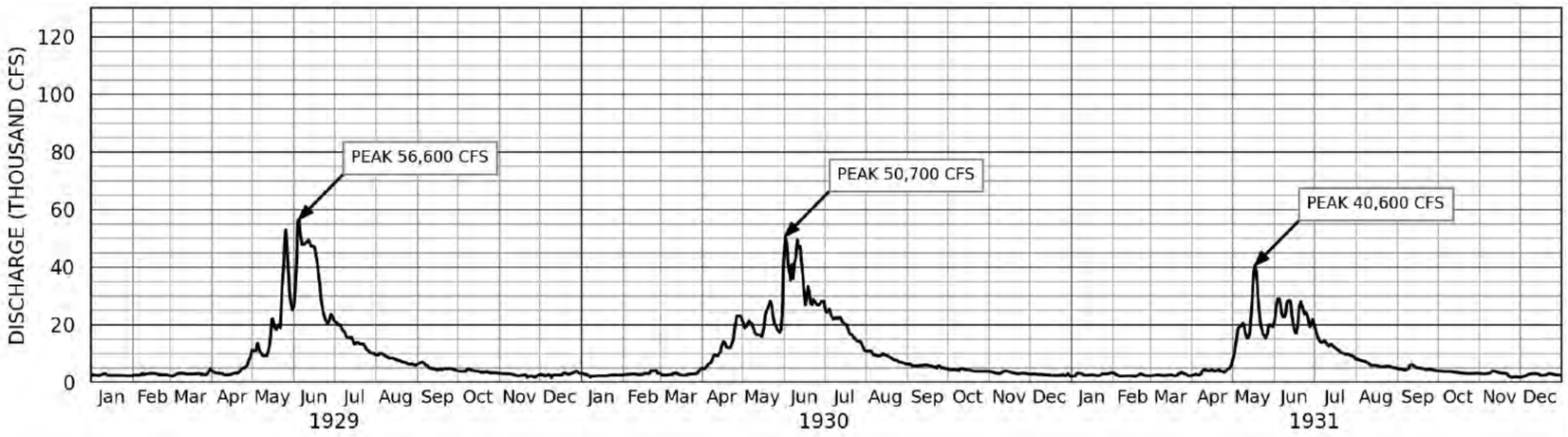
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1910-1920)

Completed by: WEST	April 2025

PLATE 4-14a







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

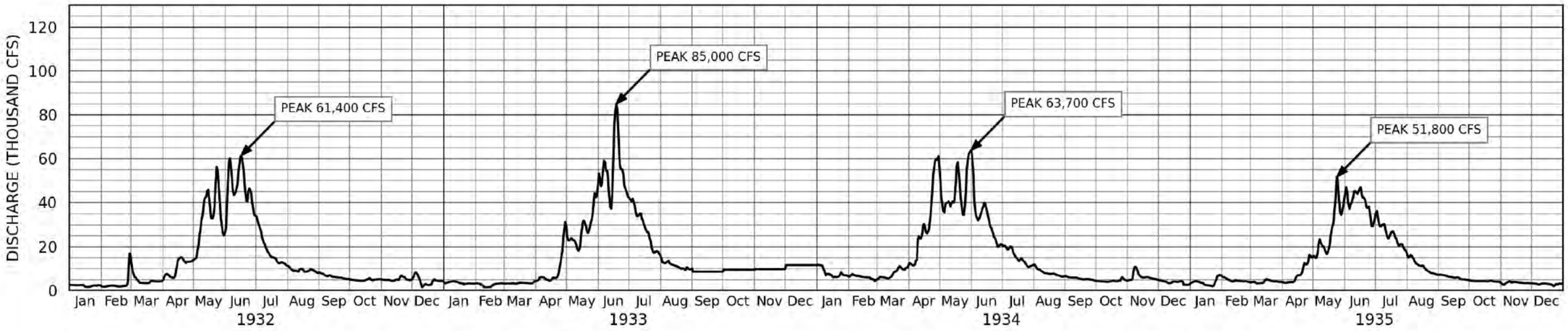
NOTE: PLATE SIZE IS 11" x 17"

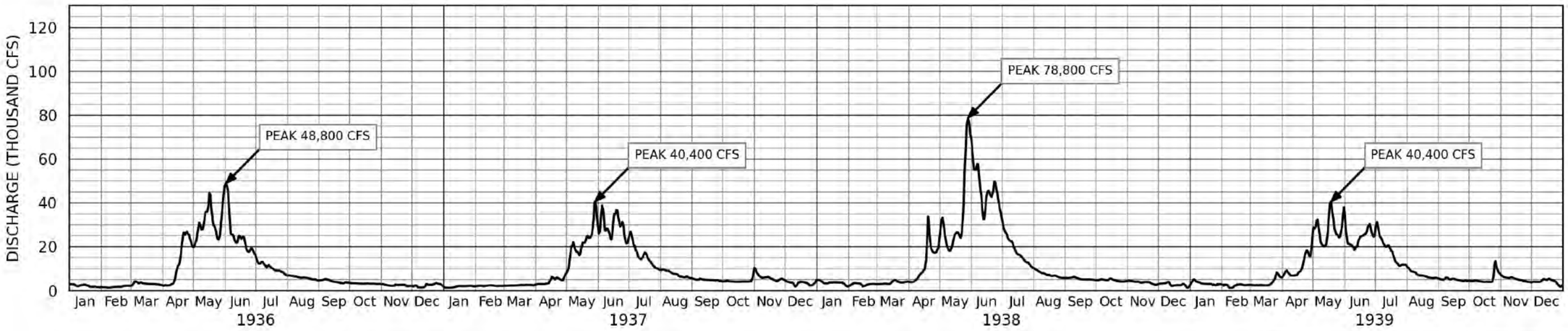
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

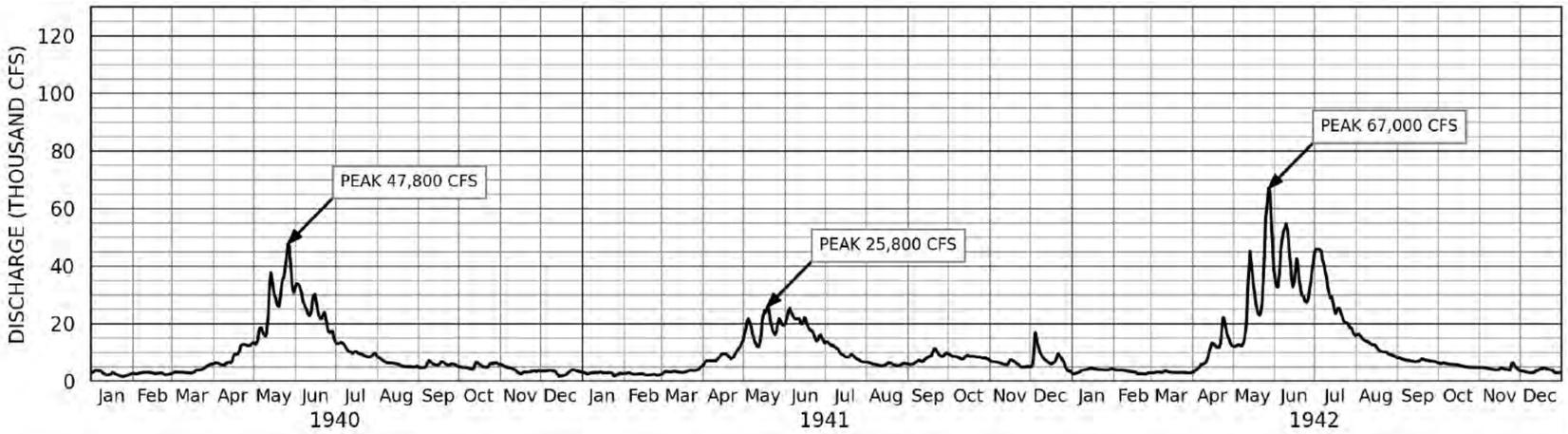
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1921-1931)

Completed by: WEST	April 2025

PLATE 4-14b







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

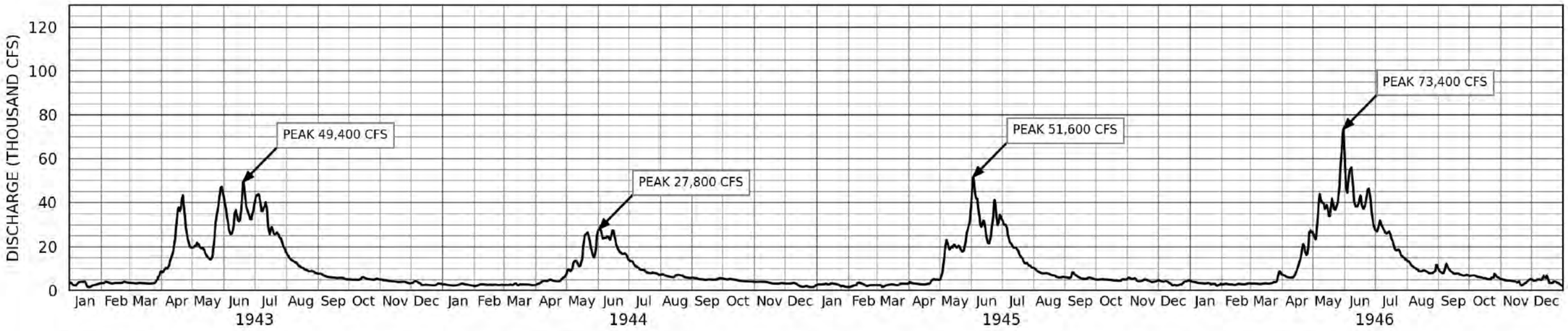
NOTE: PLATE SIZE IS 11" x 17"

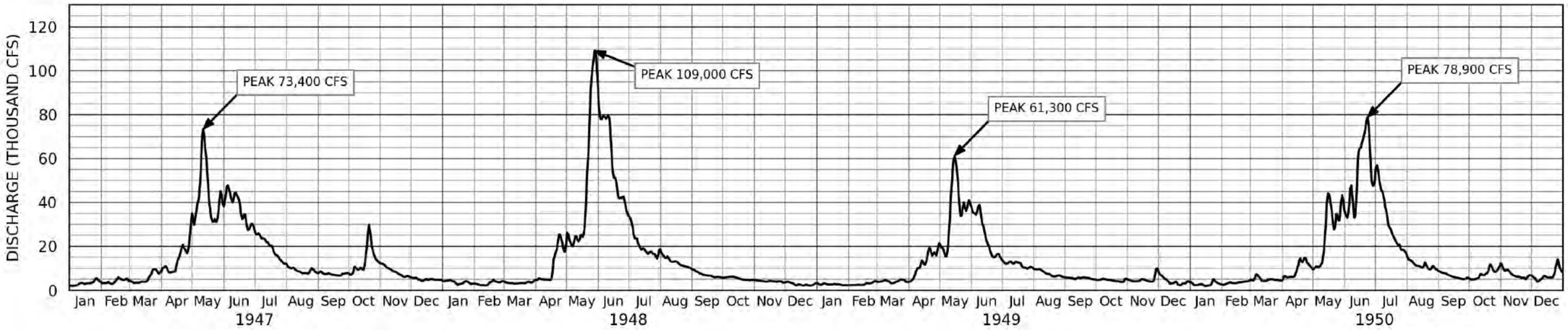
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

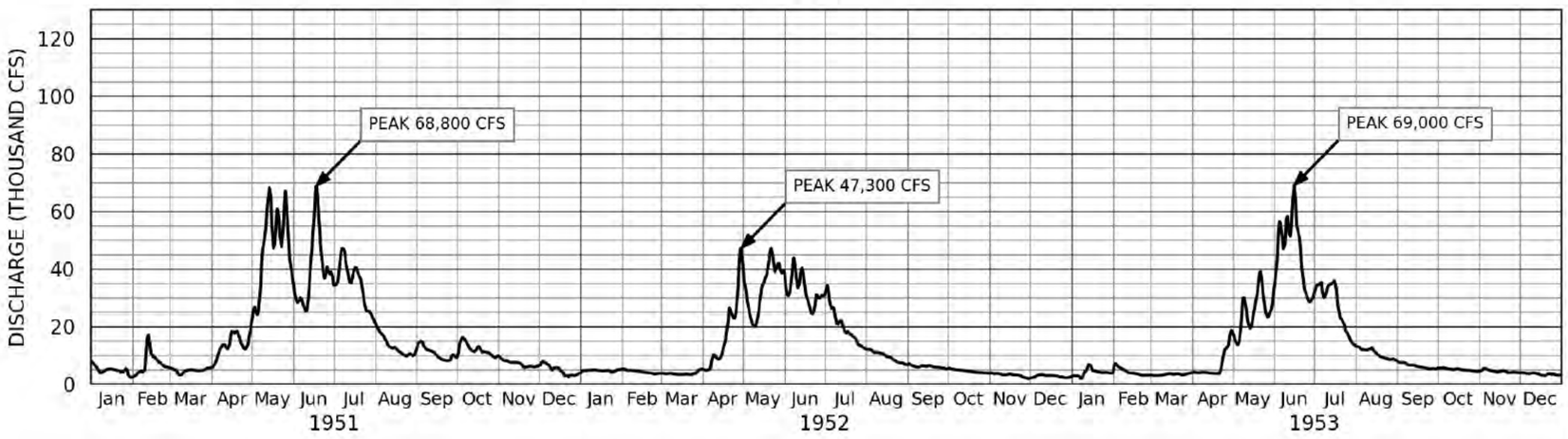
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1932-1942)

Completed by: WEST	April 2025

PLATE 4-14c







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

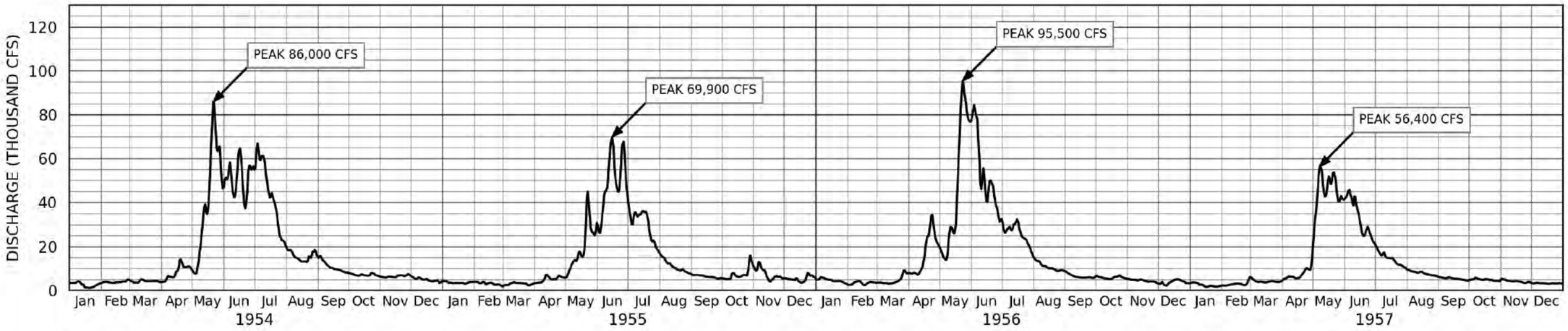
NOTE: PLATE SIZE IS 11" x 17"

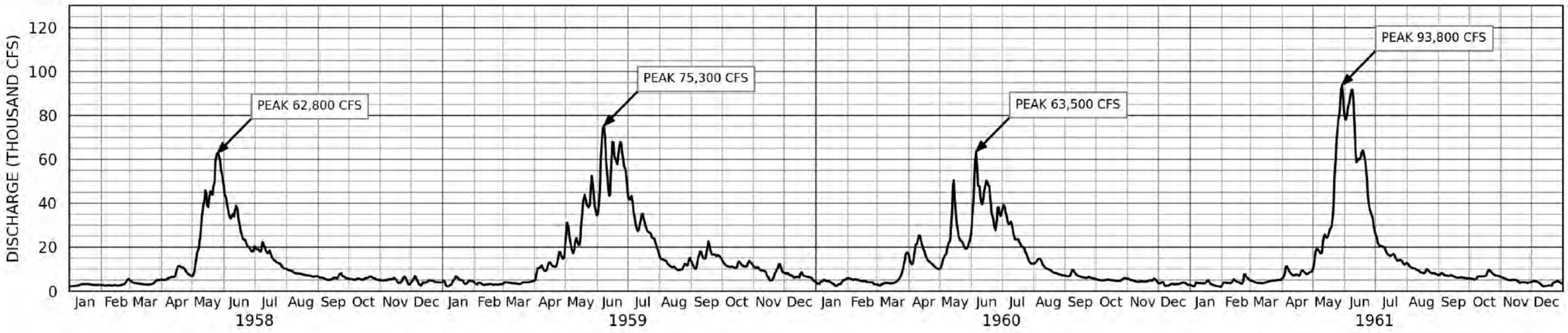
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

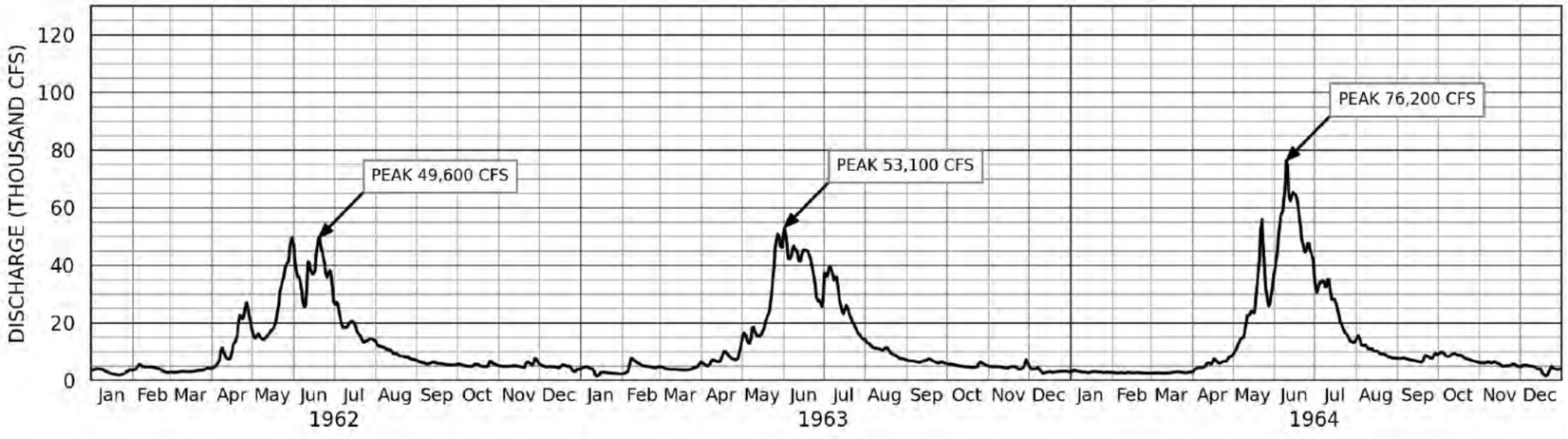
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1943-1953)

Completed by: WEST	April 2025

PLATE 4-14d







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

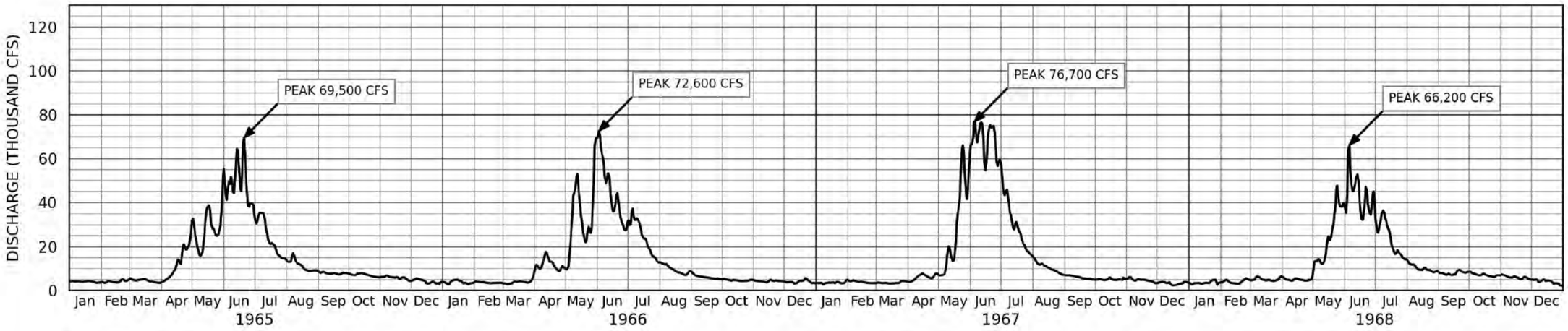
NOTE: PLATE SIZE IS 11" x 17"

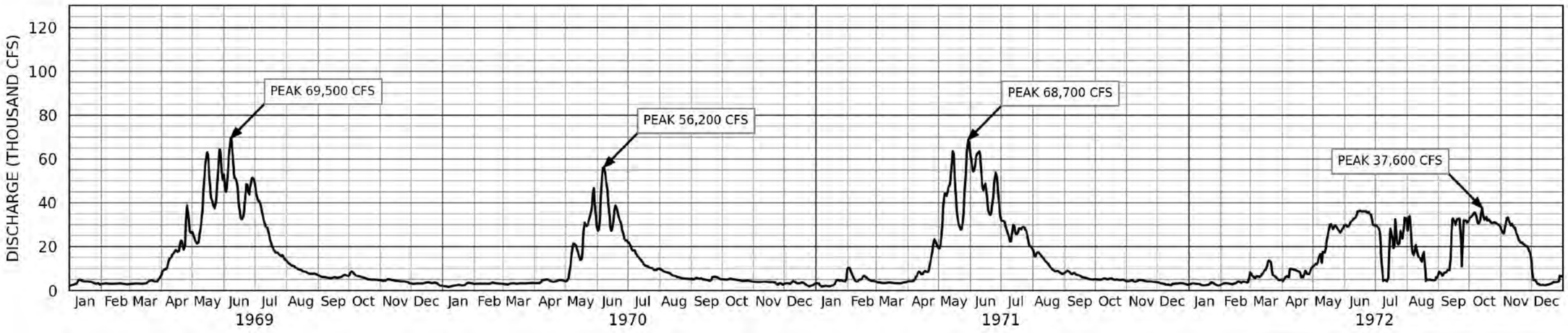
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

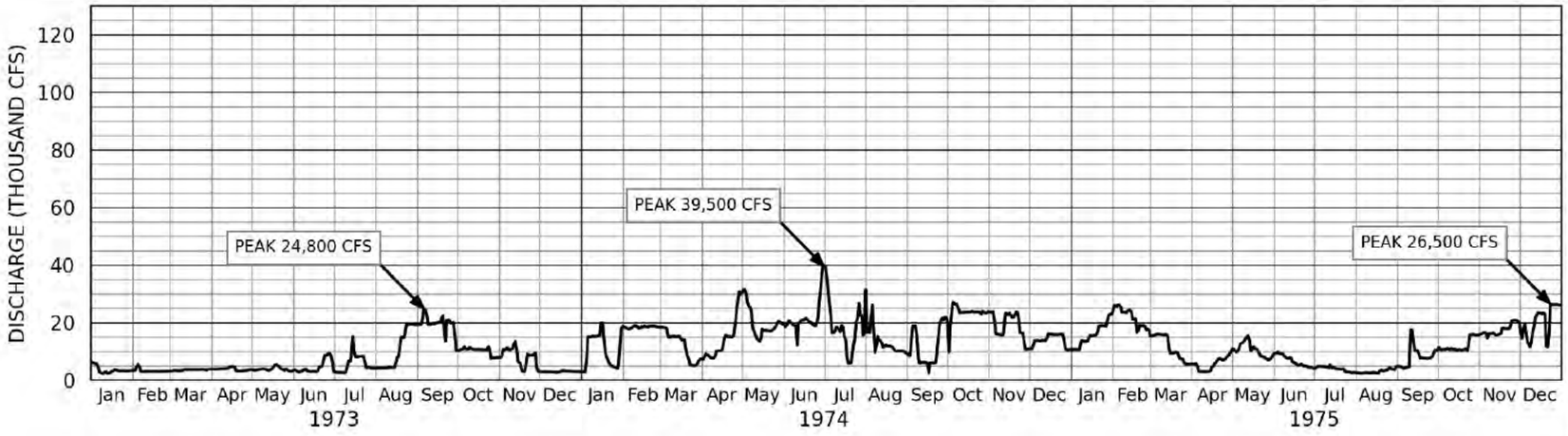
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1954-1964)

Completed by: WEST	April 2025

PLATE 4-14e







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

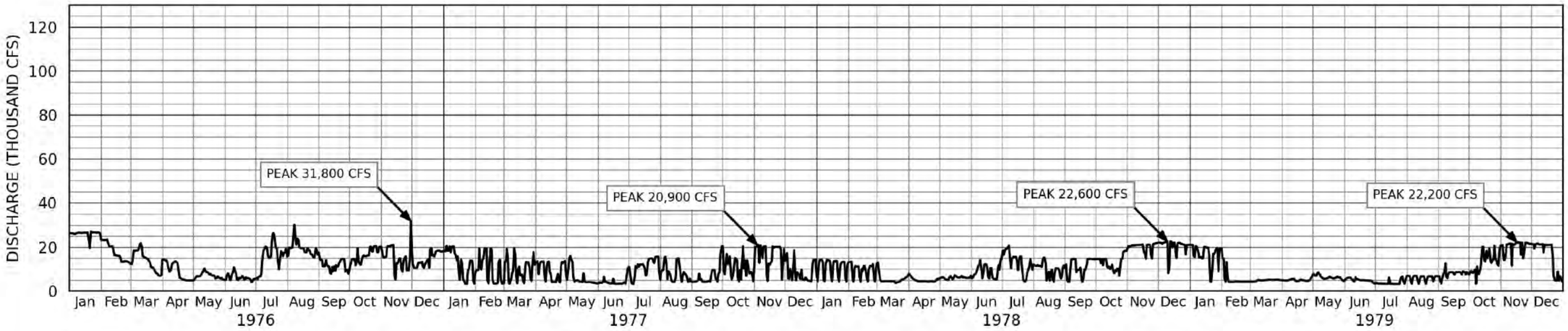
NOTE: PLATE SIZE IS 11" x 17"

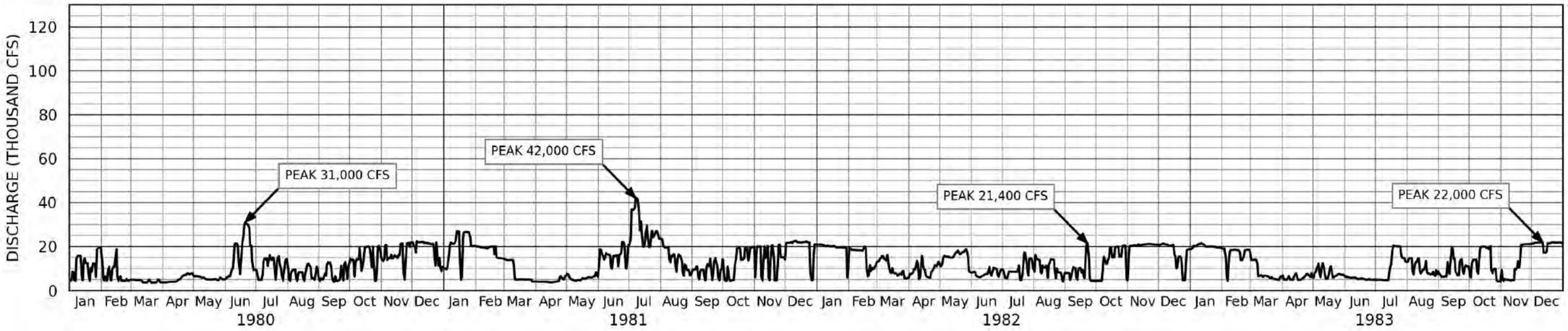
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

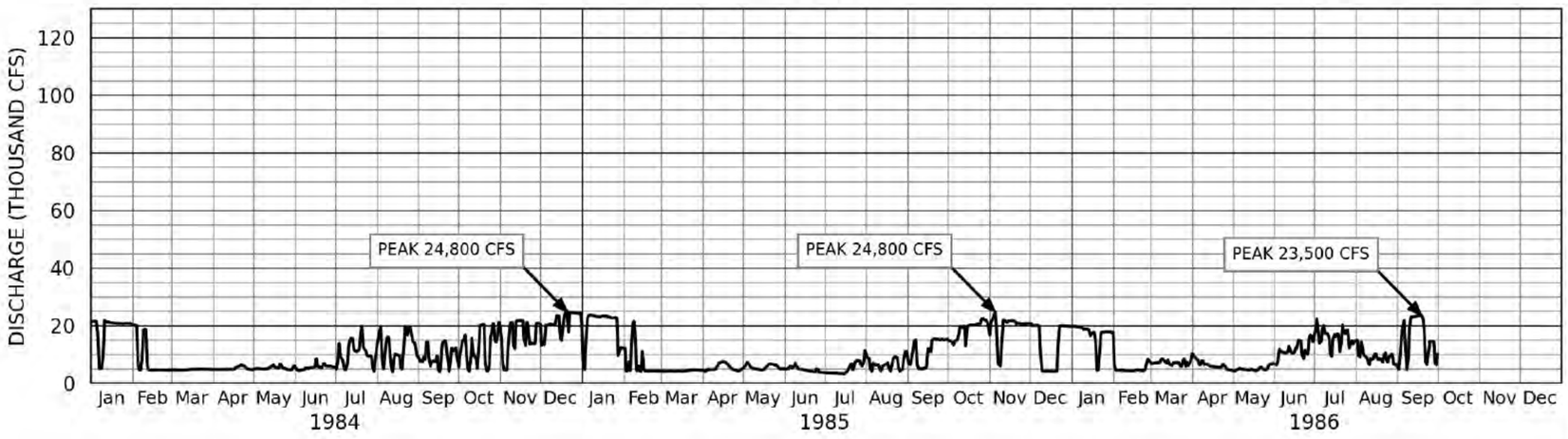
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1965-1975)

Completed by: WEST	April 2025

PLATE 4-14f







NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

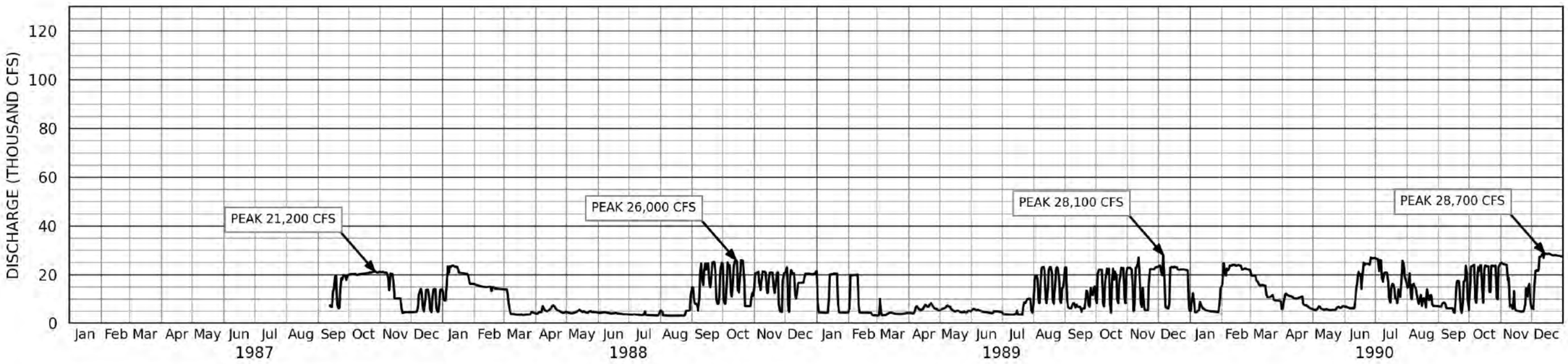
NOTE: PLATE SIZE IS 11" x 17"

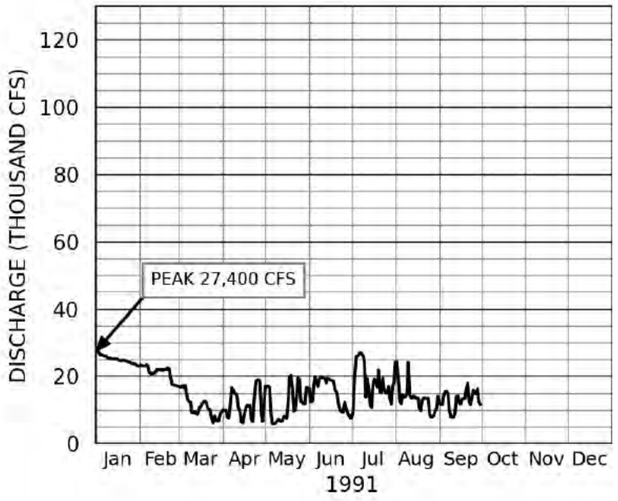
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1976-1986)

Completed by: WEST	April 2025

PLATE 4-14g





NOTE: Data obtained from USGS Gage: 12303000
(Oct 01, 1910 – Sep 29, 1991)

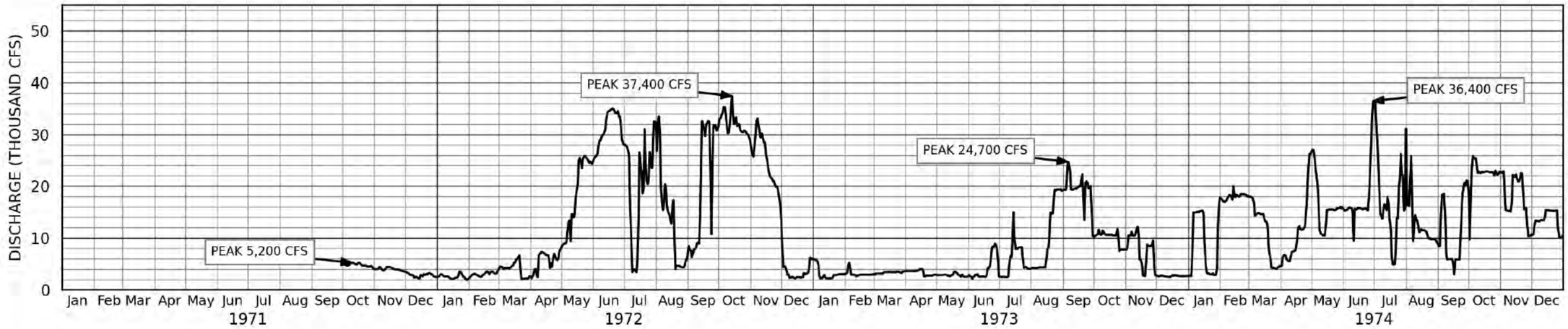
NOTE: PLATE SIZE IS 11" x 17"

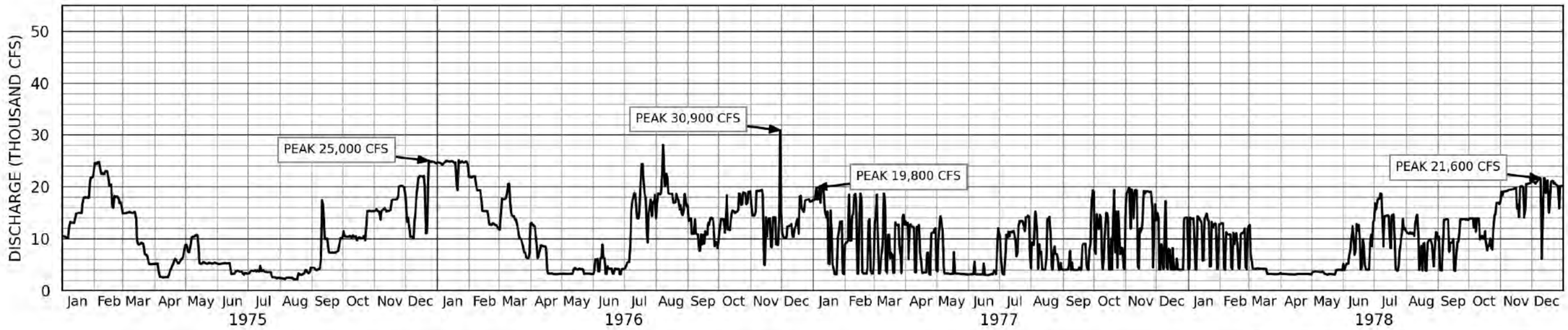
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

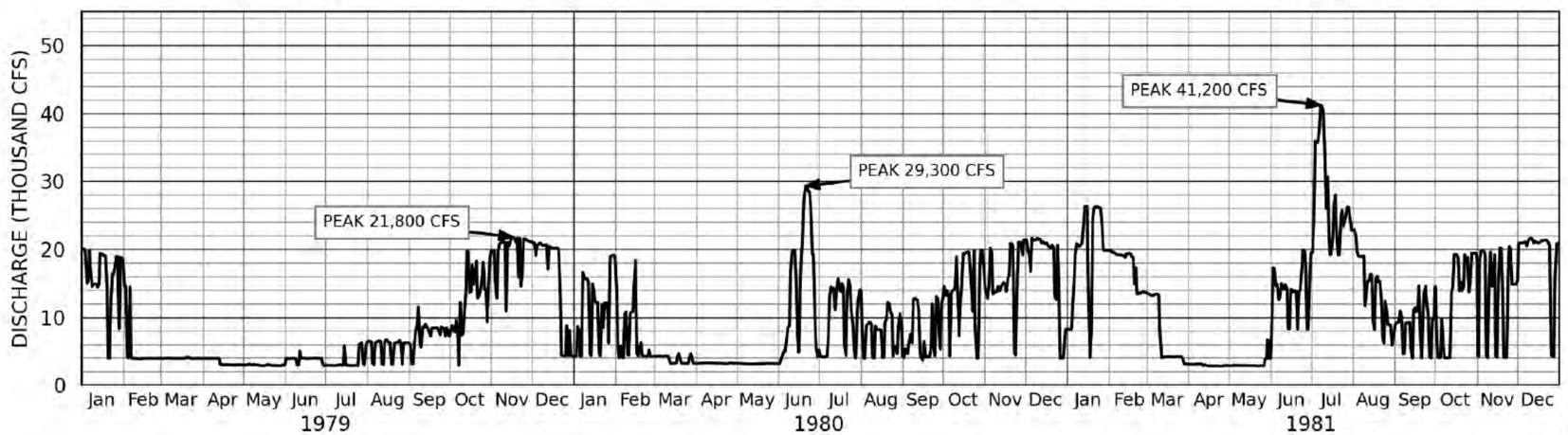
Libby Dam
Daily Discharge Hydrograph
Kootenai River at Libby, MT
(1987-1991)

Completed by: WEST	April 2025

PLATE 4-14h







NOTE: Data obtained from USGS Gage: 12301933
(Oct 01, 1971 – Dec 31, 2024)

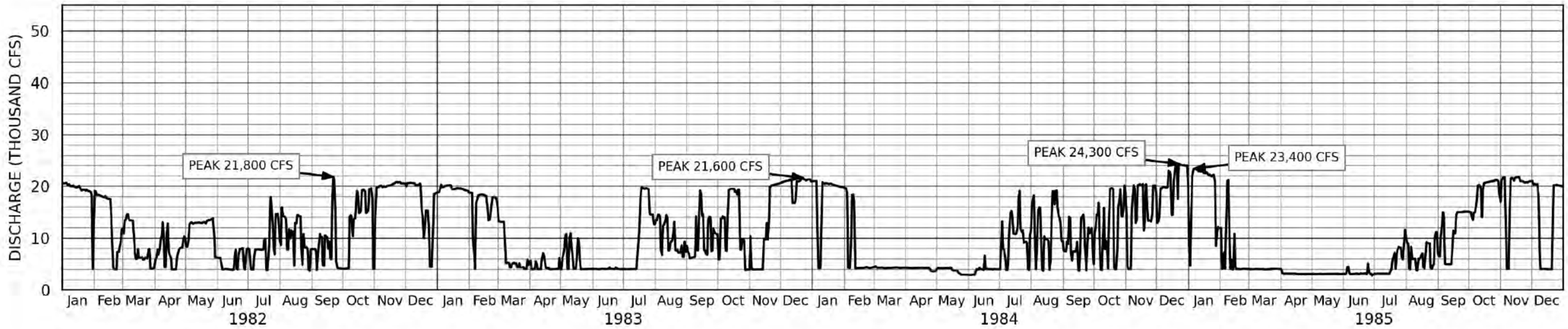
NOTE: PLATE SIZE IS 11" x 17"

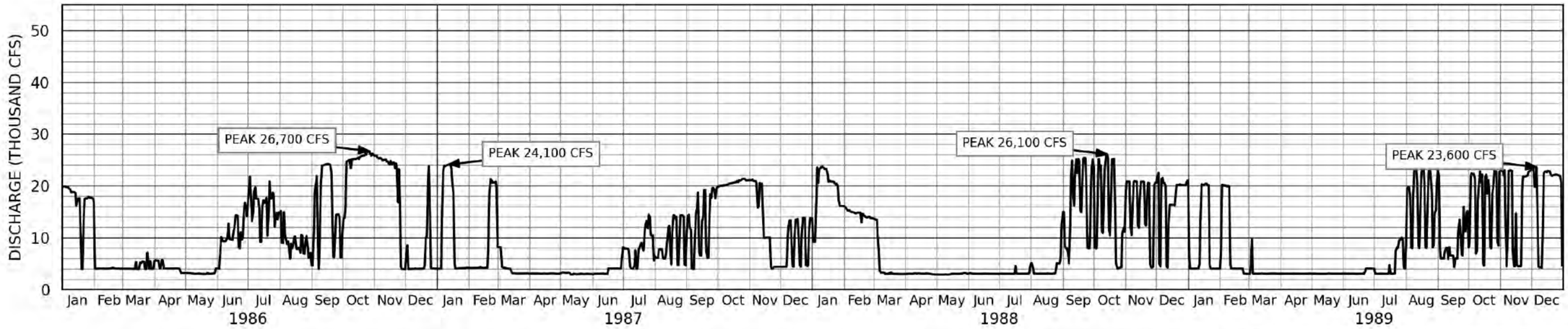
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

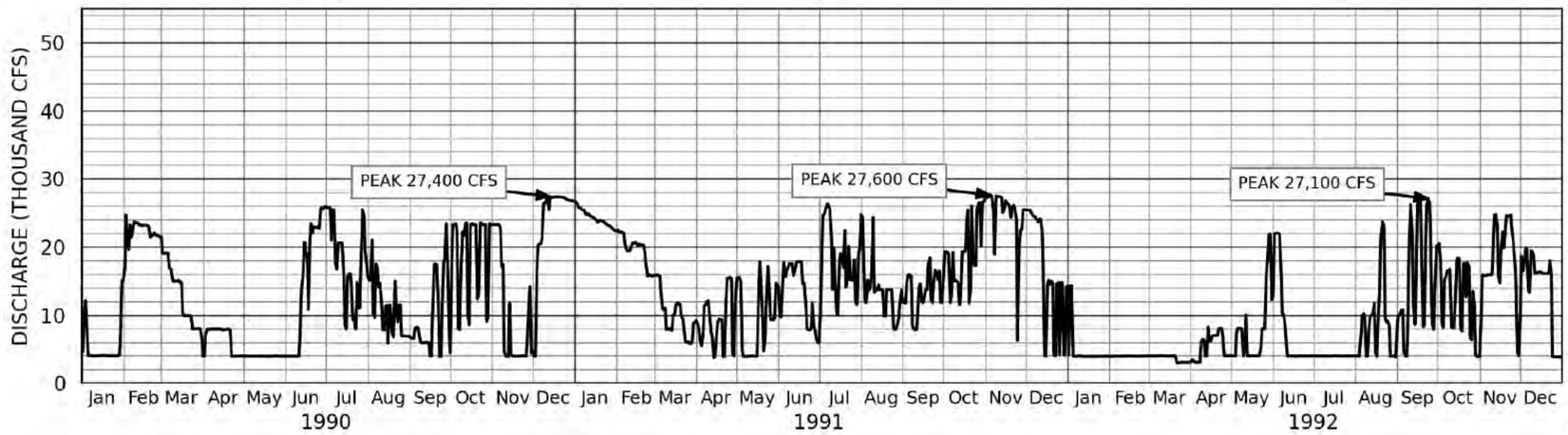
Libby Dam
Daily Discharge Hydrograph
Kootenai River bl Libby Dam nr Libby, MT
(1971-1981)

Completed by: WEST	April 2025

PLATE 4-15a







NOTE: Data obtained from USGS Gage: 12301933
(Oct 01, 1971 – Dec 31, 2024)

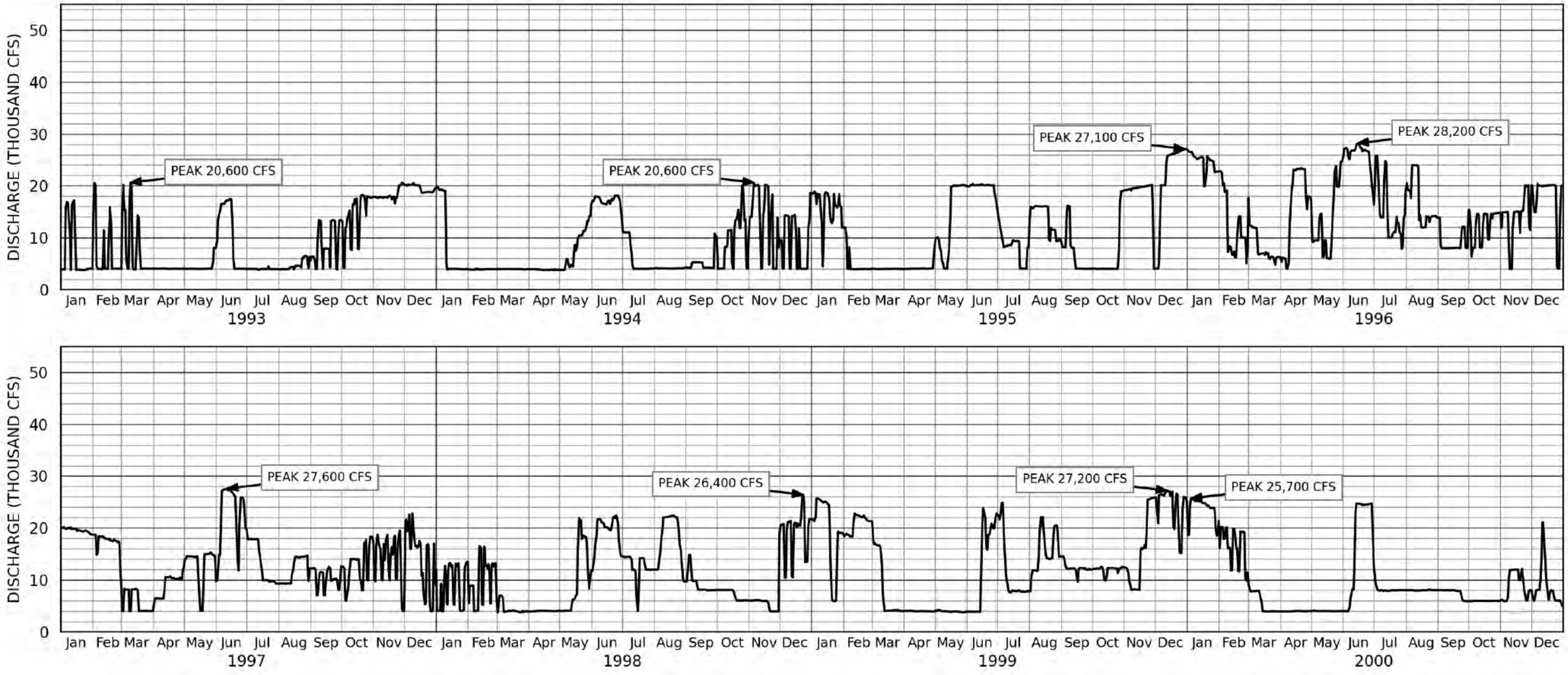
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Discharge Hydrograph
Kootenai River bl Libby Dam nr Libby, MT
(1982-1992)

Completed by: WEST	April 2025

PLATE 4-15b



NOTE: Data obtained from USGS Gage: 12301933
(Oct 01, 1971 – Dec 31, 2024)

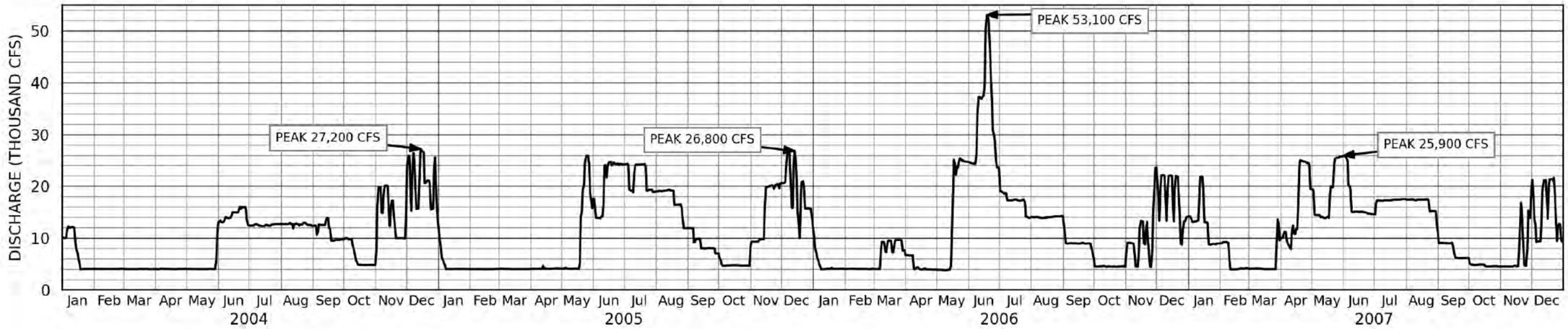
NOTE: PLATE SIZE IS 11" x 17"

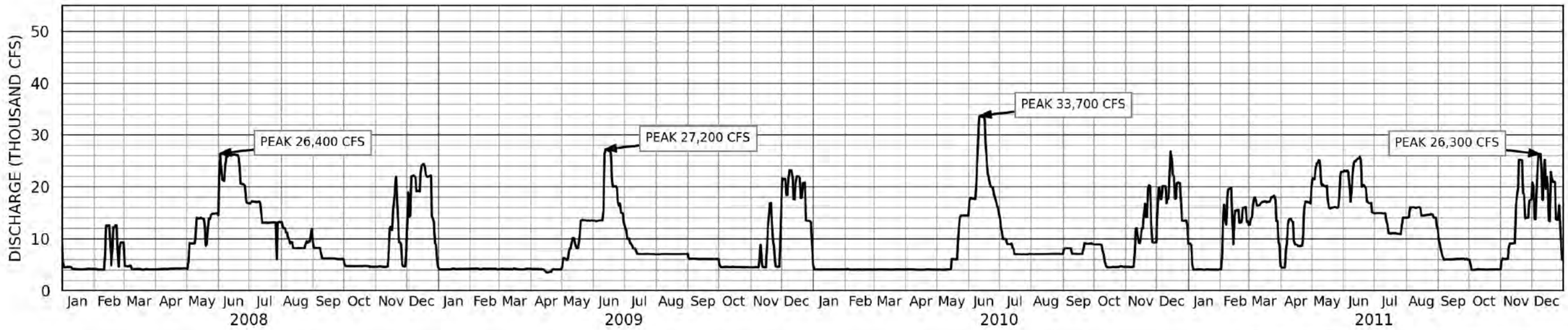
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

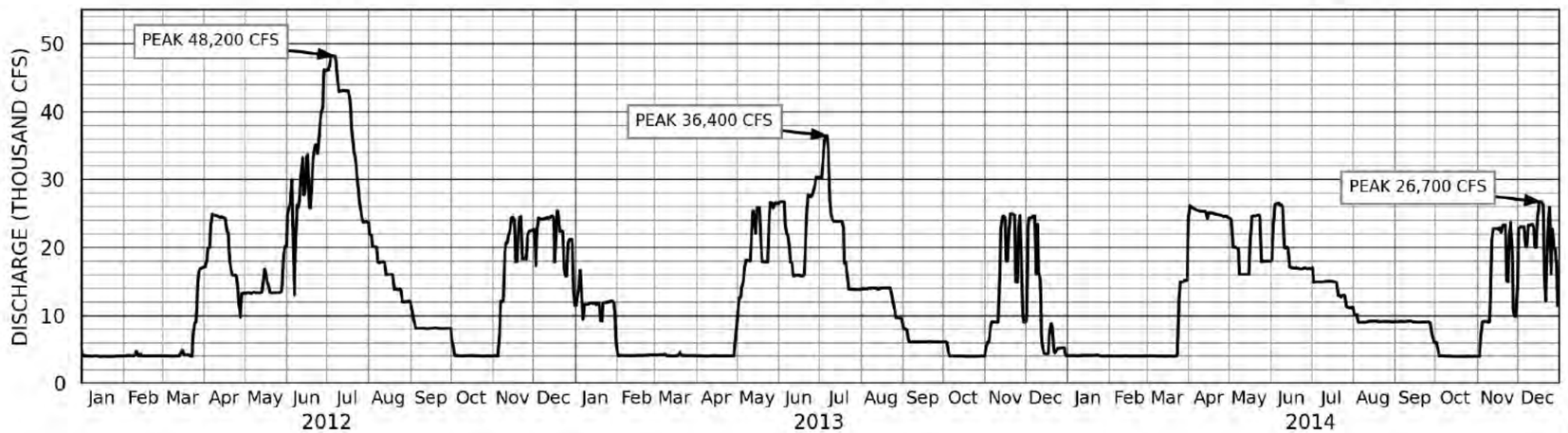
Libby Dam
Daily Discharge Hydrograph
Kootenai River bl Libby Dam nr Libby, MT
(1993-2003)

Completed by: WEST	April 2025

PLATE 4-15c







NOTE: Data obtained from USGS Gage: 12301933
(Oct 01, 1971 – Dec 31, 2024)

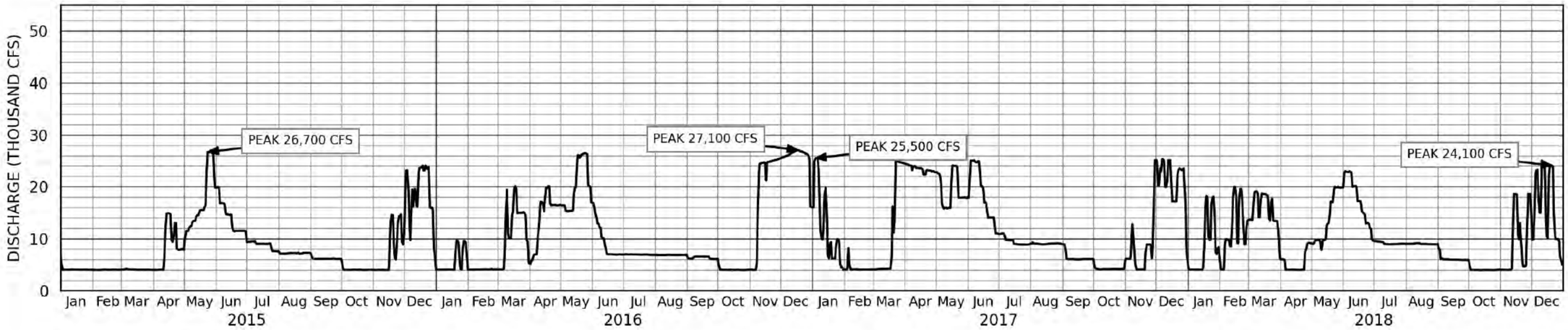
NOTE: PLATE SIZE IS 11" x 17"

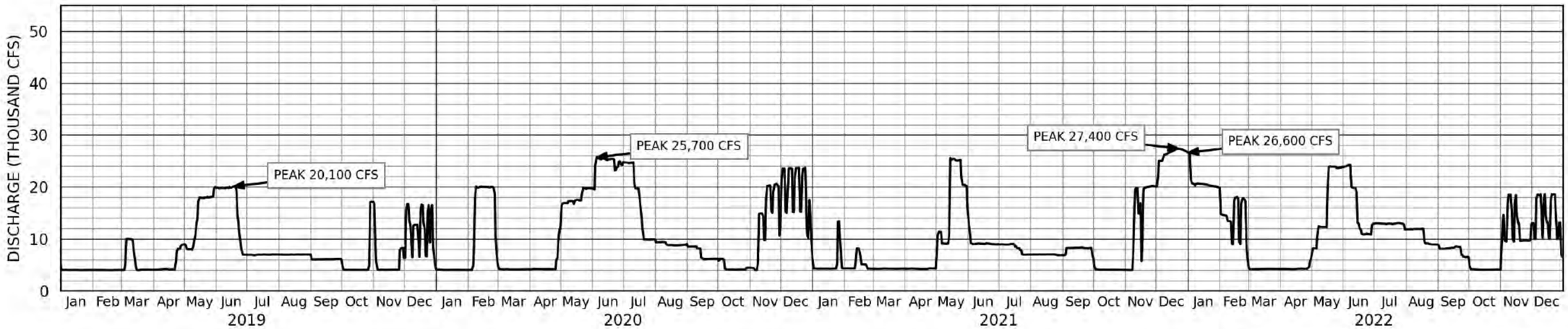
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

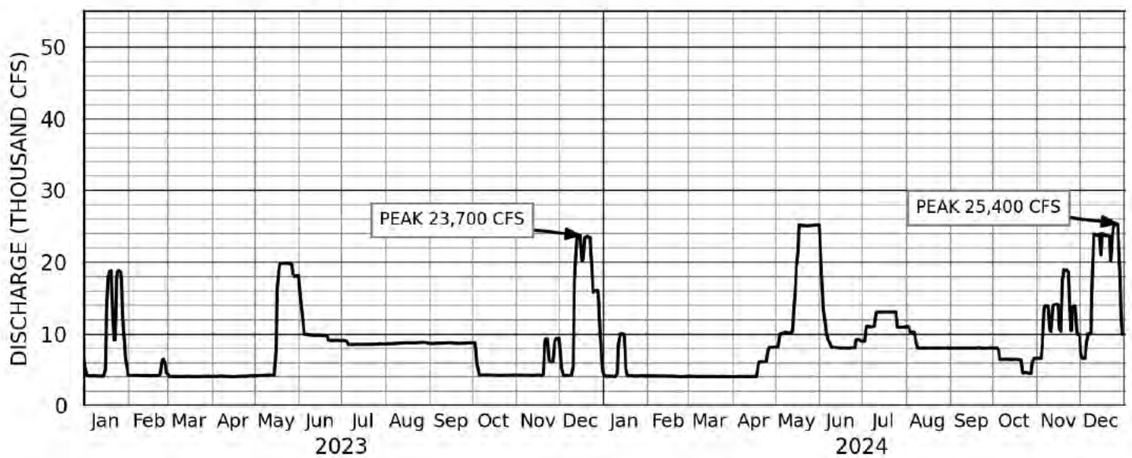
Libby Dam
Daily Discharge Hydrograph
Kootenai River bl Libby Dam nr Libby, MT
(2004-2014)

Completed by: WEST	April 2025

PLATE 4-15d







NOTE: Data obtained from USGS Gage: 12301933
(Oct 01, 1971 – Dec 31, 2024)

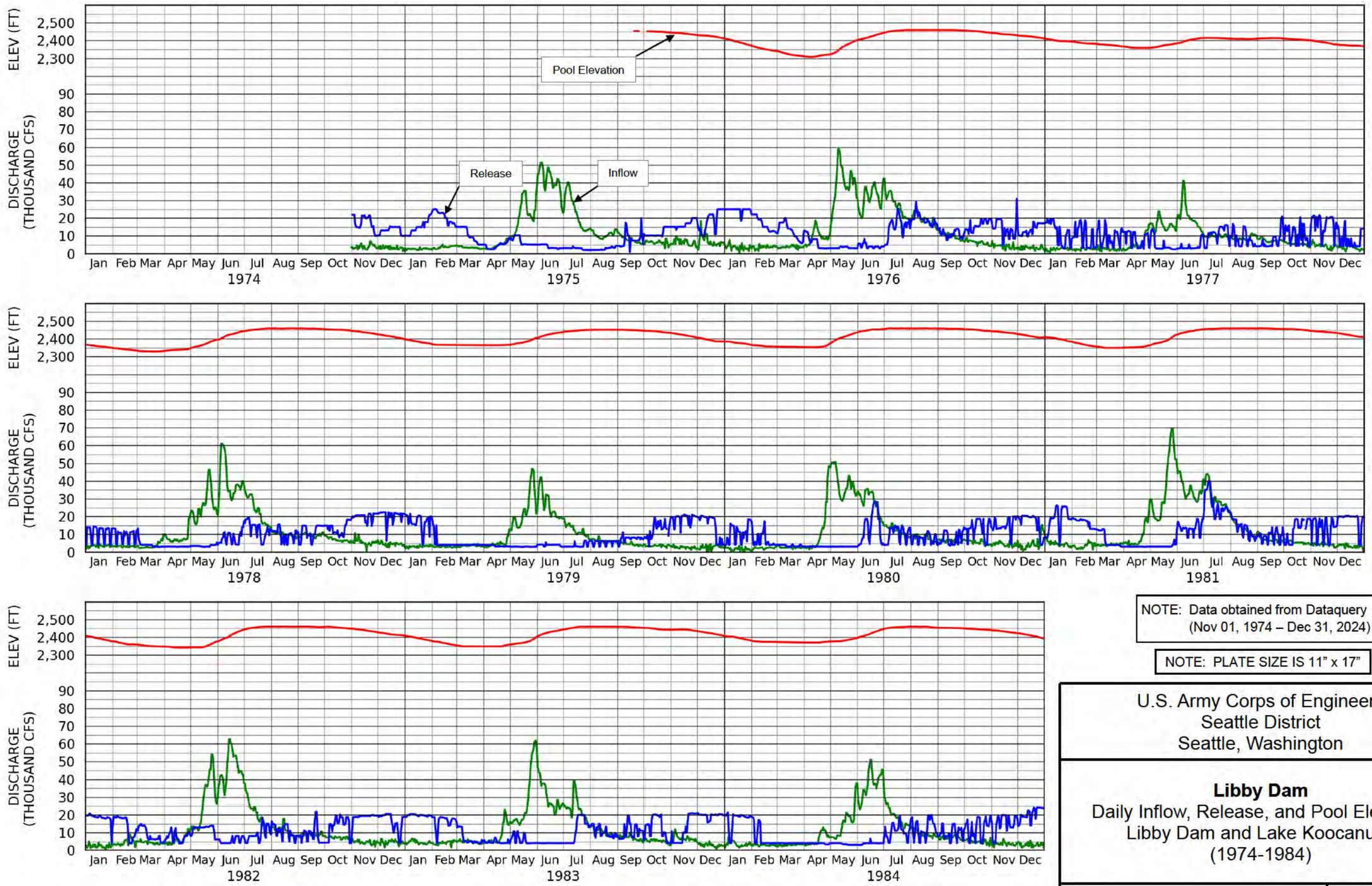
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Discharge Hydrograph
Kootenai River bl Libby Dam nr Libby, MT
(2015-2024)

Completed by: WEST	April 2025

PLATE 4-15e



NOTE: Data obtained from Dataquery (Nov 01, 1974 – Dec 31, 2024)

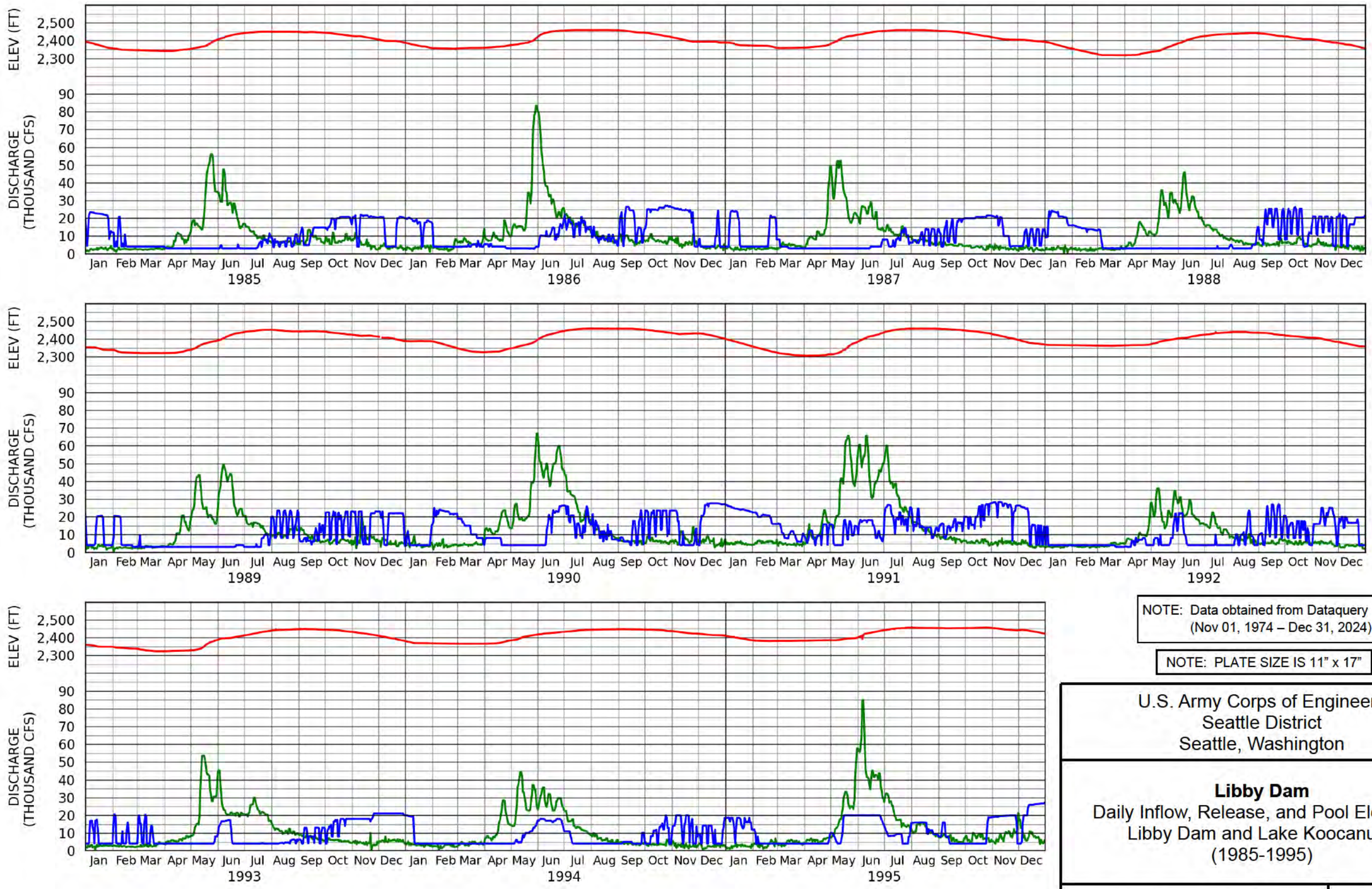
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Inflow, Release, and Pool Elevation
Libby Dam and Lake Koocanusa
(1974-1984)

Completed by: WEST	April 2025

PLATE 4-16a



NOTE: Data obtained from Dataquery (Nov 01, 1974 – Dec 31, 2024)

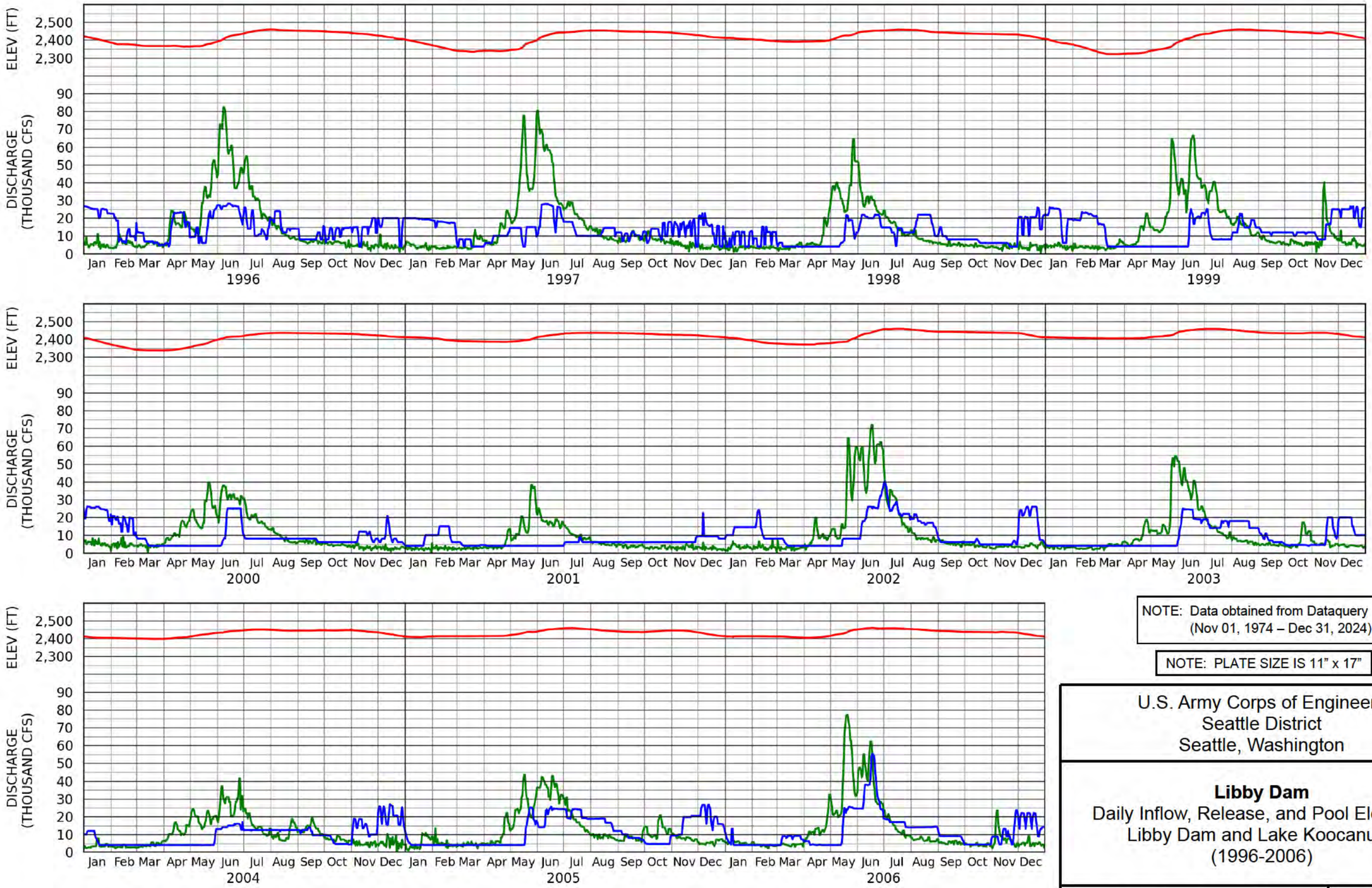
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Inflow, Release, and Pool Elevation
Libby Dam and Lake Koocanusa
(1985-1995)

Completed by: WEST	April 2025

PLATE 4-16b



NOTE: Data obtained from Dataquery (Nov 01, 1974 – Dec 31, 2024)

NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Inflow, Release, and Pool Elevation
Libby Dam and Lake Koocanusa
(1996-2006)

Completed by: WEST	April 2025

PLATE 4-16c

NOTE: Data obtained from Dataquery (Nov 01, 1974 – Dec 31, 2024)

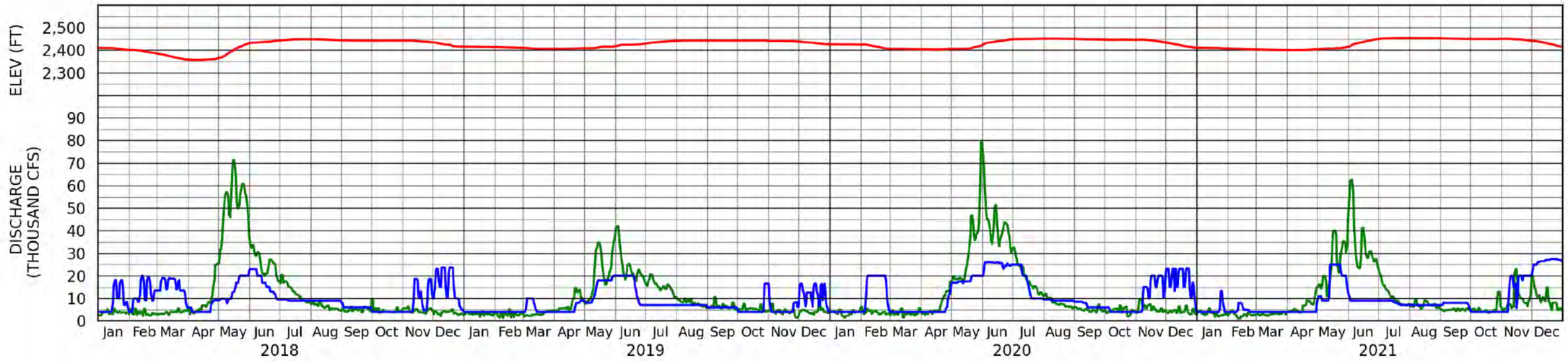
NOTE: PLATE SIZE IS 11" x 17"

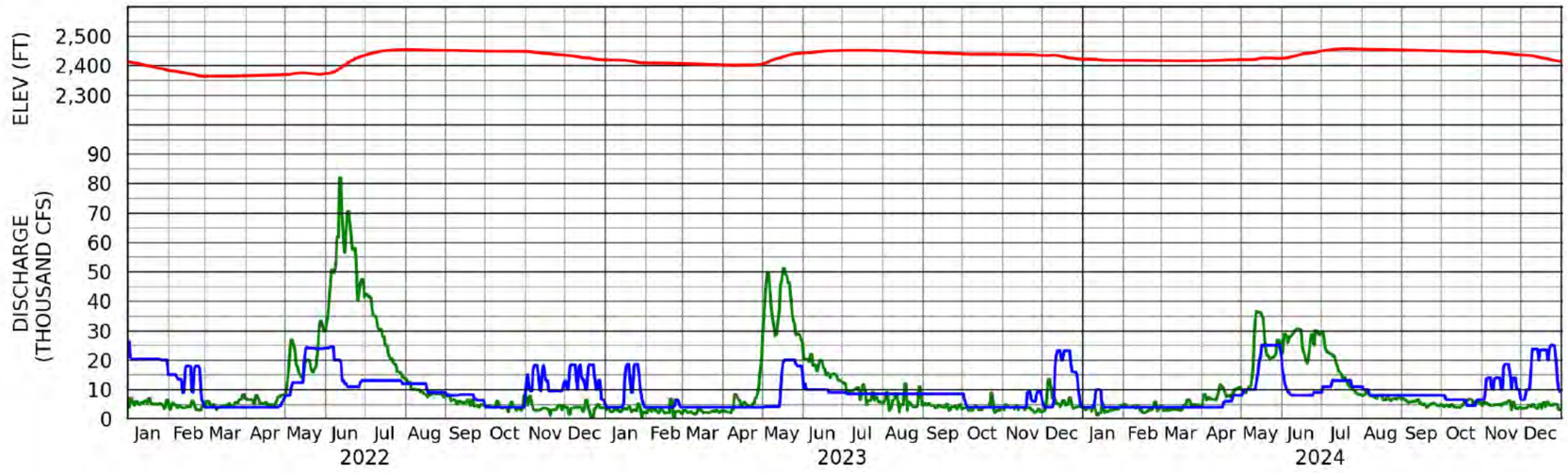
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Inflow, Release, and Pool Elevation
Libby Dam and Lake Koocanusa
(2007-2017)

Completed by: WEST	April 2025

PLATE 4-16d





NOTE: Data obtained from Dataquery (Nov 01, 1974 – Dec 31, 2024)

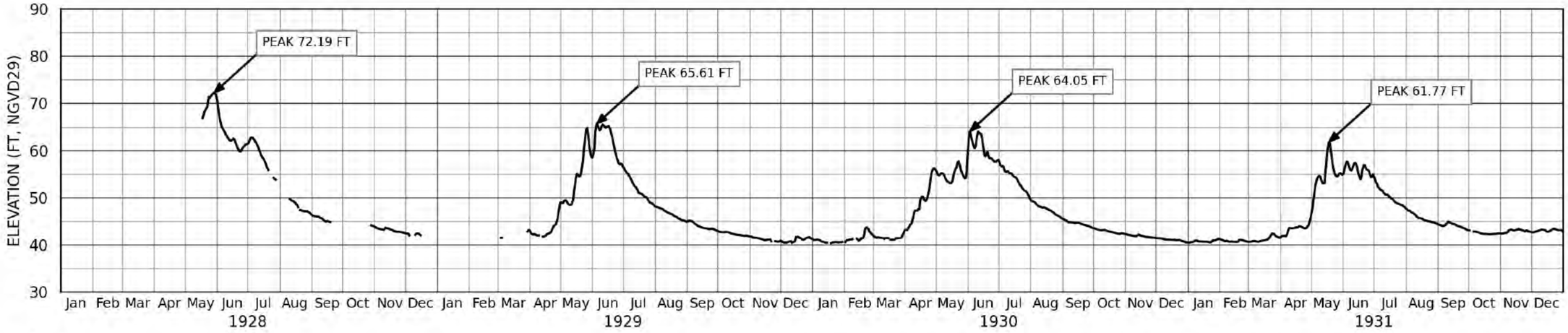
NOTE: PLATE SIZE IS 11" x 17"

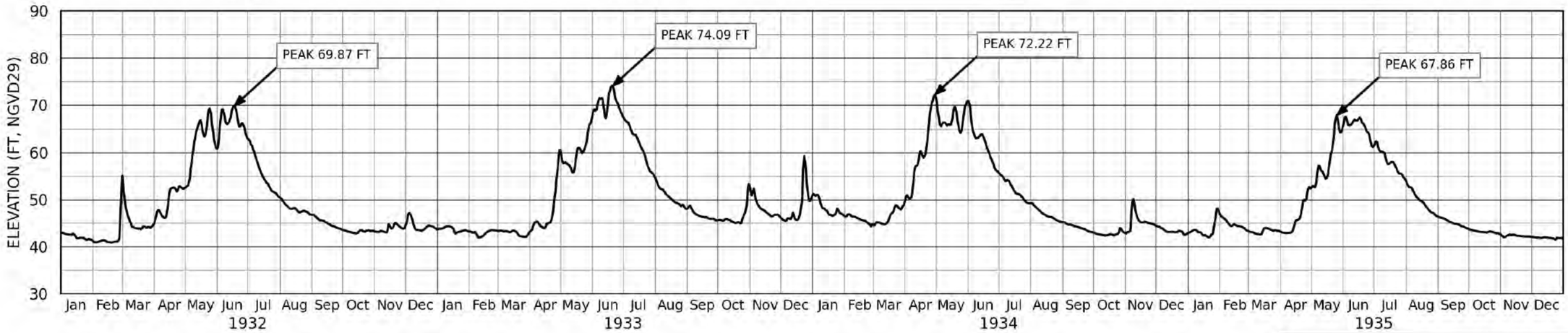
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

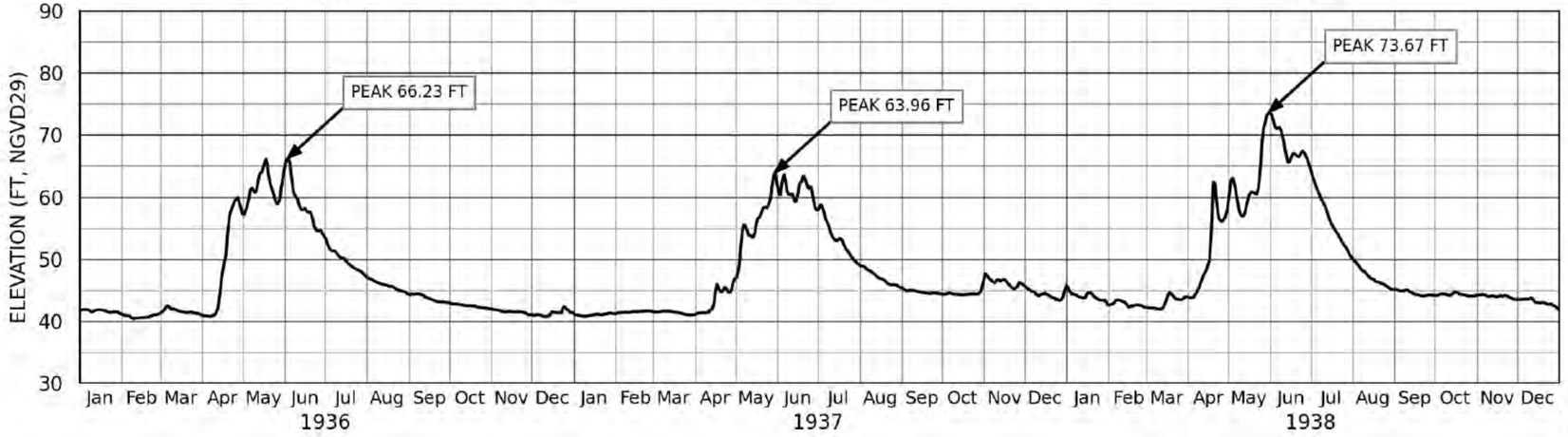
Libby Dam
Daily Inflow, Release, and Pool Elevation
Libby Dam and Lake Koocanusa
(2018-2024)

Completed by: WEST	April 2025

PLATE 4-16e







NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

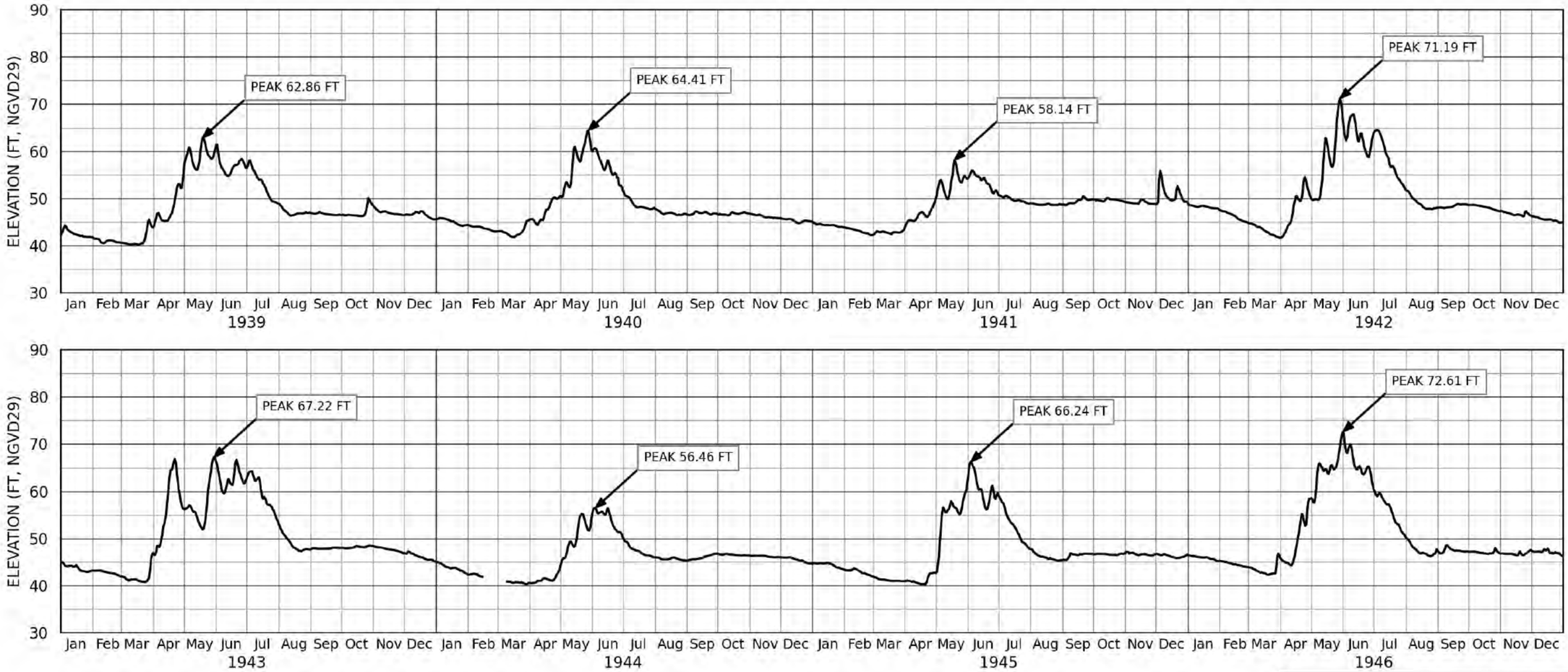
NOTE: PLATE SIZE IS 11" x 17"

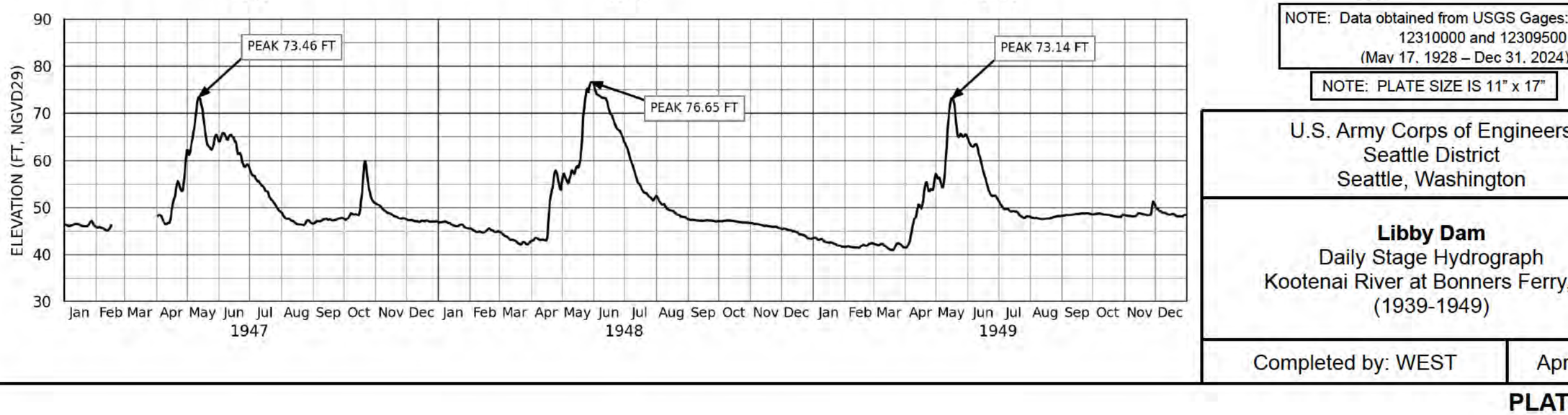
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1928-1938)

Completed by: WEST	April 2025

PLATE 4-17a





NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

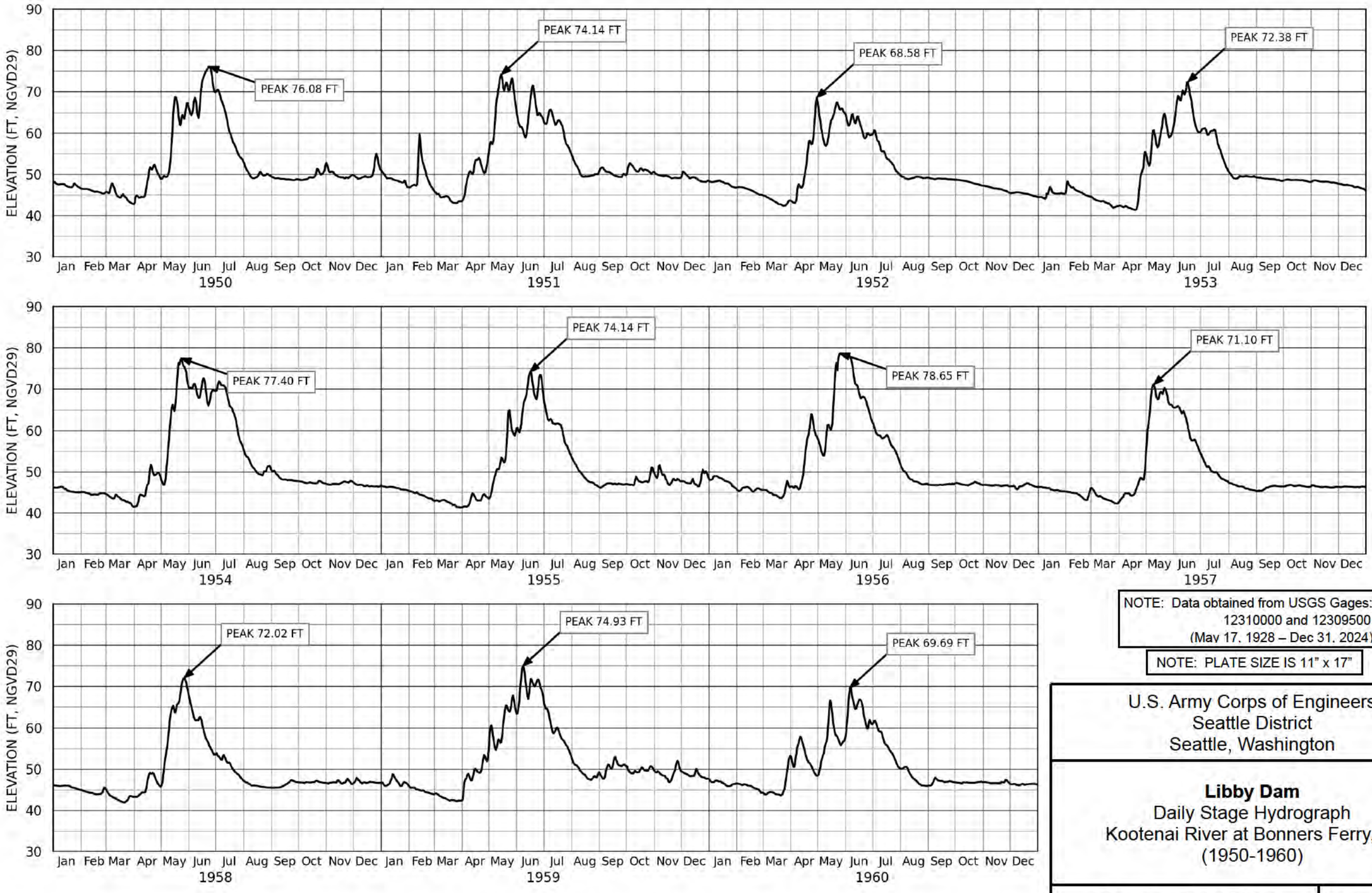
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1939-1949)

Completed by: WEST	April 2025

PLATE 4-17b



NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

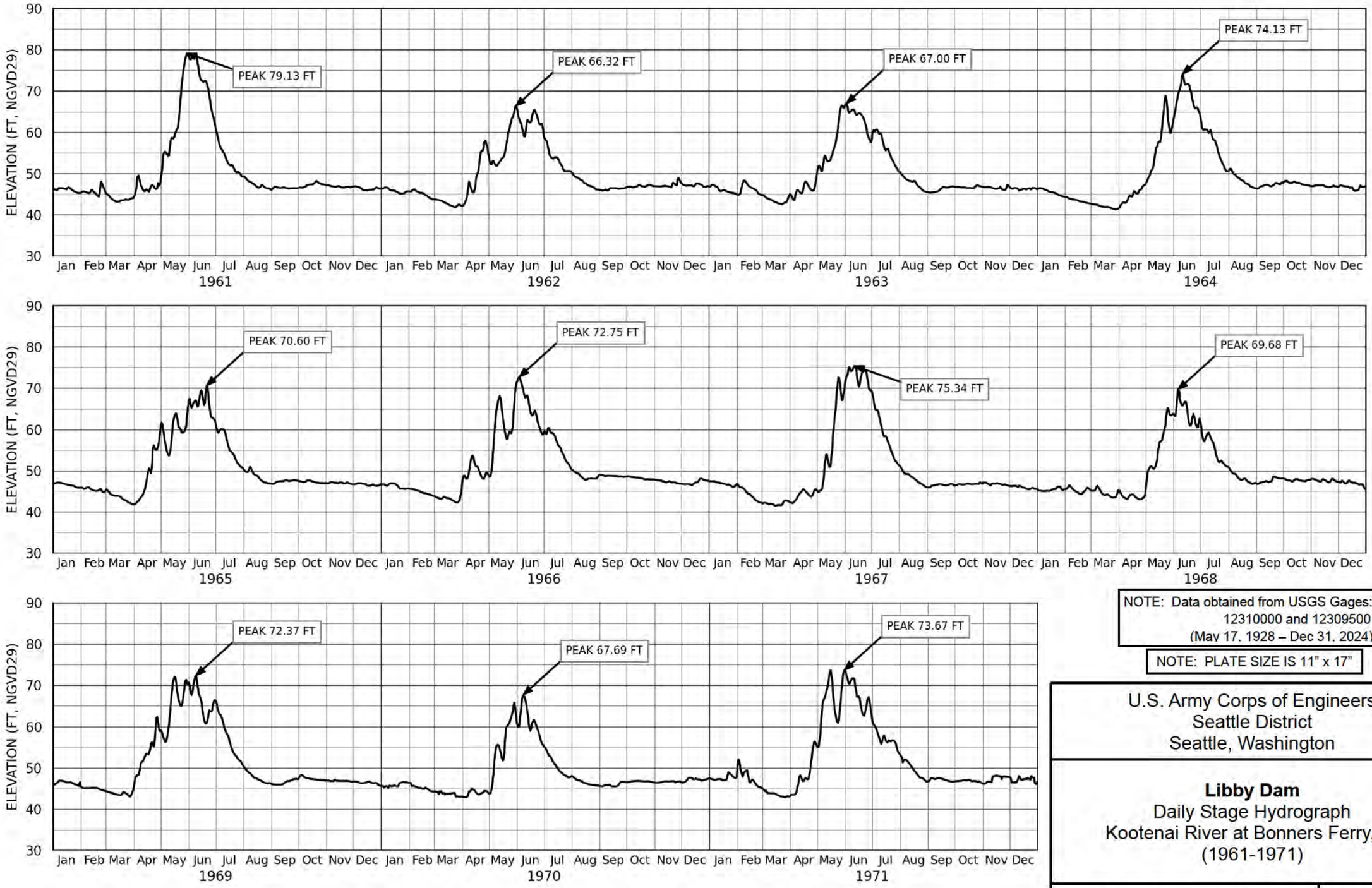
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1950-1960)

Completed by: WEST	April 2025

PLATE 4-17c



NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

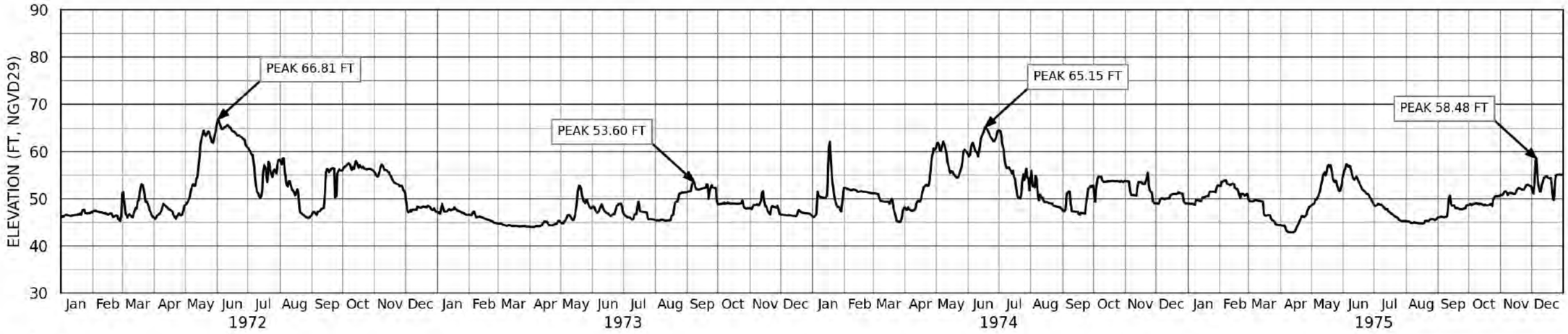
NOTE: PLATE SIZE IS 11" x 17"

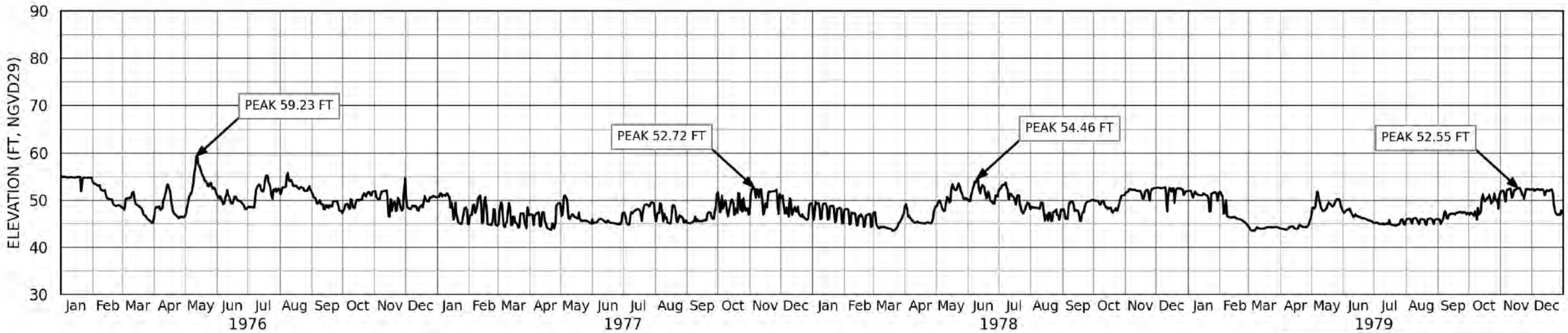
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1961-1971)

Completed by: WEST | April 2025

PLATE 4-17d







NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

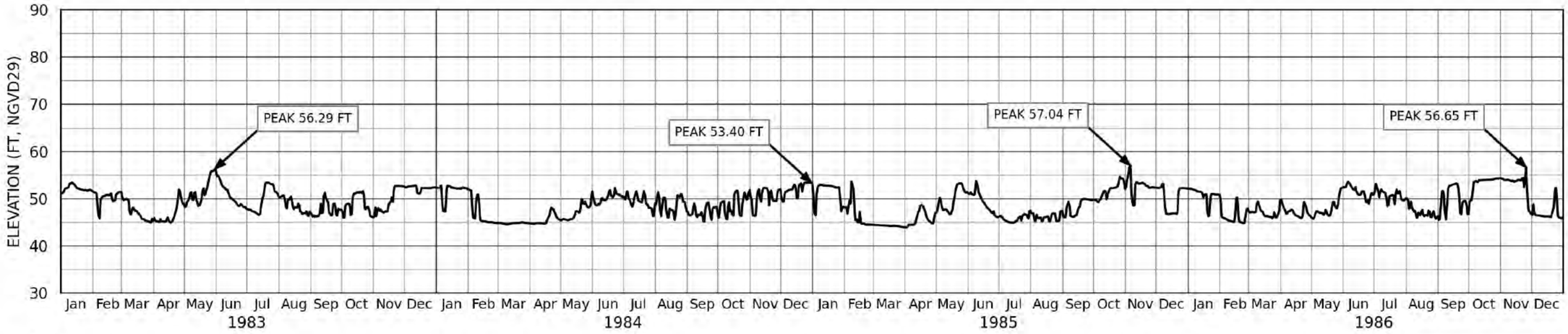
NOTE: PLATE SIZE IS 11" x 17"

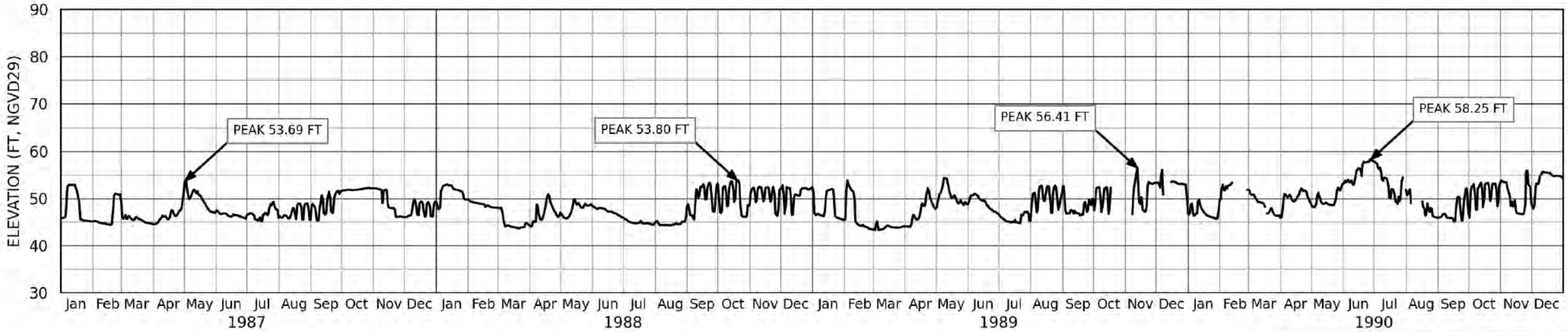
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

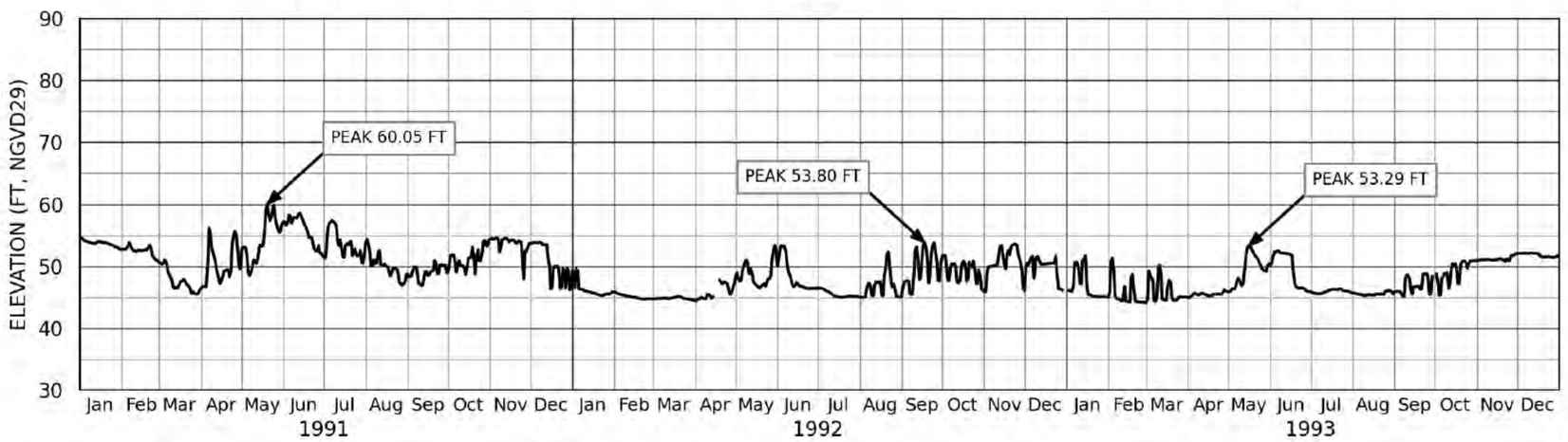
Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1972-1982)

Completed by: WEST	April 2025

PLATE 4-17e







NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

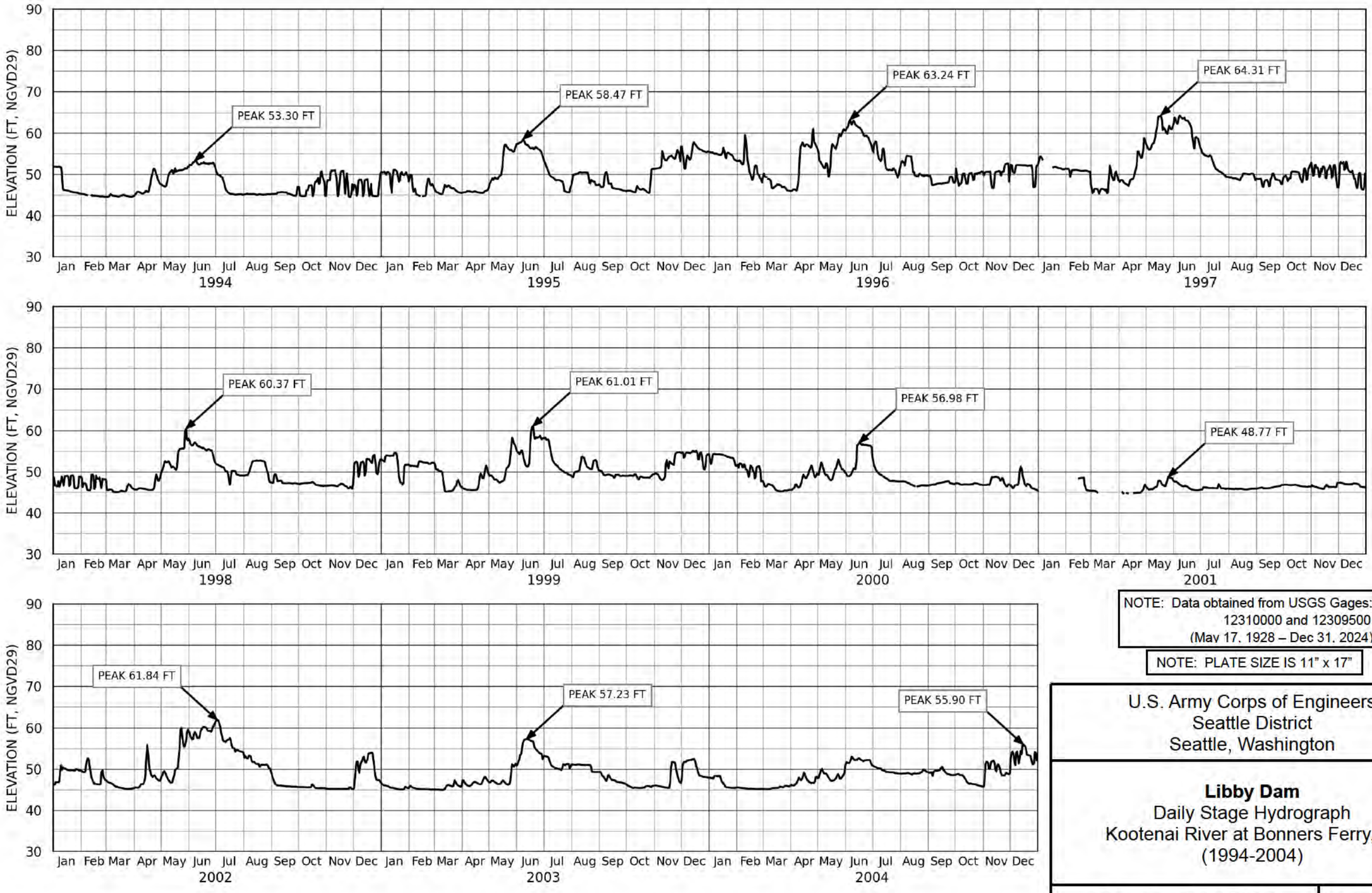
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1983-1993)

Completed by: WEST	April 2025

PLATE 4-17f



NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

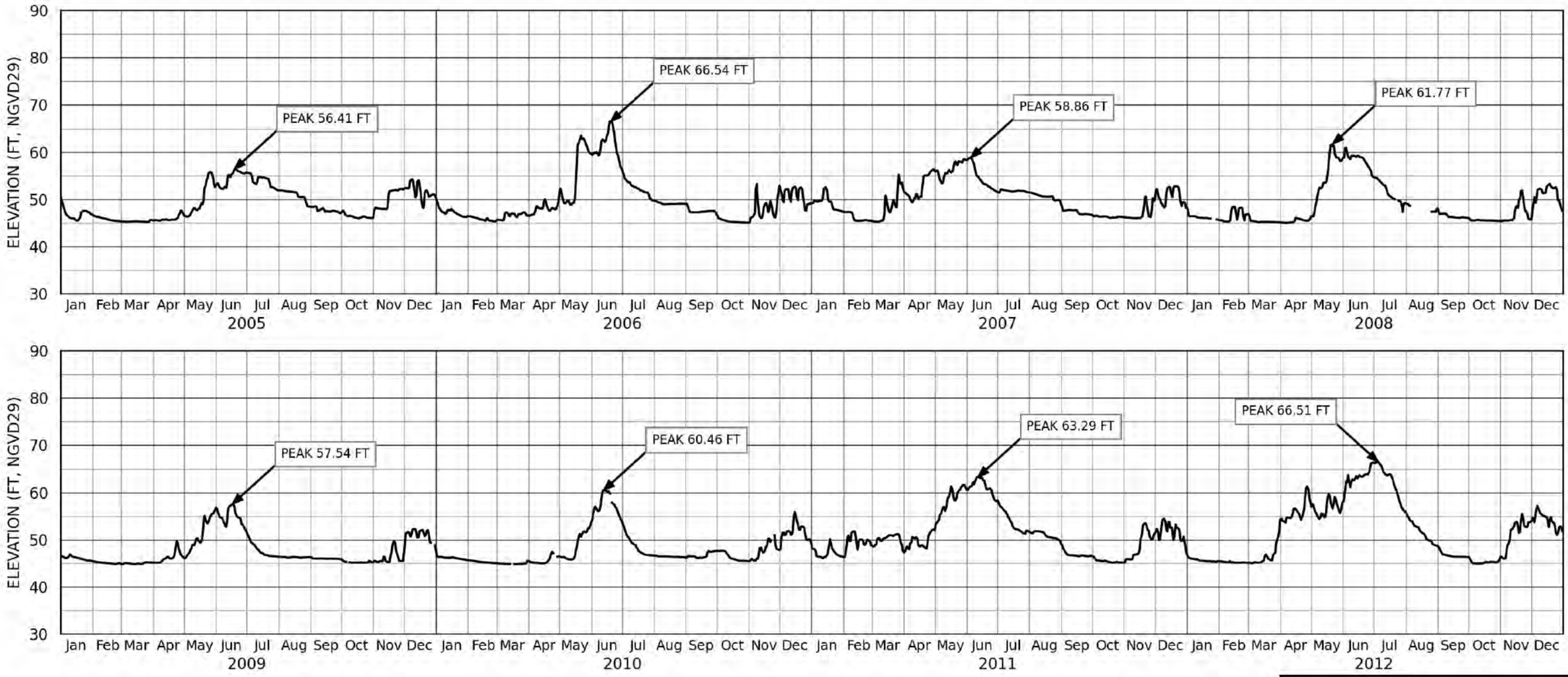
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(1994-2004)

Completed by: WEST	April 2025

PLATE 4-17g



NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

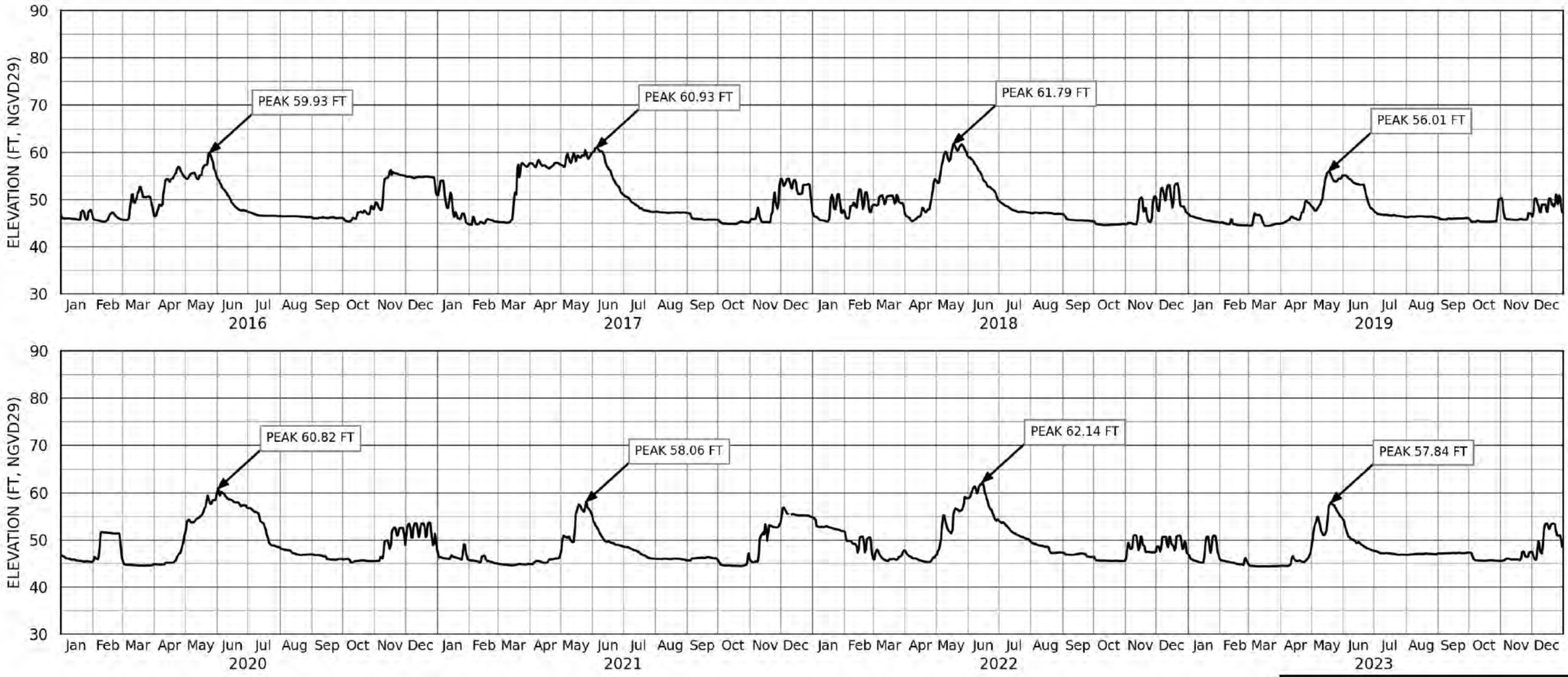
NOTE: PLATE SIZE IS 11" x 17"

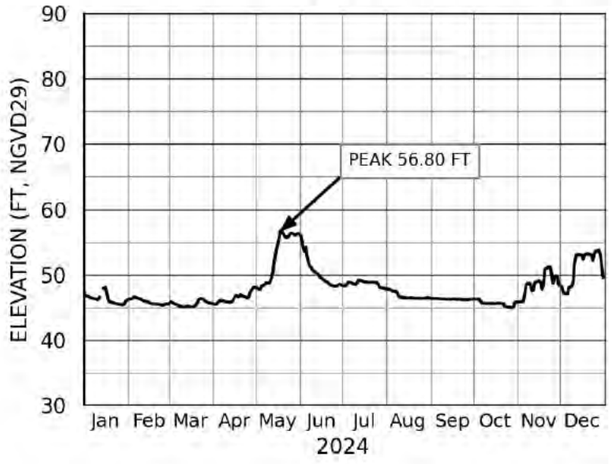
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(2005-2015)

Completed by: WEST	April 2025

PLATE 4-17h





NOTE: Data obtained from USGS Gages:
12310000 and 12309500
(May 17, 1928 – Dec 31, 2024)

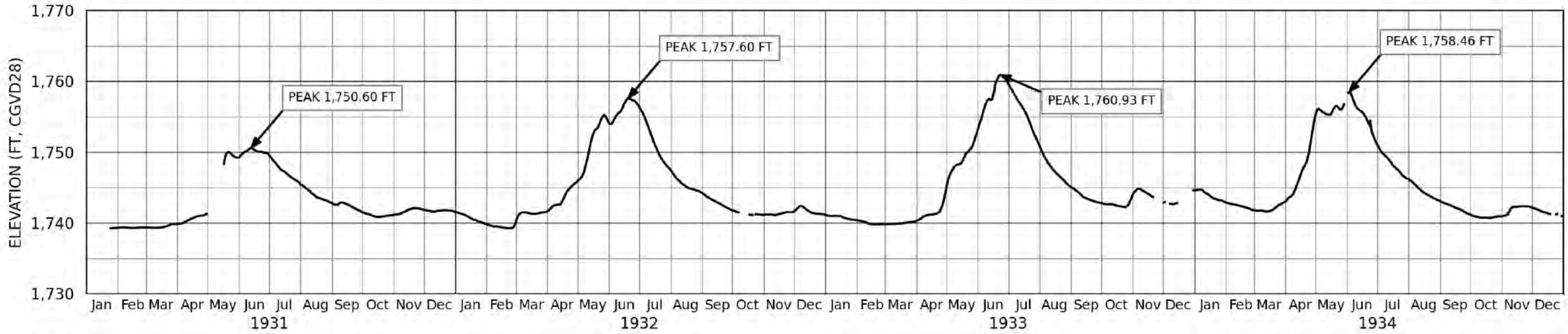
NOTE: PLATE SIZE IS 11" x 17"

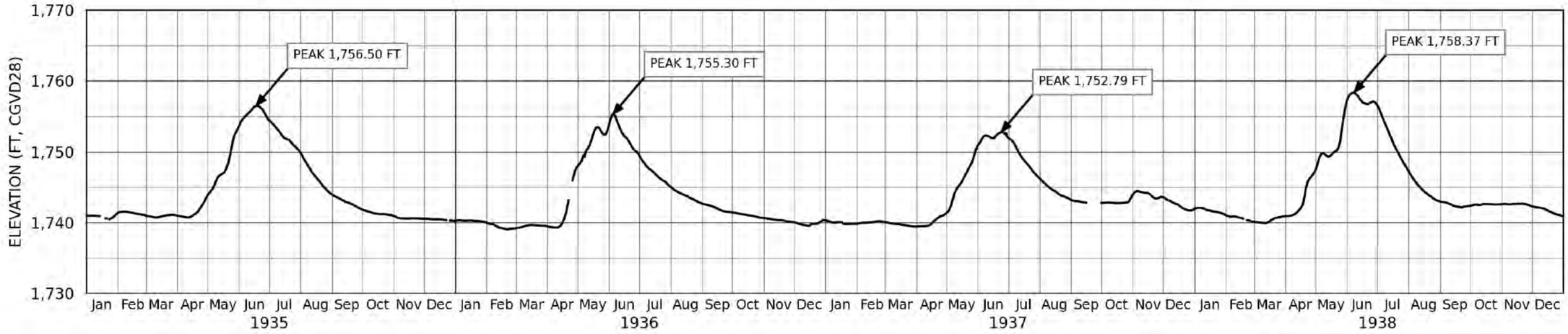
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

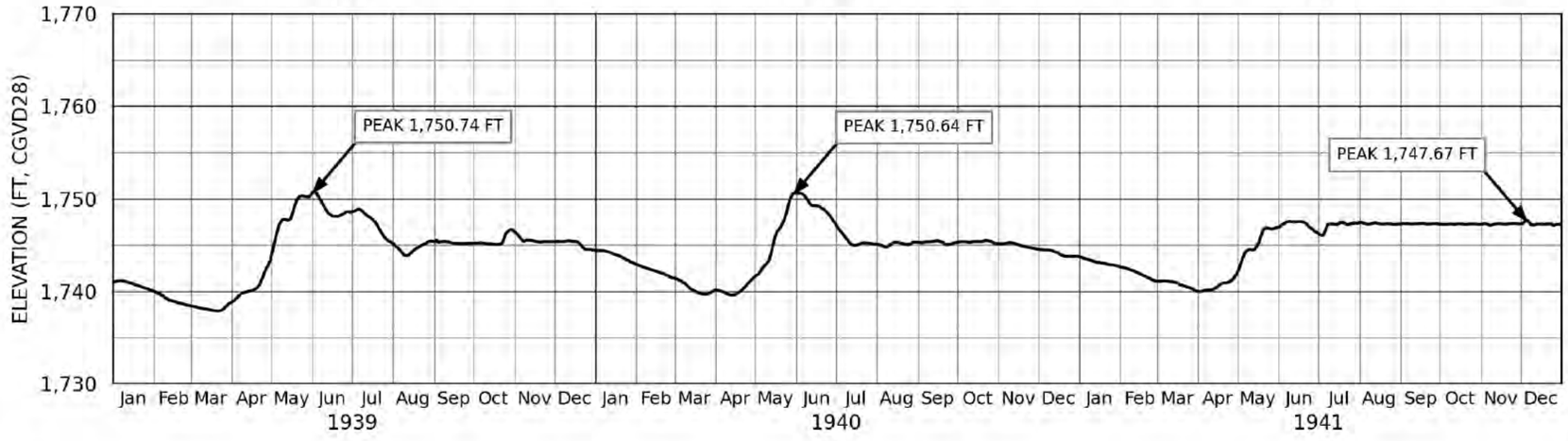
Libby Dam
Daily Stage Hydrograph
Kootenai River at Bonners Ferry, ID
(2016-2024)

Completed by: WEST	April 2025

PLATE 4-17i







NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

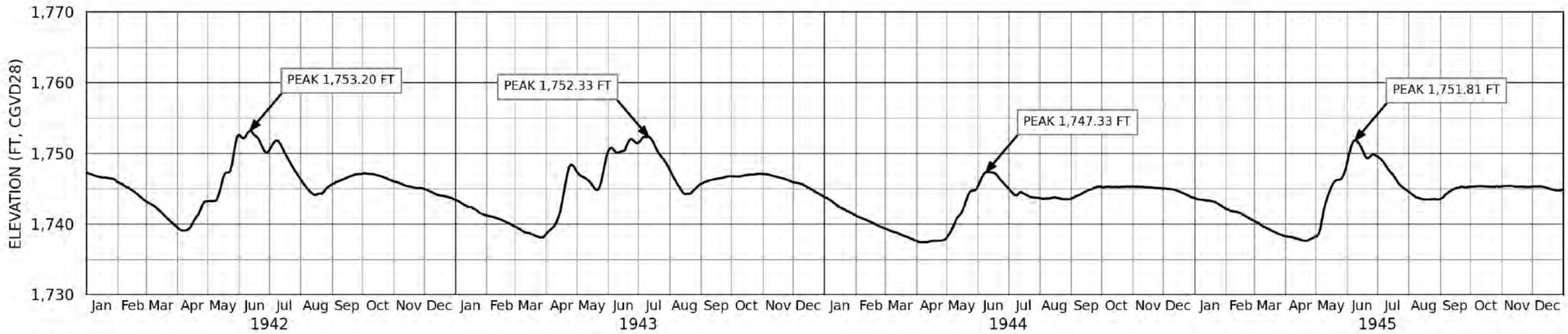
NOTE: PLATE SIZE IS 11" x 17"

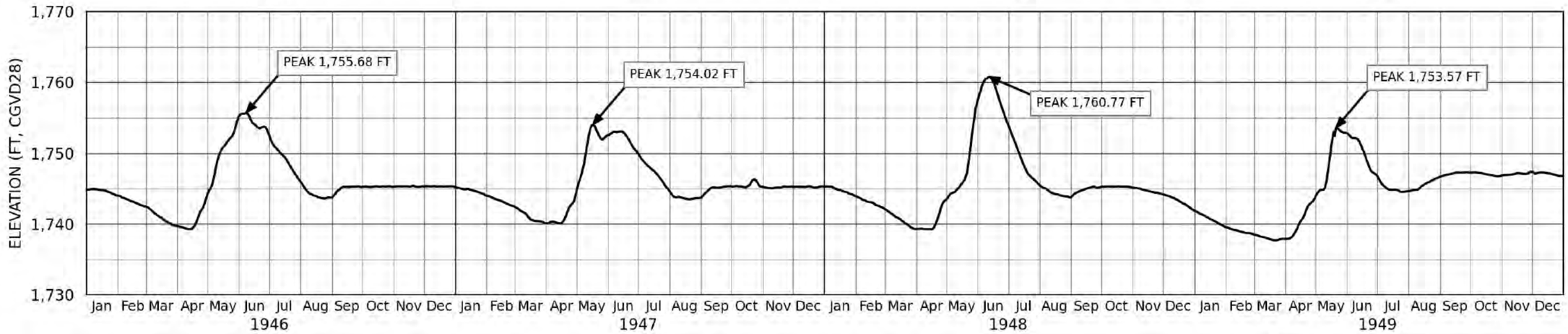
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

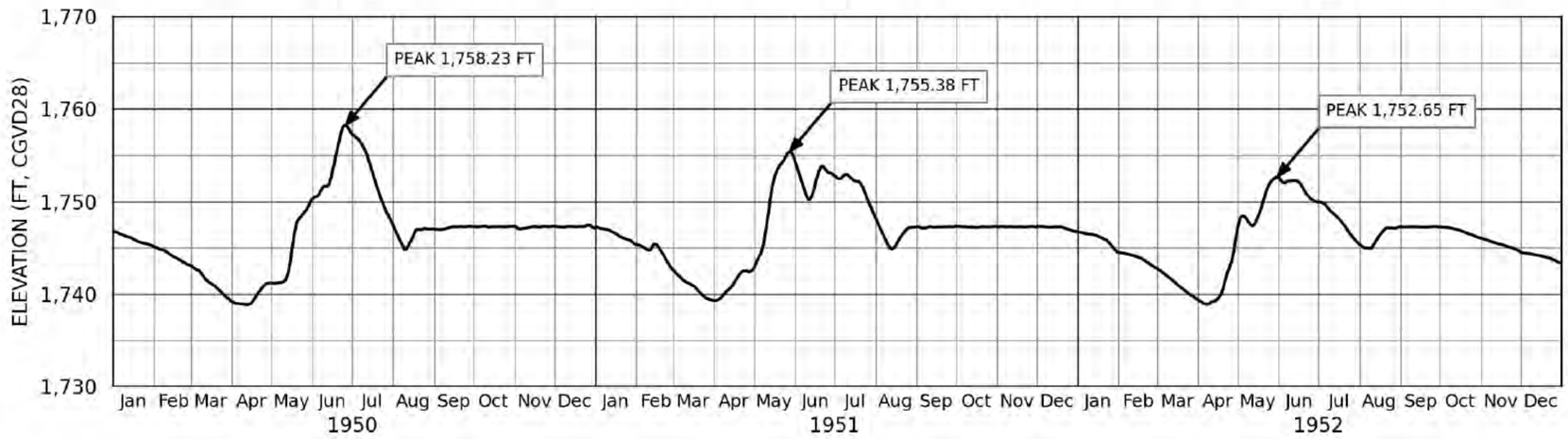
Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1931-1941)

Completed by: WEST	April 2025

PLATE 4-18a







NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

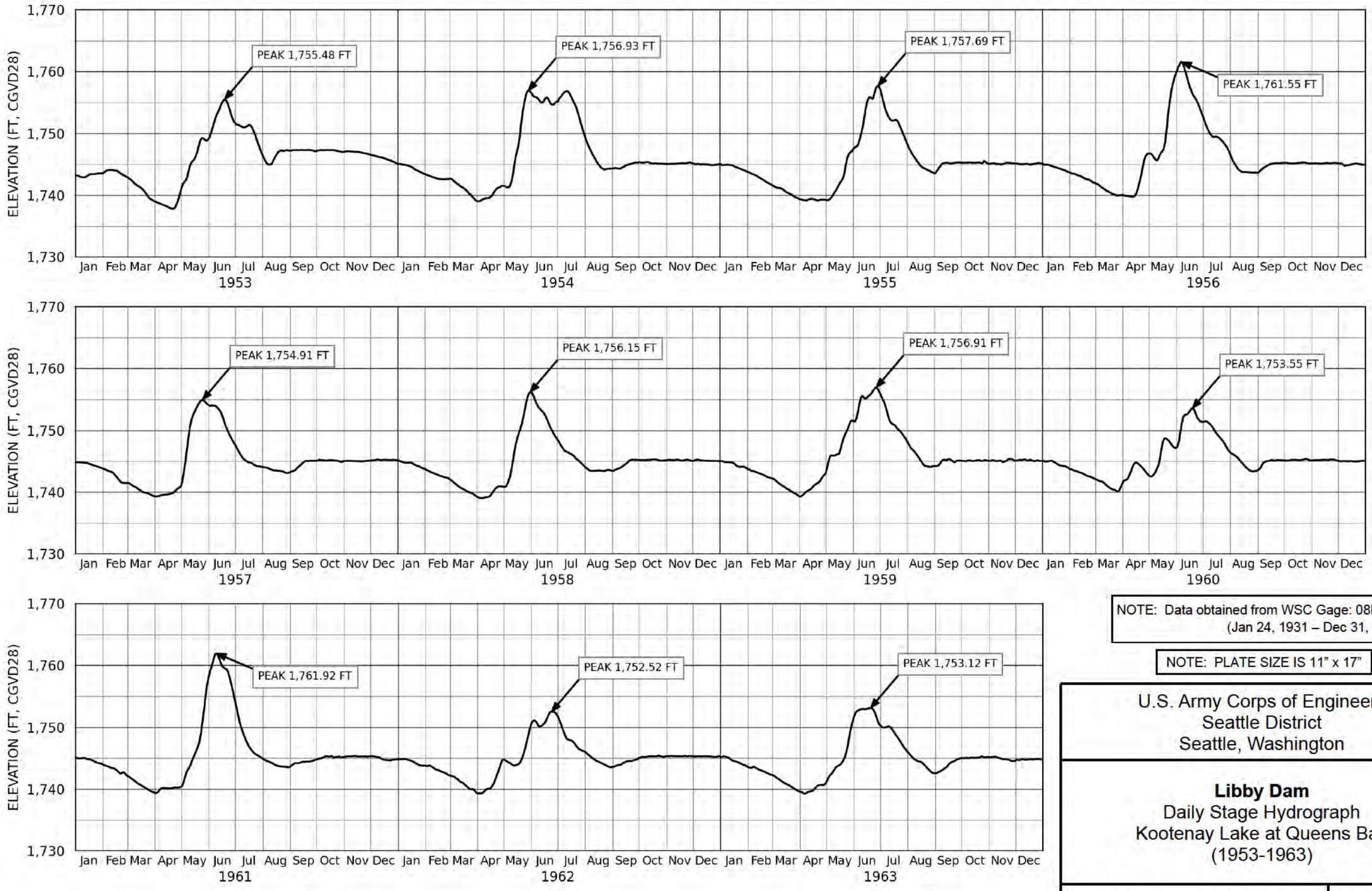
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1942-1952)

Completed by: WEST	April 2025

PLATE 4-18b



NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

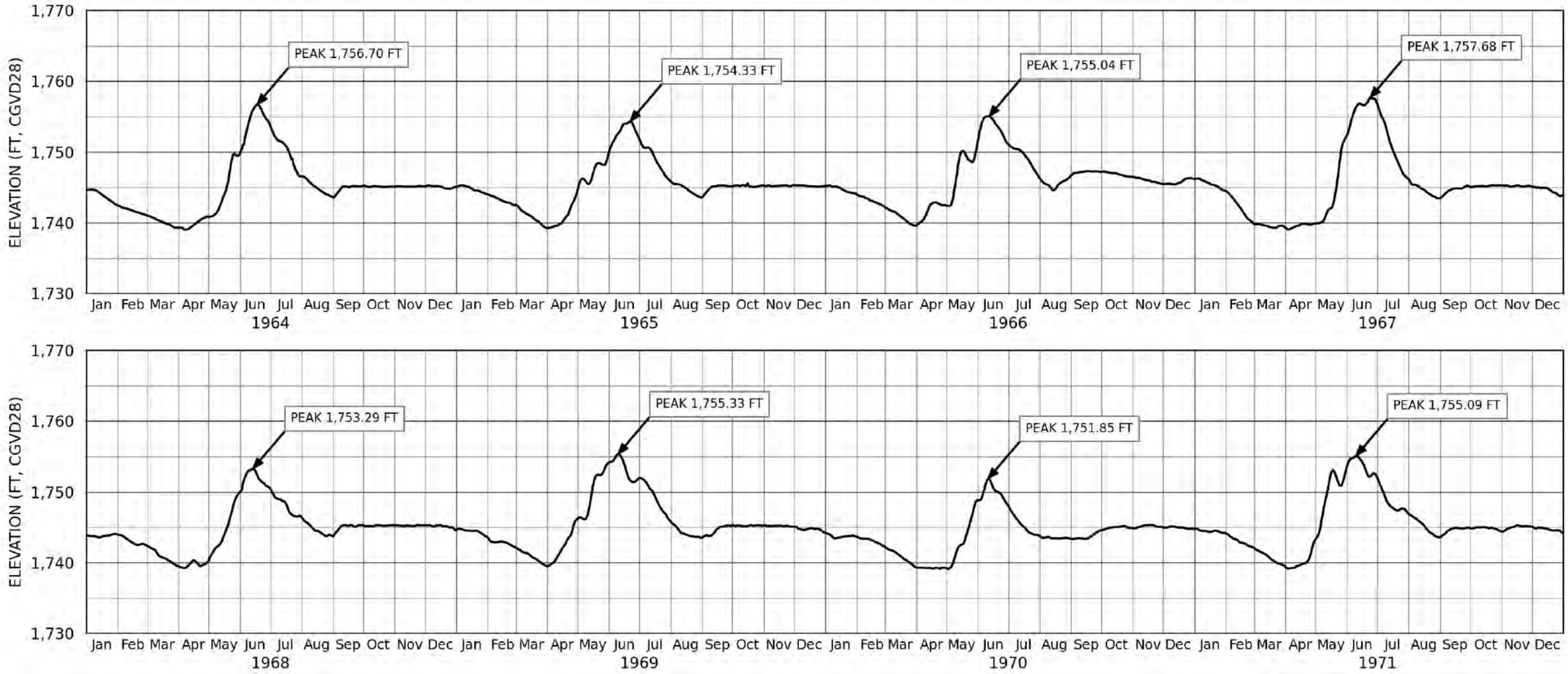
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1953-1963)

Completed by: WEST	April 2025

PLATE 4-18c



NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

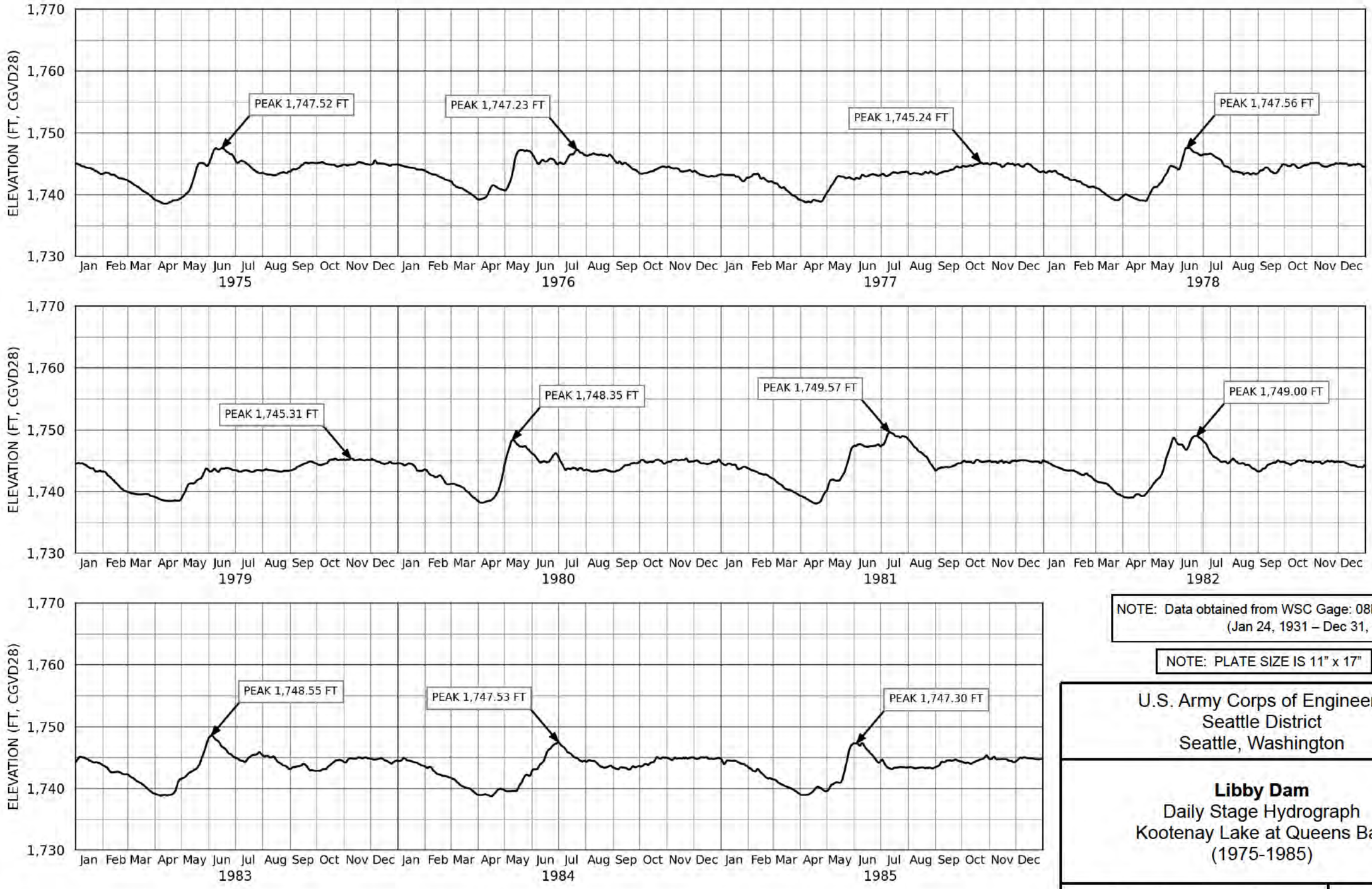
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1964-1974)

Completed by: WEST	April 2025

PLATE 4-18d



NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

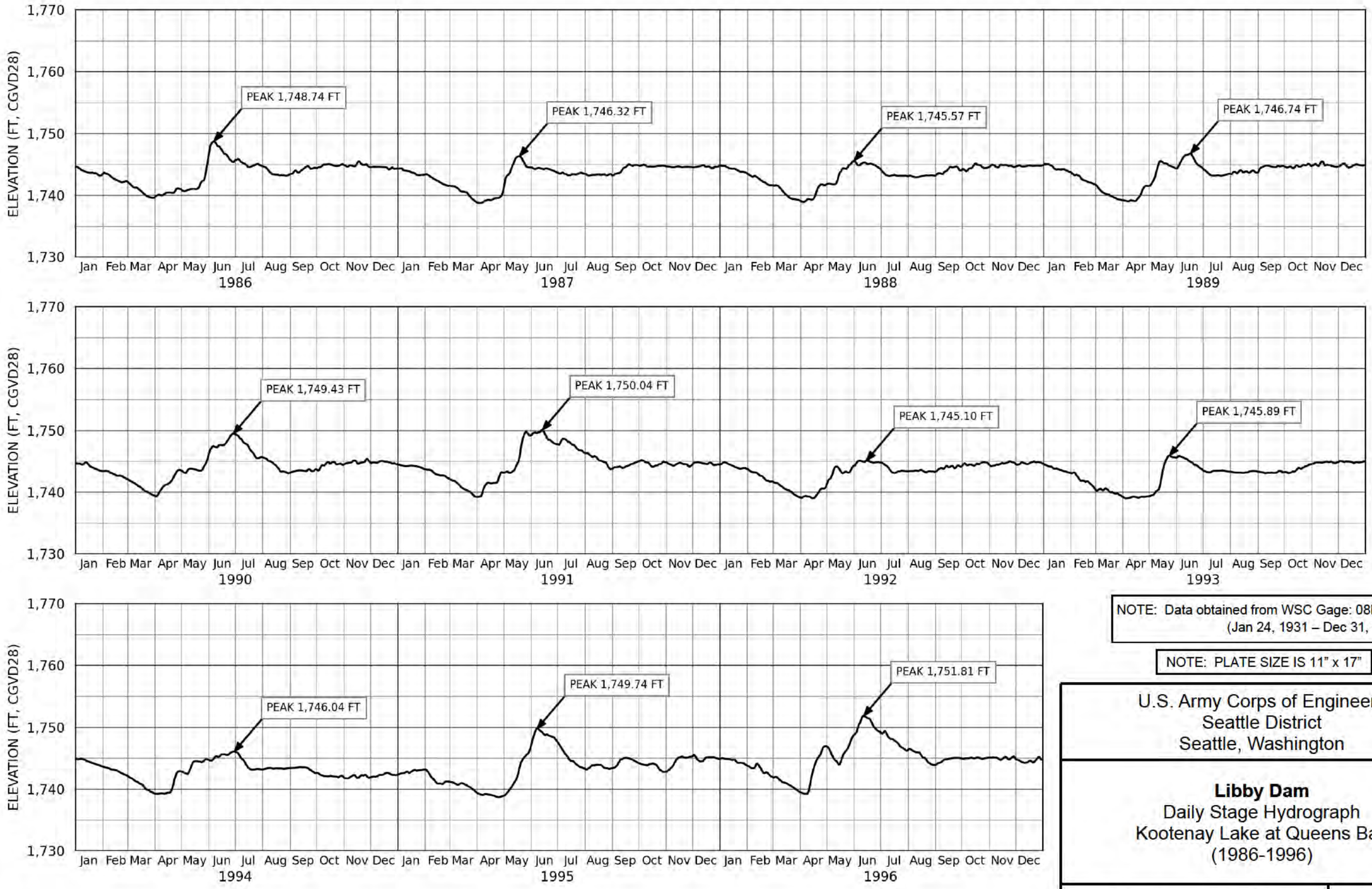
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1975-1985)

Completed by: WEST	April 2025

PLATE 4-18e



NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

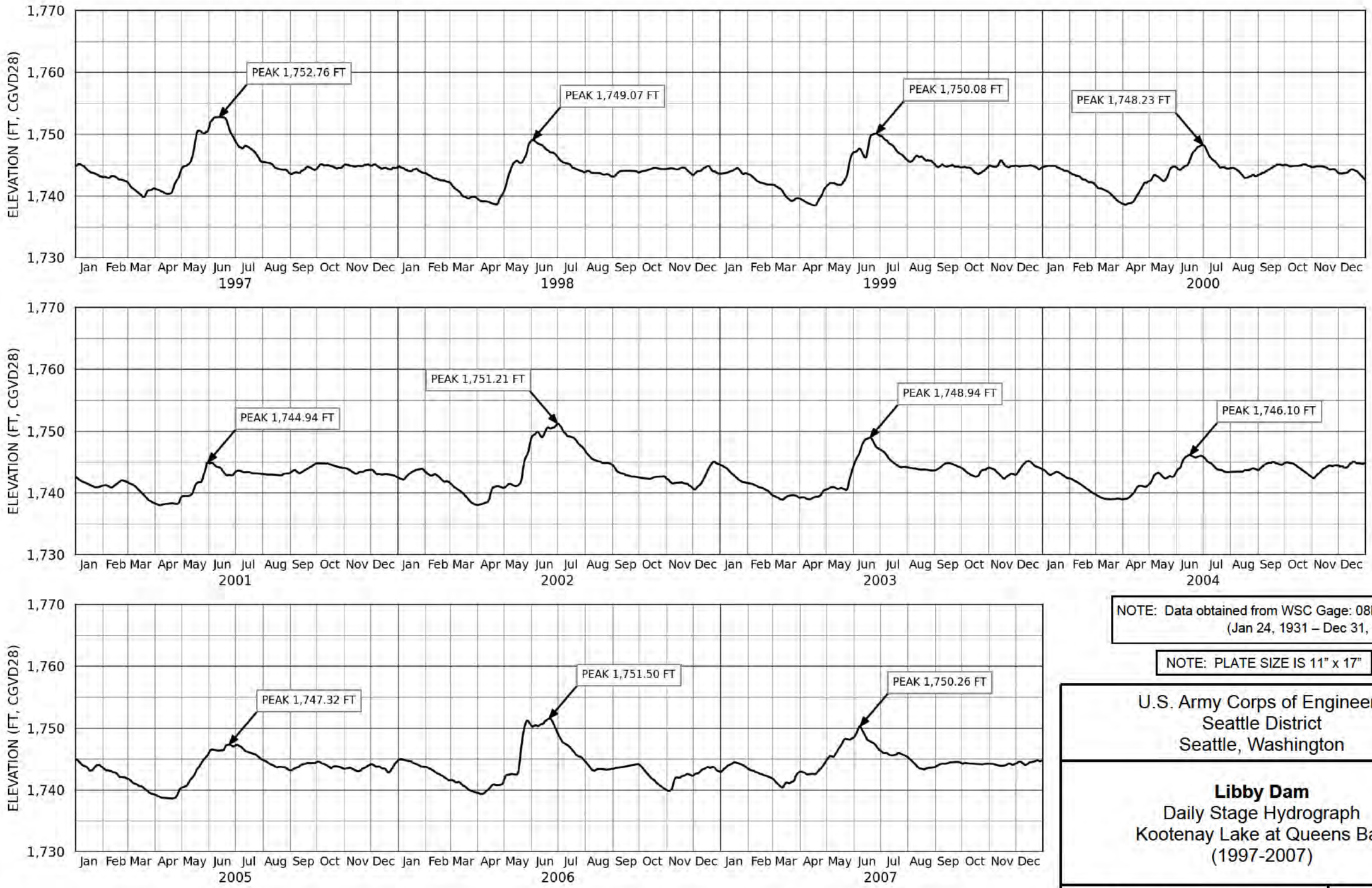
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1986-1996)

Completed by: WEST	April 2025

PLATE 4-18f



NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(1997-2007)

Completed by: WEST	April 2025

PLATE 4-18g

NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

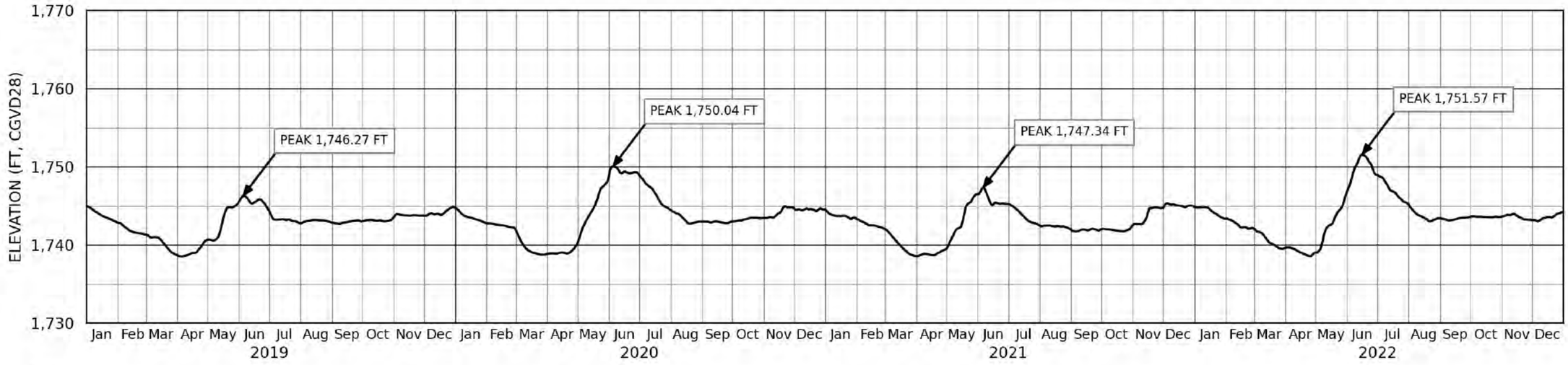
NOTE: PLATE SIZE IS 11" x 17"

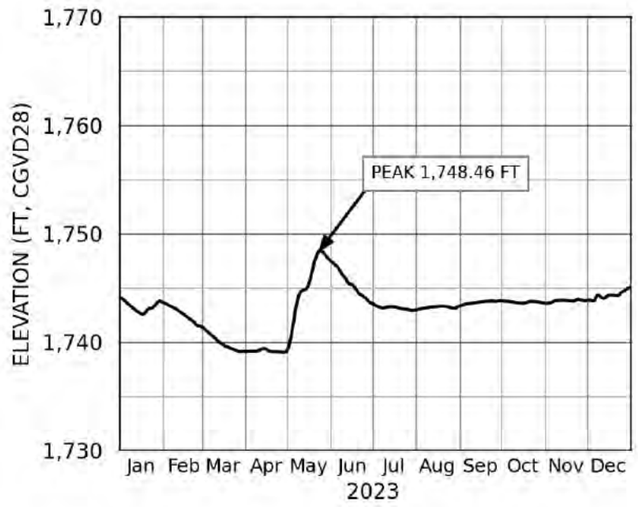
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(2008-2018)

Completed by: WEST	April 2025

PLATE 4-18h





NOTE: Data obtained from WSC Gage: 08NH64
(Jan 24, 1931 – Dec 31, 2023)

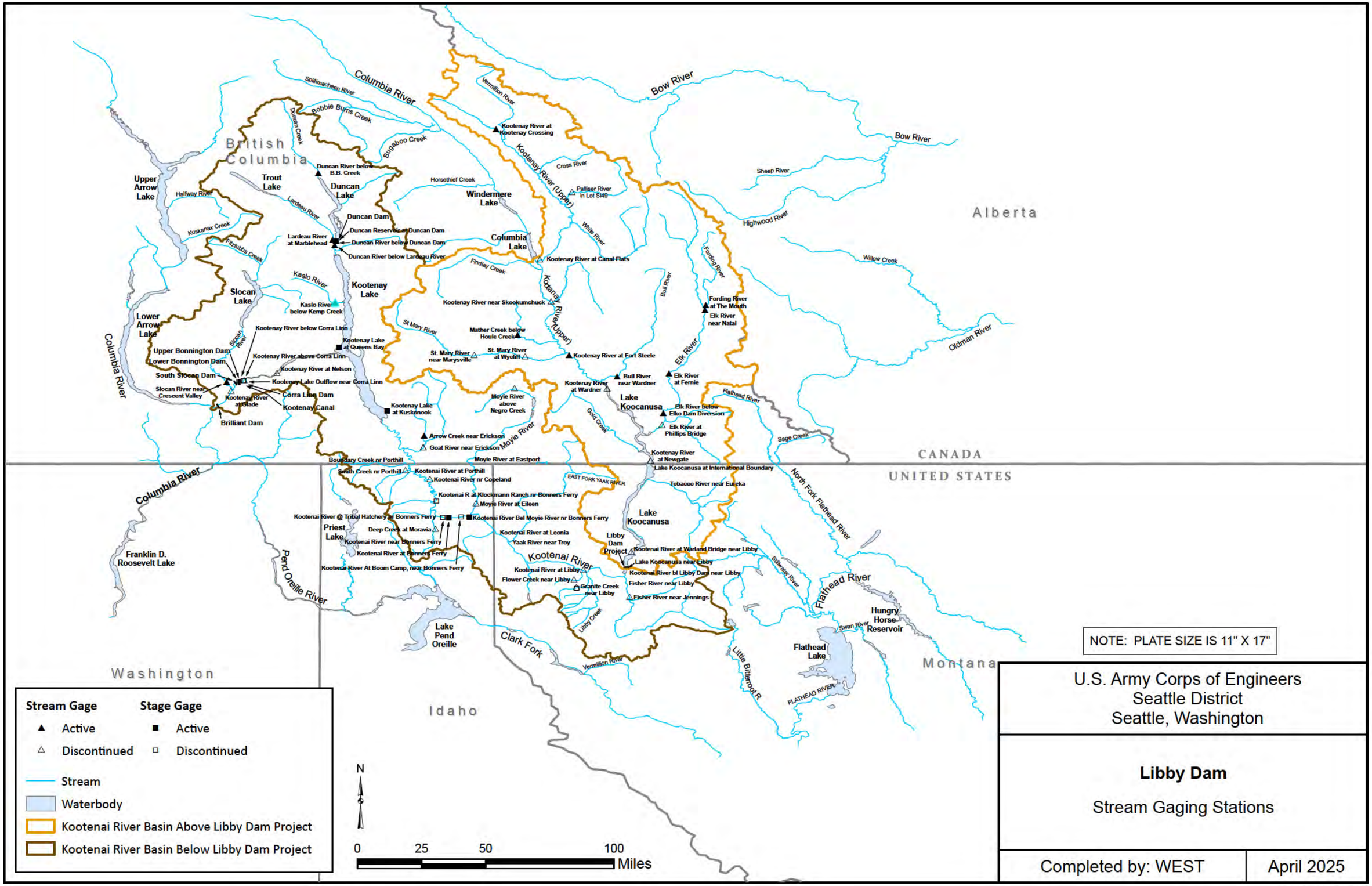
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Daily Stage Hydrograph
Kootenay Lake at Queens Bay
(2019-2023)

Completed by: WEST	April 2025

PLATE 4-18i



NOTE: PLATE SIZE IS 11" X 17"

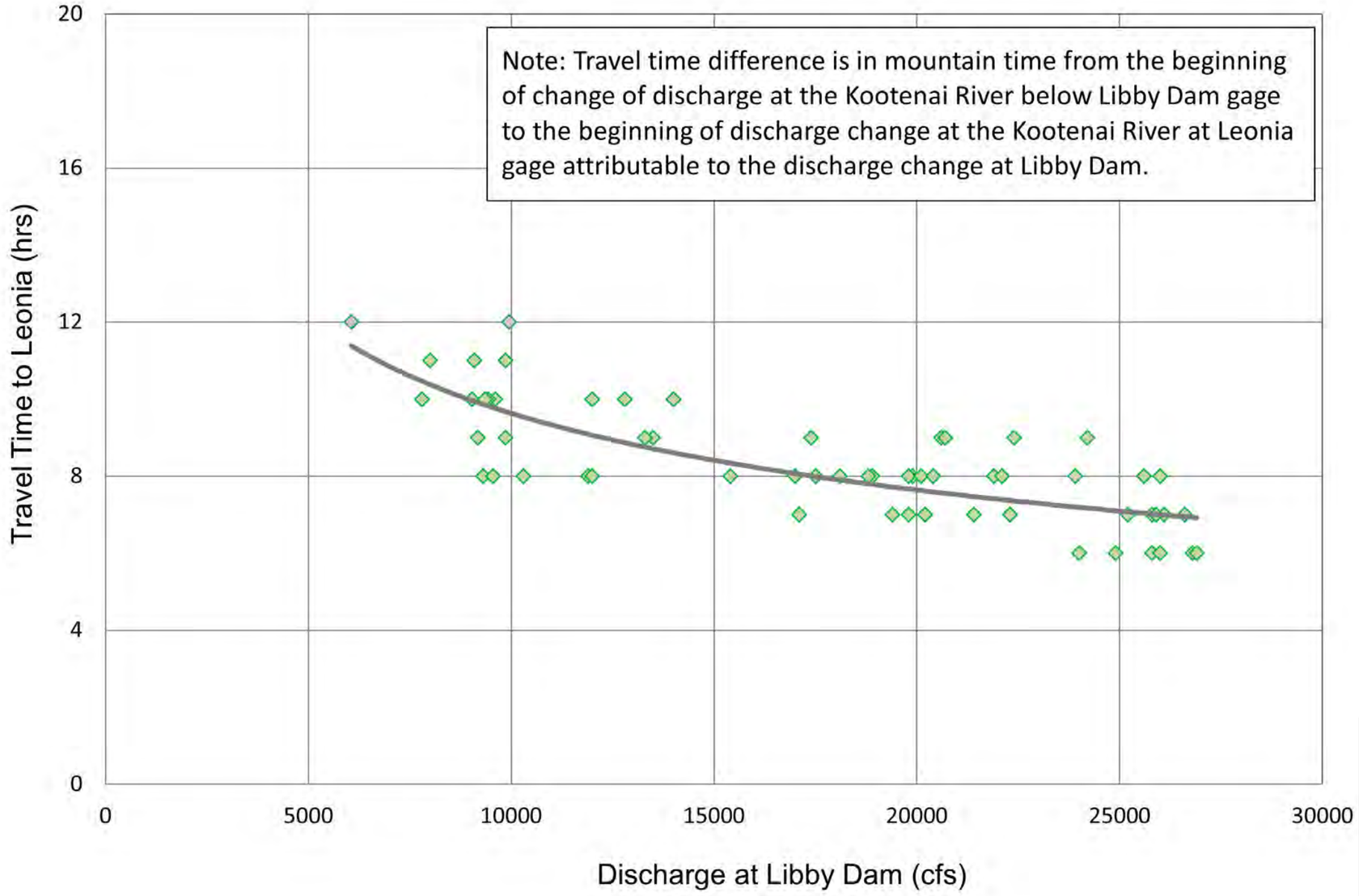
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Stream Gaging Stations

Completed by: WEST | April 2025

PLATE 4-19



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 4-8 IN THE PREVIOUS WCM DATED 2012.

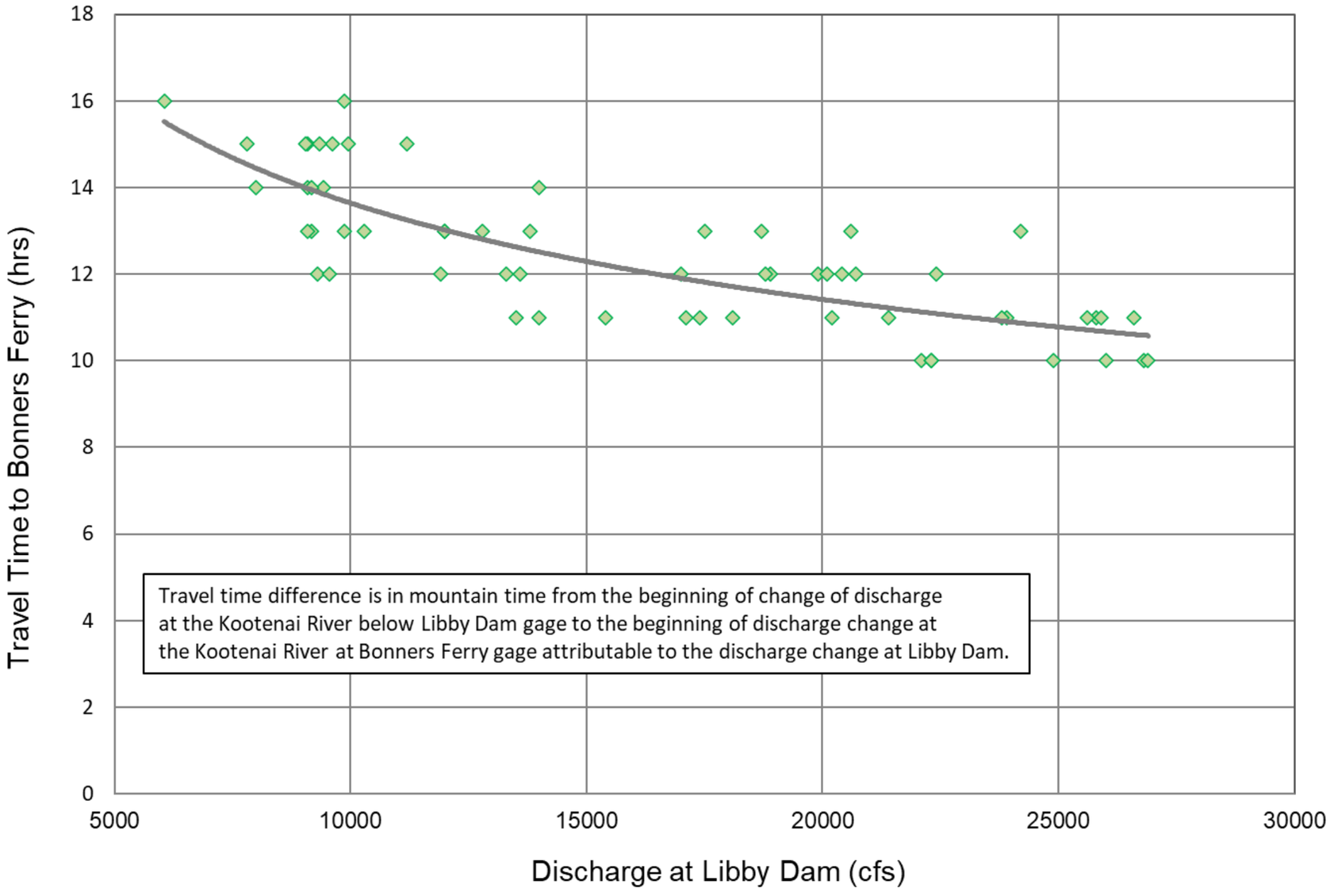
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Travel Time from Libby Dam
to Leonia, Idaho

Source: See Left Note | April 2025

PLATE 4-20



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 4-9 IN THE PREVIOUS WCM DATED 2012.

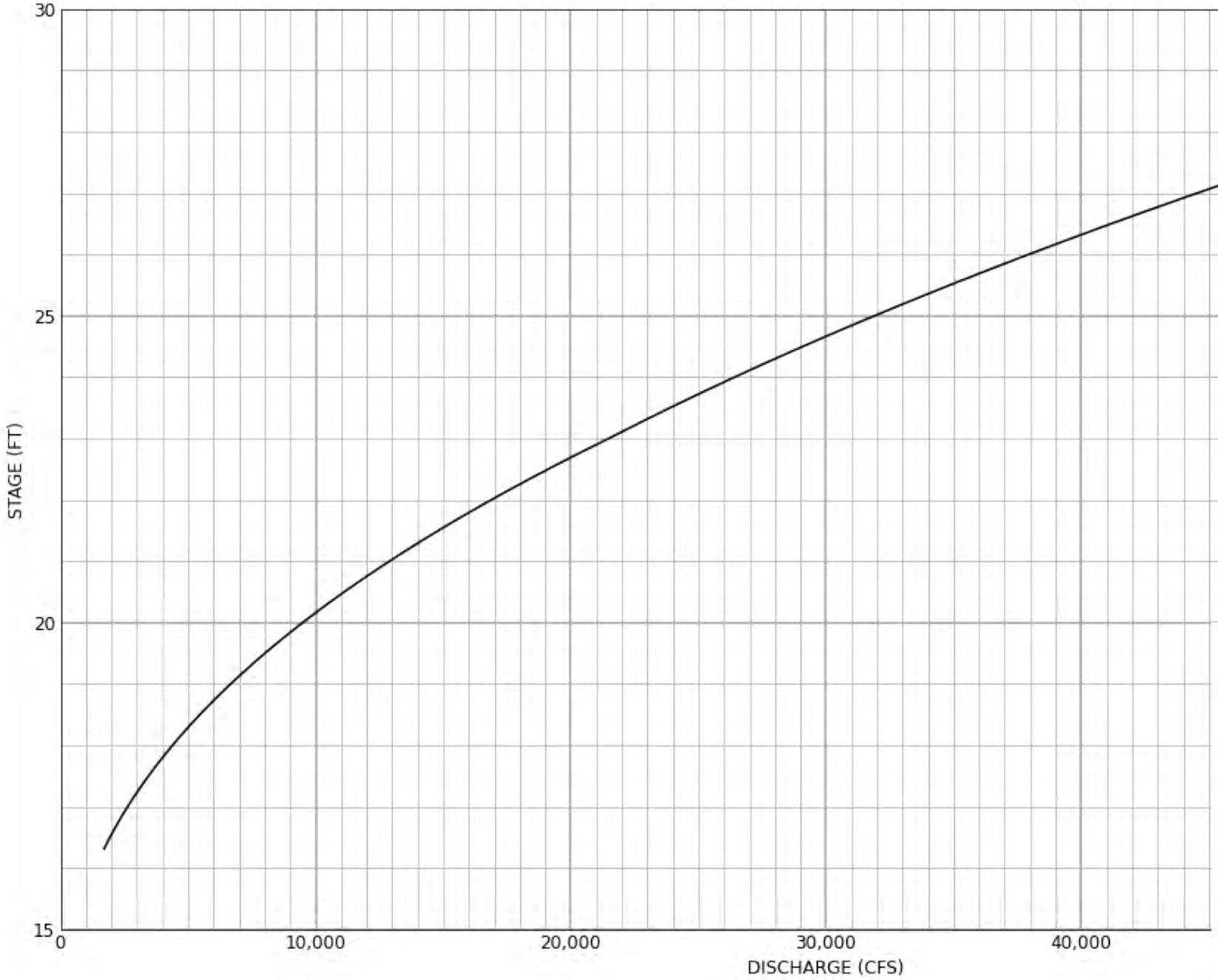
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Travel Time from Libby Dam
to Bonners Ferry, ID

Source: See Left Note | April 2025

PLATE 4-21



NOTE: Data obtained from USGS Gage: 12301933
Gage Datum: 2,100 ft, NGVD29
Latest Rating Curve Data: Feb 20th, 2025

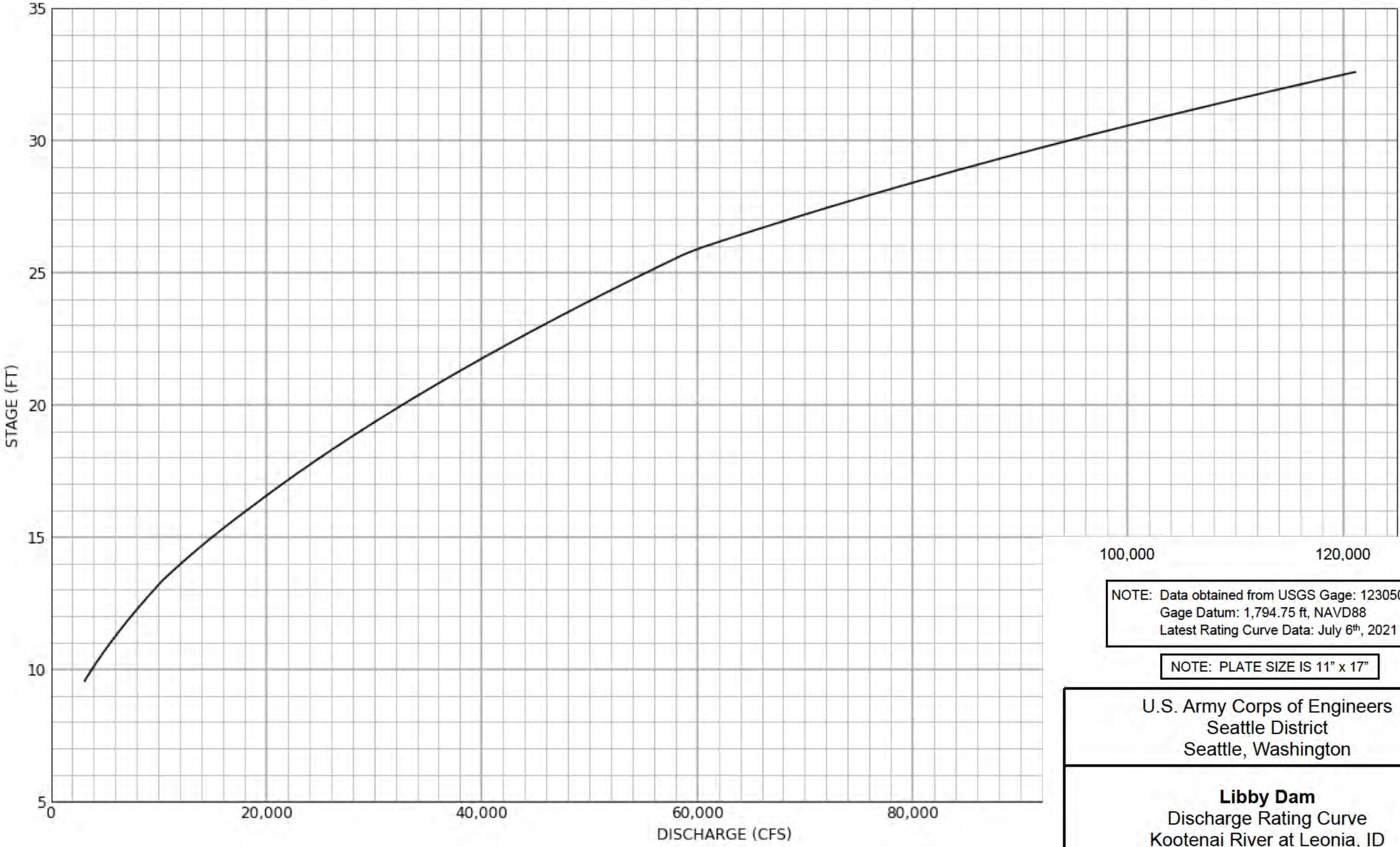
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Discharge Rating Curve
Kootenai River bl Libby Dam nr Libby, MT
USGS 12301933

Completed by: WEST	April 2025

PLATE 4-22



NOTE: Data obtained from USGS Gage: 12305000
Gage Datum: 1,794.75 ft, NAVD88
Latest Rating Curve Data: July 6th, 2021

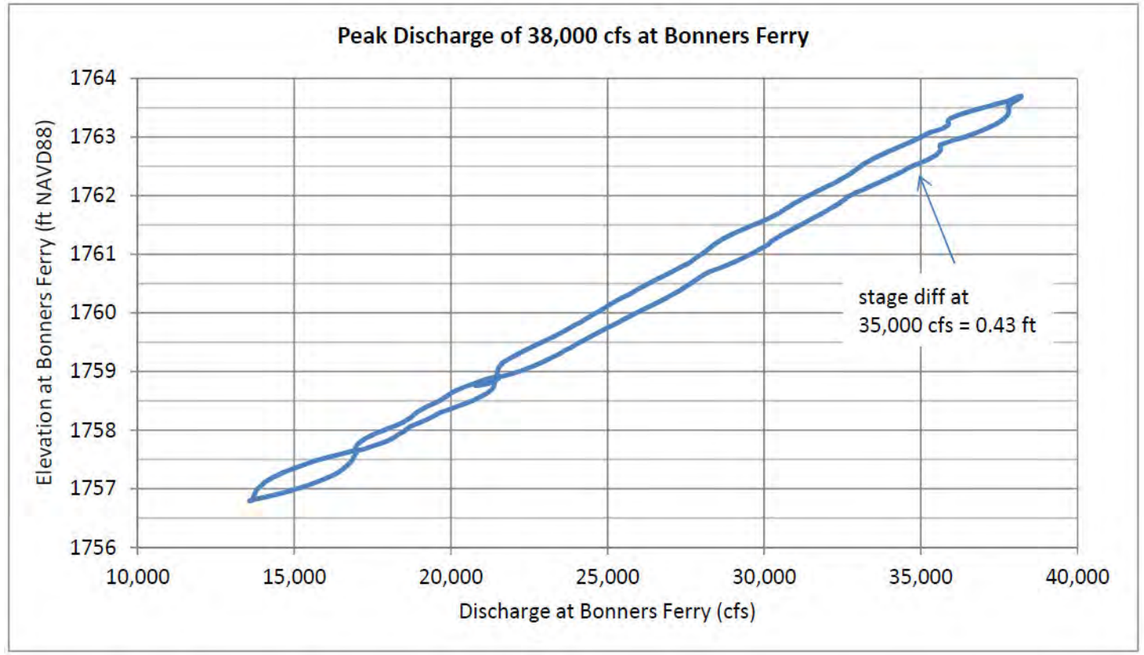
NOTE: PLATE SIZE IS 11" x 17"

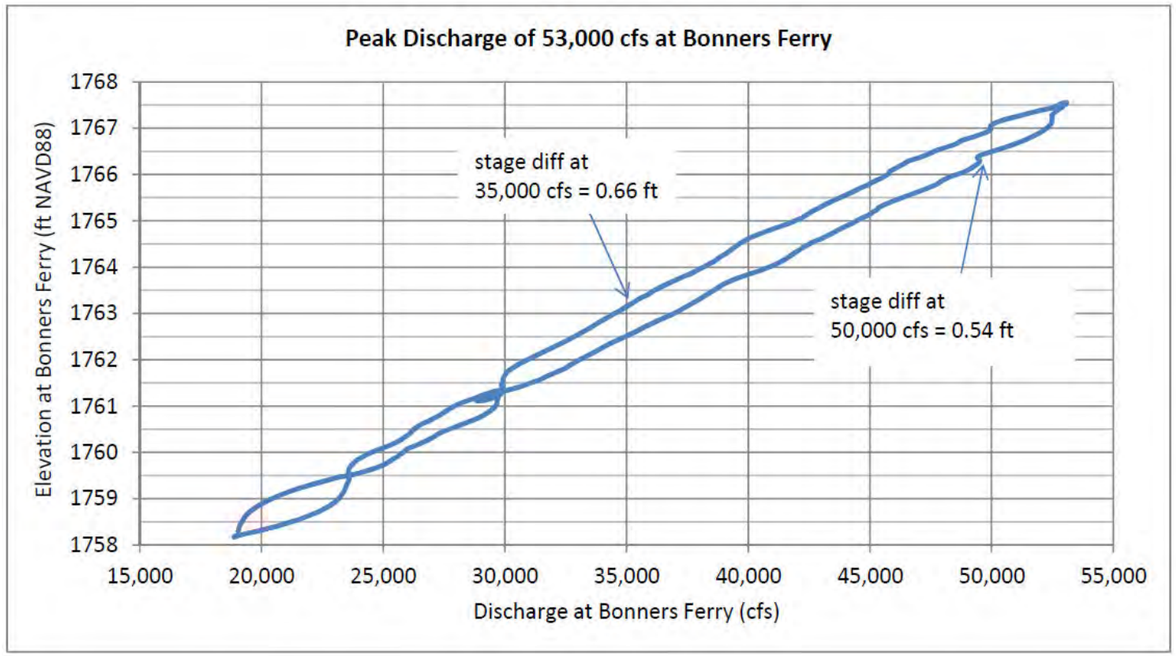
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

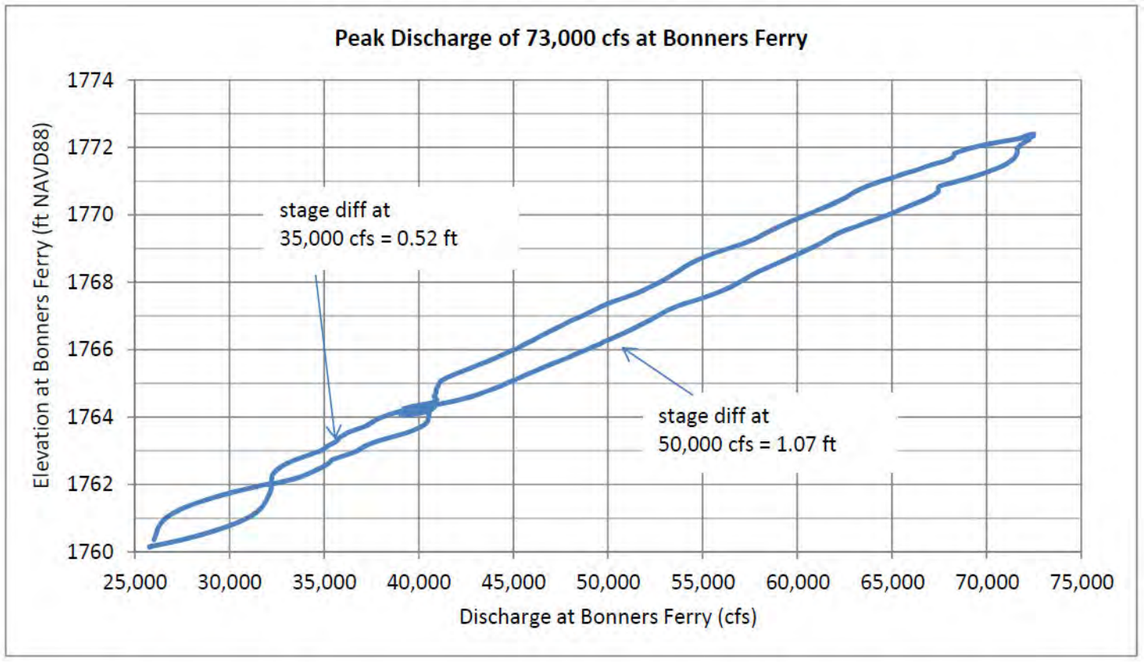
Libby Dam
Discharge Rating Curve
Kootenai River at Leonia, ID
USGS 12305000

Completed by: WEST	April 2025

PLATE 4-23







* Results from unsteady RAS model; scaled release hydrograph from Libby Dam used to obtain peak flow values of 38,000, 53,000, and 73,000 cfs at Bonners Ferry; constant downstream boundary condition of 1,755 ft, NAVD88 used

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 4-12 IN THE PREVIOUS WCM DATED 2012.

NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Variability in Stage-Discharge Rating
Kootenai River at Bonners Ferry, Idaho

Source: See Left Note | April 2025

PLATE 4-24



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM FIGURE 4-1 IN THE PREVIOUS WCM DATED 2012. NOT PICTURED: DUNCAN DAM.

NOTE: PLATE SIZE IS 11" x 17"

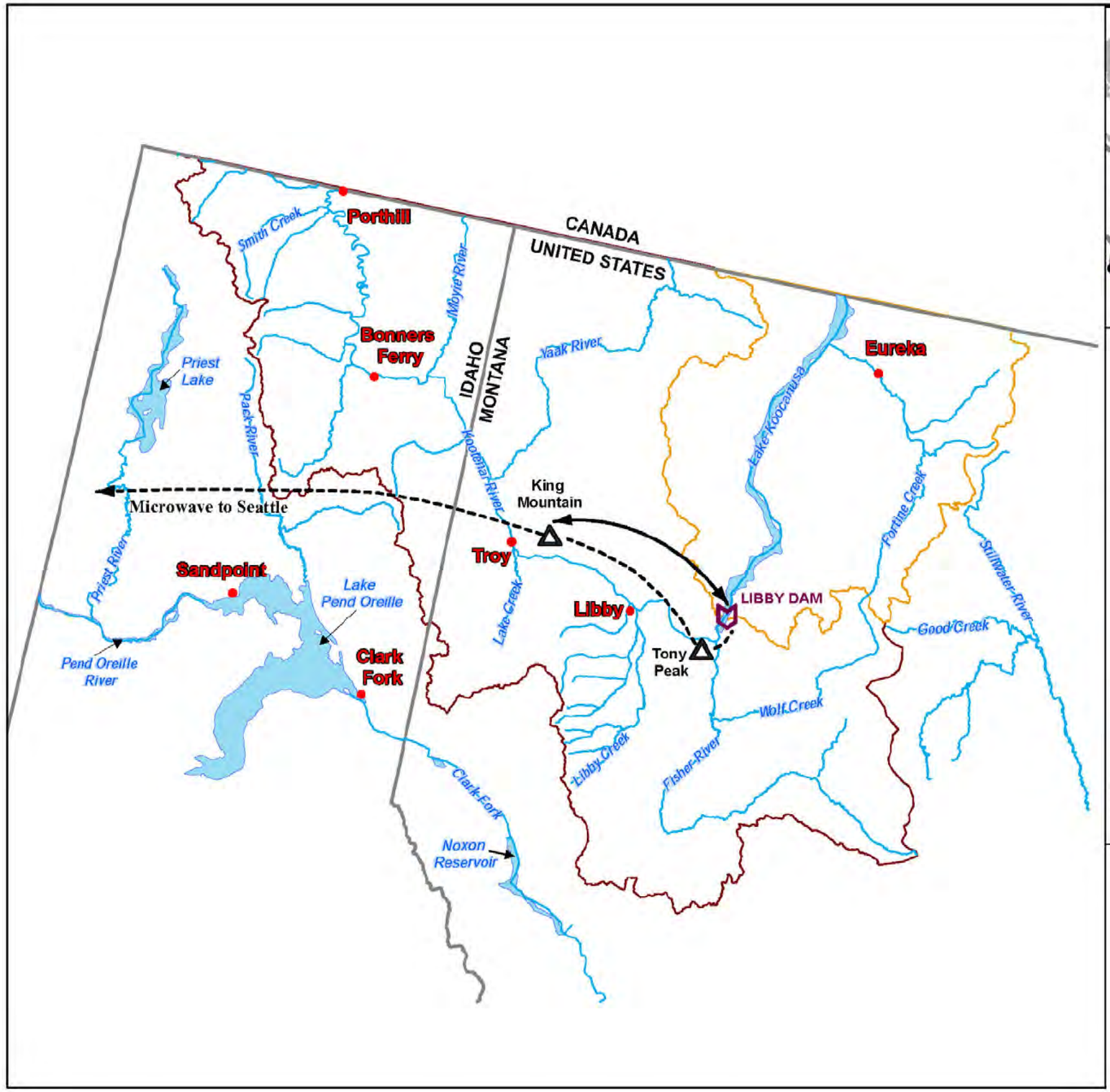
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

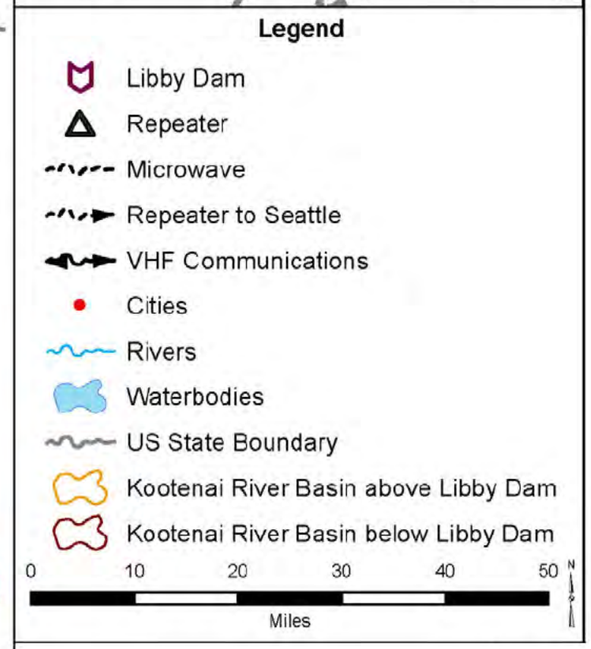
Lower Kootenai River Projects

Source: See Left Note	April 2025

PLATE 4-25







NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Hydromet Communications System

Source: See Left Note | April 2025

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 5-1 IN THE PREVIOUS WCM DATED 2012.

PLATE 5-1

US-CANADA BORDER

LIBBOR
LBOM
Roosville
Rexford
Tobacco River
Eureka
93
Yaak
Yaak River
Sylvanite
Fortine
Trego
Stryker
Lake Koocanusa
LIBTMC
Tenmile Creek
LIBBY DAM
Troy
Kootenai River
2
LIBFB
LIBM/LIBTW
Libby
Jennings
37
White Haven
2
Fisher River

Station	Description
LIBM/LIBTW	Kootenai River below Libby Dam
LIBFB	Lake Koocanusa at Forebay
LIBTMC	Lake Koocanusa at Ten Mile Creek
LIBBOR	Lake Koocanusa at International Border
LBOM	Lake Koocanusa at Canadian Border

USACE Water Quality Stations
Town
River
Highway
Lake

N

0 2.5 5 10 Miles

NOTE: PLATE SIZE IS 11" X 17"

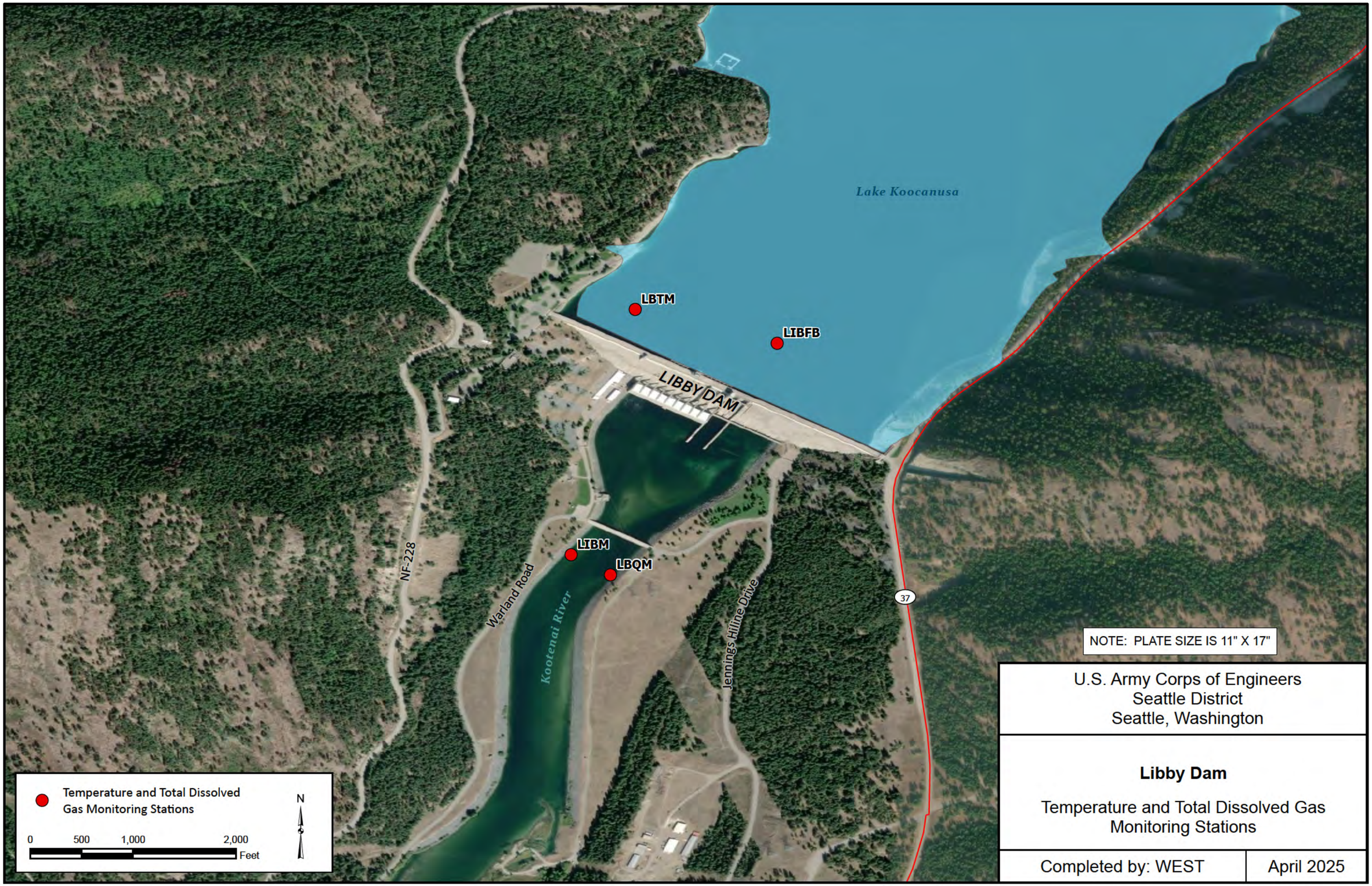
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Water Quality Stations

Completed by: WEST | December 2025

PLATE 5-2



NOTE: PLATE SIZE IS 11" X 17"

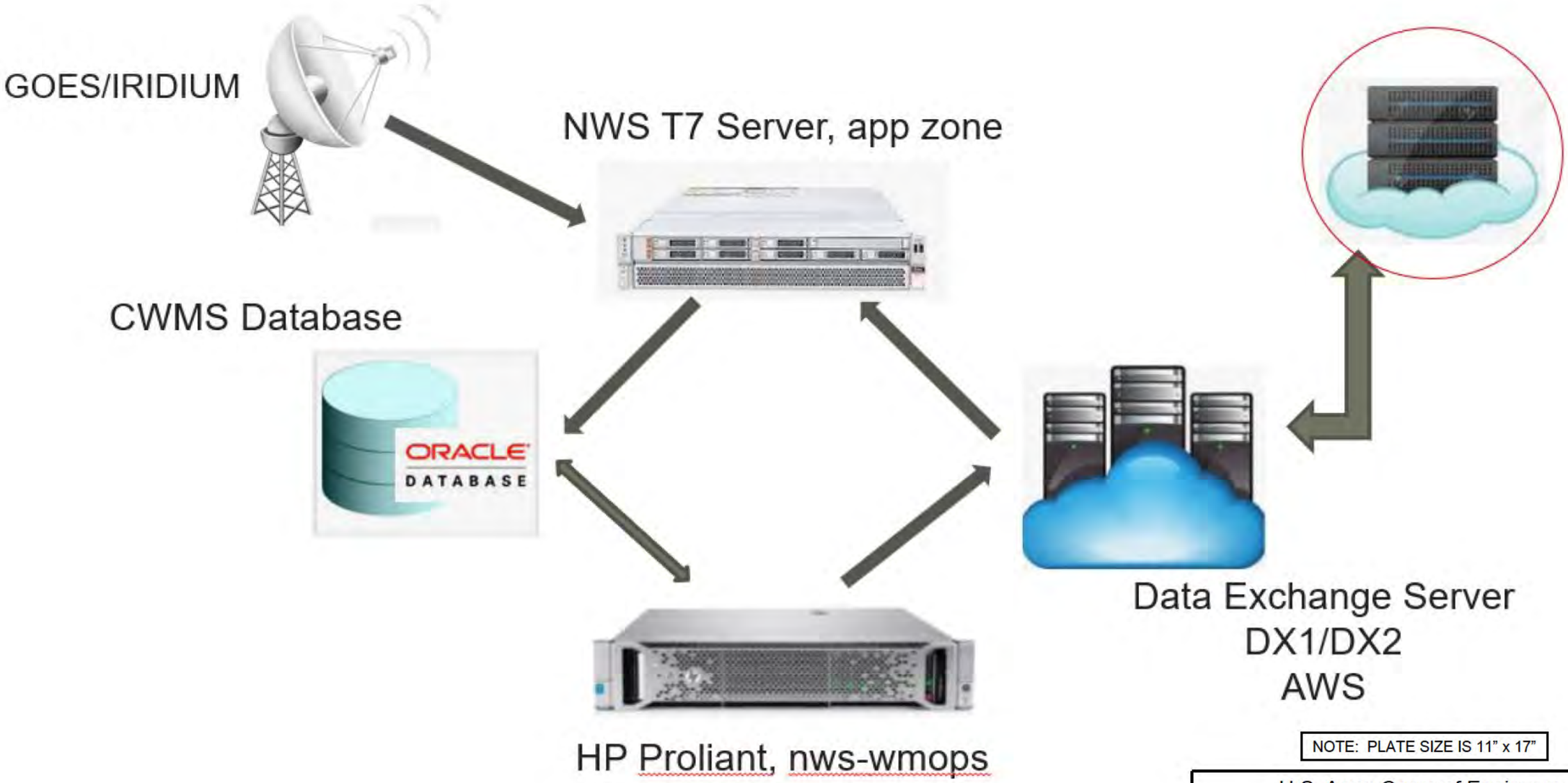
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam

Temperature and Total Dissolved Gas Monitoring Stations

Completed by: WEST	April 2025

PLATE 5-3



NOTE: PLATE SIZE IS 11" x 17"

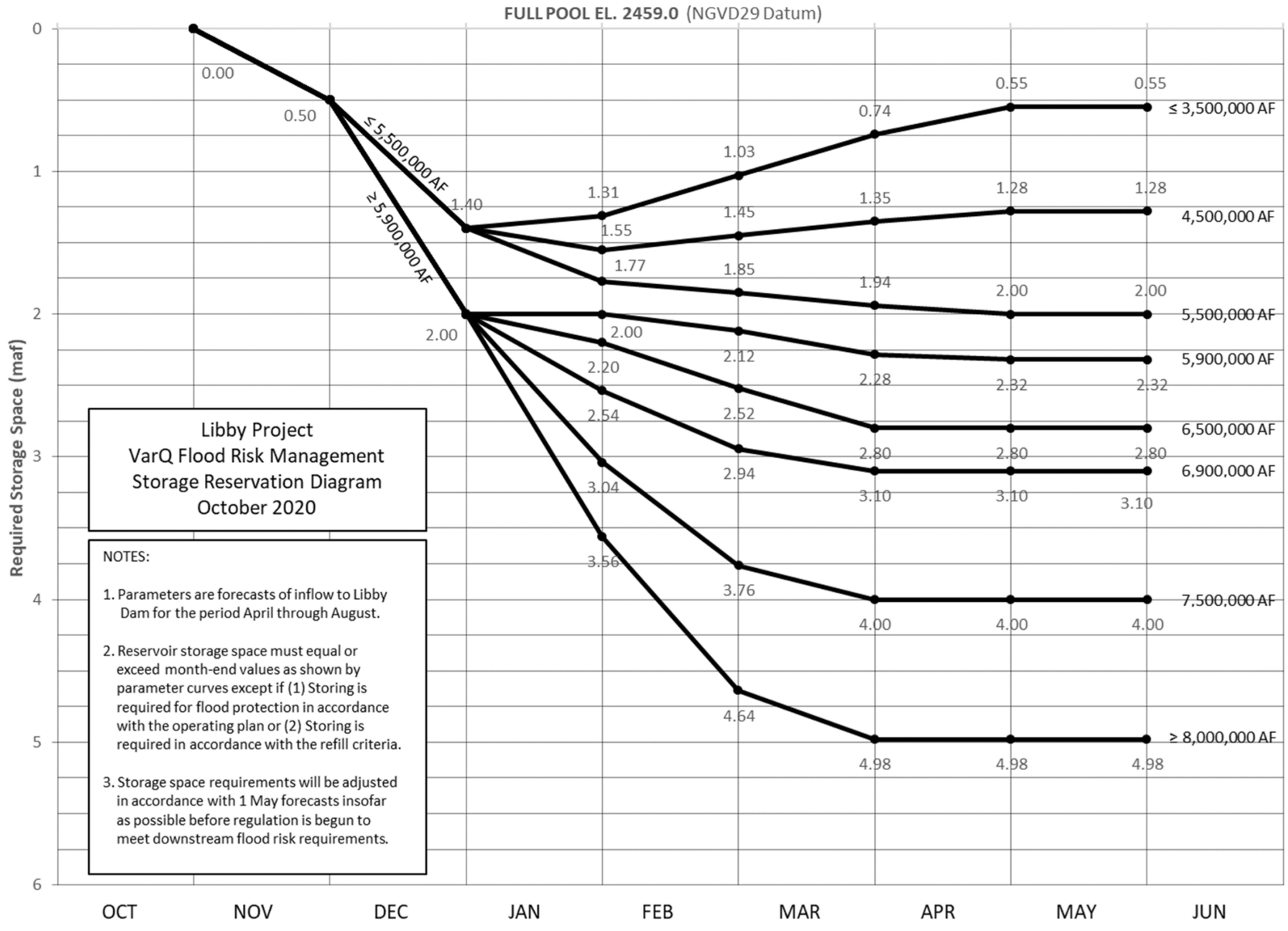
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
NWS Water Management Data System

NOTE: THIS PLATE WAS CREATED FROM A DIAGRAM PROVIDED BY THE SEATTLE DISTRICT IN APRIL 2025.

Source: See Left Note	April 2025

PLATE 5-4



Libby Project
VarQ Flood Risk Management
Storage Reservation Diagram
October 2020

NOTES:

1. Parameters are forecasts of inflow to Libby Dam for the period April through August.
2. Reservoir storage space must equal or exceed month-end values as shown by parameter curves except if (1) Storing is required for flood protection in accordance with the operating plan or (2) Storing is required in accordance with the refill criteria.
3. Storage space requirements will be adjusted in accordance with 1 May forecasts insofar as possible before regulation is begun to meet downstream flood risk requirements.

NOTE: THIS PLATE WAS PREVIOUSLY CHART 7-1 OF THE 2012 LIBBY WCM AND WAS UPDATED BY USACE TO REFLECT FORECASTING AS OF OCTOBER 2020.

NOTE: PLATE SIZE IS 11" x 17"

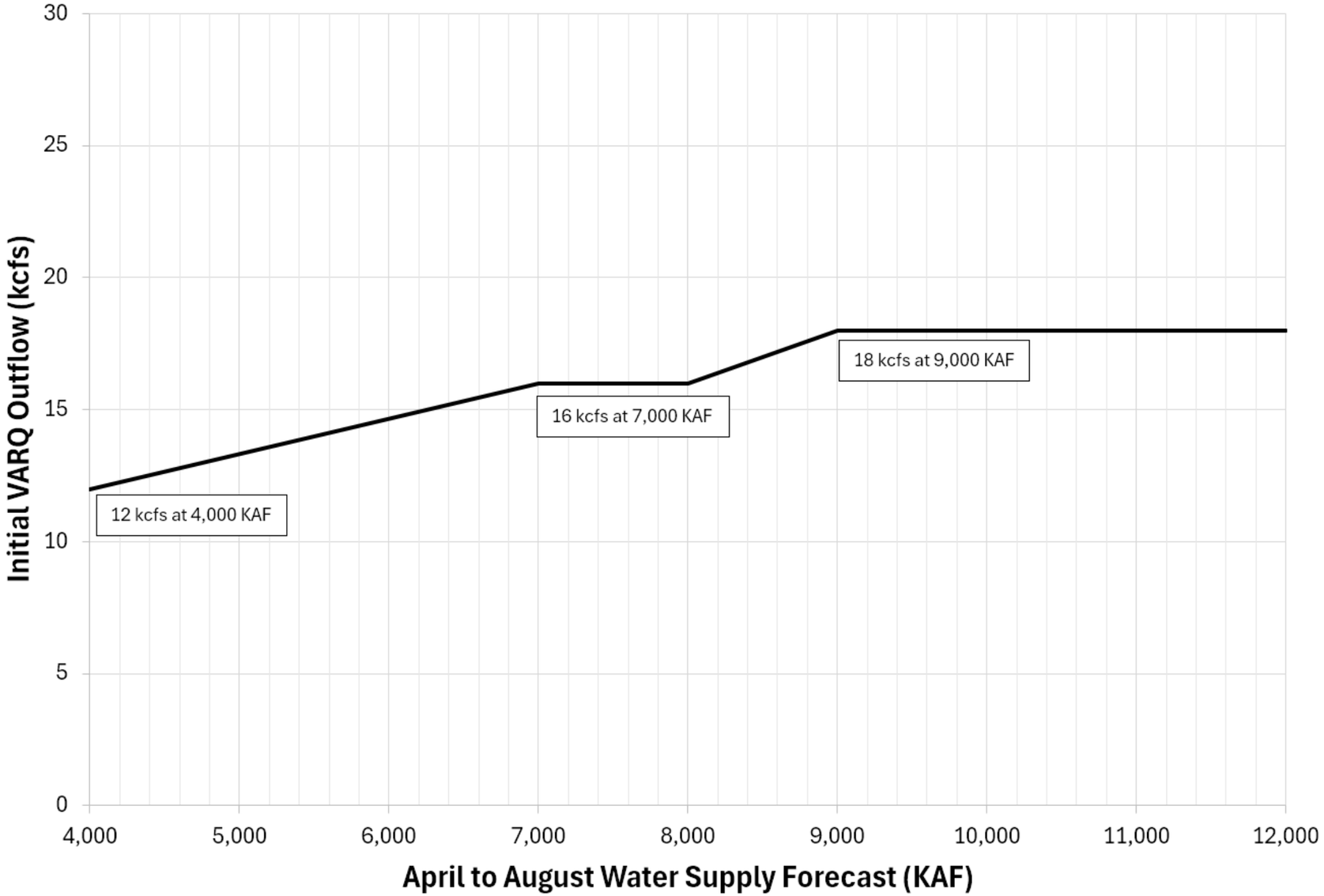
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
VarQ Flood Risk Management
Storage Reservation Diagram

Source: See Left Note | April 2025

PLATE 7-1

Libby Project Initial VARQ Outflow



NOTE: PLATE SIZE IS 11” x 17”

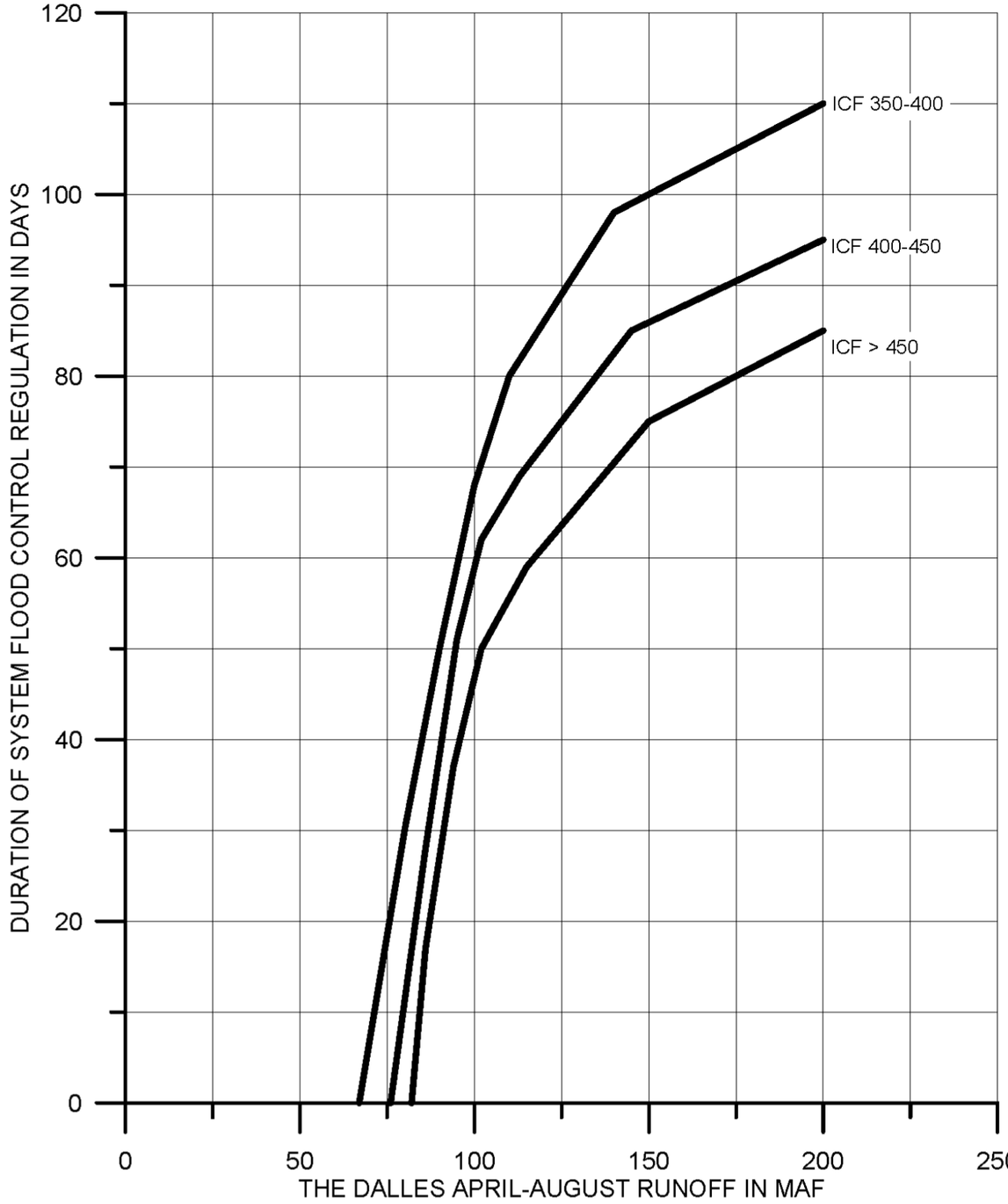
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Initial VARQ Outflow

Source: See Left Note | May 2026

NOTE: THIS PLATE WAS DEVELOPED FROM INFORMATION PROVIDED BY THE SEATTLE DISTRICT.

PLATE 7-2



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 7-4 OF THE PREVIOUS WCM DATED 2012.

DIAGRAM TO ESTIMATE DURATION OF SYSTEM
FLOOD CONTROL REGULATION

from
FLOOD CONTROL OPERATING PLAN
COLUMBIA RIVER TREATY
SEPTEMBER 1998

NOTE:
1. THIS CHART MAY BE USED AS A GUIDE, IN ADDITION TO THE USE OF DAILY SIMULATION OF STREAMFLOW AND RESERVOIR REGULATION, TO ESTIMATE THE DURATION OF THE SYSTEM FLOOD CONTROL REGULATION.

2. PARAMETERS INDICATE THE CURRENT VALUE OF THE INITIAL CONTROL FLOW (ICF) IN KCFS. THERE IS NO INTERPOLATION BETWEEN DURATION CURVES.

3. IF THE ICF IS LESS THAN 350 KCFS, FOR PURPOSES OF VARQ FC FLOW CALCULATIONS, THE SYSTEM DURATION IS ASSUMED TO BE ZERO.

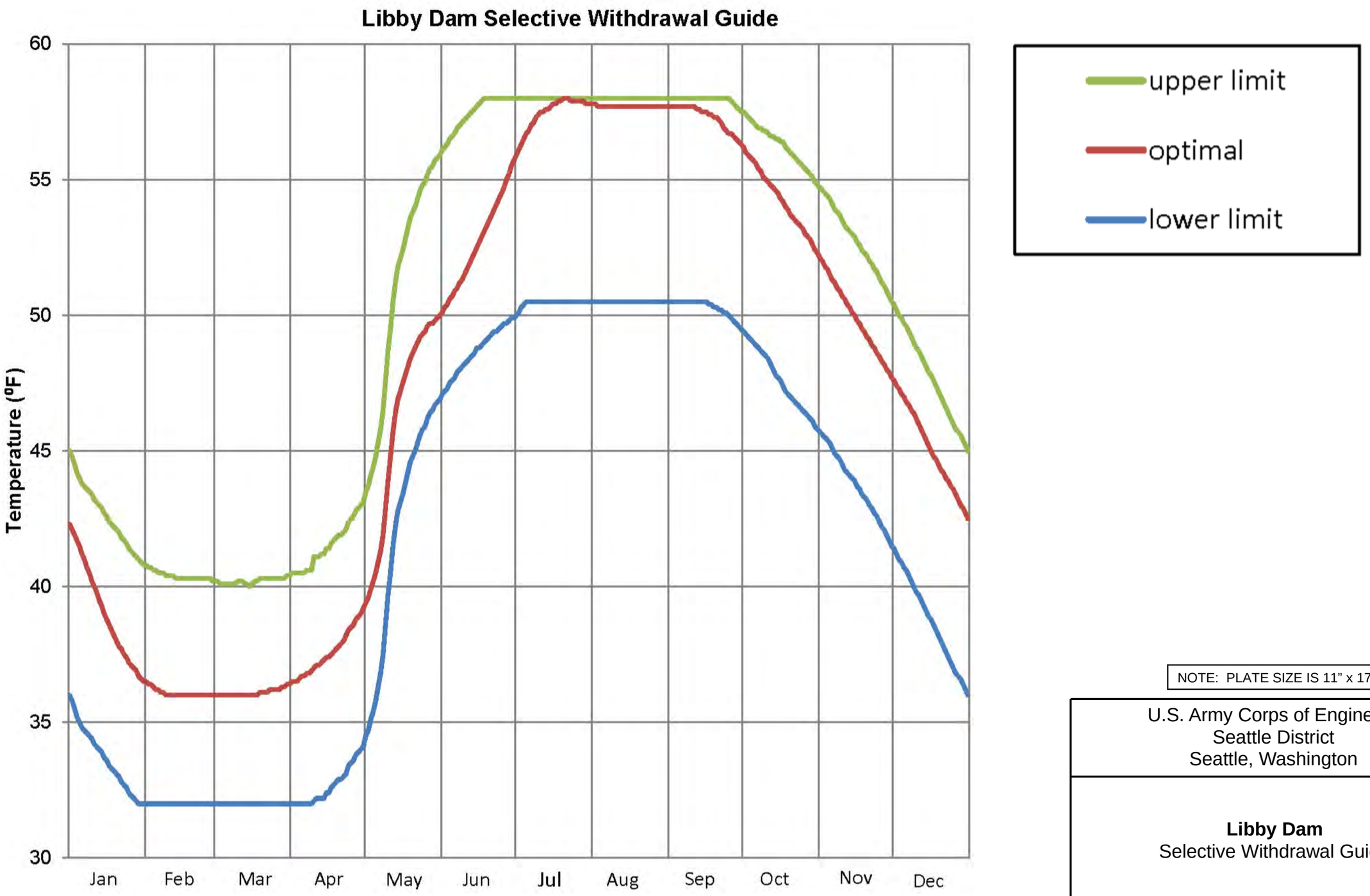
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Diagram to Estimate Duration of
System Flood Control Regulation

Source: See Left Note | April 2025

PLATE 7-3



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 7-5 OF THE PREVIOUS WCM DATED 2012.

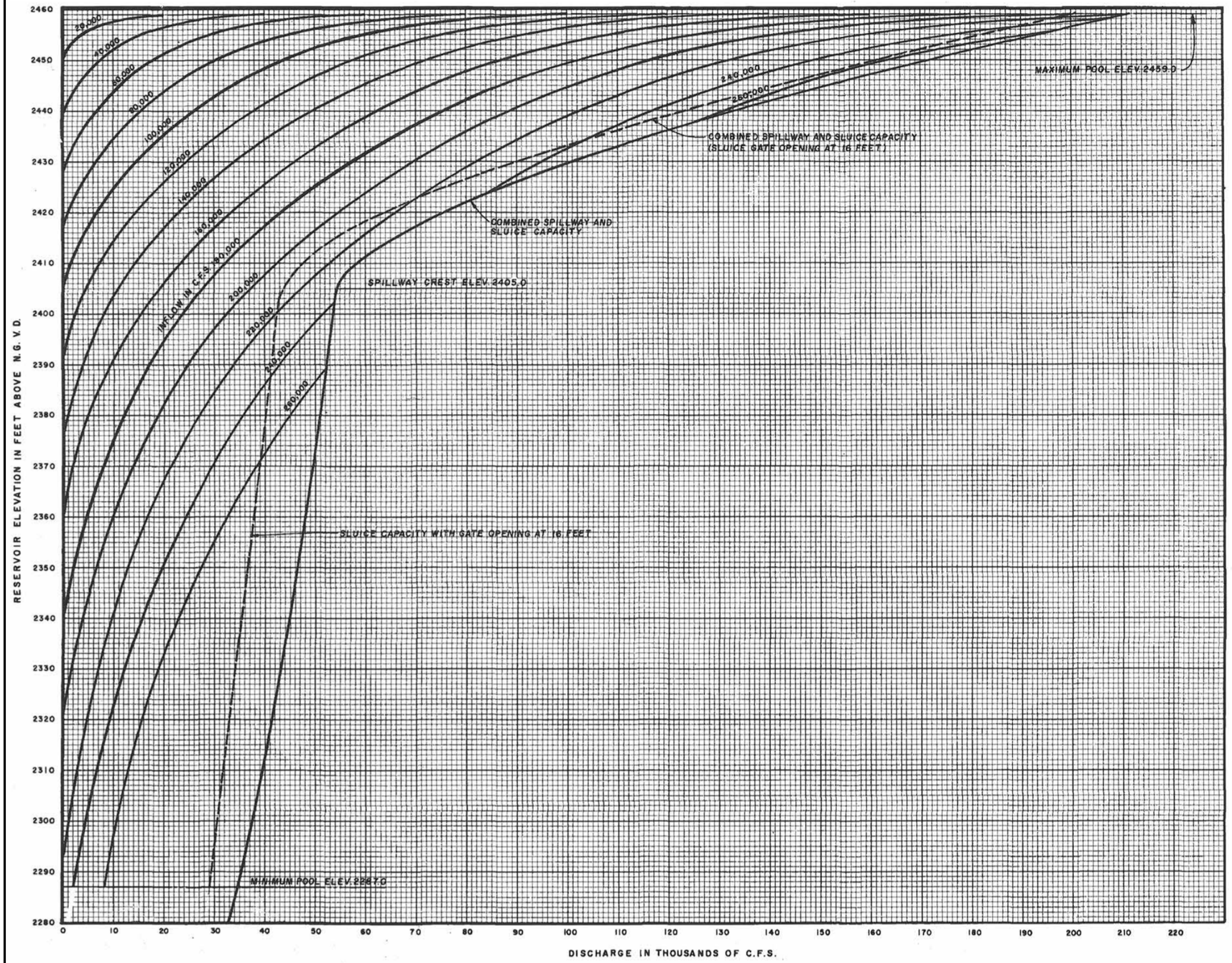
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Selective Withdrawal Guide

Source: See Left Note | April 2025

PLATE 7-4



NOTE

Operation of the sluices above an opening of 16 feet is expected to create a high cavitation potential. Gate openings are to be restricted to 16 feet except as required during large floods to limit the maximum reservoir level to elevation 2459 ft, N.G.V.D.

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 7-1 OF THE PREVIOUS WCM DATED 2012.

NOTE: PLATE SIZE IS 11” x 17”

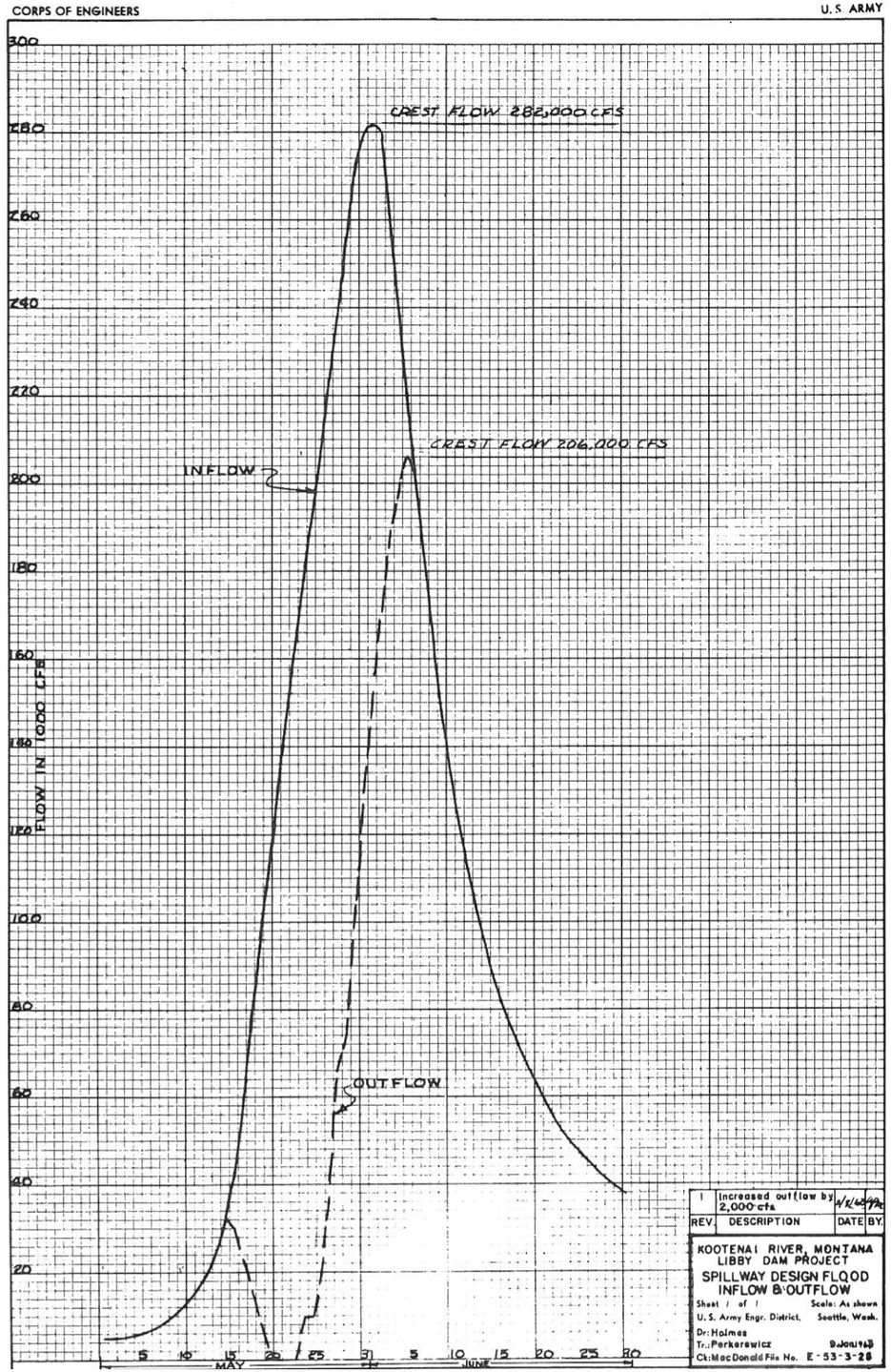
U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Discharge Regulation Schedule

Source: See Left Note	April 2025

PLATE 7-5

CORPS OF ENGINEERS U.S. ARMY



REV.	DESCRIPTION	DATE	BY
1	Increased outflow by 2,000 cfs	4/2/2025	JK

KOOTENAI RIVER, MONTANA
LIBBY DAM PROJECT
SPILLWAY DESIGN FLOOD
INFLOW & OUTFLOW

Sheet 1 of 1 Scale: As shown
U.S. Army Engr. District, Seattle, Wash.
Dr: Holmes
Tr.: Perkerewicz 9 JAN 1963
Ck: MacDonald File No. E-53-3-28

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM PLATE 8-1 IN THE PREVIOUS WCM DATED 2012.

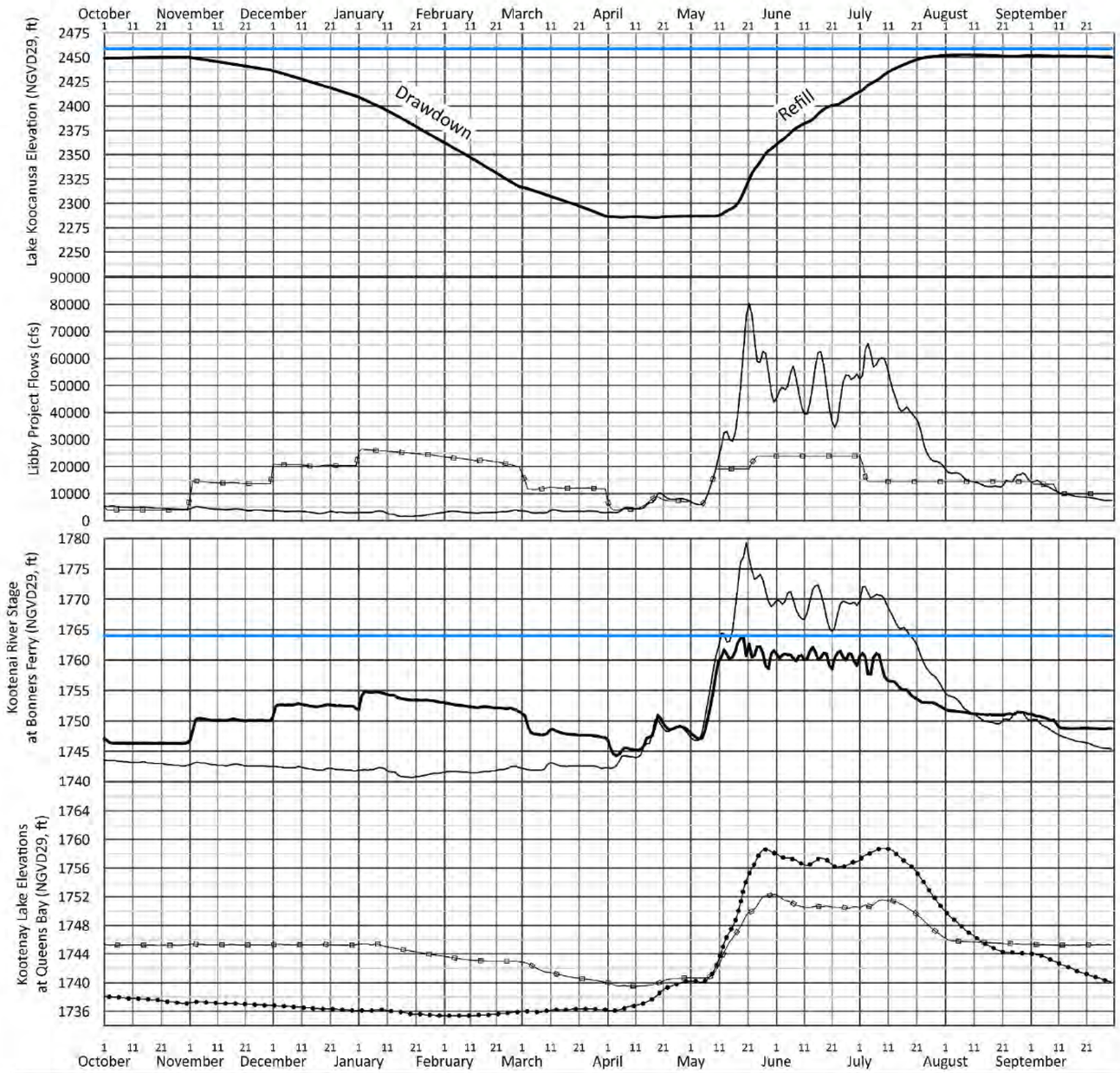
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Spillway Design Flood
Inflow & Outflow

Source: See Left Note | April 2025

PLATE 8-1



Legend
- Full Pool (ft)
- Lake Koocanusa Elevation (ft)
- Project Inflow (cfs)
- Regulated Outflow (cfs)

Legend
- Full Pool (ft)
- Unregulated Stage (ft)
- Regulated Stage (ft)
- Unregulated Stage
- Regulated Stage

Notes:
1. Hydrographs were developed from 2020-Level Modified Flows Data
2. Lake Koocanusa operations were based upon hindsight forecast using the following April - August inflow volume data:

Date of Forecast	Forecast	Date of Forecast	Forecast
Dec.	6.4 MAF	Apr.	8.7 MAF
Jan.	6.6 MAF	May	8.7 MAF
Feb.	7.4 MAF	Jun.	8.3 MAF
Mar.	8.2 MAF		

NOTE: THIS PLATE WAS DEVELOPED FROM THE 2020-LEVEL MODIFIED FLOW DATASET.

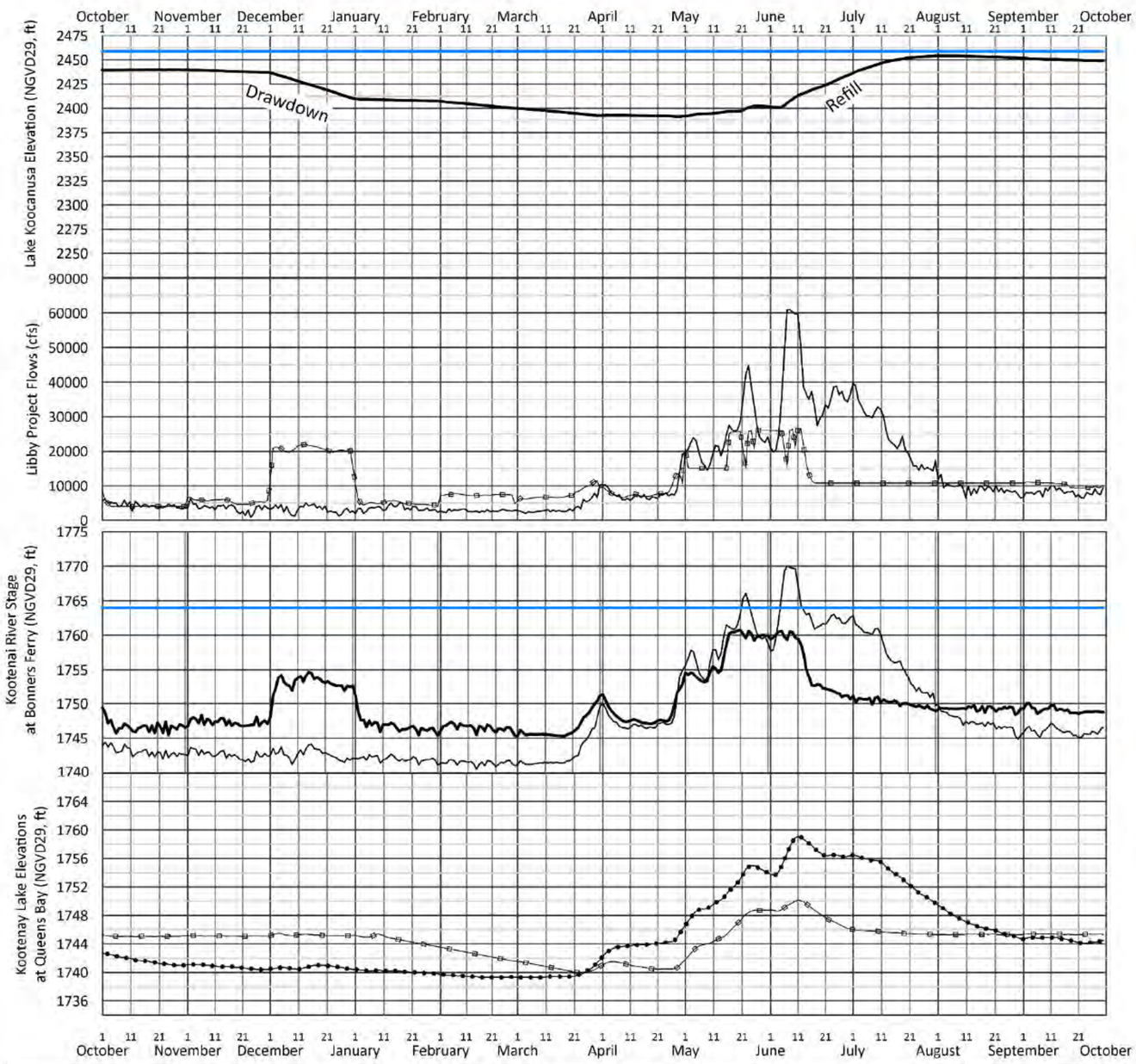
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
1954 – High Flow
Example of Reservoir Regulation for Runoff
Volume of 9.1 million Acre-Feet

Source: See Left Note | June 2026

PLATE 8-2



Legend
- Full Pool (ft)
- Lake Koocanusa Elevation (ft)
- Project Inflow (cfs)
- Regulated Outflow (cfs)

Legend
- Full Pool (ft)
- Unregulated Stage (ft)
- Regulated Stage (ft)
- Unregulated Stage (ft)
- Regulated Stage (ft)

Notes:
1. Hydrographs were developed from 2020-Level Modified Flows Data
2. Lake Koocanusa operations were based upon hindsight forecast using the following April - August inflow volume data:

Date of Forecast	Forecast	Date of Forecast	Forecast
Dec.	5.3 MAF	Apr.	6.3 MAF
Jan.	6.7 MAF	May	6.6 MAF
Feb.	6.9 MAF	Jun.	6.6 MAF
Mar.	6.6 MAF		

NOTE: THIS PLATE WAS DEVELOPED FROM THE 2020-LEVEL MODIFIED FLOW DATASET.

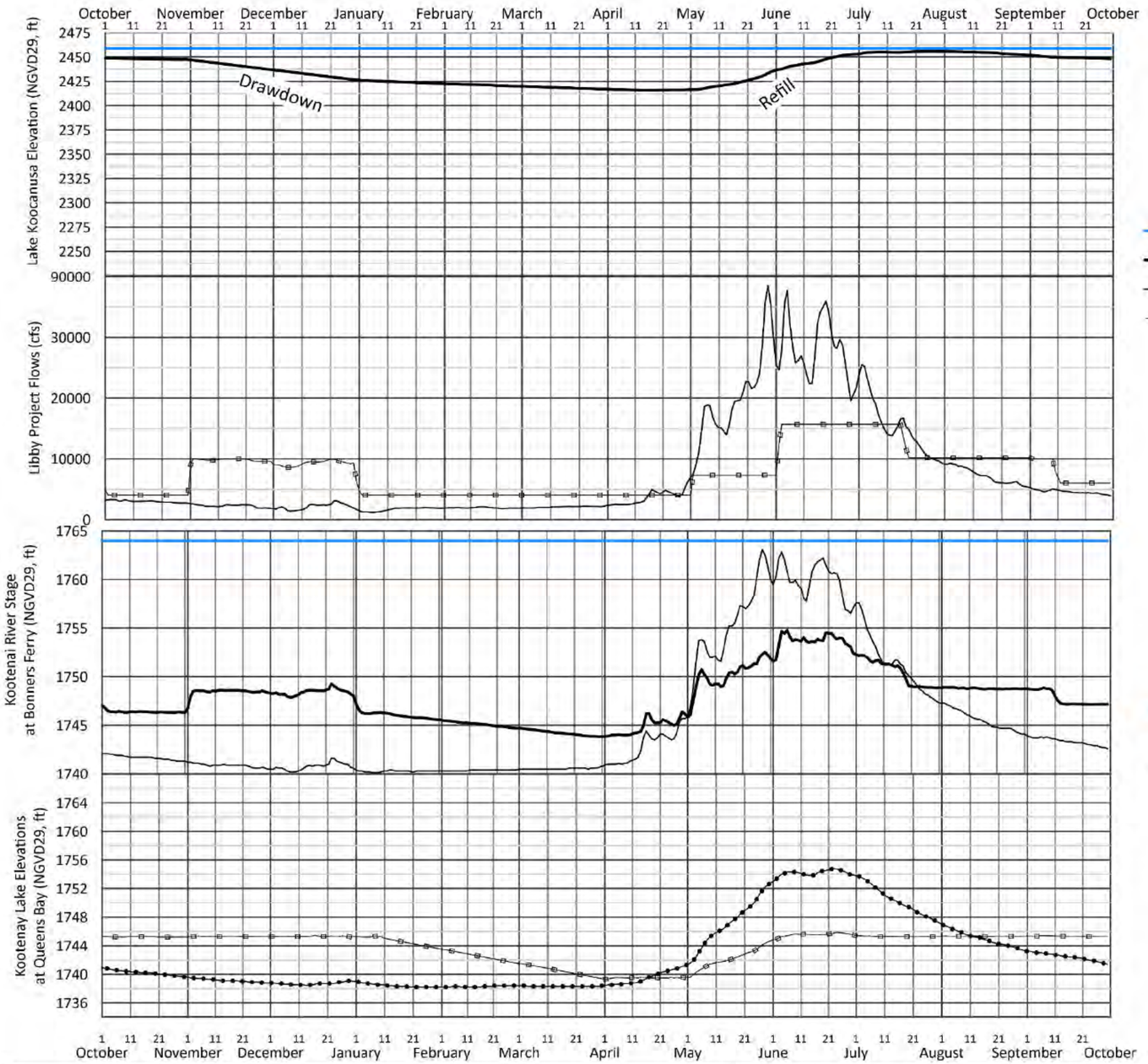
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
1978 – Average Flow
Example of Reservoir Regulation for Runoff
Volume of 6.3 million Acre-Feet

Source: See Left Note | June 2026

PLATE 8-3



Notes:
1. Hydrographs were developed from 2020-Level Modified Flows Data
2. Lake Koocanusa operations were based upon hindsight forecast using the following April - August inflow volume data:

Date of Forecast	Forecast	Date of Forecast	Forecast
Dec.	4.0 MAF	Apr.	5.1 MAF
Jan.	5.1 MAF	May	5.7 MAF
Feb.	4.9 MAF	Jun.	5.5 MAF
Mar.	5.7 MAF		

NOTE: THIS PLATE WAS DEVELOPED USING THE 2020-LEVEL MODIFIED FLOW DATASET.

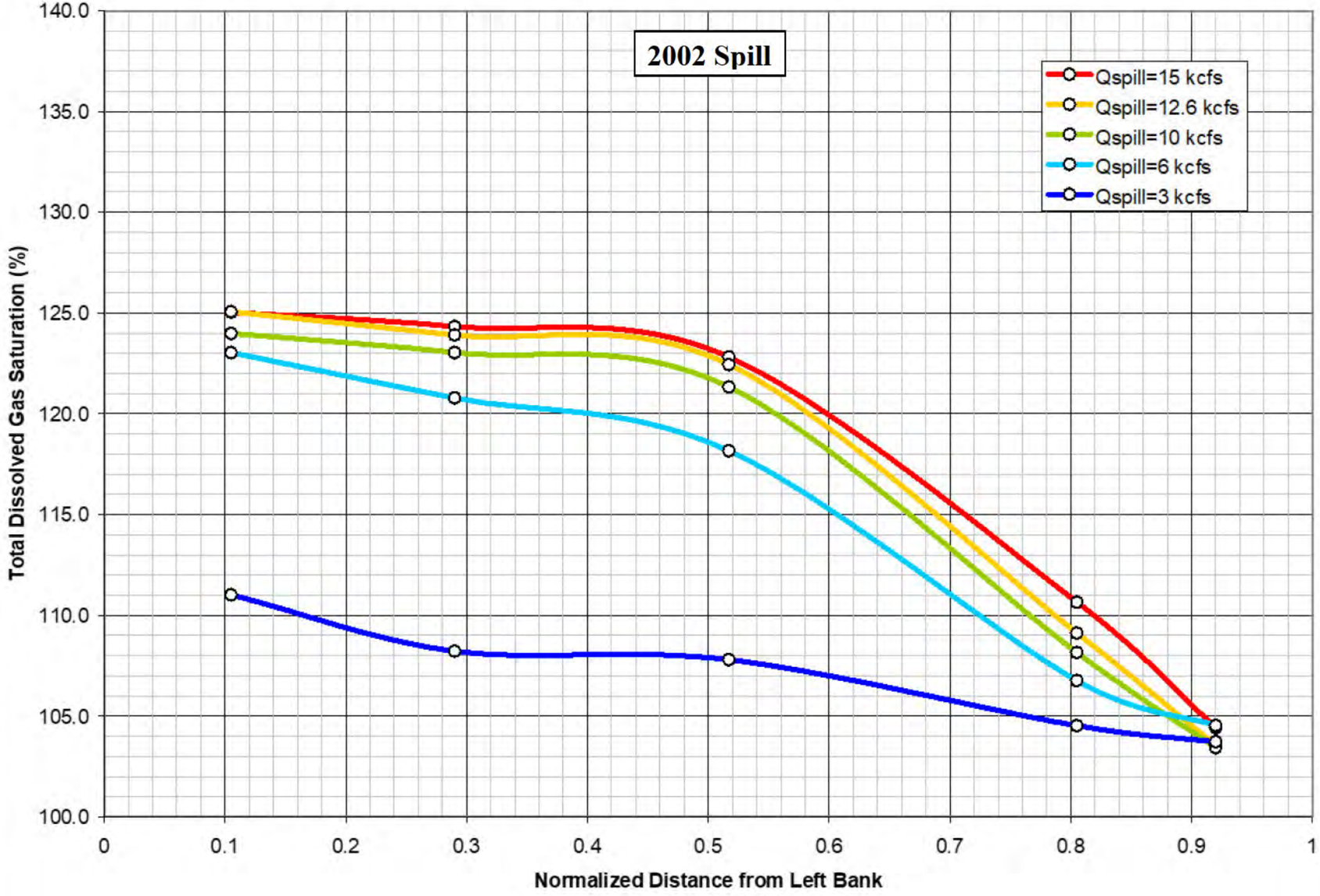
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
1937 – Low Flow
Example of Reservoir Regulation for Runoff
Volume of 4.5 million Acre-Feet

Source: See Left Note | June 2026

PLATE 8-4



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM FIGURE 8-1 IN THE PREVIOUS WCM DATED 2012.

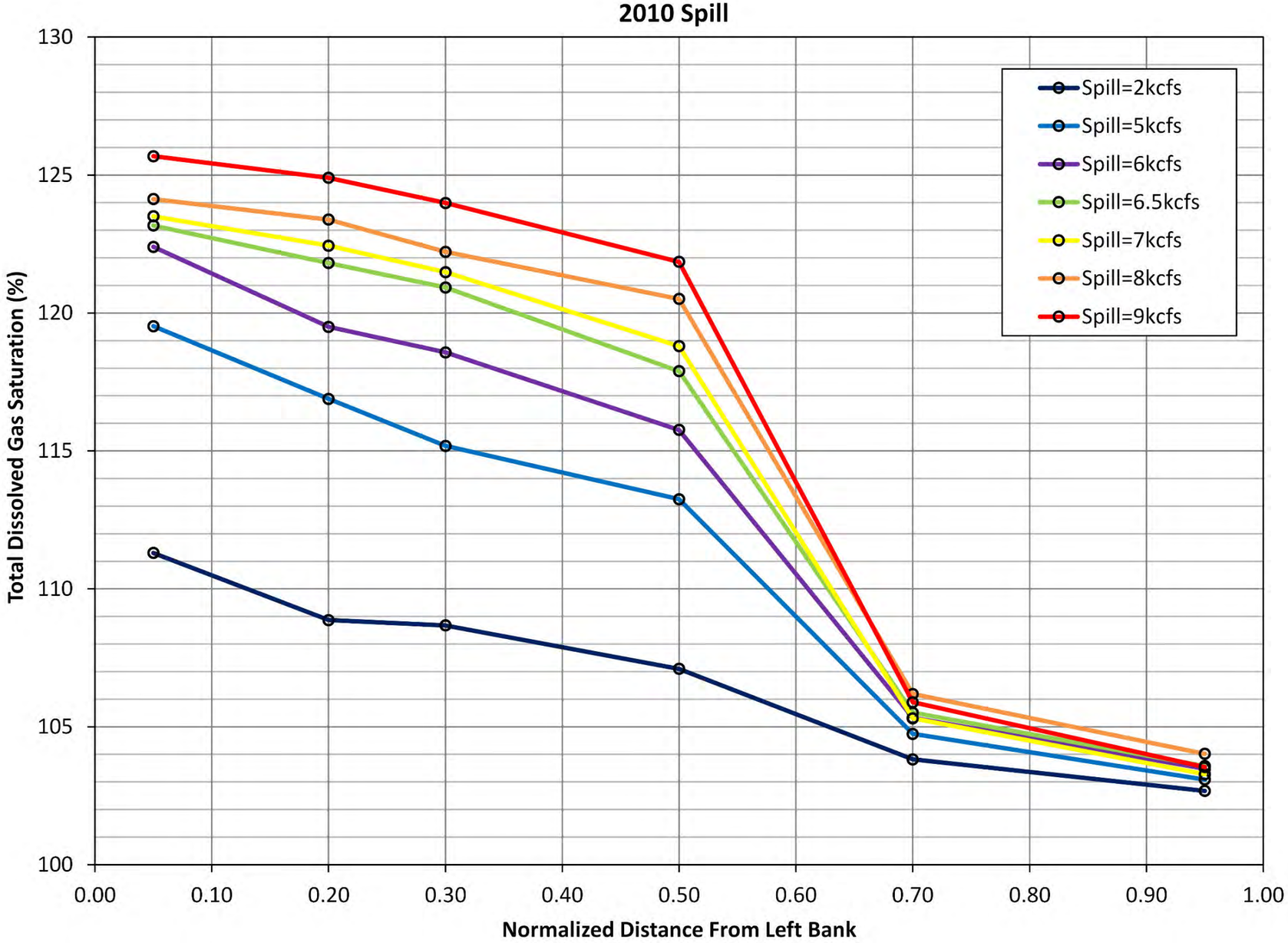
NOTE: PLATE SIZE IS 11" x 17"

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Lateral TDG Saturations Measured in the Kootenai River at Station LBQM During 2002 Spillway Operations

Source: See Left Note | April 2025

PLATE 8-5



NOTE: THIS PLATE WAS COPIED DIRECTLY FROM FIGURE 8-2 IN THE PREVIOUS WCM DATED 2012.

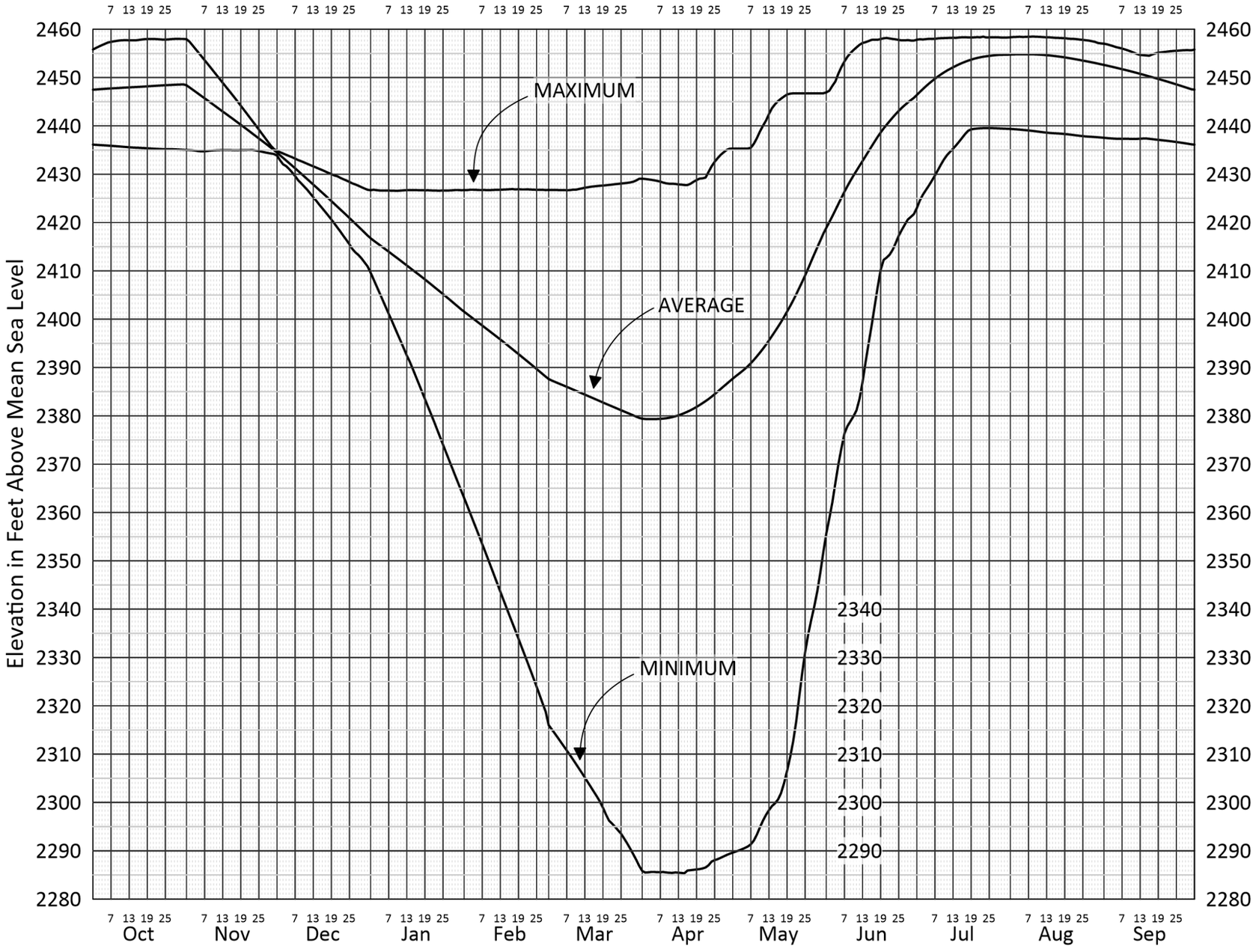
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Lateral TDG Saturations Measured in the Kootenai River at Station LBQM During 2010 Spillway Operations

Source: See Left Note | April 2025

PLATE 8-6



Simulated elevation of Lake Koocanusa at Libby Dam Forebay. Operations are based on the 2020-Level Modified Flow dataset under a continuous model for years 1929-2018.

NOTE: THIS PLATE WAS DEVELOPED USING THE 2020-LEVEL MODIFIED FLOW DATASET.

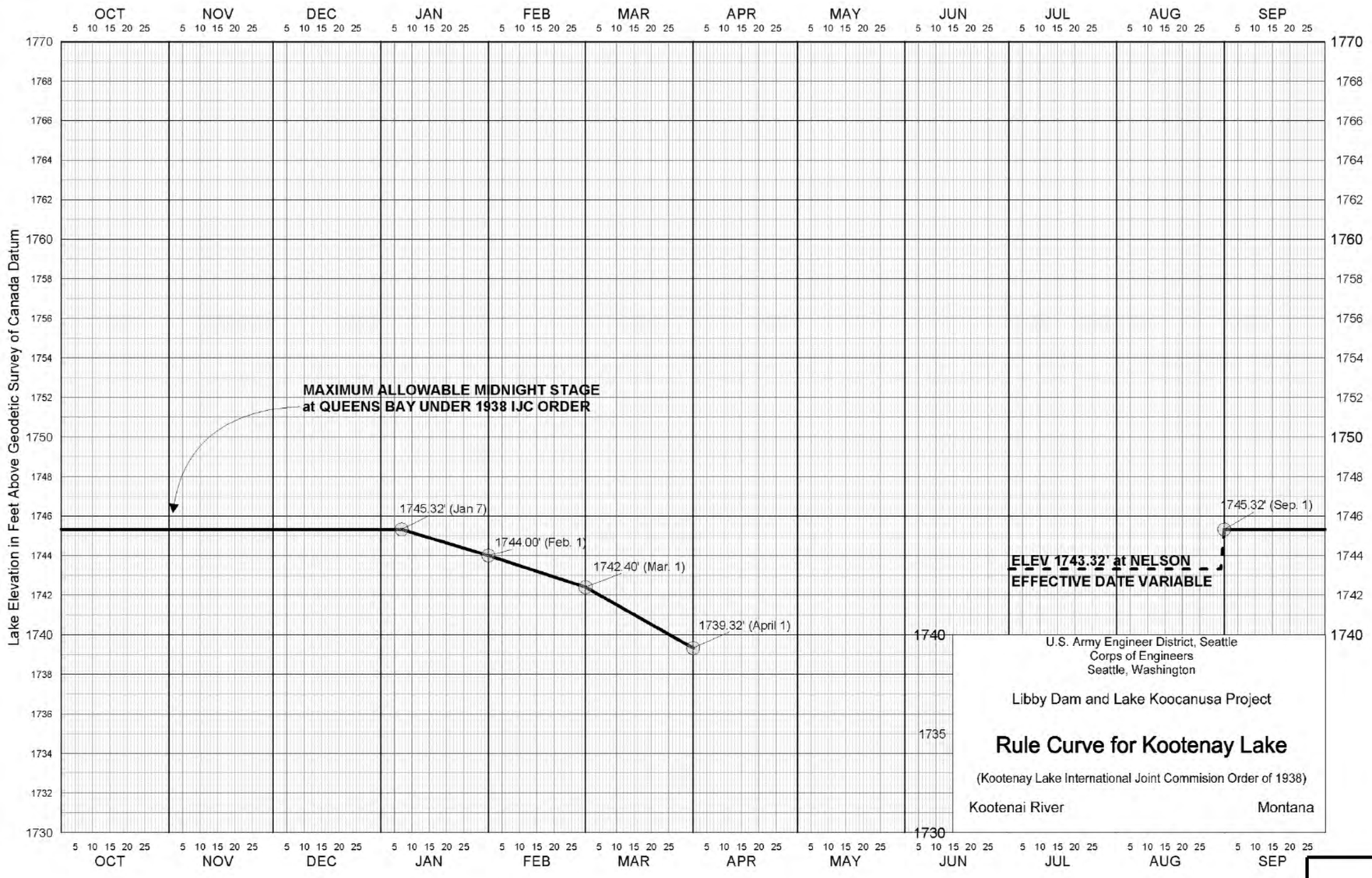
NOTE: PLATE SIZE IS 11” x 17”

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Lake Koocanusa Elevation Range

Source: See Left Note | April 2025

PLATE 8-7



NOTE: PLATE SIZE IS 11” x 17”

NOTE: THIS PLATE WAS COPIED DIRECTLY FROM CHART 9-1 IN THE PREVIOUS WCM DATED 2012.

U.S. Army Corps of Engineers
Seattle District
Seattle, Washington

Libby Dam
Rule Curve for Kootenay Lake

Source: See Left Note | April 2025

PLATE 9-1

EXHIBIT 1-1
NWDR 1165-2-2: WATER RESOURCE POLICIES AND AUTHORITIES
WATER MANAGEMENT RESPONSIBILITIES

DEPARTMENT OF THE ARMY
Corps of Engineers, Northwestern Division
P.O. Box 2870
Portland, Oregon, 97208-2870

CENWD-PDW
Regulation
No. 1165-2-2

23 January 2014

Water Resource Policies and Authorities
WATER MANAGEMENT RESPONSIBILITIES

History. This issue is a revision of the former NPDR 1165-2-2 as a result of an organizational restructure.

Summary. This regulation addresses the management of the reservoir projects and reservoir systems in the Pacific Northwest region for which the Corps is responsible, including the Columbia River Basin and coastal tributaries within the physical boundaries of the Northwestern Division (NWD) of the U.S. Army Corps of Engineers.

1. PURPOSE. To provide policy and guidance regarding the operation of the NWD Corps dams and the Corps' implementation of its authority to regulate projects owned or operated by other entities and agencies pursuant to these authorities for flood risk management and navigation (see 33 USC§ 701 and 33 CFR § 208.11). This regulation describes the organizational structure and defines specific responsibilities for the division, districts, and project offices engaged in this activity. It also defines the Water Management Board along with the associated procedures for division-district interface on water management activities.

2. APPLICABILITY. This regulation is applicable to the Columbia Basin Water Management Division (CBWM) within Headquarters, Northwestern Division (HQNWD), and the offices with water management responsibilities in the Portland, Seattle, and Walla Walla Districts. A separate guidance memorandum covers the management of the reservoirs and reservoir systems in the Missouri River Basin of NWD.

3. REQUIRED PUBLICATIONS.

a. ER 1110-2-240, Water Control Management, cited in paragraph 5a, 6c(6)(a), 6c(6)(c), 11b(5), 12a, 12b, and 13a.

b. ER 1110-2-241, Use of Storage Allocated for Flood Control and Navigation at Non-Corps Projects, cited in paragraph 5a.

c. ER 1110-2-249, Management of Water Control Data Systems, cited in paragraph 12a.

d. ER 1110-2-1400, Reservoir/Water Control Centers, cited in paragraph 4e.

e. EM 1110-2-3600, Management of Water Control Systems, cited in paragraph 5a.

*Supersedes NPDR 1165-2-2, January 1990

f. Columbia River Basin Master Water Control Manual, cited in paragraph 5c, 6c(6)(b), and 11a.

g. CENWD Master Plan for Water Control Data Systems, cited in paragraphs 6c(5)(c), 6c(5)(d), 6c(6)(a), 7c(5)(c), 7c(5)(d), 12a, and 12b.

h. NWDR 1110-2-6, Deviation Requests for Approved Water Control Manuals, cited in paragraphs 6c(2)(e) and 6c(7)(e), and 7c(2)(c).

4. BACKGROUND AND DEFINITIONS.

a. Water Management activities in the Pacific Northwest Region of the Northwestern Division are characterized by a regionally dispersed, interdependent, collaborative effort utilizing the staff and coordinated resources of the Portland District (NWP), Seattle District (NWS), Walla Walla District (NWW) and Division Columbia Basin Water Management (CBWM) offices. District and division technical water management expertise will be shared and focused as needed to shape an interdependent water management team for the Columbia Basin.

b. CBWM is responsible for executive direction and oversight responsibility of all Water Management functions throughout the Columbia River Basin and the coastal watersheds. These executive direction and oversight responsibilities are further detailed in paragraph 6(b), and generally include: (1) establishing and implementing policies and guidance; and (2) directing and managing overall execution and performance of all Corps Water Management offices in the Pacific Northwest Region. CBWM also has responsibilities regarding the regulation of projects, which are further detailed in paragraph 6(b)(2) – (b)(8); and (c)(2).

c. District offices are responsible for regulation and operation of the Columbia River tributary projects and any coastal projects in their respective areas of responsibility.

d. Division/district responsibilities for each major project are shown in Appendix A.

e. The duties and responsibilities of district and division water management offices, collectively and individually referred to as Reservoir Control Centers, are broadly defined by ER 1110-2-1400. Paragraph 8b of ER 1110-2-1400 calls for the development of a guidance memorandum to be used as the basic guide for management of water control activities in each MSC. This regulation, NWDR 1165-2-2, serves that purpose by providing specific direction and describing roles and responsibilities for the Reservoir Control Centers at NWP, NWS, NWW, and CBWM.

f. Certain key terms used in this regulation are defined in Appendix B, and contain specific or explicit definitions that apply to parties subject to this regulation.

5. WATER MANAGEMENT POLICIES AND GUIDANCE.

a. General Policies and Guidance. Corps projects will be regulated to conform to basic provisions in authorizing documents, applicable Federal statutes and regulations, and water management policies and criteria. Corps policies regarding water management are contained in

ER 1110-2-240 and ER 1110-2-241. Technical guidance in carrying out reservoir regulation is contained in EM 1110-2-3600.

b. Project Regulation Guidance. Project water control plans have been developed to define and describe regulation procedures for each Corps and non-Corps project for which the Corps has regulation responsibility. These are usually contained in the project water control manuals.

c. Policies and Guidance for System Management. The Columbia River Basin Master Water Control Manual contains policy and guidance for regulating the dams and reservoirs in the Columbia basin (excluding the system of reservoirs in the Willamette Basin) to fulfill integrated system objectives. Since the projects in the Columbia system are interrelated, regulation for individual projects and local objectives must be coordinated with objectives for the system as a whole. Project obligations to meet system objectives are described in the Columbia River Basin Master Water Control Manual. Should perceived discrepancies arise between the guidance contained in a project's Water Control Manual, the Columbia River Basin Master Water Control Manual, and/or system operating guidance, the Chief of CBWM will be contacted for clarification and resolution.

6. DIVISION OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization. Water management responsibilities within NWD are geographically divided into activities west and east of the Continental Divide. These responsibilities are assigned to the Columbia River Basin Water Management Division (CBWM) and the Missouri River Basin Water Management Division offices, respectively, which operate within the Programs Directorate of NWD. The CBWM is organized into two branches which carry out the various responsibilities relating to the water management mission described below. The organizational chart for those elements in CBWM associated with water management is provided in Appendix C. Also listed are the other agencies with which coordination is required.

b. General CBWM Responsibilities.

(1) CBWM has executive direction and oversight responsibilities for all Water Management functions throughout the Columbia River Basin and the coastal watersheds that includes:

(a) Establishing and implementing policies and guidance; and

(b) directing and managing overall execution and performance of all Corps Water Management offices in the Pacific Northwest Region.

(2) CBWM has responsibility for regulating the mainstem Columbia River and Lower Snake River projects for authorized purposes. CBWM is also responsible for regional reservoir regulation support as conditions warrant during system flood events or other situations as determined by the CBWM Chief.

(3) CBWM coordinates tributary operations with the districts in order to meet system objectives.

(4) CBWM establishes system flood control requirements and coordinates system power operations for implementation by CBWM and the districts.

(5) CBWM has responsibility for the planning and implementation of the Columbia River Treaty and PNCA.

(6) CBWM has technical capability commensurate with all of their regional responsibilities (on-call technical support will be available from the districts).

(7) CBWM serves as the point of contact for regional stakeholders for all projects as necessary to implement system water management requirements.

(8) CBWM coordinates and provides oversight function for navigation safety.

c. Specific CBWM Responsibilities

(1) System Power Coordination and Columbia River Treaty.

(a) Prepare annual operating plans for the Columbia River system in accordance with the PNCA and the Columbia River Treaty, including performing system regulation studies and coordination.

(b) Implement the Columbia River Treaty in accordance with the Treaty and related implementation documents, through the Treaty Operating Committee and Treaty Hydro meteorological Committee, including performing required studies for Treaty coordination.

(c) Represent the Corps on the Northwest Power Pool Coordinating Group and participate in other PNCA activities as needed.

(2) Reservoir Regulation.

(a) Provide primary regulation of the mainstem Columbia, Lower Snake River projects, and others as specified in Appendix A. This includes issuing regulation instructions to projects and coordinating with Bonneville Power Administration (BPA), US Bureau of Reclamation (USBR), district offices, fishery agencies, Tribes, electrical utilities, and other stakeholders.

(b) Provide backup regulation for projects specified in Appendix A when requested.

(c) Model flow and reservoir conditions for short and intermediate term reservoir system operation planning (excluding the Willamette system). Work with the National Weather Service Northwest River Forecast Center (NWRFC), NWS, and NWW. During flood or other emergencies work with NWP.

(d) Coordinate and lead the execution of long term seasonal planning models with districts.

(e) Submit a formal deviation request to the Chief of CBWM for any Columbia mainstem or Lower Snake project operation that varies from the project's Water Control Manual, in accordance with NWDR 1110-2-6.

(f) Provide requirements to district water managers regarding:

-reservoir storage space to meet Columbia River system flood control requirements during the evacuation and refill season, and

-Columbia River system flood control flow requirements during a system flood event (including the Willamette projects if needed), during evacuation and the spring refill period, and

-Columbia River system objectives for coordinated operations for power needs and various levels of power emergencies.

-Columbia River system power emergencies.

(3) Environmental Support.

(a) Act as the regional lead and coordinate with the districts on the development, planning, and implementation of the Fish Passage Plan, Water Quality Plan, Water Management Plan, and other related plans on the Columbia and Snake rivers.

(b) Act as chair for Technical Management Team (TMT). Coordinate with districts on applicable project operations before TMT meetings. Coordinate with districts to fulfill requests for any products requested of them by TMT.

(c) Review and provide timely responses to TMT System Operations Requests. Coordinate with districts as needed.

(d) Participate in or conduct regional and interagency meetings that provide information in the form of technical input, comments, or recommendations to the Corps on project operations.

(e) Act as lead Water Management POC for litigation for the FCRPS and prepare documents as necessary to support litigation effort and requirements.

(f) Perform water quality modeling as required to meet regulatory requirements.

(4) Forecasting, Studies, and Reports.

(a) Perform system flood control, power, water quality, conservation storage, and other system studies to improve regulation procedures or analyze problem areas in system operations.

(b) Provide technical coordination with district offices, BC Hydro, NWRFC, NRCS, and Treaty Hydrometeorlogical and Operating Committees on water supply forecasting techniques.

(c) Reviews and approves district water supply forecasts and forecasting procedures for projects that provide system flood control.

(5) Regional Water Control Data System (RWCDS).

(a) Operate and maintain the Regional WCDS with district offices. Maintain RWCDS consistent with the standard regional configuration.

(b) Coordinate and implement timely, efficient regional exchange of data.

(c) Perform Quality Assurance/Quality Control (QA/QC) on data, as designated in the RWCDS Master Plan.

(d) Coordinate regionally on RWCDS Master Plan updates.

(6) Plans and Manuals.

(a) Detailed plans for subsystems and networks of approved RWCDS Master Plan are approved by the Division Commander as required by ER 1110-2-240.

(b) Prepare and maintain Columbia River Master Manual.

(c) Review updates to Master Manuals as well as District Water Control Manuals. Water control plans and manuals are approved by the Division Commander as required by ER 1110-2-240.

(d) Coordinate with districts to prepare/review portions of water control plans and manuals for projects as designated in Appendix A.

(e) Prepare the Columbia River Treaty, PNCA, and other system-related reports.

(f) Prepare annual Total Dissolved Gas (TDG) Monitoring Plan.

(g) Prepare annual water quality reports describing TDG and temperature information related to project operations such as annual TDG Report.

(h) Lead development, planning, and implementation of the Fish Passage Plan, Water Quality Plan, Water Management Plan, and other related plans on the Columbia and Snake Rivers.

(7) Other.

(a) Issue public information statements as necessary.

(b) Hold and participate in public meetings for all projects as needed to present information or to solicit public comment on proposed system operations or changes to system operations.

(c) Assume necessary dam safety responsibilities relating to reservoir regulation and flood warning and notification, including coordinating the development of system dam break models, conducting and participating in emergency action plan exercises, and other related activities.

(d) Plan, implement and regularly exercise COOP procedures.

(e) Review and provide timely response to deviation requests in accordance with NWDR 1110-2-6.

(f) Prepare Water Management Budget for CBWM. Coordinate the preparation of the regional Water Management Budget.

7. DISTRICT OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization. Organizational charts for the district organizations associated with water management are provided in Appendix C.

b. General District Responsibilities.

(1) Each district has responsibility for the regulation of Corps coastal and Columbia River tributary projects within their area of responsibility (see Appendix A) for authorized project purposes. Districts are also responsible for regional reservoir regulation support as conditions warrant during system flood events or other situations as determined by the CBWM Chief.

(2) Each district has responsibility for oversight, and when necessary, flood control regulation, of non-Corps projects pursuant to applicable requirements (e.g. FERC licenses and Section 7 of the 1944 Flood Control Act projects, see Appendix A).

(3) Each district will follow Water Control Manuals, Water Management Plans and other applicable guidance to meet system requirements provided by CBWM.

(4) Each district will serve as the point of contact for local and regional stakeholders as necessary to implement district water management requirements.

(5) The districts maintain full technical capabilities and will provide on-call technical support for CBWM when requested.

c. Specific Responsibilities Common to all Districts.

(1) System Power Coordination and Columbia River Treaty.

(a) Review applicable annual operating plan and other related submittals for the PNCA and the Columbia River Treaty, as requested by CBWM.

(b) Provide technical support for Columbia River Treaty studies and investigations, as requested by CBWM.

(c) Implement requirements established by CBWM for system flood events and power emergencies.

(d) Provide data to CBWM for Actual Energy Regulation (AER) for projects where the district has primary responsibility and participate in AER coordination calls.

(2) Reservoir Regulation.

(a) Provide primary regulation of projects as specified in Appendix A. This includes issuing regulation instructions to projects and coordinating with stakeholders.

(b) Provide backup regulation for projects specified in Appendix A when requested.

(c) Submit a formal deviation request to Chief CBWM for any project operation that varies from the project's Water Control Manual, in accordance with NWDR 1110-2-6.

(3) Environmental Support.

(a) Review applicable TMT System Operations Requests and provide timely input to CBWM. Prepare products to support TMT activities as requested, and participate in TMT meetings as needed.

(b) Install and maintain real-time Fixed Monitoring System stations at projects in district area of responsibility to monitor water quality conditions.

(c) Conduct water quality studies and activities for tributary and coastal streams as needed.

(d) Perform water quality modeling as required to meet regulatory requirements.

(e) Prepare TDG QA/QC documents that are incorporated as appendices to the annual TDG report prepared by CBWM.

(f) Provide technical support to CBWM when requested, respond to memos from CBWM and other agencies, and review regional water quality related documents.

(4) Forecasting, Studies, and Reports.

(a) Perform flood control, conservation storage, and other water management studies for projects specified in Appendix A to improve regulation procedures. Analyze and anticipate potential problems or concerns for projects for which water control plan responsibility exists.

(b) Develop and after CBWM review and approval , implement water supply and streamflow forecasting procedures or utilize external agency forecasts for projects that provide system flood control.

(c) Coordinate water supply forecasts with NWRFC, BPA and other agencies; oversee forecast integrity and prepare forecasting procedures for projects listed in Appendix A.

(5) Regional Water Control Data System (RWCDS).

(a) Operate and maintain the Regional WCDS with CBWM and all district offices. Maintain RWCDS consistent with the standard regional configuration.

(b) Coordinate and implement timely, efficient regional exchange of data.

(c) Perform Quality Assurance/Quality Control (QA/QC) on data, as designated in the RWCDS Master Plan.

(d) Coordinate regionally on RWCDS Master Plan updates.

(6) Plans and Manuals.

(a) Support CBWM in the development, planning, and implementation of the Fish Passage Plan, Water Quality Plan, Water Management Plan, and other related plans on the Columbia and Snake Rivers.

(b) Maintain and update as necessary water control plans and/or water control manuals for projects as specified in Appendix A. Perform studies and coordinate with agencies and other stakeholders as appropriate.

(7) Other.

(a) Issue public information statements as necessary.

(b) Hold and participate in public meetings to present information or to solicit public comment on proposed operations or operational changes.

(c) Assume necessary dam safety responsibilities relating to reservoir regulation and flood warning and notification, including conducting and participating in emergency action plan exercises, and preparing and maintaining individual and system dam break models.

(d) Plan, implement, and regularly exercise COOP procedures.

(e) Provide technical assistance to NWD for water management, water quality, and biological studies or evaluations as needed.

(f) Prepare Water Management Budget for district.

d. Specific Responsibilities Assigned to Individual Districts.

(1) NWP prepares and maintains the Master Water Control Manual for the Willamette Basin.

(2) NWP prepares the seasonal and annual operating plans for the Willamette Valley Project dams, Rogue River Project dams, and Willow Creek Dam.

(3) NWS prepares the Libby water supply forecast. NWS oversees forecast integrity and coordinates with NWRFC, BPA, and other agencies.

(4) NWW prepares the Dworshak water supply forecast. NWW oversees forecast integrity and coordinates with NWRFC, BPA, and other agencies.

(5) NWW provides temperature modeling output to CBWM for varying Dworshak Project operations as needed for TMT.

(6) NWW is responsible for ensuring safe navigation conditions in the Snake River (Lime Point).

8. PROJECT OFFICE ORGANIZATION AND RESPONSIBILITIES.

a. Organization and Coordination. Project offices are within the purview of NWD Program Support Division and the Chief of Operations Division at each District provides oversight to the Operations Project Managers. Interface with water management personnel in division or district

offices occurs in the project regulation process. In routine regulation situations, this is normally accomplished by direct contact between division or district reservoir regulation personnel and project personnel.

b. Responsibilities. Project offices will be responsible for the following actions, with regard to water management.

(1) Coordination and implementation of division and district water control instructions.

(2) Reporting project status and hydromet data as required.

(3) Reporting and coordinating O&M activities that will affect project operability for water management purposes.

(4) Conducting water management operations during situations when division/district water control managers are unavailable, such as during a COOP.

9. WATER MANAGEMENT BOARD. The NWD Water Management Board (WMB) is established to ensure that water management activities in NWD are pursued within the regional business center (RBC) framework. The WMB will act as the working group that provides data and recommendations to the Regional Management Board (RMB), and the Regional Command Council. The goal is to provide a structured forum for corporate oversight, strategic planning, issue resolution, and assurance of the most effective program execution through the use of best business practices.

a. Membership. The WMB will be co-chaired by the Chief, Columbia River Basin Water Management Division (NWD); the Chief, Missouri River Basin Water Management Division (NWD); and the Chief, Program Support Division (NWD). The Board will also include one member from Business Resource Division, and two members from each NWD district consisting of one from the Hydraulics and Hydrology Branch and one from the Operations Division.

b. Program Development. The WMB will review and recommend a budget and work plan for division and district water management activities. This information will be reviewed annually in the March-April timeframe to determine if changes are necessary to the existing budget and work plan, and to add information as needed for future years. Upon review and concurrence by the Director of Programs Directorate, the Division water management budget and work plan will be presented to the RMB for review and approval. Upon concurrence of the RMB, the Director of Programs Directorate will make the information available as required to the Regional Command Council for information. The Division budget and work plan will then be used to develop the activity letters to the districts that initiate funding for Division water management for the next fiscal year. It will also be used as input to the overall Operations and Management budget for NWD, and for long-range strategic planning.

c. Best Business Practices. The WMB will review and evaluate the NWD Water Management Program as a whole, including current and future operations, trends, processes, practices and resource allocations, to determine if best business practices are in use. This review and evaluation will consist of both division and district Water Management activities, including sedimentation and water quality elements. Recommended changes to business practices will be reported to the Director of Programs Directorate, the RMB, and the Regional Command Council.

d. Issue Resolution. District and division representatives will be responsible for coordinating the proposed Water Management budget and any other issues with the district leadership, gathering and presenting comments to the WMB. Responses on comments from the board will be reported to district leadership through the district WMB representatives. The WMB will strive to resolve issues by ensuring that all pertinent data surrounding the issue at question is available to each WMB member, and through open dialog within the Board. If issues cannot be resolved by the WMB, the Director of Programs Directorate will mediate the disagreement in an attempt to reach consensus. If that fails, the issues will be elevated to the RMB and ultimate resolution by the Regional Command Council.

10. PUBLIC INFORMATION. In most cases, the districts have the lead responsibility for public information, including gathering input from the public, disseminating information, and organizing public meetings. The districts will work with CBWM to ensure that dissemination of public information is consistent with system objectives. CBWM has the lead responsibility for public information for issues pertaining to the Lower Snake projects and the mainstem Columbia projects as well as system operations.

11. WATER CONTROL PLANS AND MANUALS.

a. Responsibilities. District and Division responsibilities for preparing and maintaining water control plans and manuals are listed by project in Appendix A. In the case of several projects on the mainstem Columbia River which involve extensive system-wide coordination, CBWM will be involved in preparing/reviewing portions of those manuals. CBWM is responsible for preparing and maintaining the Columbia Basin Master Water Control Manual. Review and approval of water control manuals is a HQNWD responsibility. This approval responsibility applies to water control manuals for individual projects as well as master manuals.

b. Requirements. The following requirements and procedures apply to project water control manuals, with the objective of maintaining the most important parts of the manuals (including the water control plan) in an accurate and up-to-date status while utilizing a minimum of personnel resources.

(1) The water control plan for the project is to be current and accurate.

(2) The water control manual will be considered functional if it contains at a minimum an up-to-date water control plan. Preferably, it would also contain other chapters that are of a technical nature. It need not contain other chapters with general information to be a functional manual.

(3) Water control manuals will be updated such that the more important parts are given a higher priority, such as the water control plan.

(4) The manual will be contained in a loose-leaf binder with cover sheets at the front that indicate status of the chapters in the manual.

(5) District offices will prepare their annual status report to CBWM in accordance with ER 1110-2-240. A division-wide report will be submitted to HQUSACE.

12. WATER CONTROL DATA SYSTEMS.

a. Responsibilities. General responsibilities as defined in ER 1110-2-240 and ER 1110-2-249 are for district and division offices to develop and maintain Water Control Data Systems (WCDS). CBWM maintains approval authority for systems and networks through the submittal of the RWCDS Master Plan and its annual updates. Specific office responsibilities related to the RWCDS for the Columbia River Basin and coastal tributaries will be documented in the RWCDS Master Plan.

b. Requirements and Procedures. ER 1110-2-240 gives specific requirements for submittal and updating of division and district WCDS Master Plans.

13. AFTER-ACTION REPORTING.

a. Routine Reports. ER 1110-2-240 requires that a Division report on water management activities be submitted to HQUSACE annually. Another routine water management report prepared by HQNWD is the Columbia River Treaty Annual Report. Input from districts may be requested at the end of each water year for inclusion in these reports.

b. Special after-action reports. After the occurrence of large floods and other unusual events such as natural disasters, Corps Emergency Management offices may be required to prepare an after action report. Division and/or district water management personnel are typically requested to provide input to post-flood after action reports.

FOR THE COMMANDER:

Pamela D. Hertzberg

PAMELA D. HERTZBERG
Executive Officer

3 Appendices
App A – Division and District Water Management Responsibilities
App B – Definitions and Acronyms
App C – Division and District Organizations for Water Management

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NWDR 1165-2-2
APPENDIX A
DIVISION AND DISTRICT WATER MANAGEMENT RESPONSIBILITIES

PROJECT	OWNER	AUTHORITY	PRIMARY REGU-LATION	BACKUP REGU-LATION	WATER CONTROL PLAN	WATER SUPPLY FORECAST	STREAM-FLOW FORECAST	WATER CONTROL MANUAL
UPPER COLUMBIA								
Mica	BCH	Treaty	Owner/NWD	------	NWD	NWRFC*	NWRFC	------
Revelstoke	BCH	Power Coord	Owner	------	------	NWRFC*	NWRFC	------
Hugh Keenleyside	BCH	Treaty	Owner/NWD	------	NWD	NWRFC*	NWRFC	------
LIBBY	CE	Congress.	NWS	NWD	NWS/NWD	NWS	NWRFC	NWS
Duncan	BCH	Treaty	Owner/NWD	------	NWD	NWRFC*	NWRFC	------
Corra Linn	FORTISBC	Power Coord	Owner	------	------	NWRFC*	NWRFC	------
Kootenay Projects	FORTISBC	Power Coord	Owner	------	------	NWRFC*	NWRFC	
Hungry Horse	USBR	FCA 1944, sec 7	Owner/NWD	NWS	NWD	NWRFC*	NWRFC	NWS/NWD*
Kerr	PPL MONTANA	FERC Lic.	Owner/NWD	NWS	NWD	NWRFC	NWRFC	------
Thompson Falls	PPL MONTANA	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Noxon Rapids	AVISTA	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Cabinet Gorge	AVISTA	Power Coord	Owner	------	------	NWRFC	NWRFC	------
ALBENI FALLS	CE	Congress.	NWS	NWD	NWS/NWD	NWRFC	NWRFC	NWS
Box Canyon	PEND PUD	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Boundary	SEATTLE CITY LIGHT	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Seven Mile	BCH	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Waneta	TECK COMINCO	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Spokane Projects	AVISTA	Power Coord	Owner	------	------	NWRFC	NWRFC	------
Grand Coulee	USBR	FCA 1944, sec 7	Owner/NWD	------	NWD	NWRFC	NWRFC	NWD*/NWS
MID-COLUMBIA								
CHIEF JOSEPH	CE	Congress.	NWD	NWS	NWD/NWS	NWRFC	NWRFC	NWS
Wells	DOUGLAS PUD	FERC Lic.	Owner/NWD	------	NWD	NWRFC	NWRFC	NWS/NWD*
Rocky Reach	CHELAN PUD	FERC Lic.	Owner/NWD	------	NWD	NWRFC	NWRFC	NWS/NWD*
Rock Island	CHELAN PUD	FERC Lic.	Owner/NWD	------	NWD	NWRFC	NWRFC	------
Wanapum	GRANT PUD	FERC Lic.	Owner/NWD	------	NWD	NWRFC	NWRFC	NWS/NWD*
Priest Rapids	GRANT PUD	FERC Lic.	Owner/NWD	------	NWD	NWRFC	NWRFC	NWS/NWD*
Yakima Projects	USBR	------	Owner/NWD	------	NWD	NWRFC	NWRFC	------
LOWER COLUMBIA								

PROJECT	OWNER	AUTHORITY	PRIMARY REGU-LATION	BACKUP REGU-LATION	WATER CONTROL PLAN	WATER SUPPLY FORECAST	STREAM-FLOW FORECAST	WATER CONTROL MANUAL
MILL CREEK	CE	Congress.	NWW	------	NWW	------	NWW	NWW
MCNARY	CE	Congress.	NWD	NWW	NWD/NWW	NWRFC	NWRFC	NWW
WILLOW CREEK	CE	Congress.	NWP	------	NWP	NWP*	NWP	NWP
JOHN DAY	CE	Congress.	NWD	NWP	NWD / NWP	NWRFC*	NWRFC	NWP
Prineville	USBR	FCA 1944, sec 7	Owner	NWP	Owner	NWRFC*	Owner	NWP*
Ochoco	USBR	FCA 1944, sec 7	Owner	NWP	Owner	NWRFC*	Owner	NWP*
THE DALLES	CE	Congress.	NWD	NWP	NWD / NWP	NWRFC*	NWRFC	NWP
BONNEVILLE	CE	Congress.	NWD	NWP	NWD / NWP	NWRFC*	NWRFC	NWP
Swift #1	PACIFICORP	FERC Lic.	Owner	NWP	Owner/NWP	------	NWRFC	NWP*
Swift #2	PACIFICORP	FERC Lic.	Owner	NWP	Owner/NWP	------	------	------
Yale V	PACIFICORP	FERC Lic.	Owner	NWP	Owner/NWP	------	NWRFC	NWP*
Merwin	PACIFICORP	FERC Lic.	Owner	NWP	Owner/NWP	------	------	NWP*
Mossyrock/ Mayfield	TACOMA CL	FERC Lic.	Owner	NWP	Owner	------	NWRFC	NWP*
WILLAMETTE								
HILLS CREEK	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
LOOKOUT POINT	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
DEXTER	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
FALL CREEK	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
COTTAGE GROVE	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
DORENA	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
COUGAR	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
BLUE RIVER	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
FERN RIDGE	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
GREEN PETER	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
FOSTER	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
DETROIT	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
BIG CLIFF	CE	Congress.	NWP	NWD	NWP	NWP*	NWRFC / NWP	NWP
Scoggins	USBR	Section 7	Owner	NWP	Owner	Owner	Owner	NWP*
UPPER SNAKE								
Jackson Lake	USBR	Congress.	Owner /NWW	Owner	Owner/NWW	Owner/NWW*	NWRFC	NWW*
Palisades	USBR	Congress.	Owner/NWW	Owner	Owner/NWW	Owner/NWW*	NWRFC	NWW*
Ririe	USBR	Congress.	Owner/NWW	Owner	Owner/NWW	Owner/NWW*	NWRFC	NWW*
American Falls	USBR	------	Owner	------	Owner/NWW	------	NWRFC	------
Little Wood	USBR	Section 7	Owner/NWW	Owner	Owner/NWW	Owner/NWW	NWRFC	NWW

PROJECT	OWNER	AUTHORITY	PRIMARY REGU-LATION	BACKUP REGU-LATION	WATER CONTROL PLAN	WATER SUPPLY FORECAST	STREAM-FLOW FORECAST	WATER CONTROL MANUAL
Owyhee	USBR	------	Owner		Owner	NWRFC*	NWRFC	------
Anderson Ranch	USBR	Section 7**	Owner/NWW	NWW	Owner/NWW	Owner/NWW*	NWRFC	NWW
Arrowrock	USBR	Section 7**	Owner/NWW	NWW	Owner/NWW	Owner/NWW*	NWRFC	NWW
LUCKY PEAK	CE	Congress.	NWW	USBR	NWW/USBR	NWW/USBR*	NWRFC	NWW
Warm Springs	USBR	Section 7	Owner	NWW	Owner/NWW	NWW/Owner*	NWRFC	NWW*
Agency Valley	USBR	Section 7	Owner	NWW	Owner/NWW	NWW/Owner*	NWRFC	NWW*
Bully Creek	USBR	Section 7	Owner	NWW	Owner/NWW	NWW/Owner*	NWRFC	NWW*
Cascade	USBR	------	Owner	-----	Owner	Owner	NWRFC	------
Deadwood	USBR	------	Owner	-----	Owner	Owner	NWRFC	------
Mason	USBR	Section 7	Owner	NWW	Owner/NWW	Owner/NWW*	NWRFC	NWW
MID/LOWER SNAKE								
Brownlee	IDAHO POWER CO.	FERC Lic.	Owner/NWD	NWW/	NWD/NWW	NWRFC	NWRFC	NWW/NWD*
Oxbow	IDAHO POWER CO.	FERC Lic.	Owner		NWD/NWW	NWRFC	NWRFC	NWW/NWD*
Hells Canyon	IDAHO POWER CO.	FERC Lic.	Owner		NWD/NWW	NWRFC	NWRFC	NWW/NWD*
DWORSHAK	CE	Congress.	NWW	NWD	NWW/NWD	NWW	NWRFC	NWW
LOWER GRANITE	CE	Congress.	NWD	NWW	NWD/NWW	NWRFC	NWRFC	NWW
LITTLE GOOSE	CE	Congress.	NWD	NWW	NWD/NWW	NWRFC	NWRFC	NWW
LOWER MONUMENTAL	CE	Congress.	NWD	NWW	NWD/NWW	NWRFC	NWRFC	NWW
ICE HARBOR	CE	Congress.	NWD	NWW	NWD/NWW	NWRFC	NWRFC	NWW
PUGET SOUND								
Ross	SEATTLE CITY LGT	FERC Lic.	Owner/NWS	------	NWS	NRCS	NWRFC	NWS*
Upper Baker	PUGET SOUND ENERGY	FERC Lic.	Owner/NWS	------	NWS	NRCS	NWRFC	NWS*
LAKE WASHINGTON	CE	Congress.	NWS	------	NWS	------	NWRFC	NWS
HOWARD A HANSON	CE	Congress.	NWS	------	NWS	NRCS	NWRFC	NWS
MUD MOUNTAIN	CE	Congress.	NWS	------	NWS	NRCS	NWRFC	NWS
WYNOOCHEE	City of Aberdeen	Congress.	Owner/NWS	------	NWS	------	NWRFC	NWS*
UMPQUA/ROGUE								
Galesville	DOUGLAS COUNTY	Section 7	Owner	NWP	Owner	Owner	Owner	NWP*
LOST CREEK	CE	Congress.	NWP	------	NWP	NWP*	NWRFC / NWP	NWP
ELK CREEK ***	CE	Congress.	NWP	------	NWP	NWP*	NWRFC / NWP	NWP
Emigrant	USBR	Congress.	Owner	NWP	Owner	Owner	Owner	NWP*

PROJECT	OWNER	AUTHORITY	PRIMARY REGU-LATION	BACKUP REGU-LATION	WATER CONTROL PLAN	WATER SUPPLY FORECAST	STREAM-FLOW FORECAST	WATER CONTROL MANUAL
APPLEGATE	CE	Congress.	NWP	------	NWP	NWP*	NWRFC / NWP	NWP
MASTER MANUALS								
Columbia	------	------	------	------	------	------	------	NWD
Willamette	------	------	------	------	------	------	------	NWP

NOTES

1. Corps of Engineers projects are listed in capital letters
2. When joint responsibilities are shown, the office with lead responsibility is shown first.
3. Definitions of Headings:
    - "Primary Regulation" - For the purposes of this regulation the term "primary regulation" is meant to indicate the office having the lead responsibility for a regulation of a project. This involves frequent monitoring of the project, the issuing of operating instructions, and personal contact with project
    - "Backup Regulation" - Temporary assumption by another office of the roles and responsibilities of Primary Regulation (a) when requested to do so by the activity that normally provides this function, (b) in a COOP situation or COOP exercise, or (c) at the specific request of the CBWM Chief.
    - "Water Control Plan" - Development and updating of the project's Water Control Plan. This may be for either the project's Water Control Manual or an annual system operation.
    - "Water Supply Forecast" - Development and updating of water supply forecast procedure for the project.
    - "Streamflow Forecast" - Development, updating and implementation of streamflow forecasting procedure(s).
    - "Water Control Manual" - A manual used as reference for regulating a reservoir project or system of projects. It contains a Water Control Plan, a specific plan of regulation for that project.
4. A single asterisk (*) indicates that coordination with another agency is required in carrying out the responsibility. This notation was not used for the regulation function, since interagency coordination is assumed to be inherent in the process.
5. ** Arrowrock and Anderson Ranch are no longer managed as Section 7 Projects. Flood Control Space in the Boise System is managed jointly per the current Water Control Plan and Water Control Manual.
6. *** ELK CREEK DAM has been decommissioned, although it remains an authorized multipurpose storage project. It currently passes inflow through a constructed breach. No active storage is available.
7. CBWM determines system flood control requirements and coordinates power operations during power emergencies

APPENDIX B
NWDR 1165-2-2
DEFINITIONS AND ACRONYMS

Regulation/Operation The term "regulation" means the activity of monitoring the information and data on reservoir and streamflow status, analyzing information, and making reservoir regulation decisions based on current conditions and weather and streamflow forecasts, coordinating with affected parties/agencies, and issuing instructions to dam operators. In this NWDR the term "regulation" is kept distinct from "operation", the latter which refers to the actions by field personnel of maintaining and physically operating equipment at projects.

> "Backup Regulation" - Temporary assumption by another office of the roles and responsibilities of Primary Regulation (a) when requested to do so by the activity that normally provides this function, (b) in a COOP situation or COOP exercise, or (c) at the specific request of the CBWM Chief.

> "Primary Regulation" - For the purposes of this regulation the term "primary regulation" is meant to indicate the office having the lead responsibility for a regulation of a project. This involves frequent monitoring of the project, the issuing of operating instructions, and personal contact with project

BCH British Columbia Hydro and Power Authority

BPA Bonneville Power Administration

CBWM The Columbia Basin Water Management Division, one of two water management organizations within HQNWD (the other being the Missouri River Water Management Division)

COOP Continuity of Operations

Executive Direction and Oversight Responsibility for: (1) establishing and implementing policies and guidance; and (2) directing and managing overall execution and performance of all Corps Water Management offices in the Pacific Northwest Region.

FCRPS Federal Columbia River Power System

HQNWD Headquaters, Northwestern Division, in Portland, Oregon

Main Stem Main stem refers to the following projects on the main stem of the Columbia and lower Snake Rivers (Chief Joseph, McNary, John Day, The Dalles, Bonneville, Lower Granite, Little Goose, Lower Monumental, and Ice Harbor)

NRCS Natural Resources Conservation Service

NWRFC Northwest River Forecast Center, National Weather Service

POC Point of Contact
PNCA Pacific Northwest Coordination Agreement

RCC Reservoir Control Center

RWCDS (Regional Water Control Data Systems) A system of gages, telemetry, and computer processors that collects hydrometeorological data from remote sites and sends it to computer controllers for processing, storage, and use by modelers and water control managers. The system is managed regionally and data and model output may be incorporated into products made available to water control staff, managers, and stakeholders.

TDG Total Dissolved Gas

TMT Technical Management Team

Treaty Columbia River Treaty

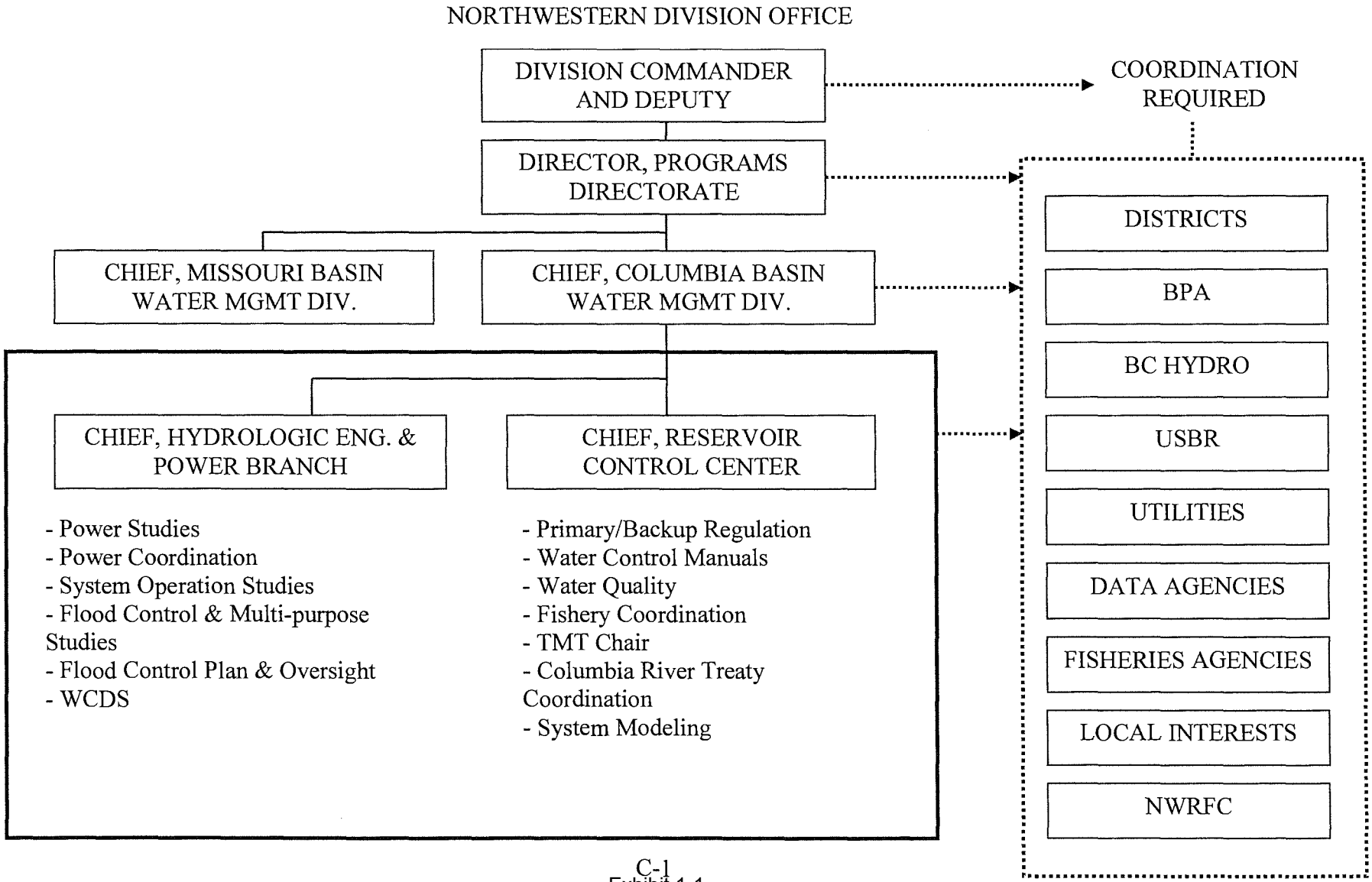
USBR U.S. Bureau of Reclamation

WMB Water Management Board

FCA 1944, Section 7 Section 7 of the Flood Control Act of 1944

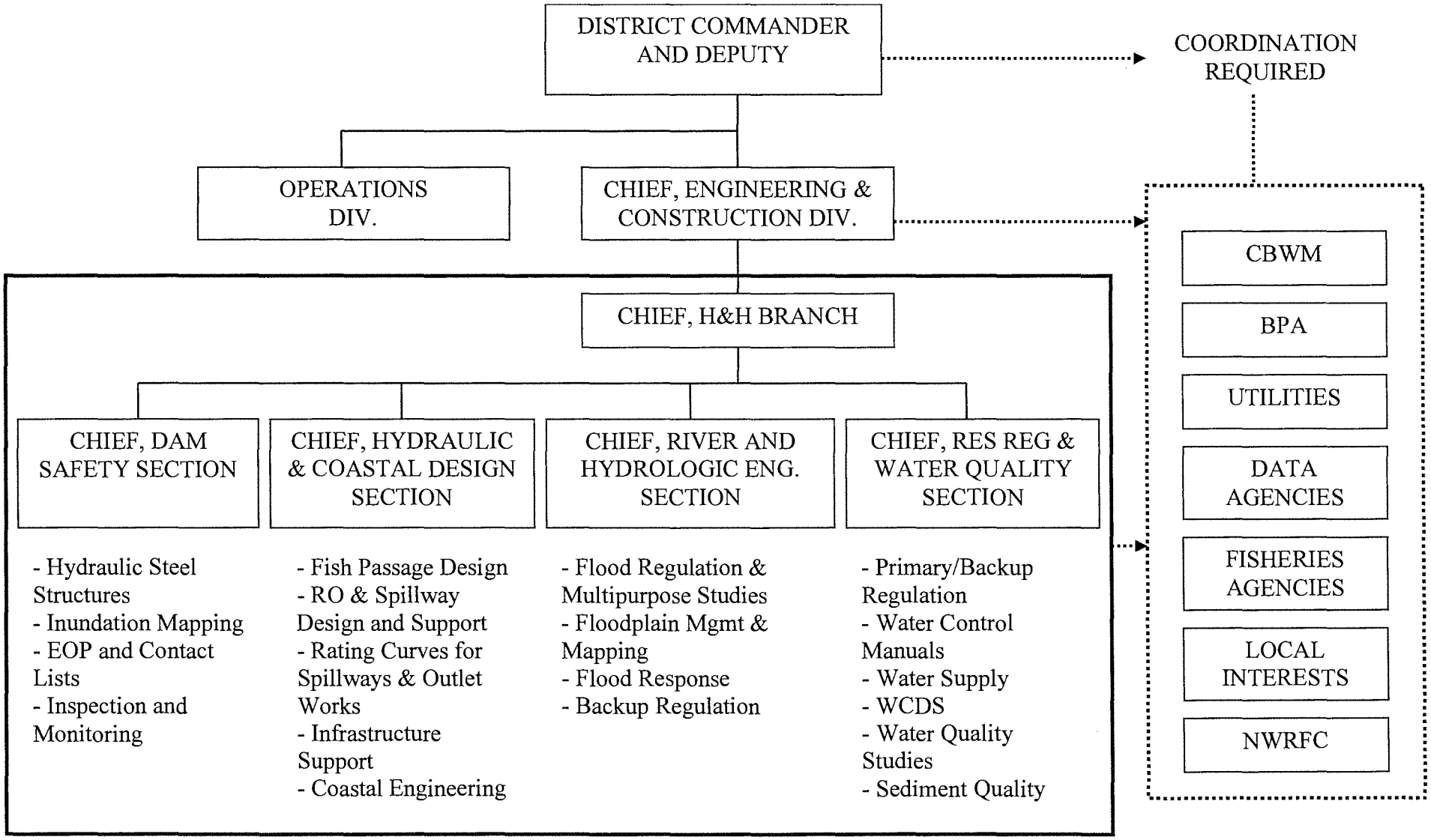
Congress Congressional Authority

APPENDIX C
NWDR 1165-2-2
DIVISION AND DISTRICT ORGANIZATION FOR WATER MANAGEMENT



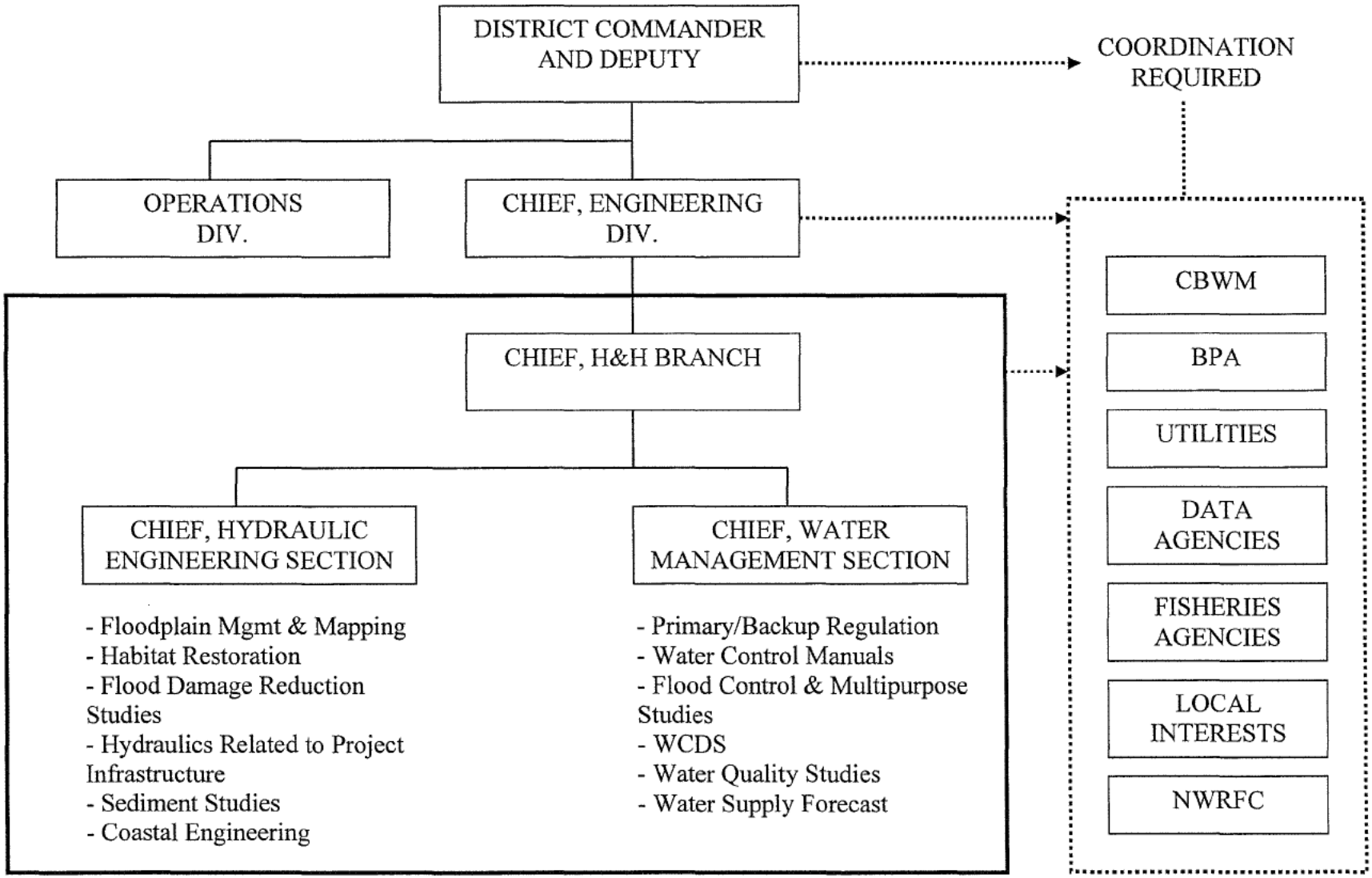
APPENDIX C
NWDR 1165-2-2
DIVISION AND DISTRICT ORGANIZATION FOR WATER MANAGEMENT

PORTLAND DISTRICT OFFICE



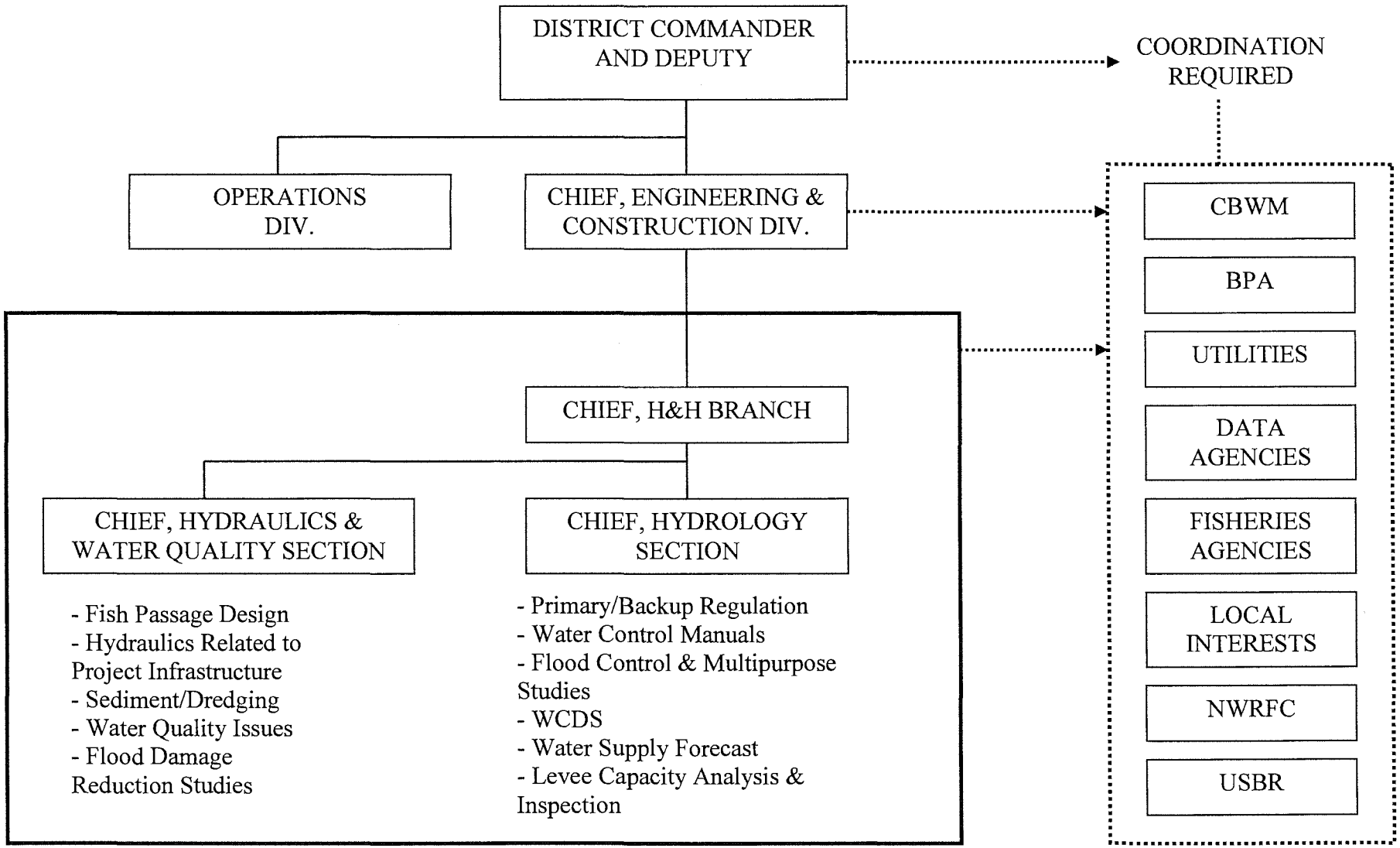
APPENDIX C
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DIVISION AND DISTRICT ORGANIZATION FOR WATER MANAGEMENT

SEATTLE DISTRICT OFFICE



APPENDIX C
NWDR 1165-2-2
DIVISION AND DISTRICT ORGANIZATION FOR WATER MANAGEMENT

WALLA WALLA DISTRICT OFFICE



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EXHIBIT 1-2
PUBLISHED DESIGN MEMORANDA, LIBBY PROJECT

Exhibit 1-2. Published Design Memoranda, Libby Projects

No.	Title	Date
1	Libby Dam - Determination of Axis and Type of Dam	
	Permanent Data	16 Jun 1952
1	Libby Dam Project - Determination of Permanent Data	21 Nov 1952
1	Determination of Axis and Type of Dam	Rev 21 Nov 1952
1	Libby Additional Units and Reregulating Dam,	
	Phase II, Project Design, Volume 1or 2 (Copy 64)	01 Jul 1975
1	Libby Reregulating Dam Power units HD #96-19	
	Phase 1 Permanent Data	15 Jan 1979
1 (Sup)	Determination of Axis and Type of Dam	15 Sep 1953
1 (Sup)	Libby Dam Upper Columbia R. R. Relocation Rt. 1,	
	Line A Prelim Cost Est., Permanent Data	27 Jul 1960
1 (Sup 1)	Libby Additional Units and Reregulating Dam,	
	Combined Spillway-Powerhouse (Copy 33)	01 May 1977
1 (Sup 1)	Libby Additional Units and Reregulating Dam,	
	Combined Spillway-Powerhouse, Larry Mann	30 May 1977
1 (Sup 2)	Libby Dam Project Drawing, Determination of Axis	
	and Type of Dam Drawings (1 Set)	01 Jan 1963
1 (Sup 2)	Libby Dam Determination of Axis and Type of Dam	
	Drawings	01 Jan 1963
1 (Sup 2)	Libby Dam Project Drawing, Determination of Axis	
	and Type of Dam (Includes 5 Appendices A-E)	
	Permanent Data	02 Jan 1963
1 (Sup 2)	Libby Dam Project, Kootenai River, Montana,	
	Determination of Axis and Type of Dam (Copy 29)	
	January 1963	31 Jan 1963
1 (Sup 2)	Libby Dam Project, Determination of Axis and Type	
	of Dam Permanent Data	31 Jan 1963
2	Libby Project Derivation of Spillway Design Flood	
	Inflow, Permanent Data (Includes 1 App A)	29 Jul 1952
2	Spillway Design Flood (Vol. 2 of 3)	01 Jan 1942
2	Spillway Design Flood (Vol. 3 of 3)	01 Jan 1948
2	Spillway Design Flood (Vol 1 of 3)	01Jan 1951
2 (Sup 1)	Libby Dam - Derivation of Spillway Design Flood	
	Inflow, Permanent Data	26 Oct 1962
3	Preliminary Master Plan (Includes 2 App)	05 Dec 1962
3 (Ltr Sup 1)	Responsibilities at Dam site for Visitor	
	Accommodations and Environmental Control	
	Aspects of Project Operations	Nov 1969
4	Hydrology and Reservoir Operations	25 Jan 1963
4	Libby Additional Units and Reregulating Dam Project,	
	Burlington Northern RR and St. Regis Log Haul	

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
	Road Relocation (Copy 32)	01 Apr 1978
4	Burlington Northern RR and St. Regis Log Haul Road	
	Relocation - Larry Mann	30 Apr 1978
4 (Sup 1)	Snowmelt Runoff Forecasts Permanent Data	01 Mar 1970
4 (Sup 1)	Runoff Volume Forecast Procedures Rev. 1970-1976	09 Jan 1976
5	Great Northern Line Change Drawings	01 Jan 1963
5	Great Northern Line Change (Includes 3 App)	25 Jan 1963
5	Great Northern Line Change Permanent Data	11 Jan 1972
5 (Rev)	Cost Estimate Rt. #1, Great Northern RR	
	Relocation - 7-Mile Tunnel	01 Jan 1964
5 (Sup 1)	Fish and Wildlife Facilities in Channel Changes	
	Permanent Data	23 Dec 1965
5 (Sup 2)	Swamp Creek to Rock Creek - Permanent Data	01 Aug 1965
5 (Sup 3)	Ariana Creek to Jennings (Includes 3 App)	
	Permanent Data	09 Jul 1965
5 (Sup 4)	Little Wolf Creek to Ariana Creek	29 Apr 1966
5 (Sup 4)	Libby Dam Great Swamp Creek Permanent Data	01 Jun 1966
5 (Sup 5)	Stryker to Swamp Creek (Includes 7 App)	Jun 1966
5 (Sup 6)	Rock Creek to Little Wolf Creek	09 Sep 1967
5 (Sup 7)	Swamp Creek to Rock Creek Structure DES Comps	
	Permanent Data	01 Apr 1966
5 (Sup 7)	Swamp Creek to Rock Creek Descriptive Text	
	Permanent Data	01 Jun 1967
5 (Sup 7)	Tunnel Ventilation System (Includes 1 App)	Oct 1966
5 (Sup 8)	Relocation of BPA Power Transmission Lines,	
	Bonneville Power Administration Permanent Data	20 Jun 1966
5 (Sup 9)	Lincoln Electric Company Co-Op Power line GNLC	
	Permanent Data	20 Jun 1966
5 (Sup 9)	Relocation of 24.9 KV Power Line, Lincoln	
	Electric Company, Inc.	Aug 1967
5 (Sup 10)	U.S. Forest Service Roads, Little Wolf Creek	
	to Jennings Permanent Data	23 Dec 1966
5 (Sup 11)	Great Northern Line Change - Station Facilities	27 Nov 1968
5 (Sup 12)	Libby Reservoir Power Supply - Great Northern Line	
	Change, Permanent Data	29 Aug 1968
5 (Ltr Sup)	Emergency Erosion Repair to Protect Facilities	
	along the Railroad	Dec 1971
6	Number and Size of Units (Includes 1 App)	
	Permanent Data	31 Jul 1963
6 (Sup 1)	Number and Size of Units - Permanent Data	30 Sep 1965
		Rev 4 Feb 1966

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
6 (Sup 2)	Number and Size of Units Permanent Data	28 Feb 1967
7	Concrete Aggregate Investigations for Dam	
	Permanent Data (Includes 4 App)	27 Jun 1963
7	Libby Dam Project Additional Units Misc	
	Correspondence	01 Jan 1976
7	Reregulating Dam Basis of Design Vol. 1 of 3 (Copy 87)	01 Jul 1978
7	Reregulating Dam Basis of Design (Vol. 2 of 3)	01 Jul 1978
7	Reregulating Dam Basis of Design (Vol. 3 of 3)	01 Jul 1978
7	Reregulating Dam Basis of Design (Vol. 3 of 3)/	
	Larry Mann	30 Jul 1978
7	Reregulating Dam Basis of Design (Vol. 2 of 3)/	
	Larry Mann	30 Jul 1978
7 (Sup 2)	Libby Additional Units and Reregulating Dam, Dynamic	
	Analysis of Libby Reregulating Dam (Copy 39)	01 Mar 1980
7 (Sup 2)	LAURD Dynamic Analysis of Libby Reregulating	
	Dam Permanent Data	10 Mar 1980
8	Plates for GDM	01 Apr 1963
8	General Design Memo (Vol. 2) (Includes 2 App A & B)	01 Jun 1963
8	General Design Memo (Copy 29)	28 Jun 1963
8	General Design Memo (Vol. 1) Permanent Data	28 Jun 1963
8	Libby Additional Units and Regulating Dam Project,	
	DM 8 - Montana State Highway 37 and Forest	
	Development Road 92.7 Relocation	30 Nov 1978
8 (Sup 1)	Support to Local School Districts Permanent Data	05 Dec 1966
8 (Sup 2)	Landing Strip Permanent Data	16 Jun 1967
8 (Sup 3)	Support to Local School Districts (2d Increment)	01 Feb 1968
8 (Sup 4)	Support to Local School Districts (3d Increment)	01 Jun 1968
8 (Sup 5)	Cultural Resources	01 Sep 1976
9	Highway and Road Relocations (Vol. 1)	01 Aug 1963
9	Highway and Road Relocations (Vol. 2) (Includes	
	1 App)	01 Aug 1963
9 (Sup 1)	Relocation, Lincoln County Roads Affected by	
	Unit 1, MSH-37 Permanent Data	Jul 1968
9 (Sup 2)	Forest Development Road Relocations, FD Unit 1	
	Permanent Data	Jun 1965
9 (Sup 3)	Reservoir Bridge Location	01 Aug 1964
9 (Sup 4)	Forest Development Road Relocations, FD Unit 2	
	Permanent Data	06 Sep 1967
9 (Sup 5)	Forest Development Road 92.7 - FD Unit 4A	Sep 1968
9 (Sup 6)	Forest Development Road 92.7 - FD Unit 3	Apr 1968
9 (Sup 6)	Forest Development Road Relocations	

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
	Permanent Data	05 Apr 1968
9 (Sup 7)	Reservoir Bridge and Approach Roads	01 Jun 1966
9 (Sup 8)	Lake Koocanusa Bridge Modifications to Pier 4	
	and 5 Pile Foundations	01 Jul 1972
9 (Sup 9)	Relocation, Montana State Highway 37, Unit 1, Cadette	
	Creek to End Relocation Permanent Data	19 May 1967
9 (Sup 10)	Forest Development Road 92.7 - FD Unit 4B	Mar 1970
9 (Sup 11)	Relocation, Montana State Highway 37, Unit 3A	
	Permanent Data	22 Mar 1966
9 (Sup 12)	Relocation, Montana State Highway 37, Unit 3B(2)	Aug 1969
9 (Sup 12)	Relocation, Montana State Highway 37	
	(Canyon Creek to Five Mile Creek)	30 Jan 1970
9 (Sup 13)	Relocation, Montana State Highway 37, Unit 3E,	
	McGuire Creek to Holdup Gulch Permanent Data	30 Jun 1969
9 (Sup 14)	Relocation, Montana State Highway 37, Unit 3C-D,	
	Five Mile Creek to McGuire Creek	12 Feb 1971
9 (Ltr Sup)	Libby Dam Ltr Sup	01 Nov 1965
9 (Sup 7,	Reservoir Bridge and Approach Roads	Feb 1970
Ltr Sup 1)		
9 (Sup 12,	Montana Highway 37, Unit 3B(2)	01 May 1970
Ltr Amdt 1)		
9 (Sup 12,	Relocation Montana Highway 37 Unit 3B, Larry Mann	30 May 1970
Ltr Amdt 1)		
10	Real Estate for Great Northern Line Change	4 Oct 1963
10	Real Estate for Great Northern Line Change	
	Permanent Data	24 Sept 1965
10	Libby Dam Project Additional Units Misc	
	Correspondence T: Cultural Resources	01 Jan 1976
10	Libby Dam and Lake Koocanusa Project (1 of 4)	01 Jan 2000
10	Libby Dam and Lake Koocanusa Project (2 of 4)	01 Jan 2000
10	Libby Dam and Lake Koocanusa Project (3 of 4)	01 Jan 2000
10	Libby Dam and Lake Koocanusa Project (4 of 4)	01 Jan 2000
10 (Sup 1)	Real Estate for Great Northern Line Change	
	Permanent Data	12 Aug 1965
10 (Sup 2)	Real Estate for Great Northern Line Change	Oct 1965
10 (Sup 2)	Contractors Staging Areas - Permanent Data	01 Oct 1965
10 (Sup 3)	Access to Construction Areas - Permanent Data	10 Nov 1965
10 (Sup 3)	Libby Jennings Private Road	10 Nov 1965
10 (Sup 4)	Fisher River Road Relocation, Change Estate to	
	Easement	01 Feb 1966
10 (Sup 5)	Borrow, Spoil, and Channel Changes, Change Estate	

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
	to Easement	05 Dec 1966
11	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	
	Permanent Data	20 Sep 1963
11	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	14 Oct 1963
11 (Sup 1)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	Feb 1966
11 (Sup 2)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	Apr 1967
11 (Sup 2)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	
	Permanent Data	14 Jun 1967
11 (Sup 4)	Boundary Line Survey and Marking	No Date
11 (Sup 5)	Downstream Effects and Compensation for Damages	
	at Kootenai Flats (Real Estate)	01 Jul 1975
11 (Sup 5)	Downstream Effects and Compensation for Damages	
	at Kootenai Flats Manual with Maps and Photos	
	(Real Estate) Permanent Data	01 Jul 1975
11 (Sup 6)	Libby Dam Real Estate For Dam, Reservoir, Highway,	
	and Road Relocation and Public Access	
	Reservoir Boundary MKG Permanent Data	17 Aug 1972
11 (Sup 6)	Real Estate for Wildlife Replacement Lands	
	Permanent Data	17 Jan 1977
11 (Sup 7)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocation, and Public Access	
	Permanent Data	06 Oct 1975
11 (Sup 7)	Borrow Source for Montana State Highway 37,	
	Unit 3A	Nov 1975
11 (Sup 9)	Real Estate Supp - Additional Area Sloughing	
	Permanent Data	18 Mar 1975
11 (Ltr Sup 3)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocations and Public Access	May 1970
11 (Ltr Sup 6)	Real Estate for Dam, Reservoir, Highway and	
	Road Relocations and Public Access	07 Aug 1972
11 (Ltr Sup 8)	Libby Dam Lake Koocanusa Project (Real Estate)	Jun 1973
12	Tailrace and Downstream Channel Excavation	Mar 1964
12	Tailrace and Downstream Channel Excavation	
	Permanent Data	09 Feb 1998
12 (Sup 1)	Tailrace and Downstream Channel Excavation	
	Permanent Data	30 Sep 1965

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
13	Detailed Plan for Cemetery and Grave Relocations,	
	Prepared by Walla Walla District (Includes 2 App)	31 Oct 1968
14	Relocation - U.S.F.S. Facilities Ranger Station	
	and Work Centers (Includes 1 App)	
	Permanent Data	01 Oct 1965
14 (Ltr Sup 1)	Relocation - U.S.F.S. Facilities Ranger Station	
	and Work Centers	May 1970
15	Fish and Wildlife (Includes 2 App)	Nov 1965
15 (Sup 1)	Environmental Evaluations and Partial Mitigation	
	for Big Game Habitat Permanent Data	01 Aug 1968
15 (Sup 2)	Mitigation of Wildlife Losses Permanent Data	29 Apr 1972
15 (Sup 3)	Libby Mitigation Hatchery. Prepared by Kramer,	
	Chin & Mayo, Inc., Consulting Engineers,	
	Architects, Applied Scientists, Seattle,	Aug 1974
	Washington (Includes 3 App)	Rev Jun 1975
15 (Sup 3)	LDP Libby Mitication Hatchery Permanent Data	Aug 1974
15 (Ltr Sup 1)	Trout Hatchery	Nov 1965
15 (Ltr Sup 1)	Young Creek Fish Barrier Dam	Jun 1969
15 (Ltr Sup 2)	Mitigation of Wildlife Losses	Nov 1965
15 (Ltr Sup 2)	Additional Big Game Habitat Improvement,	
	Waterfowl Habitat Improvement and Evaluation	
	of Big Game Habitat Improvement	May 1970
15 (Ltr Sup 3)	Additional Fish and Wildlife Resource	
	Investigations, Habitat Studies and Mitigation	
	Evaluation	Apr 1972
16	O & M Design Memo 1963 - 1970	12 Jun 1963
16	Dam - Basis of Design, 3 Vol.: Vol. 1, Main	
	Report; Vol. 2, Drawings; and Vol. 3, App A-D	
	Permanent Data	01 May 1965
16	Libby Dam Basis of Design Vol. 1 Permanent Data	28 May 1965
16 (Sup 1)	Libby Dam Basis of Design Supplemental Studies,	
	Powerhouse and Appurtenances, Permanent Data	
	(Includes 2 App)	15 Dec 1965
16 (Sup 2)	Supplemental Studies, Concrete Temperatures	
	and Instrumentation (Includes Letter Addition,	
	dated Feb 1968 and Letter Addition No.2,	
	dated Sep 1968)	Apr 1966
16 (Sup 3)	Electrical System Permanent Data (Includes 2 App)	01 Nov 1966
16 (Sup 4)	Dam - Basis of Design, Gantry Crane Permanent Data	30 Sep 1969
16 (Sup 4)	Dam - Basis of Design, Gantry Crane	30 Sep 1971
16 (Sup 4)	Dam - Basis of Design, Gantry Crane	Apr 1971

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
16 (Sup 4 Rev)	Dam - Basis of Design, Gantry Crane	29 Apr 1971
16 (Sup 5)	Kiosks and Viewing Ports, Visitor Center and	
	Resident Engineer's Building Permanent Data	May 1968
16 (Sup 6)	Stilling Basin Bridge	10 Oct 1968
16 (Sup 7)	Selective Withdrawal System for Downstream	
	Water Quality Control (Includes 7 App)	Oct 1970
16 (Sup 7)	O & M Design Memo 16, Sup 7 1970	18 Nov 1970
16 (Sup 9)	Selective Withdrawal System, Gantry Crane,	
	Prepared by North Pacific Division (Includes	
	1 App)	31 Jan 1973
16 (Sup 10)	Libby Dam and Lake Koocanusa Project, Libby Dam	
	Sluice Repair Permanent Data	01 Nov 1977
16 (Sup 17)	LDP and Lake Koocanusa Earthquake Analysis of	
	Libby Dam	01 Feb 1981
16 (Sup 17)	Libby Dam Earthquake Analysis of Libby Dam	
	Permanent Data	01 Feb 1981
16 (Sup 17)	LDP and Lake Koocanusa Earthquake Analysis of	
	Libby Dam	25 Feb 1981
16 (Sup 2,	Supplemental Studies, Concrete Temperatures	
Ltr Rpt 3)	and Instrumentation	Aug 1974
16 (Sup 7,	Selective Withdrawal System Bulkheads,	
Ltr Rpt 1)	Trash racks and Vortex Skimmers, Prepared	
	by North Pacific Division	15 Aug 1972
16 (Sup 7,	Selective Withdrawal System for Downstream Water	
Ltr Rpt 1)	Quality Control Oct. 17, 1970	17 Oct 1970
16 (Ltr Sup)	Dam - Basis of Design - Maintenance Building	Dec 1969
16 (Ltr Sup 6)	Hired Labor Landscaping and Rockscaping Program	Sep 1969
16 (Ltr Sup 7)	Security Plan	Jun 1970
16 (Ltr Rpt 1)	Project Administration Complex Permanent Data	30 Nov 1978
16 (Ltr Rpt 11)	Stilling Basin Repair Permanent Data	01 Apr 1976
16 (Ltr Rpt 12)	Left Abutment Rock Stabilization Permanent Data	20 May 1976
16 (Ltr Rpt 15)	Seal Grout Curtain Under Dam Permanent Data	01 Nov 1976
16 (Ltr Rpt 16)	Visitor Control Gates Permanent Data	27 Mar 1977
17	Relocation of Power and Inc. Interbel Telephone	
	Co-Op Inc.	29 Mar 1969
17	Relocation of Power and Telephone Lines, Lincoln	
	Electric Cooperative, Inc., and Interbel	
	Telephone Cooperative, Inc., (Includes 7 App)	Nov 1969
17 (Ltr Sup 1)	Relocation of Power and Telephone Lines, Lincoln	
	Electric Cooperative, Inc., and Interbel	
	Telephone Cooperative, Inc.	Aug 1970

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
17 (Ltr Sup 2)	Relocation of Power and Telephone Lines, Lincoln	
	Electric Cooperative, Inc., and Interbel	
	Telephone Cooperative, Inc.	Jan 1971
18	Utilities Relocation along Forest Development Road	
	Unit 1, Permanent Data, (Includes 4 App)	Nov 1965
19	Relocation of Facilities, General Telephone	
	Company of the Northwest (Includes 2 App)	
	Permanent Data	Aug 1966
20	Libby Land Interchange	Jan 1969
20	Libby Dam and Lake Koocanusa Project	01 Jan 2000
20 (Sup 1)	Libby Land Interchange (2d Increment)	
	Permanent Data	Dec 1970
20 (Sup 1)	Libby Land Interchange	04 Dec 1970
20 (Sup 1)	Libby Land Interchange	11 Dec 1970
20 (Sup 1)	Libby Dam and Lake Koocanusa Project	01 Jan 2000
20 (Sup 2)	Libby Land Interchange (3d Increment) (Not	
	Available from Library Branch)	Apr 1973
20 (Sup 2)	Libby Dam and Lake Koocanusa Project	01 Jan 2000
21	Powerhouse, Prepared by North Pacific Division	
	(Includes 8 App)	Apr 1967
22	Hydrologic and Communication Facilities	
	Hydromet Network Data 1970 - 1972	01 Jul 1970
23	Reservoir Clearing	Nov 1966
23 (Ltr Sup 1)	Reservoir Clearing	Apr 1969
24	Public Use Plan	No Date
25	Sedimentation Observation Plan	30 Sep 1971
26	Permanent Operating Equipment	No Date
27	Drift Control (Includes 3 App)	Feb 1970
27	Drift Control	26 Mar 1970
27 (Ltr Sup 1)	Drift Control	Dec 1971
29	Cost Allocation Permanent Data	26 Nov 1976
30	Relocation of Rexford, Montana (Includes 13 App)	
	(Copy 34) Permanent Data	Feb 1968
30 (Ltr Sup 1)	Relocation of Rexford, Montana	Jul 1969
30 (Ltr Sup 2)	Relocation of Rexford, Montana	Dec 1970
30 (Ltr Sup 3)	Relocation of Rexford, Montana	Jan 1971
30 (Ltr Sup 4)	Relocation of Rexford, Montana	Mar 1971
30 (Ltr Sup 5)	Relocation of Rexford, Montana	No Date
31	Powerhouse Architectural Design, Prepared by	
	North Pacific Division (Includes 4 App)	
	Permanent Data	Aug 1968

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
32	Powerhouse Structural Design, Prepared by	
	North Pacific Division (Includes 4 App) (App C,	
	due to the voluminous size of the computations	
	is included only in copies numbered 1 through	
	3; one of each is retained in OCE, North	
	Pacific Division, and Seattle District)	May 1970
33	Powerhouse Mechanical Design, Prepared by	
	North Pacific Division (Includes 14 App)	
	Permanent Data	29 Nov 1969
35	Visitor Accommodation and Landscape Restoration	15 Apr 1971
35 (Ltr Rpt 1)	Landscape Restoration	Apr 1971
35 (Ltr Rpt 1)	Powerhouse Mechanical Design	Dec 1972
35 (Ltr Rpt 2)	Souse Gulch Boat Moorage	Apr 1971
35 (Ltr Rpt 2)	Souse Gulch Boat Moorage	Jun 1974
35 (Ltr Rpt 2)	Treaty Tower Sculpturing	Aug 1973
35 (Ltr Rpt 2)	Visitor Center Modifications	No Date
35 (Ltr Rpt 3)	Lobby Window Aquarium	Mar 1974
35 (Ltr Rpt 4)	Downstream Channel Bridge	No Date
35 (Ltr Rpt 5)	Downstream Site Restoration	No Date
36	Seeding - Roads, Highway, and Railroad	
	Permanent Data	24 Dec 1969
36 (Sup 1)	Landscape Restoration Permanent Data	14 Jan 1970
40	Relocation of Power lines in Reservoir Area,	
	Pacific Power and Light Company (Copy 33)	Mar 1971
40	McGillivray Recreation Site Permanent Data	23 May 1979
41	Libby Dam Peck Gulch Recreation Site Permanent Data	01 Jun 1980
43	Libby Dam Public Use Development Plan Dispersed	
	Rec Permanent Data	01 Jul 1980
43	Libby Dam Public Use Development Plan Dispersed	
	Rec Permanent Data	28 Jul 1980
44	Libby Dam Project Lake Koocanusa Draft Master	
	Plan Correspondence	01 Jan 1983
44	Libby Dam Master Plan Camera Ready Original	01 Jan 1983
44	Libby Dam project Master Plan Design Branch	
	Correspondence	01 Jan 1983
44	Libby Dam Lake Koocanusa Project Master Plan	
	Permanent Data	01 Jun 1983
44	Libby Dam Lake Koocanusa Master Plan Original	
	Plates - File #E-53-45-58	01 Jun 1983
44	Libby Dam and Lake Koocanusa Project	01 Jan 2000
44 (Sup)	Cultural Resource Management Plan Kootenai River	

Exhibit 1-3. Published Design Memoranda, Libby Projects

No.	Title	Date
	Montana, 1987	05 May 1987
50	Reregulating Dam and Reservoir, Site Selection	
	and Land Requirement Plan (Includes 2 App)	27 Jan 1970
52	Libby Dam - Lake Koocanusa Master Plan FY 1996	06 Sep 1996
52	Libby Dam - Lake Koocanusa Project Master Plan	
	Design Sep 1997	01 Sep 1997
52	Libby Dam - Lake Koocanusa Project Master Plan	
	Design Sep 1997	30 Sep 1997
52	Libby Dam - Lake Koocanusa Project Master Plan	
	Draft July 1977	30 Sep 1997
52	Libby Dam - Lake Koocanusa Project Master Plan -	
	Camera Ready Copy	30 Sep 1997
52	Libby Dam - Lake Koocanusa Project Master Plan -	
	FY 1997	10 Oct 1997
100	Hydrometeorological Supporting Facilities	Oct 1970
No DM # Found	Libby Dam -Lake Koocanusa Project Master Plan	26 Oct 1982
No DM # Found	Libby Recreation Study Memorandum May 1989	26 May 1989
No DM # Found	Libby Reservoir Project - Previously Issued -	
	Design Memoranda Permanent Data	9 Feb 1998

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EXHIBIT 2-1
MEMORANDUM OF UNDERSTADING ON OPERATION OF LIBBY DAM SLUICE GATE OUTLETS BEFORE AND AFTER AIR VENT DIVIDER REMOVAL

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

MEMORANDUM OF AGREEMENT
AMONG
THE CHIEF OF CONSTRUCTION DIVISION,
THE CHIEF OF ENGINEERING DIVISION,
THE CHIEF OF OPERATIONS DIVISION,
AND
THE CHIEF OF PLANNING, PROGRAMS AND PROJECT MANAGEMENT DIVISION

SUBJECT: Operation of Libby Dam Sluice Gate Outlets Before and After Air Vent Divider Removal

1. References:

a. USACE, 2009. Memorandum for Record, "Approval from the CENWS Dam Safety Committee for Removal of Air Dividers that are Presently in the Existing Sluiceway Air Supply System at Libby Dam," CENWS.

b. USACE, 2011. Memorandum for Record 29 September 2011, "Operation of Libby Dam Sluice Gate Outlets Before and After Air Vent Divider Removal," CENWS.

c. USACE, 2013. Memorandum for Record 15 January 2013, "Numerical Analysis of Sluiceway Air Vent Divider Removal, Libby Dam, Kootenai River, MT," CENWS.

2. Purpose. To clearly define sluice gate operational guidance at Libby Dam both before and after removal of the air vent dividers.

3. Problem. At the 30 November 2009 Dam Safety Committee meeting, the committee recommended the removal of the air vent dividers and committed to further study how the sluice gates should be operated without the air vent dividers. A Memorandum For Record dated 29 September 2011, included as Attachment 1, outlined operational guidance of the sluiceway prior to divider removal and described preliminary operational guidance of the sluiceway following divider removal. Further analysis performed by the Hydraulic Engineering Section, recorded in an MFR dated 15 January 2013 and included as Attachment 2, provides the final operational guidance of the sluiceway following divider removal.

4. Scope. The contents of this MOA will be incorporated into the latest revision of the Libby Dam Water Control Manual and will guide sluice gate operations as directed by Water Management.

5. Understandings, agreements and support and resource needs.

a. Operational Guidance Before Divider Removal:

A memorandum providing background of sluice modifications and testing, as well as operational guidance for the sluice gates prior to air vent divider removal, is enclosed as Attachment 1. The recommendations for how the sluiceway should be operated prior to air vent divider removal, as previously approved by the Dam Safety Committee in 2011, are as follows:

i. All three sluice gates should be operated at identical openings up to a maximum of 6.5 ft each (5,000 cfs per gate at full pool elevation of 2459 ft).
ii. Further operation of the sluice gates may be considered in accordance with the Water Control Manual, if necessary to prevent dam overtopping.
iii. Inspection of each air vent divider panel should be accomplished after 25 days (600 hours) of operation at any discharge or after 24 hours of operation at 5,000 cfs (per gate). Inspections should consist of checking 100 percent of all bolt connections for proper torque as well as visual inspection of metal skin and grating bar connections.
iv. Asymmetrical operation of gates should be avoided.
v. Operation of the spillways coincident with the sluices should be avoided, except when the combined hydraulic capacity is required by the Water Control Manual to prevent dam overtopping.
vi. Emergency gate closure may result in increased air demand from the vent system and large airflow surges at the divider panels. Inspection of the vents should be accomplished if emergency gate operation is necessary.

b. Operational Guidance After Divider Removal:

A memorandum summarizing an analysis of the sluiceway air vent divider removal is enclosed as Attachment 2. The operational guidance was agreed upon by the Dam Safety Committee at the 14 January 2013 Dam Safety Committee meeting. The recommendations for how the sluiceway should be operated following air vent divider removal are as follows:

i. All three sluiceways will be operable under all gate configurations; there will be sufficient air ventilation to prevent cavitation.
ii. For safety reasons, all doors to the sluice gate chambers should be closed and personnel access to the gate chambers should be restricted during operation; it should be noted that the connected air system can draw air from all gate chambers and significant air velocities can exist in closed sluiceways when other sluiceways are in operation.
iii. Sluice gate openings should follow the minimum operating conditions shown in Attachment 3 (Plate 14 of Technical Report H-76-21, USACE, 1976); reduced maximum gate openings apply when the reservoir level is below elevation 2,320 feet.
iv. The sluiceways should be inspected after any extended use.

6. Effective date. The above operational guidance of Libby Dam sluice gates prior to air vent divider removal is unchanged from current guidance and will continue to be effective. The operating project intends to remove the air vent dividers pending the availability of funding, and the operational guidance in the above Paragraph 5.b. will be effective immediately upon the divider removal.

ARILL BERG, P.E.
Chief, Construction Division

4/4/2013
(date)

MARK OHLSTROM, P.E.
Chief, Engineering Division

3 April 2013
(date)

FRANCES COFFEY, P.E.
Chief, Operations Division

4/3/13
(date)

OLTON SWANSON, P.E., P.M.P
Chief, Planning, Programs, and
Project Management Division

4/4/13
(date)

Attachments (3)
(1) MFR, Operation of Libby Dam Sluice Gate Outlets Before and After Air Vent Divider Removal, 29 September 2011.
(2) MFR, Numerical Analysis of Sluiceway Air Vent Divider Removal, Libby Dam, Kootenai River, MT, 15 January 2013.
(3) Plate 14 from USACE, 1976, Technical Report H-76-21. Center Sluice Investigation, Libby Dam, Kootenai River, Montana, Hydraulic Model Investigation 20.

REESE/EN-HH-WM

FITZGERALD/EN-HH CF

GREEN/EN-DB GLG

SMITH/EN

EDWARDSON/OD-LI E'WE

WAGNER/OD-TS 3-18-13

BERG/CD /s/ 4/1/13

COFFEY/OD /s/ 4/3/13

OHLSTROM/EN /s/ 3 April 13

SWANSON/PM /s/ 4 Apr 13

SHAFFER/EN-HH-WM X3660

CARSON X3585

1. Background: The three radial sluice gate outlets at Libby Dam are designed with a maximum opening of 17 ft each, for a total discharge of about 51,200 cfs at a pool elevation of 2459 ft. If all gates are completely raised from the tunnels, a free-flow discharge of about 60,000 cfs is possible but not recommended due to possible cavitation on the sluiceways. Concerns over cavitation arise from design of the sluiceways. Several modifications have been made to the sluiceways, and associated air vent facilities, since 1974 to attempt to improve airflow characteristics and allow full use of the gates. The most recent modification, addition of air vent divider panels in 1981, has suffered from structural and performance issues ever since. This has led to significant uncertainty about safe sluice gate operation. A summary of events related to sluice modification and testing is given in Table 2. The sluice gates have not been used operationally through their normal range (0 to 16 ft opening) since the most recent testing in 1982 by Waterways Experiment Station (WES). Limited use of the gates was done in May of 2011, in which the outer gates were used at 2,500 cfs each and then all three gates at 1,700 cfs each (for total discharge of 5,000 cfs). Flows greater than 5,000 cfs were undesirable at the time due to dissolved oxygen levels in the tailwater. Annual maintenance checks that include actuating the gates have been completed.

Table 1: Summary of Libby Dam sluice modifications and testing

1973	Dam construction completed.
1973-1974	Significant cavitation damage occurred on center and right sluiceways.
1974	WES field tests conducted, following sluiceway repairs, to collect data on cavitation conditions.
1976	Physical model study by WES, based upon 1974 field test data, to develop fix for cavitation problems. Several sluiceway modifications (aerator slots) proposed. Model testing suggests that existing vent facilities are adequate to support air demands of modified sluiceways, however modification to provide a separate vent for each gate is recommended. No technical basis is given in the report for this recommendation.
1980	Sluiceways modified with aerator slots to eliminate negative pressures.
1980	Prototype testing of aerator slots by WES (Hart, 1981); data collected for single gate (right side) operation up to 16 ft opening with isolated air vent; verified adequate operation of aerator slot and air vent. Increased air demand from air vent observed with maximum air vent velocity of 140 ft/s.
1981	Air vent passages modified to improve flow at bends and divider panels installed to give each gate a separate vent.
1982	Prototype testing of air vent divider performance by WES (McGee, 1984). Data collected for operation of center gate and all three gates up to 16 ft opening. Excessive airflow velocities (250-300 ft/s) and surging observed in vent passages lead to uncertainties over structural adequacy of dividers. No cavitation damage

	noted.
1983-1985	Prototype testing to evaluate emergency gate operation. Several tests resulted in significant damage to the sluice facilities and emergency gates.

Analysis of air vent structural adequacy was done by Mechanical Engineering section in 1997 (USACE, 1999) following Periodic Inspection #13 (USACE, 1995). Air vent dividers were found to differ slightly from the intended design and several bolts were found loose (and subsequently re-tightened). The analysis recommended that, under the most severe conditions of center gate only operation, the dividers should function adequately for at least 25 days at individual gate discharge of 7000-9000 cfs. This guidance was developed from the estimated number of loading cycles the metal dividers can safely withstand over the duration of flows. Inspection was recommended after 600 hours (25 days) of operation at any discharge or 24 hours of operation at 5,000 cfs or greater (per gate). Dam Safety Periodic Inspection #14 (USACE, 2000) evaluated the dividers and found them to be structurally adequate (following minor modifications) for the previously recommended 7,000 to 9,000 cfs. Periodic Inspection # 15 (USACE, 2005) evaluated the dividers and found them to be structurally adequate, but additional modifications were recommended to "enhance" structural adequacy (for long term use). Periodic Inspection #16 (USACE, 2010) documents authorization for divider panel removal from the CENWS dam safety committee. Modifications recommended in PI #15 have not been completed due to expected divider panel removal. Concern over on-going maintenance requirements and performance resulted in concurrence from Mechanical Engineering, Structural Engineering, and Hydrology/Hydraulics sections to have the dividers removed (USACE, 2009). Removal is expected to occur in 2011 to 2013.

Considering that the recommended modifications from Periodic Inspection #15 were not made, some degree of conservatism should be applied to gate operations in the interim before the dividers are removed. A review of available test data and observations has provided the following operational characteristics, which are pertinent for determining allowable gate operation:

- The lowest pressure differential across the dividers (and the lowest stress) results from operation of all three gates simultaneously; the highest pressure differentials result from center gate only operation (McGee, 1984).
- Peak pressure differential (between each sluice gate and the ambient air) was found to develop at around 7-9 ft of gate opening (5,300-6,800 cfs) when tested at a pool elevation of 2458 ft (near full). Same for the lowest sluiceway invert pressures.
- Operation of the center gate by itself at any discharge may result in excessive upward forces on the divider panels, which they may not withstand due to construction deficiencies (USACE, 1999).

- Asymmetrical gate operation should be avoided due to air surging in the vents and possible stilling basin damage (McGee, 1984).
- Operation of the spillway, coincident with the sluices, causes submergence of the sluice gate exit portals. Greater airflow in the air vent passages was observed when this was tested (McGee, 1984). This is likely due to some airflow shifting from the exit portals to the air vent passages. At large gate openings, with spillway flow, it may be possible to completely fill the sluice tunnels and pressure flow to occur (USACE, 1976). This condition may cause extreme air surging.
- Emergency gate closure tests have not been successfully done without incident (McGee, 1984 and USACE, 1999). When an emergency gate is lowered under flow conditions, significant air surging occurs at the aerator slots and vent passages.

It is clear from review of existing test data and reports that airflow conditions were not improved by addition of the divider panels. Removal of the divider panels will restore interconnection of the air vent passages between all gates. The improved bends constructed between the air vent passages and gate chambers in 1981 will still exist. Aerator slots were shown to function adequately in the 1980 tests for a single outer gate (at up to 16 ft opening). Both outer gates can be assumed to function adequately because they are identical and each will have a sufficient air supply. Use of the center gate is being evaluated at the time of this MFR and operational criteria developed further. The occurrence of a spillway design flood event may necessitate use of the center gate in the interim and guidance given in the Libby Dam Water Control Manual should be followed regarding this. Normal gate operation has been restricted to 16 ft of opening due to concerns over aerator slot performance at greater openings. An exception has been authorized when the pool is expected to exceed 2459 ft, and then 17 ft is authorized as the last increment of total sluice gate discharge (USACE, 1984).

2. Restoring full use of all sluice gates: Airflow characteristics of the center gate are presently being evaluated for full use. The center gate will share the available air supply with each of the outer gates and pressures experienced in the vent system will change when the divider panels are removed. No test data presently exists for simultaneous operation of all three gates without the divider panels. However, a significant body of knowledge exists and other configurations have been tested. Recent analysis by Mechanical Engineering (USACE, 2011) has stated that all gates can be used at full capacity (i.e. up to 16 ft opening) in any combination once the air vent dividers are removed. In this analysis, it was shown that airflow to the center gate will increase considerably and airflow to the outer gates will decrease marginally once the panels are removed. Removal of the divider panels and modified junctions to the cross over duct is expected to significantly reduce energy losses in the system. This analysis is presently being reviewed by Hydraulic Engineering Section and

Dam Safety. Further analysis of transient airflow conditions is being considered. A subsequent memo will be finalized in Water Year 2012. If full gate operation of 16 ft is restored, discharges of up to about 46,200 cfs would be possible with all three gates operating. Use of all three gates at 17 ft would provide discharges of 51,200 cfs at full pool, however if operation of any gates beyond a 16 ft opening is desired significant modification to the sluiceways (in addition to the 1980 aerator slot installation) would likely be necessary (USACE, 1984 and USACE, 1976).

3. References:

Hart, D., 1981. Miscellaneous Paper HL-81-6. Air Demand Tests, Libby Dam Kootenai River, Montana.

McGee, R., 1984. Technical Report HL-84-2. Prototype Evaluation of Sluiceway Aeration System Libby Dam, Kootenai River, Montana.

USACE, 1976. Technical Report H-76-21. Center Sluice Investigation, Libby Dam, Kootenai River, Montana. Hydraulic Model investigation. 20.

USACE, 1980. EM 1110-2-1602 Hydraulic Design of Reservoir Outlet Works. Section 2-16.

USACE, 1984. Water Control Manual, Libby Dam and Lake Koocanusa.

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USACE, 2005. Periodic Inspection Report no. 15 Libby Dam, Lake Koocanusa project, Kootenai River, Montana.

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USACE, 2011. Memorandum for record, 9/19/2011 'Libby Dam Sluiceway Air vent System". Analysis from Mechanical Engineering section (Sven Lie).

CENWS-EN-HH-HE January 15, 2013

MEMORANDUM FOR RECORD

SUBJECT: Numerical Analysis of Sluiceway Air Vent Divider Removal, Libby Dam, Kootenai River, MT

1. Executive Summary:
   Due to structural inefficiencies, the Seattle District Dam Safety Committee approved the recommendation to remove air vent dividers in 2009 (USACE, 2009). The air vent dividers are still in place today, but will be removed once funding is available. The USACE (2009) recommendation also included the operational constraint that only two sluices be operated at a time until further analysis. Based on the analysis of this document, it is recommended that all operation constraints be eradicated once the air vent dividers are removed since the air vent divider system has very little impact on air supply (<10%). In addition, damage due to cavitation is unlikely with or without the air vent dividers since the aeration slots installed in each sluice in 1980 allow the water jet to be effectively aerated. However, the air vents are undersized for the increased air demand caused by the aeration slots and personnel should be aware of potentially unsafe air velocities. All access doors should be closed and personnel should be restricted from sluice gate chambers during operation.

2. Purpose
   A memorandum from Hydraulic Engineering dated 29 September 2011 (USACE 2011, b) supported the USACE (2009) recommendation to remove the air vent dividers. The operational constraint was changed slightly so that only the outer sluices could be used until further analysis. The purpose of this memorandum is to review previous air vent calculations (USACE 2011, a), review previous physical and prototype modeling, numerically analyze the air vent system without dividers, and to provide operational constraints, if any, on operating sluice gates without air vent dividers. Plates 1 through 3 depict the air vent system.

3. Background:
   Libby Dam became operational in 1972, and major cavitation damage occurred in the center and right sluices from 1973 to 1975. The U.S. Army Engineer Waterways Experiment Station (WES) Hydraulics Laboratory conducted field testing (Hart and Tool, 1976) and model studies (Dortch, 1976) to develop an aeration slot that would eliminate cavitation. Air vent dividers were not included in the original design, but were recommended by Dortch (1976). Section 35 of the report states that, "Although the capacity of the vent system should be ample, connected vents are undesirable and it is recommended that modifications be made to provide individual vents to each sluice. Operations with combined spillway and sluice flow should be avoided as much as possible."

Aeration slots were constructed and tested in 1980 (Hart, 1981), and air vent dividers were not included since connected air vents are permissible according to, EM 1110-2-1602, Section 3-17, (e): "Interconnected air vents should be avoided; but if they are necessary, the connections should be above the maximum possible elevation of the pressure grade line at the air vent exit opening to prevent cross-flow of water." The air vent connections at Libby Dam are located 71.3 feet above the sluice gate inverts and would require sluice tunnel blockage to initiate cross-flow.

The aeration slots greatly increased air demand creating unsafe air velocities. Pressure drops in the center sluice appeared to be greater than the outer sluices, and an air vent divider system was installed in 1982 to help increase air supply to the center sluice (Knutson, 1981). Modifications were also made to the gate chambers to increase safety concerns mentioned by Knutson (1981). In 1993, vibration issues arose with the air vent dividers. The decision was made in 2000 to keep the air vent divider system and maintain on a regular basis. Concerns with the structural integrity of the air vent system continued, and the NWS Dam Safety Committee approved removing the air vent system (USACE, 2009) with the operational constraint that only two sluices could be operated at a time until further analysis proved otherwise.

4. Numerical Model Development:

Data from previous prototype and physical modeling (Hart and Tool 1976, Dortch 1976, Hart 1981, and McGee 1984) was used to develop and verify a numerical model. Data does not exist for an entire sluice system without air dividers so a model was initially developed incorporating the air dividers during verification. Loss coefficients were determined from existing data and incorporated into the model. System loss coefficients, K, from air entrance to gate chamber were determined using the Bernoulli Equation. Assuming that the manifold velocity is much greater than chamber velocity and entrance velocity, the Bernoulli Equation reduces to the following:

$$\Delta p \;.\quad \rho\left(\frac{Q^2}{2A^2}\right)K \qquad \therefore \qquad = K'\sqrt{\Delta} \tag{1}$$

where

$$K' = A\sqrt{\frac{2}{\rho K}} \tag{2}$$

ρ = density of air, slugs/ft^3

Δp = pressure differential between atmospheric and the gate chamber, psf

Q = air flow, cfs

A = minimum area in manifold, ft^2

EM 1110-2-1602 recommends accounting for air compressibility when velocities exceed 200 fps. Air compressibility was considered since maximum velocities, 250 fps, exceed this

limit. The effect of velocity on density is shown in Equation 3. Compressibility was not incorporated into the analysis since the maximum Mach number of 0.25 has a negligible effect (approximately 6%) on pressure.

$$M^2 \frac{dV}{V} = \frac{d\rho}{\rho} \tag{3}$$

where

M = Mach number
V = velocity, fps
P = density, slugs/ft^3

To obtain loss coefficients, flow versus the square root of the pressure differential was plotted. The slope of the data is equivalent to K' from Equation 2. An example plot of K' values obtained from the pressure drop in the center sluice is shown in Figure 1.

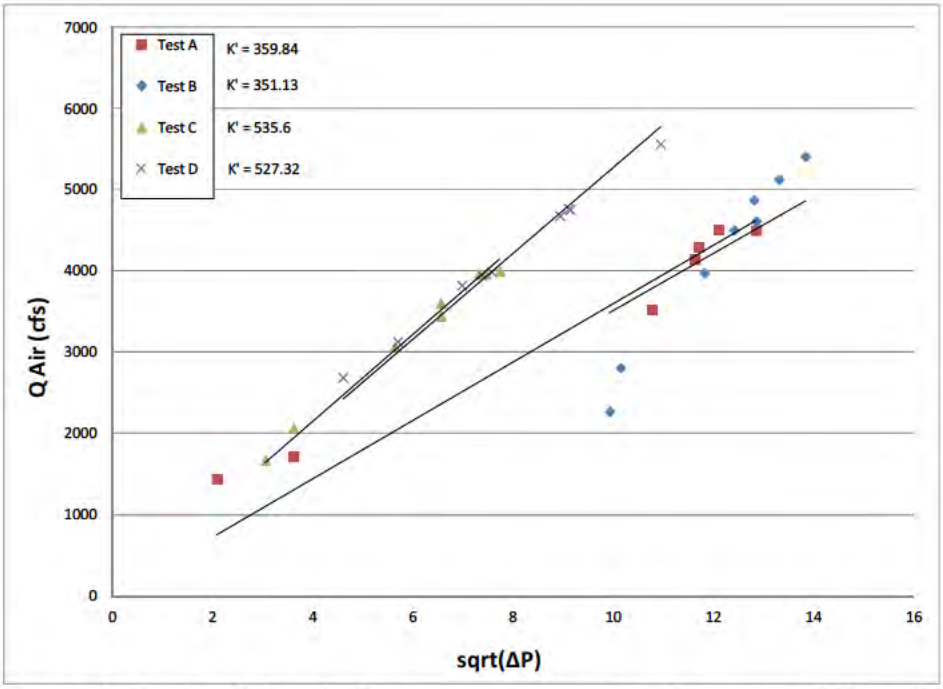


Figure 1: Center sluice air flow versus square root of pressure differential to obtain K', Equation 2.

The resulting loss coefficients, K, from the K' values are shown in Table 1. As noted in the table, it is believed that pressure differentials in the right sluice (McGee 1984) were erroneously recorded as ft of H_2O when they were actually measured in another unit.

Table 1: Calculated loss coefficients from Hart (1981) and McGee (1984).

Location	Spillway	Notes	Loss Coefficient, K
Center	No	Center only - Test A (McGee 1984)	3.6
Center	Yes	Center only - Test B (McGee 1984)	3.8
Center	No	All three gates open - Test C (McGee 1984)	1.6
Center	Yes	All three gates open - Test D (McGee 1984)	1.7
Right	No	All three gates open - Test C (McGee 1984)	0.25*
Right	Yes	All three gates open - Test D (McGee 1984)	0.29*
Right	No	Right gate isolated (Hart 1981)	3.0

* Pressure differentials for the right sluice from prototype modeling, McGee (1984), were reported in units of feet of water. The resulting large air flows are very unlikely due to the small pressure drop as shown by the loss coefficients less than 1.0. It is believed that the values were actually measured as inches of H_2O or mm of Hg. Assuming data was actually measured as mm of Hg results in K values around 1.6 (similar to the center sluice). If measured as inches of H_2O, the K values are 3.0 (similar to the loss coefficients determined in the right sluice in 1981).

5. Theoretical versus Computed Loss Coefficients:

Losses through the system depending on gate configurations and the existence of the air vent divider were determined using empirically derived values (Miller 1978). The actual values from Miller (1978) were used in the model since varying velocities and areas could be analyzed. To compare the values with the overall loss coefficients presented in Table 1, the loss coefficients were adjusted based on the cross-sectional area at the point of interest and the minimum cross-sectional area. The loss coefficient adjustment was made by using Equation 4.

$$K_{eq} = K\left(\frac{{A_{min}}^2}{A^2}\right) \quad (4)$$

where

K = Empirical loss coefficient obtained for feature (Miller 1978)
K_{eq} = Equivalent loss at location where flow area is greater than minimum
A_{min} = Minimum area of air system
A = Effective area of air system at location of head loss

The equivalent losses for the center gate are shown in Table 2 and the equivalent losses for the right and left gates are shown in Table 3. The computed values from the prototype modeling are presented in the last row of each table for comparison. The sums of the theoretical values are in agreement with the calculated prototype losses.

Table 2: Theoretical loss coefficients for **center** gate from Miller (1978).

	Right and Left Gates Closed		All Three Gates Open Equally	
Type of Loss	**Splitter**	**No Splitter**	**Splitter**	**No Splitter**
Entrance	0.1	0.1	0.5	0.5
Beginning of splitter	1.5	-	0.05	-
Friction (0.2 L/D)	0.45	0.1	0.45	0.1
90 degree bend #1	0.08	-	0.08	-
90 degree bend #2	0.16	-	0.16	-
Expansion	0.25	-	0.25	-
Split flow to 4' x 4'	-	1.0	-	1.4
Friction (0.2 L/D)	0.15	0.3	0.15	0.3
Junction to gate chamber	0.3	0.6	0.3	0.6
Exit	0.5	1.0	0.5	1.0
Total theoretical losses	3.49	3.1	2.44	3.9
Prototype model, calculated	3.6	N/A	1.6	N/A

Table 3: Theoretical loss coefficients for **right** and **left** gates from Miller (1978).

	Center Gate Closed		All Three Gates Open Equally	
Type of Loss	**Splitter**	**No Splitter**	**Splitter**	**No Splitter**
Entrance	0.1	0.5	0.5	0.5
Beginning of splitter	1.5	-	0.05	-
Friction (0.2 L/D)	0.32	0.26	0.32	0.26
Split flow to 4' x 4'	-	0.05	-	1.0
Exit	1.0	1.0	1.0	1.0
Total theoretical losses	2.92	1.81	1.87	2.31
Prototype model, calculated	1.6 – 3.0	3.0	1.6 – 3.0	3.0

6. Numerical Modeling:

   Loss coefficients obtained from the prototype data were applied to a numerical model configured with the air dividers in place. Air flows computed in the numerical model were verified since they were within 10% of the measured prototype flows. After verification of the numerical model, the model was modified to represent the system without dividers, and theoretical loss coefficients were applied. Figure 2 is a schematic of the numerical model design.

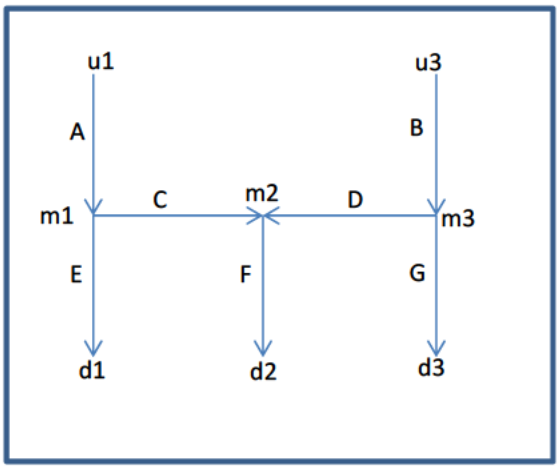


Figure 2: Numerical model schematic.

Model input was as follows: atmospheric pressure at u1 and u3; gate chamber pressures at d1, d2, and d3; and manifold area and loss coefficients at A, B, C, D, E, F, and G. To represent a closed gate, the gate chamber pressure was set to atmospheric pressure. Using input data, the model computed velocities and air flows (including reverse flows) for all segments of the system. The model was used to determine air flow for all gate openings for three scenarios: all three sluices open, sluices 1 and 3 open with sluice 2 closed, and sluice 2 open with sluices 1 and 3 closed.

7. Model Limitations:
The one-dimensional analysis did not allow air supply via the sluice outlet to be incorporated. In the prototype, air was often supplied from the downstream end of the sluice creating circular flow to the gate chamber. Since spillway flow limits air from entering the chamber at the downstream end of the sluiceway, the model is likely more accurate when spillway flow is blocking the sluice exit. Although the reason was not stated, earlier memorandums also noticed that the tests with spillway flow were in better agreement with theoretical values.

8. Model Results:
The increased loss coefficients without the air vent dividers when all gates are operating evenly resulted in gate chamber pressure decreases of approximately 10%. Assuming that gusting can result in an additional 25% decrease in instantaneous gate chamber pressure, the average pressure drop for the worst case condition is expected to be 3.4 feet of water with an instantaneous maximum of 4.3 feet of water. EM 1110-2-1602, 3-17, (b) recommends that pressure drops not exceed 1.0 feet of water. The high pressure drops at Libby Dam are acceptable since 1) sufficient air is still supplied, 2) EM 1110-2-1602 does not consider increased air flow due to aeration slots, and 3) the sluice gates are used infrequently.

9. Summary and Recommendations:
   a. Air vent connectors to the center sluice are 71.3 feet above the sluice gate inverts and are not subject to water cross-flow.
   b. Compressibility was not considered since maximum Mach values of 0.25 have a negligible effect on pressure (~6%).
   c. Sufficient air will be applied to all three sluiceways to prevent cavitation under all gate configurations.
   d. Sluice gate openings should follow the minimum operating conditions shown in Plate 14 of USACE (1976).
   e. The sluiceways should be inspected after extended use.
   f. Maximum air velocities of 250 fps are significantly higher than the recommended 100 fps. Removal of the air divider system will have negligible impact on velocities (increase of ~10%).
   g. It is believed that right sluice gate chamber pressure differentials reported by McGee (1984) were measured as mm of Hg or in of H_2O, but were recorded as ft of H_2O.
   h. If undesirable noise or air velocities occur during operation, flow can be routed through two sluices instead of three to decrease the pressure drop to the center sluice.
   i. All doors to the sluice gate chambers should be closed and personnel access to the gate chamber should be restricted during operation.
   j. Since the connected air system can draw air from all gate chambers, for safety reasons, it should be noted that significant velocities can exist in closed sluiceways when other sluiceways are in operation.

10. References:

Hart, E. 1981. Miscellaneous Paper HL-81-6, "Air Demand Tests, Libby Dam, Kootenai River, Montana," U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Knutson, S. 1981. Memorandum for the Division Engineer, 5/27/1981, "Libby Dam-Lake Koocanusa Project, Sluice Vent Modifications," North Pacific Division, Seattle District.

McGee, R. 1984. Technical Report HL-84-2. "Prototype Evaluation of Sluiceway Aeration System, Libby Dam, Kootenai River, Montana," U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Miller, D. 1978. "Internal Flow Systems: Design and Performance Prediction," 2nd Edition, Gulf Publishing Company, Houston, TX.

Hart, E., and Tool, A. 1976. Technical Report H-76-17. "Sluice Pressures, Gate Vibrations and Stilling Basin Wall Pressures, Libby Dam, Kootenai River, Montana," U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Dortch, M. 1976. Technical Report H-76-21. "Center Sluice Investigation, Libby Dam, Kootenai River, Montana," Hydraulic Model Investigation 20, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

USACE, 2009. Memorandum for Record, "Approval from the CENWS Dam Safety Committee for Removal of Air Dividers that are Presently in the Existing Sluiceway Air Supply System at Libby Dam," CENWS.

USACE, 2011 (a). Memorandum for Record, 9/19/2011. "Libby Dam Sluiceway Air Vent System." Analysis from Mechanical Engineering Section (Sven Lie), CENWS.

USACE, 2011 (b). Memorandum for Record, 9/29/2011. "Operation of Libby Dam Sluice Gate Outlets Before and After Air Vent Divider Removal," CENWS.

11. Plates:

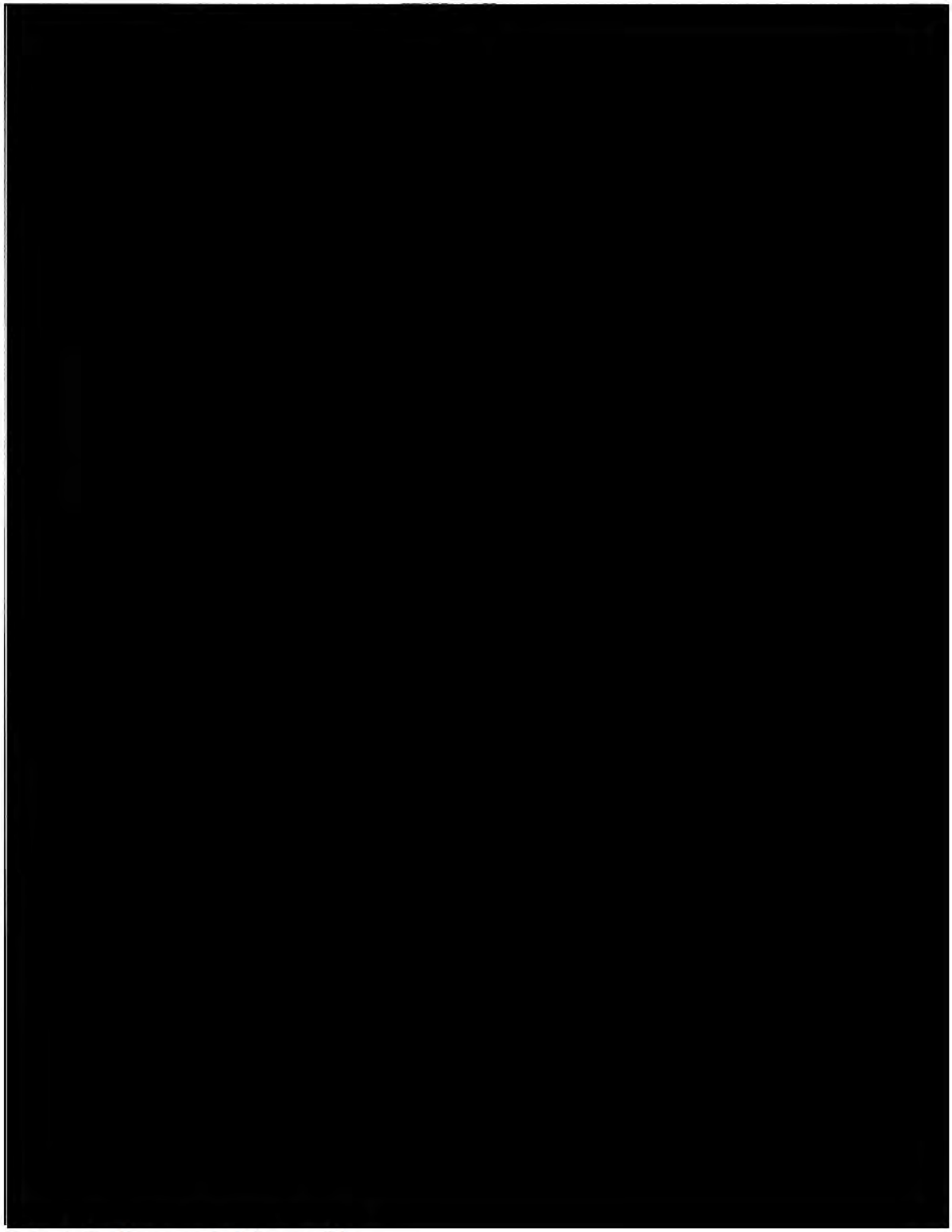


Plate 1: Spillway and sluice profile.

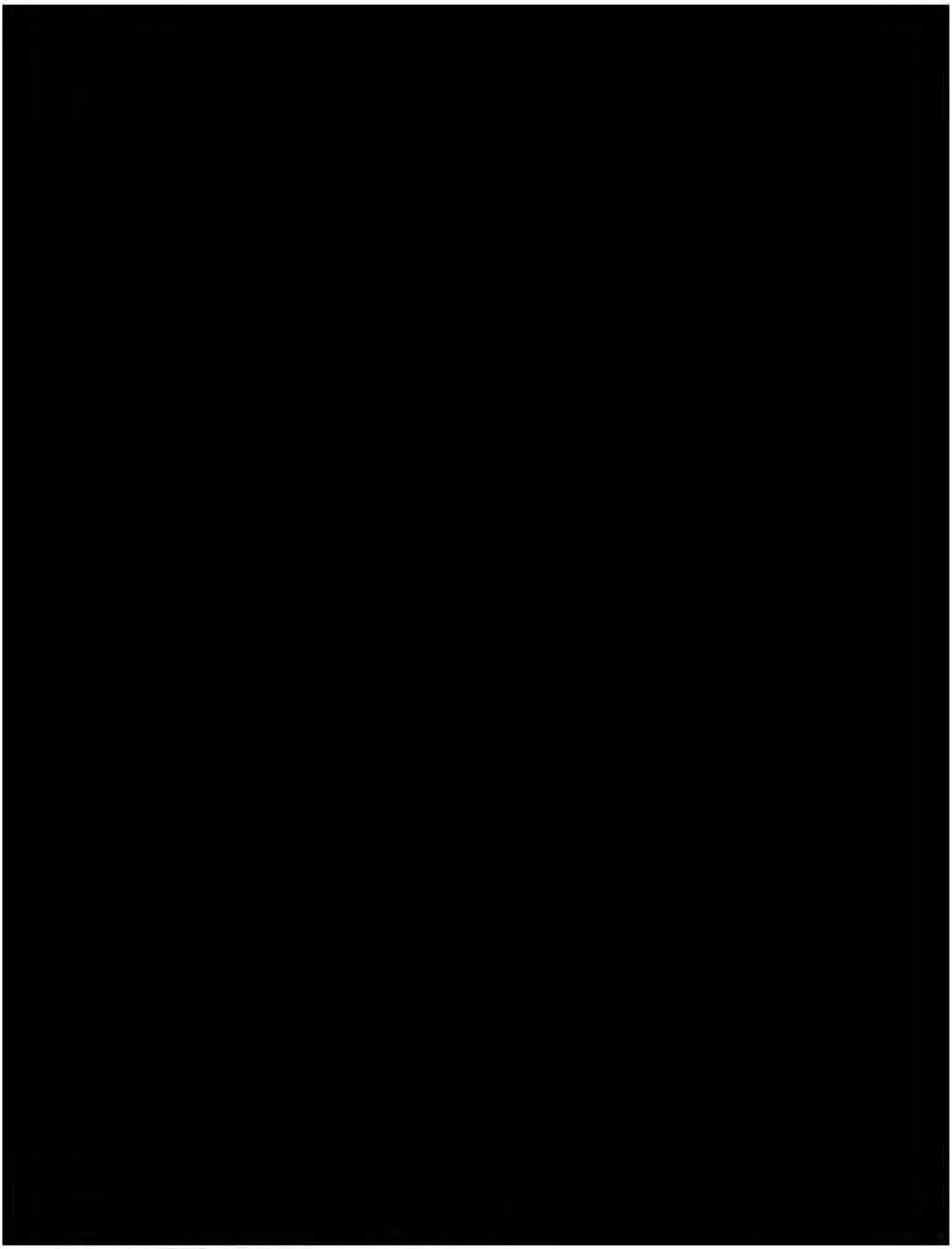


Plate 2: Spillway and sluice looking downstream.

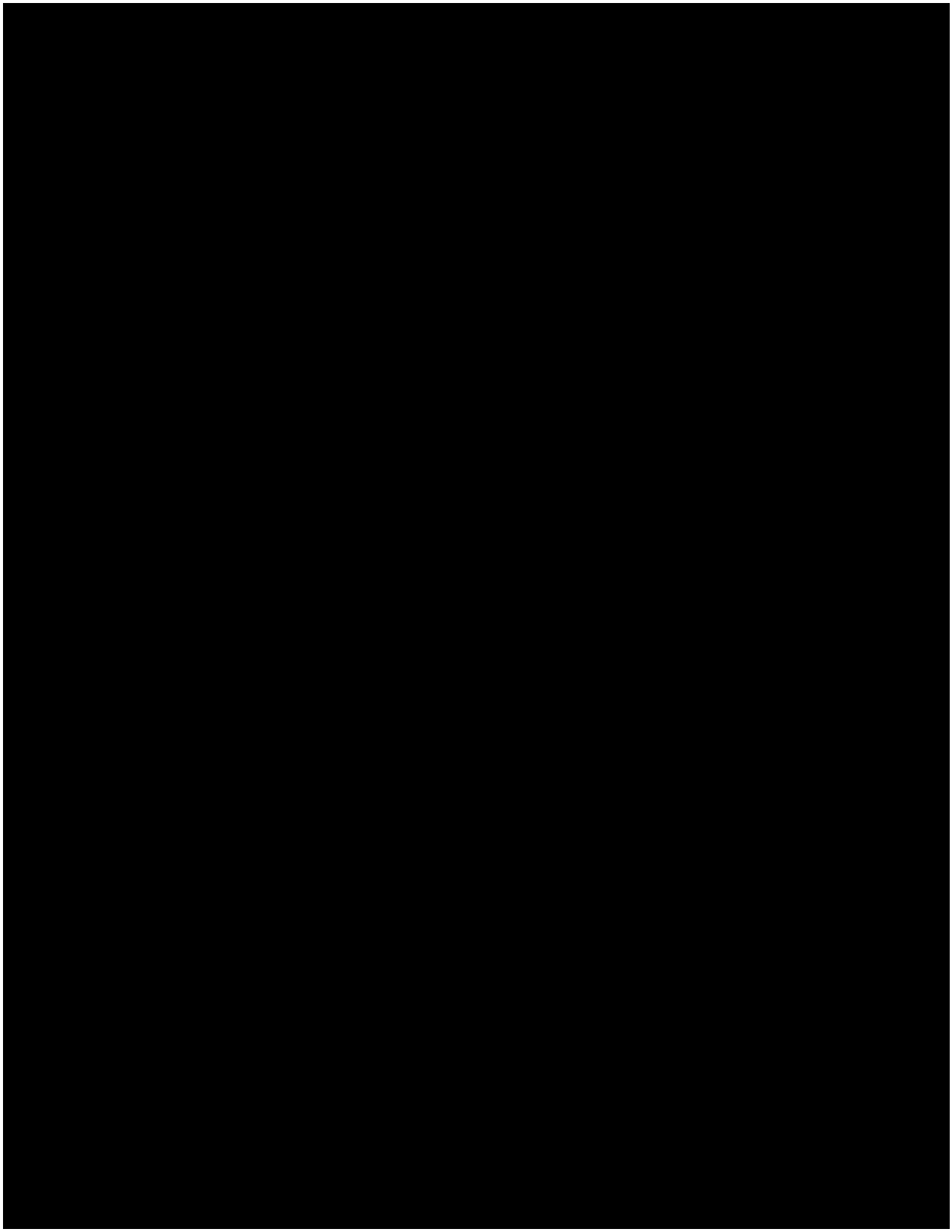


Plate 3: Sluice and air vent profile with splitter plates.

Plate 14 from:

USACE, 1976. Technical Report H-76-21. Center Sluice Investigation, Libby Dam, Kootenai River, Montana. Hydraulic Model Investigation 20.

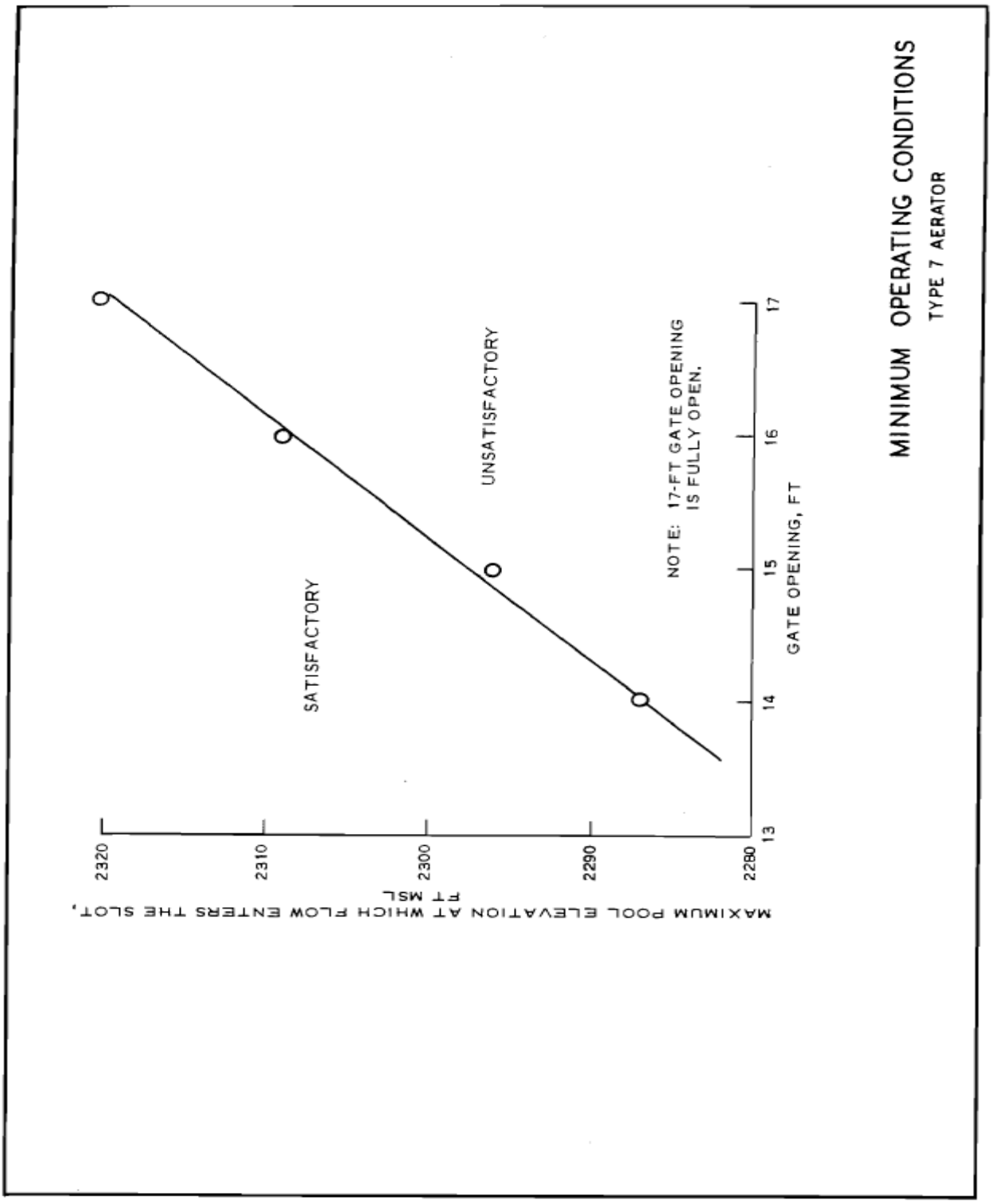


PLATE 14

EXHIBIT 6-1
WATER SUPPLY FORECASTING METHOD FOR LIBBY DAM

Table 1. Variables in the Libby WSF model

Regression Variables		Forecast Issue Date						
Type	**Variable Name**	**1-Dec**	**1-Jan**	**1-Feb**	**1-Mar**	**1-Apr**	**1-May**	**1-Jun**
CLX	SOI	Jun-Jul	Jun-Jul					
PPT	Cranbrook AP, BC	Oct-Nov	Oct-Dec	Oct-Jan	Oct-Feb	Oct-Mar	Oct-Apr	Oct-May
	Eureka, MT	Oct-Nov	Oct-Dec	Oct-Jan	Oct-Feb	Oct-Mar	Oct-Apr	Oct-May
	Fernie, BC	Oct-Nov	Oct-Dec	Oct-Jan	Oct-Feb	Oct-Mar	Oct-Apr	Oct-May
	West Glacier, MT	Oct-Nov	Oct-Dec	Oct-Jan	Oct-Feb	Oct-Mar	Oct-Apr	Oct-May
SWE	Akamina Pass, AB			1-Feb	1-Mar	1-Apr	1-May	1-Jun
	East Creek, BC			1-Feb	1-Mar	1-Apr	1-May	1-Jun
	Hawkins Lake, MT			1-Feb	1-Mar	1-Apr	1-May	1-Jun
	Moyie Mountain, BC		1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun
	Stahl Peak, MT		1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun
	Sunshine Village, AB		1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun
	South Racehorse Creek, AB			1-Feb	1-Mar	1-Apr	1-May	1-Jun
Depe ndent	Libby Inflow (in KAF)	Apr-Aug	Apr-Aug	Apr-Aug	Apr-Aug	Apr-Aug	May-Aug	Jun-Aug

Table 2. Regression coefficients for the Libby WSF model

Regression Variables		Forecast Issue Date						
Type	**Variable Name**	**1-Dec**	**1-Jan**	**1-Feb**	**1-Mar**	**1-Apr**	**1-May**	**1-Jun**
CLX	SOI	133.38	95.28					
PPT	Cranbrook AP, BC	8.79	4.58	2.84	2.73	2.99	2.80	2.03
	Eureka, MT	267.66	141.74	78.47	65.87	68.52	57.45	37.66
	Fernie, BC	1.95	1.20	0.72	0.63	0.71	0.61	0.50
	West Glacier, MT	105.96	58.42	30.95	28.51	29.47	28.04	22.46
SWE	Akamina Pass, AB			1.27	1.04	0.72	0.55	0.68
	East Creek, BC			0.75	0.65	0.73	0.57	0.43
	Hawkins Lake, MT			30.61	24.33	22.43	17.30	10.09
	Moyie Mountain, BC		1.59	1.48	1.27	1.21	0.91	0.85
	Stahl Peak, MT		34.63	22.99	19.11	19.70	16.74	10.31
	Sunshine Village, AB		2.14	1.47	1.26	1.43	1.26	0.62
	South Racehorse Creek, AB			1.53	1.40	1.35	0.83	0.64
	Constant (in KAF)	3704	2724	1291	1142	70.54	408	977
	Note: CLX variables are dimensionless values reported by NOAA. PPT and SWE values for sites in the United States assume English units (inches) and sites in Canada assume Metric units (mm).							

Table 3. Libby WSF Model Statistics

Forecast Model Statistics	Forecast Issue Date						
	1-Dec	**1-Jan**	**1-Feb**	**1-Mar**	**1-Apr**	**1-May**	**1-Jun**
Number of Training Years	29	29	29	29	29	29	29
Number of Components	1	1	1	1	1	1	1
Standard Error of Regression (over 1984-2013)	1025	1040	832	792	575	572	575
Cross Validated Standard Error (over 1984-2013)	1076	1087	875	836	620	611	618
R^2 (Over 1984-2013)	0.518	0.503	0.682	0.712	0.848	0.829	0.769
Skew of Forecast Residuals (over 1984-2013)	-0.37	-0.86	-1.05	-1.35	-0.54	-0.80	-1.82

Table 4. Stations/Variables used in Libby forecast equations, with data sources

Group	Variable/ Station Name	Station ID	Recommended data source(s) - Current data values
CLX	SOI		http://www.cpc.ncep.noaa.gov/products/CDB/CDB_Archive_pdf/CDB.monthly_color.pdf
			http://www.cpc.ncep.noaa.gov/data/indices/soi
	QBO		https://psl.noaa.gov/data/correlation/qbo.data
	PNA		http://www.cpc.ncep.noaa.gov/products/CDB/CDB_Archive_pdf/CDB.monthly_color.pdf
			ftp://ftp.cpc.ncep.noaa.gov/wd52dg/data/indices/tele_index.nh
			https://psl.noaa.gov/data/correlation/pna.data
PPT	Eureka RS, MT	242827	https://www.weather.gov/wrh/Climate?wfo=mso (select Eureka RS, MT)
	West Glacier, MT	248809	https://www.weather.gov/wrh/climate?wfo=mso (select West Glacier, MT)
	Cranbrook, BC		https://climate.weather.gc.ca/historical_data/search_historic_data_e.html (search Cranbrook A)
	Fernie, BC	1152850	https://climate.weather.gc.ca/historical_data/search_historic_data_e.html (search Fernie)
SWE	Floe Lake, BC	2C14P	http://a100.gov.bc.ca/pub/aspr/
	Sunshine Village, AB	05BB803	http://www.environment.alberta.ca/apps/basins/Map.aspx?Basin=10&DataType=4
	East Creek, BC	2D08P	http://a100.gov.bc.ca/pub/aspr/
	Stahl Peak, MT	14A12S (MT787)	http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=787&state=mt
	Gardiner Creek, AB	05AA809	http://www.environment.alberta.ca/apps/basins/Map.aspx?Basin=10&DataType=4
	Three Isle Lake, AB	05BF824	http://www.environment.alberta.ca/apps/basins/Map.aspx?Basin=10&DataType=4
	Lost Creek South, AB	05BL811	http://www.environment.alberta.ca/apps/basins/Map.aspx?Basin=10&DataType=4
	Morrissey Ridge, BC	2C09Q	http://a100.gov.bc.ca/pub/aspr/
	Hawkins Lake, MT	15A03S (MT516)	http://www.wcc.nrcs.usda.gov/nwcc/site?sitenum=516&state=mt
	South Racehorse Creek, BC	SRCQ1	https://www.nwrfc.noaa.gov/snow/snowplot.cgi?SRCQ1
INFLOW	Libby Inflow (in KAF)	LIB QIDRXZZAZD	http://www.nwd-wc.usace.army.mil/perl/dataquery.pl (Input "LIB")

Note: The online data source for Alberta snow data maintains real-time SWE data for only the most recent 48 to 72 hours. Data older than this is not readily available. Per Stephanie Smith, BC Hydro is making arrangements for the Canadian Ministry of Environment to include the Alberta stations in existing reports that are automatically generated and provided to BC Hydro. We should be able to then have reliable access to the data through BC Hydro at the Canadian Entity to the Columbia River Treaty (email to R. Wortman from S. Smith, 5/26/2010)

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EXHIBIT 7-1
STANDING INSTRUCTIONS TO PROJECT OPERATOR
LIBBY DAM

U.S. ARMY CORPS OF ENGINEERS (SEATTLE DISTRICT/NORTHWEST DIVISION)

JUNE 2026

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1 BACKGROUND AND RESPONSIBILITIES

a. General Information

These standing instructions to the project operator for water control are written in compliance with paragraph 9-2 of EM 1110-2-3600 and with ER 1110-2-240. A copy of these standing instructions must be kept on hand at the project site at all times. Any deviation from the standing instructions will require approval of the district commander.

b. Project Purposes

The Libby Dam Project is authorized for multiple uses including flood control, power generation, recreation, navigation, and fish and wildlife conservation.

c. Chain of Command

Congressional authorizations delegate responsibility to the U.S. Army Corps of Engineers (USACE) to operate projects under its jurisdiction for all authorized purposes. USACE is responsible for ensuring the maximum sustained public benefits from Libby Dam Project for all desirable purposes as an integral part of the comprehensive plan for the regulation, control, conservation, and utilization of the water resource. Responsibility for reservoir regulation activities fall to the USACE Seattle (CENWS) District Engineer. Planning seasonal regulation and directing day-to-day regulation of Libby Dam Project are the responsibility of the District Hydrology and Hydraulics Branch (CENWS-ENH-W) in consultation with Northwestern Division Water Management. Columbia Basin Water Management Division (CENWD-PDW) assumes responsibility for regulation of Libby Project in certain regional flood emergencies and has responsibility for the planning, oversight, and implementation of the Columbia River Treaty and Pacific Northwest Coordination Agreement as they relate to Libby Dam. The CENWS District Engineer also has direct responsibility for project operation and maintenance activities which are assigned to the Operations Division. The physical operation of project facilities to affect the regulation directed by Water Management and the performance of maintenance is the responsibility of the Project Engineer.

d. Structure

Libby Dam Project is located in northwestern Montana in Lincoln County. The dam site is situated in the northern half of section 33, township 31 North, range 29 West, Montana principal meridian, on the Kootenai River at river mile (RM) 221.9 (river kilometer (RK) 357.1). The dam is about 40 miles (miles) (64.4 km) south of Roosville, Montana, at the United States/Canadian international boundary; 48 miles (77.2 km) west-northwest of Kalispell, Montana; and 17 miles (27.4 km) east of Libby, Montana. Montana State Highway 37 and Montana/British Columbia Highway 93 parallel the east side of the reservoir to the reservoir northern terminus near Wardner, BC. Forest Development Road 228 parallels the west side of the reservoir to within about 2 miles (3.2 km) of the U.S./Canada border.

e. Operation and Maintenance

Operations of the physical facilities to accomplish water management objectives are the responsibility of the Libby Project personnel. Such operation will be in accordance with

the Libby operations and maintenance manuals. Flood risk management at Libby follows the VARQ FC procedure (see Chapter 7 of this manual) to meet system and local flood risk management objectives. This generally provides adequate flood reduction in both the lower Kootenai River and the Columbia River. In some circumstances, project flood risk operations needed for local and system flood risk management may conflict; in this case, the District and Division will work together to balance operations and risk.

In the event communications with the Seattle District (CENWS) Office are disrupted, the lake will be regulated in accordance with the schedule of emergency regulations for flood risk management (see Chapter 7 of this manual or Section 1.f(4) of this exhibit). In addition, the project operator will immediately make every effort to reestablish communications with CENWS.

f. Role of the Project Operator

(1) General

LIB personnel will staff the project continuously during normal operations, a declared flood alert, or periods of flood risk management operations. A list of project and Water Management personnel to be contacted in emergency situations is reviewed and disseminated each year. Project operators will only implement reservoir regulation instructions received directly from Water Management staff unless communication is interrupted, in which case regulation will be in accordance with emergency regulation procedures, Section 1.f(4) of this exhibit. All instructions pertaining to reservoir regulation will be implemented as expeditiously as possible and recorded, along with physical data, personnel involved, contacts made, etc., in the LIB Operating Logbook.

(2) Normal Operating Procedures

The project is attended 24 hours per day, 7 days per week. Normal operations are coordinated via CBT, with outflow scheduled through the near future. Project operator will contact the Water Management Eastside Regulator to coordinate any deviations from the prescribed flow schedule.

(3) Weekend and Special Coordination

The project is attended 24 hours per day, 7 days per week. Weekend operations are coordinated beforehand via CBT, with outflow scheduled through the weekend. Project operator will contact the Water Management weekend regulator to coordinate any deviations from the prescribed flow schedule.

(4) Instructions During Loss of Communication for Flood and Non-Flood

It is impossible to anticipate every unusual flood, power, or physical feature emergency or combination of events that may require special attention. If an emergency develops requiring immediate action to protect human life or prevent damage to the project, the project operator will take appropriate action following guidance in the Libby Emergency Action and Notification Plan and then immediately contact Water Management. Should an emergency develop or appear to be imminent which will affect reservoir regulation functions,

the project operator will promptly contact Water Management, report on the existing conditions, and request instructions.

In the event that telephone, VHF communication facilities, and all other modes of communication should fail during a flood alert or period of flood risk management operations, emergency regulation procedures will be followed by the project operator until Water Management staff arrive at the project or communications are restored. The project operator will have been monitoring reservoir elevations and computing inflows and will operate according to the following instructions:

- If flood risk management operations have not yet begun, continue with the current operations unless flow changes are required by the Discharge Regulation Schedule (DRS) [See Plate 7-6 and Exhibit 7-2].

- If at any time the DRS requires a higher discharge than the current operation, increase the discharge per the DRS. Once discharges are mandated per the DRS, discharge should not decrease until inflow recedes below the discharge specified by the DRS. Continue to follow the guidance provided by the DRS until the flood risk management has concluded.

2 DATA COLLECTION AND REPORTING

Powerhouse operators send hourly and daily powerhouse data through the CBT network. Hourly powerhouse data includes total generation, station service usage, mean total discharge, mean power discharge, mean spillway discharge, powerhouse forebay elevation at the beginning of the hour, powerhouse tailwater elevation at the beginning of the hour, total powerhouse head at the beginning of the hour, surplus generation capability at the end of the hour from on-line units, number of on-line units, and number of available units. Daily powerhouse data include total generation, total station service usage, daily mean inflow, daily mean total discharge, daily mean power discharge, daily mean spillway discharge, reservoir elevation at the end of the day, daily mean forebay elevation, and daily mean tailwater elevation. Generation, powerhouse flow, forebay elevation, and tailwater elevations are all reported to the operators via the Generic Data Acquisition and Control System (GDACS) output in the dam control room. Flows are calculated manually or automatically using lookup tables. All data is stored in the CROHMS database.

3 WATER CONTROL AND REPORTING

Operations of the physical facilities to accomplish water management objectives are the responsibility of the Libby Project personnel. Such operation will be in accordance with the Libby operations and maintenance manuals.

a. Normal Conditions

The Project Operator should follow Chapter 7 of the Libby Water Control Manual for normal water control actions and will report directly to the Eastside Senior Water Manager or the Seattle District RCC.

b. Emergency Conditions

The Project Operator should follow the instructions Libby Dam Emergency Action Plan.

c. Inquiries

All significant inquiries received by the Project Operator from citizens, constituents, or interest groups regarding water control procedures or actions must be referenced to the Eastside Senior Water Manager or Seattle District RCC as soon as possible.

d. Water Control Problems

The Project Operator should immediately notify the Eastside Senior Water Manager or the Seattle District RCC, by the most rapid means available, in the event that an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.

e. Potential Spillway Discharge

The Project Operator should immediately notify the Eastside Senior Water Manager or the Seattle District RCC, by the most rapid means available, in the event that the spillway must be used.

f. Hydropower Operations

Hydropower is an authorized purpose of Libby Dam. Hydropower facilities are described in Section 2-02.d of the Libby Water Control Manual. Libby is a major project in the Pacific Northwest coordinated electric power system. Libby is operated primarily as a base-load plant with peaking events occurring during the winter period during storage evacuation (November and continuing through March or April). However, per the 2020 USFWS BiOp peaking or daily load shaping is only allowed from October through March. Powerhouse releases can vary from 4,000 cfs up to powerhouse capacity of 19,000–27,200 cfs depending on head at Libby. Power generation schedules are based on day-to-day conditions and are requested by BPA then reviewed, revised if necessary, approved and then issued by Seattle District Water Management. The operators at Libby are responsible for implementing the schedules and reporting the powerhouse status to BPA hourly. Standing Orders for Powerhouse Operators are shown on the following pages.

(1) Station Standing Orders to Powerhouse Operators

The following pages contain:

- Station Standing Order No. 4: Generating Limits for Turbine Cavitation
- Station Standing Order No. 8: Downstream Notification of Discharge Changes
- Station Standing Order No. 9: Kootenai River Fluctuation Criteria During Power System Disturbances
- Station Standing Order No. 11: Station Standing Order Requests, Notification and Operational Procedures for Load and Flow Changes
- Emergency Operating Procedure No. 8: Emergency River Level Fluctuation

EXHIBIT 7-2
EXAMPLE OF DISCHARGE REGULATION SCHEDULE

EXHIBIT 7-2. Example of Discharge Regulation Schedule 1/

Date	Hour xxoo	Discharge (cfs) 2/ Inflow	Outflow	Change	Storage (acre-feet) 2/ Change	Total	Elevation Feet	End-of-Period Instantaneous Inflow (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
May								
14	12	24,000	24,000	-0-	-0-	889,924	2,287.00	
14	24	26,000	26,000	-0-	-0-	889,924	2,287.00	
15	12	30,000	30,000	-0-	-0-	889,924	2,287.00	
15	24	34,500	31,500	3,000	2,975	892,899	2,287.20	
16	12	39,000	30,500	8,500	8,429	901,328	2,287.80	
16	24	44,000	28,500	15,500	15,372	916,700	2,288.83	
17	12	52,000	25,000	27,000	26,776	943,477	2,290.61	
17	24	60,000	22,000	38,000	37,685	981,163	2,293.06	
18	12	71,000	18,000	53,000	52,549	1,033,725	2,296.35	
18	24	80,000	11,000	69,000	68,429	1,102,155	2,300.44	
19	12	89,000	10,000	79,000	78,347	1,180,502	2,304.95	
19	24	98,000	8,000	90,000	89,256	1,269,758	2,309.91	
20	12	107,000	4,000	103,000	102,148	1,371,907	2,315.41	
20	24	115,000	1,000	114,000	113,057	1,484,965	2,321.30	
21	12	123,000	-0-	123,000	121,983	1,606,948	2,327.36	
21	24	131,000	-0-	131,000	129,917	1,736,865	2,333.49	
22	12	140,000	-0-	140,000	138,842	1,875,709	2,339.80	
22	24	149,000	-0-	149,000	147,768	2,023,477	2,346.29	154,000
23	12	158,000	-0-	158,000	156,694	2,180,172	2,352.93	161,000
23	24	165,000	-0-	165,000	163,636	2,343,808	2,359.61	169,000
24	12	173,000	2,000	171,000	169,586	2,513,395	2,366.27	176,000
24	24	181,000	5,000	176,000	174,545	2,687,940	2,372.83	184,000
25	12	188,000	10,000	178,000	176,528	2,864,469	2,379.23	191,000
25	24	195,000	15,000	180,000	178,512	3,042,982	2,385.49	199,000
26	12	202,000	21,000	181,000	179,504	3,222,248	2,391.55	206,000
26	24	210,000	28,000	182,000	180,495	3,402,982	2,397.36	214,000
27	12	218,000	37,000	181,000	179,504	3,582,486	2,402.84	222,000
27	24	226,000	47,000	179,000	177,520	3,760,006	2,407.97	230,000
28	12	234,000	55,000	179,000	177,520	3,937,527	2,412.87	238,000
28	24	242,000	62,000	180,000	178,512	4,116,039	2,417.64	246,000

1/ See explanation on next page.
2/ Average discharge and storage values for each 12-hour routing interval.

EXHIBIT 7-2. Example of Discharge Regulation Schedule 1/

Date	Hour xxoo	Discharge (cfs) 2/ Inflow	Outflow	Change	Storage (acre-feet) 2/ Change	Total	Elevation Feet	End-of-Period Instantaneous Inflow (cfs)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
May								
29	12	252,000	70,000	182,000	180,495	4,296,535	2,422.33	256,000
29	24	260,000	81,000	179,000	177,520	4,474,056	2,426.81	264,000
30	12	269,000	91,000	178,000	176,528	4,650,585	2,431.17	272,000
30	24	274,000	104,000	170,000	168,595	4,819,180	2,435.24	276,000
31	12	277,500	117,000	160,000	159,173	4,978,353	2,439.01	279,000
31	24	280,000	130,000	150,000	148,760	5,127,114	2,442.37	281,000
June								
1	12	281,500	142,000	139,500	138,347	5,265,461	2,445.65	282,000
1	24	281,500	153,000	128,500	127,438	5,392,899	2,448.53	281,000
2	12	280,500	166,000	114,500	113,553	5,506,453	2,451.06	280,000
2	24	276,000	175,000	101,141	100,165	5,606,618	2,453.28	270,000
3	12	265,000	186,000	79,000	78,347	5,684,965	2,455.00	260,000
3	24	256,000	193,000	63,000	62,479	5,747,944	2,456.36	252,000
4	12	245,000	199,000	46,000	45,619	5,793,064	2,457.35	240,000
4	24	235,000	203,000	32,000	31,735	5,814,800	2,458.04	230,000
5	12	225,000	206,000	19,000	18,842	5,843,643	2,458.45	220,000
5	24	215,000	206,000	9,000	8,925	5,852,568	2,458.64	210,000
6	12	205,000						200,000

1/ EXPLANATION: The spillway design flood inflow (plate 8-1) is routed through Libby Dam project using the discharge regulation schedule (plate 7-1), a 12-hour routing interval, and the area-capacity table (table 2-1) to establish the storage capacity / elevation relationships. The flood is routed through the project from hour 0000 on 14 May to hour 2400 on 23 May, increasing total storage (column 7) by the storage change (column 6). During this time no regulation is required by the discharge regulation schedule. At hour 2400 on 23 May, with the reservoir at elevation 2,359.61 feet and with an estimated instantaneous end-of-period discharge of 169,000 cfs, the discharge regulation schedule requires a 2,000 cfs average outflow for the next routing interval. At hour 1200 on 5 June, with the reservoir at elevation 2,458.45 feet and with an estimated instantaneous discharge of 220,000 cfs, the average outflow is 206,000 cfs -- the approved spillway design flood maximum outflow rate.

2/ Average discharge and storage values for each 12-hour routing interval.

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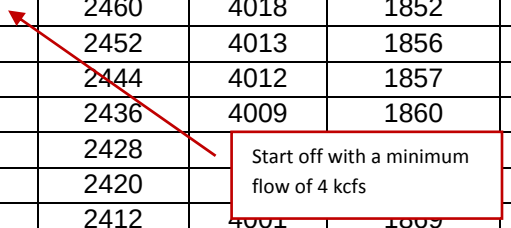
EXHIBIT 7-3
LIBBY DAM FLOOD CONTROL REFILL CURVE – EXAMPLE COMPUTATION

Exhibit 7-3
Libby Dam Flood Control Refill Curve – Example Computation

The below table illustrates an example calculation of the Flood Control Refill Curve (FCRC). The following assumptions are made in the calculation:

Gross Storage: 5869 KAF
May Issued Apr-Jul WSF: 7342 KAF
Std Error for Forecast: 508 KAF
Runoff Forecast at 95% Assurance: 6489 KAF

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	Inflow[1]	Accumulated Inflow Qin[2]	Residual Inflow Volume[3]	Minimum Flow Daily[4]	Minimum Q Thru July[5]	Available for Refill[6]	Allowable Storage Contents[7]	Flood Control Refill Curve
Date	kcfs	KAF	KAF	kcfs	KAF	KAF	KAF	ft
		0	6489[8]			6489		
1-Apr	5.8	12	6477	4	2460	4018	1852	2339
2-Apr	6.3	24	6465	4	2452	4013	1856	2339
3-Apr	4.5	33	6456	4	2444	4012	1857	2339
4-Apr	5.5	44	6445	4	2436	4009	1860	2339
5-Apr	4.7	53	6435	4	2428			2339
6-Apr	6.3	66	6423	4	2420			2339
7-Apr	5.1	76	6413	4	2412			2339
8-Apr	4.3	84	6404	4	2404	4000	1869	2340
9-Apr	4.4	93	6396	4	2396	3999	1870	2340
10-Apr	4.6	102	6386	4	2388	3998	1871	2340
11-Apr	5.4	113	6376	4	2380	3995	1874	2340
12-Apr	4.7	122	6366	4	2372	3994	1875	2340
13-Apr	4.4	131	6358	4	2364	3993	1876	2340
14-Apr	5.9	143	6346	4	2356	3990	1880	2340
15-Apr	5.4	153	6335	4	2348	3987	1883	2340
16-Apr	5.7	165	6324	4	2341	3983	1886	2340
17-Apr	4.2	173	6316	4	2333	3983	1886	2340
18-Apr	5.3	183	6305	4	2325	3980	1889	2340
19-Apr	5.4	194	6294	4	2317	3978	1892	2341
20-Apr	4	202	6286	4	2309	3978	1892	2341
21-Apr	3.8	210	6279	4	2301	3978	1891	2341
22-Apr	4.6	219	6270	4	2293	3977	1893	2341



[1] Actual or Forecasted Daily Inflow Values. Black is Actual and Red is Forecasted from this Example
[2] Accumulated Inflow
[3] 95% Assured runoff forecast minus accumulated inflow
[4] Daily Minimum Flow that will include BiOp requirements such as Bull Trout Minimums, Sturgeon Flows, and 4 kcfs
[5] Total Remaining Minimum Flow Volume
[6] Residual inflow volume minus minimum flow volume
[7] Gross storage contents minus available for refill
[8] Initial Residual Inflow Volume is the Apr-Jul WSF – 1.68*Std Error.

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	Inflow[1]	Accumulated Inflow Qin[2]	Residual Inflow Volume[3]	Minimum Flow Daily[4]	Minimum Q Thru July[5]	Available for Refill[6]	Allowable Storage Contents[7]	Flood Control Refill Curve
Date	kcfs	KAF	KAF	kcfs	KAF	KAF	KAF	ft
23-Apr	4.6	228	6261	4	2285	3976	1894	2341
24-Apr	4.7	237	6251	4	2277	3974	1895	2341
25-Apr	5.1	247	6241	4	2269	3972	1897	2341
26-Apr	5.5	258	6230	4	2261	3969	1900	2341
27-Apr	6.6	271	6217	4	2253	3964	1905	2341
28-Apr	6.1	283	6205	4	2245	3960	1910	2341
29-Apr	7.0	297	6191	4	2237	3954	1916	2342
30-Apr	6.9	311	6178	4	2229	3948	1921	2342
1-May	5.7	322	6166	4	2222	3945	1925	2342
2-May	6.5	335	6153	4	2214	3940	1930	2342
3-May	8.3	352	6137	4	2206	3931	1938	2343
4-May	12.8	377	6111	4	2198	3914	1956	2343
5-May	9.1	395	6093	4	2190	3904	1966	2344
6-May	10.4	416	6073	4	2182	3891	1978	2344
7-May	10.9	437	6051	4	2174	3877	1992	2345
8-May	12.8	463	6026	4	2166	3860	2010	2346
9-May	11.9	486	6002	4	2158	3844	2025	2346
10-May	13.4	513	5976	4	2150	3826	2044	2347
11-May	16.4	545	5943	4	2142	3801	2068	2348
12-May	21.8	589	5900	4	2134	3766	2104	2350
13-May	25.5	639	5849	4	2126	3723	2146	2352
14-May	27.3	693	5795	4	2118	3677	2193	2353
15-May	29.9	753	5736	6	2110	3625	2244	2356
16-May	38.4	829	5660	6	2099	3561	2308	2358
17-May	30.7	890	5599	6	2087	3512	2357	2360
18-May	25.8	941	5548	6	2075	3473	2396	2362
19-May	23.9	988	5500	6	2063			
20-May	25.3	1038	5450	6	2051			
21-May	29.2	1096						
22-May	33.3	1162				3299	2570	2368
23-May	36.7	1235				3238	2631	2371
24-May	40.1	1315				3170	2699	2373
25-May	40.4	1395				3102	2767	2376
26-May	40.1	1474	5014	6	1980	3035	2835	2378
27-May	44.9	1563	4925	6	1968	2957	2912	2381
28-May	47.4	1657	4831	6	1956	2875	2994	2384
29-May	44.5	1746	4743	6	1944	2799	3070	2386
30-May	47.4	1840	4649	6	1932	2717	3152	2389
31-May	56.7	1952	4536	6	1920	2616	3253	2393
1-Jun	63.0	2077	4412	15	1908	2503	3366	2396
2-Jun	66.2	2208	4280	15	1878			
3-Jun	69.6	2347	4142	20	1849			
4-Jun	69.0	2483	4005	20	1809	2196	3673	2405

Minimum Flows are increased to the Bull Trout Min of 6 kcfs

Inflows are now projected within an assumed shape and the remaining volume of the 95% assured runoff volume at the beginning of Column D minus the Accumulated inflow volume to date.

Sturgeon Pulse begins

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	Inflow[1]	Accumulated Inflow Qin[2]	Residual Inflow Volume[3]	Minimum Flow Daily[4]	Minimum Q Thru July[5]	Available for Refill[6]	Allowable Storage Contents[7]	Flood Control Refill Curve
Date	kcfs	KAF	KAF	kcfs	KAF	KAF	KAF	ft
5-Jun	62.8	2608	3881	25	1769	2111	3758	2408
6-Jun	56.1	2719	3769	25	1720	2050	3820	2410
7-Jun	54.1	2826	3662	25	1670	1992	3877	2411
8-Jun	51.6	2929	3560	25	1621	1939	3930	2413
9-Jun	46.9	3022	3467	25	1571	1896	3974	2414
10-Jun	45.3	3112	3377	25	1521	1856	4014	2415
11-Jun	47.0	3205	3284	25	1472	1812	4058	2416
12-Jun	51.1	3306	3182	25	1422	1760	4109	2417
13-Jun	53.0	3412	3077	25	1373	1704	4165	2419
14-Jun	55.9	3522	2966	25	1323	1643	4226	2421
15-Jun	58.2	3638	2851	25	1273	1577	4292	2422
16-Jun	61.1	3759	2730	25	1224	1506	4364	2424
17-Jun	59.5	3877	2612	25	1174	1437	4432	2426
18-Jun	53.2	3983	2506	25	1125	1381	4488	2427
19-Jun	47.9	4078	2411	22	1075	1336	4534	2428
20-Jun	45.7	4168	2320	20	1031	1289	4580	2429
21-Jun	43.3	4254	2235	20	992	1243	4627	2431
22-Jun	41.8	4337	2152	20	952	1200	4670	2432
23-Jun	41.4	4419	2069	20	912	1157	4712	2433
24-Jun	42.2	4503	1986	20	873	1113	4756	2434
25-Jun	44.9	4592	1897	20	833	1064	4806	2435
26-Jun	45.1	4681	1807	15	793	1014	4856	2436
27-Jun	43.3	4767	1721	15	764	958	4912	2437
28-Jun	40.5	4848	1641	15	734	907	4962	2439
29-Jun	38.9	4925	1564	15	704	860	5010	2440
30-Jun	39.1	5002	1486	15	674	812	5058	2441
1-Jul	39.1	5080	1409	15	645	764	5105	2442
2-Jul	40.5	5160	1328	15	615	713	5156	2443
3-Jul	40.9	5241	1247	15	585	662	5207	2444
4-Jul	36.5	5314	1175	15	555	619	5250	2445
5-Jul	32.8	5379	1110	15	526	584	5285	2446
6-Jul	30.8	5440	1048	15	496	553	5317	2447
7-Jul	30.4	5500	988	13	466	522	5347	2448
8-Jul	30.2	5560	928	13	440	488	5382	2448
9-Jul	29.2	5618	870	11	415	456	5414	2449
10-Jul	27.3	5672	816	9	393	423	5446	2450
11-Jul	25.7	5723	765	9	375	390	5479	2450
12-Jul	24.7	5772	716	9	357	359	5510	2451
13-Jul	24.2	5820	668	9	339	329	5540	2452
14-Jul	24.0	5868	621	9	321			
15-Jul	23.8	5915	573	9	303			
16-Jul	23.3	5962	527	9	286	241	5628	2454
17-Jul	22.7	6007	482	9	268	214	5655	2454

Tiered Bull Trout Minimum Flow of 9 kcfs

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)
	Inflow[1]	Accumulated Inflow Qin[2]	Residual Inflow Volume[3]	Minimum Flow Daily[4]	Minimum Q Thru July[5]	Available for Refill[6]	Allowable Storage Contents[7]	Flood Control Refill Curve
Date	kcfs	KAF	KAF	kcfs	KAF	KAF	KAF	ft
18-Jul	22.1	6050	438	9	250	188	5681	2455
19-Jul	21.4	6093	396	9	232	164	5706	2455
20-Jul	20.7	6134	355	9	214	140	5729	2456
21-Jul	19.9	6174	315	9	196	119	5751	2456
22-Jul	19.1	6211	277	9	179	99	5771	2457
23-Jul	18.3	6248	241	9	161	80	5789	2457
24-Jul	17.4	6282	206	9	143	64	5806	2458
25-Jul	16.5	6315	174	9	125	49	5821	2458
26-Jul	15.7	6346	143	9	107	36	5834	2458
27-Jul	15.1	6376	113	9	89	23	5846	2458
28-Jul	14.7	6405	84	9	71	12	5857	2459
29-Jul	14.4	6434	55	9	54	1	5868	2459
30-Jul	14.0	6462	27	9	36	-9	5878	2459
31-Jul	13.6	6489	0	9	18	-18	5887	2459

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EXHIBIT 7-4
GUIDANCE ON LIBBY DAM RAMPING RATES

U.S. ARMY CORPS OF ENGINEERS (SEATTLE DISTRICT/NORTHWEST DIVISION)

JUNE 2026

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1 GUIDANCE ON LIBBY DAM RAMPING RATES

a. General Information

This document provides guidance and clarification on how to implement the ramping rates at Libby Dam as per the 2020 USFWS BiOp (page 2-40, Table 2.4) and was developed in coordination with the US Army Corps of Engineers (Seattle District and Northwestern Division), Bonneville Power Administration, and the U.S. Fish and Wildlife Service. Table 2-4 of the 2020 BiOp is below with associated bullets:

Table 2.4. Daily and hourly maximum ramping rates for Libby Dam[a]

	Starting Flow	Hourly	Daily
Summer (May 1–September 30)			
Ramp Up	4–6,000 cfs	2,500 cfs	1 unit
	6–9,000 cfs	2,500 cfs	1 unit
	9–16,000 cfs	2,500 cfs	2 units
	16,000 cfs-Q_{PHC}[b]	5,000 cfs	2 units
Ramp Down	4–6,000 cfs	500 cfs	500 cfs
	6–9,000 cfs	500 cfs	1,000 cfs
	9–16,000 cfs	1,000 cfs	2,000 cfs
	16,000 cfs-Q_{PHC}[b]	3,500 cfs	1 unit
Winter (October 1–April 30)			
Ramp Up	4–6,000 cfs	2,000 cfs	1 unit
	6–9,000 cfs	2,000 cfs	1 unit
	9–16,000 cfs	3,500 cfs	2 units
	16,000 cfs-Q_{PHC}[b]	7,000 cfs	2 units
Ramp Down	4–6,000 cfs	500 cfs	1,000 cfs
	6–9,000 cfs	500 cfs	2,500 cfs
	9–16,000 cfs	1,000 cfs	1 unit
	16,000 cfs-Q_{PHC}[b]	3,500 cfs	1 unit

[a] As measured by cumulative daily flow changes within the 24-hour period (mid-night to mid-night, not daily averages), restricted by hourly rates.
[b] Q = discharge or flow; PHC = powerhouse capacity.

- To maintain varial zone productivity and habitat stability and to avoid stranding bull trout, the recommended ramping rates (Table 2-4) will be followed unless the recommended ramping rate causes a unit(s) to operate in a manner that increases vibration and cavitation that could result in premature wear or failure of the units. In this case, the project will use a ramping rate that allows all units to operate while minimizing the risk of damage to the units.

- Ramping rates to minimize impacts on fish and wildlife resources for both ramp-up and ramp-down operations will be followed to the extent possible during project operations. Table 2-4 provides the starting flow, the hourly increment of allowable change, and the units or flows affected.

- From October through February, daily load shaping may occur to maintain FRM requirements or optimize power production. Limiting daily load shaping during October through February to above the minimum flow of 6,000 cfs within the ramping rate constraints (Table 2-4) provides a minimal amount of protected foraging, migration, and overwintering (FMO) habitat while enabling hydropower generation flexibility.

b. Ramp Up & Ramp Down Clarifications

This document is intended to clarify two points of how to interpret the ramping rates proposed in the 2020 USFWS BiOp for Kootenai River white sturgeon and bull trout:

1. *What hourly and daily ramping rates are followed when ramping up or down into another flow range as seen in the table above?*

   The ramping rates within each flow range will be followed. When moving from one flow range to another, the maximum ramp for the daily or hourly rate will be from the range that ramping began (see examples below). Crossing into other flow ranges will not be additive. For example, if ramping down from 10.9 kcfs in the summer, the maximum ramp-down for the day is 2 kcfs and not 3 kcfs. Also, while ramping up from 5 kcfs the maximum ramp up is 1 unit and not 2 units.

2. *What is meant by the term “daily”?*

   Maximum daily rates apply to the **24-hour period from midnight to midnight**. Several examples of ramping down and ramping up are provided below:

(1) Ramp Down - Examples 1 & 2:

Example 1:

- Start on October 5th
- The total desired ramp-down is from 9.3 kcfs to 4.7 kcfs.

It would take until the start of the day on Oct 7th to get down to 4.7 kcfs. *The first hourly step could be 800 cfs because you were 300 cfs over the 6-9 kcfs range + the 500 cfs max per hour once in the 6-9 kcfs range.* There would be 500 cfs steps after that following Table 1. The first day would be limited to a daily ramp of 2800 cfs but at the start of Oct 6th (just past midnight of Oct. 5th) it's a new day, and 3 ramps of 500 cfs could follow from 6.5 kcfs to 5.0 kcfs in 500 cfs hourly increments. Just after midnight on Oct 7th the flow could be dropped to 4.7 kcfs.

Example 1 illustrates that even though the ramp began at a flow of 9.3 kcfs, that has a max ramp down of 5000 cfs per day, that the daily maximum would be limited to 2800 cfs (300 cfs from the 9-16 kcfs range + 2500 cfs per day from the 6-9 kcfs range).

Example 1: Ramping from 9.3 kcfs to 4.7 kcfs on Oct 5th

Day	Hours			Flow (kcfs)	
5-Oct	0:00	-	19:00	9.3	
	19:00	-	20:00	8.5	<--Ramp Down 800 cfs = 300 cfs from the 9-16 kcfs range + 500 cfs per hour **max** once in the 6-9 kcfs range
	20:00	-	21:00	8.0	<--Ramp Down 500 cfs = 500 cfs per hour from the 6-9 kcfs range
	21:00	-	22:00	7.5	
	22:00	-	23:00	7.0	
	23:00	-	24:00	6.5	<--Total Daily 2800 cfs = 300 cfs from the 9-16 kcfs range + 2500 cfs max per day from 6-9 kcfs range.
6-Oct	0:00	-	1:00	6.0	
	1:00		2:00	5.5	
	2:00		24:00	5.0	<--Total Daily 1500 cfs = 500 cfs from the 6-9 kcfs range + 1000 cfs max per day from the 4-6 kcfs range
7-Oct	0:00		24:00	4.7	

Example 2:

- Start on October 5th
- The desired total ramp-down is from 12.6 kcfs to 6.6 kcfs

For the daily rate the first day would be 1 unit (5 kcfs) and the flow could not be brought down to 6.6 kcfs until 01:00 of Oct 6th. In this example, the maximum daily ramp down is 5000 cfs.

Example 2: Ramping from 12.6 kcfs to 6.6 kcfs on Oct 5th

Day	Hours			Flow (kcfs)	
5-Oct	0:00	-	18:00	12.6	
	18:00	-	19:00	11.6	<- 1000 cfs per hour from the 9-16 kcfs range
	19:00	-	20:00	10.6	
	20:00	-	21:00	9.6	
	21:00	-	22:00	8.6	<- limited to a maximum of 1000 cfs per hour from the 9-16 kcfs range. The 500 cfs per hour limit in the 6-9 kcfs range is still upheld since only 400 cfs of the ramp is in that range.
	22:00	-	23:00	8.1	<- Now limited to 500 cfs per hour in the 6-9 kcfs range
	23:00	-	24:00	7.6	<- Limited to 1 unit day from the 9-16 kcfs range but still honors the 2500 cfs per day ramp in the 6-9 kcfs range since the ramp in that range was only 1400 cfs.
6-Oct	0:00	-	1:00	7.1	
	1:00	-	24:00	6.6	

(2) Ramp Up – Examples 3 & 4

Example 3:

- Starts on May 15th
- The desired total ramp-up is from 1 unit (5 kcfs) to 3 units (15 kcfs)

This ramp-up would occur over 2 days. The hourly maximum ramp rate of 2500 cfs applies to all of the ranges in this example.

Example 3. Ramping up from 5 kcfs to 15 kcfs on May 15th

Day	Hours			Flow (kcfs)
15-May	0:00	-	6:00	5.0
	6:00	-	7:00	7.5
	7:00	-	24:00	10.0
16-May	0:00	-	6:00	10.0
	6:00	-	7:00	12.5
	7:00	-	24:00	15.0

Example 4

- Starts on November 4th
- The desired total ramp-up is from 2 units (10 kcfs) to 5 units (25 kcfs)

This ramp-up would also take 2 days. Note in this example the hourly ramp rates vary from 3500 cfs in the 9-16 kcfs range to 5000 cfs 16+ kcfs range (anything above 16 kcfs could be ramped up 7000 cfs in an hour).

Example 4: Ramping up from 5 kcfs to 25 kcfs on Nov 4th

Day	Hours			Flow (kcfs)	
4-Nov	0:00	-	6:00	10.0	
	6:00	-	7:00	13.5	<-- 3500 cfs hourly increase while in the 9-16 kcfs range
	7:00	-	8:00	17.0	← Limited to 3500 cfs per hour because the ramp was started within the 9-16 kcfs range
	8:00	-	24:00	20.0	<-- Could have increased 7000 cfs in an hour while in the 16-QPHC[1] kcfs range but limited to 2 unit daily max
5-Nov	0:00	-	6:00	20.0	
	6:00	-	24:00	25.0	<-- Could have increased 7000 cfs in an hour while in the 16-QPHC range but limited by QPHC

[1] QPHC - flow at powerhouse capacity. For Libby rule of thumb is 25 kcfs but varies with head.

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EXHIBIT 7-5
LIBBY DAM/KOOCANUSA RESERVOIR SURCHARGE COORDINATION PROCESS

Libby Dam/Koocanusa Reservoir Surcharge Coordination Process

Introduction

This document describes the process for coordinating surcharge at Libby Dam/Koocanusa Reservoir (herein referred to as "Libby") when requested for the purpose of flood risk management to address the potential of significant flooding downstream of Libby threatening human health and safety. An objective of this coordination process between the Canadian and United States Entities is to minimize flood damages in both Canada and the United States and it is to be executed by the Columbia River Treaty Operating Committee if needed. Under the process contained herein, implementation of surcharge at Libby is limited to unusual circumstances when there is, or forecasted to be, significant flooding downstream of Libby threatening human health and safety.

Background

This coordination process builds upon the experience and knowledge acquired during the 2012 Kootenai / Kootenay River flood, at which time the U.S. Army Corps of Engineers (Corps) and BC Hydro – in coordination with the Entities – mutually agreed to surcharge Libby for flood risk management purposes in both Canada and the United States.

Coordination Process Implementation

BC Hydro, the Corps' Columbia Basin Water Management Division (CBWM), and Seattle District (NWS), with input from Bonneville Power Administration (BPA), will coordinate as needed throughout the year to determine if a surcharge of Libby, by up to 2 feet, is necessary to manage downstream (e.g. Kootenai/Kootenay Basin) flood risks. Any request to implement a surcharge at Libby will be coordinated with the Canadian Chair (BC Hydro) and United States Chairs (Corps and BPA) of the Columbia River Treaty Operating Committee (CRTOC) as detailed below. The Corps will manage all necessary coordination/consultation with stakeholders in the United States. BC Hydro will manage all necessary coordination/consultation with stakeholders in Canada. If surcharge of Libby is expected, a joint press release will be prepared and coordinated between each agency's Public Affairs Offices.

Process for initiating a surcharge request at Libby by the United States:

- The Corps Seattle District will prepare and submit a request to deviate from the approved Libby Water Control Manual (WCM) for a surcharge operation to the Chief of CBWM. This request shall contain a risk analysis demonstrating the flood risk management benefits in the United States and Canada.
- If the Chief of CBWM approves the deviation request, and the United States CRTOC Chairs make a determination that the operation would not be disadvantageous to the United States, then the United States CRTOC Chair (Corps) will provide the request to the Canadian CRTOC Chair.
- If the Canadian CRTOC Chair deems the surcharge operation to be acceptable to Canada, then the Canadian CRTOC Chair will notify the United States CRTOC Chair of its acceptance.
- The United States CRTOC Chair will notify the United States and Canadian CRT Coordinators, who will notify their respective Entity.

Process for initiating a surcharge request at Libby by Canada:

- Canadian CRTOC Chair will provide the request for a surcharge operation, with an analysis showing benefits in Canada, to the United States CRTOC Chair (Corps).
- The United States CRTOC Chair (Corps) will coordinate with CBWM, with input from the Corps Seattle District and BPA, to evaluate the Canadian request and determine whether the requested operation would be disadvantageous to the United States.
- If the United States CRTOC Chairs determine that the operation would not be disadvantageous to the United States, the Corps Seattle District will prepare and submit a request to deviate from the approved Libby WCM along with a risk analysis, to the Chief of CBWM.
- If the Chief of CBWM approves the deviation request, the United States CRTOC Chair (Corps) will notify the Canadian CRTOC Chair of its acceptance.
- The United States CRTOC Chair (Corps) will notify the United States and Canadian CRT Coordinators, who will notify their respective Entity.

After a surcharge has been approved as described above, a joint press release will be finalized and issued by the Corps and BC Hydro Public Affairs Offices as described above. At the conclusion of the flood event, the Koocanusa reservoir level will be returned to its normal operating range as soon as practical, with consideration of downstream flows, reservoir impacts, and other relevant factors in compliance with the approved deviation from the Chief of CBWM. All costs of a surcharge operation are borne by the country in which the costs occur.

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EXHIBIT 8-1
MEMORANDUM OF UNDERSTANDING – BURBOT CONSERVATION STRATEGY

Memorandum of Understanding Concerning the Kootenai River/Kootenay Lake Burbot Conservation Strategy

PARTICIPANTS

This Memorandum of Understanding (MOU) is made among the Kootenai Valley Resource Initiative (KVRI), Bonneville Power Administration (BPA), BC Hydro, the British Columbia Ministry of Water, Land, and Air Protection (MWLAP), the City of Bonners Ferry, the Boundary County of the State of Idaho, Department of Fisheries and Oceans of Canada (CDFO), the Idaho Department of Fish and Game (IDFG), the Idaho Office of Species Conservation (OSC), the Kootenai Tribe of Idaho (KTOI), Montana Fish, Wildlife and Parks (MFWP), the National Oceanic and Atmospheric Administration (NOAA), the U.S. Army Corps of Engineers, (USACE), the U. S. Fish and Wildlife Service (USFWS), and the United States Geological Survey (USGS).

The above entities are collectively known as the Participants.

RECITALS

WHEREAS, burbot (*Lota lota*) is a fish species endemic to the Kootenai River in Idaho, and the Kootenay River and Kootenay Lake in British Columbia (hereafter referred to as Kootenai River/Kootenay Lake); and

WHEREAS, imminent threats coupled with reductions in the numbers of native burbot caused populations in these areas of the Kootenai/y River Basin to be listed as a species of special concern in the States of Idaho and Montana; and

WHEREAS, the protection and conservation[1] of burbot require the coordinated effort of all the Participants; and

WHEREAS, it is the intent of the Participants to prevent extinction of local burbot populations and promote the recovery and conservation of burbot through coordinated research, management, and funding; and

WHEREAS, the KVRI was formed under a Joint Powers Agreement (JPA) between the KTOI, the City of Bonners Ferry, and Boundary County, in October 2001. Under the JPA, the KVRI is empowered to assist in restoration and enhancement of the resources of the Kootenai Valley and to foster community involvement and development. The mission of KVRI is to act as a locally based effort to improve coordination, integration, and implementation of existing local, state, and federal programs that can effectively maintain, enhance, and restore the social, cultural, and natural resource bases in the community. The KVRI membership and partners include the KTOI, regional city and county governments, private citizens and landowners, federal, state, and provincial

[1] The definition of the term "conservation" in this MOU is to restore and maintain a viable and ultimately harvestable burbot population

agencies, environmental advocacy groups, and regional representatives of business and industry; and

WHEREAS, the KTOI and the KVRI have facilitated the development of the Kootenai River/Kootenay Lake Burbot Conservation Strategy (CS) for the protection and conservation of burbot (Attachment 1); and

WHEREAS, the CS provides for coordination of conservation efforts among the Participants to adaptively manage this species and coordinate monitoring to measure success toward conservation of this species; and

WHEREAS, the actions described in the burbot CS are grounded in rigorous review and analysis of this species in the Kootenai/y River Basin, and are consistent with the Kootenai Subbasin Plan prepared for the Northwest Power and Conservation Council; and

WHEREAS, the Participants desire to formalize their commitment to implement the CS consistent with their respective authorities and responsibilities;

NOW, THEREFORE, the Participants have reached the following understanding:

A. Purpose

The purpose of the CS is to restore and maintain a viable and ultimately harvestable burbot population in the Kootenai River and in the South Arm of Kootenay Lake. In furtherance of this objective, the Participants have entered into this MOU to establish an effective and efficient process to coordinate burbot conservation activities. In coordinating their entities' efforts, the Participants desire to adaptively manage burbot by sharing information and coordinating research and monitoring activities. The CS provides the framework for implementation of this adaptive management approach and may be modified as more information is obtained.

B. Commitment to the Burbot Conservation Strategy

Burbot Restoration – The KTOI and the KVRI Burbot Committee, along with the USFWS, the IDFG, and additional committed stakeholders, have developed an integrated, innovative approach to provide a viable harvestable burbot population in the Kootenai River/Kootenay Lake.

The KTOI proposed to the USFWS that a collaborative approach be used in the Kootenai River drainage to develop, implement, and evaluate the CS for Kootenai River/Kootenay Lake burbot as a "pilot project". The project gained broad support from a wide range of stakeholders in the Kootenai/y Valley, which led to the formation of the KVRI Burbot Committee. Additionally, the project has obtained the support of the Idaho Congressional Delegation, as well as other members of the United States Congress.

It is this multifaceted international focus and commitment to implement actions to reduce threats that empower this CS. If Kootenai River/Kootenay Lake burbot are considered in any future Endangered Species Act listing decision, both the commitment to implement the adaptive management approach reflected in the CS and its effectiveness will be measured through the improved status of the burbot, and will be key considerations (See the Policy for Evaluation of Conservation Efforts, PECE, FR Vol. 65 No. 114, June 13). Please refer to the CS for more details.

C. Annual Project Communication and Management

1. The KVRI Burbot Committee is serving as the forum to coordinate implementation of the CS. The Committee will meet at least annually in the fall to discuss progress during the past year, and to be updated on priorities and funding needs for future years. The Participants commit to participation in these meetings and to exchange information, provide project updates, and discuss the course of future burbot research, conservation, and management. Annual project updates and reports currently provided by the management agencies (e.g. IDFG, KTOI, MWLAP) will be the primary sources of resource information used in discussions by the Committee regarding ongoing and future burbot research, conservation, and management.

2. Consistent with the CS (Section 9.7, "Information and Outreach"), the KVRI Burbot Committee meetings will also serve to:

   a. Increase public awareness of the need for Kootenai River/Kootenay Lake burbot conservation by sharing informational and educational materials.

   b. Pursue opportunities to link Kootenai River/Kootenay Lake burbot conservation activities with other ongoing fish and wildlife research and management, and with current and future habitat and ecosystem restoration efforts.

   c. Distribute annual monitoring, evaluation, and research reports.

   d. Continue to involve a broad coalition of interested stakeholders in burbot conservation, working collaboratively through the KVRI Process (See CS, Section 5.0, "Existing Conservation Measures" for more details).

D. Funding

1. Funding of current burbot conservation actions is primarily through the Northwest Power and Conservation Council's Fish and Wildlife Program (Program), implemented by BPA, and from Congressional appropriations granted through the Department of the Interior to the KTOI and other Participants. As the project selection process is developed, future funding under the Program will be based on regional prioritization and will be guided in part by subbasin plans. It is anticipated that these funding sources will

continue and that many of the actions within the CS will proceed upon execution of this MOU.

2. The Participants commit to continue to seek funds and/or provide support to implement the CS. It is anticipated that additional sources of funding through federal, state, provincial, private, and public sources will be needed to fully implement the CS. However, it is recognized that entities retain discretion concerning their expenditures. The Participants will work cooperatively to investigate additional funding sources and to pursue use of existing funding sources, including cost-sharing mechanisms. It is also recognized that the CS outlines funding coordination activities with other ongoing Kootenai/y Basin projects.

3. This MOU is neither a fiscal nor a funds obligation document. Nothing in the MOU will obligate any Participant to enter into any contract or otherwise create new or additional legal obligations. Any endeavor or transfer of anything of value involving reimbursement or contribution of funds between Participants to this instrument will be handled in accordance with applicable laws, regulations, and procedures, including those for Government procurement and printing. Such endeavors will be outlined in separate agreements that will be made in writing by representatives of the Participants and will be independently authorized by appropriate statutory authority. This instrument does not provide such authority. Specifically, this instrument does not establish authority for noncompetitive award to the cooperator of any contract or other agreement. Any contract or agreement for training or other services must fully comply with all applicable requirements for competition.

E. Miscellaneous Provisions

1. Successful implementation of the CS and adaptive management processes contained therein are intended to reduce the threats to Kootenai River/Kootenay Lake burbot and produce and maintain stable burbot size and age class distributions that promote fisheries conservation in the Kootenai River/Kootenay Lake.

2. Efficiency and degree of certainty of success for the implemented CS will be maximized by this MOU and the commitment of all Participants to collaboratively support implementation of CS elements, along with a formal, evolving adaptive management approach that uses the best available science.

3. If any Participant anticipates or determines that actions in the CS cannot be carried out by their agency as described, they will coordinate with other appropriate Participants to pursue alternatives that are consistent with CS objectives.

4. This MOU is intended to provide a mechanism to further the objective of burbot conservation and is not intended to, nor does it create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity against any Participant. Without limiting the applicability of rights granted to the public pursuant to any law, this MOU and the CS will not create any right or interest in the public, or any member thereof, as a third Participant beneficiary hereof, nor will they authorize anyone to maintain a suit for enforcement of the MOU, or CS, personal injury or damages. The duties, obligations, and responsibilities of the Participants to this MOU with respect to third Participants will remain as imposed under existing law.

5. This MOU does not delegate any authority or responsibility established by law, nor does it limit the discretion of any Participant. If the processes and procedures related to this MOU and/or the CS would delay the implementation of any actions for which a Participant is obligated to provide under law, that Participant reserves the right to proceed with fulfilling such obligations in the manner it deems appropriate or necessary. The Participants intend that this MOU be interpreted to be fully consistent with their respective statutory and regulatory authorities and obligations.

F. MOU Duration, Modification, and Termination

1. This MOU will become effective upon the date of signature of the last listed Participant and will remain in effect for ten years, at which time the MOU may be renewed, amended, or reconsidered.

2. Additional Participants in this MOU may be considered once the MOU is in effect. Entities interested in being considered as future Participants should notify the KVRI Burbot Committee in writing.

3. This MOU may be modified or amended only with the written consent of all Participants. This MOU may also be suspended or terminated upon unanimous written agreement of all Participants. Documentation of modification, amendment, suspension, or termination of the MOU will be provided to the KVRI Burbot Committee.

4. Any Participant may suspend or terminate its participation in the MOU by giving 90 days written notice of its intent to all other Participants.

Memorandum of Understanding Concerning the Kootenai River/Kootenay Lake Burbot Conservation Strategy

Collective Participant Signature Page

The Undersigned agree to the Memorandum of Understanding Concerning the Kootenai River/Kootenay Lake Burbot Conservation Strategy

Kootenai Valley Resource Initiative (KVRI) Co-Chair 1	Idaho Department of Fish and Game (IDFG)
Kootenai Valley Resource Initiative (KVRI) Co-Chair 2	Idaho Office of Species Conservation (OSC)
Kootenai Valley Resource Initiative (KVRI) Co-Chair 3	Kootenai Tribe of Idaho (KTOI)
Bonneville Power Administration (BPA)	Montana Fish, Wildlife and Parks (MFWP)
BC Hydro	National Oceanic and Atmospheric Administration (NOAA)
British Columbia Ministry of Water, Land, and Air Protection (MWLAP)	U.S. Army Corps of Engineers, (USACE)
City of Bonners Ferry, the Boundary County of the State of Idaho	U. S. Fish and Wildlife Service (USFWS)
Department of Fisheries and Oceans of Canada (CDFO)	United States Geological Survey (USGS)

Memorandum of Understanding Concerning the Kootenai River/Kootenay Lake Burbot Conservation Strategy

Individual Participant Signature Page

The Undersigned agrees to the Memorandum of Understanding Concerning the Kootenai River/Kootenay Lake Burbot Conservation Strategy

Dated this 15TH day of March, 2005

Name of Party: U.S. Army Corps of Engineers
Northwestern Division

By: _____
William T. Grisoli

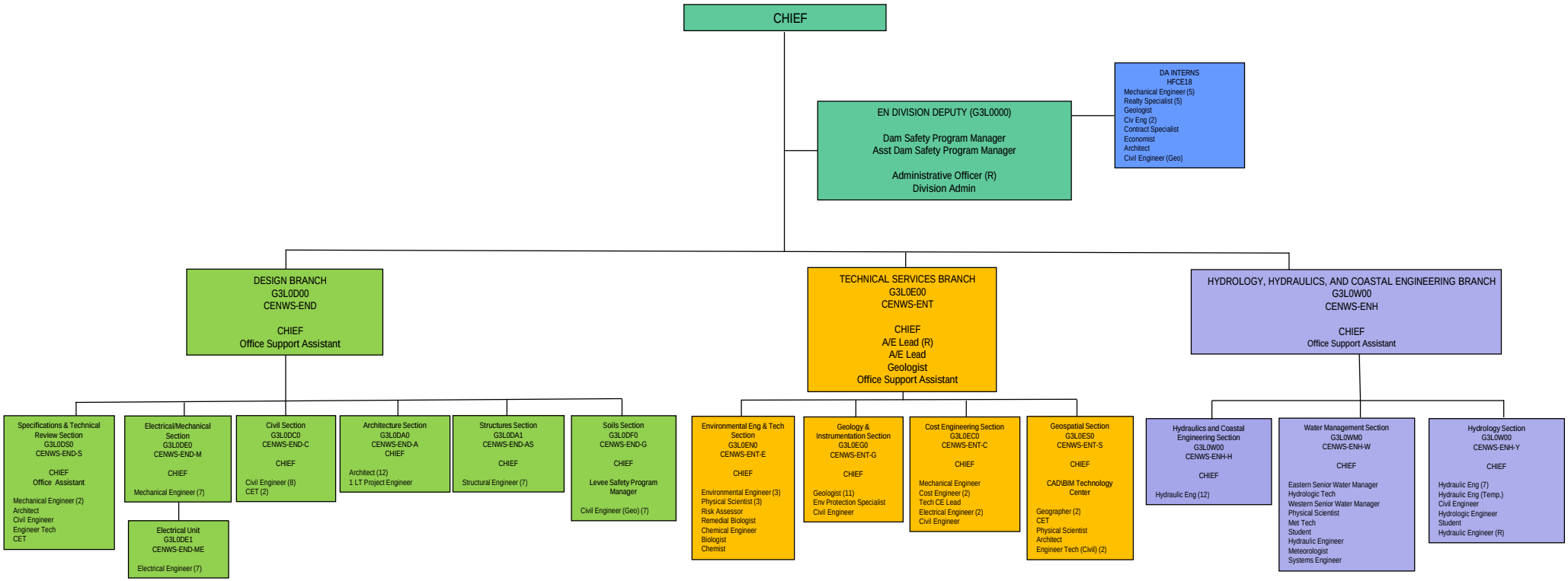
Title: Brigadier General, USA
Division Engineer

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1125 NW Couch Street
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Portland, Oregon 97209-2870

Telephone #: [redacted]

EXHIBIT 9-1
U.S. ARMY CORPS OF ENGINEERS, NORTHWESTERN DIVISION, SEATTLE DISTRICT ORGANIZATION CHARTS

ENGINEERING DIVISION
G3L0000/CENWS-EN
MAR 2024



OPERATIONS DIVISION (OD)

SUPERVISORY CIVIL ENGINEER	GS-15

ADMINISTRATIVE OFFICER	GS-12
MANAGEMENT AND PROGRAMS ASSISTANT	GS-7

REGULATORY BRANCH (ODR)

SUPERVISORY CIVIL ENGINEER	GS-14

TECHNICAL SERVICES

SUPERVISORY BIOLOGIST	GS-13
BIOLOGIST	GS-12
ECOLOGIST (NWS MITIGATION COORDINATOR)	GS-12
BIOLOGIST (MITIGATION COORDINATOR) (2)	GS-12
ENVIRONMENTAL PROTECTION SPECIALIST	GS-07
REGULATORY SUPPORT ASSISTANT (OA)	GS-07
REGULATORY SUPPORT ASSISTANT (OA) (2)	GS-06
STUDENT TRAINEE (BIOLOGY) (2)	GS-04
BIOLOGIST	GS-11

SOUTH SOUND SECTION

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ARCHAEOLOGIST	GS-13
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BIOLOGIST (4)	GS-12
BIOLOGIST	GS-07
ECOLOGIST	GS-11
BIOLOGIST (2)	GS-11

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SUPERVISORY BIOLOGIST	GS-13
BIOLOGIST (4)	GS-12
BIOLOGIST	GS-12
ENVIROMENTAL PROTECTION SPECIALIST	GS-12
GHOST LINE (2)	
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BIOLOGIST (BIL)	GS-12
BIOLOGIST (BIL)	GS-11
ECOLOGIST	GS-11

COLUMBIA BASIN

SUPERVISORY BIOLOGIST	GS-13
BIOLOGIST (3)	GS-12
ECOLOGIST (2)	GS-12
BIOLOGIST	GS-11
BIOLOGIST	GS-09
STUDENT TRAINEE (BIOLOGY)	GS-04

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SUPERVISORY BIOLOGIST	GS-13
BIOLOGIST (8)	GS-12
BIOLOGIST	GS-09
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BIOLOGIST	GS-11
BIOLOGIST (2)	GS-07
STUDENT TRAINEE (BIOLOGY)	GS-04

PROGRAM MANAGEMENT BRANCH (ODP)

PROGRAM MANAGER	GS-14
OFFICE AUTOMATION ASSISTANT (2)	GS-6

MANAGEMENT SUPPORT SECTION (ODP-MS)

PROGRAM MANAGER	GS-13
PROGRAM ANALYST (3)	GS-12
BUDGET ANALYST (4)	GS-11
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NAVIGATION SECTION (ODP-NS)

SUPERVISORY BIOLOGIST	GS-13
BIOLOGIST	GS-13
CONSTRUCTION REPRESENTATIVE	GS-12
ENVIRONMENTAL ENGINEER	GS-12
CIVIL ENGINEER	GS-13
OCEANOGRAPHER (2)	GS-12

WATERWAYS MAINTENANCE UNIT (ODP-NW)

SUPERVISORY EQUIPMENT SPECIALIST	GS-12
CRANE OPERATOR	XF-12
STUDENT TRAINEE (TRANS EQUIP WKR)	XF-03
MARINE MACHINERY MECHANIC	WG-10
SMALL CRAFT OPERATOR (2)	XH-13
SMALL CRAFT OPERATOR (3)	XF-08
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SURVEY TECHNICIAN	GS-05
SURVEY TECHNICIAN	GS-09
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SMALL CRAFT OPERATOR	XF-09
FACILITIES SERVICES ASSISTANT	GS-09

TECHNICAL SUPPORT BRANCH (ODS)

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NATURAL RESOURCES MGMT SECTION (ODS-NR)

SUPERVISORY NATURAL RESOURCE SPECIALIST	GS-13
NATURAL RESOURCES SPECIALIST (2)	GS-12
ENVIRONMENTAL PROTECTION SPECIALIST	GS-13
NATURAL RESOURCES SPECIALIST	GS-11

DREDGED MATERIAL MGMT SECTION (ODS-ND)

BIOLOGIST	GS-13
PHYSICAL SCIENTIST (2)	GS-12
BIOLOGIST	GS-12

PROJECT SUPPORT SECTION (ODS-PS)

SUPERVISORY MECHANICAL ENGINEER	GS-13
CIVIL ENGINEER (2)	GS-12
ELECTRICAL ENGINEER	GS-12
MECHANICAL ENGINEER	GS-12
INTERDISCIPLINARY	GS-07
ELECTRICAL ENGINEER	GS-13
CIVIL ENGINEER	GS-13
MECHANICAL ENGINEER	GS-13
ACQUISITION COORDINATOR	GS-13
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EMERGENCY MGMT BRANCH (CENWS-ODE)

PROGRAM MANAGER	GS-13
OFFICE AUTOMATION ASSISTANT	GS-06
CONSTRUCTION CONTROL REP (2)	GS-12
EMERGENCY MGMT SPECIALIST (3)	GS-12
EMERGENCY MGMT SPECIALIST	GS-11
EMERGENCY MGMT SPECIALIST	GS-09
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OPERATIONS DIVISION (OD)

SUPERVISORY CIVIL ENGINEER	GS-15

OFFICE OF THE CHIEF (CENWS-ODA)

PROGRAM MANAGER	GS-13

ADMINISTRATIVE SECTION

ADMINISTRATIVE OFFICER	GS-11
BUDGET ANALYST	GS-07
CONTRACT PERFORMANCE SPC	GS-09
BUDGET TECHNICIAN	GS-07
OFFICE SUPPORT ASSISTANT (OA)	GS-05
MATERIALS HANDLER	WB-C
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POWERHOUSE O&M SECTION

SUPERVISORY MECHANICAL ENGINEER	GS-13
ELECTRONIC SYSTEM CONTROL CRAFTWORKER	WB-K
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POWER PLANT ELECTRICIAN	WB-I
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POWER PLANT MECHANIC (DUAL RATE)	WB-I
POWER PLANT MECHANIC (2)	WB-I
POWER PLANT MECHANIC WORKER IN CHARGE	WB-I
UTILITY WORKER	WB-I
POWER PLANT SHIFT OPERATOR (6)	WB-J
POWER PLANT OPERATOR	WB-I
UTILITY WORKER	WB-C
ELECTRONIC SYSTEM CONTROL CRAFTWOKER (WIC)	WB-J

TECHNICAL SECTION

SUPERVISORY MECHANICAL ENGINEER	GS-13
ENGINEERING TECHNICIAN (DRAFTING)	GS-07
FACILTIES SERVICES ASSISTANT	GS-09
FACILTIES SERVICES ASSISTANT	GS-09
MECHANICAL ENGINEER	GS-12
SAFETY AND OCCUPATIONAL HEALTH SPECIALIST	GS-11
ELECTRICAL ENGINEER	GS-12

RESOURCE MANAGEMENT SECTION

SUPERVISORY NATURAL RESOURCE SPECIALIST	GS-12
MAINTENANCE MECHANIC (3)	WG-10
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NATURAL RESOURCE SPECIALIST	GS-11
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NATURAL RESOURCE SPECIALIST (RANGER) (2)	GS-09
PARK RANGER (TEMP) (6)	GS-03
FISH BIOLOGIST	GS-03

OFFICE OF THE CHIEF (ODL)

SUPERVISORY ELECTRICAL ENGINEER	GS-13

ADMINISTRATIVE SECTION

ADMINISTRATIVE OFFICER	GS-11
BUDGET ANALYST	GS-09
MATERIALS HANDLER (2)	TC-C
OFFICE AUTOMATION ASSISTANT	GS-05
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TECHNICAL SECTION

SUPERVISORY ELECTRICAL ENGINEER	GS-13
SAFETY AND OCCUPATIONAL HEALTH SPECIALIST	GS-11
ELECTRICAL ENGINEER	GS-07
MECHANICAL ENGINEER	GS-12
ENGINEERING TECHNICIAN (DRAFTING)	GS-10
CONTRACT PERFORMANCE SPECIALIST	GS-09
ENGINEERING TECHNICIAN (DRAFTING)	GS-09
STUDENT TRAINEE (ENG AND ARC)	GS-04

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LABORER (MVO)	WG-05
MAINTENANCE WORKER	WG-08
MAINTENANCE MECHANIC	WG-10
MAINTENANCE SUPERVISOR	WS-10
NATURAL RESOURCE SPECIALIST	GS-11
PARK RANGER	GS-07
PARK RANGER	GS-09
FISH BIOLOGIST	GS-12
LABORER (MVO) NO CDL	WG-05

POWERHOUSE O&M SECTION

SUPERVISORY ELECTRICAL ENGINEER	GS-13
FACILITIES SERVICES ASSISTANT	GS-05
MAINTENANCE CONTROL SPECIALIST	GS-09
ELECTRICAL ELECTRONIC CRAFTSWORKER (2)	TC-J
POWER PLANT ELECTRICIAN	TC-I
ELECTRONIC SYSTEM CONTROL CRAFTWORKER	TC-K
POWER PLANT ELECTRICAL CREW SUPERVISOR	**CF-I**
POWER PLANT ELECTRICIAN	TC-I
POWER PLANT ELECTRICIAN (DUAL RATE) (2)	TC-I
POWER PLANT ELECTRICIAN (TERM)	TC-I
POWER PLANT MECHANIC (DUAL RATE) (4)	TC-I
POWER PLANT MECHANIC	TC-I
POWER PLANT MECHANICAL CREW SUPERVISOR	**CF-I**
POWER PLANT SHIFT OPERATOR (6)	TC-J
UTILITY WORKER (3)	TC-C
POWER PLANT GENERAL MAINTENANCE WORKER-IN-CHARGE	TC-G
UTILITY WORKER (TERM)	TC-C

OFFICE OF THE CHIEF (ODM)

SUPERVISORY NATURAL RESOURCE SPECIALIST	GS-13
BIOLOGIST	GS-12
PARK RANGER	GS-07
PARK RANGER	GS-09
HEALTH AND SAFETY SPECIALIST	GS-07

ADMINISTRATIVE SECTION

ADMINISTRATIVE OFFICER	GS-11
OFFICE SUPPORT ASSISTANT (OA)	GS-06
FACILITIES SERVICES ASSISTANT	GS-09

HOWARD HANSON DAM (PROVISIONAL)

DAM EQUIPMENT MECHANIC SUPERVISOR	WS-10
DAM EQUIPMENT MECHANIC LEADER	WL-11
DAM EQUIPMENT MECHANIC (3)	WG-10
ENGINEERING EQUIPMENT OPERATOR	WG-10
ELECTRICIAN	WG-10

MUD MOUNTAIN (PROVISIONAL)

DAM EQUIPMENT MECHANIC SUPERVISOR	WS-10
DAM EQUIPMENT MECHANIC	WG-10
ENGINEERING EQUIPMENT OPERATOR	WG-11
DAM EQUIPMENT MECHANIC LEADER	WL-11
ELECTRICIAN (2)	WG-10
DAM EQUIPMENT MECHANIC (4)	WG-10
DAM EQUIPMENT MECHANIC	WL-11
DAM EQUIPMENT MECHANIC LEADER	WG-10
ENGINEERING EQUIPMENT OPERATOR	WG-10
LABORER	WG-03
LABORER (TEMP) (4)	WG-03
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DAM EQUIPMENT MECHANIC SUPERVISOR	**WG-10**
DAM EQUIPMENT MECHANIC (TEMP)	WG-05
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OFFICE OF THE CHIEF (ODW)

SUPERVISORY MECHANICAL ENGINEER	GS-13
MECHANICAL ENGINEER	GS-12
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ENVIRONMENTAL PROTECTION SPECIALIST	GS-11
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ADMINISTRATIVE SECTION

ADMINISTRATIVE OFFICER	GS-11
ADMIN SUPPORT ASSISTANT (OA)	GS-07
MATERIALS HANDLER (MVO)	WG-7
FACILITIES SERVICES ASSISTANT (OA)	GS-05
FACILITIES SERVICES ASSISTANT	GS-08

RESOURCE MANAGEMENT SECTION

SUPERVISORY NATURAL RESOURCE SPECIALIST	GS-11
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NATURAL RESOURCE SPEC (RANGER)	GS-07
GARDENER	WG-08
SECURITY SPECIALIST	GS-09
PARK RANGER	GS-05
PARK RANGER (TEMP) (3)	GS-05

LOCK OPERATIONS SECTION

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LOCK & DAM OPERATOR (2)	WY-07
LOCK & DAM OPERATOR	WY-09
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LOCK & DAM OPERATOR (3)	WY-08
LOCK & DAM OPERATOR	WY-06
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LOCK & DAM OPERATOR (4)	WY-07
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LOCK & DAM OPERATOR (2)	WY-08
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LOCK & DAM OPERATOR	WY-05
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MAINTENANCE SECTION

LOCK AND DAM EQUIPMENT MECHANIC SUPERVISOR	WA-11
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MACHINIST	WY-11
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CRANE OPERATOR	WY-11
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ELECTRONIC INTEGRATED SYSTEMS MECHANIC	WY-08
CARPENTER	WY-09
PAINTER	WY-09

ADMINISTRATIVE SECTION

ADMINISTRATIVE OFFICER	GS-11
SUPERVISORY MANAGEMENT AND PROGRAM ASSISTANT	GS-08
BUDGET ANALYST	GS-09
BUDGET TECHNICIAN	GS-05
MATERIALS HANDLER (3)	TC-C
OFFICE AUTOMATION ASSISTANT	GS-05
OFFICE SUPPORT ASSISTANT (OA)	GS-05
OFFICE SUPPORT ASSISTANT (OA)	GS-07
SUPPLY TECHNICIAN	GS-07
OFFICE AUTOMATION ASSISTANT	GS-05
TEMP NTE 18 MAY	TC-C

COMPLIANCE SECTION

PROGRAM MANAGER	GS-13
ENVIRONMENTAL PROTECTION SPECIALIST	GS-12
SAFETY & OCCUPATIONAL HEALTH SPECIALIST	GS-11
SAFETY AND OCCUPATIONAL HEALTH SPECIALIST	GS-07
ELECTRICAL ENGINEER (2)	GS-12
ELECTRICAL ENGINEER	GS-12
SECURITY SPECIALIST	GS-11
SECURITY ASSISTANT (7)	GS-07
ENVIRONMENTAL PROTECTION SPECIALIST	GS-09

ELECTRICAL UNIT

POWER PLANT ELECTRIAL CREW SUPERVISOR	WB-I
ELECTRICAL ELECTRONIC CRAFTSWORKER (4)	WB-J
ELECTRONIC SYSTEM CONTROL CRAFT WORKER IN CHARGE	WB-J
POWER PLANT ELECTRICIAN (DUAL RATE) (7)	WB-I
GHOST LINE	
POWER PLANT ELECTRICIAN (TERM (2)	WB-I

RESOURCE MANAGEMENT

SUPERVISORY NATURAL RESOURCE SPECIALIST	GS-12
NATURAL RESOURCES SPECIALIST (4)	GS-09
PARK RANGER (2)	GS-05
MAINTENANCE WORKER (MVO)	WG-09
PARK RANGER	GS-09

OFFICE OF THE CHIEF (ODC)

PROGRAM MANAGER	GS-14

HYDROPOWER PLANT TRAINING UNIT

SUPERVISORY TRAINING SPECIALIST	GS-12
POWER PLANT TRAINEE (4)	WB-B

MAINTENANCE SECTION

SUPERVISORY ELECTRICAL ENGINEER	GS-13
FACILITY SERVICES ASSISTANT (2)	GS-07
FACILITY SERVICES ASSISTANT	GS-9
POWER PLANT ELECTRICAL PLANNER (2)	WB-J

MECHANICAL UNIT

POWER PLANT MECHANICAL CREW	WB-I
POWER PLANT MECHANICAL WORKER IN CHARGE	WB-I
CRANE OPERATOR (CDL)	WB-H
POWER PLANT MECHANICAL WORKER IN CHARGE	WB-I
POWER PLANT MECHANIC (6)	WB-I
POWER PLANT MECHANIC (CDL) (3)	WB-I
POWER PLANT MECHANIC (DUAL RATE) (3)	WB-I
POWER PLANT MECHANIC (TERM)	WB-I

TECHNICAL SECTION

SUPERVISORY ELECTRICAL ENGINEER	GS-13
ELECTRICAL ENGINEER (2)	GS-11
MECHANICAL ENGINEER	GS-11
ELECTRICAL ENGINEER (2)	GS-12
ENGINEERING TECHNICIAN (DRAFTING)	GS-11
ENGINEERING TECHNICIAN (DRAFTING) (TERM)	GS-09
ENGINEERING TECHNICIAN (DRAFTING)	GS-09
MECHANICAL ENGINEER (2)	GS-12
CONTRACT PERFORMANCE SPECIALIST	GS-09
MECHANICAL ENGINEER	GS-09

GENERAL UNIT

POWER PLANT GENERAL MAINTENANCE CREW SUPv	WB-G
CARPENTER	WB-G
LABORER (5)	WB-B
LABORER (TERM) (2)	WB-B
PAINTER	WB-G
PAINTER (DUAL RATE)	WB-G
POWER PLANT GENERAL MAINTENANCE WORKER-IN-CHARGE	WB-G
UTILITY WORKER (5)	WB-C
GHOST LINE (TEMP PROMOTE)	WB-C
UTILITY WORKER (DUAL RATE)	WB-C

OPERATIONS SECTION

HYDROELECTRIC POWER OPS MANAGER	GS- 13
CHIEF POWER PLANT OPERATOR	WB-L
CHIEF POWER PLANT OPERATOR	WB-L
CHIEF POWER PLANT OPERATOR	WB-L
GHOST LINE TEMP PROMOTE	WB-L
CHIEF POWER PLANT OPERATOR (3)	WB-L
ELECTRONIC SYSTEM CONTROL (3) CRAFTWORKER	WB-K
POWER PLANT OPERATOR (12)	WB-I
POWER PLANT OPERATOR (DUAL RATE) (2)	WB-I
OPERATIONS COORDINATOR	

EXHIBIT 9-2
1938 KOOTENAY LAKE ORDER

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INTERNATIONAL JOINT COMMISSION

IN THE MATTER OF THE APPLICATION OF THE WEST KOOTENAY POWER AND LIGHT COMPANY, LIMITED, FOR PERMISSION TO CONSTRUCT AND OPERATE CERTAIN WORKS IN AND ADJACENT TO THE CHANNEL OF THE KOOTENAY RIVER IN THE PROVINCE OF BRITISH COLUMBIA, AND FOR THE RIGHT TO STORE WATER IN KOOTENAY LAKE IN THE SAID PROVINCE OF BRITISH COLUMBIA.

ORDER OF APPROVAL

November 11, 1938

In this Order whenever the word "Treaty" is used it shall mean and include the Treaty entered into between the United States of America and His Majesty the King of the United Kingdom of Great Britain and Ireland, and of the Dominions beyond the Seas, Emperor of India, dated the 11th day of January, 1909; whenever the word "Commission" is used it shall mean and include the International Joint Commission appointed under said Treaty; whenever the word "Applicant" is used it shall mean and include West Kootenay Power and Light Company, Limited; and whenever the words "Amended Application" are used, they shall mean and include the Amended Application of the Applicant dated the 8th day of February, 1932, and also the Applicant's Application dated the 7th day of September, 1938.

WHEREAS the Kootenay River is a river flowing across the international boundary between the United States and Canada, within the meaning of Article IV of said Treaty, and has its source in the Rocky Mountains in British Columbia, flows south to and across the international boundary into the State of Montana, thence into the State of Idaho, thence north into Kootenay Lake in British Columbia, and thence by way of the West Arm of that Lake and the said river to its confluence with the Columbia; and

WHEREAS there are situated in the State of Idaho in the United States of America and in the Province of British Columbia in the Dominion of Canada large tracts of fertile land (commonly known as "the Kootenay Flats") bordering on and adjacent to the Kootenay river, which in a state of nature were incapable, and some of which are still incapable, of cultivation by reason of lack of drainage therefrom to the said river, and also by reason of the lands being overflowed from the river during periods of high water; and

WHEREAS certain citizens of both countries (hereinafter referred to as "Reclamation Farmers"), through the organization of drainage districts and otherwise have constructed dykes,

dug drains and erected pumping plants for the purpose of reclaiming their lands and making them fit for cultivation; and

WHEREAS, notwithstanding the works referred to in the preceding paragraph hereof, in periods of high water said lands and the crops planted thereon are imperilled, and occasionally portions of the dykes have been washed away, and the crops on some of these lands totally destroyed, and the Reclamation Farmers affected have been compelled to rebuild their dykes, and have sustained serious damage and loss; and

WHEREAS the Applicant was at the times above referred to and still is the owner of or otherwise well and truly entitled to several water power sites on said Kootenay River in the Province of British Columbia below Kootenay Lake, hereinafter particularly referred to, at which the Applicant has erected large power plants at a cost of several millions of dollars, besides the plant known as the Corra Linn power plant, hereinafter particularly referred to; and

WHEREAS the Applicant, did on the 16th day of September, 1929, present to and file with the Commission under the provisions of Article IV of the Treaty an application dated the 6th day of September, 1929, for permission to construct and operate certain permanent works in and adjacent to the channel of the Kootenay River at a place called Granite in the Province of British Columbia, for the development of storage on Kootenay Lake; and

WHEREAS this Application came on for hearing at the City of Bonners Ferry in the State of Idaho, on the 6th and 7th days of November, 1929, after due notice to all parties interested in both countries of the filing of the Application and of the time and place of hearing; when evidence was adduced, and all parties desiring were heard; and at which hearing it was decided that additional time was necessary to enable interests located to the south of the international boundary to properly study the effect of the proposals of the Applicant; and

WHEREAS the Applicant pending disposal of the Application above referred to proceeded with the construction of a power development at a point on said river called Corra Linn, a site four miles downstream from the Granite site, and 87 miles north of the point at which the International boundary crosses the Kootenay River; and

WHEREAS the dam of the Corra Linn development is so designed as to permit its use both for storage and power purposes, and is capable of regulating the high waters of Kootenay Lake to the extent and in the manner in this Order hereinafter set forth, upon the removal of certain obstructions to the free flow of the waters of Kootenay River at a point thereon called Grohman Narrows, in British Columbia; and

WHEREAS the Applicant did at the same time enlarge the cross-sectional area of the river at constricted points in the channel from the dam upstream to a point above the rapids at Granite for the purpose of discharging the river flow without undue loss of head in the forebay; and

WHEREAS on the 15th day of February, 1932, while the above-mentioned Application was still pending, the Applicant did present to and file with the Commission under the provisions of Article IV of the Treaty, a further Application and plans dated the 8th day of February, 1932, for the approval of works completed and proposed in connection with the Corra Linn development for the purpose of storing water in Kootenay Lake, by means of certain improvements to said river, at a point called Grohman Narrows, and for the operation of said power and storage dam at Corra Linn, in the manner in this Order hereinafter more particularly set forth, which said Amended Application and plans superseded the Application and plans filed with the Commission on the 16th day of September, 1929; and

WHEREAS this Amended Application came on for hearing at the City of Nelson, in the Province of British Columbia, on the 24th day of August, 1933, and at the City of Ottawa, in the Province of Ontario, an the 2nd day of October, 1934, after due notice to all parties interested in

both countries of the filing of the Amended Application, and of the time and place of hearings, when evidence was adduced, and all parties desiring were heard; and

WHEREAS objections were raised to the construction of these works and the operation of the dam as aforesaid, by certain Reclamation Farmers, and, at the said hearing held in the City of Ottawa on the 2nd day of October, 1934, the Applicant withdrew its Application; and

WHEREAS a number of Reclamation Farmers in both countries have recently petitioned the Applicant to revive its Application for permission to proceed with the construction of said works, in connection with the Corra Linn development; and

WHEREAS the Applicant, by instrument in writing bearing date the 7th of September, 1938, and filed in the offices of the Commission on the 13th day of September, 1938, did apply for leave to revive the Amended Application of the 8th February, 1932, in such manner that when revived it would be in the same plight and condition as it was immediately preceding the time of withdrawal, with the exception that the Applicant's proposal, as set forth in Section 14 of the Amended Application, was amended by striking out the words "substantial amounts" in the fourth line of said section and substituting therefor the words “at least 250,000 cubic yards”; and

WHEREAS the Commission did grant to the Applicant leave to revive the Amended Application, and the Amended Application again came on for hearing in the City of Bonners Ferry, Idaho, on the 10th and 11th days of October, 1938, at the Town of Creston, British Columbia, on the 12th day of October, 1938, and at, the City of Nelson, British Columbia, on the 13th day of October, 1938, after due notice to all parties in both countries of the revival of the Amended Application and of the times and places of hearing, when evidence was adduced and all parties desiring to be heard were heard; and

WHEREAS the Commission is of the opinion that the works in question, with the operation of the dam as hereinafter provided, should be of substantial and lasting benefit to the lands above referred to, and should tend to lesson the danger thereto of damage by flooding in high water periods in Kootenay River and on Kootenay Lake, but that certain additional cost for pumping and otherwise my be incurred by reason of the construction and operation of the said works; and

WHEREAS the Commission has deemed it right and proper that the Applicant should make provision for any cost for pumping and otherwise that may be incurred by reason of the construction and/or operation of said works to an amount not exceeding three thousand dollars ($3000.00) in any one year, as in this Order hereinafter provided; and

WHEREAS the Commission acting under the authority conferred upon it by the Treaty, after reading the Amended Application, the statements and exhibits filed on behalf of the Applicant, the Government of Canada, the Government or the United States, and the Government of the State of Idaho, and the petitions presented by certain Reclamation Farmers in Idaho and British Columbia, and after having heard the evidence adduced and what was alleged by parties appearing before the Commission desiring to be heard, including Counsel or other representatives for the Applicant, the Government of Canada, the Government of the United States, the Government of the Province of British Columbia, the Government of the State of Idaho, and having considered the matter above referred to and all other matters, statements and documents brought to its attention, have determined that the works provided for in the said Amended Application and plans should be approved and authority given for the construction of the said works pursuant to the Treaty and subject to the conditions and regulations hereinafter particularly set forth.

NOW THEREFORE THIS COMMISSION DOTH ORDER AND DIRECT:

1. That the Amended Application for permission to raise the level of the waters of Kootenay Lake for storage purposes, and the plans for such works, copies of all of which are filed in the offices of the Commission in Ottawa and Washington and made a part of this Order, be, and the same are hereby, approved, and the construction and operation of such works authorized, under the provisions of the Treaty, subject to the conditions and regulations hereinafter set forth.

2. That the said works shall be completed, and when completed shall be operated, in manner following:

   (1) That the Applicant shall proceed forthwith with the enlargement of the cross-sectional area of Grohman Narrows by removing therefrom at least 250,000 cubic yards of rock, gravel and boulders substantially in accordance with the design laid down on the Applicant's Plan № F-271, dated July 27,1932, on file in the offices of the Commission in Ottawa and Washington, and in addition thereto shall remove at least 14,000 cubic yards of the rock bluff jutting into Grohman Narrows on the south side, and shall have at least one-half of all the said excavation completed not later than April 1,1939, and all of the said excavation completed not later that April 1,1940.

   (2) That during the low water period of 1938-39, the Applicant shall be limited to a maximum storage elevation of 1741.82 on the main lake (i.e., two and a half feet above zero of the Nelson gauge).

   (3) That following the completion of one-half of the proposed excavation, the Applicant in the low water period of 1939-40 shall be limited to a maximum storage elevation of 1743.32 on the main lake (i.e., four feet above zero of the Nelson gauge).

   (4) That following completion of all the excavation provided for in Sub-section (1) of Section 2 of this Order, the Applicant shall be permitted to store water in the main body of Kootenay lake to a maximum elevation of 1745.32, Geodetic Survey of Canada datum, 1928 adjustment (i.e. six feet above zero of the Nelson gauge), in accordance with the rule curve detailed in Sub-section (5).

   (5) That after the high water of the spring and early summer flood and when the lake level at Nelson on its falling stage recedes to elevation 1743.32, Geodetic Survey of Canada datum, 1928 adjustment, the gates of the dam may be so operated as to retain it at said level until August 31st, and after said date the level of the main lake may be raised to elevation 1745.32, which shall be the maximum storage level until January 7, and thereafter it shall be lowered that shall not exceed elevation 1744 on February 1, elevation 1742.4 on March 1, and elevation 1739.32 (i.e., zero of the Nelson gauge) on or about April 1, except under extraordinary natural high inflow conditions, when sufficient gates shall be opened and remain open throughout such period of excess so as to lower the level of the main body of Kootenay Lake to the storage level at that time obtaining as above defined.

   (6) That following the completion of all the excavation provided for in Sub-section (1) of Section 2 of this Order, and throughout the period of flood flow in each and every year, (i.e., from the commencement of the spring rise in March or April until the level of the lake at Nelson returns to elevation 1743.32, Geodetic Survey of Canada datum, 1928 adjustment, on the falling stage), a sufficient number of gates and sluiceways of the dam shall be opened to provide, in conjunction with the flow through the turbines, for the lowering of the main body of Kootenay Lake, as a result of the Applicant's completed and proposed excavation, by at least the amounts indicated in Table 2, page 21 of the Canadian Government Exhibit № 1, dated June 1, 1933, on file in the offices of the Commission in Ottawa and Washington as follows:

Discharge from Kootenay Lake under original conditions (in second feet)	Amount of lowering to be effected on main body of Kootenay Lake (in feet)
10,000	1.0
25,000	1.3
50,000	1.7
75,000	2.1
100,000	2.6
125,000	3.0
150,000	3.2
175,000	3.5
200,000	3.8
225,000	4.0

3. That the Applicant shall pay any cost incurred in the State of Idaho by reason of the construction and/or operation of said works, the amount of such payment not to exceed in the aggregate in any year the sum of three thousand dollars ($3000.00) to be paid to the Treasurer of the State of Idaho or some authority designated by that State. The first payment of three thousand dollars ($3000.00) shall be made on the 1st of January, 1940, and thereafter three thousand dollars ($3000.00) on the first day of January in each and every year. Provided always that after the first or any payment has been made, the Applicant shall not be required to make any further payments until the Treasurer of the State of Idaho, or other designated Idaho authority, has produced vouchers for payment to claimants of the amounts required to cover the said cost, and has remitted the unexpended balance, if any, to the Applicant. Provided further that the Applicant shall not be entitled to dispute the validity of any vouchers produced as aforesaid.

4. That if the Applicant at any time after the said works have been in operation for one year and payment has been made by the Applicant as provided in the preceding paragraph hereof, represents to the Commission that pumping in drainage districts in the State of Idaho, caused by the construction and operation of said works, has been diminished or does not then exist, the Applicant may apply to the Commission for a reduction of the amount of the above-mentioned payment, or cancellation of the same entirely, and the Applicant shall be entitled to set up any matter it may see fit in support of its claim, including any matters that may have arisen subsequent to the date of this Order.

5. That, in order to ensure the carrying out of the provisions of this Order, the Commission shall retain jurisdiction over the excavation at Grohman Narrows and the regulation of the levels of Kootenay Lake, through a joint board of engineers to be known as the International Kootenay Lake Board of Control (hereinafter referred to as the “Board of Control”), and to consist of one member of the engineering services of the Government of the United States and one member of the engineering services of the Government of Canada to be appointed by the Commission. This Board of Control, under the direction of the Commission, shall be charged with the duty of securing compliance with the provisions of this Order insofar as they relate to the excavation at Grohman Narrows and the regulation of the levels of Kootenay Lake; and in addition to the duties above and hereinafter particularly mentioned, it shall perform and discharge such other duties as may from time to time be assigned to it by the Commission. The Board of Control shall report to the Commission at such times as the Commission may determine. In the event of any

disagreement between the members of the Board of Control the matter shall be referred by them to the Commission for decision. The Board of Control may at any time make representations to the Commission in regard to any matter affecting or arising out of the terms of this Order.

6. That the Applicant shall maintain and operate automatic gauges in a manner and at locations and of a type satisfactory to the Board of Control, as follows:

    1. In Kootenay River at tailrace of Corra Linn power plant;
    2. In Kootenay River at forebay of Corra Linn power plant;
    3. In the West Arm of Kootenay Lake at Nelson;
    4. On Kootenay Lake in vicinity of Queens Bay near lake outlet;

    and that the records from these gauges shall be regularly made available to and filed with such authority as the Board or Control may direct. That without limiting the generality of the foregoing, the Applicant shall make adequate provision to the satisfaction of the Board of Control for the determination of the flow of the river as provided in Sub-section (6) of Section 2 hereof; and shall keep accurate and sufficient records of the foregoing determinations to the satisfaction or the Board of Control, and shall make return of such records at such time and in such form as may be required by the said Board of Control.

7. That the Applicant shall make available to the Board of Control such data having to do with the discharge through the Corra Linn dam or power house or having to do with the power load, as the Board of Control may consider to be desirable or necessary to enable it to ensure the observance of the provisions of this Order.

8. That the cost of maintaining all parts of the dam and all sluices and log sluices and the above-mentioned automatic gauges shall be borne by the Applicant, and this work and maintenance shall be done in a manner satisfactory to the Board of Control.

9. That the regulation of the flow of water through the Corra Linn dam to the extent required under conditions of this Order, shall be subject to the supervision and control of the Board of Control under the direction of the Commission.

10. That the Commission, on the report of the Board of Control during the spring freshets, may determine that an emergency condition exists, and may then request the Applicant to co-operate with the Board of Control in regulating the flow of water through the said dam, to the end that the rights and interests of all Parties may be protected so far as it is practicable so to do.

11. That the Applicant, without incurring any financial obligation or responsibility, shall co-operate and assist in any measure that may be undertaken under the authority of the Governments of the United States and the Dominion of Canada, with a view to further channel enlargement designed to improve flood water conditions in Kootenay Flats, in the Province of British Columbia and in the State of Idaho.

Dated in the City of New York, this eleventh day of November, 1938, A.D.

(Original signed by…)

A.O. Stanley
Chas. Stewart
John H. Bartlett
W.H. Hearst
Eugene Lorton
George W. Kyle

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